WORKSHOP MANUAL

N SERIES

ISUZU

PubNo. N∗R05_05-02-E

N SERIES Workshop Manual

Section No.	Applicable Component	Publication No.	MY	Remarks
0	GENERAL INFORMATION	LGGEN-WE-0552	05	EXP
0	GENERAL INFORMATION	LGGEN-WE-0551EU	05	Europe
1	HEATING AND AIR CONDITIONING	LGHAC-WE-0552	05	
2	FRAME AND CAB	LGFRM-WE-0552	05	
3	STEERING, SUSPENSION, WHEELS AND TIRES	LGSTG-WE-0552	05	
4	PROPELLER SHAFT AND AXLE	LGPRO-WE-0552	05	
5	BRAKES	LGBRA-WE-0552	05	
5A4	ABS/ASR	LGBRK-WE-0551	05	
5A5	HSA (HILL START AID)	LGHSA-WE-0551	05	
6	ENGINE 4H SERIES	LG4H-WE-0552	05	
6	ENGINE 4J SERIES	LG4J-WE-0552	05	
6	ENGINE 4HK1-TC SERIES	LG4HK-WE-0551	05	
6E	ENGINE CONTROL SYSTEM (4JH1)	4JHED-WE-0551N	05	
6E	ENGINE CONTROL SYSTEM (4HK1)	4HKED-WE-0551N	05	
7	MANUAL TRANSMISSION AND CLUTCH MSB SERIES	LGMSB-WE-0552	05	
7	MANUAL TRANSMISSION AND CLUTCH MYY SERIES	LGMYY-WE-0552	05	
7	MANUAL TRANSMISSION AND CLUTCH MZZ SERIES	LGMZZ-WE-0552	05	
7	TRANSMISSION/TRANSAXLE	LGSMT-WE-0551	05	
8	CAB AND CHASSIS ELECTRICAL (LEFT HAND DRIVE MODEL)	LGCEL-WE-0552LH	05	Europe/EXP/Taiwan
8	CAB AND CHASSIS ELECTRICAL (RIGHT HAND DRIVE MODEL)	LGCEL-WE-0552RH	05	Europe/EXP/Australia/HK
9	SEAT BELT, SRS AIRBAG	LGSRS-WE-0551	05	
PTO	POWER TAKE OFF	LGPTO-WE-0552	05	

POWER TAKE OFF

SECTION 00
POWER TAKE OFF

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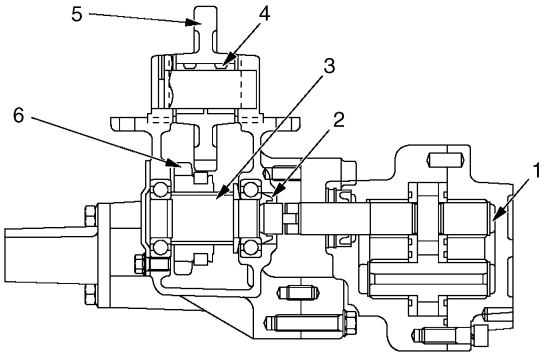
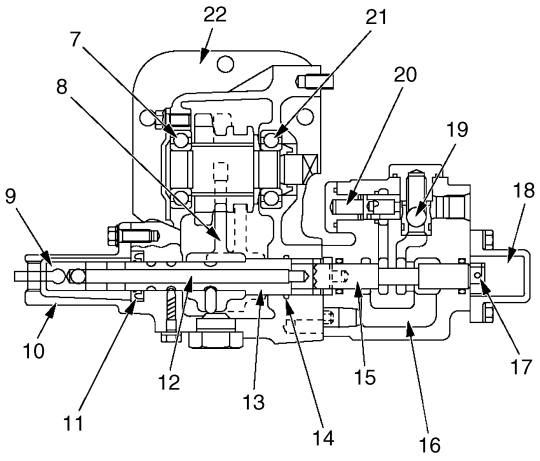
GENERAL DESCRIPTION

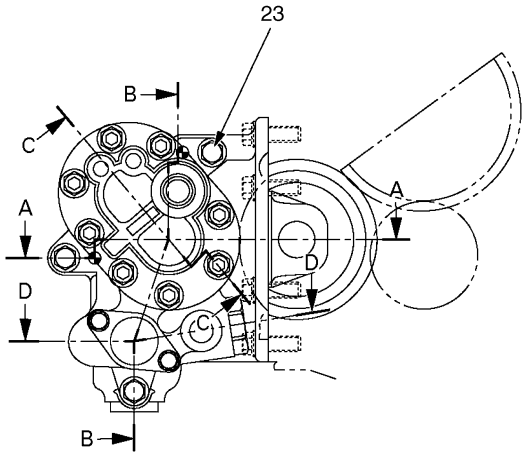
The side with an oil pump PTO integrates the PTO and the oil pump and installed in the left side of a transmission. The shift rod for switching the “ON” and “OFF” of the hydraulic circuit of the PTO is provided at the bottom of the PTO and the oil pump main unit.
The “ON” and “OFF” of the PTO uses a gear slide system and turn on and off the power by sliding the output gear. The idle gear bearing uses a needle bearing and the output shaft uses a ball bearing to ensure durability.
The oil pump section consists of the gear pump part and the hydraulic circuit switching part, and the gear pump section fixs efficiency by selecting and assembling the side plate. Further, the hydraulic circuit switching portion switches the three positions of “Up”, “Neutral”, and “Down” by the spool provided on the rod extension.
The dump control system uses a cable system.

Cross-section View



PTO oil pump assembled point assembly drawing
PTO side Section A-A, Pump side Section C-C (Illustrated by rotating by 90 degrees counterclockwise)





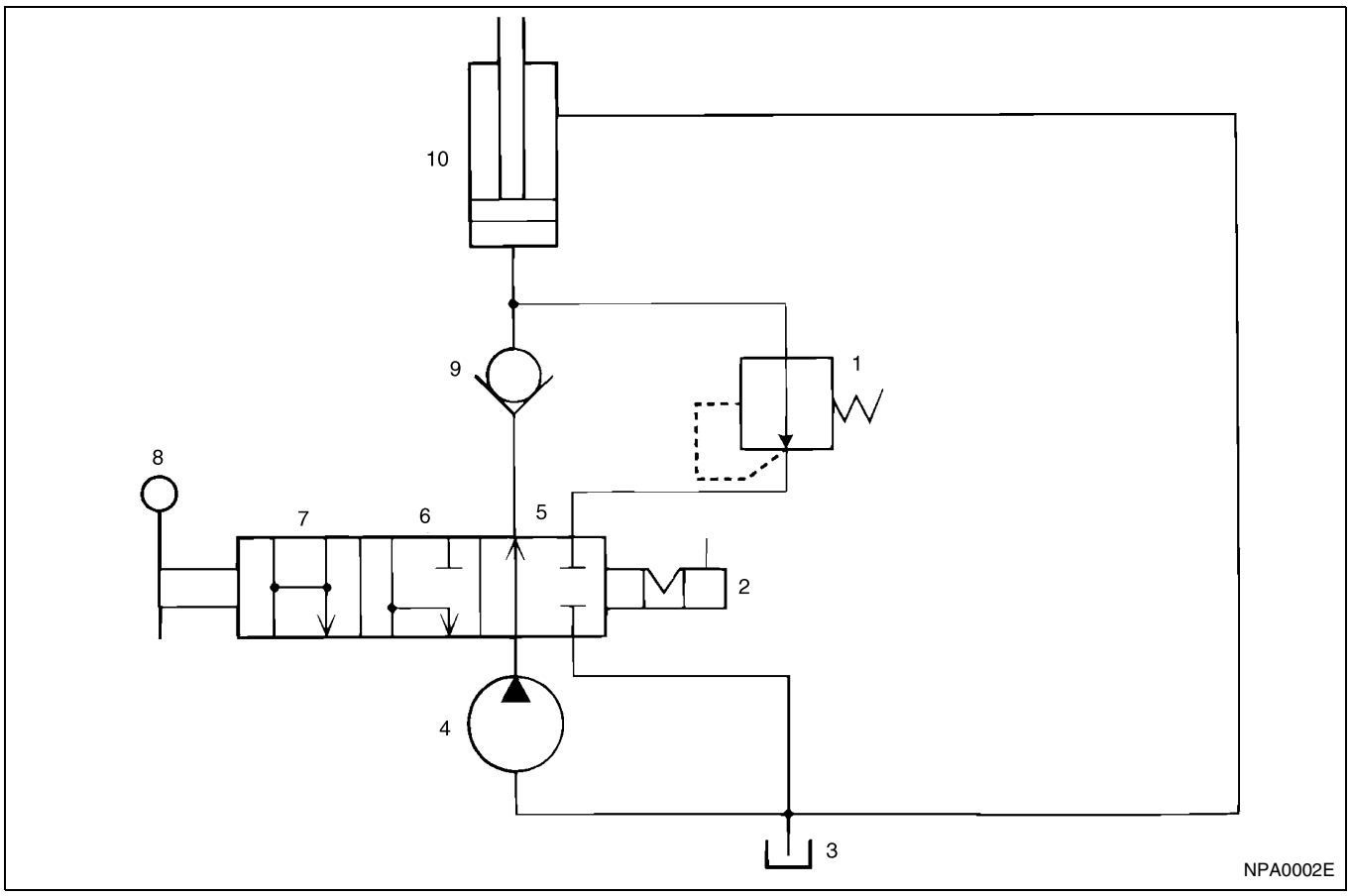
PTO oil pump hydraulic switching assembly drawing)
PTO side Section B-B, Pump side Section D-D

NPA0001E

Legend

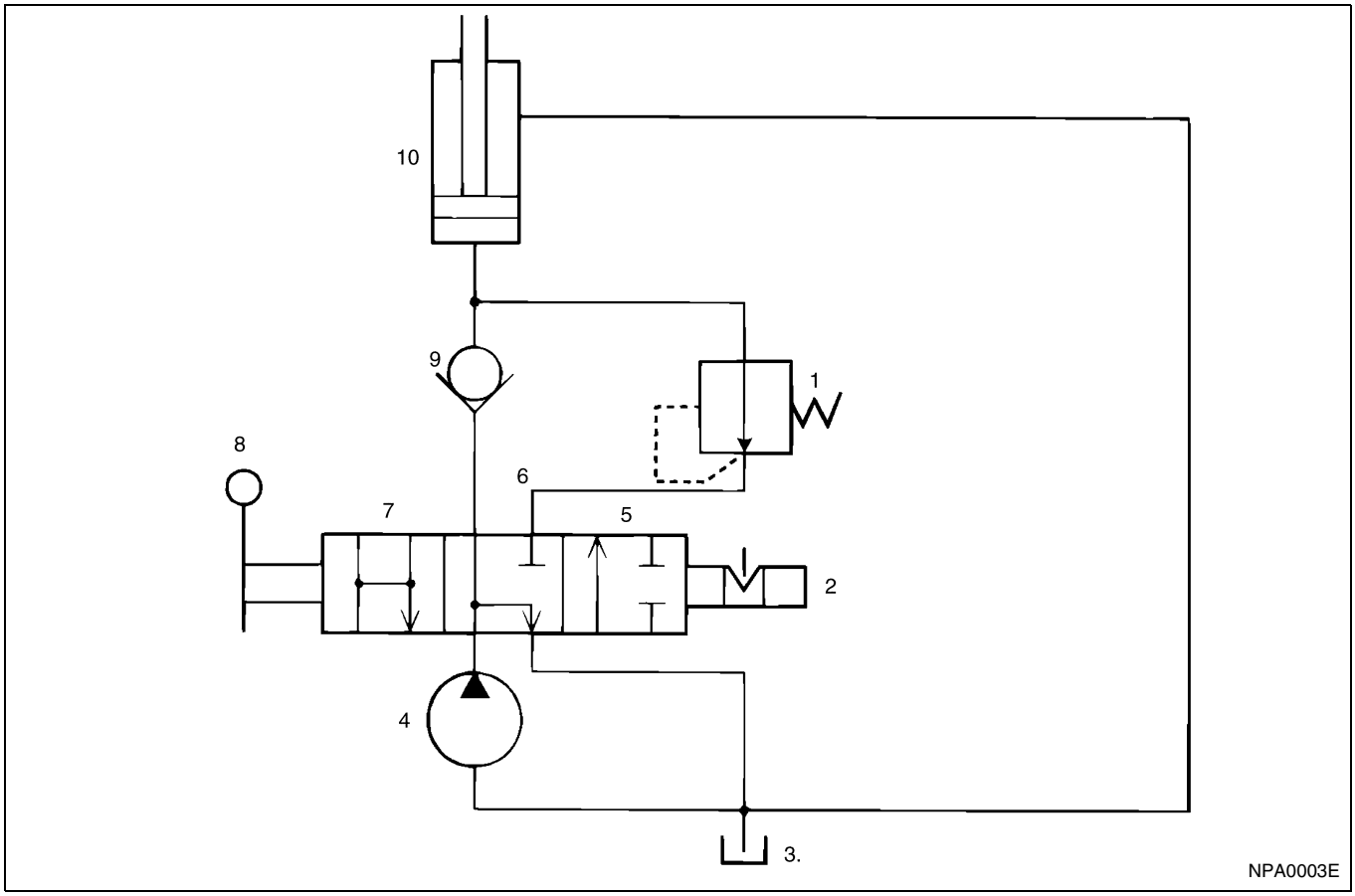
1. Oil pump (gear pump section)
2. Oil seal (output shaft side)
3. Output shaft
4. Needle bearing
5. Idle gear
6. Output gear
7. Front ball bearing
8. Shift arm
9. Control cable connector
10. Cable connector
11. Oil seal (shift rod side)
12. Inner rod
13. Shift rod
14. O-ring
15. Spool
16. Oil pump (hydraulic circuit switching section)
17. Stopper adapter
18. Shift cap
19. Check valve (swing check valve)
20. Flow control (decompression valve)
21. Rear ball bearing
22. PTO
23. Bolt (oil pump to PTO)

Hydraulic Circuit Diagram



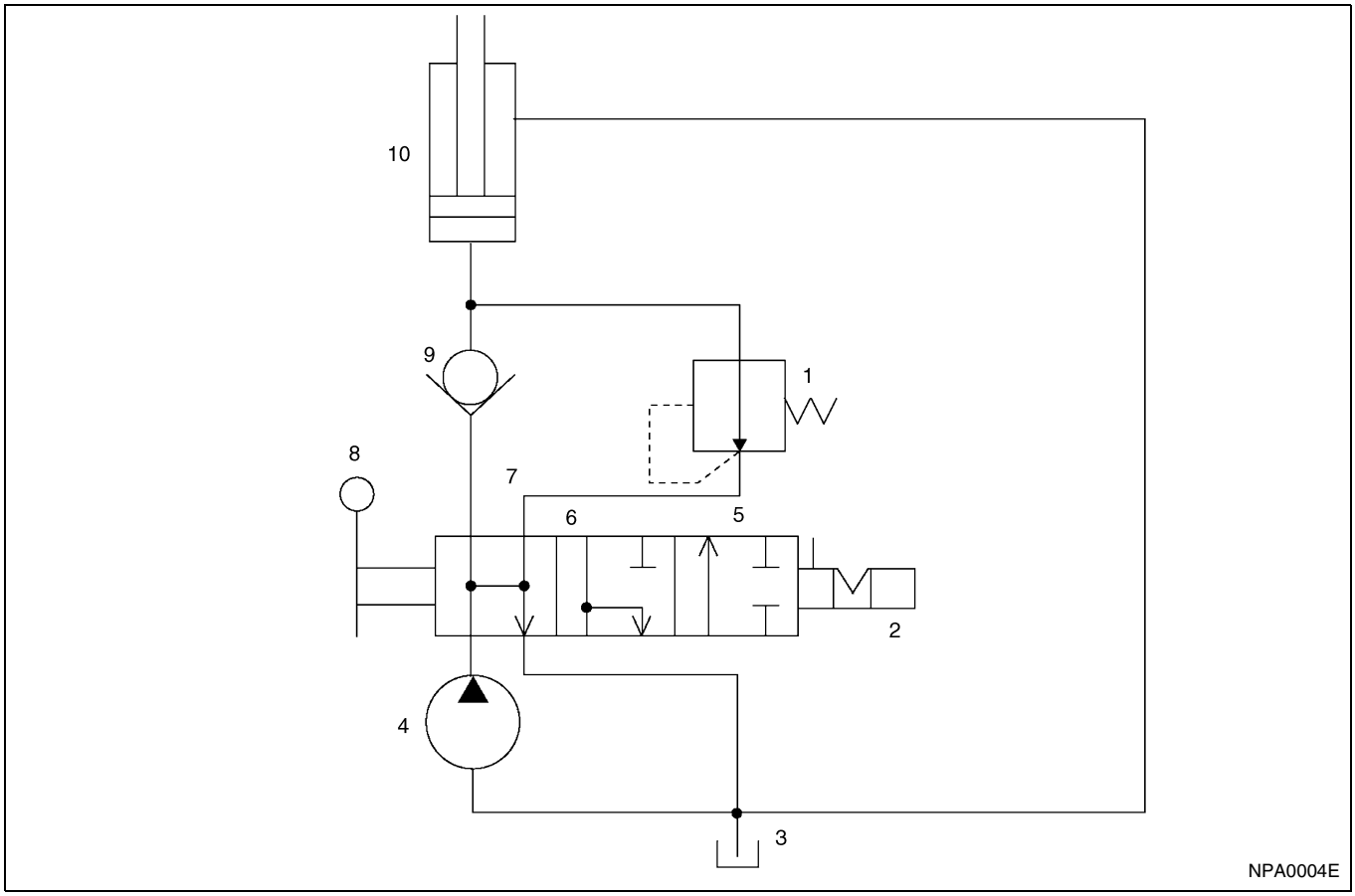
Legend

1. Flow control valve (decompression valve)
2. Spool valve
3. Oil reserve tank
4. Oil pump
5. Up
6. Neutral
7. Down
8. Operation lever (PTO interlocking)
9. Check valve (swing check valve)
10. Dump cylinder



Legend

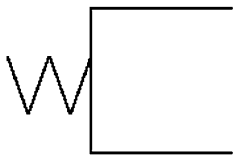
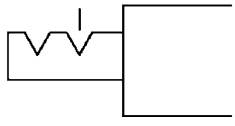
1. Flow control valve (decompression valve)
2. Spool valve
3. Oil reserve tank
4. Oil pump
5. Up
6. Neutral
7. Down
8. Operation lever (PTO interlocking)
9. Check valve (swing check valve)
10. Dump cylinder

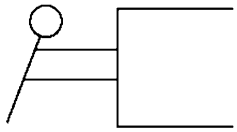
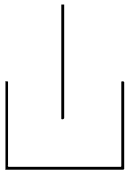


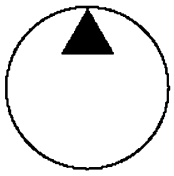
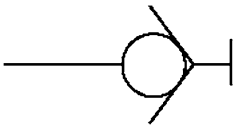
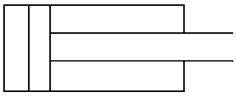
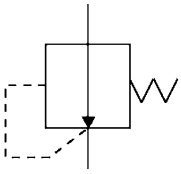
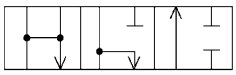
Legend

1. Flow control valve (decompression valve)
2. Spool valve
3. Oil reserve tank
4. Oil pump
5. Up
6. Neutral
7. Down
8. Operation lever (PTO interlocking)
9. Check valve (swing check valve)
10. Dump cylinder

Symbol for Hydraulic Circuit

Symbol	Meaning of symbol
 NPA0005E	Spring
 NPA0006E	Detent (position stop system)

Symbol	Meaning of symbol
 NPA0007E	Manual lever (dump lever)
 NPA0008E	Oil tank

Symbol	Meaning of symbol
 NPA0009E	Oil pump (unidirectional flow)
 NPA0010E	Check valve (swing check valve)
 NPA0011E	Cylinder
 NPA0012E	Flow control valve (decompression valve) (internal pilot method)
 NPA0013E	Hydraulic switching valve (three-position valve)

ON-VEHICLE SERVICE

Inspection and Supply of The Hydraulic Operating Fluid

Notice:
When inspecting and supplying hydraulic operating fluid, you might have incurred danger. In that case, inspect and supply hydraulic operating fluid after having fully checked safety.

Symptoms Due to Insufficient Hydraulic Operating Fluid

The following symptoms might have occurred. In that case, inspect and supply hydraulic operating fluid because it may be insufficient.

1. The body (cargo deck) is raised only immediately.
2. The body (cargo deck) is lugged during rise.
3. While the body (cargo deck) is being raised, the oil pump portion causes a large abnormal sound (such as caterwaul or grate).
4. After the body (cargo deck) has been raised, it drops generating a knock.

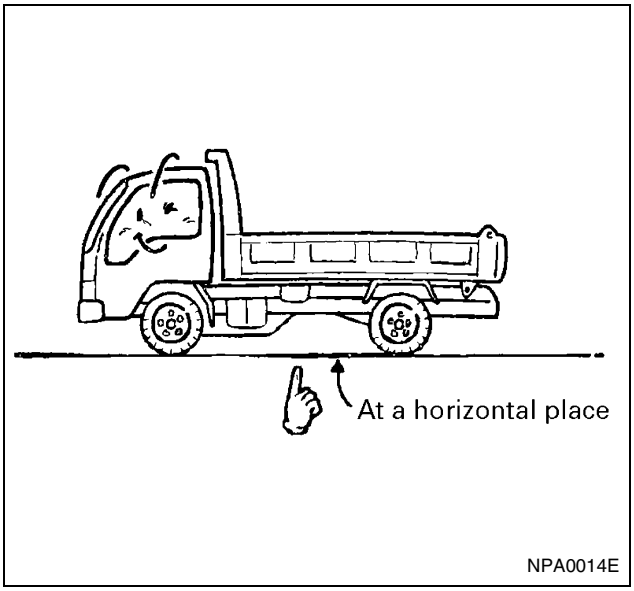
Preparing for Hydraulic Operating Fluid Supply

If there is loading, pull down the loading. Then supply hydraulic operating fluid after having safely and more carefully raised the body (cargo deck) and having firmly held the body (cargo deck) by the “safety rod” and the “safety strut” in accordance with the following “How to raise the body (cargo deck)”.

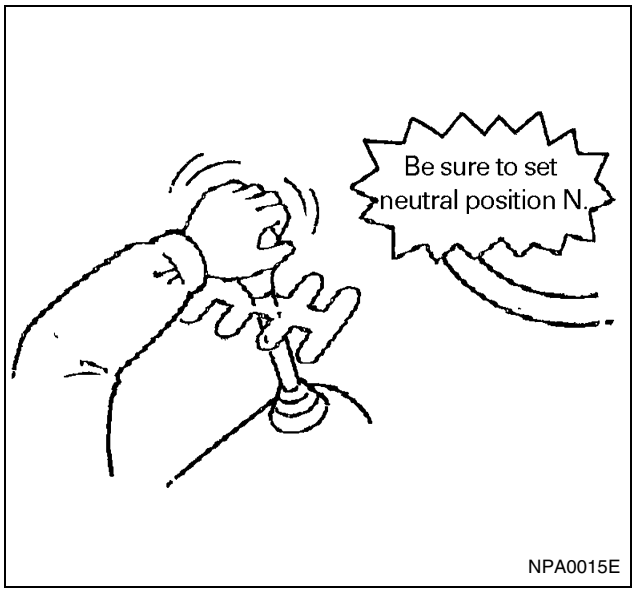
How to Raise the Body (Cargo Deck)

1. Put a truck at a horizontal place.

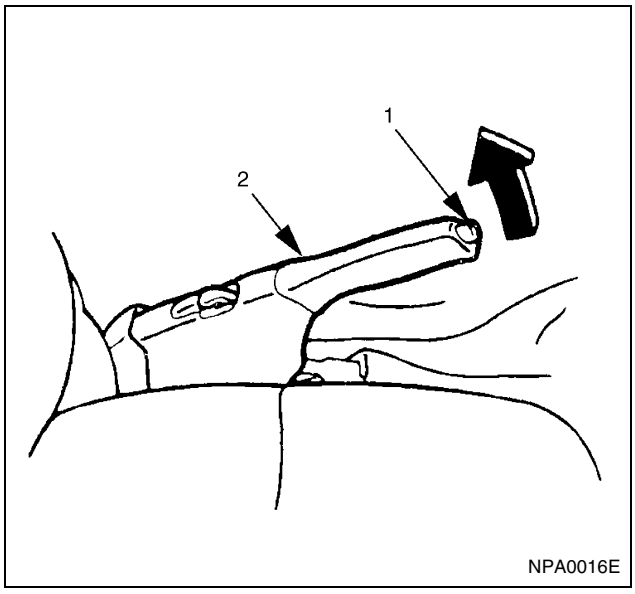
Notice:
Never raise the body (cargo deck) on tilted ground, soft ground, and unleveled ground. A truck may be inverted or warp may be generated in functional components.



2. Set the shift lever to the “Neutral” position.



3. Firmly actuate the parking brake and apply a scotch to the rear tire.

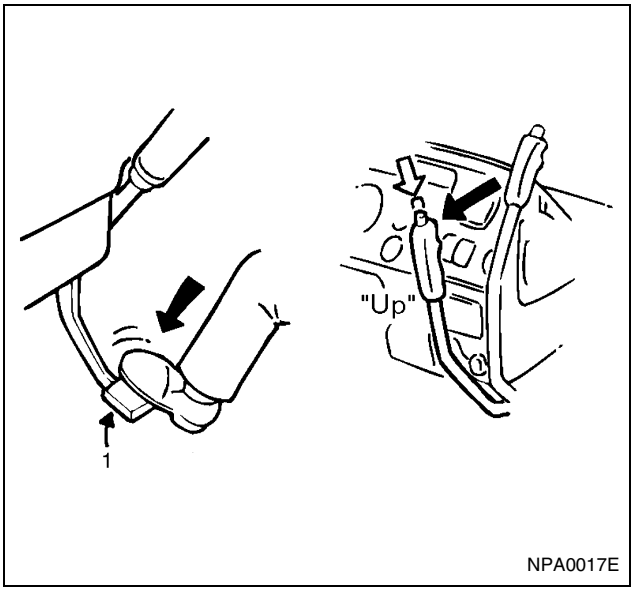


Legend
1. Release button
2. Parking brake lever

4. Start the engine and depress the clutch pedal to the floor. Push in the lock button of the dump lever and release the lock to set the “Up” position.

Notice:
Fully check that there is no person or hindrance around a truck.

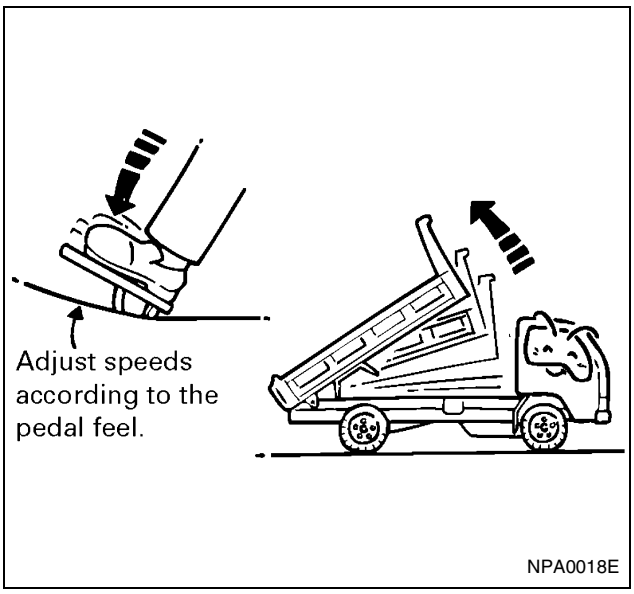
When the dump lever is operated, observe the notes of the Note label attached to the driver's seat.



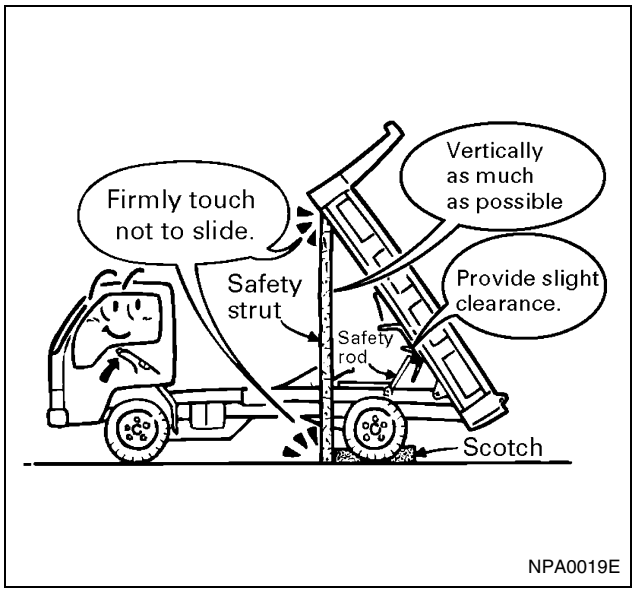
Legend
1. Clutch pedal

5. When the clutch pedal is slowly returned, the body (cargo deck) is raised.
   - Adjust raised speeds according to the pedal feel of the accelerator.
   - When raising the body (cargo deck), be sure to check the lock of the dump lever.
   - After having raised the body (cargo deck), held the body by the safety rod and the safety strut and stop the engine.

Notice:
Suddenly returning the clutch pedal is very dangerous. Use the engine at about 1,000 to 1,500 rpm, and do not perform high-speed rotation, sudden acceleration and deceleration, and unnecessary idle rotation.



Notice:
Raise the body (cargo deck) paying full attention to safety and firmly hold the body (cargo deck) by the safety rod and safety strut.



Supply Procedure of Hydraulic Operating Fluid

Notice:
Be sure to supply a specified amount (check it by the level plug) of hydraulic operating fluid using a cleaned oil supply container paying full attention so that dust or foreign matter will not be mixed in. After having supplied oil, firmly tighten each plug.

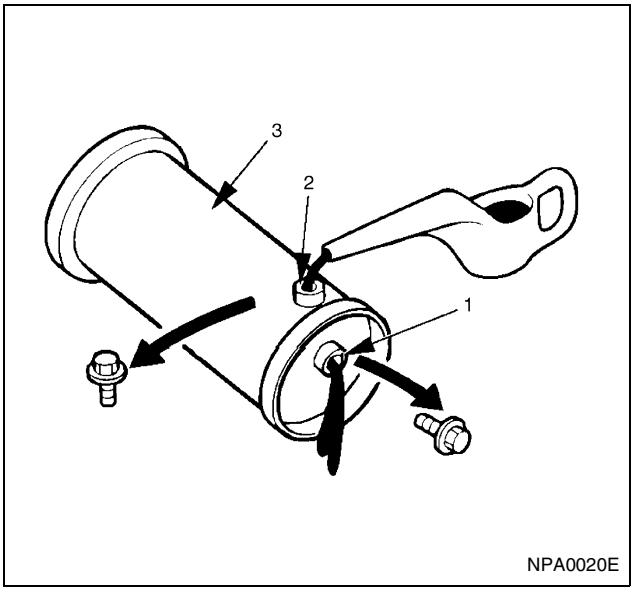
When replacing the total amount of hydraulic operating fluid, request a service network (SS store) of a body manufacturer.

1. Remove the oil supply plug and level plug of the oil tank in the engine stopped state.
2. While supplying hydraulic operating fluid from the oil filler port, supply it until the hydraulic operating fluid flows out from the level plug.
3. Remove the “Safety strut” once and raise the body (cargo deck) to the most raised position, then re-hold it by the “Safety strut and safety rod”.
4. Additionally supply hydraulic operating fluid. When the hydraulic operating fluid flows out from the level plug, install and firmly tighten the level plug and the oil filler port plug.
5. After having supplied hydraulic operating fluid, remove the “Safety strut” and store the “safety rod”. Subsequently firmly drop the body (cargo deck) and stop the engine.

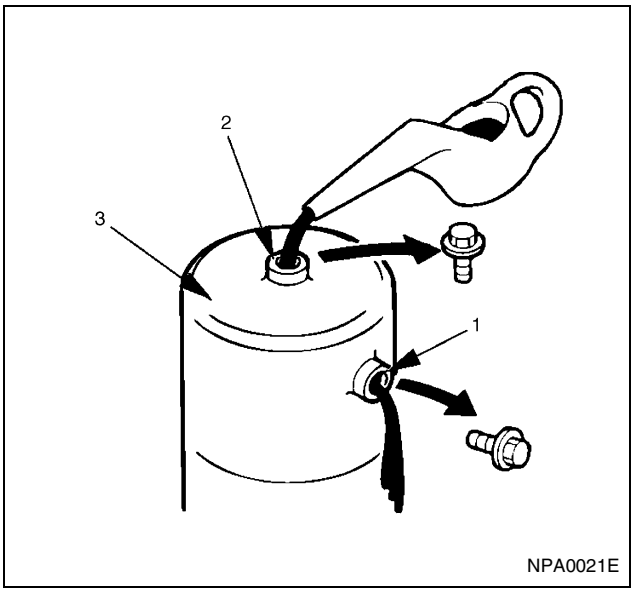
Notice:
Supply the hydraulic operating fluid used with reference to the following table.

Hydraulic Operating Fluid (Turbine Oil)

Manufactured by ShinMaywa Industries Co., Ltd.	0 to 30°C (86°F): VG32
	20°C (68°F) or more: VG56
	less than 10°C (50°F): VG22



Legend
1. Oil level
2. Oil filler port
3. Oil tank



Legend
1. Oil level
2. Oil filler port
3. Oil tank

If the Dump Rise Operation is Disabled by Itself

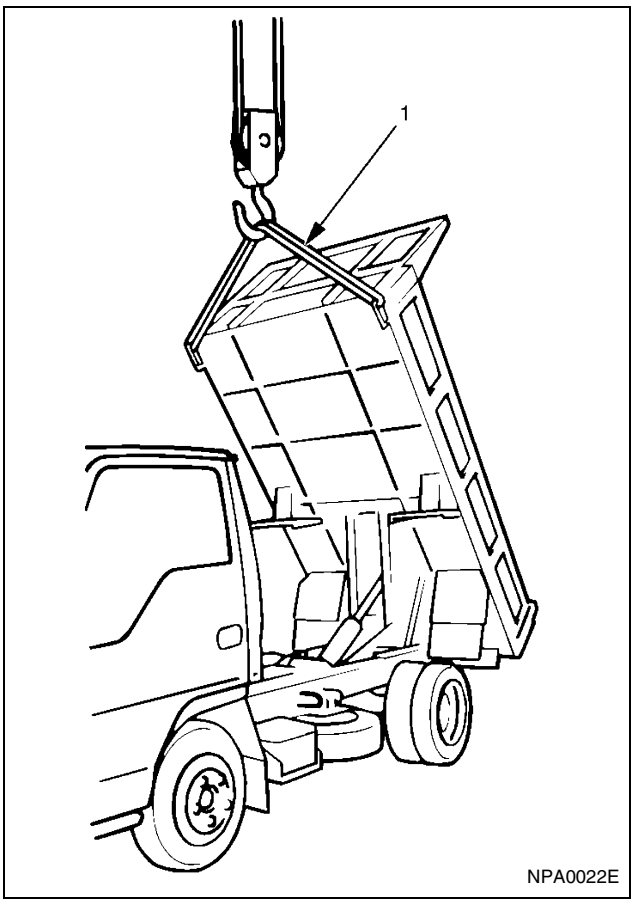
If the body (cargo deck) is kept being dropped and the “Rise” operation of the body (cargo deck) is disabled by itself, inspect the cause of rise disabled, fully identify the status, and execute maintenance and repair in accordance with the flowchart of the “Defect 1”. Dump body rise disabled” of Chapter “Troubleshooting”.
After maintenance and repair, if there is a hindrance in subsequent work advance because the “Rise” operation is disabled by itself or when the hydraulic circuit is in the following states (1) and (2) after maintenance and repair, raise the body (cargo deck), take safety measures for preventing drop, and continue the work according to the following (item of the existence of hoist or crane equipment) methods.

1. The body (cargo deck) rise is disabled due to the air mixture into the hydraulic circuit resulting from insufficient hydraulic operating fluid immediately after repair for oil pump replacement.
2. The body (cargo deck) rise is disabled due to the air mixture into the hydraulic circuit resulting from insufficient hydraulic operating fluid immediately after repair for leak of hydraulic operating fluid.

When hoist or crane equipment is provided

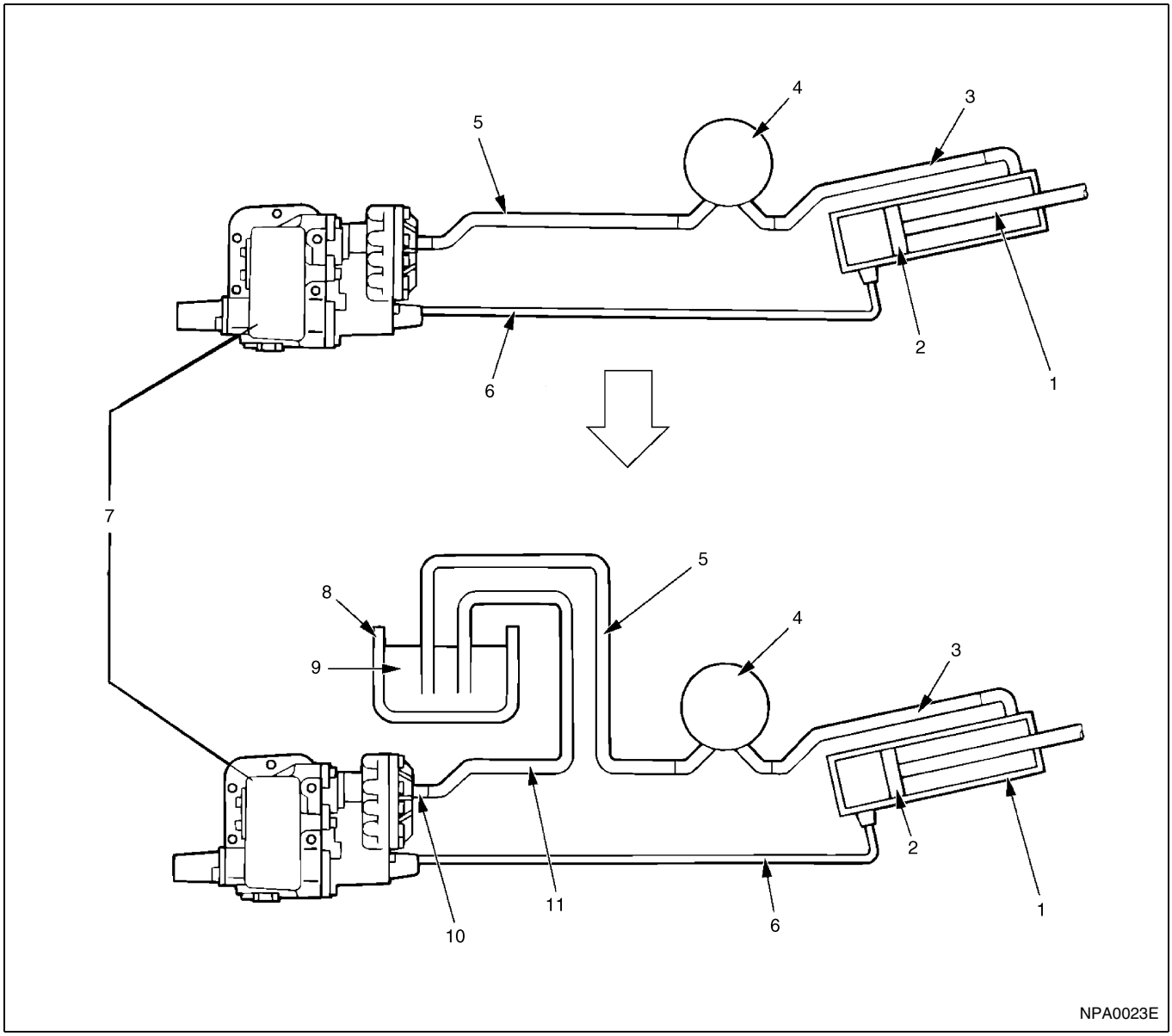
1. Firmly actuate the parking brake and apply a scotch to the rear tire.
2. Set the engine to the stopped state.
3. Set the dump lever to the “Up” position and apply a wire with ample strength to the front of the body (cargo deck).
4. Slowly hang a wire (tensile strength of 1,000 kg (9,807 N)) by a hoist or crane.
5. After having drawn up the body (cargo deck) to the most raised position, prevent the drop of the body (cargo deck) by the safety rod and the safety strut and check safety.

Notice:
For the subsequent work procedure, supply hydraulic operating fluid or perform air bleeding of the hydraulic operating fluid in accordance with each item of the text in the “Supply Procedure of Hydraulic Operating Fluid” or the “Air Bleeding Procedure of Hydraulic Operating Fluid”.



Legend
1. Wire

If neither hoist nor crane is provided
If the body (cargo deck) is kept being dropped and the “Up” operation of the dump is disabled by itself or if neither hoist nor crane is provided, raise the body (cargo deck) according to the following work procedure.



Legend

1. Hoist cylinder
2. Piston
3. Pipe
4. Oil tank
5. Low-pressure hose
6. High-pressure hose
7. PTO with oil pump
8. Hydraulic operating fluid container
9. Hydraulic operating fluid
10. Test hose joint
11. Test hose

Preparation

1. Because removal of a spare tire makes work easier according to a truck, previously check the truck.
2. Remove the intermediate fixed clip on the truck side between the oil pump and the oil tank of the low-pressure side hose and set the low-pressure hose free.
3. Prepare a cleaned hydraulic operating fluid container (a 20 L can will do), a funnel, hydraulic operating fluid, a test hose for a special tool, and a test hose joint.
4. Prepare the hydraulic operating fluid of about 10 L in the cleaned hydraulic operating fluid container.

Hydraulic Operating Fluid (Turbine Oil)

Manufactured by ShinMaywa Industries Co., Ltd.	0 to 30°C (86°F): VG32
	20°C (68°F) or more: VG56
	less than 10°C (50°F): VG22

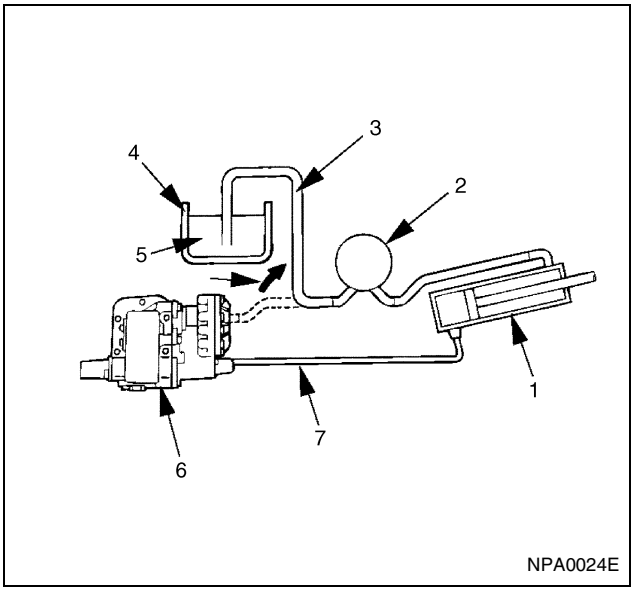
Notice:
Carefully control the prepared hydraulic operating fluid so that dust or foreign matter will not be mixed in it. Be-

sides, if the dust or foreign matter is mixed in the hydraulic operating fluid, carefully handle it because it becomes the first cause of a dump mechanism fault.

Work Procedure

1. With reference to the piping rough sketch on the preceding page, remove the low-pressure side hose of the oil pump and insert the port for removal in the prepared hydraulic operating fluid container.

Notice:
Be sure to install the hydraulic oil fluid container at a higher position than the tank pump. If it is installed at a lower position, the oil pump may be damaged because the hydraulic operating fluid applied in Item (4) flows in the hydraulic operating fluid container and air is mixed in the hose.



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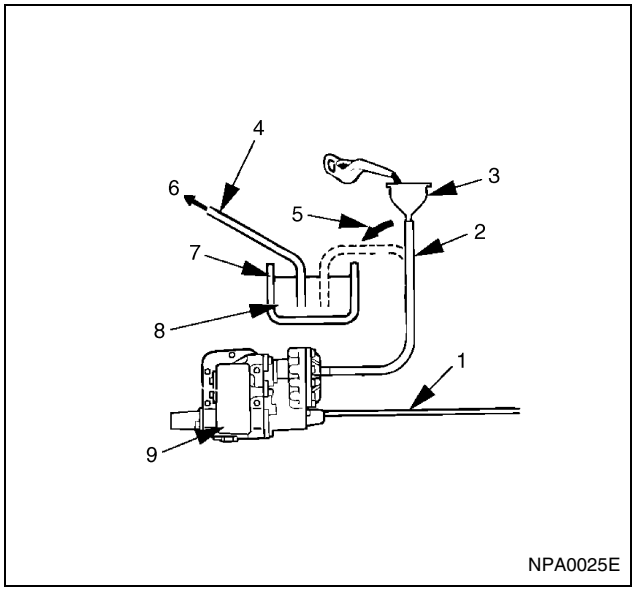
Legend

1. Hoist cylinder
2. Oil tank
3. Low-pressure hose
4. Hydraulic operating fluid container
5. Hydraulic operating fluid
6. PTO with oil pump
7. High-pressure hose

Notice:
When inserting the removed low-pressure hose in the hydraulic operating fluid, remove the hose band, be sure to clean the hose port, and handle the hose so that dust or foreign matter will not be mixed in the hydraulic operating fluid.



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Legend

1. High-pressure hose
2. Test hose
3. Funnel
4. Low-pressure hose
5. Insert
6. To oil tank
7. Hydraulic operating fluid container
8. Hydraulic operating oil pump
9. PTO with oil pump

2. Remove the low-pressure side hose joint of the oil pump.
3. Install the test hose and connecting joint on the low-pressure side of the oil pump.
   Joint (low-pressure side): 5-8840-2439-0
   Test hose: 5-8840-2435-0
4. Use the funnel from the fluid container insertion side of the test hose to fill the hose with the hydraulic operating fluid and insert the hose port in the hydraulic operating fluid container.

Notice:
The test hose is filled with hydraulic operating fluid to minimize the mixture of air in the hydraulic circuit.

Further, fix the two hoses inserted in the fluid container not to jump out from the hydraulic operating fluid.

5. Start the engine and depress the clutch pedal in the idling state, then set the dump lever to the “Up” position.
6. When slowly releasing the clutch pedal and operating the oil pump, the body (cargo deck) starts being raised.

Notice:
At this time, check that the air mixed in the hydraulic circuit is discharged in the hydraulic operating fluid as blow holes.

7. Raise the body (cargo deck) up to the most raised position in the idling state and apply the safety rod and the safety strut to the body (cargo deck). Then prevent drop and check safety.
8. After having the body (cargo deck), stop the engine and remove the test hose installed in Item (3) from the oil pump, then release it from the fluid container.
9. Remove the test hose connecting joint from the low-pressure side of the oil pump and install the joint for connecting the original low-pressure hose.
10. Release the low-pressure side hose removed from the oil pump and soaked in the fluid container in Item (1) and install it on the low-pressure side of the oil pump as before, then firmly tighten the hose band.

Notice:
For the subsequent work procedure, supply hydraulic operating fluid or perform the air bleeding of hydraulic operating fluid in accordance with each item of the text in the "Supply Procedure of Hydraulic Operating Fluid" or the "Air Bleeding Procedure of Hydraulic Operating Fluid".

Be careful of excessive supply of hydraulic operating fluid.

If an excessive amount of hydraulic operating fluid exceeding the specified amount is supplied when supplying the hydraulic operating fluid at the rise of the body (cargo deck), the hydraulic circuit will be filled with the hydraulic operating fluid because the volume of the fluid in the oil tank is increased more than necessary at the drop of the body (cargo deck).

According, the body (cargo deck) will not be dropped from a predetermined place. If it is dropped forcibly, excessive pressure applies to the hydraulic circuit (consisting of the hose, pipe, and tank) resulting in its damage or a leak of oil.

Total Replacement of Hydraulic Operating Fluid

Request a service network (SS store) of a body manufacturer of the total replacement of hydraulic operating fluid.

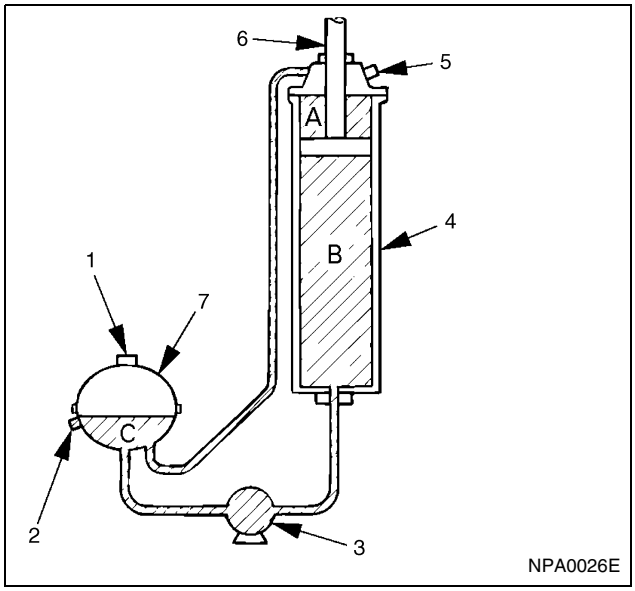
Air Bleeding Procedure of Hydraulic Operating Fluid

Notice:
Be sure to supply a specified amount of hydraulic operating fluid using a cleaned oil supply container paying full attention so that dust or foreign matter will not be mixed in. After having supplied oil, firmly tighten each plug.

[Rear Dump Truck]

<Manufactured by Shin Maywa Industries, Co., Ltd.>
Hydraulic Operating Fluid Supply

1. Raise the body (cargo deck) in accordance with the "How to raise the body (cargo deck)" described previously.
2. Remove oil filler plug (1) and level plug (2) of the oil tank and supply oil from the oil filler port until the hydraulic operating fluid flows out from level plug (1), then tighten plug (2).
3. Remove oil filler port plug (5) from the cylinder head, supply the hydraulic operating fluid to "Chamber A" so that no air will be left to fill the chamber with the fluid, and tighten oil filler port plug (5).



Legend
1. Oil filler port
2. Level plug
3. Oil pump
4. Hoist cylinder
5. Oil filler port
6. Piston rod
7. Oil tank

Air Bleeding Method

1. Raise the body (cargo deck) in accordance with the "How to raise the body (cargo deck)" described previously.
2. At the maximum rise, cylinder shaded portions "Chamber A" and "Chamber B" shown in the drawing are fully filled with hydraulic operating fluid and Section "C" is filled with the hydraulic operating fluid up to its level position.

Notice:
Supplying hydraulic operating fluid more than necessary will cause a fault.

3. First remove the oil tank oil filler port plug of (1). Then start the engine, operate the dump lever, and drop and raise the body (cargo deck) several times. Consequently, air is naturally released usually.
4. Tighten the oil tank oil filler port plug of (1).

Notice:
If the work of Item (2) is performed with plug (1) tightened, air may not be released.

Notice:
When air is mixed in hydraulic operating fluid and becomes whitely foamy, the air will not be released.

So raise the body (cargo deck) and remove plugs (1) and (5). When the hydraulic operating fluid is left alone about for 30 to 60 minutes, the air is naturally separated. Re-supply oil in accordance with the procedure of Items (2) and (3) of the “Supply Procedure of Hydraulic Operating Fluid”.

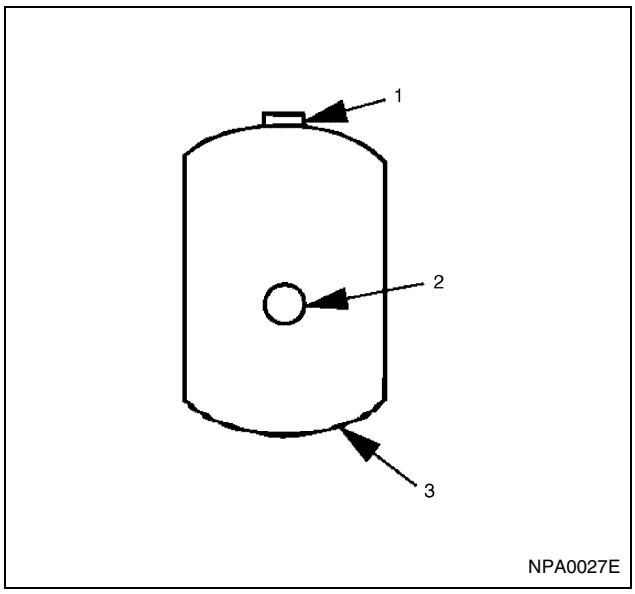
Principles Under Which Air Is Released
Between “B” and “C”
For Chamber “B” filled with hydraulic operating fluid, when the body (cargo deck) is dropped, the piston rod is dropped and the hydraulic operating fluid in “Chamber B” passes through the oil pump and is returned to the oil tank. At this time, if air is mixed in, it is discharged from “Surface C” in the oil tank as blow holes.
Between “A” and “C”
The hydraulic operating fluid pressurized and sent via the oil pump is sent from “Chamber C” to “Chamber B”. The piston cylinder is raised and the hydraulic operating oil in “Chamber A” is sent to “Chamber C”, and then the air is discharged for the same reason as between “B” and “C”.

[Three-Rotation Dump Truck]

<Manufactured by Shin Maywa Industries, Co., Ltd.]
Hydraulic Operating Fluid Supply

1. Raise the body (cargo deck) in accordance with the “How to raise the body (cargo deck)” described previously.
2. Remove oil filler plug (1) and level plug (2) of the oil tank and supply oil from the oil filler port until the hydraulic operating fluid flows out from level plug (2), then tighten plug (2).

Notice:
Supplying hydraulic operating fluid more than necessary will cause a fault.

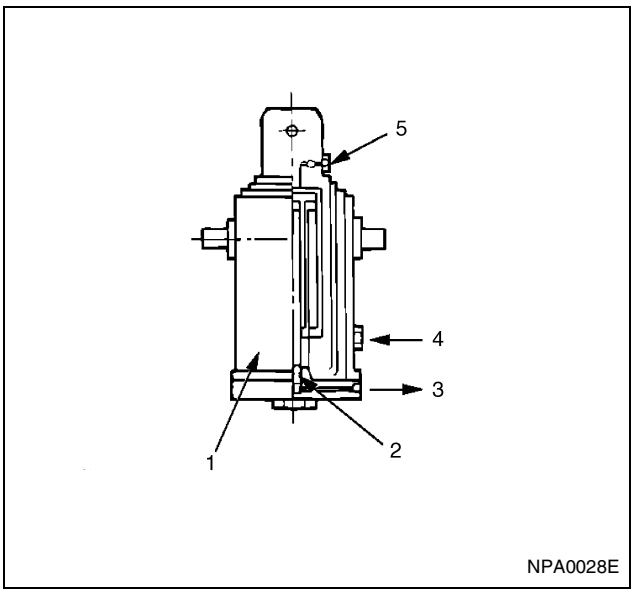


Legend
1. Oil filler port
2. Level plug
3. Oil tank

3. Set the dump lever to the “Up” position with the engine in the idling state.
4. When loosening the air bleeding plug (3) of the cylinder about once or twice, air is discharged and then hydraulic operating fluid is ejected. So quickly tighten the plug.

Notice:
When air is mixed in hydraulic operating fluid and becomes whitely foamy, the air is not released. So raise the body (cargo deck) and leave the hydraulic operating fluid alone about for one hour. The air in the hydraulic operating fluid is naturally separated and subsequently air can be released.

Even when performing air bleeding work, raise the body (cargo deck) in accordance with the “How to Raise The Body (cargo deck)” described previously.

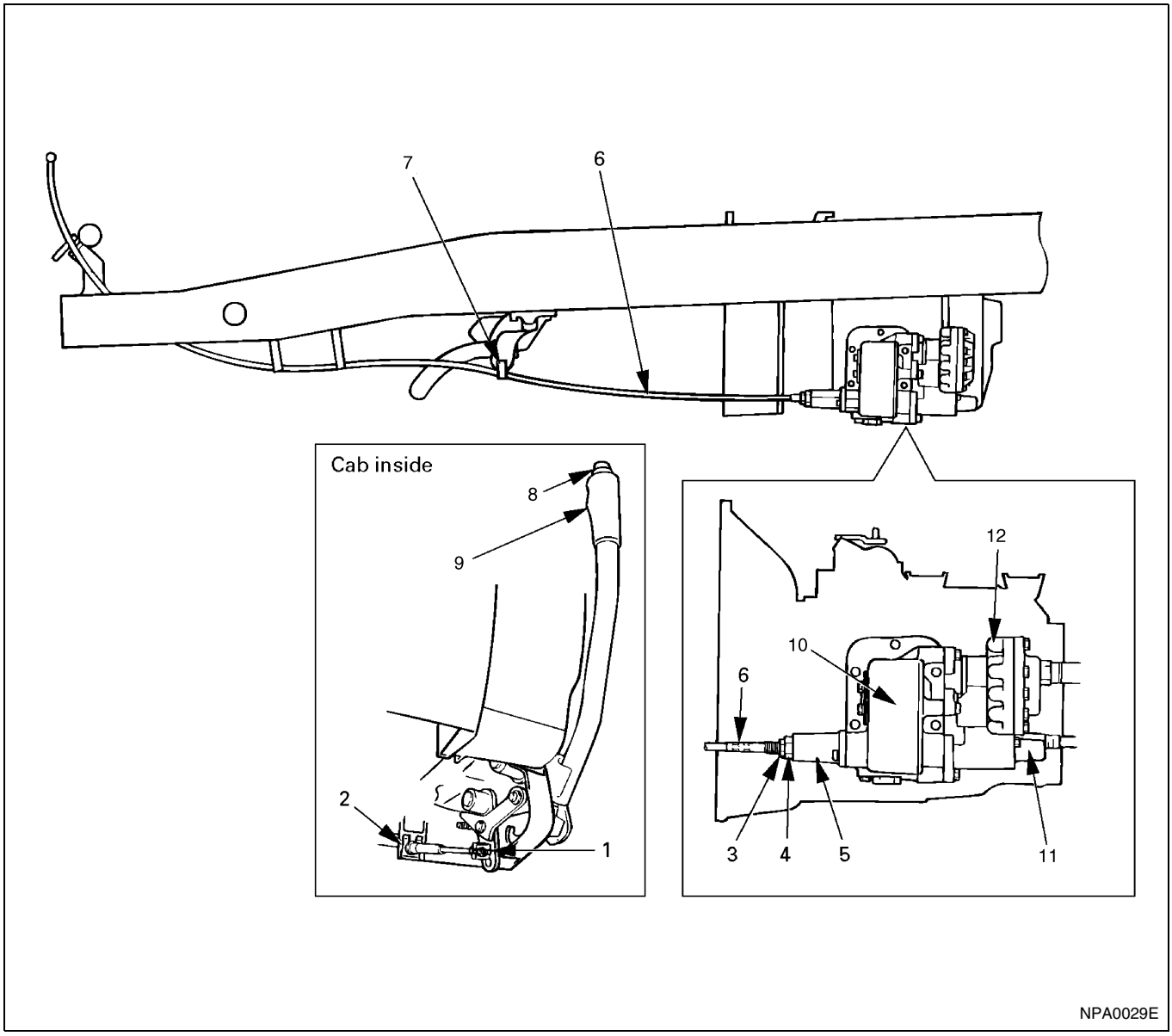


Legend

1. Cylinder main unit
2. Bypass valve
3. To oil tank
4. From oil pump (high pressure)
5. Air bleeding plug

CONTROL CABLE (FOR REAR DUMP TRUCK)

Removal and Installation



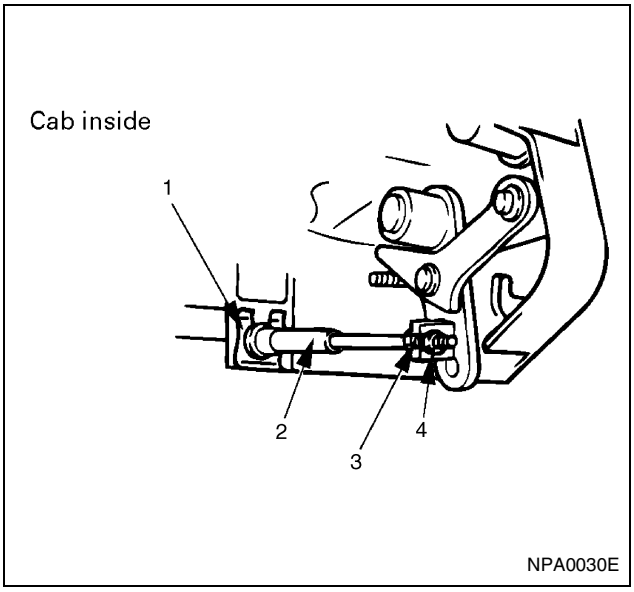
Legend

1. Lock nut (dump lever side)
2. Clip (inside cap)
3. Lock nut (PTO side)
4. Special nut
5. Cable holder
6. Control cable
7. Cable stopper clip
8. Lock button
9. Dump lever
10. PTO
11. Shift cap
12. Oil pump

Removal Steps

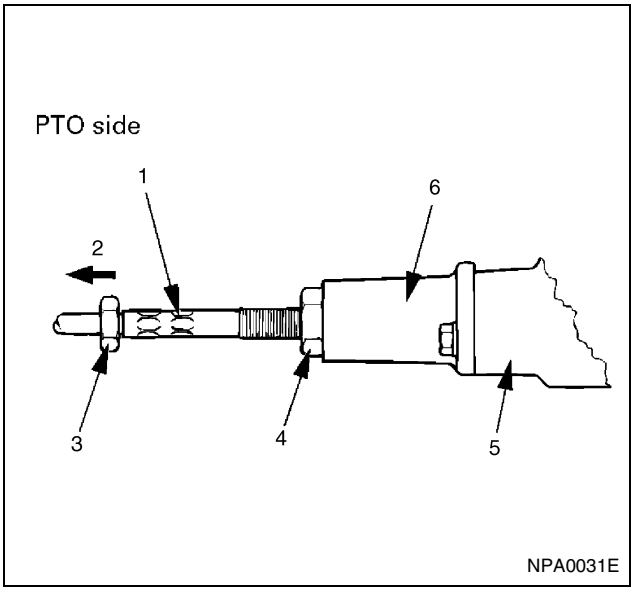
Notice:
Because a three-rotation dump truck differs in the wiring of a control cable from a rear dump truck, refer to the notes on the replacement and adjustment of the control cable for the three-rotation dump truck.

1. Lock Nut (Dump Lever Side)
   - Set the dump lever to the “Down” position and firmly lock the lever.
   - Loosen the lock nut of the control cable and remove the cable tip from the boss portion of the dump lever.
2. Clip (Inside Cab)
   - Remove the clip from the instrument panel bottom inside the cab.



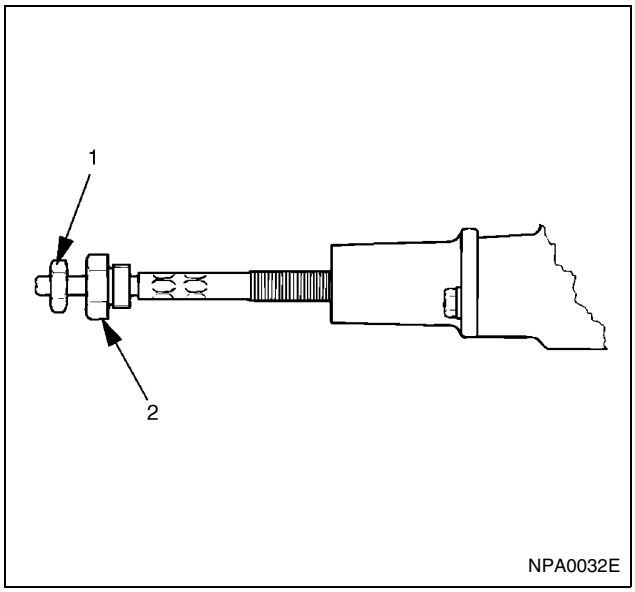
Legend
1. Clip
2. Control cable
3. Boss portion
4. Lock nut

3. Lock Nut (PTO Side)
   - Loosen the lock nut and move it toward the truck front.



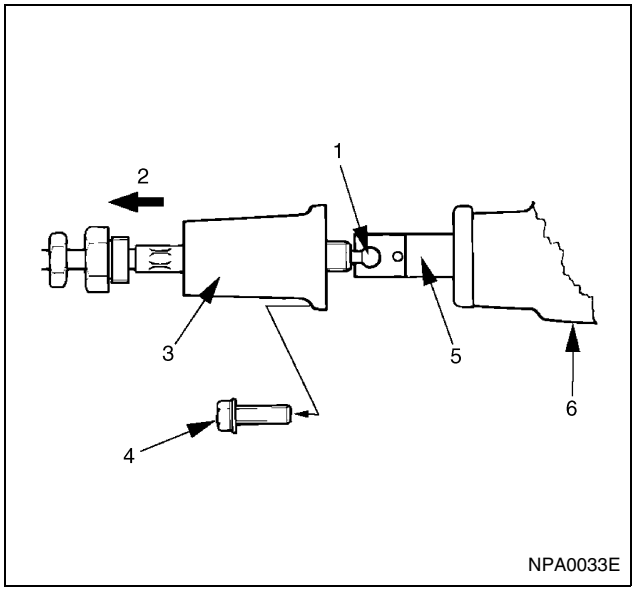
Legend
1. Control cable
2. Truck front
3. Lock nut
4. Special nut
5. PTO
6. Cable holder

4. Special Nut
   - Loosen the special nut and move it toward the truck front.



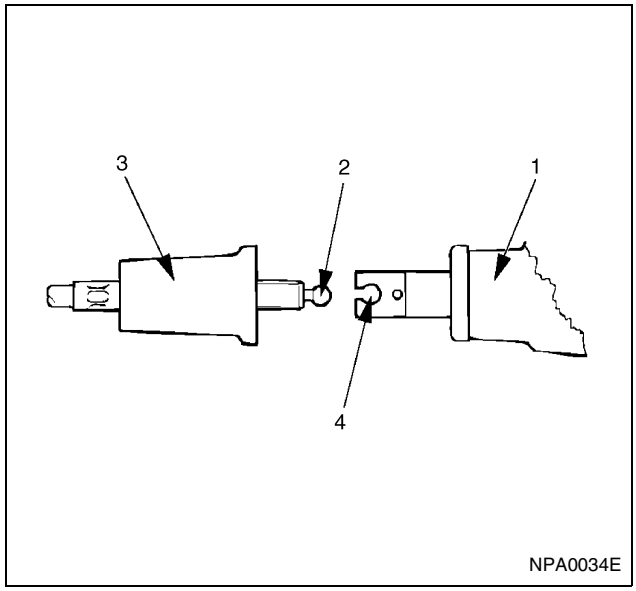
Legend
1. Lock nut
2. Special nut

5. Cable Holder
   - Remove the bolt and remove the cable holder from the PTO.
   - Move the cable holder to the truck front and provide clearance between the cable holder and PTO.



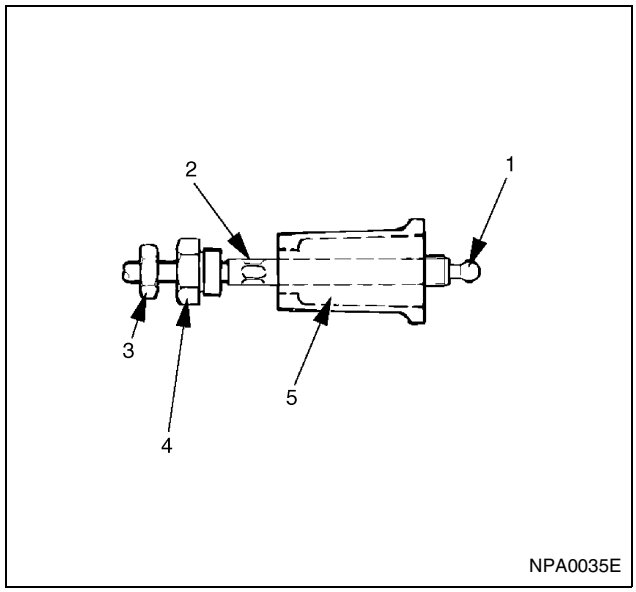
Legend
1. Rod end ball portion
2. Truck front
3. Cable holder
4. Bolt
5. Shift rod
6. PTO

6. Control Cable
   - Because the tip portion (PTO side) of the control cable is of a rod end ball type as shown in the drawing, remove the cable end portion from the cable connector groove on the PTO side sliding it along the groove.



Legend
1. PTO
2. Rod end ball portion
3. Cable holder
4. Cable connector groove

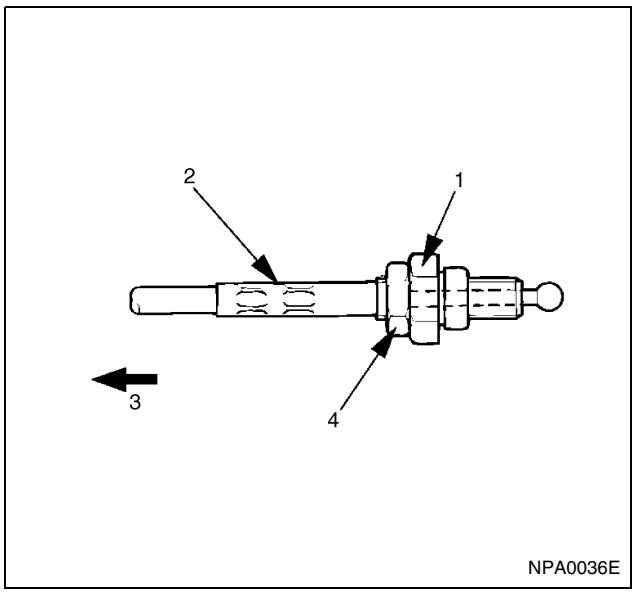
   - Remove the cable holder from the control cable.
   - Remove the control cable assembly from the truck.



Legend
1. Rod end ball portion
2. Control cable
3. Lock nut
4. Special nut
5. Cable holder

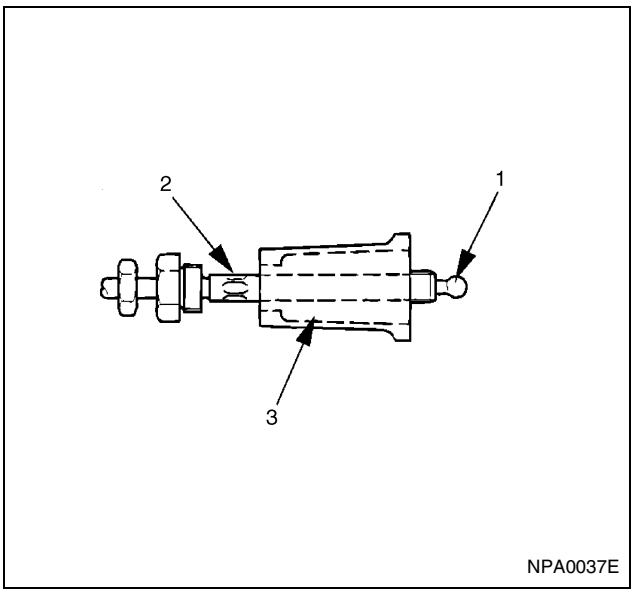
Installation Steps

1. Control Cable
   - Set the dump lever to the “Down” position and lock it.
   - Install the control cable assembly in the truck.
   - Move the lock nut (PTO side) and special nut of the cable top the truck front side.



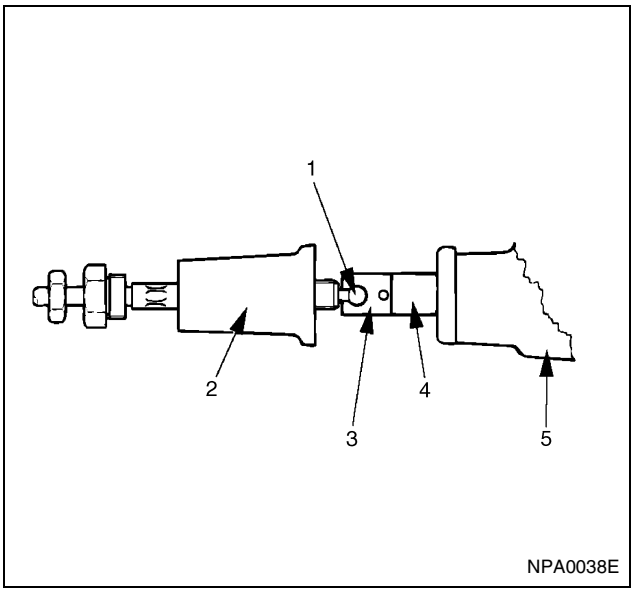
Legend
1. Special nut
2. Control cable
3. Truck front
4. Lock nut

2. Cable Holder
   - Assemble the cable holder in the control cable.



Legend
1. Rod end ball portion
2. Control cable
3. Cable holder

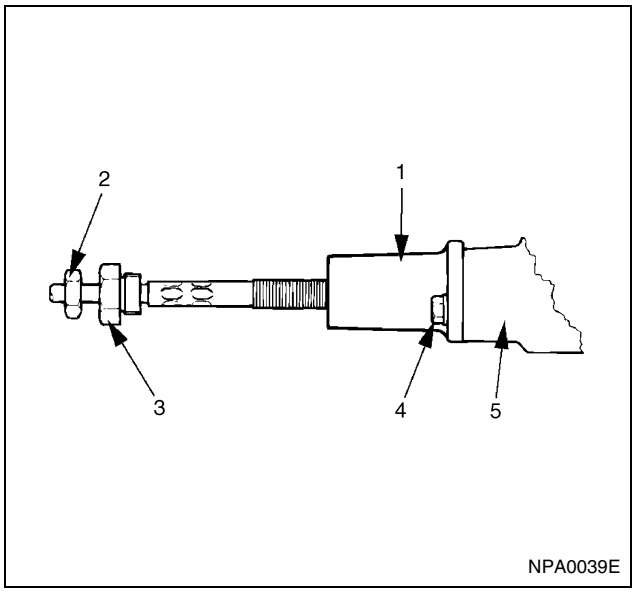
- Coat the rod end ball of the cable tip with a small amount of grease and assemble it in the groove of the control cable connector on the PTO side.



Legend
1. Rod end ball (apply a small amount of grease)
2. Cable holder
3. Cable connector
4. Shift rod
5. PTO

- Install the cable holder in the PTO and temporarily tighten the bolt.

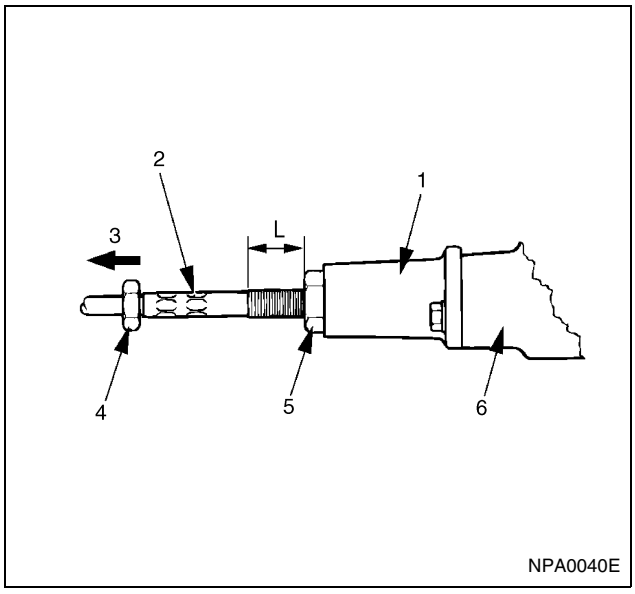
Notice:
Tighten the bolt after having adjusted it in accordance with the work procedure of the “Control Cable Adjustment”.



Legend
1. Cable holder
2. Lock nut
3. Special nut
4. Bolt
5. PTO

3. Special Nut
   - Tighten the special nut to the cable holder at a specified torque pressing down the control cable to the PTO side lightly.

Tighten:
Special nut to 147 N·m (15 kg·m / 108 lb·ft)



Legend
1. Cable holder
2. Control cable
3. Truck front
4. Lock nut
5. Special nut
6. PTO

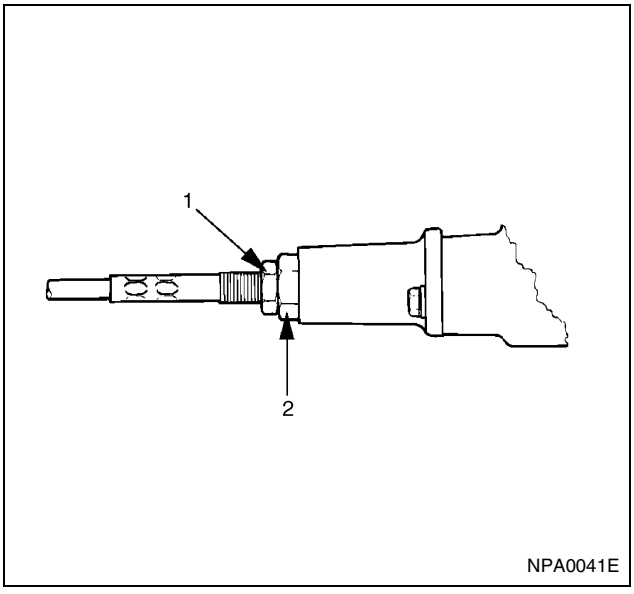
- At this time, check that the “L” dimension is 34±1 mm (1.339±0.039 inch.)
- If the “L” dimension does not satisfy the specified value, remove the cable holder from the PTO and rotate the cable holder to adjust the dimension.

Notice:
Both “clockwise rotation” and “counterclockwise rotation” indicate that the cable moves by about 0.75 mm (0.0295 inch) every time the cable holder rotates by 180 degrees.

- Re-install the cable holder on the PTO and temporarily tighten the bolt.

4. Lock Nut (PTO Side)
   - After having checked the specified value dimensions of the cable outer threaded portion, temporarily tighten the lock nut.

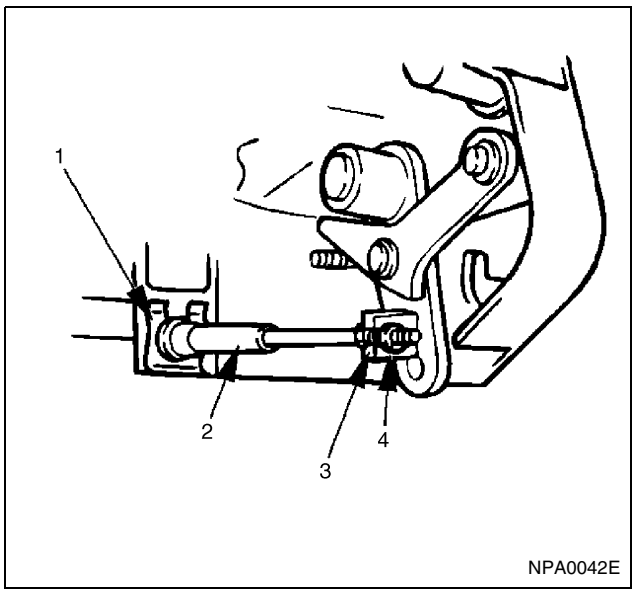
Notice:
Tighten the special nut and lock nut after having adjusted it in accordance with the work procedure of the “Control Cable Adjustment”.



Legend
1. Lock nut
2. Special nut

5. Clip (Cab Inside)
   - Draw the control cable in the instrument panel bottom inside the cab and firmly install the grommet.
   - Firmly install and fix the clip in the cable flange portion groove.
6. Lock Nut (Dump Lever Side)
   - Assemble the control cable tip in the boss portion of the dump lever and tighten the lock nut at a specified torque.

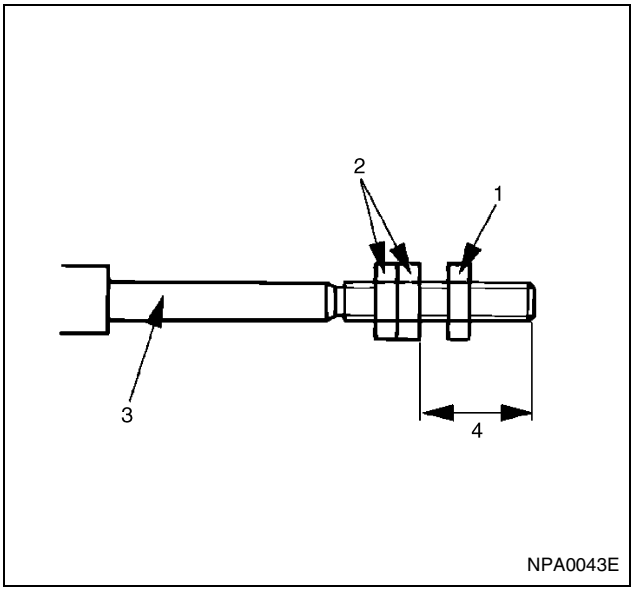
Tighten:
Lock nut to 6 N·m (0.6 kg·m / 52 lb·in)



Legend
1. Clip
2. Control cable
3. Boss portion
4. Lock nut

Notice:
If the double nut position of the control cable is not fixed, it is fixed to a reference value.

Control cable length (Reference): 18±1 mm (0.709±0.039 in)



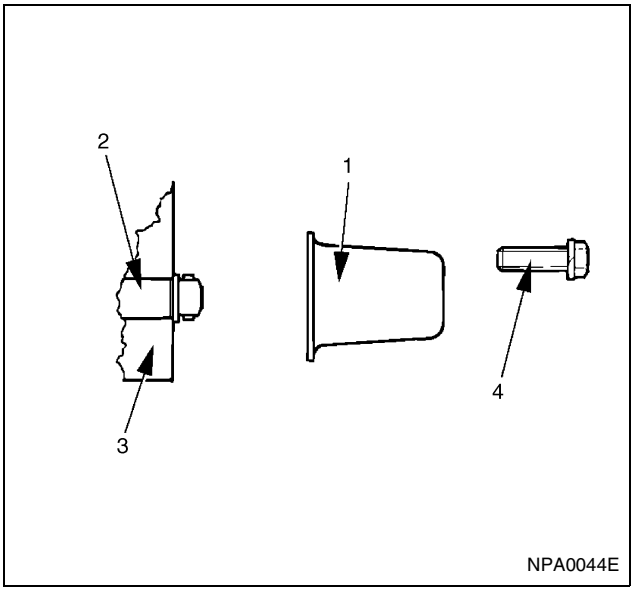
Legend
1. Lock nut
2. Double nut
3. Control cable
4. Reference valve

Control Cable Adjustment

Inspecting the Amount of Spool Extrusion

After having installed the control cable, inspect the amount of spool extrusion according to the following procedure.

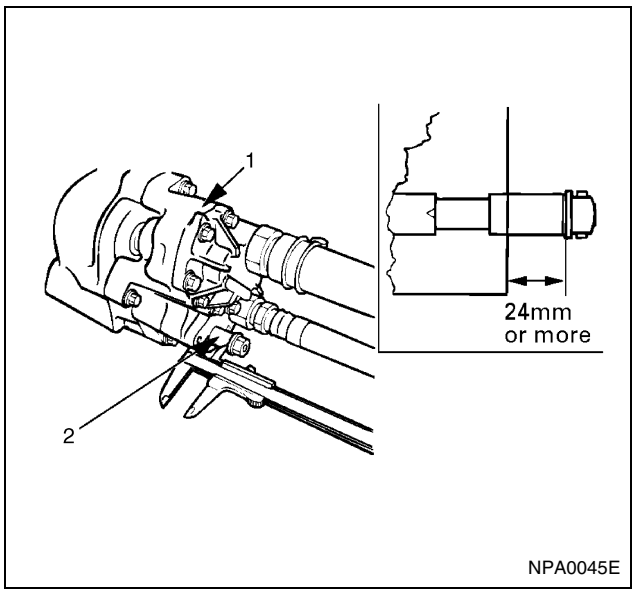
1. Remove the shift cap tightening bolt of the oil pump rear and remove the shift cap.



Legend
1. Shift cap
2. Spool
3. Oil pump rear end
4. Bolt

2. Repeat the “Up” and “Down” operations of the dump lever twice or three times and slowly set the dump lever to the “Up” position as much as possible.
3. Measure the amount of spool extrusion of the oil pump rear and check that it is a specified amount.

Amount of spool extrusion: 24 mm (0.945 in) or more

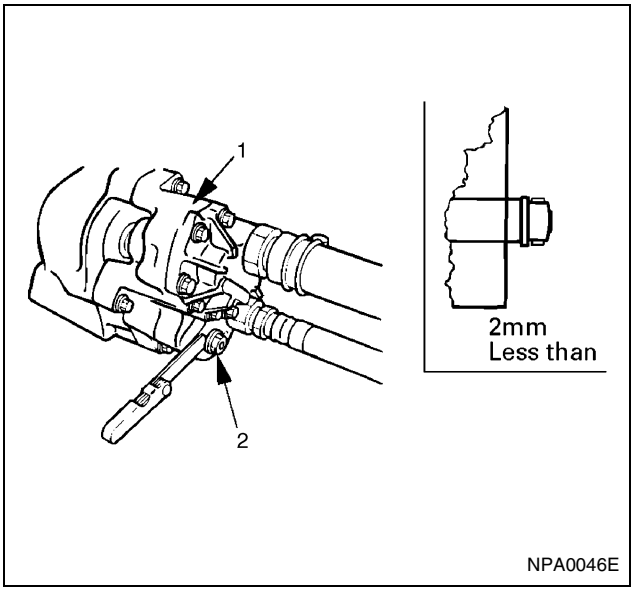


Legend
1. Oil pump
2. Spool extrusion

4. Repeat the “Up” and “Down” operations of the dump lever twice or three times and slowly set the dump lever to the “Up” position as much as possible.
5. Measure the amount of spool extrusion of the oil pump rear and check that it is a specified amount.

Amount of spool extrusion: less than 2 mm (0.0787 in)

Notice:
Both amounts of spool extrusion at “Up” and “Down” shall be within a standard value.

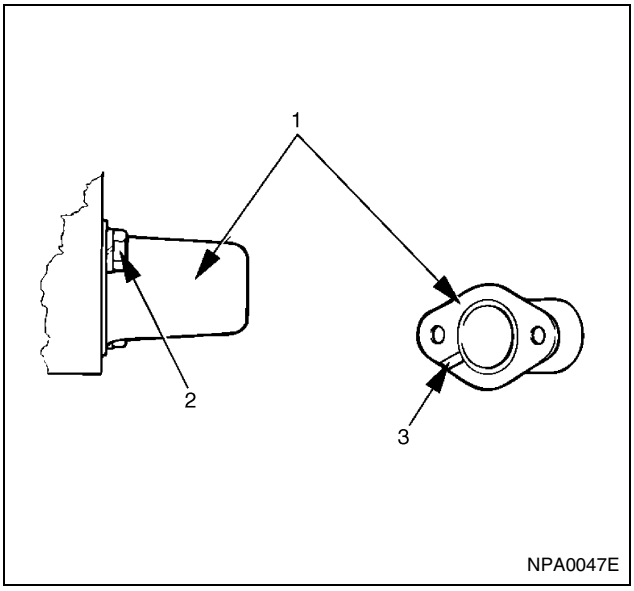


Legend
1. Oil pump
2. Spool extrusion

6. If the amount of spool extrusion is within a specified dimension, install the shift cap and tighten the bolt at a specified torque.

Tighten:
Shift cap fixing bolt to 24 N·m (2.4 kg·m / 17 lb·ft)

Notice:
If the groove is not installed facing downward, the water intruded in the shift cap is not ejected but collected. Rusting and freezing will cause an incorrect actuation.

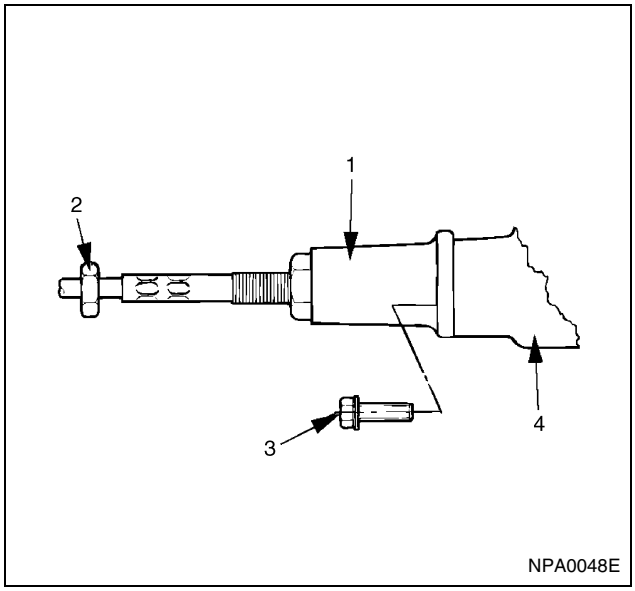


Legend
1. Shift cap
2. Bolt
3. Make groove face downward

Cable Adjustment (PTO Side)

If no specified extrusion dimensions can be obtained as a result of measuring the amount of spool extrusion described previously, adjust (PTO side) the cable so that the specified amount of spool extrusion can be obtained according to the following procedure.

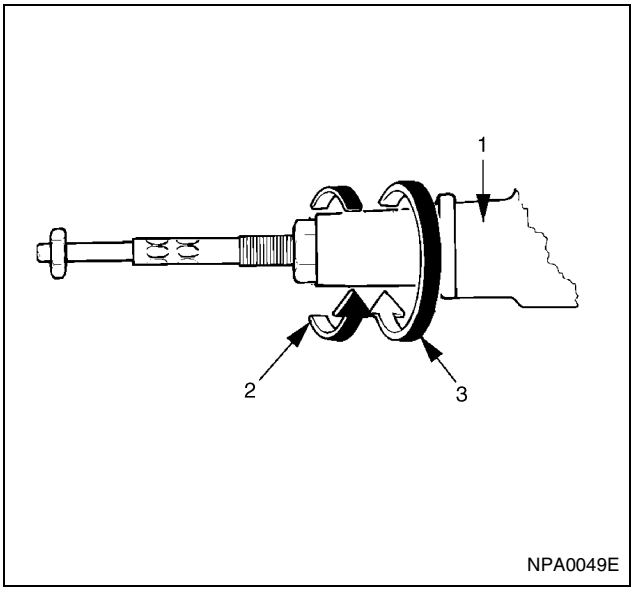
1. Loosen the lock nut of the control cable.
2. Remove the tightening bolt of the cable holder.



Legend
1. Cable holder
2. Lock nut
3. Bolt
4. PTO

3. Adjust the cable rotating the cable holder.
   - If the amount of spool extrusion is improper (insufficient) at “Dump lever Up”, rotate the cable holder toward “Counterclockwise rotation” shown by the arrow mark of the drawing.
   - If the amount of spool extrusion is improper (excessive) at “Dump lever Down”, rotate the cable holder toward “Clockwise rotation” shown by the arrow mark of the drawing.

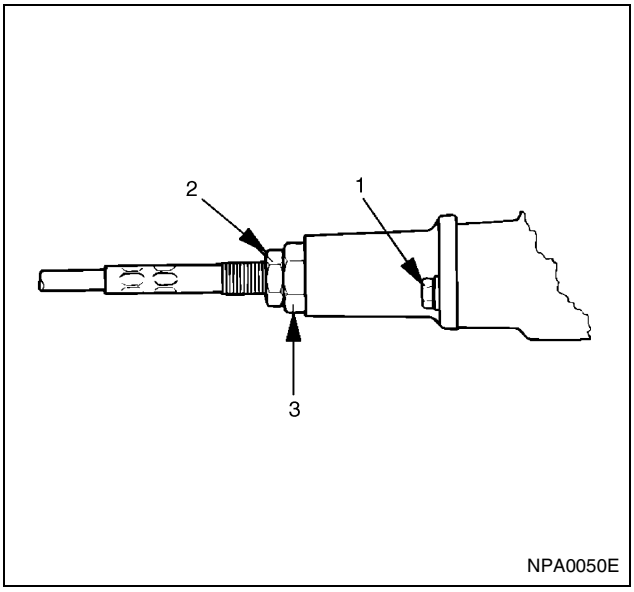
Notice:
Both “clockwise rotation” and “counterclockwise rotation” indicate that the cable moves by about 0.75 mm (0.0295 inch) every time the cable holder rotates by 180 degrees.



Legend
1. PTO
2. Counterclockwise rotation
3. Clockwise rotation

4. If the cable is adjusted in the aforementioned method and the amount of spool extrusion cannot be obtained, repeat Items (2) and (3) and adjust the cable so that the amount of spool extrusion will reach a specified extrusion dimension.
5. If a spool extrusion dimension can be obtained, tighten the cable holder tightening bolt and lock nut at a specified torque in this order.

Tighten:
- Cable holder bolt to 23 N·m (2.3 kg·m / 17 lb·ft)
- Lock nut to 21 N·m (2.1 kg·m / 15 lb·ft)



Legend
1. Bolt
2. Lock nut
3. Special nut

Operability of the dump lever, rise of the body (cargo deck), and inspection and adjustment of the rise and fall reference times

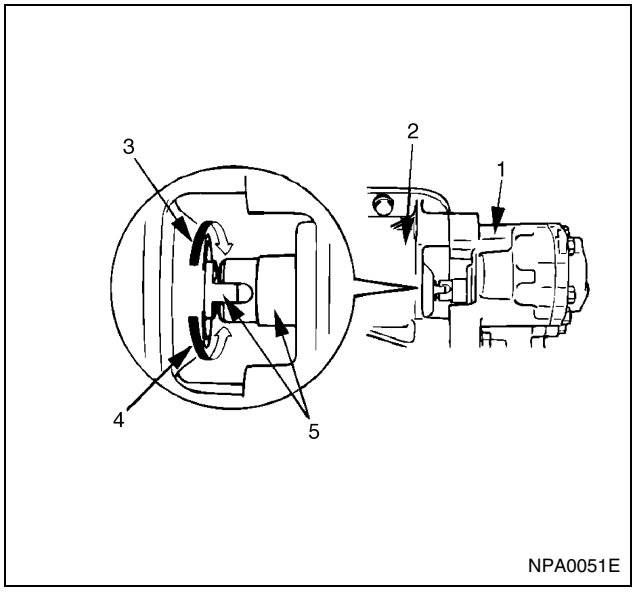
1. Check that the engine revolution per minute is 1,250 rpm and the rise and fall operations of the body (cargo deck) are performed within the following reference times.

Rise Time And Fall Time		Sec.
	Rise	Fall
Single Cab	within 20	within 20
Double Cab		within 25

2. Inspection of the dump lever control force and moderation
   - Inspect that the operation of the dump lever can lightly and smoothly be performed.

Basic Value (On the Dump Lever Knob): 10 kgf (98 N)

   - When the dump lever is in the “Up” and “Down” positions, inspect that the lock operation can be performed without a feeling of physical disorder.
3. After having repeated the “Up” and “Down” positions of the dump lever and slowly set them to the “Down” position as much as possible, inspect the shaft (driving shaft) between the PTO and oil pump.
   - Inspect that the shaft (driving shaft) rotates forward or backward.
     If the shaft slowly rotates backward, it is normal.

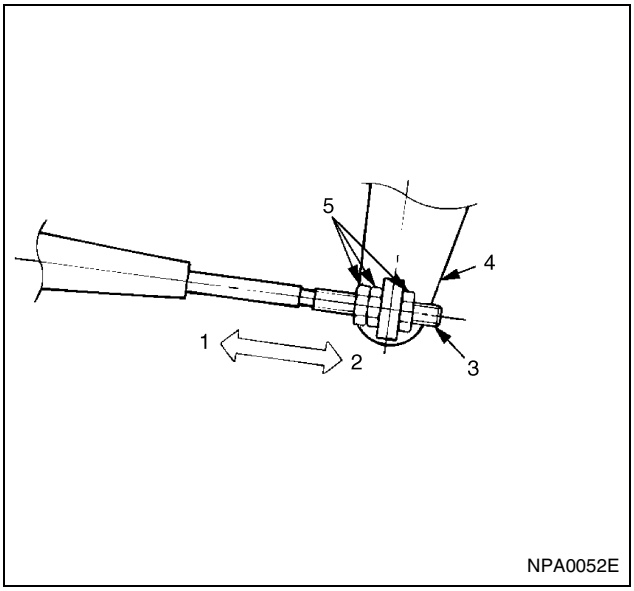


Legend
1. Oil pump
2. PTO
3. Direction of forward rotation
4. Direction of backward rotation
5. Shaft (drive shaft)

Cable Adjustment (Dump Lever Side)

If a defect is found as a result of the inspection of the aforementioned items (1) to (3), adjust the control cable in the dump lever portion inside the cab according to the following procedure.

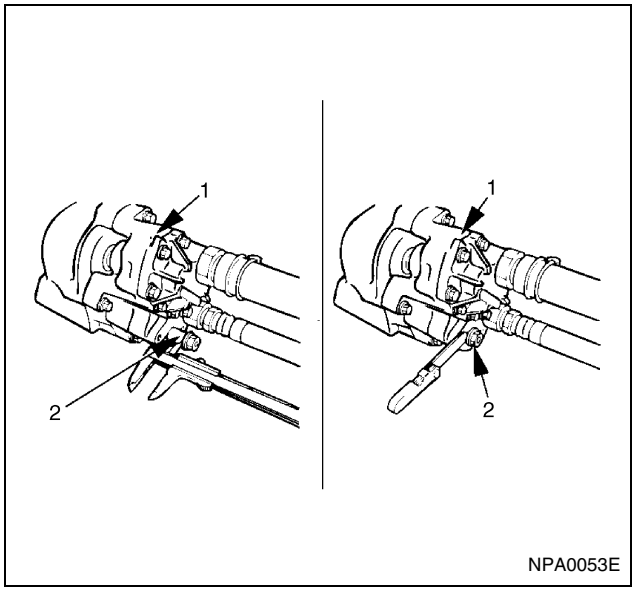
1. Set the dump lever to the “Down” position.
2. Loosen the lock nut of the control cable and adjust the cable as follows:



Legend
1. Squeeze
2. Pull out
3. Dump cable
4. Dump lever
5. Loosen

When the rise time is improper or when the shaft is inverted at “Down” time or when the dump lever is hard to lock at “Down” time, move the inner cable to Direction (1) of the drawing.
When the fall time is improper or when the dump lever is hard to lock at “Up” time or when the shaft rotates forward at “Down” time, move the inner cable to Direction (2) of the drawing.

Notice:
If the cable is adjusted on the dump lever side, be sure to re-inspect the amount of spool extrusion.



Legend
1. Oil pump
2. Spool extrusion

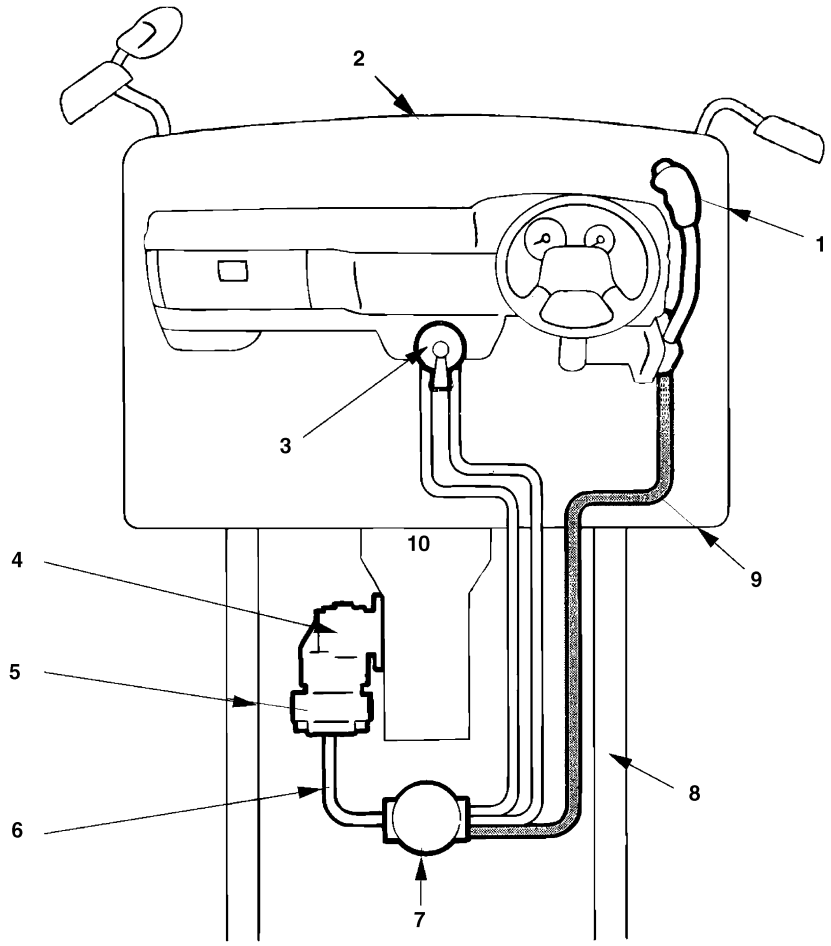
3. After adjustment, tighten the lock nut at a specified torque.

Tighten:
Lock nut to 6 N·m (0.6 kg·m / 52 lb·in)

Notes on Replacing and Adjusting Control Cable for Three-rotation Dump Truck

1. The control cable between the “Dump lever and selector” of the three-rotation dump truck is manufactured by ISUZU MOTORS LIMTED.
   This control cable is sent for (at replacement) in the Isuzu Motors Service Network, and because the selector need be disassembled, assembled, and adjusted, request a service network (SS store) of a body manufacturer of the replacement work.
2. The selector main unit for the three-rotation dump truck and the control cable between the “Selector and PTO (with oil pump) are manufactured by a body manufacturer.
   Request a service network (SS store) of a body manufacturer of the replacement work of the selector main unit and the aforementioned control cable.
3. First adjust the control cable at the dump lever bottom, adjust the control cable in the cable holder portion of the PTO (oil pump portion), and check that the shaft (driving shaft) of the oil pump will not rotate concurrently. Then because the adjustment of the selector main unit is necessary (only at down lever down, the ejection direction of the cargo deck can be selected. If this adjustment is improper, the cargo deck may fall off.), request a service network of a body manufacturer of the adjustment.

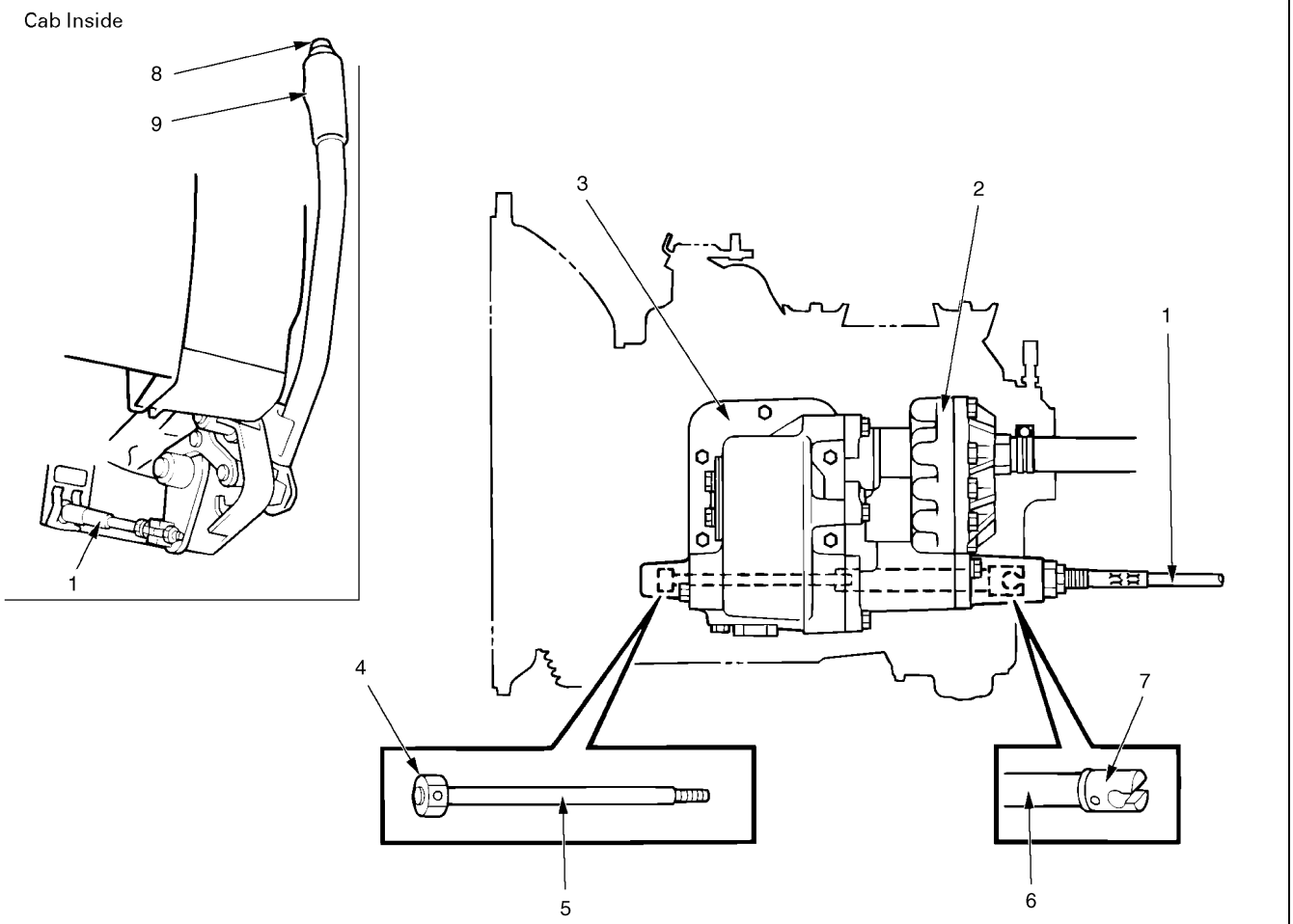
Control Cable Rough Layout Drawing for Three-Rotation Dump Truck



Legend

1. Dump lever
2. Cab
3. Dump (ejection) position switching lever
4. PTO
5. Oil pump
6. Control cable (between selector and oil pump)
7. Selector
8. Frame
9. Isuzu control cable
10. Transmission

Control Cable Adjustment for Three-rotation Dump Truck

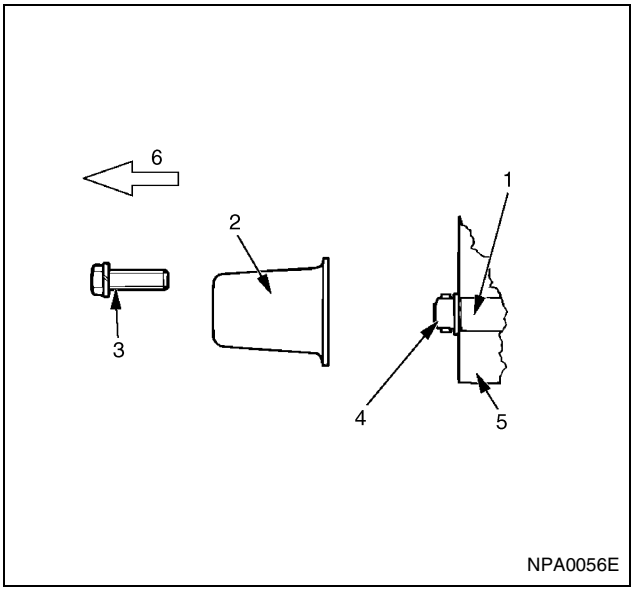


Legend

1. Control cable
2. Oil pump
3. PTO
4. Stopper adapter
5. Inner rod assembly
6. Spool
7. Cable connector
8. Lock button
9. Dump lever

Replacement

1. The control cable between the “Dump lever and selector” of the three-rotation dump truck is manufactured by Isuzu Motors Ltd. This control cable is sent for (at replacement) in the Isuzu Motors Service Network, and because the selector need be disassembled, assembled, and adjusted, request a service network (SS store) of a body manufacturer of the replacement work.
2. The selector main unit for the three-rotation dump truck and the control cable between the “Selector and PTO (with oil pump) are manufactured by a body manufacturer. Request a service network (SS store) of a body manufacturer of the replacement work of the selector main unit and the aforementioned control cable.



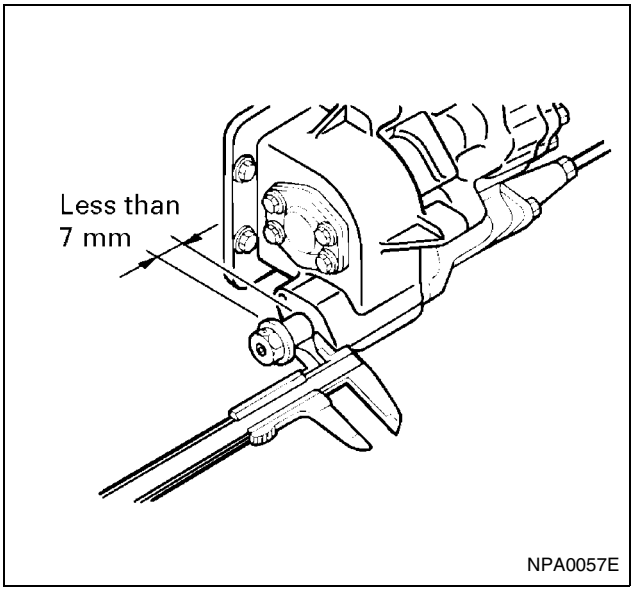
Legend

1. Inner rod
2. Shift cap
3. Bolt
4. Spool extrusion portion
5. PTO tip portion
6. Truck front

Measurement of the Amount of Spool Extrusion (PTO Tip Portion)

1. Remove the shift cap tightening bolt of the PTO tip portion and remove the shift cap.
2. Operate the dump lever twice or three times and slowly set it to the “Up” position as much as possible, then firmly lock the dump lever.
3. Measure the amount of spool extrusion at “Up” time at the PTO tip portion and check that it is a basic value.

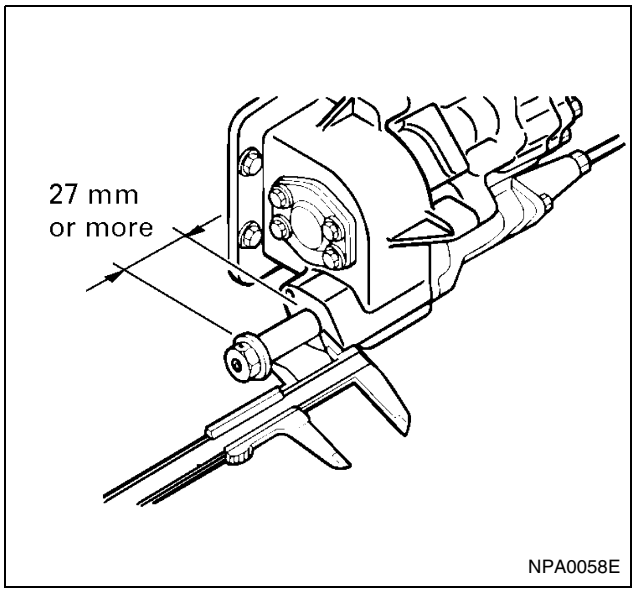
Amount of spool extrusion: less than 7 mm (0.276 in)



4. Operate the dump lever twice or three times and slowly set it to the “Down” position as much as possible, then firmly lock the dump lever.
5. Measure the amount of spool extrusion at “Down” time at the PTO tip portion and check that it is a basic value.

Amount of spool extrusion: 27 mm (1.063 in) or more

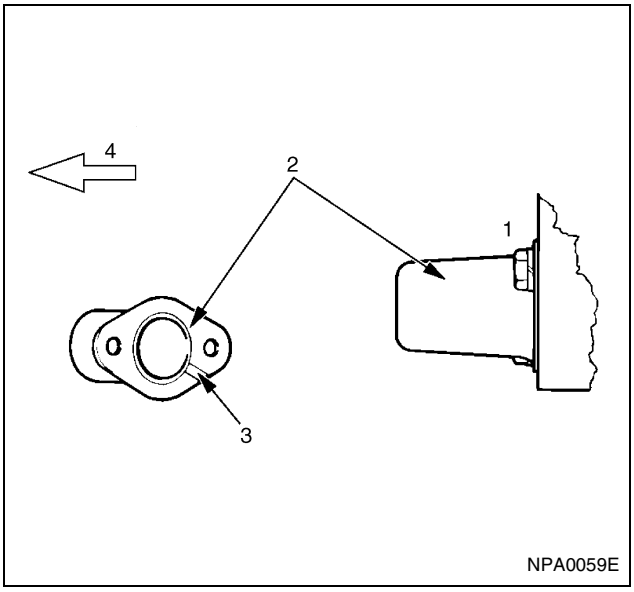
Notice:
Be sure check that both amounts of spool extrusion at “Up” and “Down” times are within basic values.



6. As a result of measurement, if the amount of spool extrusion is within a basic value, install the shift cap and tighten the bolt at a specified torque.
   - Install the shift cap so that the groove on the locating plane can locate downward.

Tighten:
Shift cap bolt to 24 N·m (2.4 kg·m / 17 lb·ft)

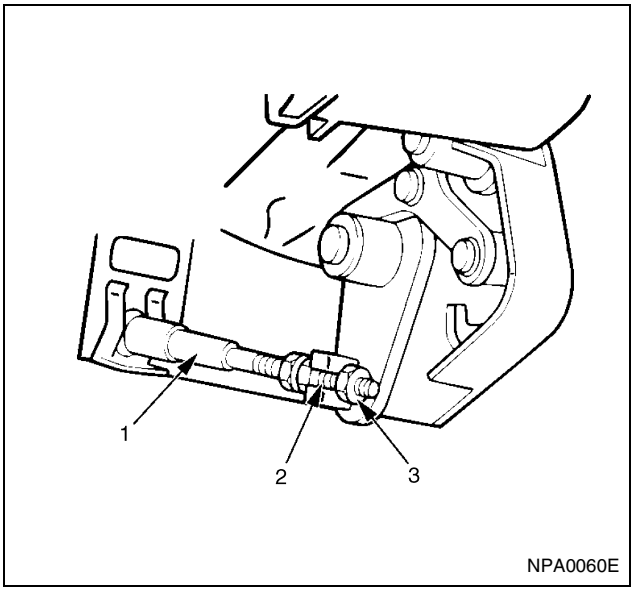
Notice:
If the groove is not installed facing downward, the water intruded in the shift cap is not ejected but collected. Rusting and freezing will cause an incorrect actuation.



Legend
1. Bolt
2. Shift cap
3. Make groove face downward
4. Truck front

Adjustment of the Amount of Spool Extrusion (Control Cable Adjustment)

Notice:
As a result of the "Measurement of The Amount of Spool Extrusion" described previously, if a specified extrusion dimension cannot be obtained, adjust the control cables on the dump lever side inside the cab and the dump lever side according to the following procedure.



Legend
1. Control cable
2. Boss portion
3. Lock nut

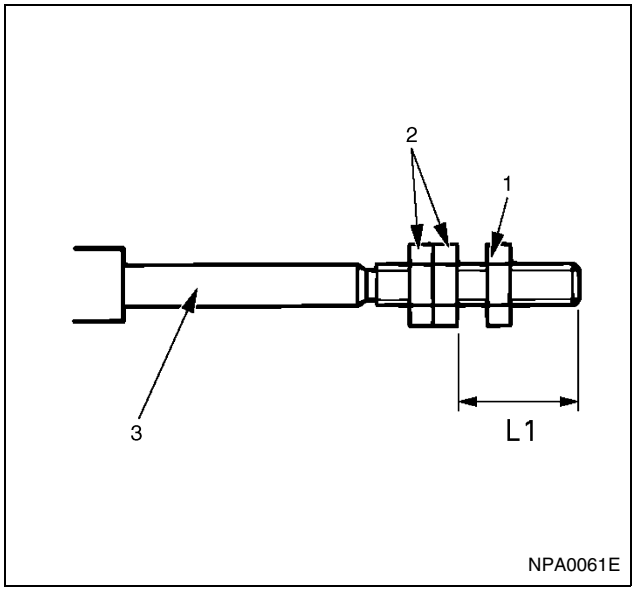
Control Cable Adjustment (Dump Lever Side Inside Cab)

1. Operate the dump lever twice or three times with the engine in the stopped state and slowly set it to the "Up" position, then firmly lock the dump lever.
2. Measure the length "L1" on the control cable tip and double nut side shown in the drawing and check that it is within the following basic value.

Length "L1": 14±1 mm (0.55±0.039 in)

3. As a result of measurement, if the length "L1" does not satisfy a basic value, loosen the lock nut and adjust the control cable so that the length "L1" will be set to a specified length "L1", then tighten the lock nut at a specified torque.

Tighten:
Lock nut to 6 N·m (0.6 kg·m / 52 lb·in)



Legend
1. Lock nut
2. Double nut
3. Control cable

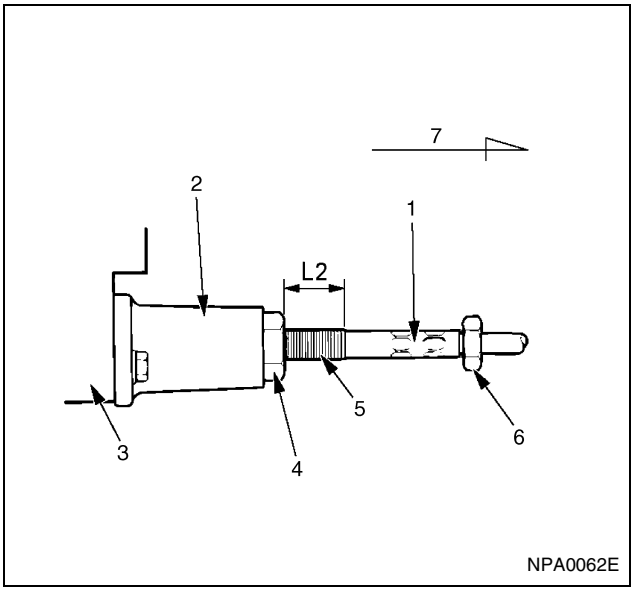
Control Cable Adjustment (Oil Pump Side)

1. Tighten the special nut in the cable holder loosening the lock nut, moving it to the truck rear, and lightly pushing the control cable against the PTO side.
2. Measure the length "L2" between the outer screw tip portion and special nut end of the control cable shown in the drawing and check that it is within a basic value.

Length "L2" (Reference): 24^{+1}_{-0} mm ($0.945^{+0.039}_{-0}$ in)

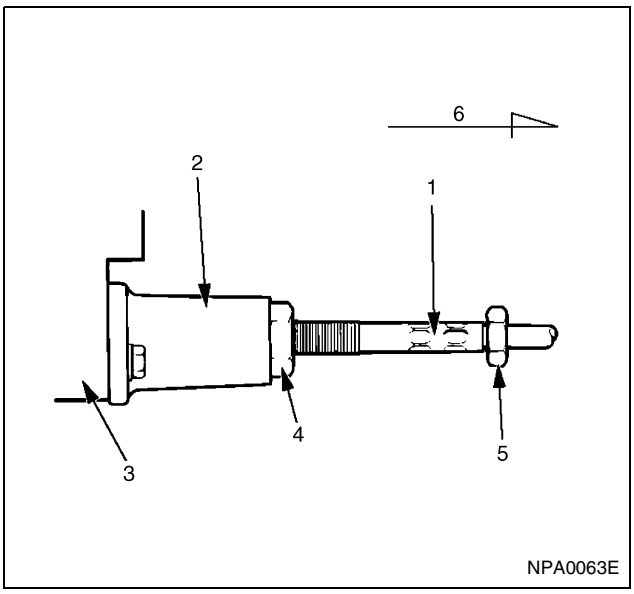
- As a result of check, if the length "L2" is satisfied, tighten the lock nut at a specified torque.

Tighten:
Lock nut to 20 N·m (2.0 kg·m / 14 lb·ft)



Legend
1. Control cable
2. Cable holder
3. Oil pump portion
4. Special nut
5. Outer threaded portion
6. Lock nut
7. Truck front

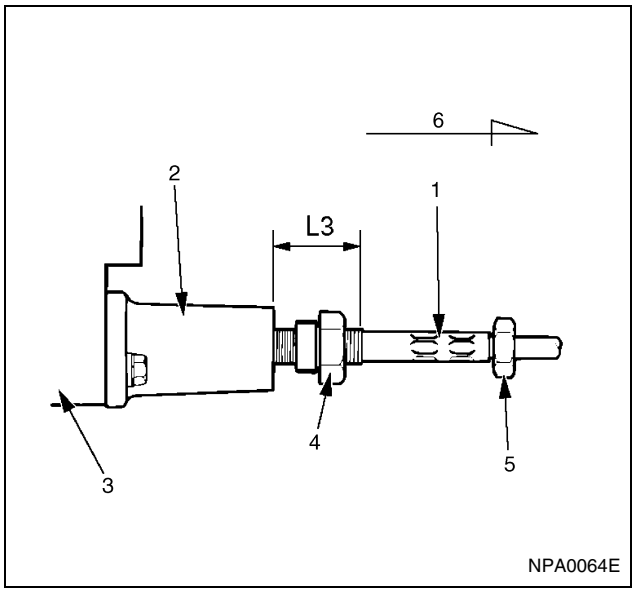
3. As a result of measurement, if the length “L2” does not satisfy a basic value, adjust the control cable according to the following procedure.



Legend
1. Control cable
2. Cable holder
3. Oil pump portion
4. Special nut
5. Lock nut
6. Truck rear

1) Loosen the special nut and move it toward the truck rear, then set the control cable free.
2) Manually holding the control cable, take in and out the cable to the front and rear. Obtain the length “L3” and temporarily tighten the special nut securing the control cable manually.

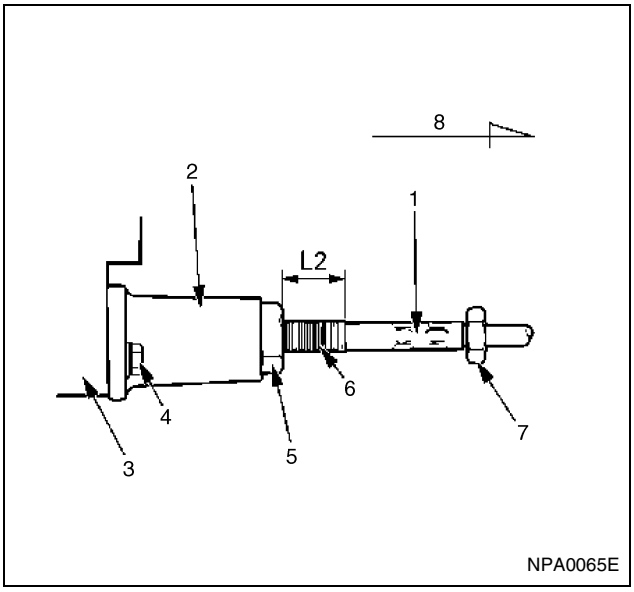
“L3” = “L2” basic value + Special Nut Thickness (10 mm)



Legend
1. Control cable
2. Cable holder
3. Oil pump portion
4. Special nut
5. Lock nut
6. Truck rear

3) Measure the length “L2” in the state of (2). If the dimension does not satisfy a basic value, repeat Items (2) and (3) and adjust so that the “L2” will be set to the basic value.
4) After having the length “L2”, tighten the special nut at a specified torque.

Tighten:
Special nut to 142 N·m (14.5 kg·m / 105 lb·ft)

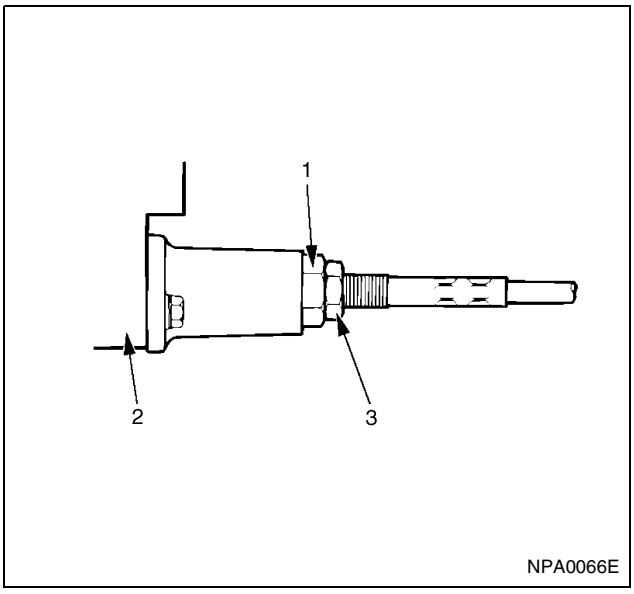


Legend

1. Control cable
2. Cable holder
3. Oil pump portion
4. Bolt
5. Special nut
6. Outer threaded portion
7. Lock nut
8. Truck rear

5) After having tightened the special nut, tighten the lock nut at a specified torque.

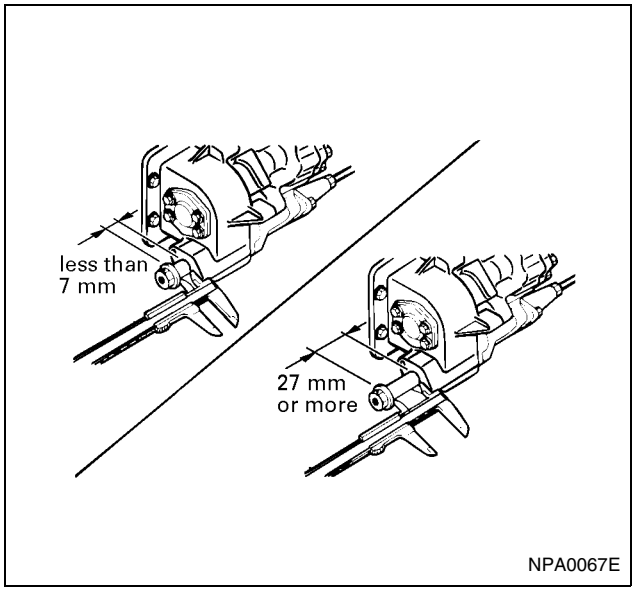
Tighten:
Lock nut to 20 N·m (2.0 kg·m / 14 lb·ft)



Legend

1. Special nut
2. Oil pump portion
3. Lock nut

4. After having adjusted the control cable, slowly operate the dump lever twice or three times and recheck the spool extrusion dimension.
(Refer to the item of Measurement of The Amount of Spool Extrusion.)

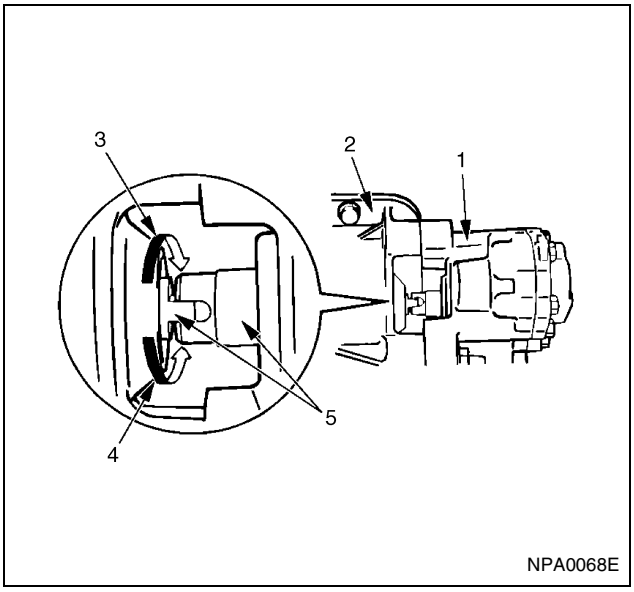


5. After having completed all measurement and adjustments, set the dump lever to the “Down” position and start the engine.

Operability of the Dump Lever, Rise of the Body (Cargo Deck), and Inspection and Adjustment of the Rise and Fall Reference Times

1. Check that the engine revolution per minute is 1,250 rpm and the rise and fall operations of the body (cargo deck) are performed within the following reference times.
Rise time = within 20 seconds
Fall time = within 20 seconds
2. Inspection of the dump lever control force and moderation
   - Inspect that the operation of the dump lever can lightly and smoothly be performed.

   Basic value = less than 10 kgf (98 N) on the dump lever knob
   - When the dump lever is in the “Up” and “Down” positions, inspect that the lock operation can be performed without a feeling of physical disorder.
3. After having repeated the “Up” and “Down” positions of the dump lever and slowly set them to the “Down” position as much as possible, inspect the shaft (driving shaft) between the PTO and oil pump.
   - Inspect that the shaft (driving shaft) rotates forward or backward.
     If the shaft slowly rotates backward, it is normal.

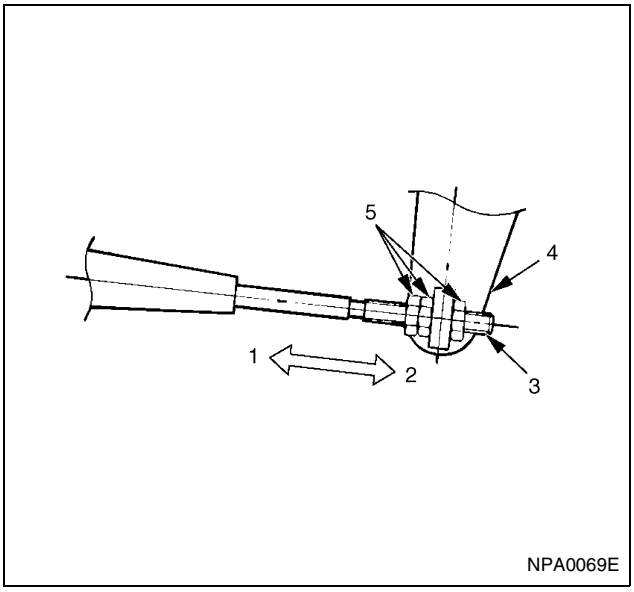


Legend

1. Oil pump
2. PTO
3. Direction of forward rotation
4. Direction of backward rotation
5. Shaft (drive shaft)

4. If a defect is found as a result of the inspection of the aforementioned items 1) to 3), adjust the control cable in the dump lever portion inside the cab according to the following procedure.
   1) Set the dump lever to the “Down” position.
   2) Loosen the lock nut of the control cable and adjust the cable as follows:

   When the rise time is improper or when the dump lever is hard to lock at “Down” time, move the inner cable to Direction (2) of the drawing on the preceding page.



Legend

1. Push in
2. Pull out
3. Dump cable
4. Dump lever
5. Loosen

When the fall time is improper or when the dump lever is hard to lock at “Up” time or when the shaft rotates forward at “Down” time, move the inner cable to Direction (1) of the drawing on the preceding page.

Notice:
If the cable is adjusted on the dump lever side, be sure to re-inspect the amount of spool extrusion.

After adjustment, tighten the lock nut at a specified torque.

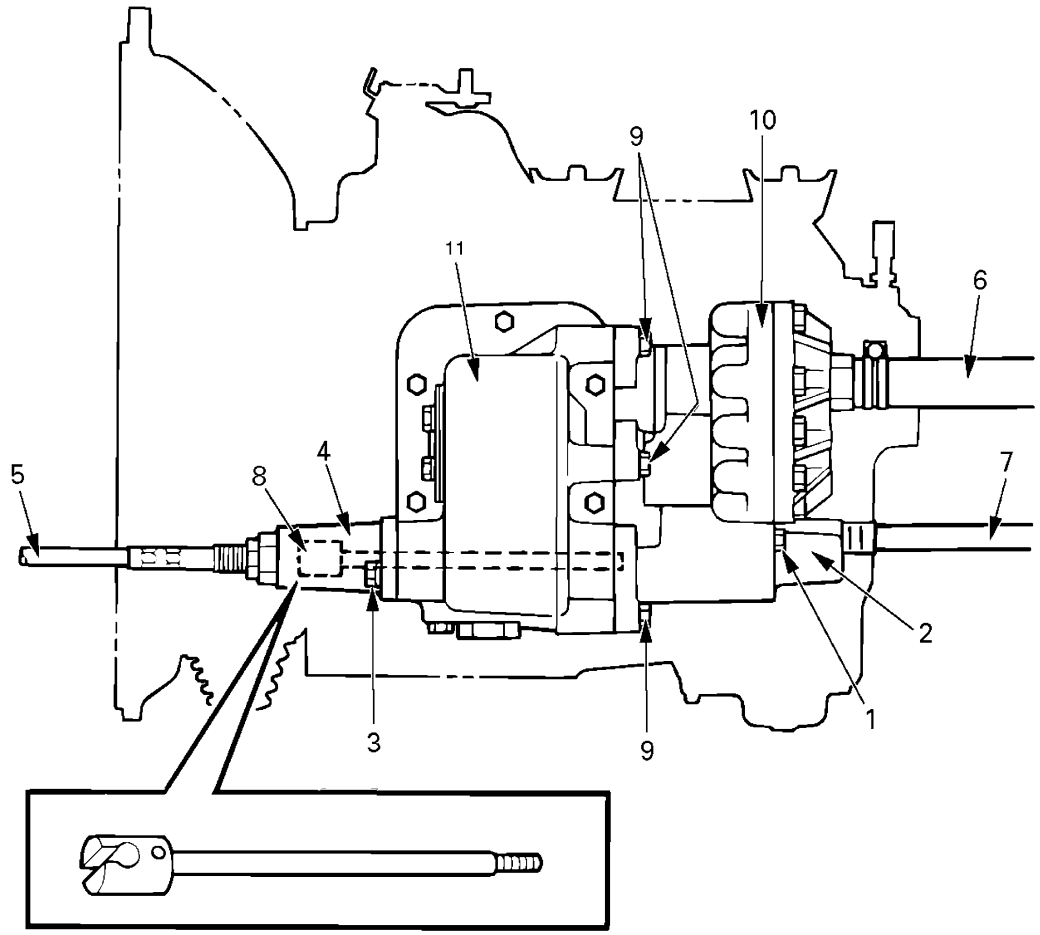
Tighten:
Lock nut to 6 N·m (0.6 kg·m / 52 lb·in)

***Selector**
The selector is adjusted so that the ejection direction of the cargo deck can be selected only at dump lever “Down”. If this adjustment is improper, the cargo deck may slide from the truck at rise. Accordingly, because the adjustment of the selector main unit is also needed after the replacement, adjustment, and inspection of the control cable, request a nearest service network (SS store) of a body builder of the adjustment.

OIL PUMP UNIT (REPLACEMENT)

Removal and Installation

This illustration is based on a rear dump truck model.



NPA0070E

Legend

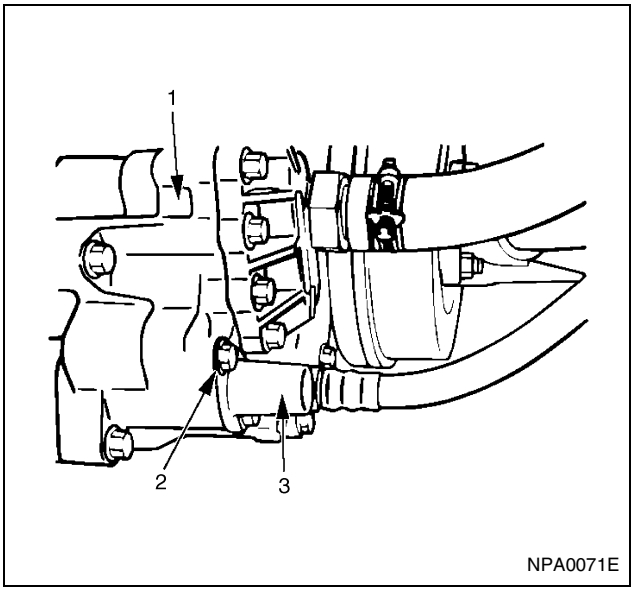
1. Bolt (shift cap)
2. Shift cap
3. Bolt (cable holder)
4. Cable holder
5. Control cable
6. Low-pressure hose
7. High-pressure hose
8. Inner rod assembly
9. Bolt (oil pump)
10. Oil pump
11. PTO

Removal Steps

Notice:
Set the dump lever inside the cab to the “Down” position and check the lever lock.

1. Bolt (Shift Cap)
2. Shift Cap

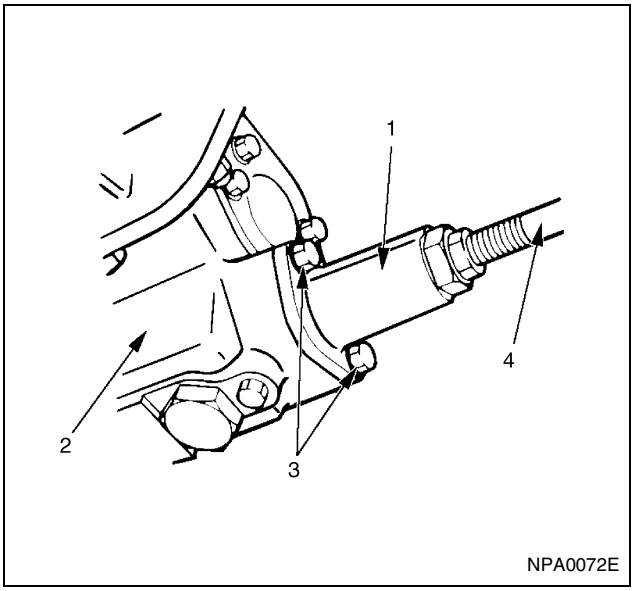
- Remove the bolt and remove the shift cap from the oil pump.



Legend
1. Oil pump
2. Bolt
3. Shift cap

3. Bolt (Cable Holder)
4. Cable Holder
5. Control Cable

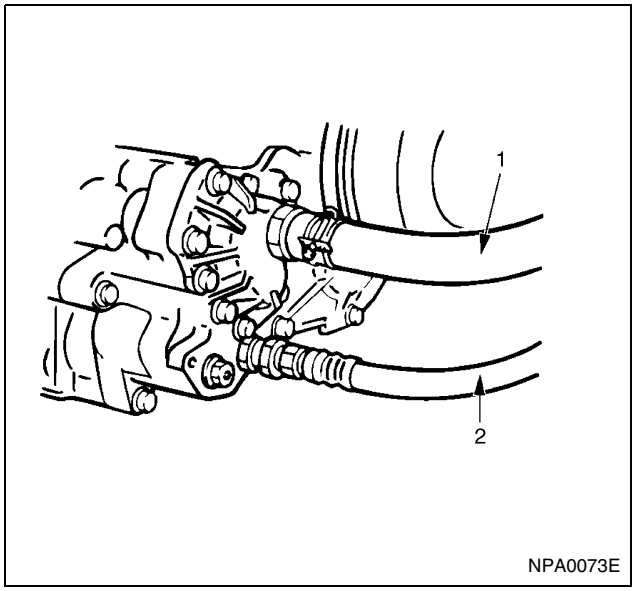
Notice:
Before removing the control cable, be sure to refer to Items 3 to 6 of “Removal” of the “Control Cable for Rear Dump Truck” described previously and perform work in accordance with the items.



Legend
1. Cable holder
2. PTO
3. Bolt
4. Control cable

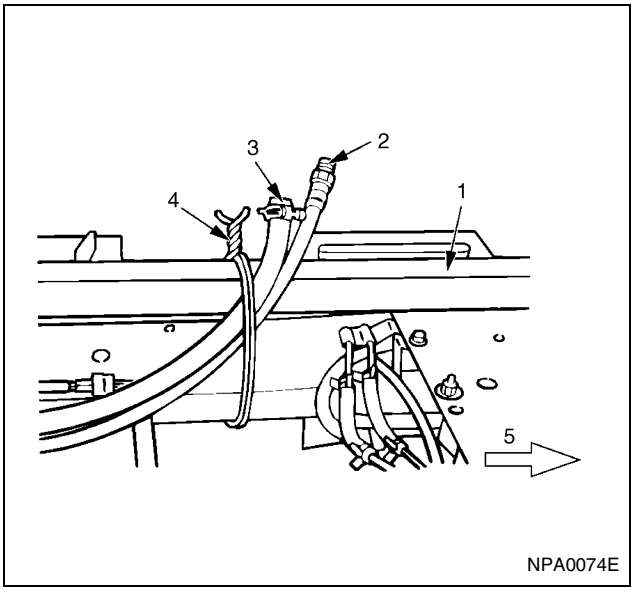
6. Low-Pressure Hose
   - Loosen the hose band and remove the hose from the oil pump.
7. High-Pressure Hose
   - Loosen the hose joint and remove the hose from the oil pump.

Notice:
For the high-pressure hose, the joint may not be removed in the oil pump fixed state according to the type of the truck and equipment. In that case, slightly loosen the joint to set the state. At the stage where the rear oil pump is removed (Item 10), remove the high-pressure hose rotating the oil pump.



Legend
1. Low-pressure hose
2. High-pressure hose

Notice:
Because hydraulic operating fluid flows out when the hose is removed, quickly make the hose port face upward and protect the hose so that dust or foreign matter will not be mixed in, then fix it to the frame with a wire.

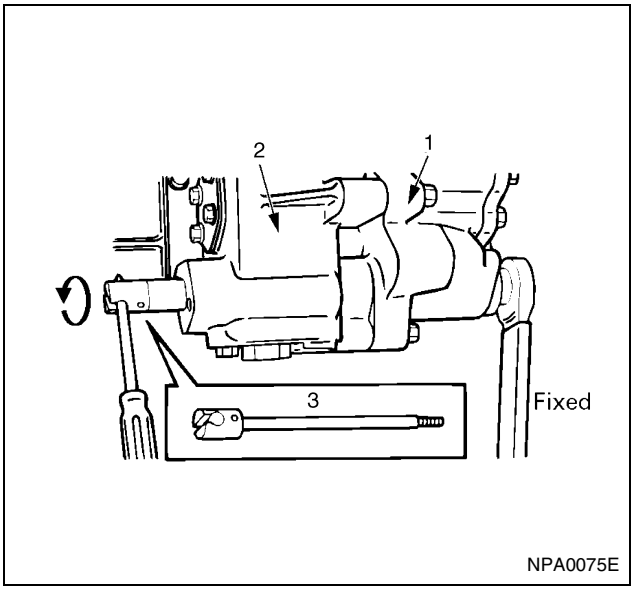


NPA0074E

Legend
1. Left frame
2. High-pressure hose
3. Low-pressure hose
4. Wire
5. Truck front

8. Inner Rod Assembly
   - To remove the inner rod assembly, as shown in the drawing, press the stopper adapter side by a wrench and insert a Phillips screwdriver (large) in the groove of the control cable connector. Then rotate it counterclockwise, loosen it, and remove it.

Notice:
Be sure to press the stopper adapter side and loosen it on the control cable connector side. (Press the stopper adapter side not to rotate the spool valve. Besides, the three-rotation dump truck is in contrast with this.)

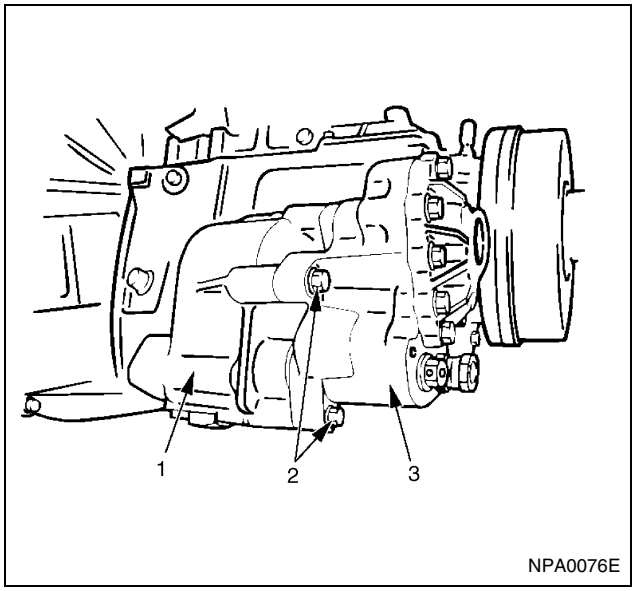


NPA0075E

Legend
1. Oil pump
2. PTO
3. Inner rod assembly

9. Bolt (Oil Pump)
10. Oil Pump
    - Remove three oil pump tightening bolts and strike them with a plastic hammer (or a wooden hammer) from the truck front side, then remove the oil pump from the PTO.
    - Remove the joint from the oil pump.

Notice:
If the high-pressure hose could not be removed in Item 7 described previously, remove the oil pump from the high-pressure hose rotating the oil pump at this time.



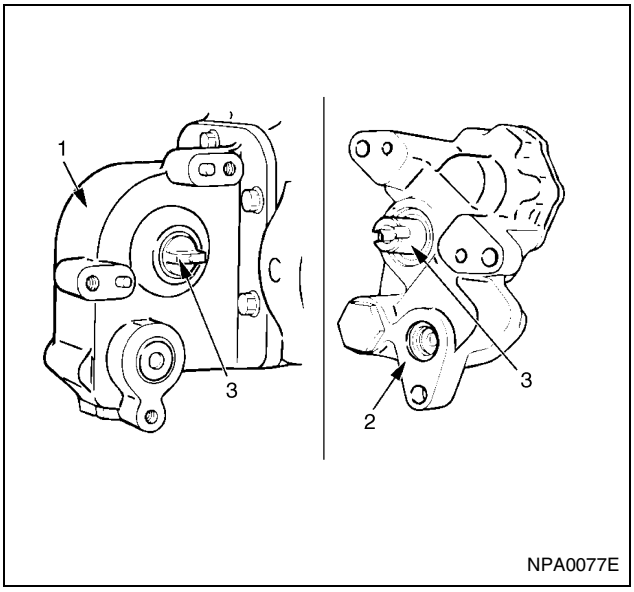
NPA0076E

Legend
1. PTO
2. Bolt
3. Oil pump

Installation Steps

1. Oil Pump
2. Bolt (Oil Pump)
   - Fully coat the oil pump shaft tip groove portion and PTO shaft tip with lithium grease (BESCO L-2 or equivalent).
   - Install the oil pump in the joint.

Notice:
If the oil pump is rotated and removed from the high-pressure hose when the oil pump is removed, install the oil pump in the high-pressure hose rotating the oil pump and slightly tighten it.

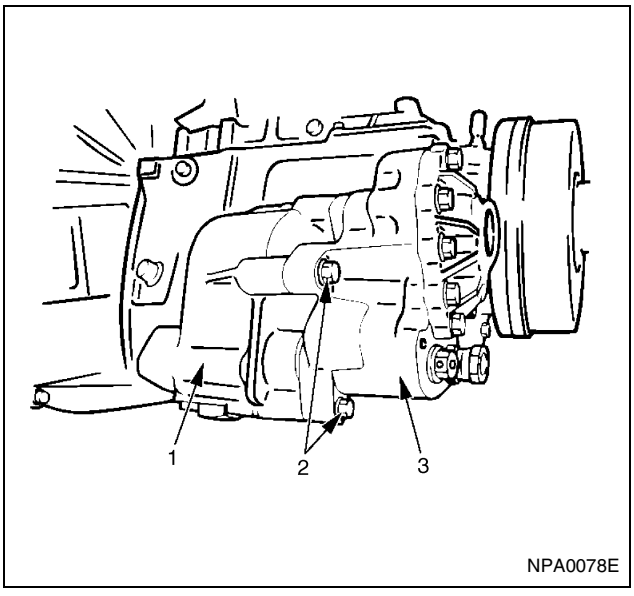


Legend
1. PTO
2. Oil pump
3. Coat shaft tip portion with grease

- Align and install the oil pump groove and the shaft width across flats of the PTO and tighten the bolt at a specified torque.

Tighten:
PTO bolt to 53 N·m (5.4 kg·m / 39 lb·ft)

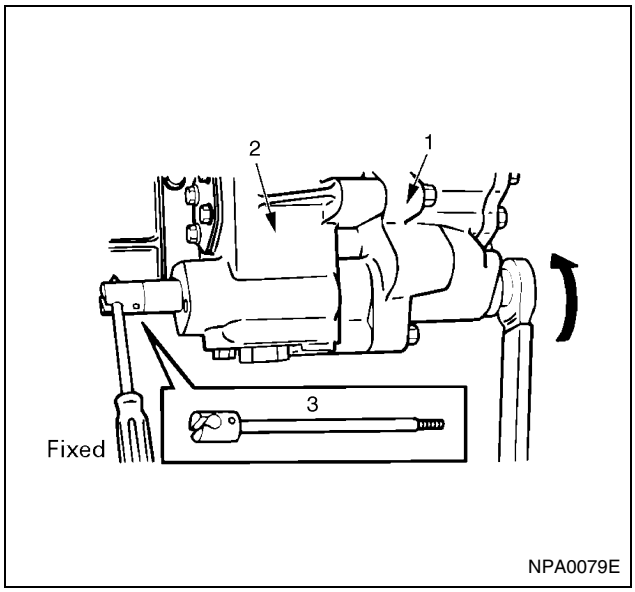
Notice:
Be fully careful so that dust or foreign matter will not be mixed in from the hose installation port of the oil pump.



Legend
1. PTO
2. Bolt
3. Oil pump

3. Inner Rod Assembly
   - Coat the threaded portion of the inner rod assembly tip with liquid gasket (LOCTITE 242 or equivalent) and insert and screw the tip from the front side of the PTO, then tighten it at a specified torque.
   - When tightening the inner rod assembly, insert a Phillips screwdriver (large) in the control cable connector groove, press it so that the spool valve will not rotate, then apply a wrench to the stopper adapter on the oil pump side to tighten it. (Besides, the three-rotation dump truck is in contrast with this.)

Tighten:
Inner rod to19 N·m (1.9 kg·m / 14 lb·ft)



Legend
1. Oil pump
2. PTO
3. Inner rod assembly

4. High-Pressure Hose
   - Install the high-pressure hose in the oil pump and firmly tighten the joint.

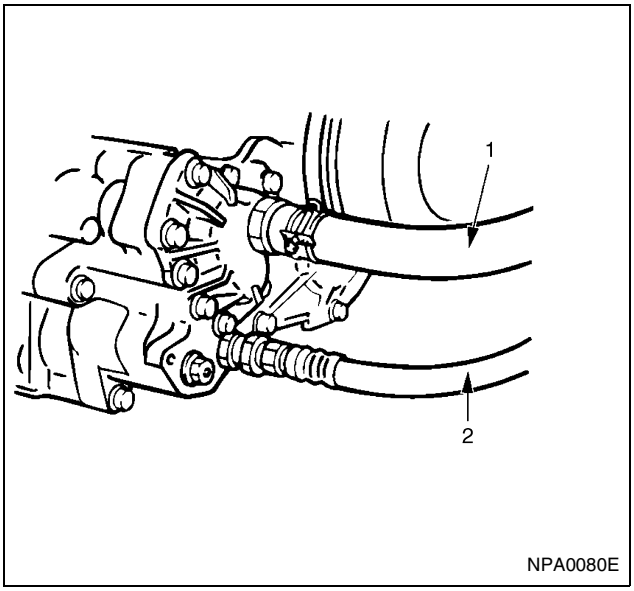
Notice:
If the oil pump is rotated and installed in the high-pressure hose in Item 10 described previously, firmly tighten the joint.

5. Low-Pressure Hose
   - Install the hose and firmly tighten the hose band.

Notice:
When installing both the high-pressure and low-pressure hoses, be fully careful so that dust or foreign matter will not be mixed in the hose port and oil pump.

Joint Torque		N·m (kg·m / lb·ft)
Item	Size	Torque
High-pressure side	PF1/2	103 (10.5 / 76)
Low-pressure side	PF3/4	147 (15 / 108)

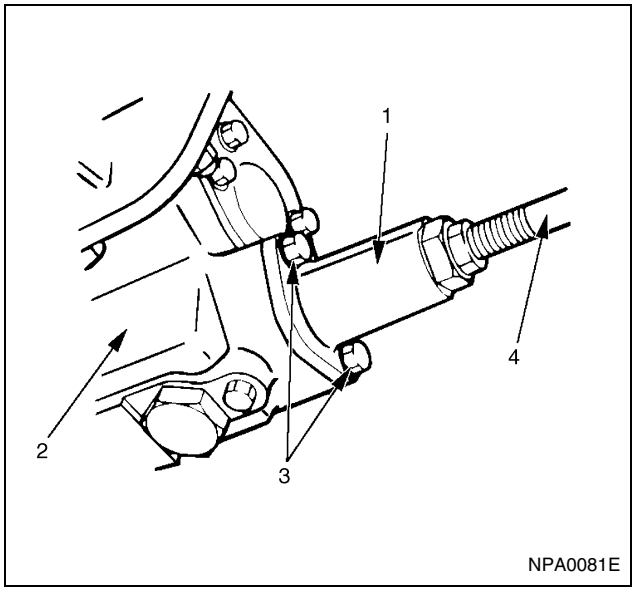
* After having tightened the joint using a recommended value, additionally tighten it if there is a leak of oil.



Legend
1. Low-pressure hose
2. High-pressure hose

6. Control Cable
7. Cable Holder
8. Bolt (Cable Holder)

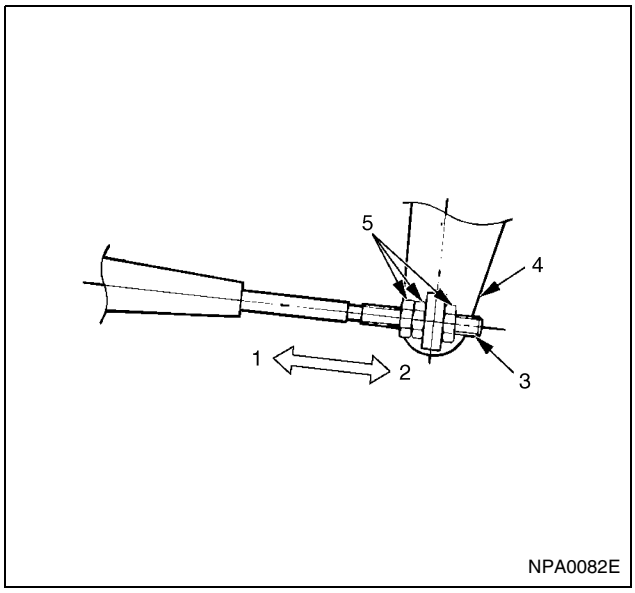
Notice:
Install the control cable and cable holder in the PTO in accordance with Items 1 to 4 of “Installation” of Removal and Installation of Control Cable for Rear Dump Truck, and after installation, inspect and adjust the spool amount in accordance with the “Amount of Spool Extrusion” described previously.



Legend
1. Cable holder
2. PTO
3. Bolt
4. Control cable

- After having adjusted the control cable and having inspected or adjusted the amount of spool extrusion, tighten the bolt and the special nut and lock nut of the control cable at a specified torque.

Tighten:
- Bolt to 24 N·m (2.4 kg·m / 17 lb·ft)
- Special nut to 206 N·m (21 kg·m / 152 lb·ft)
- Lock nut to 21 N·m (2.1 kg·m / 15 lb·ft)

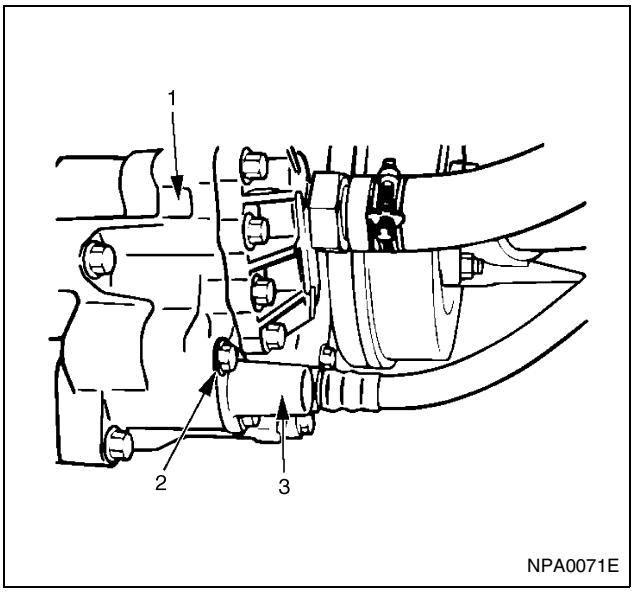


Legend
1. Push in
2. Pull out
3. Dump cable
4. Dump lever
5. Loosen

9. Shift Cap
10. Bolt (Shift Cap)
    - Install the shift cap in the oil pump making its grooved side face upward and tighten the bolt at a specified torque.

Tighten:
Shift cap bolt to 24 N·m (2.4 kg·m / 17 lb·ft)

Notice:
If the groove is not installed facing downward, the water intruded in the shift cap is not ejected but collected. Rusting and freezing will cause an incorrect actuation.



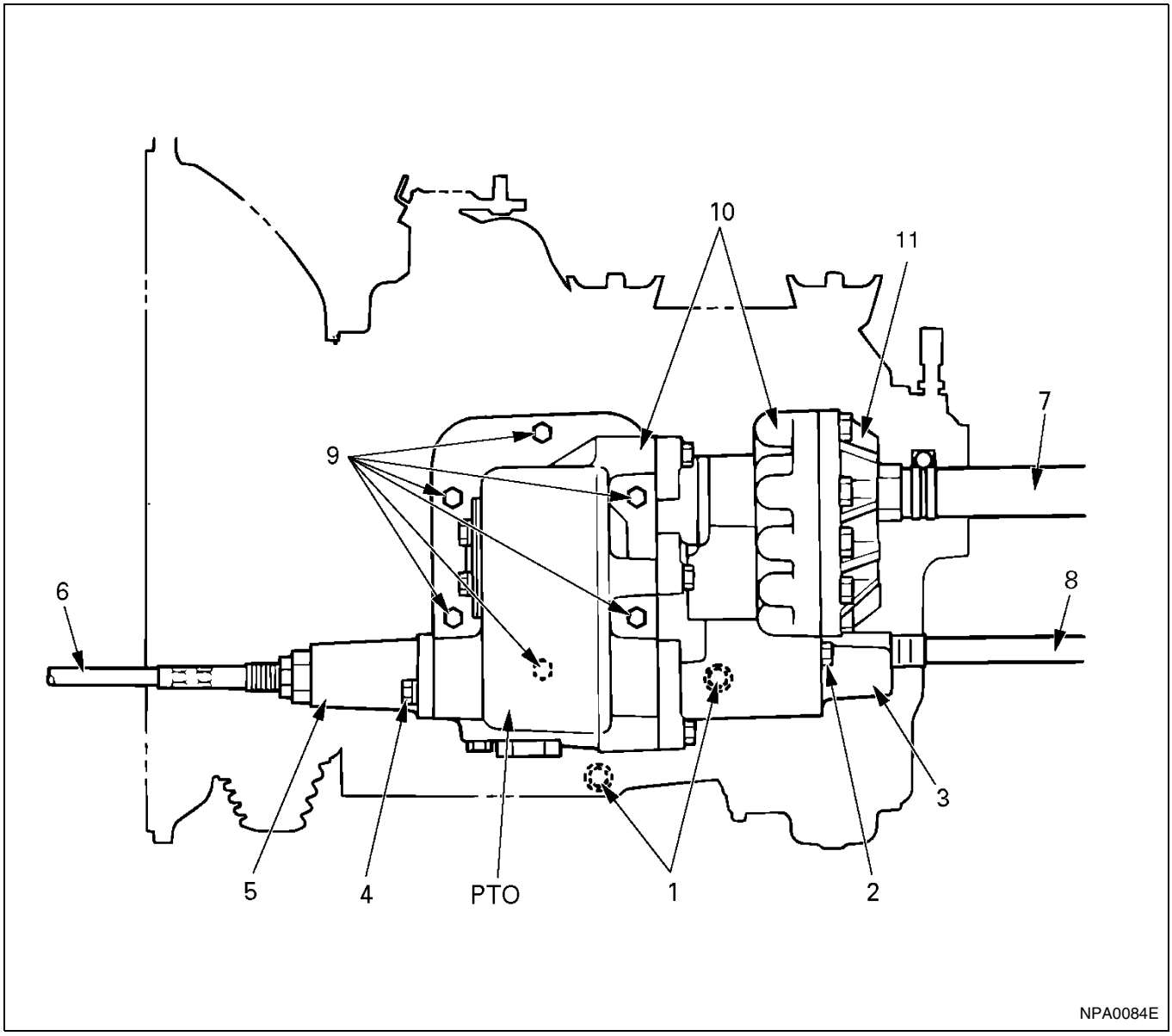
Legend
1. Oil pump
2. Bolt
3. Shift cap

Supply and Air Bleeding of Hydraulic Operating Fluid

After having installed the oil pump, supply hydraulic operating fluid and release air as requested. Supply the hydraulic operating fluid and release air in accordance with the “Inspection and Supply of The Hydraulic Operating Fluid” and the “Air Bleeding Procedure of Hydraulic Operating Fluid” described previously.

PTO (WITH OIL PUMP) ASSEMBLY

Removal and Installation



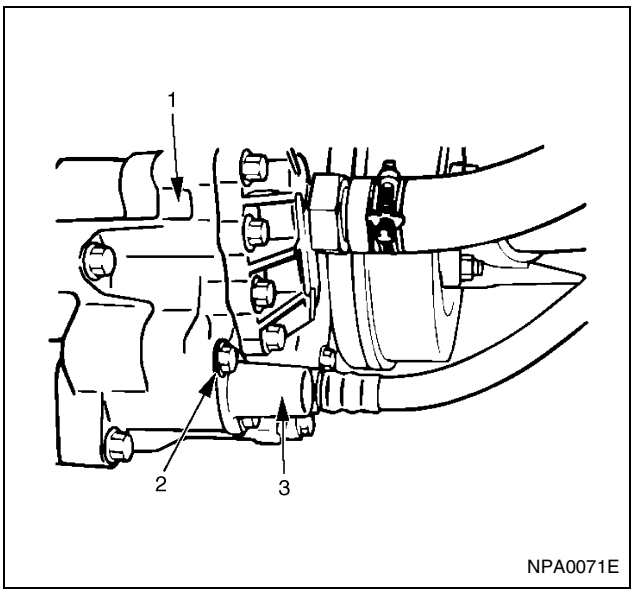
Legend

1. Drain plug, filler plug
2. Bolt (shift cap)
3. Shift cap
4. Bolt (cable holder)
5. Cable holder
6. Control cable
7. Low-pressure hose
8. High-pressure hose
9. Bolt (PTO)
10. PTO (with oil pump)
11. Oil pump

Removal Steps

Notice:
Set the dump lever inside the cab to the “Down” position and check the lever lock.

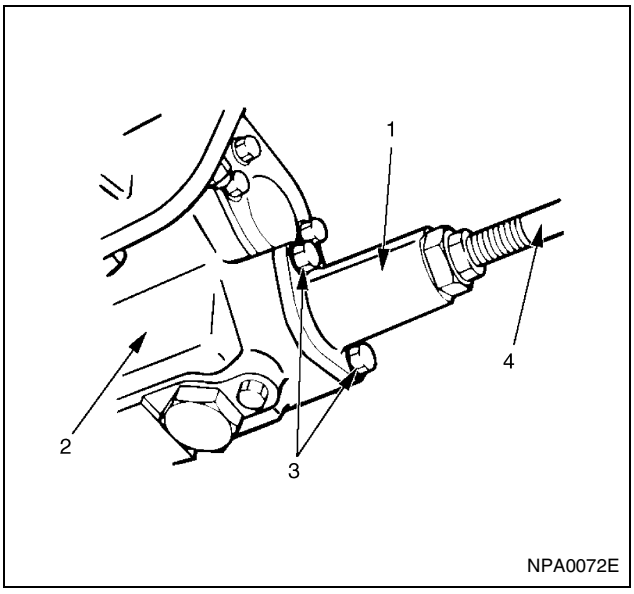
1. Drain Plug, Filler Plug
   - Remove the drain plug and filler plug of the transmission and remove the transmission oil.
2. Bolt (Shift Cap)
3. Shift Cap
   - Remove the bolt and remove the shift cap from the oil pump.



Legend
1. Oil pump
2. Bolt
3. Shift cap

4. Bolt (Cable Holder)
5. Cable Holder
6. Control Cable

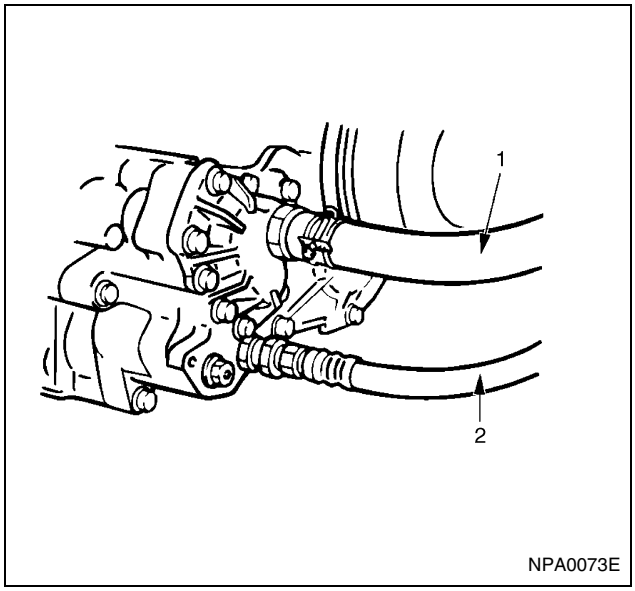
Notice:
Before removing the control cable, be sure to refer to Items 3 to 6 of “Removal” in the “Removal and Installation of Control Cable for Rear Dump Truck” in the chapter described previously and perform work in accordance with the items.



Legend
1. Cable holder
2. PTO
3. Bolt
4. Control cable

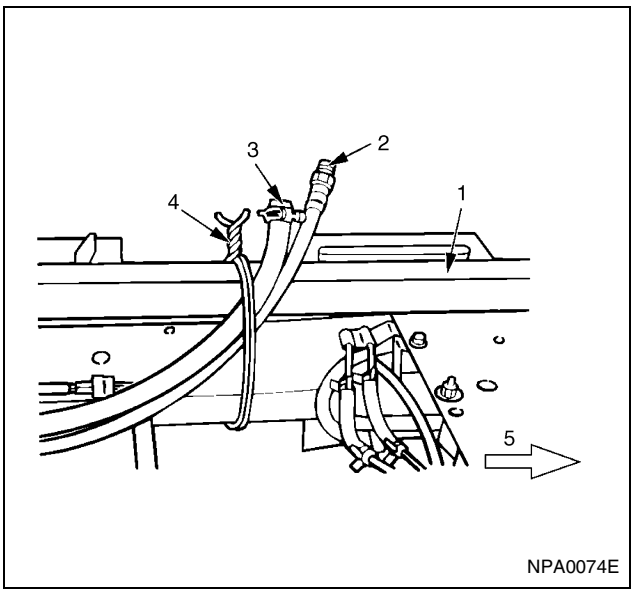
7. Low-Pressure Hose
   - Loosen the hose band and remove the hose from the oil pump.
8. High-Pressure Hose
   - Loosen the hose joint and remove the hose from the oil pump.

Notice:
For the high-pressure hose, a part of the joint may not be removed according to the type of the truck and equipment. In that case, slightly loosen the joint to set the state. At the stage where the rear PTO is removed (Item 10), remove the high-pressure hose rotating the PTO (with oil pump).



Legend
1. Low-pressure hose
2. High-pressure hose

Notice:
Because hydraulic operating fluid flows out when the hose is removed, quickly make the hose port face upward and protect the hose so that dust or foreign matter will not be mixed in, then fix it to the frame with a wire.

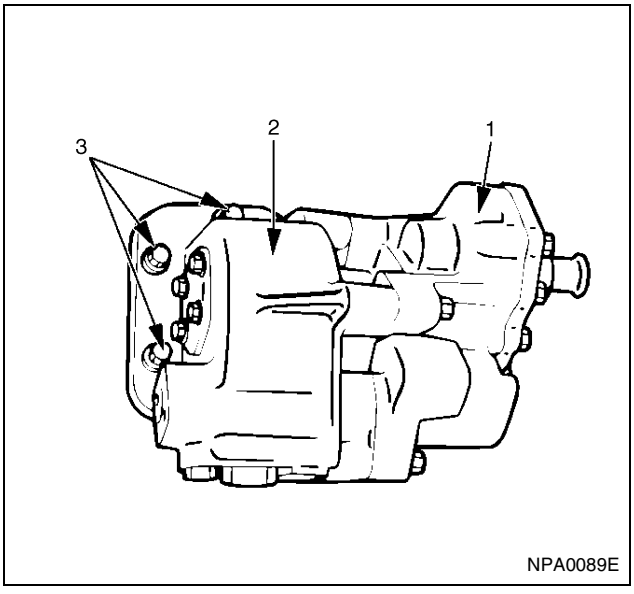


Legend
1. Left frame
2. High-pressure hose
3. Low-pressure hose
4. Wire
5. Truck front

9. Bolt (PTO)
10. PTO (with Oil Pump)
    - Remove the six tightening bolts around the PTO and remove the PTO (with oil pump) from the transmission.

Notice:
If the high-pressure hose could not be removed in Item 8 described previously, remove the PTO (with oil pump) from the high-pressure hose rotating the PTO at this time.

Besides, because this PTO (with oil pump) weighs 15 kg (147 N), be fully careful of its drop at attachment and detachment.

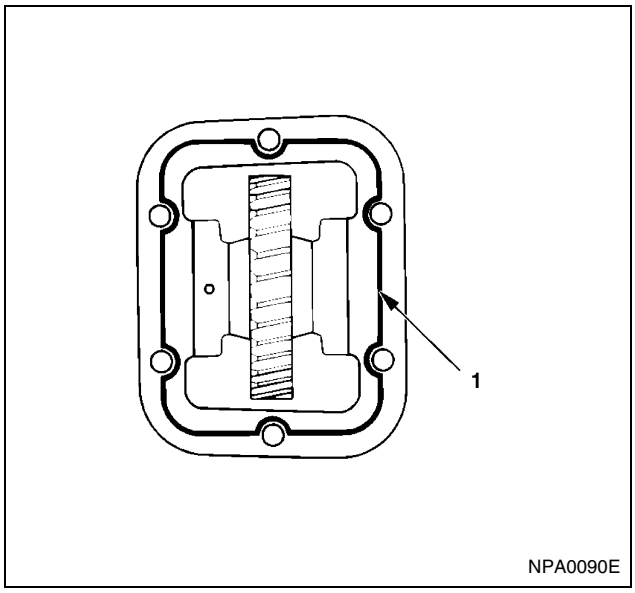


Legend
1. Oil pump
2. PTO
3. Bolt

Installation

Notice:
Before installing the PTO, cleanly remove the liquid gasket left on the PTO installation side of the transmission case and clean and degrease the transmission case by waste cloth so that oil will not adhere to it.

1. PTO (with Oil Pump)
    - After having cleaned and fully degreased the transmission installation side of the PTO, coat it with liquid gasket (LOCTITE 17430 or equivalent).

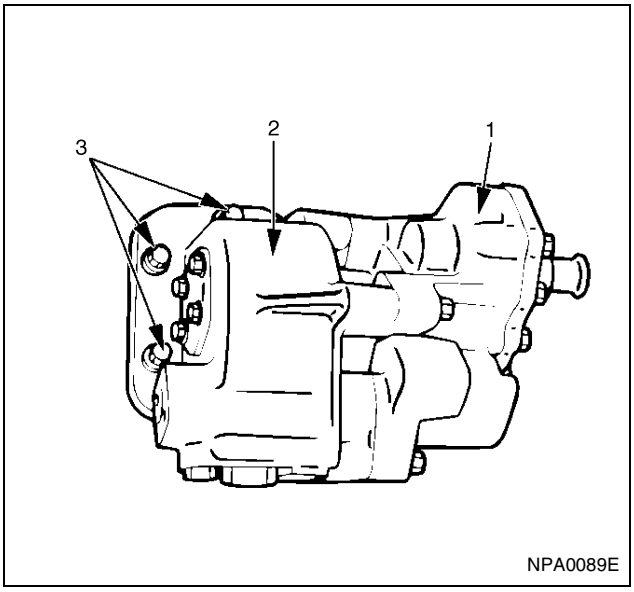


Legend
1. Apply liquid gasket

Notice:
When removing the PTO side from the high-pressure hose rotating the PTO side at PTO (with oil pump) removal, install the PTO (with oil pump) in the high-pressure hose and lightly tighten it.

2. Bolt (PTO)
    - Install the PTO (with oil pump) in the transmission and tighten the bolt at a specified torque.

Tighten:
PTO bolt to 45 N·m (4.6 kg·m / 33 lb·ft)



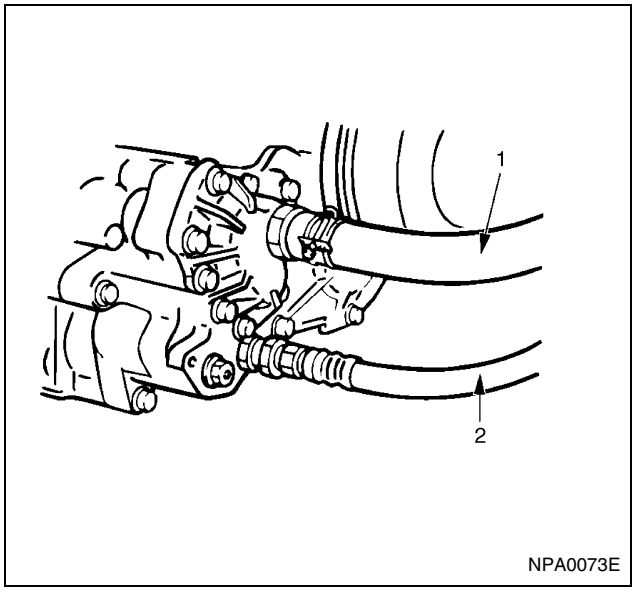
Legend
1. Oil pump
2. PTO
3. Bolt

3. High-Pressure Hose
   - Install the high-pressure hose in the oil pump and firmly tighten the joint.

Notice:
When the PTO (with oil pump) is installed in the high-pressure hose rotating the PTO in Item 10 described previously, firmly tighten the joint.

4. Low-Pressure Hose
   - Install the hose and firmly tighten the hose band.

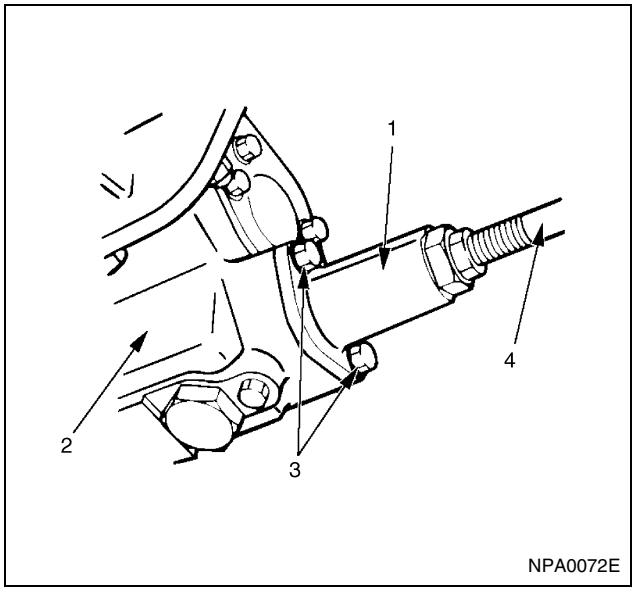
Notice:
When installing the high-pressure hose and the low-pressure hose, be fully careful so that dust or foreign matter will not be mixed in the pose port and the oil pump.



Legend
1. Low-pressure hose
2. High-pressure hose

5. Control Cable
6. Cable Holder
7. Bolt (Cable Holder)

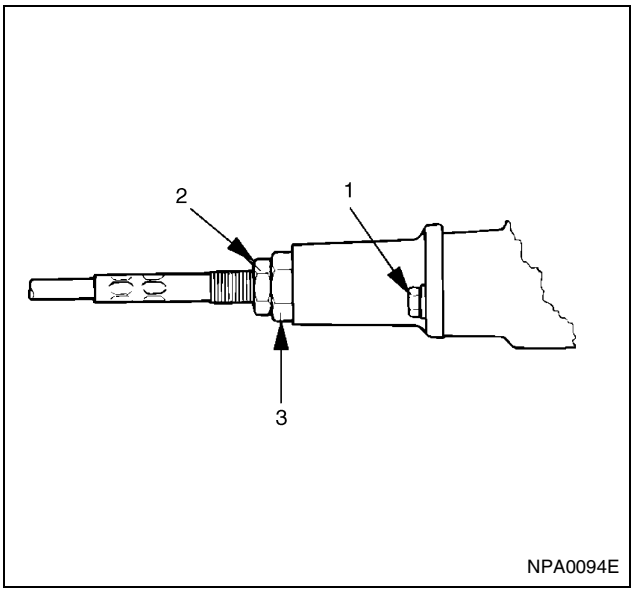
Notice:
Install the control cable and cable holder in the PTO in accordance with Items 1 to 4 of “Installation” in the “Removal and Installation of Control Cable for Rear Dump Truck”, and after installation inspect and adjust it in accordance with the “Amount of Spool Extrusion”.



Legend
1. Cable holder
2. PTO
3. Bolt
4. Control cable

- After having adjusted the control cable and having inspected or adjusted the amount of spool extrusion, tighten the bolt and the special nut and lock nut of the control cable at a specified torque.

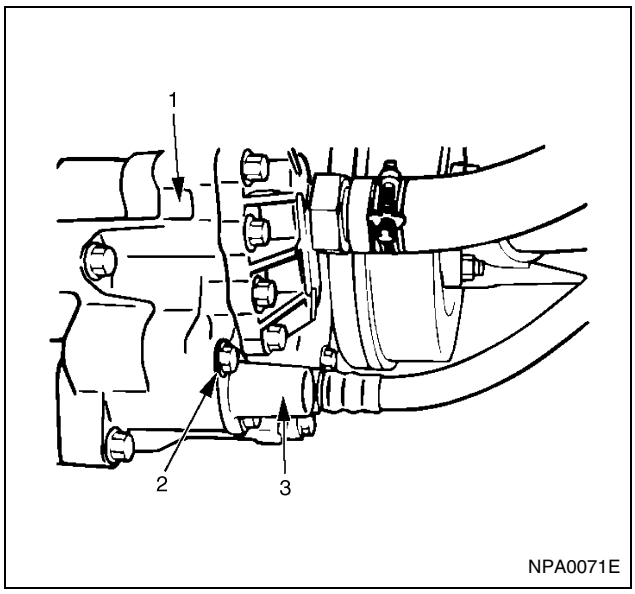
Tighten:
- Bolt to 24 N·m (2.4 kg·m / 17 lb·ft)
- Special nut to 147 N·m (15 kg·m / 108 lb·ft)
- Lock nut to 20 N·m (2.0 kg·m / 14lb·ft)



Legend
1. Bolt
2. Lock nut
3. Special nut

8. Shift Cap
9. Bolt (Shift Cap)
   - Install the shift cap in the oil pump making its grooved side face upward and tighten the bolt at a specified torque.

Tighten:
Shift cap bolt to 24 N·m (2.4 kg·m / 17 lb·ft)



Legend
1. Oil pump
2. Bolt
3. Shift cap

10. Drain Plug, Filler Plug
    - Firmly tighten the drain plug of the transmission.
    - Supply the transmission oil (BESCO gear oil transaxle (5W-30) or equivalent) until it flows out from the filler plug hole and firmly tighten the filler plug.

Amount of Oil (Reference)
5 speed: 3.2 Liters (0.85 US gal / 0.70 Imp. gal)
6 speed: 4.0 Liters (1.06 US gal / 0.88 Imp. gal)

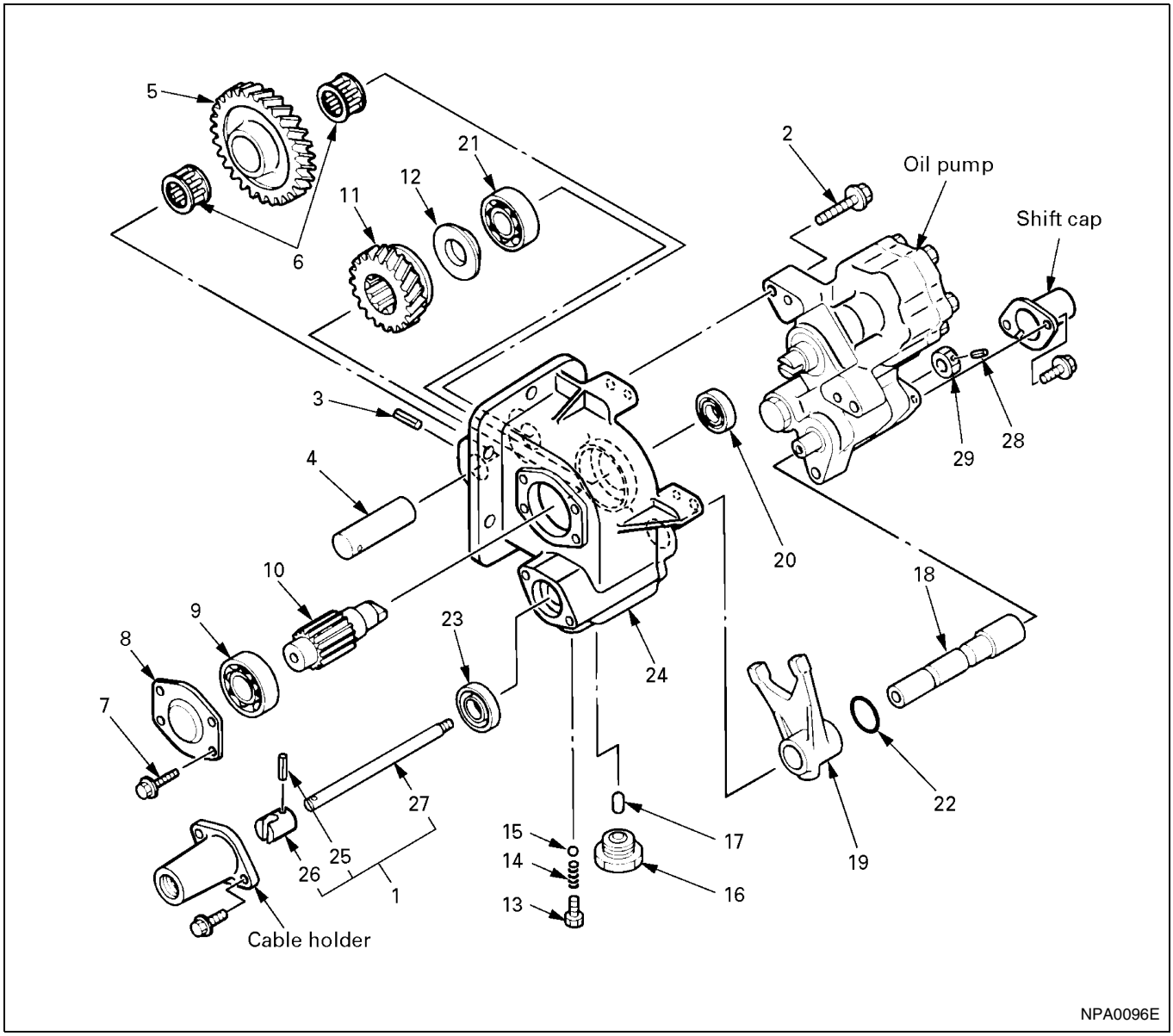
Tighten:
Drain plug and filler plug to 49 N·m (5.0 kg·m / 36 lb·ft)

Supply and Air Bleeding of Hydraulic Operating Fluid

After having installed the oil pump, supply hydraulic operating fluid and release air as requested. Supply the hydraulic operating fluid and release air in accordance with the “Inspection and Supply of The Hydraulic Operating Fluid” and the “Air Bleeding Procedure of the Hydraulic Operating Fluid” described previously.

Unit Repair

PTO Assembly



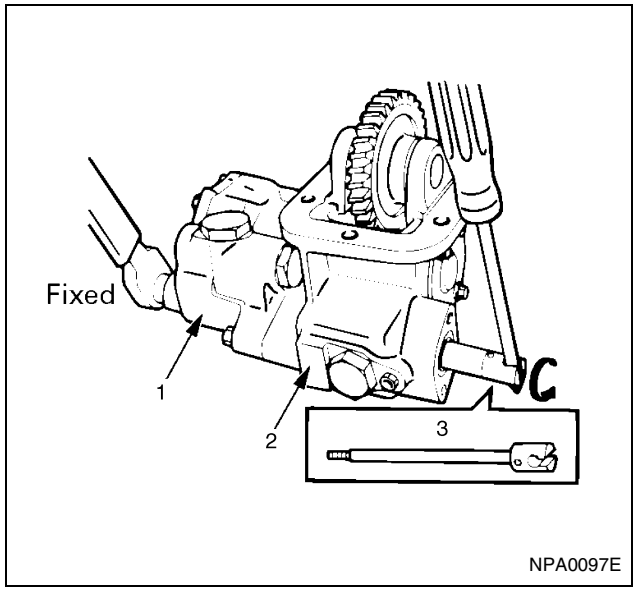
Legend

1. Inner rod assembly
2. Bolt
3. Spring pin
4. Idle gear shift
5. Idle gear
6. Needle bearing
7. Bolt
8. Case cover
9. Front ball bearing
10. Output shaft
11. Output gear
12. Thrust collar
13. Spring set bolt
14. Spring
15. Ball
16. Interlock plug
17. Interlock pin
18. Shift rod
19. Shift arm
20. Oil seal (output shaft side)
21. Rear ball bearing
22. O-ring
23. Oil seal (shift rod side)
24. Gear case
25. Spring pin
26. Cable connector
27. Inner rod
28. Spring pin
29. Stopper adapter

Disassembly Steps

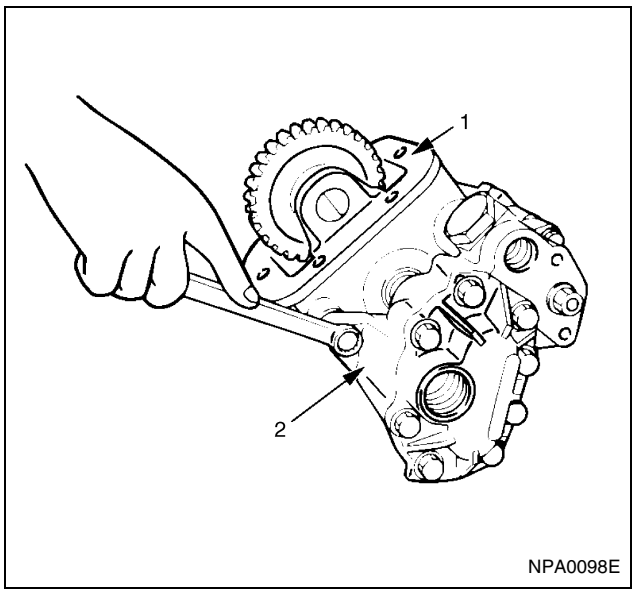
1. Inner Rod Assembly
   - Press the stopper adapter side by a wrench and insert a Phillips screwdriver (large) in the groove of the control cable connector. Then rotate it counterclockwise, loosen it, and remove it.

Notice:
Be sure to press the stopper adapter side and loosen it on the control cable connector side. (Press the stopper adapter side not to rotate the spool valve. Besides, the three-rotation dump truck is in contrast with this.)



Legend
1. Oil pump
2. PTO
3. Inner rod assembly

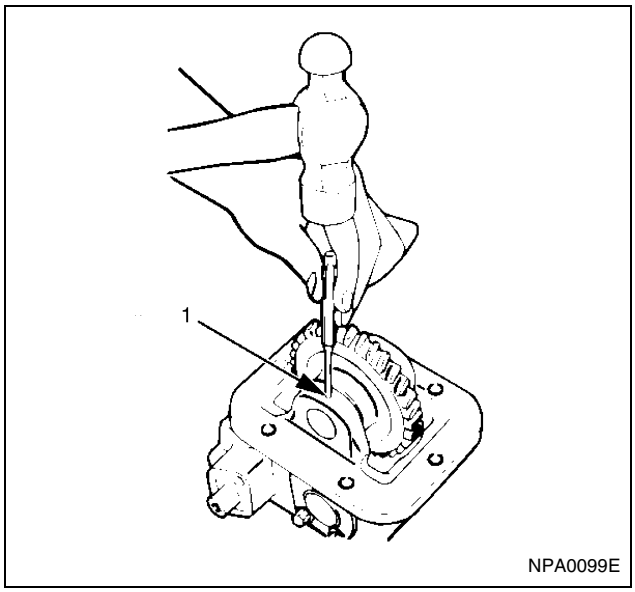
2. Bolt
   - Remove three bolts and separate the oil pump and PTO striking the oil pump by a plastic hammer (or wooden hammer).



Legend
1. PTO
2. Oil pump

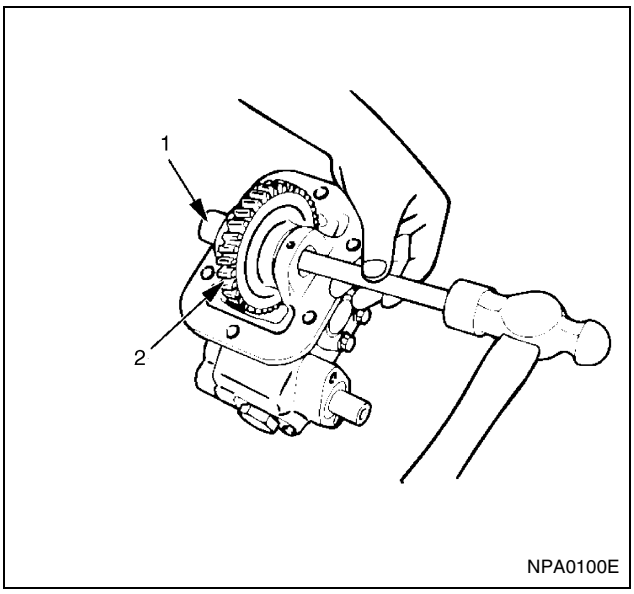
3. Spring Pin
   - Punch the spring pin in the idle gear shaft. (After having removed the idle gear shaft, punch the spring pin from the shaft.)

   Spring pin bar: 9-8529-2201-0



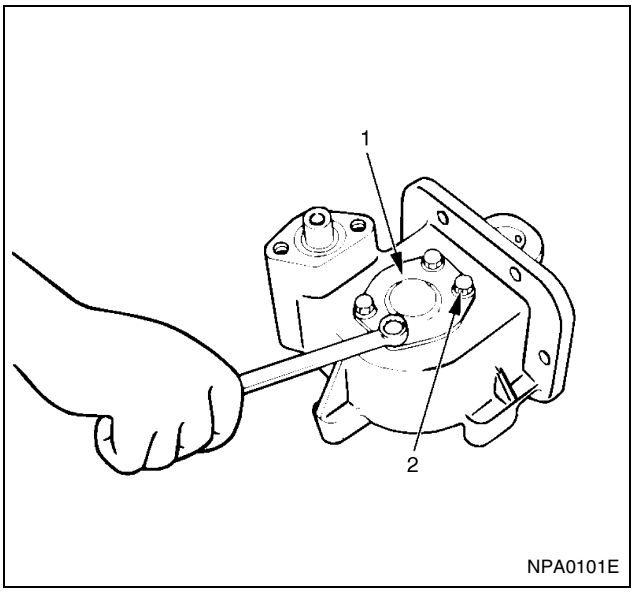
Legend
1. Spring pin

4. Idle Gear Shaft
5. Idle Gear
6. Needle Bearing
   - Strike and remove the idle gear shaft and remove the idle gear, then remove the needle bearing.



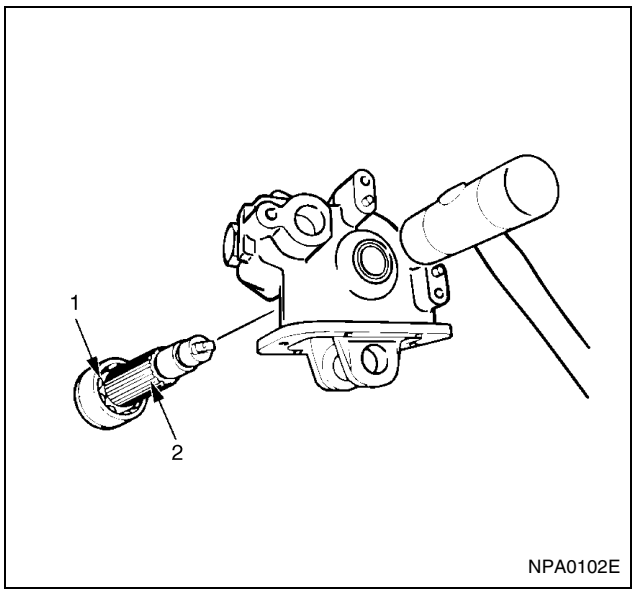
Legend
1. Idle gear shaft
2. Idle gear

7. Bolt
8. Case Cover
   - Remove the bolt and remove the case cover.



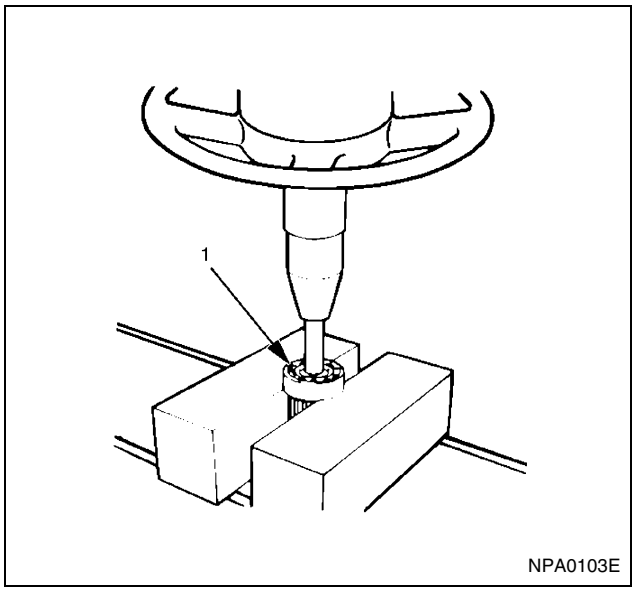
Legend
1. Case cover
2. Bolt

9. Front Ball Bearing
10. Output Shaft
    - Strike the end face of the output shaft from the rear side and remove the front ball bearing while it is being installed in the output shaft.



Legend
1. Front ball bearing
2. Output shaft

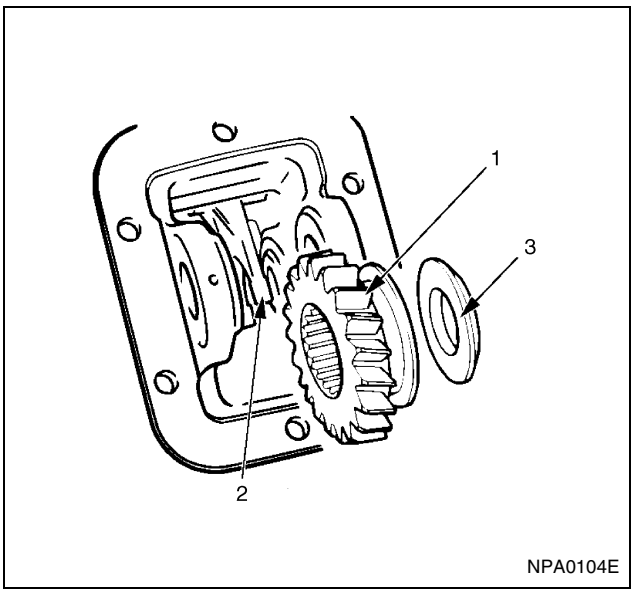
- Remove the front ball bearing from the output shaft.



Legend
1. Front ball bearing

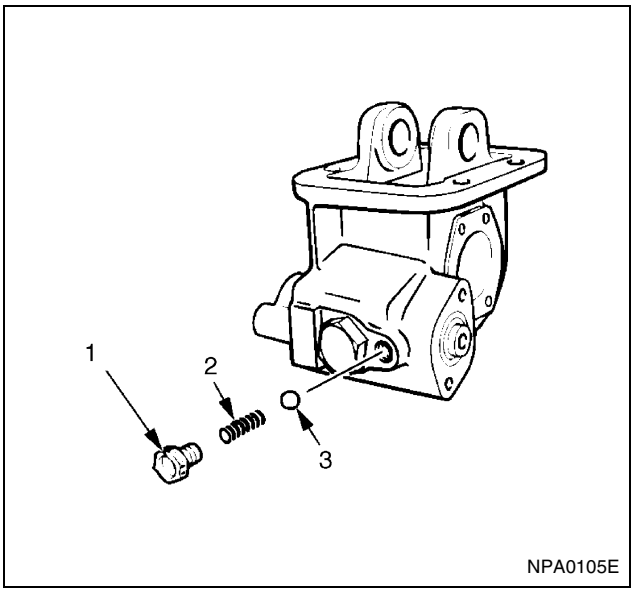
11. Output Gear
12. Thrust Collar
    - Remove the output gear and the thrust collar from the gear case.

Notice:
Check the orientation of the output gear and the thrust collar. The side in which the shift arm groove of the gear and the taper of the thrust collar exist is the rear side.



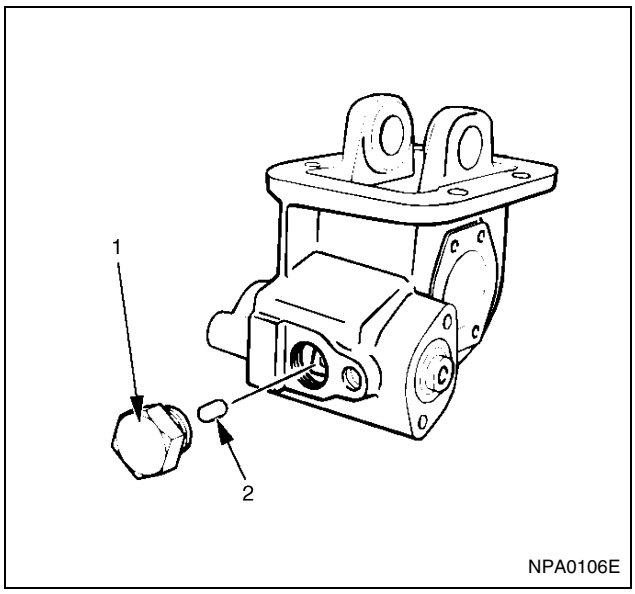
Legend
1. Output gear
2. Shift arm
3. Thrust collar

13. Spring Set Bolt
14. Spring
15. Ball
    - Remove the spring set bolt and remove the spring and ball.



Legend
1. Spring set bolt
2. Spring
3. Ball

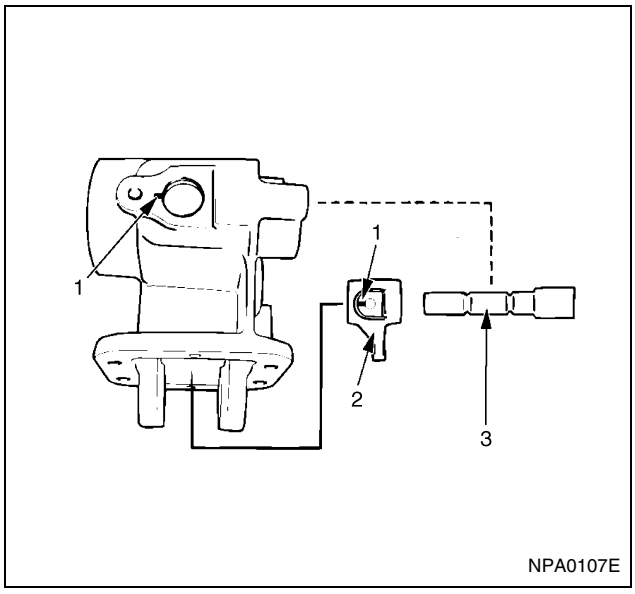
16. Interlock Plug
17. Interlock Pin
    - Remove the interlock plug and remove the interlock pin from the shift arm.



Legend
1. Interlock plug
2. Interlock pin

18. Shift Rod
19. Shift Arm
    - Pull out the shift rod to the rear side of the gear case and remove the shift arm from the inside of the gear case.

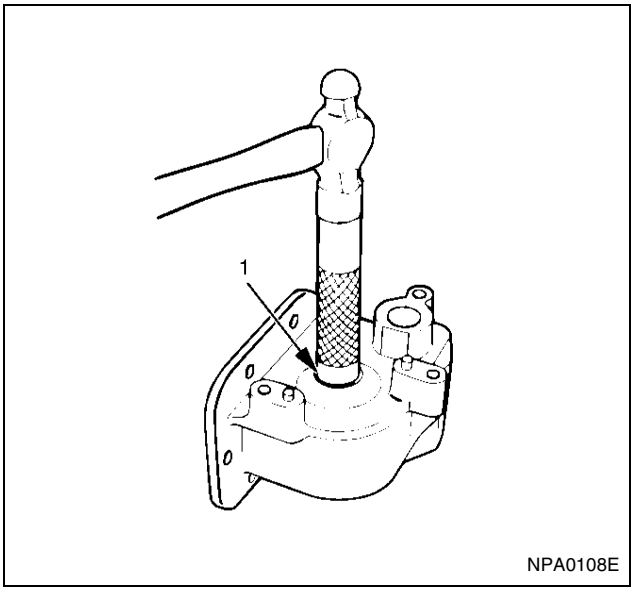
Notice:
When removing the shift arm, be sure to check the installation direction of the arm and apply the assignment mark. In that case, incorrect assembly can be prevented at subsequent assembly.



Legend
1. Alignment mark
2. Shift arm
3. Shift rod

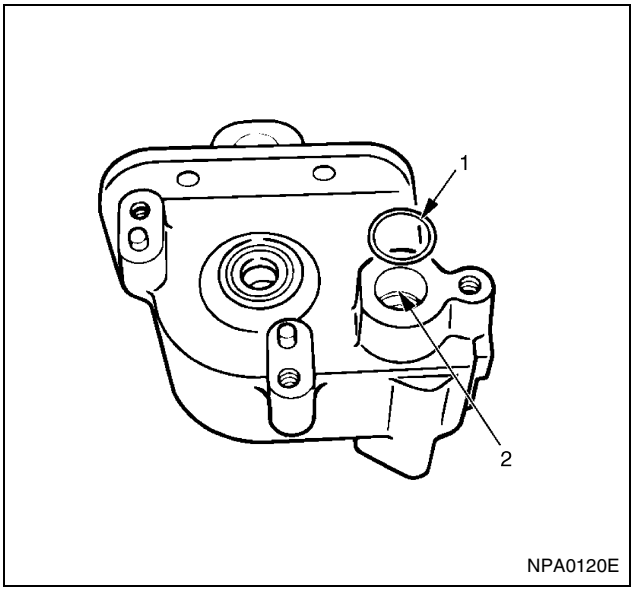
20. Oil Seal (Output Shaft Side)
21. Rear Ball Bearing
    - Pry the oil seal by a screwdriver and remove it, then strike the rear ball bearing from the rear side of the gear case and remove it.

    Bearing installer: 5-8840-2432-0



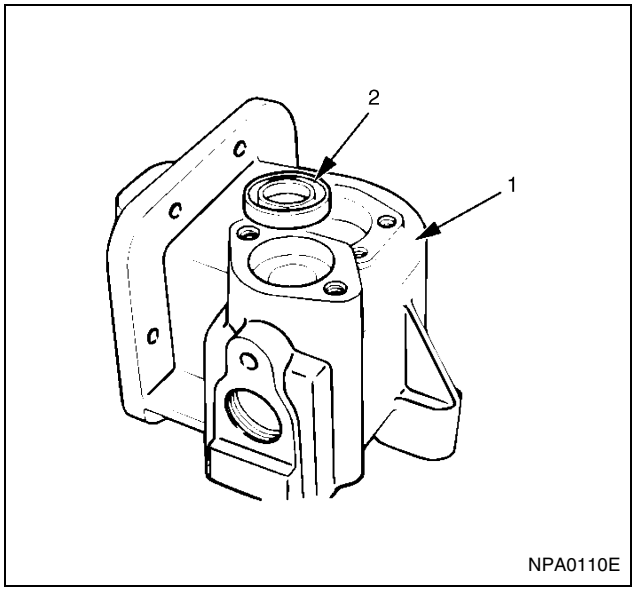
Legend
1. Rear ball bearing

22. O-Ring
    - Remove the O-ring from the shift rod hole of the gear case.



Legend
1. O-ring
2. O-ring groove

23. Oil Seal (Shift Rod Side)
    - Remove the oil seal from the gear case.
24. Gear Case



Legend
1. Rear case
2. Oil seal

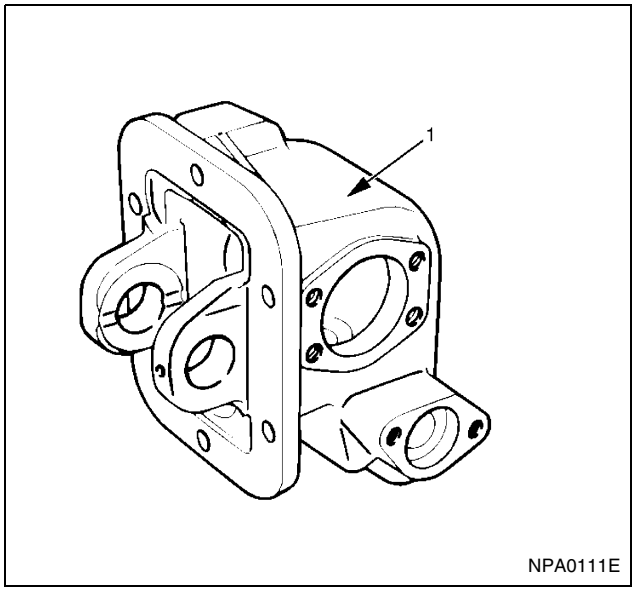
25. Spring Pin
26. Cable Connector
27. Inner Rod
28. Spring Pin
29. Stopper Adapter
    - Remove the cable connector or stopper adapter from the inner rod as requested.

Inspection and Repair

Make necessary correction or parts replacement if wear damage, or any other abnormal conditions are found through inspection.

Gear Case

- Inspect that there is a crack, a wear, or a scratch in each portion of the gear case and replace the gear case if there is a remarkable wear or scratch.

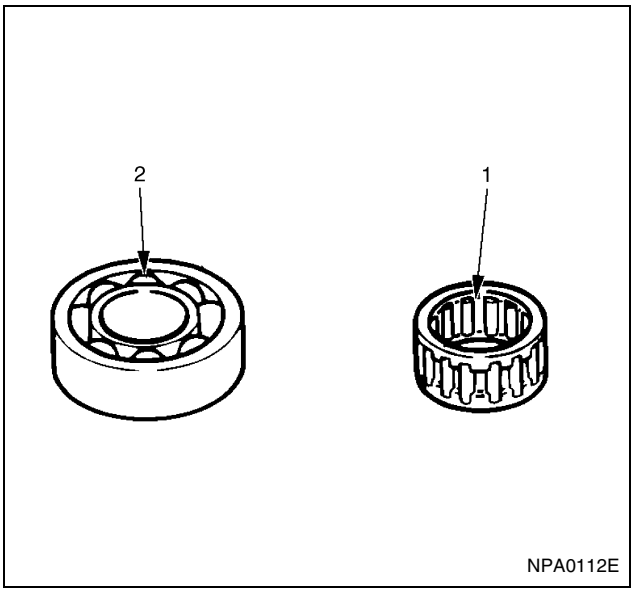


Legend
1. Gear case

Bearings

- Inspect each bearing, and replace it if the following defects are found.
  1) The rotation is not smooth.
  2) A remarkable noise is generated.
  3) There is damage or rust in the inner and outer laces.
  4) There is an abnormal play in the thrust direction.
  5) There is discoloration, remarkable wear, or hitting on the body of rotation and surface of rotation of the needle roller.

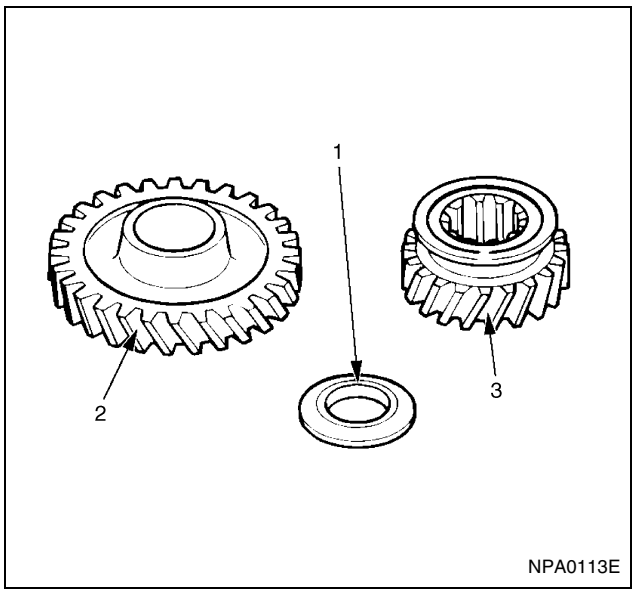
Notice:
If the ball bearing is removed, replace it by a new one.



Legend
1. Needle bearing
2. Ball bearing

Gears and Thrust Collar

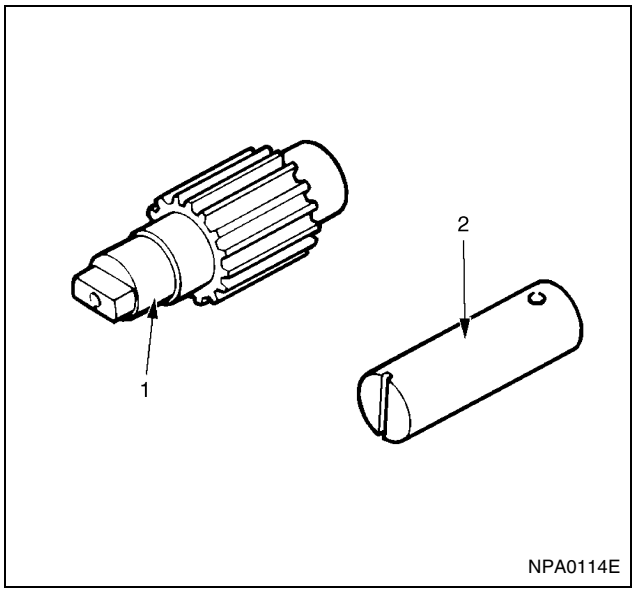
- Inspect the tooth surface of each gear and replace what has remarkable wear or damage. Further, correct lightly staged wear or a rough surface with an oil stone.
- Inspect both surfaces of the thrust collar and replace the thrust collar if there is a remarkable surface roughness or wear.



Legend
1. Thrust collar
2. Idle gear
3. Output gear

Shafts

- Inspect the damage and wear on the external surface of each shaft and the wear and damage of the spline portion and replace them if there are remarkable.



Legend
1. Output shaft
2. Idle gear shaft

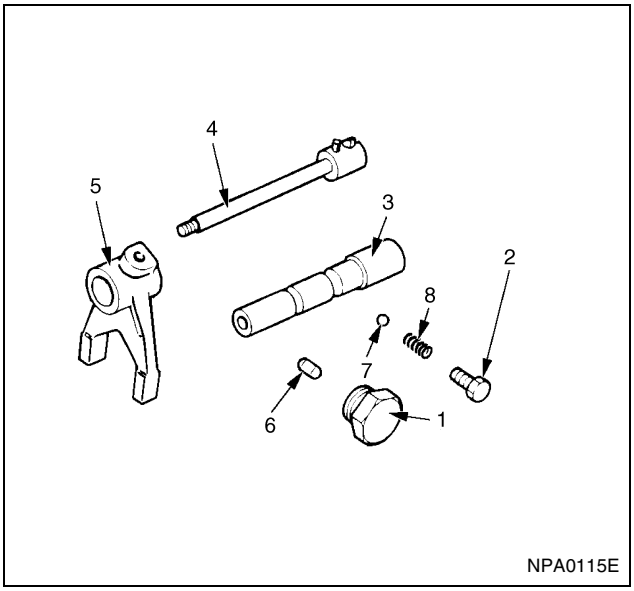
Shift Mechanism

- Inspect each portion of the shift mechanism and replace it if there is remarkable damage, deflection, or staged wear.
  1) Deflection and wear of the shift rod

2) Deformation and wear of the shift rod

Shift arm thickness
Standard: 9.0 mm (0.354 in)
Limit: 8.5 mm (0.335 in)

3) The backlash or operation between the shift rod and gear case is not smooth.
4) Wear of the ball for a detent of the shift rod and the fatigue of the spring
5) Wear of the lock pin sliding portion for the lock pin and plug
6) Deflection of the inter rod and wear of the cable connector portion

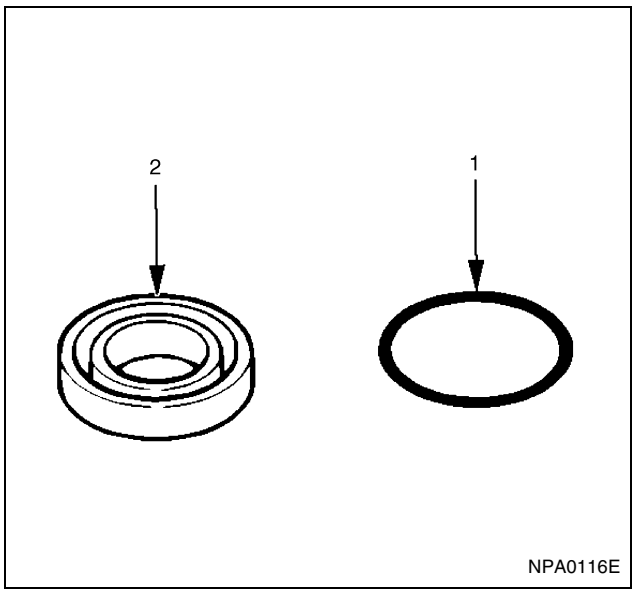


Legend
1. Interlock plug
2. Spring set bolt
3. Shift rod
4. Inner rod assembly
5. Shift arm
6. Interlock pin
7. Ball
8. Spring

Oil Seal and O-ring

- Replace the oil seal and O-ring if there is damage, wear, or aging in the lip portion of the oil seal and the O-ring.

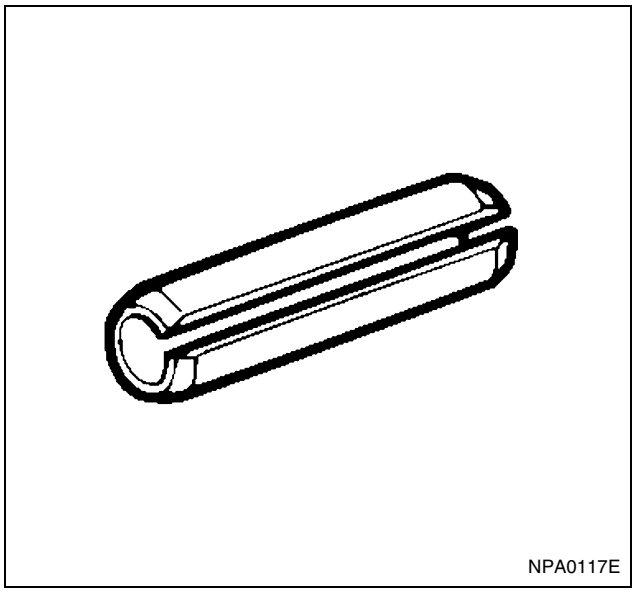
Notice:
If the PTO is disassembled, replace the oil seal and the O-ring by new ones in principle. Further, if the oil seal and the O-ring are removed, they cannot be reused.



Legend
1. O-ring
2. Oil seal

Spring Pin

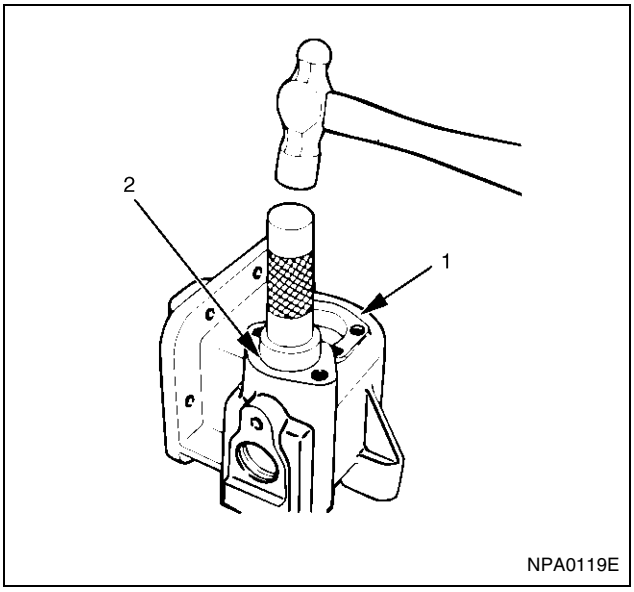
Notice:
Be sure to replace the spring pin by a new one.



Reassembly Steps

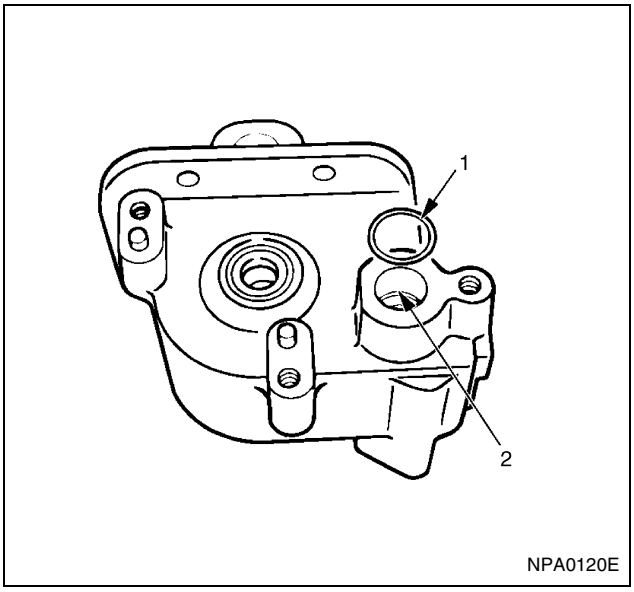
1. Gear Case
2. Oil Seal (Shift Rod Side)
   - Coat the lip portion of the oil seal with lithium grease (BESCO L-2 or equivalent), the periphery portion of the seal with liquid gasket (LOCTITE 518 or equivalent).
   - Install the lip portion of the oil seal in the shift rod side (front side) of the gear case so that the lip portion will not be damaged.

   Oil seal installer: 5-8840-2433-0



Legend
1. Gear case
2. Oil seal

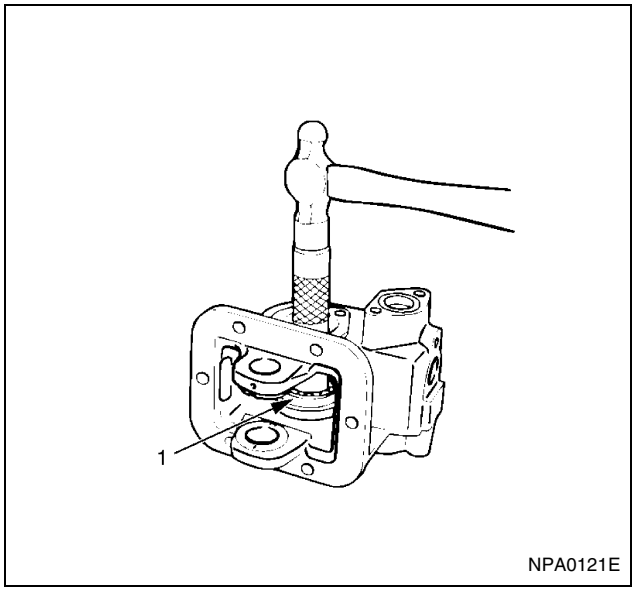
3. O-Ring
   - Thinly coat the O-ring and the O-ring groove of the gear case with lithium grease (BESCO L-2 or equivalent) and firmly assemble them in the groove so that there will be no damage and torsion.



Legend
1. O-ring
2. O-ring groove

4. Rear Ball Bearing
   - Strike and install the rear ball bearing in the gear case from the inner side of the case.

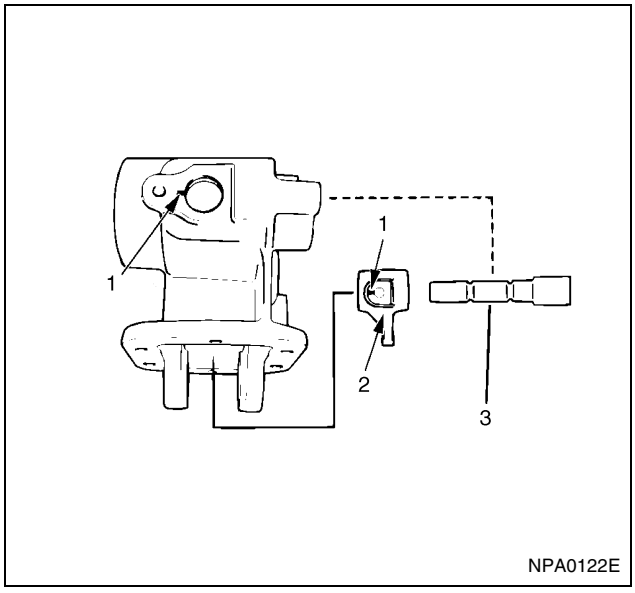
   Bearing installer: 5-8840-2432-0



Legend
1. Rear ball bearing

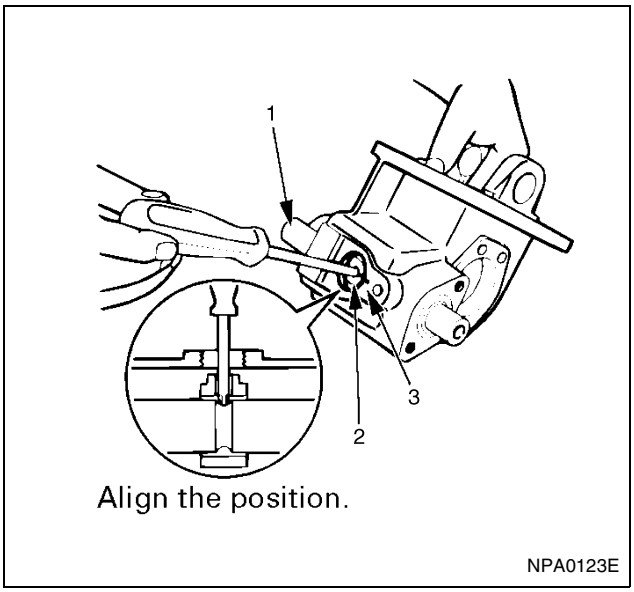
5. Shift Arm
   - Assemble the shift arm in the gear case.
6. Shift Rod
   - Thinly coat the shift rod with lithium grease (BESCO L-2 or equivalent) and insert it in the gear case, then assemble it in the shift arm.

Notice:
Align the assembly direction of the shift arm to the alignment mark at disassembly.



Legend
1. Alignment mark
2. Shift arm
3. Shift rod

- Align the position between the lock pin hole of the shift arm and the lock pin groove of the shift rod.



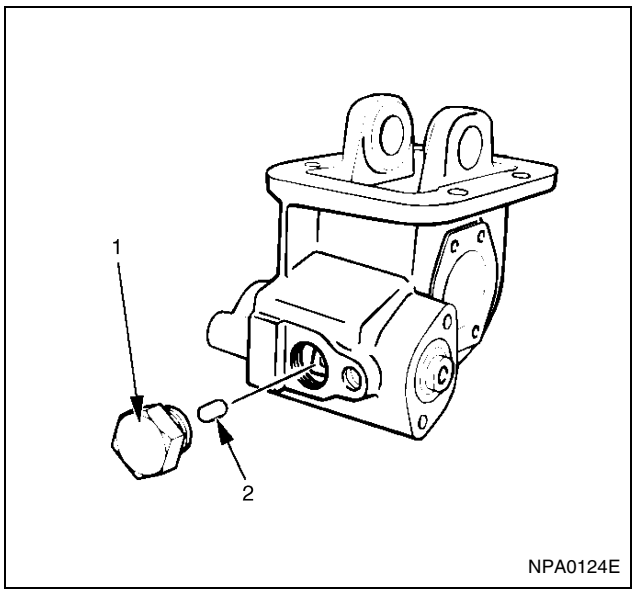
Legend
1. Shift rod
2. Shift arm
3. Alignment mark

---

7. Interlock Pin
8. Interlock Plug
   - Assemble the interlock pin in the shift arm and coat the interlock plug threaded portion with liquid gasket (LOCTITE 242 or equivalent), then tighten the interlock plug at a specified torque.

Tighten:
Interlock plug to 60 N·m (6.1 kg·m / 44 lb·ft)

Notice:
After having tightened the interlock plug, do not move the shift rod. Moving the shift rod may remove the interlock pin.

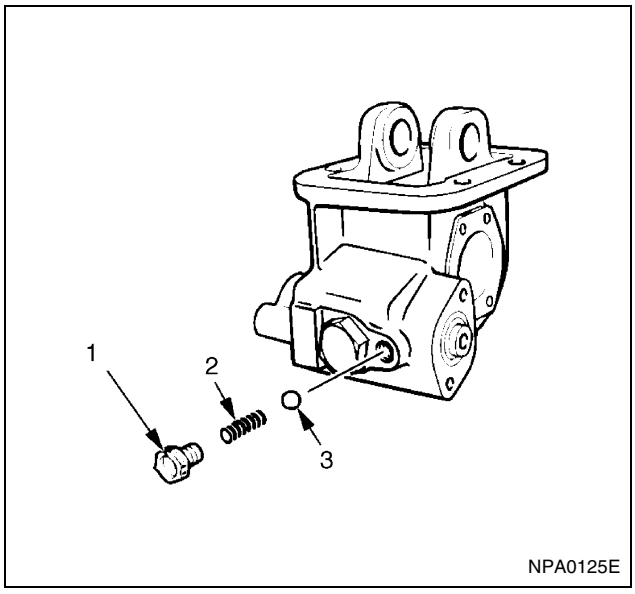


Legend
1. Interlock plug
2. Interlock pin

---

9. Ball
10. Spring
11. Spring Set Bolt
    - Assemble the ball and spring in the gear case and coat the spring set bolt threaded portion with liquid gasket (LOCTITE 242 or equivalent), then tighten the spring set bolt.

Tighten:
Set bolt to 19 N·m (1.9 kg·m / 14 lb·ft)

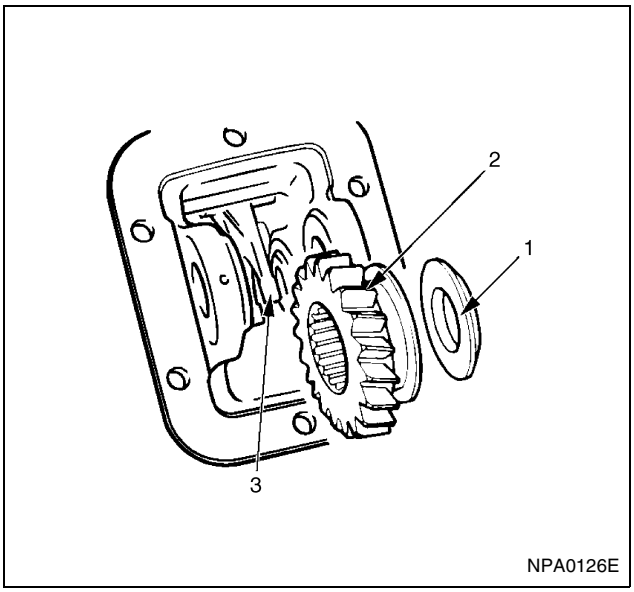


Legend
1. Spring set bolt
2. Spring
3. Ball

---

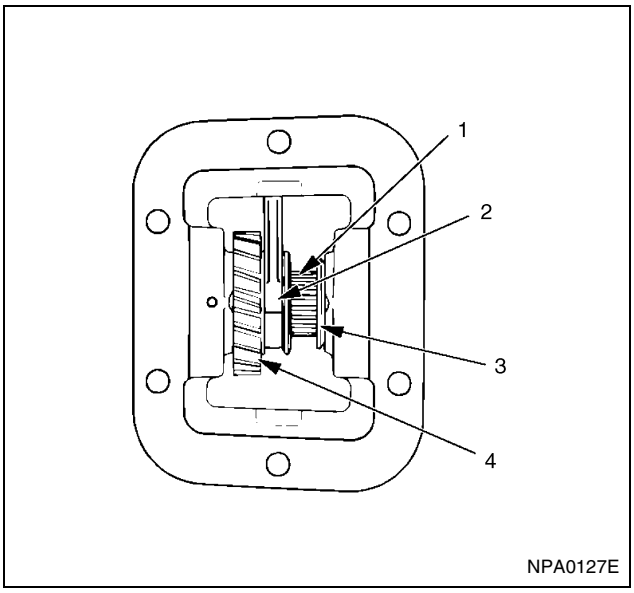
12. Output Gear

13. Thrust Collar
    - Assemble the groove (the orientation is the rear side) of the output gear in the shift arm and assemble the taper portion of the thrust collar facing the rear side.



Legend
1. Thrust collar
2. Output gear
3. Shift arm

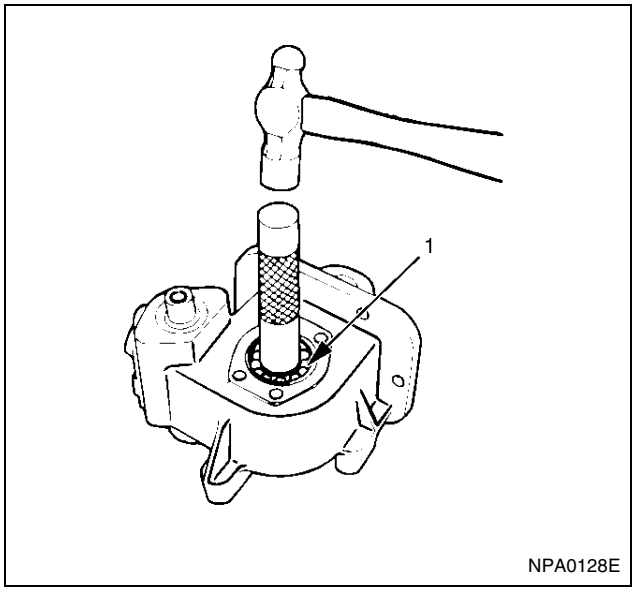
14. Output Shaft
    - Insert the output gear engaging its spline and align the output shaft tip to the inner lace of the rear bearing, then strike and install the output shaft by applying a splint to its front side head portion.



Legend
1. Output shaft
2. Shift arm
3. Thrust collar
4. Output gear

15. Front Ball Bearing
    - Align the inner lace side of the front ball bearing to the output shaft and strike and install the outer side of the bearing aligning it to the gear case.

    Bearing installer: 5-8840-2432-0

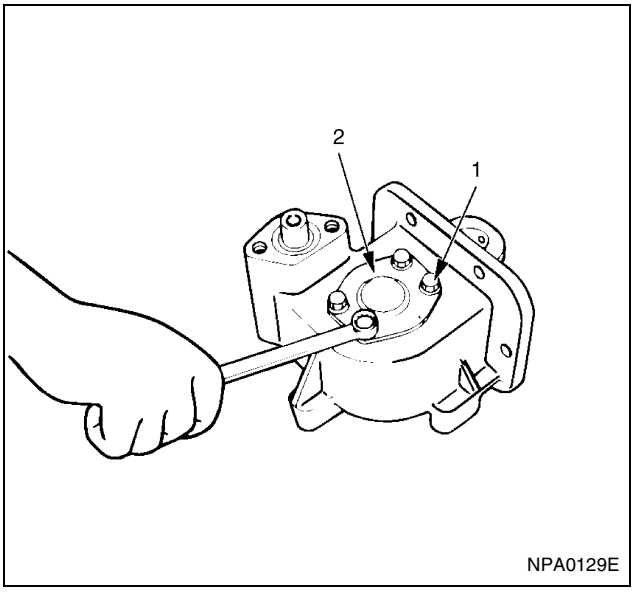


Legend
1. Front ball bearing

16. Case Cover
17. Bolt
    - Assemble the bolt by coating the match line for the gear case of the case cover with liquid gasket (LOCTITE 518 or equivalent) and the bolt threaded portion with liquid gasket (LOCTITE 242 or equivalent), then tighten the bolt at a specified torque.

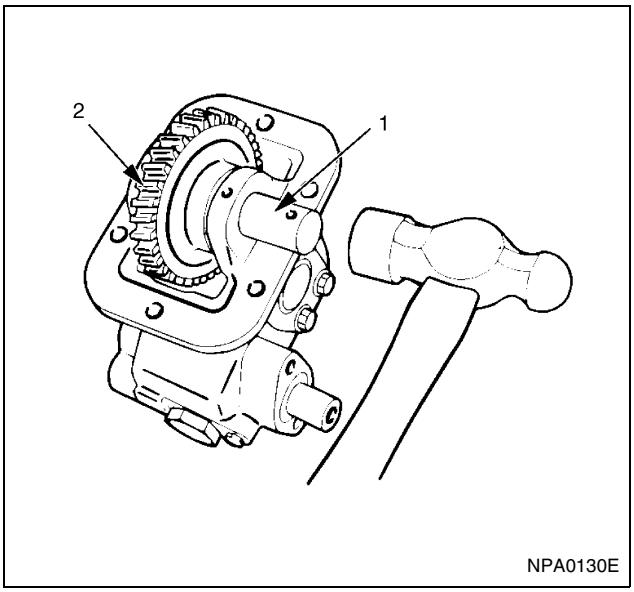
Tighten:
Case cover bolt to 24 N·m (2.4 kg·m / 17 lb·ft)

Notice:
Cleanly remove the liquid gasket adhering to the cover installation side of the case cover and gear case and clean and fully degrease the case by waste cloth so that no oil will adhere to.



Legend
1. Bolt
2. Case cover

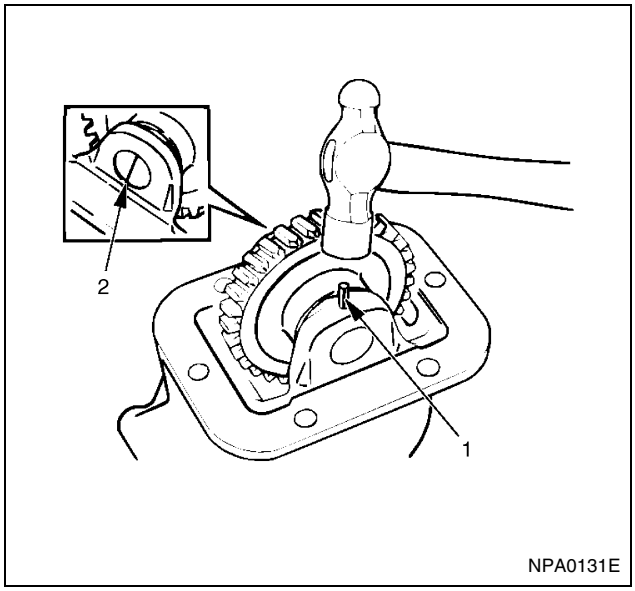
18. Needle Bearing
19. Idle Gear
    - Coat the needle bearing with assembly all amount of lithium grease (BESCO L-2 or equivalent) and assemble the needle bearing in the idle gear.
20. Idle Gear Shaft
    - Assemble the tooth round portion of the idle gear facing the front side and assemble the pin hole of the idle gear shaft facing the front side.



Legend
1. Idle gear shaft
2. Idle gear

21. Spring Pin
    - Align the spring pin hole of the gear case and the pin hole of the idle gear shaft and strike the spring pin.

Notice:
When the slit on the rear side of the idle gear shaft is set in the vertical direction, the pin hole will be aligned.

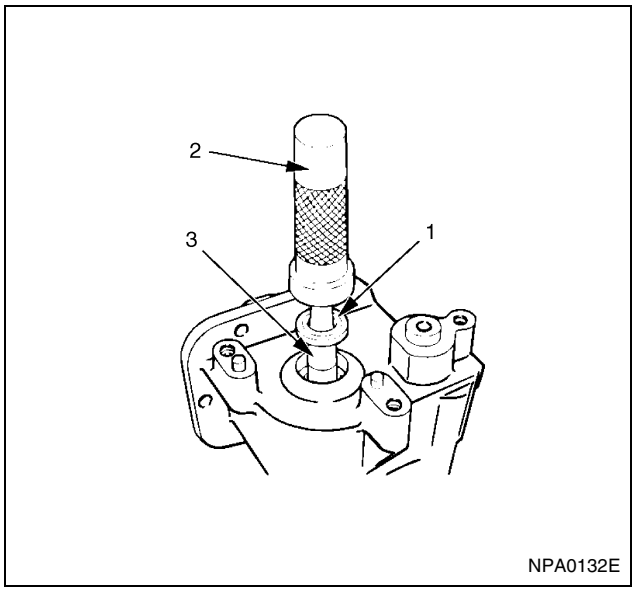


Legend
1. Spring pin
2. Slit

22. Oil Seal (Output Shaft Side)
    - Coat the oil seal lip portion with lithium grease (BESCO L-2 or equivalent) and coat the seal periphery portion with liquid gasket (LOCTITE 518 or equivalent).
    - To prevent the seal lip portion from being damaged, install it in the seal guide and press-fit it in the gear case by the oil seal installer.

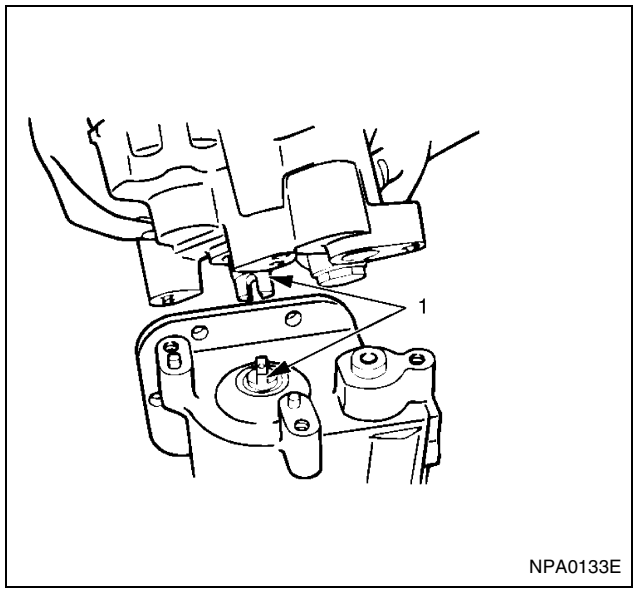
    Oil seal installer: 5-8840-2433-0

    Oil seal guide: 5-8840-2564-0



Legend
1. Oil seal
2. Oil seal installer
3. Oil seal guide

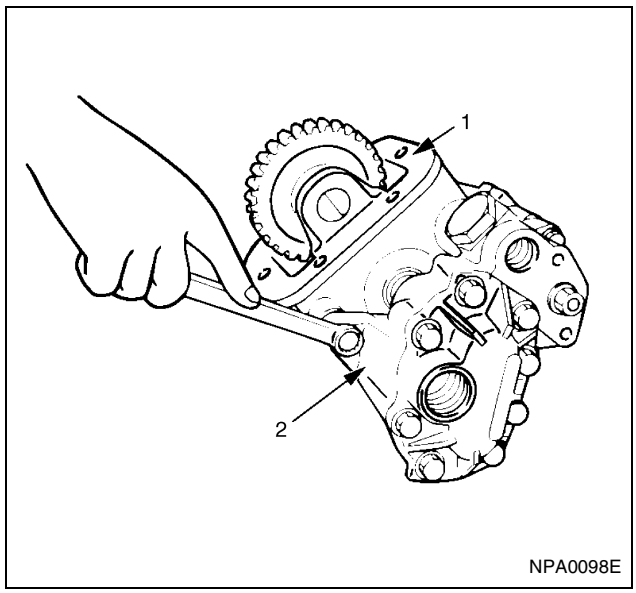
23. Bolt
    - To install the oil pump in the PTO, fully coat the shaft tip portion of the PTO and the oil pump shaft groove portion with the lithium grease (BESCO L-2 or equivalent) for rust prevention.



Legend
1. Coated with grease

    - Align and install the shaft width across flats portion on the PTO side and the shaft groove on the oil pump side and tighten the bolt at a specified torque.

Tighten:
PTO bolt to 53 N·m (5.4 kg·m / 39 lb·ft)

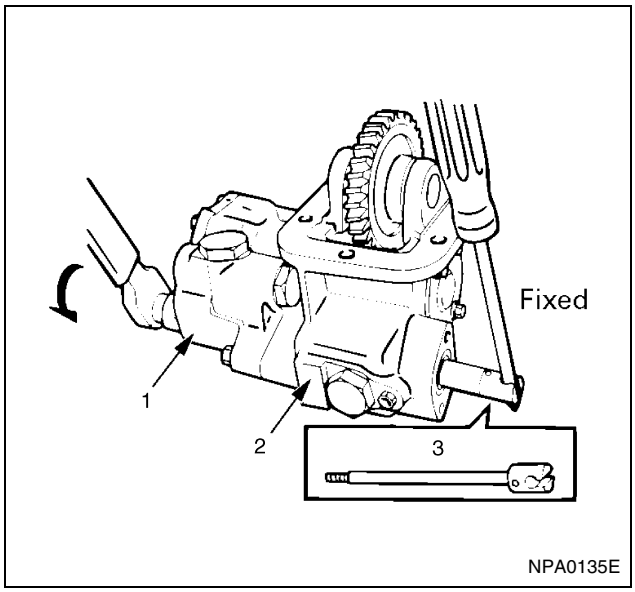


Legend
1. PTO
2. Oil pump

24. Inner rod
25. Cable connector
26. Spring pin
27. Stopper adapter
28. Spring pin
    - If the cable connector or stopper adapter is removed, install it in the inner rod.
29. Inner rod assembly
    - Coat the threaded portion of the inner rod tip with liquid gasket (LOCTITE 242 or equivalent) and insert and screw it from the front side of the PTO, and tighten the inner rod assembly at a specified torque.

Notice:
Tighten the inner rod assembly by inserting a Phillips screwdriver in the groove of the control cable connector and pressing it, then applying a wrench to the stopper adapter on the oil pump side. (The three rotation dump truck is in contrast with this.)

Tighten:
Inner rod to 19 N·m (1.9 kg·m / 14 lb·ft)

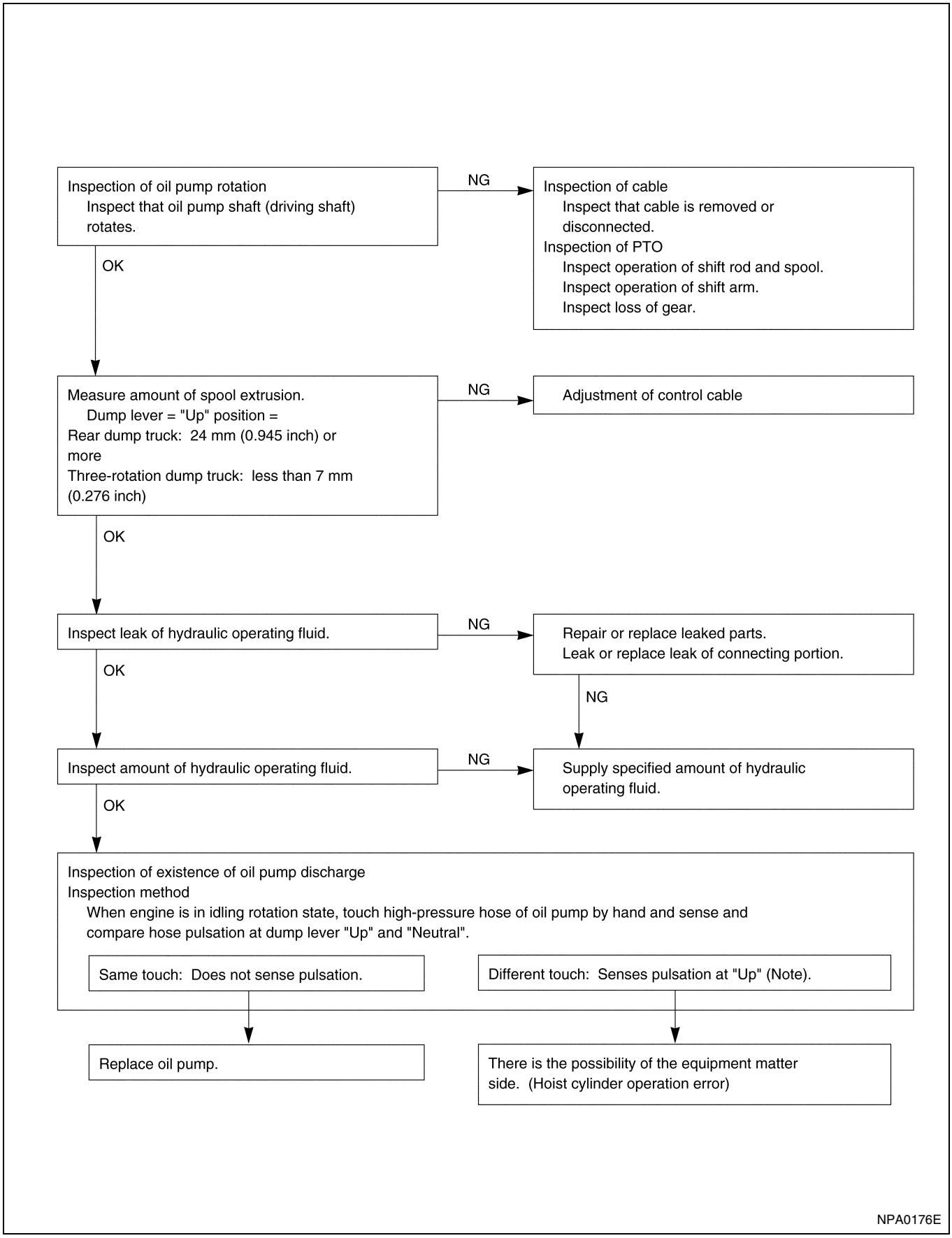


Legend
1. Oil pump
2. PTO
3. Inner rod assembly

Troubleshooting

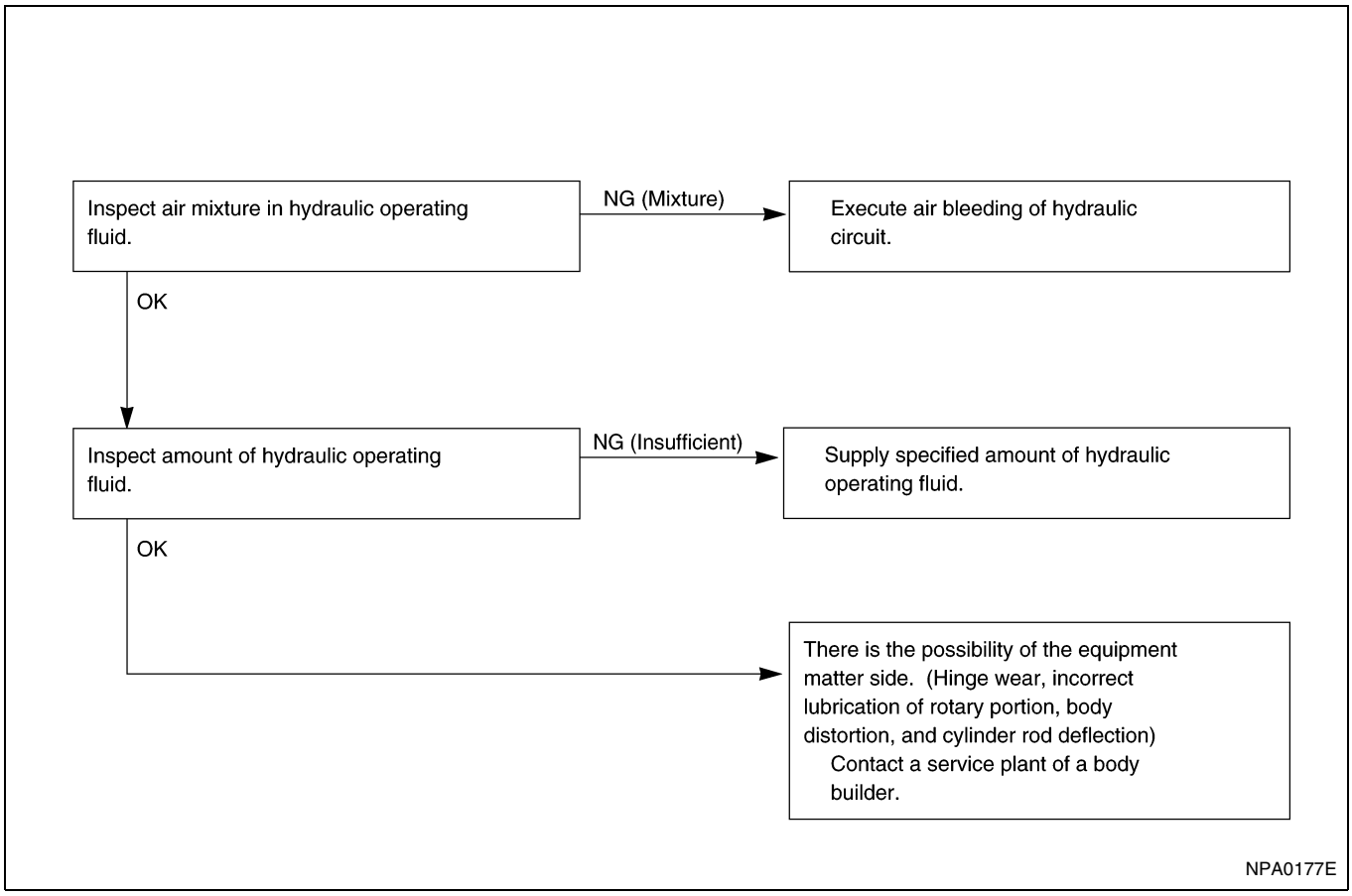
Inspection Based on Defect Symptoms

Defect 1. The Dump Body Rise is Disabled.

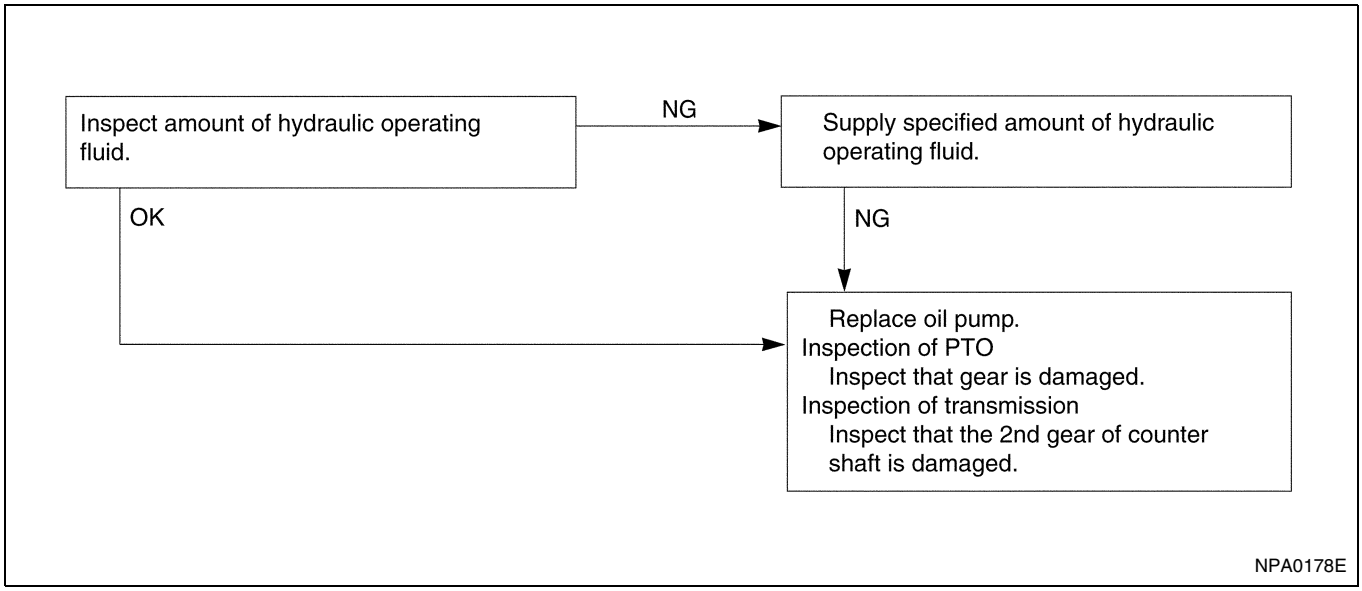


Notice:
For examination by touch on hose, be careful not to mix this pulsation with engine vibration.

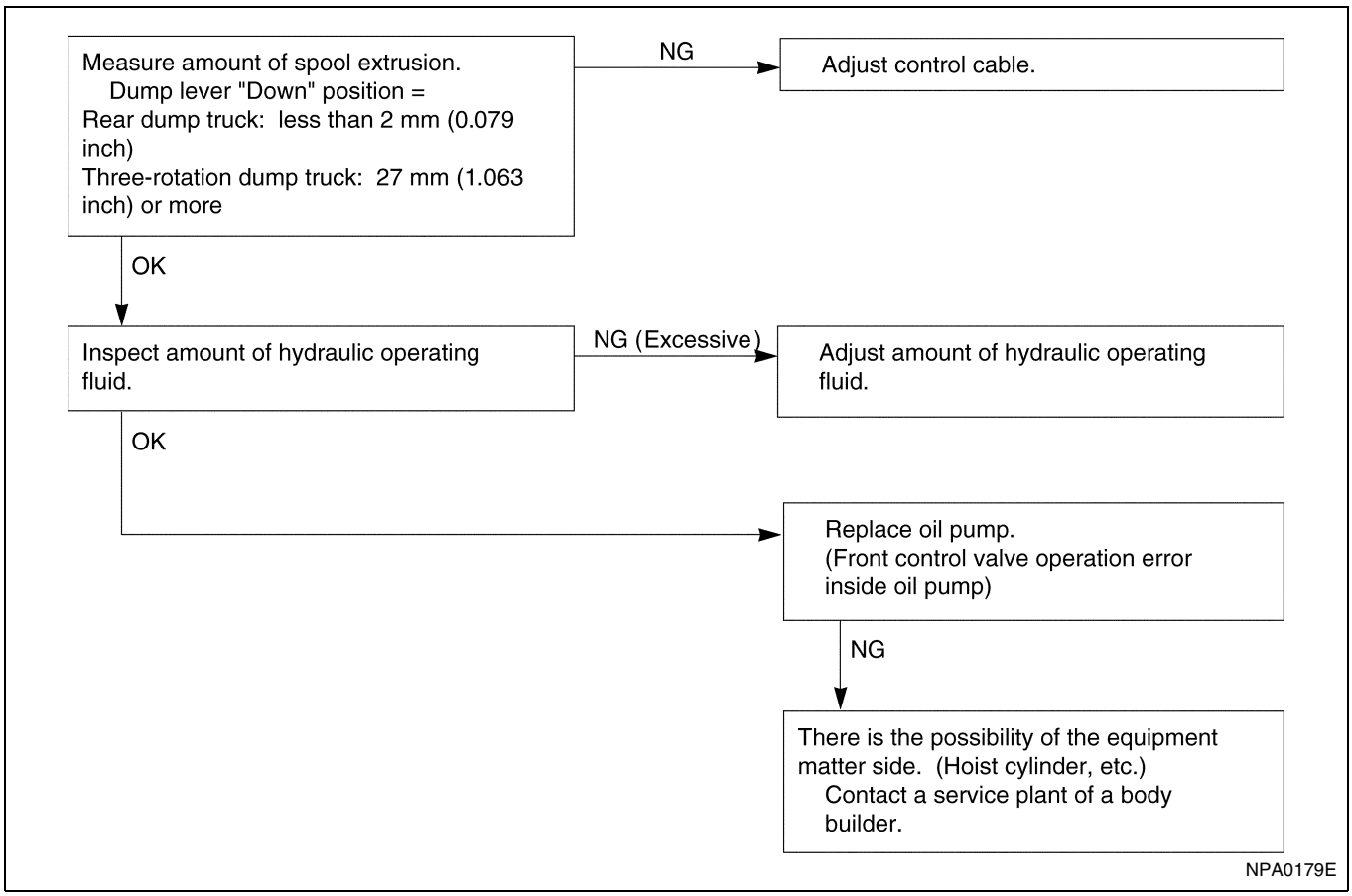
Defect 2. The Body (Cargo Deck) is Lugged During Rise.



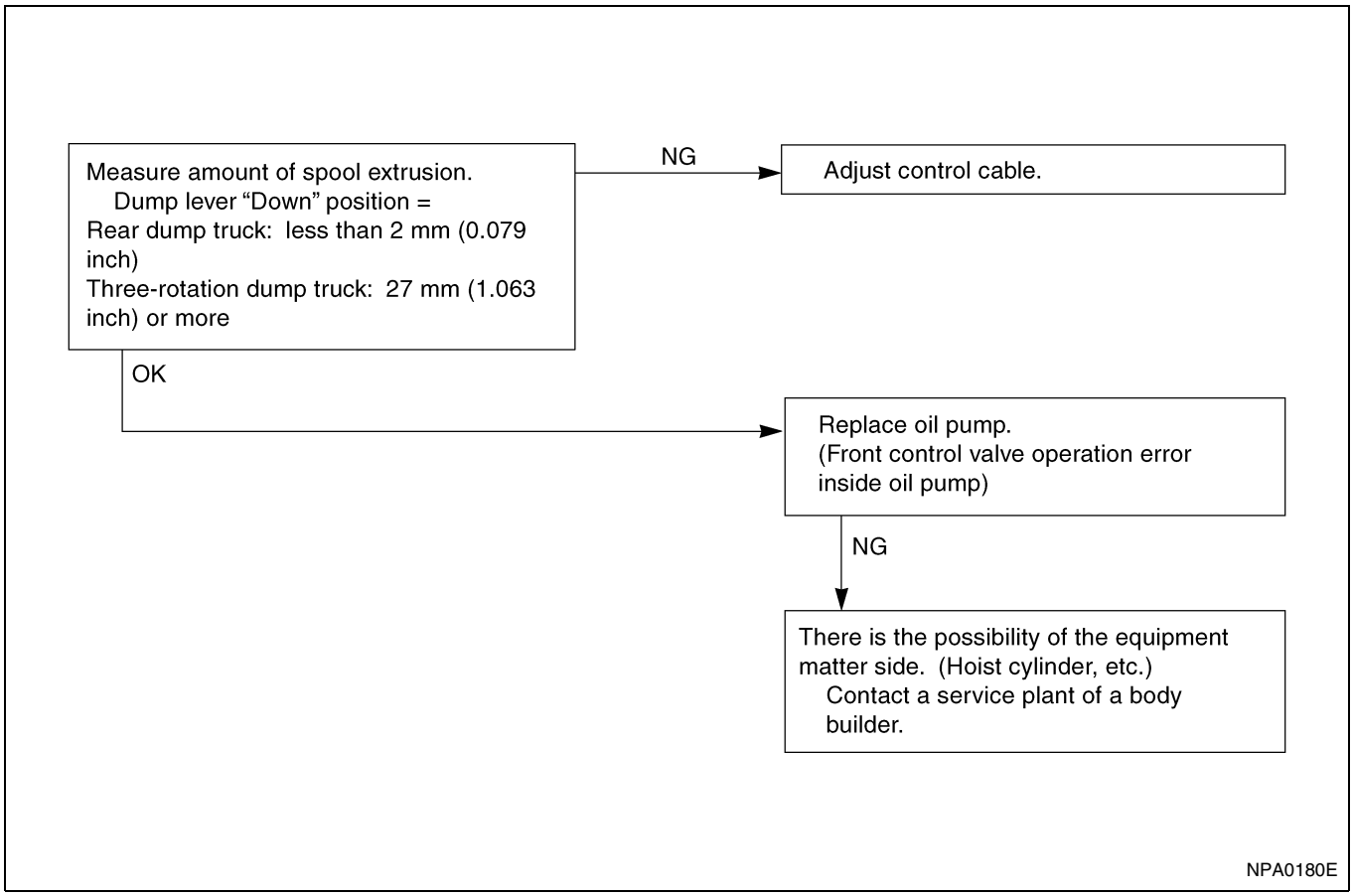
Defect 3. While the Body (Cargo Deck) is Being Raised, The Oil Pump Portion Causes a Large Abnormal Sound (Such As Caterwaul or Grate).



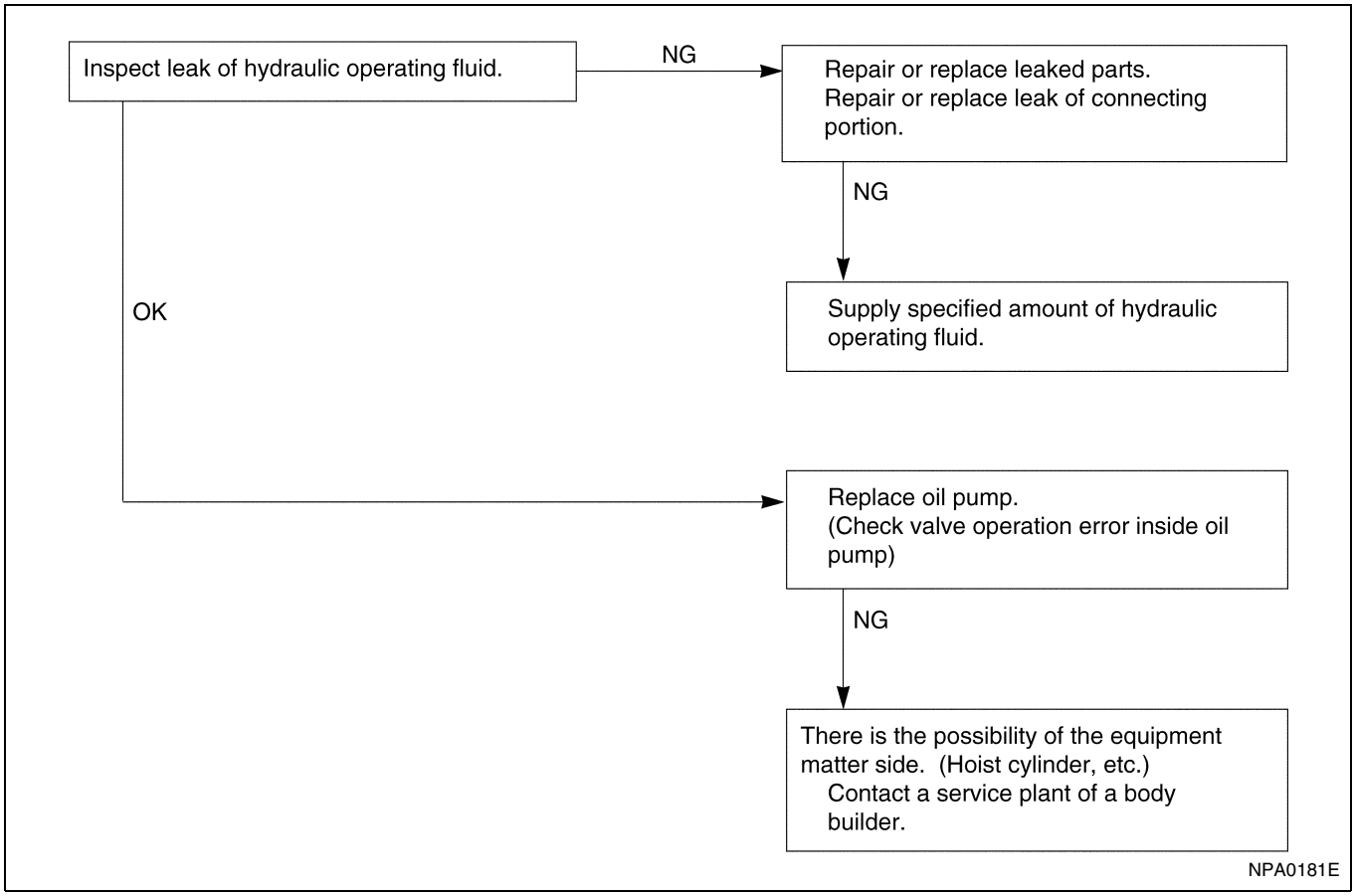
Defect 4. The Dump Body is Kept Being Raised or Does Not Drop Intermediately.



Defect 5. The Fall Speed of The Dump Body is Slow. (Basic Value: within 20 seconds for single cab, within 25 seconds for double cab (only for rear dump truck)



Defect 6. When a Load is Applied, The Dump Body Drops.



Main Data and Specifications

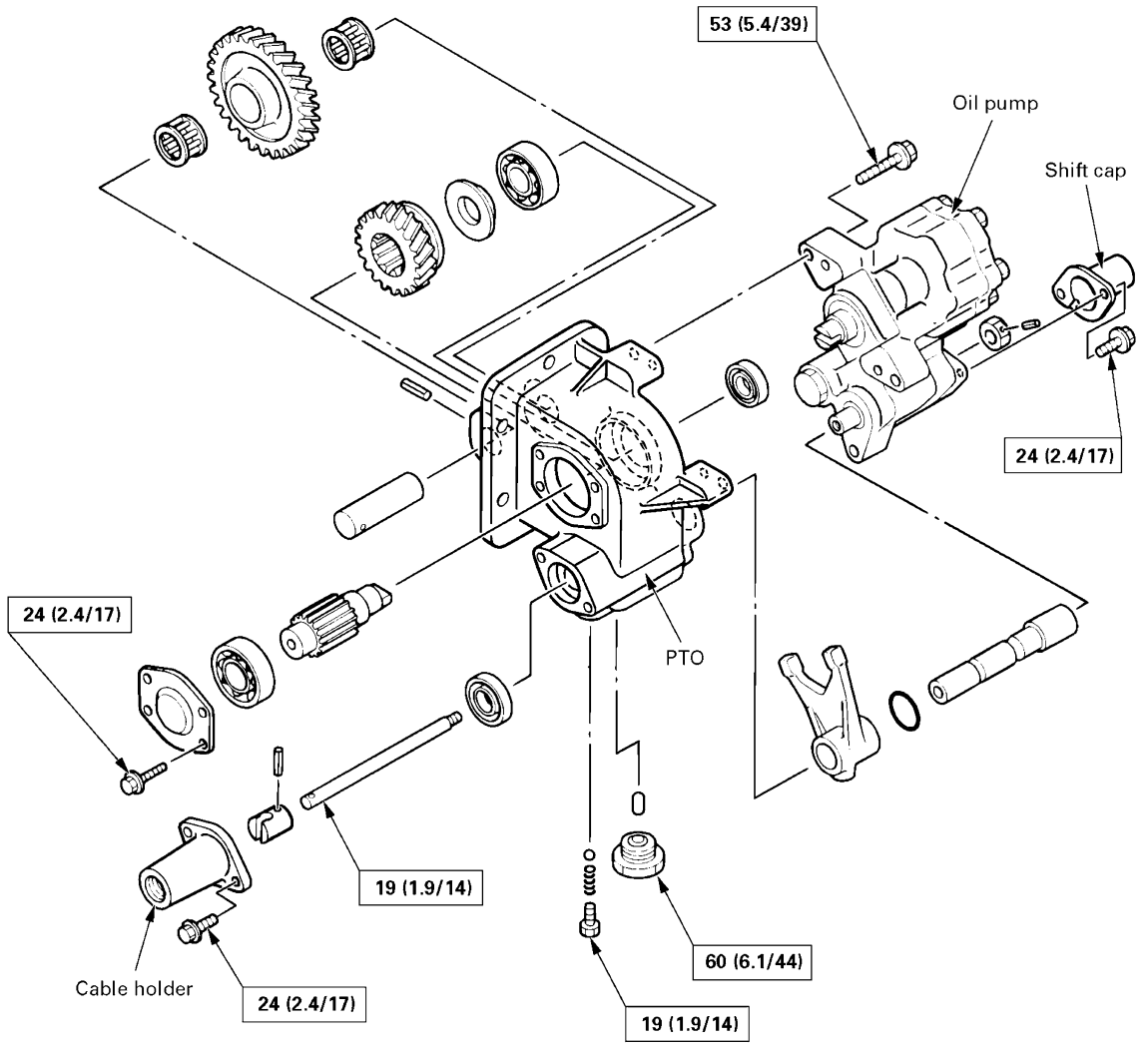
PTO with Oil Pump Assembly

Item	Specifications
Allowable maximum output torque N·m/rpm (kg·m/rpm)	98/1000 (10/1000)
Deceleration ratio (speed ratio for engine)	0.678
Direction of rotation (viewed from the rear of the PTO)	Clockwise rotation

Fixing Torque

This illustration is based on a rear dump truck model.

N·m (kg·m / lb·ft)



NPA0136E

Special Tools

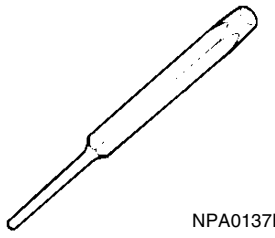
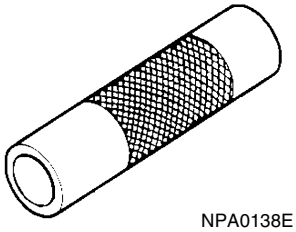
Illustration	Tool Number / Description / Remarks
 NPA0137E	9-8529-2201-0 / Spring pin bar
 NPA0138E	5-8840-2432-0 / Bearing installer

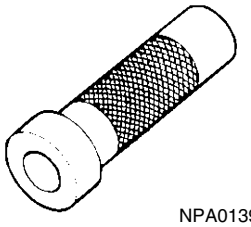
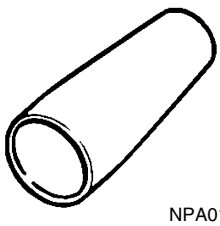
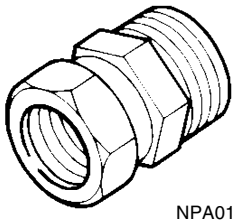
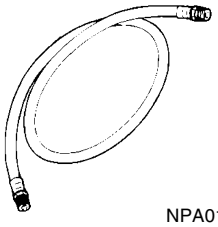
Illustration	Tool Number / Description / Remarks
 NPA0139E	5-8840-2433-0 / Oil seal installer
 NPA0140E	5-8840-2564-0 / Oil seal guide

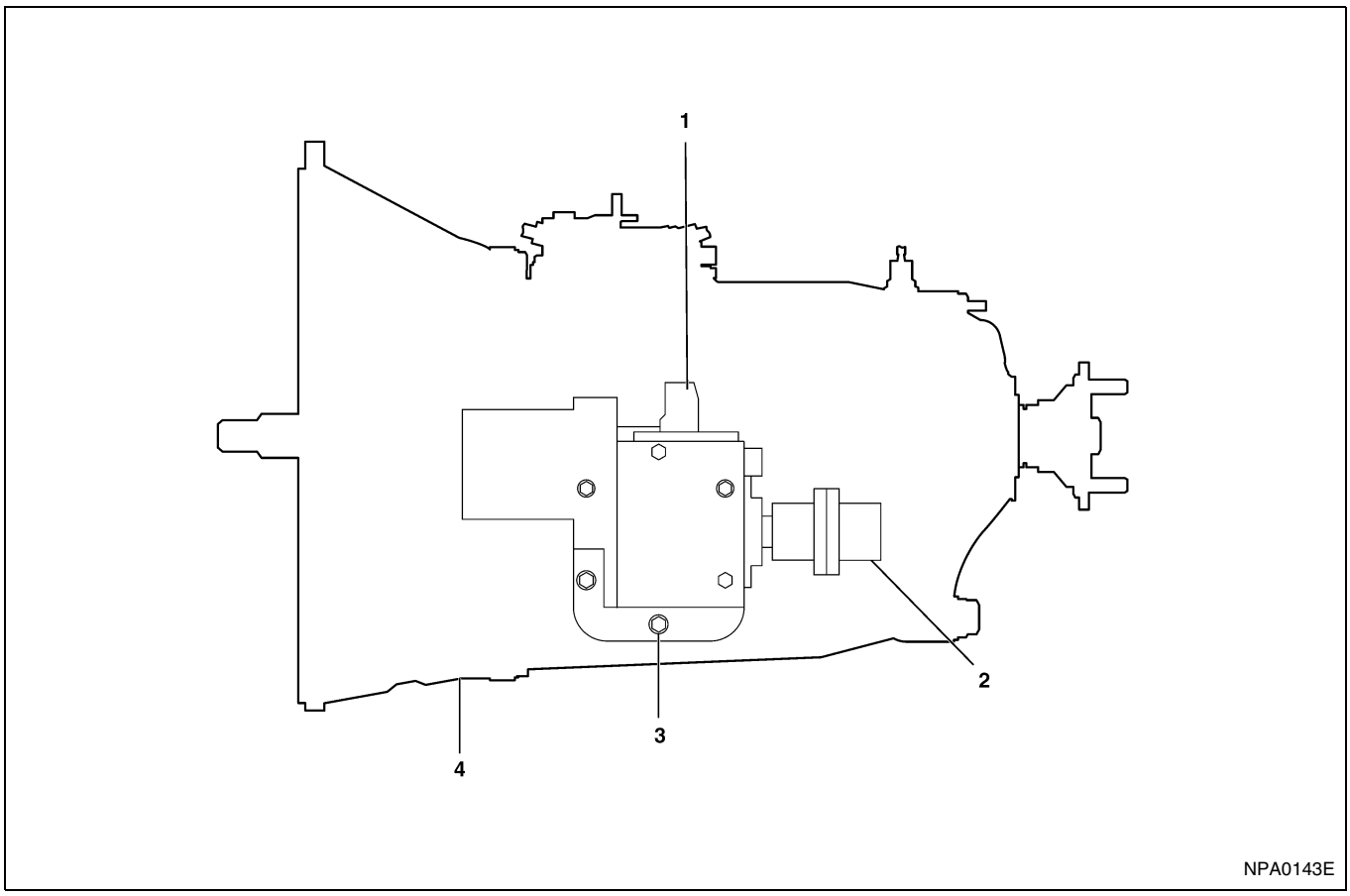
Illustration	Tool Number / Description / Remarks
 NPA0141E	5-8840-2439-0 / Joint (low-pressure side) PF3/ 4 male screw/PF1/2 nut
 NPA0142E	5-8840-2435-0 / Test hose (2 m long) (Between oil pump and oil container) Metal cap PF1/2 male screw ×2)

ELECTRONIC CONTROL TYPE PTO ASSEMBLY

Removal and Installation

Removal

1. PTO Output Propeller Shaft
   - Remove the propeller shaft, which is connected to equipment, at the flange portion of PTO.
   - Turn the PTO switch to ON, engage the gears, and loosen the nut which tightens the PTO output flange so that it can be rotated by hand at disassembly.
2. Battery Terminal
   - Disconnect the negative (–) terminal of battery terminal.
3. Transmission Oil
   - Remove the drain plug of the transmission to drain oil.
4. Wiring Connector
   - Disconnect the two wiring connectors.
5. PTO
   - Remove the bolts and nuts at six locations, which install the PTO to the transmission, and remove the PTO.



Legend

1. Wiring connector
2. PTO output propeller shaft
3. PTO
4. Transmission oil

Installation

1. PTO
   - Apply liquid gasket (THREE BOND TB1215 or equivalent) to the mating surface of the transmission case and PTO.
   - Install the PTO assembly to the transmission and tighten the bolts and nuts to the specified torque. (Apply LOCTITE 242 to the bolt threads.)

Tighten:
Bolt and nut to 37 N·m (3.8 kg·m / 27 lb·ft)

2. Wiring Connector
   - Connect wiring connector and secure them at the bracket portion.
3. Transmission Oil
   - Pour oil to the transmission.
     Specified oil: BESCO gear oil transaxle (5W-30)

4. Battery Terminal
   - Install the battery terminal securely and tighten it.
5. PTO Output Propeller Shaft
   - Turn the PTO to ON and tighten the tightening nut of PTO output flange to the specified torque.

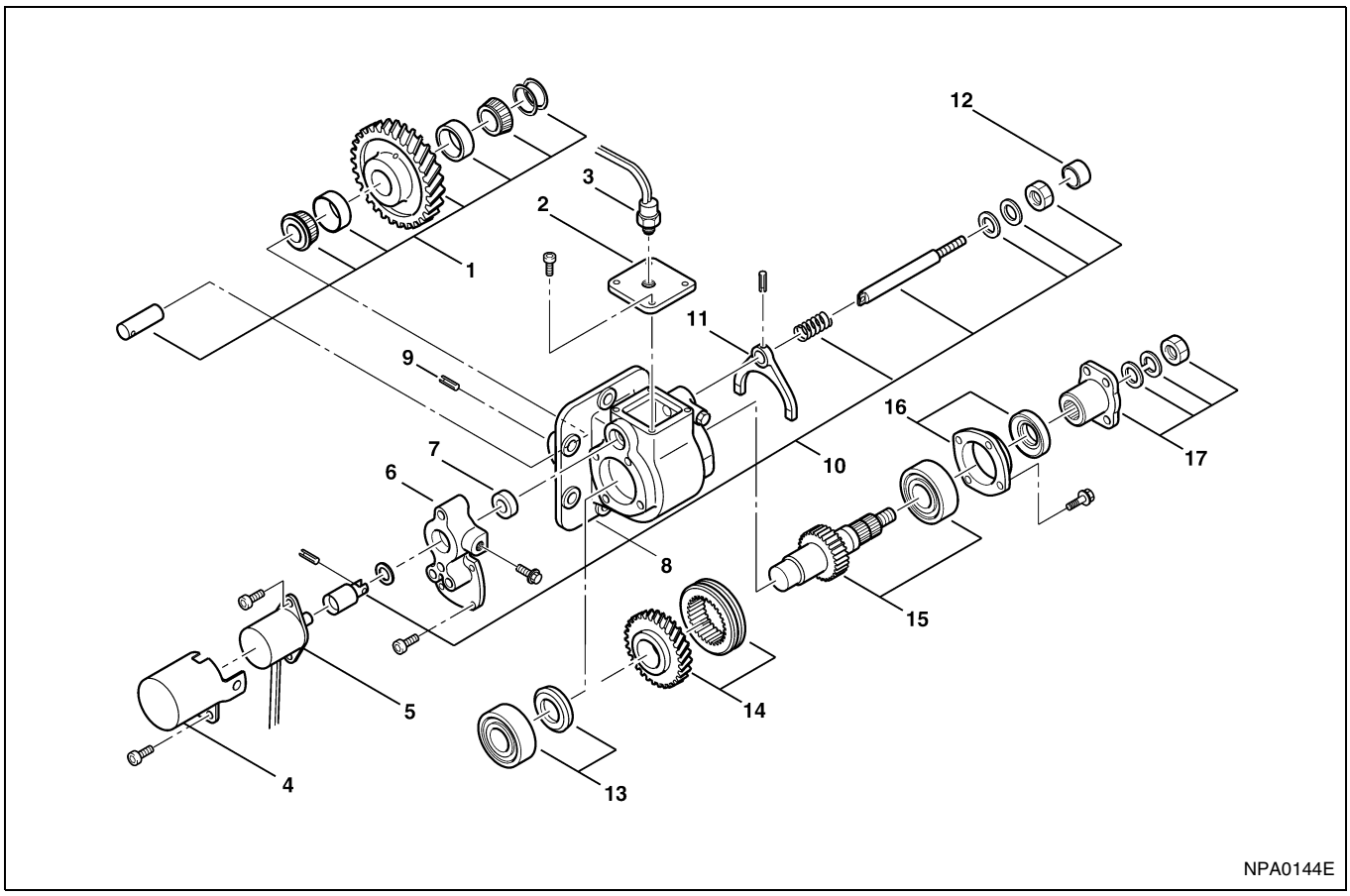
Tighten:
PTO output flange nut to 105 N·m (10.7 kg·m / 77 lb·ft)

   - Install the propeller shaft, which is connected to equipment, to the flange portion of PTO.

Tighten:
Propeller shaft to 17 N·m (1.7 kg·m / 13 lb·ft)

Unit Repair

Electronic Control Type PTO Body



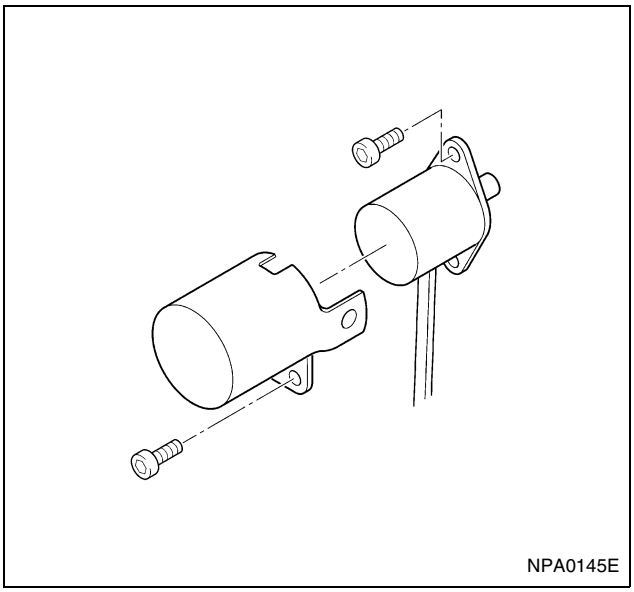
Legend

1. Idle shaft, idle gear, taper roller bearing
2. Upper cover
3. PTO switch
4. Solenoid cover
5. Solenoid assembly
6. Adapter
7. Oil seal
8. Gear case
9. Spring pin
10. Solenoid plunger, washer, shift rod, spring (plain washer, nut)
11. Shift fork
12. Plug
13. Front bearing, thrust collar
14. Gear, sleeve
15. Output shaft, rear bearing
16. Rear cover, oil seal
17. Nut, washer, flange

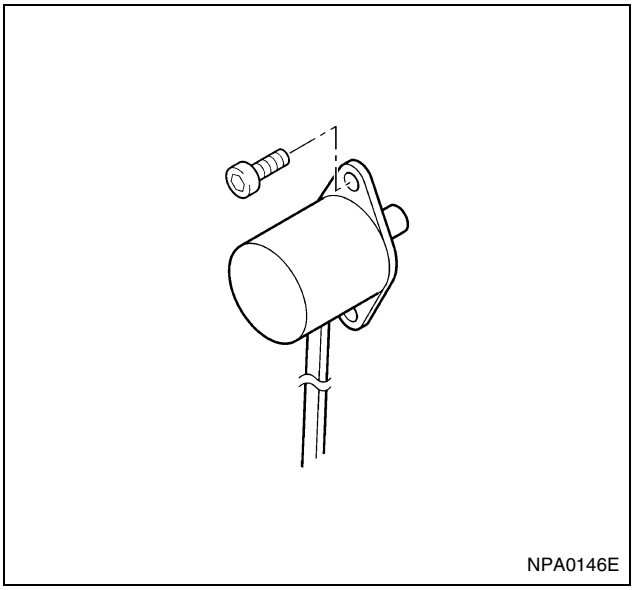
Disassembly

Disassembly Steps

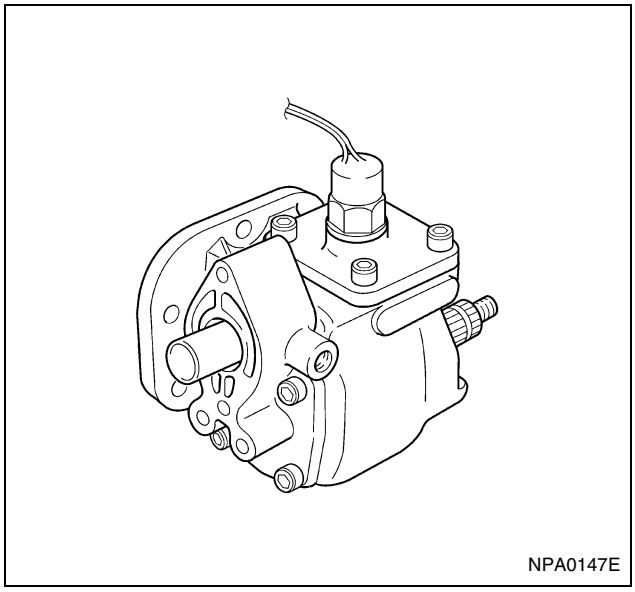
1. Cover, Solenoid
   - Remove the three bolts and remove the cover.


NPA0145E

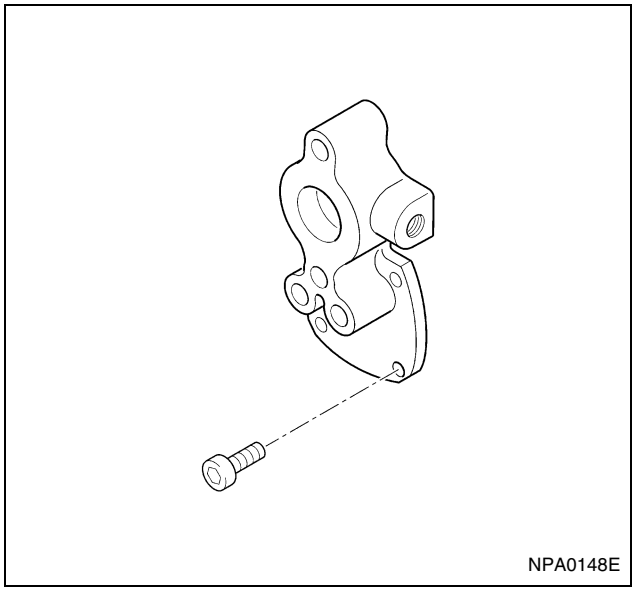
2. Solenoid
   - Disconnect the harness connector and remove the two bolts. Remove the solenoid.


NPA0146E

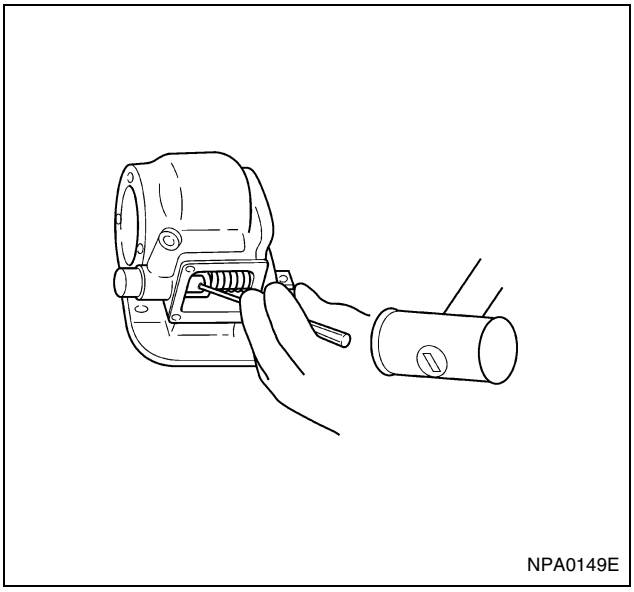
3. PTO Switch
4. Upper Cover
   - Remove the four bolts and remove the upper cover.


NPA0147E

5. Adapter
   - Remove the four bolts and remove the adapter.

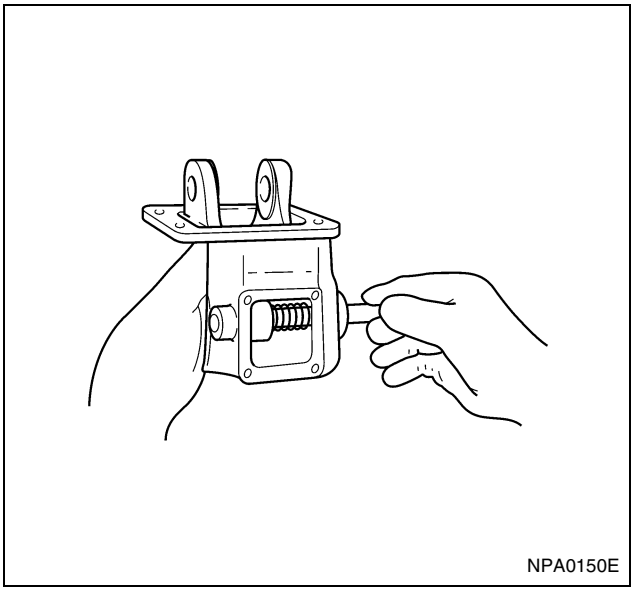

NPA0148E

6. Spring Pin
   - Punch out the spring pin of shift fork.


NPA0149E

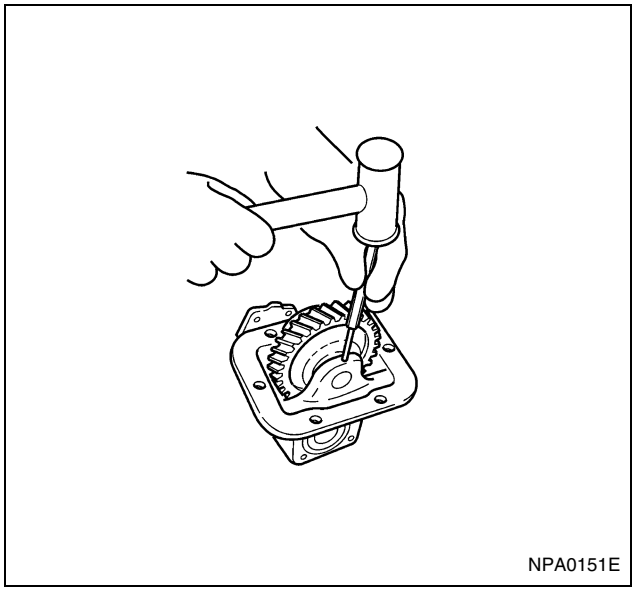
7. Shift Rod, Shift Fork, Spring Pin, Solenoid, Plunger, Washer
   - Pull out the shift rod and remove the shift fork and spring washer.
8. Oil Seal
9. Plug

Caution:
If the plug and oil seal are not faulty, removal of them is not necessary.

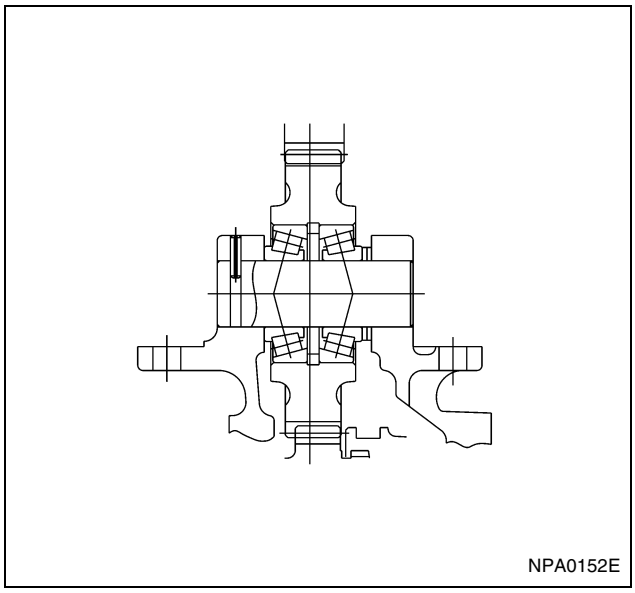

NPA0150E

10. Spring Pin
    - Punch the spring pin into the idle gear shaft. (After removing the idle gear shaft, pull the spring pin out from the shaft.)

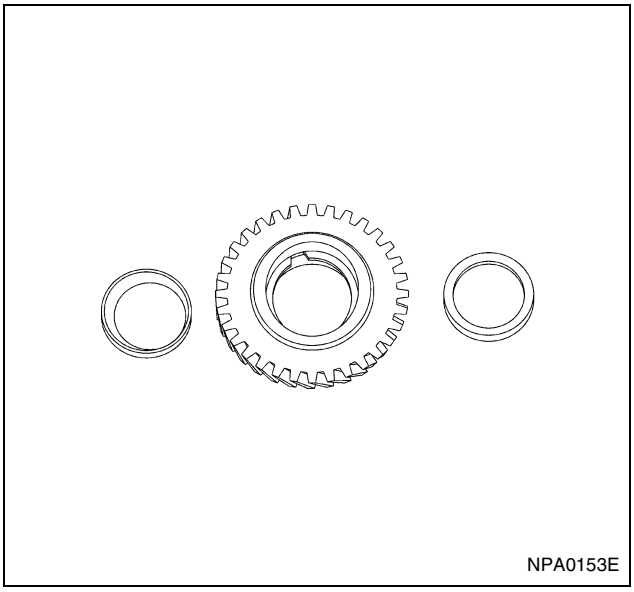
Special Tool
Spring pin remover; 9-8529-2201-0


NPA0151E

11. Idle Gear, Taper Roller Bearing, Shim, Shaft
    - Pull out the idle gear shaft and remove the idle gear (with snap ring), the taper roller bearings (two) and the shim.

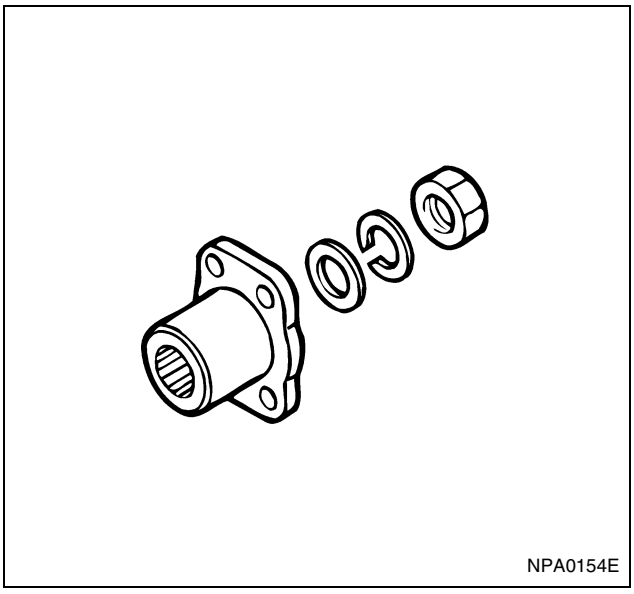

NPA0152E

- If replacing the taper roller bearing, pull out the taper roller bearing outer races (two) from the idle gear using a brass stick and a hammer. (Do not remove the snap ring.)

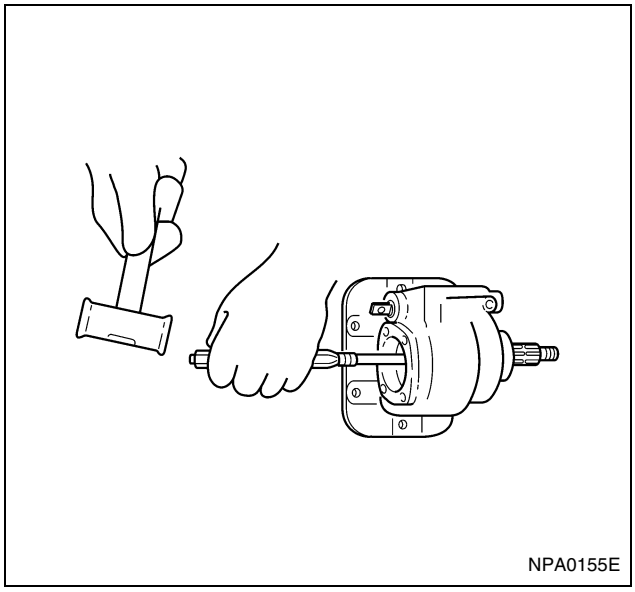

NPA0153E

12. Nut, Washer, Flange
    - Remove the tightening nut of output flange and remove the spring washer and flange.
13. Rear Cover, Oil Seal
    - Remove the rear cover (with oil seal).
    - Remove the oil seal from the rear cover.

Caution:
If the oil seal is not faulty, removal of it is not necessary.

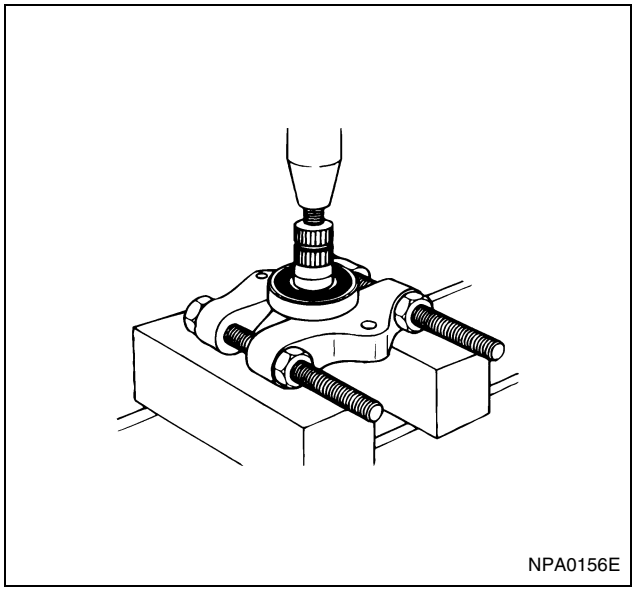

NPA0154E

14. Output Shaft, Rear Bearing, Gear, Sleeve
15. Front Bearing, Thrust Collar
    - Tap the output shaft axis from the front side, and remove the front bearing, output gear, thrust collar and sleeve. Then pull out the output shaft and rear bearing from the gear case as a unit.
    - Remove the output gear (with bushing), sleeve, thrust collar and front bearing from the inside of gear case.


NPA0155E

    - Remove the rear bearing from the output shaft.

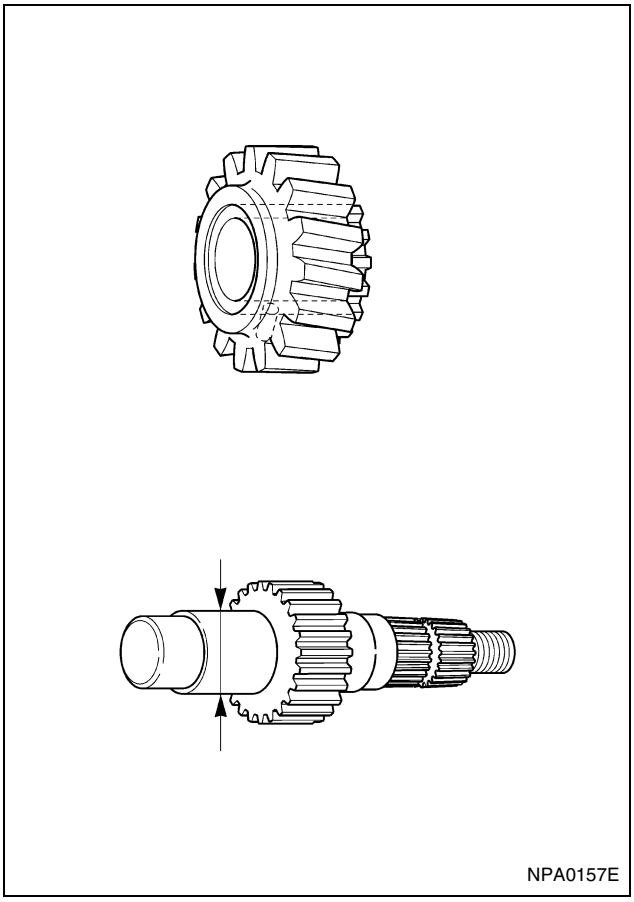
Special tool
Bearing remover; 5-8840-0015-0


NPA0156E

Assembly

- Make sure that each part has been washed. Especially, remove metal particles or cleaning solvent at the bottom of gear case.
- Right before assembly, apply engine oil to the sliding portion and the fitting portion of each part.
- Bearings
  – Check each bearing. Replace it if there is one of the following faults.
    - Its rotation is not smooth.
    - Extreme noise occurs.
    - There is extreme damage or rust.
    - There is abnormal play in the thrust direction.

  - There is discoloration, extreme wear or pitching on the rolling body and rolling surface of the needle bearing or taper roller.
  - There is extreme backlash in the output shaft and the bearing (front and rear)
    Service limit; 0.2 mm (0.008 in)
- Gears
  – Check each gear. Replace it if there is extreme fault. For minor stepped wear or rough surface, repair it using oil stone or pencil grinder.
    - Breakage, damage or wear on the cross-section
    - Wear on idle gear and shaft
      Replace the idle gear (with snap ring), the needle bearing or the taper roller bearing if there is extreme wear.
    - Gap between output shaft and output gear (with bushing)
      Service limit; 0.2 mm (0.008 in)
      Replace the output gear (with bushing) if its gap exceeds the service limit.
- Idle and output shaft
  – Check for the damage or wear on the outside surfaces of idle shaft and output shaft, wear or damage on the spline portion, bent shaft, etc. Replace it if the fault is extreme.

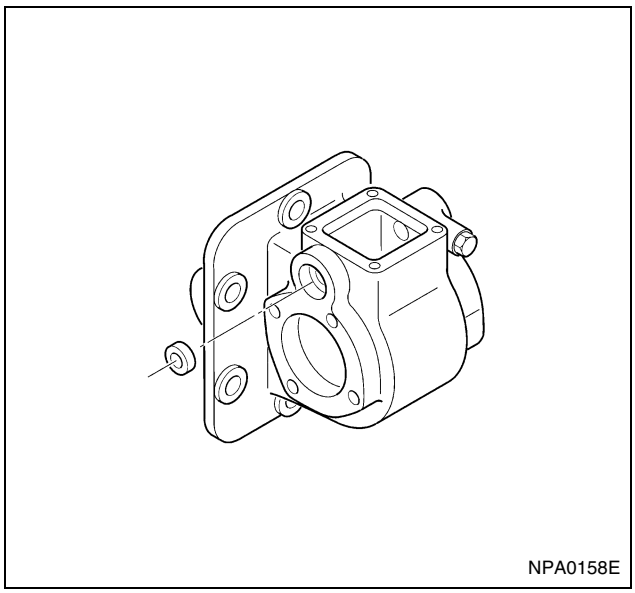

NPA0157E

- Shift mechanism
  – Check each part of shift mechanism for damage, bent, stepped wear, etc. and replace it if the fault is extreme.
    - Bent or wear of shift rod
    - Deformation or wear of shift arm
      Thickness of shift arm
      Specification; 9 mm (0.354 in)
      Service limit; 8 mm (0.315 in)
    - Backlash or rough movement of shift rod and gear case
- Oil seal
  – Replace the output shaft or shift rod if its contact surface is damaged or deteriorated.
  – Do not reuse the removed oil seal.
- Clutch
  – For minor stepped wear or damage, repair it using oil stone or pencil grinder. Replace it if there is extreme fault.
- For assembly direction of parts, refer to cross-section diagram.

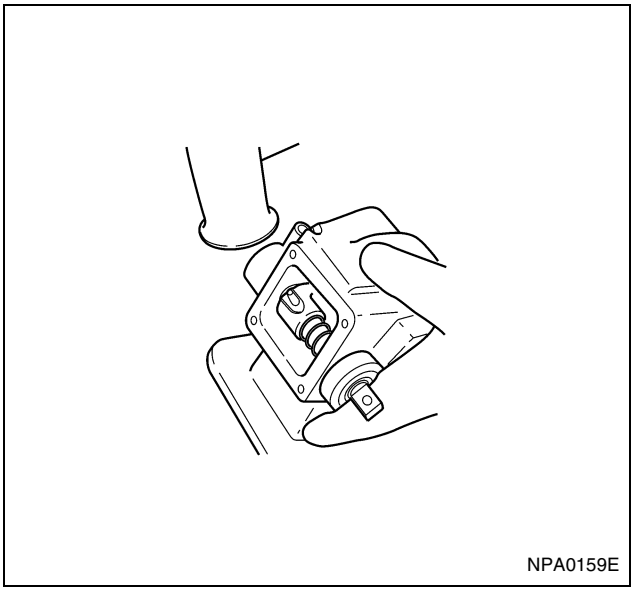
Assembly

1. Gear Case
2. Oil Seal
   - Apply liquid gasket (THREE BOND 1141E) to the circumference of oil seal and grease (BESCO L2 or equivalent) to the lip, and punch it into gear case slot portion (front side).

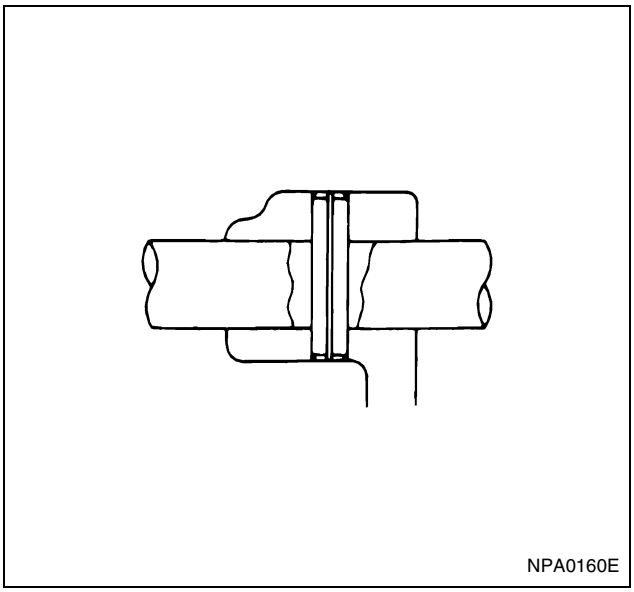
Special tool
Oil seal installer; 5-8840-2065-0


NPA0158E

3. Shift Rod, Shift Fork, Spring, Washer
   - Put the spring and the shift fork into gear case and pass the shift rod through them.

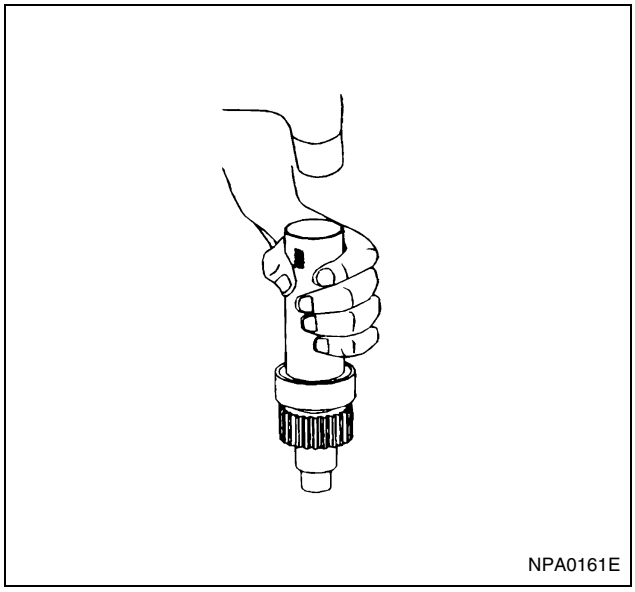

NPA0159E

4. Spring Pin
   - Punch the spring pin so that the pin is flush with the shift fork.

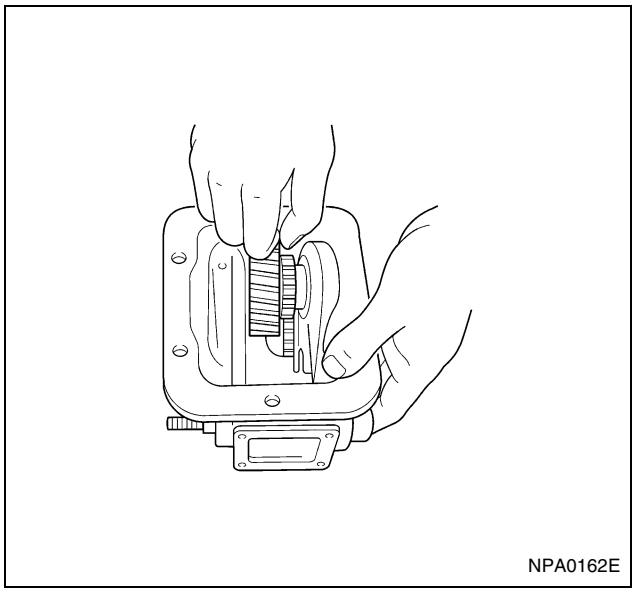

NPA0160E

5. Output Shaft, Rear Bearing
   - Press-fit the rear bearing into output shaft.

Special tool
Bearing installer; 5-8840-2066-0

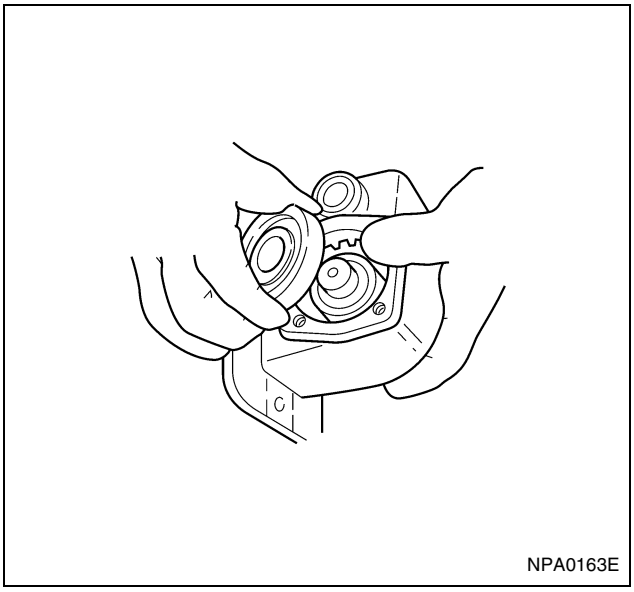

NPA0161E

6. Output Gear (with Bushing), Sleeve
   - Insert the shift fork into the sleeve groove in the gear case and assemble the output shaft (with rear bearing) to the sleeve and output gear.


NPA0162E

7. Thrust Collar, Front Bearing
   - Install the thrust collar to the front side of output shaft and press-fit the front bearing.

Special tool
Bearing installer; 5-8840-2066-0

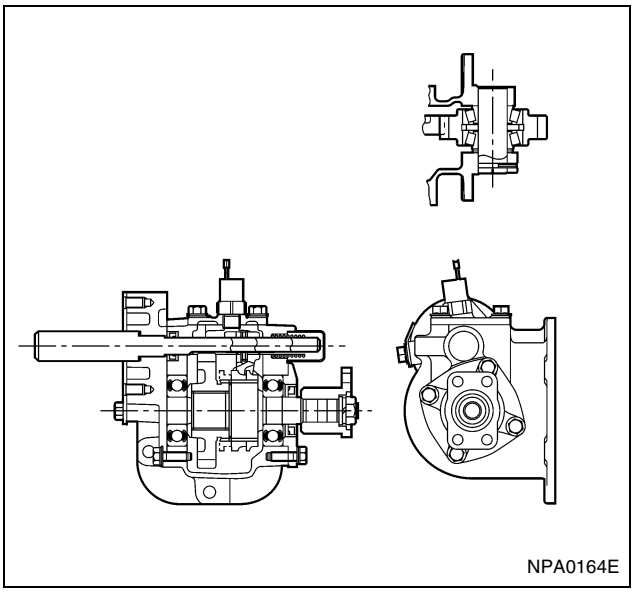

NPA0163E

8. Adapter, Solenoid
   - Apply liquid gasket (THREE BOND TB1215) to the mounting surfaces of adapter and solenoid. Let the cores of solenoid in-low portion and case slot portion of adapter come out. Assemble the bolt. Apply LOCTITE 242 to the bolt.

Caution:
Be careful not to damage the oil seal when the cores come out.

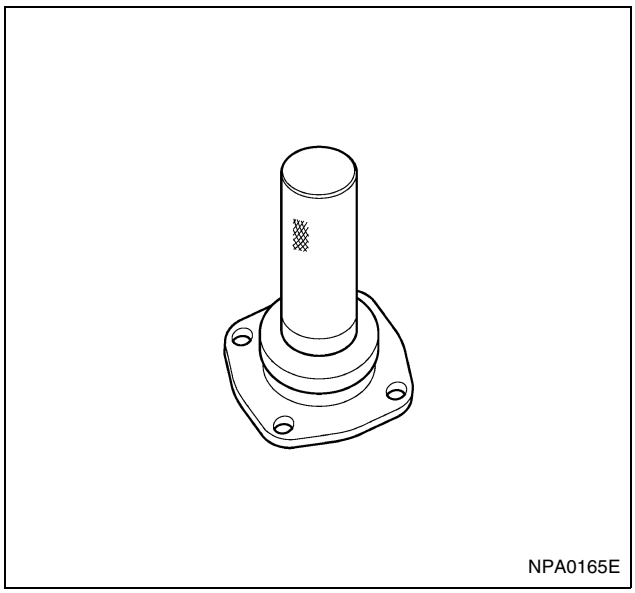
Tighten:
Bolt to 25 N·m (2.5 kg·m / 18 lb·ft)

Special tool
Setting tool; 5-8840-2452-1


NPA0164E

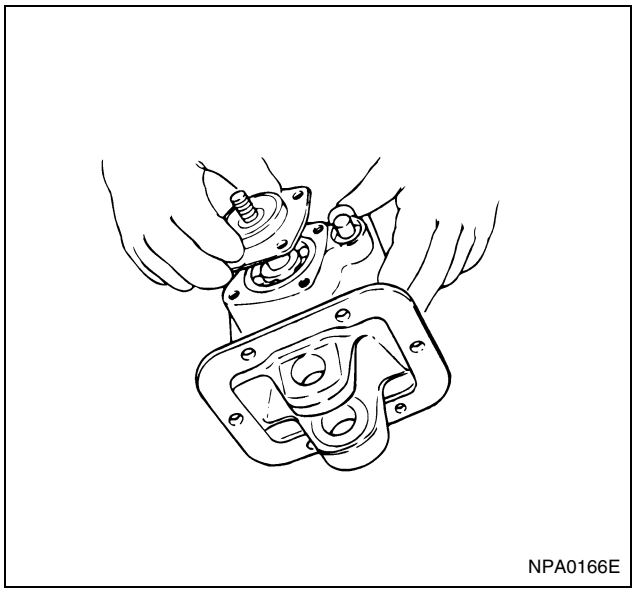
9. Rear Cover, Oil Seal
   - Fill with grease (BESCO L2 or equivalent) of approx. 3 g to the lip of oil seal and apply liquid gasket (THREE BOND 1141E) to the circumference and assemble it to the rear cover.

Special tool
Oil seal installer; 5-8840-2064-0


NPA0165E

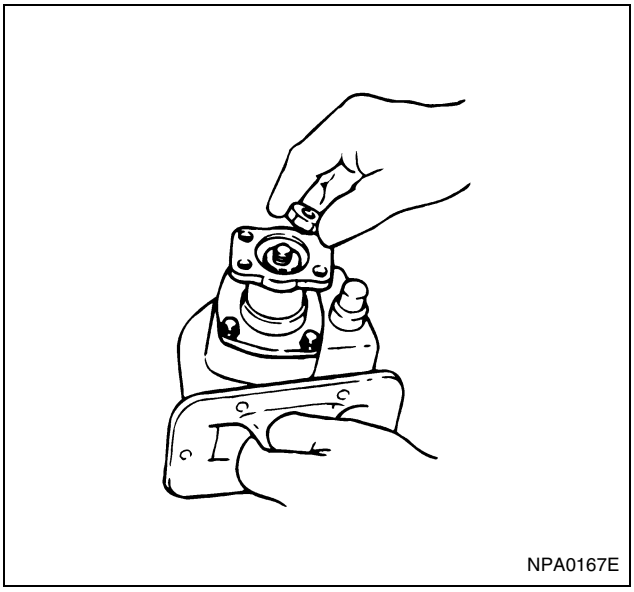
   - Apply liquid gasket (THREE BOND TB1215) to the mounting surface of rear cover and LOCTITE 242 to the bolt threads, and assemble it.

Tighten:
Bolt to 25 N·m (2.5 kg·m / 18 lb·ft)


NPA0166E

10. Flange, Washer, Nut
    - Assemble the flange to output shaft.
    - Install the plain washer and spring washer, and temporarily tighten the nut. After installing the PTO to the transmission, tighten it to the specified torque.

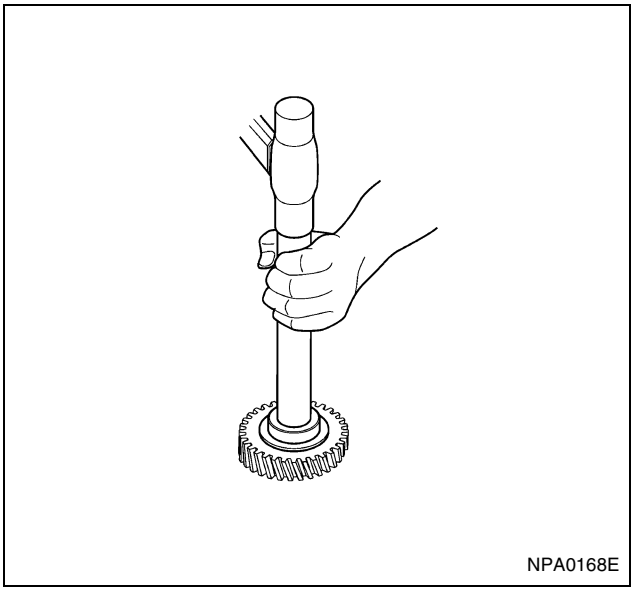
Tighten:
Nut to 105 N·m (10.7 kg·m / 77 lb·ft)


NPA0167E

11. Idle Gear, Taper Roller Bearing, Shim, Shaft
    - To replace the taper roller bearing, punch out the taper roller bearing outer races (two) from the both sides of idle gear.

Special tool
Bearing installer; 5-8522-0035-0
Grip; 5-8840-0007-0

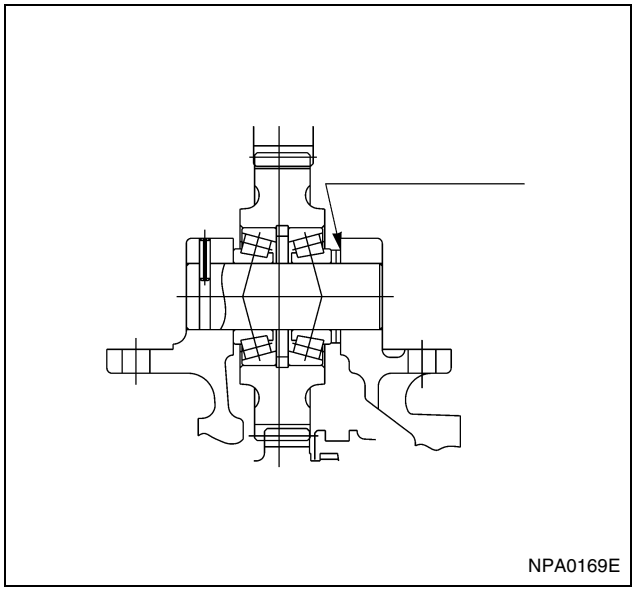
- Install the idle gear taper roller bearings (two) and shim.


NPA0168E

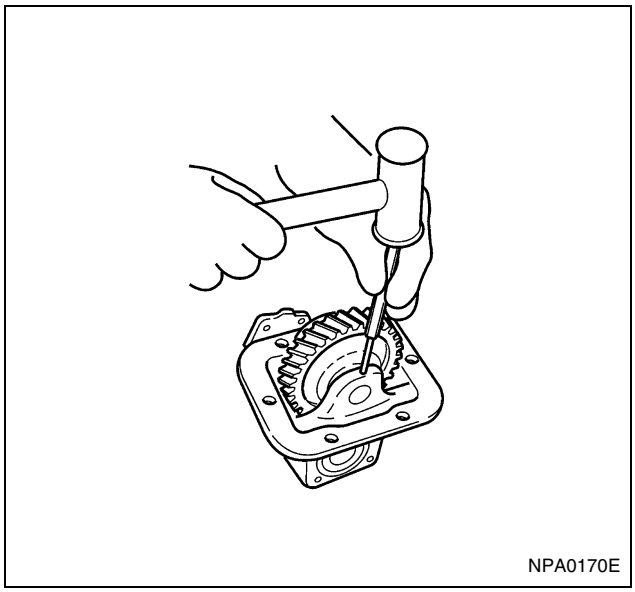
- Select the shim so that the gap shown in the illustration is specification, insert the shim between the back side taper roller bearing and the gear case, and install the idle shaft.

Gap specification between shim and case = Less than 0.08 mm (0.003 in)

Shim thickness to be selected	mm (in)
1.50 (0.059)	1.70 (0.067)
1.60 (0.063)	1.80 (0.071)
1.65 (0.065)	1.85 (0.073)

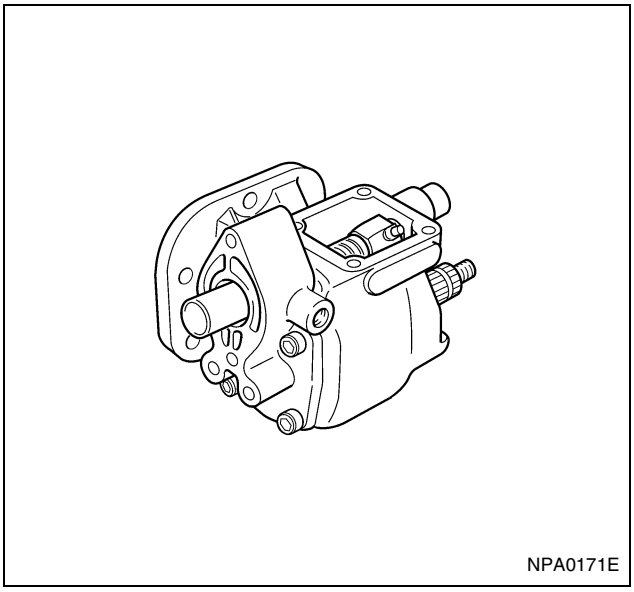

NPA0169E

12. Spring Pin
    - Punch the spring pin so that it is flush with the gear case.


NPA0170E

13. Upper Cover
    - Apply THREE BOND TB1215 to the mounting surface and LOCTITE 242 to the bolt threads, and assemble it to the case.

Tighten:
Bolt to 25 N·m (2.5 kg·m / 18 lb·ft)

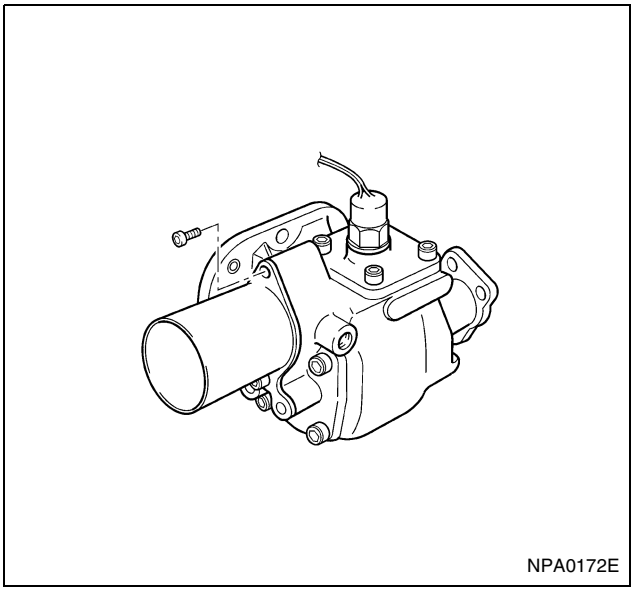

NPA0171E

14. PTO Switch
    - Apply LOCTITE 242 to the threads and assemble it.

Tighten:
PTO switch to 44 N·m (4.5 kg·m / 32 lb·ft)

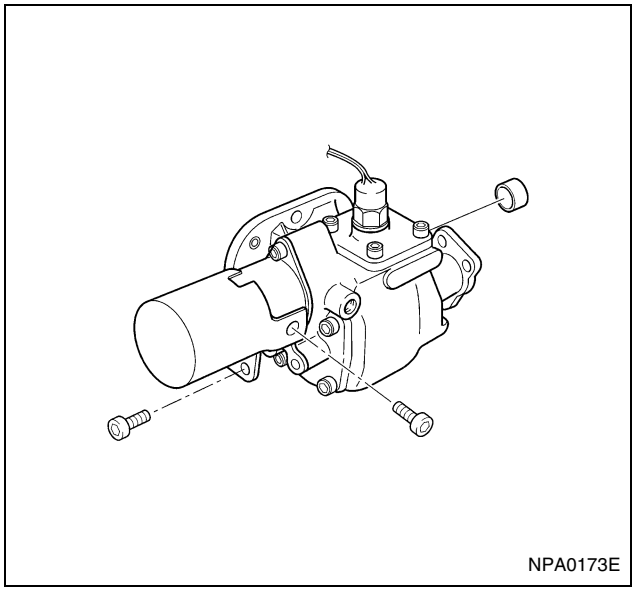
15. Solenoid Assembly
    - Apply LOCTITE 242 to the bolt threads and assemble it.

Tighten:
Bolt to 25 N·m (2.5 kg·m / 18 lb·ft)


NPA0172E

16. Cover Solenoid Plug
    - Apply LOCTITE 242 to the bolt threads of cover and solenoid and assemble them.

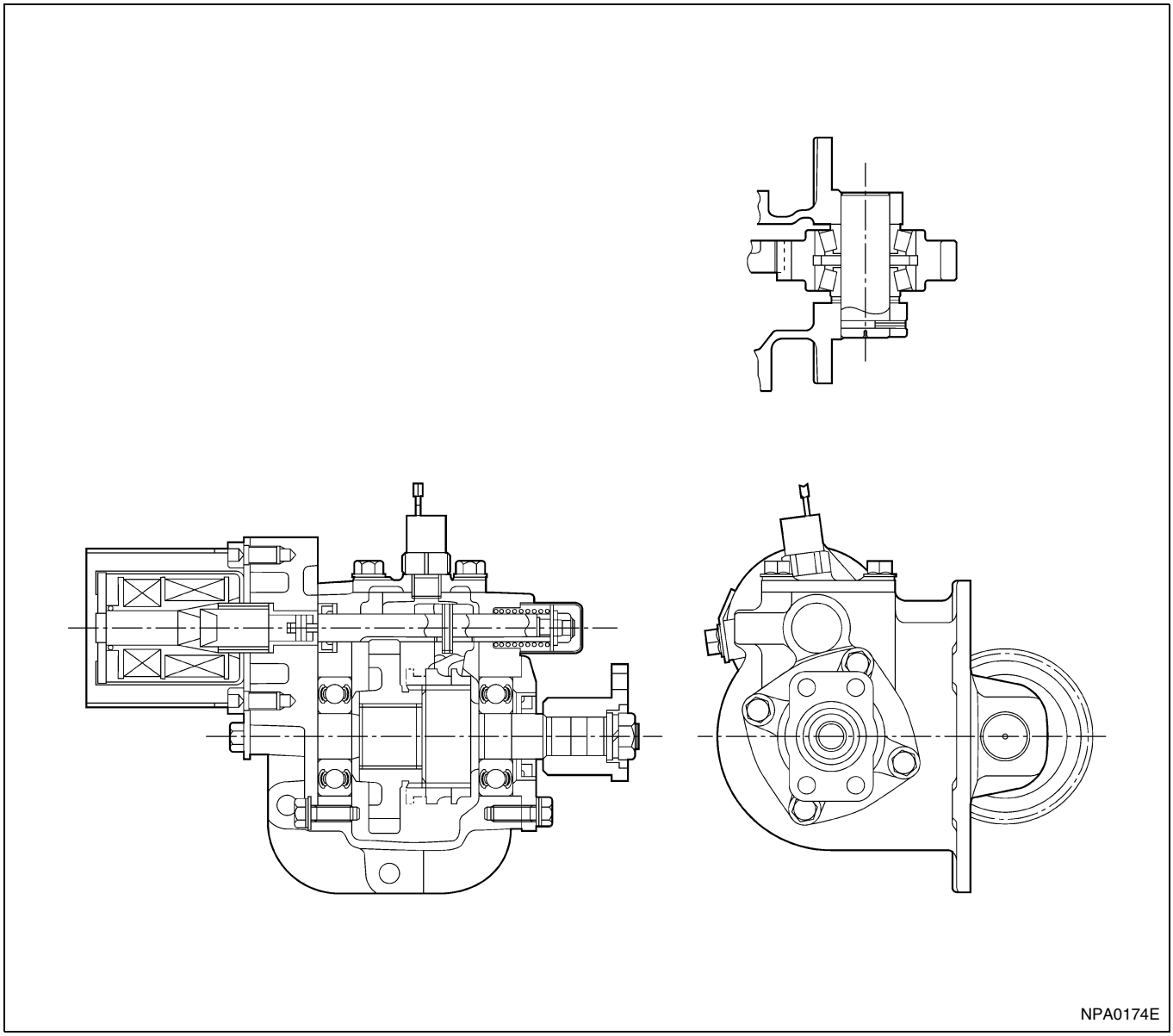
Tighten:
Bolt to 25 N·m (2.5 kg·m / 18 lb·ft)


NPA0173E

Description of function and operation

The electronic control type side PTO of MYY transmission is installed on the left side of transmission.
The gear of PTO is engaged at all times. The solenoid shifts the sleeve on output axis by the shift rod and shift arm to transmit or cut the power to the gear. The gear is the helical type as well as transmission and has a silent effect.
To maintain durability, the idle gear bearing uses the taper roller bearing, and the output axis uses the ball bearing.

Cross-section diagram

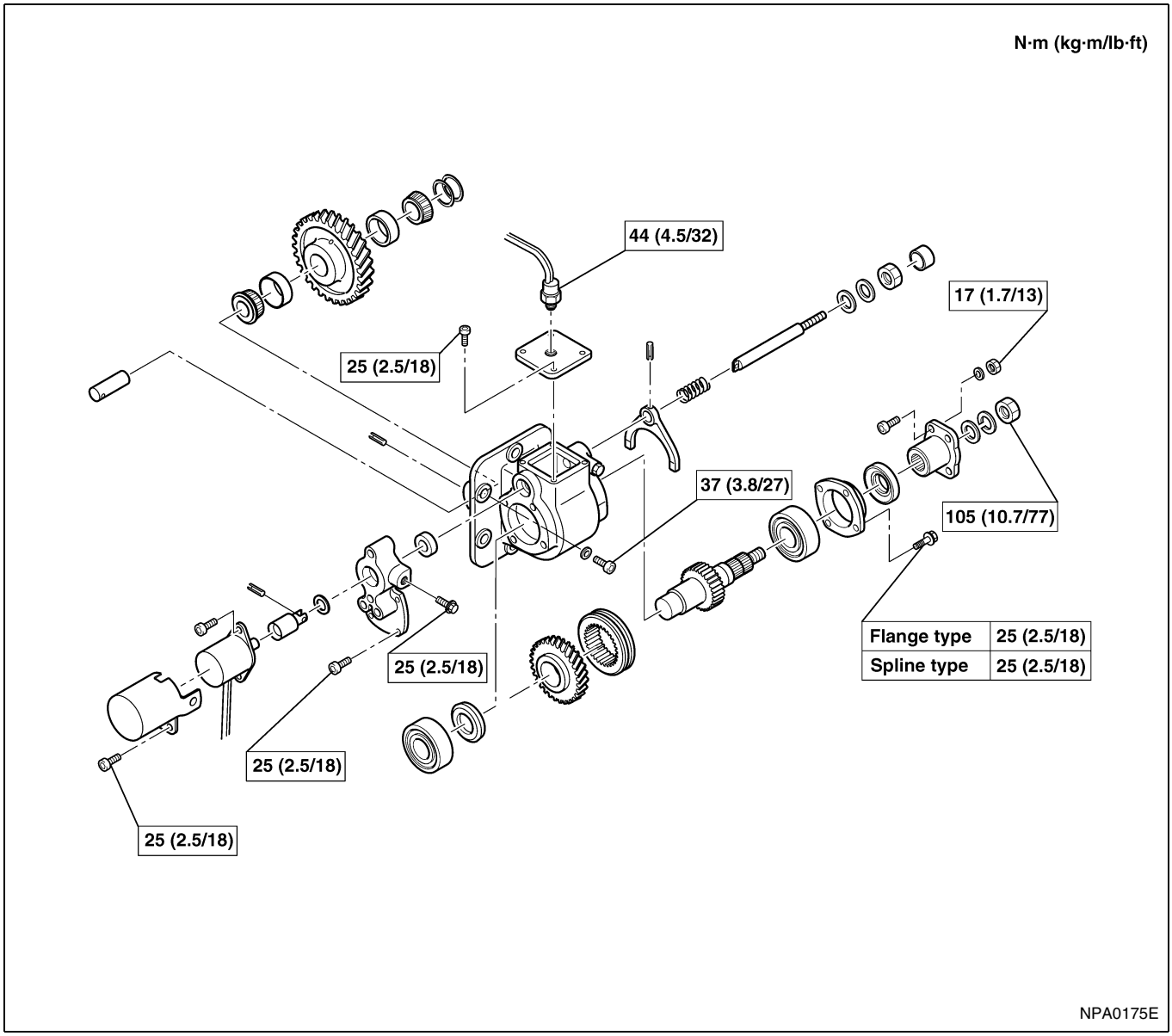


Main Data and Specifications

Electronic control type PTO

Item	Specifications
Allowance output torque N·m/rpm (kg·m/rpm)	196/1000 (20/1000)
Acceleration ratio: PTO output speed/Engine speed	5 steps 0.684 6 steps 0.676
Rotation direction (viewed from rear)	Right

Fixing Torque



Special Tools

Illustration	Tool Number / Description / Remarks
9852922010	9-8529-2201-0 / Spring pin remover
5884000150	5-8840-0015-0 / Bearing remover/Installer

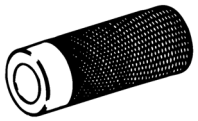
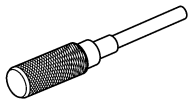
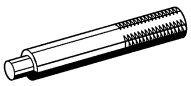
Illustration	Tool Number / Description / Remarks
5884020650	5-8840-2065-0 / Oil seal installer
 5884020660	5-8840-2066-0 / Bearing installer

Illustration	Tool Number / Description / Remarks
 5884024521	5-8840-2452-1 / Setting tool
5884020640	5-8840-2064-0 / Oil seal installer
5852200350	5-8522-0035-0 / Bearing installer
 5884000070	5-8840-0007-0 / Grip

LGPTO-WE-0552

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

First edition October, 2005

No.LGPTO-WE-0552 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

POWER TAKE OFF
(with oil pump)

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

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00	POWER TAKE OFF

GENERAL INFORMATION

SECTION 0A

GENERAL INFORMATION

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Engine Number: 0A-3
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RECOMMENDED LIQUID GASKET 0A-8
Recommended Liquid Gasket 0A-8
Application Procedure 0A-9
RECOMMENDED THREAD LOCKING AGENT . 0A-10

GENERAL REPAIR INSTRUCTIONS

General Repair Instructions

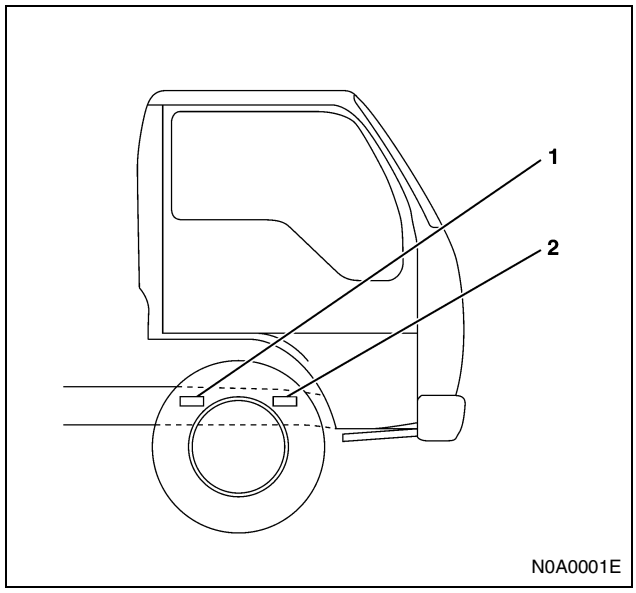
1. Park the vehicle on level ground and chock the front or rear wheels before lifting the vehicle.
2. Use covers on the vehicle body, seats, and floor to prevent damage and/or contaminations.
3. Disconnect the grounding cable from the battery before performing service operations. This will prevent cable damage or burning due to shortcircuiting.
4. Raise the vehicle with a jack set against the axle or the frame.
5. Support the vehicle on chassis stands.
6. Handle brake fluid and engine coolant with great care.
   Spilling these liquids on painted surfaces will damage the paint.
7. The use of the proper tool(s) and special tool(s) where specified is essential to efficient, reliable, and safe service operations.
8. Always use genuine ISUZU replacement parts.
9. Discard used cotter pins, gasket, O-rings, oil seals, lock washers, and self-locking nuts at disassembly.
   Normal function of these parts cannot be guaranteed if they are reused.
10. Keep the disassembled parts neatly in groups.
    This will facilitate smooth and correct reassembly.
11. Keep fixing nuts and bolts separate.
    Fixing nuts and bolts vary in hardness and design according to installation positions.
12. Clean all parts before inspection or reassembly.
13. Clean the oil ports and other openings with compressed air to make certain that they are free of dirt and obstructions.
14. Lubricate the rotating and sliding faces of all moving parts with oil or grease before installation.
15. Use the recommended liquid gasket to prevent leakage.
16. Be sure to tighten bolts and nuts to the specified torque, using a properly maintained torque wrench.
17. When service operation is completed, make a final check to be sure service has been done properly and problem has been corrected.
18. When removing or replacing parts that require refrigerant to the discharged from the Air conditioning system, be sure to use the ACR4 or equivalent to recover and recycle Refrigerant-134a, to promote the movement for the protection of the ozone layer covering the earth.
19. To assure safety, always slowly release air pressure from the air tanks before disconnecting pipes, hoses or other parts from any unit under pressure.

IDENTIFICATION

Chassis Number:

It is stamped on the front right-hand side face of the chassis side member.

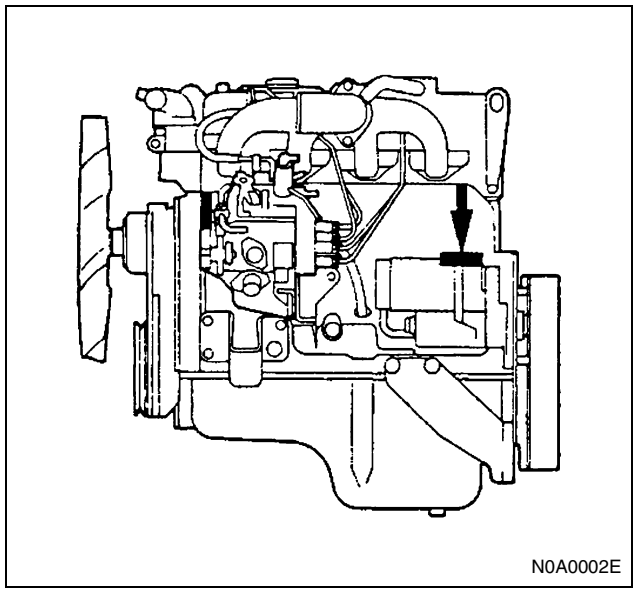
1. NKR models with independent front suspension
2. NHR, NKR, NPR, NQR and NPS models with rigid axle front suspension



Engine Number:

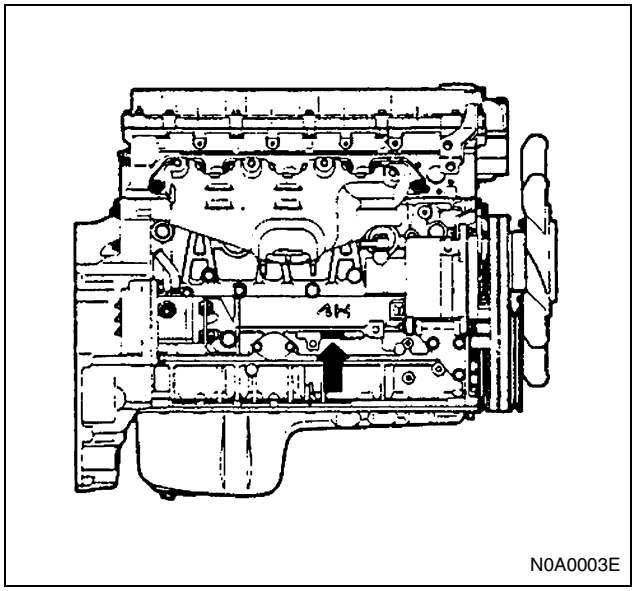
4J Series Engine

The engine number is stamped on the left side rear of the cylinder body.



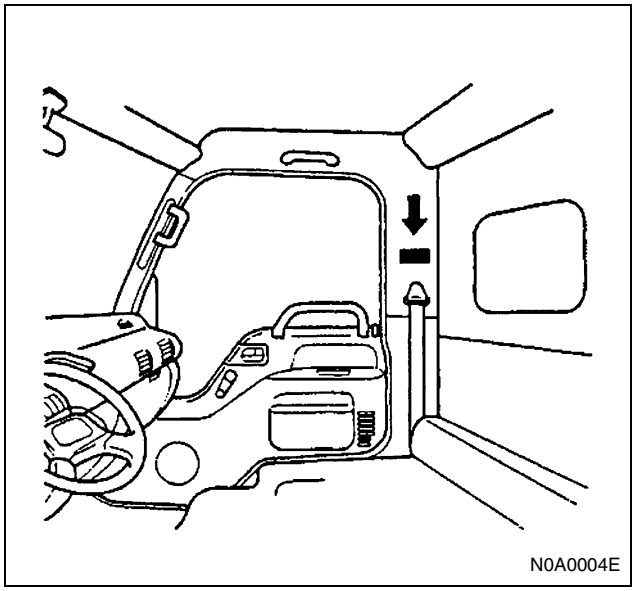
4H Series Engine

The engine number is stamped on the right side of the cylinder body.



Vehicle Identification Plate

The vehicle identification plate is attached to the interior side of the cab side panel on the right side.



LIFTING INSTRUCTION

Lifting Instruction

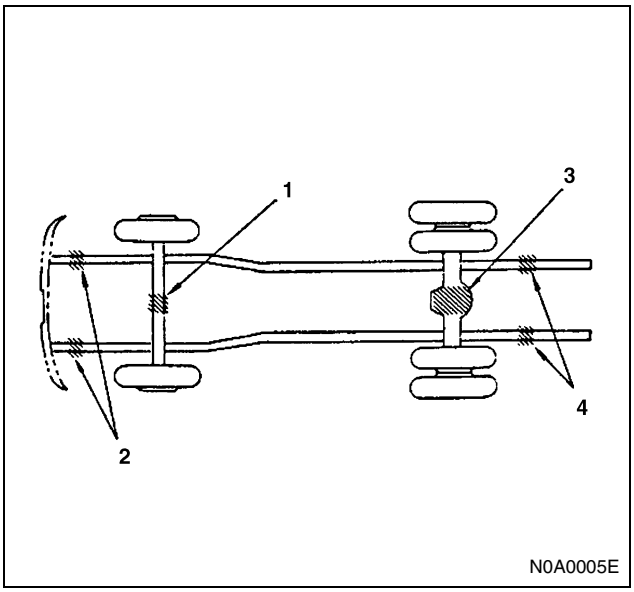
If it is necessary to use a lifting device other than the original equipment jack, see illustration for acceptable lifting points.
Lifting should only be done at the positions indicated to prevent possible damage to the vehicle.

Caution:
Failure to observe the acceptable lift points may result in unsatisfactory vehicle performance or a durability failure which may result in loss of control of the vehicle.

Garage Jack and Safety Stand

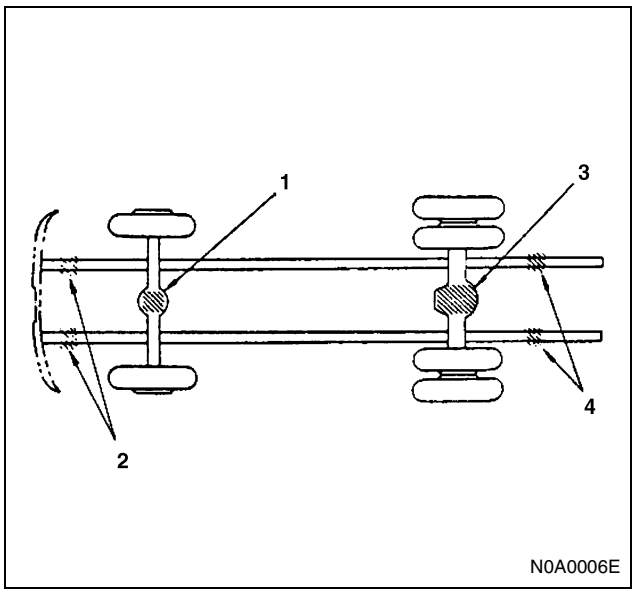
Lifting Point and Supportable Point Location

NHR, NKR, NPR, NQR



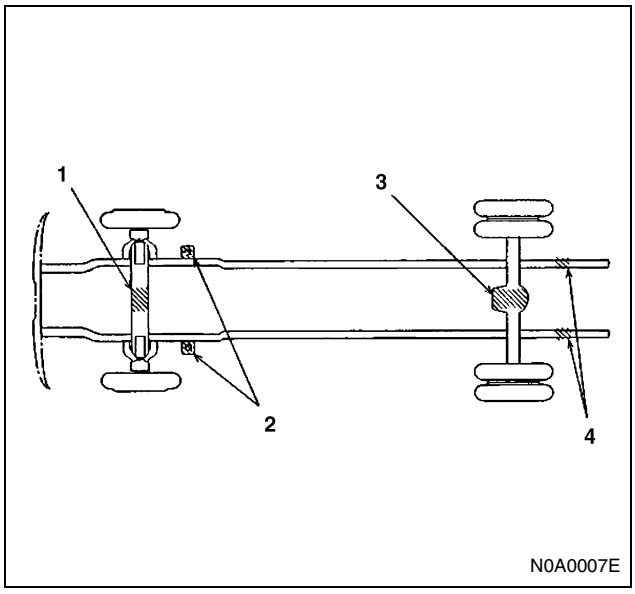
Legend
1. Front axle
2. Side frame front side
3. Rear axle center
4. Side frame rear side

NPS



Legend
1. Front axle
2. Side frame front side
3. Rear axle center
4. Side frame rear side

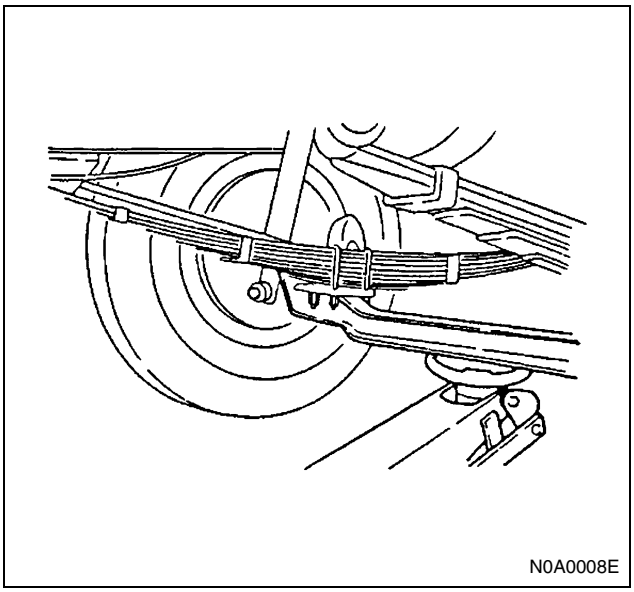
NKR (Front independent suspension)



Legend
1. Suspension cross member
2. Jack up bracket
3. Rear axle center
4. Side frame rear side

Front Side Lifting Point

Notice:
Do not lift or support on engine oil pan.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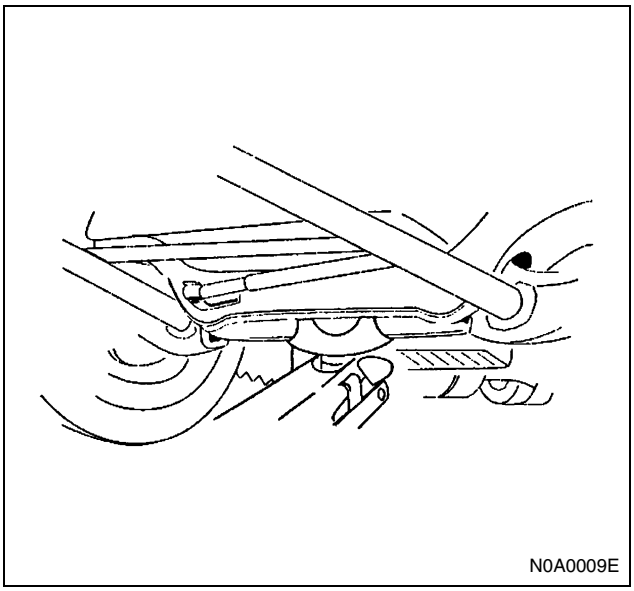
NKR (Front independent suspension)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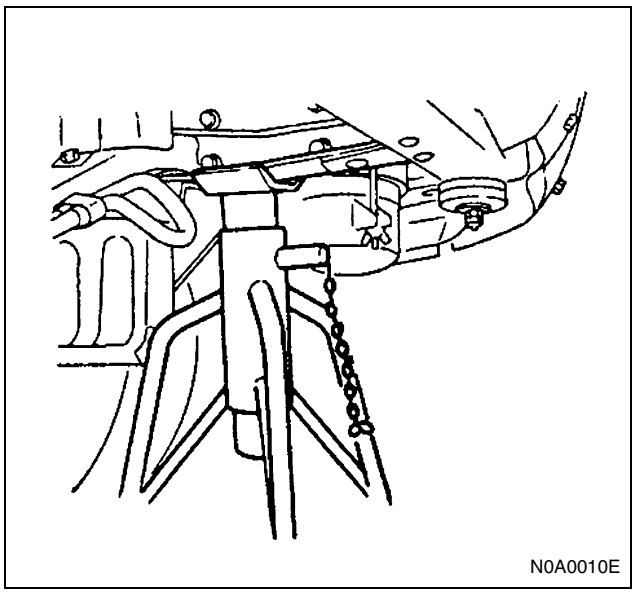
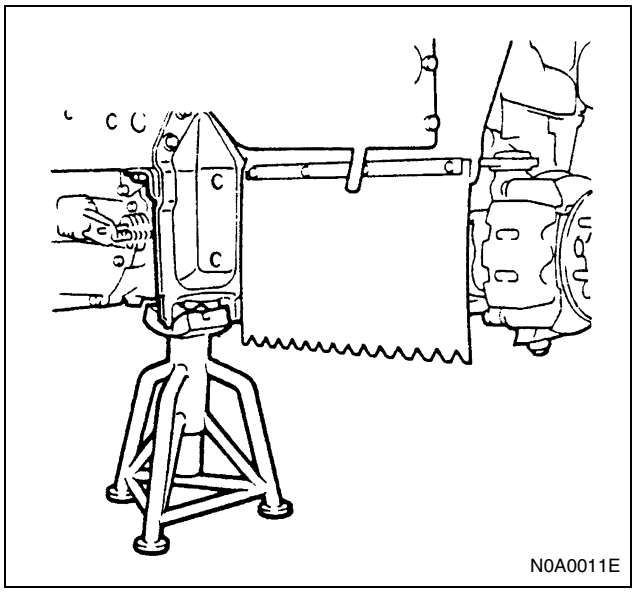
Front Side Supportable Point


N0A0010E

NKR (Front independent suspension)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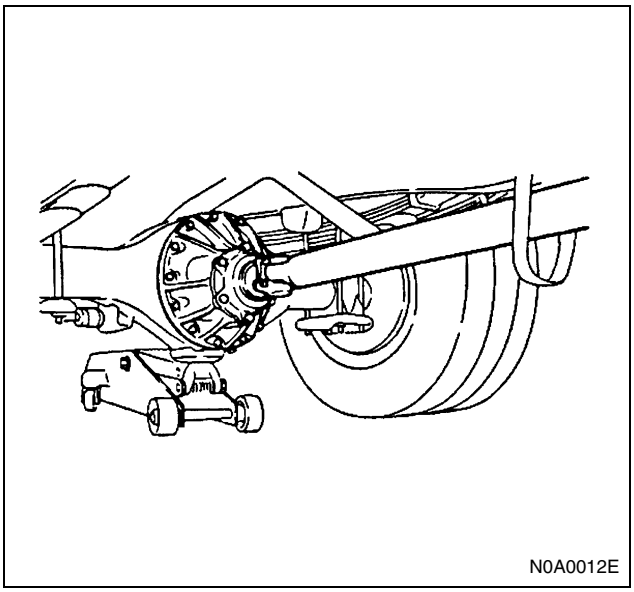
Rear Side Lifting Point

Notice:
Do not lift or support on rear axle tube.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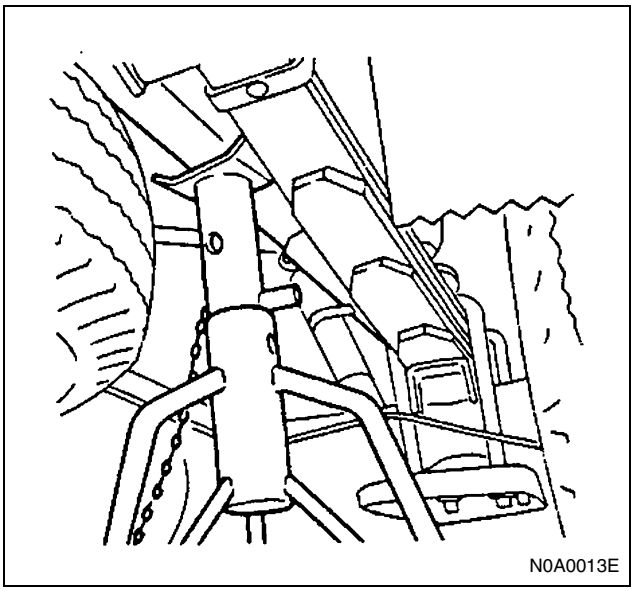
Rear Side Supportable Point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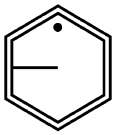
TORQUE SPECIFICATIONS

Standard Bolts

The torque values given in the following table should be applied where a particular torque is not specified.

N·m (kg·m / lb·ft)
N·m [kg·cm / lb·in]

Bolt Diameter × Pitch (mm)	Strength Class	4.8	8.8		9.8
			Refined	Non-Refined	
	Bolt Identification				
		No mark			
M6×1.0	6 [60 / 52]		7 [75 / 69]		—
M8×1.25	13 [130 / 113]		18 [180 / 156]		24 [240 / 208]
M10×1.25	27 (2.8 / 20)		37 (3.8 / 27)		50 (5.1 / 37)
M12×1.25	61 (6.3 / 45)		76 (7.7 / 56)		95 (9.7 / 70)
M14×1.5	96 (9.8 / 71)		117 (11.9 / 86)		142 (14.5 / 105)
M16×1.5	130 (13.3 / 96)		170 (14.3 / 125)		200 (20.4 / 148)
M18×1.5	188 (19.2 / 139)		244 (24.9 / 180)		287 (29.3 / 212)
M20×1.5	258 (26.3 / 190)		337 (34.4 / 249)		396 (40.4 / 292)
M22×1.5	332 (33.9 / 245)		454 (46.3 / 335)		530 (54.1 / 391)
M24×2.0	449 (45.8 / 331)		538 (54.9 / 397)		692 (70.6 / 511)
*M10×1.5	26 (2.7 / 20)		36 (3.7 / 27)		48 (4.9 / 35)
*M12×1.5	57 (2.8 / 42)		71 (7.2 / 52)		89 (9.1 / 66)
*M14×2.0	89 (9.1 / 66)		110 (11.2 / 81)		133 (13.6 / 98)
*M16×2.0	124 (12.7 / 92)		162 (16.5 / 119)		191 (19.5 / 141)

N0A0023E

The asterisk * indicates that the bolts are used for female-threaded parts that are made of soft materials such as casting, etc.

Flare Nuts

N·m (kg·m / lb·ft)

Pipe diameter mm (in)	Torque	Pipe diameter mm (in)	Torque
4.76 (0.187)	16 (1.6 / 12)	10.00 (0.94)	54 (5.5 / 40)
6.35 (0.250)	26 (2.7 / 20)	12.00 (0.472)	88 (9.0 / 65)
8.00 (0.315)	44 (4.5 / 33)	15.00 (0.591)	106 (10.8 / 78)

RECOMMENDED LIQUID GASKET

Recommended Liquid Gasket

TYPE	BRAND NAME	MANUFACTURER	APPLICATION PARTS (EXAMPLE)
RTV*	ThreeBond 1207B	ThreeBond	Engine Oil Seal Retainer
Silicon	ThreeBond 1207C	ThreeBond	Engine Oil Pan
	ThreeBond 1215	ThreeBond	Timing Gear Case
	ThreeBond 1216	ThreeBond	Cylinder Head Cover
	ThreeBond 1281	ThreeBond	Fuel Pump
Water Base	ThreeBond 1141E	ThreeBond	Rear Axle
Solvent	ThreeBond 1104	ThreeBond	etc.
	BelcoBond 4	Isuzu	
	BelcoBond 401	Isuzu	
	BelcoBond 402	Isuzu	
Anaerobic	LOCTITE 515	LOCTITE	Engine Oil Seal Retainer
	LOCTITE 518	LOCTITE	Water Pump
			Transaxle
			etc.

*RTV: Room Temperature Vulcanizer

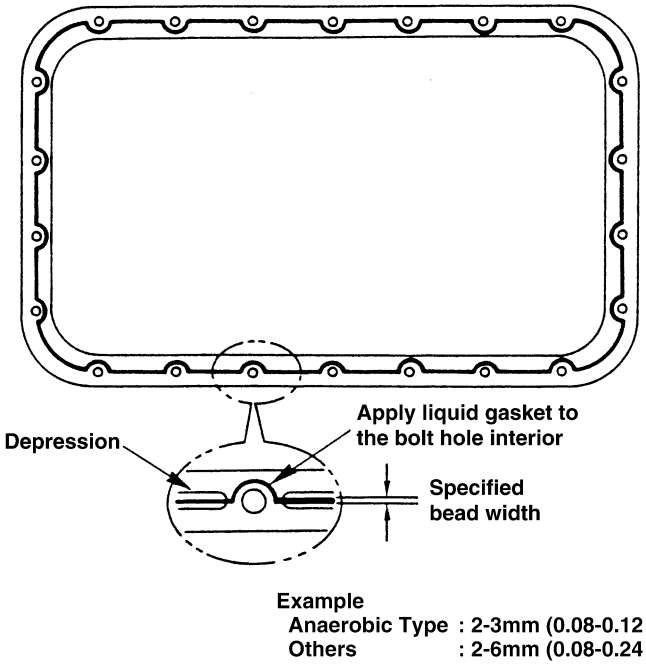
Notice:

1. It is very important that the liquid gaskets listed above or their exact equivalent be used on the vehicle.
2. LOCTITE 515 and LOCTITE 518 harden upon contact with a metal surface.
   Do not apply LOCTITE 515 or LOCTITE 518 between two metal surfaces having a clearance of greater than 0.25 mm (0.001 in). Poor adhesion will result.
3. Be careful to use the specified amount of liquid gasket.
   Follow the manufacturer’s instructions at all times.

Application Procedure

mm (in)

SCREW HOLE	DEPRESSION	JUDGE-MENT
1~3 (0.04~0.12)		OK
1~3 (0.04~0.12)	More than 2(0.08)	OK
		NG



N0A0014E

1. Completely remove lubricant and moisture from the connecting surfaces. The surfaces must be perfectly dry.
2. Apply specified bead width of liquid gasket to one of the connecting surfaces.

Notice:
When the application procedures are specified in this manual, follow them.

RECOMMENDED THREAD LOCKING AGENT

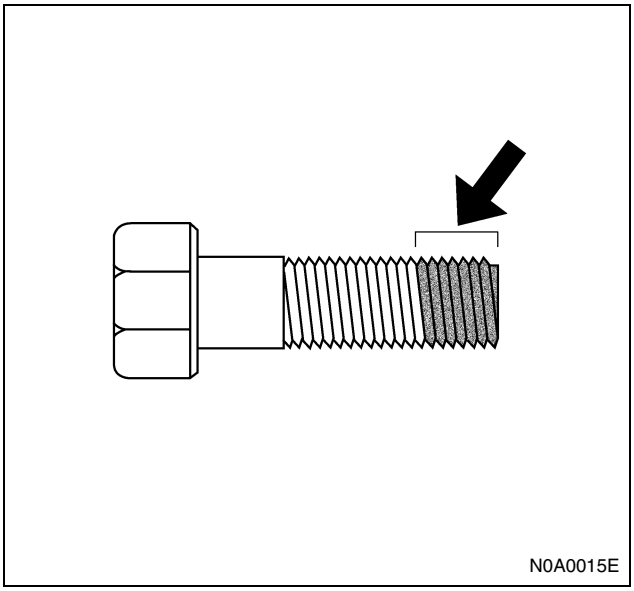
Notice:
When the application procedures are specified in this manual, follow them.

LOCTITE

TYPE	COLOR
LOCTITE 242	Blue
LOCTITE 262	Red
LOCTITE 271	Red

Application Steps

1. Completely remove all lubricant and moisture from the bolts and the female threaded surfaces of the parts to be joined.
   The surfaces must be perfectly dry.
2. Apply LOCTITE to the bolts.
   Apply LOCTITE to at least 1/3 of the bolt's threaded area.



3. Tighten the bolts to the specified torque.

Notice:
After tightening, be sure to keep the bolts free from vibration and torque for at least an hour until LOCTITE hardens.

GENERAL INFORMATION

SECTION 0B

MAINTENANCE AND LUBRICATION

Contents

MAINTENANCE SCHEDULE 0B-2
RECOMMENDED FLUIDS, LUBRICANTS AND DIESEL FUELS 0B-12
Recommended Fluids, Lubricants and Diesel Fuels 0B-12
OIL VISCOSITY CHART 0B-15
Engine Oil 0B-15
Manual Transmission and Transfer Case Oil (Engine Oil) 0B-16
Front Axle and Rear Axle Oil 0B-17
LUBRICATION CHART 0B-18
NPR75 and NQR75 Models 0B-18
NKR77 and NPR77 (Front Rigid Suspension) Models 0B-19
NKR77 (Front Independent Suspension) Model 0B-20

MAINTENANCE SCHEDULE

When performing the checks on the following items, regular inspection items should also be checked.

Abbreviations

I :Inspect, clean and correct or replace as necessary
A : Adjust
R : Replace or change
T : Tighten to specified torque
L : Lubricate
[V] : Variation (optional on some models).
[OPT] : Optional equipment.
[SA] : For Smoother model only.
*Marks: Under severe driving conditions, more frequent maintenance is required. Refer to “Maintenance schedule under severe driving conditions”.

Maintenance Schedule: 4JH1-TC Engine Model (Engine Oil that Meets or Exceeds ACEA B3 Specification)

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)								
	× 1,000 km	20	40	60	80	100	120	
	× 1,000 mile	12	24	36	48	60	72	
ENGINE								
*Engine oil		R	R	R	R	R	R	Or every 9 months
*Engine oil filter		R	R	R	R	R	R	Or every 9 months
Fuel filter		R	R	R	R	R	R	Or every 18 months
*Air cleaner element		I	I	R	I	I	R	Or every 36 months
Idling speed and acceleration		—	I	—	I	—	I	Or every 18 months
Valve clearances		—	—	A	—	—	A	Or every 36 months
Fuel tank cap and fuel pipes for loose connections or damage		—	—	I	—	—	I	Or every 36 months
Drive belt tension and damage		I	I	I	I	I	I	Or every 9 months
Radiator coolant		—	—	R	—	—	R	Or every 36 months
*Exhaust pipes and mountings for looseness or damage		—	I	—	I	—	I	Or every 18 months
Cooling system for water leakage		—	I	—	I	—	I	Or every 18 months
Engine operation condition		I	I	I	I	I	I	Or every 9 months
CLUTCH								
Clutch fluid		I	I	R	I	I	R	Or every 24 months
Clutch pedal travel and free play		I	I	I	I	I	I	Or every 6 months
TRANSMISSION								
*Manual transmission oil		I	I	R	I	I	R	Or every 24 months
Gear control mechanism for looseness		—	—	I	—	—	I	Or every 24 months
Gear control cables		—	A	—	A	—	A	Or every 12 months
PROPELLER SHAFT								
*Universal joints and sliding sleeve grease		L	L	L	L	L	L	Or every 12 months

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	× 1,000 km	20	40	60	80	100	120	
	× 1,000 mile	12	24	36	48	60	72	
Loose connections		I	I	I	I	I	I	Or every 6 months
Splines for excessive wear		—	—	I	—	—	I	Or every 24 months
Bearings and related parts for looseness		—	—	I	—	—	I	Or every 24 months
Center bearing		L	L	L	L	L	L	Or every 12 months
REAR AXLE								
*Differential gear oil		I	I	R	I	I	R	Or every 24 months
FRONT AXLE								
*Kingpins		L	L	L	L	L	L	Or every 9 months
STEERING								
Power steering system oil leakage		I	I	I	I	I	I	Or every 9 months
Power steering system for looseness or damage		I	I	I	I	I	I	Or every 9 months
Power steering fluid		—	—	R	—	—	R	Or every 36 months
Power steering hoses		—	—	—	—	—	R	Or every 72 months
Fitting of knuckles and front axle for looseness		I	I	I	I	I	I	Or every 9 months
Steering mechanism for looseness or damage		—	—	I	—	—	I	Or every 36 months
Ball joints for damage (Independent suspension model only)		I	I	I	I	I	I	Or every 9 months
Ball joints for excessive play (Independent suspension model only)		I	I	I	I	I	I	Or every 9 months
Relay lever shaft for excessive play (Independent suspension model only)		I	I	I	I	I	I	Or every 9 months
Steering wheel play		I	I	I	I	I	I	Or every 9 months
Steering function		I	I	I	I	I	I	Or every 9 months
Wheel alignment		—	—	I	—	—	I	Or every 36 months
SERVICE BRAKES								
Brake fluid		I	I	R	I	I	R	Or every 36 months
Brake system for fluid leakage		I	I	I	I	I	I	Or every 9 months
*Brake linings and drums for wear		I	I	I	I	I	I	Or every 9 months
*Disc brake pads and discs for wear		I	I	I	I	I	I	Or every 9 months
Brake pedal travel and free play		I	I	I	I	I	I	Or every 9 months
Pipes and hoses for loose connections or damage		I	I	I	I	I	I	Or every 9 months
PARKING BRAKE								

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)								
	× 1,000 km	20	40	60	80	100	120	
	× 1,000 mile	12	24	36	48	60	72	
Parking brake cables		I	I	I	I	I	I	Or every 9 months
Parking brake function		I	I	I	I	I	I	Or every 9 months
Parking brake lever travel		I	I	I	I	I	I	Or every 9 months
Linings for wear		—	—	I	—	—	I	Or every 36 months
Drum for wear or damage		—	—	I	—	—	I	Or every 36 months
Ratchet for wear or damage		—	—	I	—	—	I	Or every 36 months
SUSPENSION								
Spring leaves for damage		I	I	I	I	I	I	Or every 9 months
Torsion bar spring (Independent suspension model only)		I	I	I	I	I	I	Or every 9 months
Ball joint boots for damage (Independent suspension model only)		I	I	I	I	I	I	Or every 9 months
Ball joints for excessive play (Independent suspension model only)		—	—	I	—	—	I	Or every 36 months
Mounts for looseness or damage		I	I	I	I	I	I	Or every 9 months
Shock absorbers for oil leakage		I	I	I	I	I	I	Or every 9 months
Shock absorbers mount for looseness		I	I	I	I	I	I	Or every 9 months
Upper links (Independent suspension model only)		L	L	L	L	L	L	Or every 9 months
WHEELS								
Wheel pins and nuts		—	T	—	T	—	T	Or every 18 months
Wheel discs for damage		—	I	—	I	—	I	Or every 18 months
Hub bearings grease		—	—	R	—	—	R	Or every 36 months
Tire pressures and damage		I	I	I	I	I	I	Or every 9 months
ELECTRICAL EQUIPMENT								
Specific gravity of battery electrolyte		I	I	I	I	I	I	Or every 9 months
OTHERS								
Lights, horn, windshield, wiper and washers		I	I	I	I	I	I	Or every 9 months
Bolts and nuts on chassis and body		—	—	I	—	—	I	Or every 36 months

(I): Inspect and correct or replace as necessary (A): Adjust (R): Replace or change (T): Tighten to specified torque (L): Lubricate

Maintenance Schedule: 4JH1-TC Engine Model (ACEA B2 Specification Engine Oil)

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	× 1,000 km	15	30	45	60	75	90	105	120	135	150	
	× 1,000 mile	9	18	27	36	45	54	63	72	81	90	
ENGINE												
*Engine oil		R	R	R	R	R	R	R	R	R	R	or every 9 months
*Engine oil filter		R	R	R	R	R	R	R	R	R	R	or every 9 months
Fuel filter		—	R	—	R	—	R	—	R	—	R	or every 18 months
*Air cleaner element		I	I	I	R	I	I	I	R	I	I	or every 36 months
Idling speed and acceleration		—	I	—	I	—	I	—	I	—	I	or every 18 months
Valve clearances		—	—	—	A	—	—	—	A	—	—	or every 36 months
Fuel tank cap and fuel pipes for loose connections or damage		—	—	—	I	—	—	—	I	—	—	or every 36 months
Drive belt tension and damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Radiator coolant		—	—	—	R	—	—	—	R	—	—	or every 36 months
*Exhaust pipes and mountings for looseness or damage		—	I	—	I	—	I	—	I	—	I	or every 18 months
Cooling system for water leakage		—	I	—	I	—	I	—	I	—	I	or every 18 months
Engine operation condition		I	I	I	I	I	I	I	I	I	I	or every 9 months
CLUTCH												
Clutch fluid		I	I	I	R	I	I	I	R	I	I	or every 36 months
Clutch pedal travel and free play		I	I	I	I	I	I	I	I	I	I	or every 9 months
TRANSMISSION												
*Manual transmission oil		I	I	I	R	I	I	I	R	I	I	or every 36 months
Gear control mechanism for looseness		—	—	—	I	—	—	—	I	—	—	or every 36 months
Gear control cables		—	A	—	A	—	A	—	A	—	A	or every 18 months
PROPELLER SHAFT												
*Universal joints and sliding sleeve grease		—	L	—	L	—	L	—	L	—	L	or every 18 months
Loose connections		I	I	I	I	I	I	I	I	I	I	or every 9 months
Splines for excessive wear		—	—	—	I	—	—	—	I	—	—	or every 36 months
Bearings and related parts for looseness		—	—	—	I	—	—	—	I	—	—	or every 36 months
Center bearing		—	L	—	L	—	L	—	L	—	L	or every 18 months
REAR AXLE												
*Differential gear oil		I	I	I	R	I	I	I	R	I	I	or every 36 months
FRONT AXLE												
*Kingpins		L	L	L	L	L	L	L	L	L	L	or every 9 months
STEERING												

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	× 1,000 km	15	30	45	60	75	90	105	120	135	150	
	× 1,000 mile	9	18	27	36	45	54	63	72	81	90	
Power steering system oil leakage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Power steering system for looseness or damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Power steering fluid		—	—	—	R	—	—	—	R	—	—	or every 36 months
Power steering hoses		—	—	—	—	—	—	—	R	—	—	or every 72 months
Fitting of knuckles and front axle for looseness		I	I	I	I	I	I	I	I	I	I	or every 9 months
Steering mechanism for looseness or damage		—	—	—	I	—	—	—	I	—	—	or every 36 months
Ball joints for damage (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Ball joints for excessive play (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Relay lever shaft for excessive play (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Steering wheel play		I	I	I	I	I	I	I	I	I	I	or every 9 months
Steering function		I	I	I	I	I	I	I	I	I	I	or every 9 months
Wheel alignment		—	—	—	I	—	—	—	I	—	—	or every 36 months
SERVICE BRAKES												
Brake fluid		I	I	I	R	I	I	I	R	I	I	or every 36 months
Brake system for fluid leakage		I	I	I	I	I	I	I	I	I	I	or every 9 months
*Brake linings and drums for wear		I	I	I	I	I	I	I	I	I	I	or every 9 months
*Disc brake pads and discs for wear		I	I	I	I	I	I	I	I	I	I	or every 9 months
Brake pedal travel and free play		I	I	I	I	I	I	I	I	I	I	or every 9 months
Pipes and hoses for loose connections or damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
PARKING BRAKE												
Parking brake cables		I	I	I	I	I	I	I	I	I	I	or every 9 months
Parking brake function		I	I	I	I	I	I	I	I	I	I	or every 9 months
Parking brake lever travel		I	I	I	I	I	I	I	I	I	I	or every 9 months
Linings for wear		—	—	—	I	—	—	—	I	—	—	or every 36 months
Drum for wear or damage		—	—	—	I	—	—	—	I	—	—	or every 36 months
Ratchet for wear or damage		—	—	—	I	—	—	—	I	—	—	or every 36 months
SUSPENSION												
Spring leaves for damage		I	I	I	I	I	I	I	I	I	I	or every 9 months

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	× 1,000 km	15	30	45	60	75	90	105	120	135	150	
	× 1,000 mile	9	18	27	36	45	54	63	72	81	90	
Torsion bar spring (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Ball joint boots for damage (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Ball joints for excessive play (Independent suspension model only)		—	—	—	I	—	—	—	I	—	—	or every 36 months
Mounts for looseness or damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Shock absorbers for oil leakage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Shock absorbers mount for looseness		I	I	I	I	I	I	I	I	I	I	or every 9 months
Upper links (Independent suspension model only)		L	L	L	L	L	L	L	L	L	L	or every 9 months
WHEELS												
Wheel pins and nuts		—	T	—	T	—	T	—	T	—	T	or every 18 months
Wheel discs for damage		—	I	—	I	—	I	—	I	—	I	or every 18 months
Hub bearings grease		—	—	—	R	—	—	—	R	—	—	or every 36 months
Tire pressures and damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
ELECTRICAL EQUIPMENT												
Specific gravity of battery electrolyte		I	I	I	I	I	I	I	I	I	I	or every 9 months
OTHERS												
Lights, horn, windshield, wiper and washers		I	I	I	I	I	I	I	I	I	I	or every 9 months
Bolts and nuts on chassis and body		—	—	—	I	—	—	—	I	—	—	or every 36 months

(I): Inspect and correct or replace as necessary (A): Adjust (R): Replace or change (T): Tighten to specified torque (L): Lubricate

Maintenance schedule: 4HK1-TC engine model

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	km	11250	22500	33750	45000	56250	67500	78750	90000	
	mile	7000	14000	21000	28000	35000	42000	49000	56000	
ENGINE										
*Engine oil		Change every 20,000 km (12,000 miles)								or every 12 months
*Engine oil filter		Change every 20,000 km (12,000 miles)								or every 12 months
Fuel filter: Main fuel filter		—	R	—	R	—	R	—	R	or every 14 months
[OPT] Main fuel filter and Sub fuel filter: with Sub fuel filter		—	—	—	R	—	—	—	R	or every 28 months
*Air cleaner element		I	I	I	R	I	I	I	R	or every 28 months
Idling speed and acceleration		—	I	—	I	—	I	—	I	or every 14 months
Valve clearances		—	—	—	A	—	—	—	A	or every 28 months
Feed pump strainer		—	I	—	I	—	I	—	I	or every 14 months
Fuel tank cap and fuel pipes for loose connections or damage		—	—	—	I	—	—	—	I	or every 28 months
Drive belt tension and damage		I	I	I	I	I	I	I	I	or every 7 months
Radiator coolant		—	—	—	R	—	—	—	R	or every 28 months
*Exhaust pipes and mountings for looseness or damage		—	I	—	I	—	I	—	I	or every 14 months
Cooling system for water leakage		—	I	—	I	—	I	—	I	or every 14 months
Engine operation condition		I	I	I	I	I	I	I	I	or every 7 months
CLUTCH										
Clutch fluid		I	I	I	R	I	I	I	R	or every 28 months
Clutch pedal travel and free play		I	I	I	I	I	I	I	I	or every 7 months
TRANSMISSION										
*Manual transmission oil		I	I	I	R	I	I	I	R	or every 28 months
[SA] Smoother clutch fluid		I	I	I	R	I	I	I	R	or every 24 months
Gear control mechanism for looseness		—	—	—	I	—	—	—	I	or every 21 months
Gear control cables		—	A	—	A	—	A	—	A	or every 14 months
PROPELLER SHAFT										
*Universal joints and sliding sleeve grease		—	L	—	L	—	L	—	L	or every 14 months
Loose connections		I	I	I	I	I	I	I	I	or every 7 months
Splines for excessive wear		—	—	—	I	—	—	—	I	or every 28 months
Bearings and related parts for looseness		—	—	—	I	—	—	—	I	or every 28 months
Center bearing		—	L	—	L	—	L	—	L	or every 14 months

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	km	11250	22500	33750	45000	56250	67500	78750	90000	
	mile	7000	14000	21000	28000	35000	42000	49000	56000	
REAR AXLE										
*Differential gear oil		I	I	I	R	I	I	I	R	or every 28 months
FRONT AXLE										
*Kingpins		L	L	L	L	L	L	L	L	or every 7 months
STEERING										
Power steering system oil leakage		I	I	I	I	I	I	I	I	or every 7 months
Power steering system for looseness or damage		I	I	I	I	I	I	I	I	or every 7 months
Power steering fluid		—	—	—	R	—	—	—	R	or every 28 months
Power steering hoses		—	—	—	—	—	—	—	R	or every 56 months
Fitting of knuckles and front axle for looseness		I	I	I	I	I	I	I	I	or every 7 months
Steering mechanism for looseness or damage		—	—	—	I	—	—	—	I	or every 28 months
Steering wheel play		I	I	I	I	I	I	I	I	or every 7 months
Steering function		I	I	I	I	I	I	I	I	or every 7 months
Wheel alignment		—	—	—	I	—	—	—	I	or every 28 months
SERVICE BRAKES										
Brake fluid		I	I	I	R	I	I	I	R	or every 28 months
[V] Hydro booster fluid (ATF)		I	I	I	R	I	I	I	R	or every 28 months
Brake system for fluid leakage		I	I	I	I	I	I	I	I	or every 7 months
*Brake linings and drums for wear		I	I	I	I	I	I	I	I	or every 7 months
*Disc brake pads and discs for wear		I	I	I	I	I	I	I	I	or every 7 months
Brake pedal travel and free play		I	I	I	I	I	I	I	I	or every 7 months
Pipes and hoses for loose connections or damage		I	I	I	I	I	I	I	I	or every 7 months
PARKING BRAKE										
Parking brake cables		I	I	I	I	I	I	I	I	or every 7 months
Parking brake function		I	I	I	I	I	I	I	I	or every 7 months
Parking brake lever travel		I	I	I	I	I	I	I	I	or every 7 months
Linings for wear		—	—	—	I	—	—	—	I	or every 28 months
Drum for wear or damage		—	—	—	I	—	—	—	I	or every 28 months
Ratchet for wear or damage		—	—	—	I	—	—	—	I	or every 28 months
SUSPENSION										
Spring leaves for damage		I	I	I	I	I	I	I	I	or every 7 months
Mounts for looseness or damage		I	I	I	I	I	I	I	I	or every 7 months

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	km	11250	22500	33750	45000	56250	67500	78750	90000	
	mile	7000	14000	21000	28000	35000	42000	49000	56000	
Shock absorbers for oil leakage		I	I	I	I	I	I	I	I	or every 7 months
Shock absorbers mount for looseness		I	I	I	I	I	I	I	I	or every 7 months
WHEELS										
Wheel pins and nuts		T	T	T	T	T	T	T	T	or every 7 months
Wheel discs for damage		I	I	I	I	I	I	I	I	or every 7 months
Hub bearings grease		—	—	—	R	—	—	—	R	or every 28 months
Tire pressures and damage		I	I	I	I	I	I	I	I	or every 7 months
ELECTRICAL EQUIPMENT										
Specific gravity of battery electrolyte		I	I	I	I	I	I	I	I	or every 7 months
OTHERS										
Lights, horn, windshield, wiper and washers		I	I	I	I	I	I	I	I	or every 7 months
Bolts and nuts on chassis and body		—	—	—	I	—	—	—	I	or every 28 months

(I): Inspect and correct or replace as necessary (A): Adjust (R): Replace or change (T): Tighten to specified torque (L): Lubricate

Maintenance Schedule under Severe Driving Conditions

Severe driving conditions
A : Repeated short trips
B : Driving on rough roads
C : Driving on dusty roads
D : Driving in extremely cold weather and/or on salted roads

Item	Interval	Condition				
		A	B	C	D	A+D
Engine oil	Change every 5,000 km (3,000 miles)			❍		❍
Engine oil filter	Replace every 5,000 km (3,000 miles)			❍		❍
Air cleaner element	Replace every 20,000 km (12,000 miles)			❍		
Exhaust pipes and mountings for looseness or damage	Inspect every 10,000 km (6,000 miles)	❍	❍		❍	
Manual transmission oil and differential gear oil	Change every 20,000 km (12,000 miles)		❍			
[SA] Smoother clutch fluid	Change every 20,000 km (12,000 miles)		❍			
Universal joints and sliding sleeve grease	Lubricate every 10,000 km (6,000 miles)		❍			
Kingpins	Lubricate every 5,000 km (3,000 miles)			❍	❍	
Steering system for looseness or damage	Inspect every 5,000 km (3,000 miles)		❍			
Brake linings and drums for wear	Inspect every 5,000 km (3,000 miles)	❍	❍	❍		
Disc brake pads and discs for wear	Inspect every 5,000 km (3,000 miles)	❍	❍	❍		

RECOMMENDED FLUIDS, LUBRICANTS AND DIESEL FUELS

Recommended Fluids, Lubricants and Diesel Fuels

In order to obtain maximum performance and longest service life from ISUZU vehicles, it is very important to select and use correctly best lubricants and diesel fuels.
When lubricating, be sure to use ISUZU genuine lubricants or recommended lubricants listed below, according to the maintenance schedule for each vehicle model.
The lubrication intervals in the maintenance schedule and the coverage and period of new vehicle warranty are based on the use of ISUZU genuine lubricants or recommended lubricants as given in the chart which will serve as a guide for selecting lubricants of proper brand name.

LUBRICATION	MAKER	BRAND/TYPE	GRADE		
			API	ACEA	JASO
Diesel engine crankcase	**ISUZU GENUINE**	**BESCO MULTI-Z TYPE CF-4 (10W-30)**	**CF-4**		
	ISUZU GENUINE	**BESCO S-3 (10W, 20W, 30, 40)**	**CD**		
	Caltex/Chevron	Delo CXJ (15W-40/20W-50/40)	CF		DH-1
		Delo 400 Multigrade (15W-40)	CE/CF/CI-4	E3/E5	DH-1
	Shell	Rimula X (15W-40)	CH-4	E3	DH-1
		Rimula D (15W-40/30/40)	CF		
	Elf	Perfo 3F (15W-40)	CF-4/CE	B2/E2	
	Total	Rubia XT (15W-40)	CF-4	E2	
	Castrol	RX Super Plus (15W-40)	CH-4	E3	
		Tection J Plus (15W-40)	CH-4	E3/B3	DH-1
	BP	BP Vanellus C6 (15W-40)	CH-4	E3	
	ExxonMobil	Essolube XTJ (15W-40)	CF-4		DH-1
		Exxon/Essolube XD-3 (15W-40)	CI-4		
Differential	**ISUZU GENUINE**	**BESCO GEAR OIL SH (80W-90, 90, 140)**	**GL-5**		
	Caltex	Thuban GL-5 EP (80W-90/85W-140)	GL-5		
	Shell	Spirax A (140)	GL-5		
	Elf	Tranself Type B (80W-90/85W-140)	GL-5		
	Total	Transmission TM (80W-90/85W-140)	GL-5		
	Castrol	EPX 90 (90)	GL-5		
		Dynadrive (80W-90)	GL-5		
	BP	Energear Hypo (90)	GL-5		
		Energear EP (80W-90)	GL-5		
	ExxonMobil	Mobilube HD (80W-90)	GL-5		
		Esso Gear Oil GX (80W-90)	GL-5		

LUBRICATION	MAKER	BRAND/TYPE	GRADE		
			API	ACEA	JASO
Differential (Limited slip differential)	**ISUZU GENUINE**	**BESCO GEAR OIL LSD (140)**	***GL-5**		
	Caltex	Gear Oil LSD (90)	GL-5		
	Shell	Spirax A LS 90 (90)	GL-5		
	Elf	Tranself Type BLS (90)	GL-5		
	Total	Transmission DA (85W-90)	GL-5		
	Castrol	Hypoy LSX (90)	GL-5		
	BP	Energear LS-M (90)	GL-5		
	ExxonMobil	Mobilube LS (85W-90)	GL-5		
		Esso Gear Oil LSA (85W-90)	GL-5		
Manual transmission Transfer case	**ISUZU GENUINE**	**BESCO GEAR OIL TRANSAXLE (5W-30)**	**SG**		
	Caltex/Chevron	Delo 400 Multigrade (15W-40)	CD/CE/CF/CI-4	E3/E5	DH-1
	Shell	Helix Plus (15W-50)	SJ/CF	A3/B3	
	Elf	Super Sporti (15W-40)	SG/CD		
	Total	Quartz 5000 (15W-40/20W-50)	SJ/CF	A2/B2	
	Castrol	RX Super Plus (15W-40)	CD/CE/CF		
	BP	BP Vanellus C6 (15W-40)	CD/CE/CF		
Power steering Hydro brake booster	**ISUZU GENUINE**	**BESCO ATF II, ATF III**			
	Caltex/Texaco	Texamatic 1888 (Dexron III)			
	Shell	Donax TG (Dexron III)			
	Elf	ELFMATIC G3 (Dexron III)			
	Total	Total Fluid AT 42 (Dexron III)			
	Castrol	TQ Dexron III (Dexron III)			
	BP	Autoran DX3 (Dexron III)			
Clutch (Smoother)	**ISUZU GENUINE**	**BESCO ATF III**			
		or equivalent to BESCO ATF III			
Center bearing King pin Upper links (Multi purpose grease)	**ISUZU GENUINE**	**BESCO L-2 GREASE (No.2), L-3 GREASE (No.3)**			
	Caltex/Texaco	Starplex-2 (No.2)			
	Shell	Retinax LX2 (No.2)			
	Total	Multis EP2/EP3 (No.2/No.3)			
	Castrol	LM Grease (No.2/No.3)			
	BP	Energrease LS (No.2/No.3)			
Propeller shaft sliding yoke Universal joint (Multi purpose grease containing molybdenum disulfide)	**ISUZU GENUINE**	**ONE LUBER MO GREASE**			
	Caltex	Molytex Grease EP2 (No.2)			
	Shell	Retinax HDX2 (No.2)			
	Total	Total Multis MS2 (No.2/No.3)			

LUBRICATION	MAKER	BRAND/TYPE	GRADE		
			API	ACEA	JASO
Engine cooling system	**ISUZU GENUINE** Caltex/Texaco/ Chevron	**BESCO LLC SUPER TYPE E** Extended Life Coolant Havoline XLC Delo XLC			

* If GL-5 Limited Slip Differential Lubricant is not available, use GL-5 Lubricant together with Limited Slip Differential Lubricant additive (Parts No. 8-01052-358-0) or equivalent.

FLUID	TYPE
Clutch and brake fluid reservoir	**Besco brake fluid SUPER** Hydraulic brake fluid SAE J1703 FMVSS 116 DOT.3 grade

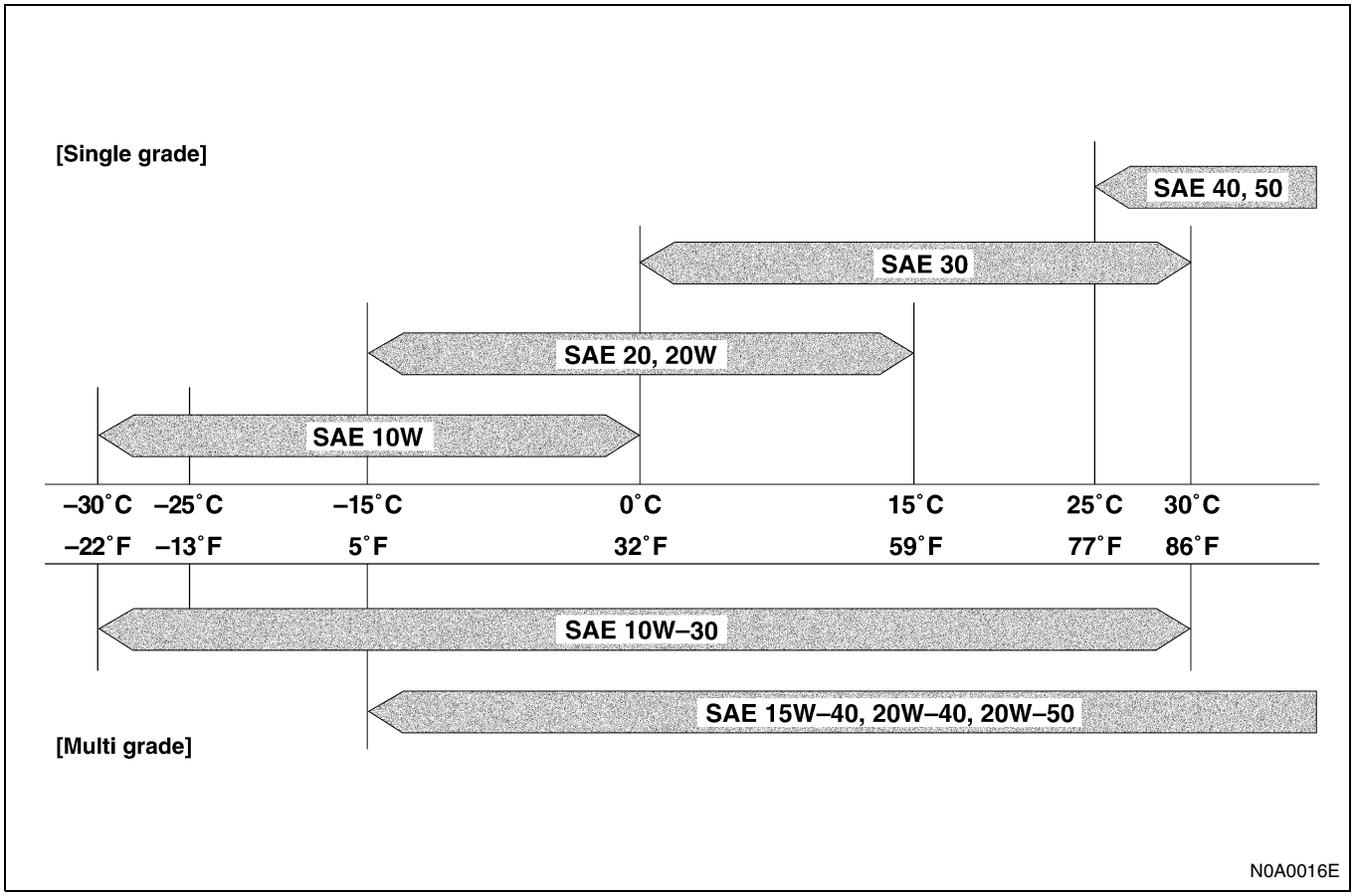
DIESEL FUEL/APPLICABLE STANDARD	
JIS (JAPANESE INDUSTRIAL STANDARD)	Based on K2204 GAS OIL
DIN (DEUTSCHE INDUSTRIE NORMEN)	Based on EN590: 1997
SAE (SOCIETY OF AUTOMOTIVE ENGINEERS)	Based on SAE J-313C
BS (BRITISH STANDARD)	Based on BS EN590-1997

Notice:
When the recommended lubricants are specified in this manual, follow them.

OIL VISCOSITY CHART

Engine Oil

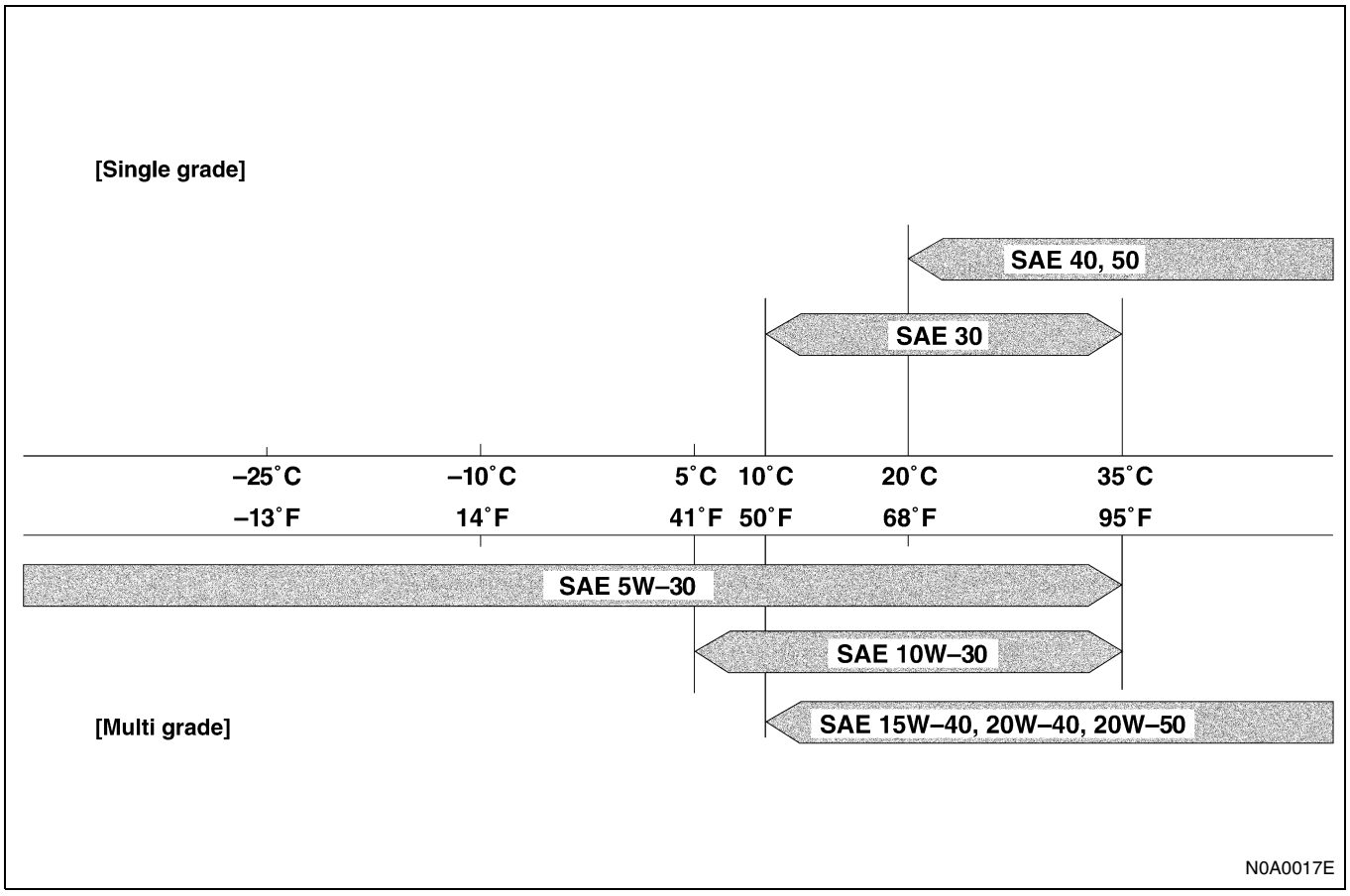
Engine Oil Viscosity Grade - Ambient Temperature



DO NOT USE SYNTHETIC OILS.
* At ambient temperatures below –25°C (–13°F), starting aids (oil pan heater, block heater, etc.) are recommended to prevent hard starting and other engine problems.

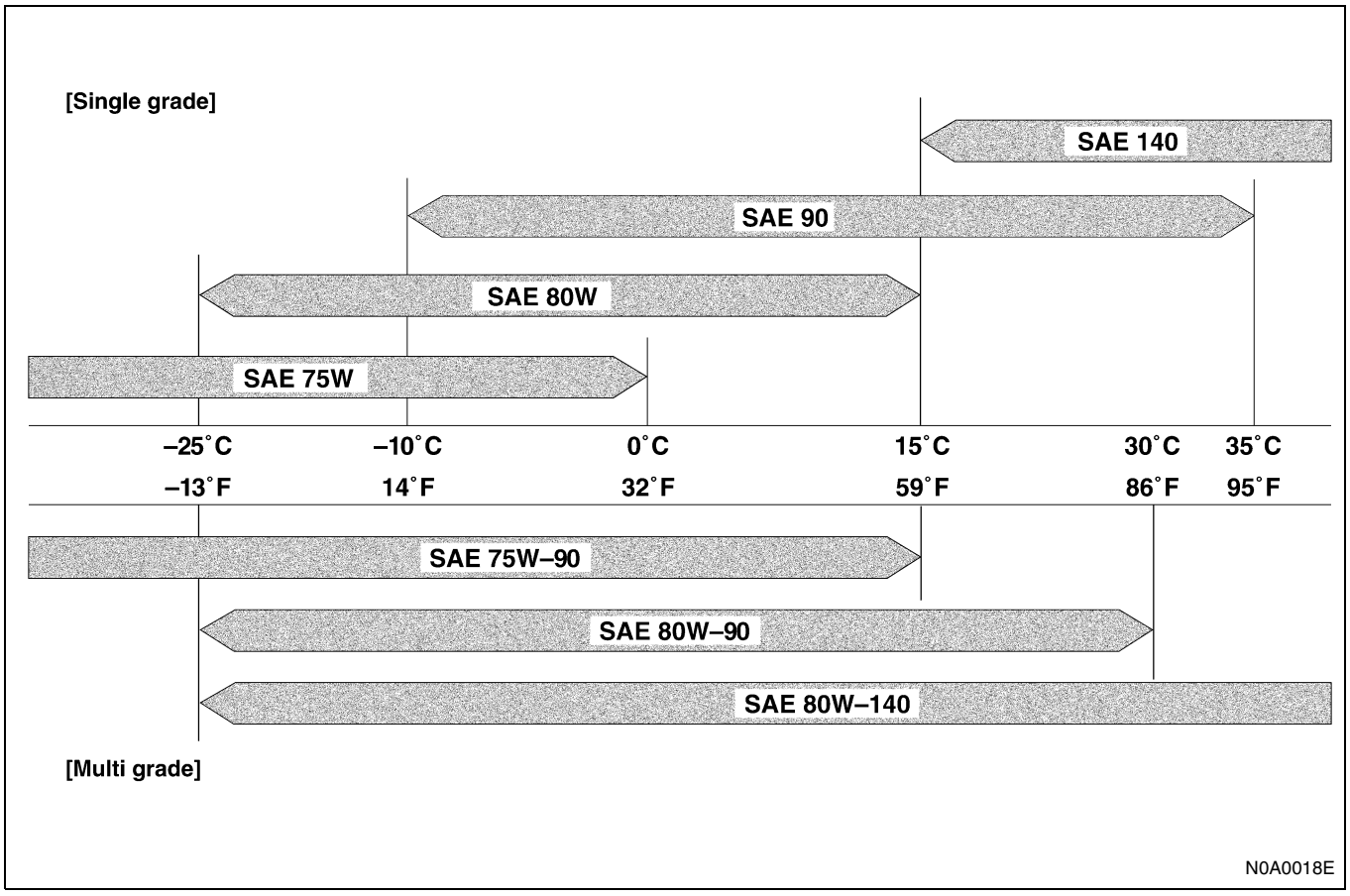
Manual Transmission and Transfer Case Oil (Engine Oil)

Viscosity Grade - Ambient Temperature



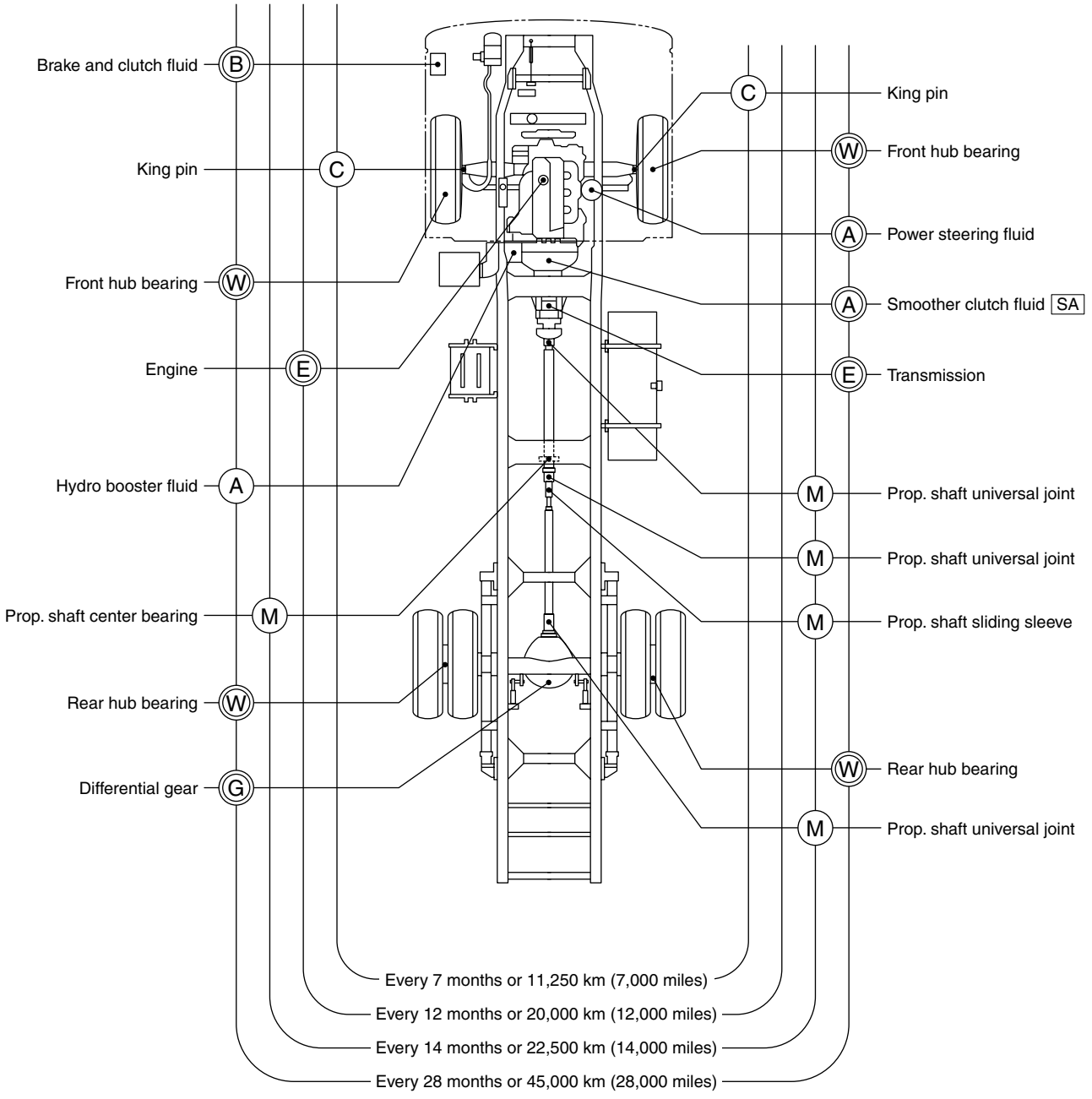
Front Axle and Rear Axle Oil

Gear Oil Viscosity Grade - Ambient Temperature



LUBRICATION CHART

NPR75 and NQR75 Models



◎ : Change

○ : Check and Replenish or Lubricate

E : Engine oil

G : Gear oil

W : Wheel bearing grease

C : Multipurpose type grease

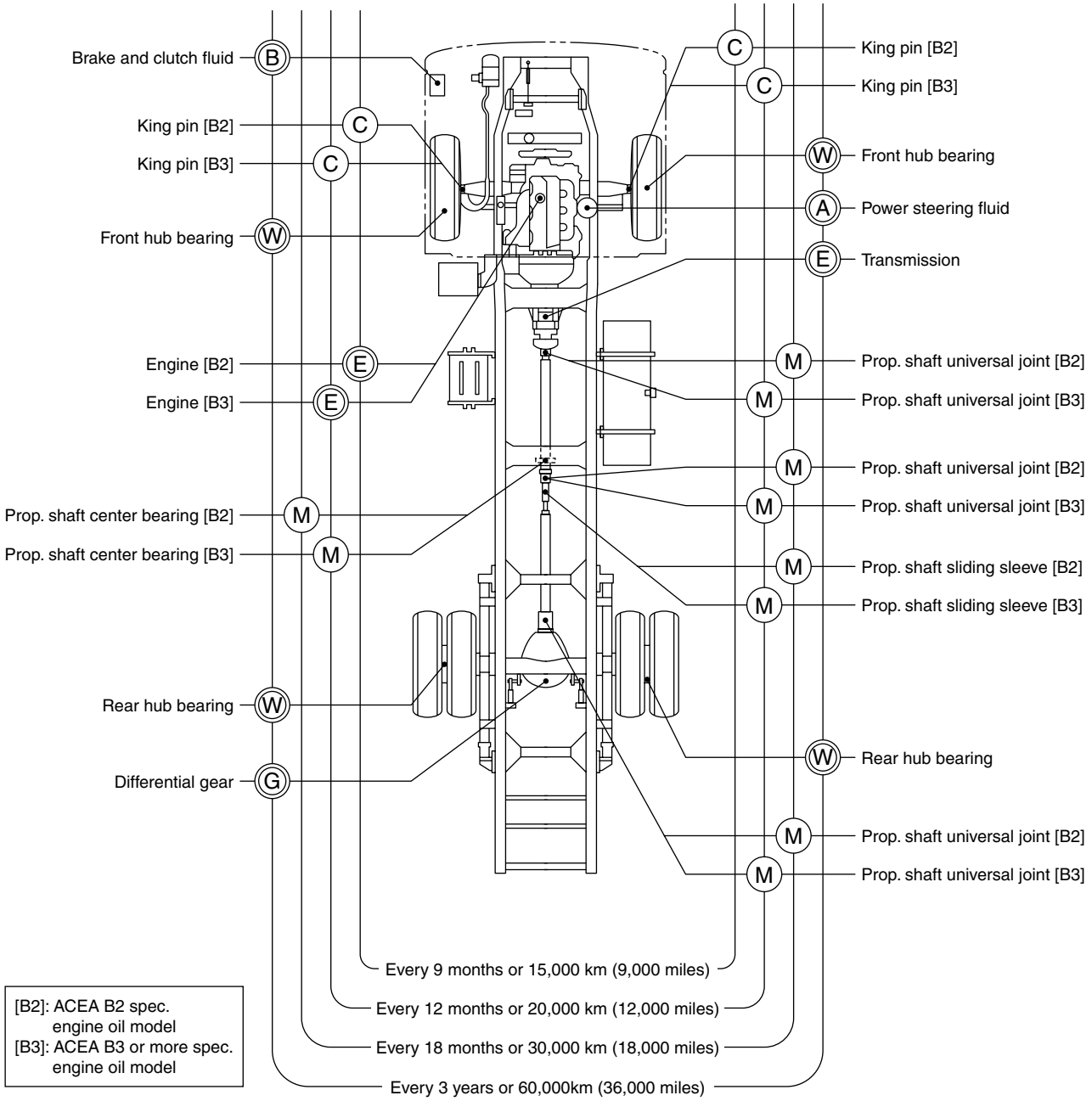
M : MoS_2 contained type grease

B : Brake fluid

A : Automatic transmission fluid

N0A0024E

NKR77 and NPR77 (Front Rigid Suspension) Models



◎ : Change

○ : Check and Replenish or Lubricate

E : Engine oil

G : Gear oil

W : Wheel bearing grease

C : Multipurpose type grease

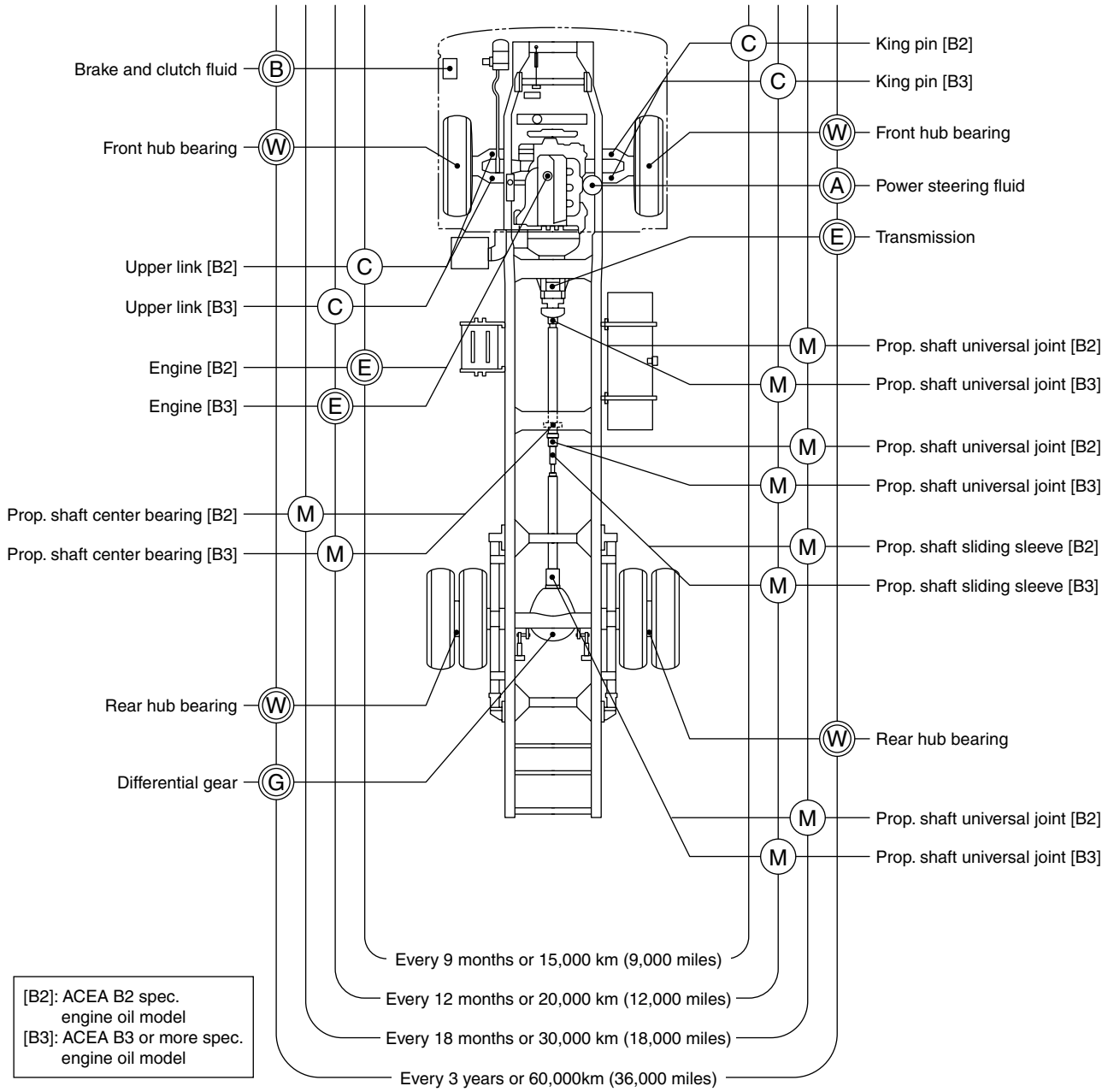
M : MoS_2 contained type grease

B : Brake fluid

A : Automatic transmission fluid

N0A0025E

NKR77 (Front Independent Suspension) Model



◎ : Change

○ : Check and Replenish or Lubricate

E : Engine oil

G : Gear oil

W : Wheel bearing grease

C : Multipurpose type grease

M : MoS_2 contained type grease

B : Brake fluid

A : Automatic transmission fluid

N0A0026E

LGGEN-WE-0551EU

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LGGEN-WE-0551EU PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

GENERAL INFORMATION

SECTION 0

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

SECTION No.	CONTENTS
0A	GENERAL INFORMATION
0B	MAINTENANCE AND LUBRICATION

GENERAL INFORMATION

SECTION 0A

GENERAL INFORMATION

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GENERAL REPAIR INSTRUCTIONS

General Repair Instructions

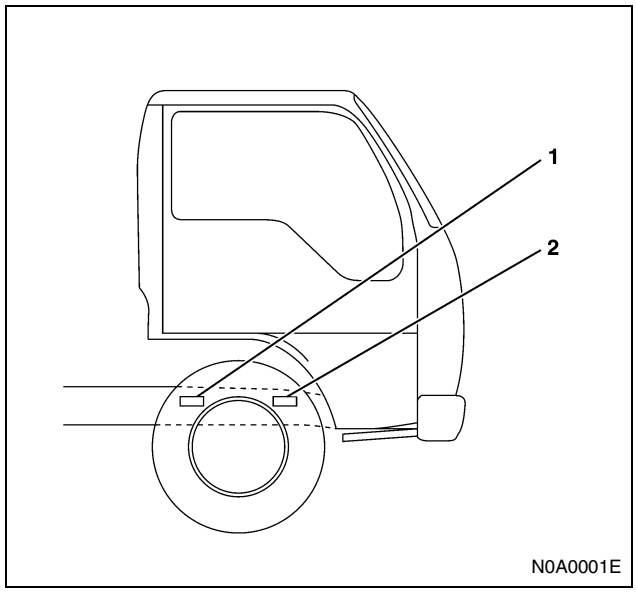
1. Park the vehicle on level ground and chock the front or rear wheels before lifting the vehicle.
2. Use covers on the vehicle body, seats, and floor to prevent damage and/or contaminations.
3. Disconnect the grounding cable from the battery before performing service operations. This will prevent cable damage or burning due to shortcircuiting.
4. Raise the vehicle with a jack set against the axle or the frame.
5. Support the vehicle on chassis stands.
6. Handle brake fluid and engine coolant with great care.
   Spilling these liquids on painted surfaces will damage the paint.
7. The use of the proper tool(s) and special tool(s) where specified is essential to efficient, reliable, and safe service operations.
8. Always use genuine ISUZU replacement parts.
9. Discard used cotter pins, gasket, O-rings, oil seals, lock washers, and self-locking nuts at disassembly.
   Normal function of these parts cannot be guaranteed if they are reused.
10. Keep the disassembled parts neatly in groups.
    This will facilitate smooth and correct reassembly.
11. Keep fixing nuts and bolts separate.
    Fixing nuts and bolts vary in hardness and design according to installation positions.
12. Clean all parts before inspection or reassembly.
13. Clean the oil ports and other openings with compressed air to make certain that they are free of dirt and obstructions.
14. Lubricate the rotating and sliding faces of all moving parts with oil or grease before installation.
15. Use the recommended liquid gasket to prevent leakage.
16. Be sure to tighten bolts and nuts to the specified torque, using a properly maintained torque wrench.
17. When service operation is completed, make a final check to be sure service has been done properly and problem has been corrected.
18. When removing or replacing parts that require refrigerant to the discharged from the Air conditioning system, be sure to use the ACR4 or equivalent to recover and recycle Refrigerant-134a, to promote the movement for the protection of the ozone layer covering the earth.
19. To assure safety, always slowly release air pressure from the air tanks before disconnecting pipes, hoses or other parts from any unit under pressure.

IDENTIFICATION

Chassis Number:

It is stamped on the front right-hand side face of the chassis side member.

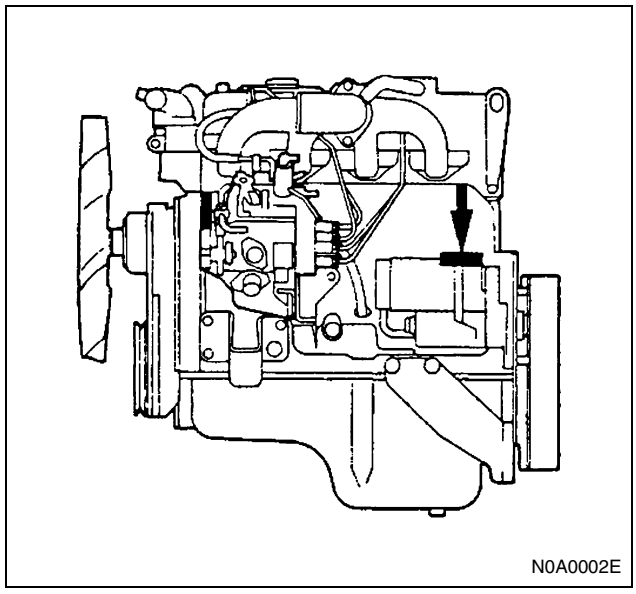
1. NKR models with independent front suspension
2. NHR, NKR, NPR, NQR and NPS models with rigid axle front suspension



Engine Number:

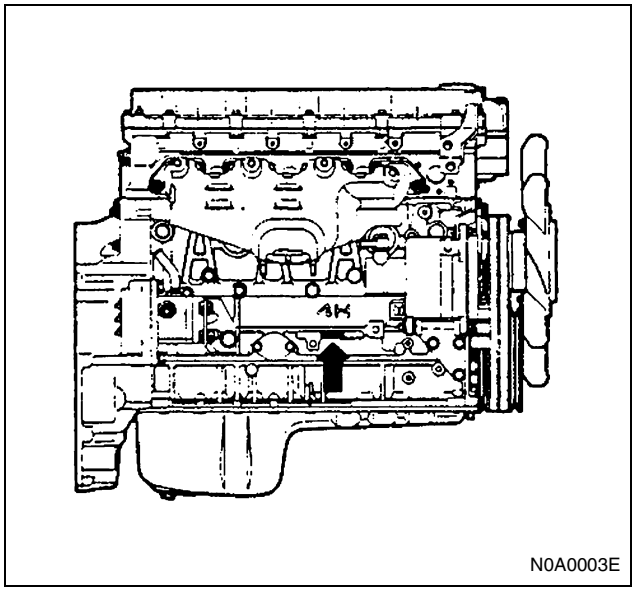
4J Series Engine

The engine number is stamped on the left side rear of the cylinder body.



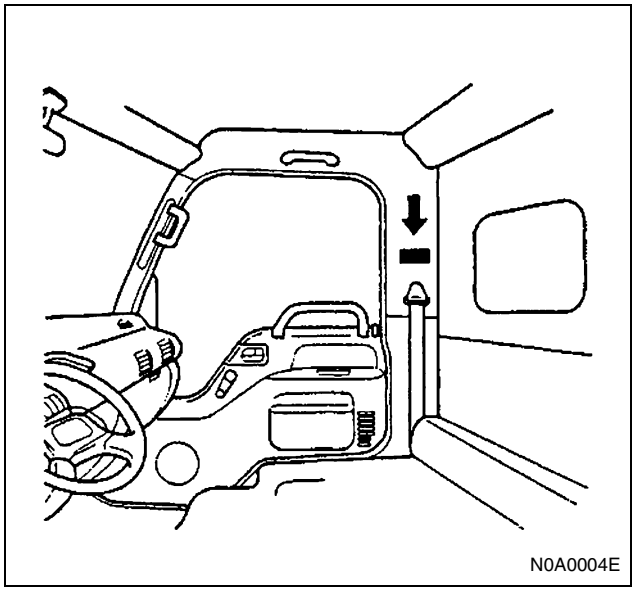
4H Series Engine

The engine number is stamped on the right side of the cylinder body.



Vehicle Identification Plate

The vehicle identification plate is attached to the interior side of the cab side panel on the right side.



LIFTING INSTRUCTION

Lifting Instruction

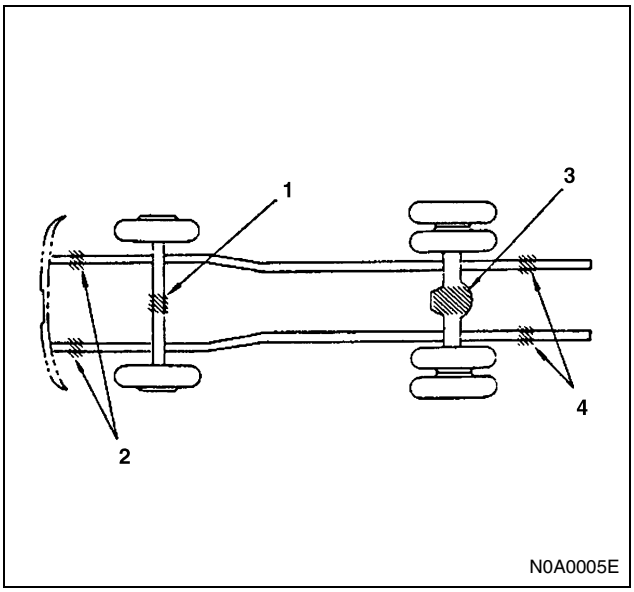
If it is necessary to use a lifting device other than the original equipment jack, see illustration for acceptable lifting points.
Lifting should only be done at the positions indicated to prevent possible damage to the vehicle.

Caution:
Failure to observe the acceptable lift points may result in unsatisfactory vehicle performance or a durability failure which may result in loss of control of the vehicle.

Garage Jack and Safety Stand

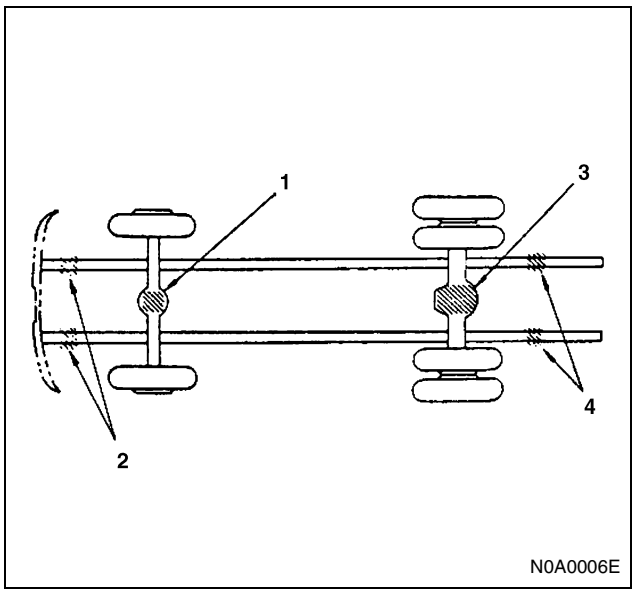
Lifting Point and Supportable Point Location

NHR, NKR, NPR, NQR



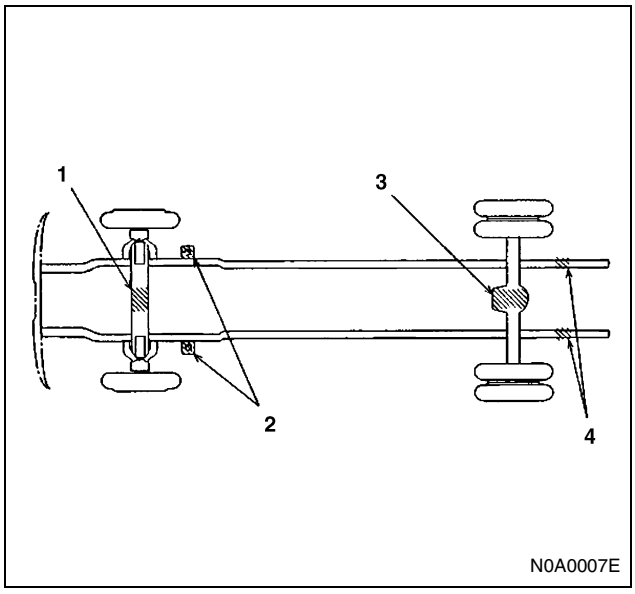
Legend
1. Front axle
2. Side frame front side
3. Rear axle center
4. Side frame rear side

NPS



Legend
1. Front axle
2. Side frame front side
3. Rear axle center
4. Side frame rear side

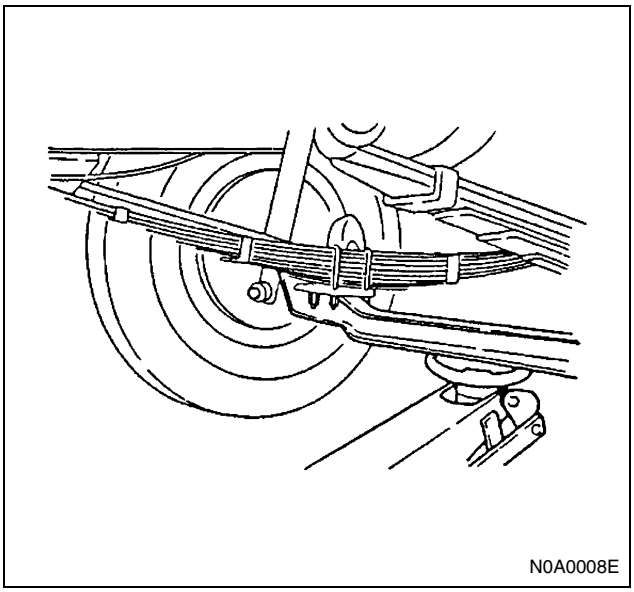
NKR (Front independent suspension)



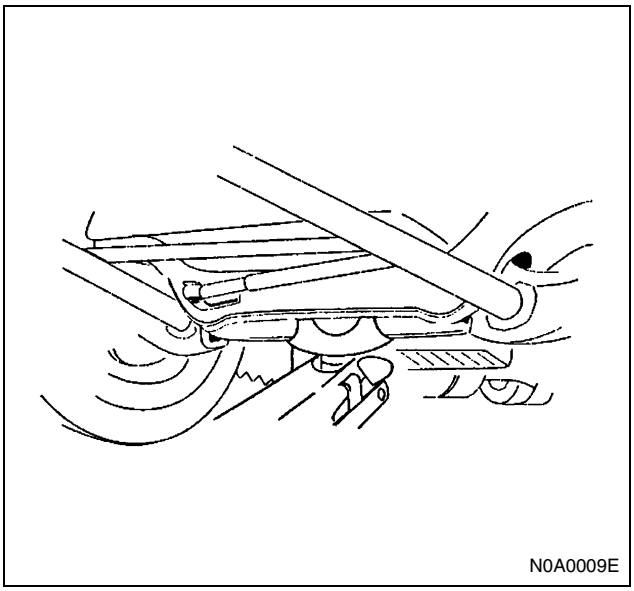
Legend
1. Suspension cross member
2. Jack up bracket
3. Rear axle center
4. Side frame rear side

Front Side Lifting Point

Notice:
Do not lift or support on engine oil pan.


N0A0008E

NKR (Front independent suspension)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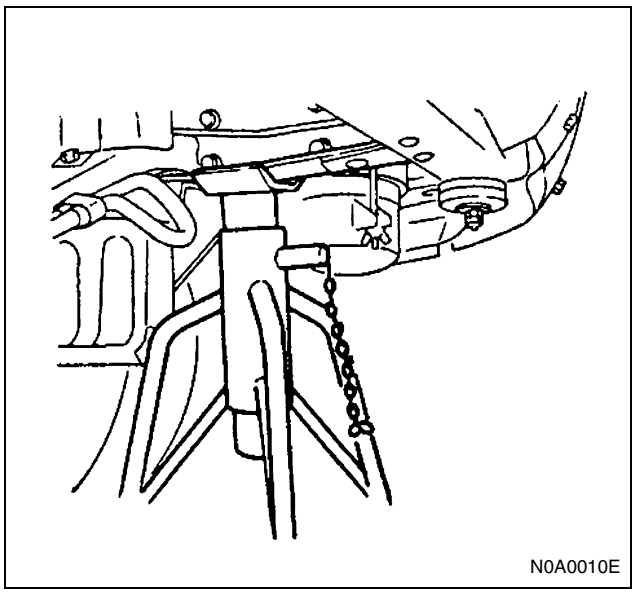
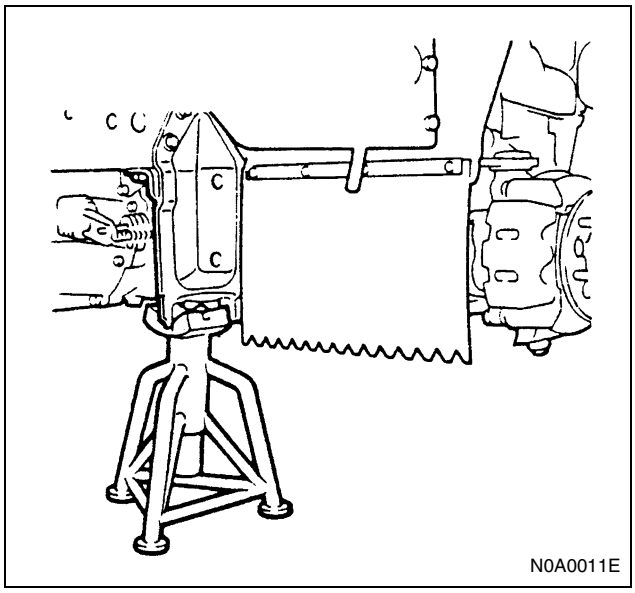
Front Side Supportable Point


N0A0010E

NKR (Front independent suspension)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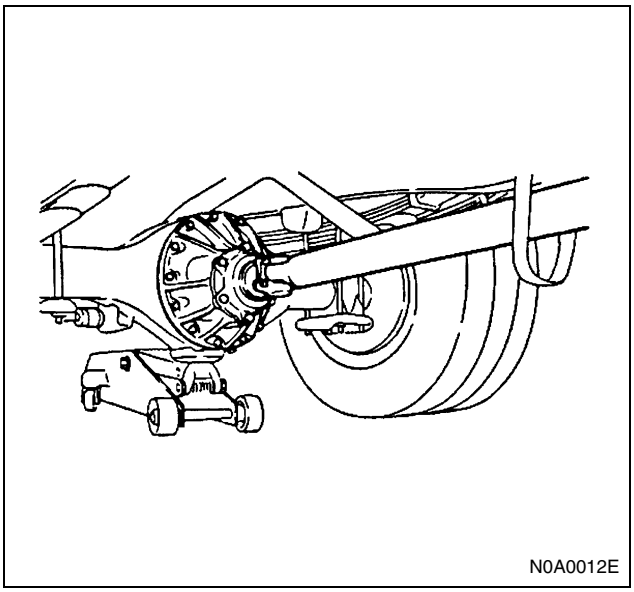
Rear Side Lifting Point

Notice:
Do not lift or support on rear axle tube.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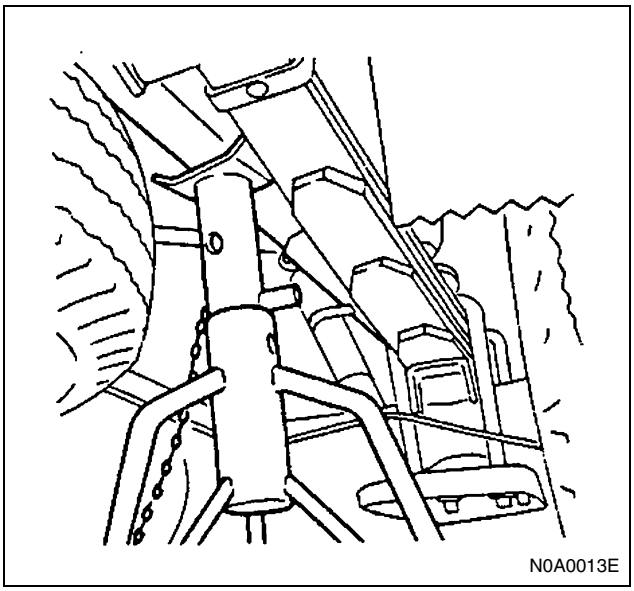
Rear Side Supportable Point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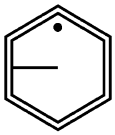
TORQUE SPECIFICATIONS

Standard Bolts

The torque values given in the following table should be applied where a particular torque is not specified.

N·m (kg·m / lb·ft)
N·m [kg·cm / lb·in]

Bolt Diameter × Pitch (mm)	Strength Class	4.8	8.8		9.8
			Refined	Non-Refined	
	Bolt Identification				
		No mark			
M6×1.0	6 [60 / 52]		7 [75 / 69]		—
M8×1.25	13 [130 / 113]		18 [180 / 156]		24 [240 / 208]
M10×1.25	27 (2.8 / 20)		37 (3.8 / 27)		50 (5.1 / 37)
M12×1.25	61 (6.3 / 45)		76 (7.7 / 56)		95 (9.7 / 70)
M14×1.5	96 (9.8 / 71)		117 (11.9 / 86)		142 (14.5 / 105)
M16×1.5	130 (13.3 / 96)		170 (14.3 / 125)		200 (20.4 / 148)
M18×1.5	188 (19.2 / 139)		244 (24.9 / 180)		287 (29.3 / 212)
M20×1.5	258 (26.3 / 190)		337 (34.4 / 249)		396 (40.4 / 292)
M22×1.5	332 (33.9 / 245)		454 (46.3 / 335)		530 (54.1 / 391)
M24×2.0	449 (45.8 / 331)		538 (54.9 / 397)		692 (70.6 / 511)
*M10×1.5	26 (2.7 / 20)		36 (3.7 / 27)		48 (4.9 / 35)
*M12×1.5	57 (2.8 / 42)		71 (7.2 / 52)		89 (9.1 / 66)
*M14×2.0	89 (9.1 / 66)		110 (11.2 / 81)		133 (13.6 / 98)
*M16×2.0	124 (12.7 / 92)		162 (16.5 / 119)		191 (19.5 / 141)

N0A0023E

The asterisk * indicates that the bolts are used for female-threaded parts that are made of soft materials such as casting, etc.

Flare Nuts

N·m (kg·m / lb·ft)

Pipe diameter mm (in)	Torque	Pipe diameter mm (in)	Torque
4.76 (0.187)	16 (1.6 / 12)	10.00 (0.94)	54 (5.5 / 40)
6.35 (0.250)	26 (2.7 / 20)	12.00 (0.472)	88 (9.0 / 65)
8.00 (0.315)	44 (4.5 / 33)	15.00 (0.591)	106 (10.8 / 78)

RECOMMENDED LIQUID GASKET

Recommended Liquid Gasket

TYPE	BRAND NAME	MANUFACTURER	APPLICATION PARTS (EXAMPLE)
RTV*	ThreeBond 1207B	ThreeBond	Engine Oil Seal Retainer
Silicon	ThreeBond 1207C	ThreeBond	Engine Oil Pan
	ThreeBond 1215	ThreeBond	Timing Gear Case
	ThreeBond 1216	ThreeBond	Cylinder Head Cover
	ThreeBond 1281	ThreeBond	Fuel Pump
Water Base	ThreeBond 1141E	ThreeBond	Rear Axle
Solvent	ThreeBond 1104	ThreeBond	etc.
	BelcoBond 4	Isuzu	
	BelcoBond 401	Isuzu	
	BelcoBond 402	Isuzu	
Anaerobic	LOCTITE 515	LOCTITE	Engine Oil Seal Retainer
	LOCTITE 518	LOCTITE	Water Pump
			Transaxle
			etc.

*RTV: Room Temperature Vulcanizer

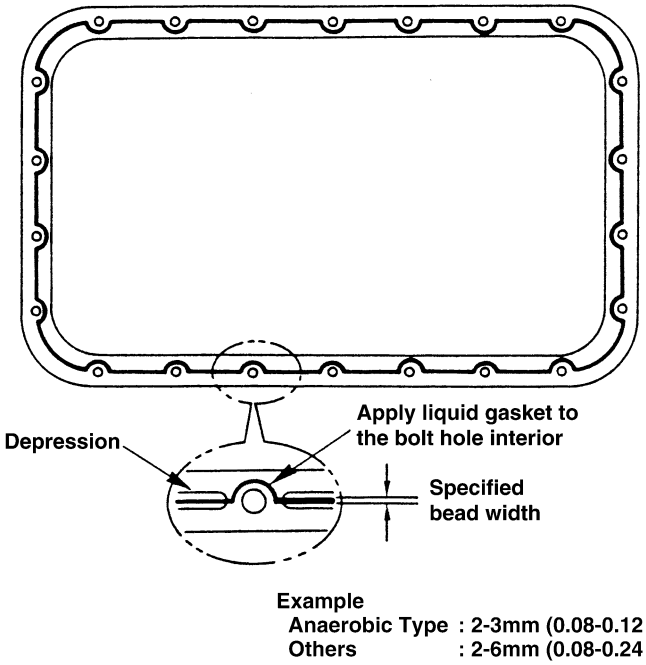
Notice:

1. It is very important that the liquid gaskets listed above or their exact equivalent be used on the vehicle.
2. LOCTITE 515 and LOCTITE 518 harden upon contact with a metal surface.
   Do not apply LOCTITE 515 or LOCTITE 518 between two metal surfaces having a clearance of greater than 0.25 mm (0.001 in). Poor adhesion will result.
3. Be careful to use the specified amount of liquid gasket.
   Follow the manufacturer’s instructions at all times.

Application Procedure

mm (in)

SCREW HOLE	DEPRESSION	JUDGE-MENT
1~3 (0.04~0.12)		OK
1~3 (0.04~0.12)	More than 2(0.08)	OK
		NG



N0A0014E

1. Completely remove lubricant and moisture from the connecting surfaces. The surfaces must be perfectly dry.
2. Apply specified bead width of liquid gasket to one of the connecting surfaces.

Notice:
When the application procedures are specified in this manual, follow them.

RECOMMENDED THREAD LOCKING AGENT

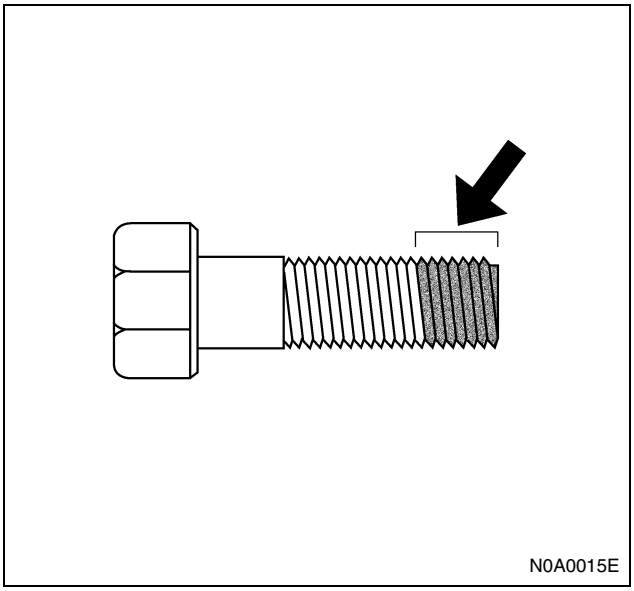
Notice:
When the application procedures are specified in this manual, follow them.

LOCTITE

TYPE	COLOR
LOCTITE 242	Blue
LOCTITE 262	Red
LOCTITE 271	Red

Application Steps

1. Completely remove all lubricant and moisture from the bolts and the female threaded surfaces of the parts to be joined.
   The surfaces must be perfectly dry.
2. Apply LOCTITE to the bolts.
   Apply LOCTITE to at least 1/3 of the bolt's threaded area.



3. Tighten the bolts to the specified torque.

Notice:
After tightening, be sure to keep the bolts free from vibration and torque for at least an hour until LOCTITE hardens.

GENERAL INFORMATION

SECTION 0B
MAINTENANCE AND LUBRICATION

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MAINTENANCE SCHEDULE

For General Export

When performing the checks on the following items, regular inspection items should also be checked.

Abbreviations

I : Inspect, clean and correct or replace as necessary
A : Adjust
R : Replace or change
T : Tighten to specified torque
L : Lubricate
[V] : Variation (optional on some models).
[OPT] : Optional equipment.
[4JG] : For 4JG2 engine model.
[4JH] : For 4JH1-TC engine model.
[4J] : For 4J engine models.
[4HF1-2] : For 4HF1-2 engine model.
[4HK1-TC] : For 4HK1-TC engine model.
[4H] : For 4H engine model.
[MT] : For manual transmission model only.
[SA] : For Smoother model only.
*Marks: Under severe driving conditions, more frequent maintenance is required. Refer to “Maintenance schedule under severe driving conditions”.

Maintenance Schedule

Use odometer reading or months whichever comes first

SERVICE INTERVAL:	× 1,000 km	1	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
	× 1,000 miles	0.6	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
	or months	1	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
[4J] ENGINE																						
*Engine oil		—	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
[4JH] *Engine oil		—	—	—	R	—	—	R	—	—	R	—	—	R	—	—	R	—	—	R	—	—
*Oil filter		—	—	R	—	R	—	R	—	R	—	R	—	R	—	R	—	R	—	R	—	R
[4JH] *Engine oil filter		—	—	—	R	—	—	R	—	—	R	—	—	R	—	—	R	—	—	R	—	—
Fuel filter		—	—	—	—	R	—	—	—	R	—	—	—	R	—	—	—	R	—	—	—	R
[4JH] Fuel filter		—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	R	—	—	—	—
*Air cleaner element		—	—	I	—	I	—	I	—	R	—	I	—	I	—	I	—	R	—	I	—	I
[4JH] *Air cleaner element		—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	R	—	—	—	—
Idling speed and acceleration		—	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I
Valve clearances		I	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	A	—	—	—	—
Fuel tank cap & fuel pipes for loose connections or damage		—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	I	—	—	—	—
[OPT] [4JG] Timing belt		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R

SERVICE INTERVAL:	× 1,000 km	1	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
	× 1,000 miles	0.6	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
	or months	1	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
Drive belt tension and damage		I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
[4JH] Drive belt tension and damage		Every 7,500 km (4,500 miles) Inspect																				
Radiator coolant		—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	R	—	—	—	—
*Exhaust pipes and mounting damage or looseness		—	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I
Cooling system		—	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I
Engine operation condition		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
[4H] ENGINE																						
*Engine oil		—	—	R	—	R	—	R	—	R	—	R	—	R	—	R	—	R	—	R	—	R
[4HK1-TC] *Engine oil		—	—	—	—	R	—	—	—	R	—	—	—	R	—	—	—	R	—	—	—	R
*Oil filter		—	—	R	—	R	—	R	—	R	—	R	—	R	—	R	—	R	—	R	—	R
[4HK1-TC] *Oil filter		—	—	—	—	R	—	—	—	R	—	—	—	R	—	—	—	R	—	—	—	R
Fuel filter: Main fuel filter		—	—	—	—	R	—	—	—	R	—	—	—	R	—	—	—	R	—	—	—	R
[OPT] Main fuel filter and Sub fuel filter: With sub fuel filter		—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	R	—	—	—	—
*Air cleaner element		—	—	I	—	I	—	I	—	R	—	I	—	I	—	I	—	R	—	I	—	I
Idling speed and acceleration		—	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I
Valve clearances		I	—	—	—	—	—	—	—	A	—	—	—	—	—	—	—	A	—	—	—	—
Feed pump strainer (Except [4HF1-2])		—	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I
Fuel tank cap & fuel pipes for loose connections or damage		—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	I	—	—	—	—
Drive belt tension and damage		I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Radiator coolant		—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	R	—	—	—	—

SERVICE INTERVAL:	× 1,000 km	1	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
	× 1,000 miles	0.6	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
	or months	1	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
*Exhaust pipes and mounting damage or looseness		—	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I
Cooling system		—	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I
Engine operation condition		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
[MT] CLUTCH																						
Clutch fluid		—	—	I	—	I	—	I	—	R	—	I	—	I	—	I	—	R	—	I	—	I
Clutch pedal travel and free play		—	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
TRANSMISSION																						
*Manual transmission oil		—	—	I	—	I	—	I	—	R	—	I	—	I	—	I	—	R	—	I	—	I
[SA] Smoother clutch fluid		—	—	I	—	I	—	I	—	R	—	I	—	I	—	I	—	R	—	I	—	I
Gear control mechanism for looseness		—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	I	—	—	—	—
Gear control cable		—	—	—	—	A	—	—	—	A	—	—	—	A	—	—	—	A	—	—	—	A
TRANSMISSION WITH TRANSFER CASE (NPS model only)																						
*Transmission with transfer case oil		—	—	I	—	I	—	I	—	I	R	I	—	I	—	—	I	R	—	R	—	I
Gear control mechanism for looseness		—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	I	—	—	—	—
Gear control cable		—	—	—	—	A	—	—	—	A	—	—	—	A	—	—	—	A	—	—	—	A
REAR PROPELLER SHAFT																						
*Universal joints and sliding sleeve		—	—	—	—	L	—	—	—	L	—	—	—	L	—	—	—	L	—	—	—	L
Loose connections		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Splines for excessive wear		—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	I	—	—	—	—

SERVICE INTERVAL:	× 1,000 km	1	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
	× 1,000 miles	0.6	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
	or months	1	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
Bearings and related parts for looseness		—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	I	—	—	—	—
Center bearing		—	—	—	—	L	—	—	—	L	—	—	—	L	—	—	—	L	—	—	—	L
FRONT PROPELLER SHAFT (NPS model only)																						
*Universal joints, double cardan joint and sliding sleeve		—	—	—	L	—	—	L	—	—	L	—	—	L	—	—	L	—	—	L	—	—
Loose connections		—	—	—	I	—	—	I	—	—	I	—	—	I	—	—	I	—	—	I	—	—
Splines for excessive wear		—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	I	—	—	—	—
REAR AXLE																						
*Differential gear oil		—	—	I	—	I	—	I	—	R	—	I	—	I	—	I	—	R	—	I	—	I
FRONT AXLE																						
*Kingpin		—	—	L	—	L	—	L	—	L	—	L	—	L	—	L	—	L	—	L	—	L
Differential gear oil (NPS model only)		—	—	—	I	—	—	I	—	—	I/R	—	—	I	—	—	I	—	—	I/R	—	—
STEERING																						
Manual steering gear oil		—	—	—	—	—	—	I	—	—	—	—	—	I	—	—	—	—	—	I	—	—
[OPT] Power steering system oil leakage		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
[OPT] Power steering fluid		—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	R	—	—	—	—
* [OPT] Power steering system for looseness or damage		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Fitting of knuckles and front axle for looseness		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Steering mechanism for looseness or damage		—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	I	—	—	—	—

SERVICE INTERVAL:	× 1,000 km	1	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
	× 1,000 miles	0.6	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
	or months	1	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
Ball joint boots for damage (Independent suspension model only)		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Ball joint for excessive play (Independent suspension model only)		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Relay lever shaft for excessive play (Independent suspension model only)		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Steering wheel play		—	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Steering function		—	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Wheel alignment		—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	I	—	—	—	—
[OPT] Power steering hose		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—
SERVICE BRAKES																						
Brake fluid		—	—	I	—	I	—	I	—	R	—	I	—	I	—	I	—	R	—	I	—	I
[V] Hydro booster fluid (ATF)		—	—	I	—	I	—	I	—	R	—	I	—	I	—	I	—	R	—	I	—	I
Brake system for fluid leakage		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
*Brake lining and drum for wear		—	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I
*Disc brake pads and discs for wear		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Brake pedal travel and free play		I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
Pipes and hoses for loose connections or damage		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
PARKING BRAKE																						
Parking brake cables		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Parking brake function		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I

SERVICE INTERVAL:	× 1,000 km	1	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
	× 1,000 miles	0.6	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
	or months	1	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
Parking brake lever travel		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Lining for wear		—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	I	—	—	—	—
Drum for wear or damage		—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	I	—	—	—	—
Ratchet for wear or damage		—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	I	—	—	—	—
SUSPENSION																						
Spring leaves for damage		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Torsion bar Spring (Independent suspension model only)		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Ball joint boots for damage (Independent suspension model only)		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Mount for looseness or damage		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Rear spring, spring pin and shackle pin (NPS model only)		—	—	L	—	L	—	L	—	L	—	L	—	L	—	L	—	L	—	L	—	L
Shock absorbers for oil leakage		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Shock absorbers mount for looseness		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Ball joint for excessive play (Independent suspension model only)		—	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	I	—	—	—	—
Upper links (Independent suspension model only)		—	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
WHEELS																						
Wheel pins and nuts		T	—	—	—	T	—	—	—	T	—	—	—	T	—	—	—	T	—	—	—	T
Wheel disc for damage		—	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I

SERVICE INTERVAL:	× 1,000 km	1	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
	× 1,000 miles	0.6	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
	or months	1	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
Hub bearing grease		—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	—	R	—	—	—	—
Tire pressure and damage		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
ELECTRICAL EQUIPMENT																						
Specific gravity of battery electro-lyte		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
OTHERS																						
Lights, horn, windshield, wiper and washer		—	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I	—	I
Drive shaft dust boots for damage (NPS model only)		—	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I	—	—	—	I
Bolts and nuts on chassis and body		I	—	—	—	—	—	—	—	I	—	—	—	—	—	—	—	I	—	—	—	—

Maintenance Schedule under Severe Driving Conditions

Severe driving conditions
A : Repeated short trips
B : Driving on rough roads
C : Driving on dusty roads
D : Driving extremely cold weather and/or on salted roads

Item	Interval	Condition				
		A	B	C	D	A+D
[4JB] [4JG] Engine oil	Change every 2,500 km (1,500 miles)			❍		❍
[4H] Engine oil	Change every 5,000 km (3,000 miles)			❍		❍
[4JB] [4JG] [4H] Engine oil filter	Replace every 5,000 km (3,000 miles)			❍		❍
Exhaust pipes and mounting	Inspect every 10,000 km (6,000 miles)	❍	❍		❍	
Air cleaner element	Replace every 20,000 km (12,000 miles)			❍		
Steering system for looseness or damage	Inspect every 5,000 km (3,000 miles)		❍			
Universal joints and sliding sleeve grease	Lubricate every 10,000 km (6,000 miles)		❍			
Manual transmission and differential gear oil	Change every 20,000 km (12,000 miles)		❍			
[SA] Smoother clutch fluid	Change every 20,000 km (12,000 miles)		❍			
Brake lining and drum for wear	Inspect every 10,000 km (6,000 miles)	❍	❍	❍		
Disc brake pads and discs for wear	Inspect every 5,000 km (3,000 miles)	❍	❍	❍		
[4JH] Engine oil	Change every 7,500 km (4,500 miles)			❍		❍

Item	Interval	Condition				
		A	B	C	D	A+D
[4JH] Engine oil filter	Replace every 7,500 km (4,500 miles)			❍		❍
[4JH] Air cleaner element	Replace every 10,000 km (6,000 miles)			❍		

For Australia and Taiwan

When performing the checks on the following items, regular inspection items should also be checked.

Abbreviations

I :Inspect, clean and correct or replace as necessary
A : Adjust
R : Replace or change
T : Tighten to specified torque
L : Lubricate
[V] : Variation (optional on some models).
[OPT] : Optional equipment.
[SA] : For Smoother model only.
*Marks: Under severe driving conditions, more frequent maintenance is required. Refer to “Maintenance schedule under severe driving conditions”.

Maintenance Schedule: 4JH1-TC Engine Model (ACEA B2 Specification Engine Oil)

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)												
	× 1,000 km	10	20	30	40	50	60	70	80	90	100	
	× 1,000 mile	6	12	18	24	30	36	42	48	54	60	
ENGINE												
*Engine oil		R	R	R	R	R	R	R	R	R	R	or every 6 months
*Engine oil filter		R	R	R	R	R	R	R	R	R	R	or every 6 months
Fuel filter		—	R	—	R	—	R	—	R	—	R	or every 12 months
*Air cleaner element		I	I	I	R	I	I	I	R	I	I	or every 24 months
Idling speed and acceleration		—	I	—	I	—	I	—	I	—	I	or every 12 months
Valve clearances		—	—	—	A	—	—	—	A	—	—	or every 24 months
Fuel tank cap and fuel pipes for loose connections or damage		—	—	—	I	—	—	—	I	—	—	or every 24 months
Drive belt tension and damage		I	I	I	I	I	I	I	I	I	I	or every 6 months
Radiator coolant		—	—	—	R	—	—	—	R	—	—	or every 24 months
*Exhaust pipes and mountings for looseness or damage		—	I	—	I	—	I	—	I	—	I	or every 12 months
Cooling system for water leakage		—	I	—	I	—	I	—	I	—	I	or every 12 months
Engine operation condition		I	I	I	I	I	I	I	I	I	I	or every 6 months
CLUTCH												
Clutch fluid		I	I	I	R	I	I	I	R	I	I	or every 24 months
Clutch pedal travel and free play		I	I	I	I	I	I	I	I	I	I	or every 6 months
TRANSMISSION												
*Manual transmission oil		I	I	I	R	I	I	I	R	I	I	or every 24 months
Gear control mechanism for looseness		—	—	—	I	—	—	—	I	—	—	or every 24 months
Gear control cables		—	A	—	A	—	A	—	A	—	A	or every 12 months
PROPELLER SHAFT												
*Universal joints and sliding sleeve grease		—	L	—	L	—	L	—	L	—	L	or every 12 months

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)												
	× 1,000 km	10	20	30	40	50	60	70	80	90	100	
	× 1,000 mile	6	12	18	24	30	36	42	48	54	60	
Loose connections		I	I	I	I	I	I	I	I	I	I	or every 6 months
Splines for excessive wear		—	—	—	I	—	—	—	I	—	—	or every 24months
Bearings and related parts for looseness		—	—	—	I	—	—	—	I	—	—	or every 24 months
Center bearing		—	L	—	L	—	L	—	L	—	L	or every 12 months
REAR AXLE												
*Differential gear oil		I	I	I	R	I	I	I	R	I	I	or every 24 months
FRONT AXLE												
*Kingpins		L	L	L	L	L	L	L	L	L	L	or every 6 months
STEERING												
Power steering system oil leakage		I	I	I	I	I	I	I	I	I	I	or every 6 months
Power steering system for looseness or damage		I	I	I	I	I	I	I	I	I	I	or every 6 months
Power steering fluid		—	—	—	R	—	—	—	R	—	—	or every 24 months
Power steering hoses		—	—	—	—	—	—	—	R	—	—	or every 48 months
Fitting of knuckles and front axle for looseness		I	I	I	I	I	I	I	I	I	I	or every 6 months
Steering mechanism for looseness or damage		—	—	—	I	—	—	—	I	—	—	or every 24 months
Ball joints for damage (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 6 months
Ball joints for excessive play (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 6 months
Relay lever shaft for excessive play (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 6 months
Steering wheel play		I	I	I	I	I	I	I	I	I	I	or every 6 months
Steering function		I	I	I	I	I	I	I	I	I	I	or every 6 months
Wheel alignment		—	—	—	I	—	—	—	I	—	—	or every 24 months
SERVICE BRAKES												
Brake fluid		I	I	I	R	I	I	I	R	I	I	or every 24 months
Brake system for fluid leakage		I	I	I	I	I	I	I	I	I	I	or every 6 months
*Brake linings and drums for wear		I	I	I	I	I	I	I	I	I	I	or every 6 months
*Disc brake pads and discs for wear		I	I	I	I	I	I	I	I	I	I	or every 6 months
Brake pedal travel and free play		I	I	I	I	I	I	I	I	I	I	or every 6 months
Pipes and hoses for loose connections or damage		I	I	I	I	I	I	I	I	I	I	or every 6 months

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	× 1,000 km	10	20	30	40	50	60	70	80	90	100	
	× 1,000 mile	6	12	18	24	30	36	42	48	54	60	
PARKING BRAKE												
Parking brake cables		I	I	I	I	I	I	I	I	I	I	or every 6 months
Parking brake function		I	I	I	I	I	I	I	I	I	I	or every 6 months
Parking brake lever travel		I	I	I	I	I	I	I	I	I	I	or every 6 months
Linings for wear		—	—	—	I	—	—	—	I	—	—	or every 24 months
Drum for wear or damage		—	—	—	I	—	—	—	I	—	—	or every 24 months
Ratchet for wear or damage		—	—	—	I	—	—	—	I	—	—	or every 24 months
SUSPENSION												
Spring leaves for damage		I	I	I	I	I	I	I	I	I	I	or every 6 months
Torsion bar spring (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 6 months
Ball joint boots for damage (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 6 months
Ball joints for excessive play (Independent suspension model only)		—	—	—	I	—	—	—	I	—	—	or every 24 months
Mounts for looseness or damage		I	I	I	I	I	I	I	I	I	I	or every 6 months
Shock absorbers for oil leakage		I	I	I	I	I	I	I	I	I	I	or every 6 months
Shock absorbers mount for looseness		I	I	I	I	I	I	I	I	I	I	or every 6 months
Upper links (Independent suspension model only)		L	L	L	L	L	L	L	L	L	L	or every 6 months
WHEELS												
Wheel pins and nuts		—	T	—	T	—	T	—	T	—	T	or every 12 months
Wheel discs for damage		—	I	—	I	—	I	—	I	—	I	or every 12 months
Hub bearings grease		—	—	—	R	—	—	—	R	—	—	or every 24 months
Tire pressures and damage		I	I	I	I	I	I	I	I	I	I	or every 6 months
ELECTRICAL EQUIPMENT												
Specific gravity of battery electrolyte		I	I	I	I	I	I	I	I	I	I	or every 6 months
OTHERS												
Lights, horn, windshield, wiper and washers		I	I	I	I	I	I	I	I	I	I	or every 6 months
Bolts and nuts on chassis and body		—	—	—	I	—	—	—	I	—	—	or every 24 months

(I): Inspect and correct or replace as necessary (A): Adjust (R): Replace or change (T): Tighten to specified torque (L): Lubricate

Maintenance Schedule: 4JH1-TC Engine Model (Engine Oil that Meets or Exceeds ACEA B3 Specification)

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	× 1,000 km	15	30	45	60	75	90	105	120	135	150	
	× 1,000 mile	9	18	27	36	45	54	63	72	81	90	
ENGINE												
*Engine oil		R	R	R	R	R	R	R	R	R	R	or every 9 months
*Engine oil filter		R	R	R	R	R	R	R	R	R	R	or every 9 months
Fuel filter		—	R	—	R	—	R	—	R	—	R	or every 18 months
*Air cleaner element		I	I	I	R	I	I	I	R	I	I	or every 36 months
Idling speed and acceleration		—	I	—	I	—	I	—	I	—	I	or every 18 months
Valve clearances		—	—	—	A	—	—	—	A	—	—	or every 36 months
Fuel tank cap and fuel pipes for loose connections or damage		—	—	—	I	—	—	—	I	—	—	or every 36 months
Drive belt tension and damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Radiator coolant		—	—	—	R	—	—	—	R	—	—	or every 36 months
*Exhaust pipes and mountings for looseness or damage		—	I	—	I	—	I	—	I	—	I	or every 18 months
Cooling system for water leakage		—	I	—	I	—	I	—	I	—	I	or every 18 months
Engine operation condition		I	I	I	I	I	I	I	I	I	I	or every 9 months
CLUTCH												
Clutch fluid		I	I	I	R	I	I	I	R	I	I	or every 24 months
Clutch pedal travel and free play		I	I	I	I	I	I	I	I	I	I	or every 6 months
TRANSMISSION												
*Manual transmission oil		I	I	I	R	I	I	I	R	I	I	or every 24 months
Gear control mechanism for looseness		—	—	—	I	—	—	—	I	—	—	or every 24 months
Gear control cables		—	A	—	A	—	A	—	A	—	A	or every 12 months
PROPELLER SHAFT												
*Universal joints and sliding sleeve grease		—	L	—	L	—	L	—	L	—	L	or every 12 months
Loose connections		I	I	I	I	I	I	I	I	I	I	or every 6 months
Splines for excessive wear		—	—	—	I	—	—	—	I	—	—	or every 24 months
Bearings and related parts for looseness		—	—	—	I	—	—	—	I	—	—	or every 24 months
Center bearing		—	L	—	L	—	L	—	L	—	L	or every 12 months
REAR AXLE												
*Differential gear oil		I	I	I	R	I	I	I	R	I	I	or every 24 months
FRONT AXLE												
*Kingpins		L	L	L	L	L	L	L	L	L	L	or every 9 months
STEERING												

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	× 1,000 km	15	30	45	60	75	90	105	120	135	150	
	× 1,000 mile	9	18	27	36	45	54	63	72	81	90	
Power steering system oil leakage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Power steering system for looseness or damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Power steering fluid		—	—	—	R	—	—	—	R	—	—	or every 36 months
Power steering hoses		—	—	—	—	—	—	—	R	—	—	or every 72 months
Fitting of knuckles and front axle for looseness		I	I	I	I	I	I	I	I	I	I	or every 9 months
Steering mechanism for looseness or damage		—	—	—	I	—	—	—	I	—	—	or every 36 months
Ball joints for damage (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Ball joints for excessive play (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Relay lever shaft for excessive play (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Steering wheel play		I	I	I	I	I	I	I	I	I	I	or every 9 months
Steering function		I	I	I	I	I	I	I	I	I	I	or every 9 months
Wheel alignment		—	—	—	I	—	—	—	I	—	—	or every 36 months
SERVICE BRAKES												
Brake fluid		I	I	I	R	I	I	I	R	I	I	or every 36 months
Brake system for fluid leakage		I	I	I	I	I	I	I	I	I	I	or every 9 months
*Brake linings and drums for wear		I	I	I	I	I	I	I	I	I	I	or every 9 months
*Disc brake pads and discs for wear		I	I	I	I	I	I	I	I	I	I	or every 9 months
Brake pedal travel and free play		I	I	I	I	I	I	I	I	I	I	or every 9 months
Pipes and hoses for loose connections or damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
PARKING BRAKE												
Parking brake cables		I	I	I	I	I	I	I	I	I	I	or every 9 months
Parking brake function		I	I	I	I	I	I	I	I	I	I	or every 9 months
Parking brake lever travel		I	I	I	I	I	I	I	I	I	I	or every 9 months
Linings for wear		—	—	—	I	—	—	—	I	—	—	or every 36 months
Drum for wear or damage		—	—	—	I	—	—	—	I	—	—	or every 36 months
Ratchet for wear or damage		—	—	—	I	—	—	—	I	—	—	or every 36 months
SUSPENSION												
Spring leaves for damage		I	I	I	I	I	I	I	I	I	I	or every 9 months

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	× 1,000 km	15	30	45	60	75	90	105	120	135	150	
	× 1,000 mile	9	18	27	36	45	54	63	72	81	90	
Torsion bar spring (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Ball joint boots for damage (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Ball joints for excessive play (Independent suspension model only)		—	—	—	I	—	—	—	I	—	—	or every 36 months
Mounts for looseness or damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Shock absorbers for oil leakage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Shock absorbers mount for looseness		I	I	I	I	I	I	I	I	I	I	or every 9 months
Upper links (Independent suspension model only)		L	L	L	L	L	L	L	L	L	L	or every 9 months
WHEELS												
Wheel pins and nuts		—	T	—	T	—	T	—	T	—	T	or every 18 months
Wheel discs for damage		—	I	—	I	—	I	—	I	—	I	or every 18 months
Hub bearings grease		—	—	—	R	—	—	—	R	—	—	or every 36 months
Tire pressures and damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
ELECTRICAL EQUIPMENT												
Specific gravity of battery electrolyte		I	I	I	I	I	I	I	I	I	I	or every 9 months
OTHERS												
Lights, horn, windshield, wiper and washers		I	I	I	I	I	I	I	I	I	I	or every 9 months
Bolts and nuts on chassis and body		—	—	—	I	—	—	—	I	—	—	or every 36 months

(I): Inspect and correct or replace as necessary (A): Adjust (R): Replace or change (T): Tighten to specified torque (L): Lubricate

Maintenance schedule: 4HE1-TC engine model

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	km	11250	22500	33750	45000	56250	67500	78750	90000	
	mile	7000	14000	21000	28000	35000	42000	49000	56000	
ENGINE										
*Engine oil		—	R	—	R	—	R	—	R	or every 14 months
*Engine oil filter		—	R	—	R	—	R	—	R	or every 14 months
Fuel filter: Main fuel filter		—	R	—	R	—	R	—	R	or every 14 months
[OPT] Main fuel filter and Sub fuel filter: with Sub fuel filter		—	—	—	R	—	—	—	R	or every 28 months
*Air cleaner element		I	I	I	R	I	I	I	R	or every 28 months
Idling speed and acceleration		—	I	—	I	—	I	—	I	or every 14 months
Valve clearances		—	—	—	A	—	—	—	A	or every 28 months
Feed pump strainer		—	I	—	I	—	I	—	I	or every 14 months
Fuel tank cap and fuel pipes for loose connections or damage		—	—	—	I	—	—	—	I	or every 28 months
Drive belt tension and damage		I	I	I	I	I	I	I	I	or every 7 months
Radiator coolant		—	—	—	R	—	—	—	R	or every 28 months
*Exhaust pipes and mountings for looseness or damage		—	I	—	I	—	I	—	I	or every 14 months
Cooling system for water leakage		—	I	—	I	—	I	—	I	or every 14 months
Engine operation condition		I	I	I	I	I	I	I	I	or every 7 months
CLUTCH										
Clutch fluid		I	I	I	R	I	I	I	R	or every 28 months
Clutch pedal travel and free play		I	I	I	I	I	I	I	I	or every 7 months
TRANSMISSION										
*Manual transmission oil		I	I	I	R	I	I	I	R	or every 28 months
Gear control mechanism for looseness		—	—	—	I	—	—	—	I	or every 21 months
Gear control cables		—	A	—	A	—	A	—	A	or every 14 months
PROPELLER SHAFT										
*Universal joints and sliding sleeve grease		—	L	—	L	—	L	—	L	or every 14 months
Loose connections		I	I	I	I	I	I	I	I	or every 7 months
Splines for excessive wear		—	—	—	I	—	—	—	I	or every 28 months
Bearings and related parts for looseness		—	—	—	I	—	—	—	I	or every 28 months
Center bearing		—	L	—	L	—	L	—	L	or every 14 months
REAR AXLE										

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	km	11250	22500	33750	45000	56250	67500	78750	90000	
	mile	7000	14000	21000	28000	35000	42000	49000	56000	
*Differential gear oil		I	I	I	R	I	I	I	R	or every 28 months
FRONT AXLE										
*Kingpins		L	L	L	L	L	L	L	L	or every 7 months
STEERING										
Power steering system oil leakage		I	I	I	I	I	I	I	I	or every 7 months
Power steering system for looseness or damage		I	I	I	I	I	I	I	I	or every 7 months
Power steering fluid		—	—	—	R	—	—	—	R	or every 28 months
Power steering hoses		—	—	—	—	—	—	—	R	or every 56 months
Fitting of knuckles and front axle for looseness		I	I	I	I	I	I	I	I	or every 7 months
Steering mechanism for looseness or damage		—	—	—	I	—	—	—	I	or every 28 months
Steering wheel play		I	I	I	I	I	I	I	I	or every 7 months
Steering function		I	I	I	I	I	I	I	I	or every 7 months
Wheel alignment		—	—	—	I	—	—	—	I	or every 28 months
SERVICE BRAKES										
Brake fluid		I	I	I	R	I	I	I	R	or every 28 months
[V] Hydro booster fluid (ATF)		I	I	I	R	I	I	I	R	or every 28 months
Brake system for fluid leakage		I	I	I	I	I	I	I	I	or every 7 months
*Brake linings and drums for wear		I	I	I	I	I	I	I	I	or every 7 months
*Disc brake pads and discs for wear		I	I	I	I	I	I	I	I	or every 7 months
Brake pedal travel and free play		I	I	I	I	I	I	I	I	or every 7 months
Pipes and hoses for loose connections or damage		I	I	I	I	I	I	I	I	or every 7 months
PARKING BRAKE										
Parking brake cables		I	I	I	I	I	I	I	I	or every 7 months
Parking brake function		I	I	I	I	I	I	I	I	or every 7 months
Parking brake lever travel		I	I	I	I	I	I	I	I	or every 7 months
Linings for wear		—	—	—	I	—	—	—	I	or every 28 months
Drum for wear or damage		—	—	—	I	—	—	—	I	or every 28 months
Ratchet for wear or damage		—	—	—	I	—	—	—	I	or every 28 months
SUSPENSION										
Spring leaves for damage		I	I	I	I	I	I	I	I	or every 7 months
Mounts for looseness or damage		I	I	I	I	I	I	I	I	or every 7 months

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)									
	km	11250	22500	33750	45000	56250	67500	78750	90000	
	mile	7000	14000	21000	28000	35000	42000	49000	56000	
Shock absorbers for oil leakage		I	I	I	I	I	I	I	I	or every 7 months
Shock absorbers mount for looseness		I	I	I	I	I	I	I	I	or every 7 months
WHEELS										
Wheel pins and nuts		T	T	T	T	T	T	T	T	or every 7 months
Wheel discs for damage		I	I	I	I	I	I	I	I	or every 7 months
Hub bearings grease		—	—	—	R	—	—	—	R	or every 28 months
Tire pressures and damage		I	I	I	I	I	I	I	I	or every 7 months
ELECTRICAL EQUIPMENT										
Specific gravity of battery electrolyte		I	I	I	I	I	I	I	I	or every 7 months
OTHERS										
Lights, horn, windshield, wiper and washers		I	I	I	I	I	I	I	I	or every 7 months
Bolts and nuts on chassis and body		—	—	—	I	—	—	—	I	or every 28 months

(I): Inspect and correct or replace as necessary (A): Adjust (R): Replace or change (T): Tighten to specified torque (L): Lubricate

Maintenance schedule: 4HK1-TC engine model

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	km	11250	22500	33750	45000	56250	67500	78750	90000	
	mile	7000	14000	21000	28000	35000	42000	49000	56000	
ENGINE										
*Engine oil		Change every 20,000 km (12,000 miles)								or every 12 months
*Engine oil filter		Change every 20,000 km (12,000 miles)								or every 12 months
Fuel filter: Main fuel filter		—	R	—	R	—	R	—	R	or every 14 months
[OPT] Main fuel filter and Sub fuel filter: with Sub fuel filter		—	—	—	R	—	—	—	R	or every 28 months
*Air cleaner element		I	I	I	R	I	I	I	R	or every 28 months
Idling speed and acceleration		—	I	—	I	—	I	—	I	or every 14 months
Valve clearances		—	—	—	A	—	—	—	A	or every 28 months
Feed pump strainer		—	I	—	I	—	I	—	I	or every 14 months
Fuel tank cap and fuel pipes for loose connections or damage		—	—	—	I	—	—	—	I	or every 28 months
Drive belt tension and damage		I	I	I	I	I	I	I	I	or every 7 months
Radiator coolant		—	—	—	R	—	—	—	R	or every 28 months
*Exhaust pipes and mountings for looseness or damage		—	I	—	I	—	I	—	I	or every 14 months
Cooling system for water leakage		—	I	—	I	—	I	—	I	or every 14 months
Engine operation condition		I	I	I	I	I	I	I	I	or every 7 months
CLUTCH										
Clutch fluid		I	I	I	R	I	I	I	R	or every 28 months
Clutch pedal travel and free play		I	I	I	I	I	I	I	I	or every 7 months
TRANSMISSION										
*Manual transmission oil		I	I	I	R	I	I	I	R	or every 28 months
[SA] Smoother clutch fluid		I	I	I	R	I	I	I	R	or every 24 months
Gear control mechanism for looseness		—	—	—	I	—	—	—	I	or every 21 months
Gear control cables		—	A	—	A	—	A	—	A	or every 14 months
TRANSMISSION WITH TRANSFER CASE (NPS model only)										
*Transmission with transfer case oil		I	I	I	R	I	I	I	R	or every 28 months
Gear control mechanism for looseness		—	—	—	I	—	—	—	I	or every 21 months
Gear control cables		—	A	—	A	—	A	—	A	or every 14 months

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	km	11250	22500	33750	45000	56250	67500	78750	90000	
	mile	7000	14000	21000	28000	35000	42000	49000	56000	
PROPELLER SHAFT										
*Universal joints and sliding sleeve grease		—	L	—	L	—	L	—	L	or every 14 months
Loose connections		I	I	I	I	I	I	I	I	or every 7 months
Splines for excessive wear		—	—	—	I	—	—	—	I	or every 28 months
Bearings and related parts for looseness		—	—	—	I	—	—	—	I	or every 28 months
Center bearing		—	L	—	L	—	L	—	L	or every 14 months
REAR AXLE										
*Differential gear oil		I	I	I	R	I	I	I	R	or every 28 months
FRONT AXLE										
*Kingpins		L	L	L	L	L	L	L	L	or every 7 months
*Differential gear oil (NPS model only)		I	I	I	R	I	I	I	R	or every 28 months
STEERING										
Power steering system oil leakage		I	I	I	I	I	I	I	I	or every 7 months
Power steering system for looseness or damage		I	I	I	I	I	I	I	I	or every 7 months
Power steering fluid		—	—	—	R	—	—	—	R	or every 28 months
Power steering hoses		—	—	—	—	—	—	—	R	or every 56 months
Fitting of knuckles and front axle for looseness		I	I	I	I	I	I	I	I	or every 7 months
Steering mechanism for looseness or damage		—	—	—	I	—	—	—	I	or every 28 months
Steering wheel play		I	I	I	I	I	I	I	I	or every 7 months
Steering function		I	I	I	I	I	I	I	I	or every 7 months
Wheel alignment		—	—	—	I	—	—	—	I	or every 28 months
SERVICE BRAKES										
Brake fluid		I	I	I	R	I	I	I	R	or every 28 months
[V] Hydro booster fluid (ATF)		I	I	I	R	I	I	I	R	or every 28 months
Brake system for fluid leakage		I	I	I	I	I	I	I	I	or every 7 months
*Brake linings and drums for wear		I	I	I	I	I	I	I	I	or every 7 months
*Disc brake pads and discs for wear		I	I	I	I	I	I	I	I	or every 7 months
Brake pedal travel and free play		I	I	I	I	I	I	I	I	or every 7 months
Pipes and hoses for loose connections or damage		I	I	I	I	I	I	I	I	or every 7 months
PARKING BRAKE										
Parking brake cables		I	I	I	I	I	I	I	I	or every 7 months

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	km	11250	22500	33750	45000	56250	67500	78750	90000	
	mile	7000	14000	21000	28000	35000	42000	49000	56000	
Parking brake function		I	I	I	I	I	I	I	I	or every 7 months
Parking brake lever travel		I	I	I	I	I	I	I	I	or every 7 months
Linings for wear		—	—	—	I	—	—	—	I	or every 28 months
Drum for wear or damage		—	—	—	I	—	—	—	I	or every 28 months
Ratchet for wear or damage		—	—	—	I	—	—	—	I	or every 28 months
SUSPENSION										
Spring leaves for damage		I	I	I	I	I	I	I	I	or every 7 months
Mounts for looseness or damage		I	I	I	I	I	I	I	I	or every 7 months
Shock absorbers for oil leakage		I	I	I	I	I	I	I	I	or every 7 months
Shock absorbers mount for looseness		I	I	I	I	I	I	I	I	or every 7 months
WHEELS										
Wheel pins and nuts		T	T	T	T	T	T	T	T	or every 7 months
Wheel discs for damage		I	I	I	I	I	I	I	I	or every 7 months
Hub bearings grease		—	—	—	R	—	—	—	R	or every 28 months
Tire pressures and damage		I	I	I	I	I	I	I	I	or every 7 months
ELECTRICAL EQUIPMENT										
Specific gravity of battery electrolyte		I	I	I	I	I	I	I	I	or every 7 months
OTHERS										
Lights, horn, windshield, wiper and washers		I	I	I	I	I	I	I	I	or every 7 months
Bolts and nuts on chassis and body		—	—	—	I	—	—	—	I	or every 28 months

(I): Inspect and correct or replace as necessary (A): Adjust (R): Replace or change (T): Tighten to specified torque (L): Lubricate

Maintenance Schedule under Severe Driving Conditions

Severe driving conditions
A : Repeated short trips
B : Driving on rough roads
C : Driving on dusty roads
D : Driving in extremely cold weather and/or on salted roads

Item	Interval	Condition				
		A	B	C	D	A+D
Engine oil	Change every 5,000 km (3,000 miles)			❍		❍
Engine oil filter	Replace every 5,000 km (3,000 miles)			❍		❍
Air cleaner element	Replace every 20,000 km (12,000 miles)			❍		
Exhaust pipes and mountings for looseness or damage	Inspect every 10,000 km (6,000 miles)	❍	❍		❍	
Manual transmission oil and differential gear oil	Change every 20,000 km (12,000 miles)		❍			
[SA] Smoother clutch fluid	Change every 20,000 km (12,000 miles)		❍			
Universal joints and sliding sleeve grease	Lubricate every 10,000 km (6,000 miles)		❍			
Kingpins	Lubricate every 5,000 km (3,000 miles)			❍	❍	
Steering system for looseness or damage	Inspect every 5,000 km (3,000 miles)		❍			
Brake linings and drums for wear	Inspect every 5,000 km (3,000 miles)	❍	❍	❍		
Disc brake pads and discs for wear	Inspect every 5,000 km (3,000 miles)	❍	❍	❍		

For Europe

When performing the checks on the following items, regular inspection items should also be checked.

Abbreviations

I :Inspect, clean and correct or replace as necessary
A : Adjust
R : Replace or change
T : Tighten to specified torque
L : Lubricate
[V] : Variation (optional on some models).
[OPT] : Optional equipment.
[SA] : For Smoother model only.
*Marks: Under severe driving conditions, more frequent maintenance is required. Refer to “Maintenance schedule under severe driving conditions”.

Maintenance Schedule: 4JH1-TC Engine Model (Engine Oil that Meets or Exceeds ACEA B3 Specification)

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	× 1,000 km	20	40	60	80	100	120	
	× 1,000 mile	12	24	36	48	60	72	
ENGINE								
*Engine oil		R	R	R	R	R	R	Or every 9 months
*Engine oil filter		R	R	R	R	R	R	Or every 9 months
Fuel filter		R	R	R	R	R	R	Or every 18 months
*Air cleaner element		I	I	R	I	I	R	Or every 36 months
Idling speed and acceleration		—	I	—	I	—	I	Or every 18 months
Valve clearances		—	—	A	—	—	A	Or every 36 months
Fuel tank cap and fuel pipes for loose connections or damage		—	—	I	—	—	I	Or every 36 months
Drive belt tension and damage		I	I	I	I	I	I	Or every 9 months
Radiator coolant		—	—	R	—	—	R	Or every 36 months
*Exhaust pipes and mountings for looseness or damage		—	I	—	I	—	I	Or every 18 months
Cooling system for water leakage		—	I	—	I	—	I	Or every 18 months
Engine operation condition		I	I	I	I	I	I	Or every 9 months
CLUTCH								
Clutch fluid		I	I	R	I	I	R	Or every 24 months
Clutch pedal travel and free play		I	I	I	I	I	I	Or every 6 months
TRANSMISSION								
*Manual transmission oil		I	I	R	I	I	R	Or every 24 months
Gear control mechanism for looseness		—	—	I	—	—	I	Or every 24 months
Gear control cables		—	A	—	A	—	A	Or every 12 months
PROPELLER SHAFT								
*Universal joints and sliding sleeve grease		L	L	L	L	L	L	Or every 12 months

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	× 1,000 km	20	40	60	80	100	120	
	× 1,000 mile	12	24	36	48	60	72	
Loose connections		I	I	I	I	I	I	Or every 6 months
Splines for excessive wear		—	—	I	—	—	I	Or every 24 months
Bearings and related parts for looseness		—	—	I	—	—	I	Or every 24 months
Center bearing		L	L	L	L	L	L	Or every 12 months
REAR AXLE								
*Differential gear oil		I	I	R	I	I	R	Or every 24 months
FRONT AXLE								
*Kingpins		L	L	L	L	L	L	Or every 9 months
STEERING								
Power steering system oil leakage		I	I	I	I	I	I	Or every 9 months
Power steering system for looseness or damage		I	I	I	I	I	I	Or every 9 months
Power steering fluid		—	—	R	—	—	R	Or every 36 months
Power steering hoses		—	—	—	—	—	R	Or every 72 months
Fitting of knuckles and front axle for looseness		I	I	I	I	I	I	Or every 9 months
Steering mechanism for looseness or damage		—	—	I	—	—	I	Or every 36 months
Ball joints for damage (Independent suspension model only)		I	I	I	I	I	I	Or every 9 months
Ball joints for excessive play (Independent suspension model only)		I	I	I	I	I	I	Or every 9 months
Relay lever shaft for excessive play (Independent suspension model only)		I	I	I	I	I	I	Or every 9 months
Steering wheel play		I	I	I	I	I	I	Or every 9 months
Steering function		I	I	I	I	I	I	Or every 9 months
Wheel alignment		—	—	I	—	—	I	Or every 36 months
SERVICE BRAKES								
Brake fluid		I	I	R	I	I	R	Or every 36 months
Brake system for fluid leakage		I	I	I	I	I	I	Or every 9 months
*Brake linings and drums for wear		I	I	I	I	I	I	Or every 9 months
*Disc brake pads and discs for wear		I	I	I	I	I	I	Or every 9 months
Brake pedal travel and free play		I	I	I	I	I	I	Or every 9 months
Pipes and hoses for loose connections or damage		I	I	I	I	I	I	Or every 9 months
PARKING BRAKE								

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)								
	× 1,000 km	20	40	60	80	100	120	
	× 1,000 mile	12	24	36	48	60	72	
Parking brake cables		I	I	I	I	I	I	Or every 9 months
Parking brake function		I	I	I	I	I	I	Or every 9 months
Parking brake lever travel		I	I	I	I	I	I	Or every 9 months
Linings for wear		—	—	I	—	—	I	Or every 36 months
Drum for wear or damage		—	—	I	—	—	I	Or every 36 months
Ratchet for wear or damage		—	—	I	—	—	I	Or every 36 months
SUSPENSION								
Spring leaves for damage		I	I	I	I	I	I	Or every 9 months
Torsion bar spring (Independent suspension model only)		I	I	I	I	I	I	Or every 9 months
Ball joint boots for damage (Independent suspension model only)		I	I	I	I	I	I	Or every 9 months
Ball joints for excessive play (Independent suspension model only)		—	—	I	—	—	I	Or every 36 months
Mounts for looseness or damage		I	I	I	I	I	I	Or every 9 months
Shock absorbers for oil leakage		I	I	I	I	I	I	Or every 9 months
Shock absorbers mount for looseness		I	I	I	I	I	I	Or every 9 months
Upper links (Independent suspension model only)		L	L	L	L	L	L	Or every 9 months
WHEELS								
Wheel pins and nuts		—	T	—	T	—	T	Or every 18 months
Wheel discs for damage		—	I	—	I	—	I	Or every 18 months
Hub bearings grease		—	—	R	—	—	R	Or every 36 months
Tire pressures and damage		I	I	I	I	I	I	Or every 9 months
ELECTRICAL EQUIPMENT								
Specific gravity of battery electrolyte		I	I	I	I	I	I	Or every 9 months
OTHERS								
Lights, horn, windshield, wiper and washers		I	I	I	I	I	I	Or every 9 months
Bolts and nuts on chassis and body		—	—	I	—	—	I	Or every 36 months

(I): Inspect and correct or replace as necessary (A): Adjust (R): Replace or change (T): Tighten to specified torque (L): Lubricate

Maintenance Schedule: 4JH1-TC Engine Model (ACEA B2 Specification Engine Oil)

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	× 1,000 km	15	30	45	60	75	90	105	120	135	150	
	× 1,000 mile	9	18	27	36	45	54	63	72	81	90	
ENGINE												
*Engine oil		R	R	R	R	R	R	R	R	R	R	or every 9 months
*Engine oil filter		R	R	R	R	R	R	R	R	R	R	or every 9 months
Fuel filter		—	R	—	R	—	R	—	R	—	R	or every 18 months
*Air cleaner element		I	I	I	R	I	I	I	R	I	I	or every 36 months
Idling speed and acceleration		—	I	—	I	—	I	—	I	—	I	or every 18 months
Valve clearances		—	—	—	A	—	—	—	A	—	—	or every 36 months
Fuel tank cap and fuel pipes for loose connections or damage		—	—	—	I	—	—	—	I	—	—	or every 36 months
Drive belt tension and damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Radiator coolant		—	—	—	R	—	—	—	R	—	—	or every 36 months
*Exhaust pipes and mountings for looseness or damage		—	I	—	I	—	I	—	I	—	I	or every 18 months
Cooling system for water leakage		—	I	—	I	—	I	—	I	—	I	or every 18 months
Engine operation condition		I	I	I	I	I	I	I	I	I	I	or every 9 months
CLUTCH												
Clutch fluid		I	I	I	R	I	I	I	R	I	I	or every 36 months
Clutch pedal travel and free play		I	I	I	I	I	I	I	I	I	I	or every 9 months
TRANSMISSION												
*Manual transmission oil		I	I	I	R	I	I	I	R	I	I	or every 36 months
Gear control mechanism for looseness		—	—	—	I	—	—	—	I	—	—	or every 36 months
Gear control cables		—	A	—	A	—	A	—	A	—	A	or every 18 months
PROPELLER SHAFT												
*Universal joints and sliding sleeve grease		—	L	—	L	—	L	—	L	—	L	or every 18 months
Loose connections		I	I	I	I	I	I	I	I	I	I	or every 9 months
Splines for excessive wear		—	—	—	I	—	—	—	I	—	—	or every 36 months
Bearings and related parts for looseness		—	—	—	I	—	—	—	I	—	—	or every 36 months
Center bearing		—	L	—	L	—	L	—	L	—	L	or every 18 months
REAR AXLE												
*Differential gear oil		I	I	I	R	I	I	I	R	I	I	or every 36 months
FRONT AXLE												
*Kingpins		L	L	L	L	L	L	L	L	L	L	or every 9 months
STEERING												

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	× 1,000 km	15	30	45	60	75	90	105	120	135	150	
	× 1,000 mile	9	18	27	36	45	54	63	72	81	90	
Power steering system oil leakage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Power steering system for looseness or damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Power steering fluid		—	—	—	R	—	—	—	R	—	—	or every 36 months
Power steering hoses		—	—	—	—	—	—	—	R	—	—	or every 72 months
Fitting of knuckles and front axle for looseness		I	I	I	I	I	I	I	I	I	I	or every 9 months
Steering mechanism for looseness or damage		—	—	—	I	—	—	—	I	—	—	or every 36 months
Ball joints for damage (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Ball joints for excessive play (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Relay lever shaft for excessive play (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Steering wheel play		I	I	I	I	I	I	I	I	I	I	or every 9 months
Steering function		I	I	I	I	I	I	I	I	I	I	or every 9 months
Wheel alignment		—	—	—	I	—	—	—	I	—	—	or every 36 months
SERVICE BRAKES												
Brake fluid		I	I	I	R	I	I	I	R	I	I	or every 36 months
Brake system for fluid leakage		I	I	I	I	I	I	I	I	I	I	or every 9 months
*Brake linings and drums for wear		I	I	I	I	I	I	I	I	I	I	or every 9 months
*Disc brake pads and discs for wear		I	I	I	I	I	I	I	I	I	I	or every 9 months
Brake pedal travel and free play		I	I	I	I	I	I	I	I	I	I	or every 9 months
Pipes and hoses for loose connections or damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
PARKING BRAKE												
Parking brake cables		I	I	I	I	I	I	I	I	I	I	or every 9 months
Parking brake function		I	I	I	I	I	I	I	I	I	I	or every 9 months
Parking brake lever travel		I	I	I	I	I	I	I	I	I	I	or every 9 months
Linings for wear		—	—	—	I	—	—	—	I	—	—	or every 36 months
Drum for wear or damage		—	—	—	I	—	—	—	I	—	—	or every 36 months
Ratchet for wear or damage		—	—	—	I	—	—	—	I	—	—	or every 36 months
SUSPENSION												
Spring leaves for damage		I	I	I	I	I	I	I	I	I	I	or every 9 months

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	× 1,000 km	15	30	45	60	75	90	105	120	135	150	
	× 1,000 mile	9	18	27	36	45	54	63	72	81	90	
Torsion bar spring (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Ball joint boots for damage (Independent suspension model only)		I	I	I	I	I	I	I	I	I	I	or every 9 months
Ball joints for excessive play (Independent suspension model only)		—	—	—	I	—	—	—	I	—	—	or every 36 months
Mounts for looseness or damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Shock absorbers for oil leakage		I	I	I	I	I	I	I	I	I	I	or every 9 months
Shock absorbers mount for looseness		I	I	I	I	I	I	I	I	I	I	or every 9 months
Upper links (Independent suspension model only)		L	L	L	L	L	L	L	L	L	L	or every 9 months
WHEELS												
Wheel pins and nuts		—	T	—	T	—	T	—	T	—	T	or every 18 months
Wheel discs for damage		—	I	—	I	—	I	—	I	—	I	or every 18 months
Hub bearings grease		—	—	—	R	—	—	—	R	—	—	or every 36 months
Tire pressures and damage		I	I	I	I	I	I	I	I	I	I	or every 9 months
ELECTRICAL EQUIPMENT												
Specific gravity of battery electrolyte		I	I	I	I	I	I	I	I	I	I	or every 9 months
OTHERS												
Lights, horn, windshield, wiper and washers		I	I	I	I	I	I	I	I	I	I	or every 9 months
Bolts and nuts on chassis and body		—	—	—	I	—	—	—	I	—	—	or every 36 months

(I): Inspect and correct or replace as necessary (A): Adjust (R): Replace or change (T): Tighten to specified torque (L): Lubricate

Maintenance schedule: 4HK1-TC engine model

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	km	11250	22500	33750	45000	56250	67500	78750	90000	
	mile	7000	14000	21000	28000	35000	42000	49000	56000	
ENGINE										
*Engine oil		Change every 20,000 km (12,000 miles)								or every 12 months
*Engine oil filter		Change every 20,000 km (12,000 miles)								or every 12 months
Fuel filter: Main fuel filter		—	R	—	R	—	R	—	R	or every 14 months
[OPT] Main fuel filter and Sub fuel filter: with Sub fuel filter		—	—	—	R	—	—	—	R	or every 28 months
*Air cleaner element		I	I	I	R	I	I	I	R	or every 28 months
Idling speed and acceleration		—	I	—	I	—	I	—	I	or every 14 months
Valve clearances		—	—	—	A	—	—	—	A	or every 28 months
Feed pump strainer		—	I	—	I	—	I	—	I	or every 14 months
Fuel tank cap and fuel pipes for loose connections or damage		—	—	—	I	—	—	—	I	or every 28 months
Drive belt tension and damage		I	I	I	I	I	I	I	I	or every 7 months
Radiator coolant		—	—	—	R	—	—	—	R	or every 28 months
*Exhaust pipes and mountings for looseness or damage		—	I	—	I	—	I	—	I	or every 14 months
Cooling system for water leakage		—	I	—	I	—	I	—	I	or every 14 months
Engine operation condition		I	I	I	I	I	I	I	I	or every 7 months
CLUTCH										
Clutch fluid		I	I	I	R	I	I	I	R	or every 28 months
Clutch pedal travel and free play		I	I	I	I	I	I	I	I	or every 7 months
TRANSMISSION										
*Manual transmission oil		I	I	I	R	I	I	I	R	or every 28 months
[SA] Smoother clutch fluid		I	I	I	R	I	I	I	R	or every 24 months
Gear control mechanism for looseness		—	—	—	I	—	—	—	I	or every 21 months
Gear control cables		—	A	—	A	—	A	—	A	or every 14 months
PROPELLER SHAFT										
*Universal joints and sliding sleeve grease		—	L	—	L	—	L	—	L	or every 14 months
Loose connections		I	I	I	I	I	I	I	I	or every 7 months
Splines for excessive wear		—	—	—	I	—	—	—	I	or every 28 months
Bearings and related parts for looseness		—	—	—	I	—	—	—	I	or every 28 months
Center bearing		—	L	—	L	—	L	—	L	or every 14 months

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	km	11250	22500	33750	45000	56250	67500	78750	90000	
	mile	7000	14000	21000	28000	35000	42000	49000	56000	
REAR AXLE										
*Differential gear oil		I	I	I	R	I	I	I	R	or every 28 months
FRONT AXLE										
*Kingpins		L	L	L	L	L	L	L	L	or every 7 months
STEERING										
Power steering system oil leakage		I	I	I	I	I	I	I	I	or every 7 months
Power steering system for looseness or damage		I	I	I	I	I	I	I	I	or every 7 months
Power steering fluid		—	—	—	R	—	—	—	R	or every 28 months
Power steering hoses		—	—	—	—	—	—	—	R	or every 56 months
Fitting of knuckles and front axle for looseness		I	I	I	I	I	I	I	I	or every 7 months
Steering mechanism for looseness or damage		—	—	—	I	—	—	—	I	or every 28 months
Steering wheel play		I	I	I	I	I	I	I	I	or every 7 months
Steering function		I	I	I	I	I	I	I	I	or every 7 months
Wheel alignment		—	—	—	I	—	—	—	I	or every 28 months
SERVICE BRAKES										
Brake fluid		I	I	I	R	I	I	I	R	or every 28 months
[V] Hydro booster fluid (ATF)		I	I	I	R	I	I	I	R	or every 28 months
Brake system for fluid leakage		I	I	I	I	I	I	I	I	or every 7 months
*Brake linings and drums for wear		I	I	I	I	I	I	I	I	or every 7 months
*Disc brake pads and discs for wear		I	I	I	I	I	I	I	I	or every 7 months
Brake pedal travel and free play		I	I	I	I	I	I	I	I	or every 7 months
Pipes and hoses for loose connections or damage		I	I	I	I	I	I	I	I	or every 7 months
PARKING BRAKE										
Parking brake cables		I	I	I	I	I	I	I	I	or every 7 months
Parking brake function		I	I	I	I	I	I	I	I	or every 7 months
Parking brake lever travel		I	I	I	I	I	I	I	I	or every 7 months
Linings for wear		—	—	—	I	—	—	—	I	or every 28 months
Drum for wear or damage		—	—	—	I	—	—	—	I	or every 28 months
Ratchet for wear or damage		—	—	—	I	—	—	—	I	or every 28 months
SUSPENSION										
Spring leaves for damage		I	I	I	I	I	I	I	I	or every 7 months
Mounts for looseness or damage		I	I	I	I	I	I	I	I	or every 7 months

SERVICE INTERVAL: (Use odometer reading or months Whichever comes first)	km	11250	22500	33750	45000	56250	67500	78750	90000	
	mile	7000	14000	21000	28000	35000	42000	49000	56000	
Shock absorbers for oil leakage		I	I	I	I	I	I	I	I	or every 7 months
Shock absorbers mount for looseness		I	I	I	I	I	I	I	I	or every 7 months
WHEELS										
Wheel pins and nuts		T	T	T	T	T	T	T	T	or every 7 months
Wheel discs for damage		I	I	I	I	I	I	I	I	or every 7 months
Hub bearings grease		—	—	—	R	—	—	—	R	or every 28 months
Tire pressures and damage		I	I	I	I	I	I	I	I	or every 7 months
ELECTRICAL EQUIPMENT										
Specific gravity of battery electrolyte		I	I	I	I	I	I	I	I	or every 7 months
OTHERS										
Lights, horn, windshield, wiper and washers		I	I	I	I	I	I	I	I	or every 7 months
Bolts and nuts on chassis and body		—	—	—	I	—	—	—	I	or every 28 months

(I): Inspect and correct or replace as necessary (A): Adjust (R): Replace or change (T): Tighten to specified torque (L): Lubricate

Maintenance Schedule under Severe Driving Conditions

Severe driving conditions
A : Repeated short trips
B : Driving on rough roads
C : Driving on dusty roads
D : Driving in extremely cold weather and/or on salted roads

Item	Interval	Condition				
		A	B	C	D	A+D
Engine oil	Change every 5,000 km (3,000 miles)			❍		❍
Engine oil filter	Replace every 5,000 km (3,000 miles)			❍		❍
Air cleaner element	Replace every 20,000 km (12,000 miles)			❍		
Exhaust pipes and mountings for looseness or damage	Inspect every 10,000 km (6,000 miles)	❍	❍		❍	
Manual transmission oil and differential gear oil	Change every 20,000 km (12,000 miles)		❍			
[SA] Smoother clutch fluid	Change every 20,000 km (12,000 miles)		❍			
Universal joints and sliding sleeve grease	Lubricate every 10,000 km (6,000 miles)		❍			
Kingpins	Lubricate every 5,000 km (3,000 miles)			❍	❍	
Steering system for looseness or damage	Inspect every 5,000 km (3,000 miles)		❍			
Brake linings and drums for wear	Inspect every 5,000 km (3,000 miles)	❍	❍	❍		
Disc brake pads and discs for wear	Inspect every 5,000 km (3,000 miles)	❍	❍	❍		

RECOMMENDED FLUIDS, LUBRICANTS AND DIESEL FUELS

Recommended Fluids, Lubricants and Diesel Fuels

In order to obtain maximum performance and longest service life from ISUZU vehicles, it is very important to select and use correctly best lubricants and diesel fuels.
When lubricating, be sure to use ISUZU genuine lubricants or recommended lubricants listed below, according to the maintenance schedule for each vehicle model.
The lubrication intervals in the maintenance schedule and the coverage and period of new vehicle warranty are based on the use of ISUZU genuine lubricants or recommended lubricants as given in the chart which will serve as a guide for selecting lubricants of proper brand name.

LUBRICATION	MAKER	BRAND/TYPE	GRADE		
			API	ACEA	JASO
Diesel engine crankcase	**ISUZU GENUINE**	**BESCO MULTI-Z TYPE CF-4 (10W-30)**	**CF-4**		
	ISUZU GENUINE	**BESCO S-3 (10W, 20W, 30, 40)**	**CD**		
	Caltex/Chevron	Delo CXJ (15W-40/20W-50/40)	CF		DH-1
		Delo 400 Multigrade (15W-40)	CE/CF/CI-4	E3/E5	DH-1
	Shell	Rimula X (15W-40)	CH-4	E3	DH-1
		Rimula D (15W-40/30/40)	CF		
	Elf	Perfo 3F (15W-40)	CF-4/CE	B2/E2	
	Total	Rubia XT (15W-40)	CF-4	E2	
	Castrol	RX Super Plus (15W-40)	CH-4	E3	
		Tection J Plus (15W-40)	CH-4	E3/B3	DH-1
	BP	BP Vanellus C6 (15W-40)	CH-4	E3	
	ExxonMobil	Essolube XTJ (15W-40)	CF-4		DH-1
		Exxon/Essolube XD-3 (15W-40)	CI-4		
Differential	**ISUZU GENUINE**	**BESCO GEAR OIL SH (80W-90, 90, 140)**	**GL-5**		
	Caltex	Thuban GL-5 EP (80W-90/85W-140)	GL-5		
	Shell	Spirax A (140)	GL-5		
	Elf	Tranself Type B (80W-90/85W-140)	GL-5		
	Total	Transmission TM (80W-90/85W-140)	GL-5		
	Castrol	EPX 90 (90)	GL-5		
		Dynadrive (80W-90)	GL-5		
	BP	Energear Hypo (90)	GL-5		
		Energear EP (80W-90)	GL-5		
	ExxonMobil	Mobilube HD (80W-90)	GL-5		
		Esso Gear Oil GX (80W-90)	GL-5		

LUBRICATION	MAKER	BRAND/TYPE	GRADE		
			API	ACEA	JASO
Differential (Limited slip differential)	**ISUZU GENUINE**	**BESCO GEAR OIL LSD (140)**	***GL-5**		
	Caltex	Gear Oil LSD (90)	GL-5		
	Shell	Spirax A LS 90 (90)	GL-5		
	Elf	Tranself Type BLS (90)	GL-5		
	Total	Transmission DA (85W-90)	GL-5		
	Castrol	Hypoy LSX (90)	GL-5		
	BP	Energear LS-M (90)	GL-5		
	ExxonMobil	Mobilube LS (85W-90)	GL-5		
		Esso Gear Oil LSA (85W-90)	GL-5		
Manual transmission Transfer case	**ISUZU GENUINE**	**BESCO GEAR OIL TRANSAXLE (5W-30)**	**SG**		
	Caltex/Chevron	Delo 400 Multigrade (15W-40)	CD/CE/CF/CI-4	E3/E5	DH-1
	Shell	Helix Plus (15W-50)	SJ/CF	A3/B3	
	Elf	Super Sporti (15W-40)	SG/CD		
	Total	Quartz 5000 (15W-40/20W-50)	SJ/CF	A2/B2	
	Castrol	RX Super Plus (15W-40)	CD/CE/CF		
	BP	BP Vanellus C6 (15W-40)	CD/CE/CF		
Power steering Hydro brake booster	**ISUZU GENUINE**	**BESCO ATF II, ATF III**			
	Caltex/Texaco	Texamatic 1888 (Dexron III)			
	Shell	Donax TG (Dexron III)			
	Elf	ELFMATIC G3 (Dexron III)			
	Total	Total Fluid AT 42 (Dexron III)			
	Castrol	TQ Dexron III (Dexron III)			
	BP	Autoran DX3 (Dexron III)			
Clutch (Smoother)	**ISUZU GENUINE**	**BESCO ATF III**			
		or equivalent to BESCO ATF III			
Center bearing King pin Upper links (Multi purpose grease)	**ISUZU GENUINE**	**BESCO L-2 GREASE (No.2), L-3 GREASE (No.3)**			
	Caltex/Texaco	Starplex-2 (No.2)			
	Shell	Retinax LX2 (No.2)			
	Total	Multis EP2/EP3 (No.2/No.3)			
	Castrol	LM Grease (No.2/No.3)			
	BP	Energrease LS (No.2/No.3)			
Propeller shaft sliding yoke Universal joint (Multi purpose grease containing molybdenum disulfide)	**ISUZU GENUINE**	**ONE LUBER MO GREASE**			
	Caltex	Molytex Grease EP2 (No.2)			
	Shell	Retinax HDX2 (No.2)			
	Total	Total Multis MS2 (No.2/No.3)			

LUBRICATION	MAKER	BRAND/TYPE	GRADE		
			API	ACEA	JASO
Engine cooling system	**ISUZU GENUINE** Caltex/Texaco/ Chevron	**BESCO LLC SUPER TYPE E** Extended Life Coolant Havoline XLC Delo XLC			

* If GL-5 Limited Slip Differential Lubricant is not available, use GL-5 Lubricant together with Limited Slip Differential Lubricant additive (Parts No. 8-01052-358-0) or equivalent.

FLUID	TYPE
Clutch and brake fluid reservoir	**Besco brake fluid SUPER** Hydraulic brake fluid SAE J1703 FMVSS 116 DOT.3 grade

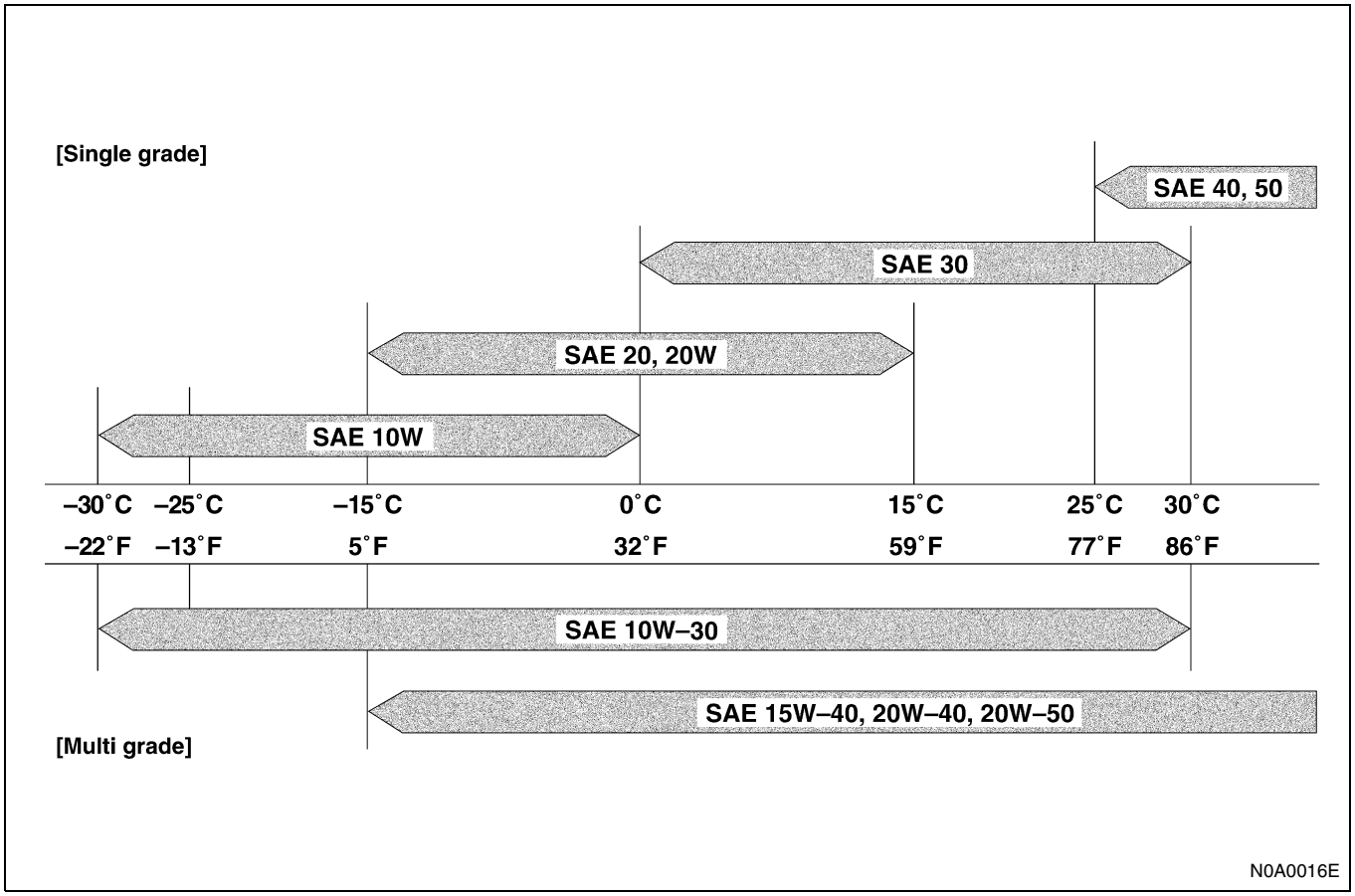
DIESEL FUEL/APPLICABLE STANDARD	
JIS (JAPANESE INDUSTRIAL STANDARD)	Based on K2204 GAS OIL
DIN (DEUTSCHE INDUSTRIE NORMEN)	Based on EN590: 1997
SAE (SOCIETY OF AUTOMOTIVE ENGINEERS)	Based on SAE J-313C
BS (BRITISH STANDARD)	Based on BS EN590-1997

Notice:
When the recommended lubricants are specified in this manual, follow them.

OIL VISCOSITY CHART

Engine Oil

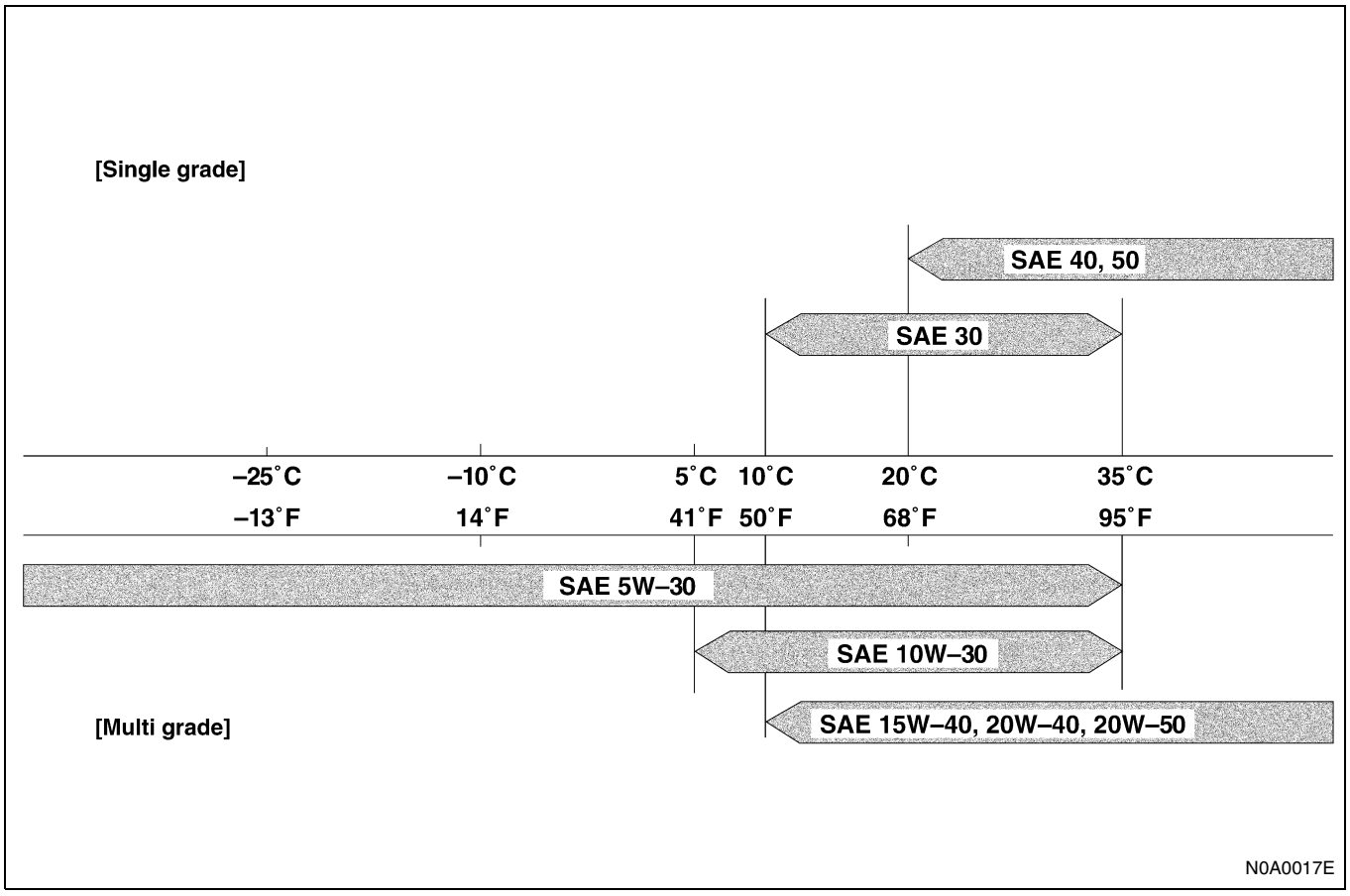
Engine Oil Viscosity Grade - Ambient Temperature



DO NOT USE SYNTHETIC OILS.
* At ambient temperatures below –25°C (–13°F), starting aids (oil pan heater, block heater, etc.) are recommended to prevent hard starting and other engine problems.

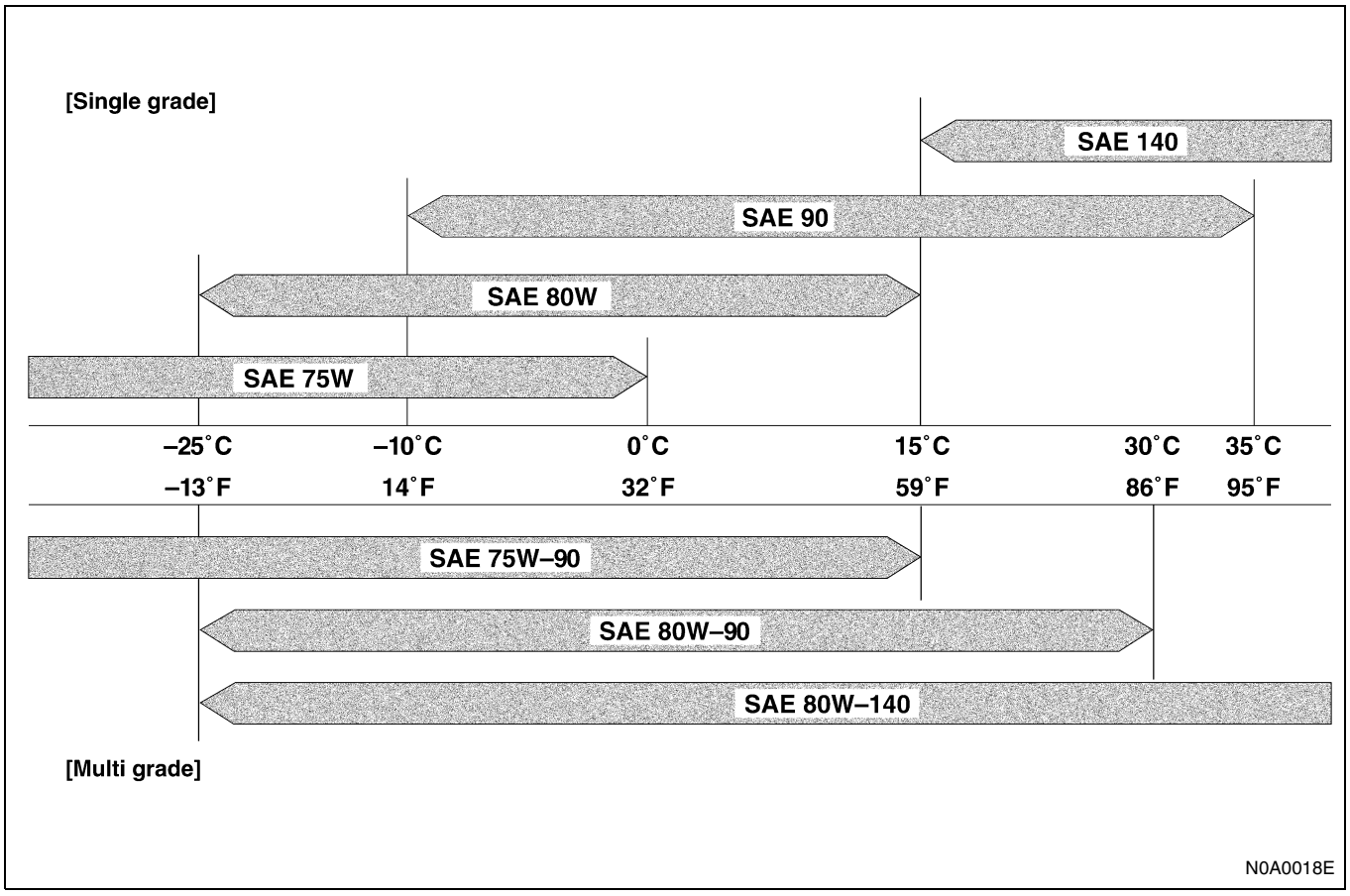
Manual Transmission and Transfer Case Oil (Engine Oil)

Viscosity Grade - Ambient Temperature



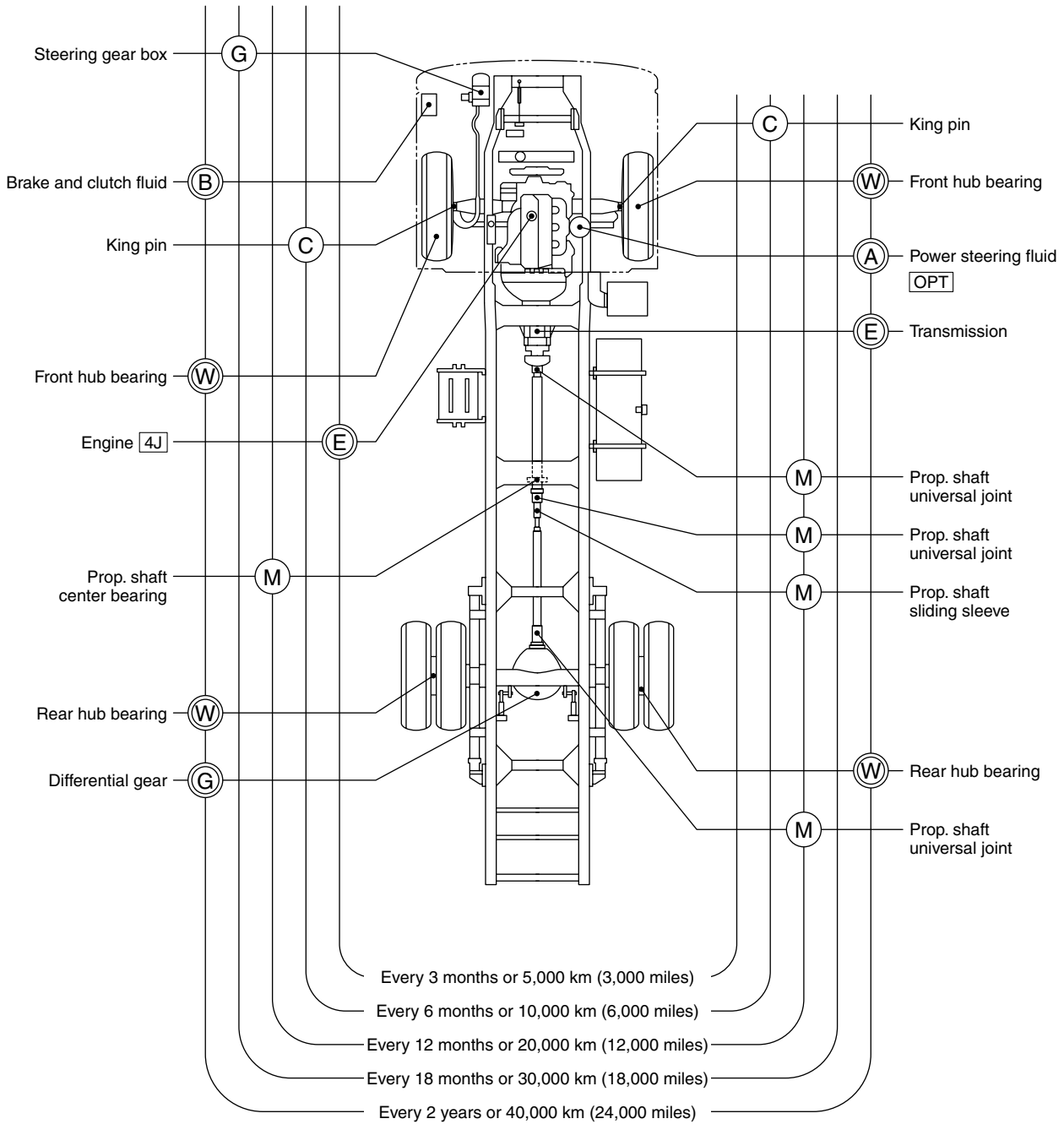
Front Axle and Rear Axle Oil

Gear Oil Viscosity Grade - Ambient Temperature



LUBRICATION CHART

NHR55/69 Models



◎ : Change

○ : Check and Replenish or Lubricate

E : Engine oil

G : Gear oil

W : Wheel bearing grease

C : Multipurpose type grease

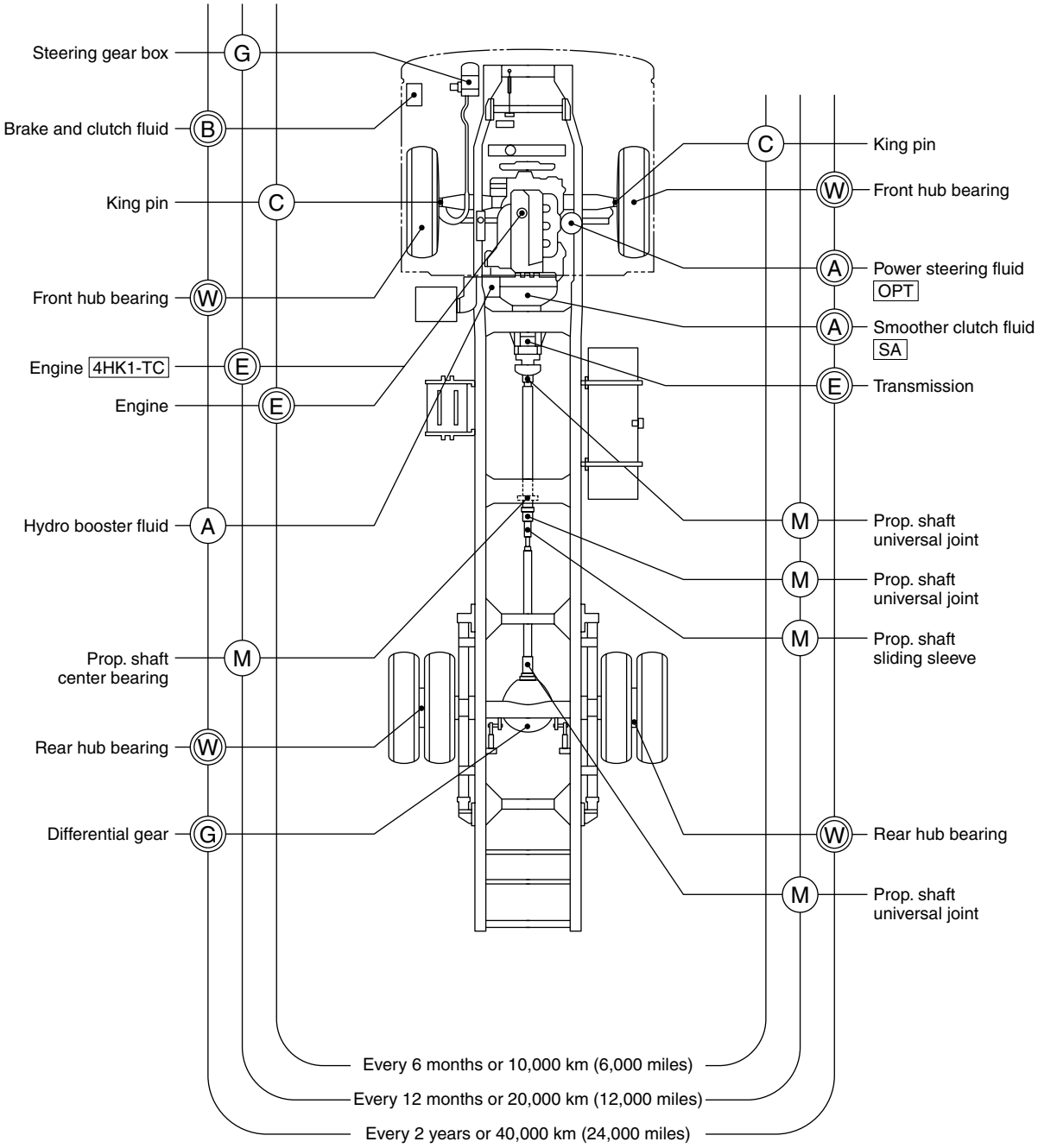
M : MoS_2 contained type grease

B : Brake fluid

A : Automatic transmission fluid

N0A0027E

NKR66/71, NPR66/70/71/75, NQR66/70/71/75 Models



◎ : Change

○ : Check and Replenish or Lubricate

E : Engine oil

G : Gear oil

W : Wheel bearing grease

C : Multipurpose type grease

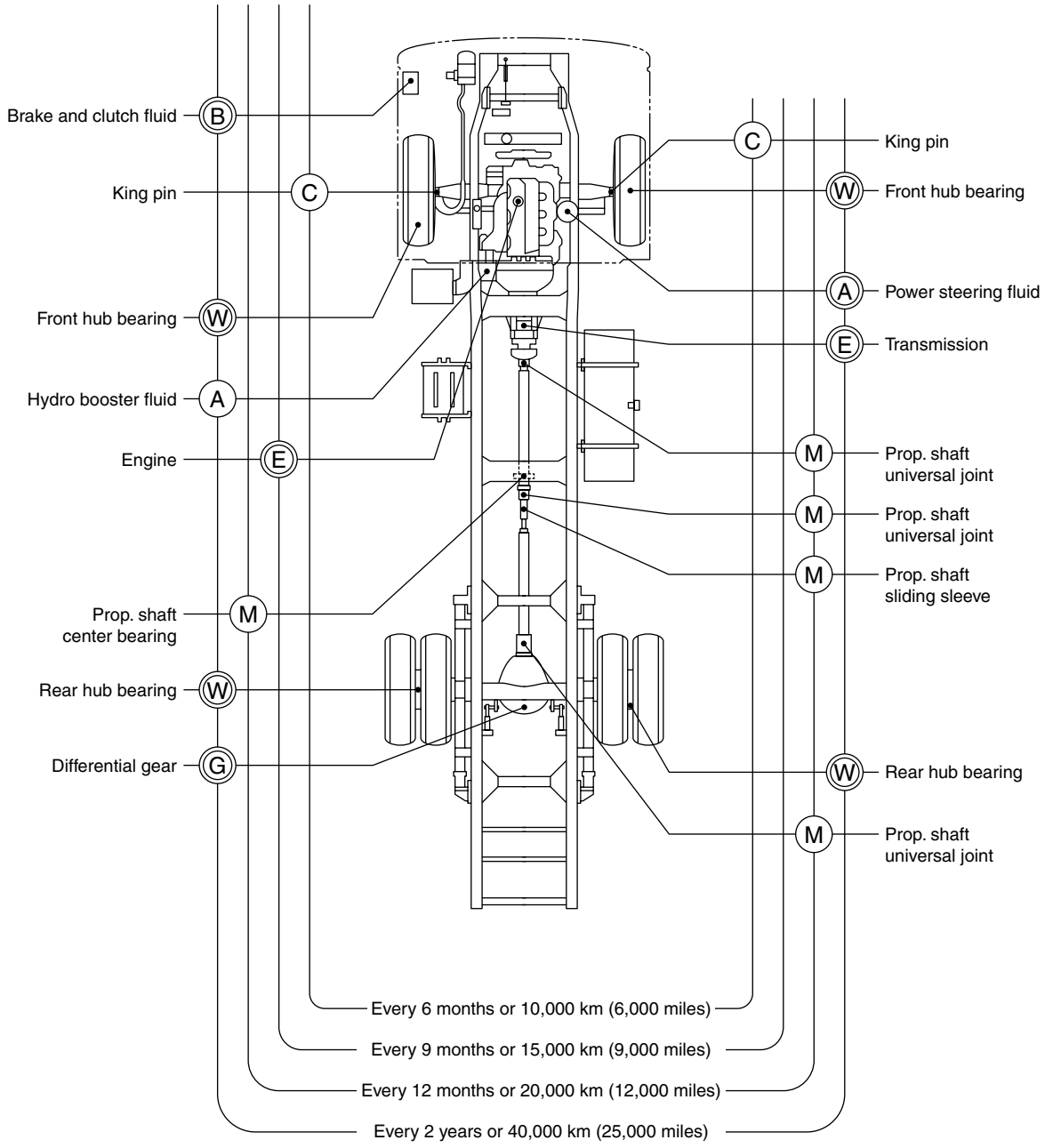
M : MoS_2 contained type grease

B : Brake fluid

A : Automatic transmission fluid

N0A0028E

NKR77 and NPR77 (Front Rigid Suspension) Models



◎ : Change

○ : Check and Replenish or Lubricate

E : Engine oil

G : Gear oil

W : Wheel bearing grease

C : Multipurpose type grease

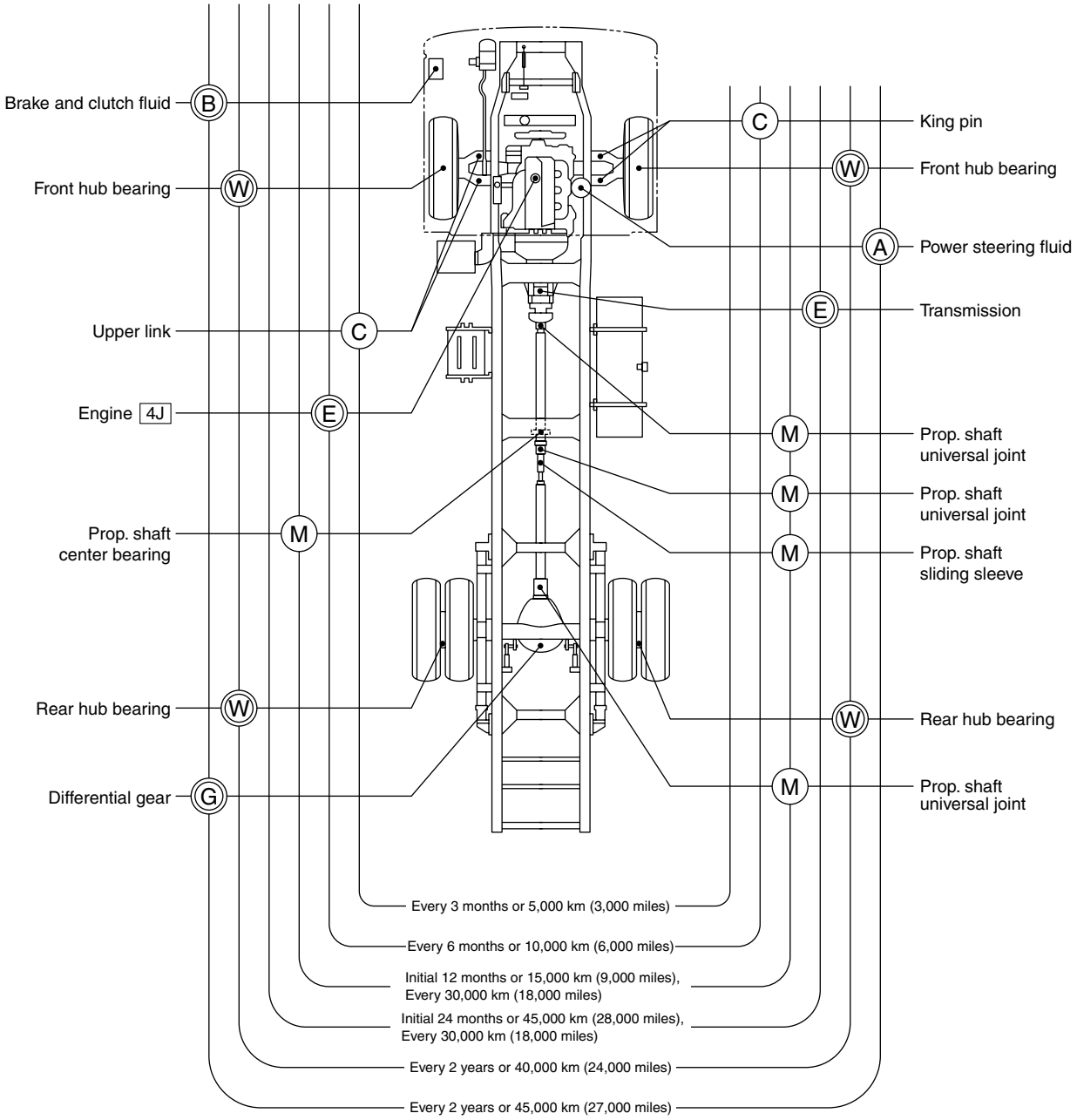
M : MoS_2 contained type grease

B : Brake fluid

A : Automatic transmission fluid

N0A0029E

NKR77 (Front Independent Suspension) Model



◎ : Change

○ : Check and Replenish or Lubricate

E : Engine oil

G : Gear oil

W : Wheel bearing grease

C : Multipurpose type grease

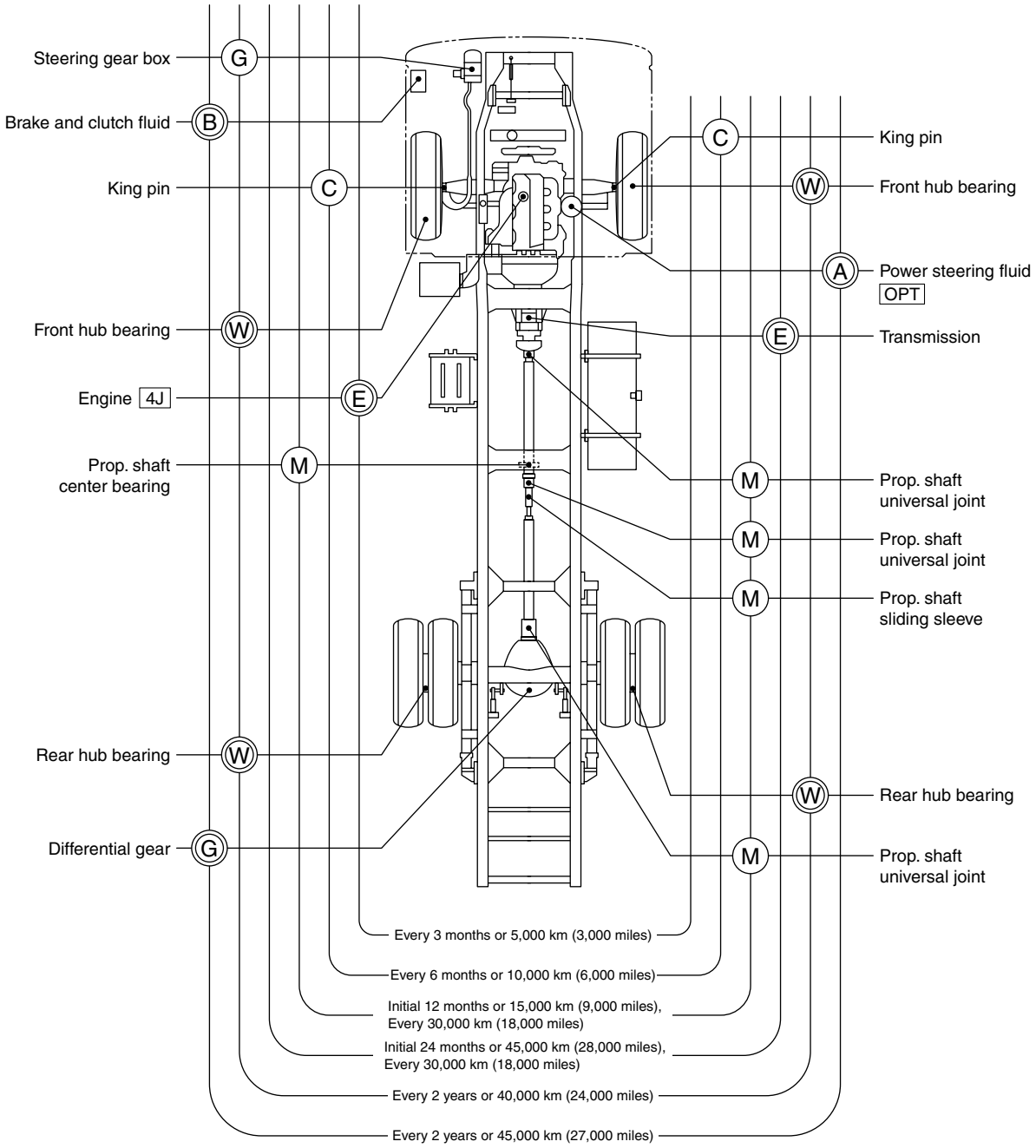
M : MoS_2 contained type grease

B : Brake fluid

A : Automatic transmission fluid

N0A0030E

NKR55 Model



◎ : Change

○ : Check and Replenish or Lubricate

E : Engine oil

G : Gear oil

W : Wheel bearing grease

C : Multipurpose type grease

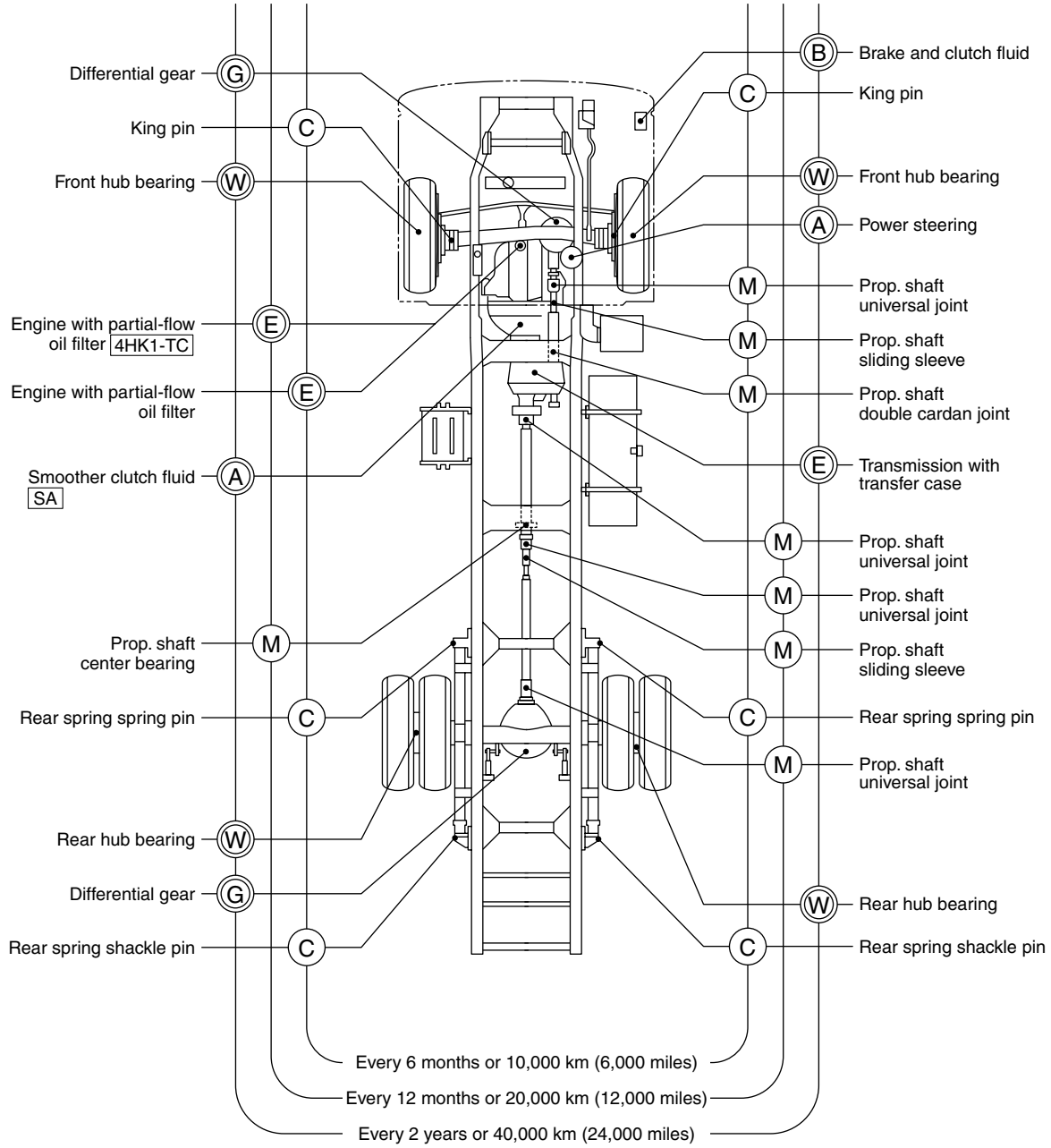
M : MoS_2 contained type grease

B : Brake fluid

A : Automatic transmission fluid

N0A0031E

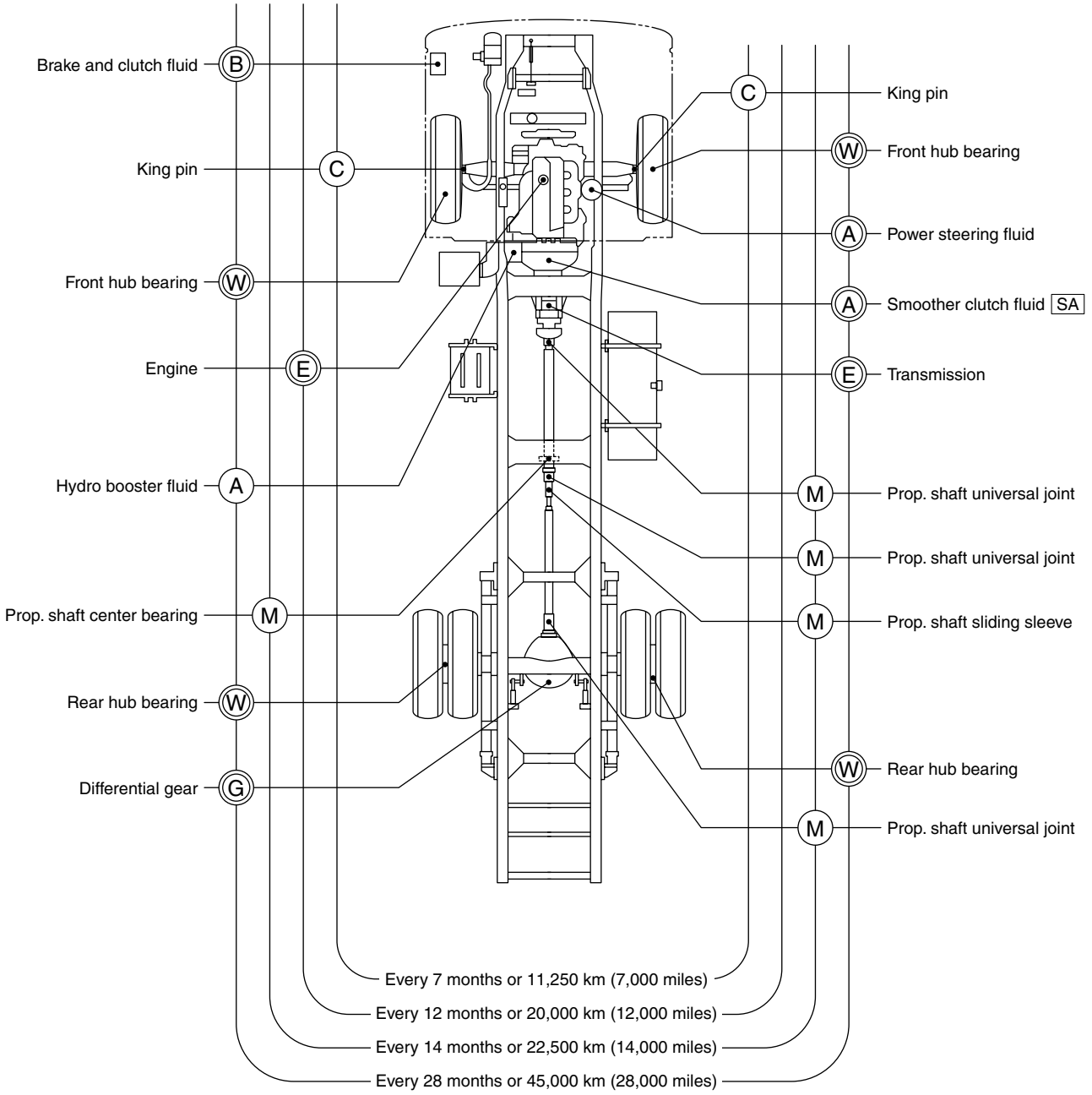
NPS71/75 Models



◎ : Change
○ : Check and Replenish or Lubricate
E : Engine oil
G : Gear oil
W : Wheel bearing grease
C : Multipurpose type grease
M : MoS_2 contained type grease
B : Brake fluid
A : Automatic transmission fluid

N0A0032E

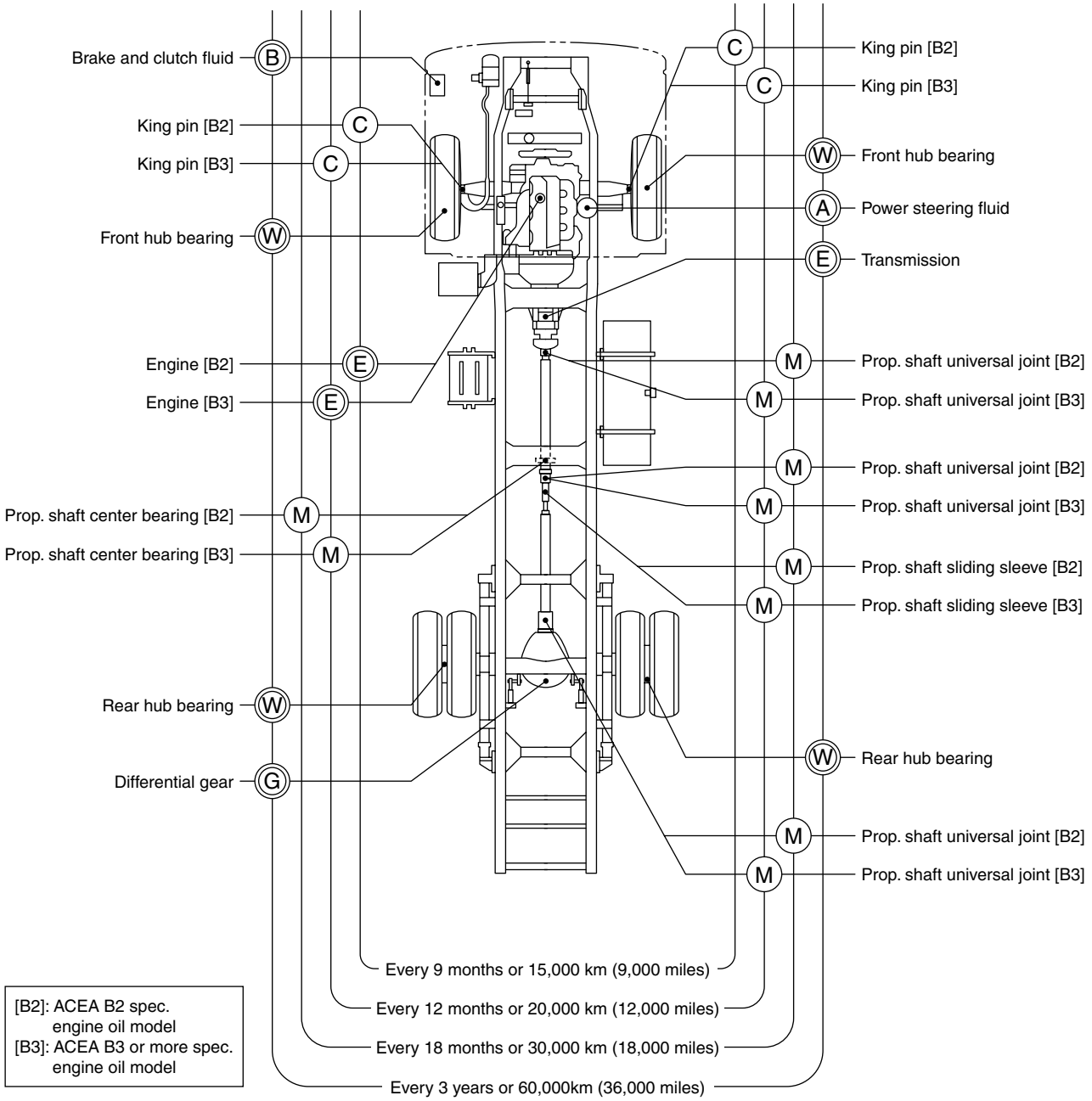
NPR75 and NQR75 Models (For Europe)



◎ : Change
○ : Check and Replenish or Lubricate
E : Engine oil
G : Gear oil
W : Wheel bearing grease
C : Multipurpose type grease
M : MoS_2 contained type grease
B : Brake fluid
A : Automatic transmission fluid

N0A0024E

NKR77 and NPR77 (Front Rigid Suspension) Models (For Europe)



◎ : Change

○ : Check and Replenish or Lubricate

E : Engine oil

G : Gear oil

W : Wheel bearing grease

C : Multipurpose type grease

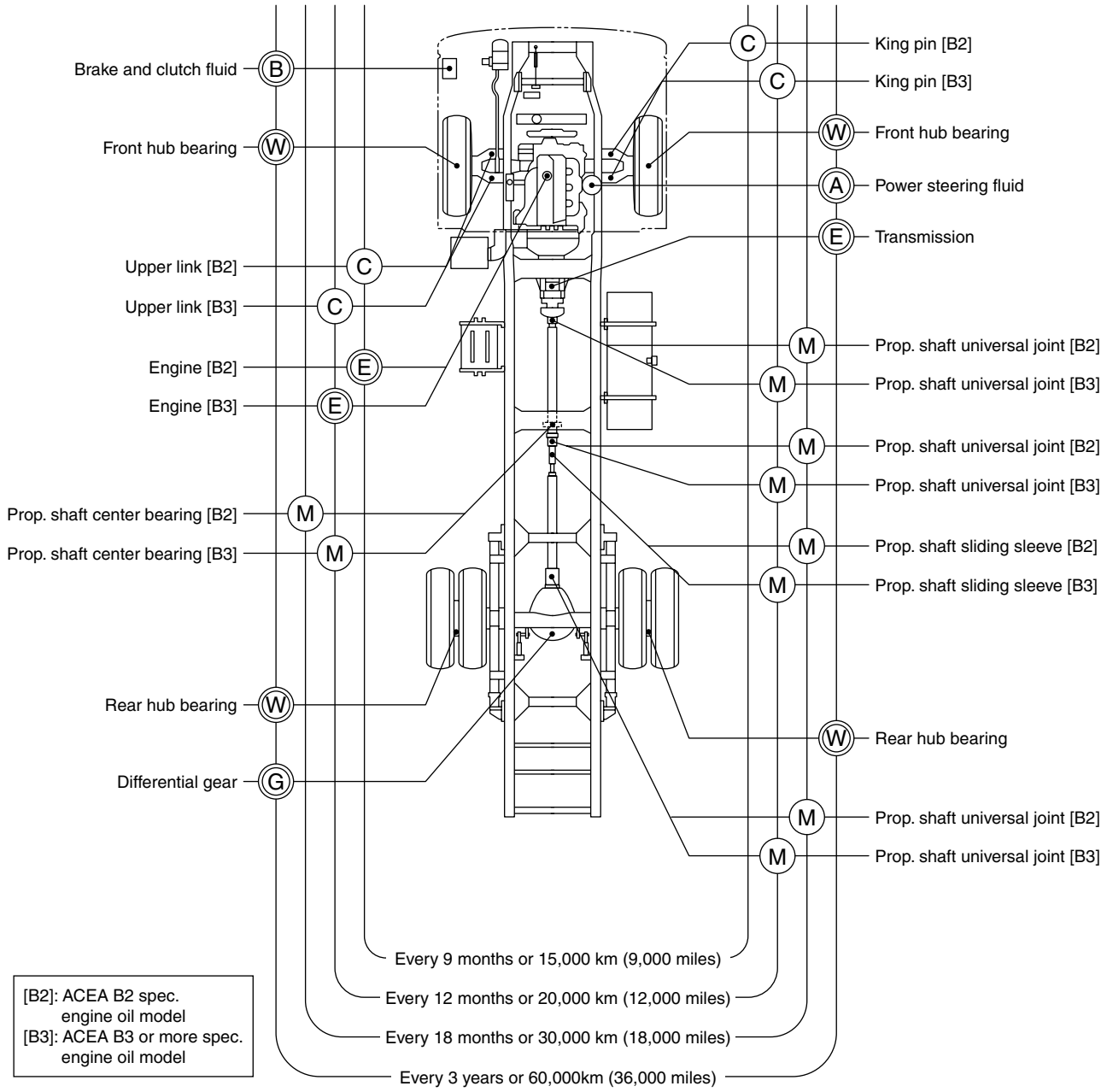
M : MoS_2 contained type grease

B : Brake fluid

A : Automatic transmission fluid

N0A0025E

NKR77 (Front Independent Suspension) Model (For Europe)



◎ : Change

○ : Check and Replenish or Lubricate

E : Engine oil

G : Gear oil

W : Wheel bearing grease

C : Multipurpose type grease

M : MoS_2 contained type grease

B : Brake fluid

A : Automatic transmission fluid

N0A0026E

LGGEN-WE-0552

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LGGEN-WE-0552 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

GENERAL INFORMATION

SECTION 0

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

SECTION No.	CONTENTS
0A	GENERAL INFORMATION
0B	MAINTENANCE AND LUBRICATION

HEATING AND AIR CONDITIONING

SECTION 00
SERVICE INFORMATION

Contents

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Fan Switch Troubleshooting 00-3
Air Conditioning Cycle Troubleshooting 00-15
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Compressor Troubleshooting 00-28
Individual Inspection 00-29
MAIN DATA AND SPECIFICATIONS 00-32
FIXING TORQUE 00-34
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Refrigerant Line Fixing Torque (4HK1-TC Engine Model For Australia) 00-35
Drive Plate / Field Coil Fixing Torque 00-36
SPECIAL TOOLS 00-37

TROUBLESHOOTING

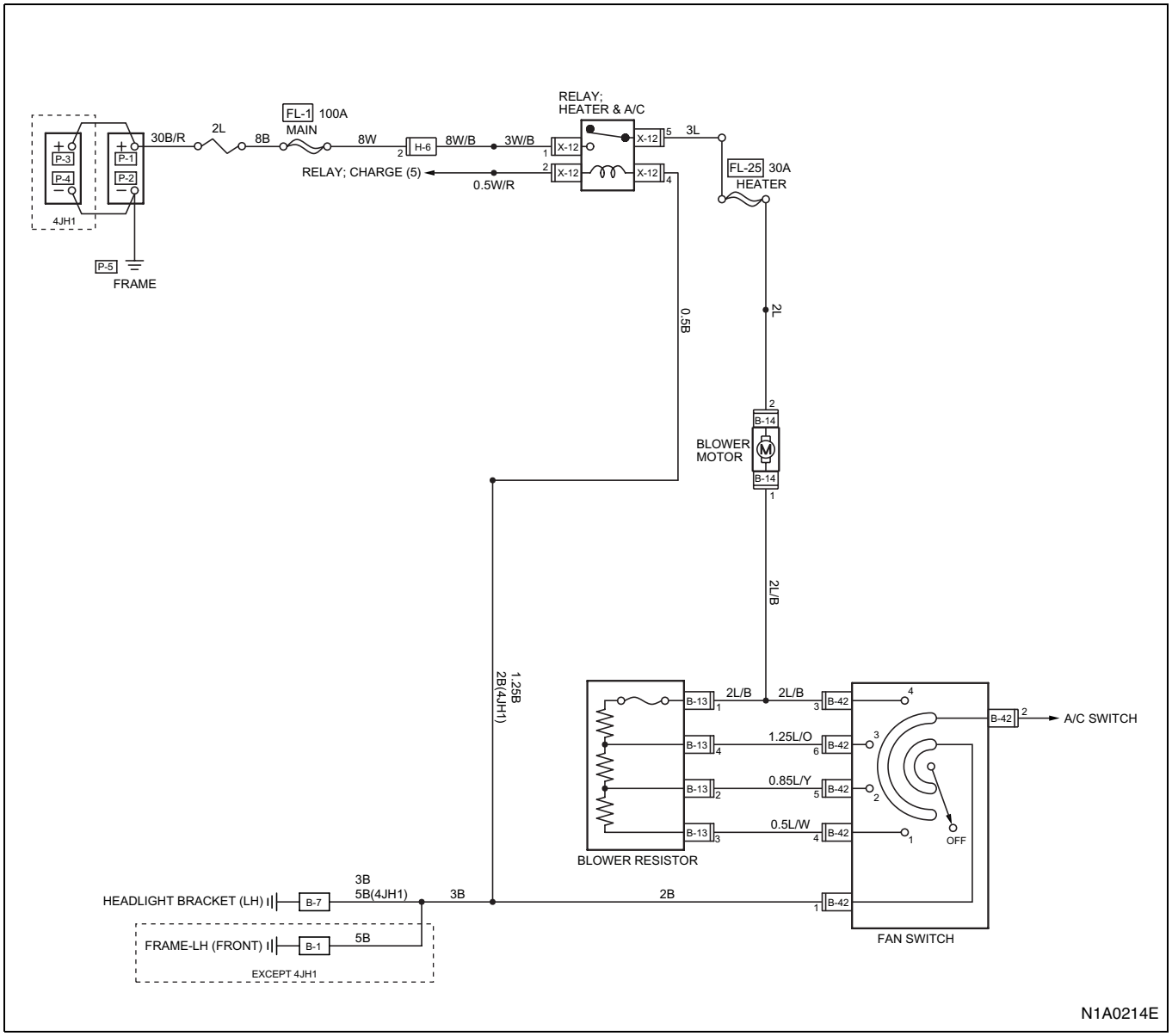
Heating Cycle Troubleshooting

TROUBLE	POSSIBLE CAUSE	CORRECTION
No heating or Insufficient heating.	1. Blower motor does not run, or runs improperly. 2. Engine coolant temperature is low. 3. Insufficient engine coolant. 4. Circulation volume of engine coolant is insufficient. 5. Heater core clogged or collapsed. 6. The heater core is not provided with air sent from the blower motor. 7. Duct connections defective or unsealing.	• Refer to “Fan Switch Troubleshooting”. • Check the engine coolant temperature after warming up the engine and check the thermostat. Replace as necessary. • Add engine coolant as required. • Check if the water hose to the heater core is clogged, collapsed or twisted. Repair or replace as necessary. • Check water pump function. Repair or replace as necessary. • Clean or replace as necessary. • Repair the temperature control link unit or mode doors. • Repair or adjust the control cables. • Repair or replace as necessary.
Control knob moves but mode door does not operate.	1. Cable attaching clip is not correct. 2. Link unit of heater unit or blower assembly defective.	• Repair. • Repair.
The mode door cannot be set to the mode selected.	1. Link unit of heater unit or blower assembly defective. 2. Control cable is not adjusted.	• Repair. • Adjust.

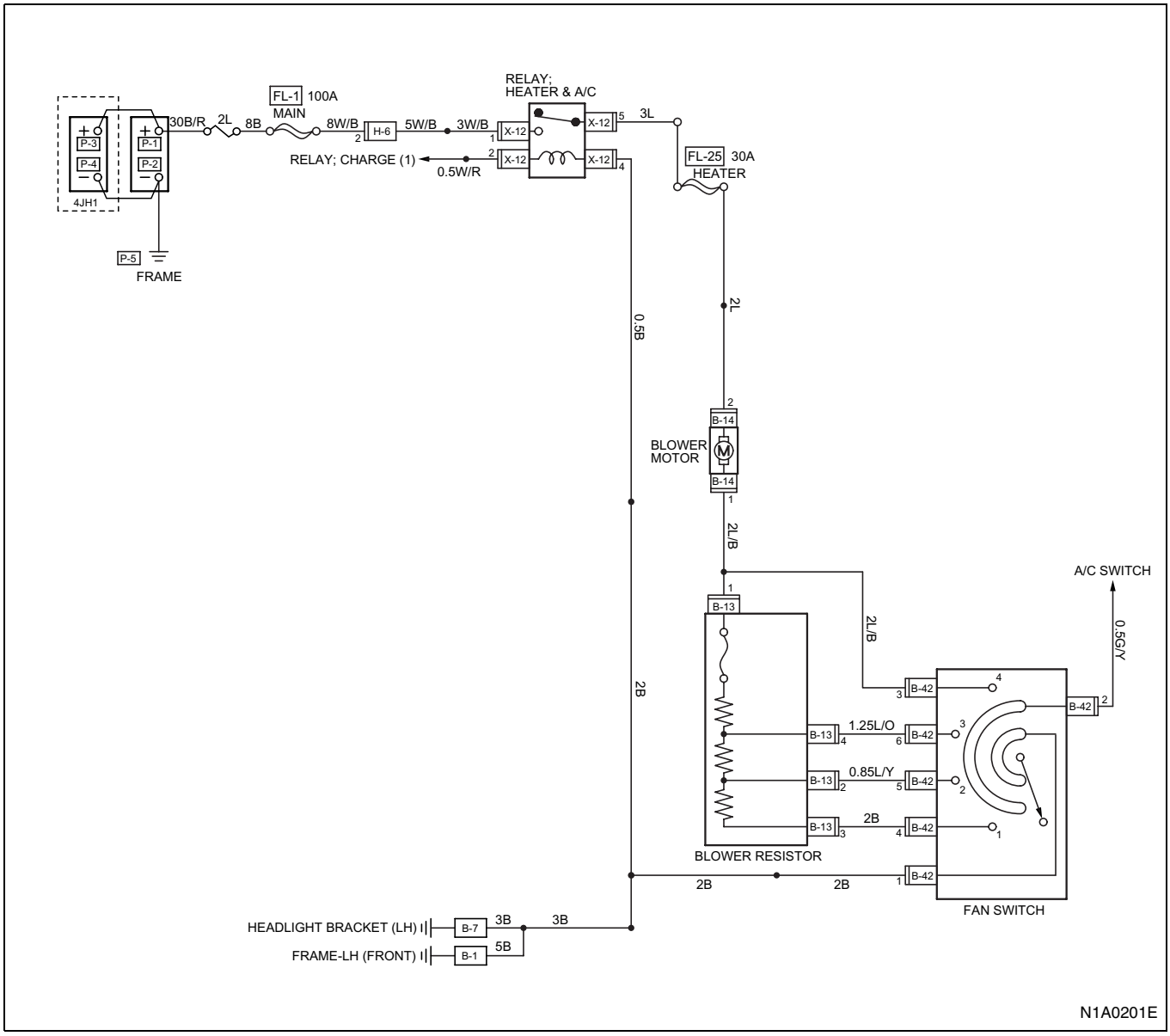
Fan Switch Troubleshooting

Current flows to the blower motor through the heater & A/C relay X-12 to activate the rotation of the blower motor by turning “ON” the fan switch.
Blower motor speed is controlled in stages by the resistor, by operating the switch from “LOW” to “HIGH.”

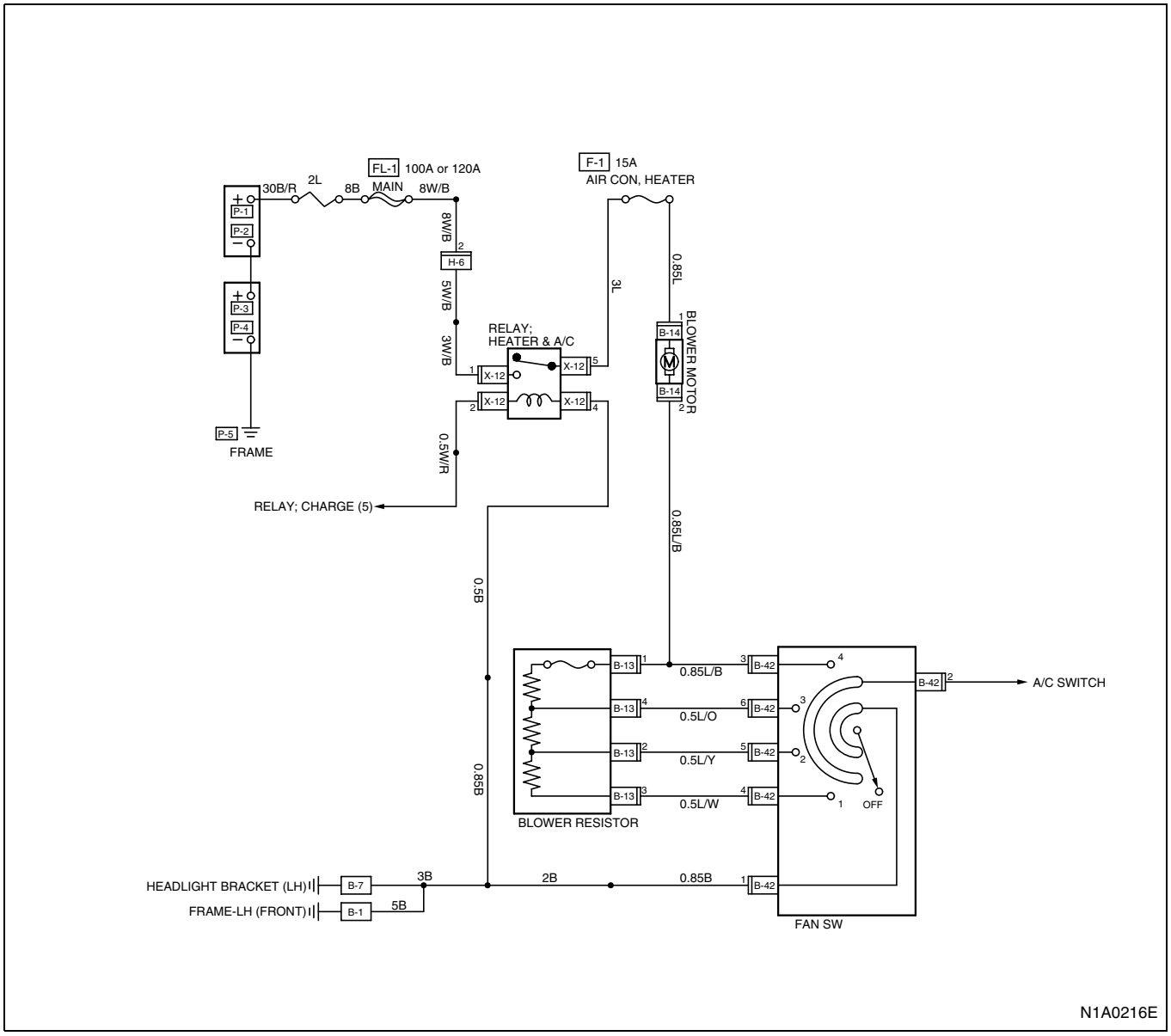
For 12 Volt (LHD Model)



For 12 Volt (RHD Model)

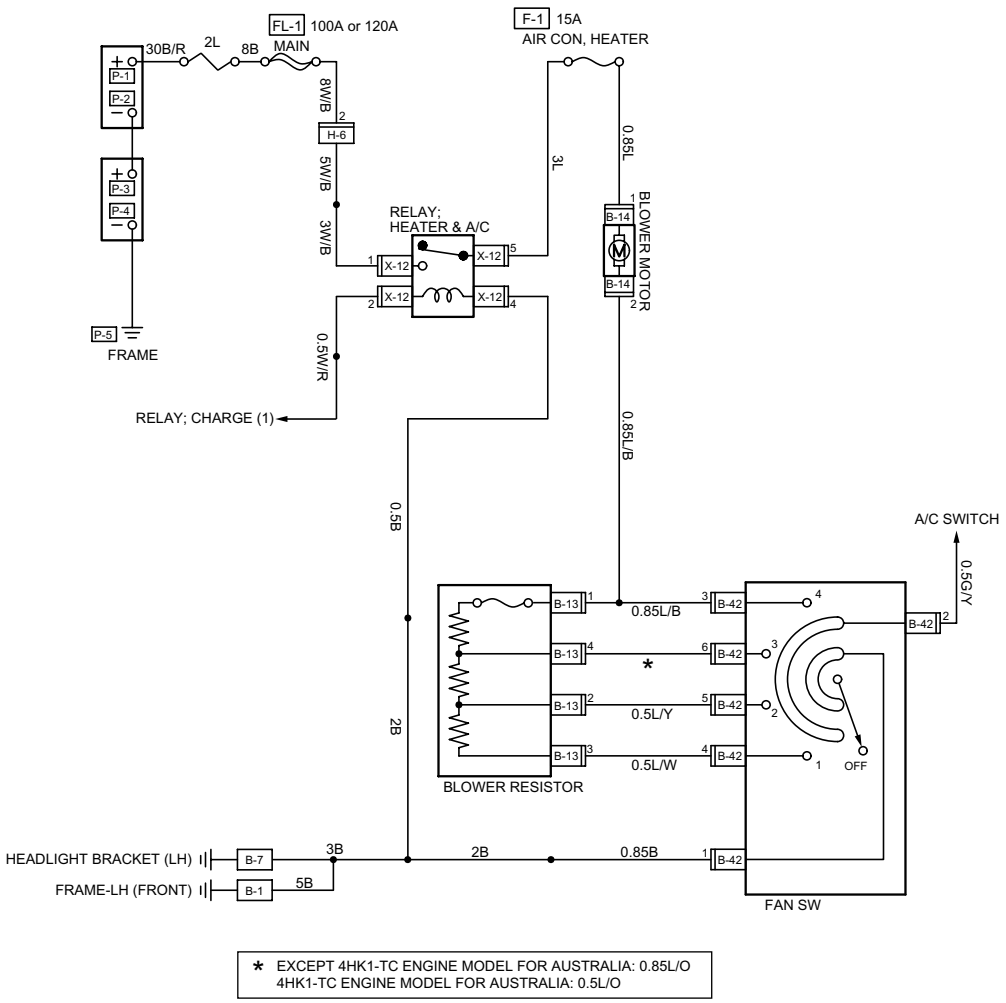


For 24 Volt (LHD Model)



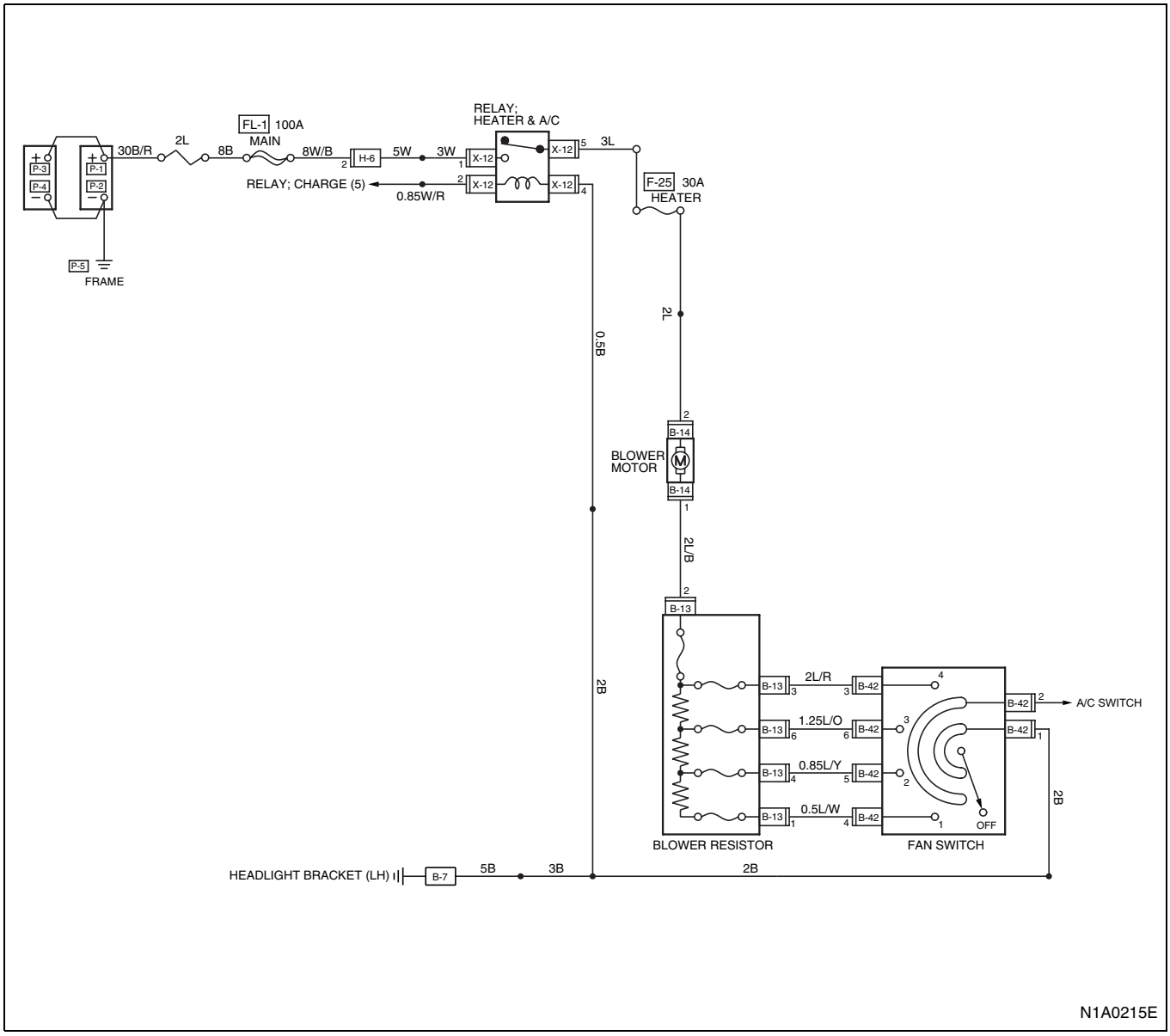
N1A0216E

For 24 Volt (RHD Model)

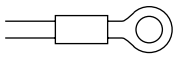
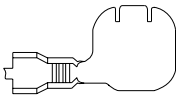
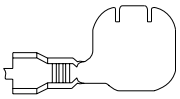
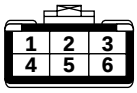
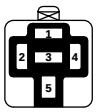


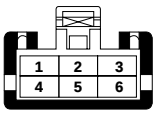
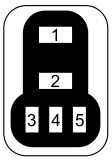
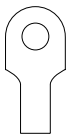
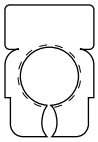
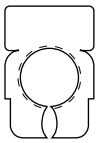
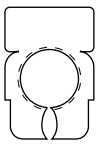
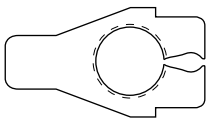
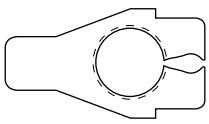
N1A0202E

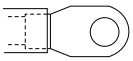
For Taiwan


RELAY;
HEATER & A/C
FL-1 100A
MAIN
30B/R
2L
8B
8W/B
H-6
5W
3W
X-12
3L
F-25 30A
HEATER
RELAY; CHARGE (5)
0.85W/R
P-3
P-1
P-4
P-2
P-5
FRAME
0.5B
2L
B-14
BLOWER
MOTOR
2L/B
B-13
2B
2L/R
1.25L/O
0.85L/Y
0.5L/W
B-42
A/C SWITCH
OFF
BLOWER RESISTOR
FAN SWITCH
HEADLIGHT BRACKET (LH)
B-7
5B
3B
2B
N1A0215E

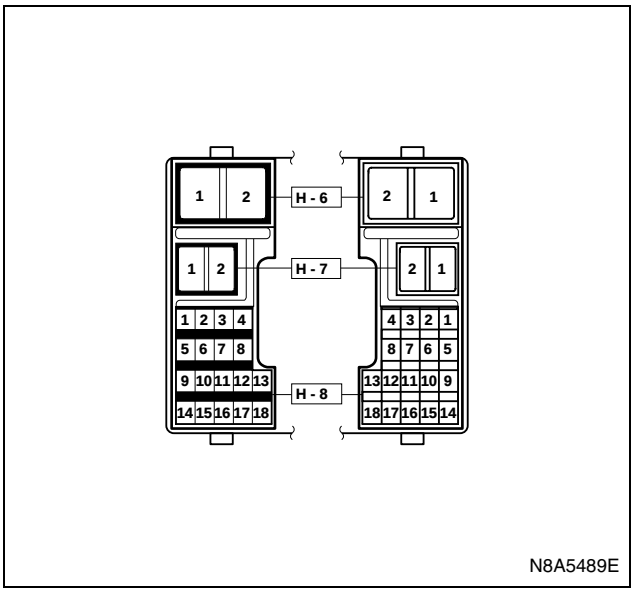
Connector List

No.	Connector Face
B-1	 000-001
B-2	 000-012
B-7	 000-012
B-13	004-010
B-13	 006-010
B-14	002-009
X-12	 005-001

No.	Connector Face
B-42	 006-001
B-42	 005-006
P-1 (12 V)	 000-003
P-2 (12 V)	 000-004
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006

No.	Connector Face
P-5 (12 V)	000-007
P-5 (24 V)	 000-002

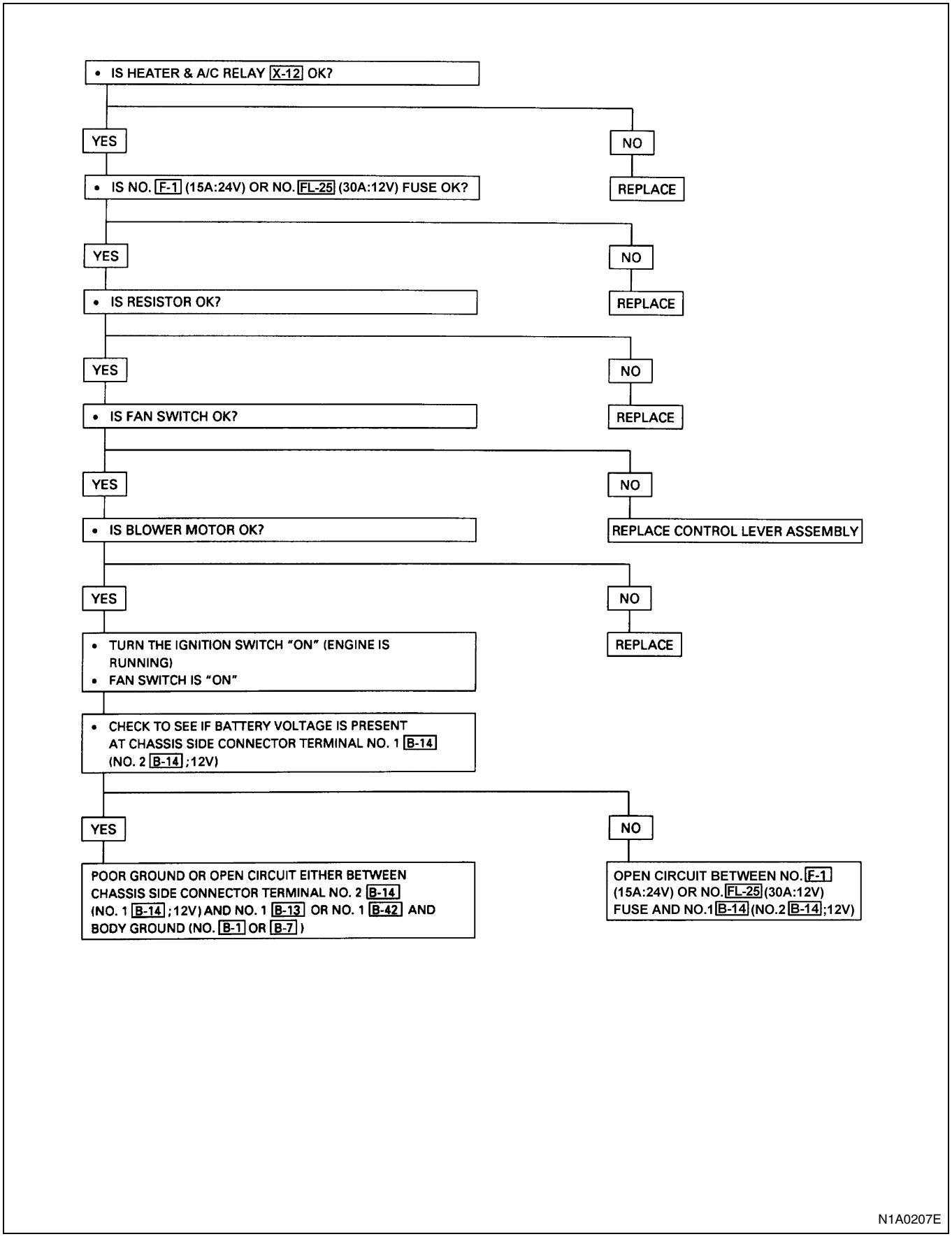
H-6



N8A5489E

Blower Motor Does Not Run

Except Taiwan



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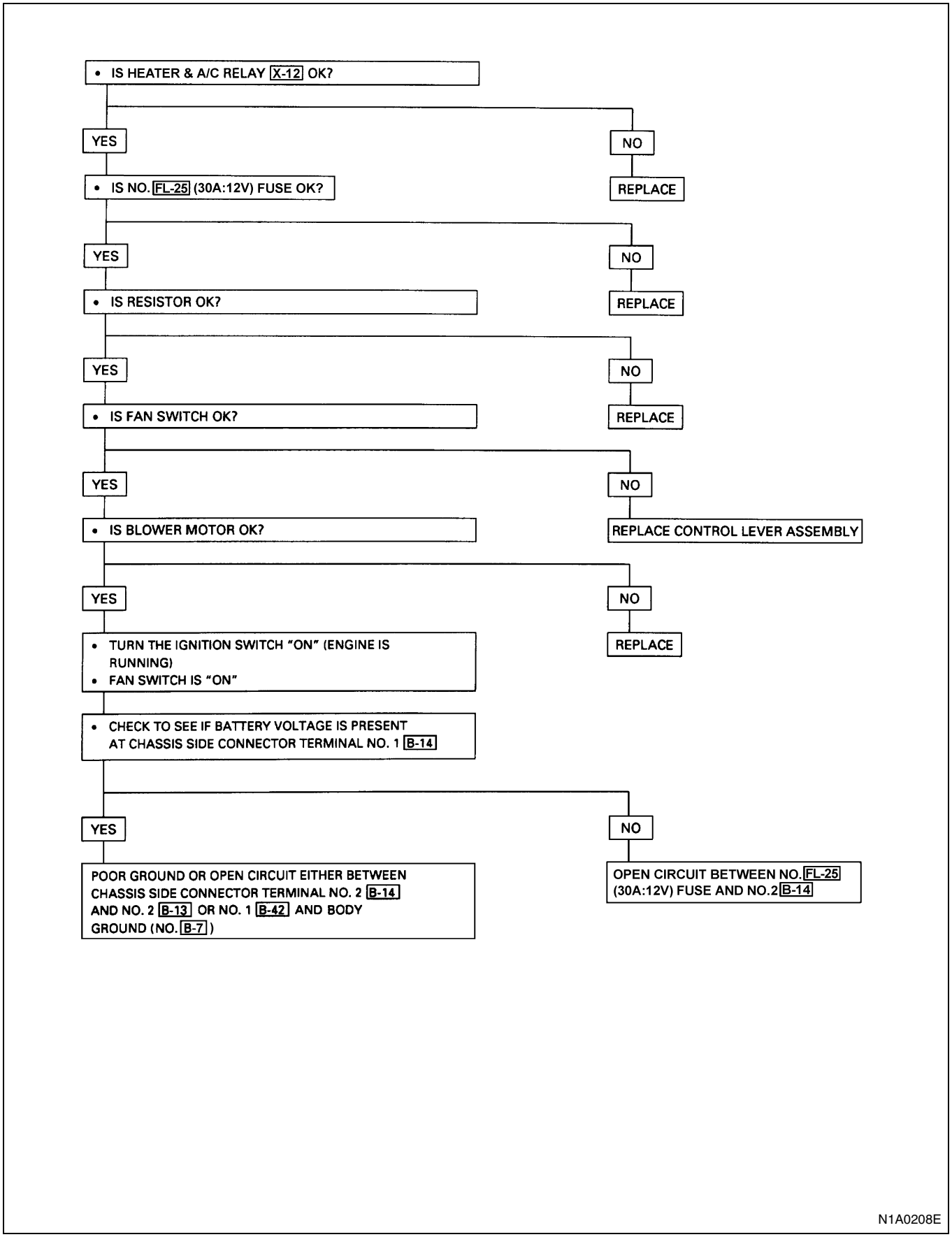
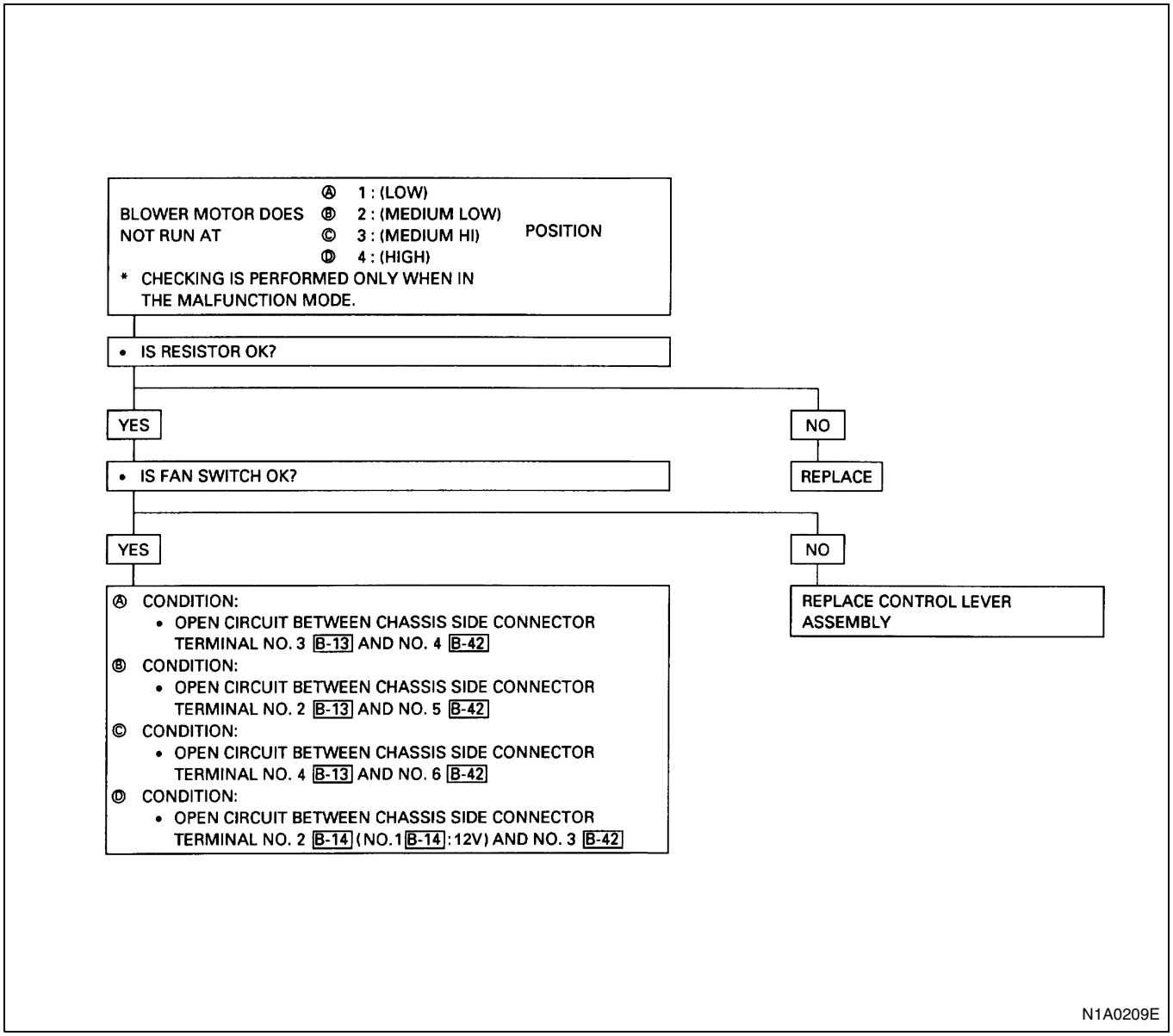
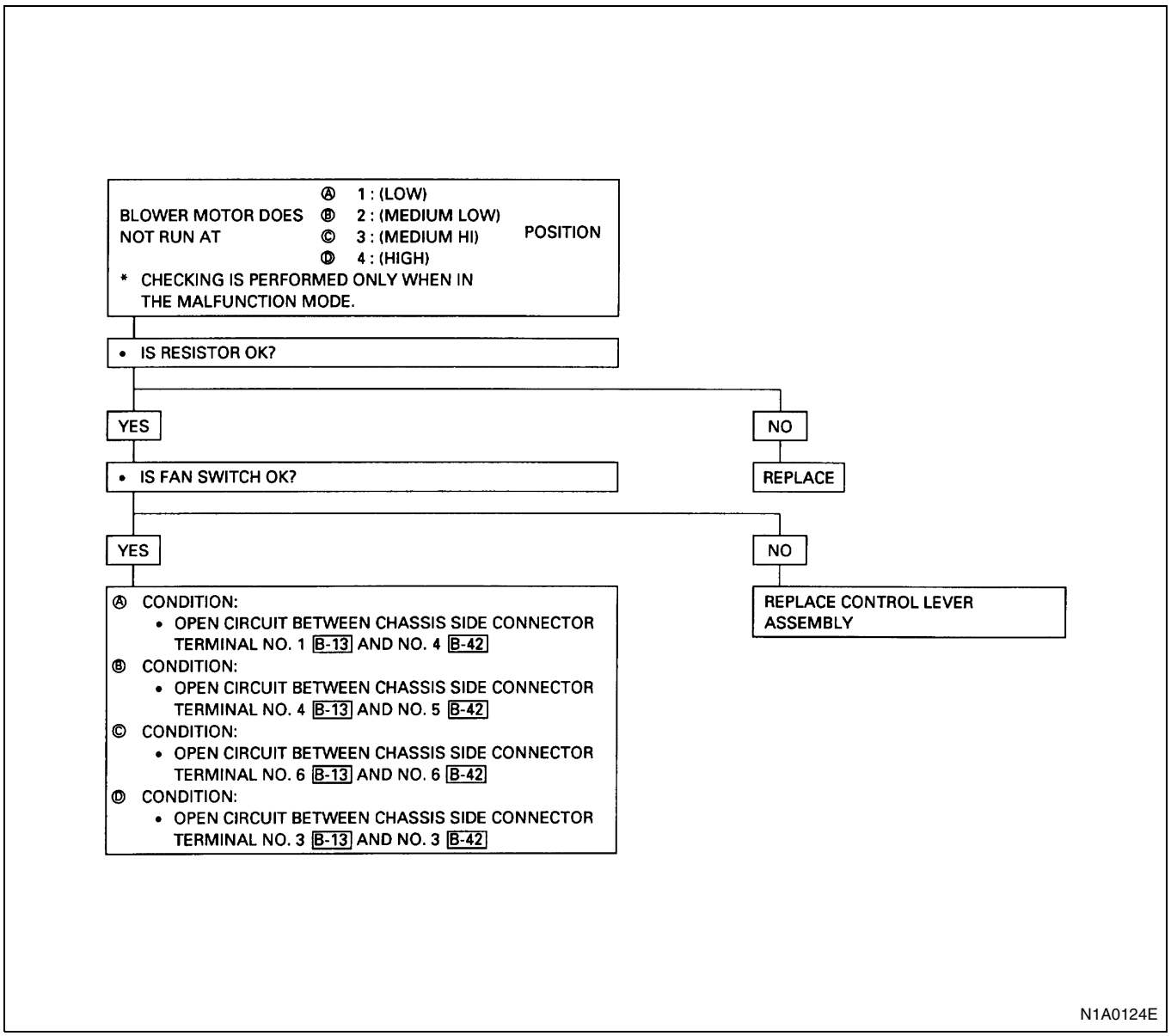

• IS HEATER & A/C RELAY X-12 OK?
YES
NO
• IS NO. FL-25 (30A:12V) FUSE OK?
REPLACE
YES
NO
• IS RESISTOR OK?
REPLACE
YES
NO
• IS FAN SWITCH OK?
REPLACE
YES
NO
• IS BLOWER MOTOR OK?
REPLACE CONTROL LEVER ASSEMBLY
YES
NO
• TURN THE IGNITION SWITCH "ON" (ENGINE IS RUNNING)
• FAN SWITCH IS "ON"
REPLACE
• CHECK TO SEE IF BATTERY VOLTAGE IS PRESENT AT CHASSIS SIDE CONNECTOR TERMINAL NO. 1 B-14
YES
NO
POOR GROUND OR OPEN CIRCUIT EITHER BETWEEN CHASSIS SIDE CONNECTOR TERMINAL NO. 2 B-14 AND NO. 2 B-13 OR NO. 1 B-42 AND BODY GROUND (NO. B-7)
OPEN CIRCUIT BETWEEN NO. FL-25 (30A:12V) FUSE AND NO.2 B-14
N1A0208E

Blower Motor Does Not Run in Certain Position

Except Taiwan

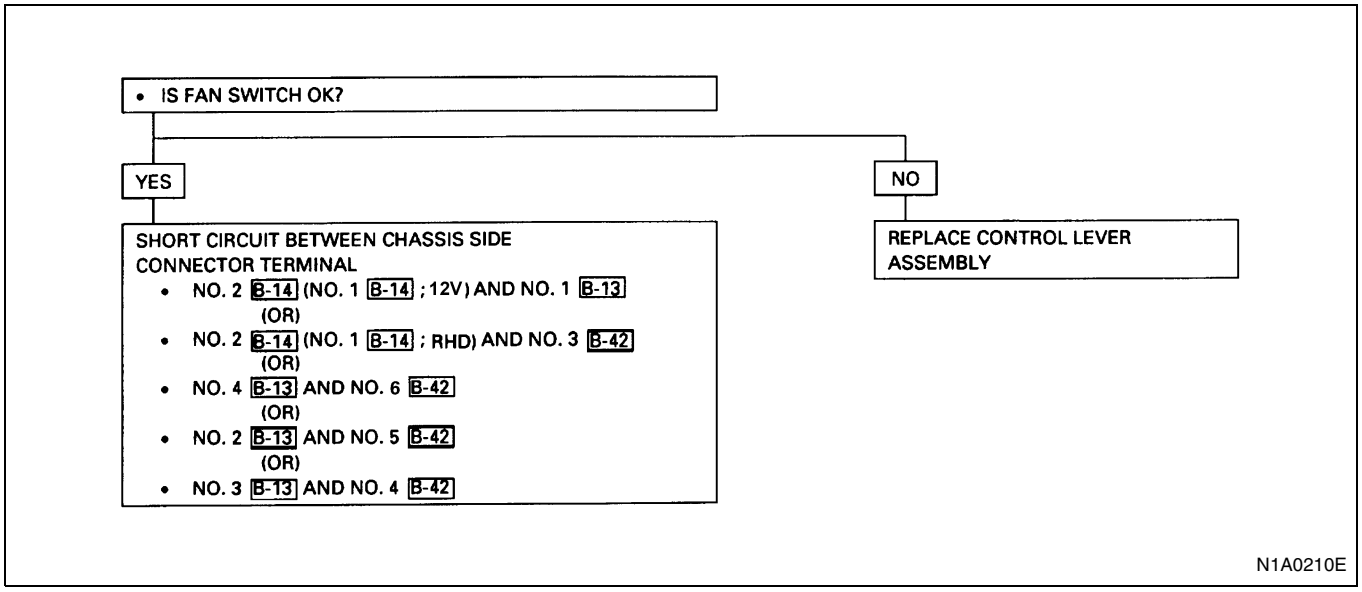


For Taiwan

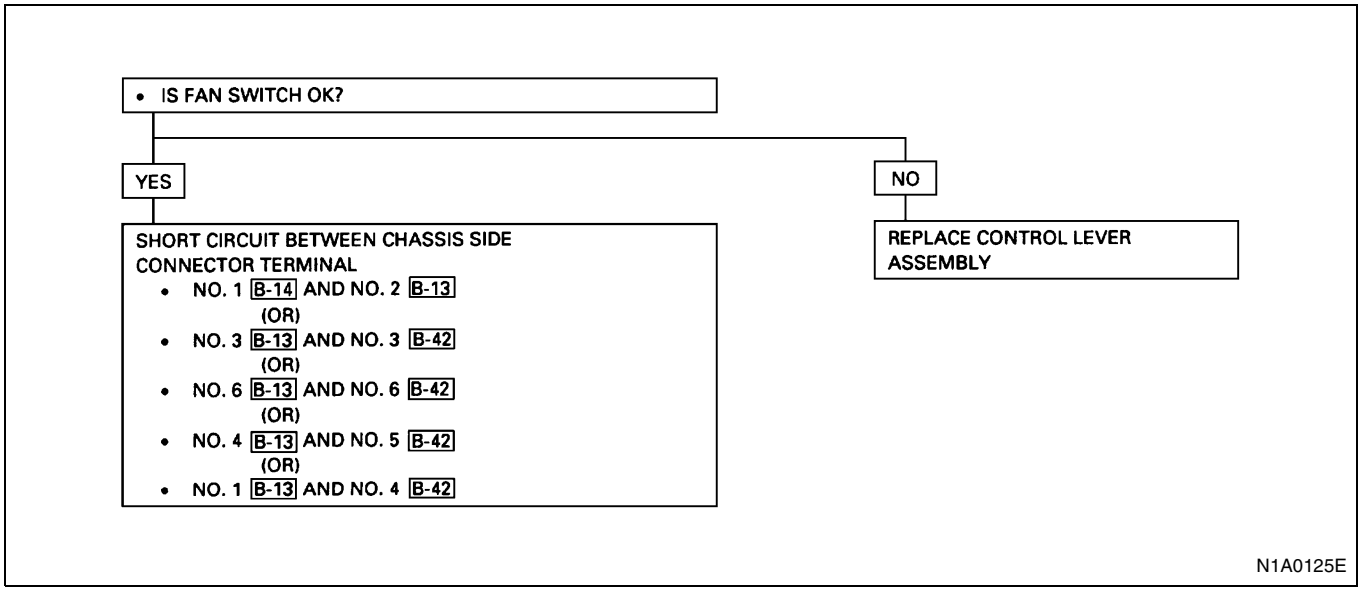

BLOWER MOTOR DOES NOT RUN AT
Ⓐ 1 : (LOW)
Ⓑ 2 : (MEDIUM LOW)
Ⓒ 3 : (MEDIUM HI)
Ⓓ 4 : (HIGH)
POSITION
* CHECKING IS PERFORMED ONLY WHEN IN THE MALFUNCTION MODE.
• IS RESISTOR OK?
YES
NO
REPLACE
• IS FAN SWITCH OK?
YES
NO
Ⓐ CONDITION:
• OPEN CIRCUIT BETWEEN CHASSIS SIDE CONNECTOR TERMINAL NO. 1 B-13 AND NO. 4 B-42
Ⓑ CONDITION:
• OPEN CIRCUIT BETWEEN CHASSIS SIDE CONNECTOR TERMINAL NO. 4 B-13 AND NO. 5 B-42
Ⓒ CONDITION:
• OPEN CIRCUIT BETWEEN CHASSIS SIDE CONNECTOR TERMINAL NO. 6 B-13 AND NO. 6 B-42
Ⓓ CONDITION:
• OPEN CIRCUIT BETWEEN CHASSIS SIDE CONNECTOR TERMINAL NO. 3 B-13 AND NO. 3 B-42
REPLACE CONTROL LEVER ASSEMBLY
N1A0124E

Blower Motor Does Not Stop at "OFF" Position

Except Taiwan



For Taiwan



Air Conditioning Cycle Troubleshooting

TROUBLE	POSSIBLE CAUSE	CORRECTION
No cooling or insufficient cooling	1. Magnetic clutch does not run	• Refer to “MAGNETIC CLUTCH TROUBLESHOOTING”
	2. Compressor is not rotating property	
	• Drive belt loosened or broken	• Adjust the drive belt to the specified tension or replace the drive belt
	• Magnetic clutch face is not clean and slips	• Clean the magnetic clutch face or replace
	• Incorrect clearance between magnetic drive plate and pulley	• Adjust the clearance (Refer to Section 1D “COMPRESSOR OVERHAUL”)
	• Compressor oil leaks from shaft seal or shell	• Replace the compressor
	• Compressor seized	• Replace the compressor
	3. Insufficient or excessive charge of refrigerant	• Discharge and recover refrigerant. Recharge to specified amount.
	4. Leaks in the refrigerant system	• Check refrigerant system for leaks and repair as necessary. Discharge and recover refrigerant. Recharge to specified amount.
	5. Condenser clogged or insufficient radiation	• Clean the condenser or replace as necessary
		• Check radiator or condenser fan function
	6. Temperature control link unit of the heater unit defective	• Repair the link unit
	7. Unsteady operation due to foreign substance in expansion valve	• Replace the expansion valve
	8. Poor operation of electronic thermostat	• Check electronic thermostat and replace as necessary
Insufficient velocity of cooling air	1. Evaporator clogged or frosted	• Check evaporator core and replace or clean the core
	2. Air leaking from cooling unit or air duct	• Check evaporator and duct connection, then repair as necessary
	3. Blower motor does not rotate properly	• Refer to “FAN SWITCH TROUBLESHOOTING”

* For the execution of the charging and discharging operation in the table above, refer to the “RECOVERY, RECYCLING, EVACUATION AND CHARGING” in section 1B.

Checking Refrigerant System with Manifold Gauge

Conditions;

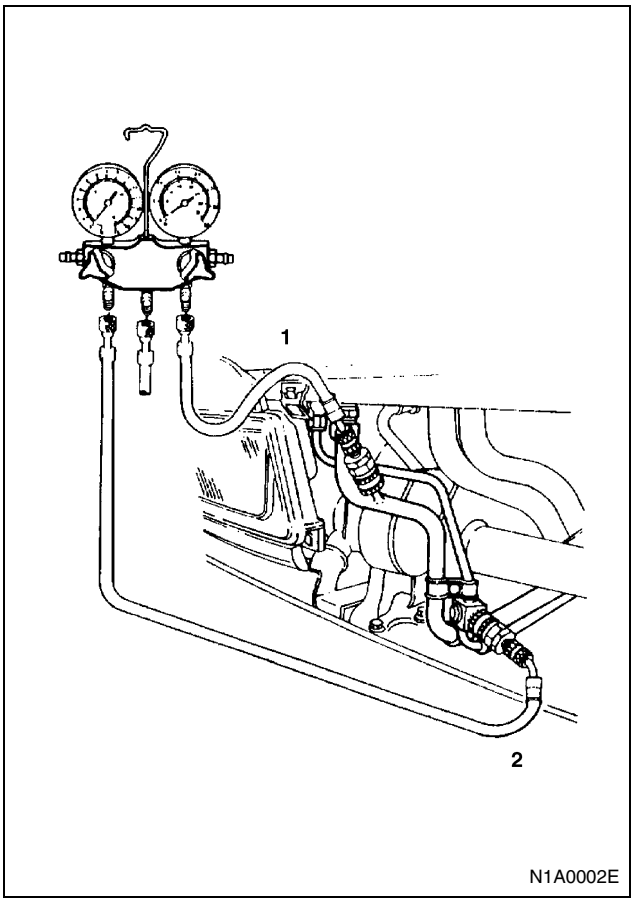
- Ambient temperature at approx. 30 — 35°C (86 — 95°F)
- Run the engine at 1,500 rpm
- A/C switch is “ON”
- Run the blower motor at “4” (high) position
- Temperature control lever sets at “MAX COLD”
- Air source selector lever at “CIRC”
- Open then the all doors and engine hood

Normal pressures kPa (kg·cm^2/PSI)

- Low-pressure side: Approx. 127 — 245 (1.3 — 2.5/ 18 — 36)
- High-pressure side: Approx. 1373 — 1667 (14 — 17/199 — 242)

Connect the manifold gauge

Low-pressure hose (LOW) - Suction side (1)
High-pressure hose (HI) - Discharge side (2)



Legend

1. Low side
2. High side

Caution:

Vehicles that use Refrigerant-134a (R-134a) is used in the air conditioning system, be sure to use manifold gauges, charging hoses and other air conditioning service tools for R-134a when checking the refrigerant system. (Refer to “ON VEHICLE SERVICE” for Precautions for R-134a Air Conditioning System in section 1B.)

RESULT	SYMPTOM	TROUBLE CAUSE	CORRECTION
Discharge (High) pressure gauge abnormally high	Reduced or no air flow through the condenser	• Condenser clogged or dirty • Radiator (condenser) fan does not operate properly	• Clean • Check cooling fan operation
	No bubbles in sight glass when condenser is cooled by water (Insufficient cooling)	• Excessive refrigerant in system	• Check sight glass. (See “Reading Sight Glass”) • Discharge and recover refrigerant. Recharge to specified amount
	After stopping air conditioning, pressure drops approx. 196 kPa (2.0 kg·cm^2/28 PSI) quickly	• Air in system	• Evacuate and charge refrigerant system
Discharge (High) pressure gauge abnormally low	Insufficient cooling and excessive bubbles in the sight glass	• Insufficient refrigerant in system	• Check sight glass. (See “Reading Sight Glass”) • Check for leaks • Discharge and recover refrigerant. Recharge to specified amount
	Low pressure gauge indicates vacuum	• Clogged or defective expansion valve	• Replace the expansion valve
	Frost or dew on refrigerant line before and after receiver/ drier or expansion valve, and low pressure gauge indicates vacuum	• Restriction caused by debris or moisture in receiver/ drier	• Check system for restriction and replace receiver/drier
	After turning off air conditioning, high and low pressure gauge balanced quickly	• Compressor seal defective • Poor compression due to defective compressor gasket	• Replace or repair compressor
Suction (Low) pressure gauge abnormally high	Low pressure gauge is lowered after condenser is cooled by water	• Excessive refrigerant in system	• Discharge and recover refrigerant Recharge to specified amount
	Low pressure hose temperature around the compressor refrigerant line connector is lower than around evaporator	• Unsatisfactory valve operation due to defective temperature sensor of expansion valve • Expansion valve opens too long	• Replace the expansion valve
	After turning off air conditioning, high and low pressure gauge is balanced quickly	• Compressor gasket is defective	• Replace
	Air conditioning turns off before passenger compartment is sufficiently cool	• Electronic thermostat defective	• Check the electronic thermostat and replace as necessary

* For the charging and discharging operations in the table above, refer to “RECOVERY, RECYCLING, EVACUATION AND CHARGING” in section 1B.

RESULT	SYMPTOM	TROUBLE CAUSE	CORRECTION
Suction (Low) pressure abnormally low	Condenser is not hot and excessive bubble in sight glass	• Insufficient refrigerant	• Check sight glass. (See “Reading Sight Glass”) • Check for leaks • Discharge and recover refrigerant. Recharge to specified amount
	Frost on the expansion valve inlet line	• Expansion valve clogged	• Replace the expansion valve
	A distinct difference in temperature between the inlet and outlet refrigerant lines of the receiver/drier	• Receiver/drier clogged	• Replace the receiver/drier
	Expansion valve outlet refrigerant line is not cold and low-pressure gauge indicates vacuum	• The temperature sensor of the expansion valve is defective, and the valve cannot regulate the correct flow of the refrigerant	• Replace the expansion valve
	Discharge temperature is low and air flow from vents is restricted	• Frozen evaporator core fins	• Check electronic thermostat and replace as necessary
	Low-pressure gauge reading is low, or a vacuum reading may be shown	• Clogged or blocked refrigerant line	• Replace refrigerant line
Suction (Low) and Discharge (High) pressure abnormally high	No bubbles in sight glass after condenser is cooled by water (Insufficient cooling)	• Excessive refrigerant in system	• Check sight glass. (See “Reading Sight Glass”) • Discharge and recover refrigerant. Recharge to specified amount
	Reduce air flow through condenser	• Condenser clogged • Radiator (condenser) fan does not rotate properly	• Clean • Check cooling fan operation
	Suction (Low) pressure hose is not cold	• Air in system	• Evacuate and charge refrigerant
Suction (Low) and Discharge (High) pressure abnormally low	Insufficient cooling and excessive bubbles in the sight glass	• Insufficient refrigerant in system	• Check sight glass. (See “Reading Sight Glass”) • Check for leaks • Discharge and recover refrigerant. Recharge to specified amount

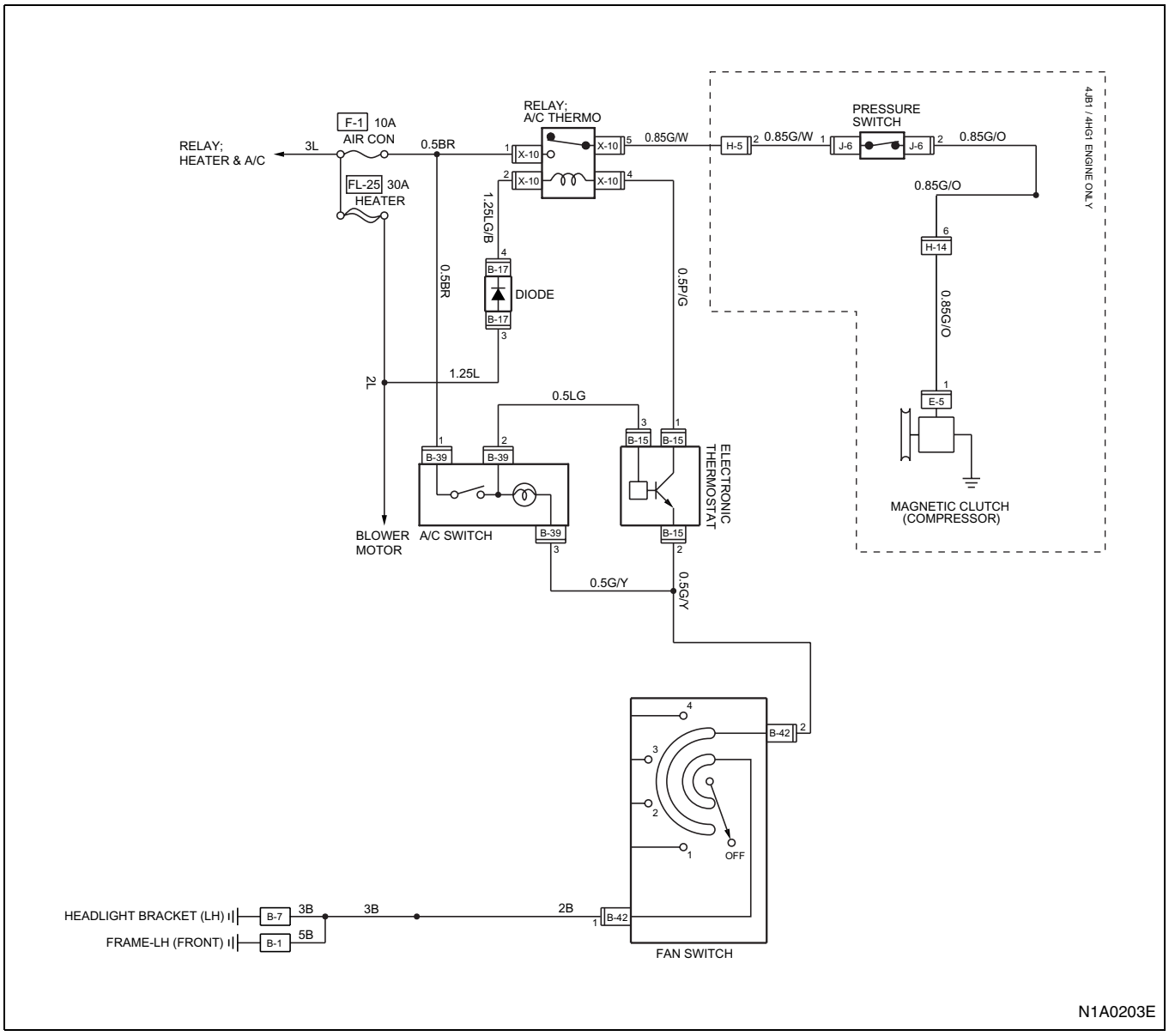
Magnetic Clutch Troubleshooting

The air conditioning is made up of the evaporator, condenser, electronic thermostat, A/C switch, fan switch and relays.

The air conditioning starts its operation when both the A/C switch and the fan switch are turned on and the magnetic clutch gets engaged through the A/C thermo relay while the engine is running. And it stops when either A/C switch or fan switch is turned off.

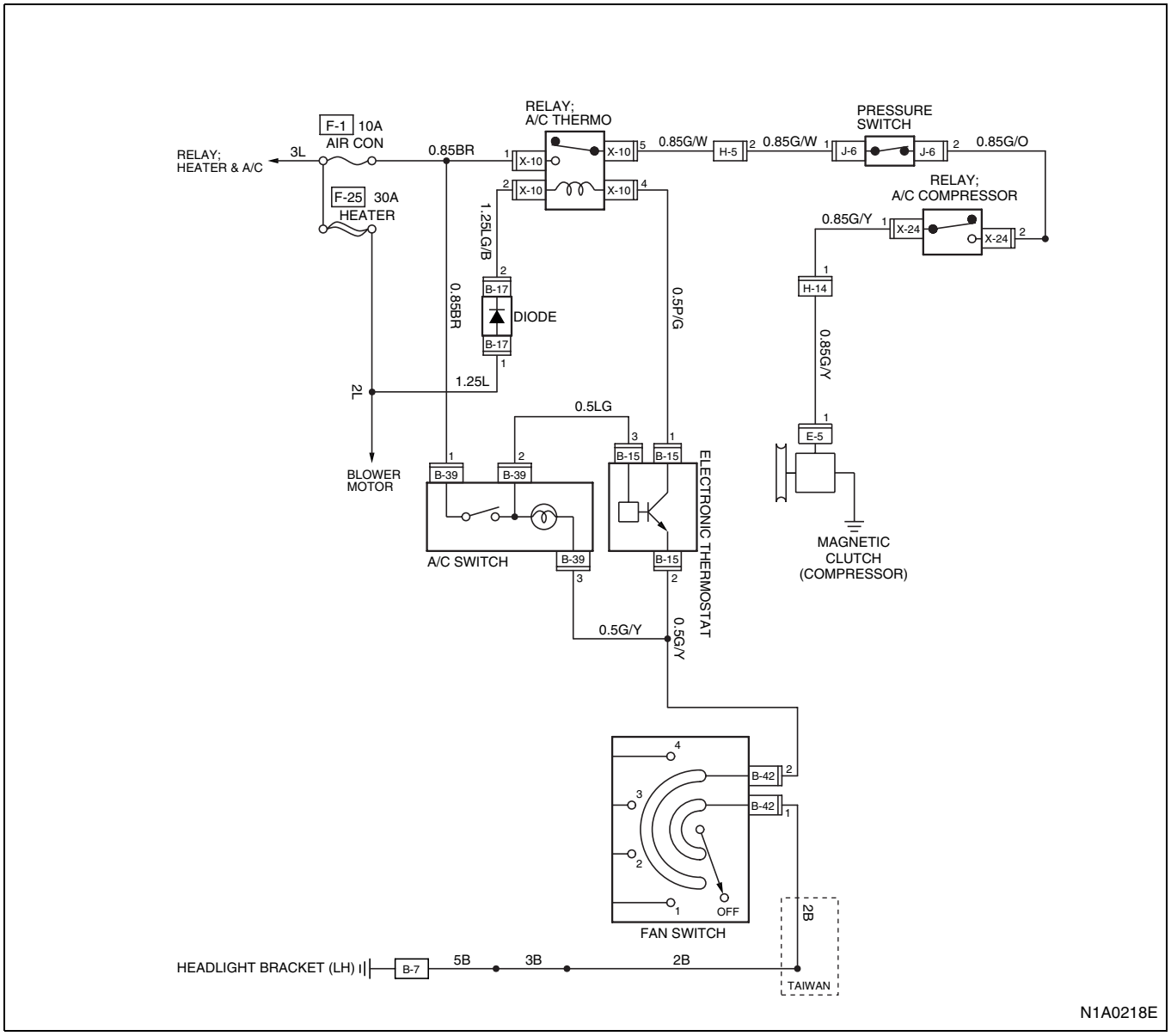
In addition to these switches, the air conditioning is also stopped by turning off the magnetic clutch temporarily under the predetermined condition when the abnormal refrigerant pressure is sensed by pressure switch, or when the air temperature is sensed by electronic thermostat that prevents the evaporator core from freezing.

For 12 Volt (LHD Model Except 4JH1)

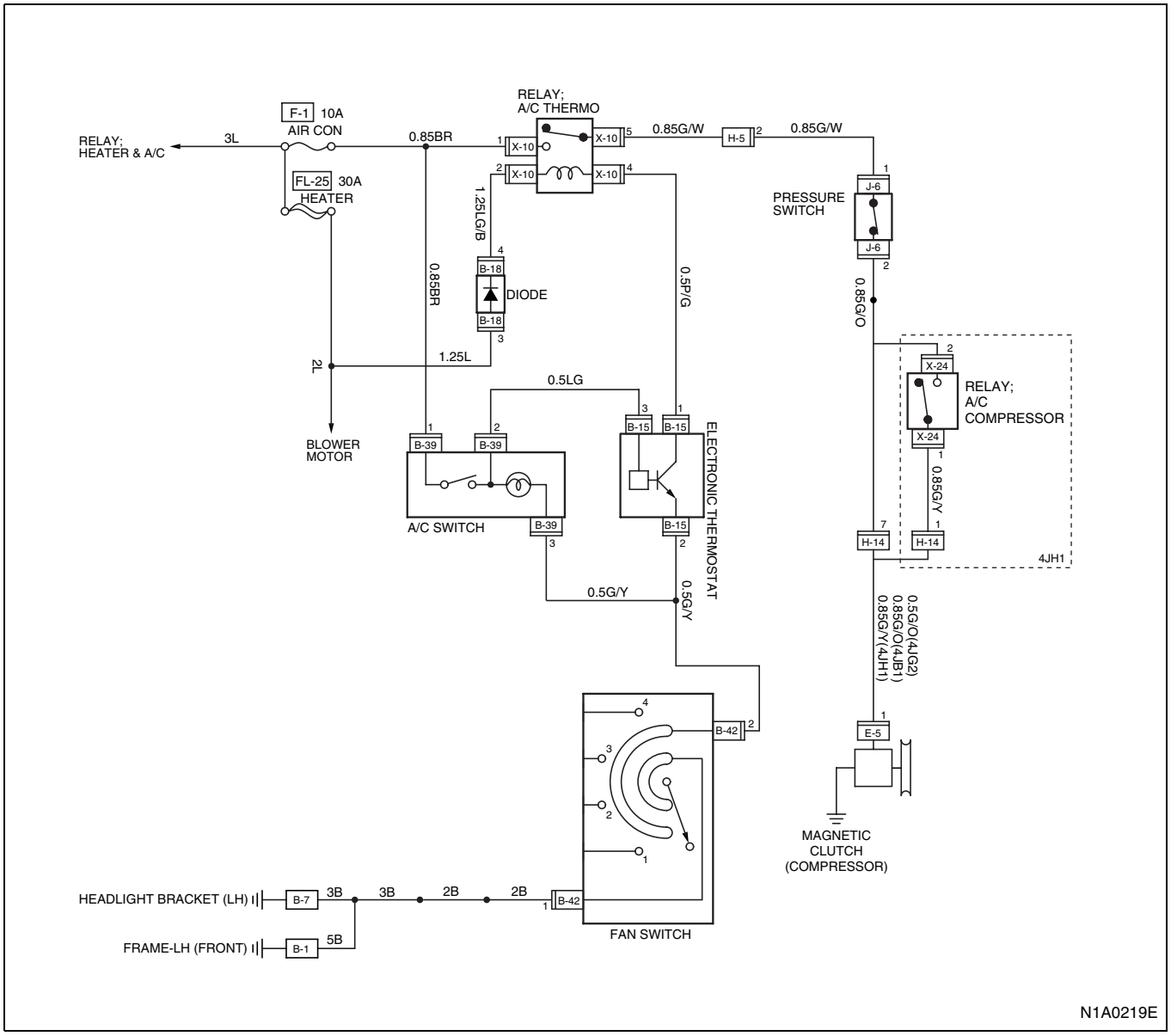


N1A0203E

For 12 Volt (LHD Model 4JH1/Taiwan)

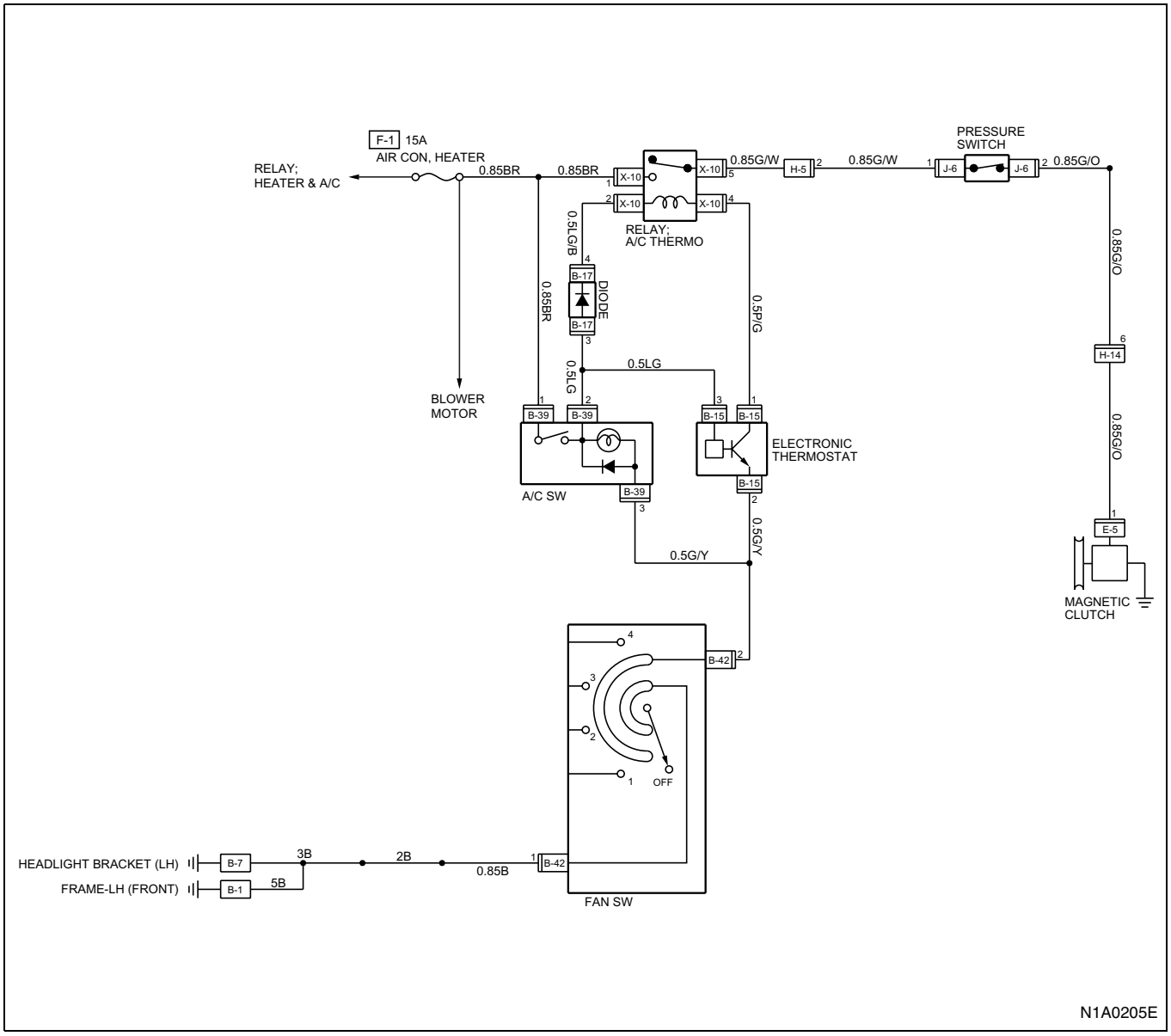


For 12 Volt (RHD Model)

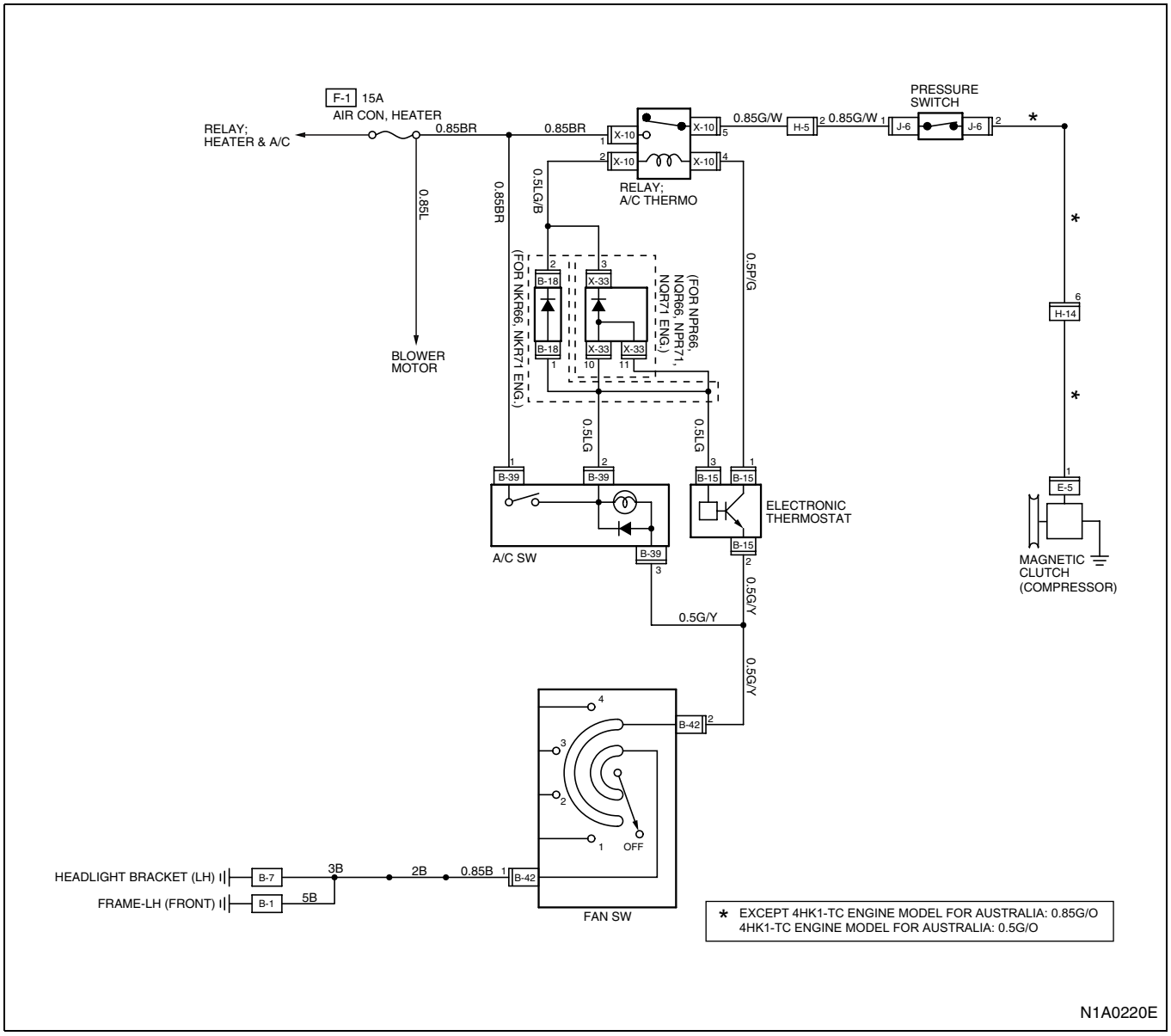


N1A0219E

For 24 Volt (LHD Model)

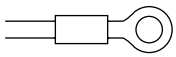
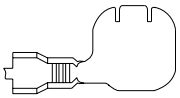
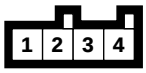
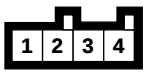
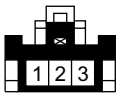
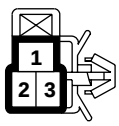


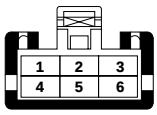
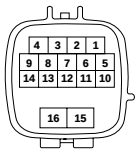
For 24 Volt (RHD Model)



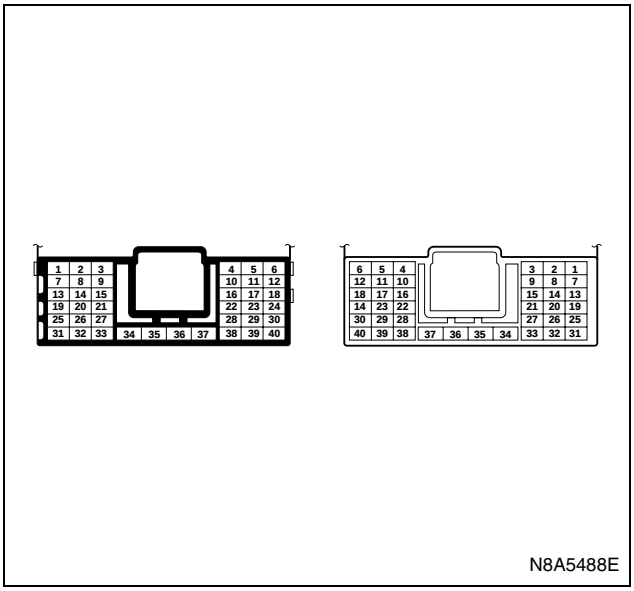
N1A0220E

Connector List

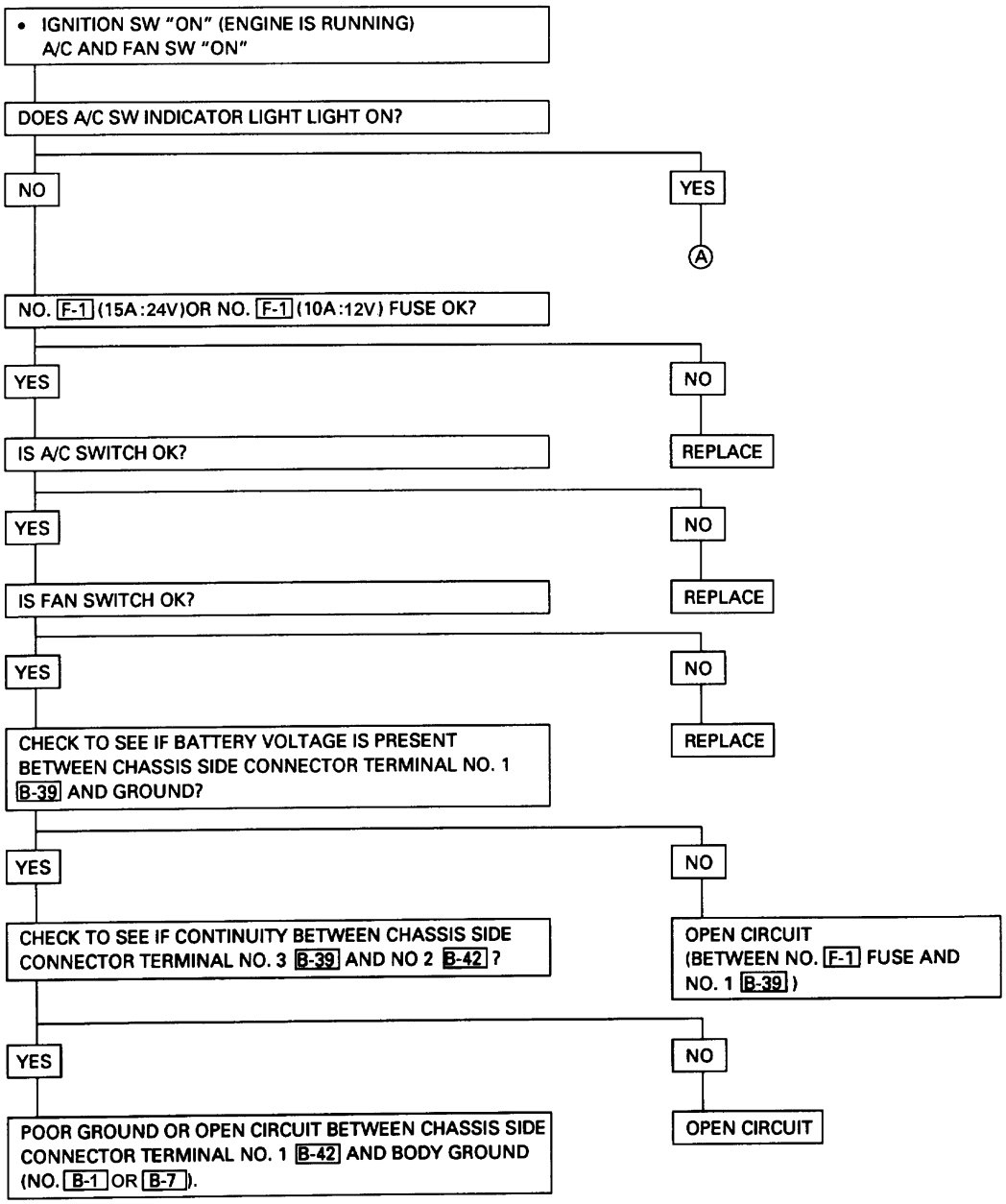
No.	Connector Face
B-1	 000-001
B-7	 000-012
B-17	 004-004
B-18	 004-004
B-15	 003-009
X-10	005-001
B-39	 003-019

No.	Connector Face
B-42	 006-001
E-5	001-013
E-5	001-014
H-14	016-003
H-14	 016-004
J-6	002-032
H-14	016-001
H-14	016-002

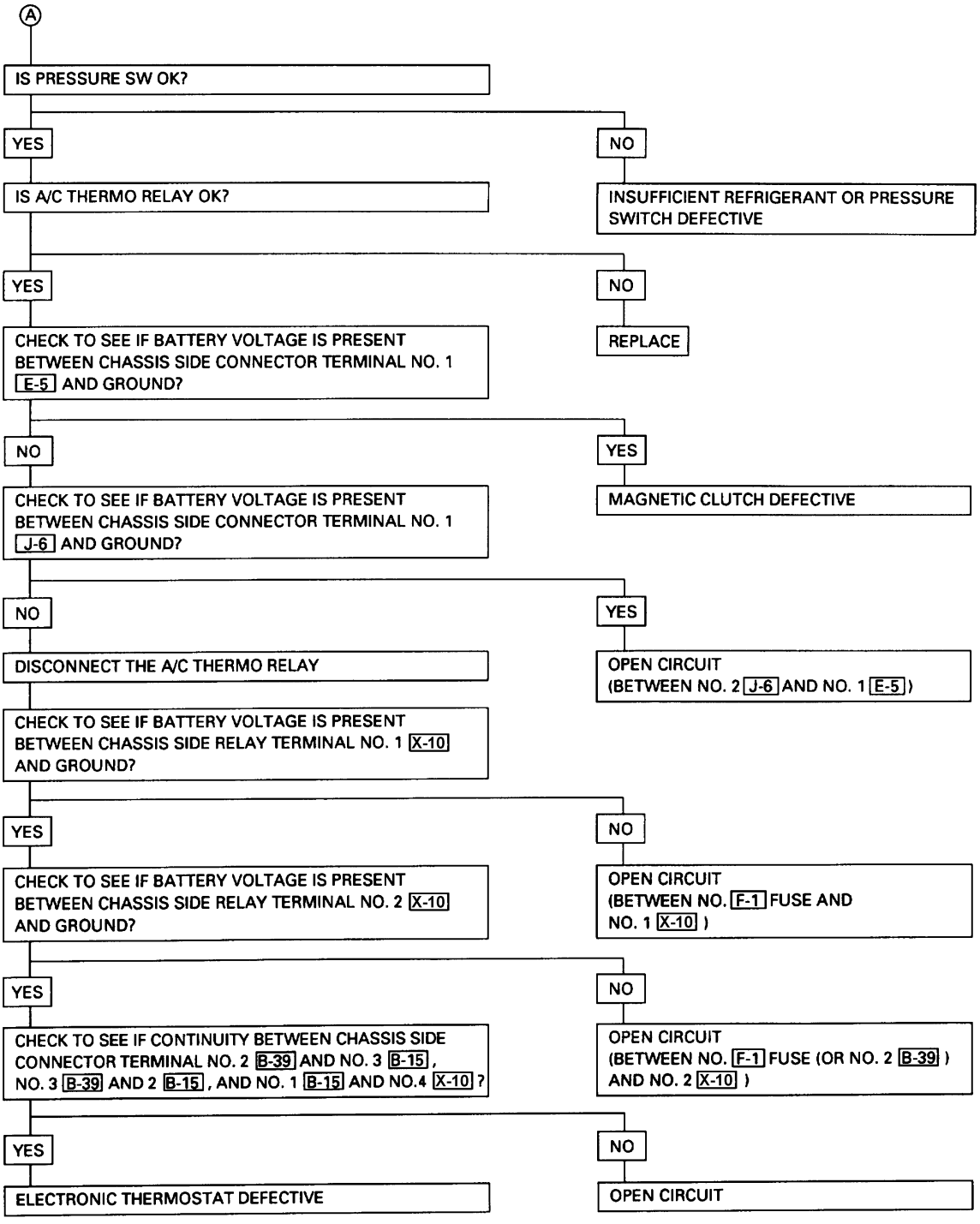
H-5


1 2 3
7 8 9
13 14 15
19 20 21
25 26 27
31 32 33 34 35 36 37
4 5 6
10 11 12
16 17 18
22 23 24
28 29 30
38 39 40
6 5 4
12 11 10
18 17 16
14 23 22
30 29 28
40 39 38
37 36 35 34
3 2 1
9 8 7
15 14 13
21 20 19
27 26 25
33 32 31
N8A5488E

Magnetic Clutch Does Not Operate



N1A0211E


Ⓐ
IS PRESSURE SW OK?
YES
NO
IS A/C THERMO RELAY OK?
INSUFFICIENT REFRIGERANT OR PRESSURE SWITCH DEFECTIVE
YES
NO
CHECK TO SEE IF BATTERY VOLTAGE IS PRESENT BETWEEN CHASSIS SIDE CONNECTOR TERMINAL NO. 1 E-5 AND GROUND?
REPLACE
NO
YES
CHECK TO SEE IF BATTERY VOLTAGE IS PRESENT BETWEEN CHASSIS SIDE CONNECTOR TERMINAL NO. 1 J-6 AND GROUND?
MAGNETIC CLUTCH DEFECTIVE
NO
YES
DISCONNECT THE A/C THERMO RELAY
OPEN CIRCUIT (BETWEEN NO. 2 J-6 AND NO. 1 E-5)
CHECK TO SEE IF BATTERY VOLTAGE IS PRESENT BETWEEN CHASSIS SIDE RELAY TERMINAL NO. 1 X-10 AND GROUND?
YES
NO
CHECK TO SEE IF BATTERY VOLTAGE IS PRESENT BETWEEN CHASSIS SIDE RELAY TERMINAL NO. 2 X-10 AND GROUND?
OPEN CIRCUIT (BETWEEN NO. F-1 FUSE AND NO. 1 X-10)
YES
NO
CHECK TO SEE IF CONTINUITY BETWEEN CHASSIS SIDE CONNECTOR TERMINAL NO. 2 B-39 AND NO. 3 B-15 , NO. 3 B-39 AND 2 B-15 , AND NO. 1 B-15 AND NO.4 X-10 ?
OPEN CIRCUIT (BETWEEN NO. F-1 FUSE (OR NO. 2 B-39) AND NO. 2 X-10)
YES
NO
ELECTRONIC THERMOSTAT DEFECTIVE
OPEN CIRCUIT

N1A0127E

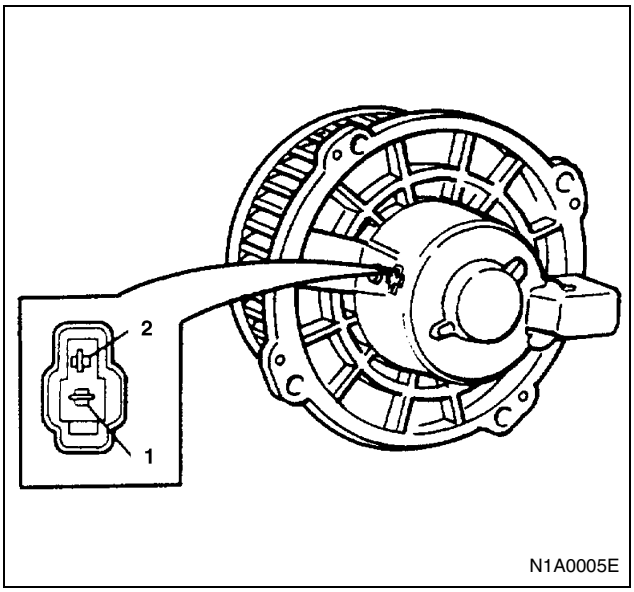
Compressor Troubleshooting

ITEM	TROUBLE	POSSIBLE CAUSE	CORRECTION
1	Noise from compressor	1. Defective Piston 2. Defective bearing 3. Defective shaft	Replace cylinder and shaft assembly Replace cylinder and shaft assembly Replace cylinder and shaft assembly
2	Noise from magnetic clutch face	1. Defective bearing 2. Defective clutch 3. Clearance between drive plate and pulley is not standard	Replace magnetic clutch Replace magnetic clutch Adjust the clearance or replace magnetic clutch
3	Insufficient cooling	1. Defective gasket 2. Defective reed valve 3. Defective suction valve	Replace gasket Replace valve plate Replace suction valve
4	Not rotating	1. Defective piston 2. Defective shaft 3. Rotating parts seized due to insufficient oil	Replace cylinder and shaft assembly Replace cylinder and shaft assembly Replace compressor
5	Oil and/or gas leakage	1. Defective seal 2. Defective O-ring	Replace shaft seal Replace

Individual Inspection

Blower Motor

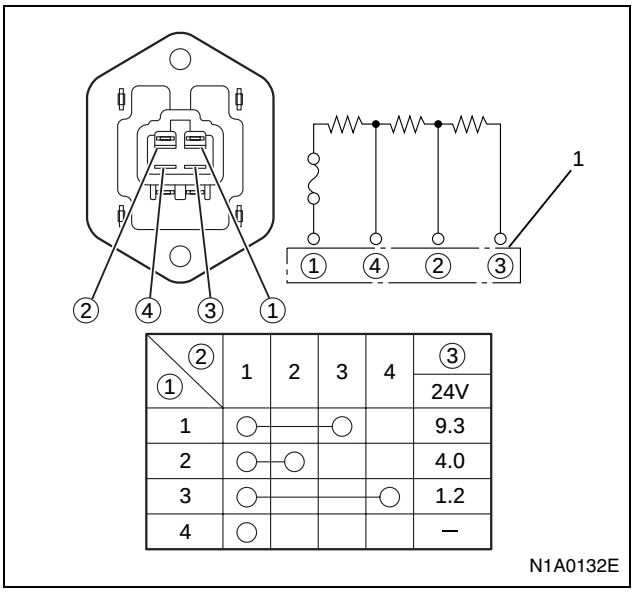
1. Disconnect the blower motor connector from the blower motor.
2. Connect the battery positive terminal to the No. 1 (No. 2; RHD) terminal of the blower motor and negative to the No. 2 (No. 1, RHD).
3. Be sure to check to see if the blower motor operates correctly.



Resistor

1. Disconnect resistor connector.
2. Check for continuity and resistance between the terminals of the resistor.

Except Taiwan

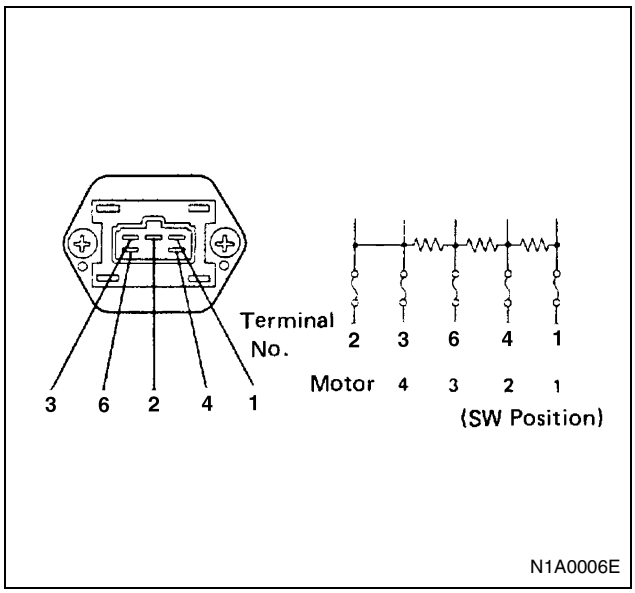


② / ①	1	2	3	4	③ 24V
1	○		○		9.3
2	○	○			4.0
3	○			○	1.2
4	○				–

Legend

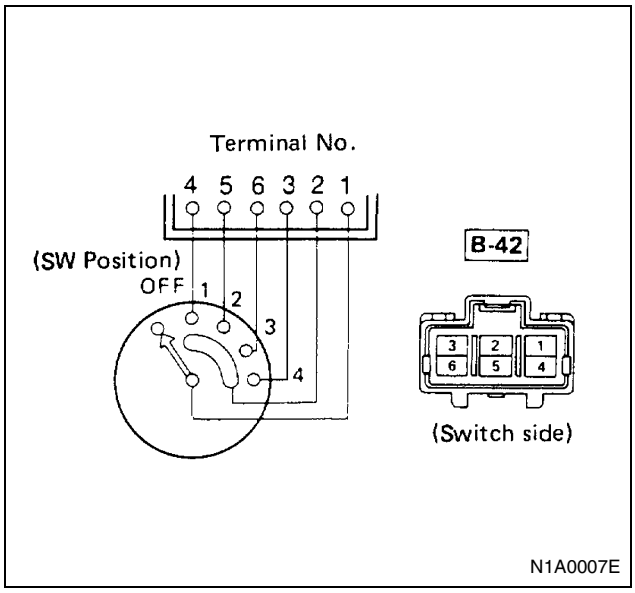
1. SW position
2. Terminal No.
3. Resistance value

For Taiwan



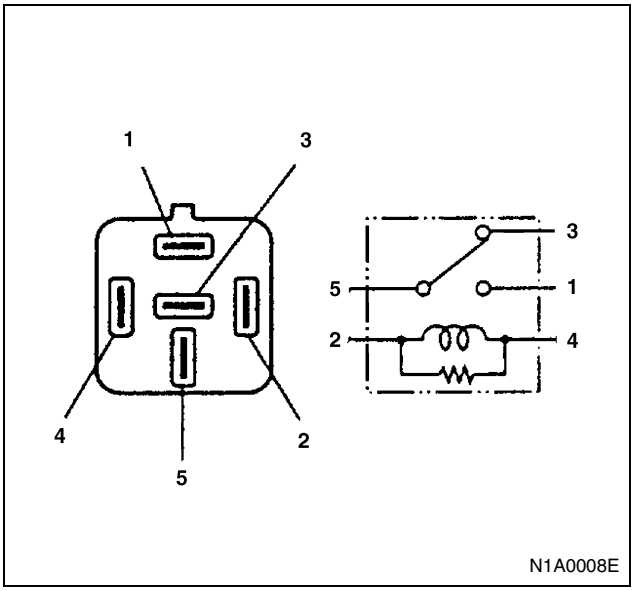
Fan Switch

Check for continuity between fan switch and A/C switch side connector terminals.



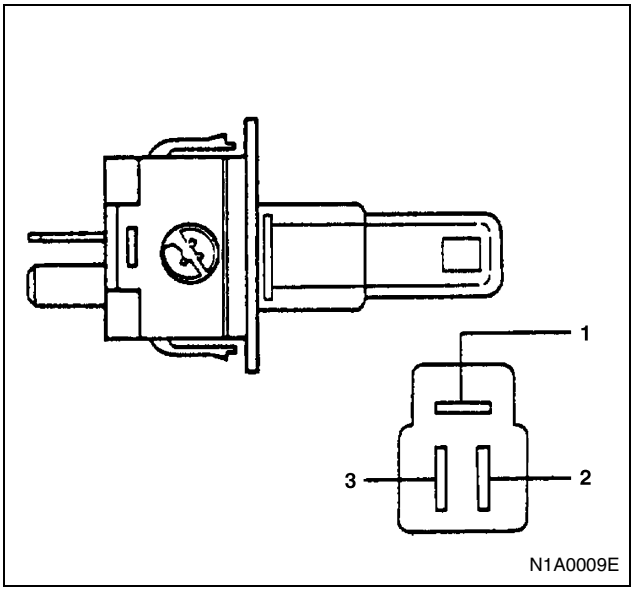
Heater & A/C and A/C Thermo Relay

Check for continuity between relay side connector terminal.
3 — 5 --- Continuity
1 — 5 --- No Continuity
When battery voltage is applied between 2 — 4
3 — 5 --- No Continuity
1 — 5 --- Continuity



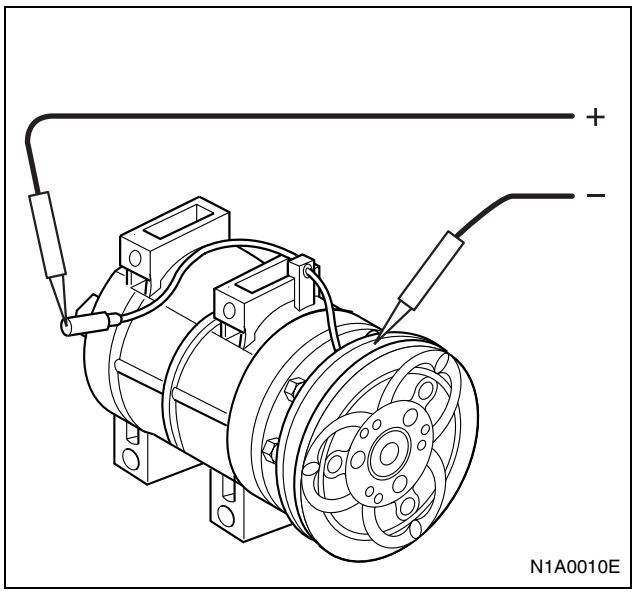
A/C Switch

Check for continuity between A/C switch side connector terminals.



Magnetic Clutch

1. Disconnect the magnetic clutch harness connectors.
2. Apply battery voltage to the clutch side connector terminal, check to see if the magnetic clutch is attracted to the pulley.

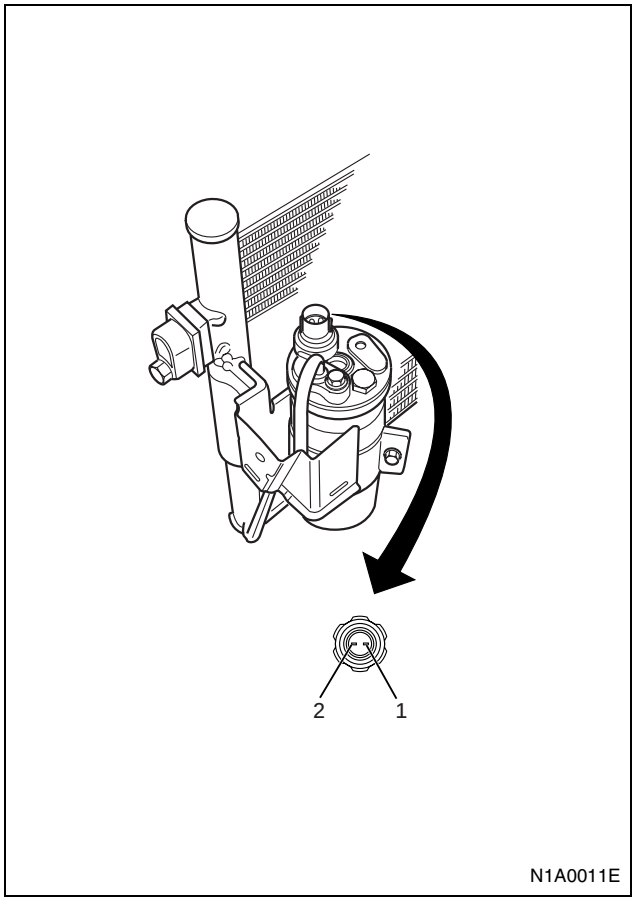


Pressure Switch

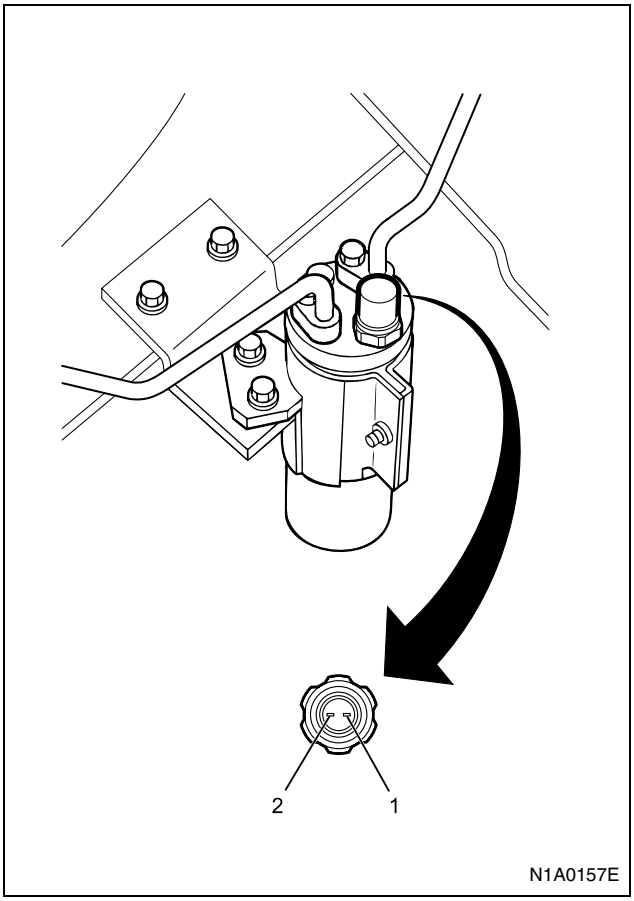
Disconnect the connector and check for continuity between pressure switch side connector terminal.

Terminal No.	Control	Continuity
1 — 2	Magnetic Clutch	Continuity

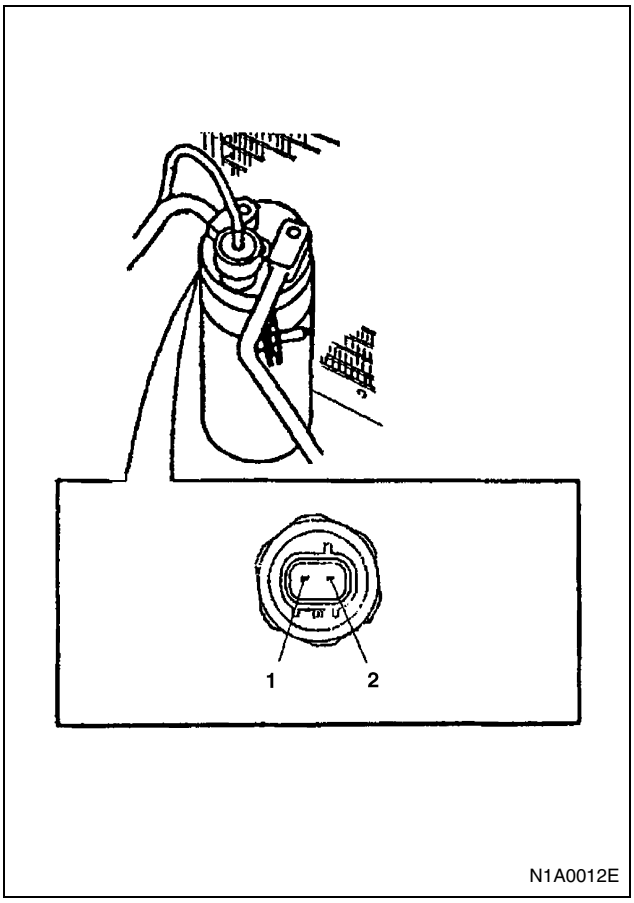
For GCC



For Australia



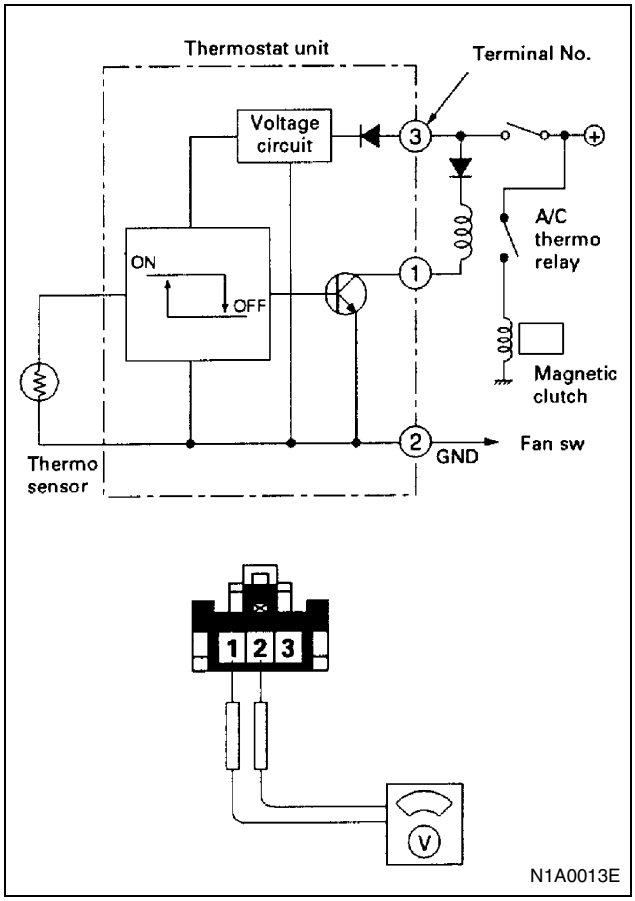
For Taiwan



Electronic Thermostat

1. With the air select lever set to “VENT” and the air source select lever to “CIRC”, start the air conditioning.
2. While shifting the temperature control lever from “FULL COOL” through the “FULL HOT”, check to see if the magnetic clutch turns on and off.
   (*Note that the time required to reach the “OFF” point depends on the warm or cold air at 3.5 ± 0.5°C at the electronic thermostat thermo sensor).
3. While the magnetic clutch is turning “ON” and “OFF”, measure the voltage between chassis side connector terminal No. 1 and No. 2.

Terminal No.	Magnetic Clutch	Voltage
1 — 2	ON	0 V
	OFF	Battery voltage



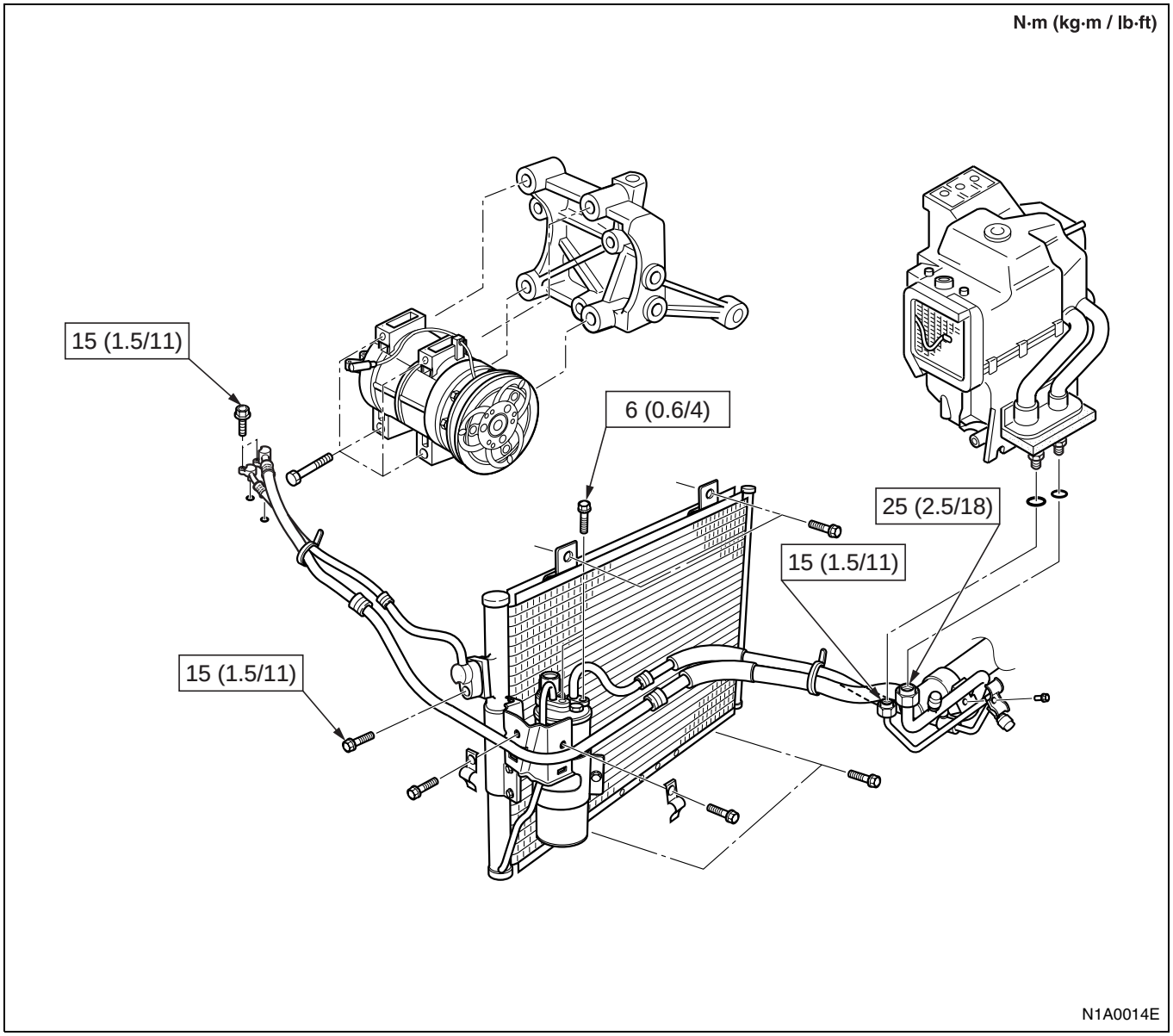
MAIN DATA AND SPECIFICATIONS

HEATER UNIT		
Temperature control		Reheat mix system
Capacity	kW (kcal)	4.30 (3,700)
Air flow	(m^3/hr)	280
HEATER CORE		
Type		Fin & tube type
EVAPORATOR ASSEMBLY		
Capacity	kW (kcal)	4.47 (3,850)
Air flow	(m^3/hr)	420
EVAPORATOR CORE		
Type		Al-laminate louver fin type
EXPANSION VALVE		
Type		External pressure equalizer type
THERMOSTAT SWITCH		
Type		Electronic thermostat
	°C (°F)	OFF: Below 3.5 ± 0.5 (38.3 ± 0.9) ON: Above 5.0 ± 0.5 (41.0 ± 0.9)
CONDENSER		
Type		Parallel flow
Radiator performance	kW (kcal)	11.0 (9,500) - NPR, NKR (for GCC) 5.1 (4,400) - NKR (for Taiwan), NPR (for Australia)
RECEIVER/DRIER		
Internal volume	cc (Imp. fl oz)	300 (8.5) - NKR (for Taiwan), NPR (for Australia) 250 (7.1) - NKR, NPR (for GCC)
PRESSURE SWITCH		
Type		Dual pressure switch (for GCC and Taiwan)
	kPa (kg/cm^2 / PSI)	• Low pressure control (for GCC) ON: 206 ± 30 (2.1 ± 0.3 / 30 ± 4) OFF: 177 ± 25 (1.8 ± 0.2 / 26 ± 3) • High pressure control (for GCC) ON: 2350 ± 200 (24.0 ± 2.0 / 341 ± 29) OFF: 2940 ± 200 (30.0 ± 2.0 / 426 ± 29) • Low pressure control (for Taiwan) ON: 221 ± 20 (2.25 ± 0.2 / 32 ± 3) OFF: 196 ± 20 (2.0 ± 0.2 / 28 ± 3) • High pressure control (for Taiwan) ON: 2350 ± 200 (24.0 ± 2.0 / 341 ± 29) OFF: 2940 ± 200 (30.0 ± 2.0 / 426 ± 29)

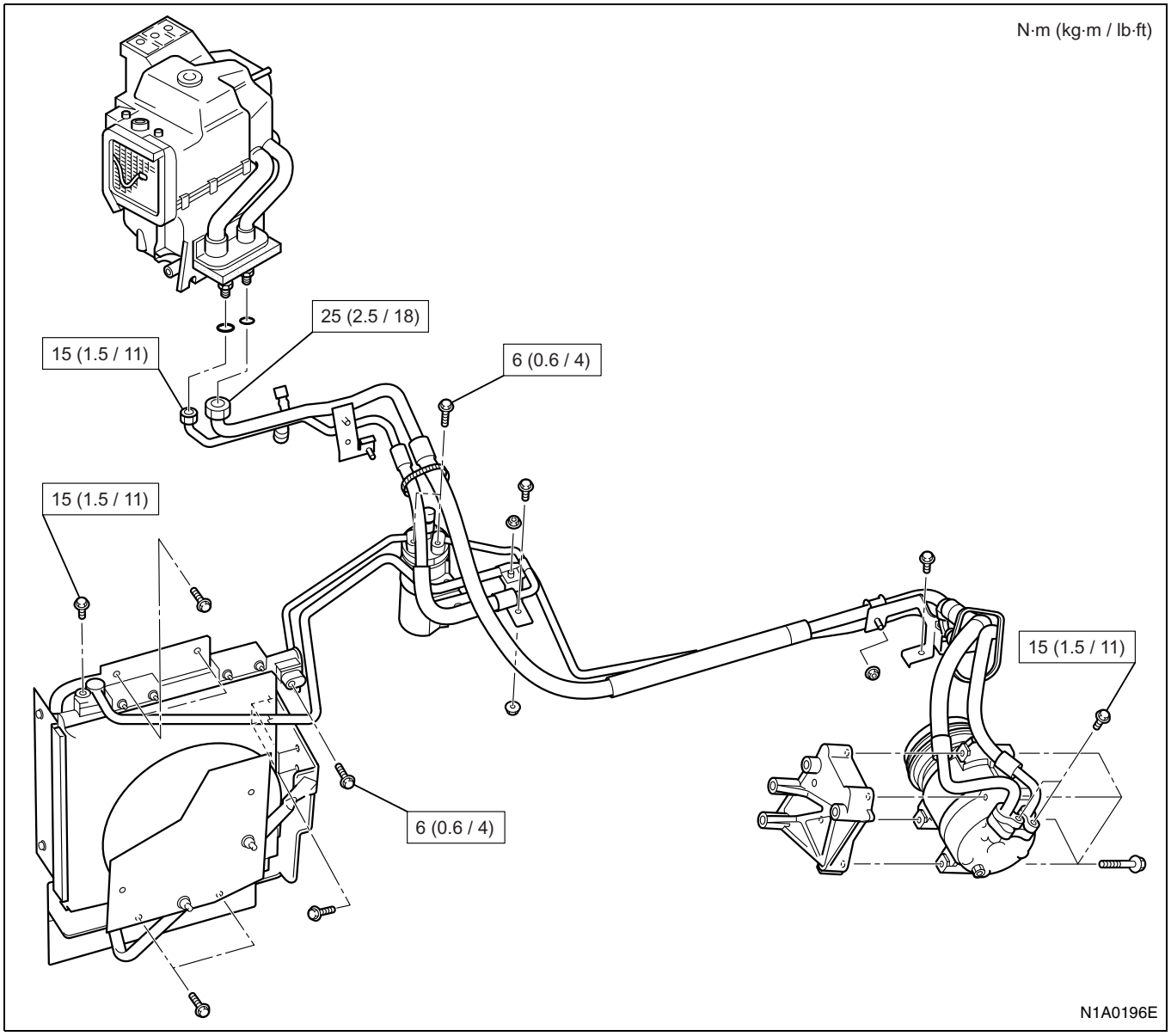
		Triple pressure switch (for Australia) • Low pressure control ON: 206 ± 30 (2.1 ± 0.3 / 30 ± 4) OFF: 177 ± 25 (1.8 ± 0.2 / 26 ± 3) • Medium pressure control ON: 1470 ± 100 (15 ± 1.0 / 213 ± 14) OFF: 1079 ± 120 (11 ± 1.2 / 156 ± 17) • High pressure control ON: 2350 ± 200 (24.0 ± 2.0 / 341 ± 29) OFF: 2940 ± 200 (30.0 ± 2.0 / 426 ± 29)
REFRIGERANT	g (lbs)	R-134a / 450 (0.99) (for GCC)
Type/Specified amount		R-134a / 600 (1.32) (for Australia, Taiwan)
COMPRESSOR		
Model		DKS-15-D (except Taiwan) DKS-13CH (for Taiwan)
Swash plate type (except Taiwan)		
Number of cylinder		10
Bore	mm (in)	30.5 (1.2)
Stroke	mm (in)	21.4 (0.8)
Displacement	cc (lmp fl oz)	156 (4.4)
Swash plate type (for Taiwan)		
Number of cylinder		6
Bore	mm (in)	36 (1.42)
Stroke	mm (in)	21.4 (0.84)
Displacement	cc (lmp fl oz)	131 (3.7)
Maximum speed	(rpm)	7,000 (up to 8,400)
Direction of rotation		Clockwise (Front-side view)
Lubrication system		Pressure differential type
Lubricant	cc (lmp fl oz)	ZXL-100PG / 180 (5.0) (ISUZU PART NO. 8-97101-338-0)
Shaft seal		Lip type
Weight	kg (lbs)	4.4 (9.7) (except Taiwan) 4.1 (9.0) (for Taiwan)
MAGNETIC CLUTCH		
Type		Electromagnetic single-plate dry clutch
Rated voltage		12 (24) Volts D.C.
Starting torque	N·m (kg·m / lb·ft)	49 (5.0 / 36)
Direction of rotation		Clockwise (Front-side view)
Weight	kg (lbs)	2.1 (4.6)

FIXING TORQUE

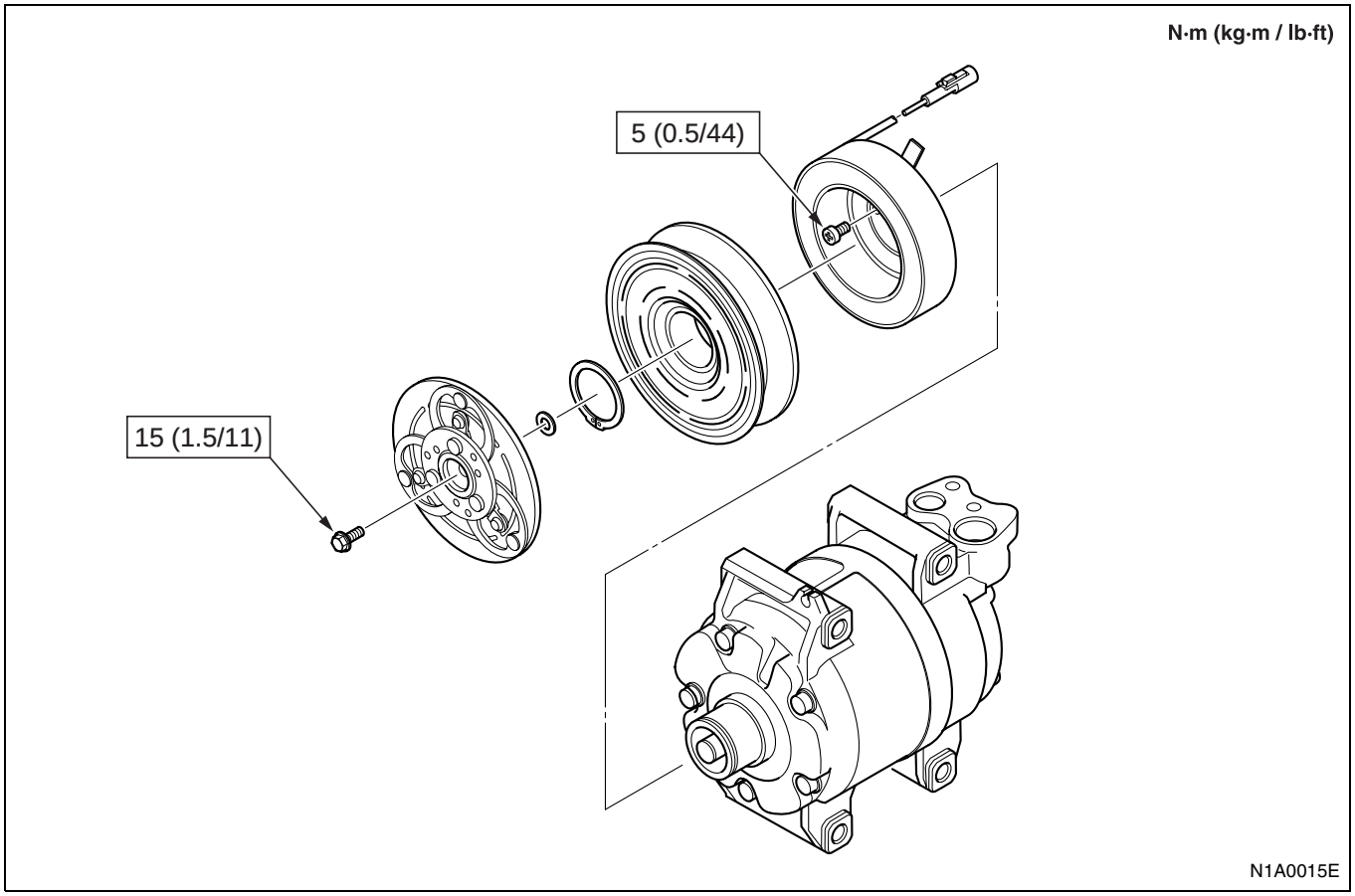
Refrigerant Line Fixing Torque (Except 4HK1-TC Engine Model For Australia)



Refrigerant Line Fixing Torque (4HK1-TC Engine Model For Australia)



Drive Plate / Field Coil Fixing Torque



SPECIAL TOOLS

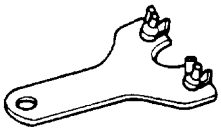
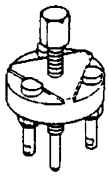
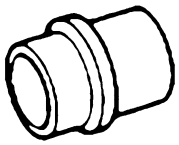
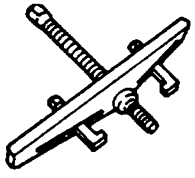
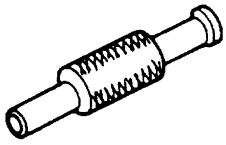
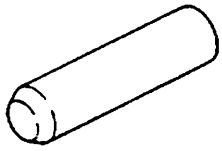
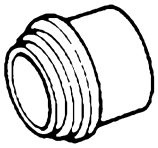
Illustration	Tool Number / Description / Remarks
5884006290	5-8840-0629-0 (J-39500-A) / ACR^4 (115V 60Hz) 5-8840-0630-0 (J-39500-220A) / ACR^4 (220-240V 50/60Hz) 5-8840-0631-0 (J-39500-220ANZ) / ACR^4 (220-240V 50/60Hz Australian model) ACR^4: R-134a Refrigerant Recovery/ Recycling / Recharging / System
 5884001170	5-8840-0117-0 (J-33939) / Drive plate holder
 5884001220	5-8840-0122-0 (J-33944-A) / Drive plate puller
5884006210	5-8840-0621-0 (J-33944) / Forcing screw
 5884001210	5-8840-0121-0 (J-33943) / Pulley puller pilot
 5884001110	5-8840-0111-0 (J-8433) / Pulley puller

Illustration	Tool Number / Description / Remarks
 5884001200	5-8840-0120-0 (J-33942) / Shaft seal remover and installer
 5884003680	5-8840-0368-0 (J-34614) / Shaft seal guide
 5884001180	5-8840-0118-0 (J-33940) / Pulley installer
5884000070	5-8840-0007-0 (J-8092) / Drive handle

HEATING AND AIR CONDITIONING

SECTION 1A
HEATING AND VENTILATION

Caution:
When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used.

Fasteners that are not reused, and those requiring thread locking compound, will be called out. The correct torque values must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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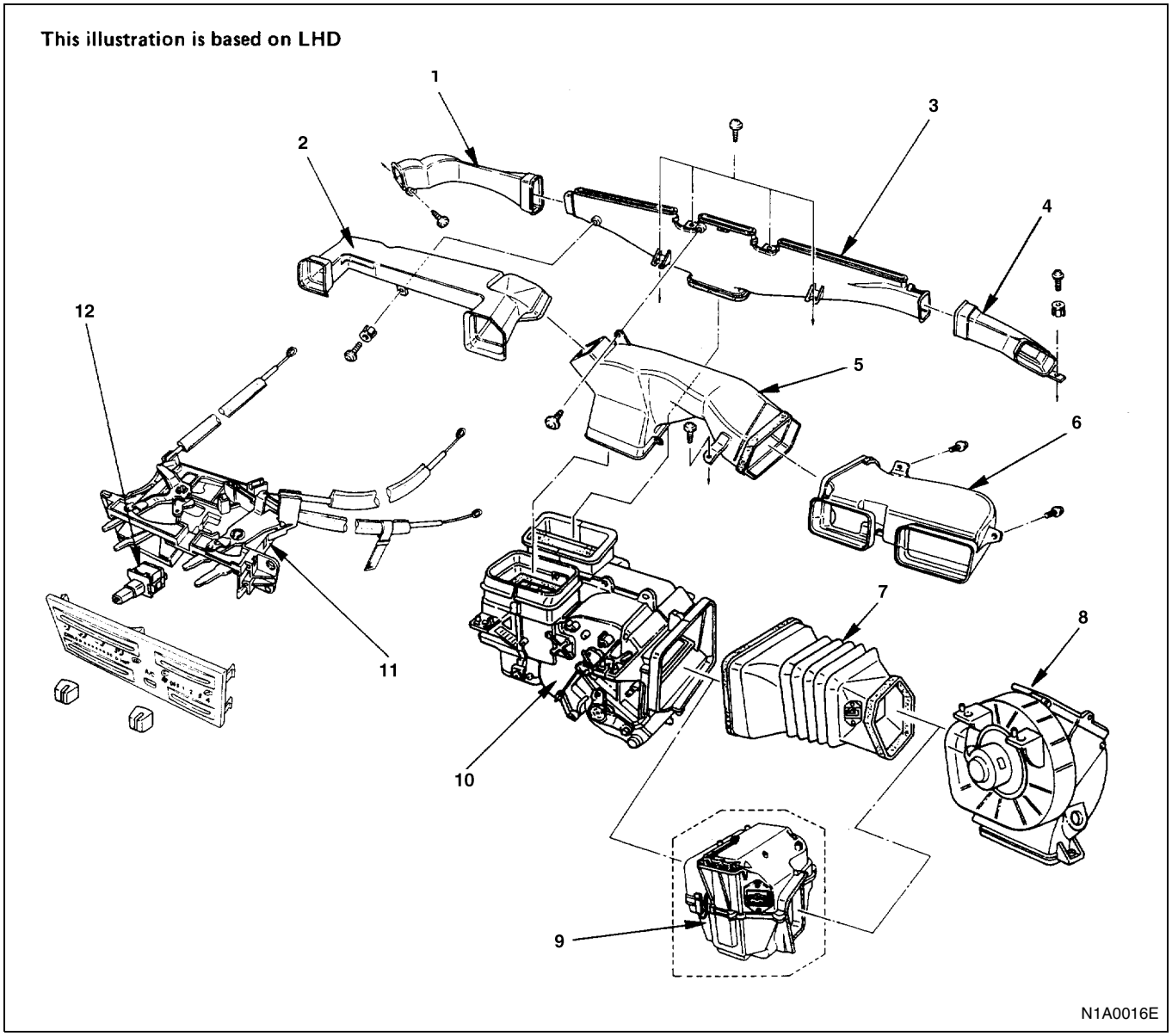
GENERAL DESCRIPTION

Heater

When the engine warming up, the warmed engine coolant is sent out into the heater core. The heater system supplies warm air into the passenger compartment to warm it up.
Outside air is circulated through the heater core of the heater unit and then back into the passenger compartment. By controlling the mixture of outside air and heater core air, the most comfortable passenger compartment temperature can be selected and maintained.
The temperature of warm air sent to the passenger compartment is controlled by the temperature control lever. This lever acts to open and close the air mix door, thus controlling the amount of air passed through the heater core.
The air select lever, with its different modes, also allows you to select and maintain the most comfortable passenger compartment temperature.
The air source select lever is used to select either “FRESH” for the introduction of the outside air, or “CIRC” for the circulation of the inside air. When the lever is set to “FRESH”, the outside air is always taken into the passenger compartment.
When setting the lever to “CIRC” position, the circulation of air is restricted only to the inside air with no introduction of the outside air and the air in the passenger compartment gets warm quickened. However, the lever is normally set to “FRESH” to prevent the windshield from clouding.

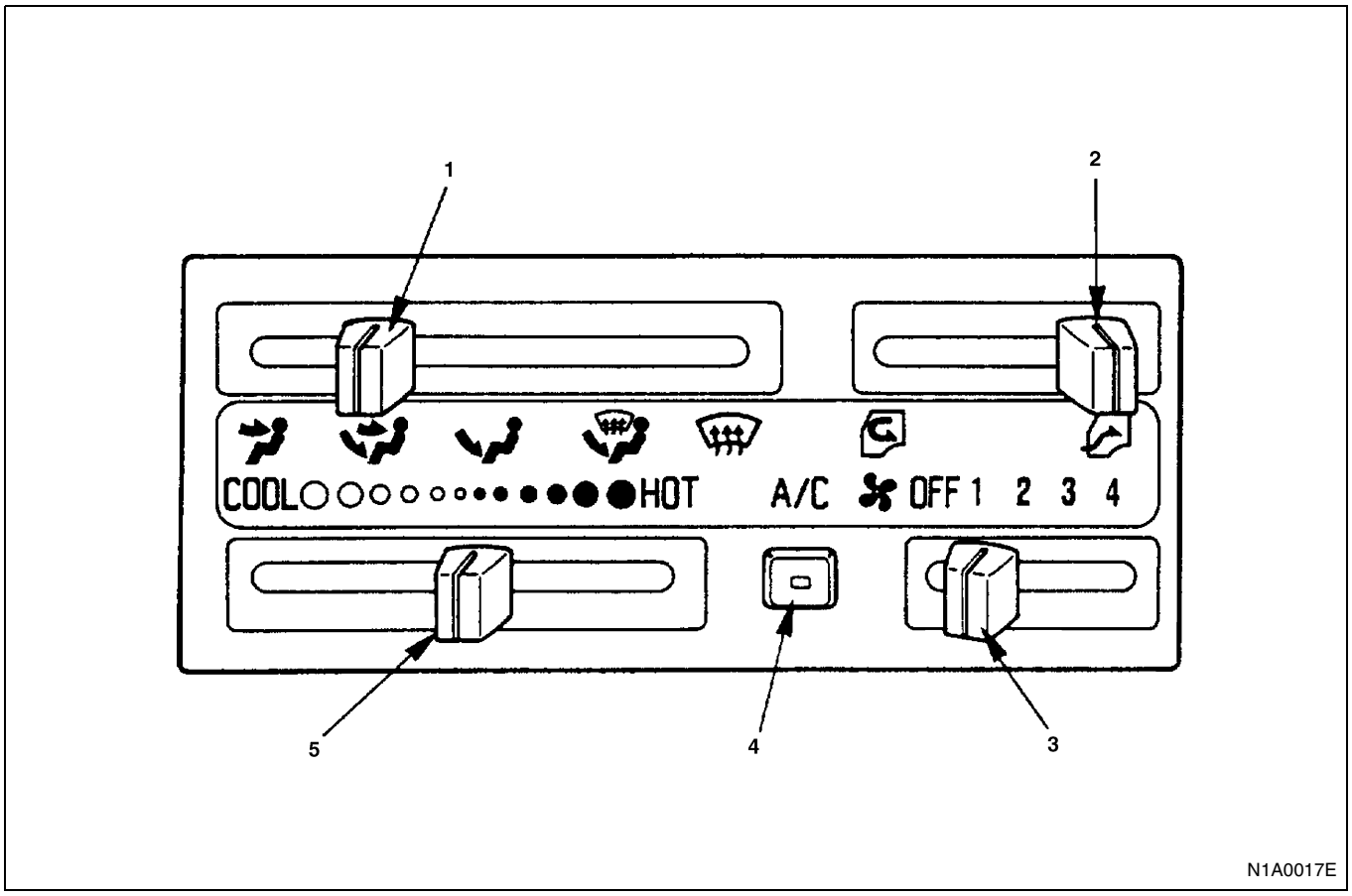


Legend

1. Side defroster nozzle (LH)
2. Ventilation duct (LH)
3. Defroster nozzle
4. Side defroster nozzle (RH)
5. Ventilation duct (Center)
6. Ventilation duct (RH)
7. Duct
8. Blower assembly
9. Evaporator assembly (W/A/C)
10. Heater unit
11. Control lever assembly
12. A/C switch

Control Lever Assembly

The vehicle has cable-control-type to control by cable the mode and temperature of the heater unit and the mode door for the air source of the blower assembly.
The fan control is used to control the amount of air sent out by the resistor at four levels from “LOW” to “HIGH”.

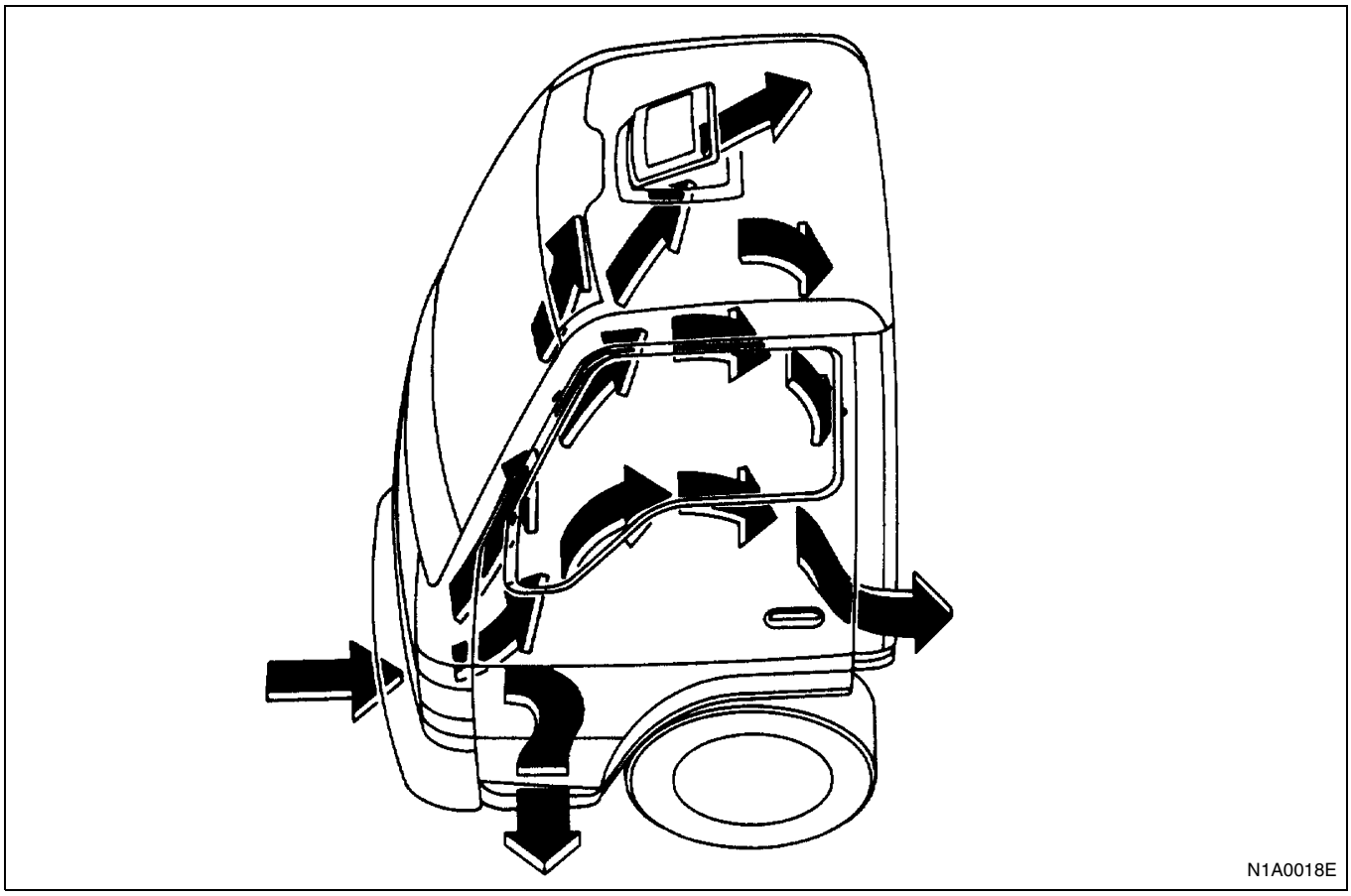


Legend

1. Air select lever
2. Air source select lever
3. Fan switch lever
4. A/C switch (W/A/C)
5. Temperature control lever

Ventilation

Set “AIR SOURCE SELECT LEVER” to “FRESH” position and turn on the blower fan. Heating can be done in this lever position, sending in fresh air from outside.
The blower fan also serves to deliver fresh outside air to the vehicle interior to assure adequate ventilation.



Air Select Lever

The air selector lever allows you to direct heated air into the passenger compartment through different outlets.

1. **Vent** - In this position, air is discharged from the upper air outlet. Air quantity is controlled by the fan control knob.
2. **Bi-Level** - In this position, air flow is divided between the upper air outlets and the foot air outlets, with warmer air delivered to the floor outlets than the air delivered to the upper air outlets.
3. **Foot** - In this position, air flow is delivered to the foot only.
4. **Def/Foot** - In this position, air flow is delivered to the foot, while sending approx, 30% of total amount of air to the windshield.
5. **Defrost** - In this position, most of the air is delivered to the windshield and a small amount is delivered to the side windows.

Air Source Select Lever

The intake of outside air and the circulation of inside air are controlled by sliding this lever left or right.
Moving the air source select lever to the “CIRC” position provides quickest heat delivery by closing the blower assembly mode door. In this position, outside air is not delivered to the passenger compartment.

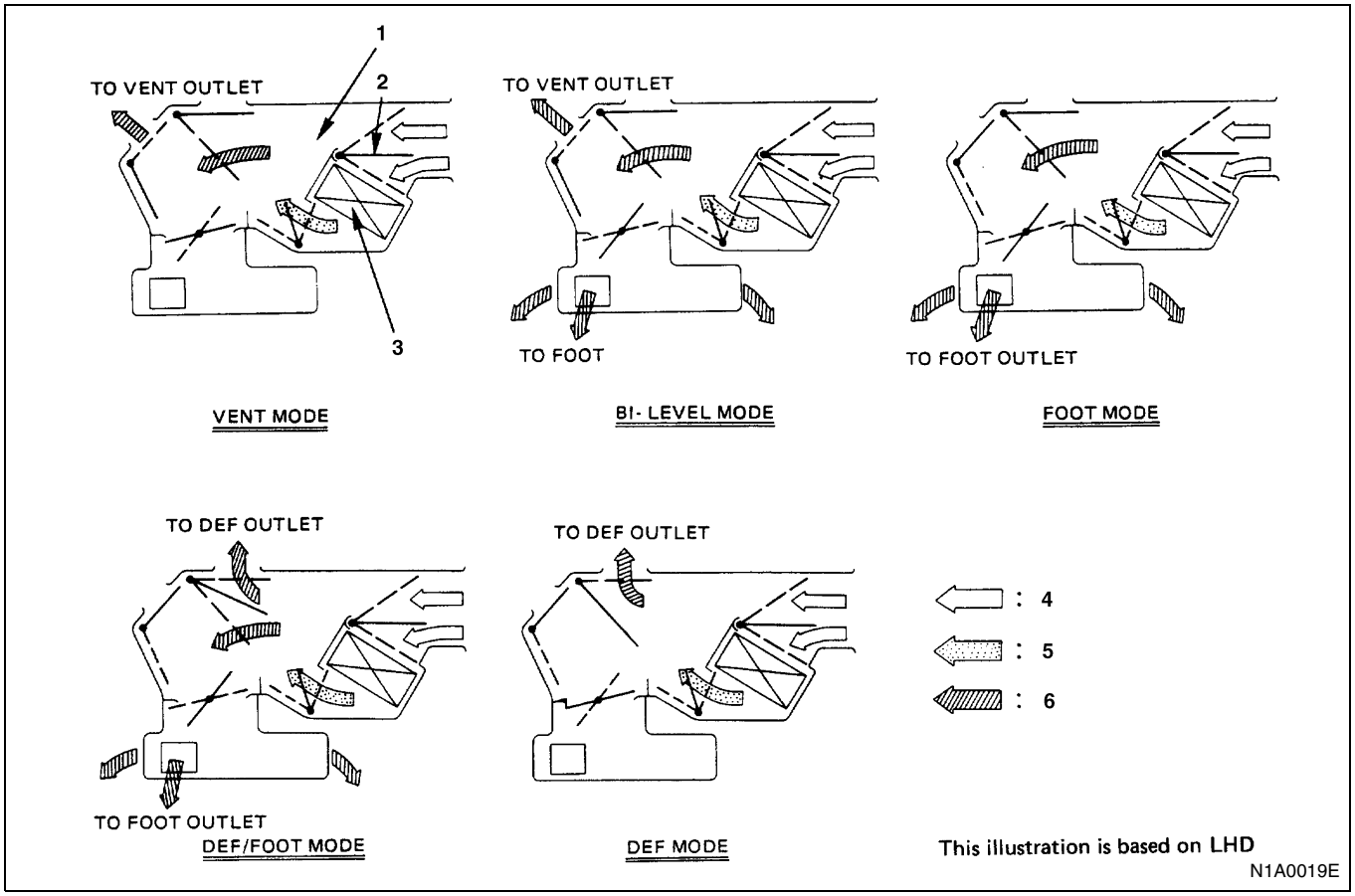
Fan Switch Lever

This lever controls the blower motor speed to regulate the amount of air delivered to the defrost, foot, and ventilation ducts:

1. Low
2. Medium Low
3. Medium High
4. High

Temperature Control Lever

When the temperature control lever is in the “COLD” position, the air mix door closes to block the flow of air to the heater core.
When the temperature control lever is in the “HOT” position, the air mix door opens to allow air to pass through the heater core and heat the passenger compartment.
Placing the lever in an intermediate position will cause a lesser or greater amount of air to reach the heater core. In this mode the passenger compartment temperature can be regulated.

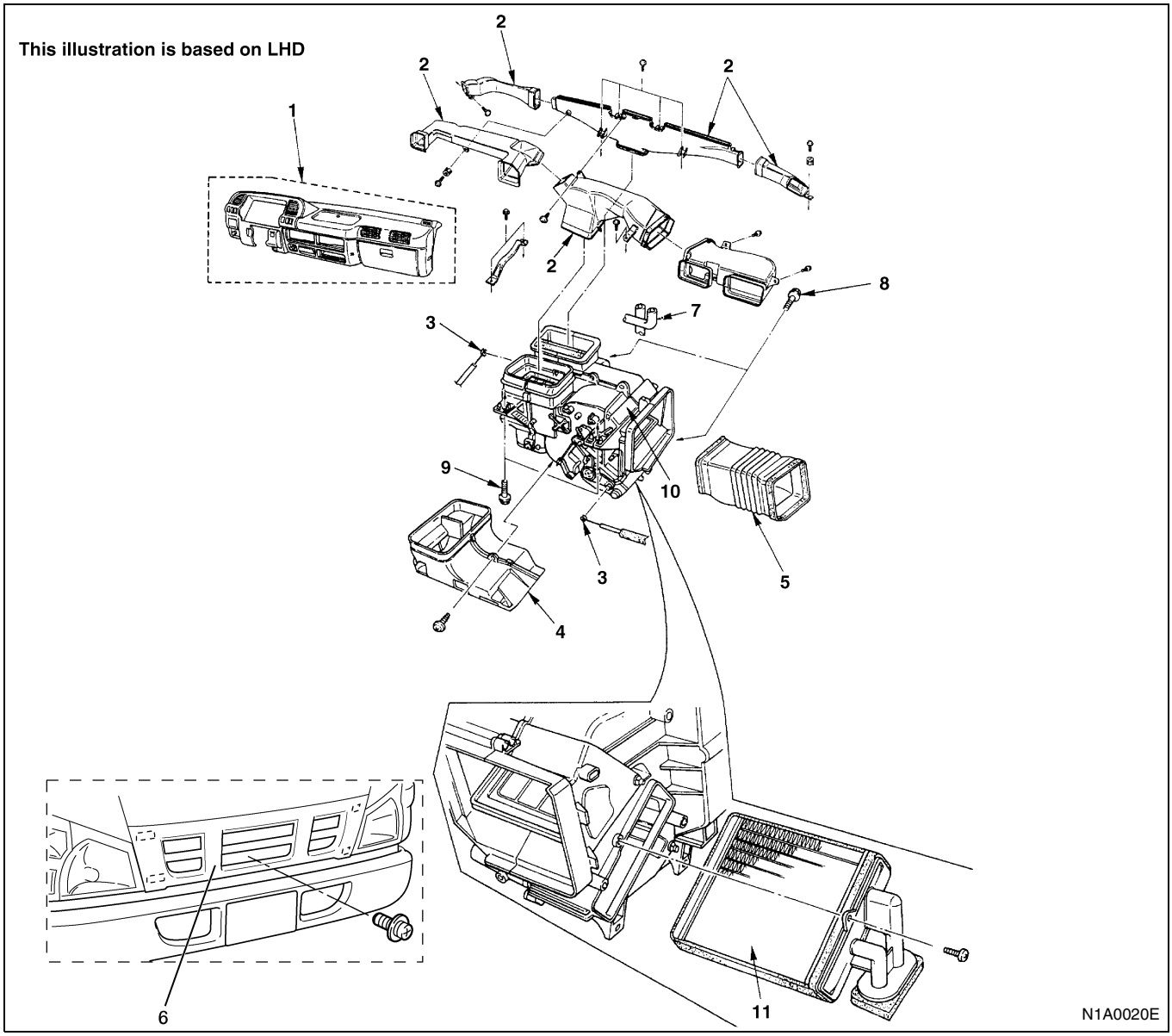


Legend

1. Heater unit
2. Air mix door
3. Heater core
4. Cold air
5. Hot air
6. Temperature controlled air

ON-VEHICLE SERVICE

Heater Unit/Heater Core



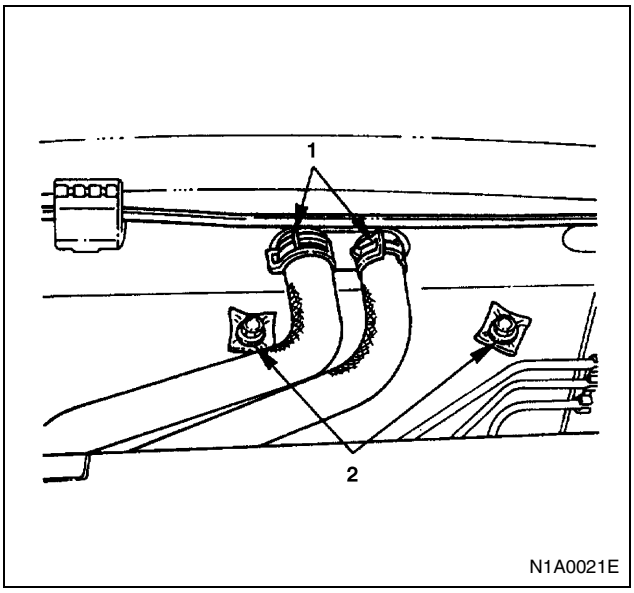
Legend

1. Instrument panel assembly
2. Defroster nozzle and ventilation duct
3. Heater control cable
4. Foot duct
5. Duct (NPR only)
6. Front grille
7. Water hose
8. Bolt (Panel - Heater unit)
9. Bolt (Heater unit - Reinforce)
10. Heater unit
11. Heater core

Removal

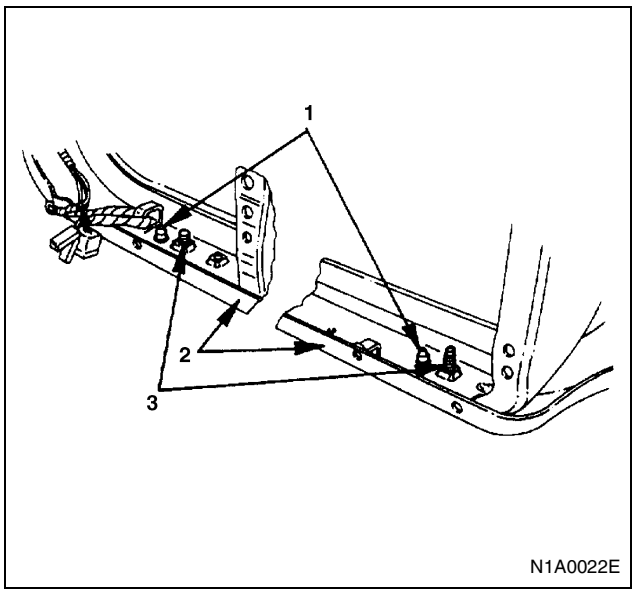
Preparation:
Disconnect the battery ground cable.

1. Instrument Panel Assembly
   Refer to Section 2 “CAB AND FRAME” for Instrument Panel Assembly removal procedure.
2. Defroster Nozzle and Ventilation Duct
   Refer to “DEFROSTER NOZZLE / VENTILATION DUCT” removal procedure in this section.
3. Heater Control Cable
   Disconnect the cables from the heater unit.
4. Foot Duct
5. Duct (NPR only)
6. Front Grille
7. Water Hose
   - Loosen the water hose clips and disconnect the water hoses from the heater unit.
   - Put caps to the openings of the heater unit and the water hoses to prevent a lot of engine coolant from spilling out of them.
8. Bolt (Panel - Heater Unit)



Legend
1. Water hose clip
2. Bolt

9. Bolt (Heater Unit - Reinforce)
10. Heater Unit
    - Drop the heater unit positioning pins from the reinforce, and remove the heater unit while sliding the engaged section between the evaporator and the heater unit.



Legend
1. Pin
2. Reinforce
3. Fixing bolt (Heater unit - Reinforce)

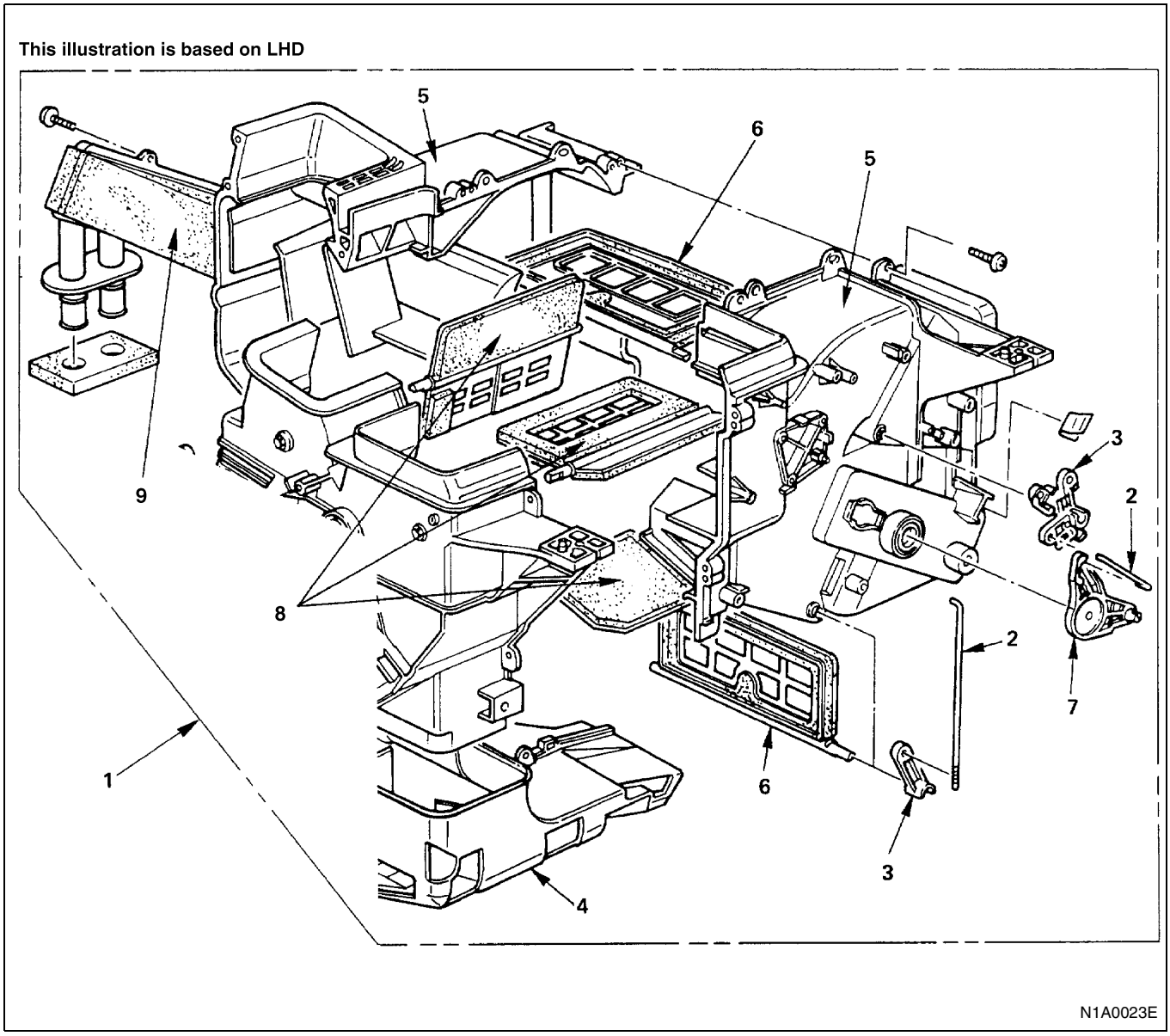
11. Heater Core

Installation

To install, follow the removal steps in the reverse order, noting the following points.

1. Adjust the heater control cable.
   Refer to “CONTROL LEVER ASSEMBLY” installation procedure in this section.
2. When installing the heater unit, defroster nozzles and ventilation ducts, be sure that proper seal is made, without any gap between them.
3. Check the engine coolant level. When the level is below the specified amount, replenish engine coolant to the proper level.

Heater Temperature Control Link Unit/Air Mix Door



Legend

1. Heater unit
2. Rod
3. Door lever
4. Foot duct
5. Upper case
6. Air mix door
7. Mix sub lever
8. Mode door
9. Heater core

Removal

Preparation:

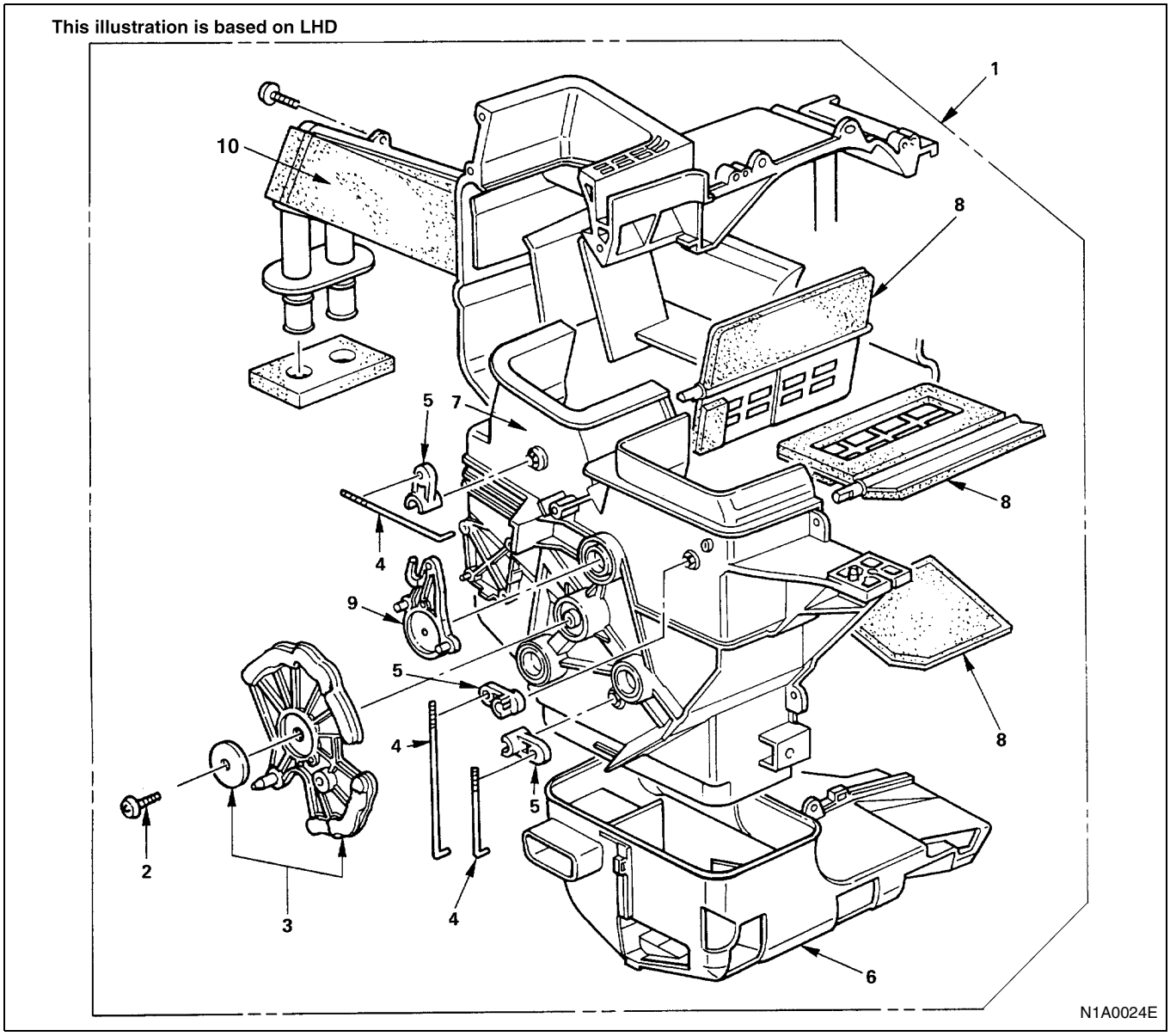
Disconnect the battery ground cable.

1. Heater Unit
   Refer to “HEATER UNIT” removal procedure in this section.
2. Rod
3. Door Lever
   Pull out the door lever while raising up the catch of the door lever.
4. Foot Duct
5. Upper Case
   Separate two halves of the upper case.
6. Air Mix Door
7. Mix Sub Lever
   Press the tab of the sub lever inward, and take out the sub lever.

Installation

To install, follow the removal steps in the reverse order.

Heater Mode Control Link Unit/Mode Door



Legend

1. Heater unit
2. Screw
3. Washer and mode main lever
4. Rod
5. Door lever
6. Foot duct
7. Upper case
8. Mode door
9. Mode sub lever
10. Heater core

Removal

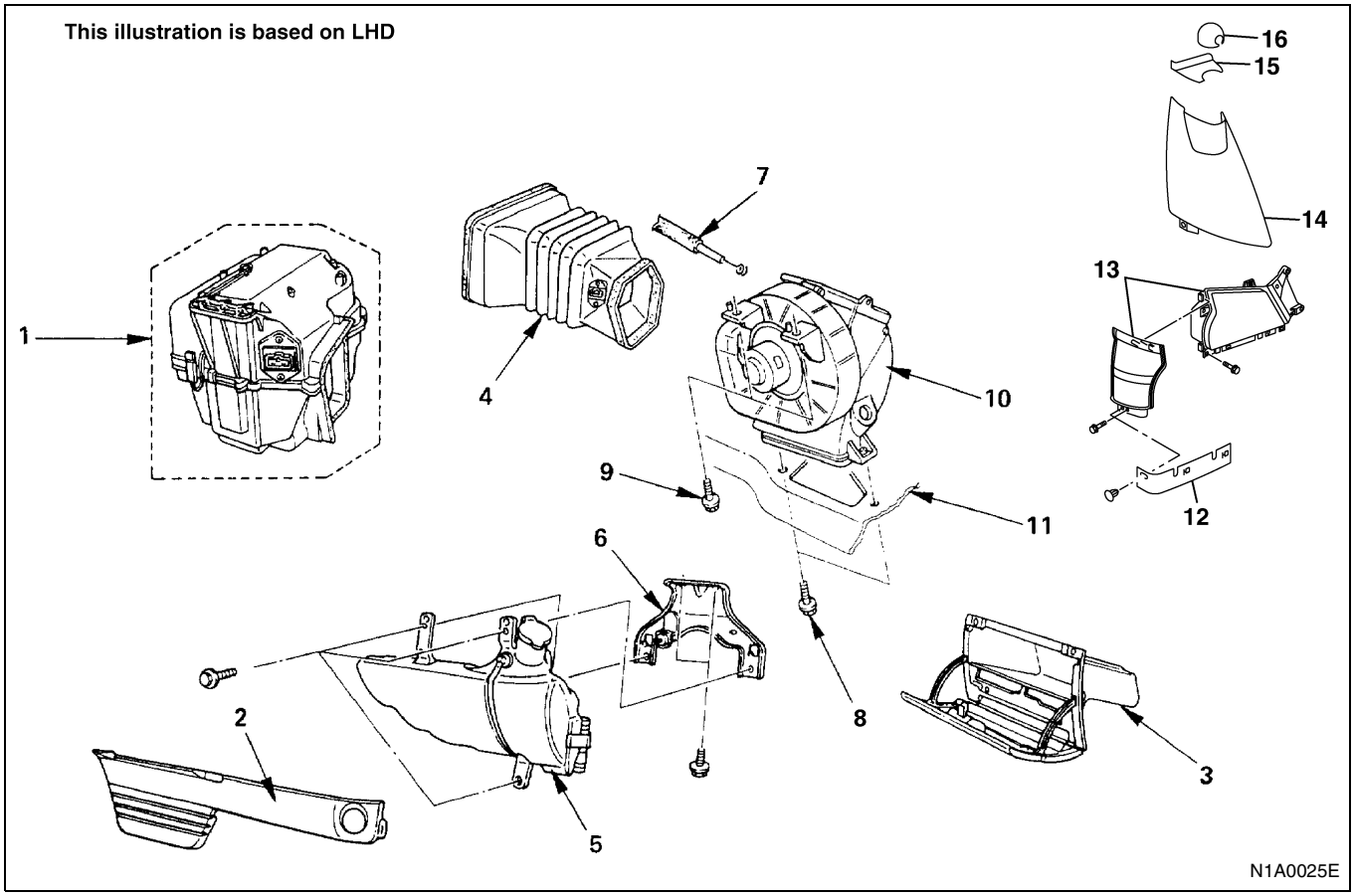
Preparation:
Disconnect the battery ground cable.

1. Heater Unit
   Refer to “HEATER UNIT” removal procedure in this section.
2. Screw
3. Washer and Mode Main Lever
4. Rod
5. Door Lever
   Pull out the door lever while raising up the catch of the door lever.
6. Foot Duct
7. Upper Case
8. Mode Door
9. Mode Sub Lever
   Press the tab of the sub lever inward, and take out the sub lever.

Installation

To install, follow the removal steps in the reverse order.

Blower Assembly



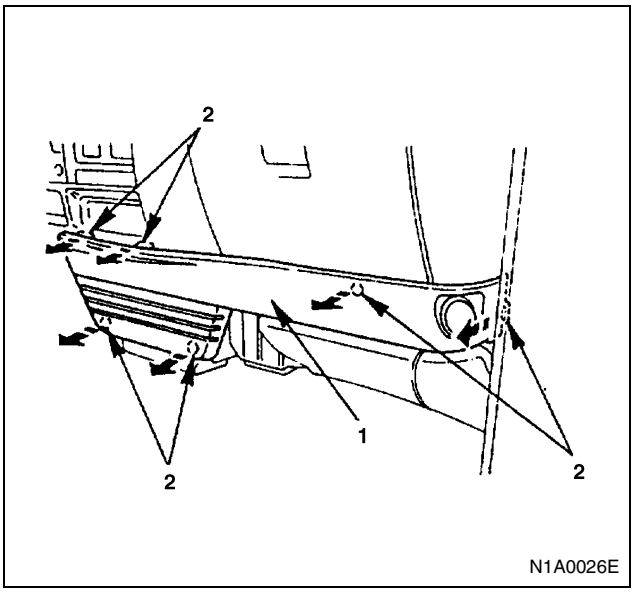
Legend

1. Evaporator assembly (A/C only)
2. Under cover (Without A/C)
3. Glove box (Without A/C)
4. Duct (Without A/C)
5. Washer tank (Without A/C)
6. Washer tank bracket
7. Blower control cable
8. Bolt (Panel-Blower assembly)
9. Bolt (Blower assembly - Reinforce)
10. Blower assembly
11. Floor panel
12. Headlight grill cover
13. Headlight assembly and combination light (RH)
14. Front side panel
15. Outside mirror cover
16. Mirror stay cap

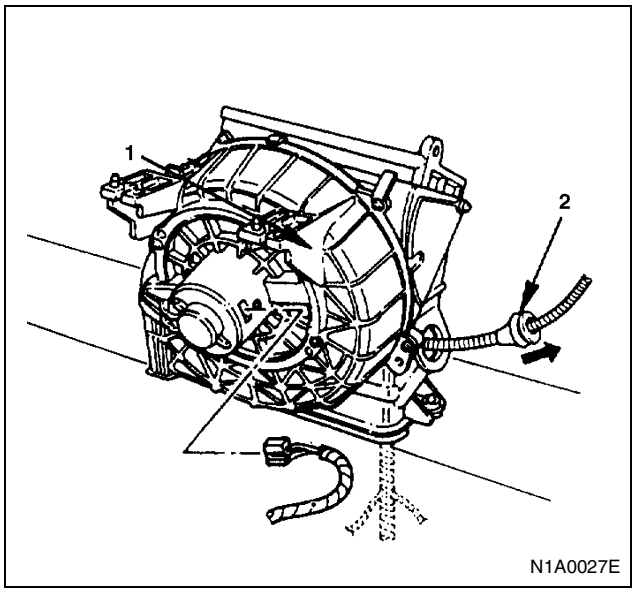
Removal

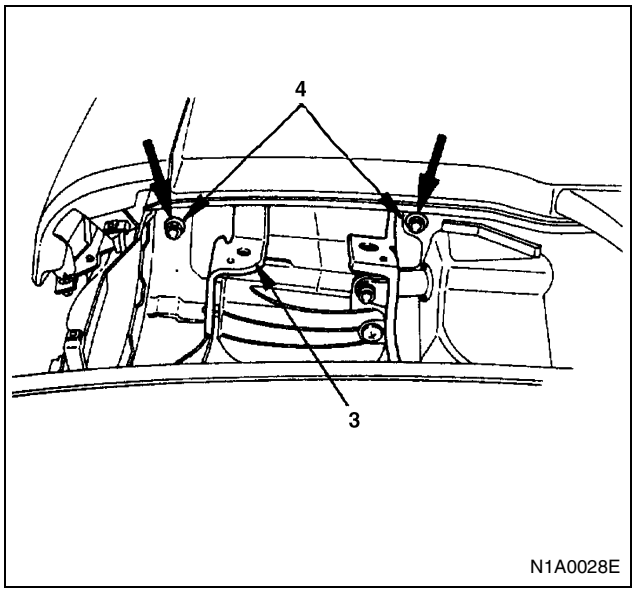
Preparation:
Disconnect the battery ground cable.
Discharge and recover refrigerant (A/C only).

1. Glove Box (Without A/C)
   Open the glove box and remove the fixing screws.
2. Under Cover (Without A/C)
   While pulling the under cover (1) with care, remove the clips (2) on the backside of the cover.



3. Washer Tank (Without A/C)
   Remove the washer tank fixing three bolts (Upper: two, Lower: one) and disconnect the connector.
4. Washer Tank Bracket
   Disconnect the harness connection connector and remove the fixing bolts.
5. Blower Control Cable
   Disconnect the blower control cable from the blower assembly.
6. Evaporator Assembly
   Refer to Section 1B “AIR CONDITIONING” for Evaporator Assembly removal procedure.
7. Duct (Without A/C)
8. Mirror Stay Cap
   Spread the stay fixing part by fingers to remove the mirror stay cap. Be careful not to break the two inside claws.
9. Outside Mirror Cover
   Insert a screwdriver to the front ends of cover to remove the outside mirror cover.
10. Front Side Panel
    Remove five clips and a bolt.
11. Headlight Grill Cover
    Remove the headlight grill cover from the claw part of headlight assembly at first, and then remove a clip.
12. Headlight Assembly and Combination Light (RH)
    - Refer to Section 8 “CAB AND CHASSIS ELECTRICAL” for Headlight removal procedure.
    - Remove the ground point bolts of headlight bracket (RH) (3) and right frame (front).
    - Remove the grommet (2) provided at the lower right side of the blower assembly (1), and pull in the harness to the room through the blower hole.
13. Bolt (Panel - Blower Assembly)

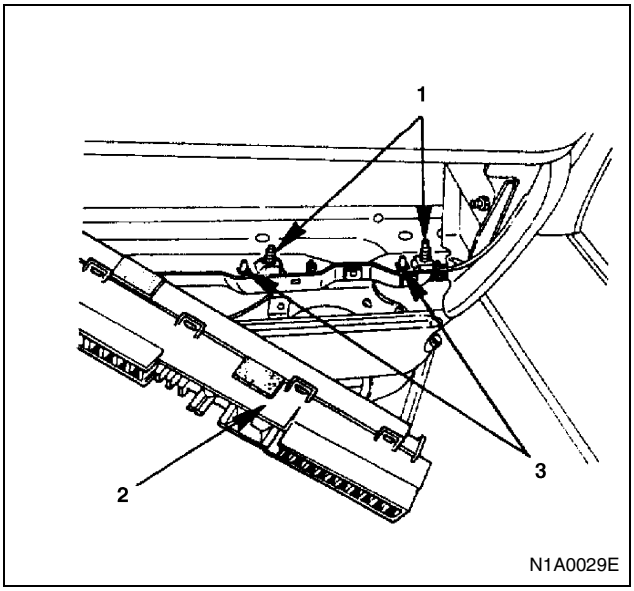




Legend

3. Headlight bracket (RH)
4. Bolt (Panel-Blower assembly)

14. Bolt (Blower Assembly - Reinforce)



Legend

1. Bolt (Blower assembly - Reinforce)
2. Fuse box
3. Pin

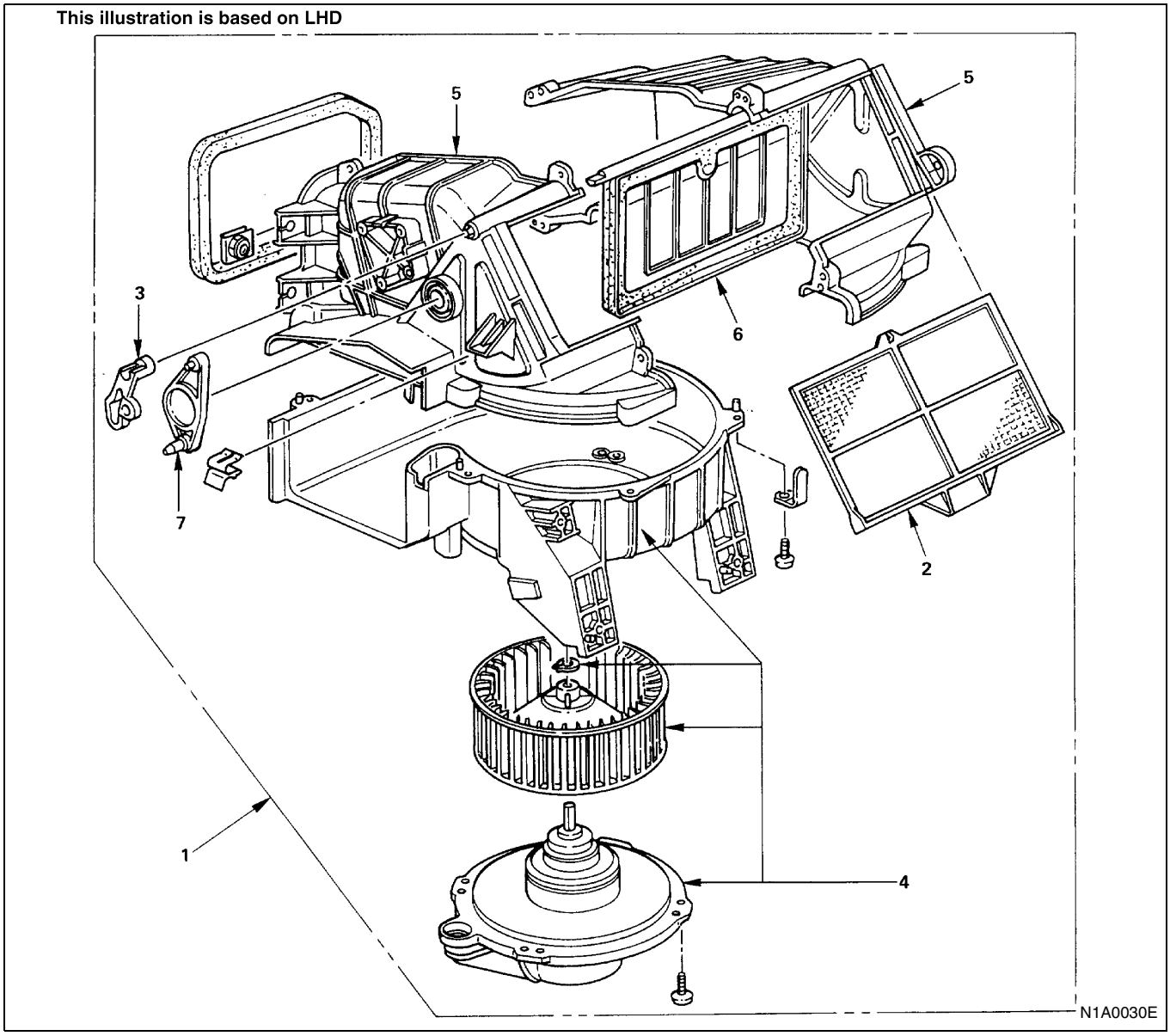
15. Blower Assembly
    - Remove the blower fixing bolts.
    - Drop the blower positioning pins from the reinforce to remove them.

Installation

To install, follow the removal steps in the reverse order, noting the following point.

1. Adjust the blower control cable.
   Refer to “CONTROL LEVER ASSEMBLY” installation procedure in this section.

Blower Link Unit/Mode Door



Legend

1. Blower assembly
2. Blower filter
3. Door lever
4. Lower case
5. Upper case
6. Mode door
7. Mode sub lever

Removal

Preparation:

Disconnect the battery ground cable.

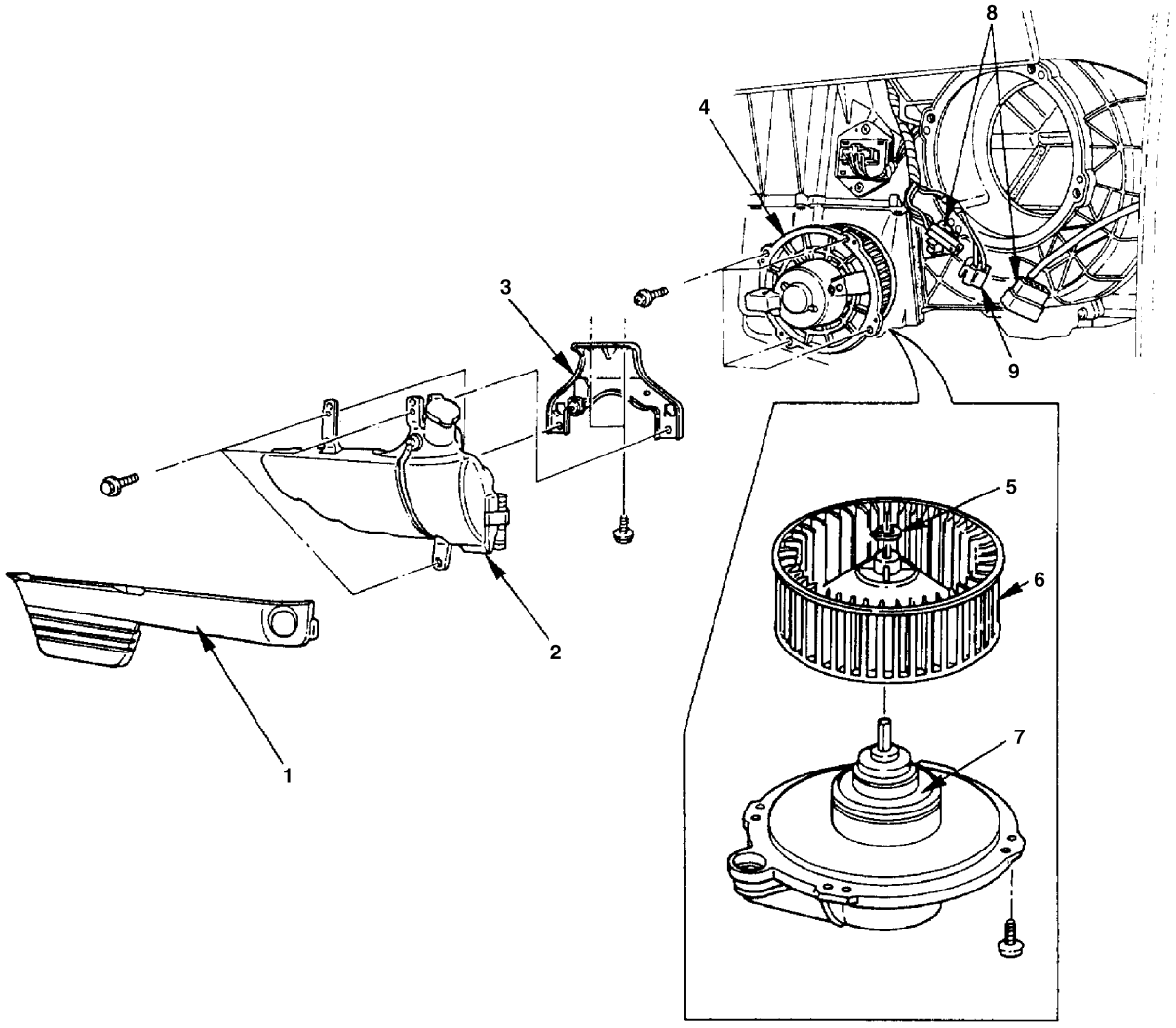
1. Blower Assembly
   Refer to “BLOWER ASSEMBLY” removal procedure in this section.
2. Blower Filter
3. Door Lever
   Pull out the door lever while raising up the catch of the door lever.
4. Lower Case
5. Upper Case
   Separate two halves of the upper case.
6. Mode Door
7. Mode Sub Lever
   Press the tab of the sub lever inward, and take out the sub lever.

Installation

To install, follow the removal steps in the reverse order.

Blower Motor

This illustration is based on LHD



N1A0031E

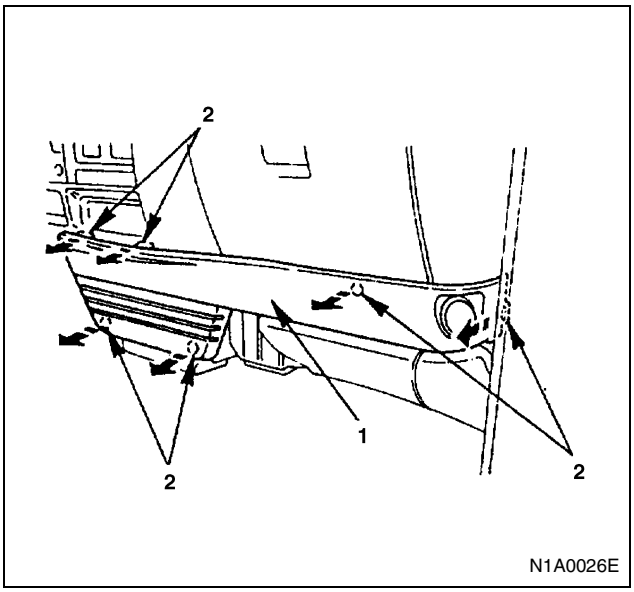
Legend

1. Under cover
2. Washer tank
3. Washer tank bracket
4. Blower motor assembly
5. Clip
6. Fan
7. Blower motor
8. Harness connection connector
9. Blower motor connector

Removal

Preparation:
Disconnect the battery ground cable.

1. Under Cover
   While pulling the under cover (1) with care, remove the clips (2) on the back side of the cover.

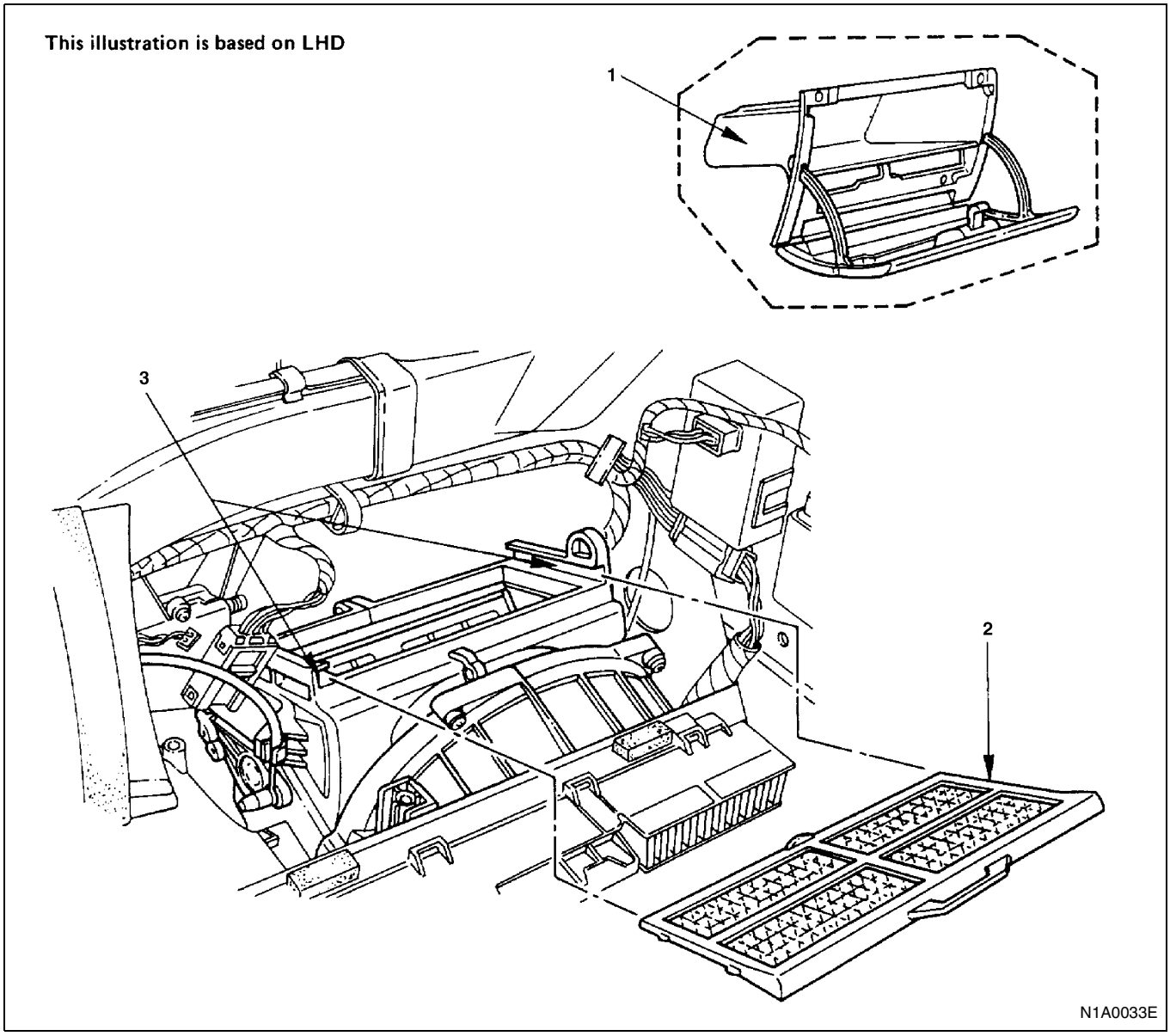


2. Washer Tank
   Remove the washer tank fixing three bolts (Upper: two, Lower: one) and disconnect the connector.
3. Washer Tank Bracket
   Disconnect the harness connection connector and remove the fixing bolts.
4. Blower Motor Assembly
   Disconnect the motor connector.
5. Clip
6. Fan
7. Blower Motor

Installation

To install, follow the removal steps in the reverse order.

Blower Filter



Legend

1. Glove box
2. Blower filter
3. Slit

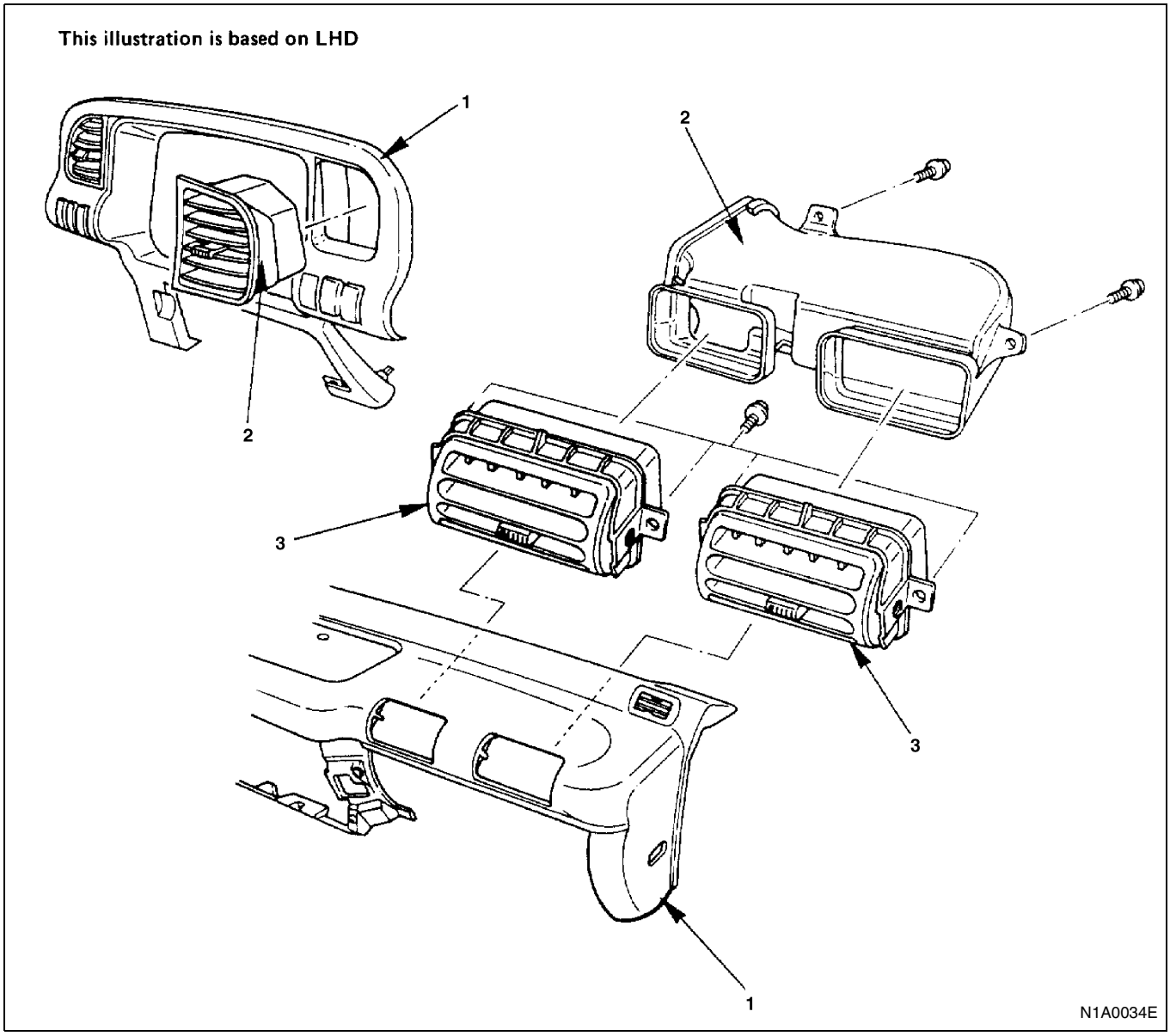
Removal

1. Glove Box
   Open the glove box and remove the fixing screws.
2. Blower Filter
   Pull out the blower filter from the blower upper slit.

Installation

To install, follow the removal steps in the reverse order.

Ventilation Grille



Legend

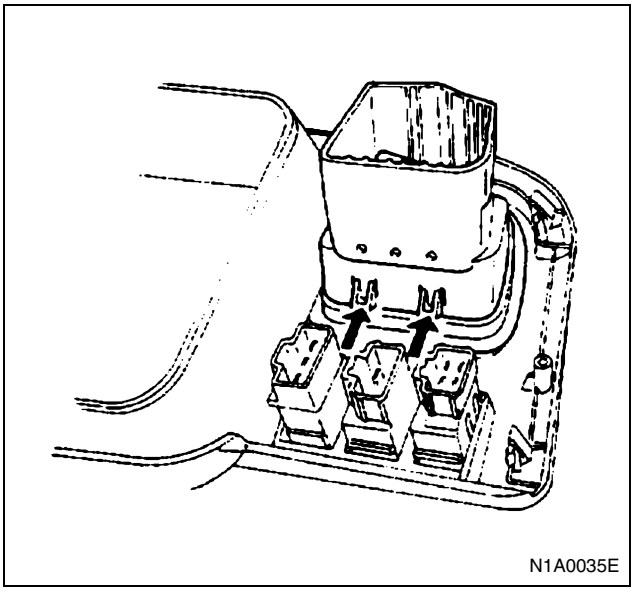
[Driver Side]
1. Meter cluster
2. Ventilation grille

[Passenger Side]
1. Instrument panel assembly
2. Ventilation duct
3. Ventilation grille

Removal

Preparation:
Disconnect the battery ground cable.
[Driver Side]

1. Meter Cluster
   Refer to Section 2 “CAB AND FRAME” for Meter Cluster removal procedure.
2. Ventilation Grille
   Push the catches of the grille on the backside of the cluster to the inside, and remove the ventilation grille.



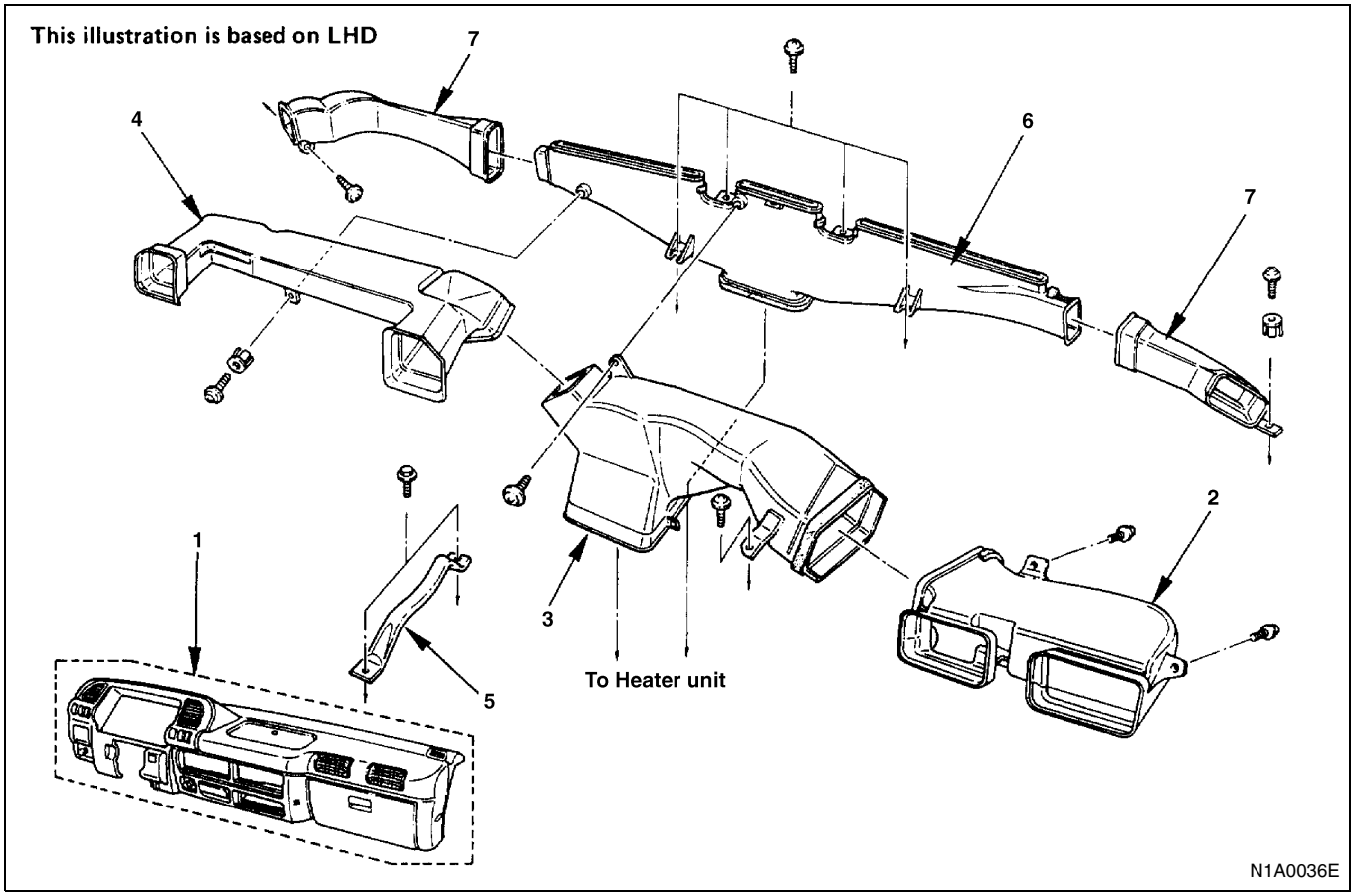
[Passenger Side]

1. Instrument Panel Assembly
   Refer to Section 2 “CAB AND FRAME” for Instrument Panel removal procedure.
2. Ventilation Duct
3. Ventilation Grille

Installation

To install, follow the removal steps in the reverse order.

Defroster Nozzle/Ventilation Duct



Legend

1. Instrument panel assembly
2. Ventilation duct (RH)
3. Ventilation duct (CTR)
4. Ventilation duct (LH)
5. Reinforcement stay
6. Defroster nozzle (It is not installed on the vehicle with forged air ventilation as an optional equipment.)
7. Side defroster nozzle (It is not installed on the vehicle with forged air ventilation as an optional equipment.)

Removal

Preparation:

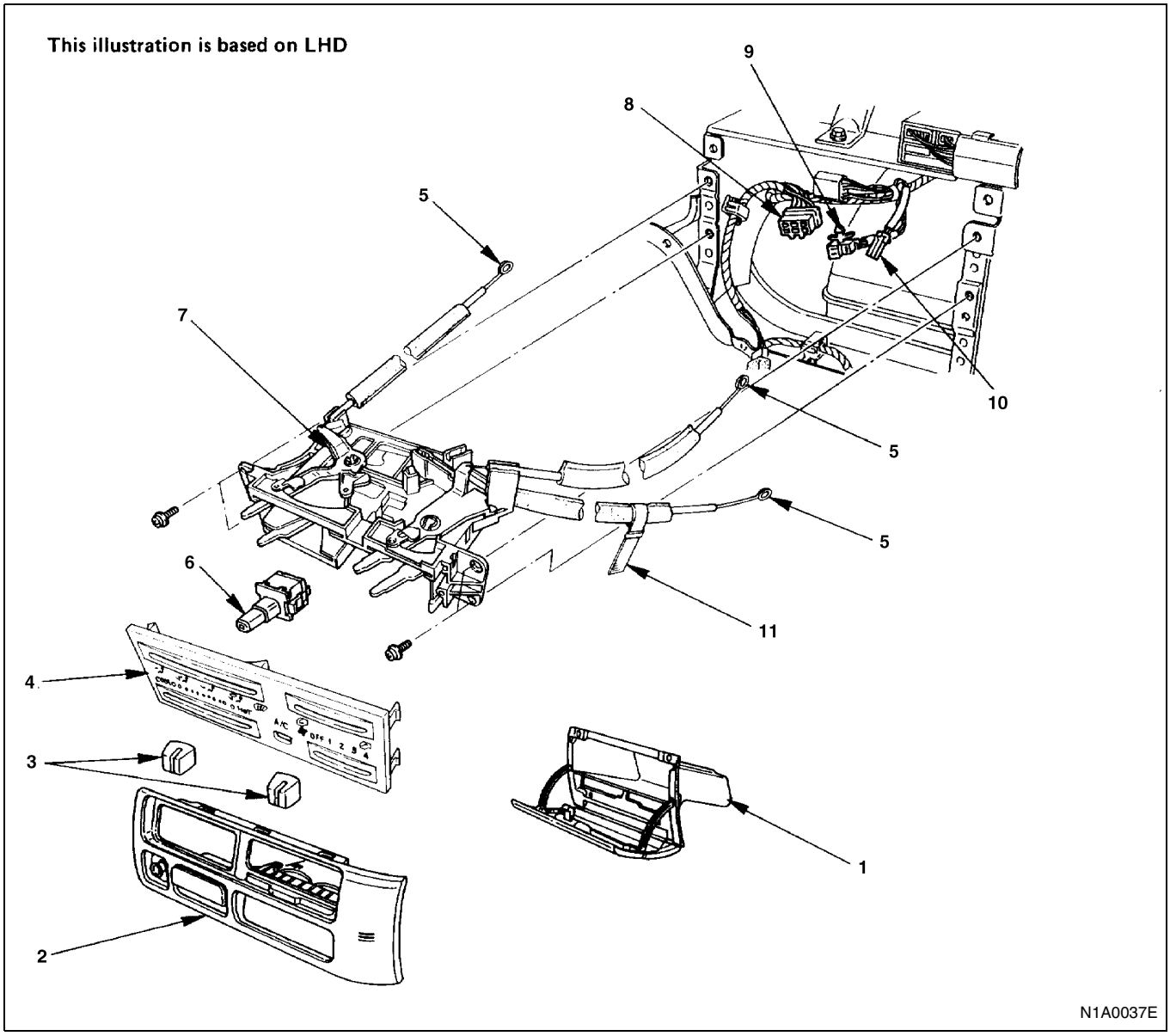
Disconnect the battery ground cable.

1. Instrument Panel Assembly
   Refer to Section 2 “CAB AND FRAME” for Instrument Panel removal procedure.
2. Ventilation Duct (RH)
3. Ventilation Duct (CTR)
4. Ventilation Duct (LH)
5. Reinforcement Stay
6. Defroster Nozzle
7. Side Defroster Nozzle

Installation

To install, follow the removal steps in the reverse order.

Control Lever Assembly



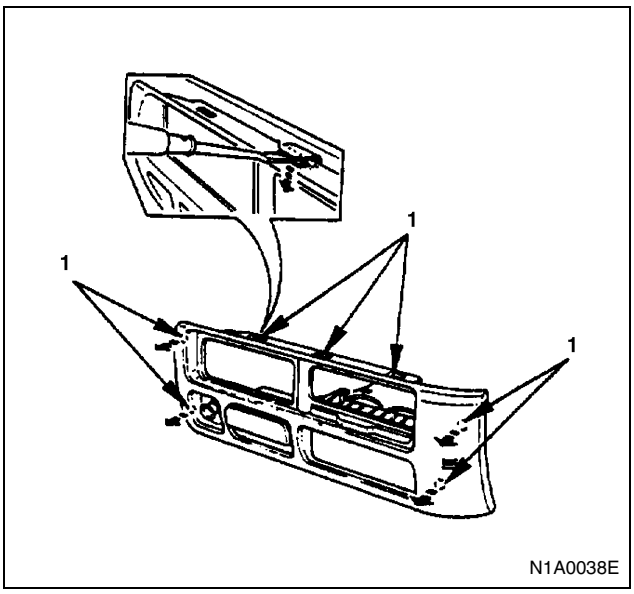
Legend

1. Glove box
2. Center cluster
3. Knob
4. Control panel bezel
5. Control cable
6. A/C switch (A/C only)
7. Control lever assembly
8. Fan switch connector
9. A/C switch connector
10. Illumination bulb connector
11. Clip

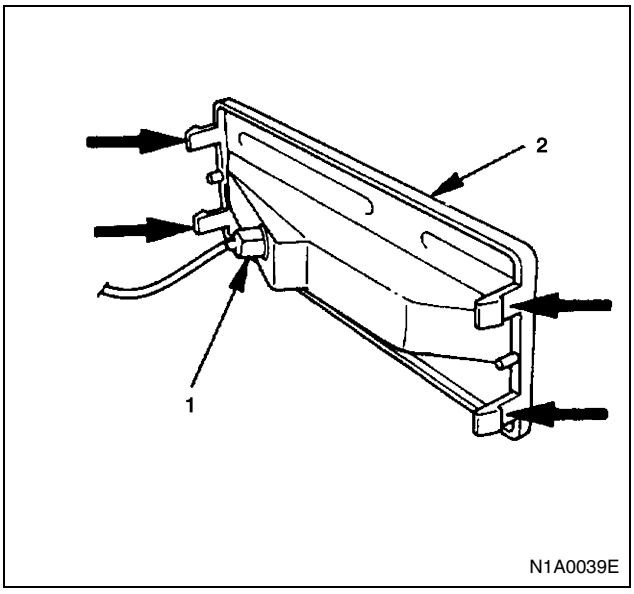
Removal

Preparation:
Disconnect the battery ground cable.

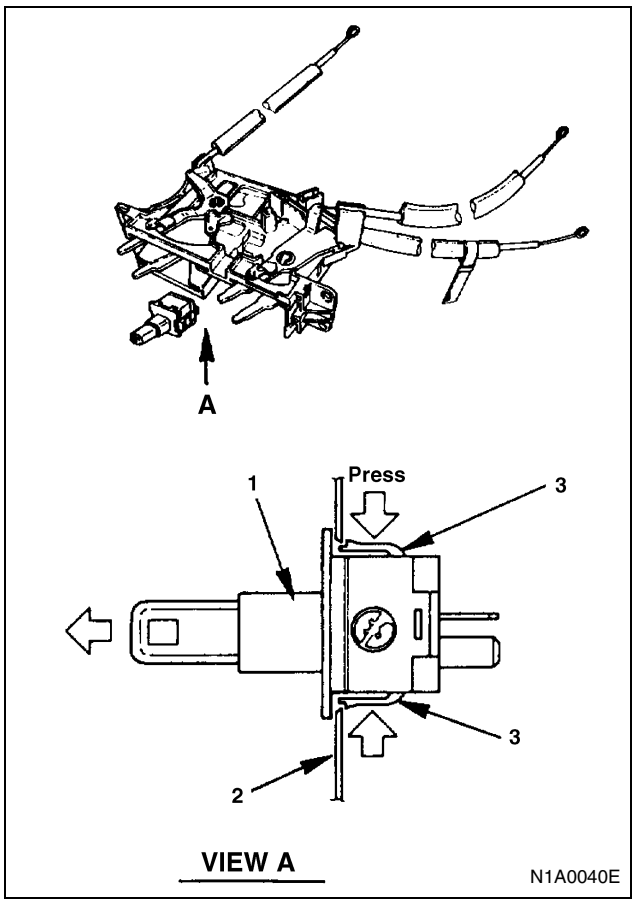
1. Glove Box
   Open the glove box and remove the fixing screws.
2. Center Cluster
   - While pulling the cluster with care, remove the upper and the back side clips (1) of the cluster.
   - Disconnect the cigar lighter and illumination connectors.



3. Knob
4. Control Panel Bezel
   Push the four catches at both sides of the bezel to the inside, and remove the illumination bulb (1) from the bezel (2).



5. Control Cable
   Disconnect the control cables from the heater and blower units.
6. A/C Switch
   Push the catches at both sides of the A/C switch to the inside, and remove the A/C switch by pulling it out.



Legend
1. A/C switch
2. Control lever
3. Catch

7. Control Lever Assembly
   - Remove the lever fixing bolts and pull the lever assembly out.
   - Disconnect the A/C switch connector clip and fan switch connector from the lever assembly.
   - Remove the control cable fixing clip.

Installation

To install, follow the removal steps in the reverse order, noting the following points:

1. Adjust the control cables.
   Air source control cable
   1) Slide the control lever to the left (“CIRC” position).
   2) Connect the control cable at the “CIRC” position of the link unit of blower assembly and fix it with the clip.

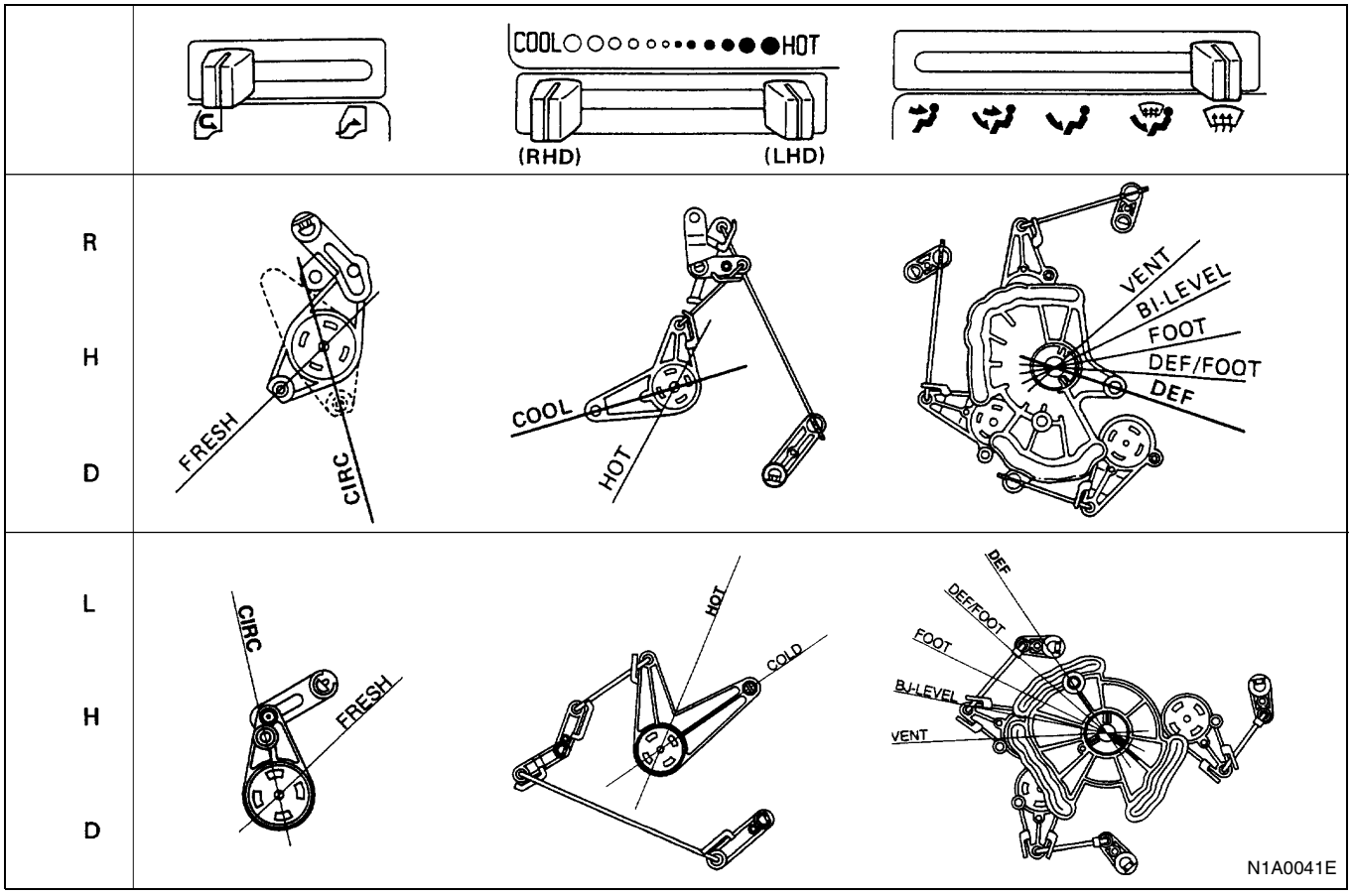
   Temperature control cable
   1) Slide the control lever to the left/right (“MAX COLD”/“MAX HOT” position).

2) Connect the control cable at the “COLD”/“HOT” position of the temperature control link of the heater unit and fix it with the clip.

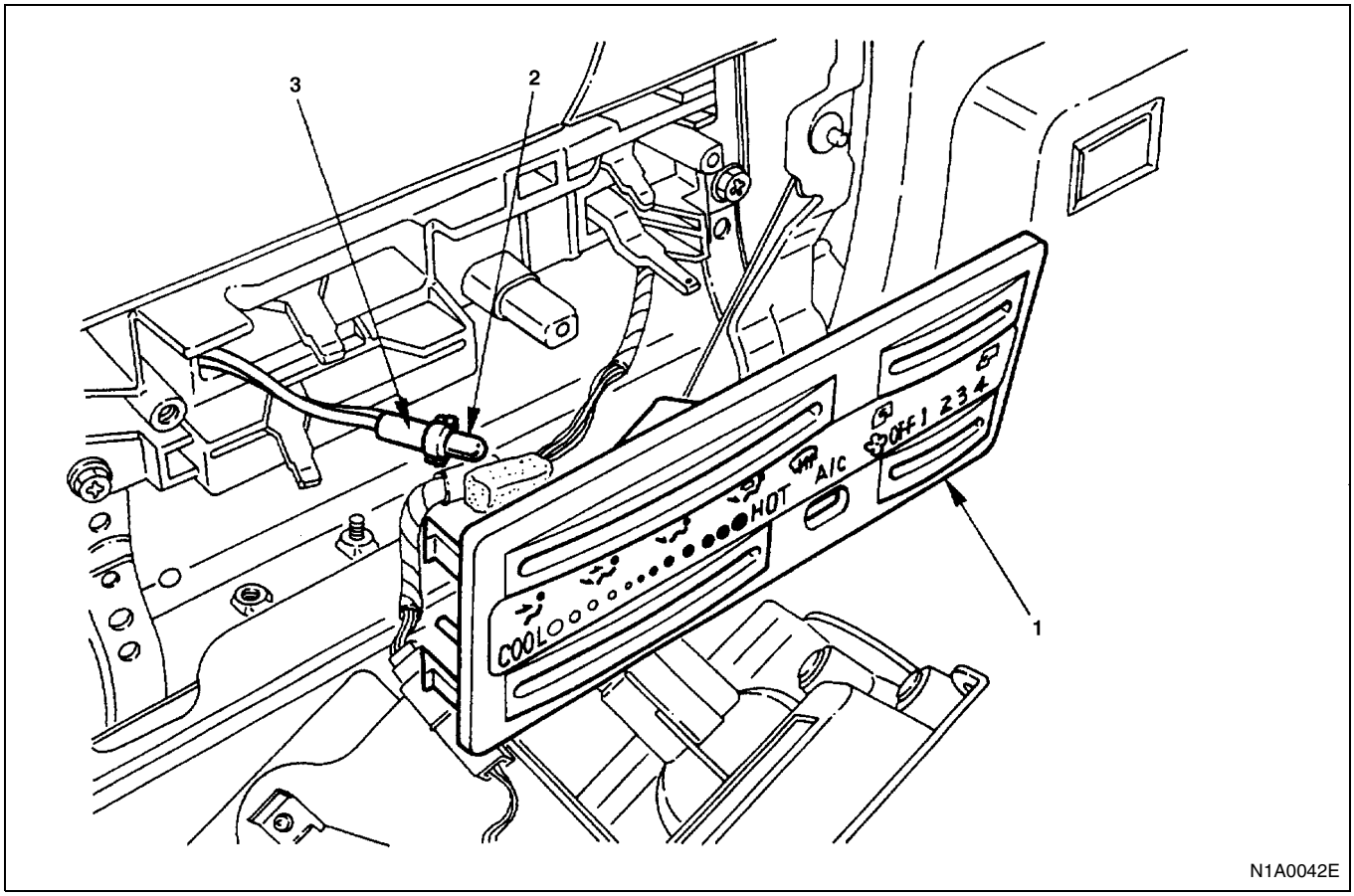
Air select control cable

1) Slide the control lever to the right (“DEFROST” position).
2) Connect the control cable at the “DEFROST” position of the mode control link of the heater unit and fix it with the clip.

2. Check control cable operation.



Control Panel Illumination Bulb



Legend

1. Control panel bezel
2. Control panel illumination bulb
3. Socket

Removal

Preparation:

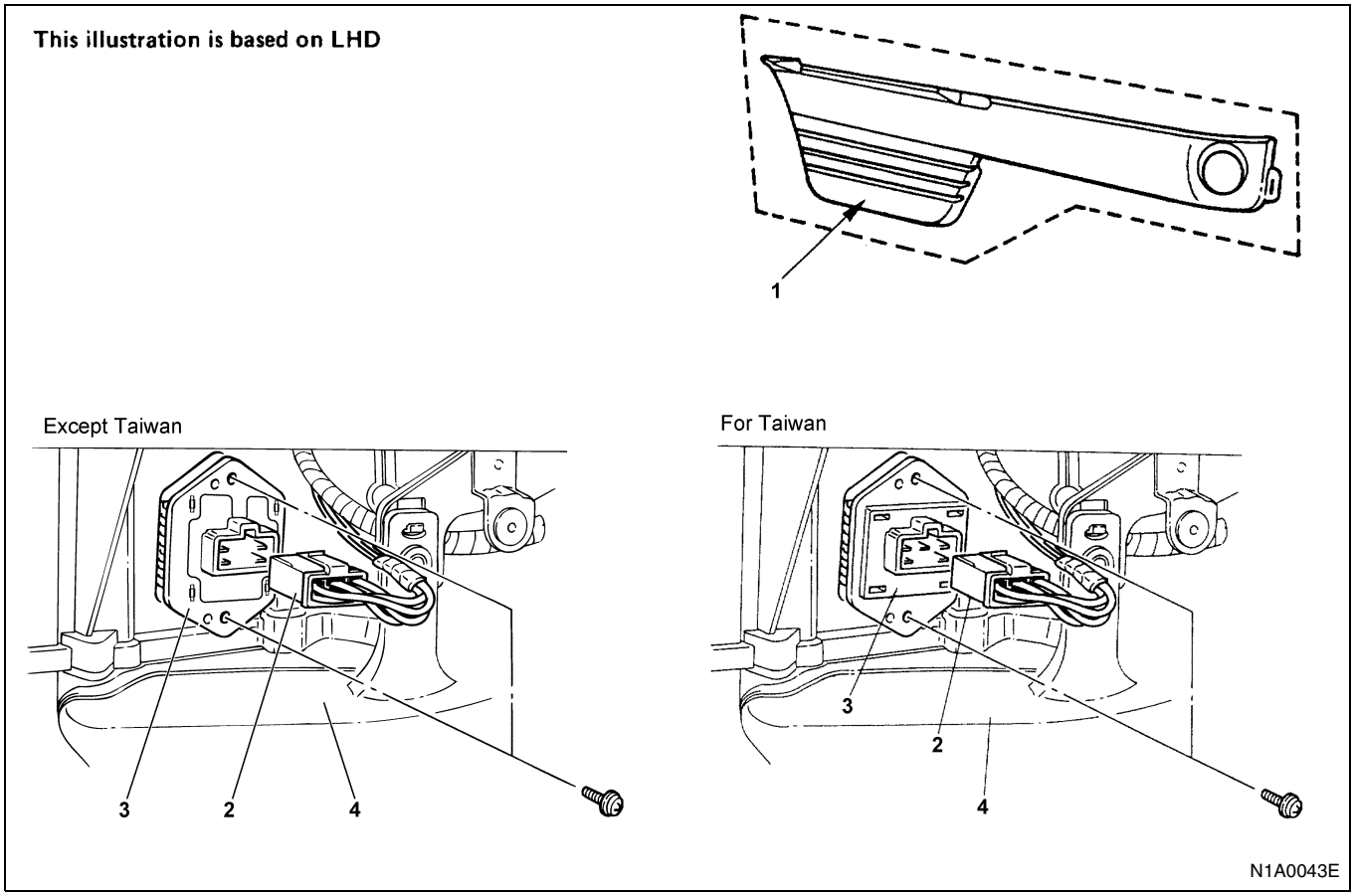
Disconnect the battery ground cable.

1. Control Panel Bezel
   Refer to “CONTROL LEVER ASSEMBLY” removal procedure.
2. Control Panel Illumination Bulb
   Pull the bulb from the bulb socket.

Installation

To install, follow the removal steps in the reverse order.

Resistor



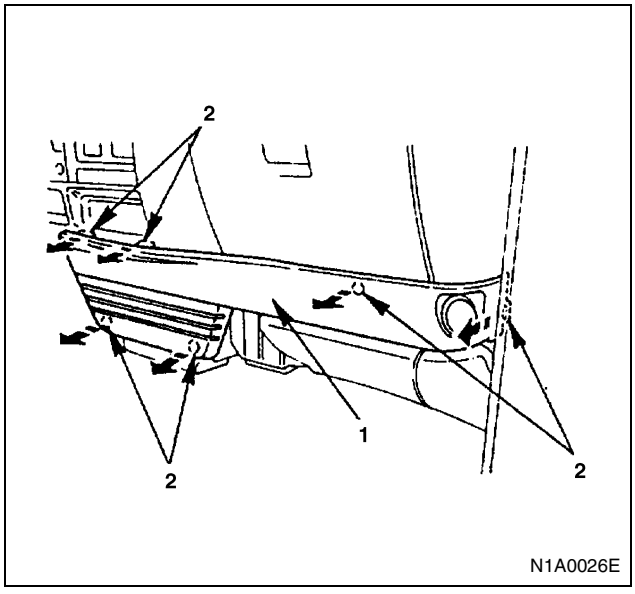
Legend

1. Under cover
2. Resistor connector
3. Resistor
4. Washer tank

Removal

Preparation:
Disconnect the battery ground cable.

1. Under Cover
   While pulling the under cover (1) with care, remove the clips (2) on the backside of the cover.



2. Resistor Connector
3. Resistor

Installation

To install, follow the removal steps in the reverse order.

HEATING AND AIR CONDITIONING

SECTION 1B
AIR CONDITIONING

Caution:
When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used.

Fasteners that are not reused, and those requiring thread locking compound, will be called out. The correct torque values must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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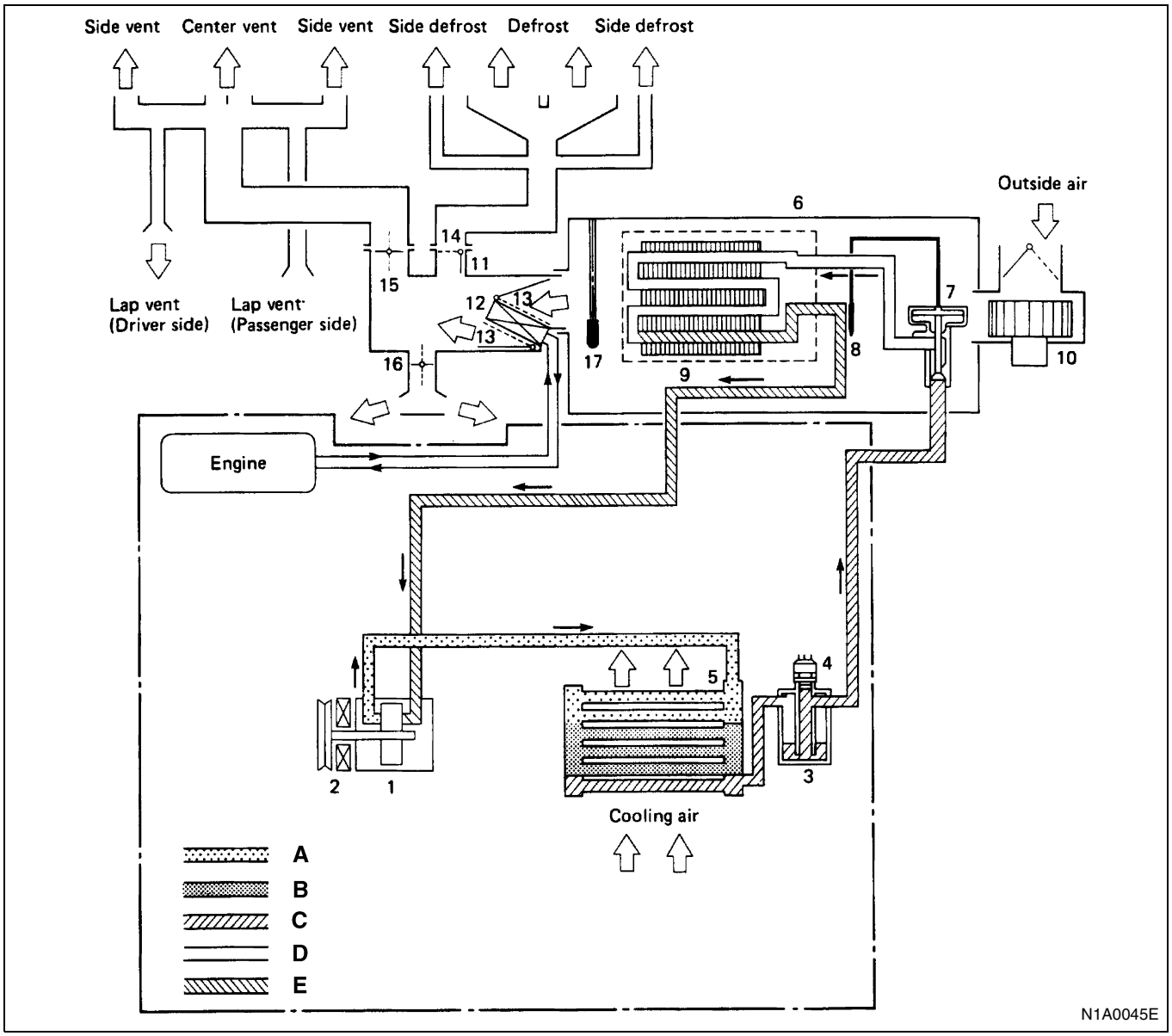
GENERAL DESCRIPTION

Caution:
This Vehicle is equipped with Refrigerant-134a (R-134a) air conditioning system.

R-134a and A-12 systems require different types of lubricating oil. Components designed solely for use with one refrigerant and oil type must never be interchanged with components designed solely for use with another refrigerant and oil type. Refer to “ON-VEHICLE SERVICE” for Precautions for R-134a Air Conditioning system in this section.

Air Conditioning Refrigerant Cycle Construction



Legend

A. High pressure, high temperature gas
B. High pressure, high temperature mixture of gas and liquid
C. High pressure, medium temperature liquid
D. Low pressure, low temperature mixture of liquid and gas
E. Low pressure, low temperature gas
1. Compressor
2. Magnetic clutch
3. Receiver / Drier
4. Pressure switch
5. Condenser
6. Evaporator assembly
7. Expansion valve
8. Temperature sensor
9. Evaporator core
10. Blower motor
11. Heater unit
12. Heater core
13. Temp. control door (Air mix door)
14. MODE (DEF) control door
15. MODE (VENT) control door
16. MODE (HEAT) control door
17. Electronic thermostat

The refrigeration cycle includes the following four processes as the refrigerant changes repeatedly from liquid to gas and back to liquid while circulating.

Evaporation

The refrigerant is changed from a liquid to a gas inside the evaporator. The refrigerant mist that enters the evaporator vaporizes readily. The liquid refrigerant removes the required quantity of heat (latent heat of vaporization) from the air around the evaporator core cooling fins and rapidly vaporizes.
Removing the heat cools the air, which is then radiated from the fins and lowers the temperature of the air inside the vehicle.
The refrigerant liquid sent from the expansion valve and the vaporized refrigerant gas are both present inside the evaporator and the liquid is converted to gas.
With this change from liquid to gas, the pressure inside the evaporator must be kept low enough for vaporization to occur at a lower temperature.
Because of that, the vaporized refrigerant is sucked into the compressor.

Compression

The refrigerant is compressed by the compressor until it is easily liquefied at normal temperature.
The vaporized refrigerant in the evaporator is sucked into the compressor. This action maintains the refrigerant inside the evaporator at a low pressure so that it can easily vaporize, even at low temperatures close to 0°C (32°F).
Also, the refrigerant sucked into the compressor is compressed inside the cylinder to increase the pressure and temperature to values such that the refrigerant can easily liquefy at normal ambient temperatures.

Condensation

The refrigerant inside the condenser is cooled by the outside air and changes from gas to liquid.
The high temperature, high pressure gas coming from the compressor is cooled and liquefied by the condenser with outside air and accumulated in the receiver/drier. The heat radiated to the outside air by the high temperature, high pressure gas in the compressor is called heat of condensation. This is the total quantity of heat (heat of vaporization) the refrigerant removes from the vehicle interior via the evaporator and the work (calculated as the quantity of heat) performed for compression.

Expansion

The expansion valve lowers the pressure of the refrigerant liquid so that it can easily vaporize.
The process of lowering the pressure to encourage vaporization before the liquefied refrigerant is sent to the evaporator is called expansion. In addition, the expansion valve controls the flow rate of the refrigerant liquid while decreasing the pressure.
That is, the quantity of refrigerant liquid vaporized inside the evaporator is determined by the quantity of heat which must be removed at a prescribed vaporization temperature. It is important that the quantity of refrigerant be controlled to exactly the right value.

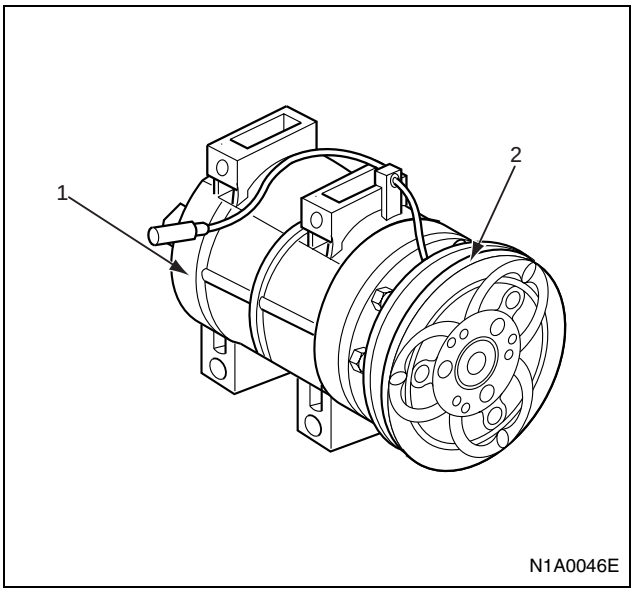
Compressor

The compressor performs two main functions:
It compresses low-pressure and low-temperature refrigerant vapor from the evaporator into high-pressure and high-temperature refrigerant vapor to the condenser. And it pumps refrigerant and refrigerant oil through the A/C system.
This vehicle is equipped with a swash plate type compressor (DKS-15 D Type, DKS-13 CH Type for Taiwan only).
Swash plate compressors have a swash (slanted) plate mounted on the shaft. When the shaft turns, the rotation of the swash plate is converted to reciprocating piston motion which sucks in and compresses the refrigerant gas.
Shaft seal (Lip type) is installed between the valve plate and shaft a cylinder head to prevent refrigerant gas leaks. A specified amount of compressor oil is contained in the oil pan.

This oil is supplied to the cylinders, bearings, etc., by an oil pump which is connected to the swash plate shaft.
With some compressors the differential between the intake pressure and discharge pressure generated while the compressor is operating is used for lubrication instead of an oil pump.
The specified amount of compressor oil is 180cc (5.0 Imp fl oz).
The oil used in the R-134a system compressor differs from that used in R-12 systems.
Also, compressor oil to be used varies according to the compressor model. Be sure to avoid mixing two or more different types of oil.
If the wrong oil is used, lubrication will be poor and the compressor will seize or malfunction.
(Refer to "ON-VEHICLE SERVICE" for Precautions for R-134a Air Conditioning System in this section)
The magnetic clutch connector is a waterproof type.

Magnetic Clutch

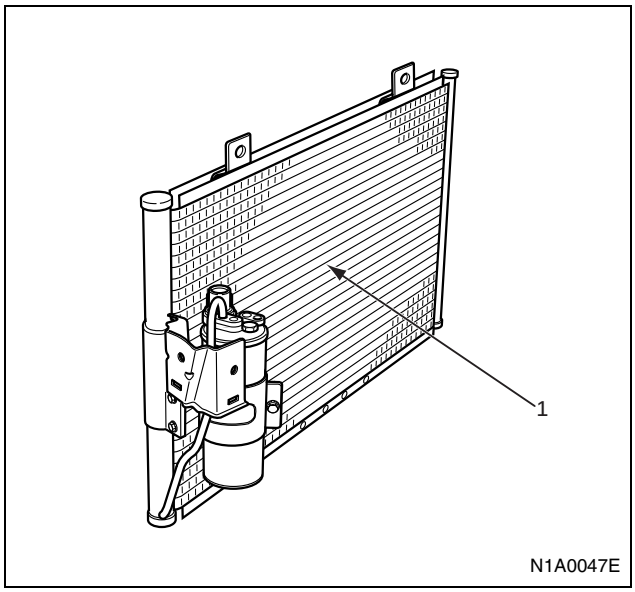
The compressor (1) is driven by the drive belt from the crank pulley of the engine. If the compressor is activated each time the engine is started, this causes too much load to the engine. The magnetic clutch (2) transmits the power from the engine to the compressor and activates it when the air conditioning is "ON". Also, it cuts off the power from the engine to the compressor when the air conditioning is "OFF". (Magnetic clutch repair procedure can be found in Section 1D)



Condenser

The condenser assembly in front of the radiator, which carry the refrigerant and cooling fins to provide rapid transfer of heat.
Also, it functions to cool and liquefy the high-pressure and high-temperature vapor sent from the compressor by the radiator fan or outside air.

A condenser (1) may malfunction in two ways: it may leak, or it may be restricted. A condenser restriction will result in excessive compressor discharge pressure. If a partial restriction is present, the refrigerant expands after passing through the restriction.
Thus, ice or frost may from immediately after the restriction. If air flow through the condenser or radiator is blocked, high discharge pressures will result. During normal condenser operation, the refrigerant outlet line will be slightly cooler than the inlet line.
The vehicle is equipped with the condenser of the parallel flow type condenser. A larger thermal transmission area on the inner surface of the tube allows the radiant heat to increase and the ventilation resistance to decrease.



Receiver/Drier

The receiver/drier performs four functions;

- As the quantity of refrigerant circulated varies depending on the refrigeration cycle conditions, sufficient refrigerant is stored for the refrigeration cycle to operate smoothly in accordance with fluctuations in the quantity circulated.
- The liquefied refrigerant from the condenser is mixed with refrigerant gas containing air bubbles. If refrigerant containing air bubbles is sent to the expansion valve, the cooling capacity will decrease considerably. Therefore, the liquid and air bubbles are separated and only the liquid is sent to the expansion valve.
- The receiver/drier utilizes a filter and dryer to remove the dirt and water mixed in the cycling refrigerant.

A receiver/drier may fail due to a restriction inside the body of the unit. A restriction at the inlet to the receiver/drier will cause high pressures.
Outlet restrictions will be indicated by low pressure and little or no cooling. An excessively cold receiver/drier outlet may indicate a restriction.

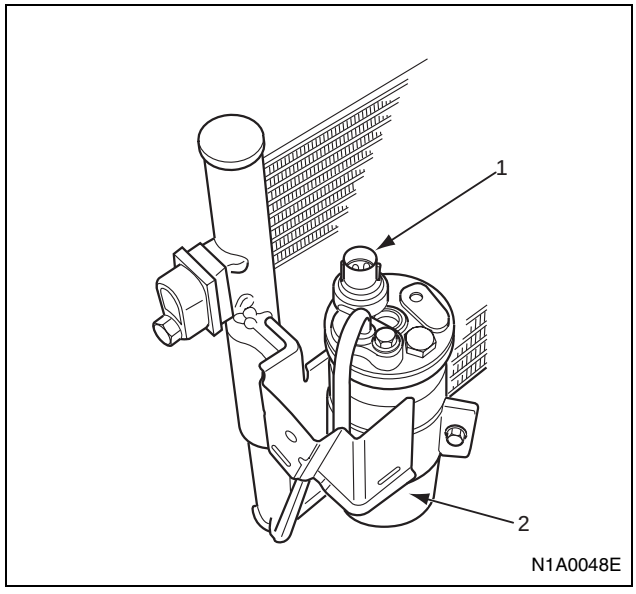
The receiver/drier of this vehicle is made of aluminum with a smaller tank. It has 250cc (7.1 Imp fl oz) refrigerant capacity.

Dual Pressure Switch (for GCC and Taiwan)

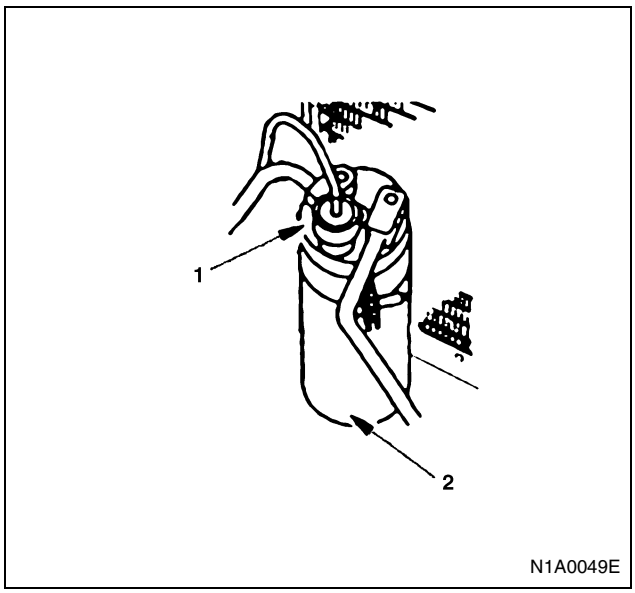
The dual pressure switch (1) is installed on the upper part the receiver/drier (2), to defect excessively high pressure (high pressure switch) and prevent compressor seizure due to the refrigerant leaking (low pressure switch), switching the compressor “ON” or “OFF” as required.
The pressure switch connector is water proof type.
R-134a refrigerant pressure characteristics differ from those of R-12. Thus, the dual pressure switch operation for R-134a systems has been changed from R-12.

- Low-pressure control (for GCC) kPa (kg/cm^2 / PSI)
  Compressor
  – ON: 206±30 (2.1±0.3 / 30±4)
  – OFF: 177±25 (1.8±0.2 / 26±3)
- High-pressure control (for GCC)
  Compressor
  – ON: 2,350±200 (24.0±2.0 / 341±29)
  – OFF: 2,940±200 (30.0±2.0 / 426±29)
- Low-pressure control (for Taiwan)
  Compressor
  – ON: 221±20 (2.25±0.2 / 32±3)
  – OFF: 196±20 (2.0±0.2 / 28±3)
- High-pressure control (for Taiwan)
  Compressor
  – ON: 2,350±200 (24.0±2.0 / 341±29)
  – OFF: 2,940±200 (30.0±2.0 / 426±29)

For GCC



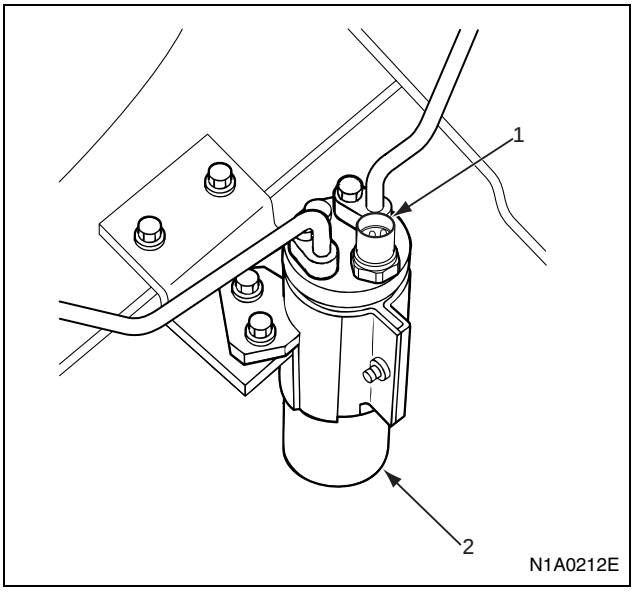
For Taiwan



Triple Pressure Switch (for Australia)

The triple pressure switch (1) is installed on the upper part of the receiver/drier (2). This switch is constructed with a unitized type of two switches. One of them is a low and high pressure switch (Dual pressure switch) to switch “ON” or “OFF” the magnetic clutch as a result of irregularly high-pressure or low-pressure of the refrigerant. The other one is a medium pressure switch (Cycling switch) to switch “ON” or “OFF” the condenser fan by sensing the condenser high side pressure.

- Low-pressure control kPa (kg/cm^2 / PSI)
  Compressor
  – ON: 206±30 (2.1±0.3 / 30±4)
  – OFF: 177±25 (1.8±0.2 / 26±3)
- Medium-pressure control
  Condenser fan
  – ON: 1,470±100 (15±1.0 / 213±14)
  – OFF: 1,079±120 (11±1.2 / 156±17)
- High-pressure control
  Compressor
  – ON: 2,350±200 (24.0±2.0 / 341±29)
  – OFF: 2,940±200 (30.0±2.0 / 426±29)



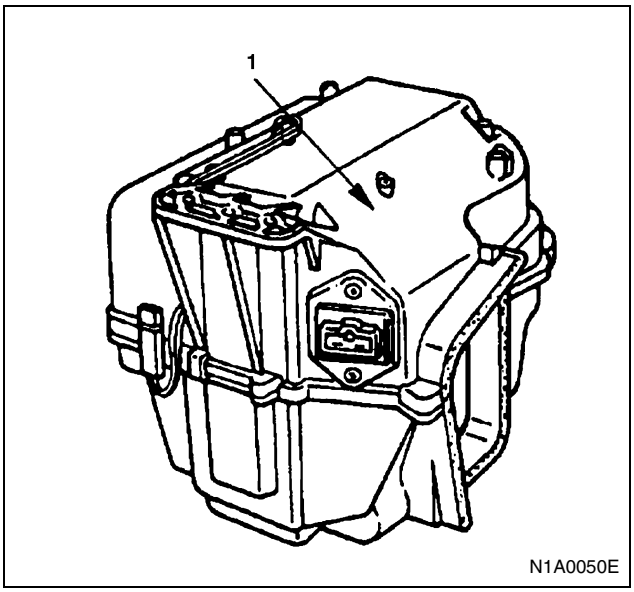
Evaporator

The evaporator (1) cools and dehumidifies the air before the air enters the vehicle. High-pressure liquid refrigerant flows through the expansion valve into the low-pressure area of the evaporator.The heat in the air passing through the evaporator core is lost to the cooler surface of the core, thereby cooling the air.

As heat is lost between the air and the evaporator core surface, moisture in the vehicle condenses on the outside surface of the evaporator core and is drained off as water.

When the evaporator malfunctions, the trouble will show up as inadequate supply of cool air. The causes is typically a partially plugged core due to dirt, or a malfunctioning blower motor.

The evaporator core with a laminate louver fin is a single-sided tank type where only one tank is provided under the core.



Expansion Valve

This expansion valve is external pressure type and it is installed at the evaporator intake port.

The expansion valve converts the high pressure liquid refrigerant sent from the receiver/drier to a low pressure liquid refrigerant by forcing it through a tiny port before sending it to the evaporator.

This type of expansion valve consists of a temperature sensor, diaphragm, ball valve, ball seat, spring adjustment screw, etc.

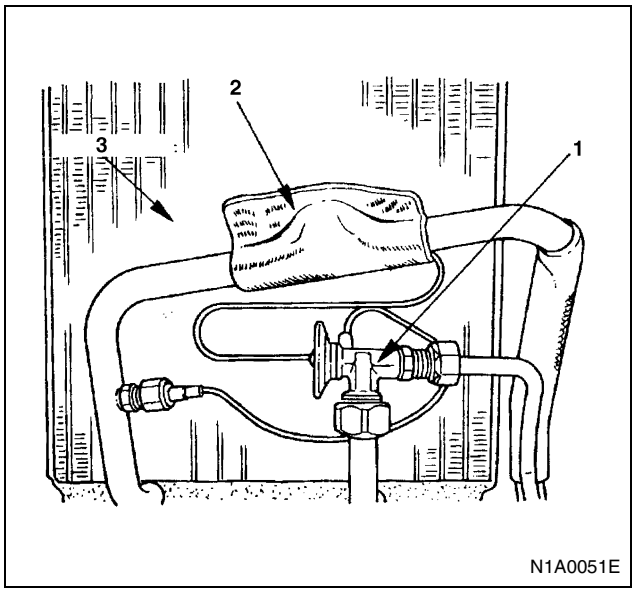
The temperature sensor contacts the evaporator outlet pipe, and converts changes in temperature to pressure. It then transmits these to the top chamber of the diaphragm.

The refrigerant pressure is transmitted to the diaphragms bottom chamber through the external equalizing pressure tube.

The ball valve is connected to the diaphragm. The opening angle of the expansion valve is determined by the force acting on the diaphragm and the spring pressure.

The expansion valve regulates the flow rate of the refrigerant. Accordingly, when a malfunction occurs to this expansion valve, both discharge and suction pressures get low, resulting in insufficient cooling capacity of the evaporator.

For R-134a air conditioning, the expansion valve calibration has been changed from R-12 to match the R-134a characteristics.

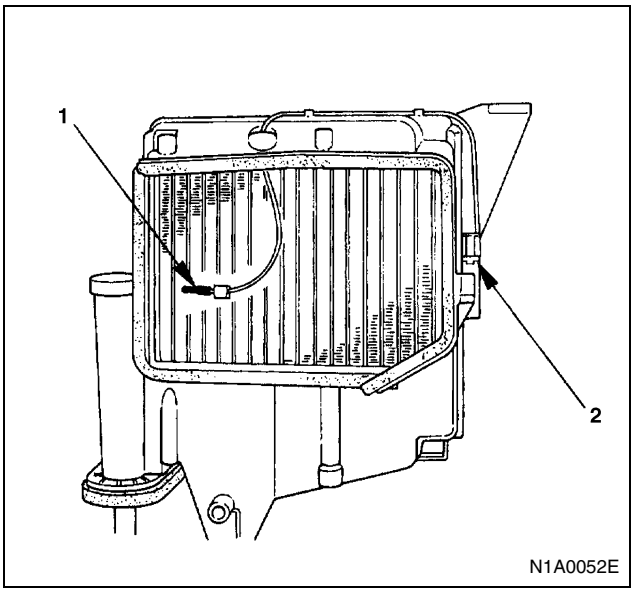


Legend

1. Expansion valve
2. Insulator
3. Evaporator core

Electronic Thermostat

The thermostat consists of the thermosensor (1) and thermostat unit (2) which functions electrically to reduce the noises being generated while the system is in operation.
The electronic thermosensor is mounted at the evaporator core outlet and senses the temperature of the cool air from the evaporator, Temperature signals are input to the thermostat unit. This information is compared by the thermo unit and the results in output to operate the A/C thermo relay and turn the magnetic clutch “ON” or “OFF” to prevent evaporator freeze-up.
A characteristic of the sensor is that the resistance decreases as the temperature increases and the resistance increases as the temperature decreases.

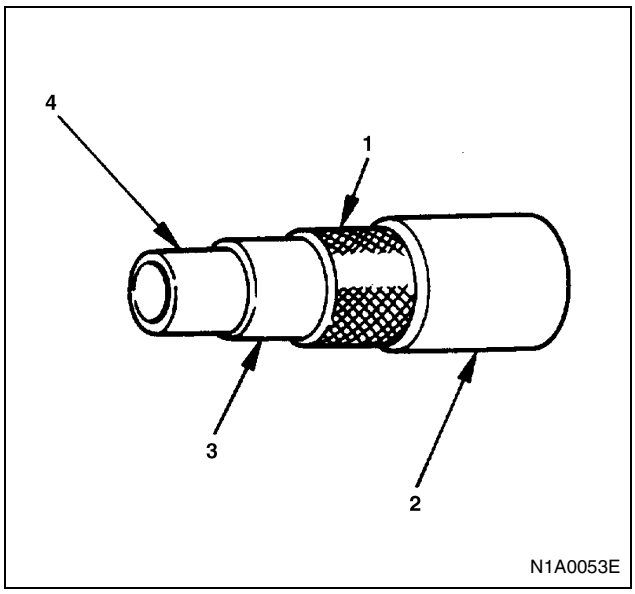


Refrigerant Line

Restrictions in the refrigerant line will be indicated by:

1. Suction line; A restricted suction line will cause low suction pressure at the compressor, low discharge pressure and little or not cooling.
2. Discharge line; A restriction in the discharge line generally will cause the discharge line to leak.
3. Liquid line; A liquid line restriction will be evidenced by low discharge and suction pressure and insufficient cooling.

Refrigerant flexible hoses that have a low permeability to refrigerant and moisture are used.
These low permeability hoses have a special nylon layer on the inside.

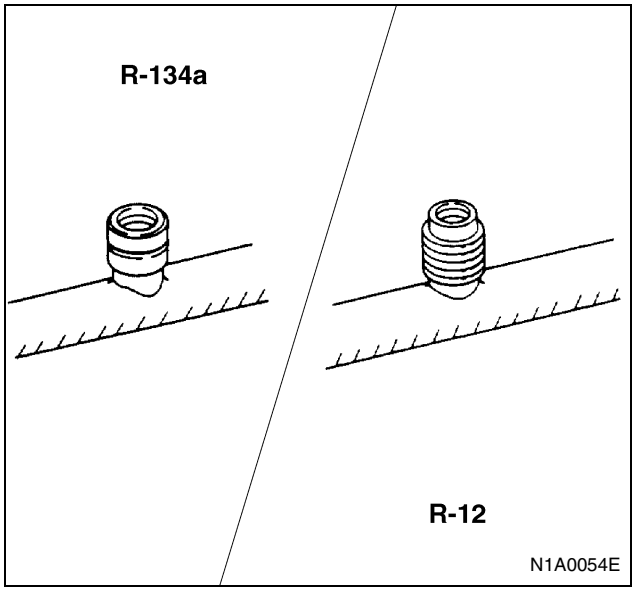


Legend

1. Reinforcement layer (Polyester)
2. External rubber layer
3. Internal rubber layer
4. Resin layer (Nylon)

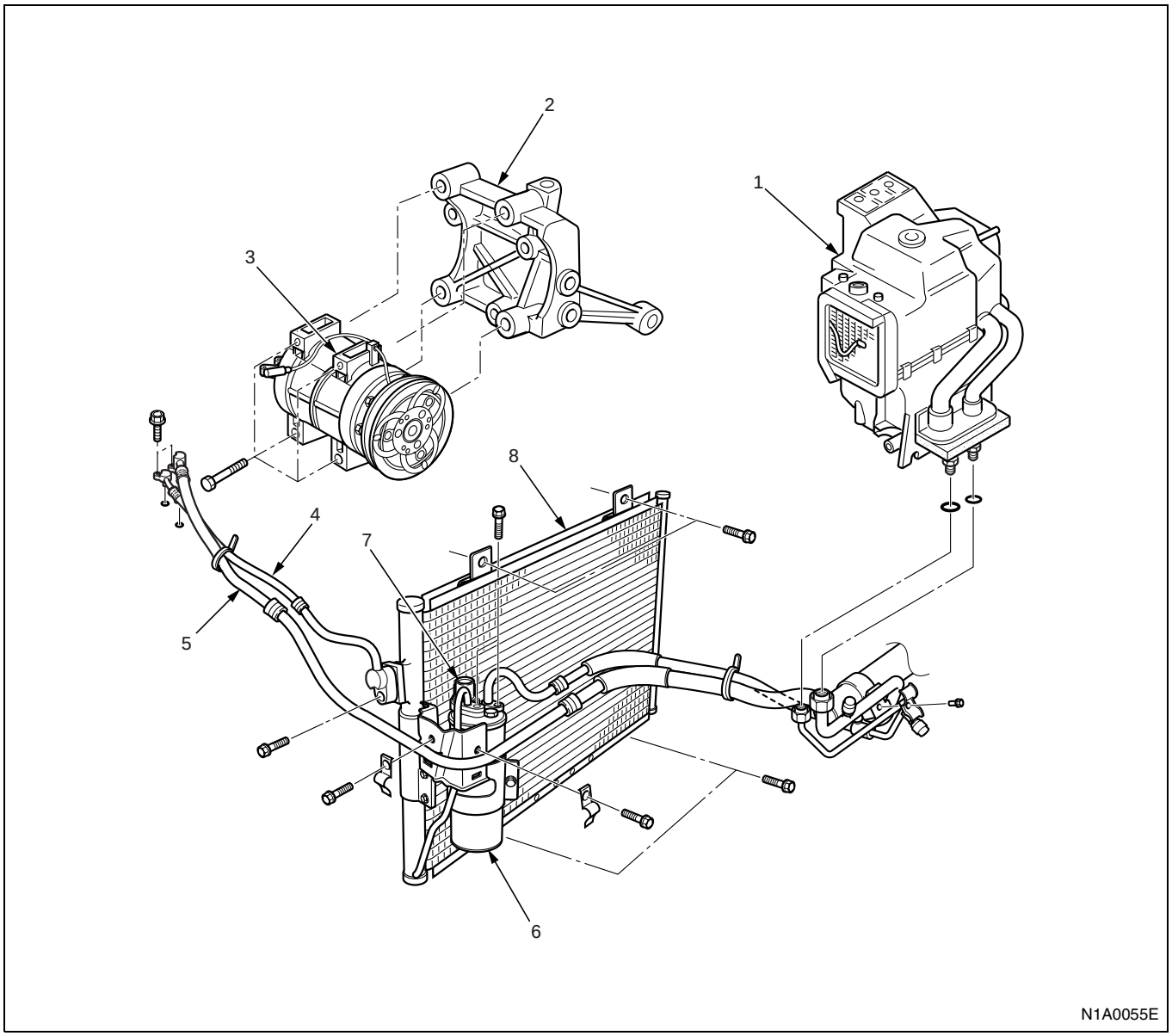
Service Charge Valves

R-134a service charge valve shapes is different from the charge valves used in the R-12 system. The charging hoses have a quick-joint type fitting, to reduce refrigerant loss during removal and installation. This type of valve also eliminates the possibility of cross charging R-12 and R-134a systems when using approved service equipment.



Air Conditioning Parts

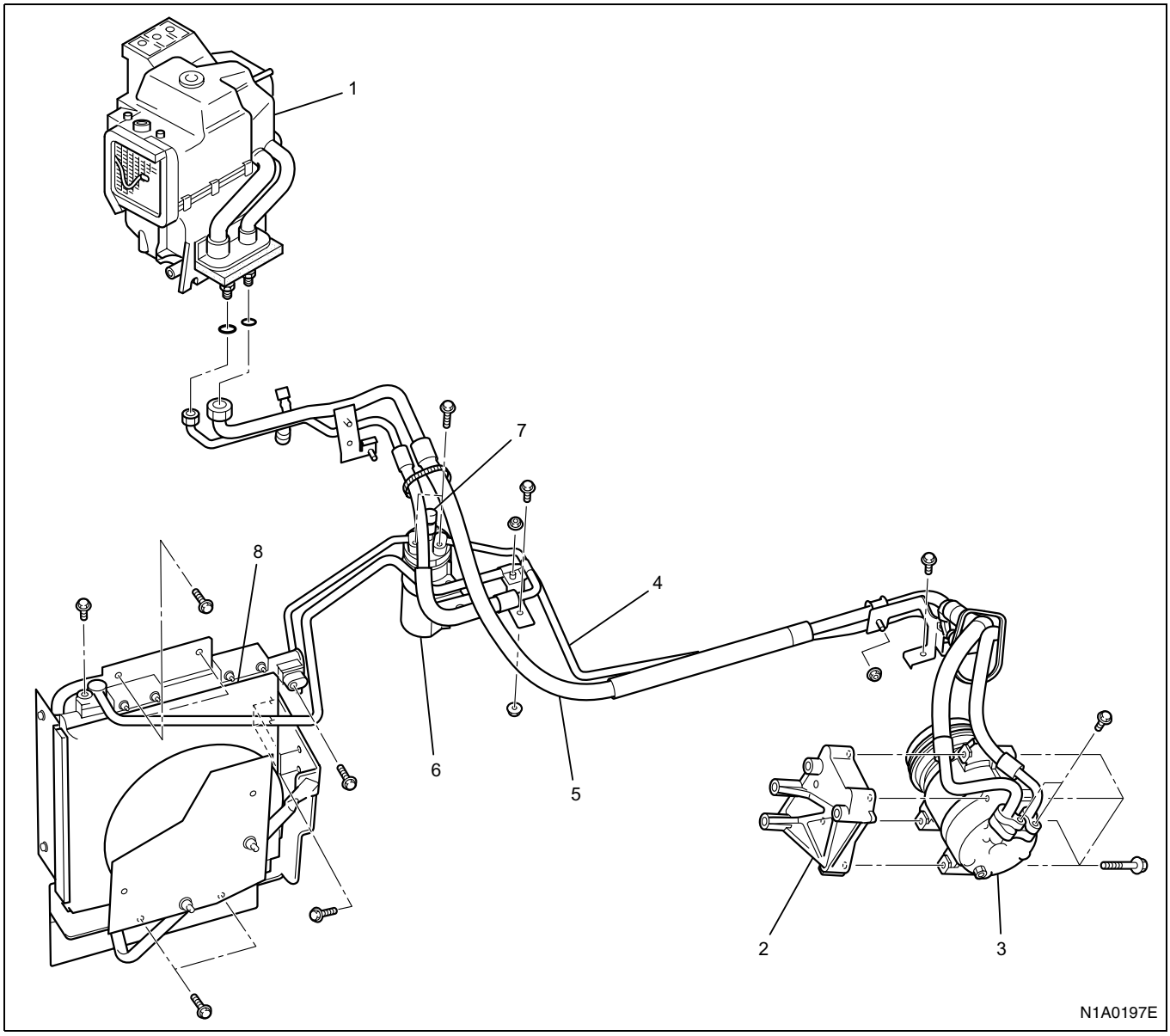
Except 4HK1-TC Engine Model For Australia



Legend

1. Evaporator
2. Compressor bracket
3. Compressor
4. Refrigerant liquid line
5. Refrigerant suction line
6. Receiver / drier
7. Pressure switch
8. Condenser

4HK1-TC Engine Model For Australia



Legend

1. Evaporator
2. Compressor bracket
3. Compressor
4. Refrigerant liquid line
5. Refrigerant suction line
6. Receiver / drier
7. Pressure switch
8. Condenser

ON-VEHICLE SERVICE

Precautions for Refrigerant -134a (R-134a) Air Conditioning System

This vehicle is equipped with Refrigerant-134a (R-134a) air conditioning system.
R-134a and R-12 systems require different types of lubricating oil. Components designed solely for use with one refrigerant and oil type must never be interchanged with components designed solely for use with another refrigerant and oil type.

R-134a Refrigerant:

- R-134a differs entirely from R-12 in its composition and, therefore, the two should never be mixed. Always charge the specified amount of R-134a.
- The pressure characteristics of R-134a differ from those of R-12. The low pressure is lower, and the high pressure is higher.

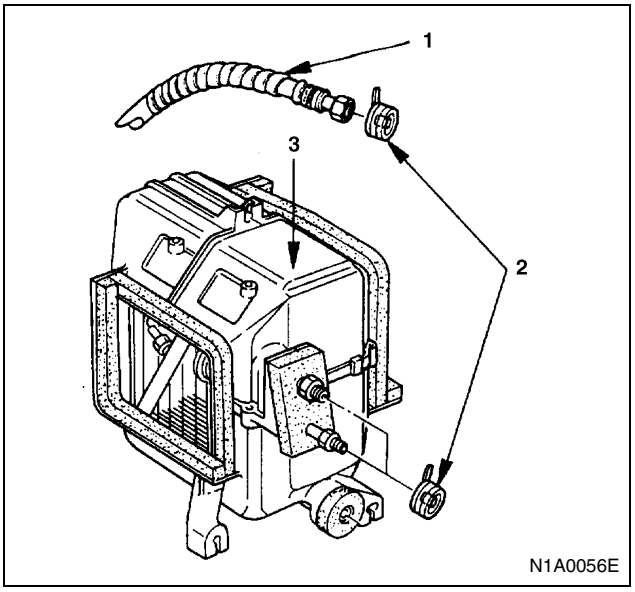
R-134a Compressor oil:

- The R-134a system requires a synthetic (PAG) compressor oil whereas the R-12 system requires a mineral compressor oil. The two oils must never be mixed.
- Compressor (PAG) oil varies according to compressor model. Be sure to use oil specified for the model of compressor.

Oil Specification

ZXL-100PG (ISUZU PART No. 8-97101-338-0)

- The PAG compressor oil for the R-134a system tends to absorb moisture more quickly than mineral oil. When air conditioning parts are removed for servicing, all the open ends of parts and components must be sealed with caps to keep out contaminants.
- The PAG compressor oil must be stored in metal containers, not in plastic containers.

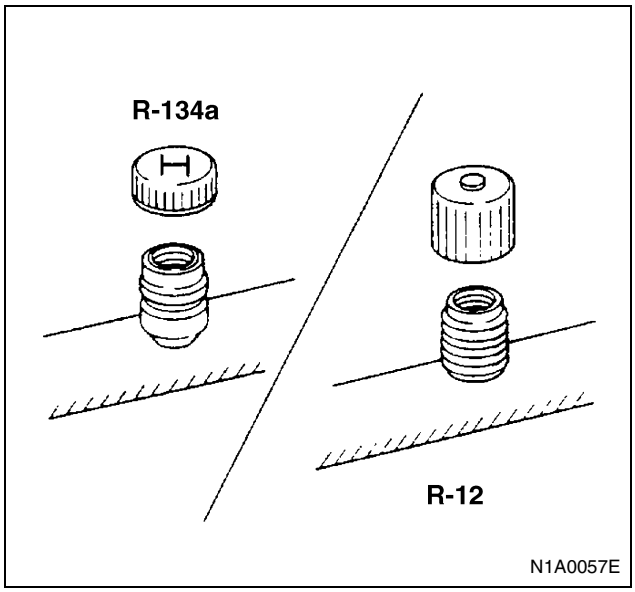


Legend

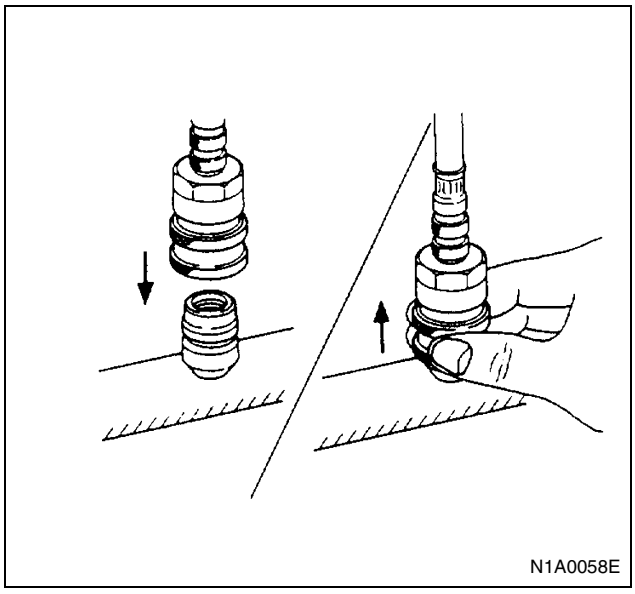
1. Refrigerant line
2. Cap
3. Evaporator

Service charge valve:

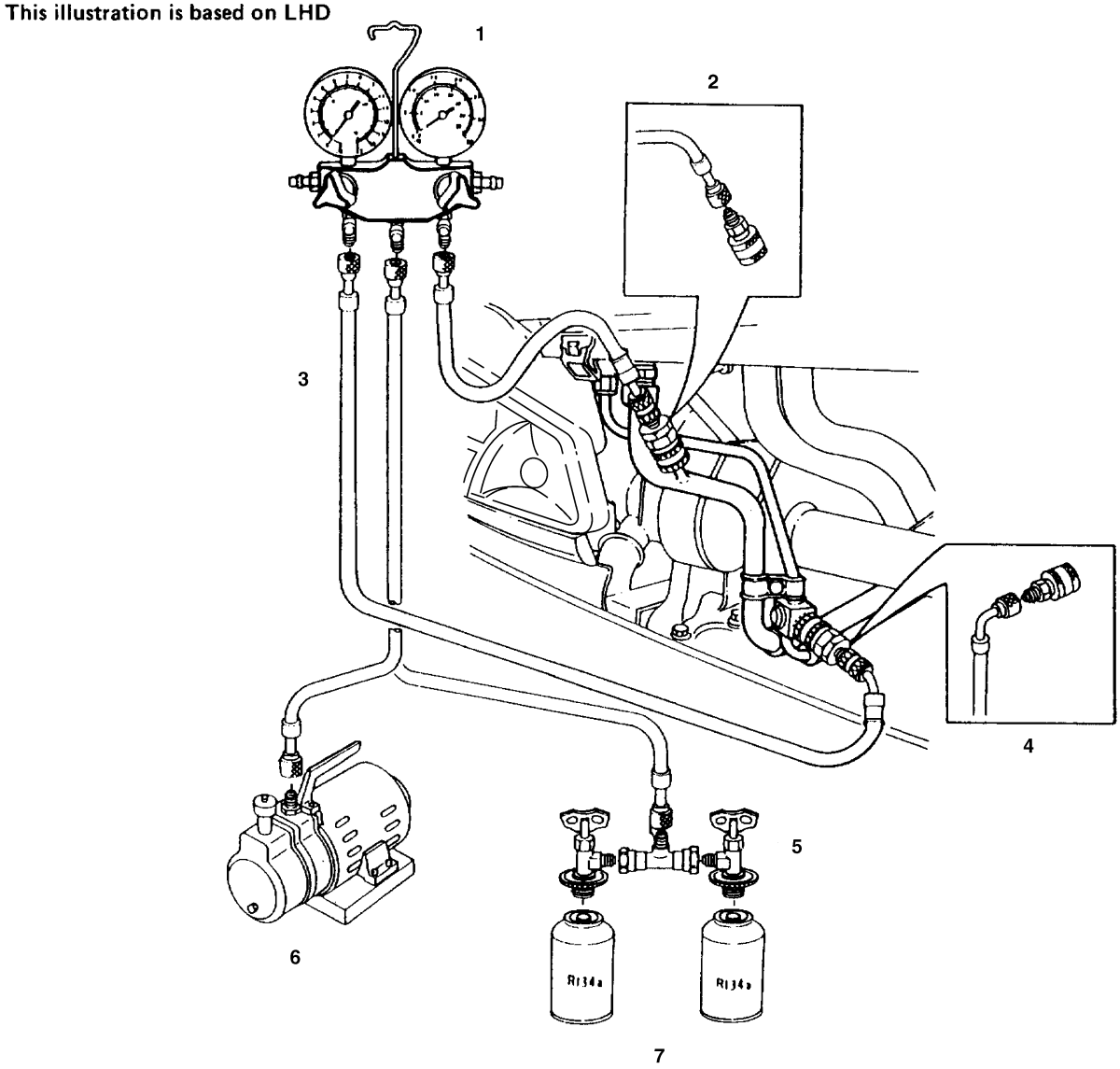
- The diameter of the service charge valve for the R-134a system is made larger than that for the R-12 system to prevent cross-contamination. In addition, the screw-in type joint of the R-12 system is replaced with a quick joint type in the R-134a system.



- To prevent refrigerant from escaping during installation and removal of charging hoses from the service charge valves, quick-joint type fittings are used.
  Connection: Push on firmly until locked (a “click” will be heard).
  Removal: Hold the grip-ring and pull to remove.



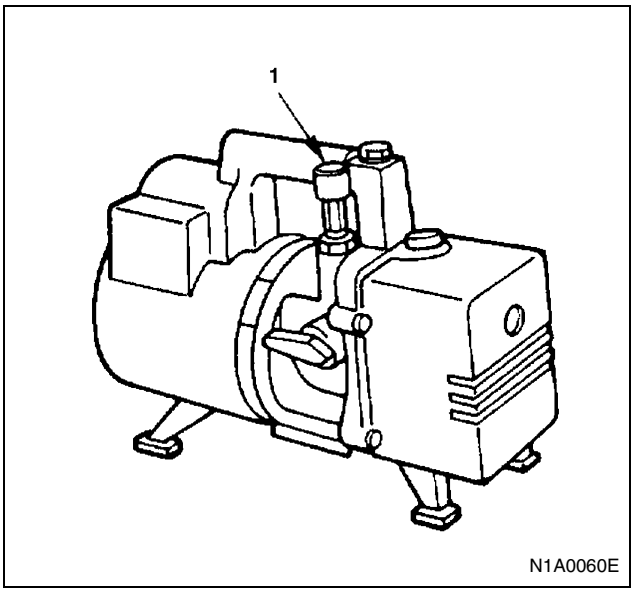
- Air conditioning manifold gauges, charging hoses and other service tools designed exclusively for the R-134a system must be used with this vehicle.



Legend

1. Manifold gauge
2. Quick joint (Low side)
3. Charging hose
4. Quick joint (High side)
5. Charge valve handle
6. Vacuum pump
7. Service container

- Do not use the same vacuum pump for evacuating the R-134a and R-12 systems interchangeably (The vacuum pump hose fitting is a M10X1.5).
- R-134a vacuum pumps must have a positive shut-off valve.



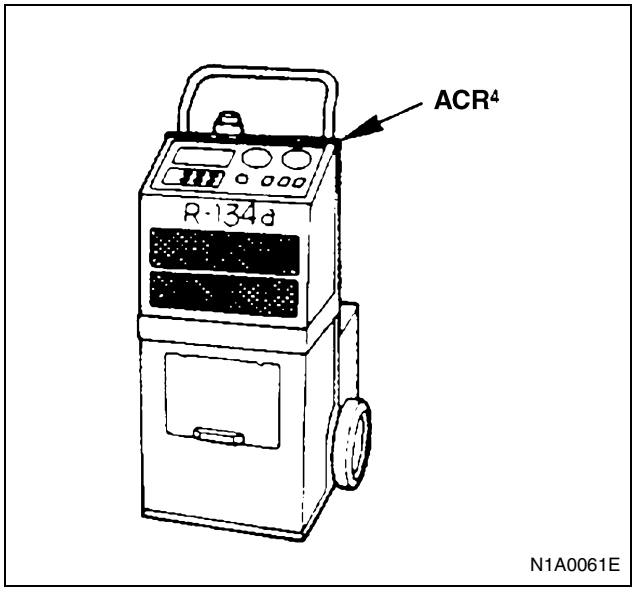
Legend

1. M10 × 1.5 (Hose fitting)

Caution:
Never use the same vacuum pump for both R-134a and R-12 systems, as cross contamination of compressor oil may occur.

Refrigerant Recovery, Recycling and Charging

- Avoid releasing the R-134a into the atmosphere. Use the ACR^4 (R-134a Refrigerant Recovery/ Recycling/ Recharging/ System) or equivalent to recover and recycle R-134a. Note that the ACR^4 (or equivalent) is not interchangeable between the R 134a and R-12 systems.
  ACR^4 (115V 60Hz): 5-8840-0629-0 (J-39500-A)
  ACR^4 (220-240V 50/60Hz): 5-8840-0630-0 (J-39500-220A)
  ACR^4 (220-240V 50/60Hz Australian model): 5-8840-0631-0 (J-39500-220ANZ)



Refrigerant Leak Inspection

- The flame type gas leak detector for the R-12 system cannot be used with the R-134a system.
- The electric leak detector for the R-12 cannot be used with the R-134a system as the R-134a particles are far smaller than the R-12 molecules and, therefore, may not be always detected. Use leak detectors designed exclusively for the R-134a system.

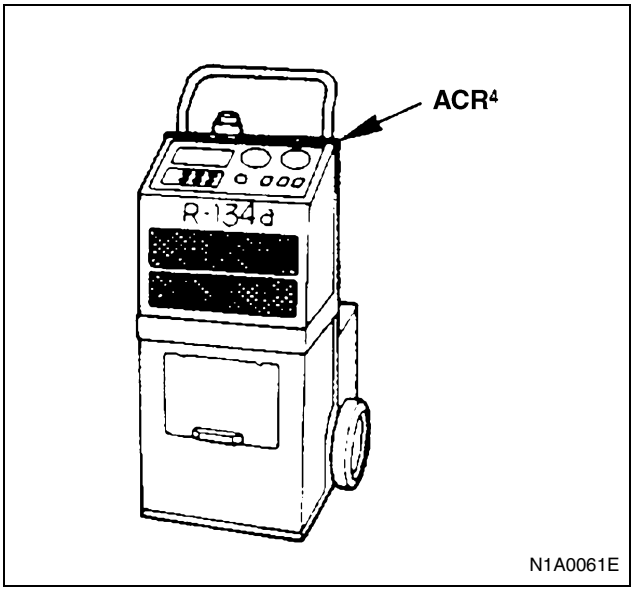
Precautions for Replacement or Repair of R-134a Air Conditioning Parts

There are certain procedure, practices and precautions that should be followed when servicing air conditioning systems:

- Keep your work area clean.
- Always wear safety goggle and protective gloves when working on refrigerant systems.
- Beware of the danger of carbon monoxide fumes caused by running the engine.
- Beware of discharged refrigerant in enclosed or improperly ventilated garages.
- Always disconnect the negative battery cable and discharge and recover the refrigerant whenever repairing the air conditioning system.
- When discharging and recovering the refrigerant, do not allow refrigerant to discharge too fast; it will draw compressor oil out of the system.
- Keep moisture and contaminants out of the system. When disconnecting or removing any lines or parts, use plugs or caps to close the fittings immediately.
  Never remove the caps or plugs until the lines or parts are reconnected or installed.
- When disconnecting or reconnecting the lines, use two wrenches to support the line fitting, to prevent from twisting or other damage.

- Always install new O-rings whenever a connection is disassembled.
- Before connecting any hoses or lines, apply new specified compressor oil to the O-rings.
- When removing and replacing any parts which require discharging the refrigerant circuit, the operations described in this Section must be performed in the following sequence:

1. Using the ACR^4 (R-134a Refrigerant Recovery/ Recycling/ Recharging/ System) or equivalent to thoroughly discharge and recover the refrigerant.
   ACR^4 (115V 60Hz): 5-8840-0629-0 (J-39500-A)
   ACR^4 (220-240V 50/60Hz): 5-8840-0630-0 (J-39500-220A)
   ACR^4 (220-240V 50/60Hz Australian model): 5-8840-06311-0 (J-39500-220ANZ)

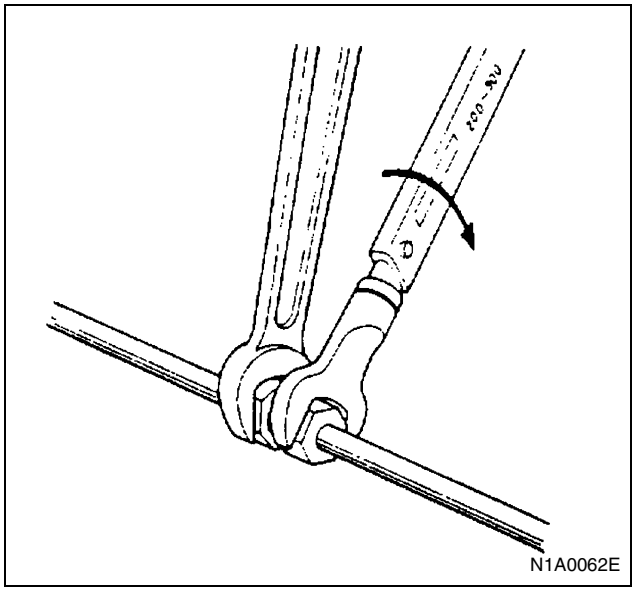


2. Remove and replace the defective part.
3. After evacuation, charge the air conditioning system and check for leaks.

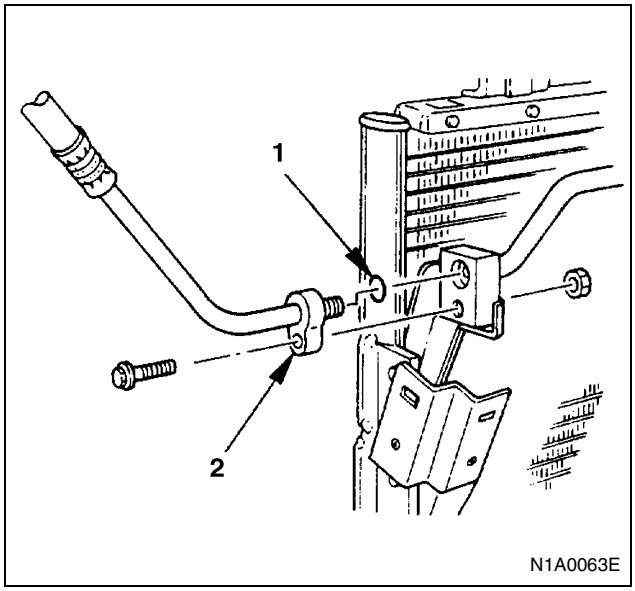
Repair of Refrigerant Leaks

Refrigerant Line Connections

Install new O-rings, if required. When disconnecting or connecting lines, use two wrenches to prevent the connecting portion from twisting or becoming damaged.



When connecting the refrigerant line at the block joint, securely insert the projecting portion of the joint portion into the connecting hole on the unit side and secure with a bolt.

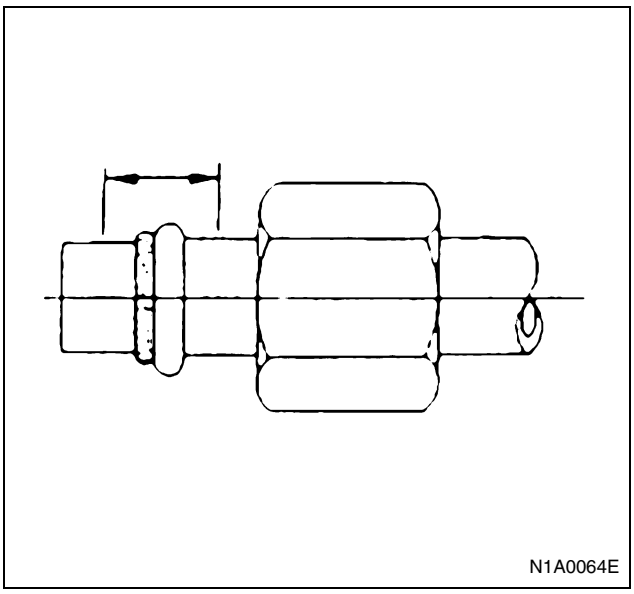


Legend

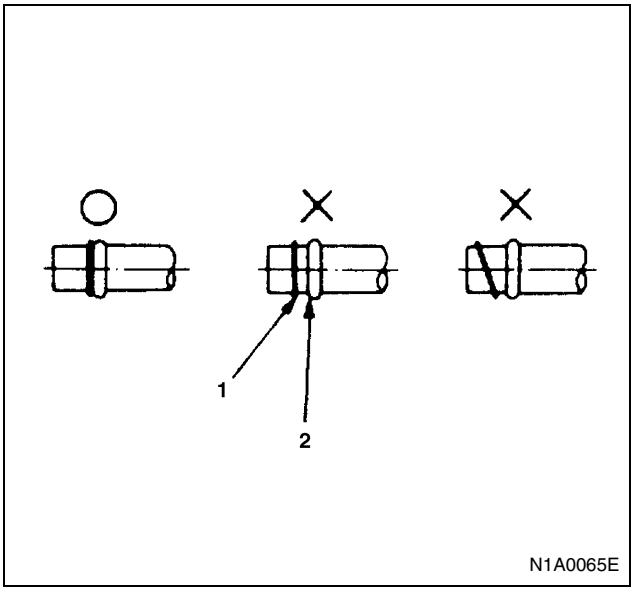
1. O-ring
2. Block joint

Apply specified compressor oil to the O-rings prior to connecting.

Caution:
Compressor (PAG) oil to be used varies according to compressor model. Be sure to apply specified oil for the model of compressor.

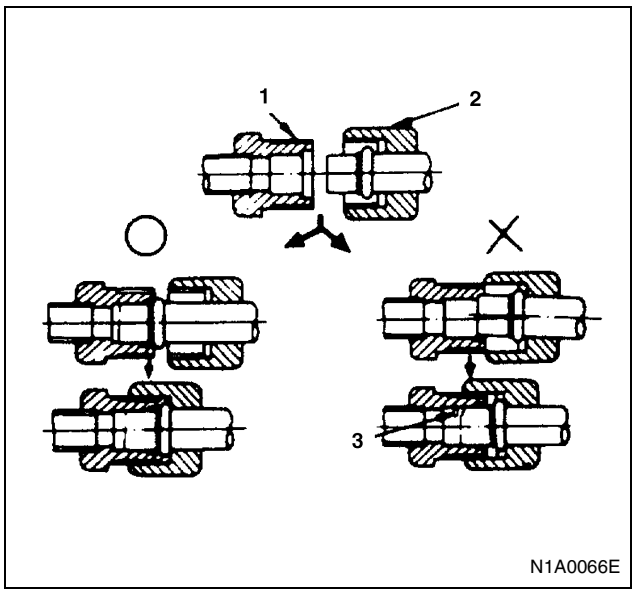


O-rings must be closely aligned with raised portion of refrigerant line.



Legend
1. O-ring
2. Raised portion

Insert nut into union. First tighten nut by hand as much as possible. Then, tighten nut to specified torque. (Refer to “SERVICE INFORMATION” for Fixing Torque in section 00)



Legend
1. Union
2. Nut
3. Damage

Leak at Refrigerant Line Connections

1. Check the torque on the refrigerant line fitting and, if too loose, tighten to the specified torque.
   - Use two wrenches to prevent twisting and damage to the Line.
   - Do not over tighten.
2. Perform a leak test on the refrigerant line fitting.
3. If the leak is still present, discharge and recover the refrigerant from the system.
4. Replace the O-rings.
   - O-rings cannot be reused. Always replace with new ones.
   - Be sure to apply specified compressor oil to the new O-rings.
5. Retighten the refrigerant line fitting to the specified torque.
   - Use two wrenches to prevent twisting and damage to the line.
6. Evacuate, charge and retest the system.

Leak in The Hose

If the compressor inlet or outlet hose is leaking, the entire hose must be replaced. Refrigerant hose must not be cut or spliced for repair.

1. Locate the leak.
2. Discharge and recover the refrigerant.
3. Remove the hose assembly.
   - Cap the open connections at once.
4. Connect the new hose assembly.
   - Use two wrenches to prevent twisting or damage to the hose fitting.

- Tighten the hose fitting to the specified torque.

5. Evacuate, charge and test the system.

Compression Leaks

If leaks are located around the compressor shaft seal or shell, replace or repair the compressor.

Recovery, Recycling, Evacuation and Charging

Handling Refrigerant-134a
Air conditioning systems contain R-134a.
This is a chemical mixture which requires special handling procedures to avoid personal injury.

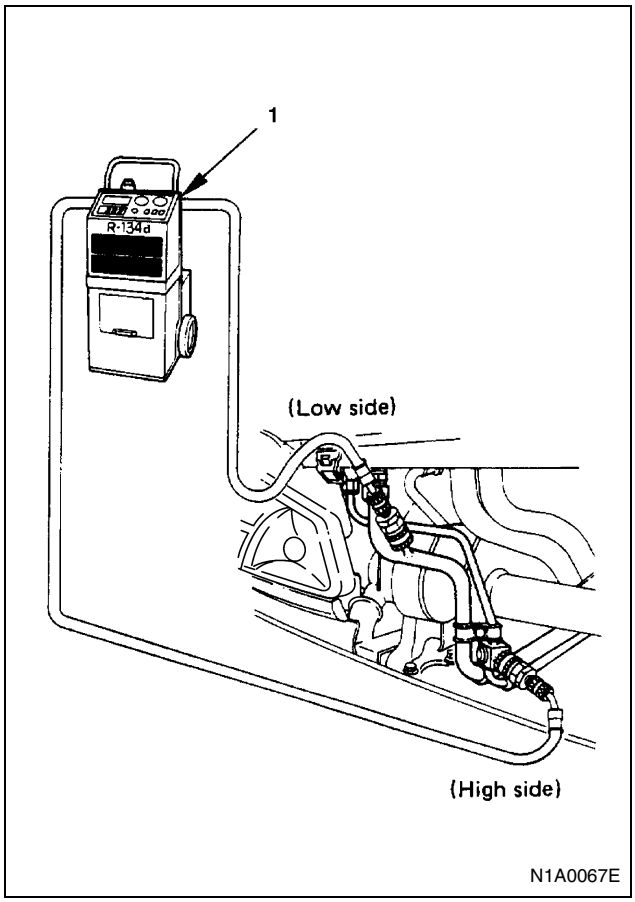
- Always wear safety goggles and protective gloves.
- Always work in a well-ventilated area. Do not weld or steam clean on or near any vehicle-installed air conditioning lines or components.
- If R-134a should come in contact with any part of the body, flush the exposed area with cold water and immediately seek medical help.
- If it is necessary to transport or carry any container of R-134a in a vehicle, do not carry it in the passenger compartment.
- If it is necessary to fill a small R-134a container from a large one, never fill the container completely. Space should always be allowed above the liquid for expansion.
- R-134a and R-12 should never be mixed as their compositions are not the same.
- R-134a PAG oil tends to absorb moisture more quickly than R-12 mineral oil and, therefore, should be handled more carefully.
- Keep R-134a containers stored below 40°C (100°F).

WARNING:

- **SHOULD R-134a CONTACT YOUR EYE(S), CONSULT A DOCTOR IMMEDIATELY.**
- **DO NOT RUB THE AFFECTED EYE(S). INSTEAD, SPLASH QUANTITIES OF FRESH COLD WATER OVER THE AFFECTED AREA TO GRADUALLY RAISE THE TEMPERATURE OF THE REFRIGERANT ABOVE THE FREEZING POINT.**
- **OBTAIN PROPER MEDICAL TREATMENT AS SOON AS POSSIBLE. SHOULD THE R-134a TOUCH THE SKIN, THE INJURY MUST BE TREATED THE SAME AS SKIN WHICH HAS BEEN FROSTBITTEN OR FROZEN.**

Refrigerant Recovery

The refrigerant must be discharged and recovered by using ACR^4 (R-134a Refrigerant Recovery/ Recycling/ Recharging/ System) (1) or equivalent before removing or mounting air conditioning parts.
ACR^4 (115V 60Hz): 5-8840-0629-0 (J-39500-A)
ACR^4 (220-240V 50/60Hz): 5-8840-0630-0 (J-39500-220A)
ACR^4 (220-240V 50/60Hz Australian model): 5-88410-0631-0 (J-39500-220ANZ)



1. Connect the high and low charging hoses of the ACR^4 (or equivalent) as shown.
2. Recover the refrigerant by following the ACR^4 Manufacture's Instructions.
3. When a part is removed, put a cap or a plug on the connecting portion so that dust, dirt or moisture cannot get into it.

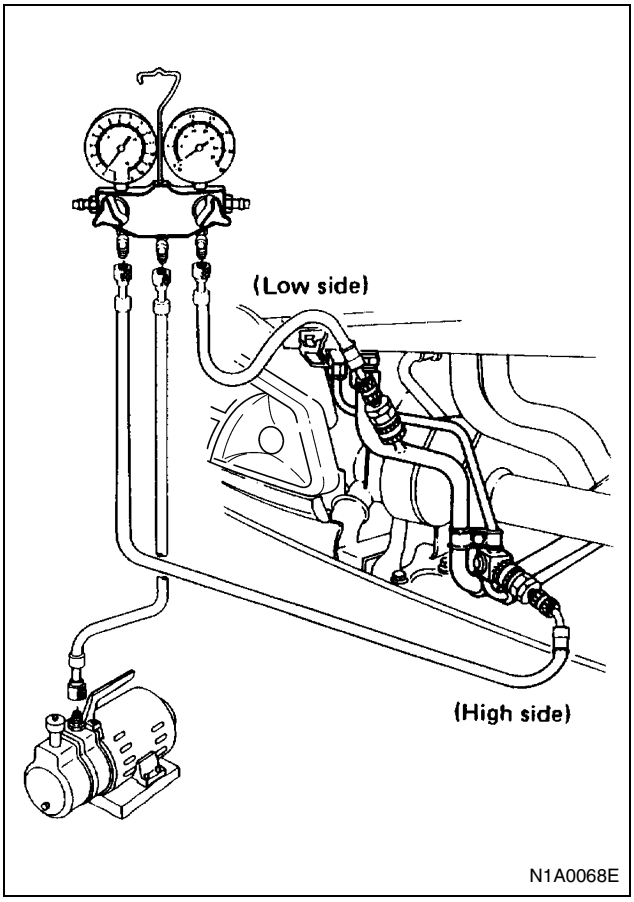
Refrigerant Recycling

Recycle the refrigerant recovered by ACR^4 or equivalent.
For the details of the actual operation, follow the steps in the ACR^4 Manufacture's Instructions.
ACR^4 (115V 60Hz): 5-8840-0629-0 (J-39500-A)
ACR^4 (220-240V 50/60Hz): 5-8840-0630-0 (J-39500-220A)
ACR^4 (220-240V 50/60Hz Australian model): 5-8840-0631-0 (J-39500-220ANZ)

Evacuation of The Refrigerant System

Notice:
Explained below is a method using a vacuum pump. Refer to ACR^4 (or equivalent) manufacture's instructions when evacuating the system with ACR^4 (or equivalent).

Air and moisture in the refrigerant will cause problems in the air conditioning system.
Therefore, before charging the refrigerant, be sure to evacuate air and moisture thoroughly from the system.



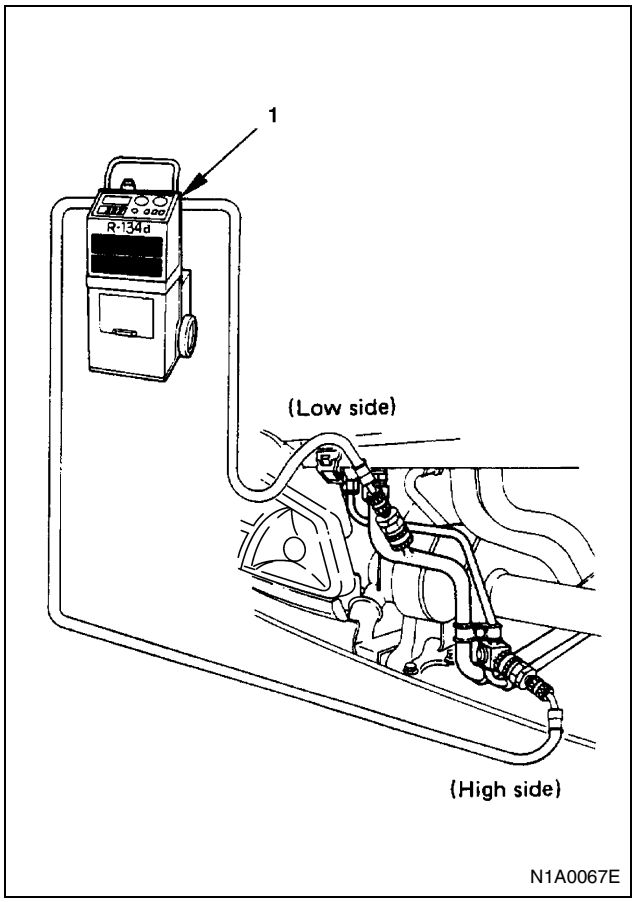
1. Connect the gauge manifold.
   - High-pressure valve (HI) — Discharge-side
   - Low-pressure valve (LOW) — Suction-side
2. Discharge and recover the refrigerant.
3. Connect the center hose of the gauge manifold set to the vacuum pump inlet.
4. Operate the vacuum pump, open shutoff valve and then open both hand valves.
5. When the low-pressure gauge indicates approx. 750 mmHg (30 inHg), continue the evacuation for 5 minutes or more.
6. Close both hand valves and stop the vacuum pump.
7. Check to ensure that the pressure does not change after 10 minutes or more.
   - If the pressure changes, check the system for leaks.
   - If leaks occur, retighten the refrigerant line connections and repeat the evacuation steps.
8. If no leaks are found, again operate the vacuum pump for 20 minutes or more. After confirming that the gauge manifold pressure is at 750 mmHg(30 inHg), close both hand valves.
9. Close positive shutoff valve.
   Stop the vacuum pump and disconnect the center hose from the vacuum pump.

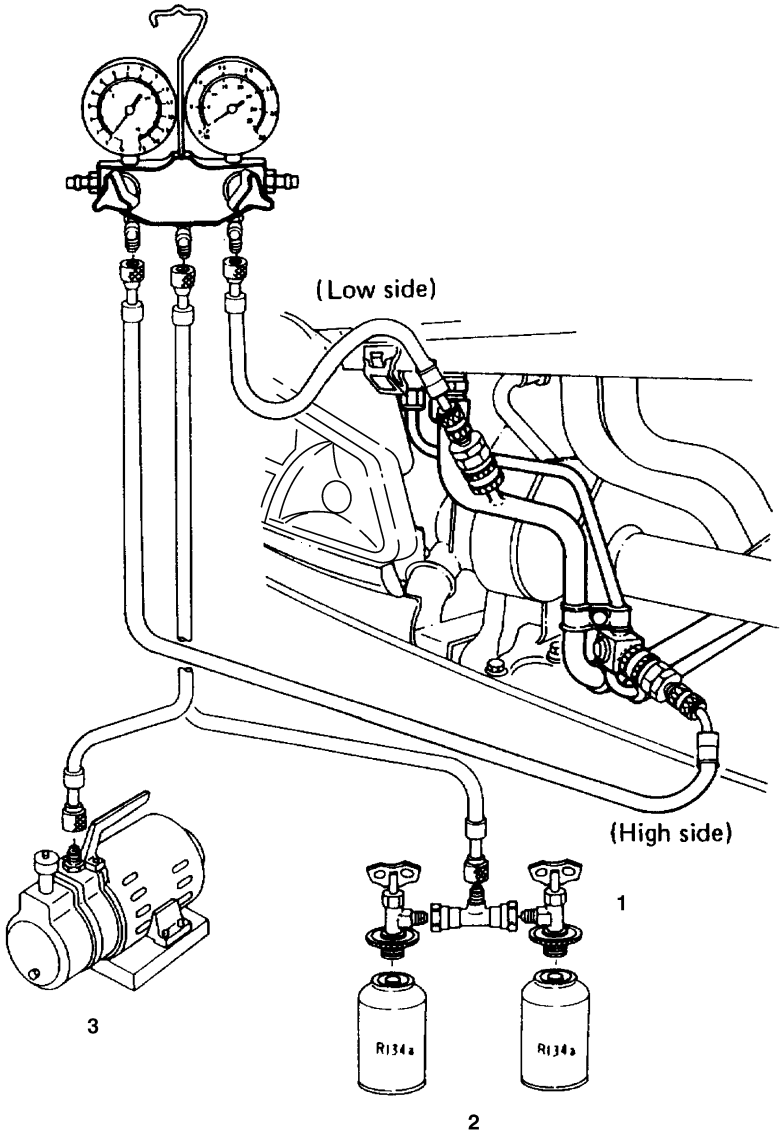
Charging The Refrigerant System

There are various methods of charging refrigerant into the air conditioning system.
These include using ACR^4 (R-134a Refrigerant Recovery/ Recycling/ Recharging/ System) or equivalent and direct charging with a manifold gauge charging station.
ACR^4 (115V 60Hz): 5-8840-0629-0 (J-39500-A)
ACR^4 (220-240V 50/60Hz): 5-8840-0630-0 (J-39500-220A)
ACR^4 (220-240V 50/60Hz Australian model): 5-8840-0631-0 (J-39500-220ANZ)

Charging procedure

- ACR^4 (or equivalent) method
  For the charging of refrigerant recovery by ACR^4 (1), follow the manufacture's instruction.





N1A0070E

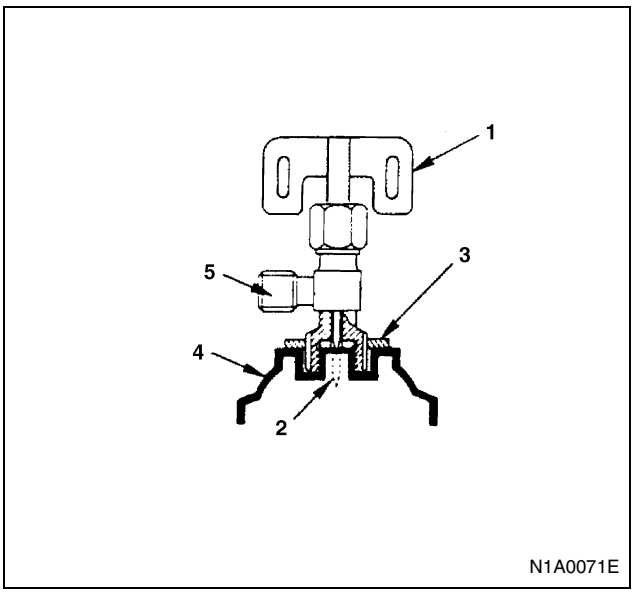
Legend

1. Charge valve handle
2. Service container
3. Vacuum pump

- Direct charging with a manifold gauge charging station method
  Handling the charging valve handle when installing refrigerant container.

1. Before attaching the charge valve to the refrigerant container, turn the charge valve handle (1) counterclockwise until the needle (2) is fully retracted.
2. Turn the plate nut (3) counterclockwise until it reaches its highest position relative to the charge valve.
3. Install the charge valve onto the refrigerant container (4).
4. Turn the plate nut clockwise and connect the center hose of the manifold gauge to the charge valve (5).
5. Tighten the plate nut sufficiently by hand. Then turn the charge valve handle clockwise to lower the needle and bore a hole in the refrigerant container.
6. Turn the charge valve handle counterclockwise to raise the needle. The refrigerant in the refrigerant container is charged into the air conditioning system by the operation of the manifold gauge.

- Be absolutely sure not to reuse the emptied refrigerant container.



1. Make sure the evacuation process is correctly completed.
2. Connect the center-hose of the manifold gauge to the refrigerant container.
   - Turn the charge valve handle counterclockwise to purge the charging line and purge any air existing in the center-hose of the manifold gauge.
3. Open the low-pressure hand valve and charge the refrigerant about 200 g (0.44 lbs.).
   - Make sure the high-pressure hand valve is closed.
   - Avoid charging the refrigerant by turning the refrigerant container upside down.
4. Close the low-pressure hand valve of the manifold gauge.
   - Check to ensure that the degree of pressure does not charge.
5. Check the refrigerant leaks by using a R-134a leak detector.
   - If a leak occurs, repair the leak connection, and start all over again from the first step of evacuation.
6. If no leaks are found, open the low-pressure hand valve of the manifold gauge. Then continue charging refrigerant to the system.
   - When charging the system becomes difficult:
     1) Run the engine at 1,300 — 1,500 rpm and open the all vehicle doors.
     2) A/C switch is “ON”.
     3) Set the fan control knob (fan switch) to its highest position.

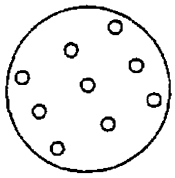
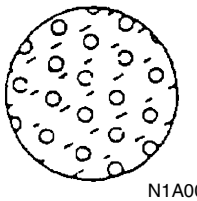
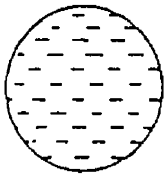
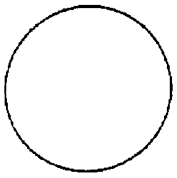
WARNING:
BE ABSOLUTELY SURE NOT TO OPEN THE HIGH-PRESSURE HAND VALVE. SHOULD THE HIGH-PRESSURE HAND VALVE BE OPENED, THE HIGH-PRESSURE REFRIGERANT GAS WOULD FLOW BACKWARD, AND THIS MAY CAUSE THE REFRIGERANT CONTAINER TO BURST.

7. When the refrigerant container is emptied, use the following procedure to replace it with a new refrigerant container.
   1) Close the low pressure hand valve.
   2) Raise the needle upward and remove the charge valve.
   3) Reinstall the charge valve to the new refrigerant container.
   4) Purge any air existing in the center hose of the manifold gauge.
8. Charge the system to the specified amount and then close the low-pressure hand valve.

Refrigerant Amount	g (lbs.)
450 (0.99) GCC, 600 (1.32) Australia & Taiwan	

   - A fully charged system is indicated by the sight glass on the receiver/drier being free of any bubbles (Refer to “Reading Sight Glass”).
   - Check the high and low pressure value of the manifold gauge.
   - Check for refrigerant leaks by using a R-134a leak detector.
     Immediately after charging refrigerant, both high and low pressures are slightly high and to the left of the gauge, but they settle down to the guide pressure valves as shown below:
   - Ambient temperature; 30 — 35°C (86 — 95°F)
   - Guide pressure
     High-pressure side;
     Approx. 1373 — 1667 kPa (14 — 17 kg/cm^2 / 199 — 242 PSI)
     Low-pressure side;
     Approx. 127 — 245 kPa (1.3 — 2.5 kg/cm^2 / 18 — 36 PSI)
9. Close the low pressure hand valve and charge valve of the refrigerant container.
10. Stop the air conditioning and the engine.
11. Disconnect the high and low pressure hoses from the manifold gauge fittings.

Reading Sight Glass

High and low pressure pipe temperature	The high pressure pipe is hot and the low pressure pipe is cold. There is a distinct difference in temperature between them.	The high pressure pipe is warm and the low pressure pipe is cool. There is no great difference in temperature between them.	There is little difference in temperature between the high pressure pipe and the low pressure pipe.	The high pressure pipe is hot and the low pressure pipe is slightly warm. There is a difference in temperature between them.
Sight glass condition	Almost transparent. A flow of bubbles can be seen, but they disappear when the throttle is opened.  N1A0072E	A flow of bubbles always can be seen. It appears sometimes transparent, and sometimes frothy.  N1A0073E	Something like fog faintly can be seen.  N1A0074E	Even at idle with the fan at “HI” (with the window fully open), the bubbles cannot be seen.  N1A0075E
Air conditioner cycle condition	OK	NG (Not enough refrigerant)	NG (Almost no refrigerant)	NG (Too much refrigerant)

The sight glass provides accurate diagnosis only under the following conditions.
If the vehicle can be tested under these conditions, check the sight glass appearance and compare to the chart.

- Engine speed 1,500 RPM
- A/C switch “ON”
- Blower fan operating at highest speed
- Air source selector lever at “RECIRC”
- Temperature control knob at coldest position
- Ambient temperature below 35°C (95°F) and humidity below 70%

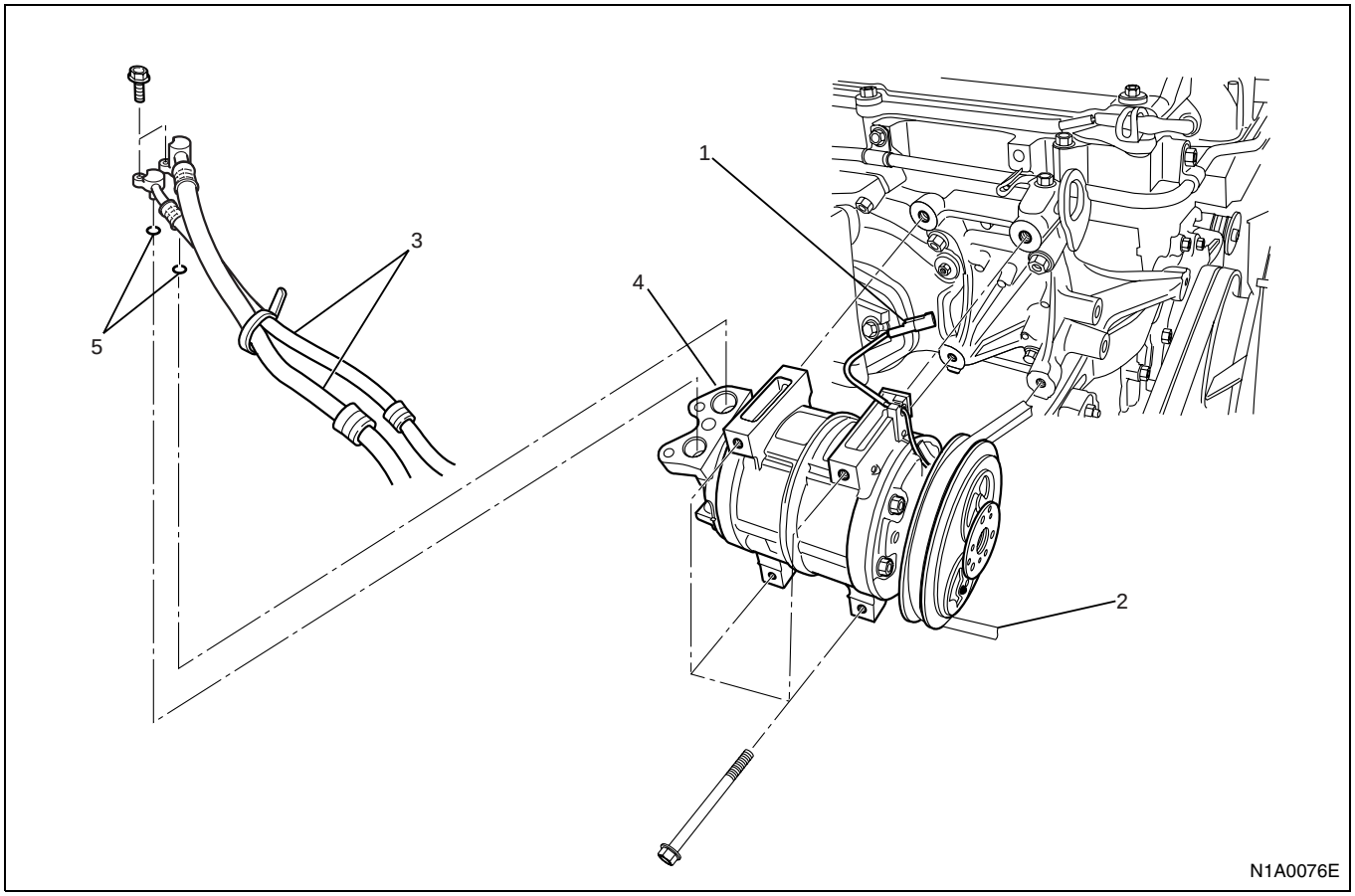
Notice:
If the vehicle cannot be moved to a testing location that meets these specifications, then the sight glass cannot be used for diagnosis. You must discharge and recover the refrigerant, then recharge the system with the specified amount of refrigerant. Then continue checking the system performance.

- High side pressure less than 1667 kPa (17 kg·cm^2 / 242 PSI)

Notice:
If the high side pressure is greater than stated, the sight glass cannot be used for diagnosis. You must discharge and recover the refrigerant, then recharge the system with the specified amount of refrigerant.

Then continue checking system performance.

Compressor



Legend

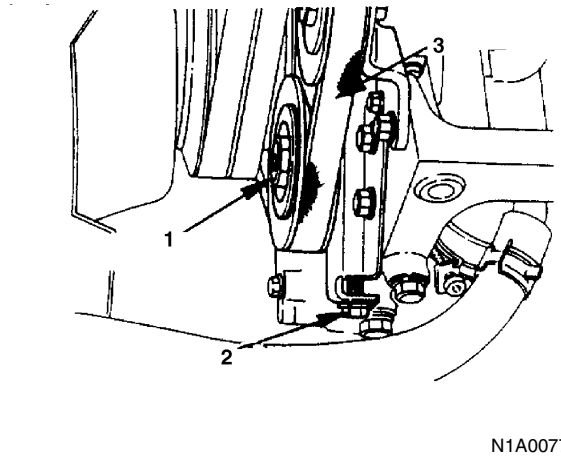
1. Magnetic clutch harness connector
2. Drive belt
3. Refrigerant line
4. Compressor
5. O-ring

Removal

Preparation:
Disconnect the battery ground cable.
Discharge and recover refrigerant.

1. Magnetic clutch harness connector
2. Drive Belt
   Loosen the tension pulley center nut (1) and tension adjustment bolt (2), then remove the drive belt (3).

This illustration is based in 4HF1 engine



3. Refrigerant line
   When removing the line connector, the connecting part should immediately be plugged or capped to prevent foreign matter from being mixed into the line.
4. Compressor

Installation

1. Compressor
   Tighten the compressor fixing bolts to the specified torque.

Tighten:
Compressor Bolt to 19 N·m (1.9 kg·m/14 lb·ft).

2. Refrigerant Line
   - Tighten the refrigerant line fixing bolt to the specified torque.

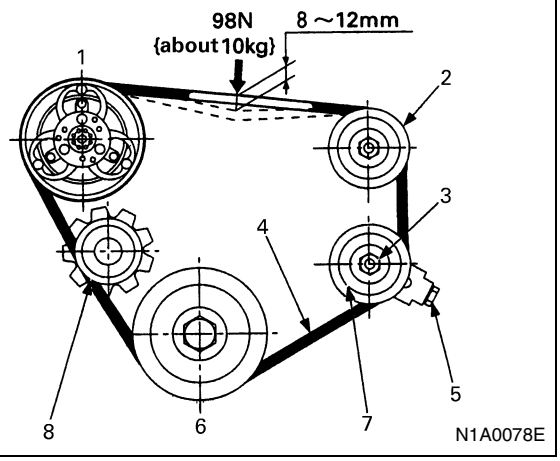
Tighten:
Refrigerant Line Bolt to 27 N·m (2.8 kg·m/20 lb·ft).

- O-ring cannot be reused. Always replace with new ones.
- Be sure to apply new specified compressor oil to the O-rings when connecting refrigerant lines.

3. Drive Belt
   Push the drive belt with the force of 10 kg (22 lbs) and adjust the drive belt tension by tightening idle pulley tension adjustment bolt, until the 8 — 12 mm (0.31 — 0.47 in) deflection of the belt is obtained. Then tighten the pulley center nut.

Tighten:
Idle Pulley Center nut to 39 N·m (4.0 kg·m/29 lb·ft).

This illustration is based in 4HF1 engine



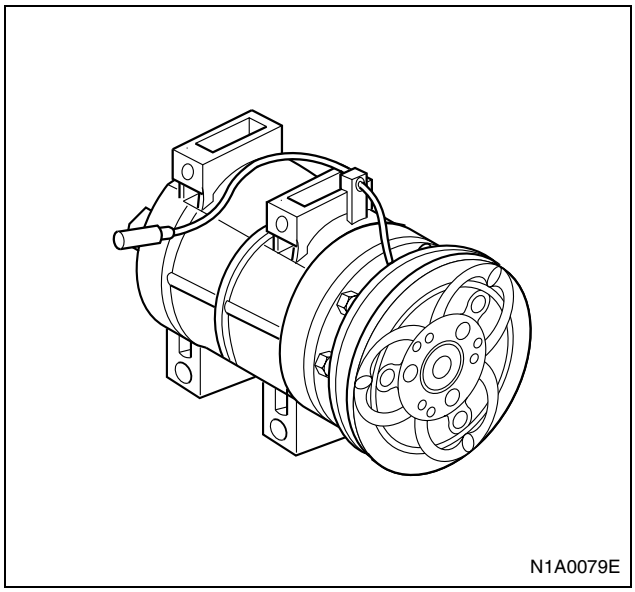
Legend

1. A/C compressor
2. Pulley
3. Center nut
4. Drive belt
5. Adjustment bolt
6. Crank pulley
7. Tension pulley
8. Generator

4. Magnetic Clutch Harness Connector

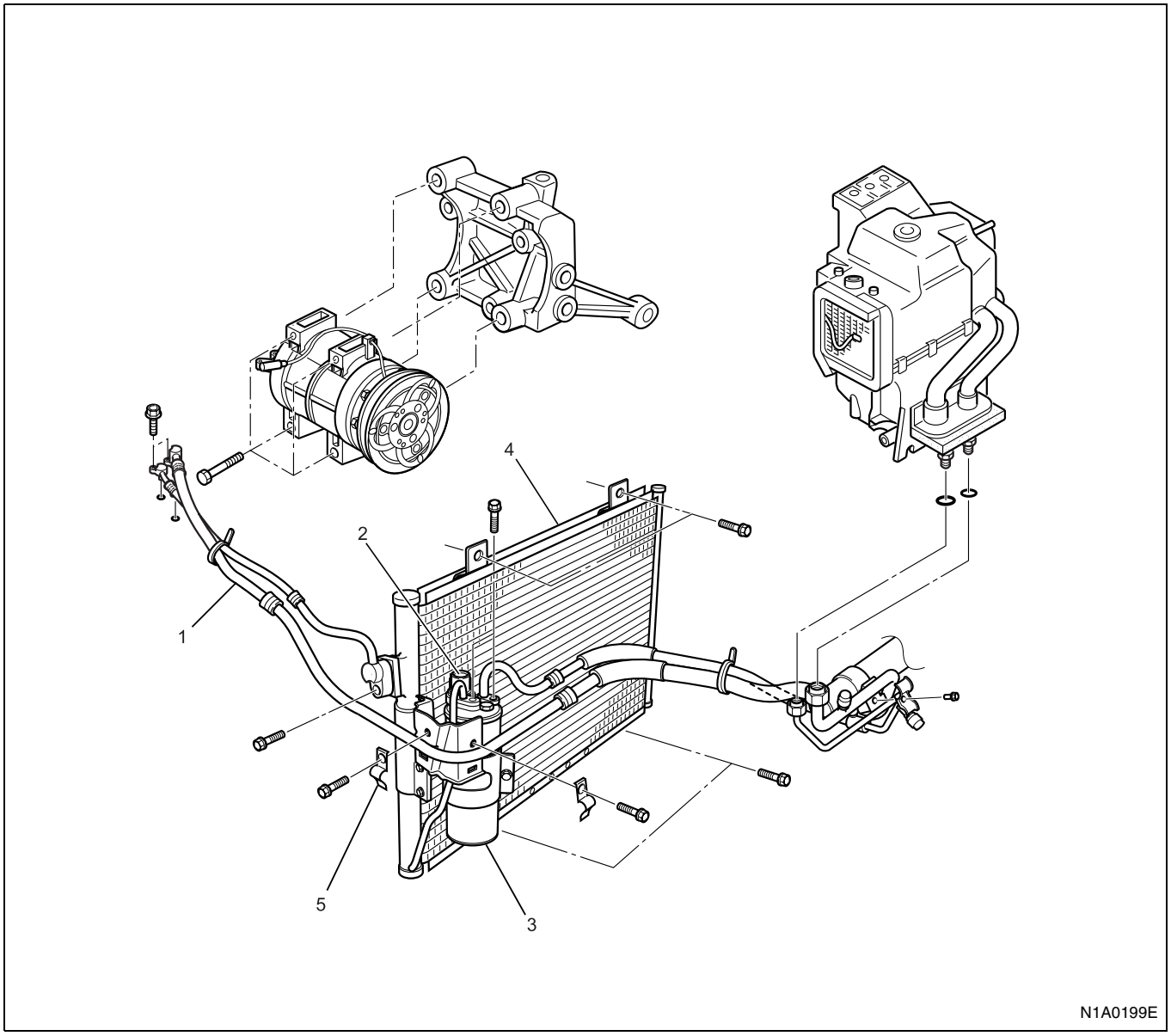
New Compressor Installation

The new compressor is filled with 180cc (5.0 Imp fl oz) of compressor oil and nitrogen gas. When mounting the compressor on the vehicle, perform the following steps;



1. Gently release nitrogen gas from the rear head of the new compressor.
   - Take care not to let the compressor oil flow out.
   - Inspect O-rings and replace if necessary.
2. Turn the compressor several times by hand and release the compressor oil in the cylinder.
3. When installing on a new system, the compressor should be installed as it is. When installing on a used system, the compressor should be installed after adjusting the amount of compressor oil. (Refer to Section 1D “COMPRESSOR OVERHAUL” for General Information.)

Condenser Assembly (Except 4HK1-TC Engine Model For Australia)



Legend

1. Refrigerant line
2. Pressure switch
3. Receiver / drier
4. Condenser assembly
5. Refrigerant line fixing clamp

Removal

Preparation:
Disconnect the battery ground cable.
Discharge and recover refrigerant.

1. Pressure switch connector
2. Refrigerant line fixing clamp
3. Refrigerant Line
   - Use a back up wrench when disconnecting and re-connecting the refrigerant lines.
   - When removing the line, the connecting part should immediately be plugged or capped to prevent foreign matter from being mixed into the line.
4. Condenser assembly
   - Remove the radiator stay before condenser (GCC).

Installation

1. Condenser Assembly
   - If installing a new condenser, be sure to add 30cc (0.8 Imp fl oz) of new specified compressor oil to a new one.
   - Tighten the condenser bolt to the specified torque.
2. Refrigerant Line
   - Tighten the inlet line to the specified torque.

Tighten:
Inlet line to 15 N·m (1.5 kg·m/11 lb·ft)

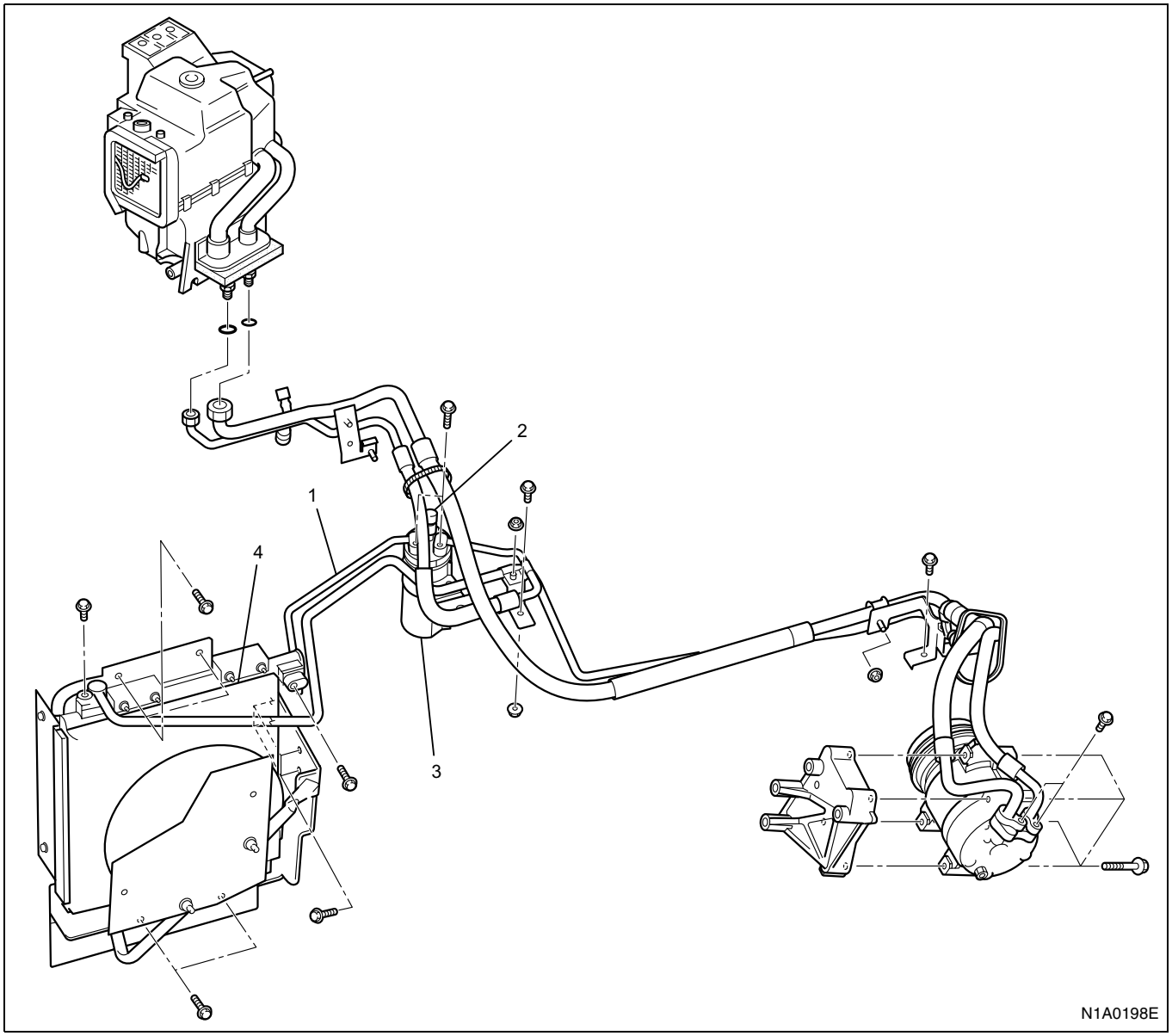
- Tighten the outlet line to the specified torque.

Tighten:
Outlet line to 6 N·m (0.6 kg·m/4 lb·ft)

- O-rings cannot be reused. Always replace with new ones.
- Be sure to apply new specified compressor oil to the O-rings when connecting refrigerant line.

3. Refrigerant Line Fixing Clamp
4. Pressure Switch Connector

Condenser Assembly (4HK1-TC Engine Model For Australia)



Legend

1. Refrigerant line
2. Pressure switch
3. Receiver / drier
4. Condenser assembly

Removal

Preparation:
Disconnect the battery ground cable.
Discharge and recover refrigerant.

1. Refrigerant Line
   - Use a back up wrench when disconnecting and re-connecting the refrigerant lines.
   - When removing the line, the connecting part should immediately be plugged or capped to prevent foreign matter from being mixed into the line.
2. Condenser assembly

Installation

1. Condenser Assembly
   - If installing a new condenser, be sure to add 30cc (0.8 Imp fl oz) of new specified compressor oil to a new one.
   - Tighten the condenser bolt to the specified torque.
2. Refrigerant Line
   - Tighten the inlet line to the specified torque.

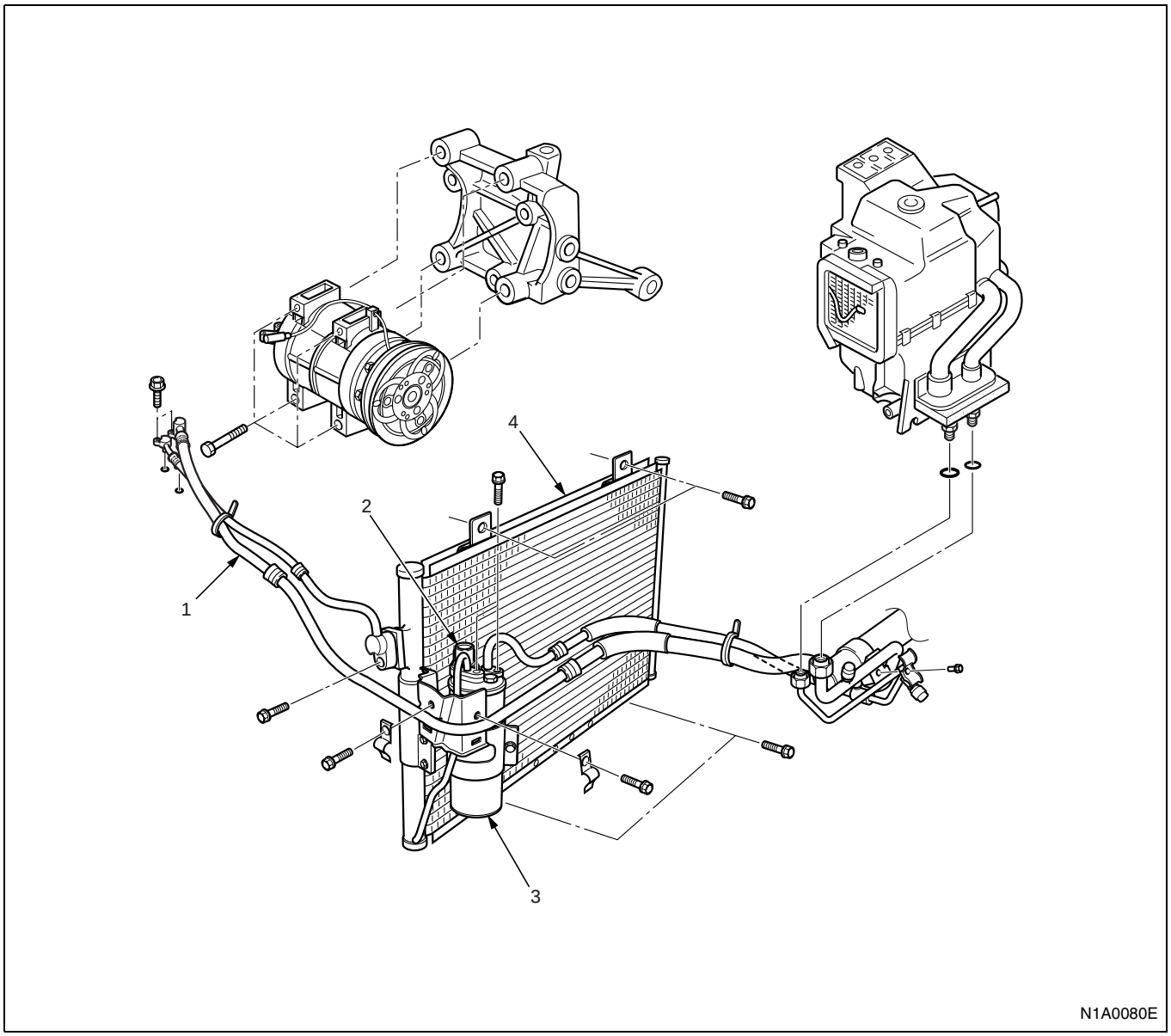
Tighten:
Inlet line to 15 N·m (1.5 kg·m/11 lb·ft)

- Tighten the outlet line to the specified torque.

Tighten:
Outlet line to 6 N·m (0.6 kg·m/4 lb·ft)

- O-rings cannot be reused. Always replace with new ones.
- Be sure to apply new specified compressor oil to the O-rings when connecting refrigerant line.

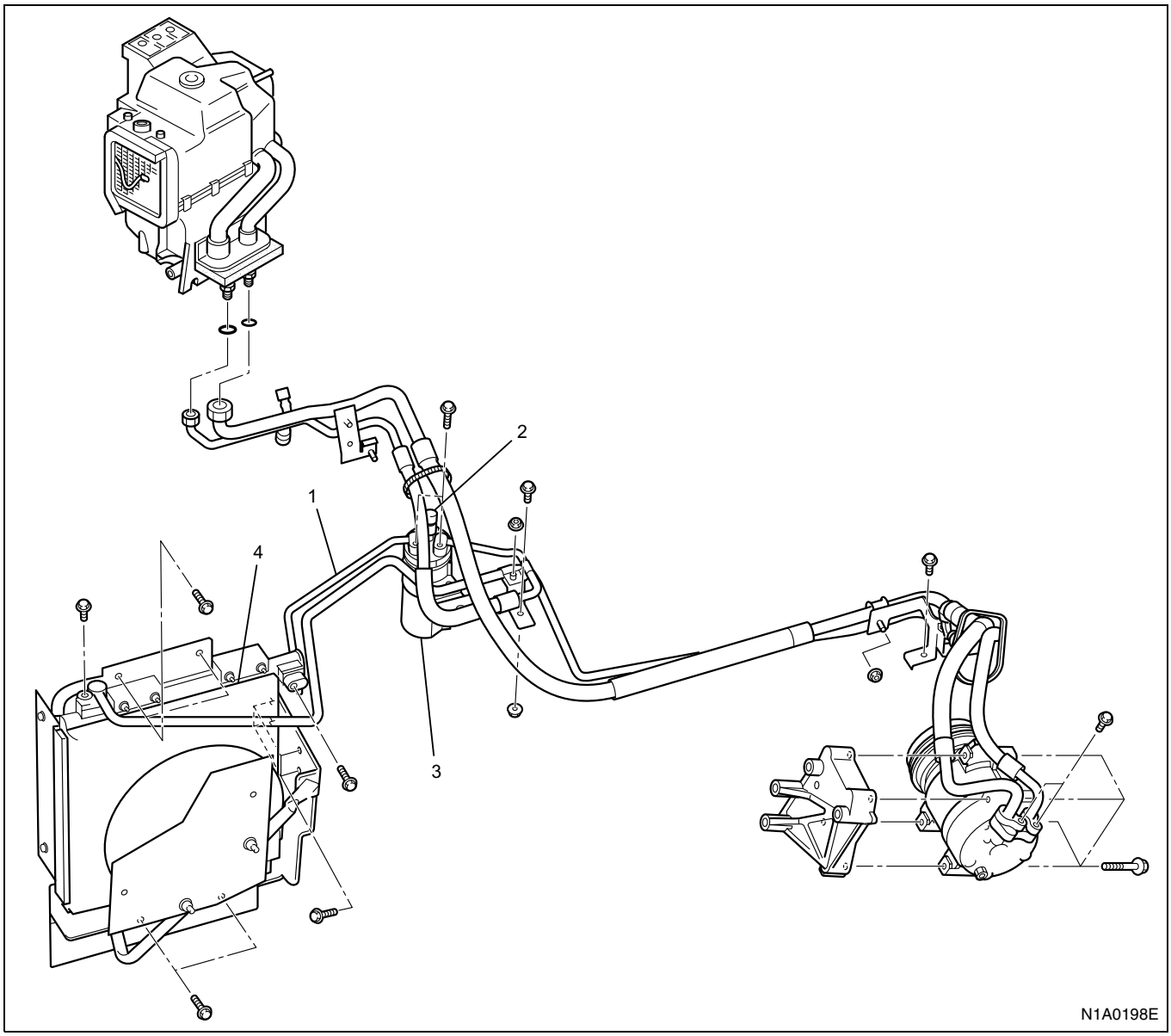
Receiver / Drier (Except 4HK1-TC Engine Model For Australia)



Legend

1. Refrigerant line
2. Pressure switch
3. Receiver / drier
4. Condenser assembly

Receiver / Drier (4HK1-TC Engine Model For Australia)



Legend

1. Refrigerant line
2. Pressure switch
3. Receiver / drier
4. Condenser assembly

Removal

Preparation:
Disconnect the battery ground cable.
Discharge and recover refrigerant.

1. Pressure Switch Connector
2. Refrigerant line
   - Use a back up wrench when disconnecting and reconnecting the refrigerant line.
   - When removing the line connected part, the connecting part should immediately be plugged or capped to prevent foreign matter from being mixed into the line.
3. Receiver / Drier
   - Loosen the fixing bolt and carefully pull out the receiver/drier.

Installation

To install, follow the removal steps in the reverse order, noting the following points:

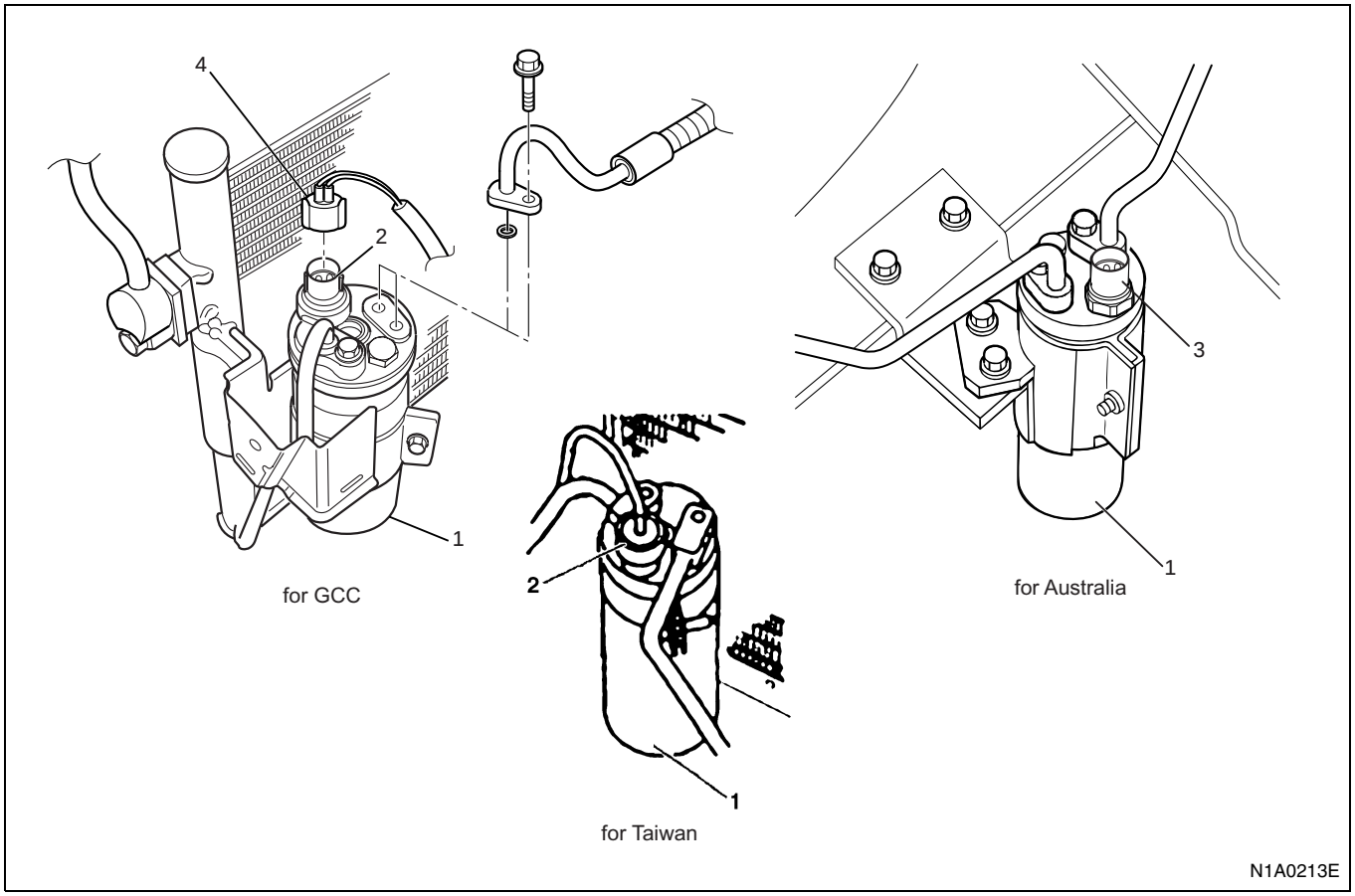
1. If installing a new receiver/drier, be sure to add 30 cc (0.8 Imp fl oz) of new specified compressor oil to a new one.
2. Put the receiver/drier in the bracket, and connect with the refrigerant line. Check that no excessive force is imposed on the line. Fasten the fixing bolt to the receiver/drier.

3. Tighten the line to the specified torque.

Tighten:
Refrigerant Line to 6 N·m (0.6 kg·m/4 lb·ft)

4. O-rings cannot be reused. Always replace with new ones.
5. Be sure to apply new specified compressor oil to the O-rings when connecting refrigerant line.

Pressure Switch



Legend

1. Receiver / drier
2. Dual pressure switch
3. Triple pressure switch
4. Pressure switch connector

Removal

Preparation:
Disconnect the battery ground cable.
Discharge and recover refrigerant.

1. Pressure Switch Connector
2. Pressure Switch
   - Turn the pressure switch counterlockwise to remove it.
   - When removing the switch connected part, the connecting part should immediately be plugged or capped to prevent foreign matter from being mixed into the line.

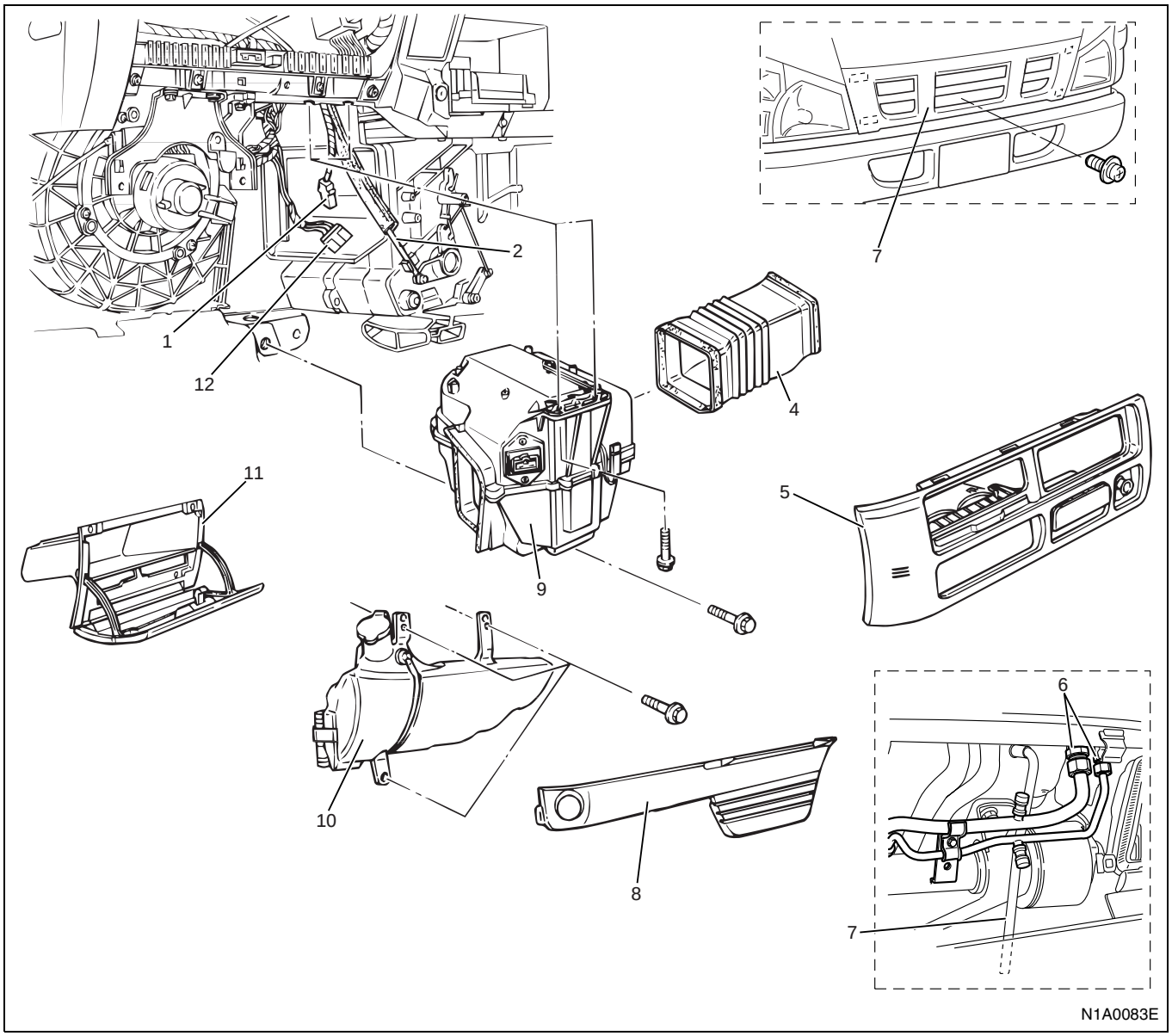
Installation

To install, follow the removal steps in the reverse order, noting the following points:

1. O-ring cannot be reused. Always replace with a new one.
2. Be sure to apply new specified compressor oil to the O-ring when connecting pressure switch.
3. Tighten the pressure switch to the specified torque.

Tighten:
Pressure switch to 10 N·m (1.0 kg·m/7.4 lb·ft)

Evaporator Assembly



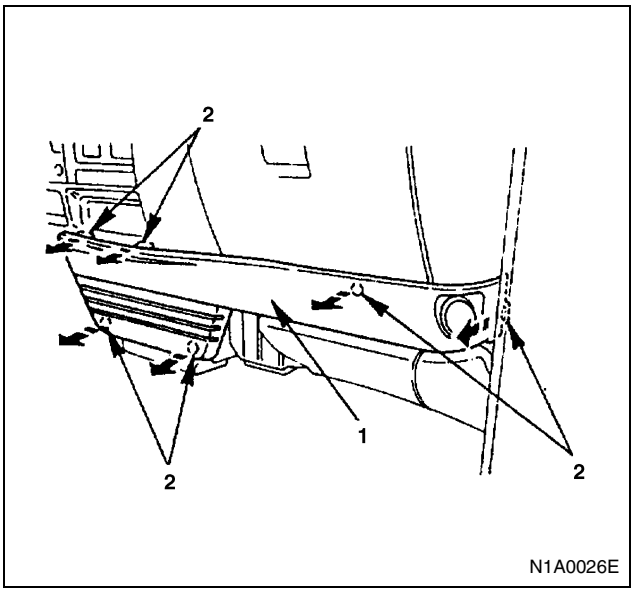
Legend

1. Electronic thermostat connector
2. Temperature control cable
3. Front grille
4. Duct (NPR only)
5. Center cluster
6. Refrigerant line
7. Drain hose
8. Under cover
9. Evaporator assembly
10. Washer tank
11. Glove box
12. Resistor connector

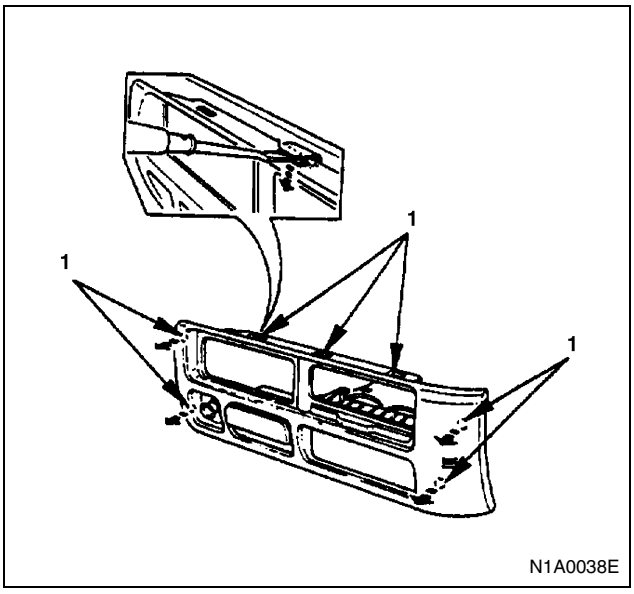
Removal

Preparation:
Disconnect the battery ground cable.
Discharge and recover refrigerant.

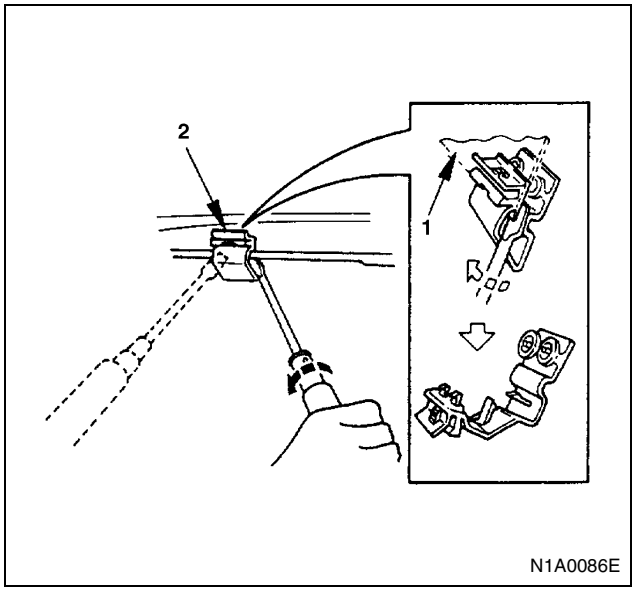
1. Glove Box
   Open the glove box and remove the fixing screws.
2. Under Cover
   While pulling the under cover (1) with care, remove the clips (2) on the back side of the cover.



3. Washer Tank
   - Remove the washer tank fixing three bolts (Upper: two, Lower: one) and disconnect the connector.
   - Do not disconnect the washer tank tube.
4. Center Cluster
   - While pulling the cluster with care, remove the upper and back side clips (1) of the cluster.
   - Disconnect the cigar lighter and illumination connectors.

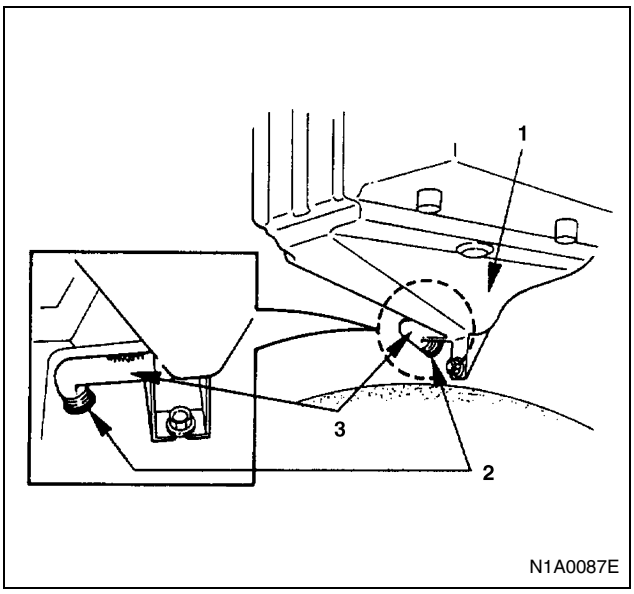


5. Temperature Control Cable
   Disconnect the temperature control cable of the control lever assembly from the heater unit.
6. Duct (NPR only)
7. Front Grille
   After removing the grille, remove the grille fixing clip (RH).



Legend
1. Panel
2. Clip

8. Refrigerant Line
   - Use a back up wrench when disconnecting and reconnecting the refrigerant line.
   - When removing the refrigerant line connected part, the connecting part should immediately be plugged or capped to prevent foreign matter from being mixed into the line.
9. Evaporator Assembly
   - Disconnect the resistor and thermostat connectors.
   - Disconnect the drain hose.



Legend
1. Evaporator
2. Grommet
3. Drain hose

Installation

To install, follow the removal steps in the reverse order, noting the following points:

1. To install a new evaporator assembly, add 50cc (1.4 lmp fl oz) of new specified compressor oil to a new core.
2. Tighten the refrigerant outlet line to the specified torque.

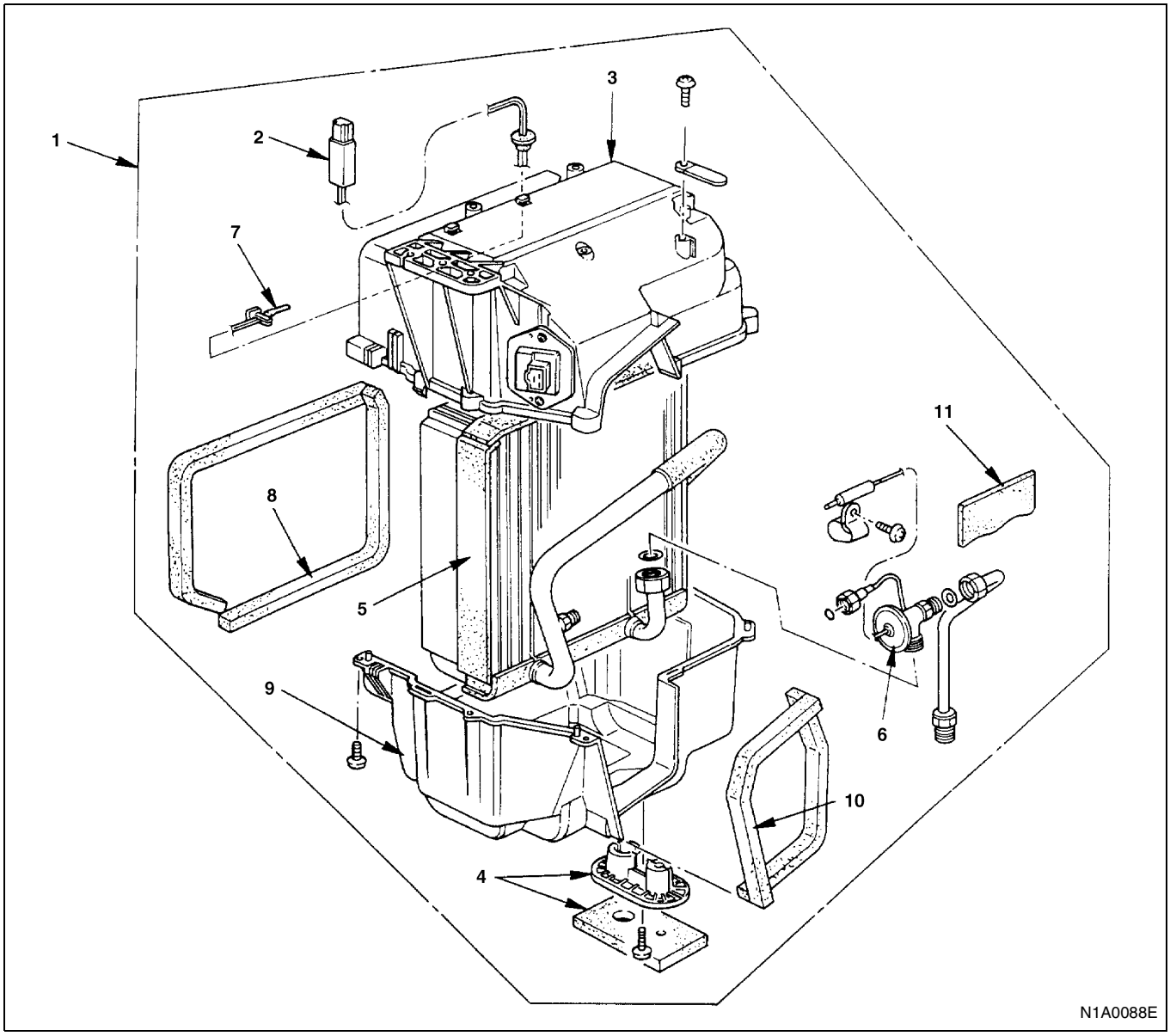
Tighten:
Outlet line to 28 N·m (2.8 kg·m/21 lb·ft)

3. Tighten the refrigerant inlet line to the specified torque.

Tighten:
Inlet line to 15 N·m (1.5 kg·m/11 lb·ft)

4. O-rings cannot be reused. Always replace with new ones.
5. Be sure to apply new specified compressor oil to the O-rings when connecting lines.

Evaporator Core / Expansion Valve (LHD Model)



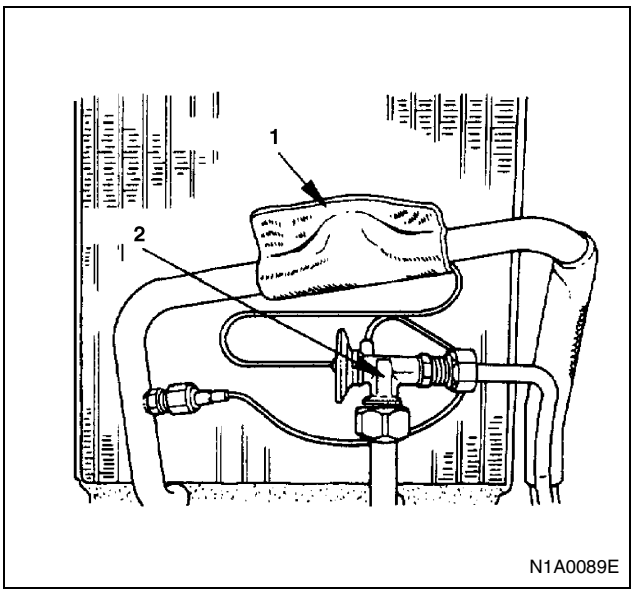
Legend

1. Evaporator assembly
2. Electronic thermostat
3. Upper case
4. Insulator and under cover
5. Evaporator core
6. Expansion valve
7. Thermo sensor
8. Lining
9. Lower case
10. Lining
11. Insulator

Removal

Preparation:
Disconnect the battery ground cable.
Discharge and recover refrigerant.

1. Evaporator Assembly
   Refer to "EVAPORATOR ASSEMBLY" removal procedure in this section.
2. Electronic Thermostat
   - Remove the sensor fixing clip.
   - Pull out the grommet from the upper case to remove the thermostat.
3. Upper Case
   - Separate the upper and lower case.
   - Slit the case parting face with a knife since the lining is separated.
4. Insulator and Under Cover
5. Evaporator Core
   Pull up the core from the lower case.
6. Expansion Valve
   - Tear off the insulator (1) carefully.
   - Remove the sensor fixing clip.
   - Use a back up wrench when disconnecting all refrigerant pipes, and remove the expansion valve (2).

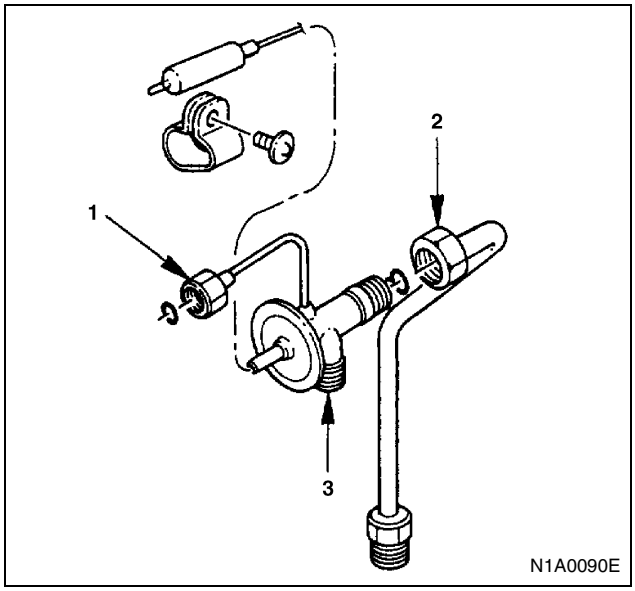


Installation

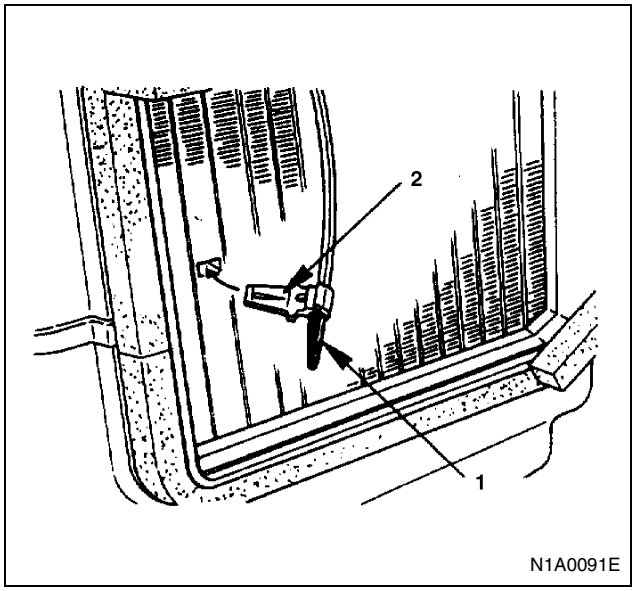
To install, follow the removal steps in the reverse order, noting the following points:

1. O-rings cannot be reused. Always replace new ones.
2. Be sure to apply new specified compressor oil to the O-rings when connecting lines.
3. Be sure to install the expansion valve sensor and the insulator on the place where it was before.
4. To install a new evaporator core, add 50cc (1.4 Imp. fl oz) of new specified compressor oil to a new core and install the thermostat sensor to the evaporator core specified position with the clip where it was before.
5. Tighten the refrigerant lines to the specified torque.

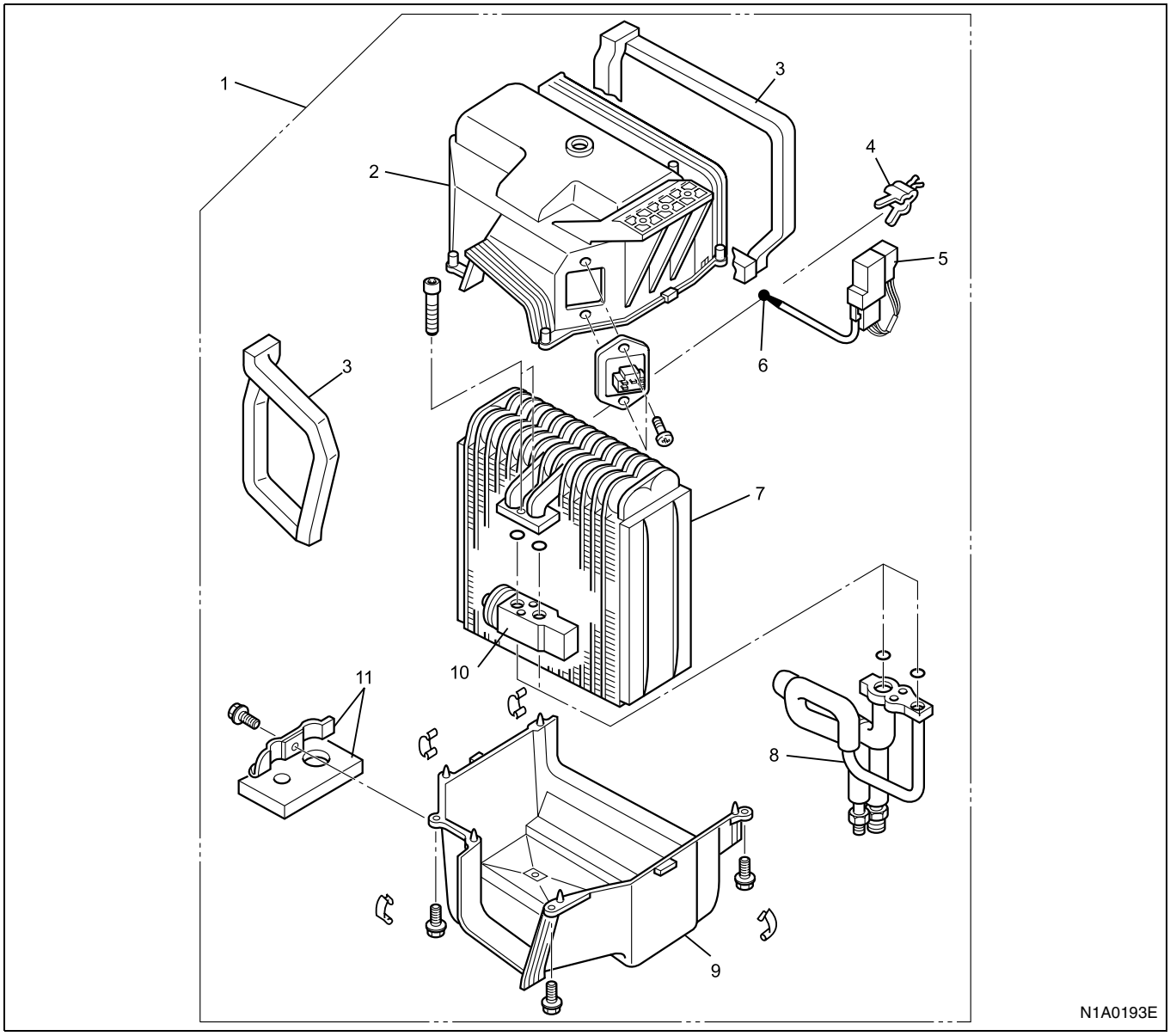
Tighten:
- Refrigerant line 1 to 10 N·m (1.0 kg·m/7 lb·ft)
- Refrigerant line 2 to 15 N·m (1.5 kg·m/11 lb·ft)
- Refrigerant line 3 to 20 N·m (2.0 kg·m/14 lb·ft)



6. Apply an adhesive to parting face of lining when assembling evaporator assembly.
7. The thermostat sensor (1) is installed on the core with the clip (2) and it must not interfere with the core.



Evaporator Core / Expansion Valve (RHD Model)



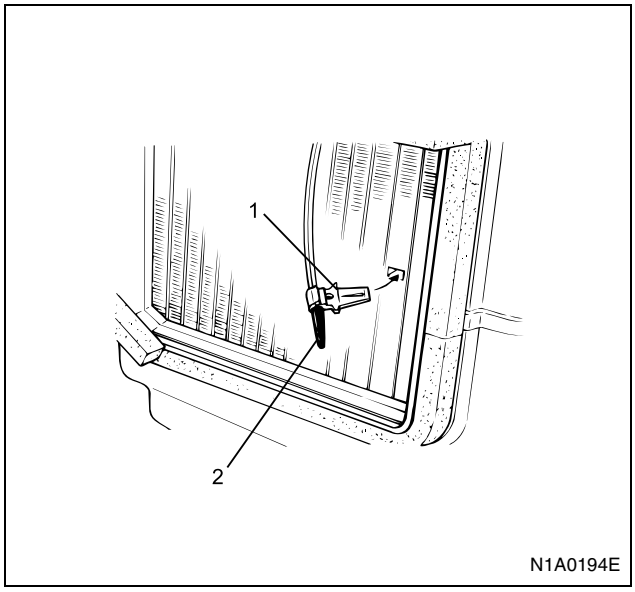
Legend

1. Evaporator assembly
2. Upper case
3. Lining
4. Clip
5. Amplifier & Thermistor
6. Thermo sensor
7. Evaporator core
8. Pipe assembly
9. Lower case
10. Expansion valve
11. Insulator and cover

Removal

Preparation:
Disconnect the battery ground cable.
Discharge and recover refrigerant.

1. Evaporator Assembly
   Refer to “EVAPORATOR ASSEMBLY” removal procedure in this section.
2. Amplifier & Thermistor
   - Remove the sensor fixing clip.
   - Pull out the grommet from the upper case to remove the thermostat.
3. Upper Case
   - Separate the upper and lower case.
   - Slit the case parting face with a knife since the lining is separated.
4. Insulator and Cover
5. Evaporator Core
   Pull up the core from the lower case.
6. Expansion Valve
   Take off two installation bolts and subsequently remove pipe assembly and expansion valve sequentially.



Installation

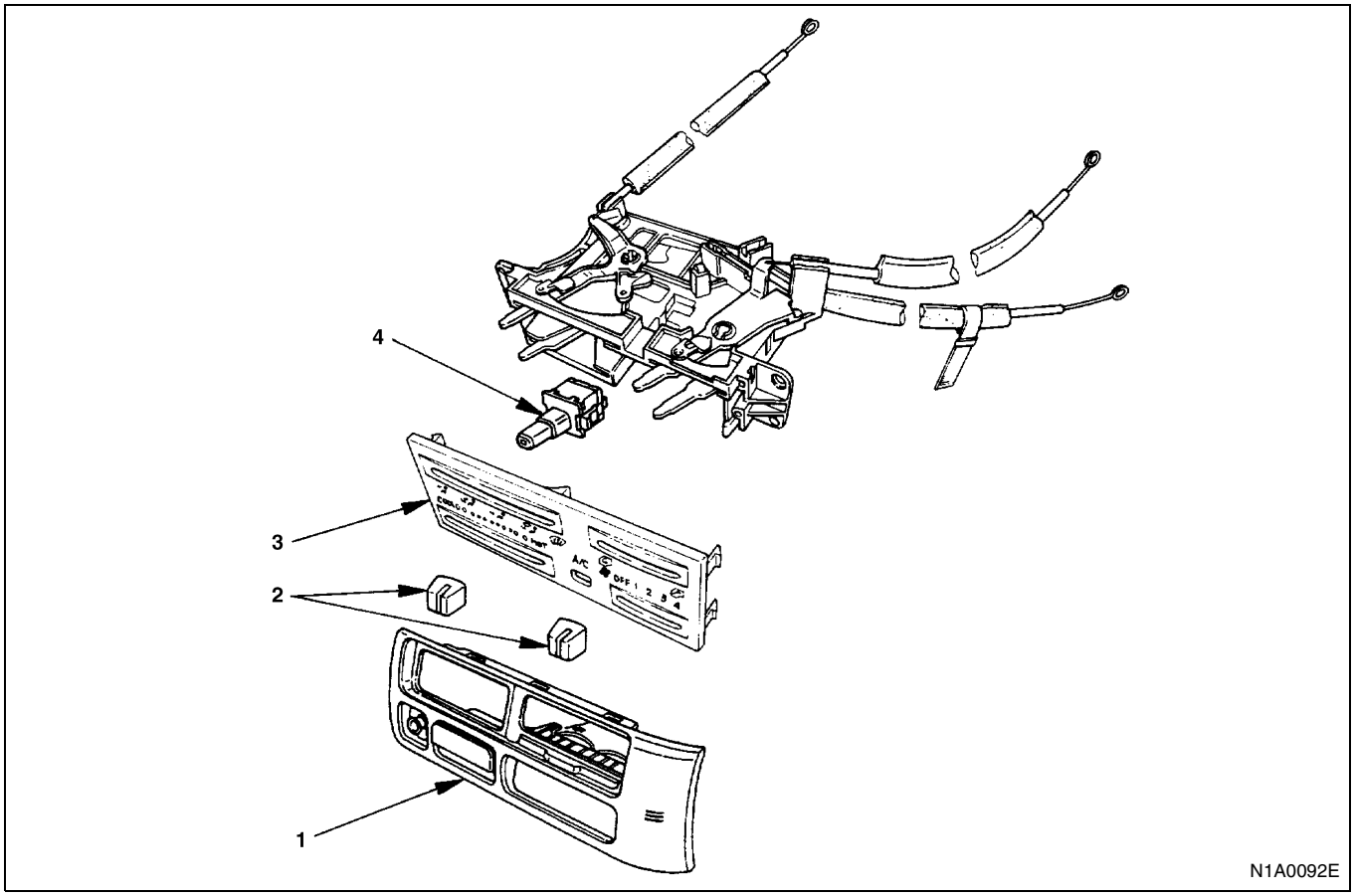
To install, follow the removal steps in the reverse order, noting the following points:

1. Tighten the expansion valve to the specified torque.

Tighten:
Installation bolts to 5 N·m (0.5 kg·m/3.7 lb·ft)

2. O-rings cannot be reused. Always replace new ones.
3. Be sure to apply new specified compressor oil to the O-rings when connecting lines.
4. To install a new evaporator core, add 50cc (1.4 Imp. fl oz) of new specified compressor oil to a new core.
5. Apply an adhesive to parting face of lining when assembling evaporator assembly.
6. Install the amplifier & thermistor sensor (2) surely to the evaporator core specified position with the clip (1) where it was before.

A/C Switch



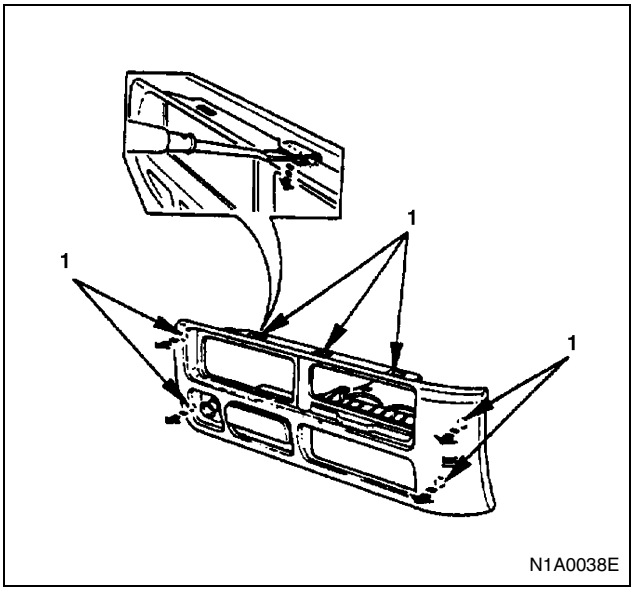
Legend

1. Center cluster
2. Knob
3. Control panel bezel
4. A/C switch

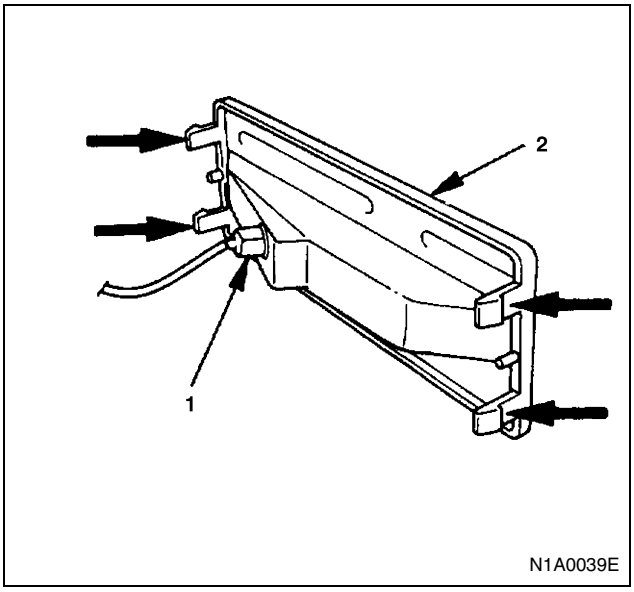
Removal

Preparation:
Disconnect the battery ground cable.

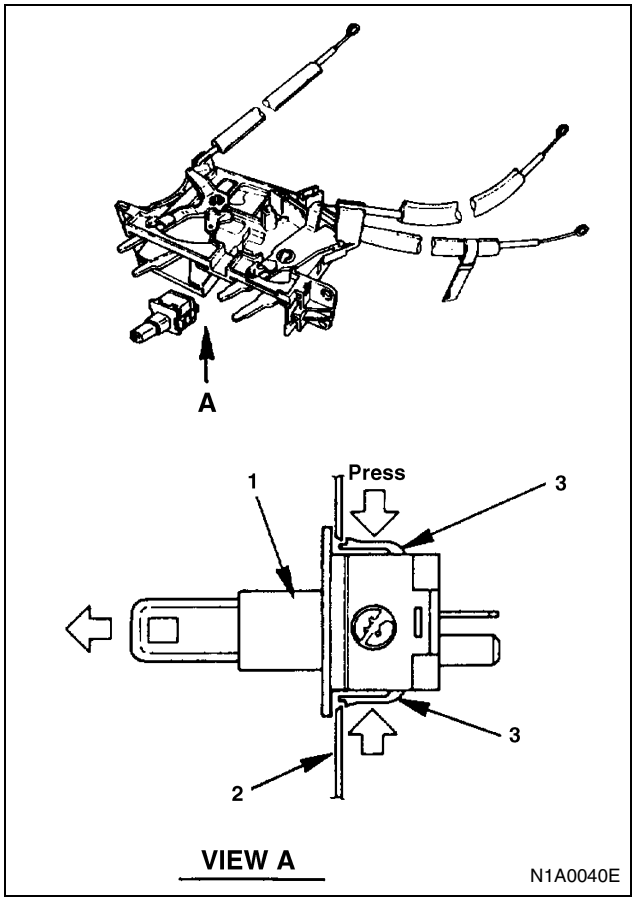
1. Center Cluster
   - While pulling the cluster with care, remove the upper and backside clips (1) of the cluster.
   - Disconnect the cigar lighter and illumination connectors.



2. Knob
3. Control Panel Bezel
   Push the four catches at both sides of the bezel to the inside, and remove the illumination bulb (1) from the bezel (2).



4. A/C Switch
   Push the catches at both sides of the A/C switch to the inside, and remove the switch by pulling it out.



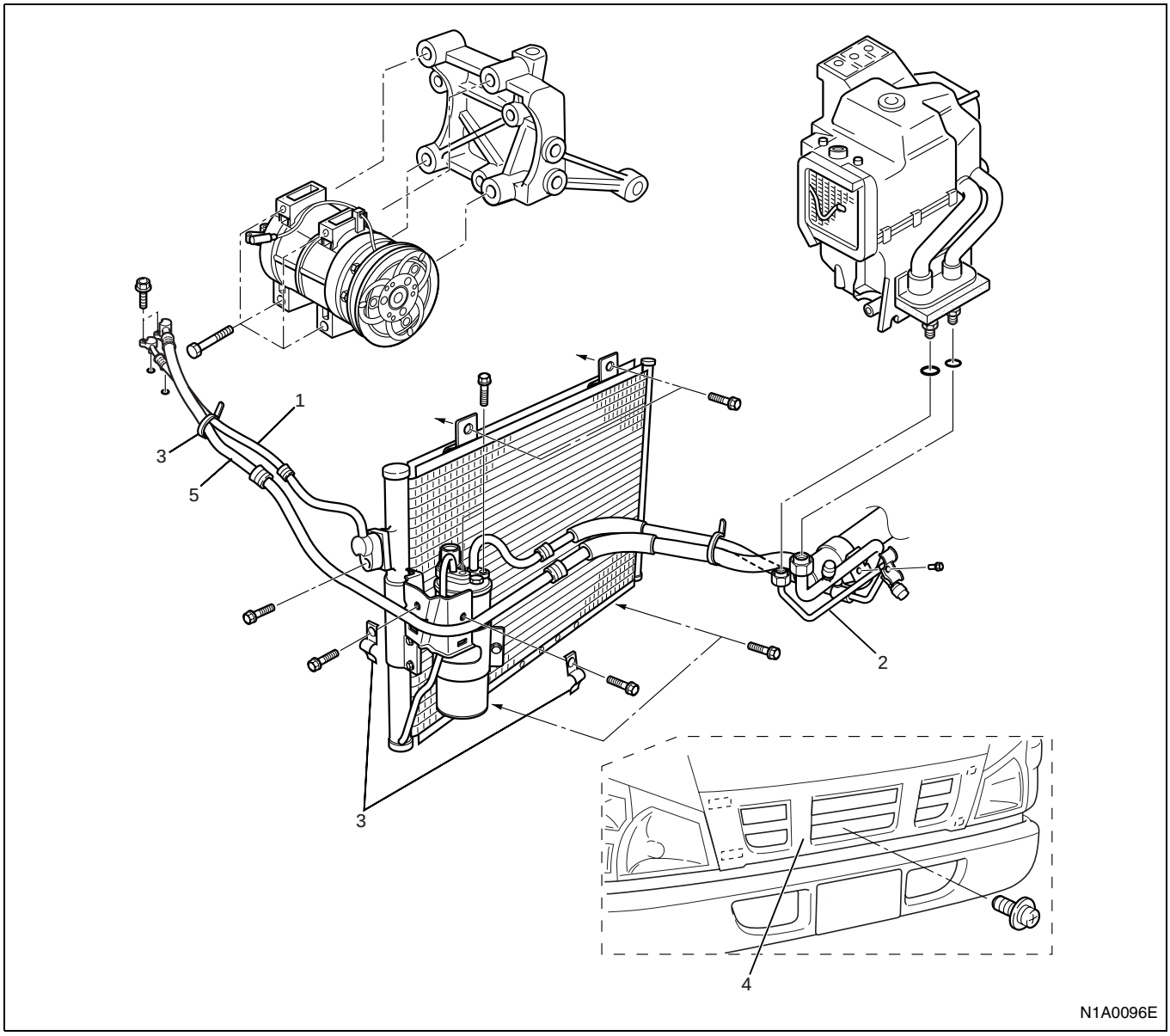
Legend

1. A/C switch
2. Control lever
3. Catch

Installation

To install, follow the removal steps in the reverse order.

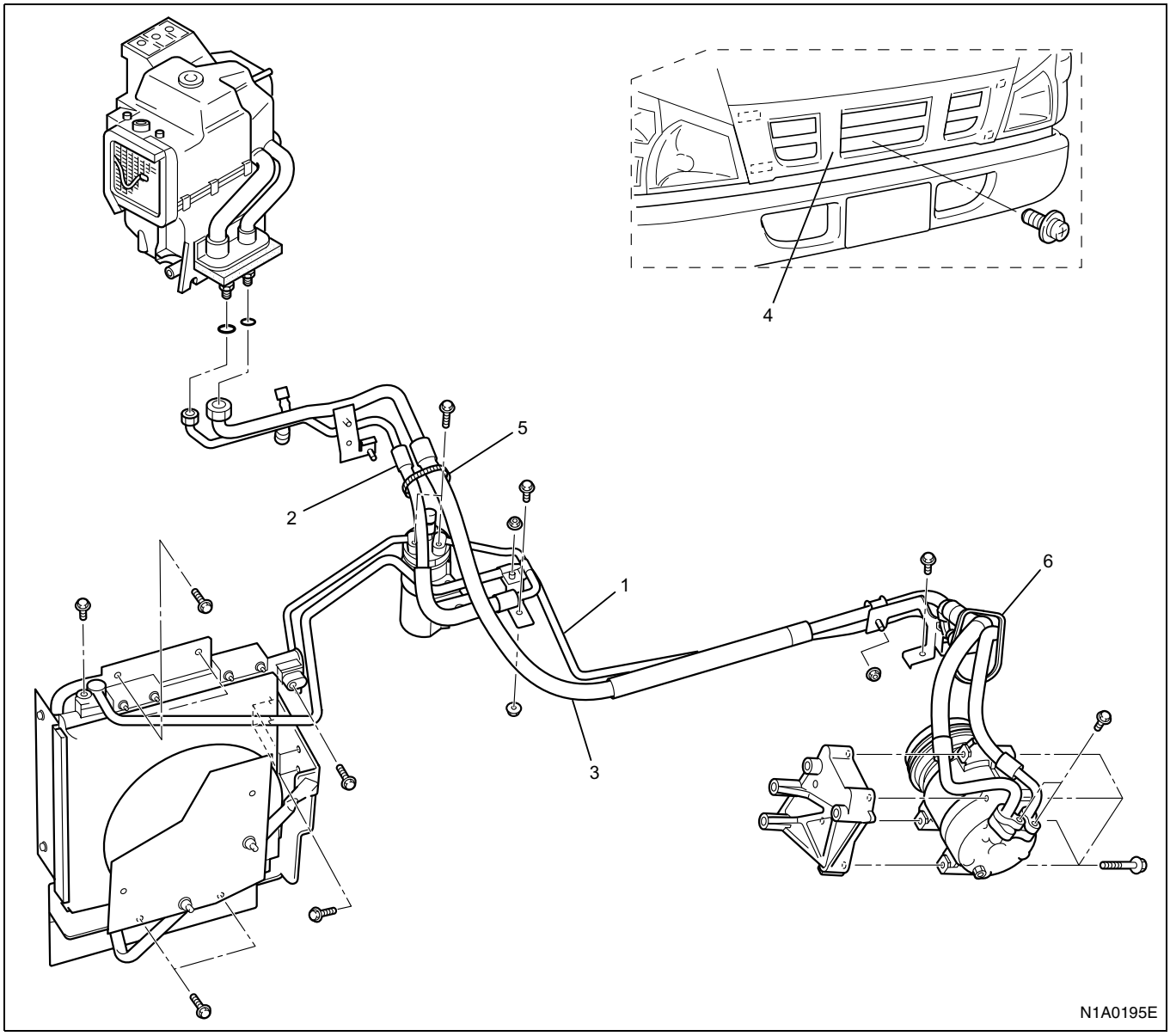
Refrigerant Line (Except 4HK1-TC Engine Model For Australia)



Legend

1. Refrigerant line (Compressor — Condenser)
2. Refrigerant line (Receiver / Drier — Evaporator)
3. Clamp / Clip
4. Front grille
5. Refrigerant line (Compressor — Evaporator)

Refrigerant Line (4HK1-TC Engine Model For Australia)



Legend

1. Refrigerant line (Compressor — Condenser)
2. Refrigerant line (Receiver / Drier — Evaporator)
3. Refrigerant line (Compressor — Evaporator)
4. Front grille
5. Band clip
6. Band clip

Removal

Preparation:
Disconnect the battery ground cable.
Discharge and recover refrigerant.

1. Front grille
2. Clamp / Clip (Except 4HK1-TC Engine Model For Australia)
3. Band clip (4HK1-TC Engine Model For Australia)
4. Refrigerant line (Compressor — Condenser)
5. Refrigerant line (Compressor — Evaporator)
6. Refrigerant line (Receiver / Drier — Evaporator)

- Use a back-up wrench when disconnecting and re-connecting the refrigerant lines.
- When removing the refrigerant line connecting part, the connecting part should immediately be plugged or capped to prevent foreign matter from being mixed into the line.

Installation

To install, follow the removal steps in the reverse order, noting the following points:

1. O-rings cannot be reused. Always replace new ones.
2. Be sure to apply new specified compressor oil to the O-rings when connecting refrigerant lines.
3. If installing a new refrigerant line, be sure to add 10 cc (0.3 lmp fl oz) of new specified compressor oil to a new one.
4. Tighten the refrigerant line to the specified torque. (Refer to “SERVICE INFORMATION” for FIXING TORQUE in section 00.)

HEATING AND AIR CONDITIONING

SECTION 1D1

COMPRESSOR OVERHAUL EXCEPT TAIWAN

Caution:
When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used.

Fasteners that are not reused, and those requiring thread locking compound, will be called out. The correct torque values must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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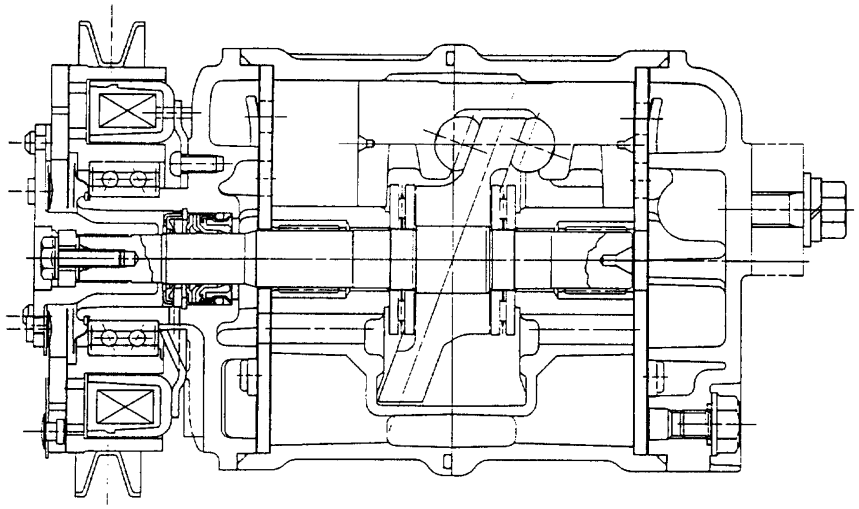
GENERAL DESCRIPTION



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When servicing the compressor, keep dirt or foreign material from getting on or into the compressor parts and system. Clean tools and a clean work area are important for proper service. The compressor connections and the outside of the compressor should be cleaned before any "On-Vehicle" repair, or before removal of the compressor. The parts must be kept clean at all times and any parts to be reassembled should be cleaned with Trichloroethane, naphtha, kerosene, or equivalent solvent, and dried with dry air. Use only lint free cloths to wipe parts.
The operations described below are based on bench overhaul with compressor removed from the car, except as noted. They have been prepared in order of accessibility of the components. When the compressor is removed from the car for servicing, the oil remaining in the compressor should be discarded and new refrigerant oil added to the compressor.
Magnetic clutch assembly repair procedures require that the system be discharged of refrigerant. (Refer to Section 1B for "REFRIGERANT RECOVERY".)
Compressor malfunction will appear in one of four ways: noise, seizure, leakage or low discharge pressure. Resonant compressor noises are not cause for alarm; however, irregular noise or rattles may indicate broken parts or excessive clearances due to wear. To check seizure, de-energize the magnetic clutch and check to see if the drive plate can be rotated. If rotation is impossible, the compressor is seized. Low discharge pressure may be due to a faulty internal seal of the compressor, or a restriction in the compressor. Low discharge pressure may also be due to an insufficient refrigerant charge or a restriction elsewhere in the system. These possibilities should be checked prior to servicing the compressor. If the compressor is inoperative, but is not seized, check to see if current is being supplied to the magnetic clutch coil terminals.
This vehicle is provided with a swash plate type compressor.
Swash plate compressors have a swash (slanted) plate mounted on the shaft. When the shaft turns, the rotation of the swash plate is converted to reciprocating piston motion which sucks in and compresses the refrigerant gas.
Shaft seal (Lip type) is installed between the valve plate and shaft a cylinder head to prevent refrigerant gas leaks. A specified amount of compressor oil is contained in the oil pan.
This oil is supplied to the cylinders, bearings, etc., by an oil pump which is connected to the swash plate shaft.
With some compressors the differential between the intake pressure and discharge pressure generated while the compressor is operating is used for lubrication instead of an oil pump.
Three pistons are arranged at 120 degree intervals around the center of the swash plate shaft. These pistons are connected to the ends of the swash plate through balls.
The rotation of the swash plate causes reciprocating movement of the piston inside the cylinders, with each piston operating as two cylinders. Because of that, the compressor operates as though it has 6 cylinders.
The specified amount of the compressors oil is 180 cc (5.0 Imp fl oz).
The oil used in the R-134a system compressor differs from that used in R-12 systems.
Also, compressor oil to be used varies according to the compressor model. Be sure to avoid mixing two or more different types of oil.
If the wrong oil is used, lubrication will be poor and the compressor will seize or malfunction.
(Refer to Section 1B "ON-VEHICLE SERVICE" for Precautions for R-134a Air Conditioning System in this manual.)

GENERAL INFORMATION

Compressor Oil

Oil specification

- The R-134a system requires a synthetic (PAG) compressor oil whereas the R-12 system requires a mineral compressor oil.
  The two oils must never be mixed.
- Compressor (PAG) oil varies according to compressor model. Be sure to use oil specified for the model of compressor.

Specified Compressor Oil
ZXL-100PG (ISUZU PART NO. 8-97101-338-0)

Handling of oil

- The oil should be free from moisture, dust, metal powder, etc.
- Do not mix with other oil.
- The water content in the oil increases when exposed to the air. After use, seal oil from air immediately.
  (R-134a PAG Compressor Oil absorbs moisture very easily than R-12.)
- The compressor oil must be stored in steel containers, not in plastic containers.

Compressor oil check

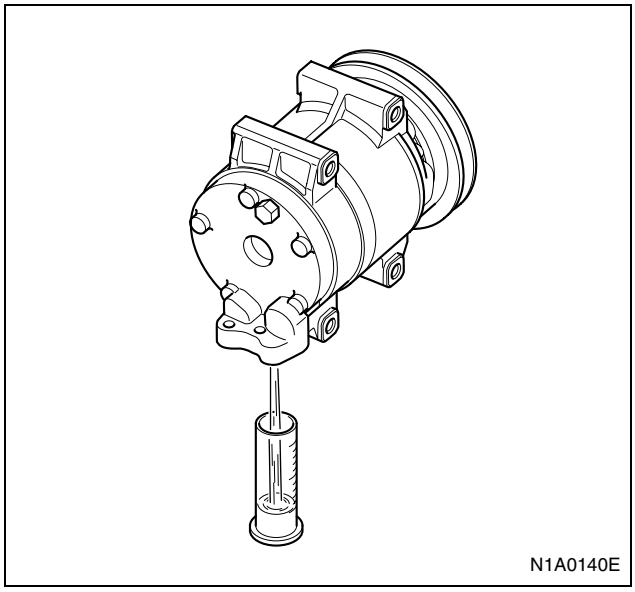
The oil used to lubricate the compressor is circulating with the refrigerant.
Whenever replacing any component of the system or a large amount of gas leakage occurs, add oil to maintain the original amount of oil.

Oil Capacity

Capacity total in system	180 cc (5.0 Imp fl oz)
Compressor (Service parts) charging amount	180 cc (5.0 Imp fl oz)

Checking and Adjusting for Used Compressor

1. Perform Oil return operation.
   (Refer to “Oil Return Operation” in this section.)
2. Discharge refrigerant and remove the compressor.
3. Drain the compressor oil and measure the extracted oil with a measuring cylinder.



4. If the amount of oil drained is much less than 90 cc (2.5 Imp fl oz), some refrigerant may have leaked out. Conduct leak tests on connections of each system, and if necessary, repair or replace faulty parts.
5. Check the compressor oil for contamination.
   (Refer to “Contamination of Compressor Oil” in this section.)
6. Adjust oil level following the procedure below.

Collected Amount	Charging Amount
more than 120 cc (3.4 Imp fl oz)	same as collected amount
less than 120 cc (3.4 Imp fl oz)	120 cc (3.4 Imp fl oz)

7. Install the compressor, then evacuate, charge and perform oil return operation.
8. Check system operation.

When it is impossible to perform oil return operation, the compressor oil should be checked in the following order:

1. Discharge refrigerant and remove the compressor.
2. Drain the compressor oil and measure the extracted oil with a measuring cylinder.
3. Check the oil for contamination.
4. If more than 120 cc (3.4 Imp fl oz) of oil is extracted from the compressor, supply same amount of oil to the compressor to be installed.
   If the amount of oil extracted is less than 120 cc (3.4 Imp fl oz), recheck the compressor oil in the following order:
5. Supply 120 cc (3.4 Imp fl oz) of oil to the compressor and install it on to the vehicle.
6. Perform oil return operation.

Checking and Adjusting for Compressor Replacement

180 cc (5.0 Imp fl oz) of oil is charged in compressor (service parts). So it is necessary to drain the proper amount of oil from the new compressor.

1. Perform oil return operation.
2. Discharge refrigerant and remove the compressor.
3. Drain the compressor oil and measure the extracted oil.
4. Check the compressor oil for contamination.
5. Adjust oil level as required.

Amount of oil drained from used compressor	Draining amount of oil from new compressor
less than 180 cc (3.4 Imp fl oz)	Same as drained amount
more than 180 cc (3.4 Imp fl oz)	180 cc (3.4 Imp fl oz)

6. Evacuate, charge and perform oil return operation.
7. Check system operation.

Contamination of compressor oil

Unlike engine oil, no cleaning agent is added to the compressor oil. Even if the compressor runs for a long period of time (approximately 1 season), the oil never becomes contaminated as long as there is nothing wrong with the compressor or its method of use.

Inspect the extracted oil for any of the following conditions:

- The capacity of the oil has increased.
- The oil has changed color to red.
- Foreign substances, metal powder, etc., are present in the oil.

If any of these conditions exists, compressor oil is contaminated. Whenever contaminated compressor oil is discovered, the receiver/drier must be replaced.

Oil return operation

There is close affinity between the oil and the refrigerant. During normal operation, part of the oil recirculates with the refrigerant in the system.

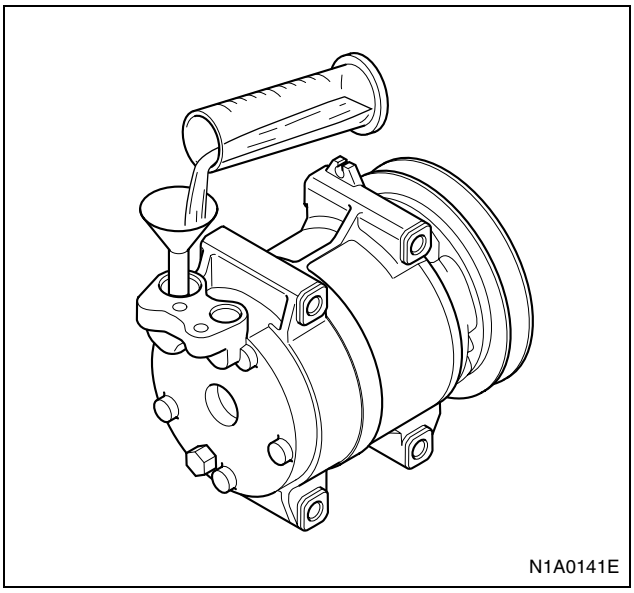
When checking the amount of oil in the system, or replacing any component of the system, the compressor must be run in advance for oil return operation. The procedure is as follows:

1. Open the all doors and engine hood.
2. Start the engine and A/C switch is “ON”. Set the fan control knob at its highest position.
3. Run the compressor for more than 20 minutes between 800 and 1,000 rpm in order to operate the system.
4. Stop the engine.

Replacement of component parts

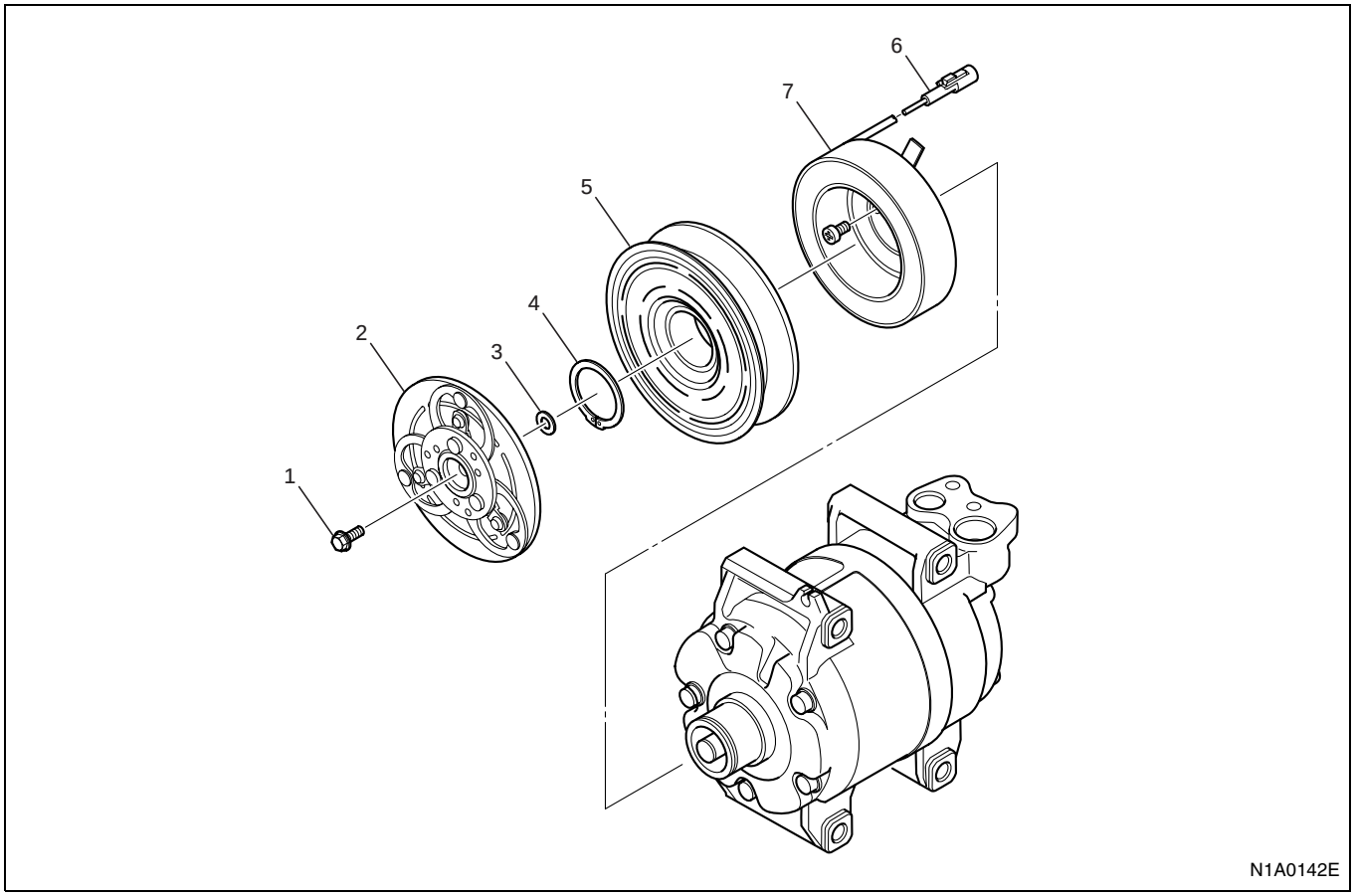
When replacing system component parts, supply the following amount of oil to the component parts to be installed.

Component parts to be installed	Amount of oil
Evaporator	50 cc (1.4 Imp fl oz)
Condenser	30 cc (0.8 Imp fl oz)
Receiver/drier	30 cc (0.8 Imp fl oz)
Refrigerant line (One piece)	10 cc (0.3 Imp fl oz)



SERVICE PROCEDURES

Compressor Overhaul

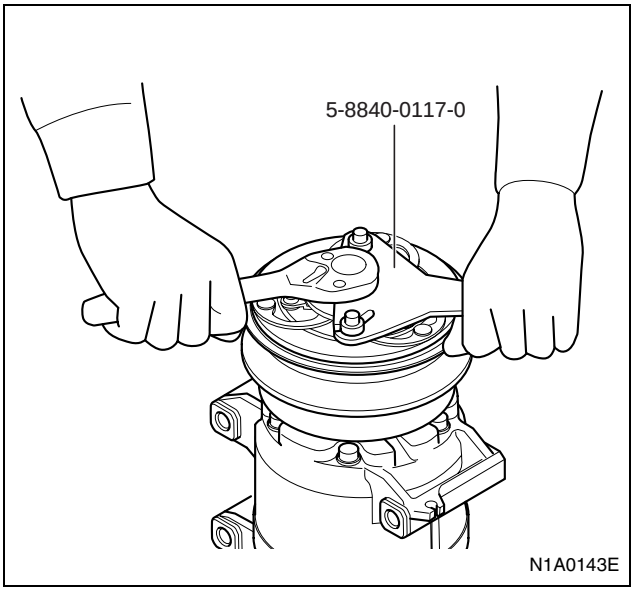


Legend

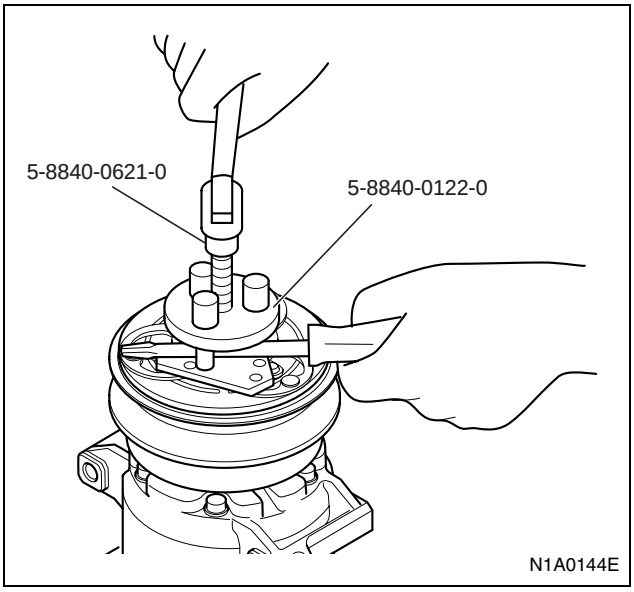
1. Drive plate bolt
2. Drive plate
3. Shim(s)
4. Snap ring
5. Pulley assembly
6. Lead wire connector
7. Field coil

Disassembly

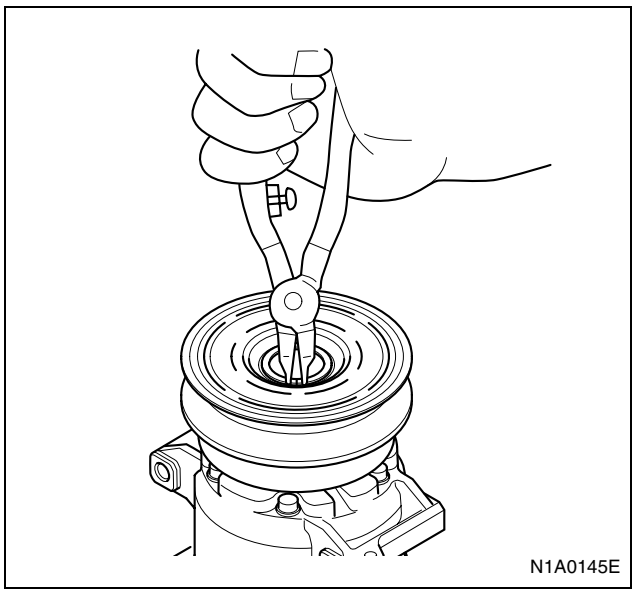
1. Drive Plate Bolt
   Using drive plate holder to prevent the drive plate from rotating, then remove the bolt.
   Drive Plate Holder: 5-8840-0117-0 (J-33939)



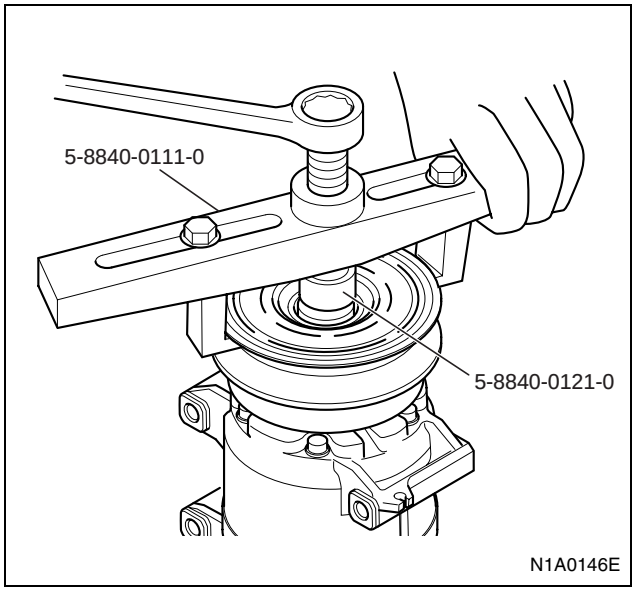
2. Drive Plate
   Using drive plate puller and forcing screw to remove the drive plate.
   Drive Plate Puller: 5-8840-0122-0 (J-33944-A)
   Forcing Screw: 5-8840-0621-0 (J-33944-4)
   If the frictional surface shows signs of damage due to excessive heat, the drive plate and pulley should be replaced.



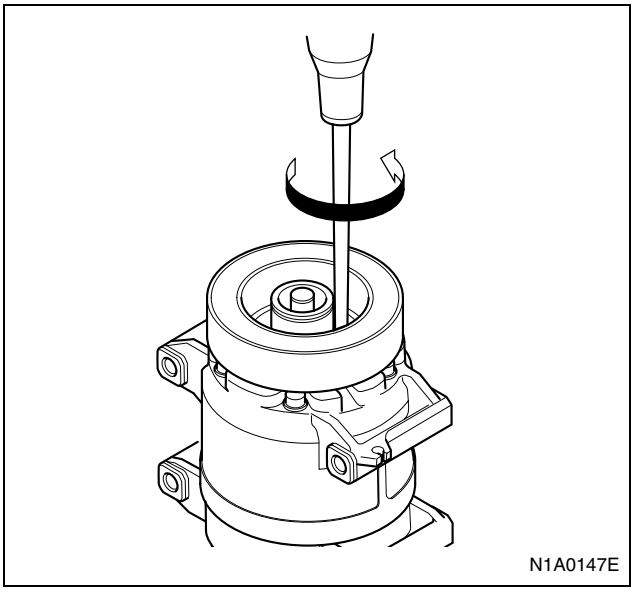
3. Shim(s)
4. Snap Ring
5. Cover (If so equipped)
   Using snap ring pliers to remove the snap ring.



6. Pulley Assembly
   Using pulley puller pilot and pulley puller to remove the pulley assembly.
   Pulley Puller Pilot: 5-8840-0121-0 (J-33943)
   Pulley Puller: 5-8840-0111-0 (J-8433)
   Check the appearance of the pulley assembly. If the frictional surface of the pulley shows signs of excessive grooving due to slippage, both the pulley and drive plate should be replaced. The frictional surfaces of the pulley assembly should be cleaned with a suitable solvent before reinstallation.



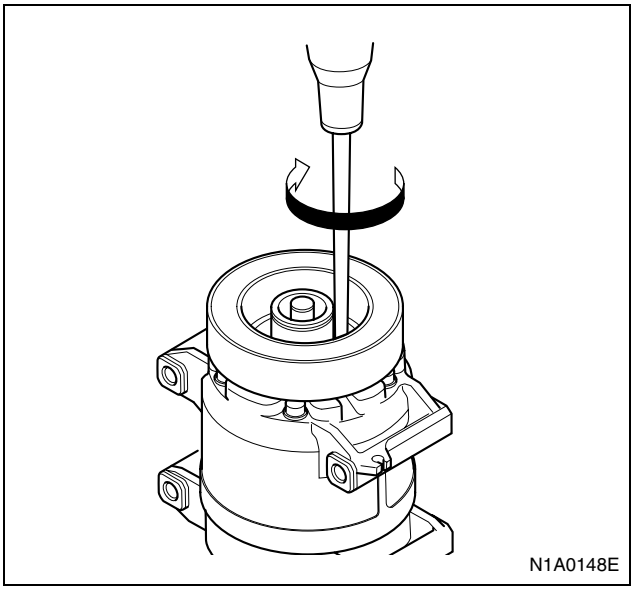
7. Lead Wire Connector
   Remove the lead wire from lead wire fixing bush.
8. Field Coil
   Loosen three screws and remove the field coil with lead wire.
   Check coil for loose connector or cracked insulation.



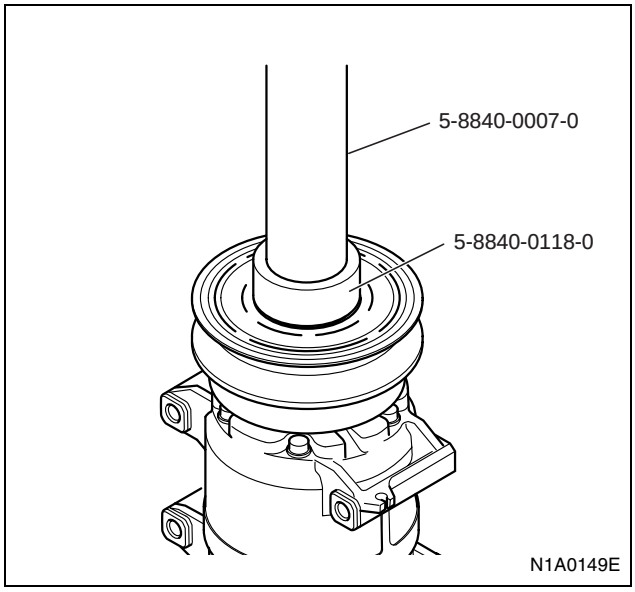
Reassembly

1. Field Coil
2. Lead Wire Connector
   Install the field coil to the compressor.
   Lead wire must be facing up.
   Tighten the field coil fixing screws to the specified torque.

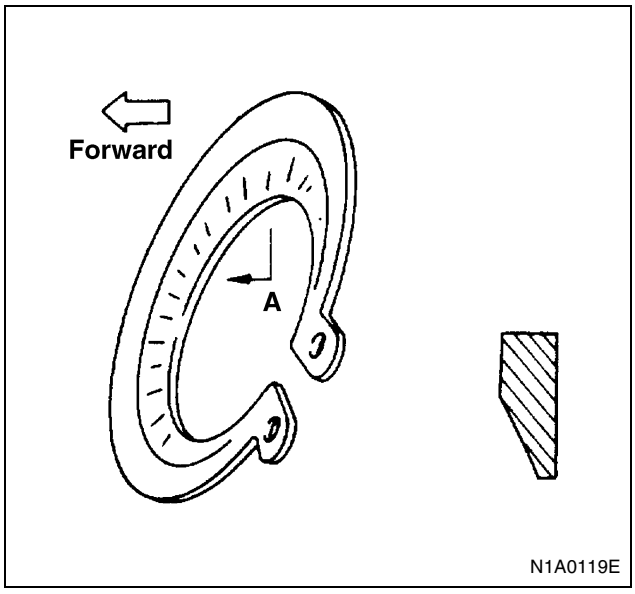
Tighten:
Field coil screw to 5 N·m (0.5 kg·m / 44 lb·ft)



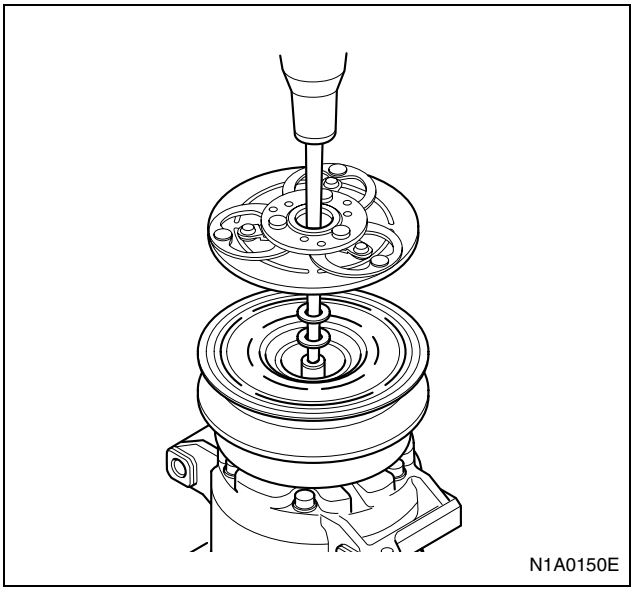
3. Pulley Assembly
   Using pulley installer and drive handle to install the pulley assembly.
   Pulley Installer: 5-8840-0118-0 (J-33940)
   Drive Handle: 5-8840-0007-0 (J-8092)



4. Cover (If so equipped)
5. Snap Ring
   Install the snap ring with the inside indented portion facing out.



6. Shim(s)
7. Drive Plate
   Install the drive plate to the compressor drive shaft together with the original shim(s).
   Press the drive plate by hand.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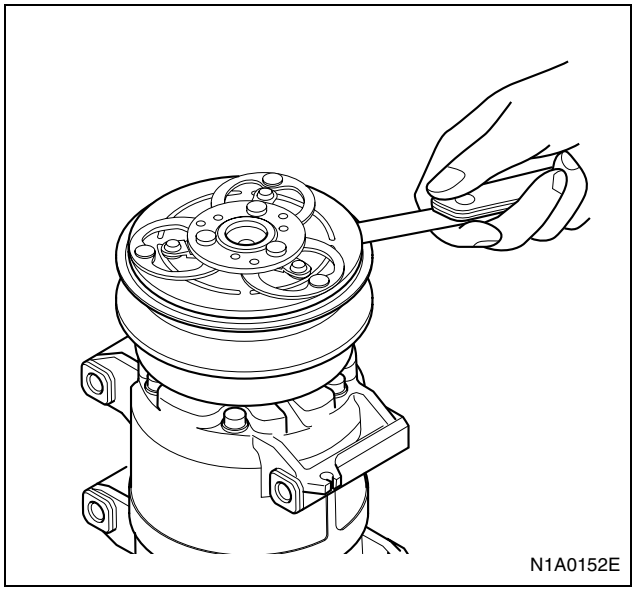
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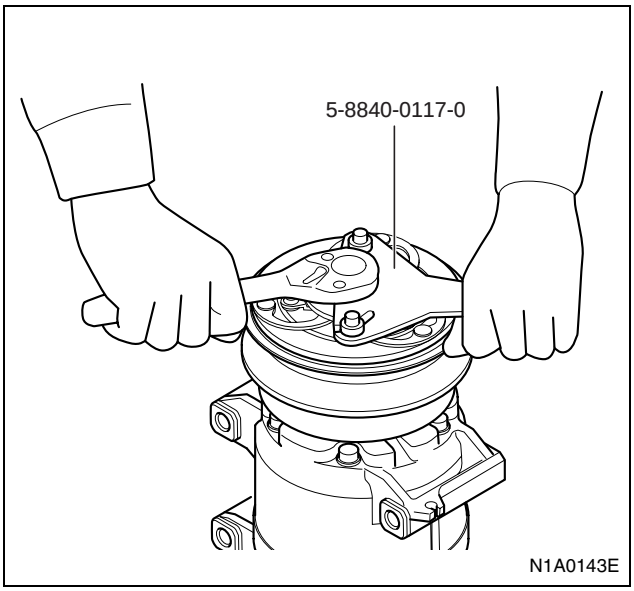
8. Drive Plate Bolt
   Using drive plate holder to prevent the drive plate from rotating.
   Drive Plate Holder: 5-8840-0117-0 (J-33939)
   Tighten the bolt to the specified torque.

Tighten:
Drive plate bolt to 15 N·m (0.5 kg·m / 11 lb·ft)



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After tightening the bolt, check to be sure the pulley rotates smoothly.

Check to be sure that the clutch clearance is between 0.3 — 0.6 mm (0.01 — 0.02 in).

If necessary, install adjusting shim(s).

Adjusting shims are available in the following thickness.

Thickness	0.1 mm (0.0039 in)
	0.3 mm (0.0118 in)
	0.5 mm (0.0197 in)

HEATING AND AIR CONDITIONING

SECTION 1D2

COMPRESSOR OVERHAUL FOR TAIWAN

Caution:
When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used.

Fasteners that are not reused, and those requiring thread locking compound, will be called out. The correct torque values must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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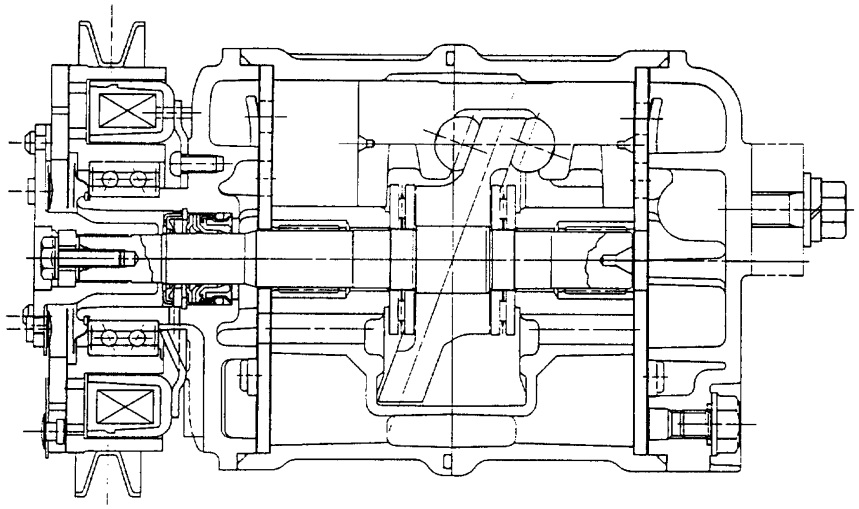
GENERAL DESCRIPTION



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The operations described below are based on bench overhaul with compressor removed from the car, except as noted. They have been prepared in order of accessibility of the components. When the compressor is removed from the car for servicing, the oil remaining in the compressor should be discarded and new refrigerant oil added to the compressor.
Magnetic clutch assembly repair procedures require that the system be discharged of refrigerant. (Refer to Section 1B for "REFRIGERANT RECOVERY".)
Compressor malfunction will appear in one of four ways: noise, seizure, leakage or low discharge pressure. Resonant compressor noises are not cause for alarm; however, irregular noise or rattles may indicate broken parts or excessive clearances due to wear. To check seizure, de-energize the magnetic clutch and check to see if the drive plate can be rotated. If rotation is impossible, the compressor is seized. Low discharge pressure may be due to a faulty internal seal of the compressor, or a restriction in the compressor. Low discharge pressure may also be due to an insufficient refrigerant charge or a restriction elsewhere in the system. These possibilities should be checked prior to servicing the compressor. If the compressor is inoperative, but is not seized, check to see if current is being supplied to the magnetic clutch coil terminals.
This vehicle is provided with a swash plate type compressor.
Swash plate compressors have a swash (slanted) plate mounted on the shaft. When the shaft turns, the rotation of the swash plate is converted to reciprocating piston motion which sucks in and compresses the refrigerant gas.
Shaft seal (Lip type) is installed between the valve plate and shaft a cylinder head to prevent refrigerant gas leaks. A specified amount of compressor oil is contained in the oil pan.
This oil is supplied to the cylinders, bearings, etc., by an oil pump which is connected to the swash plate shaft.
With some compressors the differential between the intake pressure and discharge pressure generated while the compressor is operating is used for lubrication instead of an oil pump.
Three pistons are arranged at 120 degree intervals around the center of the swash plate shaft. These pistons are connected to the ends of the swash plate through balls.
The rotation of the swash plate causes reciprocating movement of the piston inside the cylinders, with each piston operating as two cylinders. Because of that, the compressor operates as though it has 6 cylinders.
The specified amount of the compressors oil is 180 cc (5.0 Imp fl oz).
The oil used in the R-134a system compressor differs from that used in R-12 systems.
Also, compressor oil to be used varies according to the compressor model. Be sure to avoid mixing two or more different types of oil.
If the wrong oil is used, lubrication will be poor and the compressor will seize or malfunction.
(Refer to Section 1B "ON-VEHICLE SERVICE" for Precautions for R-134a Air Conditioning System in this manual.)

GENERAL INFORMATION

Compressor Oil

Oil specification

- The R-134a system requires a synthetic (PAG) compressor oil whereas the R-12 system requires a mineral compressor oil.
  The two oils must never be mixed.
- Compressor (PAG) oil varies according to compressor model. Be sure to use oil specified for the model of compressor.

Specified Compressor Oil
ZXL-100PG (ISUZU PART NO. 8-97101-338-0)

Handling of oil

- The oil should be free from moisture, dust, metal powder, etc.
- Do not mix with other oil.
- The water content in the oil increases when exposed to the air. After use, seal oil from air immediately.
  (R-134a PAG Compressor Oil absorbs moisture very easily than R-12.)
- The compressor oil must be stored in steel containers, not in plastic containers.

Compressor oil check

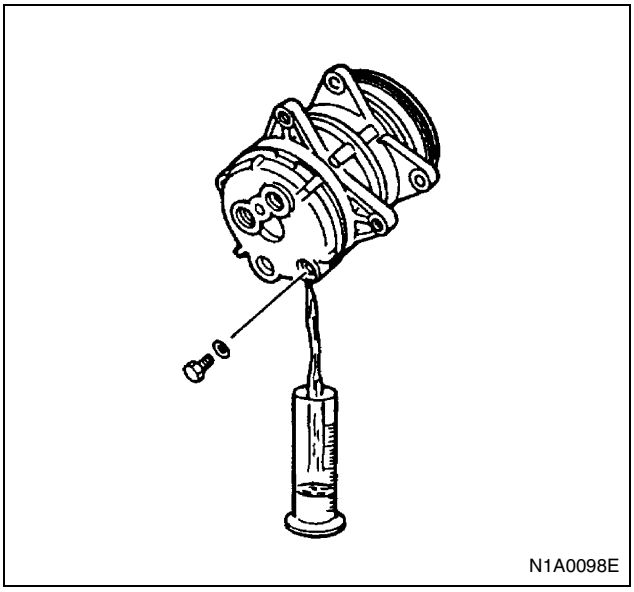
The oil used to lubricate the compressor is circulating with the refrigerant.
Whenever replacing any component of the system or a large amount of gas leakage occurs, add oil to maintain the original amount of oil.

Oil Capacity

Capacity total in system	180 cc (5.0 Imp fl oz)
Compressor (Service parts) charging amount	180 cc (5.0 Imp fl oz)

Checking and Adjusting for Used Compressor

1. Perform Oil return operation.
   (Refer to “Oil Return Operation” in this section.)
2. Discharge refrigerant and remove the compressor.
3. Drain the compressor oil and measure the extracted oil with a measuring cylinder.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4. If the amount of oil drained is much less than 90 cc (2.5 Imp fl oz), some refrigerant may have leaked out. Conduct leak tests on connections of each system, and if necessary, repair or replace faulty parts.
5. Check the compressor oil for contamination.
   (Refer to “Contamination of Compressor Oil” in this section.)
6. Adjust oil level following the procedure below.

Collected Amount	Charging Amount
more than 120 cc (3.4 Imp fl oz)	same as collected amount
less than 120 cc (3.4 Imp fl oz)	120 cc (3.4 Imp fl oz)

7. Install the compressor, then evacuate, charge and perform oil return operation.
8. Check system operation.

When it is impossible to perform oil return operation, the compressor oil should be checked in the following order:

1. Discharge refrigerant and remove the compressor.
2. Drain the compressor oil and measure the extracted oil with a measuring cylinder.
3. Check the oil for contamination.
4. If more than 120 cc (3.4 Imp fl oz) of oil is extracted from the compressor, supply same amount of oil to the compressor to be installed.
   If the amount of oil extracted is less than 120 cc (3.4 Imp fl oz), recheck the compressor oil in the following order:
5. Supply 120 cc (3.4 Imp fl oz) of oil to the compressor and install it on to the vehicle.
6. Perform oil return operation.

Checking and Adjusting for Compressor Replacement

180 cc (5.0 Imp fl oz) of oil is charged in compressor (service parts). So it is necessary to drain the proper amount of oil from the new compressor.

1. Perform oil return operation.
2. Discharge refrigerant and remove the compressor.
3. Drain the compressor oil and measure the extracted oil.
4. Check the compressor oil for contamination.
5. Adjust oil level as required.

Amount of oil drained from used compressor	Draining amount of oil from new compressor
less than 180 cc (3.4 Imp fl oz)	Same as drained amount
more than 180 cc (3.4 Imp fl oz)	180 cc (3.4 Imp fl oz)

6. Evacuate, charge and perform oil return operation.
7. Check system operation.

Contamination of compressor oil

Unlike engine oil, no cleaning agent is added to the compressor oil. Even if the compressor runs for a long period of time (approximately 1 season), the oil never becomes contaminated as long as there is nothing wrong with the compressor or its method of use.

Inspect the extracted oil for any of the following conditions:

- The capacity of the oil has increased.
- The oil has changed color to red.
- Foreign substances, metal powder, etc., are present in the oil.

If any of these conditions exists, compressor oil is contaminated. Whenever contaminated compressor oil is discovered, the receiver/drier must be replaced.

Oil return operation

There is close affinity between the oil and the refrigerant. During normal operation, part of the oil recirculates with the refrigerant in the system.

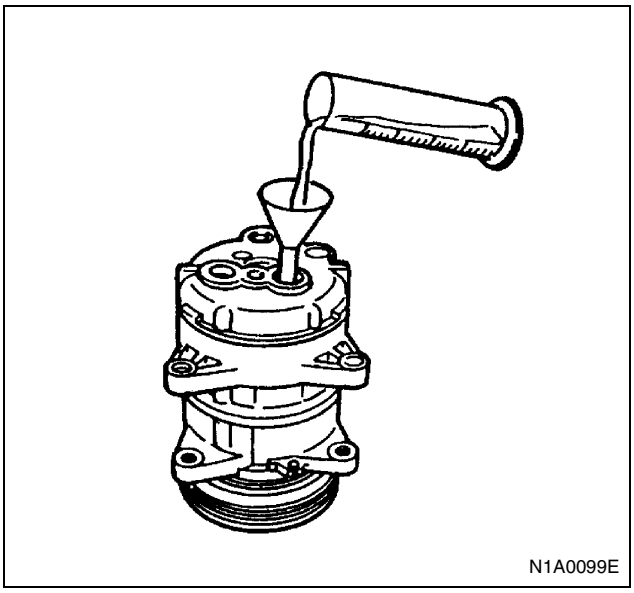
When checking the amount of oil in the system, or replacing any component of the system, the compressor must be run in advance for oil return operation. The procedure is as follows:

1. Open the all doors and engine hood.
2. Start the engine and A/C switch is “ON”. Set the fan control knob at its highest position.
3. Run the compressor for more than 20 minutes between 800 and 1,000 rpm in order to operate the system.
4. Stop the engine.

Replacement of component parts

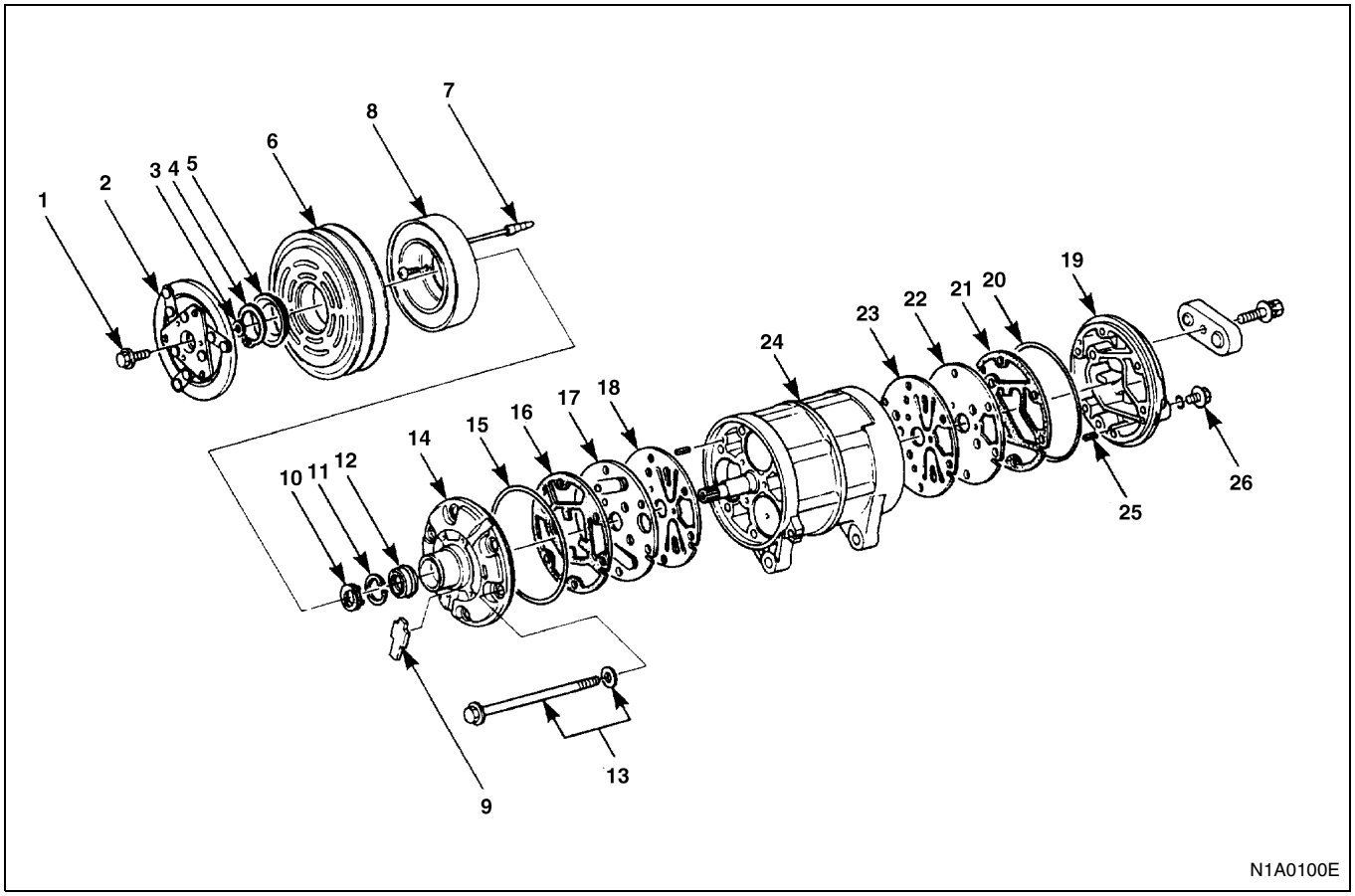
When replacing system component parts, supply the following amount of oil to the component parts to be installed.

Component parts to be installed	Amount of oil
Evaporator	50 cc (1.4 Imp fl oz)
Condenser	30 cc (0.8 Imp fl oz)
Receiver/drier	30 cc (0.8 Imp fl oz)
Refrigerant line (One piece)	10 cc (0.3 Imp fl oz)



SERVICE PROCEDURES

Compressor Overhaul

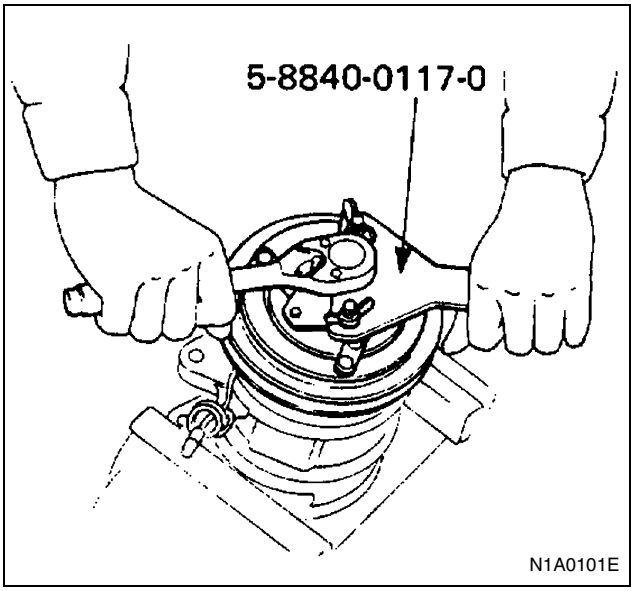


Legend

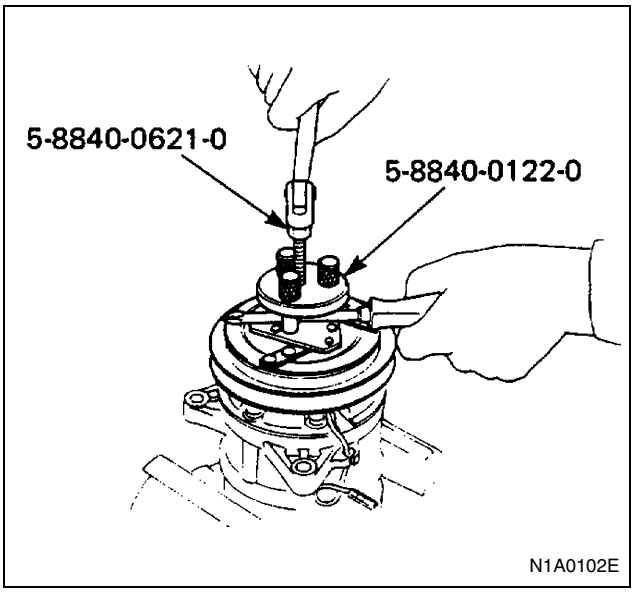
1. Drive plate bolt
2. Drive plate
3. Shim(s)
4. Snap ring
5. Cover (If so equipped)
6. Pulley assembly
7. Lead wire connector
8. Field coil
9. Felt (If so equipped)
10. Shaft seal cover (If so equipped)
11. Snap ring
12. Shaft seal assembly
13. Through bolt with gasket
14. Front cylinder head
15. O-ring
16. Gasket
17. Front valve plate
18. Front suction valve
19. Rear cylinder head
20. O-ring
21. Gasket
22. Rear valve plate
23. Rear suction valve
24. Cylinder and shaft assembly
25. Key
26. Oil drain plug

Disassembly

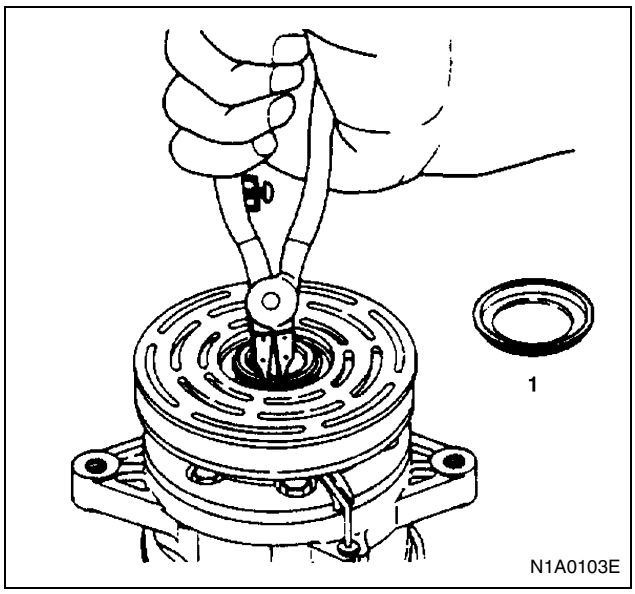
1. Drive Plate Bolt
   Using drive plate holder to prevent the drive plate from rotating, then remove the bolt.
   Drive Plate Holder: 5-8840-0117-0 (J-33939)



2. Drive Plate
   Using drive plate puller and forcing screw to remove the drive plate.
   Drive Plate Puller: 5-8840-0122-0 (J-33944-A)
   Forcing Screw: 5-8840-0621-0 (J-33944-4)
   If the frictional surface shows signs of damage due to excessive heat, the drive plate and pulley should be replaced.

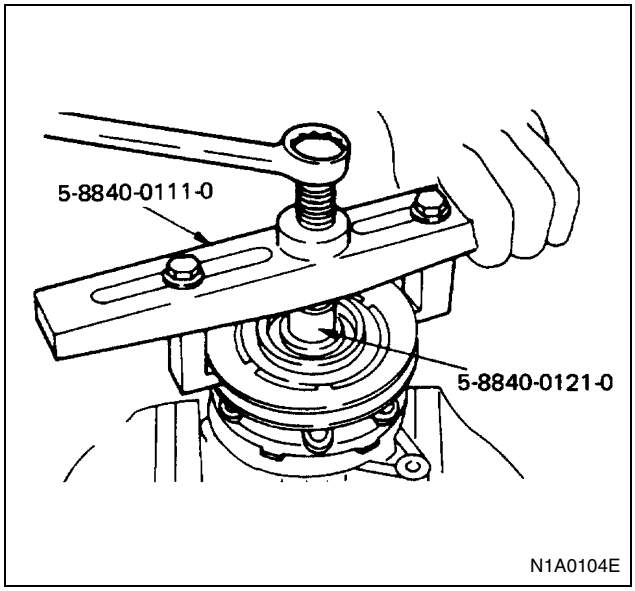


3. Shim(s)
4. Snap Ring
5. Cover (If so equipped)
   Using snap ring pliers to remove the snap ring.



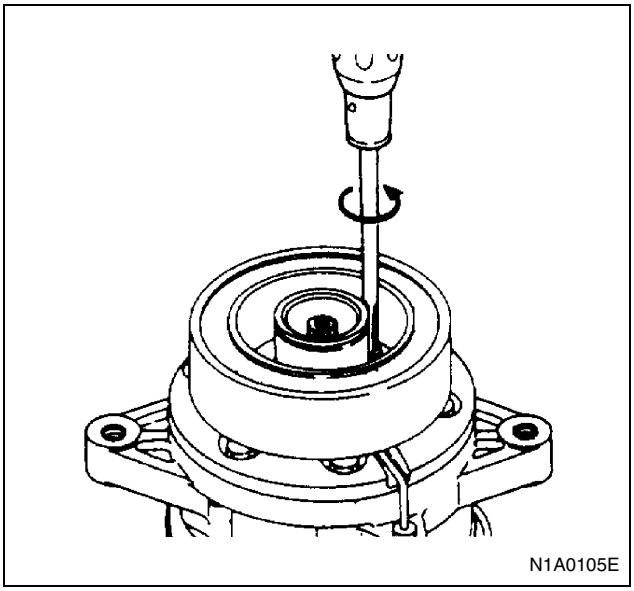
Legend
1. Cover

6. Pulley Assembly
   Using pulley puller pilot and pulley puller to remove the pulley assembly.
   Pulley Puller Pilot: 5-8840-0121-0 (J-33943)
   Pulley Puller: 5-8840-0111-0 (J-8433)
   Check the appearance of the pulley assembly. If the frictional surface of the pulley shows signs of excessive grooving due to slippage, both the pulley and drive plate should be replaced. The frictional surfaces of the pulley assembly should be cleaned with a suitable solvent before reinstallation.

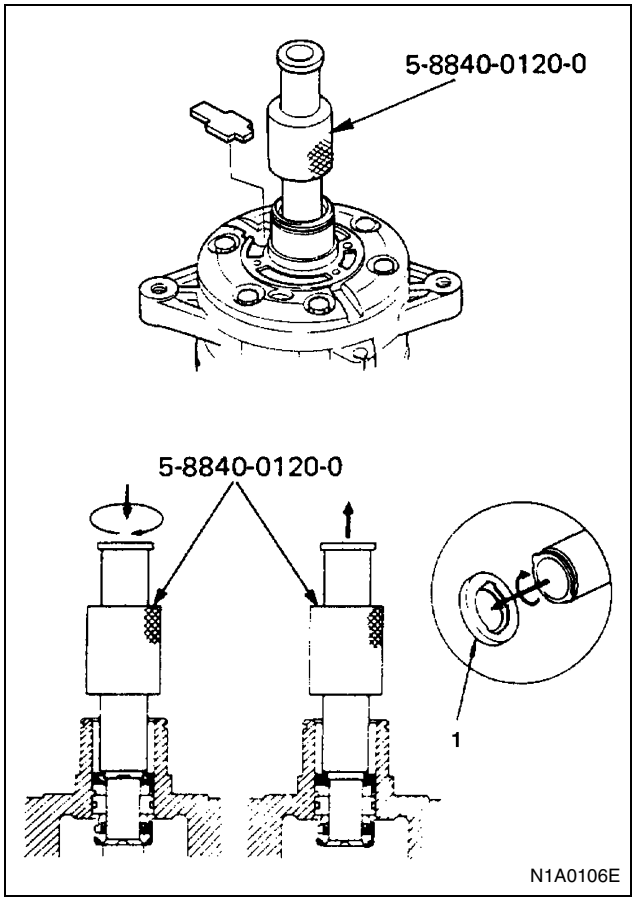


7. Lead Wire Connector
   Remove the lead wire from lead wire fixing bush.

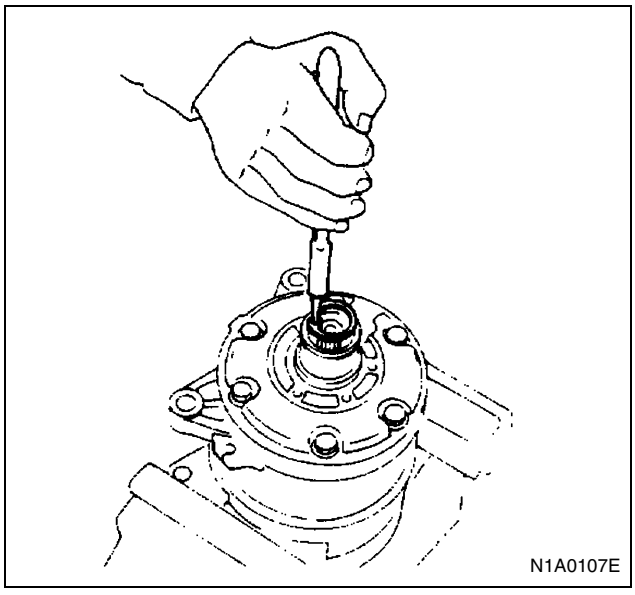
8. Field Coil
   Loosen three screws and remove the field coil with lead wire.
   Check coil for loose connector or cracked insulation.



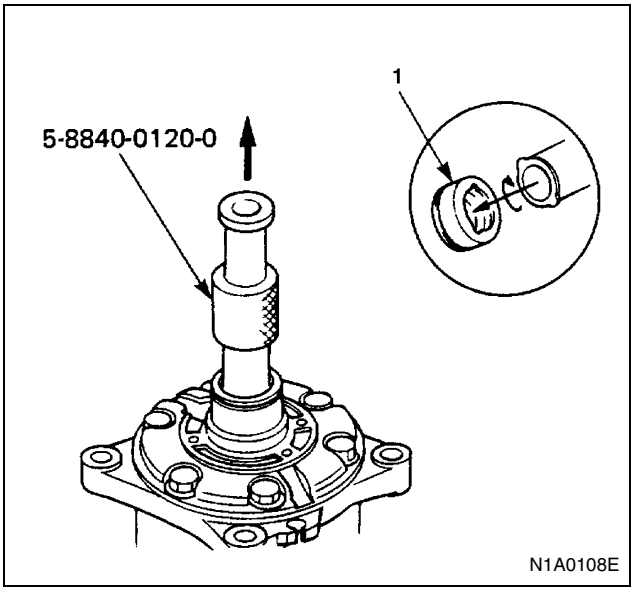
9. Felt (If so equipped)
10. Shaft Seal Cover (If so equipped)
    Using shaft seal remover to remove the shaft seal cover (1).
    Engage the remover hook with the shaft seal cover groove and slowly draw the shaft seal cover out.
    Shaft Seal Remover: 5-8840-0120-0 (J-33942)



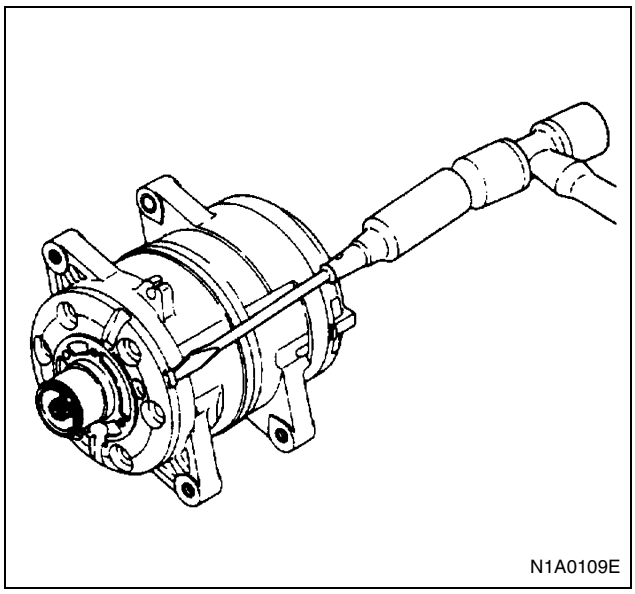
11. Snap Ring
    Using snap ring pliers to remove the snap ring.



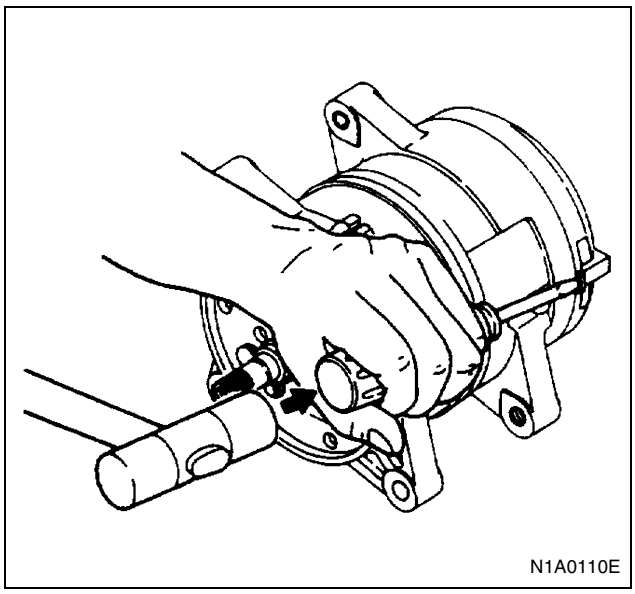
12. Shaft Seal Assembly
    Using shaft seal remover to remove the shaft seal assembly.
    Engage the remover hook with the shaft seal assembly groove and slowly draw the shaft seal assembly out.
    Shaft Seal Remover: 5-8840-0120-0 (J-33942)
    The shaft seal (1) is precision-machined and its critical parts are finished to extremely close tolerances. The assembly must be handled with great care, it slips face demanding particularly careful handling.
    The shaft seal can not be reused. Install a new shaft seal at reassembly.
    Take care not to scratch or otherwise damage the shaft seal face.
    Keep the shaft seal free from lint and dirt.



13. Through Bolt with Gasket
14. Front Cylinder Head
15. O-ring
    Alternately tap the projections on the circumference of the front cylinder head with a screwdriver and a plastic hammer to remove the front cylinder head.



16. Gasket
17. Front Valve Plate
18. Front Suction Valve
    Check the front valve plate for scratching and bending.
    Check the front valve plate and the front cylinder head for nicks and burrs on the sealing surface.
    Buff or replace the valve plate and cylinder head if nicks and burrs are present.
    Check that the front valve plate passage is free from obstructions.
    Check the front valve plate and the cylinder head for cracks.
    Replace the valve plate and cylinder head if cracks are present.
19. Rear Cylinder Head
20. O-ring
    Alternately tap the projections on the circumference of the rear cylinder head with a screwdriver and a plastic hammer to remove the rear cylinder head.



21. Gasket
22. Rear Valve Plate
23. Rear Suction Valve
24. Cylinder and shaft assembly
    Check the rear valve plate for scratching and bending.

    Check the rear valve plate and the rear cylinder head for nicks and burrs on the sealing surface.

    Buff or replace the valve plate and cylinder head if nicks and burrs are present.

    Check that the rear valve plate passage is free from obstructions.

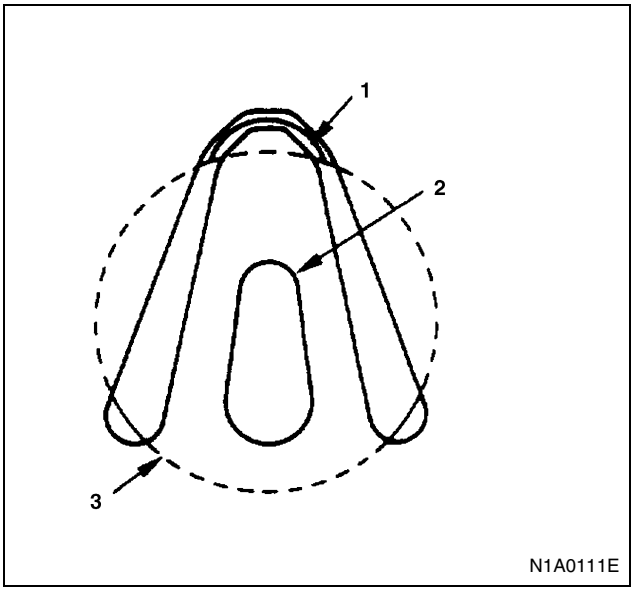
    Check the rear valve plate and the cylinder head for cracks.

    Replace the valve plate and cylinder head if cracks are present.

Reassembly

1. Cylinder and Shaft Assembly
   Clamp the cylinder shaft assembly in a vise. The rear side of the cylinder shaft assembly must be facing up.
2. Rear Suction Valve
   Apply a coat of new compressor oil to the new suction valve.

   Install the suction valve by aligning it with the spring pin and the cylinder valve relief grooves.



Legend

1. Escape groove
2. Suction valve
3. Piston

3. Rear Valve Plate
   Apply a coat of new compressor oil to the new valve plate.

   Install the valve plate to the suction valve by aligning it with the spring pin.

Notice:
Do not mix up the front and rear valve plates.

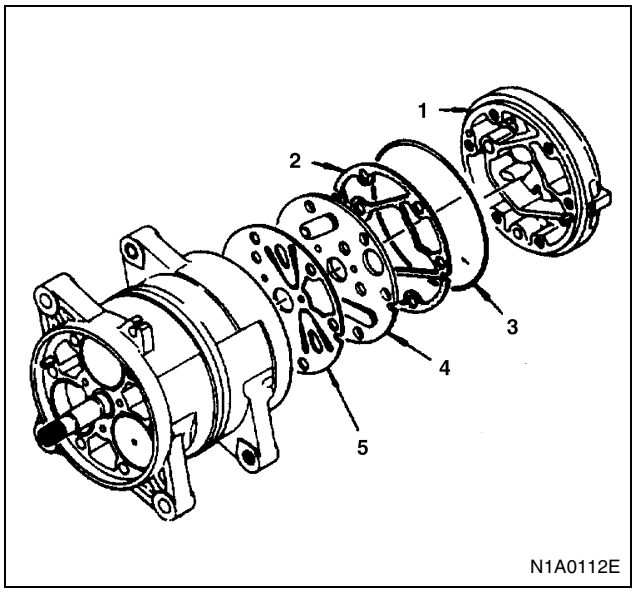
4. Gasket
   Apply a coat of new compressor oil to the new gasket.

   Install the gasket to the valve plate.
5. O-ring
6. Rear Cylinder Head
   Apply a coat of new compressor oil to the new O-ring.

   Install the O-ring to the rear cylinder head.

   Install the rear cylinder head.

   Tap the rear cylinder head into place with a plastic hammer.



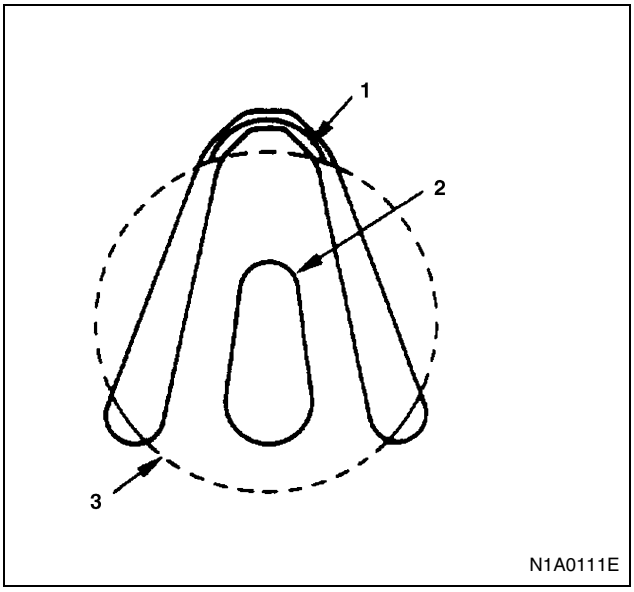
Legend

1. Rear cylinder head
2. Gasket
3. O-ring
4. Valve plate
5. Suction valve

7. Front Suction Valve
   Set the cylinder shaft assembly with the front side facing up.

   Apply a coat of new compressor oil to the new suction valve.

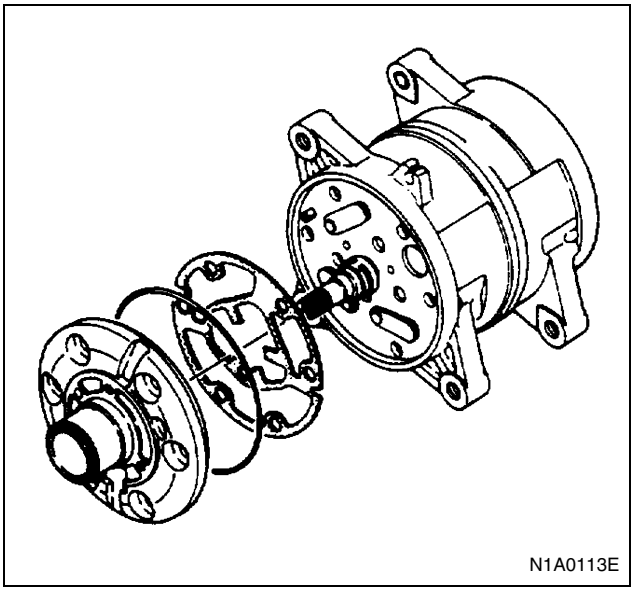
   Install the suction valve by aligning it with the spring pin and the cylinder valve relief grooves.



Legend
1. Escape groove
2. Suction valve
3. Piston

8. Front Valve Plate
   Apply a coat of new compressor oil to the new valve plate.
   Install the valve plate to the suction valve by aligning it with the spring pin.

Notice:
Do not mix up the front and rear valve plates.

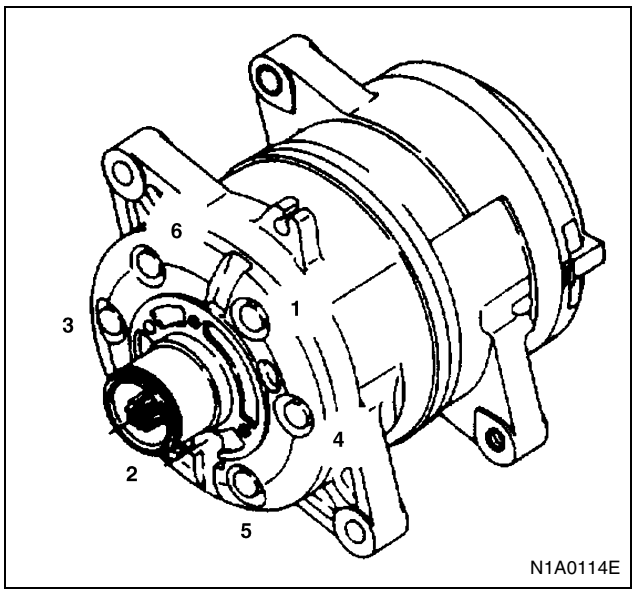


9. Gasket
   Apply new compressor oil to the new gasket.
   Install the gasket to the valve plate by aligning it with the spring pin.
10. O-ring
11. Front Cylinder Head
    Apply a coat of new compressor oil to the new O-ring.
    Install the O-ring to the front cylinder head.
    Install the front cylinder head.
    Tap the front cylinder head into place with a plastic hammer.

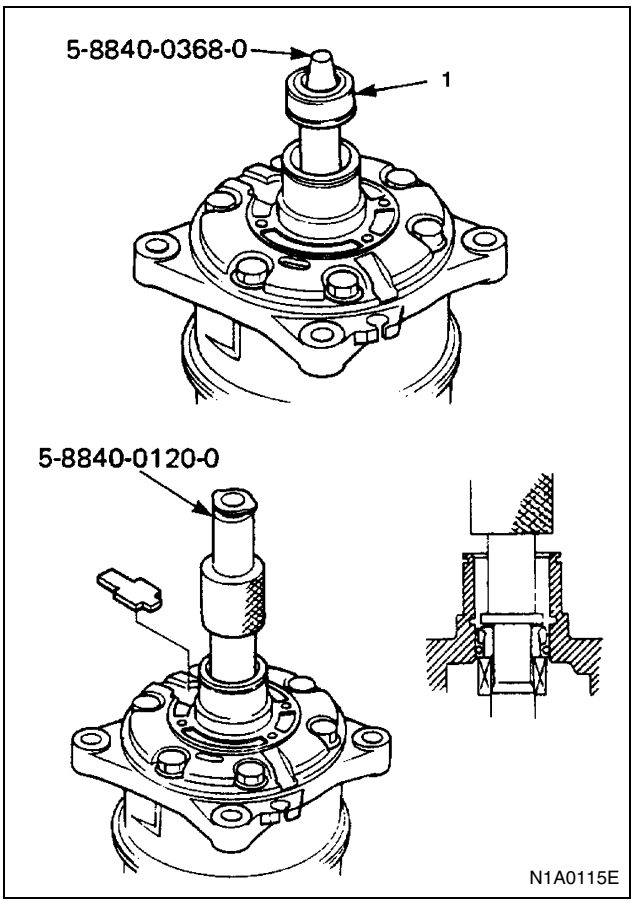
Notice:
When installing the cylinder head, be careful that the end of the drive shaft does not damage the shaft seal assembly surface in the cylinder head.

12. Through Bolt with Gasket
    Gaskets cannot reused. Always replace new ones.
    Tighten the bolts to the specified torque a little at a time in the sequence shown in the illustration.

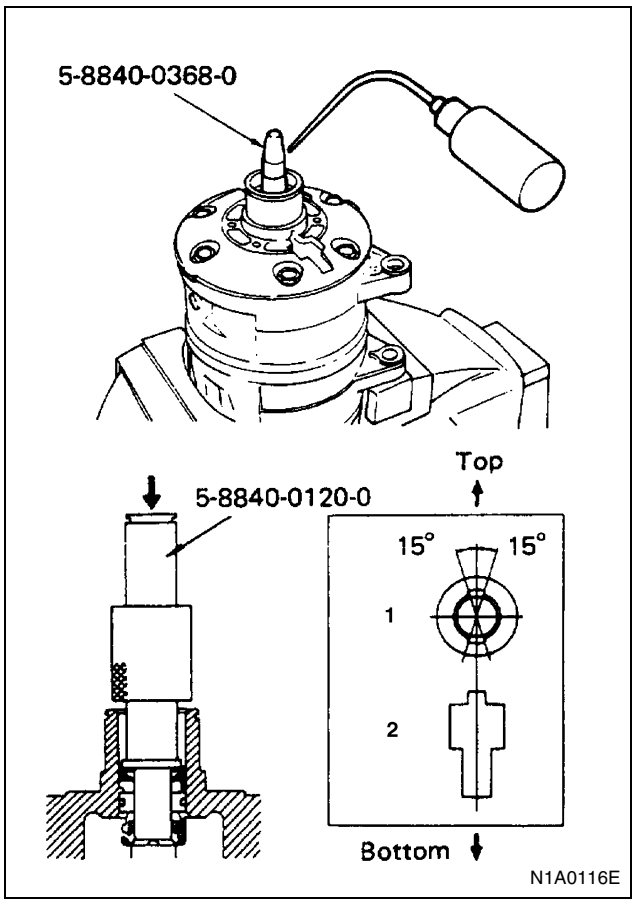
Tighten:
Through bolt to 22 N·m (2.2 kg·m / 16 lb·ft)



    Rotate the compressor drive shaft two or three times to make sure that it moves smoothly.
13. Shaft Seal Assembly
    Clean the sealing portion of the compressor and shaft seal (1).
    Install the shaft seal guide onto the end of the drive shaft.
    Shaft Seal Guide: 5-8840-0368-0 (J-34614)
    Apply new compressor oil to the shaft seal guide.
    Install the shaft seal onto the compressor drive shaft head by using shaft seal installer.
    Shaft Seal Installer: 5-8840-0120-0 (J-33942)



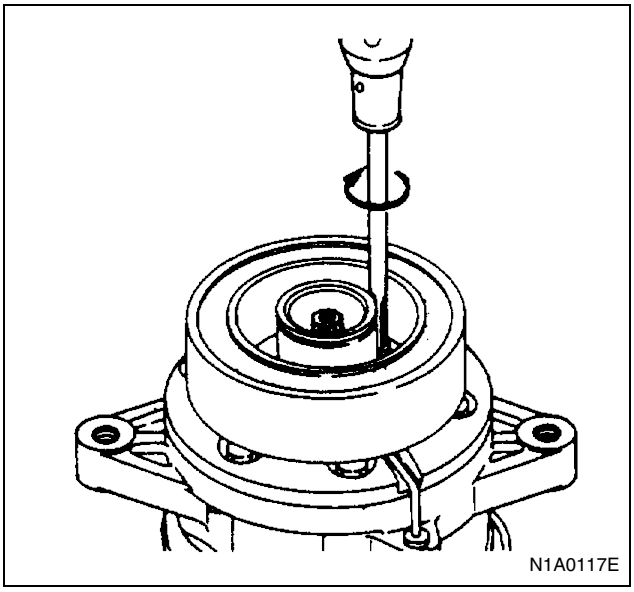
14. Snap Ring
    Using snap ring pliers to install the snap ring.
15. Shaft Seal Cover (If so equipped)
16. Felt (If so equipped)
    Clean the sealing portion of the compressor and shaft seal cover.
    Install the shaft seal guide onto the end of the drive shaft.
    Shaft Seal Guide: 5-8840-0368-0 (J-34614)
    Apply new compressor oil to the shaft seal guide.
    Install the shaft seal cover onto the drive shaft by using shaft seal installer.
    The installation position of the shaft seal cover is shown in the illustration.
    Shaft Seal Installer: 5-8840-0120-0 (J-33942)



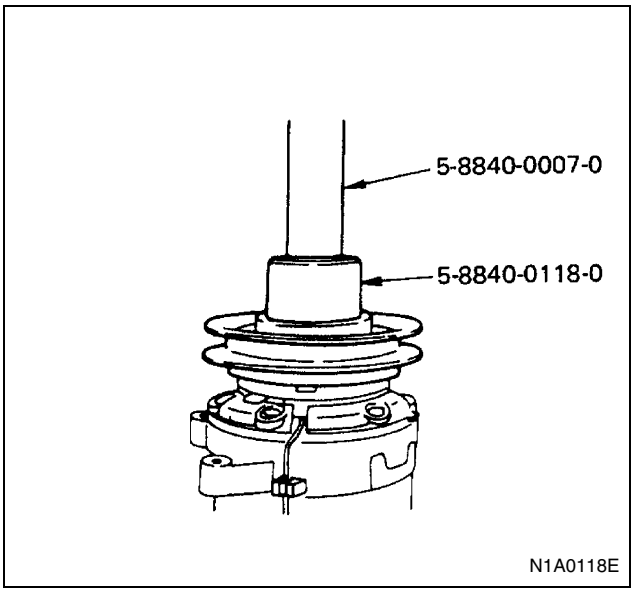
Legend
1. Shaft seal cover
2. Felt

17. Field Coil
18. Lead Wire Connector
    Install the field coil to the compressor.
    Lead wire must be facing up.
    Tighten the field coil fixing screws to the specified torque.

Tighten:
Field coil screw to 5 N·m (0.5 kg·m / 44 lb·ft)

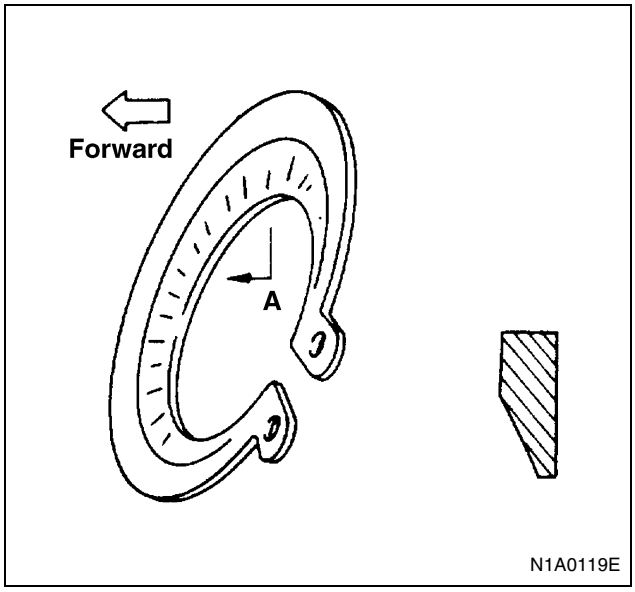

N1A0117E

19. Pulley Assembly
    Using pulley installer and drive handle to install the pulley assembly.
    Pulley Installer: 5-8840-0118-0 (J-33940)
    Drive Handle: 5-8840-0007-0 (J-8092)



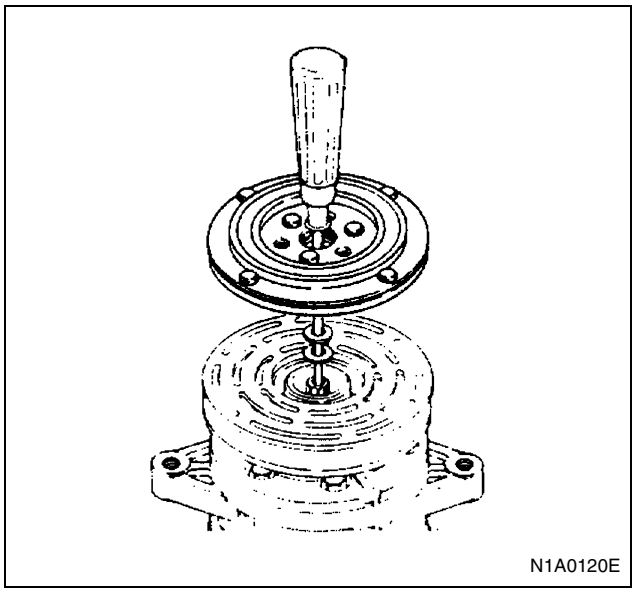
N1A0118E

20. Cover (If so equipped)
21. Snap Ring
    Install the snap ring with the inside indented portion facing out.



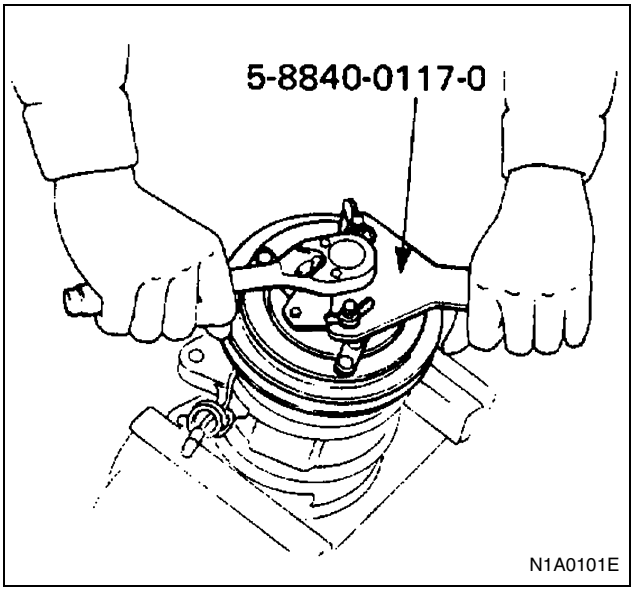
N1A0119E

22. Shim(s)
23. Drive Plate
    Install the drive plate to the compressor drive shaft together with the original shim(s).
    Press the drive plate by hand.


N1A0120E

24. Drive Plate Bolt
    Using drive plate holder to prevent the drive plate from rotating.
    Drive Plate Holder: 5-8840-0117-0 (J-33939)
    Tighten the bolt to the specified torque.

Tighten:
Drive plate bolt to 15 N·m (0.5 kg·m / 11 lb·ft)



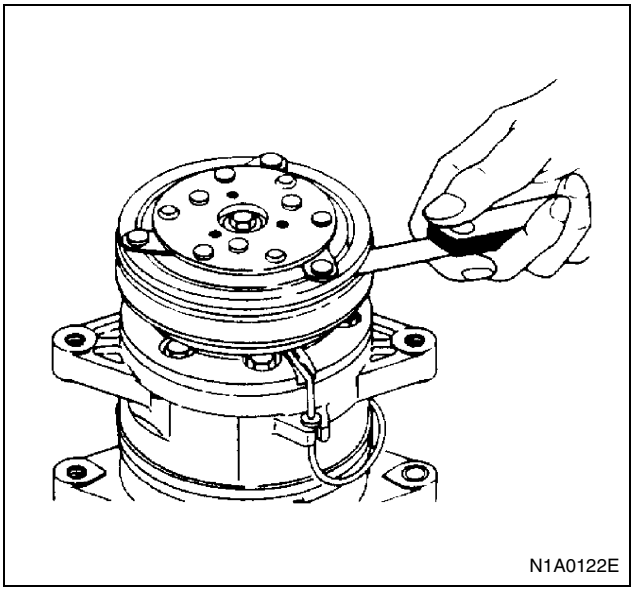
After tightening the bolt, check to be sure the pulley rotates smoothly.

Check to be sure that the clutch clearance is between 0.3 — 0.6 mm (0.01 — 0.02 in).

If necessary, install adjusting shim(s).

Adjusting shims are available in the following thickness.

Thickness	0.1 mm (0.0039 in)
	0.3 mm (0.0118 in)
	0.5 mm (0.0197 in)



LGHAC-WE-0552

You are requested to order this manual using the manual number that is shown above.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LGHAC-WE-0552 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

HEATING AND AIR CONDITIONING

SECTION 1

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

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00	SERVICE INFORMATION
1A	HEATING AND VENTILATION
1B	AIR CONDITIONING
1C	—
1D1	COMPRESSOR OVERHAUL EXCEPT TAIWAN
1D2	COMPRESSOR OVERHAUL FOR TAIWAN

FRAME AND CAB

SECTION 00

SERVICE INFORMATION

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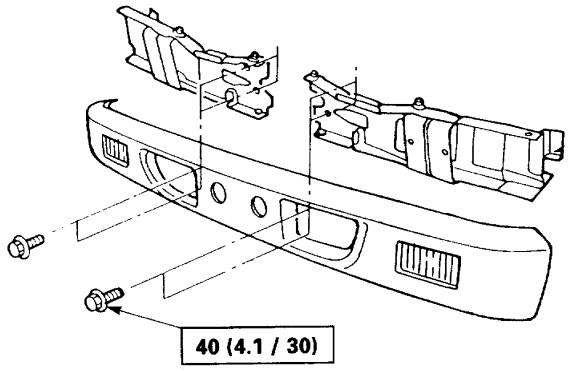
FIXING TORQUE

Front Bumper Fixing Bolts

N·m (kg·m / lb·ft)



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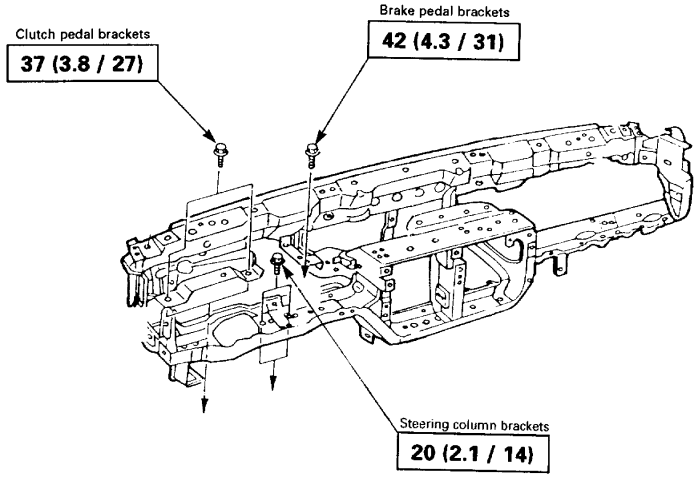
Instrument Panel

N·m (kg·m / lb·ft)



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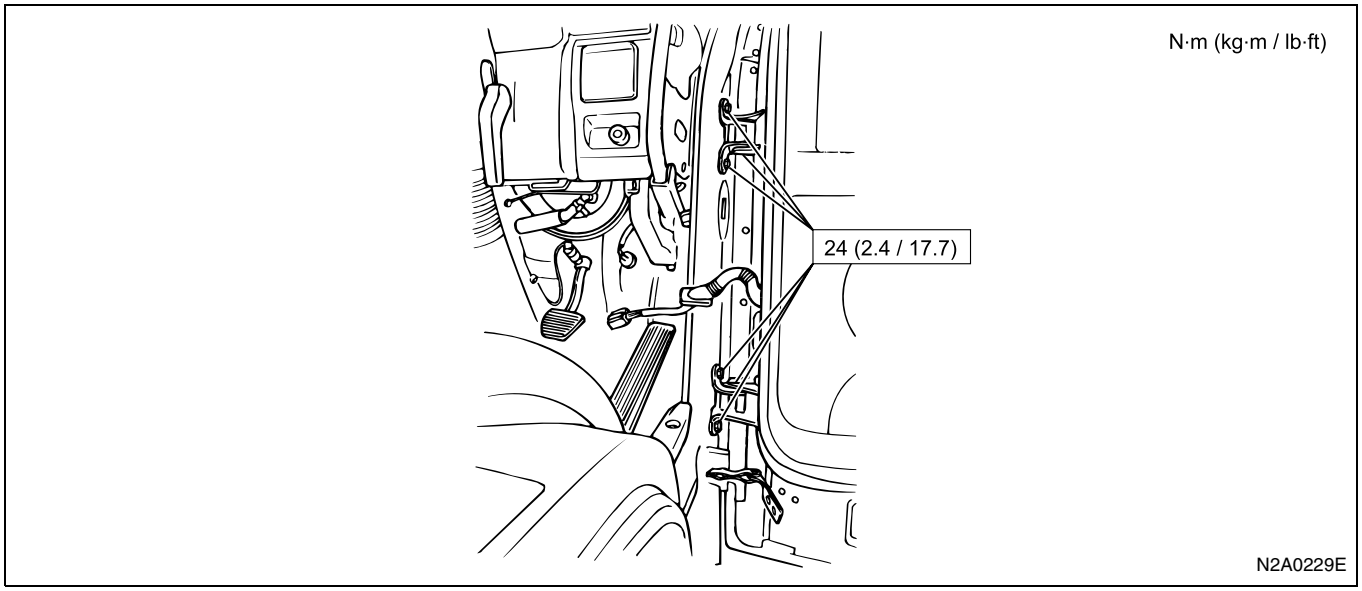
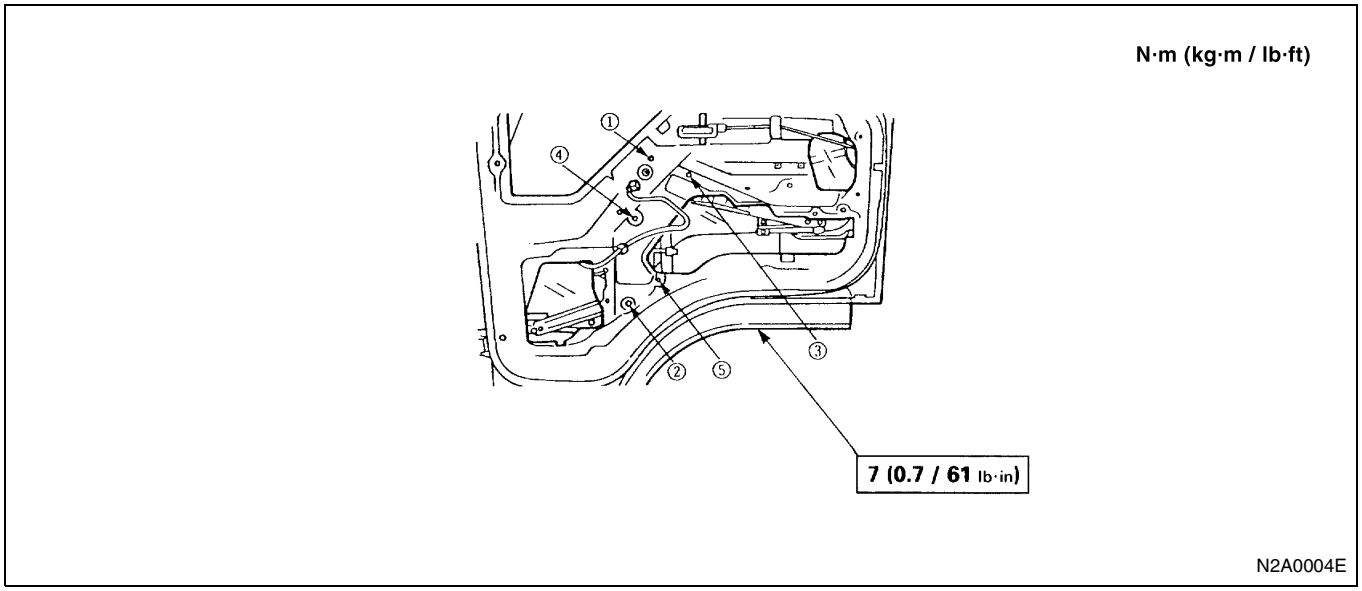
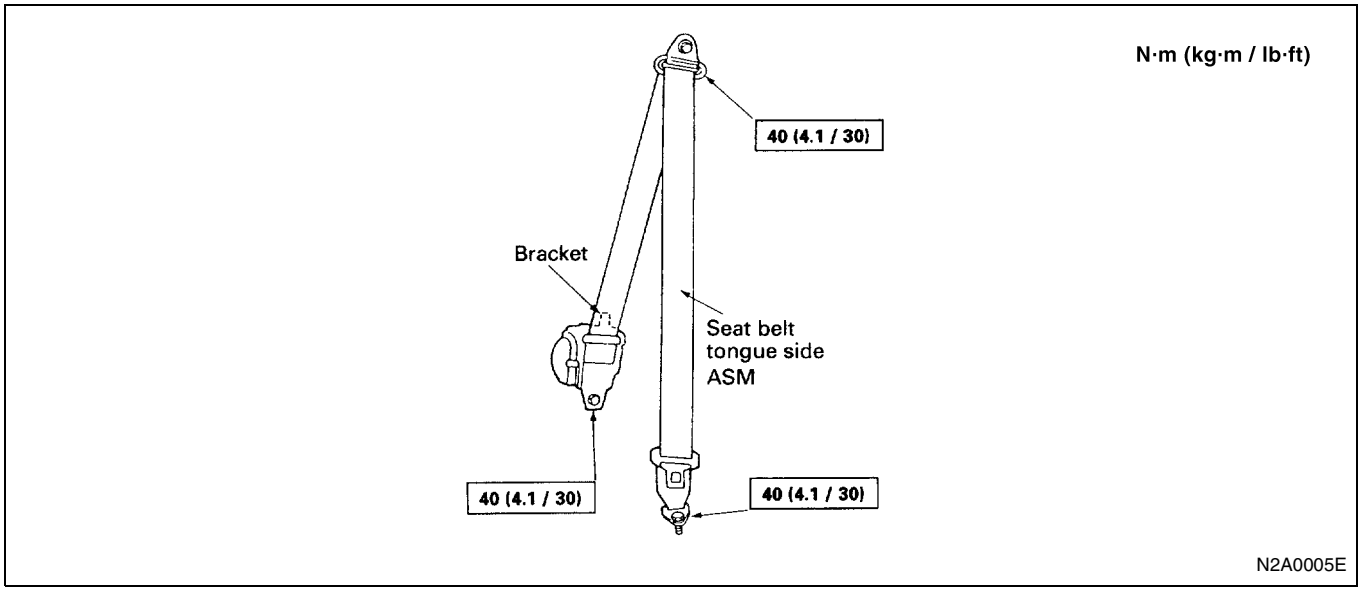
Front Door Fixing Bolts



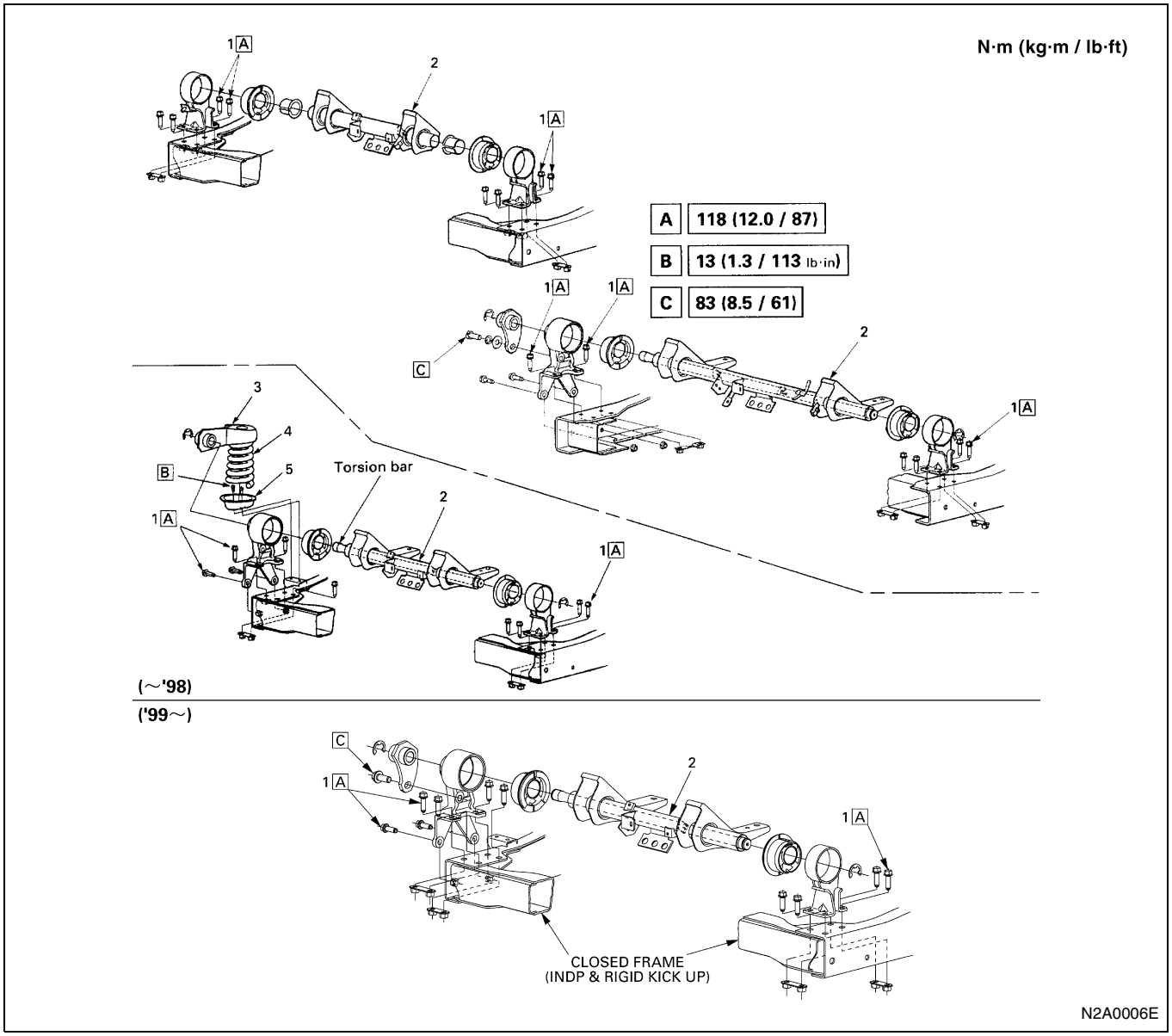
Window Regulator Fixing Bolts



Seat Belts Fixing Bolts



Front Mounting Fixing Bolts



FRAME AND CAB

SECTION 2
CAB AND FRAME

Caution:
At assembly and installation, install parts properly with the specified tightening torque values.

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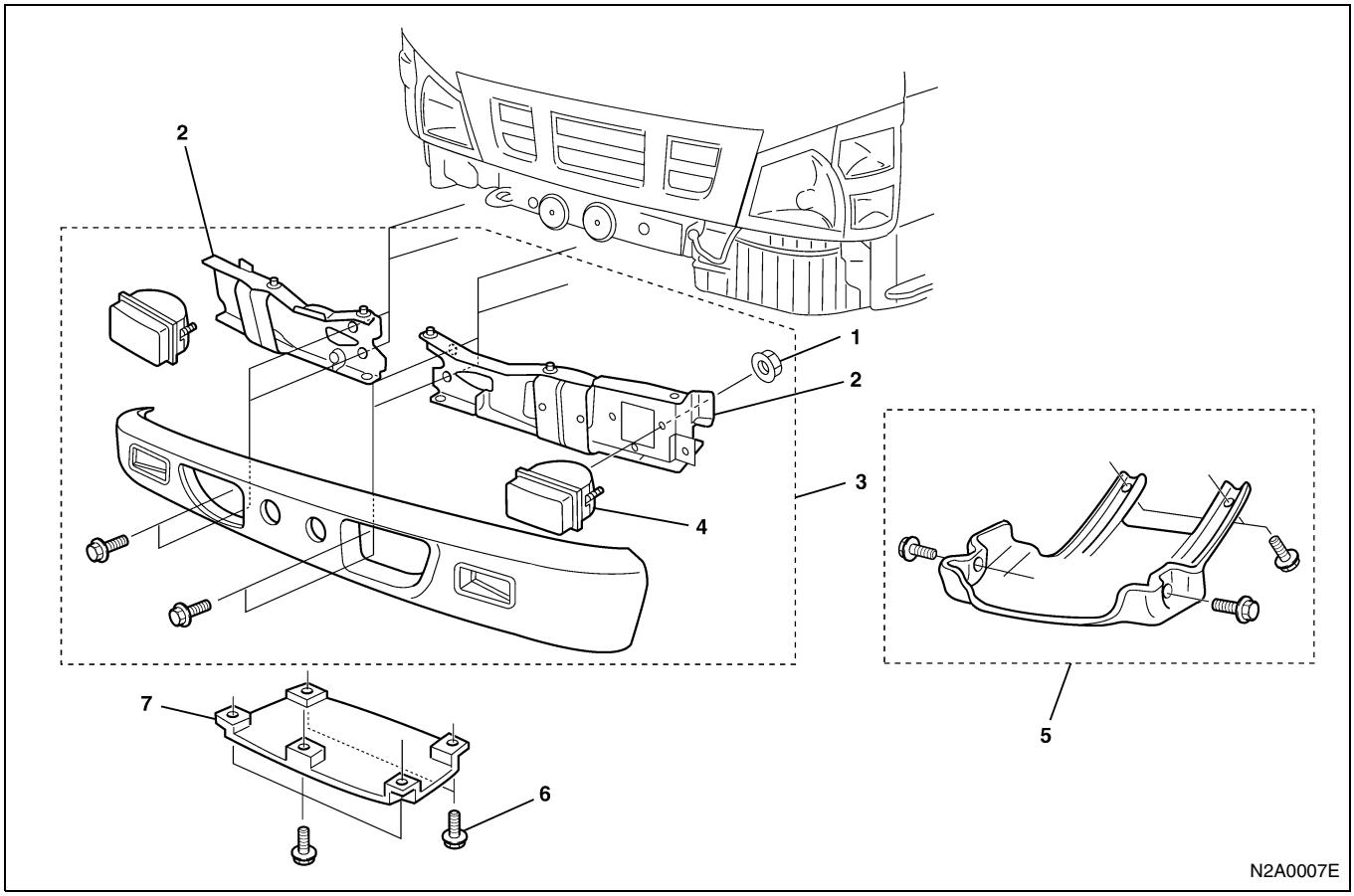
GENERAL DESCRIPTION

General Description

This Section describes the installation and removal procedures for the main parts related to the N series body (cab). Each service procedure is applicable to all N series unless otherwise specified.

BUMPER

Front Bumper (Except NPS Rigid Axle Model)



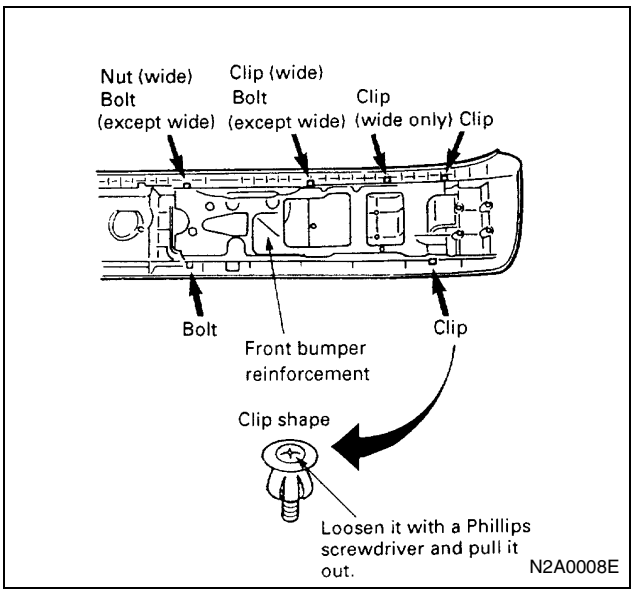
Legend

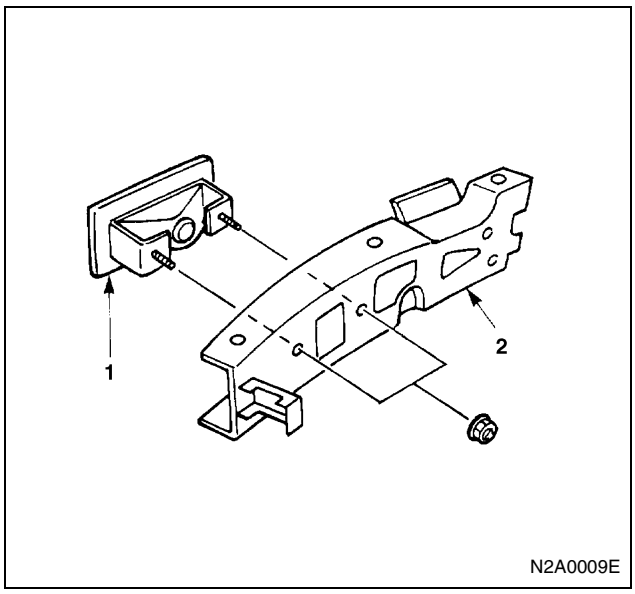
1. Fog lamp fixing nuts
2. Front bumper reinforcement
3. Front bumper assembly
4. Fog lamp assembly
5. Air guide (Independent suspension)
6. Air guide fixing bolts
7. Air guide (Rigid suspension)

Removal

1. Air guide fixing bolts
   - Remove the rear-side bolts/washers fixing the air guide.
2. Front bumper assembly
   - Remove the two fixing bolts on each side of the left and right front bumper assembly.
     And disconnect fog lamp harness connection.
3. Front bumper reinforcement
   - Loosen the fixing nuts and bolts, and clips and pull them out.

	(1)	(2)	(3)	(4)	(5)
Wide Cab	Nut	Clip	Clip	Clip	Bolt
Others than Wide	Bolt	Bolt	—	Clip	Bolt





4. Fog lamp assembly
   - Remove the fixing nuts and pull out the fog lamp (1) to forward from reinforcement (2).

Installation

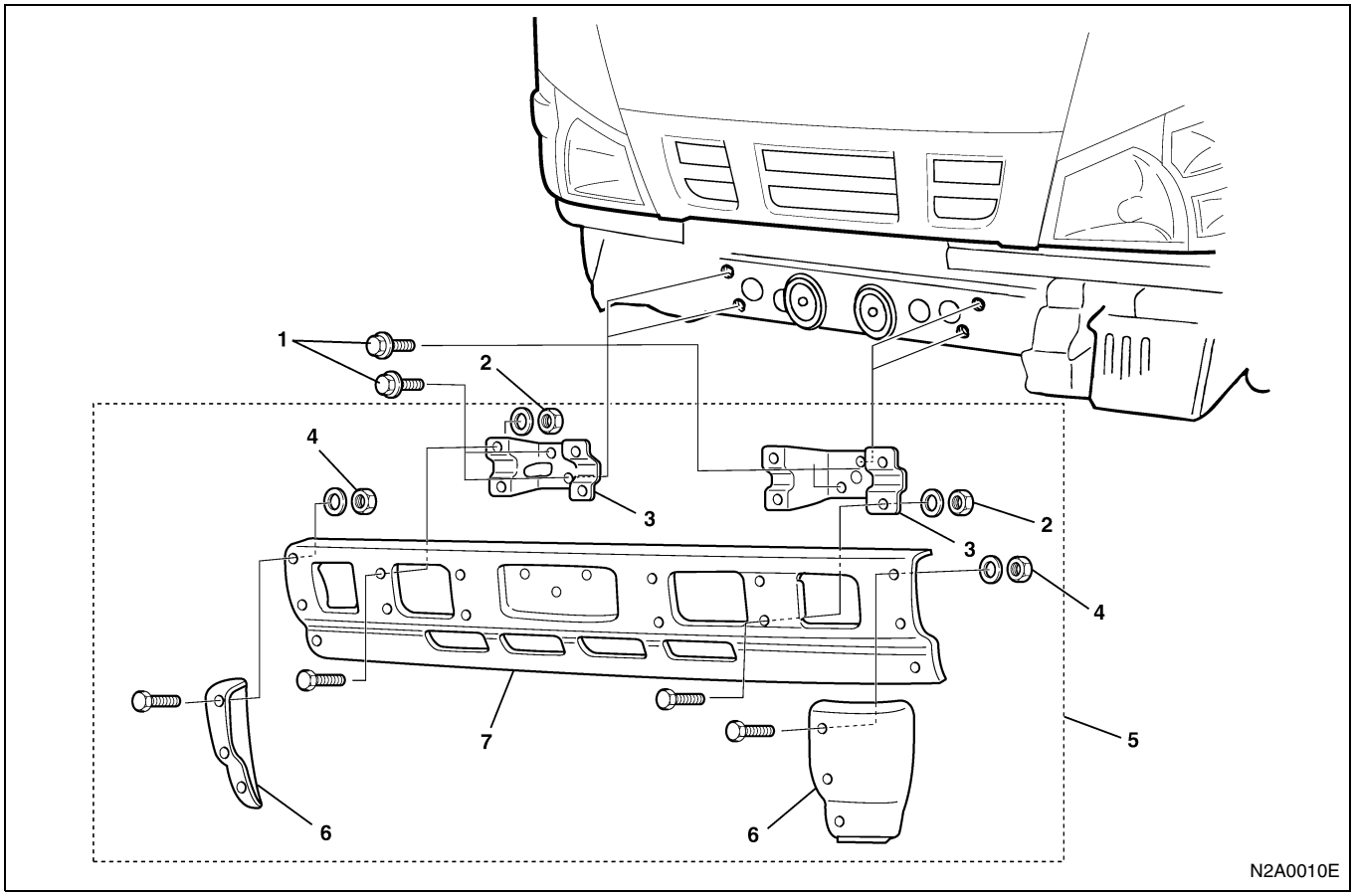
For installation, reverse the removal procedure taking the following points into consideration.

1. Tighten the front bumper assembly fixing bolts to the specified tightening torque.

Tighten:
40 N·m (4.1 kg·m/29.5 lb·ft)

2. Adjust the installation position referring to “Basic sizes for installation of the front bumper”.

Front Bumper (NPS Rigid Axle Model)



Legend

1. Bolt A
2. Nut C
3. Front bumper back bar
4. Nut B
5. Front bumper assembly
6. Front side bumper
7. Front center bumper

Removal

1. Front bumper assembly
   - Remove the 2 fixing bolts A on each side of the left and right front bumper assembly.
2. Front side bumper
   - Remove the 3 fixing bolts/nuts B on each side to remove front side bumper from front center bumper.
3. Front bumper back bar
   - Remove the 4 fixing bolt/nut C on each side.

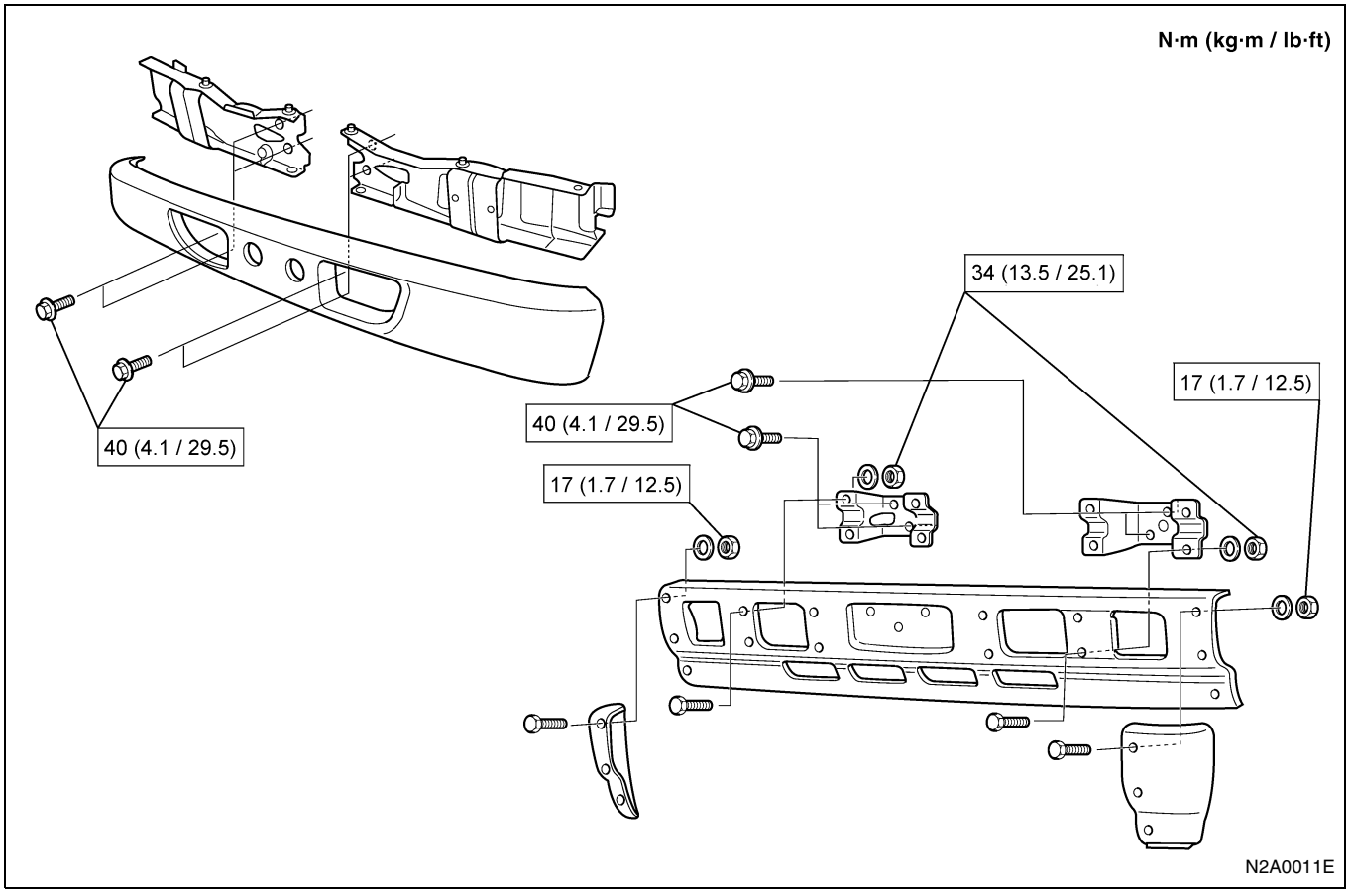
Installation

For installation, reverse the removal procedure taking the following points into consideration.
Tighten each fixing bolts/nuts to the specified tightening torque.

Tighten:

- Bolt A (M10 × 1.25) to 40 N·m (4.1 kg·m/29.5 lb·ft)
- Nut B (M8 × 1.25) to 17 N·m (1.7 kg·m/12.5 lb·ft)
- Nut C (M10 × 1.25) to 34 N·m (3.5 kg·m/25.1 lb·ft)

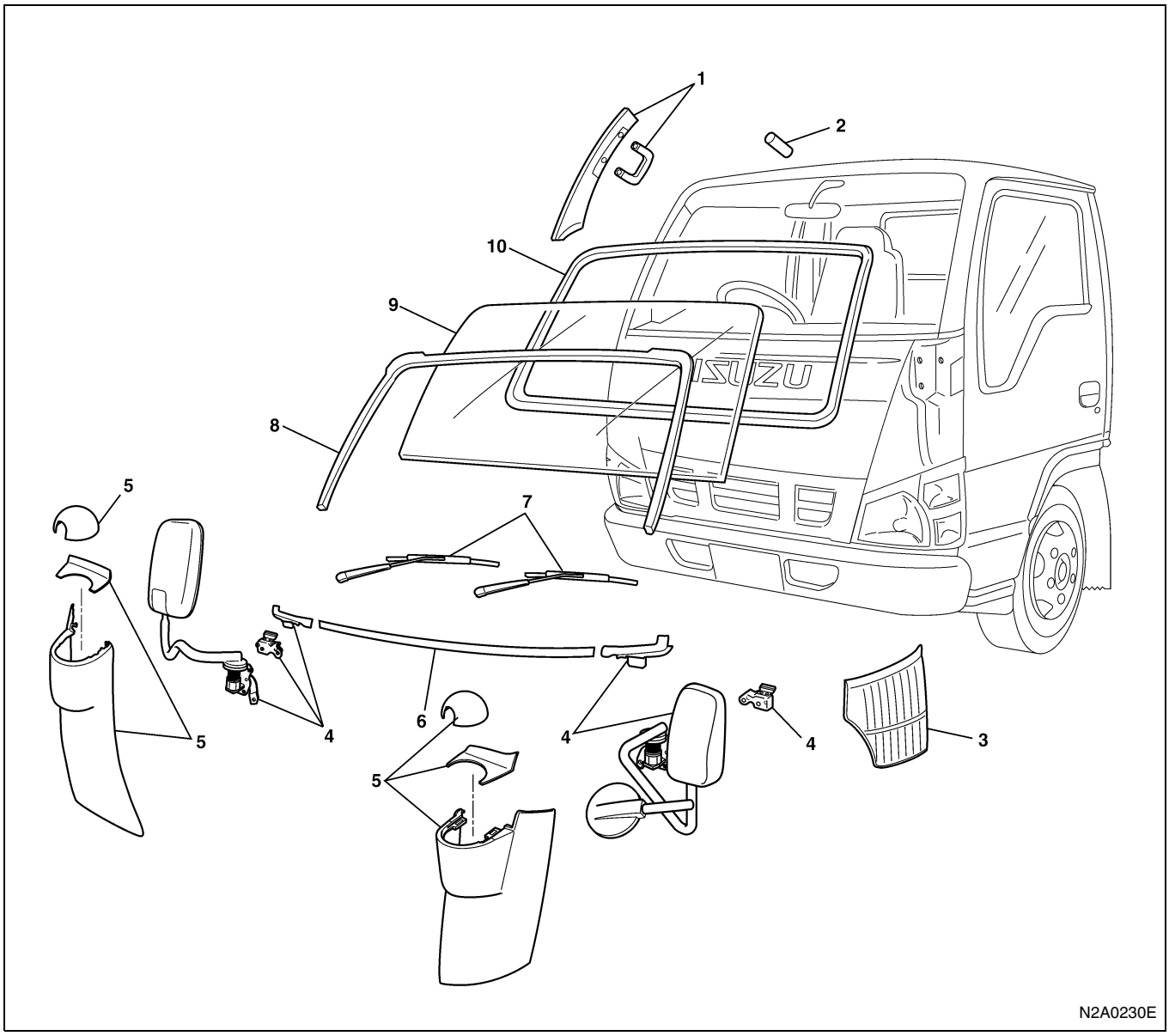
Fixing Torque



GLASS

Front Window Glass

Component

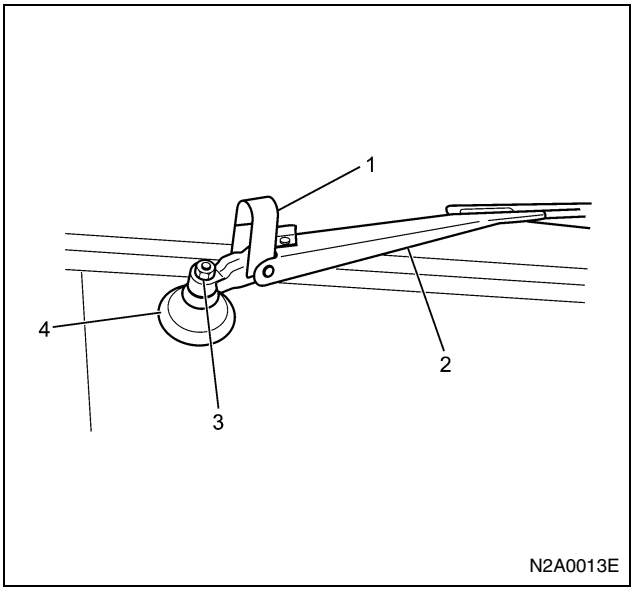


Legend

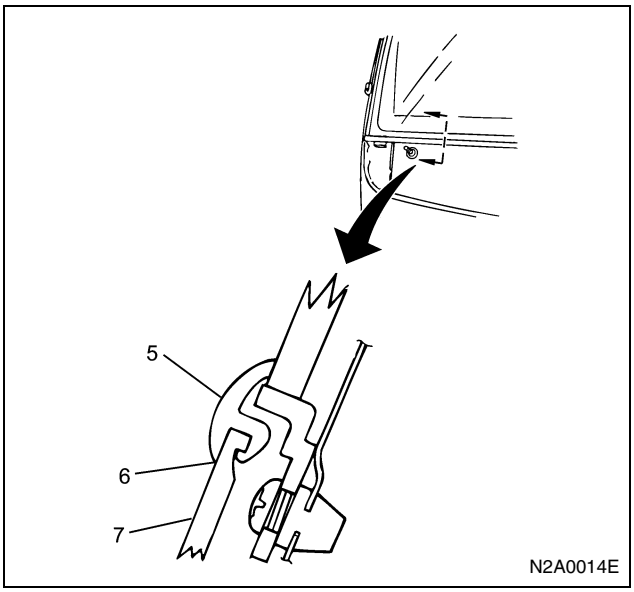
1. Front pillar grip/trim cover
2. Room mirror stopper rubber
3. Clearance lamp
4. Outside mirror assembly/outside mirror attachment/molding
5. Outside mirror stay cap/front panel side/sub cover
6. Ornament grille/upper molding
7. Front wiper arm
8. Front window molding
9. Front window glass
10. Front window glass finisher

Removal

1. Front wiper arm (2)
   - Open the cover (1) and remove the fixing nut (3).



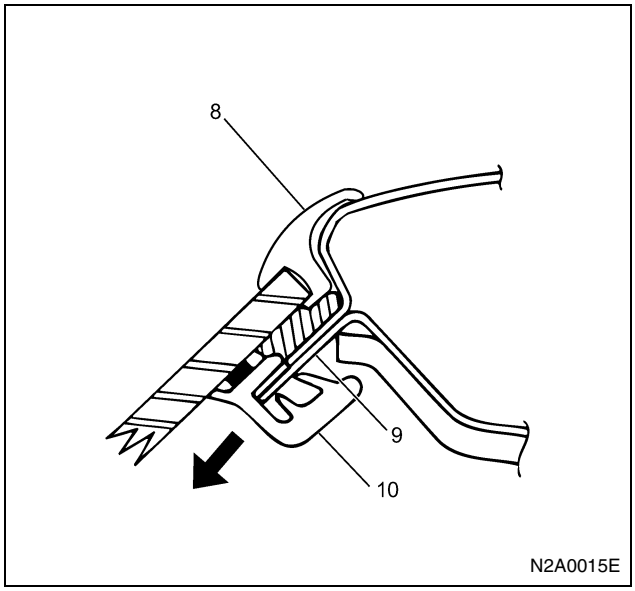
2. Clearance lamp
   - Refer to “Lighting System”.
3. Outside mirror stay cap/front panel side/sub cover
4. Outside mirror assembly/outside mirror attachment/molding
   - Refer to “Outside Mirror Assembly” in this Section.
5. Ornament grille upper molding (5)
   - Remove the lower part (6) of upper molding from ornament grille (7) with a bladed screwdriver.



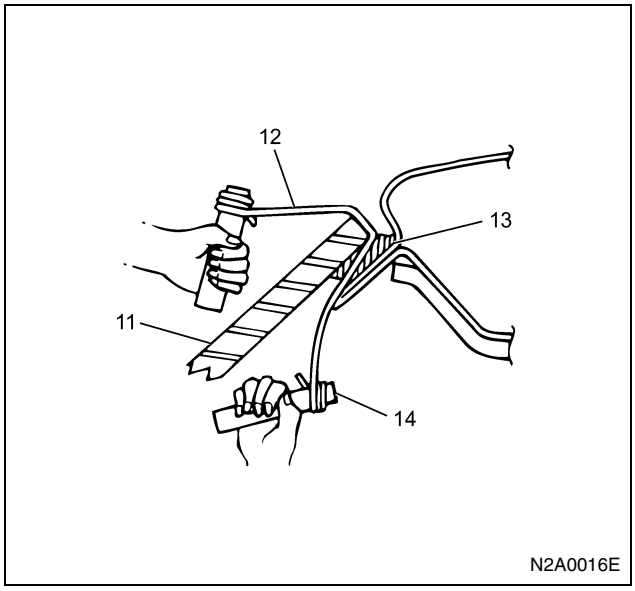
6. Front window molding (8)
   - Remove it according to the same procedure as step 3. Don’t reuse it.

Caution:
If the painted surface is scratched, this causes rust.

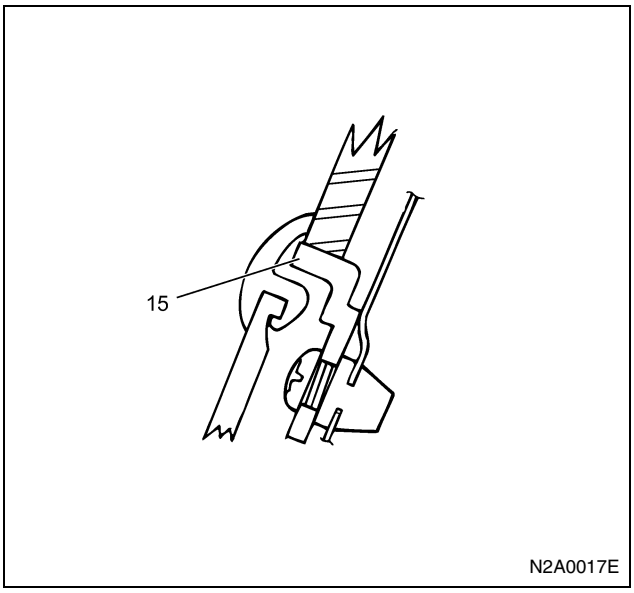
7. Room mirror stopper rubber
8. Front pillar grip/trim cover
   - Refer to “Front Side Trim Cover” in Interior & Exterior Trim Section.
9. Front window finisher (10)
   - Pull it from body flange.
   - Don’t reuse it.



10. Front window glass (11)
    - Pass the piano wire (12) of ϕ0.5 mm or so to the room inside through the adhesive part (13) of front window glass. Bind both ends of this piano wire on the wooden piece (14) etc., and cut the adhering part in the whole periphery of the glass moving it back and forth inside and outside the room. Remove the glass.



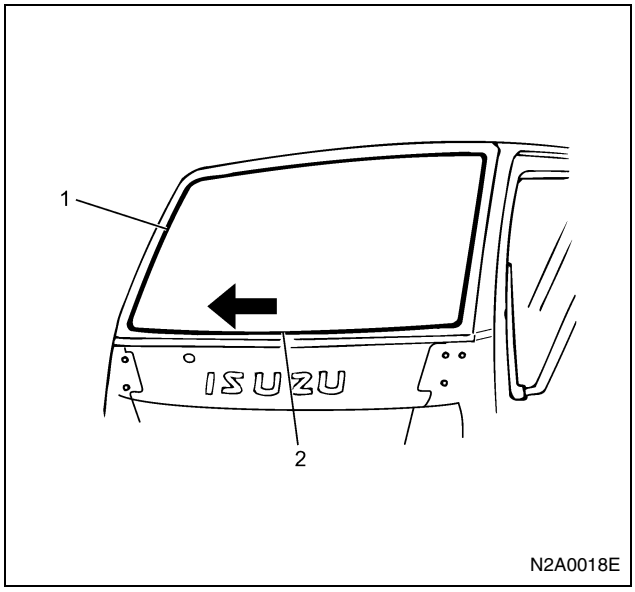
Caution:
Completely remove the adhesive remaining on the body flange and perform cleaning. If there is any convex or concave portion, this causes imperfect contact when installing the glass, leading to cracks or water leakage. To reuse the removed glass, perform the same treatment on the adhering surface of the glass side as well as the flange side. When the glass is an adhesion type, take care not to damage the glass stopper which must be reused. If the painted surface of the body flange is scratched, this will cause rust. Accordingly, repair it completely.



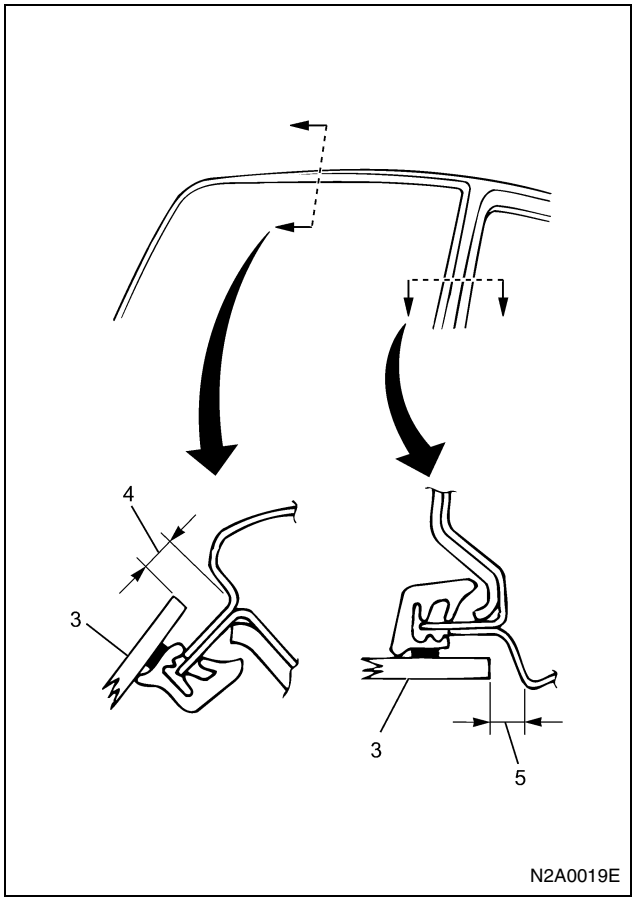
Installation

Preparation

- Be sure to perform the position alignment check of the front window glass before installation.
- Be sure to use a new front glass finisher (1). Set the deposit (2) in the central lower part. Insert the flange sequentially from the deposit. After setting, proceed to the next step without peeling off the exfoliate paper of two-sided adhesive tape.



- Temporarily set the front window glass (3), perform positioning marking so that the left/right clearance (5) may be uniform. Next, when the top clearance (4) is equal to the left/right clearance, proceed to the installation step. At this time, If the clearance must be adjusted, remove the ornament grille and adjust the glass stopper.
- Refer to “Ornament Grille” in Interior & Exterior Trim Section for removal of ornament grille.



1. Front window glass finisher (1)
   - Be sure to use a new one.
   - Apply the primer to the whole periphery of body side.

Caution:
Check that there remains no adhesive on the flange surface to which the primer is to be applied. If the primer is applied on the residual adhesive, the contact of the adhesive for glass to be applied later may be imperfect, resulting in cracks or water leakage. After applying the primer, keep the status for 3 minutes or more.

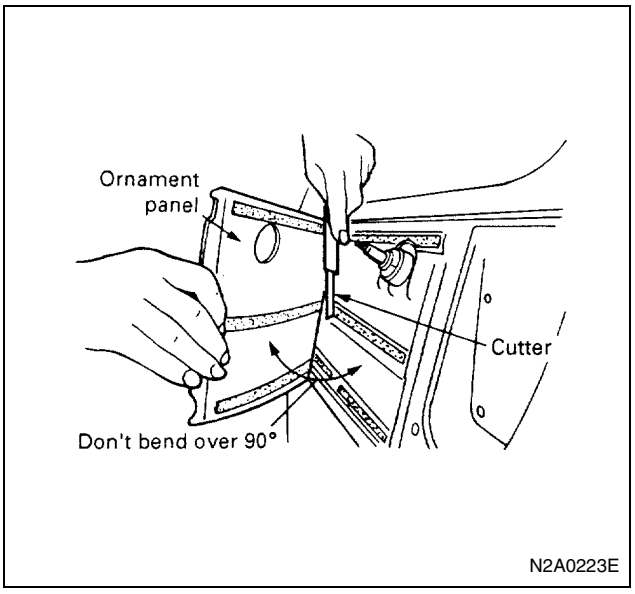
Primer: PRIMER RC-50E for painting manufactured by The Yokohama Rubber Co., Ltd. or equivalent

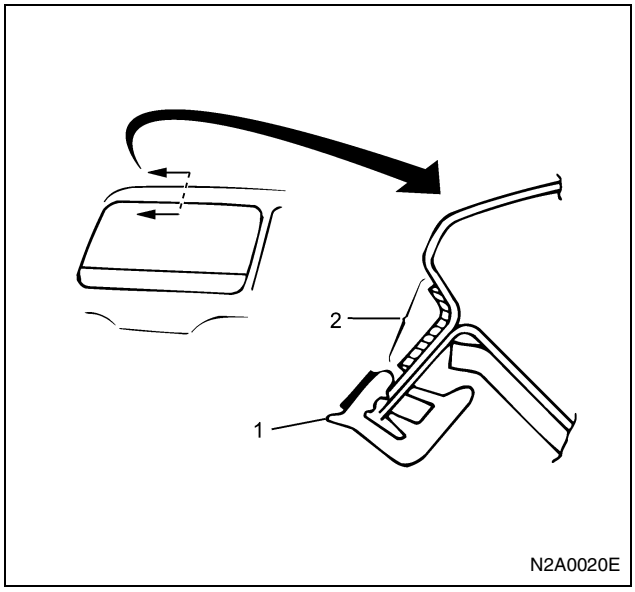
Mounting/Dismounting Procedure for Ornament Panel

- First, remove the washer nozzle (refer to Section 8 “Electrical Equipment Workshop Manual”), cut off the two-sided adhesive tape fixing the ornament panel with a cutter and remove it from the front panel. At this time, don’t bend the ornament panel over 90°. Take care not to scratch the painted surface of the body panel. If it is scratched, repair it completely to prevent rust. When installing the ornament panel, completely remove the two-sided adhesive tape remaining on the ornament panel side and install the ornament panel with a new two-sided adhesive tape.

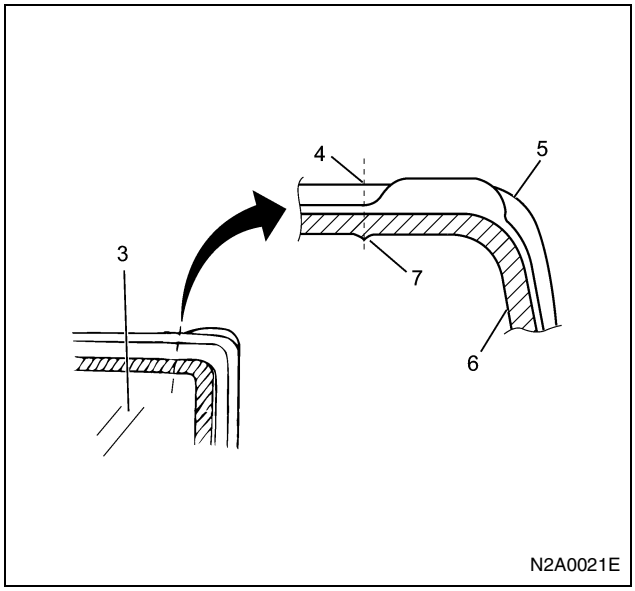
Caution:
After removing the washer nozzle, take care not to drop the washer tube to the inside of the front panel.

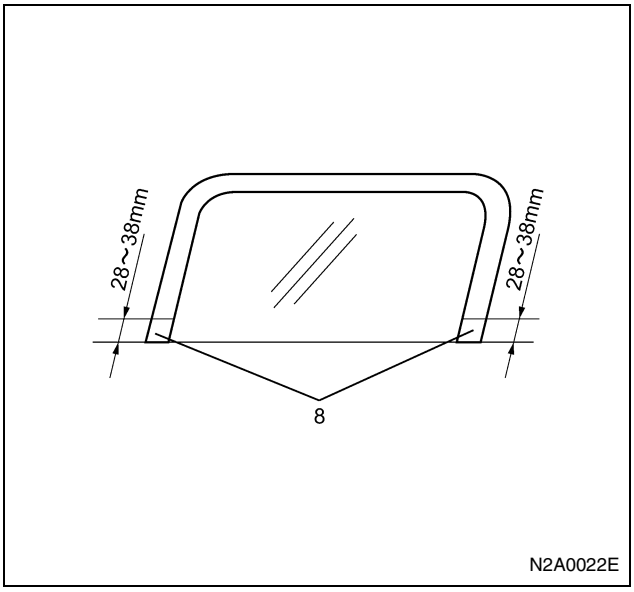
After removing the ornament panel, connect the nozzle to the tube and fix it.





2. Front window molding (5)
   - Align the paint marking part of the back side of molding with the alignment mark (7) on the glass ceramic painting part (6), insert the upper ends (left and right) and fix the both sides. Be sure to use a new one.
   - The margin (8) of molding should be equal at both ends.

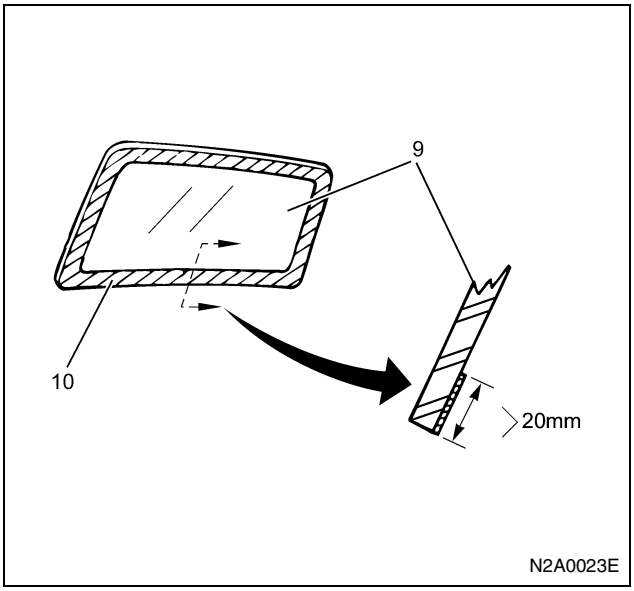




3. Front window glass (9)
   - Apply the primer (10) to the outer periphery on the room side of the glass. Apply it over 20 mm from the end.

Caution:
Before reusing the glass, completely remove the residual adhesive and perform cleaning. If the primer is applied on the residual adhesive, the contact of the adhesive for glass to be applied later may be imperfect, resulting in cracks or water leakage. After applying the primer, keep the status for 3 minutes or more.

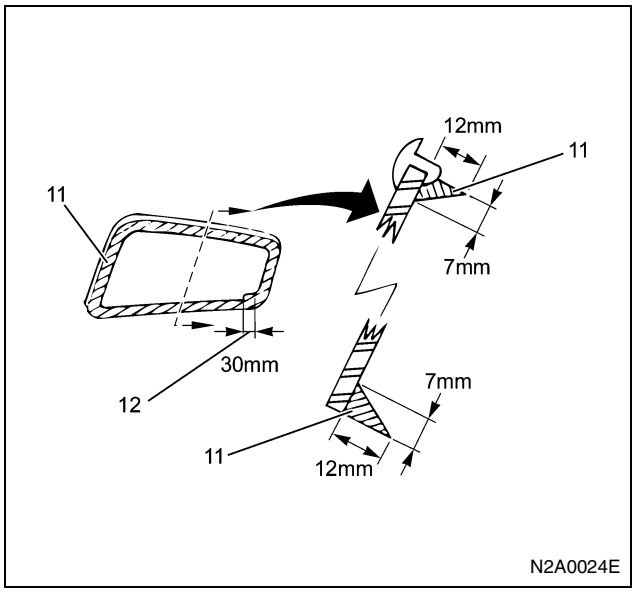
Primer: PRIMER MS-80 for both sides of glass manufactured by The Yokohama Rubber Co., Ltd. or equivalent



   - After keeping the status for 3 minutes or more after primer application, apply the adhesive. Apply it to the whole outer periphery and make a 30 mm lap allowance.

Adhesive: ADHESIVE WS-90F for glass manufactured by The Yokohama Rubber Co., Ltd. or equivalent

Caution:
Install the glass on the cab within 5 minutes after applying the adhesive. At this time, peel off the exfoliate paper of the two-sided adhesive tape of front window glass finisher and set the glass by pressing accurately at the installation position determined in the positioning procedure described on the previous step. Harden the adhesive at temperature of 20 to 30°C for 24 hours. Press the periphery by using a gummed tape as an auxiliary means. Imperfect press fitting will cause water leakage.



4. Front pillar grip/trim cover
   - For the grip, be sure to use the specified bolt.
   - Be sure to use a new two-sided adhesive tape for the trim cover.

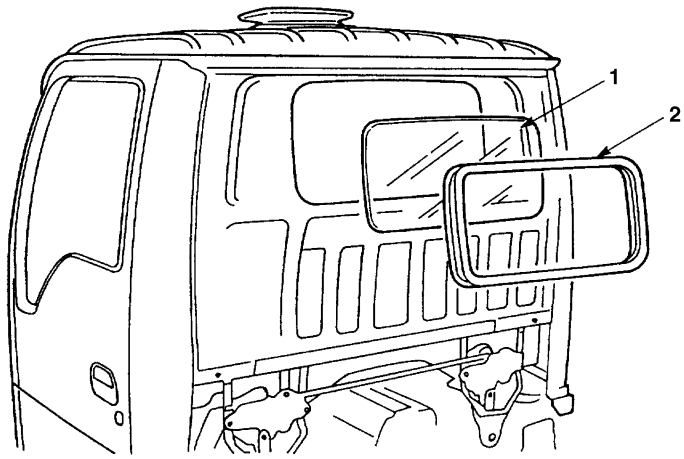
Caution:
Take care not to push the glass from the inside of the room at installation.

5. Ornament panel upper molding
6. Outside mirror assembly/outside mirror attachment/molding
   - Be sure to use a new two-sided tape for molding.
7. Outside mirror stay cap/front panel side/sub cover
8. Clearance lamp
   - Refer to “Outside Mirror Assembly” in this Section.
9. Front wiper arm
10. Room mirror stopper rubber
    - Install this rubber after adhesive for the front window glass becomes completely hard.

Precautions after installation

- As described before, fix the periphery by using a gummed tape as an auxiliary means in the period of 24 hours when the adhesive for the front window glass is hardened.
- After installation, avoid driving within 24 hours.
- Within 24 hours after installation, open or close the doors with the side window glass or roof ventilation open. When the door must be opened or closed inevitably in the closed status, open it slowly without giving any vibration or shock to it.
- Make a water leakage test.

Backlight Glass (Single Cab Model)



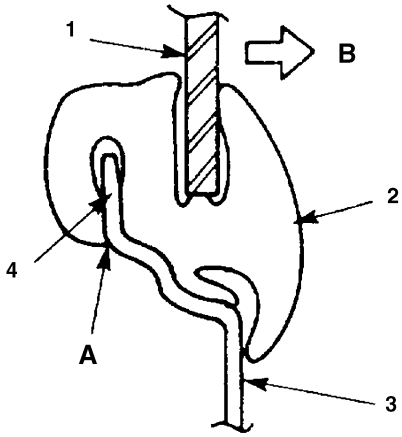
N2A0025E

Legend

1. Backlight glass
2. Backlight glass weather strip

Removal

1. Backlight glass
   - Pry off the top edge of the backlight glass and the weather strips on the both angles from the position (A) and remove them from the body flange. Push out the backlight glass toward (B).
2. Backlight glass weather strip
   - Remove the weather strip from the backlight glass.



N2A0026E

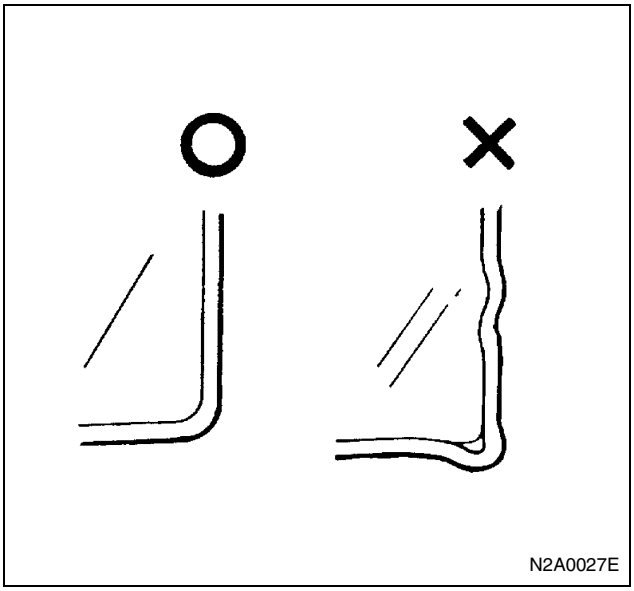
Legend

1. Backlight glass
2. Backlight glass weather strip
3. Back panel
4. Flange

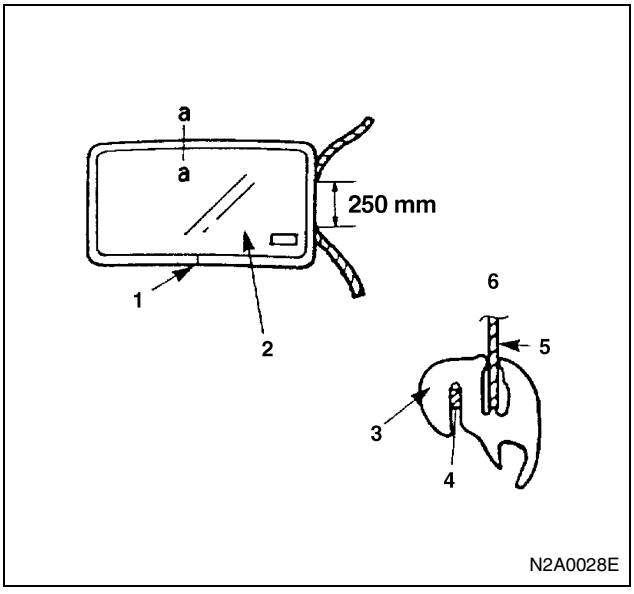
Installation

1. Backlight glass weather strip
   - Fit the backlight glass weather strip into the backlight glass. At this time, turn the deposit of the weather strip downward.

Caution:
Bring each portion into close contact without any float or corrugation.

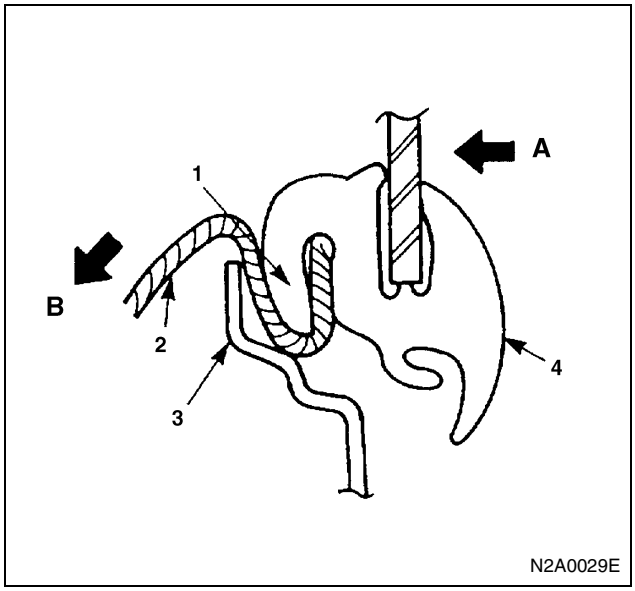


2. Backlight glass
   - Set the string for installing the window shield of ϕ5 — 6 mm into the portion (A) of the backlight glass weather strip installed on the backlight glass.
     Cause the string to go round and cross it about 250 mm in the center on the left of the backlight glass.



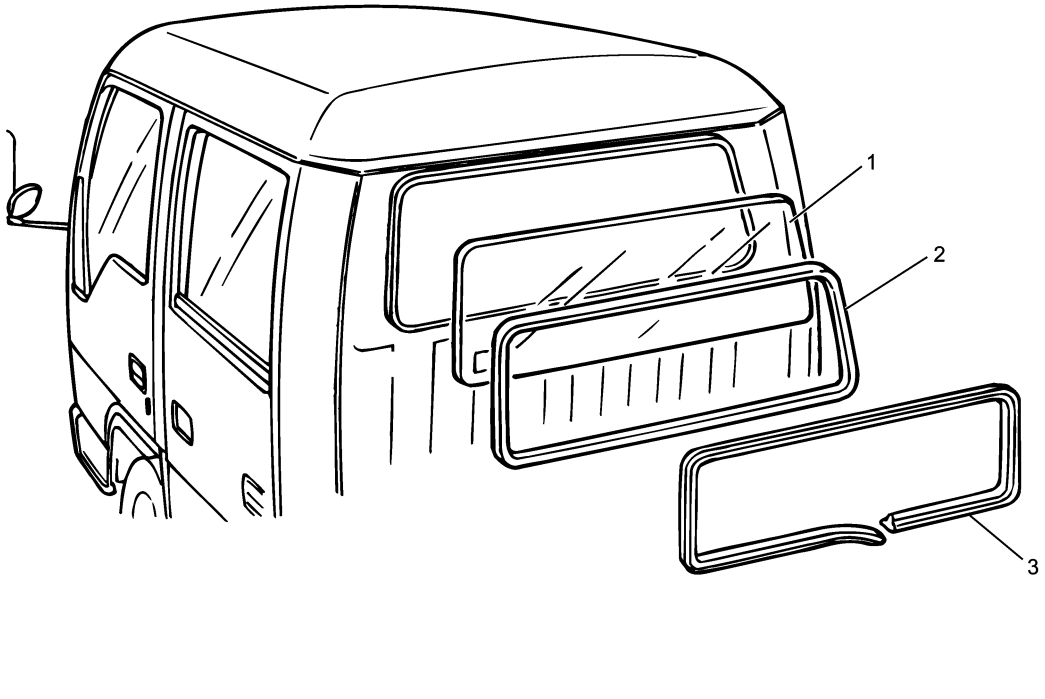
Legend
1. Deposit
2. Backlight glass
3. Backlight glass weather strip
4. String
5. Backlight glass
6. Section a — a

   - Adjust the backlight glass to the body position. Pushing down the backlight glass from the direction (A), pull the string toward (B) and fit the lip into the flange. To make the contact between the weather strip and body flange better, strike a glass position of about 150 mm from the outside weather strip equally with a hammer.



Legend
1. Lip
2. String
3. Flange
4. Weather strip

Backlight Glass (Crew Cab Model)



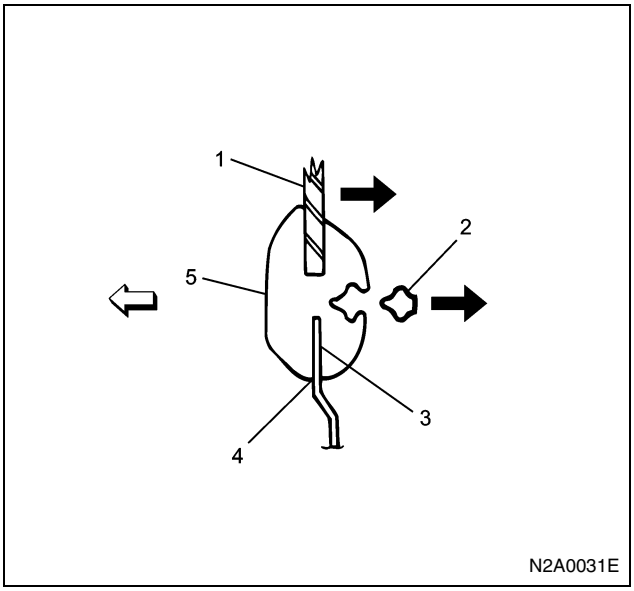
N2A0030E

Legend

1. Backlight glass
2. Backlight glass weather strip
3. Wedge rubber

Removal

1. Wedge Rubber (2)
   - Draw out the wedge rubber from the bottom end of the backlight glass weather strip.
2. Backlight glass (1)
   - Pry off the weather strip (5) at the top edge and both angles of the backlight glass from the position (4) and remove it from the body flange (3). Push out the backlight glass toward B.



N2A0031E

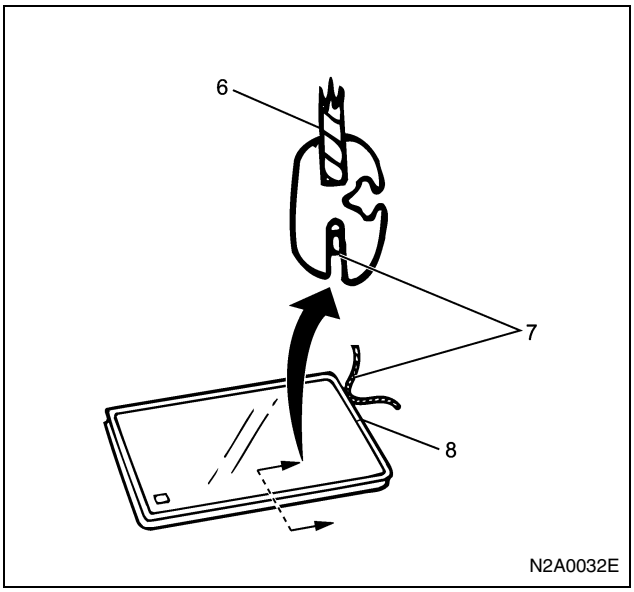
3. Backlight glass weather strip
   - Remove the weather strip from the backlight glass.

Installation

1. Backlight glass weather strip
   - Fit the backlight weather strip into the backlight glass. At this time, turn the deposit (8) of the weather strip to the right side of the vehicle.

Caution:
Bring each portion into close contact without any float or corrugation.

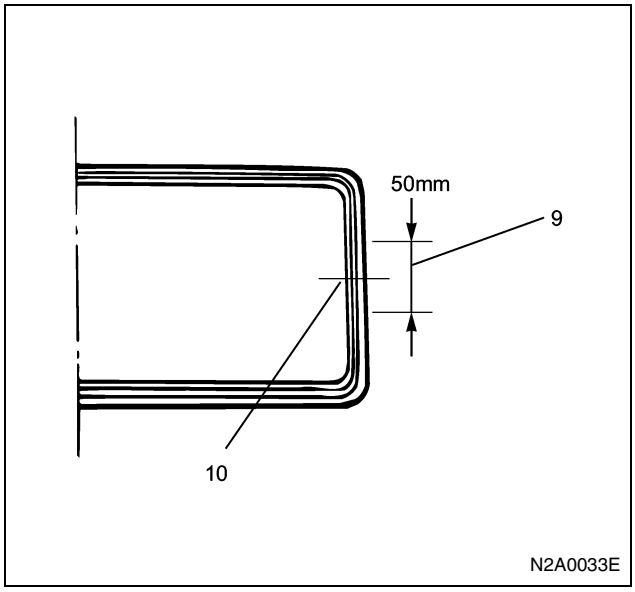
2. Backlight glass (6)
   - Set a ϕ5 to 6 mm string for installing the window shield into the portion (7) of the backlight weather strip installed on the backlight glass by means of a metal tube of about 8 mm.
     Adjusting the center of the glass to that of the body, push down the glass with force from the outside and pull the string toward the center of the glass from the inside.
     Thus, set the lip into the body flange in succession.



   - After installing the backlight glass, fill the portion (10) in the range of 50 mm up and down (9) of the deposit of the weather strip with sealant.

     Sealant: CS3061D

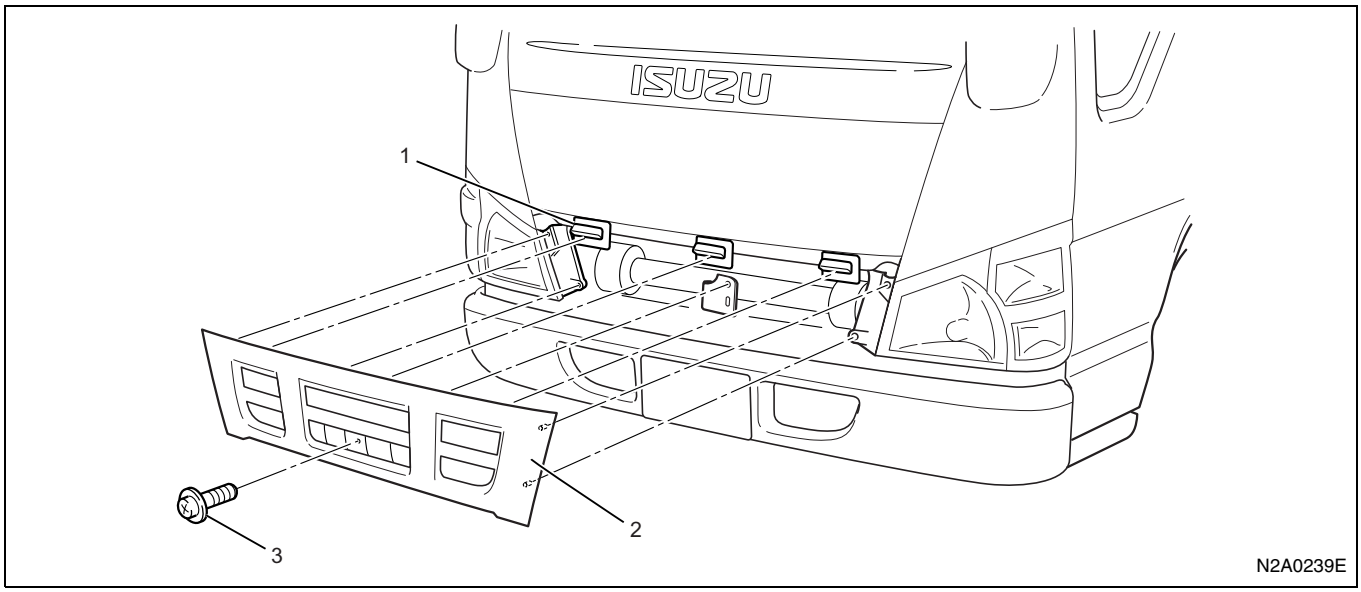
Caution:
Fill the portion B in the specified range with sealant securely. Completely remove overflowed sealant.



3. Wedge rubber
   - Fit the wedge rubber securely into the bottom end of the backlight glass weather strip.

FRONT GRILLE

Component

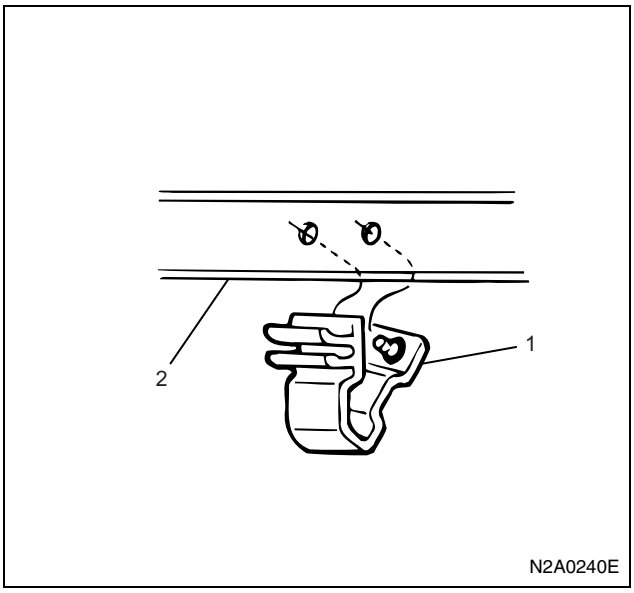


Legend

1. Clip
2. Front grille
3. Bolt

Removal

1. Remove the front grille.
   - Remove the front grille by pulling the fixing screw at the center, the three (narrow cab) or four (wide cab) clips which install cab panel, and the four clips which install headlamp.
2. Remove the fixing clip (1).
   - Open the clip (1) to remove it from cab panel (2).



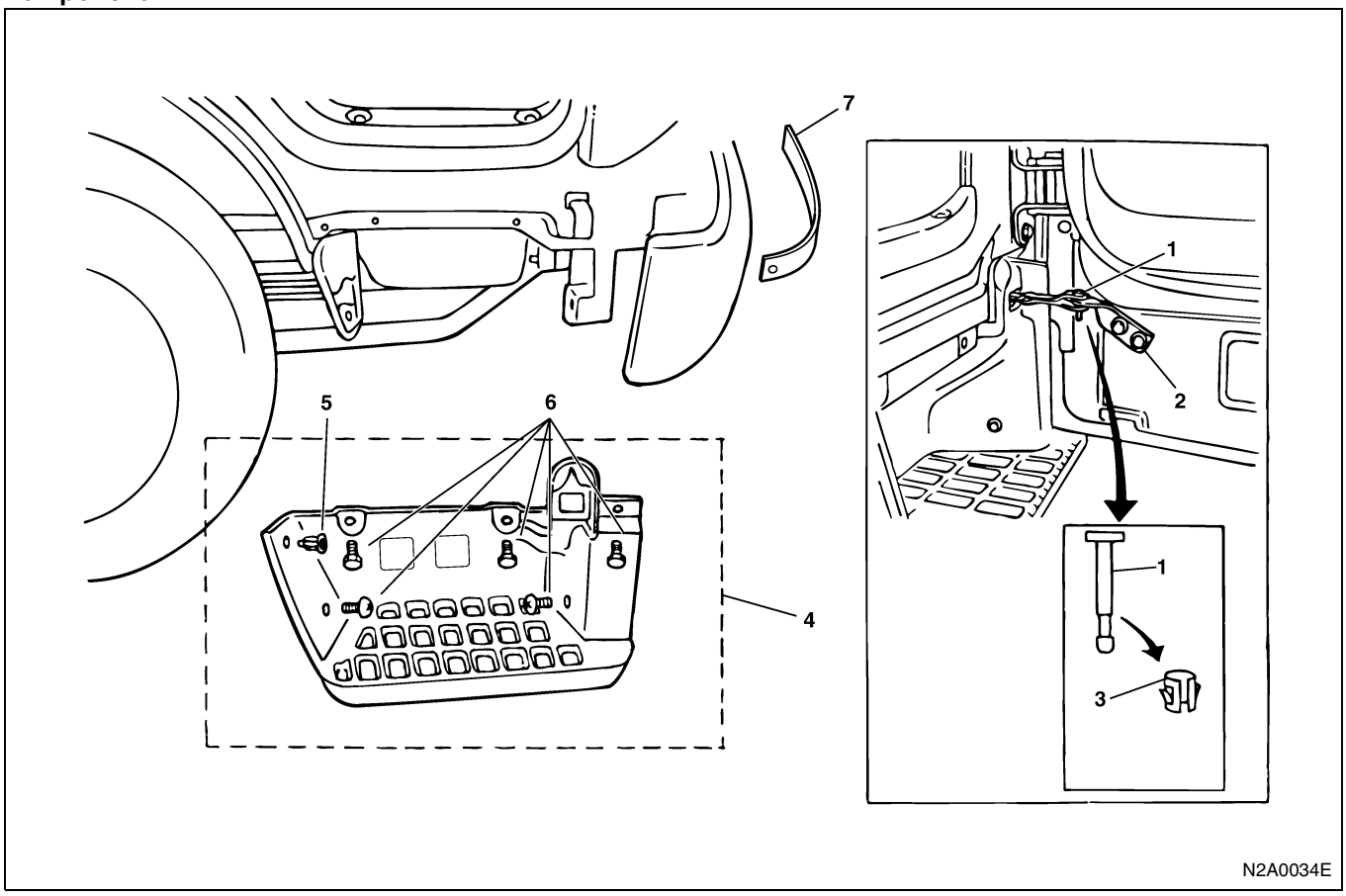
Installation

Install in the reverse order of removal.

STEP

Front Step (Except NPS Front Rigid Suspension Model)

Component



Legend

1. Front door check arm pin
2. Check arm bracket
3. Clip
4. Front step assembly
5. Clip
6. Bolt
7. Headlamp lower cover

Removal

1. Headlamp lower cover
   - Pull the mating part of clip to remove it.
2. Front combination lamp
3. Front door check arm pin
   - Expand the notch on the tip of pin to remove, and tap the pin from the bottom with a plastic hammer.
4. Check arm bracket
   - Remove the 2 mounting bolts on the door side.
5. Front step assembly
   - Remove the 3 mounting bolts, 2 screws and a clip.

Installation

For installation, reverse the removal procedure taking the following points into consideration.

1. Tighten the mounting bolt of front step assembly to the specified torque.

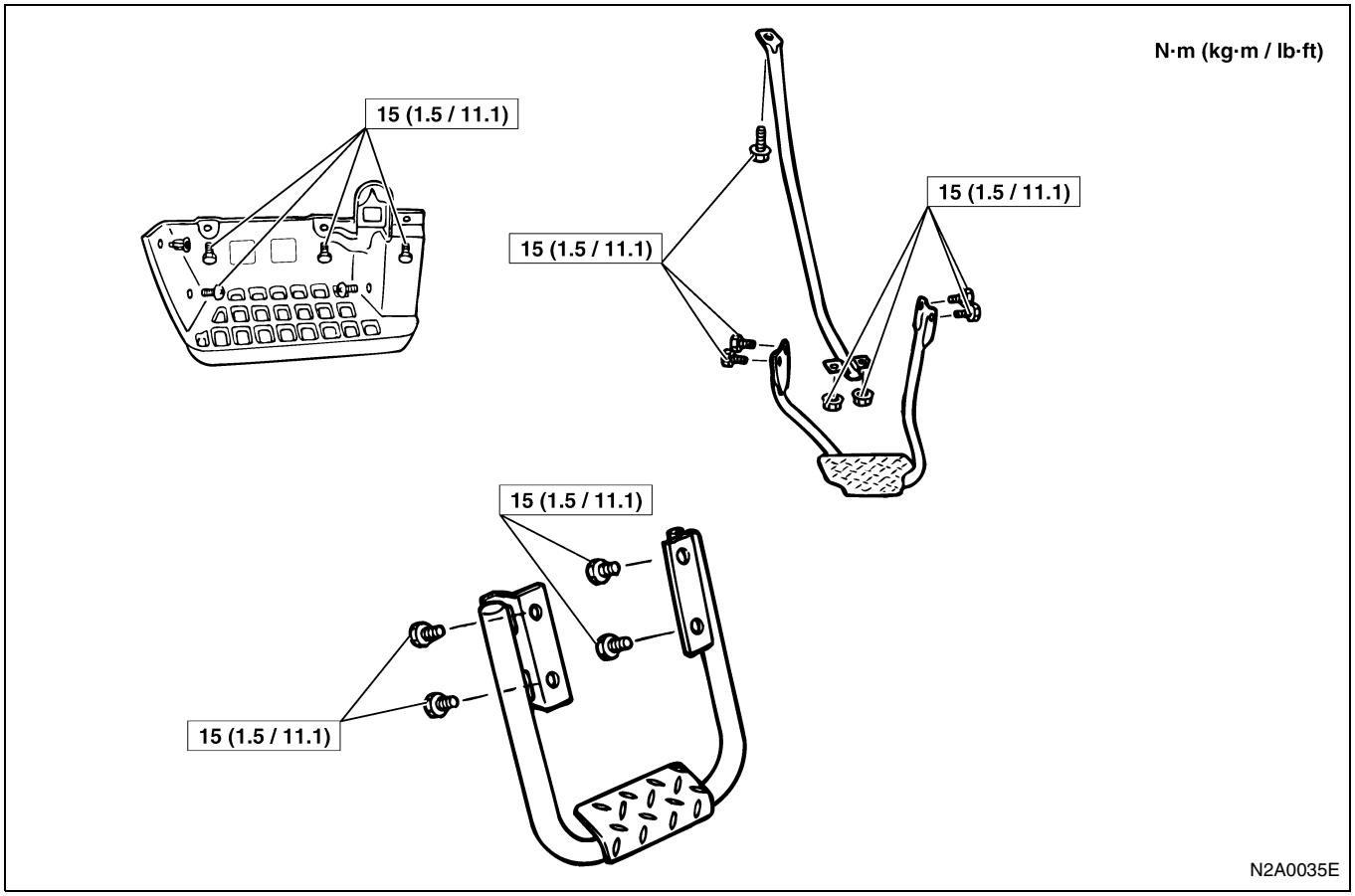
Tighten:
Mounting bolt to 15 N·m (1.5 kg·m/11.1 lb·ft)

2. Tighten the mounting bolt of check arm bracket to the specified torque.

Tighten:
Mounting bolt to 25 N·m (2.5 kg·m/18.4 lb·ft)

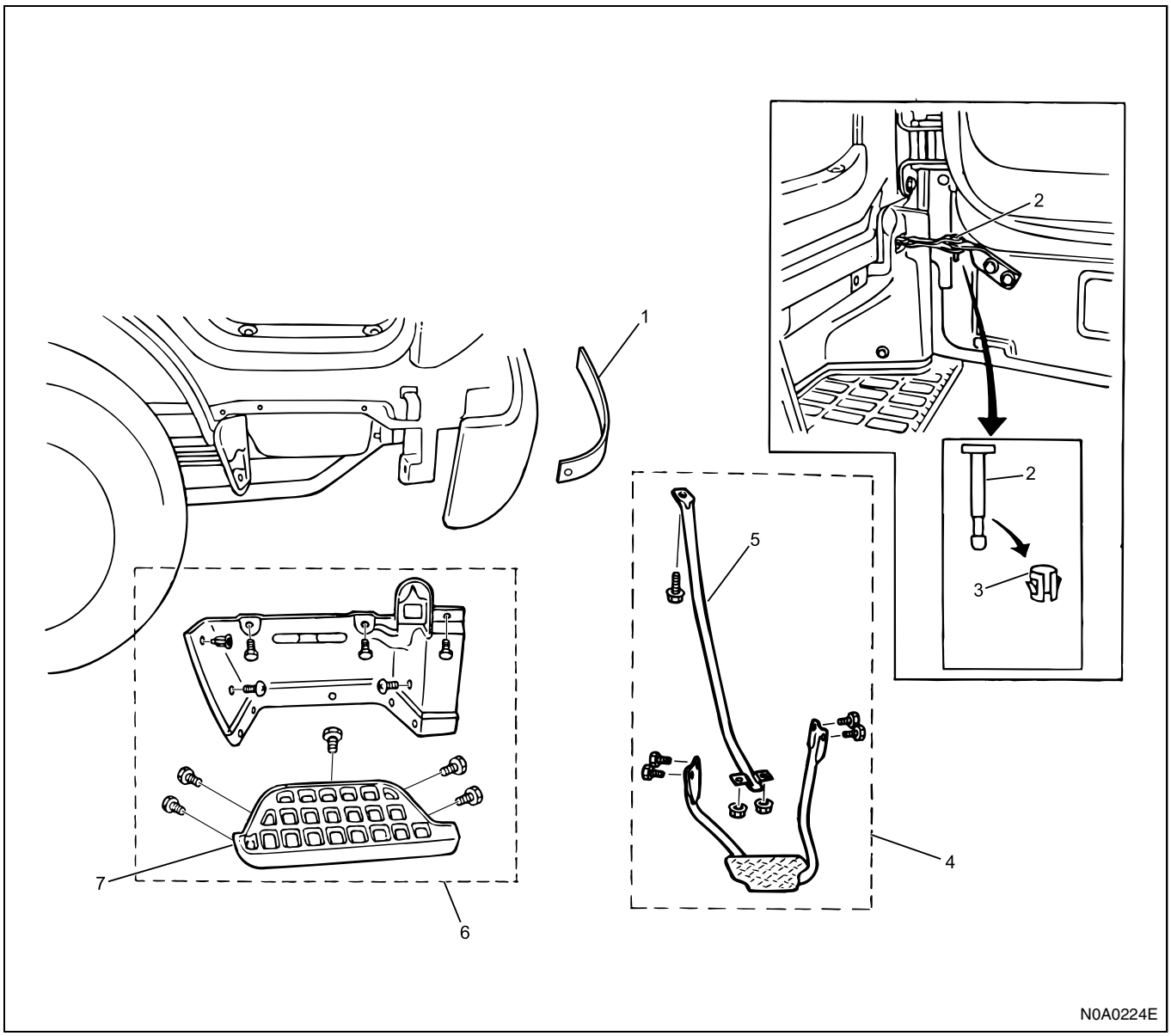
3. Make sure that the clip gets caught the tip of check arm pin securely.

Fixing Torque



Front Step (NPS Front Rigid Suspension Model)

Component



Legend

1. Headlamp lower cover
2. Front door check arm pin
3. Clip
4. Lower step plate assembly
5. Lower step rod
6. Front step assembly
7. Step plate

Removal

1. Lower step plate
   - Remove the 5 mounting bolts.
2. Lower step rod
   - Remove the 2 mounting nuts.
3. Headlamp lower cover
   - Pull the mating part of clip to remove it.
4. Front combination lamp
5. Front door check arm pin
   - Expand the notch on the tip of pin to remove, and tap the pin from the bottom with a plastic hammer.
6. Front step assembly
   - Remove the 3 mounting bolts, 2 screws and a clip.
7. Step plate
   - Remove 5 mounting bolts.

Installation

For installation, reverse the removal procedure taking the following points into consideration.

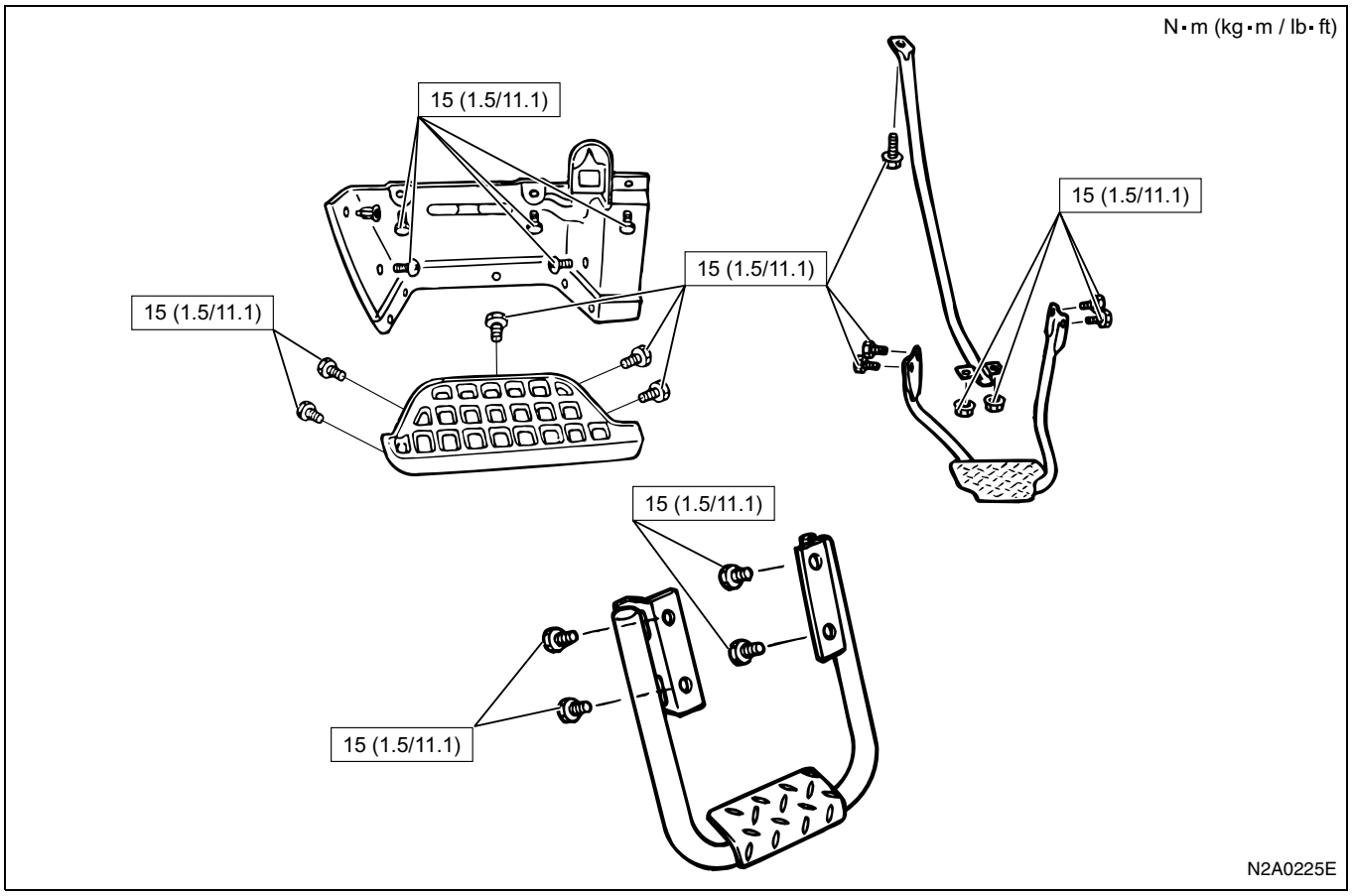
1. Tighten the mounting bolts and nuts to the specified tightening torque.

Tighten:

Mounting bolts and nuts to 15 N·m (1.5 kg·m/11.1 lb·ft)

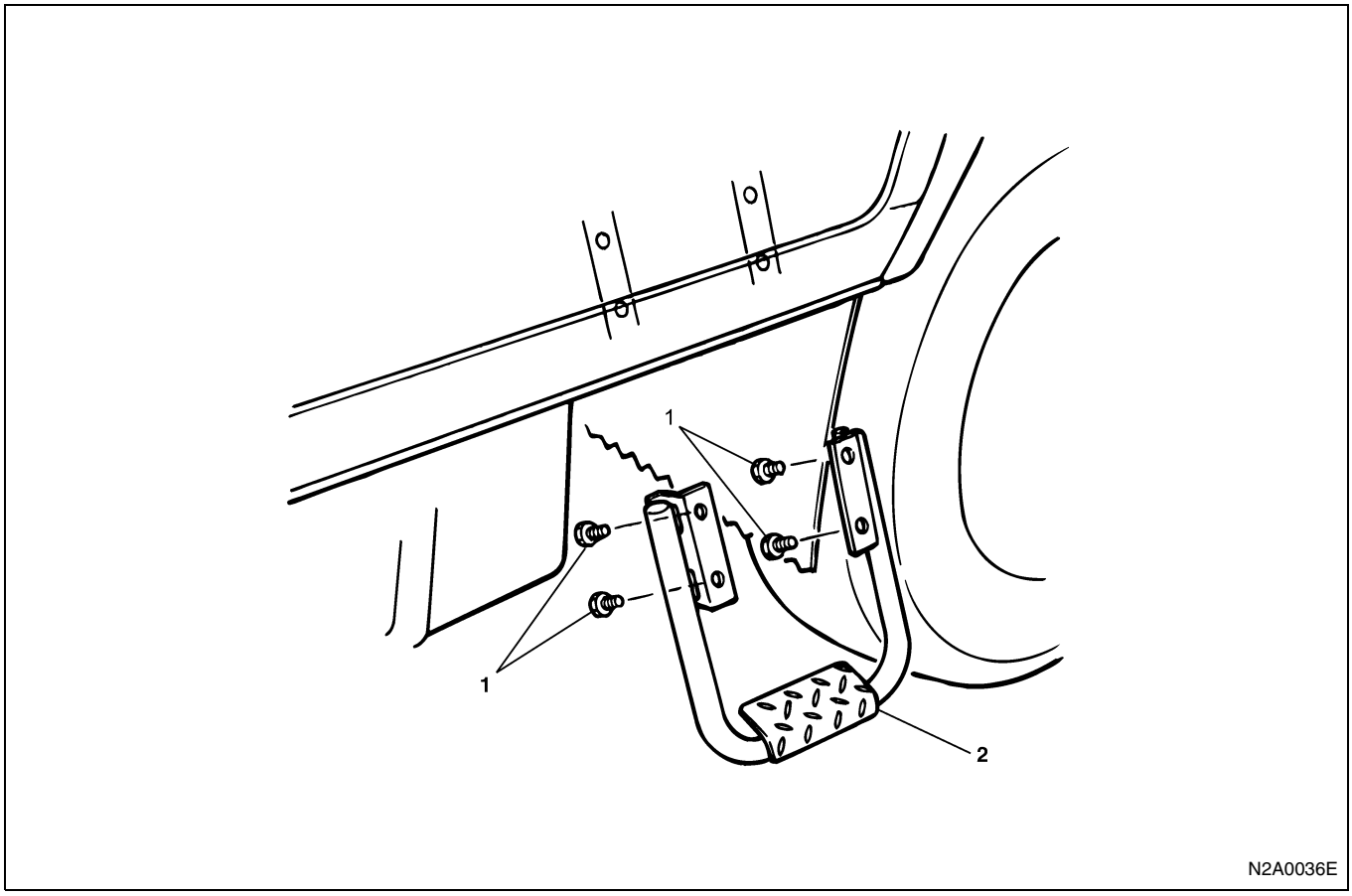
2. Make sure that the clip gets caught the tip of check arm pin securely.

Fixing Torque



Rear Step (Crew Cab Model)

Component



Legend

1. Fixing bolt
2. Rear step

Removal

1. Fixing bolts
   - Remove the 4 fixing bolts.
2. Rear step

Installation

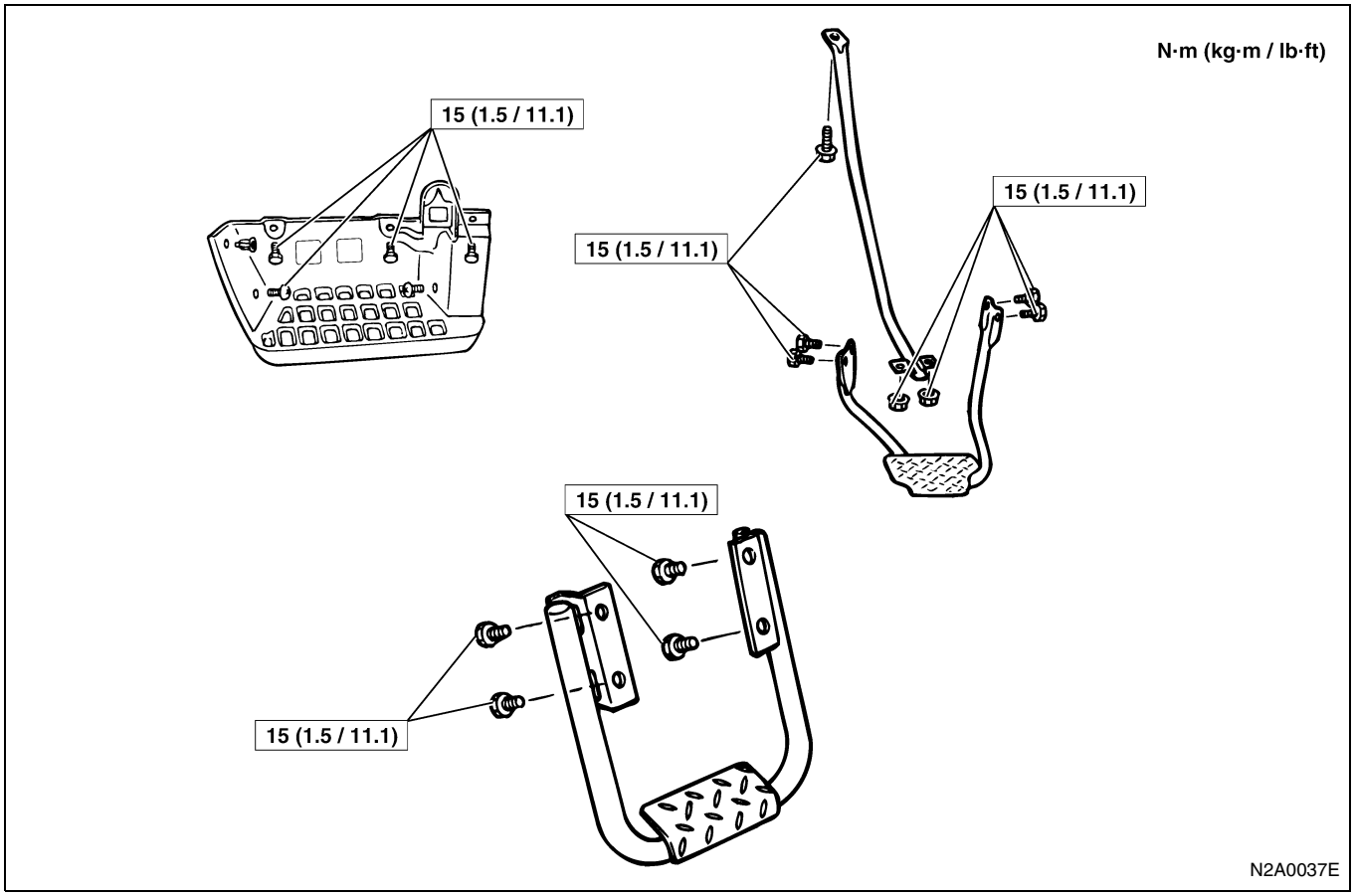
For installation, reverse the removal procedure taking the following points into consideration.

1. Tighten the fixing bolts to the specified torque.

Tighten:

Fixing bolt to 15 N·m (1.5 kg·m/11.1 lb·ft)

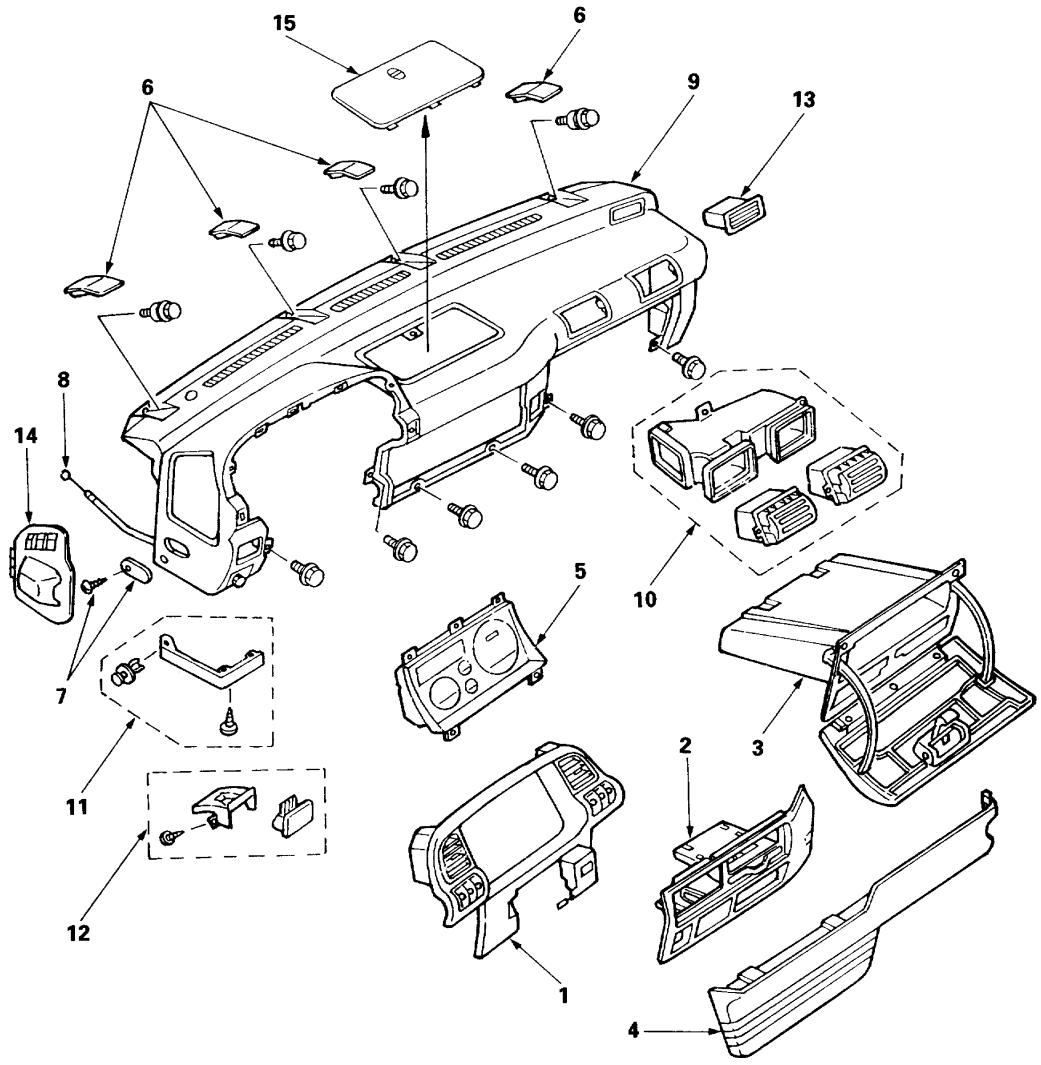
Fixing Torque



INSTRUMENT PANEL

Instrument Panel Assembly

This illustration is based on LHD.



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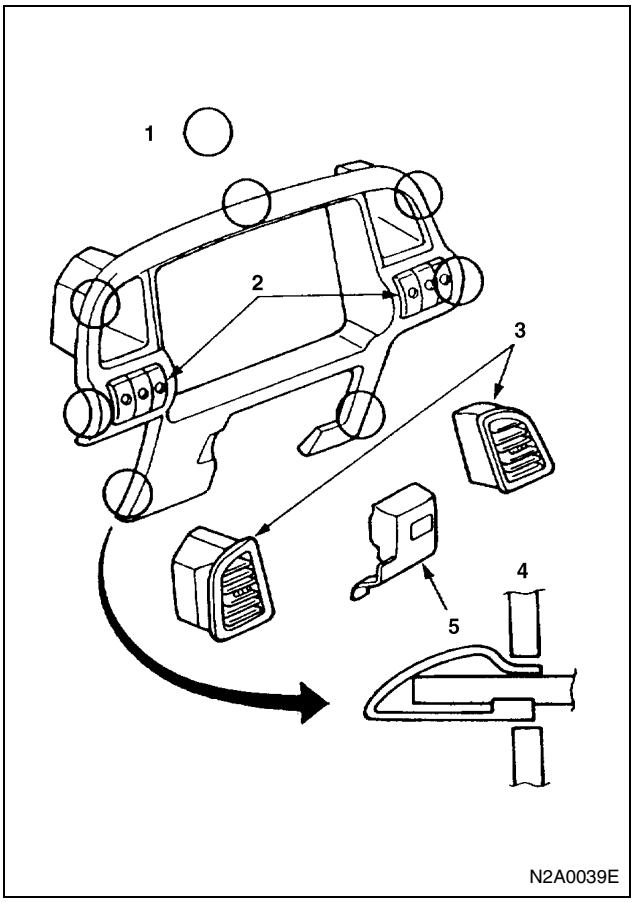
Legend

1. Meter cluster
2. Center cluster
3. Glove box
4. Under cover
5. Meter assembly
6. Front cover
7. Instrument side grommet
8. Idling control cable
9. Instrument panel assembly
10. Vent duct
11. Instrument panel extension
12. Ashtray (driver's seat side)
13. Side defroster nozzle
14. Fluid tank cover
15. Relay lid

Removal

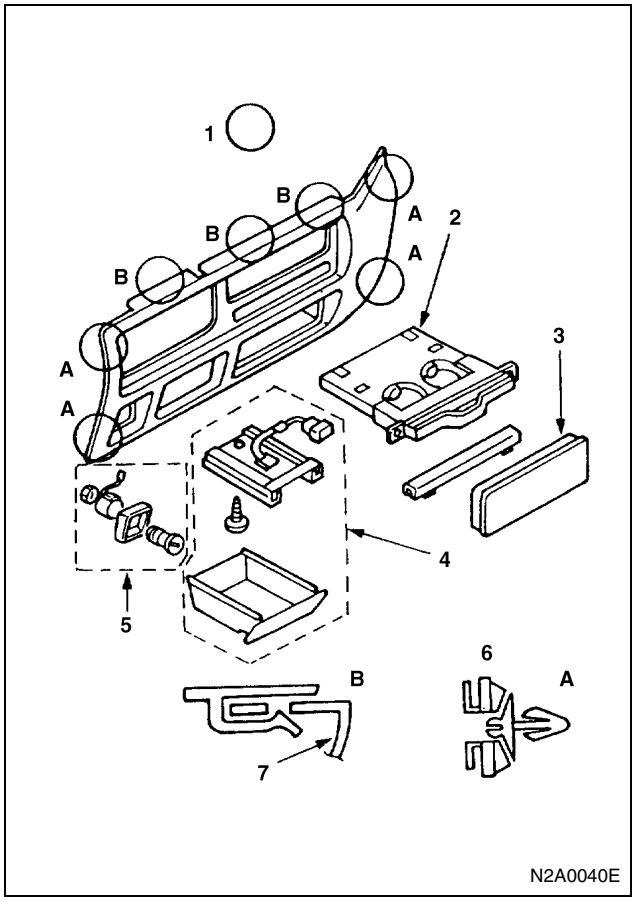
1. Meter cluster
   - Pull the main unit toward you and remove the clips at 7 positions. Remove each switch connector. When switches are mounted on the switch cover, remove the connectors.
   - Remove the vent grille, switch cover and each switch from the cluster proper.



Legend
1. Clip position
2. Switch
3. Vent grill
4. Clip section
5. Switch cover

2. Center cluster
   - Pull the main unit toward you and remove the clips A at 4 positions, clips B at 3 positions, cigar lighter power source and ashtray lighting connector. When an auto air conditioner is mounted, remove the room sensor.
   - Remove the drink holder, control unit cover (or glove compartment), ashtray and cigar lighter from the center cluster proper.

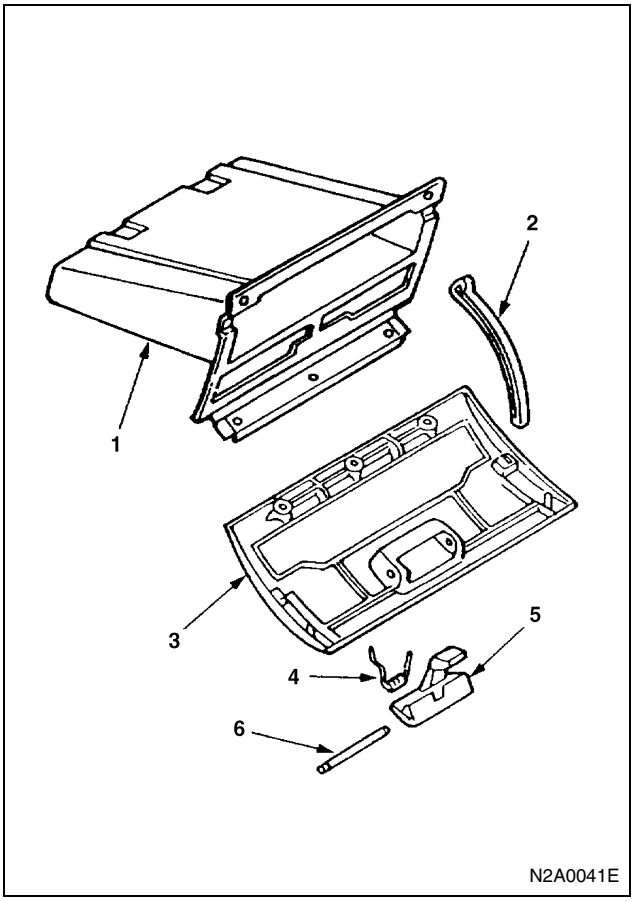
Caution:
Remove the clips B with a bladed screwdriver.



Legend
1. Clip position
2. Drink holder
3. Control unit cover
4. Ashtray
5. Cigar lighter
6. Clip section
7. Center cluster

3. Glove box
   - Open the lid and remove the 4 mounting screws.
     Then, remove the main unit.
   - Remove the left and right stays, remove the 3 mounting screws, and remove the lid.
   - Pull out the pin from the lid and remove the spring and lever.

Caution:
The Instrument panel assembly of this item can be removed without disassembling each of the parts of above items 1 — 3.

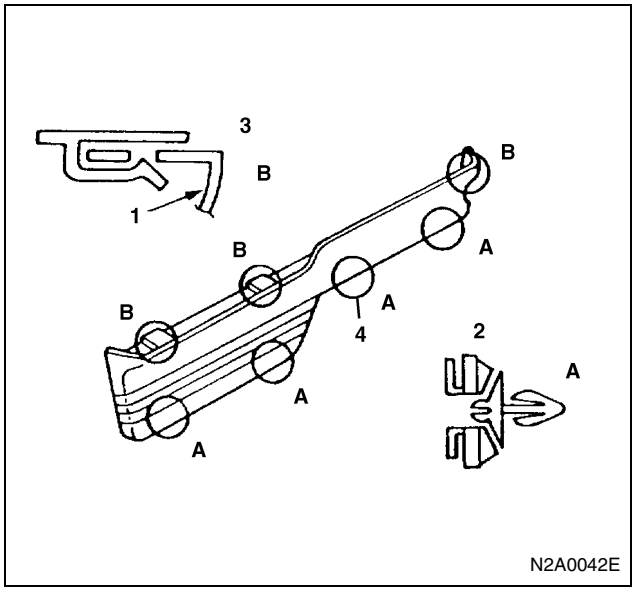


Legend

1. Glove box
2. Stay
3. Glove box lid
4. Spring
5. Lever
6. Pin

4. Under cover
   - Pull the main unit toward you and remove the clips A at 3 positions (4 positions for the wide cab) and clips B at 3 positions. First remove the clips B.

Caution:
The above parts of 1 to 4 can be removed in any order, or each of them can be removed independently.

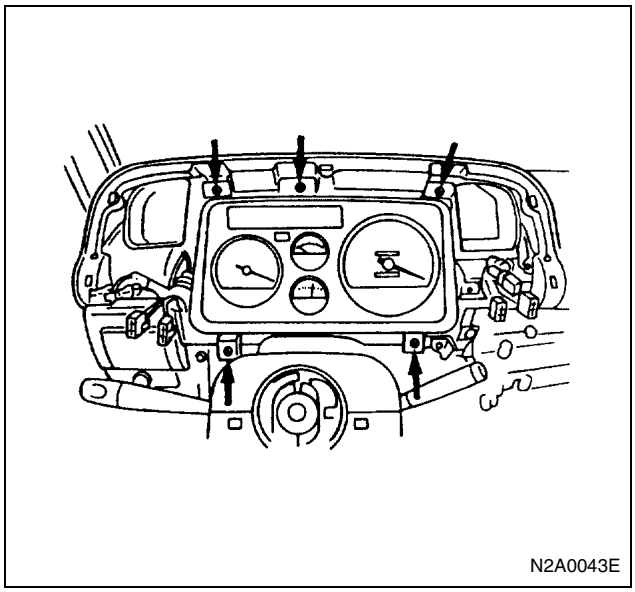


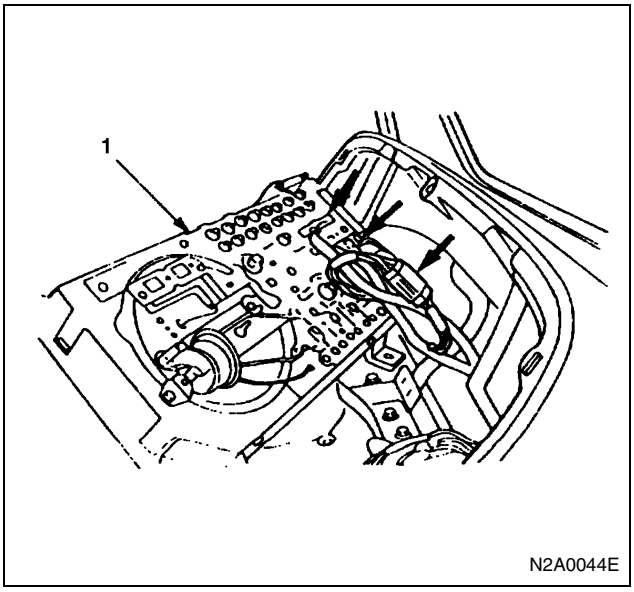
Legend

1. Center cluster
2. Clip section A
3. Clip section B
4. NPR only

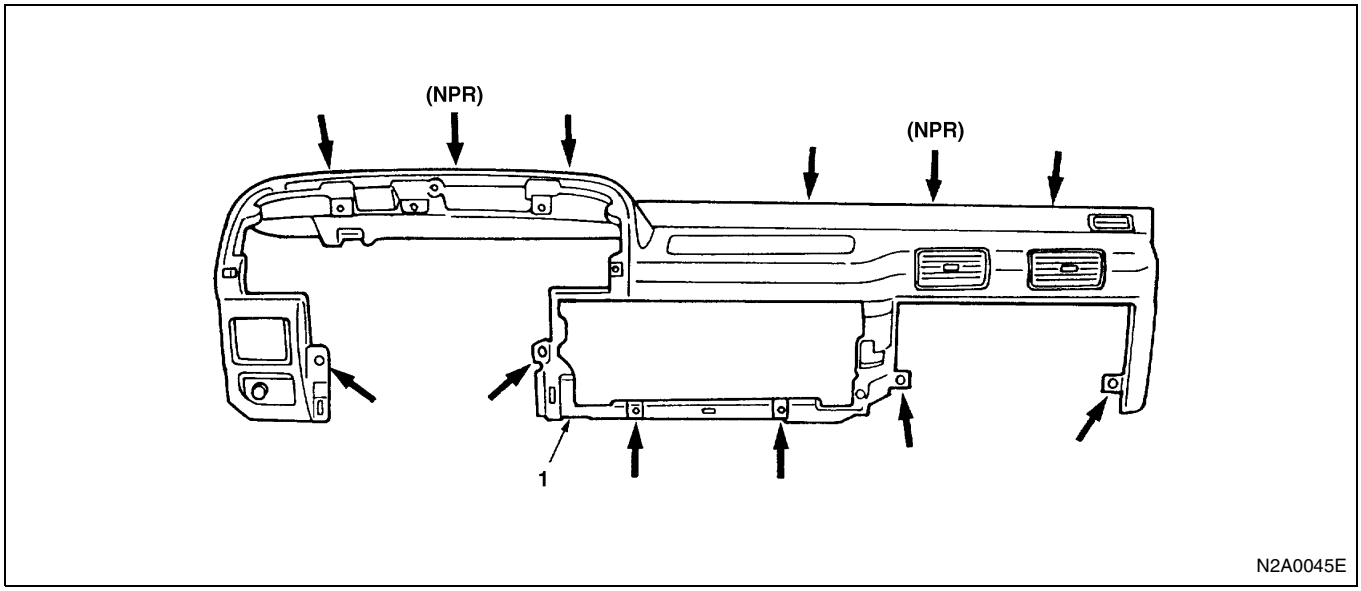
5. Meter assembly
   - Remove the 5 mounting screws.
   - Remove the connector.

Caution:
To remove only the meter assembly (1), it can be attained by removing the meter cluster.





6. Front cover
7. Instrument side grommet
   - Remove the screws and pull out the instrument side grommet.
8. Idling control cable
   - Remove the clip on the accelerator pedal side.
9. Instrument Panel assembly
   - Remove the 10 mounting bolts (Wide cab=12 bolts). When the vehicle is provided with an auto air conditioner, remove the solar radiation sensor connector and harness clips from the duct and push the instrument panel assembly (1) from the rear side.



10. Vent duct
    - Remove the mounting screws.
11. Instrument panel extension
    - Remove the mounting screws and clips.
12. Ashtray (driver's seat side)
    - Pull out the main unit and remove the tray mounting screws.
13. Side defroster nozzle
    - Push out the side defroster nozzle from the rear side of the instrument panel assembly.
14. Fluid tank cover
    - Pull out the fluid tank cover.
15. Relay lid

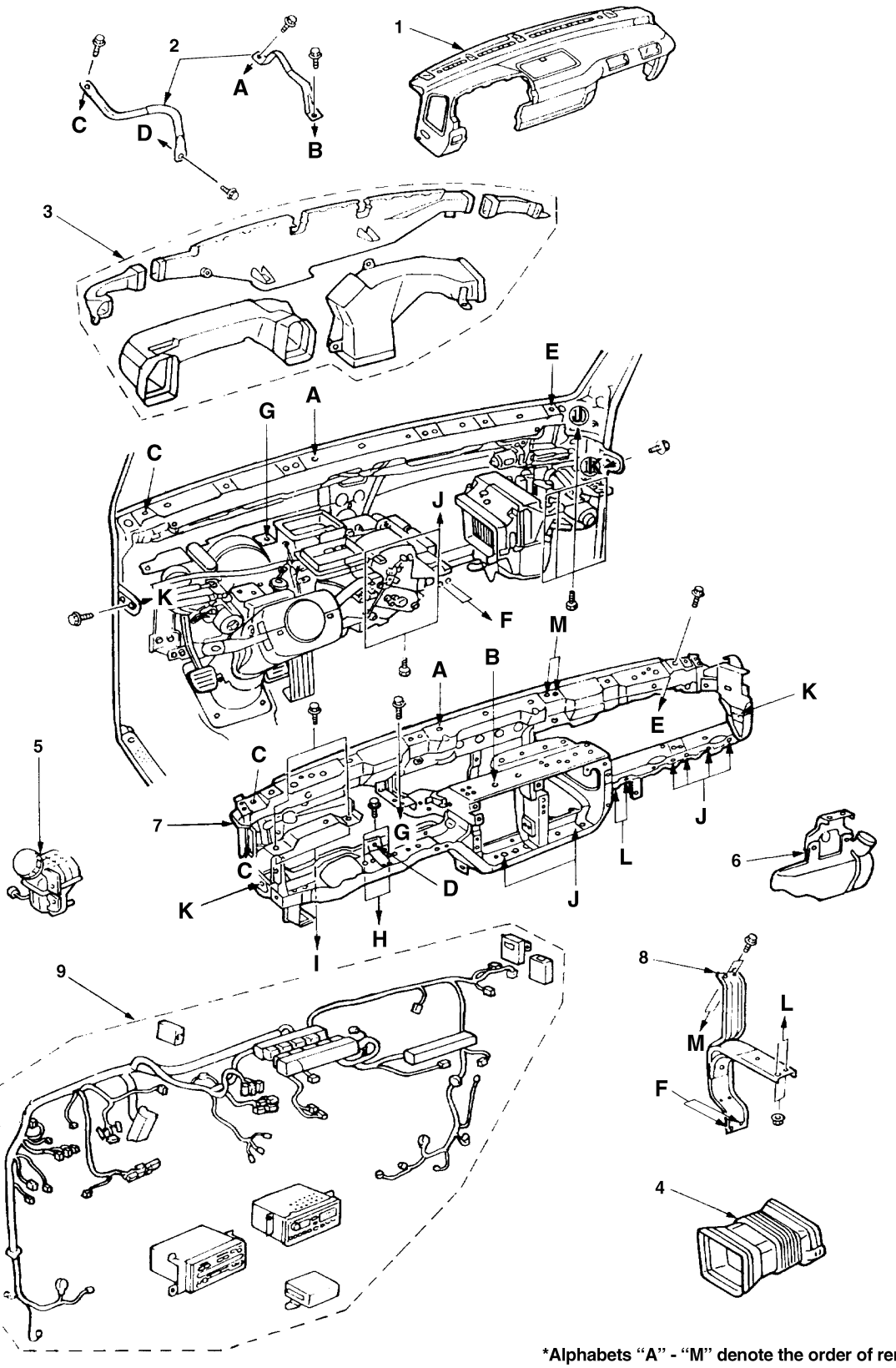
Installation

For installation, reverse the removal procedure taking the following points into consideration.

1. After installing each connector, check the operation of each equipment.

Instrument Reinforcement Assembly

This illustration is based on LHD.



*Alphabets "A" - "M" denote the order of removing bolts.

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Legend

1. Instrument panel assembly
2. Instrument center/side stay
3. Defroster nozzle/ventilation duct
4. Intermediate duct (wide cab model)
5. Brake/clutch fluid reserve tank
6. Washer tank/bracket
7. Instrument reinforcement assembly
8. Instrument support bracket (wide cab model)
9. Body harness/controller/radio

Removal

1. Instrument panel assembly
   - Refer to “Instrument panel assembly” in this Section.
2. Instrument center/side stay
   - Remove the mounting bolts A — D.
3. Defroster nozzle/ventilation duct
   - Refer to “Heater/Air Conditioner Workshop Manual”.
4. Intermediate duct (wide cab model)
5. Brake/clutch fluid reserve tank
   - Remove the level switch connector and remove the 4 nuts.
   - Extract the fluid and remove each tube.

Caution:
Don’t apply the brake/clutch fluid to the resign portions and painted portions in any case.

6. Washer tank/bracket
   - Remove the washer motor connector and washer tube and remove the two bolts fixing the bracket and the one bolt in the lower part of the tank.
7. Instrument reinforcement assembly
   - Remove all the connectors of electrical equipments.
   - Remove the mounting bolts E — K.
   - When the vehicle is provided with a manual air conditioner, remove each control cable. For removal, refer to “Heater/Air conditioner Workshop Manual”.
8. Instrument support bracket (wide cab model)
   - Remove the bolts L and M and remove the instrument support bracket from the instrument reinforcement assembly.
9. Body harness/controller/radio
   - Remove the body harness/controller/radio from the instrument reinforcement assembly. Refer to “Electrical Equipment Workshop Manual” and “Heater/Air Conditioner Workshop Manual”.

Installation

For installation, reverse the removal procedure taking the following points into consideration.

1. Tighten each bolt to the specified tightening torque.

Tighten:

- G: Clutch pedal bracket upper bolt to 37 N·m (3.8 kg·m/27 lb·ft)
- H: Steering column bracket bolt to 20 N·m (2.1 kg·m/14 lb·ft)
- I: Brake pedal bracket upper bolt to 42 N·m (4.3 kg·m/32 lb·ft)

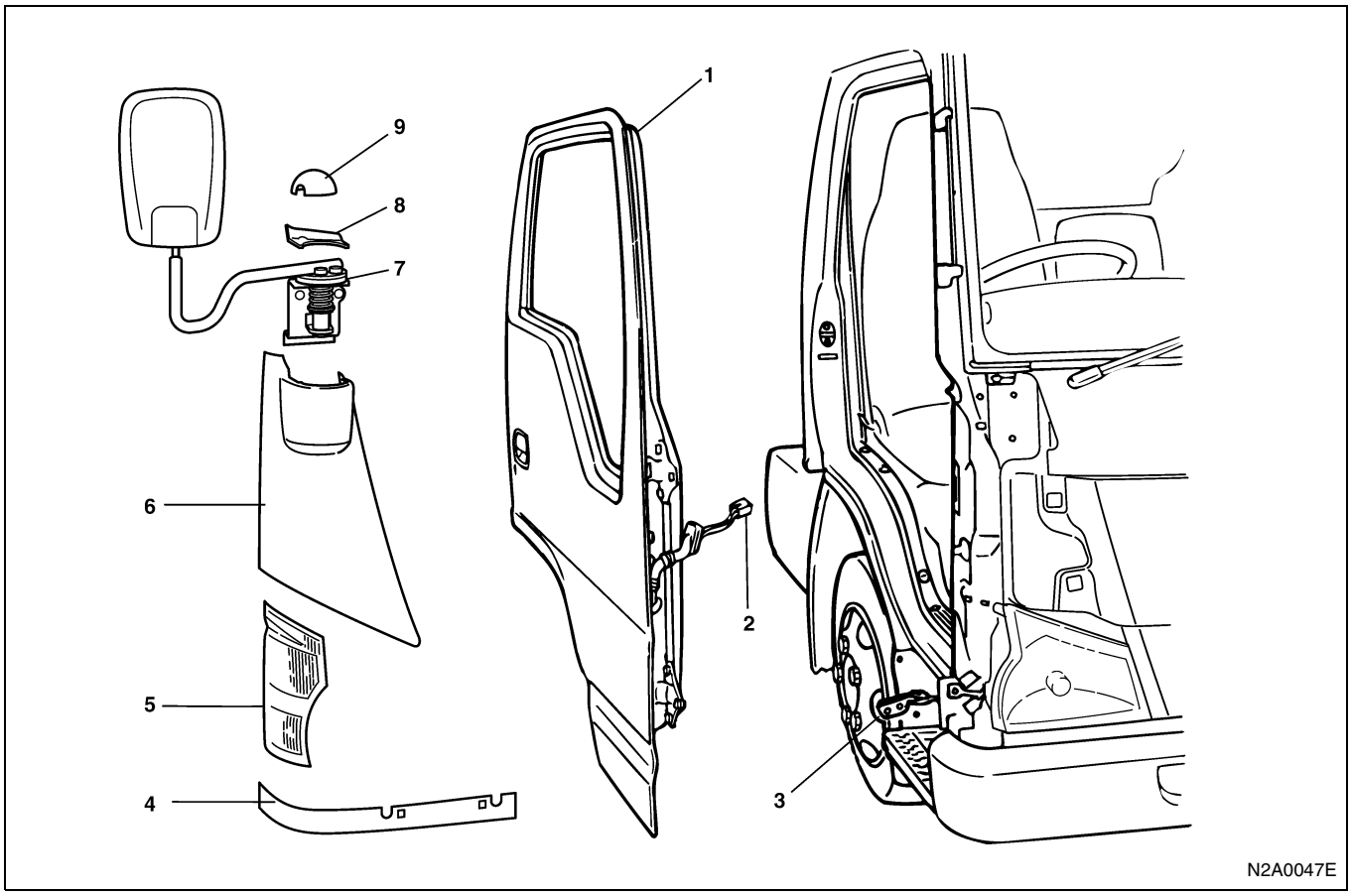
Tighten the other bolts and nuts to the standard torque.

2. Perform air bleeding for the brake and clutch.

DOOR

Front Door Assembly

Component

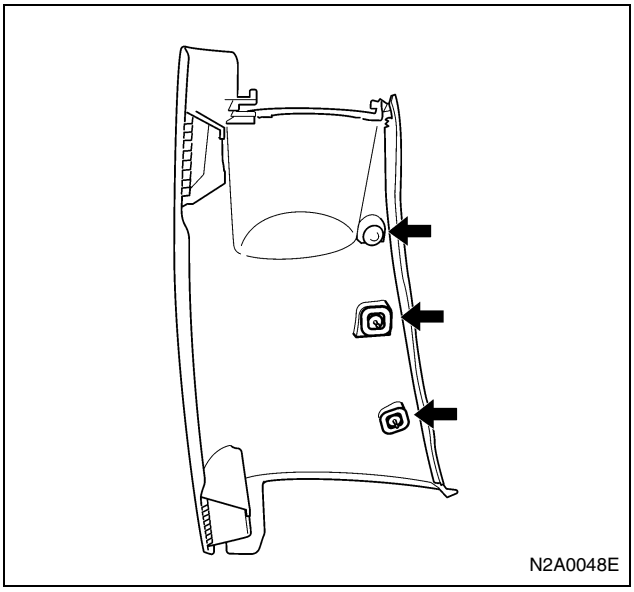


Legend

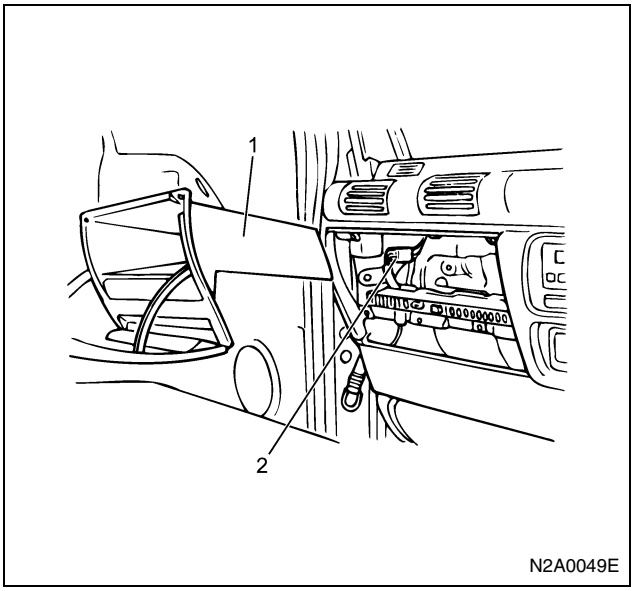
1. Front door assembly
2. Door harness connector
3. Door check arm
4. Headlamp lower cover
5. Front combination lamp
6. Front panel side
7. Outside mirror
8. Outside mirror sub cover
9. Outside mirror stay cap

Removal

1. Disconnect the battery ground cable.
2. Headlamp grille
   - Pull out the head lamp grille toward you.
3. Front combination lamp
   - Remove the mounting screw and disconnect the connector.
4. Front panel side
   - Remove the bolt.
   - Be careful the 3 clips shown in the figure when removing the front panel side.


N2A0048E

5. Outside mirror/molding
   - Refer to “Outside Mirror Assembly” in this Section.
6. Disconnect the door harness connector (2).
   - To remove the door on the assistant’s seat side, remove the glove box (1) and disconnect the connector.



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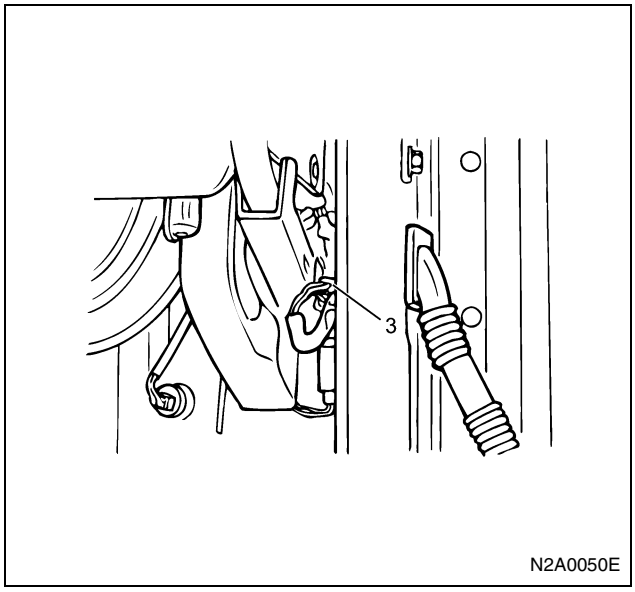
   - To remove the door on the driver’s seat side, disconnect the connector (3) from the bottom side of the instrument panel.



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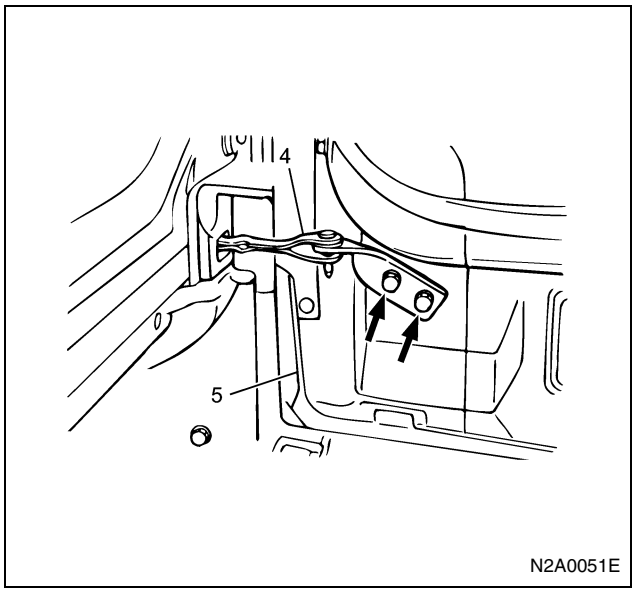
7. Door check arm (4)
   - Remove the 2 mounting bolts on the door side (5).



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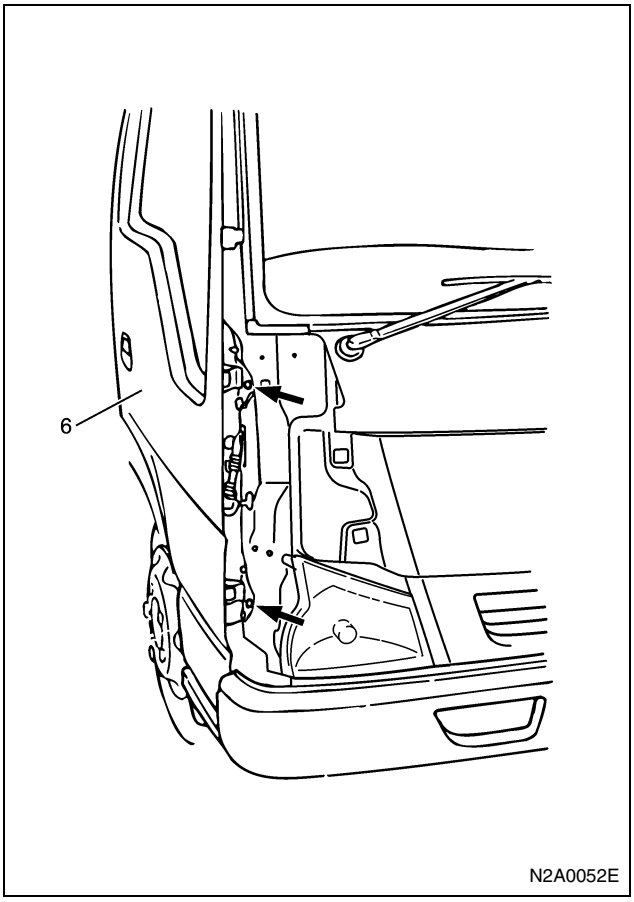
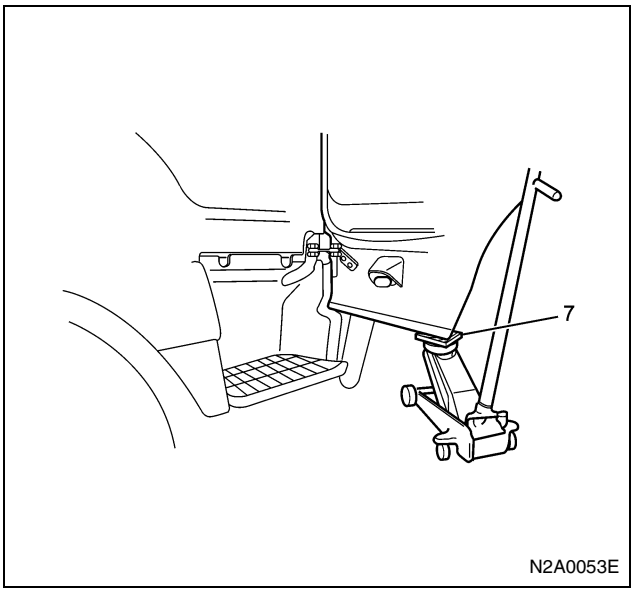
8. Front door assembly (6)
   - Remove the one mounting bolt for each hinge on the front side while the door is closed.
   - Put mark on the hinge beforehand.

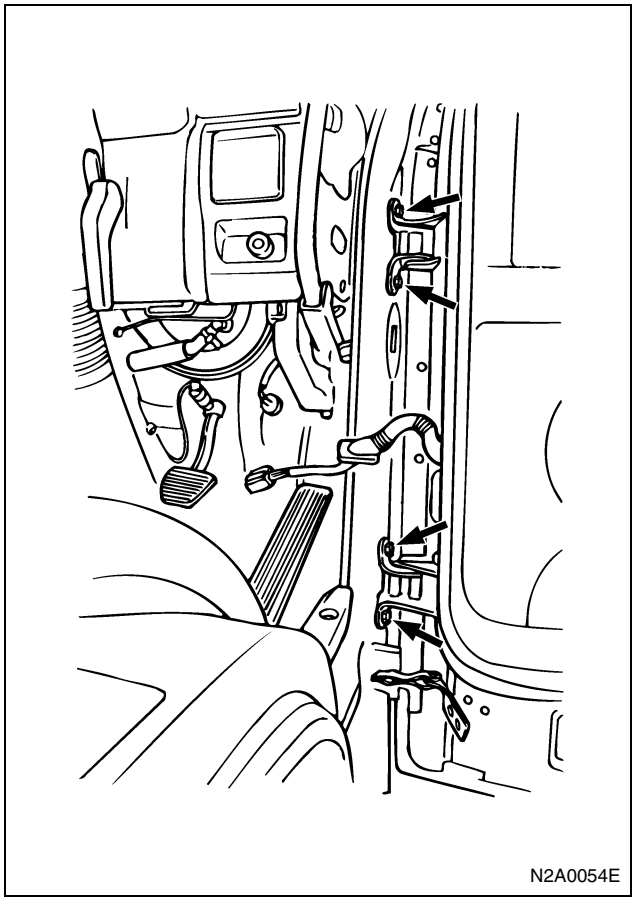


- Open the door and support it with garage jack etc.

Caution:
To prevent scratches, support it with a waste cloth or wooden piece (7).



- Remove the 2 mounting bolts for each hinge on the rear side while the door is open.



Installation

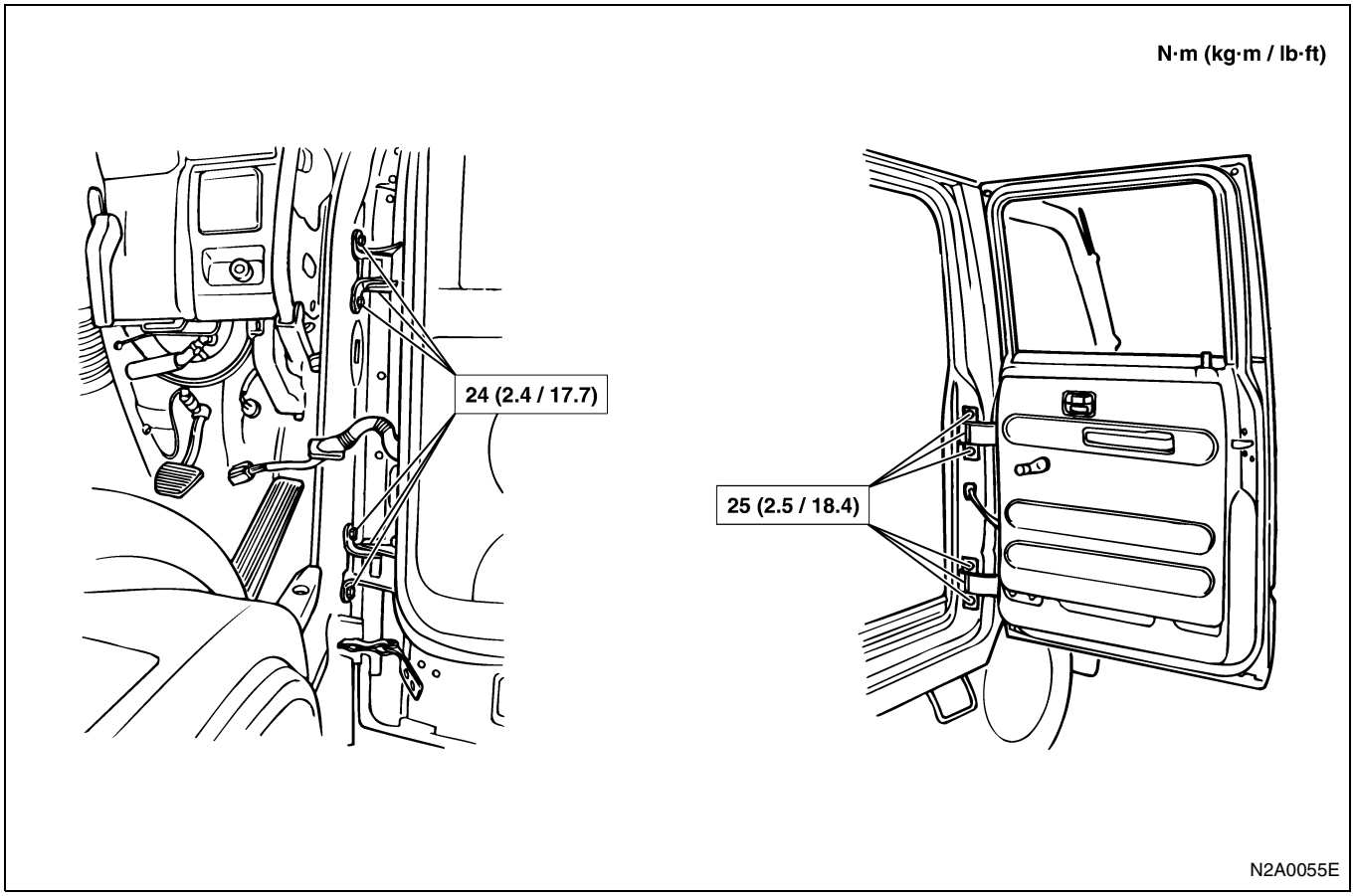
For installation, reverse the removal procedure taking the following points into consideration.

1. Tighten the mounting bolts to the specified torque.

Tighten:
Mounting bolt to 24 N·m (2.4 kg·m/17.7 lb·ft)

2. Adjust the door installation position referring to “Body Panel Assembly” in Body Panel Section.

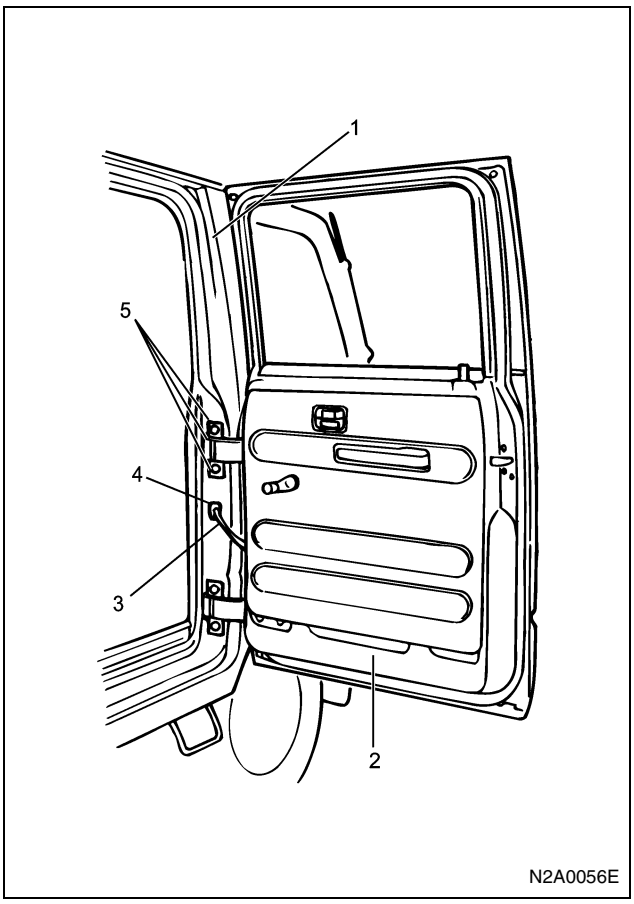
Fixing Torque



Rear Door Assembly

Removal

1. Rear door harness connector (4)
   - Remove the harness grommet (3) and disconnect the connector inside center pillar (1).
2. Rear door assembly mounting bolt (5)
   - Support the rear door assembly and remove the 3 bolts on each hinge. (Put mark on the hinge beforehand.)
3. Rear door assembly (2)



Installation

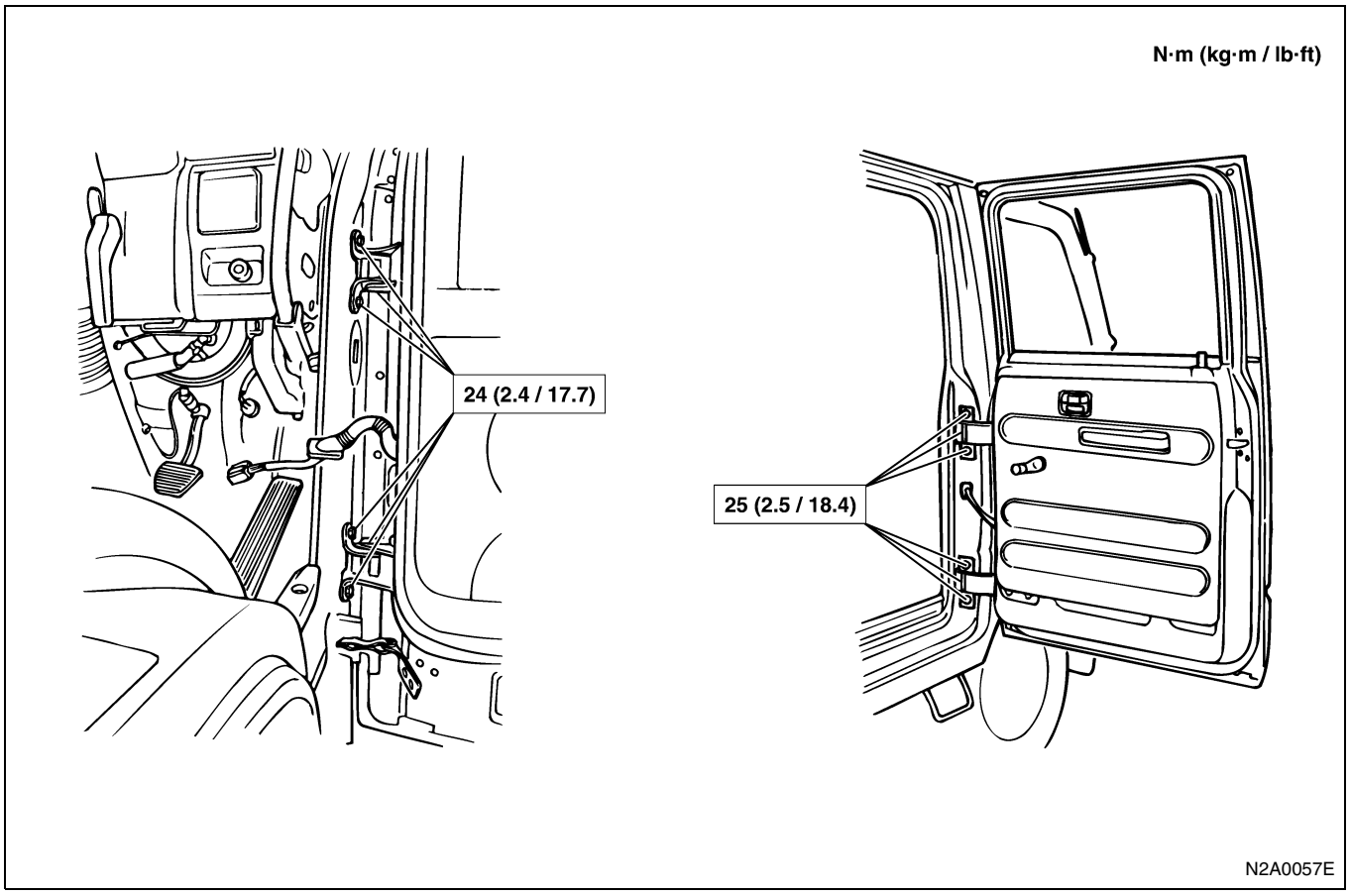
For installation, reverse the removal procedure taking the following points into consideration.

1. Tighten the rear door assembly mounting bolts to the specified torque.

Tighten:

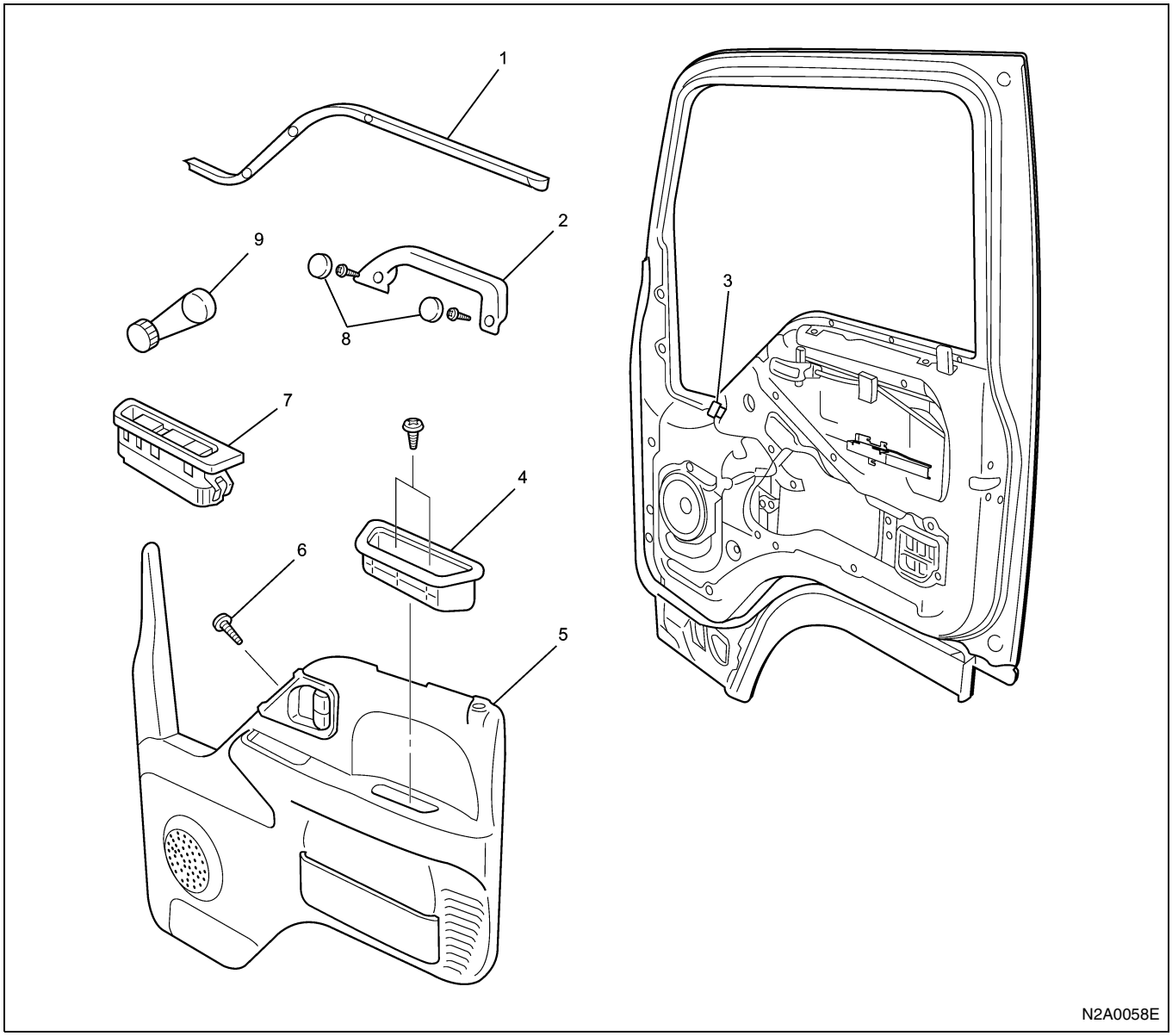
Rear door assembly mounting bolt to 25 N·m (2.5 kg·m/ 18.4 lb·ft)

Fixing Torque



Front Door Trim Pad

Component

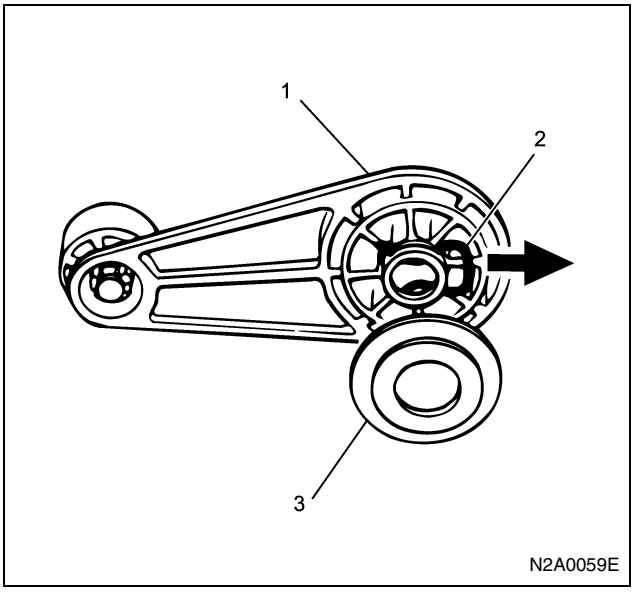


Legend

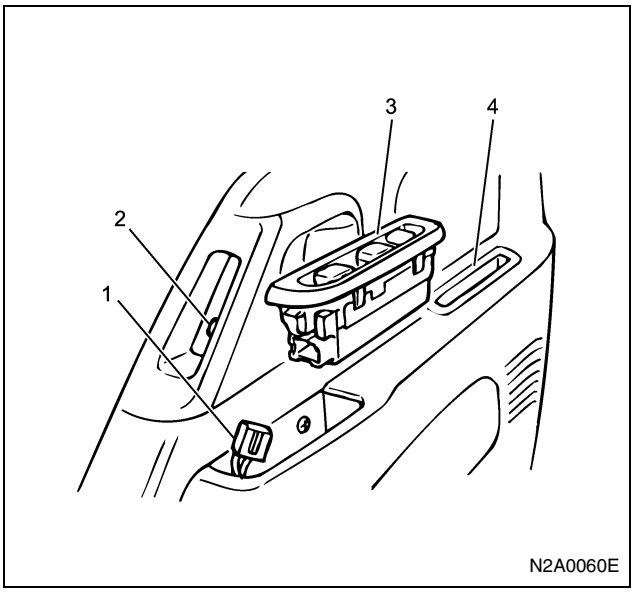
1. Inner waist seal
2. Guard bar (High cab model, wide cab model)
3. Power window switch connector
4. Door pull case
5. Front door trim pad
6. Screw
7. Power window switch
8. Grommet
9. Window regulator handle (if equipped)

Removal

1. Disconnect the battery ground cable.
2. Guard bar (high cab model, wide cab model)
   - Open the grommet and remove the 2 screws.
3. Inner waist seal
   - Remove the clips one by one with a bladed screwdriver. Note that excessive force will cause deformation. Be careful not scratch the pillar with their edge while removing.
4. Window regulator handle (1). (if equipped)
   - Pull the fixing pin (2) to remove the washer (3) and body.

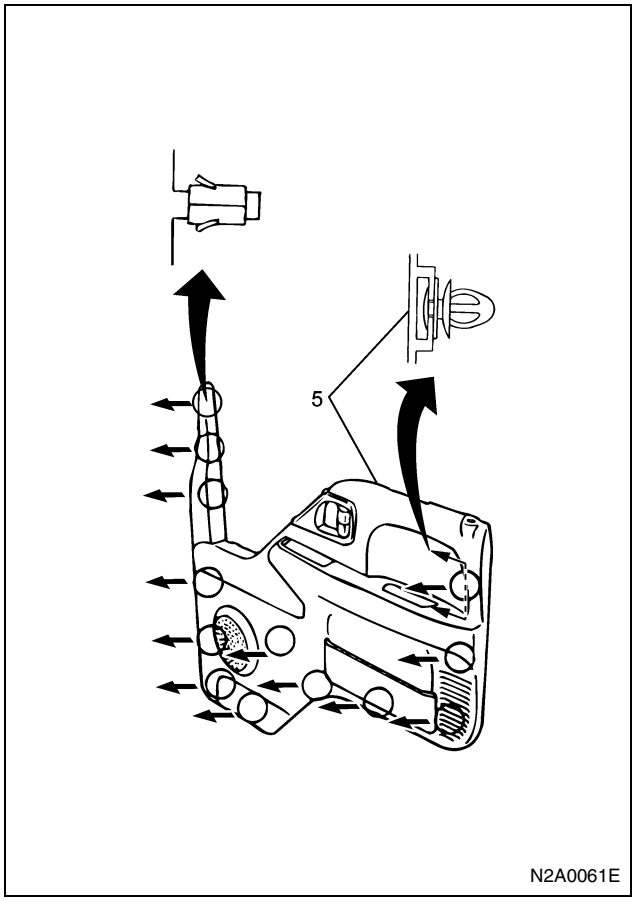


5. Power window switch (3)
   - Pull out the switch from the door trim pad and disconnect the connector (1).
6. Screw (2)
7. Door pull case (4)
   - Remove the 2 mounting screws.



Caution:
The above parts 3 to 5 can be removed in any order or each of them can be removed independently.

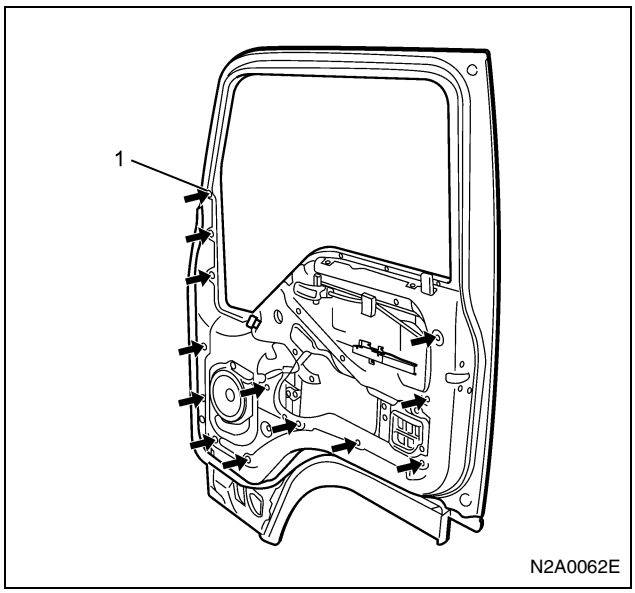
8. Front door trim pad (5)
   - Remove the clips at 13 positions.



Installation

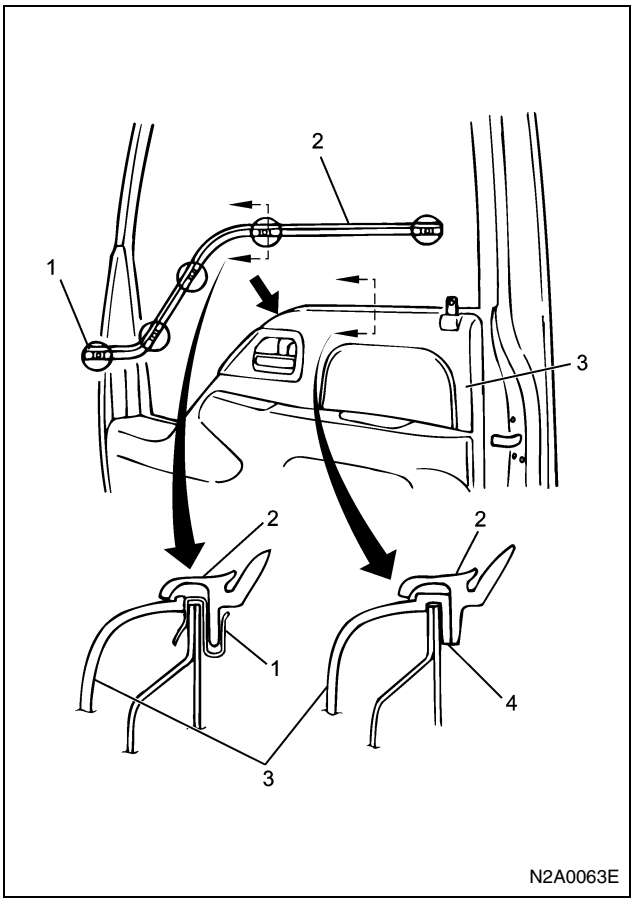
For installation, reverse the removal procedure taking the following points into consideration.

1. Adjust the trim pad clip to the mounting hole (1) on the door panel side and install the trim pad so as to prevent any float, skewness or door harness bite.



2. To install the inner waist seal (2), align the front end so that the seal hang over the 4 claws (4) of upper part of the trim pad (3) and insert the clips in sequence starting from the front end clip (1). Note that applying force in transverse direction will cause deformation.

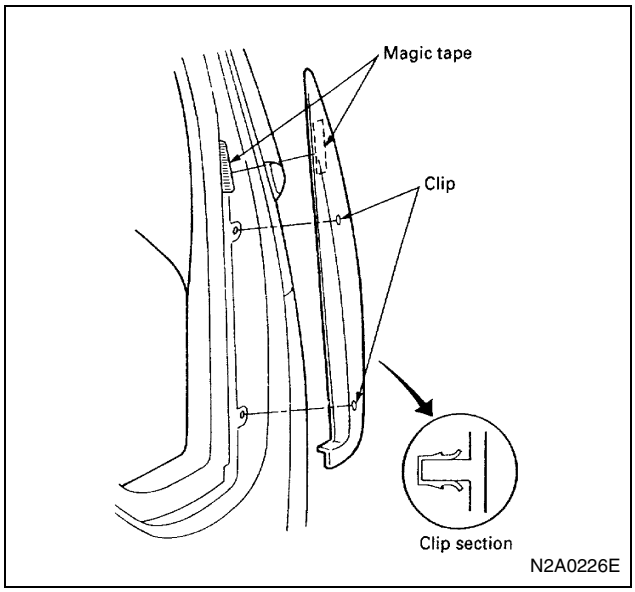
Caution:
Be extremely careful that the painted surface of pillar bottom part may be scratched by the cored bar of the both ends of inner waist seal during removal. If it get damaged, touch up it with appropriate color to prevent rust.



Front Pillar Garnish

Removal

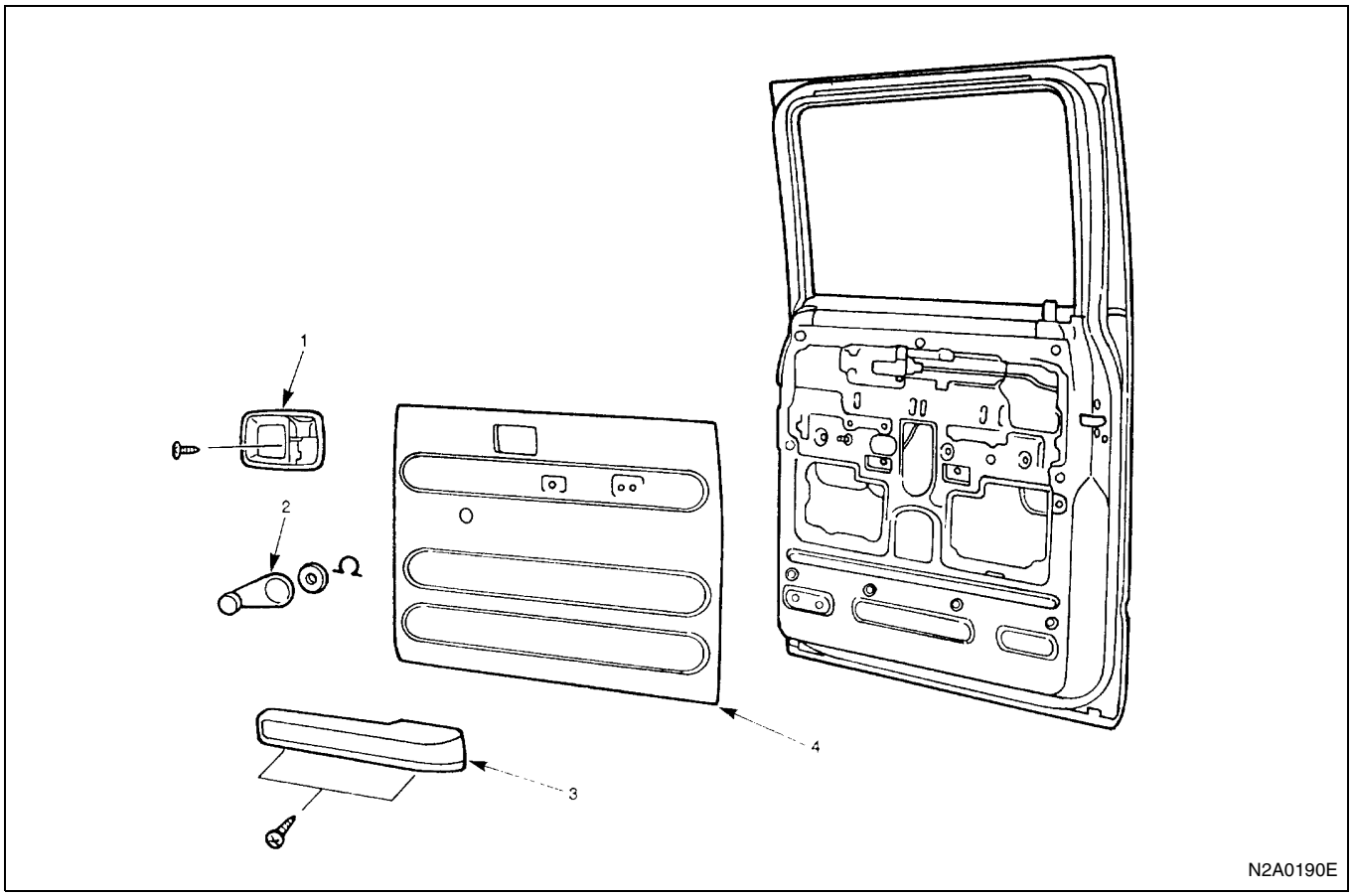
1. Front pillar garnish
   Peel off the magic tape and pull it toward you. Pull out the clips at 2 positions.



Installation

For installation, reverse the removal procedure.

Rear Door Trim Pad

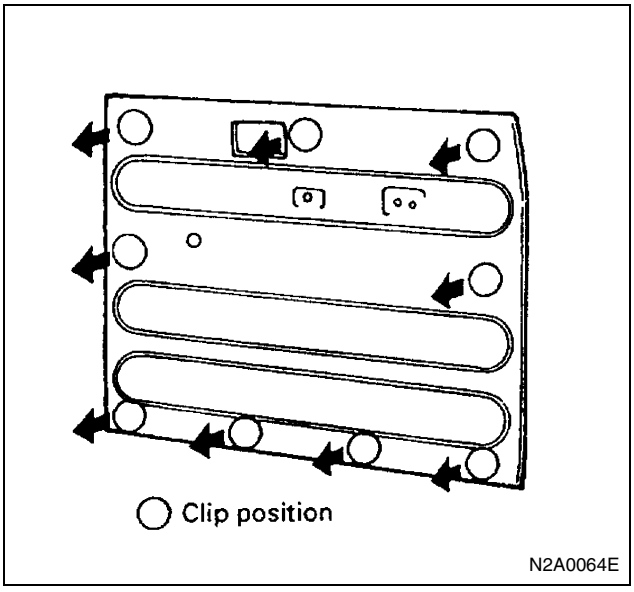


Legend

1. Inside lever bezel
2. Window regulator handle
3. Arm rest assembly
4. Rear door trim pad

Removal

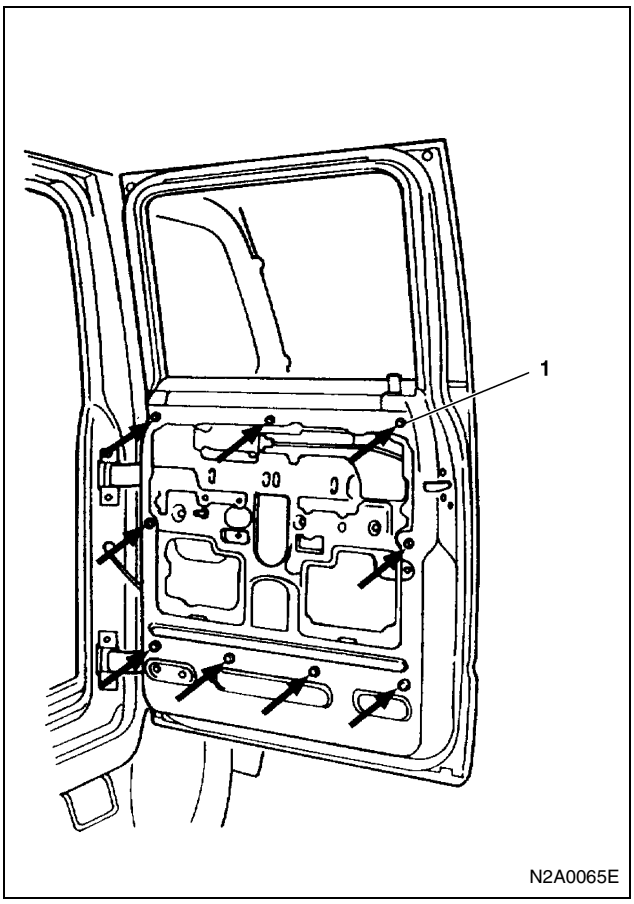
1. Inside lever bezel
   - Remove the mounting screws and draw out the bezel forward by pulling the inside lever.
2. Window regulator handle
   - Draw out the hook and dismount the handle.
3. Arm rest assembly
   - Remove the 2 mounting screws.
4. Rear door trim pad
   - Remove the clip fitting at 9 positions.



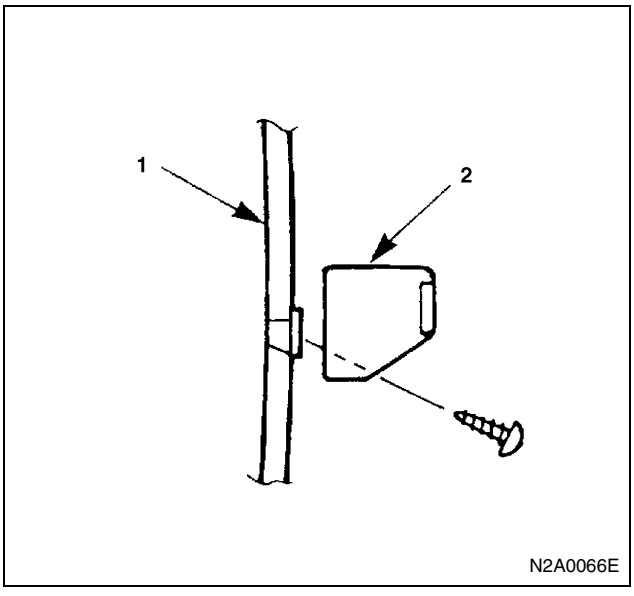
Installation

For installation, reverse the removal procedure taking the following points into consideration.

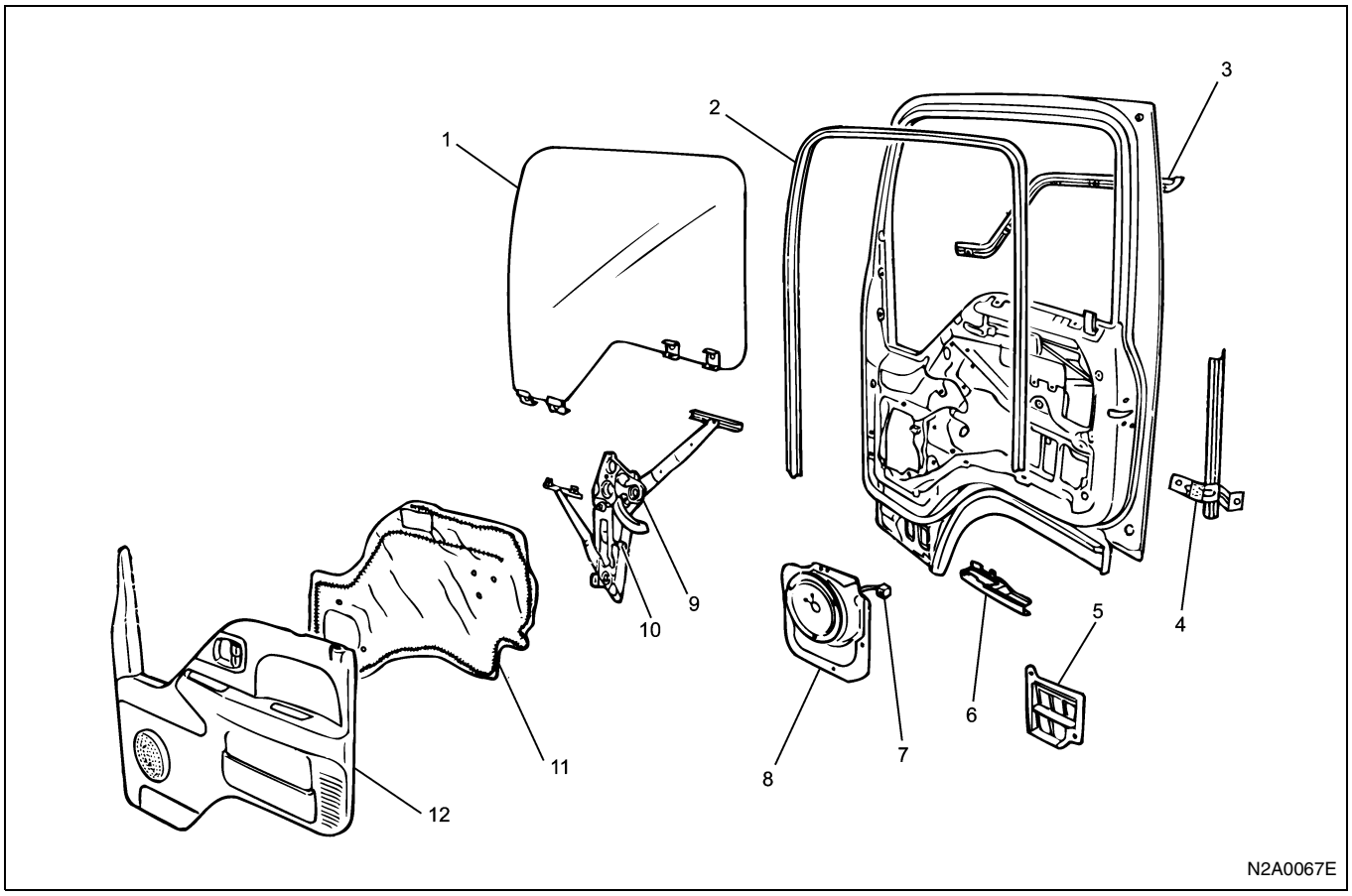
1. Install the rear door trim pad by adjusting the trim pad grip to the mounting hole (1) on the door panel side so that any float, skewness, harness bite may not exist.



2. Take care not mistake the tightening direction for the arm rest assembly (2) mounting screws.



Door Window Glass, Regulator and Glass Run

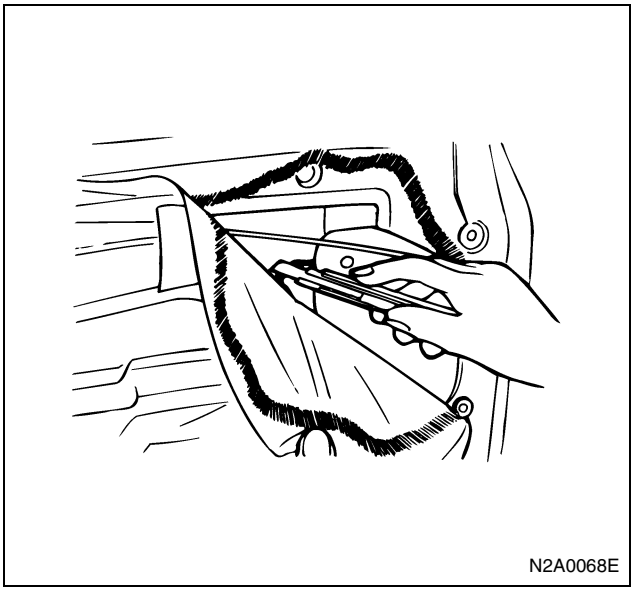


Legend

1. Glass
2. Glass run
3. Outer waist seal
4. Glass run rear channel
5. Door-out one way valve
6. Door pull case bracket
7. Speaker connector
8. Speaker
9. Window regulator
10. Power window motor connector
11. Water-proof sheet
12. Front door trim pad

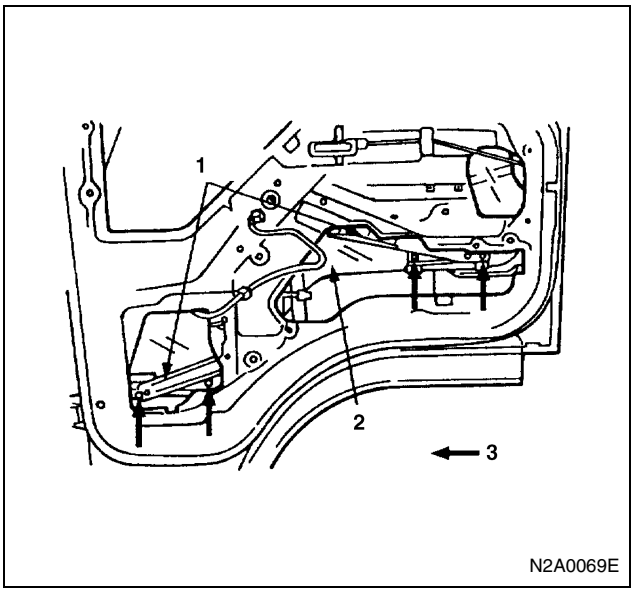
Removal

1. Front door trim pad
   - Refer to “Front door trim pad” in this Section.
2. Speaker
   - Remove the 3 screws and 1 clip and disconnect the connector.
3. Door pull case bracket
4. Door-out one-way valve
5. Water-proof sheet
   - Peel off the water-proof sheet carefully with a cutter or knife. Take care not to damage it when peeling it off.



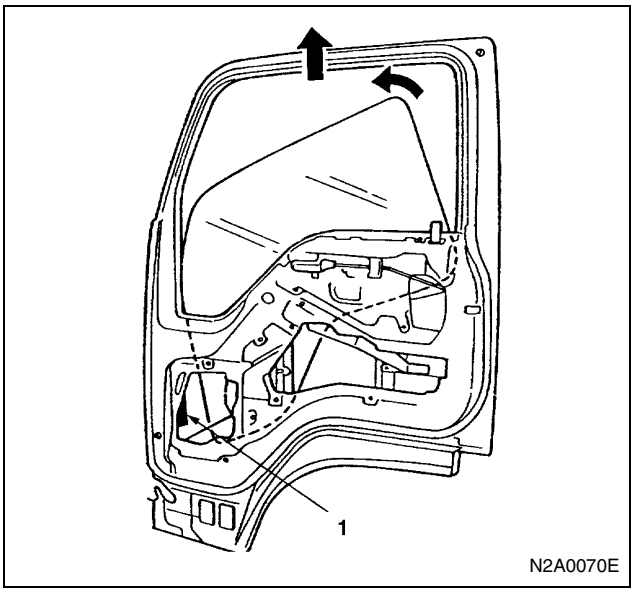
6. Outer waist seal

7. Glass
   - Lower the glass to a position where the mounting screw can be seen, and remove the 4 screws.



Legend
1. Window regulator
2. Glass
3. Screw

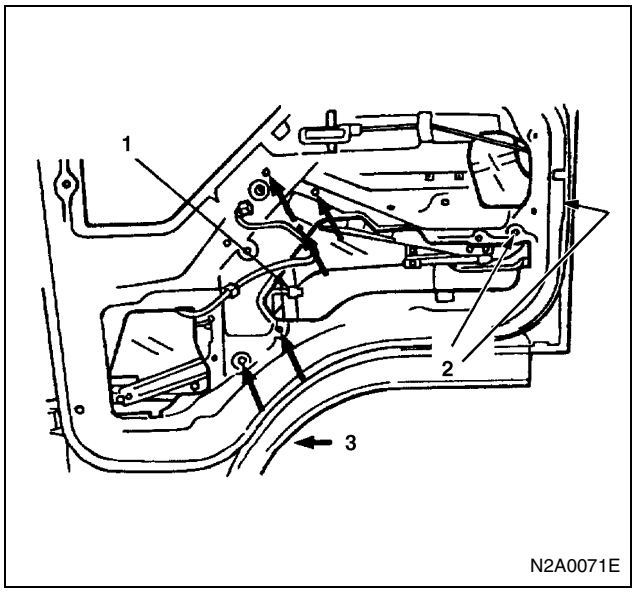
   - Lower the front side of the glass. After the front side of the glass comes off from the glass run, pull up the rear side of the glass.



Legend
1. Glass run

8. Window regulator
   - Disconnect the harness connector of the power window motor and remove the 5 mounting screws.

9. Glass run
   - Pull out the glass run from the door frame groove.
10. Glass run rear channel
   - Pull out the 2 mounting screws.

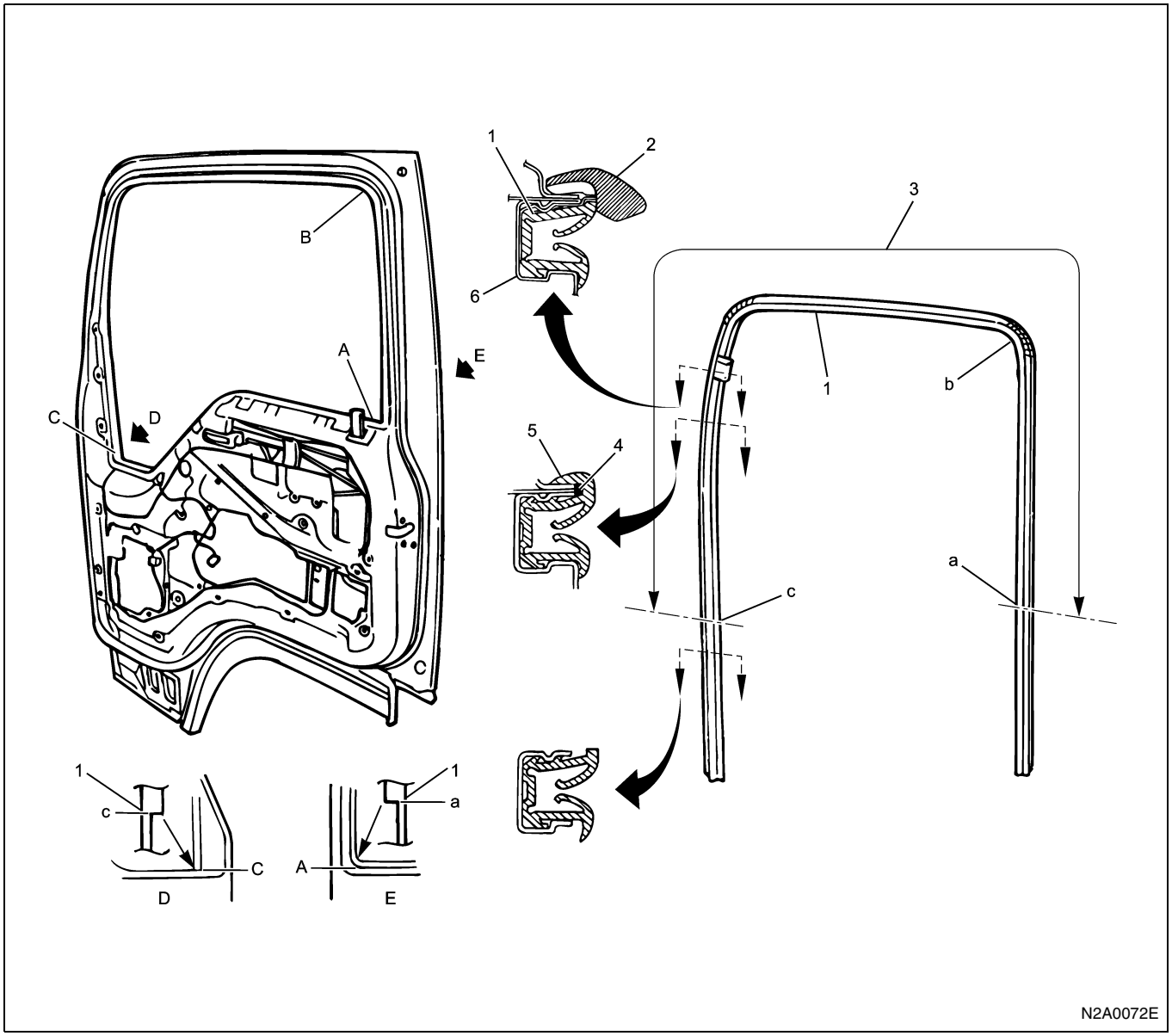


Legend
1. Power window motor connector
2. Glass run rear channel mounting screw
3. Mounting screw position

Installation

For installation, reverse the removal procedure taking the following points into consideration.

1. Align the notch a of the glass run lip with the door outer waist line A. Align the glass run slit b with the door B and fit the glass run between A and B. Next, align the notch c of the glass run lip with the door outer waist line C and fit the glass run between B and C. Fit the glass run in the channel within the door. (Refer to the illustration shown on the next.)



Legend

1. Glass run
2. Glass guide
3. Sealant application range
4. Sealant
5. Lip
6. Channel within the door

- Fit the glass run with the lip toward the outside of the vehicle.

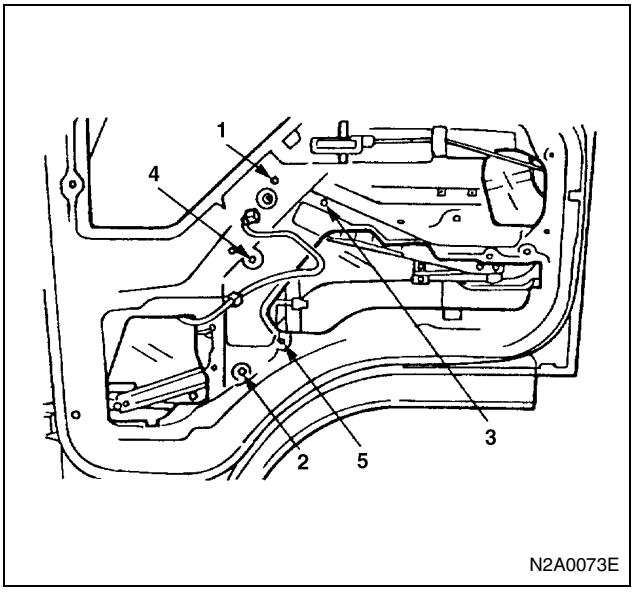
2. While the front side of the glass is lowered, insert the glass into the door panel. First, insert the rear side of the glass into the glass run, then insert the front side into the glass run. Raise the front side gradually along the glass run.

Caution:
When reusing the glass run, apply the sealant to the range shown in the figure.

Sealant: CEMEDINE 366DX or equivalent

3. Temporarily tighten the window regulator mounting screw (3) (basic hole) and tighten (1) to (5) firmly. Lastly, tighten (3) (basic hole) firmly.

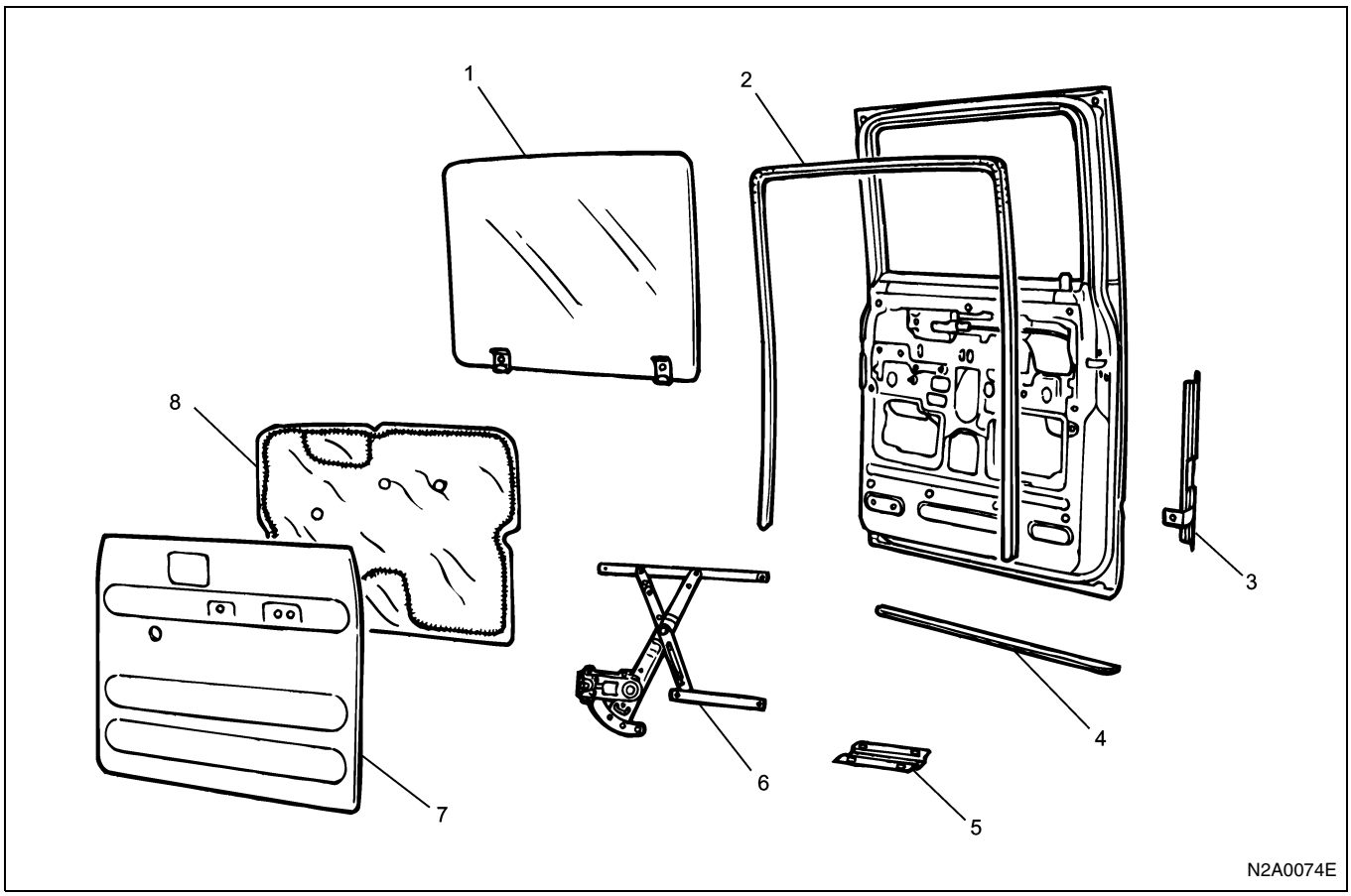
Tighten:
Window regulator mounting screw to 6 N·m (0.6 kg·m/4 lb·ft) — 7.8 N·m (0.8 kg·m/6 lb·ft)



4. Glue the water-proof sheet with an IIR tape securely.
   Check the water-proof sheet for breakage.

Rear Window Glass and Regulator

Component

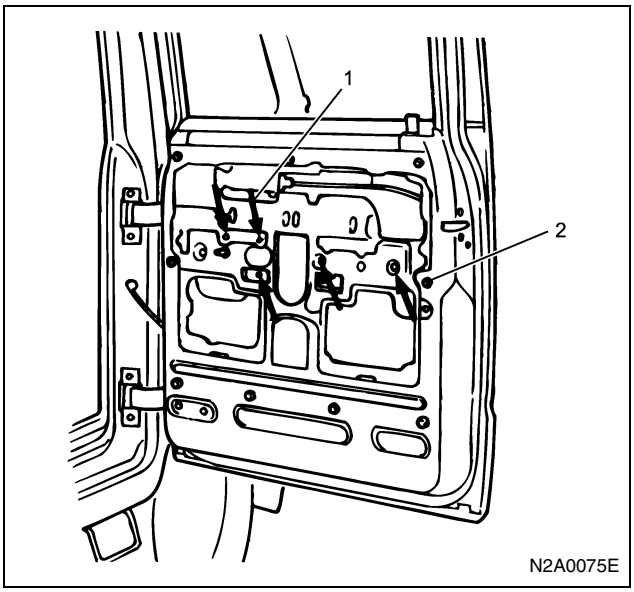


Legend

1. Rear door glass
2. Glass run
3. Glass run rear channel
4. Rear door glass plug
5. Door bottom bracket
6. Window regulator
7. Rear door trim pad
8. Water-proof sheet

Removal

1. Rear door trim pad
   - Refer to “Rear Door Trim Pad” in Interior & Exterior Trim Section.
2. Water-proof sheet
   - Peel off it carefully with a cutter or knife. Take care not to damage it when peeling it off.
3. Bottom bracket
   - Remove the 4 screws.
4. Rear door glass plug
5. Rear door glass
   - Lower the glass to a position of working holes where the mounting screws can be seen, remove the 2 screws and pull out them through the working holes in the bottom of door.
6. Window regulator
   - Remove the 5 mounting screws (1) and pull out them through the working holes.
7. Glass run
   - Pull out the glass run from the channel.
8. Glass run rear channel
   - Remove the mounting screw (2) and pull it out.



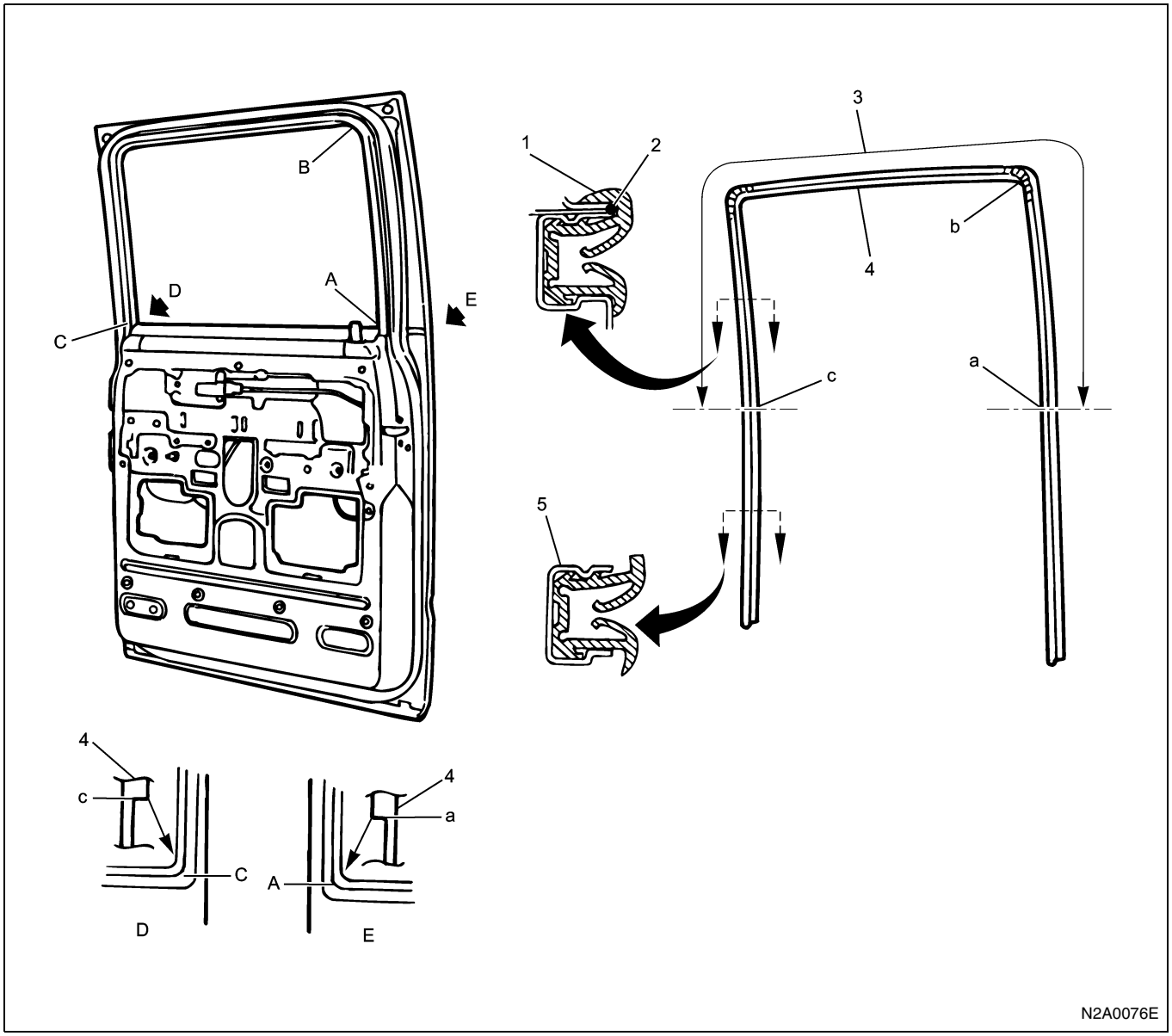
Installation

For installation, reverse the removal procedure taking the following points into consideration.

1. Align the notch (a) of the glass run lip (4) with the door outer waist line (A). Align the glass run slit (b) with the door (B) and fit the glass run between A and B. Next, align the notch (c) of the glass run lip with the door outer waist line (C) and fit the glass run between B and C. Fit the glass run in the channel (5) within the panel with the lip (1) toward the outside of the vehicle.

Caution:
When reusing the glass run, apply the sealant to the range shown in the figure.

Sealant: CEMEDINE 366DX or equivalent



Legend

1. Lip
2. Sealant application range
3. Sealant
4. Glass run
5. Channel within panel

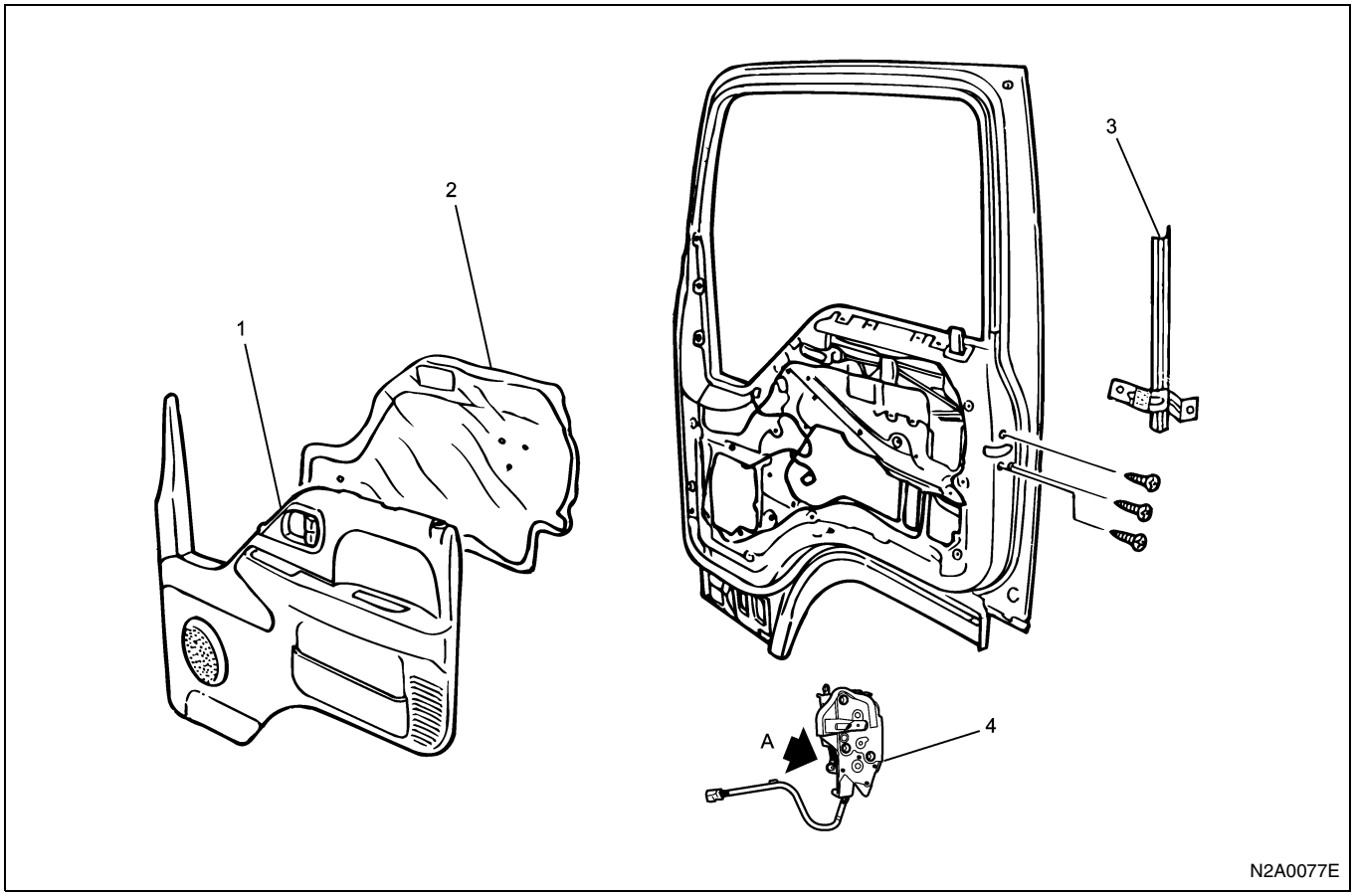
2. Insert the window regulator through the working hole to tighten the 5 mounting screws to the specified torque.

Tighten:

Window regulator mounting screw to 7 N·m (0.7 kg·m/ 5.2 lb·ft)

3. Glue the water-proof sheet with butyl tape securely. Check it for breakage.

Door Lock Assembly



Legend

1. Door trim pad
2. Water-proof sheet
3. Glass run rear channel
4. Door lock assembly

Removal

1. Door trim pad
2. Water-proof sheet
   - Refer to “Window regulator” in this Section.
3. Glass run rear channel
   - Pull out the 2 mounting screws.
4. Door lock assembly
   - Disconnect each link and remove the 3 mounting screws.

Installation

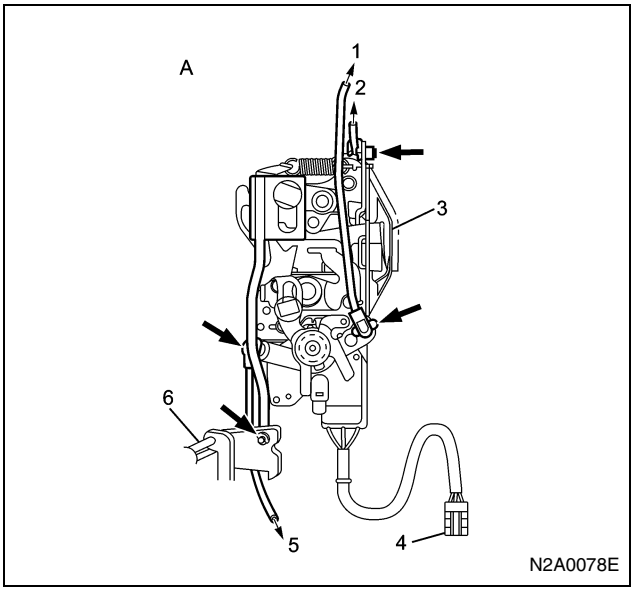
For installation, reverse the removal procedure taking the following points into consideration.

1. Tighten the door lock assembly to the specified torque.

Tighten:

- 15 N·m (1.5 kg·m/11.1 lb·ft)

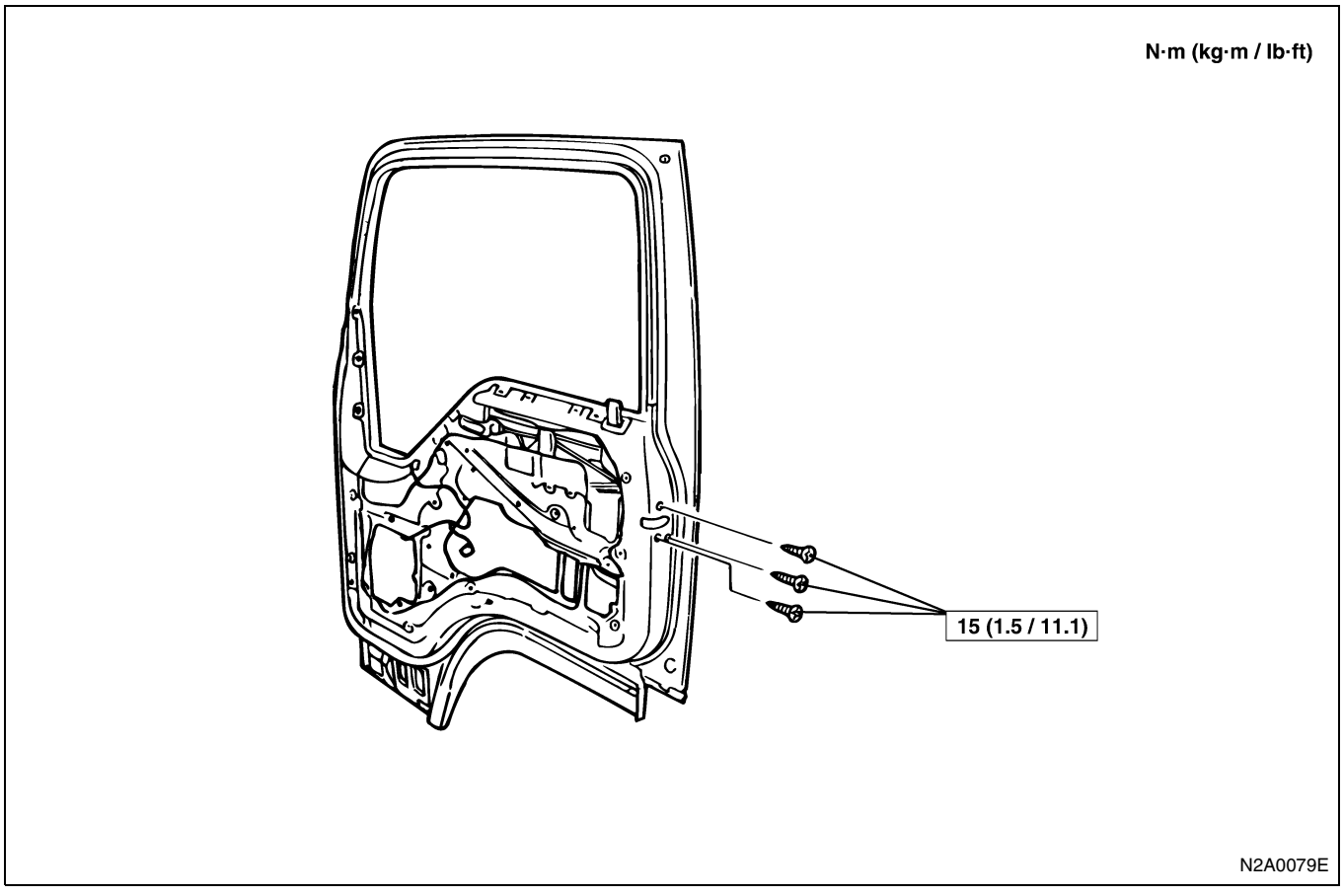
2. After installation, check the operation.



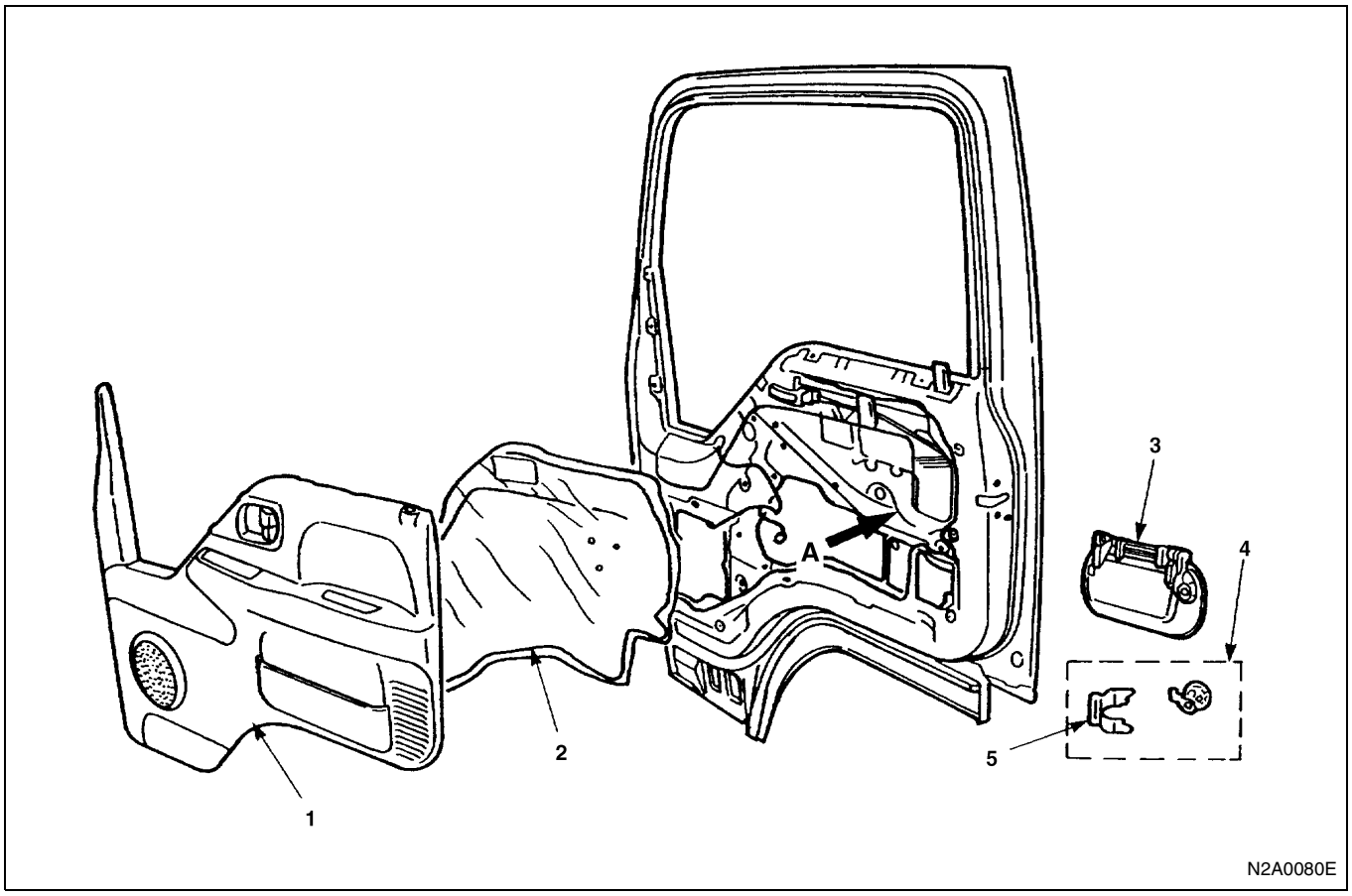
Legend

1. Door inside lock knob
2. Door inside handle
3. Door lock assembly
4. Door lock switch connector
5. Door lock cylinder
6. Door outside handle

Fixing Torque



Door Outside Handle and Door Lock Cylinder

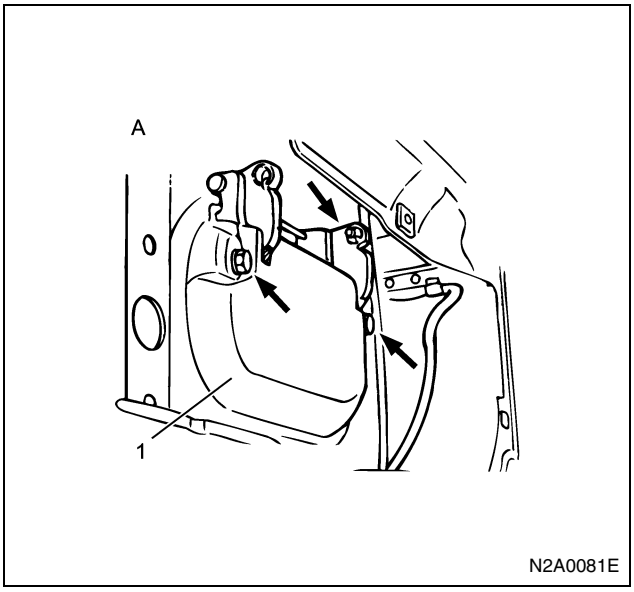


Legend

1. Door trim pad
2. Water-proof sheet
3. Door outside handle
4. Door lock cylinder
5. Clip

Removal

1. Door trim pad
2. Water-proof sheet
   - Refer to “Window regulator” in this Section.
3. Door outside handle (1)
   - Disconnect the link and remove the 2 mounting bolts.



4. Door lock cylinder
   - Disconnect the link and pull out the clip.

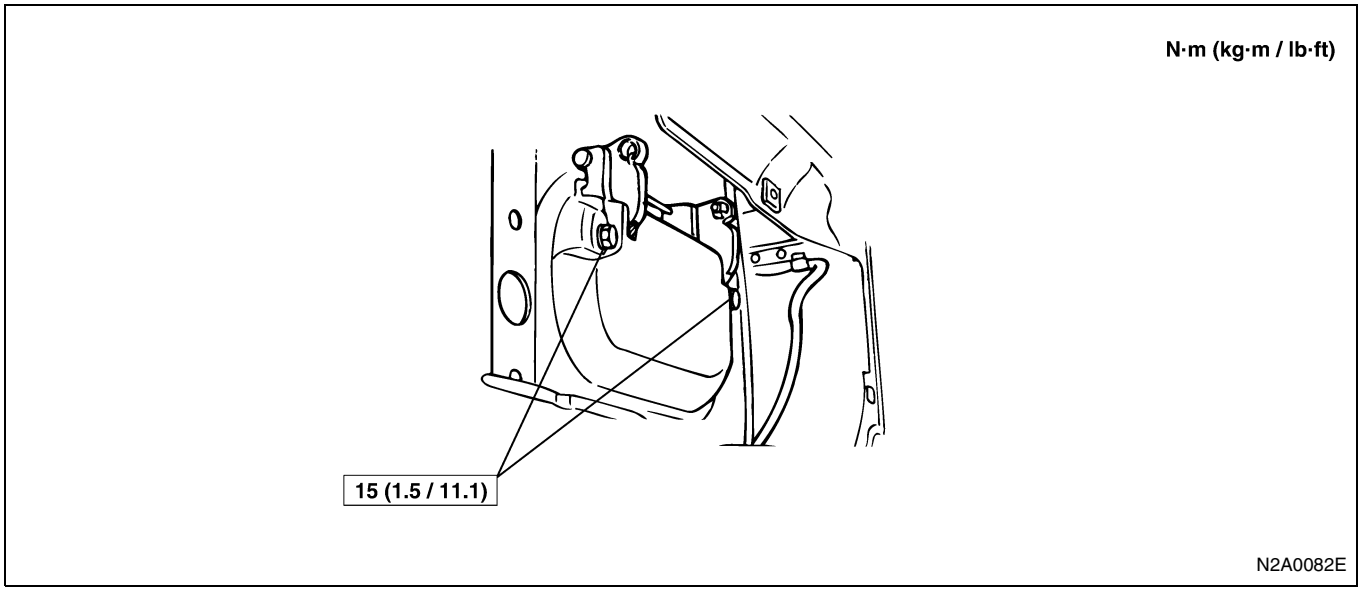
Installation

For installation, reverse the removal procedure taking the following point into consideration.

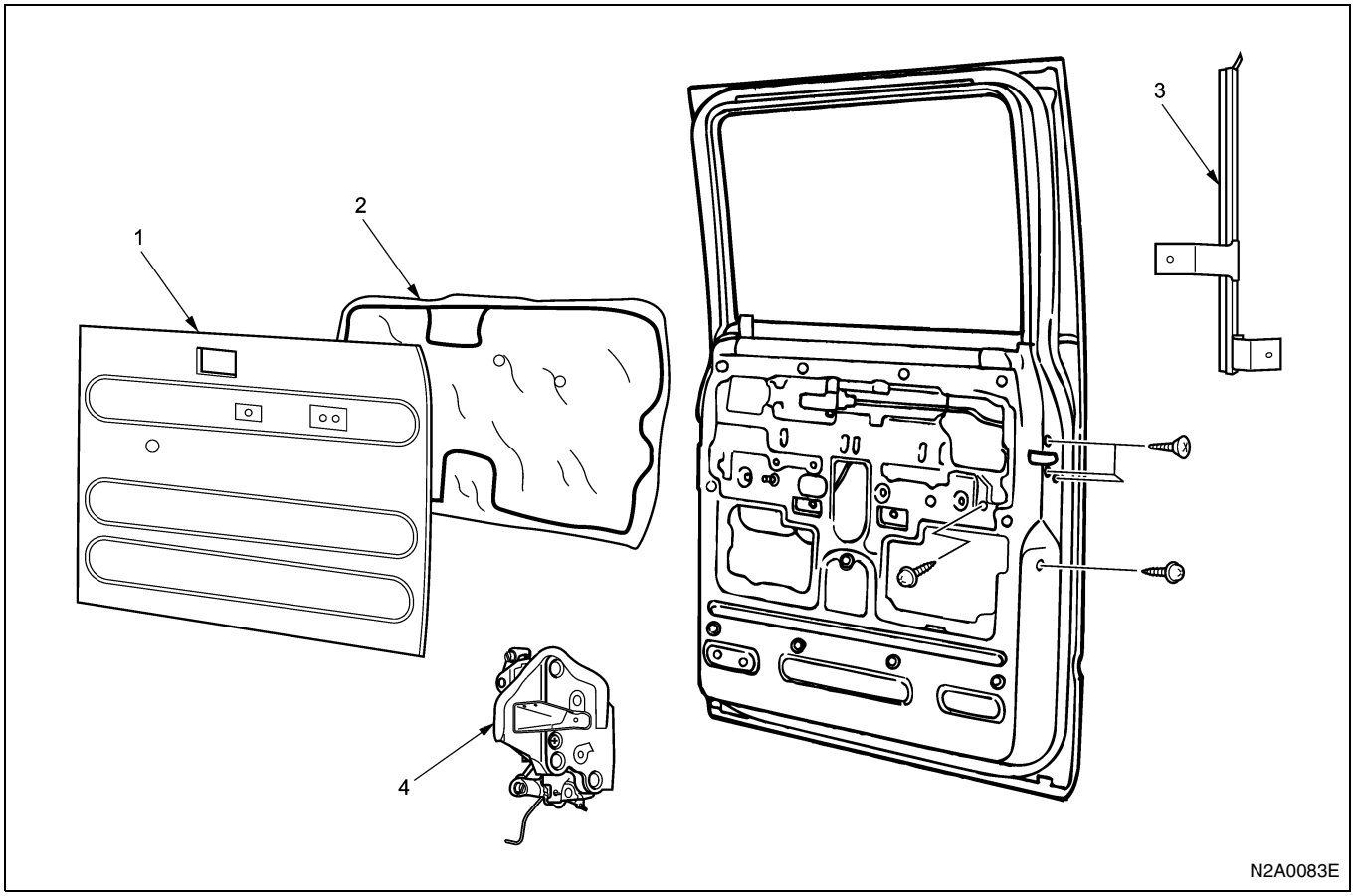
1. Tighten the door outside handle mounting bolts to the specified tightening torque.

Tighten:
15 N·m (1.5 kg·m/11.1 lb·ft)

Fixing Torque



Rear Door Lock Mechanism

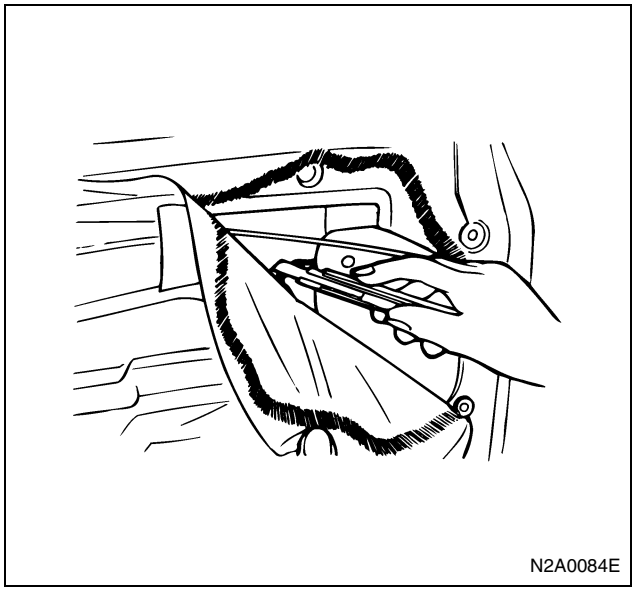


Legend

1. Rear door trim panel
2. Water-proof sheet
3. Glass run rear channel
4. Lock mechanism

Removal

1. Remove the Rear door trim panel.
   - Refer to “Rear door trim panel” in this section.
2. Peel off the water-proof sheet carefully with a cutter or knife. Take care not to damage it when peeling it off and remove the water-proof sheet.



3. Remove the 2 mounting screws and pull the rear channel out and remove the glass run rear channel.
4. Remove the 3 mounting screws and disconnect the locking links and remove the lock mechanism.

Installation

To install, follow the removal steps in the reverse order, noting the following points:

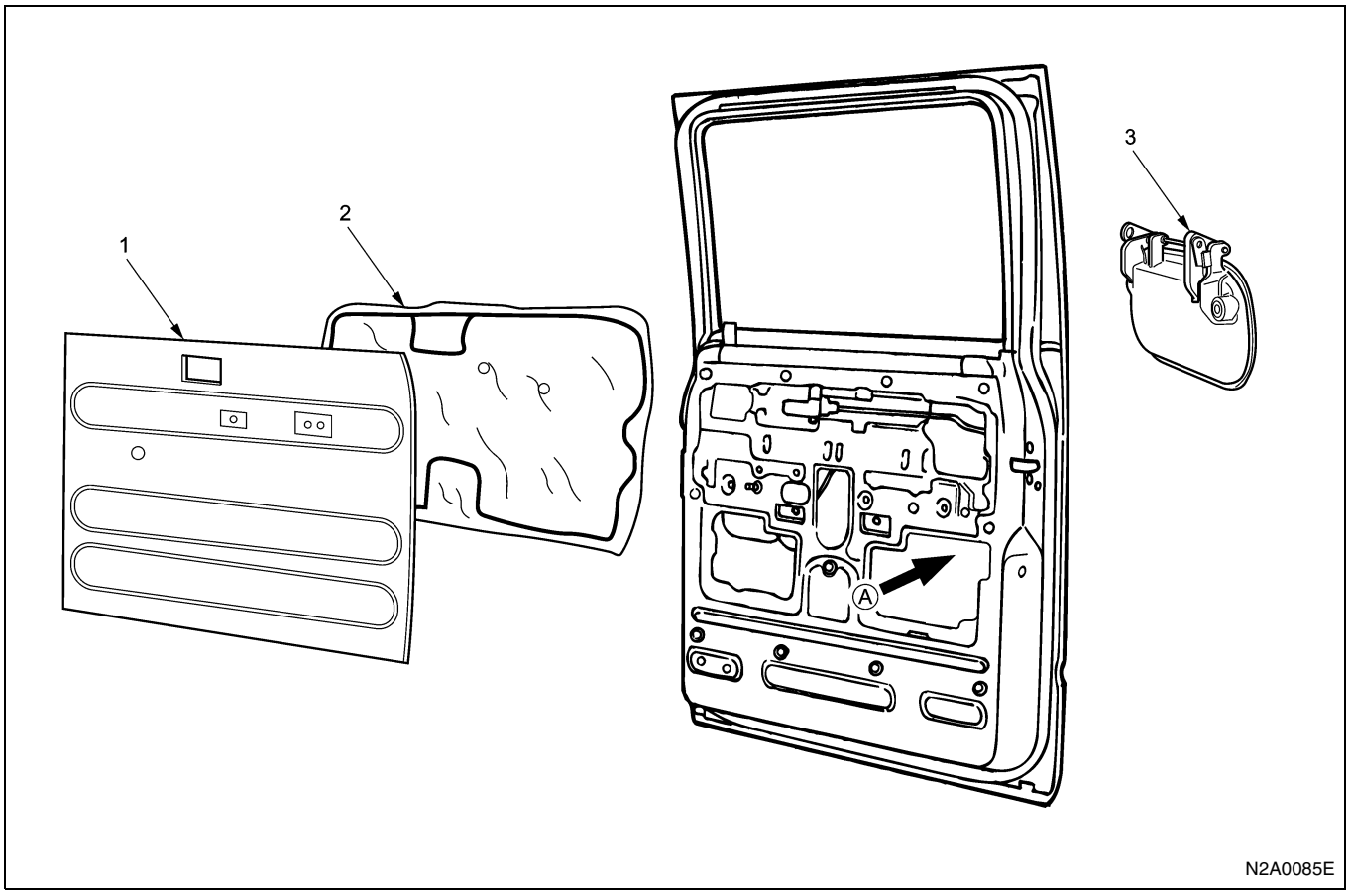
1. Tighten the mounting screw to the specified torque.

Tighten:

- Rear door lock mechanism mounting screws to 6 N·m (61.1 kg·cm/52 lb·in)

2. After installation, check the operation.

Rear Door Outside Door Release Handle

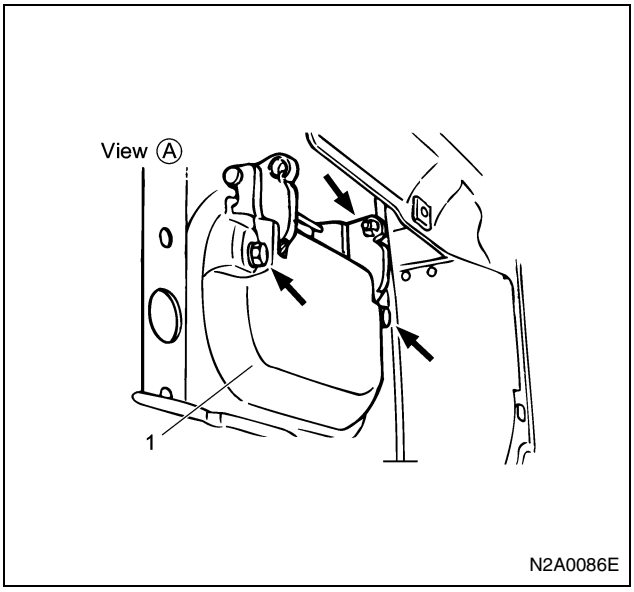


Legend

1. Rear door trim panel
2. Water-proof sheet
3. Outside door release handle

Removal

1. Remove the rear door trim panel.
   - Refer to “Rear door trim panel” in this section.
2. Remove the water-proof sheet.
   - Refer to “Rear door lock mechanism” in this section.
3. Disconnect the link and remove the 2 mounting bolts and remove the Outside door release handle.



Legend

1. Outside door release handle

Installation

To install, follow the removal steps in the reverse order, noting the following point:

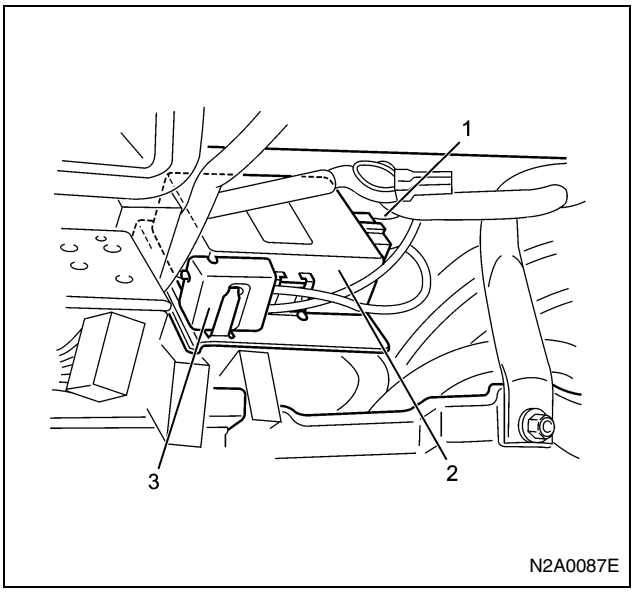
1. Tighten the mounting bolt to the specified torque.

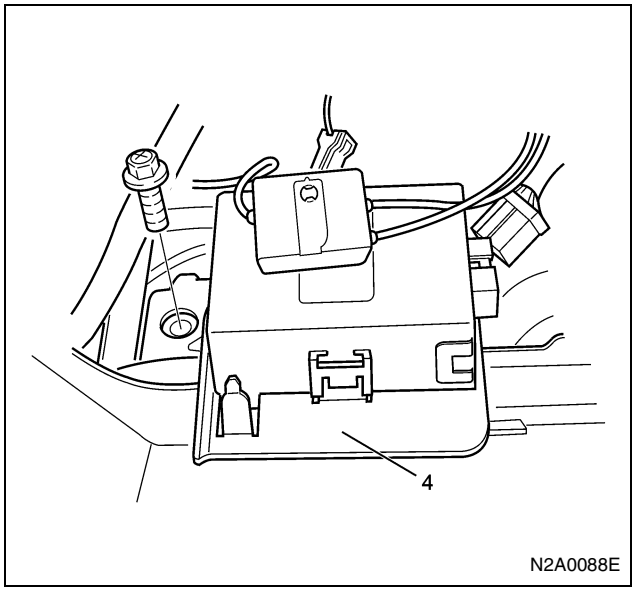
Tighten:

- Outside door release handle mounting bolts to 13 N·m (132.6 kg·cm/113 lb·in) — 18 N·m (1.8 kg·m/13 lb·ft)

Keyless Entry Control Unit

Removal





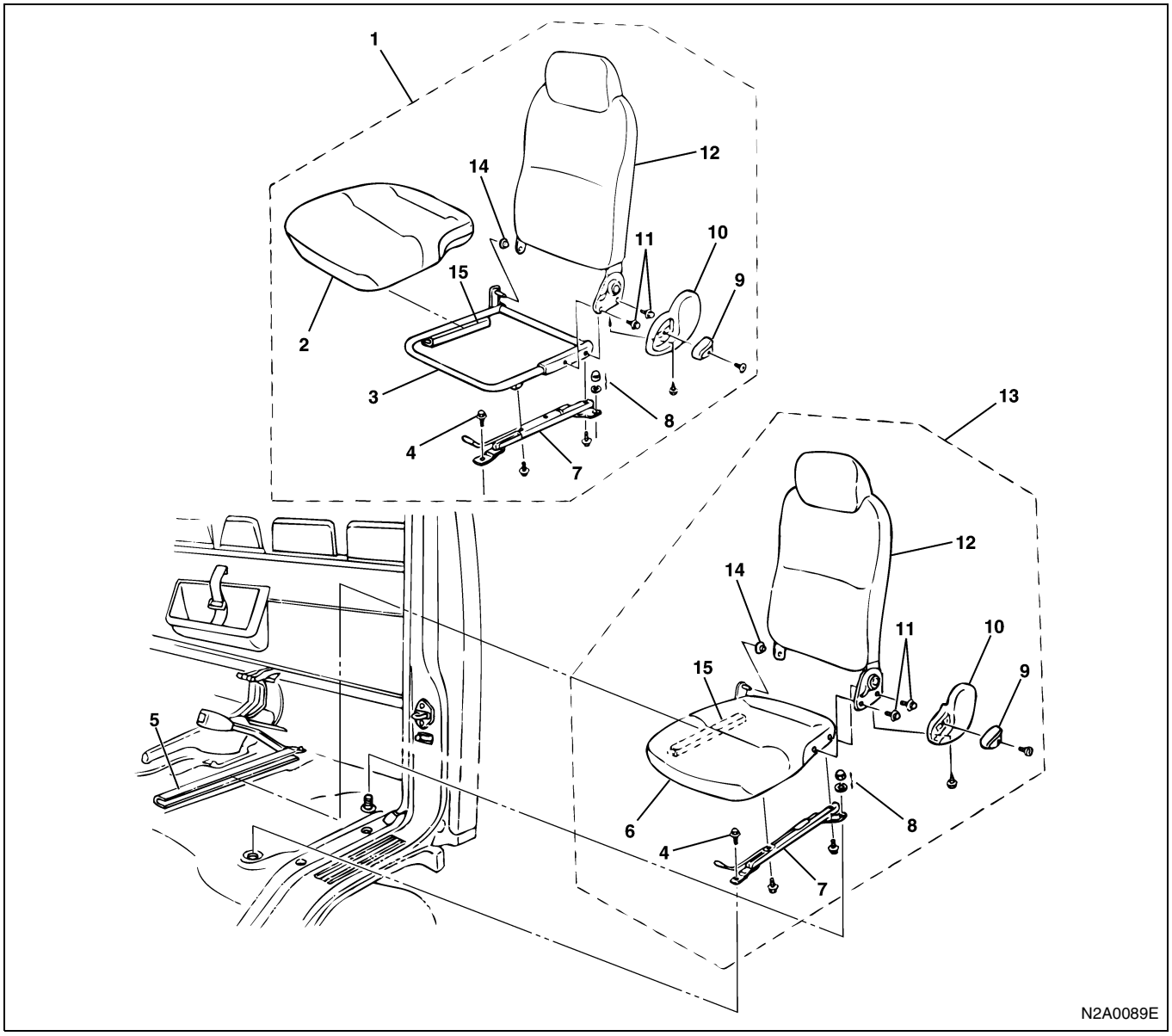
1. Meter cluster
   - Refer to “Meter Assembly” in Meter Section.
2. Tail/stop lamp malfunction warning relay
   - Release the claw to remove it together with bracket.
   - Disconnect the connector (1).
   - Remove the distributor (3) from bracket.
   - Remove the mounting screw and remove the control unit (2) together with bracket (4).
3. Register the ID code.
   - Refer to “Keyless Entry” in Wiring Diagram Section.
4. Check whether the keyless entry system operates properly.

Installation

For installation, reverse the removal procedure taking the following points into consideration.

SEAT

Driver Side (Except LHD Wide Cab Model)



Legend

1. Seat assembly (Non-tilt cab model)
2. Seat cushion assembly (Removable type)
3. Seat cushion frame
4. Seat bolt
5. Seat rail (Cab side)
6. Seat cushion assembly
7. Seat adjuster assembly
8. Cap nut
9. Reclining lever
10. Reclining cover
11. Reclining adjuster assembly mounting bolt
12. Seat back assembly
13. Seat assembly (Tilt-cab model)
14. Bushing
15. Seat rail (Seat frame side)

Removal

1. Cap nut
   - Slide the seat forward and remove the cap nut.
2. Seat bolt
   - Slide the seat backward and remove the seat bolt.
3. Seat assembly
4. Reclining lever
   - Remove the one screw.

5. Reclining cover
   - Remove the one screw.
6. Reclining adjuster assembly
   - Remove the fixing bolt.
7. Seat cushion assembly (Non-tilt cab model only)
8. Seat back assembly
9. Seat adjuster
   - Remove the 2 bolts.

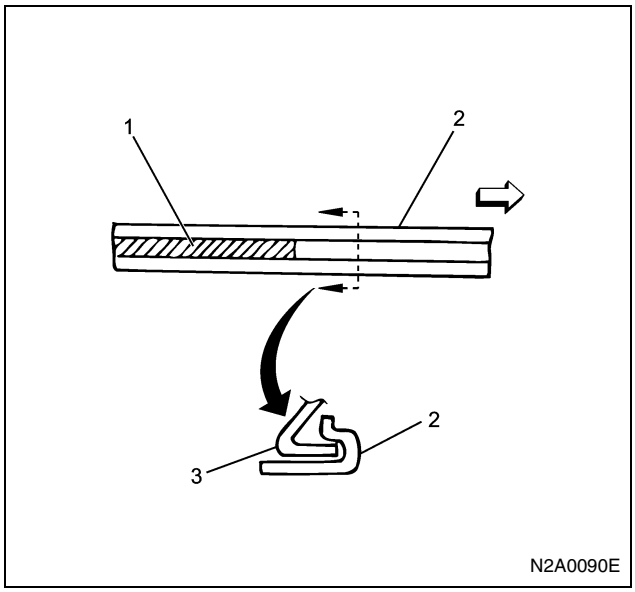
Installation

For installation, reverse the removal procedure taking the following point into consideration.

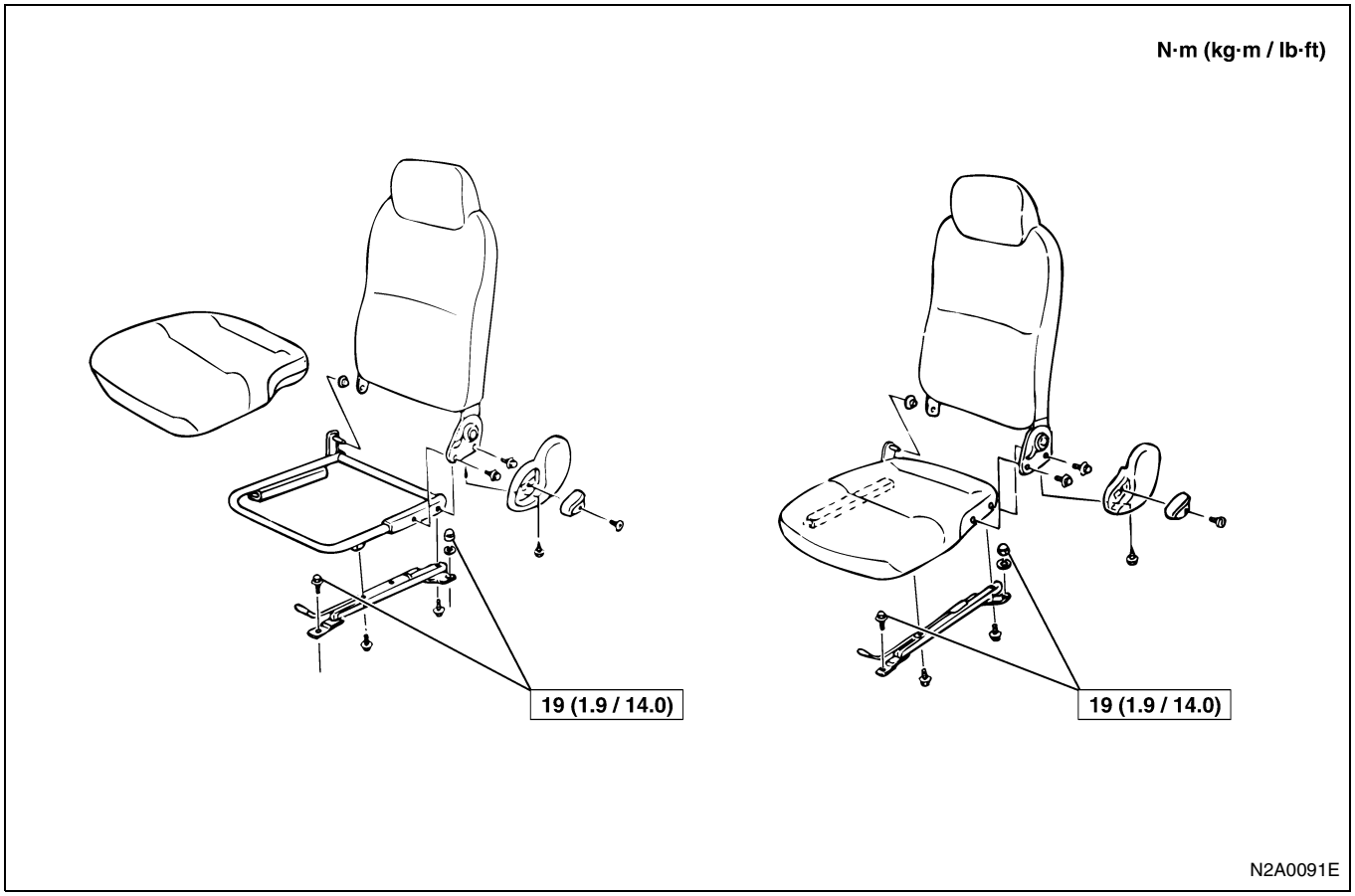
1. Before installing the seat assembly, apply grease (1) to the backward half of the cab-side seat rail (2) and set the claw on the seat frame side (3).
   After that, tighten the cap nut (with lock), plain washer and seat bolt (with Loctite) securely.

Tighten:
19 N·m (1.9 kg·m/14.0 lb·ft)

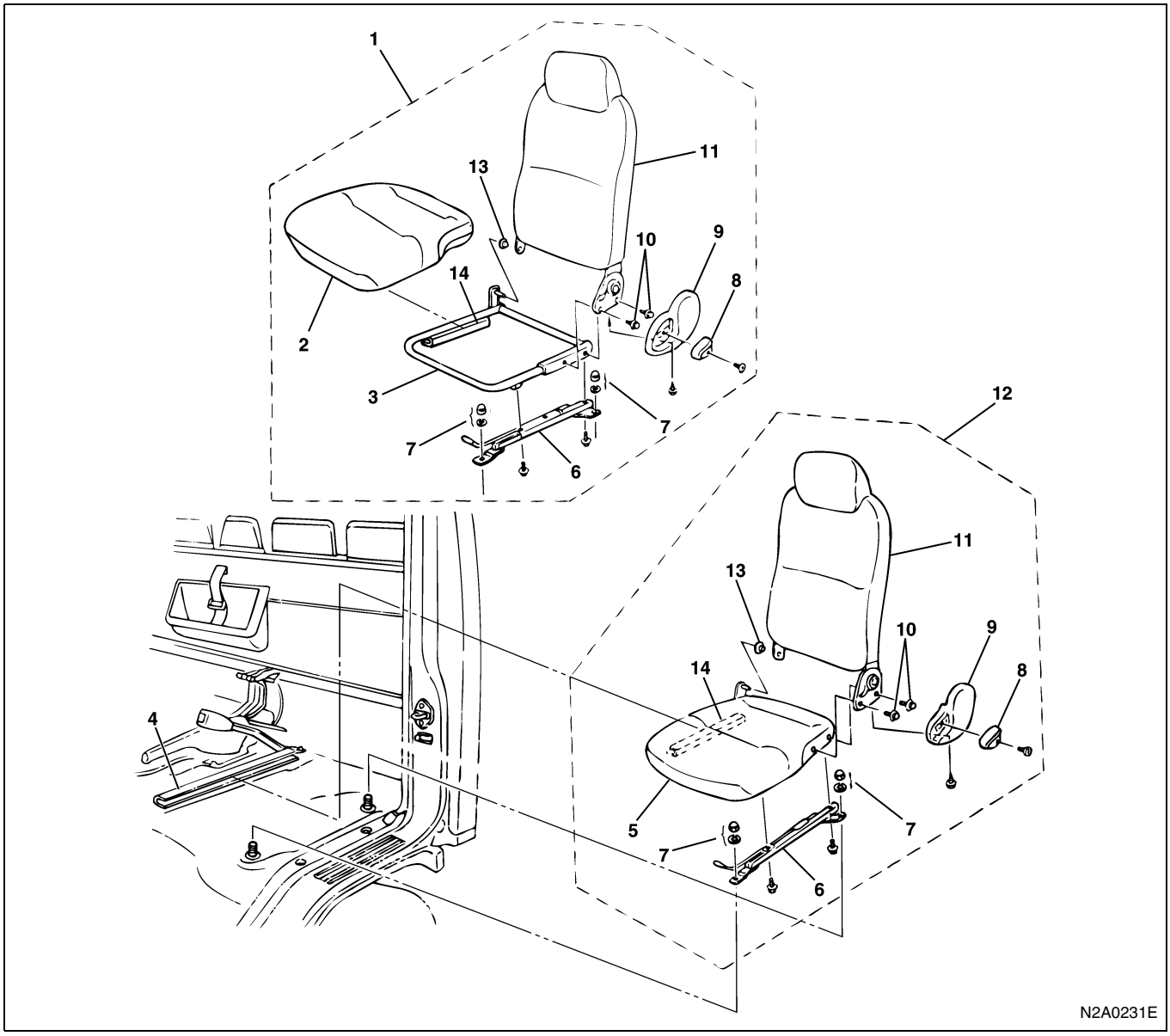
Grease: MITSUBISHI MULTI-PURPOSE No.2 or equivalent



Fixing Torque



Driver Side (LHD Wide Cab Model)



Legend

1. Seat assembly (Non-tilt cab model)
2. Seat cushion assembly (Removable type)
3. Seat cushion frame
4. Seat rail (Cab side)
5. Seat cushion assembly
6. Seat adjuster assembly
7. Cap nut and washer
8. Reclining lever
9. Reclining cover
10. Reclining adjuster assembly mounting bolt
11. Seat back assembly
12. Seat assembly (Tilt-cab model)
13. Bushing
14. Seat rail (Seat frame side)

Removal

1. Cap nut
   - Slide the seat forward and remove the cap nut of the rear side.
   - Slide the seat backward and remove the cap nut of the front side.
2. Seat assembly
3. Reclining lever
   - Remove the one screw.
4. Reclining cover
   - Remove the one screw.
5. Reclining adjuster assembly
   - Remove the fixing bolt.
6. Seat cushion assembly (Non-tilt cab model only)
7. Seat back assembly

8. Seat adjuster
   - Remove the 2 bolts.

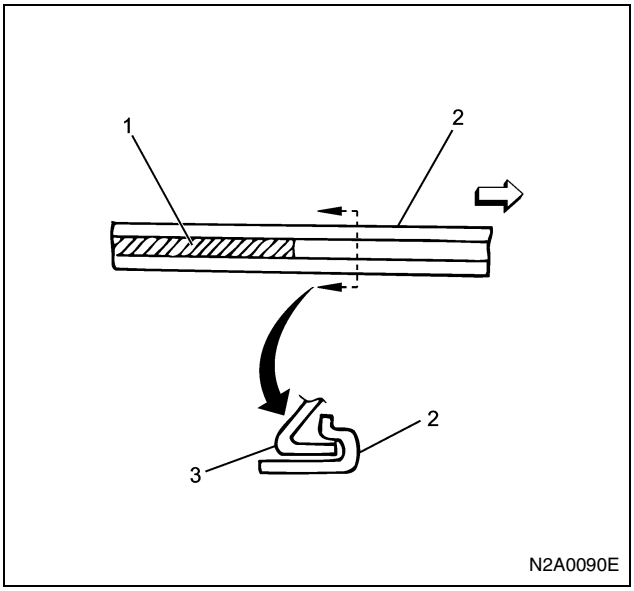
Installation

For installation, reverse the removal procedure taking the following point into consideration.

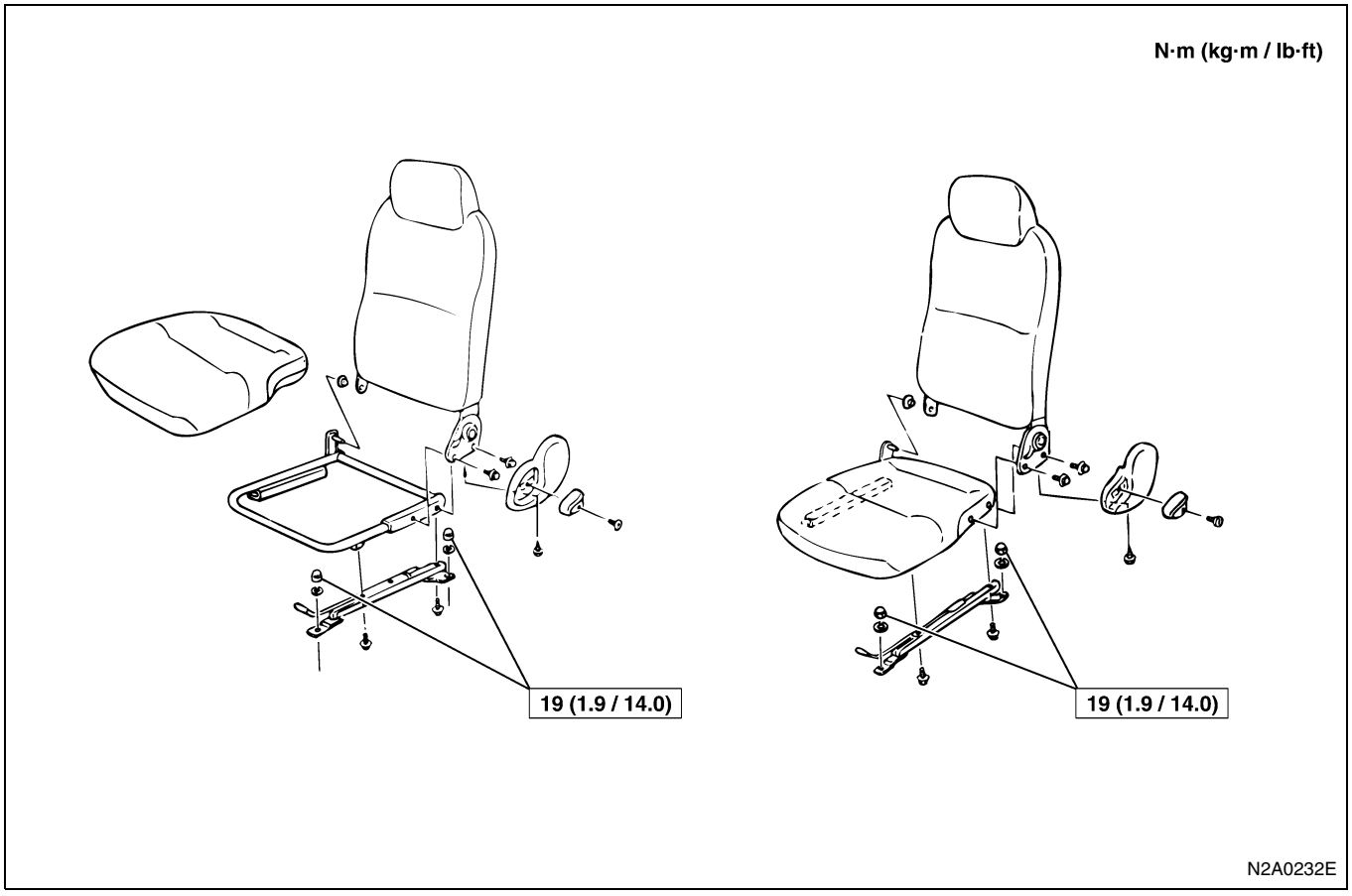
1. Before installing the seat assembly, apply grease (1) to the backward half of the cab-side seat rail (2) and set the claw on the seat frame side (3). After that, tighten the cap nuts (with lock) and plain washers securely.

Tighten:
19 N·m (1.9 kg·m/14.0 lb·ft)

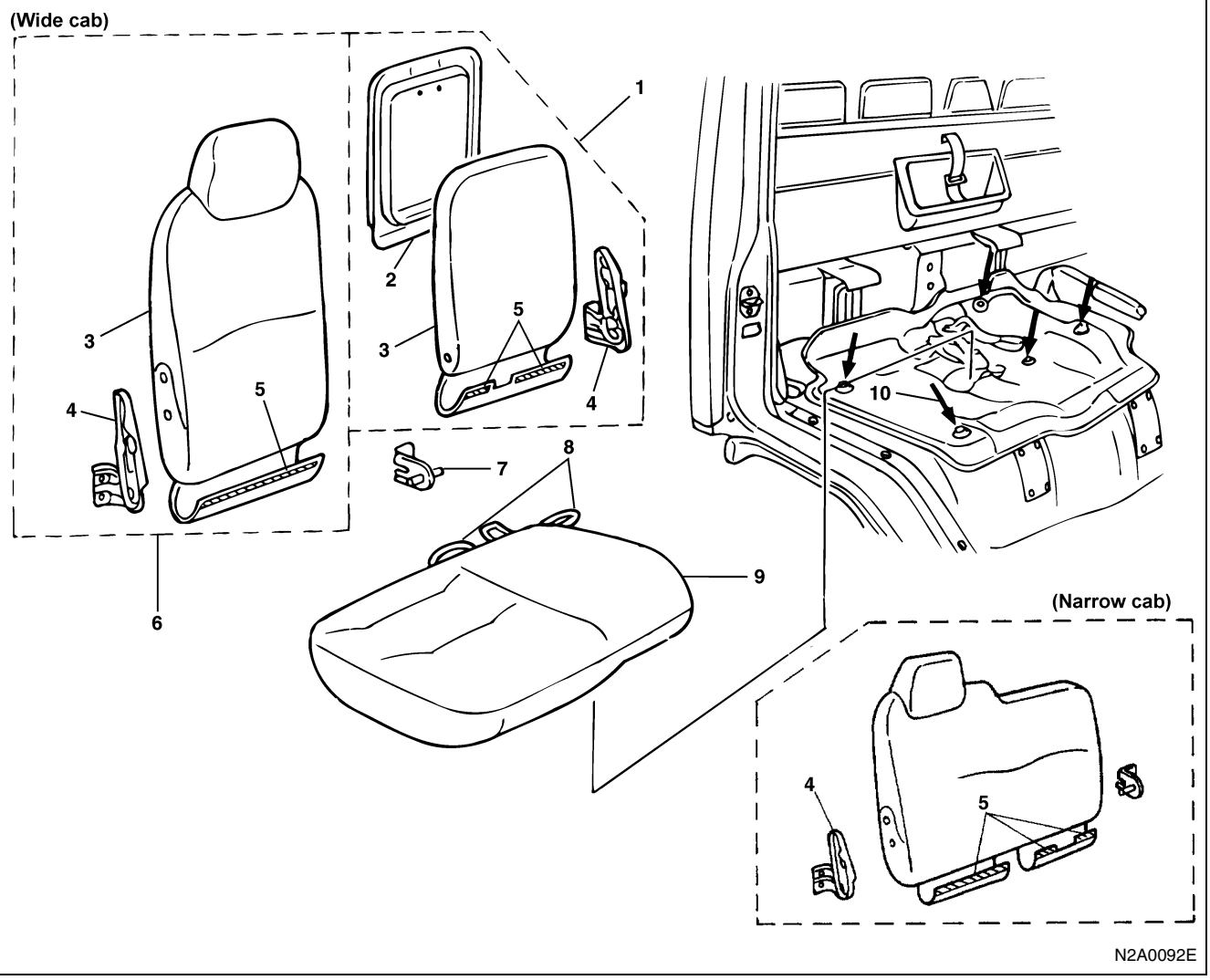
Grease: MITSUBISHI MULTI-PURPOSE No.2 or equivalent



Fixing Torque



Center and Passenger Side



Legend

1. Center seat back assembly (if equipped)
2. Seat back tray
3. Seat back
4. Hinge assembly
5. Magic fastener
6. Passenger seat back assembly
7. Hinge bracket
8. Seat belt band
9. Seat cushion assembly
10. Clip positions (five)

Removal

1. Seat cushion assembly
   - Raise the cushion and remove the clips and peel off the magic fasteners at 5 positions and pull out the seat belt from the band.
2. Center seat back assembly (Wide cab model)
   - Remove the 2 hinge fixing bolts.
   - Remove the 2 fixing bolts and remove the hinge assembly.
   - Remove the fixing screw and remove the seat back tray.
3. Passenger seat back assembly
   - Remove the 2 hinge fixing bolts.
   - Remove the 2 fixing bolts and remove the hinge assembly.
4. Hinge bracket
   - Remove 2 fixing bolts.

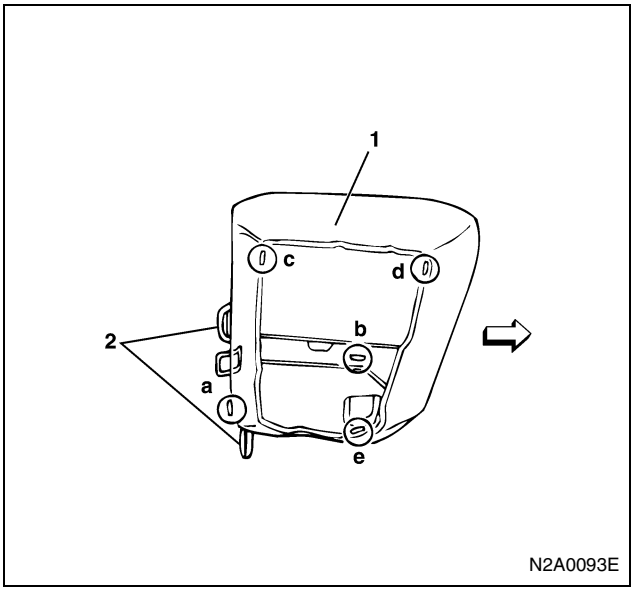
Installation

For installation, reverse the removal procedure taking the following point into consideration.

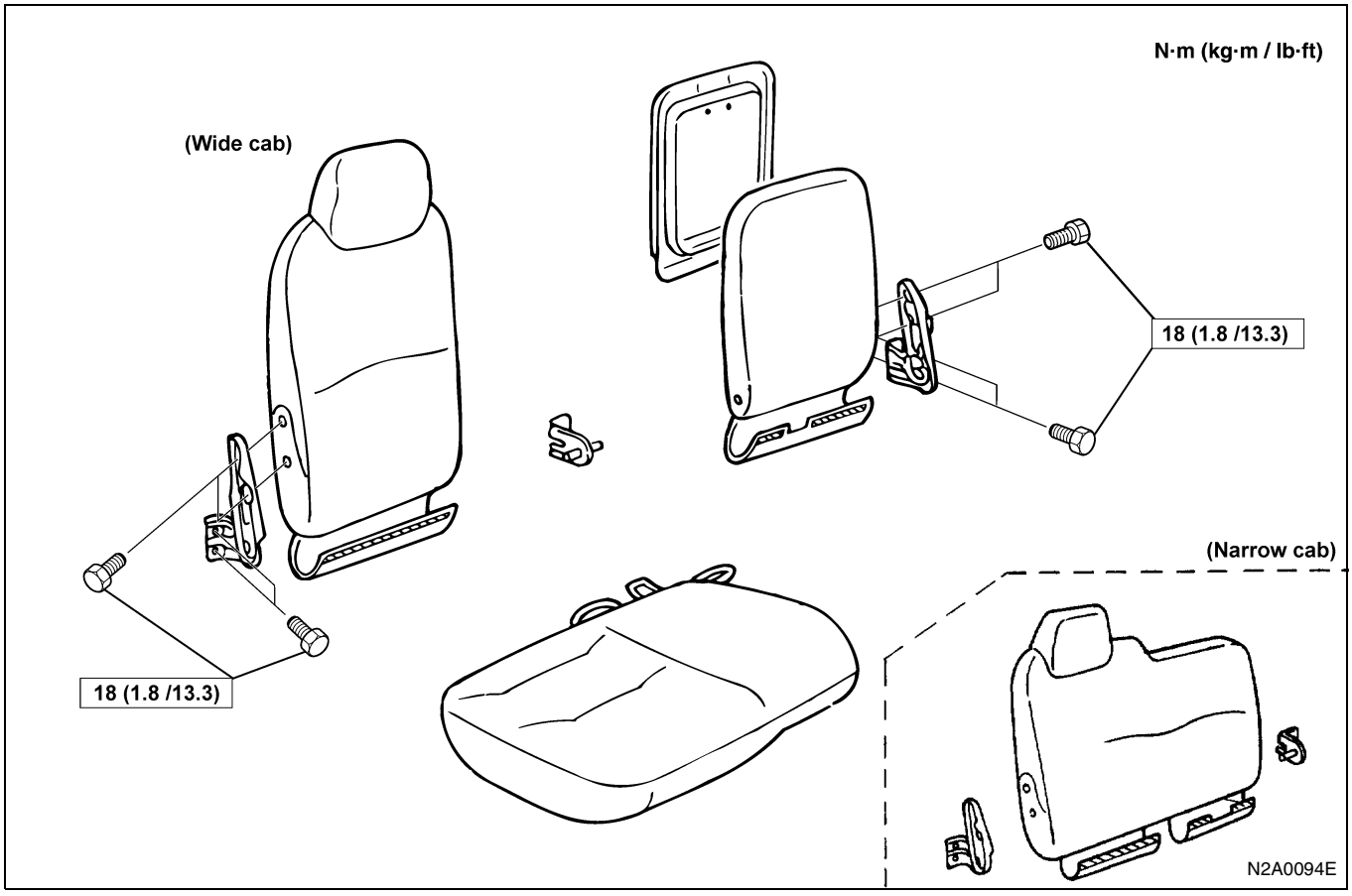
1. Tighten each hinge of the seat back with the specified bolts (with Loctite) securely.

Tighten:
18 N·m (1.8 kg·m/13.3 lb·ft)

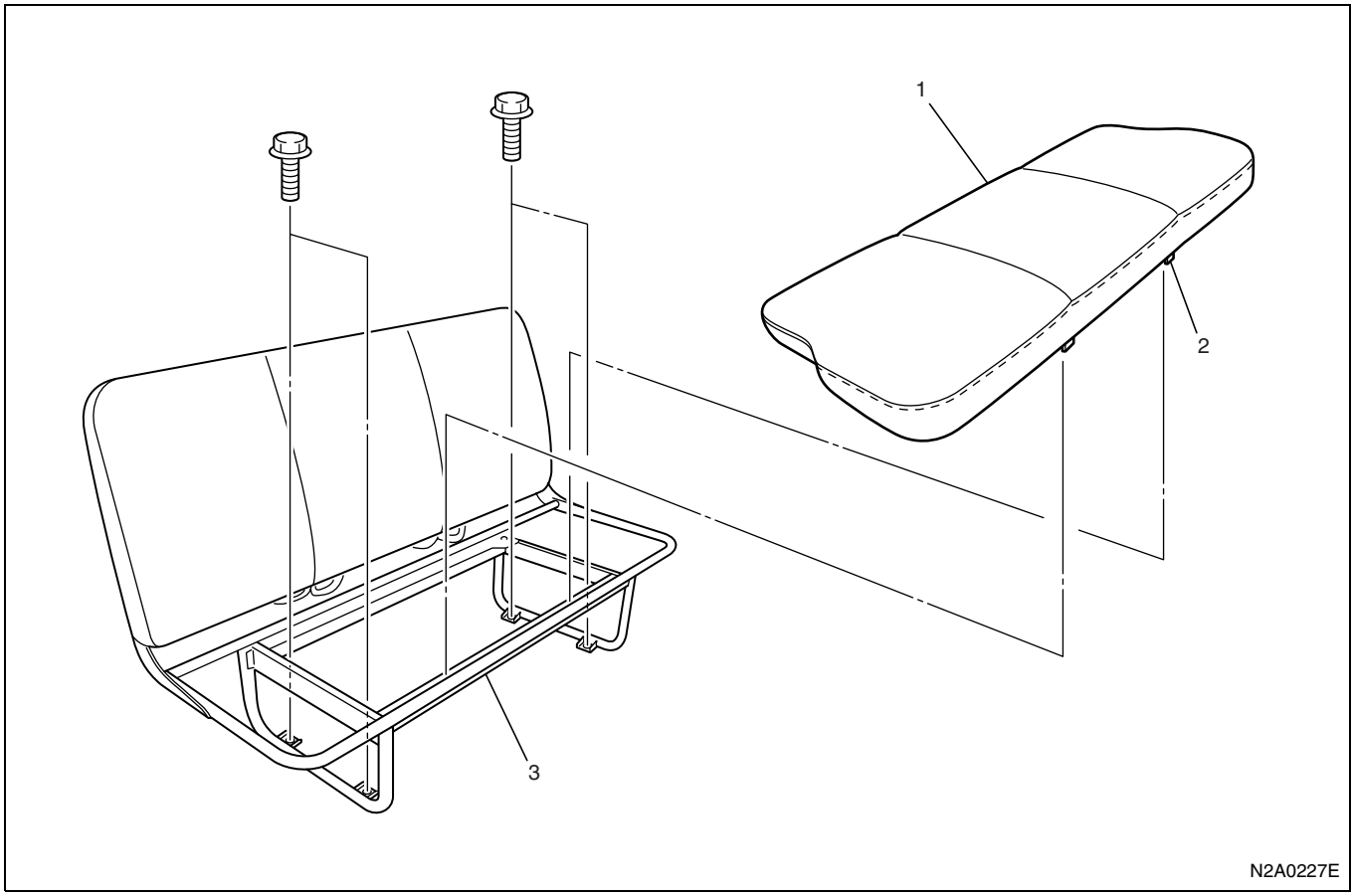
2. Check the direction of seat cushion fixing clip and set its mate clip on the engine cover.
3. Pass the seat belt through the seat cushion band (2).
4. Install the seat cushion (1) in the following order:
   a → b → c → d → e



Fixing Torque



Rear Seat (NKR)



Legend

1. Rear Seat Cushion
2. Clip
3. Rear Seat Frame

Removal

1. Pull the seat cushion at the three clip positions from the seat frame and remove the rear seat cushion.
2. Remove the 4 bolts and remove the rear seat frame.

Installation

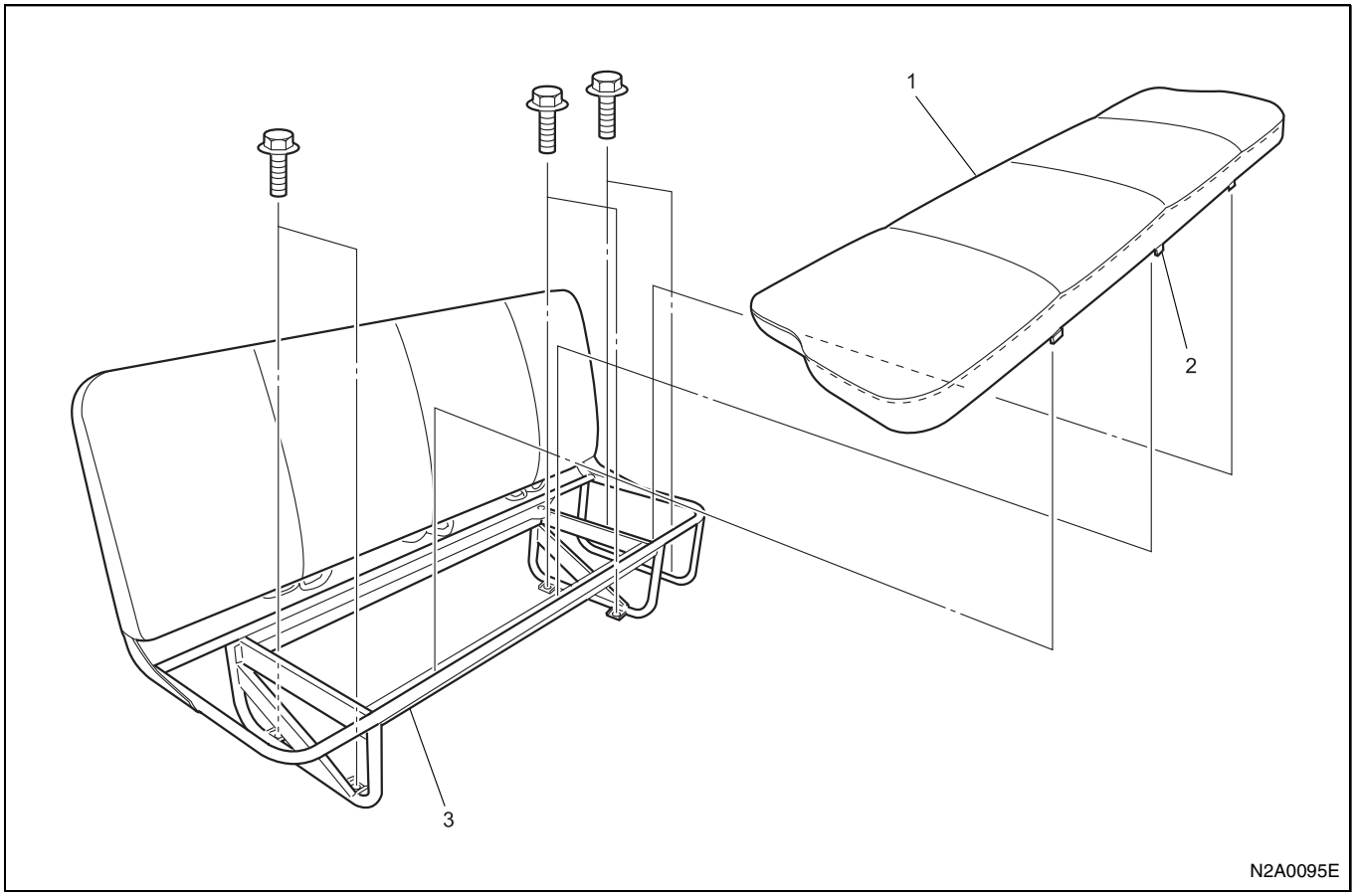
To install, follow removal steps in the reverse order, noting the following point.

1. Tighten the rear seat frame mounting bolts to the specified torque.

Tighten:

Rear seat frame bolts to 13 N·m (1.3 kg·m/9.6 lb·ft)

Rear Seat (NPR, NQR)



Legend

1. Rear Seat Cushion
2. Clip
3. Rear Seat Frame

Removal

1. Pull the seat cushion at the three clip positions from the seat frame and remove the rear seat cushion.
2. Remove the 6 bolts and remove the rear seat frame.

Installation

To install, follow removal steps in the reverse order, noting the following point.

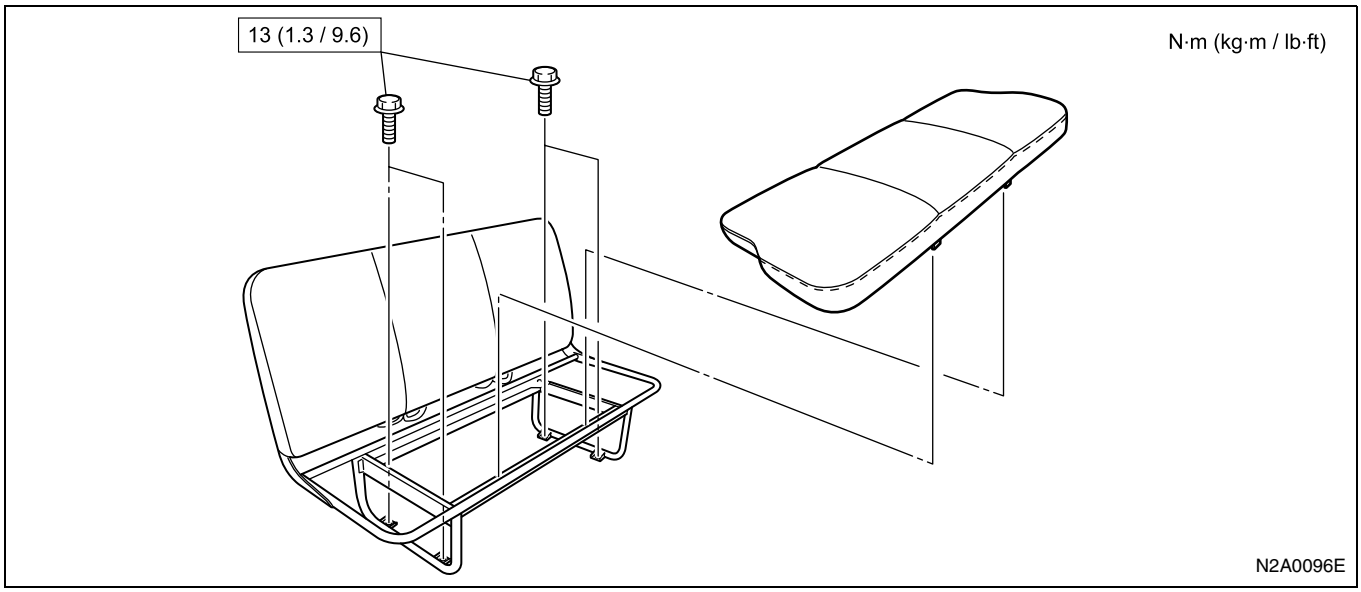
1. Tighten the rear seat frame mounting bolts to the specified torque.

Tighten:

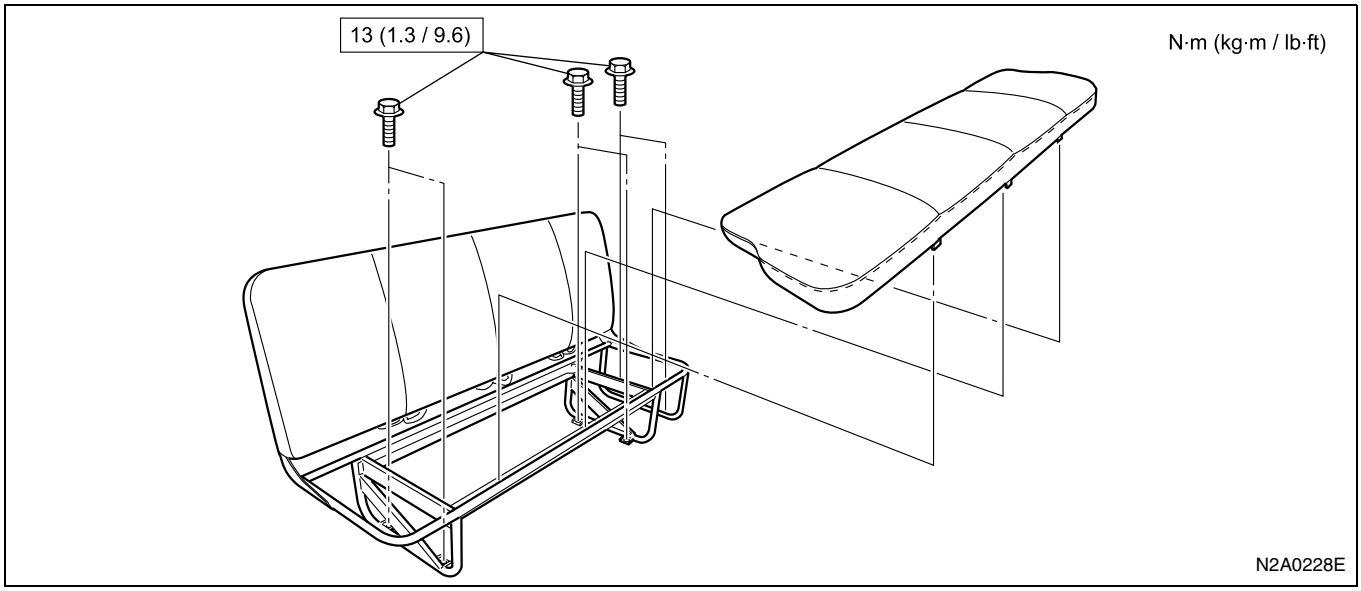
Rear seat frame bolts to 13 N·m (1.3 kg·m/9.6 lb·ft)

Fixing Torque

NKR



NPR, NQR



INTERIOR TRIM

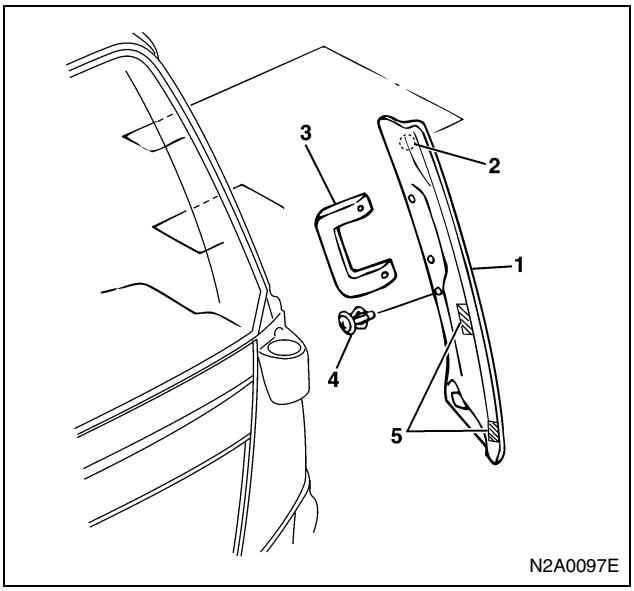
Front Pillar Trim Cover

Removal

1. Front grip (3)
   - Remove the 2 mounting screws.

Caution:
These screws are coated with Loctite. When removing them, take care not to damage their heads.

2. Front pillar trim cover (1)
   - Remove the one clip at the position (2) and peel off the two-sided adhesive tape at the position (5) shown in the figure.
     For the high cab or wide cab, remove the clip (4).

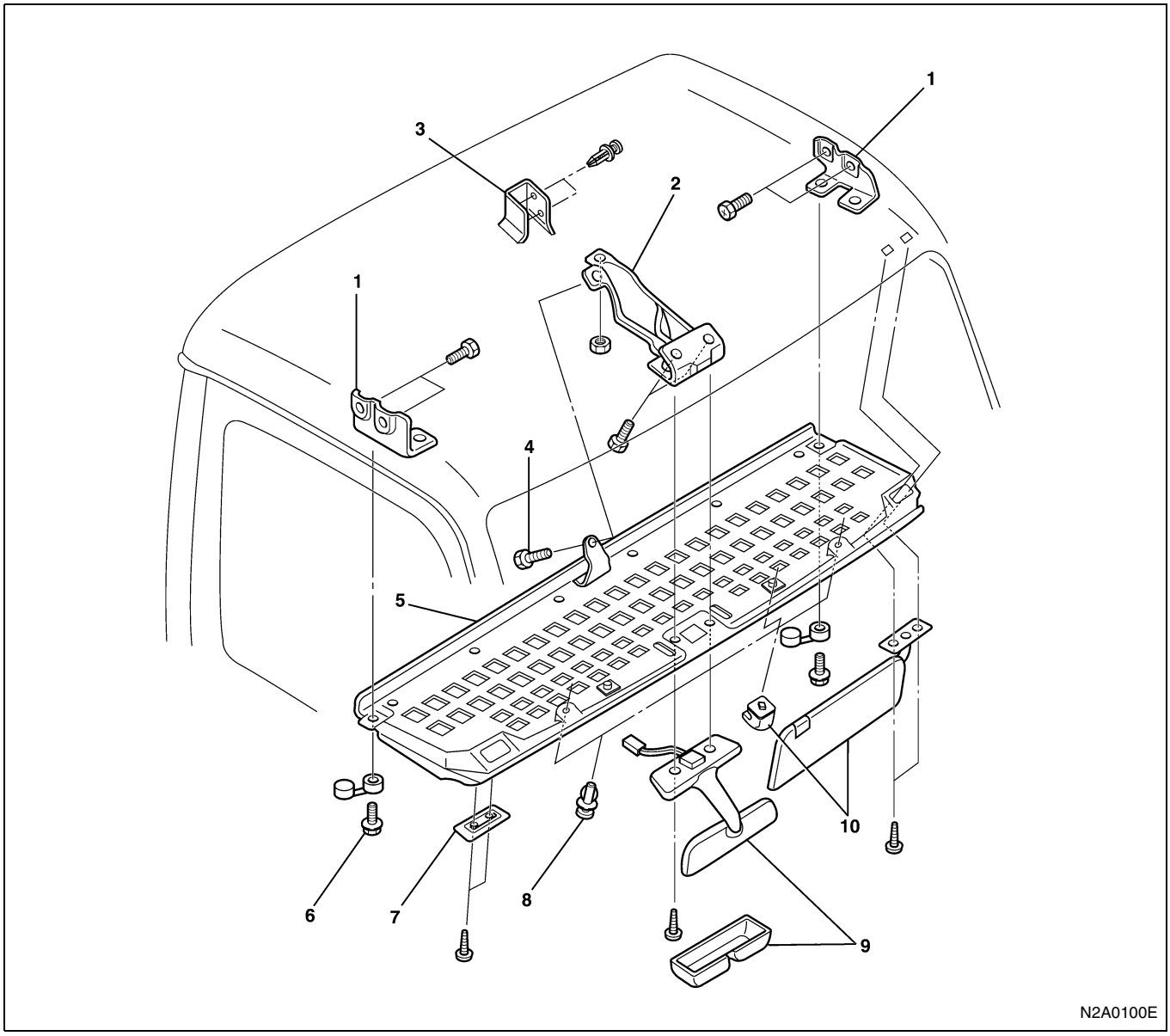


Installation

For installation, reverse the removal procedure taking the following point into consideration.

- Use a new two-sided adhesive tape and stick it securely by press at installation.

Header Shelf



Legend

1. Side bracket
2. Center bracket
3. Bracket cover (without roof ventilation)
4. Screw
5. Header shelf assembly
6. Screw
7. Grommet
8. Clip
9. Room lamp/mirror
10. Sun visor/holder

Removal

1. Battery ground cable
2. Room lamp/mirror
   - Remove the lens and remove 2 mounting screws and connector.
3. Sun visor/grommet
   - Remove the 2 mounting screws. For a custom vehicle, a sun visor is mounted on each of the left and right sides.
4. Mounting screw
   - Slide the left-hand 1 screws and right-hand 1 screws and the roof ventilator cover backward, then pull them out. Remove the one screw in the center of the rear side.
5. Header shelf assembly
6. Center bracket
   - Remove the 2 mounting screws and 1 nut. (With roof ventilation)
   - Remove the 2 clips. (Without roof ventilation)
7. Side bracket

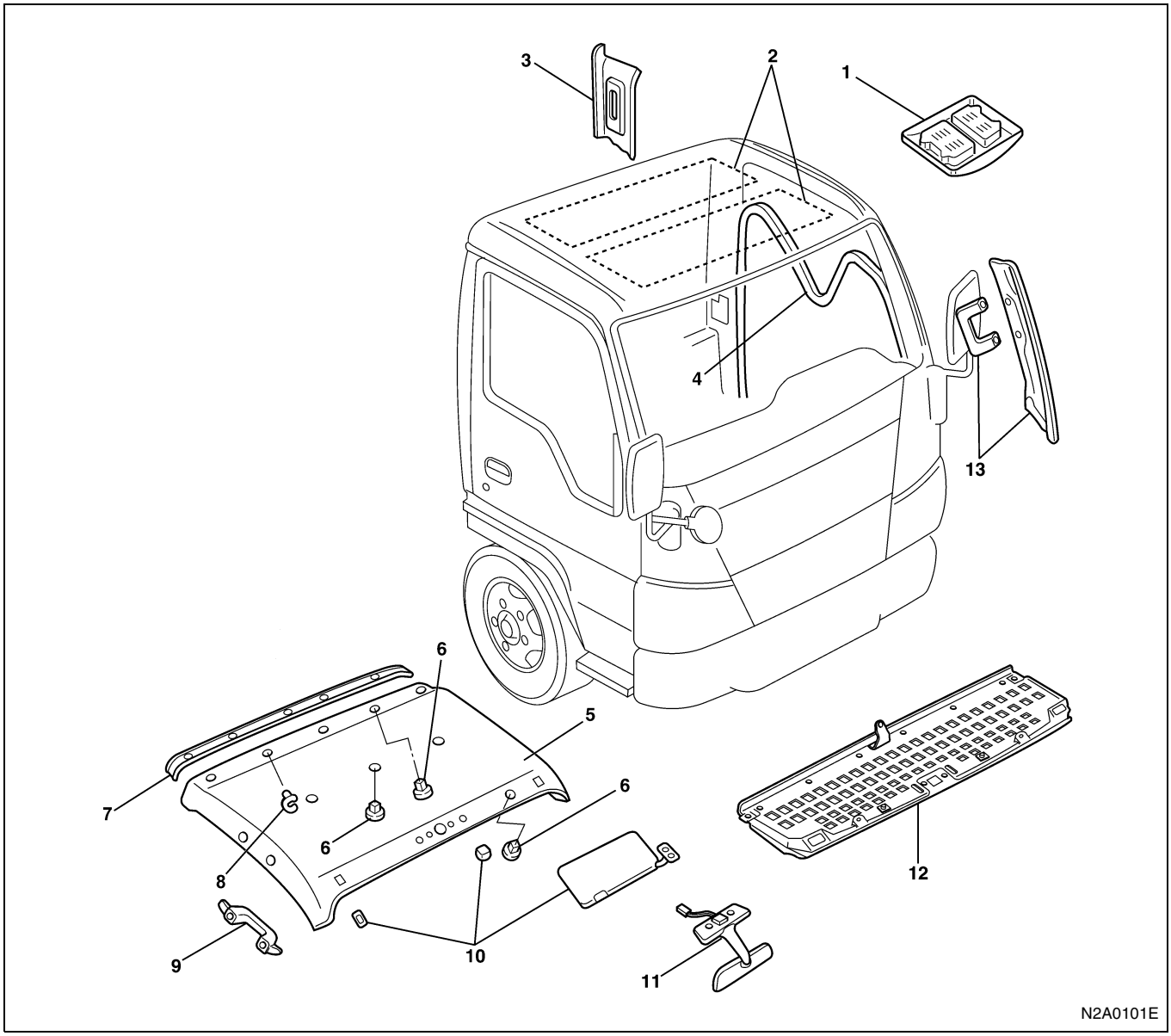
- Remove the 2 mounting screws each.

Installation

For installation, reverse the removal procedure.

Head Lining (Single Cab Model)

Component



Legend

1. Roof ventilator grille (High cab, wide cab; Option equipment)
2. Insulator
3. Rear pillar upper trim cover (Option equipment)
4. Body side finisher (Option equipment)
5. Head lining (Option equipment)
6. Clip
7. Rear retainer/clip (High cab, wide cab option equipment)
8. Coat hanger
9. Assist grip
10. Sun visor/holder/grommet (Standard cab)
11. Room lamp/mirror (Standard cab)
12. Header shelf (High cab, wide cab except limited model)
13. Front grip/front pillar trim cover

Removal

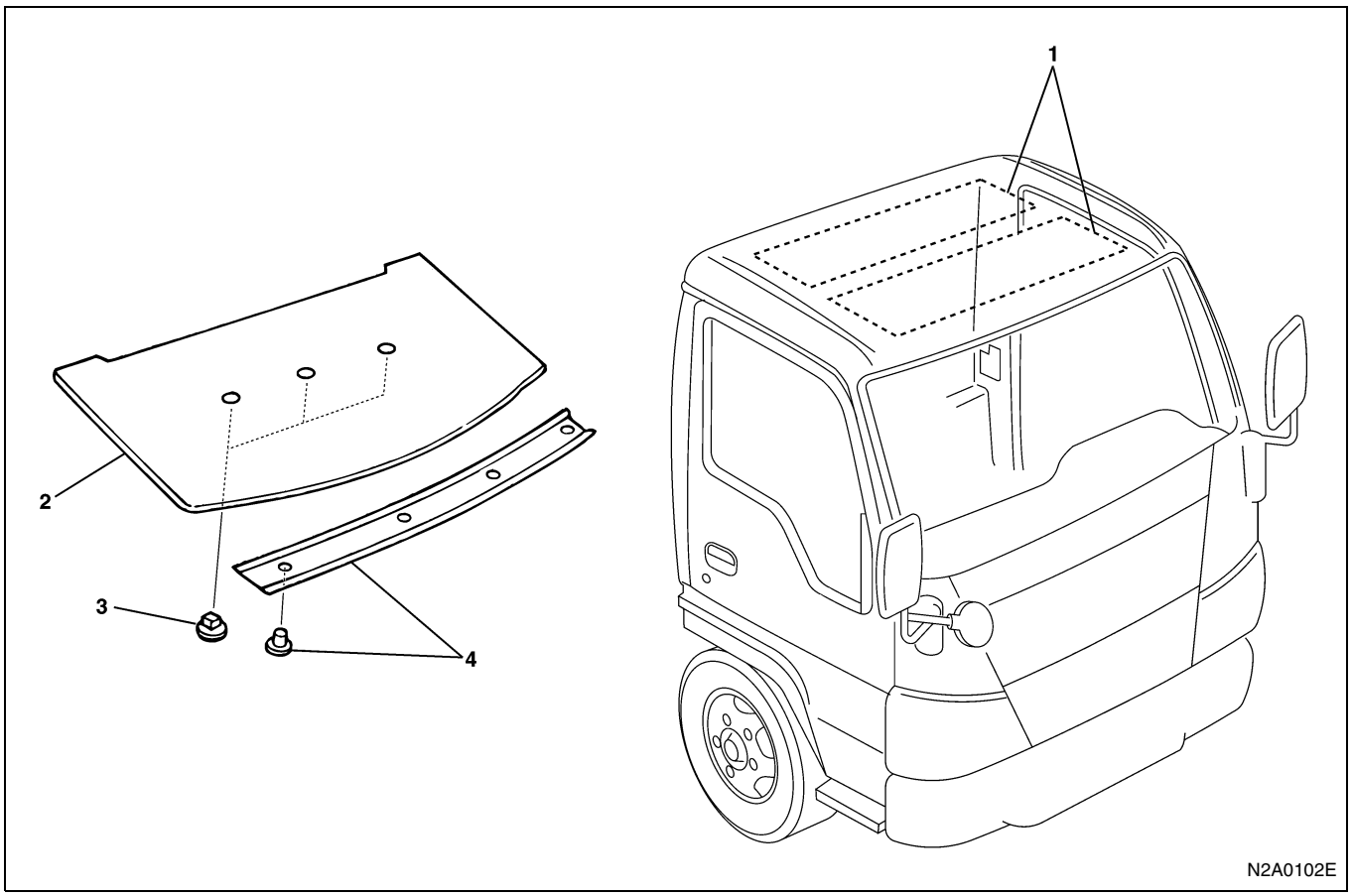
1. Disconnect the battery ground cable.
2. Sun visor/holder/grommet (Standard cab)
   - Remove the 2 mounting screws to remove the sun visor.
   - Pull the sun visor holder while rotating it 45°.
   - Pry the sun visor grommet with a bladed screwdriver.
3. Room lamp/mirror (Standard cab)
   - Pry the room lamp lens with a bladed screwdriver, and remove the 2 mounting screws of room mirror to disconnect the connector.
4. Header shelf (High cab, wide cab except limited model)
   - Refer to “Header Shelf” in this Section.
5. Assist grip
   - Open the covers at 2 positions and remove the mounting screws.
6. Coat hanger
   - Turn it 45° for removal.
7. Fluorescent (Option equipment)
   - Refer to “Fluorescent Working with Room Lamp” in Repair Manual for electrical equipment.
8. Roof ventilator grille (High cab/wide cap; option equipment)
   - Refer to “Roof Ventilator” in this Section.
9. Front grip/front pillar trim cover
   - Refer to “Front Pillar Trim Cover” in this Section.
10. Rear upper trim cover
    - Refer to “Rear Side Trim Cover” in this Section.
11. Clip
    - Standard cab; Top: 3 positions, Rear: 2 positions
    - High cab, wide cab; Top: 3 positions, Front: 4 positions (High cab), 5 positions (Wide cab), Rear 3 positions
12. Rear retainer/clip (High cab, wide cab)
    - Remove the clip to remove the retainer.
13. Body side finisher (upper)
    - Pull only the upper side from panel flange.
14. Head lining
15. Insulator

Installation

For installation, reverse the removal procedure.

Head Lining (B Pack Model)

Component



Legend

1. Insulator
2. Head lining
3. Clip
4. Retainer/clip

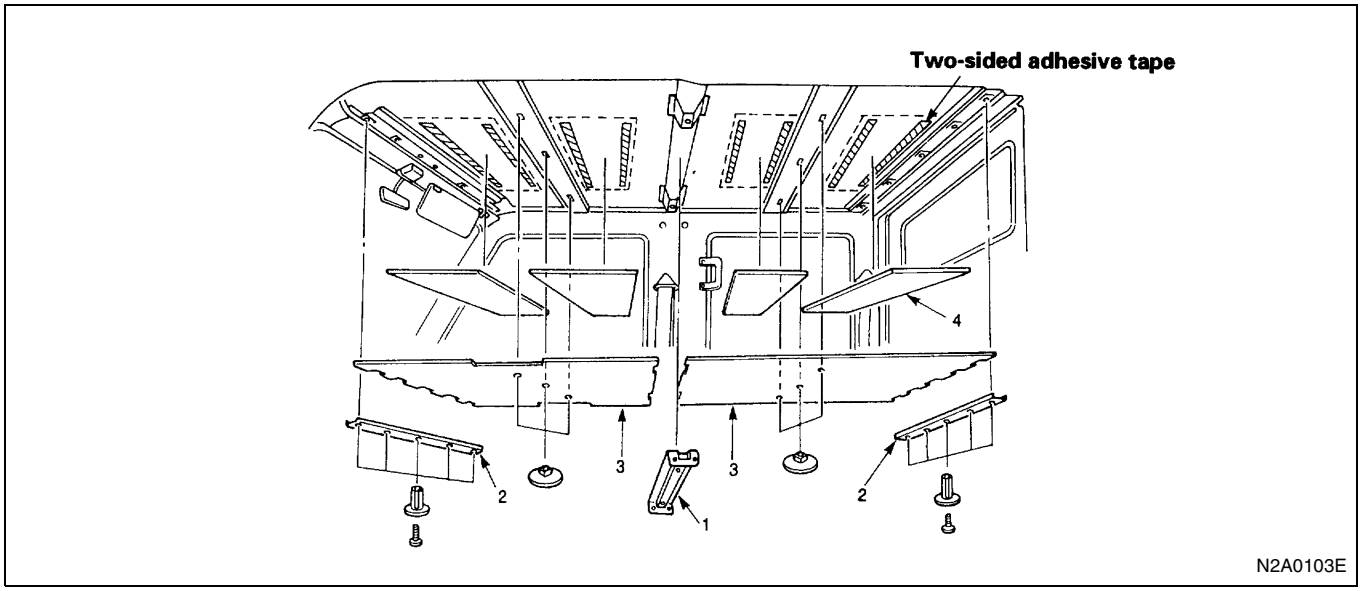
Removal

1. Retainer/clip
   - Remove the clip to remove the retainer.
2. Clip
3. Head lining
4. Insulator

Installation

For installation, reverse the removal procedure.

Head Lining (Crew Cab Model)



Legend

1. Roof reinforcement
2. Retainer
3. Head lining
4. Insulator

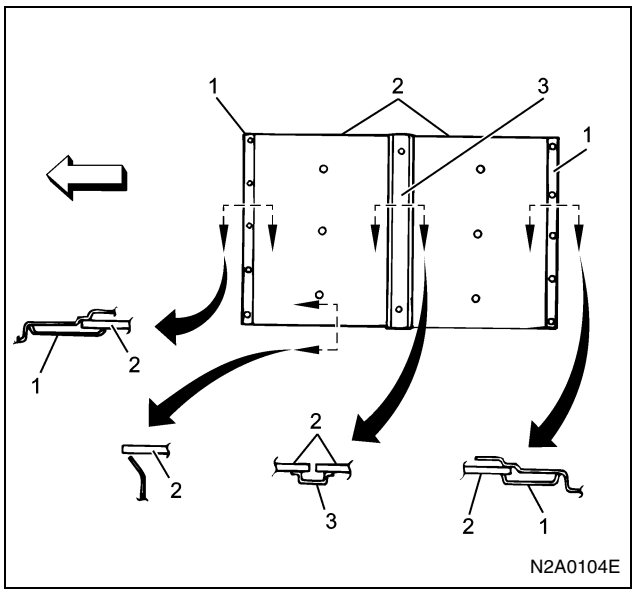
Removal

1. Roof reinforcement
   - Remove the 3 left fixing bolts and 3 right fixing bolts.
2. Retainer
   - Remove the 5 front clips and 5 back clips.
3. Head lining
   - Remove the 5 front clips and 5 back clips.
4. Insulator

Installation

For installation, reverse the removal procedure.

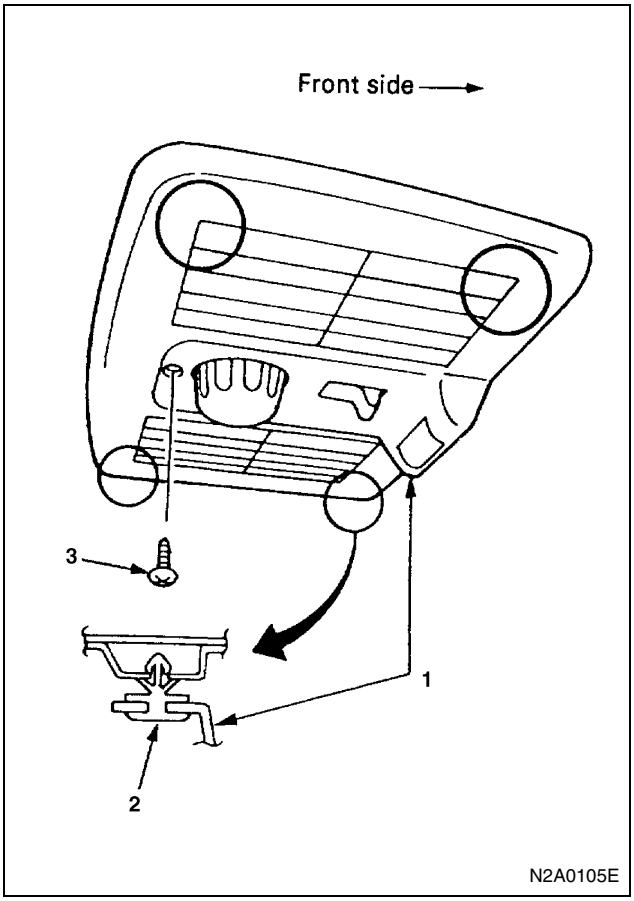
1. When installing the insulator, be sure to use a new two-sided adhesive tape.
2. Install the head lining (2) by nipping it with the front and back retainers (1) and the central reinforcement (3).



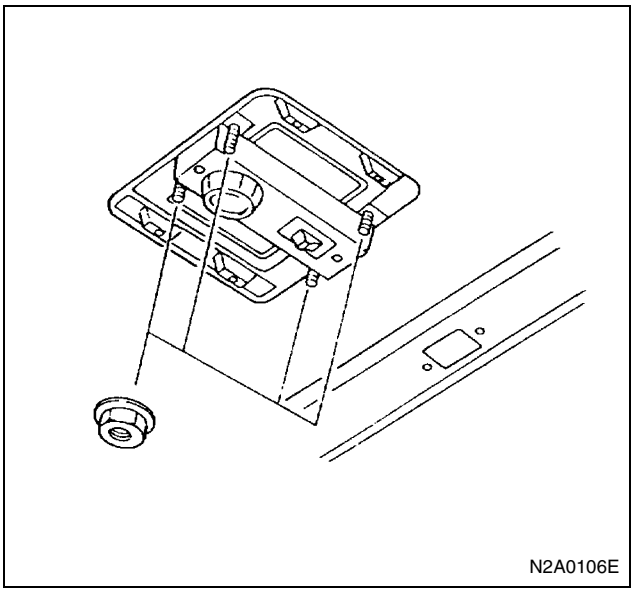
Roof Ventilator

Removal

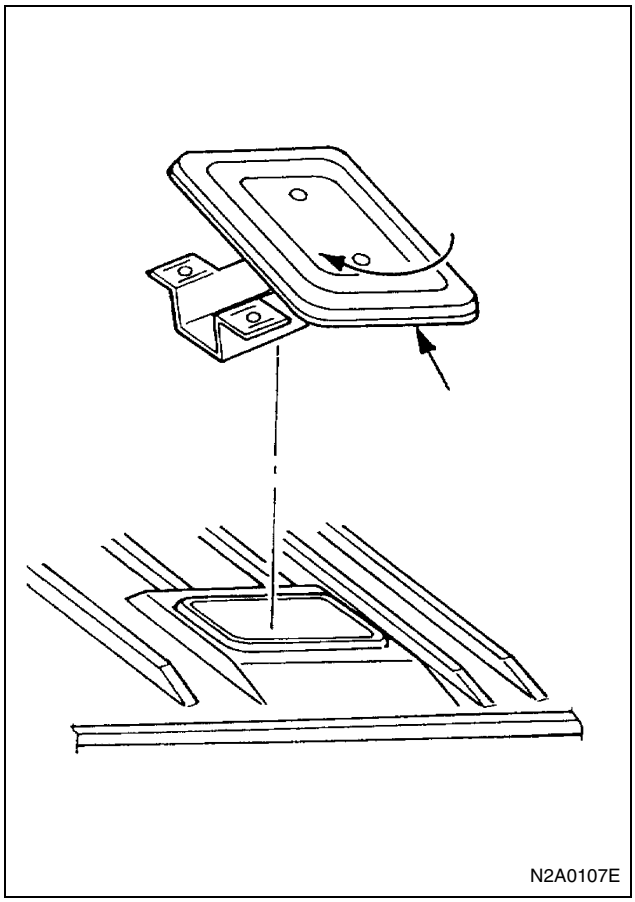
1. Roof ventilator grille (1)
   - Remove the one mounting screw (3) and pull out the clips (2) at 4 positions.



2. Roof ventilator mounting nut
   - Remove the nuts at 4 positions.



3. Roof ventilator assembly
   - Align the main unit with the inlet side and remove it from the stud. Turn it 90° and pull it out.



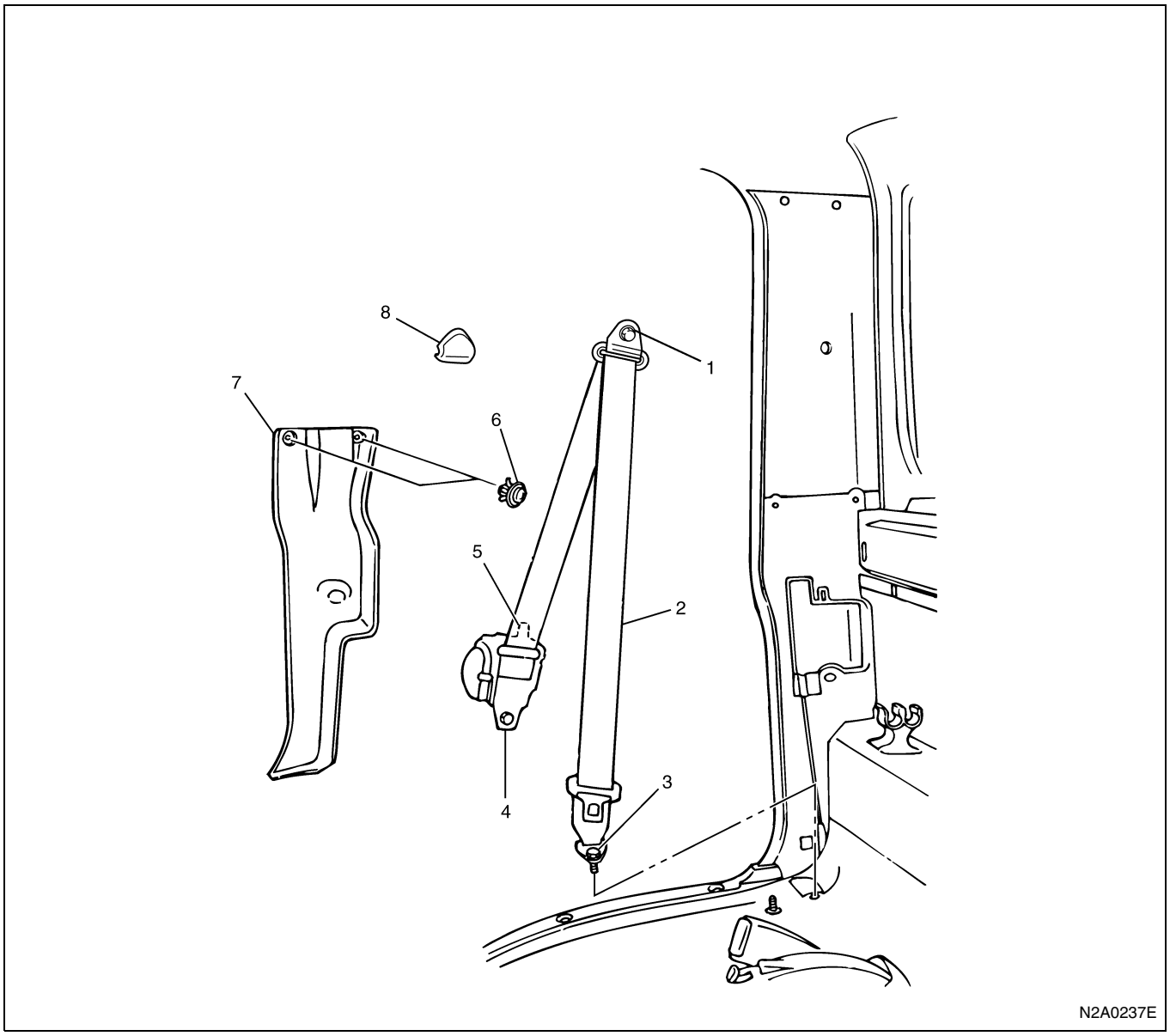
Installation

For installation, reverse the removal procedure.

SEAT BELT

Tongue Side Seat Belt (Single Cab Model)

Component



Legend

1. Seat belt upper anchor bolt
2. Tongue side seat belt assembly
3. Seat belt lower anchor bolt
4. Retractor bolt
5. Bracket
6. Clip
7. Rear piller lower trim cover
8. Through anchor cover

Removal

1. Seat belt lower anchor bolt
2. Rear pillar lower trim cover
3. Through anchor cover
4. Seat belt upper anchor bolt
5. Retractor fixing bolt
   - Remove the bolt and pull out the upper bracket of the retractor from the panel.

Installation

For installation, reverse the removal procedure taking the following points into consideration.

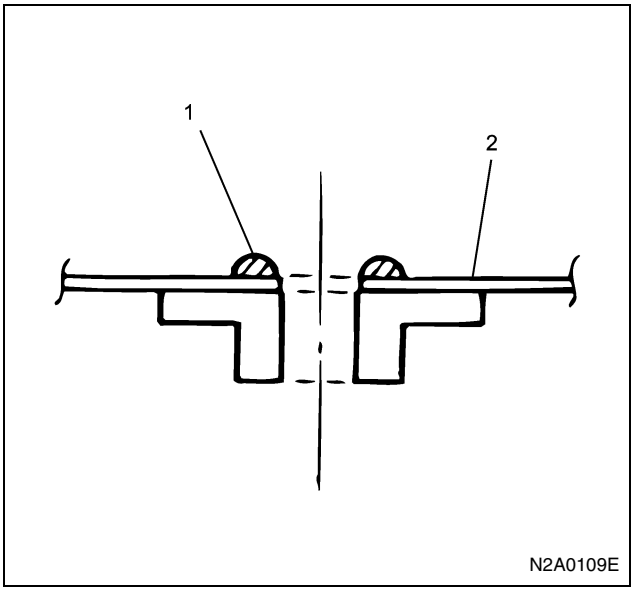
1. Tighten the seat belt upper anchor bolt to the specified torque.

Tighten:

Anchor bolt to 44 N·m (4.5 kg·m/32.5 lb·ft)

2. Apply the sealant (1) around the seat belt lower anchor bolt mounting hole on the floor part (2).

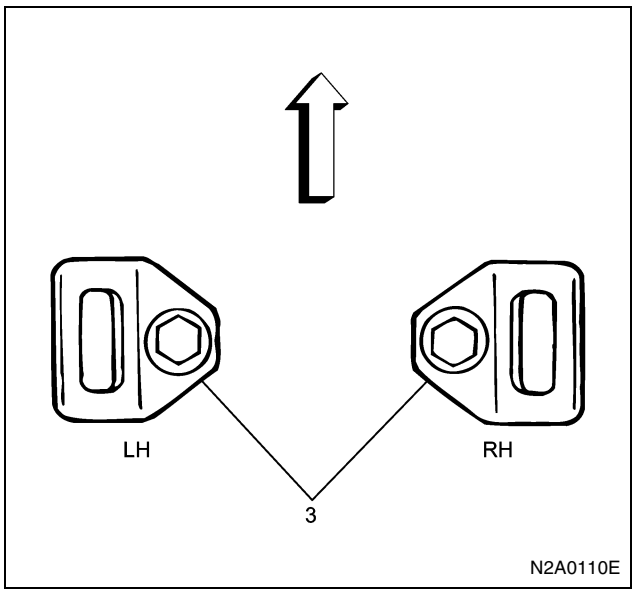
Sealant: TOKIWA CHEMICAL INDUSTRY 770GA or equivalent



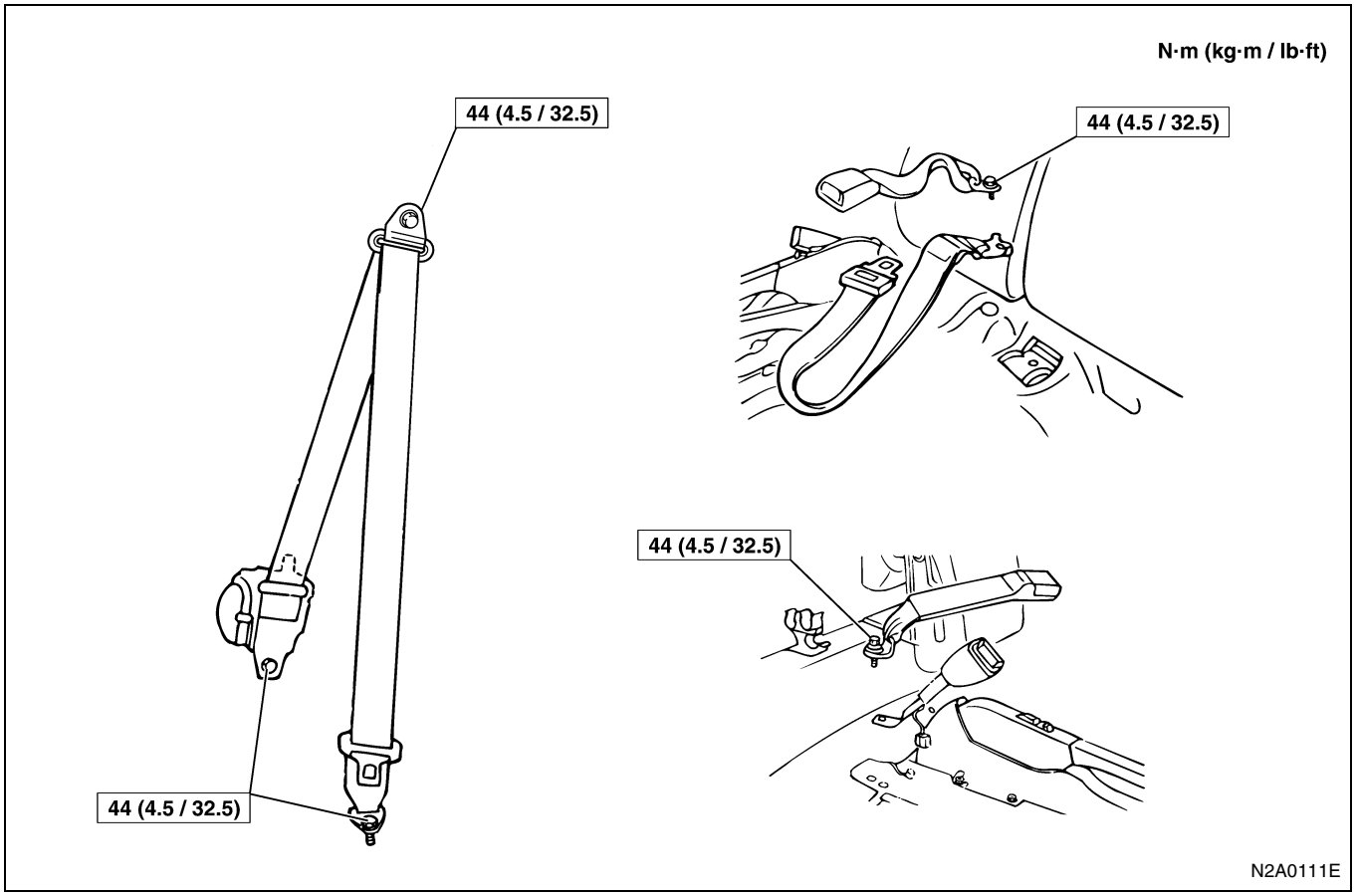
3. Install the seat belt lower anchor (3) in the specified direction, and tighten it to the specified torque.

Tighten:
Anchor bolt to 44 N·m (4.5 kg·m/32.5 lb·ft)

Caution:
Install the seat belt lower anchor so that it may not run on the anchor detent bead.

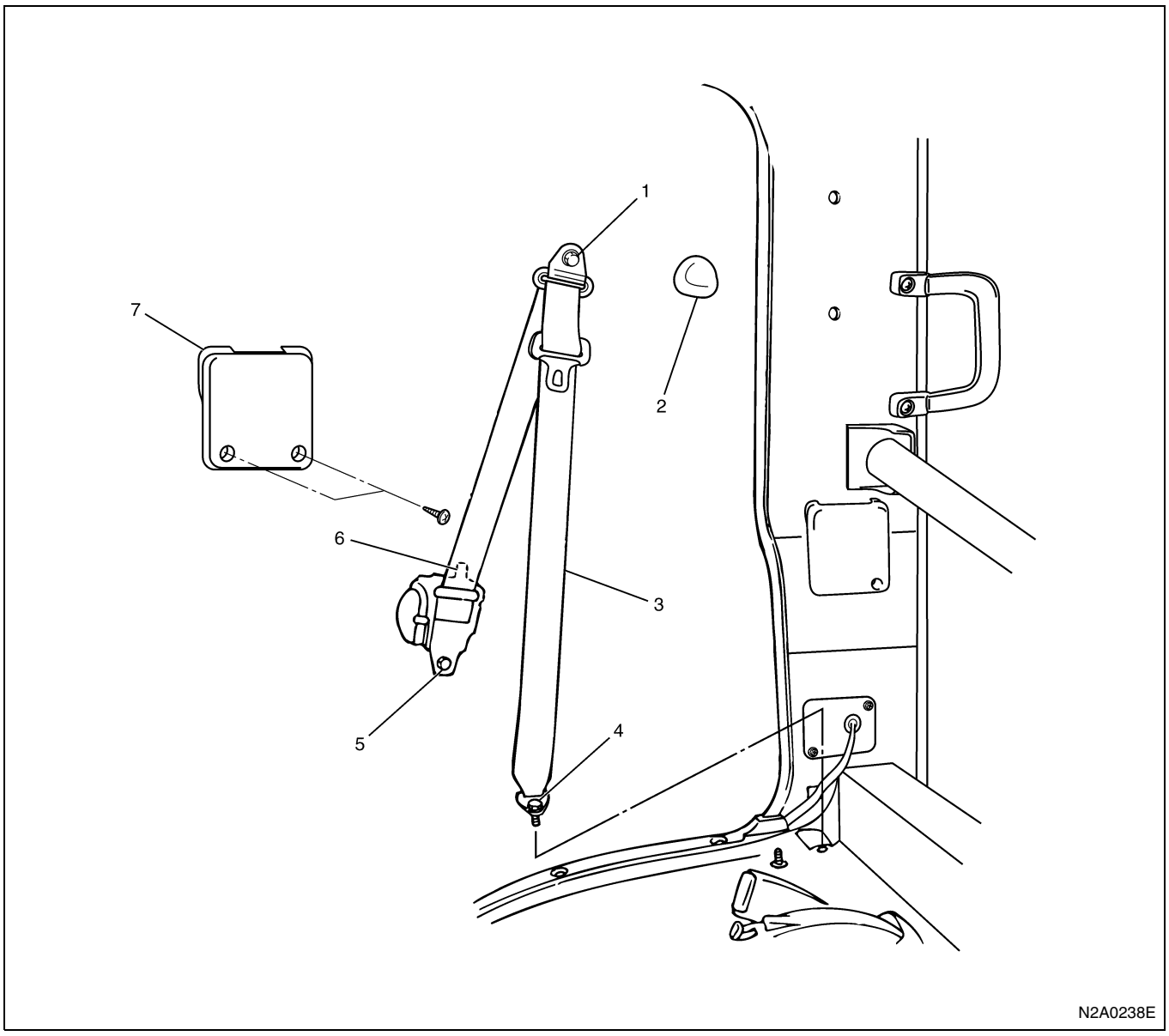


Fixing Torque



Tongue Side Seat Belt (Crew Cab Model)

Component



Legend

1. Seat belt upper anchor bolt
2. Through anchor cover
3. Tongue side seat belt assembly
4. Seat belt lower anchor bolt
5. Retractor fixing bolt
6. Bracket
7. Retractor cover

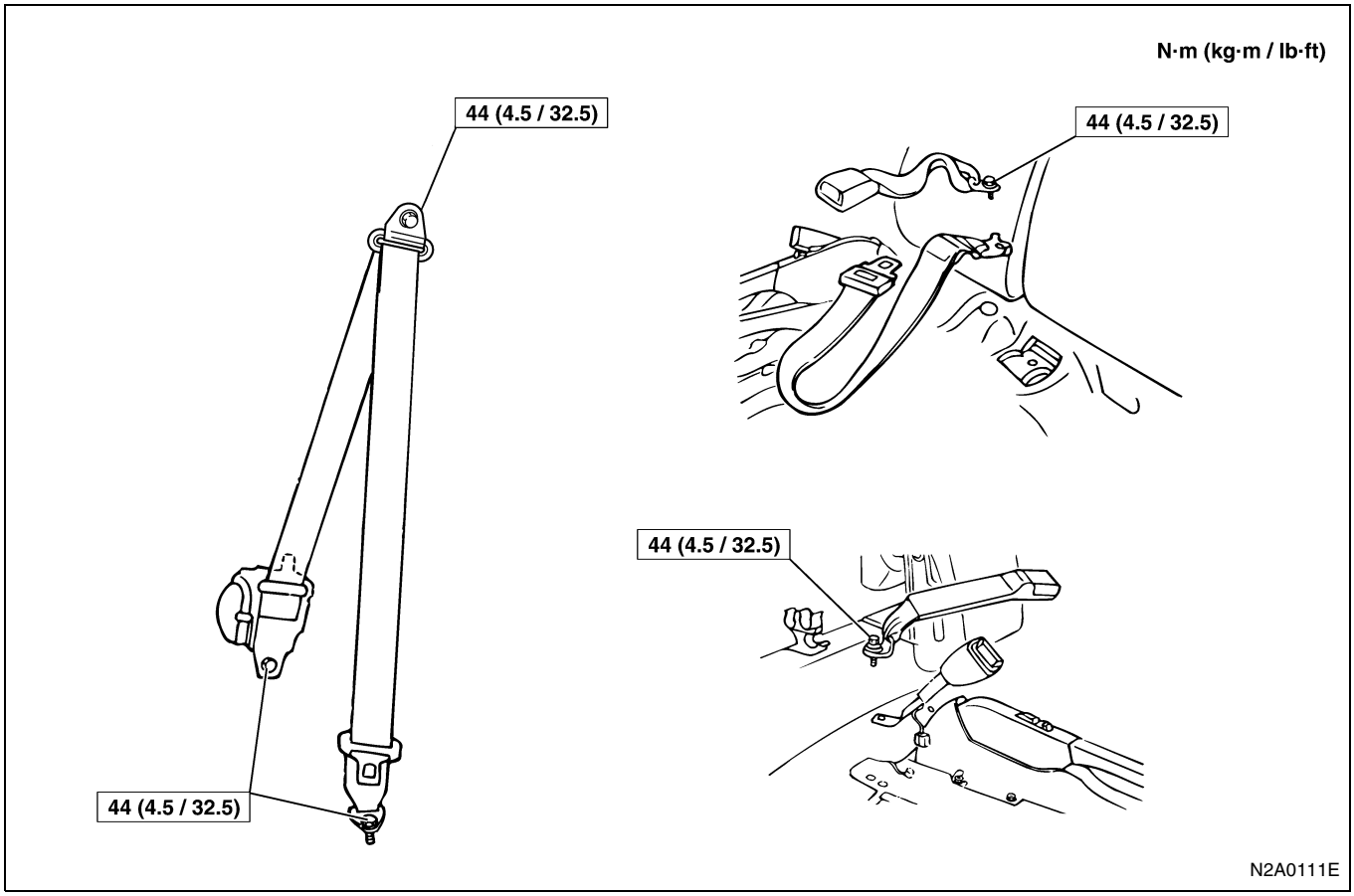
Removal

1. Seat belt lower anchor bolt
2. Retractor cover
   - Remove the 2 fixing screws.
3. Through anchor cover
4. Seat belt upper anchor bolt
5. Retractor fixing bolt
   - Remove the bolt and pull the retractor upper bracket from panel to remove.
6. Adjuster cover

Installation

For installation, refer to “Tongue Side Seat Belt (Single Cab Model)” in this section, and reverse the removal procedure.

Fixing Torque

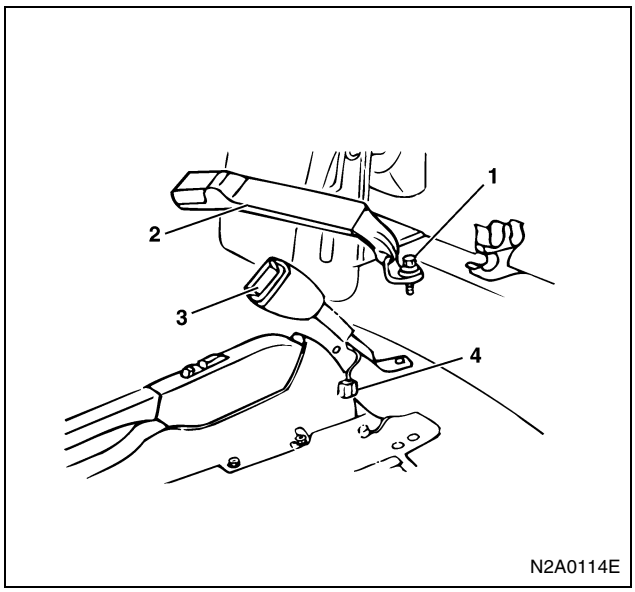


Front Center and Driver's Side Seat Belt Buckle

Removal

1. Disconnect the battery ground cable.
2. Fixing bolt (1)
3. Center seat belt buckle (2)
4. Disconnect the seat belt warning connector (4).
5. Driver's side seat belt buckle (3)

Caution:
For wide cab model, perform the steps 1 and 2 (Center), or the steps 1, 3 and 4 (Driver's side).

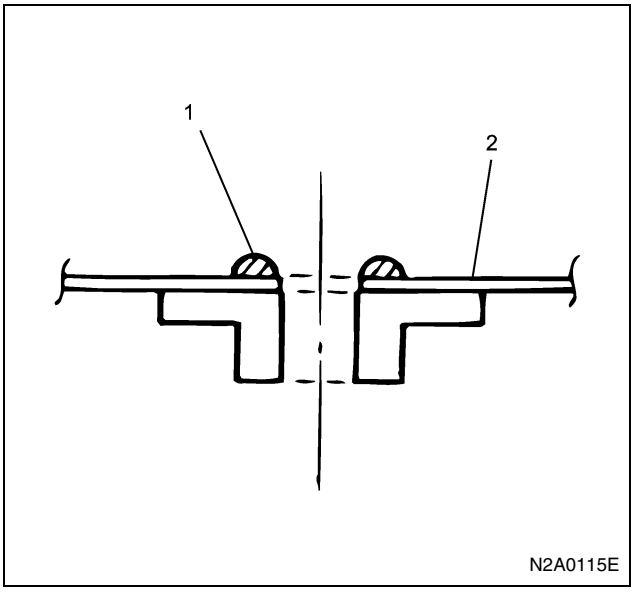


Installation

For installation, reverse the removal procedure taking the following points into consideration.

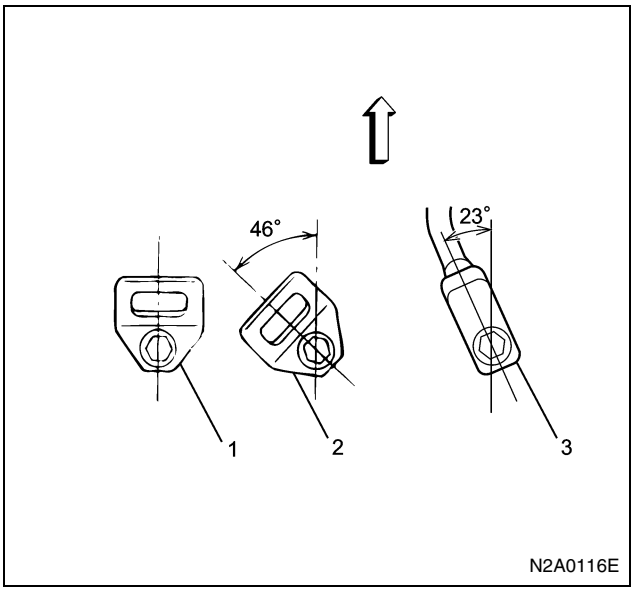
1. Apply the sealant (1) around the fixing bolt mounting hole on the floor part (2).

Sealant: TOKIWA CHEMICAL INDUSTRY 770GA or equivalent



2. Install the anchor in the specified direction, and tighten it to the specified torque.

Tighten:
Fixing bolt to 44 N·m (4.5 kg·m/32.5 lb·ft)

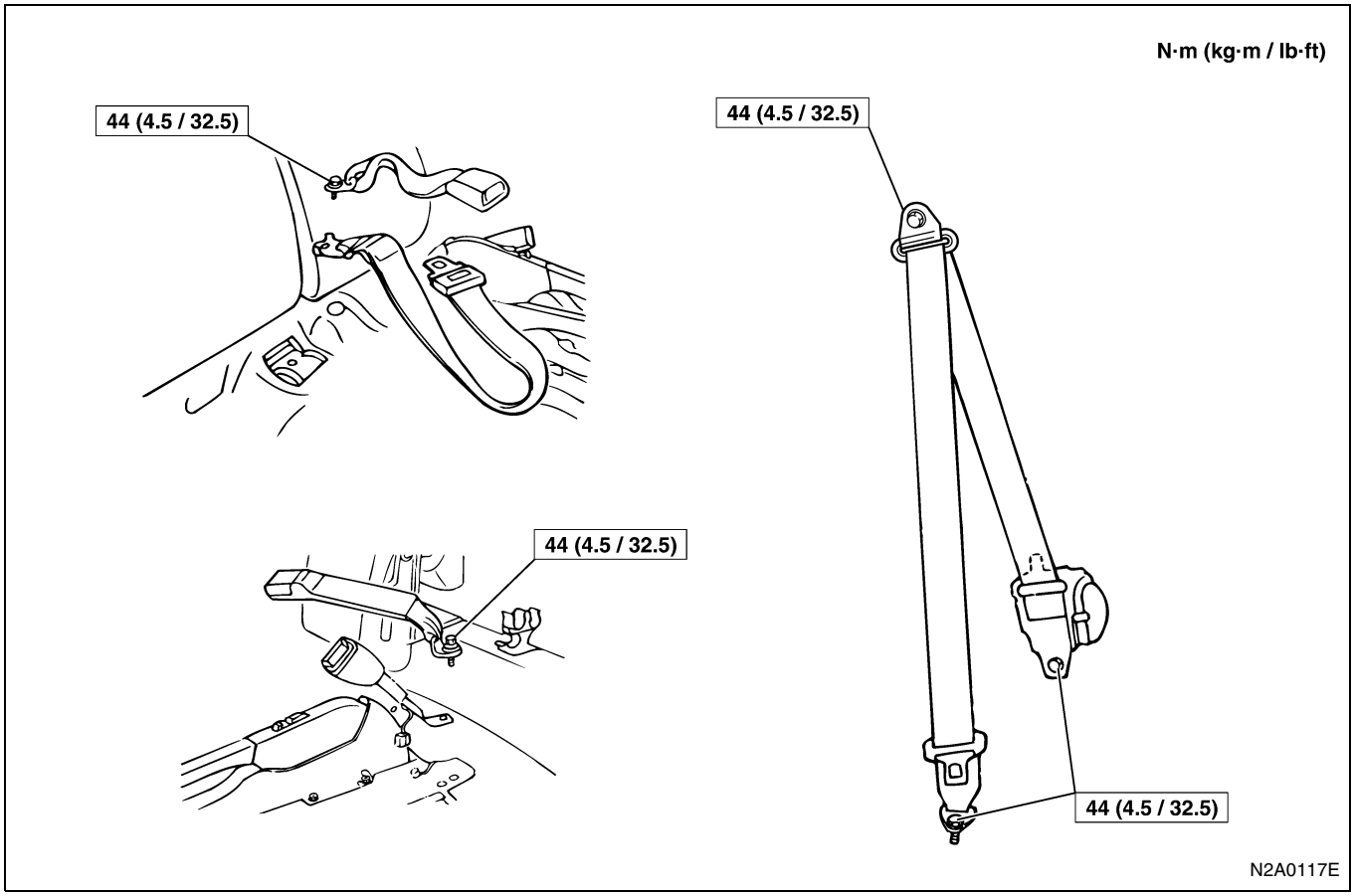


Legend
1. Center seat belt buckle (Wide cab model)
2. Center seat belt buckle (Except wide cab model)
3. Driver's side seat belt buckle

3. Pass the center seat belt buckle through the band on the end of seat cushion.

Caution:
Install the anchor so that it may not run on the anchor detent bead.

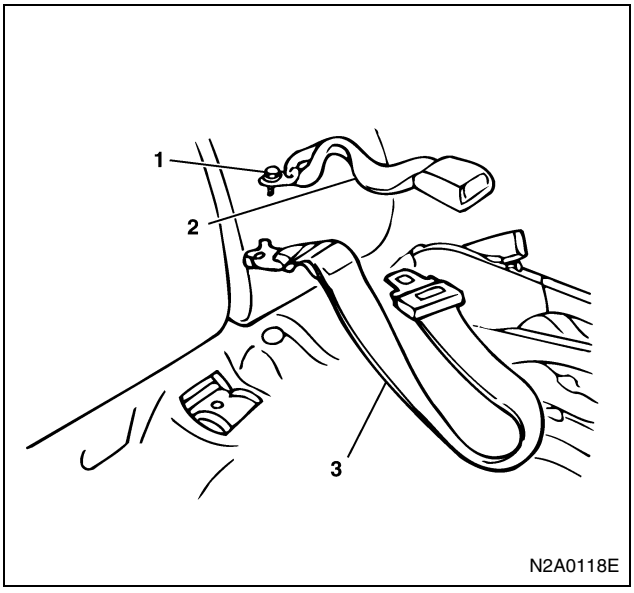
Fixing Torque



Front Center Seat Belt and Assistant's side Seat Belt Buckle

Removal

1. Assistant's seat cushion (three-passenger vehicle)
   - Refer to "Center and Passenger Side" in Seat Section of Cab Repair Manual.
2. Fixing bolt (1)
3. Passenger side seat belt buckle (2)
4. Center seat belt (3)



Installation

For installation, reverse the removal procedure taking the following points into consideration.

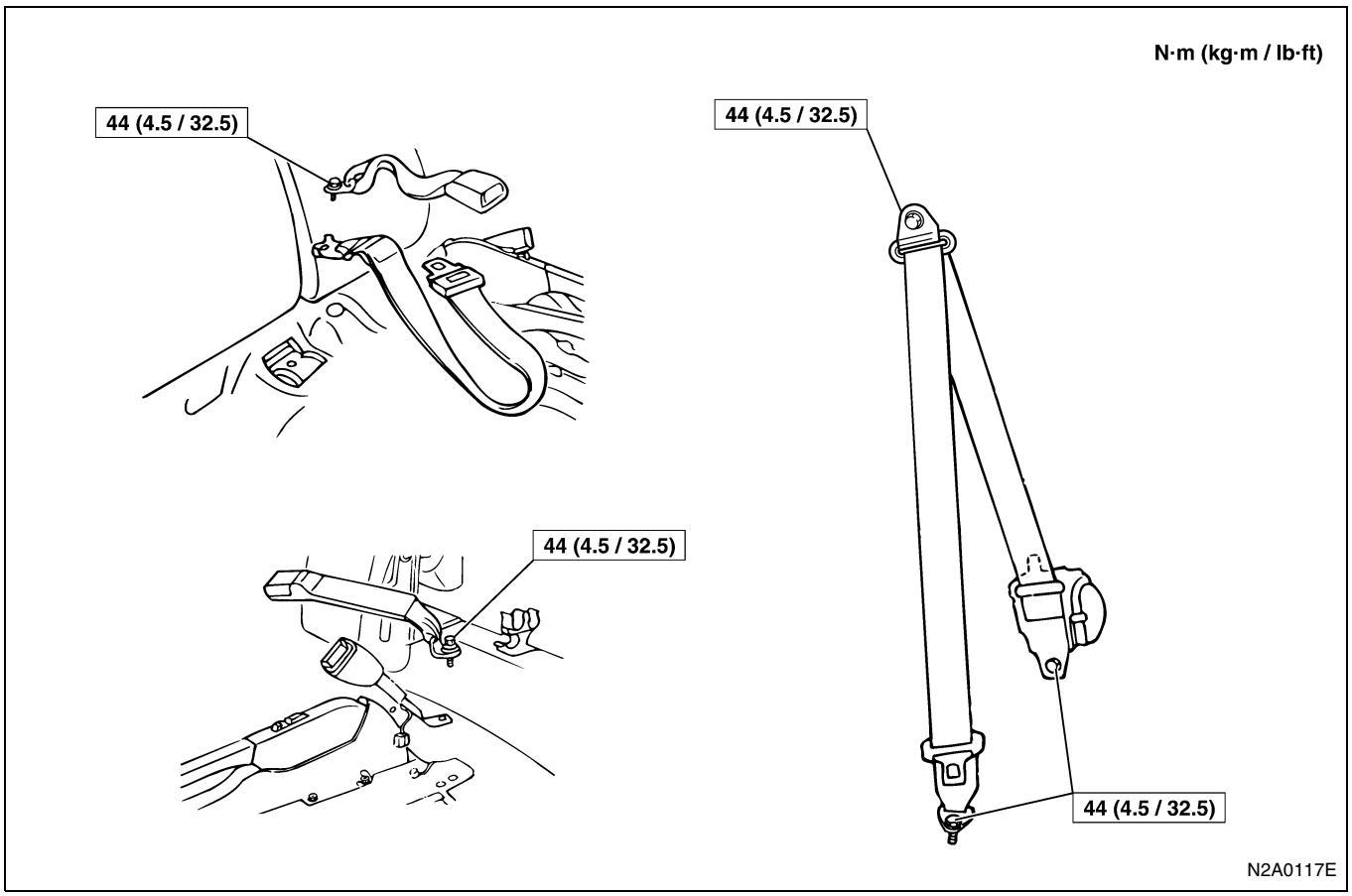
1. Apply the sealant (1) around the fixing bolt mounting hole.

Sealant: TOKIWA CHEMICAL INDUSTRY 770GA or equivalent

2. Install the anchor parallel to the traveling direction of vehicle.
3. Tighten the fixing bolts to the specified torque.

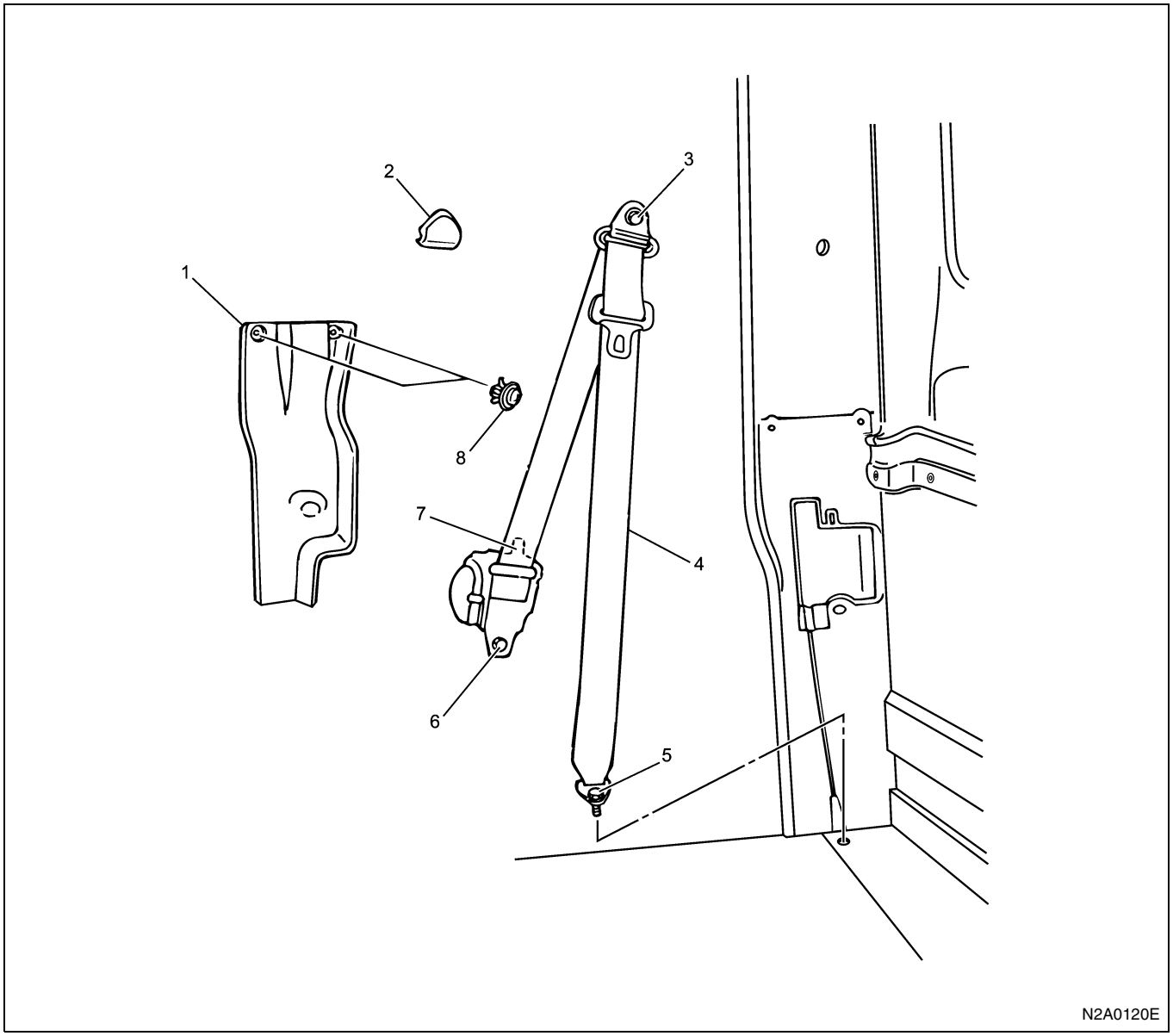
Tighten:
Fixing bolt to 44 N·m (4.5 kg·m/32.5 lb·ft)

Fixing Torque



Rear Seat Belt (Crew Cab Model)

Component



Legend

1. Rear pillar lower trim cover
2. Through anchor cover
3. Seat belt upper anchor bolt
4. Rear seat belt assembly
5. Seat belt lower anchor bolt
6. Retractor fixing bolt
7. Bracket
8. Clip

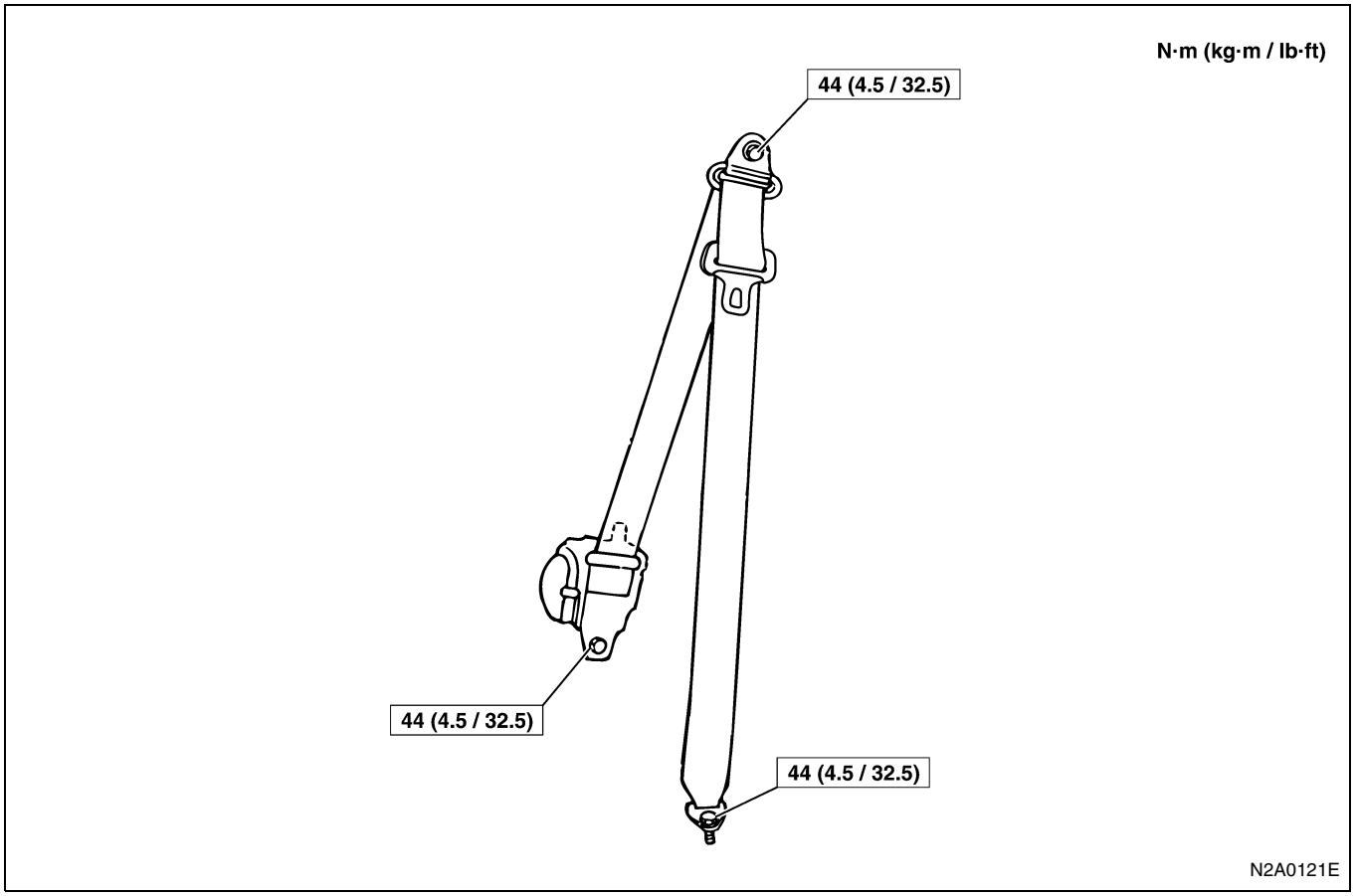
Removal

1. Seat belt lower anchor bolt
2. Rear pillar lower trim cover
   - Remove the 2 clips and pull it upward.
3. Through anchor cover
4. Seat belt upper anchor bolt
5. Retractor fixing bolt
   - Remove the bolt, and pull the retractor upper bracket from panel to remove it.

Installation

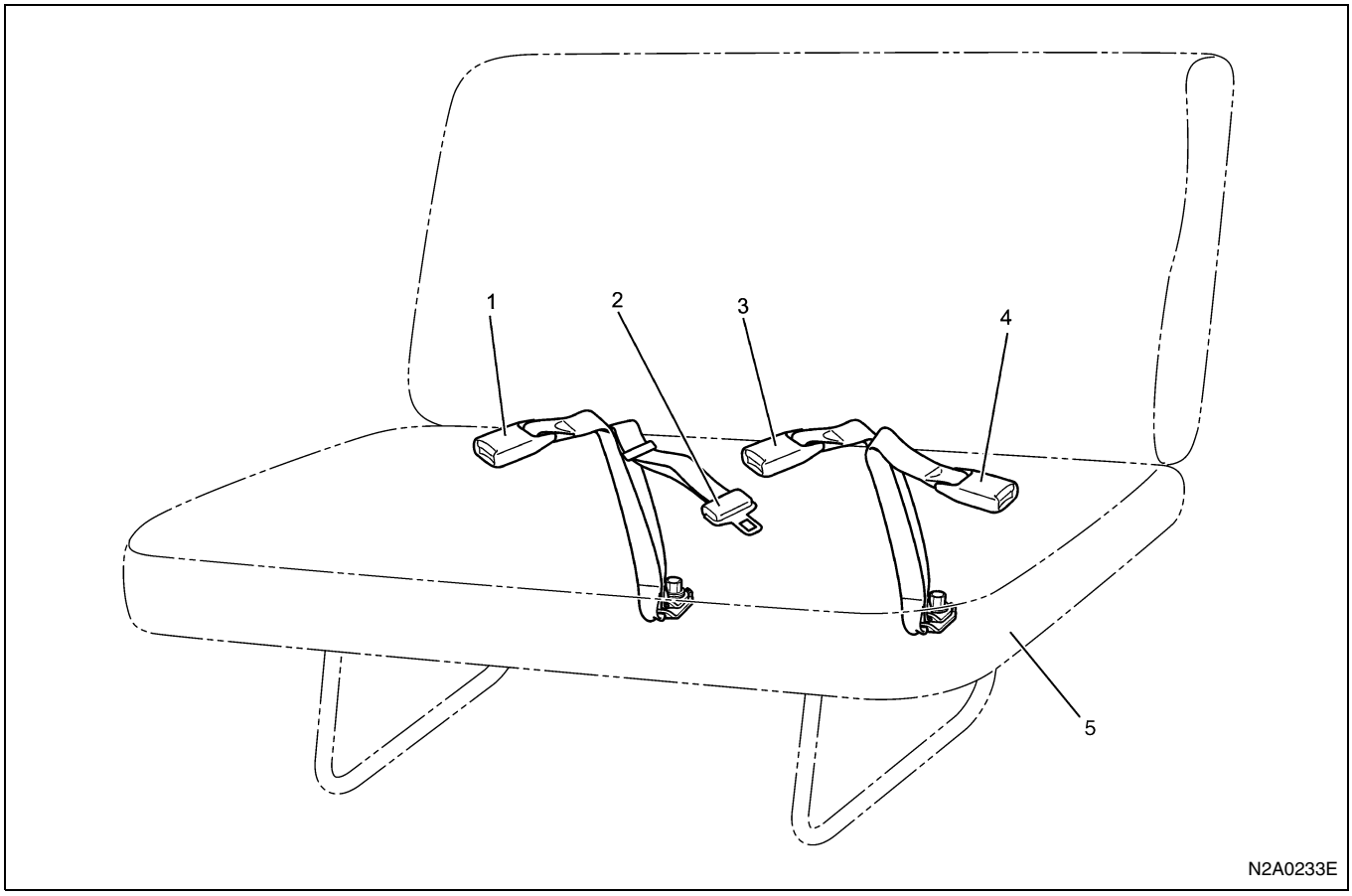
For installation, refer to “Tongue Side Seat Belt (Single Cab Model)” in this Section, and reverse the removal procedure.

Fixing Torque



Rear Seat Belt Buckle and Rear Center Seat Belt/Buckle (Narrow Cab Model)

Component



Legend

1. Rear seat belt buckle (RH)
2. Rear center seat belt
3. Rear center belt buckle
4. Rear seat belt buckle (LH)
5. Rear seat cushion

Removal

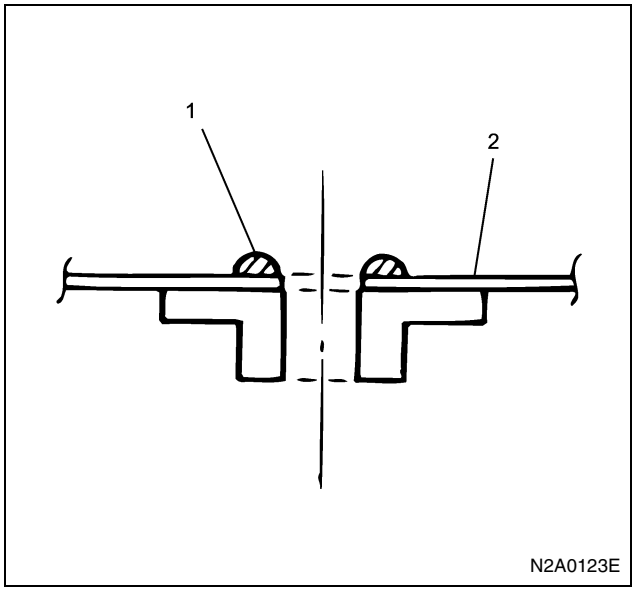
1. Fold the rear seat cushion.
   - Pull out each seat belt buckle and seat belt from the interval of the seat cushion and release the lock lever of rear seat cushion stay to fold it.
2. Fixing bolt of each seat belt

Installation

For installation, reverse the removal procedure taking the following points into consideration.

1. Apply the sealant (1) around the fixing bolt mounting hole on the floor part (2).

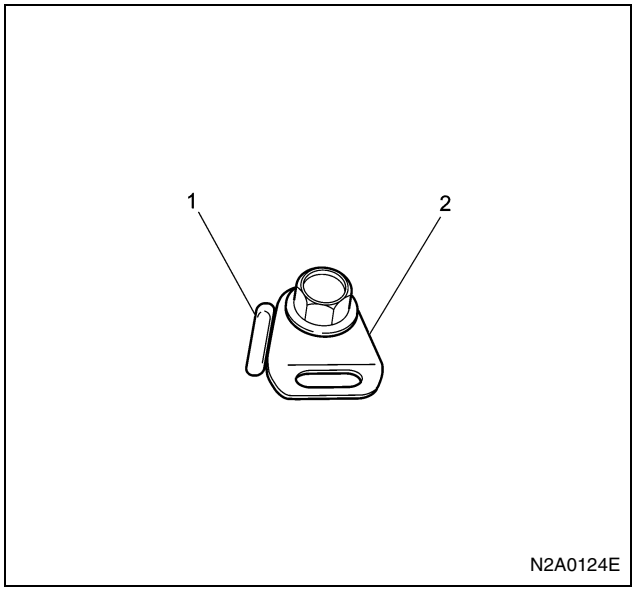
   Sealant: TOKIWA CHEMICAL INDUSTRY 770GA or equivalent



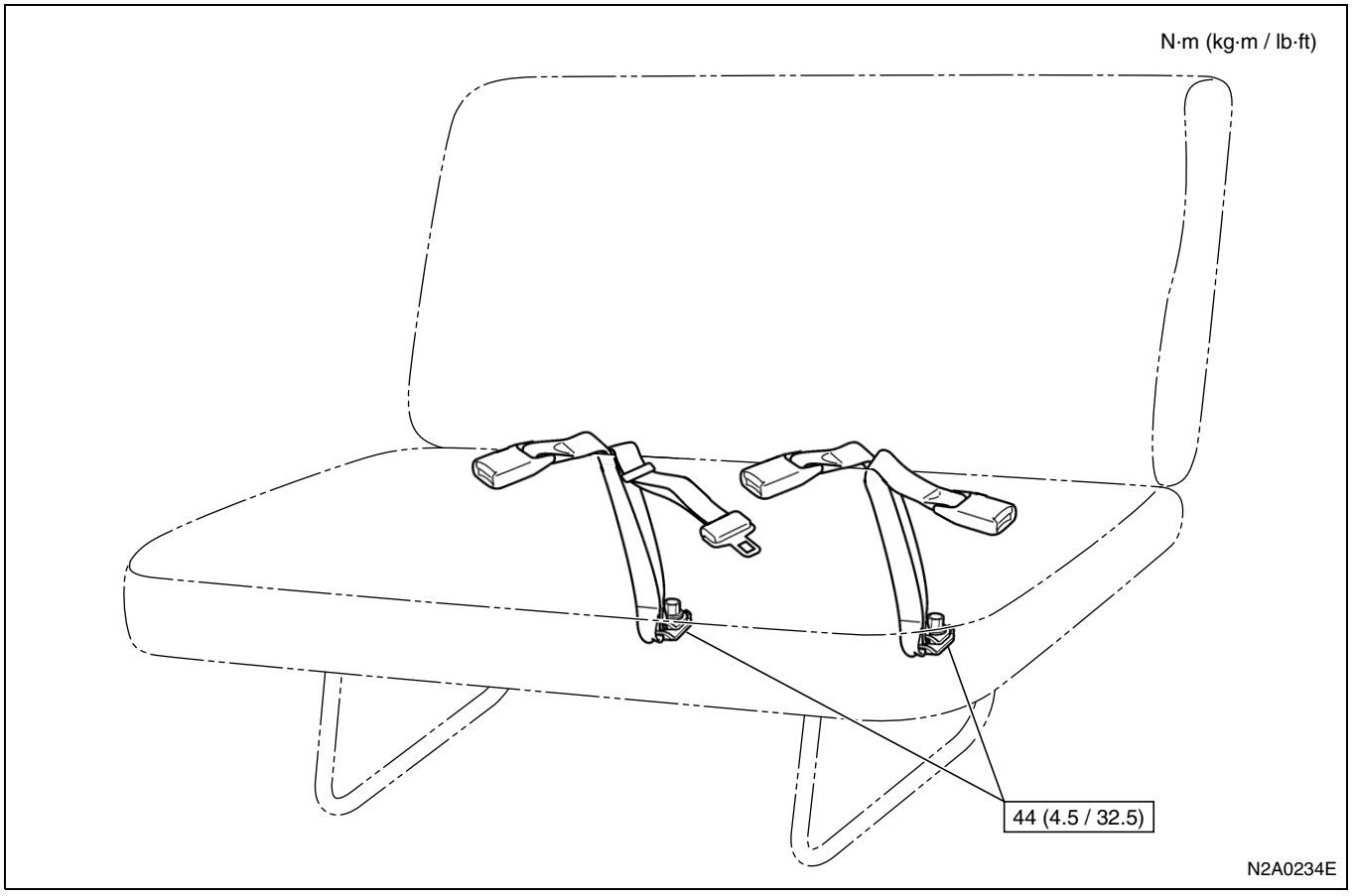
2. Install the anchor parallel to the traveling direction of vehicle.
3. Tighten the fixing bolts to the specified torque.

Tighten:
Fixing bolts to 44 N·m (4.5 kg·m/32.5 lb·ft)

Caution:
Install the anchor bracket (2) so that it may not run on the anchor detent bead (1).

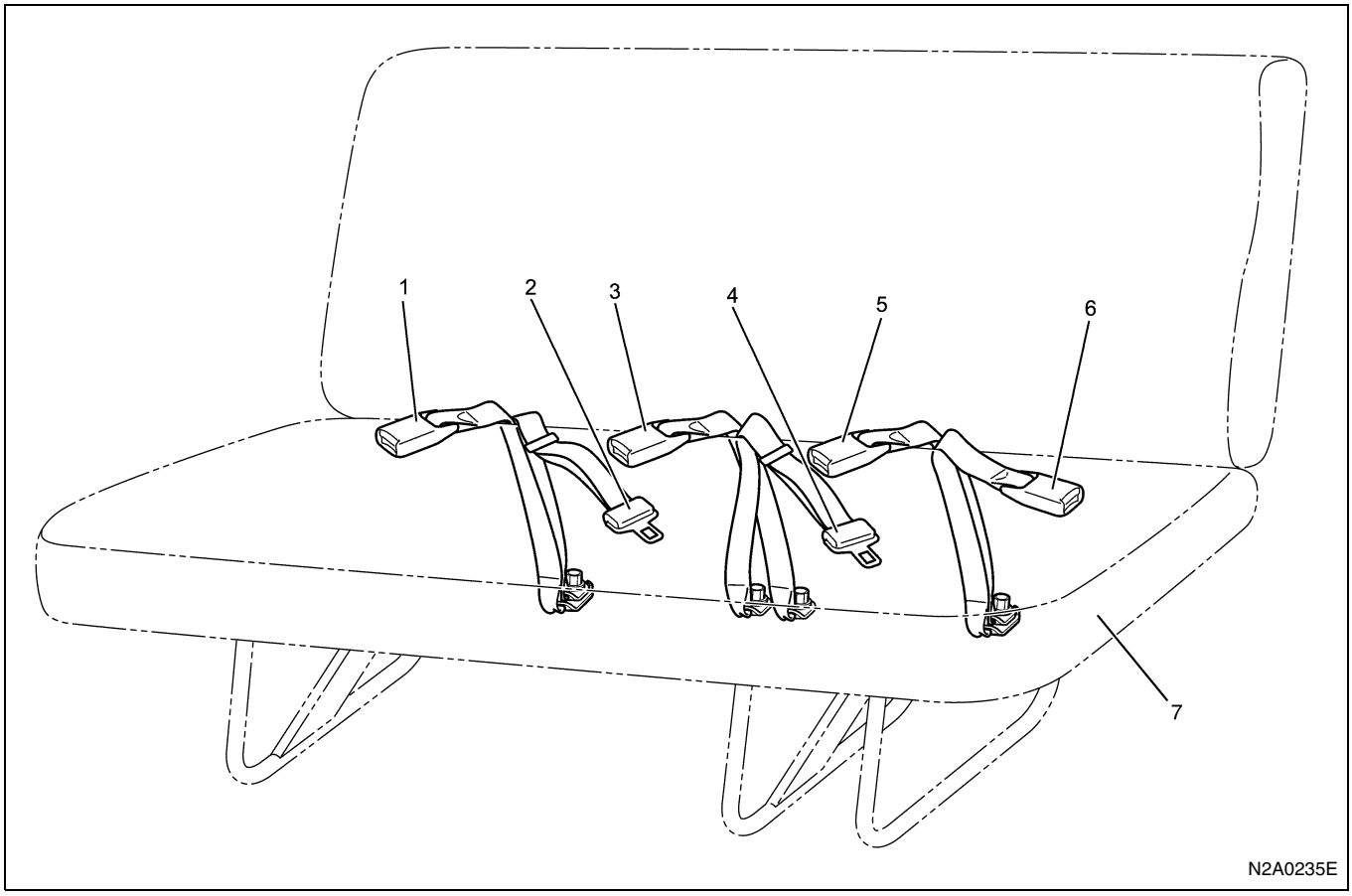


Fixing Torque



Rear Seat Belt Buckle and Rear Center Seat Belt/Buckle (Wide Cab Model)

Component



Legend

1. Rear seat belt buckle (RH)
2. Rear center seat belt (RH)
3. Rear center seat belt buckle (RH)
4. Rear center seat belt (LH)
5. Rear center seat belt buckle (LH)
6. Rear seat belt buckle (LH)
7. Rear seat cushion

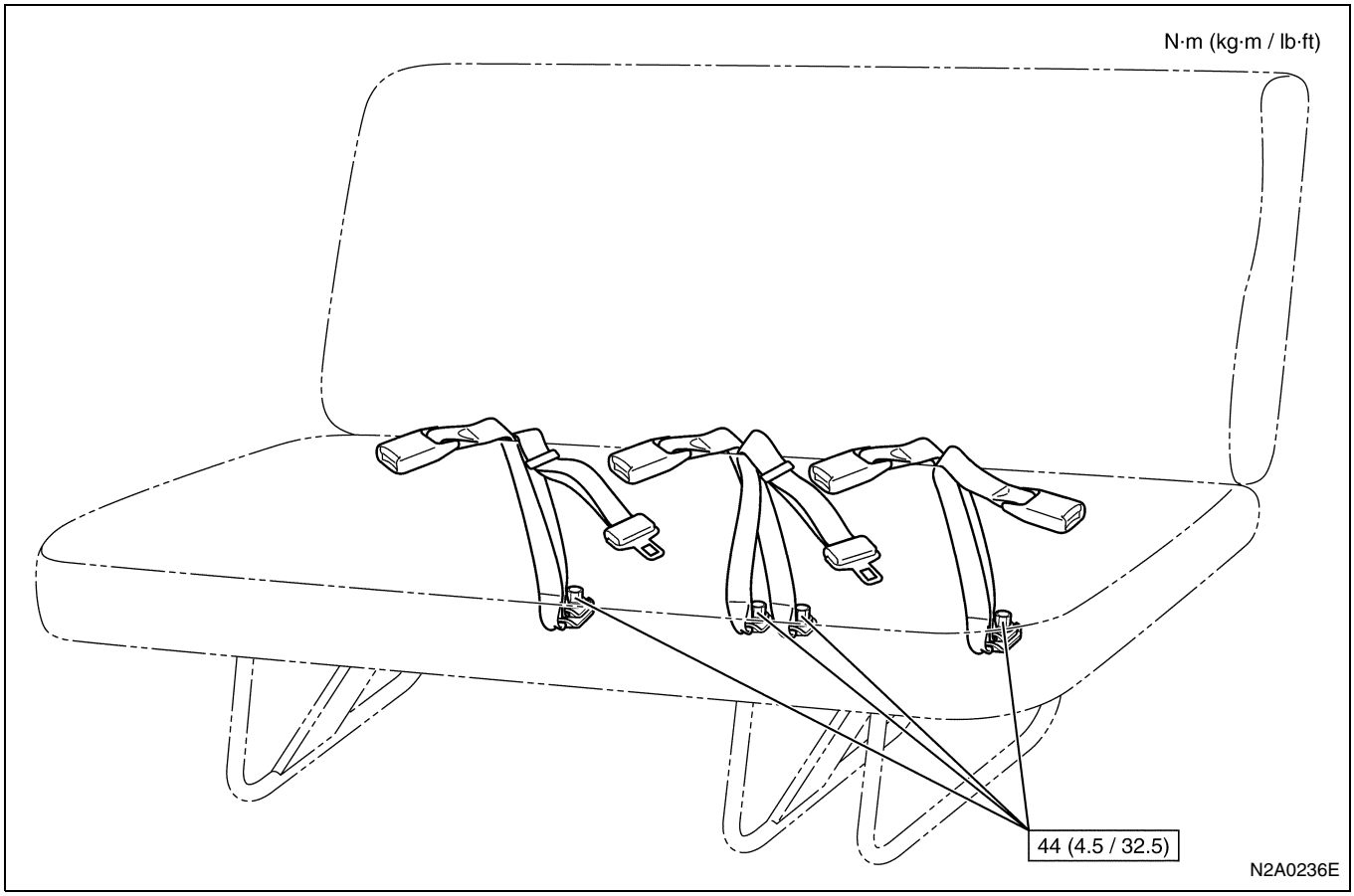
Removal

Refer to “Rear Seat Belt Buckle and Rear Center Seat Belt/Buckle (Narrow Cab Model)” in this section for removal.

Installation

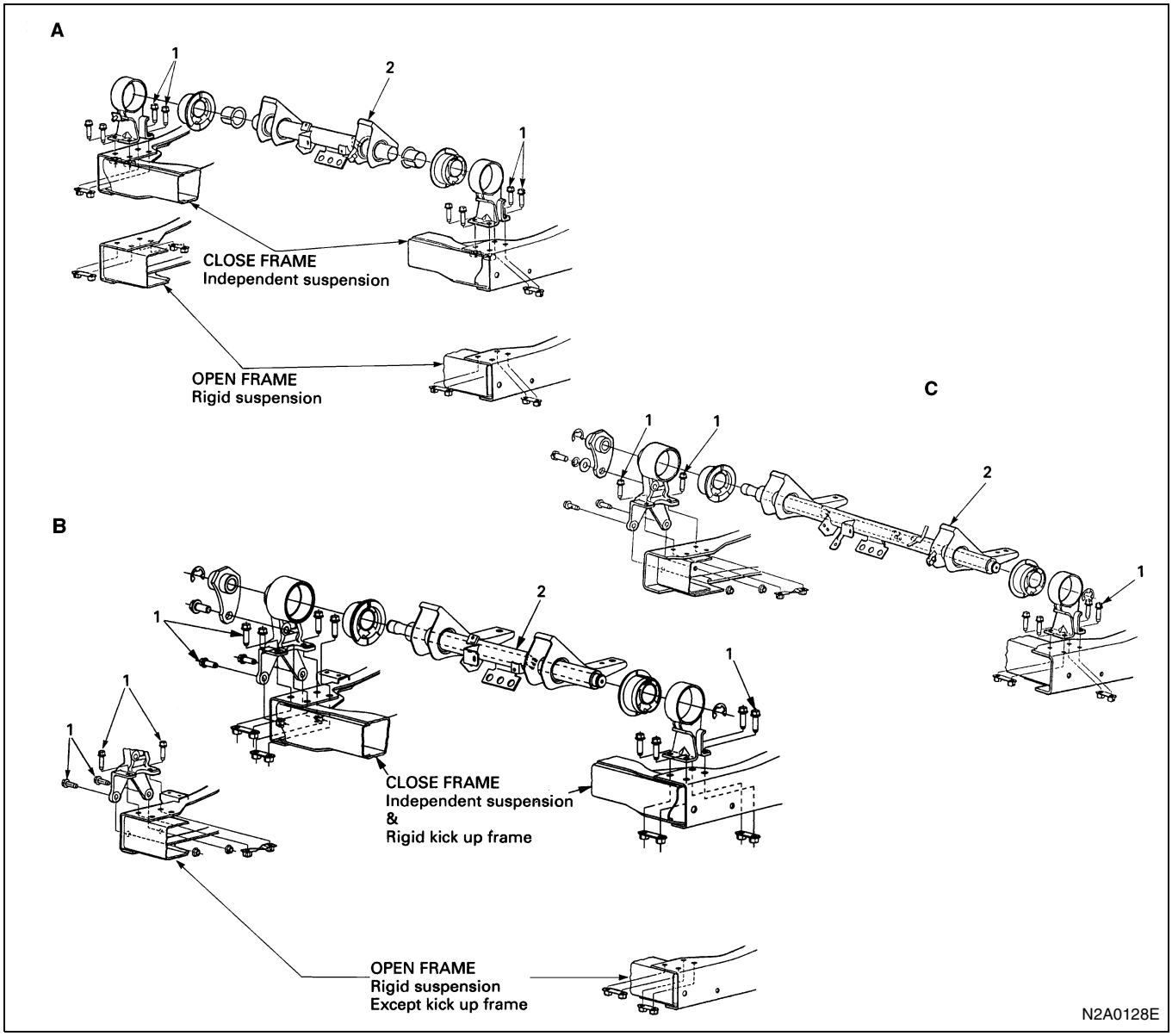
Refer to “Rear Seat Belt Buckle and Rear Center Seat Belt/Buckle (Narrow Cab Model)” in this section for installation.

Fixing Torque



CAB MOUNTING

Front Mounting



Legend

A. Non-tilt cab
B. Tilt cab (wide)
C. Tilt cab (narrow)
1. Cab mounting bracket fixing bolt
2. Cab mounting lever assembly

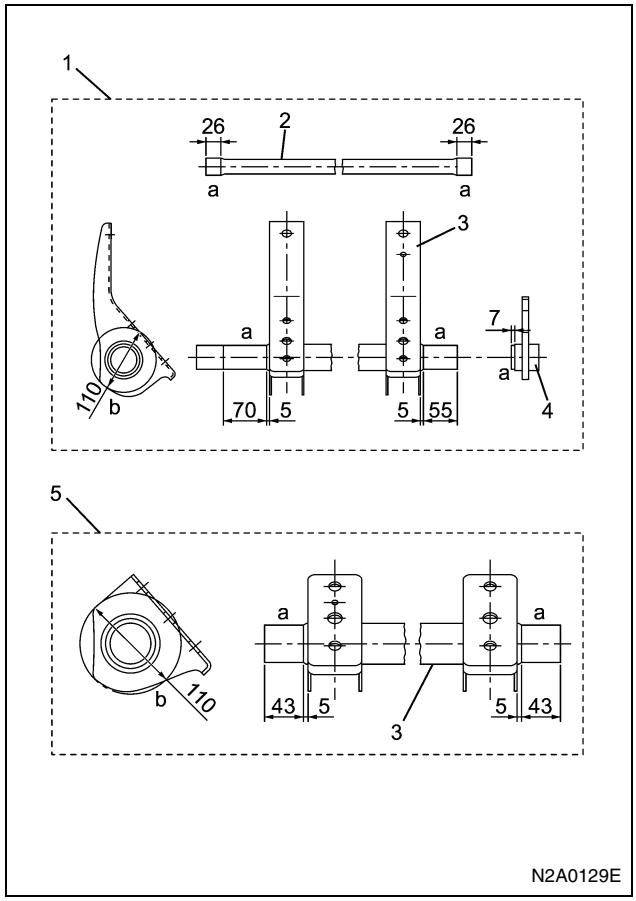
Removal

1. Cab assembly
   - Refer to “Removal and Installation of Cab Assembly” in this Section.
2. Anchor bolt (Tilt cab model)
   - Loosen the anchor bolt, remove the adjusting bolt, and then remove the anchor bolt.
3. Front cab mounting bracket
   - For RH side, remove the 4 fixing bolts. The nut side is classified into 2 types, weld and plate, depending on models.
   - For LH side, remove the 2 fixing bolts from the upper and 2 fixing bolts from the side. The nut side is classified into 2 types, weld and plate, depending on models, similarly to RH side.
4. Anchor arm
   - Remove the snap ring in the end of torsion bar.
5. Cab mounting lever assembly

Installation

For installation, reverse the removal procedure taking the following points into consideration.

1. Apply grease to the designated locations.
   a. BESCO L-2 applied area
   b. BESCO rubber grease application range
   • Apply it to the outer side of the body with mounting rubber.



N2A0129E

Legend

1. Tilt cab model
2. Torsion bar
3. Cab mounting lever assembly
4. Anchor arm
5. Non-tilt cab model

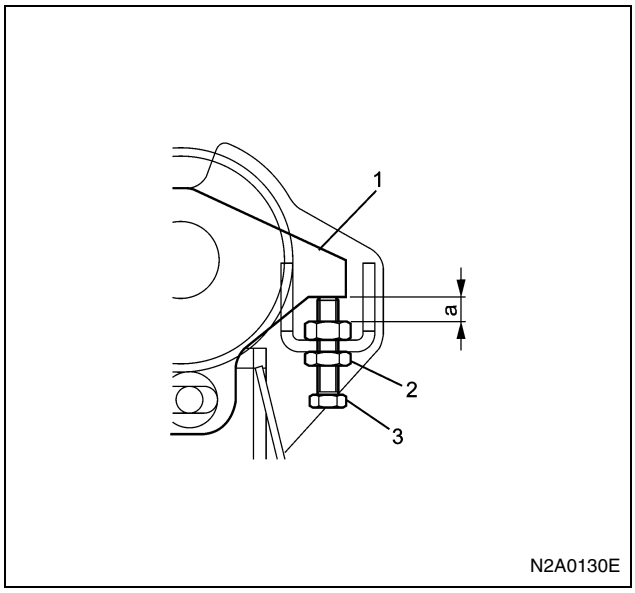
2. Tighten the fixing bolt of cab mounting bracket to the specified torque.

Tighten:
Fixing bolt to 117±11.8 N·m (11.9±1.2 kg·m/86.3±8.7 lb·ft)

3. When installing anchor arm, align the match mark (I mark) with the missing tooth of the torsion bar.
4. Adjust the amount of projection for anchor arm assembly (1) with adjusting bolt (3), and fix with the lock nut (2). (Tilt cab model)

The following dimensions are guide values.
When adjustment of operating force is necessary, refer to “7. Operating Force Adjustment”.

Dimension	Bolt projection amount mm (in)	Model type	Remarks
a	18±2.5 (0.7±0.1)	NKR slide door, NPS	Adjustment dimension
	13.5±2.5 (0.5±0.1)	Except above	



N2A0130E

5. Tighten the lock nut to the specified torque.

Tighten:
Lock nut to 76 N·m (7.7 kg·m/56.1 lb·ft)

6. Tighten the anchor arm anchor bolt to the specified torque.

Tighten:
Anchor arm anchor bolt to 95 N·m (9.7 kg·m/70.1 lb·ft)

7. Cab tilt operating force adjustment
   • Perform the following procedure when the cab equips heavy items such as roof rack, or any other occasion which require cab tilt operating force adjustment.
   a. Tilt-up the cab.

Caution:
Never perform adjustment with the cab tilt-down, since the torsion bar torque is applied to the adjusting bolt and nut of the anchor arm.

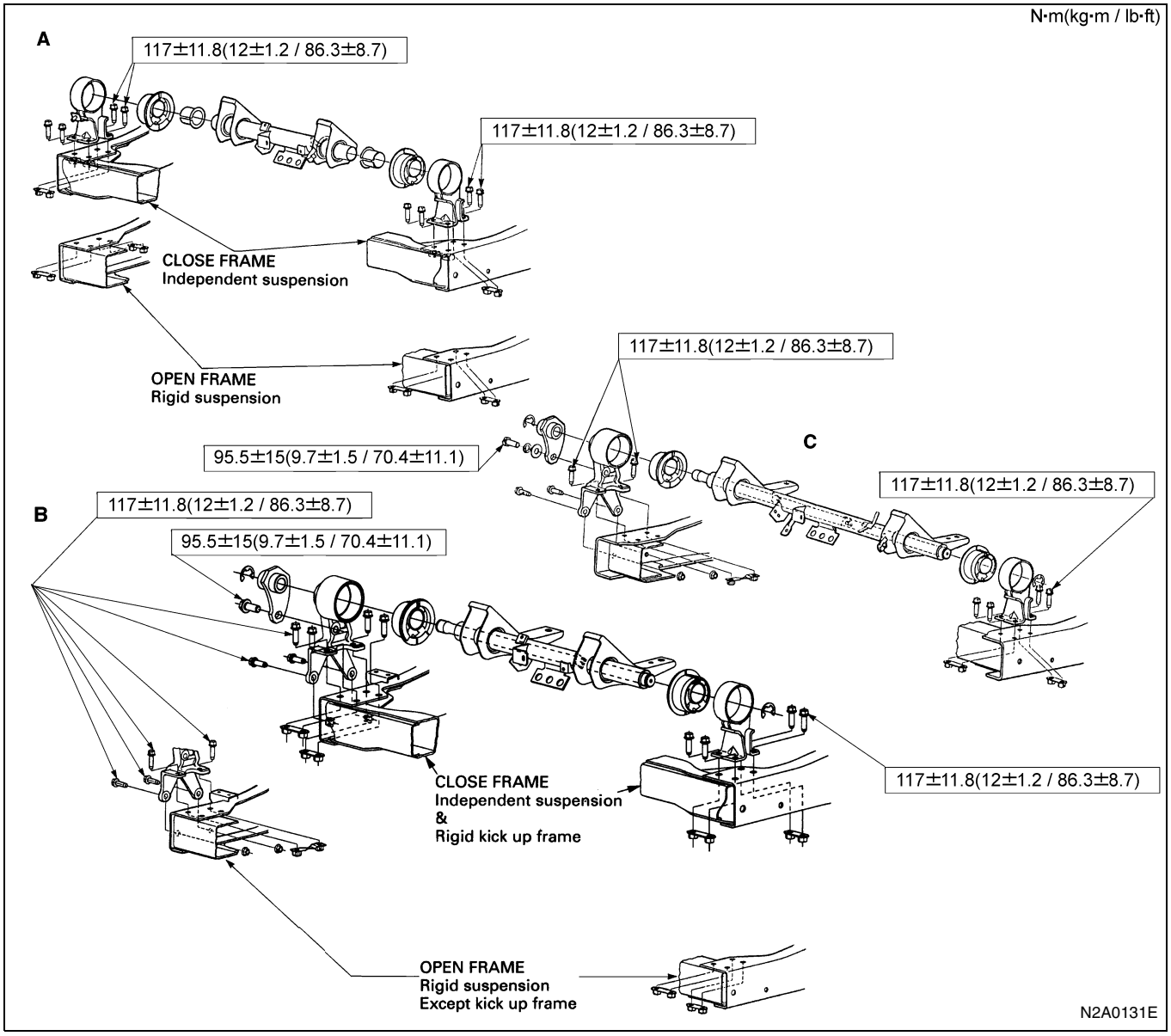
   b. Loosen the anchor bolt to the degree that allows you to turn it by hand.
   c. Turn the adjusting bolt to adjust the operating force.
      • Clockwise direction: Reduces cab tilt operating force.
      • Counterclockwise direction: Increase cab tilt operating force.

Notice:
One turn of the bolt changes ±4kg of cab tilt operating force.

d. Check that the adjusting bolt tip contacts the anchor arm side face.
e. Tighten the anchor bolt and lock nut to the specified torque.
f. Tilt-up or down the cab to make sure that the operating force is well-balanced. Repeat the steps (a) to (f) until the above condition is satisfactory.

Notice:
Specification for adjustment bolt projection amount is described in “4. Projection amount adjustment”.

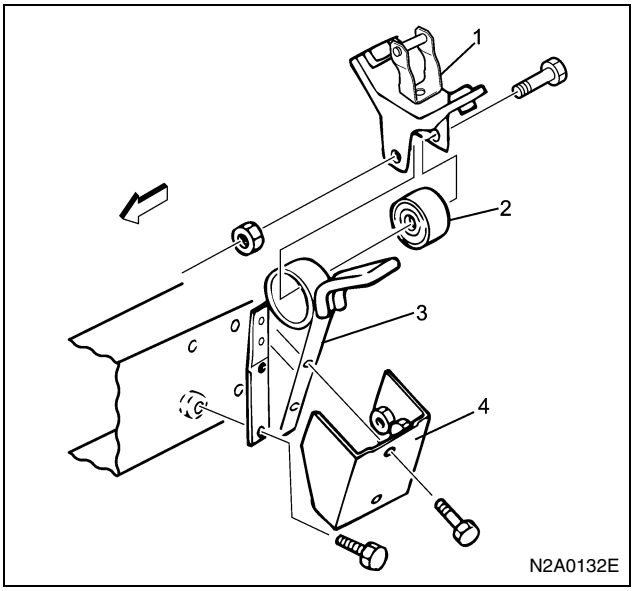
Fixing Torque



Rear Mounting (Model with Rubber Bushing except Wide Cab Model)

Removal

1. Tilt-up the cab.
2. Cab rear mounting bracket (1)
   - Remove the bolt and nut.
3. Cab mounting bracket (3)
   - Remove the cover (4) and remove the installing bolts. (Independent: 5 bolts, Rigid: 4 bolts)
4. Rubber bushing assembly (2)



Installation

For installation, reverse the removal procedure taking the following points into consideration.

1. Tighten the cab mounting bracket to the specified torque.

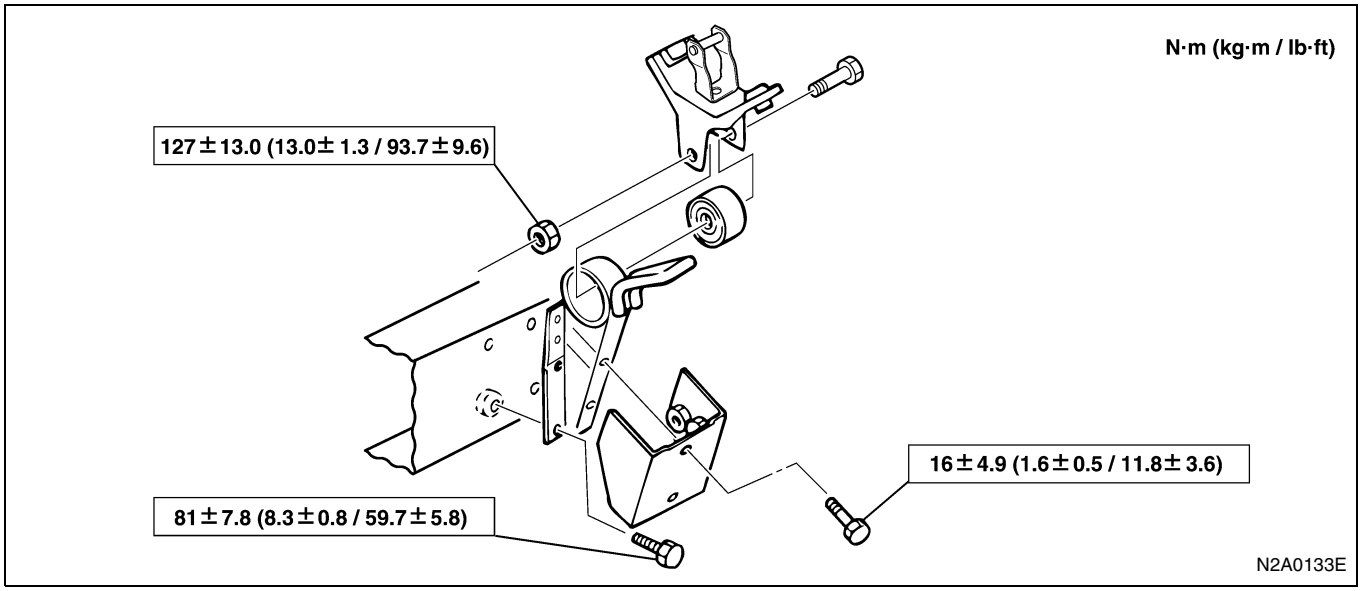
Tighten:
Cab mounting bracket to 81±7.8 N·m (8.3±0.8 kg·m/ 59.7±5.8 lb·ft)

2. Tighten the cab rear mounting bracket to the specified torque.

Tighten:
Cab rear mounting bracket to 127±13 N·m (13.0±1.3 kg·m/93.7±9.6 lb·ft)

3. Set the tilt of cab rear mounting bracket to ±2°or less.

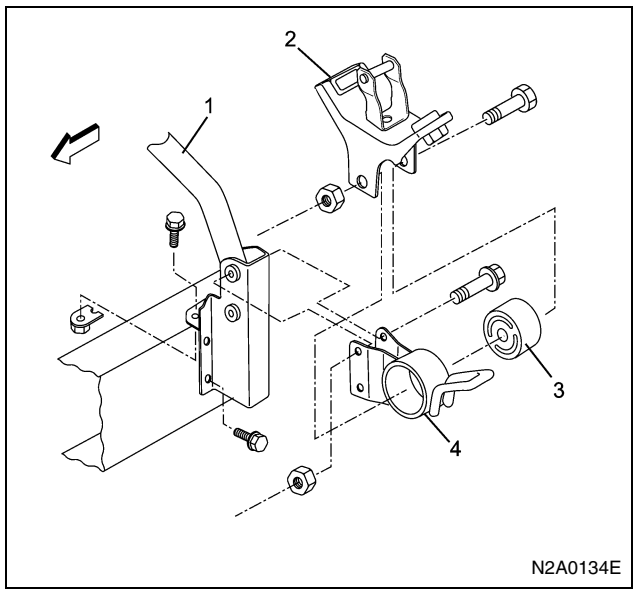
Fixing Torque



Rear Mounting (Wide Cab Model)

Removal

1. Tilt-up the cab.
2. Cab rear mounting bracket (2)
   - Remove the bolt and nut.
3. Cab mounting bracket (4)
   - Remove 2 pairs of bolts and nuts.
4. Rubber bushing assembly (3)
5. Cab back crossmember (1)
   - Remove the fixing bolt and nut.



Installation

For installation, reverse the removal procedure taking the following points into consideration.

1. Tighten the cab back crossmember.

Tighten:
Cab back crossmember to 81 N·m (8.3 kg·m/59.7 lb·ft)

2. Tighten the cab mounting bracket to the specified torque.

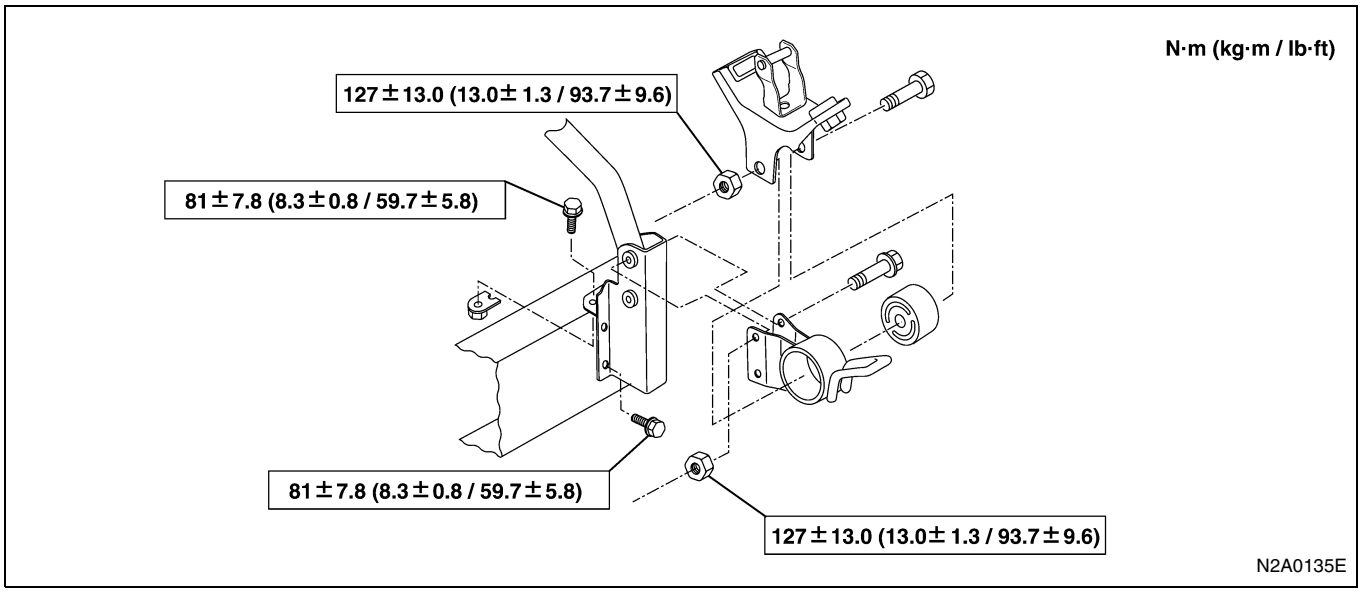
Tighten:
Cab mounting bracket to 127 N·m (13.0 kg·m/93.7 lb·ft)

3. Tighten the cab rear mounting bracket to the specified torque.

Tighten:
Cab rear mounting bracket to 127 N·m (13.0 kg·m/93.7 lb·ft)

4. Set the tilt of cab rear mounting bracket to ±2°or less.

Fixing Torque

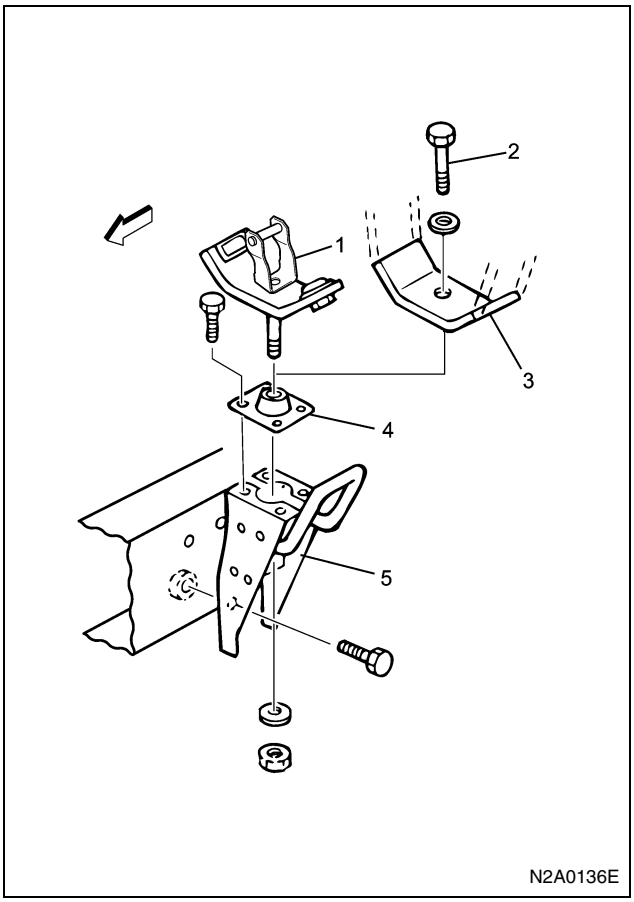


Rear Mounting (Model without Rubber Bushing)

Removal

1. For a tilt vehicle, tilt-up the cab.
2. Cab rear mounting bracket (1) (Tilt cab model)
   - Remove the nut and pull it up.

   Cab mounting rear bolt (Non-tilt cab model)
   - Remove the bolt (2) from the cab side bracket (3).
3. mounting rubber (4)
   - Remove the 4 bolts.
4. Cab mounting bracket (5)
   - Remove the bolts. (Independent: 5 bolts, Rigid: 4 bolts)



Installation

For installation, reverse the removal procedure taking the following points into consideration.

1. Tighten the cab mounting bracket to the specified torque.

Tighten:
Cab mounting bracket to 81±7.8 N·m (8.3±0.8 kg·m/59.7±5.8 lb·ft)

2. Tighten the mounting rubber to the specified torque.

Tighten:
Mounting rubber to 50±5.9 N·m (5.1±0.6 kg·m/36.9±4.4 lb·ft)

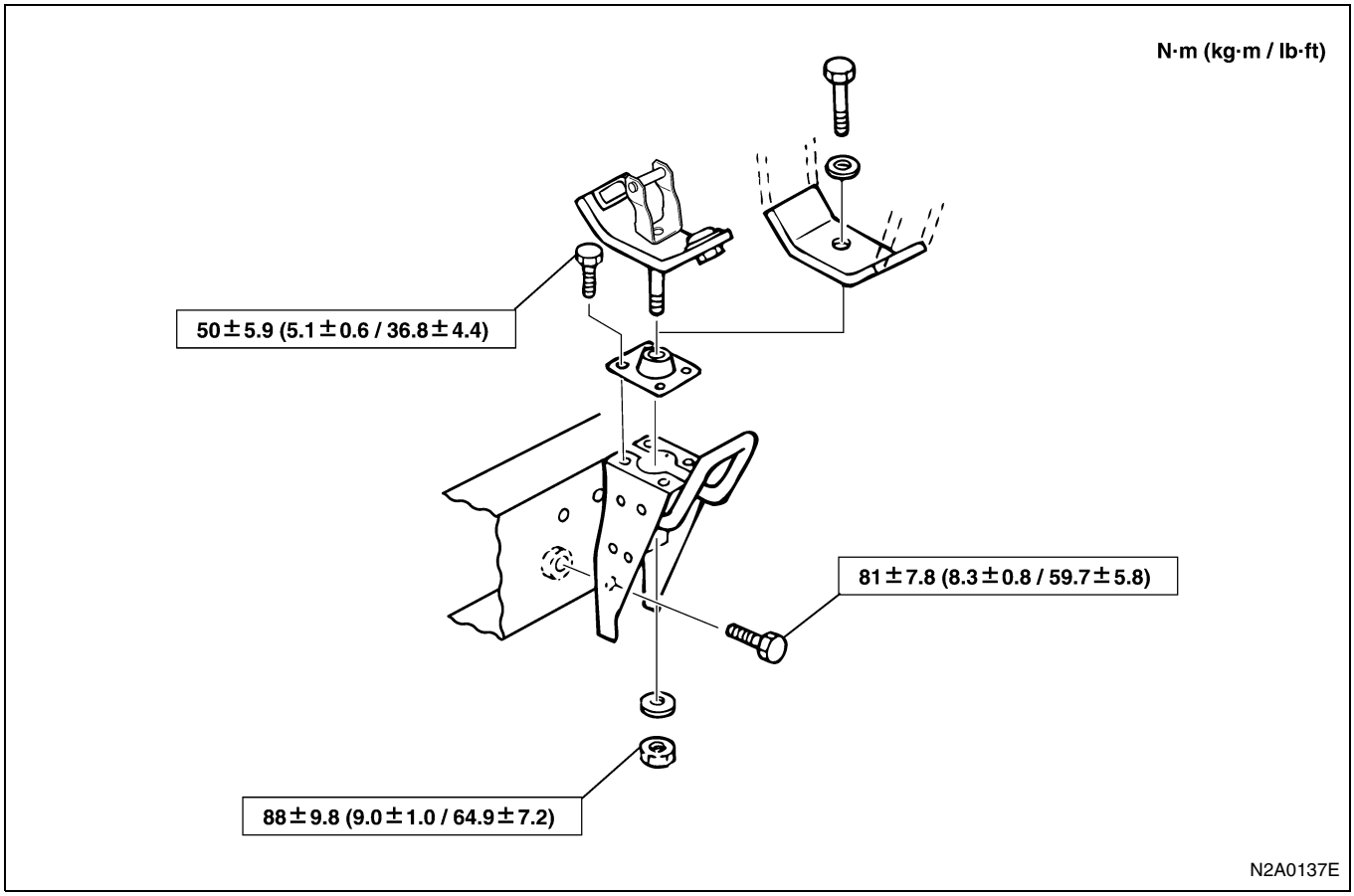
3. Tighten the cab rear mounting bracket to the specified torque. (Tilt cab model)

Tighten:
Cab rear mounting bracket to 88±9.8 N·m (9.0±1.0 kg·m/64.9±7.2 lb·ft)

4. Tighten the cab rear mounting bolt to the specified torque. (Non-tilt cab model)

Tighten:
Cab rear mounting bolt to 88 N·m (9.0 kg·m/64.9 lb·ft)

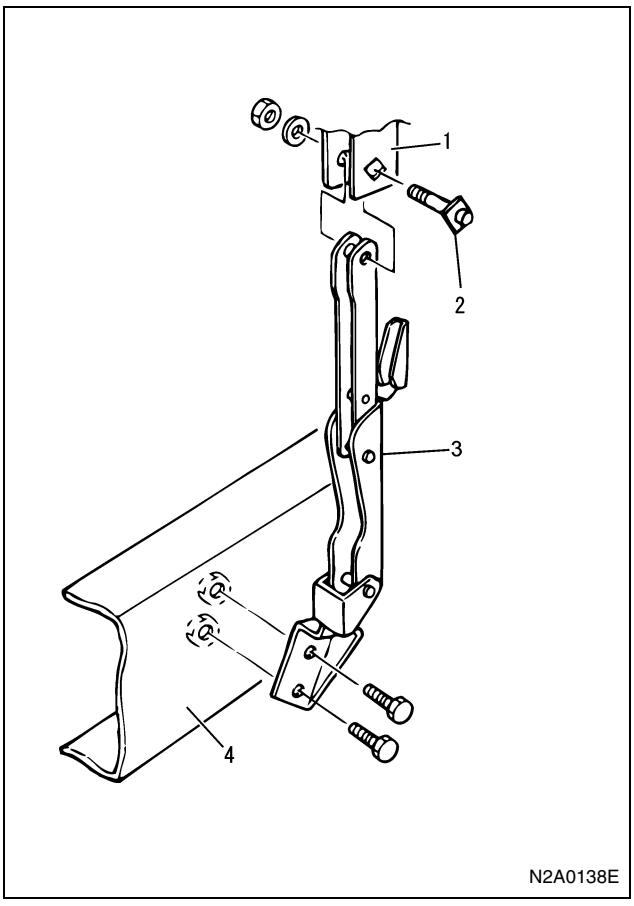
Fixing Torque



Cab Stay

Removal

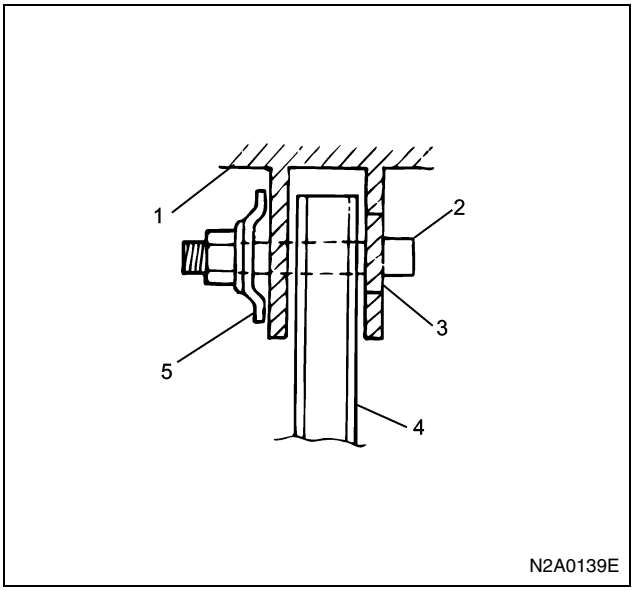
1. Cab stay pin
   - Remove the pin (2), nut, and washer from cab side bracket (1).
2. Cab stay (3)
   - Remove the 2 fixing bolts from frame side (4).



Installation

For installation, reverse the removal procedure taking the following points into consideration.

1. When installing the cab stay (4) to the cab side bracket (1), completely fit the cab stay pin (2) to the bracket square hole (3).
2. Assemble the washer (5) convex to face the nut side.



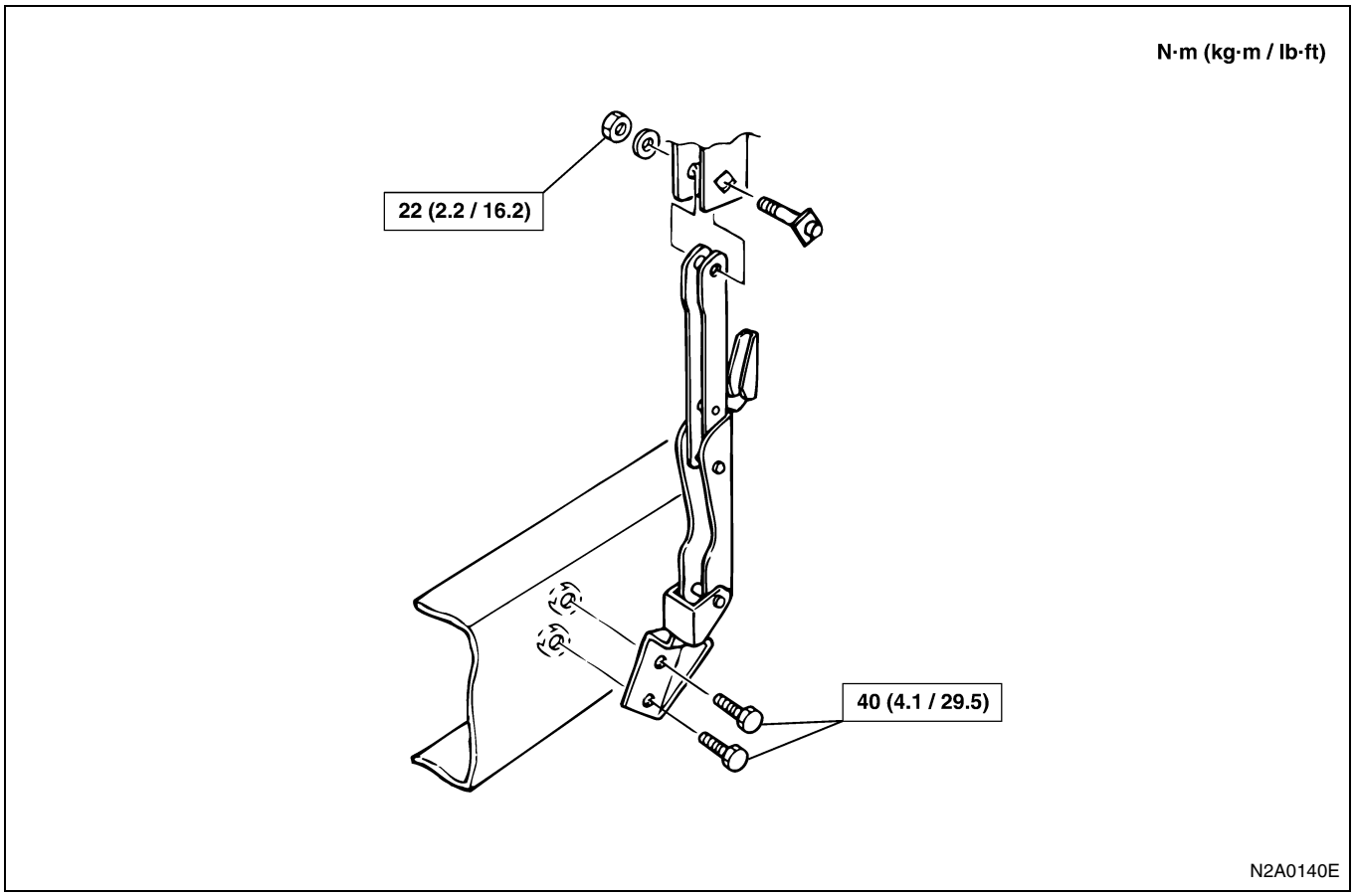
3. Tighten the cab stay pin fixing nut to the specified torque.

Tighten:
Cab stay pin fixing nut to 22 N·m (2.2 kg·m/16.2 lb·ft)

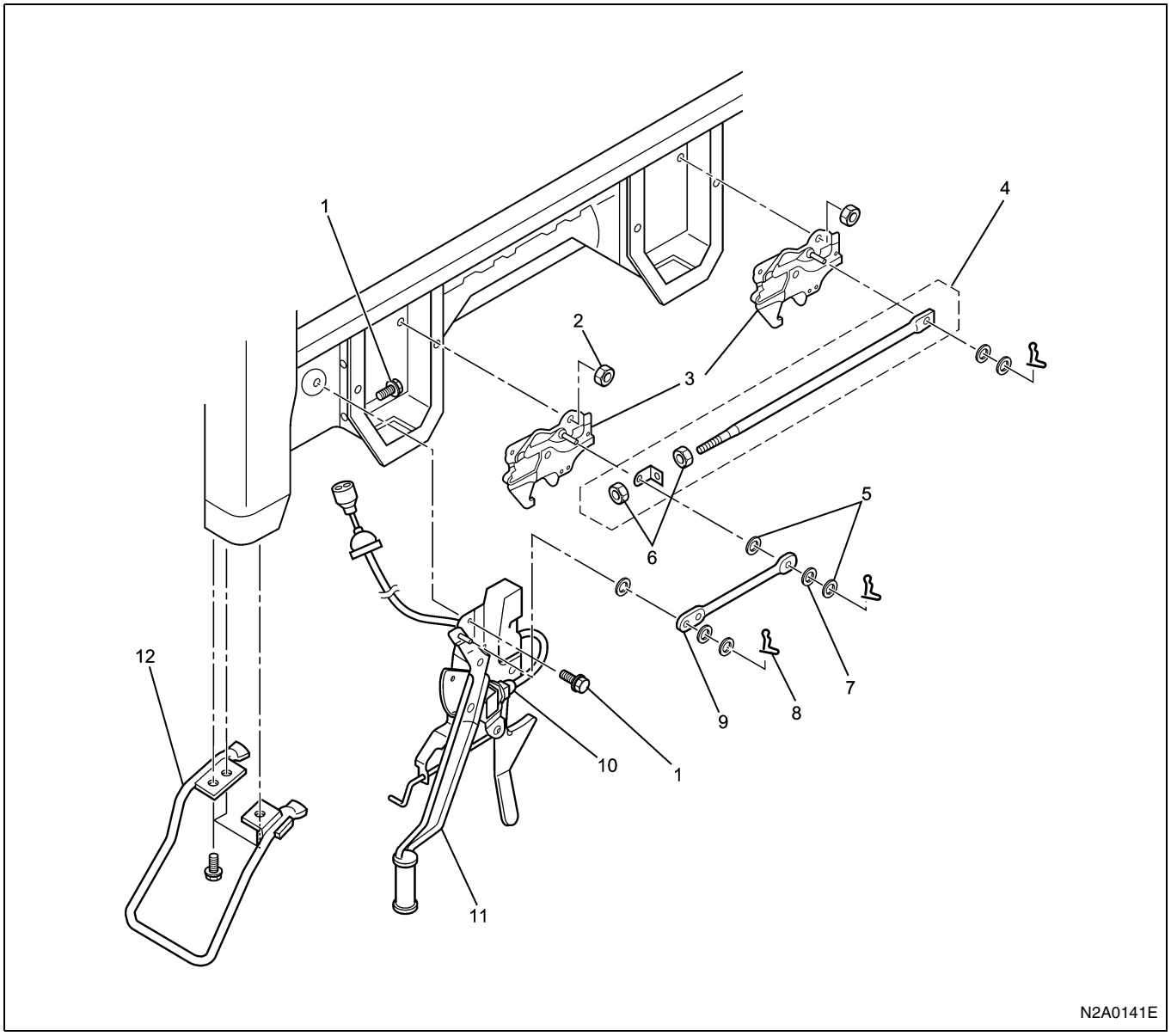
4. Tighten the cab stay frame side fixing bolt to the specified torque.

Tighten:
Cab stay frame side fixing bolt to 40 N·m (4.1 kg·m/29.5 lb·ft)

Fixing Torque



Cab Lock Assembly



Legend

1. Cab lock control unit fixing bolt
2. Cab lock assembly fixing nut
3. Cab lock assembly
4. Hook rod assembly
5. Washer
6. Adjust nut
7. Wave washer
8. Snap pin
9. Hand lever hook rod
10. Cab tilt switch
11. Cab control unit assembly
12. Tilt handle assembly

Removal

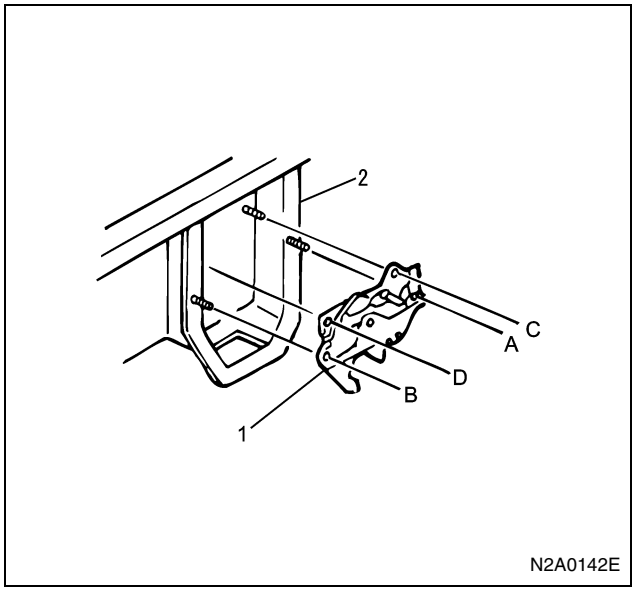
1. Disconnect the battery cable.
2. Hand lever hook rod
   - Pull out the snap pins and remove the washers and wave washers.
3. Hook rod assembly
4. Cab lock assembly
   - Remove the 4 fixing nuts.
5. Cab lock control unit assembly
   - Remove the 3 fixing bolts, and disconnect the harness connector of cab tilt switch.
6. Tilt handle assembly
   - Remove the 3 tilt handle fixing bolts.

Installation

For installation, reverse the removal procedure taking the following points into consideration.

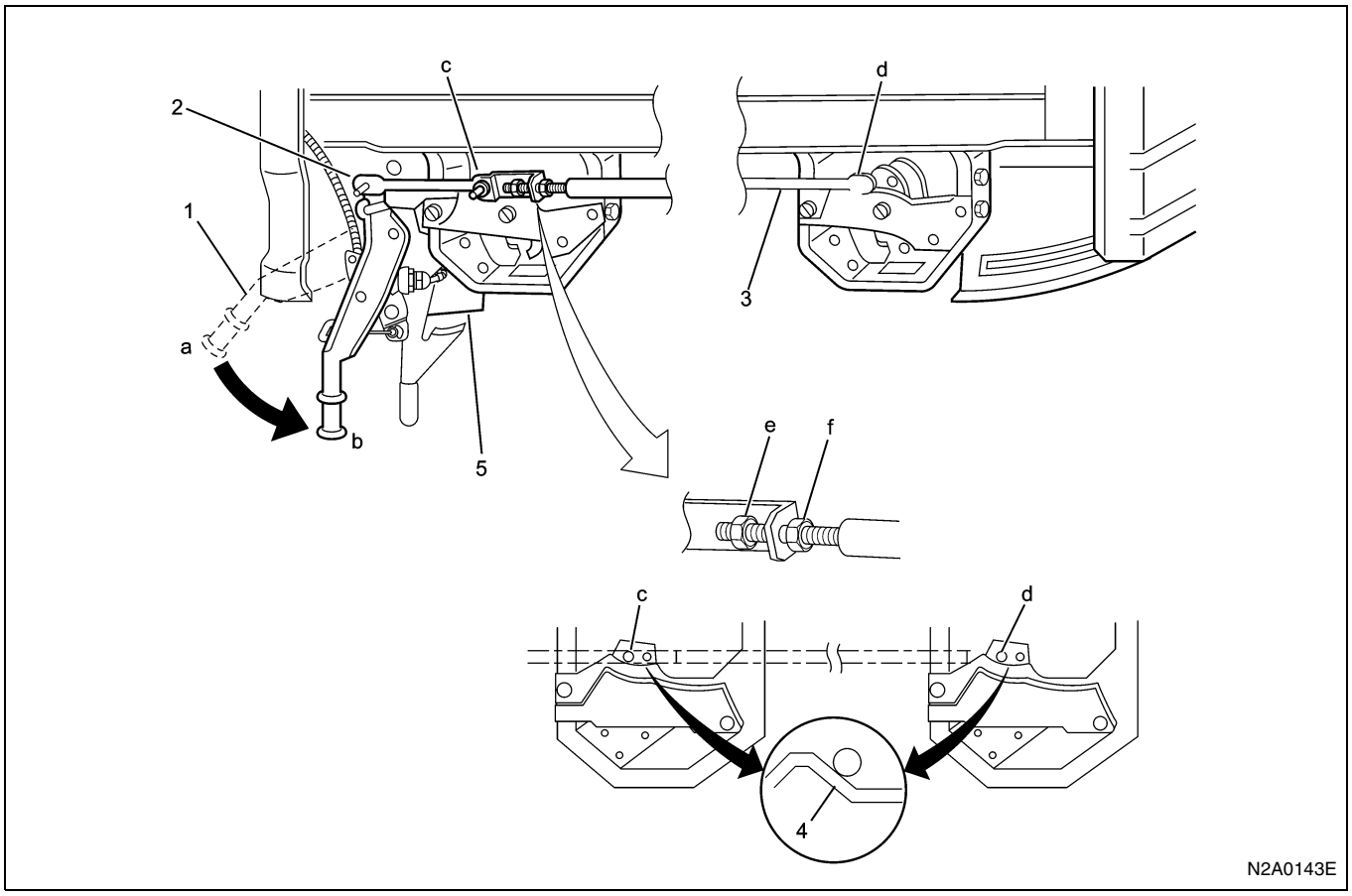
1. When installing cab lock assembly (1) to the rear mounting (2), install the LH and RH cab lock assembly, and tighten the nuts in the following sequence. First, temporarily tighten A, then tighten B to D to the specified torque, and lastly tighten A firmly.

Tighten:
Nut to 19 N·m (1.9 kg·m/14.0 lb·ft)

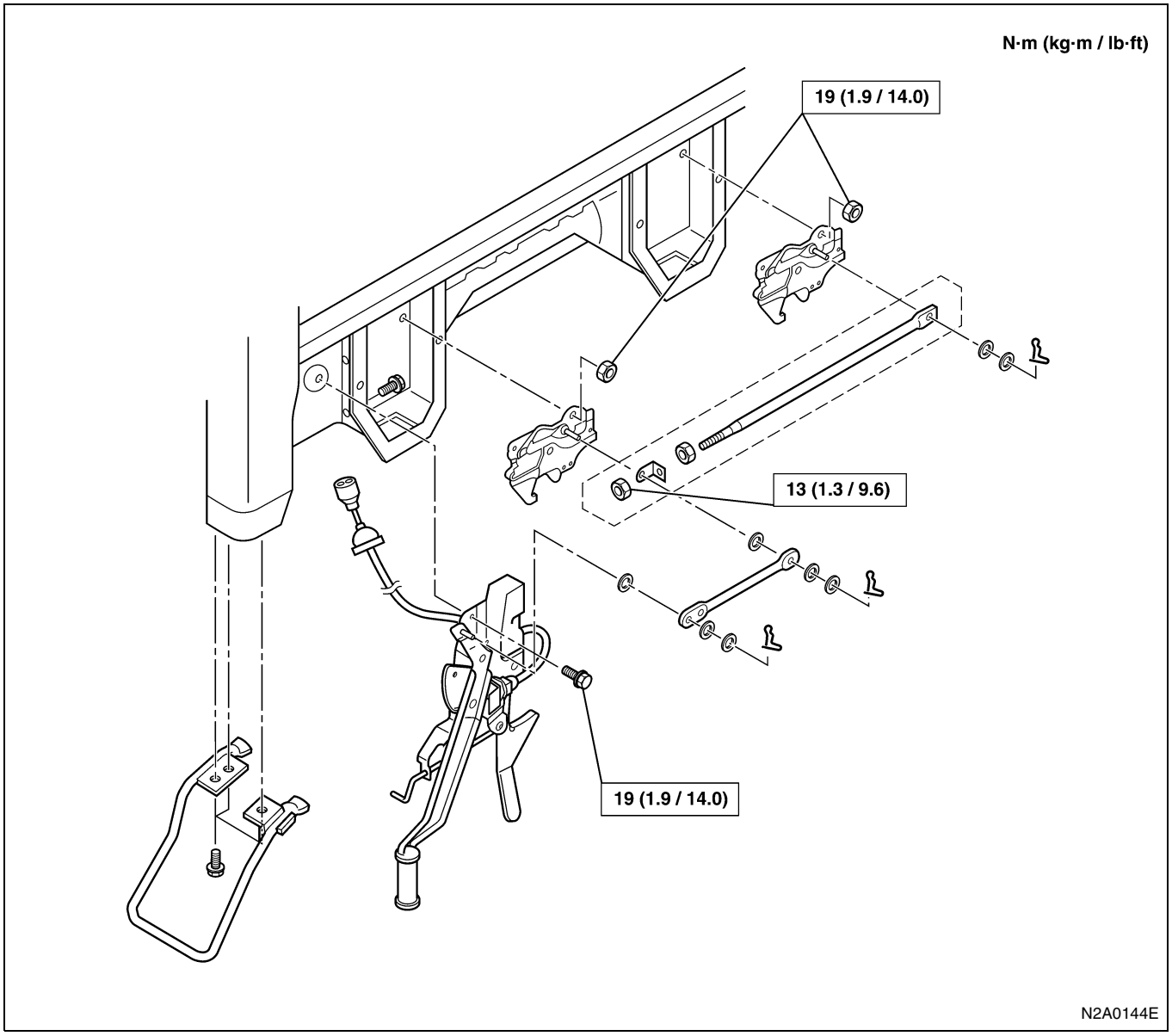


2. Install the hook rod assembly (3) and handle lever hook rod (2) and adjust.
   - Move the control lever (1) “a” to “b”. While holding “c” attached to the bracket (4), adjust the lock nut “e” and “f”. And then tighten to the specified torque so that both “c” and “d” contact to the bracket.

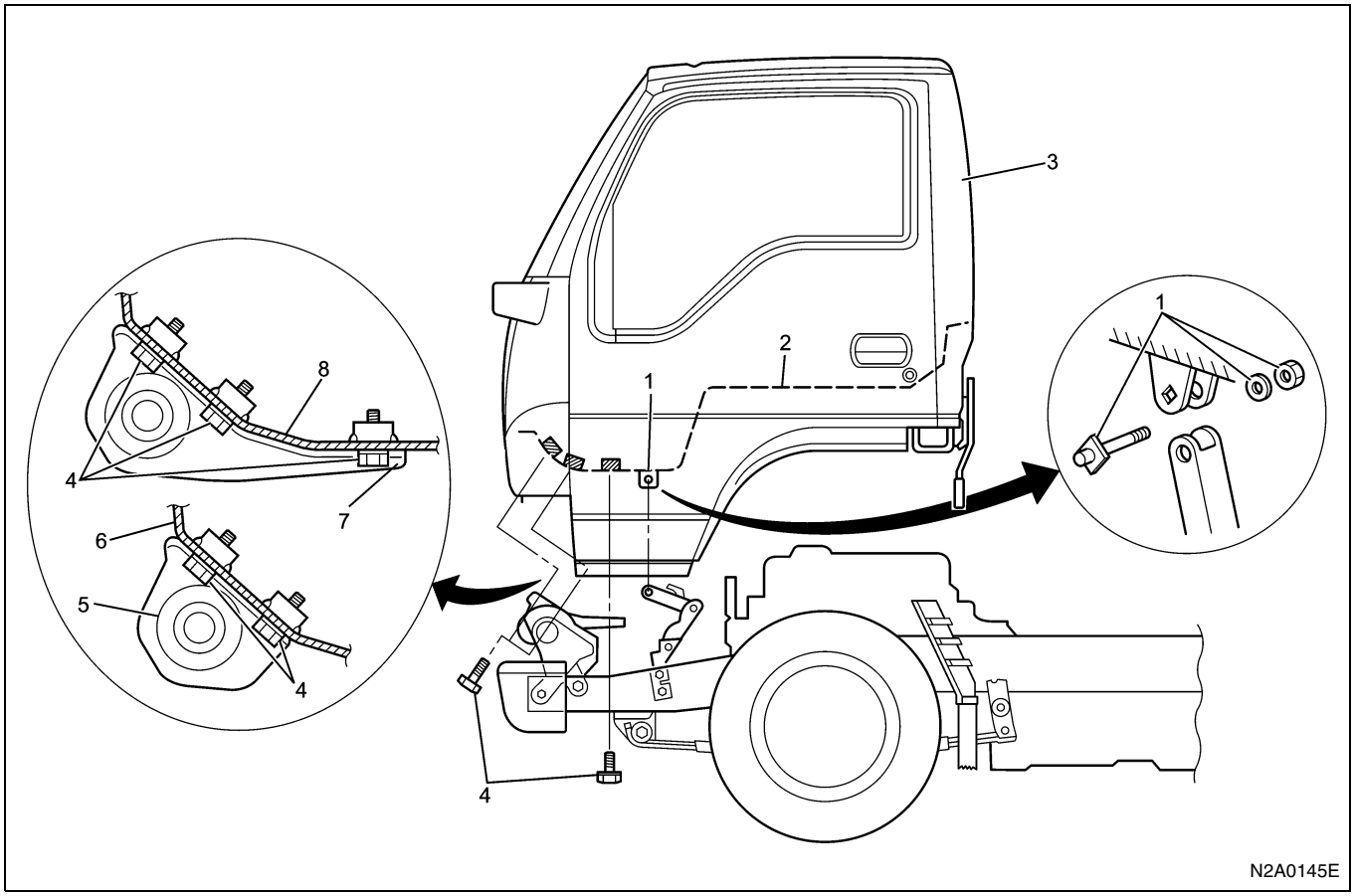
Tighten:
Lock nut to 13 N·m (1.3 kg·m/9.6 lb·ft)



Fixing Torque



Removal and Installation of Cab Assembly



Legend

1. Cab stay pin/nut (Tilt cab model)
2. Floor
3. Cab assembly
4. Cab fixing bolt
5. Frame side mounting lever (Non-tilt cab model)
6. Cab side front mounting rail (Non-tilt cab model)
7. Frame side front mounting lever (Tilt cab model)
8. Cab side front mounting rail (Tilt cab model)

Removal

Preparations

- Before removal or installation of the cab assembly, remove the following connections. The removal order is free. However, perform each step surely referring to each workshop manual.

1. Heater hose/air conditioner piping
   - Refer to “Heater and Ventilator” and “Air Conditioner”.
2. Accelerator control cable
   - Refer to “Fuel System” in Section 6C. Perform the work surely according to the procedure fit for the mounted engine.
3. Brake fluid piping
   - Refer to “Hydraulic Brake”.
4. Hydraulic clutch piping
   - Refer to “Clutch”.
5. Gear control cable
   - Refer to “Gear Control Cable”. Perform the work surely according to the procedure fit for the mounted engine.
6. Parking brake control cable
   - Refer to “Parking Brake”.
7. Steering linkage
   - Refer to “Steering Linkage”.
8. Harness connector/frame earth bolt
   - Refer to “Electrical Equipment”.
9. PTO control cable
   - Refer to “Power take-off (PTO)”. Perform the work surely according to the procedure fit for each type of PTO.
   - After disconnecting all the above connections, tilt the cab for a tilt cab vehicle or remove the rear mounting connection for a non-tilt vehicle. For removal of the rear mounting, refer to “Cab mounting” in this Section.
10. Cab stay pin and nut (tilt cab vehicle)
11. Cab mounting bolt
12. Cab assembly

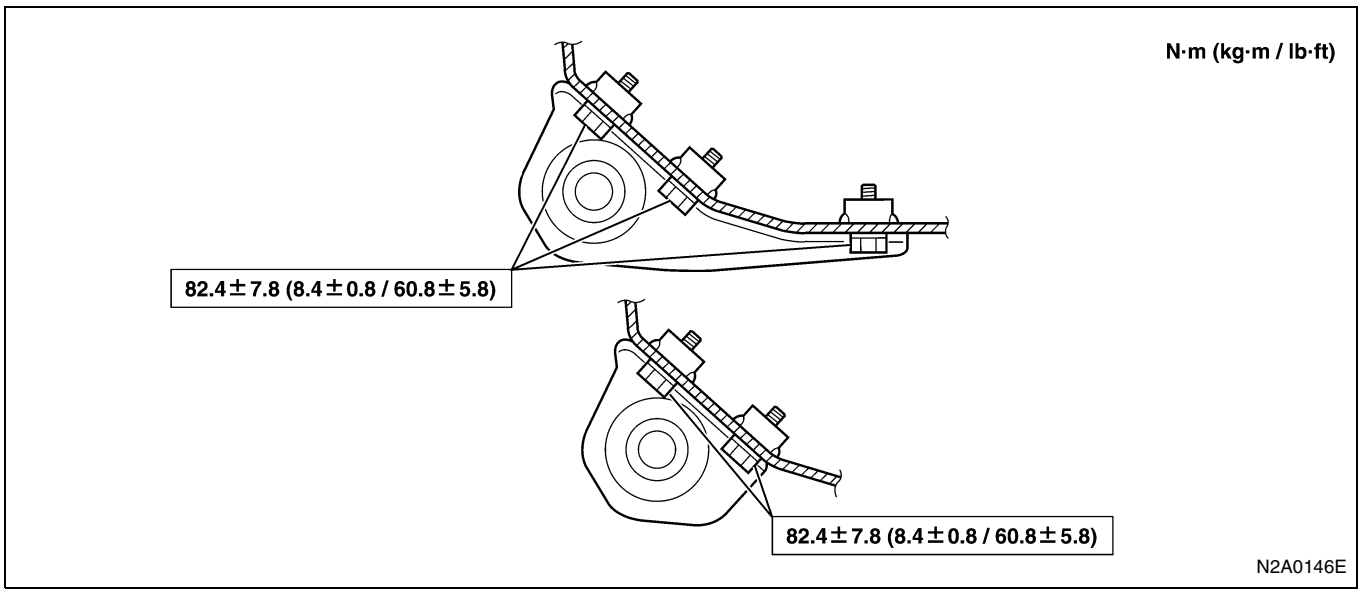
Installation

For installation, reverse the removal procedure taking the following point into consideration.

- Tighten the cab mounting bolt to the specified torque.

Tighten:
82.4±7.8 N·m (8.4±0.8 kg·m/60.8±5.8 lb·ft)

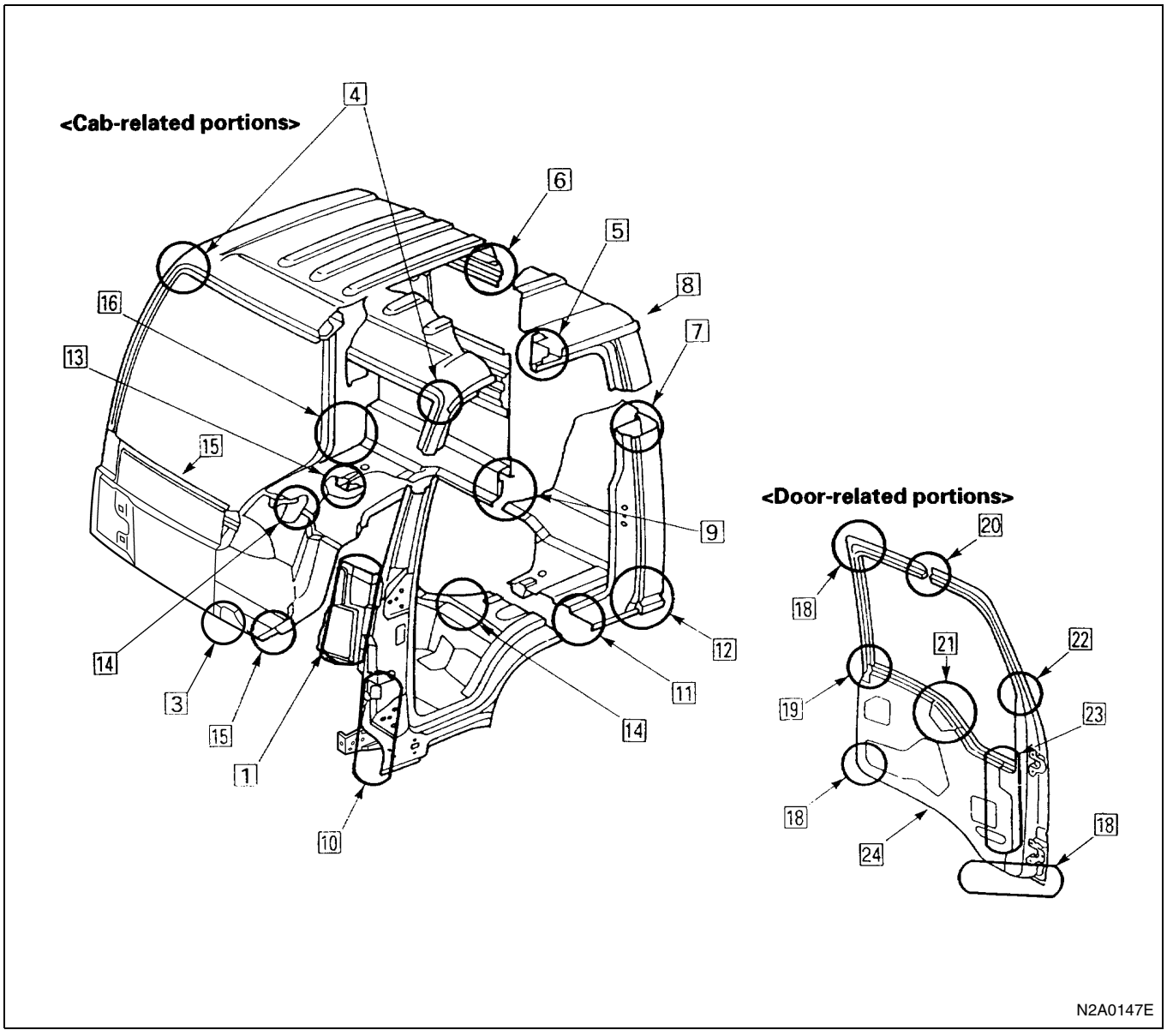
Fixing Torque



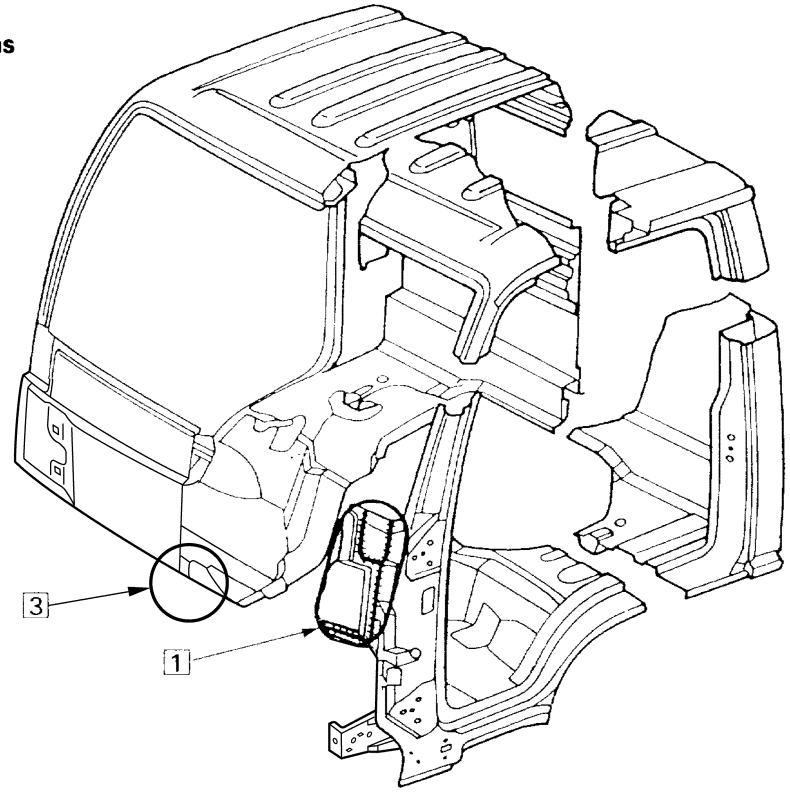
BODY PANEL SEALING (SINGLE CAB MODEL)

This paragraph describes body panel sealing. The sealing procedure described in this text should be performed as follows.

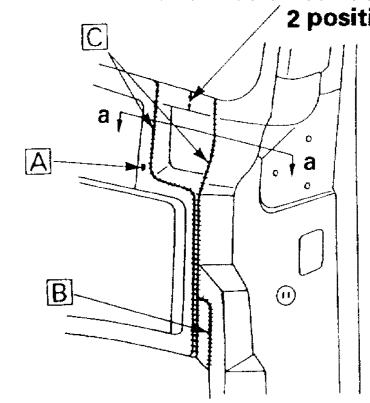
Purpose	1	Anti-rust	2	Air-water tightness	3	Sound insulation
External finish	A	Specially important	B	Important	C	Common
Sealing range						
Vehicle model	N	Narrow cab	W	Wide cab		

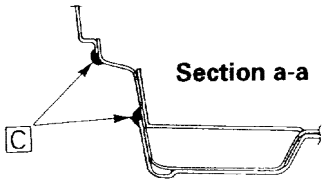


Front-related portions



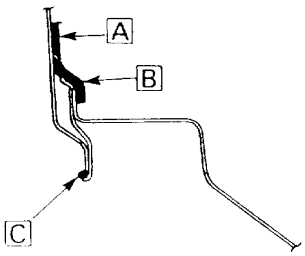
1





A: Center front panel location hole ø12 (l = 38) x 2
B: Hinge lower reinforcement + side panel junction l = 75 x 2
C: Center front panel + hinge reinforcement junction
Side panel + hinge reinforcement junction
l = 800 x 2 ①,②-Ⓒ
※ The indicated portion should be smoothed.

3



A: Center floor panel to front mounting rail Extension + front floor panel melting sheet sticking
B: Front mounting extension + front mounting rail junction Sealing ②-Ⓒ
C: Center front panel + front mounting extension junction Sealing ①,②-Ⓒ

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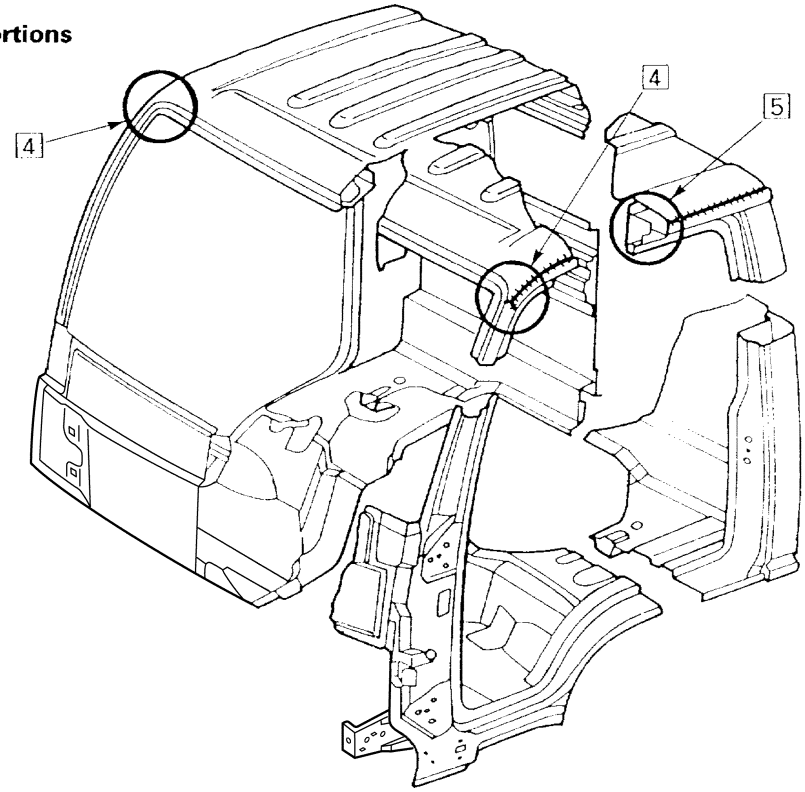
Roof-related portions



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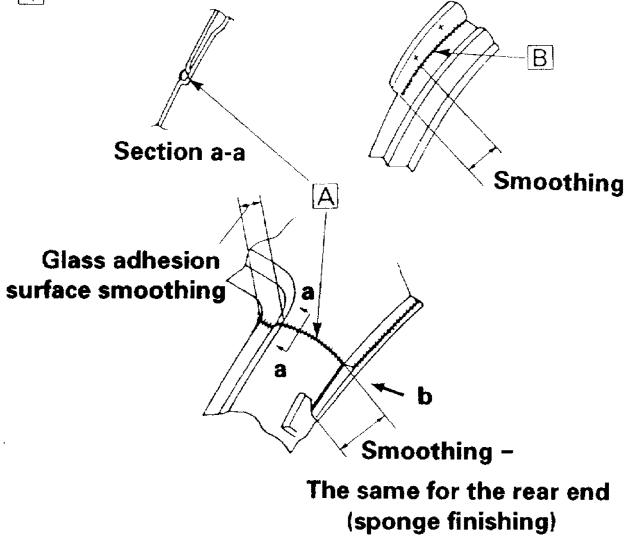
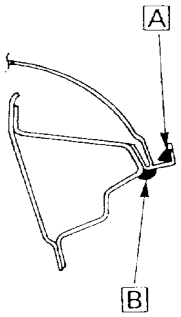


A: **Side panel + roof panel + side drip junction**
l = 120 x 2 ①-Ⓐ
※Perform finishing without any corrugation or curvature.
The indicated portion should be smoothed.

B: **Side panel + side drip junction**
①,②-Ⓐ
l = 1040 x 2
※The indicated portion should be smoothed.

5



A: **Roof panel + side drip junction**
①,②-Ⓒ
l = 1000 x 2
※No break should be found on sealing.

B: **Refer to 4-B**

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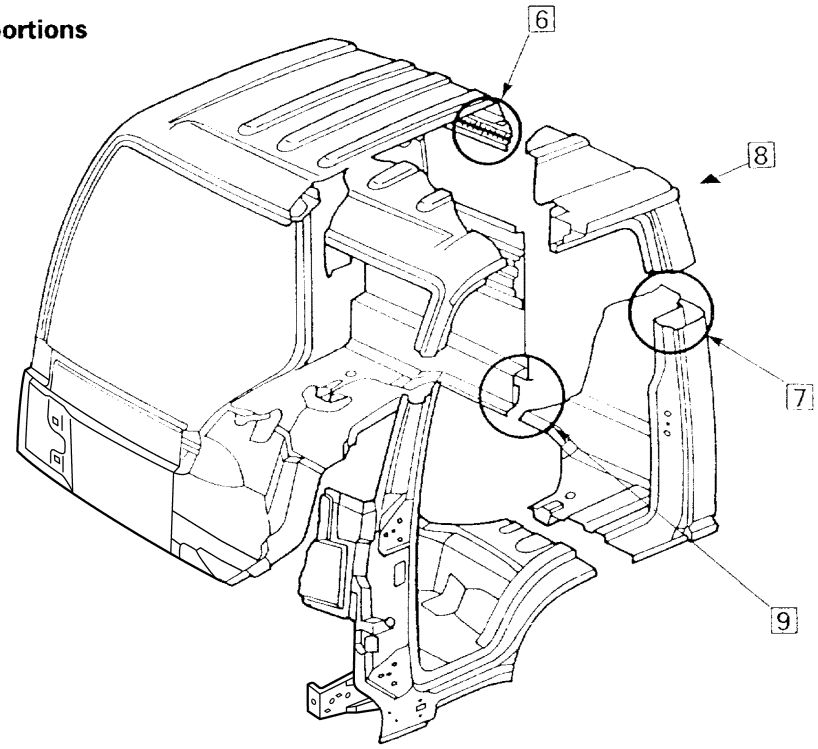
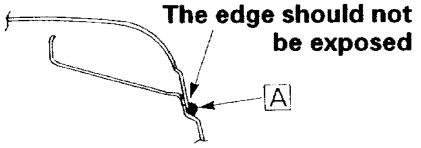
Back panel-related portions

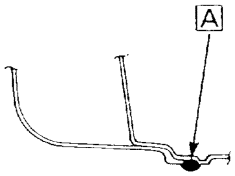


6



A: Roof panel + back panel junction
Narrow cab l = 1300 ①,②-Ⓐ
Wide cab l = 1720

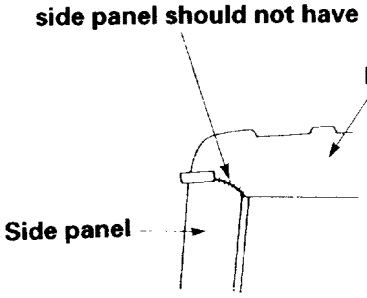
7



A: Side panel + back panel junction
①,②-Ⓐ
l = 845 x 2
※Uniformity is required without any corrugation.

8

The junction between the roof panel and side panel should not have any exposed edge.



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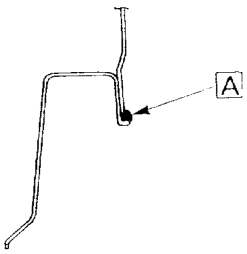

A: Back panel + rear mounting rail junction
Narrow cab l = 1320
Wide cab l = 1700
※Uniformity should be required without any corrugation.

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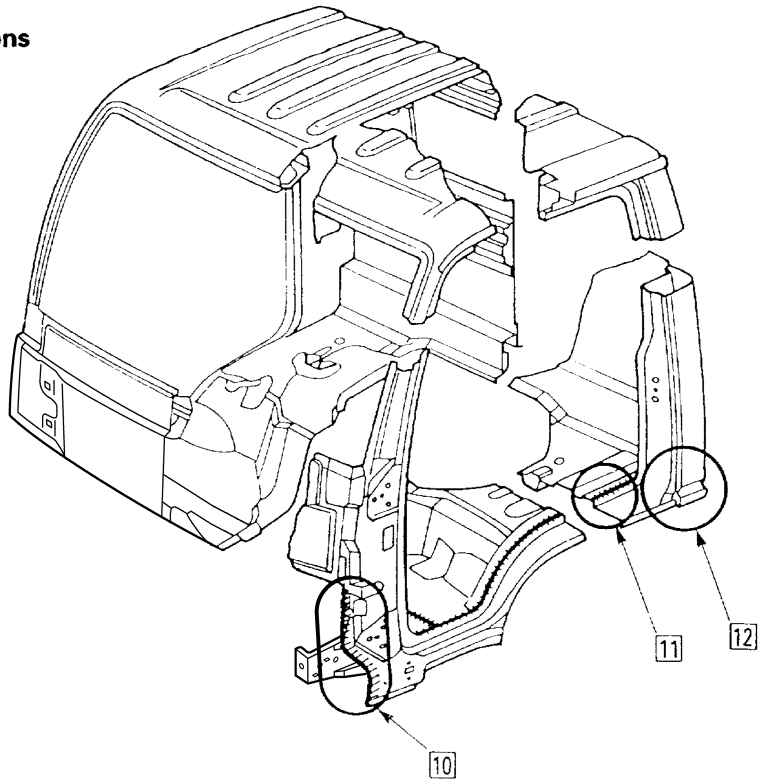
Side panel-related portions



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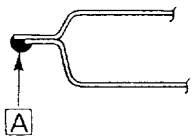
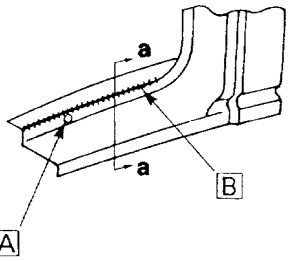
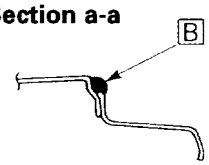


A: Side panel + hinge lower reinforcement junction
l = 300 x 2 ②-Ⓒ

11

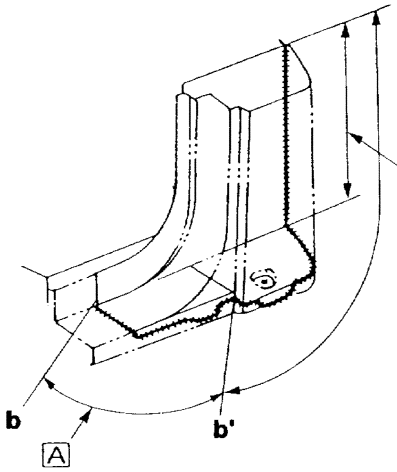


Section a-a



A: Side panel location hole periphery
ø8 (l = 25) x 2 ①-Ⓒ
※Don't block up the hole.
B: Side panel + floor panel junction
l = 1000 x 2 ②-Ⓒ

12



A: Side panel + rear pillar lower closing junction
l = 280 x 2 ①,②,③-Ⓒ
※Completely fill up the clearance between b and b'.

This section should not have any exposed edge.

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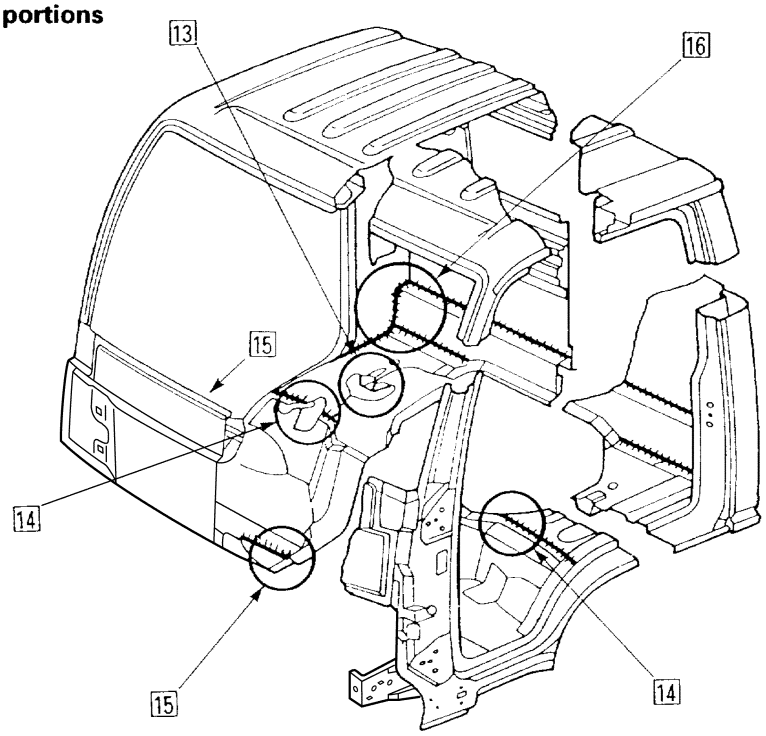
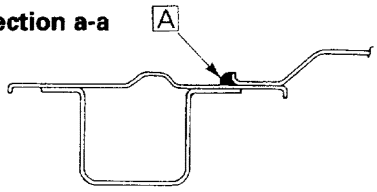
Floor panel-related portions



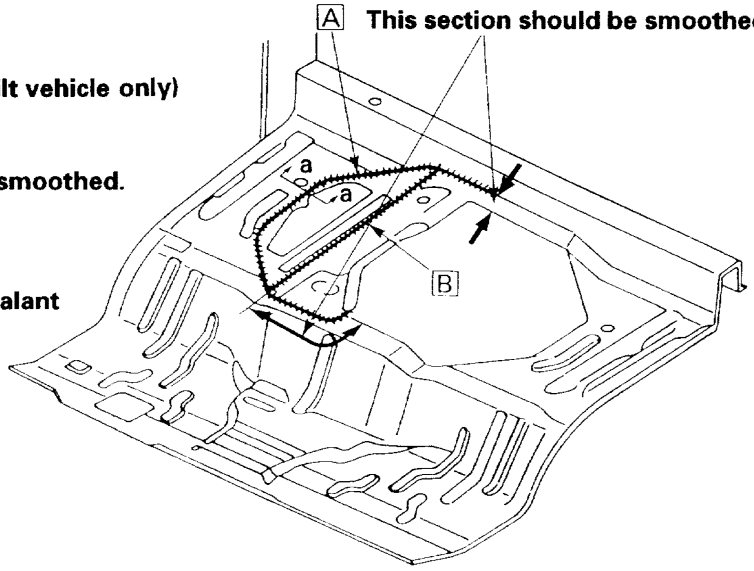
13

Section a-a



A: Support cover + floor panel + rear mounting rail junction periphery (tilt vehicle only)
Narrow cab l = 1580 ②-Ⓒ
Wide cab l = 1760
※The indicated portion should be smoothed.

B: Support cover + engine lever reinforcement junction
l = 720 ②-Ⓒ
※Perform finishing without any sealant break or clearance.



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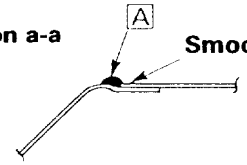
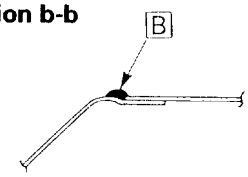
14

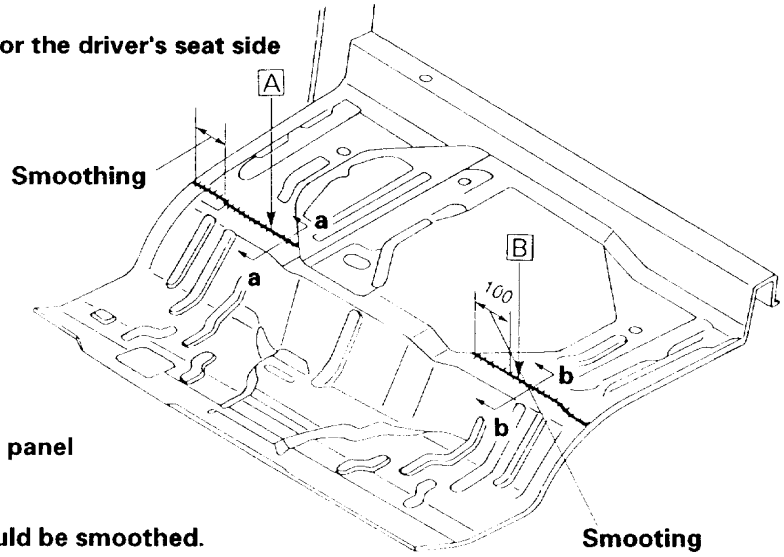
Section a-a



Smoothing for the driver's seat side

Section b-b

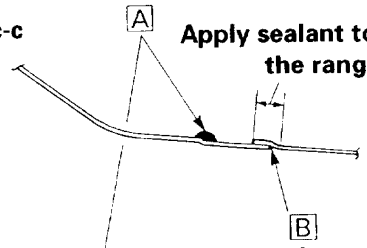




A, B: Front floor panel + rear floor panel junction
l = 400
※The indicated portion should be smoothed.

15

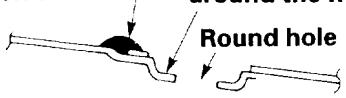
Section c-c

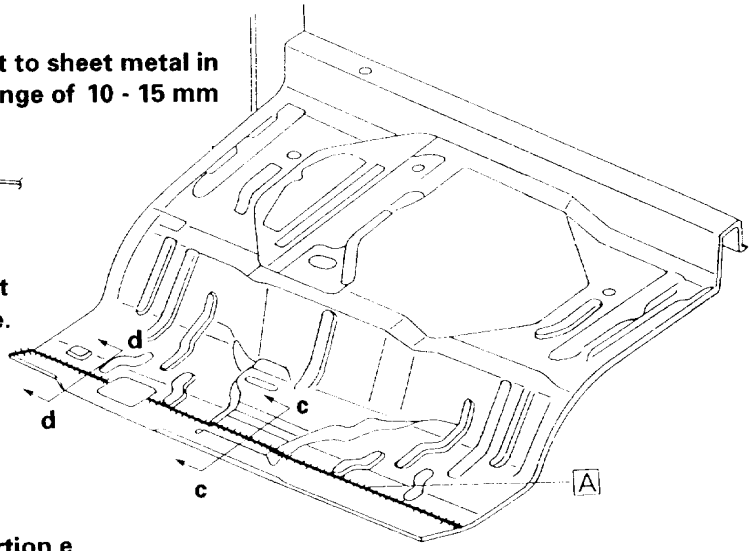


Apply sealant to sheet metal in the range of 10 - 15 mm

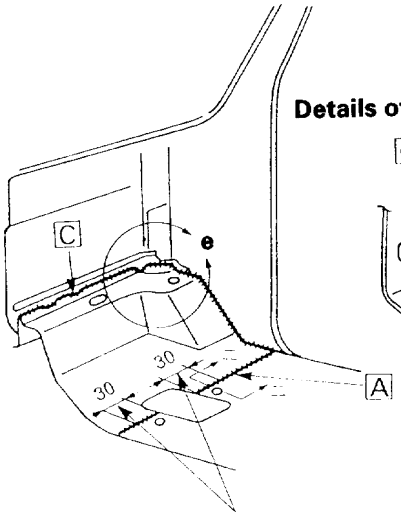
Don't apply sealant around the hole.

Section d-d



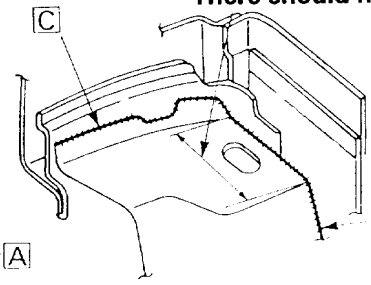


Details of portion e



Perform brushing in the width of 30 mm without touching the grommet hole.

There should not be any swell around the hole.



A: Front mounting rail + front floor panel junction
Narrow cab l = 1330
Wide cab l = 1620 ②-Ⓒ
※The indicated portion should be smoothed.

D B: Front floor panel end
Apply sheet metal sealant.
10 - 15 mm

C: Front mounting rail + front mounting rail extension junction
Narrow cab l = 1450
Wide cab l = 1750 ②-Ⓒ

D: Front pillar lower closing + front mounting + front floor panel junction
l = 370 x 2 ②-Ⓒ
※Apply sheet metal sealant without touching the grommet hole.

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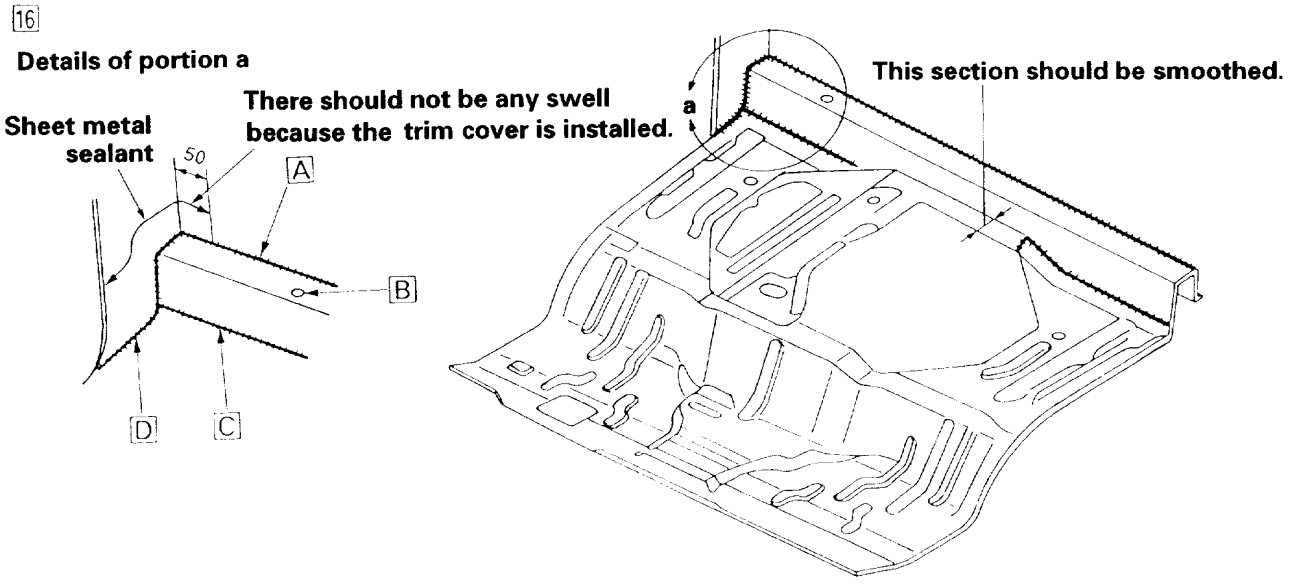
16



A: Rear mounting rail + back panel junction
Narrow cab l = 1320 ①,②-Ⓒ
※The indicated portion should be smoothed.
Perform finishing without any clearance between both ends.

B: Rear mounting rail location hole
ø20 (l = 63) x 2 ②-Ⓒ

C: Rear floor panel + rear mounting rail junction
l = 460 x 2 ②-Ⓒ
※The indicated portion should be smoothed,

D: Rear pillar lower closing + rear floor panel + rear mounting rail junction
l = 590 x 2 ②-Ⓒ
※Sheet metal sealant

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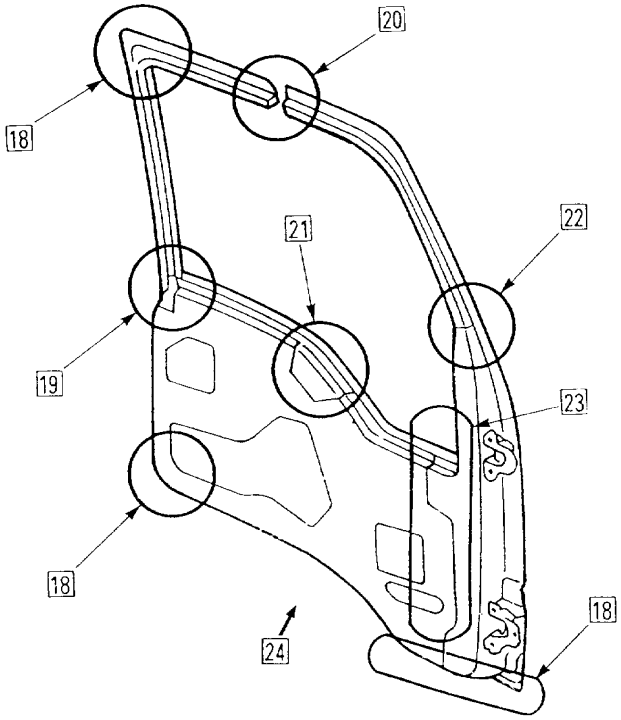
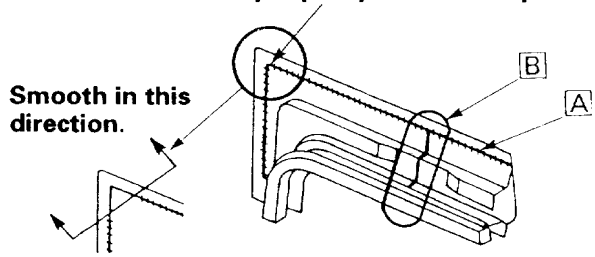
Door-related portions

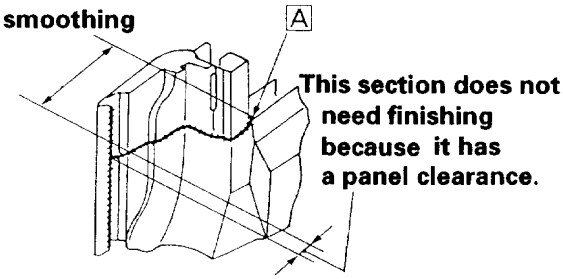


18

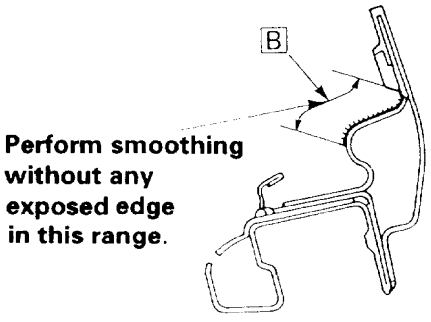


A: Door outer panel + door inner panel junction
l = 4970 x 2 ①,②-Ⓐ
※The indicated portion should be smoothed.

19

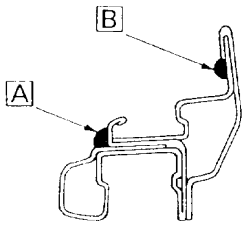


A: Door outer panel + door sash junction
l = 120 x 2 ①,②-Ⓐ
※Be careful about finishing.



B: Door sash rear + door sash front junction
①-Ⓐ
※The indicated portion should be smoothed.

20



A: Door sash junction
①-Ⓒ
B: Refer to 18-A

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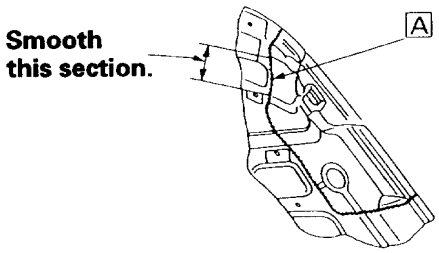
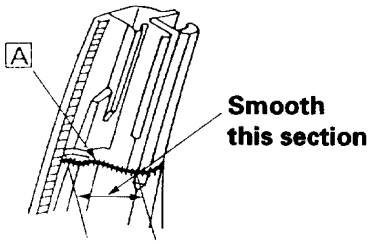
21



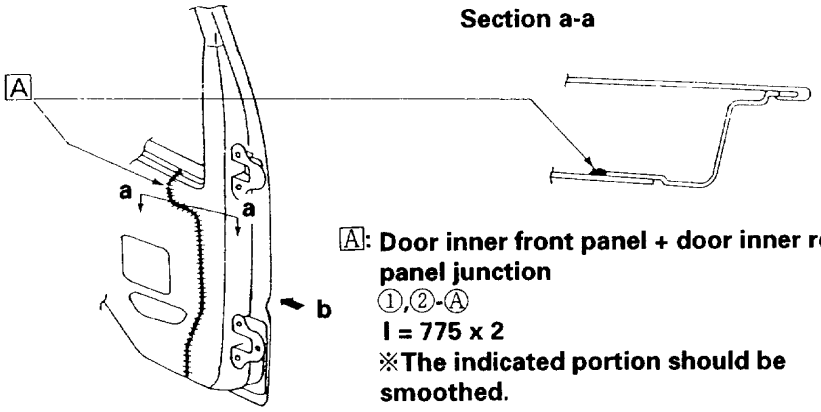
A: Door inner panel + door pull handle reinforcement junction
l = 400 x 2 ②-Ⓒ
※The indicated portion should be smoothed.

22



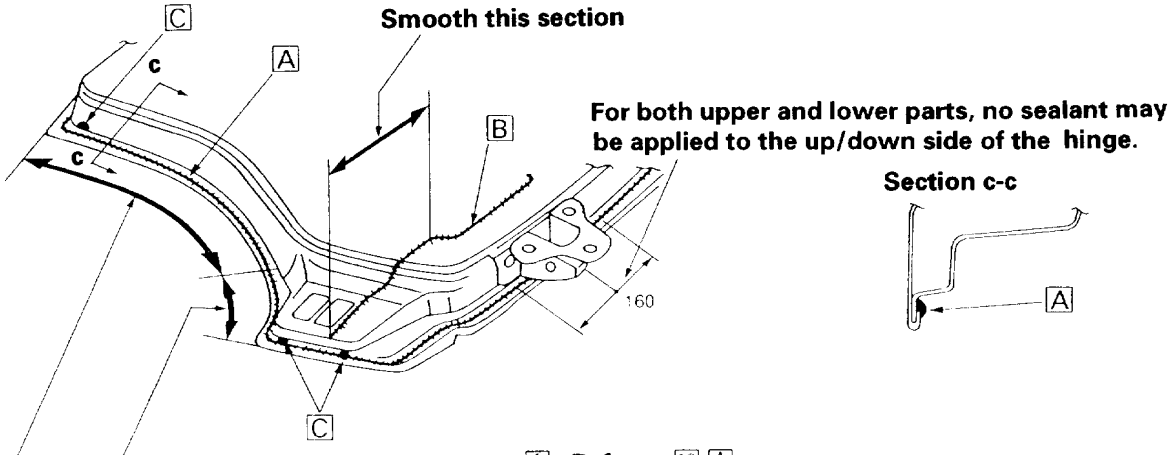
A: Door inner panel + door frame ASM junction
①,②-Ⓐ
※The indicated portion should be smoothed.

23



A: Door inner front panel + door inner rear panel junction
①,②-Ⓐ
l = 775 x 2
※The indicated portion should be smoothed.

24



A: Refer to 18-A.
B: Refer to 23-A.
C: Door outer panel + door inner panel junction drain hole
l = 30 x 3 positions x 2

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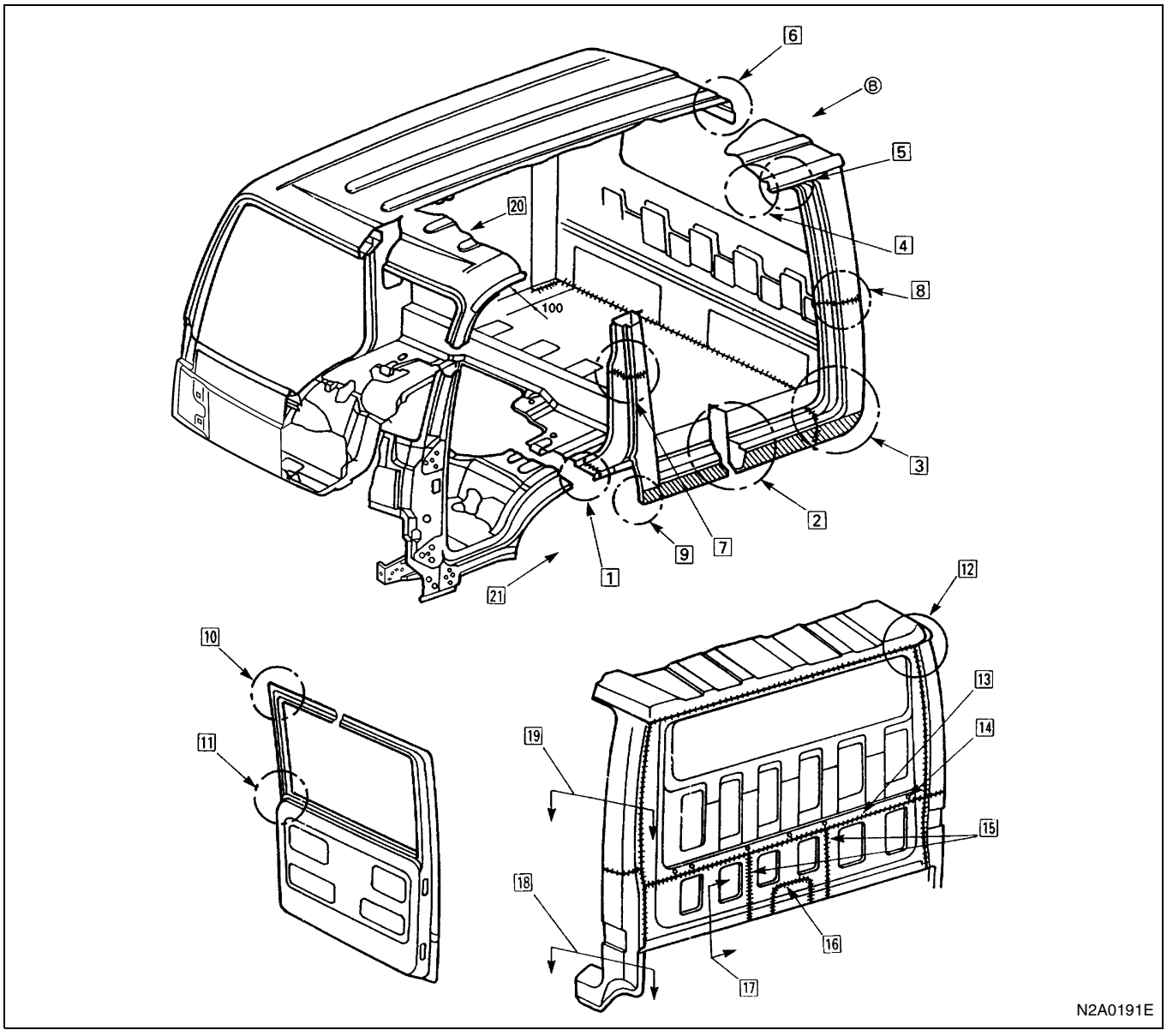
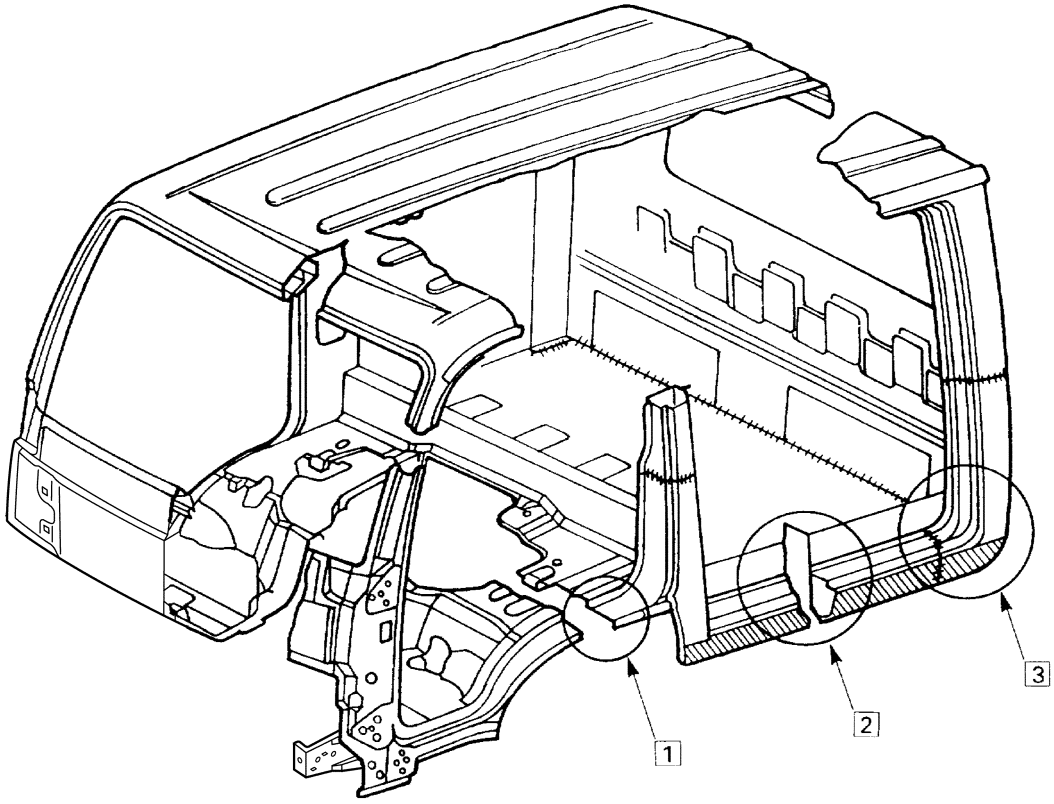
BODY PANEL SEALING (CREW CAB MODEL)

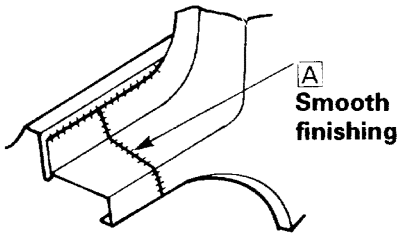
This Chapter describes the sealing procedure for body panel.
The sealing procedure described in the text should conform to the following.

Purpose	1	Rust prevention	2	Air-tightness and water-tightness	3	Sound insulation
External finish	A	Specially important	B	Important	C	Common
Sealing range						



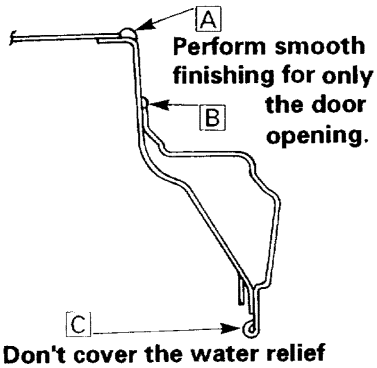


1



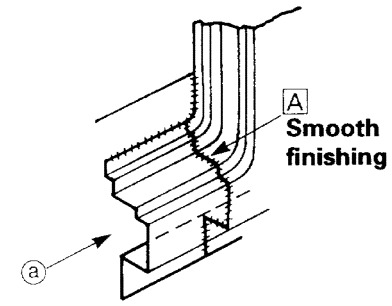
A: Floor panel + Side panel + Center pillar fitting.
①-B
※Perform smooth finishing.

2

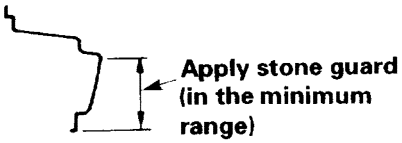


A: Rear floor panel + Floor side panel fitting
①, ②-B
※Perform smooth finishing for the door opening.
B: Outer sill + Floor side panel fitting
①
D: Outer sill + Floor side panel fitting
①-C
※Don't cover the water relief hole.

3



View ⓐ



A: Rear pillar + Outer sill fitting
①-B
※Perform smooth finishing.

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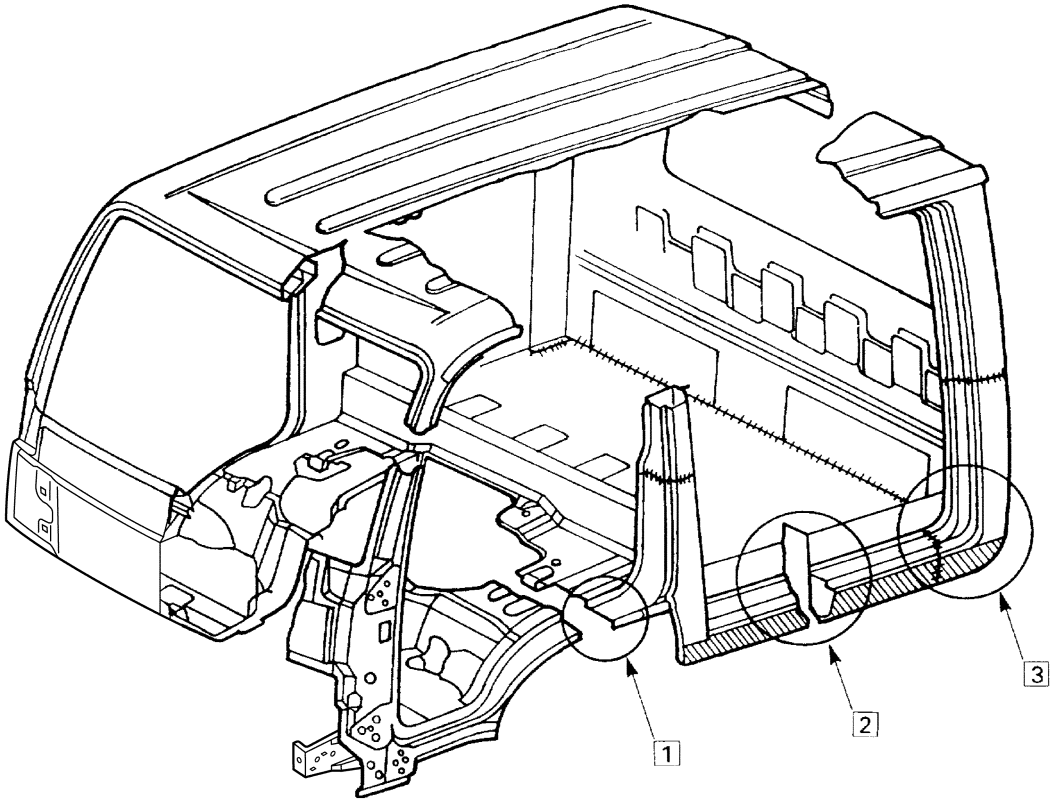
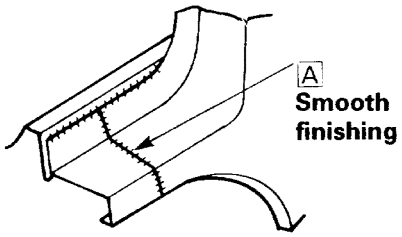
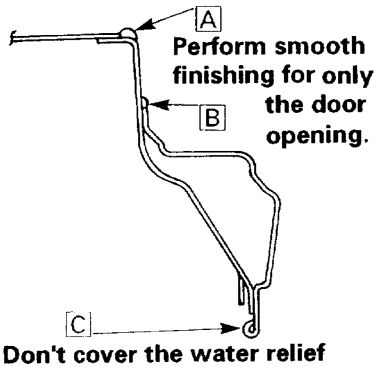


1



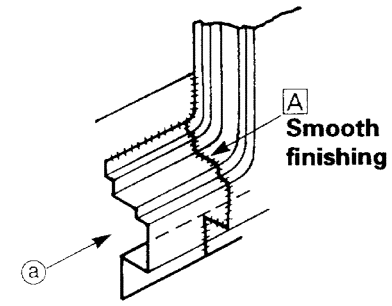
A: Floor panel + Side panel + Center pillar fitting.
①-B
※Perform smooth finishing.

2

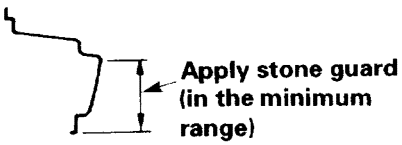


A: Rear floor panel + Floor side panel fitting
①, ②-B
※Perform smooth finishing for the door opening.
B: Outer sill + Floor side panel fitting
①
D: Outer sill + Floor side panel fitting
①-C
※Don't cover the water relief hole.

3



View ⓐ



A: Rear pillar + Outer sill fitting
①-B
※Perform smooth finishing.

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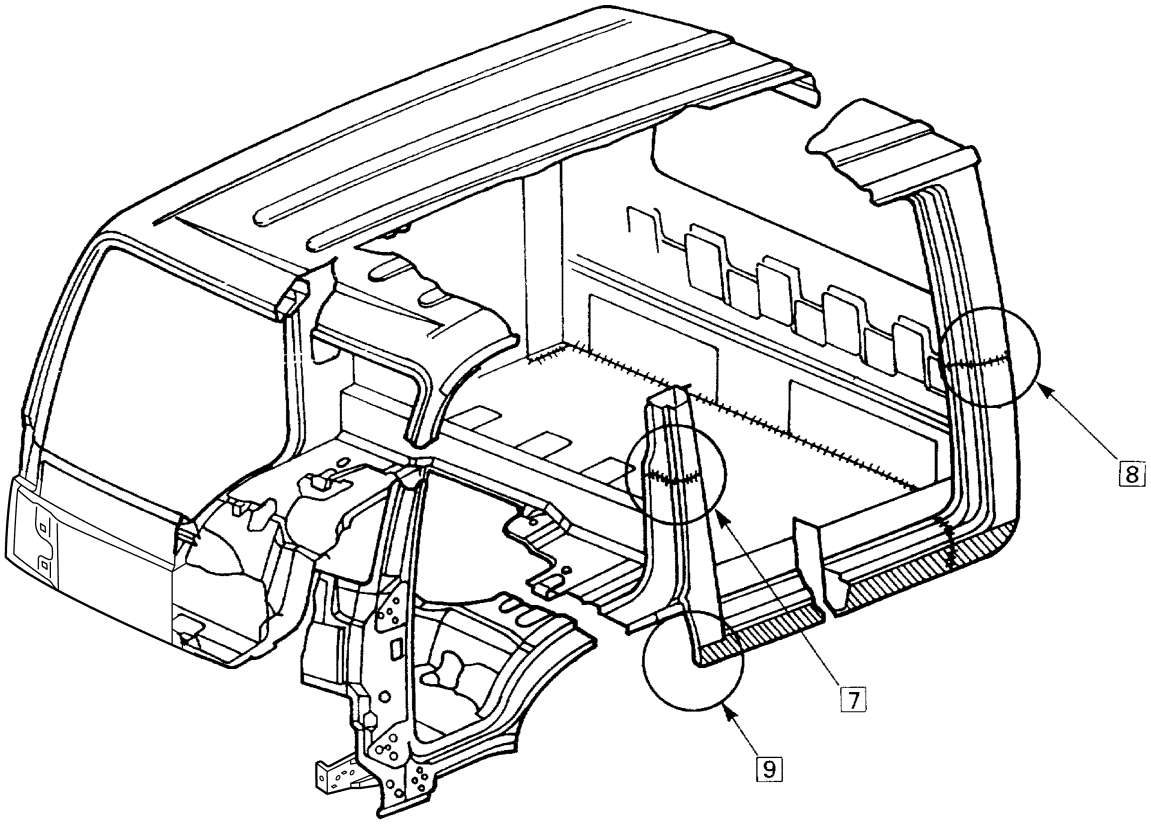
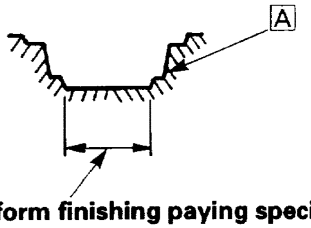


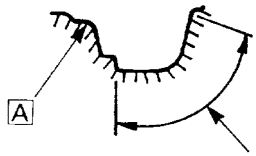
7



Perform finishing paying special attention to this section.

A: Center pillar upper + Center pillar lower fitting
①, ②-A
※The indicated range is the most important in respect of external finishing.

8

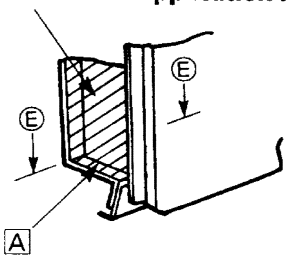


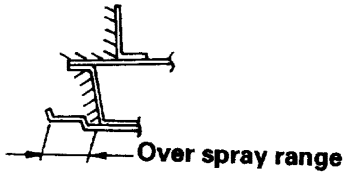
Perform finishing paying special attention to this section.

A: Rear pillar upper + Rear pillar lower fitting
①, ②-A
※The indicated range is the most important in respect of external finishing.

9

Under coat application range





A: Rear door hinge + Floor side panel + Center pillar lower fitting
①, ②-B

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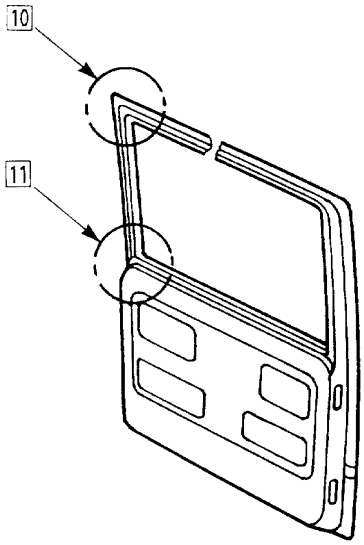
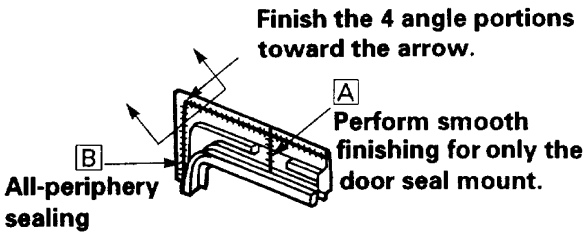


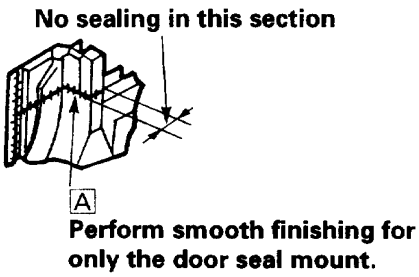
10



A: Door sash extension front + Door sash extension rear fitting
①-A
※Perform smooth finishing for only the door seal mount.

B: Door outer panel + Door inner panel fitting
①-A
※Perform sealing for all the periphery of the door. Finish the 4 angle portions toward the indicated arrow.

11



A: Door sash extension + Door inner panel fitting
①-A
※Perform smooth finishing for the door seal mount.

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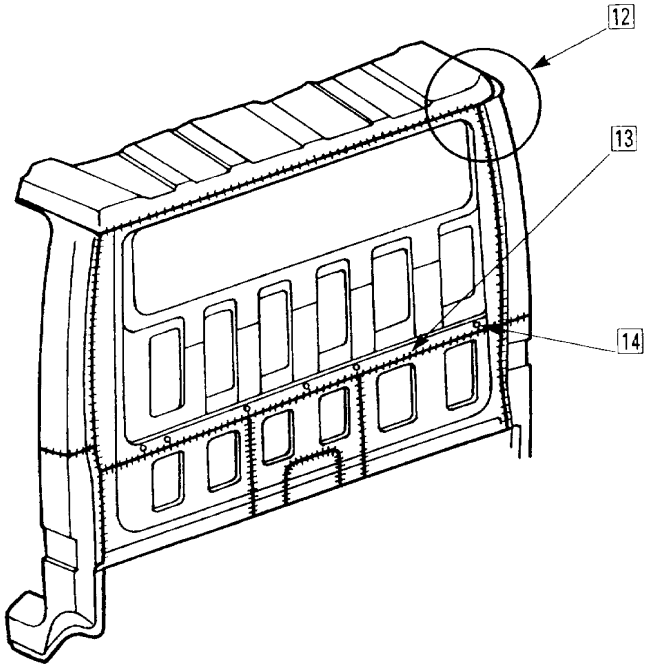
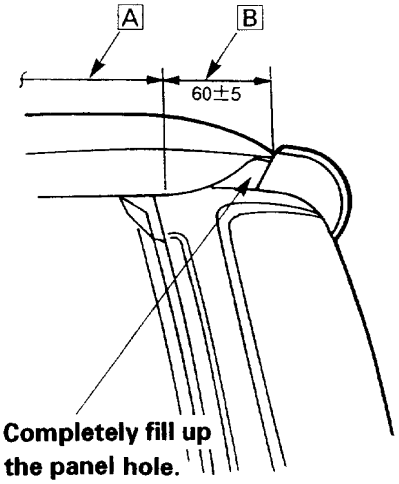
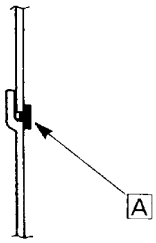


12



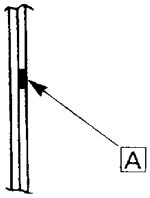
A: Roof panel + Back panel fitting
①, ②-C
B: Roof panel + Back panel fitting
①, ②-B
※Perform smooth finishing for the section from the end to a 60 ±5 mm position and completely fill up the panel hole.

13



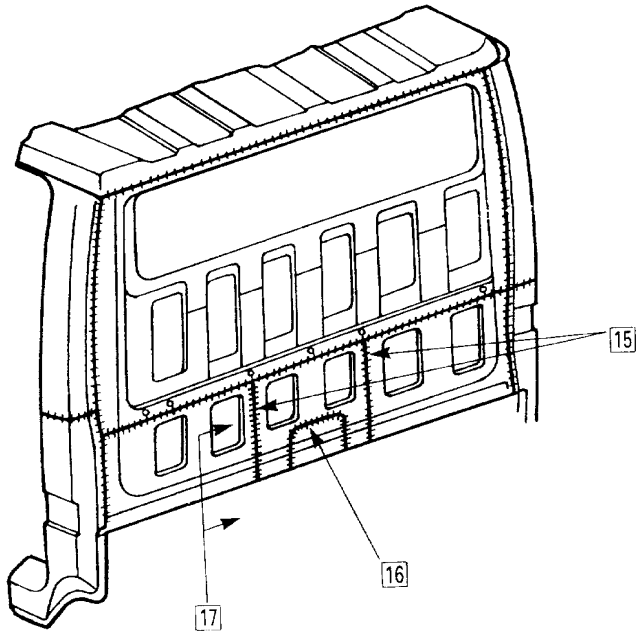
A: Back panel + Back panel lower fitting
①, ②-C
※Perform smooth finishing for the section from the end to a 5 ±3 mm position and don't expose the panel edge.

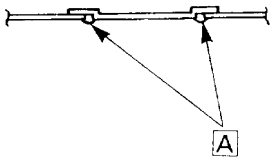
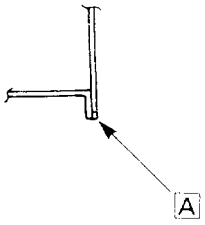
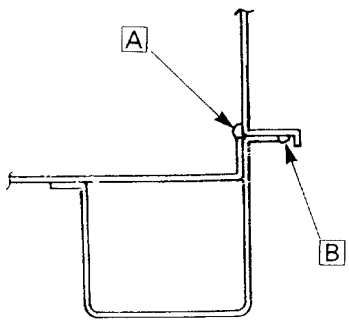
14



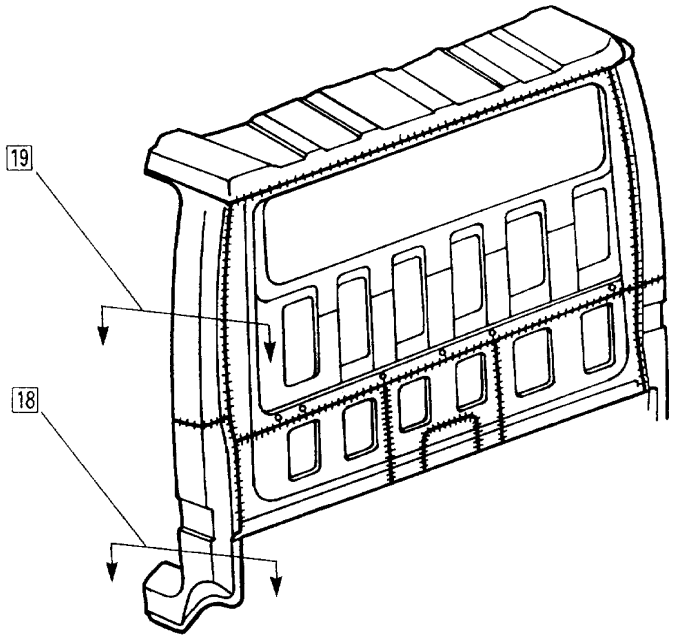
A: All the periphery of the back panel hole
①, ②-B

N2A0196E

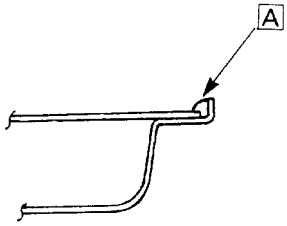


15 (Wide cab only)	16 (Fire engine only)	17
		
A: back panel lower side + Back panel center fitting **①, ②-C** **※Don't expose the panel edge.**	**A: Back panel lower + P.T.O. cover fitting** **①-C** **※Fill up the panel angle securely with care because of its large gap.**	**A: Back panel lower + Rear floor panel bolster fitting** **②-B** **B: Back panel + Rear bolster fitting** **①-C**

N2A0197E

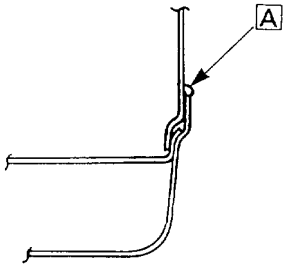


18



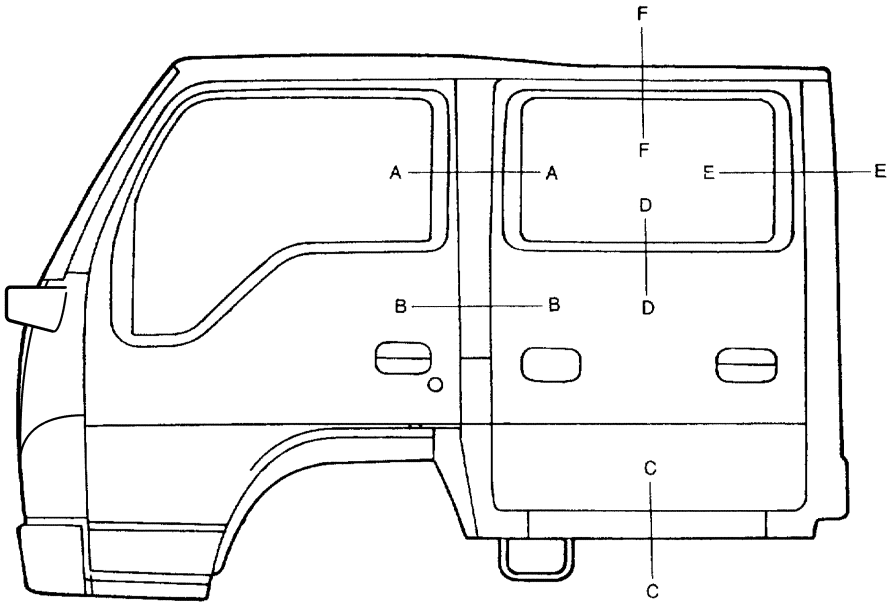
A: **Front side panel + Rear pillar fitting**
①, ②-**B**
Refer to 2-C.

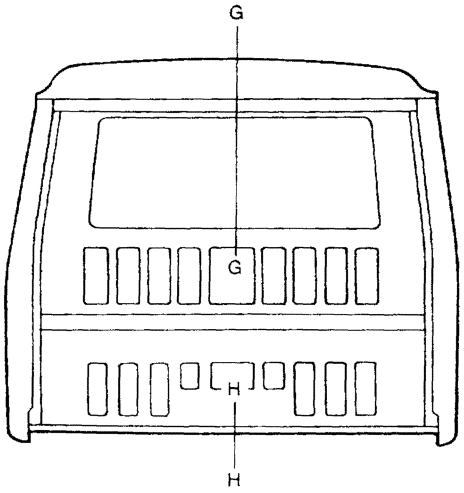
19



A: **Rear pillar + Back panel fitting**
①, ②-**A**

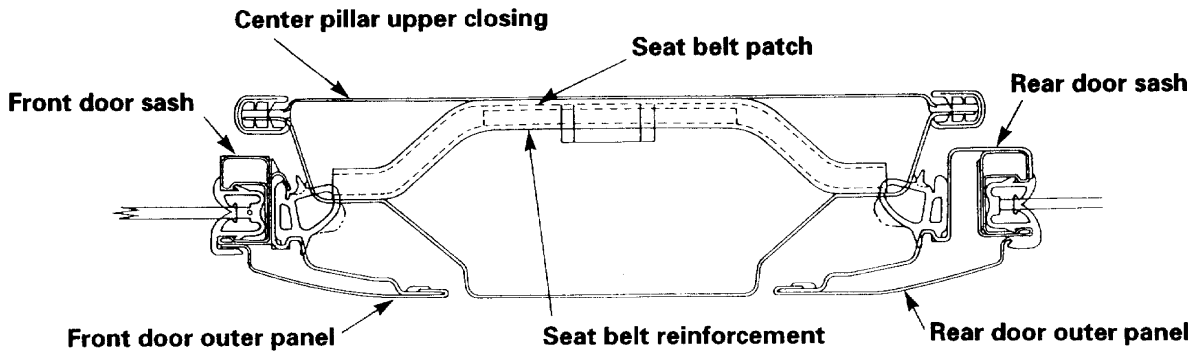
N2A0198E



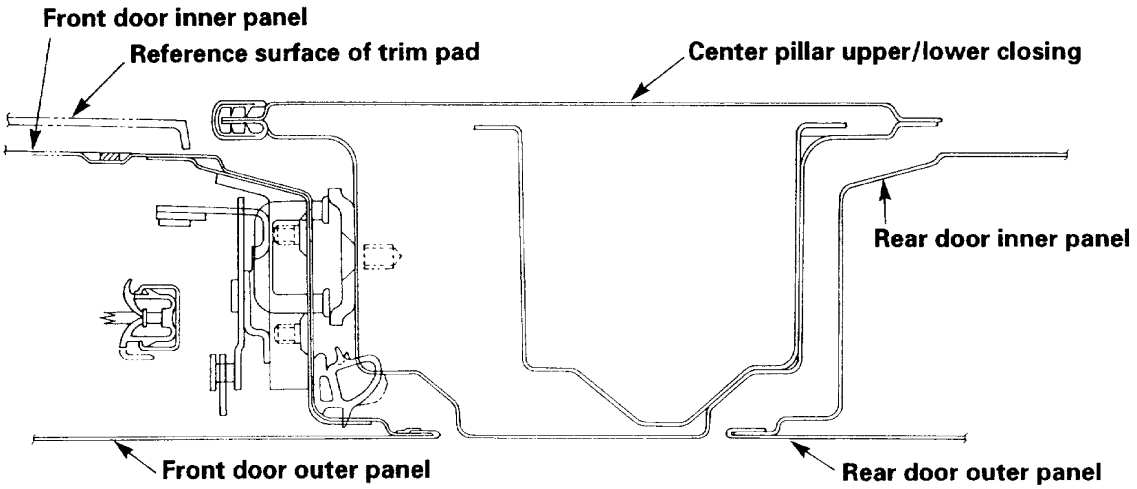


N2A0199E

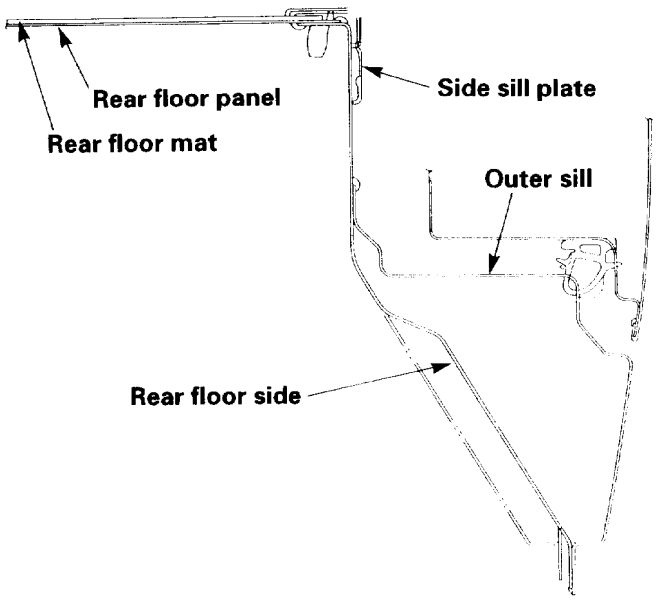
Section A-A



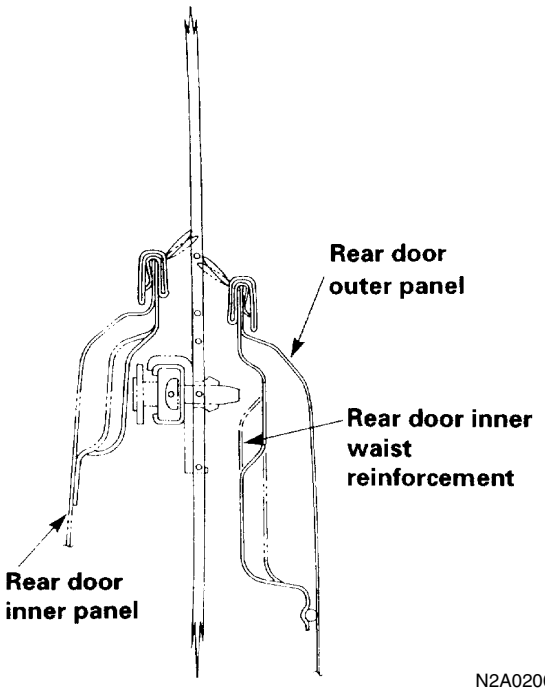
Section B-B



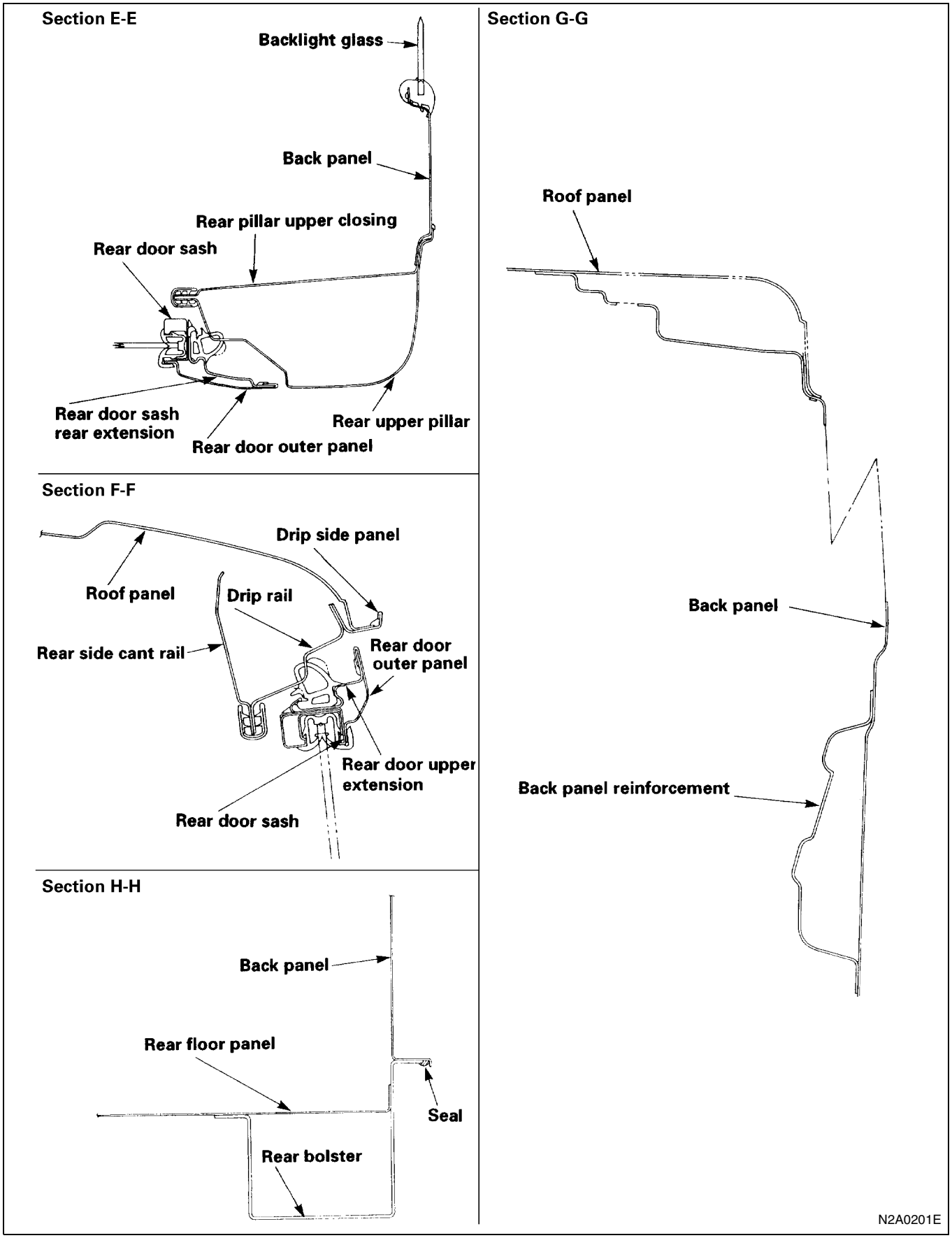
Section C-C



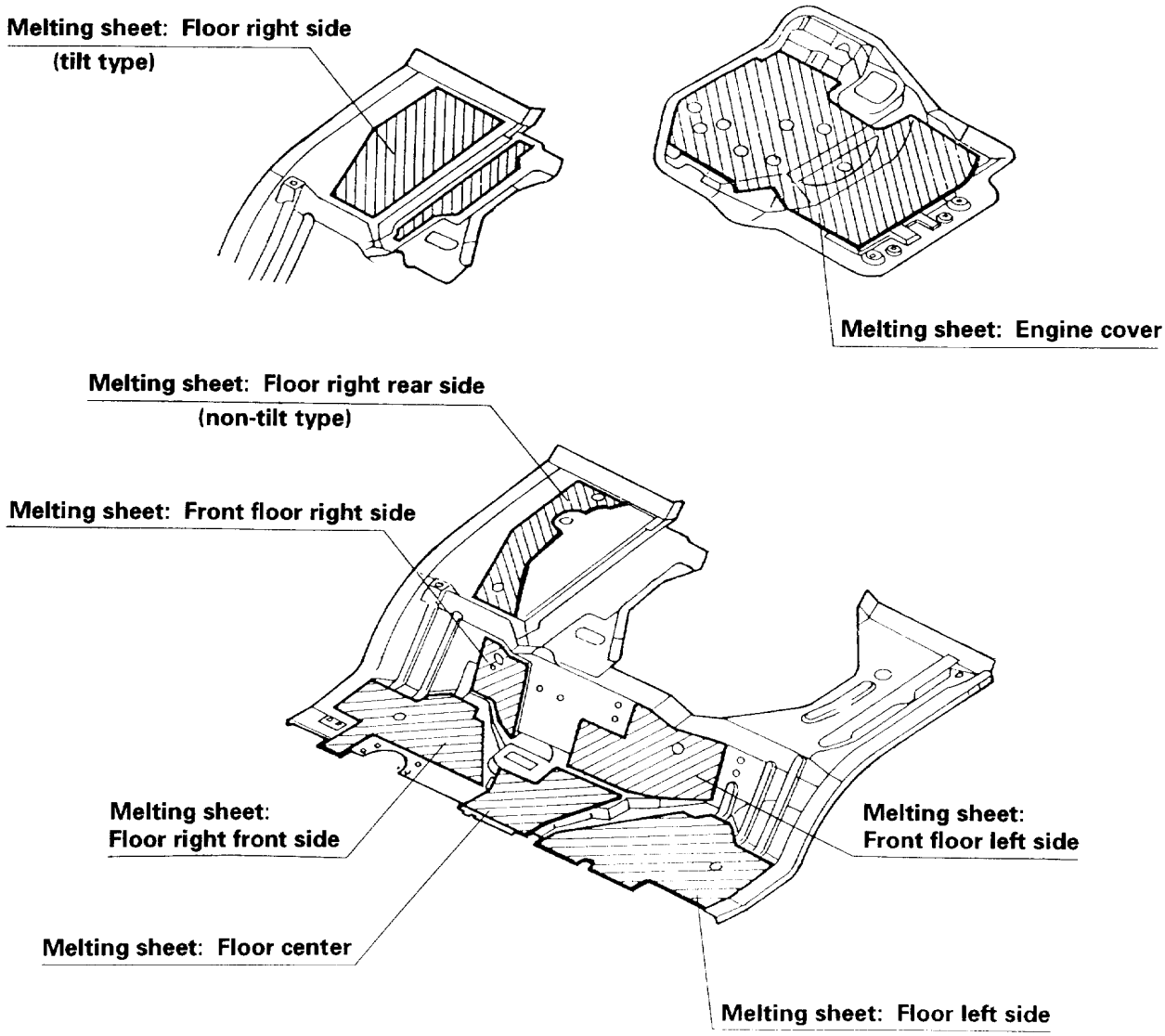
Section D-D



N2A0200E

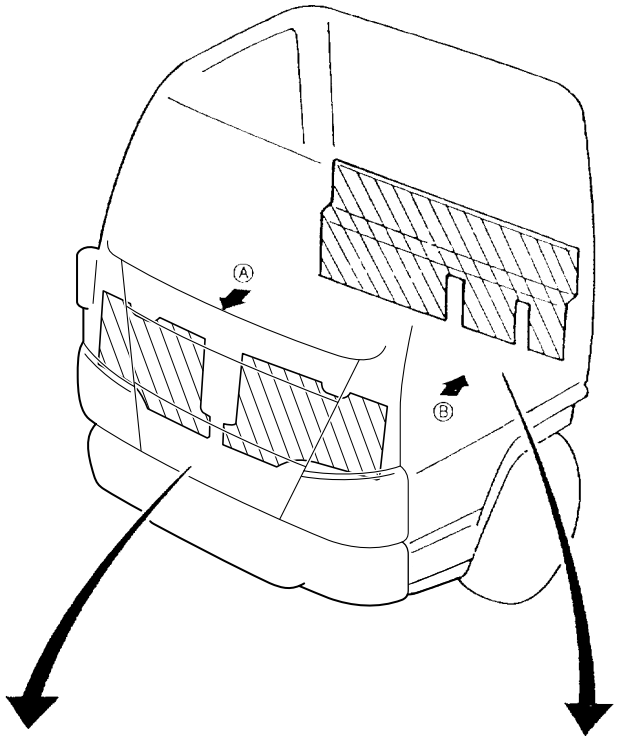

Section E-E
Backlight glass
Back panel
Rear pillar upper closing
Rear door sash
Rear door sash rear extension
Rear door outer panel
Rear upper pillar
Section F-F
Drip side panel
Roof panel
Drip rail
Rear side cant rail
Rear door outer panel
Rear door upper extension
Rear door sash
Section H-H
Back panel
Rear floor panel
Seal
Rear bolster
Section G-G
Roof panel
Back panel
Back panel reinforcement
N2A0201E

MELTING SHEET STICKING POSITIONS

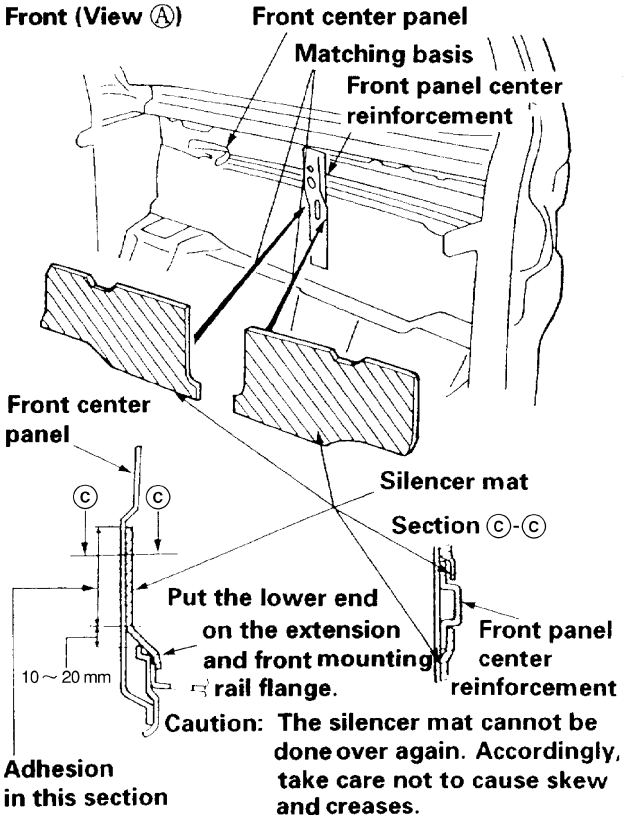


N2A0157E

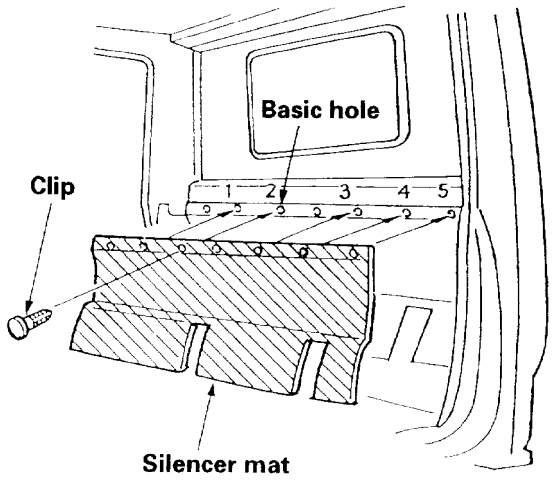
SILENCER MAT SETTING POSITIONS



Front (View Ⓐ)



Rear (View Ⓑ)

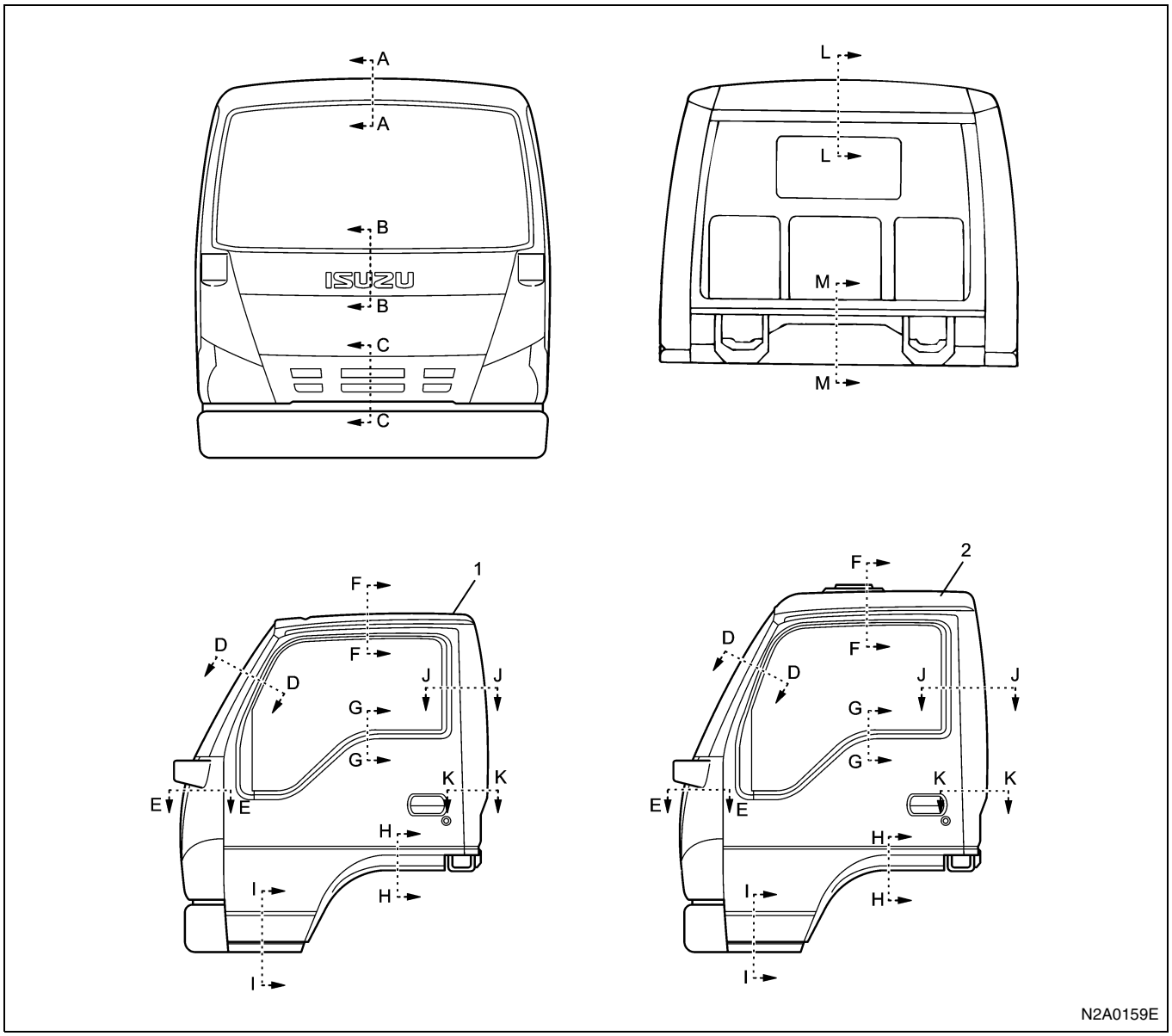


Insert clips into two basic holes and fix the remaining 4 positions with clips.

N2A0158E

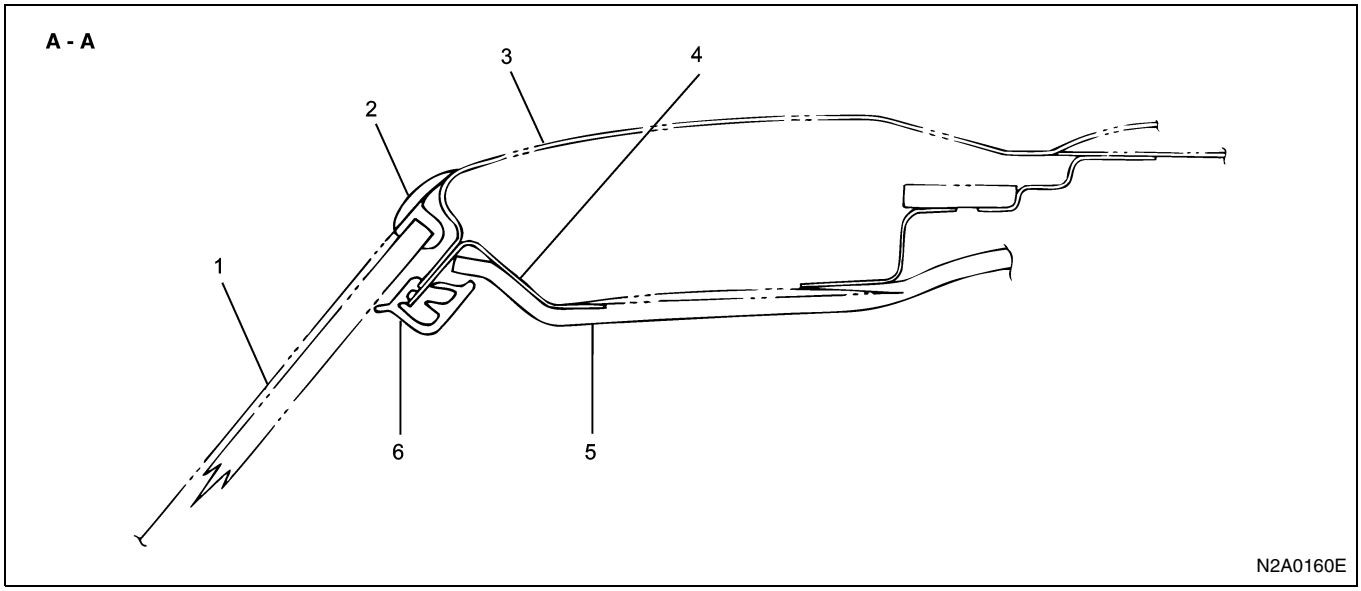
BODY PANEL SECTIONAL SHAPES (SINGLE CAB MODEL)

Component



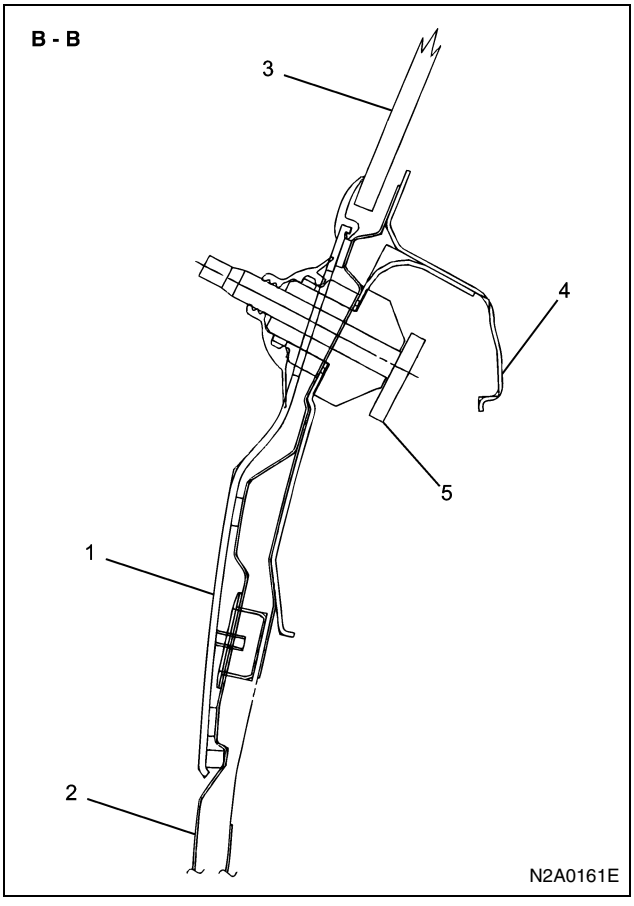
Legend

1. Narrow standard cab
2. Wide cab and High cab



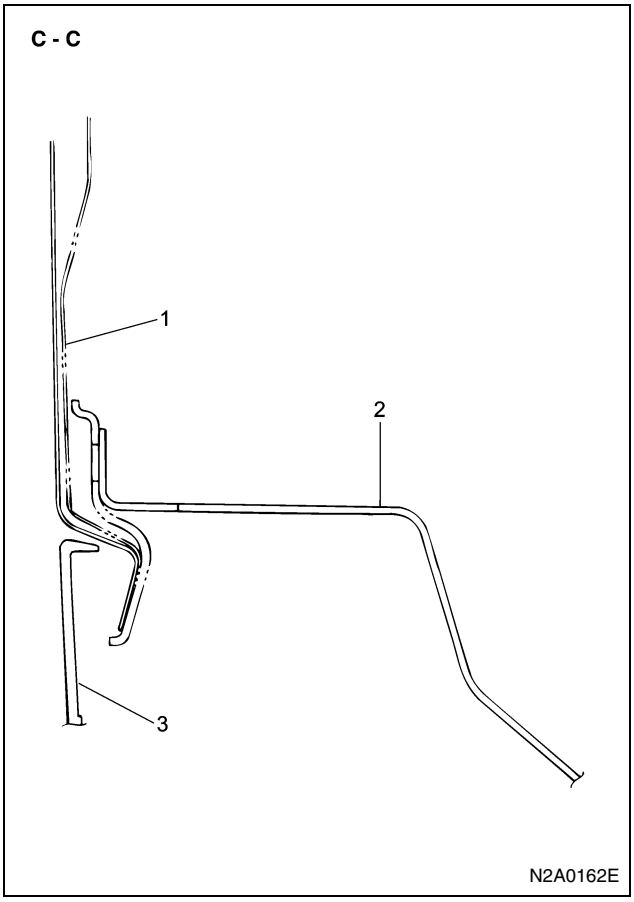
Legend

1. Front window glass
2. Molding
3. Roof panel
4. Header
5. Head lining
6. Finisher



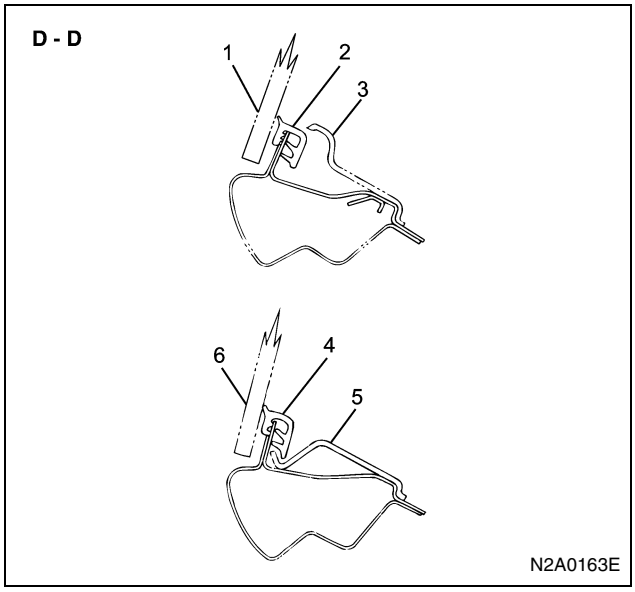
Legend

1. Ornament panel
2. Front center panel
3. Front window glass
4. Front reinforcement
5. Wiper pivot



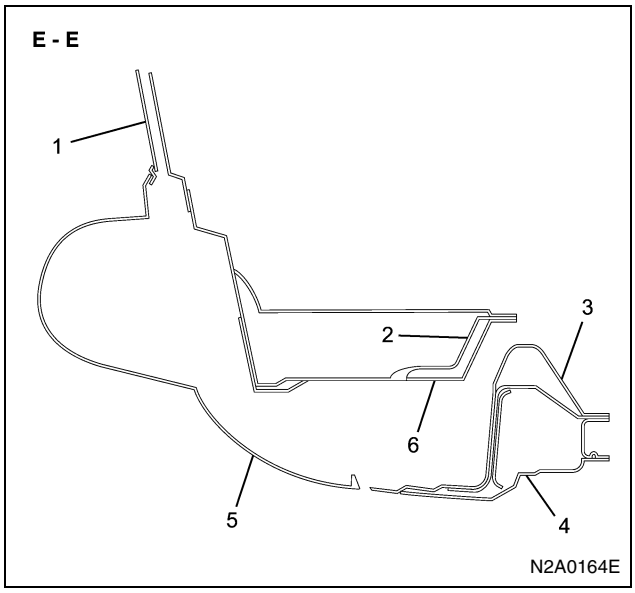
Legend

1. Front center panel
2. Front mounting rail
3. Radiator grille



Legend

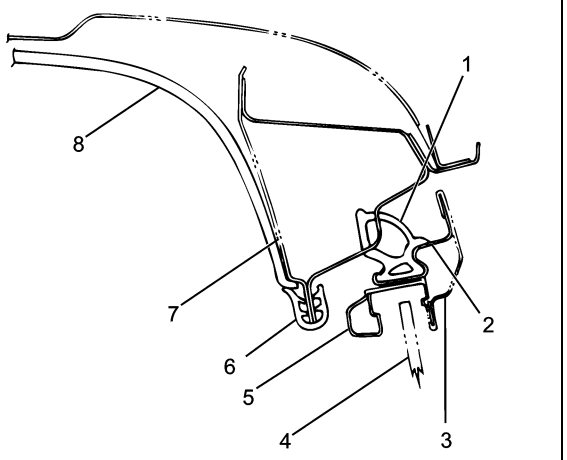
1. Front window glass (High cab, Wide cab model)
2. Finisher (High cab, Wide cab model)
3. Front pillar trim cover (High cab, Wide cab model)
4. Finisher (Standard cab model)
5. Front pillar trim cover (Standard cab model)
6. Front window glass (Standard cab model)



Legend

1. Ornament panel
2. Upper door hinge reinforcement
3. Door inner panel
4. Door outer panel
5. Front corner panel
6. Side panel

F - F

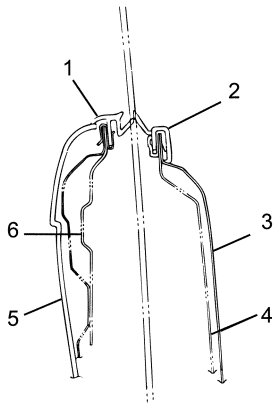


N2A0165E

Legend

1. Door seal
2. Sash extension
3. Door outer panel
4. Door glass
5. Front door sash
6. Body side finisher
7. Rear side cant rail
8. Head lining

G - G

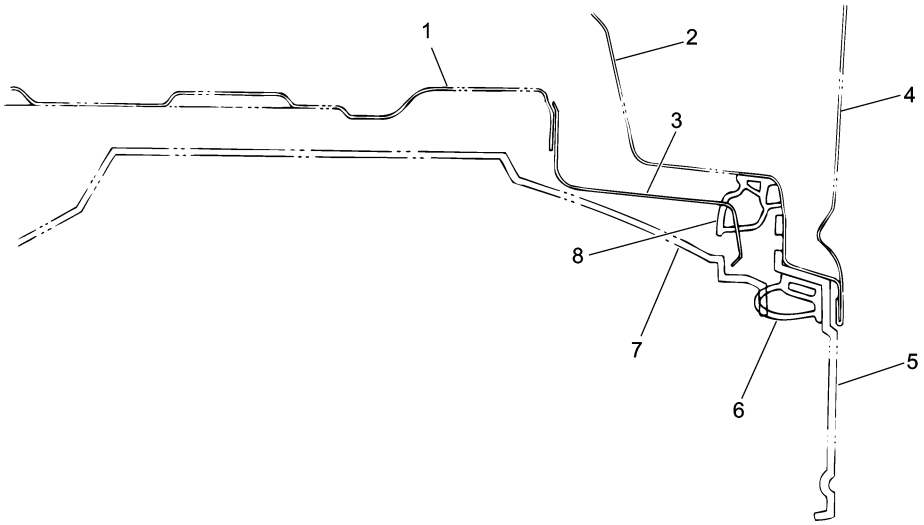


N2A0166E

Legend

1. Inner waist seal
2. Outer waist seal
3. Door outer panel
4. Door outer reinforcement
5. Door trim pad
6. Door inner waist reinforcement

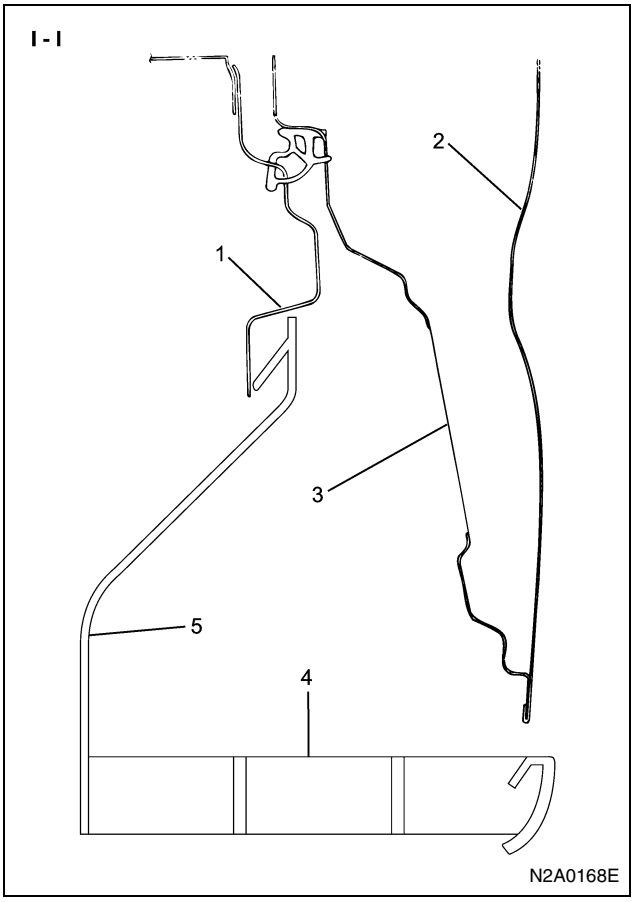
H - H



N2A0167E

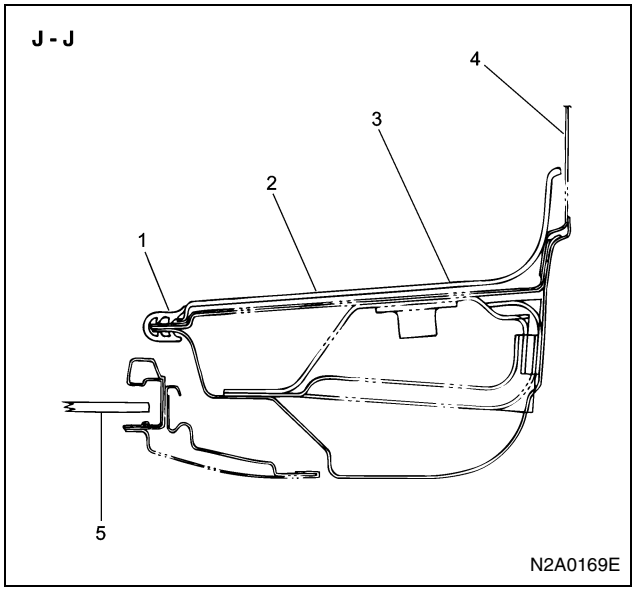
Legend

1. Floor panel
2. Door inner panel
3. Side panel
4. Door outer panel
5. Door lower liner
6. Sub seal
7. Tire house liner
8. Door seal



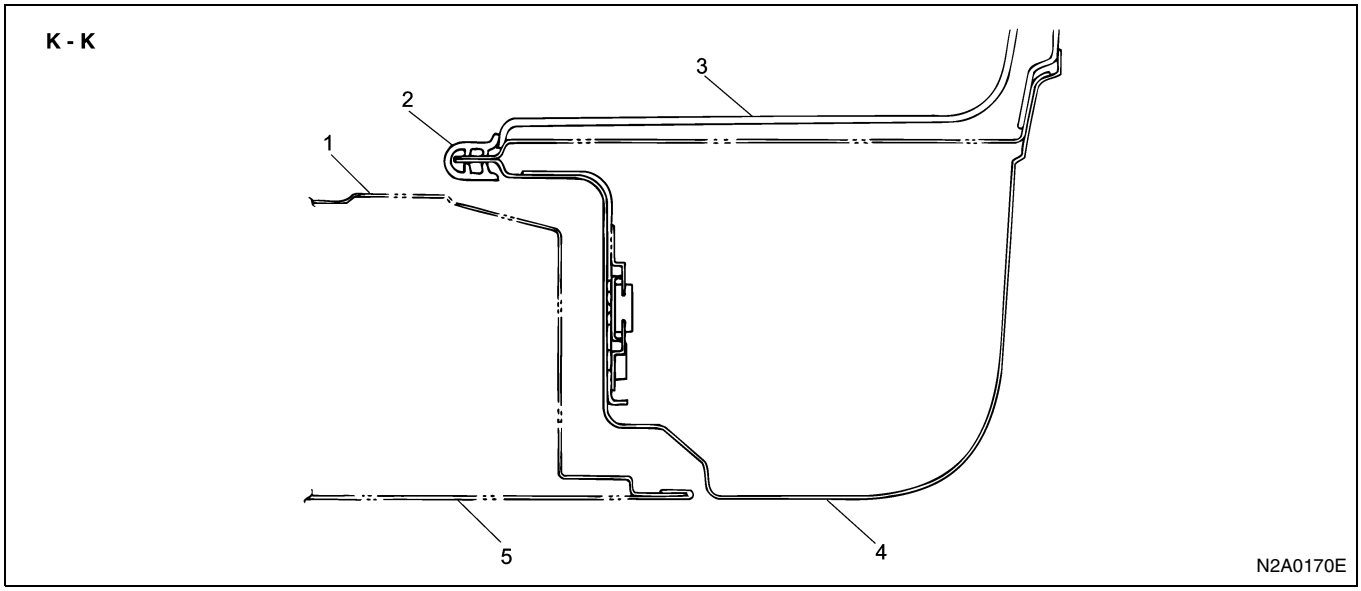
Legend

1. Side panel
2. Door outer panel
3. Door inner panel
4. Step plate
5. Step support



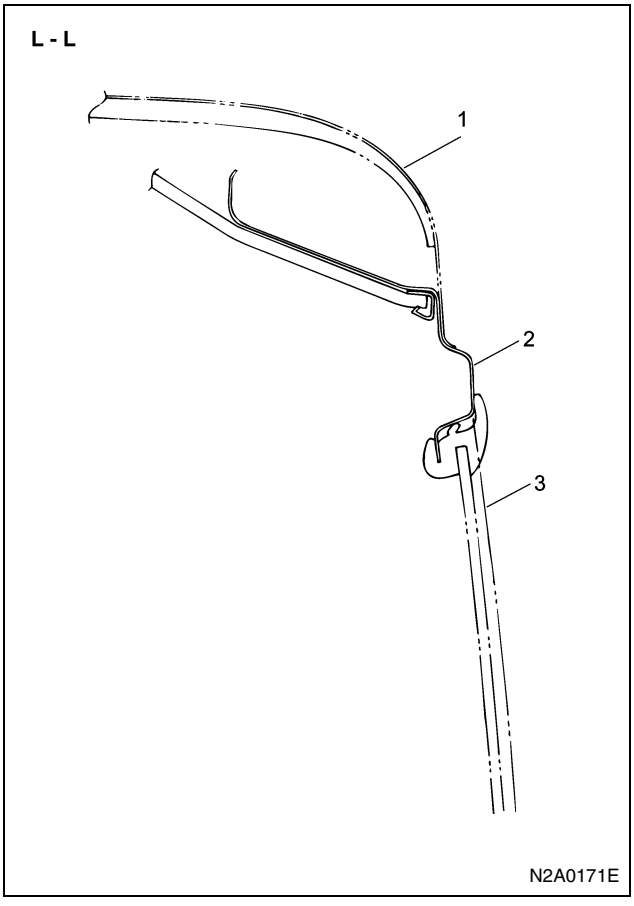
Legend

1. Finisher
2. Rear pillar upper trim cover
3. Rear pillar upper closing
4. Back panel
5. Door glass



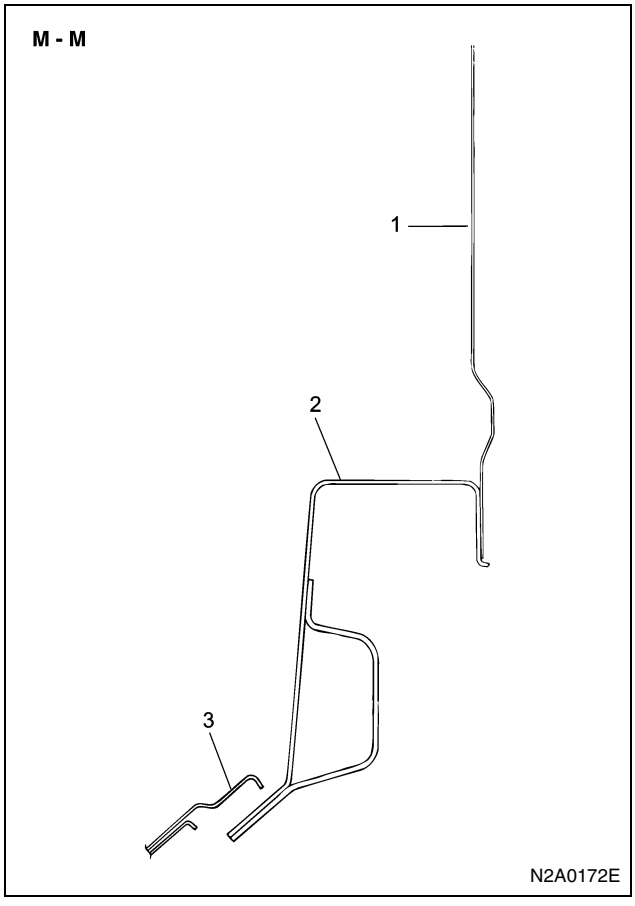
Legend

1. Door inner panel
2. Finisher
3. Rear pillar lower trim cover
4. Side panel
5. Door outer panel



Legend

1. Roof
2. Back panel
3. Back light glass

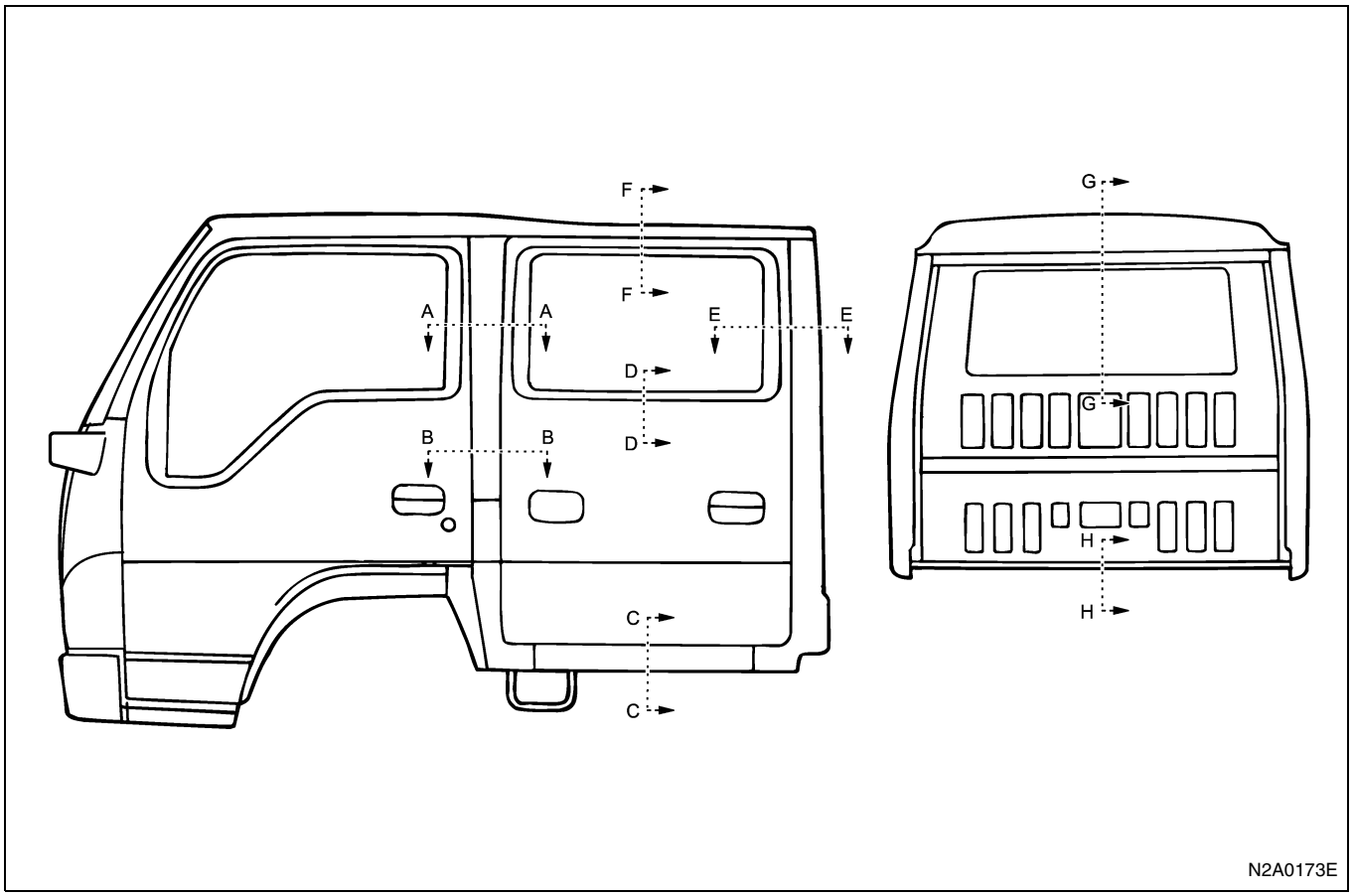


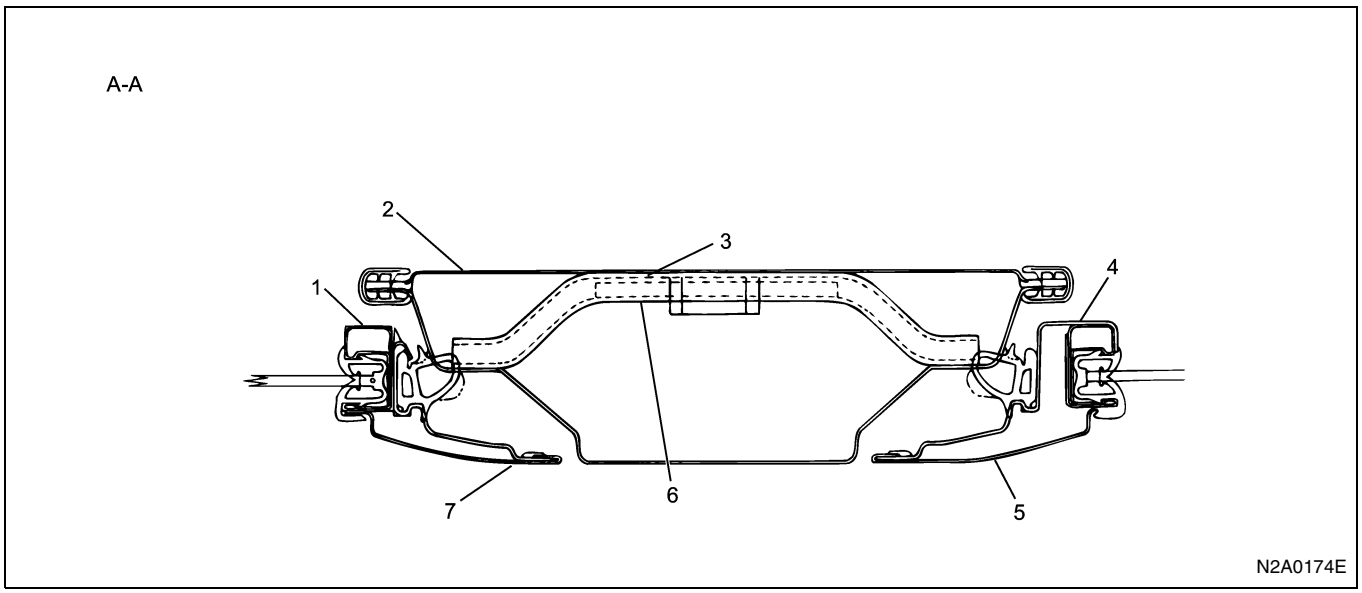
Legend

1. Back panel
2. Rear mounting rail
3. Engine cover

BODY PANEL SECTIONAL SHAPES (CREW CAB MODEL)

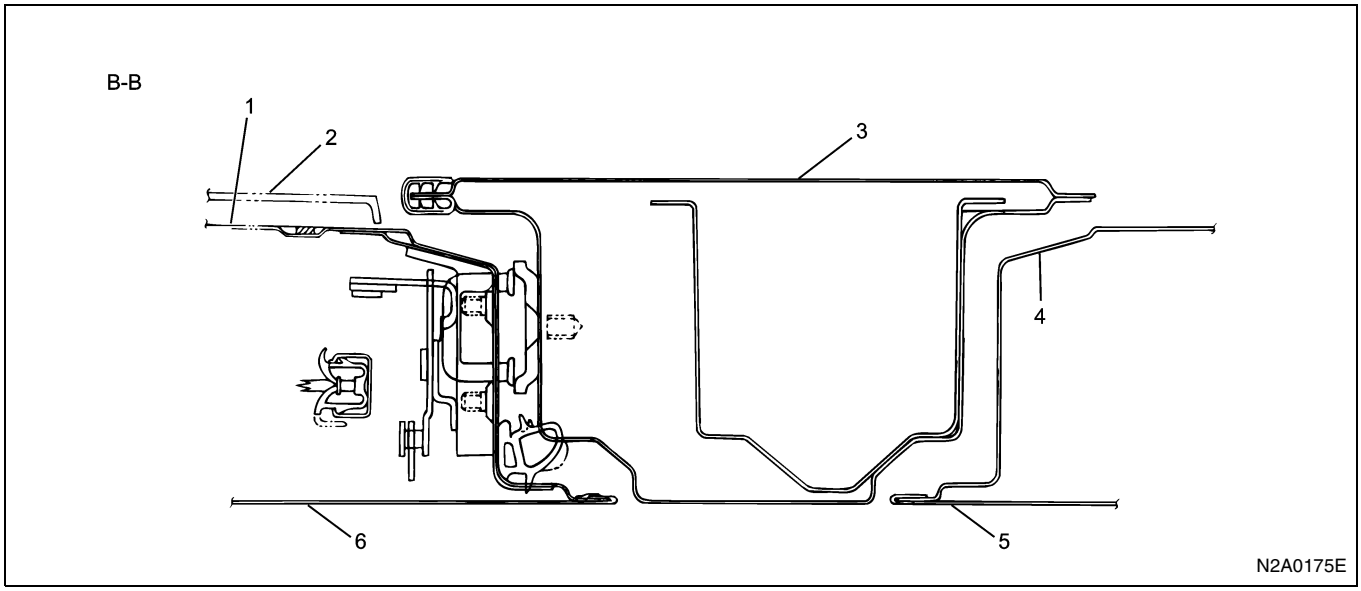
Component





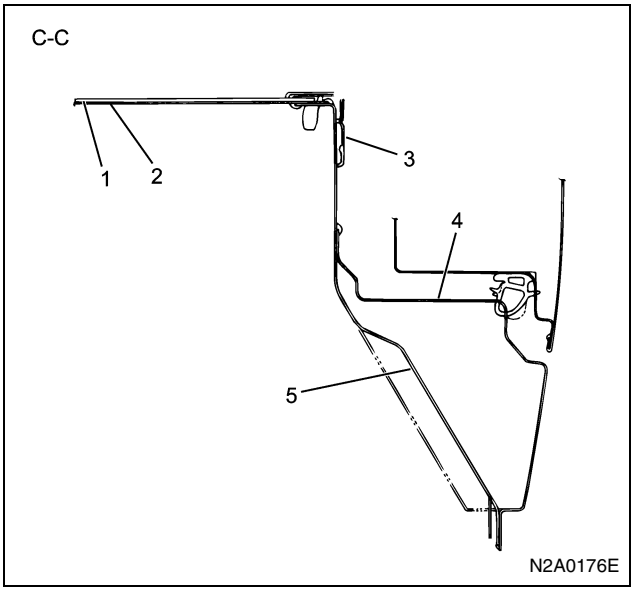
Legend

1. Front door sash
2. Center pillar upper closing
3. Seat belt patch
4. Rear door sash
5. Rear door outer panel
6. Seat belt reinforcement
7. Front door outer panel



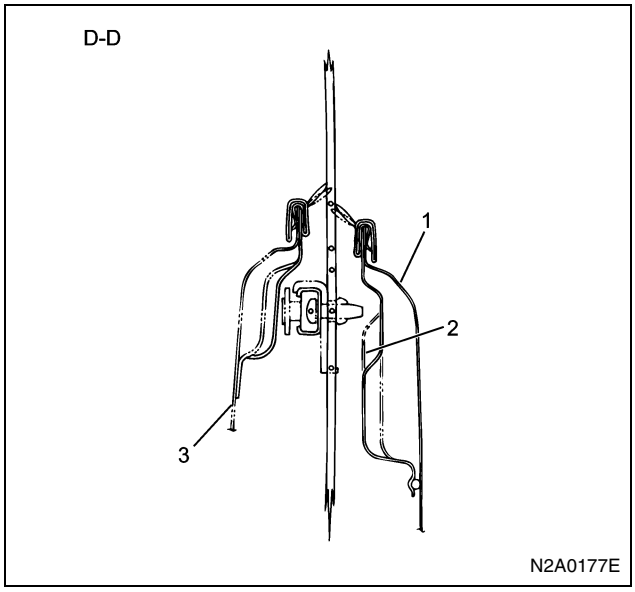
Legend

1. Front door inner panel
2. Trim pad reference surface
3. Center pillar upper/lower closing
4. Rear door inner panel
5. Rear door outer panel
6. Front door outer panel



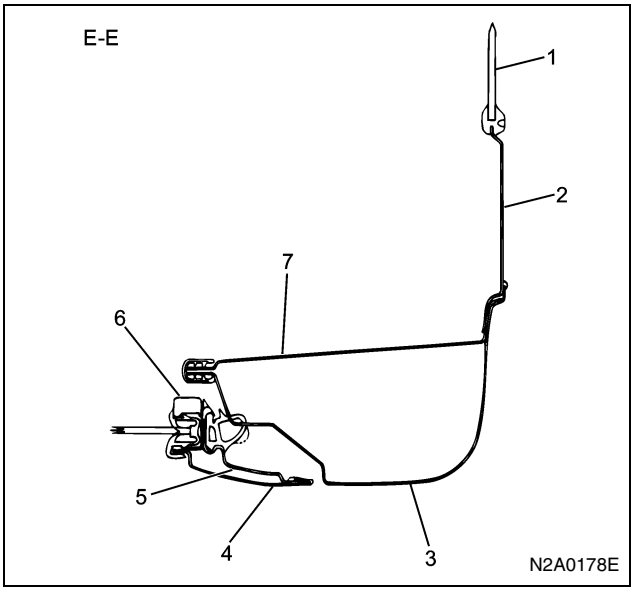
Legend

1. Rear floor mat
2. Rear floor panel
3. Side sill plate
4. Outer sill
5. Rear floor side



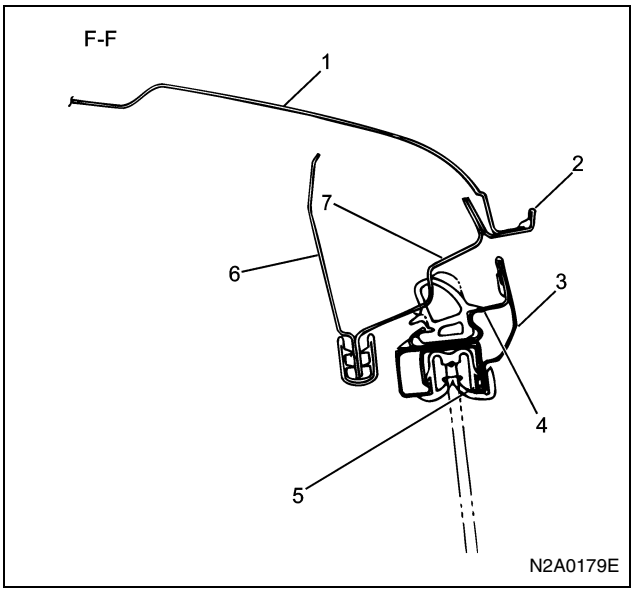
Legend

1. Rear door outer panel
2. Rear door inner waist reinforcement
3. Rear door inner panel



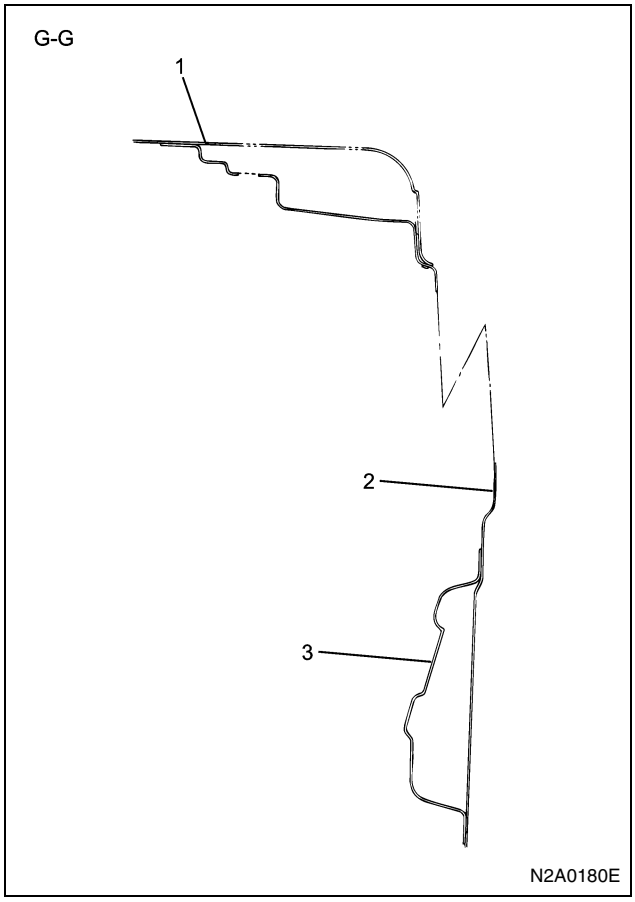
Legend

1. Back light glass
2. Back panel
3. Rear upper pillar
4. Rear door outer panel
5. Rear door sash/rear extension
6. Rear door sash
7. Rear pillar upper closing



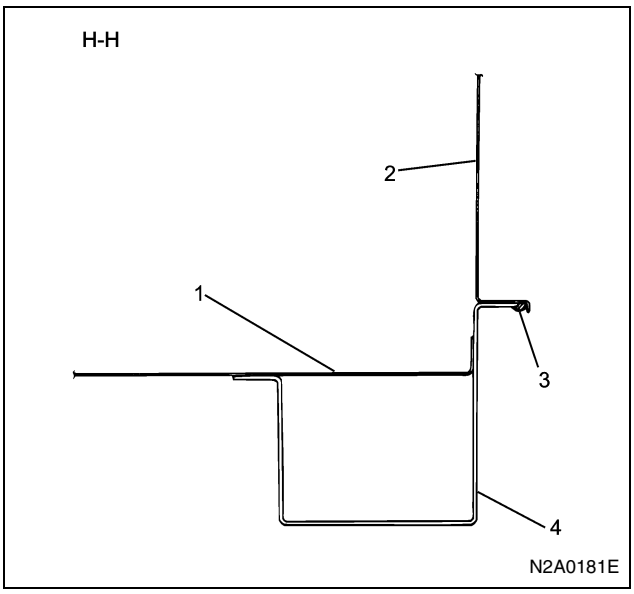
Legend

1. Roof panel
2. Drip side panel
3. Rear door outer panel
4. Rear door upper extension
5. Rear door sash
6. Rear side cant rail
7. Drip rail



Legend

1. Roof panel
2. Back panel
3. Back panel reinforcement



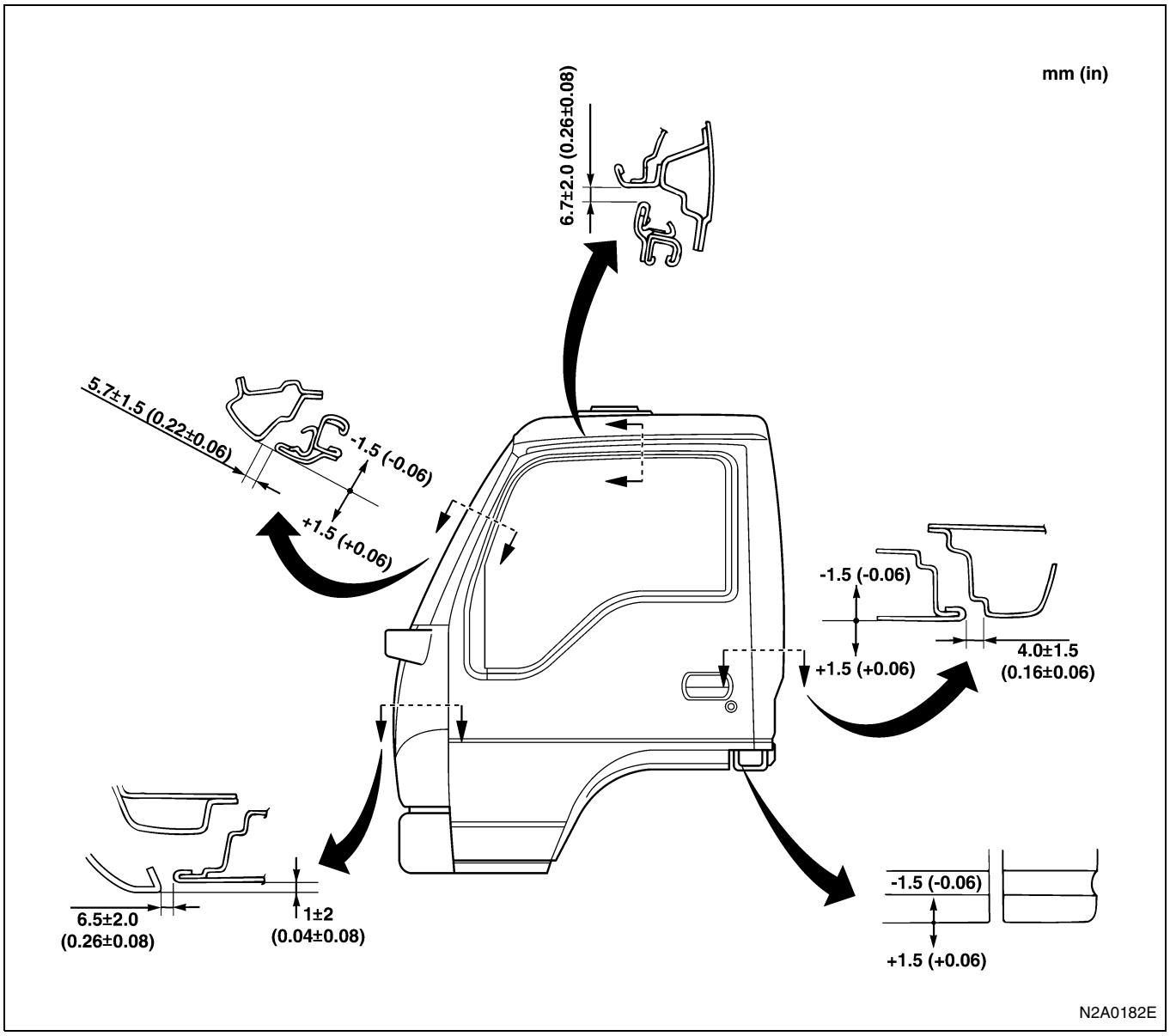
Legend

1. Rear floor panel
2. Back panel
3. Seal
4. Rear bolster

BODY PANEL ASSEMBLY

Specifications

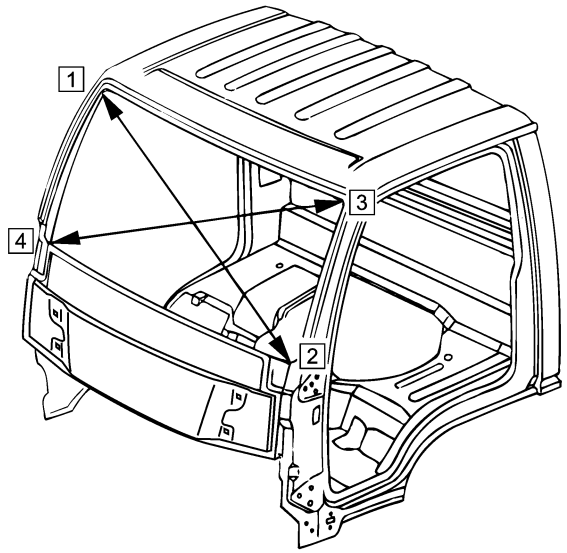
Body Dimensions (Door Opening Clearance and Level Difference)



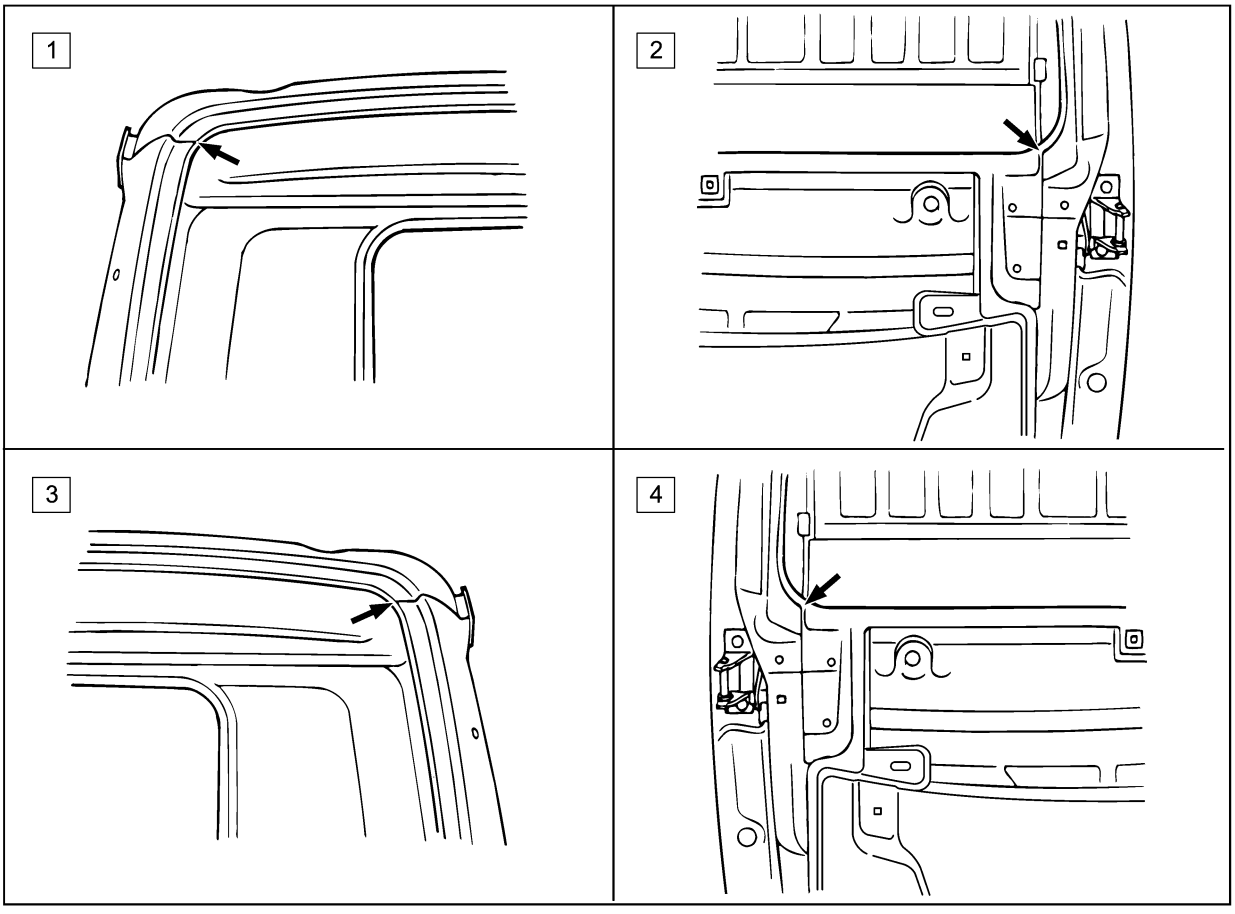
- Adjust the parallelism (difference in clearance) to 2.0 mm (0.08 in) or less.

Body Dimensions (Front Window Frontage Sizes)

mm (in)



	1 ~ 2	3 ~ 4
Standard cab	1542.73 (60.74)	←
High cab	1553.03 (61.14)	←
Wide cab	1830.37 (72.06)	←



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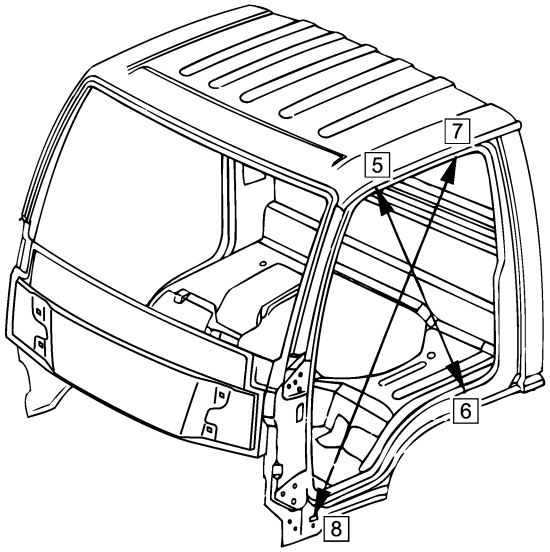
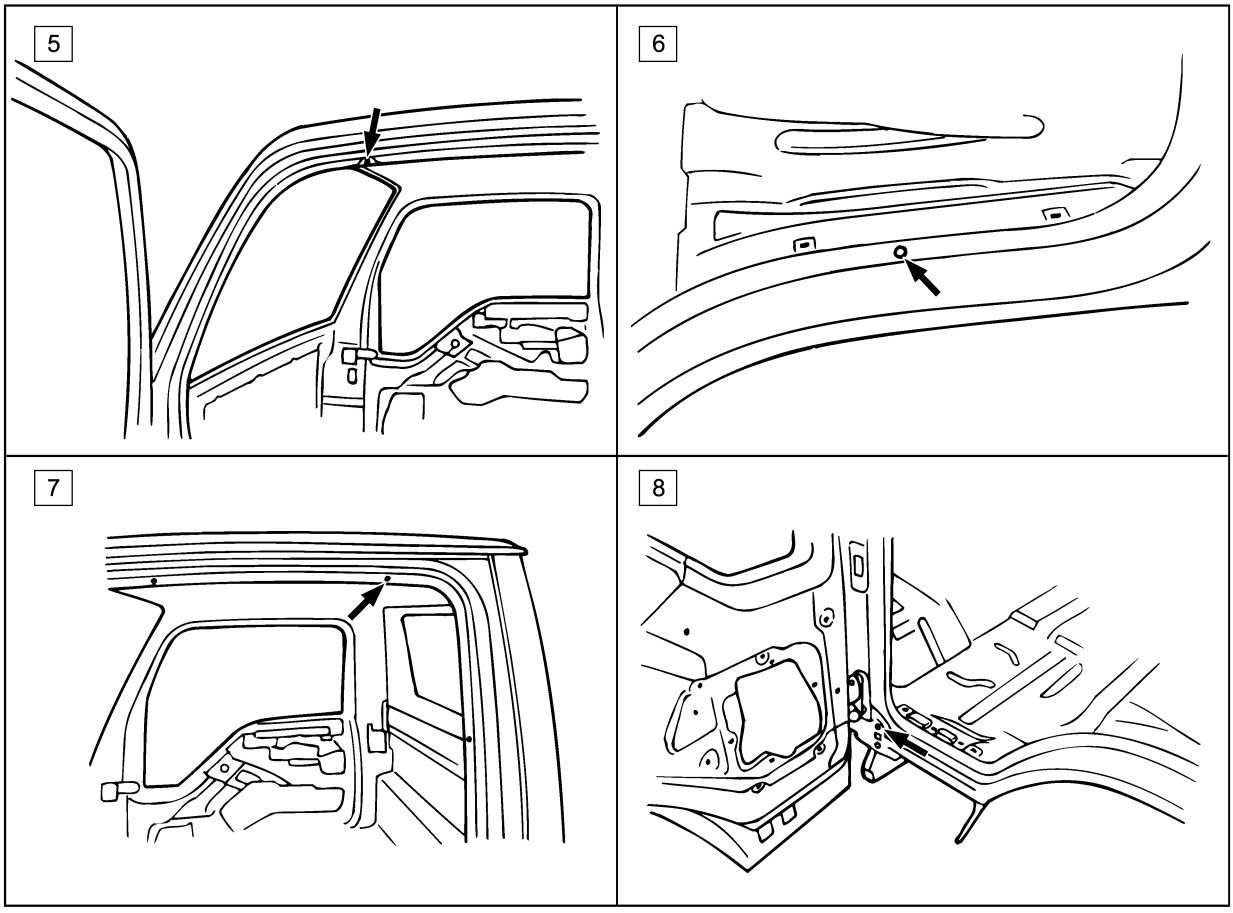
Body Dimensions (Door Frontage Sizes)



mm (in)

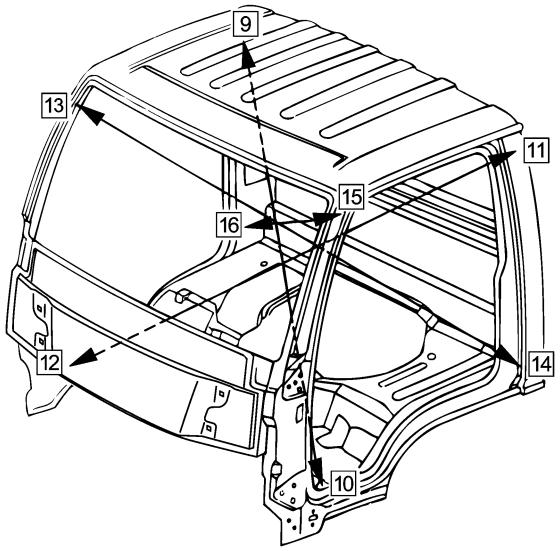
	5 ~ 6	7 ~ 8
Standard cab	1010.86 (39.80)	1515.20 (59.65)
High cab	1079.69 (42.51)	1577.49 (62.11)
Wide cab	1079.69 (42.51)	1577.49 (62.11)



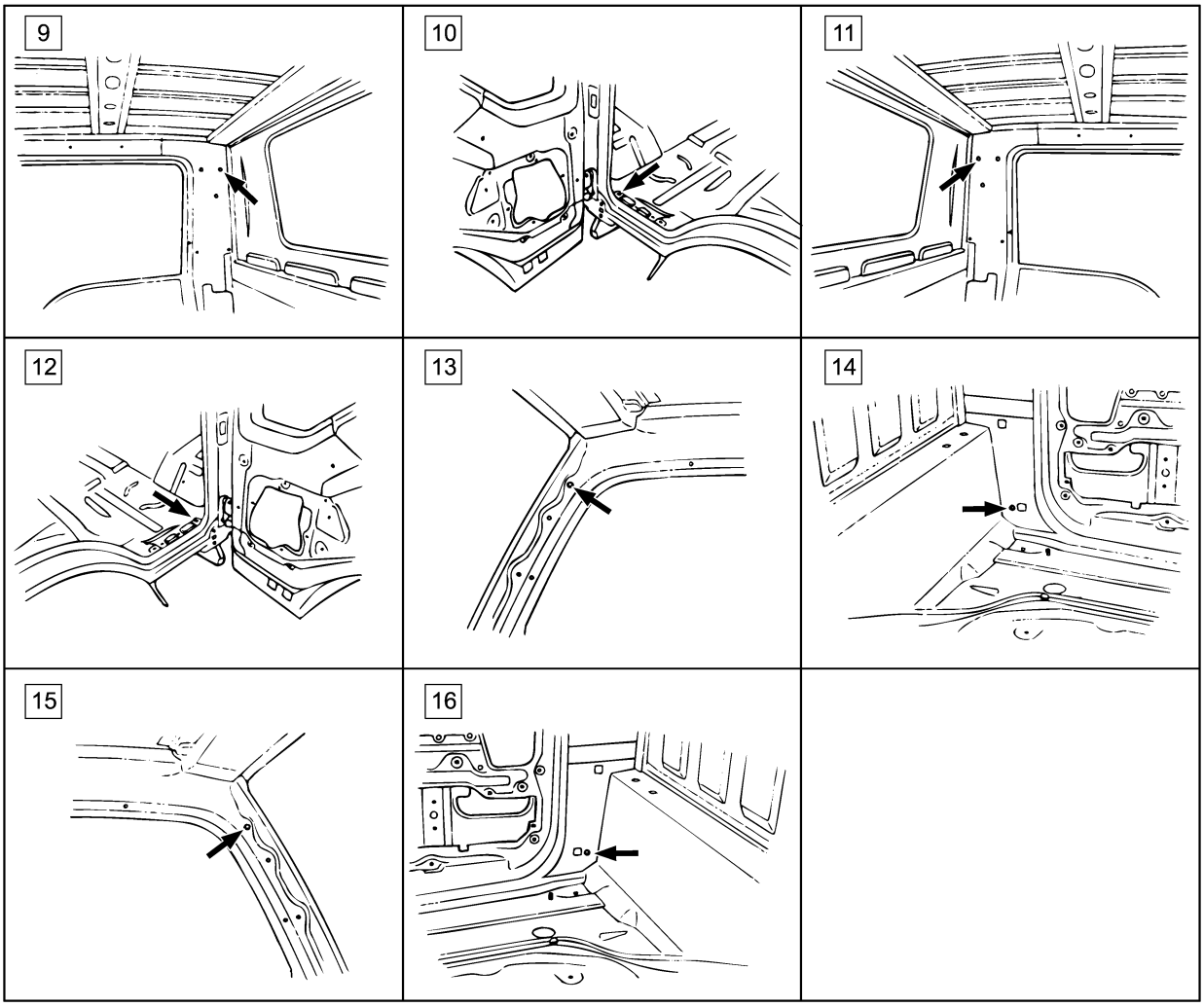
N2A0184E

Body Dimensions (Room Diagonal Sizes)

mm (in)

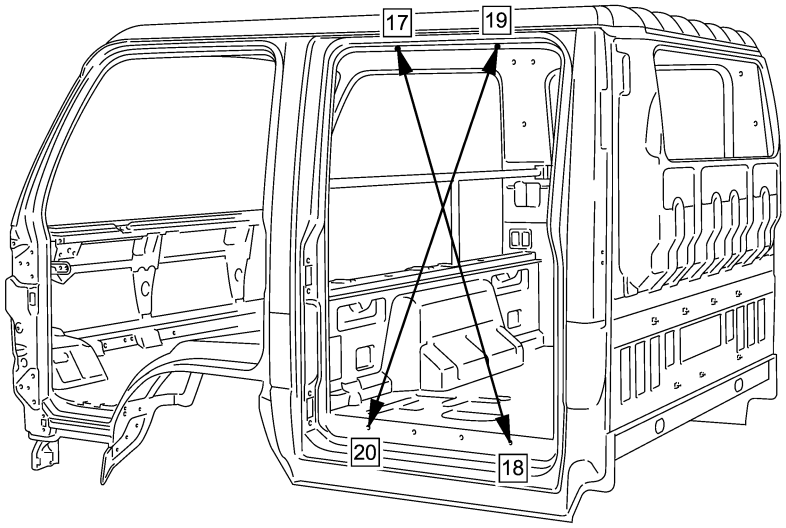


	9 ~ 10 11 ~ 12	13 ~ 14 15 ~ 16
Standard cab	**2094.15 (82.45)**	**1884.51 (74.19)**
High cab	**2136.32 (84.11)**	**1886.05 (74.25)**
Wide cab	**2336.98 (92.01)**	**2128.51 (83.80)**



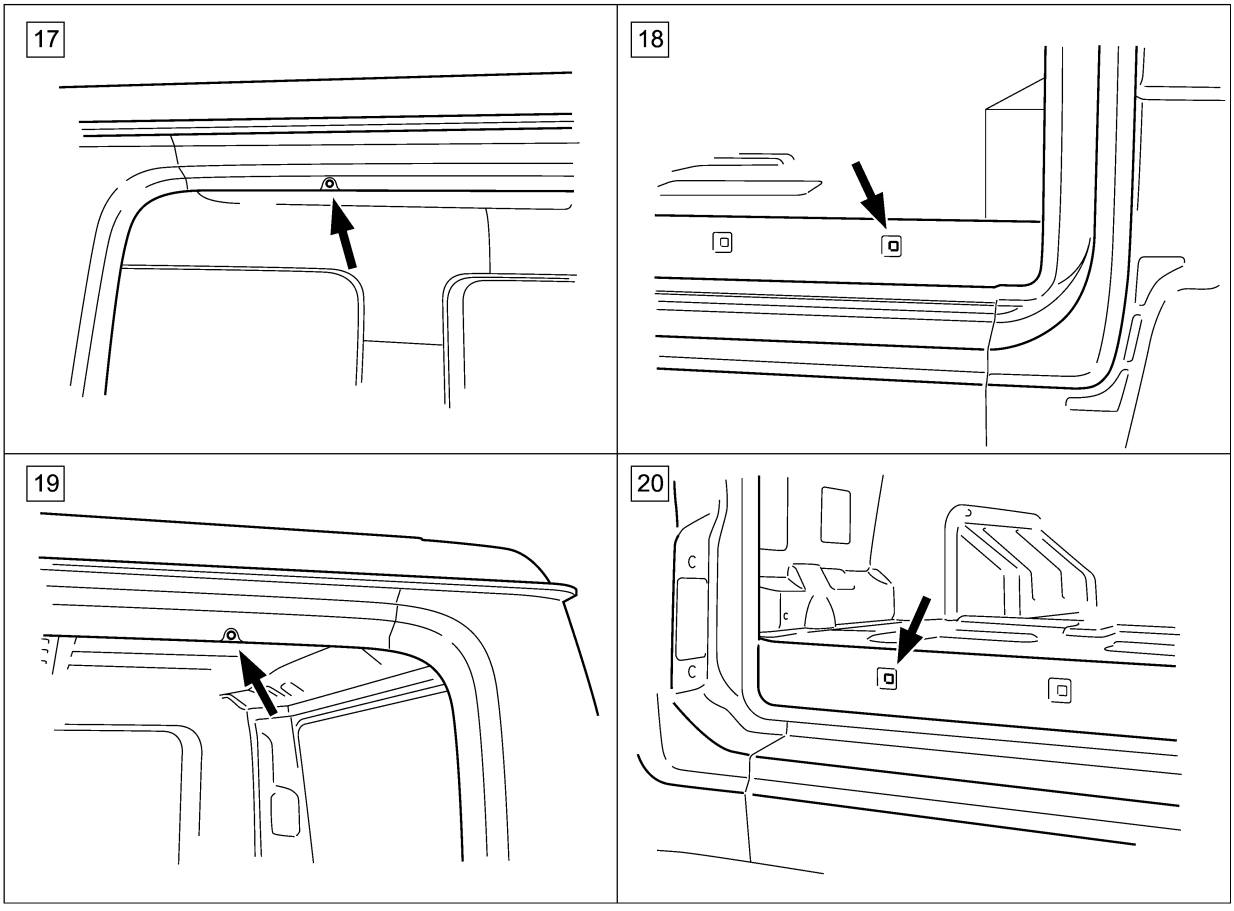
N2A0185E

Body Dimensions (Rear Door Frontage Sizes, Double Cab Model)



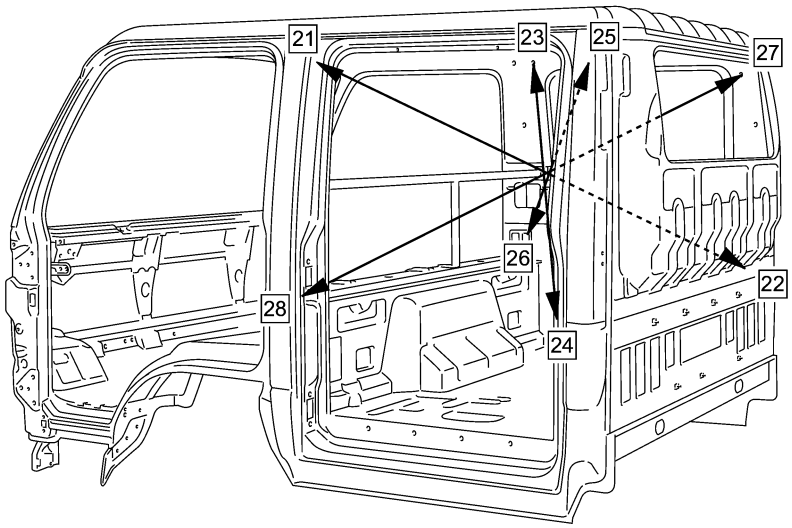
mm (in)

	17 ~ 18	19 ~ 20
Standard cab	1223.6 (48.17)	1223.3 (48.16)
High cab	1293.1 (50.91)	1292.8 (50.90)
Wide cab	1293.1 (50.91)	1292.8 (50.90)



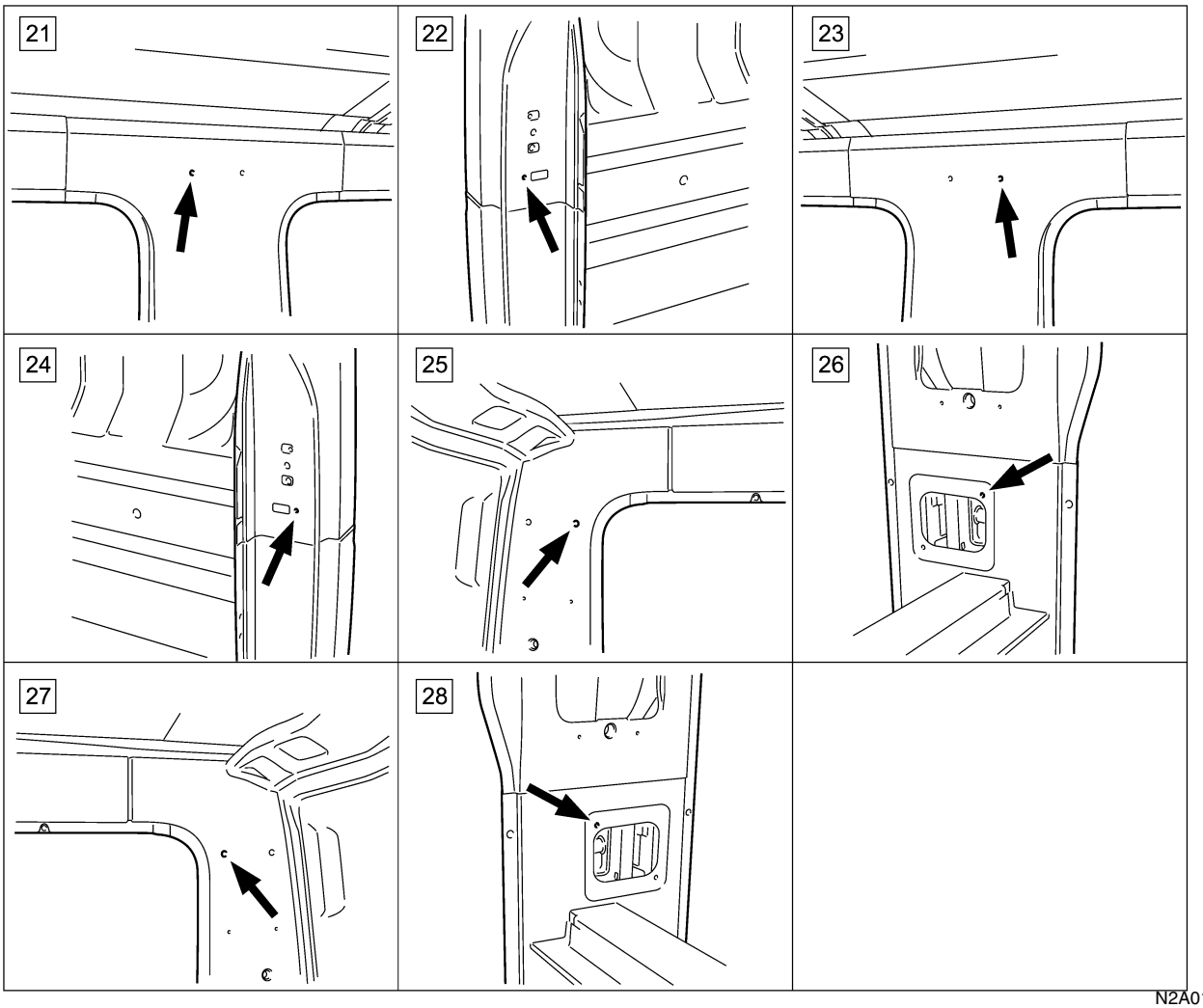
N2A0186E

Body Dimensions (Room Diagonal Sizes, Double Cab Model)



mm (in)

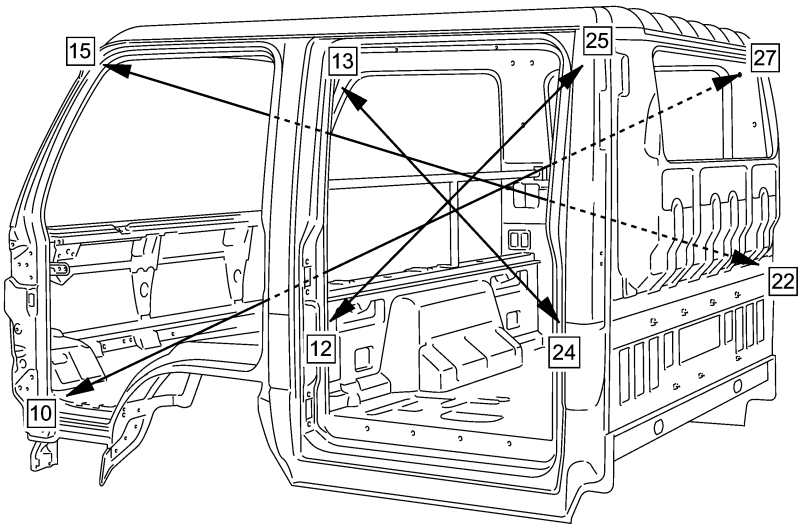
	21 ~ 22 23 ~ 24	25 ~ 26 27 ~ 28
Standard cab	**1865.1 (73.43)**	**1814.8 (71.45)**
High cab	**1906.8 (75.07)**	**1827.3 (71.94)**
Wide cab	**2149.8 (84.64)**	**2073.6 (81.64)**



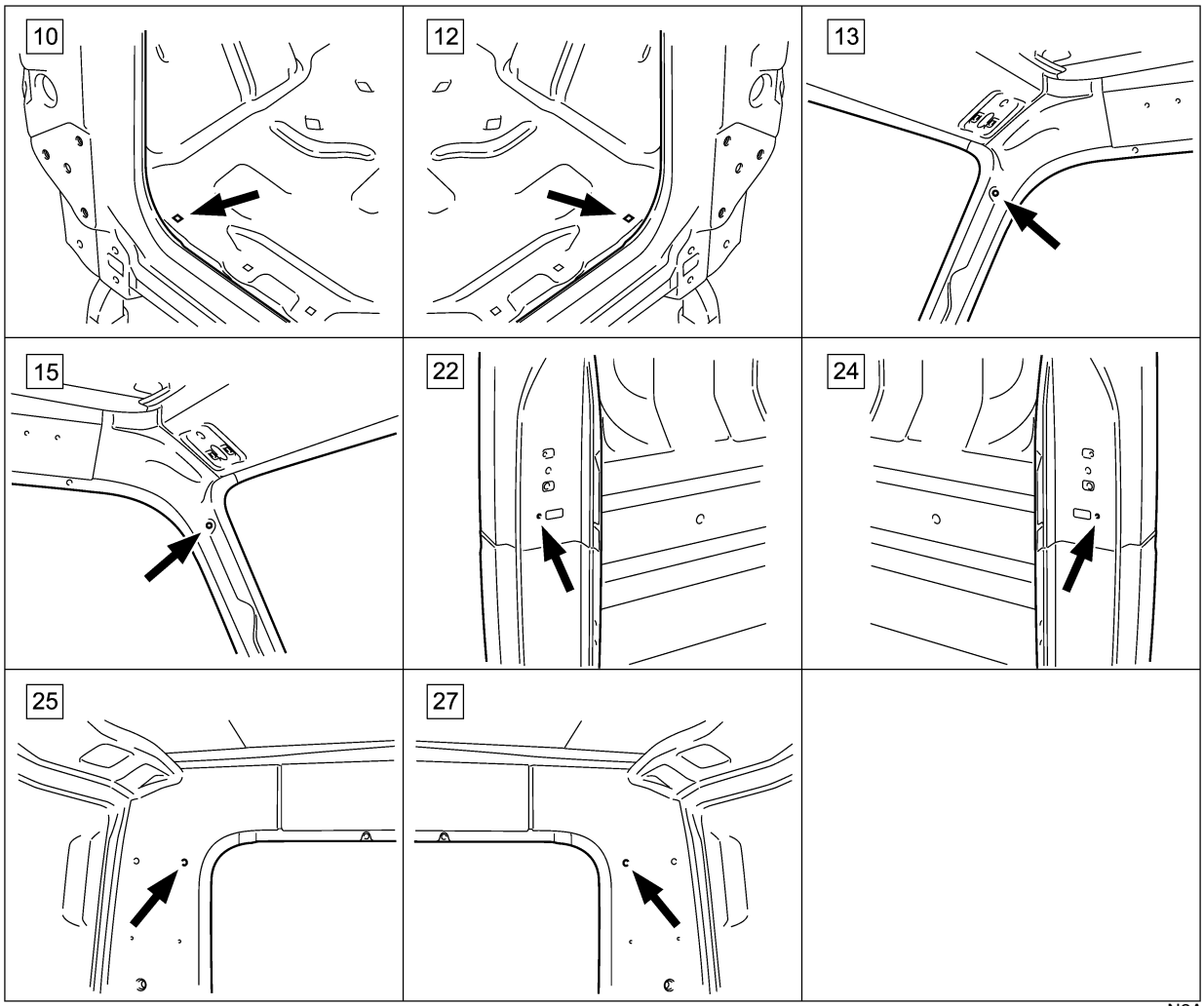
N2A0187E

Body Dimensions (Room Diagonal Sizes, Double Cab Model)

mm (in)

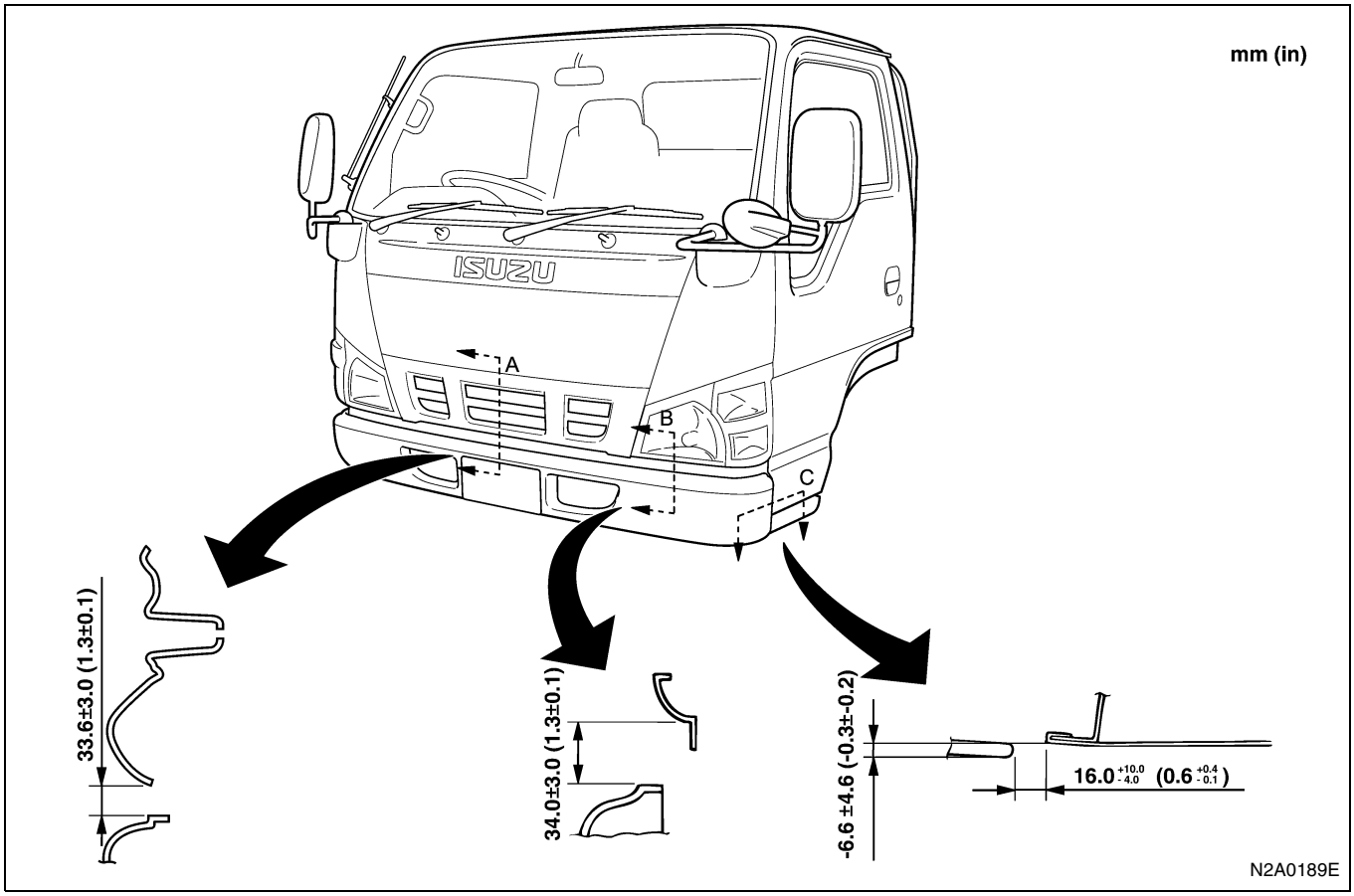


	15 ~ 22 13 ~ 24	10 ~ 27 12 ~ 25
Standard cab	2506.7 (98.69)	2714.4 (106.87)
High cab	2488.9 (97.99)	2737.4 (107.77)
Wide cab	2682.0 (105.59)	2905.0 (114.37)



N2A0188E

Body Dimensions (Front Bumper Installation Basic Sizes)



- Section B parallelism (difference in clearance) size
  Vertical 3.0 mm (0.1 in) or less
- Section C parallelism (difference in clearance) size
  Vertical 3.0 mm (0.1 in) or less
  Horizontal 5.0 mm (0.2 in) or less
- Section D parallelism (level difference) size
  Vertical 3.0 mm (0.1 in) or less
  Horizontal 5.0 mm (0.2 in) or less

LGFRM-WE-0552

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LGFRM-WE-0552 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

FRAME AND CAB

SECTION 2

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

SECTION No.	CONTENTS
00	SERVICE INFORMATION
2	CAB AND FRAME

STEERING, SUSPENSION, WHEELS AND TIRES

SECTION 00
SERVICE INFORMATION

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TROUBLE SHOOTING

Steering System

PROBLEM	POSSIBLE CAUSE	CORRECTION
Objectionable “Hiss”	Noisy relief valve. There is some noise in all power steering systems. One of the most common is a hissing sound most evident at standstill parking. Hiss is a high frequency noise similar to that experienced while slowly closing a water tap. The noise is present in every valve and results from high velocity fluid passing valve orifice edges. There is no relationship between this noise and performance of the steering. “Hiss” may be expected when the steering wheel is at end of travel of when slowly turning at stand still.	Do not replace the valve unless “hiss” is extremely objectionable. A replacement valve will also exhibit slight noise and is not always a cure.
Rattle or Chuckle Noise in the Steering Gear	1. Gear housing loose on frame. 2. Steering linkage looseness. 3. Pressure house touching other parts of the truck. 4. Loose pitman shaft over center adjustment. A slight rattle may occur on turns because of increased clearance off the “high point.” This is normal and clearance must not be reduced below specified limits to eliminate this slight rattle. 5. Loose pitman arm.	1. Check gear mounting. Torque the bolts to specifications. 2. Check linkage pivot points for wear. Replace if necessary. 3. Adjust the hose position. Do not bend tubing by hand. 4. Adjust. 5. Torque the pitman arm nut.
Groan Noise in the Steering Pump	1. Low oil level. 2. Air in the oil. Poor pressure house connection.	1. Fill the reservoir to the proper level. 2. Torque the connector. Bleed the system.
Rattle or Knock Noise in the Steering Pump	Loose pump gear nut.	Torque the nut.
Rattle Noise in the Steering Pump	1. Vanes not installed properly. 2. Vanes sticking in the rotor slots.	1. Install properly. 2. Repair or replace.
Switch Noise in the Steering Pump	Defective flow control valve.	Replace or repair.
Whine Noise in the Steering Pump	Pump shaft bearing scored.	Replace the housing and shaft. Flush and bleed the system.
Growl Noise in the Steering Pump	Excessive back pressure in houses or the steering gear caused by restriction.	Locate the restriction and correct. Replace the part if necessary.
Growl Noise in the Steering Pump (Particularly Noticeable at Standstill Parking)	1. Scored pressure plates, thrust plate or rotor. 2. Extreme wear of the cam ring.	1. Replace the parts and flush the system. 2. Replace the parts.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Excessive Play or Looseness in the Steering System (Steering Wanders)	1. Front wheel bearing loosely adjustment.	1. Adjust the bearing or replace with new parts as necessary.
	2. Worn coupling or steering shaft joints.	2. Replace.
	3. Worn steering linkage ball joints.	3. Replace steering linkage.
	4. Worn upper or lower ball joints.	4. Replace ball joints.
	5. Steering wheel loose on the shaft, loose pitman arm, tie rods, steering arms, or steering linkage ball studs.	5. Torque the fastener.
	6. Steering gear worm bearing loosely adjusted.	6. Adjust the preload.
	7. Excessive pitman shaft to ball nut lash in the steering gear.	7. Adjust the preload.
	8. Toe-in out of adjustment or worn drag link or tie rod sockets.	8. Replace the tie rod ends if worn, adjust to correct the toe-in, and inspect the steering arm and tie rod for bent condition.
	9. Steering system out of alignment.	9. Align caster, camber, and toe-in. Inspect spring components for condition and wear. Repair or replace as required.
	10. Tires badly worn, edge of the tires are rounded off.	10. Install new tires, and check alignment; abnormal tire wear indicates improper alignment.
	11. Lack of lubrication in the linkage and kingpins.	11. Lubricate. Free up any components which are frozen and will not take lubrication.
	12. Air in the system.	12. Add oil to the pump reservoir and bleed the system. Check hose connectors for proper torque.
	13. Steering gear mounting loose.	13. Tighten attaching bolts to the specified torque.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Vibration and Shimmy	1. Seal damage and leakage resulting in loss of lubricant, corrosion and excessive wear.	1. Replace damaged parts as necessary.
	2. Tires, wheels, or brake drums out of balance.	2. Balance the tires and wheels, preferably with an on-vehicle type balancer, as this method balances the entire wheel and drum assembly.
	3. Bent wheel or out of bound tire. Wheel nuts torqued unevenly.	3. Replace the wheel and remount the tire, or replace the assembly.
	4. Loose steering linkage components.	4. Adjust, torque, and repair the linkage as necessary.
	5. Worn steering linkage ball joints.	5. Replace steering linkage.
	6. Worn upper or lower end ball joints.	6. Replace ball joints.
	7. Wheel loose on the hub.	7. Inspect the wheel bolt holes for damage, and replace the wheel or torque the nuts.
	8. Drive line universal joints rough or defective. This condition may be confused with steering vibration.	8. Repair the drive line.
	9. Engine misses or is out of balance, this may also be confused with steering shimmy.	9. Correct the miss in the engine, or repair the out of balance condition, clutch, pressure plate, or harmonic balancer, etc.
	10. Faulty shock absorbers.	10. Replace the shock absorbers.
Hard Steering or Excessive Effort Required at Steering Wheel	1. Low or uneven tire pressure.	1. Inflate to specified pressures.
	2. Steering linkage kingpins or ball joints need lubrications.	2. Lubricate, and free up kingpins or ball joints. Make certain all fittings take lubricant properly.
	3. Tight or frozen intermediate rod, tie rod or idler socket.	3. Lubricate or replace as necessary.
	4. Steering gear to column misalignment.	4. Align the column.
	5. Steering gear adjust too tightly.	5. Adjust preload.
	6. Front wheel alignment incorrect.	6. Check alignment and correct as necessary.
	7. Steering gear adjusted too tight.	7. Adjust the steering gear.
	8. Frozen or tight shaft bearings.	8. Replace the bearings.
	9. Lower the U-joint flange rubbing against the adjuster.	9. Loosen the bolt, assemble and torque properly.
	10. Tight or binding conditions in steering column.	10. Adjust the steering column.
	11. Power cylinder rod nicked or marred.	11. Replace the cylinder.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Pump Inoperative, Poor, or No Assist (Hard Steering)	1. Low oil level. 2. Air in the oil. 3. Defective hoses or steering gear. 4. Flow control valve stuck. 5. Loose nut in end of flow control valve. 6. Pressure plate not flat against ring. 7. Extreme wear of pump ring. 8. Scored pressure plate, thrust plate. 9. Vanes not installed properly. 10. Vanes sticking in rotor slots. 11. Faulty flow control valve assembly.	1. Fill the reservoir to the proper level. 2. Locate the source of the air leak and correct it. 3. Repair or replace. 4. Repair or replace. 5. Torque nut. 6. Repair or replace. 7. Repair or replace. 8. Repair or replace. 9. Repair or replace. 10. Repair or replace. 11. Repair or replace.
Moment Increase in Effort when Turning Wheel Fast to Right or Left	1. Low oil level in pump. 2. High internal leakage in hydraulic pump. 3. High internal leakage in steering gear.	1. Add power steering fluid as required. 2. Check the pump pressure. (See the pump pressure test.) 3. Repair
Steering Wheel Surges or Jerks when Turning with Engine Running Especially During Parking	1. Low oil level. 2. Insufficient pump pressure. 3. Defective gear relief valve. 4. Sticky flow control valve.	1. Fill as required. 2. Check the pump pressure. (See the pump pressure test.) Replace relief valve if defective. 3. Replace the gear relief valve. 4. Repair or replace.
Steering Pulls to Left or Right	1. Camber incorrectly adjusted. Steering will generally pull to the side of the axle having the greatest positive camber. 2. Low air pressure in the right or left tire. Steering will pull to the side having the air pressure. 3. Axle loose and shifted at the spring U-bolts. 4. Rear axle loose at the spring U-bolt. If shifted axle is shifted at one side, it will cause the steering to pull. 5. Unbalanced steering gear valve. If this is the cause, steering effort will be very light in the direction of the lead and heavy in the opposite direction.	1. Adjust camber. 2. Inflate the tire to the correct pressure, check for air leak and repair as required. 3. Align the axle, and torque the U-bolt nuts. Inspect for damaged parts. Replace if required. 4. Align the rear axle and replace the defective parts, if any. Torque the U-bolt. 5. Replace the valve.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Poor Return of the Steering Wheel	1. Lack of lubrication in the linkage.	1. Lubricate the linkage.
	2. Steering gear to column misalignment.	2. Align the steering column.
	3. Tires not properly inflated.	3. Inflate to the specified pressure.
	4. Improper front wheel alignment.	4. Check and adjust as necessary.
	5. Steering linkage binding.	5. Replace the pivots.
	6. Steering wheel rubbing against the directional signal housing. (Turn the steering wheel and listen for internal rubbing in the column.)	6. Adjust the steering jacket.
	7. Tight steering shaft bearings.	7. Replace the bearings.
	8. Sticky or plugged valve spool.	8. Repair or replace valve.
	9. Steering gear out of adjustment.	9. Check adjustment. Adjust as required.
	10. Tight kingpin bushings.	10. Lubricate or replace as required.
	11. Lower U-joint flange rubbing against the steering gear adjust plug.	11. Loosen the pinch bolt and assemble it properly.
	12. Upper or lower end ball joint blinding.	12. Replace ball joints.
Snapping or Chucking in the Steering Column or Wheel	1. Loose steering gear at the frame.	1. Torque the mounting bolts.
	2. Worn steering shaft universal joints.	2. Replace and repair the joints as necessary.
	3. Worn steering linkage components. The effect of these components will telescope through the steering system and be felt in the steering wheel.	3. Adjust, torque, and repair the components.
	4. Steering gear incorrectly adjusted.	4. Adjust steering gear.
Excessive Road Shock	1. Tire air pressure too high.	1. Deflate to the correct pressure.
	2. Wheel bearings adjusted too loose.	2. Adjust the bearings.
	3. Camber adjustment incorrect.	3. Adjust the camber.
	4. Weak or broken front spring.	4. Replace the spring.
	5. Defective shock absorbers.	5. Replace the shock absorbers.
	6. Loose suspension components.	6. Inspect, adjust or repair, and replace as necessary.

Front and Rear Suspension

PROBLEM	POSSIBLE CAUSE	CORRECTION
Spring Noise	1. Loose U-bolts.	1. Tight to recommended torque.
	2. Loose or worn eye bushings.	2. Replace eye bushings.
	3. Lack of lubrication.	3. Lubricate as required.
	4. Defective shock absorber.	4. Replace shock absorber.
Spring Sag or Bottom	1. Inoperative shock absorber.	1. Replace shock absorbers.
	2. Broken spring leaf.	2. Replace leaf or spring assembly.
	3. Severe operation or overloading.	3. Check load capacity rating.
Spring Breakage	1. Loose U-bolts.	1. Tighten to recommended torque.
	2. Normal fatigue.	2. Replace springs.
	3. Overloading.	3. Do not overload vehicle.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Excessive Road Shock	1. Tire air pressure too high. 2. Wheel bearings adjusted too loose. 3. Camber adjustment incorrect (Negative camber contributes to road shock). 4. Weak or broken spring. 5. Defective shock absorbers. 6. Loose suspension components.	1. Deflate to correct pressure. 2. Adjust bearings. 3. Adjust camber. 4. Replace spring. 5. Replace shock absorbers. 6. Inspect, adjust or repair and replace as necessary.

Wheels

PROBLEM	POSSIBLE CAUSE	CORRECTION
Wheel Hop (Vehicle Vibration and Rough Steering)	**Wheels** 1. Rocks and debris wedged between dual disc wheels. 2. Out-of- balance tire and/or hub and drum/rotor assembly. 3. Improper positioning of the side rings split. **Vehicle** Loose or worn driveline or suspension.	1. Remove rocks and debris. 2. Determine the out-of-balance component and balance or replace. 3. Reassemble with ring split opposite (180 degrees) the valve opening to improve balance. Identify location of vibration carefully as it may be transmitted through the frame making a rear end vibration appear to come from the front. Then repair or replace loose or worn parts. (Refer to PROPELLER SHAFT [SEC. 4A] for vehicle vibration.)
Stripped Threads	Excessive clamp load.	Replace studs — follow proper torque procedure.
Rust Streaks from Stud Holes Correction	Loose cap nuts.	Check complete assembly, replace damaged parts and follow proper torque procedure.

Tires

PROBLEM	POSSIBLE CAUSE	CORRECTION
Wobble (Vehicle Vibration and Rough Steering)	**Wheels** 1. Bent or distorted disc from overloading or improper handling. 2. Loose mountings, damaged studs, cap nuts, enlarged stud holes, worn or broken hub face, or foreign material on mounting surfaces. 3. Improper positioning of the side rings split. **Vehicle** 1. Improper alignment. 2. Loose, worn or broken suspension parts.	1. Replace wheel. 2. Replace worn or damaged parts. Clean mounting surfaces. 3. Reassemble with ring split opposite (180 degrees) the valve opening to improve balance. 1. Have vehicle aligned. 2. Repair or replace.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Cracked or Broken Wheel Discs (Cracks Develop in the Wheel Disc from Handhole to Rim, or from Handhole to Stud)	Metal fatigue resulting from overloading.	Replace wheel. Check position of wheel on vehicle for working load specifications.
Damaged Stud Holes (Stud Holes Become Worn, Elongated or Deformed, Metal Builds up Around Stud Hole Edges, Cracks Develop from Stud Hole to Stud Hole)	Loose wheel mounting.	Replace wheel and check for: • Installation of correct studs and nuts. • Cracked or broken studs — replace. • Worn hub face — replace. • Broken or cracked hub barrel — replace. • Clean mounting surfaces and retorque cap nuts periodically. • Rust streaks fanning out from stud holes indicate that the cap nuts are or have been loose.
Damaged Stud Threads	Sliding wheel across studs during assembly	Replace stud following proper wheel installation.
Loose Drum	Improper drum bolt.	Replace with proper length bolt.
Loose Inner Wheel	1. Excessive stud standout from mounting face of hub allowing wheel nut to bottom out. 2. Improper torque.	1. Replace with proper length bolt. 2. Use recommended torque procedure.
Broken Wheel Studs	1. Loose cap nuts. 2. Overloading.	1. Replace stud and follow proper torque procedure. 2. Replace stud.
Tire Slippage on Rim	1. Improper storage or operating conditions. 2. Poor maintenance. 3. Rust, corrosion on bead seating. 4. Loss of pressure.	1. Correct as required. 2. Follow proper maintenance procedures. 3. Correct as required. 4. Follow proper maintenance procedures.
Tire Mounting Difficulties	1. Mismatch tire and rim sizes. 2. Defective or mismatched rings for rim use. 3. Overinflation of tires. 4. Corrosion and dirt.	1. Correct as required. 2. Correct as required. 3. Follow recommended tire pressure. 4. Correct as required.
Tires Show Excessive Wear on Edges of Tread	1. Underinflated tires. 2. Vehicle overloading. 3. High speed cornering. 4. Incorrect toe-in setting.	1. Properly inflate to recommended pressure. 2. Correct as required. 3. Correct as required. 4. Set to correct specifications.
Tires Show Excessive Wear in Center of Tread	Tire overinflated.	Properly inflate to recommended pressure.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Excessive Tire Wear	1. Improper tire pressure. 2. Incorrect tire/wheel usage. 3. Defective shock absorbers. 4. Front end out of alignment. 5. Loose, worn or damaged steering linkage, joints, suspension components, bushing and ball joints.	1. Properly inflate to recommended pressure. 2. Install correct tire/wheel combination. 3. Repair or replace. 4. Align front end. 5. Inspect, repair or replace as required.
Dual Tires Rubbing	Insufficient wheel spacing.	Check tire and wheel sizes.

MAIN DATA AND SPECIFICATIONS

Front End Alignment

		Wishbone Suspension	NHR Rigid	NKR Rigid	NPR	NQR	NPS
Steering Angle							
Inner	(deg.)	38.0°	37.5°	38.5° (7.00-15 Tire) 35.5° (7.00-16 Tire)	47.5° (7.00-16 Tire) 42.5° (7.50-16 Tire)	42.5° (7.50-16 Tire) 36.5° (8.25-16 Tire)	37.5°
Outer	(deg.)	35.0°	33.0°	29.5° (7.00-15 Tire) 27.9° (7.00-16 Tire)	35.0° (7.00-16 Tire) 32.7° (7.50-16 Tire)	32.7° (7.50-16 Tire) 30.0° (8.25-16 Tire)	29.8°
Wheel Alignment							
Toe-in	mm (in.)	−2−2 (−0.08−0.08)					
Camber	(deg.)	0°15′±45′	1°15′±45′	0°15′±45′	0°15′±45′	0°15′±45′	0°15′±45′
Caster	(deg.)	1°00′±1°	1°30′±1°	3°00′±1°	2°45′±1°	2°45′±1°	2°00′±1°
King Pin Inclination	(deg.)	9°45′±30′	7°15′	12°00′	12°00′	12°00′	7°15′

Power Steering Unit

		Right Hand Drive	Left Hand Drive
Type		Integral rotary valve type	
Number of Ball		28	
Gear Ratio		22.6 NKR (Indep) 22.6 NKR (Rigid) 18.8 — 20.9 NPR, NQR, NPS (Rigid)	
Ball Screw Lead	mm (in.)	9.172 (0.361) NHR, NKR (Rigid) 9.922 (0.391) NPR, NQR, NPS 9.922 (0.391) NKR (Indep)	
Torsion Bar Spring Constant	N·cm/deg (kg·cm/deg.)	15.7 (16.0)	
Valve Operating Angle	(deg.)	±7°	
Regulated Oil Pressure	kPa (kg/cm^2/psi)		
	NHR, NKR	10,297 (105/1,439)	
	NPR, NQR, NPS	11,287 (115/1,635)	
Regulated Oil Flow Volume (minimum)	liter/min (US gal/min / UK gal/min)	8 (2.11/1.76)	

Power Steering Oil Pump Unit

		4J Series Engine	4H Series Engine
Type		Vane type	
Theoretical Delivery	(cm^3/rev)	7.2	8.1
Regulated Oil Flow volume	(liter/min)	8.5 — 6.5	8.0 — 6.5
Regulated Oil Pressure	kPa (kg/cm^2/psi)		
	NHR, NKR	10,297 (105/1,493)	10,297 (105/1,493)
	NPR, NPS		10,787 (110/1,564)
	NQR		11,278 (115/1,635)
Maximum Allowable Speed	(r.p.m)	6,500	6,500

Tandem Hydraulic Pump

		Hydraulic Booster Pump	Power Steering Pump
Type		Vane type	
Theoretical Delivery	(cm^3/rev)	13	8.4
Regulated Oil Flow volume	(liter/min)	8.0	8.0 — 6.5
Regulated Oil Pressure	kPa (kg/cm^2/psi)	11,770 (120/1,706)	10,790 (110/1,564)
Maximum Allowable Speed	(r.p.m)	6,500	

Manual Steering Unit

		NHR, NKR	NPR, NQR
Type		Recirculating ball type	
Sector Shaft Outside Diameter	mm (in.)	34.295	38.1
Number of Ball		28 × 2	50 × 2
Gear Ratio		24.5 — 28.5	27.7 — 31.7

SERVICE STANDARD

ITEMS		SERVICE STANDARD	SERVICE LIMIT
Power Steering			
Sector Shaft Outside Diameter	mm (in)		
RHD&LHD		39,975 (1.574)	
Play between Sector Shaft and Bearing	mm (in)		
RHD		—	0.12 (0.0047)
LHD		—	0.20 (0.0080)
Backlash between Sector Shaft and Ball Nut	mm (in)		
RHD&LHD		0.12 (0.0047)	
Steering Wheel Free Play	mm (in)	10 — 50 (0.4 — 2.0)	
Power Steering Fluid Pressure (at idling engine speed)	kPa (kg/cm^2/psi)		
NQR without HBB		11,278 (115/1,635)	
NPR/NPS/NQR with HBB		10,787 (110/1,564)	
except Above Models		10,297 (105/1,493)	
Manual Steering			
Sector Shaft Outside Diameter	mm (in)		
NHR, NKR		34.925 (1.375)	34.825 (1.371)
NPR, NQR		38.100 (1.500)	38.000 (1.496)
Play between Sector Shaft and Needle Bearing	mm (in)	—	0.2 (0.008)
Ball Nut Axial Play	mm (in)	—	0.1 (0.004)
Worm Shaft Starting			
Torque	N·m (kg·m/lb·ft)		
(Without Sector Shaft)			
NHR, NKR		0.34 — 0.64 (0.035 — 0.065/ 0.25 — 0.47)	
NPR, NQR		0.29 — 0.69 (0.030 — 0.070/ 0.22 — 0.51)	
(With Sector Shaft)			
NHR, NKR		0.54 — 1.03 (0.055 — 0.105/ 0.40 — 0.76)	
NPR, NQR		0.98 (0.1/0.72) or less	
Backlash between Sector Shaft and Ball Nut	mm (in)		
NHR, NKR		0.2 (0.0079) or less	
NPR, NQR		0.5 (0.0197) or less	
Steering Wheel Free Play	mm (in)	10 — 30 (0.4 — 1.2)	
Suspension			
Spring Pin Outside Diameter	mm (in)	25 (0.98)	24.7 (0.019)

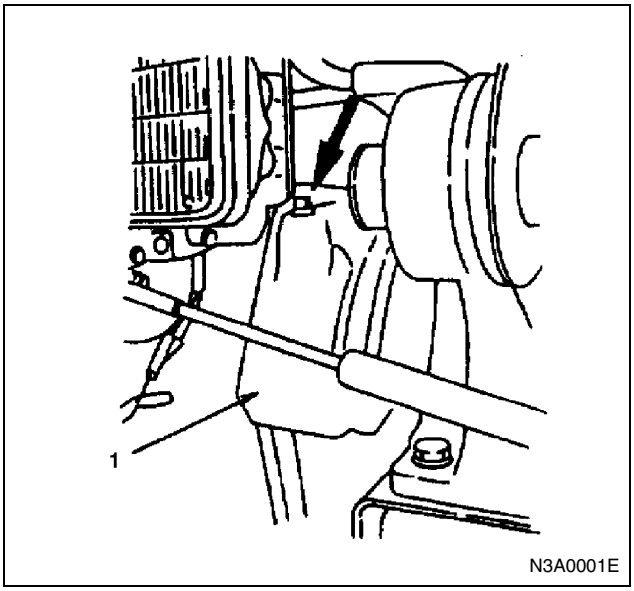
ITEMS	SERVICE STANDARD	SERVICE LIMIT
Clearance between Shackle Pin and Bushing mm (in)	0.1 (0.0039)	0.5 (0.019)

SERVICING

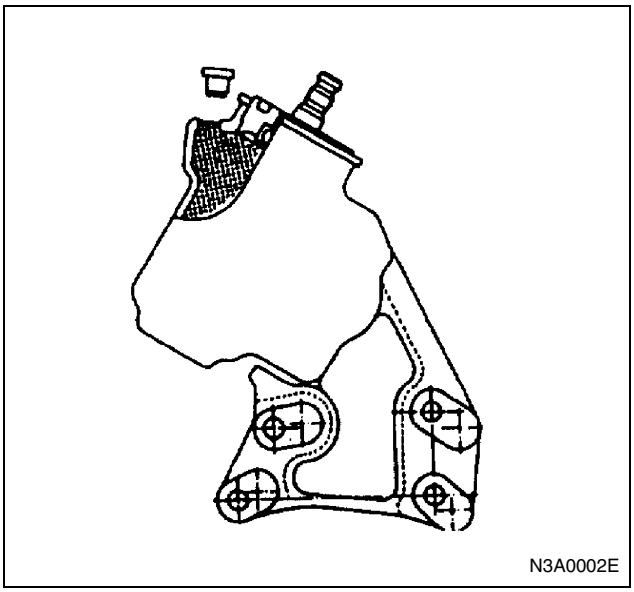
Steering System

Manual Steering Gear Oil

1. Remove the filler plug on the steering unit (1).



2. Fill the gear box to the level of filler plug with specified gear oil through the filler hole.
3. Install and tighten the filler plug.



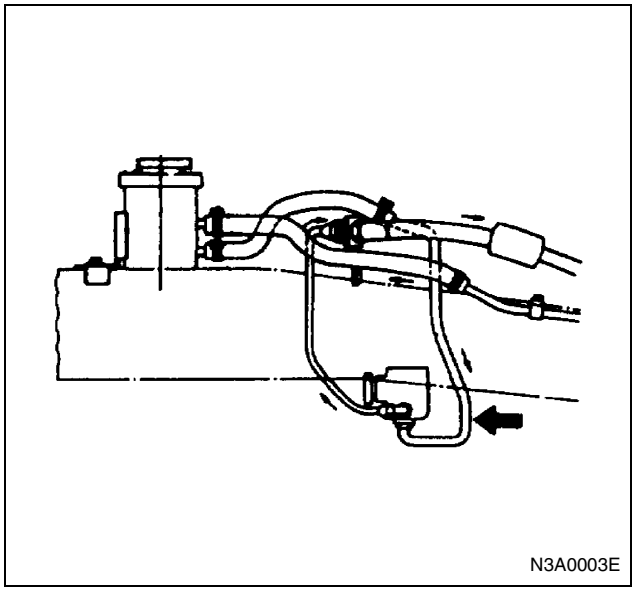
Power Steering Fluid

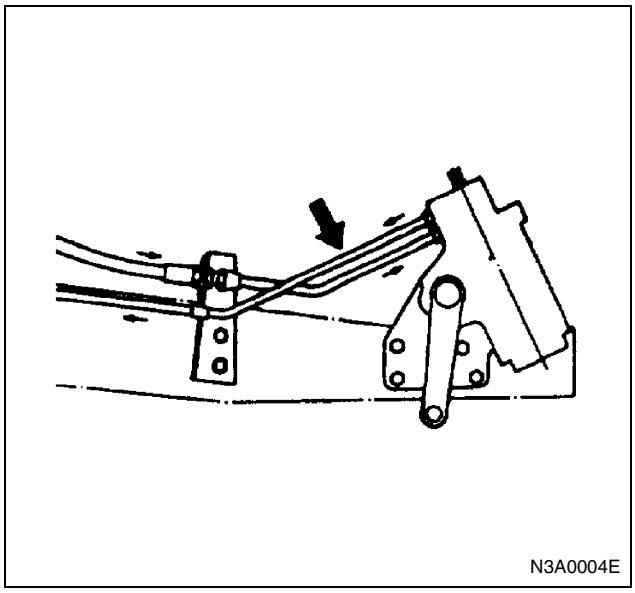
Draining

1. Jack up the front wheels until they are clear of the ground.
2. Disconnect the fluid pipes between the steering unit and fluid reservoir, and the fluid hose between the pump and the fluid reservoir.
3. When draining is completed, remove remaining fluid within hydraulic system by turning the steering wheel to stop in both directions several times.

Hose Replacement

Replace the power steering hoses at intervals of fluid change.





Refilling

1. Connect the fluid lines securely and fill the fluid reservoir with specified automatic transmission fluid.
2. When the fluid reservoir is filled to specified level, allow 2 or 3 minutes. While refilling, keep fluid reservoir replenished as necessary to prevent air from entering the hydraulic system.
3. Lower the front wheels to the ground. Start and let the engine idle for a few minutes.
   Recheck the fluid level and replenish if necessary.

Steering Wheel Free Play

Inspection

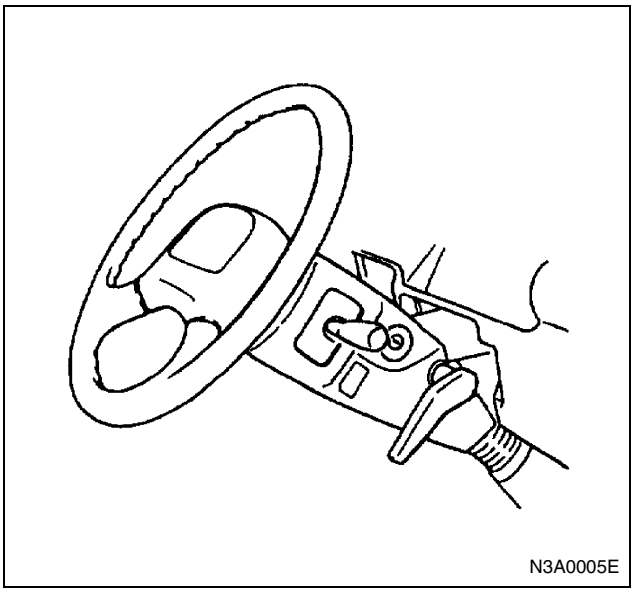
1. Check the amount of the steering wheel play by turning the wheel in both directions until the tires

begin to move with the front wheels properly in the straight ahead position.

Notice:
If the vehicle is equipped with a power steering unit, the wheel free play should be checked with the engine running.

Steering Wheel Free Play
Manual Steering: 10 — 30 mm (0.4 — 1.2 in)
Power Steering: 10 — 50 mm (0.4 — 2.0 in)

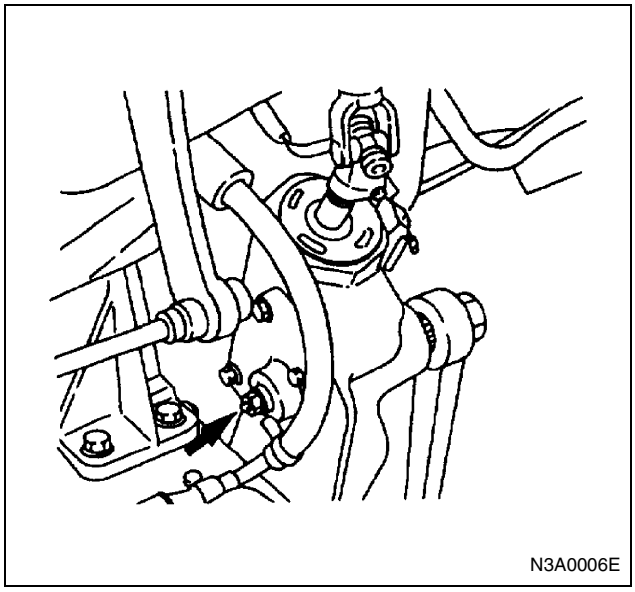
2. Also check the steering wheel for play and looseness in mount by moving it back and forth and sideways. While driving, check for hardsteering, shimmy and tendency of steering to pull to one side.


N3A0005E

Adjustment

1. Align the front wheels properly in the straight ahead position.
2. Loosen the lock nut on the adjusting screw of the steering unit.
3. Turn the adjust screw clockwise to decrease free play or counter-clockwise to increase.
4. After check of specified free play, tighten the lock nut to specified torque.

Tighten:
- Lock nut to
  Manual Steering: 25 N·m (2.5 kg·m / 18 lb·ft)
  Power Steering: 69 N·m (7.0 kg·m / 51 lb·ft)


N3A0006E

Power Steering Fluid Pressure

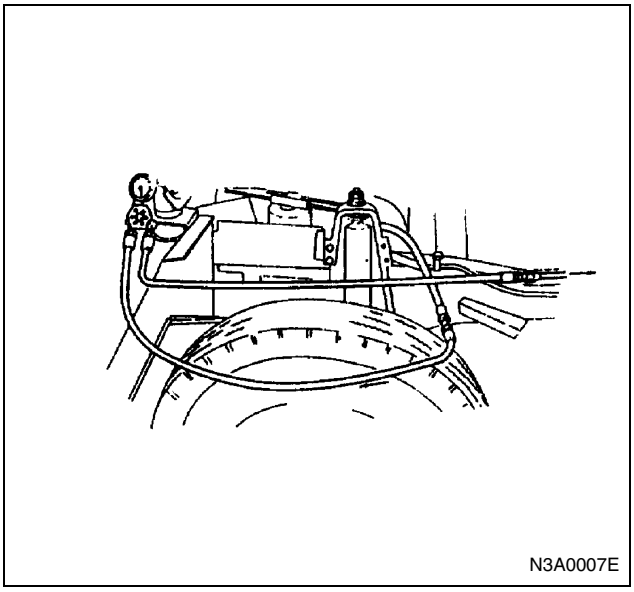
Preparation

1. Install the power steering fluid pressure gauge between the pump and steering unit as figure.
   Gauge: 5-8840-0162-0
2. Start and let the engine idle until oil temperature reaches 50 — 60°C (122 — 140°F).
3. Take measurement of the pressure gauge when the steering wheel is turned clockwise or counterclockwise to lock.

Standard Pressure (at idle speed)
- NQR without HBB: 11,275 kPa (115 kg/cm^2/1,635 psi)
- NPR/NPS/NQR with HBB: 10,787 kPa (110 kg/cm^2/1,563 psi)
- except Above Models: 10,297 kPa (105 kg/cm^2/1,439 psi)

Excess pressure means pump trouble.
Less pressure means steering unit trouble.

Notice:
This test should be done within ten seconds.


N3A0007E

Steering Function

Check the following items.

- Steering wheel shake
- Steering shimmy
- Hard steering
- Turning radius
- Steering wheel return
- Steering pull to one side

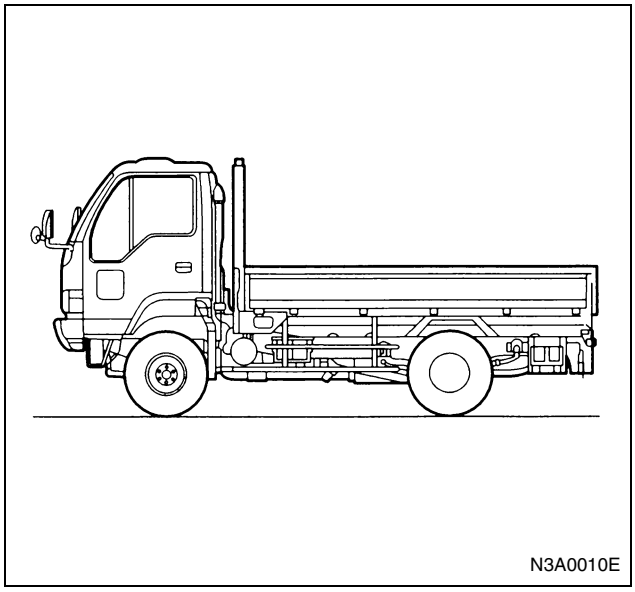
Inspection of Wheel Alignment

The points listed below must be checked prior to inspection front wheel alignment.

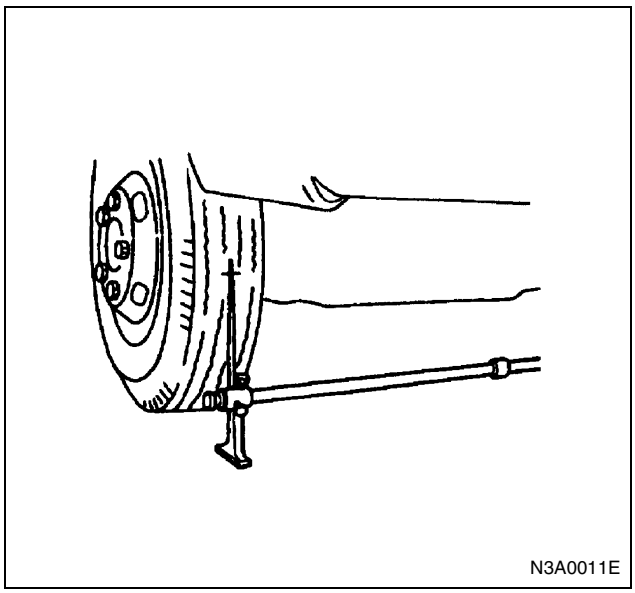
- Tire pressure and abnormal wear
- Front hub bearing for axial play
- Ball joint on steering linkage for play
- Operation of shock absorbers
- Tightness of suspension parts
- King pin bearings for play

Toe-In

Measurement should be taken with the vehicle on a surface plate.
If a surface plate is not available, toe-in should be checked with the vehicle parked on a level floor.

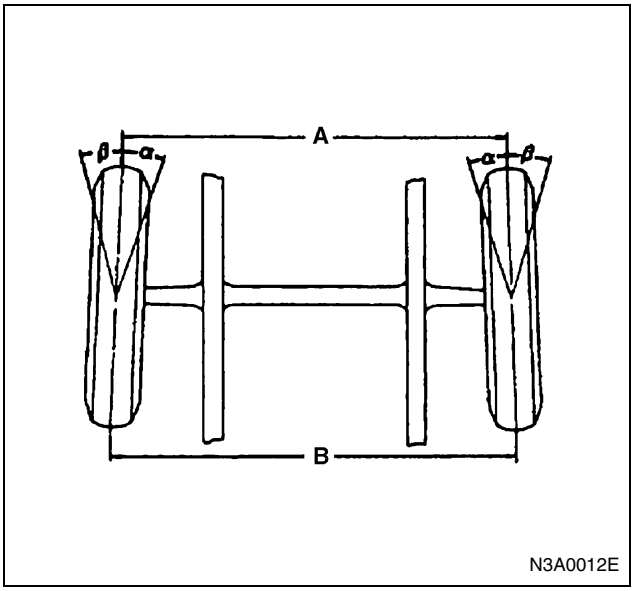

N3A0010E

1. Set front wheels to its straight ahead position.
2. Align the toe-in gauge with center height of each wheels at front end.
3. Apply center marks to each wheel, then take measurement of distance A between the center marks on each wheel.
4. Move slowly the vehicle rearward until center marks get its rear end position.
5. Take measurement of distance B between the center marks at rear end.


N3A0011E

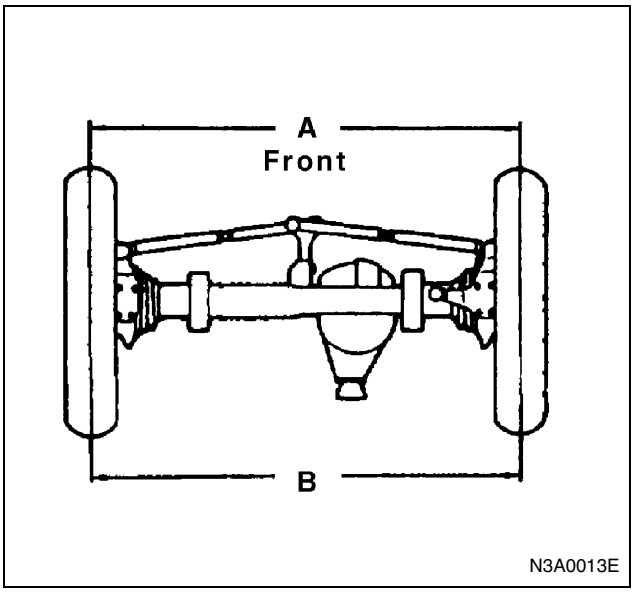
Toe-in can be calculated with next formula.
Toe-in = B − A
Toe-in
−2 — 2 mm (−0.08 — 0.08 in)

• Rigid Suspension



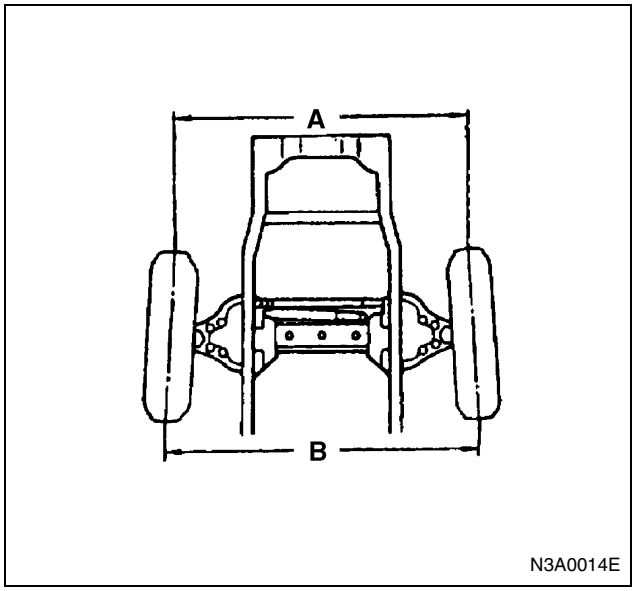
N3A0012E

• NPS



N3A0013E

• Wishbone Suspension



N3A0014E

Adjustment

1. Loosen the lock nuts on the tie rod or outer truck rod ends.
2. Adjust length of the tie rod by turning the connecting rod on outer truck rod.
3. Tighten the lock nuts to specified torque.

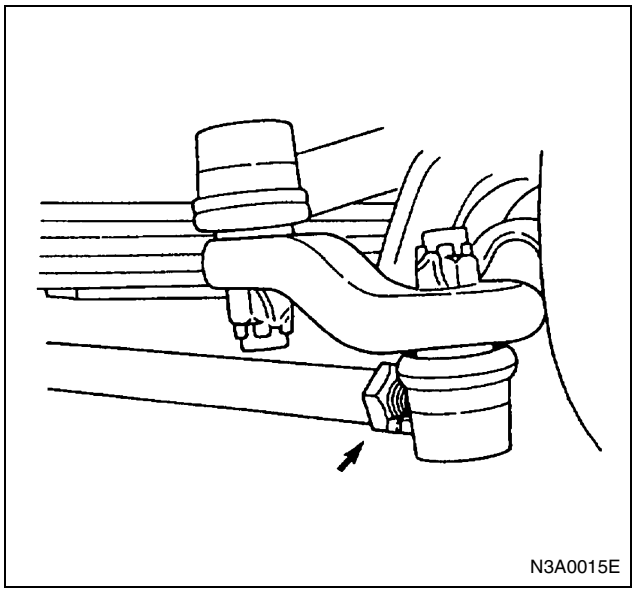
Tighten:

• Lock nut to

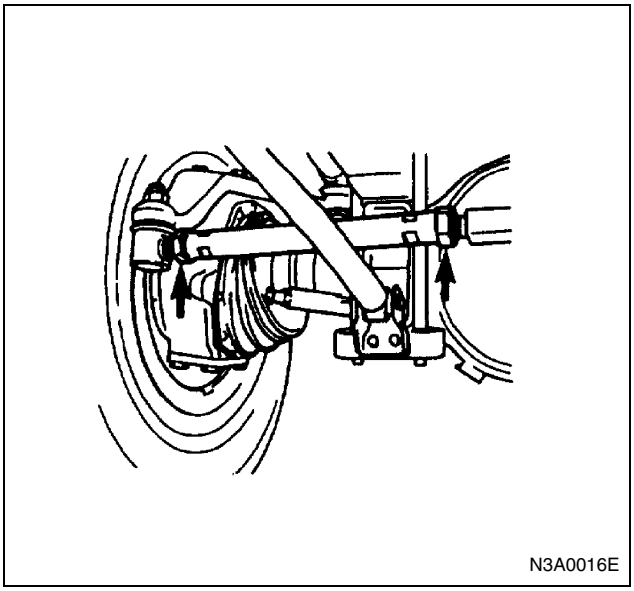
Rigid Suspension, NPS: 113 N·m (11.5 kg·m / 183 lb·ft)

Wishbone Suspension: 167 N·m (17.0 kg·m / 123 lb·ft)

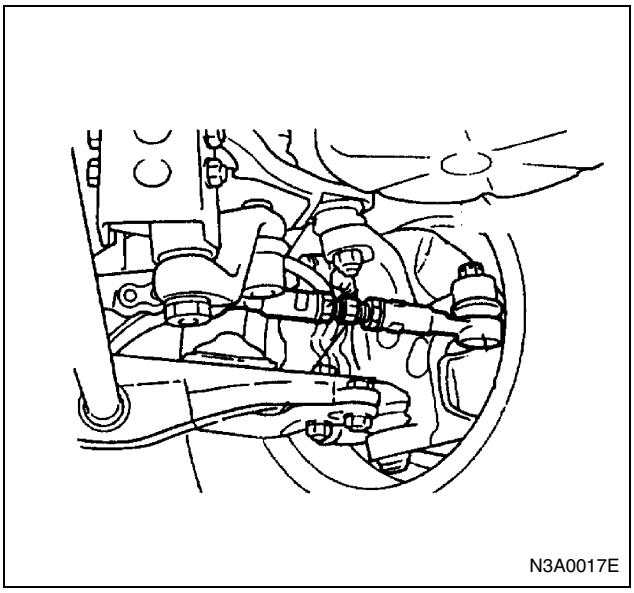
• Rigid Suspension


N3A0015E

- NPS



- Wishbone Suspension

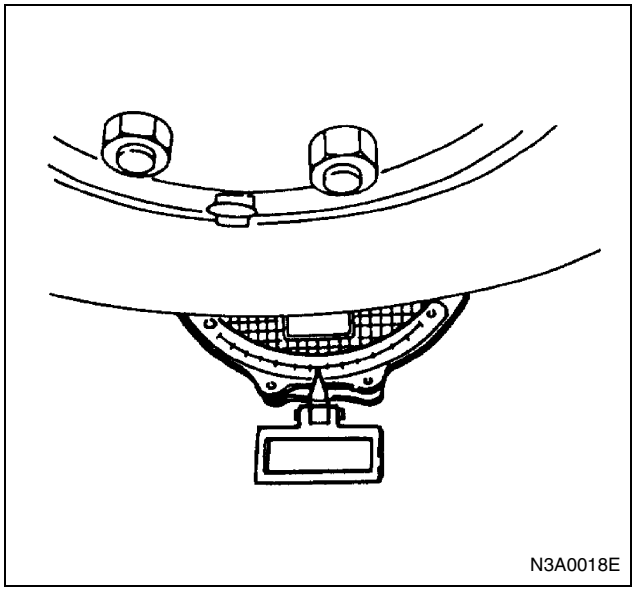


Turning Radius

1. Position a suitable piece of wood equivalent in thickness to the turning radius gauge under each rear wheel.
2. Position each front wheel on a turning radius gauge by aligning the tire center line with the center of the turning radius gauge.
3. Turn the steering wheel clockwise or counterclockwise until the front wheels are locked.

Notice:
Turn the steering wheel with the brake pedal depressed using brake pedal pusher.

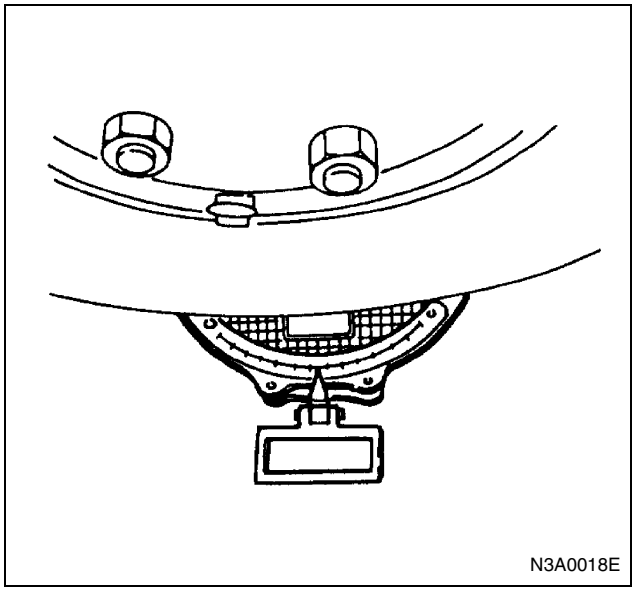
Reading of the turning radius gauge directly indicates the steering angle.



Steering Angle

Wishbone Suspension Model		(deg.)
Vehicle Model	Outer	Inner
NKR (7.00-15 Tire)	35.0	38.0

Rigid Suspension Model		(deg.)
Vehicle Model	Outer	Inner
NHR	33.0	37.5
NKR (7.00-15 Tire)	29.5	38.5
NKR (7.00-16 Tire)	27.9	35.5
NPR (7.00-16 Tire)	35.0	47.5
NPR, NQR (7.50-16 Tire)	32.7	42.5
NQR (8.25-16 Tire)	30.0	36.5
NPS	29.8	37.5

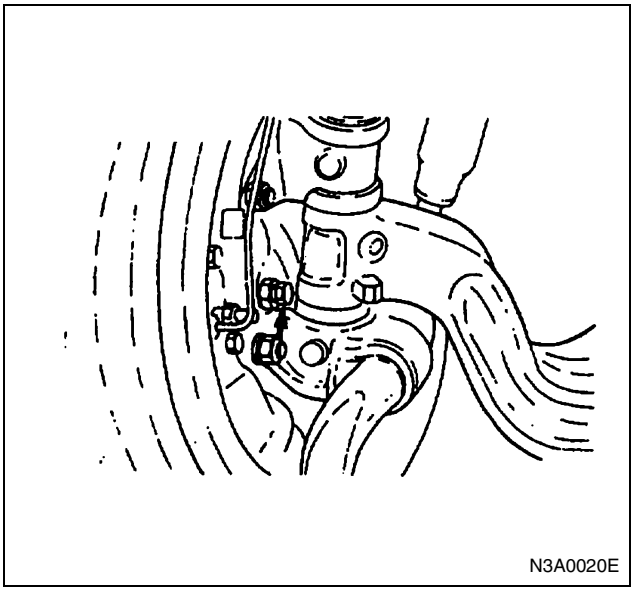


Adjustment

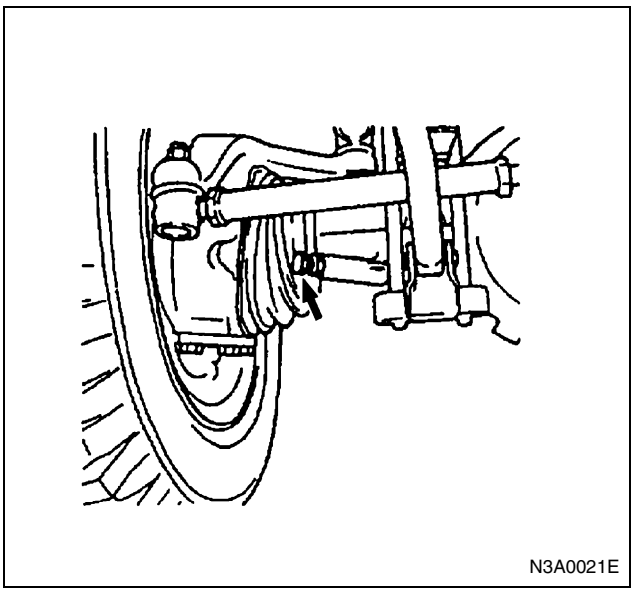
1. Loosen the lock nuts on the steering knuckle or the axle case.
2. Adjust projecting height of the stopper bolts.
3. Tighten the lock nuts to specified torque.

Tighten:

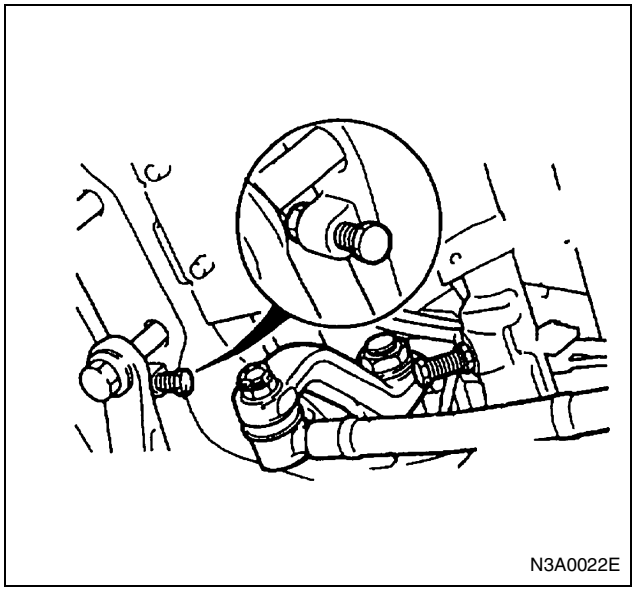
- Stopper bolt to
  Rigid suspension: 186 N·m (19.0 kg·m / 137 lb·ft)
  NPS: 49 N·m (5.1 kg·m / 36 lb·ft)
  Wishbone suspension: 82 N·m (8.4 kg·m / 61 lb·ft)
  - Rigid Suspension


N3A0020E

- NPS


N3A0021E

- Wishbone Suspension


N3A0022E

Camber Angle

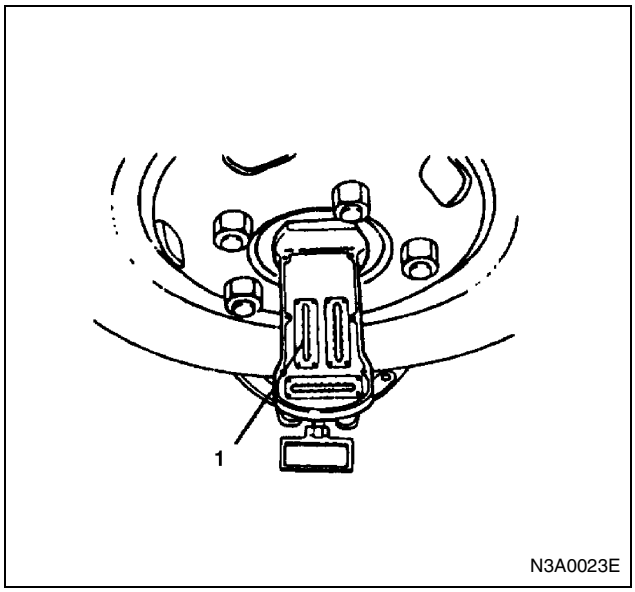
All Model except NPS

Toe-in can be checked on the gauge simultaneously.

1. When inspection of turning radius is completed, calibrate the scale of the turning radius gauge to zero.
2. Remove the front hub cap.
   Install camber, caster and king pin inclination gauge on end of the knuckle spindle horizontally.

Notice:

When removing hub cap, take care so as not to cause damage to gauge fitting face at end of the spindle. If end of the spindle has been scratched or damaged, correct before setting the gauge.



N3A0023E

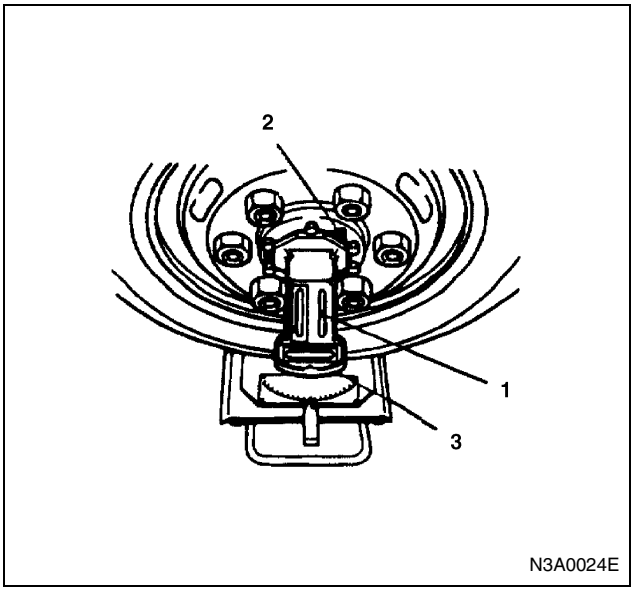
Legend

1. Camber angle

NPS

Remove the free wheel hub lock cover assembly, then install gauge adapter on end of the knuckle spindle. Install camber, caster and king pin inclination gauge on end of gauge adapter.

Gauge Adapter: 5-8840-2188-0



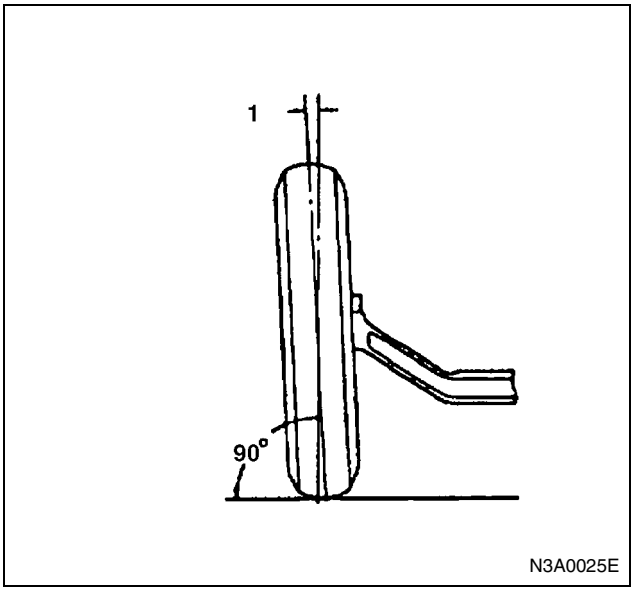
Legend

1. Camber angle
2. Gauge adapter
3. Wheel alignment tester

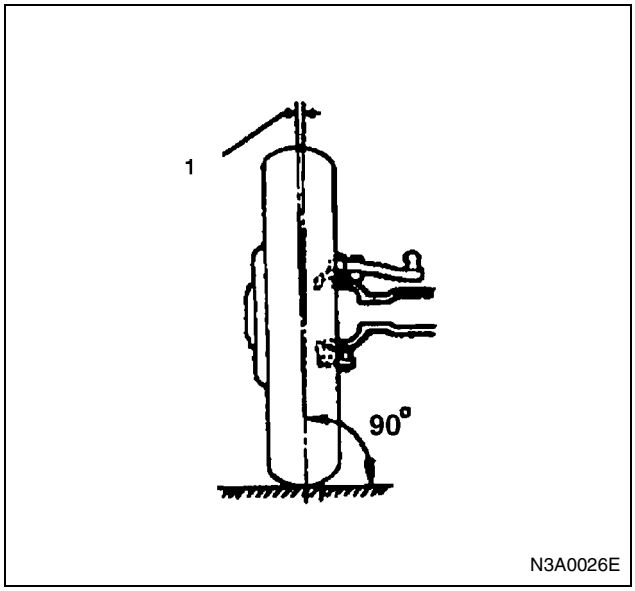
3. Reading of the camber scale directly indicates the camber angle (1).

Camber Angle	(deg.)
NHR Rigid Suspension	1°15′±45′
Rigid Suspension (except NHR)	0°15′±45′
Wishbone Suspension, NPS	0°15′±45′

- NHR, NKR, NPR and NQR



- NPS

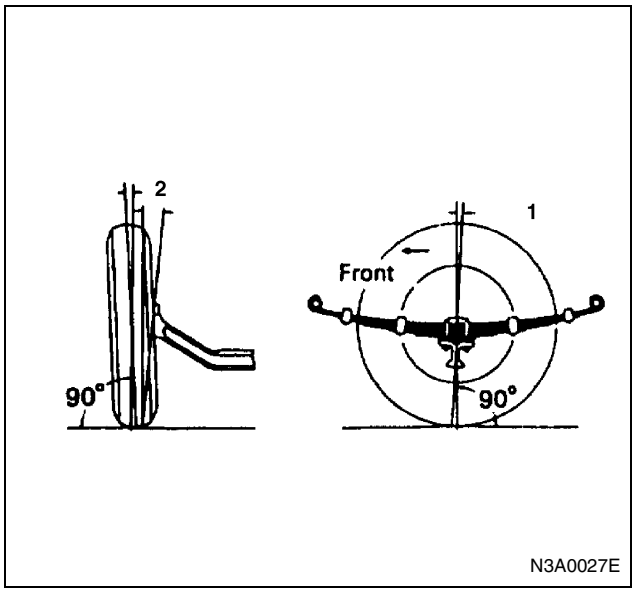


Caster Angle and King Pin Inclination

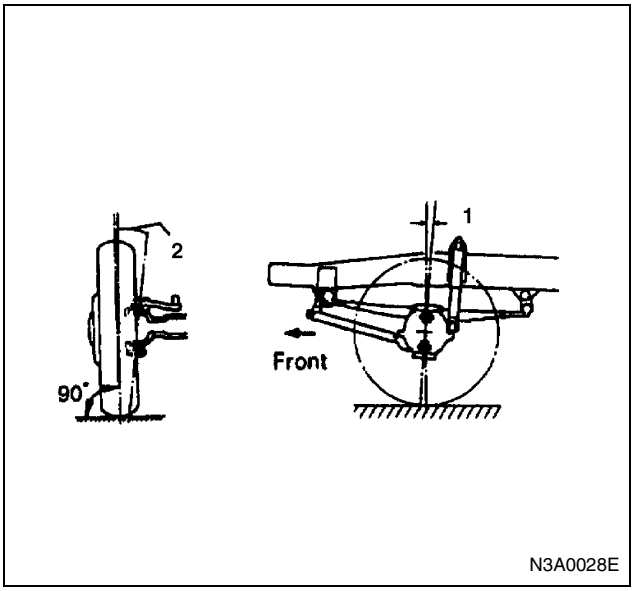
The caster angle and king pin inclination can be checked on the gauge simultaneously.

1. When inspection of camber angle is completed, calibrate the scale of the turning radius gauge to zero and turn the steering wheel clockwise (counterclockwise for checking caster angle (1) and king pin inclination (2) on the left side front wheel) until the front wheels are steered 20 degrees from the straight-ahead position.

- Rigid Suspension

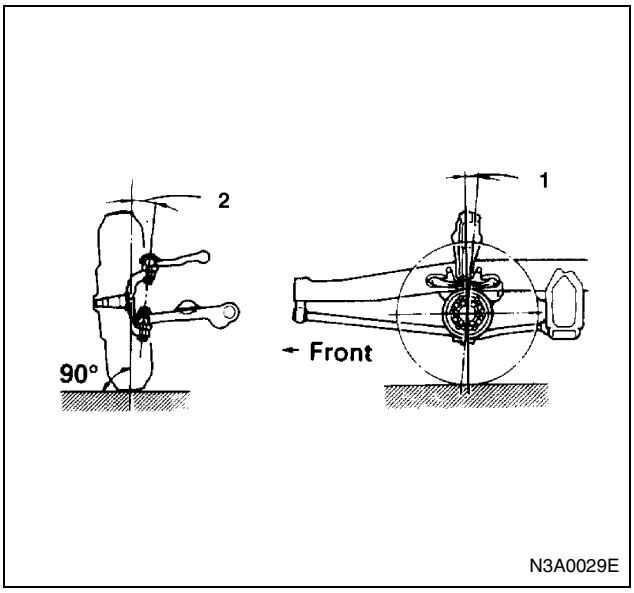


- NPS



N3A0028E

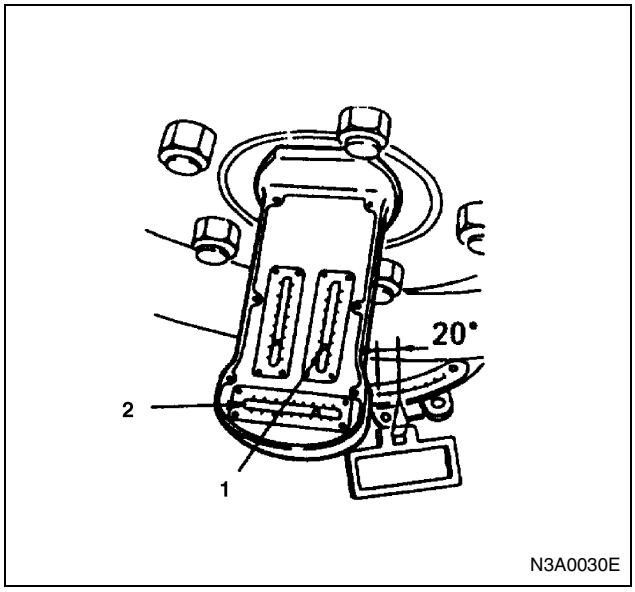
- Wishbone Suspension



N3A0029E

Notice:
Turn the steering wheel with the brake pedal depressed using brake pedal pusher.

2. When the front wheels are turned 20 degrees, calibrate the caster and king pin scales to zero turning the camber, caster and king pin gauge adjuster.

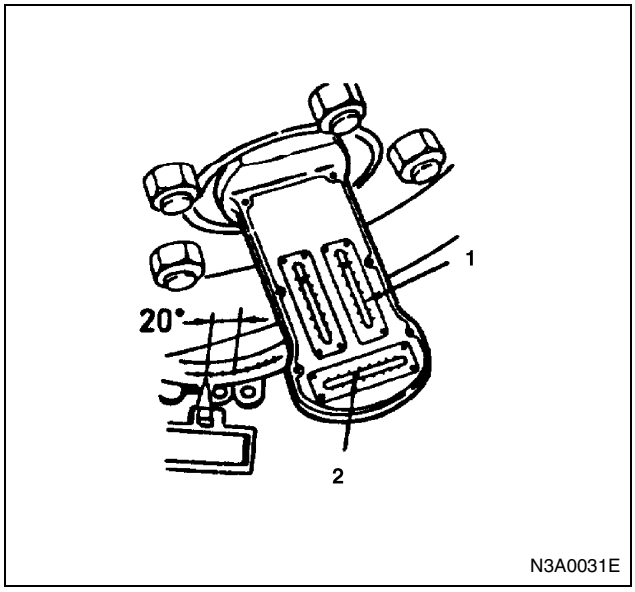


N3A0030E

Legend
1. Caster angle
2. King pin inclination

3. Turn the steering wheel in the opposite direction until the front wheels are steered 20 degrees in the opposite direction. Reading of the caster and king pin scales directly indicates the caster and king pin inclination angles being checked.

Caster Angle and King Pin Inclination (deg.)		
	Caster Angle	King Pin Inclination
NHR	1°30′±1°	7°15′
NKR Rigid Suspension	3°00′±1°	12°00′
NPR, NQR	2°45′±1°	12°00′
Wishbone Suspension	1°00′±1°	9°45′±30′
NPS	2°00′±1°	7°15′



N3A0031E

Legend

1. Caster angle
2. King pin inclination

Adjustment

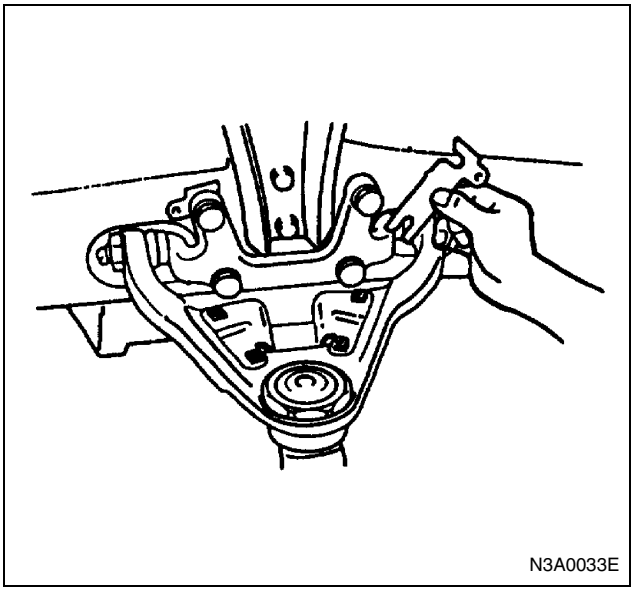
Rigid Suspension

The camber, caster and king pin inclination are built into front end and are not adjustable. If the camber, caster or king pin inclination is found to be out of alignment, check to locate the cause of trouble against the listing below and replace the parts necessary.

- Front springs for weakening
- Front I-beam (axle case) for distortion
- Bushing in king pin, King pin bearings for wear or determination

Wishbone Suspension

1. Set the jack under the cross member of the suspension and then raise the lower link with the jack and retain the jack with applied in the place.
2. Remove the shock absorber.
3. Attach the fulcrum pin and loosen the bolts to the degree that it will not fall a part to adjust the camber angle using the shims.



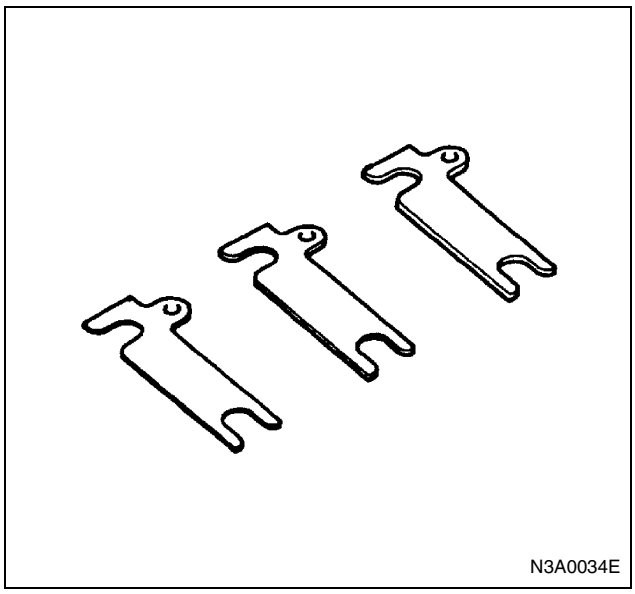
N3A0033E

Camber Angle

If the number of shims are evenly increased both at fore and aft, the camber angle becomes acute, while if decreased, the angle becomes obtuse.

Caster Angle

When the caster angle is obtuse, increase the number of shims at the fore side, while the angle is acute, increase the number of shims at the aft side.



N3A0034E

Thickness of Shims Available

0.8 mm (0.031 in), 1.6 mm (0.063 in), 3.2 mm (0.126 in)

Conditions Where The Shims are Used

Numbers of Shims: 4 or less

Thickness: 9.6 mm (0.378 in) or less

Difference of Thickness (between Front and Rear): 4.8 mm (0.189 in) or less

In case the shim has already reached at the limitation in its number or its thickness, decrease the number of shims at the aft side to adjust the obtuse caster angle, while decrease the number at the fore side to adjust the acute caster angle.

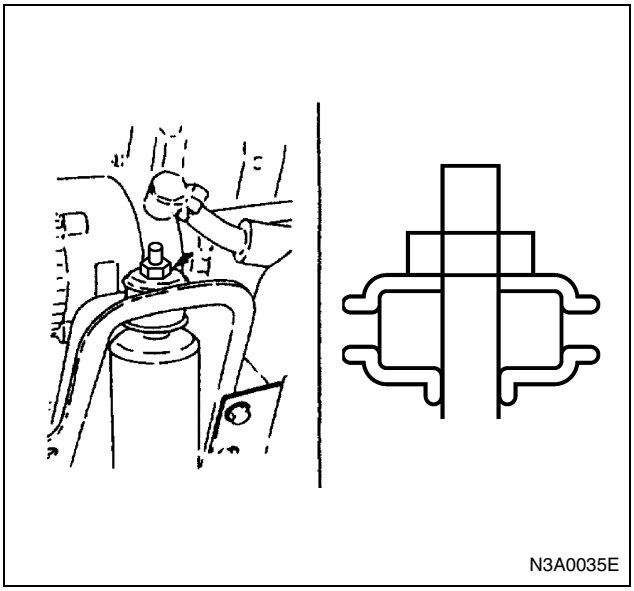
Notice:

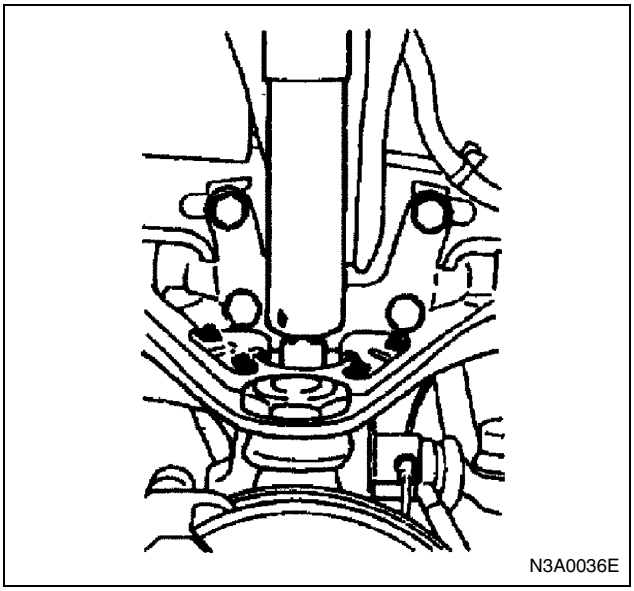
Since the number of shims needed for caster angle adjustment varies depending on the conditions of the car, perform the adjustment procedures which are the most suitable for the car conditions.

4. Tighten the mounting bolts of the front shock absorber.

Tighten:

- Shock absorber bolt and nut to
  Upper: 21 N·m (2.1 kg·m / 16 lb·ft)
  Lower: 103 N·m (10.5 kg·m / 76 lb·ft)


N3A0035E


N3A0036E

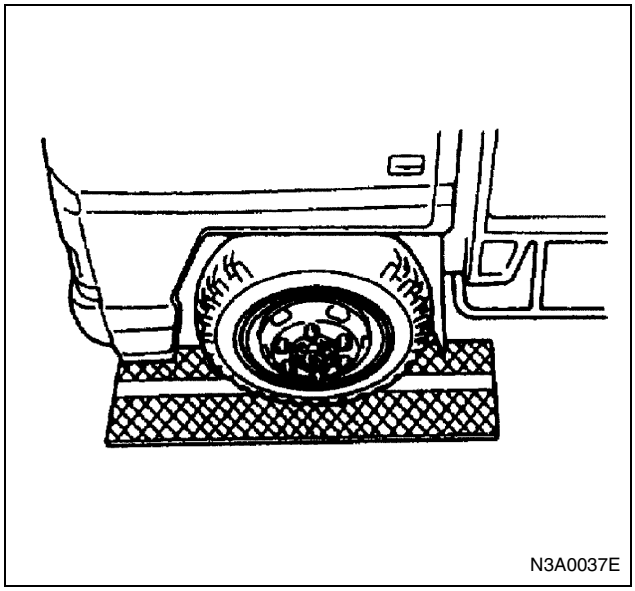
Measurement of Side Slippage

When inspection and adjustments of toe-in, camber, caster and king pin inclination are completed, check for side slippage using a side slip tester.

Roll the wheels over the side slip tester as slowly as possible and take reading on the tester, If the amount of side slippage is in excess of 5 mm per 1 m, recheck the wheel alignment.

Side Slippage

Limit: 5.0 (0.197) Per 1m


N3A0037E

Front and Rear Suspension

Suspension Function

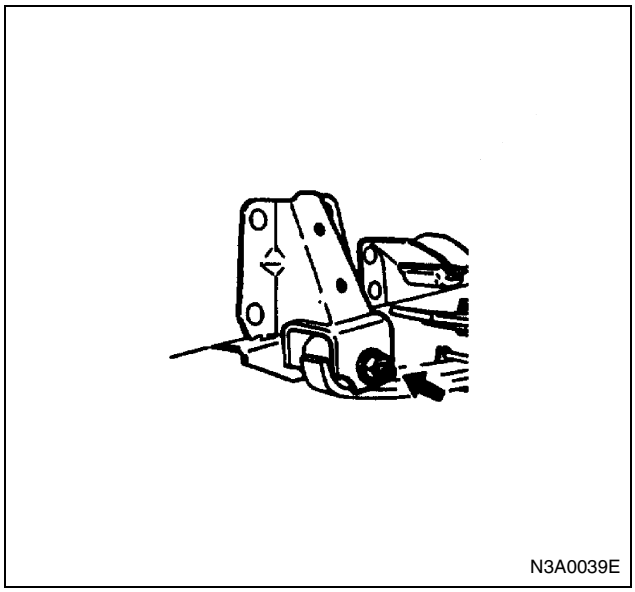
Check the following items.

- Leaf spring breakage
- Body inclination
- Reduction of ground clearance

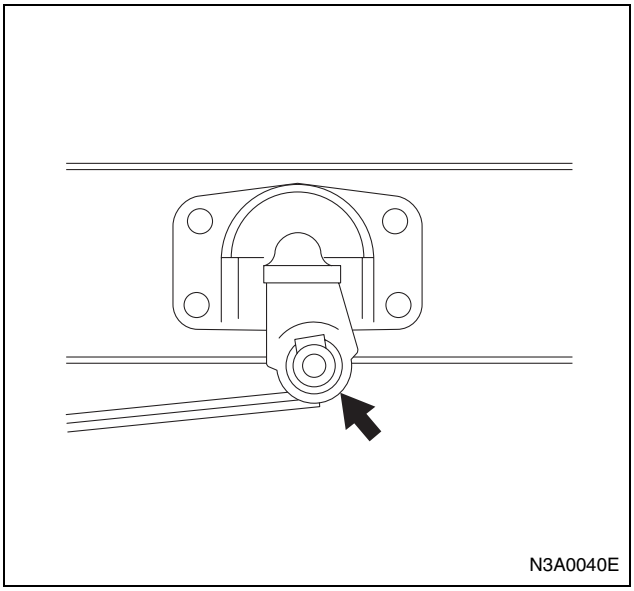
Lubrication

Lubricate the following points with multi- purpose type grease.

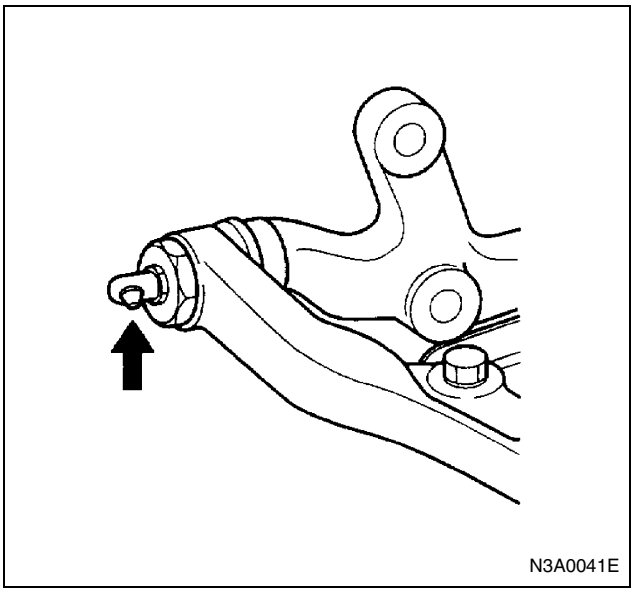
- Spring Pin (NPS only)

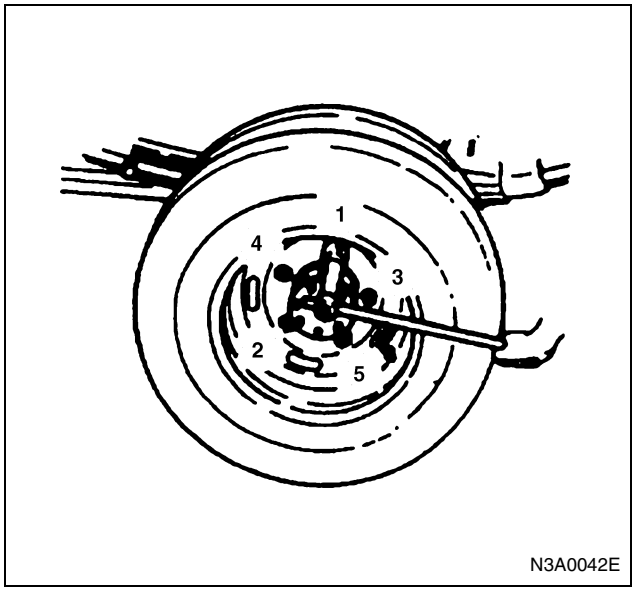

N3A0039E

- Shackle Pin (NPS only)

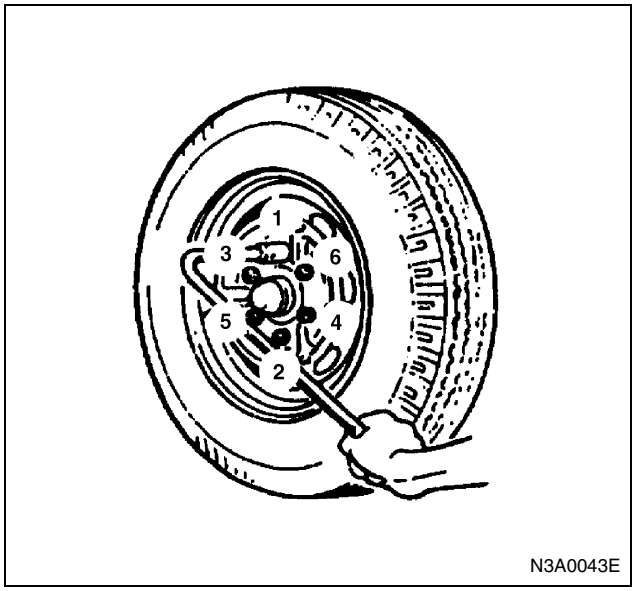

N3A0040E

- Upper Arm (for Wishbone Suspension)


N3A0041E



N3A0042E



N3A0043E

Wheel and Tires

Wheel Nut Retightening

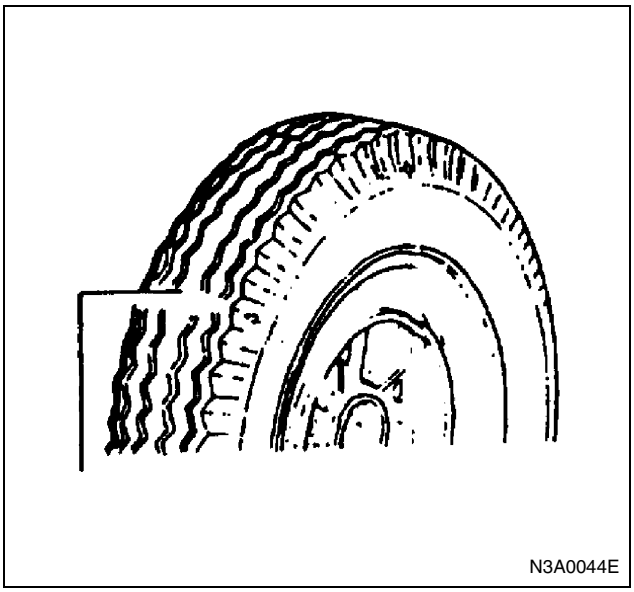
Retighten the wheel nuts to specified torque in sequence as shown in the figure.

Tighten:

- Front wheel nut to
  NHR / NKR single tire, NKR flat low: 167 N·m (17 kg·m / 123 lb·ft)
  Except above models: 441 N·m (45 kg·m / 325 lb·ft)
- Rear wheel nut to
  NHR / NKR single tire: 167 N·m (17 kg·m / 123 lb·ft)
  NHR dual tire, NKR flat low: 294 N·m (30 kg·m / 217 lb·ft)
  Except above models: 441 N·m (45 kg·m / 325 lb·ft)

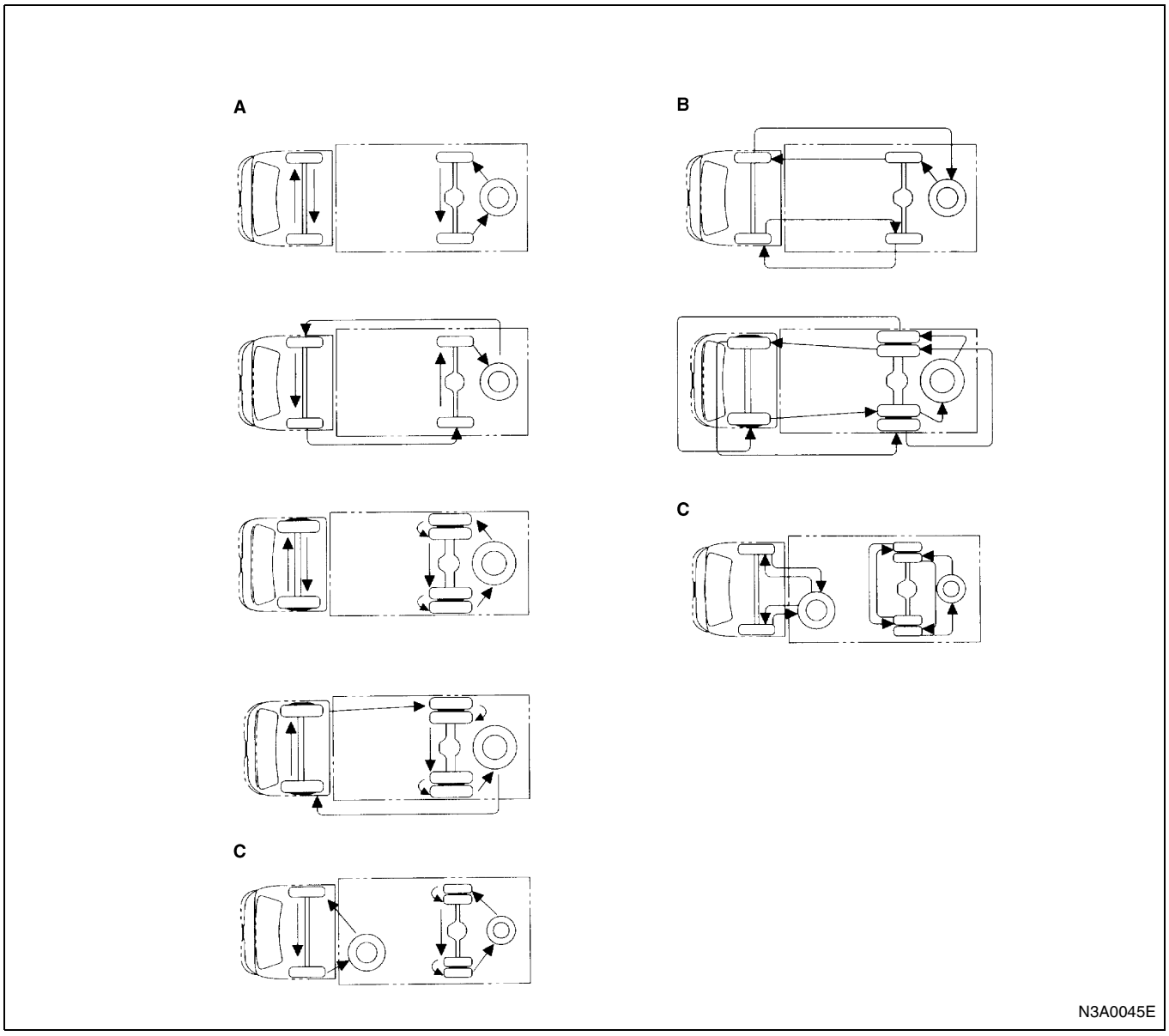
Tread Wear Indicators

The original equipment tires have built-in tread wear indicators to show when tires need replacement.
These indicators may appear as wide bands. When the indicators appear in two or more grooves at three locations, tire replacement is recommended.



Tire Rotation

To allow the tires to wear evenly and to prolong their life, exchange the front and rear tire locations as shown in the figure.

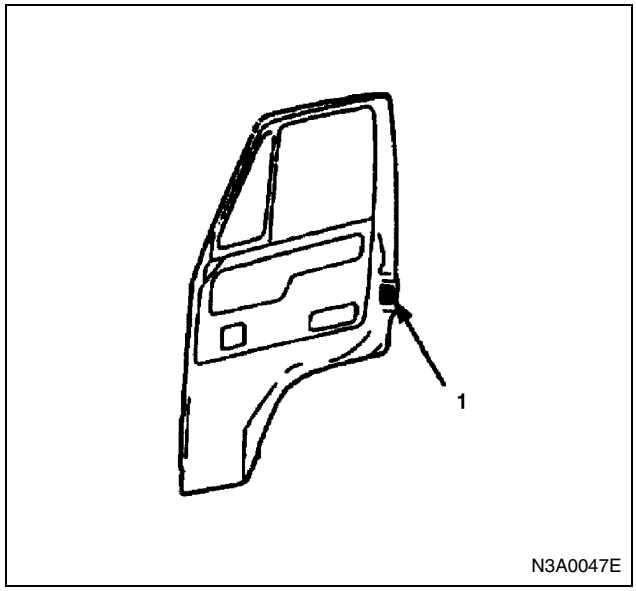


Legend

A. For bias tires
B. For radial tires
C. Flat low (Small dual tire)

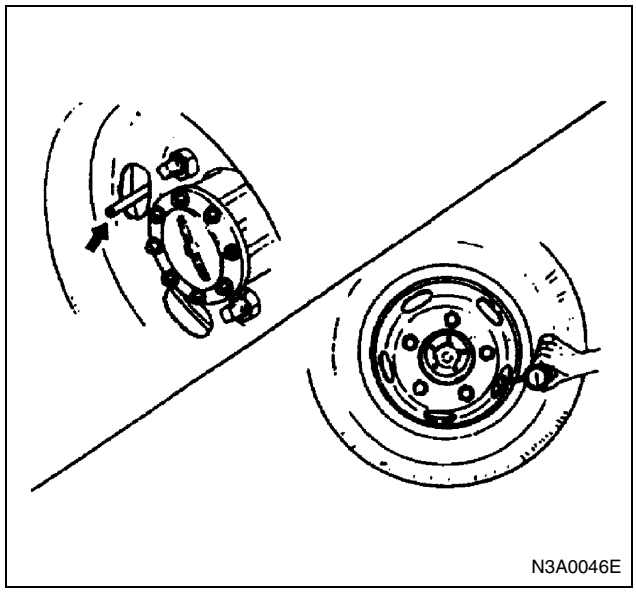
Tire Inflation Pressure

Tire pressure, in cold condition (after vehicle has set for three hours or more, or driven less than one mile), should be checked monthly or before any extended trip. Tire pressure increases approx. 15% when the tires become hot during driving. The pressure specification is shown on the label as figure.



Legend

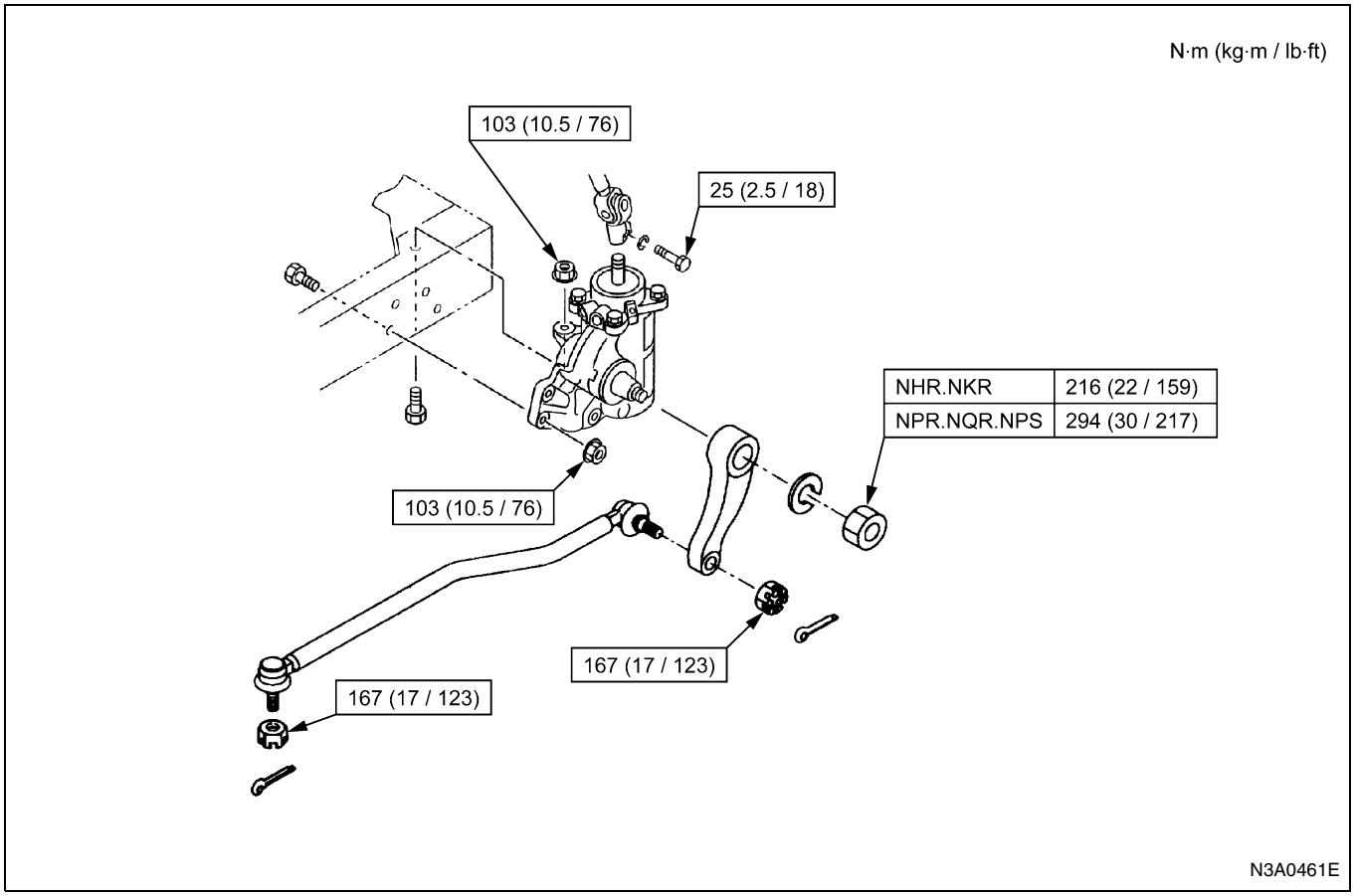
1. Tire air pressure plate (The position of LHD vehicle is opposite)



For tire size and tire inflation pressure, refer to “Tires”.

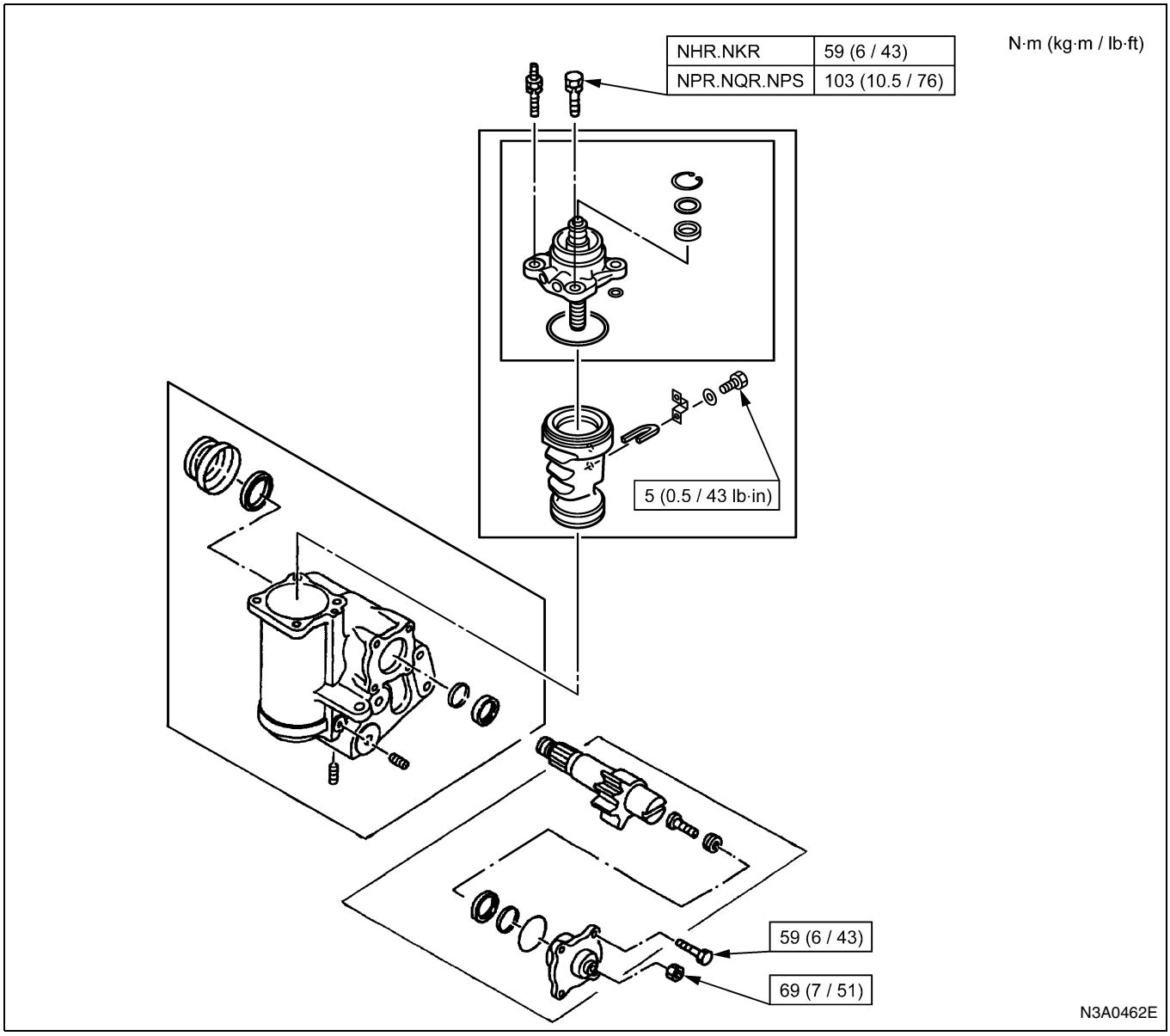
FIXING TORQUE

Steering Unit, Pitman Arm and Drag Link



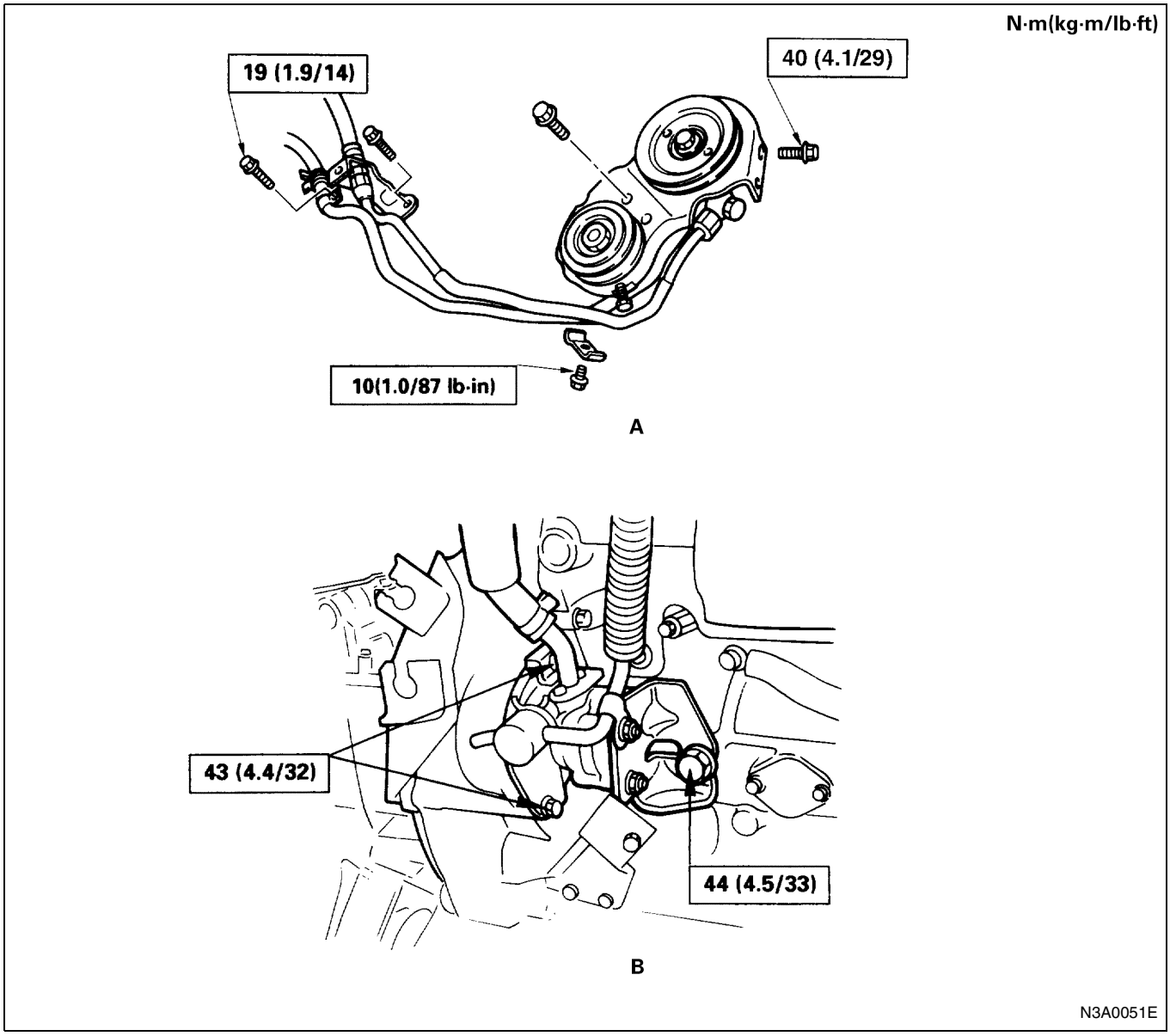
(This illustration is NHR and NKR model.)

Power Steering Unit



(This illustration is based on RHD model. Illustration for LHD model are symmetrically opposite.)

Power Steering Pump

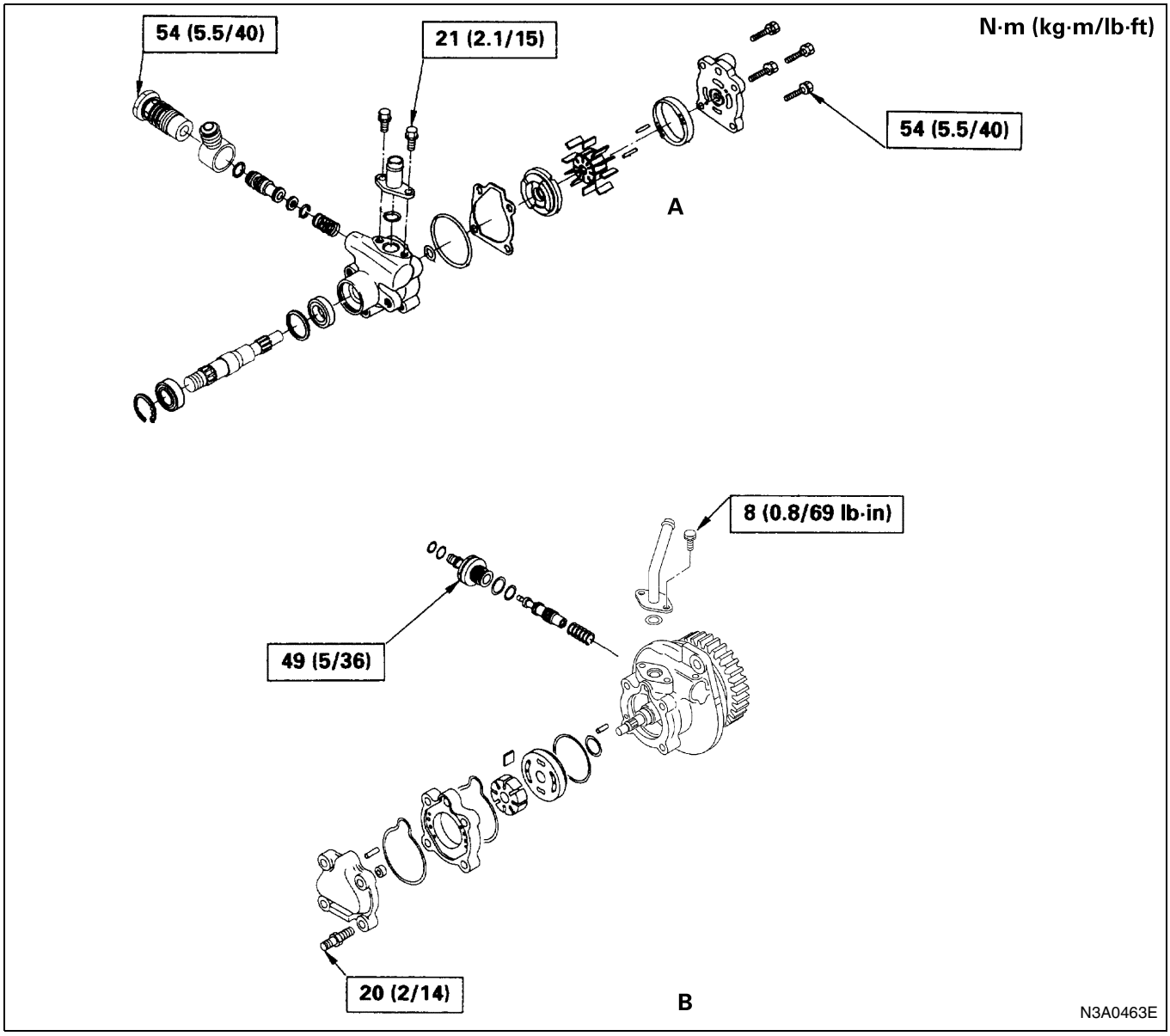


Legend

A. 4J series engine

B. 4H series engine

Power Steering Pump Assembly

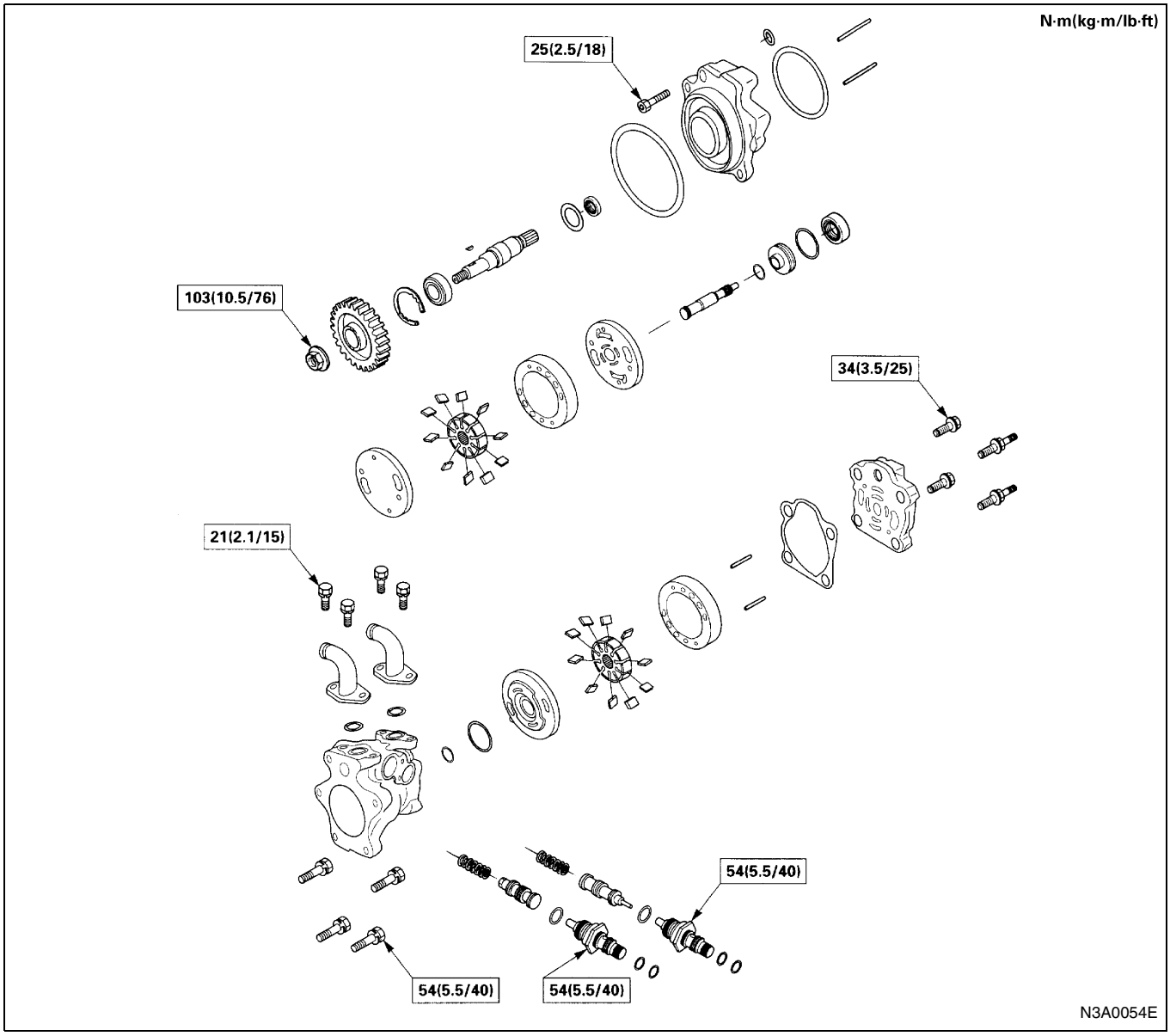


Legend

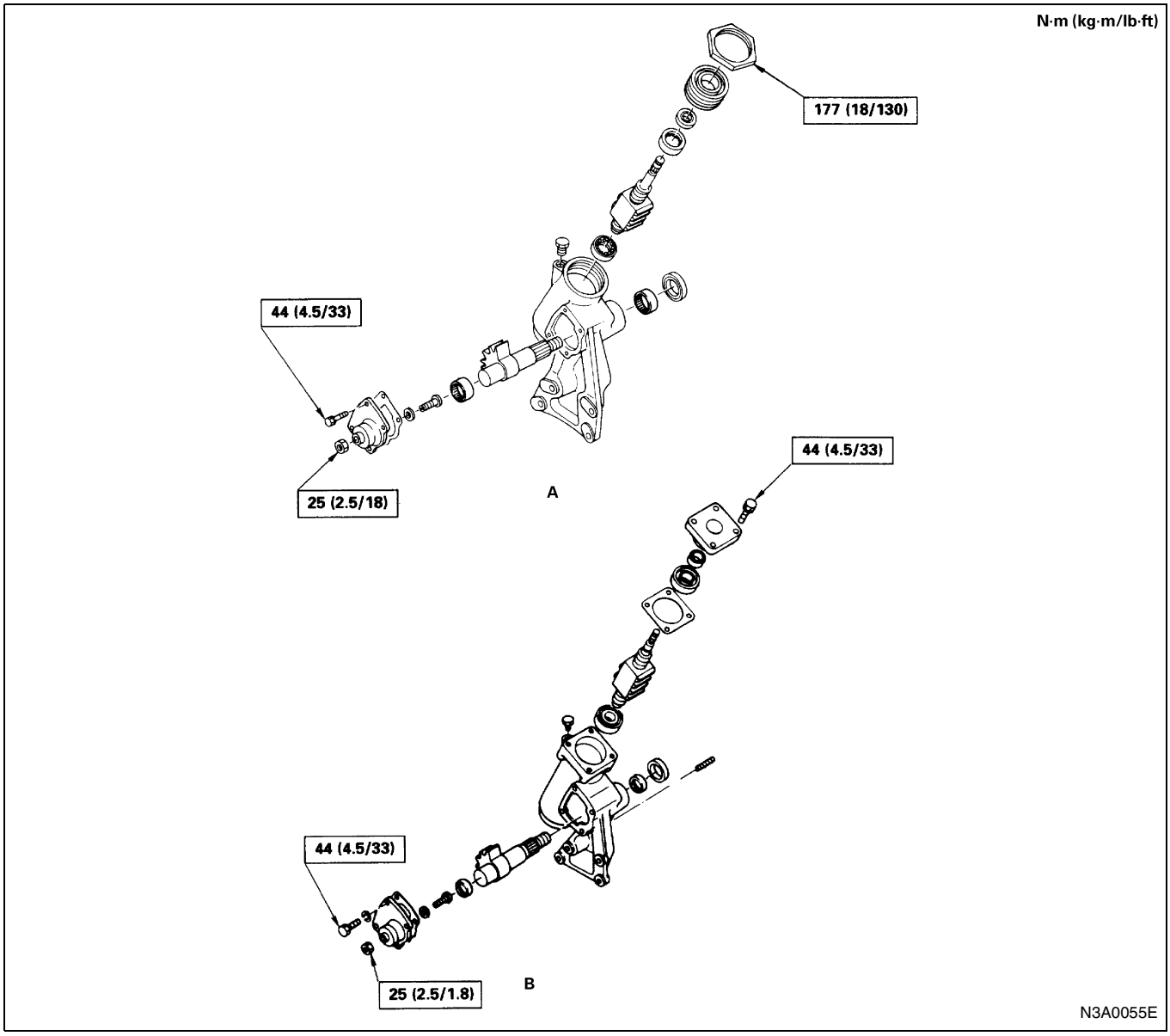
A. 4J series engine

B. 4H series engine

Tandem Hydraulic Pump



Manual Steering Unit

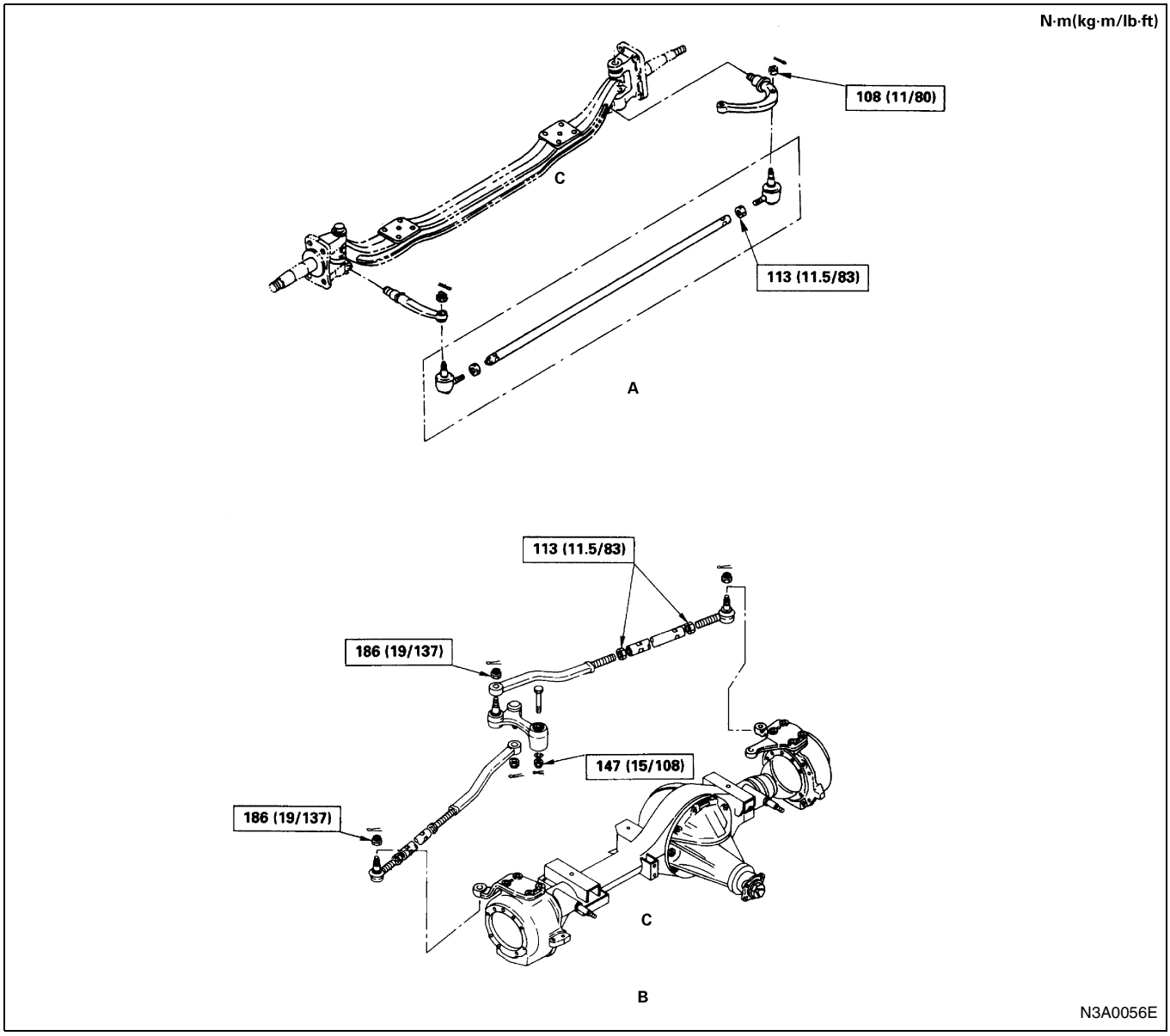


Legend

A. NHR, NKR

B. NPR

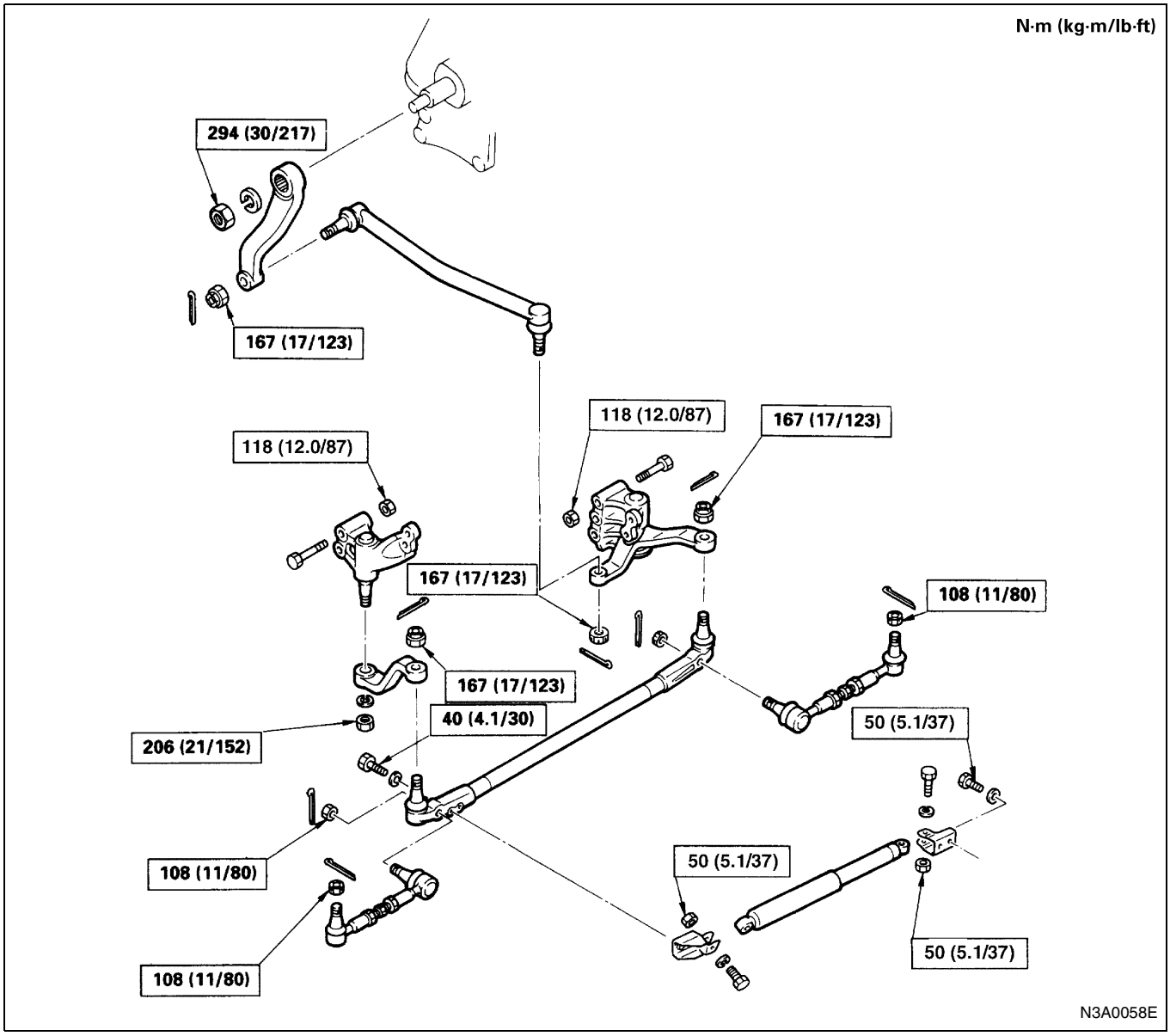
Steering Linkage (Rigid Suspension)



Legend

A. NHR, NKR, NPR
B. NPS
C. Front axle

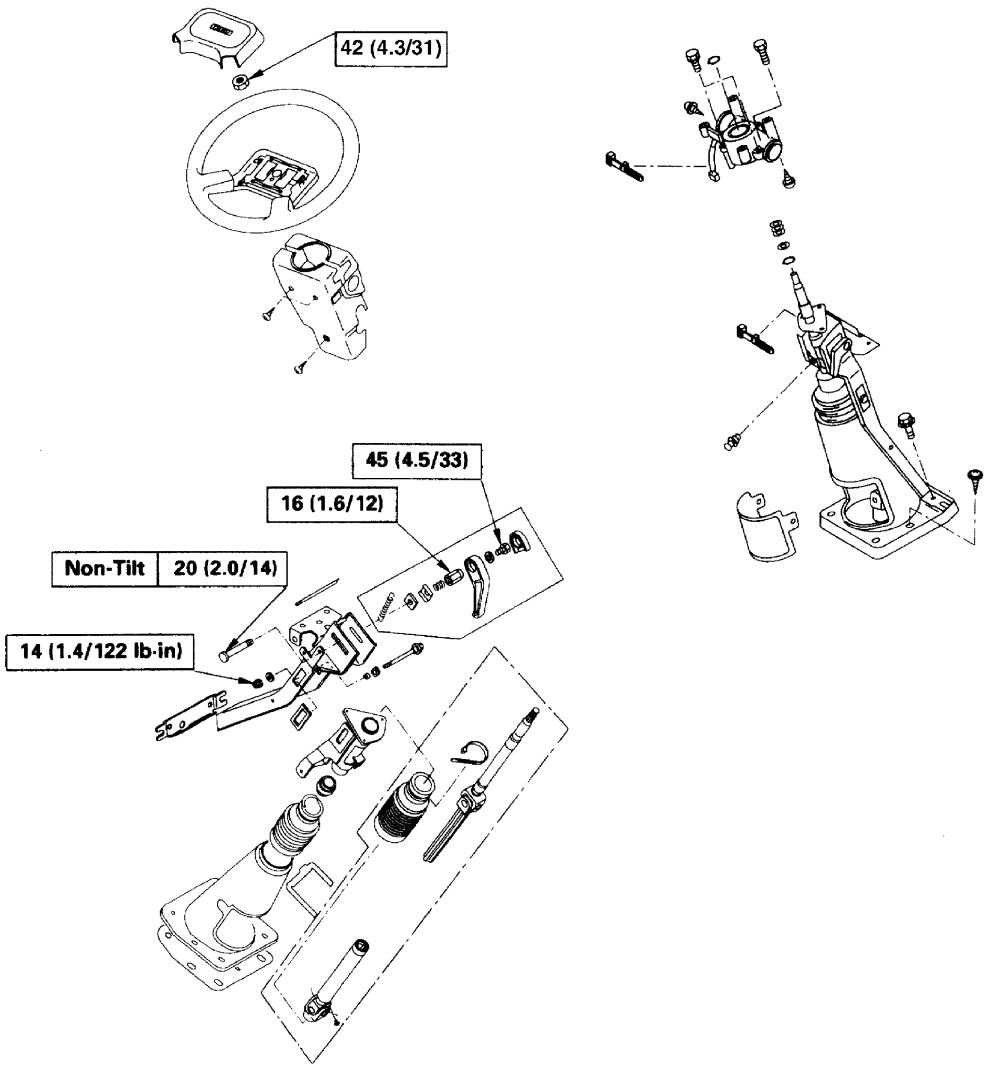
Steering Linkage (Wishbone Suspension)



Steering Column

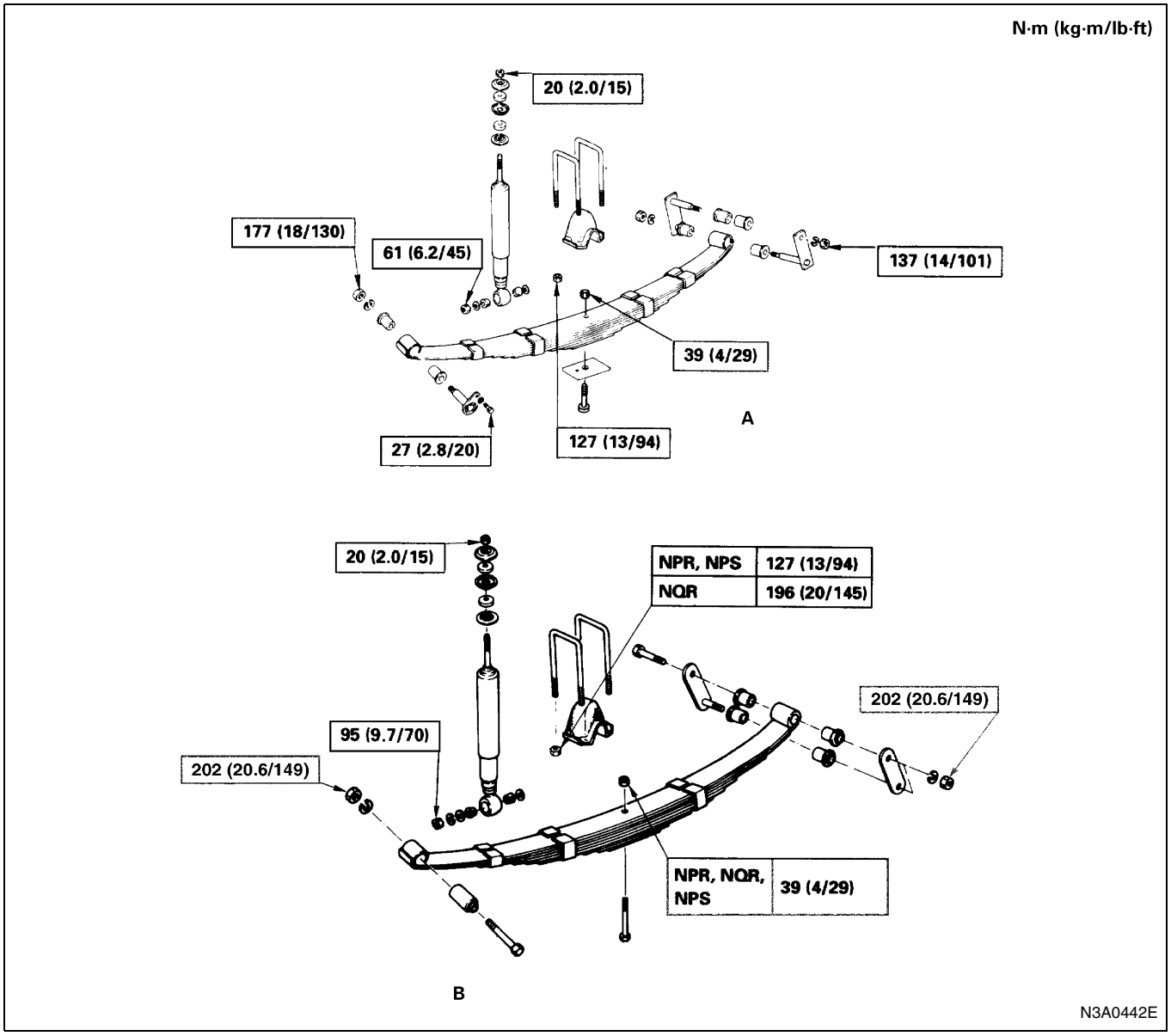
N·m (kg·m/lb·ft)

This illustration is based on tilt and telescopic control type.



N3A0060E

Front Leaf Spring and Shock Absorber

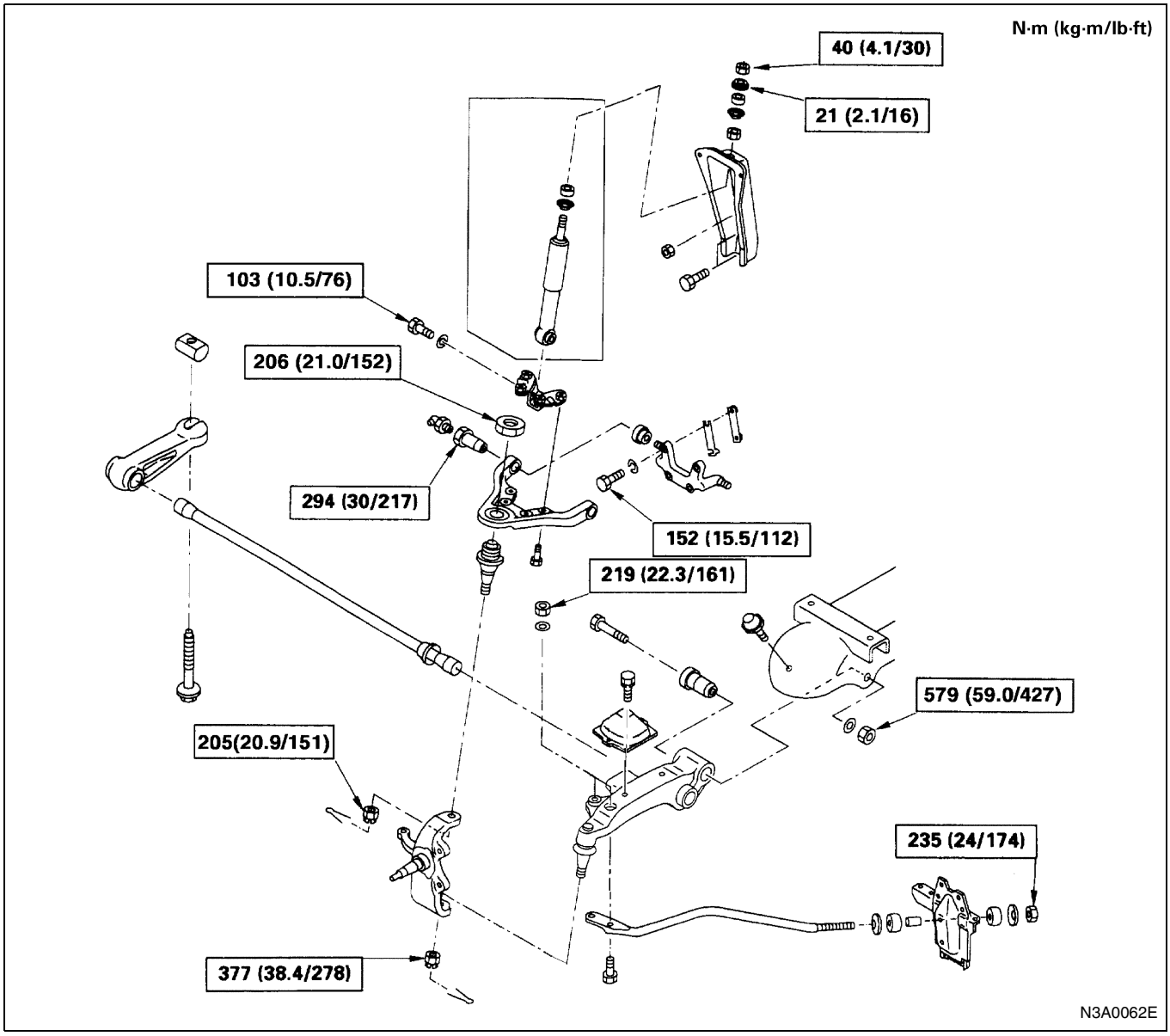


Legend

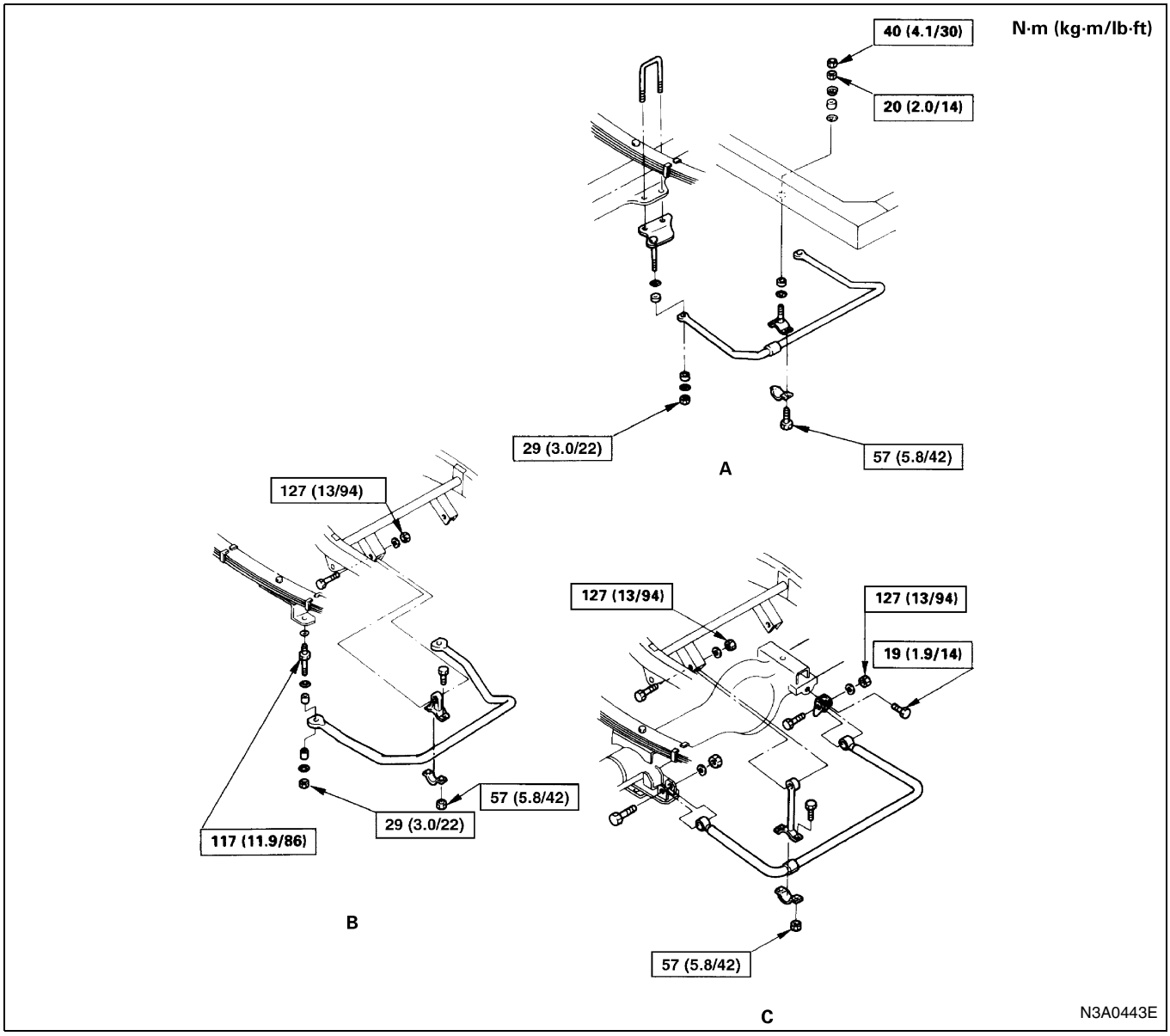
A. NHR, NKR

B. NPR, NQR, NPS

Upper, Lower Link, Torsion Bar and Strut Bar (Wishbone Suspension)



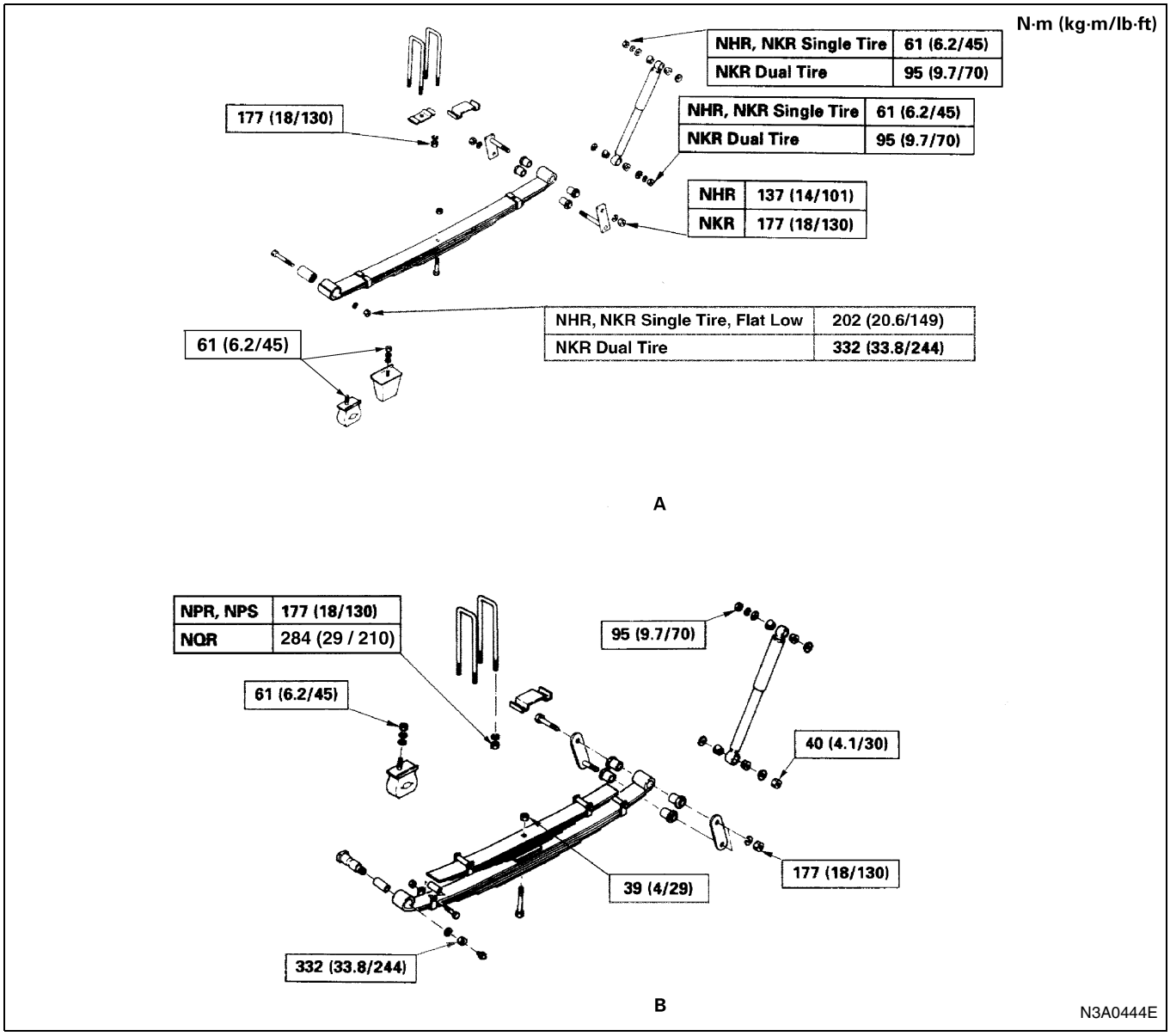
Front Stabilizer



Legend

A. NKR
B. NPR
C. NPS

Rear Leaf Spring and Shock Absorber

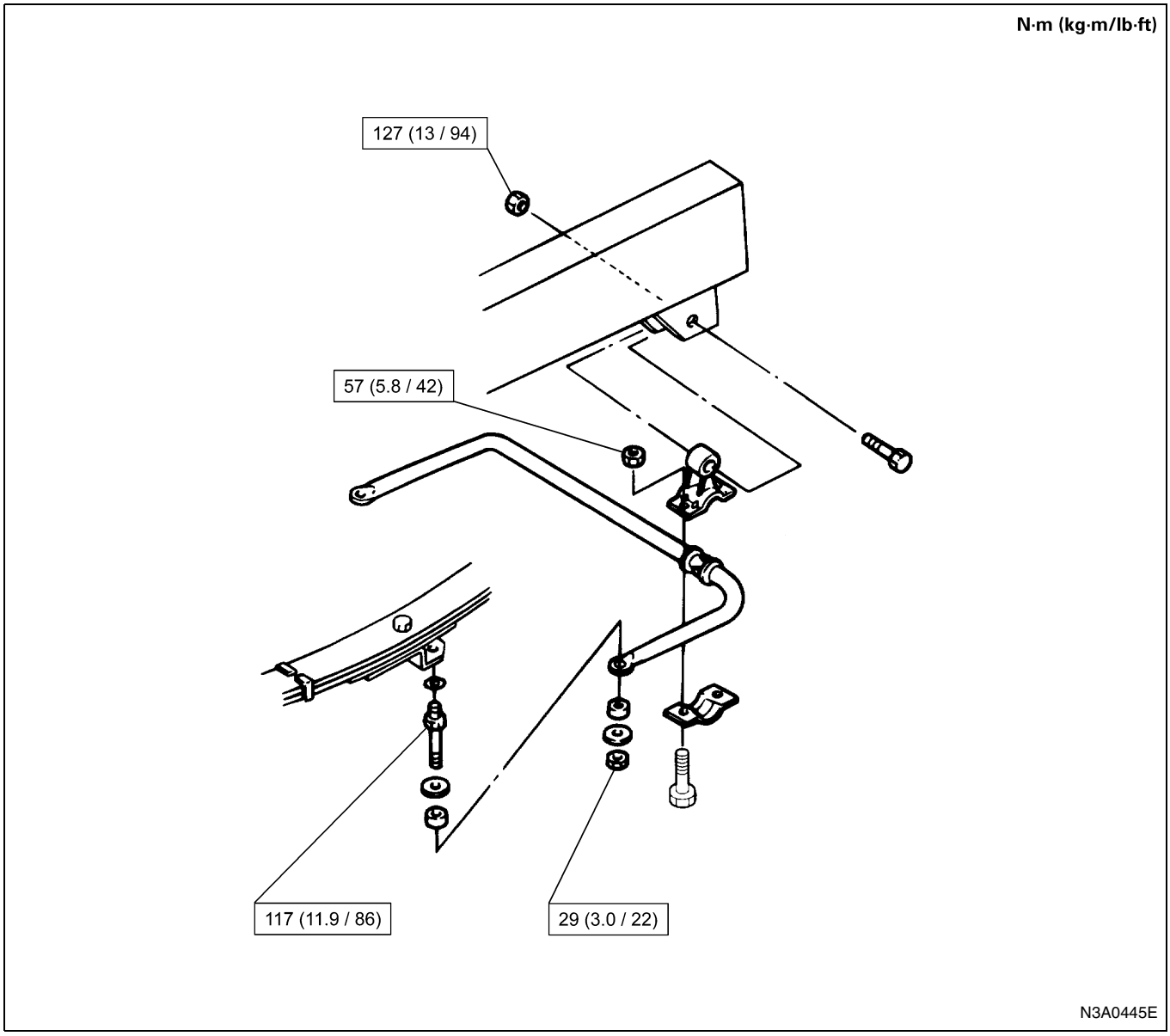


Legend

A. NHR, NKR

B. NPR, NQR, NPS

Rear Stabilizer



SPECIAL TOOLS

Steering System

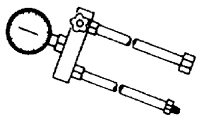
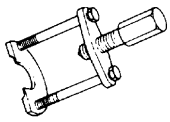
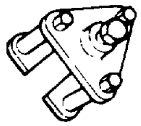
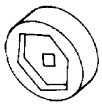
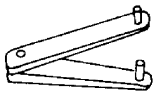
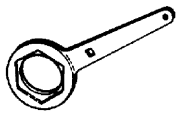
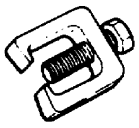
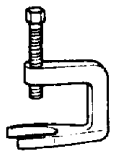
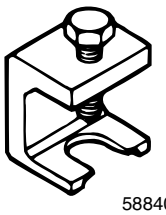
Illustration	Tool Number / Description / Remarks
 5884001620	5-8840-0162-0 / Power steering fluid pressure gauge
 5884020170	5-8840-2017-0 / Ball joint remover
 5884020511	5-8840-2051-1 / Pitman arm puller
 5884020590	5-8840-2059-0 / Lock nut wrench / for Power steering (Left hand drive)
 5884020600	5-8840-2060-0 / End cover wrench / for Power steering (Left hand drive)
5884020540	5-8840-2054-0 / Steering shaft driver

Illustration	Tool Number / Description / Remarks
 5884020520	5-8840-2052-0 / Steering lock nut wrench / for Manual steering (NHR, NKR)
5884020530	5-8840-2053-0 / Wrench / for Manual steering (NHR, NKR)
 5884020180	5-8840-2018-0 / Tie rod end remover / for 2WD rigid suspension (assistant side)
 5884022150	5-8840-2215-0 / Steering wheel puller
 5884021890	5-8840-2189-0 / Ball joint remover

Suspension

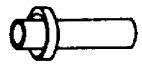
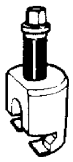
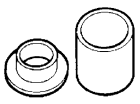
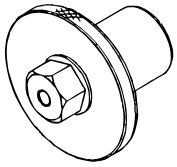
Illustration	Tool Number / Description / Remarks
 5884020480	5-8840-2048-1 / Leaf spring bushing remover and installer
5884020490	5-8840-2049-1 / Leaf spring bushing remover and installer / for metal bushing
 5884023660	5-8840-2366-0 / Lower link ball joint remover / for wishbone suspension
5884023640	5-8840-2364-0 / Upper link ball joint remover / for wishbone suspension
 5884023650	5-8840-2365-0 / Upper link ball joint installer / for wishbone suspension

Illustration	Tool Number / Description / Remarks
5884023670	5-8840-2367-0 / Lower link bushing remover and installer / for wishbone suspension
 5884021880	5-8840-2188-0 / Wheel alignment gauge adapter

STEERING, SUSPENSION, WHEELS AND TIRES

SECTION 3A

FRONT END ALIGNMENT

Contents

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Caster Angle 3A-2
Toe-In 3A-2
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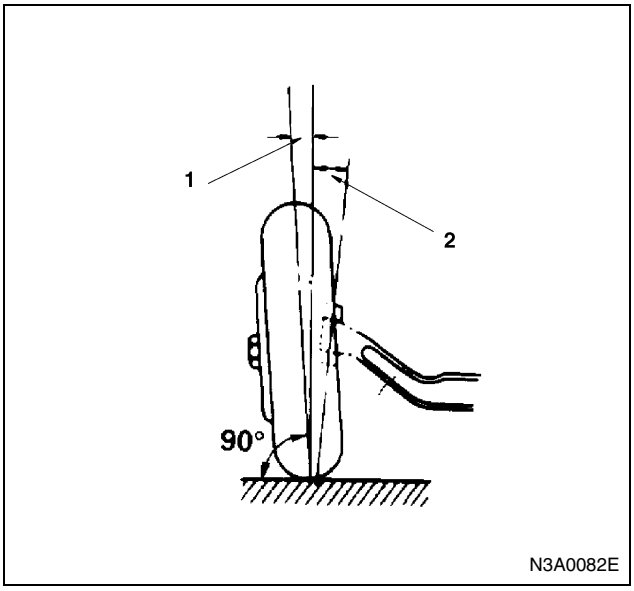
Toe-in 3A-3
Turning Radius 3A-5
Camber Angle 3A-6
Caster Angle and King Pin Inclination 3A-7
Trim Height (Wishbone Suspension Only) 3A-10

GENERAL DESCRIPTION

Camber Angle

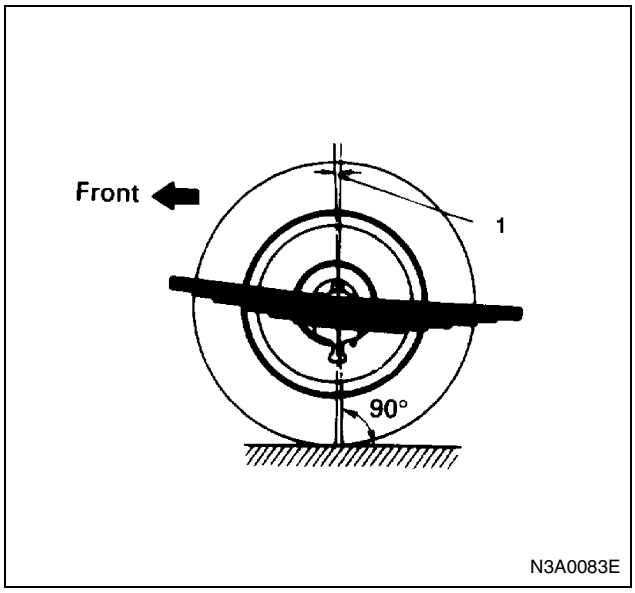
The reason why the camber is so important in wheel alignment is that it affects greatly the tire wear and characteristics. The front wheels of most cars lean slightly either inward or outward when seen from the front. This tilt of the wheel is called the camber. When the center line of the tire is completely vertical to the road, the tire has “zero camber”. In the positive camber, the wheels incline outward at the tops while in the negative camber they incline inward at the tops. Excessive positive camber causes the outer edge of tire to excessively wear. On the other hand, excessive negative camber causes the inner edge of tire to wear.
Improper wheel camber setting will not only cause the tires’ excessive wear, but also the tire will tend to move in the direction of the wheel which has a larger camber angle affecting the car’s straight traveling ability. When measuring the camber, it is indicated by the angle.



Legend
1. Camber angle
2. Kingpin inclination

Caster Angle

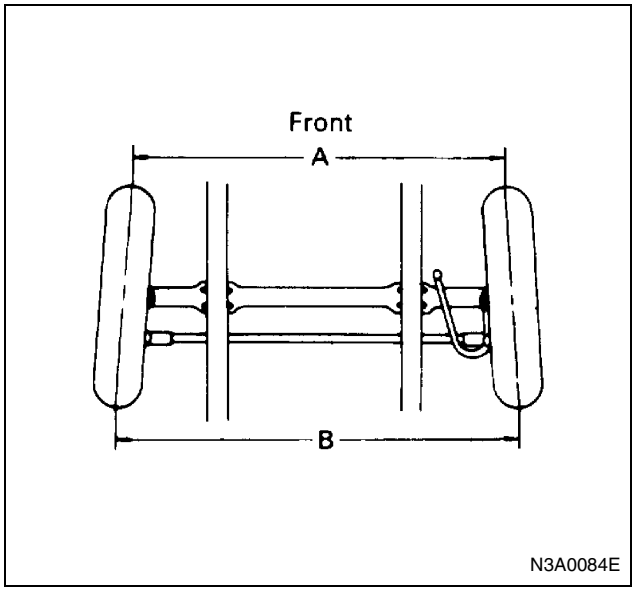
Caster is the angle between the rearward inclination of king pin axis and a vertical center line of the wheel when the car is seen from its side. Like camber, it is also indicated by the angle. Caster angle affects greatly the straight traveling ability of the car, steering wheel maneuverability, self alignment effort and the returning ability of the car to the straight ahead position.



Legend
1. Caster angle

Toe-In

When seen from the top of the car, the front edges of the front wheels are slightly closer each other. The amount of this slight inward turning is called toe-in and usually expressed by millimeter.
The toe-in can be calculated with next formula.
Toe-in = B – A



ON-VEHICLE SERVICE

Inspection

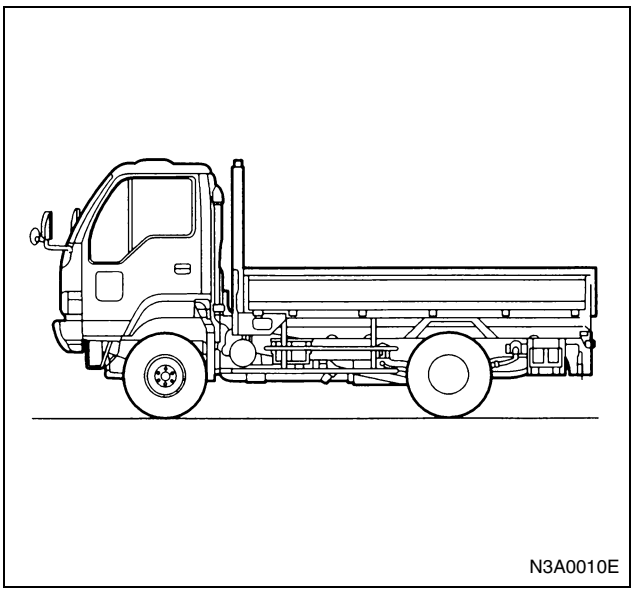
The points listed below must be checked prior to inspection front wheel alignment.

- Tire pressure and abnormal wear
- Front hub bearing for axial play
- Ball joint on steering linkage for play
- Operation of shock absorbers
- Tightness of suspension parts
- King pin bearings for play

Toe-in

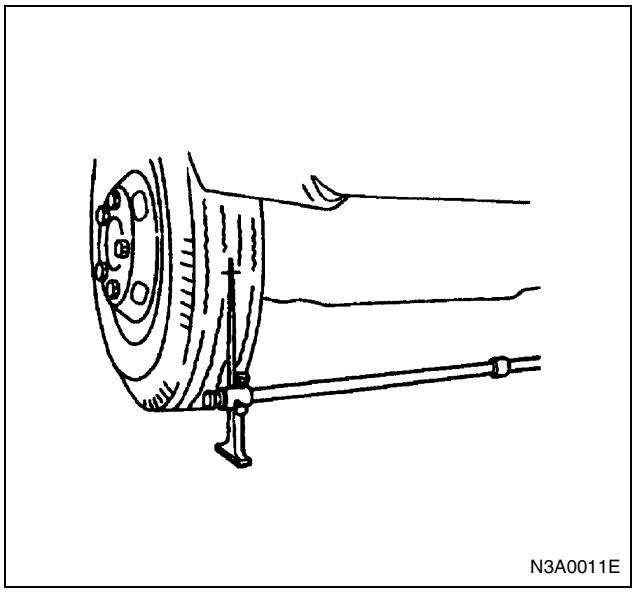
Inspection

Measurement should be taken with the vehicle on a surface plate.
If a surface plate is not available, toe-in should be checked with the vehicle parked on a level floor.


N3A0010E

1. Set front wheels to its straight ahead position.
2. Align the toe-in gauge with center height of each wheels at front end.
3. Apply center marks to each wheel, then take measurement of distance A between the center marks on each wheel.
4. Move the vehicle slowly rearward until center marks get its rear end position.
5. Take measurement of distance B between the center marks at rear end.

The toe-in can be calculated with next formula.
Toe-in = B − A
Toe-in
−2 — 2 mm (−0.08 — 0.08 in)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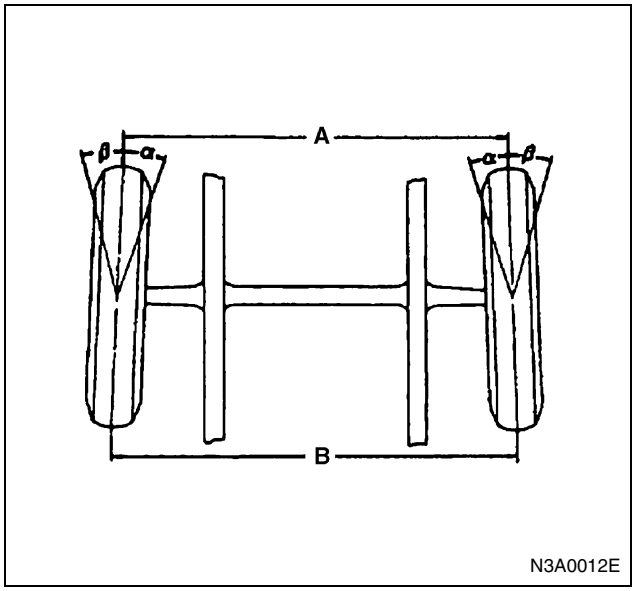
- Rigid Suspension



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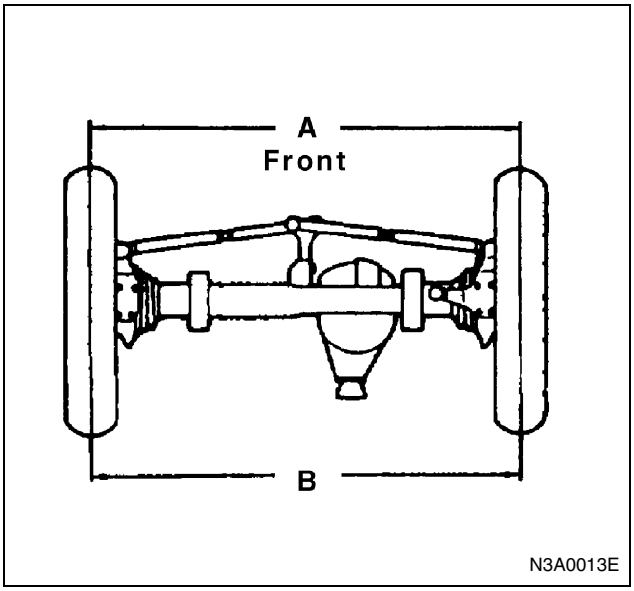
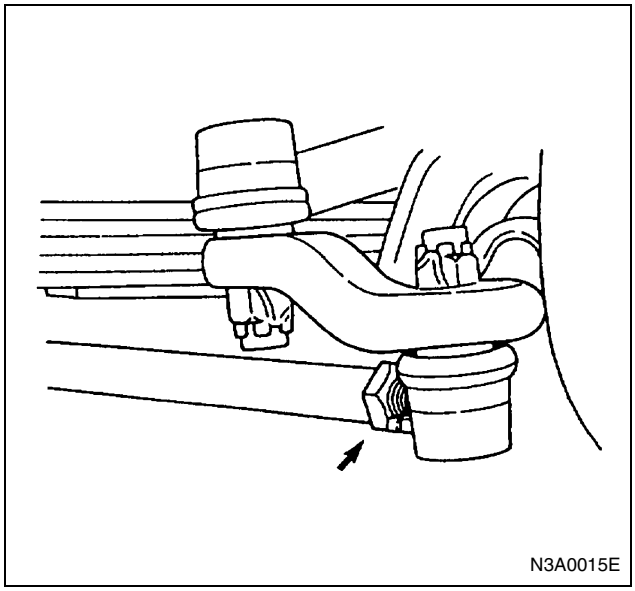
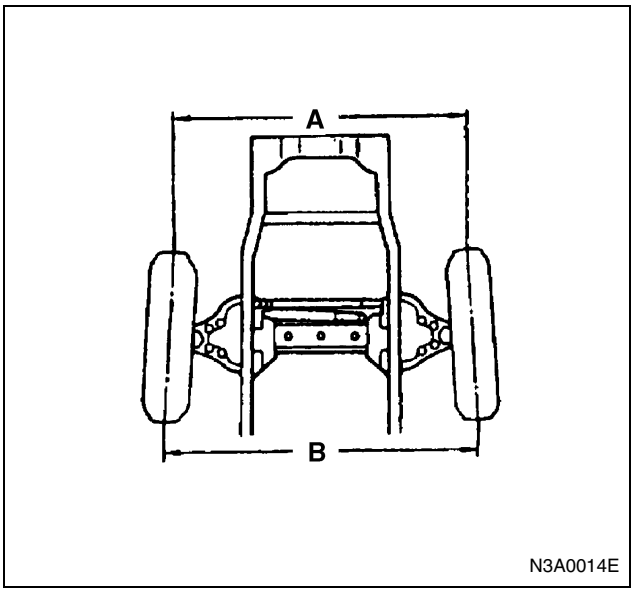
• NPS



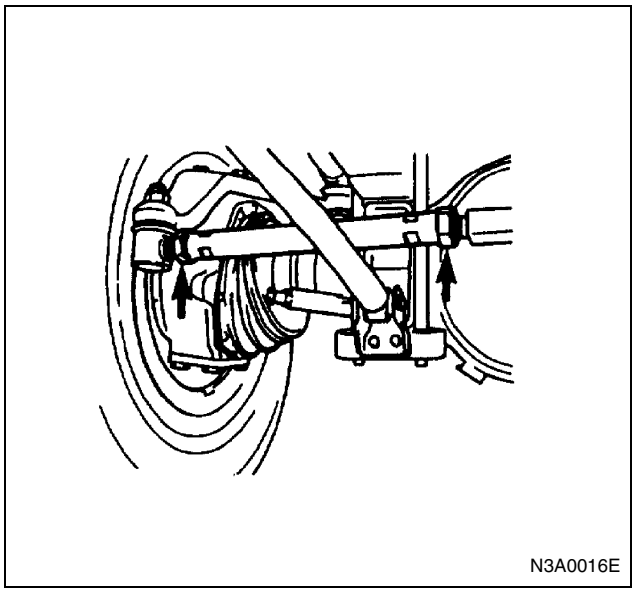
• Rigid Suspension



• Wishbone Suspension



• NPS



Adjustment

1. Loosen the lock nuts on the tie rod or outer truck rod ends.
2. Adjust length of the tie rod by turning the connecting rod on outer truck rod.
3. Tighten the lock nuts to specified torque.

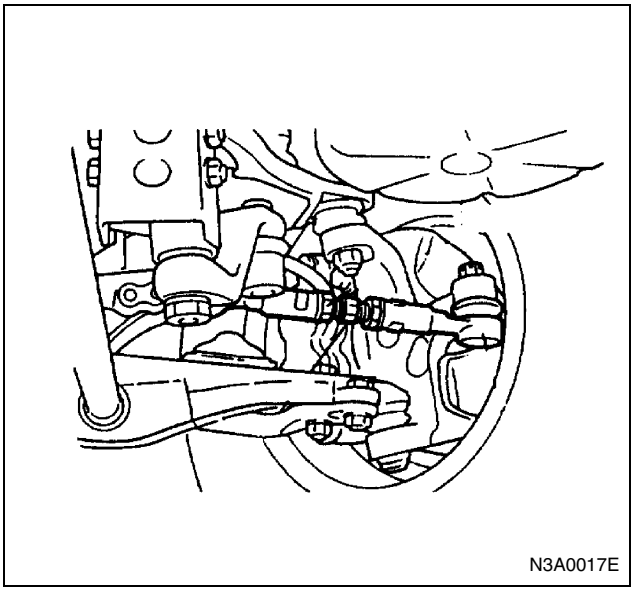
Tighten:

• Lock nut to

Rigid suspension, NPS: 113 N·m (11.5 kg·m / 183 lb·ft)

Wishbone suspension: 167 N·m (17.0 kg·m / 123 lb·ft)

• Wishbone Suspension

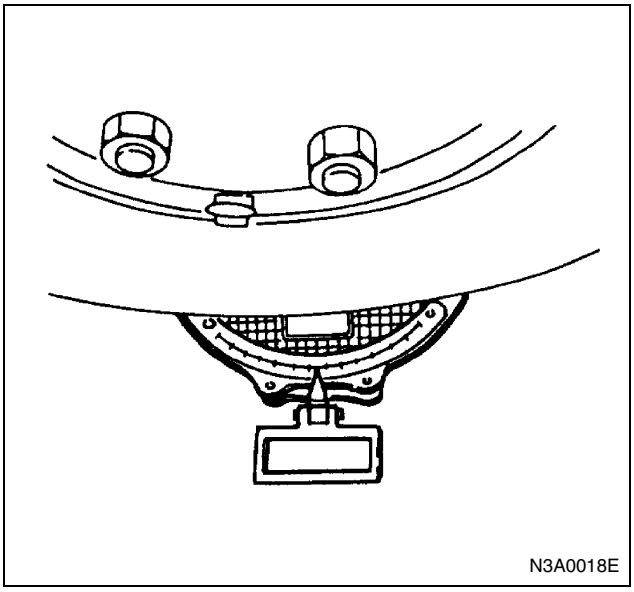


Turning Radius

Inspection

1. Position a suitable piece of wood equivalent in thickness to the turning radius gauge under each rear wheel.
2. Position each front wheel on a turning radius gauge by aligning the tire center line with the center of the turning radius gauge.
3. Turn the steering wheel clockwise or counterclockwise until the front wheels are locked.

Notice:
Turning the steering wheel with the brake pedal depressed using brake pedal pusher.

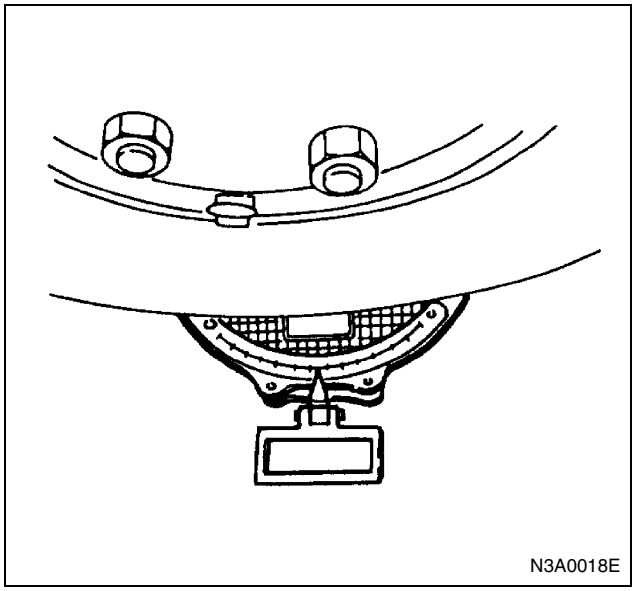


Reading of the turning radius gauge directly indicates the steering angle.

Steering Angle

Wishbone Suspension Model		(deg.)
Vehicle Model	Outer	Inner
NKR (7.00-15 Tire)	35.0	38.0

Rigid Suspension Model		(deg.)
Vehicle Model	Outer	Inner
NHR	33.0	37.5
NKR (7.00-15 Tire)	29.5	38.5
NKR (7.00-16 Tire)	27.9	35.5
NPR (7.00-16 Tire)	35.0	47.5
NPR, NQR (7.50-16 Tire)	32.7	42.5
NQR (8.25-16 Tire)	30.0	36.5
NPS	29.8	37.5

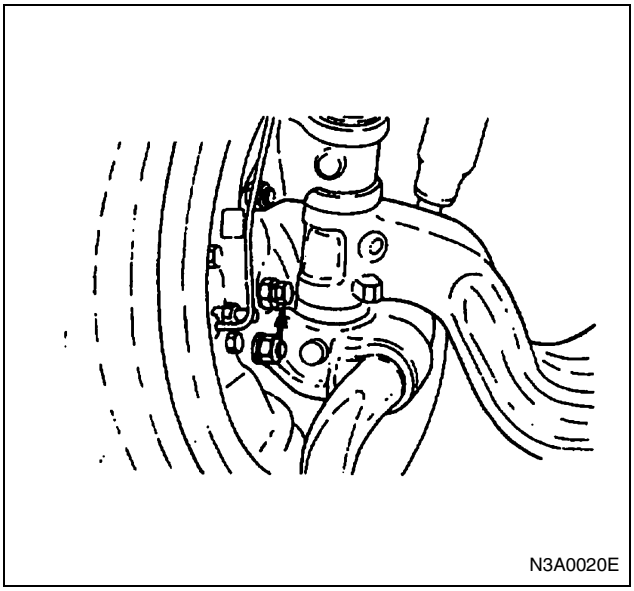


Adjustment

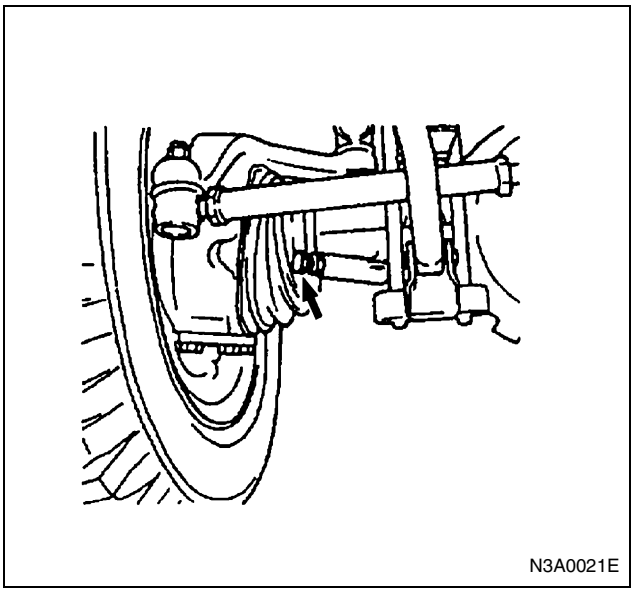
1. Loosen the lock nuts on the steering knuckle or the axle case.
2. Adjust projecting height of the stopper bolts.
3. Tighten the lock nuts to specified torque.

Tighten:
• Stopper bolt to
Rigid suspension: 186 N·m (19.0 kg·m / 137 lb·ft)
NPS: 49 N·m (5.1 kg·m / 36 lb·ft)
Wishbone suspension: 82 N·m (8.4 kg·m / 61 lb·ft)

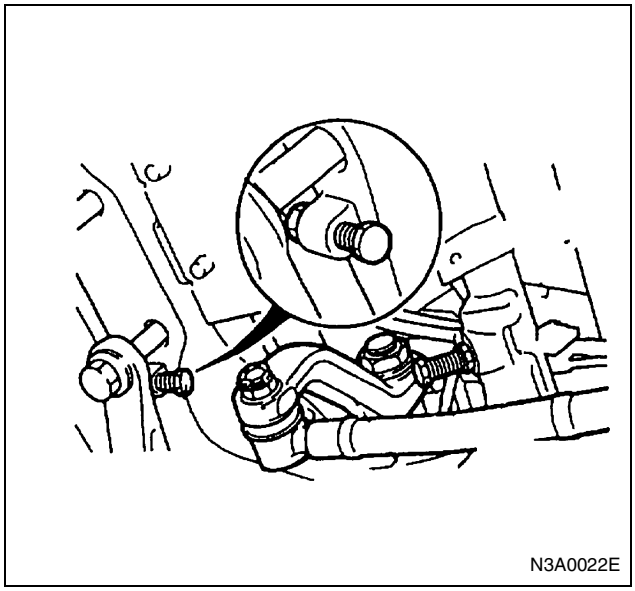
• Rigid Suspension



• NPS



• Wishbone Suspension



Camber Angle

Inspection

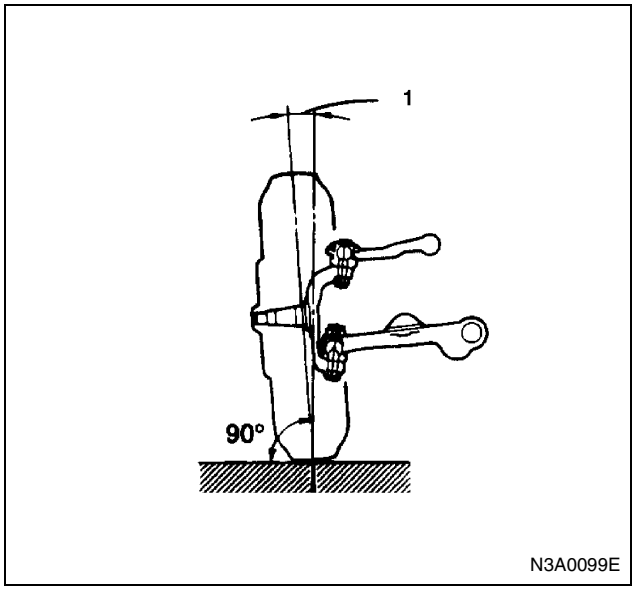
All Model except NPS

The toe-in can be checked on the gauge simultaneously.

1. When inspection of turning radius is completed, calibrate the scale of the turning radius gauge to zero.
2. Remove the front hub cap.
   Install camber, caster and king pin inclination gauge on end of the knuckle spindle horizontally.

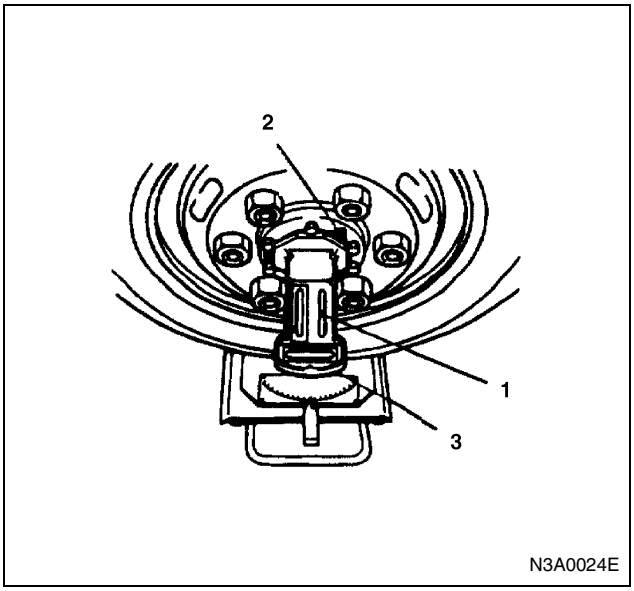
Notice:

When removing hub cap, take care so as not to cause damage to gauge fitting face at end of the spindle. If end of the spindle has been scratched or damaged, correct before setting the gauge.



Legend
1. Camber angle

NPS
Remove the free wheel hub lock cover assembly, then install gauge adapter on end of the knuckle spindle. Install camber, caster and king pin inclination gauge on end of gauge adapter.
Gauge Adapter: 5-8840-2188-0

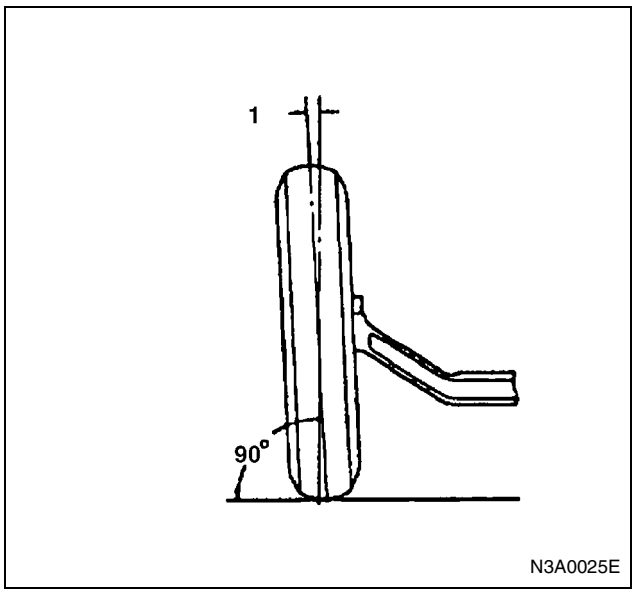


Legend
1. Camber angle
2. Gauge adapter
3. Wheel alignment tester

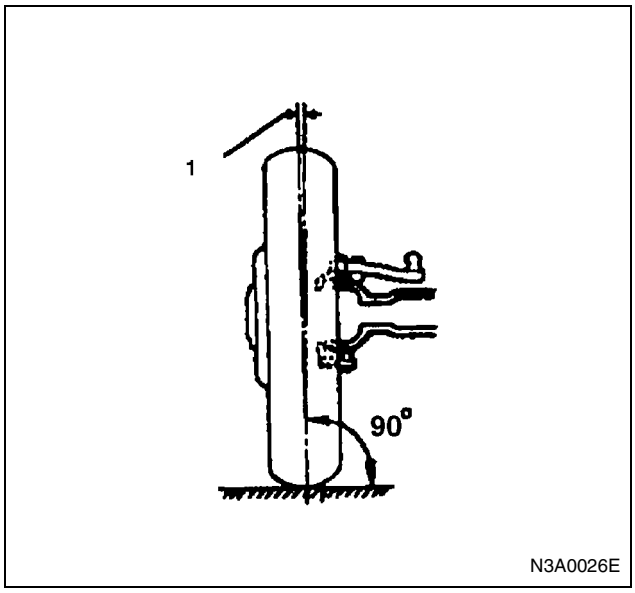
3. Reading of the camber scale directly indicates the camber angle (1).

Camber Angle	(deg.)
NHR Rigid Suspension	1°15′±45′
Rigid Suspension (except NHR)	0°15′±45′
Wishbone Suspension, NPS	0°15′±45′

- Rigid Suspension



- NPS



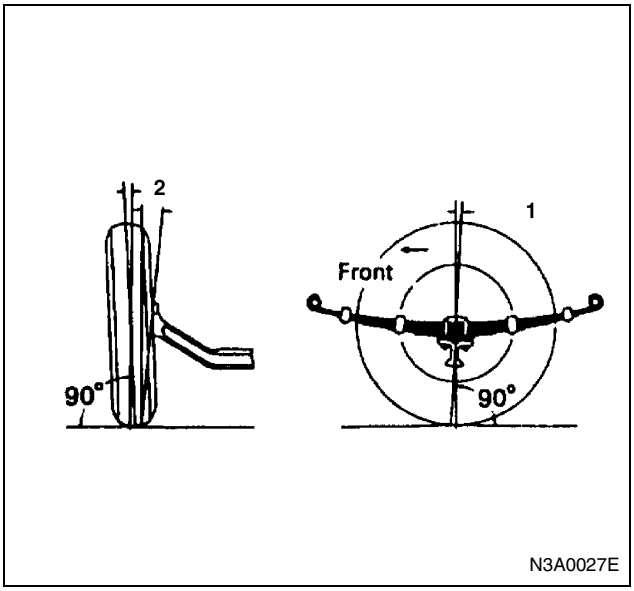
Caster Angle and King Pin Inclination

Inspection

The caster angle and king pin inclination can be checked on the gauge simultaneously.

1. When inspection of camber angle is completed, calibrate the scale of the turning radius gauge to zero and turn the steering wheel clockwise (counterclockwise for checking caster angle (1) and king pin inclination (2) on the left side front wheel) until the front wheels are steered 20 degrees from the straight-ahead position.

- Rigid Suspension



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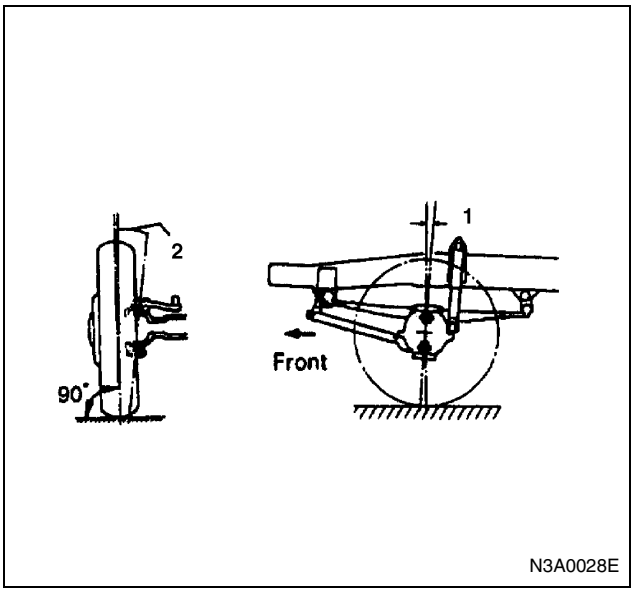
- NPS



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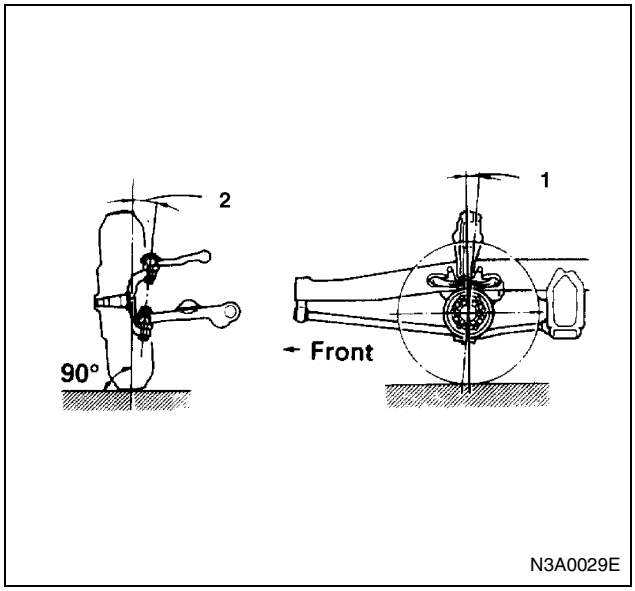
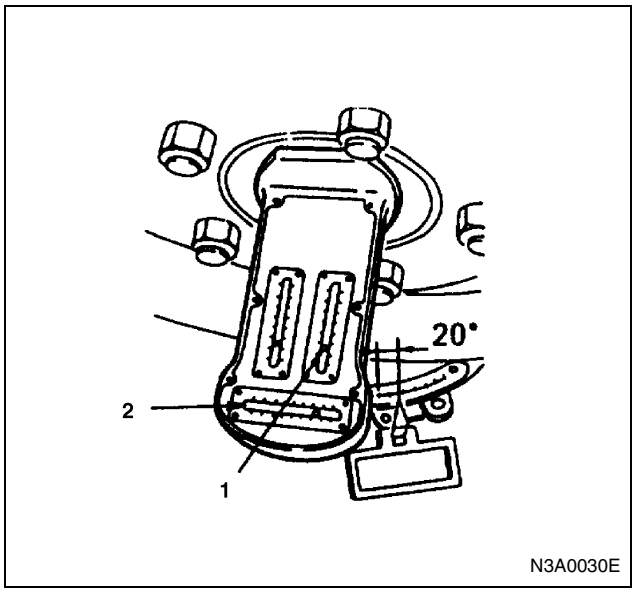
- Wishbone Suspension



N3A0029E

Notice:
Turn the steering wheel with the brake pedal depressed using brake pedal pusher.

2. When the front wheels are turned 20 degrees, calibrate the caster and king pin scales to zero turning the camber, caster and king pin gauge adjuster.



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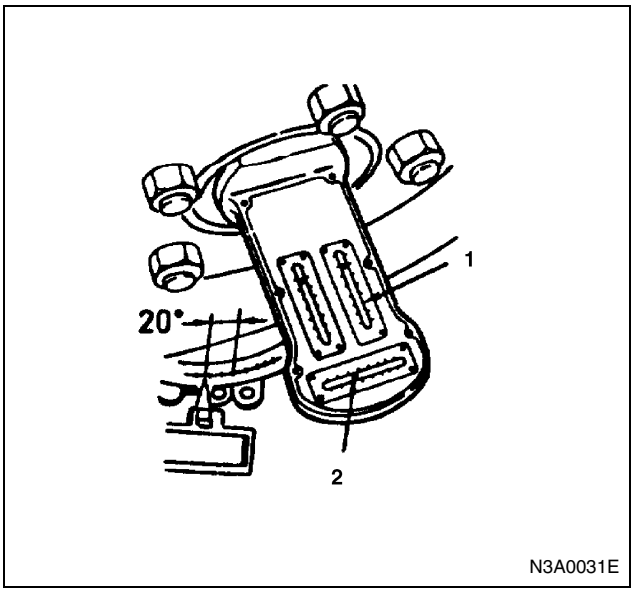
Legend
1. Caster angle
2. King pin inclination

3. Turn the steering wheel in the opposite direction until the front wheels are steered 20 degrees in the opposite direction. Reading of the caster and king pin scales directly indicates the caster and king pin inclination angles being checked.

Caster Angle and King Pin Inclination (deg.)		
	Caster Angle	King Pin Inclination
NHR	1°30′±1°	7°15′
NKR Rigid Suspension	3°00′±1°	12°00′
NPR, NQR	2°45′±1°	12°00′
Wishbone Suspension	1°00′±1°	9°45′±30′
NPS	2°00′±1°	7°15′



Legend
1. Caster angle
2. King pin inclination

Adjustment

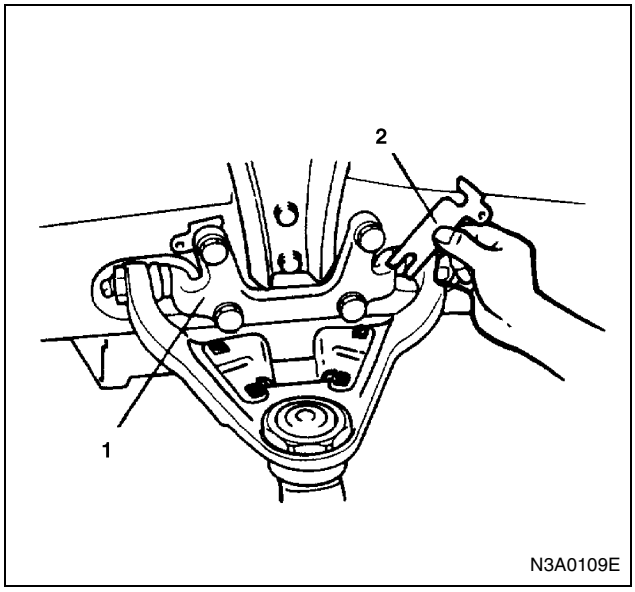
Rigid Suspension

The camber, caster and king pin inclination are built into front end and are not adjustable. If the camber, caster or king pin inclination is found to be out of alignment, check to locate the cause of trouble against the listing below and replace the parts necessary.

- Front springs for weakening
- Front I-beam (axle case) for distortion
- Bushing in king pin, King pin bearings for wear or determination

Wishbone Suspension

1. Set the jack under the cross member of the suspension and then raise the lower link with the jack and retain the jack with applied in the place.
2. Remove the shock absorber.
3. Attach the fulcrum pin (1) and loosen the bolts to the degree that it will not fall a part to adjust the camber angle using the shims (2).

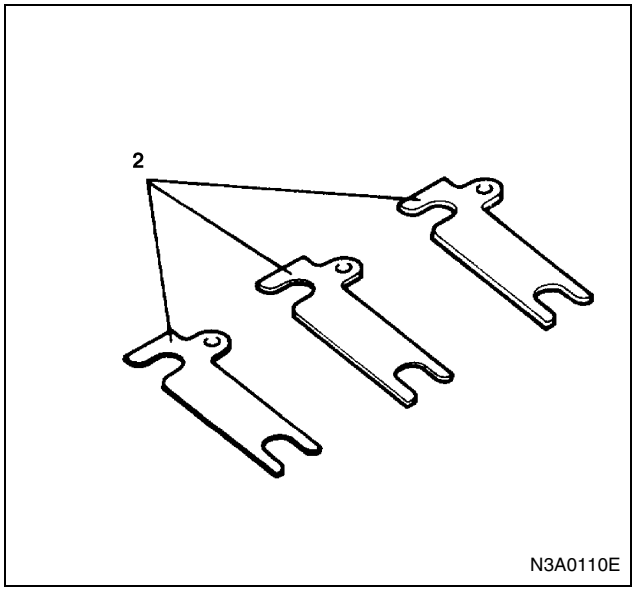


Camber Angle

If the number of shims (2) are evenly increased both at fore and aft, the camber angle becomes acute, while if decreased, the angle becomes obtuse.

Caster Angle

When the caster angle is obtuse, increase the number of shims (2) at the fore side, while the angle is acute, increase the number of shims (2) at the aft side.



Thickness of Shims Available

0.8 mm (0.031 in), 1.6 mm (0.063 in), 3.2 mm (0.126 in)

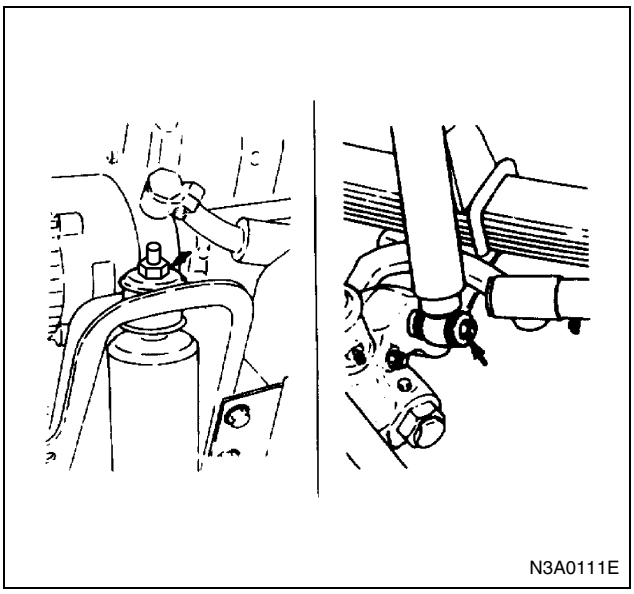
Conditions Where The Shims are Used

Number of Shims: 4 or less
Thickness: 9.6 mm (0.378 in) or less
Difference of Thickness (between Front and Rear): 4.8 mm (0.189 in) or less
In case the shim has already reached at the limitation in its number or its thickness, decrease the number of shims at the aft side to adjust the obtuse caster angle, while decrease the number at the fore side to adjust the acute caster angle.

Notice:
Since the number of shims needed for caster angle adjustment varies depending on the conditions of the car, perform the adjustment procedures which are the most suitable for the car conditions.

4. Tighten the mounting bolts of the front shock absorber.

Tighten:
- Shock absorber bolt and nut to
  Upper: 21 N·m (2.1 kg·m / 16 lb·ft)
  Lower: 103 N·m (10.5 kg·m / 76 lb·ft)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Trim Height (Wishbone Suspension Only)

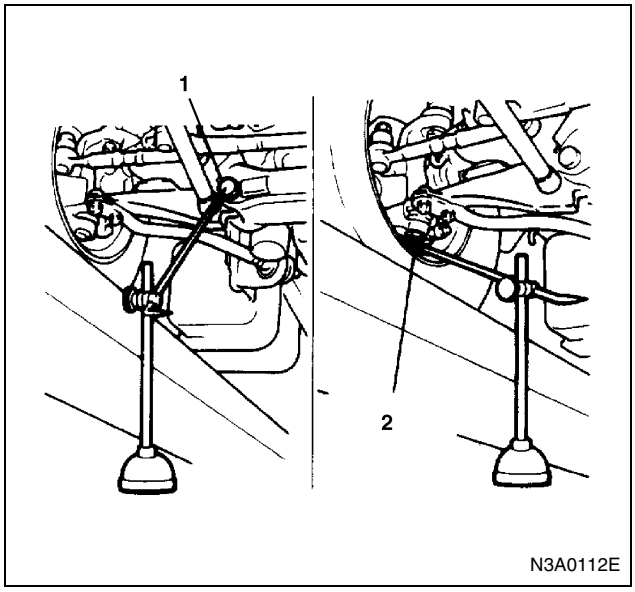
Adjustment

Adjust the trim height by means of adjusting bolt on the height control arms.

Caution:
When adjusting front end alignment, be sure to begin with trim height as trim height adjustment may change other adjusted alignments.

1. Check and adjust the tire inflation pressures.
2. Park the vehicle on a level ground and move the front of the vehicle up and down several times to settle the suspension.
3. Make necessary adjustment with the adjusting bolt on the height control arms.

Trim Height
101.4±5 mm (3.992±0.197 in)



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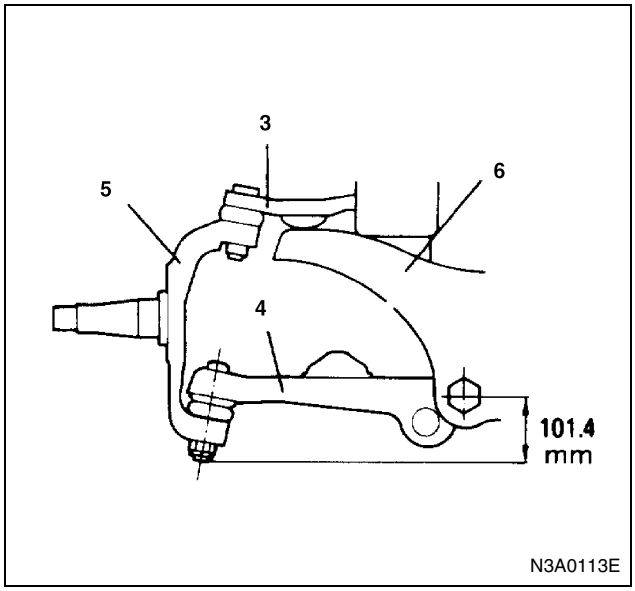

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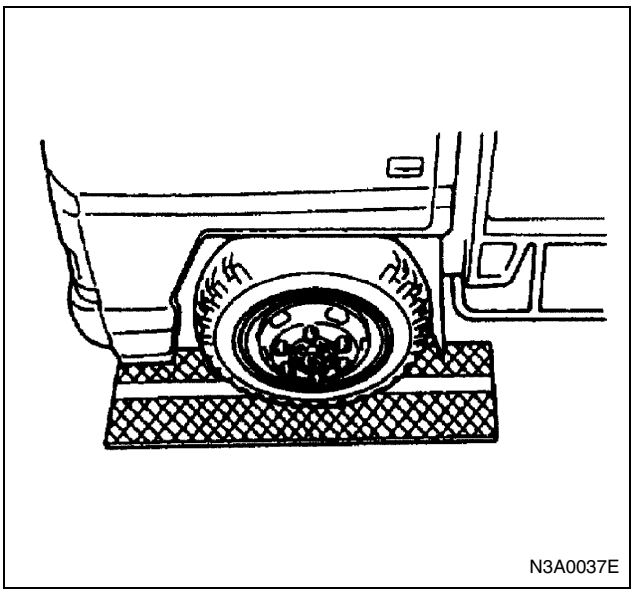
Legend
1. Lower link bolt
2. Lower joint ball
3. Upper link
4. Lower link
5. Knuckle arm
6. Crossmember

Measurement of Side Slippage
When inspection and adjustments of toe-in, camber, caster and king pin inclination are completed, check for side slippage using a side slip tester.
Roll the wheels over the side slip tester as slowly as possible and take reading on the tester. If the amount of side slippage is in excess of 5 mm per 1 m, recheck the wheel alignment.

Side Slippage
Limit: 5.0 mm (0.197 in) Per 1m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STEERING, SUSPENSION, WHEELS AND TIRES

SECTION 3B1

POWER STEERING

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Power Steering Pump (4H Series Engine without Hydraulic Booster Brake) 3B1-29
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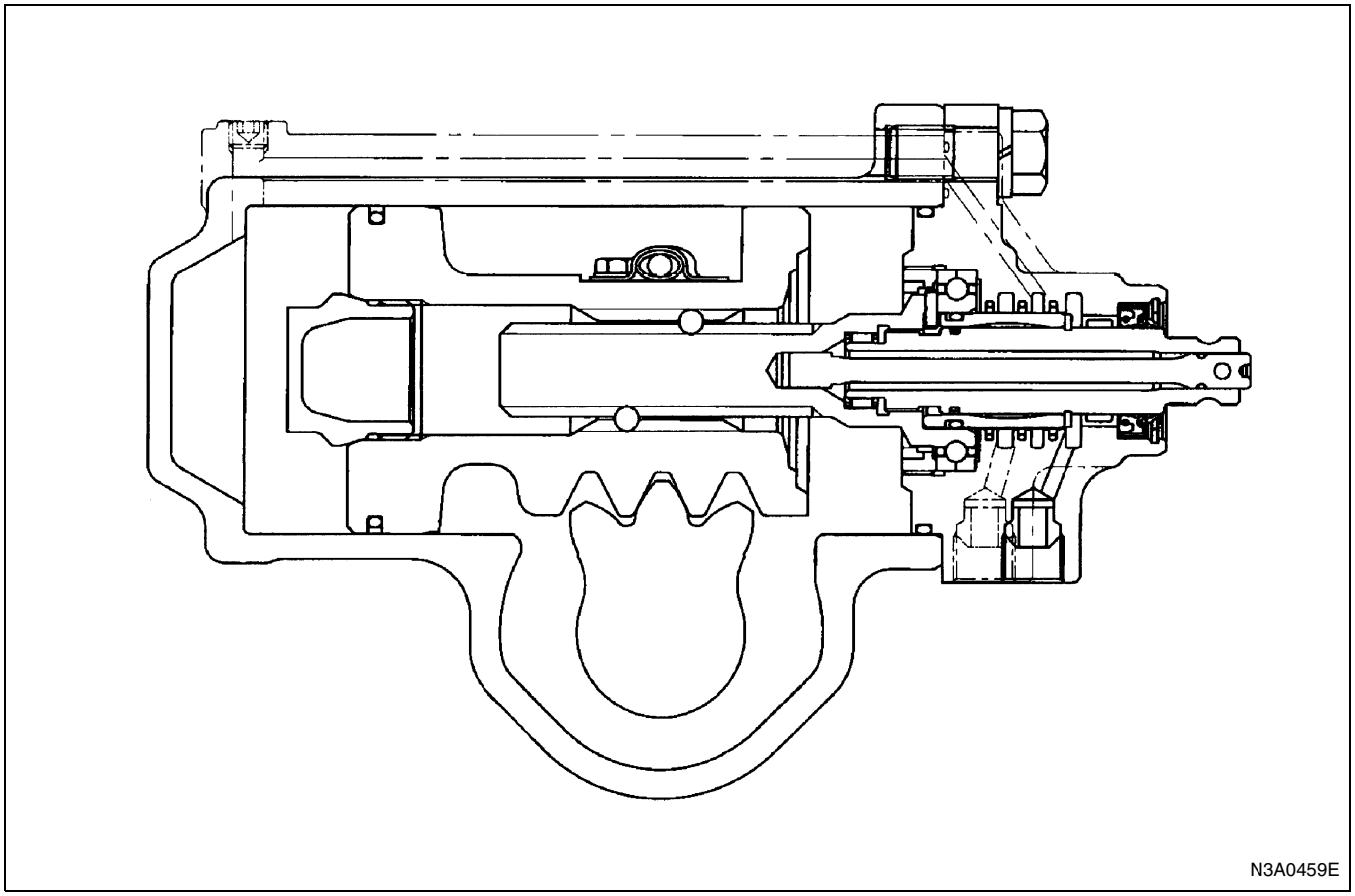
GENERAL DESCRIPTION

Power Steering Unit



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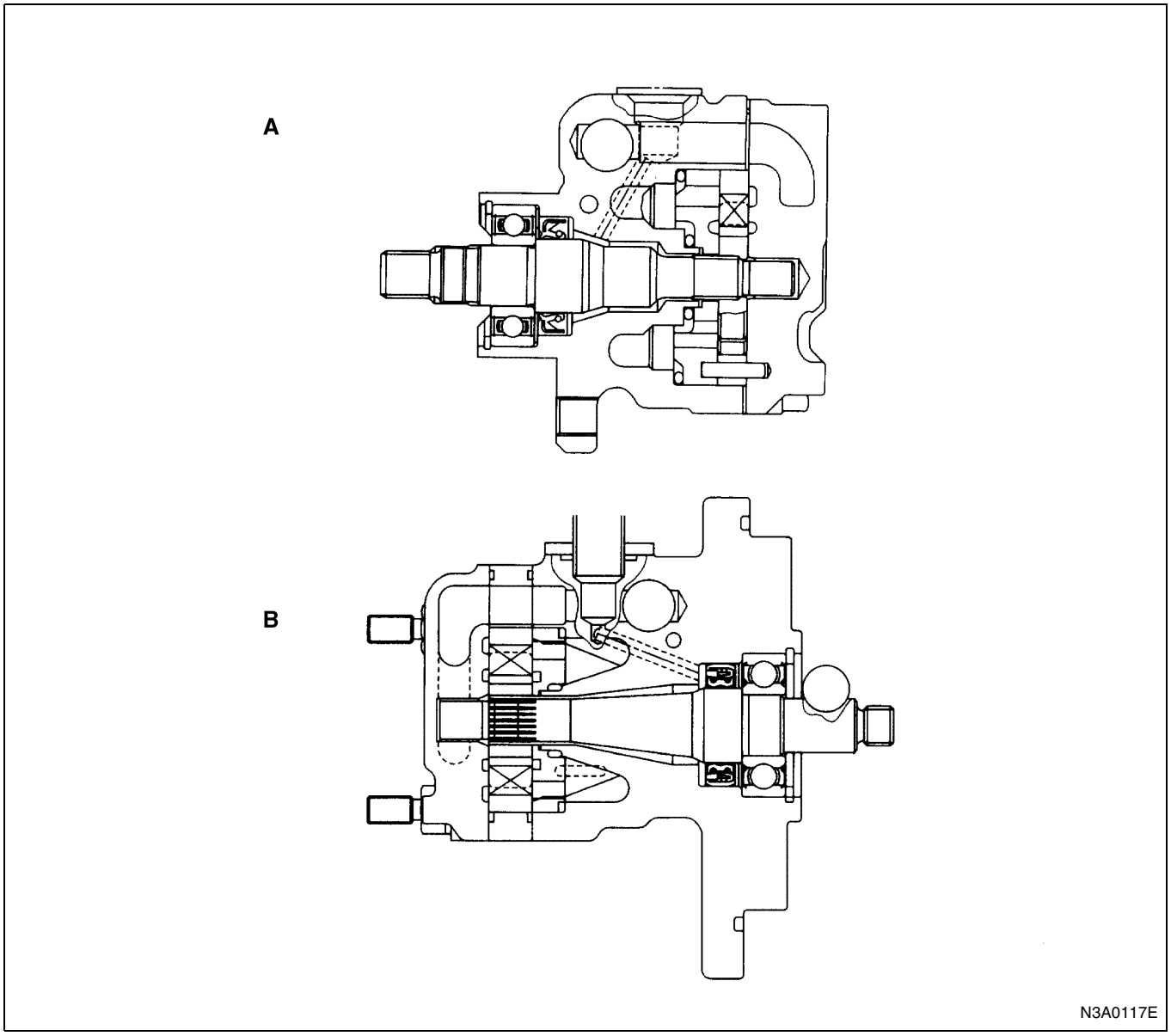
Power Steering Pump



Legend

A. 4J series engine
B. 4H series engine

Tandem Hydraulic Pump

A tandem hydraulic pump has two independent hydraulic pumps inside one casing. Its main parts can be classified into the following three.

- hydraulic pump (vane type)
- flow control valve
- pressure relief valve

The following is a description of the functions and operation of the main parts.

Hydraulic pump

Functions

The heart of the system, namely the part that supplies hydraulic pressure, which operates the hydro boost and the P/S. The hydraulic pump is installed directly to the engine and is driven by gears. It smoothly adapts itself to severe conditions of use, including a wide range of rotation speeds, changes in the temperature at which it is used, and frequent changes in load pressure, and it is able to fully perform its functions.

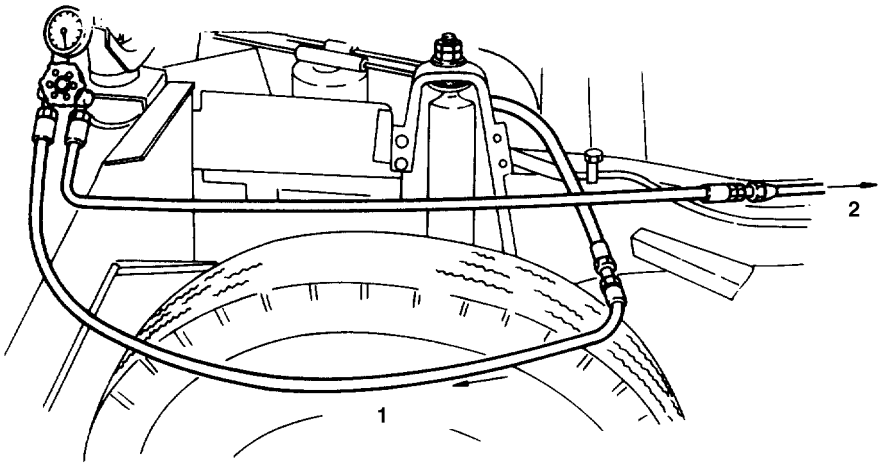
Operation

Its drive is transmitted by gears from the engine to the drive shaft of the oil pump, and it turns a rotor that is fitted into the spline part of the drive shaft. When the rotor rotates, the ten vanes built into the rotor groove fly out by centrifugal force, are pressed against the inside surface of the cam ring, and rotate along the inside surface so that the pump operates.

Suction and discharge of the hydraulic oil is done by a pressure plate and side plate attached to both ends of the cartridge.
Suction openings and discharge openings are provided in two locations each in symmetrical positions with respect to the axis of rotation, and because the load on the bearings due to the discharge pressure is balanced, a tandem oil pump is also called a balanced hydraulic pump.
Because it has a double pump effect per rotation, this pump provides large discharge flow in proportion to the space it occupies. Also, some of the hydraulic oil that is discharged is led to the base of the vanes and ensures the quality of the seal between the vane tips and the cam, and even if the vanes and cam rings become a little worn, the seal is hardly affected at all (with respect to discharge, oil tightness).

ON-VEHICLE SERVICE

Power Steering System



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Legend

1. From oil pump
2. To steering unit

Preparation

- Inspect the fluid reservoir for proper fluid level.
- Inspect the pump belt for proper tension.

System Test Procedure

1. Place a container under the pump to catch the fluid when disconnecting or connecting the hoses.
2. With the engine NOT running, install the power steering fluid pressure gauge unit between the power steering unit and discharge side of oil pump. The gauge must be between the stop valve and oil pump.

   Gauge kit: 5-8840-0162-1
3. Check the fluid level. Fill the reservoir with Dexron®-III to "Full" mark. Check the connections at gauge kit for leakage.
4. Fully open the stop valve, and bleed the system. Refer to "Power Steering System Bleeding" of this section.
5. Start the engine and being idled, and raise oil temperature to 50 — 60°C (122 — 144°F). Check the fluid level again. Fill the reservoir with Dexron®-III to "Full" mark if required.
6. Hold the steering wheel in the forward position. Fully close the stop valve, and record the highest value of fluid pressure.

Caution:
Do not continue this test. It should be done within 10 seconds, because otherwise oil temperature would rise to excess to cause trouble.

Standard Operating Pressure

- NQR without HBB: 11,278 kPa (115 kg/cm^2/1,635 psi)
- NPR/NPS/NQR, with HBB: 10,787 kPa (110 kg/cm^2/1,563 psi)
- except Above Models: 10,297 kPa (105 kg/cm^2/1,493 psi)

HBB: Hydraulic Booster Brake

- If the pressure recorded is within specified range, the steering system is functioning within its specifications.
- If the pressure recorded is higher than specified range, oil pump relief valve is defective.
- If the pressure recorded is lower than specified range, oil pump or relief valve is defective.

7. Fully open the stop valve and keep engine idled. Turn and hold steering wheel to full left lock, and record the highest value of fluid pressure.

   Turn and hold steering wheel to full right lock, and record the highest value of fluid pressure.

Caution:
Do not continue this test. It should be done within 5 seconds.

Standard Operating Pressure

- NQR without HBB: 11,278 kPa (115 kg/cm^2/1,635 psi)
- NPR/NPS/NQR, with HBB: 10,787 kPa (110 kg/cm^2/1,563 psi)

- except Above Models: 10,297 kPa (105 kg/cm^2/ 1,493 psi)

HBB: Hydraulic Booster Brake

- If the pressure recorded is within specified range, the steering system is functioning within its specifications.
- If the pressure recorded is lower than specified range, steering unit is leaking internally and must be disassembled and repaired.

Power Steering System Bleeding

1. Raise the front wheels with a jack. (It is recommended that a turn-table should be placed under right hand and left hand side front wheels at this time.)
2. Replenish the fluid tank with ATF Dexron®-III, and repeat the full steering (turning to the extreme ends of the steering) in both right hand side and left hand side directions quietly with the engine stopped.

Caution:
Under this condition, the air trapped in the fluid piping will be released from the fluid tank to the atmosphere in the form of large air bubbles.

3. Whenever the fluid level in tank is lowered, replenish the tank with ATF Dexron®-III in the amount equivalent to the consumption.

Caution:
Pay extra care over the fluid level so that fluid will not run out.

4. Start the engine and repeat the full steering several times quietly with the engine kept idling.

Caution:
The time needed for full steering should be less than five minutes. (Prolonged full steering of more than five seconds will cause the fluid temperature to raise significantly.)

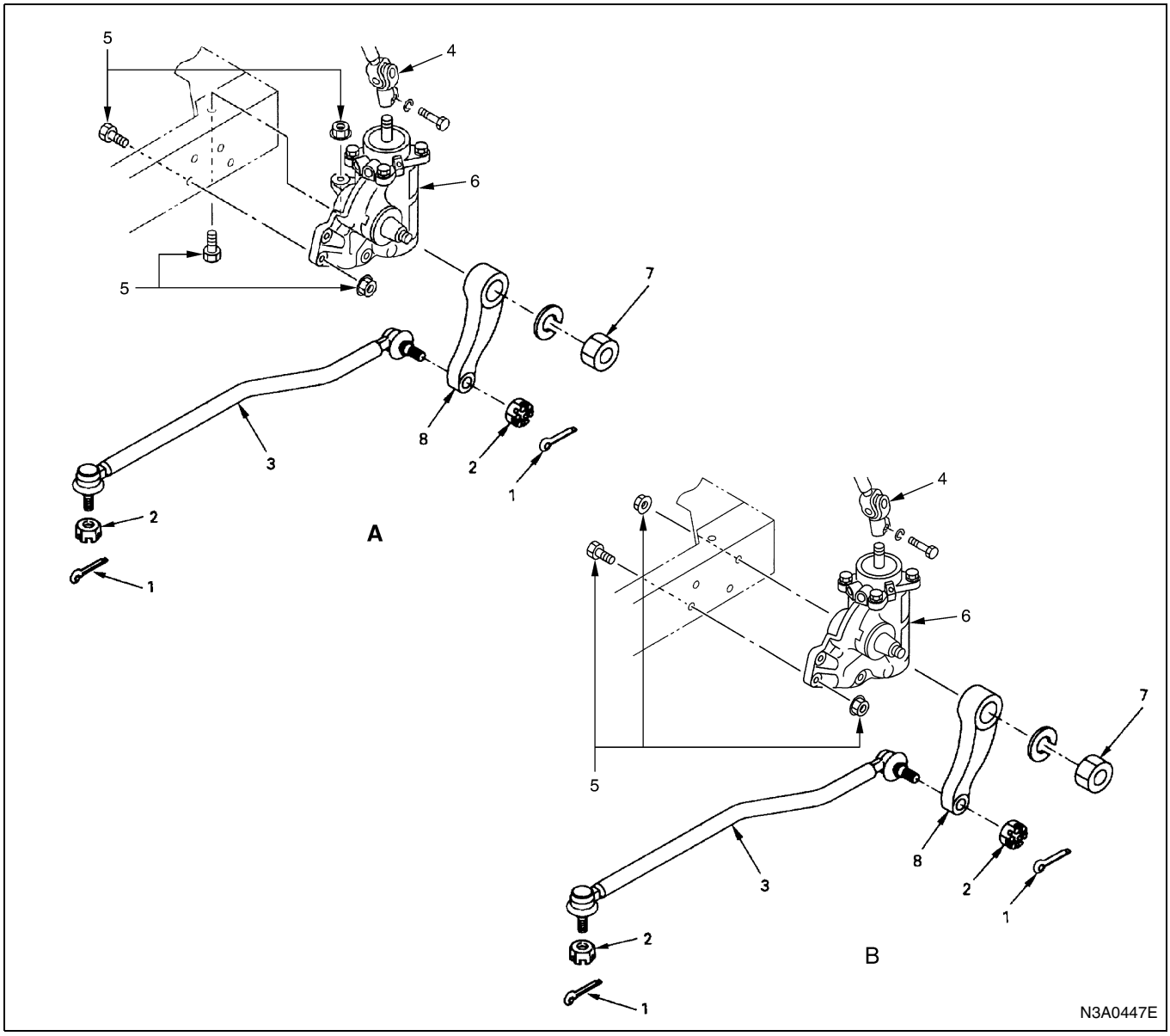
5. Lower the front wheels and turn the steering wheel in both left hand and right hand sides several times with the engine run. If no abnormal noise can be heard at this time, air might be completely released.

Caution:
If the abnormal noise (creaky, “zi-zi” sound etc.) can be heard in the piping after the step No. 5 has been completed, the air is still trapped in the piping and air release has not been completed.

In this case, continue repetition of steering wheel turn in the both directions of left hand and right hand sides until the fluid temperature is increased up to around 50 — 80°C (122 — 176°F). When the temperature reaches this degree, stop the engine and leave the engine for about five minutes. (Within five minutes, air bubbles can be collected.) Start the engine again and repeat the full steering several times.

6. After air release has been completed, check the fluid level in the tank and also confirm that the joints have no fluid leak.

Power Steering Unit

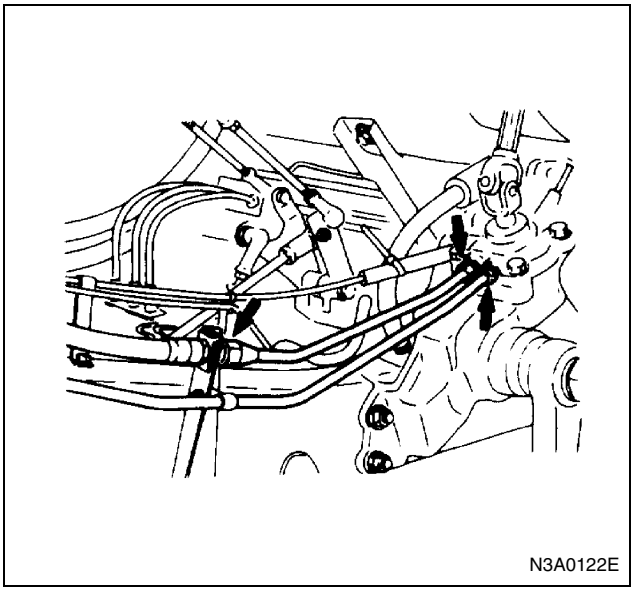


Legend

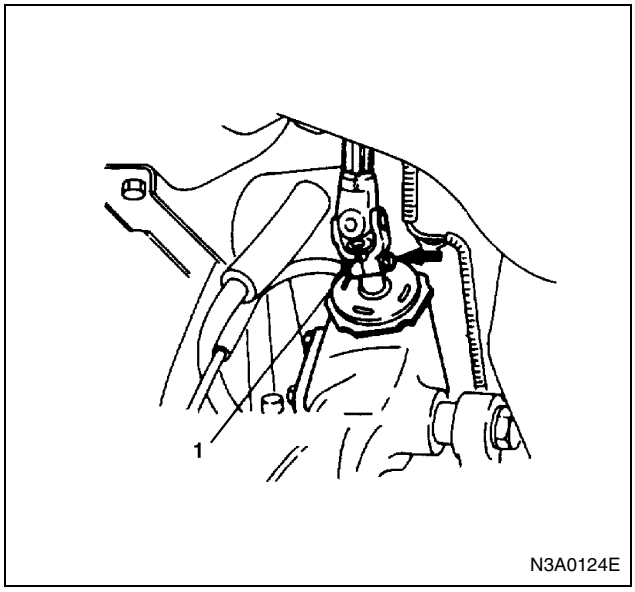
A. NHR, NKR
B. NPR, NQR, NPS
1. Cotter pin
2. Nut
3. Drag link
4. Universal joint
5. Unit fixing nut and bolt
6. Power steering unit
7. Nut
8. Pitman arm

Removal

1. Remove the head light assembly. (for Non-Tilt Cab Model, driver side only) Refer to “Headlight Replacement”.
2. Remove the under panel. (for Non-Tilt Cab Model)
3. Remove the front bumper assembly. (for Non-Tilt Cab Model)
4. Remove the oil pipe.
   Before disconnecting the oil pipe, clean the steering unit paying particular attention to the area around the joint and plug or tape the oil port after disconnecting the pipe to prevent entry of dust or other foreign matter.

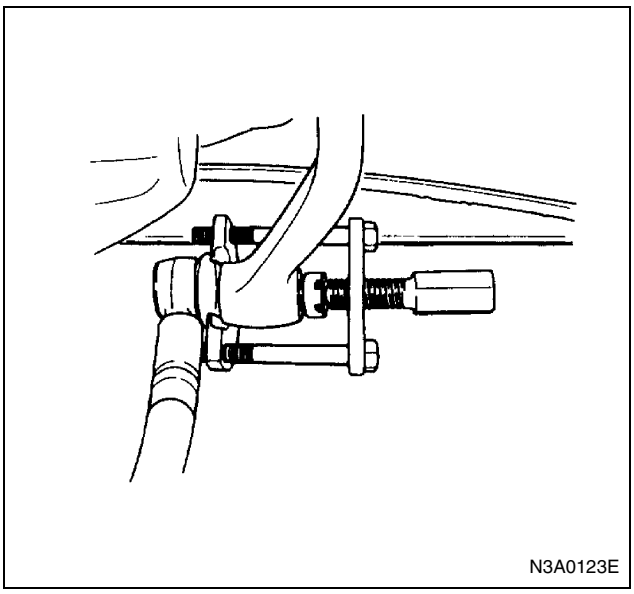

N3A0122E

5. Cotter Pin
6. Nut
7. Drag Link
   Disconnect the drag link at the knuckle arm and the pitman arm.
   Remover: 5-8840-2017-0

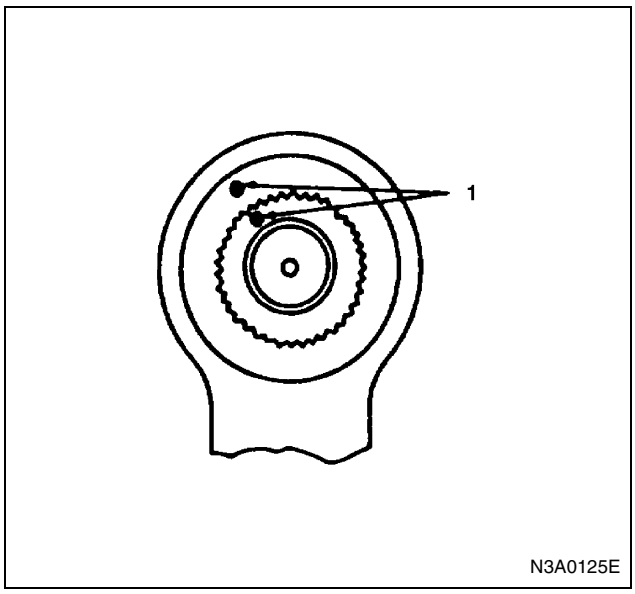


N3A0124E

9. Unit Fixing Bolt and Nut
10. Power Steering Unit
11. Nut
12. Pitman Arm
    Apply a setting mark (1) across the pitman arm and worm shaft.

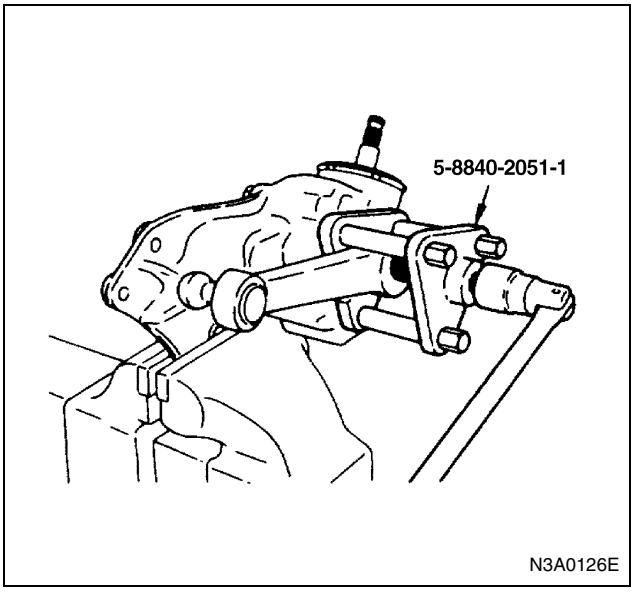

N3A0123E

8. Universal Joint
   Apply a setting mark (1) across the yoke and worm shaft in unit to ensure reassembly of the parts in the original position.



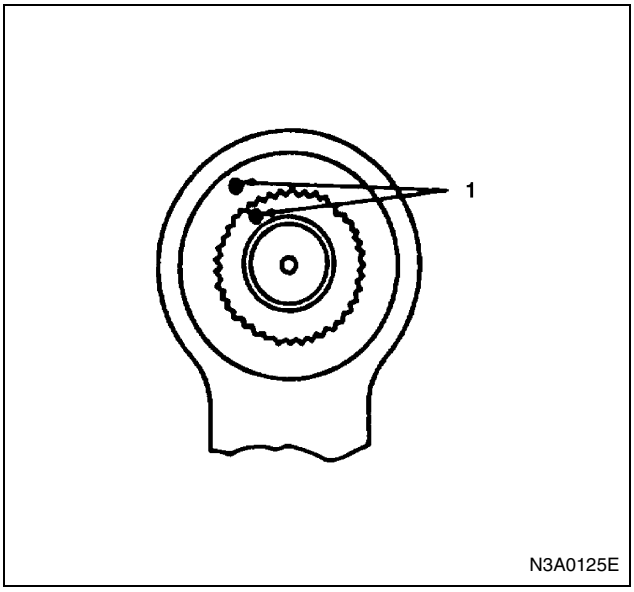
N3A0125E

Puller: 5-8840-2051-1



Installation

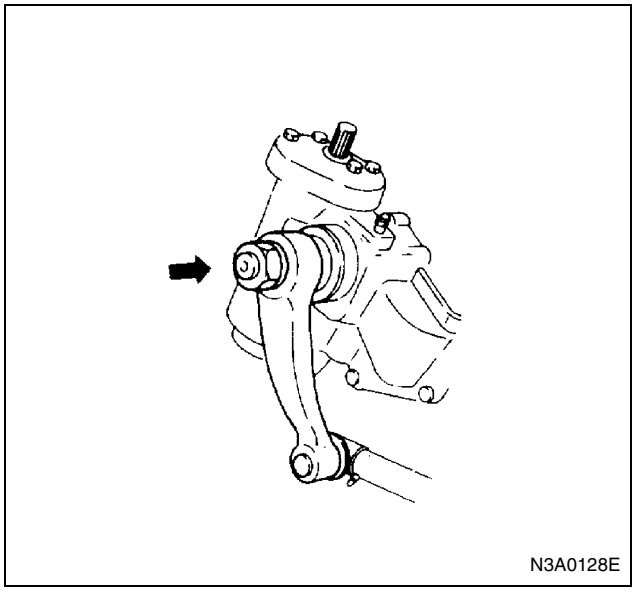
1. Pitman Arm
   Align the setting mark (1) applied at removal.



2. Nut

Tighten:

- Pitman arm nut to
  NHR, NKR Rigid suspension: 216 N·m (22 kg·m / 159 lb·ft)
  NPR, Wishbone suspension: 294 N·m (30 kg·m / 217 lb·ft)



3. Power Steering Unit
4. Unit Fixing Nut and Bolt

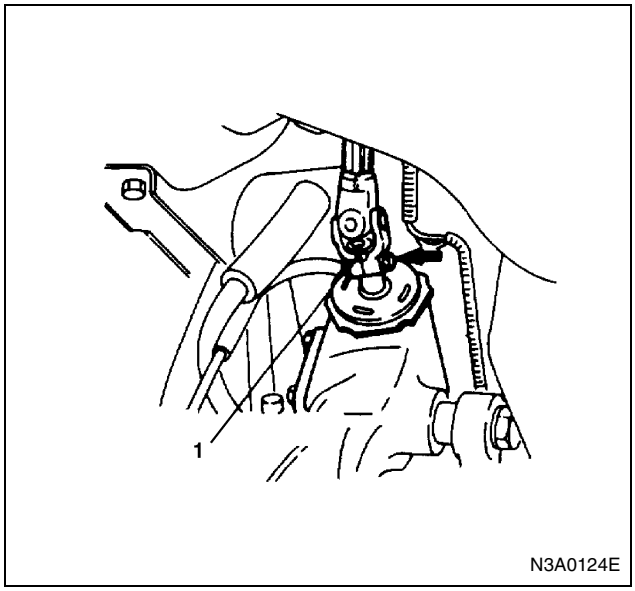
Tighten:

- Nut and bolt to 103 N·m (10.5 kg·m / 76 lb·ft)

5. Universal Joint
   Install the parts by aligning setting marks (1) applied at removal.

Tighten:

- Universal joint bolt to
  M8 bolt: 25 N·m (2.5 kg·m / 18 lb·ft)



6. Drag Link
7. Nut
8. Cotter Pin
   1) Install the drag link to the pitman arm and the knuckle arm.
   2) Tighten nuts to specified torque, with just enough additional torque to align cotter pin holes. Install new cotter pin.

Tighten:
- Nut to 167 N·m (17 kg·m / 123 lb·ft)
  - Connect the oil pipe. Tighten flare nuts to specified torque.

Tighten:
- Flare nut to 44 N·m (4.5 kg·m / 33 lb·ft)

9. Install the bumper assembly. (for Non-Tilt Cab Model)

Tighten:
- Bumper bolt to 40 N·m (4.1 kg·m / 30 lb·ft)

10. Install the under panel. (for Non-Tilt Cab Model)
11. Install the head light assembly, front grille and front combination light assembly. (for Non-Tilt Cab Model) Refer to “Headlight Replacement”.

Notice:
After installation, adjust head light aiming. Refer to “Cab and Chassis Electrical”. (Non-Tilt Cab Model)

Power Steering Pump

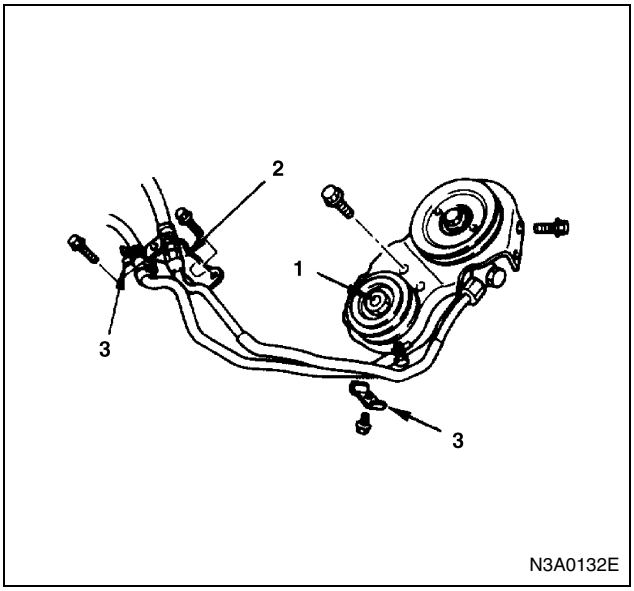
Preparation

- Drain the fluid through the pipe which is connected to the return board for the power steering pump.
- Disconnect the fluid piping.

Removal

4J Series Engine

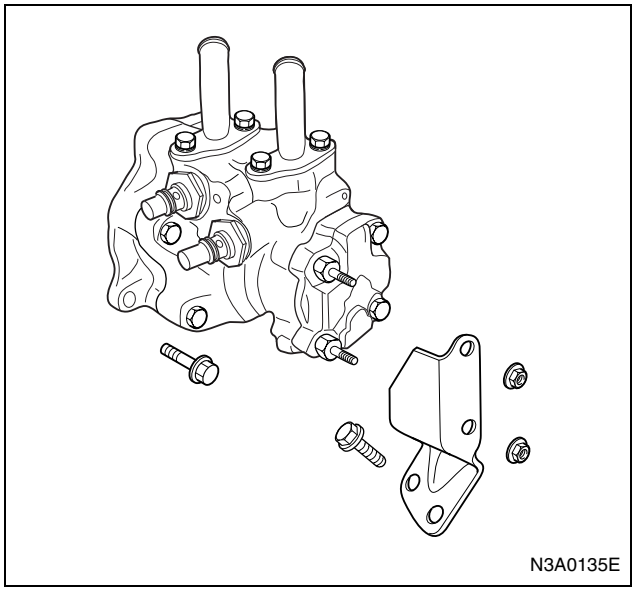
- Loosen the idler pulley locking nuts (1) for the power steering pump.
- Loosen the adjusting bolts for the drive belt and remove the drive belt.
- Remove the pipe brackets (2) and clips (3) on the alternator side.
- Remove the pump mounting brackets.



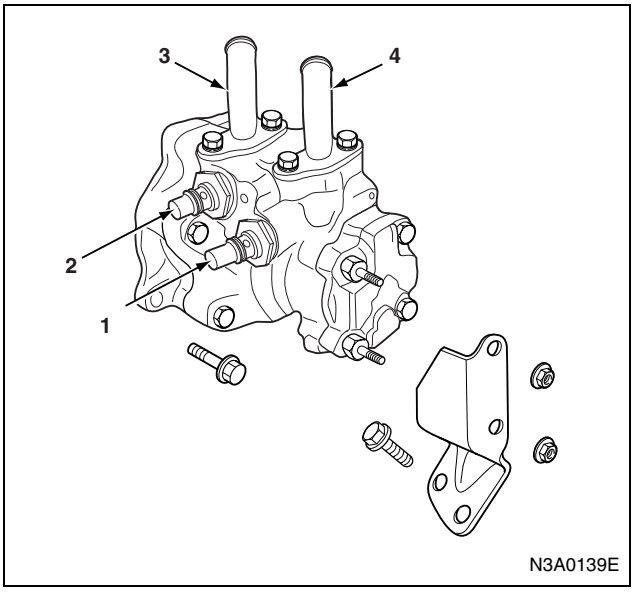
4HE1 Engine

- Block the vehicle wheels and apply the parking brake.
- Disconnect the battery ground cable.

1. Disconnect air intake hose at turbocharger side.
2. Raise the vehicle and remove front exhaust pipe with exhaust brake.
   - Remove bolts at manifold, silencer and support bracket.
3. Place a container under the hydraulic pump assembly to catch fluid when disconnecting hoses. Clean the surfaces around fittings before removing them.

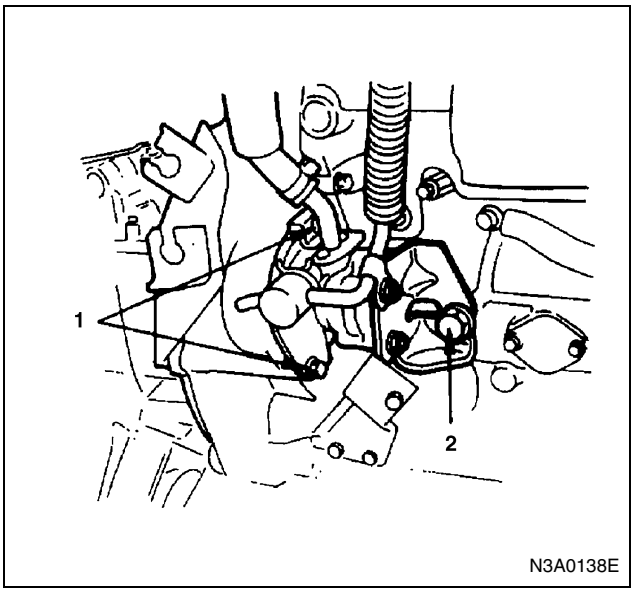


4. Remove power steering outlet flexible hose (1) and nut.
5. Remove hydraulic booster outlet pipe (2) nut.
6. Remove two clips for hydraulic booster lines on the flywheel housing.
7. Remove clip for hydraulic booster lines on the left side member.
8. Hydraulic booster inlet hose (3).
9. Power steering inlet hose (4).
10. Remove hydraulic booster pipe from the pump.
11. Remove hydraulic pump assembly with bracket and O-ring.



4HF1 Engine

- Loosen three fixing bolts for power steering pump (Two on the flywheel side (1) and one on the cylinder body side (2)) and remove them.



Installation

4J Series Engine

Tighten:

- Bolt and nut to

  Pump and bracket assembly: 19 N·m (1.9 kg·m / 14 lb·ft)

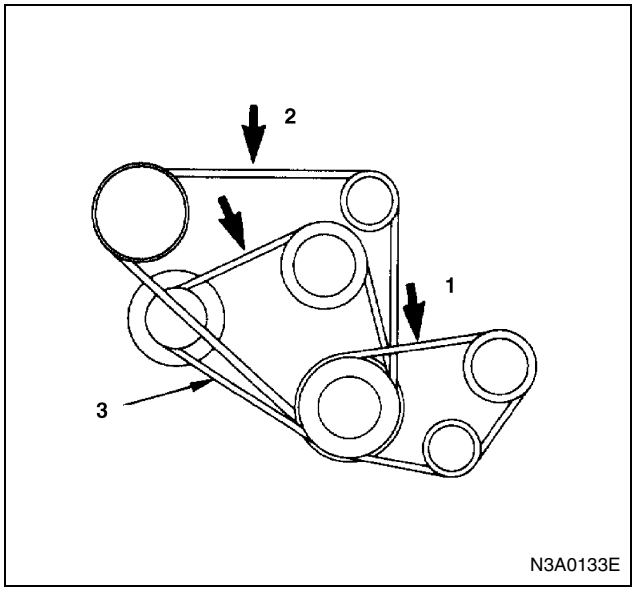
  Oil pipe bracket: 19 N·m (1.9 kg·m / 14 lb·ft)

  Clip bolt: 10 N·m (1.0 kg·m / 87 lb·in)

- Install the drive belt for the power steering pump and adjust the belt tension. Press the middle of the belt with a 98N (10kg) weight to measure the deflection of the belt.

Belt Deflection

8 — 12 mm (0.315 — 0.472 in)

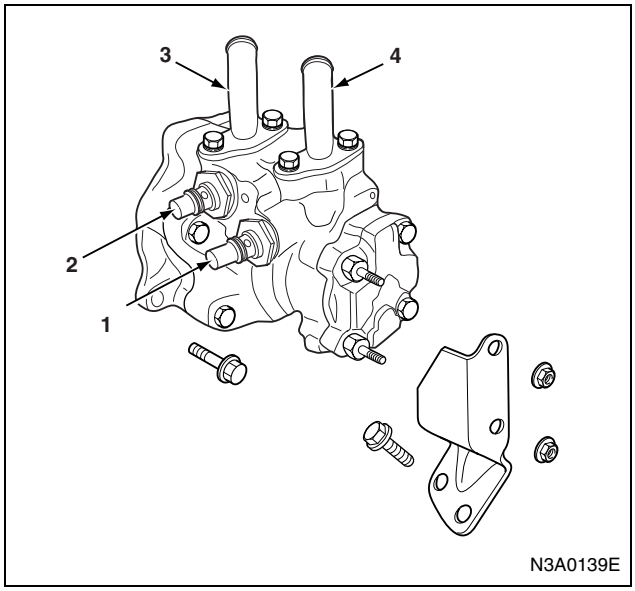


Legend

1. Power steering pump drive belt
2. A/C compressor drive belt
3. A/C generator cooling fan drive belt

4HE1 Engine

1. Attach new O-ring and install hydraulic pump assembly to the engine.



2. Install booster outlet pipe (2) and nut.

Tighten:

- Nut to 23.5 N·m (2.4 kg·m / 17 lb·ft)

3. Install power steering outlet flexible hose (1) and nut.

Tighten:

- Nut to 23.5 N·m (2.4 kg·m / 17 lb·ft)

4. Connect hydraulic booster inlet hose (3).
5. Connect power steering inlet hose (4).
6. Install clips for hydraulic booster lines.
7. Connect air intake hose.

8. Install exhaust pipe with exhaust brake.
9. Fill the power steering and hydraulic booster systems with DEXRON®-III.
   Bleed the power steering system as outlined in this section.
   Bleed the hydraulic booster system. Refer to “Hydraulic Booster Line Bleeding” in Section 5.

4HF1 Engine

- Attach new O-rings and tighten them to the specified torque.

Tighten:

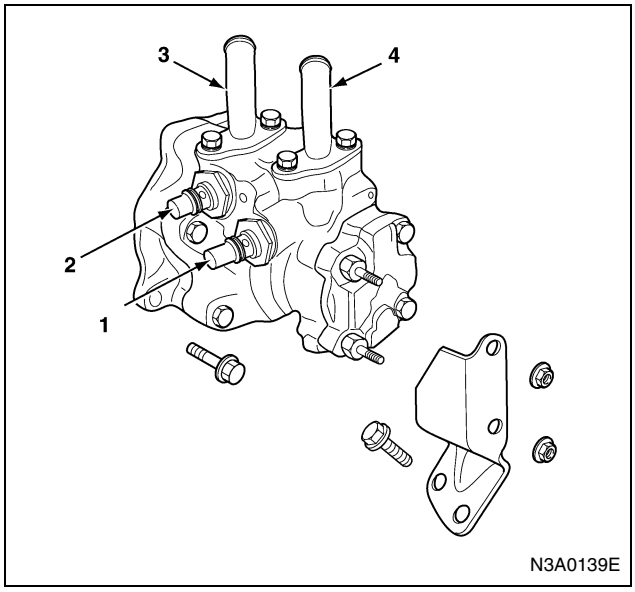
- Power steering pump bolt to
  Flywheel side: 43 N·m (4.4 kg·m / 32 lb·ft)
  Cylinder body side: 44 N·m (4.5 kg·m / 33 lb·ft)

Tandem Hydraulic Pump

Removal

- Block the vehicle wheels and apply the parking brake.
- Disconnect the battery ground cable.

1. Disconnect air intake hose at turbocharger side.
2. Raise the vehicle and remove front exhaust pipe with exhaust brake.
   - Remove bolts at manifold, silencer and support bracket.
3. Place a container under the hydraulic pump assembly to catch fluid when disconnecting hoses. Clean the surfaces around fittings before removing them.
4. Remove power steering outlet flexible hose (1) and nut.
5. Remove hydraulic booster outlet pipe nut.
6. Remove clips for hydraulic booster lines on the flywheel housing.
7. Remove clip for hydraulic booster lines on the left sidemember.
8. Hydraulic booster inlet hose (3).
9. Power steering inlet hose (4).
10. Remove hydraulic booster outlet pipe (2) from the pump.
11. Remove hydraulic pump assembly with bracket and O-ring.



Installation

1. Attach new O-ring and install hydraulic pump assembly to the engine.
2. Install booster outlet pipe (2) and nut.

Tighten:

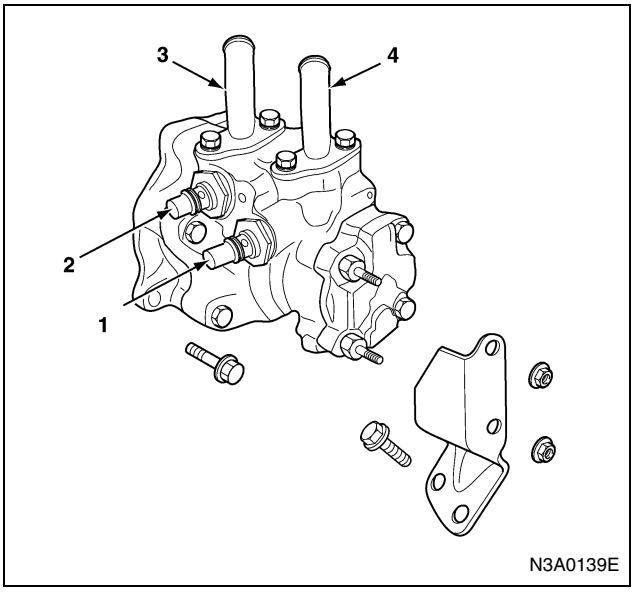
- Bolt and nut to 23.5 N·m (2.4 kg·m / 17 lb·ft)

3. Install power steering outlet flexible hose (1) and nut.

Tighten:

- Bolt and nut to 23.5 N·m (2.4 kg·m / 17 lb·ft)
  - Put the cap on the eye joint and clamp the cap with the fastener.

4. Connect hydraulic booster inlet hose (3).
5. Connect power steering inlet hose (4).
6. Install clips for hydraulic booster lines.
7. Connect air intake hose.
8. Install exhaust pipe with exhaust brake.
9. Fill the power steering and hydraulic booster systems with ATF DEXRON®-III.
   Bleed the power steering system as outlined in this section.
   Bleed the hydraulic booster system. Refer to “Hydraulic Booster Line Bleeding” in Section 5.

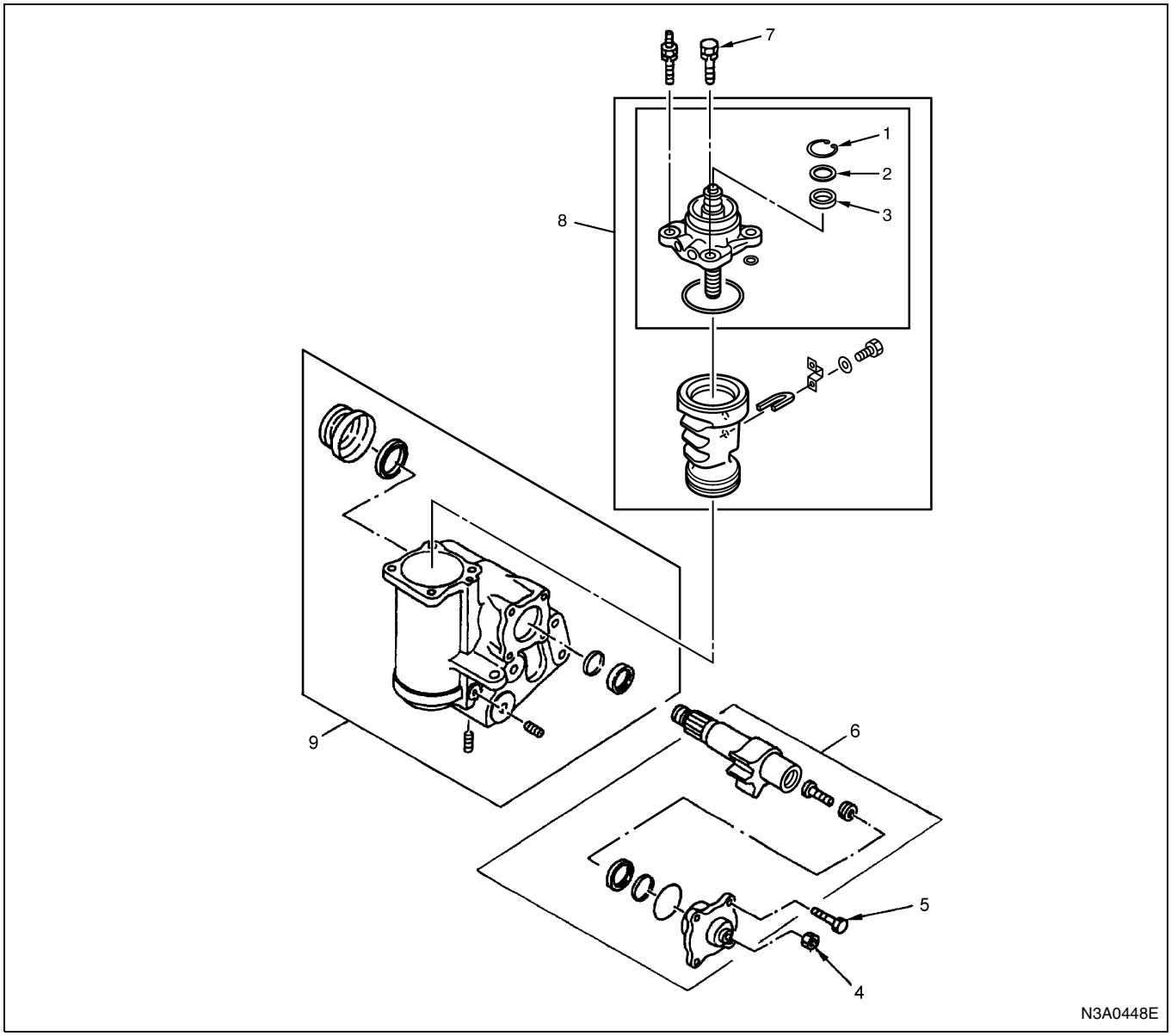

3
4
2
1
N3A0139E

UNIT REPAIR

Power Steering Unit

Illustrations of this section are based on RHD model.
Illustrations for LHD model are symmetrically opposite.

Power Steering Unit



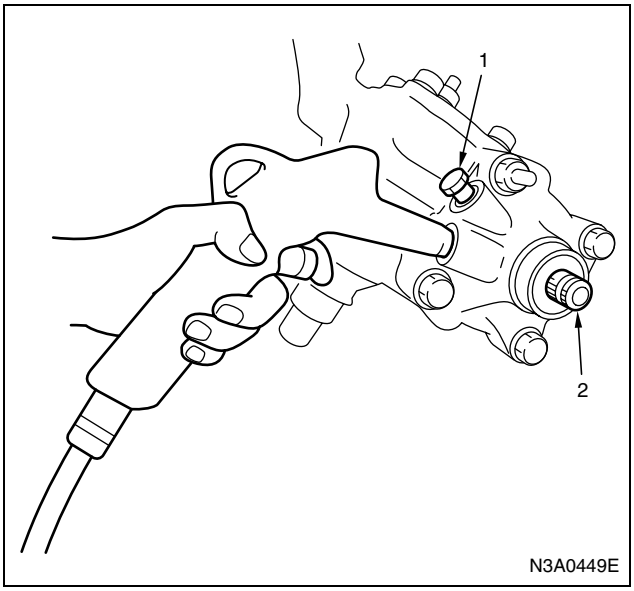
Legend

1. Retaining ring
2. Dust seal
3. Oil seal
4. Lock nut
5. Bolt
6. Sector shaft assembly and side cover assembly
7. Bolt
8. Valve housing and worm shaft assembly
9. Body assembly

Disassembly

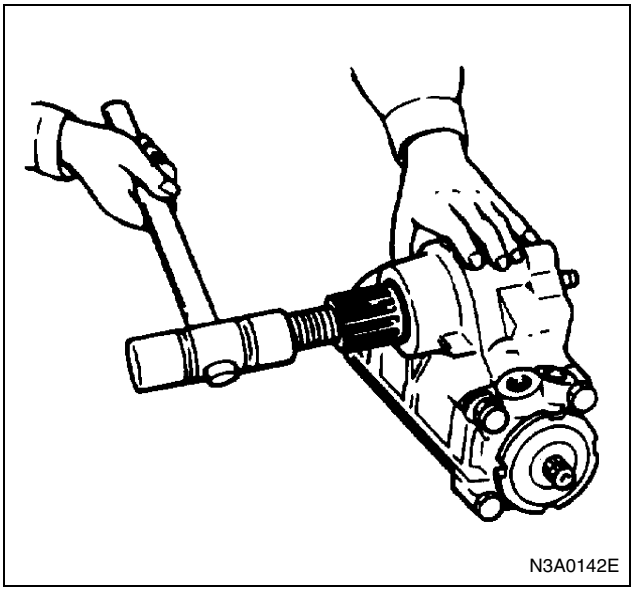
1. Retaining ring
2. Dust seal
3. Oil seal
   - Clean around the stub shaft.
   - Plug the hose hole on the inlet side.
   - Blow air through the hole on the outlet side to remove the oil seal.

Caution:
- Be careful because the oil seal may suddenly fly out due to air pressure.
- Take care not to damage the pipe seating area in port.

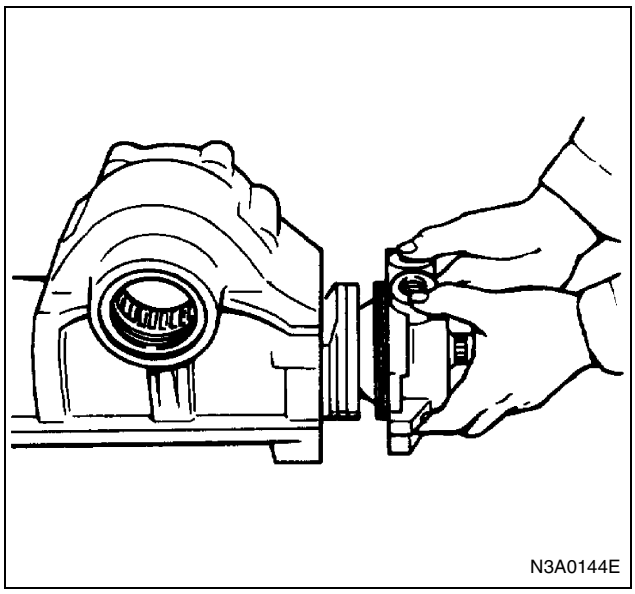


Legend
1. Plug
2. Stub shaft

4. Lock Nut
5. Bolt
6. Sector Shaft Assembly and Side Cover Assembly
   When removing, take care so as not to cause damage to the serrations, threads and oil seal.



7. Bolt
8. Valve Housing and worm shaft Assembly
   Remove piston with valve housing.
   Always keep ball-nut assembly in a horizontal position and avoid holding it vertically.



9. Body Assembly

Inspection and Repair

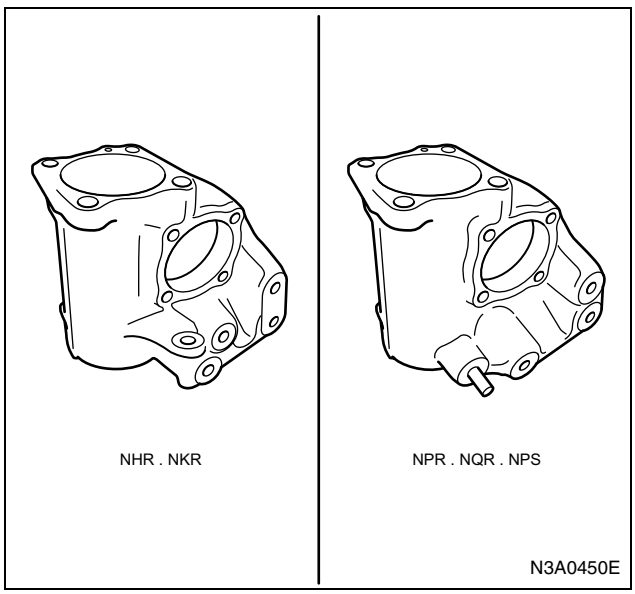
Make necessary correction or parts replacement if wear, damage or any other abnormal conditions are found through inspection.

Visual Check

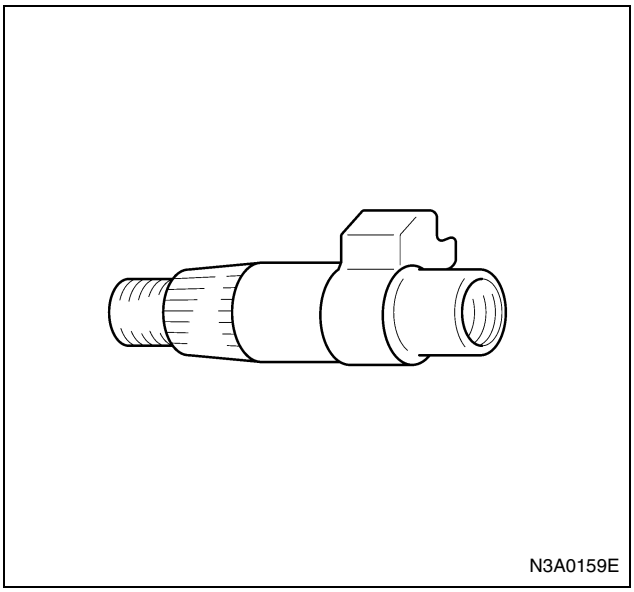
Inspect the following parts for wear, damage or other abnormal conditions.
- Gear box
- Sector shaft
- Needle roller bearing
- Piston and worm shaft
- Oil seal, Dust cover, Y-gasket, O-ring and seal ring

Gear Box

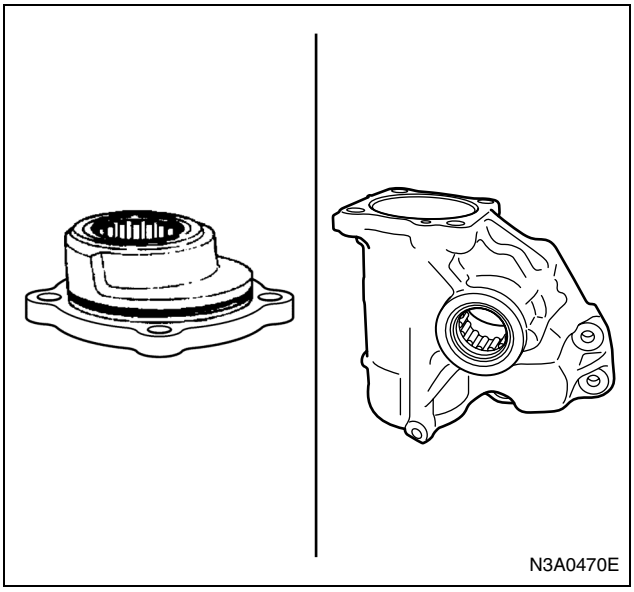
Check the body for cracks, and body inner surface and piston sliding surface for scratches.



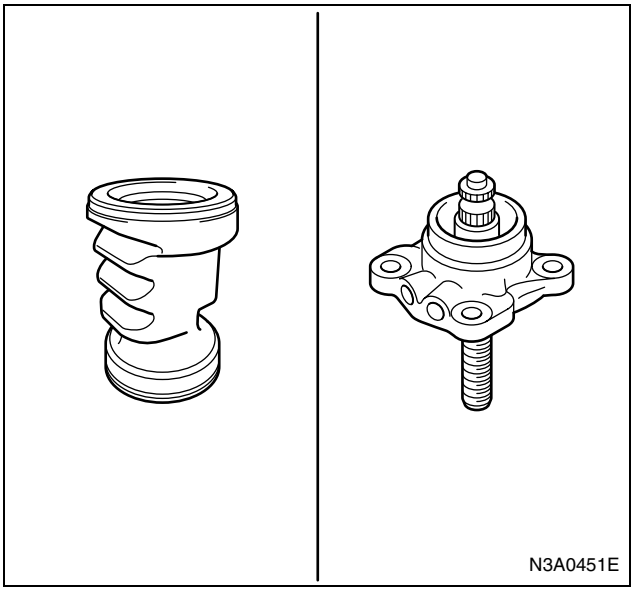
Sector Shaft
If the shaft is worn, twisted, scratched or partially worn, replace it with a new one.



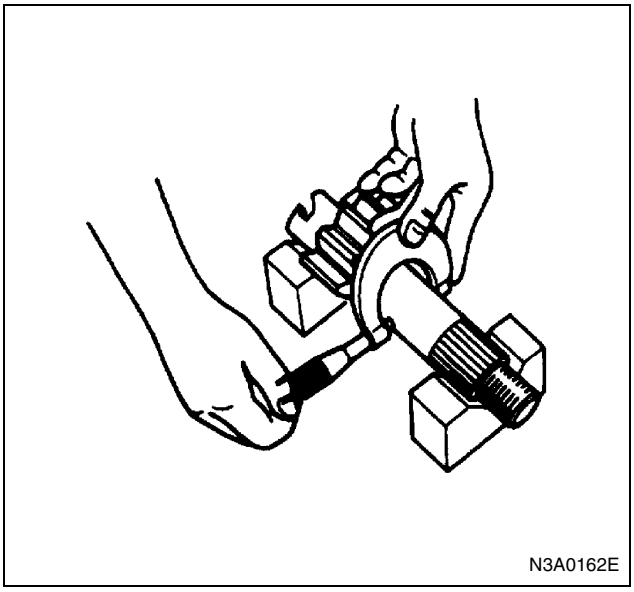
Bearing
If the bearing race surface is worn, scratched or seized, replace it with a new assembly.



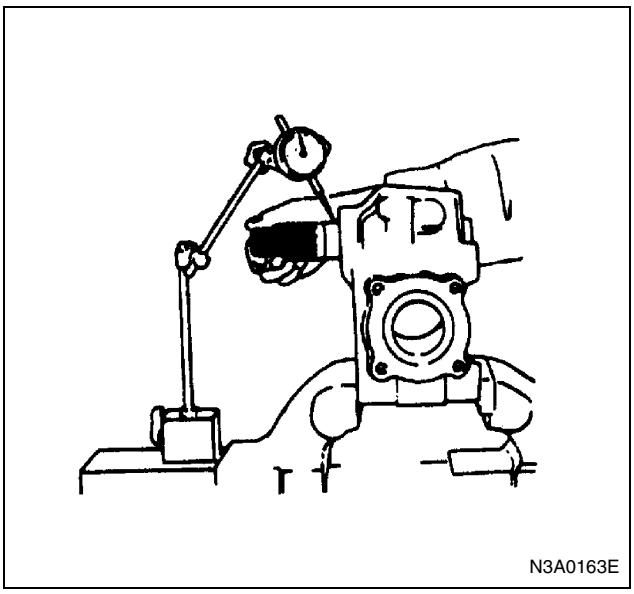
Piston and Worm Shaft
If the piston surface is remarkable worn or play is excessive, replace with a new assembly.



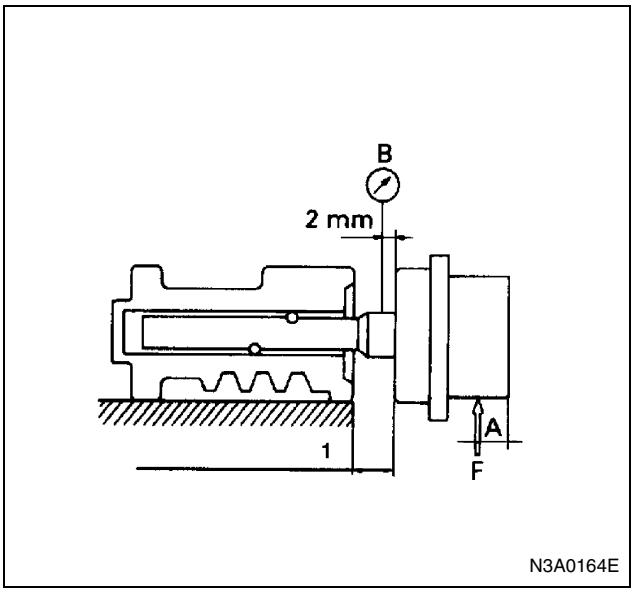
Measurement of Sector Shaft Outside Diameter
Standard: 39.975 mm (1.574 in)
Limit: 39.925 mm (1.572 in)



Measurement of Play between Sector Shaft and Needle Roller Bearing
Limit: 0.12 mm (0.0047 in)


N3A0163E

Valve Housing Assembly
Measure the end play of the ball screw in the axial direction.
A: 16 mm (0.6299 in)
F: 39 N (4 kg/11 lb)
B (end play): 0.5 mm (0.0197 in) or less



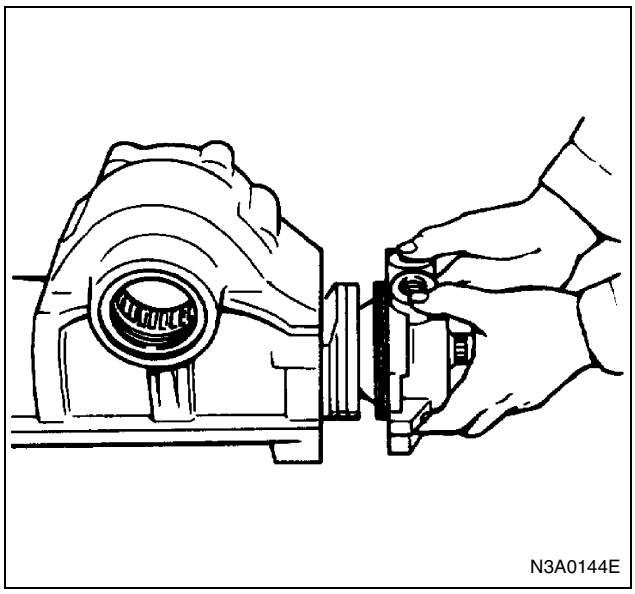
N3A0164E

Legend
1. Neutral position

Reassembly

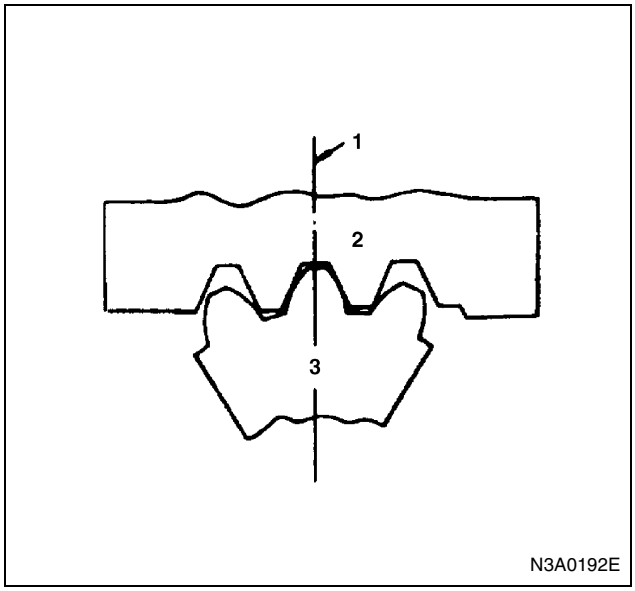
1. Body Assembly
2. Valve Housing Assembly

Tighten:
- Valve housing and worm shaft assembly bolt to
  NHR, NKR: 59 N·m (6.0 kg·m / 43 lb·ft)
  NPR, NQR, NPS: 103 N·m (10.5 kg·m / 76 lb·ft)
  Install the parts with the valve side turned to front and worm gear of piston toward the sector gear. Apply liquid to the valve housing contact surface.


N3A0144E

3. Bolt
4. Sector Shaft Assembly and Side Cover Assembly
5. Bolt

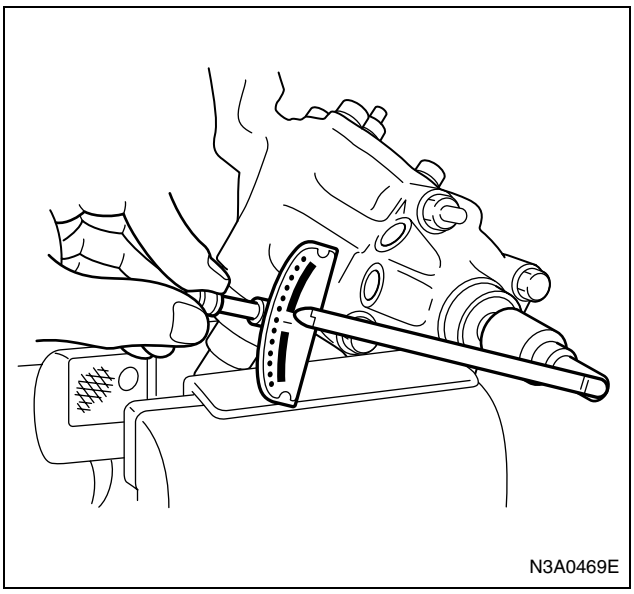
Tighten:
- Side cover bolt to 59 N·m (6.0 kg·m / 43 lb·ft)
  Align the center tooth (1) of piston (ball nut (2)) with that of the sector shaft (3).



N3A0192E

6. Lock Nut
   1) Install drop arm.
   2) Hold the sector shaft in a straight ahead position.
   3) With the adjuster screw, adjust the preload to specification.

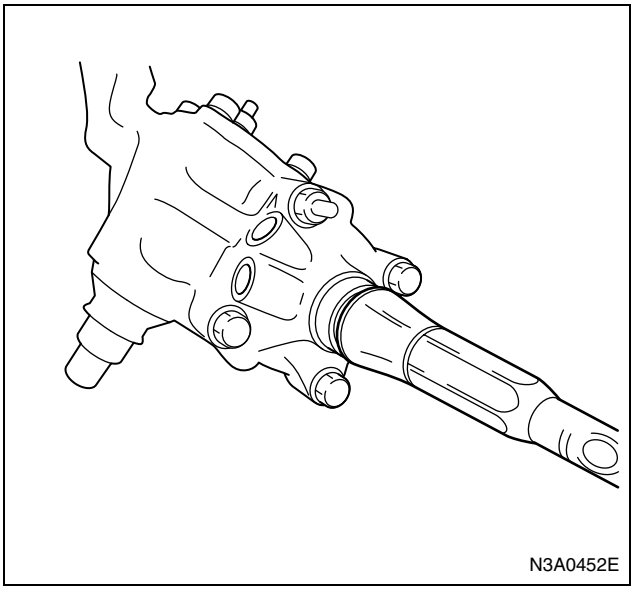
Preload Between Sector Shaft and Ball Nut
1.3 N·m (0.13 kg·m/1 lb·ft) or less



4) Apply liquid gasket to the lock nut. Adhesive liquid gasket (JIS K6820 Category 1), HERME SEAL 101Y, THREE BOND 1102 or equivalent
5) Tighten the lock nut.

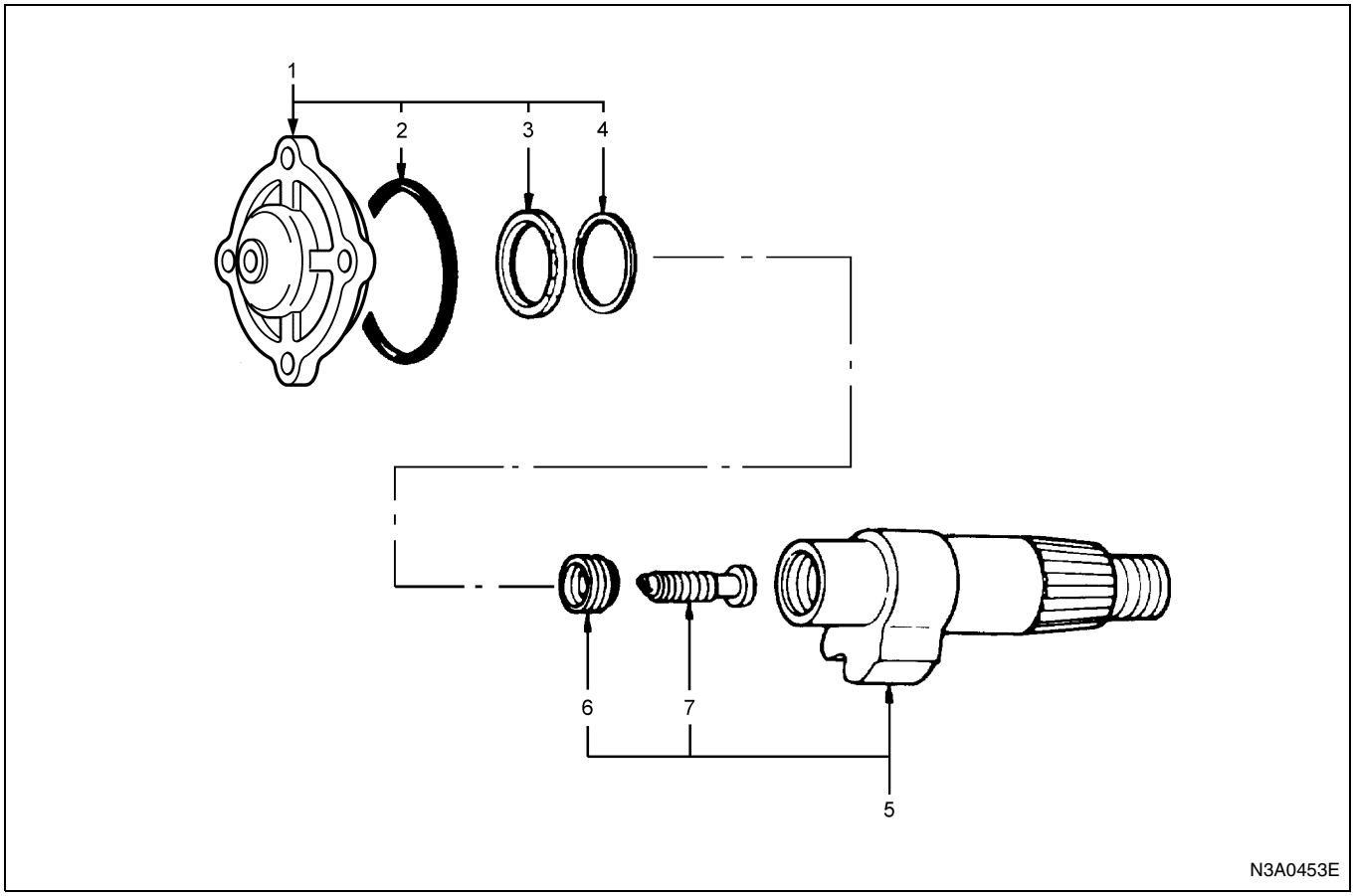
Tighten:
- Lock nut to 69 N·m (7.0 kg·m / 51 lb·ft)

7. Oil seal
   - Use new one.
   - Apply a thin coat of power steering fluid to the lip, and check the installation direction.
     Installer: 5-8522-0026-0



8. Dust seal
   - Face the dust lip side outward.
9. Retaining ring
   - Face the surface with chamfered periphery toward the oil seal side.
   - Use new one.

Side Cover and Sector Shaft Assembly



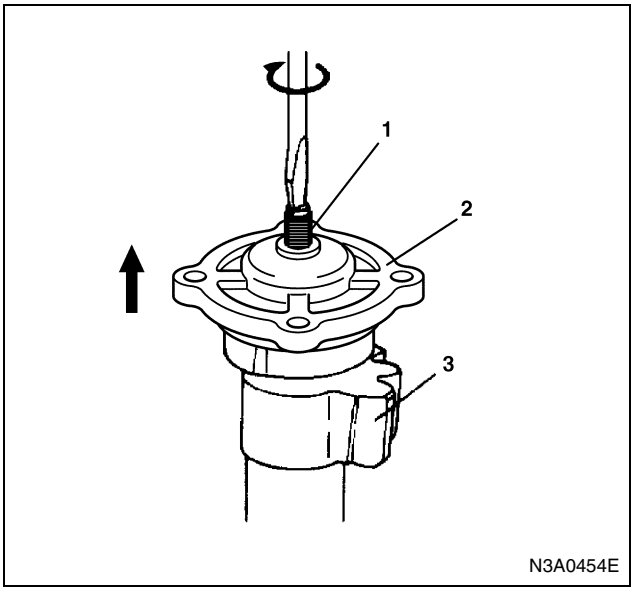
Legend

1. Side cover assembly
2. O-ring
3. Back up ring
4. Y-gasket
5. Sector shaft assembly
6. Retainer
7. Adjuster screw

Disassembly

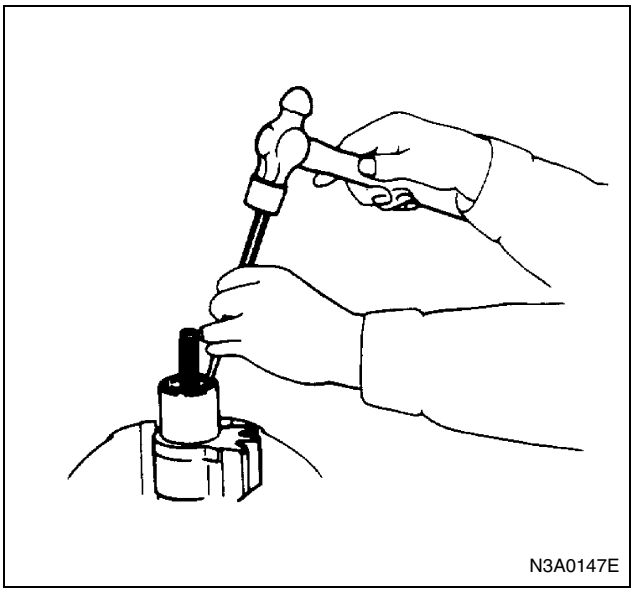
If the sector shaft is going to be fixed on the bench vice during disassembly, be sure to protect the sector shaft with cloth or other soft material.

1. Side Cover
   Gradually turn the adjuster screw (1) clockwise, and the side cover assembly will be lifted. Thus, you can separate the side cover assembly (2) from the sector shaft assembly (3).

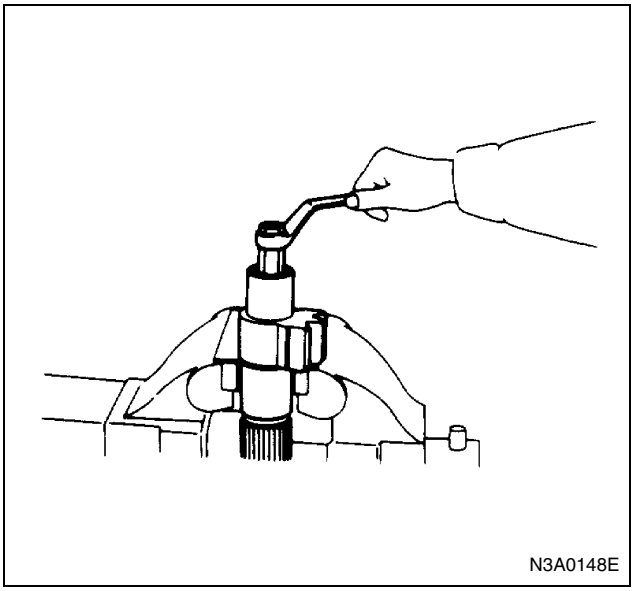


2. O-ring
3. Back Up Ring

4. Y-Gasket
   Using needle, scriber or equivalent.
5. Sector Shaft Assembly
   Unless otherwise a problem, it is not necessary to disassembly.
6. Retainer
   1) Raise the two lips of the retainer.


N3A0147E

   2) Using retaining bar.


N3A0148E

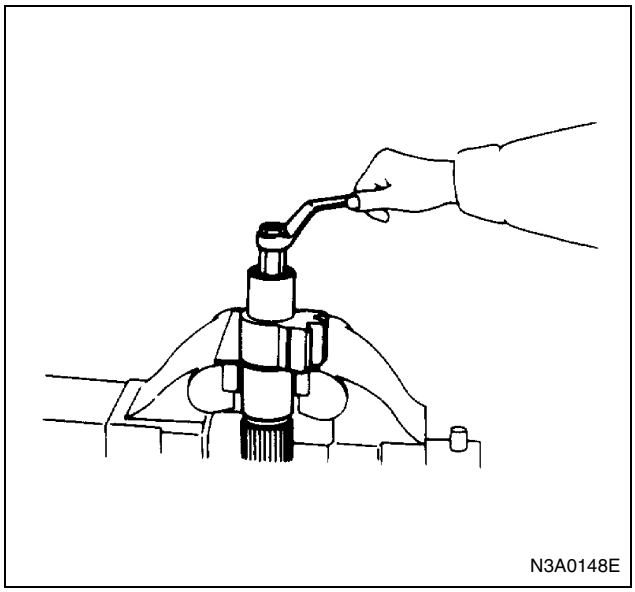
7. Adjuster Screw

Inspection and Repair

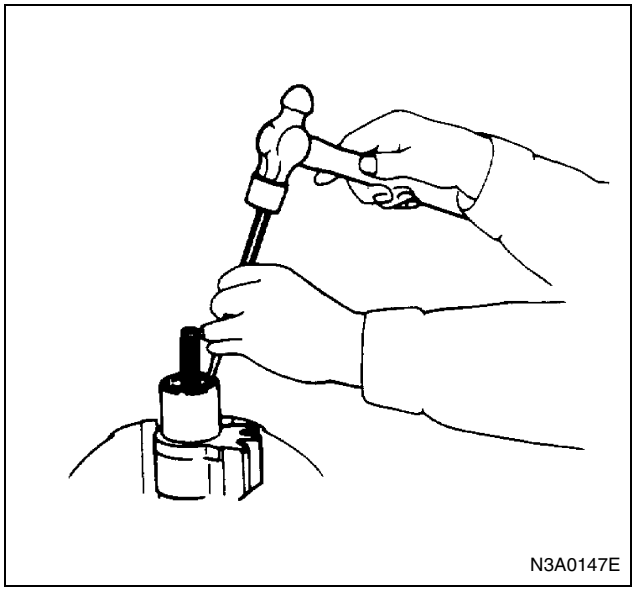
Refer to “Power Steering Unit” in this section.

Reassembly

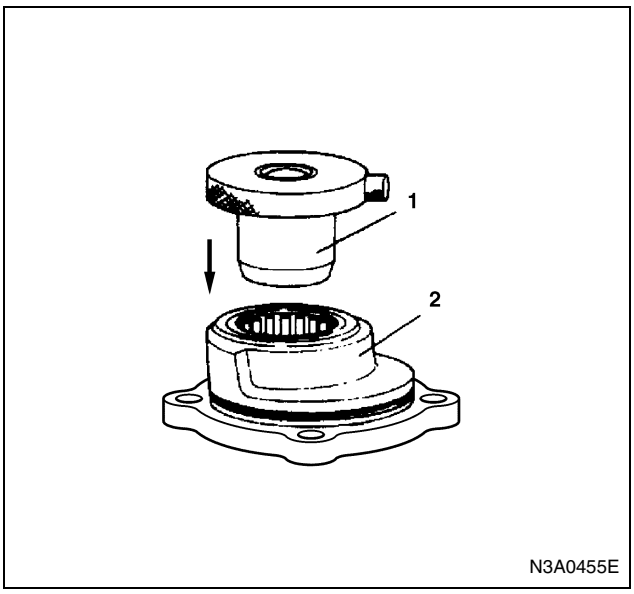
1. Adjuster Screw
2. Retainer
   Discard used retainer and install a new one.
   Install and fully tighten the retainer and back off 180 degrees.
   Retighten to a torque of 39 N (4 kg /44 lb) and back off 20 degrees. Check that the adjuster screw turns smoothly.


N3A0148E

   Caulk the retainer in position.

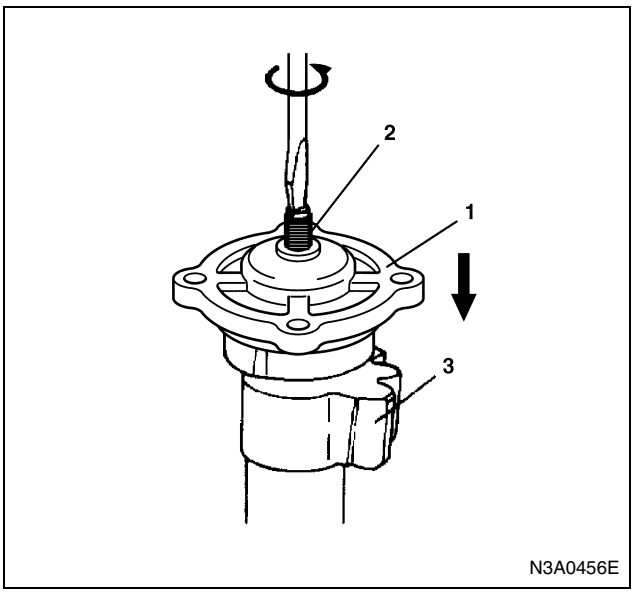

N3A0147E

3. Sector Shaft Assembly
4. Y-Gasket
   Install the gasket so that its lip faces to the bearing.
   If the lip is deformed, correct.
   Apply grease to Y-gasket.
5. Back Up Ring
   When the back up ring is installed, use installer for alignment.

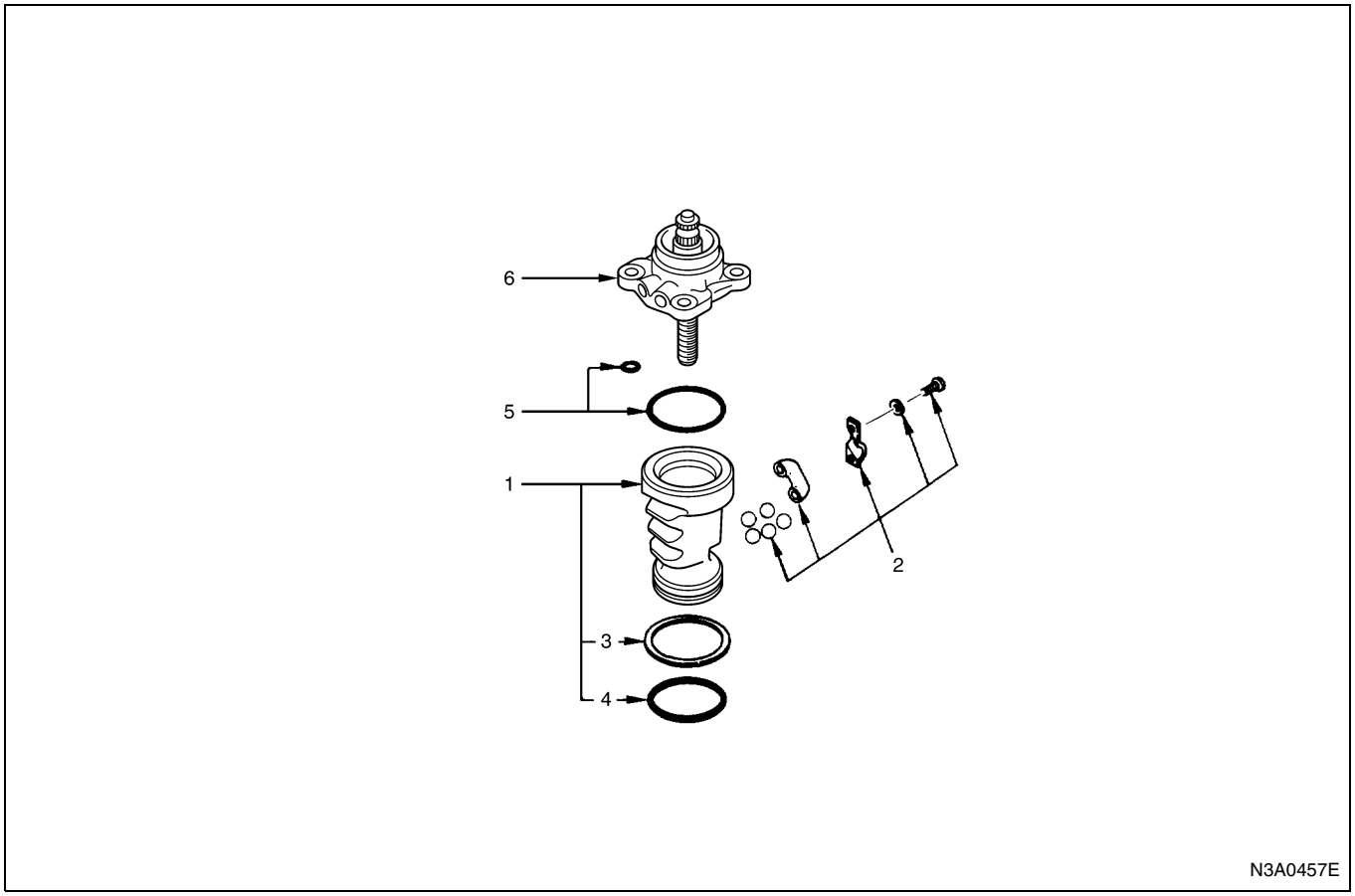


Legend
1. Installer
2. Side cover

6. O-ring
7. Side Cover Assembly
   Mate the screw hole at the center of the side cover (1) with the adjuster screw (2) on the sector shaft assembly (3), and fix the side cover assembly to the sector shaft assembly by turning the adjuster screw counterclockwise.



Valve Housing Assembly



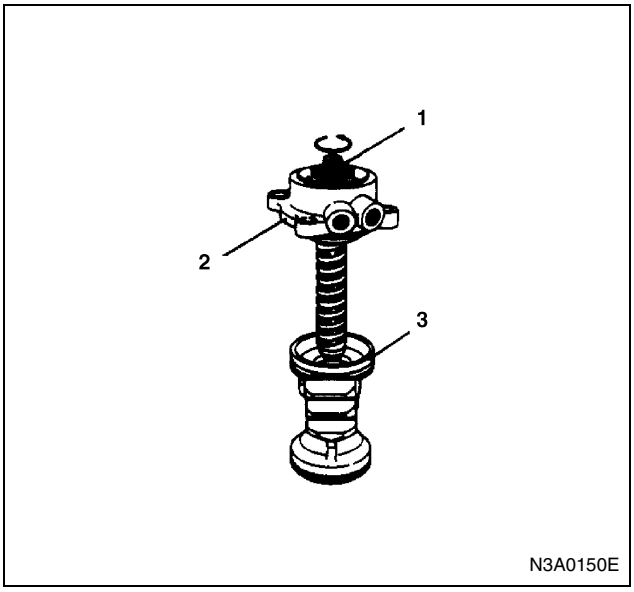
Legend

1. Piston assembly
2. Ball, tube, tube grip, screw and washer
3. Seal ring
4. O-ring
5. O-ring
6. Valve housing and worm shaft assembly

Disassembly

1. Piston Assembly
   Hold the housing with the piston end facing downward, and turn the stub shaft counterclockwise. Then, the worn shaft can be removed from the piston.

Caution:
The steel ball put in the ball race for the piston and worm shaft will drop inside of the piston. Be careful not to let the piston fall down.



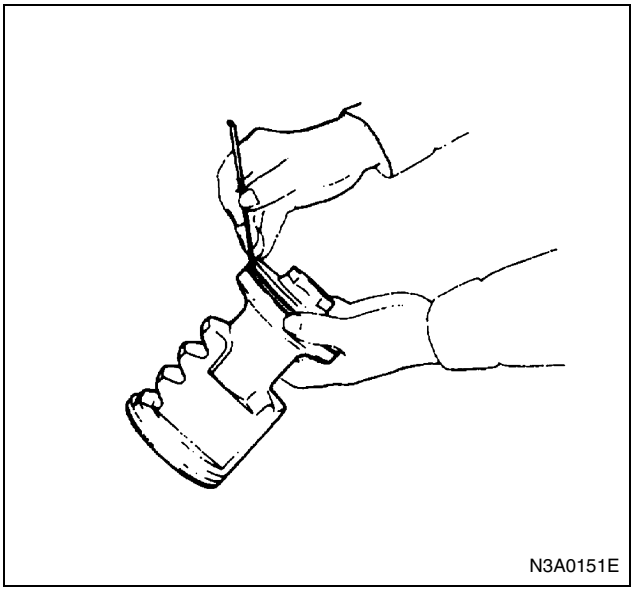
Legend

1. Stub shaft
2. Valve housing
3. Piston

2. Ball, Tube, Tube Grip, Screw and Washer
   Be careful not to lose the ball when remove the ball tube.

Number of Balls: 28

3. Seal Ring



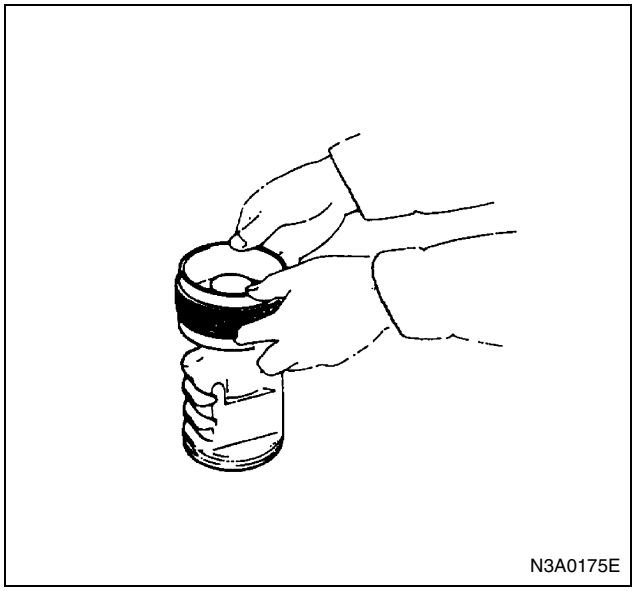
4. O-ring
5. O-ring
   Using needle, scriber or equivalent.
6. Valve housing and worm shaft assembly.

Inspection and Repair

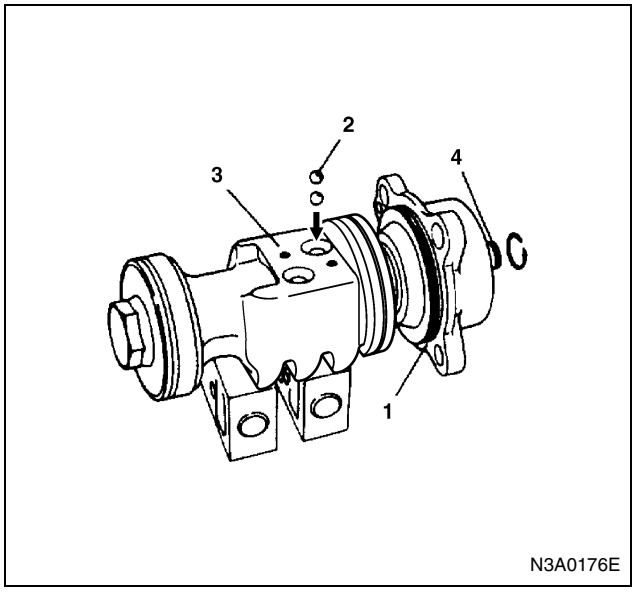
Refer to “Power Steering Unit” in this section.

Reassembly

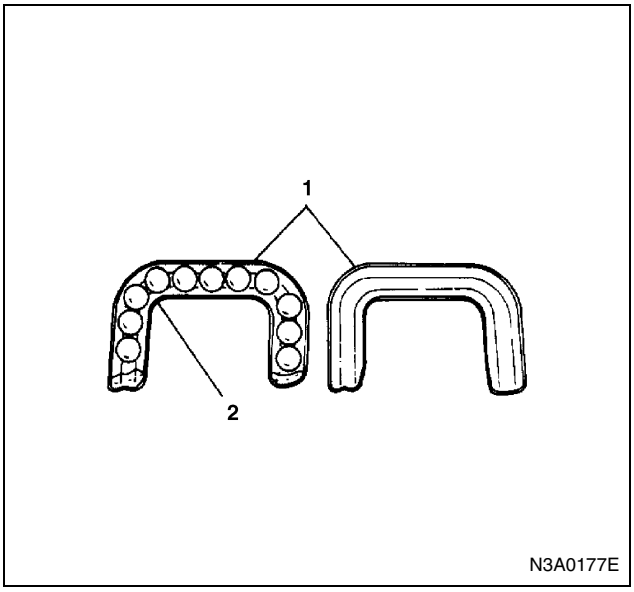
1. Valve housing and worm shaft assembly
2. O-ring
3. O-ring
4. Seal Ring
   When the O-ring and seal ring are installed, use installer for alignment.



5. Piston Assembly
6. Ball, Tube, Tube Grip, Screw and Washer
   1) Put the valve housing assembly (1) horizontally. Insert the ball (2) into the ball tube hole in the piston (3) while rotating the stub shaft (4). Thus, the ball can be easily mounted.



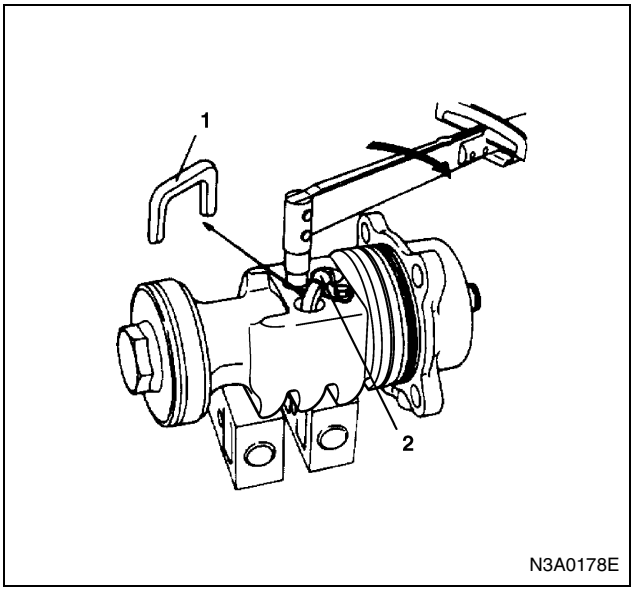
   2) Apply a sufficient amount of grease to the inner surface of the tube (1). Put and paste the balls (2) to the inner surface of the tube. Then, put the other ball tube onto the tube to which grease has been applied and the balls have been pasted.



3) Then, tighten the screw.

Tighten:

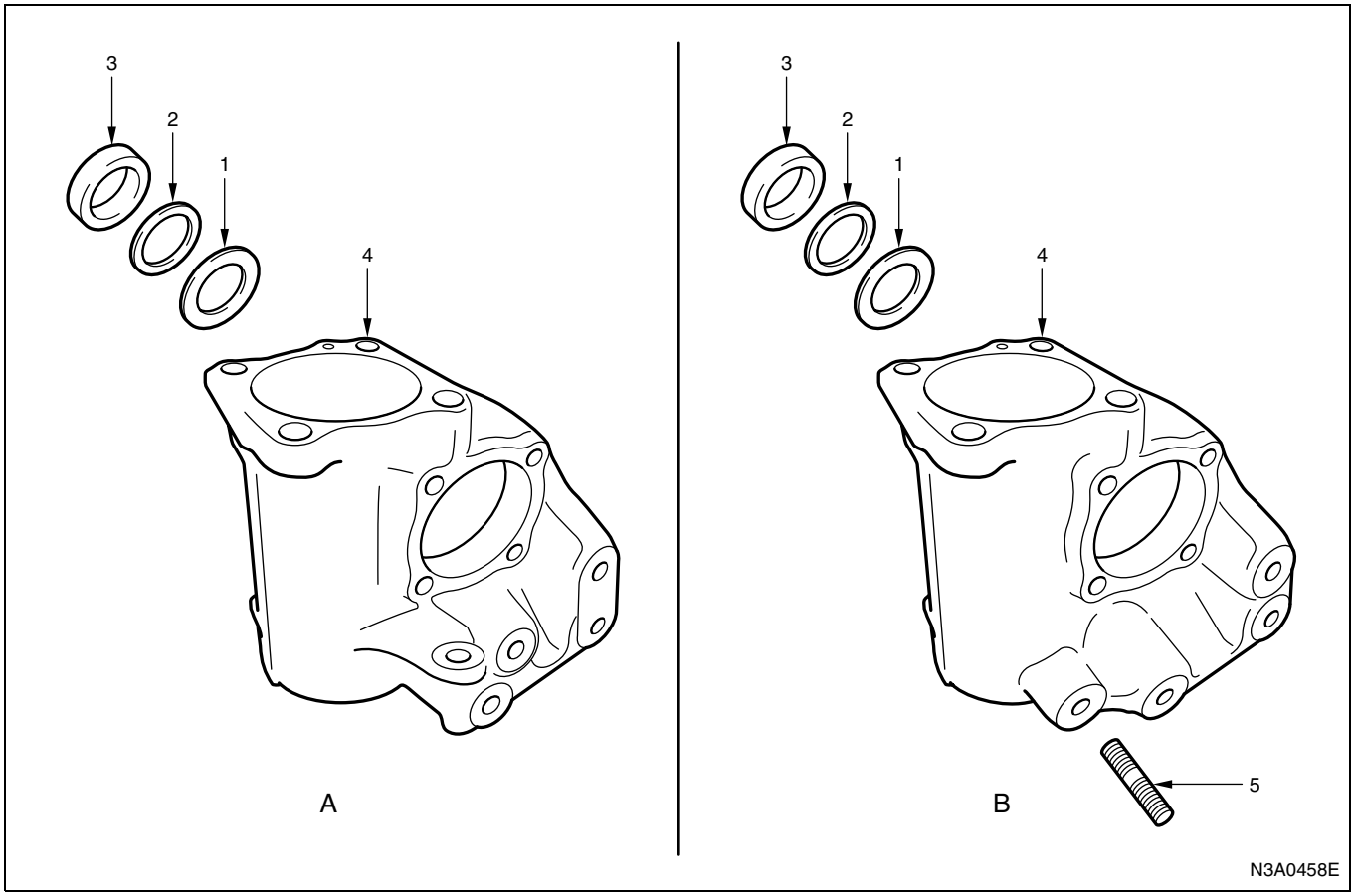
- Tube screw to 5 N·m (0.5 kg·m / 43 lb·in)



Legend

1. Tube
2. Tube grip

Body Assembly



Legend

A. NHR, NKR
B. NPR, NQR, NPS
1. Y-gasket
2. Back up ring
3. Oil seal
4. Body
5. Stud

Disassembly

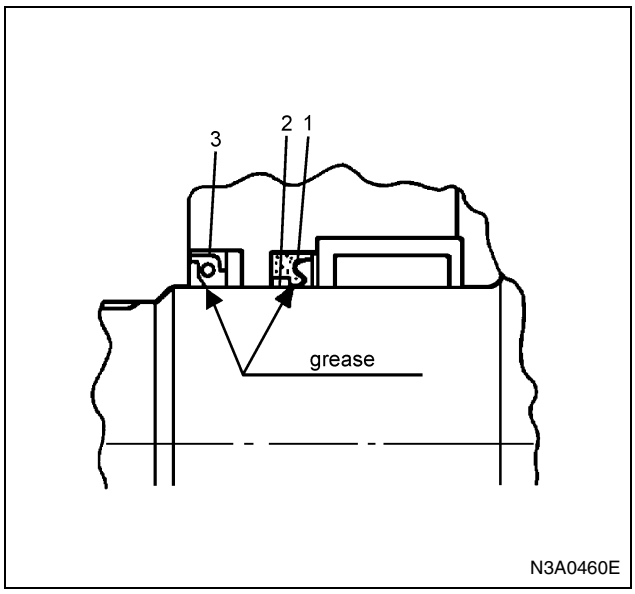
1. Y-gasket
2. Back Up Ring
3. Oil Seal
4. Body
5. Stud

Inspection and Repair

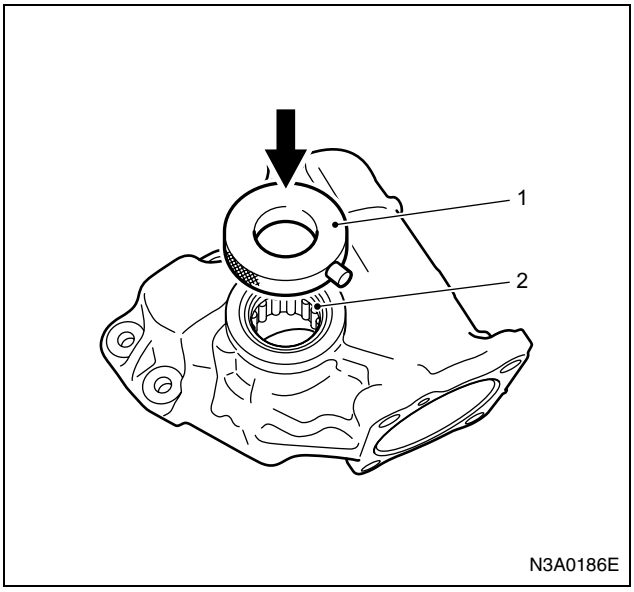
Refer to “Power Steering Unit” in this section (3B1-15).

Reassembly

Note the direction of installation.
Apply grease to these parts.

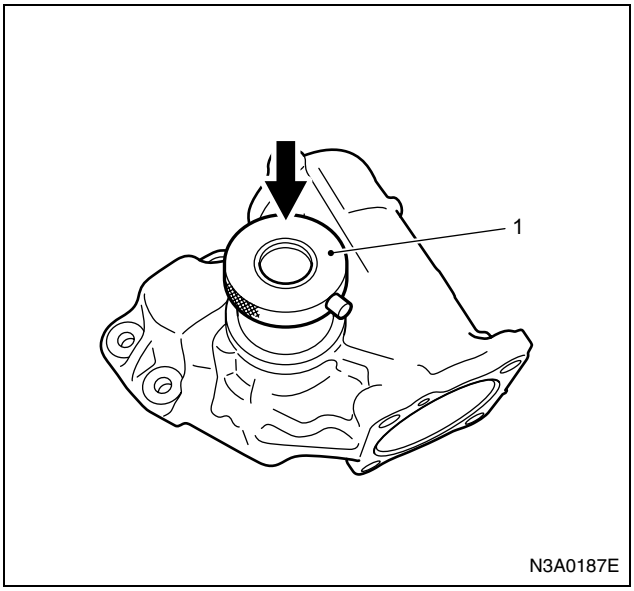


1. Body
2. Oil Seal
   Using installer.



Legend
1. Installer
2. Oil seal

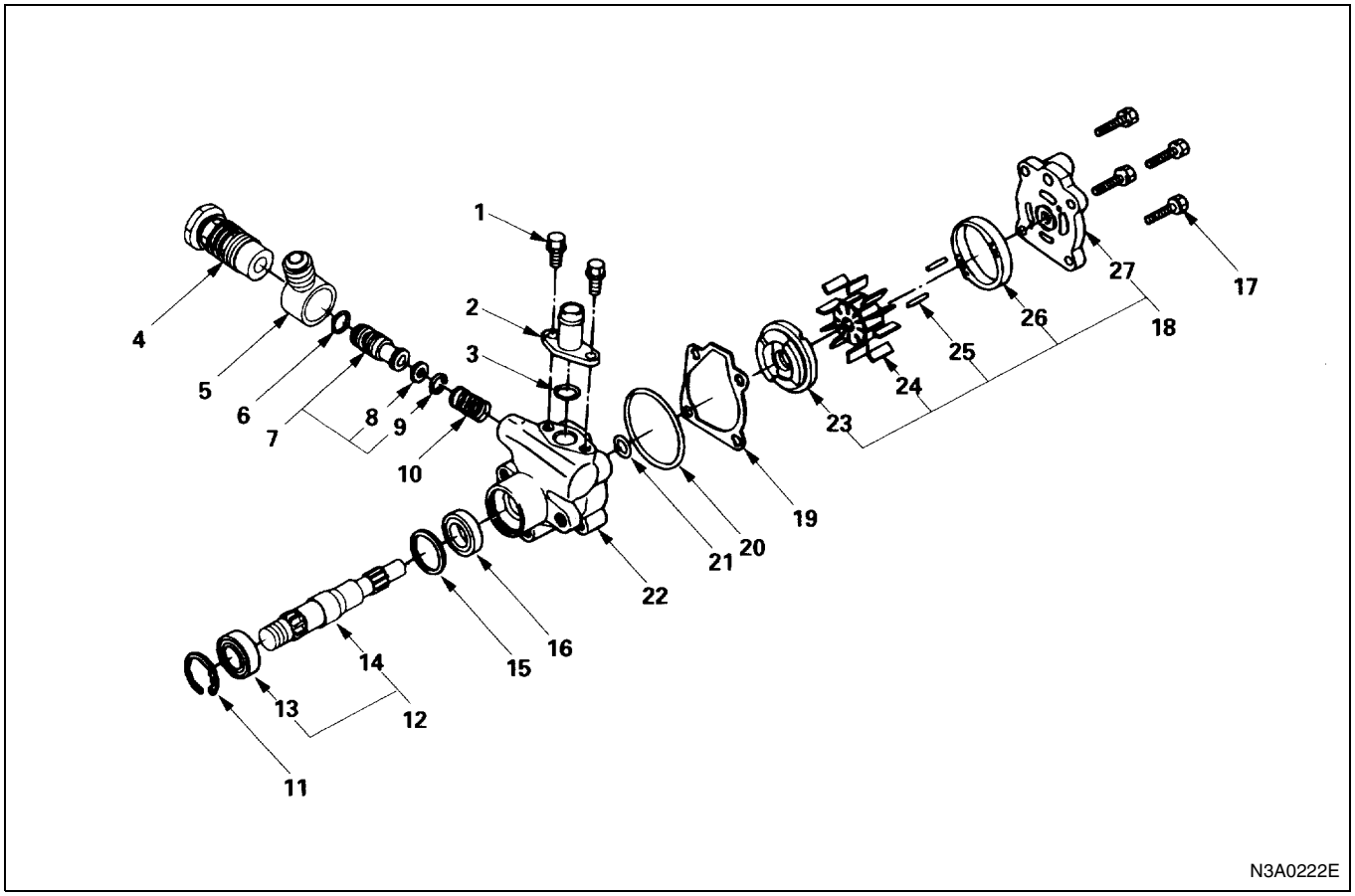
3. Y-gasket
4. Back Up Ring
   When the back up ring is installed, use installer (1) for alignment.



5. Stud

Tighten:
- Stud to 40 N·m (4.1 kg·m / 29.5 lb·ft)

Power Steering Pump (4J Series Engine)



Legend

1. Bolt
2. Pipe, suction
3. O-ring
4. Connector
5. Connector
6. O-ring
7. Valve
8. Retaining ring
9. Filter
10. Spring
11. Snap ring
12. Shaft assembly
13. Bearing
14. Shaft
15. Retaining ring
16. Oil seal
17. Bolt
18. Rear housing assembly and pump cartridge
19. Gasket
20. O-ring
21. O-ring
22. Front housing
23. Pressure plate
24. Rotor and vane
25. Cam
26. Pin
27. Rear housing

Disassembly

Preparation

Clean oil pump with solvent (its plug discharge and suction port to prevent the entry of solvent). Be careful not to expose the oil seal of shaft assembly to solvent.

1. Bolt
2. Pipe, Suction
3. O-ring
4. Connector
5. O-ring
6. Valve
7. Retaining Ring
8. Filter
9. Spring
10. Retaining Ring
11. Shaft Assembly
12. Bearing
13. Shaft
14. Retaining Ring
15. Oil Seal

Caution:
When removing the oil seal, be careful not to damage the housing.

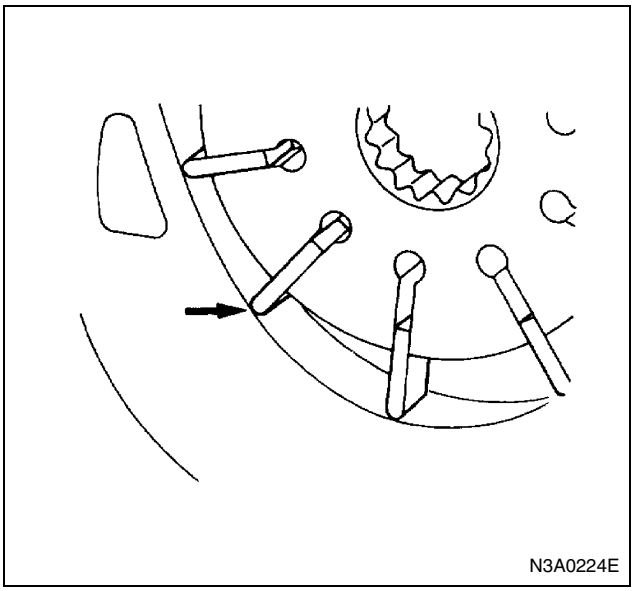
16. Bolt
17. Rear Housing Assembly and Pump Cartridge
18. Gasket
19. O-ring
20. O-ring
21. Front Housing
22. Pressure Plate
23. Rotor and Vane
24. Cam
25. Pin
26. Rear Housing

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Reassembly

1. Rear Housing
2. Pin
3. Cam
4. Rotor and Vane
   Install the vane with curved face in contact with the inner wall of the cam.



5. Pressure Plate

Caution:
When install pressure plate, be careful not to damage its inner surface. Damaged pressure plate may cause poor pump performance, pump seizure or oil leakage.

6. Front Housing
7. O-ring
   Be sure to discard used parts, and always use new parts for installation.
8. O-ring
   Be sure to discard used parts, and always use new parts for installation.
9. Gasket
   Be sure to discard used parts, and always use new parts for installation.
10. Rear Housing Assembly and Pump Cartridge
11. Bolt

Tighten:
- Rear housing bolt to 54 N·m (5.5 kg·m / 40 lb·ft)

12. Oil Seal
    Be sure to discard used parts, and always use new parts for installation.

Caution:
When install pressure plate, be careful not to damage its inner surface. Damaged pressure plate may cause poor pump performance, pump seizure or oil leakage.

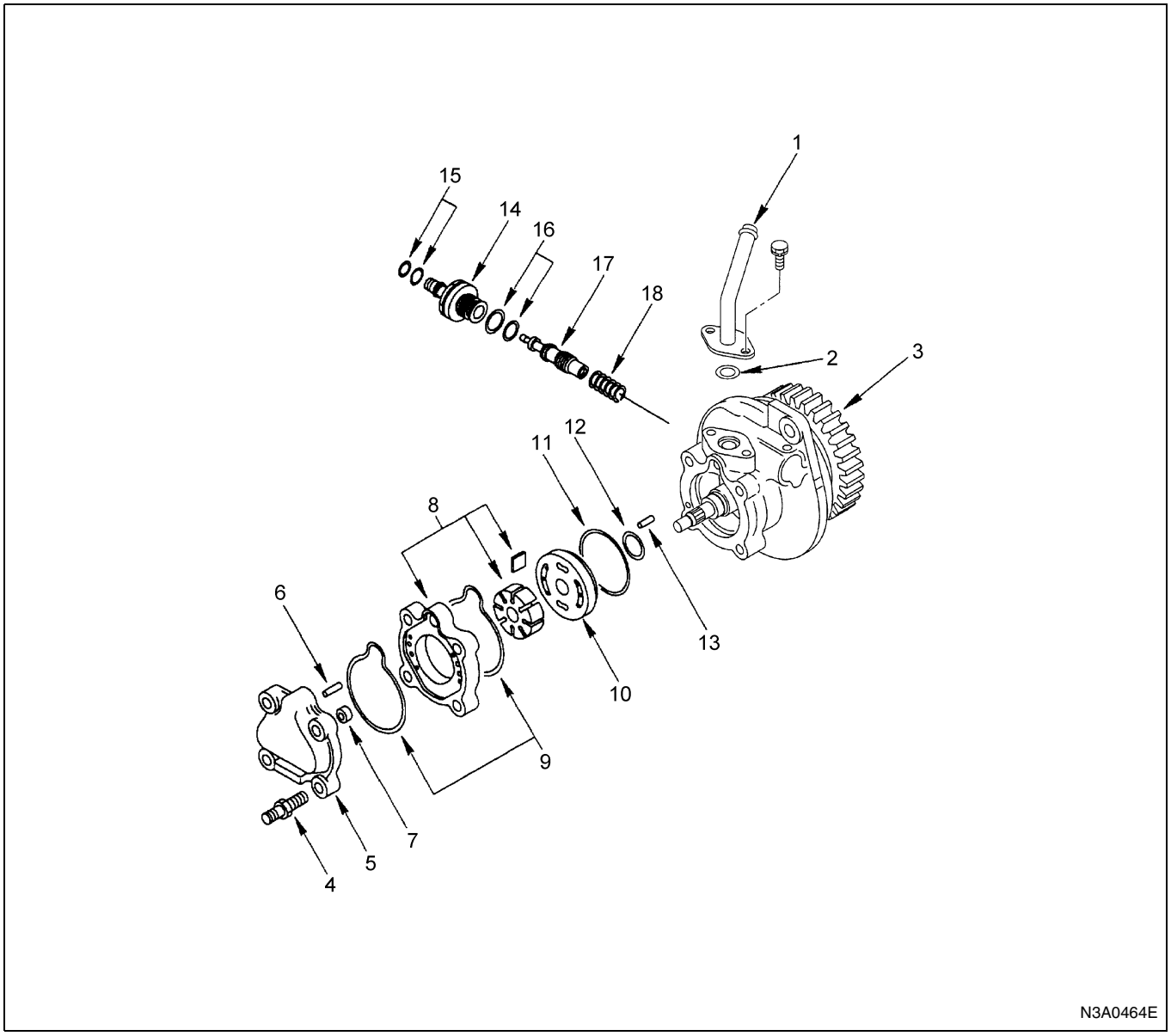
13. Retaining Ring
14. Shaft
15. Bearing
16. Shaft Assembly
17. Retaining Ring
18. Spring
19. Filter
20. Retaining Ring
21. Valve
22. O-ring
    Be sure to discard used parts, and always use new parts for installation.
23. Connector

Tighten:
- Connector to 54 N·m (5.5 kg·m / 40 lb·ft)

24. O-ring
    Be sure to discard used parts, and always use new parts for installation.
25. Pipe, Suction
26. Bolt

Tighten:
- Suction pipe bolt to 21 N·m (2.1 kg·m / 15 lb·ft)

Power Steering Pump (4H Series Engine without Hydraulic Booster Brake)



Legend

1. Suction pipe
2. O-ring
3. Body and gear
4. Bolt
5. Rear cover
6. Pin
7. Bushing
8. Cartridge assembly
9. O-ring
10. Side plate
11. O-ring
12. O-ring
13. Pin
14. Connector
15. O-ring
16. O-ring
17. Valve assembly
18. Spring

Disassembly

1. Suction Pipe
2. O-ring
3. Bolt
4. Rear Cover
5. Pin
6. Bushing
7. Cartridge Assembly
8. O-ring
9. Side Plate
10. O-ring
11. O-ring

12. Pin

Caution:
When removing the oil seat, be careful not to damage the housing.

13. Connector
14. O-ring
15. O-ring
16. Valve Assembly
17. Spring
18. Body and gear

Inspection and Repair

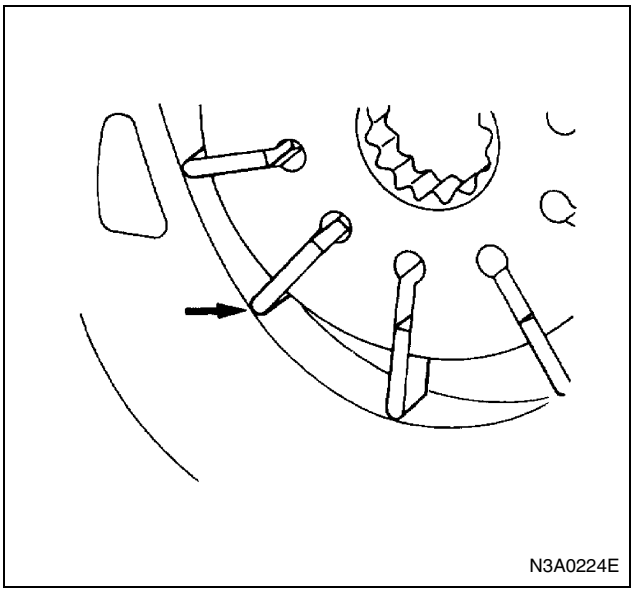
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Reassembly

1. Body and gear
2. Spring
3. Valve Assembly
4. O-ring
5. O-ring
6. Connector

Tighten:
- Connector to 49 N·m (5 kg·m / 36 lb·ft)

7. Pin
8. O-ring
9. O-ring
10. Cartridge Assembly
    Install the vane with curved face in contact with the inner wall of the cam.



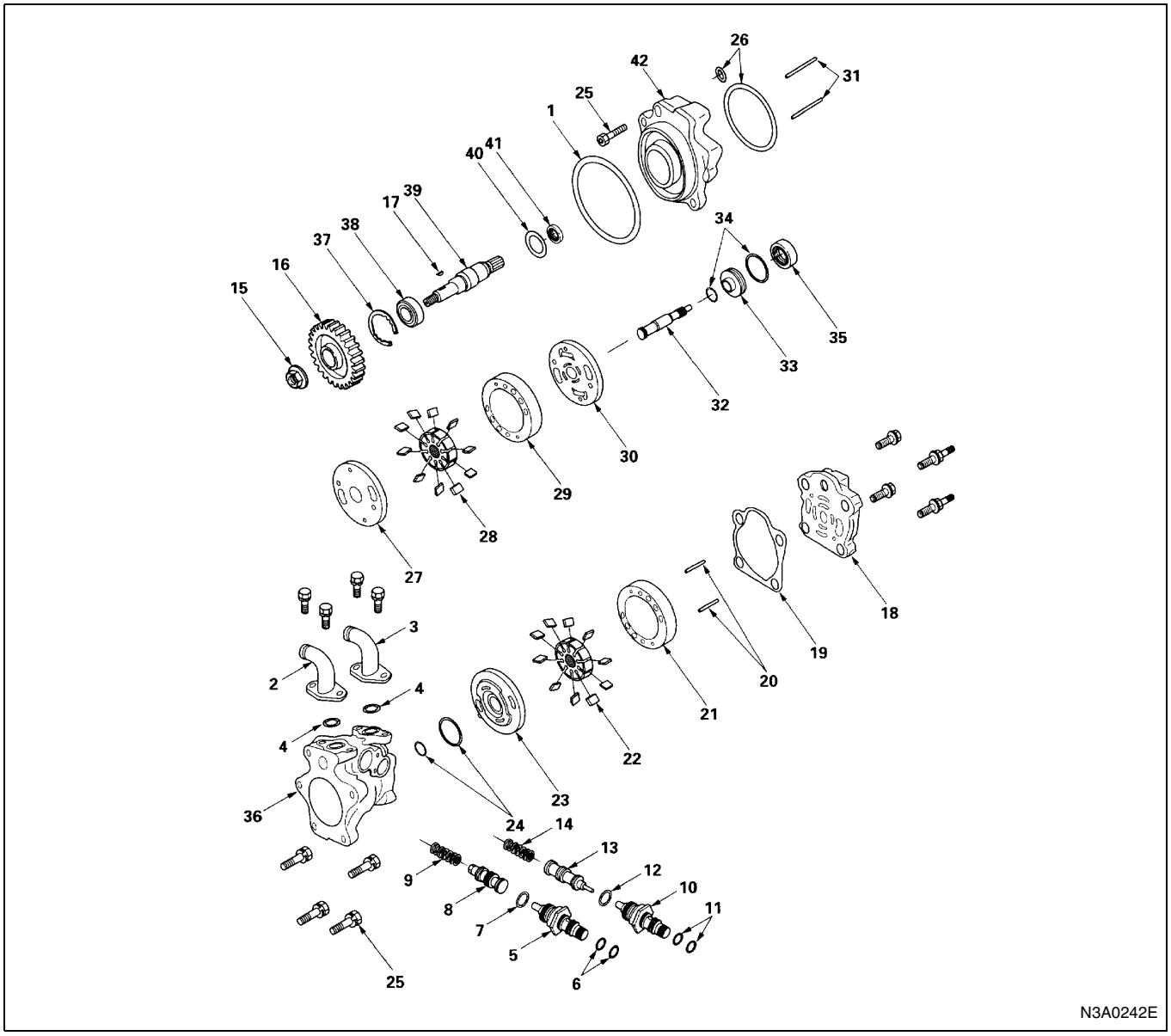
11. O-ring
12. Pin
13. Side Plate
14. Bushing
15. Rear Cover
16. Bolt

Tighten:
- Rear cover bolt to 20 N·m (2 kg·m / 14 lb·ft)

17. O-ring
18. Suction Pipe

Tighten:
- Suction pipe bolt to 8 N·m (0.8 kg·m / 69 lb·in)

Tandem Hydraulic Pump



Legend

1. O-ring
2. Hose connector: HBB
3. Hose connector: P/S
4. O-ring
5. Connector: HBB
6. O-ring
7. O-ring
8. Valve
9. Spring
10. Connector: P/S
11. O-ring
12. O-ring
13. Valve
14. Spring
15. Nut
16. Gear
17. Key
18. Rear body
19. Gasket
20. Pin
21. Cam
22. Rotor and vane: P/S
23. Pressure plate
24. O-ring
25. Bolt
26. O-ring
27. Side Plate
28. Rotor and vane: HBB
29. Cam
30. Pressure plate
31. Pin
32. Shaft
33. Retainer
34. O-ring
35. Oil seal
36. Pump housing
37. Snap ring
38. Ball bearing
39. Shaft
40. Retainer ring
41. Oil seal
42. Front body

P/S: Power steering
HBB: Hydraulic booster brake

Disassembly

1. O-ring
2. Hose Connector: HBB
3. Hose Connector: P/S
4. O-ring
5. Connector: HBB
6. O-ring
7. O-ring
8. Valve
9. Spring
10. Connector: P/S
11. O-ring
12. O-ring
13. Valve
14. Spring
15. Nut
16. Gear
17. Key
18. Rear Body
19. Gasket
20. Pin
21. Cam
22. Rotor and Vane: P/S
23. Pressure Plate
24. O-ring
25. Bolt
26. O-ring
27. Side Plate
28. Rotor and Vane: HBB
29. Cam
30. Pressure Plate
31. Pin
32. Shaft
33. Retainer
34. O-ring
35. Oil Seal
36. Pump Housing
    - Use a brass drift to remove the oil seal from the pump housing.
37. Snap Ring
    - Use a mallet to remove the shaft assembly from the front body.
38. Ball Bearing
39. Shaft
    - A press and rod will be necessary to remove the ball bearing from the shaft.
40. Retainer Ring
41. Oil Seal
42. Front Body
    - Use a brass drift to remove the oil seal from the front body.

Clean

- All parts in a suitable solvent and blow dry with compressed air. Be sure to use clean solvent to clean internal parts.

Inspection

- Cartridge assembly

– Vane tips of cartridge assembly for wear.
– Vanes for scoring or wear.
– Inner surface of the ring for scoring, wear, damage, etc.
– Fit of the vanes in the rotor. The vanes must fit property in the rotor slots, without sticking or excessive play. Also check for burrs in the rotor slots, and excessive wear at the thrust faces.
– If heavy wear is present, or if parts are damaged, replace the entire cartridge assembly.

• Side place for wear at the thrust faces.

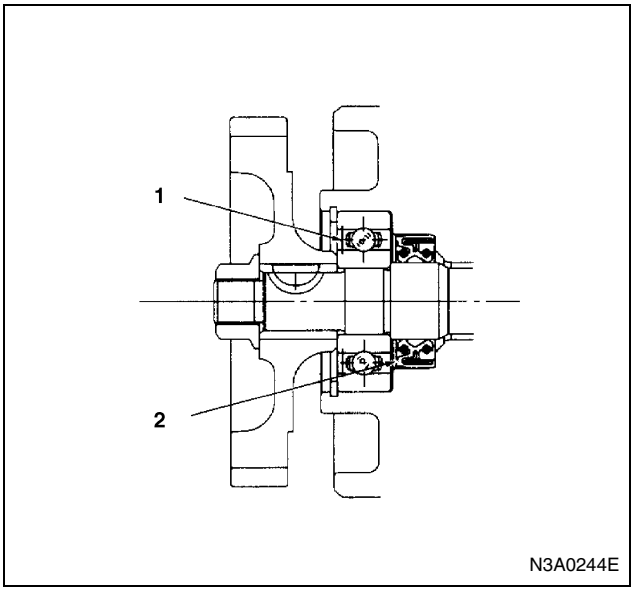
Replace if excessive wear is evident.

• Ball bearing. If the bearing is rough or loose, replace it.
• Seal contact area of the shaft. If fretting or roughness is present, replace the shaft.
• Gear for rough or chipped teeth.
• Flow control valve assembly for scoring or burrs. Also, inspect the flow control valve bore in the pump housing for burrs.

If heavy damage is present, replace pump housing assembly together with valves.

Reassembly

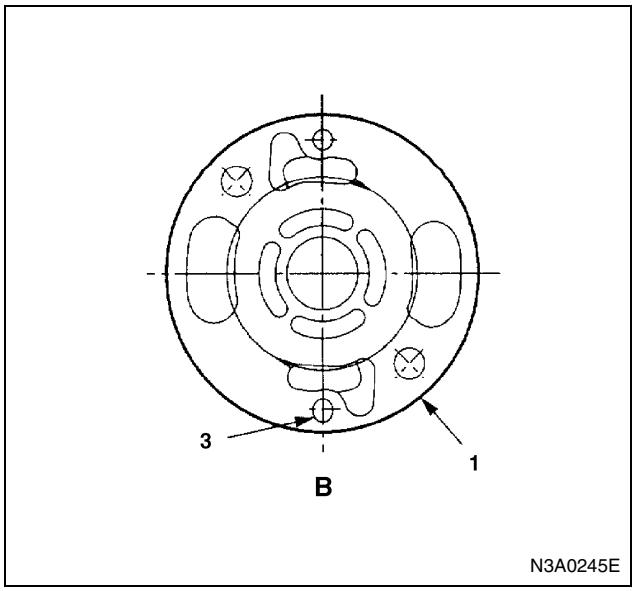
1. Oil Seal
2. Front Body
   • Oil seal into the front body using a proper size rod and press or hammer.
3. Shaft
4. Ball Bearing
   • Press the shaft, into the ball bearing as illustration.

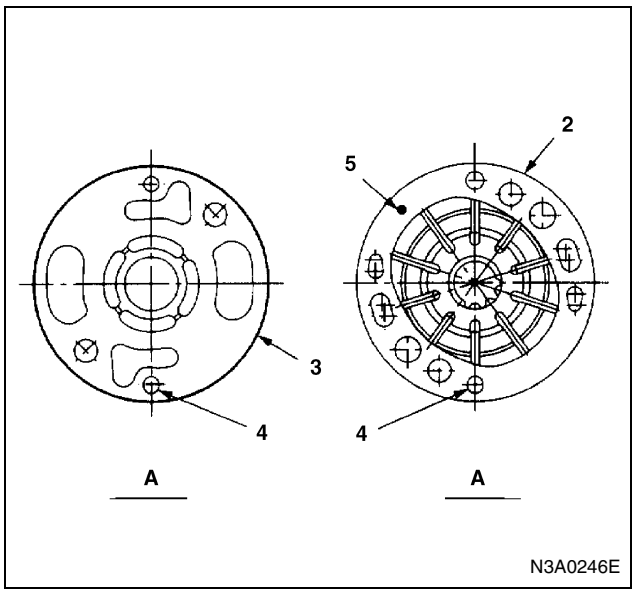


Legend

1. Shield plate
2. Stamping

5. Retaining Ring
   • Place the retaining ring in the front body and install the shaft assembly into the front body using a press or hammer.
6. Snap Ring
   • Snap ring into front body.
7. Oil Seal
8. Pump Housing
   • Oil seal into pump housing using a proper size rod and press or hammer.
9. O-ring
10. Retainer
11. Shaft
12. Pressure Plate
13. Cam
14. Rotor and Vane: HBB
15. Side Plate
16. Pin
    • Set pressure plate, cam, rotor and vane, side plate, and pins into pump housing as illustration.



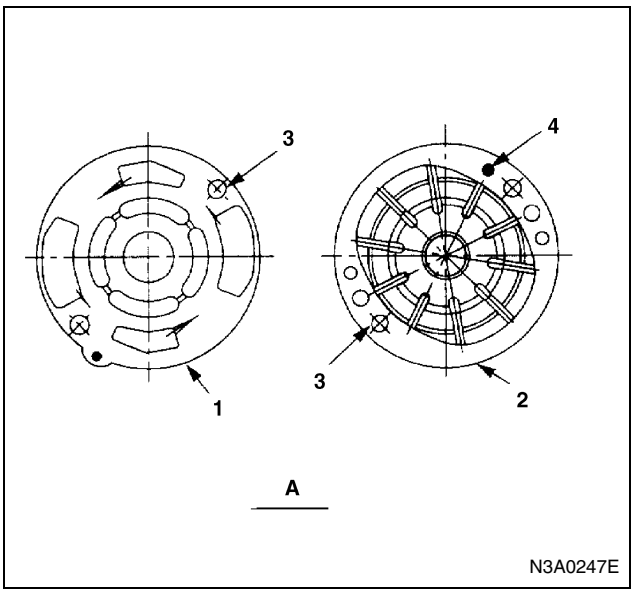


Legend
A. Front view
B. Rear view
1. Pressure plate
2. Cam, Rotor and vane
3. Side plate
4. Oblong hole
5. Stamping

17. O-ring
18. Bolt
    • Attach O-rings into front body grooves and assemble front body and pump housing by tightening bolts.

Tighten:
• Bolt and nut to
4 (four) bolts: 54 N·m (5.5 kg·m / 40 lb·ft)
1 (one) bolt: 25 N·m (2.5 kg·m / 18 lb·ft)

19. O-ring
20. Pressure Plate
21. Rotor and Vane: P/S
22. Cam
23. Pin
    • Set pressure plate, rotor and vane, cam and pins into pump housing as illustration.



Legend
A. Front view
1. Pressure plate
2. Rotor and vane, Cam
3. Oblong hole
4. Stamping

24. Gasket
25. Rear Body

Tighten:
• Bolt and nut to 34 N·m (3.5 kg·m / 25 lb·ft)

26. Key
27. Gear
28. Nut
    • Key, gear and nut onto shaft.
    • The long hub of the gear faces front body.

Tighten:
• Bolt and nut to 103 N·m (10.5 kg·m / 76 lb·ft)

29. Spring
30. Valve
31. O-ring
32. O-ring
33. Connector: P/S
    • Spring, valve, O-ring, O-rings and connector into pump housing.

Tighten:
• Bolt and nut to 54 N·m (5.5 kg·m / 40 lb·ft)

34. Spring
35. Valve
36. O-ring
37. O-ring
38. Connector: HBB
    • Spring, valve, O-ring, O-rings and connectors into pump housing.

Tighten:
• Bolt and nut to 54 N·m (5.5 kg·m / 40 lb·ft)

39. O-ring
40. Hose Connector: P/S
41. Hose Connector: HBB

Tighten:
• Bolt and nut to 21 N·m (2.1 kg·m / 15 lb·ft)

42. O-ring

STEERING, SUSPENSION, WHEELS AND TIRES

SECTION 3B2

MANUAL STEERING

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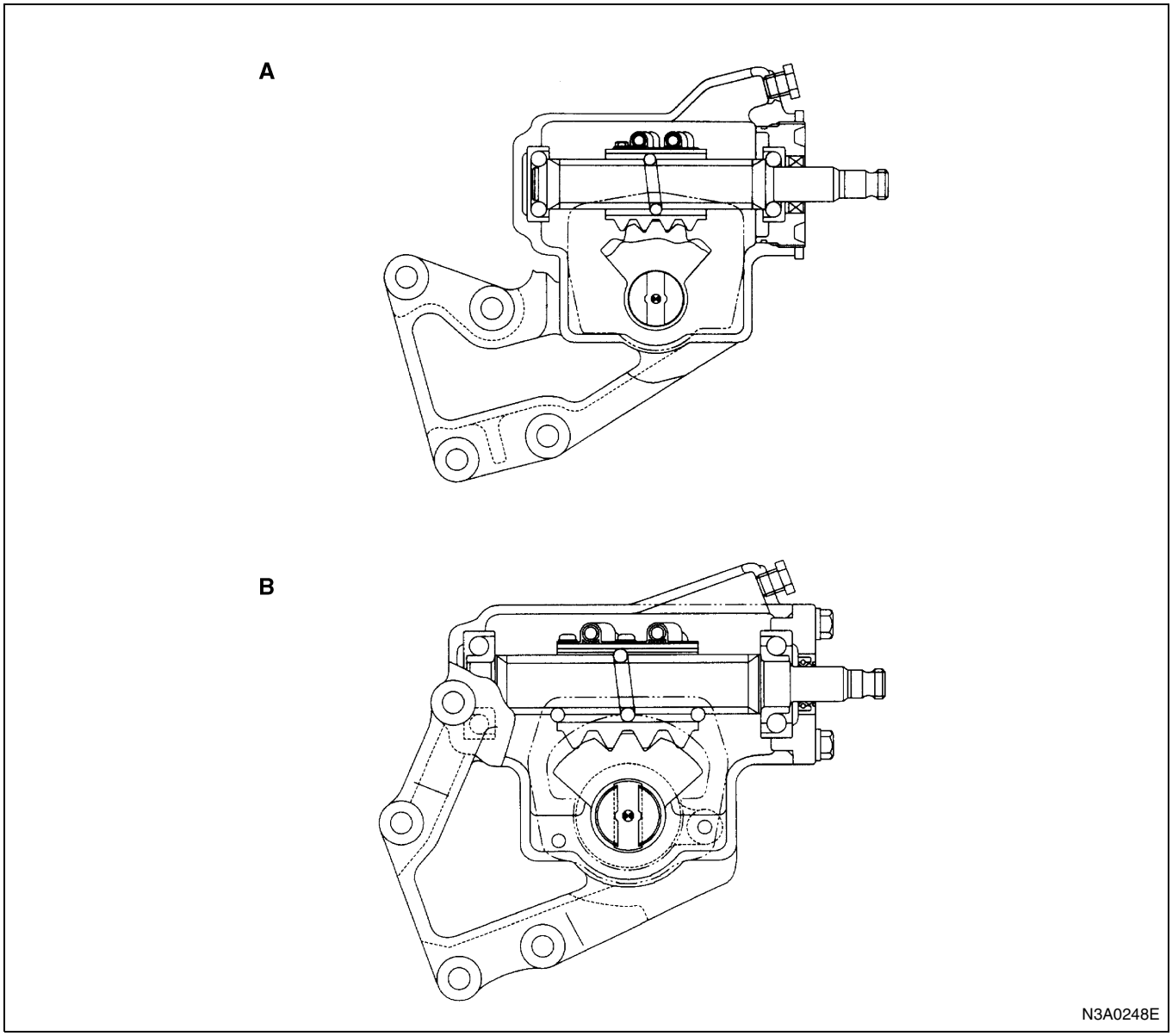
GENERAL DESCRIPTION

Manual Steering Unit



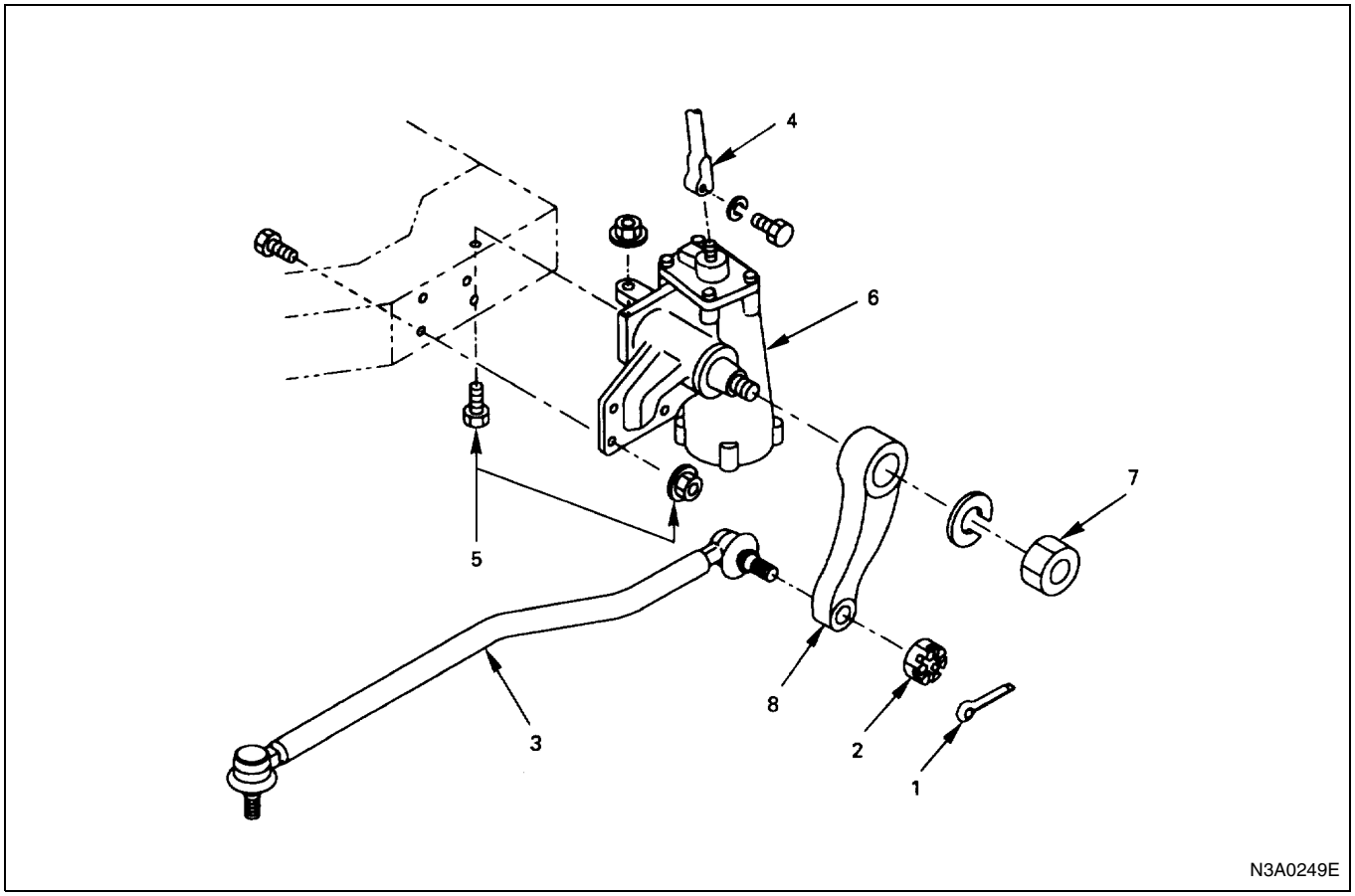
Legend

A. NHR, NKR

B. NPR, NQR

ON-VEHICLE SERVICE

Manual Steering Unit Replacement

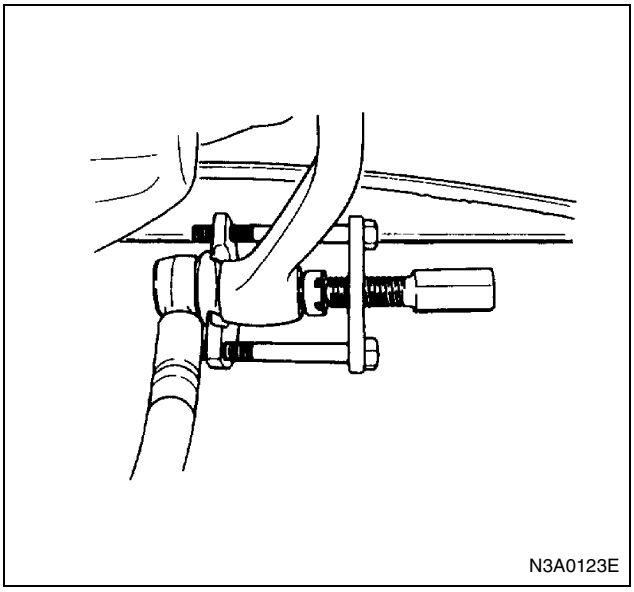


Legend

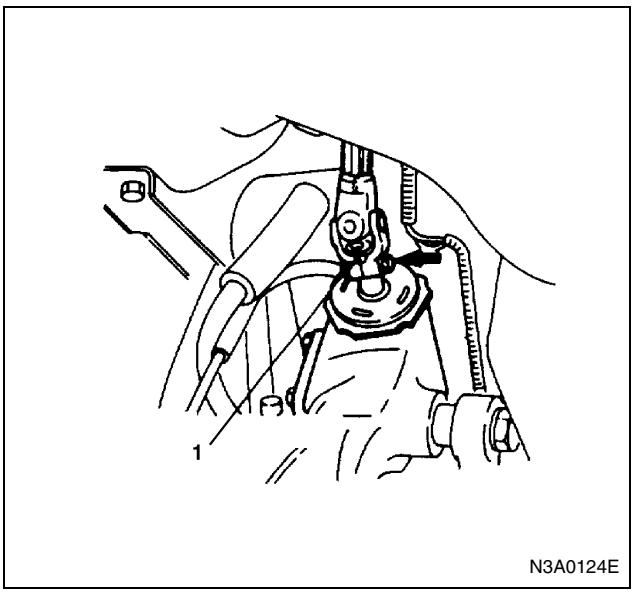
1. Cotter pin
2. Nut
3. Drag link
4. Universal joint
5. Unit fixing nut and bolt
6. Steering unit
7. Pitman arm fixing nut
8. Pitman arm

Removal

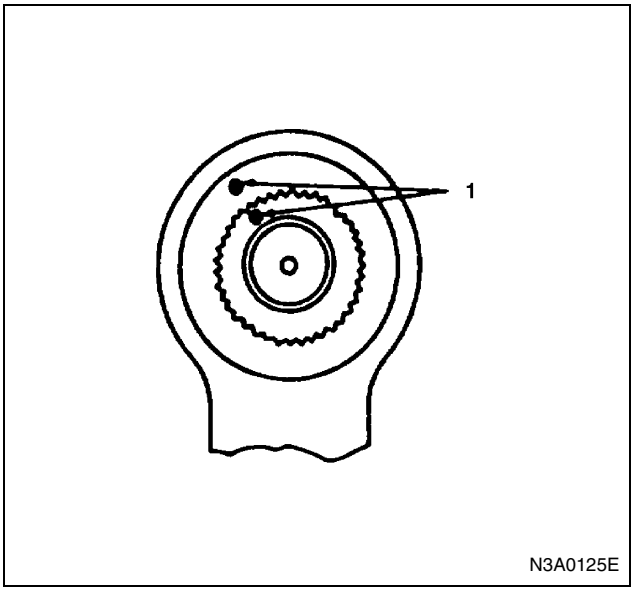
1. Remove the head light assembly. (for Non-Tilt Cab Model, driverside only)
   Refer to “Headlight Replacement”.
2. Remove the under panel. (Non-Tilt Cab Model)
3. Remove the front bumper assembly. (Non-Tilt Cab Model)
4. Cotter Pin
5. Nut
6. Drag Link
   Disconnect the drag link at the knuckle arm and the pitman arm.
   Remover: 5-8840-2017-0



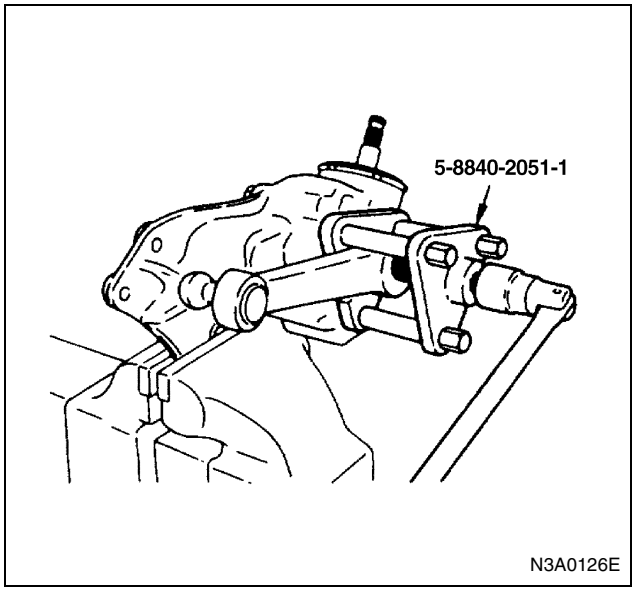
7. Universal Joint
   Apply a setting mark (1) across the yoke and worm shaft in unit to ensure reassembly of the parts in the original position.



8. Unit Fixing Nut and Bolt
9. Steering Unit
10. Pitman Arm Fixing Nut
11. Pitman Arm
    1) Apply a setting mark (1) across the pitman arm and worm shaft.

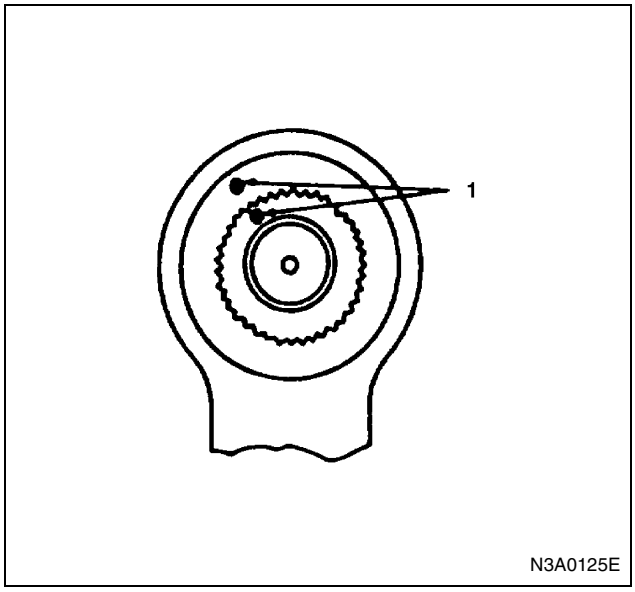


Puller: 5-8840-2051-1



Installation

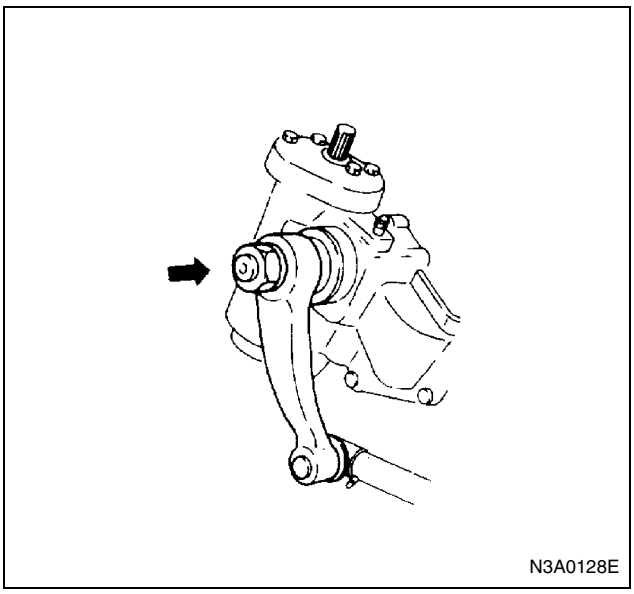
1. Pitman Arm
   Align the setting mark (1) applied at removal.



2. Pitman Arm Fixing Nut

Tighten:

- Nut to
  NHR, NKR: 216 N·m (22 kg·m/159 lb·ft)
  NPR, NQR: 294 N·m (30 kg·m/217 lb·ft)

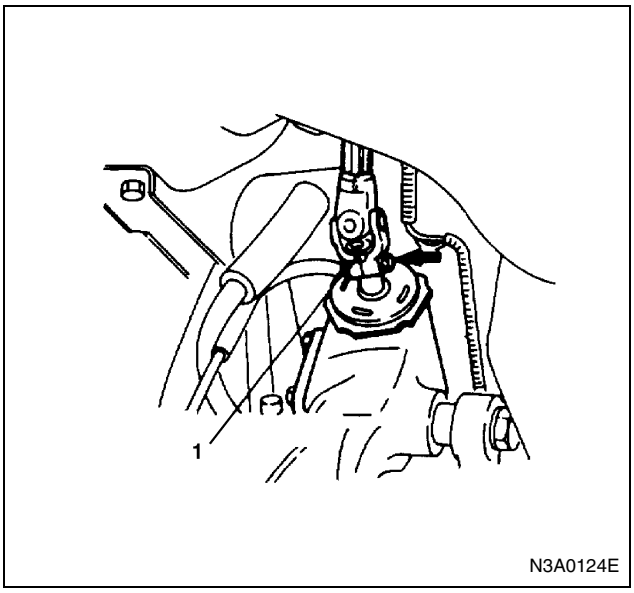

N3A0128E

3. Steering Unit
4. Unit Fixing Nut and Bolt

Tighten:
Nut and bolt to 103 N·m (10.5 kg·m/76 lb·ft)

5. Universal Joint
   Install the parts by aligning setting marks (1) applied at removal.

Tighten:
- Universal joint bolt to
  M8 bolt: 25 N·m (2.5 kg·m/18 lb·ft)



N3A0124E

6. Drag Link
7. Nut
8. Cotter Pin
   1) Install the drag link to the pitman arm and the knuckle arm.
   2) Tighten nuts to specified torque, with just enough additional torque to align cotter pin holes.
      Install new cotter pin.

Tighten:
- Nut to 167 N·m (17 kg·m/123 lb·ft)

9. Install the bumper assembly. (Non-Tilt Cab Model)

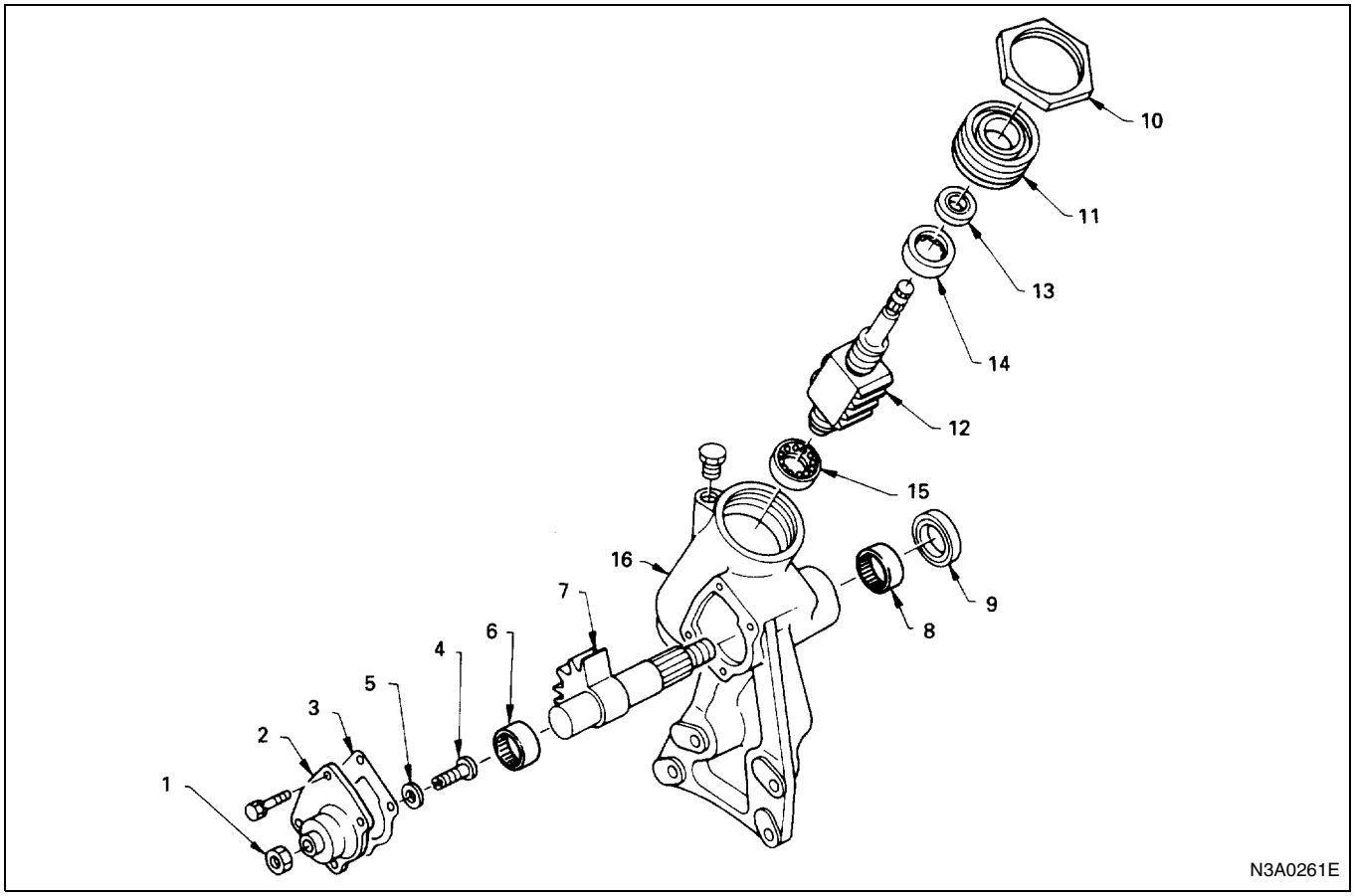
Tighten:
- Bumper bolt to 40 N·m (4.1 kg·m /30 lb·ft)

10. Install the under panel. (Non-Tilt Cab Model)
11. Install the head light assembly, front grille and front combination light assembly. (for Non-Tilt Cab Model)
    Refer to “Headlight Replacement”.

Notice:
After installation, adjust head light aiming. Refer to “Cab and Chassis Electrical” in Section 8. (Non-Tilt Cab Model)

UNIT REPAIR

Manual Steering Unit (NHR, NKR)

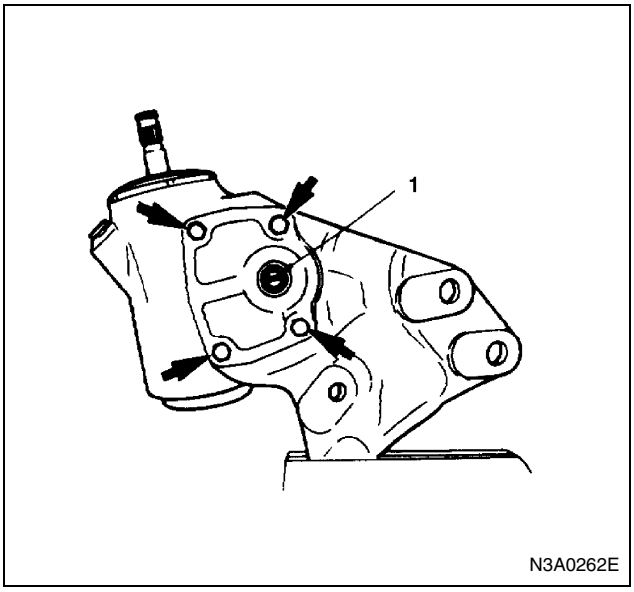


Legend

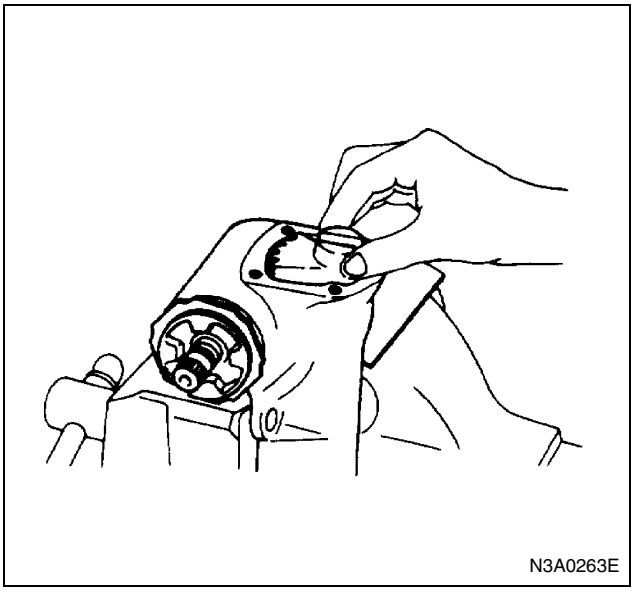
1. Lock nut
2. Side cover
3. Gasket
4. Adjuster screw
5. Adjuster shim
6. Needle bearing
7. Sector shaft
8. Needle bearing
9. Oil seal
10. Lock nut
11. End cover
12. Ball nut and worm shaft
13. Oil seal
14. Bearing
15. Bearing
16. Gear box

Disassembly

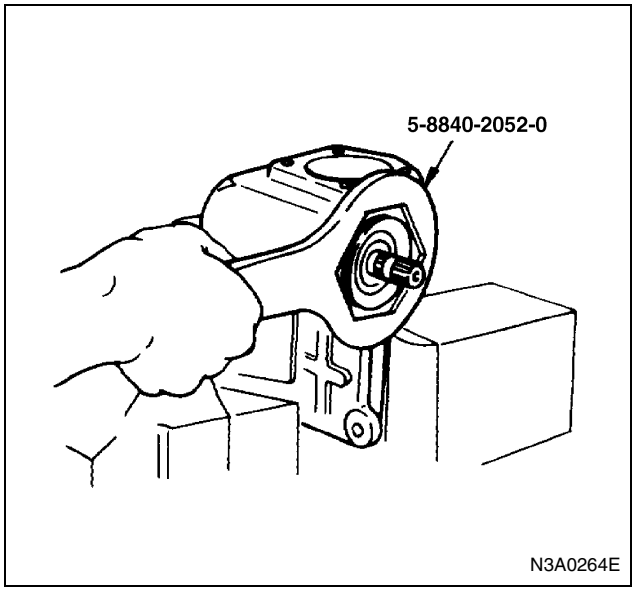
1. Lock Nut
2. Side Cover
   1) Turn the adjuster screw (1) counterclockwise slightly, then remove the side cover fixing bolt. (Arrowed in the illustration.)
   2) Turn the adjuster screw clockwise with the side cover held from turning.



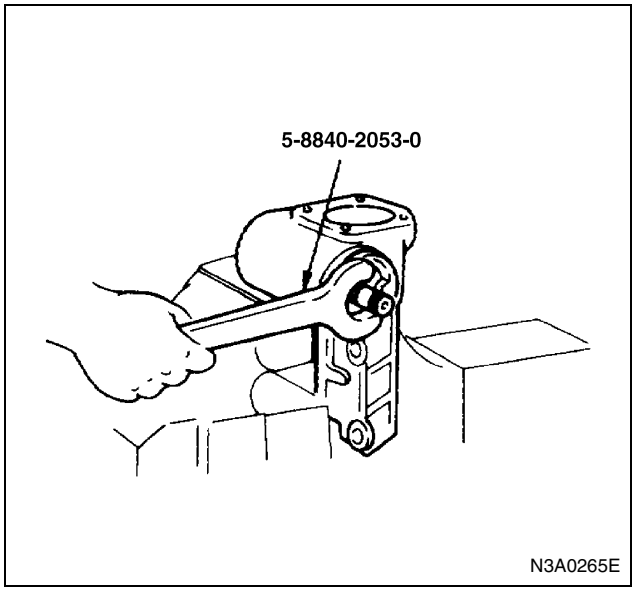
3. Gasket
4. Adjuster Screw
5. Adjuster Shim
6. Needle Bearing
7. Sector Shaft
   When removing, be careful not to damage the serrations, threads and oil seal.



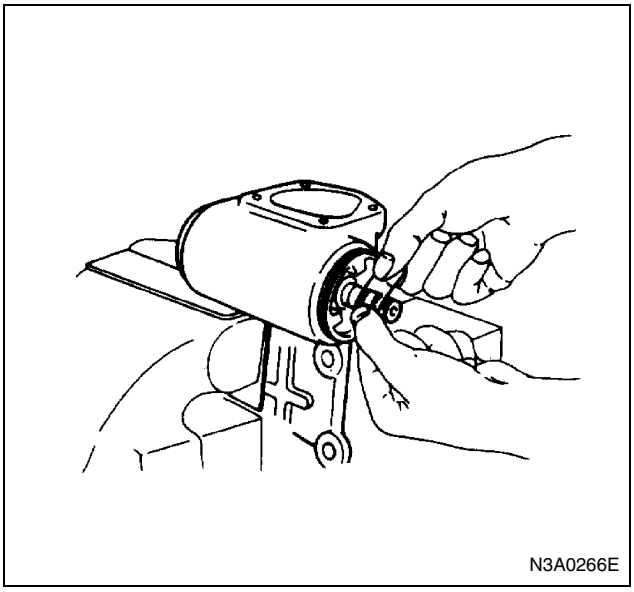
8. Needle Bearing
9. Oil Seal
10. Lock Nut
    Steering Lock Nut Wrench : 5-8840-2052-0



11. End Cover
    1) Wrench : 5-8840-2053-0



    2) When removing, be careful not to damage the oil seal.
       Taping the splines will provide some protection.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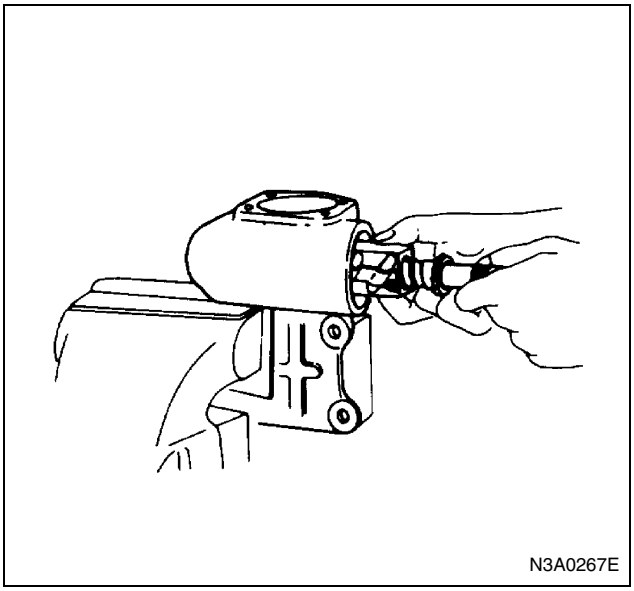
12. Ball Nut and Worm Shaft
    Always keep ball nut assembly in a horizontal position and avoid holding it vertically, or ball nut will slide out.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13. Oil Seal
14. Bearing
15. Bearing
16. Gear Box

Inspection and Repair

Make necessary correction or parts replacement if wear damage, or any other abnormal conditions are found through inspection.

Visual Check

Inspect the following parts for wear, damage or other abnormal conditions.

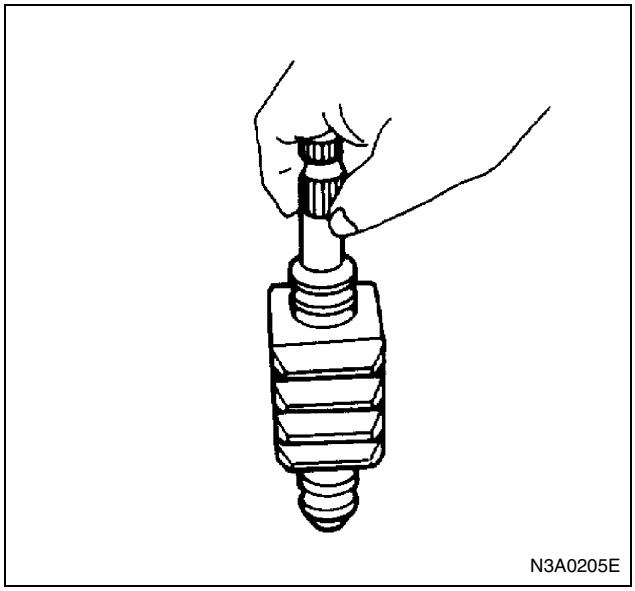
- Bearing
- Sector shaft
- Ball nut and worm shaft

Ball Nut Rotation

Hold the worm shaft vertically and see if the ball nut lowers with turning motion smoothly. If lowering of the ball nut with its own weight is unsmooth, check the worm shaft for bending and ball-groove for burrs, dents and presence of foreign matter.

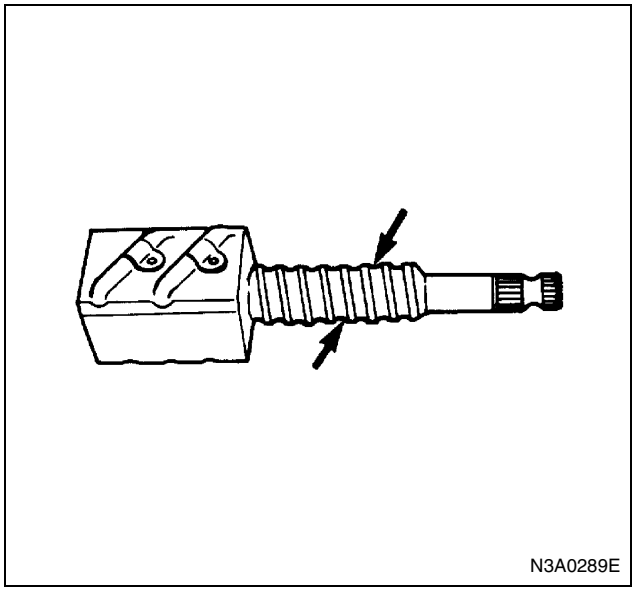
Notice:

When making a test on the ball nut assembly, exercise care so as not to strike ball nut against end of worm shaft, or damage to the ball tubes will result.


N3A0205E

If any of the parts in the ball nut and worm shaft assembly is found to be defective, the entire parts should be replaced using a new worm shaft assembly.

As these parts are of selective combination and are sealed to prohibit disassembly, the faulty parts should not be replaced individually.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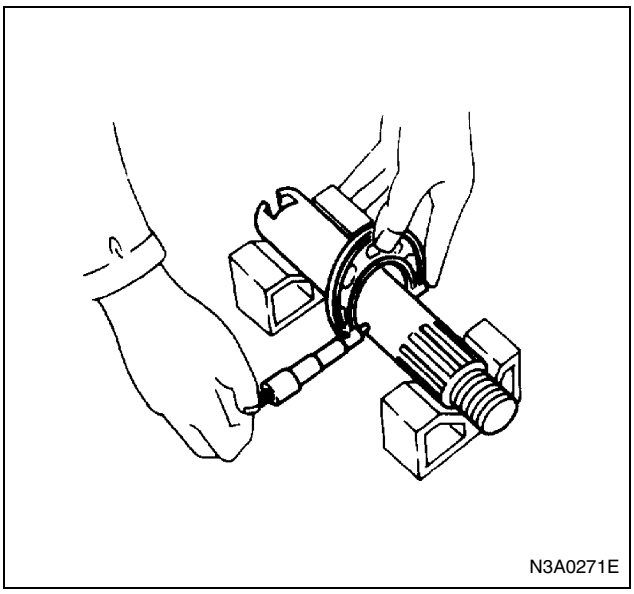
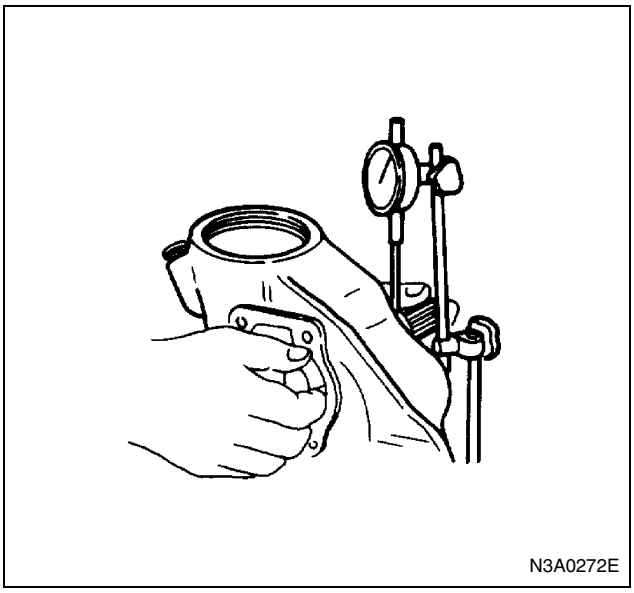
Sector Shaft Outside Diameter

Standard : 34.925 mm (1.375 in)

Limit : 34.825 mm (1.371 in)


N3A0271E

Sector Shaft and Needle Bearing Play
Limit : 0.2 mm (0.008 in)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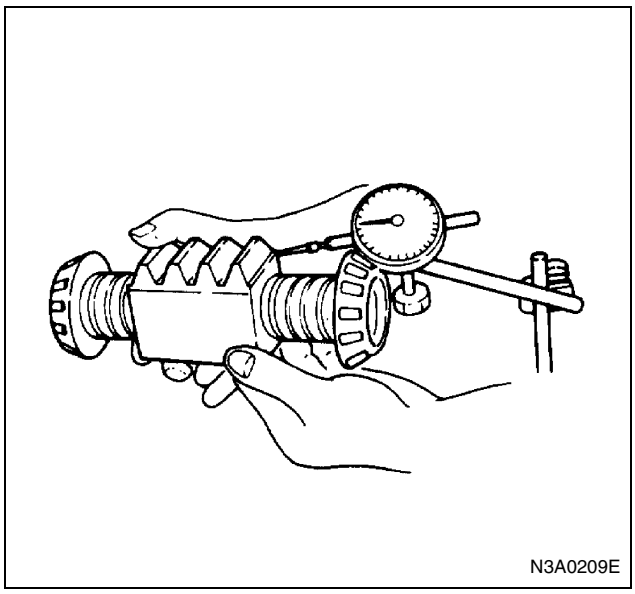
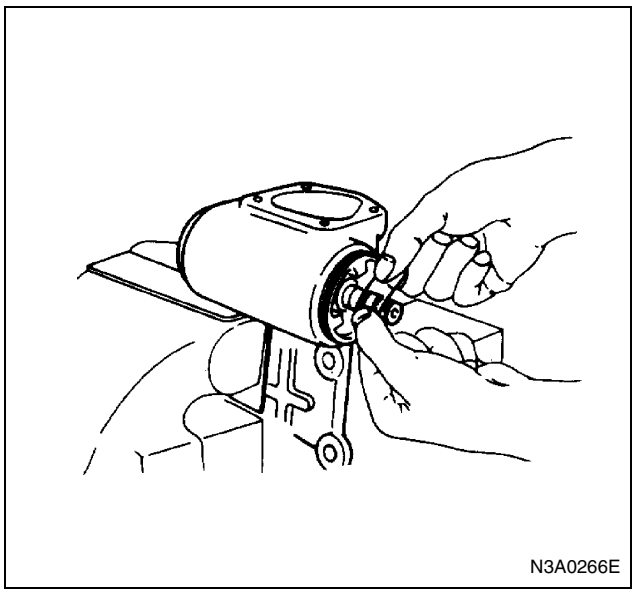
Ball Nut Axial Play
Limit : 0.1 mm (0.004 in)


N3A0209E

Reassembly

1. Gear Box
2. Bearing
3. Bearing
4. Oil seal
5. Ball Nut and Worm Shaft
6. End Cover
   1) When installing, be careful not to damage the oil seal.
      Taping the splines will provide some protection.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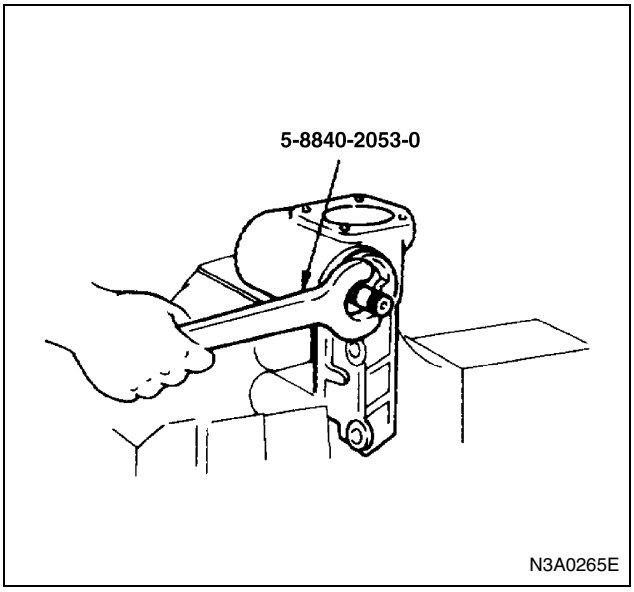
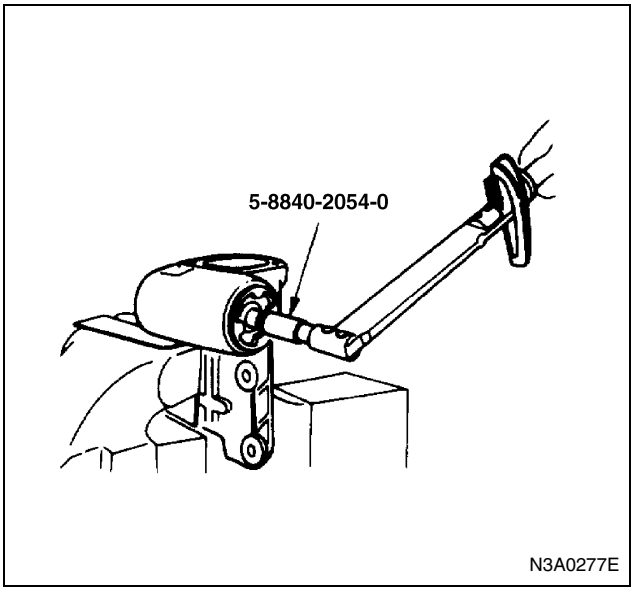
   2) Adjust the starting torque of steering input shaft by turning the end cover with a special tool.
      Wrench : 5-8840-2053-0

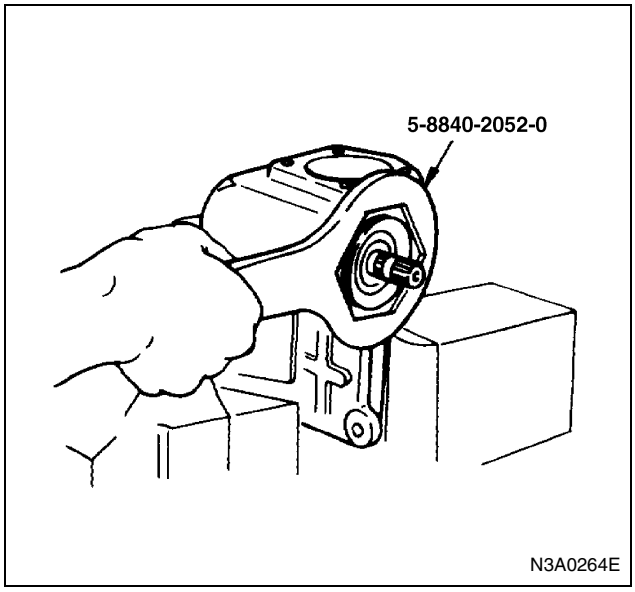


Starting Torque
0.34 — 0.64 N·m (0.035 — 0.065 kg·m/0.25 — 0.47 lb·ft)
Steering Shaft Driver : 5-8840-2054-0

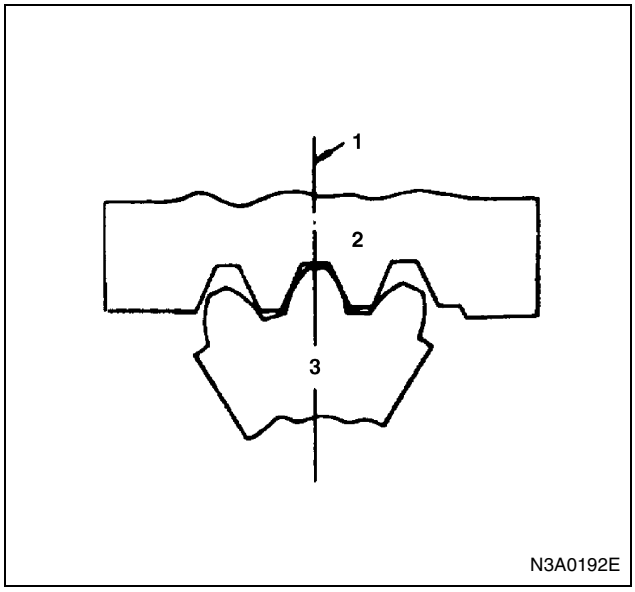


7. Lock Nut
   Steering Lock Nut Wrench : 5-8840-2052-0

Tighten:
- Lock Nut to 177 N·m (18 kg·m/30 lb·ft)

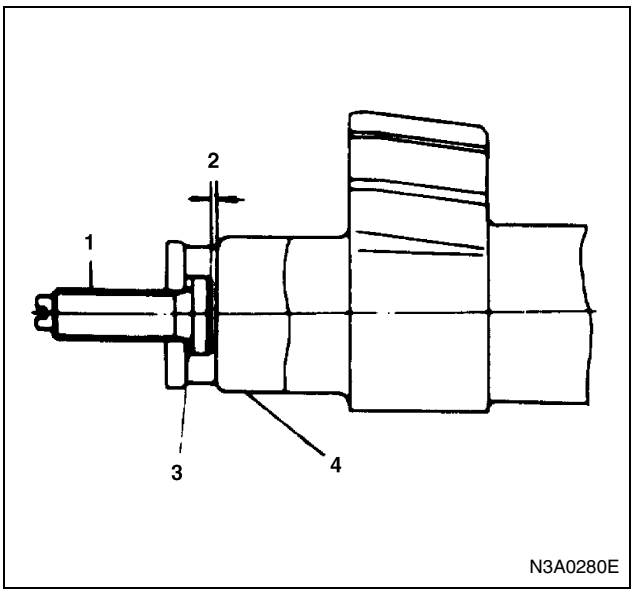


8. Sector Shaft
   Align the center tooth (1) of ball nut (2) with the center tooth (1) of the sector shaft (3).



9. Needle Bearing
10. Oil Seal
11. Needle Bearing
12. Adjuster Shim
13. Adjuster Screw
    Adjust the clearance and check that the adjuster screw slides freely.

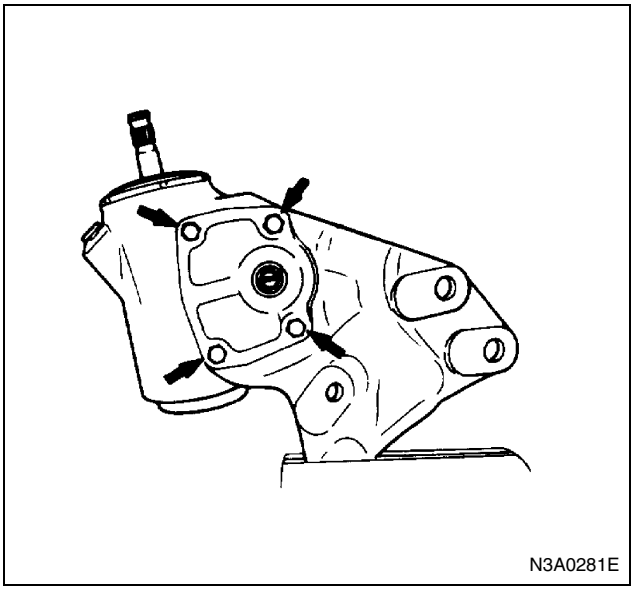
Clearance
0.1 mm (0.0039 in)
Adjust Shims Available
1.53 mm (0.060 in), 1.56 mm (0.061 in), 1.59 mm (0.063 in), 1.62 mm (0.064 in), 1.65 mm (0.065 in)



Legend
1. Adjuster screw
2. Clearance
3. Shim
4. Sector shaft

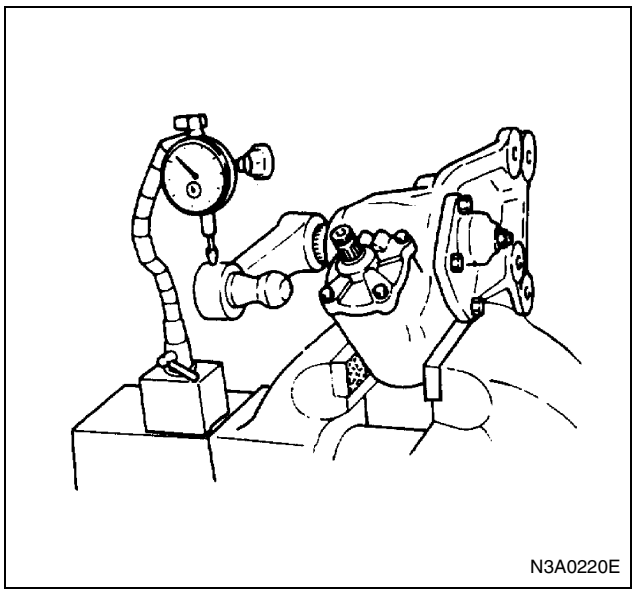
14. Gasket
15. Side Cover

Tighten:
- Side cover bolt to 44 N·m (4.5 kg·m/33 lb·ft)



16. Lock Nut
    Adjust the backlash between the sector gear and ball nut.
    1) Install the pitman arm.
    2) Set the sector shaft in a straight ahead position.
    3) With the adjuster screw, adjust the backlash to the specification.

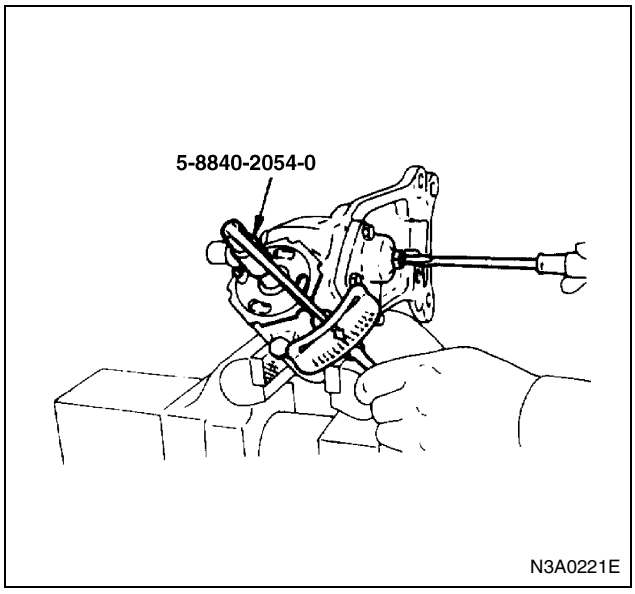
Backlash (at End of Pitman Arm)
0.2 mm (0.0079 in) or less



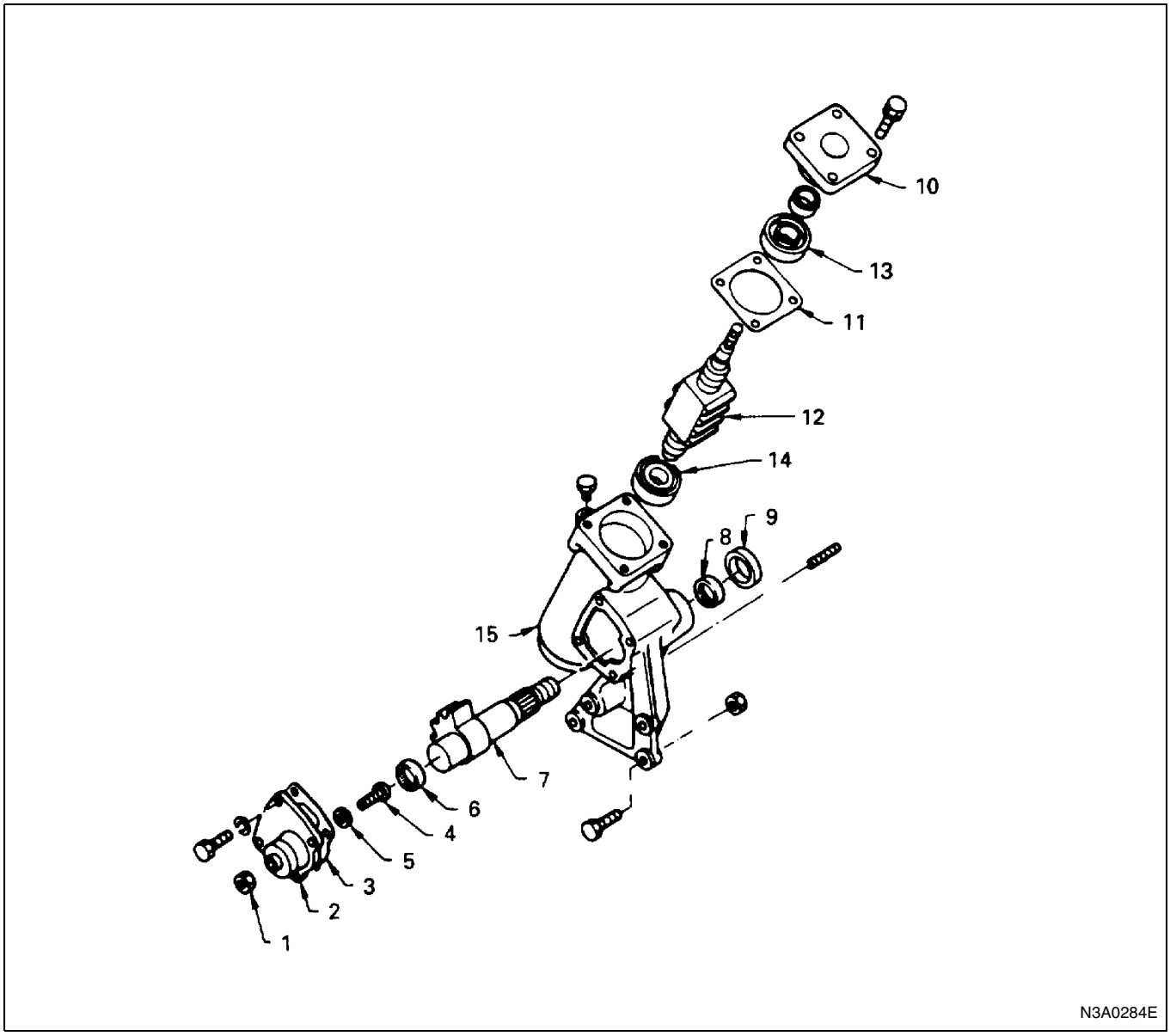
    4) Lock adjuster screw with lock nut.

Tighten:
- Lock Nut to 25 N·m (2.5 kg·m/18 lb·ft)
    5) Inspect the starting torque of the steering input shaft.

Starting Torque
0.54 — 1.03 N·m (0.055 — 0.105 kg·m/0.40 — 0.76 lb·ft)
Steering Shaft Driver : 5-8840-2054-0



Manual Steering Unit (NPR, NQR)

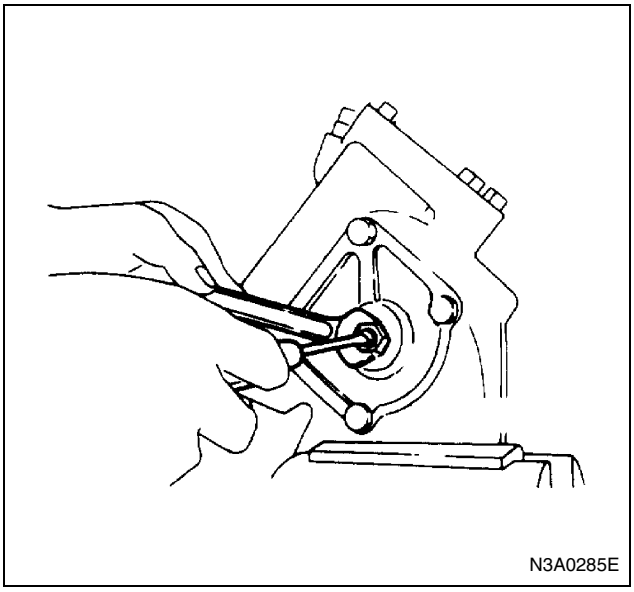


Legend

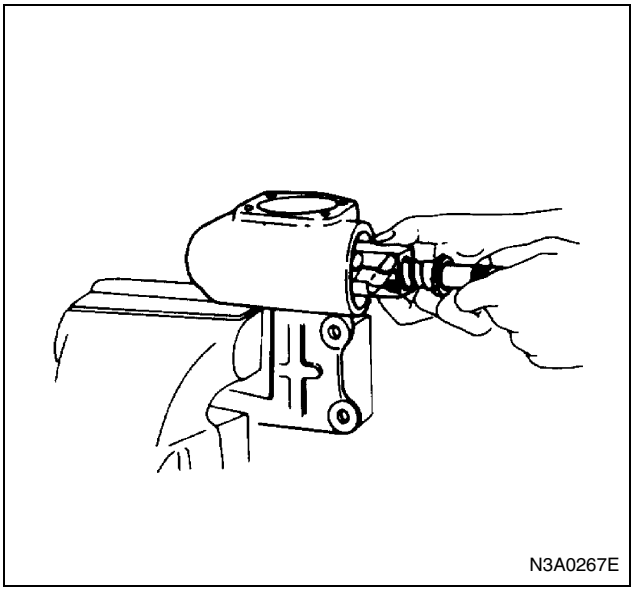
1. Lock nut
2. Side cover
3. Gasket
4. Adjuster screw
5. Adjuster shim
6. Needle bearing
7. Sector shaft
8. Needle bearing
9. Oil seal
10. End cover
11. Adjuster shim
12. Ball nut and worm shaft
13. Bearing
14. Bearing
15. Gear box

Disassembly

1. Lock Nut
2. Side Cover
   1) Turn the adjuster screw counterclockwise slightly, then remove the side cover fixing bolt.
   2) Turn the adjuster screw clockwise with the side cover held from turning.


N3A0285E

3. Gasket
4. Adjuster Screw
5. Adjuster Shim
6. Needle Bearing
7. Sector Shaft
   When removing, be careful not to damage the serrations, threads and oil seal.
8. Needle Bearing
9. Oil Seal
10. End Cover
11. Adjuster Shim
12. Ball Nut and Worm Shaft
    Always keep ball nut assembly in a horizontal position and avoid holding it vertically, or ball nut will slide out.


N3A0267E

Inspection and Repair

Make necessary correction or parts replacement if wear, damage or any other abnormal conditions are found through inspection.

Visual Checks

Inspect the following parts for wear, damage or other abnormal conditions.

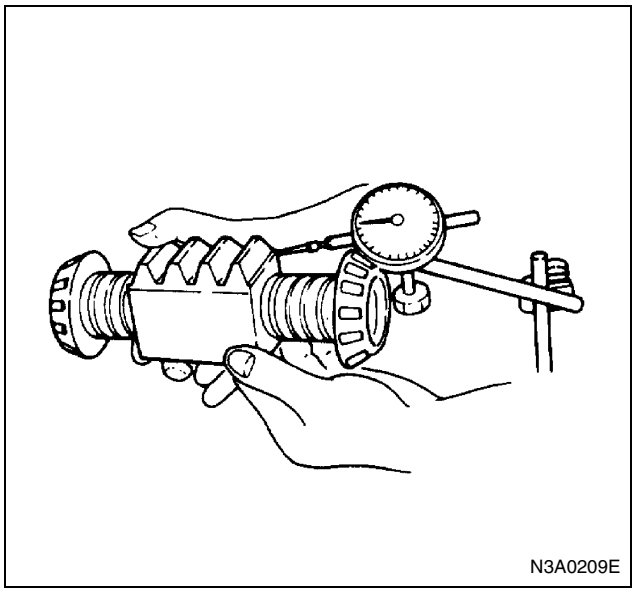
- Bearing
- Sector shaft
- Ball nut and worm shaft

Ball Nut Rotation

Hold the worm shaft vertically and see if the ball nut lowers with turning motion smoothly. If lowering of the ball nut with its own weight is unsmooth, check the worm shaft for bending and ball-groove for burrs, dents and presence of foreign matter.

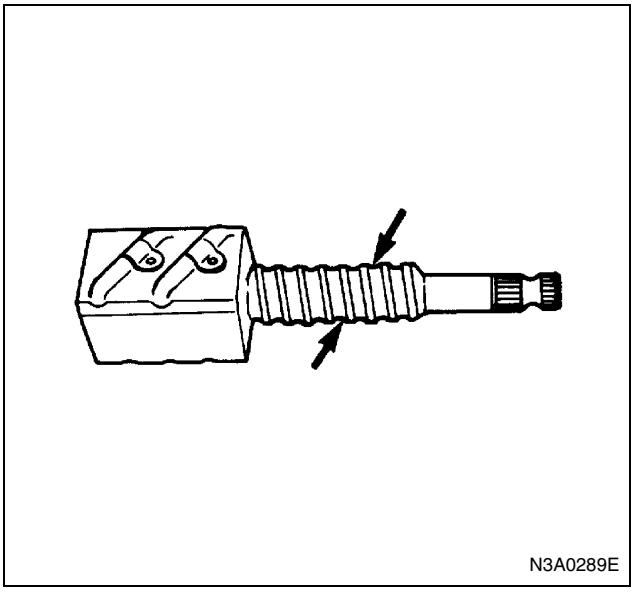
Notice:

When making a test on the ball nut assembly, exercise care so as not to strike ball nut against end of worm shaft, or damage to the ball tubes will result.

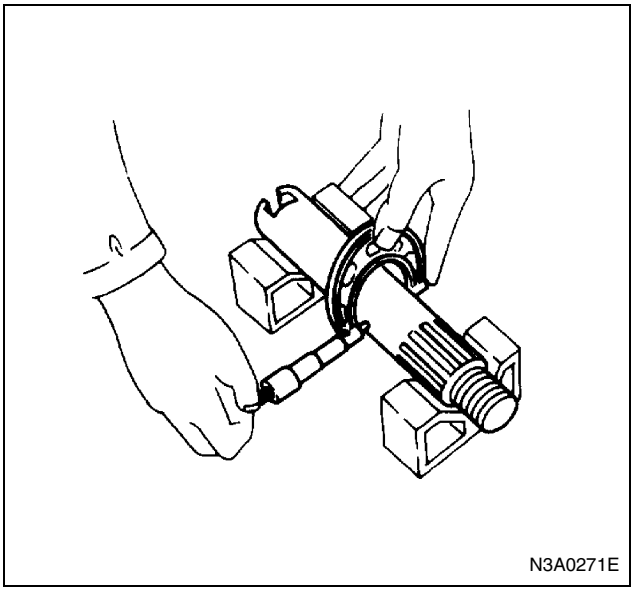

N3A0209E

If any of the parts in the ball nut and worm shaft assembly is found to be defective, the entire parts should be replaced using a new worm shaft assembly.

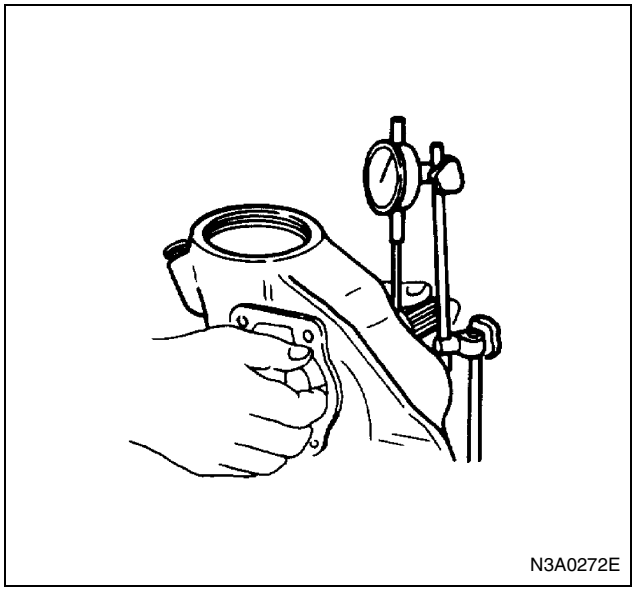
As these parts are of selective combination and are sealed to prohibit disassembly, the faulty parts should not be replaced individually.



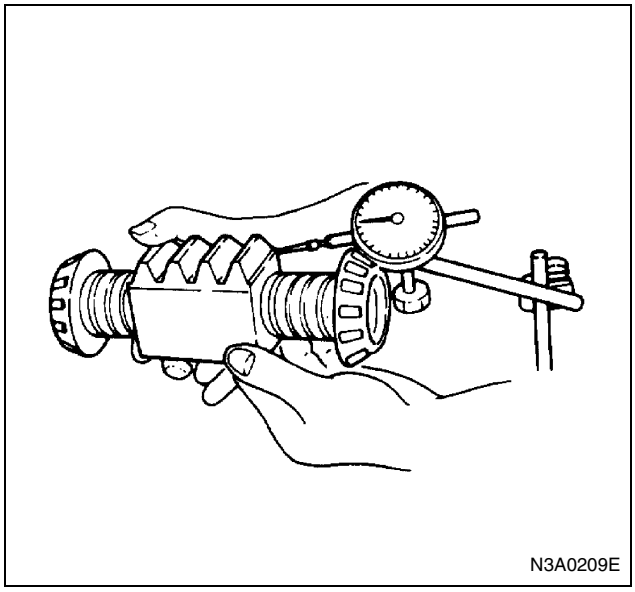
Sector Shaft Outside Diameter
Standard : 38.1 mm (1.50 in)
Limit : 38.0 mm (1.496 in)



Sector Shaft and Needle Bearing Play
Limit : 0.2 mm (0.008 in)



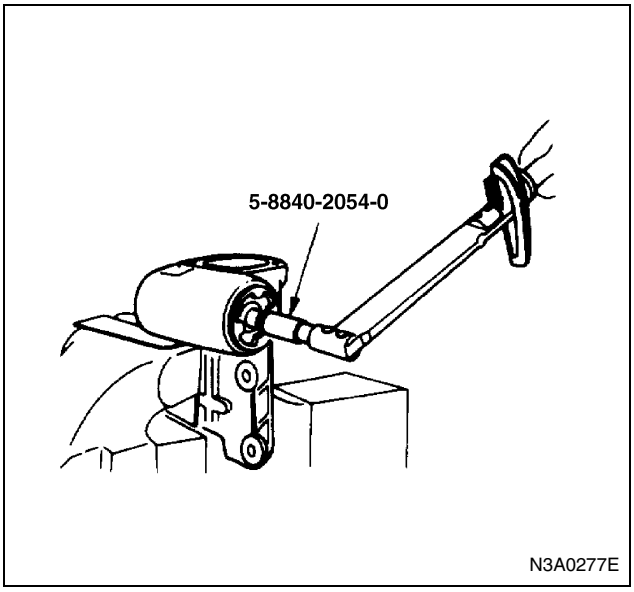
Ball Nut Axial Play
Limit : 0.1 mm (0.004 in)



Reassembly

1. Gear box
2. Bearing
3. Bearing
4. Ball Nut and Worm Shaft
5. Adjuster Shim
   1) Adjust the starting torque of input shaft by varying shim thickness.
      Steering Shaft Driver : 5-8840-2054-0

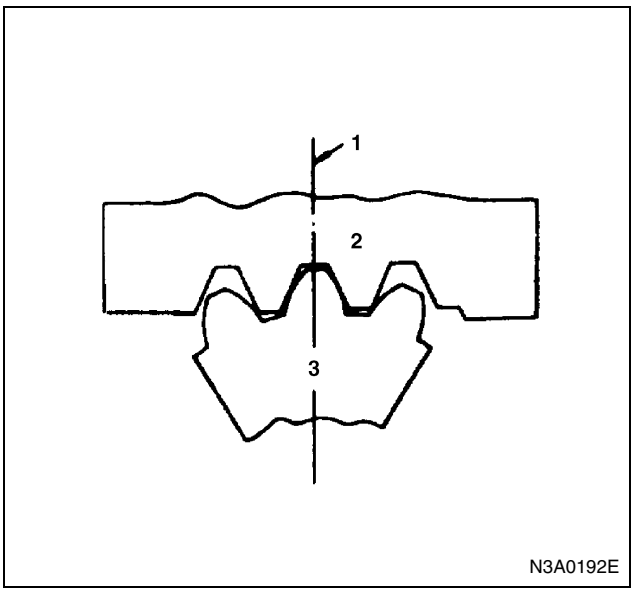
Starting Torque
0.29 — 0.69 N·m (0.030 — 0.070 kg·m/0.22 — 0.51 lb·ft)
Adjust Shims Available
0.01 mm (0.0004 in), 0.02 mm (0.0008 in), 0.05 mm (0.0020 in), 0.07 mm (0.0028 in), 0.08 mm (0.0031 in)



6. End Cover

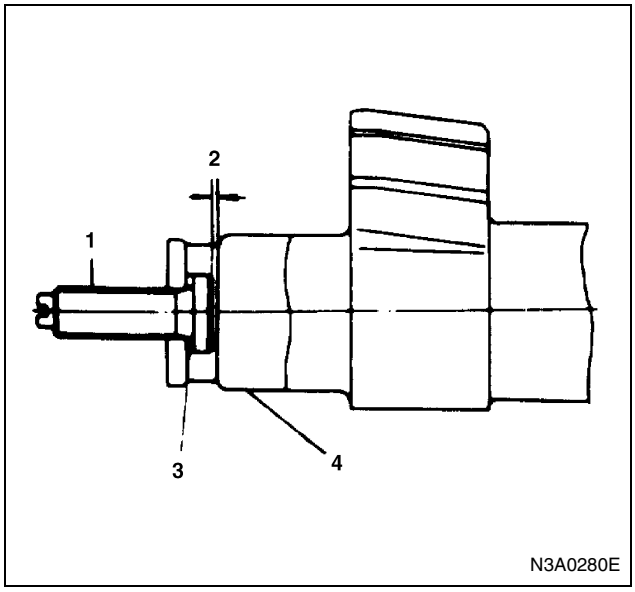
Tighten:
- Fixing bolt to 44 N·m (4.5 kg·m/33 lb·ft)

7. Oil Seal
8. Sector Shaft
   Align the center tooth (1) of ball nut (2) with that of the sector shaft (3).



9. Sector Shaft
10. Needle Bearing
11. Adjuster Shim
12. Adjuster Screw
    Adjust the clearance and check that the adjuster screw slides freely.

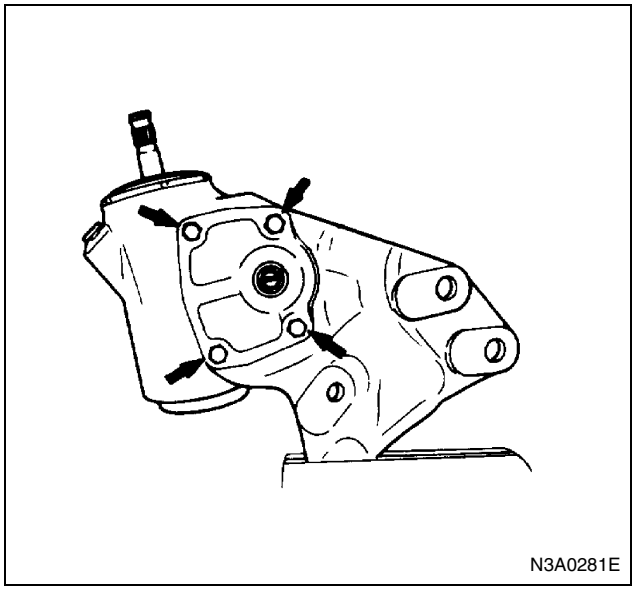
Clearance
0.1 mm (0.0039 in)
Adjust Shims Available
1.53 mm (0.060 in), 1.56 mm (0.061 in), 1.59 mm (0.063 in), 1.62 mm (0.064 in), 1.65 mm (0.065 in)



Legend
1. Adjuster screw
2. Clearance
3. Shim
4. Sector shaft

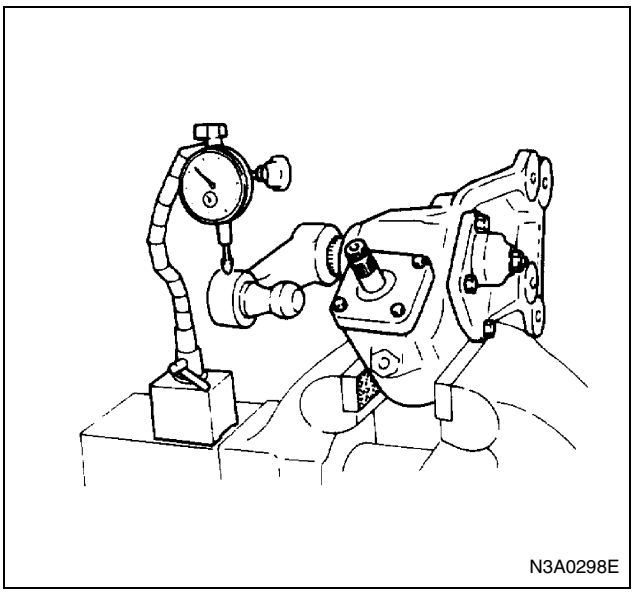
13. Gasket
14. Side Cover

Tighten:
- Side cover bolt to 44 N·m (4.5 kg·m/33 lb·ft)



15. Lock Nut
    Adjust the backlash between the sector gear and ball nut.
    1) Install the pitman arm.
    2) Set the sector shaft in a straight ahead position.
    3) With the adjuster screw, adjust the backlash to the specification.

Backlash (at End of Pitman Arm)
0.5 mm (0.0197 in) or less



4) Lock adjuster screw with lock nut.

Tighten:

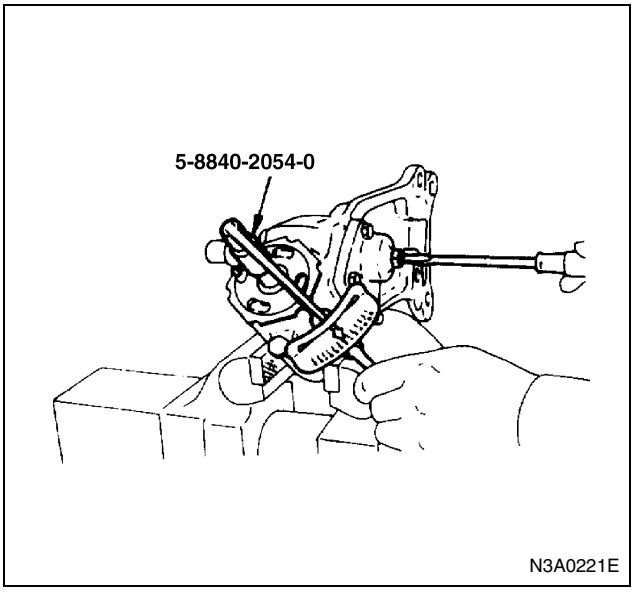
- Lock nut to 25 N·m (2.5 kg·m/ 1.8 lb·ft)

5) Inspect the starting torque of the input shaft.

Starting Torque

0.98 N·m (0.1 kg·m/0.72 lb·ft) or less

Steering Shaft Driver : 5-8840-2054-0



STEERING, SUSPENSION, WHEELS AND TIRES

SECTION 3B3
STEERING LINKAGE

Contents

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Drag Link and Pitman Arm 3B3-2
Tie Rod Assembly 3B3-2
Steering Link Assembly 3B3-3
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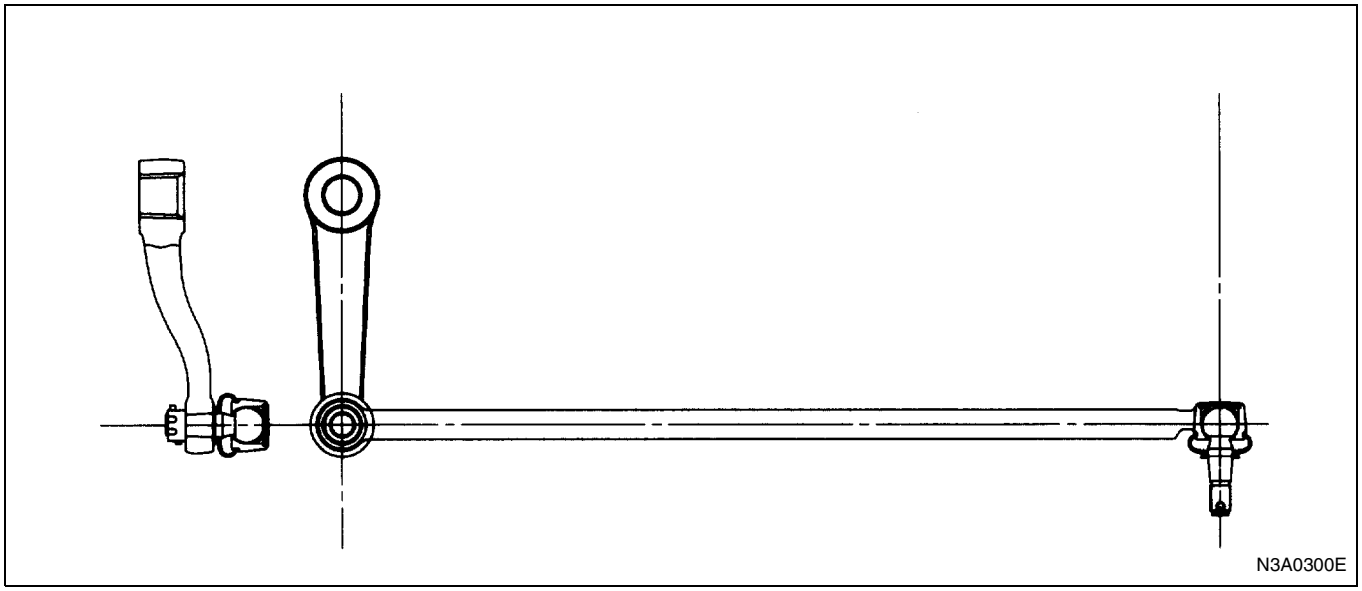
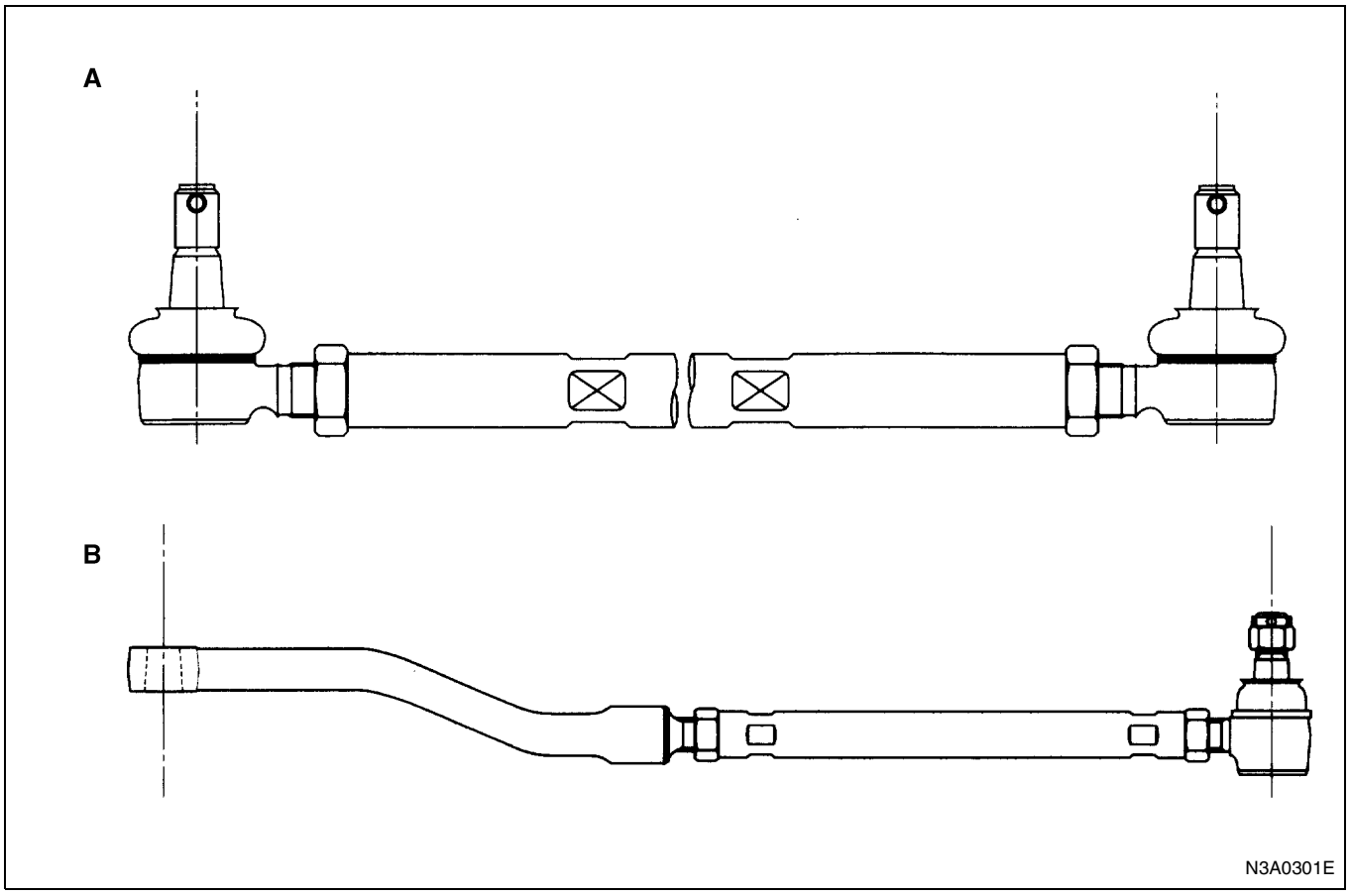
Tie Rod Replacement (2WD Rigid Suspension) 3B3-5
Tie Rod Replacement (NPS) 3B3-8
Steering Link Replacement (Wishbone Suspension) 3B3-11

GENERAL DESCRIPTION

Drag Link and Pitman Arm



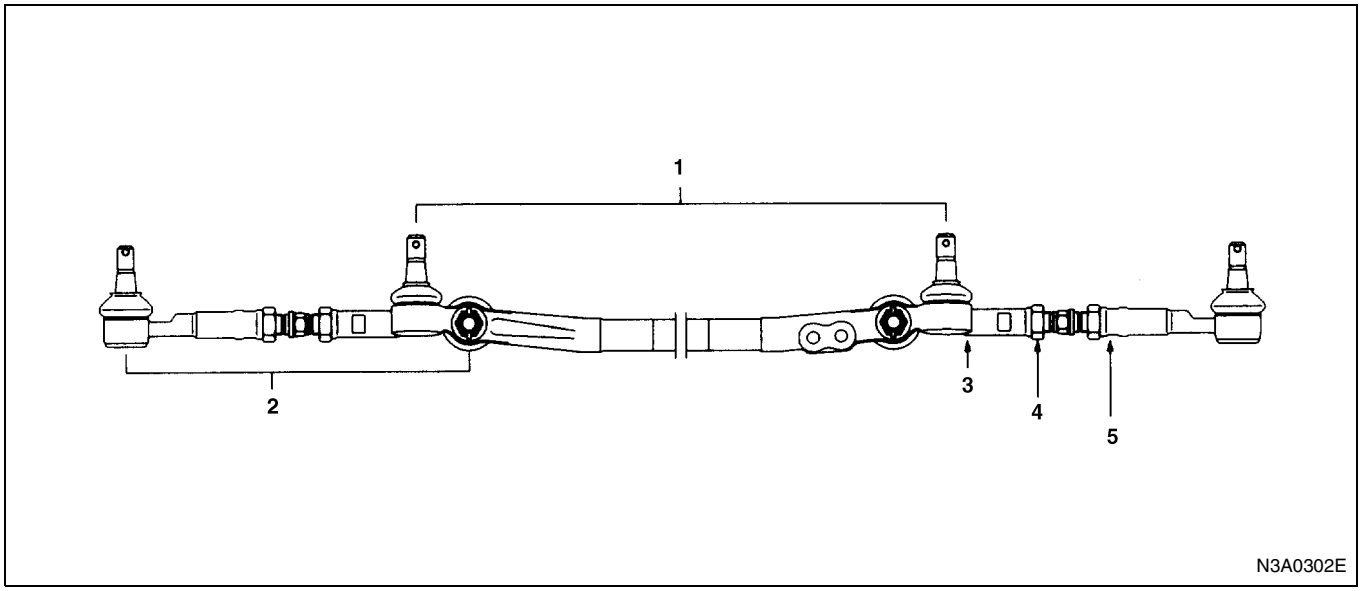
Tie Rod Assembly



Legend

A. Rigid suspension
B. NPS

Steering Link Assembly

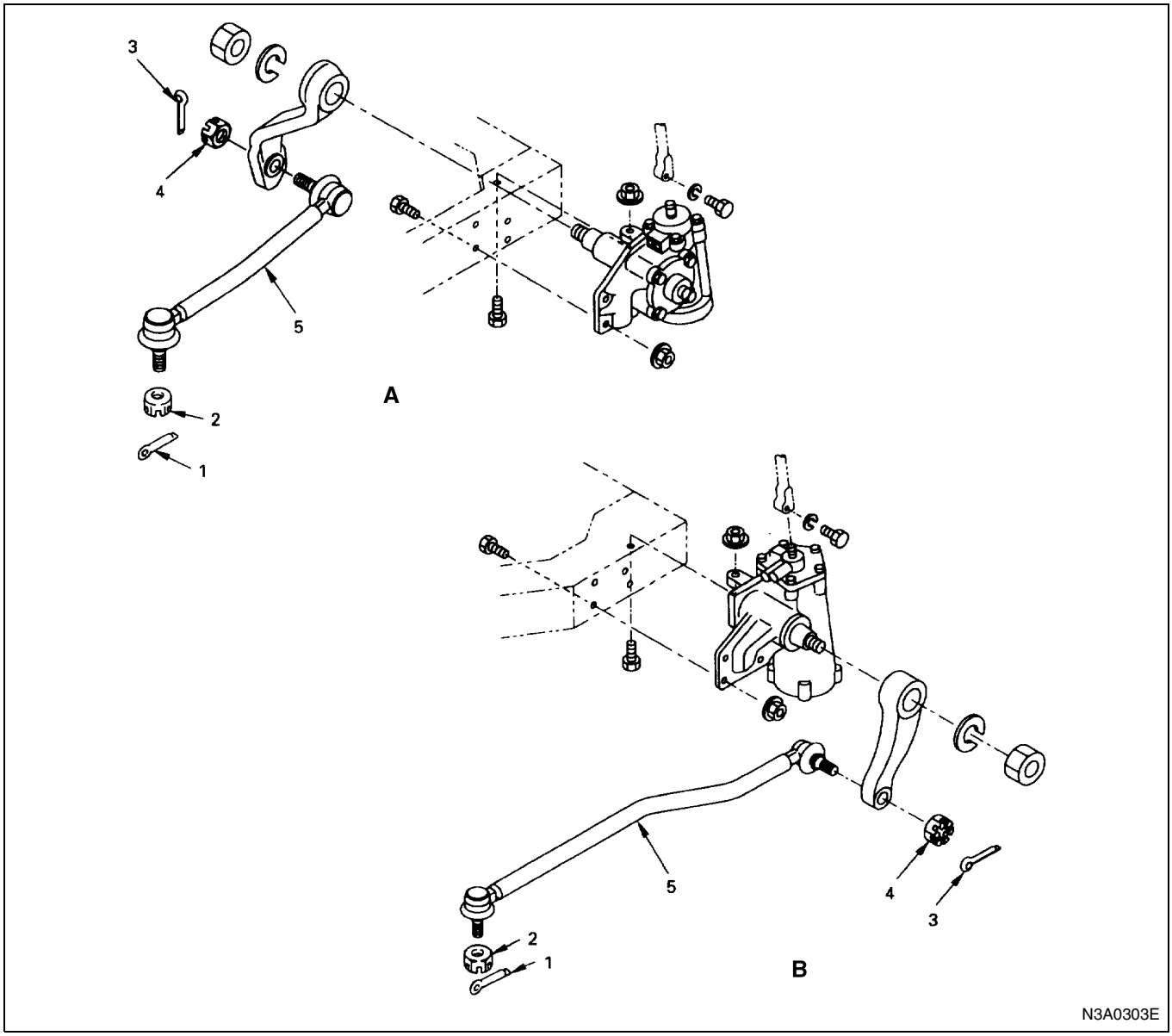


Legend

1. Center track rod assembly
2. Outer track rod assembly
3. Rod end (inner)
4. Track rod
5. Rod end (outer)

ON-VEHICLE SERVICE

Drag Link Replacement



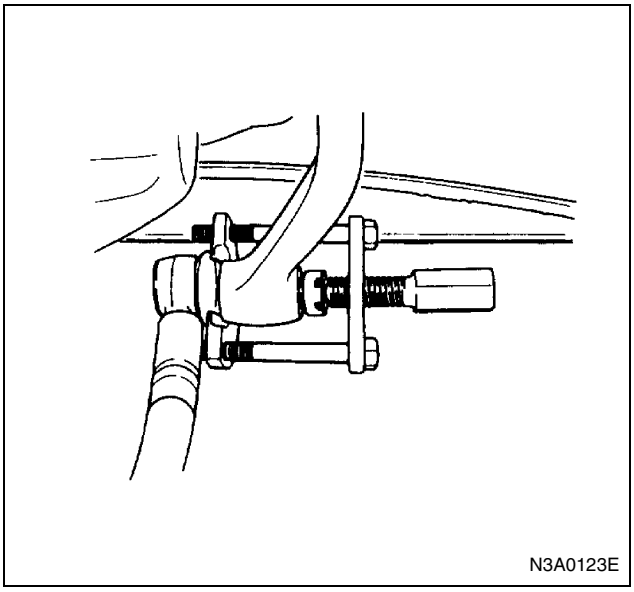
Legend

A. Wishbone suspension
B. Rigid suspension
1. Cotter pin
2. Nut
3. Cotter pin
4. Nut
5. Drag link

Removal

1. Cotter Pin
2. Nut
3. Cotter Pin
4. Nut
5. Drag Link
   Remove the drag link using a special tool.
   Remover: 5-8840-2017-0

Caution:
Be careful not to damage the ball joint boot.



Inspection and Repair

Make necessary correction or parts replacement if wear, damage, corrosion, bending, deteriorations or any other abnormal conditions are found through inspection.
Check the following parts.

- Ball joint (Boot, screws and tapered surface)

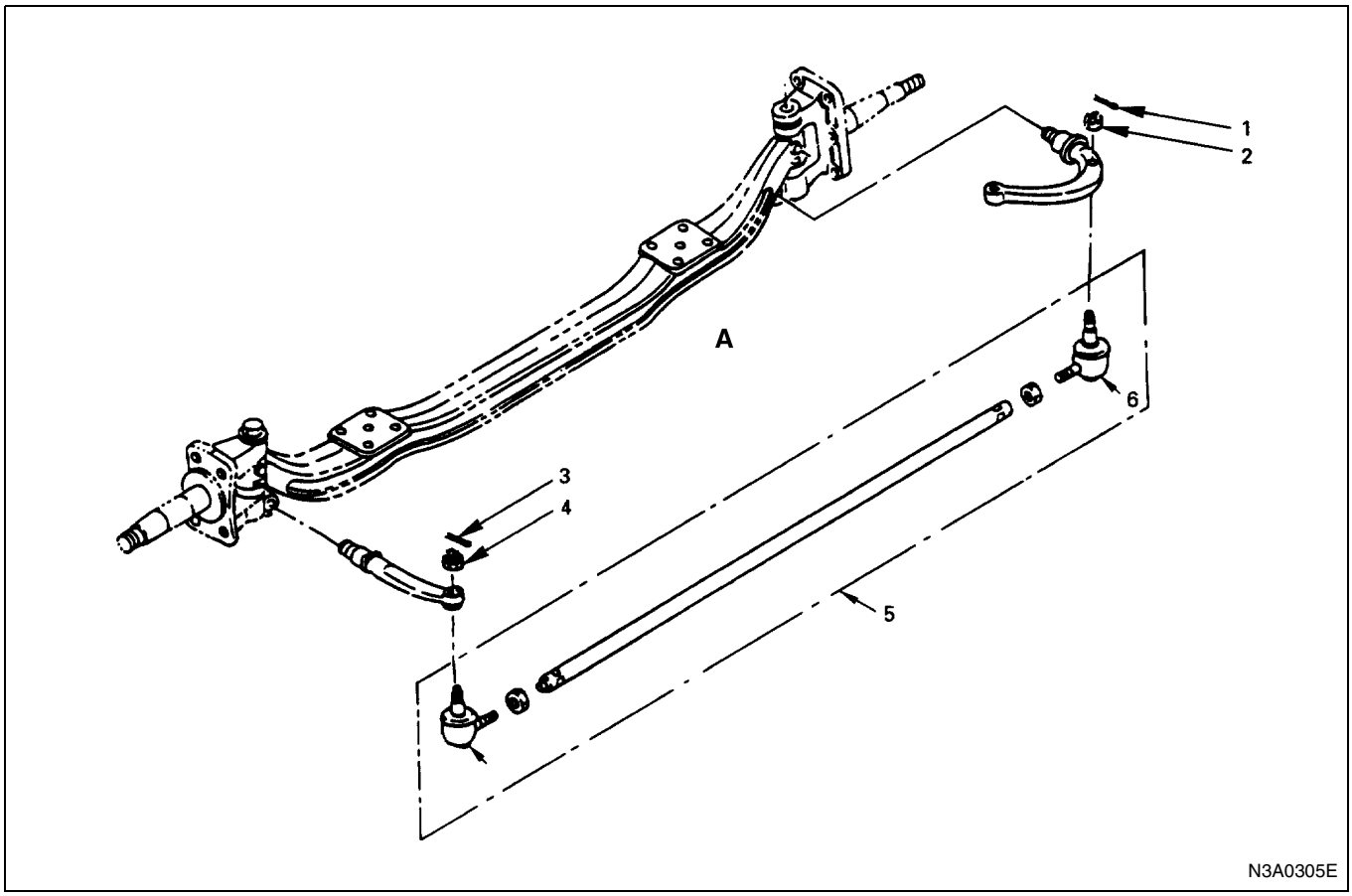
Installation

1. Drag Link
2. Nut
3. Cotter Pin
4. Nut
5. Cotter Pin
   Tighten the nut to the specified torque, with just enough additional torque to align cotter pin holes.
   Install new cotter pin.

Tighten:

- Drag link nut to 167 N·m (17 kg·m / 123 lb·ft)

Tie Rod Replacement (2WD Rigid Suspension)

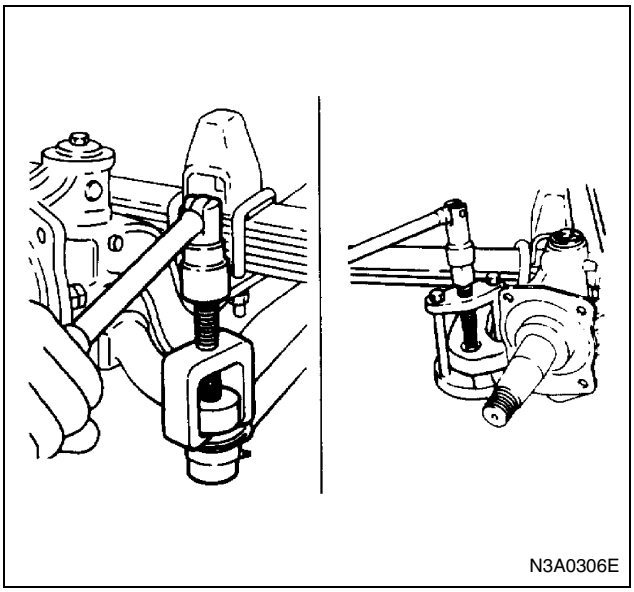


Legend

A. Front Axle
1. Cotter pin
2. Nut
3. Cotter pin
4. Nut
5. Tie rod assembly
6. Tie rod end

Removal

1. Cotter Pin
2. Nut
3. Cotter Pin
4. Nut
5. Tie Rod Assembly
   Remove the tie rod assembly using a special tool.
   Remover
   Driver side: 5-8840-2017-0
   Assistant side: 5-8840-2018-0



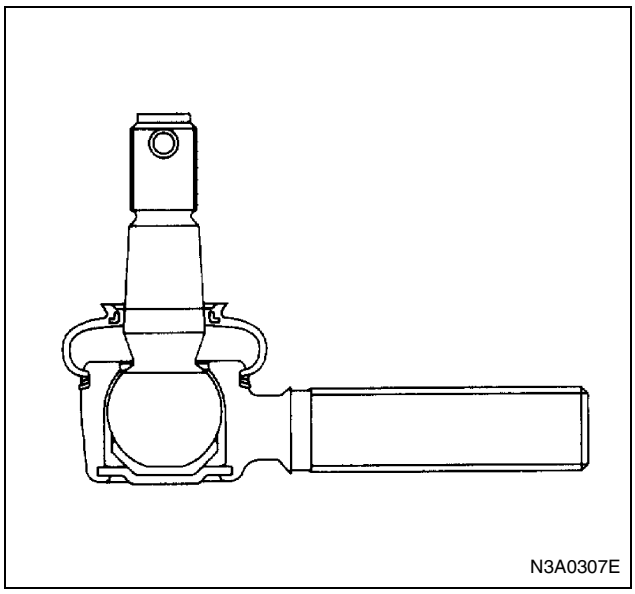
6. Tie Rod End

Inspection and Repair

Make necessary correction or parts replacement if wear, damage, or any other abnormal conditions are found through inspection.

Tie Rod End

Inspect the ball joint taper fitting part for contact condition or abnormal wear.
Inspect the boot for damage or grease leak. Move the ball joint to confirm its normal movement.
If abnormal condition is found, replace the assembly because it cannot be disassembled.



Tie Rod

Inspect the tie rod tube for bending or damaged threads. If abnormal condition is found, replace the assembly or correct if bending is small.

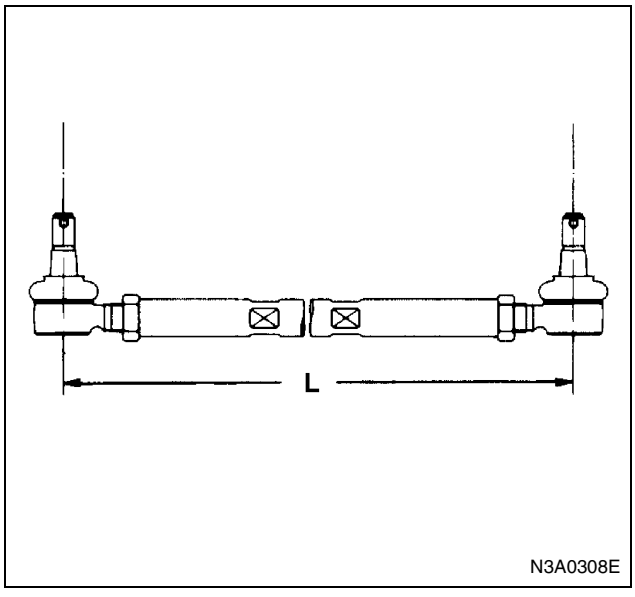
Installation

1. Tie Rod End
2. Tie Rod Assembly
   1) Install the tie rod end to the tie rod.
   2) Adjust length of tie rod by turning the connecting rod.

Tie Rod Length (L)

NHR: 1153.5 mm (45.413 in)
NKR: 1160.5 mm (45.925 in)
NPR, NQR: 1446.5 (56.949 in)

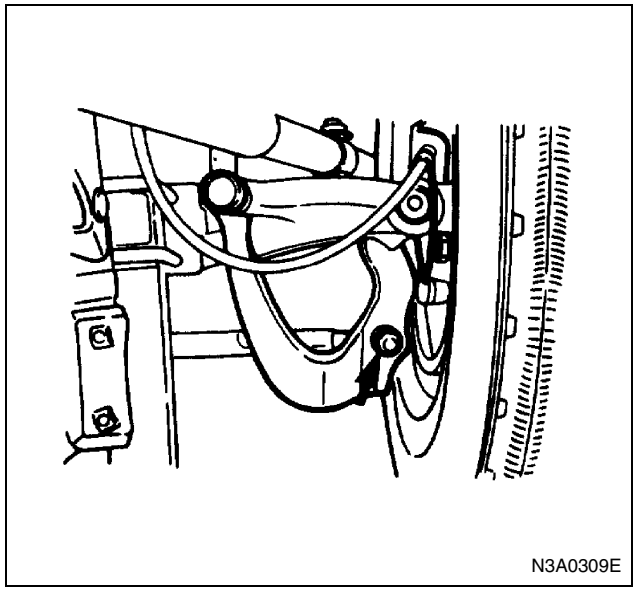
   3) After adjustment of length, temporarily tighten the tie rod end lock nut.



3. Nut
4. Cotter Pin
5. Nut

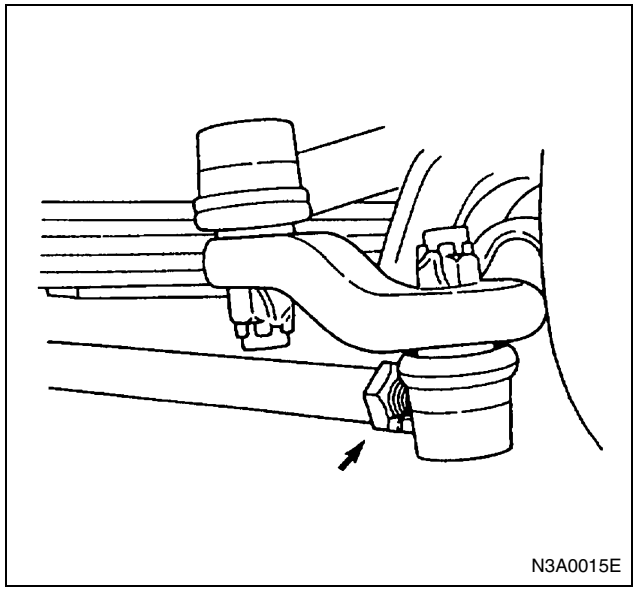
6. Cotter Pin
   1) Tighten the nut to specified torque, with just enough additional torque to align cotter pin hole.
      Install new cotter pin.

Tighten:
- Tie rod nut to 108 N·m (11 kg·m / 80 lb·ft)

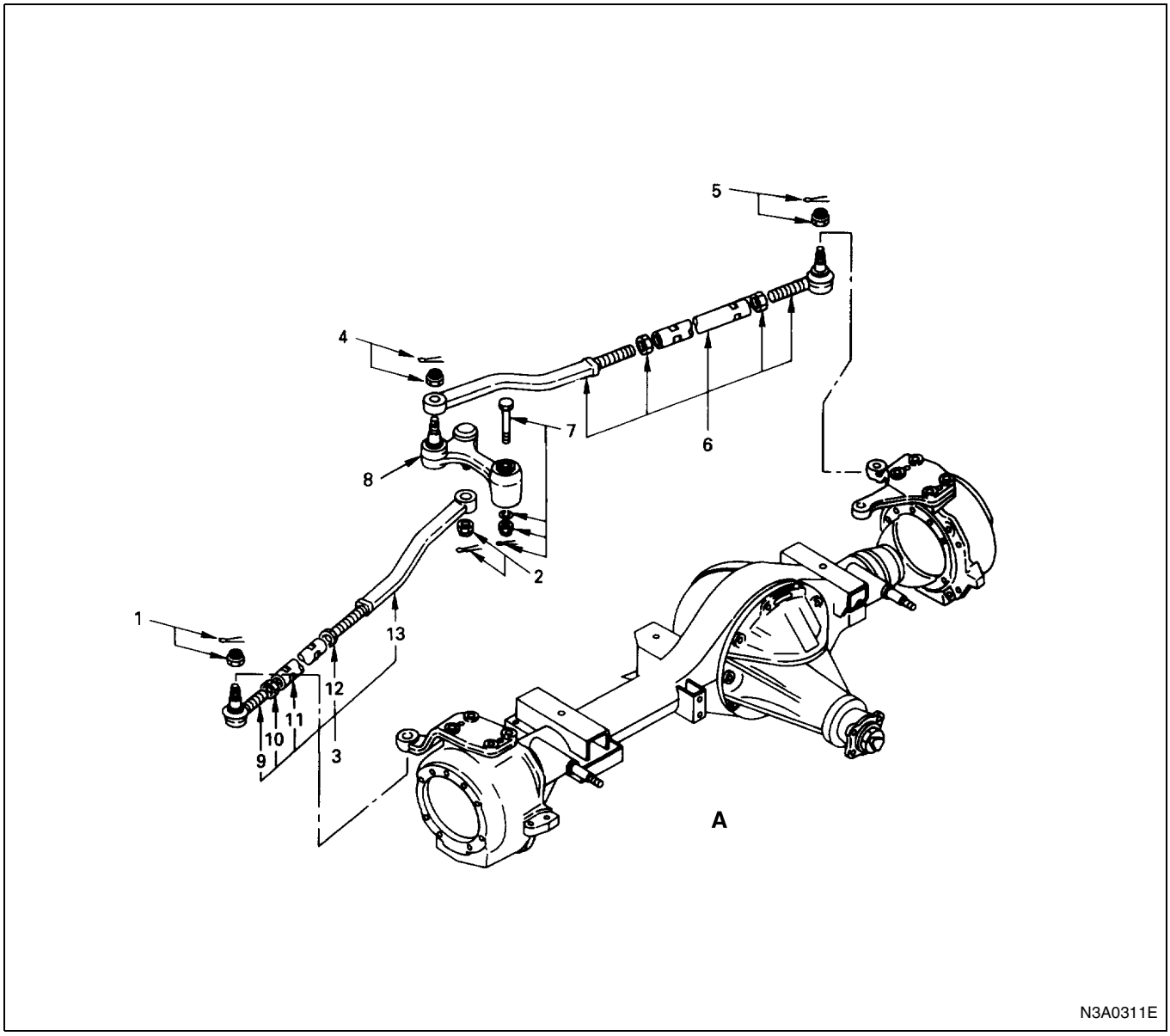


   2) Adjust the front end alignment after installation. Refer to “Front end alignment”.
   3) Tighten tie rod end lock nuts to specified torque after adjustment of front end alignment.

Tighten:
- Lock nut to 113 N·m (11.5 kg·m / 83 lb·ft)



Tie Rod Replacement (NPS)

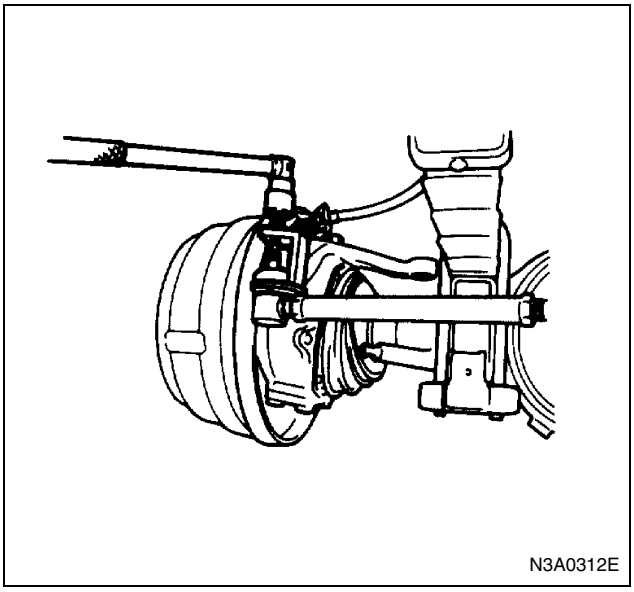


Legend

A. Front Axle
1. Nut and cotter pin
2. Nut and cotter pin
3. Tie rod assembly
4. Nut and cotter pin
5. Nut and cotter pin
6. Tie rod assembly
7. Bolt, nut, washer and cotter pin
8. Relay lever
9. Tie rod end
10. Lock nut
11. Tie rod tube
12. Lock nut
13. Tie rod

Removal

1. Nut and Cotter Pin
2. Nut and Cotter Pin
3. Tie Rod Assembly
4. Nut and Cotter Pin
5. Nut and Cotter Pin
6. Tie Rod Assembly
   Remover: 5-8840-2189-0


N3A0312E

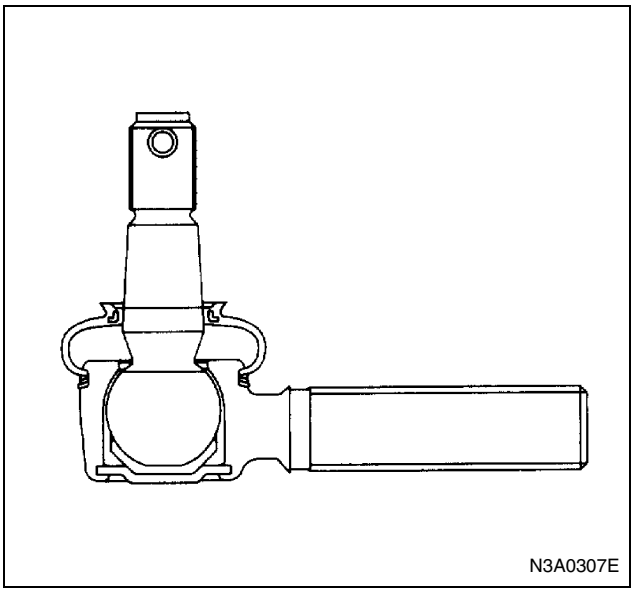
7. Bolt, Nut, Washer and Cotter Pin
8. Relay Lever
9. Tie Rod End
10. Lock Nut
11. Tie Rod Tube
12. Lock Nut
13. Tie Rod

Inspection and Repair

Make necessary correction or parts replacement if wear, damage, or any other abnormal conditions are found through inspection.

Tie Rod End

- Inspect the ball joint taper fitting part for contact condition or abnormal wear.
- Inspect the boot for damage or grease leak.
- Move the ball joint to confirm its normal movement.
- If abnormal condition is found, replace the assembly because it cannot be disassembled.


N3A0307E

Tie Rod

Inspect the tie rod tube for bending or damaged threads. If abnormal condition is found, replace the assembly or correct if bending is small.

Relay Lever

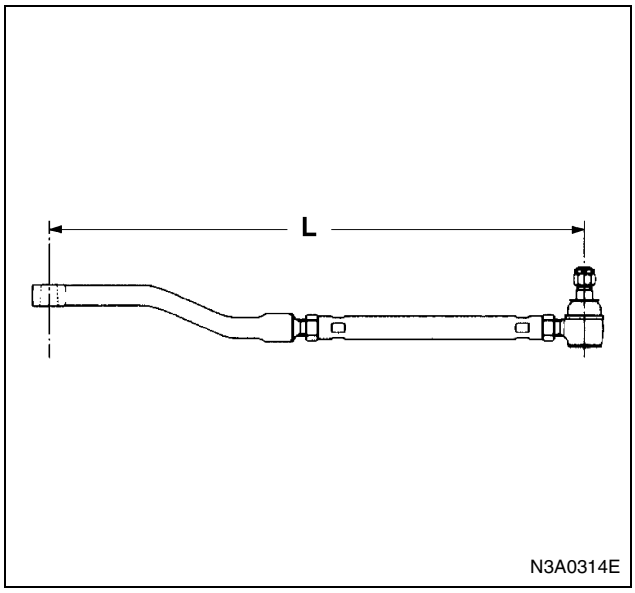
Inspect the relay lever bushing. If bushing is defective, replace the relay lever assembly.

Installation

1. Tie Rod
2. Lock Nut
3. Tie Rod Tube
4. Lock Nut
5. Tie Rod End
   1) Install all parts and adjust tie rod length (L).

Tie Rod Length (L)

781 mm (30.748 in)

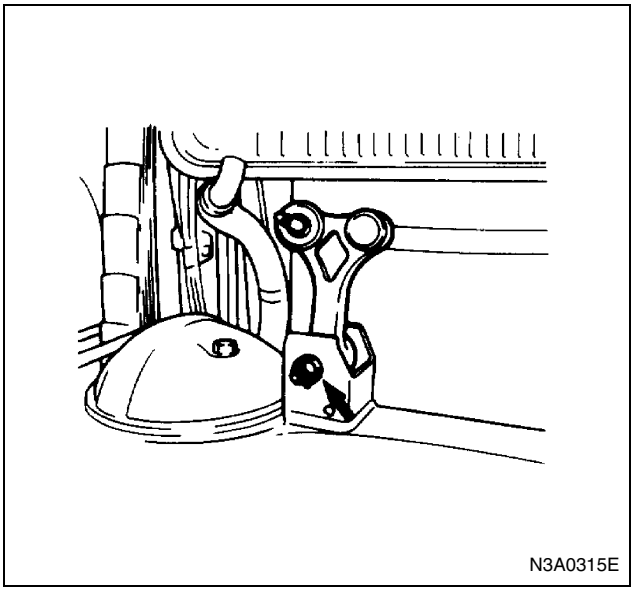


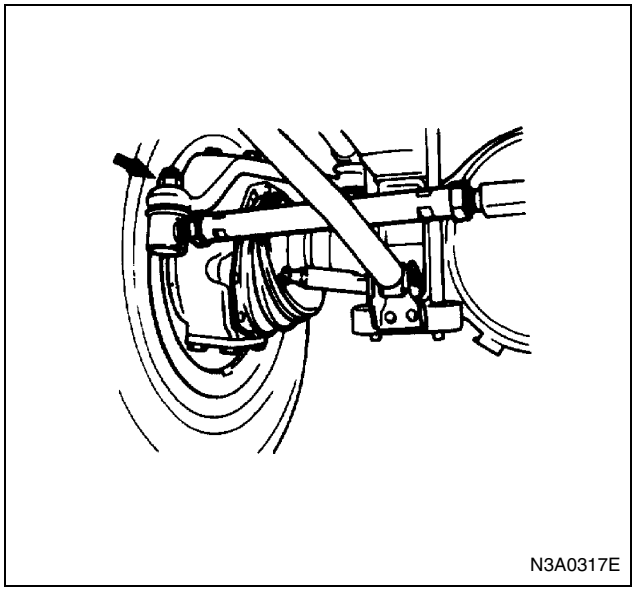
N3A0314E

   2) After adjustment, tighten lock nuts temporarily.
6. Relay Lever
7. Bolt, Nut, Washer and Cotter Pin
   1) Install the relay lever to the bracket.
   2) Tighten the nut to specified torque, with just enough additional torque to align cotter pin hole.
   3) Install new cotter pin.

Tighten:

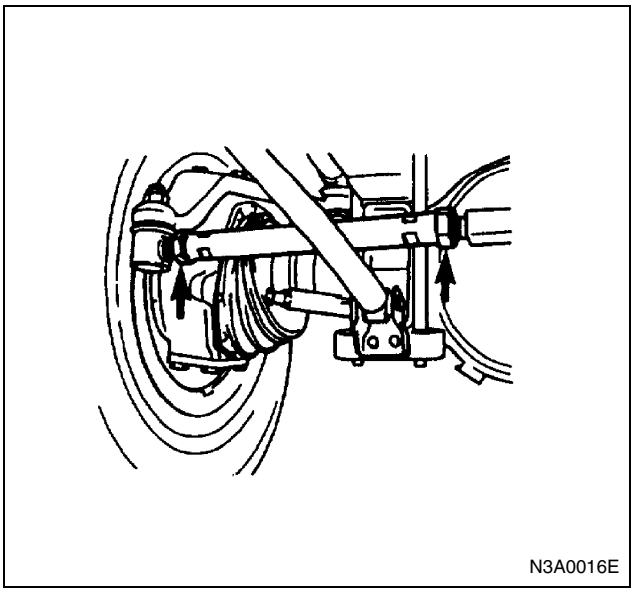
- Relay lever nut to 147 N·m (15 kg·m / 108 lb·ft)


N3A0315E


N3A0317E

8. Tie Rod Assembly
9. Nut and Cotter Pin
10. Nut and Cotter Pin
11. Tie Rod Assembly
12. Nut and Cotter Pin
13. Nut and Cotter Pin
    1) Tighten tie rod end nut to specified torque, with just enough additional torque to align cotter pin hole.
       Install new cotter pin.

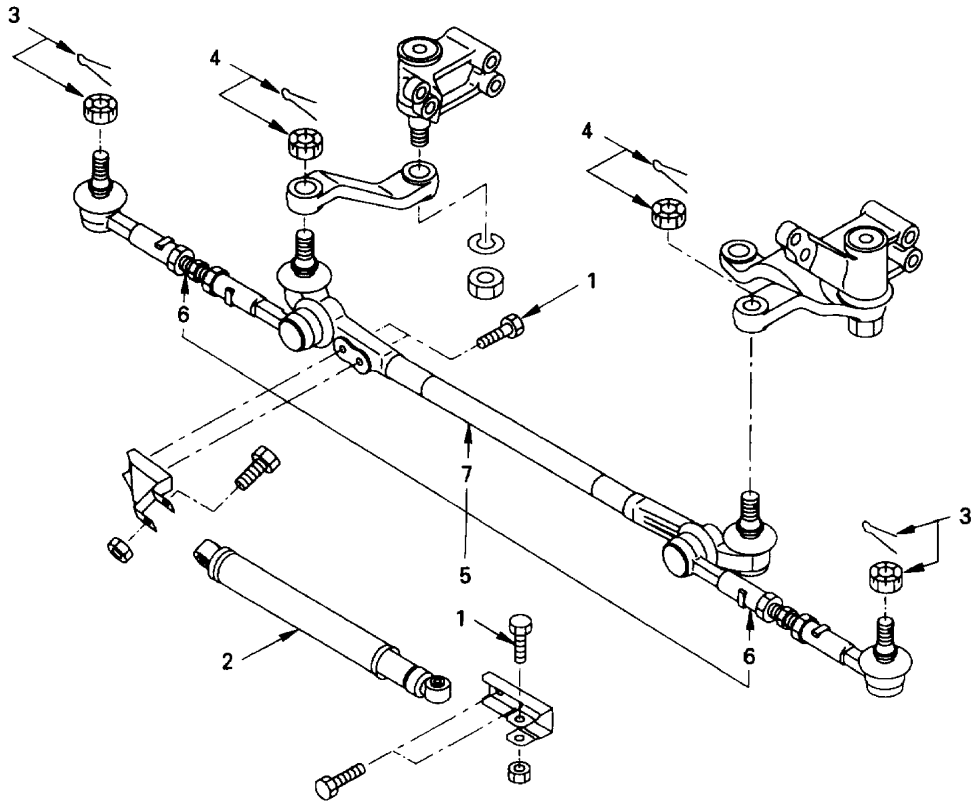
Tighten:
- Tie rod end nut to 186 N·m (19 kg·m / 137 lb·ft)


N3A0016E

    2) Adjust the front end alignment after installation. Refer to “Front end alignment”.
    3) After adjustment, tighten the lock nuts to specified torque.

Tighten:
- Lock nut to 113 N·m (11.5 kg·m / 83 lb·ft)

Steering Link Replacement (Wishbone Suspension)



Legend

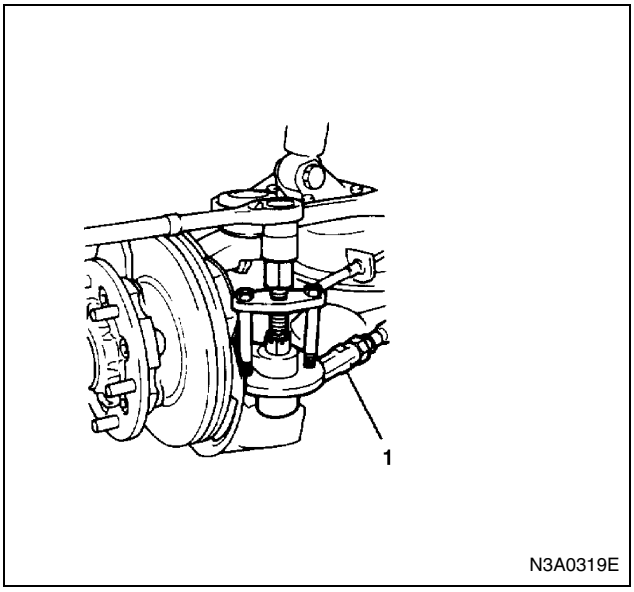
1. Bolt
2. Steering damper
3. Nut and cotter pin
4. Nut and cotter pin
5. Steering link assembly
6. Outer track rod
7. Center track rod

Removal

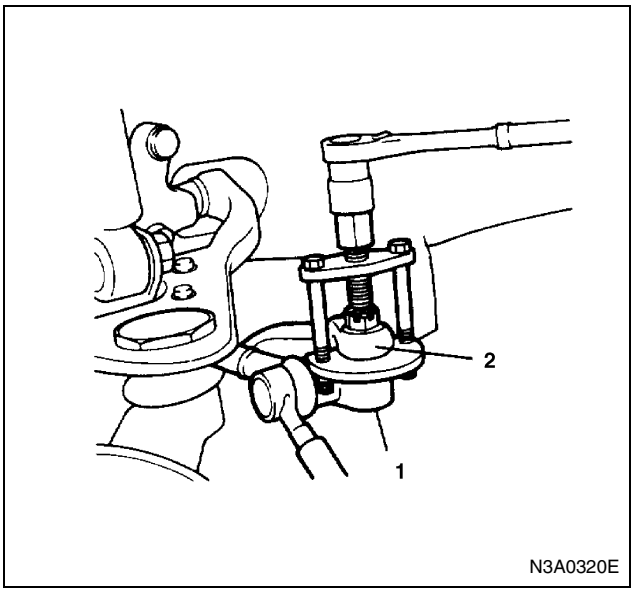
Preparation

Raise the vehicle and support the frame with suitable safety stands.

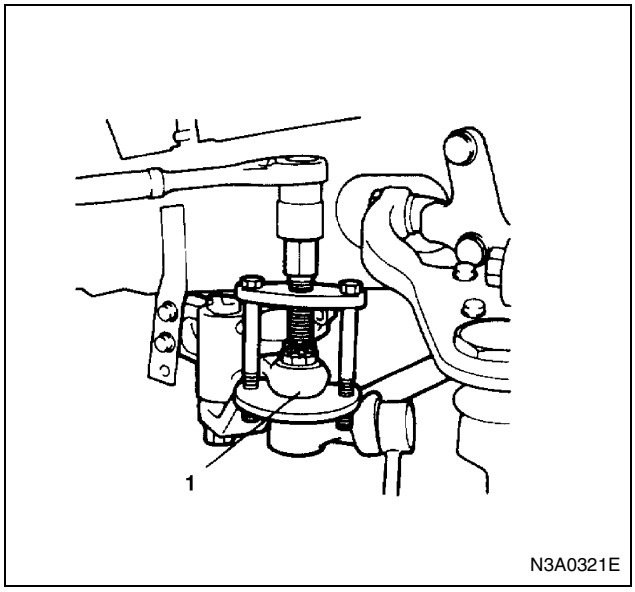
1. Bolt
2. Steering Damper
3. Nut and Cotter Pin
   Disconnect outer track rods (1) from knuckle.
   Remover: 5-8840-2017-0



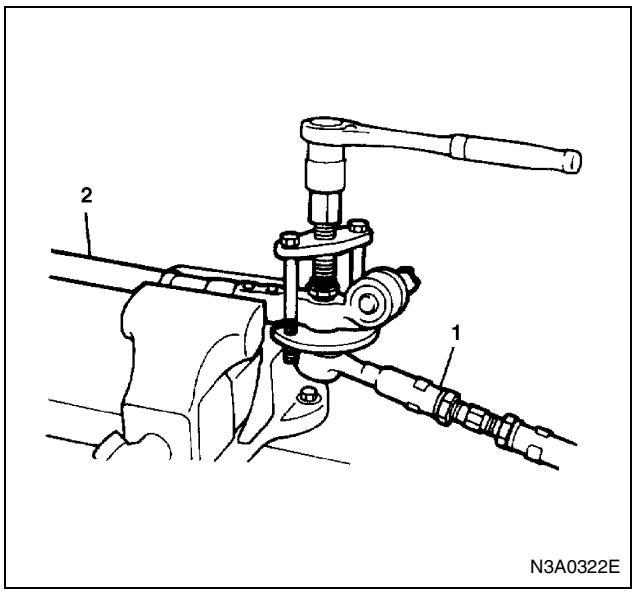
4. Nut and Cotter Pin
   1) Disconnect center track rod (1) from relay lever (2).
      Remover: 5-8840-2017-0



   2) Disconnect center track rod from idler arm (1).
      Remover: 5-8840-2017-0



5. Steering Link Assembly
6. Outer Track Rod
7. Center Track Rod
   Disconnect outer track rods (1) from center track rod (2).
   Remover: 5-8840-2017-0



Inspection

Make necessary correction or parts replacement if wear, damage or any other abnormal conditions are found through inspection.

Outer Track Rod End

- Inspect the ball joint taper fitting part for contact condition or abnormal wear.
- Inspect the boot for damage or grease leak.
- Move the ball joint to confirm its normal movement. If abnormal condition is found, replace the rod end assembly because it cannot be disassembled.

Center Track Rod

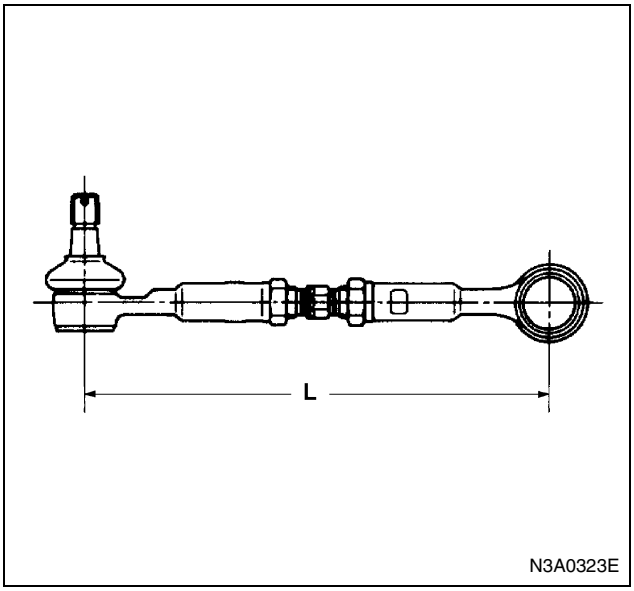
- Inspect the center track rod for bending or any other abnormal conditions.

- Inspect the ball joint taper fitting part for contact condition or abnormal wear.
- Inspect the boot for damage or grease leak.
- Move the ball joint to confirm its normal movement. If abnormal condition is found, replace the center track rod assembly because it cannot be disassembled.

Installation

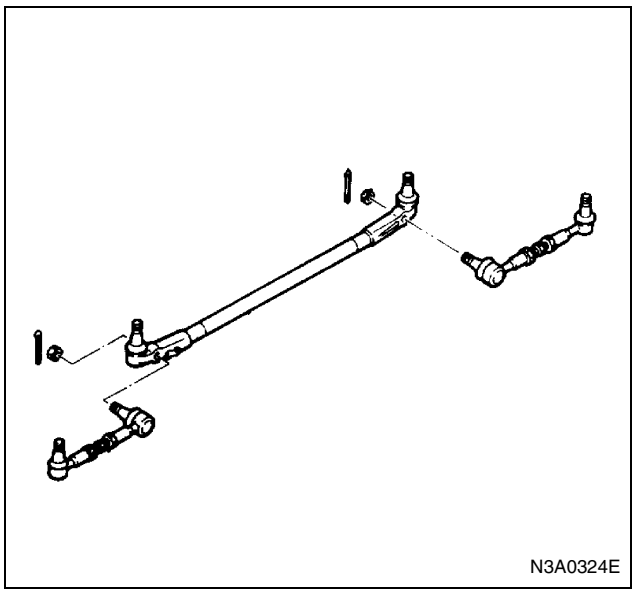
1. Center Track Rod
2. Outer Track Rod
   1) Adjust outer track rod length (L) to specified length.

Rod Length (L)
323.5 mm (12.736 in)



   2) After adjustment, tighten track rod end lock nut temporarily.
   3) Install outer track rods to the center track rod. Tighten nuts to specified torque, with just enough additional torque to align cotter pin hole.
      Install new cotter pin.

Tighten:
- Outer track rod nut to 108 N·m (11 kg·m / 80 lb·ft)



3. Steering Link Assembly
4. Nut and Cotter Pin
5. Nut and Cotter Pin
   1) Connect center track rod ends to the idler arm and relay lever.
   2) Connect outer track rod ends to knuckle.
   3) Tighten nuts to specified torque, with just enough additional torque to align cotter pin hole.
      Install new cotter pin.

Tighten:
- Center track rod end nut to 167 N·m (17 kg·m / 123 lb·ft)
- Outer track rod end nut to 108 N·m (11 kg·m / 80 lb·ft)
   4) Adjust the front end alignment after installation. Refer to “Front end alignment” in Section 3A.
   5) Tighten outer track rod end lock nuts to specified torque after adjustment of front end alignment.

Tighten:
- Lock nut to 167 N·m (17 kg·m / 123 lb·ft)

6. Steering Damper
7. Bolt

Tighten:
- Steering damper bolt to 50 N·m (5.1 kg·m / 37 lb·ft)

STEERING, SUSPENSION, WHEELS AND TIRES

SECTION 3B4

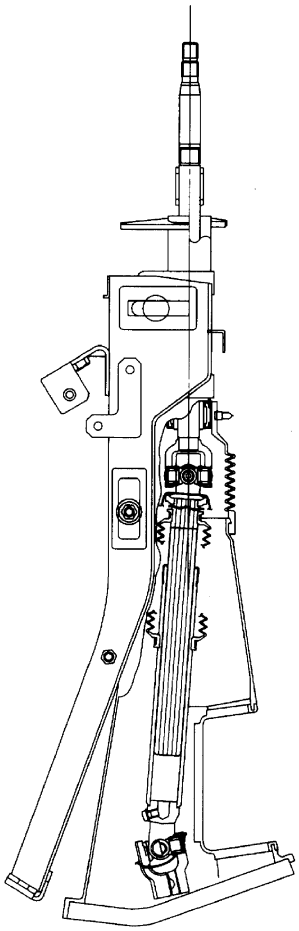
STEERING COLUMN

Contents

GENERAL DESCRIPTION 3B4-2
ON-VEHICLE SERVICE 3B4-3
Steering Wheel, Shaft and Column 3B4-3

GENERAL DESCRIPTION

This illustration is based on tilt and telescopic control type.



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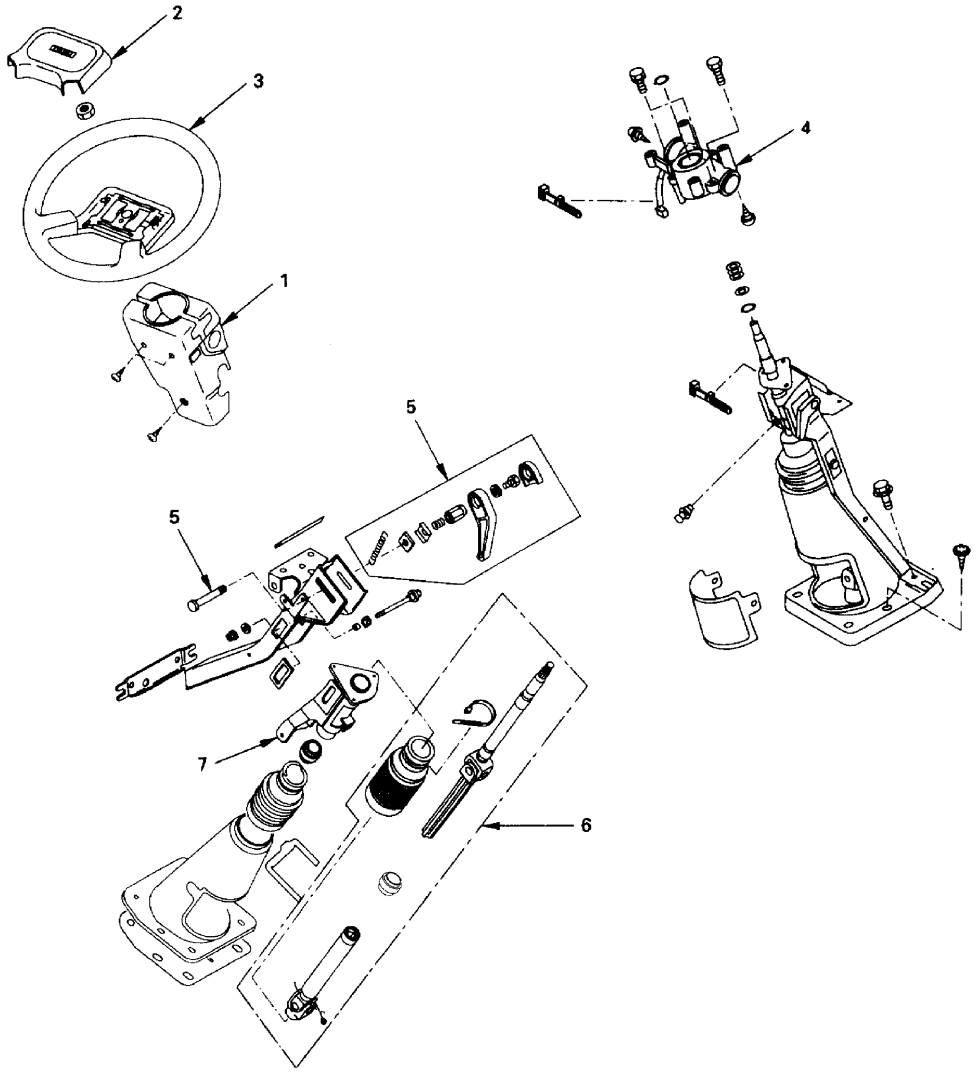
ON-VEHICLE SERVICE

Steering Wheel, Shaft and Column

This illustration is based on tilt and telescopic control type.



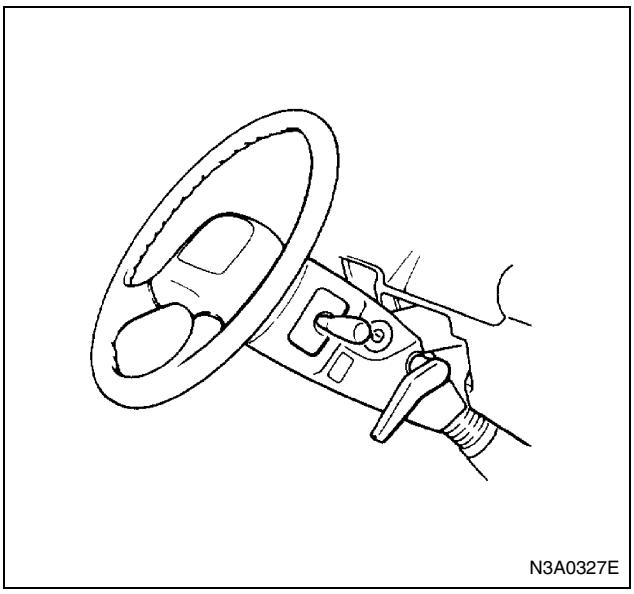
N3A0465E

Legend

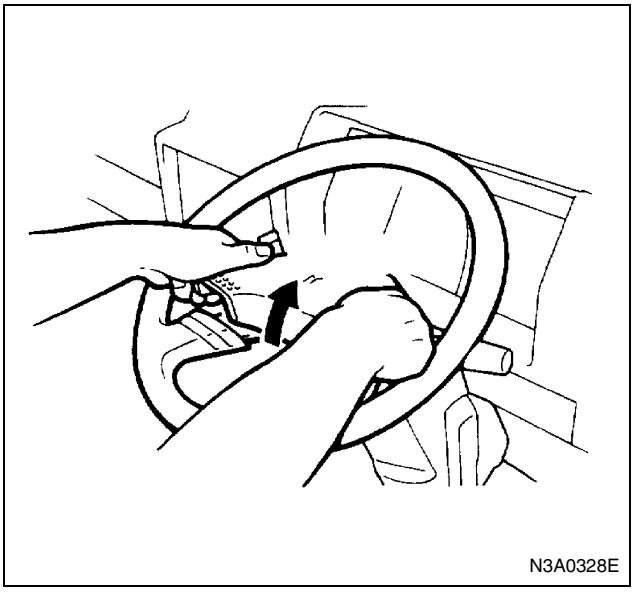
1. Steering cowl
2. Horn button
3. Steering wheel
4. Starter switch and key cylinder assembly
5. Tilt control (or support bolt)
6. Steering shaft assembly
7. Steering column

Removal

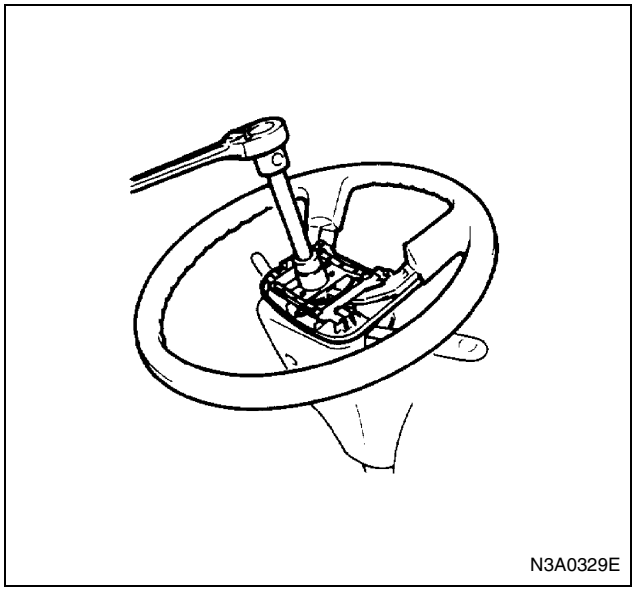
1. Steering Cowl



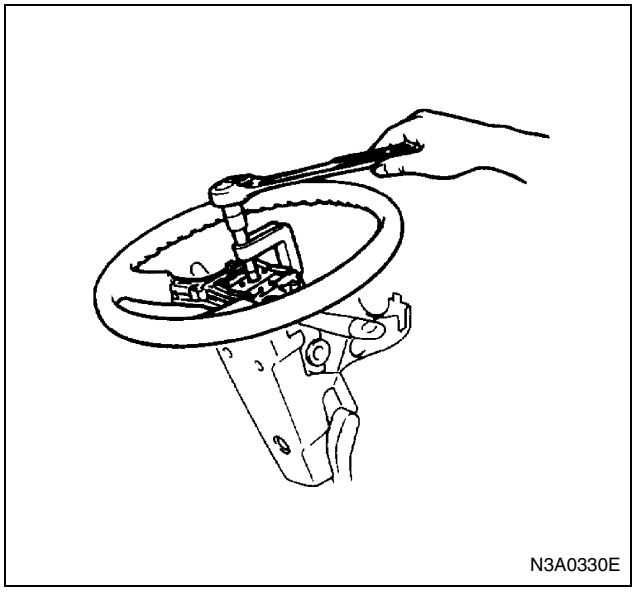
2. Horn Button



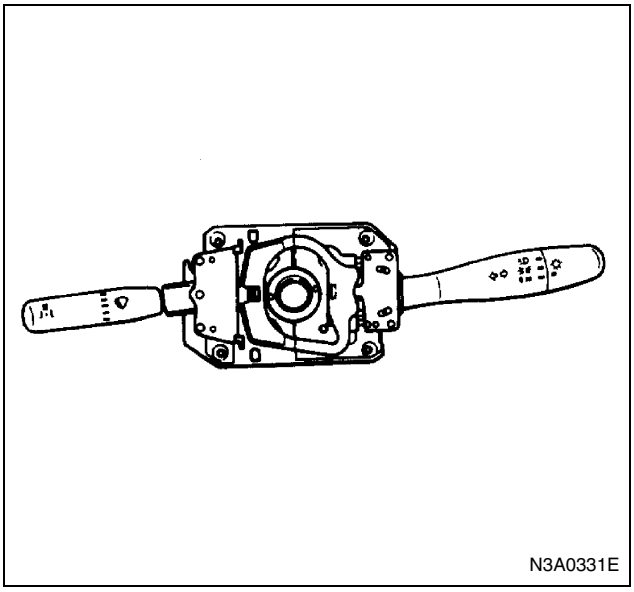
3. Steering Wheel
   - Remove the locking nuts for the steering wheel.



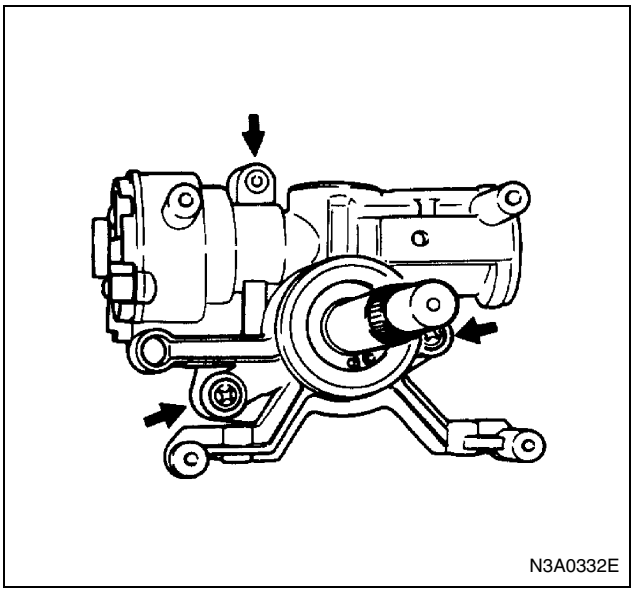
- Remove the steering wheel using the special tool.
  Remover: 5-8840-2215-0



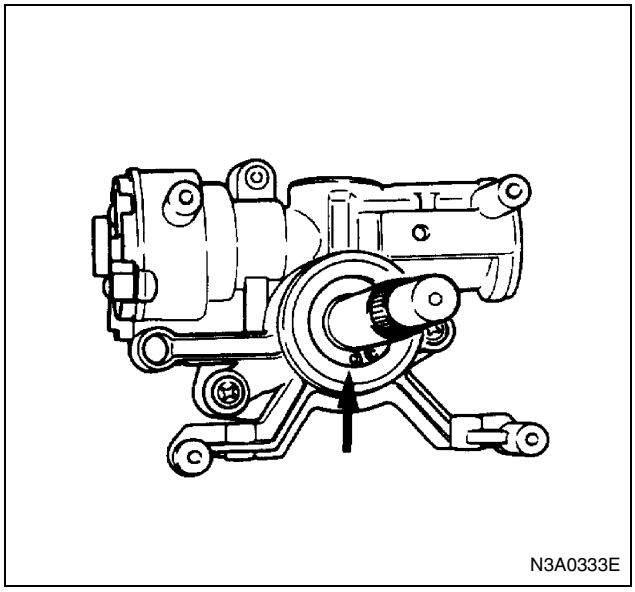
- Take out the combination switch.


N3A0331E

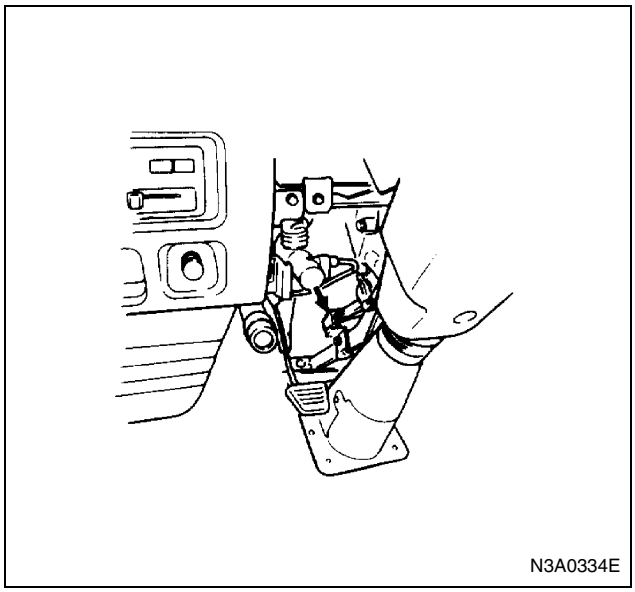
4. Starter Switch and Key Cylinder Assembly
   - Cut the steering lock with a hack-saw to loosen the screws.


N3A0332E

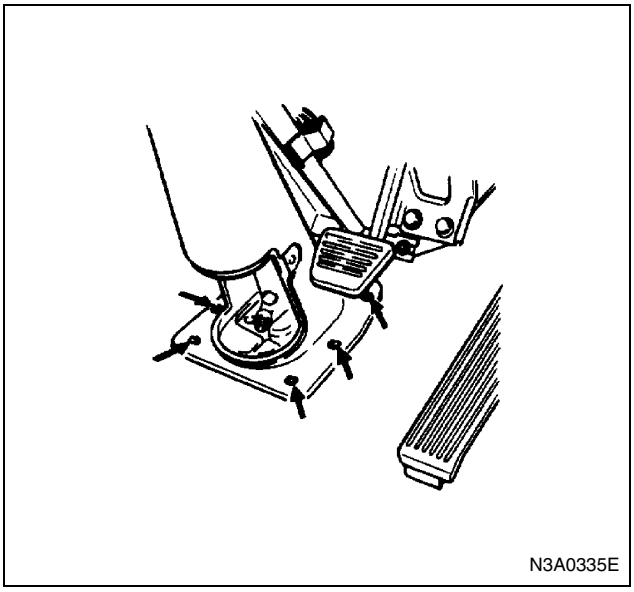
- Remove the snap rings and remove the steering lock assembly.


N3A0333E

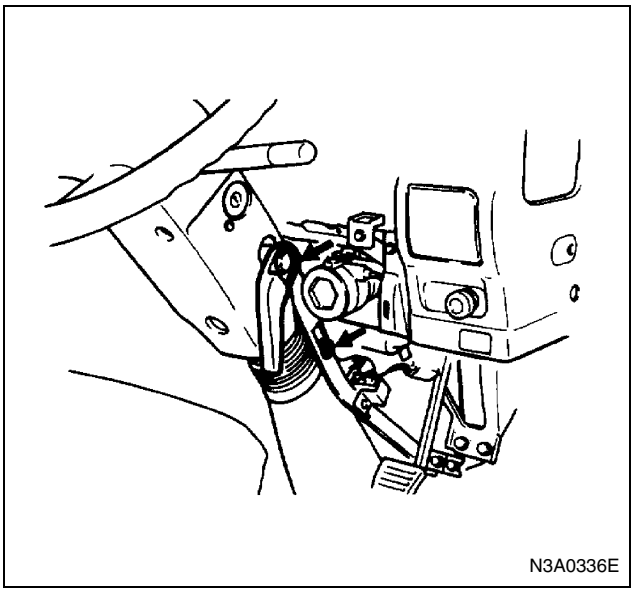
- Remove the harness connectors.


N3A0334E

- Remove the inspection window in the boots to describe a mating mark on the steering shaft and the yoke of universal joint.

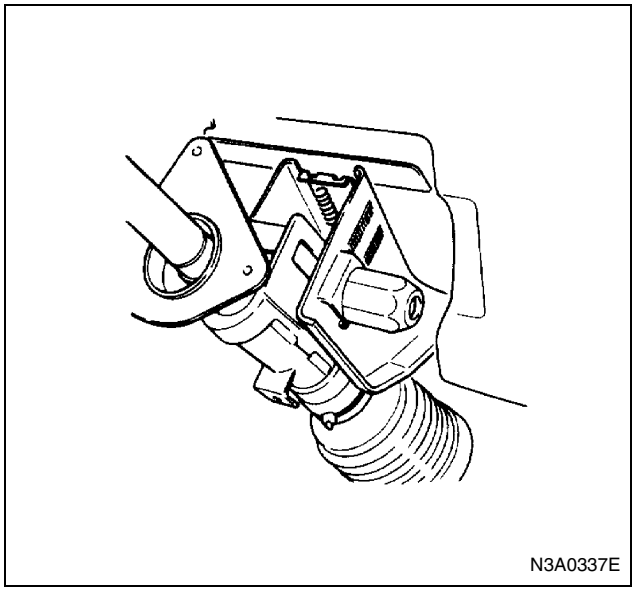

N3A0335E

5. Tilt control
   - Remove the tilt control and the support brackets retaining bolts for the steering wheel column.

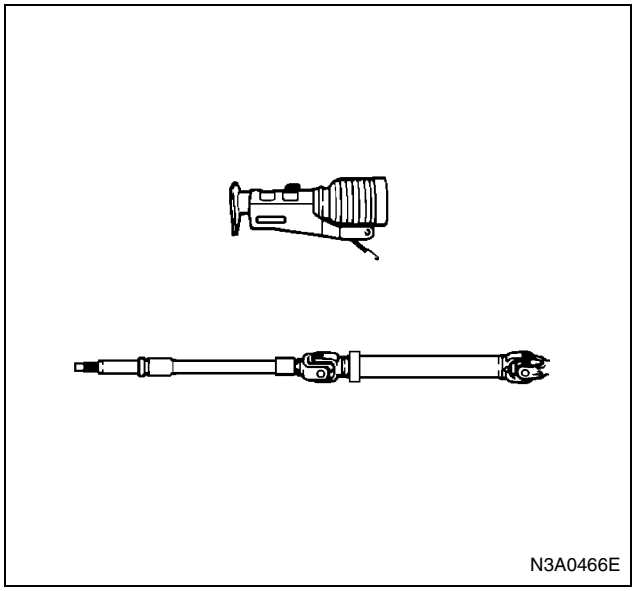

N3A0336E

for Tilt Steering

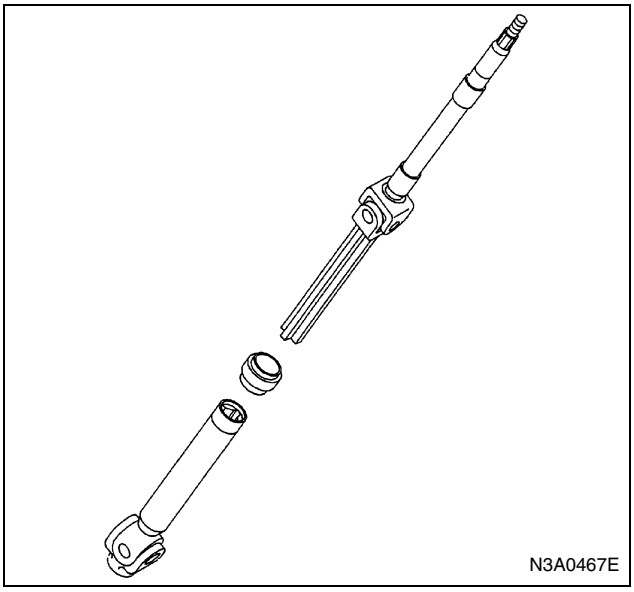
- Remove the tilt spring.


N3A0337E

6. Steering Shaft
   - Pull the steering shaft out of the column.


N3A0466E

- Describe a mating mark on the spline shaft and steering shaft and dismantle them.



7. Steering Column

Inspection and Repair

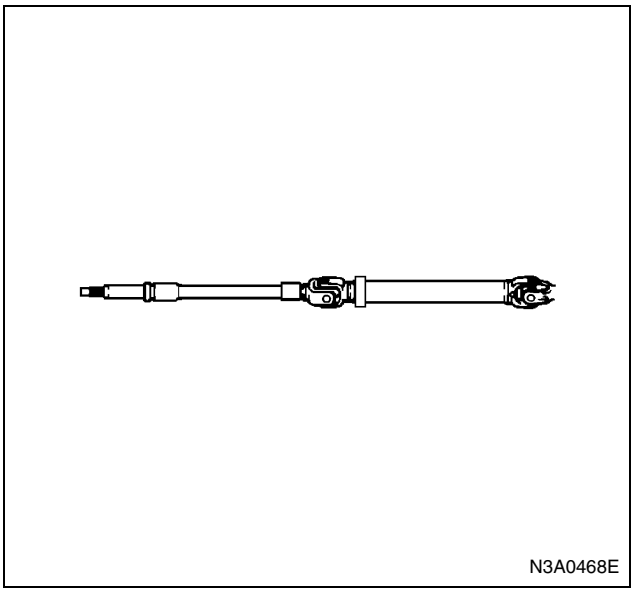
Clean up the dismantled components to perform inspection over each component.

Steering Shaft

- Inspect the bend.
- Inspect the universal joint.
  Check the yoke for crack and deformation.
  Chattering in the joint pairing.

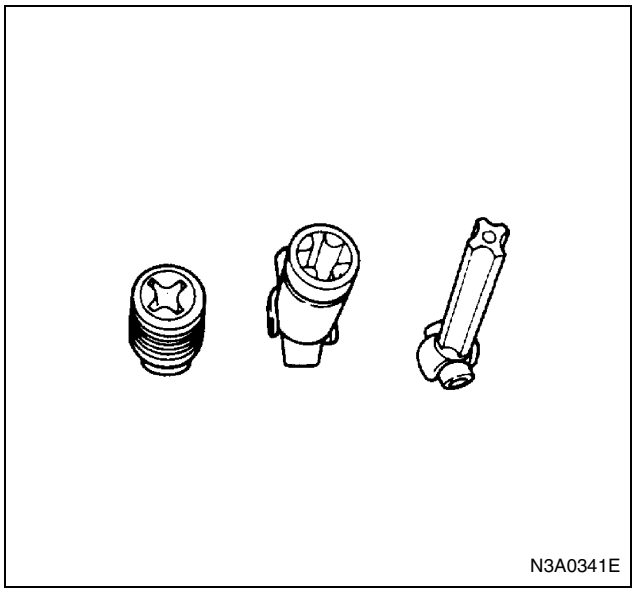
Caution:
The universal joint is non-repairable type.

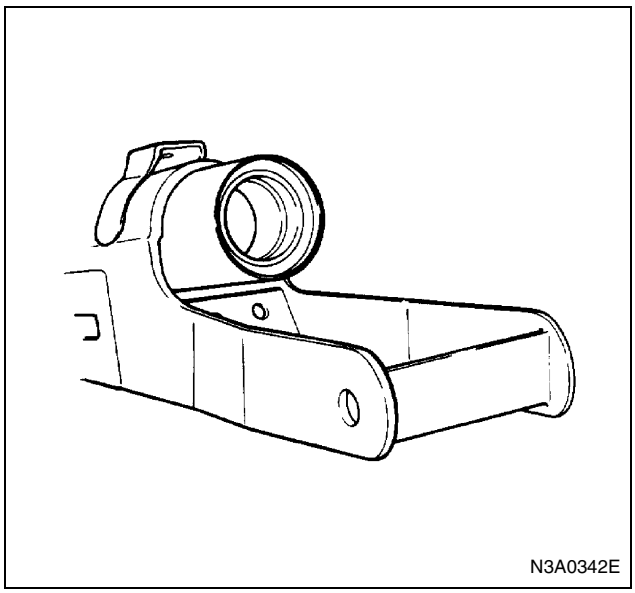
- Inspect the spline shaft.
  Significant chattering in the turning direction of steering shaft
  Chattering in the joints
  Fracture and deterioration in the boots



Steering Column

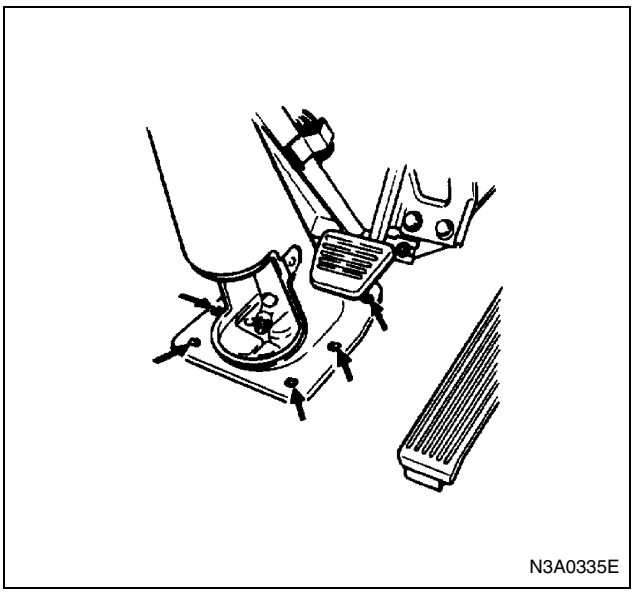
- Check to see if there is no significant deformation in the steering column.
- Check the boots for fracture and deterioration.
- Check the bushing for wear and deformation.



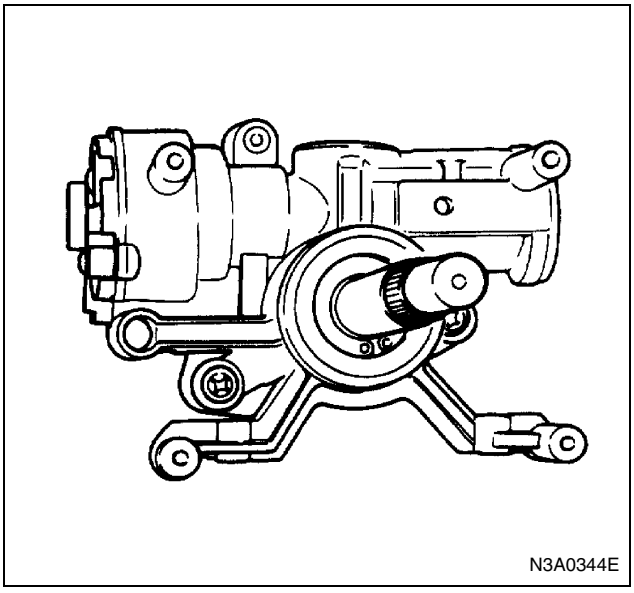


Installation

1. Steering Column
2. Steering Shaft
   - Assemble the steering shaft referring to the mating mark described at the time of dismantling and install the shaft.
   - Install the steering shaft to the steering unit referring to the mating mark described at the time of dismanting.

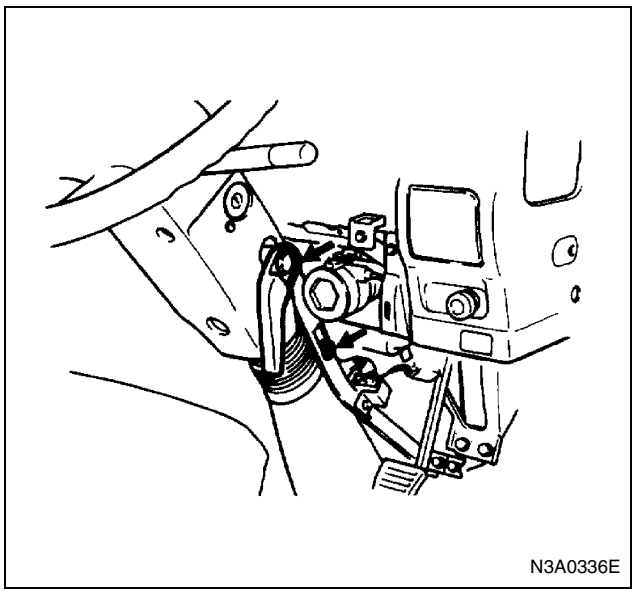

N3A0335E

3. Starter Switch and Key Cylinder Assembly
   - Install the steering lock assembly and insert the snap ring positively.
   - Use new screws.


N3A0344E

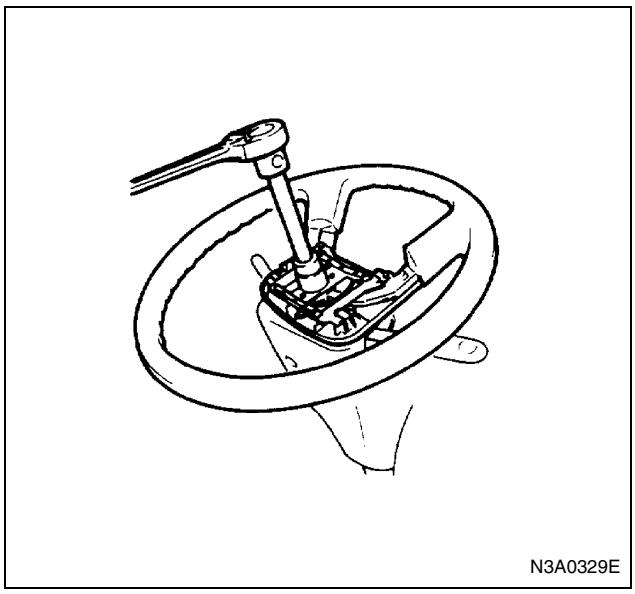
4. Tilt Control (or Support Bolt)
   - Tighten the retaining nuts for the lower steering column support brackets to the specified torque.
   - Tighten the nuts outside the tilt control to the specified torque to install the lever, and tighten the lever retaining bolts to the specified torque.

Tighten:
- Lower support bolt and nut to 14 N·m (1.4 kg·m/122 lb·ft)
- Tilt control bolt and nut to
  Bolt : 45 N·m (4.5 kg·m/33 lb·ft)
  Nut : 16 N·m (1.6 kg·m/12 lb·ft)
  Nut (Non-tilt) : 20 N·m (2.0 kg·m/14 lb·ft)


N3A0336E

5. Steering Wheel
   - Install the combination switch.
   - Install the steering wheel and tighten the nuts to the specified torque.

Tighten:
- Steering wheel nut to 50 N·m (5 kg·m/36 lb·ft)


N3A0329E

6. Horn Button
7. Steering Cowl
   - Hook up the harness connectors and install the steering cowl.

STEERING, SUSPENSION, WHEELS AND TIRES

SECTION 3C

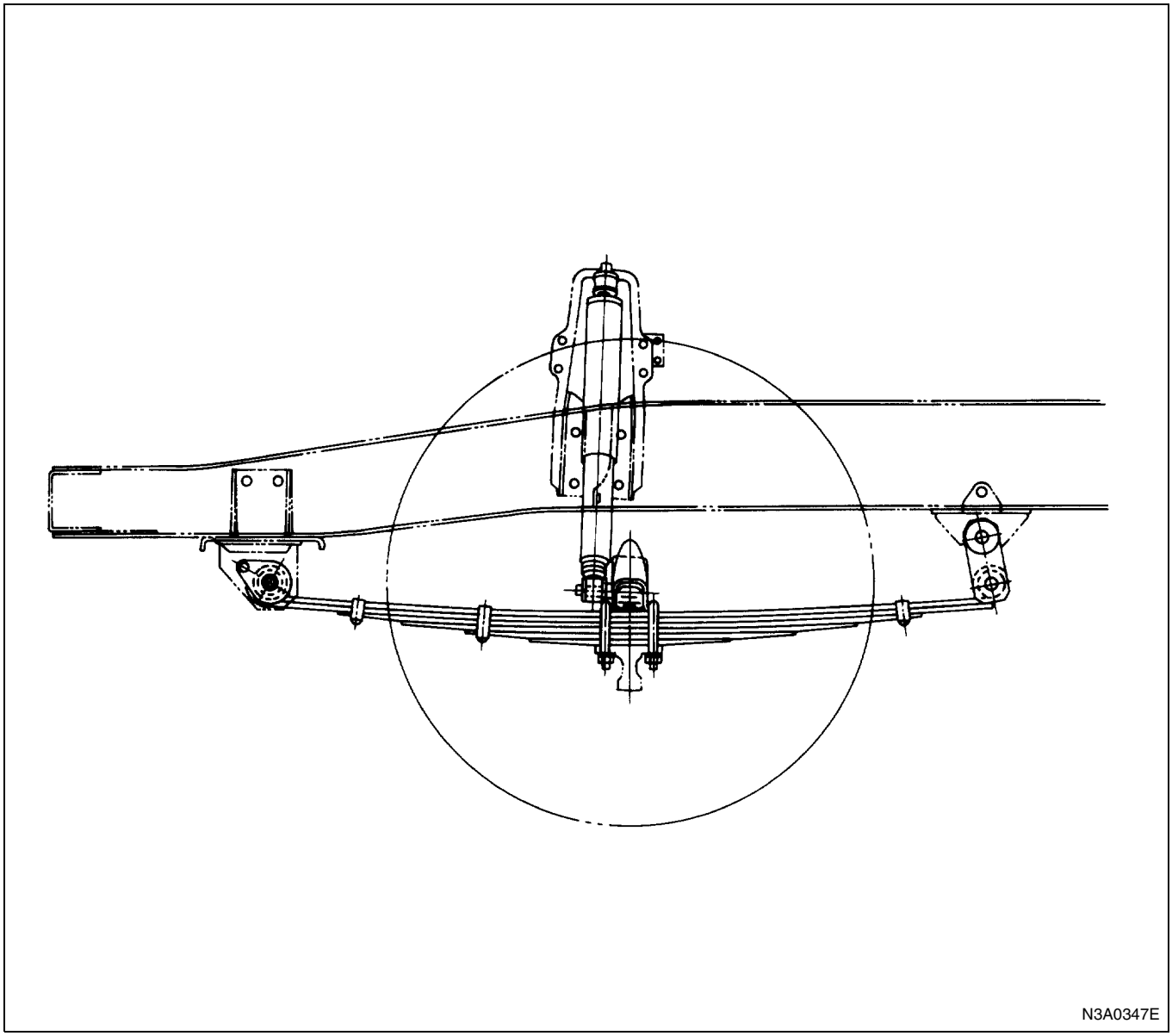
FRONT SUSPENSION

Contents

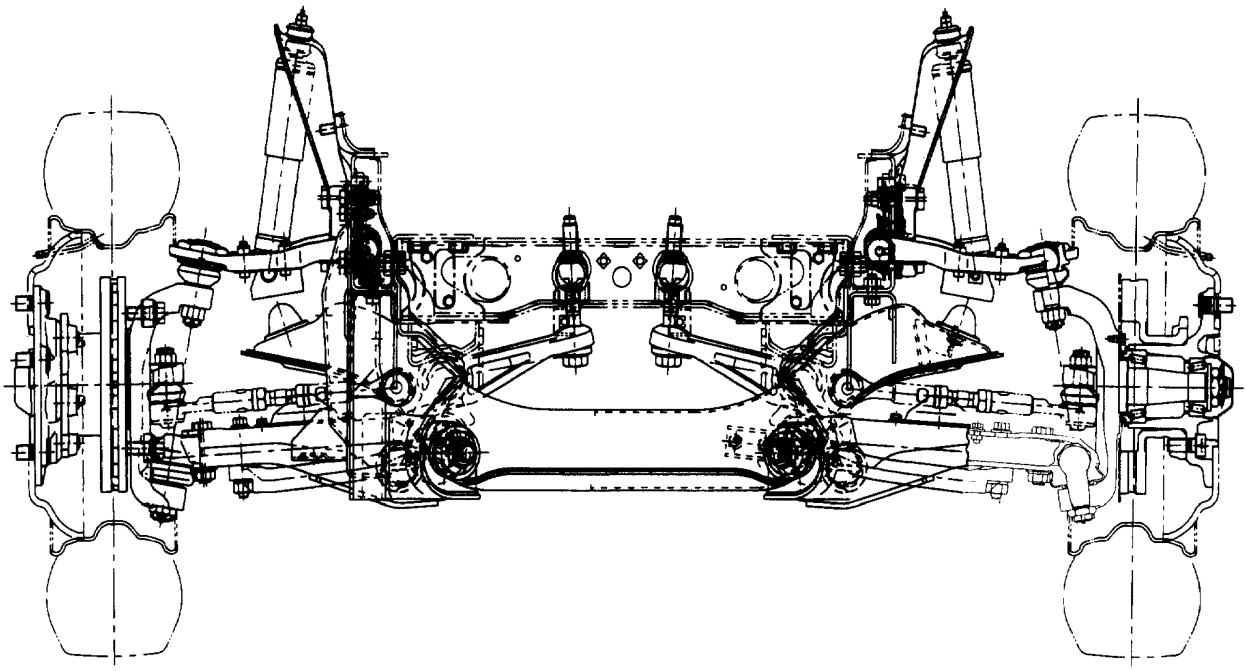
GENERAL DESCRIPTION 3C-2
Rigid Suspension.....3C-2
Wishbone Suspension.....3C-3
ON-VEHICLE SERVICIE 3C-4
Front Suspension (Rigid Suspension).....3C-4
Front Suspension (Wishbone Suspension).....3C-17

GENERAL DESCRIPTION

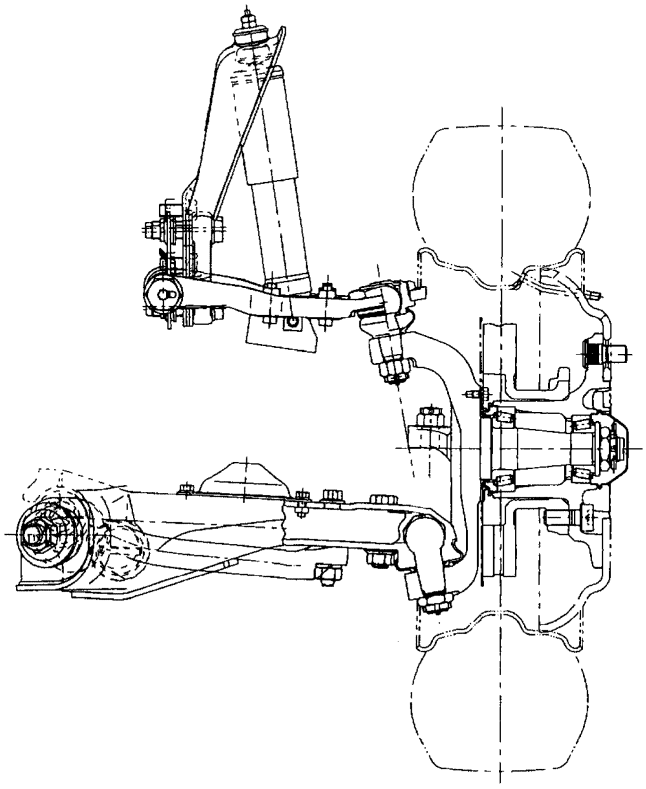
Rigid Suspension



Wishbone Suspension



N3A0348E

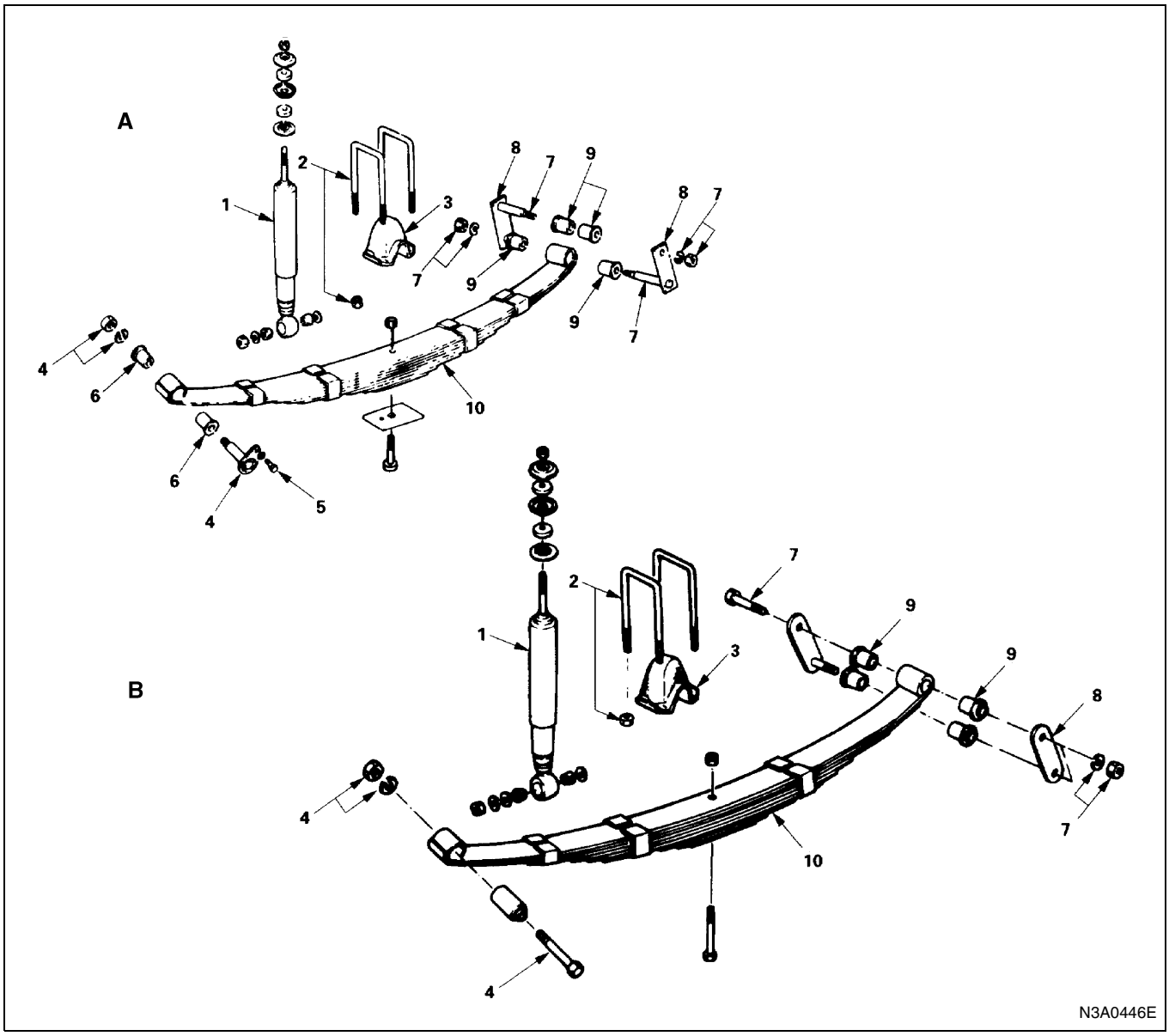


N3A0349E

ON-VEHICLE SERVICIE

Front Suspension (Rigid Suspension)

Leaf Spring



Legend

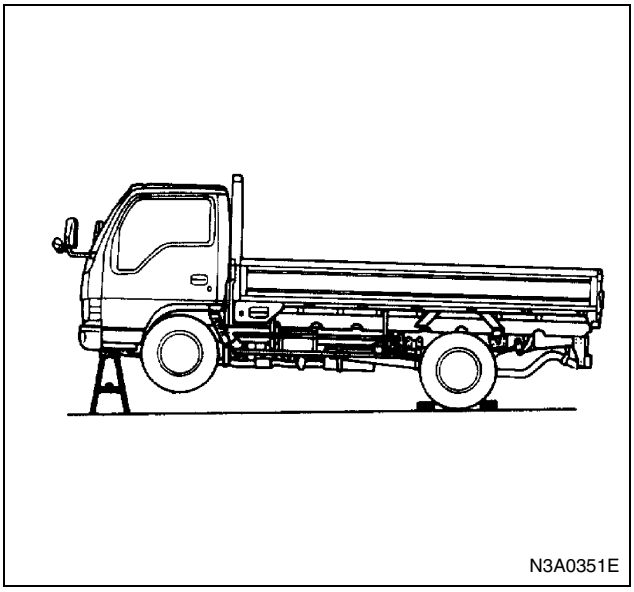
A. NHR and NKR
B. NPR, NQR and NPS
1. Shock absorber
2. U-bolt and nut
3. Helper rubber
4. Spring pin, nut and washer
5. Bolt
6. Rubber bushing
7. Shackle pin, nut and washer
8. Shackle
9. Rubber bushing
10. Leaf spring

Removal

Preparation

Make the following preparation before removing the leaf spring.

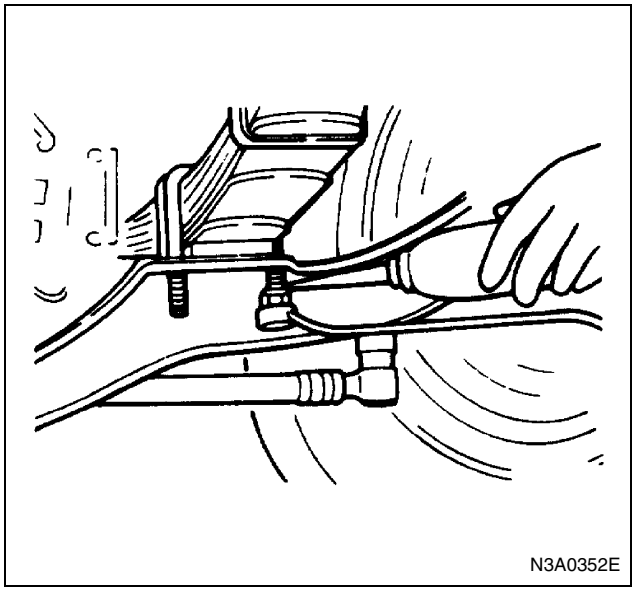
1. Brace the rear wheels.
2. Jack up the front axle until the front wheels are lifted off the ground and position safety stand under the chassis frame.
   Refer to “Lifting Instruction” in Section 0A for acceptable lifting point and supportable point location.


N3A0351E

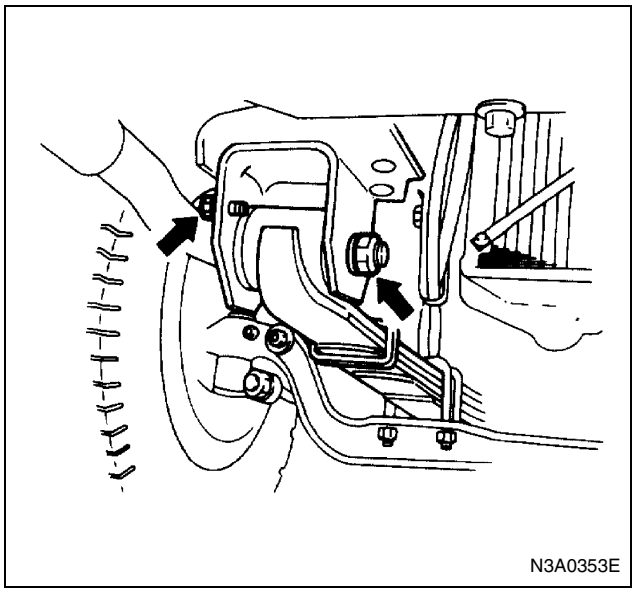
3. Position a garage jack under the front axle.
4. For the vehicle model with a stabilizer, remove the mounting portion on the axle side of the stabilizer in advance before removing the leaf spring. (Refer to the removal procedure of the stabilizer.)

NHR and NKR

1. Shock Absorber
2. U-bolt and Nut
3. Helper Rubber
   If the U-bolts are heavily rusted, apply a generous amount of oil to the threads before loosening them to prevent seizure.


N3A0352E

4. Spring Pin, Nut and Washer
5. Bolt
6. Rubber Bushing
   Take out the rubber bushings after removal of the spring pin.


N3A0353E

7. Shackle Pin, Nut and Washer
8. Shackle
9. Rubber Bushing
   Take out the rubber bushings after removal of the shackle.
10. Leaf Spring
    Lower the garage jack slowly and remove the front spring assembly. When removing the front spring assembly, exercise care not to cause damage to the brake flexible hoses and drag link. Also, exercise care not to cause the spring to come down.

NPR, NQR and NPS

1. Shock Absorber
2. U-bolt and Nut
   Refer to page NHR and NKR.

3. Helper Rubber
4. Spring Pin, Nut and Washer
   Drive out the spring pin with a hammer using a brass bar after removal of the spring pin nut.
5. Shackle Pin, Nut and Washer
6. Shackle
   Drive out the shackle pin with a hammer using a brass bar after removal of the shackle pin nut.
7. Rubber Bushing
8. Leaf Spring
   Refer to NHR and NKR.

Inspection and Repair

Make the necessary adjustments, repairs and part replacements if excessive wear or damage is discovered during inspection.

Visual Check

Inspect the following parts for wear, damage or other abnormal conditions.

- Leaf spring assembly
- Clip
- Center bolt
- U-bolt
- Spring pin
- Shackle pin
- Helper rubber
- Rubber bushing

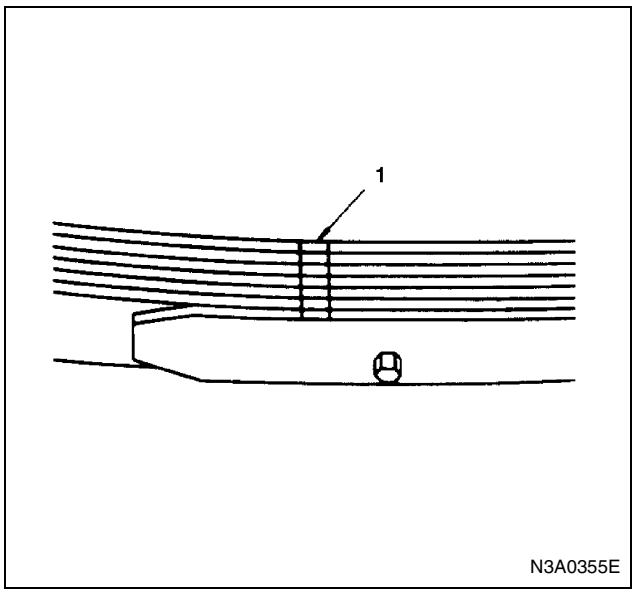
Shock Absorber

1. Inspect for extreme oil leakage.
   Slight oil leakage is allowed.
2. Inspect for temperature after running.
   Unchanged temperature indicates deteriorated function.
3. Inspect if large resistance is felt when the shock absorber is expanded and contracted by holding either end, or if play is eliminated after several times of expansion and contraction.
   The function has deteriorated if the above condition is not observed.
4. Inspect the bushing for wear or deterioration.
   Replace if abnormality is found.

Leaf Spring Assembly Replacement

- Apply a setting mark (1) across the springs before disassembling the leaf spring assembly.
- Apply grease to both faces of each leaf spring at reassembly.
- Use a bench press for disassembly and reassembly.
- Discard center bolt and install a new one.

When replacing the leaf spring assembly, use the leaf spring with the same camber represented by “+, -, I” on both right and left sides.

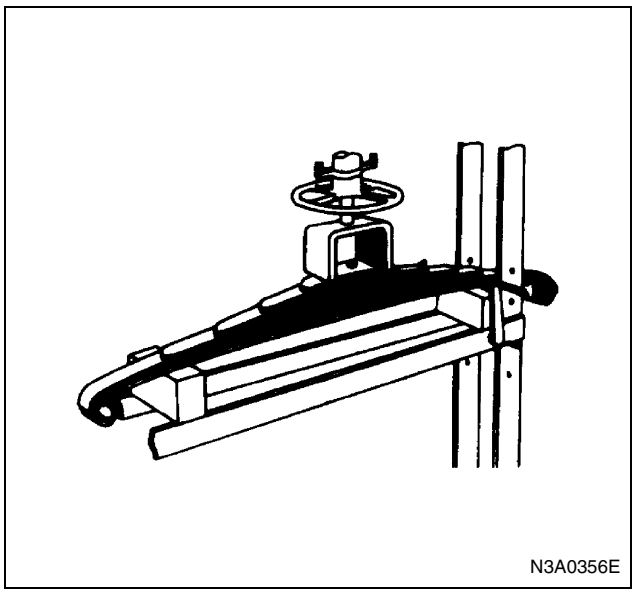


Center Bolt

Tighten the center bolt nut to the specified torque.

Tighten:

- Center bolt to 39 N·m (4 kg·m/29 lb·ft)

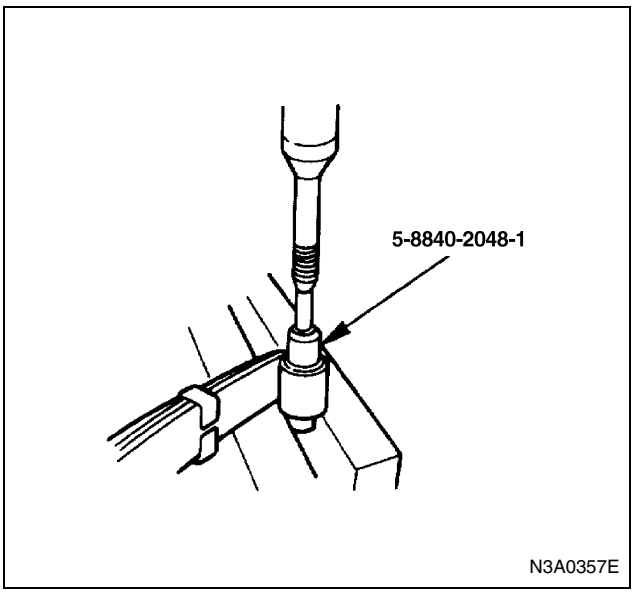


Bushing Replacement

When replacing bushing, drive out the bushing using a bench press.

Leaf Spring Rubber Bush Remover & Installer:
5-8840-2048-1

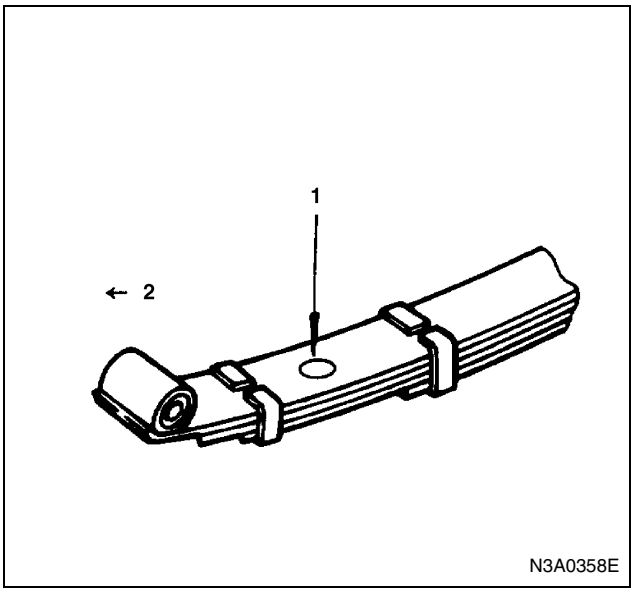
Leaf Spring Metal Bush Remover & Installer:
5-8840-2049-1



Installation

NHR and NKR

1. Leaf Spring
   Install the leaf spring assembly with the camber mark (1) turned to front side (2) on the front axle.



2. Helper Rubber
3. U-Bolt and Nut
   Position the U-bolts and helper rubber on the leaf spring assemblies and jack up the front axle.
   When tightening the nuts, apply oil as necessary to prevent damaging the threads.

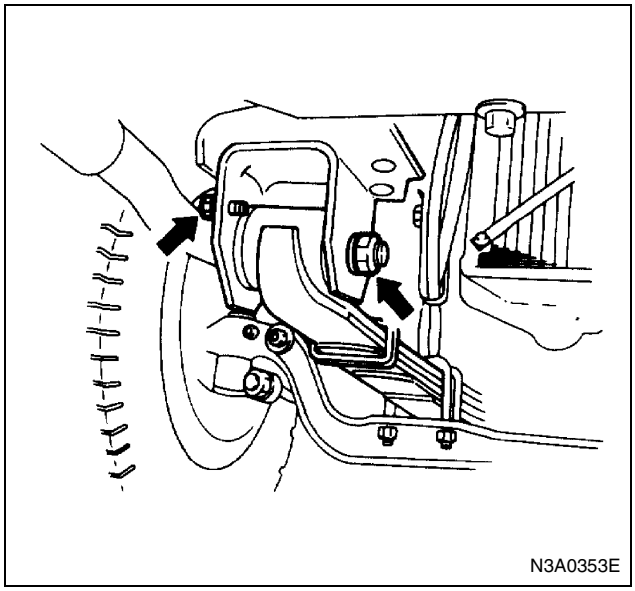
Tighten:

- U-bolt nut to 127 N·m (13 kg·m/94 lb·ft)

4. Rubber Bushing
5. Spring Pin, Nut and Washer
6. Bolt
   Finger tighten first, and tighten to specified torque after lowering the vehicle to ground.

Tighten:

- Spring pin bolt and nut to
  Bolt: 27 N·m (2.8 kg·m/20 lb·ft)
  Nut: 177 N·m (18 kg·m/130 lb·ft)



7. Rubber Bushing
8. Shackle
9. Shackle Pin, Nut and Washer
   Finger tighten first, and tighten to specified torque after lowering the vehicle to ground.

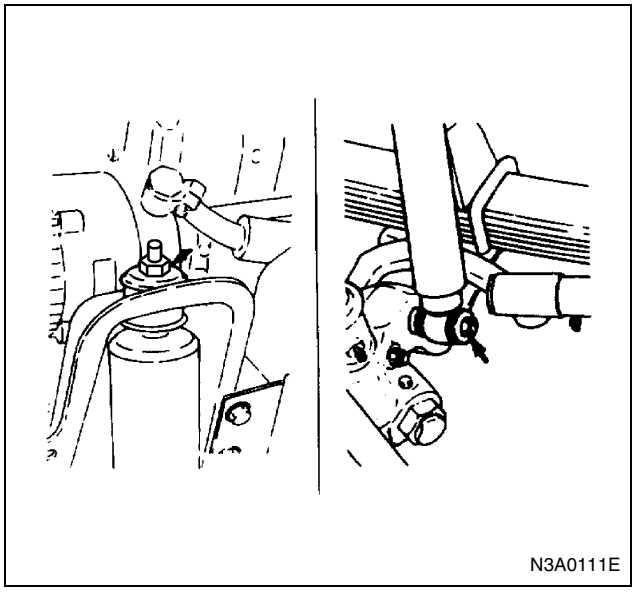
Tighten:

- Shackle pin nut to 137 N·m (14 kg·m /101 lb·ft)

10. Shock Absorber

Tighten:

- Shock absorber nut to
  Upper nut: 21 N·m (2.1 kg·m/16 lb·ft)
  Lower nut: 61 N·m (6.2 kg·m/45 lb·ft)



NPR, NQR and NPS

1. Leaf Spring
   Refer to NHR and NKR.
2. Helper Rubber
3. U-Bolt and Nut

Tighten:

- U-bolt nut to
  NPR, NPS: 127 N·m (13 kg·m/94 lb·ft)
  NQR: 196 N·m (20 kg·m/145 lb·ft)

4. Spring Pin, Nut and Washer
   Refer to NHR and NKR.

Tighten:

- Shackle pin nut to 202 N·m (20.6 kg·m/149 lb·ft)

5. Rubber Bushing
6. Shackle
7. Shackle Pin, Nut and Washer
   Refer to NHR and NKR.

Tighten:

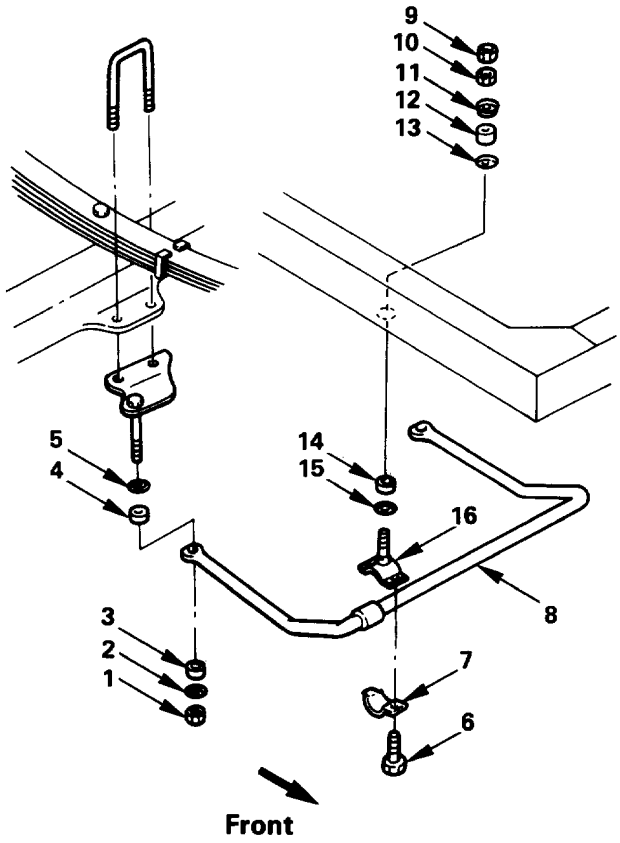
- Shackle pin nut to 202 N·m (20.6 kg·m/149 lb·ft)

8. Shock Absorber

Tighten:

- Shock absorber nut to
  Upper nut: 21 N·m (2.1 kg·m/16 lb·ft)
  Lower nut: 95 N·m (9.7 kg·m/70 lb·ft)

Front Stabilizer (NKR)



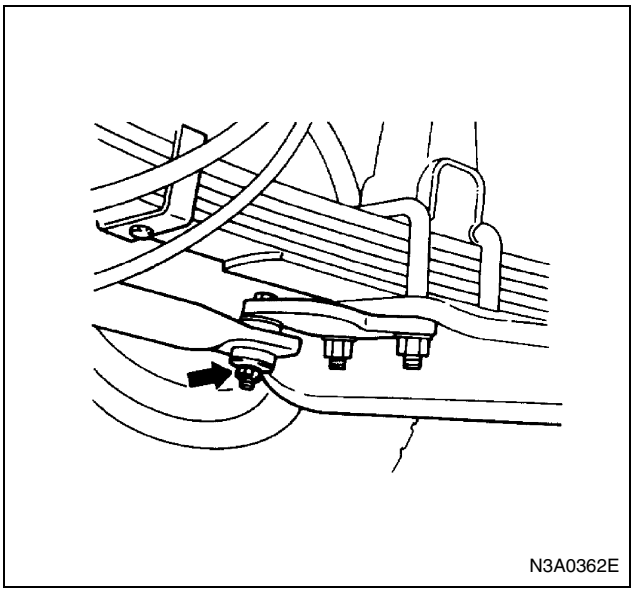
N3A0361E

Legend

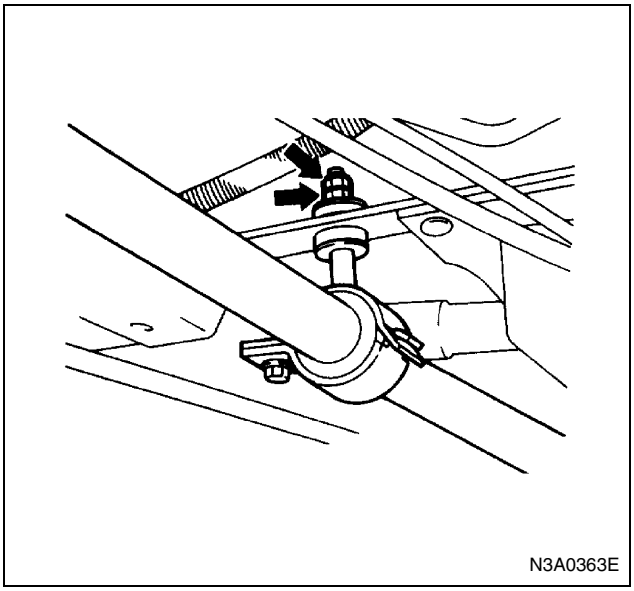
1. Nut
2. Washer
3. Rubber bushing
4. Rubber bushing
5. Washer
6. Bolt
7. Rod link cap
8. Stabilizer bar
9. Nut
10. Nut
11. Washer
12. Rubber bushing
13. Washer
14. Rubber bushing
15. Washer
16. Rod link

Removal

1. Nut
2. Washer
3. Rubber Bushing
4. Rubber Bushing
5. Washer



6. Bolt
7. Rod Link Cap
8. Stabilizer Bar
9. Nut
10. Nut
11. Washer
12. Rubber Bushing
13. Washer
14. Rubber Bushing
15. Washer
16. Rod Link



Inspection and Repair

Make the necessary adjustments, repairs and part replacements if excessive wear or damage is discovered during inspection.

Stabilizer

Inspect the stabilizer bar and attachments for the following conditions:

1. Cracks, bends or damage to the bar.
2. Worn bushings.
3. Damaged brackets.
   - Replace any worn or damaged parts.

Installation

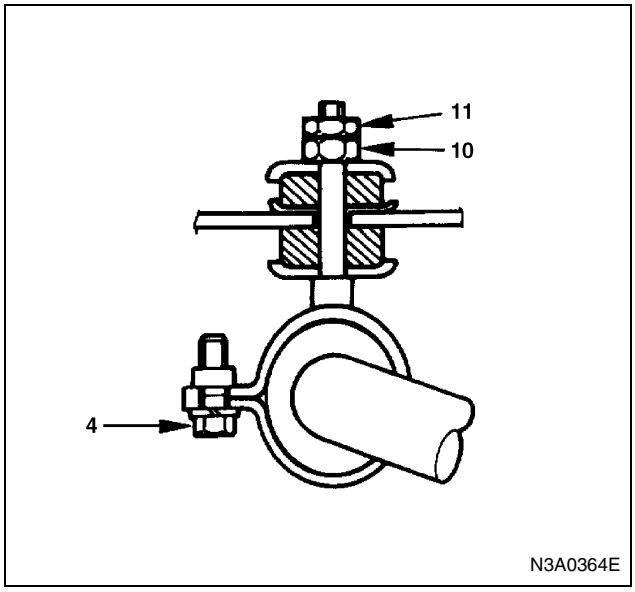
Notice:

During installation, place the vehicle on flat ground and tighten each part to the specified torque.

1. Stabilizer Bar
2. Rod Link
3. Rod Link Cap
4. Bolt
5. Washer
6. Rubber Bushing
7. Washer
8. Rubber Bushing
9. Washer
10. Nut
11. Nut

Tighten:

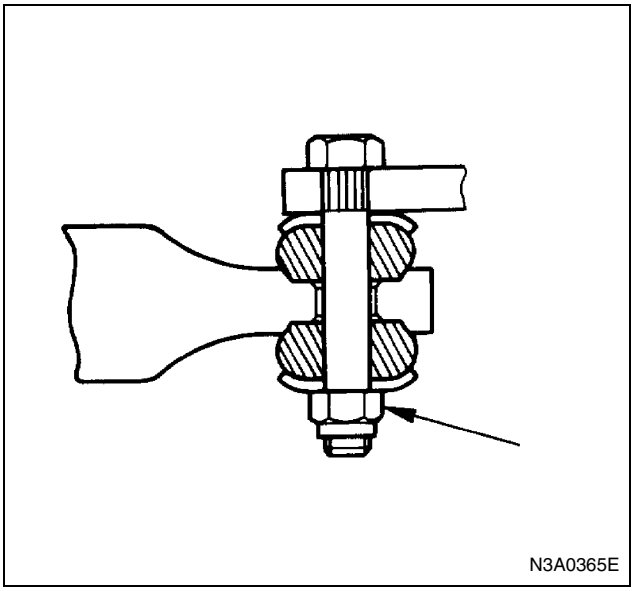
- Rod link bolt and nut to
  4. Bolt: 57 N·m (5.8 kg·m/42 lb·ft)
  10. Nut: 20 N·m (2.0 kg·m/14 lb·ft)
  11. Nut: 40 N·m (4.1 kg·m/30 lb·ft)



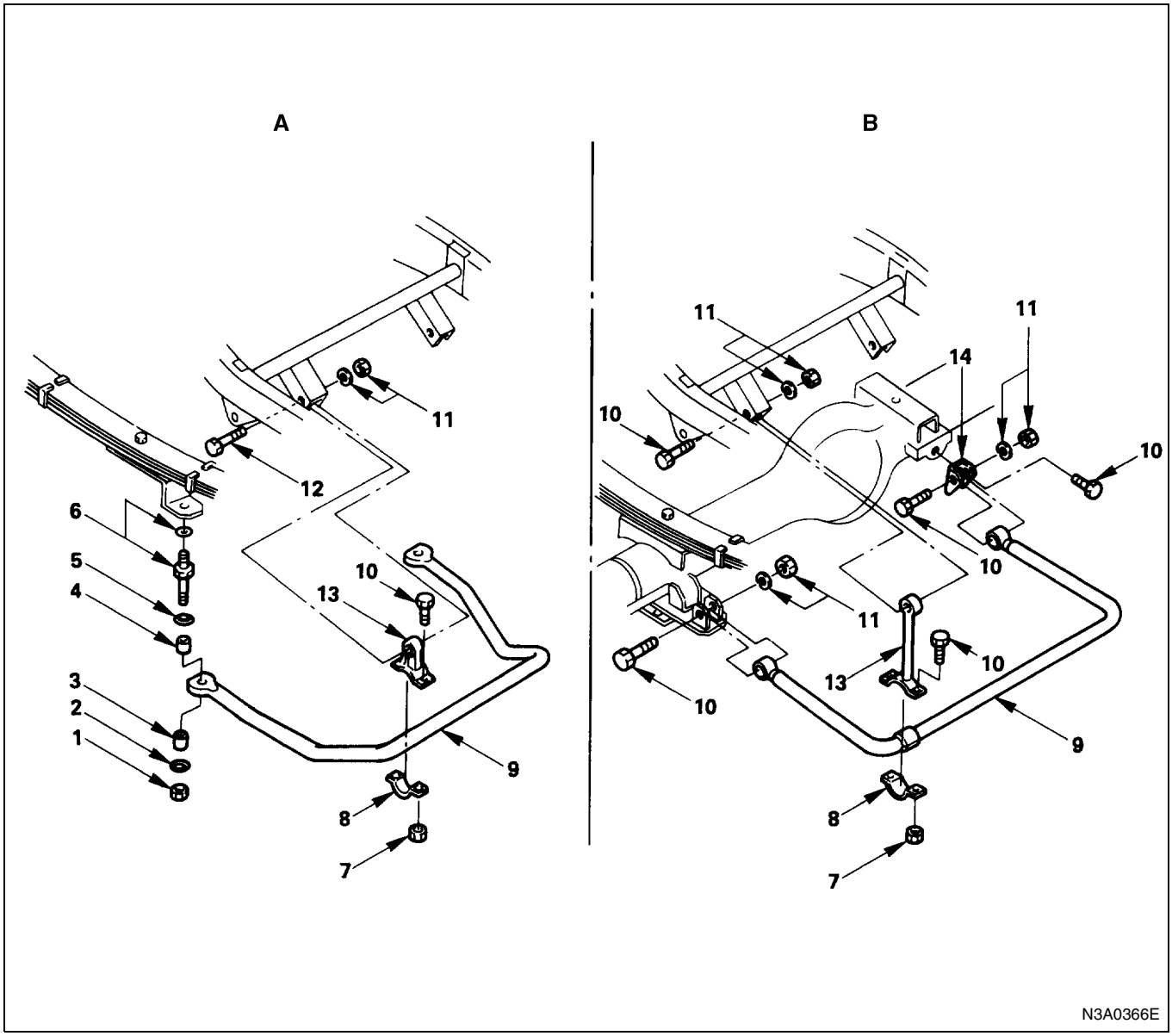
12. Washer
13. Rubber Bushing
14. Rubber Bushing

15. Washer
16. Nut

Tighten:
- Nut to 29 N·m (3.0 kg·m/22 lb·ft)



Front Stabilizer (NPR, NQR and NPS)



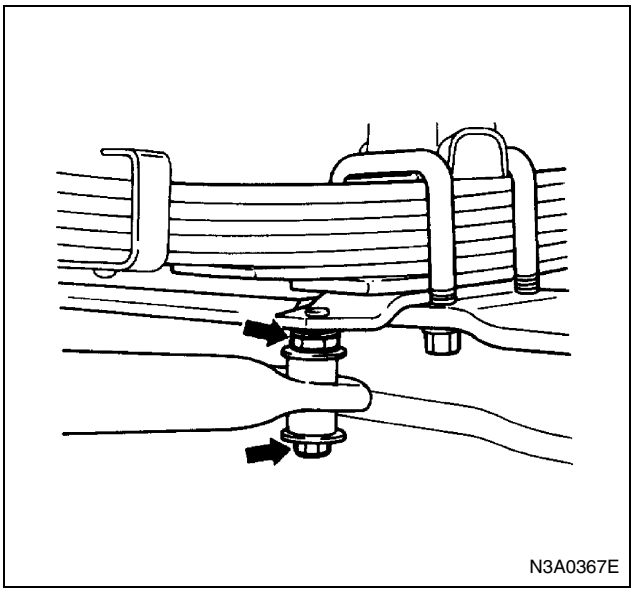
Legend

A. NPR and NQR
B. NPS
1. Nut
2. Washer
3. Rubber bushing
4. Rubber bushing
5. Washer
6. Stud bolt and spring washer
7. Nut
8. Rod link cap
9. Stabilizer bar
10. Bolt
11. Nut and spring washer
12. Bolt
13. Rod link
14. Stabilizer bracket

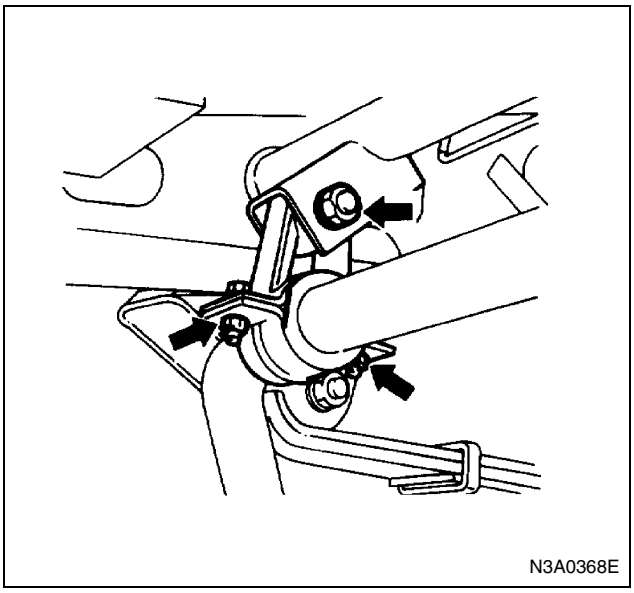
Removal

NPR and NQR

1. Nut
2. Washer
3. Rubber Bushing
4. Rubber Bushing
5. Washer
6. Stud Bolt and Spring Washer

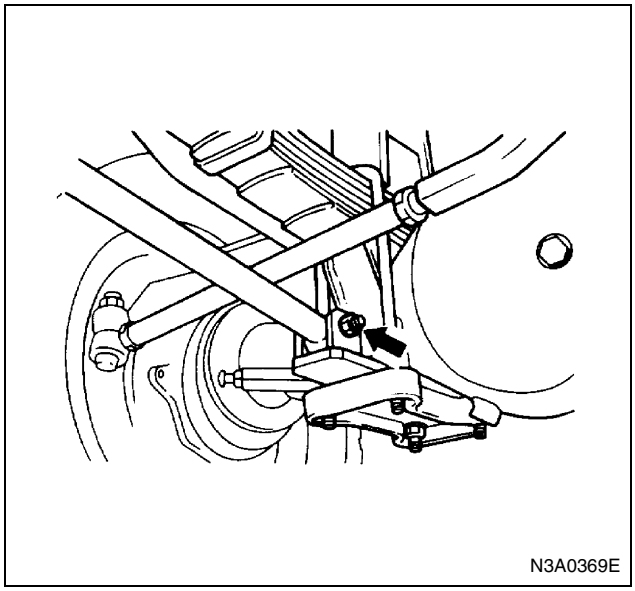

N3A0367E

7. Nut
8. Rod Link Cap
9. Stabilizer Bar
10. Bolt
11. Nut and Spring Washer
12. Bolt
13. Rod Link

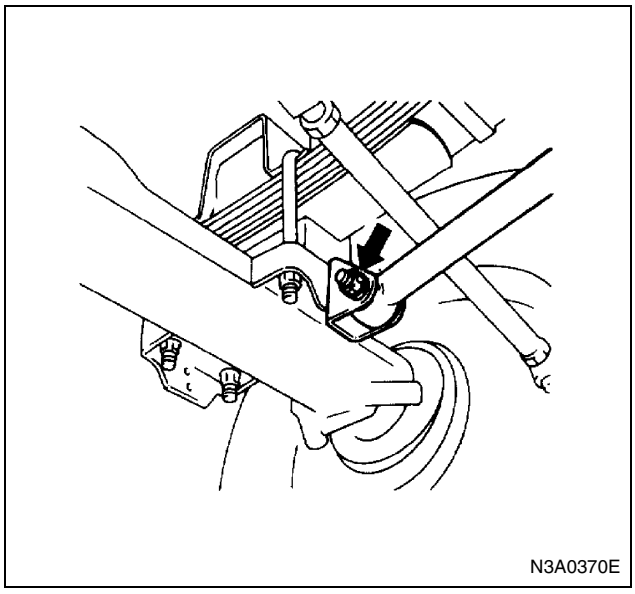

N3A0368E

NPS

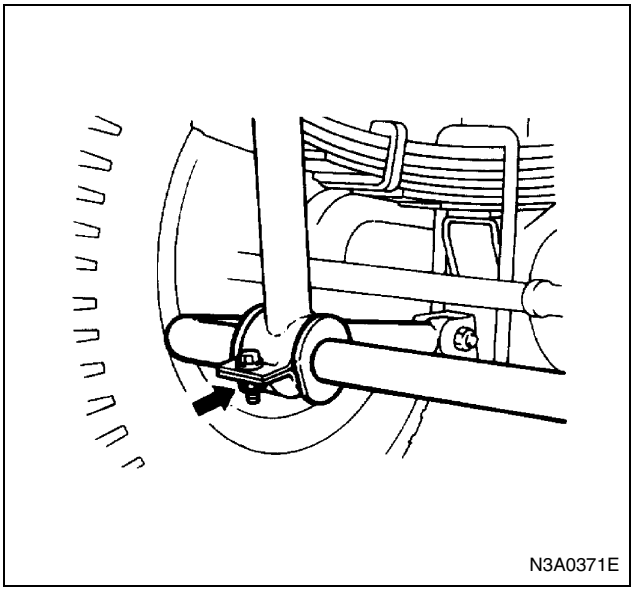
1. Nut and Spring Washer
2. Bolt


N3A0369E

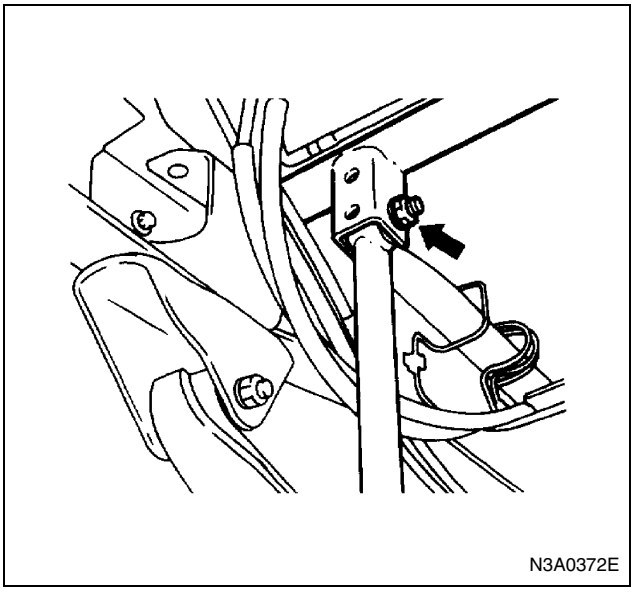
3. Nut and Spring Washer
4. Bolt
5. Bolt
6. Stabilizer Bracket


N3A0370E

7. Nut
8. Rod Link Cap
9. Stabilizer Bar
10. Bolt



11. Nut and Spring Washer
12. Bolt
13. Rod Link



Inspection and Repair

Make the necessary adjustments, repairs and part replacements if excessive wear or damage is discovered during inspection.

Stabilizer

Inspect the stabilizer bar and attachments for the following conditions:

1. Cracks, bends or damage to the bar.
2. Worn bushings.
3. Damaged brackets.

- Replace any worn or damaged parts.

Installation

Notice:

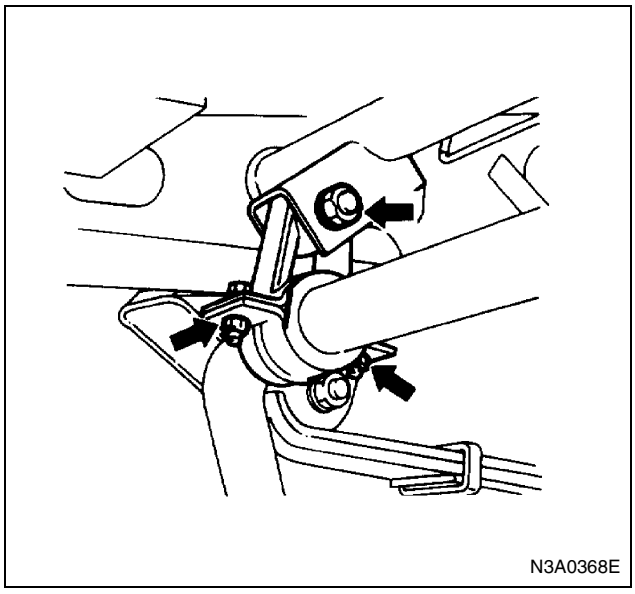
During installation, place the vehicle on flat ground and tighten each part to the specified torque.

NPR and NQR

1. Stabilizer Bar
2. Rod Link
3. Rod Link Cap
4. Bolt
5. Nut
6. Bolt
7. Nut and Spring Washer

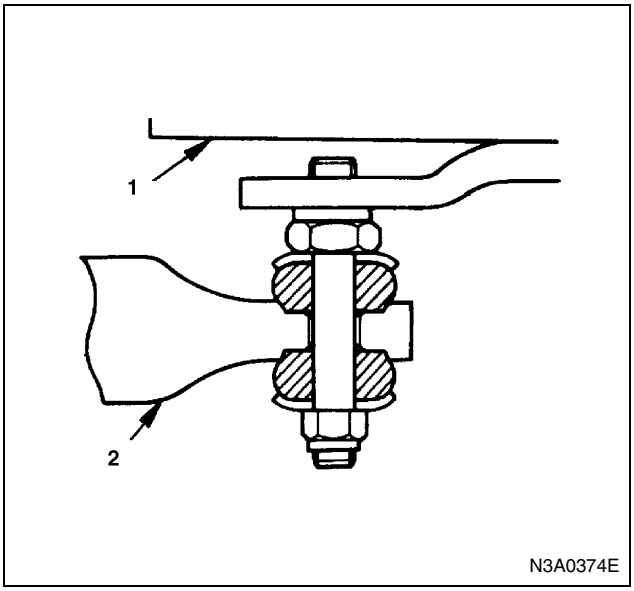
Tighten:

- Rod link nut to
  Rod link cap nut: 57 N·m (5.8 kg·m/42 lb·ft)
  Rod link bracket nut: 127 N·m (13 kg·m/94 lb·ft)



8. Stud Bolt and Spring Washer
9. Washer
10. Rubber Bushing
11. Rubber Bushing
12. Washer
13. Nut

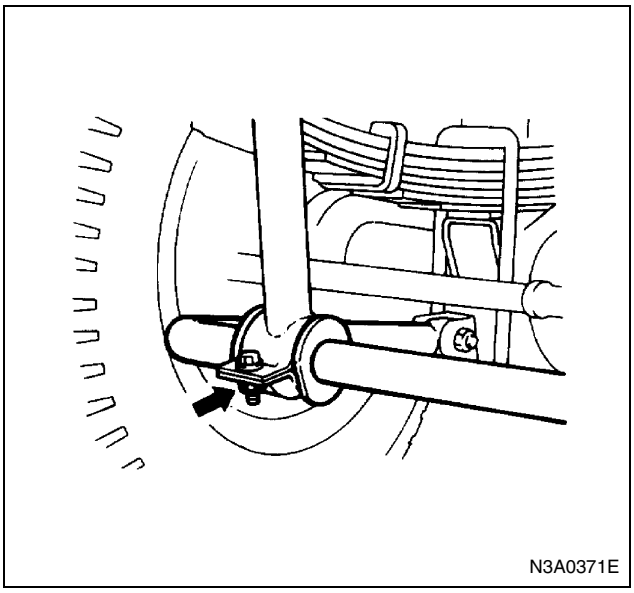
Tighten:
- Stud bolt and nut to
  Stud bolt: 117 N·m (11.9 kg·m/86 lb·ft)
  Nut: 29 N·m (3.0 kg·m/22 lb·ft)



Legend
1. Leaf spring
2. Stabilizer

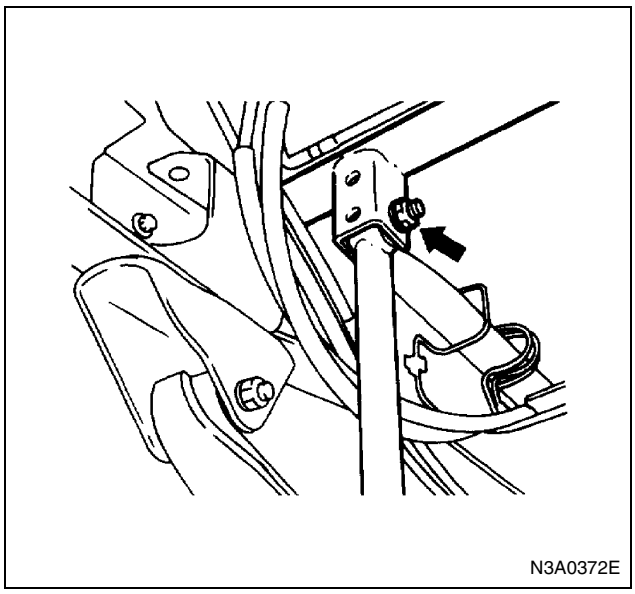
NPS
1. Stabilizer Bar
2. Rod Link
3. Rod Link Cap
4. Bolt
5. Nut

Tighten:
- Nut to 57 N·m (5.8 kg·m/42 lb·ft)



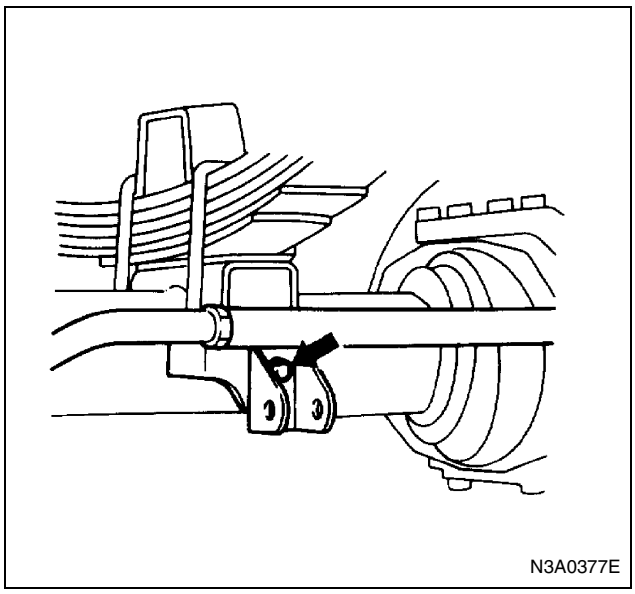
6. Bolt
7. Nut and Spring Washer

Tighten:
- Nut to 127 N·m (13 kg·m/94 lb·ft)



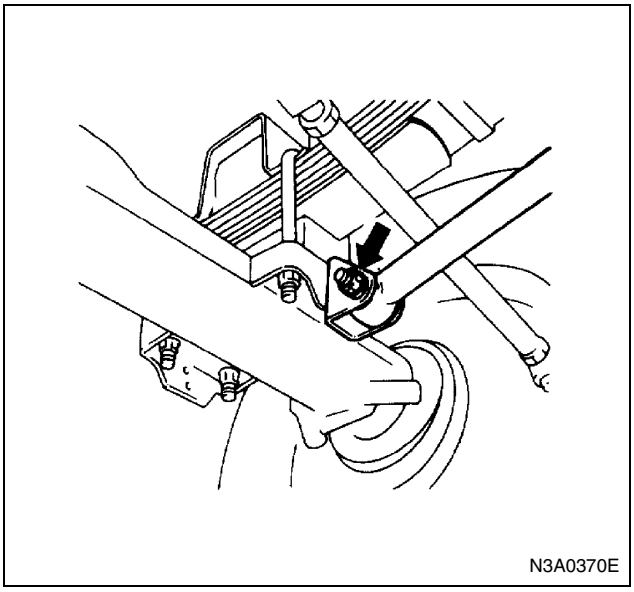
8. Stabilizer Bracket
9. Bolt

Tighten:
- Bolt to 19 N·m (1.9 kg·m/14 lb·ft)



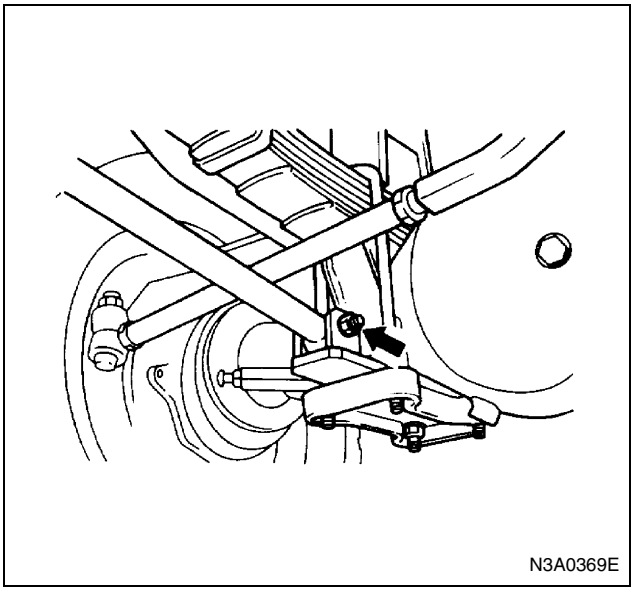
10. Bolt
11. Nut and Spring Washer

Tighten:
- Nut to 127 N·m (13 kg·m/94 lb·ft)

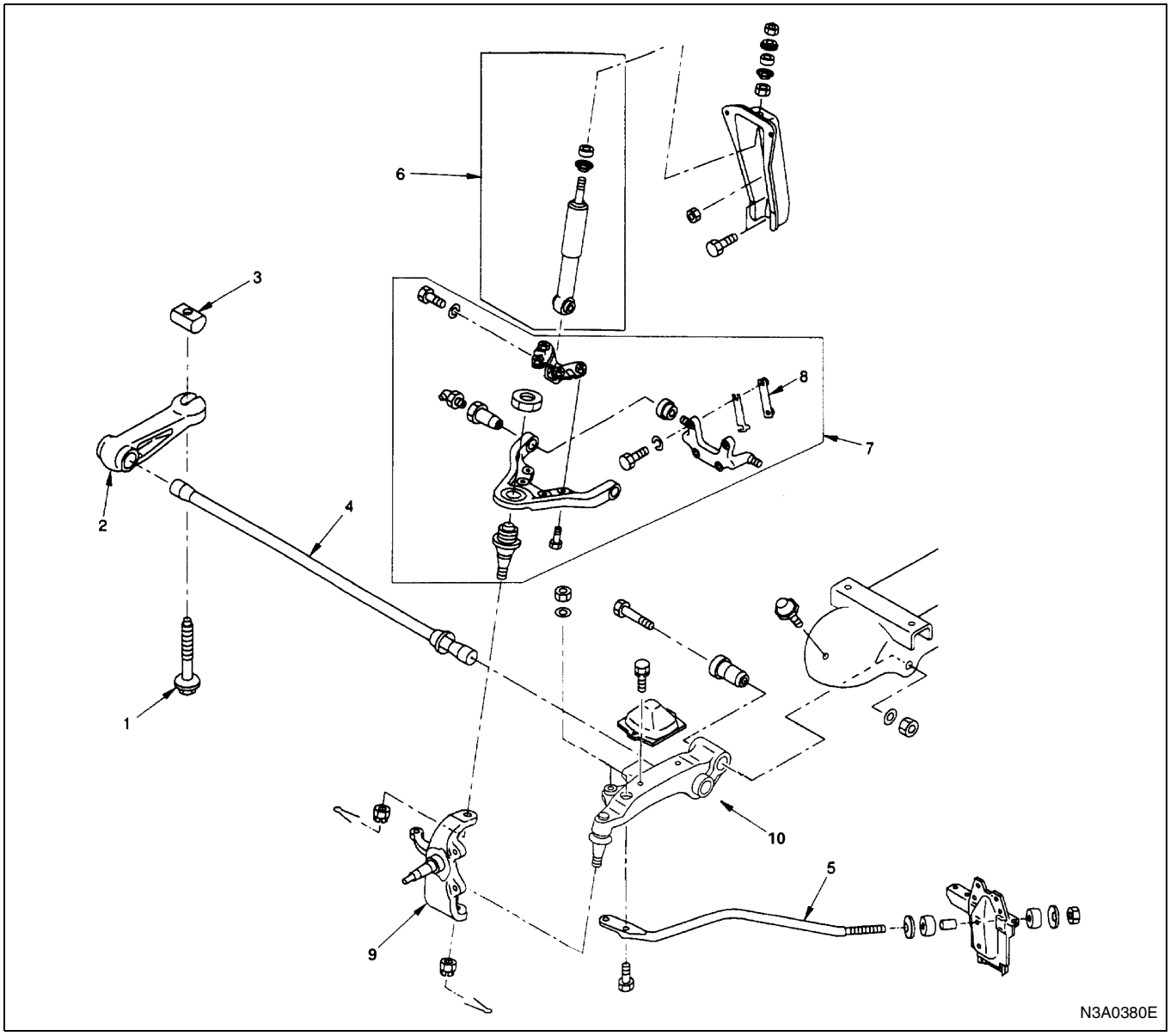


12. Bolt
13. Nut and Spring Washer

Tighten:
- Nut to 127 N·m (13 kg·m/94 lb·ft)



Front Suspension (Wishbone Suspension)



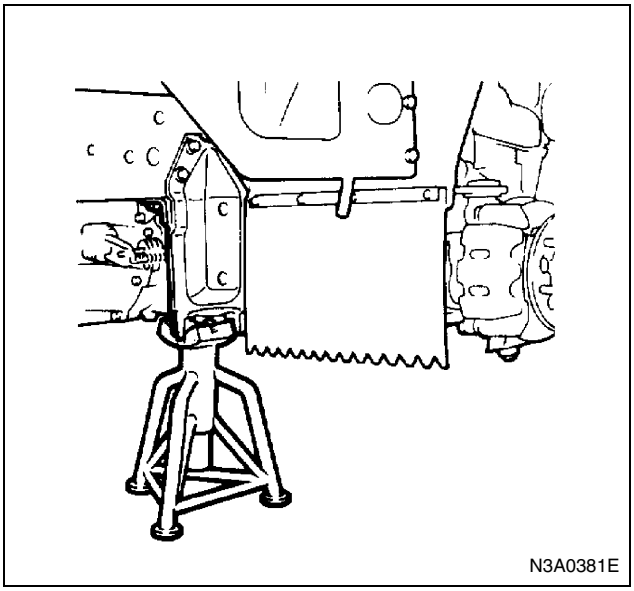
Legend

1. Adjusting bolt
2. Height control arm
3. End piece
4. Torsion bar
5. Strut bar assembly
6. Shock absorber assembly
7. Upper link assembly
8. Adjusting shim
9. Knuckle
10. Lower link

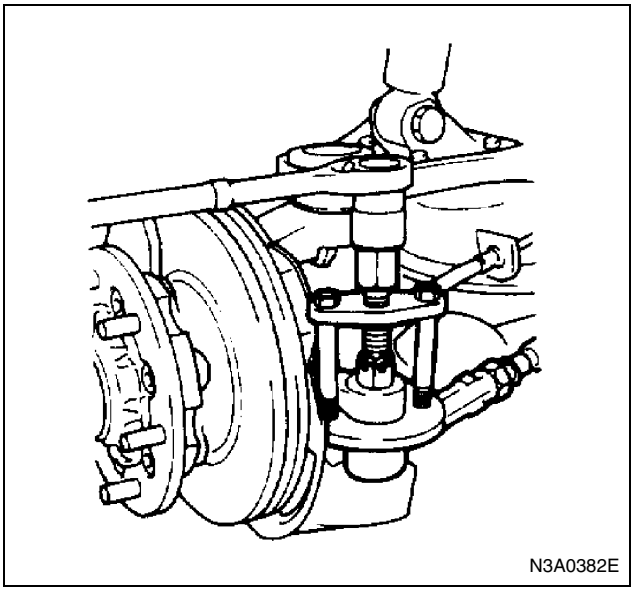
Removal

Preparations

- Raise the vehicle and support the jack up point with suitable safety stands. Refer to “Lifting Instruction” in Section 0A.
- Remove front tire and wheels. Refer to “Wheels and Tires” in Section 3E.
- Remove brake caliper assembly. Refer to “Hydraulic Brakes” in Section 5A.
- Remove hub and rotor assembly. Refer to “Front Axle” in Section 4C.

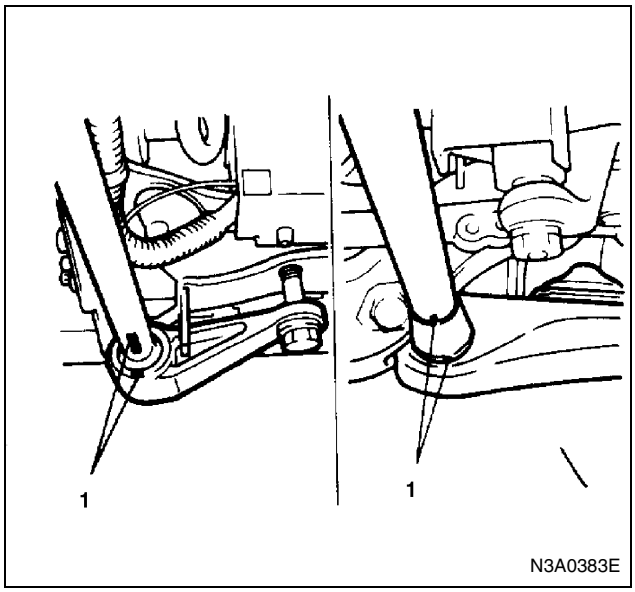

N3A0381E

- Disconnect the outer track rod ball joint from the knuckle.
  Remover: 5-8840-2017-0


N3A0382E

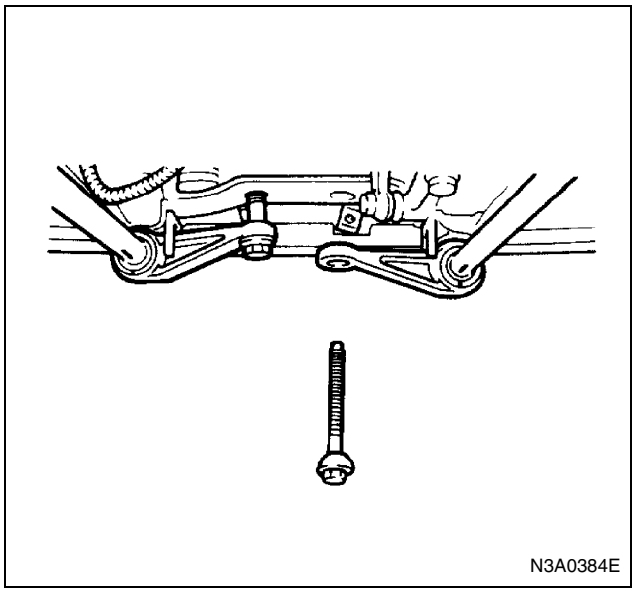
1. Adjusting Bolt
2. Height Control Arm
3. End Piece
4. Torsion Bar

- Apply setting marks (1) to torsion bar, height control arm and lower link to ensure installation of the parts in their original position.

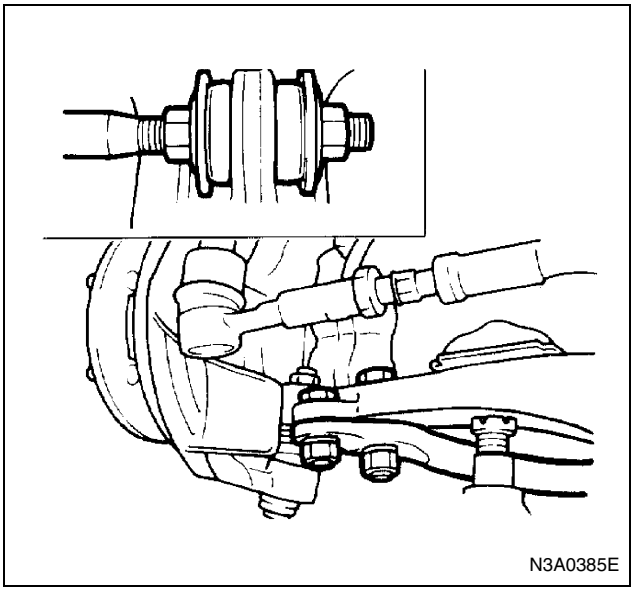


N3A0383E

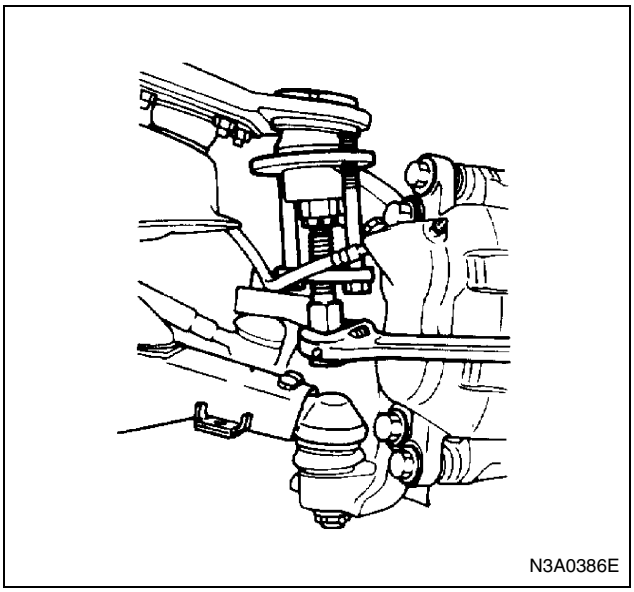
Apply setting marks to adjusting bolt threads to ensure installation of the parts in their original position.


N3A0384E

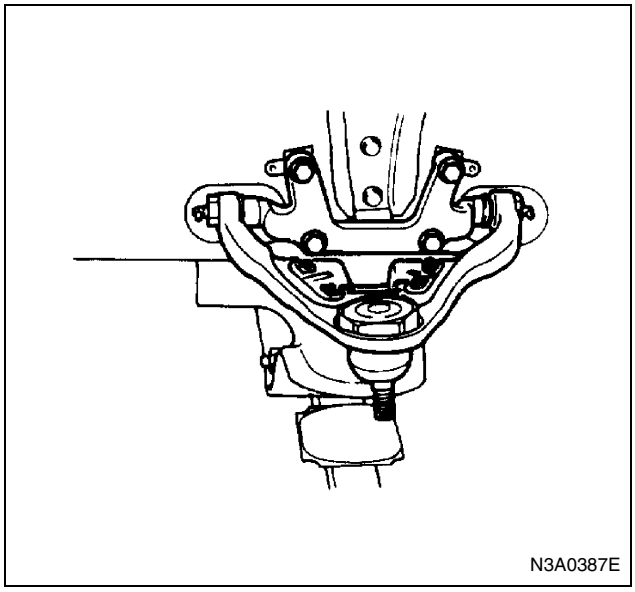
5. Strut Bar Assembly
   - Raise and support the lower link with a jack.
   - Loosen the rear side nut, and remove the nut, washer and rubber bushing.
   - Loosen two fixing bolts of lower link side and remove the strut bar to front side.


N3A0385E

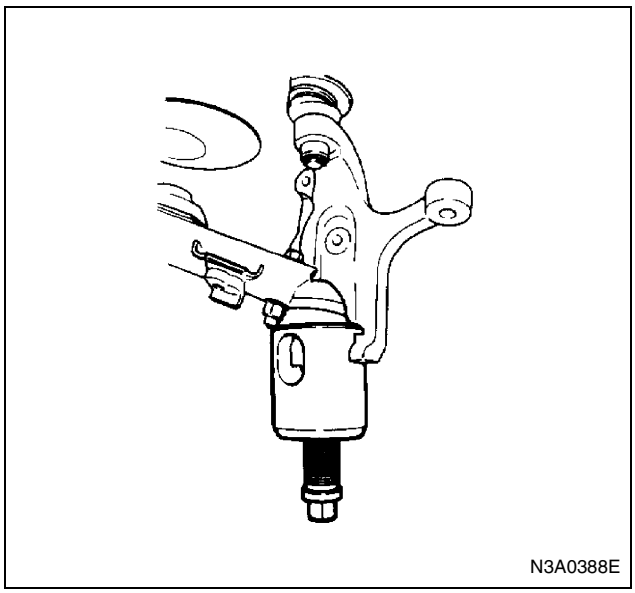
6. Shock Absorber
7. Upper Link Assembly
8. Adjusting Shim
   Disconnect upper link joint ball at the knuckle.
   Remover: 5-8840-2017-0


N3A0386E

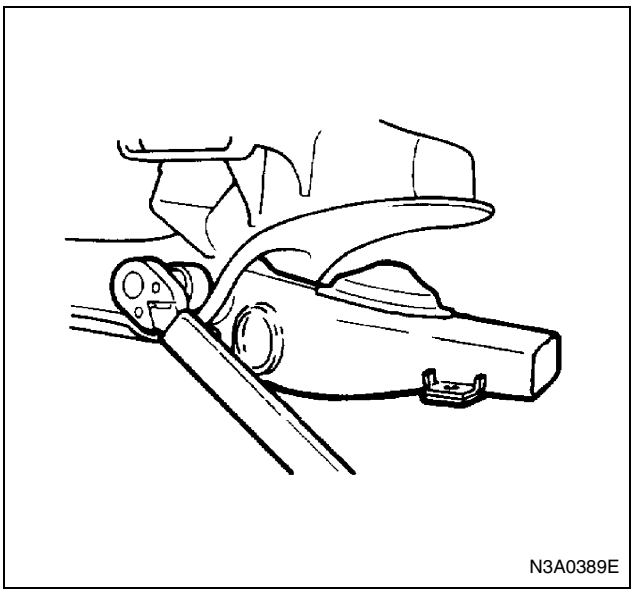
- Remove the fulcrum pin fixing bolt.
- Note the thickness and number of shims.


N3A0387E

9. Knuckle
   - Disconnect the lower link ball joint at the knuckle.
     Remover: 5-8840-2366-0
   - Remove two fixing bolts and the ball joint from lower link.


N3A0388E

10. Lower Link


N3A0389E

Inspection and Repair

Make necessary correction or parts replacements if excessive wear, damage, corrosion or any other abnormal condition are found through inspection.

Visual Check

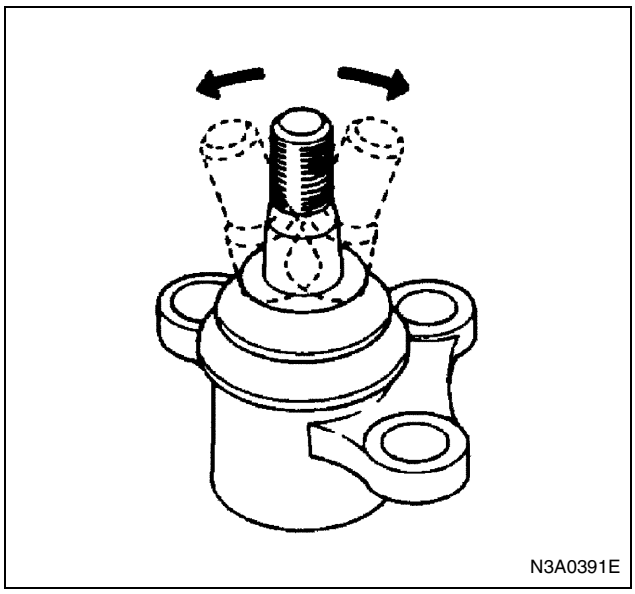
Inspect the following parts for excessive wear, damage, bending, oil leak or any other abnormal conditions.

- Torsion Bar
- End Piece
- Height Control Arm
- Rubber Bushings
- Strut Bar
- Shock Absorber

Ball Joint

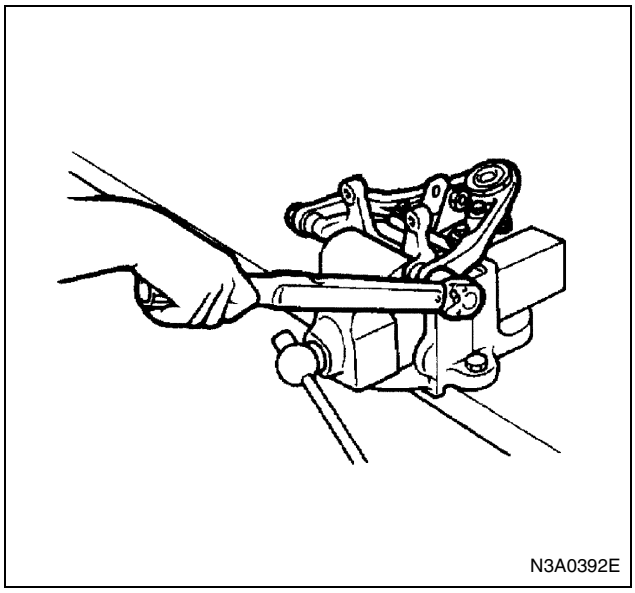
- Inspect the ball joint boot for damage or grease leak.
- Move the ball joint to confirm its normal movement.
- Inspect screw / taper area of ball for flaws.

If any defects are found by the above inspections, replace the ball joint with new one.


N3A0391E

Upper Ball Joint Replacement

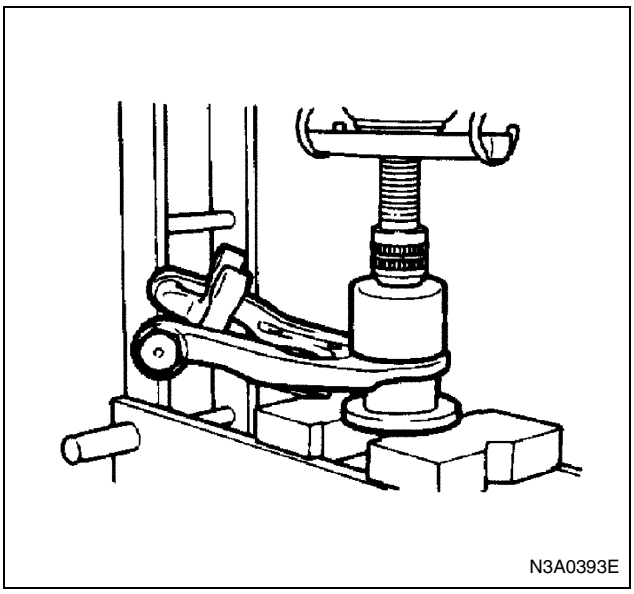
- Remove the ball joint fixing nut (Hex. 63mm).
- Remove the ball joint from the upper link using a special tool.
  Remover: 5-8840-2364-0


N3A0392E

- Install the ball joint to the upper link using a bench press and special tool.
  Installer: 5-8840-2365-0
- Tighten nut to specified torque.

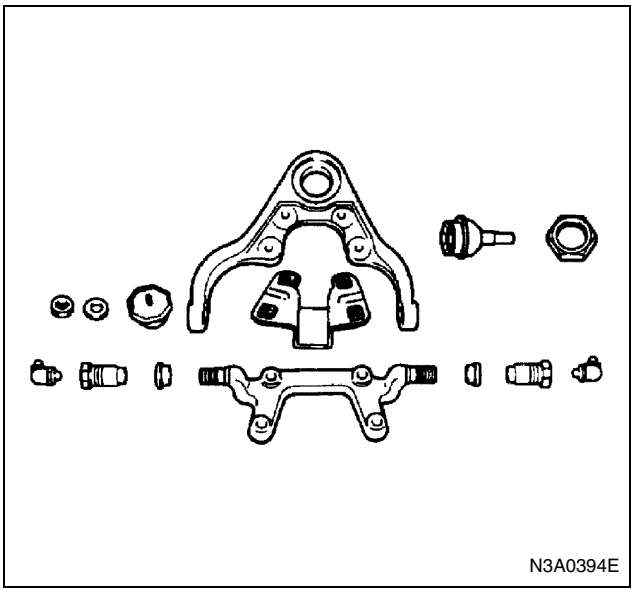
Tighten:

- Joint ball nut to 206 N·m (21.0 kg·m/152 lb·ft)


N3A0393E

Upper Link Assembly

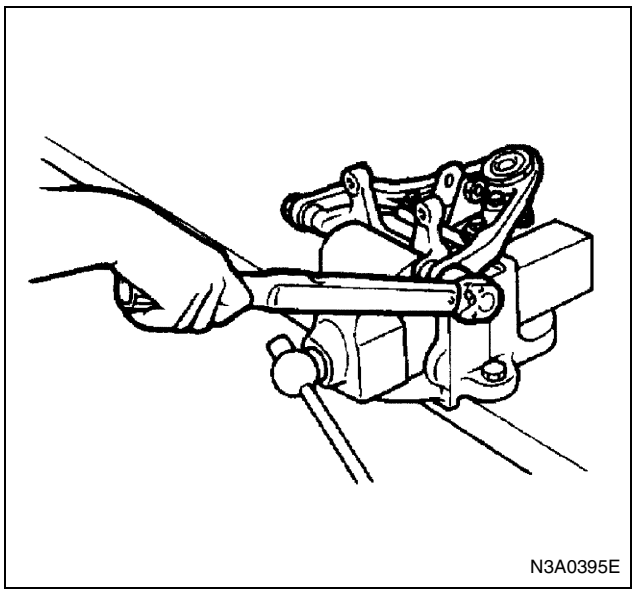
- Disassemble the upper link assembly.
- Inspect the following parts as shown in the figure for wear, damage, bending or any other abnormal conditions.


N3A0394E

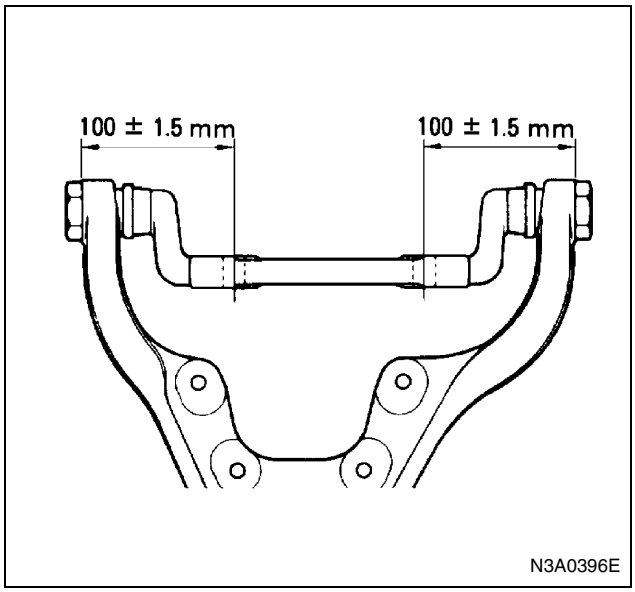
- Reassemble the upper link assembly.
- Apply multi-purpose with MoS_2 grease to the fulcrum pin threads.
- Fill multi-purpose with MoS_2 grease to bushings.
- Install the fulcrum pin to the upper link and tighten bushings to specified torque.

Tighten:

- Bushing to 294 N·m (30 kg·m/217 lb·ft)

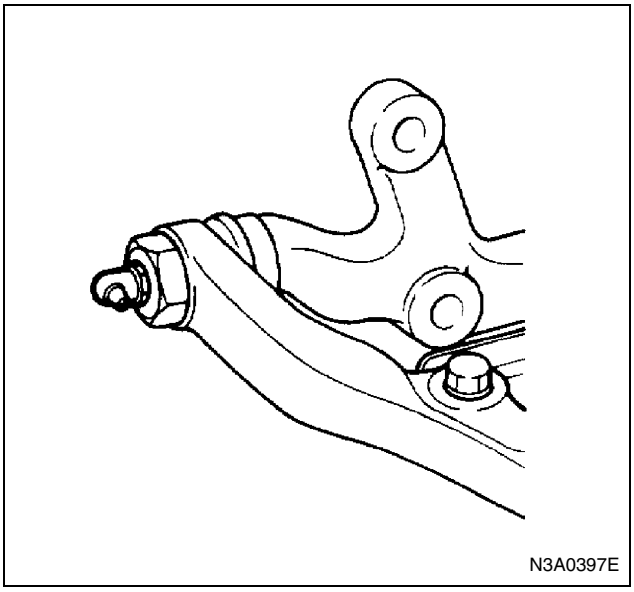

N3A0395E

- Adjust the fulcrum pin as shown in the figure.



N3A0396E

- Install grease fitting to upper link in parallel with upper link.


N3A0397E

Lower Link Bushing Replacement

- Remove the lower link bushing using a bench press and special tool.
  Remover: 5-8840-2367-0
- Inspect the bushing for wear, damage or any other abnormal condition.
- Install the bushing to the lower link from vehicle forward direction.
  Installer: 5-8840-2367-0

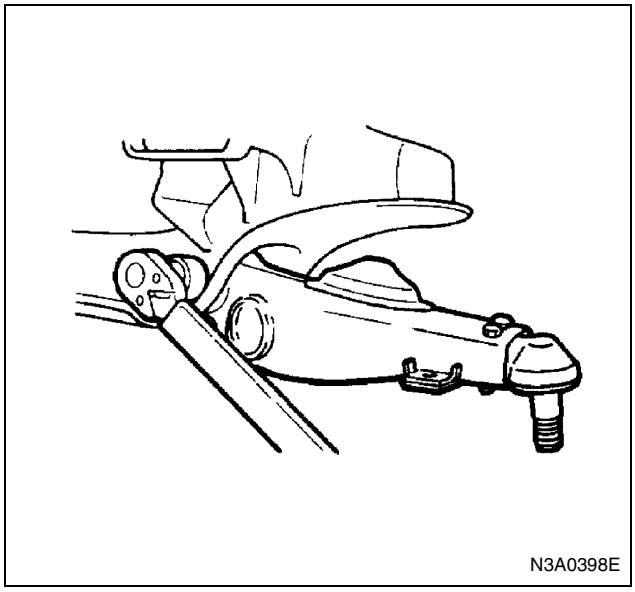
Installation

1. Lower Link
   - Install the lower link fixing bolt from the vehicle forward direction and set the bolt head to the bolt stopper completely.
   - Tighten the nut temporarily.

Notice:
Tighten nuts to specified torque after following steps;

- Park the vehicle on a level ground.
- Move the front of the vehicle up and down several times to settle the suspension.

Tighten:
- Lower link nut to 579 N·m (59.0 kg·m/427 lb·ft)

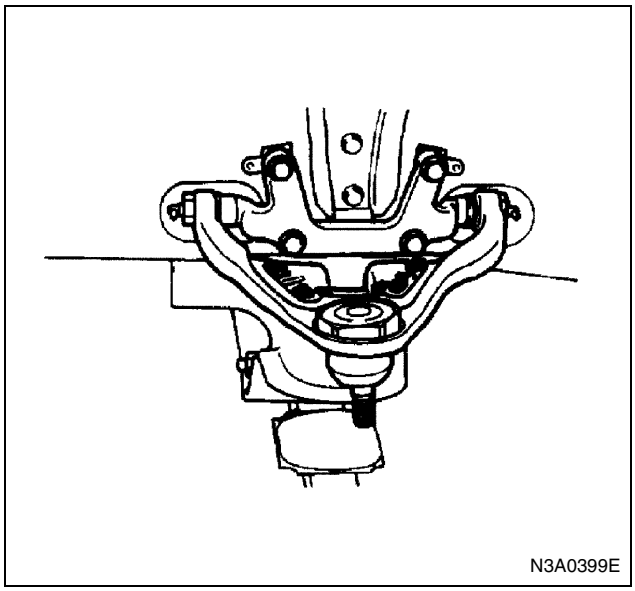

N3A0398E

2. Shim
3. Upper Link Assembly
   - Install the shims and upper link assembly.
   - Tighten the fixing bolts to the specified torque.

Thickness of Shims Available
0.8 mm (0.031 in), 1.6 mm (0.063 in), 3.2 mm (0.126 in)

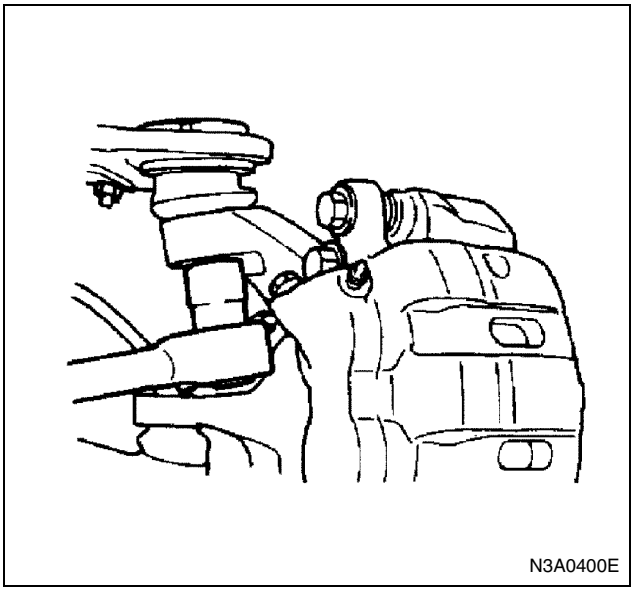
Tighten:
- Upper link bolt to 152 N·m (15.5 kg·m/112 lb·ft)

  For adjustment of camber and caster angle, refer to “Front End Alignment” in Section 3A.


N3A0399E

4. Knuckle
   - Connect the upper ball joint, lower ball joint to the knuckle.
   - Tighten the fixing nuts temporarily.
   - After installation of tie rod end and strut bar assembly, tighten fixing nuts to specified torque, with just enough additional torque to align cotter pin holes.
     Install new cotter pin.

Tighten:
- Ball joint nut to
  Upper: 205 N·m (20.9 kg·m/151 lb·ft)
  Lower: 377 N·m (38.4 kg·m/278 lb·ft)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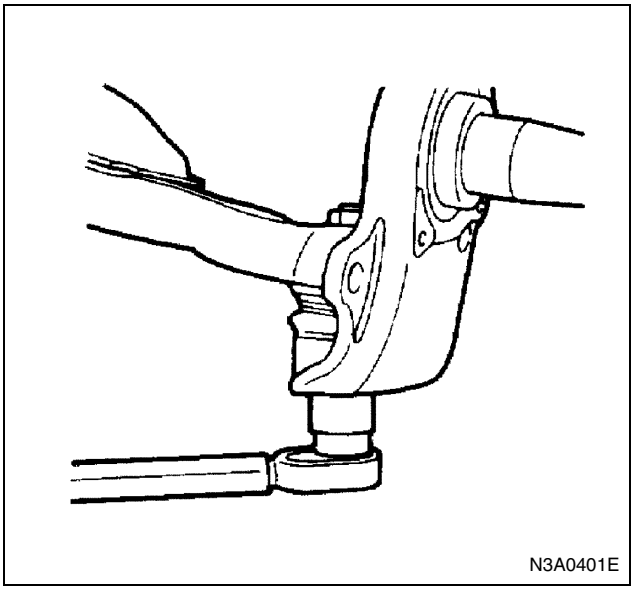
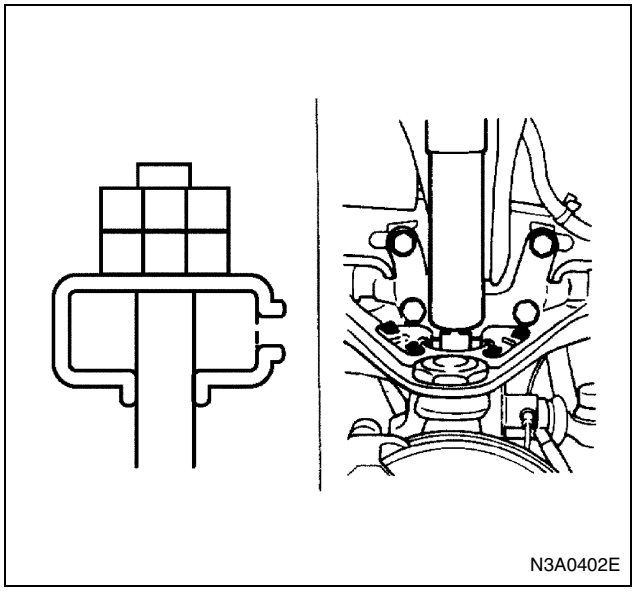
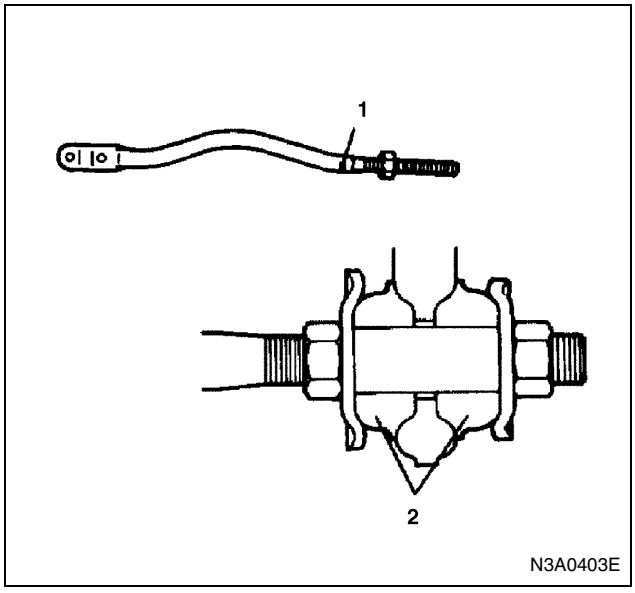

N3A0401E

5. Shock Absorber Assembly

Tighten:
- Shock absorber bolt and nut to
  Double nut (upper): 40 N·m (4.1 kg·m/30 lb·ft)
  Double nut (lower): 21 N·m (2.1 kg·m/16 lb·ft)
  Lower: 103 N·m (10.5 kg·m/76 lb·ft)


N3A0402E

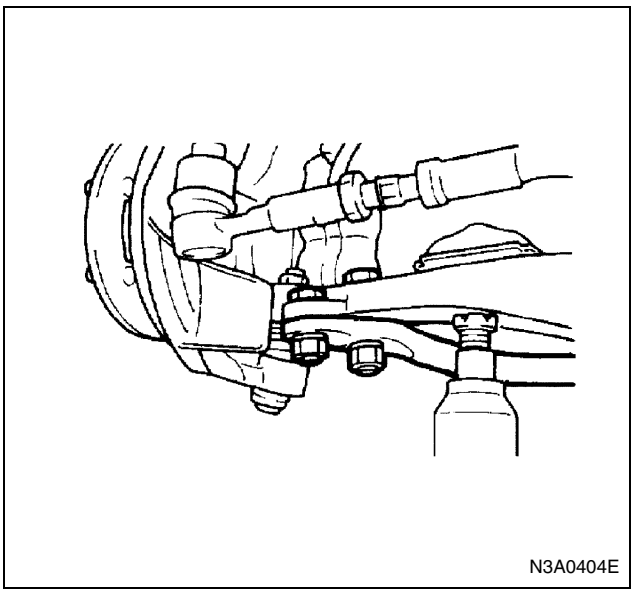
6. Strut Bar Assembly
   - Install the strut bar assembly.
   - White paint (1) is aligned to right side strut bar. Be careful not to install to the opposite side.
   - Apply a thin coat of rubber grease to inside of the rubber bushing (2).
   - Tighten the rear side fixing nuts temporarily.



N3A0403E

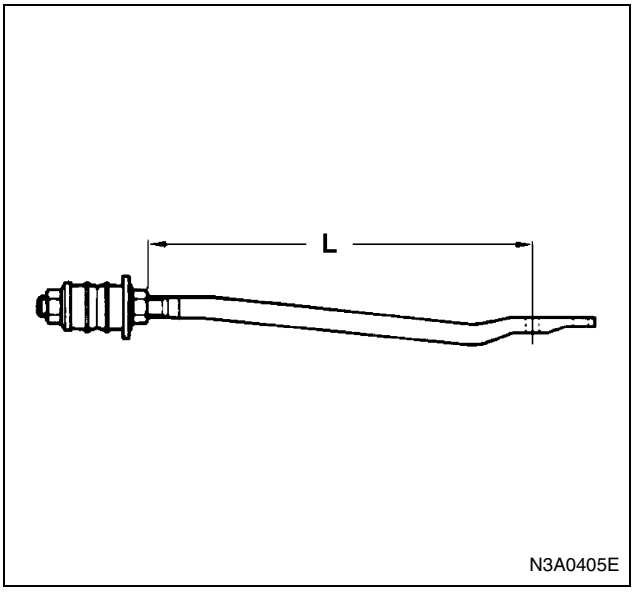
   - Tighten the lower link side fixing bolts to specified torque.

Tighten:
- Strut bar bolt and nut to 219 N·m (22.3 kg·m/161 lb·ft)


N3A0404E

- Adjust the strut bar length (L) after installation.

Strut Bar Length (L)
485.0 mm (19.095 in)

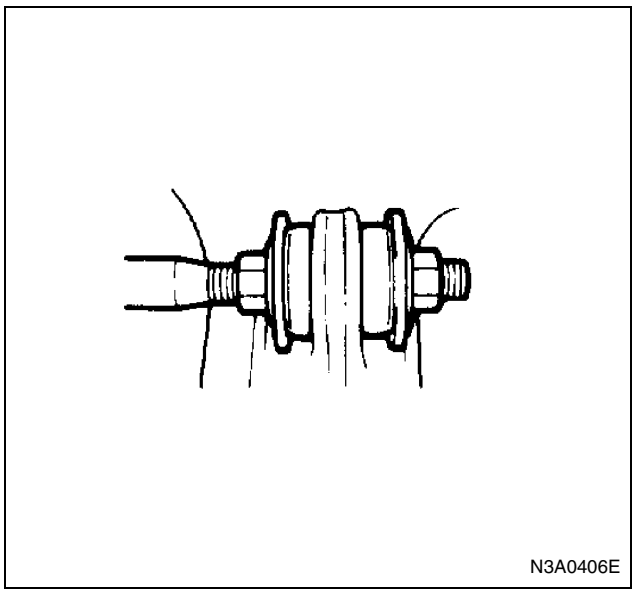


N3A0405E

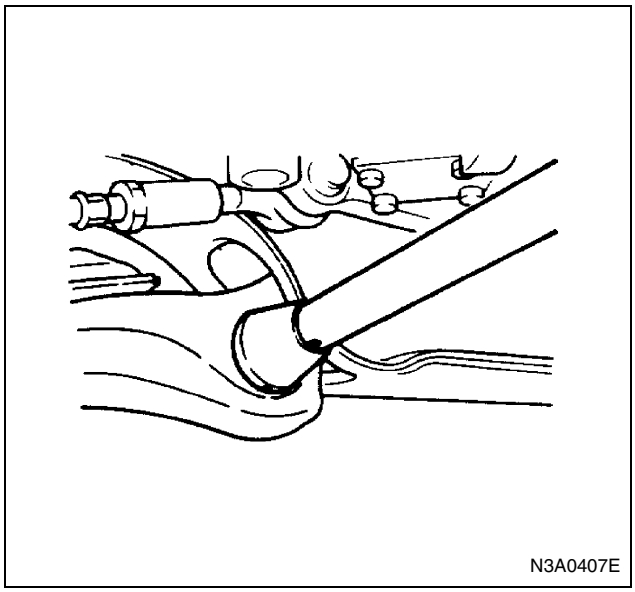
Notice:
Tighten nuts to specified torque after following steps;

- Park the vehicle on a level ground.
- Move the front of the vehicle up and down several times to settle the suspension.

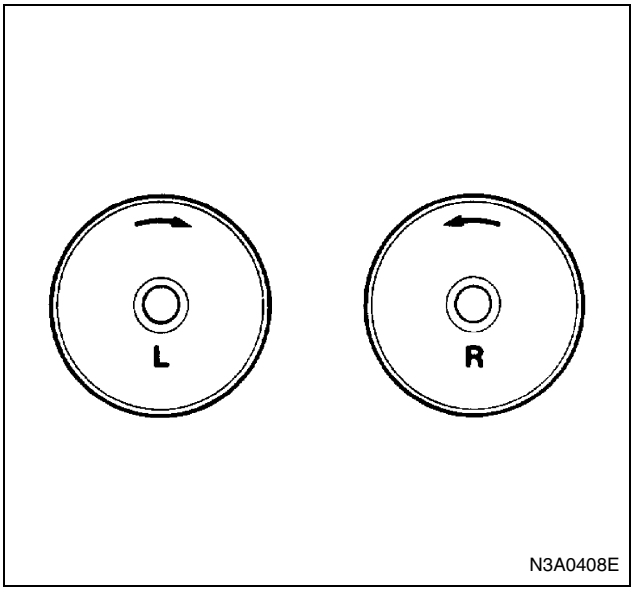
Tighten:
- Strut bar nut to 235 N·m (24 kg·m/174 lb·ft)


N3A0406E

7. Torsion Bar
8. End Piece
9. Height Control Arm
10. Adjusting Bolt
    - Apply chassis type grease to serrated portions of torsion bar, lower arms, threaded portion of end piece.
    - Make sure the bars are on their correct respective sides.


N3A0407E

- Align the setting marks applied at removal.



- Tighten adjusting bolts to the original portion temporarily.
- Install the outer track rod end to the knuckle. Tighten nuts to specified torque, with just enough additional torque to align cotter pin holes.
  Install new cotter pin.

Tighten:
- Tie rod end nut to 108 N·m (11 kg·m/80 lb·ft)
  - Park the vehicle on a level ground.
  - Move the front of the vehicle up and down several times to settle the suspension.
  - Tighten temporarily tightening bolts and nuts to specified torque.
  - Install the hub and rotor assembly. Refer to “Front Axle”.
  - Install the brake caliper assembly. Refer to “Hydraulic Brakes”.

Tighten:
- Brake caliper bolt to 219 N·m (22.3 kg·m/161 lb·ft)
  - Install front wheel and tire assembly. Refer to “Wheels and Tires” in Section 3E.
  - Adjust the trim height.

Notice:
Adjust the front end alignment. Refer to “Front End Alignment”.

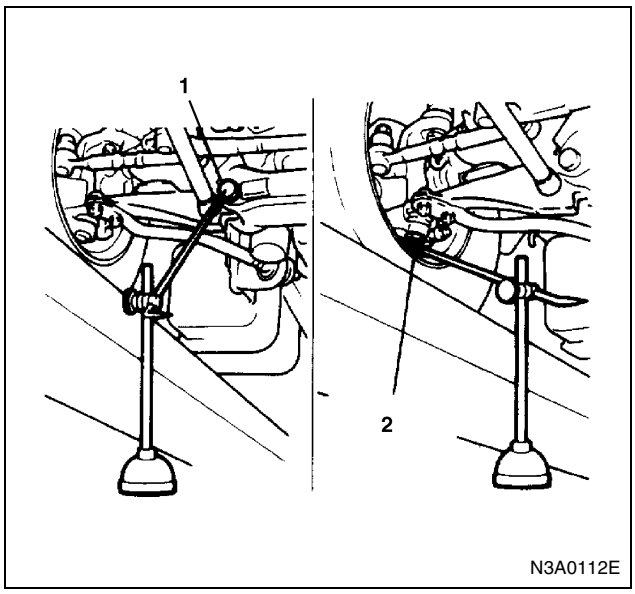
Bleed brakes. Refer to “Brake Bleeding”.

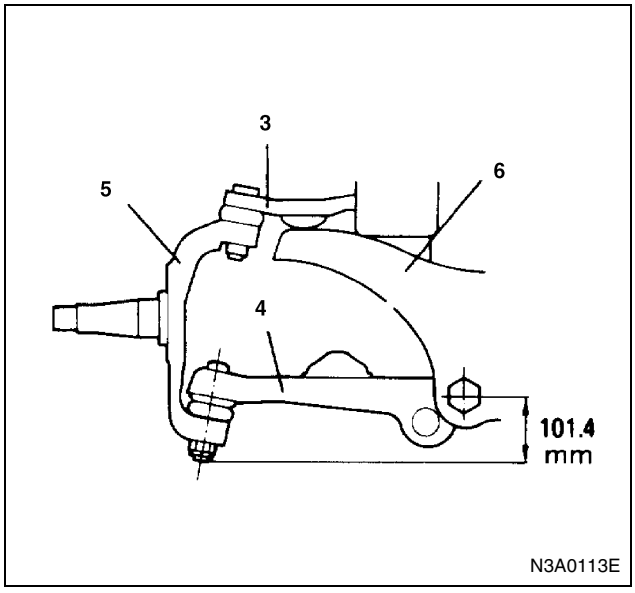
Adjustment of Trim Height
Adjust the trim height by means of adjusting bolt on the height control arms.

Caution:
When adjusting front end alignment, be sure to begin with trim height as trim height adjustment may change other adjusted alignments.

1. Check and adjust the tire inflation pressures.
2. Park the vehicle on a level ground and move the front of the vehicle up and down several times to settle the suspension.
3. Make necessary adjustment with the adjusting bolt on the height control arms.

Trim Height
101.4±5 mm (3.992±0.197 in)





Legend
1. Lower link bolt
2. Lower joint ball
3. Upper link
4. Lower link
5. Knuckle arm
6. Cross member

STEERING, SUSPENSION, WHEELS AND TIRES

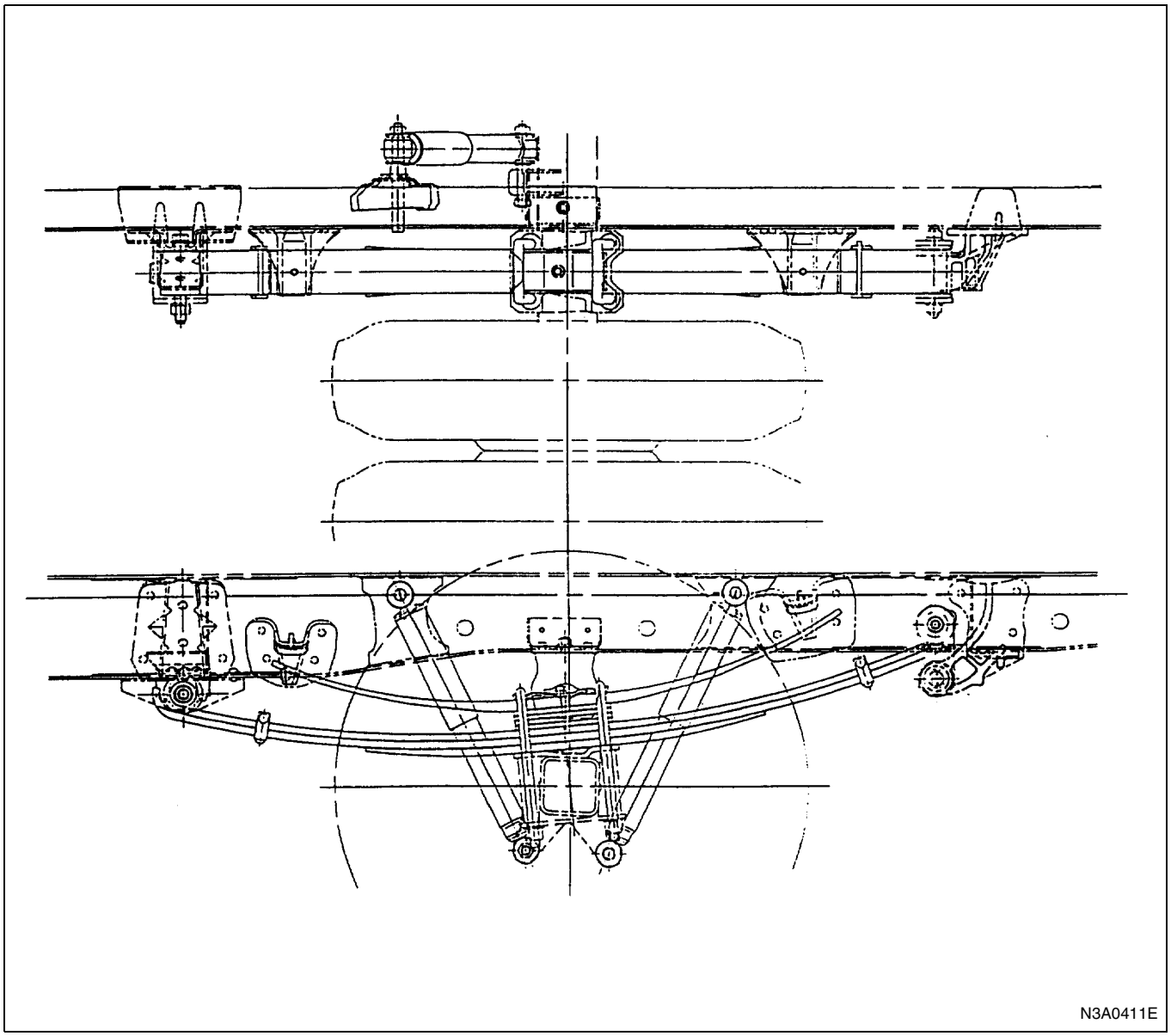
SECTION 3D

REAR SUSPENSION

Contents

GENERAL DESCRIPTION 3D-2
ON-VEHICLE SERVICE 3D-3
Rear Suspension 3D-3

GENERAL DESCRIPTION



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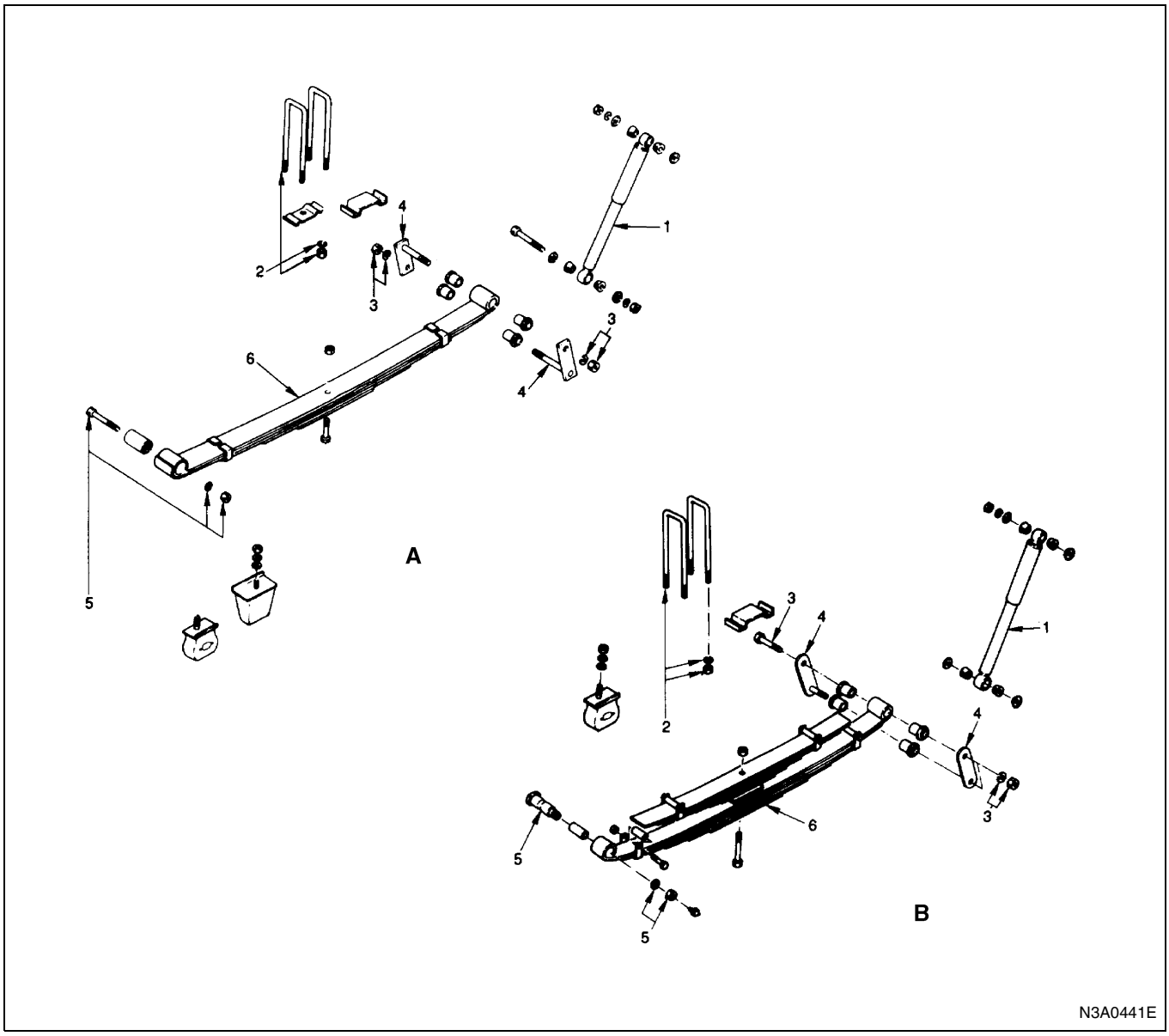
ON-VEHICLE SERVICE

Rear Suspension

Leaf Spring



Legend

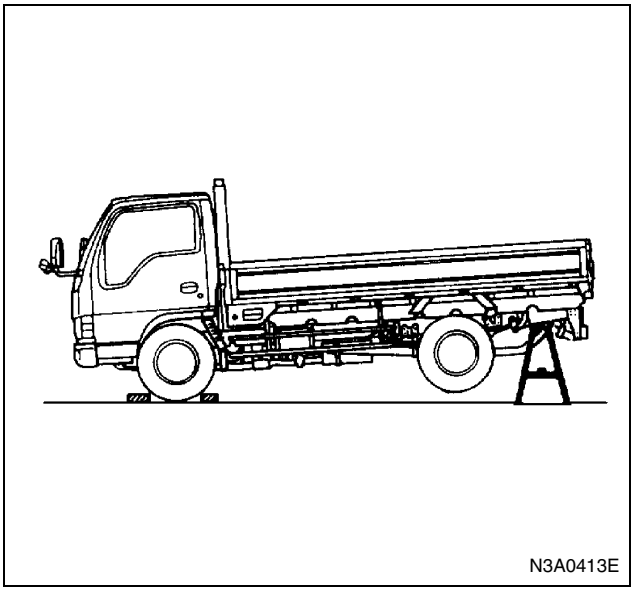
A. NHR, NKR
B. NPR, NPS
1. Shock absorber
2. U-bolt, nut and washer
3. Shackle pin, nut and washer
4. Shackle
5. Spring pin, nut and washer
6. Leaf spring

Removal

Preparation

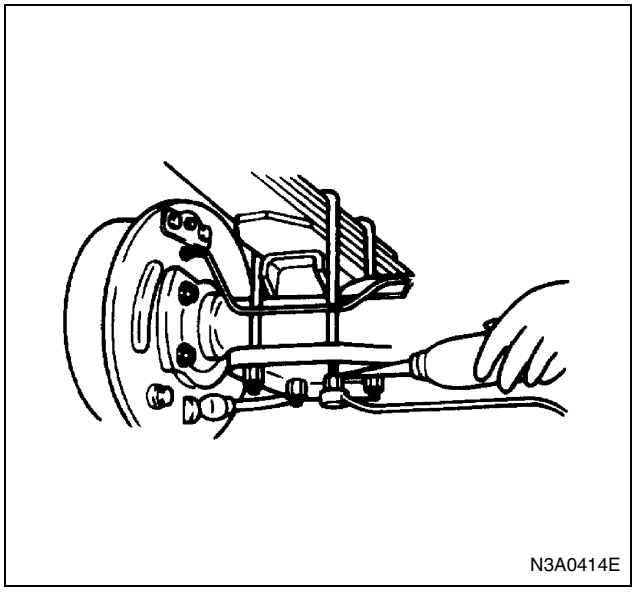
Make the following preparation before removing the leaf spring.

1) Brace the front wheels.
2) Jack up the rear axle until the rear wheels are lifted off the ground and position safety stand under the chassis frame.
   Refer to “Lifting Instruction” in Section 0A for acceptable lifting point and supportable point location.

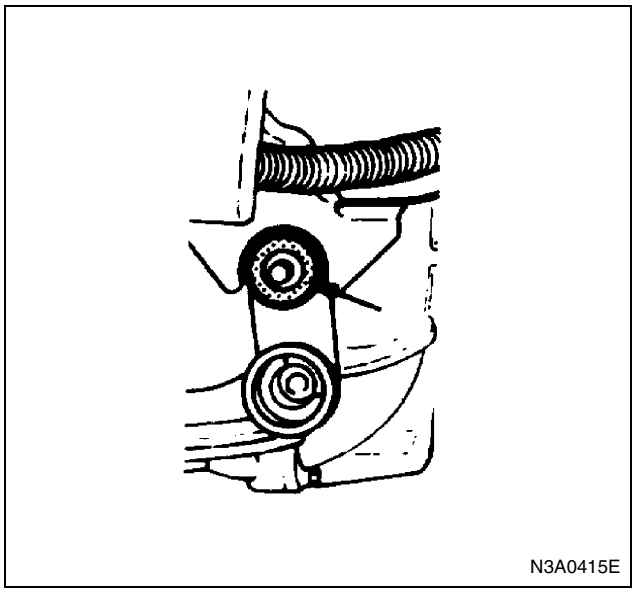


3) Position a garage jack under the rear axle.
4) For the vehicle model with a stabilizer, remove the mounting portion on the axle side of the stabilizer in advance before removing the leaf spring. (Refer to the removal procedure of the stabilizer.)

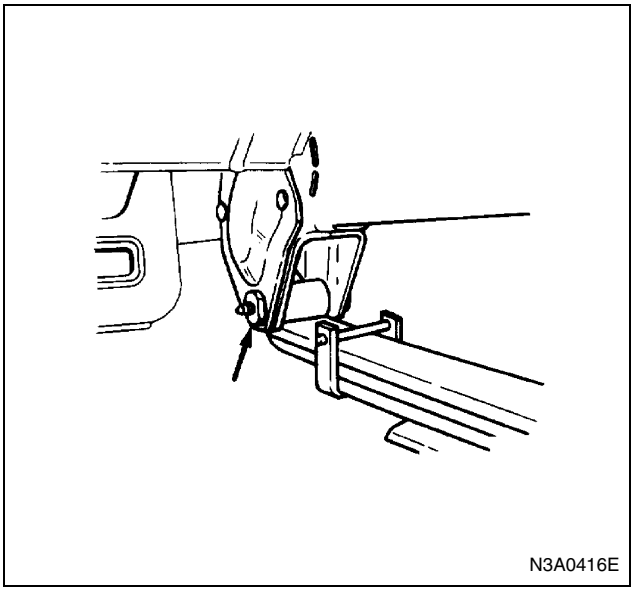
1. Shock Absorber
2. U-bolt, Nut and Washer
   If the U-bolt are heavily rusted, apply a generous amount of oil to the threads before loosening them to prevent seizure.



3. Shackle Pin, Nut and Washer
4. Shackle
   Take out the rubber bushings after removal of the shackle.



5. Spring Pin, Nut and Washer
   Drive out the shackle pin with a hammer using a brass bar after removal of the shackle pin nut.


N3A0416E

6. Leaf Spring
   Lower the garage jack slowly and remove the rear spring assembly. When removing the rear spring assembly, exercise care not to cause damage to the brake flexible hoses. Also, exercise care not to cause the spring to come down.

Installation and Repair

Make necessary correction or parts replacement if wear, damage or any other abnormal conditions are found through inspection.

Visual Check

Inspect the following parts for wear, damage or other abnormal conditions.

- Leaf spring assembly
- Clip
- Center bolt
- U-bolt
- Spring pin
- Shackle pin
- Shock absorber
- Helper rubber
- Rubber bushing
- Sub spring stopper rubber
- Helper rubber seat

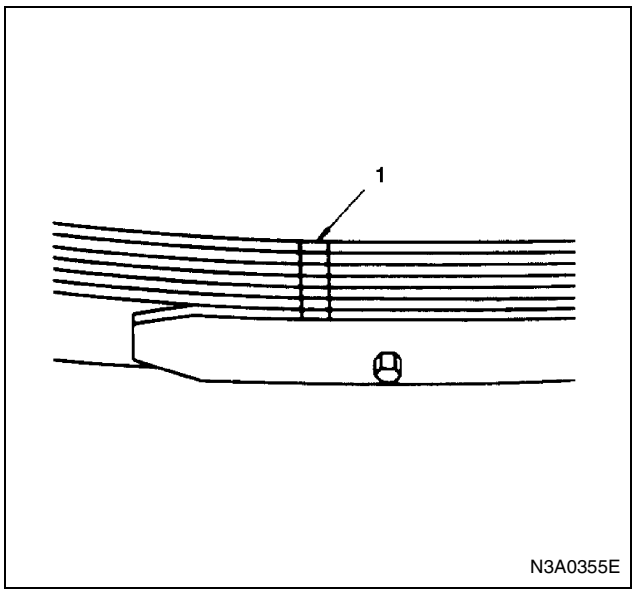
Shock Absorber

1. Inspect for extreme oil leakage. Slight oil leakage is allowed.
2. Inspect for temperature after running. Unchanged temperature indicates deteriorated function.
3. Inspect if large resistance is felt when the shock absorber is expanded and contracted by holding either end, or if play is eliminated after several times of expansion and contraction. The function has deteriorated if the above condition is not observed.
4. Inspect the bushing for wear or deterioration. Replace if abnormality is found.

Leaf Spring Assembly Replacement

- Apply a setting mark (1) across the springs before disassembling the leaf spring assembly.
- Apply grease to both faces of each leaf spring at reassembly.
- Use a bench press for disassembly and reassembly.
- Discard removed center bolt and install a new one.

When replacing the leaf spring assembly, use the leaf spring with the same camber represented by "+, –, ❍" on both right and left sides.



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Center Bolt

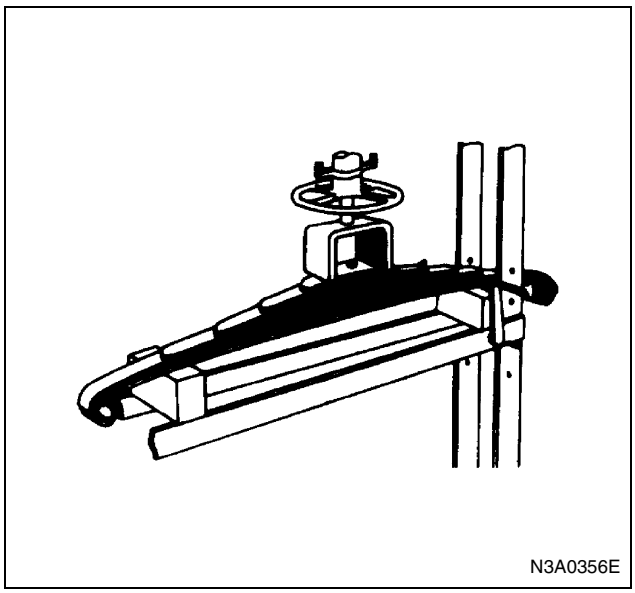
Tighten:

- Center bolt to 39 N·m (4 kg·m/29 lb·ft)

Clip Bolt

Tighten:

- Clip bolt to 20 N·m (2 kg·m/14 lb·ft)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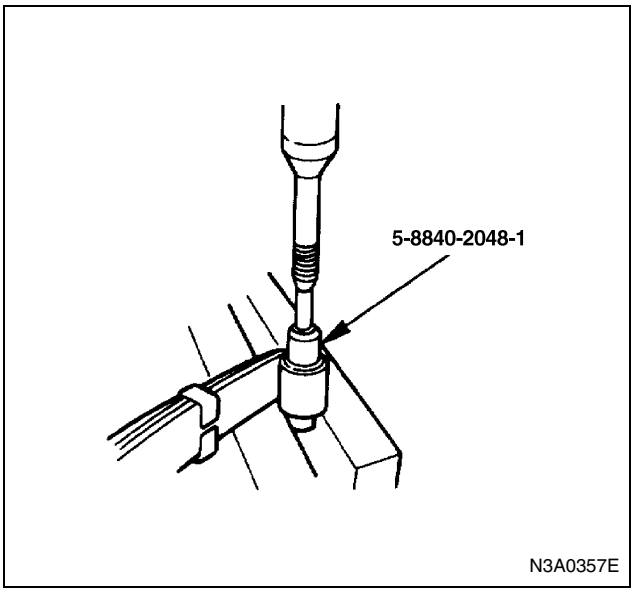
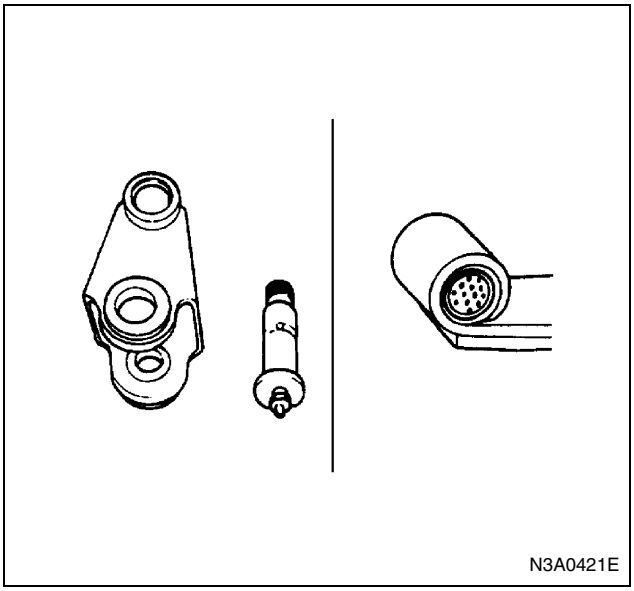
Bushing Replacement
When replacing bushing, drive out the bushing using a bench press.
Leaf Spring Rubber Bush Remover & Installer: 5-8840-2048-1
Leaf Spring Metal Bush Remover & Installer: 5-8840-2049-1

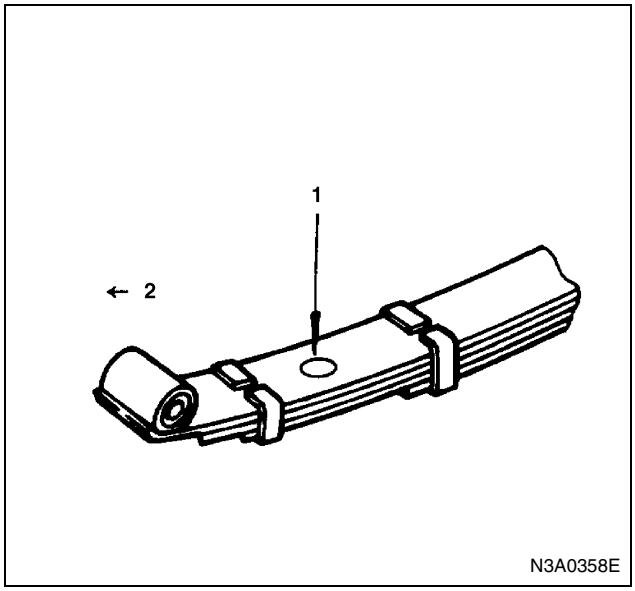


Measurement of Outer Diameter of Spring Pin
Standard: 25 mm (0.98 in)
Limit: 24.7 mm (0.97 in)
Clearance between Shackle Pin and Bushing
Standard: 0.1 mm (0.0039 in)
Limit: 0.5 mm (0.019 in)



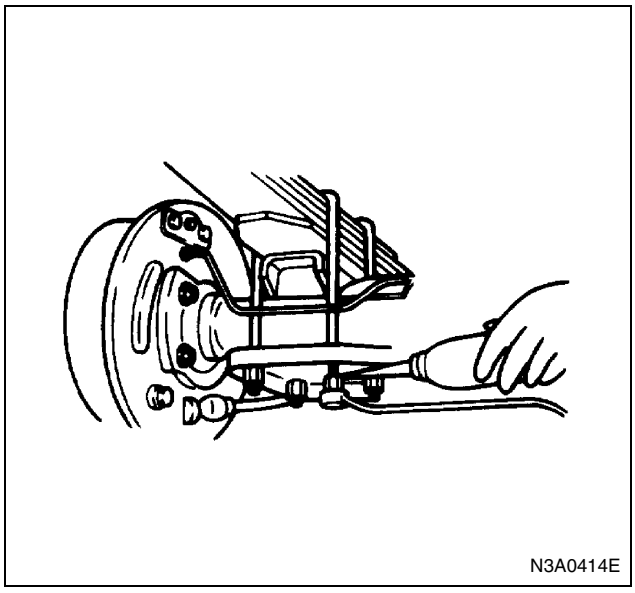
Installation

1. Leaf Spring
   Install the leaf spring assembly with the camber mark (1) turned to front side (2) on the rear axle.



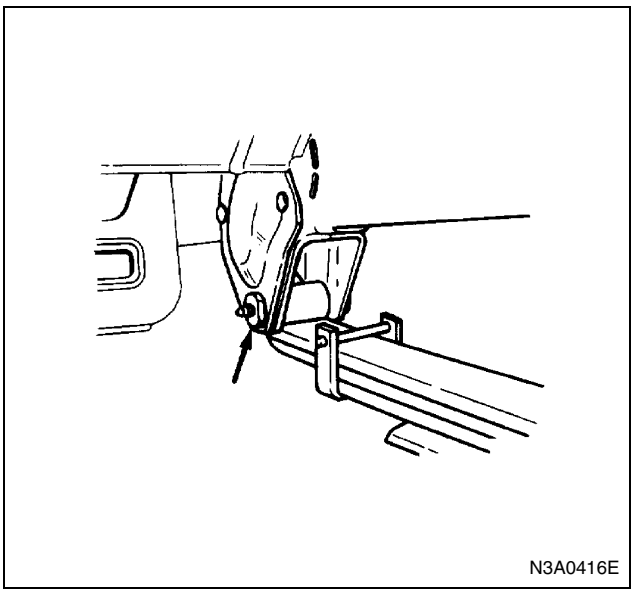
2. U-bolt, Nut and Washer
   Position the U-bolts and clamp on the leaf spring assemblies and jack up the rear axle.
   When tightening the nuts, apply oil as necessary to prevent damaging the threads.

Tighten:
- U-bolt nut to
  NQR: 284 N·m (29 kg·m/210 lb·ft)
  Except NQR: 177 N·m (18 kg·m/130 lb·ft)



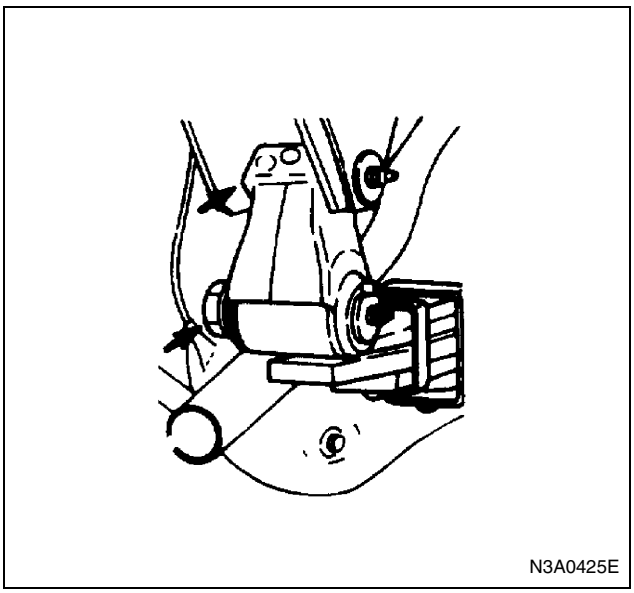
3. Spring Pin, Nut and Washer
4. Shackle
   Finger tighten first, and tighten to specified torque after lowering the vehicle to ground.

Tighten:
- Shackle pin nut to
  NHR, NKR Single tire, Flat low: 202 N·m (20.6 kg·m/149 lb·ft)
  NKR Dual tire, NPR, NQR, NPS: 332 N·m (33.8 kg·m/244 lb·ft)


N3A0416E

5. Shackle Pin Nut and Washer
   Finger tighten first, and tighten to specified torque after lowering the vehicle to ground.

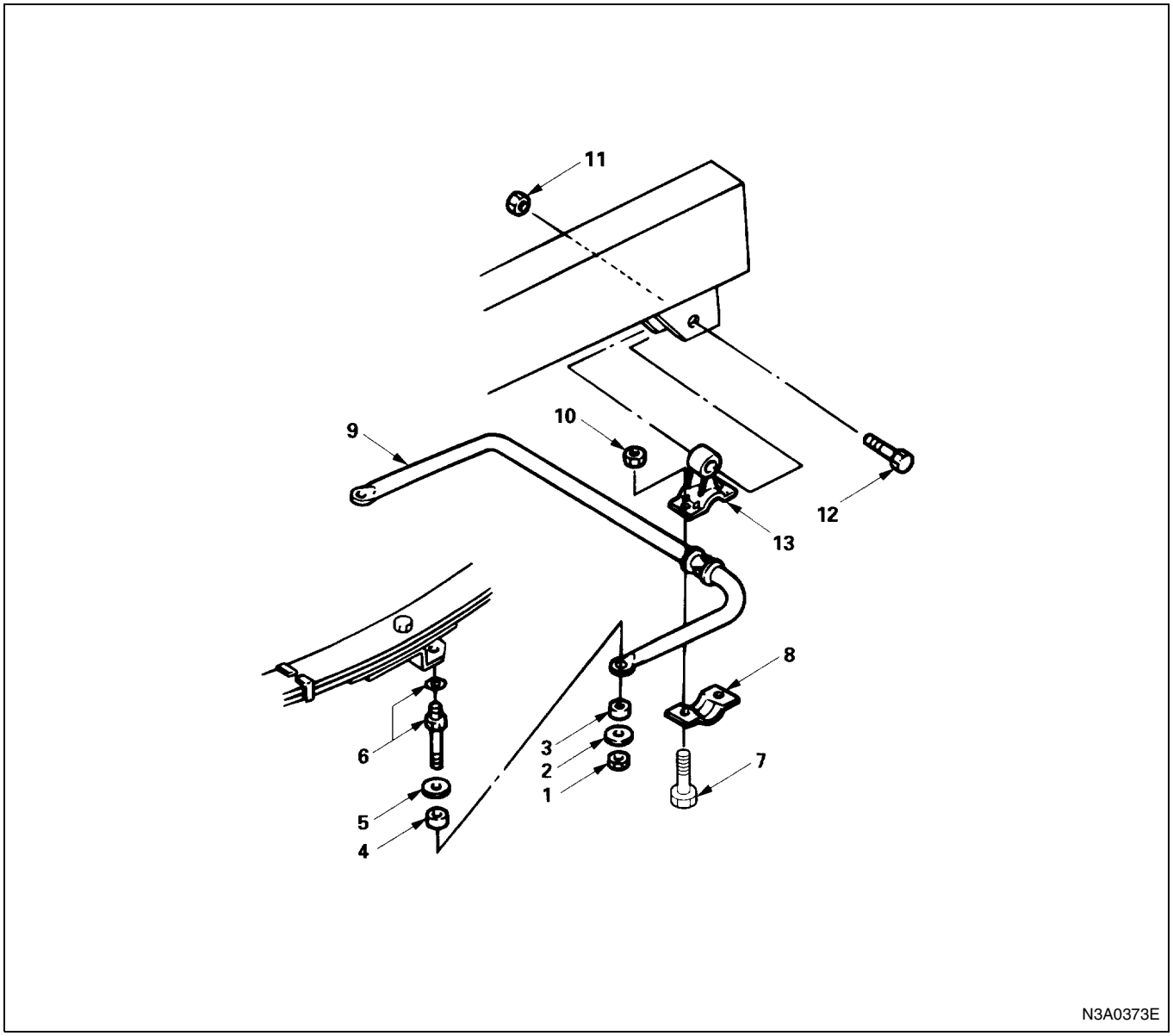
Tighten:
- Spring pin nut to
  NHR: 137 N·m (14 kg·m/101 lb·ft)
  Except NHR: 177 N·m (18 kg·m/130 lb·ft)


N3A0425E

6. Shock Absorber

Tighten:
- Shock absorber upper nut to
  NHR, NKR single tire: 61 N·m (6.2 kg·m/45 lb·ft)
  Except above models: 95 N·m (9.7 kg·m/70 lb·ft)
- Shock absorber lower nut to
  NHR, NKR Single tire: 61 N·m (6.2 kg·m/45 lb·ft)
  NKR Dual Tire: 95 N·m (9.7 kg·m/70 lb·ft)
  NPR, NPS, NQR: 40 N·m (4.1 kg·m/30 lb·ft)

Stabilizer

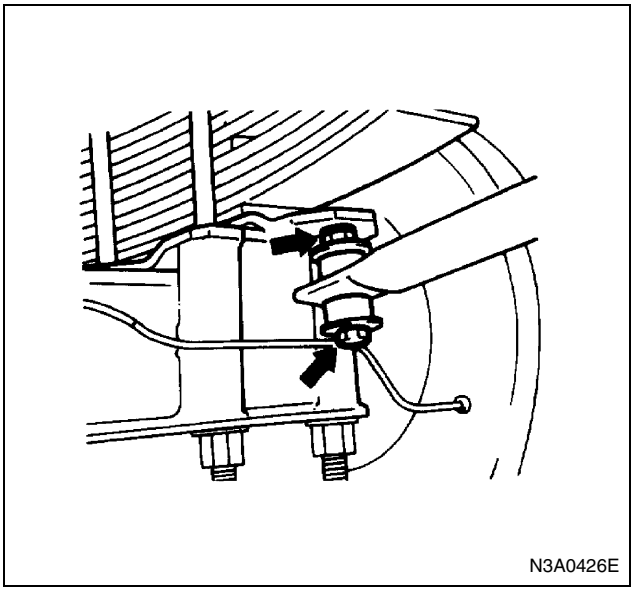


Legend

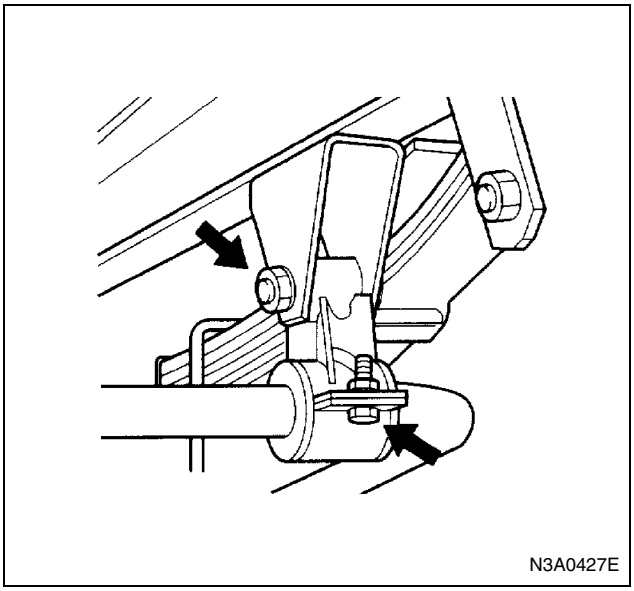
1. Nut
2. Washer
3. Rubber bushing
4. Rubber bushing
5. Washer
6. Stud bolt and spring washer
7. Bolt
8. Rod link cap
9. Stabilizer bar
10. Nut
11. Nut
12. Bolt
13. Rod link

Removal

1. Nut
2. Washer
3. Rubber Bushing
4. Rubber Bushing
5. Washer
6. Stud Bolt and Spring Washer


N3A0426E

7. Bolt
8. Rod Link Cap
9. Stabilizer Bar
10. Nut
11. Nut
12. Bolt
13. Rod Link


N3A0427E

Inspection and Repair

Make necessary correction or parts replacement if wear, damage or any other abnormal conditions are found through inspection.

Stabilizer

Inspect the stabilizer bar and attachments for the following conditions:

1. Cracks, bends or damage to the bar.
2. Worn bushings.
3. Damaged brackets.

- Replace any worn or damaged parts.

Installation

Notice:

During installation, place the vehicle on flat ground and tighten each part to the specified torque.

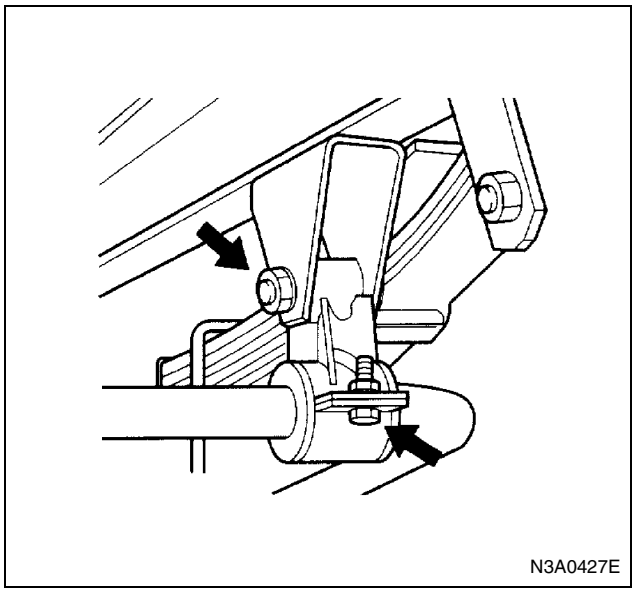
1. Stabilizer Bar
2. Rod Link
3. Rod Link Cap
4. Bolt
5. Nut
6. Bolt
7. Nut

Tighten:

- Nut to

  Rod link cap nut: 57 N·m (5.8 kg·m/42 lb·ft)

  Rod link bracket nut: 127 N·m (13 kg·m/94 lb·ft)


N3A0427E

8. Stud Bolt and Spring Washer
9. Washer
10. Rubber Bushing
11. Rubber Bushing
12. Washer
13. Nut

Tighten:
- Stud bolt and nut to
  Stud bolt: 117 N·m (11.9 kg·m/86 lb·ft)
  Nut: 29 N·m (3.0 kg·m/22 lb·ft)

STEERING, SUSPENSION, WHEELS AND TIRES

SECTION 3E
WHEELS AND TIRES

Contents

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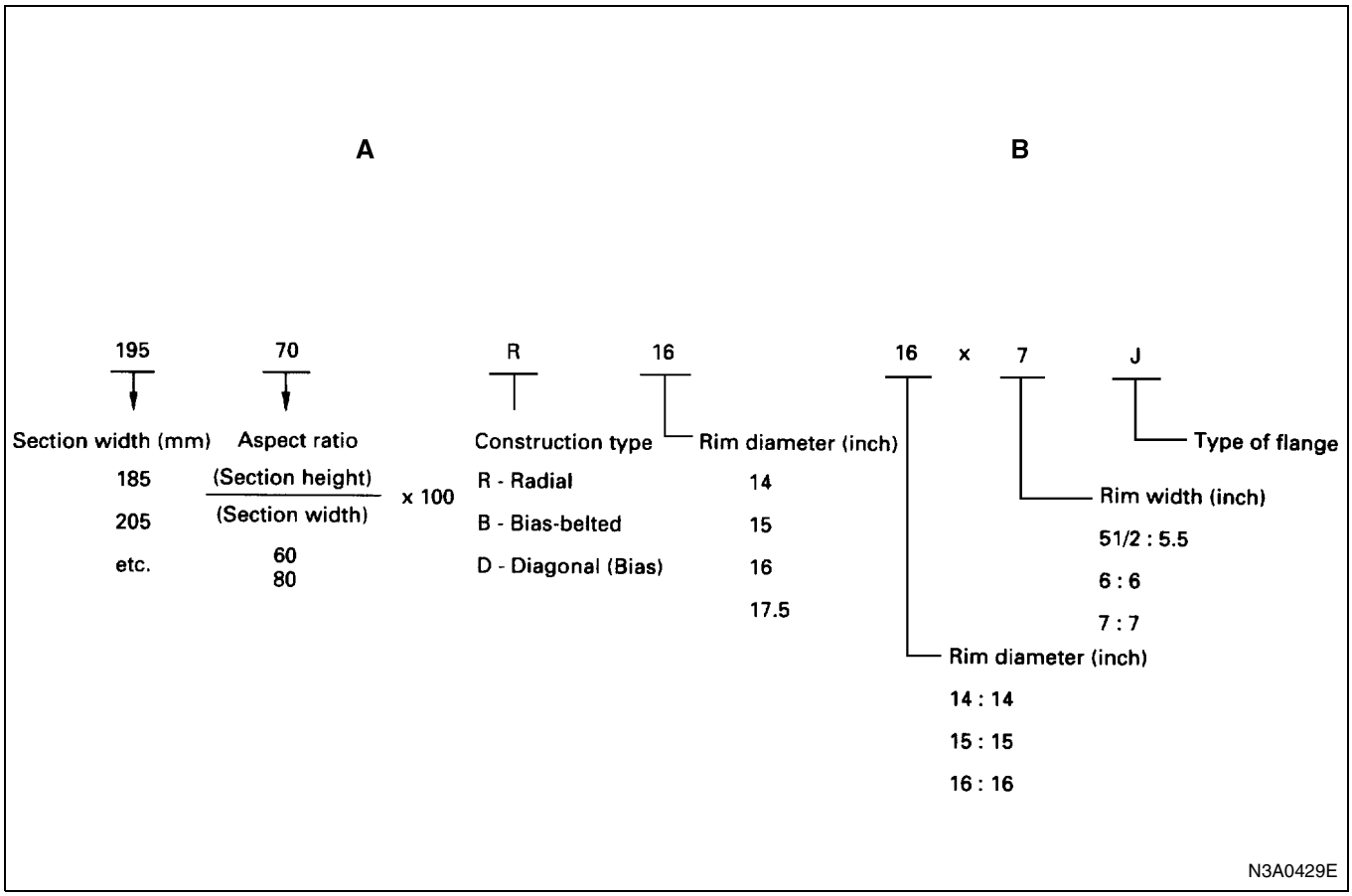
GENERAL DESCRIPTION



Legend

A. Metric tire size format

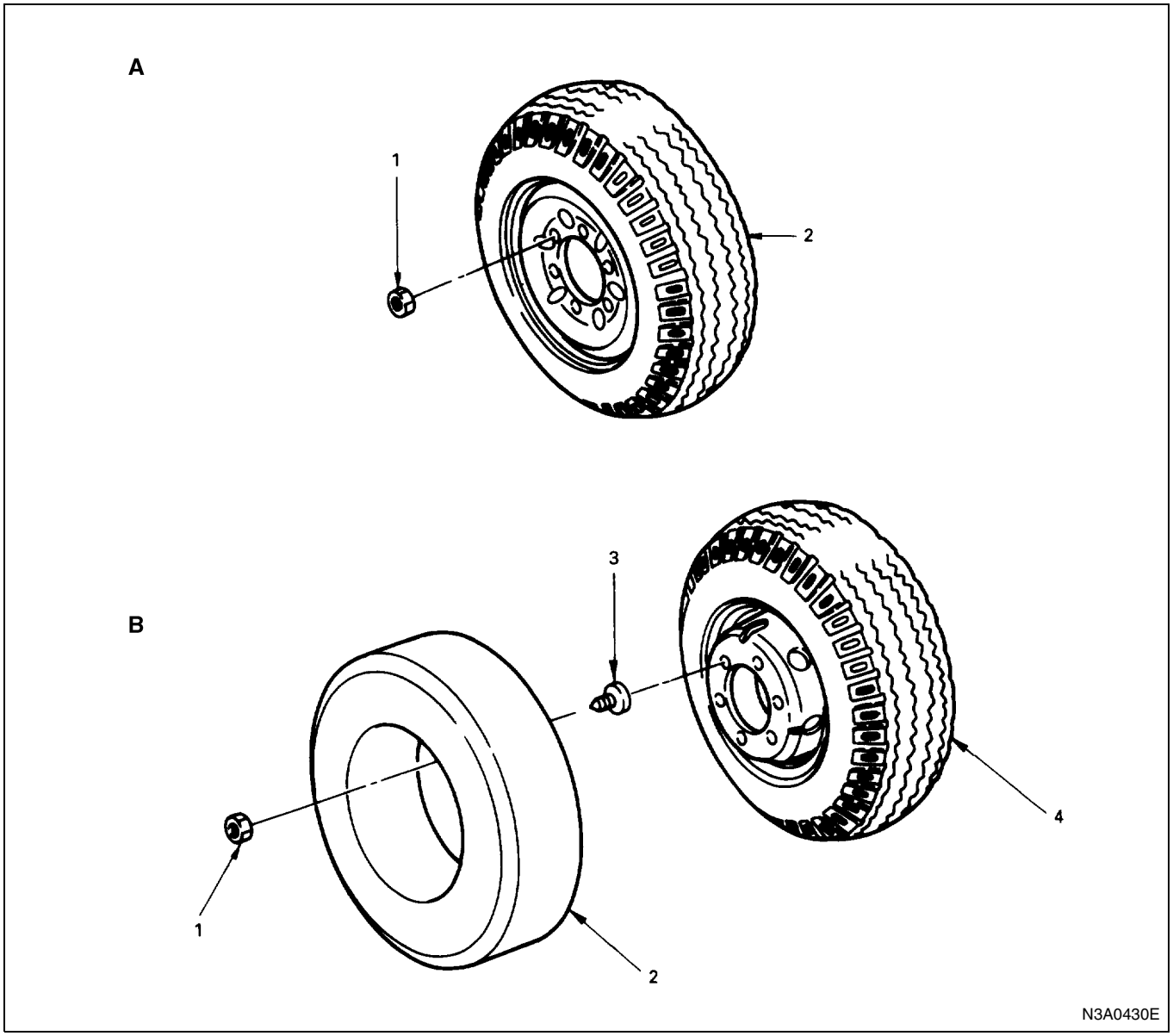
B. Rim size format

Replaced wheels or tires must be equivalent to the original one in load capacity, specified dimension and mounting configuration. Improper size or type may affect bearing life, brake performance, speedometer/ odometer calibration, vehicle ground clearance and tire clearance to the body and chassis.

All models are equipped with metric sized steel belted radial tires. Correction of tire pressures and driving habits have an important influence on tire life. Heavy cornering, excessively rapid acceleration and unnecessary sharp braking increase premature and uneven wear.

ON-VEHICLE SERVICE

Wheel and Tire Assembly



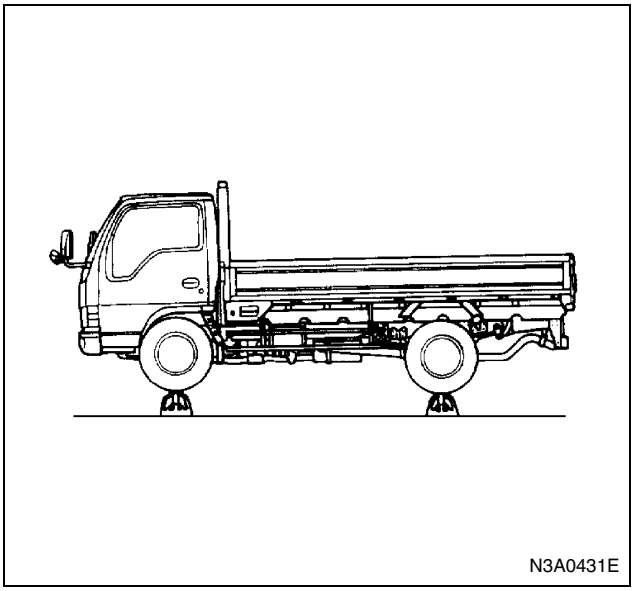
Legend

A. Front tire, Rear single tire
B. Rear dual tire
1. Wheel nut (outer)
2. Wheel and tire assembly (front or outer)
3. Wheel nut (inner)
4. Wheel and tire assembly (inner)

Removal

Preparations

- Raise the vehicle and support jack up point with suitable safety stands. Refer to “Lifting Instruction” in Section 0A.



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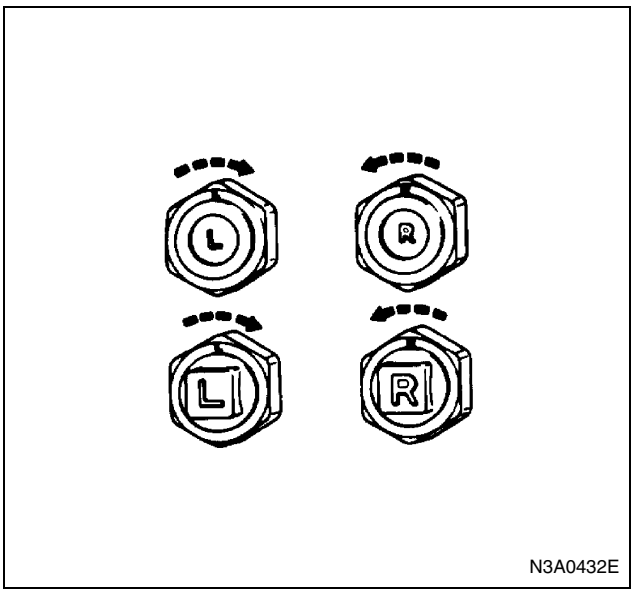
1. Wheel Nut (Outer)
2. Wheel and Tire Assembly (Front or Outer)
3. Wheel Nut (Inner)
4. Wheel and Tire Assembly (Inner)
   Loosen the wheel nuts with the wheel nut wrench.
   The wheel nuts on the right side wheels have right-hand threads and the wheel nuts on the left side wheels have left-hand threads.



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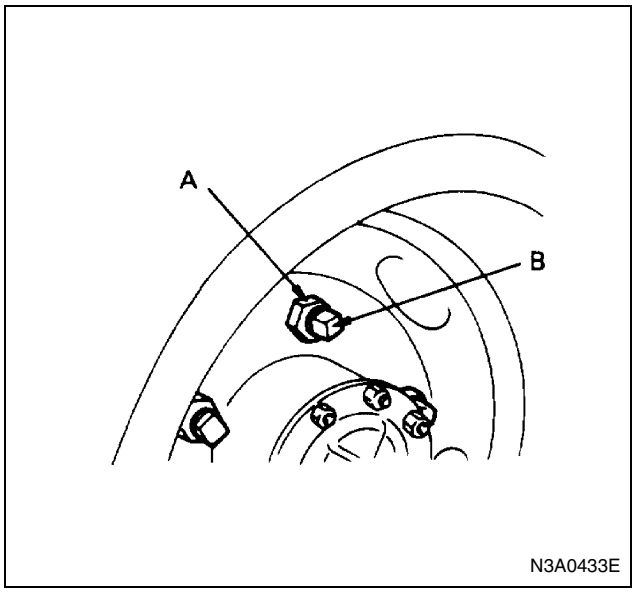
To change the inner wheel on either side of the rear of the vehicle:

1) Completely loosen the six-sided outer wheel nut (A) with the wheel wrench.
2) Using the opposite side of the wheel wrench, unscrew the four-sided inner wheel nut (B) approximately one full turn.
3) Repeat this procedure with the remaining outer and inner wheel nuts.



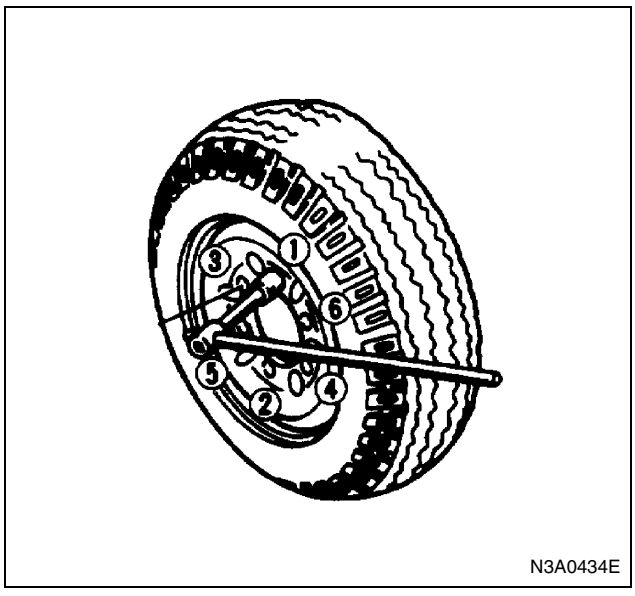
N3A0433E

Installation

1. Wheel and Tire Assembly (Inner)
2. Wheel Nut (Inner)
3. Wheel and Tire Assembly (Front or Outer)
4. Wheel Nut (Outer)
   Tighten wheel nuts in numerical sequence.

Tighten:

- Front wheel nut to
  NHR, NKR Single tire, NKR Flat low: 167 N·m (17 kg·m/123 lb·ft)
  Except above models: 441 N·m (45 kg·m/325 lb·ft)
- Rear wheel nut to
  NHR, NKR Single tire: 167 N·m (17 kg·m/123 lb·ft)
  NHR Dual tire, NKR Flat low: 294 N·m (30 kg·m/217 lb·ft)
  Except above models: 441 N·m (45 kg·m/325 lb·ft)
  - 6 studs



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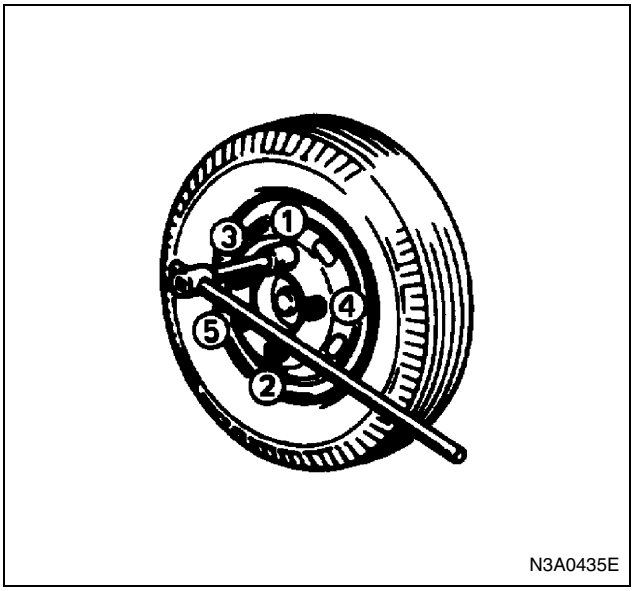
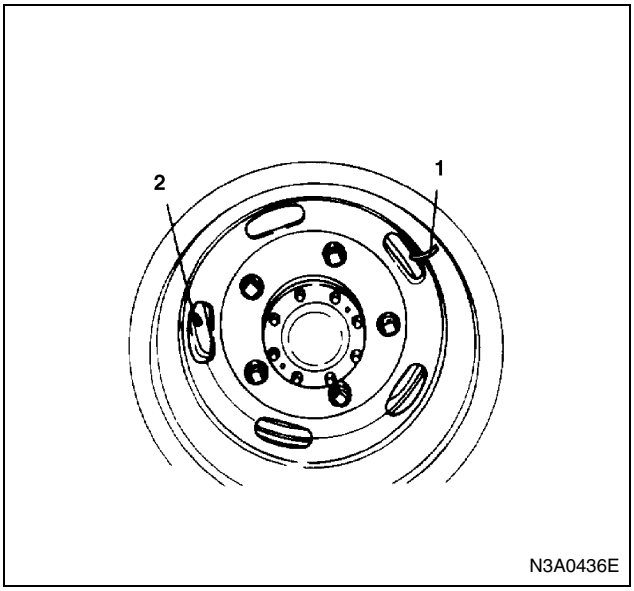
- 5 studs



Notice:
When installing the rear wheels, take care so that the dual tires' valves (1) (2) are dislocated or that the inner valve (2) will not be hidden.



UNIT REPAIR

Tires

Replacement

When replacement is necessary, the original metric tire size should be used. Most metric tire sizes do not have exact corresponding alphanumeric tire sizes. It is recommended that new tires be installed in pairs on the same axle, if necessary to replace only one tire, it should be paired with tire having the most tread, to equalize braking traction.

Caution:
Do not mix different types of tires such as radial, bias and bias-belted tires except in emergencies, because car handling may be seriously affected and may result in loss of control.

Tire Dismounting

Remove valve cap on valve stem and deflate the air.
Then use a tire changing machine to mount or dismount tires. Follow the equipment manufacturer's instruction. Do not use hand tools or tire lever alone to change tires as they may damage the tire beads or wheel rim.

Tire Mounting

Rim bead seats should be cleaned with a wire brush or coarse steel wool to remove lubricants and light rust. Before mounting a tire, the bead area should be well lubricated with an approved tire lubricant.
After mounting, inflate the tire to 196kPa (2 kg/cm^2, 28 psi) so that beads are completely seated. Inflate the air to specified pressure and install valve cap to the stem.

WARNING:
NEVER STAND OVER TIRE WHEN INFLATING. BEAD MAY BREAK WHEN BEAD SNAPS OVER RIM'S SAFETY HUMP AND CAUSE SERIOUS PERSONAL INJURY.

NEVER EXCEED SPECIFIED PRESSURE WHEN INFLATING. IF SPECIFIED PRESSURE WILL NOT SEAT BEADS, DEFLATE, RE-LUBRICATE AND RE-INFLATE.

OVER INFLATION MAY CAUSE THE BEAD TO BREAK AND CAUSE SERIOUS PERSONAL INJURY.

Tire Repair

There are many different materials on the market used to repair tires.
Manufacturers have published detailed instructions on how and when to repair tires. These instructions can be obtained from the tire manufacturer if they are not included with the repair kit.

Tire Size and Tire Inflation Pressure

	Tire size		Tire inflation pressure kPa (kg/cm^2, psi)	
Vehicle model	Front	Rear	Front	Rear
NHR55	6.00-15-8PR	5.50-13-8PR	417 (4.25, 60)	417 (4.25, 60)
	6.00R15-8PR	155R13-8PR	441 (4.50, 64)	441 (4.50, 64)
	6.50-15-10PR	6.50-15-10PR	490 (5.00, 71)	490 (5.00, 71)
	6.50-15-6PR	7.00-15-10PR	319 (3.25, 46)	490 (5.00, 71)
	7.00-15-8PR	7.00-15-8PR	417 (4.25, 60)	417 (4.25, 60)
	7.00-15-10PR	7.00-15-10PR	490 (5.00, 71)	490 (5.00, 71)
	185/80R15	175R14-8	441 (4.50, 64)	441 (4.50, 64)
	205/80R15	205/80R15	441 (4.50, 64)	441 (4.50, 64)
NHR55 (For GCC)	185/80R15	155R13-8PR	441 (4.50, 64)	441 (4.50, 64)
	205/80R15	205/80R15	441 (4.50, 64)	441 (4.50, 64)
	7.00R15-10PR	7.00R15-10PR	515 (5.25, 75)	515 (5.25, 75)
	6.00R15-8PR	155R13-8PR	441 (4.50, 64)	441 (4.50, 64)
NHR69	6.00-15-8PR	5.50-13-8PR	417 (4.25, 60)	392 (4.00, 57)
	6.00R15-8PR	155R13-8PR	441 (4.50, 64)	441 (4.50, 64)

	Tire size		Tire inflation pressure kPa (kg/cm^2, psi)	
Vehicle model	Front	Rear	Front	Rear
NKR55	7.00-15-8PR	6.00-13-8PR	417 (4.25, 60)	417 (4.25, 60)
	7.00-15-8PR	7.50-15-10PR	417 (4.25, 60)	515 (5.25, 75)
	7.50-15-10PR	7.50-15-10PR	515 (5.25, 75)	515 (5.25, 75)
	7.00-15-8PR	7.00-15-8PR	417 (4.25, 60)	417 (4.25, 60)
	7.00R16-10PR	7.00R16-10PR	515 (5.25, 75)	515 (5.25, 75)
	7.00-15-10PR	7.50-15-12PR	490 (5.00, 71)	564 (5.75, 82)
	7.00-15-10PR	7.00-15-10PR	490 (5.00, 71)	490 (5.00, 71)
	7.00R15-10PR	7.00R15-10PR	515 (5.25, 75)	515 (5.25, 75)
	7.00-16-10PR	7.00-16-10PR	490 (5.00, 71)	490 (5.00, 71)
	7.00-16-8PR	7.00-16-8PR	417 (4.25, 60)	417 (4.25, 60)
NKR66	7.00-15-8PR	7.50-15-10PR	417 (4.25, 60)	515 (5.25, 75)
	7.00-15-8PR	7.00-15-8PR	417 (4.25, 60)	417 (4.25, 60)
	7.00-16-14PR	7.00-16-14PR	711 (7.25, 103)	711 (7.25, 103)
	7.00R16-10PR	7.00R16-10PR	515 (5.25, 75)	515 (5.25, 75)
	7.50-15-10PR	7.50-15-10PR	515 (5.25, 75)	515 (5.25, 75)
	7.00-15-10PR	7.50-15-12PR	490 (5.00, 71)	564 (5.75, 82)
	7.00R15-10PR	7.00R15-10PR	515 (5.25, 75)	515 (5.25, 75)
	7.00-16-10PR	7.00-16-10PR	490 (5.00, 71)	490 (5.00, 71)
	7.00-16-8PR	7.00-16-8PR	417 (4.25, 60)	417 (4.25, 60)
	195/85R16	195/85R16	588 (6.00, 85)	588 (6.00, 85)
	7.00-15-10PR	7.00-15-10PR	490 (5.00, 71)	490 (5.00, 71)
	205/85R16	205/85R16	588 (6.00, 85)	588 (6.00, 85)
NKR66 (For GCC)	195/85R16	195/85R16	588 (6.00, 85)	588 (6.00, 85)
	205/85R16	205/85R16	588 (6.00, 85)	588 (6.00, 85)
	7.00R16-10PR	7.00R16-10PR	515 (5.25, 75)	515 (5.25, 75)
	195/85R16	195/85R16	588 (6.00, 85)	588 (6.00, 85)
NKR69	7.00-15-8PR	7.50-15-10PR	417 (4.25, 60)	515 (5.25, 75)
	7.00-15-8PR	7.00-15-8PR	417 (4.25, 60)	417 (4.25, 60)
	7.00-15-10PR	7.50-15-12PR	490 (5.00, 71)	564 (5.75, 82)
	7.00-15-10PR	7.00-15-10PR	490 (5.00, 71)	490 (5.00, 71)
	7.00-16-8PR	7.00-16-8PR	417 (4.25, 60)	417 (4.25, 60)
	7.00-16-10PR	7.00-16-10PR	490 (5.00, 71)	490 (5.00, 71)
	7.00R16-10PR	7.00R16-10PR	515 (5.25, 75)	515 (5.25, 75)
	7.50-15-10PR	7.50-15-10PR	515 (5.25, 75)	515 (5.25, 75)
NKR71	7.00-16-14PR	7.00-16-14PR	711 (7.25, 103)	711 (7.25, 103)

	Tire size		Tire inflation pressure kPa (kg/cm^2, psi)	
Vehicle model	Front	Rear	Front	Rear
NKR77	195/85R16	175R14-8PR	588 (6.00, 85)	441 (4.50, 64)
	7.00-15-8PR	7.00-15-8PR	417 (4.25, 60)	417 (4.25, 60)
	195/75R16C	195/75R16C	475 (4.75, 68)	475 (4.75, 68)
	195/85R16	195/85R16	588 (6.00, 85)	588 (6.00, 85)
	205R16C-8PR	205R16C-8PR	450 (4.50, 64)	450 (4.50, 64)
	7.00R16-10PR	7.00R16-10PR	515 (5.25, 75)	515 (5.25, 75)
	7.00-15-10PR	7.00-15-10PR	490 (5.00, 71)	490 (5.00, 71)
	7.00-16-8PR	7.00-16-8PR	417 (4.25, 60)	417 (4.25, 60)
	7.00-16-10PR	7.00-16-10PR	490 (5.00, 71)	490 (5.00, 71)
NPR66	7.00-16-10PR	7.00-16-10PR	490 (5.00, 71)	490 (5.00, 71)
	7.50-16-10PR	7.50-16-10PR	515 (5.25, 75)	515 (5.25, 75)
	7.50-16-12PR	7.50-16-12PR	588 (6.00, 85)	588 (6.00, 85)
	7.00-16-12PR	7.00-16-12PR	564 (5.75, 82)	564 (5.75, 82)
	7.00R16-10PR	7.00R16-10PR	515 (5.25, 75)	515 (5.25, 75)
	7.50-16-8PR	7.50-16-8PR	417 (4.25, 60)	417 (4.25, 60)
	7.50-16-14PR	7.50-16-14PR	637 (6.50, 92)	637 (6.50, 92)
	7.50R16-10PR	7.50R16-10PR	564 (5.75, 82)	564 (5.75, 82)
	7.50R16-12PR	7.50R16-12PR	637 (6.50, 92)	637 (6.50, 92)
NPR66 (For GCC)	205/85R16	205/85R16	588 (6.00, 85)	588 (6.00, 85)
	225/85R16	225/85R16	588 (6.00, 85)	588 (6.00, 85)
	7.50R16-12PR	7.50R16-12PR	637 (6.50, 92)	637 (6.50, 92)
	7.50-16-12PR	7.50-16-12PR	588 (6.00, 85)	588 (6.00, 85)
	7.50R16-10PR	7.50R16-10PR	564 (5.75, 82)	564 (5.75, 82)
	215/75R17.5	215/75R17.5	600 (6.00, 85)	600 (6.00, 85)
	215/85R16	215/85R16	588 (6.00, 85)	588 (6.00, 85)
NPR70	7.00-16-10PR	7.00-16-10PR	490 (5.00, 71)	490 (5.00, 71)
	7.50-16-10PR	7.50-16-10PR	515 (5.25, 75)	515 (5.25, 75)
	215/75R17.5	215/75R17.5	600 (6.00, 85)	600 (6.00, 85)
	215/85R16	215/85R16	588 (6.00, 85)	588 (6.00, 85)
	7.00-16-12PR	7.00-16-12PR	564 (5.75, 82)	564 (5.75, 82)
	7.00R16-10PR	7.00R16-10PR	515 (5.25, 75)	515 (5.25, 75)
	7.50-16-8PR	7.50-16-8PR	417 (4.25, 60)	417 (4.25, 60)
	7.50-16-12PR	7.50-16-12PR	588 (6.00, 85)	588 (6.00, 85)
	7.50-16-14PR	7.50-16-14PR	637 (6.50, 92)	637 (6.50, 92)
	7.50R16-10PR	7.50R16-10PR	564 (5.75, 82)	564 (5.75, 82)
	7.50R16-12PR	7.50R16-12PR	637 (6.50, 92)	637 (6.50, 92)

	Tire size		Tire inflation pressure kPa (kg/cm^2, psi)	
Vehicle model	Front	Rear	Front	Rear
NPR75	195/85R16	195/85R16	588 (6.00, 85)	588 (6.00, 85)
	205/75R17.5	205/75R17.5	750 (7.65, 108.7)	750 (7.65, 108.7)
	215/75R17.5	215/75R17.5	600 (6.00, 85)	600 (6.00, 85)
	215/75R16C	215/75R16C	525 (5.36, 76)	525 (5.36, 76)
NPR77	195/75R16C	195/75R16C	475 (4.75, 68)	475 (4.75, 68)
NPS71	7.50R16-12PR	7.50R16-12PR	637 (6.50, 92)	637 (6.50, 92)
NPS75	8.5R17.5	8.5R17.5	625 (6.4, 90.6)	625 (6.4, 90.6)
NQR66	7.50-16-14PR	7.50-16-14PR	637 (6.50, 92)	637 (6.50, 92)
	8.25-16-14PR	8.25-16-14PR	564 (5.75, 82)	564 (5.75, 82)
	8.25-16-12PR	8.25-16-12PR	490 (5.00, 71)	490 (5.00, 71)
NQR70	7.50-16-14PR	7.50-16-14PR	637 (6.50, 92)	637 (6.50, 92)
	215/75R17.5	215/75R17.5	600 (6.00, 85)	600 (6.00, 85)
	7.50-16-10PR	7.50-16-10PR	515 (5.25, 75)	515 (5.25, 75)
	7.50R16-10PR	7.50R16-10PR	564 (5.75, 82)	564 (5.75, 82)
	7.50R16-12PR	7.50R16-12PR	637 (6.50, 92)	637 (6.50, 92)
NQR71	7.50-16-14PR	7.50-16-14PR	637 (6.50, 92)	637 (6.50, 92)
	8.25-16-14PR	8.25-16-14PR	564 (5.75, 82)	564 (5.75, 82)
NQR71	8.25-16-12PR	8.25-16-12PR	490 (5.00, 71)	490 (5.00, 71)
NQR71 (For GCC)	215/75R17.5	215/75R17.5	600 (6.00, 85)	600 (6.00, 85)
NQR75	7.50-16-14PR	7.50-16-14PR	637 (6.50, 92)	637 (6.50, 92)
	215/75R17.5	215/75R17.5	600 (6.00, 85)	600 (6.00, 85)
	225/70R19.5	225/70R19.5	850 (8.50, 122)	850 (8.50, 122)
	7.50-16-10PR	7.50-16-10PR	515 (5.25, 75)	515 (5.25, 75)
	7.50-16-12PR	7.50-16-12PR	588 (6.00, 85)	588 (6.00, 85)
	7.50R16-10PR	7.50R16-10PR	564 (5.75, 82)	564 (5.75, 82)
	7.50R16-12PR	7.50R16-12PR	637 (6.50, 92)	637 (6.50, 92)

Wheels

Replacement

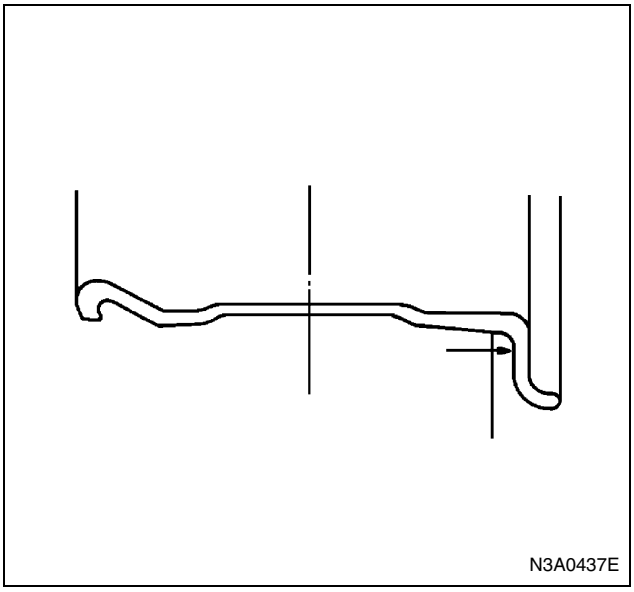
Damaged wheels and wheels with excessive run-out must be replaced.

Wheel Run-out at Rim

1.5 mm (0.059 in) or less

Caution:

Wheel repairs that use welding, heating or preening are not permitted. Replace wheel lug nuts if they are bent, dented, have excessive lateral or radial run-out, leak air through welds, have elongated bolt holes, will not stay tight, or if they are heavily rusted.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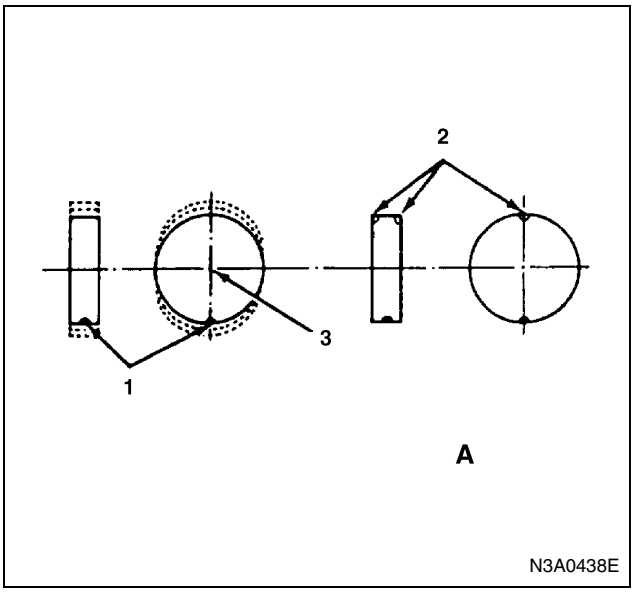
General Balance Procedure

Deposits of mud, etc. must be cleaned from the inside of the rim.
The tire should be inspected for the following: match mount paint marks, bent rims, bulges, irregular tire wear, proper wheel size and inflation pressure. Then balance according to the equipment manufacturer's recommendations.
There are two types of wheel and tire balance.
Static balance is the equal distribution of weight around the wheel.
Assemblies that are statically unbalanced cause a bouncing action called tramp. This condition will eventually cause uneven tire wear.

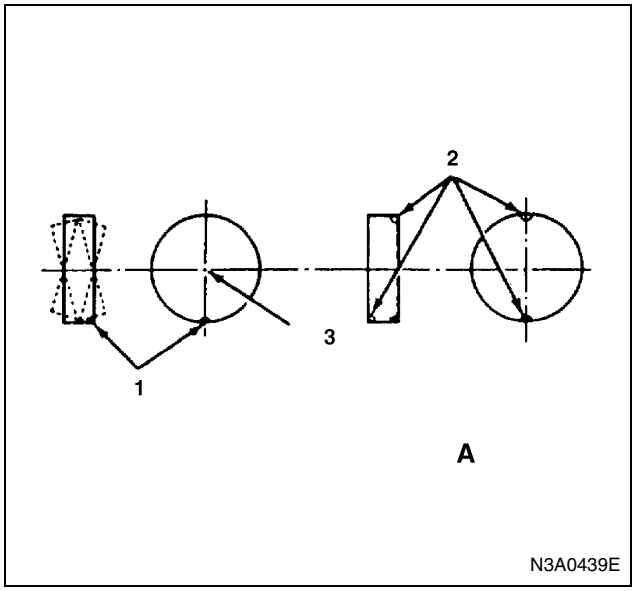


N3A0438E

Legend

A. Corrective weights
1. Heavy spot wheel tramp
2. Add balance weights here
3. Center line of spindle

Dynamic balance is the equal distribution of weight on each side of the wheel center-line, so when the tire spins, there is no tendency for the assembly to move from side to side. Assemblies that are dynamically unbalanced may cause shimmy.



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Legend

A. Corrective weights
1. Heavy spot wheel shimmy
2. Add balance weights here
3. Center line of spindle

WARNING:
STONES SHOULD BE REMOVED FROM THE TREAD TO AVOID OPERATOR INJURY DURING SPIN BALANCING AND TO OBTAIN A GOOD BALANCE.

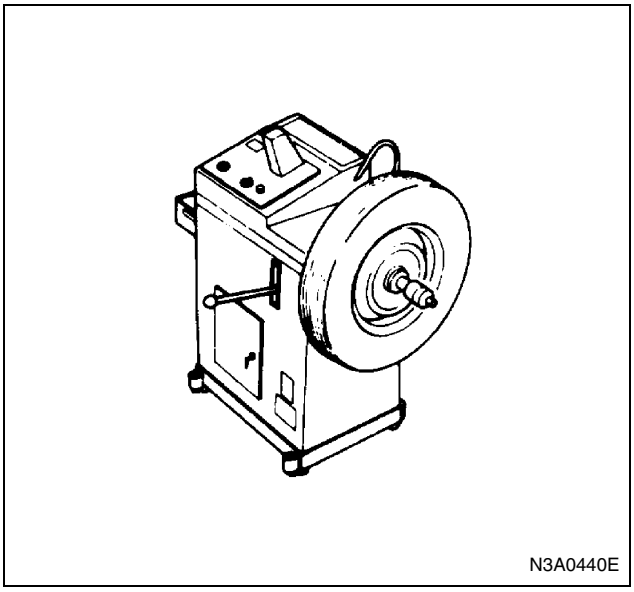
Balancing Wheel and Tire

On-Vehicle Balancing

On-Vehicle balancing methods vary with equipment and tool manufacturers. Be sure to follow each manufacturer's instructions during balancing operation.

Off-Vehicle Balancing

Most electronic off-vehicle balancers are more accurate than the on-vehicle spin balancers. They are easy to use and give a dynamic balance. Although they do not correct for drum or disc unbalance (as on vehicle spin balancing does), they are very accurate.



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LGSTG-WE-0552

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LGSTG-WE-0552 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

STEERING, SUSPENSION, WHEELS AND TIRES

SECTION 3

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

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3B2	MANUAL STEERING
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3B4	STEERING COLUMN
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PROPELLER SHAFT AND AXLE

SECTION 00
SERVICE INFORMATION

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TROUBLESHOOTING

Propeller Shaft

PROBLEM	POSSIBLE CAUSE	CORRECTION
Noises from Propeller Shaft	1. Worn spline yoke. 2. Worn or stuck spider bearing. 3. Worn center bearing.	1. Replace the spline yoke. 2. Replace the center bearing. 3. Replace the center bearing.
Vibration from Propeller Shaft	1. Incorrect shaft run-out. 2. Out of shaft balance. 3. Stuck spline yoke.	1. Replace the propeller shaft. 2. Adjust the shaft balance. 3. Replace the spline yoke.

Rear Axle and Front Driving Axle

PROBLEM	POSSIBLE CAUSE	CORRECTION
Oil Leak at Front Axle or Rear Axle	1. Worn or defective oil seal. 2. Axle housing cracked.	1. Replace the oil seal. 2. Repair or replace.
Oil Leak at Pinion Shaft	1. Too much gear oil. 2. Oil seal worn or defective. 3. Pinion flange loose or damaged.	1. Correct the oil level. 2. Replace the oil seal. 3. Tighten or replace.
Noises in Front Axle or Rear Axle	1. Insufficient gear oil. 2. Wrong or poor grade gear oil. 3. Drive pinion to ring gear backlash incorrect. 4. Worn or chipped ring gear, pinion gear or side gear. 5. Pinion shaft bearing worn. 6. Wheel bearing worn. 7. Differential bearing loose or worn.	1. Replenish the gear oil. 2. Replace the gear oil. 3. Adjust the backlash. 4. Replace the ring gear, pinion gear or side gear 5. Replace the pinion shaft bearing. 6. Replace the wheel bearing. 7. Tighten or replace.

MAIN DATA AND SPECIFICATIONS

Propeller Shaft

		NHR55, 69	NKR55	NKR66, 71, 77 NPR66, 70, 71, 77 NQR66, 71, NPS71	NQR70, 75 NPR75 NPS75
Bearing retention method		Inside snap ring		Outside snap ring	
Spider length	mm (in)	69 (2.72)		85 (3.35) 95 (3.74) <for Taiwan, Australia and GCC>	96 (3.780)
Spider outside dia.	mm (in)	18.46 (0.73)		21.94 (0.86)	23.02 (0.9065)
Tube-outside dia. diameter × thickness	mm (in)	68.9 × 2.0 (2.71 × 0.08)		82.6 × 2.3 (3.25 × 0.09)	90 × 3.2 (3.54 × 0.13)
Flange bolt size		M10		M12	M12
Flange bolt P.C.D.	mm (in)	85 (3.35)		100 (3.94)	110 (4.33)

Rear Axle

		Vehicle series			
		NHR55, 69		NKR55, 69 (For general export; Turkey, Chile)	
		Single	Dual Small	Single	Dual Small (For Turkey)
Rear axle type		Banjo semi-floating	Banjo full floating		
Gear type		Hypoid			
Number of differential pinion		4			
Ring gear pitch diameter	mm (in)	244 (9.6)			
Amount of hub grease (each wheel)	g (oz)	80 (2.8)	285 (10.1)	280 (9.9)	285 (10.1)
Oil capacity	lit (US/Imp qt)	2.7 (2.9/2.4)			

	Vehicle series							
	NPR66, 71 (Singapore, Turkey) 70 (Taiwan, Chile), 77	NPS71	NKR55, 69, 71	NKR66		NKR77		
	Dual			Single	Dual	Single	Dual	Dual Small
Rear axle type	Banjo full floating							
Gear type	Hypoid							
Number of differential pinion	4							
Ring gear pitch diameter mm (in)	292 (11.5)							
Amount of hub grease (each wheel) g (oz)	285 (10.1)							
Oil capacity lit (US/ Imp qt)	3.0 (3.2/2.6)							

	Vehicle series			
	NPS75	NPR70 (Hong Kong) 71 (Colombia), 75	NQR66, 70, 71, 75	NKR71
	Dual			
Rear axle type	Banjo full floating			
Gear type	Hypoid			
Number of differential pinion	4			
Ring gear pitch diameter mm (in)	320 (12.5)			
Amount of hub grease (each wheel) g (oz)	285 (10.1)			
Oil capacity lit (US/ Imp qt)	3.4 (3.6/3.0) (A) 3.4 (3.6/3.0) (B) 4.3 (4.5/3.8) (C) 5.2 (5.5/4.6)			

(A): for 2003 year model except straight frame
(B): for 2003 year model and straight frame, except Colombia
(C): for 2003 year model, straight frame and Colombia

Front Axle

Specifications		NPS
Front axle type		Banjo full floating
Tread		1,665 (65.55)
Gear type		Hypoid
Number of differential pinion		4
Ring gear pitch diameter	mm (in)	244 (9.6)
Amount of hub grease (each wheel)	g (oz)	200 (7.1)
Oil capacity	lit (US/Imp qt)	2.7 (2.9/2.4)

SERVICE STANDARD

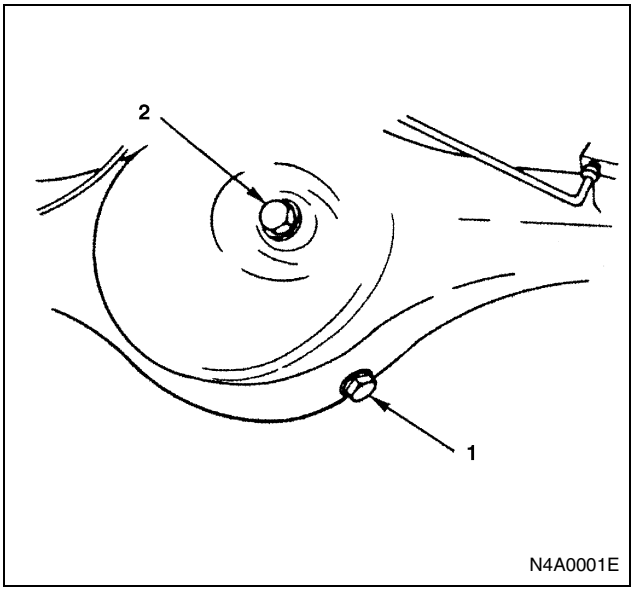
Items		Service Standard			Limit		
PROPELLER SHAFT		NHR55, 69 NKR55	NKR66, 71, 77, NPR70, 71 77, NQR66, 71, NPS71	NQR70, 75 NPR75 NPS75	NHR55, 69 NKR55	NKR66, 71, 77, NPR 70, 71 77, NQR66, 71, NPS71	NQR70, 75 NPR75 NPS75
Outside Diameter of Spider Pin	mm (in)	18.46 (0.73)	21.94 (0.86)	24.00 (1.001)	18.36 (0.72)	21.84 (0.8598)	23.90 (0.941)
Propeller Shaft Run-Out	mm (in)	0.5 (0.02) or less		0.3 (0.12) or less	1.0 (0.039)		0.5(0.02)
Play between the Sleeve Yoke and the Propeller Shaft Spline	mm (in)	0.1 (0.0039)			0.3 (0.012)		
Play in the Universal Joint	mm (in)	0.1 (0.0039)			—		
REAR AXLE SHAFT							
Axle Shaft Run-Out	mm (in)	—			1.0 (0.039)		
Axle Shaft Flange Run-Out	mm (in)	—			0.05 (0.0097) <except 2003 year model> 0.15 (0.006)		
REAR DIFFERENTIAL		244 mm	292 mm	320 mm	244 mm	292 mm	320 mm
Pinion Bearing Preload							
New Bearing	N (kg/lb)	16-29 (1.6-3.0/ 3.5-6.6)	13-25 (1.3-2.6/ 2.9-5.7)	26-38 (2.7-3.9/ 6.0-8.6)	—		
Used Bearing	N (kg/lb)	8-14.5 (0.8-1.5/ 1.8-3.3)	6.5-12.5 (0.65-1.3/ 1.5-2.9)	13-19 (1.35-1.95/3.0-4.3)	—		
Pinion Bearing Starting Torque							
New Bearing	N·m (kg·cm/ lb·in)	0.69-1.27 (7-13/6.1-11.3)	0.98-1.96 (10-20/ 8.7-17.4)	2.3-3.2 (23-33/ 20-28.6)	—		
Used Bearing	N·m (kg·cm/ lb·in)	0.35-0.64 (3.5-6.5/ 3.1-5.7)	0.49-0.98 (5-10/4.3-8.7)	1.2-1.6 (12-16/ 10.4-13.9)	—		
Ring Gear Backlash	mm (in)	0.15-0.20 (0.006-0.008)	0.18-0.23 (0.007-0.009)	0.19-0.29 (0.007-0.011)	—		
Ring Gear Run-Out	mm (in)	0.07 (0.003)	0.07 (0.003)	0.08 (0.003)	0.2 (0.008)	0.2 (0.008)	0.25 (0.01)
Clearance between the Differential Pinion and the Spider	mm (in)	0.07-0.13 (0.003-0.005)	0.07-0.13 (0.003-0.005)	0.05-0.13 (0.002-0.005)	0.2 (0.008)	0.2 (0.008)	0.2 (0.008)

Items		Service Standard			Limit		
Clearance between the Side Gear and the Differential Cage	mm (in)	0.05-0.11 (0.002-0.004)	0.05-0.11 (0.002-0.004)	0.13-0.2 (0.005-0.008)	0.25 (0.01)	0.25 (0.01)	0.25 (0.01)
Play in Splines between the Side Gear and the Axle Shaft	mm (in)	0.02-0.12 (0.0008-0.005)	0.08-0.15 (0.003-0.006)	0.2 (0.008)	0.25 (0.01)	0.3 (0.012)	0.5 (0.02)
Clearance between the back face of the Side Gear and the Differential Cage	mm (in)	0.13-0.18 (0.005-0.007)	0.21-0.28 (0.008-0.011)	0.10-0.38 (0.004-0.015)	—		
REAR HUB							
Rear Hub Bearing Preload (At Wheel Pin)	N (kg/lb)	42-52 (4.3-5.3/9.5-11.7)		38-48.0 (3.9-4.9/8.6-10.8)	—		
FRONT DIFFERENTIAL							
Pinion Bearing Preload							
New Bearing	N (kg/lb)	16-29 (1.6-3.0/3.5-6.6)			—		
Used Bearing	N (kg/lb)	8-14.5 (0.8-1.5/1.8-3.3)			—		
Pinion Bearing Starting Torque							
New Bearing	N·m (kg·cm/lb·in)	0.69-1.27 (7.0-13.0/6.1-11.3)			—		
Used Bearing	N·m (kg·cm/lb·in)	0.35-0.64 (3.5-6.5/3.1-5.7)			—		
Ring Gear Backlash	mm (in)	0.15-0.20 (0.006-0.008)			—		
Ring Gear Run-Out	mm (in)	0.07 (0.003)			0.2 (0.008)		
Clearance between the Differential Pinion and the Spider	mm (in)	0.07-0.13 (0.003-0.005)			0.2 (0.008)		
Clearance between the Side Gear and the Differential Cage	mm (in)	0.04-0.1 (0.002-0.004)			0.25 (0.01)		
Play in Splines between the Side Gear and the Axle Shaft	mm (in)	0.02-0.12 (0.0008-0.005)			0.25 (0.01)		
Clearance between the Back Face of the Side Gear and the Differential Cage	mm (in)	0.13-0.18 (0.005-0.007)			—		
FRONT HUB							
Front Hub Bearing Preload (At wheel pin)							
New Bearing and New Oil Seal	N (kg/lb)	NHR, NPR, NQR: 9.8-34.3 (1.0-3.5/2.2-7.7) NKR: 11.8-36.3 (1.2-3.7/2.6-8.0)			—		
Reused Bearing and New Oil Seal	N (kg/lb)	14-28 (1.4-2.9/3.1-6.4)			—		
FREE WHEEL HUB							
Clearance between the Free Wheeling Hub Body and the Snap Ring	mm (in)	0-0.5 (0-0.02)			—		

SERVICING

Change The Rear Differential Gear Oil

1. Remove the drain plug (1) and filler plug (2) and, drain the gear oil.



2. Tighten the drain plug to specified torque.

Tighten:
Drain plug to 78 N·m (8.0 kg·m / 57 lb·ft)

3. Fill the rear axle case with hypoid gear lubricant, to just below the filler hole.

Rear Axle Case Oil Capacity	L (US/Imp qt)
244 mm Diff.	2.7 (2.9/2.4)
292 mm Diff.	3.0 (3.2/2.6)
320 mm Diff.	(A) 3.4 (3.6/3.0) / (B) 4.3 (4.5/3.8) / (C) 5.2 (5.5/4.6)

A: Except Straight Frame model
B: For Straight Frame model
C: For Straight Frame model, Colombia

Notice:
Limited Slip Differential (LSD)-Friction Type Model:

Use GL-5 LSD gear lubricant together with LSD Lubricant Additive (ISUZU part No. 8-01052-358-0, GM part No. #1052358) or equivalent.

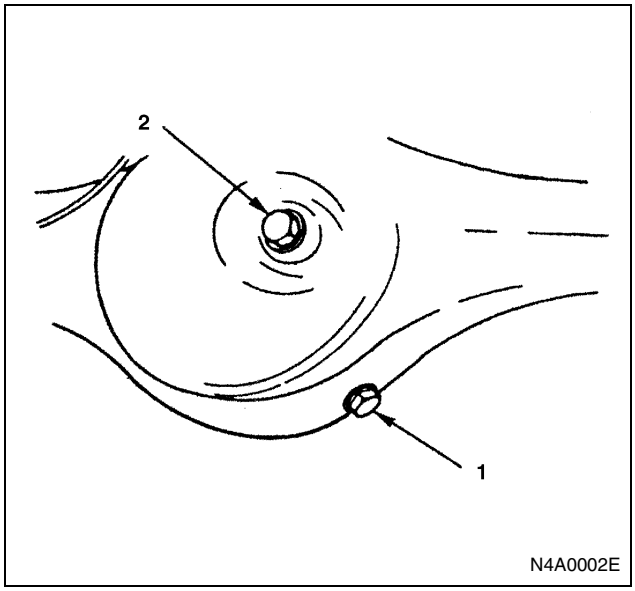
Quantity
LSD Lubricant additive, 4 oz (112 g)

4. Tighten the filler plug to specified torque.

Tighten:
Filler plug to 78 N·m (8.0 kg·m / 57 lb·ft)

Change The Front Differential Gear Oil

1. Remove the drain plug (1) and filler plug (2), and drain the gear oil.



2. Tighten the drain plug to specified torque.

Tighten:
Drain plug to 83 N·m (8.5 kg·m / 61 lb·ft)

3. Fill the front axle case with hypoid gear lubricant, to just below the filler hole.

Front axle case oil capacity, 2.7 Liters (2.9 US / 2.4 Imp·qt)

4. Tighten the filler plug to specified torque.

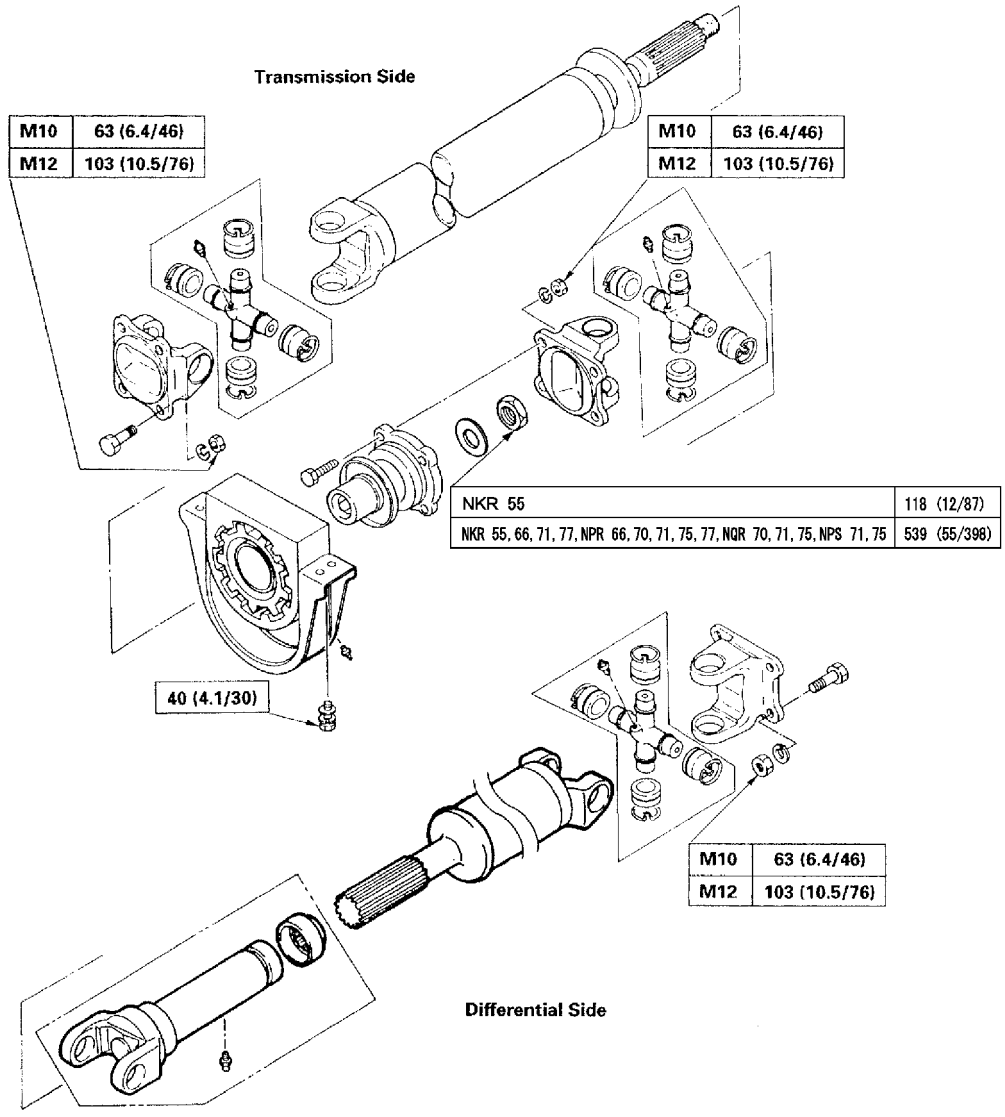
Tighten:
Filler plug to 83 N·m (8.5 kg·m / 61 lb·ft)

FIXING TORQUE

Propeller Shaft

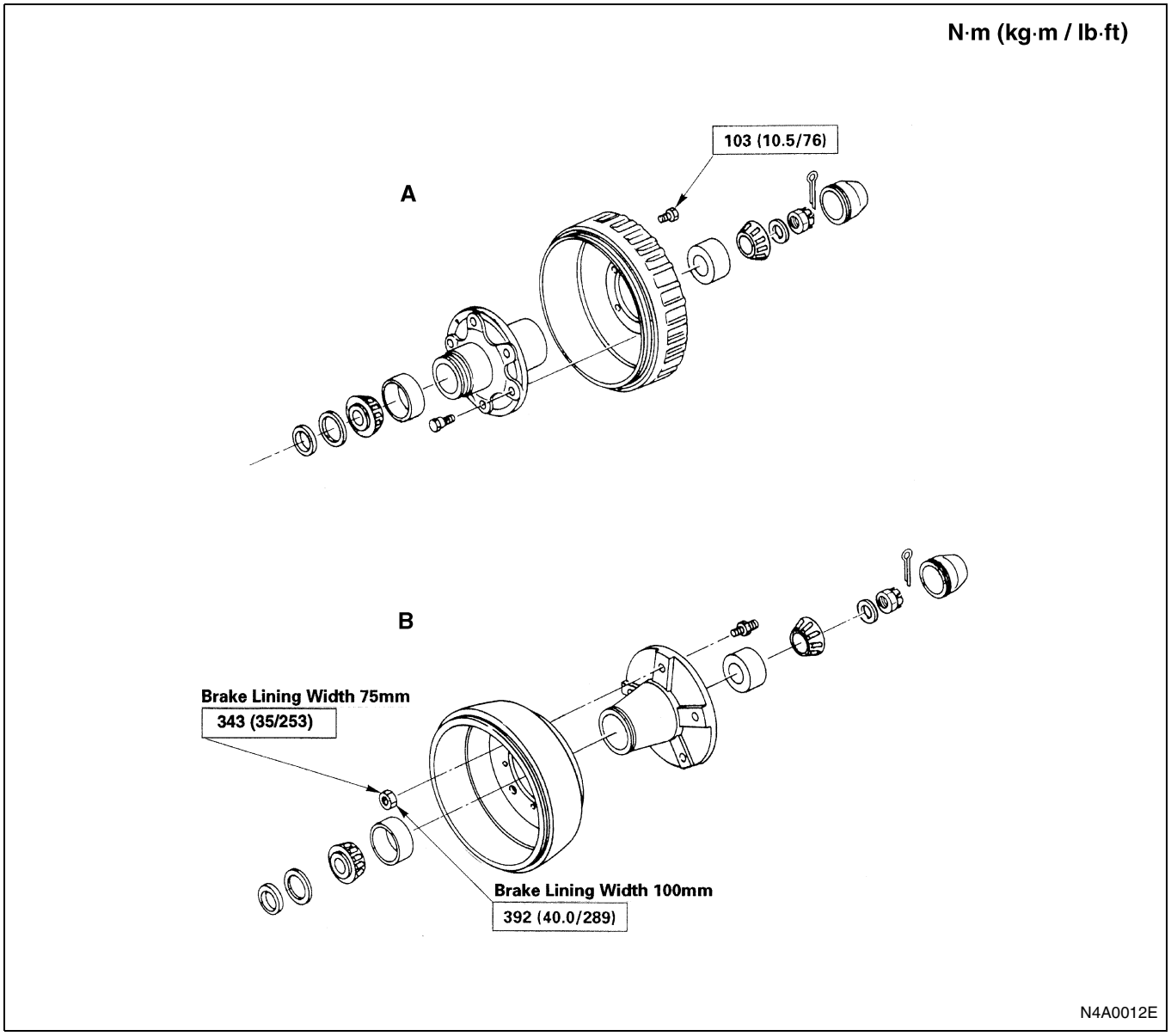
Rear propeller shaft

N·m (kg·m / lb·ft)



N4A0420E

Front Hub and Brake Drum (4 × 2 Model)



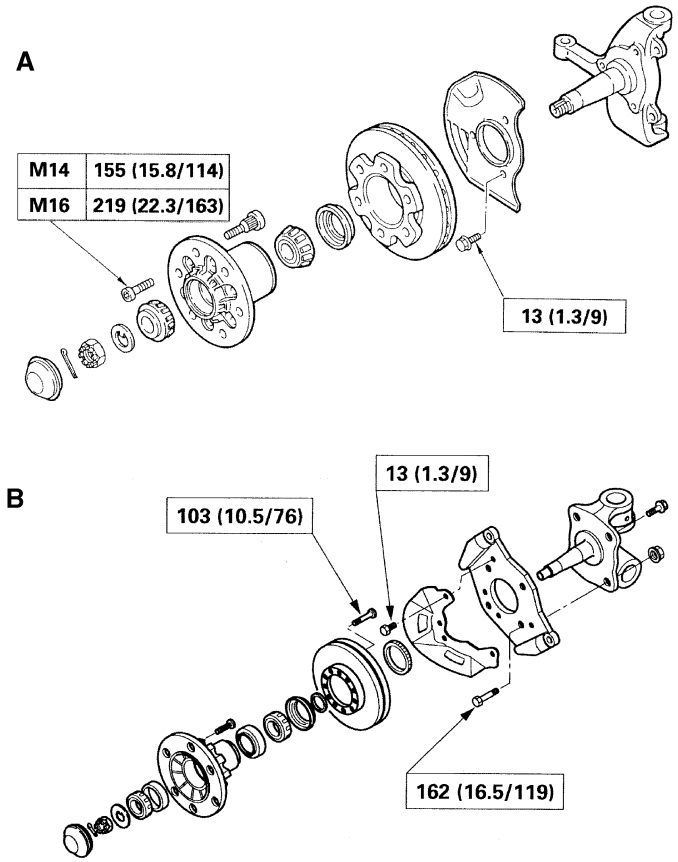
Legend

A. NHR, NKR models (rear single and dual small tire)

B. NPR, NQR models (rear dual tire)

Front Hub and Disc (4 × 2 Model)

N·m (kg·m / lb·ft)

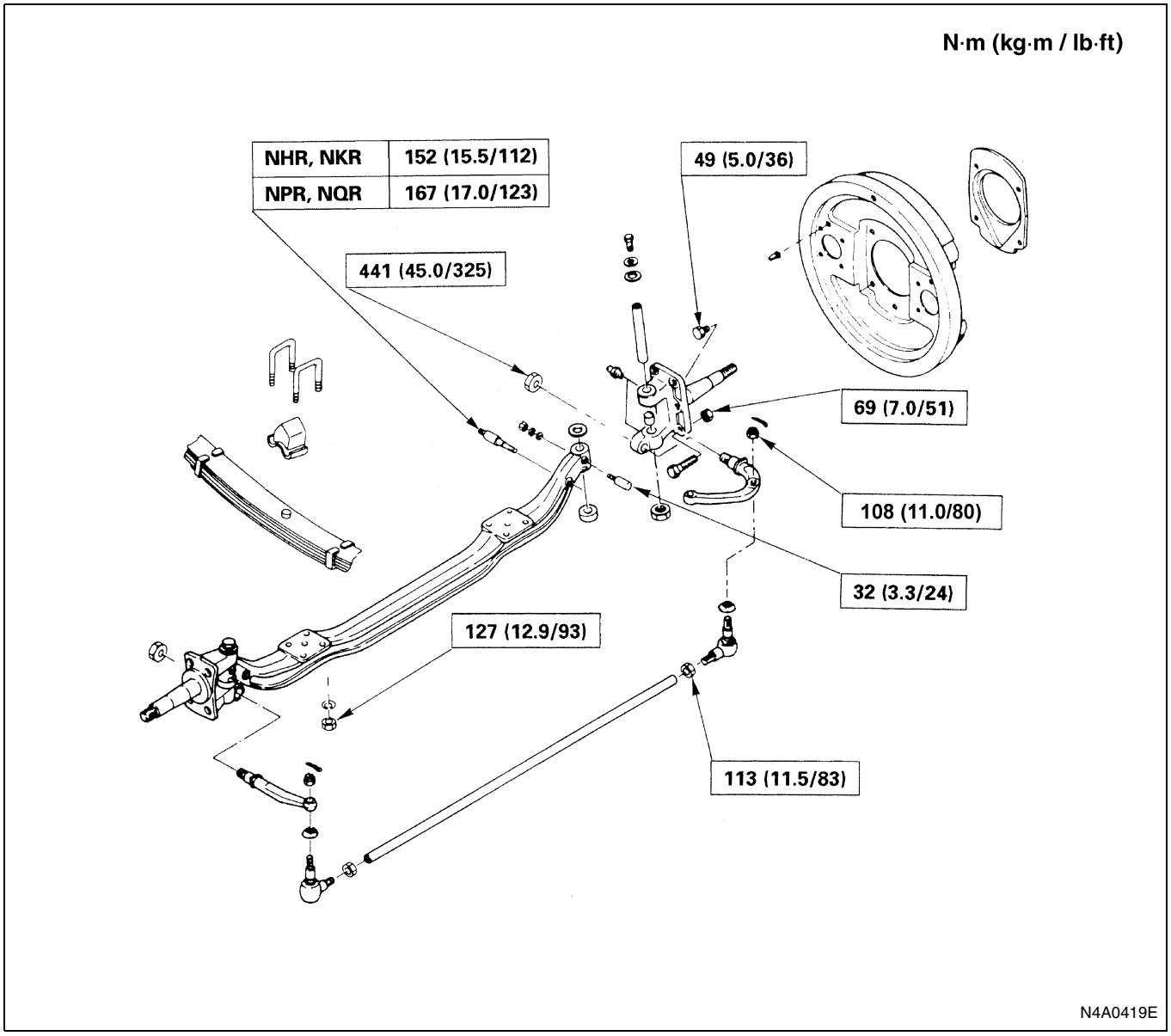


N4A0013E

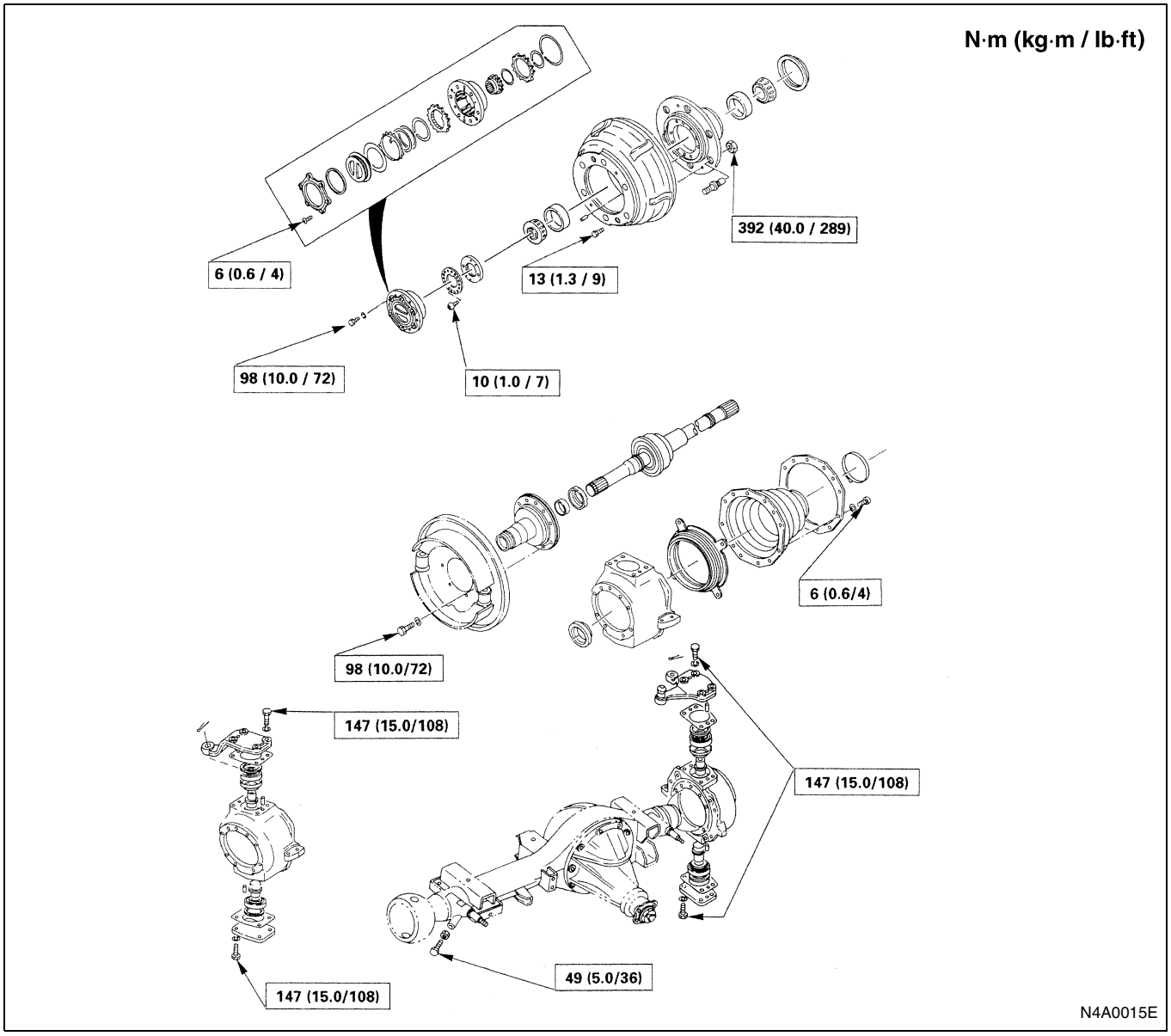
Legend

A. Independent suspension model
B. Rigid axle model (293 & 310 mm disc)

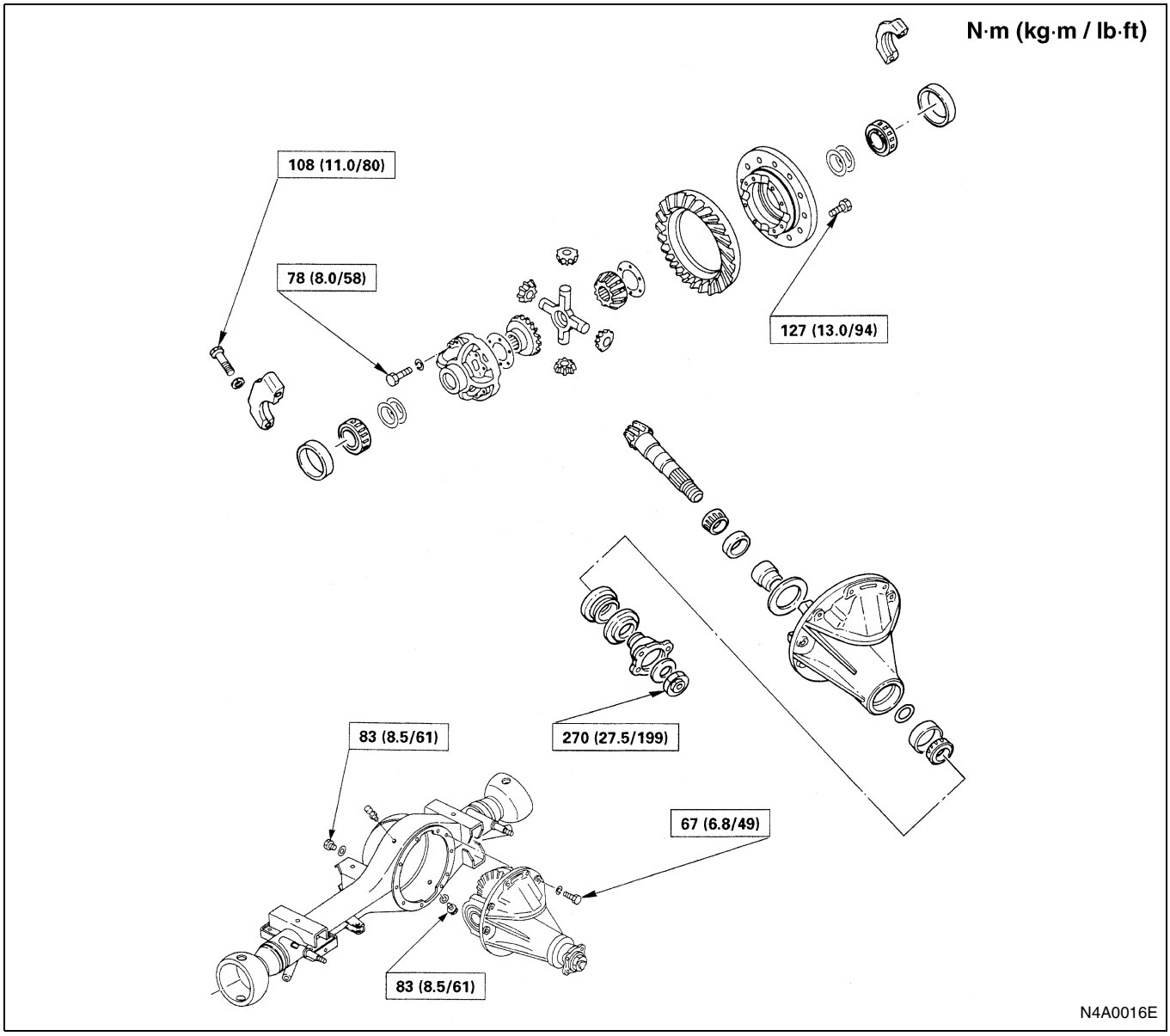
Front Axle, Knuckle and King Pin (4 × 2 Model)



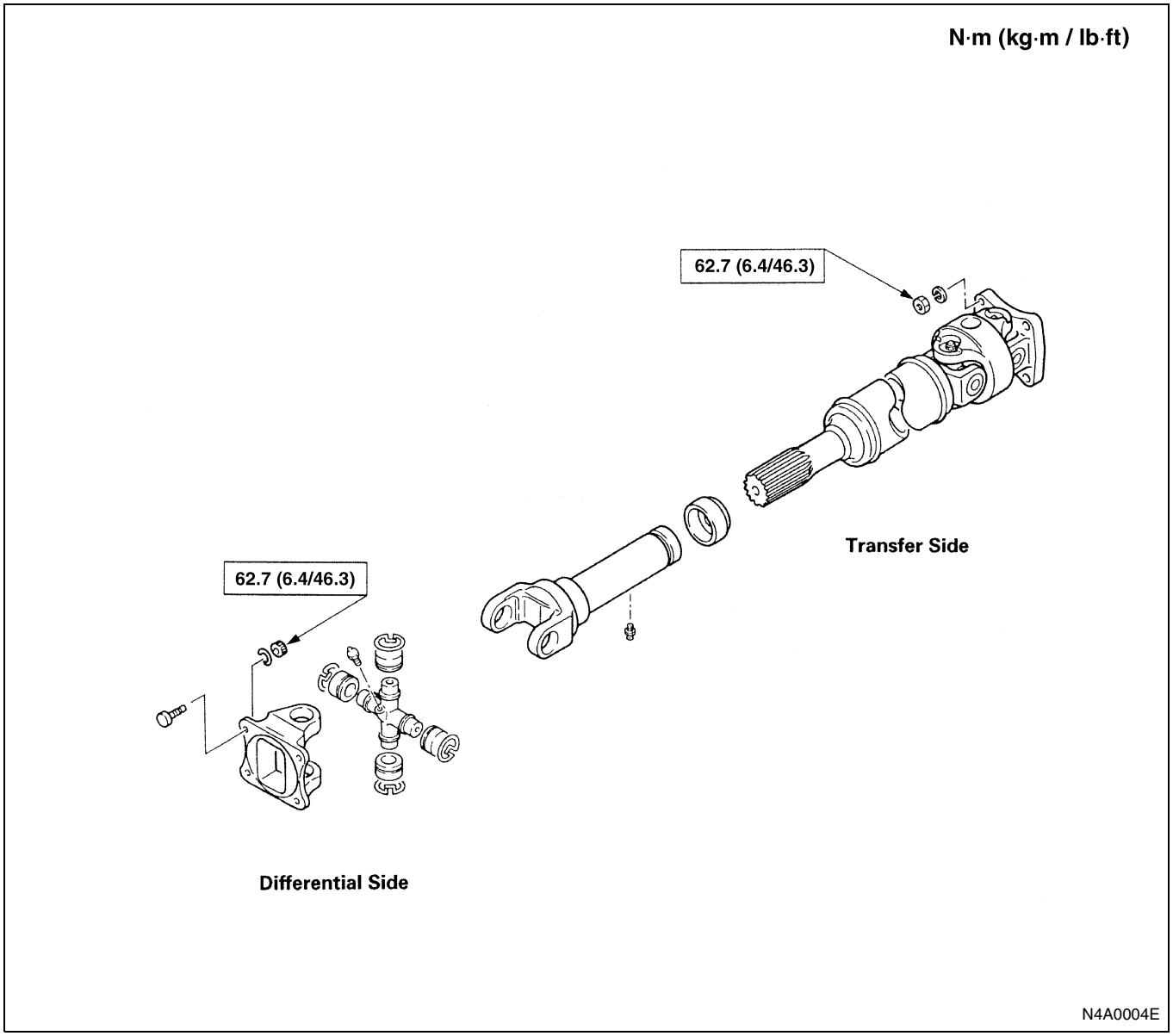
Front Hub, Brake Drum Spindle, Drive Shaft, Knuckle and King Pin (4 × 4 Model)



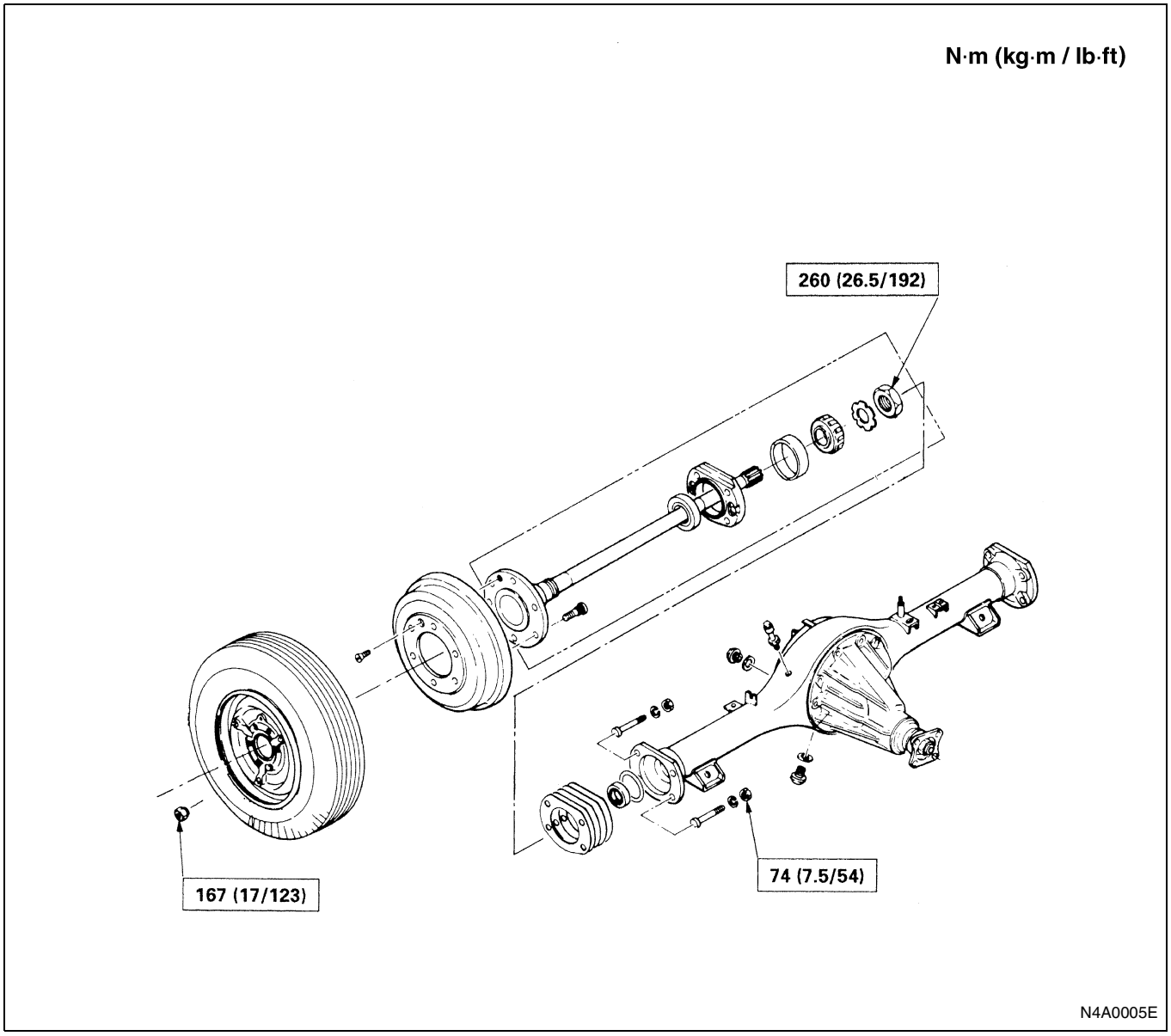
Front Differential Assembly



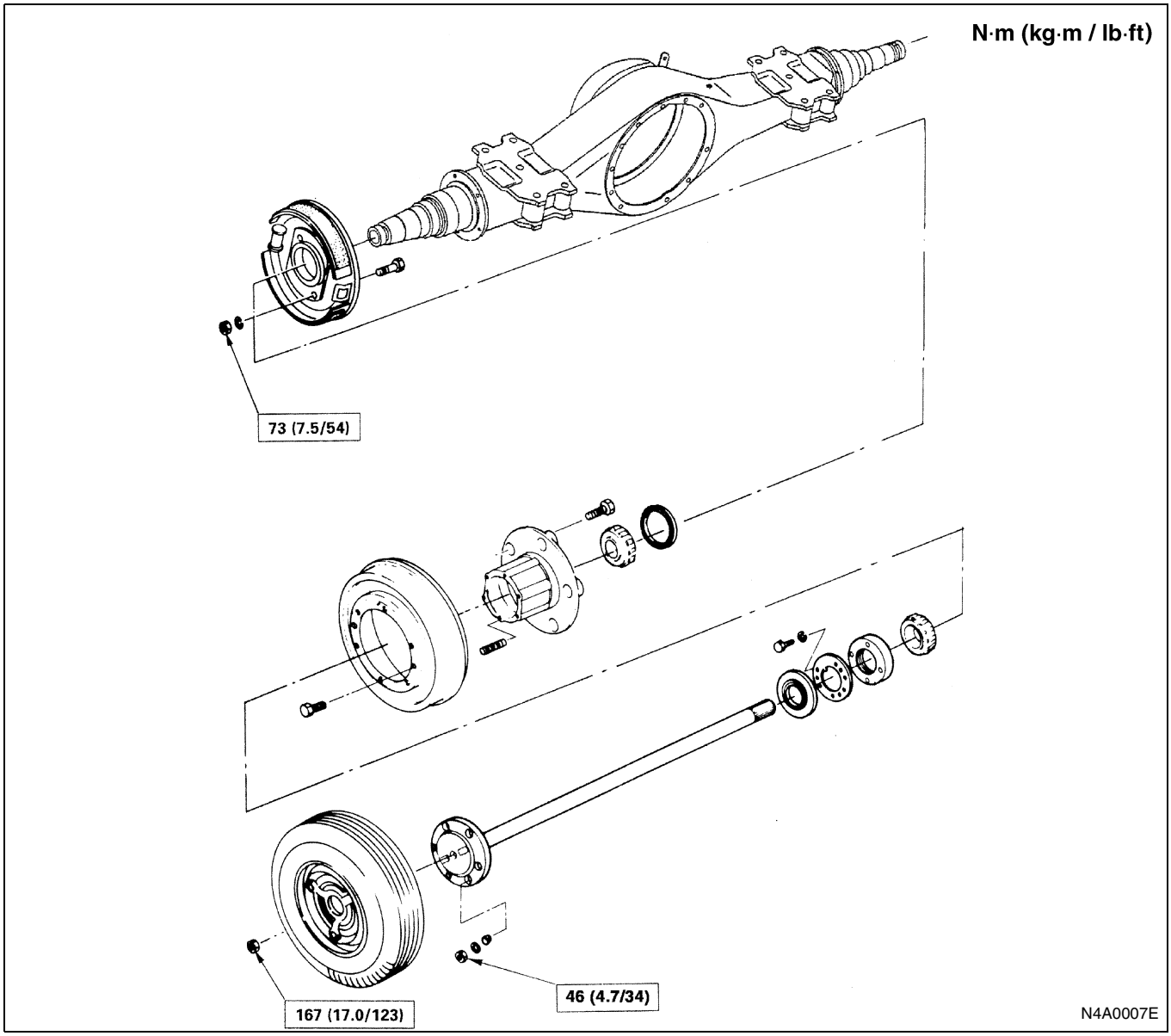
Front propeller shaft



Rear Hub, Brake Drum and Axle Shaft (NHR Single Tire Model)

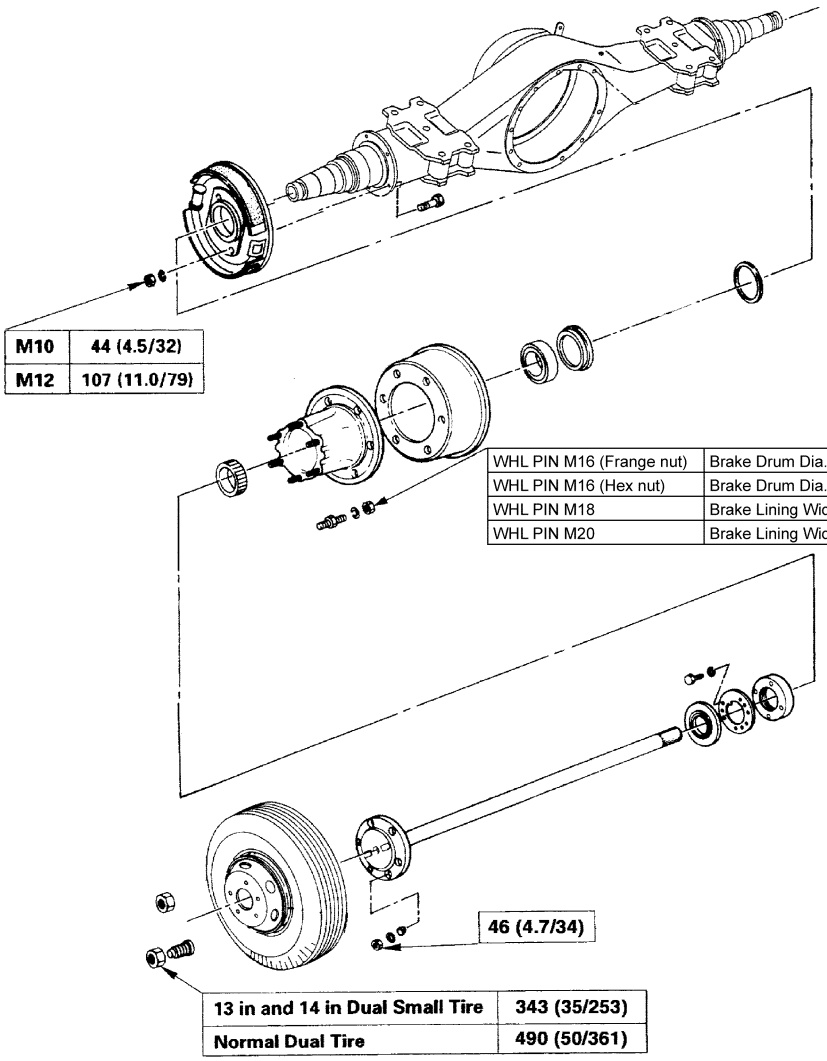


Rear Hub, Brake Drum and Axle Shaft (NKR Single Tire Model; Full Floating)



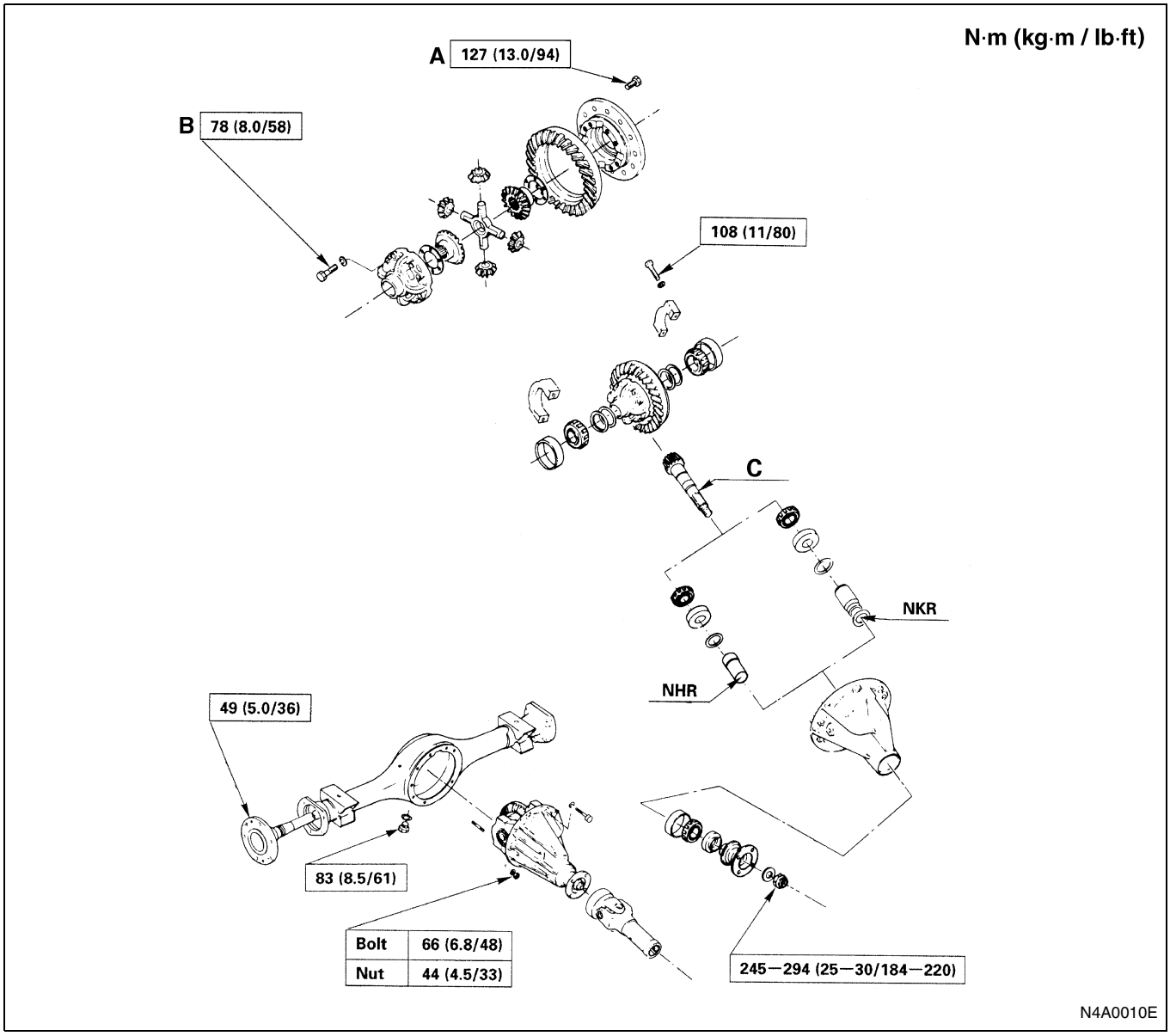
Rear Hub, Brake Drum and Axle Shaft (NHR Dual Small Tire, NKR Dual Tire, NPR, NQR, NPS Models; Full Floating)

N·m (kg·m / lb·ft)



N4A0417E

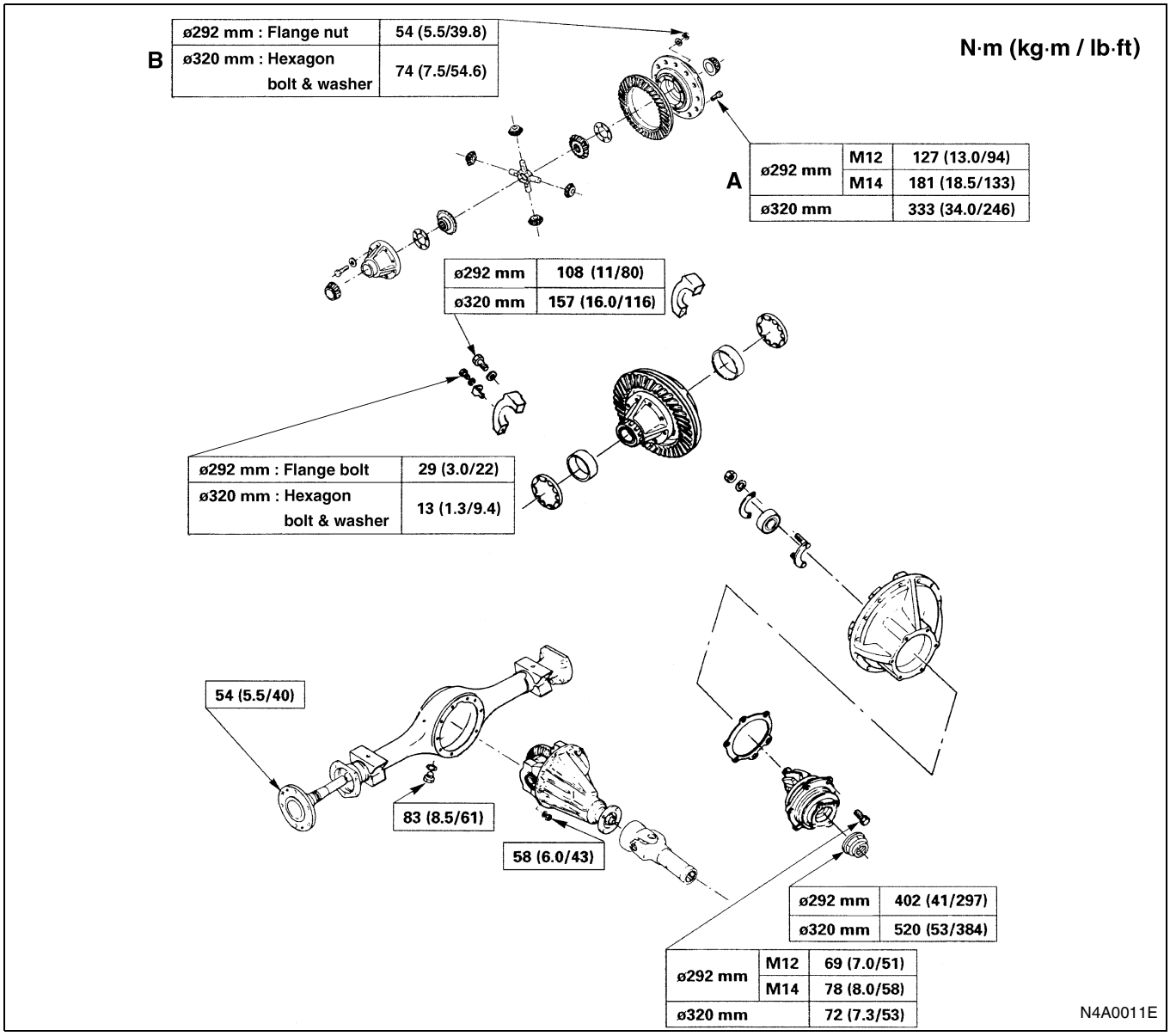
Rear Differential Assembly (244 mm)



Legend

A. Apply stud lock
B. Apply gear oil to bolt thread
C. Apply oil

Rear Differential Assembly (292/320 mm)



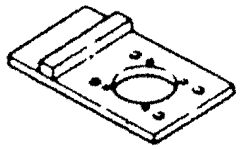
Legend

A. Apply stud lock

B. Apply gear oil to bolt thread

SPECIAL TOOLS

Propeller Shaft

Illustration	Tool Number / Description / Remarks
 9852921010	9-8529-2101-0 / Drive pinion flange bracket

Rear Axle

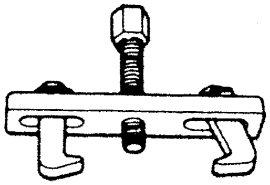
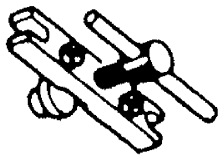
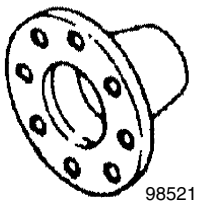
Illustration	Tool Number / Description / Remarks
 5884020270	5-8840-2027-0 / Universal puller
 9852101160	9-8521-0116-0 / Rear hub remover
 9852125010	9-8521-2501-0 / Rear hub remover
9852117720	9-8521-1772-0 / Axle shaft bearing outer race remover

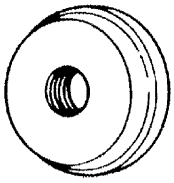
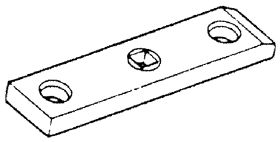
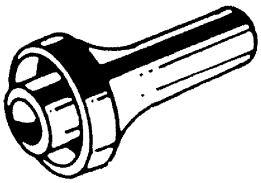
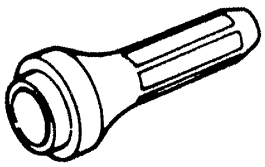
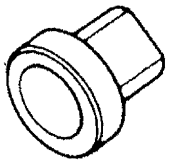
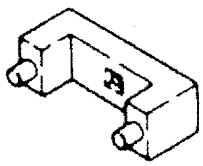
Illustration	Tool Number / Description / Remarks
 9852212680	9-8522-1268-0 (J-24259) / Axle shaft bearing outer race installer
 5884020030	5-8840-2003-0 (J-24246) / Bearing holder nut wrench
 9852212690	9-8522-1269-0 (J-24255) / Bearing holder oil seal installer
 9852212720	9-8522-1272-0 (J-24254) / Axle case oil seal installer
 9852212710	9-8522-1271-0 (J-8609-01) / Axle shaft bearing installer
 9852211880	9-8522-1188-0 / Rear hub bearing nut wrench {For 70mm (2.8 in.)}

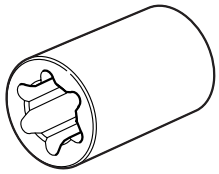
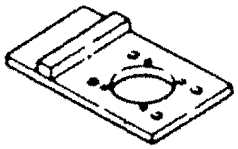
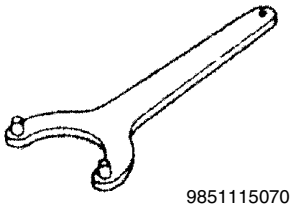
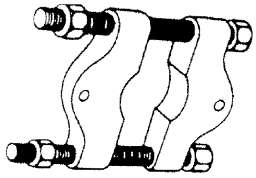
Illustration	Tool Number / Description / Remarks
 5884028300	5-8840-2830-0 / Ring gear bolt wrench
 9852921010	9-8529-2101-0 / Drive pinion flange yoke bracket
 9851115070	9-8511-1507-0 (J-29042) / Drive pinion flange holding wrench
 5884000150	5-8840-0015-0 (J-22912-01) / Drive pinion inner bearing remover
9852211960	9-8522-1196-0 / Drive pinion inner bearing outer race installer
5884020460	5-8840-2046-0 / Drive pinion inner bearing outer race installer (For 292mm)
9852211970	9-8522-1197-0 / Drive pinion outer bearing outer race installer

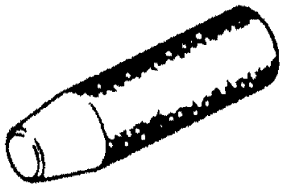
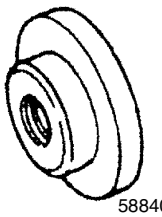
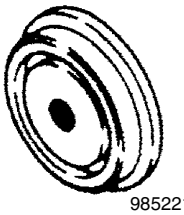
Illustration	Tool Number / Description / Remarks
9852216130	9-8522-1613-0 / Drive pinion outer bearing outer race installer (For 292mm)
9852200180	9-8522-0018-0 / Drive pinion inner bearing inner race installer
 9852216150	9-8522-1615-0 / Drive pinion inner bearing inner race installer
 5884020470	5-8840-2047-0 / Drive pinion oil seal installer
 9852216070	9-8522-1607-0 / Drive pinion oil seal installer
9852100610	9-8521-0061-0 / Differential side bearing remover
5884020310	5-8840-2031-0 / Differential side bearing remover adaptor

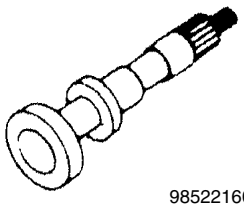
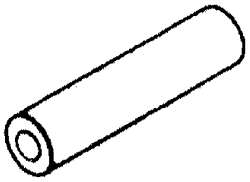
Illustration	Tool Number / Description / Remarks
9852127010	9-8521-2701-0 / Differential side bearing remover adaptor
5884020500	5-8840-2050-0 / Differential side bearing installer
9852216140	9-8522-1614-0 / Differential side bearing installer
 9852216030	9-8522-1603-0 / Dummy pinion shaft
9852216240	9-8522-1624-0 / Dummy nut
 9852211380	9-8522-1138-0 / Dummy shaft
9852211370	9-8522-1137-0 / Dummy bearing (2 pcs required)

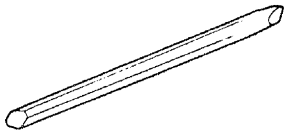
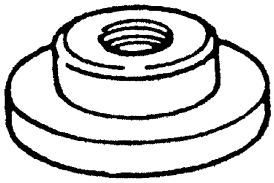
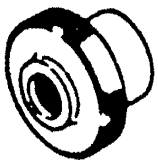
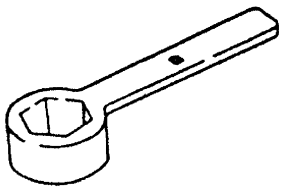
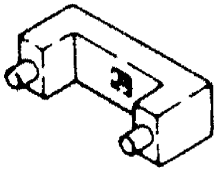
Illustration	Tool Number / Description / Remarks
 5884022930	5-8840-2293-0 (J-39209) / Punch: End nut lock
5884023730	5-8840-2373-0 / Differential side bearing remover (For 320mm)
 5884023770	5-8840-2377-0 / Drive pinion oil seal installer (For 320mm)
5884023790	5-8840-2379-0 / Drive pinion inner bearing outer race installer (For 320mm)
 5884023760	5-8840-2376-0 / Drive pinion outer bearing outer race installer (For 320mm)
 5884023290	5-8840-2329-0 / Hub nut wrench
 9852216060	9-8522-1606-0 / Rear hub bearing nut wrench {For 74mm (2.9 in.)}

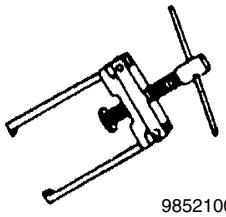
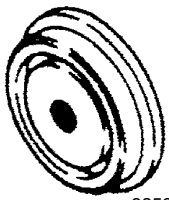
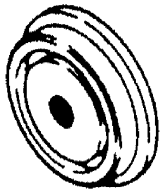
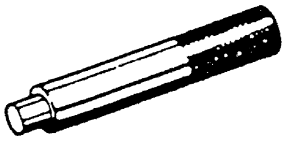
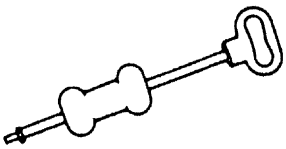
Illustration	Tool Number / Description / Remarks
 9852100920	9-8521-0092-0 / Rear hub inner bearing remover
 9852216070	9-8522-1607-0 / Rear hub oil seal installer (For 292mm)
 5884024270	5-8840-2427-0 / Rear hub oil seal installer
9852211940	9-8522-1194-0 / Rear hub inner bearing outer race installer
9852216090	9-8522-1609-0 / Rear hub inner bearing outer race installer
5884024260	5-8840-2426-0 / Rear hub inner bearing outer race installer
9852211950	9-8522-1195-0 / Rear hub outer bearing outer race installer

Illustration	Tool Number / Description / Remarks
9852216100	9-8522-1610-0 / Rear hub outer bearing outer race installer
9852216080	9-8522-1608-0 / Grip
 9852211480	9-8522-1148-0 / Grip
 5884000840	5-8840-0084-0 (J-2619-01) / Sliding hammer

Front Axle

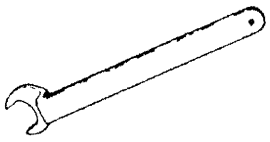
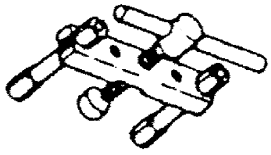
Illustration	Tool Number / Description / Remarks
 5884020150	5-8840-2015-0 / Front hub nut wrench
 9852101150	9-8521-0115-0 / Front hub remover (6 studs)

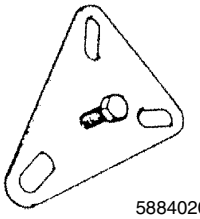
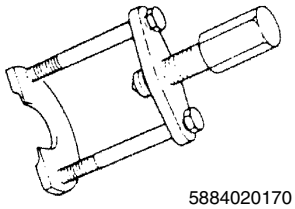
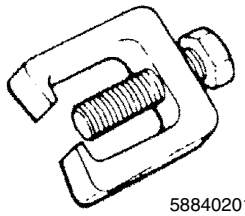
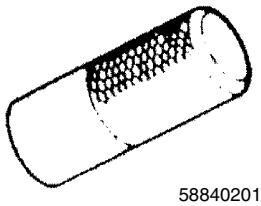
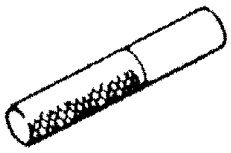
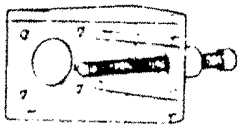
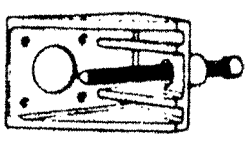
Illustration	Tool Number / Description / Remarks
 5884020160	5-8840-2016-0 / Front hub remover (5 studs)
 5884020170	5-8840-2017-0 / Tie rod end remover (driver side)
 5884020180	5-8840-2018-0 / Tie rod end remover (assist side)
 5884020190	5-8840-2019-0 / Tie rod arm & knuckle arm remover
 5884020200	5-8840-2020-0 / King pin key bolt remover
 5884020210	5-8840-2021-0 / King pin remover
 5884020220	5-8840-2022-0 / King pin remover

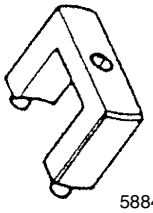
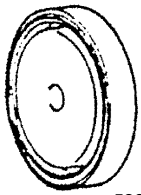
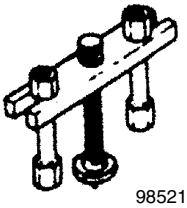
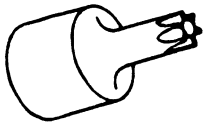
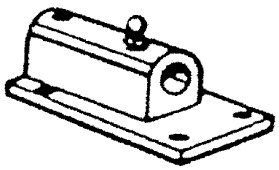
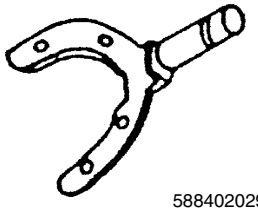
Illustration	Tool Number / Description / Remarks
5884020230	5-8840-2023-0 / Front hub inner bearing outer race installer
5884020240	5-8840-2024-0 / Front hub inner bearing outer race installer
5884020250	5-8840-2025-0 / Front hub outer bearing outer race installer
5884020260	5-8840-2026-0 / Front hub outer bearing outer race installer
5884022350	5-8840-2235-0 / Front hub Oil Seal installer
 5884021820	5-8840-2182-0 / Front hub bearing nut wrench
 5884021870	5-8840-2187-0 / Front hub oil seal installer

Illustration	Tool Number / Description / Remarks
5884021840	5-8840-2184-0 / Front hub inner bearing outer race installer
5884021830	5-8840-2183-0 / Front hub outer bearing outer race installer
 9852101870	9-8521-0187-0 / Front hub remover (6 studs)
 5884023680	5-8840-2368-0 / Torx bit (T70) (Disc Brake Only)
 5884000030	5-8840-0003-0 (J-3289-20) / Holding fixture base
 5884020290	5-8840-2029-0 / Differential holding fixture

PROPELLER SHAFT AND AXLE

SECTION 4A

PROPELLER SHAFT

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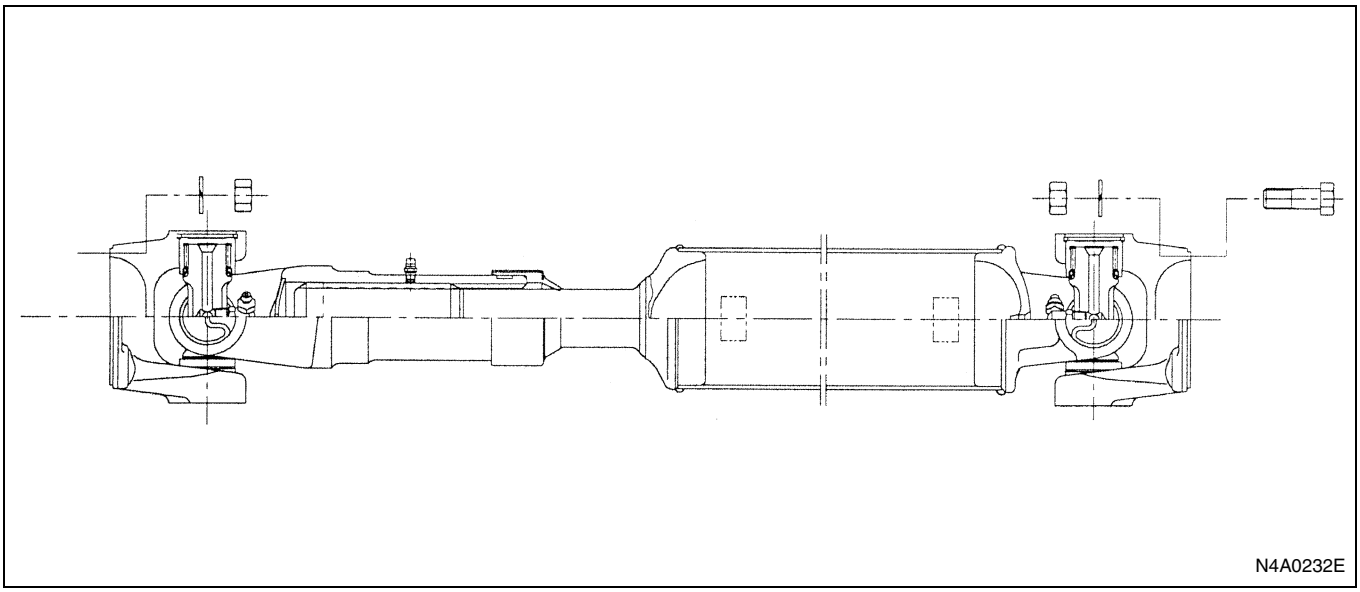
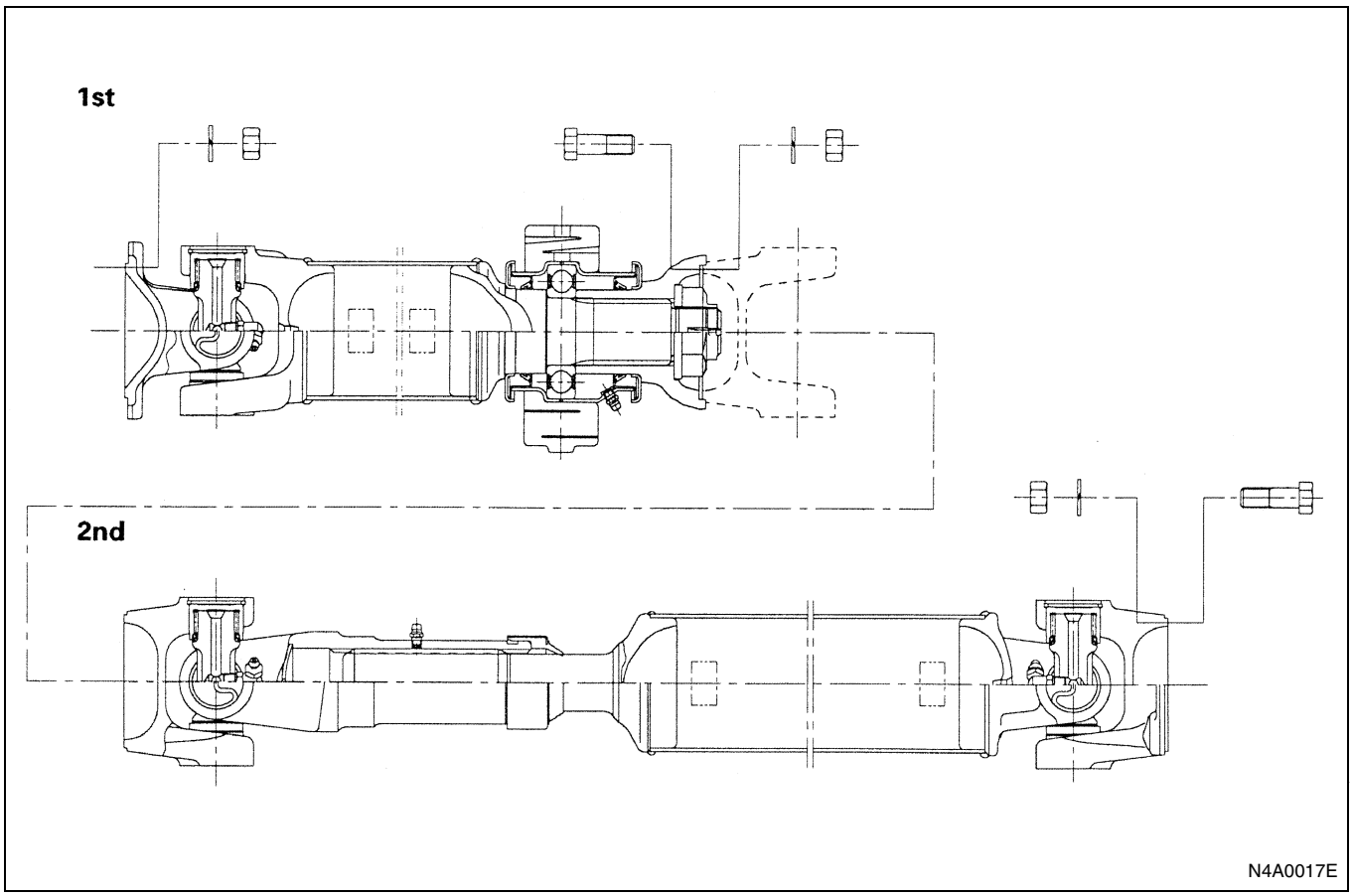
GENERAL DESCRIPTION

Rear Drive Propeller Shaft

Short Wheel Base Models

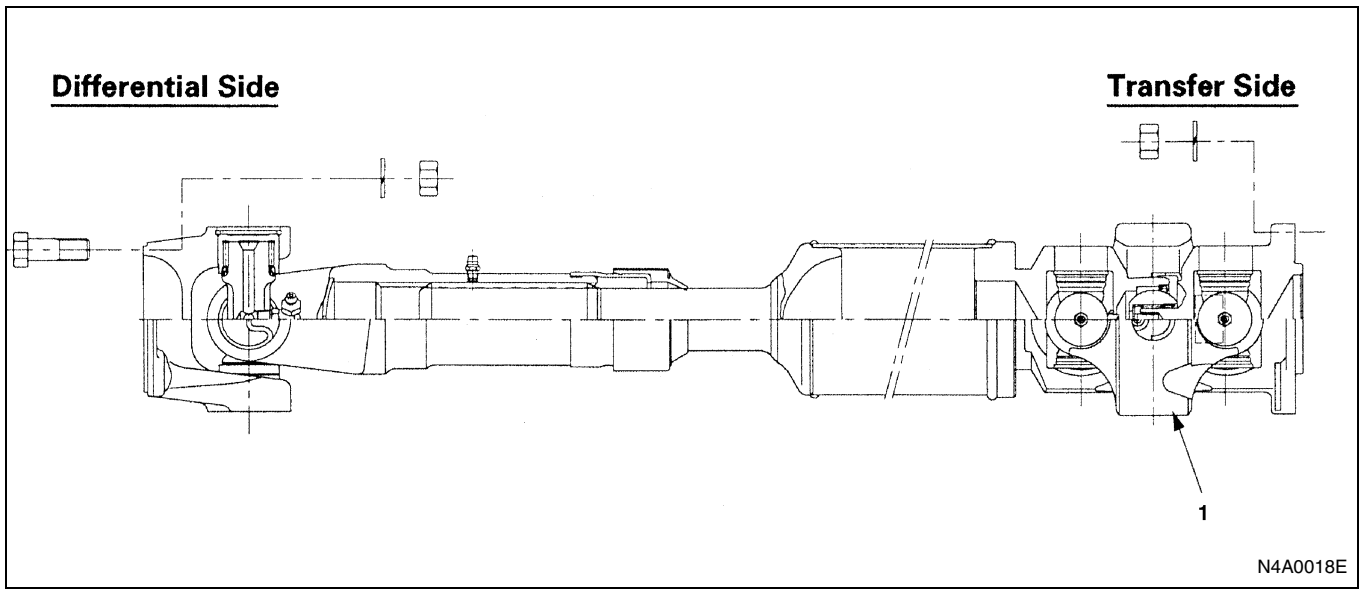


Long Wheel Base Models



Front Drive Propeller Shaft

NPS Model

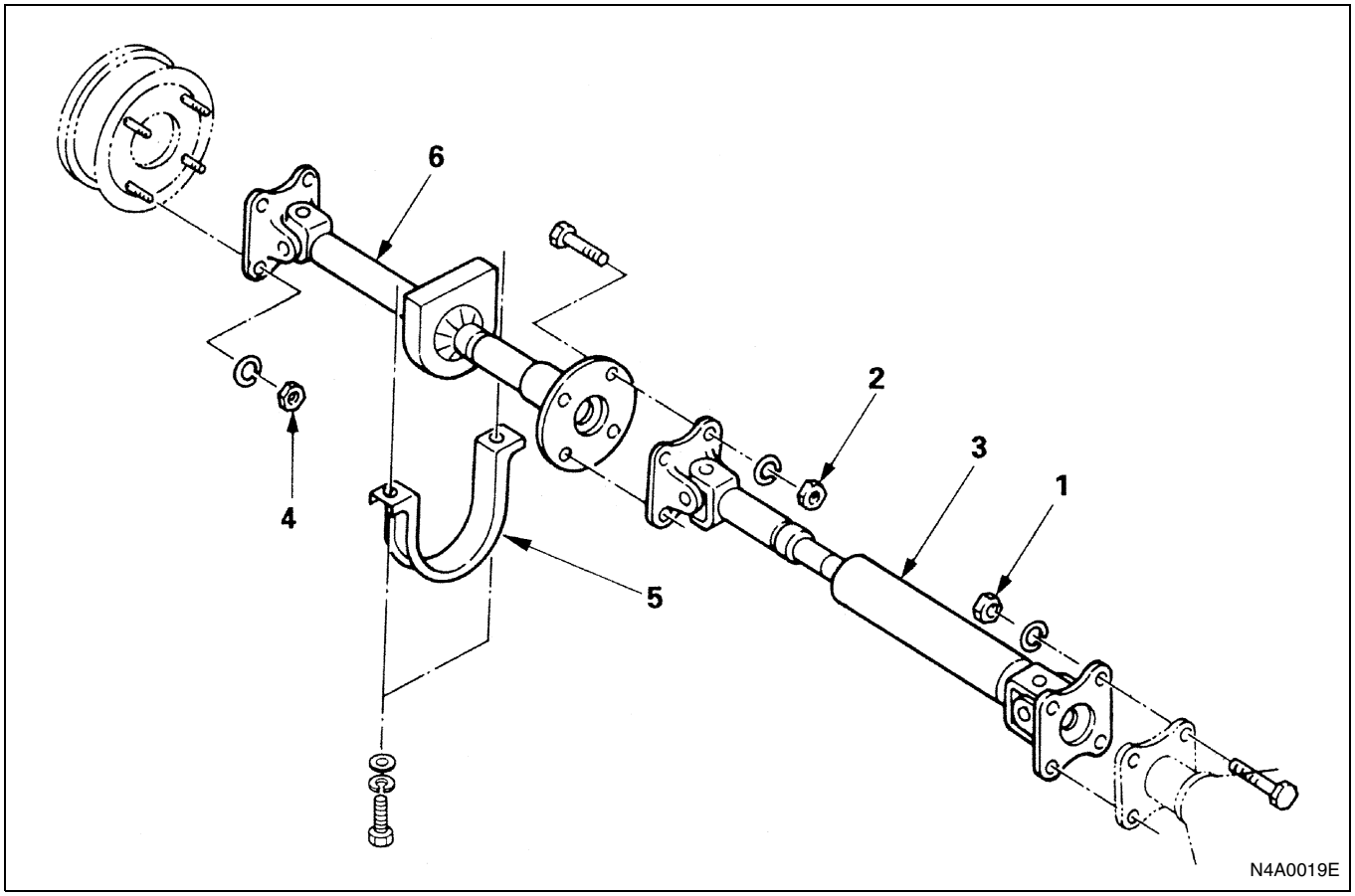


Legend

1. Double cardan joint

ON-VEHICLE SERVICE

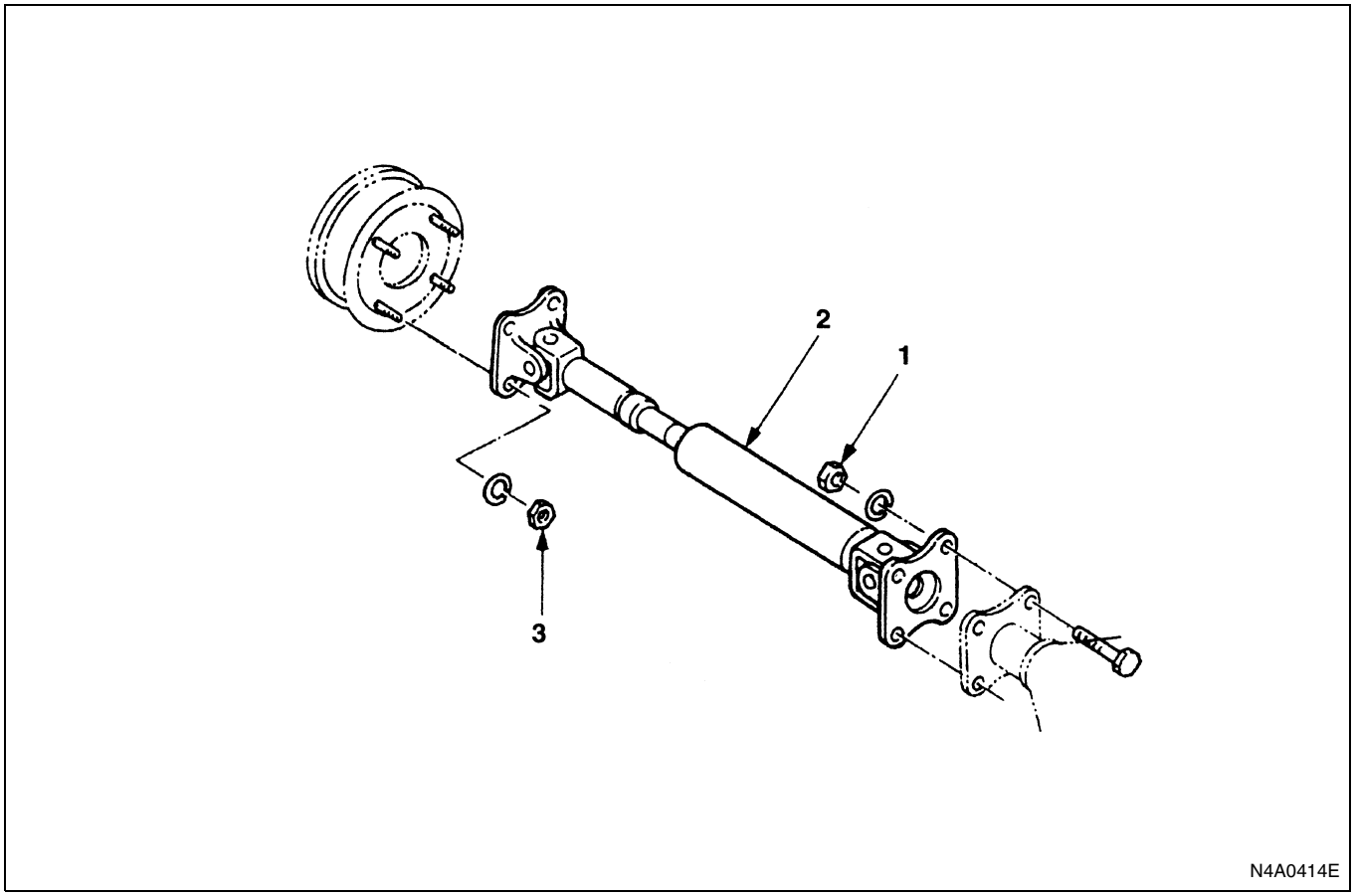
Rear Drive Propeller Shaft (Long Wheel Base Models)



Legend

1. Differential side nut
2. Center bearing side nut
3. 2nd propeller shaft
4. Transmission side nut
5. Center bearing bracket
6. 1st propeller shaft

Rear Drive Propeller Shaft (Short Wheel Base Models)



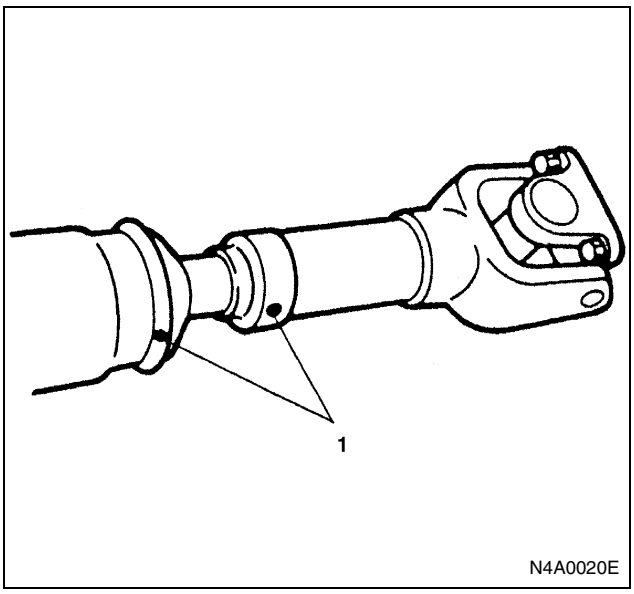
Legend

1. Differential side nut
2. Propeller shaft assembly
3. Transmission side nut

Removal

Preparation:

- Since the propeller shaft assembly is carefully balanced, a setting mark (1) should be applied to the joints (1st propeller shaft and parking brake drum, 1st propeller shaft and 2nd propeller shaft, 2nd propeller shaft and final drive flange), before removal in to original position.



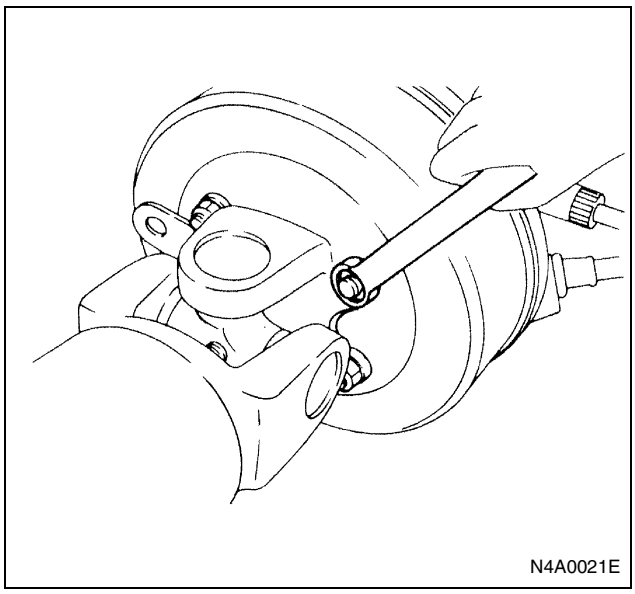
1. Differential Side Nut
2. Center Bearing Side Nut
3. 2nd Propeller Shaft
4. Transmission Side Nut
5. Center Bearing Bracket
6. 1st Propeller Shaft

Installation

1. 1st Propeller Shaft
2. Center Bearing Bracket
3. Transmission Side Nut

Tighten:
Transmission side nut to

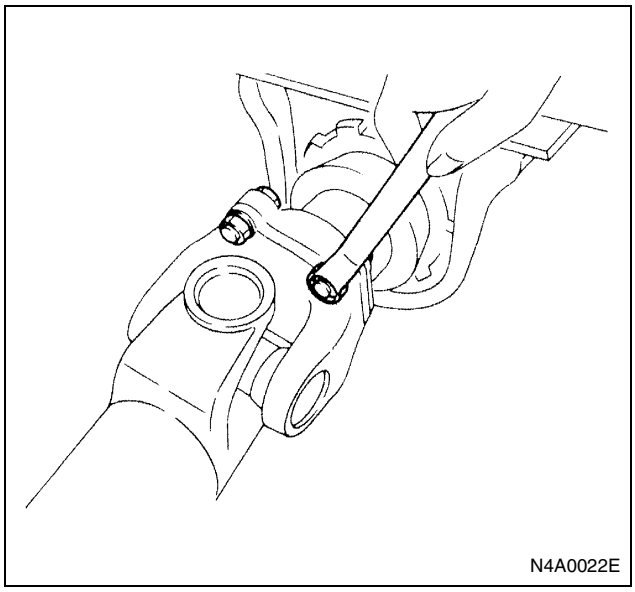
- M10: 63 N·m (6.4 kg·m / 46 lb·ft)
- M12: 103 N·m (10.5 kg·m / 76 lb·ft)



4. 2nd Propeller Shaft

Tighten:
Center bearing side nut to

- M10: 63 N·m (6.4 kg·m / 46 lb·ft)
- M12: 103 N·m (10.5 kg·m / 76 lb·ft)

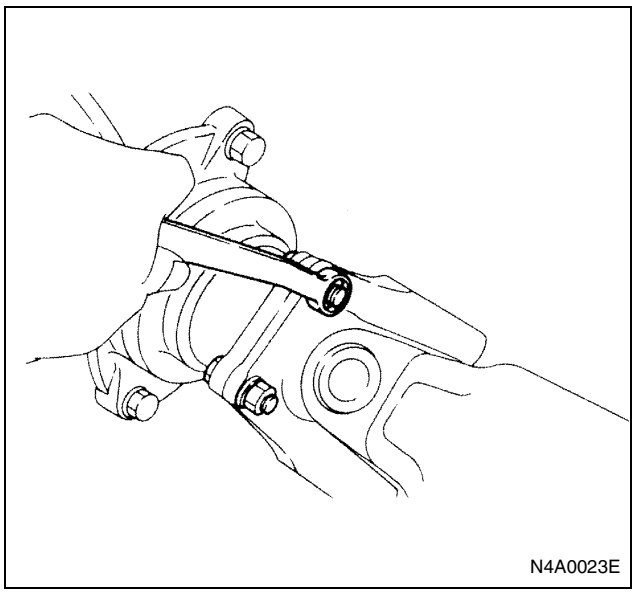


5. Center Bearing Side Nut

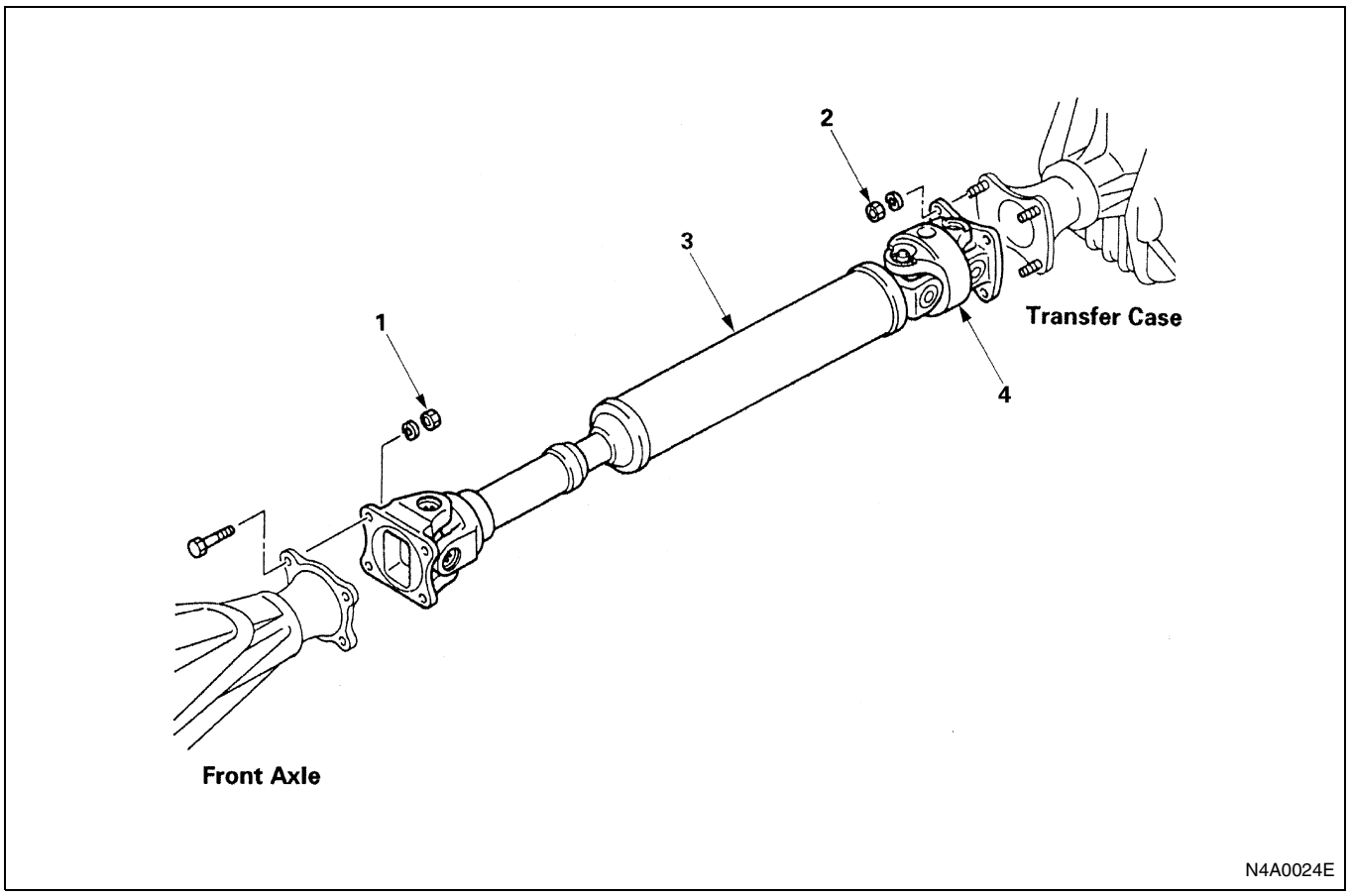
Tighten:
Center bearing bracket bolt to 40 N·m (4.1 kg·m / 30 lb·ft)

6. Differential Side Nut

Tighten:
Differential side nut to
- M10: 63 N·m (6.4 kg·m / 46 lb·ft)
- M12: 103 N·m (10.5 kg·m / 76 lb·ft)


N4A0023E

Front Drive Propeller Shaft

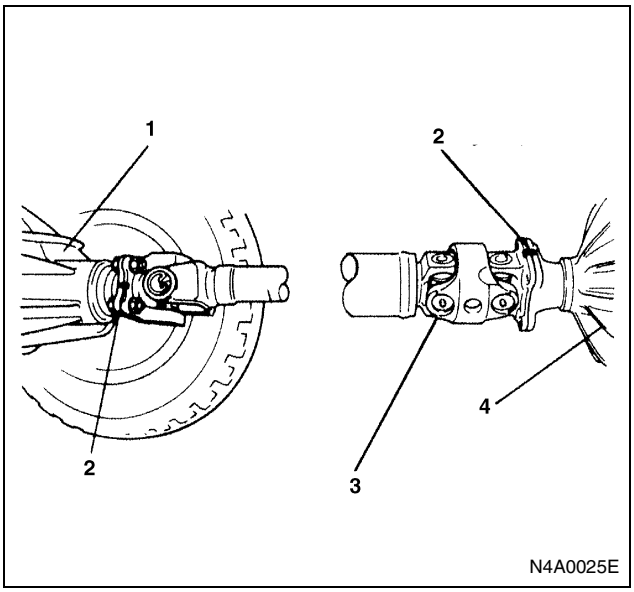


N4A0024E

Legend
1. Differential side nut
2. Transfer case side nut
3. Propeller shaft assembly
4. Double cardan joint

Removal

Preparation:
Since the propeller shaft assembly is carefully balanced, a setting mark should be applied to the joints, before removal in to original position.



Legend
1. Front differential
2. Setting mark
3. Double cardan joint
4. Transfer

1. Differential Side Nut
2. Transfer Case Side Nut
3. Propeller Shaft Assembly

Notice:
- The double cardan joint can not be disassembled. When it is defective, replace it as a propeller shaft assembly.
- Be sure not to bend double cardan joint at an angle of 25° or more. Further, be careful removing or carrying the assembly not to shock the double cardan joint.

Installation

1. Propeller Shaft Assembly
2. Transfer Case Side Nut

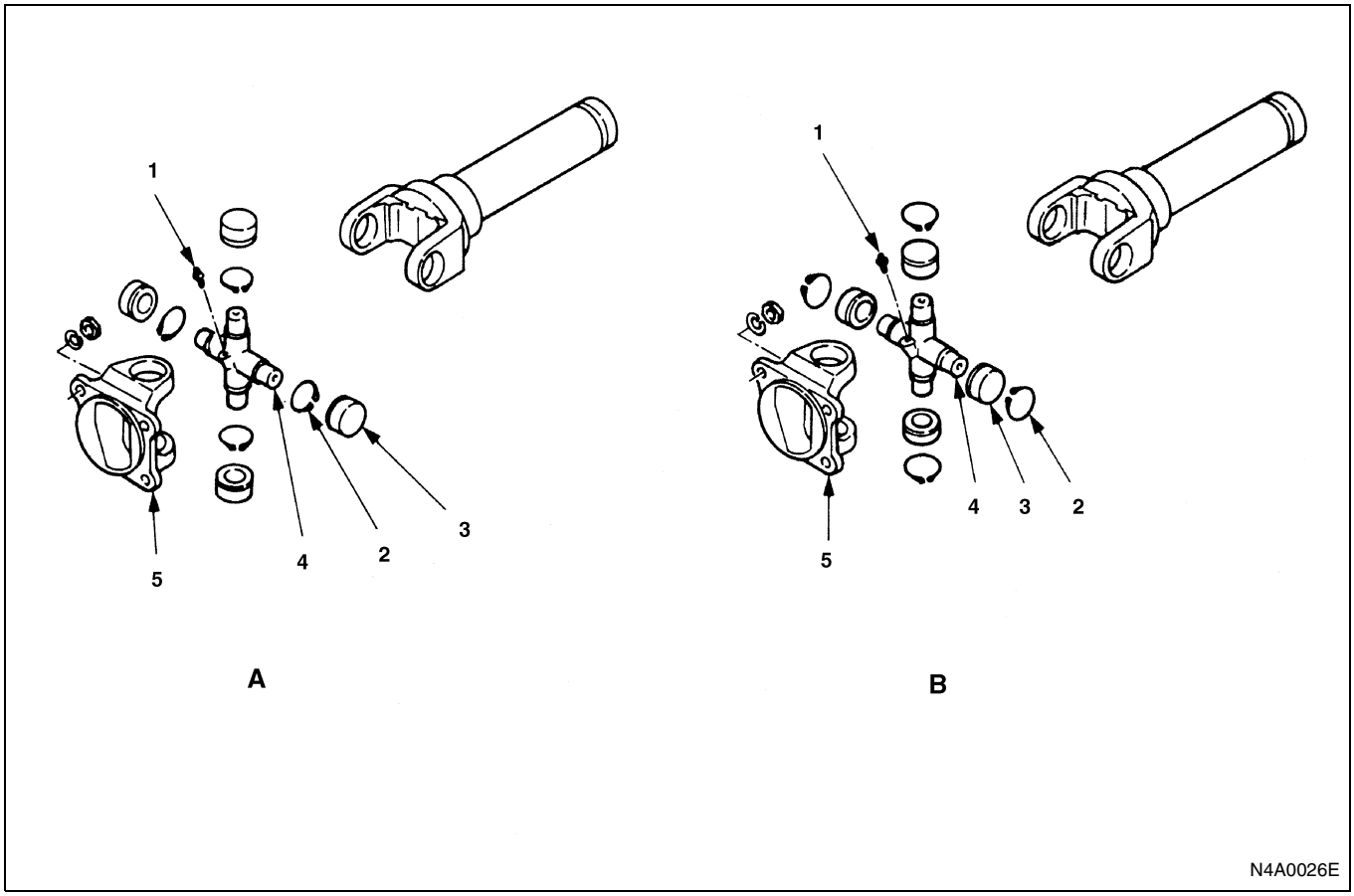
Tighten:
Transfer case side nut to
- M10: 62.7 N·m (6.4 kg·m / 46.3 lb·ft)

3. Differential Side Nut

Tighten:
Differential side nut to
- M10: 62.7 N·m (6.4 kg·m / 46.3 lb·ft)

UNIT REPAIR

Universal Joint



Legend

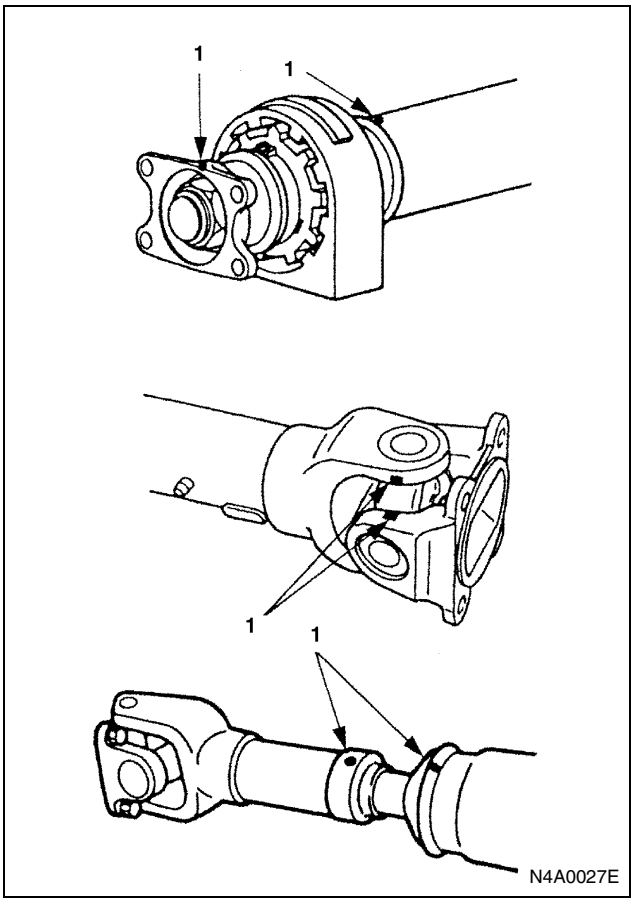
A. Inside Type
NHR
NKR 55

B. Outside Type
NKR 66,71,77
NPR 66,70,77
NQR 66
NPS 71

1. Grease fitting
2. Snap ring
3. Needle roller bearing
4. Spider
5. Flange yoke

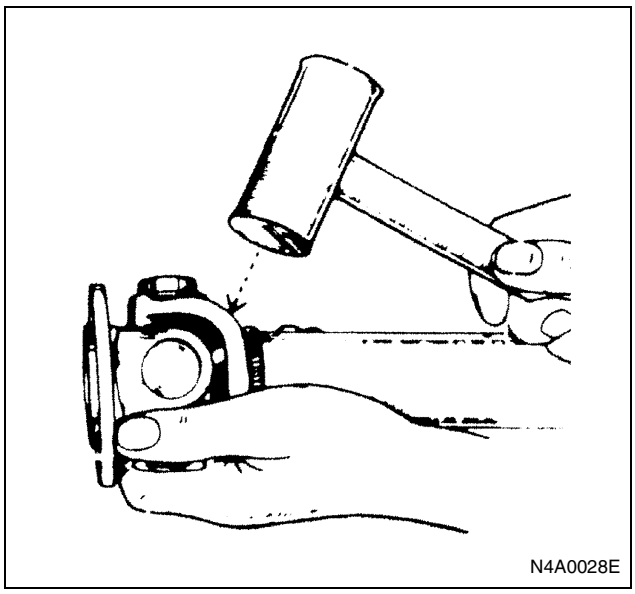
Disassembly

Preparation:
Since the propeller shaft assembly is carefully balanced, a setting mark (1) should be applied to the joints, before disassembly.



1. Grease Fitting
2. Snap Ring
3. Needle Roller Bearing

Tap out the bearing by applying a shock to the shoulder of the yoke, using a copper hammer.
Remove the needle roller bearings remaining in position by tapping lightly on the spider.
Remove the remaining bearings in the similar manner.



4. Spider
5. Flange Yoke

Inspection and Repair

Make necessary correction or parts replacement if wear, damage or any other abnormal conditions are found through inspection.

Visual Check

Inspect following parts for wear, damage or other abnormal conditions.

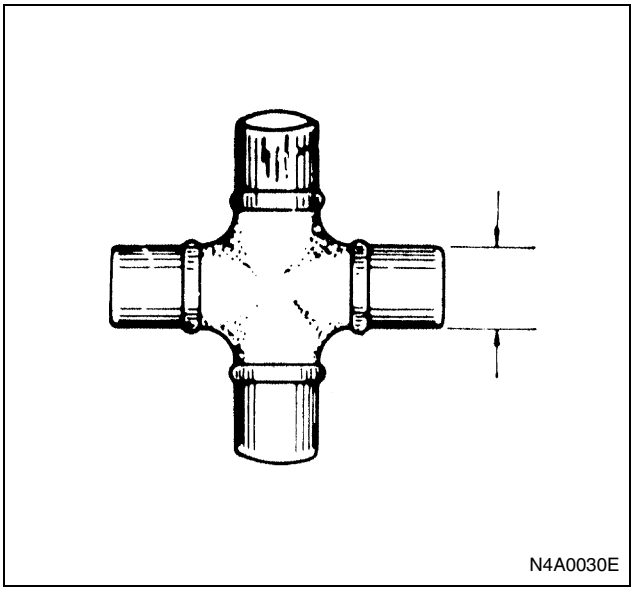
Notice:
When any part of the journal assembly requires replacement, be sure to replace the entire assembly.

- Spider
- Needle roller bearing
- Yoke
- Flange
- Center bearing
- Cushioning rubber
- Bracket

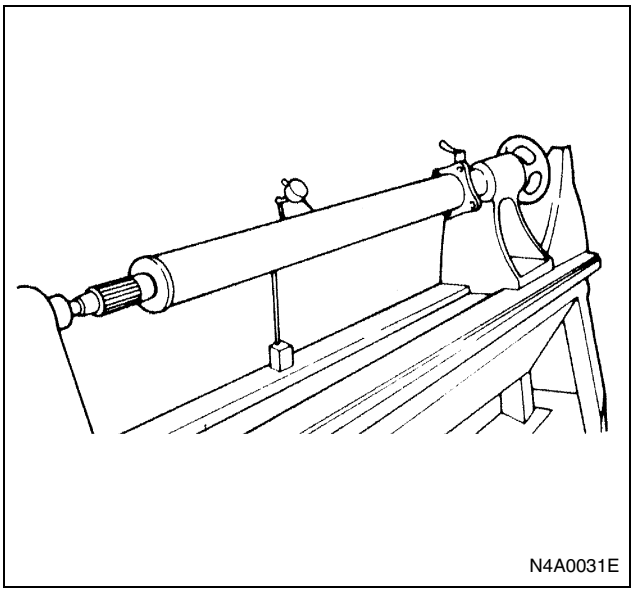
Outside Diameter of Spider Pins

mm (in.)

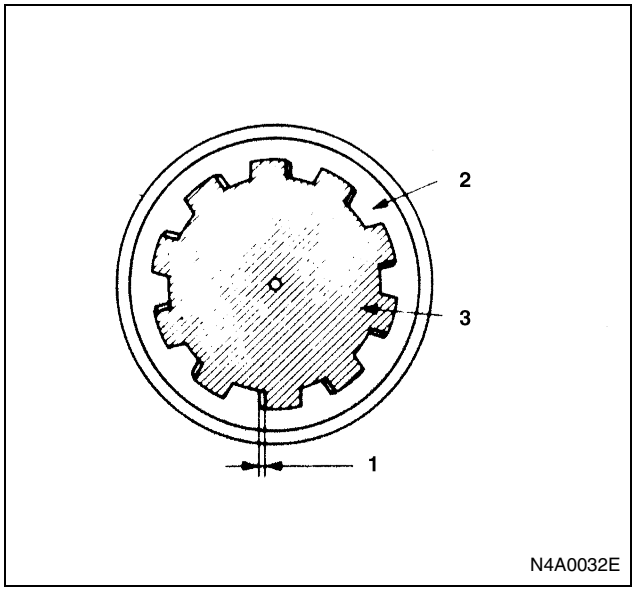
	Standard	Limit
NHR, NKR55	18.46 (0.73)	18.36 (0.72)
NKR 66,71,77 NPR 66, 70,77 NQR66, 71,NPS 71	21.94 (0.86)	21.84 (0.8598)
NQR70, 75 NPR75 NPS75	24.00 (0.945)	23.9 (0.941)


N4A0030E

Propeller Shaft Run-Out
Support the propeller shaft at its ends and check for run-out by holding the probe of a dial indicator agains the center part of the shaft.
If the amount of run-out it beyond the standard value for assembly, correct with a bench press or replace with a new one.
Standard: 0.5 mm (0.02 in) or less
Limit: 1.0 mm (0.039 in)


N4A0031E

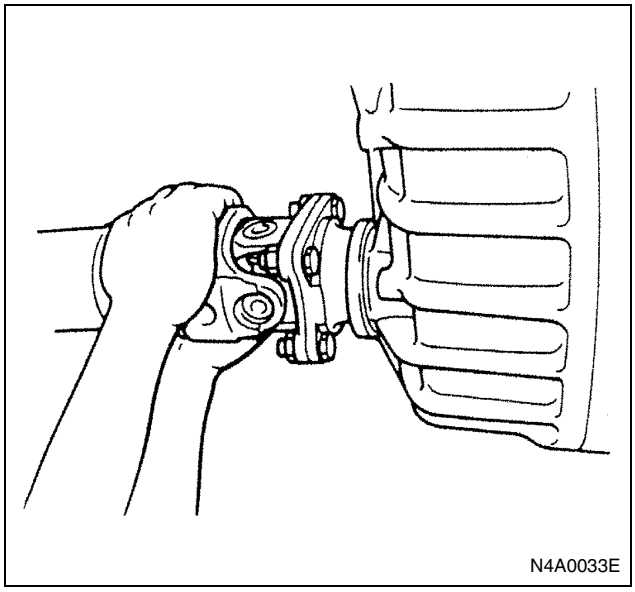
Play in Splines in Normal Direction of Rotation
Check the amount of play (1) in the sleeve yoke (2) and propeller shaft (3) splines in direction of rotation using a pointed feeler gauge.
Standard: 0.1 mm (0.0039 in)
Limit: 0.3 mm (0.012 in)

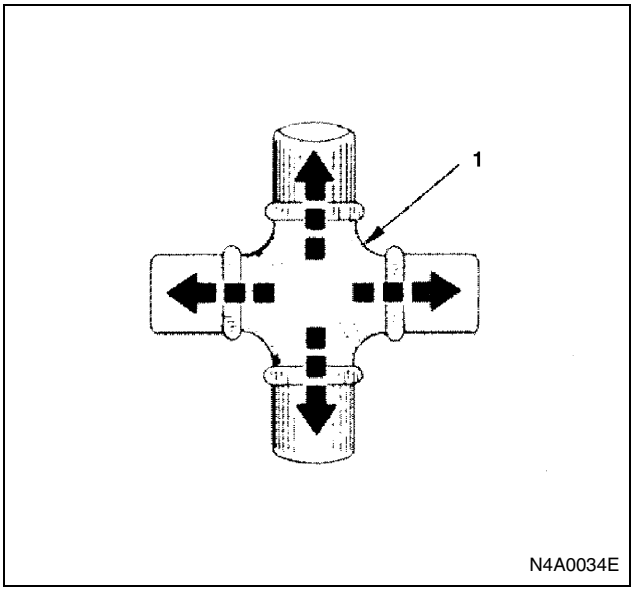


N4A0032E

Checking of Play of Double Cardan Joint (Front Propeller Shaft Only)

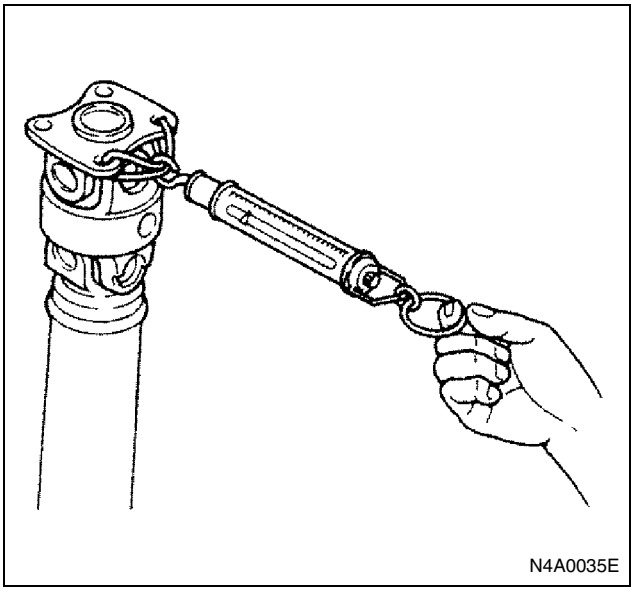
1. Check the double cardan joint for play in the direction of the spider (1) shaft. When there is an excessive play found, replace it as a propeller shaft assembly.


N4A0033E



Preload Checking of The Double Cardan Joint (Front Propeller Shaft Only)

1) As shown in the illustration, tie a wire firmly by passing it through the bolt holes which are in the same direction with the flange yoke shaft.



2) Hook a spring balance at the center of the wire, and pull the spring balance in the direction of a right angle.
3) Measure the value and check if the reading of the spring balance is within the specified value at the moment when the flange starts to move.

Preload, 52 N (5.3 kg / 11.7 lb)

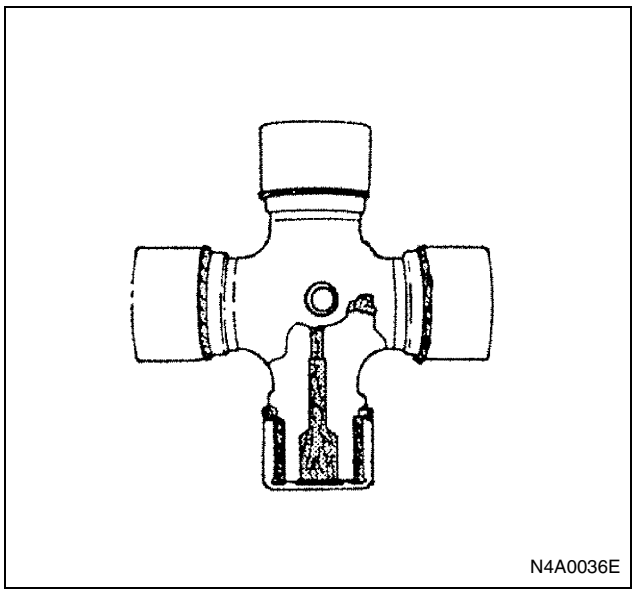
Lubrication

Universal Joints

Universal joints are drilled and provided with a lubrication fitting through which the lubricant travels to all four bearing caps, direct to the needle bearing.

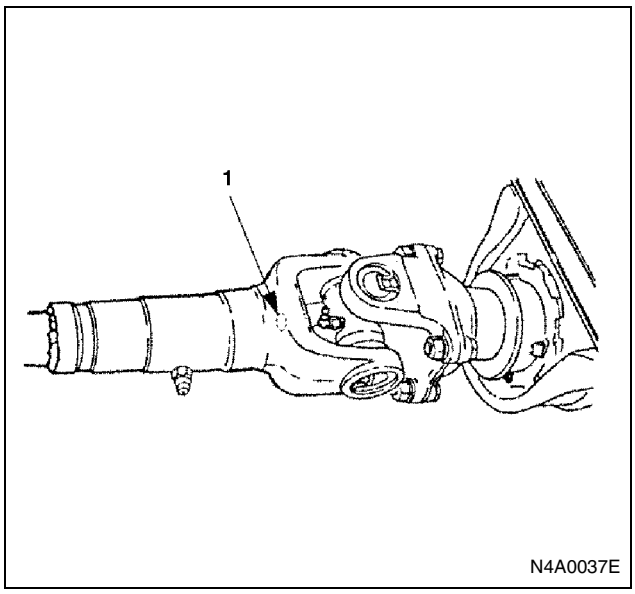
Needle bearings are protected against lubricant leakage and the entrance of foreign matter by seals.

1) Lubricate with a chassis lubricant.
2) When greasing the joint, a flow of grease at all four trunnion seals must be visible to ensure lubrication of the U-joint. If grease does not appear at all four trunnion seals, the universal joint should be rotated while applying lubricant under pressure to relieve any air lock inside the joint which would prevent lubricant from reaching the bearing area.



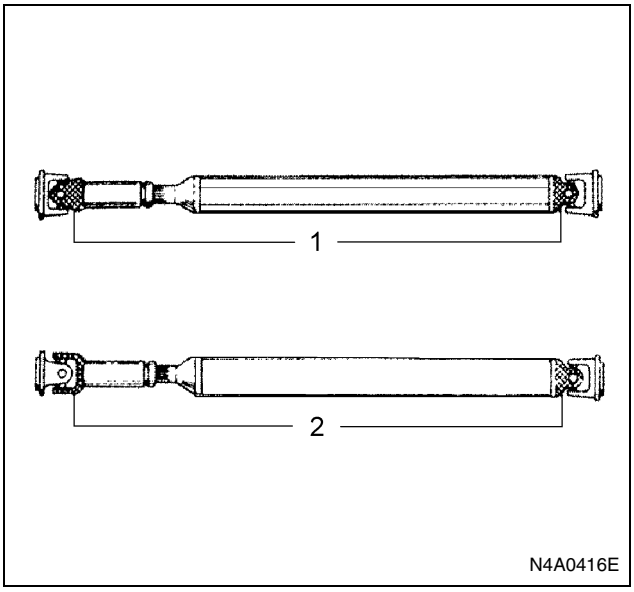
Sliding Spline Sections

Apply grease gun pressure to the lubrication fitting until lubricant appears at the pressure relief hole (1) as shown in the figure. Now cover the pressure relief hole with your finger and continue to apply pressure until grease appears at the sleeve yoke seal as shown in the figure.



Reassembly

1. Flange Yoke
   The flange yoke at end of the propeller shaft should be in alignment with the spline yoke as illustrated.
   The direction of the flange yoke at each end of the propeller shafts (setting mark) are in alignment.



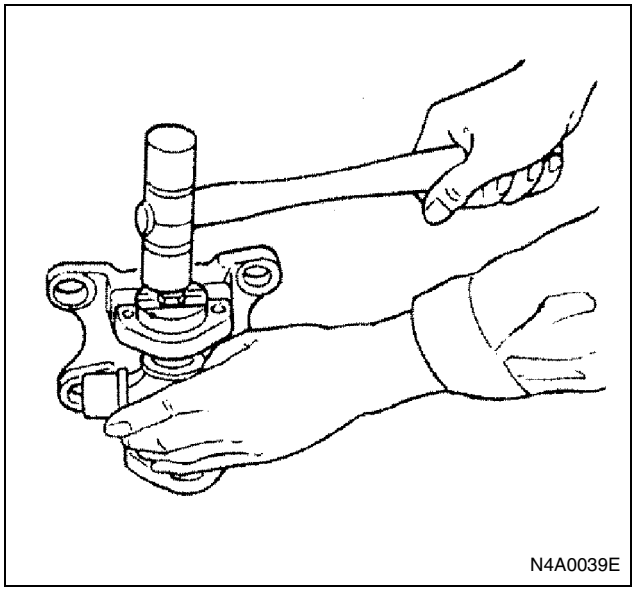
Legend
1. Correct
2. Incorrect

2. Spider
3. Needle Roller Bearing
   Apply MoS_2 grease to lip of the oil seal and needle roller bearing.

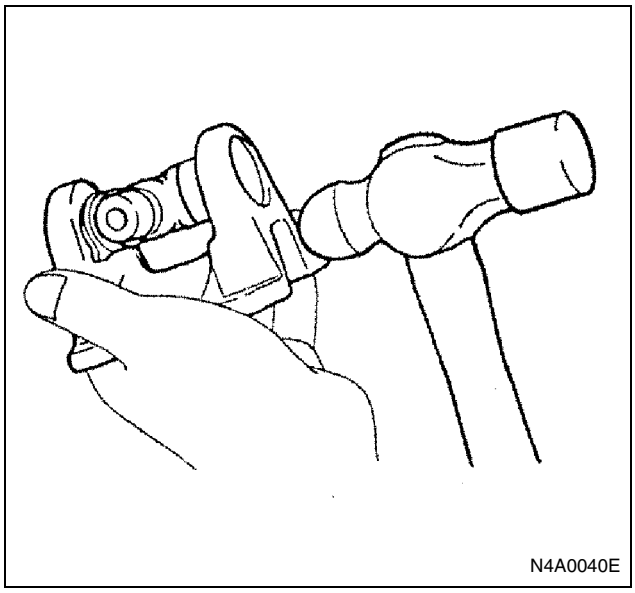
Notice:
Excessive greasing could make the bearing difficult to install or make accurate data unobtainable for the selection of the right snap ring.

Assemble the spider to the flange yoke. Using the spider as a guide, install the needle roller bearing into the hole in the arm of the flange yoke by press or tapping with a soft-faced hammer.

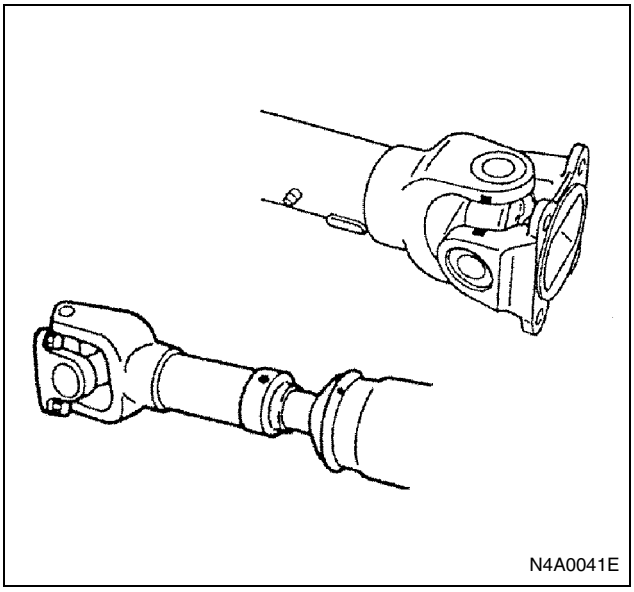
Caution:
- The needle roller bearing cannot be installed smoothly if is set at an incorrect angle with the flange.
- Excessive hammering will damage the needle roller bearing.

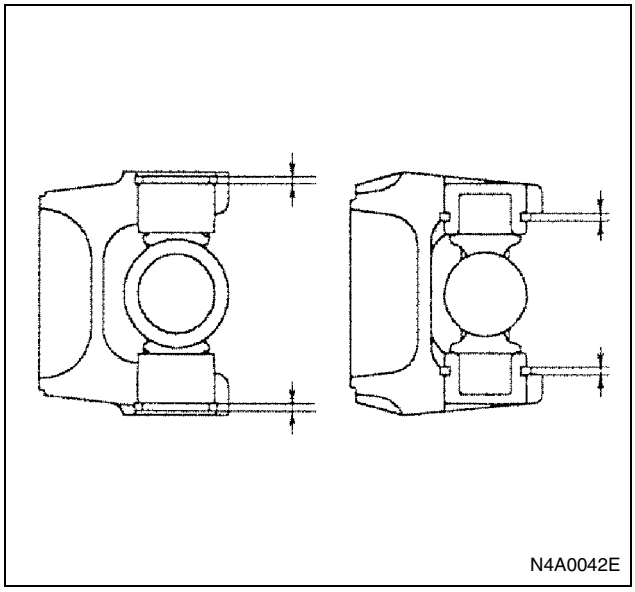


Eliminate the clearance between snap ring and bearing by striking the yoke with a hammer.



Align setting marks and join the yokes.


N4A0041E


N4A0042E

4. Snap Ring

Discard used snap ring and install new one.
When the bearing is fitted into position, select and install the snap ring of suitable thickness so that the end play of the spider pin is held within 0.1 mm.

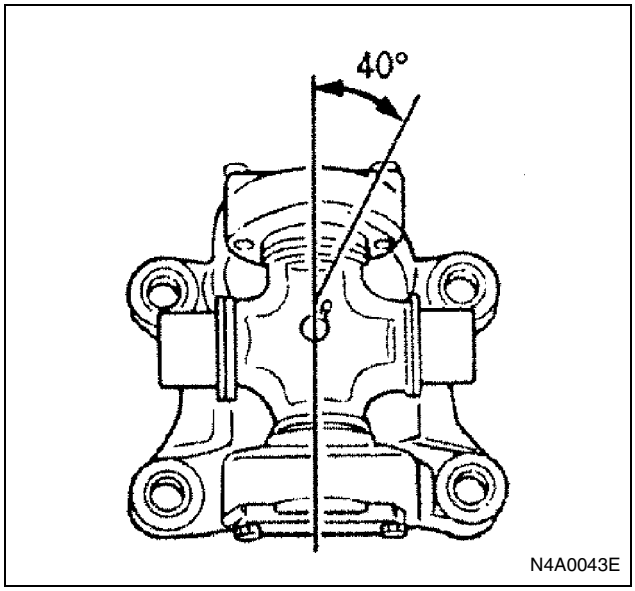
Thickness of Snap Ring Available mm (in.)	
NHR, NKR55	
Snap ring thickness	Identification color
1.5 (0.059)	Blue
1.53 (0.060)	White
1.59 (0.063)	Yellow
1.62 (0.064)	Green
1.68 (0.066)	Not colored

NKR 66, 71, 77, NPR 66, 70, 77, NQR66, 71, NPS 71	
Snap ring thickness	Identification color
1.95 (0.077)	Blue
2.00 (0.079)	White
2.05 (0.081)	Yellow or Not colored

Notice:
Be sure to use snap rings of the same thickness on both sides.

5. Grease Fitting

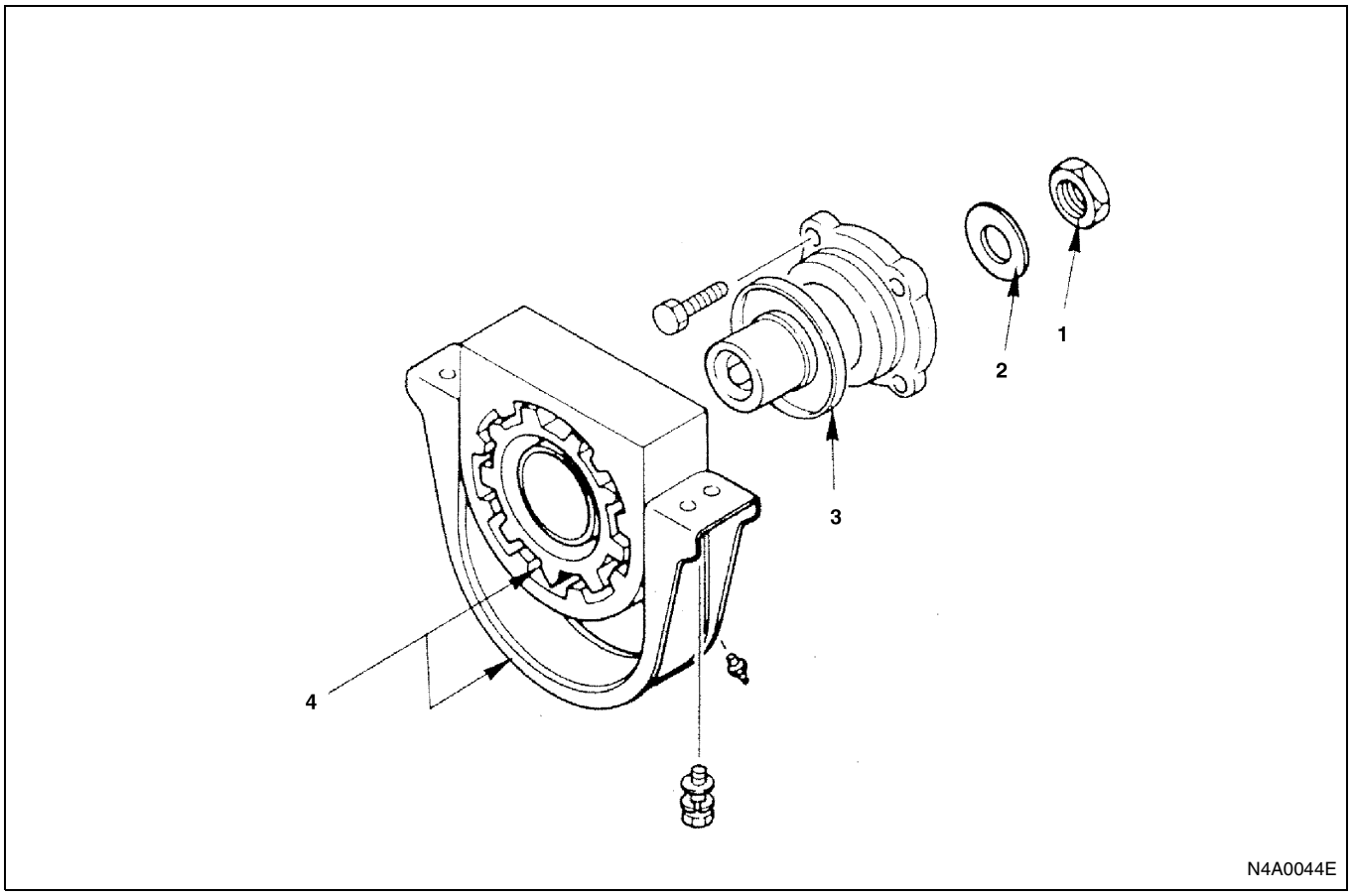
Install the grease fitting at an angle of approximately 40 degrees to the spider. The parts should be so installed that all grease fittings are pointed upward.



N4A0043E

Center Bearing

NKR 66, 71, 77
NPR 66, 70, 71
NQR 66, 70, 71
NPS 71



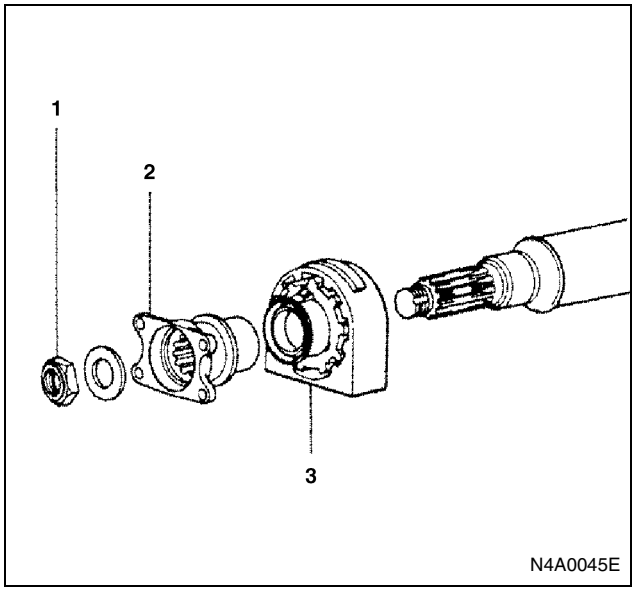
Legend

1. Lock nut
2. Washer (NQR70 only)
3. Coupling driver
4. Center bearing assembly

Disassembly

1. Lock Nut
2. Washer (NQR70 only)
3. Coupling Driver
   Apply alignment marks on the flange and tube assembly.
4. Center Bearing Assembly

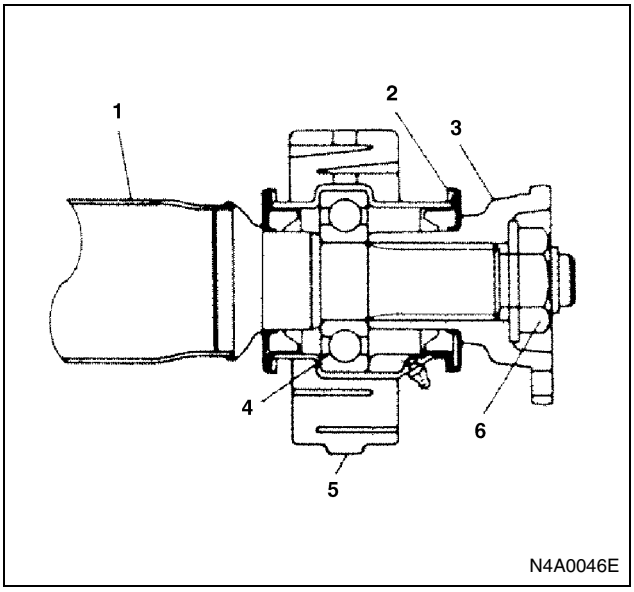
Notice:
The center bearing can not be disassembled.



Legend
1. Coupling driver lock nut
2. Coupling driver
3. Center bearing assembly

Reassembly

1. Center Bearing Assembly
   Install the center bearing assembly so that the grease fitting side is faced toward the coupling driver side.
   When pressing in the center bearing, the bearing should be pressed through a coupling driver to avoid bearing damage.



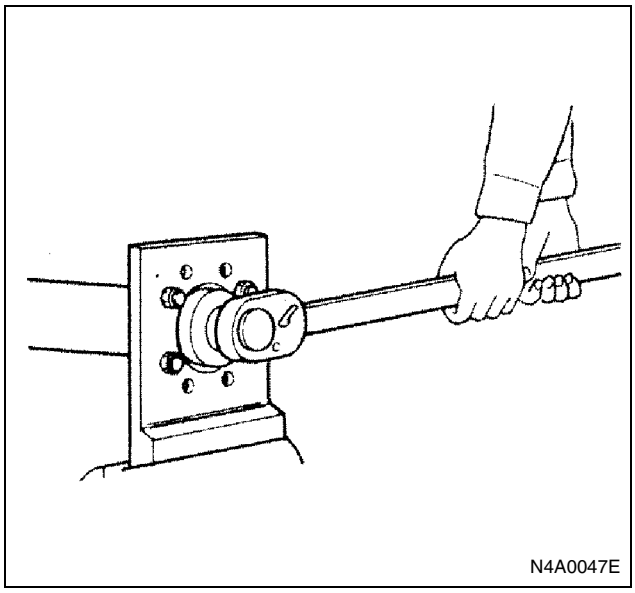
Legend
1. Propeller shaft
2. Oil seal
3. Coupling driver
4. Center bearing
5. Rubber
6. Lock nut

   Apply bearing grease to lip of the oil seal and center bearings.

Amount of grease required,
Except NQR70: 20 — 25 g (0.7 — 0.9 oz)
NQR70: 40 — 50 g (1.4 — 1.8 oz)

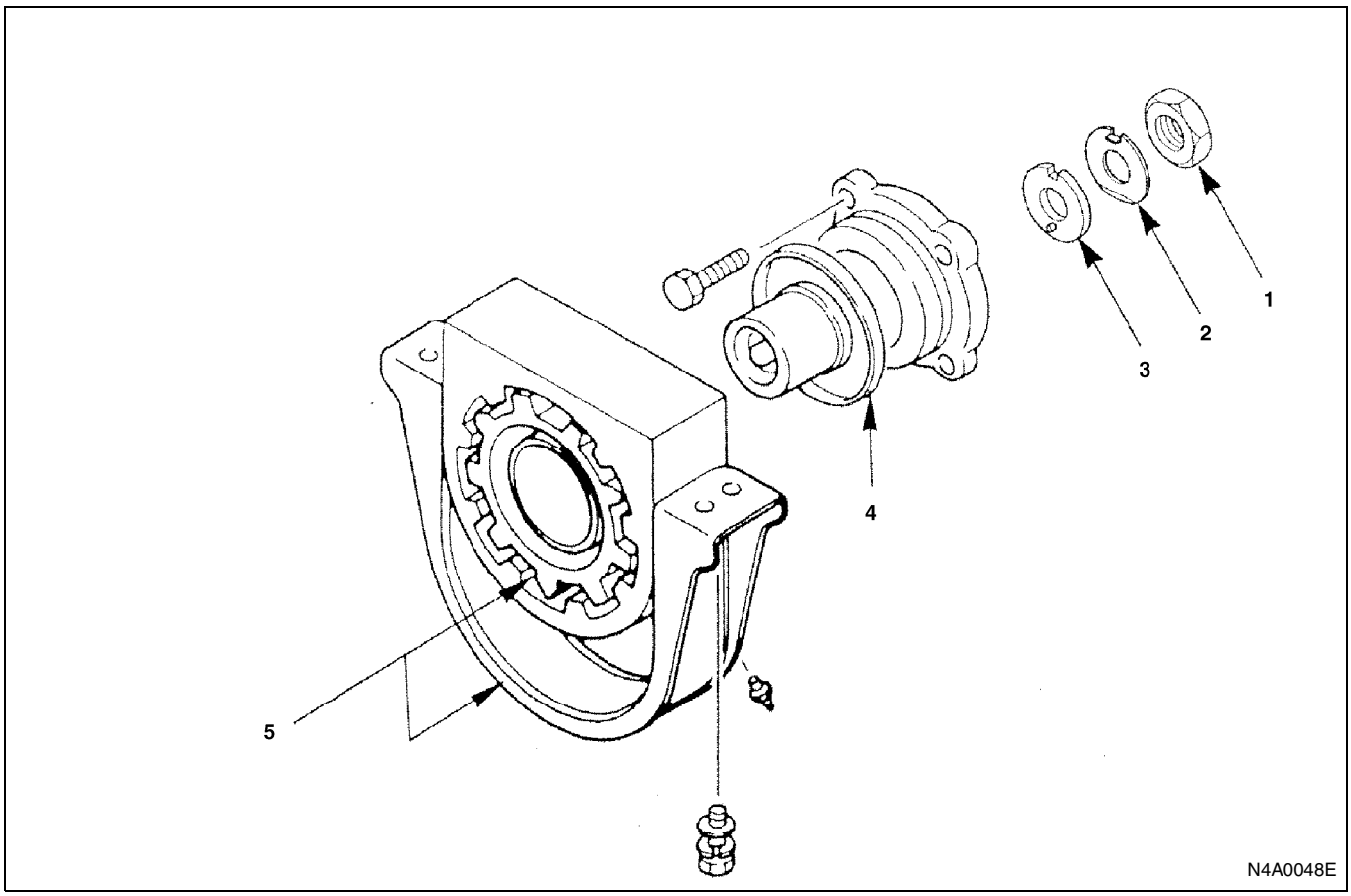
2. Coupling Driver
   Be sure to align the setting marks described before disassembling.
3. Washer
4. Lock Nut
   Set a special tool into a vice then attach the propeller shaft assembly.
   Flange bracket: 9-8529-2101-0
   Discard used flange nut and install new one.

Tighten:
Lock nut to
- NHR55, 69, NKR55: 118 N·m (12 kg·m / 87 lb·ft)
- NQR70: 441 N·m (45 kg·m / 325 lb·ft)
- Other models: 539 N·m (55 kg·m / 398 lb·ft)



Caulk the lock nut at the V-shaped groove portion of the shaft.

NKR 55



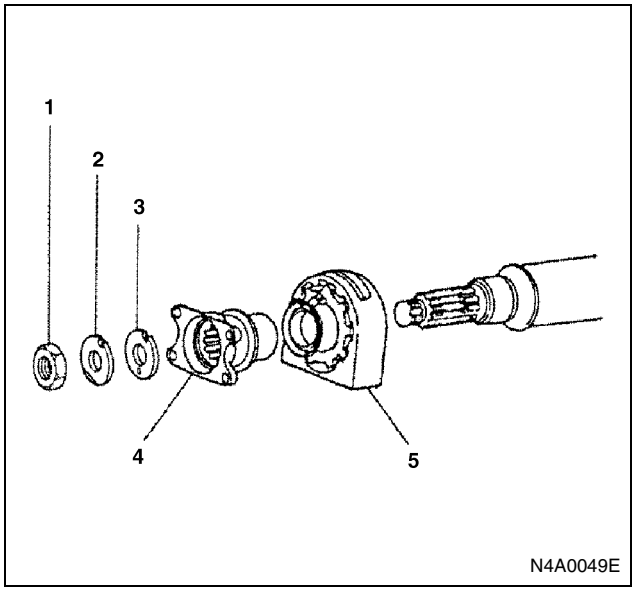
Legend

1. Lock nut
2. Lock washer
3. Washer assembly
4. Coupling driver
5. Center bearing assembly

Disassembly

1. Lock Nut
2. Lock Washer
3. Washer Assembly
4. Coupling Driver
   Apply alignment marks on the flange and tube assembly.
5. Center Bearing Assembly

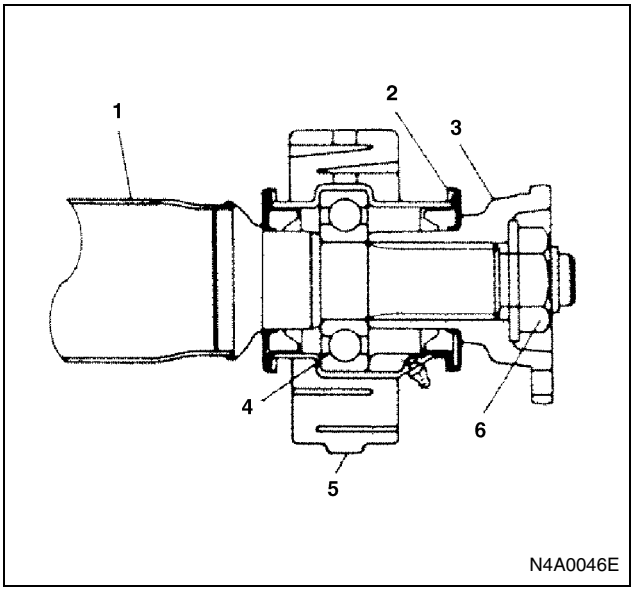
Notice:
The center bearing can not be disassembled.



Legend
1. Lock nut
2. Lock washer
3. Washer assembling
4. Coupling driver
5. Center bearing assembly

Reassembly

1. Center Bearing Assembly
   Install the center bearing assembly so that the grease fitting side is faced toward the coupling driver side.
   When pressing in the center bearing, the bearing should be pressed through a coupling driver to avoid bearing damage.

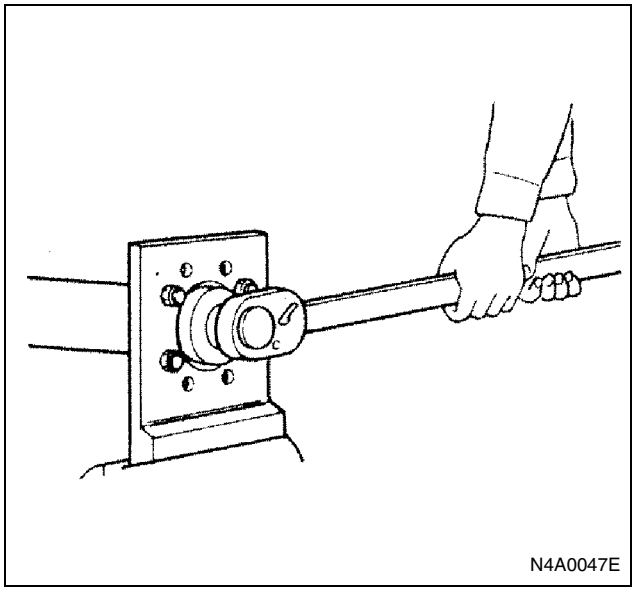


Legend
1. Propeller shaft
2. Oil seal
3. Coupling driver
4. Center bearing
5. Rubber
6. Lock nut

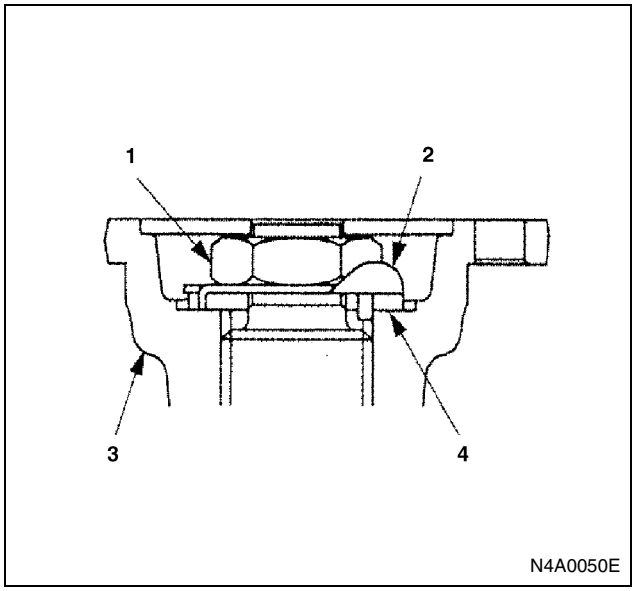
Apply bearing grease to lip of the oil seal and center bearing.
Amount of grease required, 20 — 25 g (0.7 — 0.9 oz)

2. Coupling Driver
   Be sure to align the setting marks described before disassembling.
3. Washer Assembly
4. Lock Washer
   Discard used lock washer and install new one.
5. Lock Nut
   Set a special tool into a vice then attach the propeller shaft assembly.
   Flange bracket: 9-8529-2101-0

Tighten:
Lock nut to 118 N·m (12 kg·m / 87 lb·ft)



After tightening the lock nut to specified torque, bend a part of the lock washer to the nut side.



Legend
1. Lock nut
2. Lock washer
3. Coupling driver
4. Washer assembly

PROPELLER SHAFT AND AXLE

SECTION 4B
REAR AXLE

Contents

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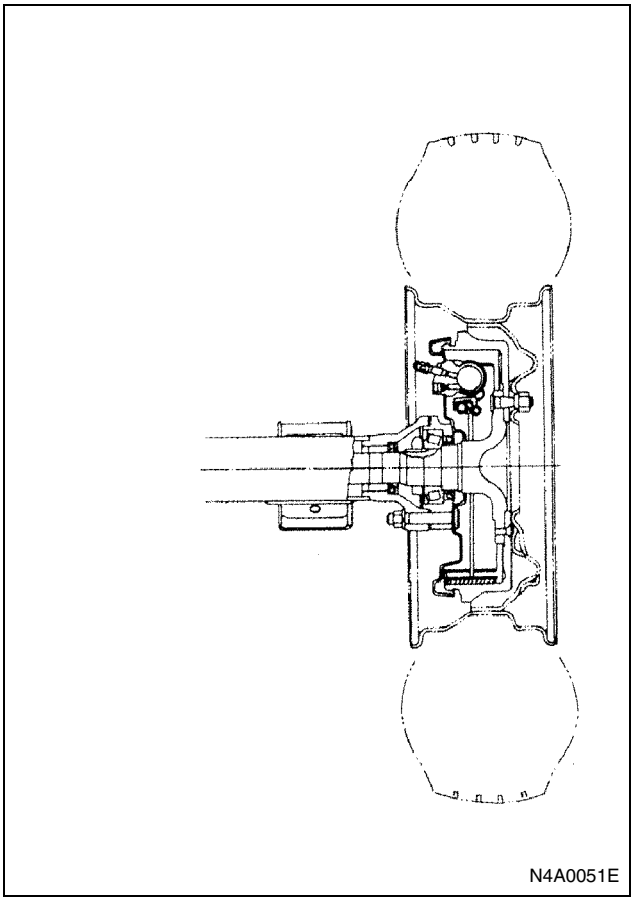
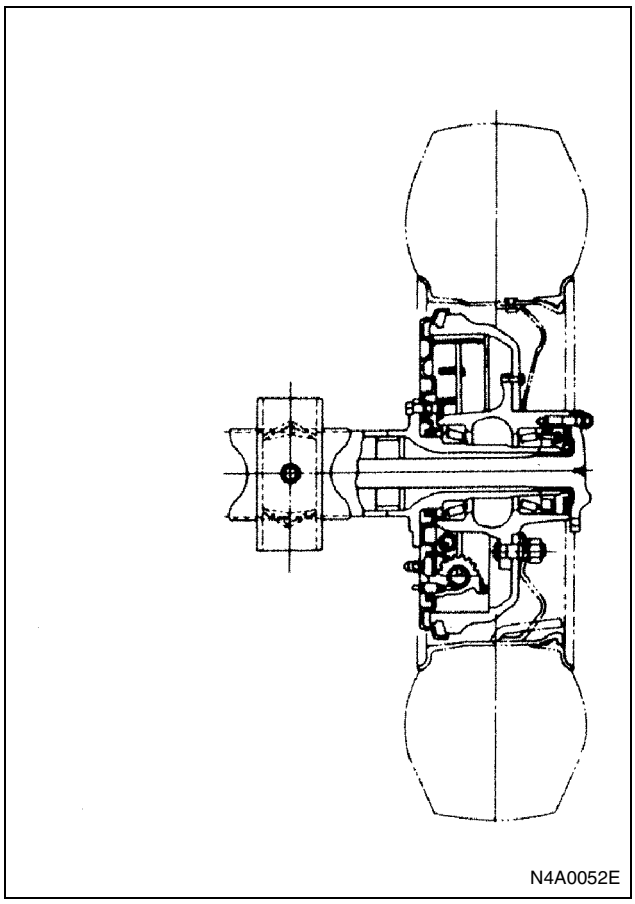
GENERAL DESCRIPTION

Hub and Drum

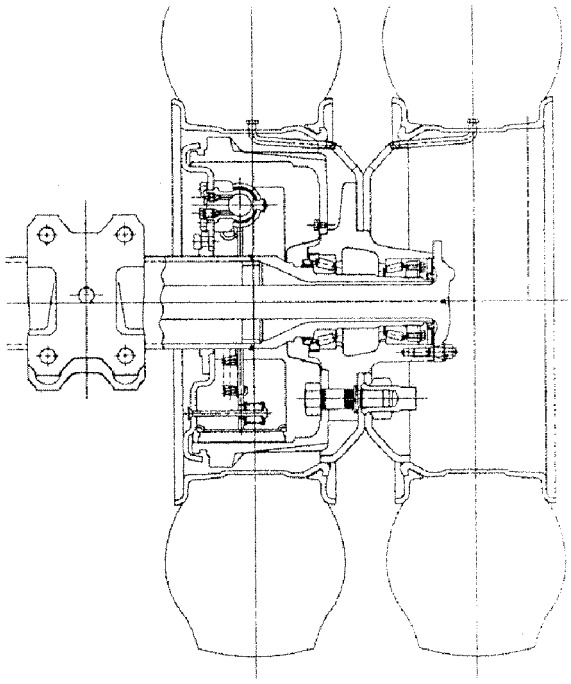
NHR Model (Single Tire (Semi Floating Type))



NKR Model (Single Tire (Full Floating Type))



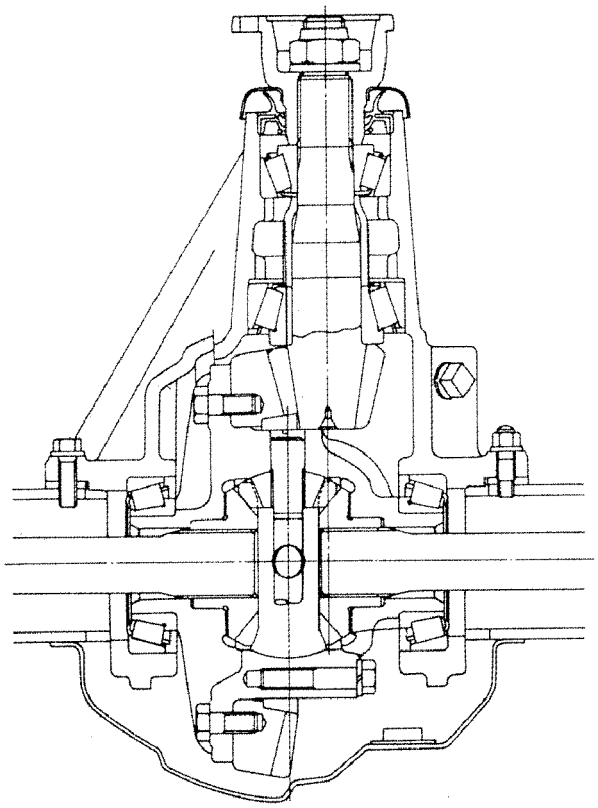
NHR55, 69, NKR55, 66, 69, 71, 77, NPR66, 70, 71, 75, 77, NQR66, 70, 71, 75, NPS71, 75 Models (Dual Tire)



N4A0053E

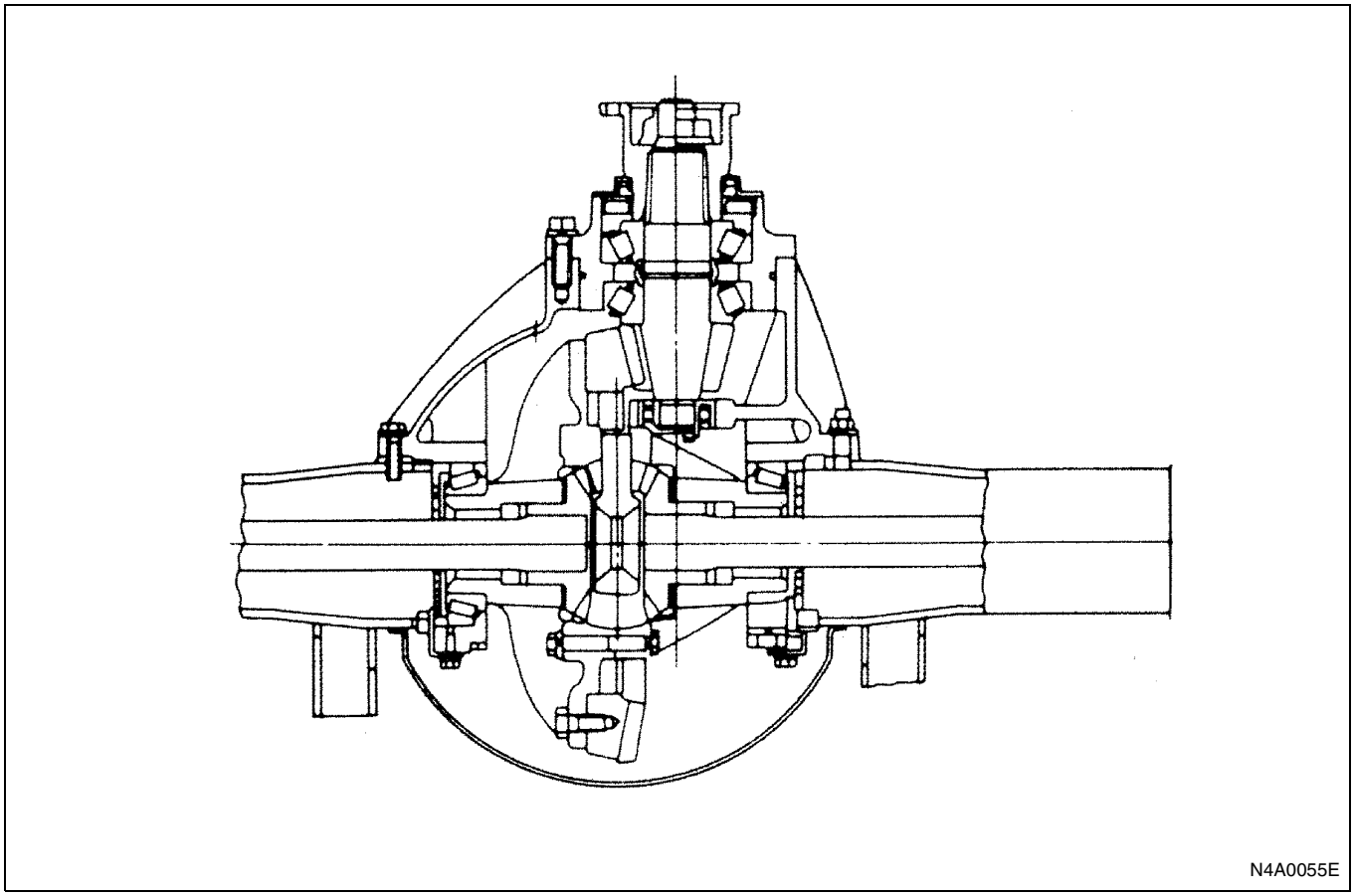
Differential Carrier Assembly

244 mm (9.6 in) size



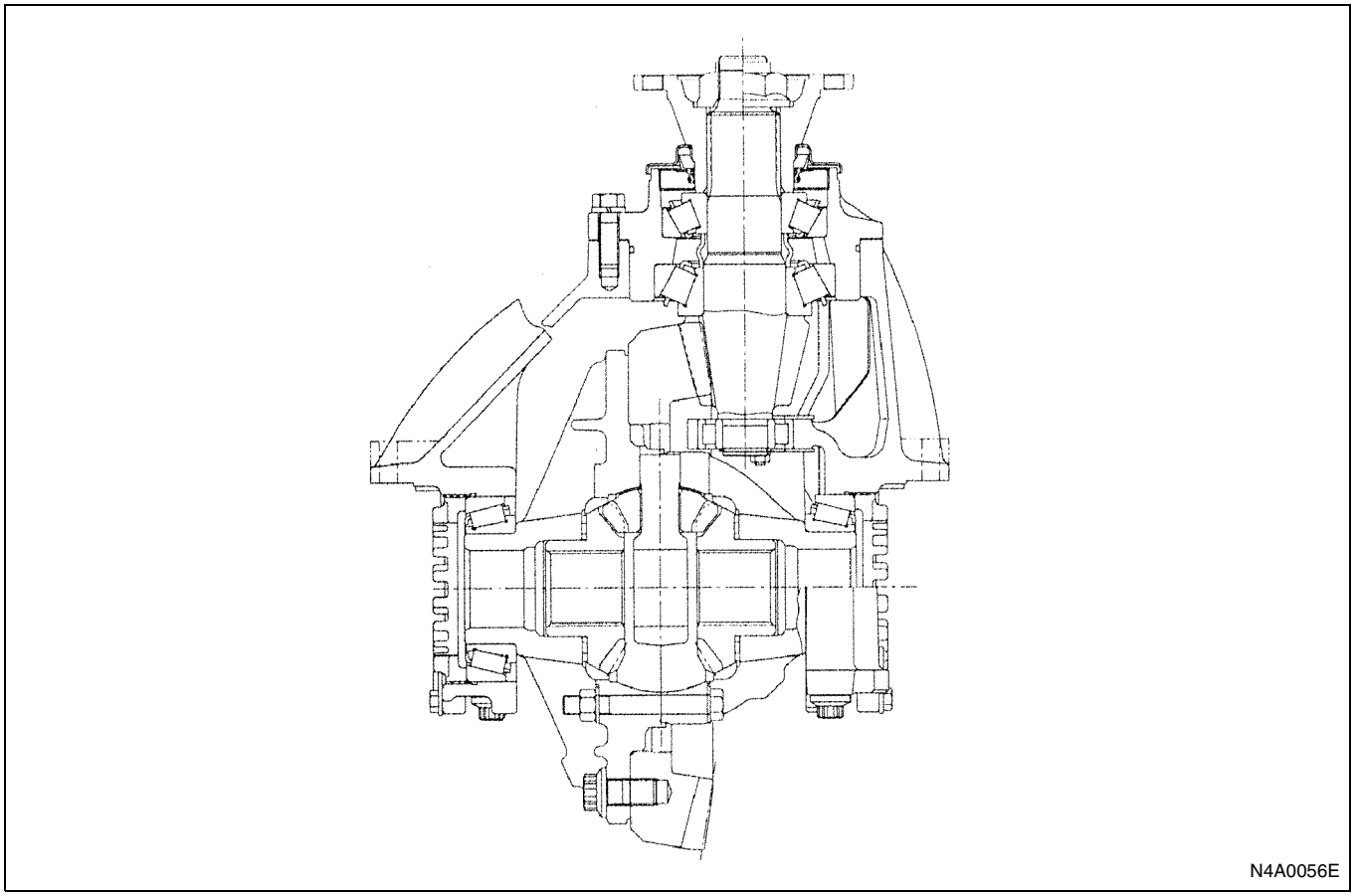
N4A0054E

292 mm (11.5 in) size



N4A0055E

320 mm (12.5 in) size

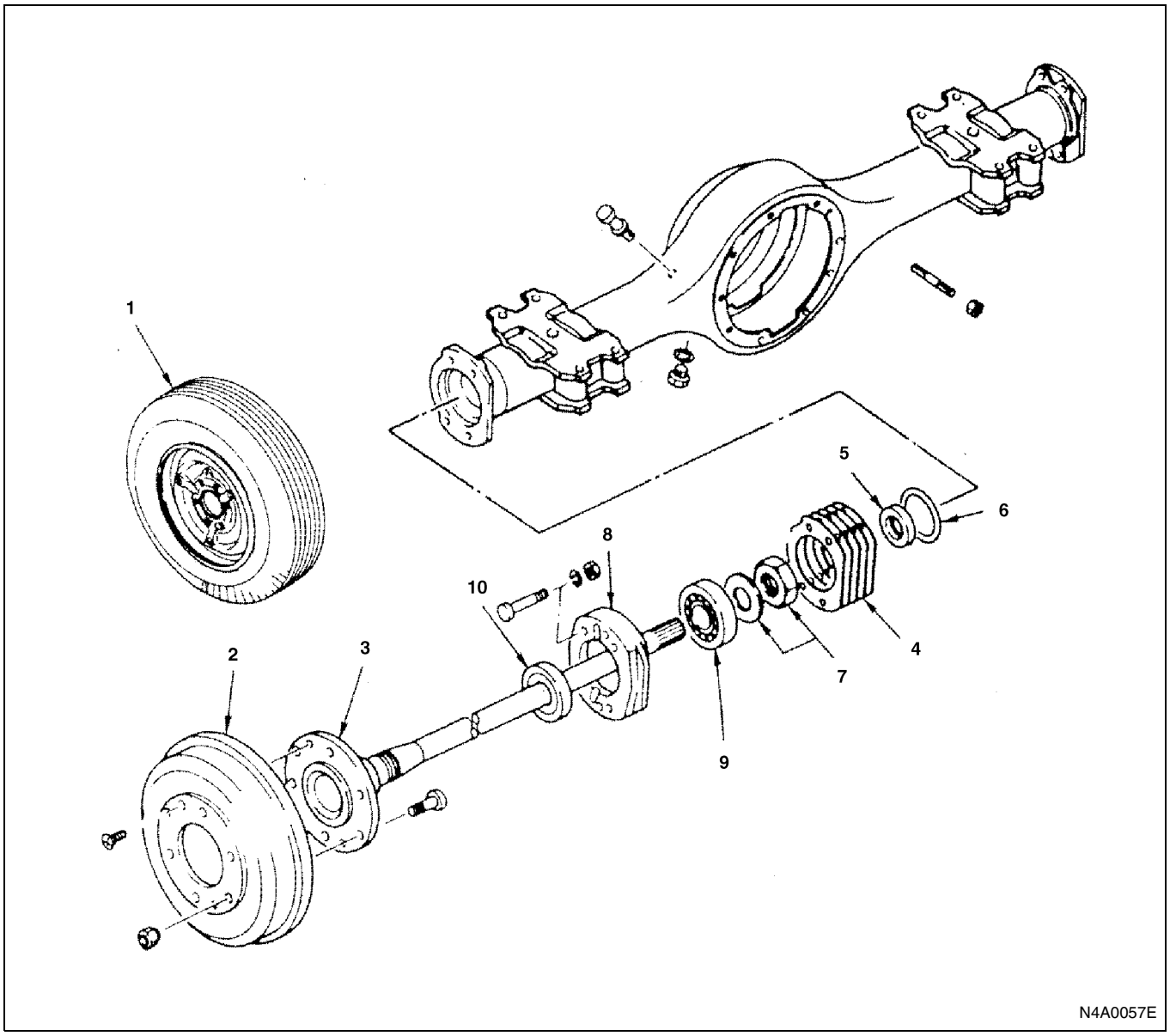


N4A0056E

ON-VEHICLE SERVICE

Rear Hub and Brake Drum (NHR Model; Semi Floating)

Single Tire

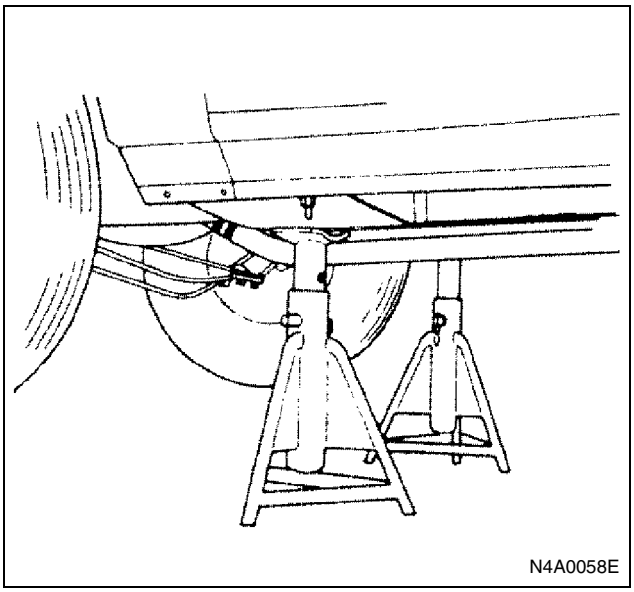


Legend

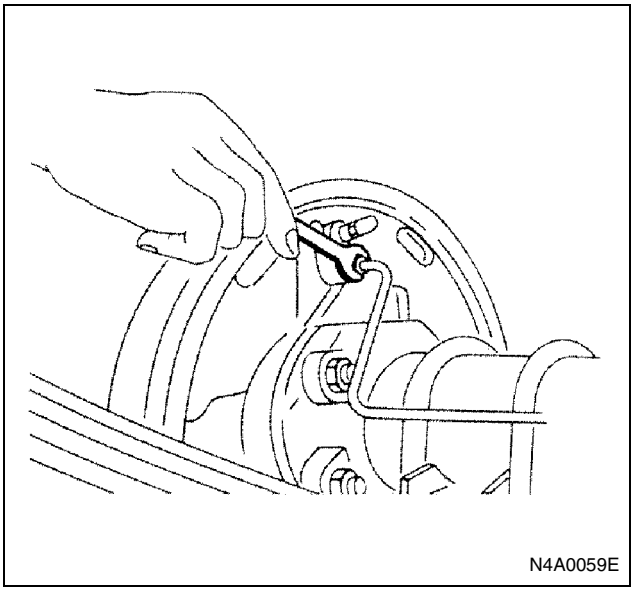
1. Wheel and tire
2. Brake drum
3. Axle shaft with brake assembly
4. Shim
5. Axle case oil seal
6. O-ring
7. Bearing lock nut and washer
8. Bearing holder
9. Bearing
10. Oil seal

Removal

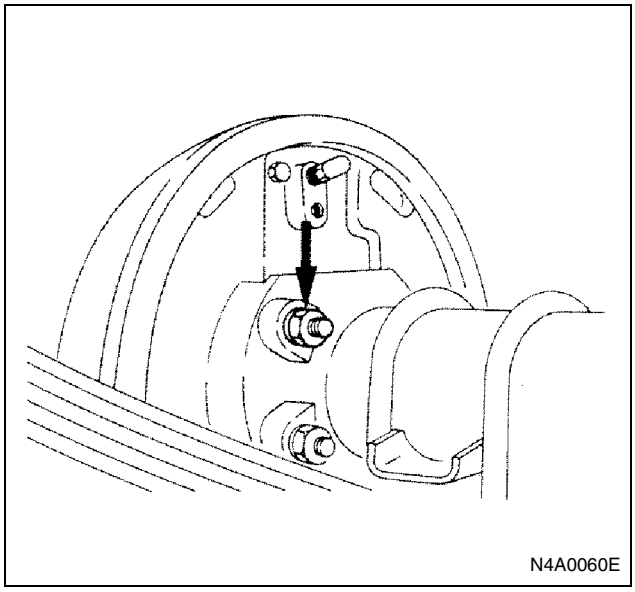
Preparation:
Raise vehicle to working level.
Support the axle assembly with a suitable jack and chassis stands.


N4A0058E

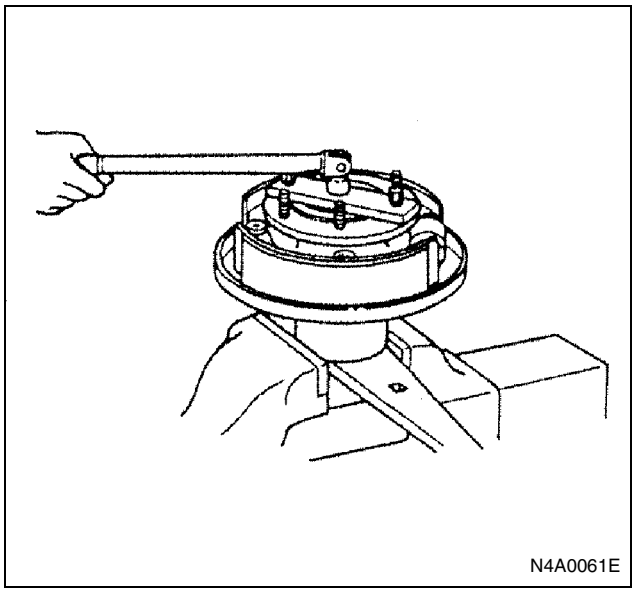
1. Wheel and Tire
2. Brake Drum
   Before disassembly of axle shaft assembly, disconnect the following parts.
   Disconnect the brake pipe from brake wheel cylinder on the back plate.


N4A0059E

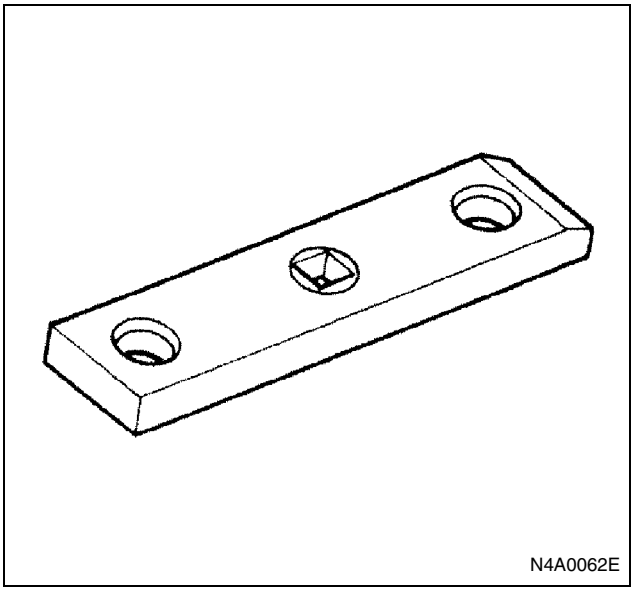
3. Axle Shaft with Brake Assembly
   Remove four nuts from the bearing holder fixing-bolts.


N4A0060E

4. Shim
5. Axle Case Oil Seal
6. O-ring
7. Bearing Lock Nut and Washer
   1) Flatten the locking portion on the lock nut.
   2) Clamp special tool; wrench into vise, and mount axle shaft into wrench.
      Wrench: 5-8840-2329-0
   3) Install special tool onto flange studs, lock into position with two wheel nuts, and turn axle shaft loose from lock nut.
      Remover: 5-8840-2003-0

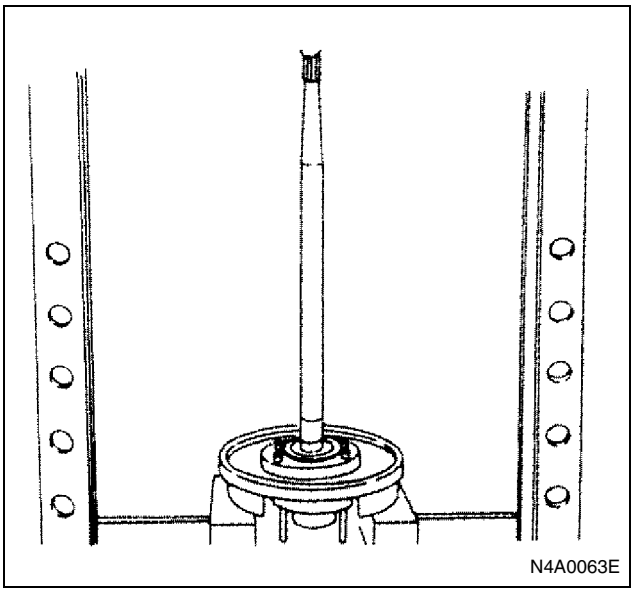

N4A0061E

Notice:
Because of the high torque on the locknut, it is sometimes advantageous to have an assistant when performing this operation.

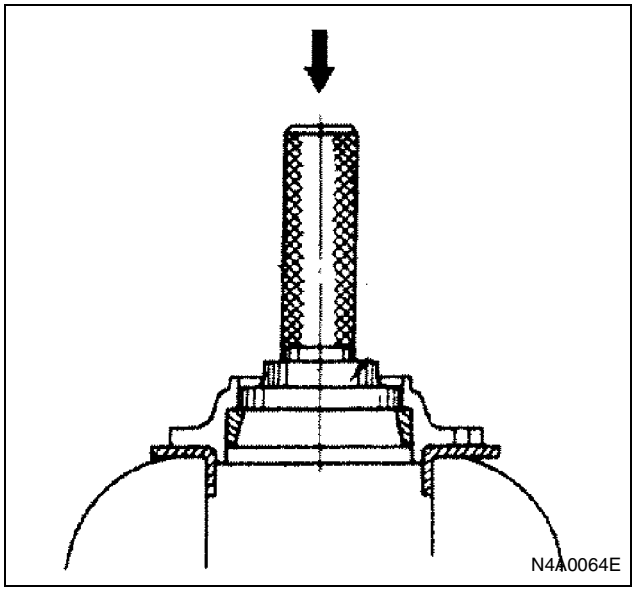


8. Bearing Holder
   Remove the bearing holder and bearing from the axle shaft by means of a press.

Notice:
Only a slight amount of pressure from the press is required to loosen bearing from the shaft. Be sure to support the backing plate solidly, and to hold onto the axle shaft to prevent it from falling to the floor.



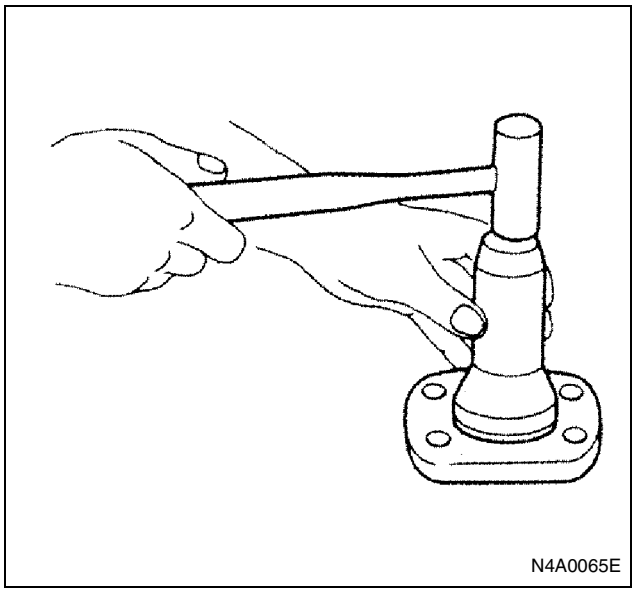
9. Bearing
   Drive out the bearing outer race using a special tool.
   Remover: 9-8521-1772-0
   Grip: 9-8522-1148-0



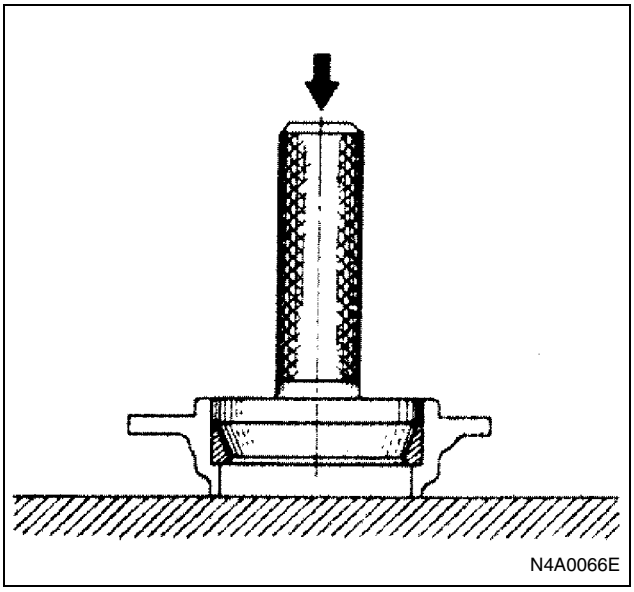
10. Oil Seal

Installation

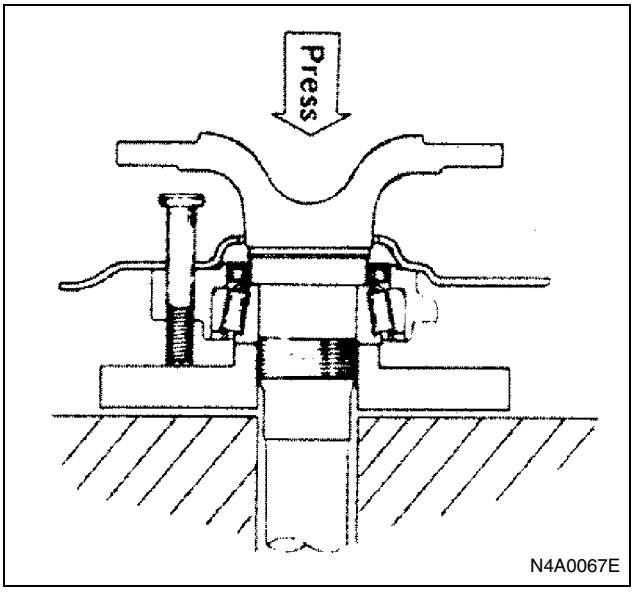
1. Oil Seal
   Installer: 9-8522-1269-0



2. Bearing
   Installer: 9-8522-1268-0
   Grip: 9-8522-1148-0
   Apply generous amount of grease to the bearing inner race.


N4A0066E

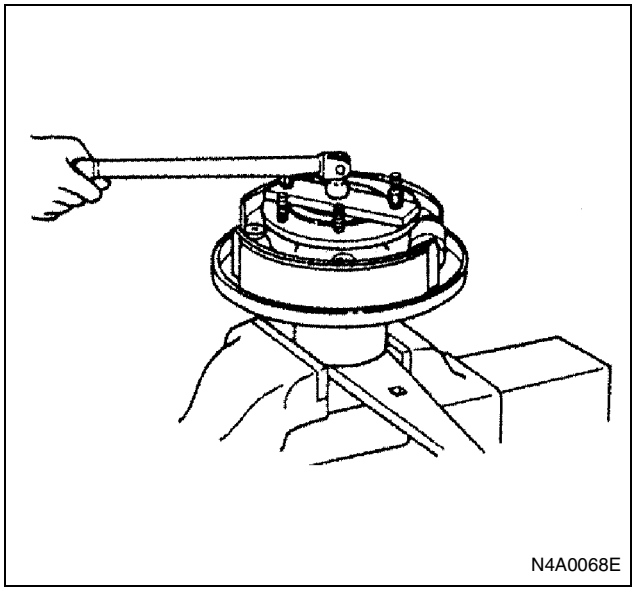
3. Bearing Holder
   1) Insert four through-bolts into back plate.
   2) Install bearing holder to back plate.
   3) Install the above parts onto the axle shaft.
   4) Install bearing over axle shaft and press into bearing holder.
      Installer: 9-8522-1271-0



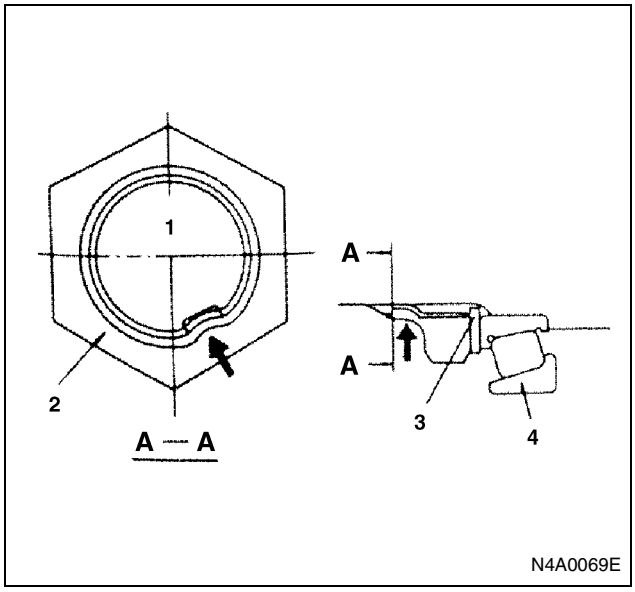
N4A0067E

4. Bearing Lock Nut and Washer
   1) Install the washer with the washer tab inserted to the groove on the axle shaft.
   2) Discard used bearing lock nut and install a new one into the position by using a vise and special tools.
      Installer: 5-8840-2003-0
      Wrench: 5-8840-2329-0

Tighten:
Bearing lock nut to 260 N·m (26.5 kg·m / 192 lb·ft)


N4A0068E

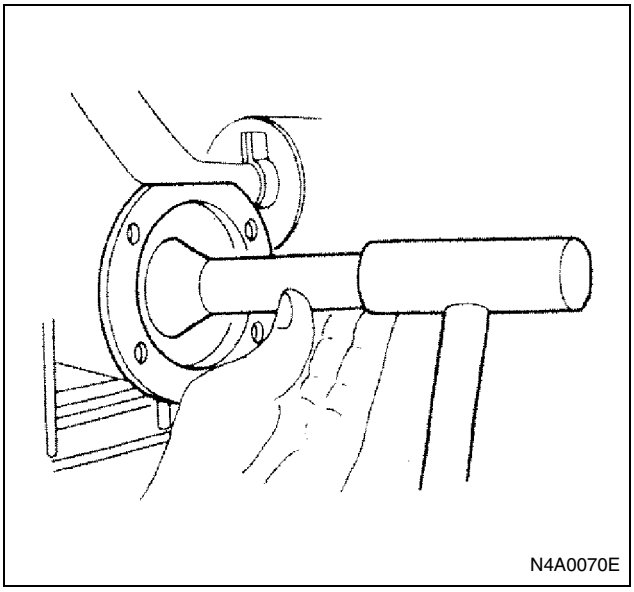
   3) Stake the bearing lock nut at groove portion on the axle shaft.



N4A0069E

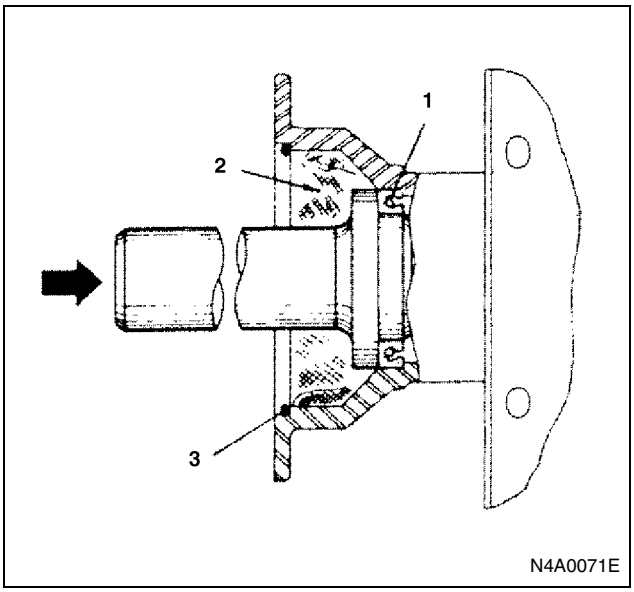
Legend
1. Axle shaft
2. Nut
3. Bearing lock nut
4. Bearing

5. O-Ring
6. Oil seal; Axle Case
   1) Installer: 9-8522-1272-0


N4A0070E

2) Apply measured amount of good quality grease to the inner face of the rear axle case.

Type of grease: Wheel bearing grease of Multipurpose type grease
Amount of grease required: 80 g (2.8 oz)

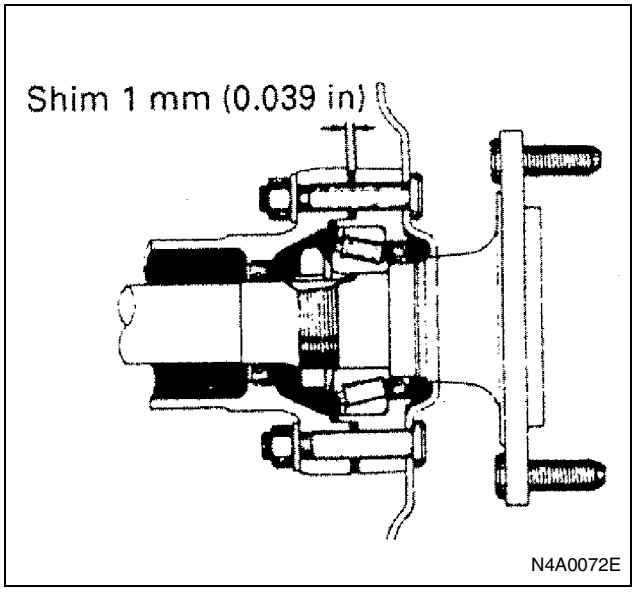


N4A0071E

Legend
1. Oil seal
2. Grease
3. O-ring

7. Shim
   Install the axle shaft assembly to the axle case with a 1 mm (0.039 in) thick shim fitted in position between the bearing holder and axle case flange. Install and tighten the bolts evenly in progression.

Tighten:
Bearing holder nut to 74 N·m (7.5 kg·m / 54 lb·ft)



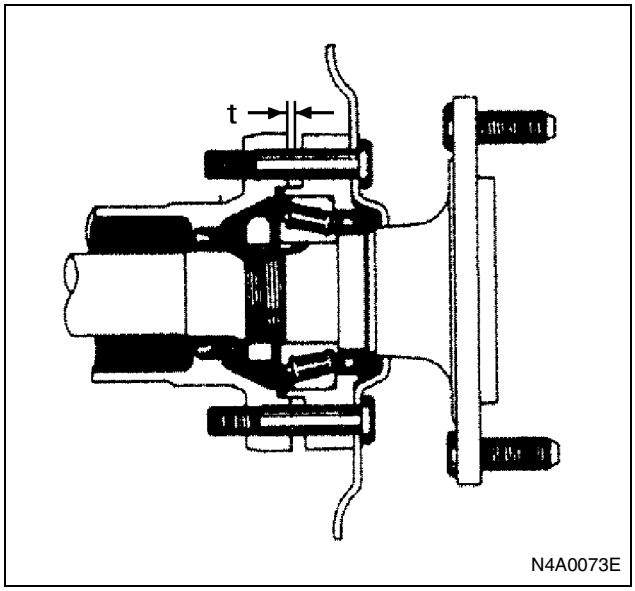
N4A0072E

Install the axle shaft assembly on the opposite side and push it in until it is fitted against the differential thrust block.

Then, measure the clearance (t) between the bearing holder and axle case flange and determine the thickness of the shim to be installed by the following formula:

Measured clearance (t) + 0.3 mm (0.012 in.) = thickness of shim to be installed.

Thickness of shims available, 0.05, 0.076, 0.13, 0.5, 1.0 mm (0.002, 0.003, 0.005, 0.02, 0.04 in)



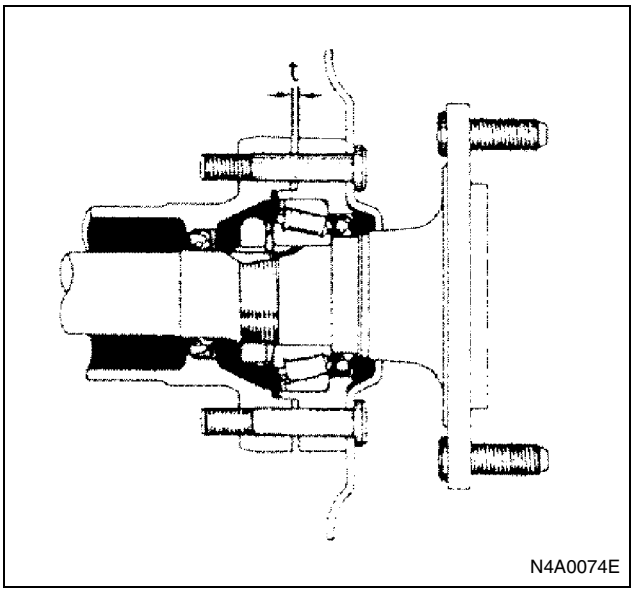
N4A0073E

8. Axle Shaft with Brake Assembly

Tighten:
Bearing holder nut to 74 N·m (7.5 kg·m / 54 lb·ft)

- Connect the brake pipes to wheel cylinder.
- Brake air bleeding, refer to servicing to Section 5 “Brake”.

Notice:
To install the axle shaft assembly, follow the reassembly procedure outline under the Section 5 “Brake”.

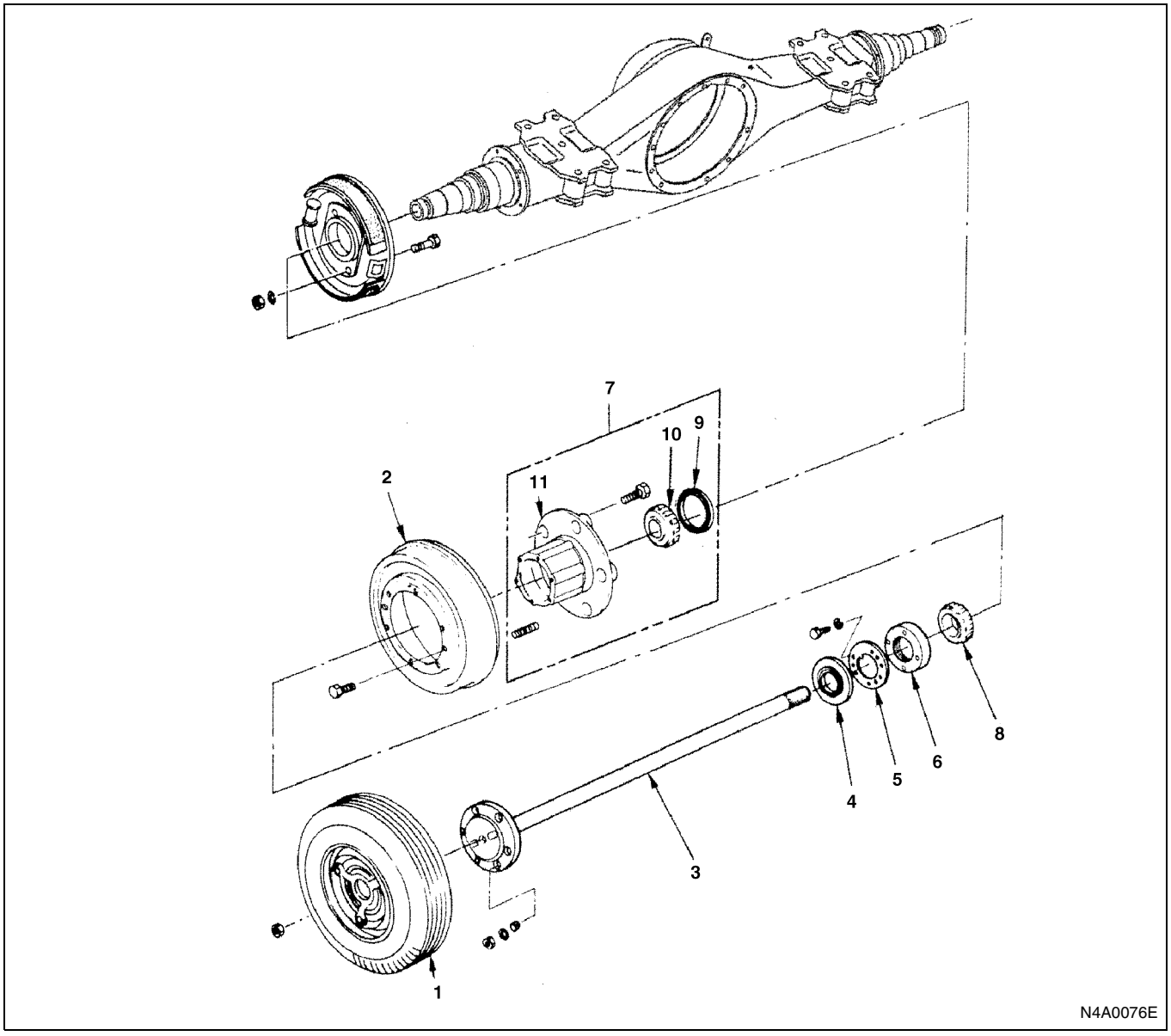


9. Brake Drum
10. Wheel and Tire

Tighten:
Wheel nut to 167 N·m (17 kg·m / 123 lb·ft)

Rear Hub and Brake Drum (NKR Model; Full Floating)

Single Tire



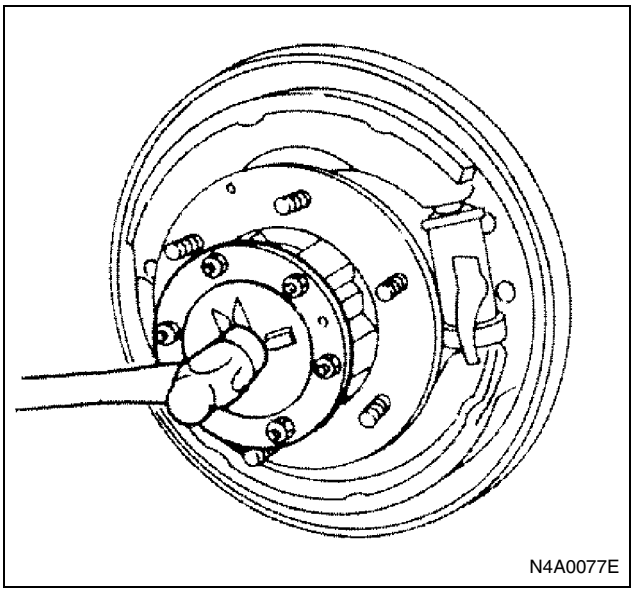
Legend

1. Wheel and tire
2. Brake drum
3. Axle shaft
4. Outer oil seal
5. Lock washer
6. Bearing lock nut
7. Hub assembly
8. Outer bearing
9. Inner oil seal
10. Inner bearing
11. Hub

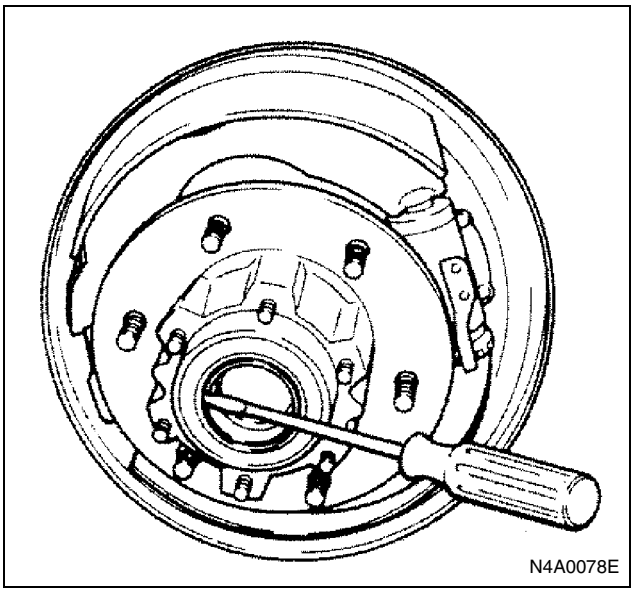
Removal

Preparation:
Jack up and support the vehicle on stands.

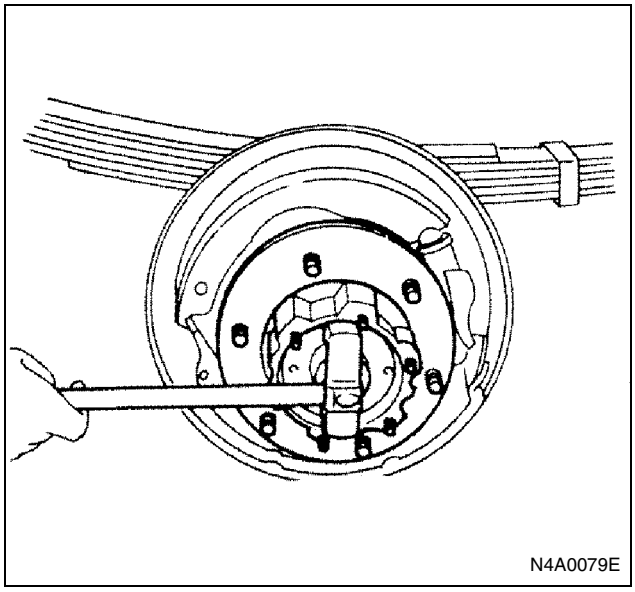
1. Wheel and Tire
2. Brake Drum
3. Axle Shaft
   Remove the collar by tapping on the upper face of the axle shaft with a hammer, then remove the axle shaft.


N4A0077E

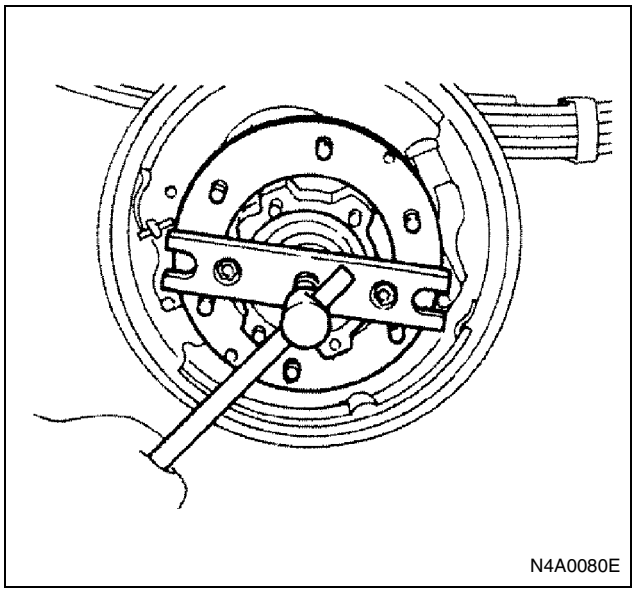
4. Outer Oil Seal
   Take out the hub outer oil seal using a screwdriver.


N4A0078E

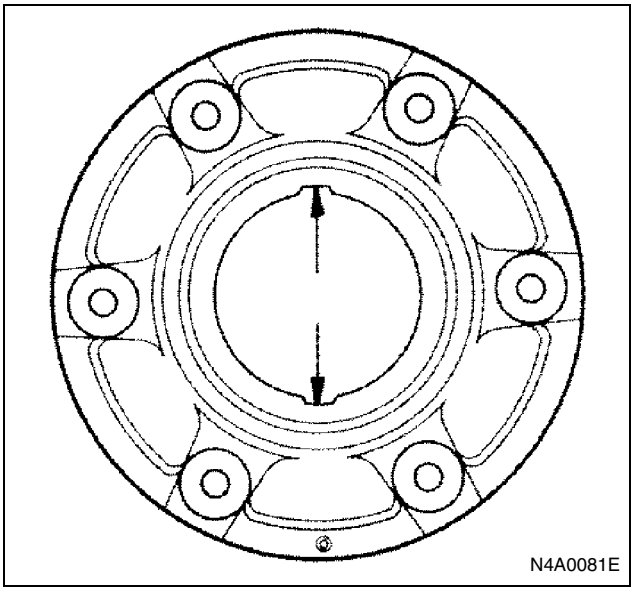
5. Lock Washer
6. Bearing Lock Nut
   Wrench: 9-8522-1188-0


N4A0079E

7. Hub Assembly
   Remover: 9-8521-0116-0
   If the hub inner bearing and the hub inner oil seal remain on the axle tube, remove the hub inner bearing using a special tool.
   Remover: 9-8521-0092-0


N4A0080E

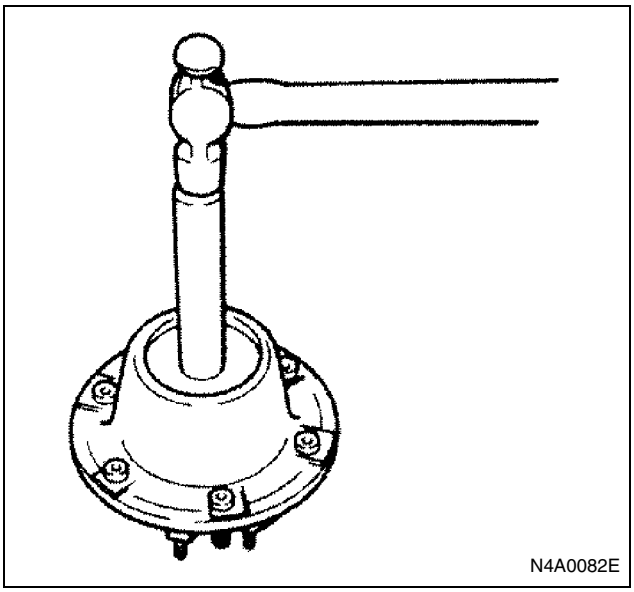
8. Outer Bearing
9. Inner Oil Seal
10. Inner Bearing
    Drive out the hub inner bearing outer race together with the hub inner bearing inner race and the hub inner oil seal by using a proper bar through two notches.



11. Hub

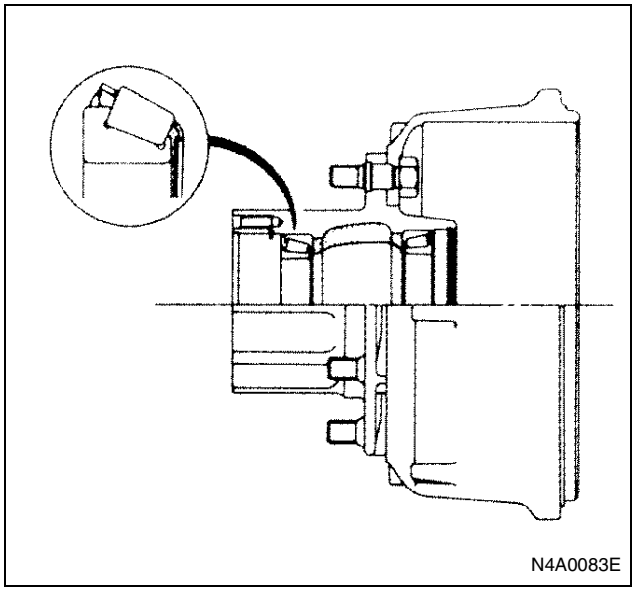
Installation

1. Hub
2. Inner Bearing
   Install the bearing outer race.
   Installer: 9-8522-1194-0
   Grip: 9-8522-1148-0
   If removed outer bearing outer race, install the bearing outer race.
   Installer: 9-8522-1195-0
   Grip: 9-8522-1148-0

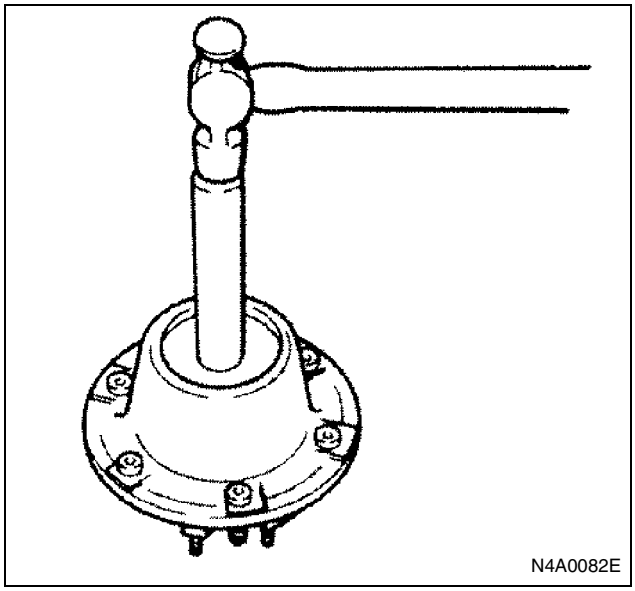


   Apply specified grease into the bearing and grease well in the hub.

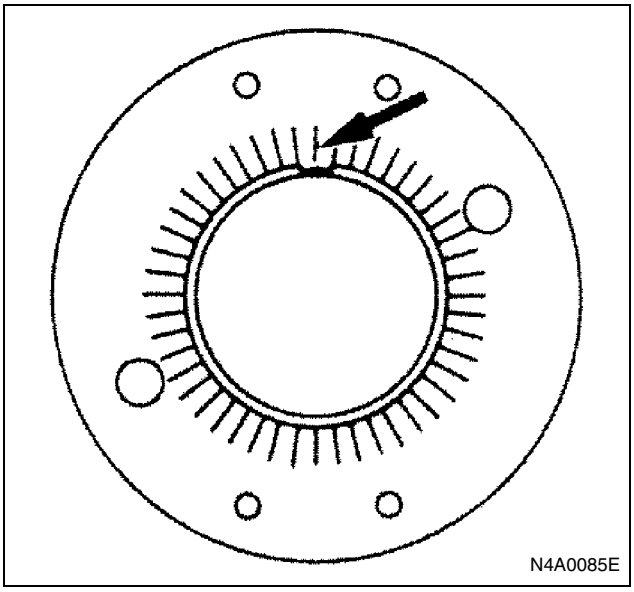
Amount of grease: 280 g (9.8 oz)



3. Inner Oil Seal
   Installer: 9-8522-1607-0
   Grip: 9-8522-1608-0



4. Outer Bearing
5. Hub Assembly
6. Bearing Lock Nut
   1) Install the bearing nut, so that its side with notched line is turned outward.
      The forty eight (48) slits are provided on the bearing nut, to ensure locking and easy maintenance.

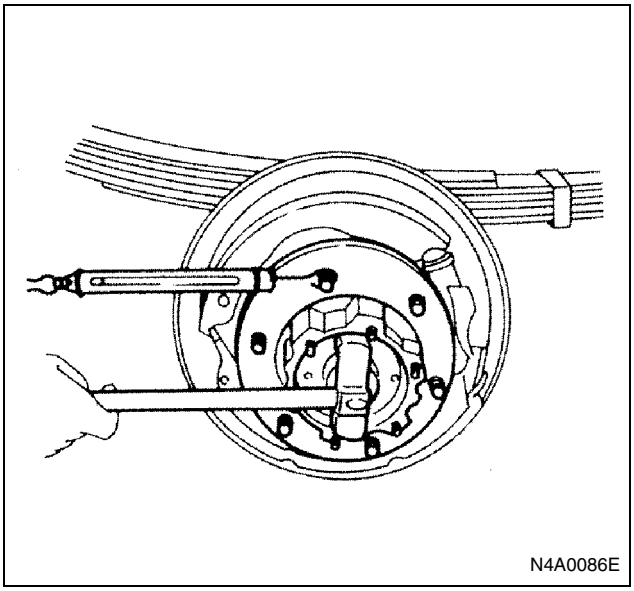


2) Align notched line on the bearing nut with the center of groove in the axle case, so that two threaded holes in the bearing nut line up with two holes in the lock washer.
Wrench: 9-8522-1188-0

3) Adjustment of wheel bearing preload.

Bearing preload (at wheel pin), 42 — 52 N (4.3 — 5.3 kg / 9.5 —11.7 lb)

4) While the wheel bearing pre-load is adjusted, if the notched line on the bearing nut is not aligned with the groove on the axle case, adjust to turn the lock nut clockwise to align.



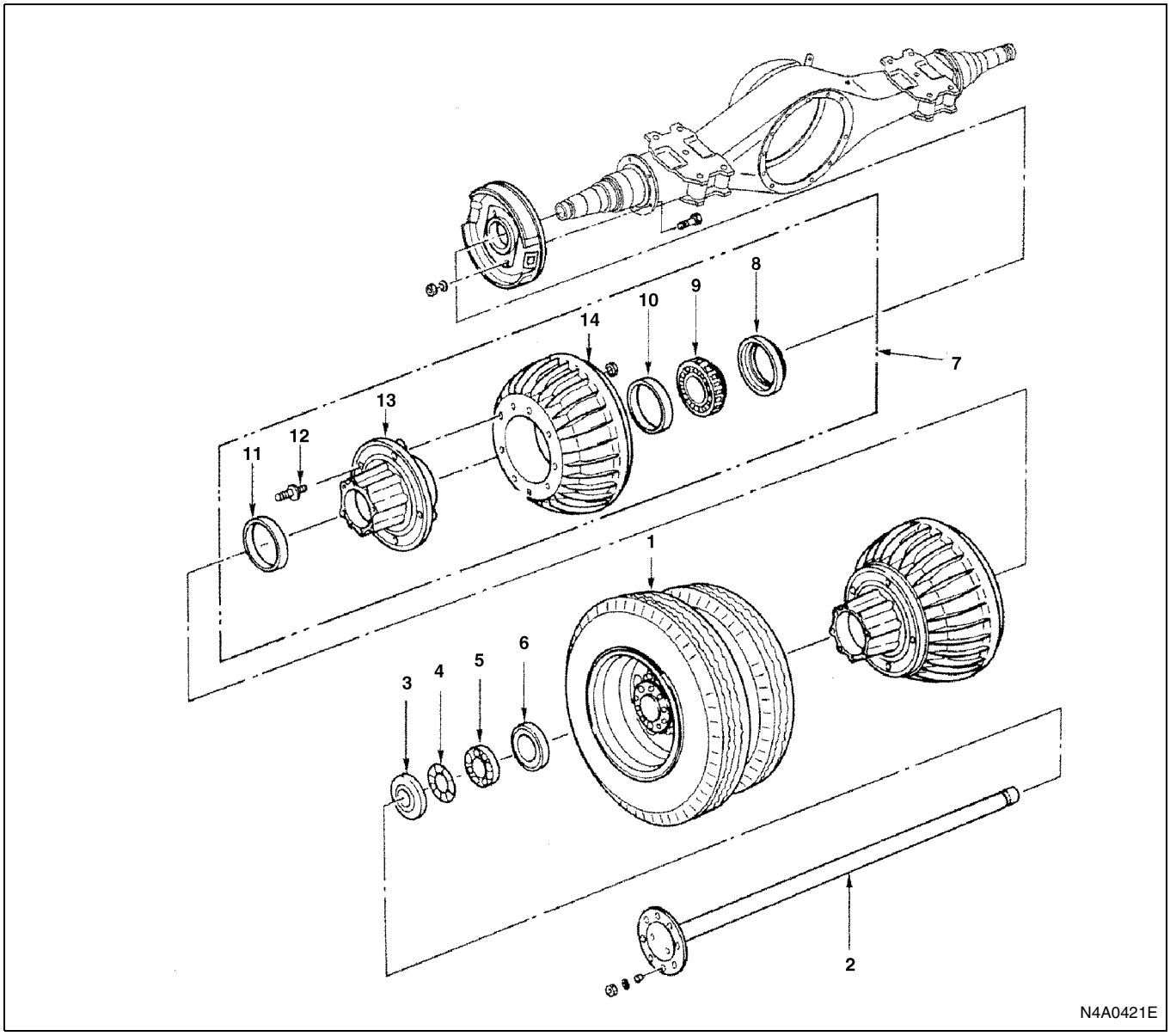
7. Lock Washer
   Install lock washer and fix it to the bearing nut by the lock bolt. The lug of lock washer should be inserted to the groove on the axle case.
8. Outer Oil Seal
9. Axle Shaft

Tighten:
Axle shaft nut to 46 N·m (4.7 kg·m / 34 lb·ft)

10. Brake Drum
11. Wheel and Tire

Tighten:
Wheel nut to 167 N·m (17 kg·m / 123 lb·ft)

Rear Hub and Brake Drum (NHR, NKR, NQR, NPS Models; Full Floating)

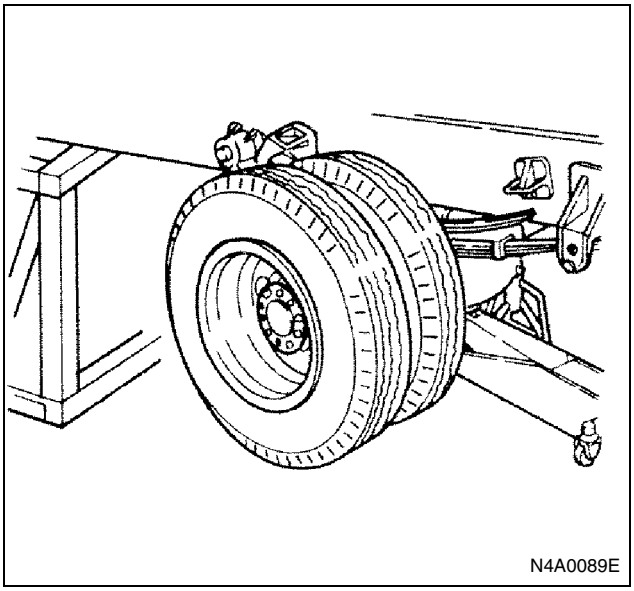


Legend

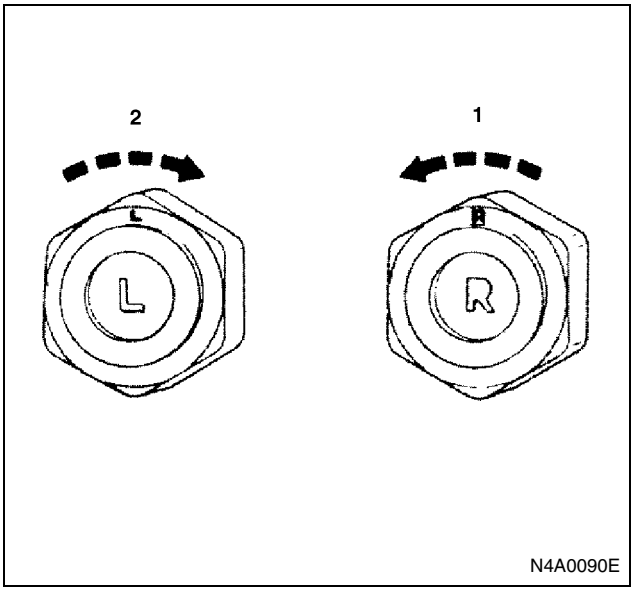
1. Wheel and tire
2. Axle shaft
3. Outer oil seal
4. Lock washer
5. Bearing lock nut
6. Outer bearing
7. Hub and brake drum
8. Inner oil seal
9. Inner bearing
10. Inner bearing outer race
11. Outer bearing outer race
12. Wheel pin
13. Hub
14. Brake drum

Removal

Preparation:
Jack up and support the vehicle on stands.

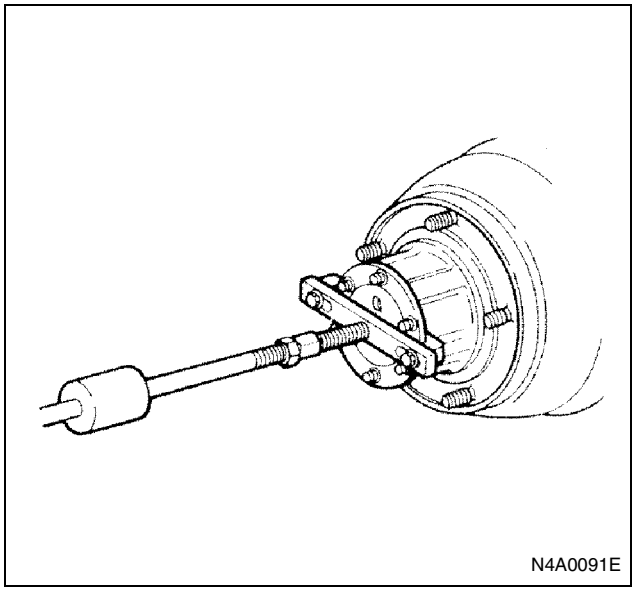

N4A0089E

1. Wheel and Tire
   Right side wheel nut (1) have right hand threads and left side wheel nut (2) have left hand threads.

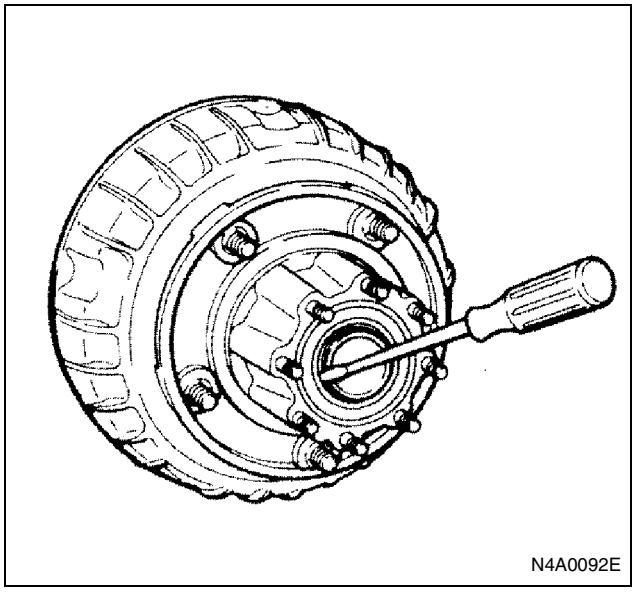


N4A0090E

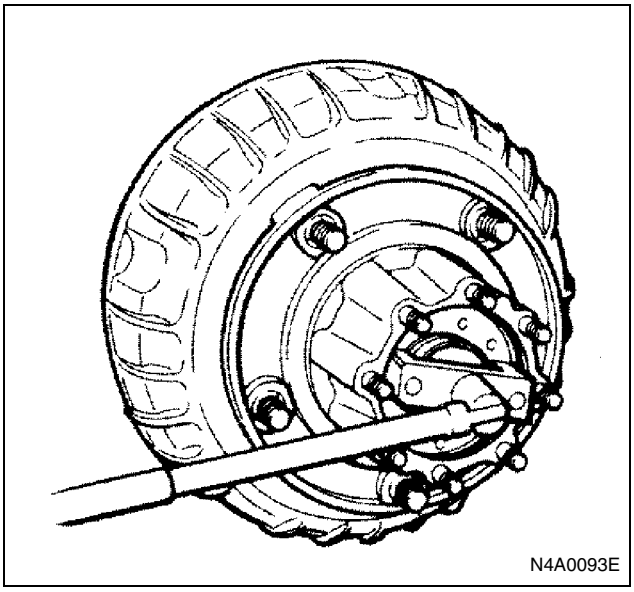
2. Axle Shaft
   Use the axle shaft remover and the sliding hammer to remove the axle shaft.
   Axle Shaft Remover: 5-8840-2027-0
   Sliding Hammer: 5-8840-0084-0


N4A0091E

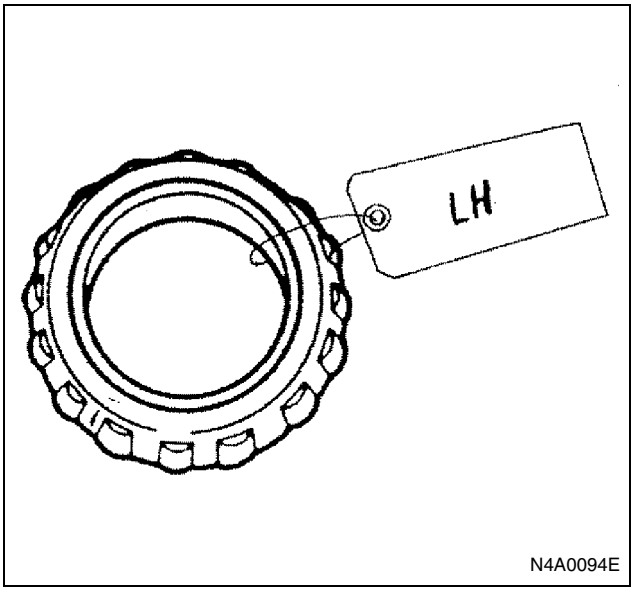
3. Outer Oil Seal
   Use a pry bar to pry the oil seal from the axle case.


N4A0092E

4. Lock Washer
5. Bearing Lock Nut
   Use the lock nut remover to remove the lock nut.
   Lock Nut Remover:
   9-8522-1188-0 (For lock bolt P.C.D. 70 mm (2.8 in.))
   9-8522-1606-0 (For lock bolt P.C.D. 74 mm (2.9 in.))

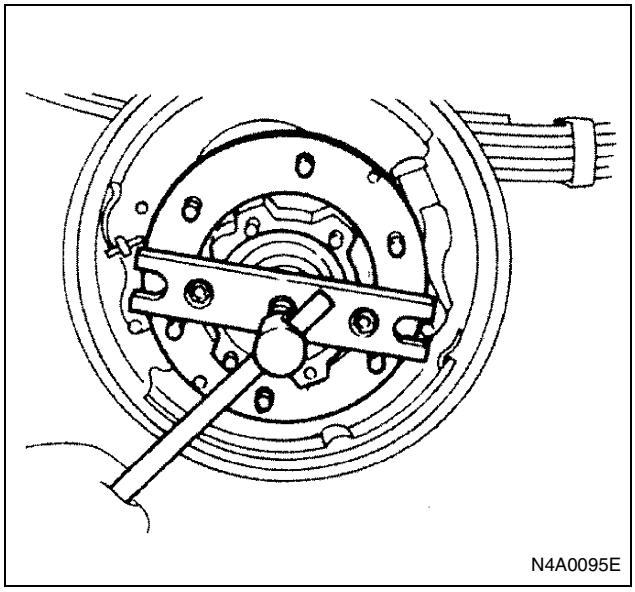

N4A0093E

6. Outer Bearing
   If the bearings are to be reinstalled, tag each bearing with the fitting position from which it was removed.

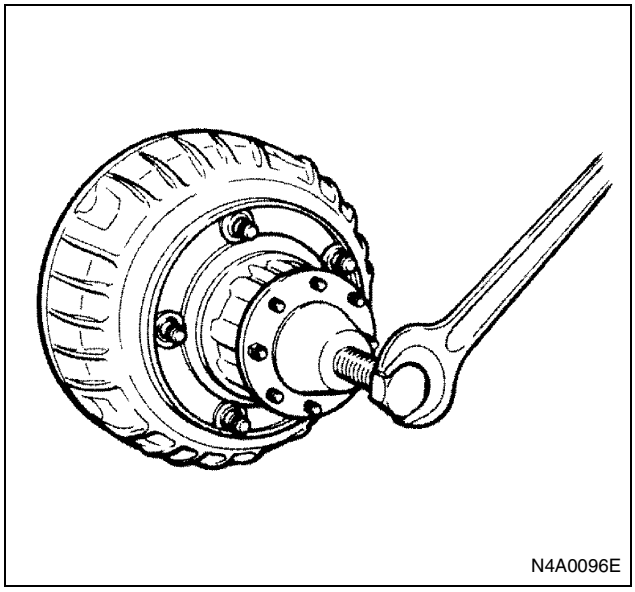


N4A0094E

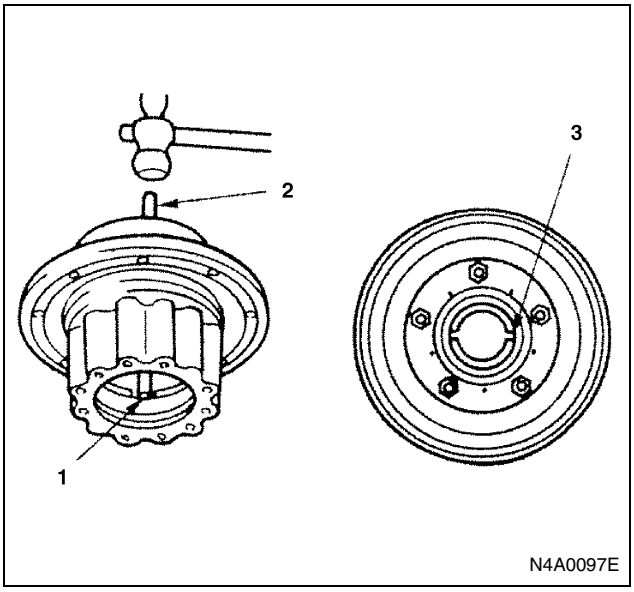
7. Hub and Brake Drum
   Use the rear hub remover to remove the hub and the brake drum.
   Rear Hub Remover:
   9-8521-0116-0 (For NHR, NKR Flat Low)


N4A0095E

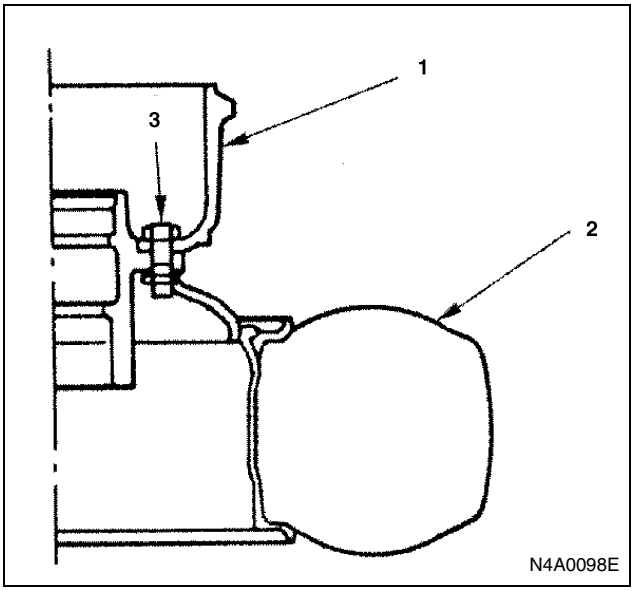
   Rear Hub Remover:
   9-8521-2501-0 (For except NHR, NKR Flat Low)


N4A0096E

8. Inner Oil Seal
9. Inner Bearing
10. Inner Bearing Outer Race
11. Outer Bearing Outer Race
    Use a hammer and a brass bar (2) to drive the outer races (3) from the hub (1) at the two points shown in the illustration.



12. Wheel Pin
    1) Set the rear hub with brake drum (1) to the wheel with tire (2) previously removed from the vehicle.
       Turn the wheel pin nuts (3) counterclockwise to loosen them.
    2) The pin nuts are loosened counterclockwise on both sides of the vehicle.



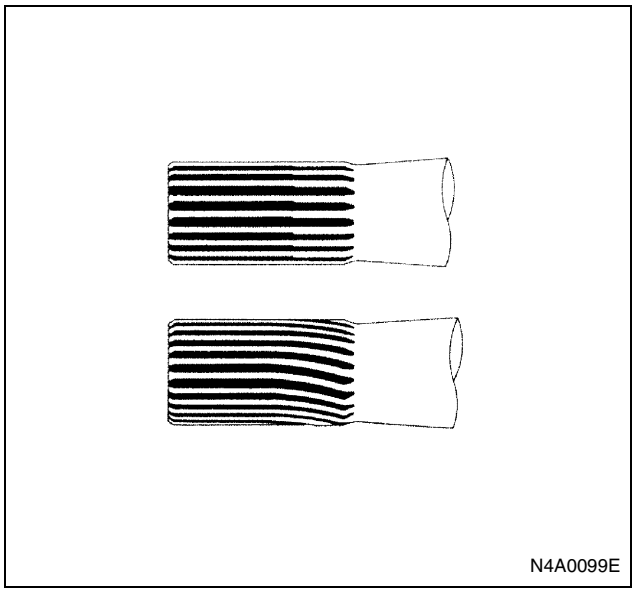
    3) Remove the brake drum from the rear hub.
    4) Discard the wheel pins and nuts.
       The wheel pins and nuts cannot be reused.
13. Hub
14. Brake Drum

Inspection and Repair

Make necessary adjustments, repairs, and part replacement if excessive wear or damage is discovered during inspection.

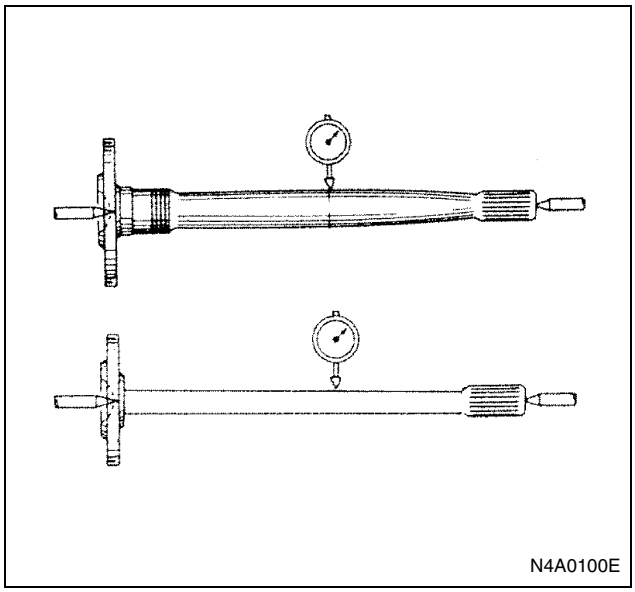
Axle Shaft Spline

Inspect the spline for wear, damage or other abnormal conditions.



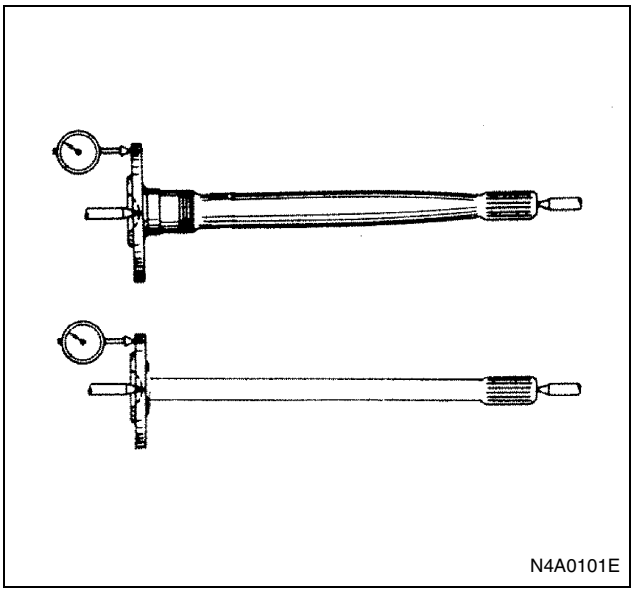
Axle Shaft Run-Out

Limit, 1 mm (0.039 in)



Axle Shaft Flange Run-Out

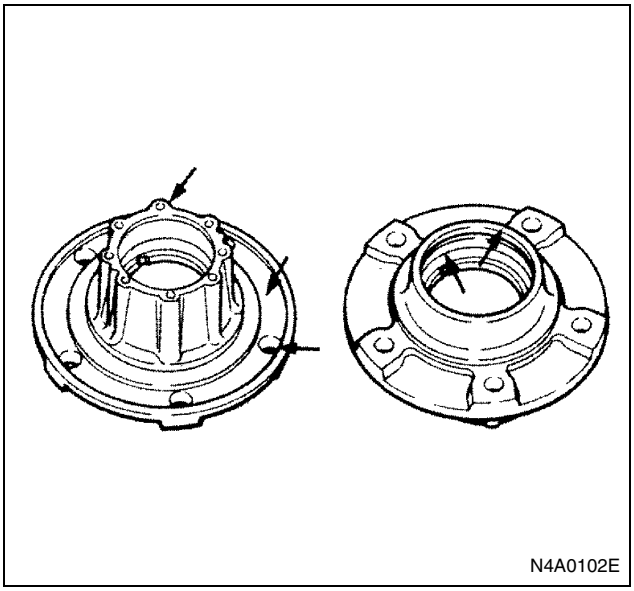
Limit, 0.15 mm (0.00591 in)



Hub

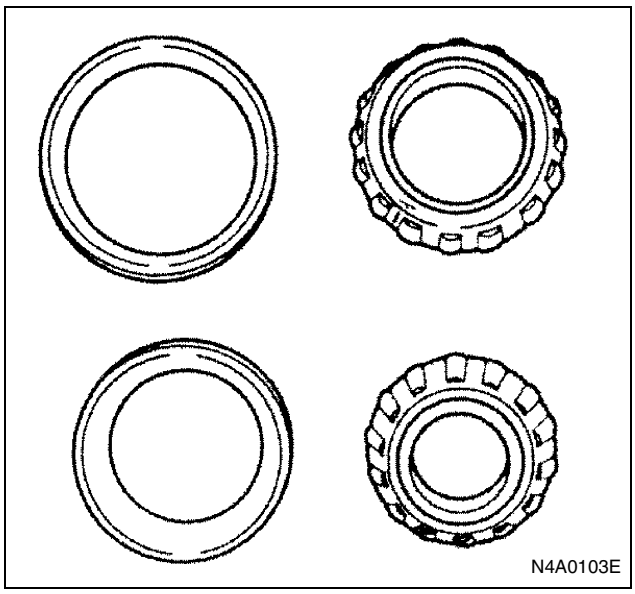
Inspect the oil seal and bearing fitting faces for excessive wear and damage.

Inspect the wheel pin threads and stud bolt threads for excessive damage and cracks.



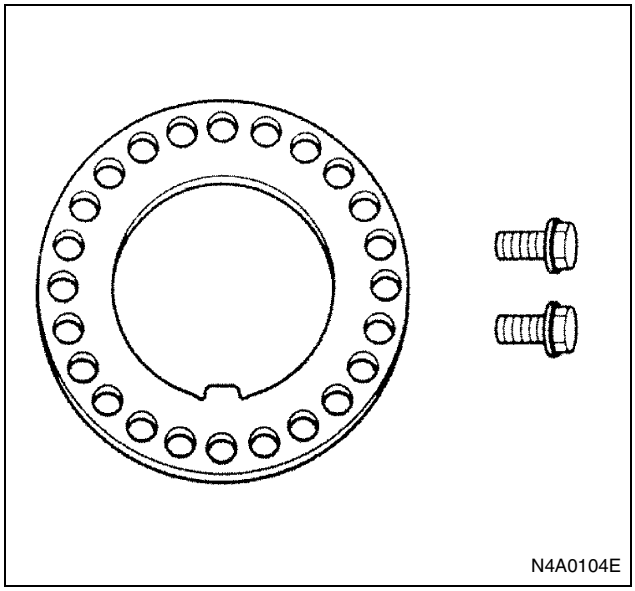
Bearing

Inspect the bearing for excessive wear, abnormal noise, rough rotation, and freezing.



Lock Washer

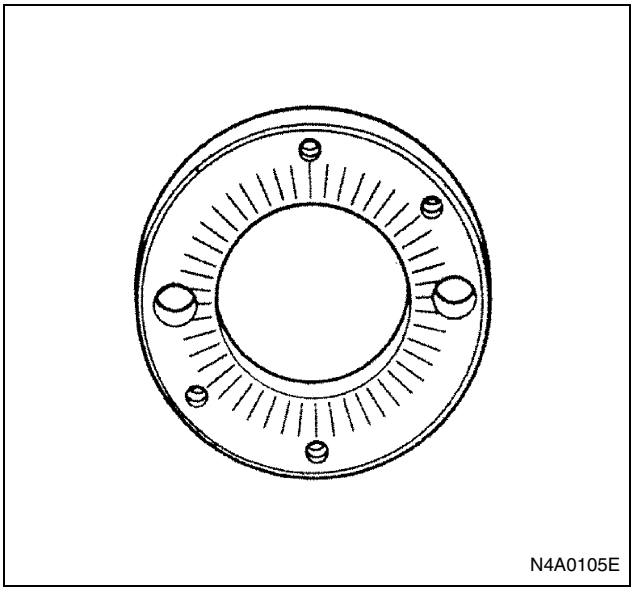
Inspect the lock washer for excessive wear, cracks, warpage, and other damage.



Bearing Lock Nut

Inspect the bearing lock nut threads and contact surfaces for excessive wear, warpage, and other damage.

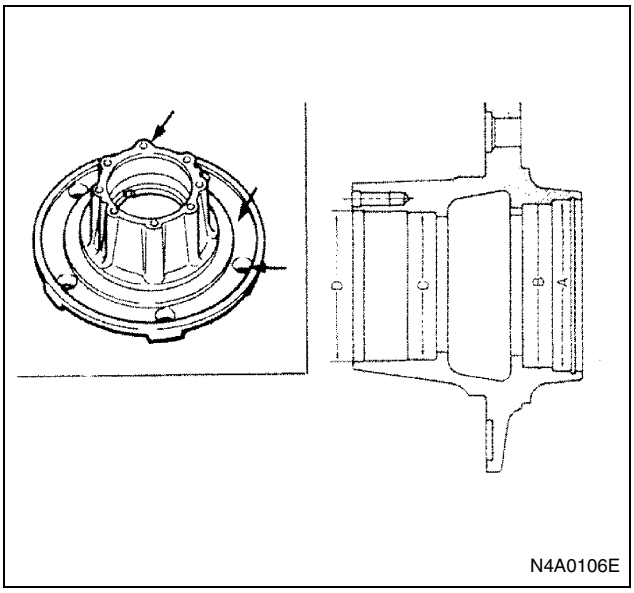
Light damage to the contact surfaces can be repaired with an oil stone or a piece of fine sandpaper.


N4A0105E

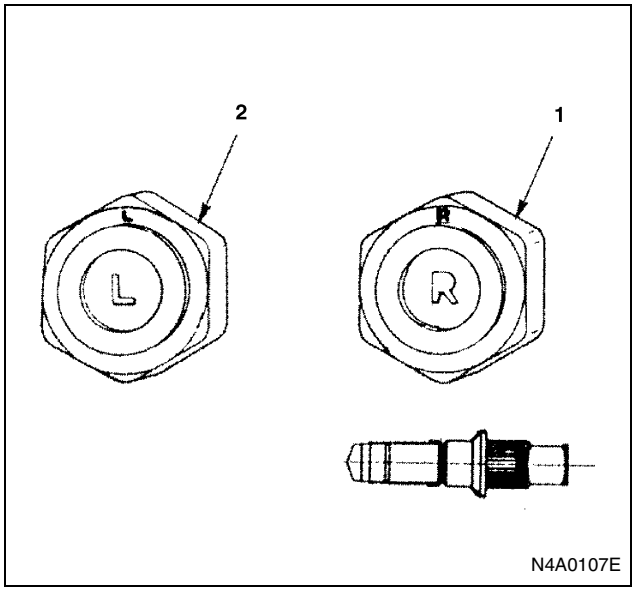
Installation

1. Brake Drum
2. Hub
   1) Clean the hub inside and outside surfaces.
   2) Apply bearing grease to the hub cavity.

Hub bearing grease amount, 285 g (10.1 oz)

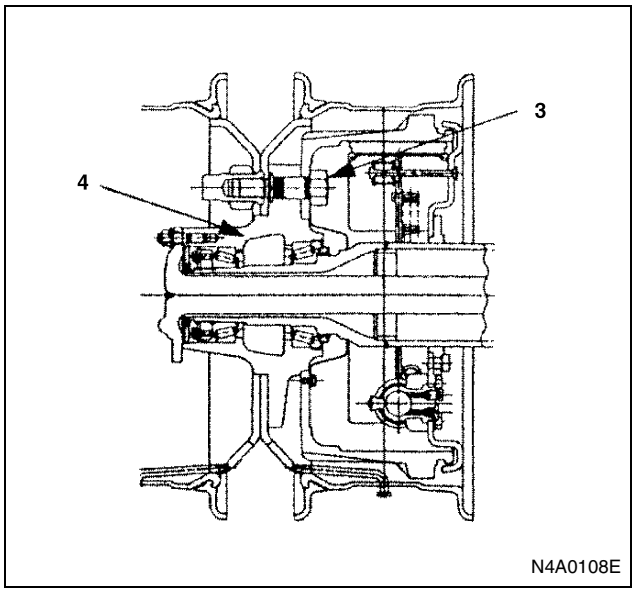

N4A0106E

3. Wheel Pin
   1) Right side hub wheel pins (1) have right hand threads and left side hub wheel pins (2) have left hand threads.



N4A0107E

   2) Install the wheel pins (3) to the hub (4).
   Note the installation direction shown in the illustration.
   Tap the wheel pin into the hub with a hammer.



N4A0108E

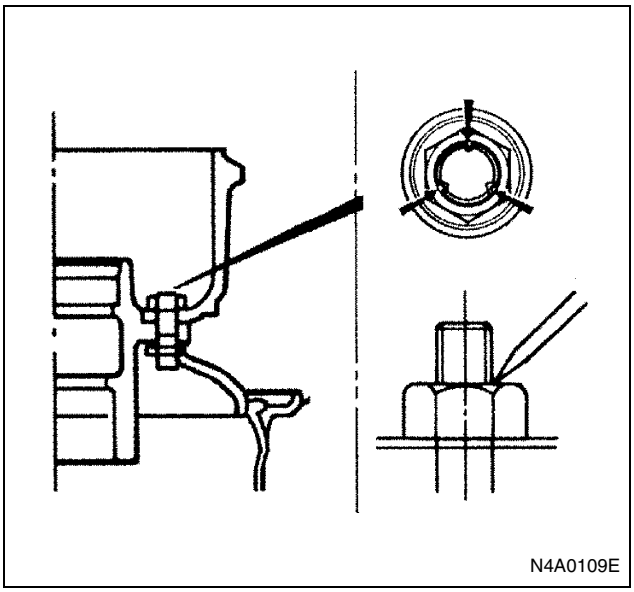
   3) Wheel Pin Nut Torque

Brake drum diameter 228 mm: 206 N·m (21 kg·m / 152 lb·ft)
Brake lining width 75 mm: 343 N·m (35 kg·m / 253 lb·ft)
Brake lining width 100 mm: 392 N·m (40 kg·m / 289 lb·ft)

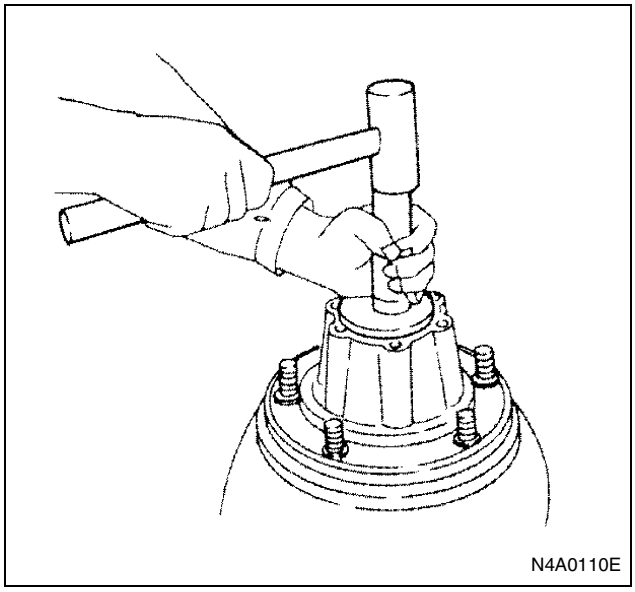
		N·m (kg·m/lb·ft)
(WHLPIN M16 Flange nut)	Brake drum diameter 228 mm / 240 mm / 260 mm	270 (27.6/200)
(WHLPIN M16 Hex nut)	Brake drum diameter 228 mm / 240 mm / 260 mm	235 (24/173)
(WHLPIN M18)	Brake lining width 75 mm / 100 mm	343 (35/253)

		N·m (kg·m/lb·ft)
(WHLPIN M20)	Brake lining width 100 mm / 120 mm	392 (40/289)

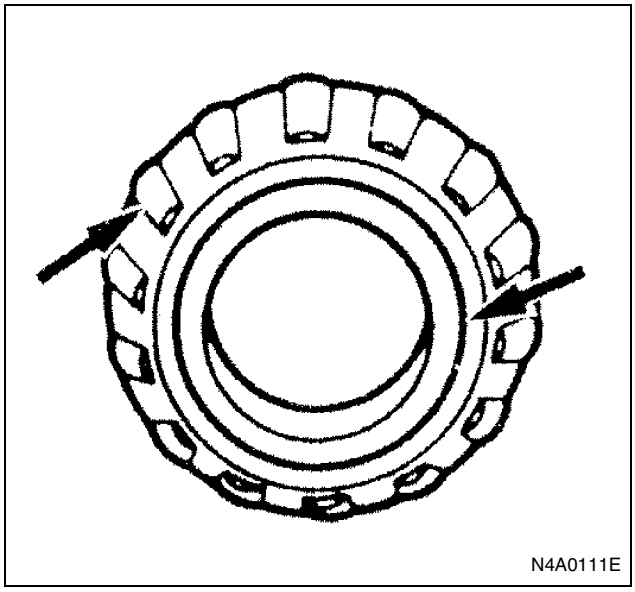
4) Caulk three portions of each wheel nut to prevent them from loosening.


N4A0109E

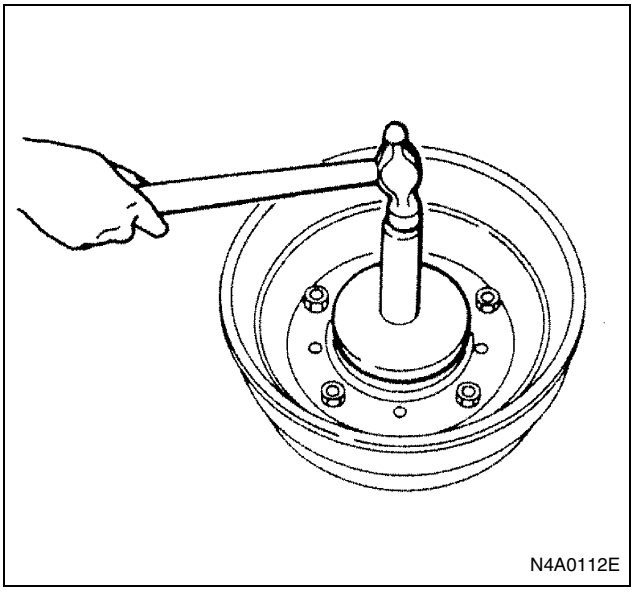
4. Outer Bearing Outer Race
5. Inner Bearing Outer Race
   Use the bearing outer race installer and the drive handle to install the outer race to the hub.
   Outer Bearing Outer Race Installer:
   9-8522-1195-0
   (Outer race outside diameter 92 mm (3.6 in.))
   9-8522-1610-0
   (Outer race outside diameter 97.6 mm (3.8 in.))
   Drive Handle:
   9-8522-1608-0
   Inner Bearing Outer Race Installer:
   9-8522-1194-0
   (Outer race outside diameter 101.6 mm (4 in.))
   9-8522-1609-0
   (Outer race outside diameter 108 mm (4.3 in.))
   5-8840-2426-0
   (Outer race outside diameter 120 mm (4.72 in.))
   Drive Handle:
   9-8522-1148-0


N4A0110E

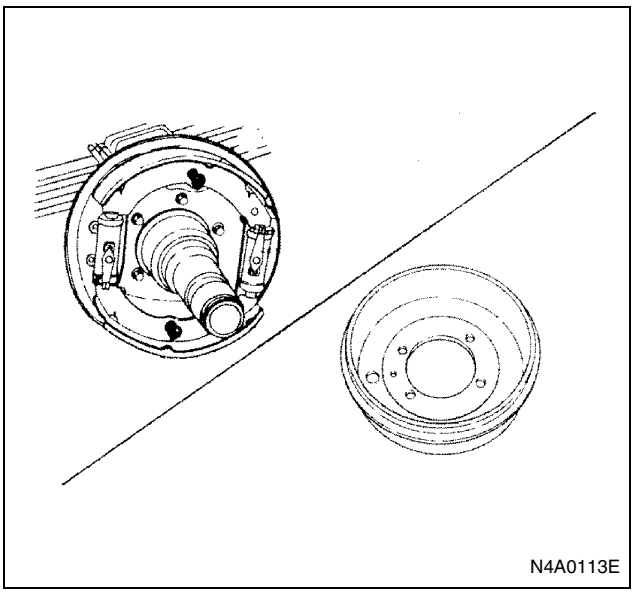
6. Inner Bearing
   Apply an ample coat of bearing grease between the inner race and the roller cage.


N4A0111E

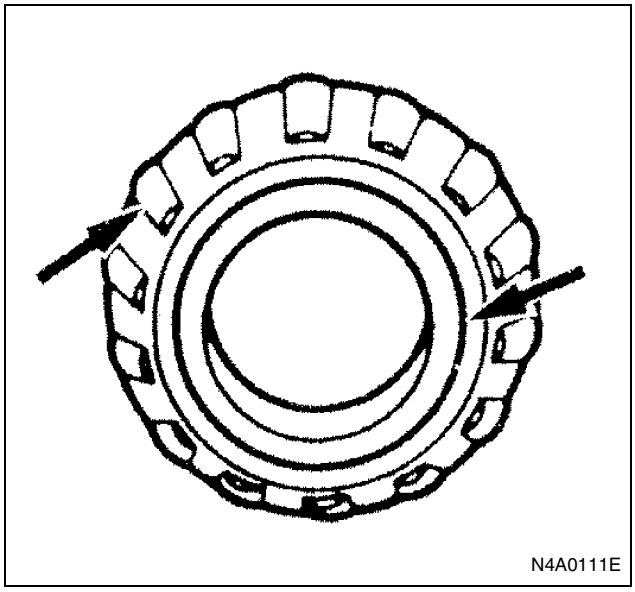
7. Inner Oil Seal
   1) Apply grease to the oil seal lip inner and outer circumferences.
   2) Use the oil seal installer and the drive handle to install the oil seal to the hub.
      Oil Seal Installer:
      9-8522-1607-0 (Except NQR70)
      Oil Seal Installer:
      5-8840-2427-0 (NQR70)
      Drive Handle:
      9-8522-1608-0


N4A0112E

8. Hub and Brake Drum
   1) Wipe away any oil or other foreign material from the brake linings and the brake drum inside surfaces.
   2) Clean the rear axle case tip.
   3) Install the hub assembly to the rear axle case.


N4A0113E

9. Outer Bearing
   Apply an ample coat of bearing grease between the inner race and the roller cage.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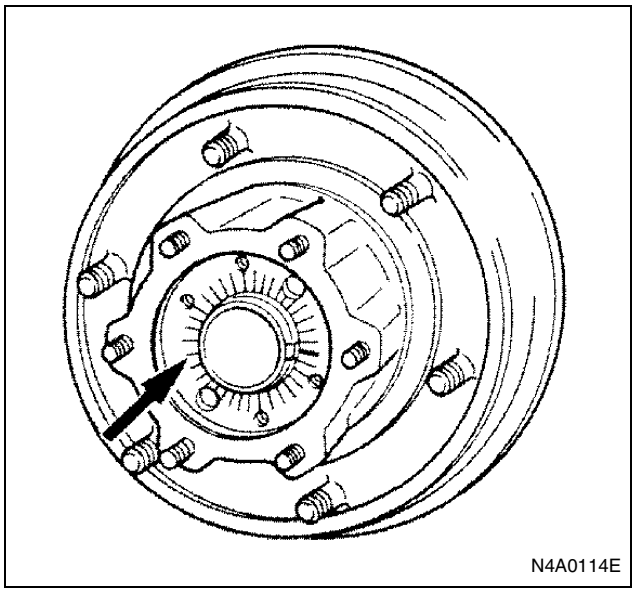
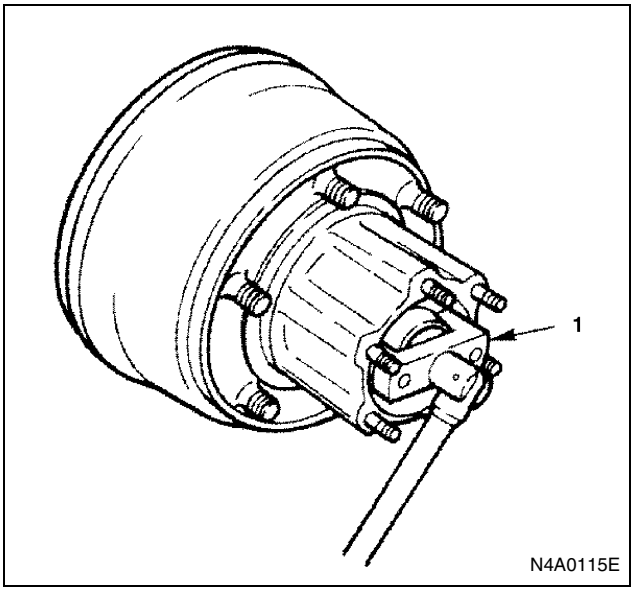
10. Bearing Lock Nut
    Install the lock nut with the notched line facing out.


N4A0114E

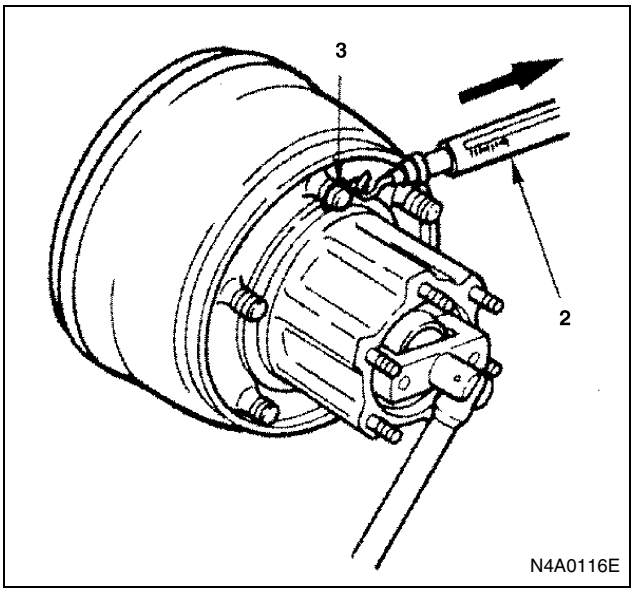
Hub Bearing Preload Measuring Method

1) Turn the hub to the left and right several times to establish bearing conformity.
2) Use the bearing nut wrench (1) to tighten the bearing nut until the hub can not be manually rotated.
   Bearing Nut Wrench:
   9-8522-1188-0 (For lock bolt P.C.D. 70 mm (2.8 in.))
   9-8522-1606-0 (For lock bolt P.C.D. 74 mm (2.9 in.))



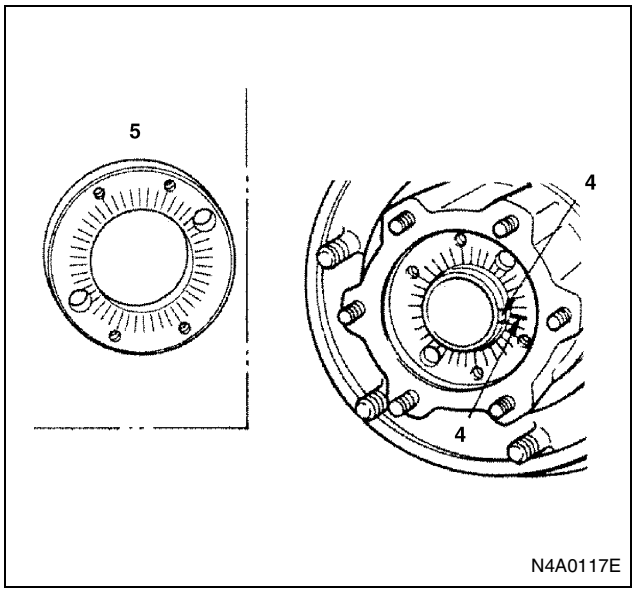
3) Loosen the bearing nut until hub rotates easily.
4) Set the spring balancer (2) to the wheel pin (3) in the position shown in the illustration.
5) Measure the hub bearing preload by carefully pulling on the spring balancer and noting the indicator reading.

Hub Bearing Preload (At Wheel Pin)	N (kg/lb)
P.C.D.139.7	61.1 — 75.6 (6.2 — 7.7/13.7 — 17)
P.C.D.170	50.2 — 62.2 (5.1 — 6.3/11.2 — 13.9)
P.C.D.184.15	46.3 — 57.4 (4.7 — 5.9/10.4 — 13)
P.C.D.203.2	42 — 52 (4.3 — 5.3/ 9.5 — 11.7)
P.C.D.222.25	38 — 48.0 (3.9 — 4.9/ 8.6 — 10.8)



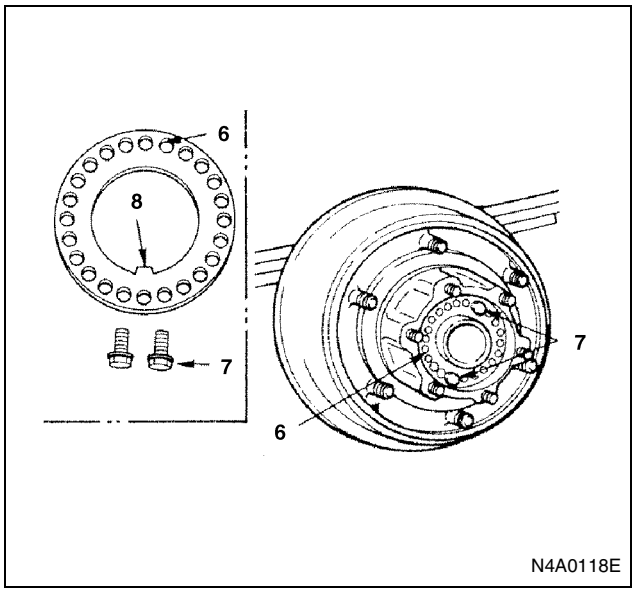
6) Rotate the hub several times to the right and left.
7) Measure the bearing preload a second time.
8) Align the axle case groove with the closest bearing nut slit.

Notice:
If it is difficult to align the axle case and bearing nut, slightly tighten the bearing nut.

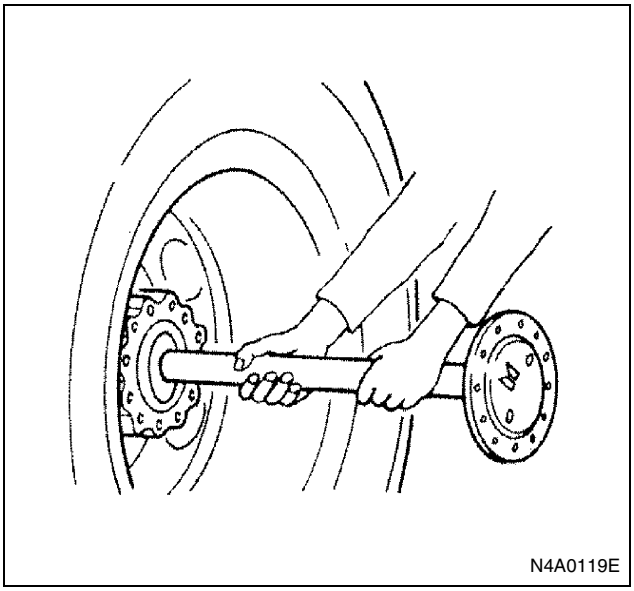


Legend
4. Bearing nut slit
5. Lock nut

11. Lock Washer
    1) Install the lock washer (6) with the lock washer tabs inserted to the axle case grooves.
    2) Install the lock bolts (7) to prevent the bearing nut from loosening.
    3) Check that the lock washer tabs (8) are inserted to the axle case grooves.

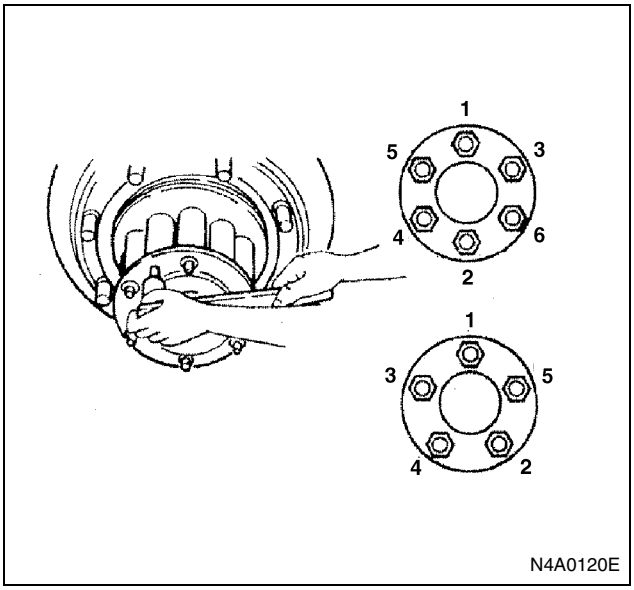


12. Outer Oil Seal
    Apply grease to the oil seal lip inner and outer circumferences.
13. Axle Shaft
    1) Clean the axle shaft.
    2) Apply gear oil to the axle shaft spline.
    3) Insert the axle shaft into the axle case.
       Take care not to damage the oil seal.


N4A0119E

    4) Tighten the axle shaft nuts to the specified torque a little at a time in the numerical order shown in the illustration.

Tighten:
Axel shaft nut to 46 N·m (4.7 kg·m / 34 lb·ft)

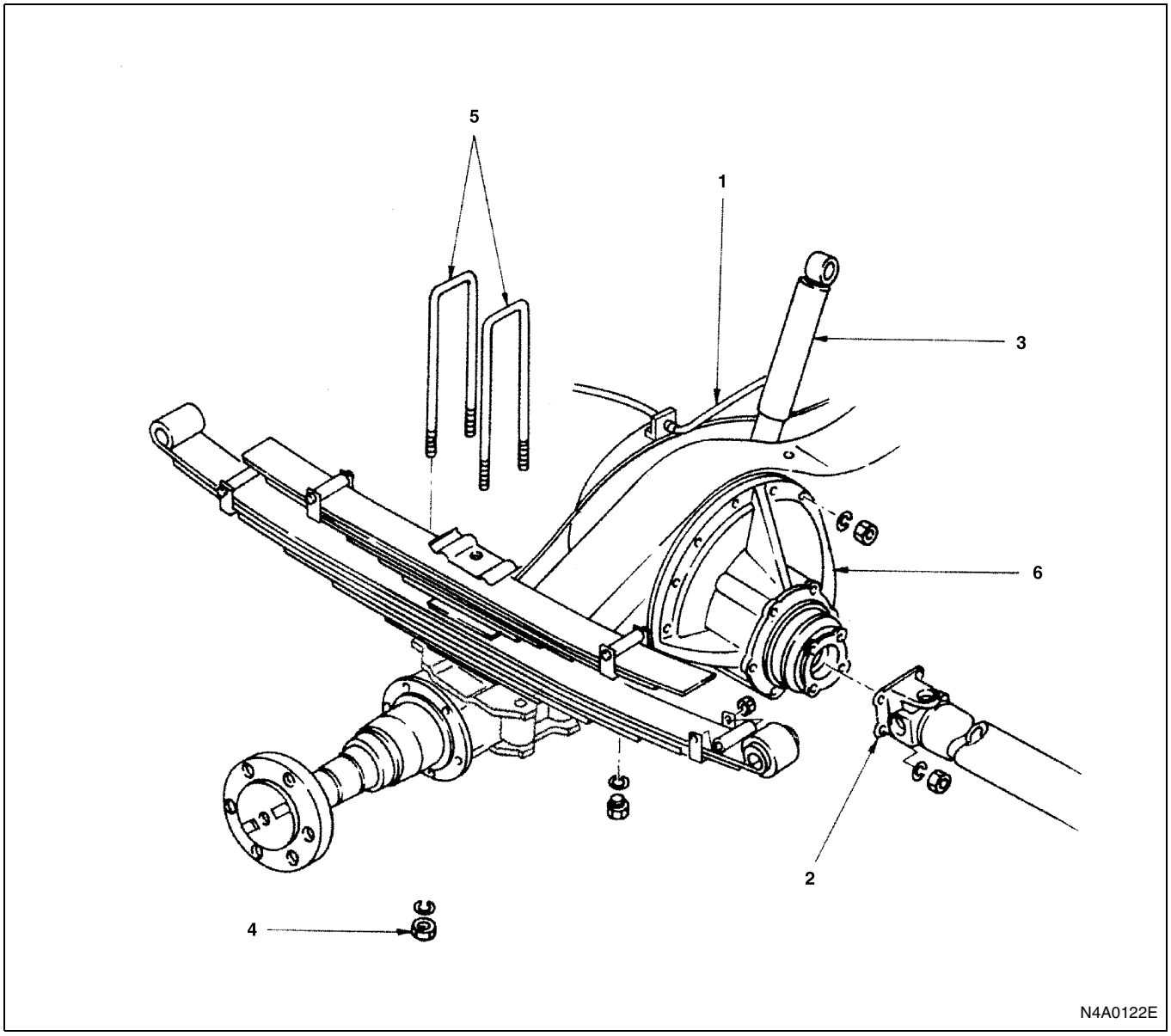


N4A0120E

14. Wheel and Tire

Tighten:
Wheel nut to
- NHR Dual Tire, NKR NPR Flat low: 343 N·m (35 kg·m / 253 lb·ft)
- Except above models: 490 N·m (50 kg·m / 361 lb·ft)
- NHR, NKR, S/Tire: 167 N·m (17 kg·m / 123 lb·ft)

Rear Axle Assembly



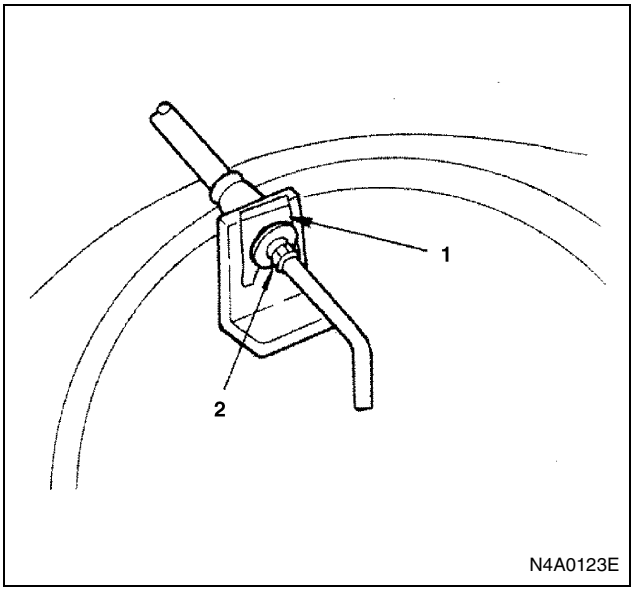
Legend

1. Rear flexible hose
2. Rear propeller shaft
3. Rear shock absorber
4. Nut and washer
5. U-bolt
6. Rear axle assembly

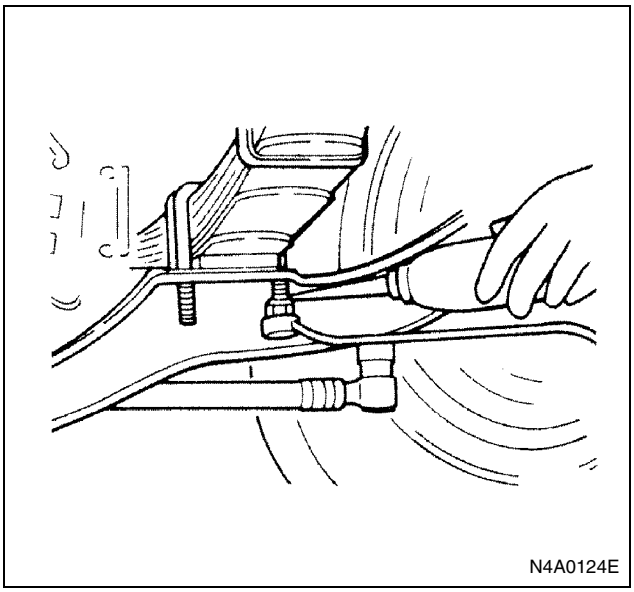
Removal

Preparation:
Jack up and support the vehicle on stands.

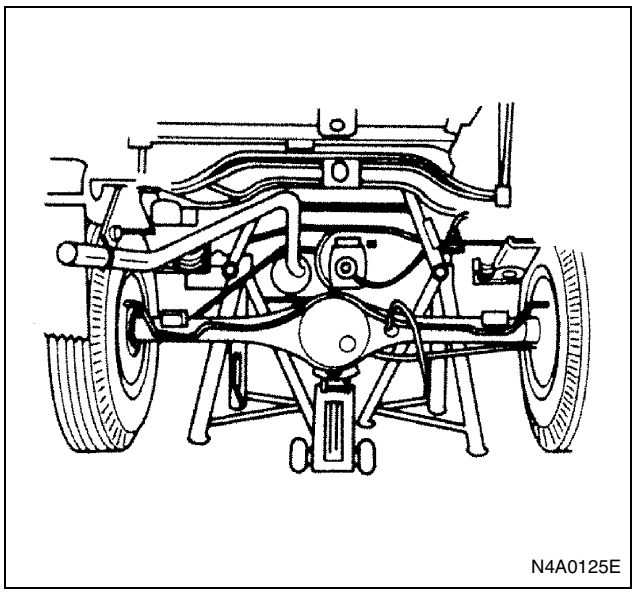
1. Rear Flexible Hose
   Loosen the nut (1), then ply off a clip (2).



2. Rear Propeller Shaft
3. Rear Shock Absorber
   Remove the shock absorber lower end.
4. Nut and Washer
   If the U-bolt are heavily rusted, apply a generous amount of oil to the threads when turning them loose the prevent seizure.



5. U-bolt
6. Rear Axle Assembly
   Move to the rear axle side.

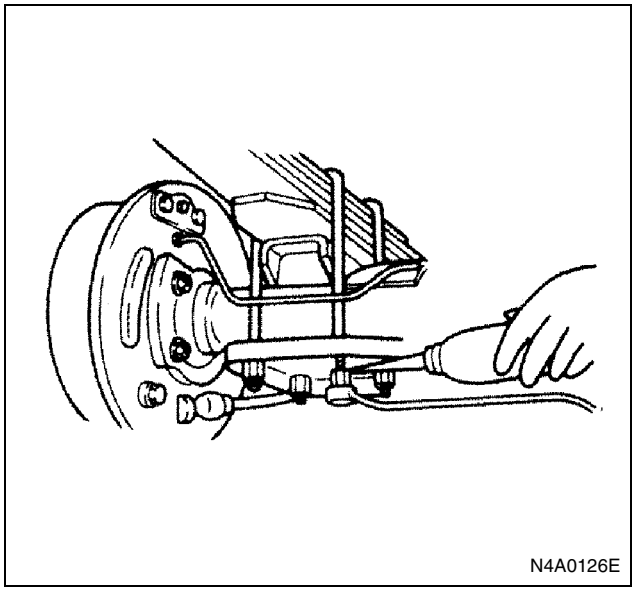


Installation

1. Rear Axle Assembly
2. U-bolt
3. Nut and Washer
   When tightening the nuts apply oil as necessary to prevent damaging the threads.

Tighten:
U-bolt nut

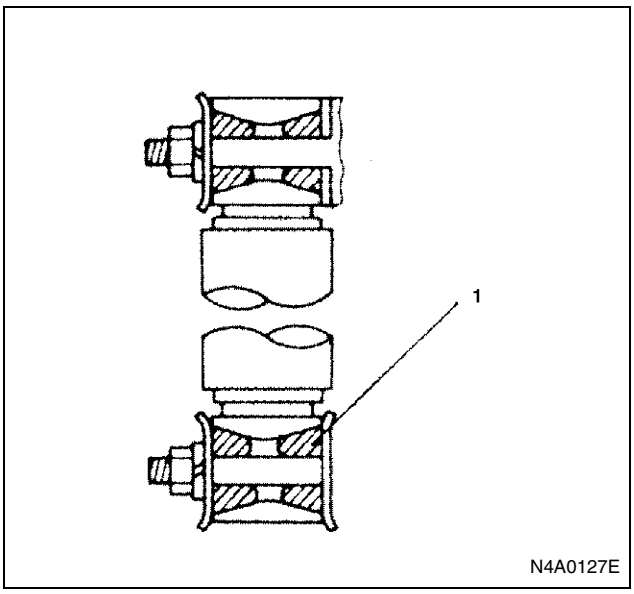
- NQR: 294 N·m (30 kg·m / 217 lb·ft)
- Except NQR: 177 N·m (18 kg·m / 130 lb·ft)



4. Rear Shock Absorber
   Refer to the drawing for parts installation.

Tighten:
Shock absorber lower nut

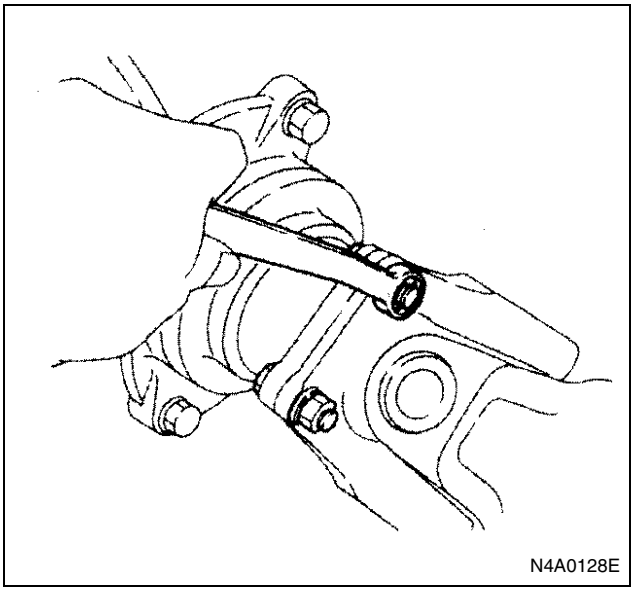
- NHR, NKR single tire: 61 N·m (6.2 kg·m /45 lb·ft)
- NKR dual tire: 95 N·m (9.7 kg·m / 70 lb·ft)
- NPR, NQR, NPS: 40 N·m (4.1 kg·m / 30 lb·ft)



Legend
1. Rubber bushing

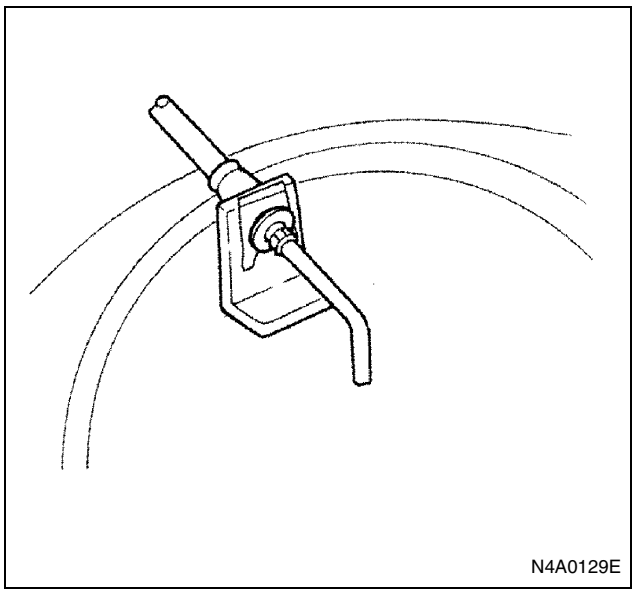
5. Rear Propeller Shaft
   Connect the propeller shaft assembly after tightening U-bolt nuts.

Tighten:
Propeller shaft nut
- M10: 63 N·m (6.4 kg·m / 46 lb·ft)
- M12: 103 N·m (10.5 kg·m / 76 lb·ft)



6. Rear Flexible Hose
   To install, follow the disassemble procedure in reverse order.

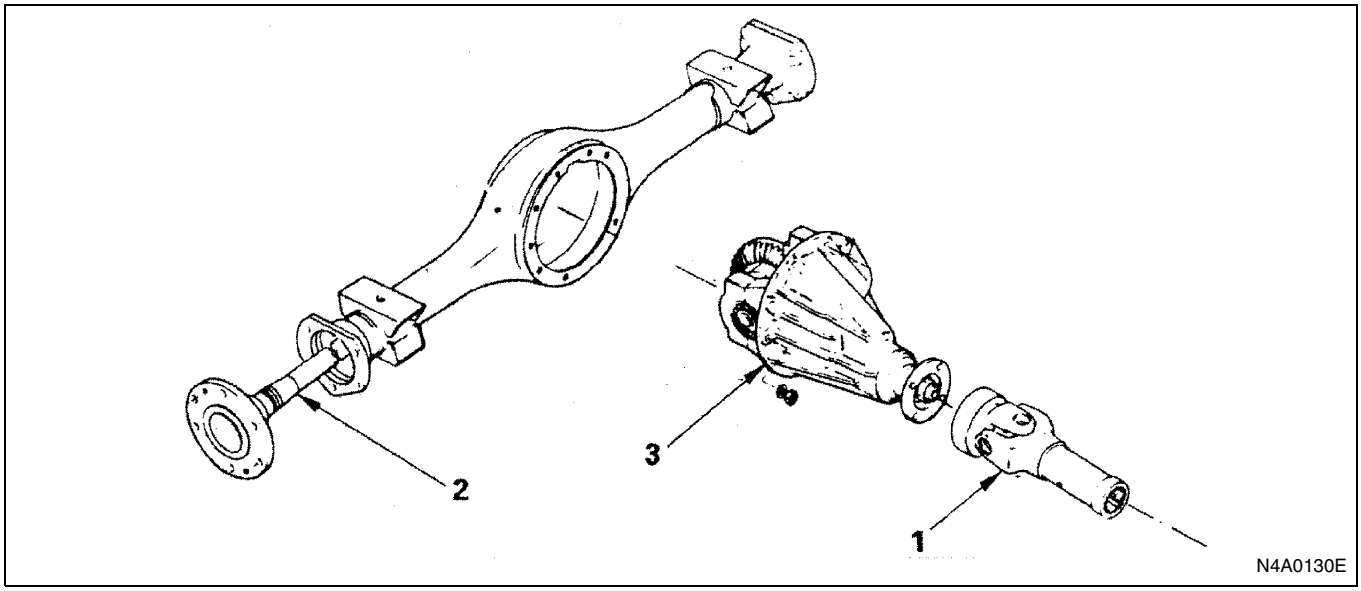
Tighten:
Flare nut to 16 N·m (1.6 kg·m / 12 lb·ft)



Perform bleeding operation after installation of the brake flexible hoses.

Refer to Section 5 “Service information” for brake oil air bleeding procedure.

Differential Assembly (NHR Single Tire Model; Semi-Floating)



Legend

1. Propeller shaft
2. Axle shaft with brake assembly
3. Differential assembly

Removal

Preparation:

- Raise vehicle to working level.
- Support the axle assembly with suitable jack and chassis stand.
- Drain the oil from the axle case.

1. Propeller Shaft
2. Axle Shaft with Brake Assembly
   To remove the axle shaft assembly, follow the removal procedure outlined under “Rear Hub and Brake Drum” after finding the axle assembly is semi-floating rear axle.
3. Differential Assembly

Installation

1. Differential Assembly
   Apply liquid gasket (BELCO BOND NO. 4 or equivalent) to the jointing faces of the axle case and carrier.

Tighten:
Differential carrier bolt and nut to

- Bolt: 64 N·m (6.5 kg·m / 47 lb·ft)
- Nut: 64 N·m (6.5 kg·m / 47 lb·ft)

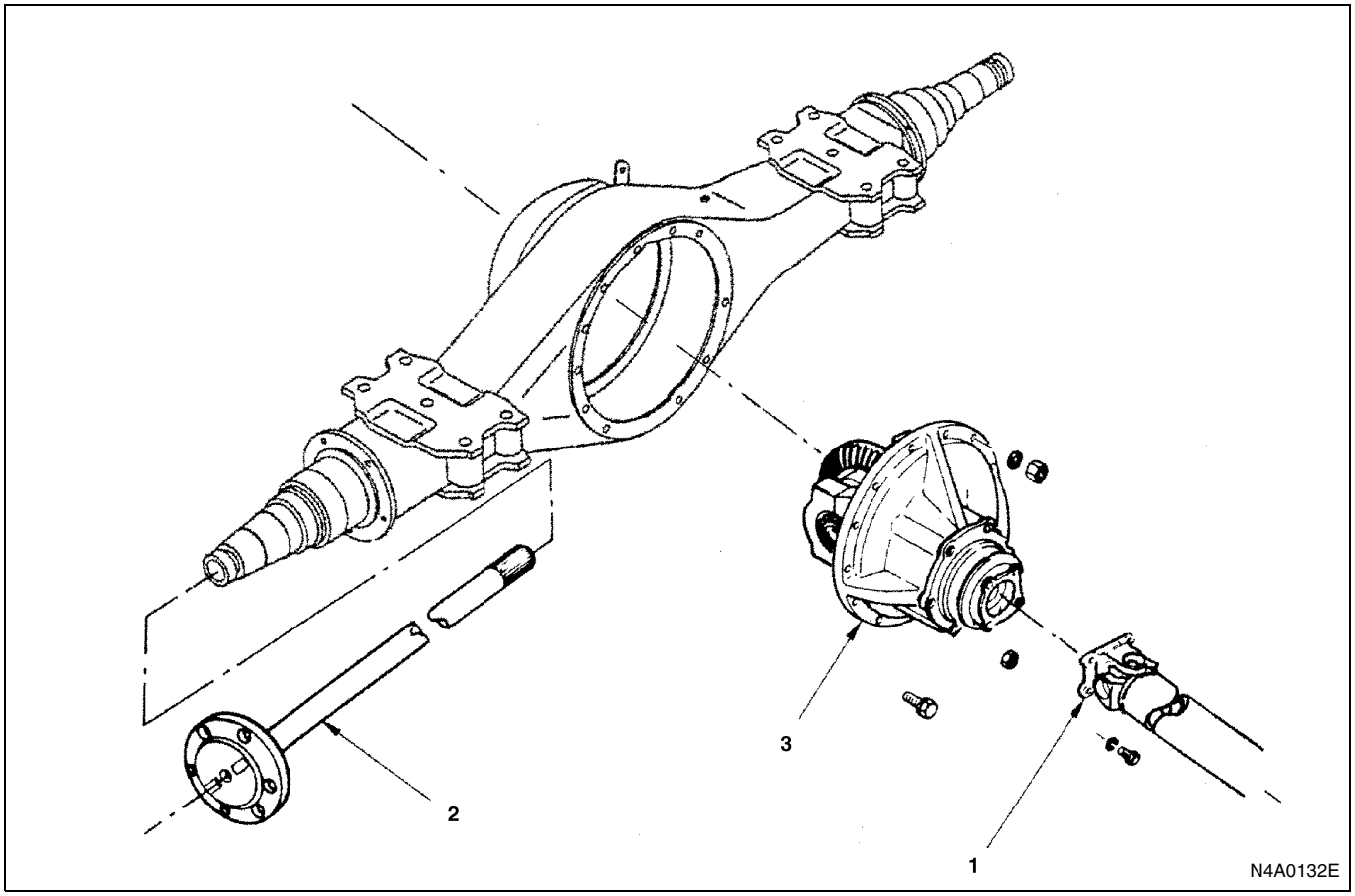
2. Axle Shaft with Brake Assembly
   To install the axle shaft assembly, follow the installation procedure outlined under “Rear Hub and Brake Drum” after finding the axle assembly is semi-floating rear axle.

Tighten:
Bearing holder nut to: 74 N·m (7.5 kg·m / 54 lb·ft)

3. Propeller Shaft

Tighten:
Propeller shaft nut torque: 63 N·m (6.4 kg·m / 46 lb·ft)

Differential Assembly (NKR Single Tire and All Dual Tire Models; Full Floating)



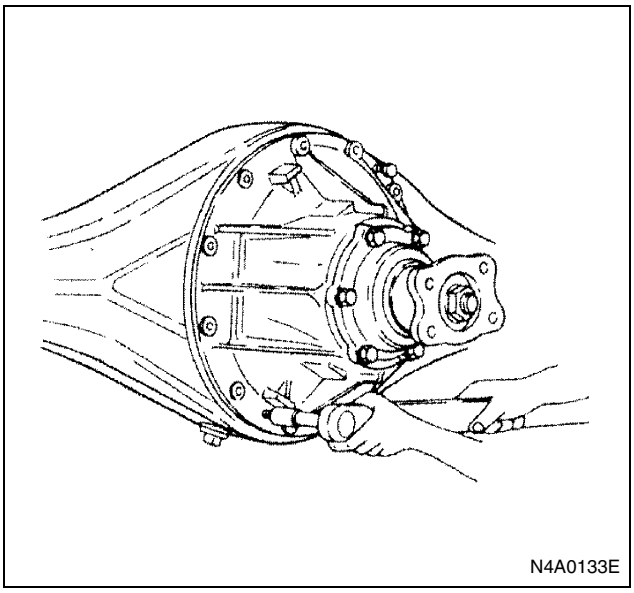
Legend

1. Propeller shaft
2. Axle shaft
3. Differential assembly

Removal

Preparation:
Drain the oil from the axle case.

1. Propeller Shaft
2. Axle Shaft
3. Differential Assembly
   To remove, turn push bolt into threaded holes in the differential carrier, so that differential assembly is lifted off the position.

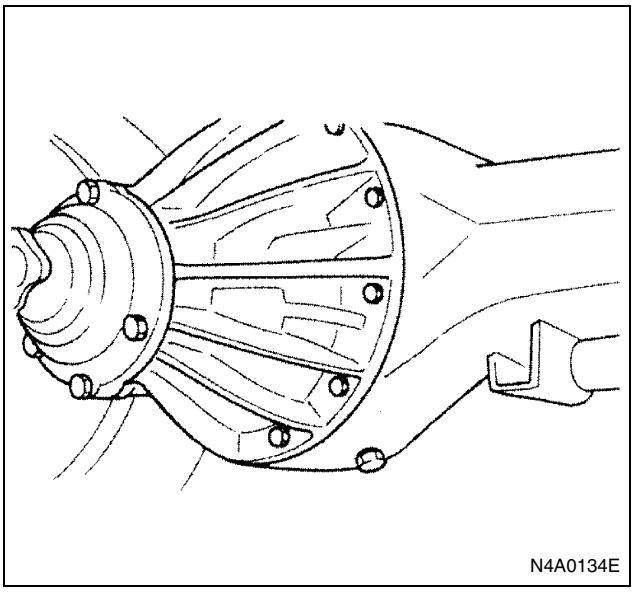

N4A0133E

Installation

1. Differential Assembly
   Apply liquid gasket (BELCO BOND No. 4 or equivalent) to the joining faces of the axle case and carrier.

Tighten:
Differential carrier bolt and nut to

- 244 — 320 mm differential: 64 N·m (6.5 kg·m / 47 lb·ft)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2. Axle Shaft

Tighten:
Axle shaft nut to 46 N·m (4.7 kg·m / 34 lb·ft)

3. Propeller Shaft

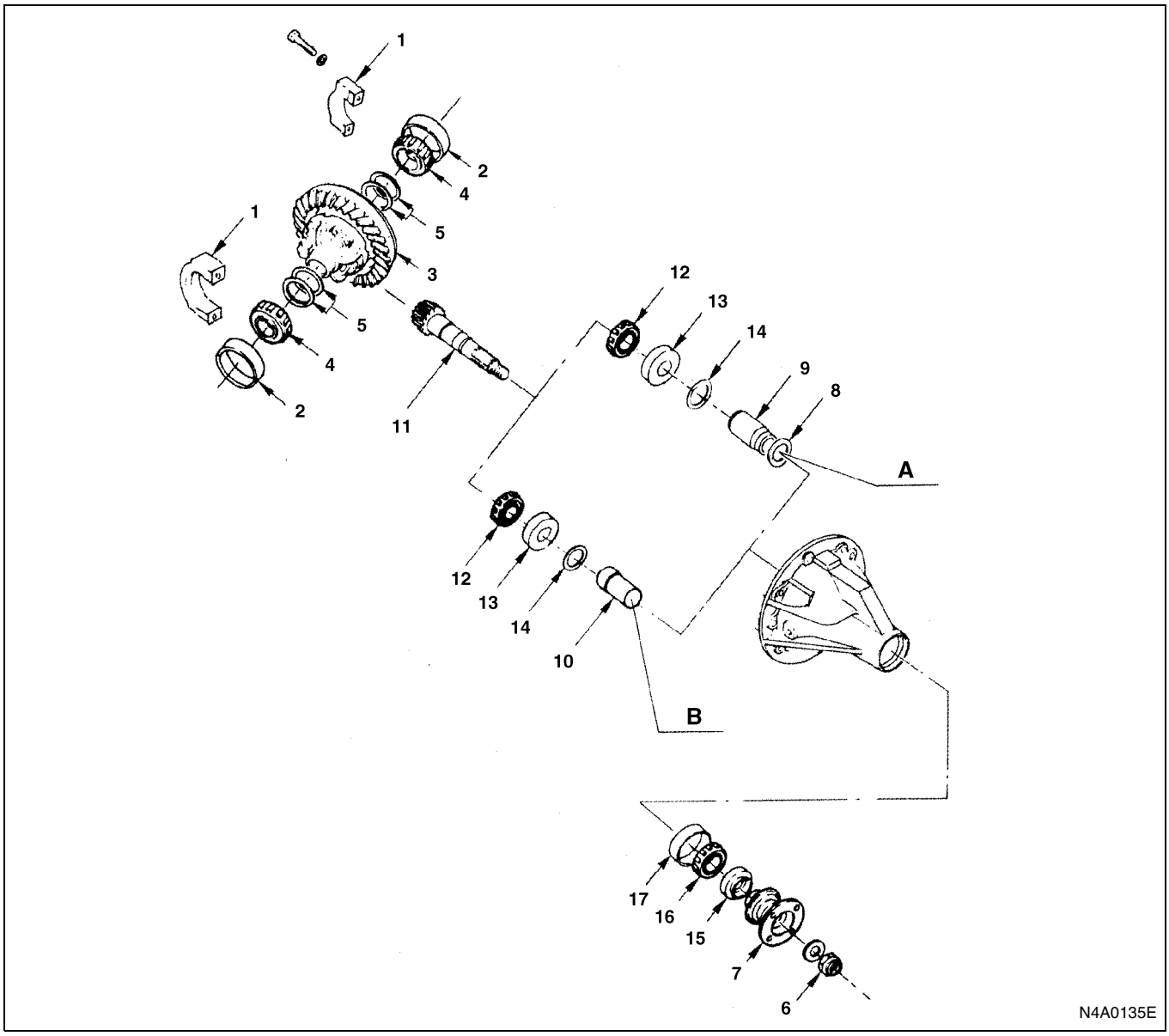
Tighten:
Propeller shaft nut to

- M10: 62.7 N·m (6.4 kg·m / 46 lb·ft)
- M12: 103 N·m (10.5 kg·m / 76 lb·ft)

UNIT REPAIR

244 mm Rear Differential

Major Components

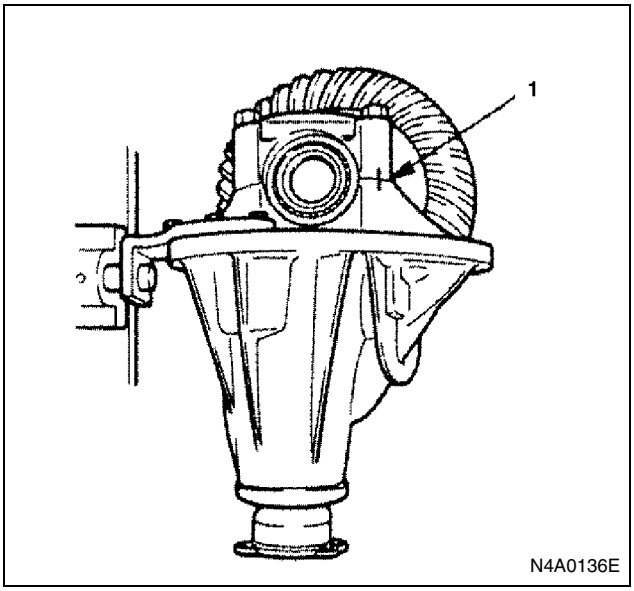


Legend

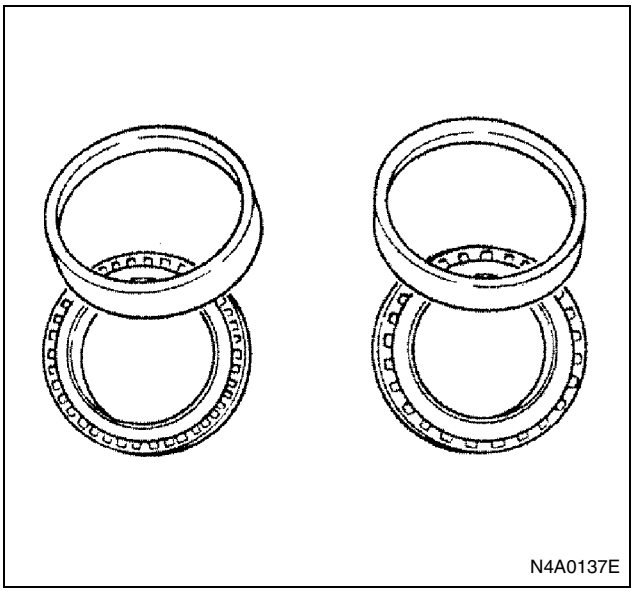
A. NKR
B. NHR
1. Bearing Cap
2. Side bearing outer race
3. Differential cage assembly
4. Side bearing inner race
5. Backlash and preload adjusting shim
6. Flange nut
7. Flange
8. Bearing preload adjusting shim
9. Distance piece (NKR model)
10. Collapsible spacer (NHR model)
11. Drive pinion
12. Inner bearing inner race
13. Inner bearing outer race
14. Pinion depth adjusting shim
15. Oil seal
16. Outer bearing inner race
17. Outer bearing outer race

Disassembly

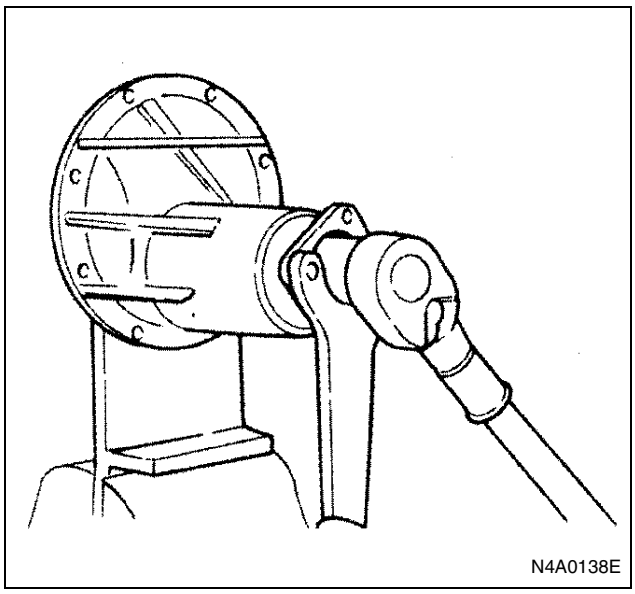
1. Bearing cap
   Set the differential assembly onto a special fixture.
   Apply a setting mark (1) to the side bearing cap and differential carrier.
   Fixture: 5-8840-2029-0
   Base: 5-8840-0003-0



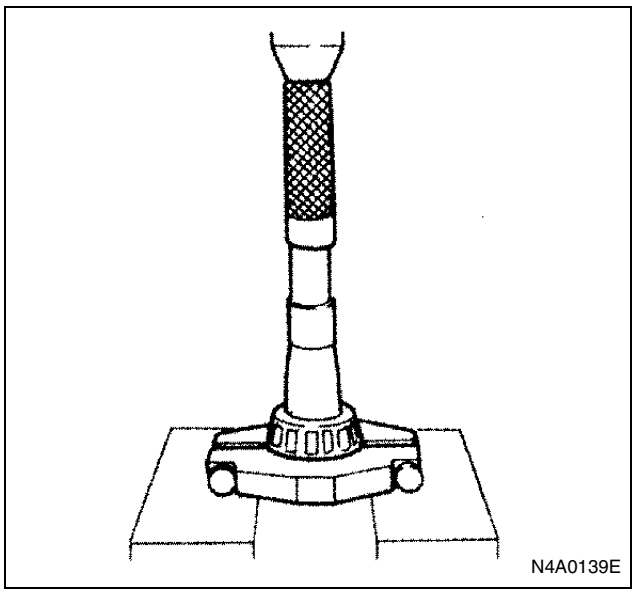
2. Side Bearing Outer Race
   After removal, keep right and left side bearing assemblies separate to maintain inner and outer race combinations.



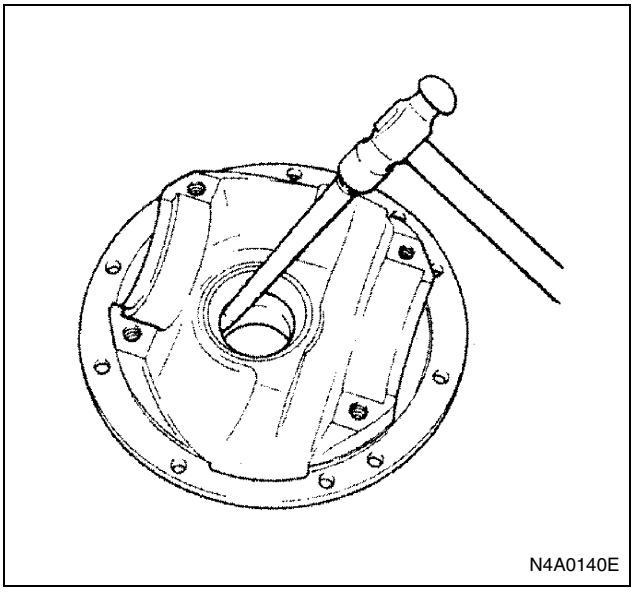
3. Differential Cage Assembly
4. Side Bearing Inner Race
   Remover: 9-8521-0061-0
   Adapter: 5-8840-2031-0
5. Backlash and Preload Adjusting Shim
6. Flange Nut
   Holding wrench: 9-8511-1507-0



7. Flange
8. Bearing Preload Adjusting Shim
9. Distance Piece (NKR model)
10. Collapsible Spacer (NHR model)
11. Drive Pinion
12. Inner Bearing Inner Race
    Remover: 5-8840-0015-0



13. Inner Bearing Outer Race
14. Pinion Depth Adjusting Shim
15. Oil Seal
16. Outer Bearing Inner Race
17. Outer Bearing Outer Race
    Drive out the inner bearing outer race or the outer bearing outer race together with the outer bearing inner race and oil seal by using a proper bar through two notches.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Reassembly

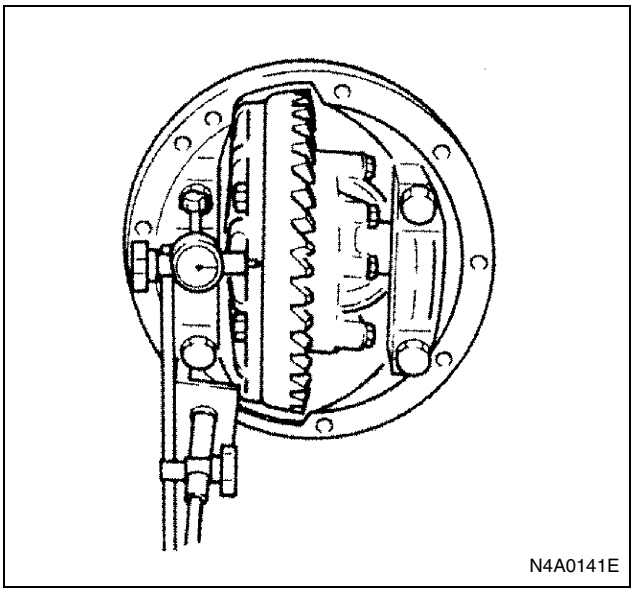
Measurement of ring gear run-out

Install dummy bearing into the differential assembly, then install these parts in the differential carrier.
Install and tighten the bearing cap.
Dummy bearing: 9-8522-1137-0

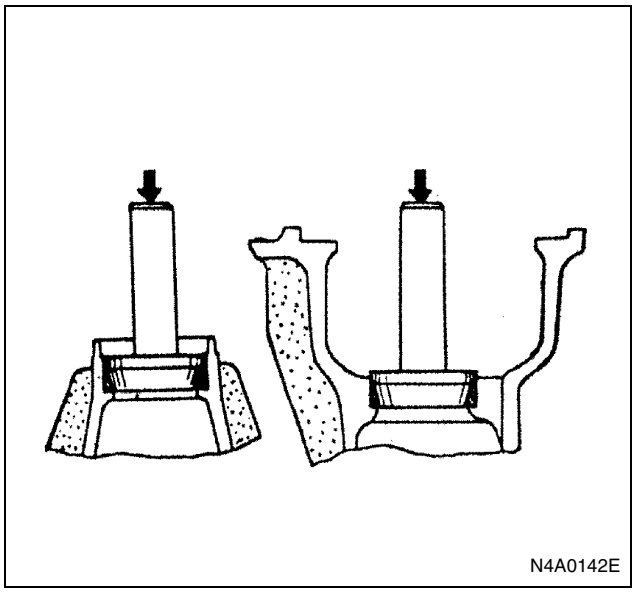
Tighten:

Bearing cap bolt to 108 N·m (11.0 kg·m / 80 lb·ft)

Ring gear run-out,
Standard: 0.05 mm (0.002 in)
Limit: 0.2 mm (0.008 in)

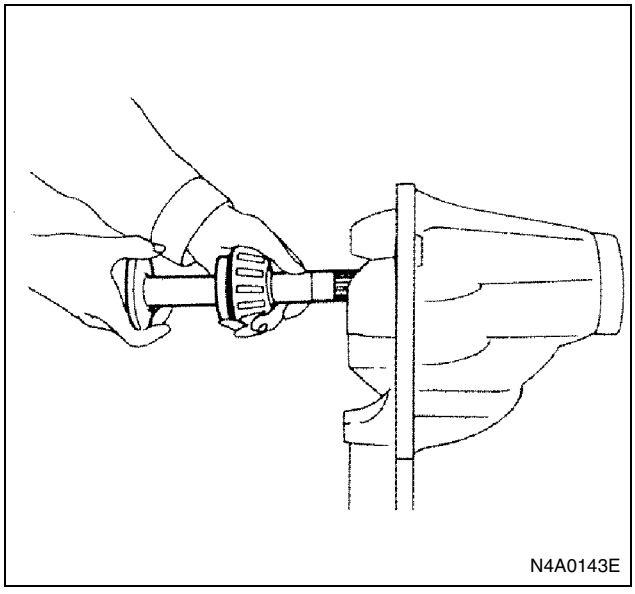

N4A0141E

1. Outer Bearing Outer Race
2. Pinion Depth Adjusting Shim
3. Inner Bearing Outer Races
   Adjustment of drive pinion engagement depth.
   Install the inner and outer bearing outer races without shims into the differential carrier using a bench press.
   Installer (inner): 9-8522-1196-0
   (Outer): 9-8522-1197-0
   Grip: 9-8522-1148-0


N4A0142E

Assemble the inner bearing inner race to the dummy pinion shaft, then install these parts into the carrier.

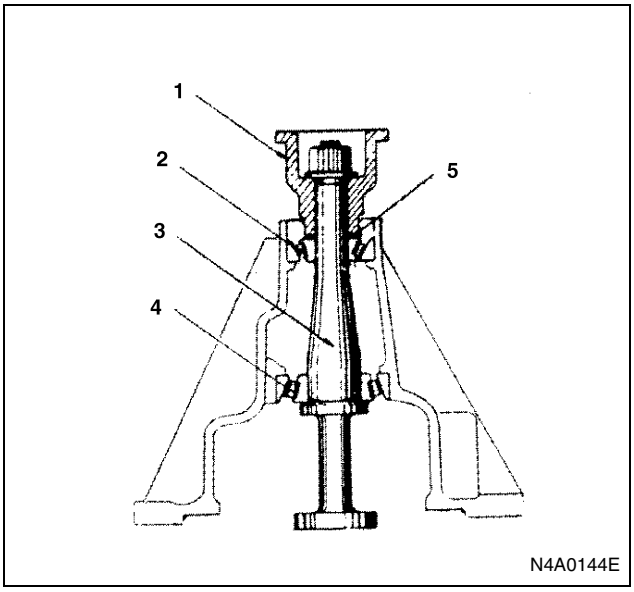
Dummy Pinion Shaft: 9-8522-1603-0


N4A0143E

Install the outer bearing inner race, flange, washer and dummy nut.

Lubricate the bearing before tighten the dummy nut.

Dummy Nut: 9-8522-1624-0



Legend

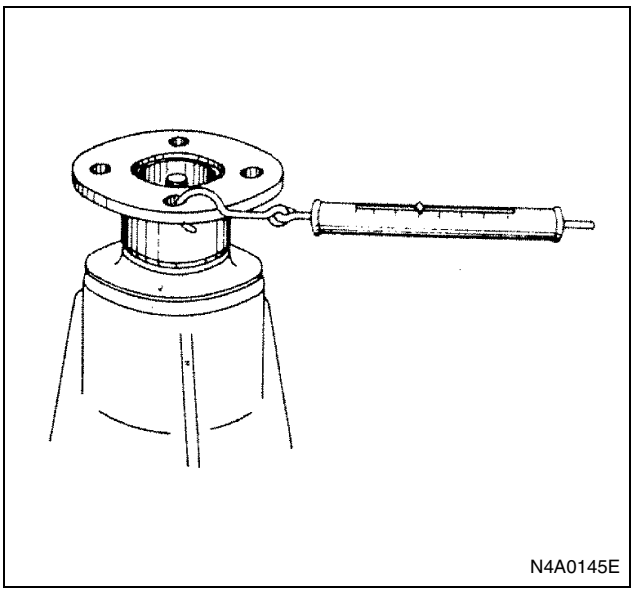
1. Coupling driver
2. Outer bearing
3. Dummy pinion shaft
4. Inner bearing
5. Shim

Tighten the dummy nut until specified preload are required to rotate the bearing.

Bearing preload
New bearing: 16 — 29 N (1.6 — 3.0 kg / 3.5 — 6.6 lb)
Used bearing: 8 — 14.5 N (0.8 — 1.5 kg / 1.8 — 3.3 lb)

Tighten:
Starting to

- New bearing: 0.69 — 1.27 N·m (7.0 — 13.0 kg·cm / 6.1 — 11.3 lb·in)
- Used bearing: 0.35 — 0.64 N·m (3.5 — 6.5 kg·cm / 3.1 — 5.7 lb·in)

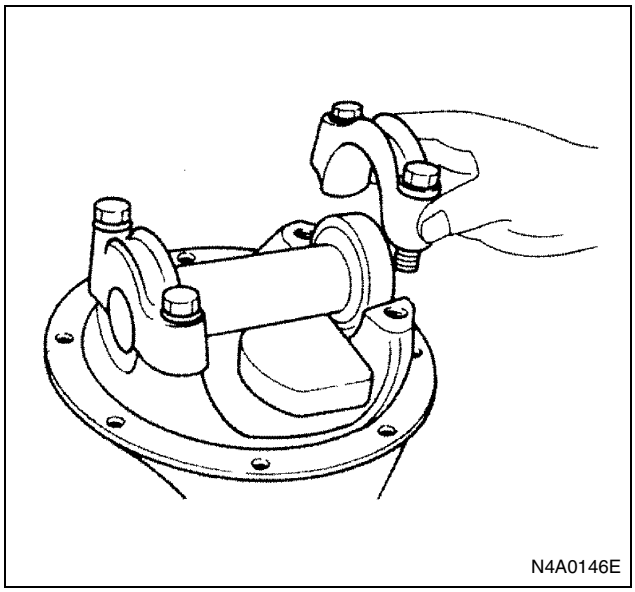


Install dummy bearing on dummy shaft and install these parts into the carrier. Install and tighten the bearing cap.

Dummy Shaft: 9-8522-1138-0

Dummy Bearing: 8-8522-1137-0

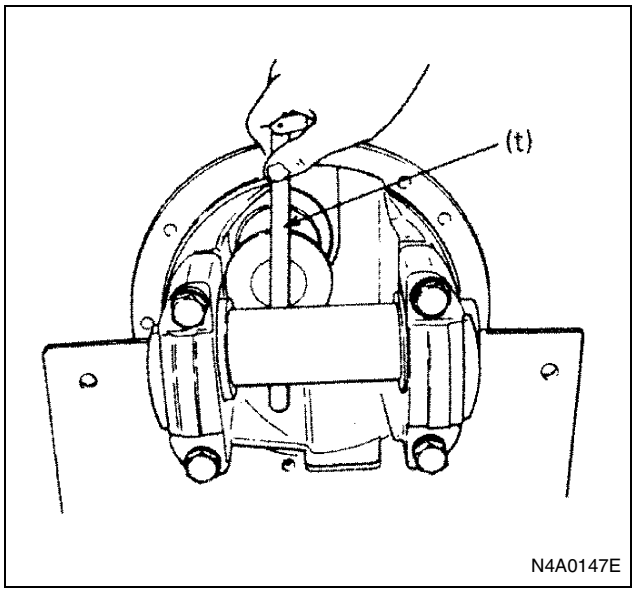
Tighten:
Bearing cap bolt to 108 N·m (11.0 kg·m / 80 lb·ft)



Measure the clearance (t) with a feeler gauge.

The clearance (t) is equal to the shim in thickness.

Thickness of shim available, 2.12, 2.16 ... 2.52, 2.56 mm (0.083, 0.085 ... 0.099, 0.100 in)

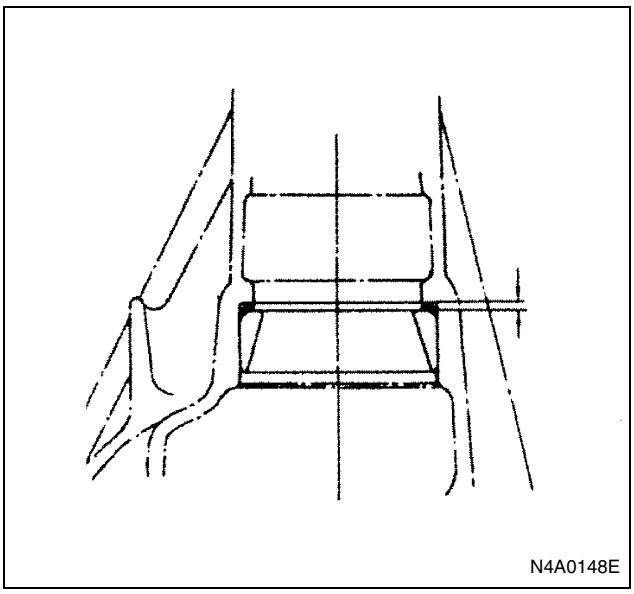


Remove dummy pinion, dummy shaft, dummy bearing and inner bearing outer race.

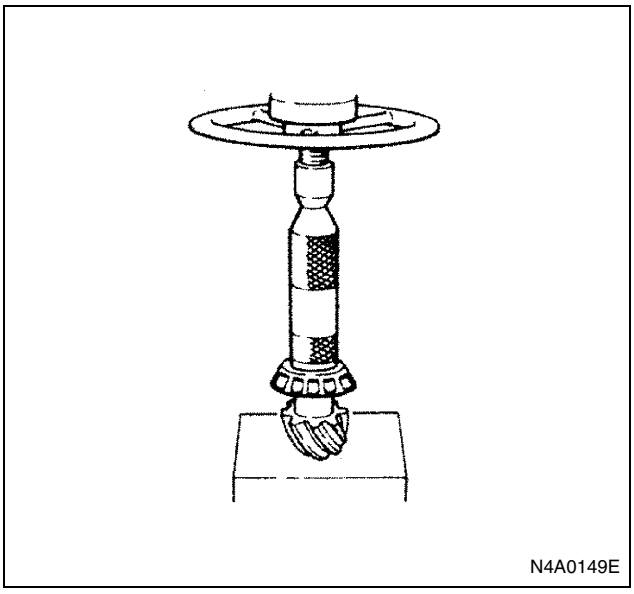
Install pinion depth adjusting shim of specified thickness in position between the inner bearing outer race and the carrier, then install the inner bearing outer race.

Installer: 9-8522-1196-0

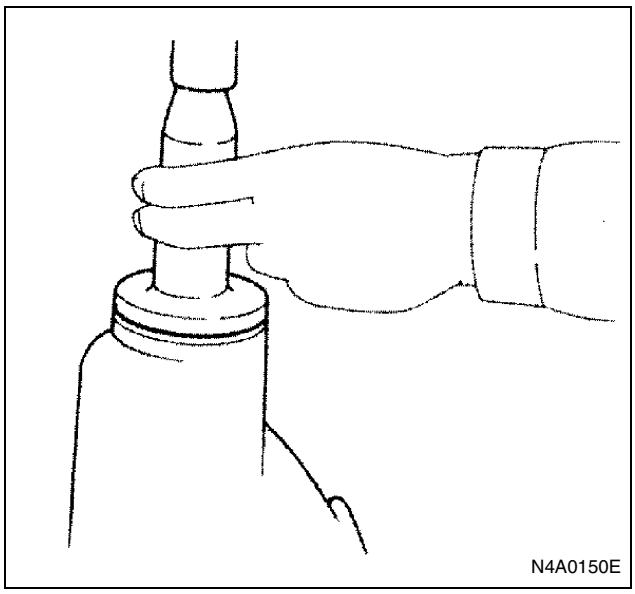
Grip: 9-8522-1148-0


N4A0148E

4. Inner Bearing Inner Race
   Installer: 9-8522-0018-0
   Apply gear oil to the pinion shaft before installing final drive pinion assembly into carrier.


N4A0149E

5. Outer Bearing Inner Race
6. Oil seal
   Installer: 5-8840-2047-0

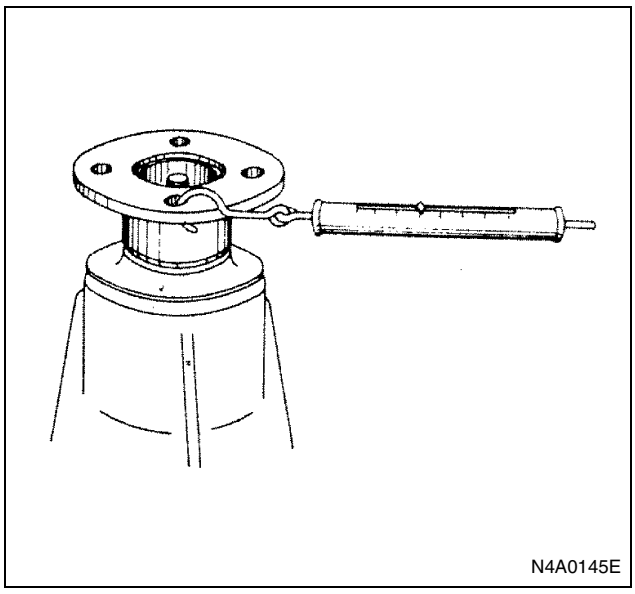

N4A0150E

7. Drive Pinion
8. Collapsible Spacer (NHR model)
   Discard used collapsible spacer and install a new one.
9. Distance Piece (NKR model)
10. Bearing Preload Adjusting Shim (NKR model)
    Use a dummy nut until specified bearing preload is obtained.

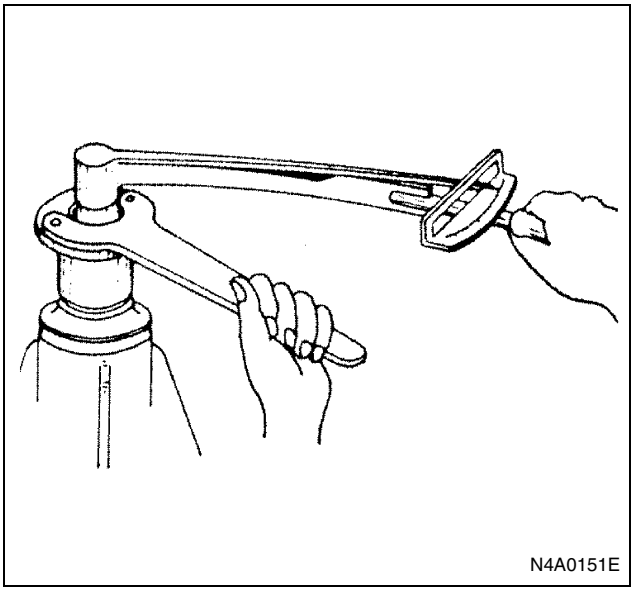
Bearing preload
New bearing: 16 — 29 N (1.6 — 3.0 kg / 3.5 — 6.6 lb)
Used bearing: 8 — 14.5 N (0.8 — 1.5 kg / 1.8 — 3.3 lb)

Tighten:
Starting to

- New bearing: 0.69 — 1.27 N·m (7.0 — 13.0 kg·cm / 6.1 — 11.3 lb·in)


N4A0145E

Tighten:
Dummy nut to 270 N·m (27.5 kg·m / 199 lb·ft)

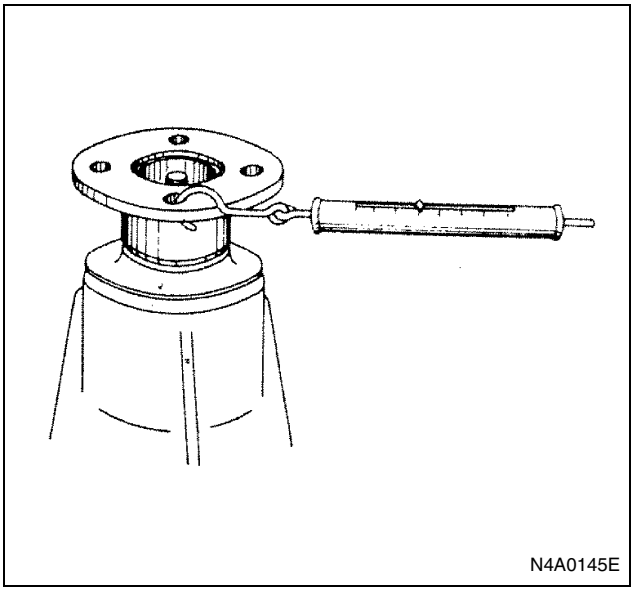

N4A0151E

Thickness of shim available, 1.53, 1.56 ... 2.07, 2.10 mm (0.060, 0.061 ... 0.081, 0.082 in)

11. Flange
12. Flange Nut
    (NHR only for collapsible spacer)
    1) Tighten the flange nut to a torque of 245 N·m (25 kg·m/181 lb·ft).
    2) Make an adjustment by tightening the flange nut until specified bearing pre-load is obtained.

Bearing preload
New bearing: 16 — 29 N (1.6 — 3.0 kg / 3.5 — 6.6 lb)
Used bearing: 8 — 14.5 N (0.8 — 1.5 kg / 1.8 — 3.3 lb)

Tighten:
Starting to
- New bearing: 0.69 — 1.27 N·m (7.0 — 13.0 kg·cm / 6.1 — 11.3 lb·in)
- Used bearing: 0.35 — 0.64 N·m (3.5 — 6.5 kg·cm / 3.1 — 5.7 lb·in)


N4A0145E

    3) The flange nut should be within the specified range when specified bearing preload is obtained.

Tighten:
Flange nut to 245 — 294 N·m (25 — 30 kg·m / 181 — 217 lb·ft)

Discard used flange nut and install new one.

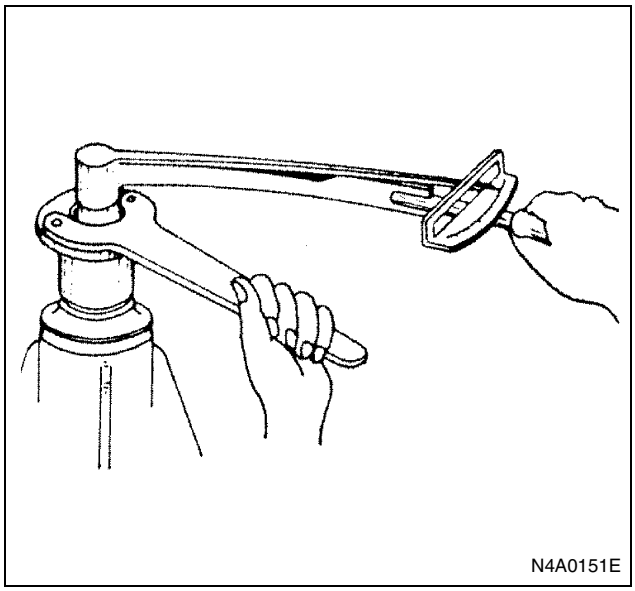
(NKR only for distance piece)

Once specified bearing preload is obtained by dummy nut, remove dummy nut and replace with flange nut.

Tighten the flange nut until specified bearing preload and nut torque.

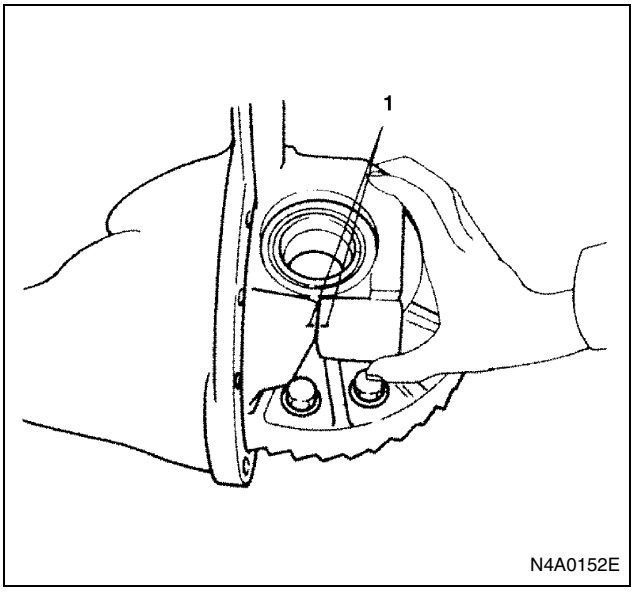
Using special tool, stake the flange nut at two points.

Punch: 5-8840-2293-0


N4A0151E

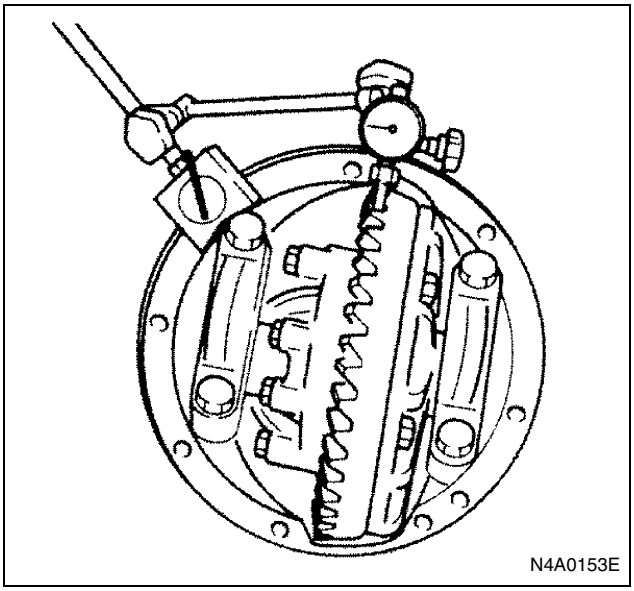
13. Backlash and Preload Adjusting Shim
    1) Adjustment of Backlash
    - Install dummy bearing in the differential cage assembly, then install differential cage assembly and ring gear into the differential carrier. Install the bearing caps after checking to make certain setting marks (1) applied at disassembly are in alignment.

Tighten:
Bearing cap bolt to 108 N·m (11.0 kg·m /80 lb·ft)

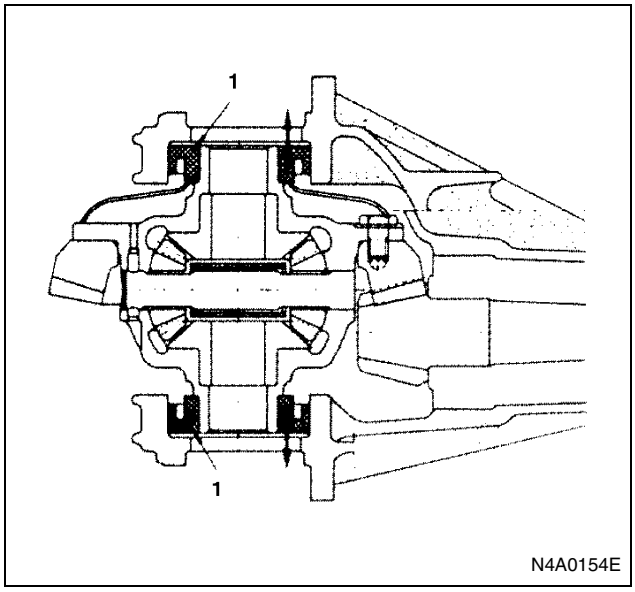


- Set the dial indicator and measure the backlash between the drive pinion and ring gear at the foot portion of the ring gear.

Backlash, 0.15 — 0.20 mm (0.006 — 0.008 in)

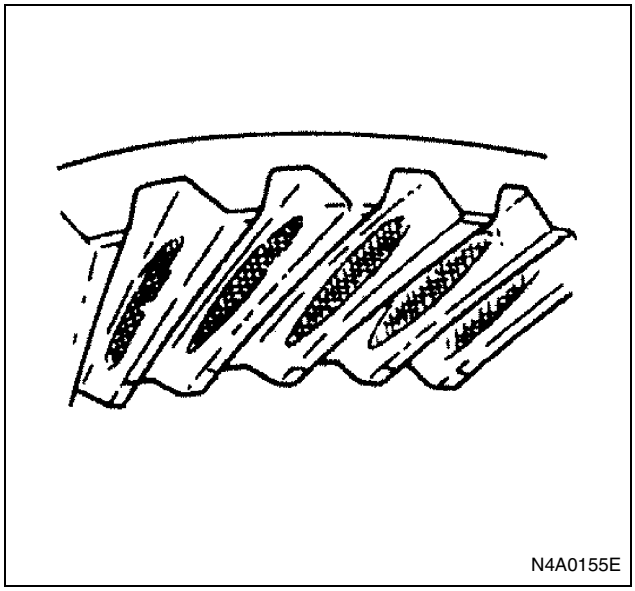


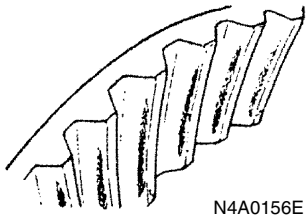
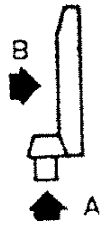
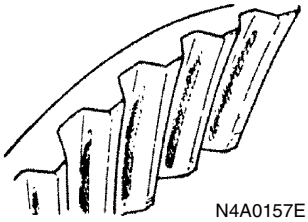
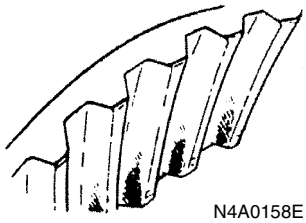
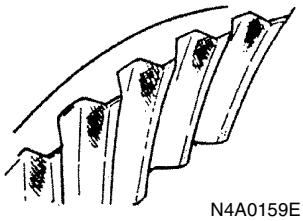
- To adjust backlash, loosen bearing cap bolts slightly and move the dummy bearing (1) as necessary.
  A clearance should not be provided between dummy bearing and bearing fitting face of the differential cage.



2) Inspection of drive pinion and ring gear tooth contact.

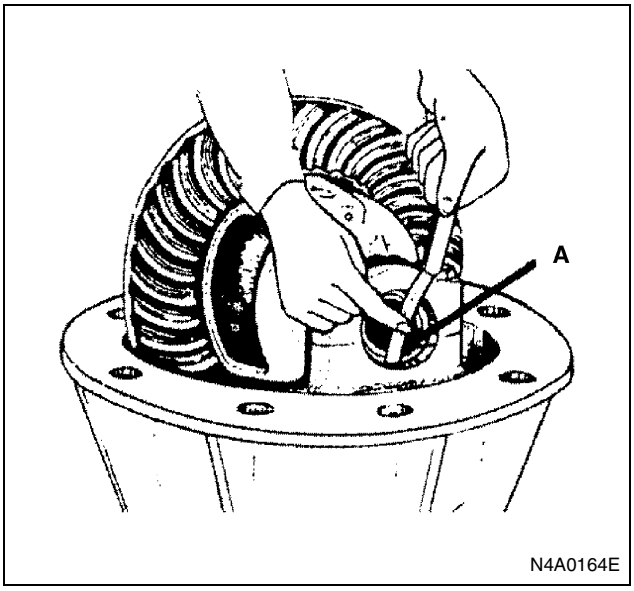
- Apply a thin coat of red check to faces of the 7 — 8 teeth of the ring gear.
- Check the impression of contact (Right contact) obtained on the ring gear teeth and make necessary adjustment as described below if the contact is abnormal.



TOOTH CONTACT	CASE	ADJUSTMENT PROCEDURE
 N4A0156E	Drive pinion is too far away from ring gear.	1. Move the drive pinion in toward the ring gear by decreasing the thickness of pinion depth adjusting shims. 2. Adjust the backlash by moving ring gear away from the drive pinion.  N4A0160E
 N4A0157E	Drive pinion is too close to the ring gear.	1. Move the drive pinion away from the ring gear by increasing thickness of pinion depth adjusting shims. 2. Adjust the backlash by moving ring gear in toward the drive pinion. N4A0161E
 N4A0158E	Ring gear is too close to the drive pinion.	1. Move the drive pinion in toward the ring gear by decreasing thickness of pinion depth adjusting shims. 2. Adjust the backlash by moving ring gear away from the drive pinion. N4A0162E
 N4A0159E	Ring gear is too for away from drive pinion.	1. Move the drive pinion away from the ring gear by increasing thickness of pinion depth adjusting shims. 2. Adjust the backlash by moving ring gear in toward the drive pinion. N4A0163E

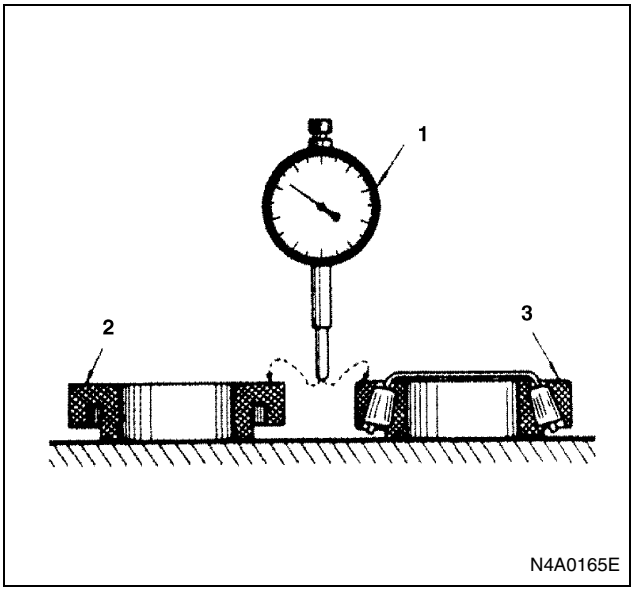
3) Selection of Preload Adjusting Shim

- Measure the clearance (A) between the differential carrier and right and left side (dummy) bearings by using a feeler gauge.
  Carefully note the relationship between the values obtained through measurement at each side and dummy bearings.



N4A0164E

- Measure the thickness of dummy bearing and side bearing.
  Comparison should be made between the thicknesses of dummy bearing and side bearing installed in the same position.



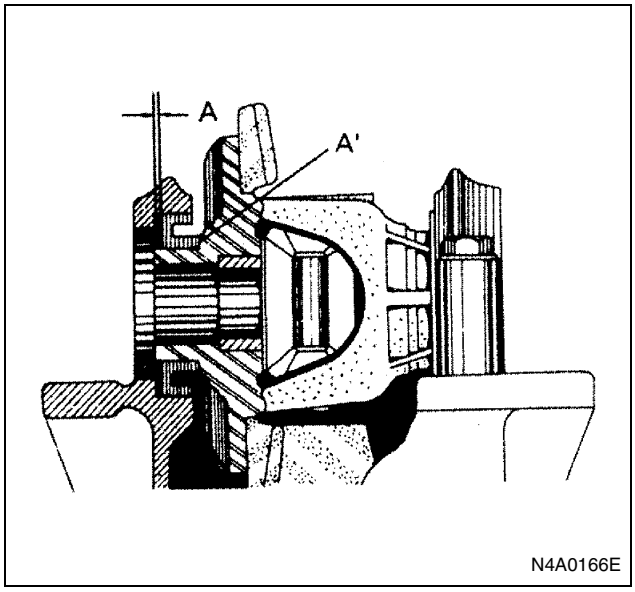
Legend
1. Dial gauge
2. Dummy bearing
3. Side bearing

When side bearing is thinner:
A+(dummy bearing thickness–side bearing thickness)=(X)
When side bearing is thicker:
A–(side bearing thickness–dummy bearing thickness)=(X)

- (X)+0.025=Shim thickness
  Allowance for bearing preload at one side=0.025

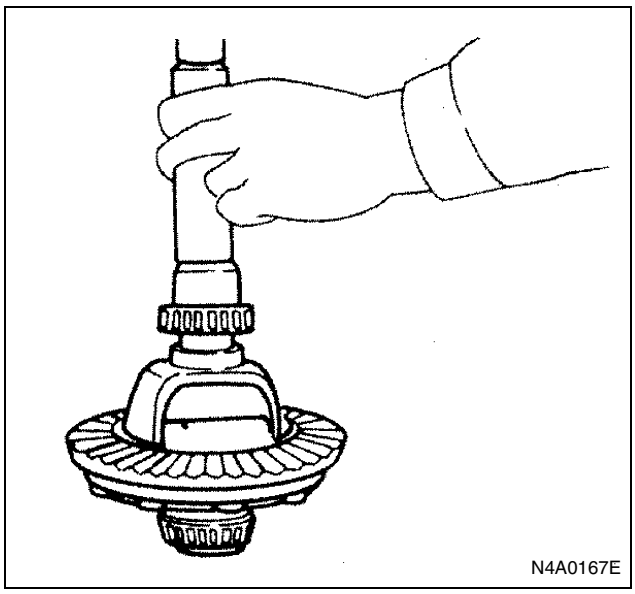
Example of calculation	mm (in.)
Measured Clearance A:	+0.85 (+0.033)
Suppose that the side bearing is thicker [thinner] than dummy bearing by 0.05 mm	–0.05 (–0.002) [+0.05 (+0.002)]
An allowance for bearing preload:	+0.025 (+0.0009)
Thickness of shims to be installed:	0.825 (0.032) [0.925 (0.036)]

Thickness of shim available, 0.25, 0.30, 0.35, 0.5 mm (0.009, 0.012, 0.014, 0.019 in)



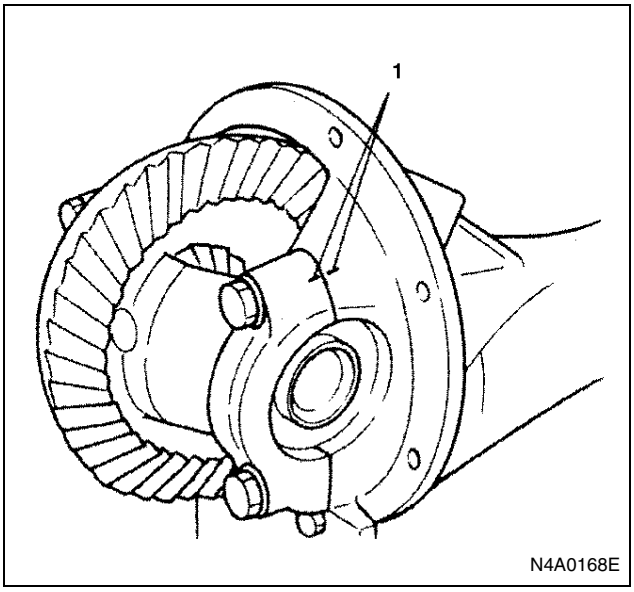
Legend
A. Measured clearance
A′. Shim installed position

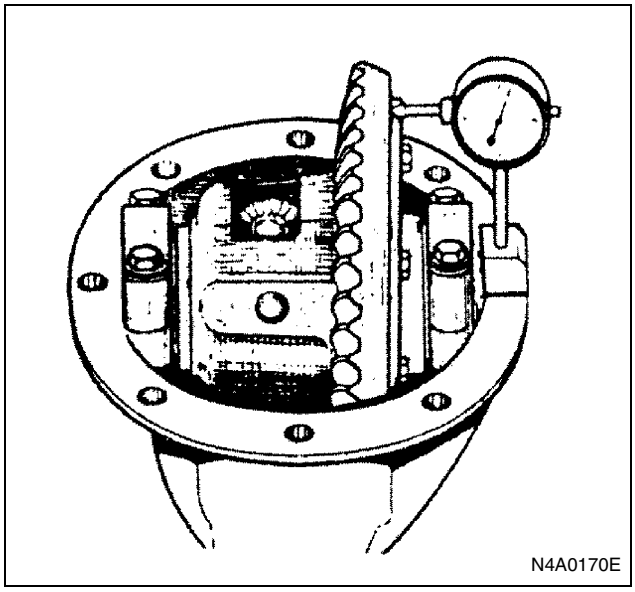
14. Side Bearing Inner Race
    Installer: 5-8840-2050-0
    Grip: 9-8522-1608-0



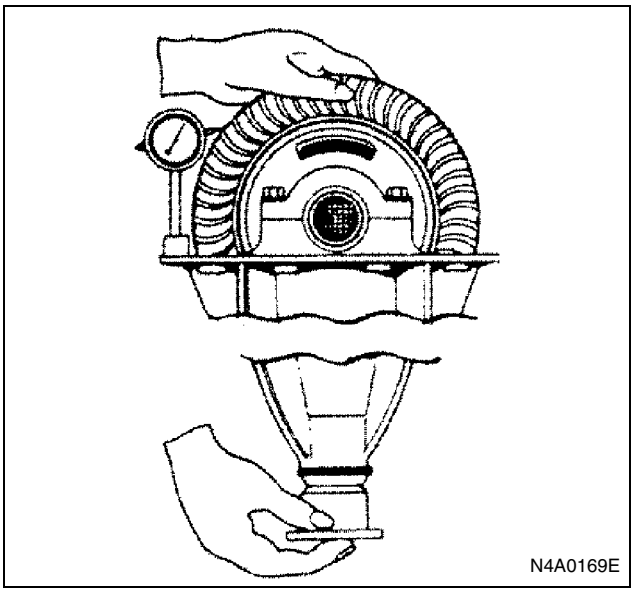
15. Differential Cage Assembly
16. Side Bearing Outer Race
17. Bearing Cap
    1) Install bearing caps by aligning setting marks (1) applied at disassembly.

Tighten:
Bearing cap bolt to 108 N·m (11.0 kg·m /80 lb·ft)





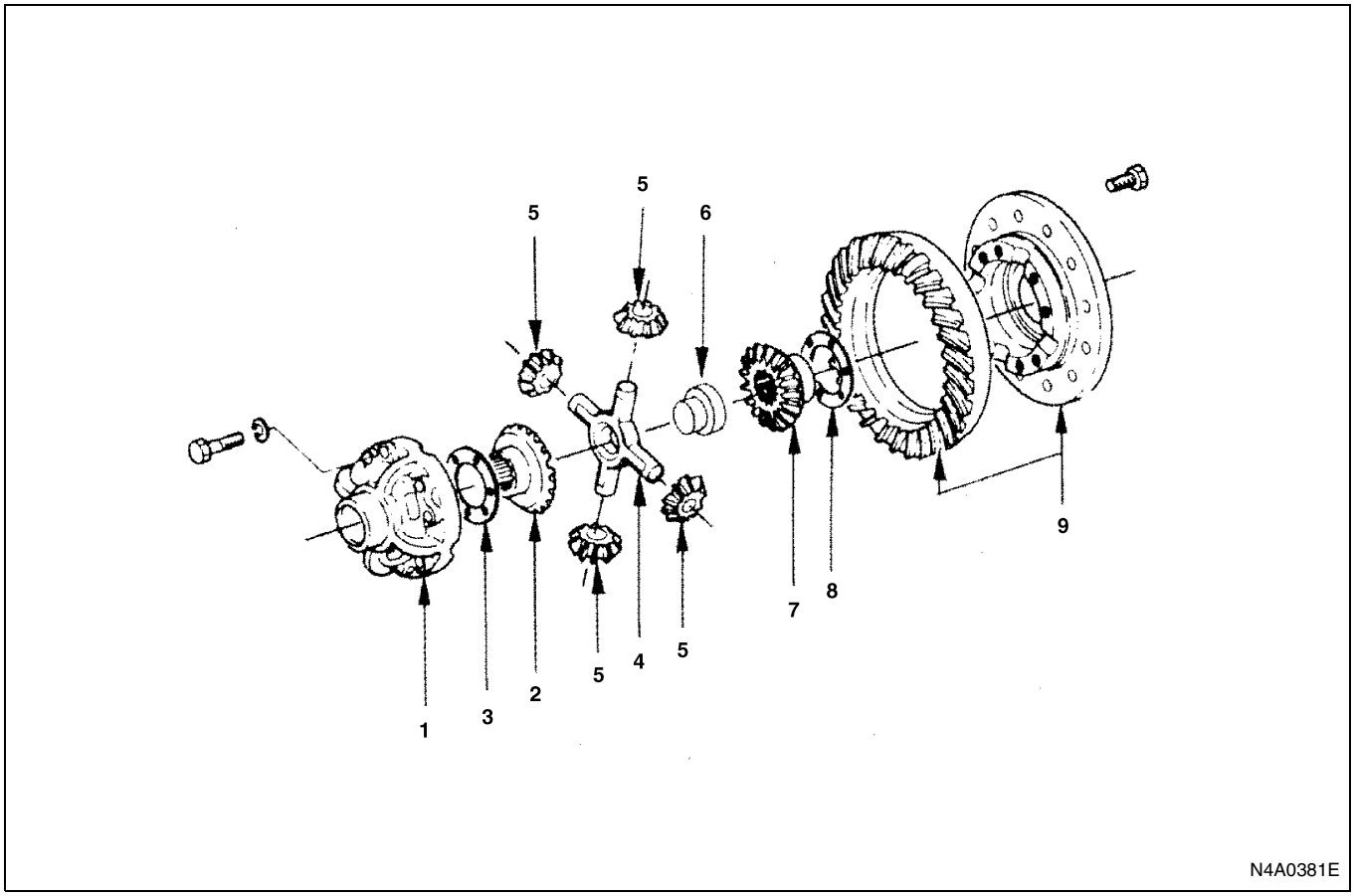
2) Recheck the backlash. If measurement indicates that the backlash deviates from the specified range, make an adjustment by shifting the position of shims in use without varying the total thickness.



Recheck the ring gear for run-out at the rear face. If the amount of run-out is excessive, repeat the disassembly and reassembly steps.

Ring gear run-out,
Standard: 0.05 mm (0.002 in)
Limit: 0.2 mm (0.008 in)

Differential Cage Assembly

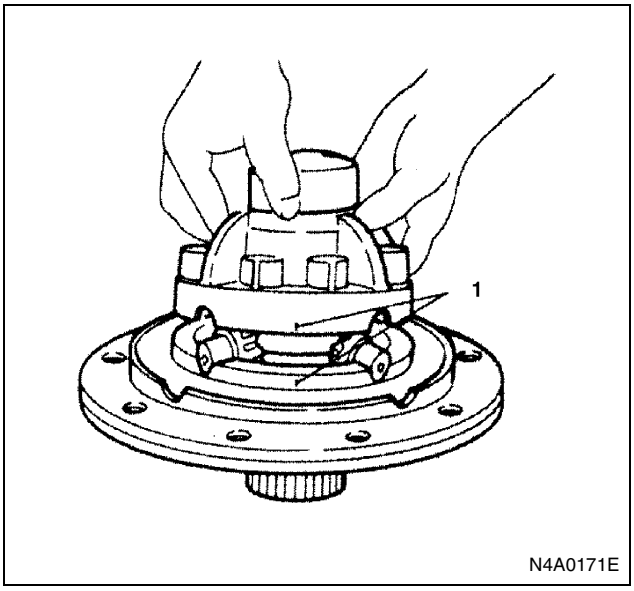


Legend

1. Differential cage B
2. Side gear
3. Thrust washer
4. Spider
5. Differential pinion gear
6. Thrust piece
7. Side gear
8. Thrust washer
9. Differential cage A and ring gear

Disassembly

1. Differential Cage B
   Apply a setting mark (1) to the differential cage assembly.
2. Side Gear
3. Thrust Washer
4. Spider
5. Differential Pinion Gear
6. Thrust Piece
7. Side Gear
8. Thrust Washer
9. Differential Cage A and Ring Gear



Inspection and Repair

Make necessary correction or parts replacement if wear, damage or any other abnormal conditions are found through inspection.

Visual Check

Inspect the following parts for wear, damage or other abnormal conditions.

- Gear
- Bearing
- Oil seal
- Differential cage
- Drive pinion cage
- Parts organizing limited slip differential assembly

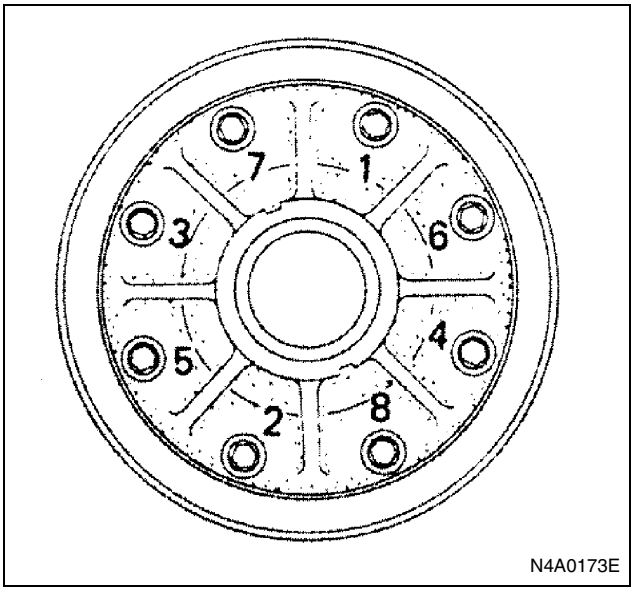
Ring Gear Replacement

The ring gear should always be replaced with drive pinion as a set.

When installing ring gear, apply stud lock to the threaded holes and bolts after treatment of the bolts with primer N.

Tighten:

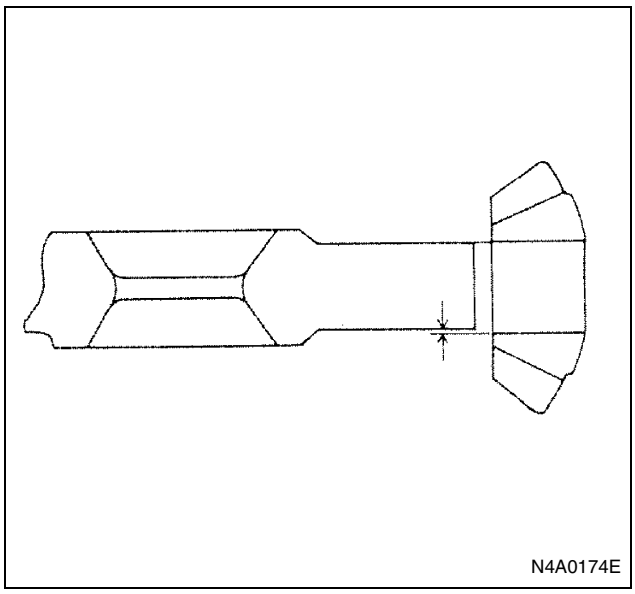
Ring gear bolt to 127 N·m (13.0 kg·m / 94 lb·ft)



Clearance between Differential Pinion and Spider

Standard: 0.07 — 0.13 mm (0.003 — 0.005 in)

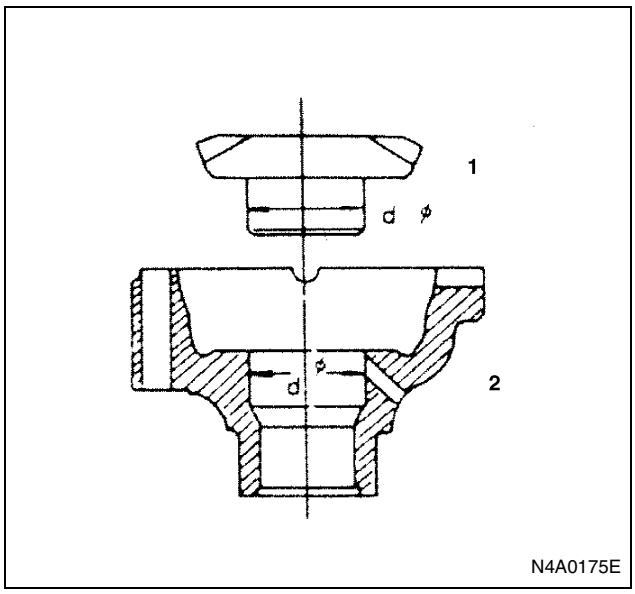
Limit: 0.2 mm (0.008 in)



Clearance between Side Gear and Differential Cage

Standard: 0.05 — 0.11 mm (0.002 — 0.004 in)

Limit: 0.25 mm (0.01 in)



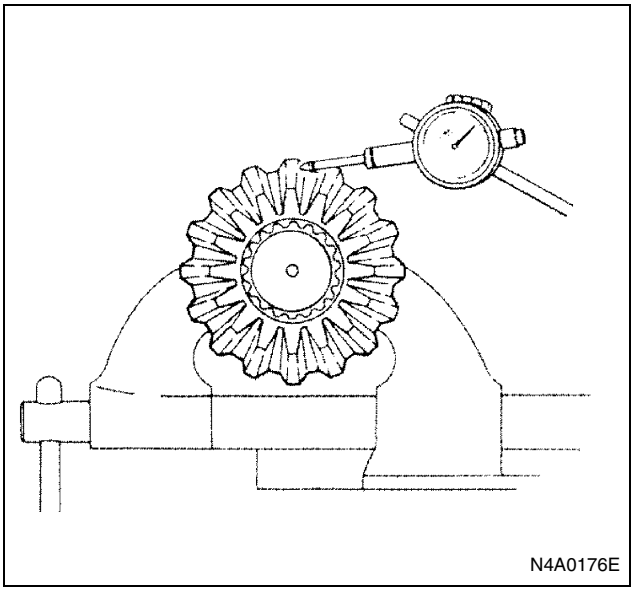
Legend

1. Side gear
2. Differential cage

Play in Splines between Side Gear and Axle Shaft

Standard: 0.02 — 0.12 mm (0.0008 — 0.005 in)

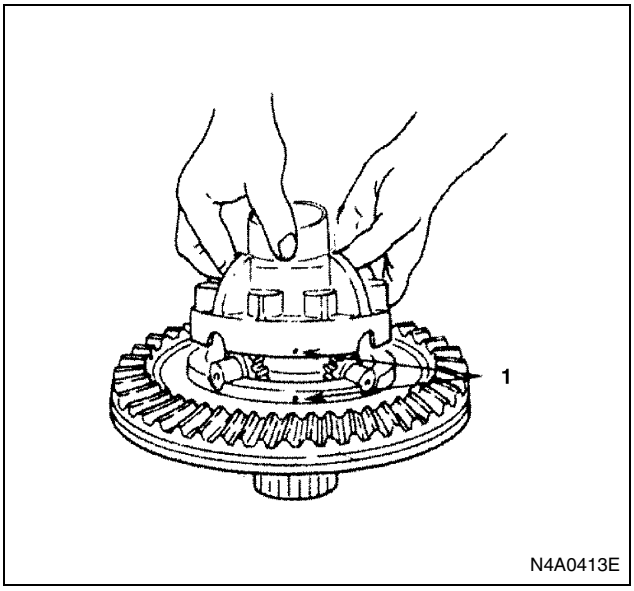
Limit: 0.25 mm (0.01 in)


N4A0176E

Reassembly

1. Differential Cage A and Ring Gear
2. Thrust Washer
3. Side Gear
4. Thrust Piece
5. Differential Pinion Gear
6. Spider
7. Thrust Washer
8. Side Gear
9. Differential Cage B
   1) Apply oil to the threaded portion of the bolts before installation.
   2) Fasten the differential cages A and B so that the setting marks (1) are correctly aligned.

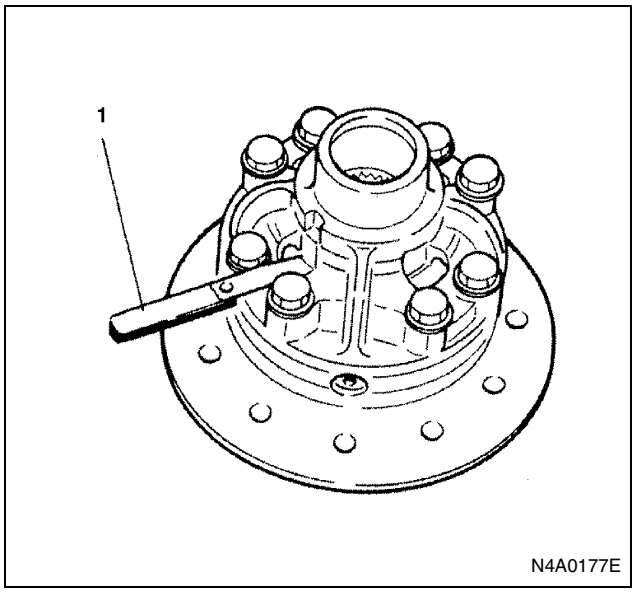
Tighten:
Differential cage bolt to 78 N·m (8.0 kg·m / 58 lb·ft)



N4A0413E

3) Measure the clearance between the back face of the side gear and the differential cage B by inserting a feeler gauge (1) through the hole on the cage B.

Clearance, 0.13 — 0.18 mm (0.005 — 0.007 in)

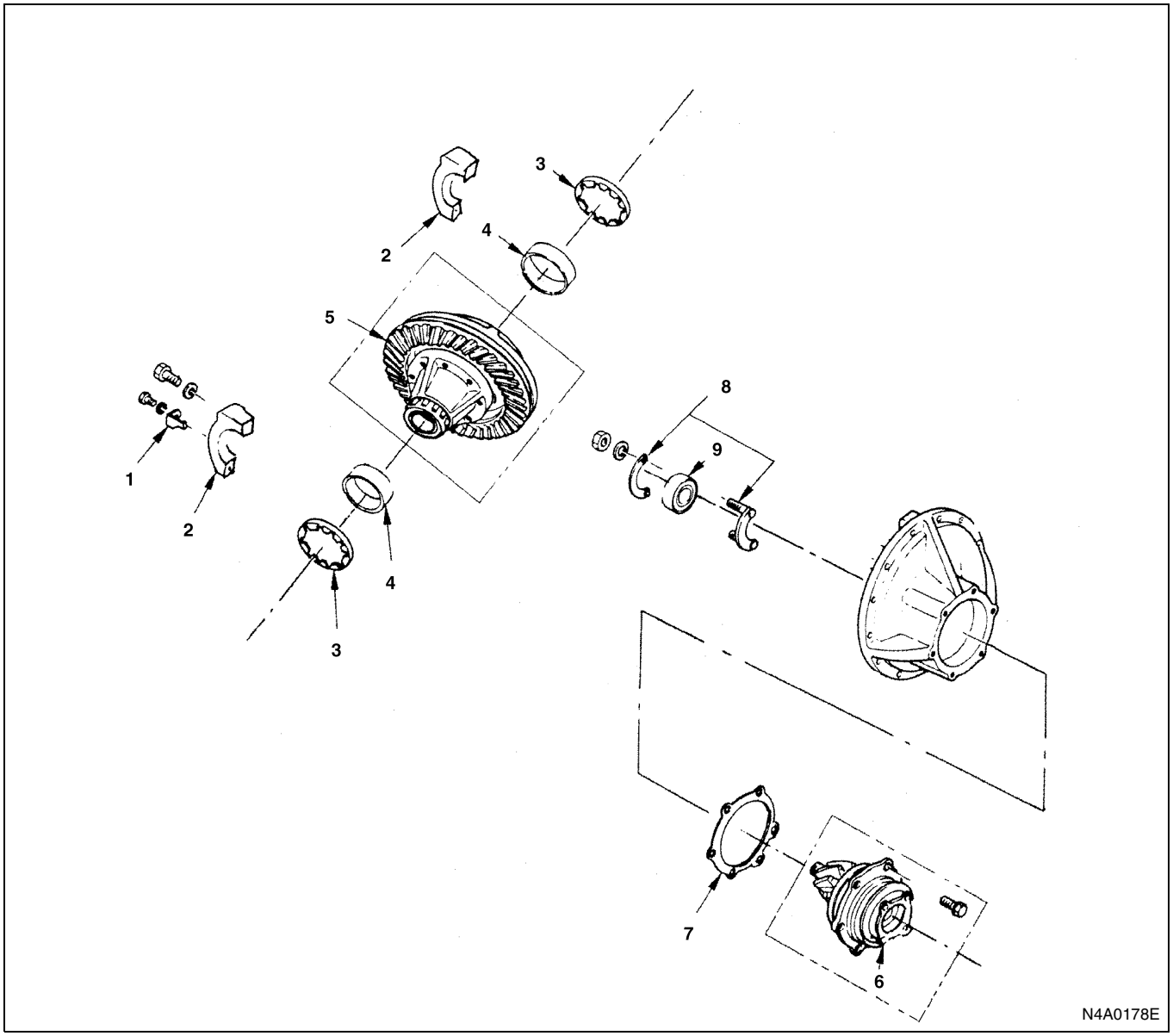


N4A0177E

When the clearance exceed a limit, replace the thrust washer or side gear.

292 mm/320 mm Rear Differential

Major Components



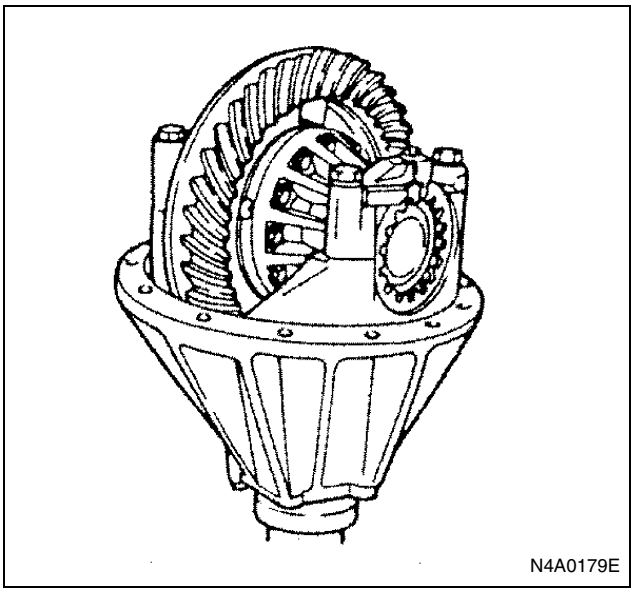
Legend

1. Lock plate
2. Bearing cap
3. Adjust nut
4. Side bearing outer race
5. Differential cage assembly
6. Drive pinion cage assembly
7. Shim
8. Pilot bearing retainer
9. Pilot bearing

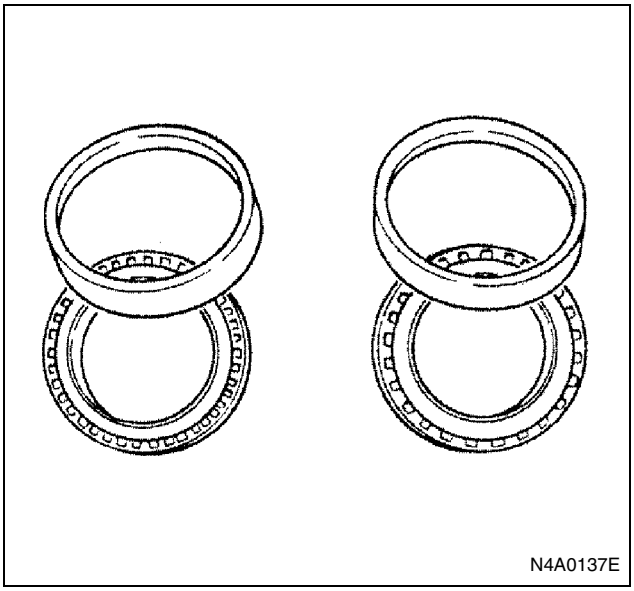
This illustration is based on the 292 mm differential.

Disassembly

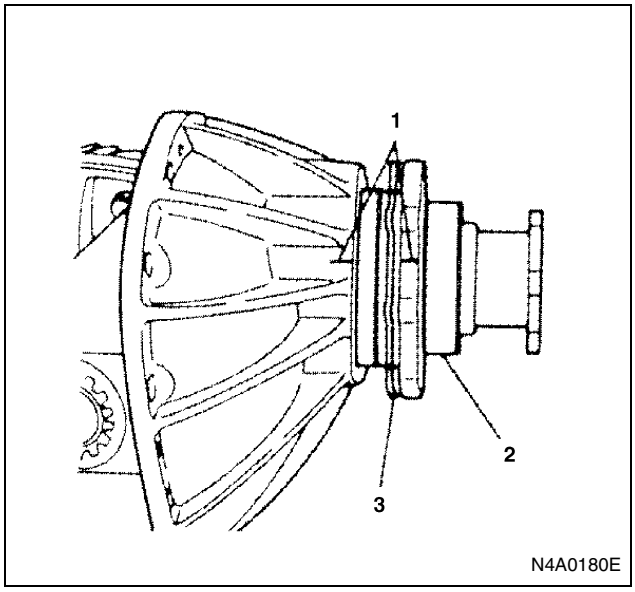
1. Lock Plate
2. Bearing Cap
   Set the differential assembly onto a special fixture.
   Apply a setting mark to the right and left side bearing caps to prevent interchanging.


N4A0179E

3. Adjust Nut
4. Side Bearing Outer Race
   Keep the side bearing outer race and inner races separate to prevent interchanging.
5. Differential Cage Assembly


N4A0137E

6. Drive Pinion Cage Assembly



N4A0180E

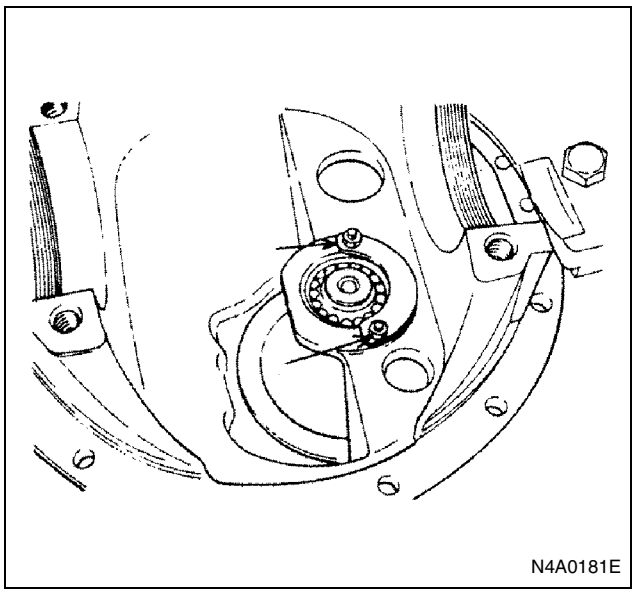
Legend

1. Setting mark
2. Pinion cage
3. Shim

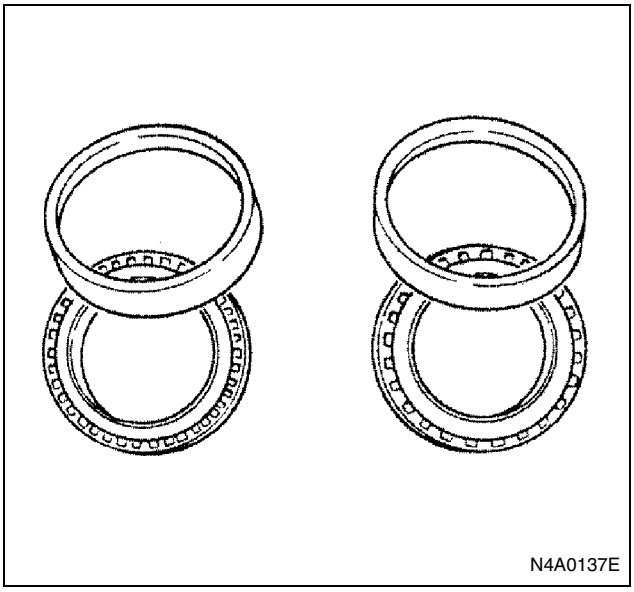
7. Shim
8. Pilot Bearing Retainer
9. Pilot Bearing

Reassembly

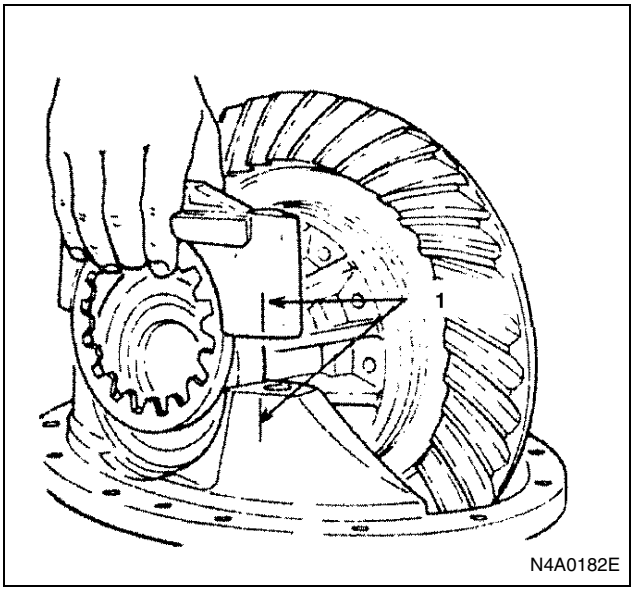
1. Pilot Bearing
2. Pilot Bearing Retainer
   The fixing nut should be on the inboard side of the case.


N4A0181E

3. Differential Cage Assembly
4. Side Bearing Outer Race
   Install the outer and inner races, so that original combination is maintained.

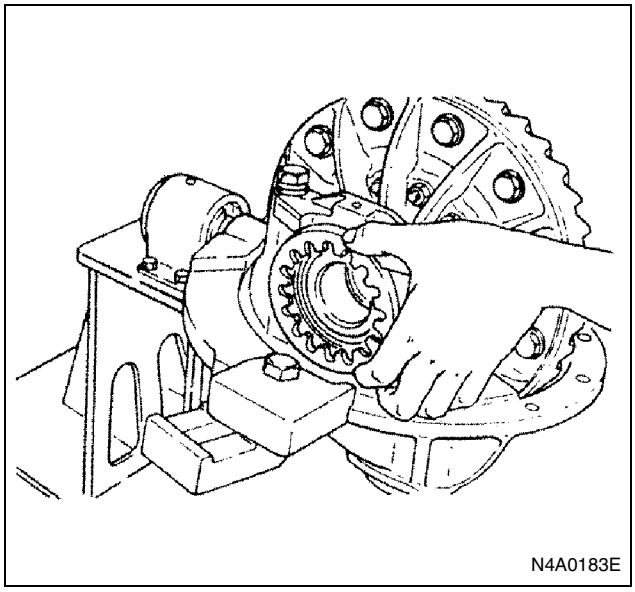

N4A0137E

5. Bearing Cap
   Install the bearing caps by aligning setting marks (1) applied at disassembly.



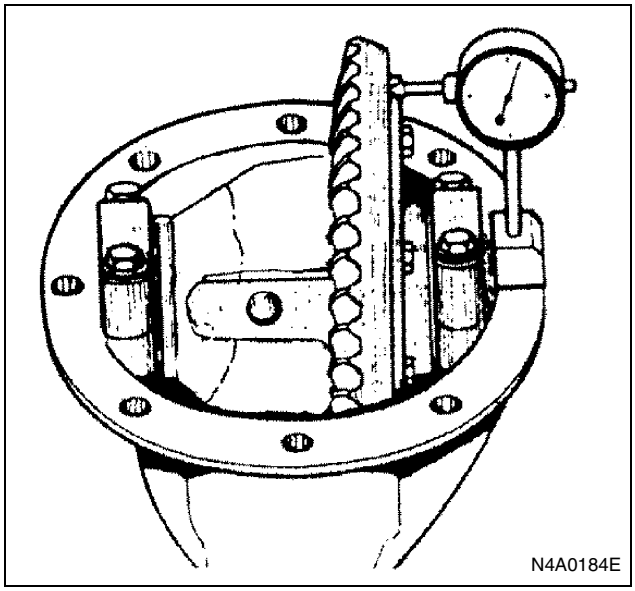
N4A0182E

6. Adjust Nut
   1) Threaded groove in nut should be properly aligned with threaded groove in the carrier.
   2) Tighten the adjust nuts so that they can be turned after installing and semi-tightening bearing caps.


N4A0183E

Inspection of Ring Gear for Run-Out

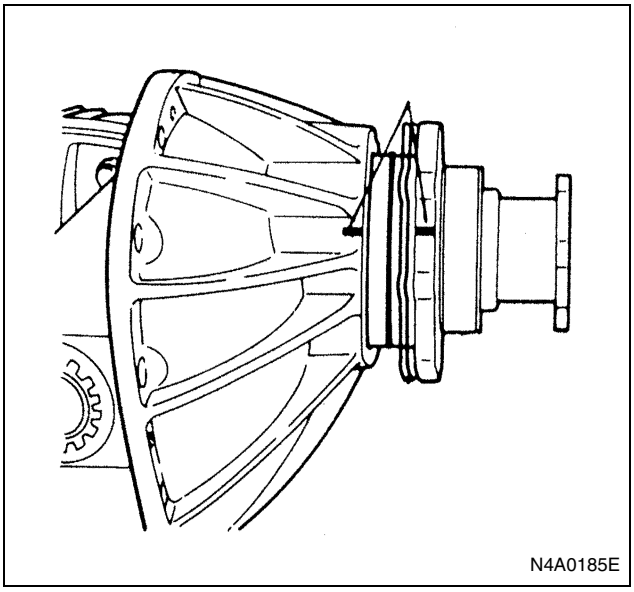
- 292 mm differential
  Standard: 0.05 mm (0.002 in)
  Limit: 0.2 mm (0.008 in)
- 320 mm differential
  Standard: 0.08 mm (0.003 in)
  Limit: 0.25 mm (0.010 in)


N4A0184E

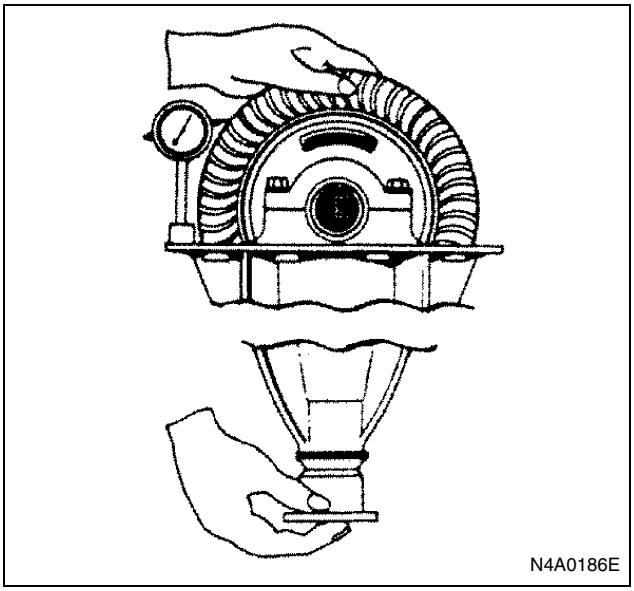
7. Shim
8. Drive Pinion Cage Assembly
   Install the shim removed and pinion aligning the oil hole or setting mark applied on removal.

Tighten:
Drive pinion cage bolt to

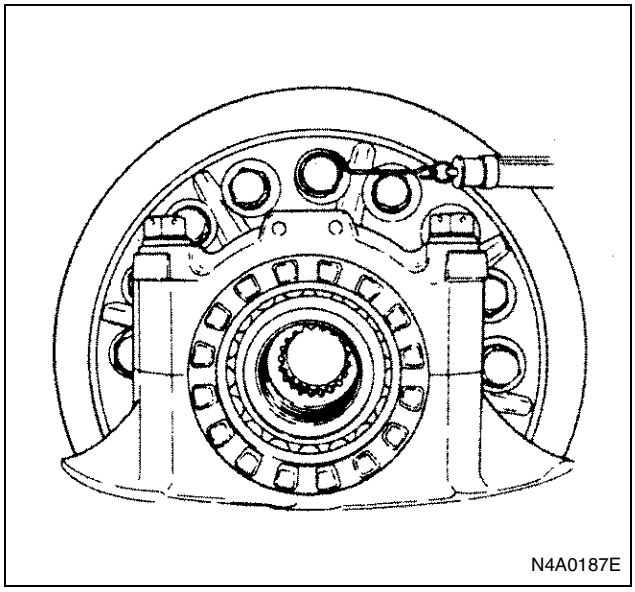
- 292 mm differential: M12 bolt to 69 N·m (7.0 kg·m / 51 lb·ft), M14 bolt to 78 N·m (8.0 kg·m / 58 lb·ft)
- 320 mm differential: 72 N·m (7.3 kg·m / 53 lb·ft)


N4A0185E

Backlash between Drive Pinion and Ring Gear
Backlash,
292 mm differential: 0.18 — 0.23 mm (0.007 — 0.009 in)
320 mm differential: 0.19 — 0.29 mm (0.007 — 0.011 in)


N4A0186E

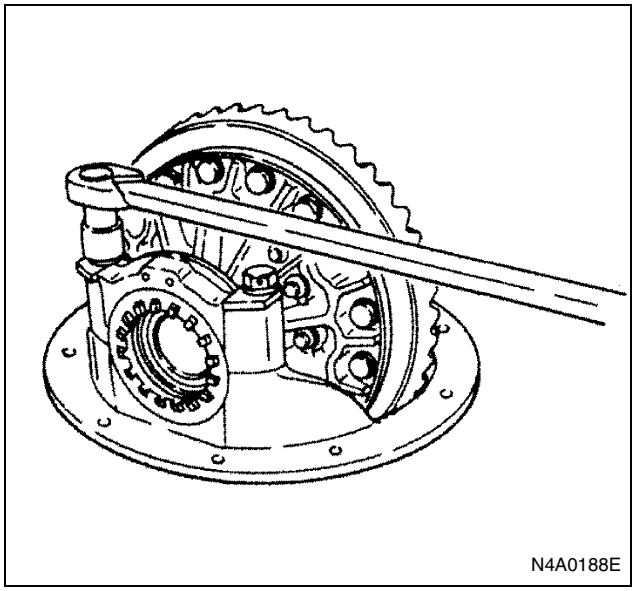
Bearing preload,
N.S.K. bearing: 5.7 — 13.0 N (0.58 — 1.33 kg / 1.3 — 2.9 lb)
Koyo bearing 11.5 — 17.9 N (1.17 — 1.83 kg /2.6 — 4.0 lb)


N4A0187E

Side Bearing Preload Adjustment
Thread the adjust nut on the ring gear side into 2 notches to give a proper bearing preload when correct backlash and tooth contact are obtained.
Fully tighten the bearing cap bolts.

Tighten:
Bearing cap bolt to
- 292 mm differential: 108 N·m (11 kg·m / 80 lb·ft)
- 320 mm differential: 157 N·m (16 kg·m / 116 lb·ft)

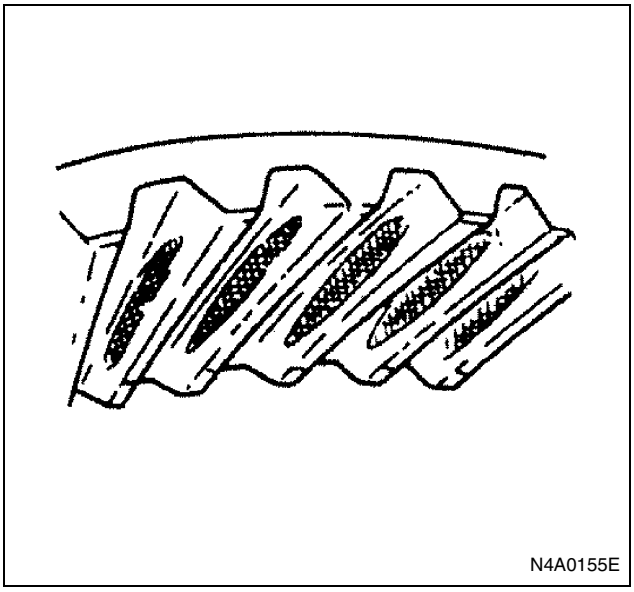
Recheck the backlash after tightening the bearing cap bolts.

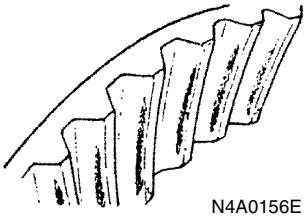
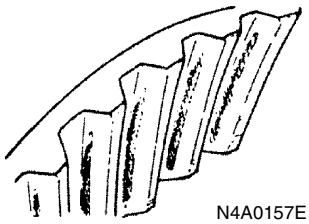
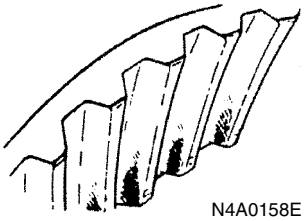
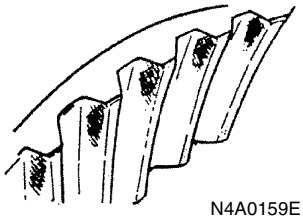

N4A0188E

Inspection of Drive Pinion and Ring Gear Tooth Contact

- Apply a thin coat of red check to the faces of the 7 — 8 teeth of the ring gear.
- Check the impression of contact (Right contact) obtained on the ring gear teeth and make necessary adjustment as described below if the contact is abnormal.

Adjusting shims available,
0.10, 0.12, 0.14, 0.16, 0.18, 0.20 mm (0.004, 0.0047, 0.0055, 0.0063, 0.0071, 0.0079 in)

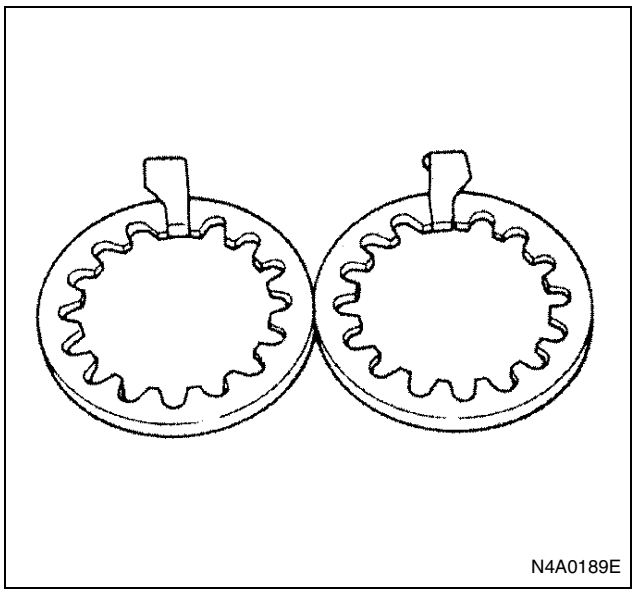

N4A0155E

TOOTH CONTACT	CASE	ADJUSTMENT PROCEDURE
 N4A0156E	Drive pinion is too far away from ring gear.	1. Move the drive pinion in toward the ring gear by decreasing the thickness of pinion depth adjusting shims. 2. Adjust the backlash by moving ring gear away from the drive pinion. N4A0160E
 N4A0157E	Drive pinion is too close to the ring gear.	1. Move the drive pinion away from the ring gear by increasing thickness of pinion depth adjusting shims. 2. Adjust the backlash by moving ring gear in toward the drive pinion. N4A0161E
 N4A0158E	Ring gear is too close to the drive pinion.	1. Move the drive pinion in toward the ring gear by decreasing thickness of pinion depth adjusting shims. 2. Adjust the backlash by moving ring gear away from the drive pinion. N4A0162E
 N4A0159E	Ring gear is too for away from drive pinion.	1. Move the drive pinion away from the ring gear by increasing thickness of pinion depth adjusting shims. 2. Adjust the backlash by moving ring gear in toward the drive pinion. N4A0163E

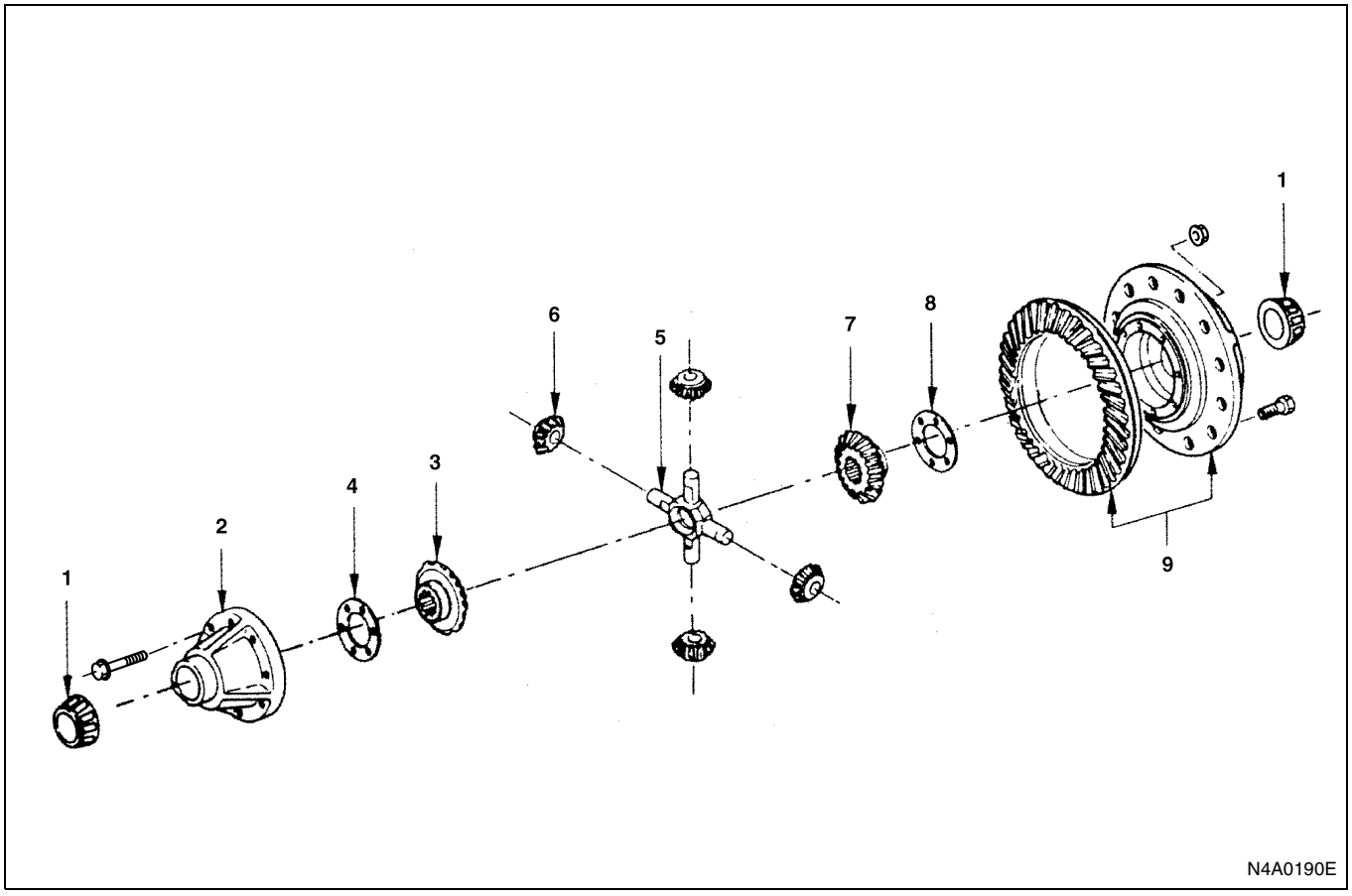
9. Lock Plate

Tighten:
Lock plate bolt to
- 292 mm differential: 29 N·m (3.0 kg·m / 22 lb·ft)
- 320 mm differential: 13 N·m (1.3 kg·m / 9 lb·ft)

The lock plates are available in 2 different kinds to permit gradual adjustment by 1/2 notch of the adjust nut.


N4A0189E

Differential Cage Assembly



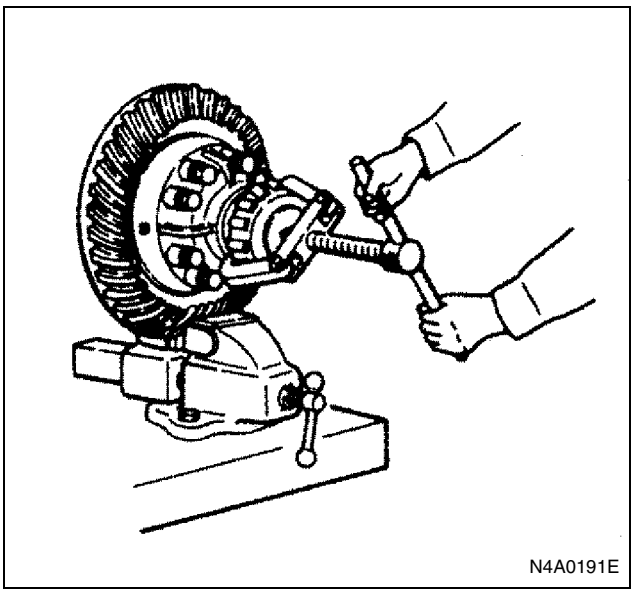
N4A0190E

Legend
1. Side bearing inner race
2. Differential cage B
3. Side gear
4. Thrust washer
5. Spider
6. Differential pinion
7. Side gear
8. Thrust washer
9. Differential cage A and ring gear

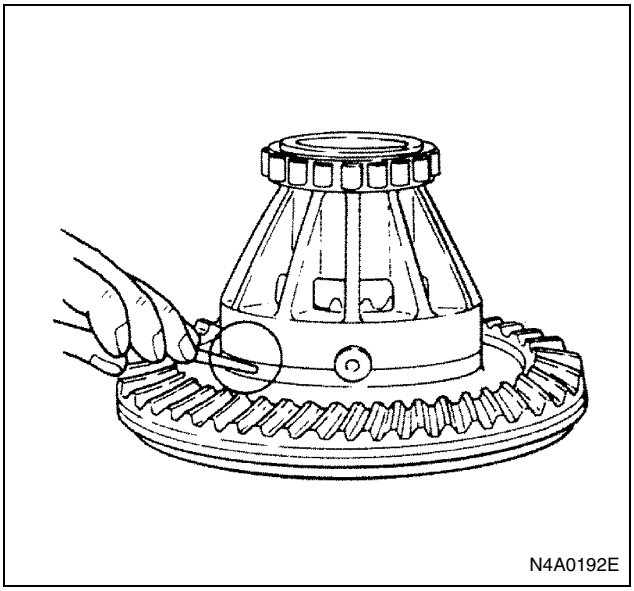
This illustration is based on the 292 mm differential

Disassembly

1. Side Bearing Inner Race
   Remover:
   9-8521-0061-0 (292 mm)
   5-8840-2373-0 (320 mm)
   Adapter:
   9-8521-2701-0


N4A0191E

2. Differential Cage B
   Apply a setting mark before removing the differential cage B to ensure reassembly into original position.


N4A0192E

3. Side Gear
4. Thrust Washer
5. Spider
6. Differential Pinion
7. Side Gear
8. Thrust Washer
9. Differential Cage A and Ring Gear

Inspection and Repair

Make necessary correction or parts replacement if wear, damage or any other abnormal conditions are found through inspection.

Visual Check

Inspect the following parts for wear, damage or other abnormal conditions.

- Gear
- Bearing
- Oil seal
- Differential cage
- Drive pinion

Ring Gear Replacement

The ring gear should always be replaced together with the drive pinion as a matched set.

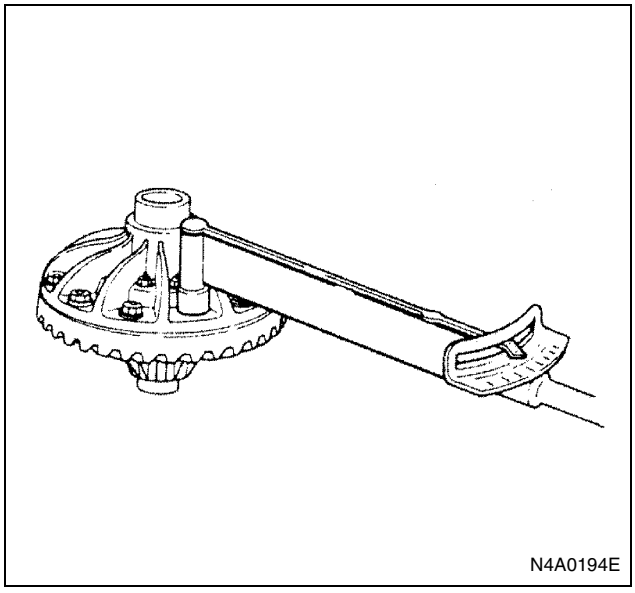
When installing ring gear, apply stud lock to the thread holes and bolts after treatment of the bolts with primer N.

Ring gear bolt wrench;
5-8840-2830-0 (for 292 mm differential)

Tighten:

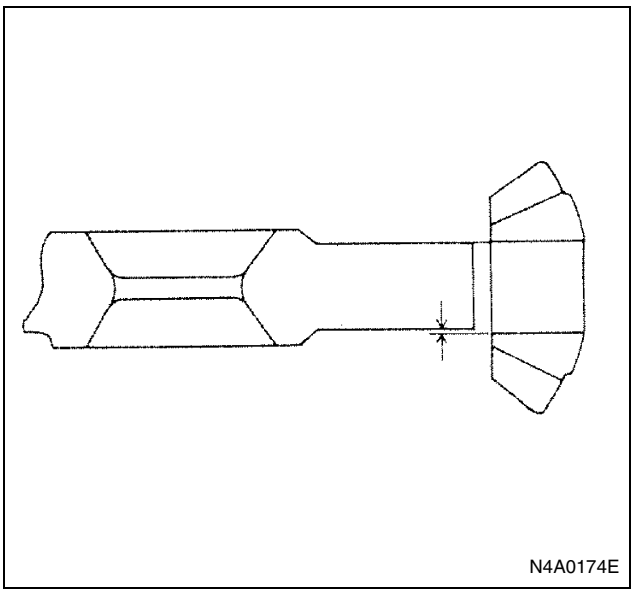
Ring gear bolt to

- 292 mm differential: M12 bolt (E12) to 127 N·m (13 kg·m / 94 lb·ft), M14 bolt to 181 N·m (18.5 kg·m / 133 lb·ft)
- 320 mm differential: 333 N·m (34 kg·m / 246 lb·ft)


N4A0194E

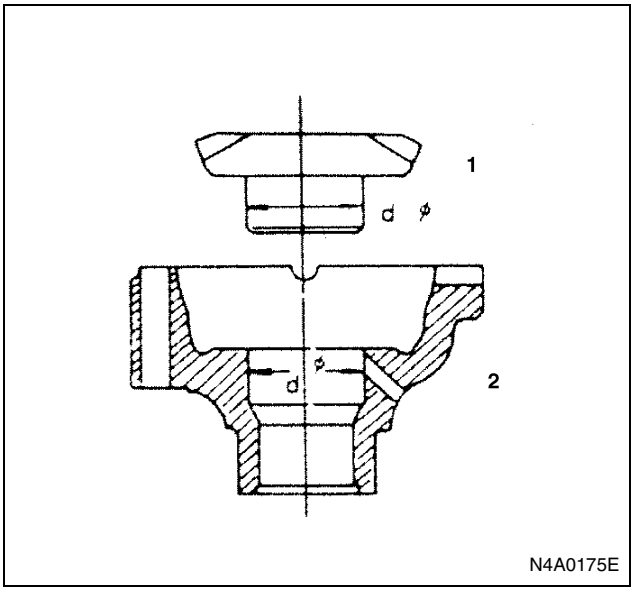
Clearance between Spider and Differential Pinion

- 292 mm differential
  Standard: 0.07 — 0.13 mm (0.003 — 0.005 in)
  Limit: 0.2 mm (0.008 in)
- 320 mm differential
  Standard: 0.05 — 0.13 mm (0.002 — 0.005 in)
  Limit: 0.2 mm (0.008 in)


N4A0174E

Clearance between Side Gear and Differential Cage

- 292 mm differential
  Standard: 0.05 — 0.11 mm (0.002 — 0.004 in)
  Limit: 0.25 mm (0.01 in)
- 320 mm differential
  Standard: 0.13 — 0.20 mm (0.005 — 0.008 in)
  Limit: 0.25 mm (0.01 in)



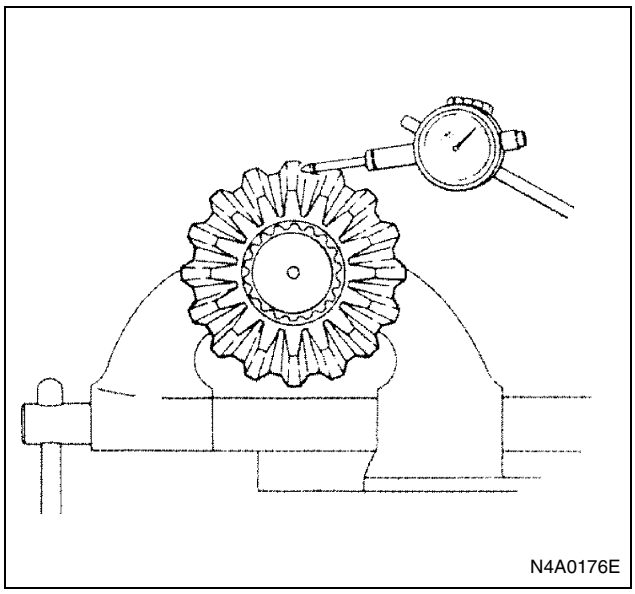
N4A0175E

Legend

1. Side gear
2. Differential gear

Play in Spline between Side Gear and Axle Shaft

- 292 mm differential
  Standard: 0.08 — 0.15 mm (0.003 — 0.006 in)
  Limit: 0.3 mm (0.012 in)
- 320 mm differential
  Standard: 0.2 mm (0.008 in)
  Limit: 0.5 mm (0.02 in)


N4A0176E

REASSEMBLY

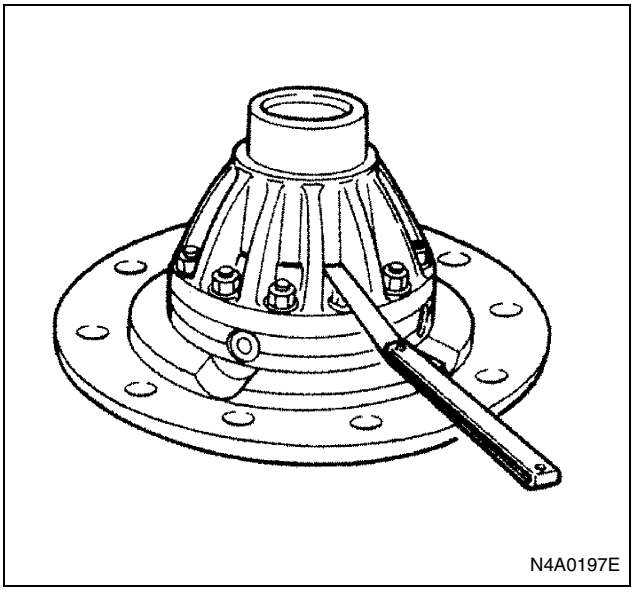
1. Differential Cage A and Ring Gear
2. Thrust Washer
3. Side Gear
4. Differential Pinion
5. Spider
6. Thrust Washer
7. Side Gear
8. Differential Cage B
   1) Install by aligning setting marks.
   2) Apply oil to threaded portion of bolts before installation.

Tighten:
Differential cage B nut to

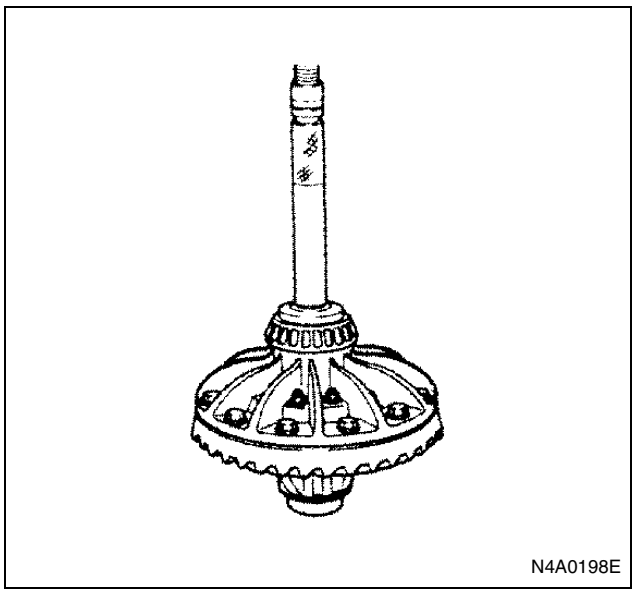
- 292 mm differential: 54 N·m (5.5 kg·m / 39.8 lb·ft)
- 320 mm differential: 74 N·m (7.5 kg·m / 54.6 lb·ft)

   3) Measure the clearance between the back face of the side gear and the differential cage B by inserting a feeler gauge through the hole on the cage B.

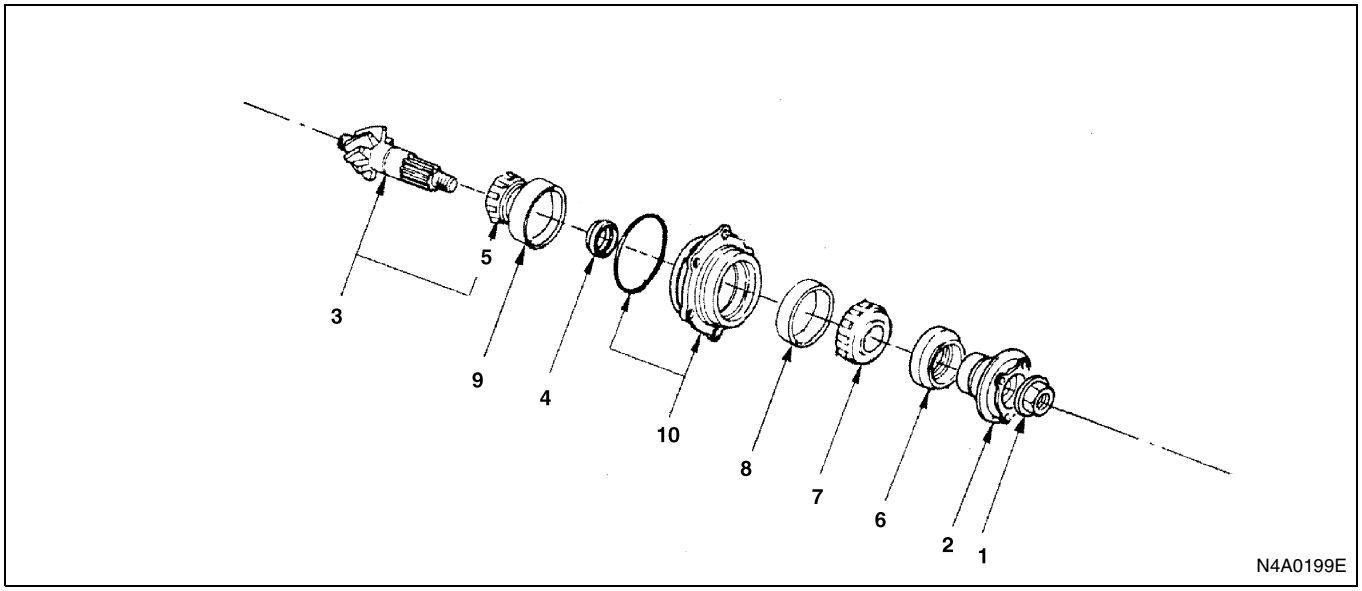
Clearance,
292 mm differential: 0.21 — 0.28 mm (0.008 — 0.011 in)
320 mm differential: 0.10 — 0.38 mm (0.004 — 0.015 in)
When the clearance exceed a limit, replace the thrust washer or side gear.


N4A0197E

9. Side Bearing Inner Race
   Installer: 9-8522-1614-0
   Grip: 9-8522-1148-0


N4A0198E

Drive Pinion Cage Assembly



N4A0199E

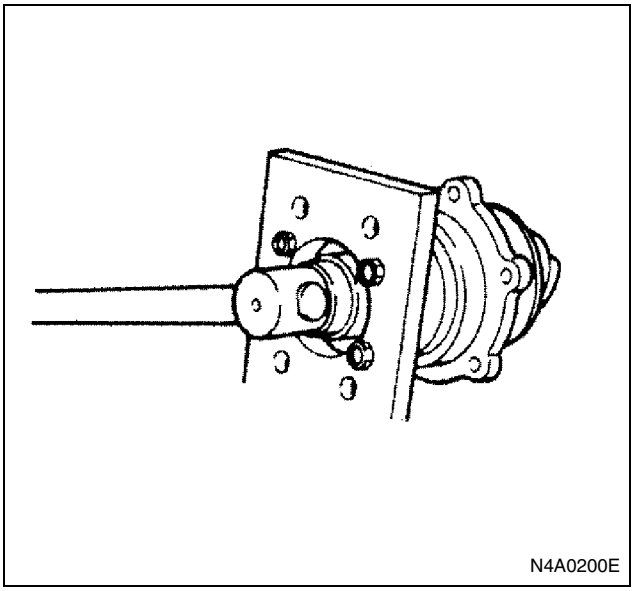
Legend

1. Flange nut
2. Flange
3. Drive pinion
4. Collapsible spacer
5. Inner bearing inner race
6. Oil seal
7. Outer bearing inner race
8. Outer bearing outer race
9. Inner bearing outer race
10. Pinion cage and O-ring

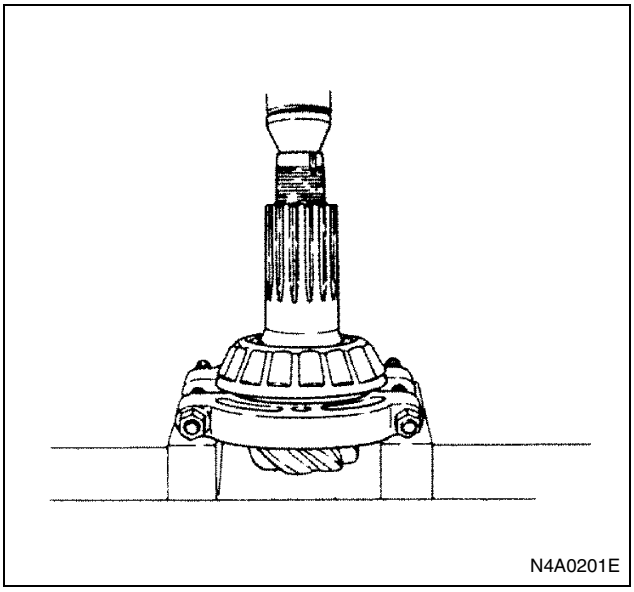
This illustration is based on the 292 mm differential.

Disassembly

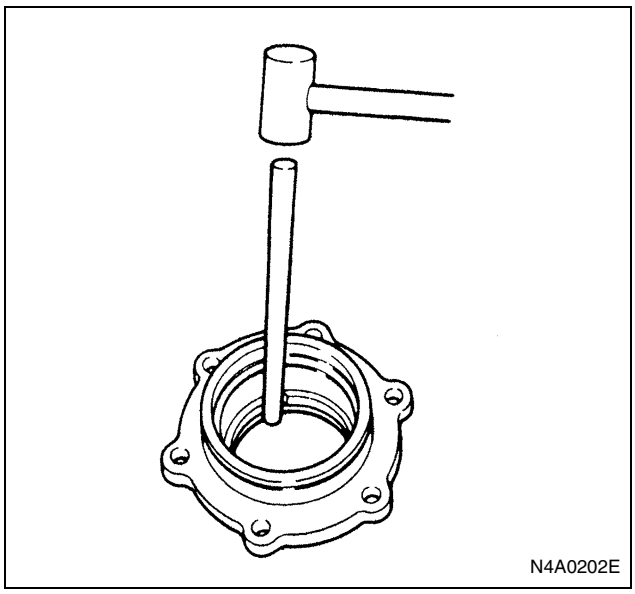
1. Flange Nut
   Flange Bracket: 9-8529-2101-0


N4A0200E

2. Flange
3. Drive Pinion
4. Collapsible Spacer
5. Inner Bearing Inner Race
   Remover: 5-8840-0015-0


N4A0201E

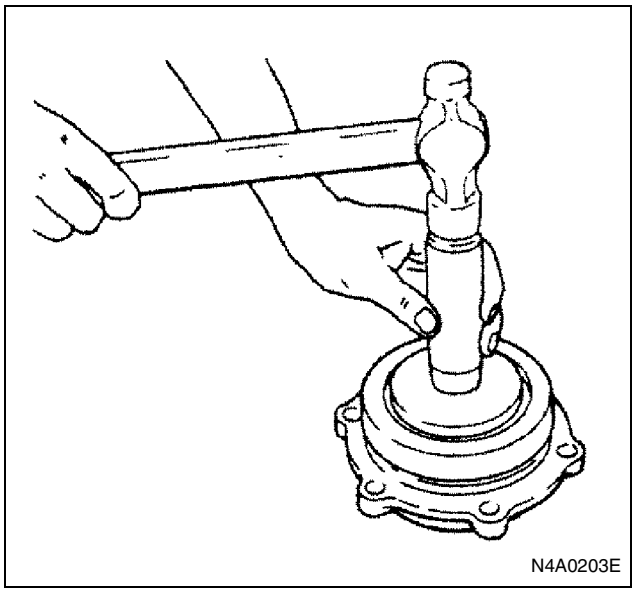
6. Oil Seal
7. Outer Bearing Inner Race
8. Outer Bearing Outer Race
   Drive out the outer bearing outer race together with the outer bearing inner race and oil seal or the inner bearing outer race by using a proper bar through the two notches.


N4A0202E

9. Inner Bearing Outer Race
10. Pinion Cage and O-ring

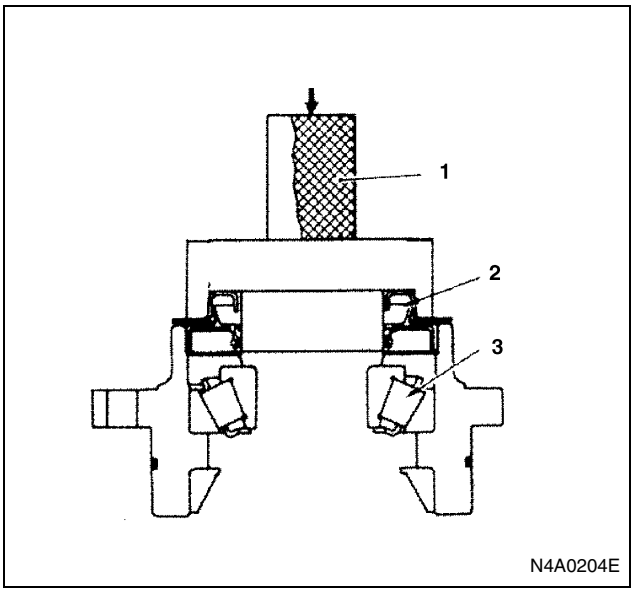
Reassembly

1. Pinion Cage and O-ring
   Discard used O-ring and install a new one.
2. Inner Bearing Outer Race
   Installer:
   5-8840-2046-0 (292 mm)
   5-8840-2379-0 (320 mm)
   Grip:
   9-8522-1608-0


N4A0203E

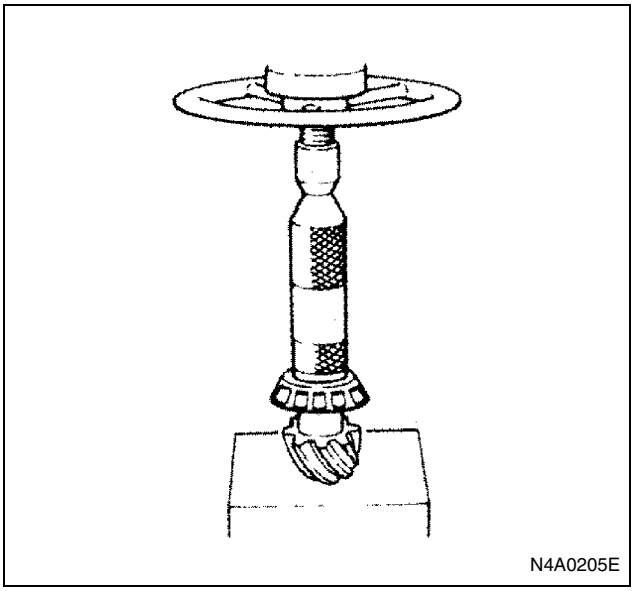
3. Outer Bearing Outer Race
   Installer:
   9-8522-1613-0 (292 mm)
   5-8840-2376-0 (320 mm)
   Grip:
   9-8522-1608-0
4. Outer Bearing Inner Race

5. Oil Seal
   Installer:
   9-8522-1607-0 (292 mm)
   5-8840-2377-0 (320 mm)
   Grip:
   9-8522-1608-0



Legend
1. Installer
2. Oil seal
3. Outer bearing

6. Inner Bearing Inner Race
   Installer:
   9-8522-1615-0



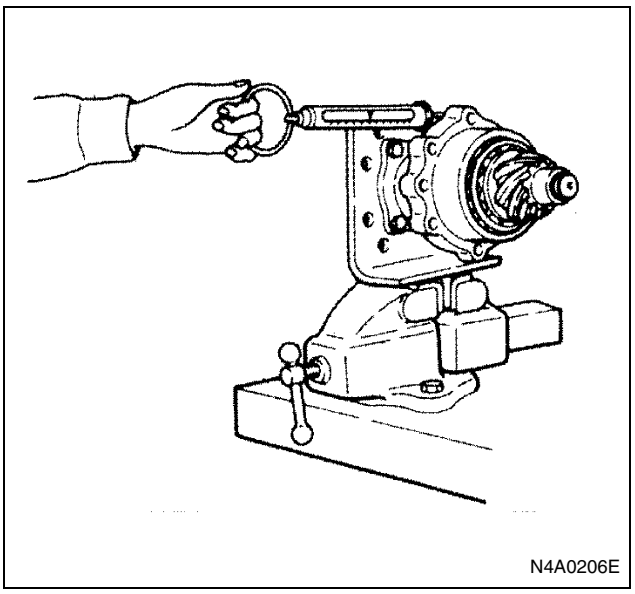
7. Collapsible Spacer
   Discard used collapsible spacer and install a new one.
8. Drive Pinion
9. Flange
10. Flange Nut
    Discard used flange nut and install a new one at re-assembly.
    Adjustment of bearing preload.
    1) Tighten the flange nut to a torque of 245 N·m (25 kg·m/181lb·ft).
    2) Adjust bearing preload by tightening the flange nut until specified preload is obtained.
    3) The flange nut should be within the specified range when specified preload is obtained.

Tighten:
Flange nut to
- 292 mm differential: 324 — 480 N·m (33 — 49 kg·m / 238 — 354 lb·ft)
- 320 mm differential: 441 — 598 N·m (45 — 61 kg·m / 325 — 441 lb·ft)

  Apply oil to seated surface of nut when tightening.

Preload at Cage Fixing Hole		N (kg/lb)
292 mm	New bearing	13 — 25 (1.3 — 2.6/2.9 — 5.7)
	Used bearing	6.5 — 12.5 (0.65 — 1.3/ 1.5 — 2.9)
320 mm	New bearing	26 — 38 (2.7 — 3.9/6.0 — 8.6)
	Used bearing	13 — 19 (1.35 — 1.95/3.0 — 4.3)

Starting Torque		N·m (kg·cm/lb·in)
292 mm	New bearing	0.98 — 1.96 (10.0 — 20.0/ 8.7 — 17.4)
	Used bearing	0.49 — 0.98 (5.0 — 10.0/ 4.3 — 8.7)
320 mm	New bearing	2.3 — 3.2 (23.0 — 33.0/20 — 28.6)
	Used bearing	1.2 — 1.6 (12.0 — 16.0/ 10.4 — 13.9)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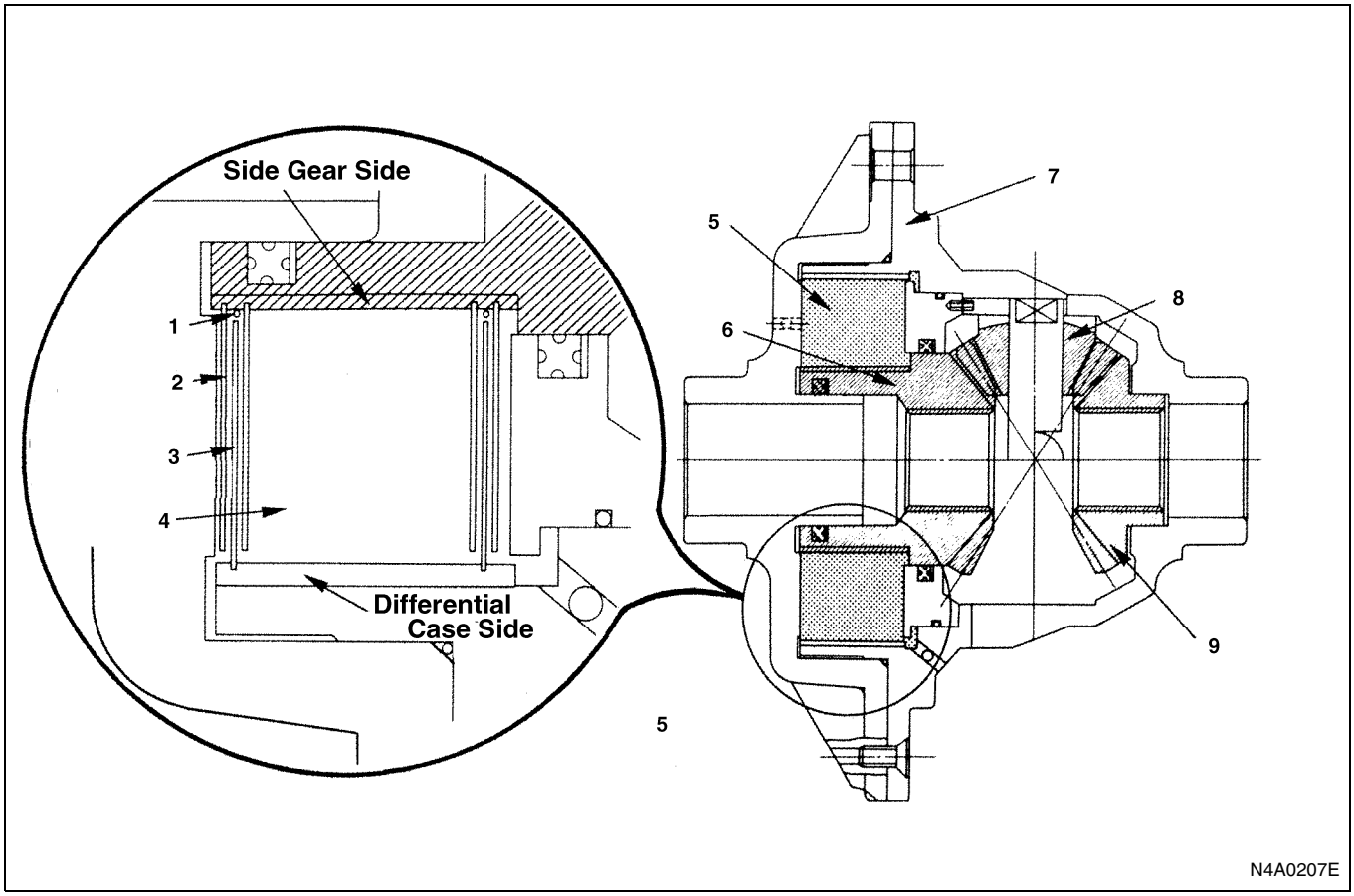
4) Using special tool, stake the flange nut at two points.
Punch: 5-8840-2293-0

Limited Slip Differential (LSD); Viscous Type

Function (NPS Model Only) <Except Taiwan, Australia and GCC>



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Legend

1. Spacer ring
2. Inner plates (20 plate in all)
3. Outer plates (19 plate in all)
4. Silicon oil
5. Viscous coupling
6. Side gear (LH)
7. Differential case
8. Spider pinion
9. Side gear (RH)

The viscous-type limited slip differential is of the structure filled with viscous (high viscosity silicone oil) between the outer plates connected to the differential case and the inner plates connected to the side gear on the left side. While driving, the difference in the number of revolutions between the right and left wheels causes the difference in the number of revolutions also between the differential case and the side gear on the left side. This difference in the number of revolutions results in shearing of silicone oil to generate viscous torque between the plates.
When either one of the wheels is caught up in muddy or snow melting road and starts racing while driving, the operation of the viscous torque mentioned above makes it facilitate to drive the vehicle by providing a driving force to the other wheel on the road where the road condition is better.

Caution:
The LSD assembly cannot be disassembled. When there occurs anything abnormal with the LSD assembly, replace it as an assembly. (Please note that when the silicone oil which has been sealed inside drains out while in disassembly, the LSD assembly will fail to display its intrinsic performance.)

Performance Check (Except Taiwan, Australia and GCC)
Check the performance by following the procedure given below.

1. Set the transmission gearshift lever to the neutral position.
2. Lift up the rear axle.
3. Rotate with a gathered momentum either one of the wheels on the rear axle in the forward direction.

When the wheel on the opposite side rotates in the forward direction while in the operation of (3) above, it is considered that the performance of viscous coupling functions normally, and otherwise, that the viscous coupling has a lowered performance.

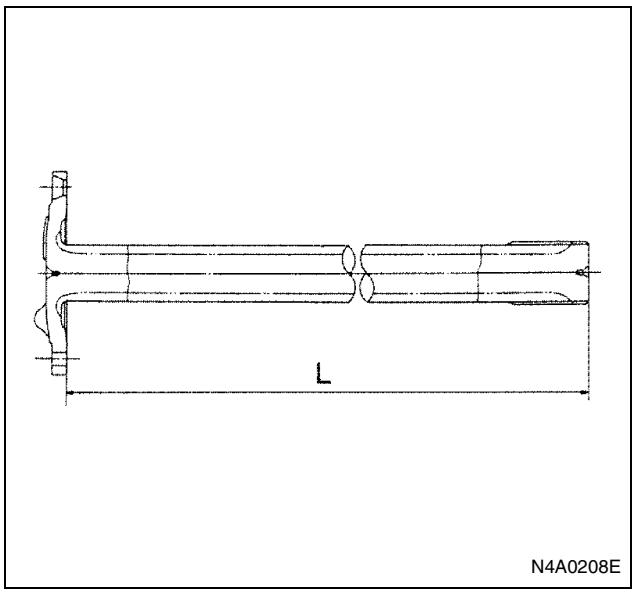
WARNING:
WHEN EITHER ONE OF THE REAR WHEELS IS LIFTED UP AND A DRIVING FORCE IS APPLIED TO THE REAR AXLE, THE VEHICLE IS IN DANGER OF STARTING ABRUPTLY. BE SURE NOT TO APPLY A DRIVING FORCE TO THE REAR AXLE IN THIS CONDITION.

For detailed information of disassembling, assembling, checking and servicing of parts other than the LSD assembly, refer to “292 MM DIFFERENTIAL”.

Rear Axle Shaft (Except 2003 year model)

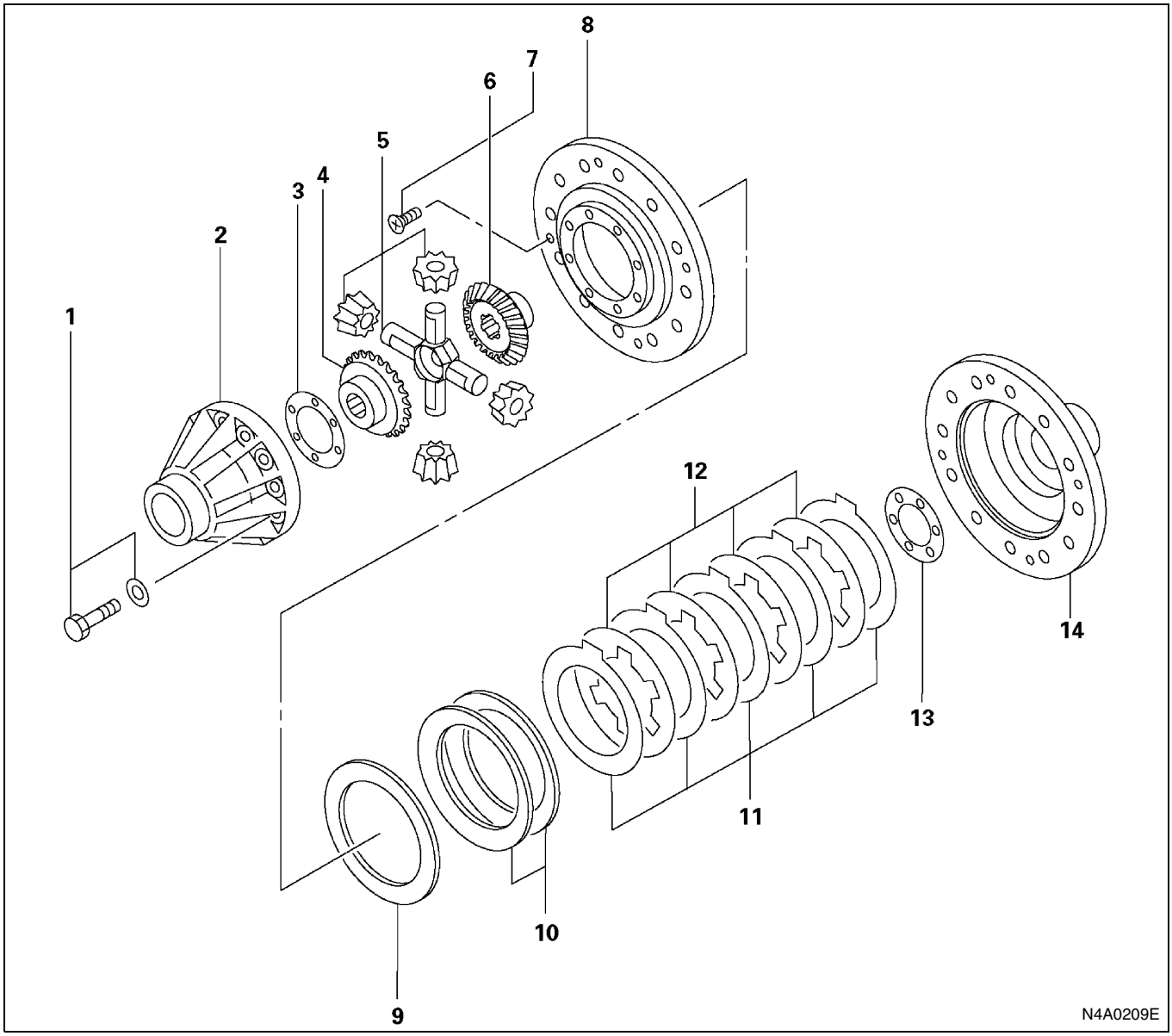
Notice:
For vehicles provided with the LSD assembly, the length of the rear axle shafts is different from each other on the right and left sides. Be careful not to confuse one with another when replacing the rear axle shaft.

L (in the illustration)
Right side: 800 ± 2 mm (31.5 ± 0.08 in)
Left side: 856 ± 2 mm (33.7 ± 0.08 in)



Limited Slip Differential (LSD); Friction Type

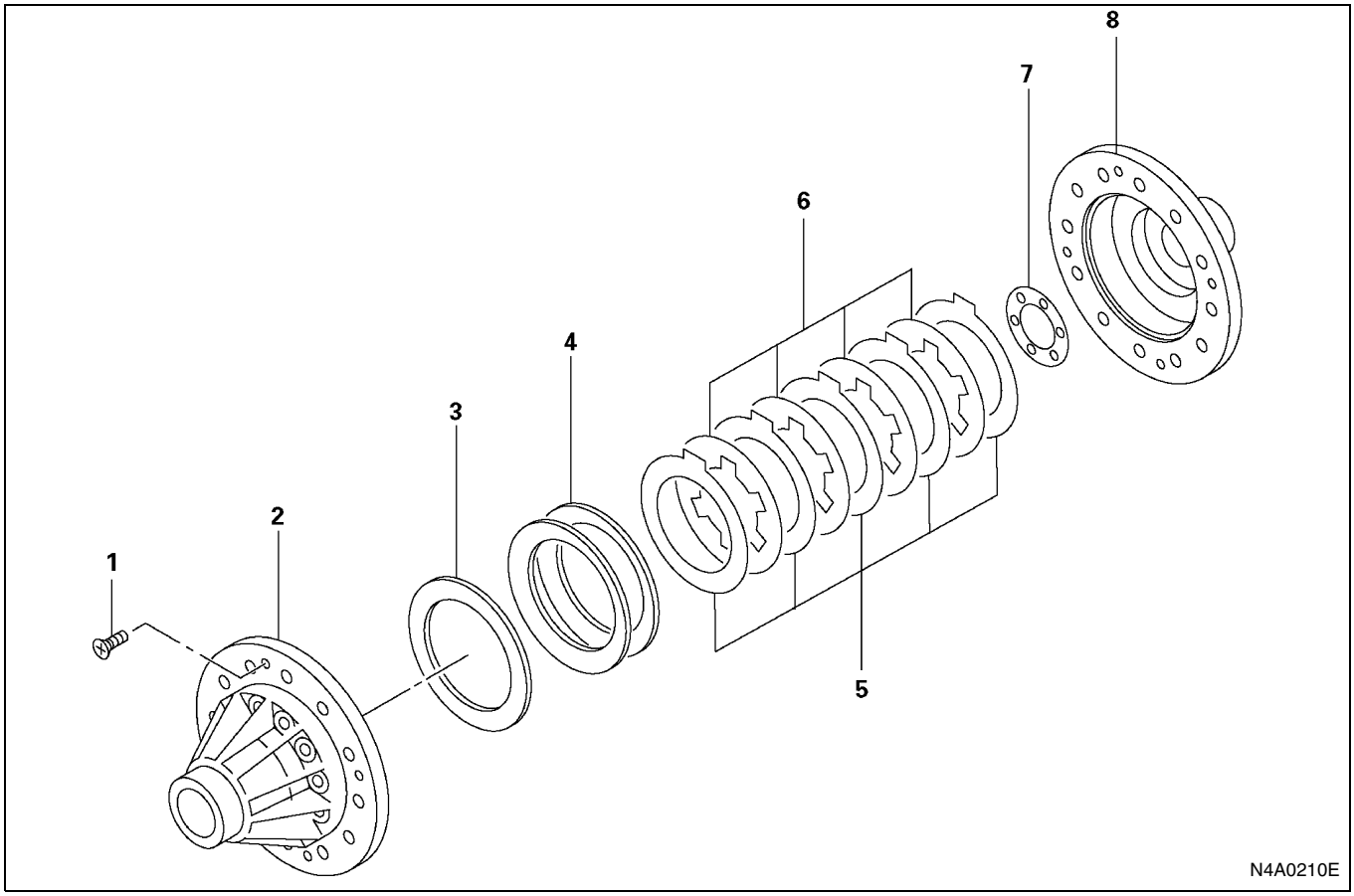
Disassembled View



Legend

1. Bolt and washer
2. Differential cage B
3. Thrust washer
4. Side gear
5. Spider and differential pinion
6. Side gear
7. Screw
8. Differential cage A′
9. Spacer
10. Spring disc
11. Friction plate
12. Friction disc
13. Thrust washer
14. Differential cage A

Limited Slip Differential (LSD)

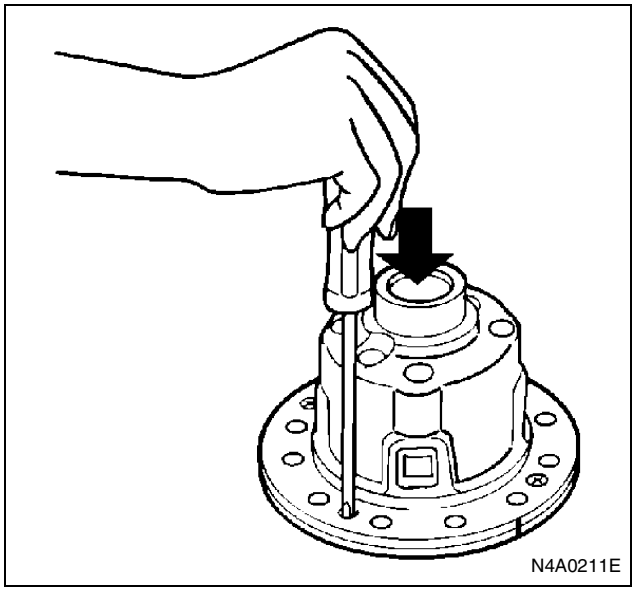


Legend

1. Screw
2. Differential cage B
3. Spacer
4. Spring disc
5. Friction plate
6. Friction disc
7. Thrust washer
8. Differential cage A

Disassembly

1. Screw
   Apply a setting mark before removing the differential cages A and B.
   Press the differential cage B and hold it.
   Gradually and evenly loosen the fixing screws of the differential cages.



2. Differential cage B
3. Spacer

4. Spring disc
   When removing the spring disc, friction plate, friction disc, place them in order for clear.
5. Friction plate
6. Friction disc
7. Thrust washer and side gear
8. Differential cage A

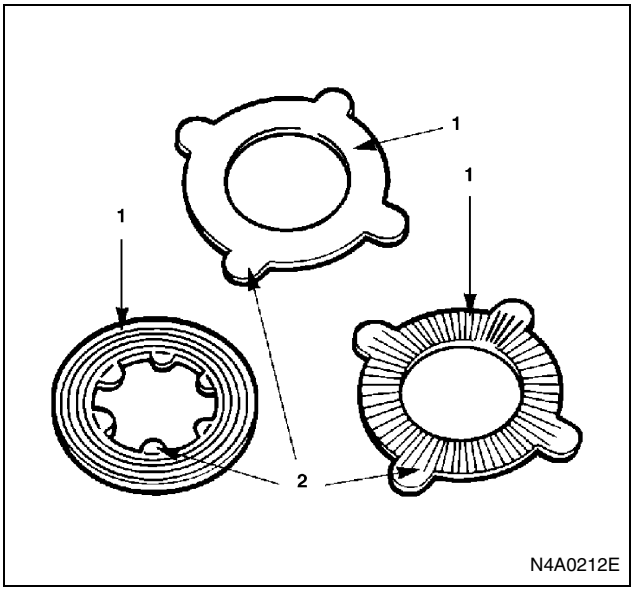
Inspection and Repair

Make necessary correction or parts replacement if wear, damage, corrosion or any other abnormal condition is found through inspection.

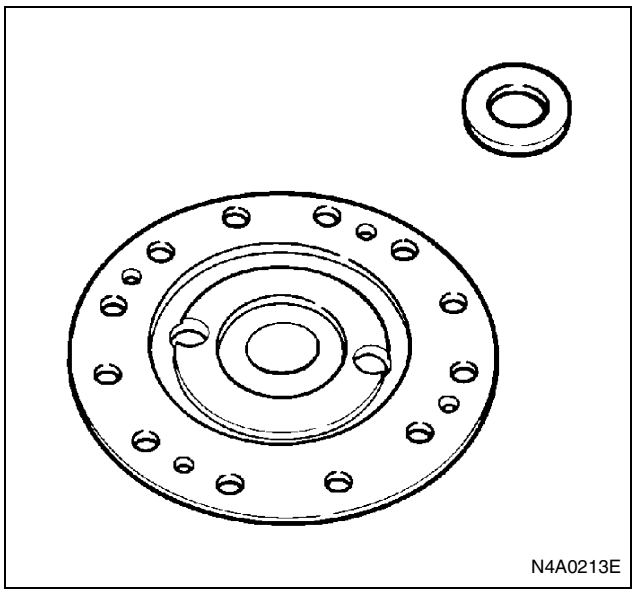
Visual Check

Check the following parts for wear, damage, noise or any other abnormal conditions.

- Friction disc, friction plate and spring disc.
  1) Sliding surfaces
  2) Projections

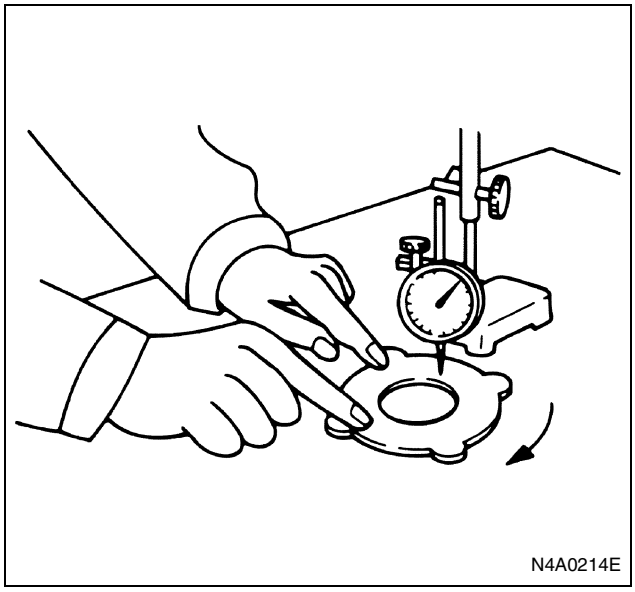


- Differential cage
  Inner groove of the differential cages. Repair light nicks and burrs using an oil stone.



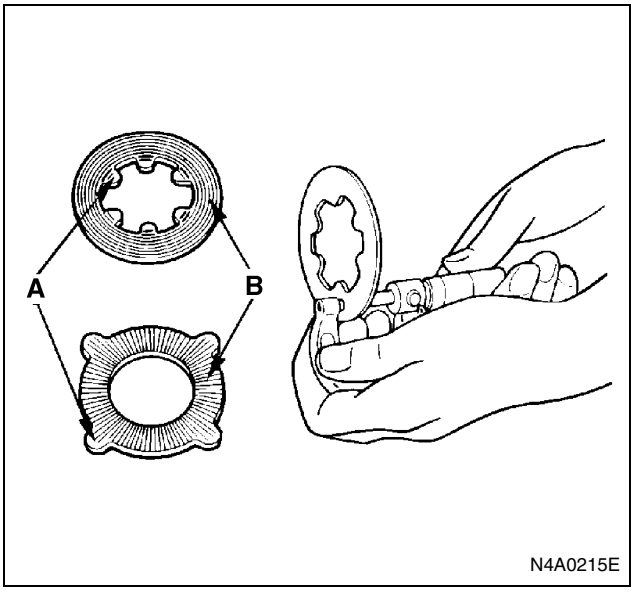
Deformation of the Friction Disc & Plate

Deformation of the friction disc & plate: 0.2 mm (0.008 in)



Wear of the Friction Plate & Disc

Wear of the friction plate & disc: 0.1 mm (0.004 in)
Remarks:
A = Inner or outer projections
B = Sliding surface subject to abrasion

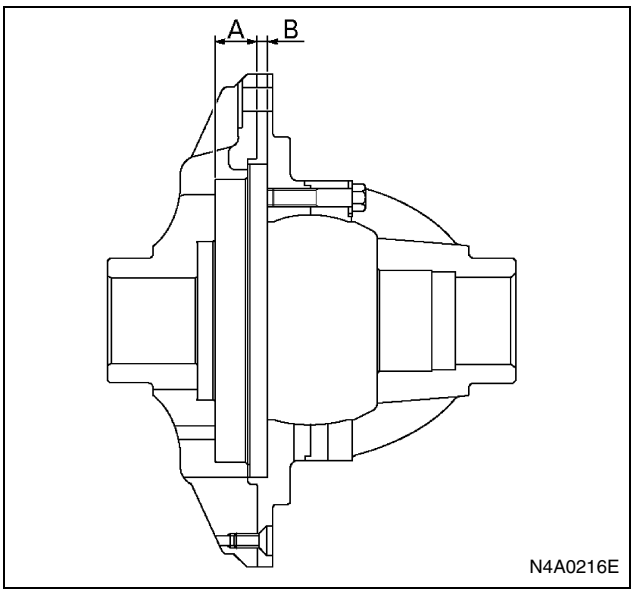


Reassembly

Clearance adjustment

1) Measuring the depth of the differential cages.

Depth of the differential cage,
Standard (A): 23.0 mm (0.9 in)
Standard (B): 5.8 mm (0.23 in)



2) Measuring the Combined thickness of the spring disc (C), friction disc (D) and friction plate (E).
3) Select and install the appropriate spacer (F) to create the specified clearance.
Clearance = (A+B) − (C+D+E+F)

Clearance,
Standard: 2.4 — 2.7 mm (0.094 — 0.106 in)
Thickness of spacer available: 2.85, 3.0, 3.15, 3.3, 3.45, 3.6, 3.75 mm

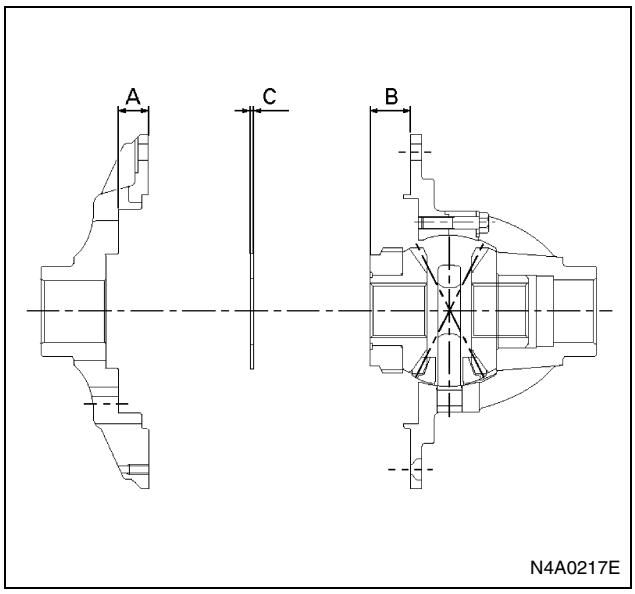
Notice:
When assembling the parts, apply recommended gear oil sufficiently to each of the parts, especially, to the contact surfaces and sliding surface.

Recommended oil:
Gear oil 5 LSD (limited slip differential) or equivalent

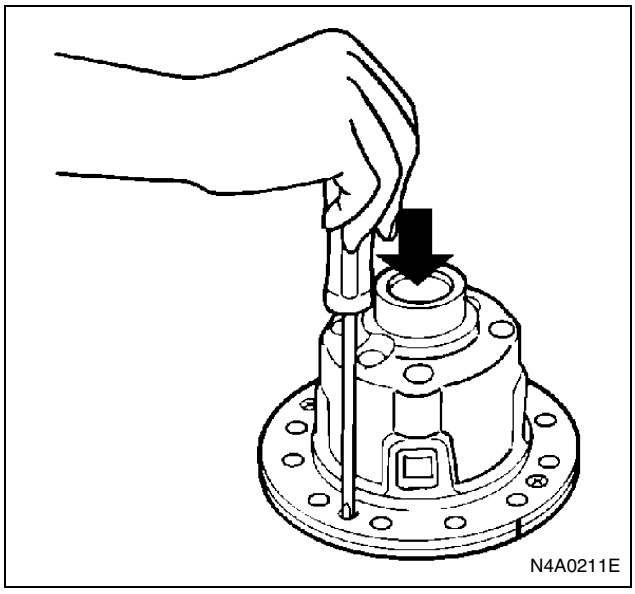
1. Differential Cage A
2. Thrust Washer
   Measure the clearance the back face of the side gear and the differential cage A.

Clearance=A−B−C,
Standard: 0−0.235 mm (0−0.09 in)
C: Thrust washer thickness

Thickness of thrust washer available: 1.3, 1.4, 1.5, 1.6 mm

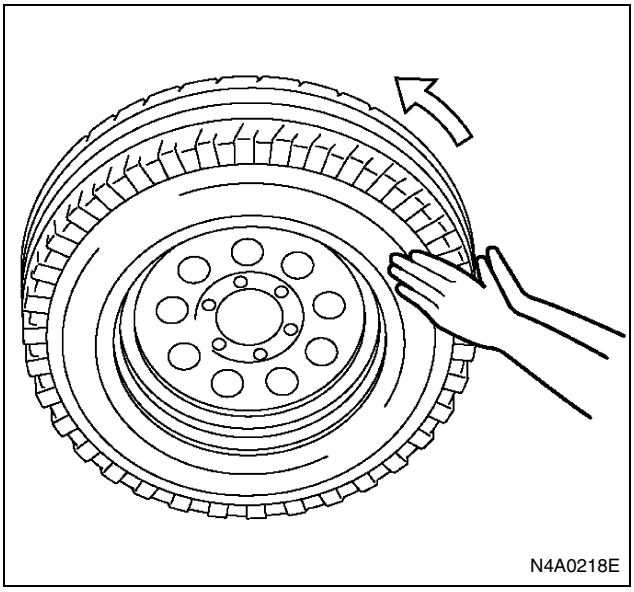


3. Friction plate and Friction Disc
4. Spring Disc
5. Spacer
6. Differential Cage B
7. Screw
   Matching the guide marks of the differential cages.
   Press the differential cage B and hold it.
   Tighten the screws evenly in the diagonal order.



Inspection (After installation to the vehicle)
Check parking brake function.

1) Make sure the vehicle is empty.
2) Set the parking brake.
3) Jack up the rear of the vehicle.
4) Check that the rear wheels do not turn when force is applied to them.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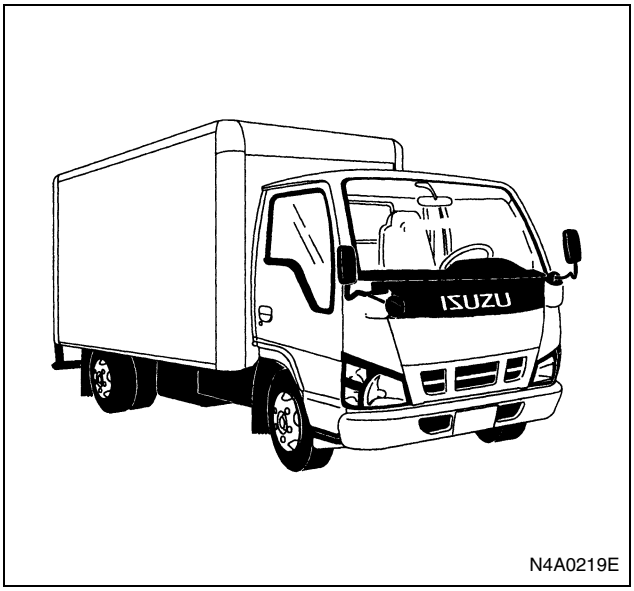
Road test
Drive the vehicle on the open road. Check that the limited slip differential operates when the vehicle is drive in a circular pattern and during cornering.



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PROPELLER SHAFT AND AXLE

SECTION 4C
FRONT AXLE

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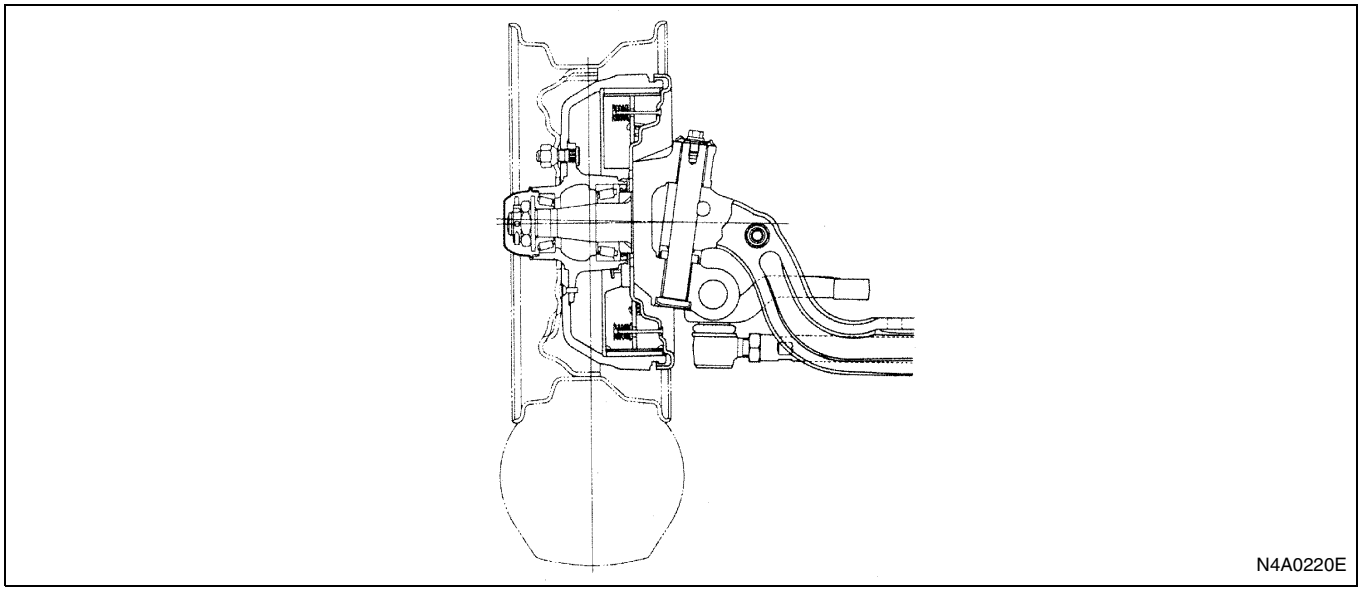
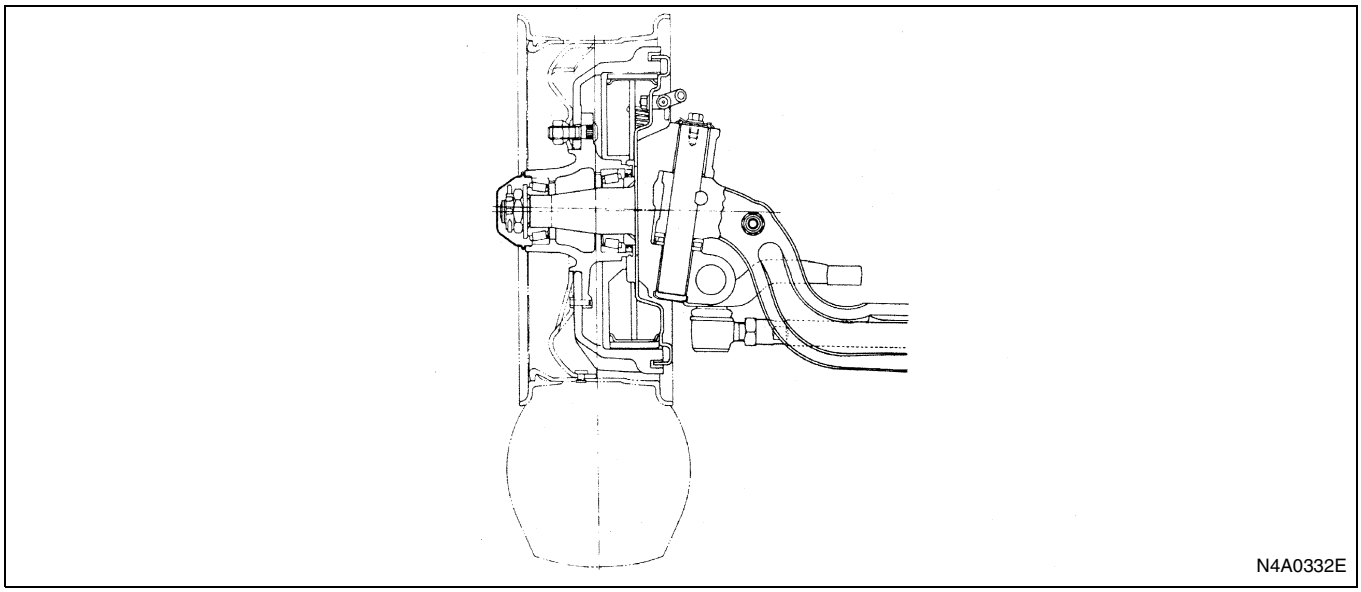
GENERAL DESCRIPTION

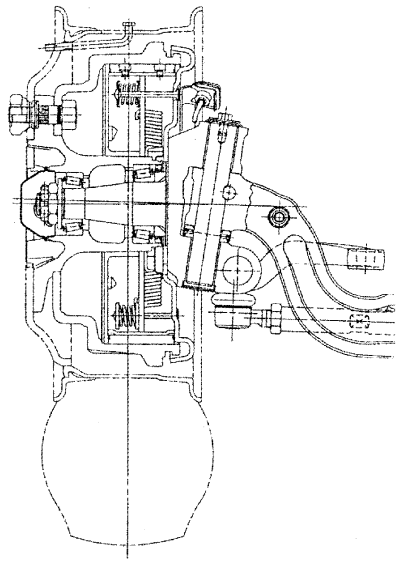
NHR Front Drum Brake Model (4 × 2 Model)



NKR Front Drum Brake Model (Rear Single Tire) (4 × 2 Model)



NKR Front Drum Brake Model (Rear Dual Tire) (4 × 2 Model)



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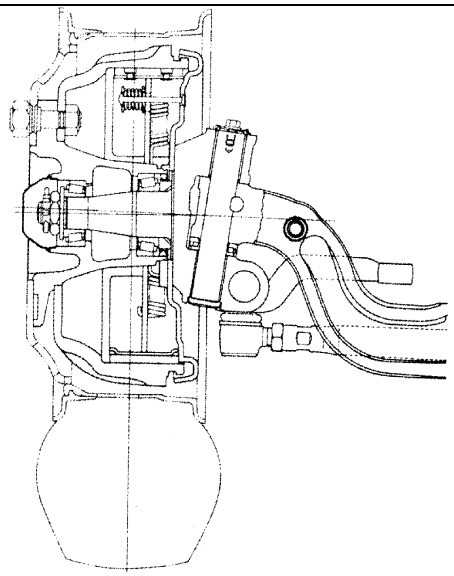
NPR, NQR Front Drum Brake Model (4 × 2 Model)



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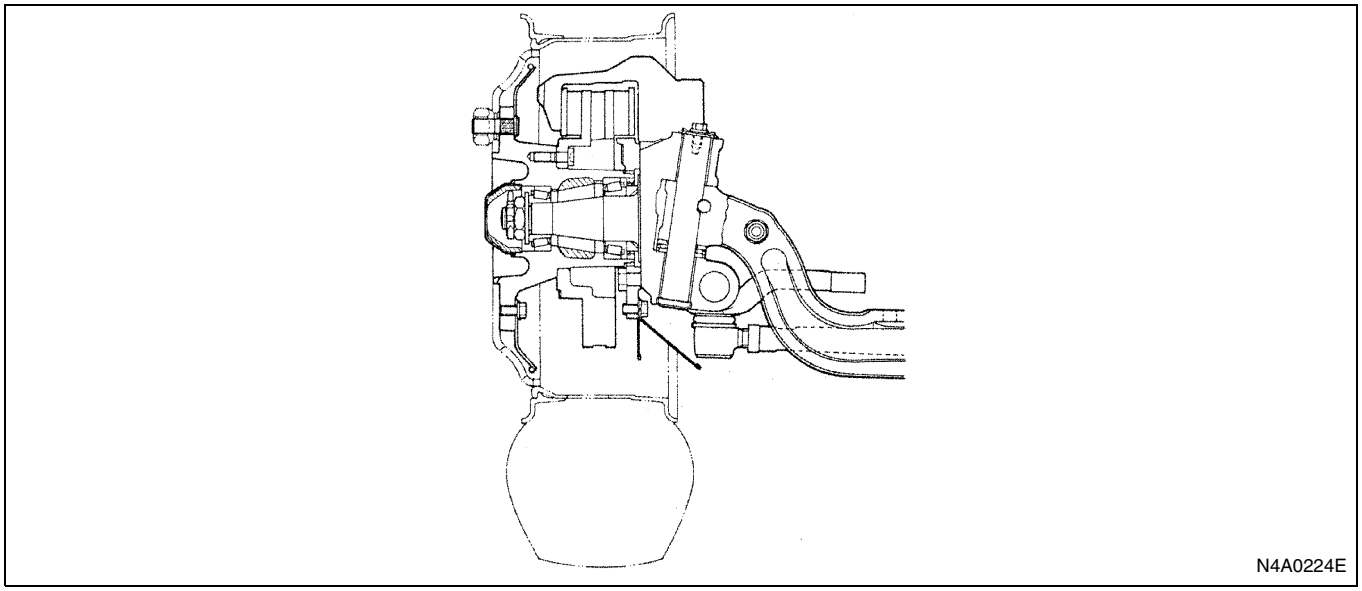
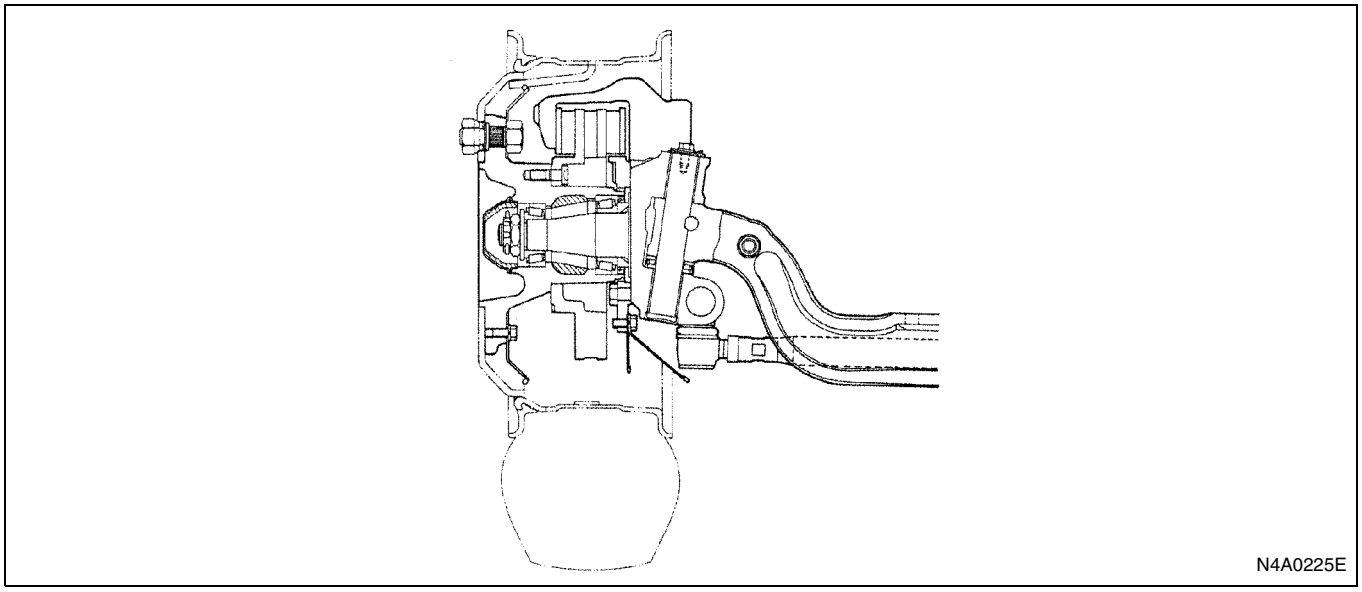
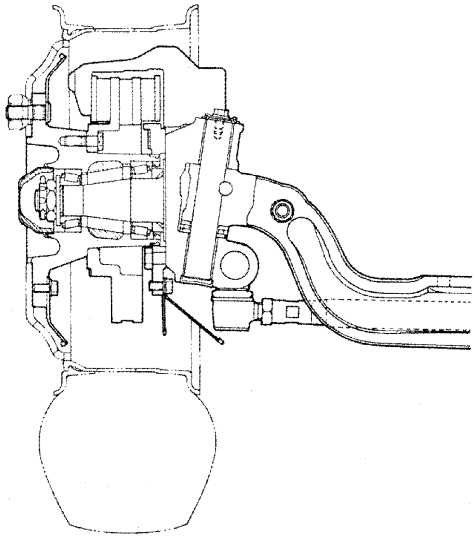
NKR Front Disc Brake Model (4 × 2 Model)



NPR Front Disc Brake Model (5 studs) (4 × 2 Model)



NPR, NQR Front Disc Brake Model (6 studs) (4 × 2 Model)



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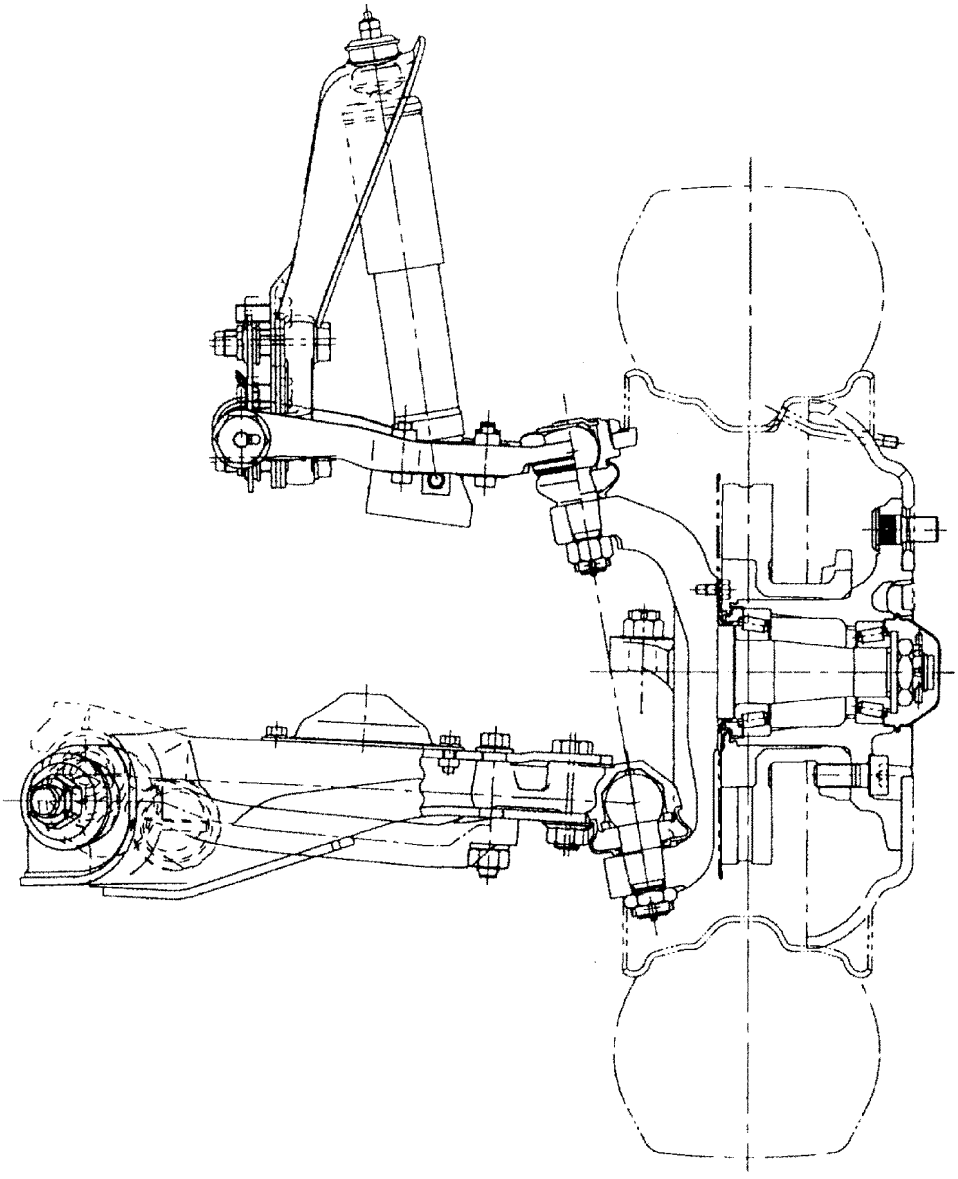
NKR Front Disc Brake Model (Independent Suspension, 4 × 2 Model)



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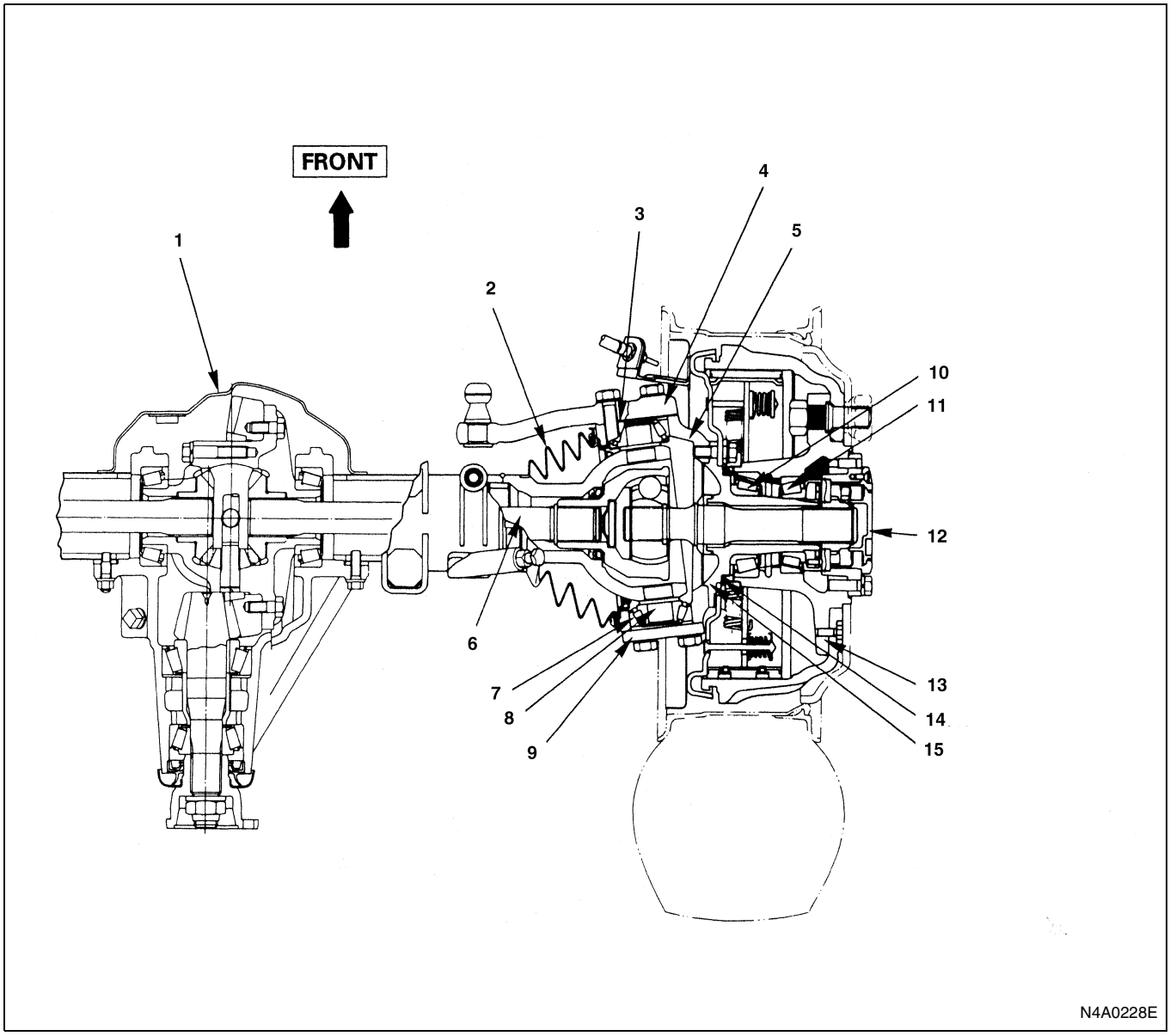
Front Axle (4 × 4 Model)

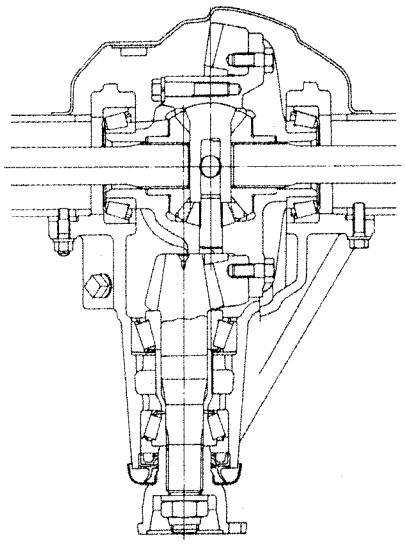


Legend

1. Front final drive
2. Front axle tube end boot
3. Shim
4. Knuckle arm
5. Front axle knuckle
6. Front drive shaft
7. King pin bearing
8. King pin
9. King pin cover
10. Front axle hub inner bearing
11. Front axle hub outer bearing
12. Free wheel hub
13. Front axle hub
14. Front hub oil seal
15. Spindle

The front axle is full floating axle tube type with Birfield joints. The front axle supports the weight of the front of the vehicle and transfers it to the front tires. It also functions as a part of the steering system. The front axle is also designed to transmit the driving force to the front wheels in the four wheels drive mode.

Front Final Drive (244mm (9.6 in.) Size)



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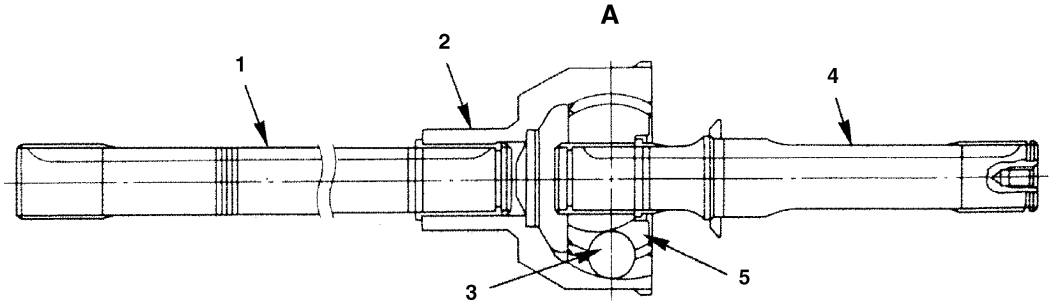
The differential system employs a hypoid gearing which is higher in strength and durability and quieter in operation than the spiral bevel gears to lower the center of gravity of the vehicle thereby improving running stability. The differential gear box which includes the side gears and pinion gears is mounted to the differential carrier via the two (2) taper roller bearings. The final drive gear reduces and changes axial rotary force (drive power) of transfer output to rectangular direction, and also it distributes the power to the drive wheels.

Front Drive Shaft (Birfield Joint)



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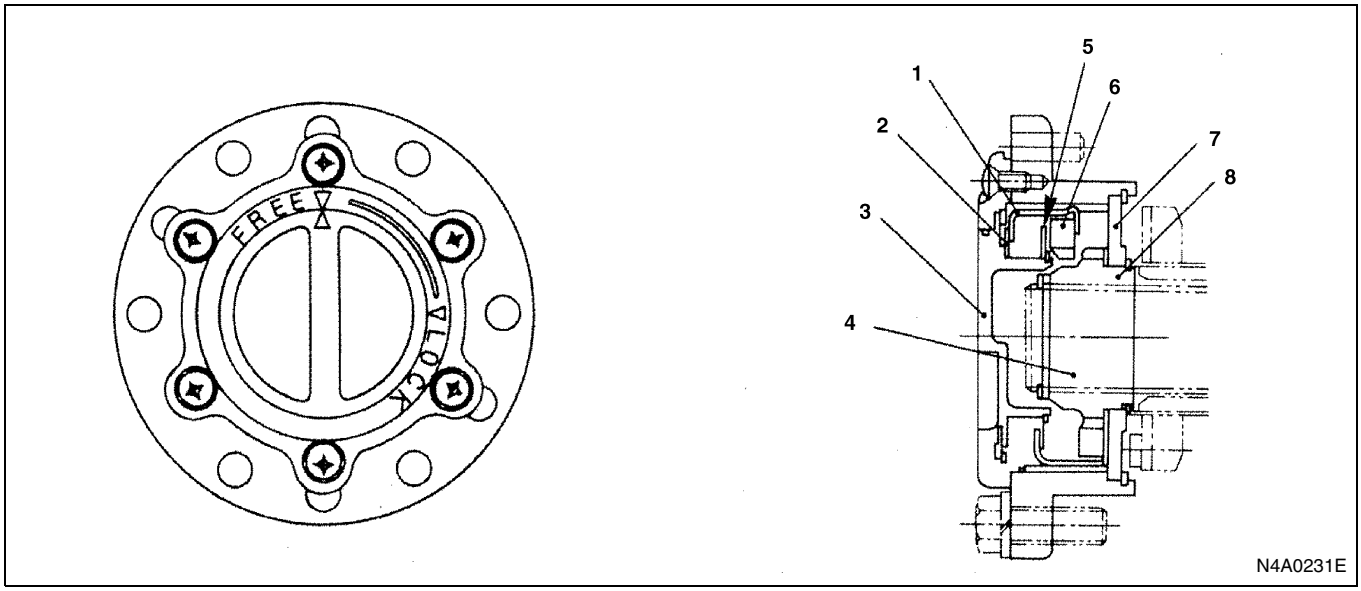
Legend

A. Birfield section
1. Outer shaft
2. Outer ring
3. Ball
4. Inner shaft
5. Inner ring

The drive power from the reduction and differential is transmitted from the outer drive shaft to the outer ring of Birfield joint to its ball to its inner ring to the inner drive shaft finally to drive the tire. When the vehicle is steered the balls automatically move according to the steering angle thereby operating as a complete constant velocity joint.

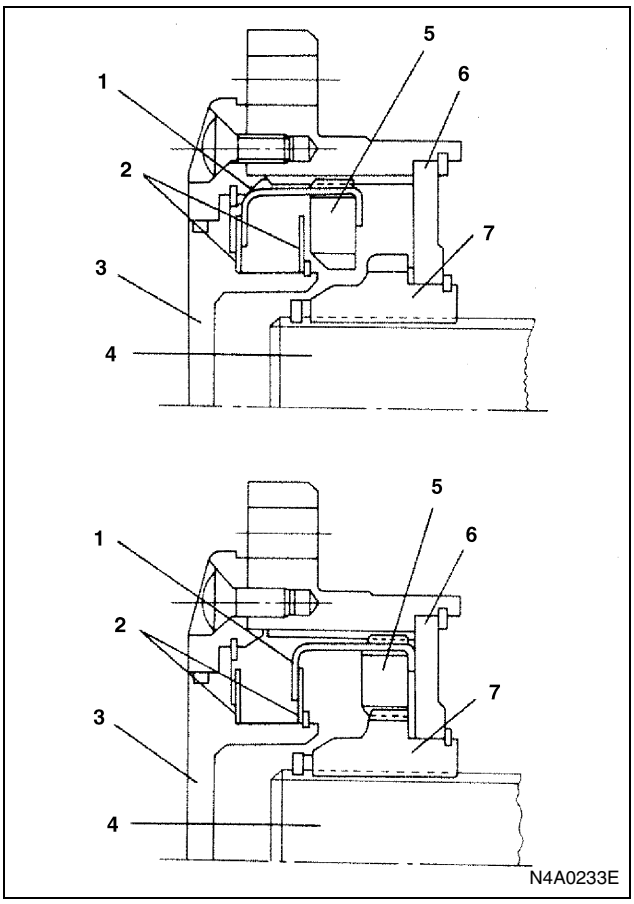
Free Wheel Hub (Manual Type)



Legend

1. Retainer
2. Lock spring
3. Handle
4. Drive shaft
5. Lock spring
6. Hub lock clutch
7. Hub lock ring
8. Hub lock inner

The free wheel hub, a hub lock device installed on the hub, transmits engine torque to the front wheels by engaging the dog clutch in the 4-wheel drive mode, or disengages the dog clutch in the 2-wheel drive mode to make free the front wheel drive system, so that it can improve fuel economy and reduce noise.
Engagement or disengagement of dog clutch is done by handle operation.



Legend

1. Retainer
2. Lock spring
3. Handle
4. Drive shaft
5. Hub lock clutch
6. Hub lock ring
7. Hub lock inner

[Operational Description]

(FREE status)

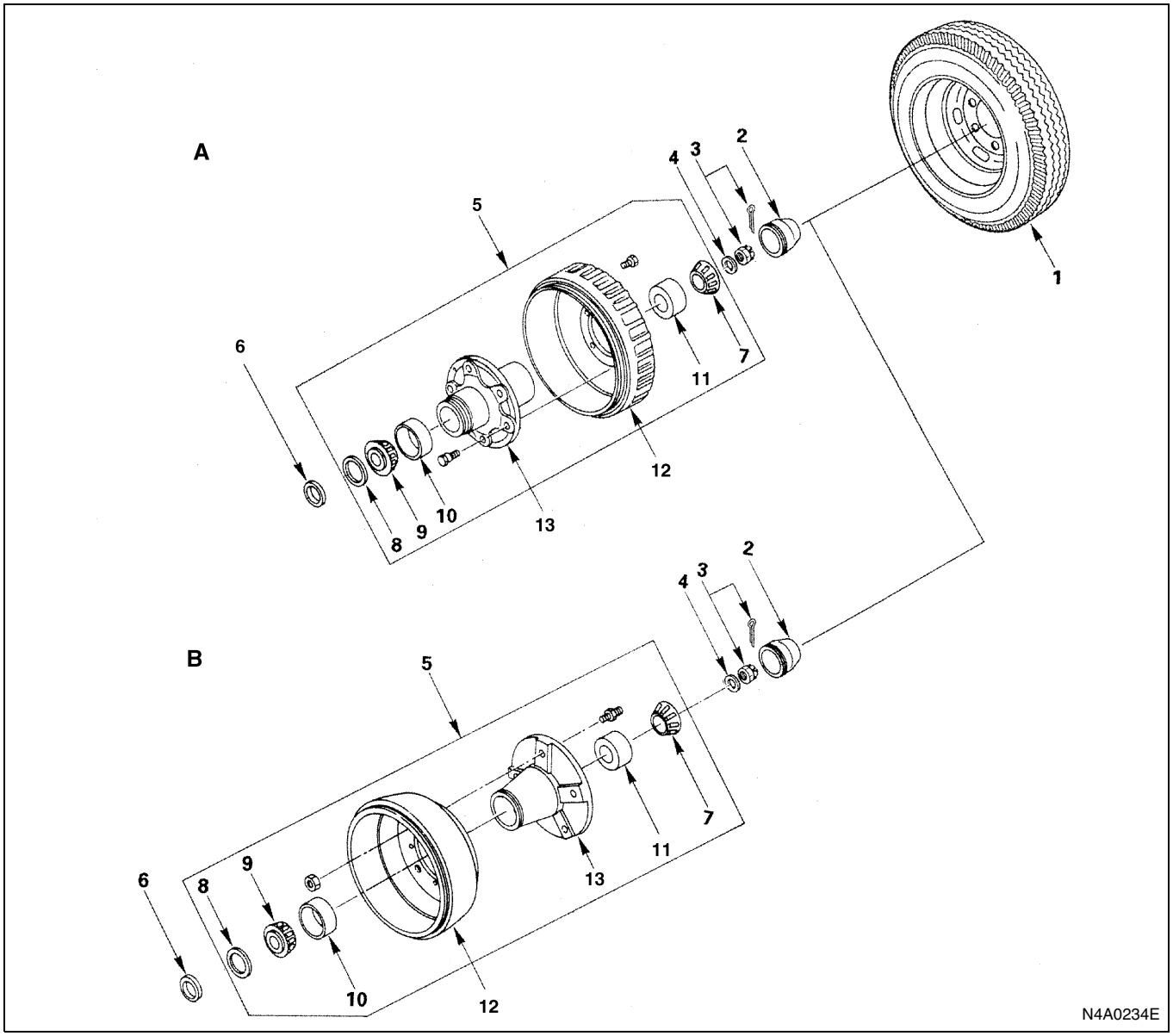
As the handle is rotated in the FREE direction, a lock spring assembled in the handle also rotates. Since the retainer lug moves along the slant face of lock spring, the hub lock clutch calked to the retainer is disengaged from lock inner, resulting in free status. If, however, the hub lock clutch is not disengaged from lock inner due to spline resistance, the lock spring is compressed to store spring force. Upon elimination of spline resistance, the hub lock clutch is disengaged by means of spring force.

(LOCK status)

As the handle is rotated in the LOCK direction, the retainer lug moves along the slant face of lock spring, and the hub lock clutch is engaged with lock inner, resulting in lock status. If, however, phase between hub lock clutch and lock inner is not coincident, the lock spring is compressed to store spring force. Upon coincidence of phase, the hub lock clutch is engaged by means of spring force.

ON-VEHICLE SERVICE

Front Hub and Brake Drum (4 × 2 Model)



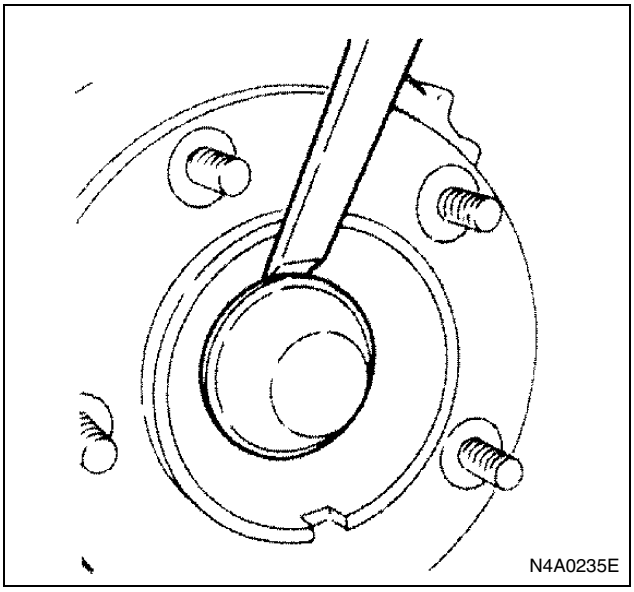
Legend

A. NHR, NKR models (rear single and dual small tire)
B. NKR, NPR models (rear dual tire)
1. Wheel and tire
2. Hub cap
3. Hub bearing nut
4. Lock washer
5. Hub with brake drum assembly
6. Distance piece
7. Outer bearing
8. Oil seal
9. Inner bearing
10. Inner bearing outer race
11. Outer bearing outer race
12. Brake drum
13. Hub

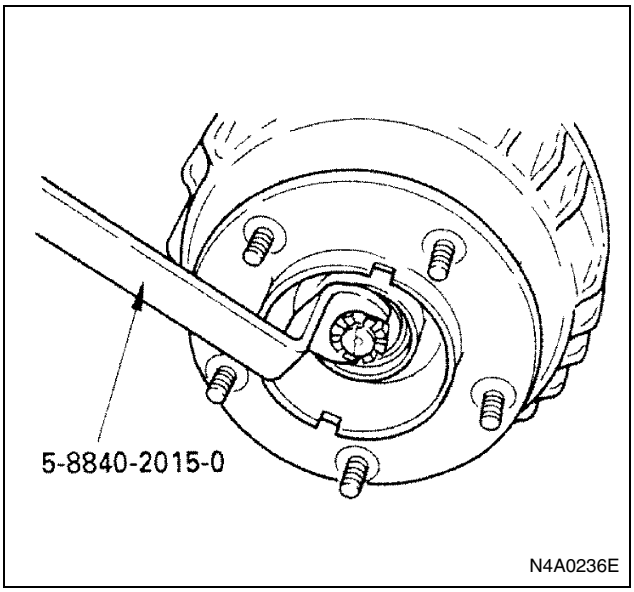
Removal

Preparation:
Jack up and support the vehicle on stands.

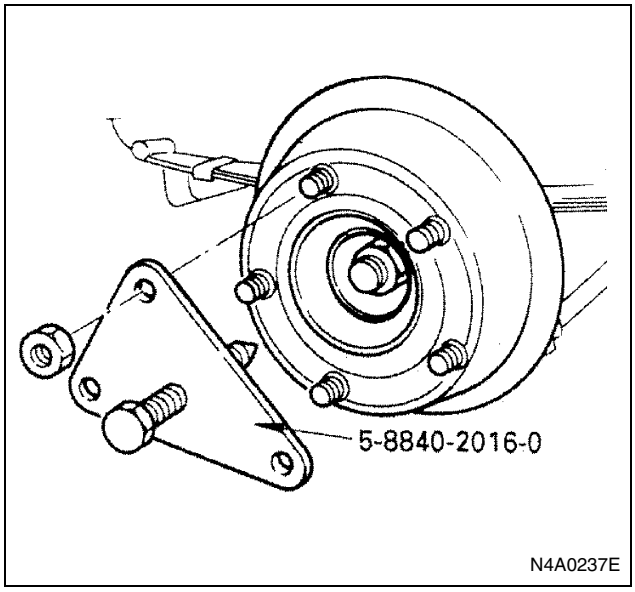
1. Wheel and Tire
2. Hub Cap
   When removing hub cap, exercise care so as not to scratch or distort hub fitting face.



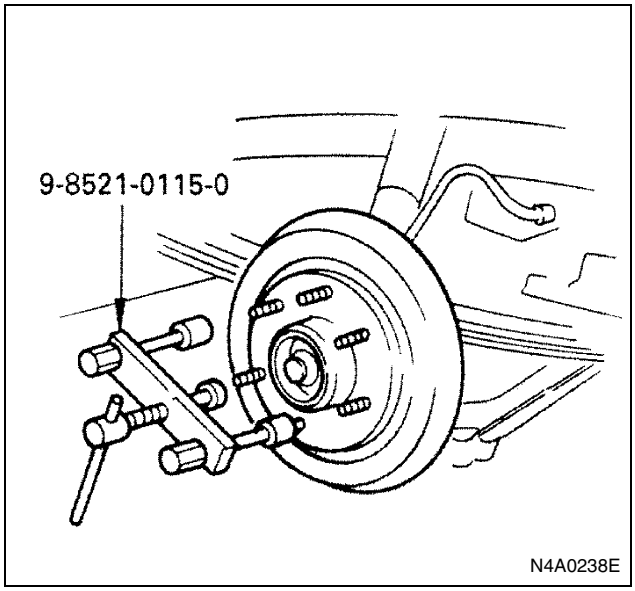
3. Hub Bearing Nut
   Hub Nut Wrench: 5-8840-2015-0



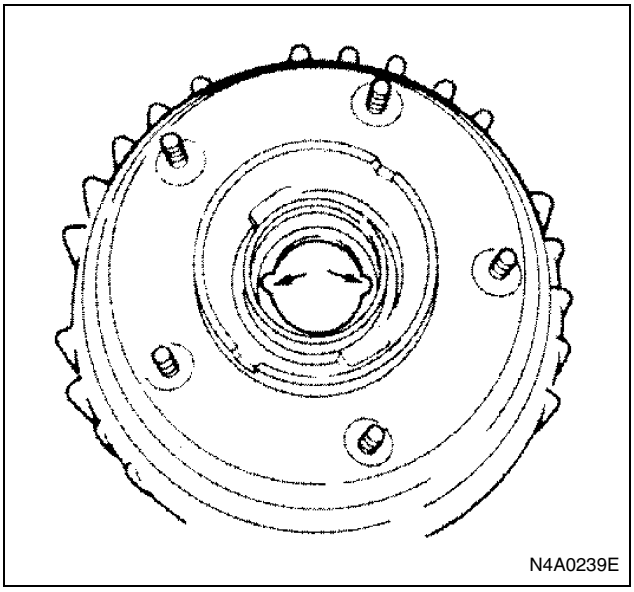
4. Lock Washer
5. Hub with Brake Drum Assembly
   5 studs
   Hub Remover: 5-8840-2016-0



   6 studs
   Hub Remover: 9-8521-0115-0 (NHR, NKR rear small tire)



6. Distance Piece
7. Outer Bearing
8. Oil seal
9. Inner Bearing
10. Inner Bearing Outer Race
    Drive out the inner bearing outer race together with the oil seal with a proper bar through two notches.


N4A0239E

11. Outer Bearing Outer Race
12. Brake Drum
13. Hub

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

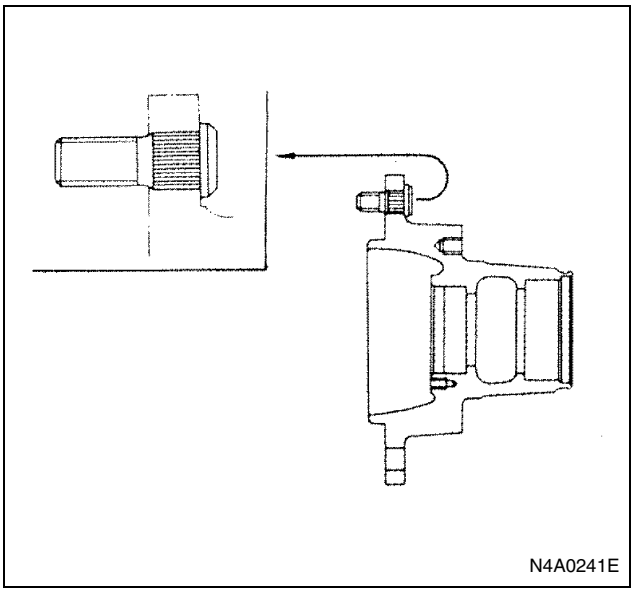
Visual Check

Inspect the following parts for wear, damage or other abnormal conditions.

- Hub
- Hub bearing, oil seal
- Knuckle spindle
- Brake
- Brake shoe, lining etc.

(NHR, NKR MODELS)

Check bolt for looseness.


N4A0241E

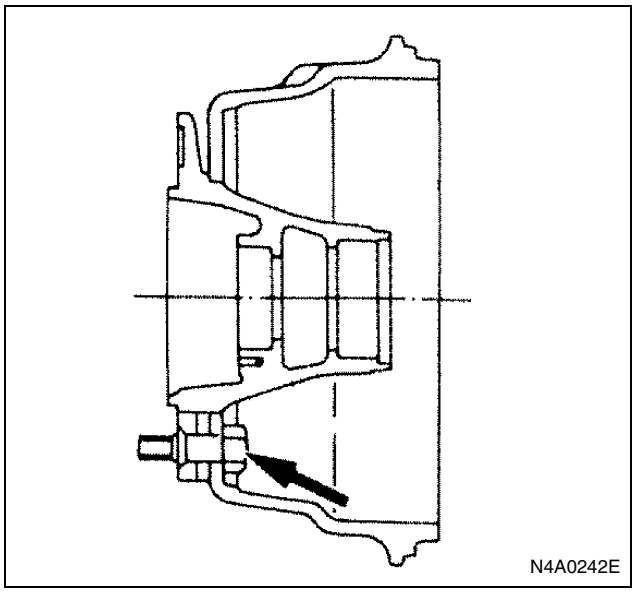
Installation

1. Hub
2. Brake Drum
   Tighten the brake drum wheel nuts to the specified torque.

Tighten:

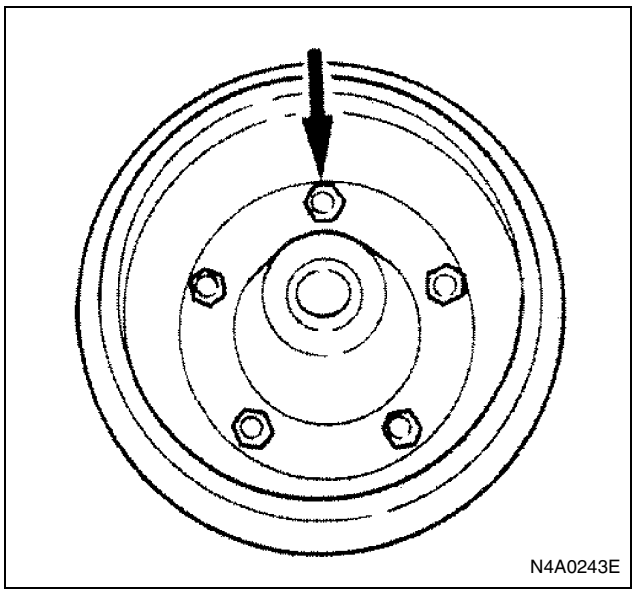
Wheel nut to

- Brake lining width 75 mm: 343 N·m (35 kg·m / 253 lb·ft)
- Brake lining width 100 mm: 392 N·m (40 kg·m / 289 lb·ft)


N4A0242E

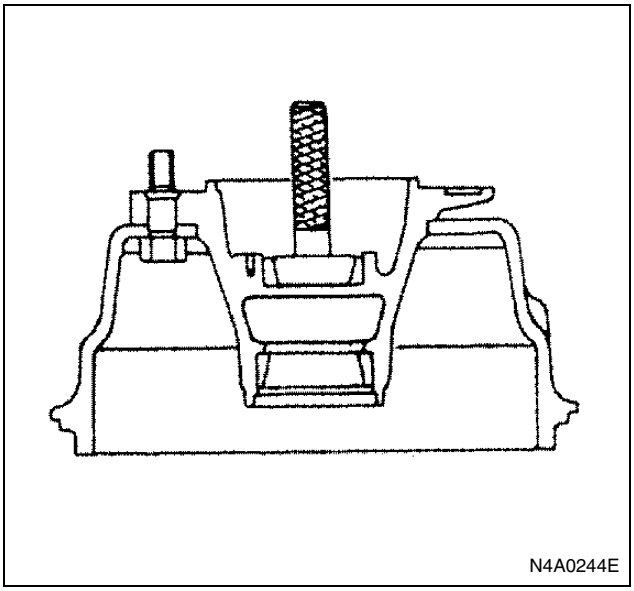
When replacement of hub or drum is completed, stake 3 portions of each wheel pin nut.

This illustration is based on 5 studs.


N4A0243E

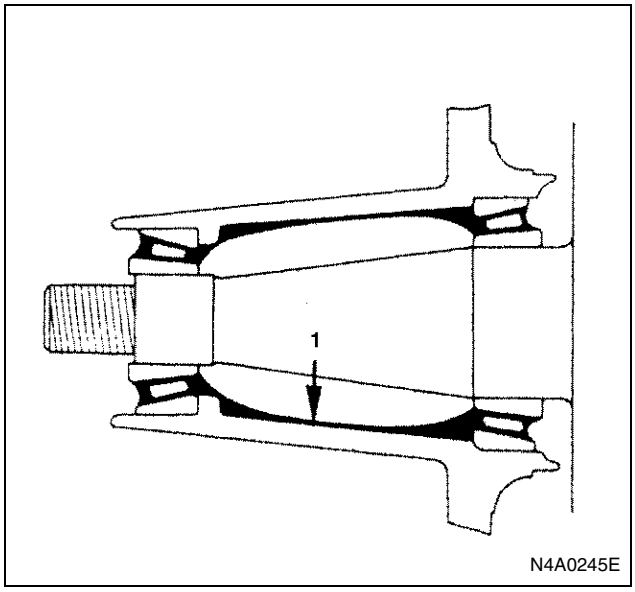
3. Outer Bearing Outer Race
4. Inner Bearing Outer Race

Bearing Outer Race Installer		
	Parts No.	Remarks
All	9-8522-1148-0	Grip
NHR	5-8840-2023-0	Inner Bearing
NKR	5-8840-2025-0	Outer Bearing
NPR	5-8840-2024-0	Inner Bearing
NQR	5-8840-2026-0	Outer Bearing



Apply grease (1) in the hub and bearing rollers

Hub Grease Amount			g (oz)
		Hub	Hub cap
NHR	Rear Single and Dual Small Tire	55 (1.9)	30 (1.1)
NKR	Rear Single and Dual Small Tire	80 (2.8)	40 (1.4)
NKR	Rear Dual Tire	90 (3.2)	
NPR	NQR	160 (5.6)	

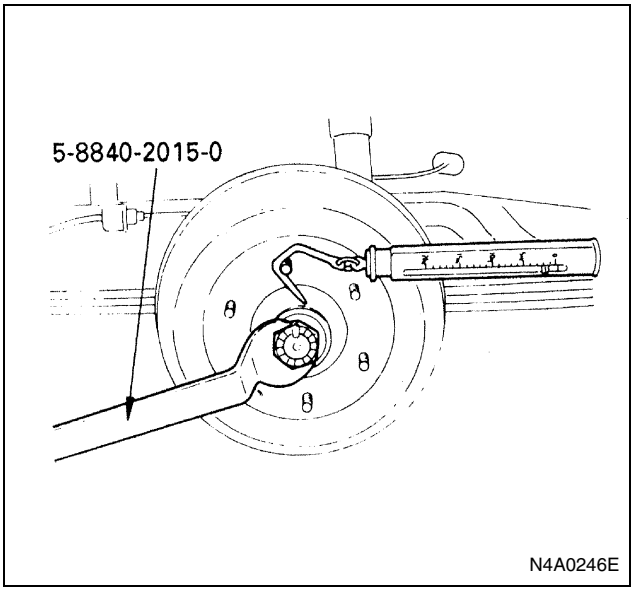


5. Inner Bearing
6. Oil Seal
   Drive the oil seal into the hub flush with the hub end surface.
7. Outer Bearing
8. Distance Piece
9. Hub with Brake Drum Assembly
10. Lock Washer
11. Hub Bearing Nut
    Check the brake lining clearances first to avoid friction loss.
    Adjust the hub bearing preload at the wheel pin.

Hub Bearing Preload (at Wheel Pin) N (kg/lb)		
NHR	New	9.8 — 34.3 (1.0 — 3.5/2.2 — 7.7)
	Reused	7.8 — 22.5 (0.8 — 2.3/1.8 — 5.0)
NKR	New	11.8 — 26.5 (1.2 — 2.7/2.6 — 5.9)
	Reused	6.9 — 21.6 (0.7 — 2.2/1.5 — 4.8)
NPR NQR	New	9.8 — 34.3 (1.0 — 3.5/2.2 — 7.7)
	Reused	4.9 — 19.6 (0.5 — 2.0/1.1 — 4.4)

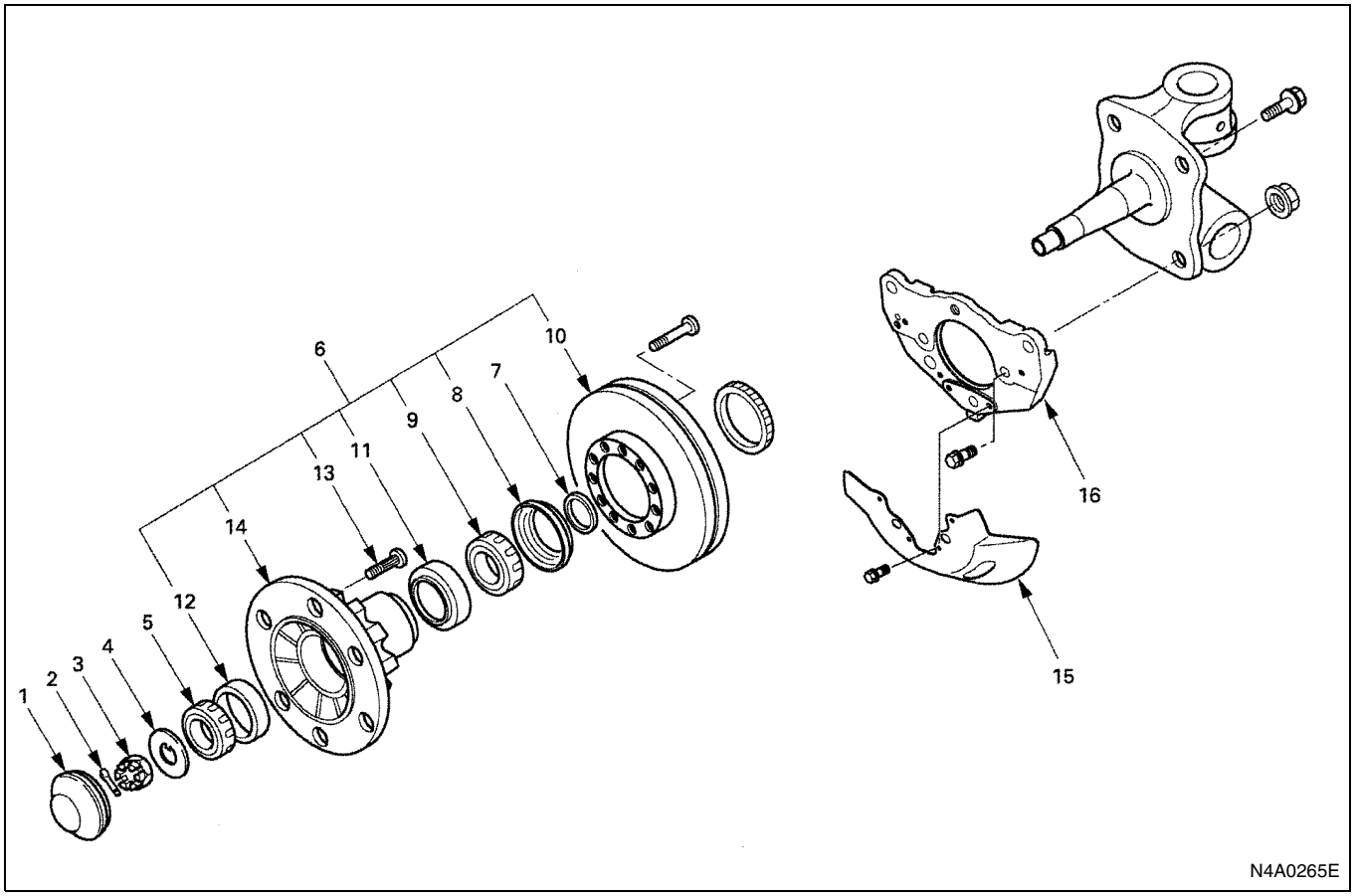
Hub Nut Wrench: 5-8840-2015-0

In case of misalignment of locking hole, align in direction of retightening.



12. Hub Cap
13. Wheel and Tire

Front Hub and Disc (4 × 2 Model, 293 & 310mm Disc)



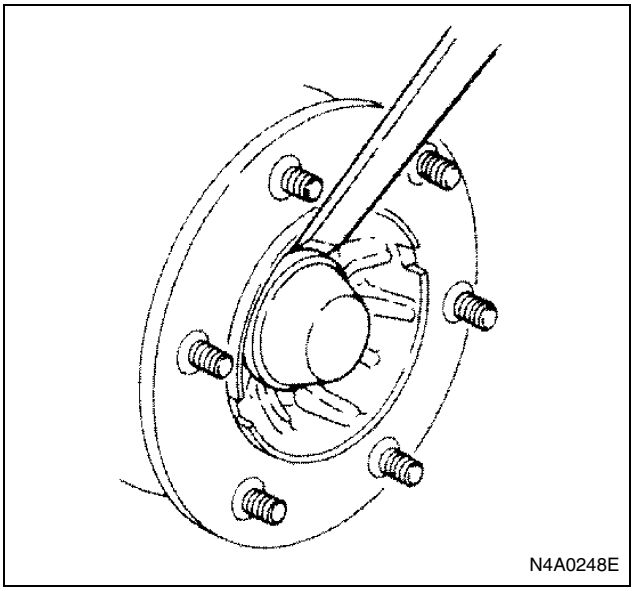
Legend

1. Hub cap
2. Cotter pin
3. Nut
4. Washer
5. Outer bearing
6. Hub and disc assembly
7. Spacer
8. Oil seal
9. Inner bearing
10. Disc
11. Inner bearing race
12. Outer bearing race
13. Stud
14. Hub
15. Dust shield
16. Adapter

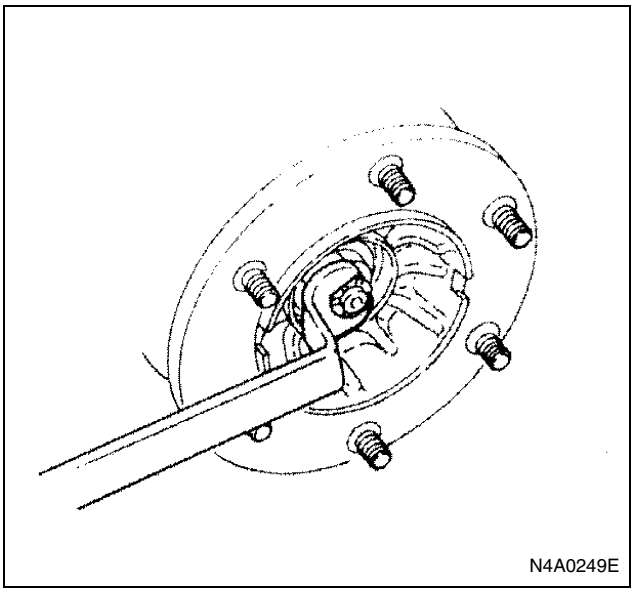
Removal

Preparation:
Jack up and support the vehicle on stands.

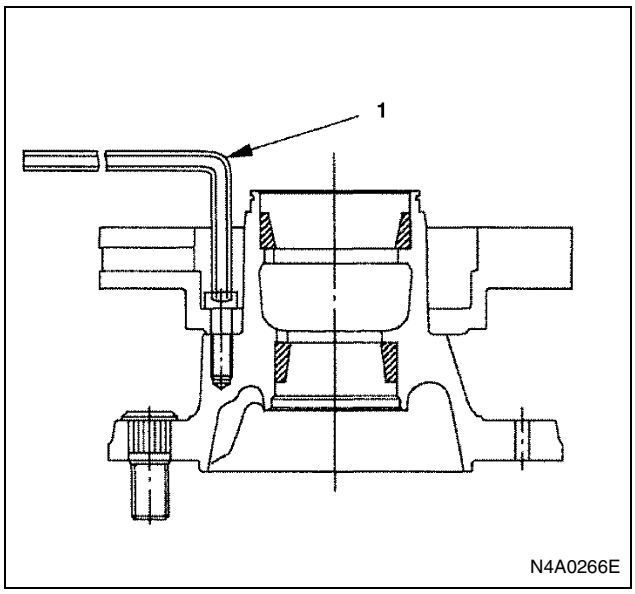
1. Hub cap
   Use a lever to pry the hub cap from the hub.


N4A0248E

2. Cotter Pin
3. Nut
   Use a wrench to remove the nut.

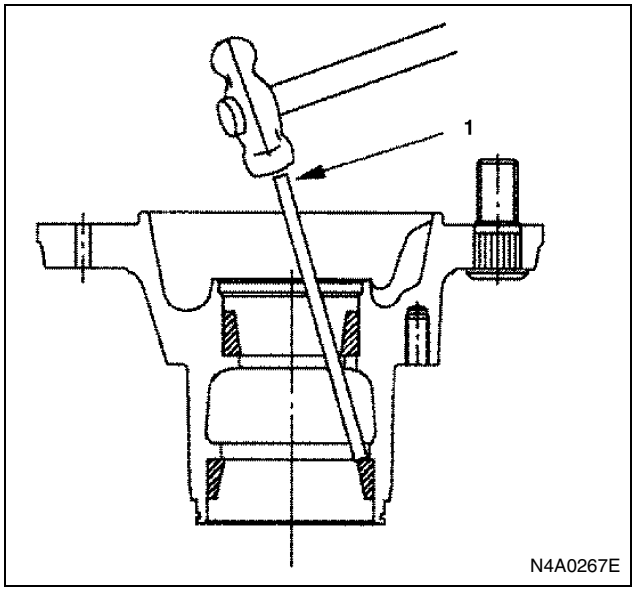

N4A0249E

4. Washer
5. Outer Bearing
6. Hub and Disc Assembly
   1) Turn the caliper assembly up and around the guide pin.
   2) Remove the hub and disc assembly from the knuckle.
7. Spacer
8. Oil Seal
9. Inner Bearing
10. Disc
    1) Use an inner hex wrench (1) to loosen the disc fixing bolts.
    2) Remove the disc from the hub.



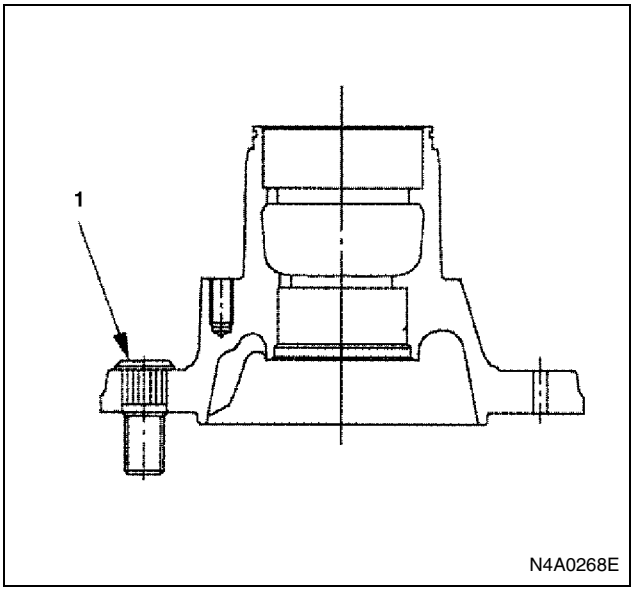
N4A0266E

11. Inner Bearing Race
12. Outer Bearing Race
    Use a hammer and a brass bar (1) to remove the inner race and the outer race from the hub.



N4A0267E

13. Stud
    Place hub on a suitable work surface and remove the studs (1) by using a hammer.



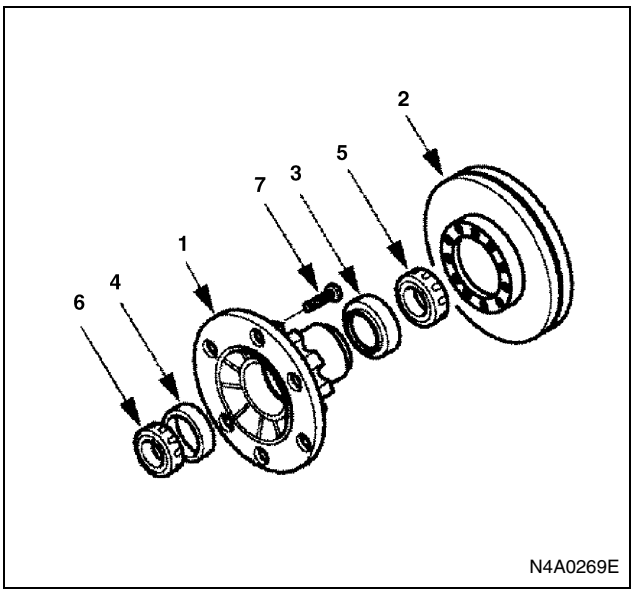
14. Hub
15. Dust Shield
16. Adapter

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Visual Inspection

Inspect the following parts for cracking, deformation, and corrosion.

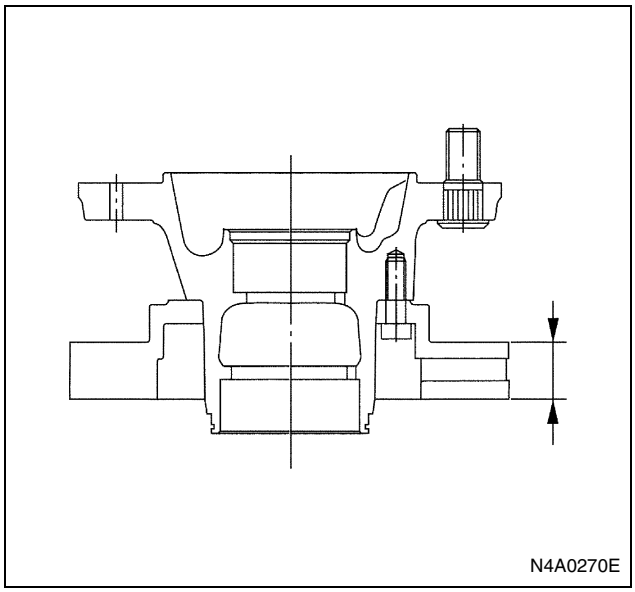


Legend

1. Hub
2. Disc
3. Inner bearing race
4. Outer bearing race
5. Inner bearing
6. Outer bearing
7. Wheel pins

Disc

Use a vernier caliper to measure the disc thickness.
If the measured value is less than the specified limit, the disc must be replaced.
Disc thickness,
Standard: 42.0 mm (1.654 in)
Limit: 39.0 mm (1.535 in)



Installation

1. Adapter

Tighten:

Adapter fixing bolt to 162 N·m (16.5 kg·m / 119 lb·ft)

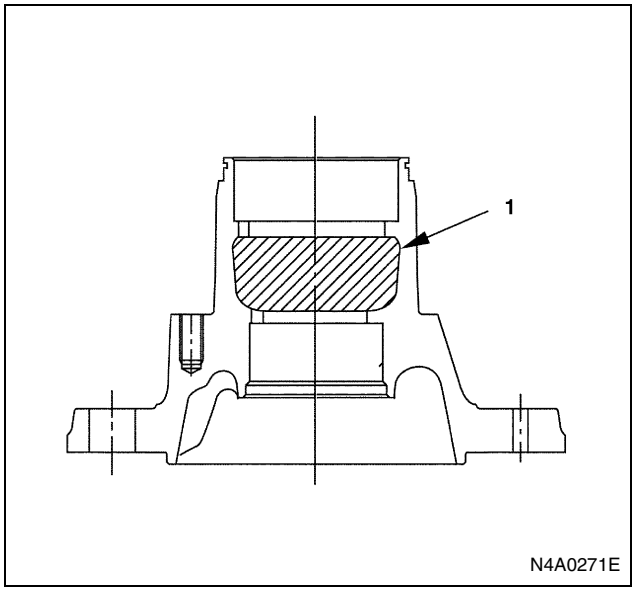
2. Dust Shield

Tighten:

Dust shield fixing to 13 N·m (1.3 kg·m / 113 lb·ft)

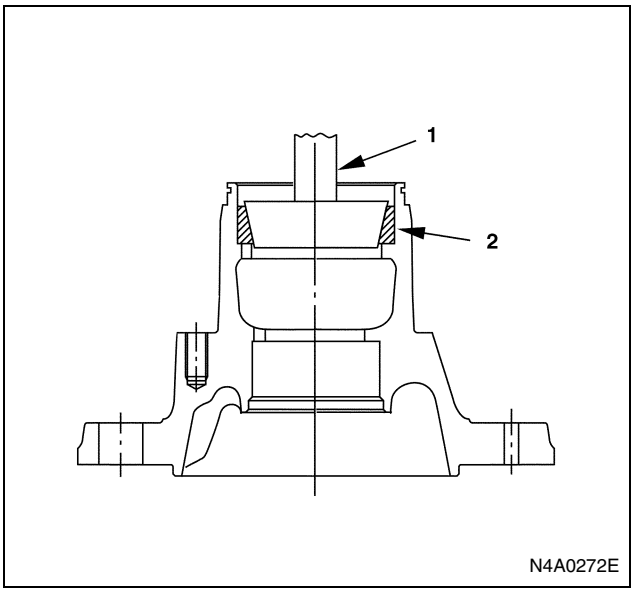
3. Hub
   Apply the specified amount of the approved grease to the hub cavity (1).

Grease amount: 160 g (5.6 oz)

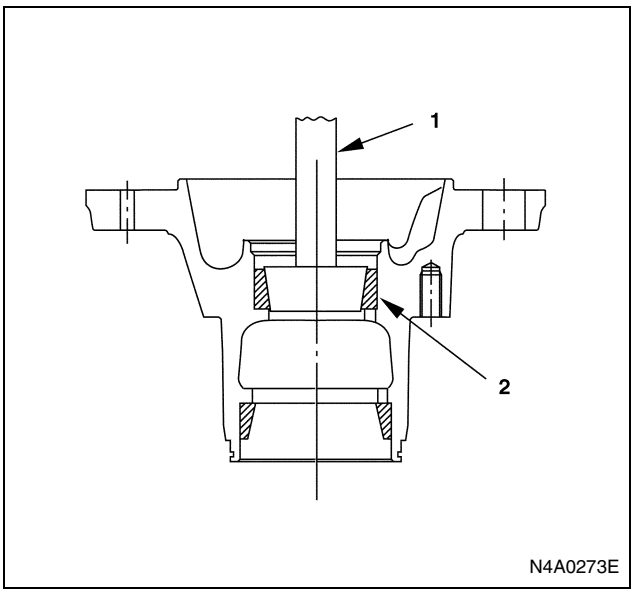


4. Inner Bearing Race

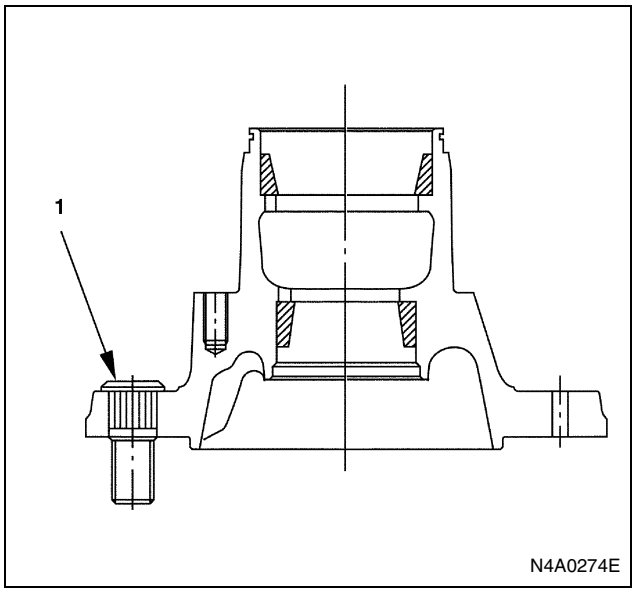
5. Inner Bearing
6. Oil Seal
   1) Use a hammer and the installer (1) to install the inner bearing race (2) to the hub.
      Be sure that the race is completely seated in the hub.
      Installer: 5-8840-2235-0



   2) Apply grease to the inner bearing.
   3) Install the inner bearing to the hub.
   4) Use a plastic hammer to carefully tap the oil seal into place.
      The oil seal surfaces must be flat.
      Use a new oil seal.
7. Outer Bearing Race
   Use a hammer and the installer (1) to install the outer bearing race (2) to the hub.
   Be sure that the race is completely seated in the hub.
   Installer: 5-8840-2026-0

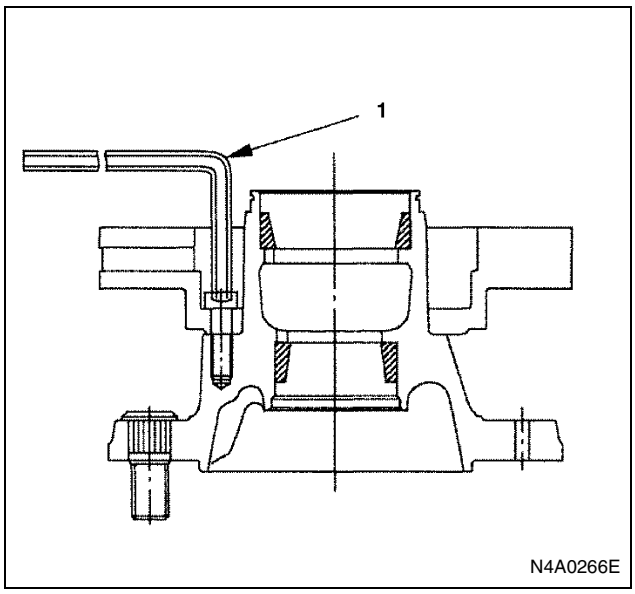


8. Stud
   Insert a stud (1) using a hammer.

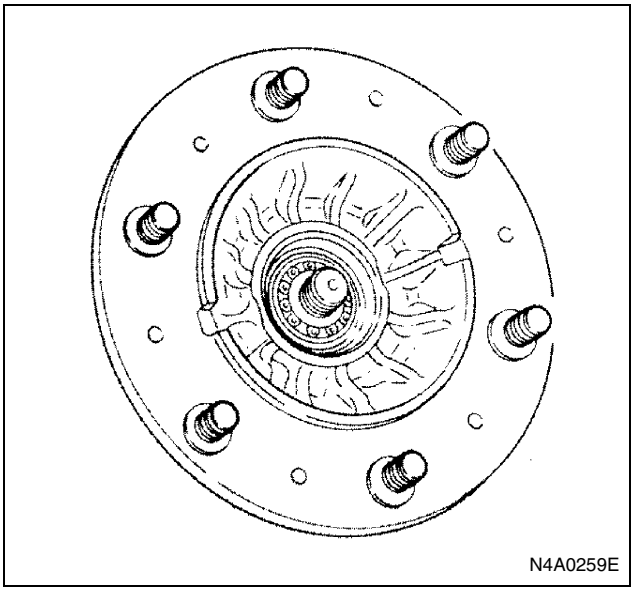


9. Disc
   1) Install the disc to the hub.
   2) Use an inner hex wrench (1) to tighten the disc bolts to the specified torque.

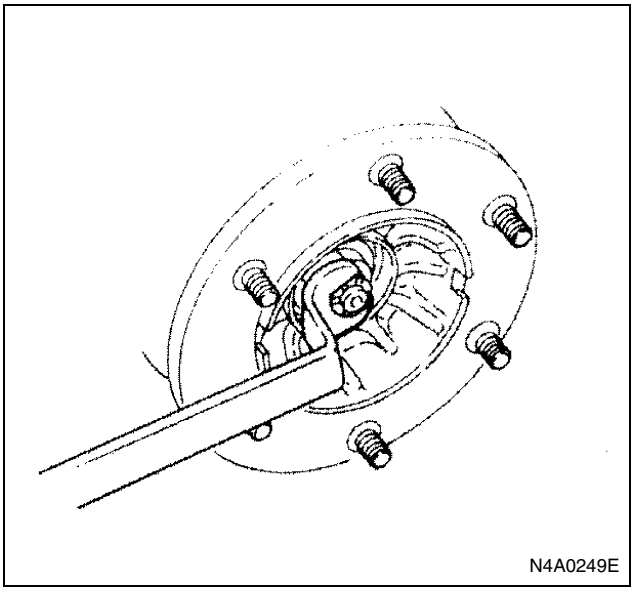
Tighten:
Disc bolt to 103 N·m (10.5 kg·m / 76 lb·ft)



10. Spacer
11. Hub and Disc Assembly
12. Outer Bearing
    1) Turn the caliper assembly up and around the guide pin.
    2) Install the spacer and the hub and disc assembly to the knuckle.
    3) Apply grease to the outer bearing.
    4) Install the bearing to the hub.

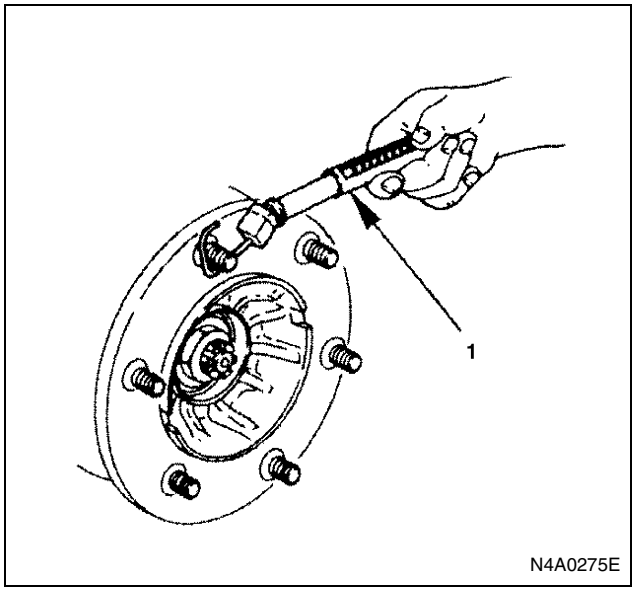

N4A0259E

13. Washer
14. Nut
15. Cotter Pin
    1) Install the washer to the hub.
    2) Tighten the nut until you are unable to manually rotate the hub and disc assembly.


N4A0249E

    3) Loosen the nut.
    4) Attach a spring balancer (1) to one wheel pin. Gradually retighten the nut until the hub and disc assembly bearing is adjusted to the specified preload.

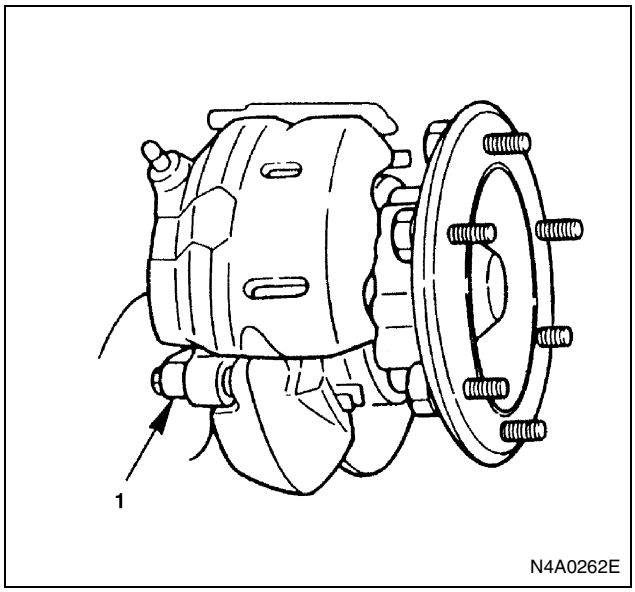
Hub bearing preload,
New Hub bearing: 17 — 31 N (1.7 — 3.2 kg / 3.7 — 7.1 lb)
Reused Hub bearing: 14 — 28 N (1.4 — 2.9 kg / 3.1 — 6.4 lb)



N4A0275E

    5) Align the nut slot with the knuckle cotter pin hole.
       If necessary, slightly tighten the nut to align the slot and the hole.
    6) Insert the cotter pin to the slot and hole.
    7) Bend back the cotter pin to lock the nut.
    8) Return the caliper assembly to its original position.
    9) Tighten the lock pin bolt (1) to the specified torque.
       Use a new cotter pin.

Tighten:
Lock pin bolt to137 N·m (14 kg·m / 101 lb·ft)



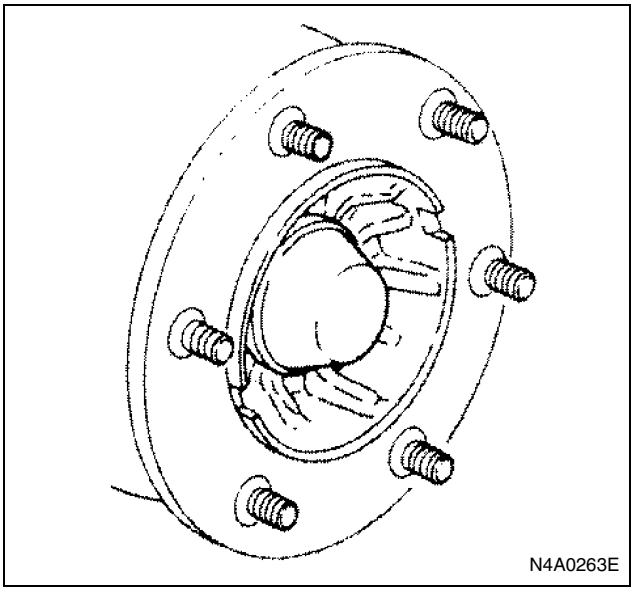
N4A0262E

16. Hub Cap
    1) Apply LOCTITE or liquid gasket to the engagement part with hub.
    2) If severe deformation is found, replace with a new one.

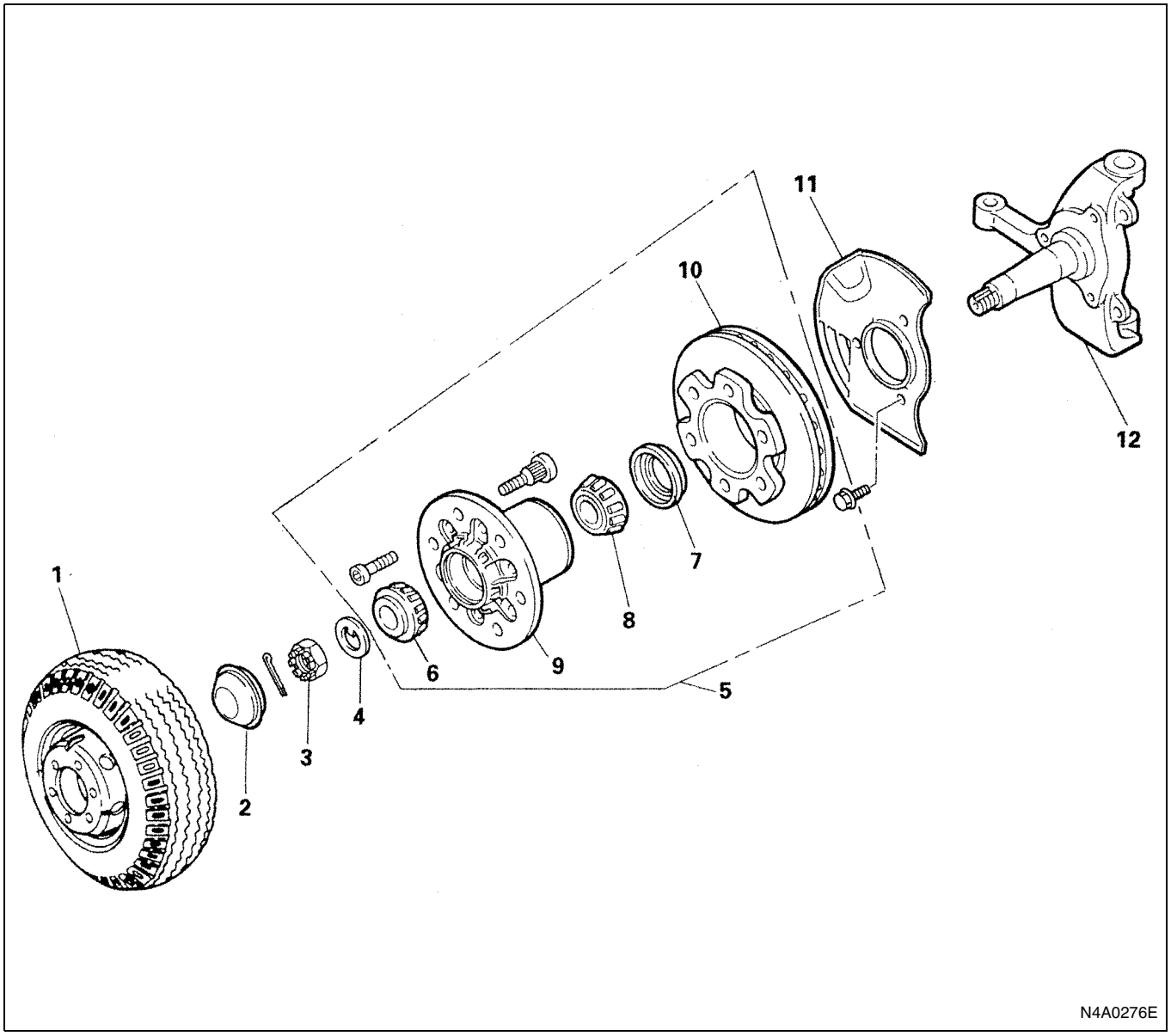
3) Apply the specified amount of the approved grease to the hub cap.

Grease amount: 40 g (1.4 oz)

4) Use a plastic hammer to install the hub cap to the hub.



Front Hub, Disc and Knuckle (4 × 2, Independent Suspension Model)



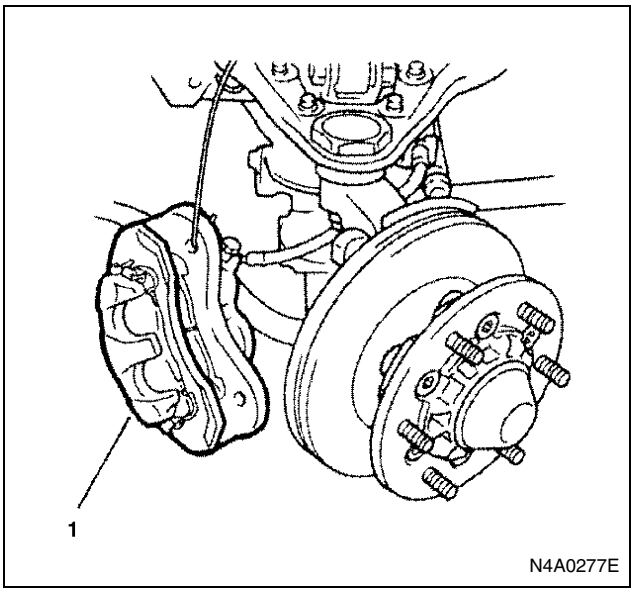
Legend

1. Wheel and tire
2. Hub cap
3. Hub nut
4. Thrust washer
5. Hub and disc assembly
6. Outer bearing
7. Oil seal
8. Inner bearing
9. Hub
10. Disc
11. Back plate
12. Knuckle

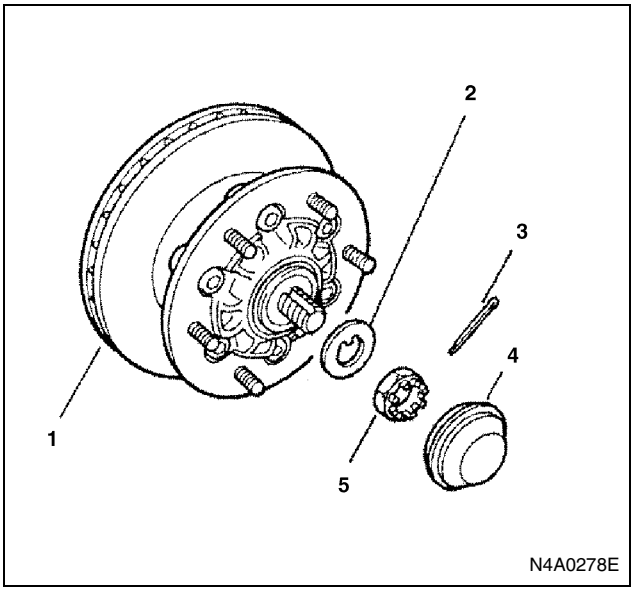
Removal

Preparation:
Jack up and support the vehicle on stands.

1. Wheel and Tire
   Remove the disc brake caliper assembly (1) with brake hose and wire it to frame.

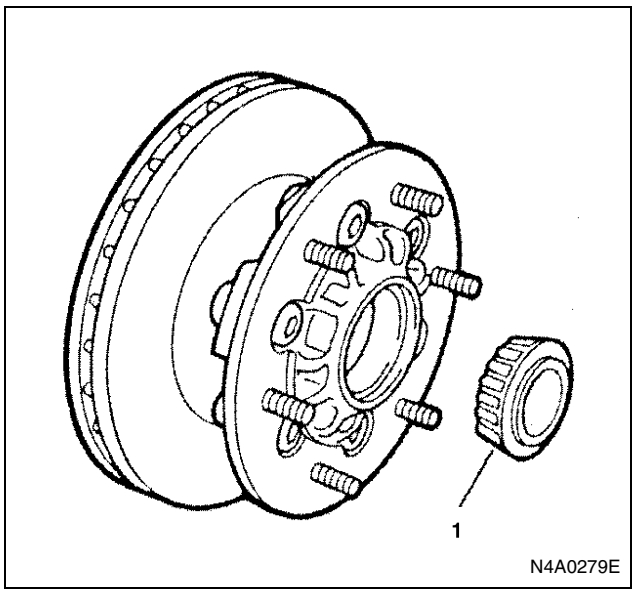


2. Hub Cap
3. Hub Nut
4. Thrust Washer
5. Hub and Disc Assembly
   Remove the hub and disc assembly from the knuckle.



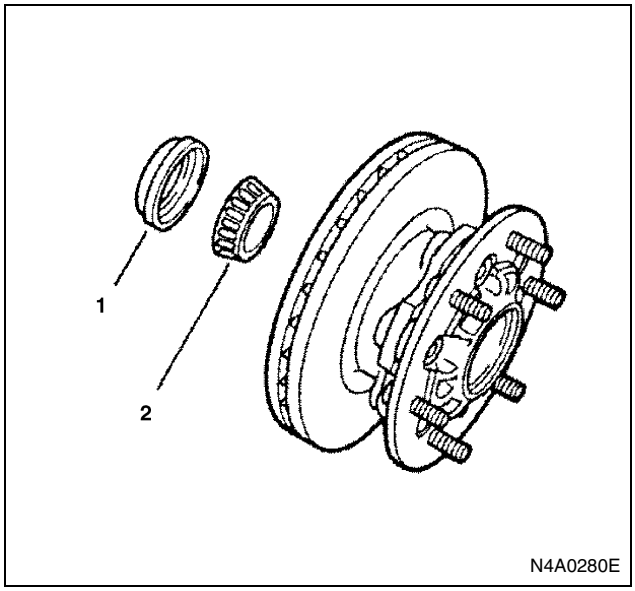
Legend
1. Hub and disc assembly
2. Thrust washer
3. Cotter pin
4. Hub cap
5. Hub nut

6. Outer Bearing



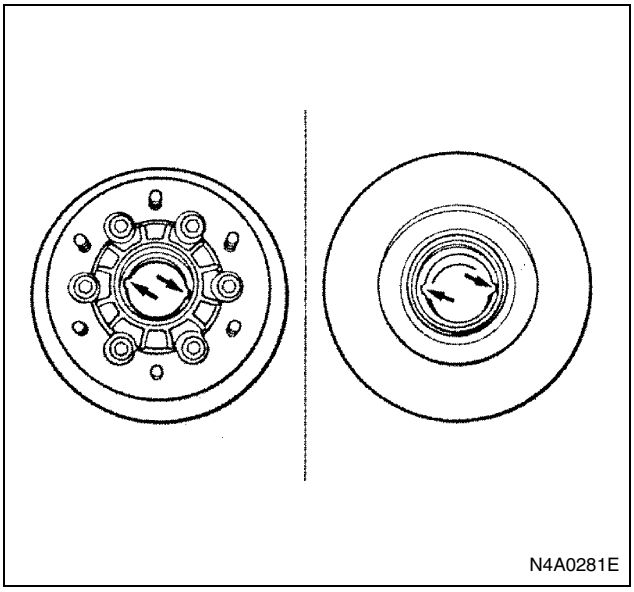
Legend
1. Outer bearing

7. Oil Seal
8. Inner Bearing

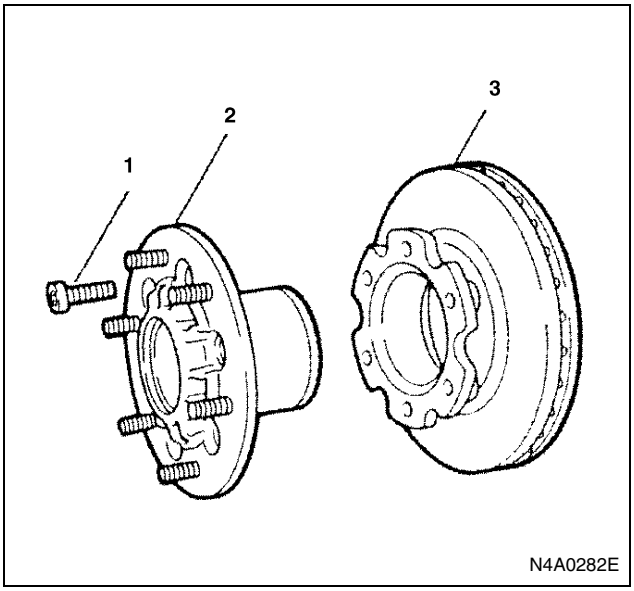


Legend
1. Oil seal
2. Inner bearing

- Drive out the bearing outer races using with a proper bar through two notches.


N4A0281E

9. Hub
10. Disc
    - If need, separate the hub on disc.
      Torx bit (T70): 5-8840-2368-0
11. Back Plate

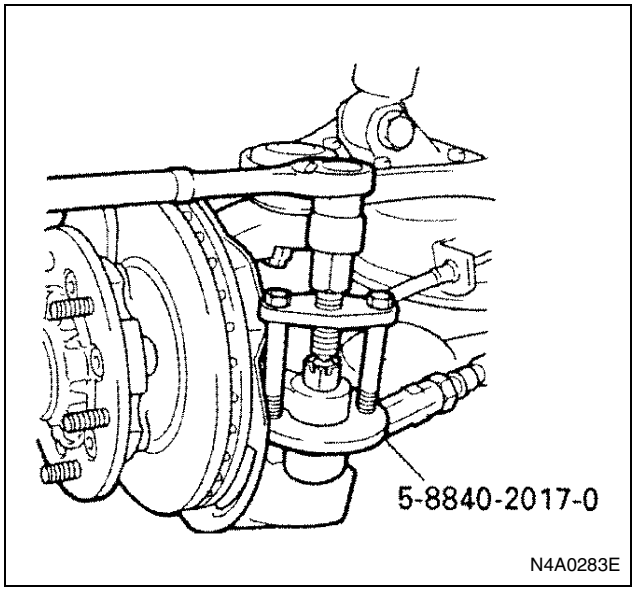


N4A0282E

Legend

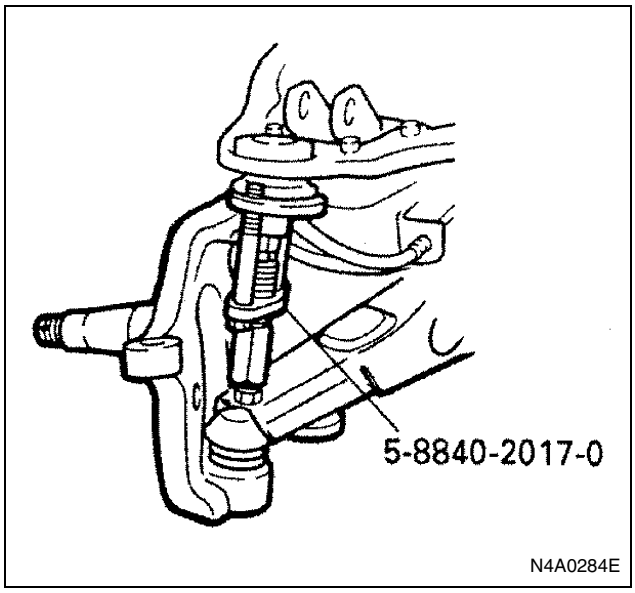
1. Bolt
2. Hub
3. Disc

12. Knuckle
    - Disconnect the tie rod end joint and upper link end joint from the knuckle.
      Tie Rod End Remover: 5-8840-2017-0



N4A0283E

- Remove the two bolts fixing the lower link end and remove the knuckle together with the lower link end.
- Remove the lower link end from the knuckle.



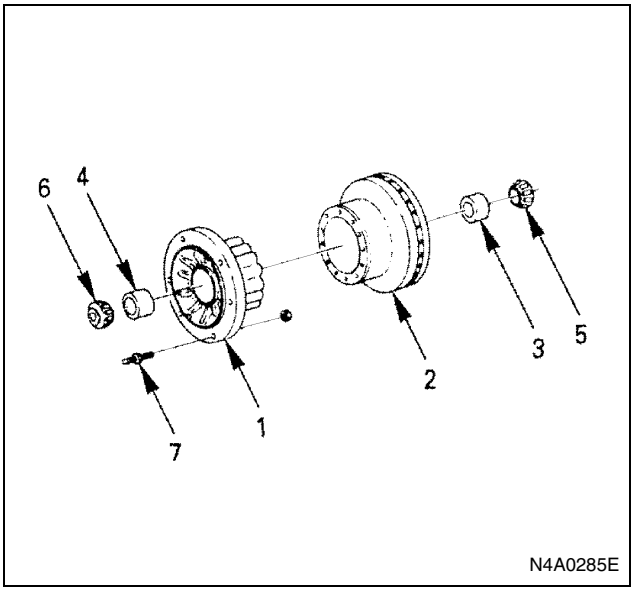
N4A0284E

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Visual Inspection

Inspect the following parts for cracking, deformation, and corrosion.

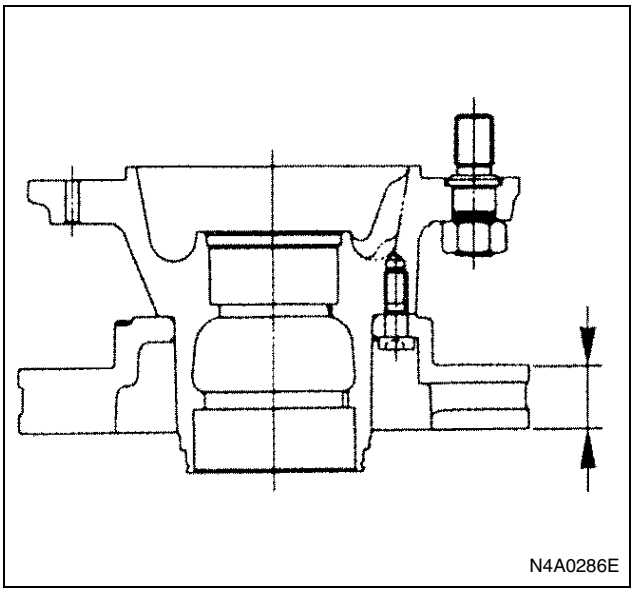


Legend

1. Hub
2. Disc
3. Inner race
4. Outer race
5. Inner bearing
6. Outer bearing
7. Wheel pins

Disc

Use a vernier caliper to measure the disc thickness.
If the measured value is less than the specified limit, the disc must be replaced.
Disc thickness,
Standard: 35.0 mm (1.38 in)
Limit: 33.5 mm (1.32 in)



Installation

1. Knuckle

Tighten:

- Lower link joint nut to 377 N·m (38.4 kg·m / 278 lb·ft)
- Lower link end bolt to 219 N·m (22.3 kg·m / 161 lb·ft)
- Upper link joint nut to 205 N·m (20.9 kg·m / 151 lb·ft)
- Tie rod joint nut to 108 N·m (11 kg·m / 80 lb·ft)
    - Discard used cotter pin and install new one.

2. Back Plate

Tighten:

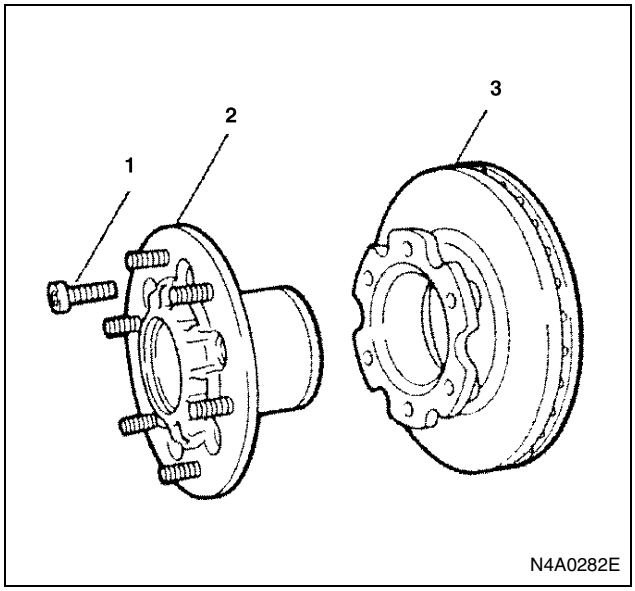
Back plate bolt to 13 N·m (1.3 kg·m / 113 lb·ft)

3. Disc
4. Hub

Tighten:

Disc bolt to

- M14: 155 N·m (15.8 kg·m / 114 lb·ft)
- M16: 219 N·m (22.3 kg·m / 163 lb·ft)

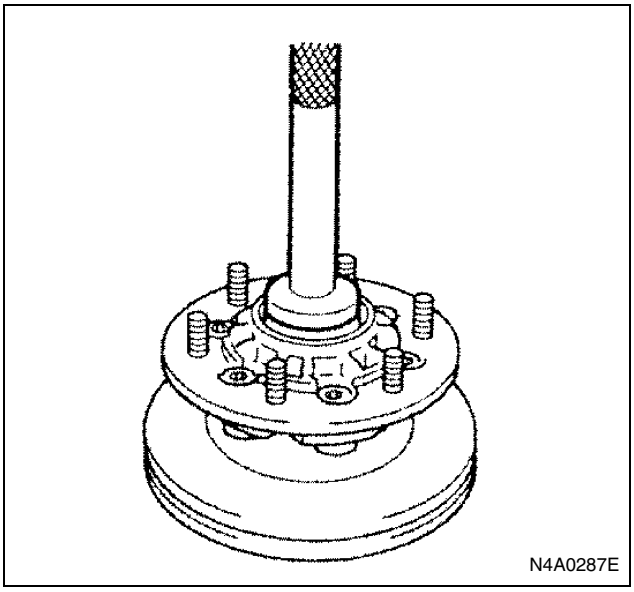


Legend

1. Bolt
2. Hub
3. Disc

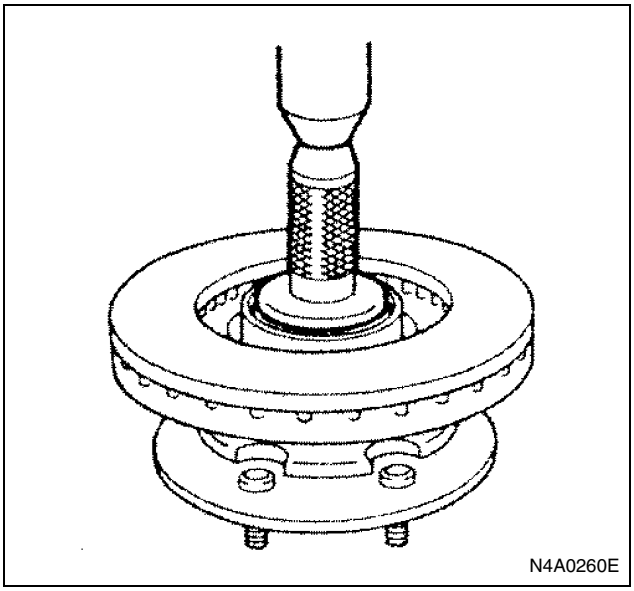
Be sure that the race is completely seated in the hub.

Outer Bearing Outer Race Installer: 5-8840-2026-0


N4A0287E

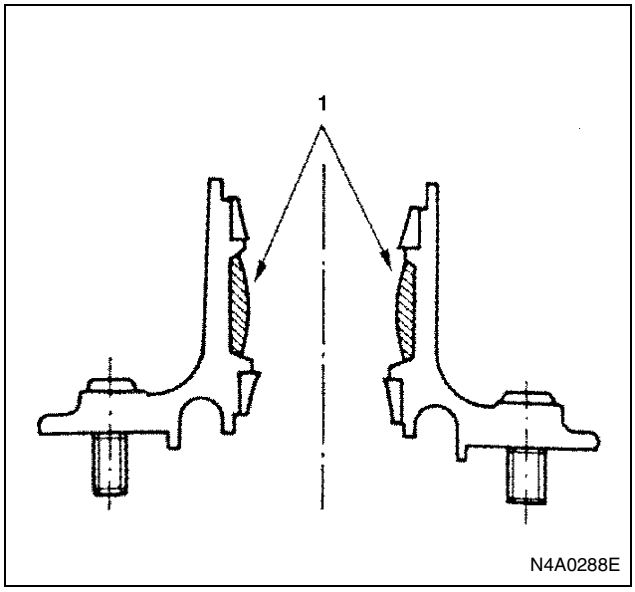
Be sure that the race is completely seated in the hub.

Inner Bearing Outer Race Installer: 5-8840-2235-0


N4A0260E

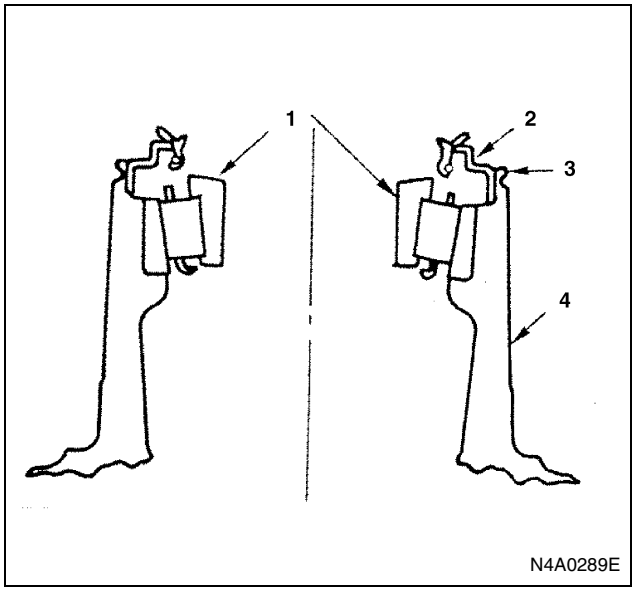
Apply the specified amount of the multipurpose type grease (1) to the hub cavity.

Grease amount: 96 g (3.4 oz)



N4A0288E

5. Inner Bearing
   Apply grease (multipurpose type) to the inner bearing.
6. Oil Seal
   Use a hammer and installer to install the oil seal. The oil seal surfaces must be flat.
   Use a new oil seal.
   Oil Seal Installer: 5-8840-2235-0



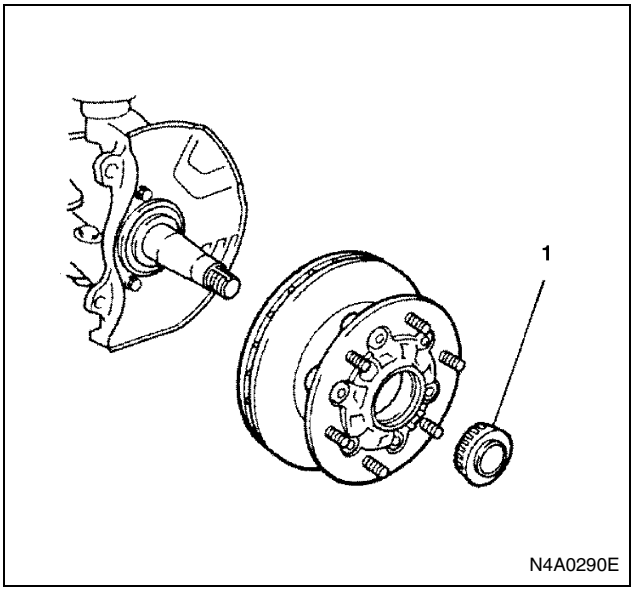
N4A0289E

Legend

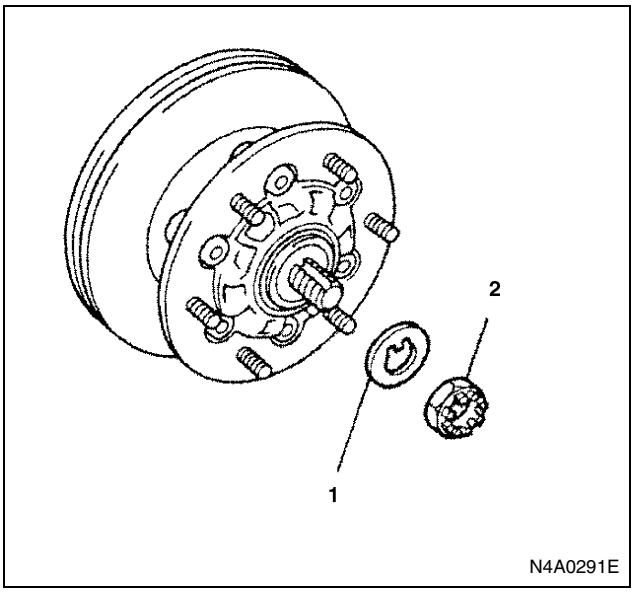
1. Inner bearing
2. Oil seal
3. Flat
4. Hub

7. Outer Bearing
8. Hub and Disc Assembly
   1) Install the hub and disc assembly to the knuckle.
   2) Apply grease (multipurpose type) to the outer bearing (1).

3) Install the bearing to the hub.

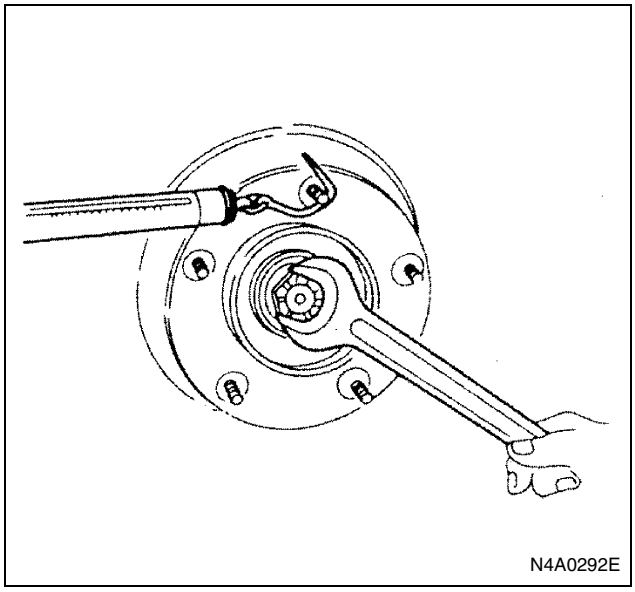


9. Thrust Washer
10. Hub Nut
    1) Install the thrust washer (1) and hub nut (2).



    2) Tighten the nut until you are unable to manually rotate the hub and disc assembly.
    3) Loosen the nut.
    4) Attach a spring balancer to one wheel pin. Gradually retighten the nut until the hub and disc assembly bearing is adjusted to the specified preload.

Hub bearing preload,
NHR new bearing: 14 — 28 N (1.4 — 2.9 kg·m / 3 — 6 lb·ft)
NKR new bearing: 12 — 26 N (1.2 — 2.7 kg·m / 3 — 6 lb·ft)
NHR · NKR reused bearing: 7 — 22 N (0.7 — 2.2 kg·m / 2 — 5 lb·ft)



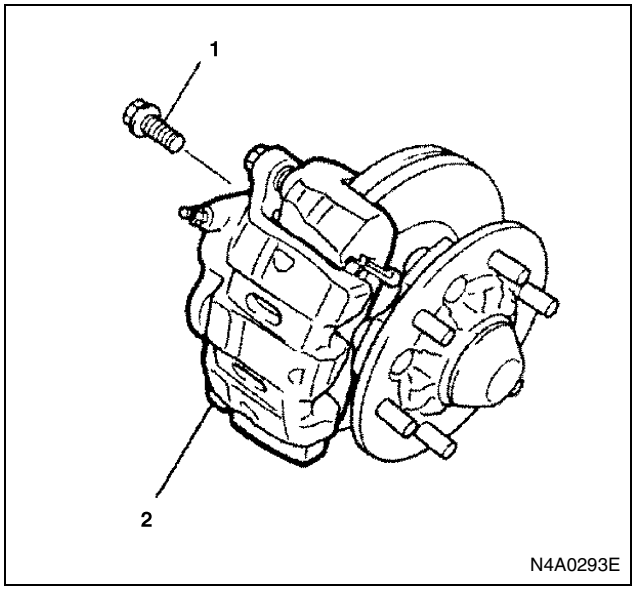
    5) Align the nut slot with the knuckle cotter pin hole.
       If necessary, slightly tighten the nut to align the slot and the hole.
    6) Discard used cotter pin and install new cotter pin.

11. Hub Cap
    1) Apply LOCTITE or liquid gasket to the engagement part with hub.
    2) If severe deformation is found, replace with a new one.
    3) Apply the specified amount of the approved grease (Multipurpose type) to the hub cap.

Grease amount: 40 g (1.4 oz)

    4) Install the disc brake caliper assembly to the knuckle.

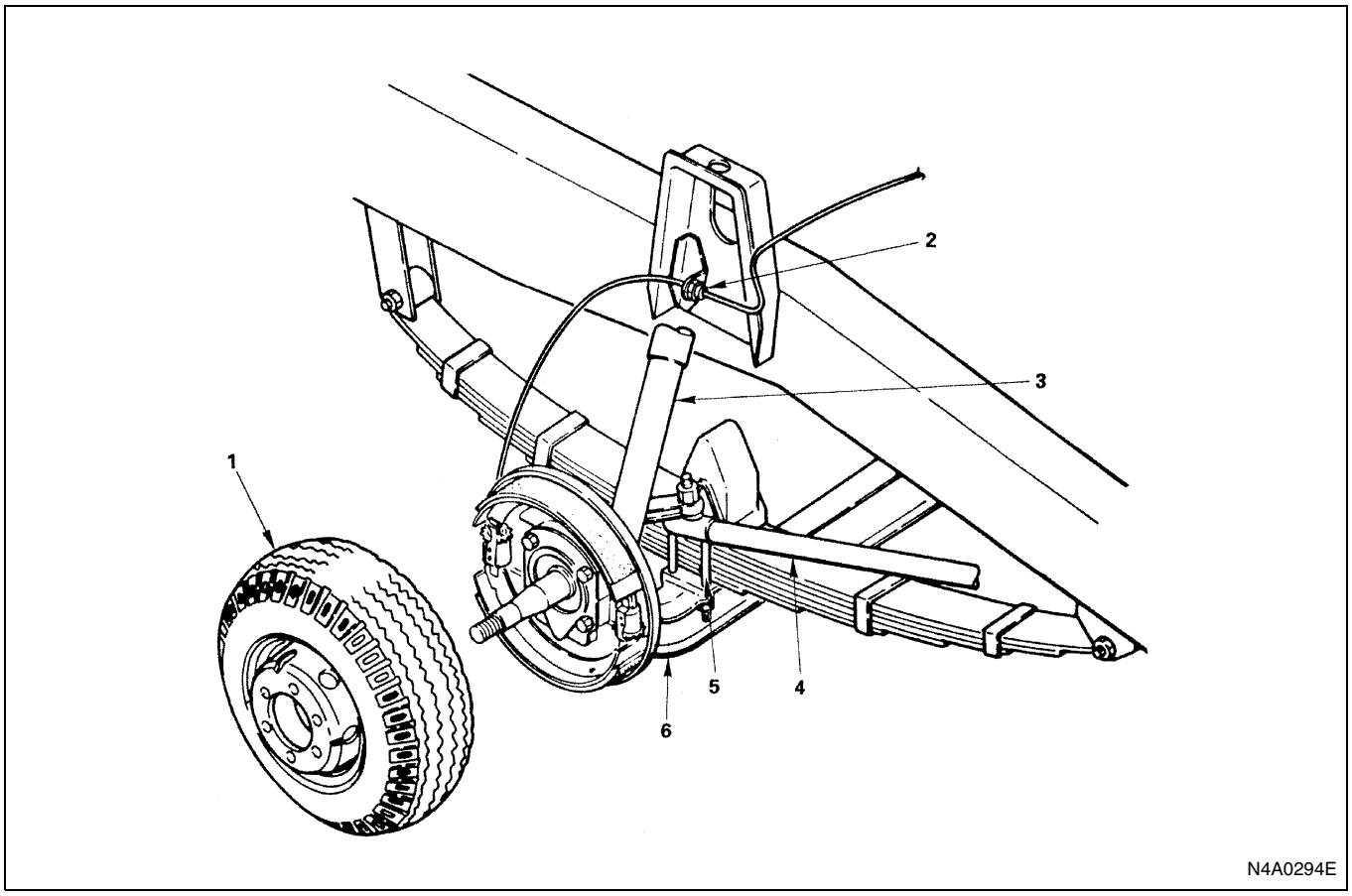
Tighten:
Disc brake caliper bolt to 219 N·m (22.3 kg·m / 161 lb·ft)



Legend
1. Bolt
2. Disc brake caliper assembly

12. Wheel and Tire

Front Axle Assembly (4 × 2 Model)

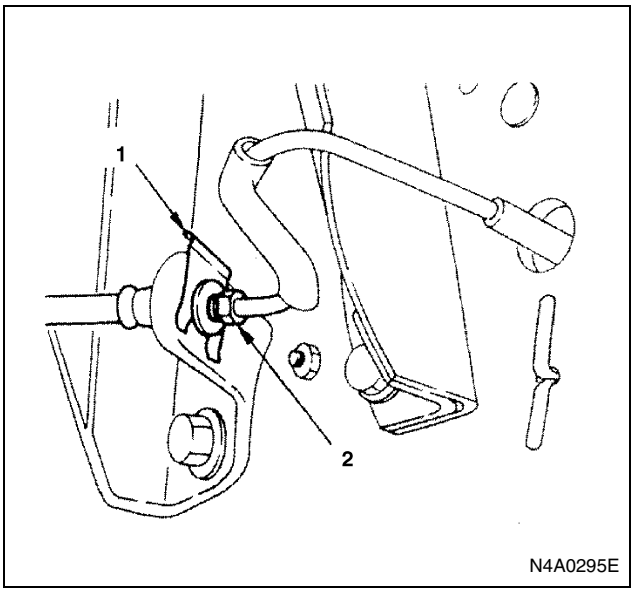


Legend
1. Wheel and tire
2. Brake flexible hose
3. Shock absorber
4. Drag link
5. U-bolt
6. Front axle assembly

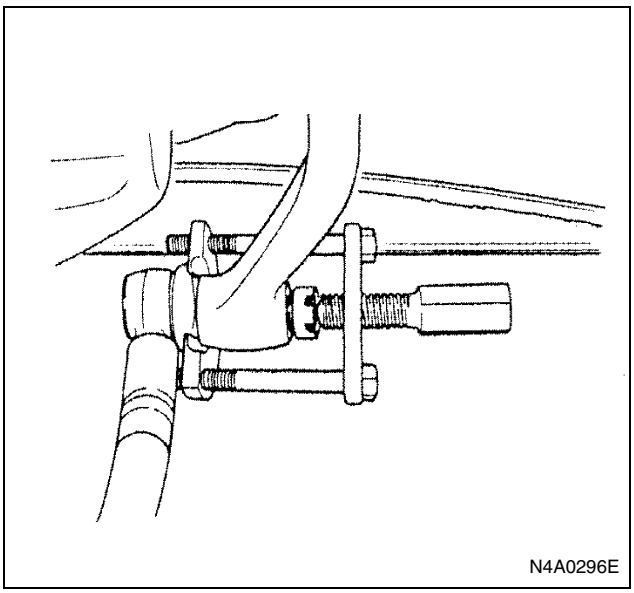
Removal

Preparation:
Jack up and support the vehicle on stands.

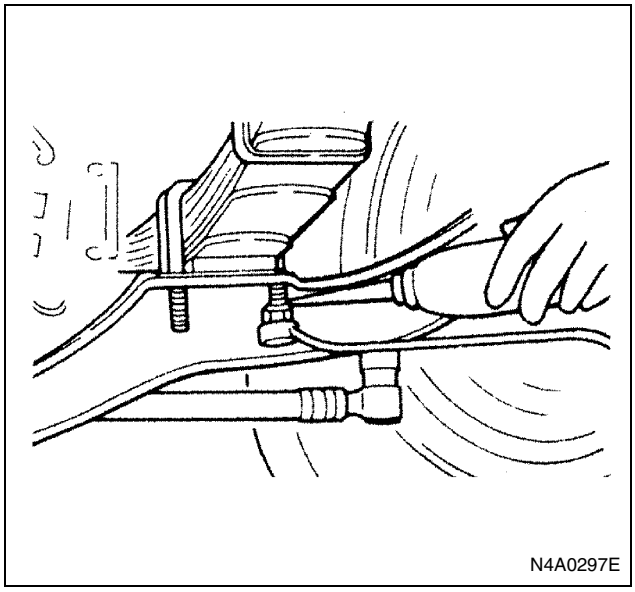
1. Wheel and Tire
2. Brake Flexible Hoses
   Loosen the nut (2), then pry off a clip (1).



3. Shock Absorber
4. Drag Link
   Disconnect the drag link, using a special tool.
   Remover: 5-8840-2017-0



5. U-Bolt
   Loosen the U-bolts after setting jack against the front axle. If the U-bolts are heavily rusted, apply a generous amount of oil to the threads before loosening them to prevent seizure.



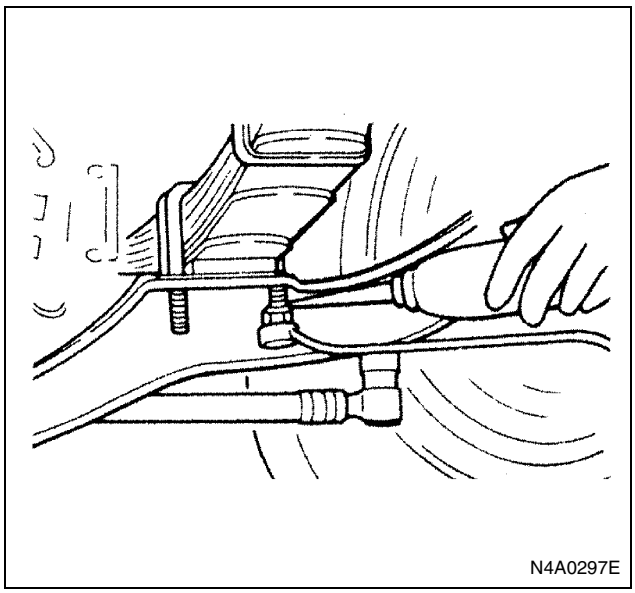
6. Front Axle Assembly

Installation

1. Front Axle Assembly
2. U-bolt and Nut
   Position the U-bolts and helper rubber on the leaf spring assemblies and jack up the front axle. When tightening the nuts, apply oil as necessary to prevent damaging the threads.

Tighten:
U-bolt nut to

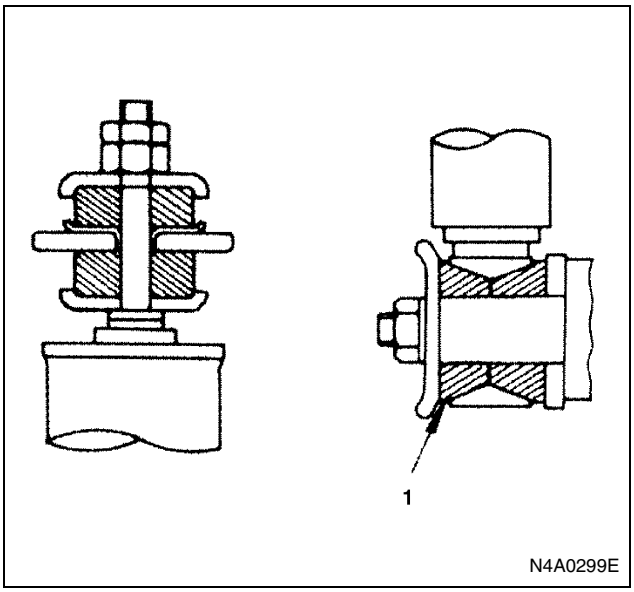
- NQR: 196 N·m (20 kg·m / 145 lb·ft)
- NHR, NKR, NPR: 127 N·m (13 kg·m / 94 lb·ft)



3. Drag Link
   Tighten drag link nut to specified torque, with just enough additional torque to align cotter pin holes.
   Install new cotter pin.

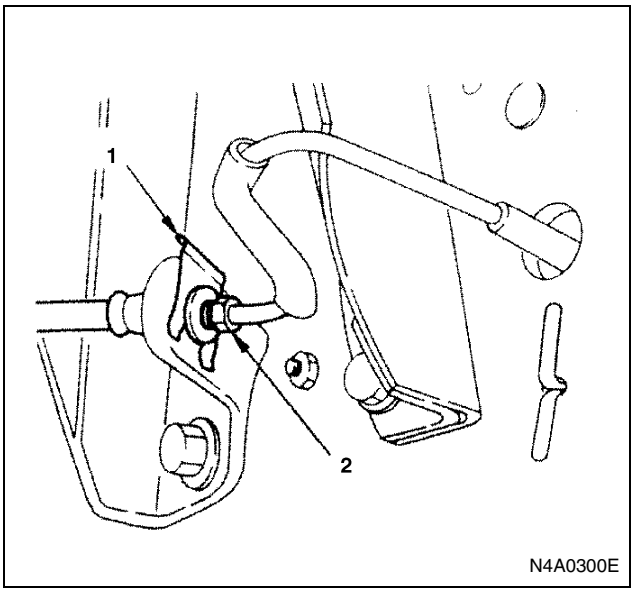
Tighten:
Drag link nut to 167 N·m (17 kg·m / 123 lb·ft)

4. Shock Absorber
   Refer to illustration for installation of shock absorber, nut, washer and rubber bushing (1).



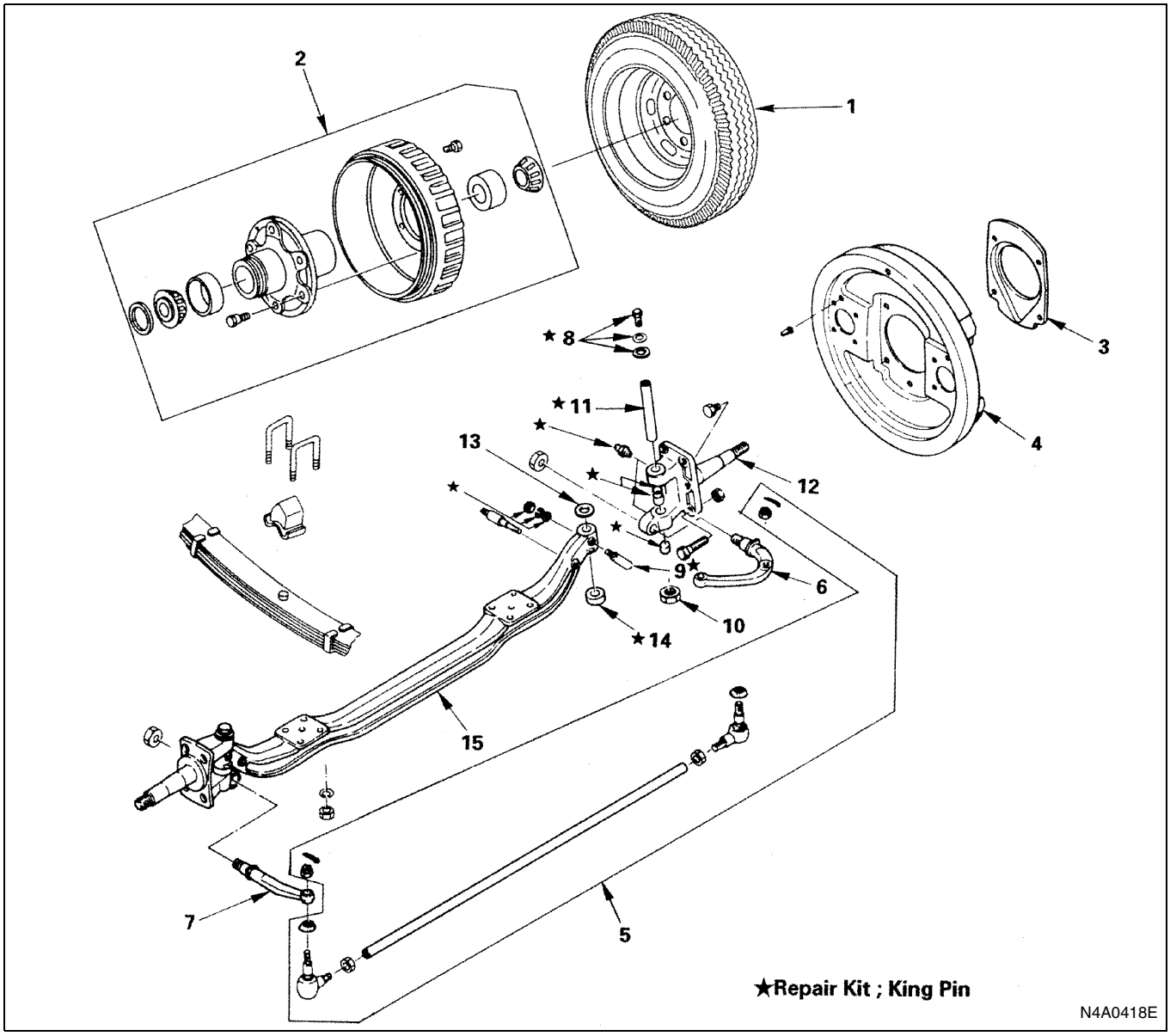
5. Brake Flexible Hose
   Set first the wheels in the straight going position, then attach the flexible hose to the bracket without torsion using a (1).
   Connect the pipe, then tighten the nut (2) to the specified torque.

Tighten:
Brake flexible hose to 16 N·m (1.6 kg·m / 12 lb·ft)



   Perform bleeding operation after installation of the brake flexible hoses.
   Refer to Section 5 “Service information” for brake fluid air bleeding procedure.
   Also inspect wheel alignment after completion of front axle removal and installation.
6. Wheel and Tire

Knuckle and King Pin (4 × 2 Model)



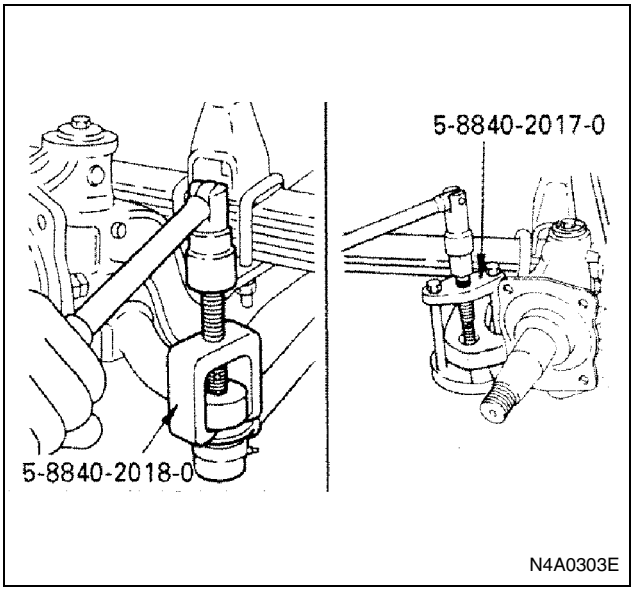
Legend

1. Wheel and tire
2. Hub with brake drum
3. Cover
4. Wheel brake assembly
5. Tie rod assembly
6. Knuckle arm
7. Tie rod arm
8. King pin cover
9. Key bolt
10. Plate plug
11. King pin
12. Knuckle
13. Shim
14. Thrust bearing
15. I-beam

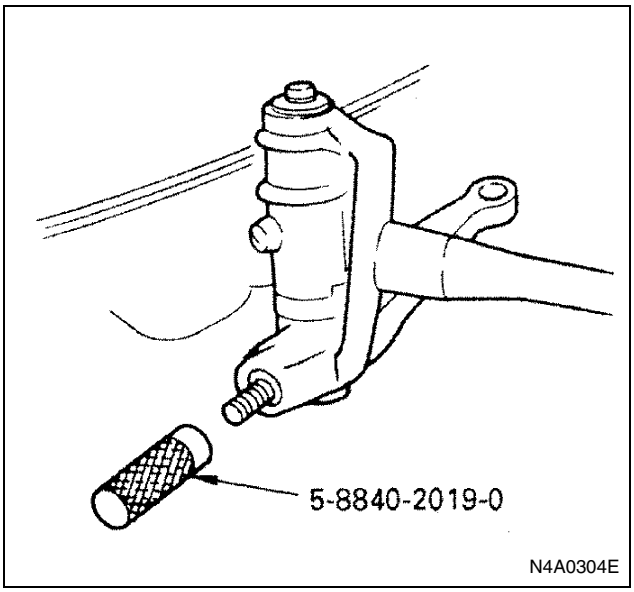
Removal

Preparation:
Jack up and support the vehicle on stands.

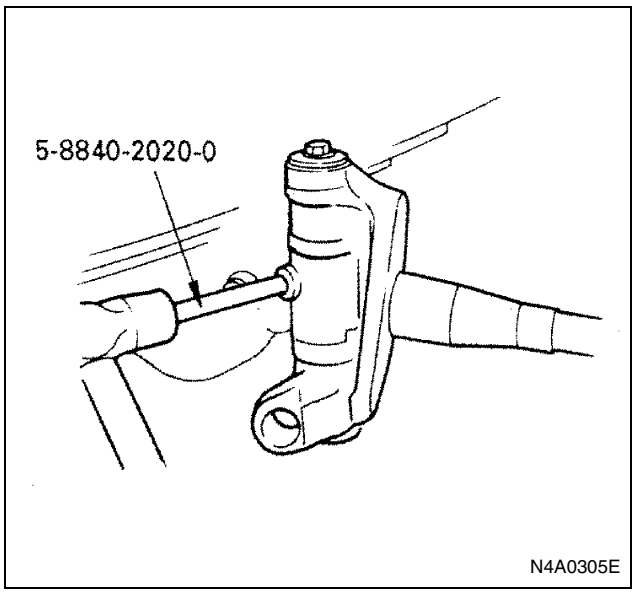
1. Wheel and Tire
2. Hub with Brake Drum
3. Cover
4. Wheel Brake Assembly
5. Tie Rod Assembly
   Remover
   Driver Side: 5-8840-2017-0
   Assistant Side: 5-8840-2018-0



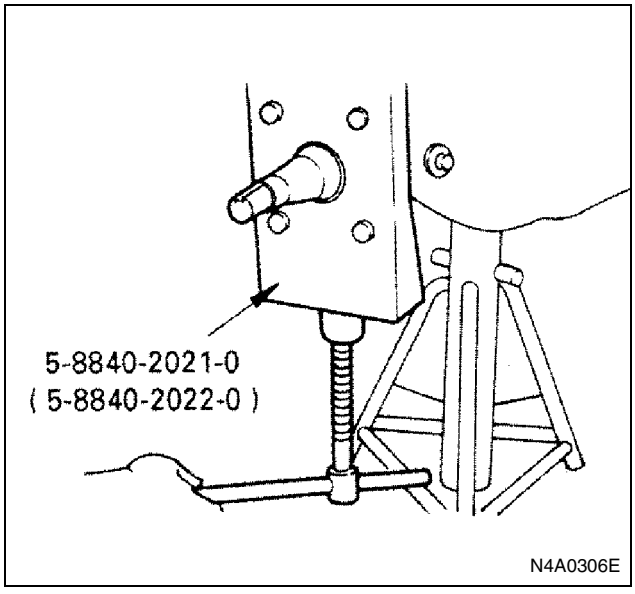
6. Knuckle Arm
7. Tie Rod Arm
   Remover: 5-8840-2019-0
   Drive out with a heavy hammer.



8. King Pin Cover
9. Key Bolt
   Remover: 5-8840-2020-0



10. Plate Plug
11. King Pin
    Remover:
    NHR 5-8840-2021-0
    NKR, NPR 5-8840-2022-0
    NQR 5-8840-2022-0



12. Knuckle
13. Shim
14. Thrust Bearing
15. I-Beam

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Visual Check

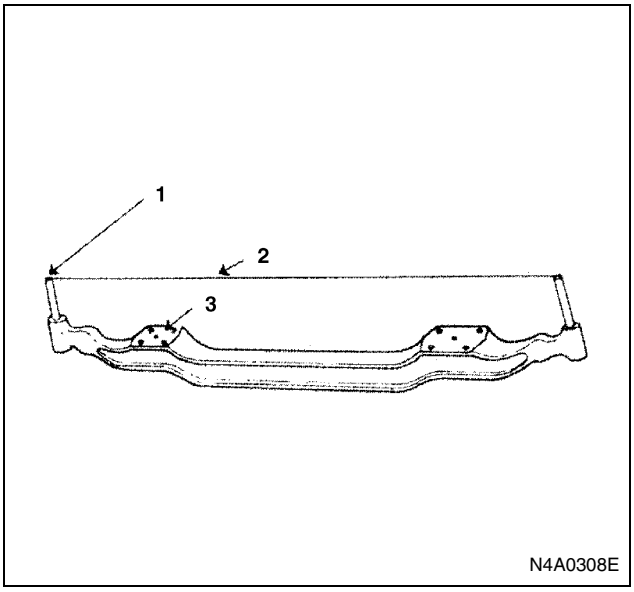
Inspect the following parts for wear, damage or other abnormal conditions.

- I-beam
- Knuckle

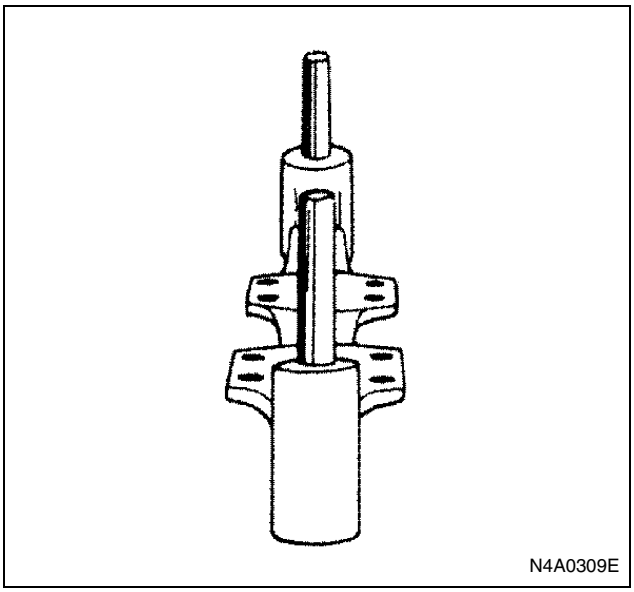
- Knuckle arm, tie rod arm
- Tie rod, tie rod end
- King pin, bushing, thrust bearing and shims
- Joint ball
- Front hub, bearing and oil seal
- Brake drum
- Brake shoe, lining etc.

I-Beam (when removed from the vehicle)

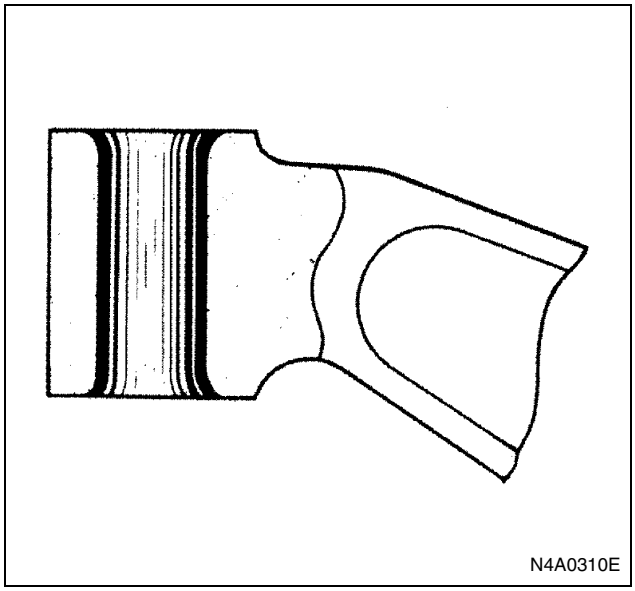
1. Fit the king pin or test bar (1) into the king pin hole.
2. Stretch a cord (2) across the centers of king pin or test bars.
3. Check to see if the cord is in line with the centers of the center bolt holes (3) in the spring seat when looked down from above the cord.



4. Also check to see if the king pins or test bar are in good parallel alignment as viewed from the side.

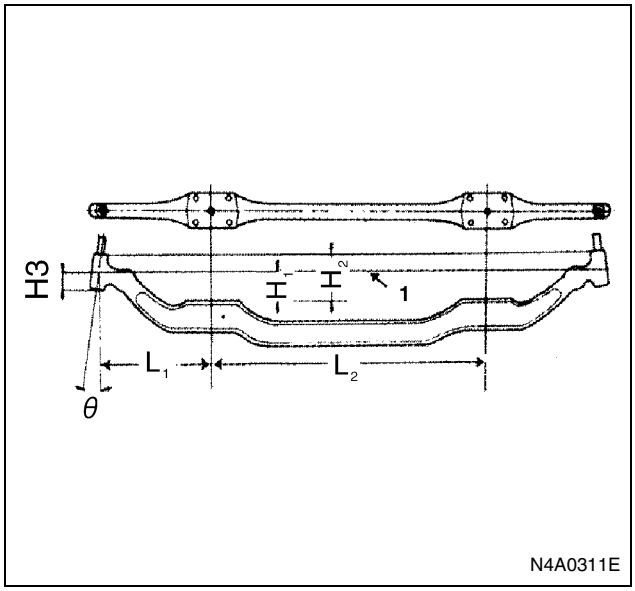


5. Check to see if the king pin holes is worn.



6. Stretch a cord (1) and check the following dimensions.

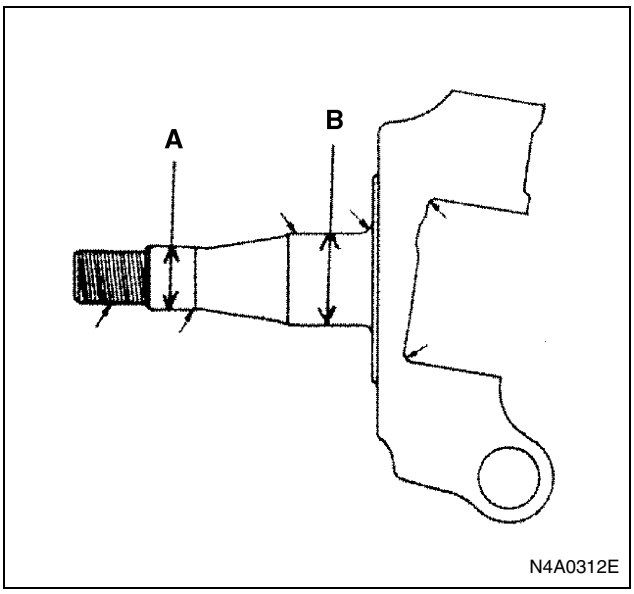
'05 model						mm (in)
	θ	H1	H2	H3	L1	L2
NHR	12°	97 (3.8)	135.3 (5.3)	25.2 (0.99)	260 (10.2)	690 (27.2)
NKR		97 (3.8)	134.4 (5.3)		260 (10.2)	690 (27.2)
NPR		83 (3.3)	120.4 (4.7)		315 (12.4)	860 (33.9)
NQR		83 (3.3)	120.4 (4.7)		315 (12.4)	860 (33.9)



Cracks in Knuckles

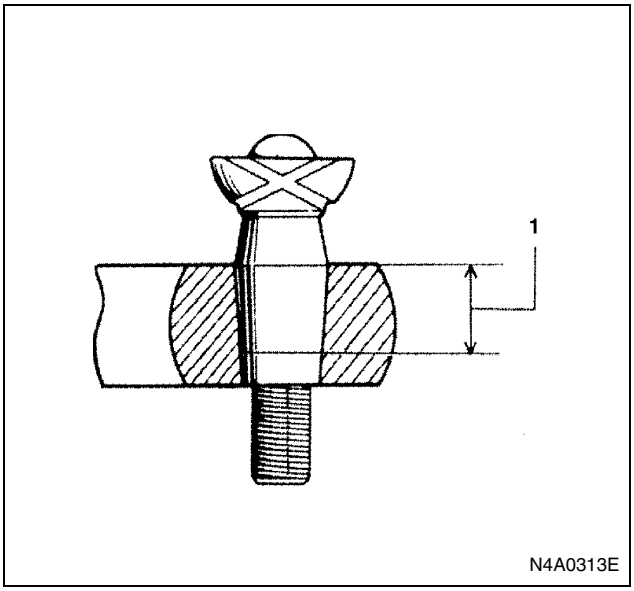
Check the knuckles for cracks or damage paying a particular attention to the areas indicated by arrows.
Use a magnetic flaw detector or red check.

- NHR
  A: 30 mm (1.19 in)
  B: 40 mm (1.57 in)
- NKR, NPR, NQR
  A: 35 mm (1.38 in)
  B: 50 mm (1.97 in)



Knuckle Arm and Tie Rod Arm

Check tapered portion of the knuckle arms and tie-rod arms for abnormal contact in the following manner.:
Apply a thin coat of red check evenly to the tapered portion of the shaft and insert the shaft into the tapered hole. Remove the shaft and check impression of contact obtained on the shaft.
Correction or parts replacement is necessary if the contact is uneven or if contact area is smaller than 3/4 of the entire length of the shaft.

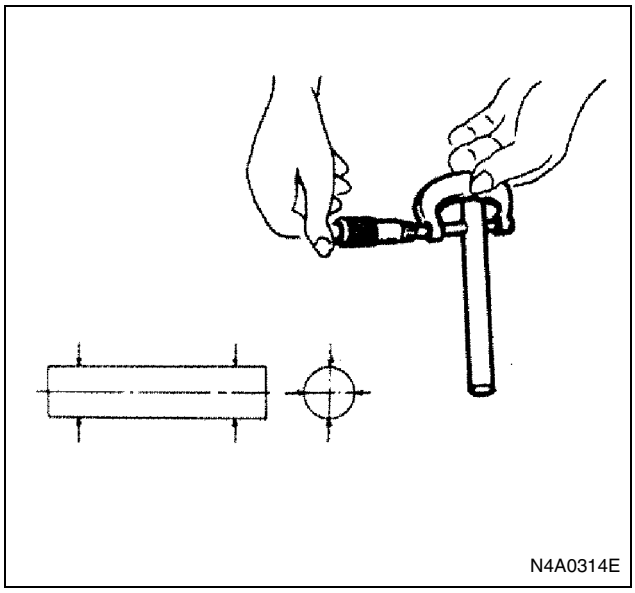


Legend

1. Contact are is longer than 3/4 of the entire length of the shaft.

King Pin Diameter

- NHR
  A: 25.0 mm (0.984 in)
  B: 24.9 mm (0.980 in)
- NKR, NPR, NQR
  A: 30.0 mm (1.181 in)
  B: 29.9 mm (1.177 in)

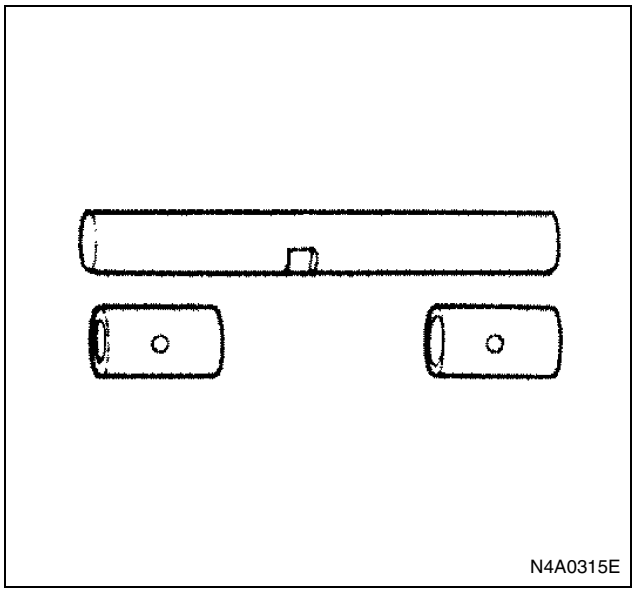


Clearance between King Pin and Bushing

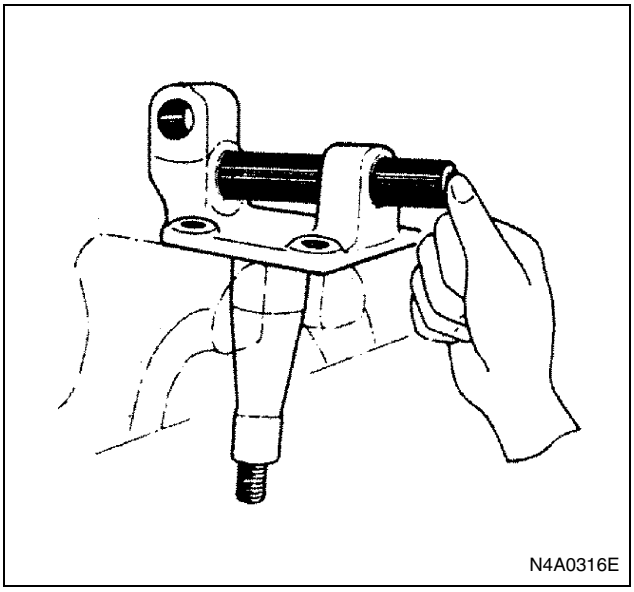
Standard: 0.06 mm (0.0024 in)
Limit: 0.15 mm (0.0059 in)

Notice:

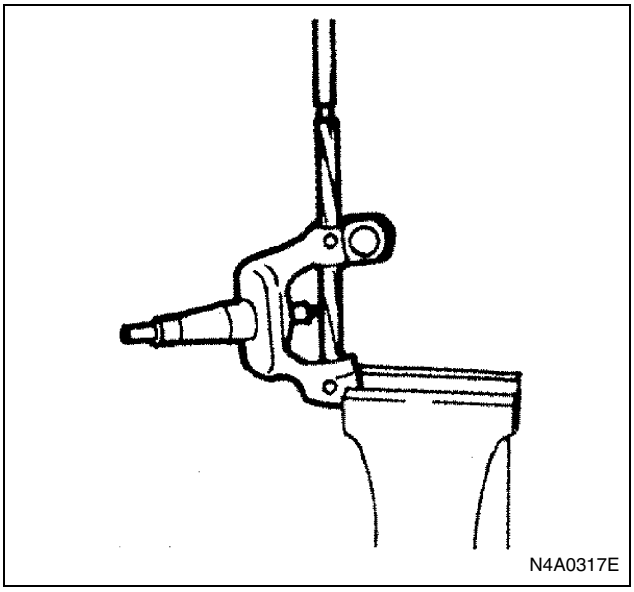
Install the king pin bushing by aligning its grease hole with grease fitting hole in the knuckle.



Fit of king pin into the king pin bushing can be checked in the following manner.
Clamp the knuckle with king pin bushings in a vise and insert the king pin into the bushings. Check for radial play by moving the king pin in direction at a right angle to its axis, then move the king pin endwise with finger.

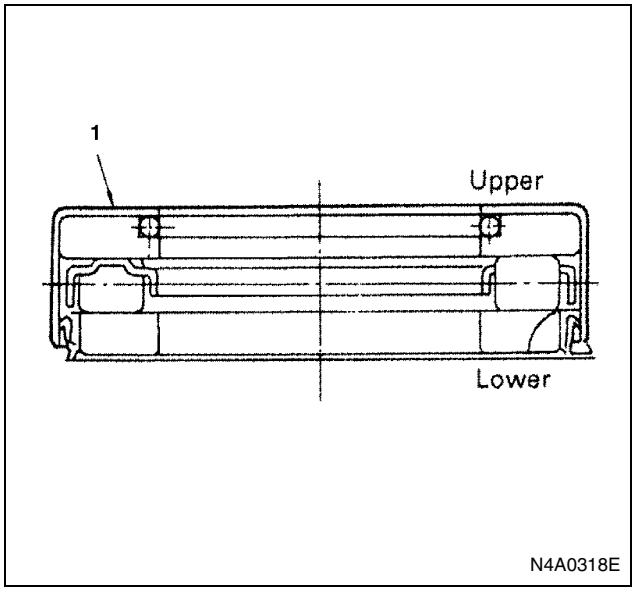

N4A0316E

If fitting of king pin into the bushing is too tight, carefully cut inner face of the bushing with a reamer, so that upper and lower holes in the knuckle are well centered.


N4A0317E

Installation

1. I-Beam
2. Knuckle
3. Thrust Bearing
   1) Apply grease.
   2) Turn the bearing case-side upward.



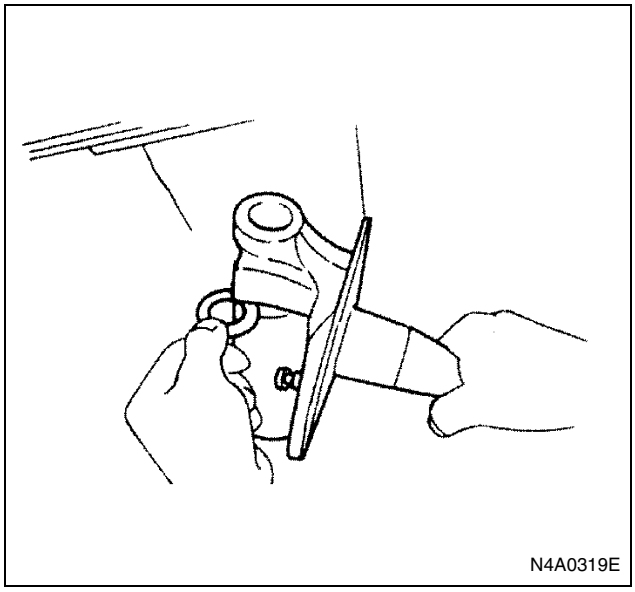
N4A0318E

Legend

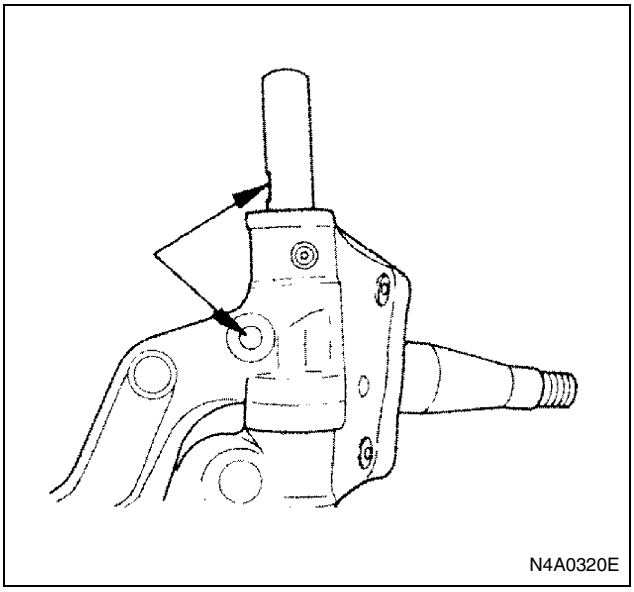
1. Case

4. Shim
   Check the clearance between the knuckle and front axle.

Standard: 0 — 0.10 mm (0 — 0.004 in)
Limit: 0.20 mm (0.0079 in)
Shim available thickness, 0.50, 0.55, 0.60, 0.65, 0.70, 0.80, 0.90 mm (0.019, 0.022, 0.024, 0.026, 0.028, 0.031, 0.035 in)

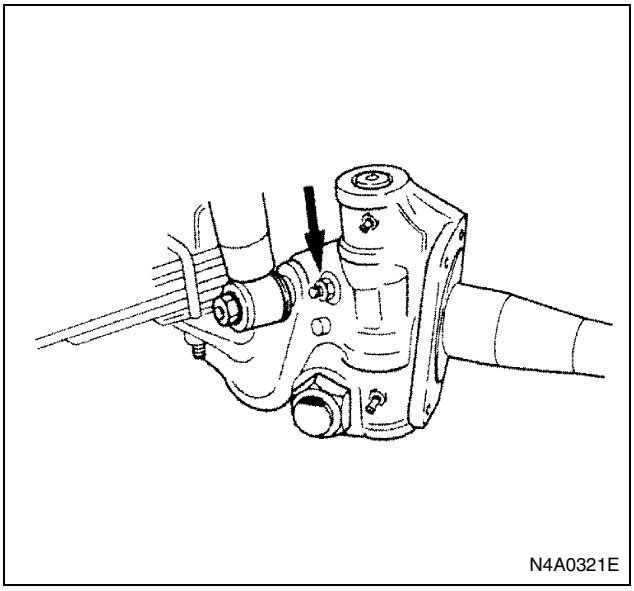

N4A0319E

5. King Pin
   1) Apply grease.
   2) Align the key groove with the key bolt hole in the front axle.
   3) After installing the king pin, check that the knuckle turns smoothly.

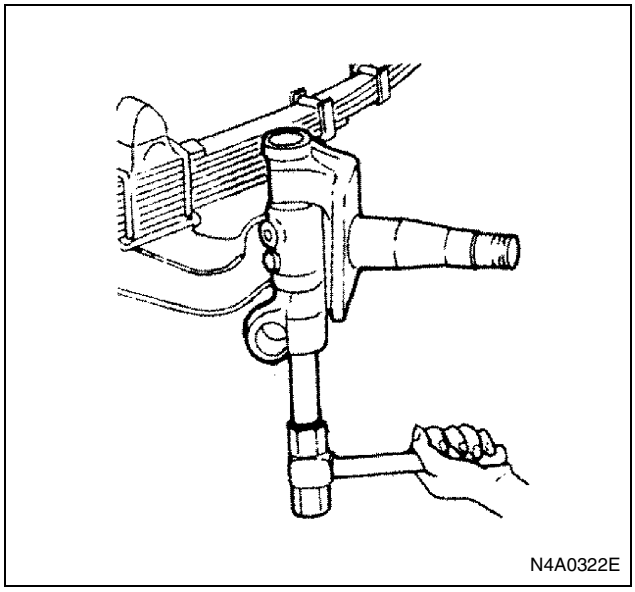

N4A0320E

6. Key Bolt

Tighten:
Key bolt to 32 N·m (3.3 kg·m / 24 lb·ft)


N4A0321E

7. King Pin Cover
8. Plate Plug
   Drive the plate plug upward into position with an appropriate bar fitted against the lower end.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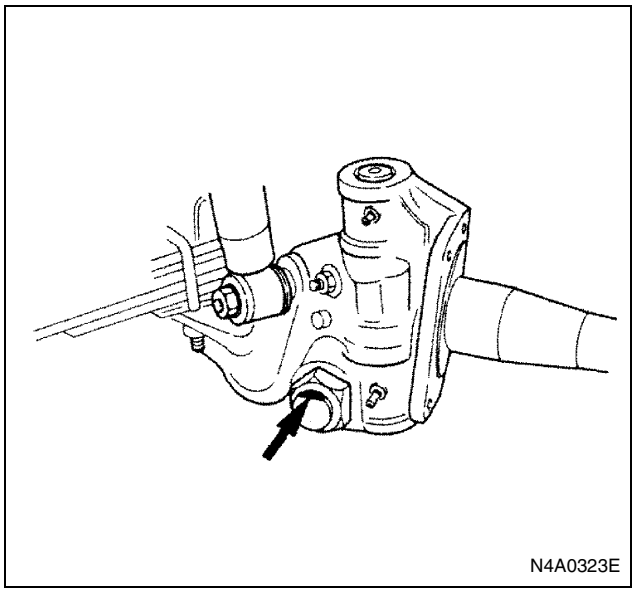
9. Tie Rod Arm
10. Knuckle Arm

Tighten:
Knuckle arm nut to 441 N·m (45 kg·m / 325 lb·ft)

After tightening, stake nut.
Use a new nut.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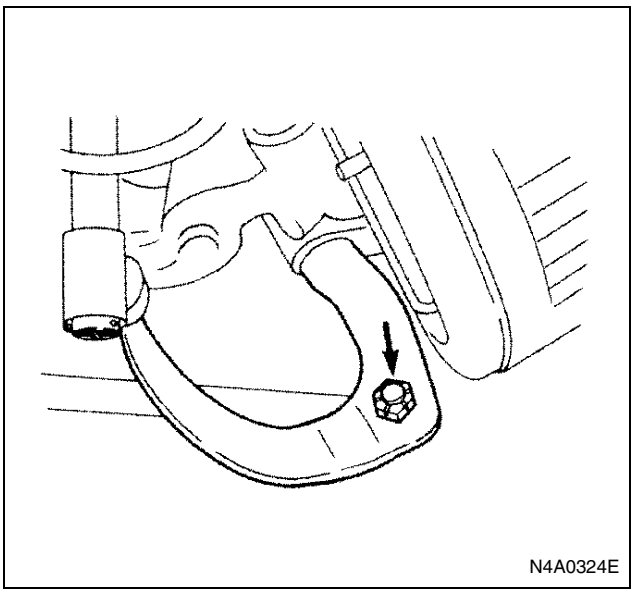
11. Tie Rod Assembly
    Use a new nut.

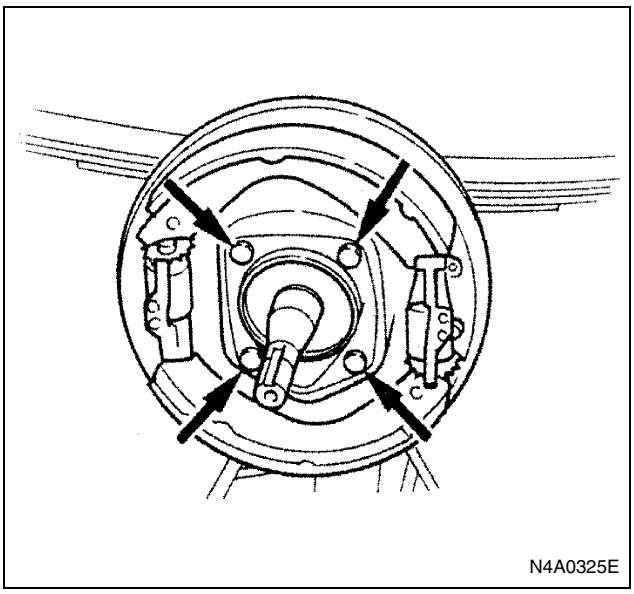
Tighten:
Tie rod end nut to 186 N·m (19 kg·m / 137 lb·ft)

Be sure to install a new cotter pin. If the hole and the slot are not aligned, turn in the direction of tightening to align them.



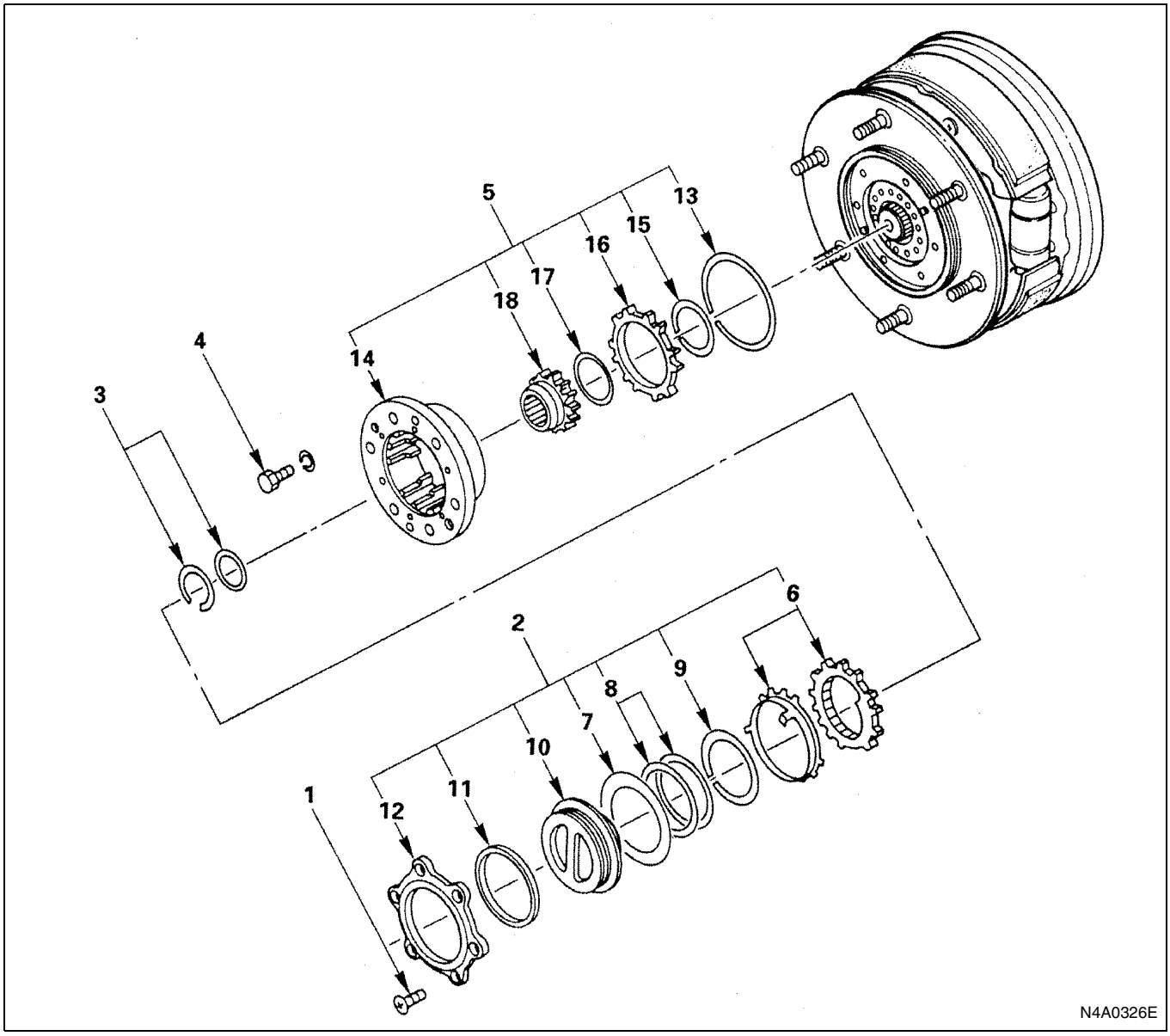
12. Wheel Brake Assembly
13. Cover

Tighten:
Wheel brake bolt to 69 N·m (7 kg·m / 51 lb·ft)



14. Hub with Brake Drum
15. Wheel and Tire

Free Wheel Hub (Manual Locking Hub) (4 × 4 Model)

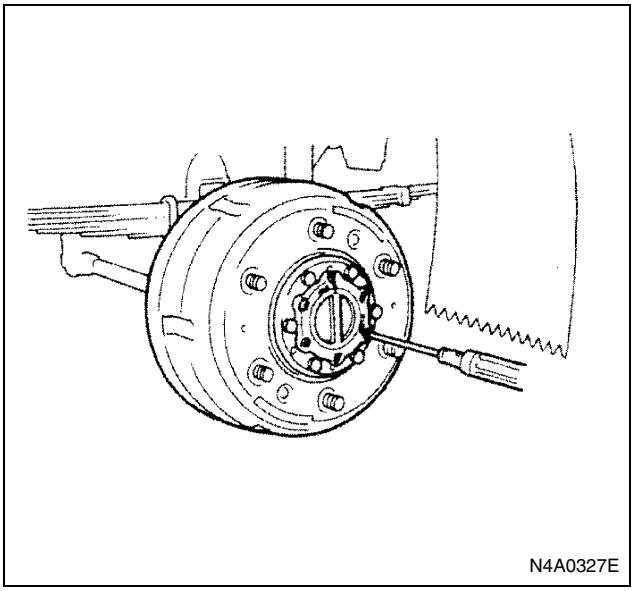


Legend

1. Screw
2. Cover assembly
3. Snap ring and shim
4. Bolt
5. Body assembly
6. Clutch assembly
7. Inner snap ring
8. Tension spring
9. Inner snap ring
10. Handle
11. Ring
12. Cover
13. Inner snap ring
14. Body
15. Outer snap ring
16. Ring
17. Spacer
18. Inner hub lock

Removal

1. Screw
2. Cover Assembly
   Set handle into “FREE” position and then remove cover assembly.
   (During removal, take care not to damage the flange on rear side of cover. Remove wheel (tire) as necessary.)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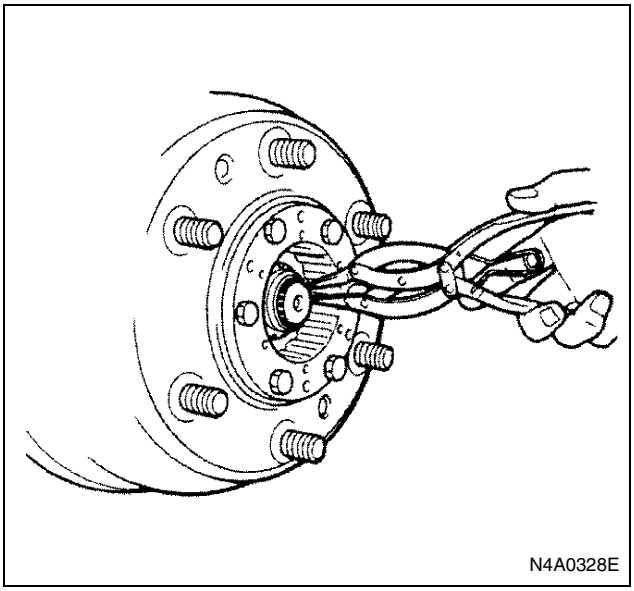
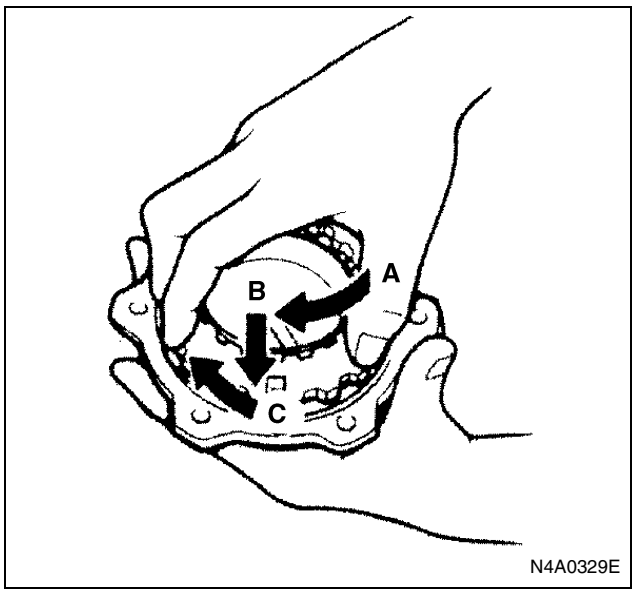
3. Snap Ring and Shim
   Confirm the quantity of shims.


N4A0328E

4. Bolt
5. Body Assembly
   Remove the body assembly using a push bolt (M10 × 1.5).
   During removal, do not damage the flange of body by hitting with a screwdriver or the like.
6. Clutch Assembly
   1) With the handle in FREE position, hold the cover and rotate fully the clutch assembly clockwise as shown (A).
      At this time, the lug of clutch retainer gets stuck by the L-shaped part at the edge of tension spring (0 it is pinched by double parts of tension spring).



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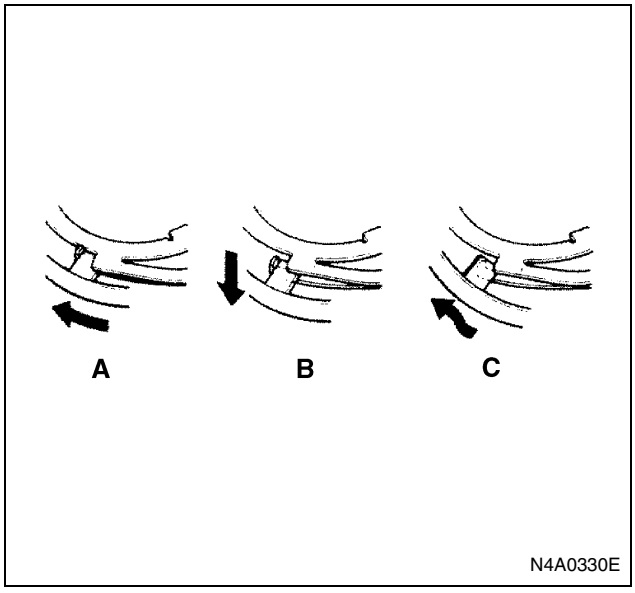
   2) Under the condition of 1) above, rotate further the clutch assembly clockwise while pushing it (B).
      Consequently, the clutch retainer lug is freed from the L-shaped part at the edge of tension spring (C).
      Do not try to further disassemble the clutch assembly.



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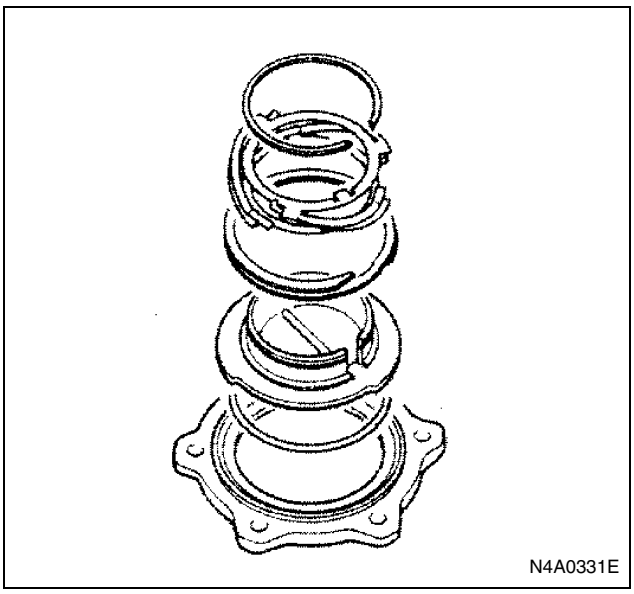
7. Inner Snap Ring
8. Tension Spring
   Remove the snap ring and then remove the tension spring from the cover.
9. Inner Snap Ring
10. Handle
    Remove the inner snap ring and then remove the handle from the cover.

11. Ring
    Remove the ring from the handle.
12. Cover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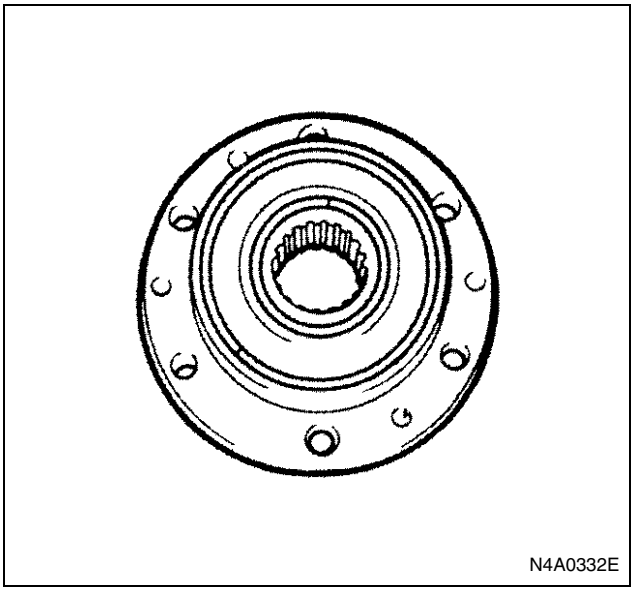
13. Inner Snap Ring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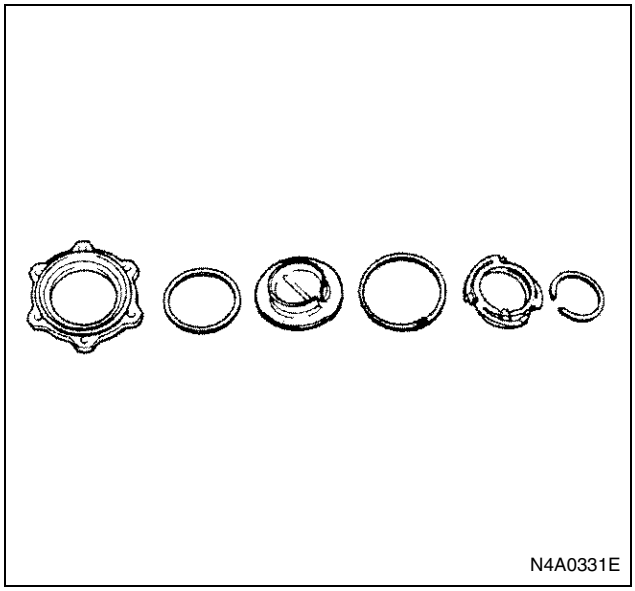
14. Body
    Remove the inner snap ring from the back of body.
15. Outer Snap Ring
16. Ring
    Remove the outer snap ring that joints inner and ring, so that they are separated.
17. Spacer
18. Inner Hub Lock

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

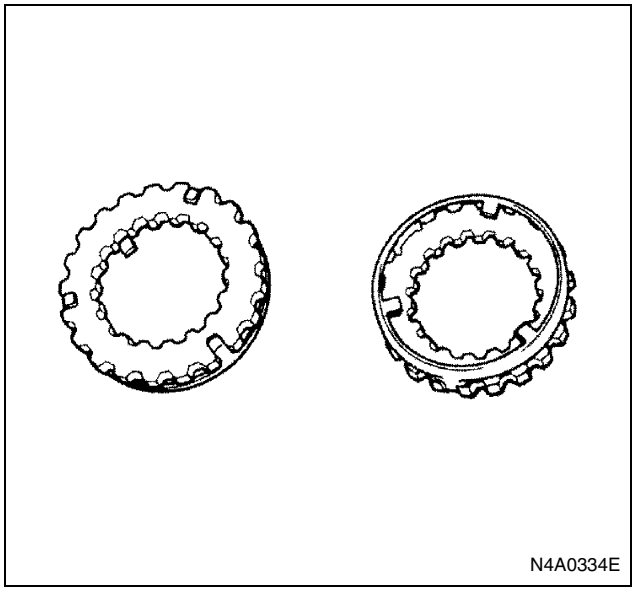
Cover Assembly

1. Inspect the cover and handle for presence of crack or damage particularly in a sliding part.
2. Inspect the inner snap ring of cover for local wear in the mounting groove.
3. Inspect the tension spring for wear, damage or break.


N4A0331E

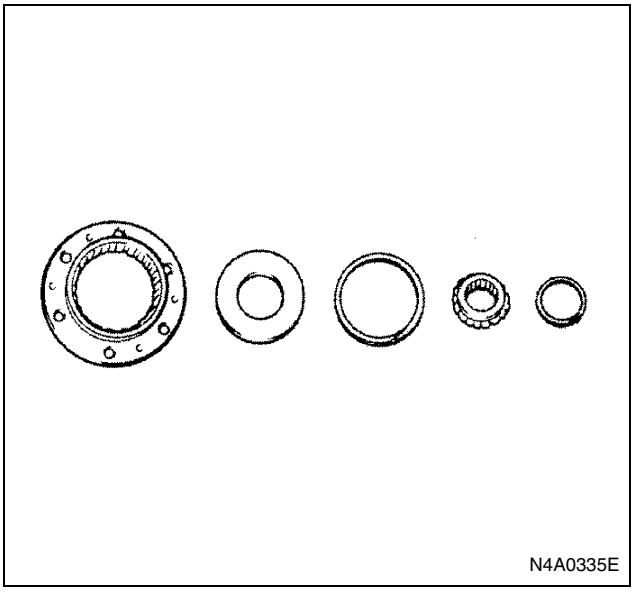
Clutch Assembly

1. Inspect the retainer of clutch assembly for play in the calked parts (3 places).
   Re-calk if the axial play exceeds 0.1 mm.
2. Inspect the clutch teeth for crack, wear or damage, and also the retainer lug for break or wear. Replace the assembly if clutch or retainer is defective.


N4A0334E

Body Assembly

1. Inspect the body, ring, inner snap ring, outer snap ring and inner hub lock for crack, wear or damage particularly in the teeth.
2. Inspect the inner snap ring mounting groove of the hub lock body and the outer snap ring mounting groove of the hub lock inner for an uneven wear.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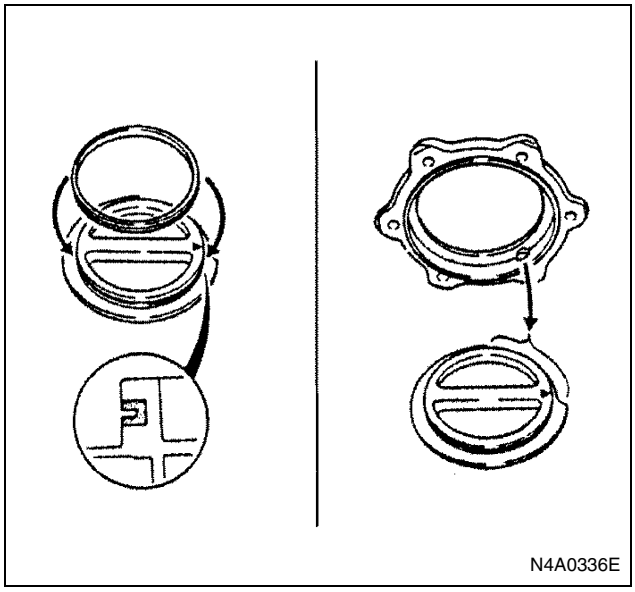
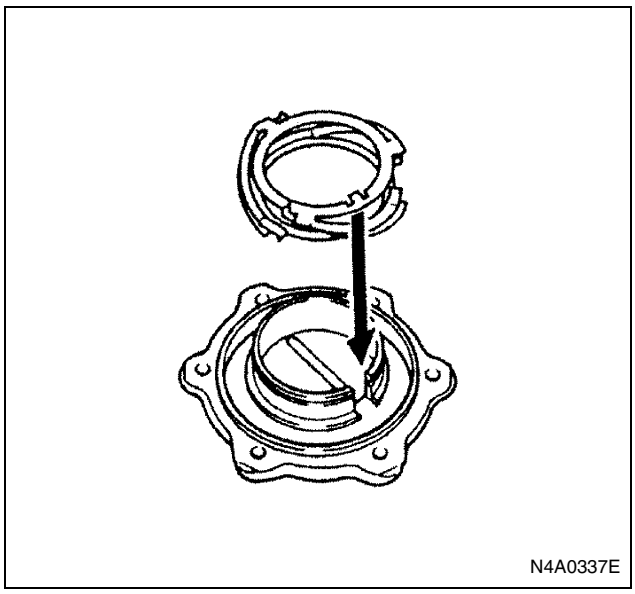

N4A0336E

Installation

1. Inner Hub Lock
2. Spacer
3. Ring
4. Outer Snap Ring
   Apply grease (Multipurpose type) to each part of inner hub lock and install it to the hub lock ring (flange should face rear side), then fix it with outer snap ring.
5. Body
6. Inner Snap Ring
   1) Install the inner hub lock to hub lock ring, then to the body, and fix them with inner snap ring.
   2) Make sure that the inner hub lock and outer snap rings are installed properly.
7. Cover
8. Ring
   Apply grease (Multipurpose type) to the ring and install the ring to the handle.
   Make sure that the ring is free from torsion.
9. Handle
10. Inner Snap Ring
    1) Install the handle to the cover, and fix with inner snap ring.
    2) Make sure that the inner snap ring is installed properly.
11. Tension Spring
    1) Apply grease (Multipurpose type) to the tension spring.
    2) Insert the tension spring into the cover assembly with the nail of spring engaged with the groove.
       There is no discrimination such as face or back in the tension spring.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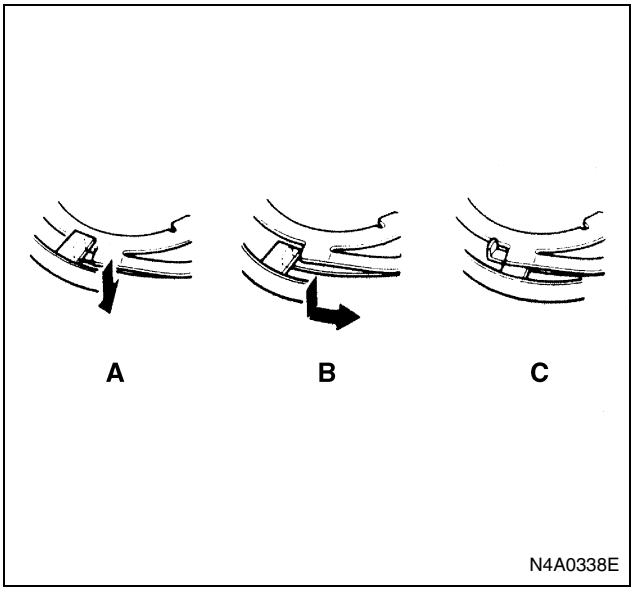
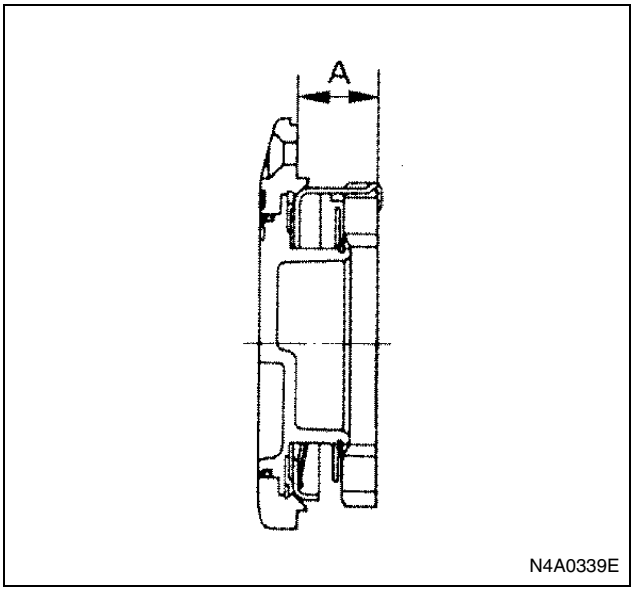
12. Inner Snap Ring
    Fix the tension spring with inner snap ring.
13. Clutch Assembly
    1) With the retainer lugs met with L-shaped parts (3 places) at the edge of tension spring (A), push and rotate spirally the retainer (B) so that it is pinched by springs (C).



2) The clutch must be in retract status when the handle is set in FREE position.
3) Install the clutch assembly to the cover, and measure the dimension “A” to confirm that it satisfies the standard.

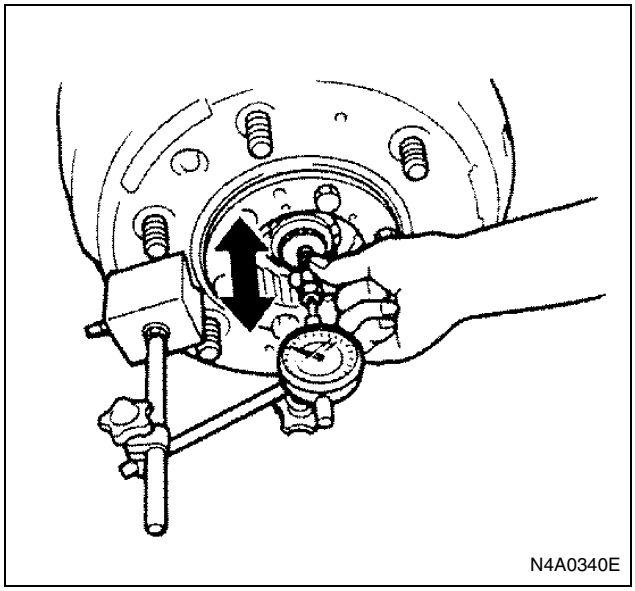
FREE status: 22.4 — 23.7 mm (0.88 — 0.93 in)
LOCK status: 32.6 — 33.9 mm (1.28 — 1.33 in)



14. Body Assembly
    1) Apply grease (Multipurpose type) to the teeth of hub lock body assembly.
    2) Apply adhesive (LOCTITE 515 or equivalent) to the flange surface of the body assembly.
15. Bolt
    Apply adhesive (LOCTITE 242 or equivalent) to the threads of body assembly fixing bolts, and tighten them to the specified torque.

Tighten:
Body assembly bolt to 98 N·m (10 kg·m / 72 lb·ft)

Measurement of axial play of front drive shaft
After installation of body assembly, measure axial play of front drive shaft. If it is out of the standard range, adjust with shims listed below.
Standard play: 0 — 0.5 mm (0 — 0.020 in)
Kind of shims, 1.0, 0.5, 0.3 mm (0.039, 0.020, 0.012 in)



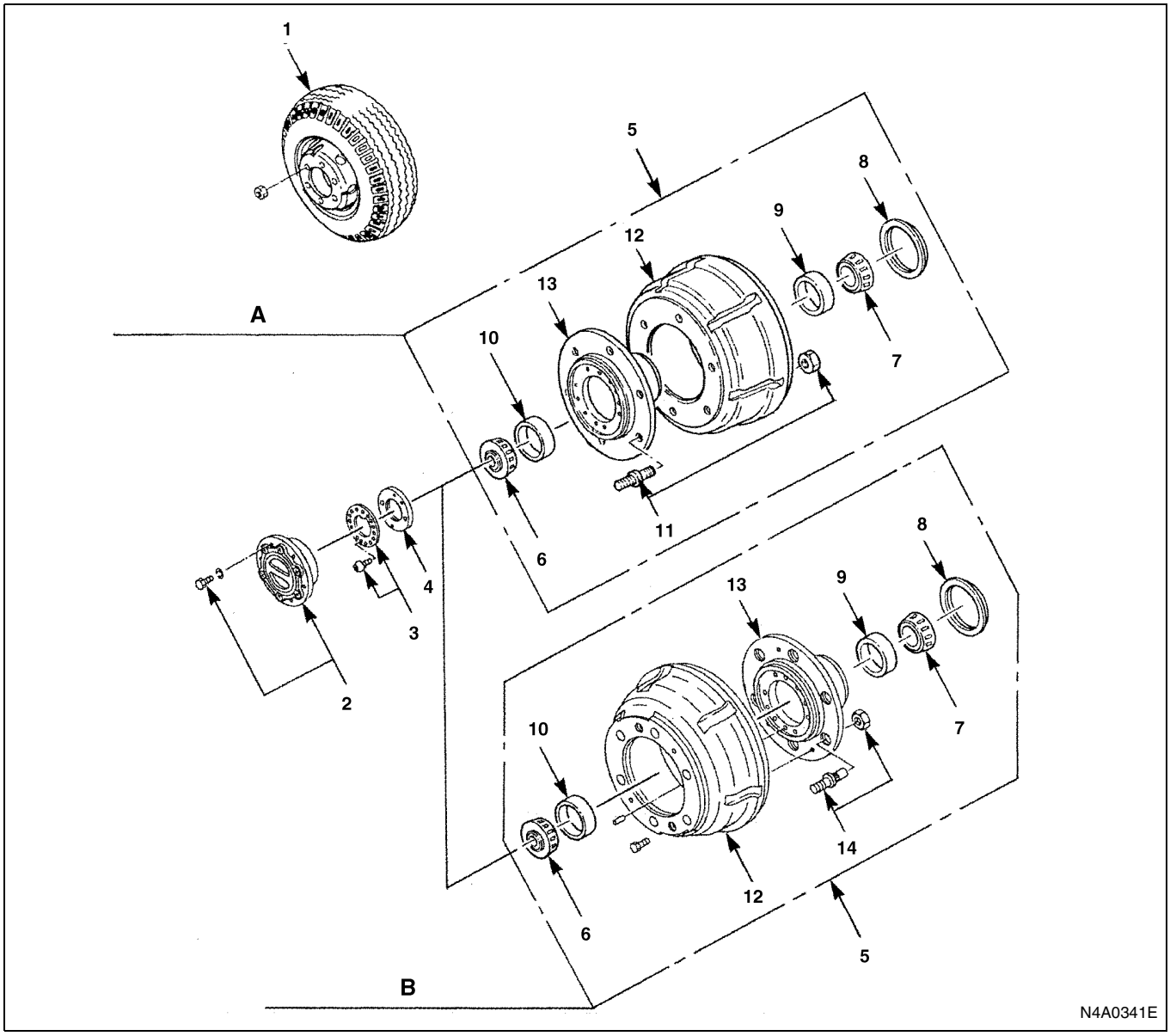
16. Snap Ring and Shim
    Install the snap ring properly.
17. Cover Assembly
    Apply adhesive (Three Bond 1215 or equivalent) to the flange surface of the cover assembly.
18. Screw
    With the handle in FREE position (clutch is disengaged), adjust three grooves of body and tighten the screws to the specified torque after applying adhesive (LOCTITE 242 or equivalent) to the threads.

Tighten:
Screws to 6 N·m (0.6 kg·m / 52 lb·ft)

<Inspection of free wheel hub locking operation>
1. With the handle in FREE position, rotate the front drive shaft. Normal if no load is applied.
2. With the handle in LOCK position, rotate the front drive shaft. Normal if load is applied.
   - Reference value
     Load of front drive shaft: 3 N·m (0.3 kg·m / 26 lb·ft)
3. Return the handle from LOCK to FREE position, rotate the front drive shaft. Normal if no load is applied.

<Inspection of hub lock handle operating force>
The handle should be operated smooth and be moderate in functioning when it is operated two or three times.
[Reference] Handle operating force:10 kg·cm or less at 10°C or above 100 kg·cm or less at –30°C.

Front Hub and Brake Drum (4 × 4 Model)



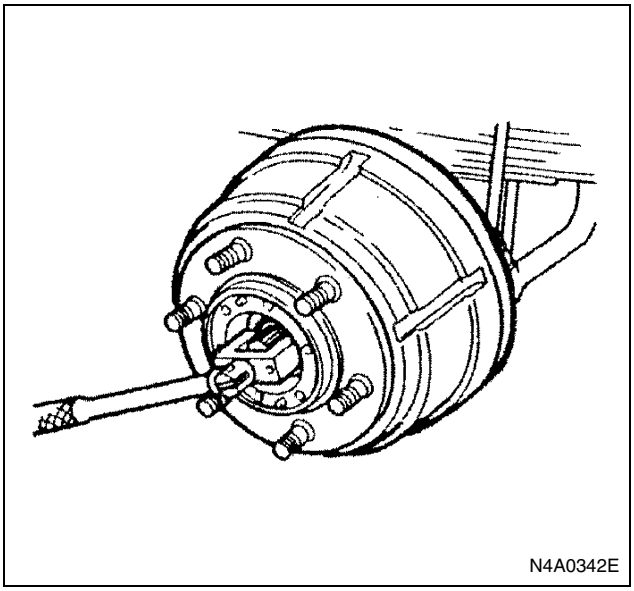
Legend

A. Inside drum fixing type
B. Outside drum fixing type
1. Wheel and tire
2. Front locking hub set
3. Front hub bearing lock washer
4. Front hub bearing lock nut
5. Front hub and brake drum assembly
6. Front axle hub outer bearing
7. Front axle hub inner bearing
8. Front hub oil seal
9. Front axle hub inner bearing outer race
10. Front axle hub outer bearing outer race
11. Front wheel pin and nut (Inside drum fixing type)
12. Brake drum
13. Front axle hub
14. Front wheel pin and nut (Outside drum fixing type)

Removal

Preparation:
Jack up and support the vehicle on stands.

1. Wheel and Tire
2. Front Locking Hub Set
   Refer to “FREE WHEEL HUB” previously in this section.
3. Front Hub Bearing Lock Washer
4. Front Hub Bearing Lock Nut
   Front Hub Bearing Lock Nut Wrench:
   5-8840-2182-0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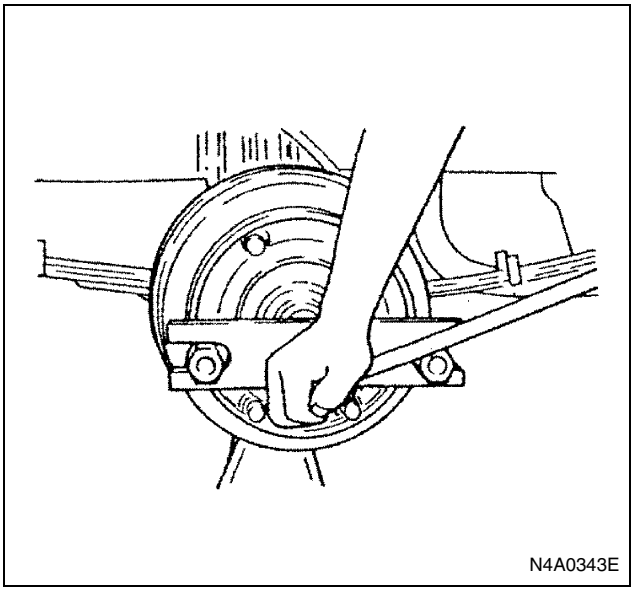
5. Front Hub and Brake Drum Assembly
   Hub Remover: 9-8521-0187-0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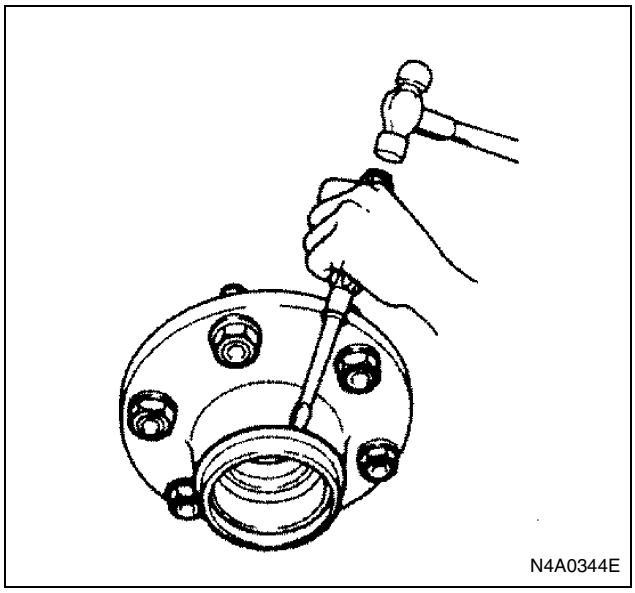
6. Front Axle Hub Outer Bearing
7. Front Axle Hub Inner Bearing
   If the inner bearing is left on the spindle side, gouge from left and right with a screwdriver, and if floating up, pull to remove it.
8. Front Hub Oil Seal
   When removing the oil seal, hit the outer flange of oil seal. The oil seal must not be reused.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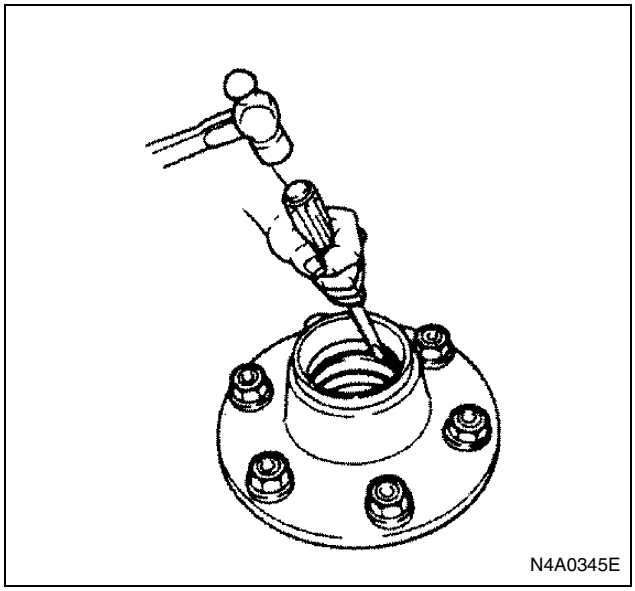
9. Front Axle Hub Inner Bearing Outer Race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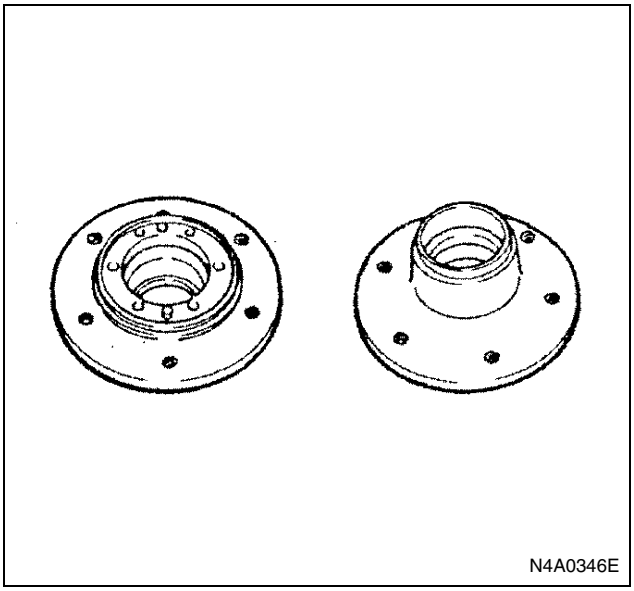
10. Front Axle Hub Outer Bearing Outer Race
    Remove the outer race by driving out race from the hub with a brass drift inserted behind race in notches in the hub.
11. Front Wheel Pin and Nut (Inside Drum Fixing Type)
    Remove nuts and hit with hammer, or use a press to remove wheel pin.
    Remove the wheel pin as necessary.
12. Brake Drum
13. Front Axle Hub
14. Front Wheel Pin and Nut (Outside Drum Fixing Type)
    Remove nuts and hit with hammer, or use a press to remove wheel pin.
    Remove the wheel pin as necessary.

Inspection and Repair

Make necessary adjustments, repairs, and part replacement if excessive wear or damage is discovered during inspection.

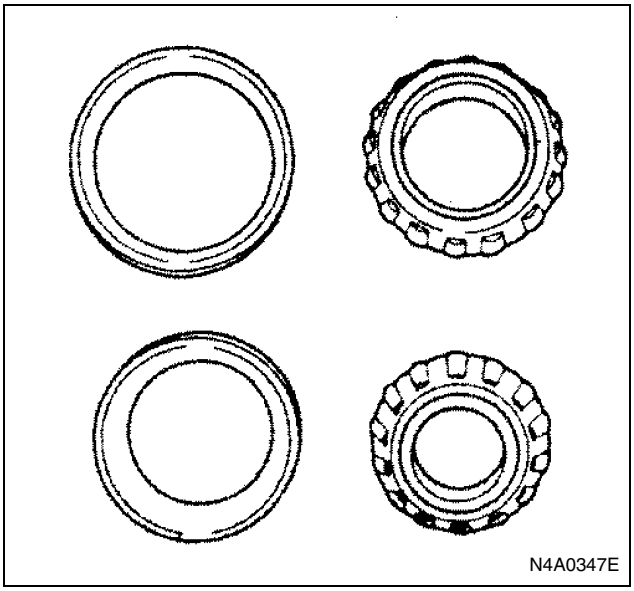
Front Axle Hub

1. Inspect the inner surface of front axle hub.
   Inspect the fitting portions of front axle hub bearing outer race and hub lock body assembly for crack, damage or wear.
2. Inspect the outer surface of front axle hub.
   Inspect the flange and oil seal fitting portion for crack, deformation or damage.



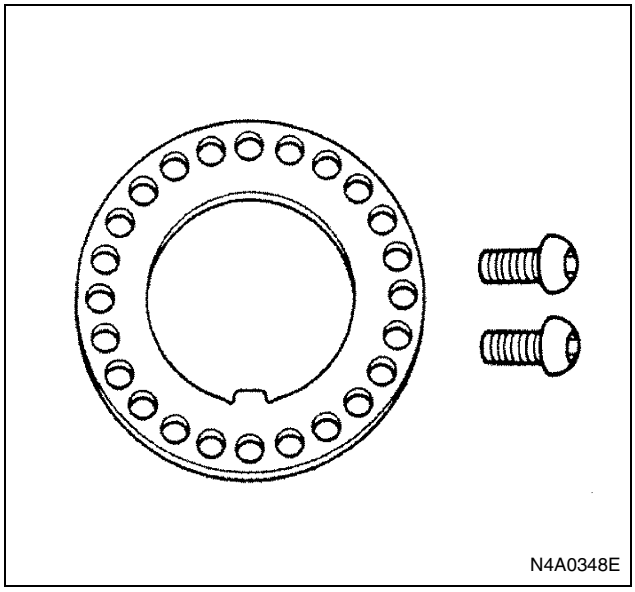
Bearing

Inspect the bearing for excessive wear, abnormal noise, rough rotation, and seizure



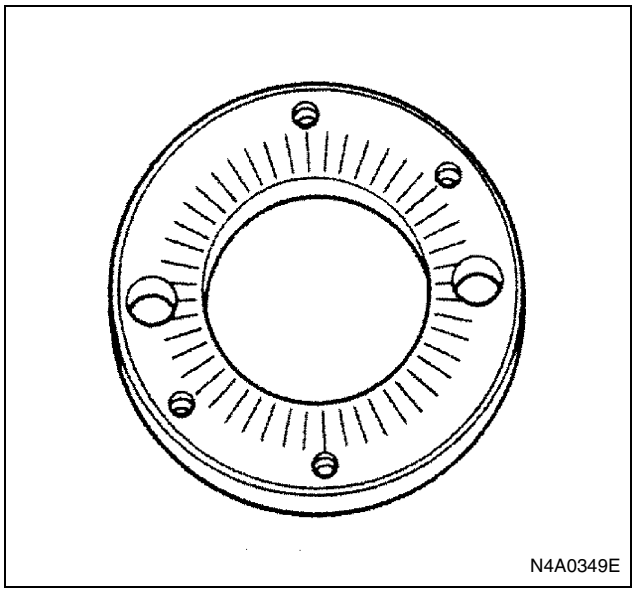
Front Hub Bearing Lock Washer

Inspect the lock washer for wear, deformation or crack, and also the lug for break.



Front Hub Bearing Lock Nut

Inspect the bearing lock nut threads and contact surfaces for excessive wear, warpage, and other damage. Light damage to the contact surfaces can be repaired with an oil stone or a piece of fine sandpaper.

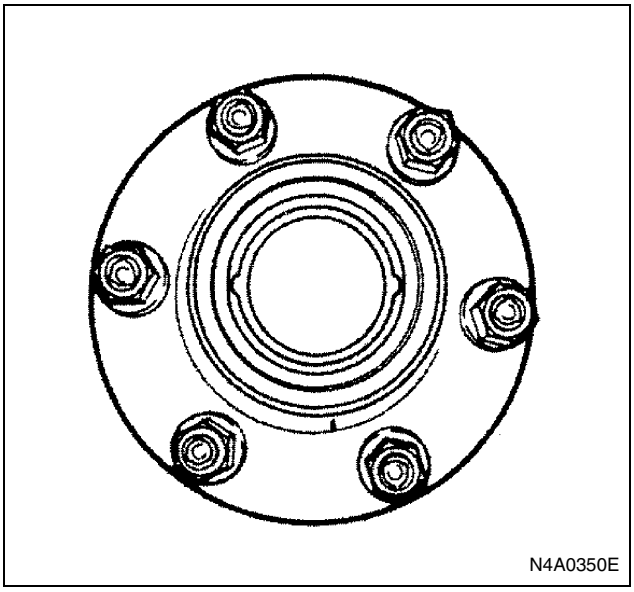


Installation

1. Front Wheel Pin and Nut (Outside Drum Fixing Type)
   If a wheel pin is replaced or removed, tighten the nut to the specified torque and calk the nut at three places per pin.

Tighten:

Front wheel pin nut to 392 N·m (40 kg·m / 289 lb·ft)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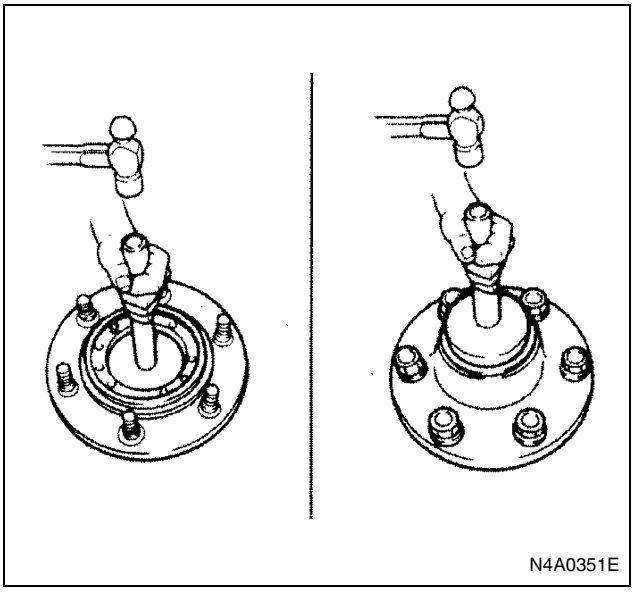
2. Front Axle Hub
3. Brake Drum
   On the model with outside drum fixing type, tighten the brake drum bolts to the specified torque.

Tighten:
Brake drum bolt to 13 N·m (1.3 kg·m / 113 lb·in)

4. Front Wheel Pin and Nut (Inside Drum Fixing Type)
   Tighten the nut to the specified torque and calk the nut at three places per pin.

Tighten:
Front wheel pin nut to 392 N·m (40 kg·m / 289 lb·ft)

5. Front Axle Hub Outer Bearing Outer Race
6. Front Axle Hub Inner Bearing Outer Race
   Use the bearing outer race installer to install the outer race to the hub.
   Inner Bearing Outer Race Installer:
   5-8840-2184-0
   Outer Bearing Outer Race Installer:
   5-8840-2183-0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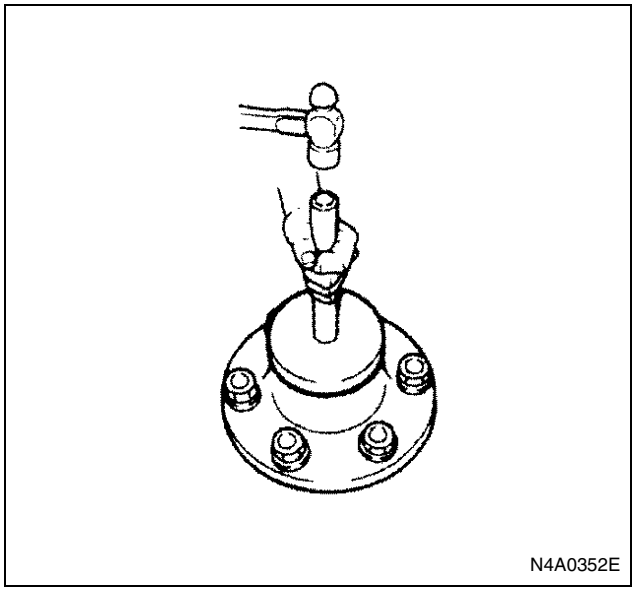
7. Front Hub Oil Seal
   1) Apply grease (Multipurpose type) to the oil seal lip inner circumferences.
   2) Use the oil seal installer to install the oil seal to the hub.
      Oil Seal Installer: 5-8840-2187-0
      During installation of oil seal, do not press or hit it other than outer flange of seal.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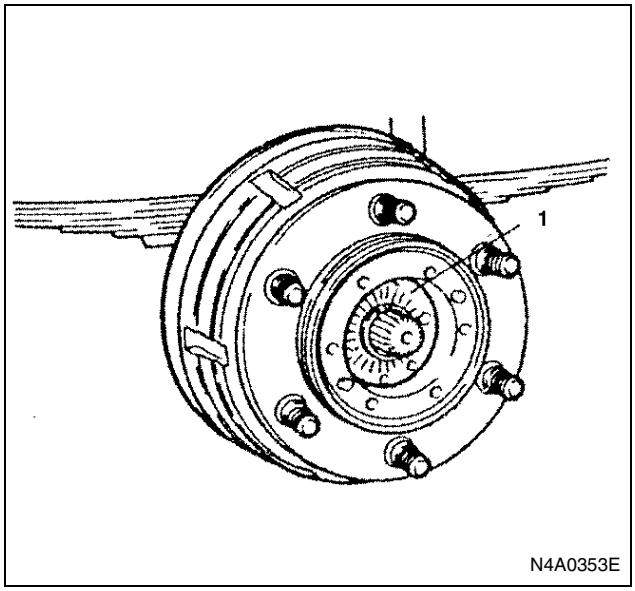
Apply the specified amount of the approved grease to the hub cavity, the outer bearing and the inner bearing.
Grease amount: 200 g (7.1 oz) per each side

8. Front Axle Hub Inner Bearing
   Install the inner bearing to the spindle.
9. Front Axle Hub Outer Bearing
   Install the outer bearing to the front hub assembly.
10. Front Hub and Brake Drum Assembly
11. Front Hub Bearing Lock Nut
    Install the hub bearing lock nut with (1) slits facing outside, and tighten provisionally.



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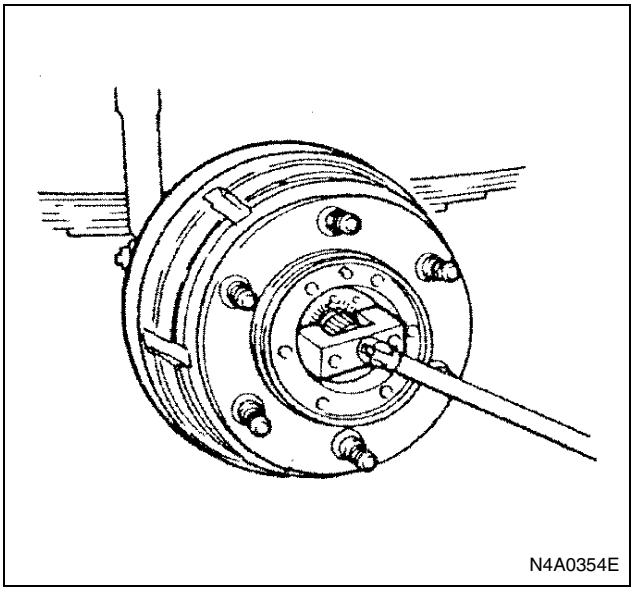
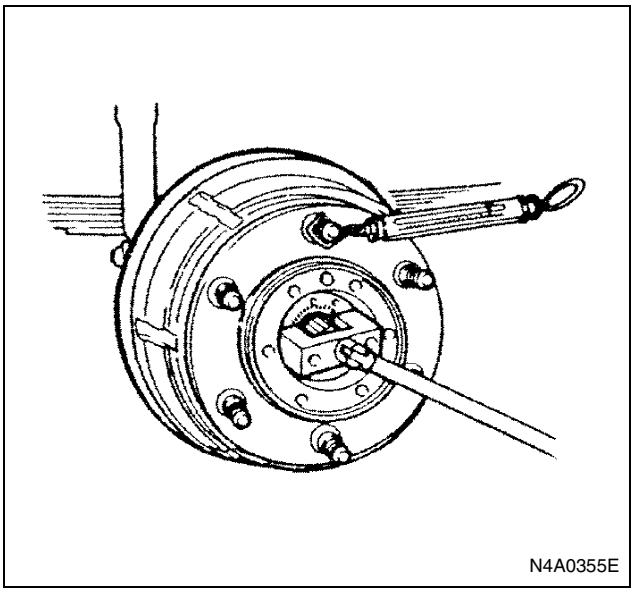
<Adjustment of Hub Bearing Preload>

1) Turn the hub to the left and right several times to establish bearing conformity.
2) Use the bearing nut wrench to tighten the bearing nut until the hub can not be manually rotated.
   Bearing Nut Wrench:5-8840-2182-0
3) Loosen the bearing nut until hub rotates easily.

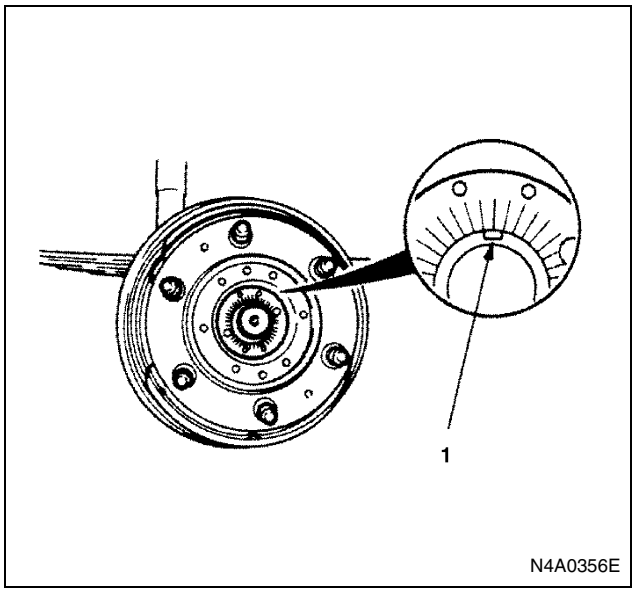

N4A0354E

4) Set the spring balancer to the wheel pin in the position shown in the illustration.
   Gradually retighten the nut until the hub bearing is adjusted to the specified preload.

Hub bearing preload,
New Hub bearing: 17 — 31 N·m (1.7 — 3.2 kg·m / 3.7 — 7.1 lb·ft)
Reused Hub bearing: 14 — 28 N·m (1.4 — 2.9 kg·m / 3.1 — 6.4 lb·ft)


N4A0355E

5) Rotate the hub several times to the right and left.
   Measure the bearing preload a second time.
6) Align the axle case groove (1) with the closest bearing nut slit.



N4A0356E

Notice:
If it is difficult to align the axle case and bearing nut, slightly tighten the bearing nut.

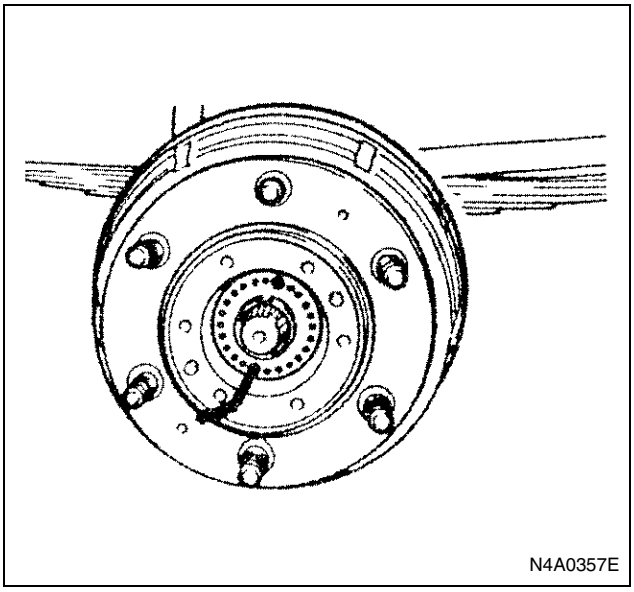
12. Front Hub Bearing Lock Washer
    Engage the lug of lock washer with a notch in the spindle.

    Apply adhesive (LOCTITE 242 or equivalent) to the threads of lock washer bolt, and tighten the hub bearing lock nut with lock washer.

Tighten:
Lock washer bolt to 10 N·m (1.0 kg·m / 87 lb·in)

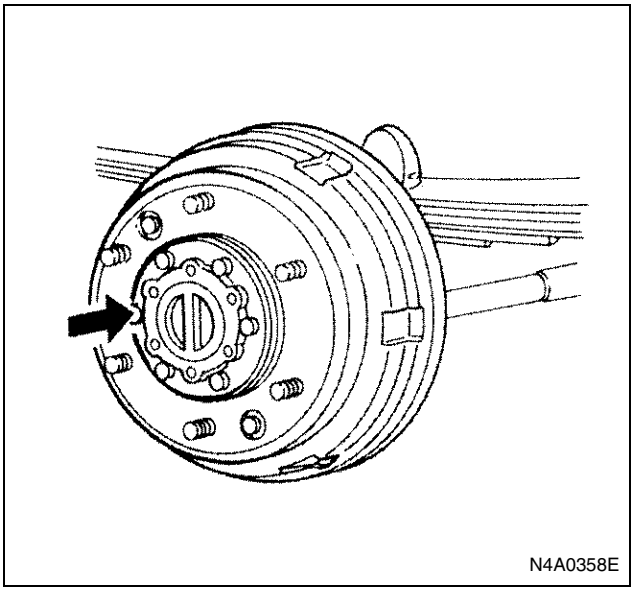
In order to ensure locking, equally spaced 48 slits are scribed on the hub bearing lock nut. The tapped holes in hub bearing lock nut will meet either hole in lock washer (two holes provided at symmetric position) if a slit of hub bearing lock nut is aligned with the notch center at the threads of spindle end.

Under this condition, tightening the bolts fix surely the hub bearing lock nut.


N4A0357E

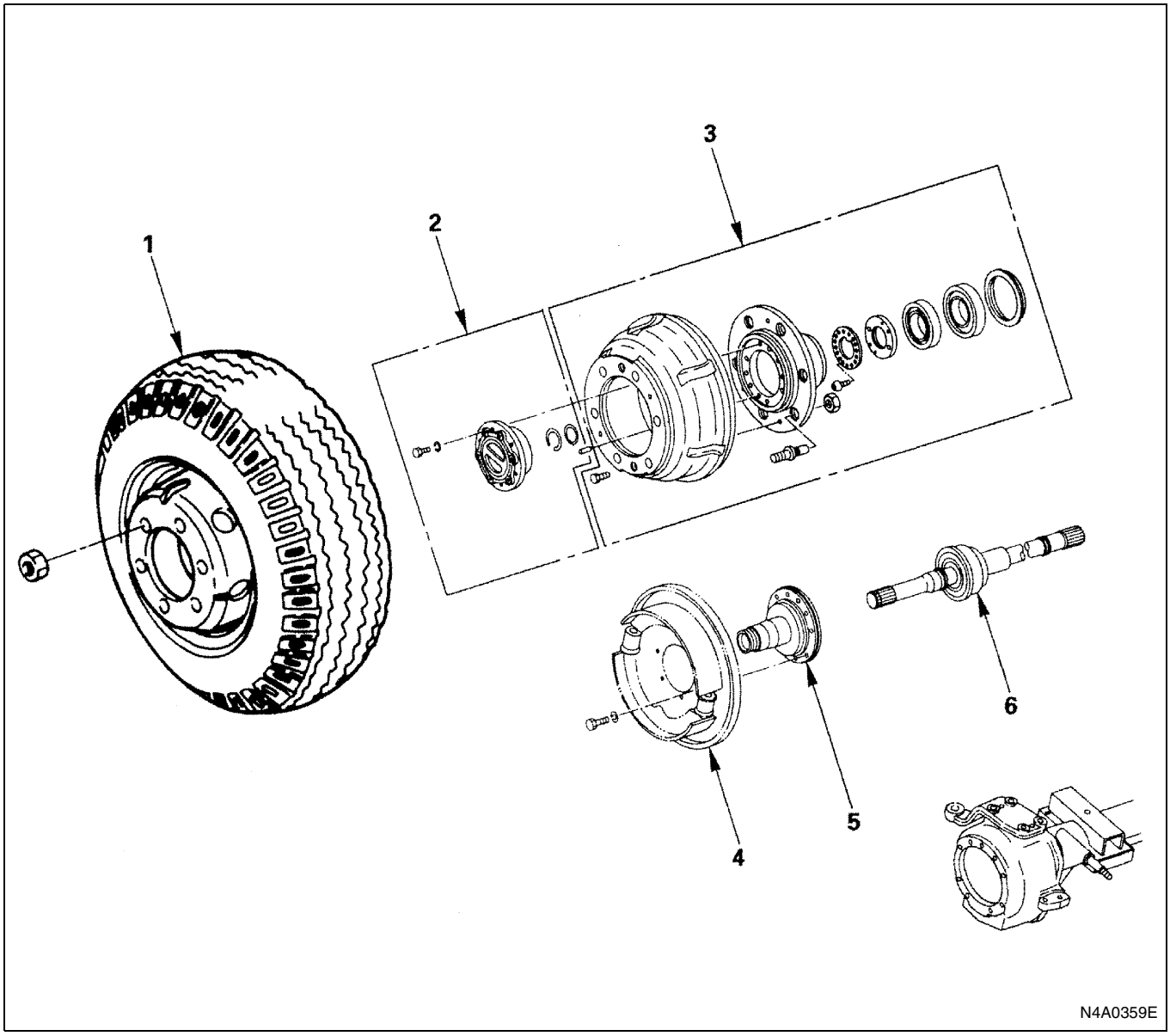
13. Front Locking Hub Set
    Refer to “FREE WHEEL HUB” previously in this section.

Tighten:
Front locking hub set bolt to 98 N·m (10.0 kg·m / 72 lb·ft)


N4A0358E

14. Wheel and Tire

Spindle and Drive Shaft (4 × 4 Model)



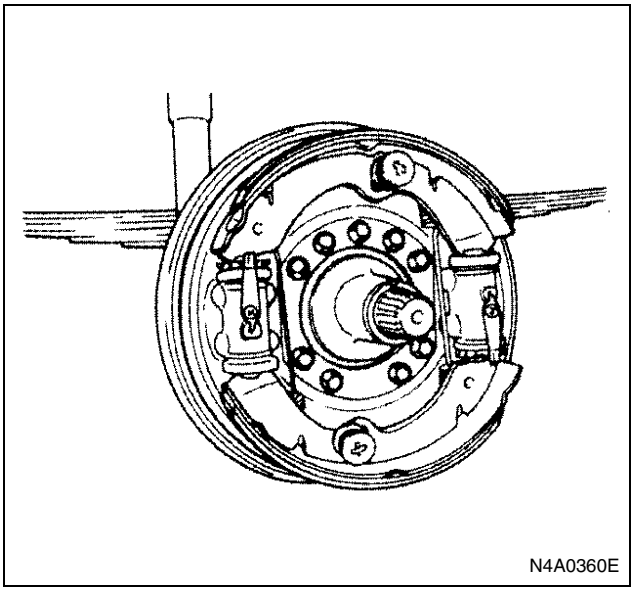
Legend

1. Wheel and tire
2. Front locking hub set
3. Front axle hub, brake drum and related parts
4. Front brake assembly
5. Spindle
6. Front drive shaft assembly

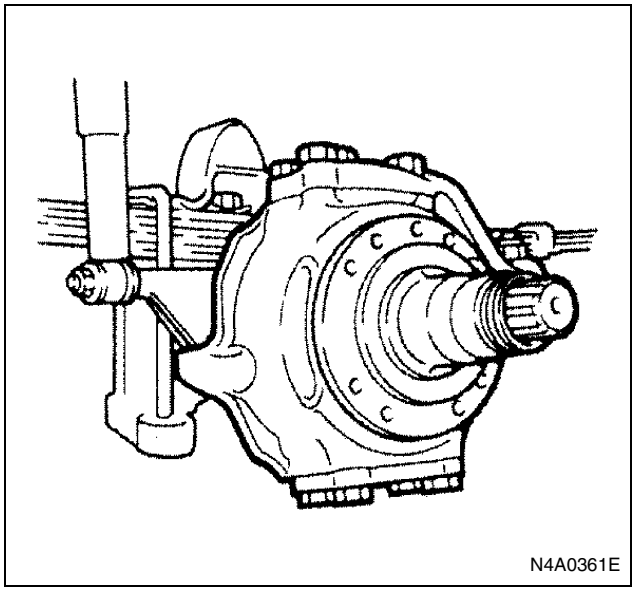
Removal

Preparation:
Jack up and support the vehicle on stands.

1. Wheel and Tire
2. Front Locking Hub Set
   Refer to “FREE WHEEL HUB” previously in this section.
3. Front Axle Hub, Brake Drum and Related Parts
   Refer to “FRONT HUB and BRAKE DRUM (4 × 4 Model)” previously in this section.
4. Front Brake Assembly
   1) Remove fixing bolts and front oil shield cover, then the brake assembly.
      The front oil shield cover, spindle and back plate are tightened together.
   2) Using a wire, sling the brake assembly to the frame to hold. At this time, take care not to damage or bend the brake hose.


N4A0360E

5. Spindle
   Hitting lightly the spindle end with a wood or plastic hammer, remove the spindle from knuckle.
   Do not use an iron hammer. Special care should be taken to protect the threads at the spindle end from damage.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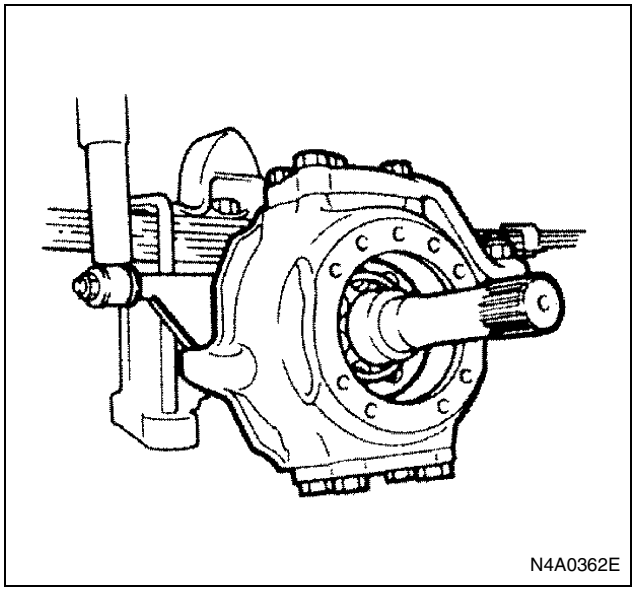
6. Front Drive Shaft Assembly
   Pull and remove the front drive shaft to your side.

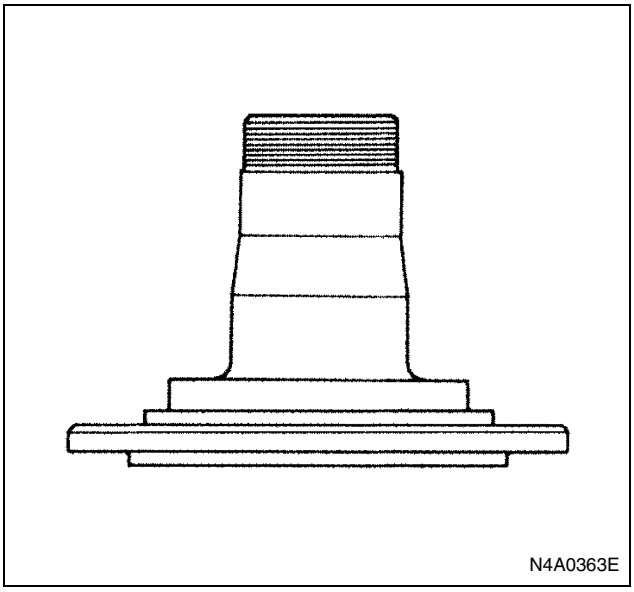

N4A0362E

Inspection and Repair

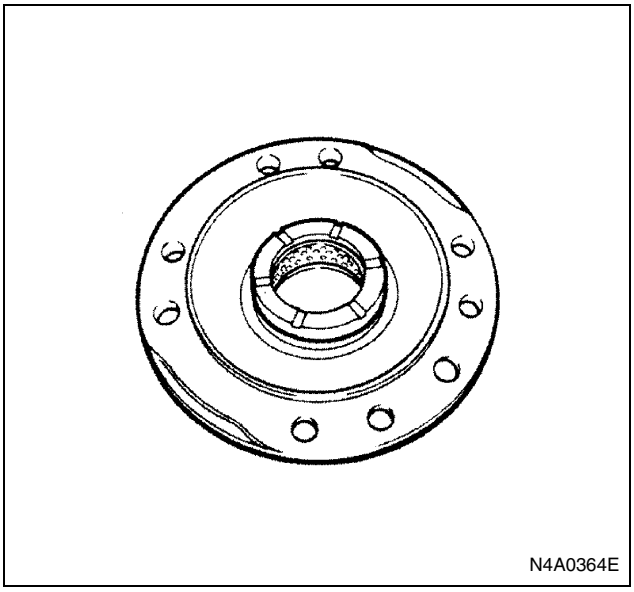
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Spindle

1. Inspect the whole of the spindle for crack, wear or damage.
   Replace the spindle if any abnormal condition is noticeable.
   Use a visible dye-penetrant flaw detection method or a magnetic flaw detector.

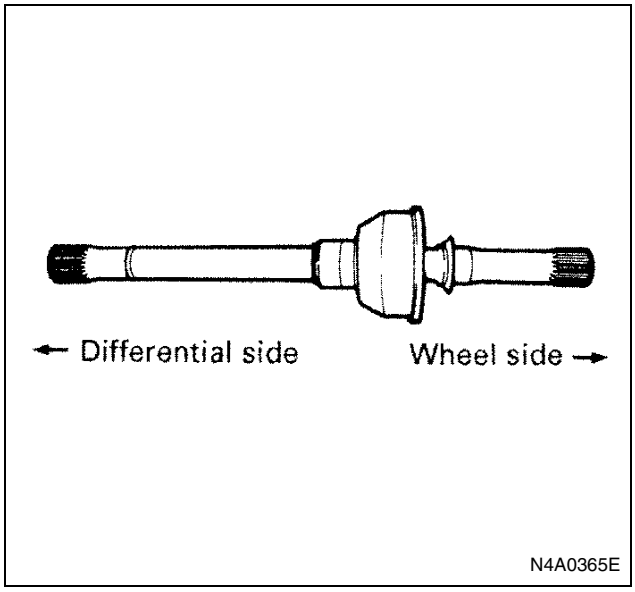

N4A0363E

2. Inspect the front axle shaft thrust washer or bushing for wear and damage.


N4A0364E

Front Drive Shaft Assembly

1. Inspect the front drive shaft for bending or distortion.



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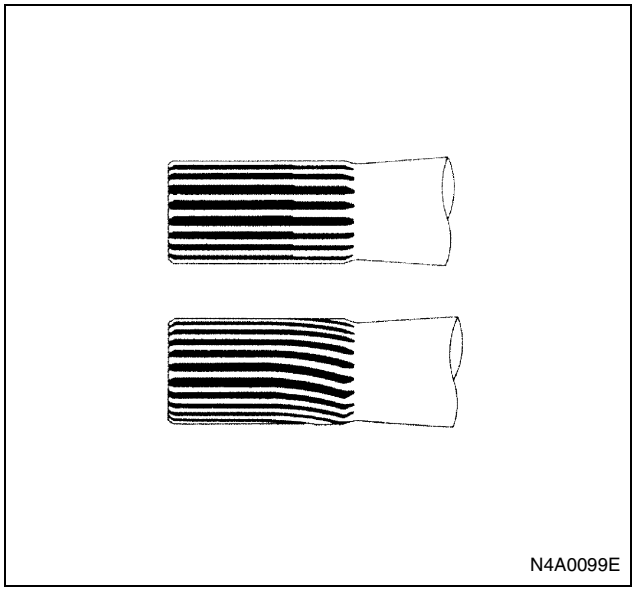
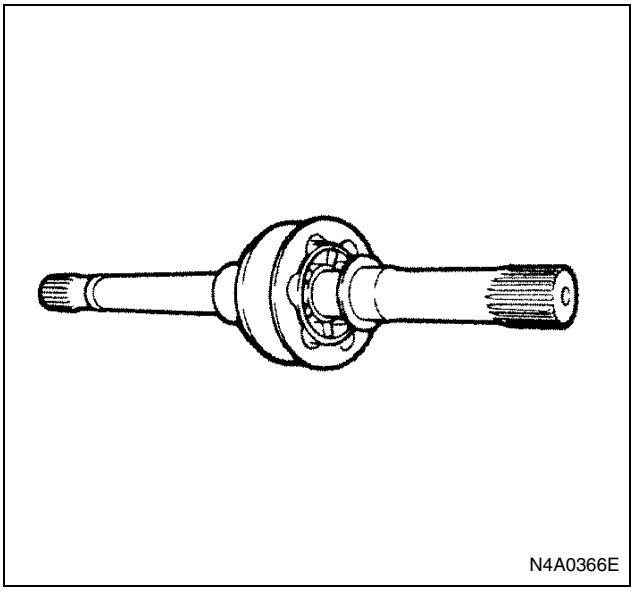
2. Inspect the front drive shaft spline for wear or distortion.
   Replace the front drive shaft assembly if wear or distortion is found.


N4A0099E

3. Inspect the stopper contact face (on the spindle's side) for wear or damage.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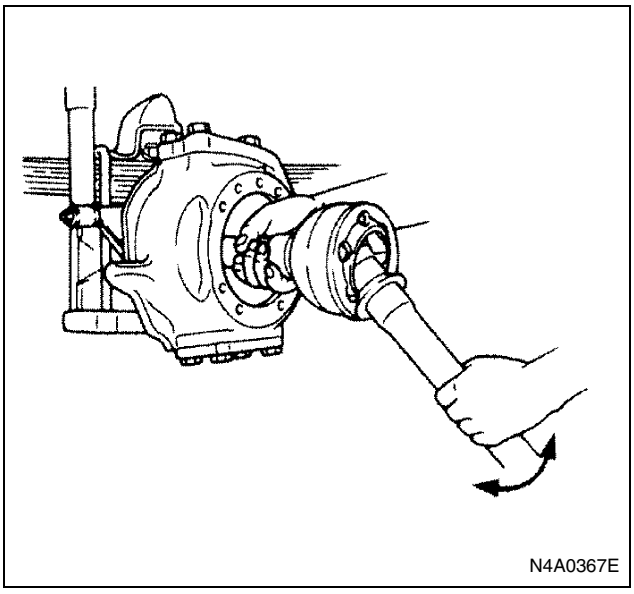
4. Moving the front drive shaft joint as shown, inspect for smooth operation or presence of excessive play.
   Replace the front drive shaft assembly if it does not move smoothly or there is excessive play.

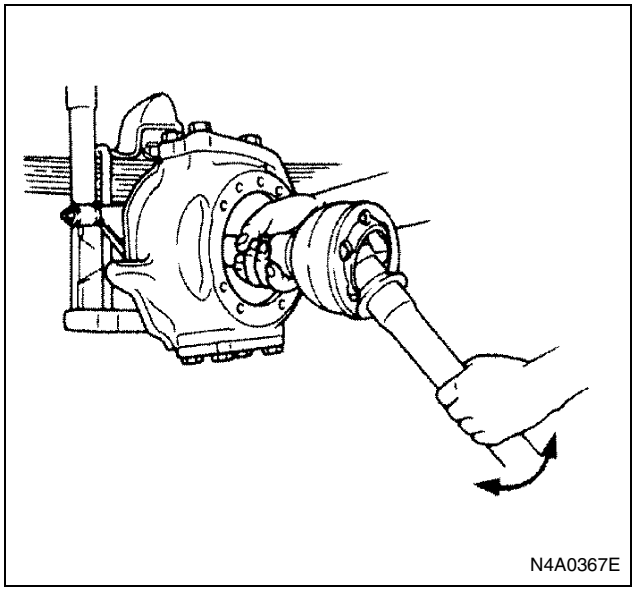

N4A0367E

Installation

1. Front Drive Shaft Assembly
   1) Apply the MoS2 contained type grease into the universal joint.

Grease amount: 94 — 106 g (3.3 — 3.7 oz)

   2) Install the front drive shaft assembly into the front axle case.
      During installation, take care not to damage the oil seal lip on the front axle case side.
      To install, bend the front drive shaft as shown, and moving the shaft a little to the left or right, push it into the spline on the differential side gear.

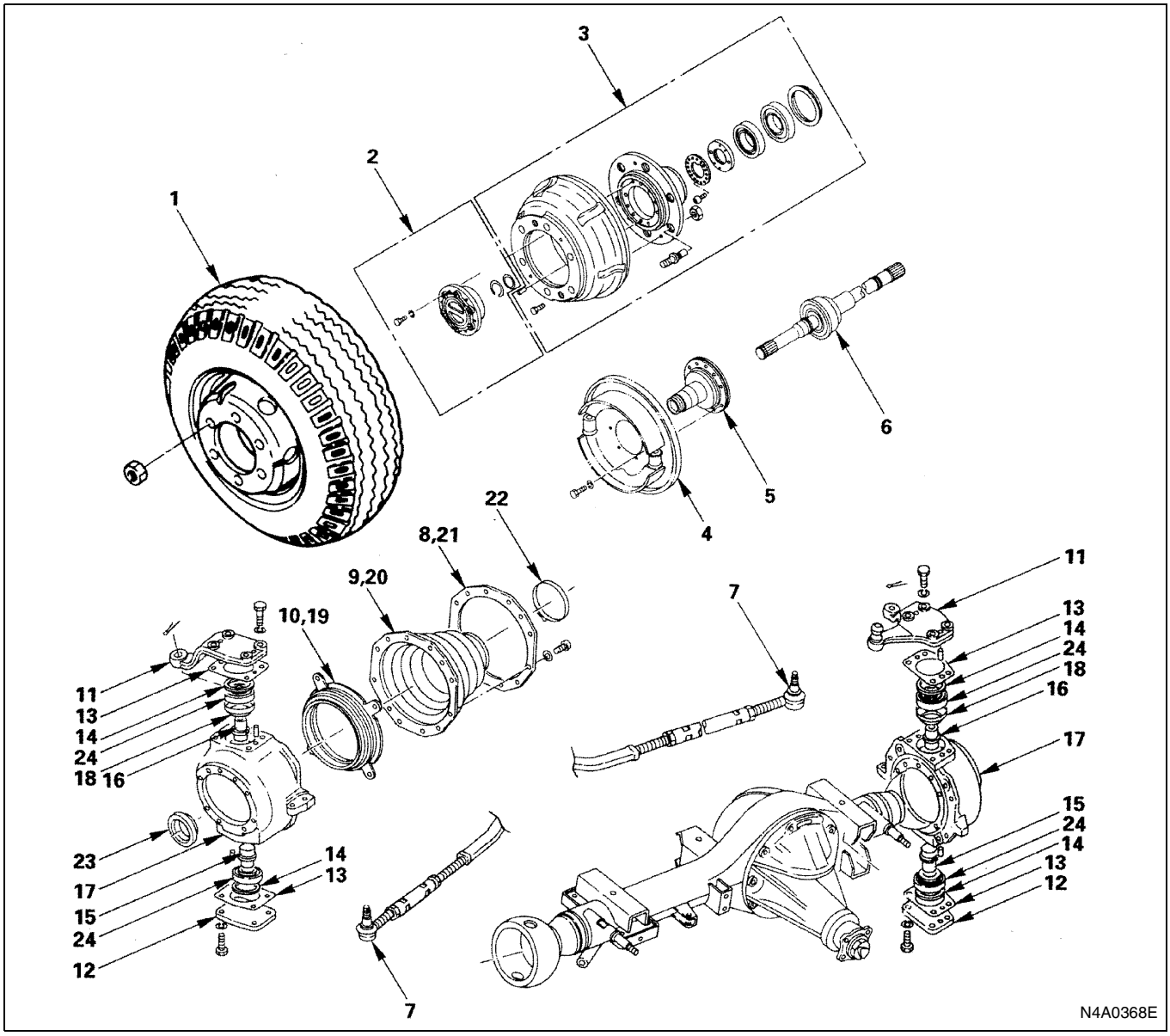

N4A0367E

2. Spindle
   1) Apply MoS2 contained type grease to the surfaces of the thrust washer and bushing of spindle.
   2) Apply adhesive (LOCTITE 515 or equivalent) to the spindle flange, and install the spindle to the knuckle. At this time, a bolt hole of the spindle should be met with that of knuckle.
3. Front Brake Assembly
   1) Install the front oil shield cover with a cut in outer surface facing inside.
   2) Apply adhesive (LOCTITE 242 or equivalent) to the threads of fixing bolts and tighten them to the specified torque.

Tighten:
Front brake assembly fixing bolt to 98 N·m (10 kg·m / 72 lb·ft)

4. Front Axle Hub, Brake Drum and Related Parts
   Refer to “FRONT HUB and BRAKE DRUM (4 × 4 Model)” previously in this section.
5. Front Locking Hub Set
   Refer to “FREE WHEEL HUB” previously in this section.
6. Wheel and Tire

Knuckle and King Pin (4 × 4 Model)



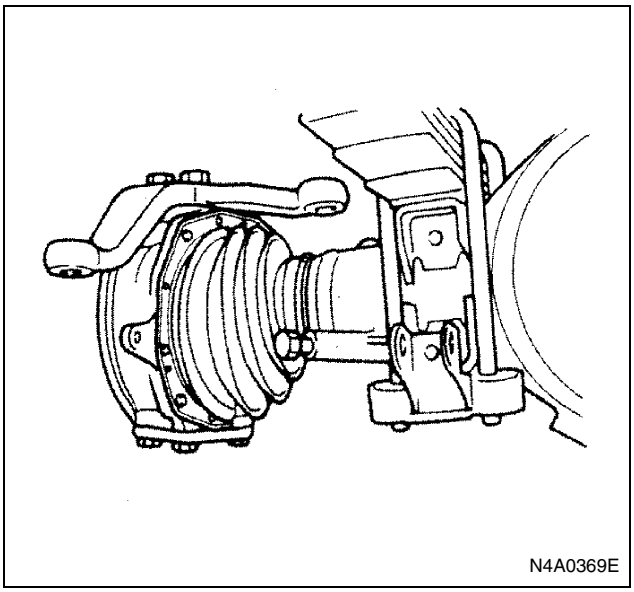
Legend

1. Wheel and tire
2. Front locking hub set
3. Front axle hub, brake drum and relative parts
4. Front brake assembly
5. Spindle
6. Front drive shaft assembly
7. Tie rod end
8. Front axle tube end boot holder
9. Front axle tube end boot
10. Knuckle oil seal
11. Knuckle arm and tie rod arm
12. King pin cover
13. King pin bearing shim
14. Bearing distance collar
15. Front axle lower king pin
16. Front axle upper king pin
17. Front axle knuckle
18. King pin receiver
19. Knuckle oil seal
20. Front axle tube end boot
21. Front axle tube end boot holder
22. Front axle tube end boot band
23. Front axle shaft oil seal
24. King pin bearing

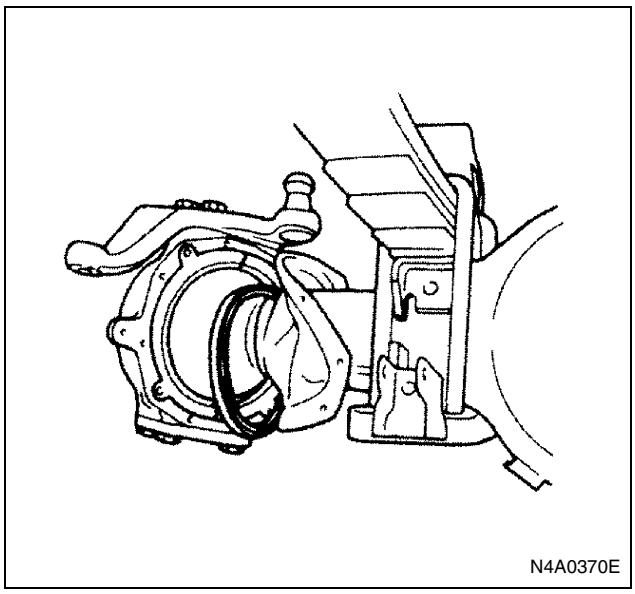
Removal

Preparation:
Jack up and support the vehicle on the stands.

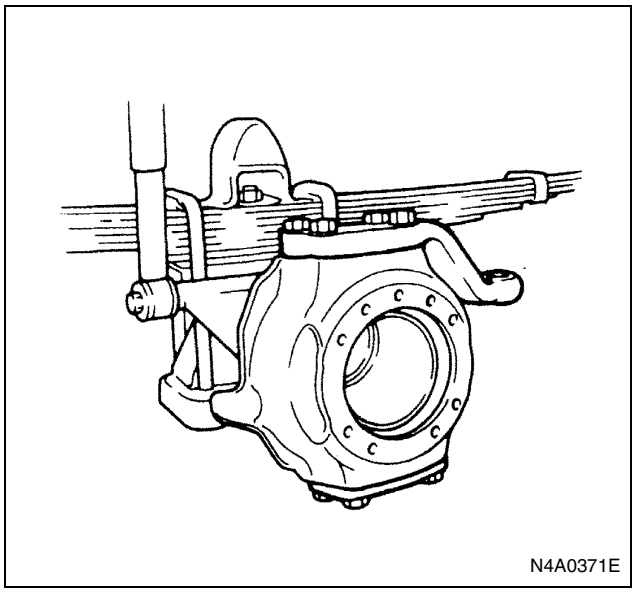
1. Wheel and Tire
2. Front Locking Hub Set
   Refer to “FREE WHEEL HUB” previously in this section.
3. Front Axle Hub, Brake Drum and Relative Parts
   Refer to “FRONT HUB and BRAKE DRUM (4 × 4 Model)” previously in this section.
4. Front Brake Assembly
5. Spindle
6. Front Drive Shaft Assembly
7. Tie Rod End
8. Front Axle Tube End Boot Holder
   Remove the front axle tube end boot holder at the back of knuckle. (The front axle tube end boot holder is divided into two pieces in horizontal directions.)
9. Front Axle Tube End Boot
   Remove the front axle tube end boot fixing bolts, and peel and shift the boot toward the differential.


N4A0369E

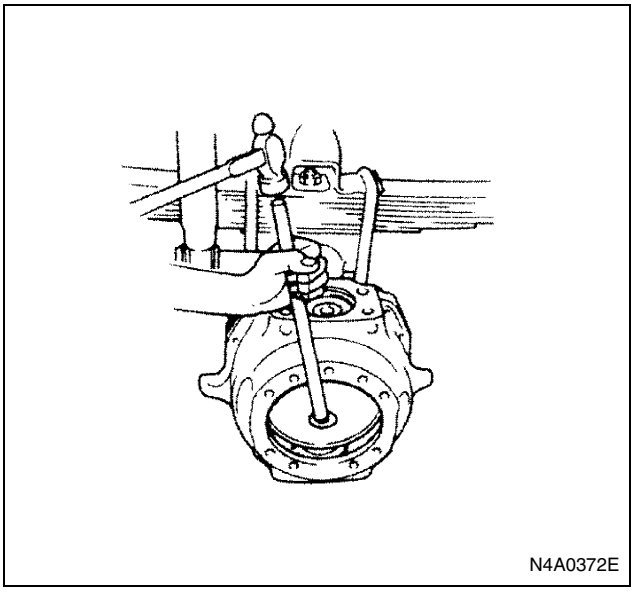
10. Knuckle Oil Seal
    1) Remove the outer side of oil seal holder. (The oil seal holder outer is divided into two pieces in vertical direction.)
    2) Shift the oil seal toward the front axle tube end boot (on Differential side).
    3) Remove the inner side of oil seal holder. (The oil seal holder inner is divided into two pieces in horizontal direction.)


N4A0370E

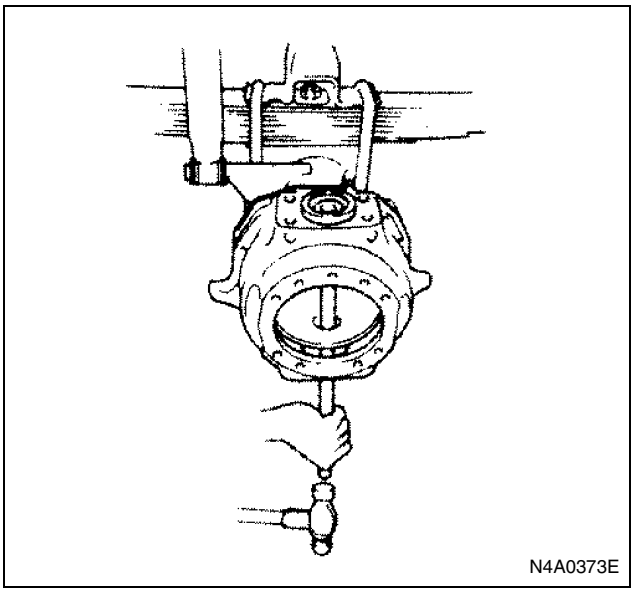
11. Knuckle Arm and Tie Rod Arm
12. King Pin Cover
13. King Pin Bearing Shim
    Confirm the quantity of shims and components when removing the knuckle arm, tie rod arm and king pin cover.


N4A0371E

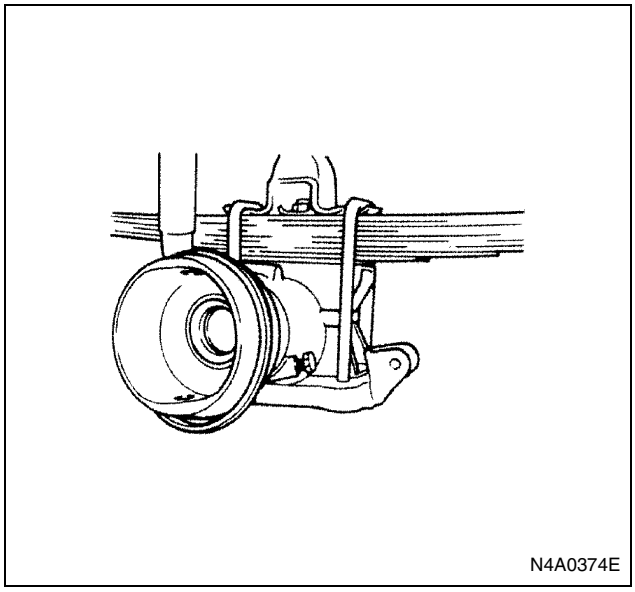
14. Bearing Distance Collar
15. Front Axle Lower King Pin
    Attach a bar to the center recess of king pin from tube end (spherical part) of front axle case, and hit with a hammer to remove the king pin downward.


N4A0372E

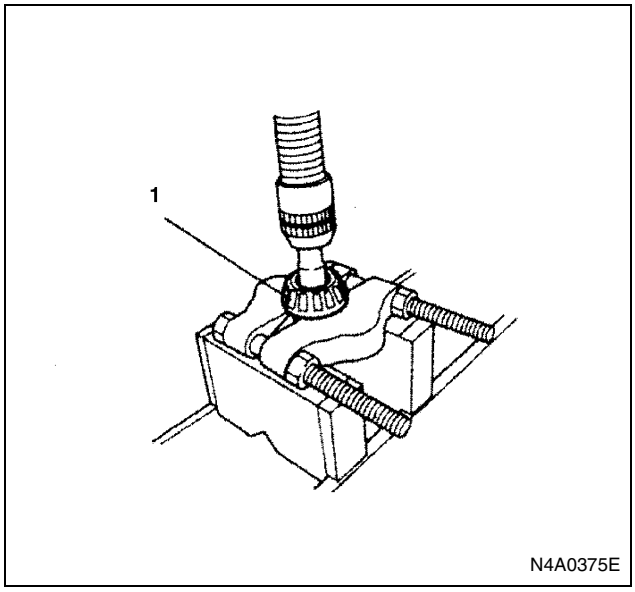
16. Front Axle Upper King Pin
17. Front Axle Knuckle
    1) From under the knuckle, hit a bar attached to the upper king pin to remove the outer race of king pin bearing first.
    2) At this time, support the knuckle with both hands and raise it to remove to your side.
    3) Again hit the king pin to remove.


N4A0373E

18. King Pin Receiver
19. Knuckle Oil Seal
    Remove the oil seal from the front axle case.
    At this time, make sure the direction of oil seal.


N4A0374E

20. Front Axle Tube End Boot
21. Front Axle Tube End Boot Holder
22. Front Axle Tube End Boot Band
    Loosen and remove the tube end boot band.
    Avoid frequent removal of tube end boot band except when it is to be replaced or removal is necessary for servicing.
23. Front Axle Shaft Oil Seal
    The oil seal must not be reused.
24. King Pin Bearing
    Remove the bearing with a press.
    Some components are different between upper and lower king pin bearings (1), and do not confuse them.



N4A0375E

Inspection and Repair

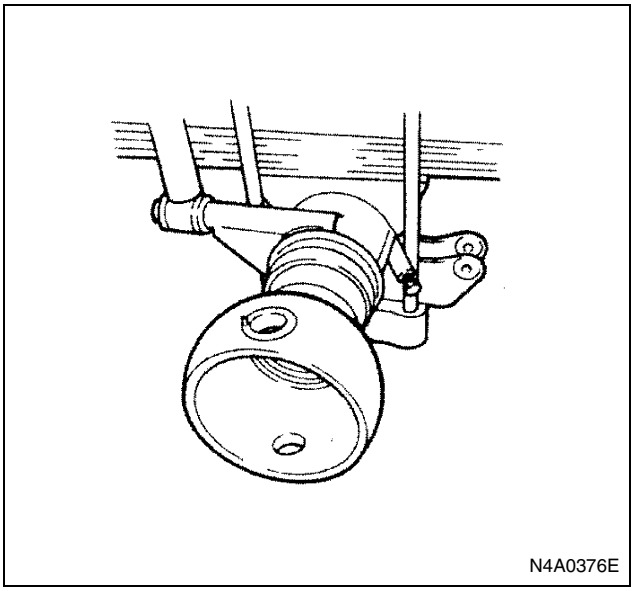
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Front Axle Tube End

Inspect the front axle case tube end sphere for crack, wear, damage or rust. Slight rust of sphere should be polished with a sand paper.

To check the tube end sphere for crack, use a red-check or a magnetic flaw detector.

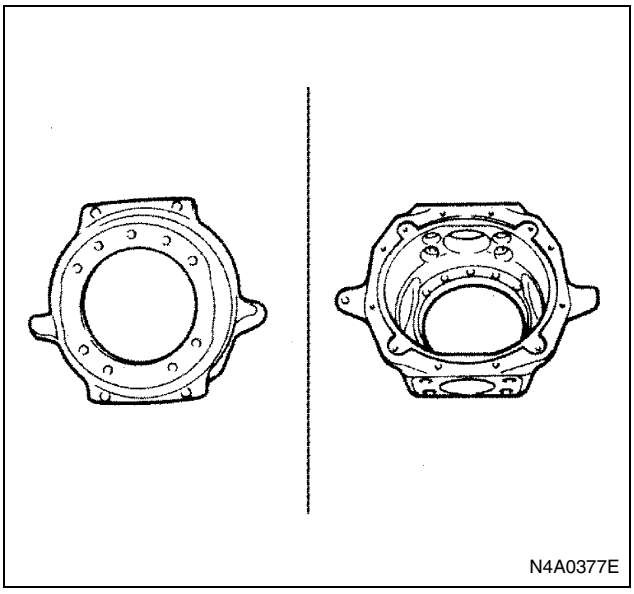
If a crack is found, replace the front axle case assembly.



Front Axle Knuckle

Inspect the whole of the knuckle for cracks, wear or damage using a magnetic flaw detector or red-check.

Replace the knuckle if any abnormal condition is noticeable.



King Pin

Inspect the king pin for cracks.

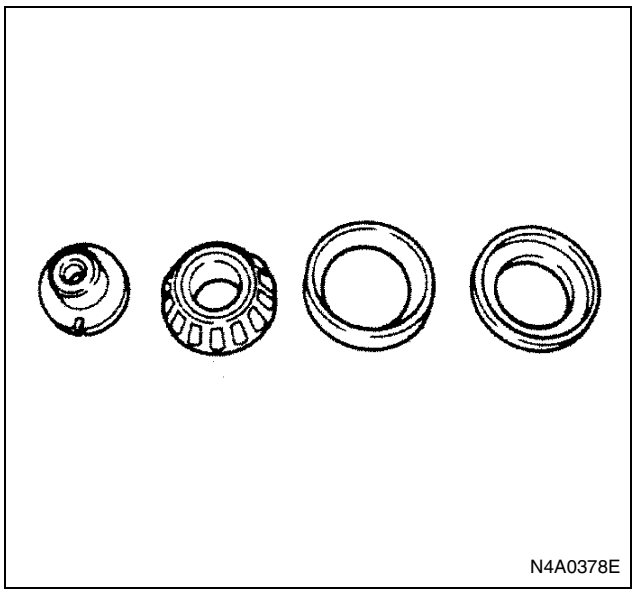
Use a magnetic flaw detector or red-check.

Replace king pin, if any cracks are found.

King Pin Bearing

Inspect the bearing for wear, seizure, damage and rough rotation.

Replace any flawed or damaged bearing.



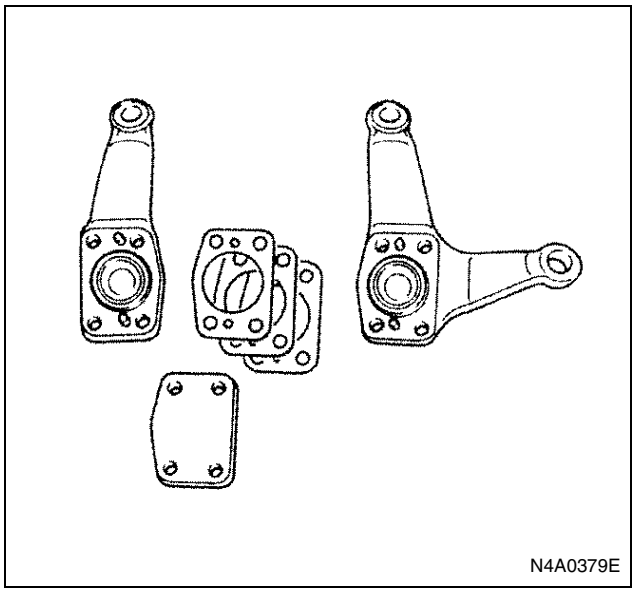
Knuckle Arm
Tie Rod Arm
King Pin Cover

Inspect the knuckle arm, tie rod arm and king pin cover for cracks, damage or wear.

Replace the these parts if any abnormal condition is noticeable.

To check the arm for crack, use a visible dye-penetrant flaw detection method or a magnetic flaw detector.

Replace the arm if a crack is found.

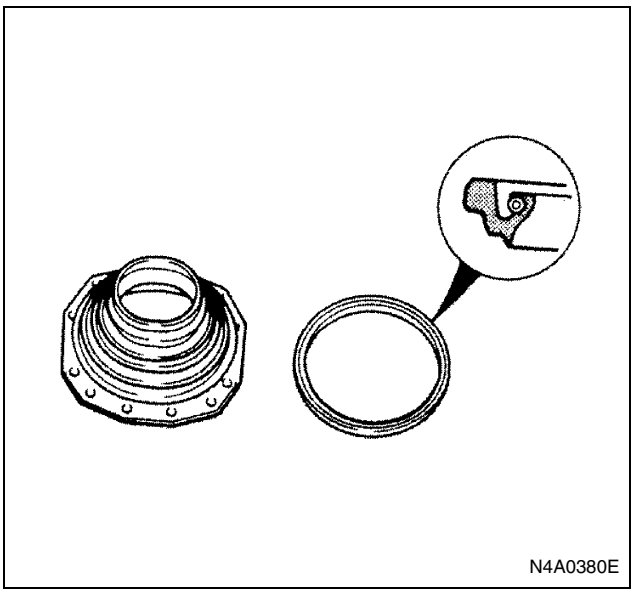


Front Axle Tube End Boot

Inspect the front axle tube end boot and replace if broken. It should be replaced if even one hole or crack is found.

Oil Seal

Inspect the oil seal, and replace it if its lip is damaged, worn or hardened.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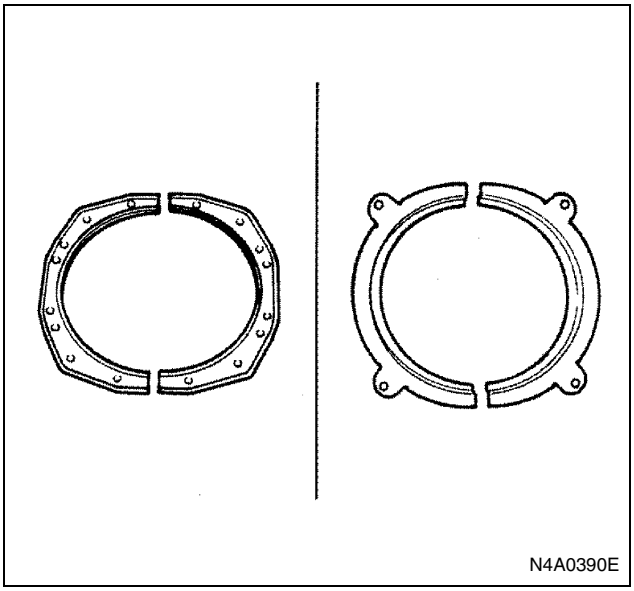
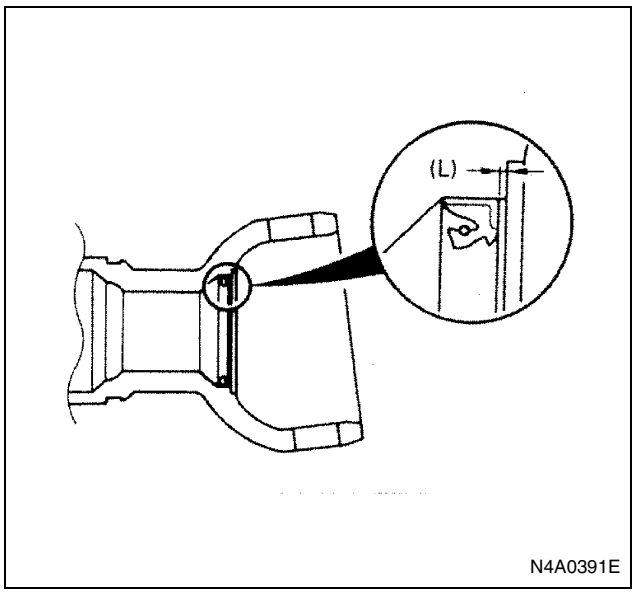
Front Axle Tube End Boot Holder, Oil Seal Holder
Inspect the oil seal holder and front axle tube end boot holder, and replace if excessive deformation or rust is found.


N4A0390E

Installation

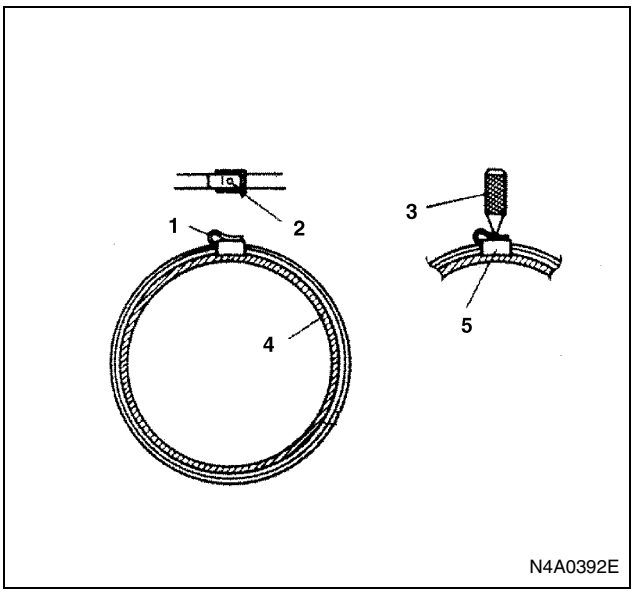
1. Front Axle Shaft Oil Seal
   1) Drive in the oil seal to the dimension as shown. Take care not to damage the oil seal lip.
   2) Apply grease (Multipurpose type) to the oil seal lip.

Oil seal drive in depth (L): 0 — 0.5 mm (0 — 0.020 in)



N4A0391E

2. Front Axle Tube End Boot Holder
3. Front Axle Tube End Boot
   1) Apply gear oil GL-5 grade (SAE90) to the entire surface of front axle tube end sphere.
   2) Warm the front axle tube end boot to 70 — 80°C with hot water.
   3) Reverse the front axle tube end boot, and install into the front axle case. During this work, do not touch the front axle tube end boot by bear hand because it is too hot.
   4) After installation in the front axle case, remove the moisture immediately.
   5) Return the front axle tube end boot to original form, and insert the leading end of boot into the front axle tube end boot groove of the front axle case.
4. Knuckle Oil Seal
5. Front Axle Tube End Boot Band
   1) Fix the boot with front axle tube end boot band. Wind the front axle tube end boot band twice and tighten it up to eliminate looseness.
   2) Then, calk the center of fitting on the front axle tube end boot band with a punch.
   3) Turn back the front axle tube end boot band at the fitting, and again calk the center of front axle tube end boot band.
   4) Cut the front axle tube end boot band at the end face of fitting.



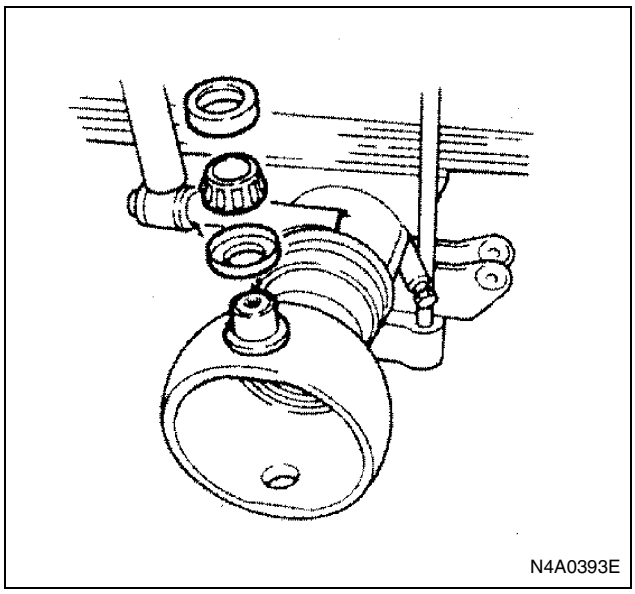
Legend

1. Bend
2. Calking point
3. Punch
4. Front axle tube end boot
5. Fitting

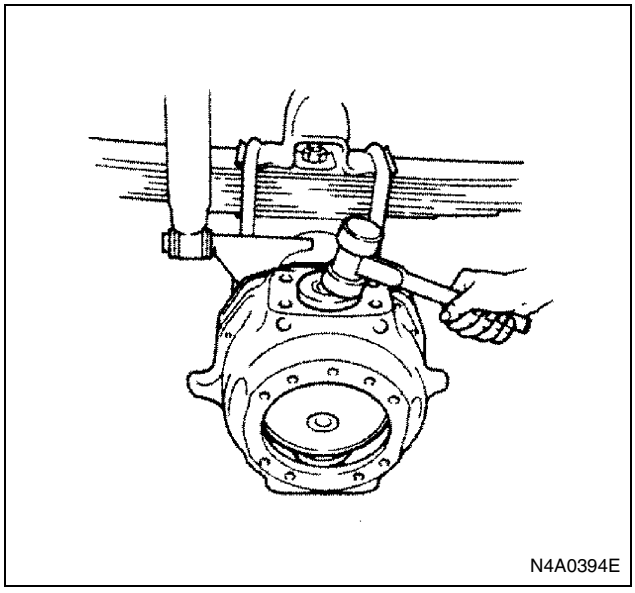
Install the oil seal to the front axle. (Apply Multipurpose type grease, to the entire surface of oil seal, and install it with care not to damage the oil seal lip.

In installing the oil seal, position the spring side on the differential side.)

6. Front Axle Upper King Pin
7. Front Axle Lower King Pin
   1) Seal multi-purpose grease NLGI No.2 in the king pin bearing.
   2) Install only the king pins (both upper and lower) in the front axle case.
   3) Align the locking groove of the king pin with the locking pin on the front axle tube end surface, and then drive in the king pin.



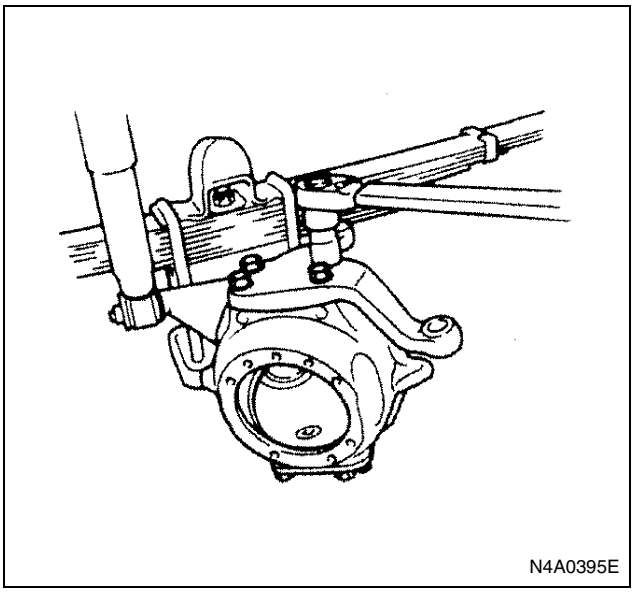
8. King Pin Receiver
9. King Pin Bearing
   Install the king pin bearing to the king pin. For the upper side, install the receiver, king pin bearing in this order.
10. Front Axle Knuckle
    1) Install the knuckle to the front axle. (Holding the knuckle with both hands, align the upper hole of knuckle to the upper king pin bearing and lower it slowly while passing the lower king pin bearing.)
    2) Install upper and lower king pin bearing outer races. (Fit the king pin bearing outer race completely with the knuckle, and hit lightly the outer race until it gets stuck.)



11. Bearing Distance Collar
12. King Pin Bearing Shim
13. King Pin Cover
14. Knuckle Arm and Tie Rod Arm

1) Install the knuckle arm (or tie rod arm) and the king pin cover. (Install the distance collar and shim in this order. Then, install knuckle arm (or tie rod arm) and the king pin cover and fix provisionally with bolts. Use the number of shims that were removed previously, and tighten the bolts lightly. At this time, do not apply LOCTITE to the shims, arms and king pin cover yet.
2) Tighten the bolts on knuckle arm (or tie rod arm) and king pin cover to the specified torque while turning the knuckle to the left and right several times to run-in the king pin bearing.

Tighten:
Knuckle arm, tie rod arm and king pin cover bolt to147 N·m (15 kg·m / 108 lb·ft)


N4A0395E

<Adjustment of Front Axle Knuckle Preload>

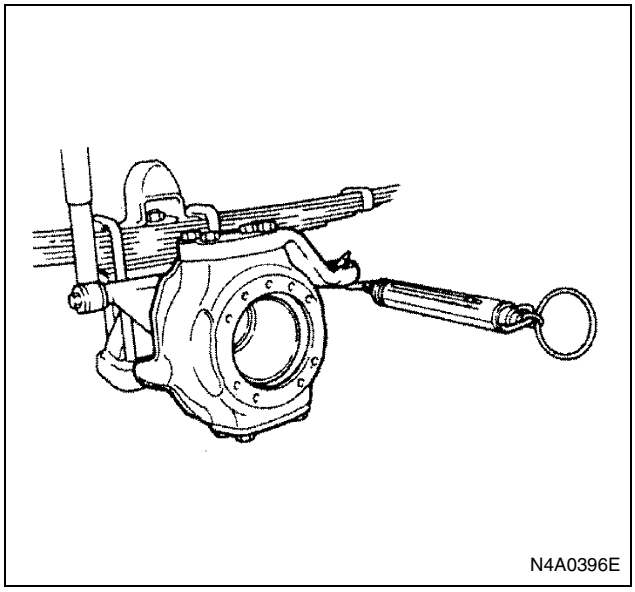
1) Hook a spring balance to the edge of knuckle arm (or tie rod arm), and pull it in tangential direction to check if the spring balance reading at the start of movement is within the standard range.
(Measure preload in tangential direction.)

Front axle knuckle preload, 3.1 — 5.5 N (6.8 — 12.1 kg / 30.4 — 53.9 lb)

2) If it does not satisfy the standard, adjust with shims.

Shim thickness available: 0.3 mm (0.01 in)

3) After adjustment, measure the preload again.


N4A0396E

<Tighten completely the knuckle arm (or tie rod arm) and king pin cover>

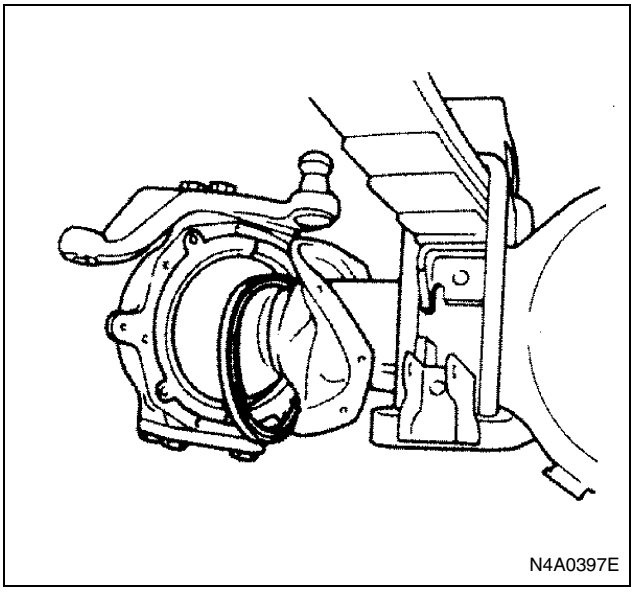
1) Remove each arm and king pin cover once, and apply adhesive (LOCTITE 515 or equivalent) to the shims, each arm and king pin cover evenly.
2) Tighten fixing bolts to the specified torque.

Tighten:
Knuckle arm, tie rod arm and king pin cover bolt to147 N·m (15 kg·m / 108 lb·ft)

3) Reconfirm the preload.
If it is out of standard, readjust by repeating the above steps.

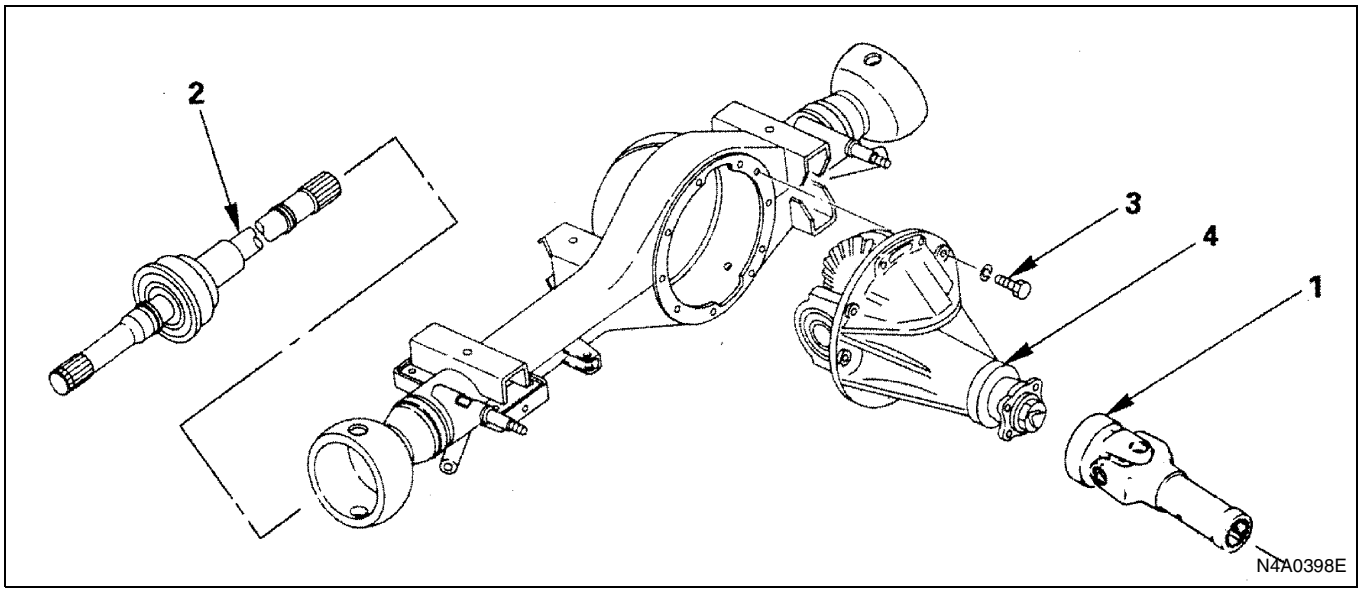
15. Knuckle Oil Seal
    1) Install the inner oil seal holder to the knuckle.
    Install the inner oil seal holder in longitudinal direction.
    2) Install the oil seal, then the outer oil seal holder.
    Install the outer oil seal holder in vertical direction (a mating face should be shifted 90° against the inner holder).
16. Front Axle Tube End Boot
17. Front Axle Tube End Boot Holder
    Install the front axle tube end boot, and tighten bolts to the specified torque via the front axle tube end boot holder.
    Install the front axle tube end boot holder in longitudinal direction.

Tighten:
Front axle tube end boot holder bolt to 6 N·m (0.6 kg·m / 52 lb·ft)


N4A0397E

18. Tie Rod End
19. Front Drive Shaft Assembly
20. Spindle
21. Front Brake Assembly
22. Front Axle Hub, Brake Drum and Relative Parts
    Refer to “FRONT HUB and BRAKE DRUM (4 × 4 Model)” previously in this section.
23. Front Locking Hub Set
    Refer to “FREE WHEEL HUB” previously in this section.
24. Wheel and Tire

Front Differential Assembly (4 × 4 Model)



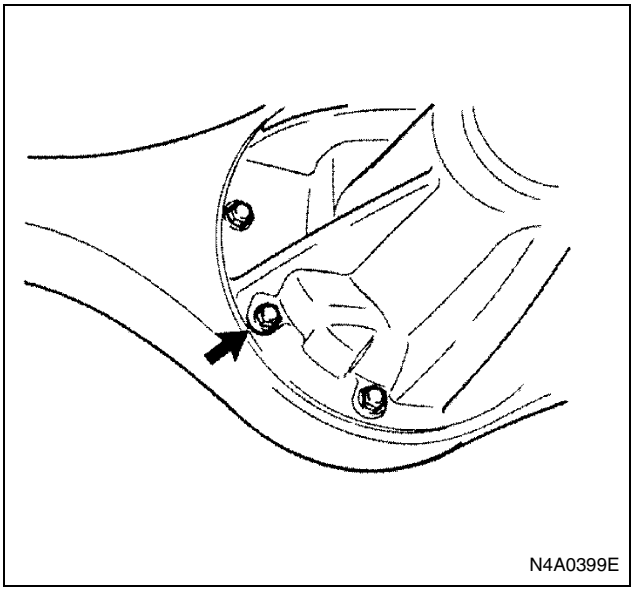
Legend

1. Propeller shaft assembly
2. Front drive shaft assembly
3. Front axle case bolt
4. Front differential assembly

Removal

Support the front axle with a suitable jack and chassis stands.
Drain the front axle case by removing the drain plug on the lower part of the front axle case.

1. Propeller Shaft Assembly
   Remove the propeller shaft assembly.
2. Front Drive Shaft Assembly
   Refer to “Spindle and Drive Shaft” previously in this section.
3. Front Axle Case Bolt
   Put jack under the center of front axle then remove the front axle case bolts.
4. Front Differential Assembly
   Remove the front differential assembly from the front axle case.



Installation

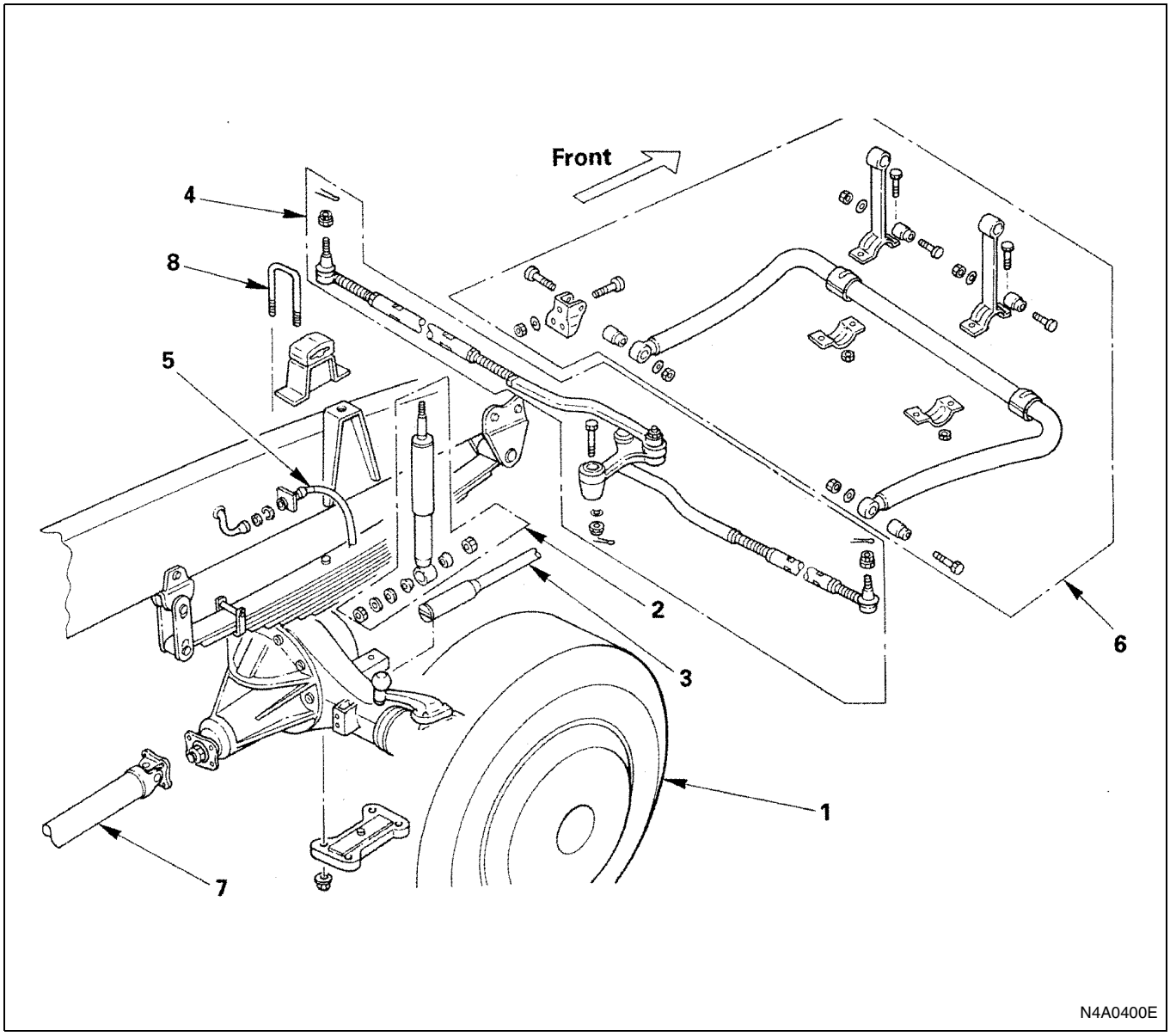
1. Front Differential Assembly
   Clean the faces of the front axle case and the final drive carrier.
   Apply the recommended liquid gasket (Three Bond 1215 or its equivalent) to the sealing side of the front axle case and the final drive carrier.
2. Front Axle Case Bolt
   Attach the front final drive assembly to the front axle case and tighten the bolts.

Tighten:
Front axle case bolt to 67 N·m (6.8 kg·m / 49 lb·ft)

3. Front Drive Shaft Assembly
4. Propeller Shaft Assembly
   Fill the axle case with hypoid gear lubricant to just below the filler hole.

Lubricant capacity, 2.7 liter (2.9 US qt / 2.4 Imp qt)

Front Axle Assembly (4 × 4 Model)



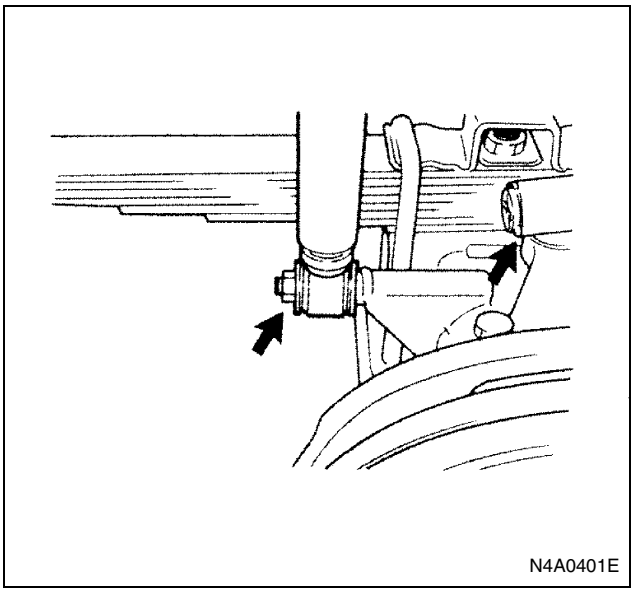
Legend

1. Wheel and tire
2. Shock absorber
3. Drag link
4. Tie rod assembly
5. Brake flexible hose
6. Stabilizer assembly
7. Front propeller shaft
8. Leaf spring U-bolt

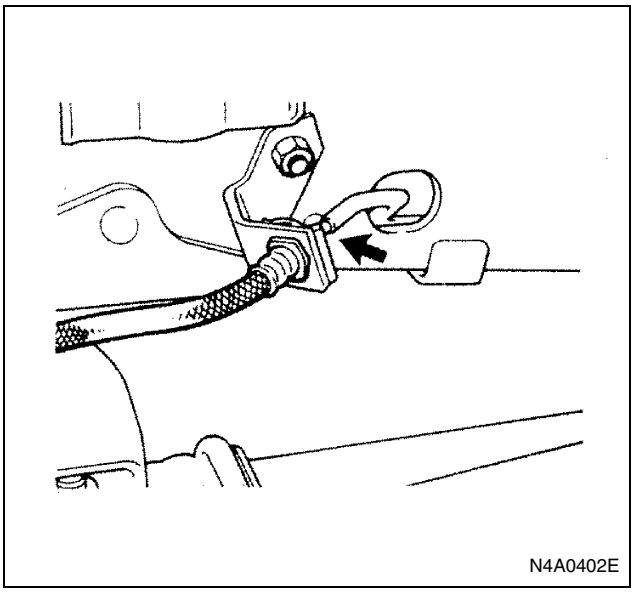
Removal

Preparation:
Jack up and support the vehicle on stands.

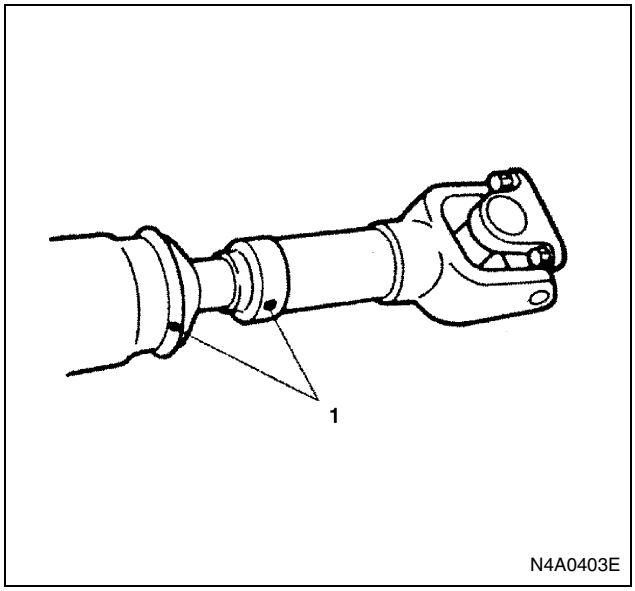
1. Wheel and Tire
2. Shock Absorber
   Remove lower side of shock absorber.


N4A0401E

3. Drag Link
   Remove the drag link (on the knuckle arm side).
4. Tie Rod Assembly
   Remove the tie rod assembly (with relay lever attached). Refer to STEERING LINKAGE (4 × 4 Model) in section 3B.
5. Brake Flexible Hose
   Remove a clip on the brake hose bracket.
   After the hose is disconnected, prevent brake fluid running out and invasion of foreign matters.

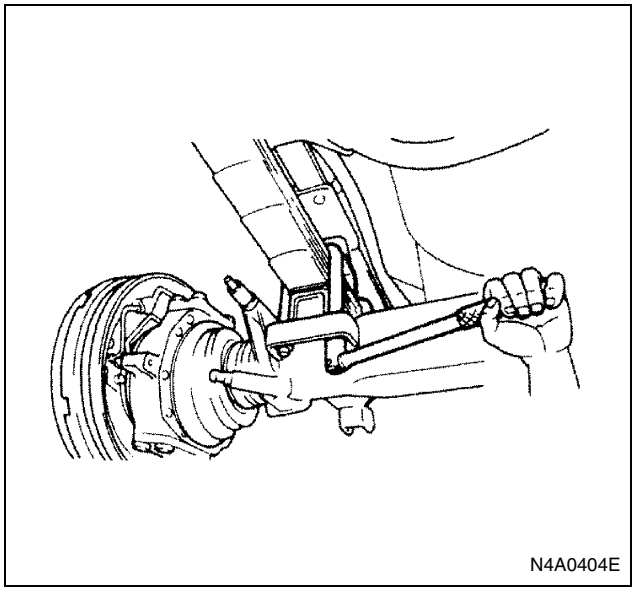

N4A0402E

6. Stabilizer Assembly
   Refer to STABILIZER in section 3C.
7. Front Propeller Shaft
   Draw setting marks (1) on the front and rear flanges.
   Also, draw setting marks as shown if the propeller shaft is removed at the spline yoke.



N4A0403E

8. Leaf Spring U-Bolt
   1) Put jack under the center part of front axle then remove the U-bolts.
   2) Lower the front axle assembly and roll out toward the front of vehicle.
      Use care so as not to cause damage to brake hose, back plate and front axle tube end boot.

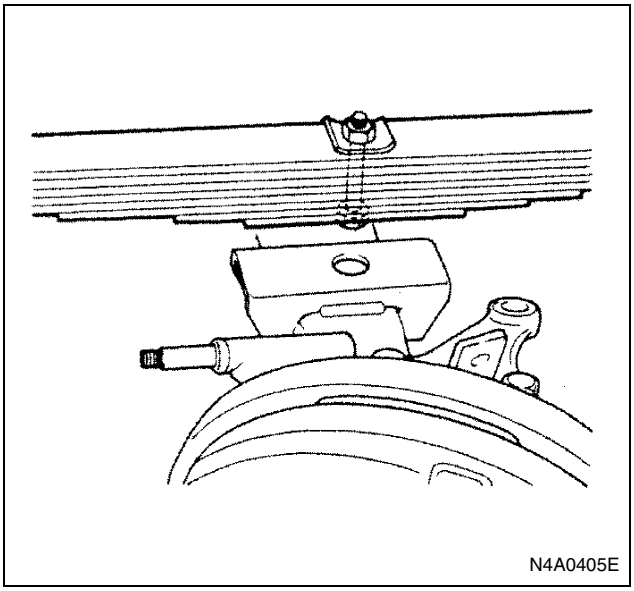

N4A0404E

9. Front Axle Assembly

Installation

1. Front Axle Assembly
2. Leaf Spring U-Bolt
   Align a hole in the center of spring seat in the front axle case with the center bolt of leaf spring, and tighten the leaf spring U-bolt.

Tighten:
U-bolt nut to 126 N·m (12.9 kg·m / 93 lb·ft)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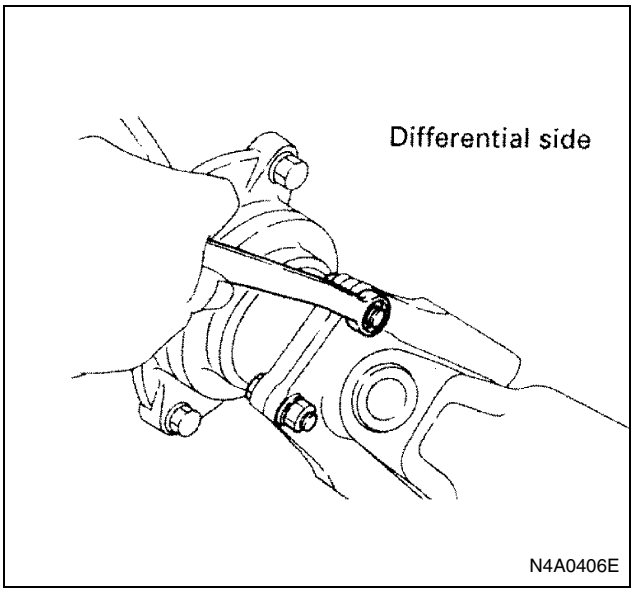
3. Front Propeller Shaft

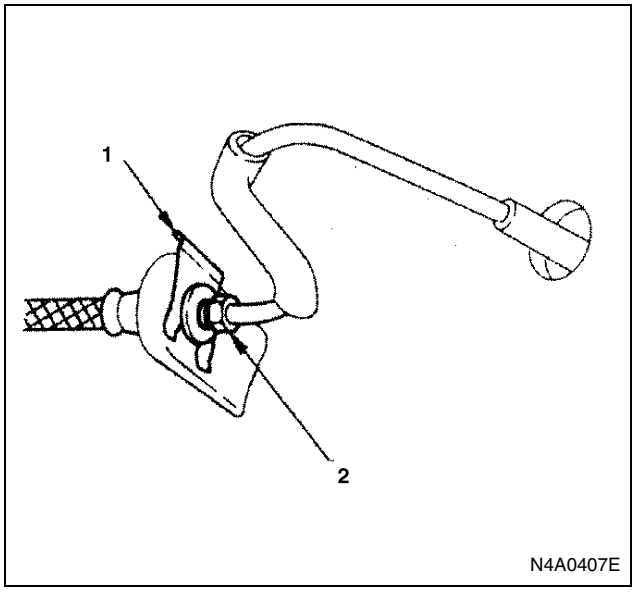
Tighten:
Front propeller shaft bolt to 103 N·m (10.5 kg·m / 76 lb·ft)



N4A0406E

4. Stabilizer Assembly
   1) Refer to STABILIZER.
5. Brake Flexible Hose
   Set first the wheels in the straight going position, then attach the flexible hose to the bracket without torsion using a clip (1).
   Connect the pipe, then tighten the nut (2) to the specified torque.

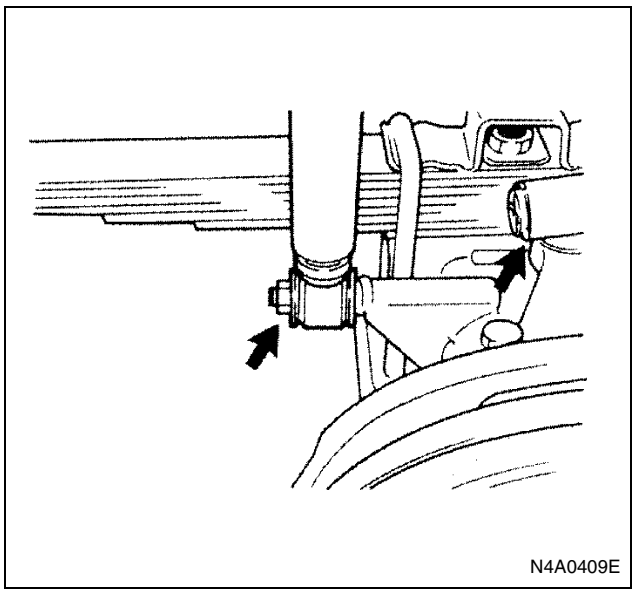
Tighten:
Brake flexible nut to 16 N·m (1.6 kg·m / 12 lb·ft)



N4A0407E

   Perform bleeding operation after installation of the brake flexible hoses.
   Refer to “Service information” for brake fluid air bleeding procedure.
6. Tie Rod Assembly
   Refer to STEERING LINKAGE (4 × 4 Model).
7. Drag Link
   Refer to STEERING LINKAGE (4 × 4 Model).
8. Shock Absorber

Tighten:
Shock absorber under side nut to 95 N·m (9.7 kg·m / 70 lb·ft)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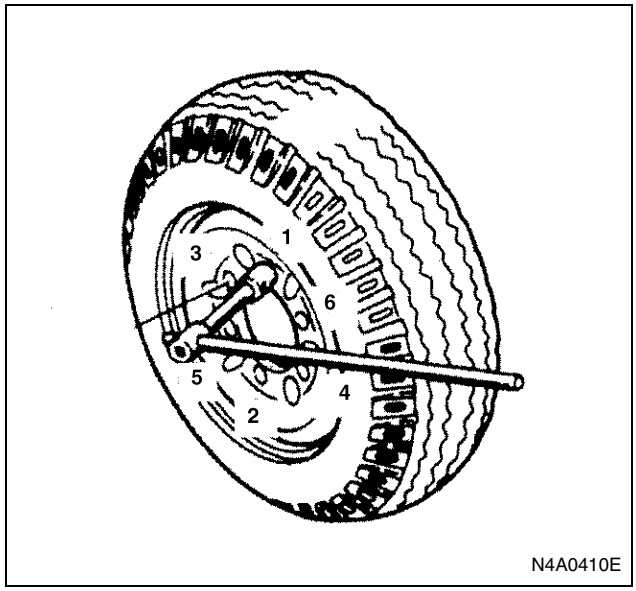
9. Wheel and Tire

Tighten:
Wheel nut to 441 N·m (45 kg·m / 325 lb·ft)

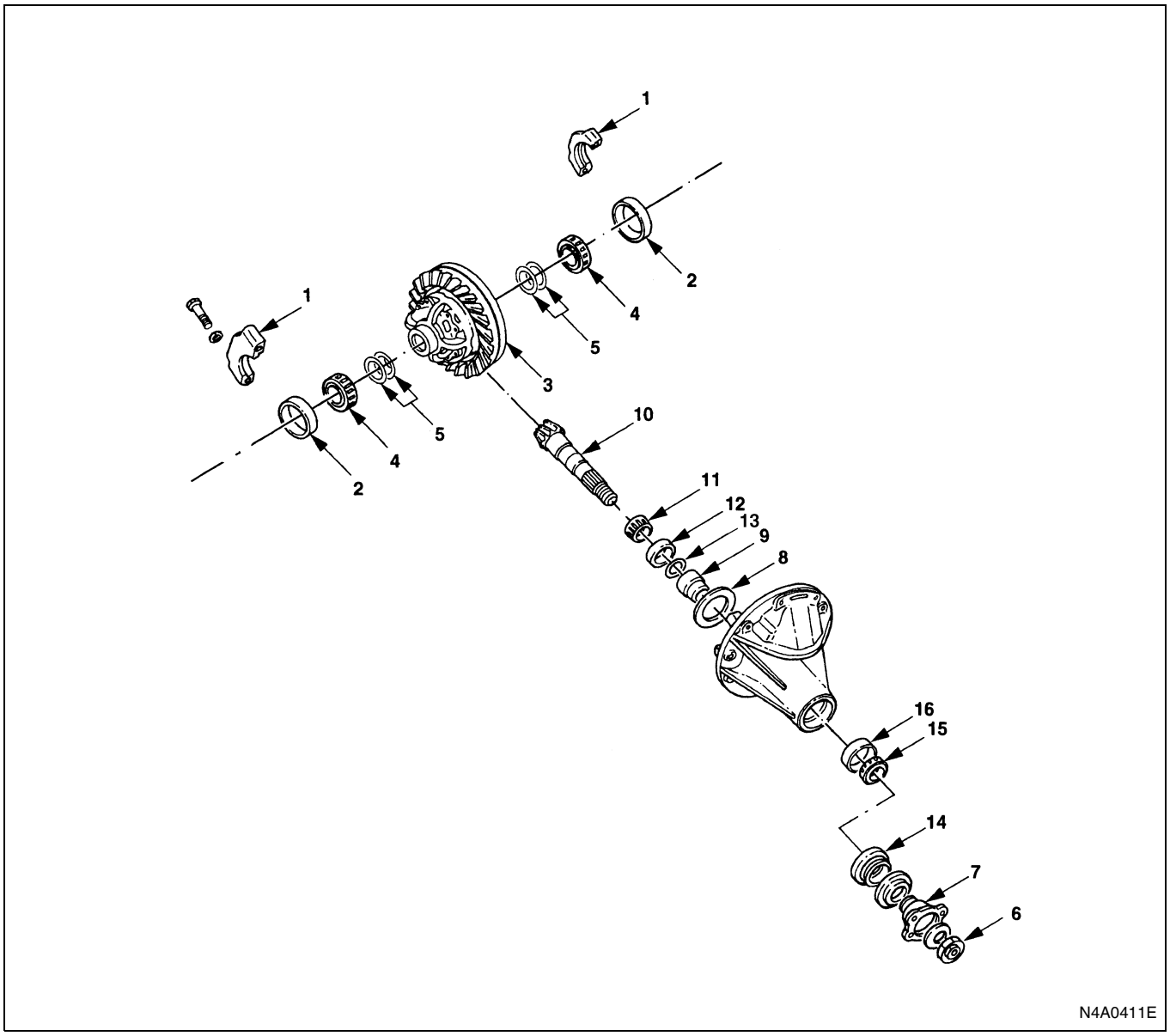
6 studs



UNIT REPAIR

Front Differential

Major Components

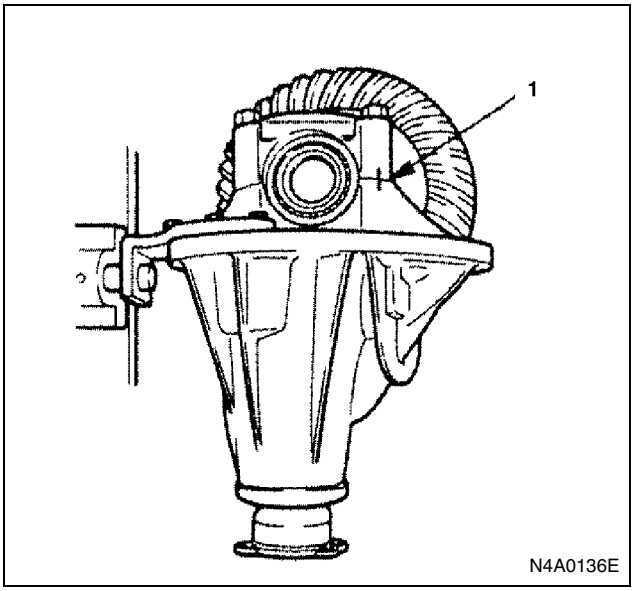


Legend

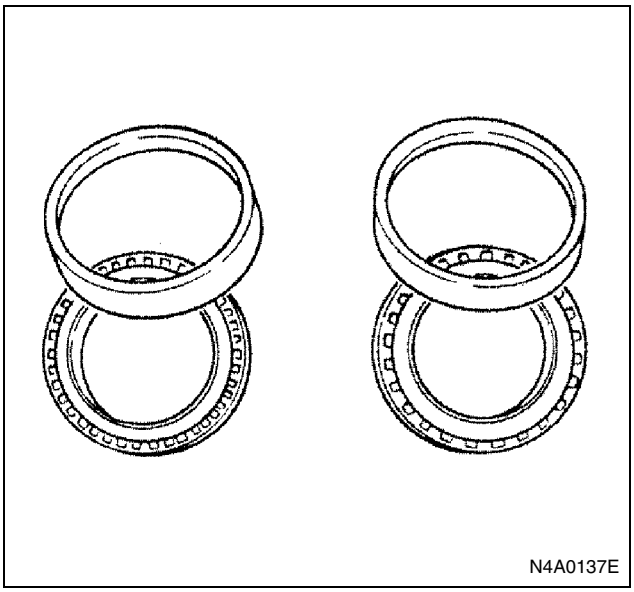
1. Bearing cap
2. Side bearing outer race
3. Differential cage assembly
4. Side bearing inner race
5. Backlash and preload adjusting shim
6. Flange nut
7. Flange
8. Bearing preload adjusting shim
9. Distance piece
10. Drive pinion
11. Inner bearing inner race
12. Inner bearing outer race
13. Pinion depth adjusting shim
14. Oil seal
15. Outer bearing inner race
16. Outer bearing outer race

Disassembly

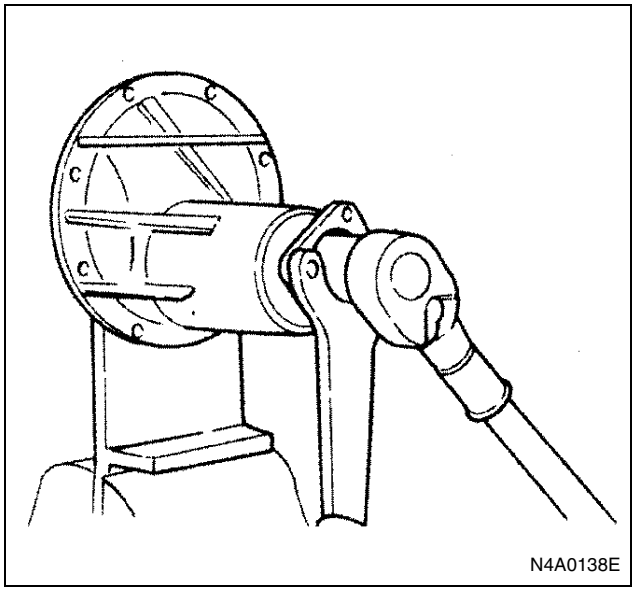
1. Bearing Cap
   Set the differential assembly onto a special fixture.
   Apply a setting mark (1) to the side bearing cap and differential carrier.
   Fixture: 5-8840-2029-0
   Base: 5-8840-0003-0



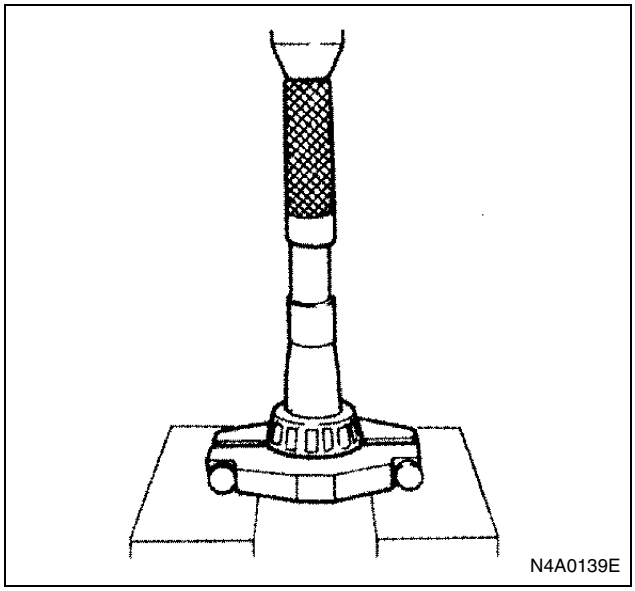
2. Side Bearing Outer Race
   After removal, keep right and left side bearing assemblies separate to maintain inner and outer race combinations.



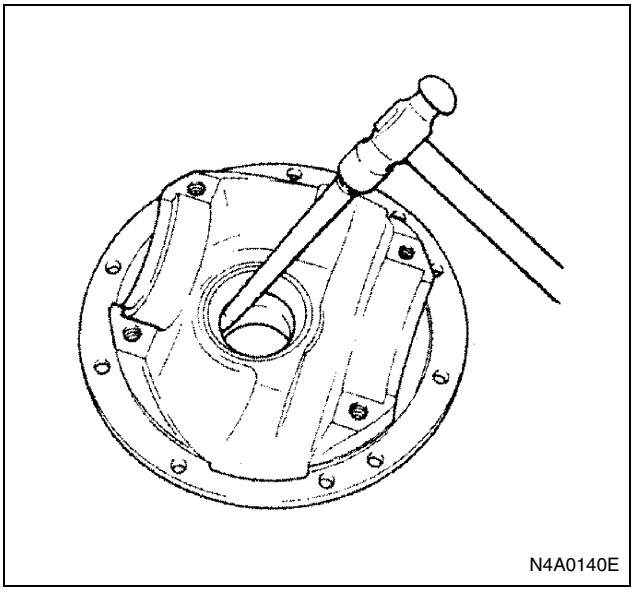
3. Differential Cage Assembly
4. Side Bearing Inner Race
   Remover: 9-8521-0061-0
   Adapter: 5-8840-2031-0
5. Backlash and Preload Adjusting Shim
6. Flange Nut
   Holding wrench: 9-8511-1507-0



7. Flange
8. Bearing Preload Adjust Shim
9. Distance Piece
10. Drive Pinion
11. Inner Bearing Inner Race
    Remover: 5-8840-0015-0



12. Inner Bearing Outer Race
13. Pinion Depth Adjusting Shim
14. Oil Seal
15. Outer Bearing Inner Race
16. Outer Bearing Outer Race
    Drive out the inner bearing outer race or the outer bearing outer race together with the outer bearing inner race and oil seal by using a proper bar through two notches.


N4A0140E

REASSEMBLY

Measurement of ring gear run-out.

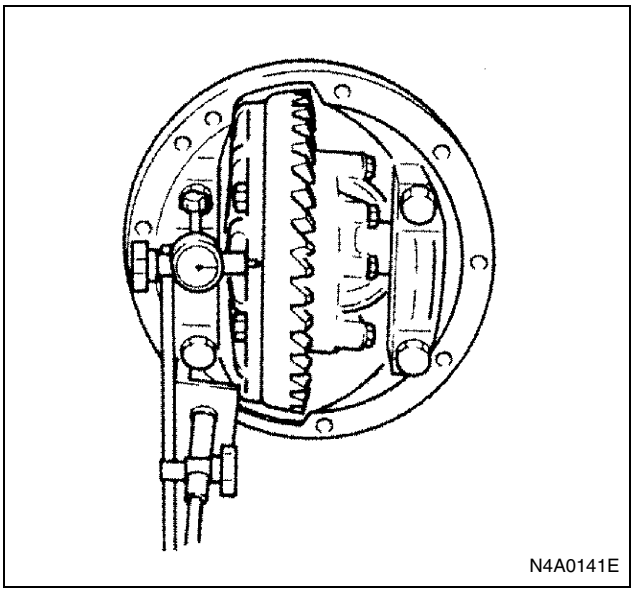
Install dummy bearing into the differential assembly, then install these parts in the differential carrier. Install and tighten the bearing cap.

Dummy bearing: 9-8522-1137-0

Tighten:

Bearing cap bolt to 108 N·m (11.0 kg·m / 80 lb·ft)

Ring gear run-out,
Standard: 0.05 mm (0.002 in)
Limit: 0.2 mm (0.008 in)


N4A0141E

1. Outer Bearing Outer Race
2. Pinion Depth Adjusting Shim
3. Inner Bearing Outer Races

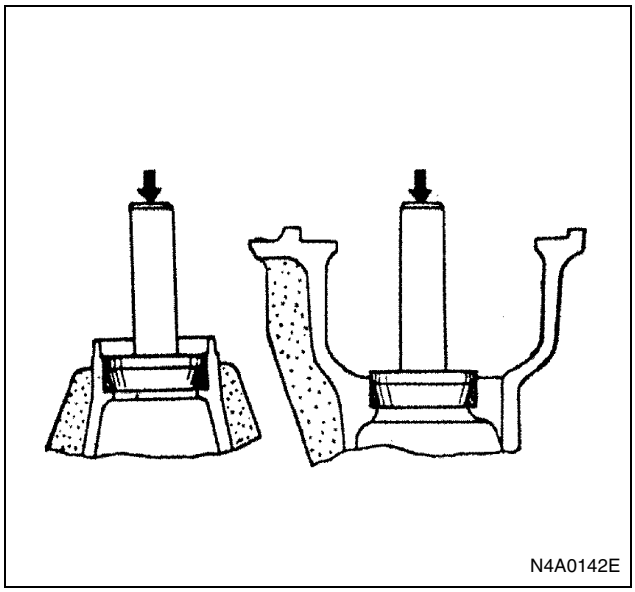
   Adjustment of drive pinion engagement depth.

   Install the inner and outer bearing outer races without shims into the differential carrier using a bench press.

   Installer (Inner): 9-8522-1196-0

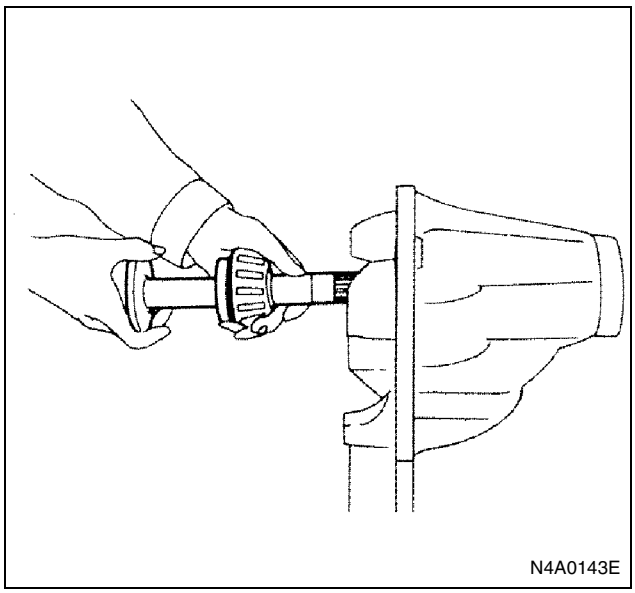
   (Outer): 9-8522-1197-0

   Grip: 9-8522-1148-0


N4A0142E

Assemble the inner bearing inner race to the dummy pinion shaft, then install these parts into the carrier.

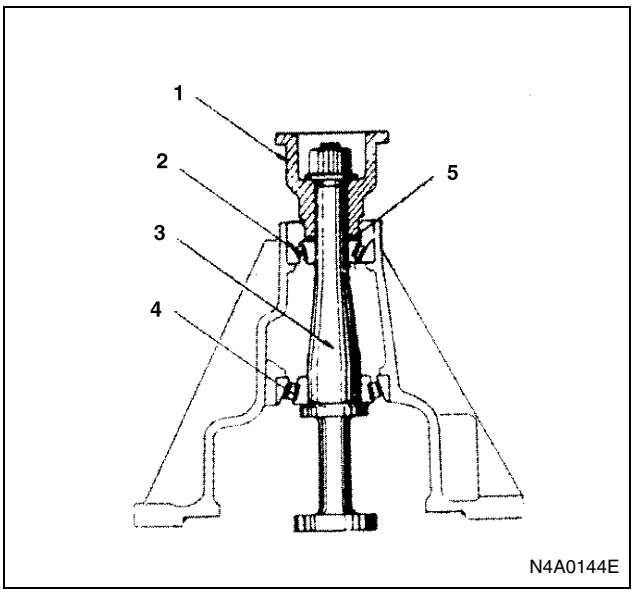
Dummy Pinion Shaft: 9-8522-1603-0


N4A0143E

Install the outer bearing inner race flange, washer and dummy nut.

Lubricate the bearing before tighten the dummy nut.

Dummy Nut: 9-8522-1624-0



Legend

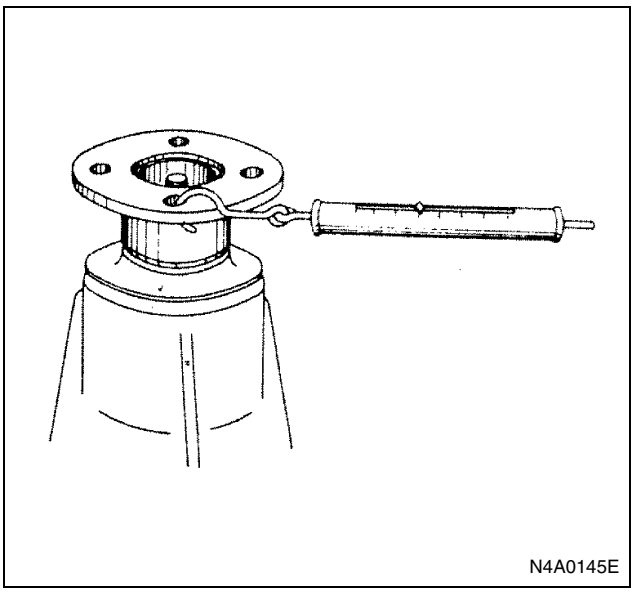
1. Coupling driver
2. Outer bearing
3. Dummy pinion shaft
4. Inner bearing
5. Shim

Tighten the dummy nut until specified preload are required to rotate the bearing.

Bearing preload,
New bearing: 16 — 29 N (1.6 — 3.0 kg / 3.5 — 6.6 lb)
Used bearing: 8 — 14.5 N (0.8 — 1.5 kg / 1.8 — 3.3 lb)

Tighten:
Bearing starting to

- New bearing: 0.69 — 1.27 N·m (7.0 — 13.0 kg·cm / 6.1 — 11.3 lb·in)
- Used bearing: 0.35 — 0.64 N·m (3.5 — 6.5 kg·cm / 3.1 — 5.7 lb·in)

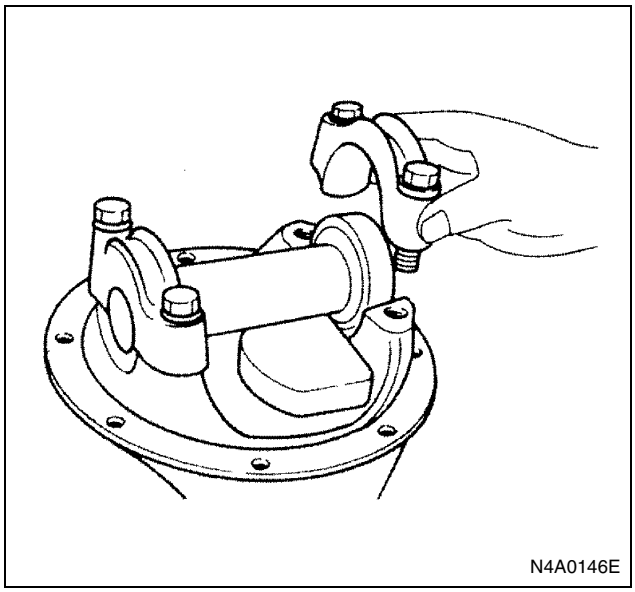


Install dummy bearing on dummy shaft and install these parts into the carrier. Install and tighten the bearing cap.

Dummy Shaft: 9-8522-1138-0

Dummy Bearing: 9-8522-1137-0

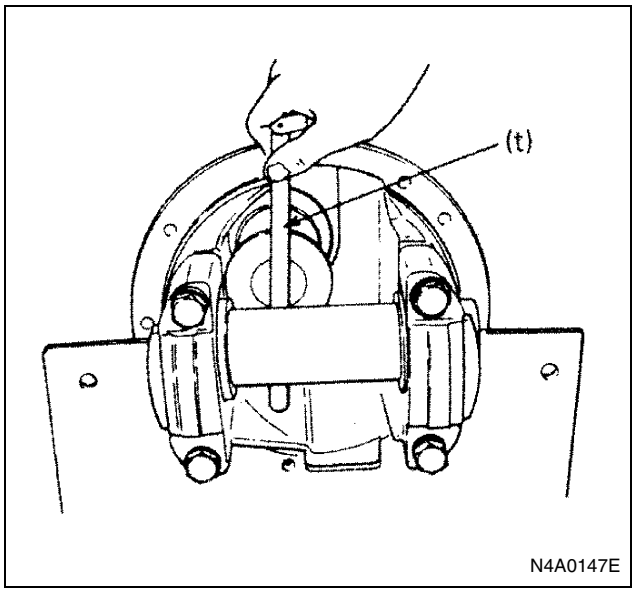
Tighten:
Bearing cap bolt to 108 N·m (11.0 kg·m / 80 lb·ft)



Measure the clearance (t) with a feeler gauge.

The clearance (t) is equal to the shim in thickness.

Thickness of shim available: 2.12, 2.16 ... 2.52, 2.56 mm (0.083, 0.085 ... 0.099, 0.100 in)

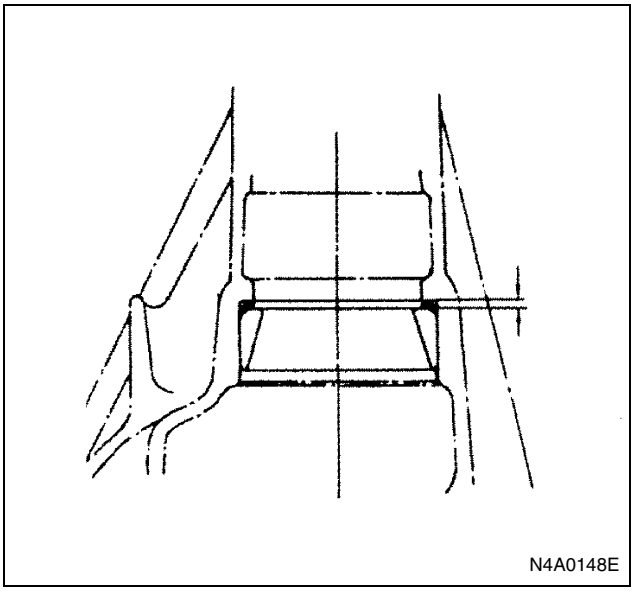


Remove dummy pinion, dummy shaft, dummy bearing and inner bearing outer race.

Install pinion depth adjusting shim of specified thickness in position between the inner bearing outer race and the carrier, then install the inner bearing outer race.

Installer: 9-8522-1196-0

Grip: 9-8522-1148-0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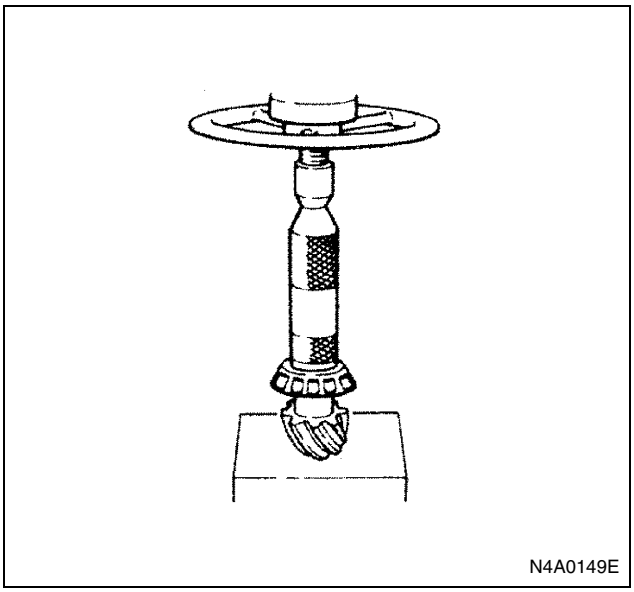
4. Inner Bearing Inner Race
   Installer: 9-8522-0018-0
   Apply gear oil to the pinion shaft before installing final drive pinion assembly into carrier.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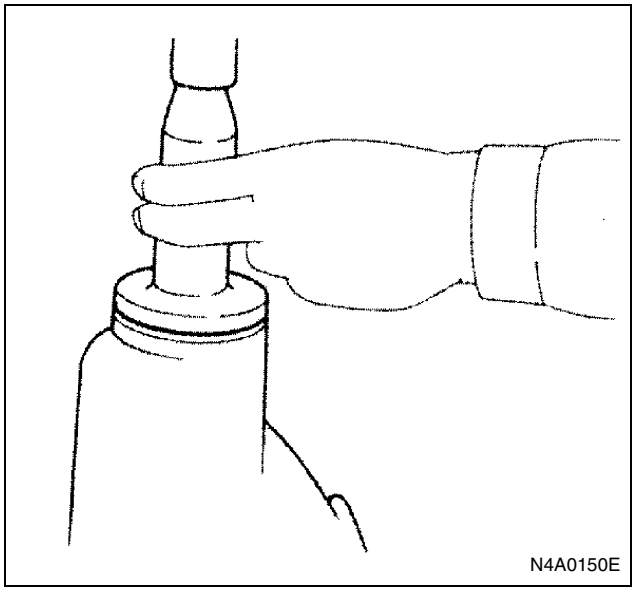
5. Outer Bearing Inner Race
6. Oil Seal
   Installer: 5-8840-2047-0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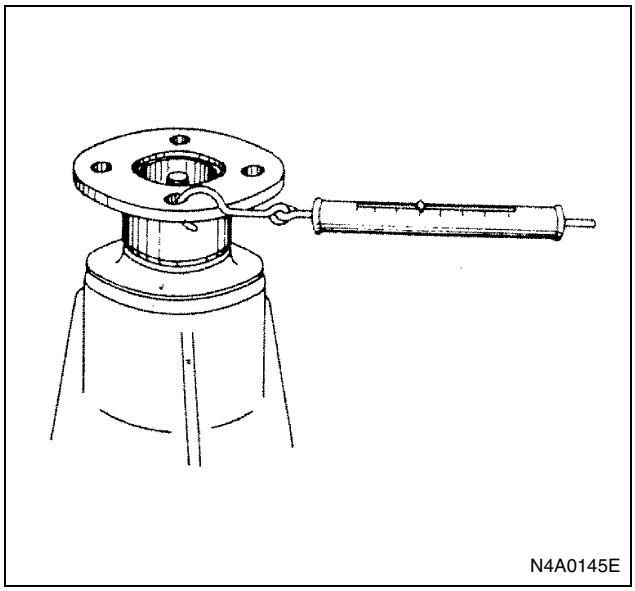
7. Drive Pinion
8. Distance Piece (NKR model)
9. Bearing Preload Adjusting Shim
   Use a dummy nut until specified bearing preload is obtained.

Bearing preload,
New bearing: 16 — 29 N (1.6 — 3.0 kg / 3.5 — 6.6 lb)
Used bearing: 8 — 14.5 N (0.8 — 1.5 kg / 1.8 — 3.3 lb)

Tighten:
Bearing starting to

- New bearing: 0.69 — 1.27 N·m (7.0 — 13.0 kg·cm / 6.1 — 11.3 lb·in)
- Used bearing: 0.35 — 0.64 N·m (3.5 — 6.5 kg·cm / 3.1 — 5.7 lb·in)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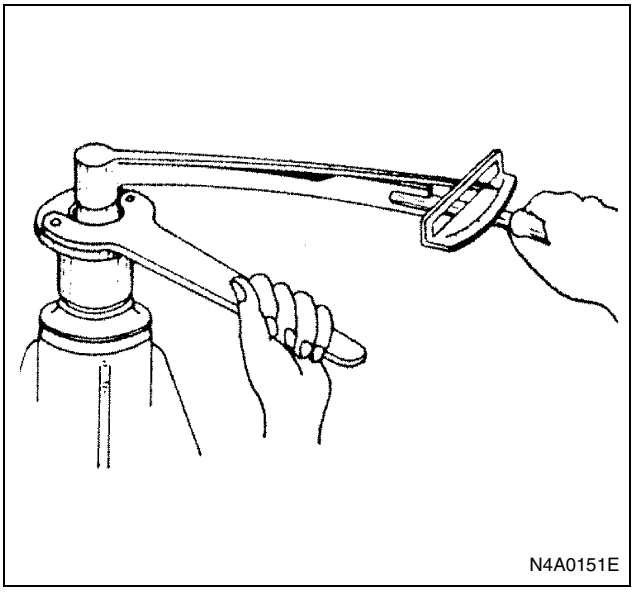
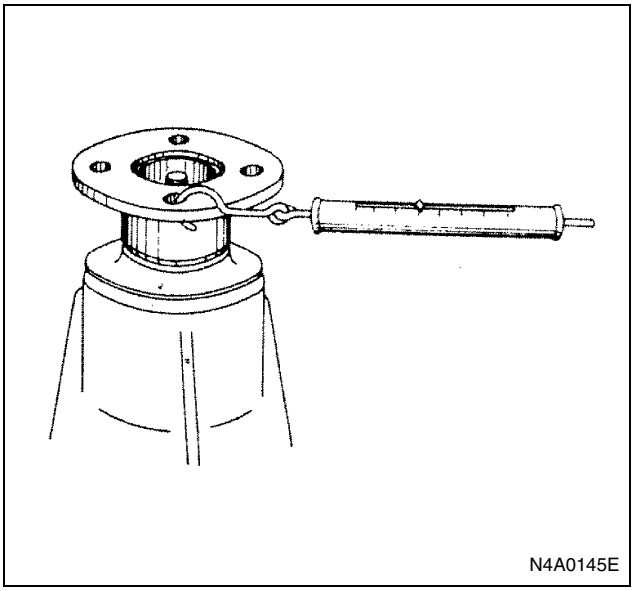
Tighten:
Dummy nut to 270 N·m (27.5 kg·m / 199 lb·ft)

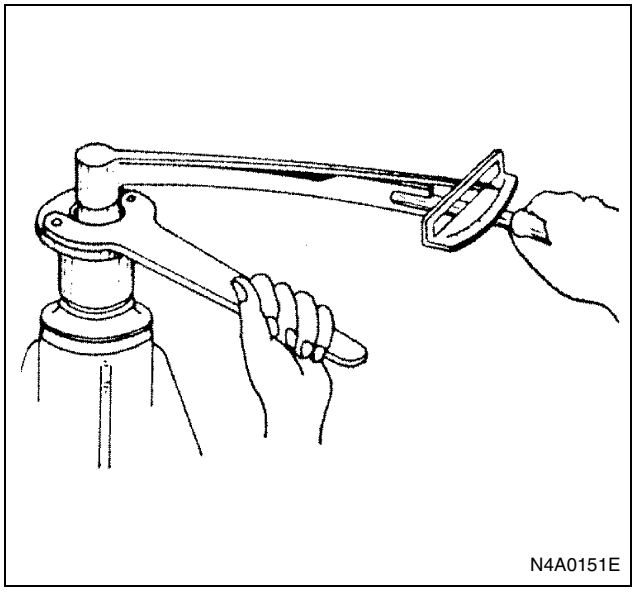


Thickness of shim available: 1.53, 1.56 ... 2.07, 2.10 mm (0.060, 0.061 ... 0.081, 0.082 in)

10. Flange
11. Flange Nut
    Once specified bearing preload is obtained by dummy nut, remove dummy nut and replace with flange nut.
    Tighten the flange nut until specified bearing preload and nut torque.
    Using special tool, stake the flange nut at two points.
    Punch: 5-8840-2293-0

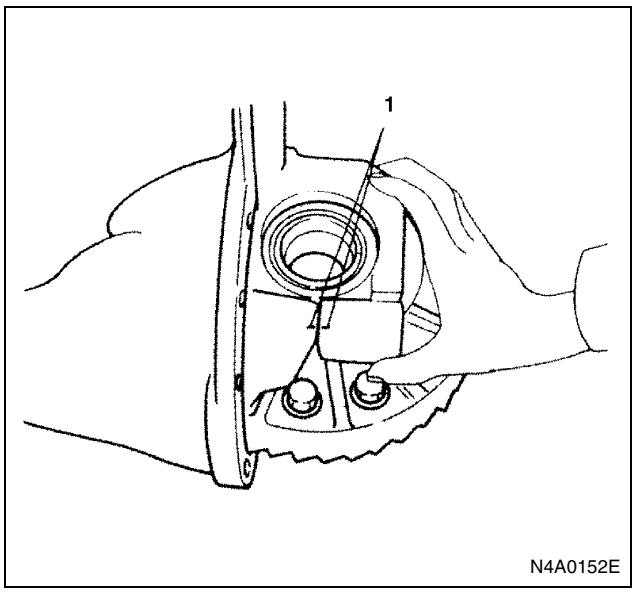


12. Backlash and Preload Adjusting Shim
    1) Adjustment of Backlash
    • Install dummy bearing in the differential cage assembly, then install differential cage assembly and ring gear into the differential carrier.



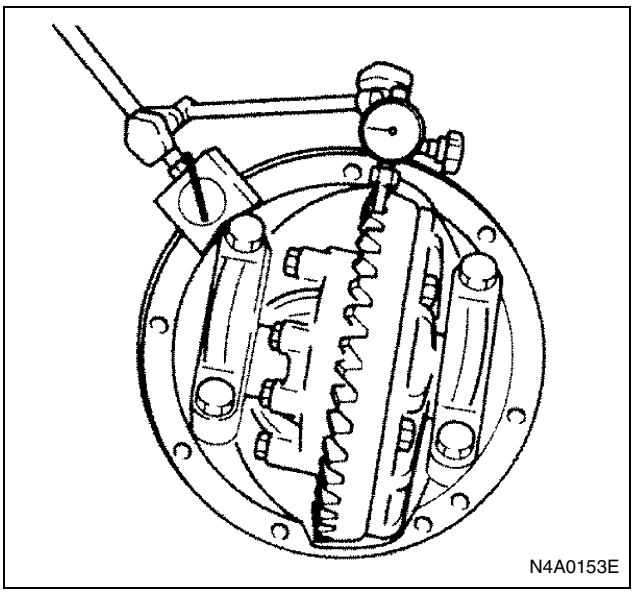
Install the bearing caps after checking to make certain setting marks (1) applied at disassembly are in alignment.

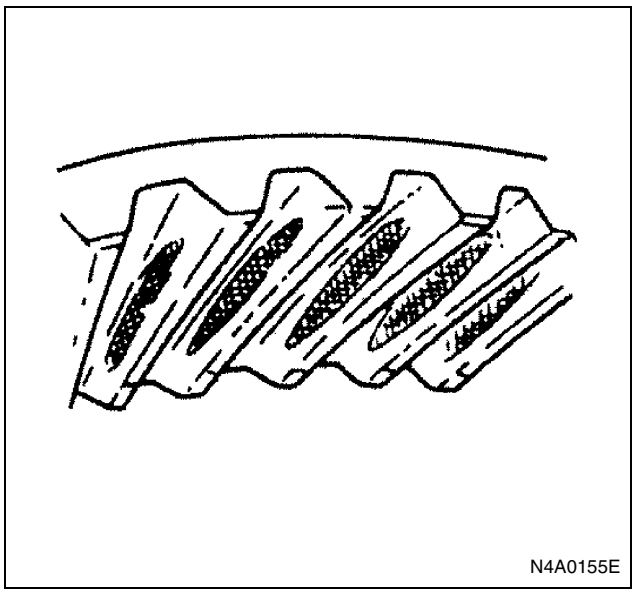
Tighten:
Bearing cap bolt to 108 N·m (11.0 kg·m / 80 lb·ft)



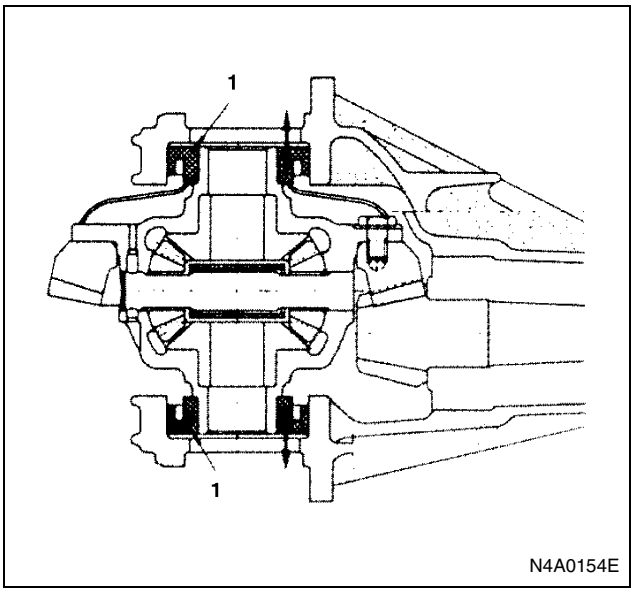
• Set the dial indicator and measure the backlash between the drive pinion and ring gear at the foot portion of the ring gear.

Backlash: 0.15 — 0.20 mm (0.006 — 0.008 in)


N4A0153E


N4A0155E

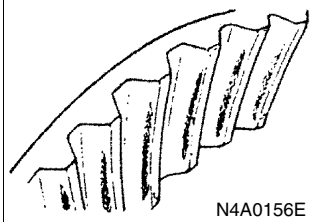
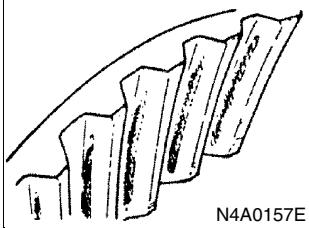
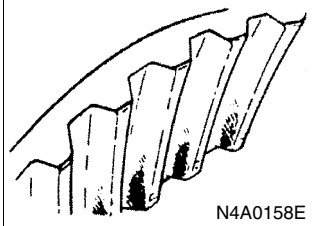
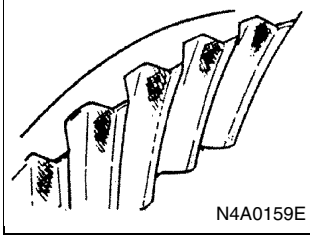
- To adjust backlash, loosen bearing cap bolts slightly and move the dummy bearing (1) as necessary.
  A clearance should not be provided between dummy bearing and bearing fitting face of the differential cage.



N4A0154E

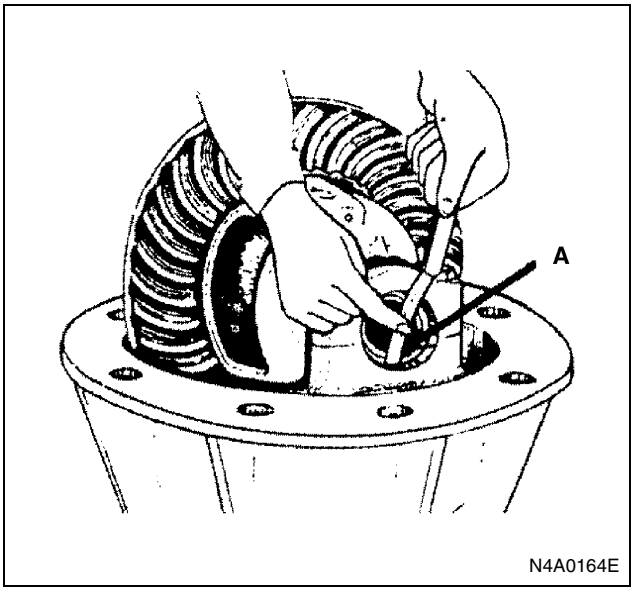
2) Inspection of drive pinion and ring gear tooth contact.

- Apply a thin coat of red check to faces of the 7 — 8 teeth of the ring gear.
- Check the impression of contact obtained on the ring gear teeth and make necessary adjustment as described below if the contact is abnormal.

TOOTH CONTACT	CASE	ADJUSTMENT PROCEDURE
 N4A0156E	Drive pinion is too far away from ring gear.	1. Move the drive pinion in toward the ring gear by decreasing the thickness of pinion depth adjusting shims. 2. Adjust the backlash by moving ring gear away from the drive pinion. N4A0160E
 N4A0157E	Drive pinion is too close to the ring gear.	1. Move the drive pinion away from the ring gear by increasing thickness of pinion depth adjusting shims. 2. Adjust the backlash by moving ring gear in toward the drive pinion. N4A0161E
 N4A0158E	Ring gear is too close to the drive pinion.	1. Move the drive pinion in toward the ring gear by decreasing thickness of pinion depth adjusting shims. 2. Adjust the backlash by moving ring gear away from the drive pinion. N4A0162E
 N4A0159E	Ring gear is too far away from drive pinion.	1. Move the drive pinion away from the ring gear by increasing thickness of pinion depth adjusting shims. 2. Adjust the backlash by moving ring gear in toward the drive pinion. N4A0163E

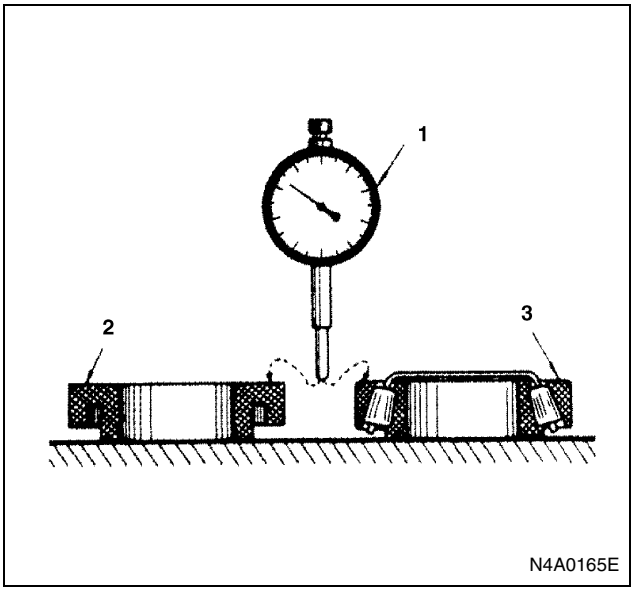
3) Selection of Preload Adjusting Shim

- Measure the clearance between the differential carrier and right and left side (dummy) bearings by using a feeler gauge.
  Carefully note the relationship between the values obtained through measurement at each side and dummy bearings.



N4A0164E

- Measure the thickness of dummy bearing and side bearing.
  Comparison should be made between the thicknesses of dummy bearing and side bearing installed in the same position.



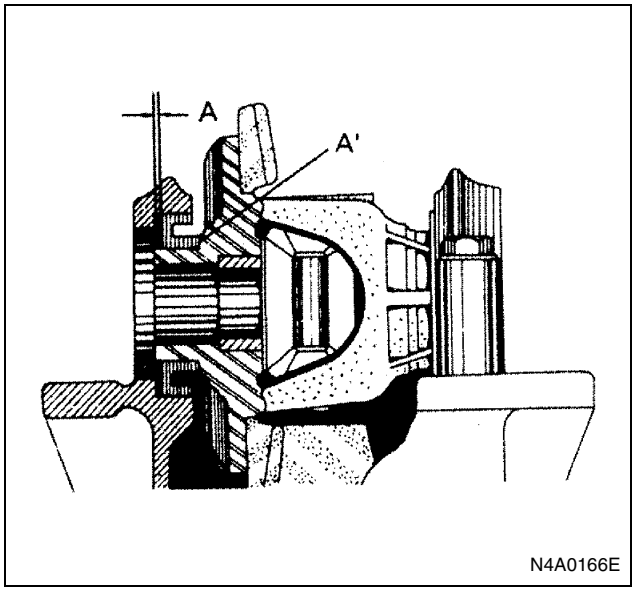
Legend
1. Dial gauge
2. Dummy bearing
3. Side bearing

When side bearing is thinner:
A + (dummy bearing thickness − side bearing thickness) = (X)
When side bearing is thicker:
A − (side bearing thickness − dummy bearing thickness) = (X)

- (X) + 0.025 = Shim thickness
  Allowance for bearing preload at one side = 0.025
- Example of calculation

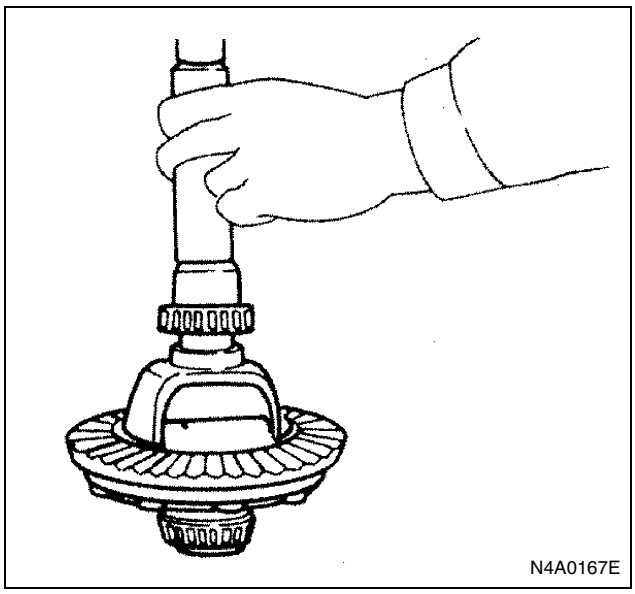
	mm (in.)
Measured Clearance A:	+0.85 (+0.033)
Suppose that the side bearing is thicker [thinner] than dummy bearing by 0.05 mm	−0.05 (−0.002) [+0.05 (+0.002)]
An allowance for bearing preload:	+0.025 (+0.0009)
Thickness of shims to be installed:	0.825 (0.032) [0.925 (0.036)]

Thickness of shim available: 0.25, 0.30, 0.35, 0.5 mm (0.009, 0.012, 0.014, 0.019 in)



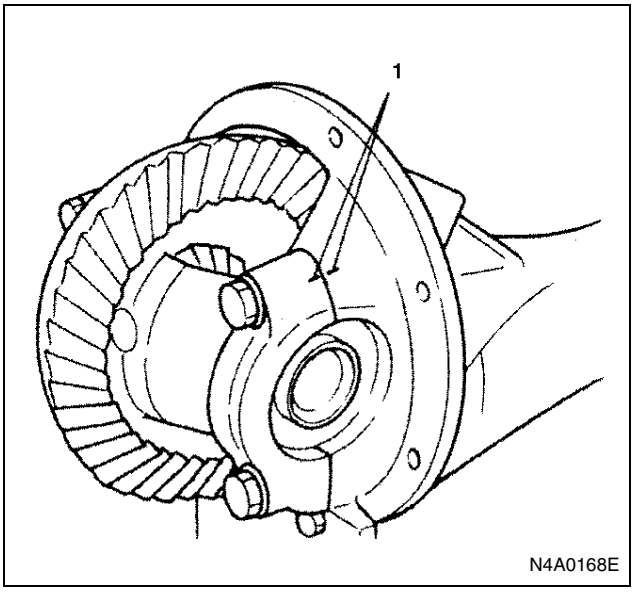
Legend
A. Measured clearance
A′. Shim installed position

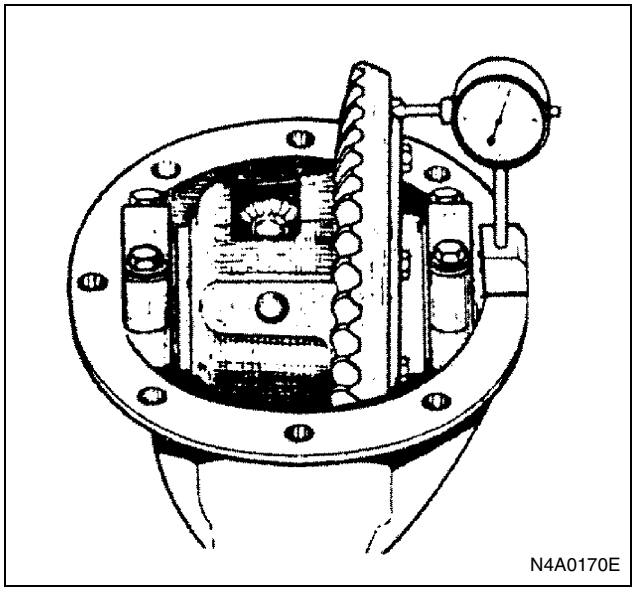
13. Side Bearing Inner Race
    Installer: 5-8840-2050-0
    Grip: 9-8522-1608-0



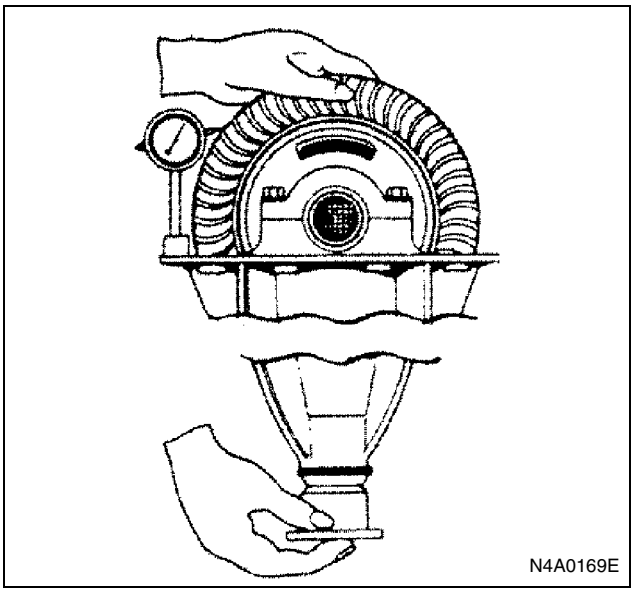
14. Differential Cage Assembly and Ring Gear
15. Side Bearing Outer Race
16. Bearing Cap
    1) Install bearing caps by aligning setting marks (1) applied at disassembly.

Tighten:
Bearing cap bolt to 108 N·m (11.0 kg·m / 80 lb·ft)





2) Recheck the backlash. If measurement indicates that the backlash deviates from the specified range, make an adjustment by shifting the position of shims in use without varying the total thickness.

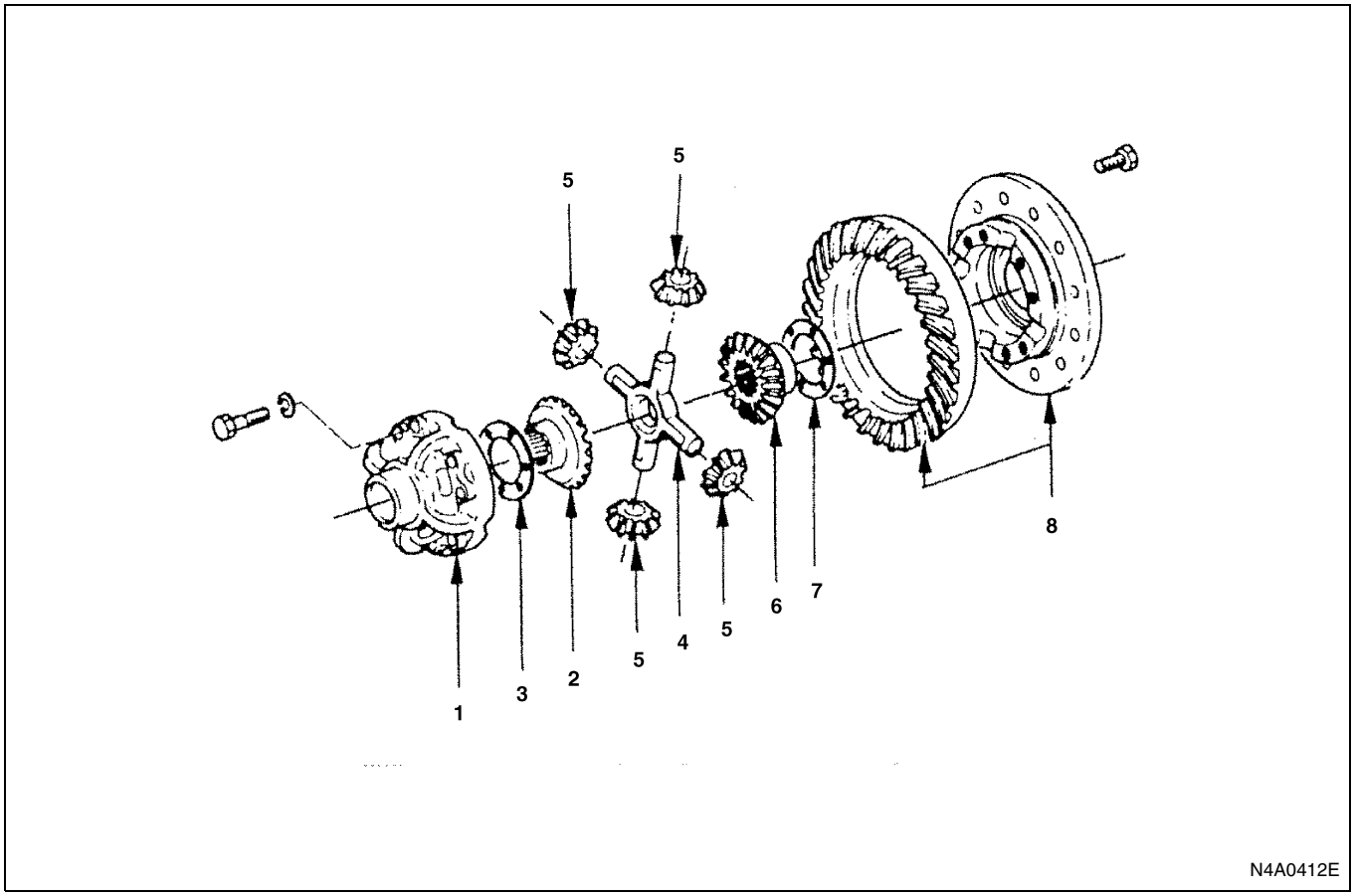


Recheck the ring gear for run-out at the rear face.

If the amount of run-out is excessive, repeat the disassembly and reassembly steps.

Ring gear run-out,
Standard: 0.05 mm (0.002 in)
Limit: 0.2 mm (0.008 in)

Differential Cage Assembly

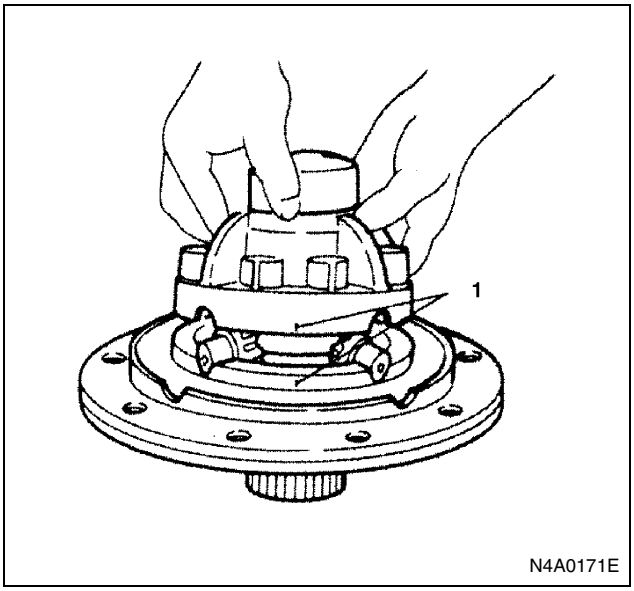


Legend

1. Differential cage B
2. Side gear
3. Thrust washer
4. Spider
5. Differential pinion
6. Side gear
7. Thrust washer
8. Differential cage A and ring gear

Disassembly

1. Differential Cage B
   Apply a setting mark (1) to the differential cage assembly.



2. Side Gear
3. Thrust Washer
4. Spider
5. Differential Pinion
6. Side Gear
7. Thrust Washer
8. Differential Cage A and Ring Gear

Inspection and Repair

Make necessary correction or parts replacement if wear, damage or any other abnormal conditions are found through inspection.

Visual Check

Inspect the following parts for wear, damage or other abnormal conditions.

- Gear
- Bearing
- Oil seal
- Differential cage
- Drive pinion cage
- Parts organizing limited slip differential assembly

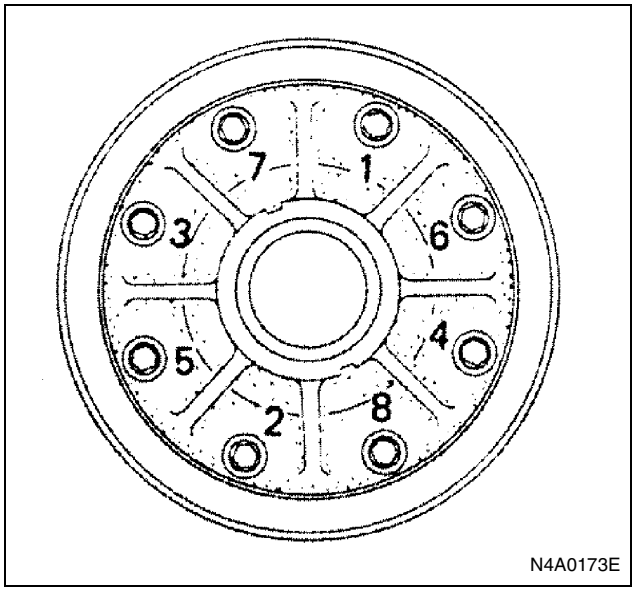
Ring Gear Replacement

The ring gear should always be replaced with drive pinion as a set.

When installing ring gear, apply stud lock to the threaded holes and bolts after treatment of the bolts with primer N.

Tighten:

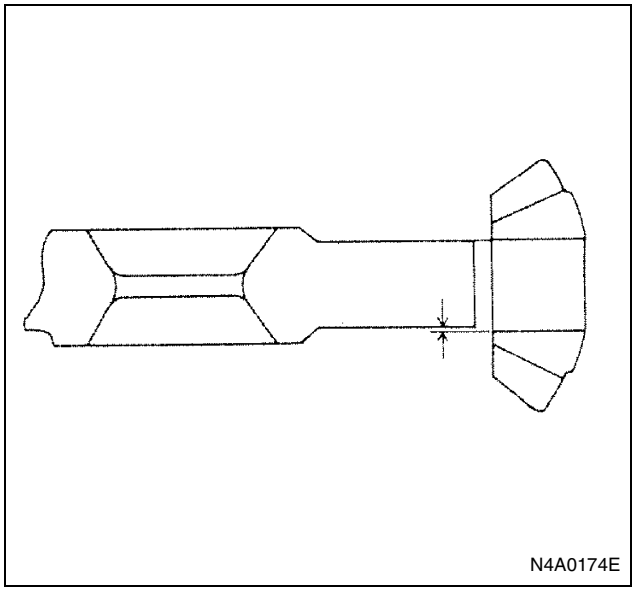
Ring gear bolt to 127 N·m (13.0 kg·m / 94 lb·ft)



Clearance between Differential Pinion and Spider

Standard: 0.07 — 0.13 mm (0.003 — 0.005 in)

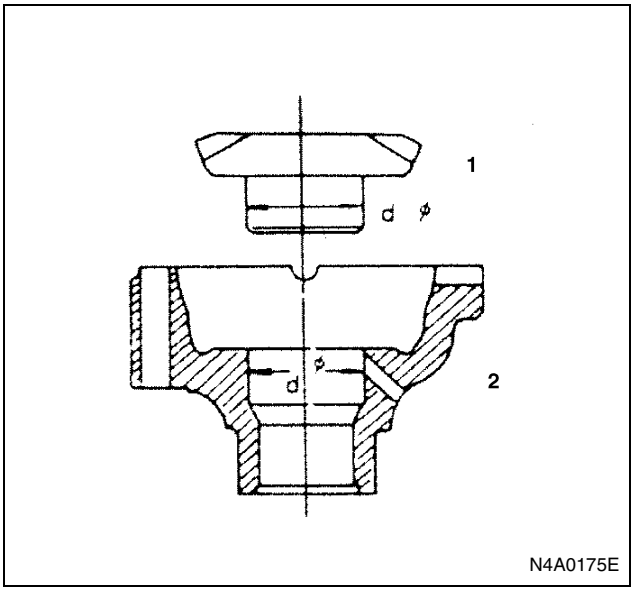
Limit: 0.2 mm (0.008 in)



Clearance between Side Gear and Differential Cage

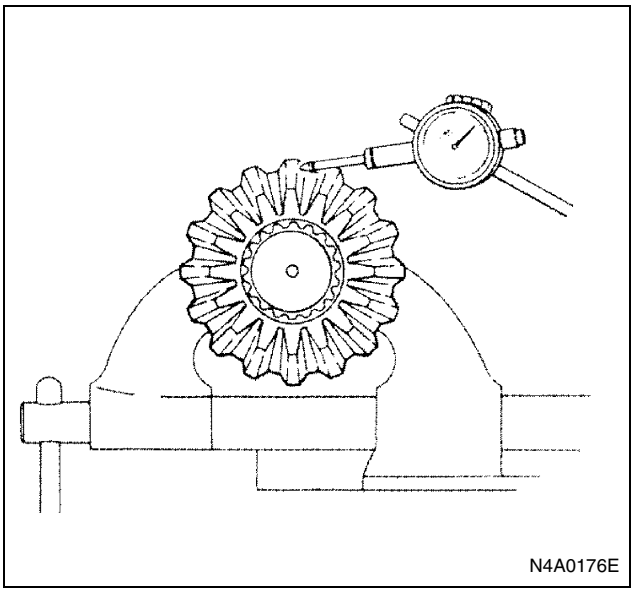
Standard: 0.05 — 0.11 mm (0.002 — 0.004 in)

Limit: 0.25 mm (0.01 in)



Legend
1. Side gear
2. Differential cage

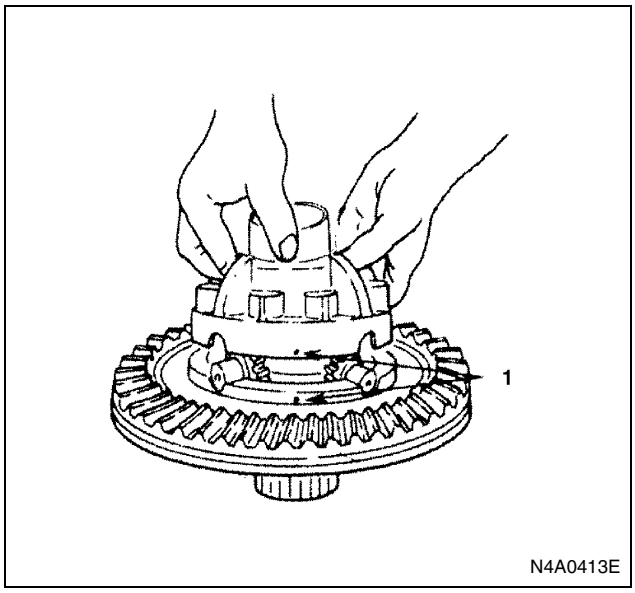
Play in Splines between Side Gear and Axle Shaft
Standard: 0.02 — 0.12 mm (0.0008 — 0.005 in)
Limit: 0.25 mm (0.01 in)



Reassembly

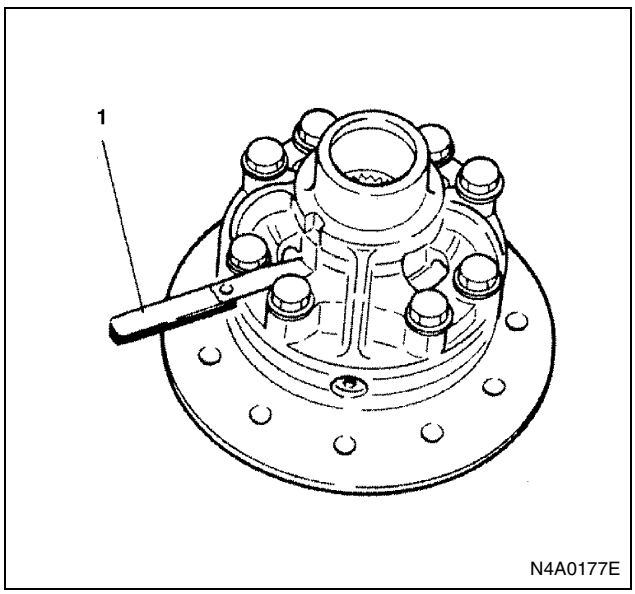
1. Differential Cage A and Ring Gear
2. Thrust Washer
3. Side Gear
4. Differential Pinion
5. Spider
6. Thrust Washer
7. Side Gear
8. Differential Cage B
   1) Apply oil to the threaded portion of the bolts before installation.
   2) Fasten the differential cages A and B so that the setting marks (1) are correctly aligned.

Tighten:
Differential cage bolt to 78 N·m (8.0 kg·m / 58 lb·ft)



   3) Measure the clearance between the back face of the side gear and the differential cage B by inserting a feeler gauge (1) through the hole on the cage B.

Clearance: 0.13 — 0.18 mm (0.005 — 0.007 in)



When the clearance exceed a limit, replace the thrust washer or side gear.

LGPRO-WE-0552

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LGPRO-WE-0552 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

PROPELLER SHAFT AND AXLE

SECTION 4

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
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Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

SECTION No.	CONTENTS
00	SERVICE INFORMATION
4A	PROPELLER SHAFT
4B	REAR AXLE
4C	FRONT AXLE

BRAKES

SECTION 00

SERVICE INFORMATION

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TROUBLESHOOTING

Brake System

PROBLEM	POSSIBLE CAUSE	CORRECTION
No Brakes	1. Restricted tubing or hose. 2. Brakes out of adjustment. 3. No fluid.	1. Replace defective parts. 2. Adjust. 3. Fill the reservoir with brake fluid.
Insufficient Brakes	1. Pedal improperly adjusted. 2. Worn linings/pads or drum/discs. 3. Plugged, crimped, restricted lines or hoses.	1. Adjust. 2. Replace as necessary. 3. Repair or replace.
Slow Brake Application	1. Pedal binding. 2. Wheel cylinder piston sticking. 3. Restriction in the lines. 4. Worn linings/pads or drums/discs.	1. Lubricate pivot pin, clean-check for foreign objects. 2. Repair the wheel cylinder. 3. Remove the restriction or replace the line. 4. Replace as necessary.
Uneven Braking (Front or Rear Brakes not Working)	1. Damaged hydraulic lines. 2. No brake fluid at the master cylinder. 3. Safety valve not opened.	1. Repair or replace. 2. Check for plugged, kinked or damaged hose to the reservoir. 3. Correct.
Wet Weather: Brakes Grab or won't Hold	1. Linings too sensitive to water. 2. Dirty brakes. 3. Bent mounting plate - opening. 4. Scored drums/discs.	1. Replace in axle sets. 2. Clean out. 3. Replace. 4. Machine in pairs. Replace if necessary.
Brakes Squeak	1. Mounting plate bent or shoes twisted. 2. Metallic particles or dust imbedded in the lining. 3. Lining rivets loose or lining not held tightly against the shoe at the ends. 4. Drums distorted tampered, or not Square. 5. Incorrect lining/pad. 6. Mixed size linings. 7. Weak or broken return spring. 8. Loose wheel bearings. 9. Loose mounting plate, drum, wheel cylinder. 10. Linings/pads located wrong on the shoes. 11. Linings/pads worn out. 12. Lining glazed. 13. Cracked or threaded drums/discs.	1. Replace damaged parts. 2. Replace the linings/pads in axle sets. 3. Replace the rivets and/or tighten the lining by riveting. 4. Machine or replace drums/discs. 5. Replace the linings/pads in axle sets. 6. Use all standard or oversize linings in a brake. 7. Replace the return spring. 8. Tighten to the proper setting. 9. Tighten. 10. Install the linings correctly. 11. Reline the brakes. 12. Replace. 13. Replace in axle pairs.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Brakes Chatter	1. Incorrect lining/pad to drum/disc clearance.	1. Adjust to specification.
	2. Loose mounting plate.	2. Tighten securely.
	3. Grease, fluid, road dust on the lining pad.	3. Clean or reline.
	4. Weak or broken return spring.	4. Replace the return spring.
	5. Loose wheel bearings.	5. Readjust.
	6. Drums out-of-round.	6. Machine the drums in axle sets.
	7. Discs warped.	7. Machine the discs in axle sets.
	8. Cocked or distorted shoes.	8. Straighten or replace.
	9. Distorted, tapered, or barrel- shaped drums.	9. Machine drums in pairs. Replace if necessary.
	10. Incorrect lining/pad material.	10. Reline with correct linings/pads.
	11. Linings/pads worn out.	11. Reline the brake.
	12. Lining loose on the shoes.	12. Rerivet the linings to the shoes. Replace if necessary. Check for damaged or distorted shoes.
	13. Foreign material imbedded in the linings/pads.	13. Replace the linings/pads in axle sets.
	14. Cracked or threaded drums/discs.	14. Replace in axle pairs.
Shoe Click	1. Return spring weak.	1. Replace the spring.
	2. Shoe bent.	2. Straighten or replace.
Noise and Chatter Squealing, clicking, or scraping sound upon brake application	1. Bent, damaged or incorrect shoes.	1. Replace with the correct shoes and lining. Always replace in axle sets.
	2. Worn out lining/pad.	2. Replace the shoes and lining/pad in axle sets.
	3. Foreign material embedded in the lining/pad.	3. Replace the shoes and lining/pad in axle sets.
	4. Broken shoe return spring.	4. Replace the return spring.
	5. Cracked or threaded drums/discs (lathe marks).	5. Replace the drums/discs in axle sets.
Pulls to One Side	1. Grease or fluid soaked lining/pad.	1. Replace in axle sets.
	2. Loose wheel bearings, loose (or distorted) mounting plate on the rear or front axle or loose spring bolts.	2. Adjust the wheel bearing, tighten (or replace) the mounting plate to the axle and tighten the spring bolts.
	3. Linings/pads not of the recommended kind.	3. Install recommended linings/pads. Install the shoes correctly.
	4. Tires not properly or evenly inflated or unequal wear of tread. Different tread non-skid design.	4. Inflate the tires to recommended pressures. Rearrange the tires so that a pair of non-skid tread surfaces of similar design and equal wear will be installed on the front wheels, and an other pair with like tread will be installed on the rear wheels.
	5. Water, mud, etc., in the brakes.	5. Remove any foreign material from all of the brake parts and inside of the drums.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Pulls to One Side (Cont.)	6. Wheel cylinder sticking.	6. Repair or replace the wheel cylinder.
	7. Weak or broken shoe return spring.	7. Check the spring-replace distorted, open coiled, or cracked spring.
	8. Out-of-round drums or different sized drums on the same axle.	8. Refinish or replace the drums in axle pairs.
	9. Brake dragging.	9. Check for loose lining. Adjust. (Refer to “Dragging Brakes”.)
	10. Weak chassis springs, loose U-bolts, loose steering gear, etc.	10. Replace the spring, tighten the U-bolts, adjust the steering gear, etc.
	11. Loose steering.	11. Repair and adjust.
	12. Unequal camber.	12. Adjust to specifications.
	13. Restricted brake line or hose.	13. Check for soft hose or damaged lines. Replace as necessary.
	14. Wheel cylinder size different on opposite sides.	14. Replace with correct cylinders.
	15. Loose kingpin.	15. Replace the kingpins or bushing.
	16. Distorted, damaged, or scored drum/ disc.	16. Refinish the drums/discs in axle pairs. Replace if necessary.
	17. Front end alignment.	17. Align the front end.
	18. Excessively worn lining/pad.	18. Replace in axle sets.
	19. Uneven adjustment of brake lining clearance.	19. Adjust the brake lining clearance in all wheels.
	20. Water/wet linings.	20. Apply the brakes a few times while moving at a slow speed to dry the linings.
One Wheel Locks	1. Gummy lining/pad.	1. Replace in axle sets.
	2. Tire tread slick.	2. Match up tire treads from side to side.
	3. Brake adjustment not correct.	3. Adjust the brakes.
	4. Restricted brake line or hoses.	4. Check for soft hoses or damaged lines. Replace as necessary.
	5. Incorrect lings/pads.	5. Replace. Linings/pads must be the same on the axle.
	6. Grease or fluid soaked lining/pads.	6. Replace in axle sets.
	7. Foreign material in the brakes.	7. Remove the material.
Light Pedal Pressure Brakes too Severe (Grabby Brakes)	1. Brake adjustment not correct.	1. Adjust the brakes.
	2. Loose mounting plate on the front axle.	2. Tighten the plates.
	3. A small amount of grease or fluid on the lining/pad.	3. Replace the linings/pads.
	4. Incorrect lining/pad.	4. Install factory specified linings/pads.
	5. Wheel bearings loose.	5. Adjust the wheel bearings.
	6. Lining loose on the shoe.	6. Replace the lining or the shoe and lining.
	7. Excessive dust and dirt in the drum.	7. Clean and sand the drums and linings.
	8. Out-of-round drum.	8. Turn the drums in pairs or replace.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Low Pedal or Pedal Goes to Floor	1. Excessive clearance between the linings and drum.	1. Adjust the brakes.
	2. Pedal stop not adjusted, or missing.	2. Adjust or install the pedal stop.
	3. Weak brake hose.	3. Replace with new hose.
	4. Leaking wheel cylinder.	4. Clean and rebuild.
	5. Air in the hydraulic system.	5. Bleed the hydraulic system.
	6. Improper brake fluid (low boiling point).	6. Flush the system and refill with recommended brake fluid.
	7. Low fluid level.	7. Fill the reservoir with brake fluid; check for leaks and bleed system.
	8. Bent or distorted brake shoes.	8. Replace in axle sets.
	9. Leaks at hydraulic line connections.	9. Check for hydraulic leaks and repair.
Slow Brake Release	1. Foot pedal binding.	1. Lubricate the pivot pin; clean-check for foreign objects.
	2. Restriction in the line.	2. Remove the restriction or replace line.
	3. Weak shoe return spring.	3. Replace the spring.
Poor Assist or Loss of Assit	1. Low brake fluid level.	1. Fill the reservoir to the proper level. Bleed the system.
	2. Air in the hydraulic system.	2. Locate the source of the air leak and repair. Bleed the system.
	3. Weak brake hose.	3. Replace.
	4. Loss of vacuum.	4. Inspect for vacuum leaks or malfunctioning pump. Repair or replace as necessary.
	5. No brake fluid at the master cylinder.	5. Check for plugged, kinked, or damaged hose to the reservoir.
Brake Fade	1. Incorrect lining/pad.	1. Replace with recommended lining/pad.
	2. Poor lining/pad contact.	2. Grind the lining/pad to the proper radius; adjust.
	3. Thin drum.	3. Replace the drum.
	4. Dragging brakes.	4. Adjust.
	5. All conditions listed under “Pulls to One Side”.	5. All corrections listed under “Pulls to One Side”.
All Brakes Drag when Adjustment is Known to be Correct	1. Pedal does not return to stop.	1. Lubricate the pedal linkage; adjust the pedal.
	2. Improper fluid.	2. Replace rubber parts and fill with the recommended brake fluid.
	3. Use of incorrect rubber parts.	3. Install the proper parts.

PROBLEM	POSSIBLE CAUSE	CORRECTION
One Wheel Drags	1. Weak or broken shoe return spring.	1. Replace the return spring.
	2. Brake shoe to drum clearance too small.	2. Adjust to specification.
	3. Loose wheel bearings.	3. Adjust or replace the wheel bearings.
	4. Wheel cylinder piston cups swollen and distorted or piston stuck.	4. Rebuild the cylinders. Flush the hydraulic system and fill with recommended fluid.
	5. Pistons sticking in the wheel cylinder.	5. Clean or replace the pistons; clean the cylinder bore.
	6. Drum out-of-round.	6. Machine the drum.
	7. Disc warped.	7. Machine the disc.
	8. Restricted brake line or hose.	8. Check for soft hoses or damaged lines. Replace as necessary.
	9. Distorted shoe.	9. Replace.
	10. Defective lining/pad.	10. Replace with the recommended lining/pad.
	11. Loose or bent mounting plate.	11. Tighten the fasteners; replace the plate.
	12. Loose calipers.	12. Tighten the fasteners.
Dragging Brakes	1. Improper fluid.	1. Flush the hydraulic system and fill with recommended brake fluid, and replace rubber components.
	2. Brake pedal adjustment incorrect.	2. Adjust the pedal.
	3. Incorrect shoe return spring.	3. Replace the shoe return spring.
	4. Brake pedal linkage interference or binding.	4. Free the linkage and lubricate.
	5. Incorrect lining/pad.	5. Replace the linings/pads.
	6. All conditions listed under “One Wheel Drags”.	6. All corrections under “One Wheel Drags”.

Hydraulic Booster

PROBLEM	POSSIBLE CAUSE	CORRECTION
Large force pressing on the brake pedal (boosting insufficient)	1. Booster operation insufficient • Large internal leakage • Sticking of the spool valve • Insufficient sliding around the input and output rods	• With the engine on, press the brake pedal repeatedly, and confirm the presence of manual operation. With regard to manual operation, turn the engine off, and judge whether the pedal is as stiff and its play is as small as when the pedal is pressed repeatedly ten times or more. • When there is manual operation, the hydro boost assembly is replaced.
Brake dragging	1. Bad dimensions of the booster • The amount of protrusion of the output rod is large	• Confirm whether the amount of protrusion of the output rod (the distance from surface of the master cylinder attachment flange to the end of the rod) is no greater than 18.2 mm (0.717 in). • If the above dimension is outside the range, replace the hydro boost assembly.
	2. Bad pedal circumference attachment dimensions • Clevis position dimension is large	• Confirm whether the clevis position dimension (the distance from surface of the vehicle attachment flange to the center of the clevis center) is in the range 109 $\pm$ 1 mm (4.29 $\pm$ 0.04 in). • If the above dimension is outside the range, loosen the lock nut and adjust the clevis position dimension to be inside the above range. After making this adjustment, be sure to securely tighten the lock nut and to do a stop light switch reconfirmation.
	3. Booster return is bad • Input-output rod circumference sticks • Bad spool valve operation	• With the engine on, repeatedly press the brake pedal and confirm the pedal return state. • If the pedal does not return, replace the hydro boost assembly as necessary.
Oil leakage	1. Hydro boost assembly external leakage • Leakage from the seal material	• If the oil leakage is caused by looseness in the piping connections, retighten the connections. • If there is oil leakage from the connections of the accumulator, replace the affected seals of the connections with new seals. • If there is any oil leakage from parts other than the above that are included in the hydro boost assembly, replace the hydro boost assembly or the repair setting parts (accumulator).

PROBLEM	POSSIBLE CAUSE	CORRECTION
Bad brake operation (lack of smoothness in operation)	1. Poor operation of the booster • Input-output rod circumference sticks • Bad spool valve operation	• With the engine on, repeatedly press the brake pedal and confirm the pedal operation state. • If there is sticking or some other abnormality in the pedal operation, replace the hydro boost assembly as necessary.
Abnormal brake noise (when pressing the pedal)	1. Air in the hydraulic booster lines	• With the engine running, check the amount of hydraulic fluid remaining in the reserve tank for the hydraulic booster. • If low, add fluid (Besco ATF III) and bleed to remove air as necessary before starting the engine. Operate the pump and repeatedly step on the pedal to confirm the gear noise (caused by cavitation).
	2. Water in the hydraulic fluid	• Check the color of the hydraulic fluid in the reserve tank for the hydraulic booster (normal: purple, abnormal: milky white). • If the hydraulic fluid is milky white, change the fluid (Besco ATF III) and bleed to remove air as necessary before starting the engine. Operate the pump and strongly press the pedal until reaching full boost range to confirm the gear noise (caused by cavitation). The length of time to keep the pedal pressed all the way down is no more than five seconds.
No pedal boosting effect immediately after turning the engine off	1. Faulty charge valve • Gas leaking from the accumulator • Leakage inside the charge valve	• Keep the engine running for more than 10 seconds. Turn off the engine, and within 60 seconds, step on the pedal once to confirm boosting effect. Boosting effect means the same pedal effort if the engine was running. • If boosting effect does not exist, either the hydraulic booster assembly or the accumulator may need to be replaced.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Warning buzzer continuously sounds	1. Faulty hydraulic booster assembly • Faulty pressure switch • Leakage inside the charge valve	• Confirm that the electric devices (pressure switch, relay, buzzer, etc.) are working correctly. • If all are working correctly, pump the brake pedal at least 10 times after turning the engine off to reduce pressure in the hydraulic booster. Start the engine, and release the parking brake. Check to see if the alarm stops within ten seconds (if it does, the electrical devices are working properly). • When testing the electrical devices, always keep your foot on the brake pedal with just enough pressure to prevent the vehicle from moving. If the alarm does not stop, the hydraulic booster assembly may have to be replaced.
Charge operation remains in effect	1. Bad charge valve operation • Bad valve switching operation	• Turn the engine on, and without pressing the brake pedal, check whether any charging sound continues, such as the sound of the fluid. • If it continues and will not stop, replace the hydro boost assembly as necessary.

Notice:

- When the brake pedal is operated after the engine is turned off and the oil pump stops, during a few operations a fluid sound due to the flow of high-pressure oil or a sound of movement by the charge spool may be produced, but this sound is not abnormal; it merely indicates that boosting by the accumulator (accumulator operation) is proceeding normally.
  Also, a similar fluid sound is produced during quick operation of the brake pedal even if the engine is on, but this too is normal.
- If the pressure of the oil in the accumulator drops with operation of the brake pedal after the engine is turned off or when the engine has been off for a long time, then immediately after the engine is turned on, fluid sound during charge valve operation or switching sound when charging ends will be produced, but this sound is not abnormal; it merely indicates that the accumulator is being normally charged.
  Also, a similar charging operation sometimes occurs and sound is sometimes produced when the pressure inside the accumulator drops even when the engine is on and charging has ended, due to such causes as rapid operation of the brake pedal, internal leakage that is too slight to affect brake performance, or a change in temperature; this too is normal.
- When the brake pedal is pressed strongly as far as the booster full load region while the engine is on, sometimes sound is produced by the flow of hydraulic oil discharged from the oil pump, but this is not abnormal. Also, pressing the pedal in as far as this booster full load region can cause a significant increase in the oil temperature inside the oil pump and can lead to a failure, so keep the pedal pressed for no longer than 5 seconds.

Brake Lining

PROBLEM	POSSIBLE CAUSE	CORRECTION
Poor Contact at the Center of Shoe	1. Bell-mouthed drum. 2. Distorted mounting plate. 3. Bent brake shoe. 4. Undersize linings. 5. Loose wheel bearing.	1-5. Repair or replace as required.
Unequal Wear on the Shoes in the Same Brake	1. Brake linings not a balanced set. 2. Sticking wheel cylinder piston.	1-2. Repair or replace as required.
Material at the Center of the Shoe Excessively Thin	1. Undersize linings. 2. Oversize drum.	1-2. Repair or replace as required.
Lining Tapered across the Width	1. Bell-mouthed drum. 2. Bent shoe. 3. Distorted mounting plate.	1-3. Repair or replace as required.
Lining Worn at One End	Bent mounting plate.	Repair or replace as required.
Linings Glazed	1. Grease on lining. 2. Wrong type lining for service involved.	1-2. Repair or replace as required.
Rivets Tear Loose	1. Improper set rivet. 2. Improper setting of the rivet. 3. Enlarged rivet holes in the shoe.	1-3. Repair or replace as required.
Unequal Wear Opposite Brakes, Same Axle	1. Weak shoe return spring. 2. Obstructed hydraulic line. 3. Stuck wheel cylinder piston. 4. Brake drum surface in poor condition. 5. Loose wheel bearing.	1-5. Repair or replace as required.
Linings at Scored	1. Scored drum. 2. Abrasive material between the lining and drum.	1-2. Repair or replace as required.
Cracks at Rivet Holes	1. Wrong type rivets. 2. Rivets not properly set. 3. Dirt or rust on the shoe table. 4. Wrong size lining.	1-4. Repair or replace as required.
Elongation of the Rivet Holes	1. Loose rivets. 2. Wrong size rivets.	1-2. Repair or replace as required.
Wear on the Edge of the Lining	1. Wrong width lining. 2. Holes improperly drilled. 3. Loose wheel bearing. 4. Bent shoe.	1-4. Repair or replace as required.
Groove on the Edge of the Lining	1. Lining too wide. 2. Worn drum.	1-2. Repair or replace as required.

Brake Drum

PROBLEM	POSSIBLE CAUSE	CORRECTION
Brake Drum Heat Checked in Spots	1. Out-of-round brake drum. 2. Eccentric mounting of the drum. 3. Loose wheel bearing.	1-3. Repair or replace as required.
Drum Uniformly Heat Checked	1. Improper friction materials. 2. Overworked brake. 3. Driver abuse.	1-3. Repair or replace as required.
Excessive Scoring of the Drum	1. Improper friction materials. 2. Overworked brake. 3. Abrasive material between the lining and drum. 4. Soft drum. 5. Bent or warped shoe.	1-5. Repair or replace as required.
Excessive Drum Cracks	1. Drive abuse. 2. Weak drum. 3. Wrong friction material. 4. Overworked brake.	1-4. Repair or replace as required.

Exhaust Brake

PROBLEM	POSSIBLE CAUSE	CORRECTION
Exhaust Brake does not Operate	1. Blown fuse. 2. Improperly adjusted or faulty accelerator or clutch switches. 3. Poor connections or corroded terminals at switches or control valve. 4. Improperly adjusted or seized exhaust brake valve. 5. Vacuum lines kinked, restricted, or plugged with ice. 6. Seized vacuum chamber. 7. Valve linkage broken. 8. Chamber or control valve jammed with ice. 9. Faulty control valve. Valve should open when approximate battery(s) voltage is applied to terminals. 10. Faulty vacuum chamber. 11. Broken wire in wiring harness.	1. Replace. 2. Adjust or replace. 3. Clean or replace. 4. Adjust, or repair. 5. Repair. 6. Repair. 7. Repair. 8. Melt ice and drain lines of water. 9. Replace. 10. Replace. 11. Repair.
Exhaust Brake SIow to Operate	1. Tighten exhaust brake valve or linkage. 2. Improperly adjusted accelerator or clutch switches.	1. Free up and lubricate. 2. Adjust.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Weak Braking Action	1. Improperly adjusted or tight exhaust brake valve. 2. Tight linkage. 3. Vacuum lines kinked or partially plugged with ice. 4. Leaking fittings at vacuum lines. 5. Leaky vacuum chamber.	1. Free up and/or adjust. Lubricate as needed. 2. Free up and lubricate. 3. Repair. 4. Tighten. 5. Replace.
Exhaust Brake will not Shut Off (Exhaust Brake Control Switch “Off”)	1. Seized exhaust brake valve or linkage. 2. Control valve or chamber jammed with ice. 3. Short in wiring harness (approximate battery(s) voltage) at control solenoid regardless of control switch position. 4. Faulty control switch.	1. Free up and lubricate. 2. Melt ice and drain lines. 3. Repair. 4. Replace.
Exhaust Brake “On” Continuously when Exhaust Brake Control Switch is “On” (not Controlled by Clutch or Accelerator Switches)	1. Improperly adjusted clutch or accelerator switches. 2. Switches improperly wired. 3. Short in wiring harness.	1. Adjust. 2. Check wiring against wiring diagram. Repair as needed. 3. Repair.
Engine Overheats or Loses Power	1. Engine brake valve stuck partially closed. 2. Engine brake valve adjusted so that it is partially closed.	1. Free up and lubricate or replace. 2. Adjust.

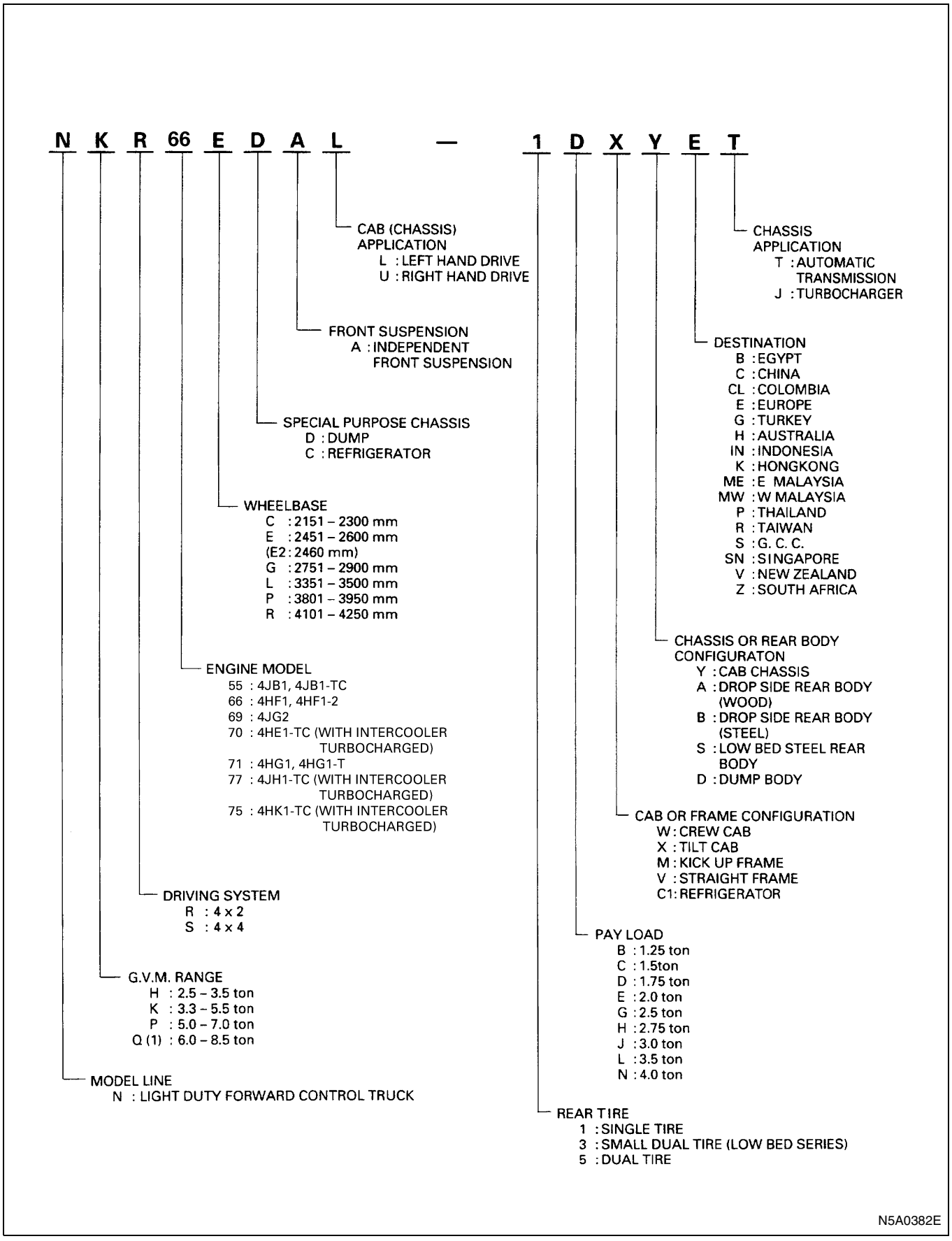
Parking Brakes

Insufficient Braking Force

PROBLEM	POSSIBLE CAUSE	CORRECTION
Brake lining and drum clearance	Clearance between the brake lining and the brake drum excessive	Adjust the brake lining and the brake drum clearance.
Brake lining	Brake lining worn out	Replace the brake lining.
Camshaft	Camshaft worn out	Replace the camshaft.
Control wire	Control wire stretched	Adjust the control wire length or replace the control wire.

MAIN DATA AND SPECIFICATIONS

Model Designation (Explanation Only)



—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	FRONT BRAKE																				
		DISC BRAKE									DRUM BRAKE											
		WHEEL CYL			DISC						Type		WHEEL CYL.			DRUM.			LINING			
		Inside dia. (in)			Thickness (mm)			Outside dia. (mm)			2L	D2L	Inside dia. (in)			Inside dia. (in)			Width (mm)			
		2+1/8	2	2+1/4	35	40	42	265	293	310			1+1/8	1+3/16	1+3/8	279.4	300	320	60	75	100	120
1	NHR55EU-1CB										❍		❍			❍			❍			
2	NHR55EU-1CY										❍		❍			❍			❍			
3	NHR55EU-1CYIN										❍		❍			❍			❍			
4	NHR55EU-1BWS										❍		❍			❍			❍			
5	NHR55EU-3CB										❍		❍			❍			❍			
6	NHR55EU-3CYZJ										❍		❍			❍			❍			
7	NHR55EU-3CBSN										❍		❍			❍			❍			
8	NHR55EL-1CBS										❍		❍			❍			❍			
9	NHR55EL-1CYS										❍		❍			❍			❍			
10	NHR55EL-1CY										❍		❍			❍			❍			
11	NHR55EL-1CXY										❍		❍			❍			❍			
12	NHR55EL-1CYCLJ										❍		❍			❍			❍			
13	NHR55EL-1BWS										❍		❍			❍			❍			
14	NHR55EL-3CBS										❍		❍			❍			❍			
15	NHR55EL-3CYS										❍		❍			❍			❍			
16	NHR55EL-3CB										❍		❍			❍			❍			

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	REAR BRAKE																PARKING BRAKE								BRAKE CONTROL								
		DRUM BRAKE																																
		Type		WHEEL CYL					DRUM.					LINING					DRUM.				LINING				MASTER CYL								
		D2L (W/O AUTO)	D2L (W AUTO)	Inside dia. (in)					Inside dia. (mm)					Width (mm)					Inside dia. (in)				Width (mm)				Inside dia. (in)				DSPV	LSPV	EXHAUST BRAKE	HBB	ABS
				7/8	1	1+3/16	1+5/16	1+3/8	228.6	240	279.4	300	320	60	75	90	100	120	178	190	203	254	35	45	50	60	1+1/16	1+1/8	1+1/4	1+3/8					
No.	Models	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1	NHR55EU-1CB	❍		❍					—		❍			❍	—				❍				❍				❍				❑		❑		
2	NHR55EU-1CY	❍		❍					—		❍			❍	—				❍				❍				❍				—		❑		
3	NHR55EU-1CYIN	❍		❍					—		❍			❍	—				❍				❍				❍				—		❑		
4	NHR55EU-1BWS	❍		❍					—		❍			❍	—				❍				❍				❍				❑		❑		
5	NHR55EU-3CB	❍		❍					❍		—			—	❍				❍				❍				❍				❑		❑		
6	NHR55EU-3CYZJ	❍		❍					❍		—			—	❍				❍				❍				❍				—	❍	❑		
7	NHR69EU-3CBSN	❍		❍					❍		—			—	❍				❍				❍				❍				❑		❑		
8	NHR55EL-1CBS	❍		❍					—		❍			❍	—				❍				❍				❍				❑		❑		
9	NHR55EL-1CYS	❍		❍					—		❍			❍	—				❍				❍				❍				—		❑		
10	NHR55EL-1CY	❍		❍					—		❍			❍	—				❍				❍				❍				—		❑		
11	NHR55EL-1CXY	❍		❍					—		❍			❍	—				❍				❍				❍				—		❑		
12	NHR55EL-1CYCLJ	❍		❍					—		❍			❍	—				❍				❍				❍				—	❍	❑		
13	NHR55EL-1BWS	❍		❍					—		❍			❍	—				❍				❍				❍				❑		❑		
14	NHR55EL-3CBS	❍		❍					❍		—			—	❍				❍				❍				❍				❑		❑		
15	NHR55EL-3CYS	❍		❍					❍		—			—	❍				❍				❍				❍				—		❑		
16	NHR55EL-3CB	❍		❍					❍		—			—	❍				❍				❍				❍				❑		❑		

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	FRONT BRAKE																				
		DISC BRAKE									DRUM BRAKE											
		WHEEL CYL			DISC						Type		WHEEL CYL.			DRUM.			LINING			
		Inside dia. (in)			Thickness (mm)			Outside dia. (mm)			2L	D2L	Inside dia. (in)			Inside dia. (in)			Width (mm)			
		2 + 1/8	2	2 + 1/4	35	40	42	265	293	310			1 + 1/8	1 + 3/16	1 + 3/8	279.4	300	320	60	75	100	120
1	NKR55EU-1EXY	—	—		—	—		—	—		❍	—	❍	—			❍	—		❍		
2	NKR77EAU-1DXYEJ	—	❍		❍	—		❍	—		—	—	—	—			—	—		—		
3	NKR66EU-1EYIN2	—	—		—	—		—	—		❍	—	❍	—			❍	—		❍		
4	NKR77E2U-5DXYEJ	❍	—		—	❍		—	❍		—	—	—	—			—	—		—		
5	NKR77E2U-5HXYKJ	❍	—		—	❍		—	❍		—	—	—	—			—	—		—		
6	NKR66E2U-5HXY2	—	—		—	—		—	—		❍	—	❍	—			❍	—		❍		
7	NKR77E2U-5EXYHJ	❍	—		—	❍		—	❍		—	—	—	—			—	—		—		
8	NKR77LU-5EXYHJ	❍	—		—	❍		—	❍		—	—	—	—			—	—		—		
9	NKR55LU-5HXY	—	—		—	—		—	—		❍	—	❍	—			❍	—		❍		
10	NKR66LU-5HXYZ	—	—		—	—		—	—		❍	—	❍	—			—	❍		❍		
11	NKR77LU-5HXYKJ	❍	—		—	❍		—	❍		—	—	—	—			—	—		—		
12	NKR77LU-5DXYEJ	❍	—		—	❍		—	❍		—	—	—	—			—	—		—		
13	NKR66LU-5HXY2	—	—		—	—		—	—		❍	—	❍	—			❍	—		❍		

—	Not available
❍	Standard
❑	Factory option
	Non

		REAR BRAKE																														
		DRUM BRAKE																														
		Type		WHEEL CYL					DRUM.					LINING				DRUM.				LINING				MASTER CYL							
		D2L (W/O AUTO)	D2L (W AUTO)	Inside dia. (in)					Inside dia. (mm)					Width (mm)				Inside dia. (in)				Width (mm)				Inside dia. (in)				DSPV	LSPV	EXHAUST BRAKE	HBB	ABS
				7/8	1	1+3/16	1+5/16	1+3/8	228.6	240	290	300	320	60	75	100	120	178	190	203	254	35	45	50	60	1+1/16	1+1/8	1+3/16	1+1/4					
No.	Models	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
1	NKR55EU-1EXY	❍	—	❍	—	—			—		—	❍	—		❍	—		❍	—			❍	—				❍	—		—	—	❑		—
2	NKR77EAU-1DXYEJ	—	❍	—	❍	—			—		❍	—	—		❍	—		—	❍			—	❍				❍	—		—	❍	❍		❑
3	NKR66EU-1EYIN2	❍	—	❍	—	—			—		—	❍	—		❍	—		—	❍			—	❍				❍	—		—	—	❍		—
4	NKR77E2U-5DXYEJ	—	❍	—	❍	—			—		—	—	❍		❍	—		—	❍			—	❍				—	❍		—	❍	❍		❑
5	NKR77E2U-5HXYKJ	—	❍	—	❍	—			—		—	—	❍		❍	—		—	❍			—	❍				—	—	❍	—	❍	❍		❑
6	NKR66E2U-5HXY2	❍	—	—	❍	—			—		—	❍	—		❍	—		—	❍			—	❍				❍	—		—	—	❍		—
7	NKR77E2U-5EXYHJ	—	❍	—	❍	—			—		—	—	❍		❍	—		—	❍			—	❍				—	—	❍	—	❍	❍		❑
8	NKR77LU-5EXYHJ	—	❍	—	❍	—			—		—	—	❍		❍	—		—	❍			—	❍				—	—	❍	—	❍	❍		❑
9	NKR55LU-5HXY	❍	—	—	❍	—			—		—	❍	—		❍	—		❍	—			❍	—				❍	—		—	—	❑		—
10	NKR66LU-5HXYZ	❍	—	—	❍	—			—		—	—	❍		❍	—		—	❍			—	❍				❍	—		—	❍	❑		—
11	NKR77LU-5HXYKJ	—	❍	—	❍	—			—		—	—	❍		❍	—		—	❍			—	❍				—	—	❍	—	❍	❍		❑
12	NKR77LU-5DXYEJ	—	❍	—	❍	—			—		—	—	❍		❍	—		—	❍			—	❍				—	❍		—	❍	❍		❑
13	NKR66LU-5HXY2	❍	—	—	❍	—			—		—	❍	—		❍	—		—	❍			—	❍				❍	—		—	—	❍		—

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	FRONT BRAKE																					
		DISC BRAKE									DRUM BRAKE												
		WHEEL CYL			DISC						Type			WHEEL CYL.			DRUM.			LINING			
		Inside dia. (in)			Thickness (mm)			Outside dia. (mm)			2L (W/O AUTO)	2L (W AUTO)	D2L	Inside dia. (in)			Inside dia. (in)			Width (mm)			
		2+1/8	2	2+1/4	35	40	42	265	293	310				1+1/8	1+3/16	1+3/8	279.4	300	320	60	75	100	120
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		
14	NKR66LU-5HYIN2	—	—		—	—		—	—		❍	—	—	❍	❑			—	❍		❍	❑	
15	NKR71LU-5LYIN	—	—		—	—		—	—		❍	—	—	—	❍			—	❍		—	❍	
16	NKR66LU-5GWY2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
17	NKR77EU-3EXYHJ	❍	—		—	❍		—	❍		—	—	—	—	—			—	—		—	—	
18	NKR55EL-1EY	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
19	NKR55EL-1EXY	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
20	NKR55EL-1DXYG	—	—		—	—		—	—		—	❍	—	❍	—			❍	—		❍	—	
21	NKR69EL-1EXYCH	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
22	NKR77EAL-1DXYEJ	—	❍		❍	—		❍	—		—	—	—	—	—			—	—		—	—	
23	NKR66EL-1EXY2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
24	NKR77E2L-5DXYEJ	❍	—		—	❍		—	❍		—	—	—	—	—			—	—		—	—	
25	NKR55E2L-5HXY	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
26	NKR55E2L-5HXYCLJ	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
27	NKR66E2L-5HXY2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
28	NKR66E2L-5HXA2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
29	NKR66E2L-5HXYS2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	REAR BRAKE																PARKING BRAKE								BRAKE CONTROL								
		DRUM BRAKE																																
		Type		WHEEL CYL					DRUM.					LINING				DRUM.				LINING				MASTER CYL								
		D2L (W/O AUTO)	D2L (W AUTO)	Inside dia. (in)					Inside dia. (mm)					Width (mm)				Inside dia. (in)				Width (mm)				Inside dia. (in)				DSPV	LSPV	EXHAUST BRAKE	HBB	ABS
				7/8	1	1+3/16	1+5/16	1+3/8	28.6	240	290	300	320	60	75	100	120	178	190	203	254	35	45	50	60	1+1/16	1+1/8	1+3/16	1+1/4					
No.	Models	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
14	NKR66LU-5HYIN2	❍	—	—	❍	❑			—		—	—	❍		❍	❑		—	❍			—	❍				❍	—	❑	—	—	❍		
15	NKR71LU-5LYIN	❍	—	—	—	❍			—		—	—	❍		—	❍		—	❍			—	❍				—	—	❍	—	—	❍		
16	NKR66LU-5GWY2	❍	—	—	❍	—			—		—	❍	—		❍	—		—	❍			—	❍				❍	—	—	—	—	❍		
17	NKR77EU-3EXYHJ	—	❍	—	❍	—			—	❍	—	—	—	❍	—	—		—	❍			—	❍				—	—	❍	—	❍	❍		❑
18	NKR55EL-1EY	❍	—	❍	—	—			—		—	❍	—		❍	—		❍	—			❍	—				❍	—	—	—	—	❑		
19	NKR55EL-1EXY	❍	—	❍	—	—			—		—	❍	—		❍	—		❍	—			❍	—				❍	—	—	—	—	❑		
20	NKR55EL-1DXYG	—	❍	—	❍	—			—		❍	—	—		❍	—		❍	—			❍	—				—	❍	—	—	❍	❑		
21	NKR69EL-1EXYCH	❍	—	❍	—	—			—		—	❍	—		❍	—		❍	—			❍	—				❍	—	—	—	—	❑		
22	NKR77EAL-1DXYEJ	—	❍	—	❍	—			—		❍	—	—		❍	—		—	❍			—	❍				❍	—	—	—	❍	❍		❑
23	NKR66EL-1EXY2	❍	—	❍	—	—			—		—	❍	—		❍	—		—	❍			—	❍				❍	—	—	—	—	❍		
24	NKR77E2L-5DXYEJ	—	❍	—	❍	—			—		—	—	❍		❍	—		—	❍			—	❍				—	❍	—	—	❍	❍		❑
25	NKR55E2L-5HXY	❍	—	—	❍	—			—		—	❍	—		❍	—		❍	—			❍	—				❍	—	—	—	—	❑		
26	NKR55E2L-5HXYCLJ	❍	—	—	❍	—			—		—	❍	—		❍	—		❍	—			❍	—				❍	—	—	—	—	❑		
27	NKR66E2L-5HXY2	❍	—	—	❍	—			—		—	❍	—		❍	—		—	❍			—	❍				❍	—	—	—	—	❍		
28	NKR66E2L-5HXA2	❍	—	—	❍	—			—		—	❍	—		❍	—		—	❍			—	❍				❍	—	—	❑	—	❍		
29	NKR66E2L-5HXYS2	❍	—	—	❍	—			—		—	❍	—		❍	—		—	❍			—	❍				❍	—	—	—	—	❑		

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	FRONT BRAKE																					
		DISC BRAKE									DRUM BRAKE												
		WHEEL CYL			DISC						Type			WHEEL CYL.			DRUM.			LINING			
		Inside dia. (in)			Thickness (mm)			Outside dia. (mm)			2L (W/O AUTO)	2L (W AUTO)	D2L	Inside dia. (in)			Inside dia. (in)			Width (mm)			
		2+1/8	2	2+1/4	35	40	42	265	293	310				1+1/8	1+3/16	1+3/8	279.4	300	320	60	75	100	120
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
30	NKR66EDL-5EMXD2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
31	NKR66EDL-5EMXDS2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
32	NKR55LL-5HXY	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
33	NKR77LL-5DXYEJ	❍	—		—	❍		—	❍		—	—	—	—	—			—	—		—	—	
34	NKR69LL-5HXYCH	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
35	NKR66LL-5HXY2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
36	NKR66LL-5HXA2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
37	NKR66LL-5HXYS2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
38	NKR66LL-5HXAS2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
39	NKR66LL-5GWY2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
40	NKR66LL-5GWA2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
41	NKR66LL-5GWYS2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
42	NKR66LL-5GWAS2	—	—		—	—		—	—		❍	—	—	❍	—			❍	—		❍	—	
43	NKR55EL-3DXYG	—	—		—	—		—	—		—	❍	—	❍	—			❍	—		❍	—	

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	REAR BRAKE																PARKING BRAKE								BRAKE CONTROL								
		DRUM BRAKE																																
		Type		WHEEL CYL					DRUM.					LINING				DRUM.				LINING				MASTER CYL.								
				Inside dia. (in)					Inside dia. (mm)					Width (mm)				Inside dia. (in)				Width (mm)				Inside dia. (in)								
		D2L (W/O AUTO)	D2L (W AUTO)	7/8	1	1+3/16	1+5/16	1+3/8	228.6	240	290	300	320	60	75	100	120	178	190	203	254	35	45	50	60	1+1/16	1+1/8	1+3/16	1+1/4	DSPV	LSPV	EXHAUST BRAKE	HBB	ABS
No.	Models	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
30	NKR66EDL-5EMXD2	❍	—	—	❍	—			—	—	—	❍	—		❍	—		—	❍			—	❍				❍	—	—	—	—	❍		
31	NKR66EDL-5EMXDS2	❍	—	—	❍	—			—	—	—	❍	—		❍	—		—	❍			—	❍				❍	—	—	—	—	❑		
32	NKR55LL-5HXY	❍	—	—	❍	—			—	—	—	❍	—		❍	—		❍	—			❍	—				❍	—	—	—	—	❑		
33	NKR77LL-5DXYEJ	—	❍	—	❍	—			—	—	—	—	❍		❍	—		—	❍			—	❍				—	❍	—	—	❍	❍		❑
34	NKR69LL-5HXYCH	❍	—	—	❍	—			—	—	—	❍	—		❍	—		❍	—			❍	—				❍	—	—	—	—	❍		
35	NKR66LL-5HXY2	❍	—	—	❍	—			—	—	—	❍	—		❍	—		—	❍			—	❍				❍	—	—	—	—	❍		
36	NKR66LL-5HXA2	❍	—	—	❍	—			—	—	—	❍	—		❍	—		—	❍			—	❍				❍	—	—	—	—	❍		
37	NKR66LL-5HXYS2	❍	—	—	❍	—			—	—	—	❍	—		❍	—		—	❍			—	❍				❍	—	—	—	—	❑		
38	NKR66LL-5HXAS2	❍	—	—	❍	—			—	—	—	❍	—		❍	—		—	❍			—	❍				❍	—	—	—	—	❑		
39	NKR66LL-5GWY2	❍	—	—	❍	—			—	—	—	❍	—		❍	—		—	❍			—	❍				❍	—	—	—	—	❍		
40	NKR66LL-5GWA2	❍	—	—	❍	—			—	—	—	❍	—		❍	—		—	❍			—	❍				❍	—	—	—	—	❍		
41	NKR66LL-5GWYS2	❍	—	—	❍	—			—	—	—	❍	—		❍	—		—	❍			—	❍				❍	—	—	—	—	❑		
42	NKR66LL-5GWAS2	❍	—	—	❍	—			—	—	—	❍	—		❍	—		—	❍			—	❍				❍	—	—	—	—	❑		
43	NKR55EL-3DXYG	—	❍	—	❍	—			—	❍	—	—	—	❍	—	—		❍	—			❍	—				—	❍	—	—	❍	❍		

Front Brakes (NKR)

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	FRONT BRAKE																					
		DISC BRAKE								DRUM BRAKE										LINING			
		WHEEL CYL			DISC					Type			WHEEL CYL.			DRUM.			Width (mm)			
		Inside dia. (in)			Thickness (mm)			Outside dia. (mm)					Inside dia. (in)			Inside dia. (in)						
		2 + 1/8	2 + 2	2 + 1/4	3 5	4 0	4 2	2 6 5	2 9 3	3 1 0	2 L (W/O AUTO)	2 L (W AUTO)	D 2 L	1 + 1/8	1 + 3/16	1 + 3/8	2 7 9 . 4	3 0 0	3 2 0 0	6 0 0	7 5	1 0 0	1 2 0
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
44	NKR77EL-3EXYRJ	—	—		—	—		—	—		❍	—	—	❍	—		—	❍	—		❍	—	
45	NKR77EL-3EXARJ	—	—		—	—		—	—		❍	—	—	❍	—		—	❍	—		❍	—	
46	NKR77LL-5EXYRJ	—	—		—	—		—	—		❍	—	—	❍	—		—	❍	—		❍	—	
47	NKR77LL-5HXYRJ	—	—		—	—		—	—		❍	—	—	❍	—		—	❍	—		❍	—	

Rear Brakes (NKR)

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	REAR BRAKE																			PARKING BRAKE												BRAKE CONTROL											
		DRUM BRAKE																																										
		Type		WHEEL CYL.					DRUM.				LINING								DRUM.				LINING								MASTER CYL.											
		D22L (W/O AUTO)	D22L (W AUTO)	Inside dia. (in)					Inside dia. (mm)				Width (mm)								Inside dia. (in)				Width (mm)								Inside dia. (in)											
				7/8	1	1 + 3/16	1 + 5/16	1 + 3/8	2 24/32	2 24/32	2 24/32	3	6/0	7/0	1 1/0	1 2/0	1 7/8	1 9/16	2 0/32	2 0/32	2 5/32	3/4	4/5	5/0	6/0	1 + 1/16	1 + 3/16	1 + 1/8	1 + 1/4															
1		❍	—	—	❍	—	—	❍	—	—	—	—	—	❍	—	—	—	❍	—	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍
2	NKR77EL-3EXYRJ	❍	—	—	❍	—	—	❍	—	—	—	—	—	❍	—	—	—	❍	—	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍
3	NKR77EL-3EXARJ	❍	—	—	❍	—	—	❍	—	—	—	—	—	❍	—	—	—	❍	—	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍
4	NKR77LL-5EXYRJ	❍	—	—	❍	—	—	❍	—	—	—	❍	—	❍	—	—	—	❍	—	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍
5	NKR77LL-5HXYRJ	❍	—	—	❍	—	—	❍	—	—	—	❍	—	❍	—	—	—	❍	—	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍	—	—	—	❍

—	Not available
❍	Standard
❑	Factory option
	Non

		FRONT BRAKE																						
		DISC BRAKE										DRUM BRAKE												
		WHEEL CYL.			DISC							Type			WHEEL CYL.			DRUM.			LINING			
		Inside dia. (in)			Thickness (mm)			Outside dia. (mm)				2L (W/O AUTO)	2L (W AUTO)	D2L	Inside dia. (in)			Inside dia. (in)			Width (mm)			
		2+1/8	2	2+1/4	35	40	42	265	293	310	363				1+1/8	1+3/16	1+3/8	279	300	320	60	75	100	120
No.	Models	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	NPR66GU-5JXY2	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
2	NPR66GU-5JXY	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
3	NPR77GU-5DXYEJ	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
4	NPR75GU-5EXYHJ2	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
5	NPR66GDU-5LX	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
6	NPR66GU-5LXY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
7	NPR70GU-5JXYKJ	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
8	NPR70GU-5LXYKJ	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
9	NPR77LU-5DXYEJ	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
10	NPR77LU-5HXYEJ	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
11	NPR75LU-5EXYHJ2	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
12	NPR66LU-5JXA2	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
13	NPR66LU-5JXY2	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
14	NPR66LU-5JVXYZ	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
15	NPR66LU-5LXA	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
16	NPR66LU-5LXY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
17	NPR66LU-5LVXYZ	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
18	NPR75LU-5JXYHJ2	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
19	NPR71LU-5JXYSNJ	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
20	NPR75LU-5JXYEJ2	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	REAR BRAKE																				PARKING BRAKE				BRAKE CONTROL									
		DRUM BRAKE																																	
		Type		WHEEL CYL.					DRUM.						LINING							DRUM.		LINING		MASTER CYL.									
		D2L (W/O AUTO)	D2L (W AUTO)	Inside dia. (in)					Inside dia. (in)						Width (mm)							Inside dia. (in)		Width (mm)		Inside dia. (in)							DSPV	LSPV	EXHAUST BRAKE	HBB	ABS
				7/8	1	1+3/16	1+5/16	1+3/8	228	260	279	300	320	370	60	75	90	100	120	150	190	203	45	50	8+9T	9+10T	1+1/16	1+1/8	1+1/4	1+3/8					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
1	NPR66GU-5JXY2	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
2	NPR66GU-5JXY	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
3	NPR77GU-5DXYEJ	—	❍		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❑
4	NPR75GU-5EXYHJ2	—	❍		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❍
5	NPR66GDU-5LX	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
6	NPR66GU-5LXY	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
7	NPR70GU-5JXYKJ	—	❍		—	❍	—	—		—			❍	—		—	—	❍	—	—	—	❍	—	❍	—	❍		—	❍	—		❍	❍	—	❑
8	NPR70GU-5LXYKJ	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		❍	❍	❍	❑
9	NPR77LU-5DXYEJ	—	❍		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❑
10	NPR77LU-5HXYEJ	—	❍		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❍
11	NPR75LU-5EXYHJ2	—	❍		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❍
12	NPR66LU-5JXA2	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
13	NPR66LU-5JXY2	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
14	NPR66LU-5JVXYZ	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		❍	❍	—	—
15	NPR66LU-5LXA	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
16	NPR66LU-5LXY	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
17	NPR66LU-5LVXYZ	❍	—		—	—	❍	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	—
18	NPR75LU-5JXYHJ2	—	❍		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❍
19	NPR71LU-5JXYSNJ	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
20	NPR75LU-5JXYEJ2	—	❍		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❍

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	FRONT BRAKE																						
		DISC BRAKE										DRUM BRAKE												
		WHEEL CYL.			DISC							Type			WHEEL CYL.			DRUM.			LINING			
		Inside dia. (in)			Thickness (mm)			Outside dia. (mm)				2L (W/O AUTO)	2L (W AUTO)	D2L	Inside dia. (in)			Inside dia. (in)			Width (mm)			
		2+1/8	2+2	2+1/4	35	40	42	265	293	310	363				1+1/8	1+3/16	1+3/8	279	300	320	60	75	100	120
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
21	NPR70LU-5JXYKJ	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
22	NPR70LU-5LXYKJ	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
23	NPR75LU-5LXYHJ2	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
24	NQR75LU-5LXYEJ	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
25	NQR75LU-5LXYEJ2	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
26	NQR75LU-5NXYHJ	—		❍		—	❍		—	—	❍	—	—	—	—	—	—			—		—	—	—
27	NPR75LU-5KWYHJ2	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
28	NPR75LU-5HWYEJ2	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
29	NPR70LU-5HWYKJ	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
30	NPR66PU-5JXA2	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
31	NPR66PU-5JXY2	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
32	NPR66PU-5LXA	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
33	NPR66PU-5LXY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
34	NPR66PU-5LVXY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
35	NPR66PBU-5LVY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
36	NPR66PU-5LVXYZ	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
37	NQR66PU-5NVXY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	—	❍
38	NQR71PU-5NVXY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	—	❍
39	NPR75PU-5JXYEJ2	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
40	NPR70PU-5JXYKJ	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—

—	Not available
❍	Standard
❑	Factory option
	Non

		REAR BRAKE																				PARKING BRAKE				BRAKE CONTROL									
		DRUM BRAKE																																	
		Type		WHEEL CYL.					DRUM.						LINING							DRUM.		LINING		MASTER CYL.									
		D2L (W/O AUTO)	D2L (W AUTO)	Inside dia. (in)					Inside dia. (in)						Width (mm)							Inside dia. (in)		Width (mm)		Inside dia. (in)						DSPV	LSPV	EXHAUST BRAKE	HBB	ABS
				7/8	1	1+3/16	1+5/16	1+3/8	228	260	279	300	320	370	60	75	90	100	120	150	190	203	45	50	8+9T	9+10T	1+1/16	1+1/8	1+1/4	1+3/8					
No.	Models	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
21	NPR70LU-5JXYKJ	—	❍		—	❍	—	—		—			❍	—		—	—	❍	—	—	—	❍	—	❍	—	❍		—	❍	—		❍	❍	—	❑
22	NPR70LU-5LXYKJ	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		❍	❍	❍	❑
23	NPR75LU-5LXYHJ2	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	—		—	—	❍		❍	❍	❍	❍
24	NQR75LU-5LXYEJ	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		❍	❍	❍	❍
25	NQR75LU-5LXYEJ2	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	—		—	—	❍		❍	❍	❍	❍
26	NQR75LU-5NXYHJ	—	❍		—	—	❍	—		—			—	❍		—	—	—	—	❍	—	❍	—	❍	—	—		—	—	❍		❍	❍	❍	❍
27	NPR75LU-5KWYHJ2	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	—		—	—	❍		❍	❍	❍	❍
28	NPR75LU-5HWYEJ2	—	❍		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❍
29	NPR70LU-5HWYKJ	—	❍		—	❍	—	—		—			❍	—		—	—	❍	—	—	—	❍	—	❍	—	❍		—	❍	—		❍	❍	—	❑
30	NPR66PU-5JXA2	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
31	NPR66PU-5JXY2	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
32	NPR66PU-5LXA	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
33	NPR66PU-5LXY	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
34	NPR66PU-5LVXY	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
35	NPR66PBU-5LVY	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
36	NPR66PU-5LVXYZ	❍	—		—	—	❍	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	—
37	NQR66PU-5NVXY	❍	—		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
38	NQR71PU-5NVXY	❍	—		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
39	NPR75PU-5JXYEJ2	—	❍		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❍
40	NPR70PU-5JXYKJ	—	❍		—	❍	—	—		—			❍	—		—	—	❍	—	—	—	❍	—	❍	—	❍		—	❍	—		❍	❍	—	❑

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	FRONT BRAKE																						
		DISC BRAKE										DRUM BRAKE												
		WHEEL CYL.			DISC							Type			WHEEL CYL.			DRUM.			LINING			
		Inside dia. (in)			Thickness (mm)			Outside dia. (mm)				2L (W/O AUTO)	2L (W AUTO)	D2L	Inside dia. (in)			Inside dia. (in)			Width (mm)			
		2+1/8	2+2	2+1/4	35	40	42	265	293	310	363				1+1/8	1+3/16	1+3/8	279	300	320	60	75	100	120
No.	Models	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
41	NPR70PU-5LXYKJ	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
42	NPR75PU-5LXYHJ2	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
43	NQR75PU-5LXYEJ	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
44	NQR75PU-5LXYEJ2	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
45	NQR70PU-5NXYKJ	—		—		—	—		—	—	—	❍	—	—	—	—	❍			❍		—	—	❍
46	NQR66RU-5NVXY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	—	❍
47	NQR71RU-5NVXY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	—	❍
48	NQR75RU-5NXYZJ	—		—		—	—		—	—	—	❍	—	—	—	—	❍			❍		—	—	❍
49	NQR75RBU-5NXYZJ	—		—		—	—		—	—	—	❍	—	—	—	—	❍			❍		—	—	❍
50	NQR75RU-5NXYHJ	—		❍		—	❍		—	—	❍	—	—	—	—	—	—			—		—	—	—
51	NQR70RU-5NXYKJ	—		—		—	—		—	—	—	❍	—	—	—	—	❍			❍		—	—	❍
52	NQR75TU-5JXYEJ	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
53	NQR75TU-5LXYEJ2	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
54	NQR75TU-5KWYEJ	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
55	NQR75TU-5KWYEJ2	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
56	NPR71LU-4EXYSNJ	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
57	NPS75LU-5JXYHJ2	—		—		—	—		—	—	—	—	—	❍	—	❍	—			❍		❍	—	—
58	NPS71LU-5JXYIN	—		—		—	—		—	—	—	—	—	❍	—	❍	—			❍		❍	—	—
59	NPR77GL-5DXYEJ	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
60	NPR66GL-5JXY2	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	REAR BRAKE																				PARKING BRAKE				BRAKE CONTROL									
		DRUM BRAKE																																	
		Type		WHEEL CYL.					DRUM.						LINING							DRUM.		LINING		MASTER CYL.									
		D2L (W/O AUTO)	D2L (W AUTO)	Inside dia. (in)					Inside dia. (in)						Width (mm)							Inside dia. (in)		Width (mm)		Inside dia. (in)						DSPV	LSPV	EXHAUST BRAKE	HBB	ABS
				7/8	1	1+3/16	1+5/16	1+3/8	228	260	279	300	320	370	60	75	90	100	120	150	190	203	45	50	8+9T	9+10T	1+1/16	1+1/8	1+1/4	1+3/8					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
41	NPR70PU-5LXYKJ	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		❍	❍	❍	❑
42	NPR75PU-5LXYHJ2	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	—		—	—	❍		❍	❍	❍	❍
43	NQR75PU-5LXYEJ	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		❍	❍	❍	❍
44	NQR75PU-5LXYEJ2	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	—		—	—	❍		❍	❍	❍	❍
45	NQR70PU-5NXYKJ	❍	—		—	—	—	❍		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		—	❍	❍	—
46	NQR66RU-5NVXY	❍	—		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
47	NQR71RU-5NVXY	❍	—		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
48	NQR75RU-5NXYZJ	❍	—		—	—	—	❍		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		❍	❍	❍	—
49	NQR75RBU-5NXYZJ	❍	—		—	—	—	❍		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		❍	❍	❍	—
50	NQR75RU-5NXYHJ	—	❍		—	—	❍	—		—			—	❍		—	—	—	—	❍	—	❍	—	❍	—	—		—	—	❍		❍	❍	❍	❍
51	NQR70RU-5NXYKJ	❍	—		—	—	—	❍		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		—	❍	❍	—
52	NQR75TU-5JXYEJ	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		❍	❍	❍	❍
53	NQR75TU-5LXYEJ2	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	—		—	—	❍		❍	❍	❍	❍
54	NQR75TU-5KWYEJ	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		❍	❍	❍	❍
55	NQR75TU-5KWYEJ2	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	—		—	—	❍		❍	❍	❍	❍
56	NPR71LU-4EXYSNJ	—	❍		❍	—	—	—		❍			—	—		—	❍	—	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
57	NPS75LU-5JXYHJ2	❍	—		—	—	❍	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
58	NPS71LU-5JXYIN	❍	—		—	—	❍	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
59	NPR77GL-5DXYEJ	—	❍		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	❑
60	NPR66GL-5JXY2	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	FRONT BRAKE																						
		DISC BRAKE										DRUM BRAKE												
		WHEEL CYL.			DISC							Type			WHEEL CYL.			DRUM.			LINING			
		Inside dia. (in)			Thickness (mm)			Outside dia. (mm)				2L (W/O AUTO)	2L (W AUTO)	D2L	Inside dia. (in)			Inside dia. (in)			Width (mm)			
		2+1/8	2	2+1/4	35	40	42	265	293	310	363				1+1/8	1+3/16	1+3/8	279	300	320	60	75	100	120
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
61	NPR66GL-5JXY	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
62	NPR66GDL-5LX	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
63	NPR66GDL-5LXS	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
64	NPR66GL-5LXY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
65	NPR66GL-5LXYS	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
66	NPR70GL-5LXYRJ2	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
67	NPR77LL-5DXYEJ	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
68	NPR66LL-5EXYG	—		—		—	—		—	—	—	—	—	❍	—	❍	—			❍		—	❍	—
69	NPR77LL-5HXYEJ	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
70	NPR66LL-5JXA2	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
71	NPR66LL-5JXY2	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
72	NPR66LL-5JXAS	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
73	NPR66LL-5JXYS	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
74	NPR70LL-5JXYRJ2	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
75	NPR66LL-5LXA	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
76	NPR66LL-5LXY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
77	NPR66LL-5LYB	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
78	NPR71LL-5LXYGJ	—		—		—	—		—	—	—	—	❍	—	—	❍	—			❍		—	—	❍
79	NPR66LL-5LVXY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
80	NQR71LL-5NVXY	—		—		—	—		—	—	—	❍	—	—	—	❍	❑			❍		—	—	❍

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	REAR BRAKE																				PARKING BRAKE				BRAKE CONTROL									
		DRUM BRAKE																																	
		Type		WHEEL CYL.					DRUM.						LINING							DRUM.		LINING		MASTER CYL.									
		D2L (W/O AUTO)	D2L (W AUTO)	Inside dia. (in)					Inside dia. (in)						Width (mm)							Inside dia. (in)		Width (mm)		Inside dia. (in)							DSPV	LSPV	EXHAUST BRAKE	HBB	ABS
				7/8	1	1+3/16	1+5/16	1+3/8	228	260	279	300	320	370	60	75	90	100	120	150	190	203	45	50	8+9T	9+10T	1+1/16	1+1/8	1+1/4	1+3/8					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
61	NPR66GL-5JXY	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
62	NPR66GDL-5LX	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
63	NPR66GDL-5LXS	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
64	NPR66GL-5LXY	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
65	NPR66GL-5LXYS	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
66	NPR70GL-5LXYRJ2	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
67	NPR77LL-5DXYEJ	—	❍		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❑
68	NPR66LL-5EXYG	—	❍		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	—
69	NPR77LL-5HXYEJ	—	❍		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❍
70	NPR66LL-5JXA2	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
71	NPR66LL-5JXY2	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
72	NPR66LL-5JXAS	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❑	—	—
73	NPR66LL-5JXYS	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❑	—	—
74	NPR70LL-5JXYRJ2	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
75	NPR66LL-5LXA	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
76	NPR66LL-5LXY	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
77	NPR66LL-5LYB	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
78	NPR71LL-5LXYGJ	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	—		—	—	❍		❍	❍	❍	❍
79	NPR66LL-5LVXY	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
80	NQR71LL-5NVXY	❍	—		—	—	❍	❑		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	❍		—	❍	❑		—	❍	❑	—

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	FRONT BRAKE																						
		DISC BRAKE										DRUM BRAKE												
		WHEEL CYL.			DISC							Type			WHEEL CYL.			DRUM.			LINING			
		Inside dia. (in)			Thickness (mm)			Outside dia. (mm)				2L (W/O AUTO)	2L (W AUTO)	D2L	Inside dia. (in)			Inside dia. (in)			Width (mm)			
		2+1/8	2	2+1/4	35	40	42	265	293	310	363				1+1/8	1+3/16	1+3/8	279	300	320	60	75	100	120
81	NPR75LL-5JXYEJ2	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
82	NPR70LL-5LXYRJ2	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
83	NPR71LL-5LVXYCLJ	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
84	NQR75LL-5LXYEJ	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
85	NQR75LL-5LXYEJ2	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
86	NPR77LL-5CWYEJ	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
87	NPR66LL-5HWY	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
88	NPR75LL-5HWYEJ2	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
89	NPR66PL-5JXA2	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
90	NPR66PL-5JXY2	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
91	NPR66PL-5JXAS	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
92	NPR66PL-5JXYS	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
93	NPR66PL-5JXY	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
94	NPR70PL-5JXYRJ2	—		—		—	—		—	—	—	❍	—	—	❍	—	—			❍		❍	—	—
95	NPR66PL-5LXA	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
96	NPR66PL-5LXY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
97	NPR66PL-5LXAS	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
98	NPR66PL-5LXYS	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
99	NPR66PBL-5LVY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
100	NPR66PL-5LVXY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	REAR BRAKE																				PARKING BRAKE				BRAKE CONTROL									
		DRUM BRAKE																																	
		Type		WHEEL CYL.					DRUM.						LINING							DRUM.		LINING		MASTER CYL.									
				Inside dia. (in)					Inside dia. (in)						Width (mm)							Inside dia. (in)		Width (mm)		Inside dia. (in)									
		D2L (W/O AUTO)	D2L (W AUTO)	7/8	1	1+3/16	1+5/16	1+3/8	228	260	279	300	320	370	60	75	90	100	120	150	190	203	45	50	8+9T	9+10T	1+1/16	1+1/8	1+1/4	1+3/8	DSPV	LSPV	EXHAUST BRAKE	HBB	ABS
No.	Models	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
81	NPR75LL-5JXYEJ2	—	❍		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❍
82	NPR70LL-5LXYRJ2	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
83	NPR71LL-5LVXYCLJ	❍	—		—	—	❍	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
84	NQR75LL-5LXYEJ	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		❍	❍	❍	❍
85	NQR75LL-5LXYEJ2	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	—		—	—	❍		❍	❍	❍	❍
86	NPR77LL-5CWYEJ	—	❍		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❑
87	NPR66LL-5HWY	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
88	NPR75LL-5HWYEJ2	—	❍		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❍
89	NPR66PL-5JXA2	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
90	NPR66PL-5JXY2	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
91	NPR66PL-5JXAS	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
92	NPR66PL-5JXYS	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
93	NPR66PL-5JXY	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
94	NPR70PL-5JXYRJ2	❍	—		❍	—	—	—		—			❍	—		❍	—	—	—	—	❍	—	❍	—	❍	—		❍	—	—		—	❍	—	—
95	NPR66PL-5LXA	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
96	NPR66PL-5LXY	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
97	NPR66PL-5LXAS	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
98	NPR66PL-5LXYS	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
99	NPR66PBL-5LVY	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
100	NPR66PL-5LVXY	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	FRONT BRAKE																						
		DISC BRAKE										DRUM BRAKE												
		WHEEL CYL.			DISC							Type			WHEEL CYL.			DRUM.			LINING			
		Inside dia. (in)			Thickness (mm)			Outside dia. (mm)				2L (W/O AUTO)	2L (W AUTO)	D2L	Inside dia. (in)			Inside dia. (in)			Width (mm)			
		2+1/8	2+2	2+1/4	35	40	42	265	293	310	363				1+1/8	1+3/16	1+3/8	279	300	320	60	75	100	120
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
101	NPR66PL-5LVXYS	—		—		—	—		—	—	—	❍	❑	—	—	❍	—			❍		—	❍	❑
102	NQR66PL-5NVXA	—		—		—	—		—	—	—	❍	—	—	—	❍	❑			❍		—	—	❍
103	NQR71PL-5NVXY	—		—		—	—		—	—	—	❍	—	—	—	❍	❑			❍		—	—	❍
104	NQR71PL-5NVXYJ	—		—		—	—		—	—	—	—	❍	—	—	❍	—			❍		—	—	❍
105	NQR71PL-5NVXYS	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	—	❍
106	NPR75PL-5JXYEJ2	❍		—		❍	—		❍	—	—	—	—	—	—	—	—			—		—	—	—
107	NPR70PL-5LXYRJ2	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
108	NPR71PL-5LVXYCLJ	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
109	NPR70PL-5LXYCHJ	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
110	NQR75PL-5LXYEJ	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
111	NQR75PL-5LXYEJ2	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
112	NQR70PL-5NXYRJ	—		—		—	—		—	—	—	❍	—	—	—	—	❍			❍		—	—	❍
113	NQR70PBL-5LYRJ	—		—		—	—		—	—	—	❍	—	—	—	—	❍			❍		—	—	❍
114	NQR75PL-5LXYGJ	—		—		—	—		—	—	—	—	❍	—	—	❍	—			❍		—	—	❍
115	NQR71RL-5NVXY	—		—		—	—		—	—	—	❍	—	—	—	❍	❑			❍		—	—	❍
116	NQR71RL-5NVXYS	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	—	❍
117	NQR71RBL-5NVY	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	—	❍
118	NQR71RBL-5LVYB	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	—	❍
119	NQR71RL-5NVXYB	—		—		—	—		—	—	—	❍	—	—	—	❍	❑			❍		—	—	❍
120	NQR70RL-5LYXJ2	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	—	❍

—	Not available
❍	Standard
❑	Factory option
	Non

		REAR BRAKE																				PARKING BRAKE				BRAKE CONTROL									
		DRUM BRAKE																																	
		Type		WHEEL CYL.					DRUM.						LINING							DRUM.		LINING		MASTER CYL.									
		D2L (W/O AUTO)	D2L (W AUTO)	Inside dia. (in)					Inside dia. (in)						Width (mm)							Inside dia. (in)		Width (mm)		Inside dia. (in)						DSPV	LSPV	EXHAUST BRAKE	HBB	ABS
				7/8	1	1+3/16	1+5/16	1+3/8	228	260	279	300	320	370	60	75	90	100	120	150	190	203	45	50	8+9T	9+10T	1+1/16	1+1/8	1+1/4	1+3/8					
No.	Models	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
101	NPR66PL-5LVXYS	❍	❑		—	❍	❑	—		—			❍	—		—	—	❍	❑	—	❍	—	❍	—	—	❍		—	❍	❑		❑	❍	❑	❑
102	NQR66PL-5NVXA	❍	—		—	—	❍	❑		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	❍		—	❍	❑		—	❍	❑	—
103	NQR71PL-5NVXY	❍	—		—	—	❍	❑		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	❍		—	❍	❑		—	❍	❑	—
104	NQR71PL-5NVXYJ	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	—		—	—	❍		❍	❍	❍	❍
105	NQR71PL-5NVXYS	❍	—		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
106	NPR75PL-5JXYEJ2	—	❍		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		❍	❍	—	❍
107	NPR70PL-5LXYRJ2	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
108	NPR71PL-5LVXYCLJ	❍	—		—	—	❍	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
109	NPR70PL-5LXYCHJ	❍	—		—	❍	—	—		—			❍	—		—	—	❍	—	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
110	NQR75PL-5LXYEJ	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		❍	❍	❍	❍
111	NQR75PL-5LXYEJ2	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	—		—	—	❍		❍	❍	❍	❍
112	NQR70PL-5NXYRJ	❍	—		—	—	—	❍		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		—	❍	❍	—
113	NQR70PBL-5LYRJ	❍	—		—	—	—	❍		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		—	❍	❍	—
114	NQR75PL-5LXYGJ	—	❍		—	—	❍	—		—			❍	—		—	—	—	❍	—	—	❍	—	❍	—	—		—	—	❍		❍	❍	❍	❍
115	NQR71RL-5NVXY	❍	—		—	—	❍	❑		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	❍		—	❍	❑		—	❍	❑	—
116	NQR71RL-5NVXYS	❍	—		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
117	NQR71RBL-5NVY	❍	—		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
118	NQR71RBL-5LVYB	❍	—		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—
119	NQR71RL-5NVXYB	❍	—		—	—	❍	❑		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	❍		—	❍	❑		—	❍	❑	—
120	NQR70RL-5LYXJ2	❍	—		—	—	❍	—		—			❍	—		—	—	—	❍	—	❍	—	❍	—	—	❍		—	❍	—		—	❍	—	—

—	Not available
❍	Standard
❑	Factory option
	Non

No.	Models	FRONT BRAKE																						
		DISC BRAKE										DRUM BRAKE												
		WHEEL CYL.			DISC							Type			WHEEL CYL.			DRUM.			LINING			
		Inside dia. (in)			Thickness (mm)			Outside dia. (mm)				2L (W/O AUTO)	2L (W AUTO)	D2L	Inside dia. (in)			Inside dia. (in)			Width (mm)			
		2+1/8	2+2	2+1/4	35	40	42	265	293	310	363				1+1/8	1+3/16	1+3/8	279	300	320	60	75	100	120
No.	Models	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
121	NQR70RL-5LYXJT	—		—		—	—		—	—	—	❍	—	—	—	—	❍			❍		—	—	❍
122	NQR70RL-5NXYRJ	—		—		—	—		—	—	—	❍	—	—	—	—	❍			❍		—	—	❍
123	NQR75TL-5LXYEJ	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
124	NQR75TL-5LXYEJ2	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
125	NQR75TL-5KWYEJ	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
126	NQR75TL-5KWYEJ2	—		❍		—	❍		—	❍	—	—	—	—	—	—	—			—		—	—	—
127	NPS71LL-5JXY	—		—		—	—		—	—	—	—	—	❍	—	❍	—			❍		❍	—	—
128	NPR71LU-5LXYPJ	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
129	NQR70LU-5NXYPJ	—		—		—	—		—	—	—	❍	—	—	—	—	❍			❍		—	—	❍
130	NQR75LU-5NXYPJ	—		—		—	—		—	—	—	❍	—	—	—	—	❍			❍		—	—	❍
131	NPR71PU-5LXYPJ	—		—		—	—		—	—	—	❍	—	—	—	❍	—			❍		—	❍	—
132	NQR70RU-5NXYPJ	—		—		—	—		—	—	—	❍	—	—	—	—	❍			❍		—	—	❍
133	NQR75RU-5NXYPJ	—		—		—	—		—	—	—	❍	—	—	—	—	❍			❍		—	—	❍

Rear Brakes (NPR / NQR / NPS)

—	Not available
❍	Standard
❑	Factory option
Non	

No.	Models	REAR BRAKE																						PARKING BRAKE				BRAKE CONTROL													
		DRUM BRAKE																																							
		Type			WHEEL CYL.						DRUM.					LINING									DRUM.			LINING			MASTER CYL.												
		D 2 L (W/O AUTO)	D 2 L (W AUTO)		Inside dia. (in)						Inside dia. (in)					Width (mm)									Inside dia. (in)			Width (mm)			Inside dia. (in)												
					7/8	1	1 3/16	1 5/16	1 3/8	2 8	2 6 0	2 7 9 0	3 0 0	3 2 0 0	3 7 0 0	6 0 0	7 5	9 0 0	1 0 0	1 2 0 0	1 5 0 0				1 9 0 0	2 0 3 0		4 5	5 0	8 + 9 T	9 + 10 T	1 + 1 / 16	1 + 1 / 8	1 + 1 / 4	1 + 3 / 8	D S V	L S P V	E X H A U S T	H B B	A B S
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34							
121	NQR70RL-5LYXJT	❍	—		—	—	—	❍		—		❍	—		—		—	❍	—		—	❍	—	❍	—	—	❍	—	❍		—	❍	❍	—						
122	NQR70RL-5NXYRJ	❍	—		—	—	—	❍		—		❍	—		—		—	❍	—		—	❍	—	❍	—	—	❍	—	❍		—	❍	❍	—						
123	NQR75TL-5LXYEJ	—	❍		—	—	❍	—		—		❍	—		—		—	❍	—		—	❍	—	❍	—	—	❍	—	❍		—	❍	❍	❍						
124	NQR75TL-5LXYEJ2	—	❍		—	—	❍	—		—		❍	—		—		—	❍	—		❍	—	❍	—	—	—	❍	—	❍		—	❍	❍	❍						
125	NQR75TL-5KWYEJ	—	❍		—	—	❍	—		—		❍	—		—		—	❍	—		❍	—	❍	—	—	—	❍	—	❍		—	❍	❍	❍						
126	NQR75TL-5KWYEJ2	—	❍		—	—	❍	—		—		❍	—		—		—	❍	—		❍	—	❍	—	—	—	❍	—	❍		—	❍	❍	❍						
127	NPS71LL-5JXY	❍	—		—	—	❍	—		—		❍	—		—		—	❍	—		❍	—	❍	—	—	—	❍	—	—		—	❍	❍	—						
128	NPR71LU-5LXYPJ	❍	—		—	❍	—	—		—		❍	—		—		—	❍	—		❍	—	❍	—	—	—	❍	—	❍		—	❍	❍	—						
129	NQR70LU-5NXYPJ	❍	—		—	—	—	❍		—		❍	—		—		—	❍	—		—	❍	—	❍	—	—	❍	—	❍		—	❍	❍	❍						
130	NQR75LU-5NXYPJ	❍	—		—	—	—	❍		—		❍	—		—		—	❍	—		—	❍	—	❍	—	—	❍	—	❍		—	❍	❍	❍						
131	NPR71PU-5LXYPJ	❍	—		—	❍	—	—		—		❍	—		—		—	❍	—		❍	—	❍	—	—	—	❍	—	❍		—	❍	❍	—						
132	NQR70RU-5NXYPJ	❍	—		—	—	—	❍		—		❍	—		—		—	❍	—		—	❍	—	❍	—	—	❍	—	❍		—	❍	❍	❍						
133	NQR75RU-5NXYPJ	❍	—		—	—	—	❍		—		❍	—		—		—	❍	—		—	❍	—	❍	—	—	❍	—	❍		—	❍	❍	❍						

SERVICE STANDARD

ITEMS		SERVICE STANDARD	SERVICE LIMIT
FRONT DISC BRAKE ASSEMBLY			
Pad Thickness (ϕ 265 mm)	mm (in)	14.0 (0.551)	1.0 (0.039)
Pad Thickness (ϕ 293 & ϕ 310 mm)	mm (in)	13.0 (0.510)	1.0 (0.039)
Piston and Cylinder Clearance	mm (in)	0.08 — 0.18 (0.0031 — 0.0071)	0.23 (0.0091)
Disc Lateral Run out	mm (in)	0.13 (0.005) or less	—
Disc Maximum Parallelism	mm (in)	0.02 (0.0008)	—
Disc Thickness (ϕ 265 mm)	mm (in)	35.0 (1.378)	28.5 (1.122)
Disc Thickness (ϕ 293 mm)	mm (in)	40.0 (1.575)	37.0 (1.457)
Disc Thickness (ϕ 310 mm)	mm (in)	42.0 (1.654)	39.0 (1.535)
FRONT DRUM BRAKE ASSEMBLY			
Brake Drum Inside Diameter	mm (in)	279.4 (11.00) 300.0 (11.81) 320.0 (12.60)	281.0 (11.06) 301.5 (11.87) 321.5 (12.66)
Brake Drum Run-out	mm (in)	0.13 (0.005) or less	—
Brake Lining Thickness or Rivet Depth	mm (in)	—	1.0 (0.039)
Wheel Cylinder and Piston Clearance	mm (in)	—	0.15 (0.006)
REAR DRUM BRAKE ASSEMBLY			
Brake Drum Inside Diameter	mm (in)	228.6 (9.00) 240.0 (9.45) 260.0 (10.24) 279.4 (11.0) 290.0 (11.42) 300.0 (11.81) 320.0 (12.60) 370.0 (14.57)	230.0 (9.06) 241.5 (9.51) 261.5 (10.30) 281.0 (11.06) 291.5 (11.48) 301.5 (11.87) 321.5 (12.66) 372.0 (14.64)
Brake Drum Run-out	mm (in)	0.13 (0.005) or less	—
Brake Lining Thickness or Rivet Depth	mm (in)	—	1.0 (0.039)
Wheel Cylinder and Piston Clearance	mm (in)	—	0.15 (0.006)
BRAKE PEDAL AND CONTROL			
Master Cylinder and Piston Clearance	mm (in)	0.11 — 0.195 (0.004 — 0.008)	0.22 (0.009)
PARKING BRAKE			
Brake Drum Inside Diameter	mm (in)	178.0 (7.01) 190.0 (7.48) 203.2 (8.00)	179.0 (7.05) 191.0 (7.52) 205.0 (8.07)
Brake Drum Run-out	mm (in)	0.05 (0.002) or less	—
Brake Lining Thickness	mm (in)	—	1.0 (0.039)
EXHAUST BRAKE			
Butterfly Valve and Body Clearance			
(4HF1 Engine)	mm (in)	0.4 — 0.6 (0.016 — 0.024)	—
(Other Engine)	mm (in)	0.1 — 0.2 (0.004 — 0.008)	—

SERVICING

Service Brakes

Wheel Brake Adjustment

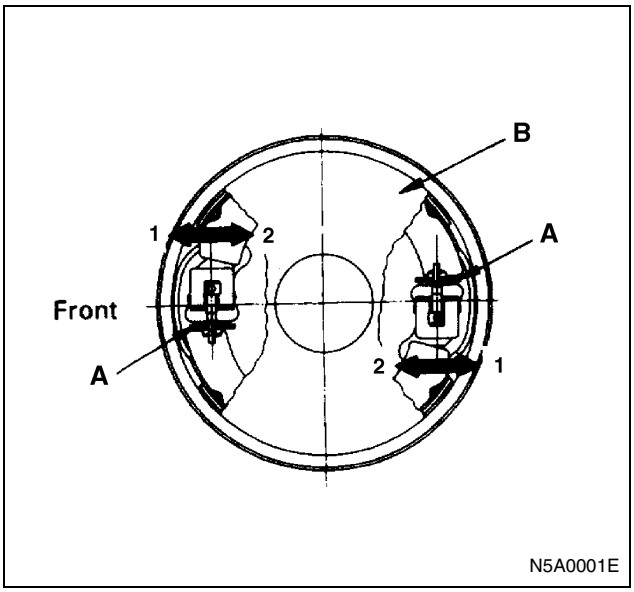
Brake Lining Clearance Adjustment (2L and D2L)

Without auto-adjuster type

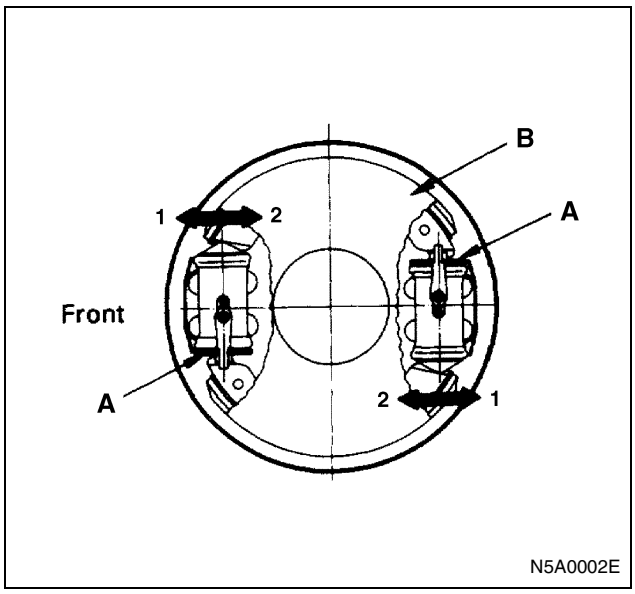
1. Chock the wheels not being adjusted.
2. Jack up the axle until the wheels can be turned freely.
3. Manually shake the wheel to check for excessive play.
4. Remove the grommet fitted to one of the brake drum cover adjuster holes.
5. Insert a screwdriver into the adjuster hole. Manually rotate the wheel while turning the adjuster (A) in the direction of the arrow (1) until resistance is felt at the wheel.
6. Back off the adjuster (A) in the direction of the arrow (2) the specified number of notches.

Specified Notches	
Front Rear	5-6

2L



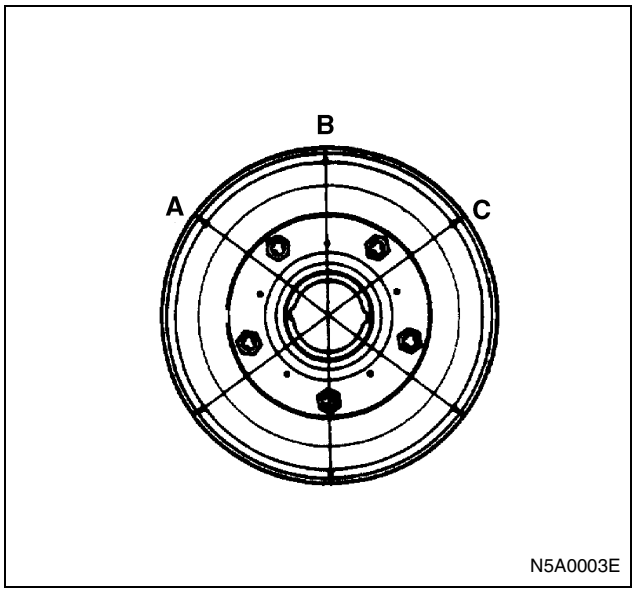
D2L



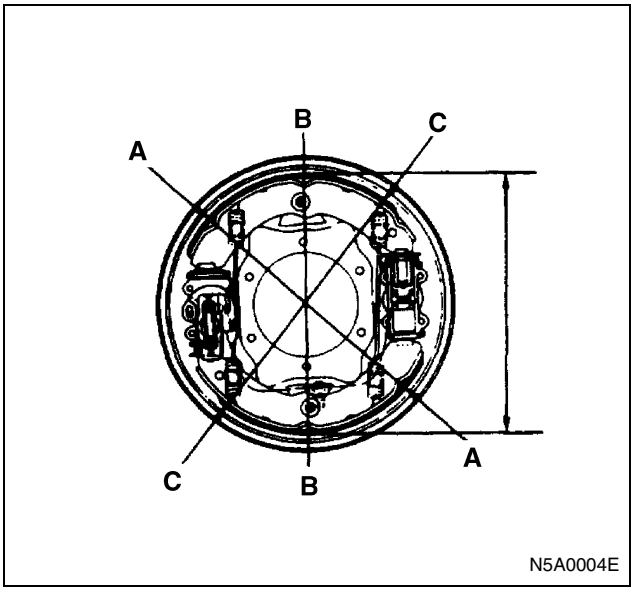
7. Install the grommet to the adjuster hole.
8. Repeat Steps 4 through 7 on the other wheels.
9. Lower the vehicle to the ground.

With auto-adjuster type

1. Measure the internal diameter of the brake drum.
   - Take measurement of the distance at (A), (B) and (C) points.



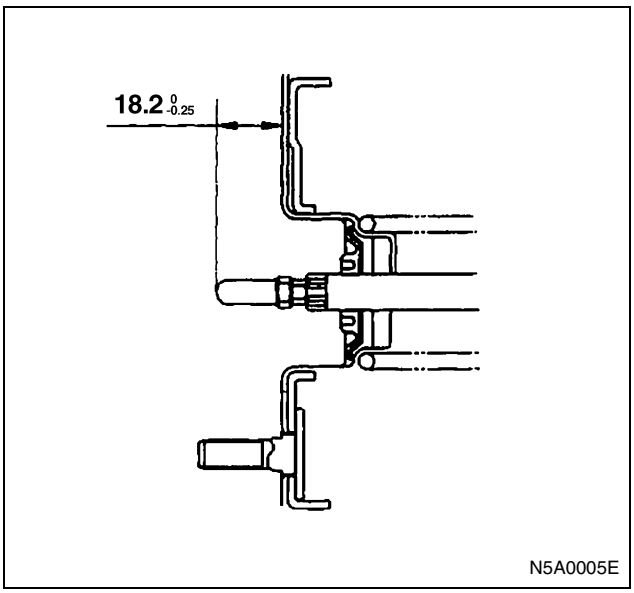
2. Measure the external diameter of the brake shoe.
   - Take measurement of the distance at (A), (B) and (C) points.



3. Turn the adjuster gear so that the difference between the internal diameter of the brake drum and the external diameter of the brake shoe becomes 0.6 mm (0.024 in).
4. Step on the brake hard while turning the brake drum in the forward direction, or while driving forward.

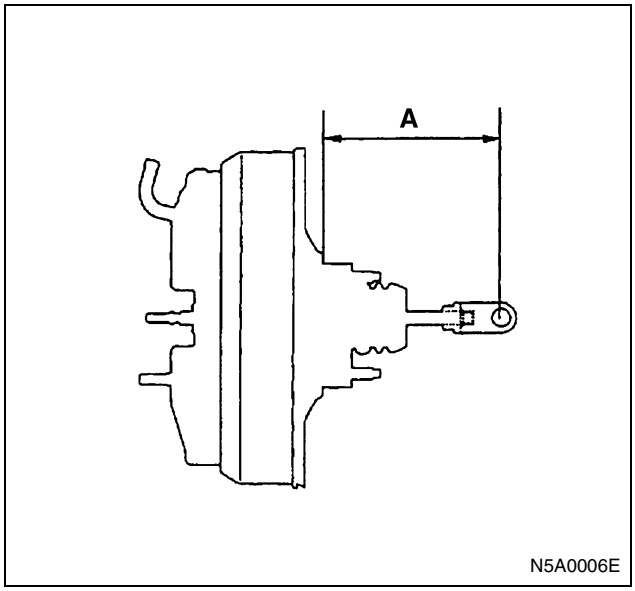
Brake Pedal Adjustment

Brake Pedal Height and Free Play Adjustment
Vacuum Booster (Master Vac) Type:
The height of push rod should be adjusted so that the distance from its master cylinder mounting surface to end measures 18.2 mm (0.717 in).



For push rod length adjustment, the distance from the center of crevis pin hole to brake pedal bracket mounting surface should be set at 109 mm (4.291 in); without spacer, 129 mm (5.079 in); with spacer.
When fixed under this condition, there is no need to adjust the height of brake pedal from floor and free play.

Notice:
- As vacuum booster (Master Vac) is undetachable type, it should be replaced as an assembly if it does not work well.
- Be sure to adjust the stop light switch.



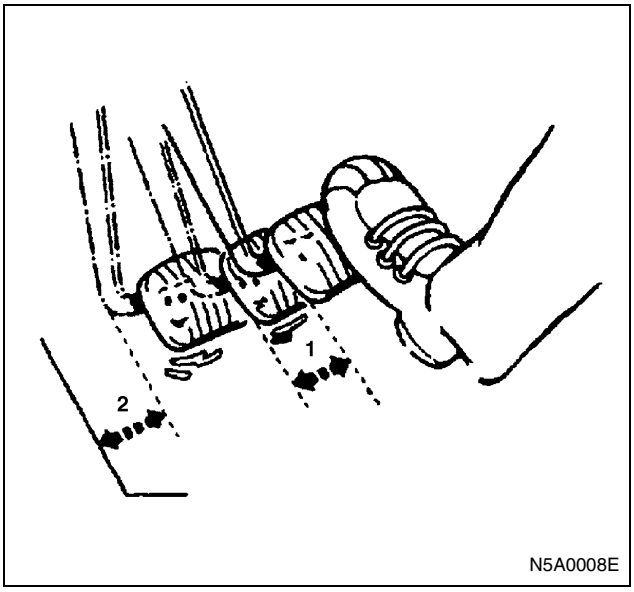
Brake Pedal Free Play and Allowance
Standard value
1. Free play: 4 to 7 mm (0.16 to 0.28 in)
   24 to 29 mm (0.94 to 1.14 in) for HBB type

2. Allowance			mm (in)
NHR	Front Drum Brake		50 (1.97)
NKR	Front Disc Brake Model		40 (1.57)
	Front Drum Brake Model	Less than GVM 6.5 ton	60 (2.36)
		GVM 6.5 ton	40 (1.57)
NPR NQR	Front Disc Brake Model		40 (1.57)
	Front Drum Brake Model	Less than GVM 6.5 ton	60 (2.36)
		GVM 6.5 ton or more	40 (1.57)
NPS	Front Drum Brake		40 (1.57)

(When depressed with force of the 490 N (50 kg / 110 lbs).)

NPR, NQR (HBB type)	Front Disc Brake Model	35 (1.38)
	Front Drum Brake Model	45 (1.77)

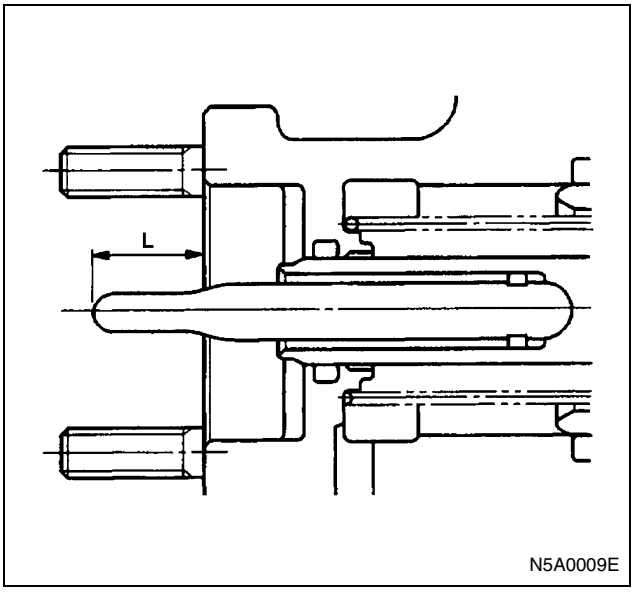
(When depressed with force of the 294 N (30 kg / 66 lbs).)



Hydraulic Booster Type

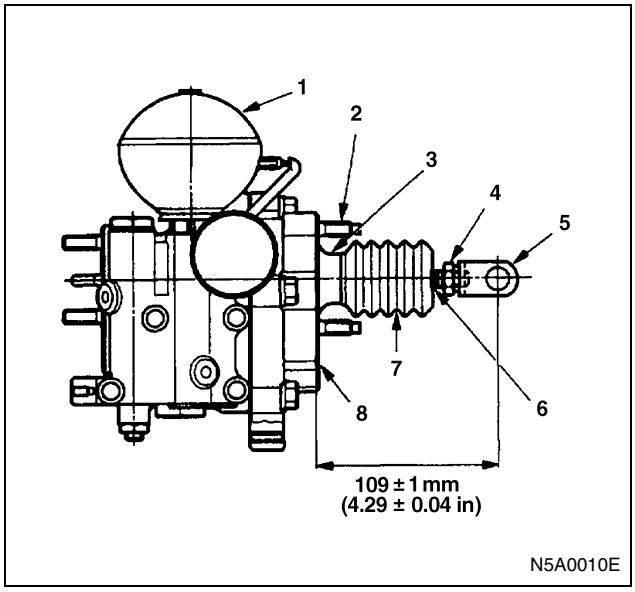
Push Rod Length

- Use a scale to measure the push rod length (push rod to flange face clearance).
  Push Rod Length "L" to 17.95 — 18.2 mm (0.707 — 0.717 in).
  If the push rod length is not equal to the specification, the hydraulic booster assembly must be replaced.



Operating Rod Length

1. Loosen the jam nut at the stop light switch.
2. Loosen the jam nut on the hydraulic booster operating rod.
3. Turn the operating rod until the distance from the center of clevis pin hole to mounting surface of the brake pedal bracket should be set at 109 ± 1 mm (4.29 ± 0.04 in).
   When fixed under this condition, there is no need to adjust the brake pedal height and free play.



Legend

1. Accumulator
2. Stud bolt
3. Cover boss
4. Lock nut
5. Clevis
6. Operating rod
7. Guard
8. Flange

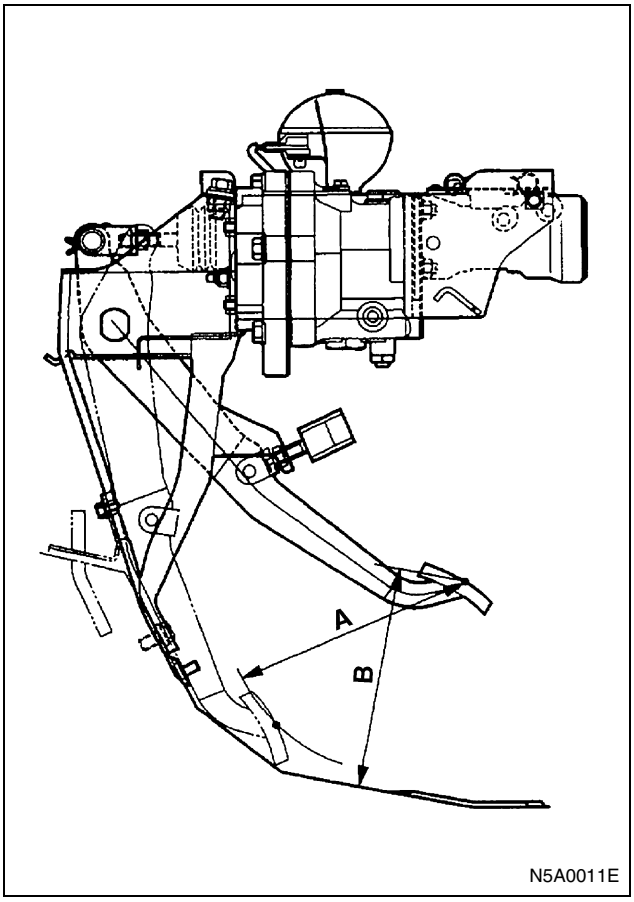
4. Tighten the operating rod jam nut.

Tighten:
Jam nut to 20 N·m (2.0 kg·m / 14 lb·ft)

5. Stop light switch so that the end of the switch threaded portion contacts the brake pedal, then back off the switch 1/2 turn.

Tighten:
Stop light switch locknut to 20 N·m (2.0 kg·m / 14 lb·ft)

6. Check light pedal operation to be sure that it is operating properly.
   - Measure the brake pedal free play, after reducing the pressure of the hydraulic oil in the accumulator by pedal operations at least 10 times with engine off.
     Brake pedal normal play is between 21 — 24 mm (0.83 — 0.94 in).
   - Pressing the brake pedal with a force of 294 N (30 kg / 66 lb) with the engine on, the clearance between the brake pedal and floor panel is more than 35 mm (1.4 in).
   - Brake pedal height "B" is 167 mm (6.58 in) (reference).
   - Brake pedal travel "A" is between 180 ± 5 mm (7.09 ± 0.2 in) (reference).



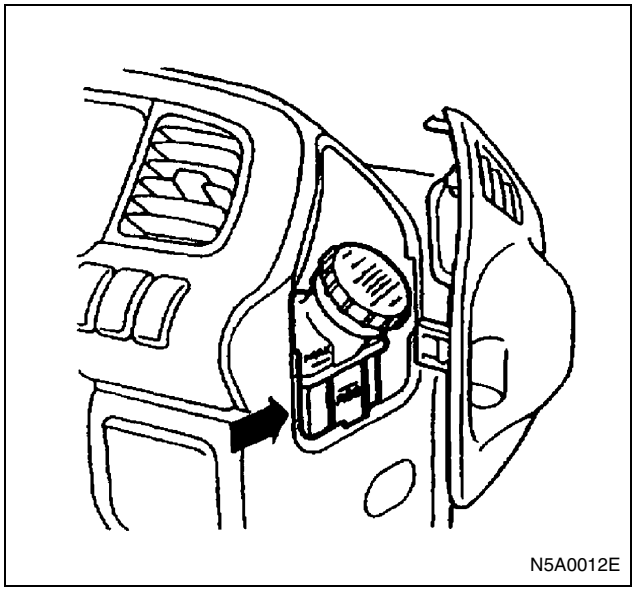
Legend

A. Pedal travel
(Reference).....180 ± 5 mm (7.09 ± 0.2 in)
B. Pedal height
(Reference).....167 mm (6.58 in)

Brake Bleeding

Brake Bleeding Precautions

Air in the brake hydraulic circuit will result in dangerous reduced braking efficiency.
The brake hydraulic circuit must be bled whenever the vehicle has been operated with the reservoir brake fluid level at an excessively low level or any time the brake pipes have been disconnected in the course of brake servicing.
The brake bleeding procedure requires the cooperative action of two men.



Brake Bleeding Procedure

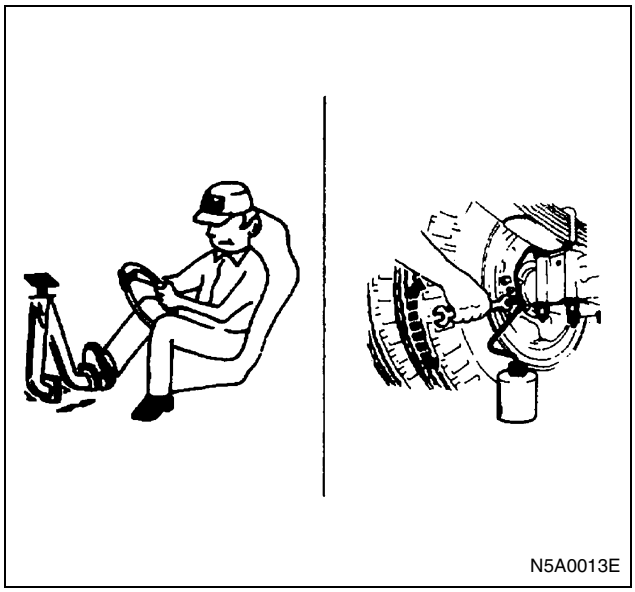
Bleed the brake hydraulic circuit in the following sequence.

LHD

Left-hand rear wheel (vehicle equipped with ABS) → Right-hand rear wheel → DSPV or LSPV → (If so equipped) → Right-hand front wheel → Left-hand front wheel

RHD

Left-hand rear wheel (vehicle equipped with ABS) → Right-hand rear wheel → DSPV or LSPV (If so equipped) → Left-hand front wheel → Right-hand front wheel



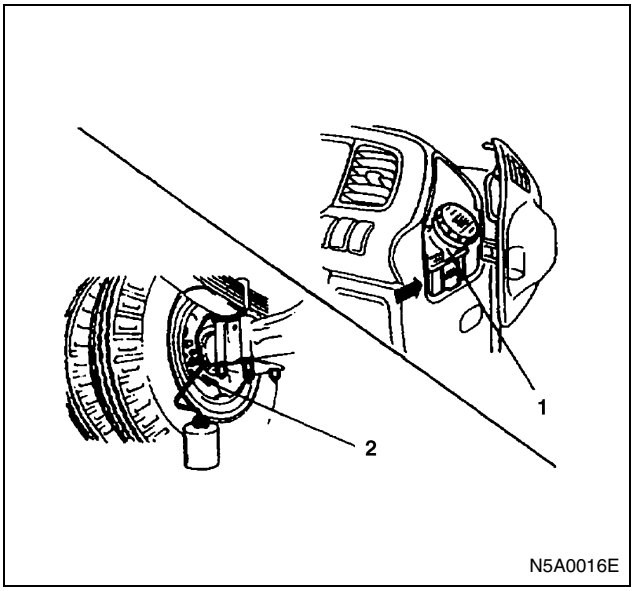
1. Check to make sure that the service area is well ventilated.
   Apply the parking brake firmly. Start the engine and allow it to run until the vacuum pressure rises sufficiently.

Notice:

Brake booster (master-vac) will be adversely effected if bleeding operation is performed without running engine.

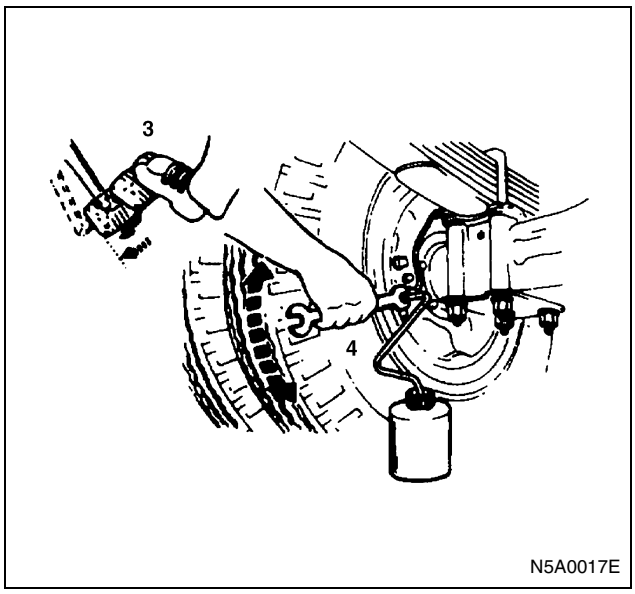
If the vehicle is equipped with ABS, be sure to remove the ABS fuse (60 A) from the fuse box before beginning the air bleeding procedure. If this is not done, air is not bled completely from ABS unit, so that ABS unit will be broken. (Be sure to install the ABS fuse (60 A) in specified position when the air bleeding procedure is completed.)

2. Fill the brake fluid reservoir (1) up to the “MAX” level with clean brake fluid.
   It may be necessary to replenish the brake fluid reservoir several times during the bleeding procedure to maintain the required level of brake fluid.

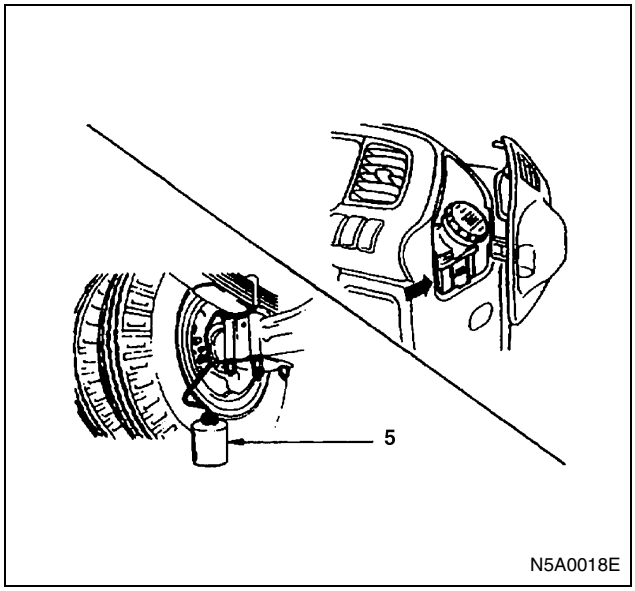


Notice:
Pour the brake fluid carefully so as not to produce air bubbles.

3. Remove the right hand rear wheel cylinder (left hand rear wheel cylinder if ABS is equipped) bleeder screw rubber cap and wipe it clean.
4. Connect one end of a vinyl tube (2) to the bleeder screw.
5. Insert the other end of the vinyl tube into a transparent container approximately 1/3 full of brake fluid.
6. Depress the brake pedal (3) slowly 3 times and hold it depressed.



7. Loosen the bleeder screw (4) approximately 1/2 of a turn.
   This will release the brake fluid with air bubbles into the transparent container (5).



8. When the brake fluid being released into the transparent container is completely free of air bubbles, retighten the bleeder screw (4).
9. Slowly release the brake pedal.
10. Replace the bleeder screw rubber cap.

Notice:
In order to bleed the air completely from the brake line, repeat the above procedures.

Bleeding of the brake fluid circuit should be performed for front wheel 10 times or more, for rear wheel 15 times or more.

11. Repeat Steps 3 through 10 for each bleeder screws as mentioned before.
12. After the air bleeding procedure is finished in all wheels, depress the brake pedal, and verify wheth-

er there is no abnormality in operation of the brake system.

13. After the air bleeding procedure for individual wheel is completed, inspect the fluid level of the reservoir tank. If it is insufficient, replenish brake fluid. Do not overfill above “MAX” level.
14. Stop the engine.

Hydraulic Booster Line Bleeding

Bleeding Precautions

After removing the hydro boost assembly or piping and making repairs, do not run the vehicle until you perform the below-described air bleeding and then verify that everything is normal, including hydro boost boosting and accumulator operation.

Bleeding Procedure

1. Attach the hydro boost and the master cylinder to the vehicle and connect the piping.
2. Fill the hydro boost reservoir with hydraulic oil between its minimum and maximum range.
3. Turn the engine on for about 5 seconds.
4. Then turn the engine off and check the quantity of hydraulic oil in the reservoir.
5. If the hydraulic oil is below the minimum, pour in more hydraulic oil so that it is in the range from minimum to maximum.
6. Repeat the above steps 2 — 5 until there is no foaming or change in the level of the hydraulic oil in the reservoir. But if the hydraulic oil foams during the above steps, let it stand for a while, wait for the foam to dissipate, then continue the work.
7. With the engine on, repeatedly press the brake pedal slowly about five times.
8. Then turn the engine off and check the quantity of hydraulic oil in the reservoir. If the hydraulic oil is below the minimum, once again pour in more hydraulic oil so that it is in the range from minimum to maximum.
9. Leaving the engine off, repeatedly press the brake pedal at least ten times.
10. Verify that there is no foam or change in the level of the hydraulic oil in the reservoir. If any foam remains, let it stand for a while, wait for the foam to dissipate, then repeat the above steps 7 — 9.
11. If it is necessary at this time to bleed out the air from the brake fluid pressure system, such as the master cylinder or the wheel cylinder, be sure to first complete step 10 above and make sure that the engine is on.
12. With the engine on, strongly press the brake pedal as far as the booster full load region slowly and repeatedly about 30 times (for 1 — 3 seconds each time). When doing so, do not keep the pedal at the full load region (no longer than 1 second).
13. Then turn the engine off and repeatedly press the brake pedal at least 10 times.
14. Check the state of the hydraulic oil in the reservoir, and if there is no foaming or change in the level of the oil, the operation of bleeding the air out is considered completed. If any foam remains, let it stand for a while, wait for the foam to dissipate, then repeat the above steps 12 — 13.

Notice:

Precautions when bleeding the air from the brake fluid pressure system

When doing air bleeding of the brake fluid pressure system, such as the master cylinder or wheel cylinder, verify that the air has been bled out of the hydro boost, and make sure that the engine is on.

Be aware that if air bleeding of the brake fluid system is to be done with the engine off, air bleeding cannot be done.

If air bleeding of the brake fluid pressure system is to be done at the same time as air bleeding of the hydro boost, do so when the operation of the above hydro boost air bleeding method 10 has been completed.

Supply Parts Replacement

1. The hydro boost is a precision part that operates with high-pressure hydraulic oil. Never remove any parts from the hydro boost except replacement parts.
   Trouble may occur if a part other than a replacement part is removed and a non-matching part is included or the assembly is bad. For example, misoperation may occur and the brake becomes ineffective, or a bad seal may allow high-temperature hydraulic oil under high pressure to spatter and cause a burn.
2. The hydraulic oil to be used for the hydro boost is ATF DEXRON® III. Using any other hydraulic oil could adversely affect the rubber parts and cause poor operation or oil leakage.
   In particular, the hydraulic oil for the hydro boost is quite different from the brake fluid that is used in the master cylinder.

   Be careful that hydro boost parts do not come into contact with the brake fluid for the master cylinder, and that master cylinder parts do not come into contact with the hydraulic oil for the hydro boost.

   Any mixing together of the hydraulic oil for the hydro boost and the brake fluid for the master cylinder could cause degradation such as the swelling of rubber parts, brake failure due to oil leakage or bad operation, or a serious mishap such as a vehicle fire caused by brake friction.
3. Operation of the pump while the engine is on will cause the hydro boost hydraulic oil to get hot. In particular, frequent repeated operation of the brake will sometimes increase the temperature of the hydraulic oil in the hydro boost assembly to 100°C (212°F) or more. Be careful in handling.
   When performing work such as removing the hydro boost assembly from the vehicle, before starting

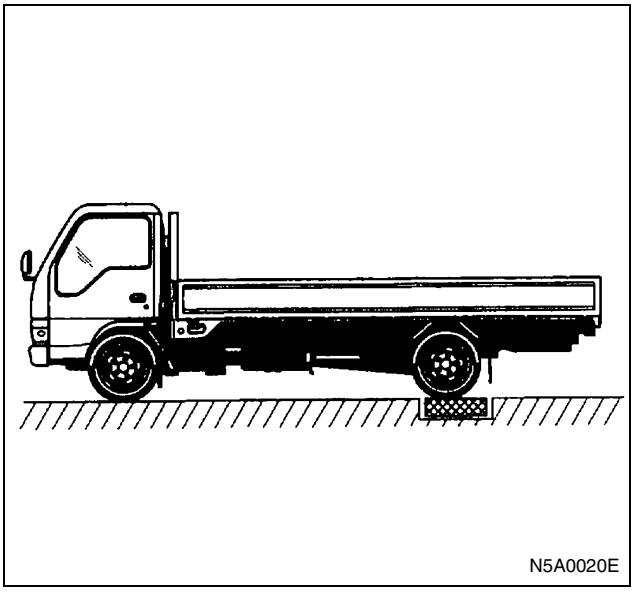
the work, first turn the engine off, wait 30 minutes, and verify that the temperature has cooled off.

4. Even when a long time passes after the engine is turned off, the high-pressure hydraulic oil in the accumulator of the hydro boost remains stored under pressure.
   Before removing the hydro boost assembly or piping, be sure to repeatedly press the brake pedal at least ten times with the engine off, and make sure the pressure of the hydraulic oil in the accumulator has been reduced to atmospheric pressure before doing the work.
   In particular, when removing the replacement-part accumulator from the hydro boost assembly, the hydraulic oil may spatter if it remains stored under high pressure inside the accumulator, so be careful of this.

Parking Brake

Parking Brake Adjustment

Before beginning to adjust the parking brake, park the vehicle on a level surface, chock all of the wheels, and place the parking brake lever in the released (off) position.
Then loosen the parking brake control wire lock nut (1), and turn the adjuster (2) to completely loosen the parking brake control wire.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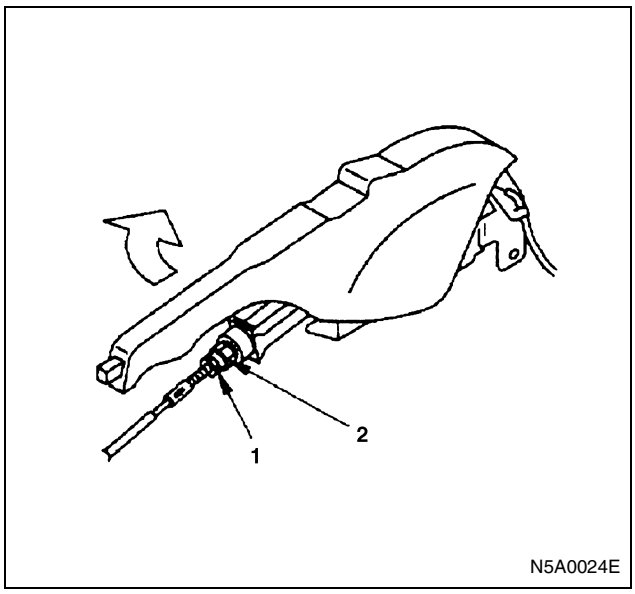

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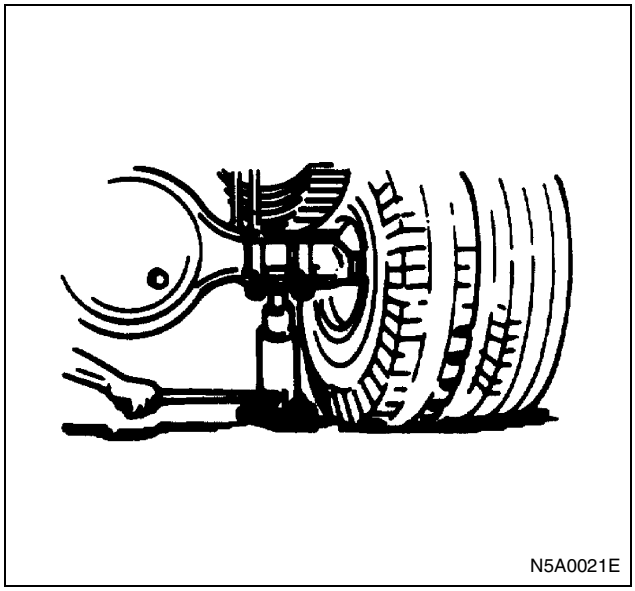
Parking Brake Lining Clearance Adjustment

1. Jack up the rear axle until the wheels can be turned freely.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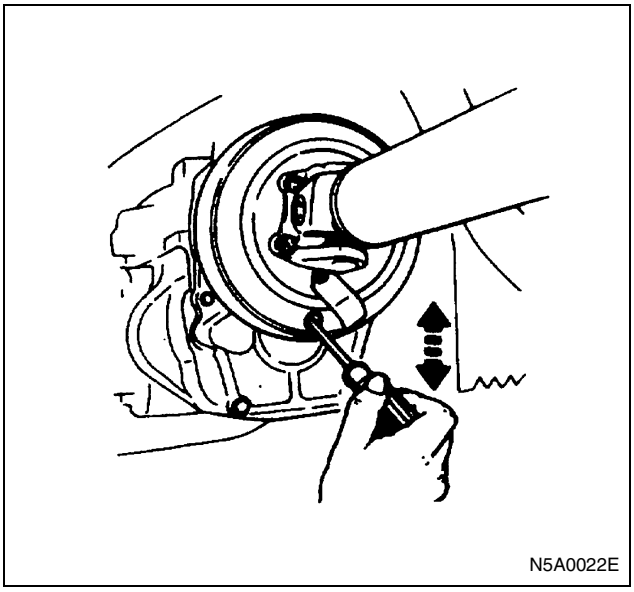
2. Remove one of the two check hole covers from the parking brake drum.
3. Rotate the brake drum to align the check hole with the adjusting screw.
4. Move the camshaft lever from side to side several times to center the brake shoes.
5. Insert a screwdriver into the check hole and rotate the adjusting screw by pushing it upward.
   Continue doing this until the brake shoes begin to drag on the drum.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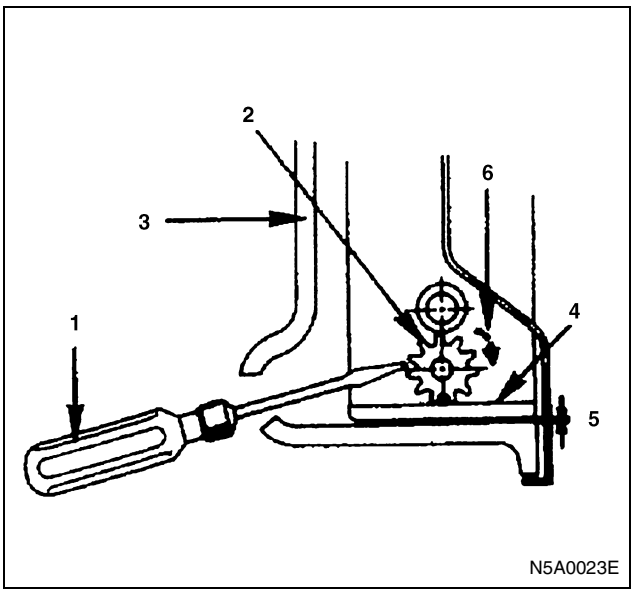
6. Back off the adjusting screw the specified number of notches.

Adjusting Screw Notches and Clearance		
Brake Type mm (in)	Notches	Clearance mm (in)
178 (7.008), 190 (7.480)	30	0.75 (0.029)
203.2 (8.000)	8	0.23 (0.009)



N5A0023E

Legend

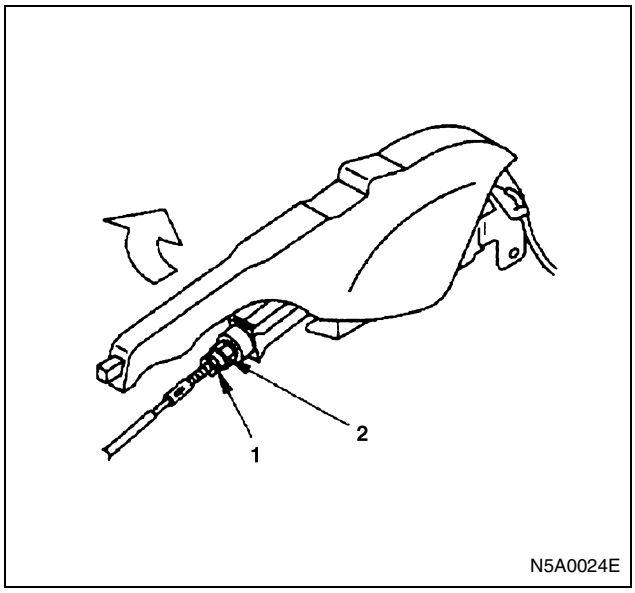
1. Screwdriver
2. Adjusting screw
3. Brake drum
4. Brake shoe
5. Clearance
6. Direction of brake shoe expansion (for 178 mm, 190 mm)
   Brake Type (203 mm) is direction to the counter rotation.

7. Reinstall the check hole cover.
8. Lower the rear wheels to the floor.

Parking Brake Lever Travel Adjustment

1. Fully set the parking brake lever and release it several times.
   Leave the parking brake lever in the released position.
2. Loosen the parking brake control wire lock nut (1).
3. Turn the adjuster (2) to adjust the lever travel to the specified notches.

Parking brake lever travel at 147 N (15 kg / 33 lbs) notches
6 to 8



N5A0024E

4. Retighten the control wire lock nut (1).
5. Check the parking brake lever travel (measured in notches).

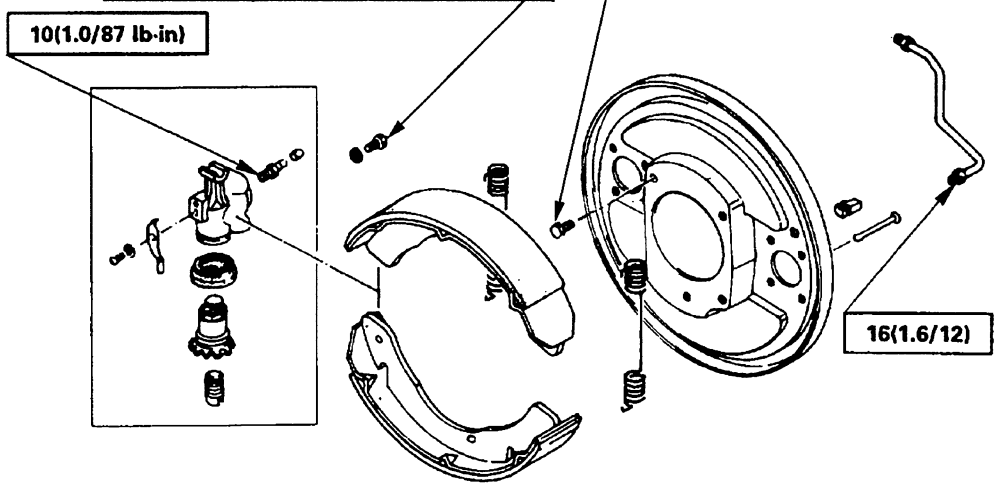
FIXING TORQUE

Front Wheel Brake (NHR / NKR / NPR / NQR)

N·m (kg·m / lb·ft)

Drum Inside Dia. mm (in)	Lining Width mm (in)	Fixing Torque
279.4 (11.00)	60 (2.36)	27 (2.8 / 20)
300.0 (11.81)	75 (2.95)	34 (3.5 / 25)
320.0 (12.60)		43 (4.4 / 32)
320.0 (12.60)	100 (3.94)	74 (7.5 / 54)
320.0 (12.60)	120 (4.72)	94 (9.5 / 69)

Lining Width mm (in)	Fixing Torque
60 (2.36)	88 (9.0 / 65)
75 (2.95)	
100 (3.94)	
120 (4.72)	157 (16.0 / 116)



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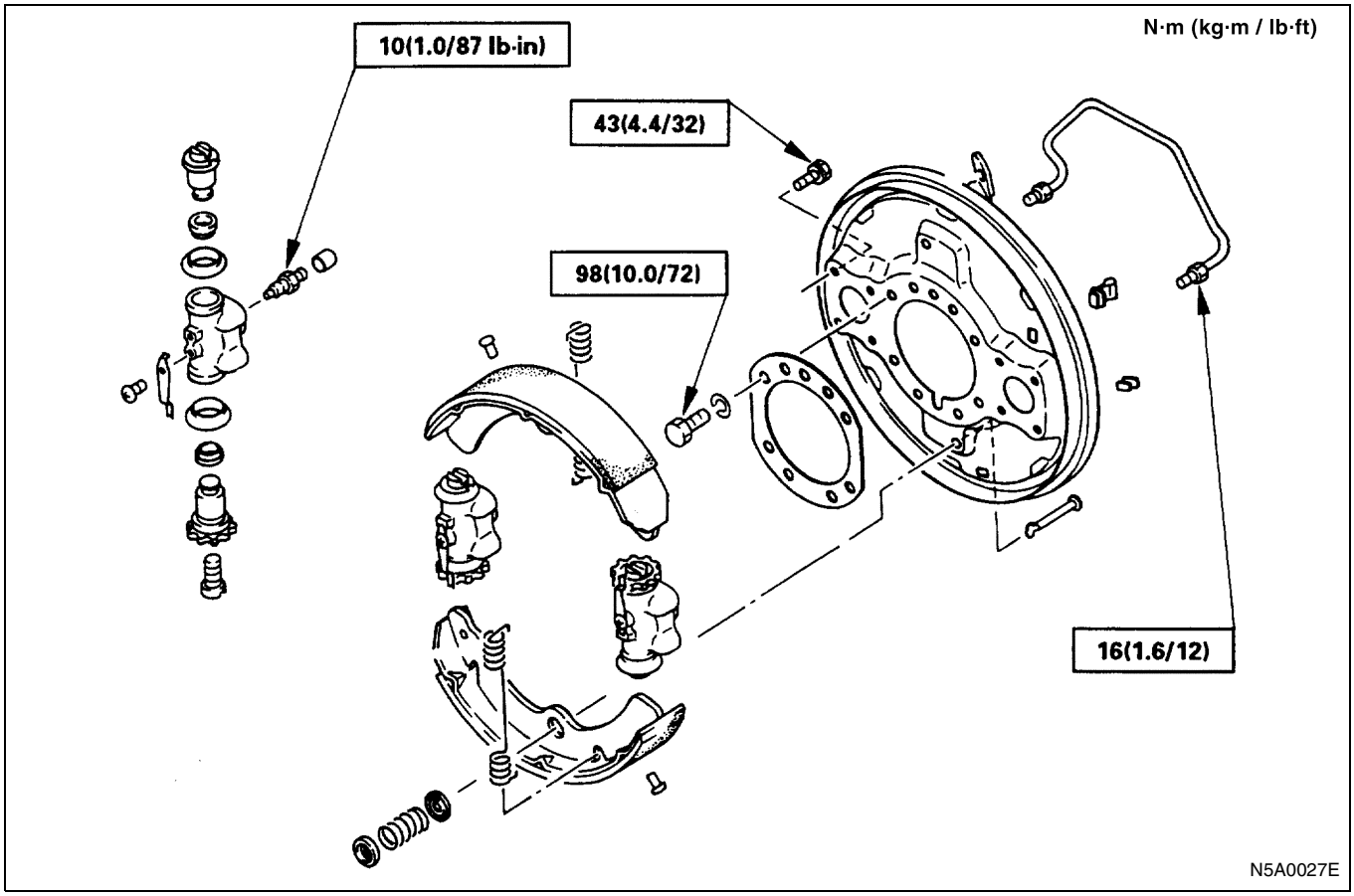
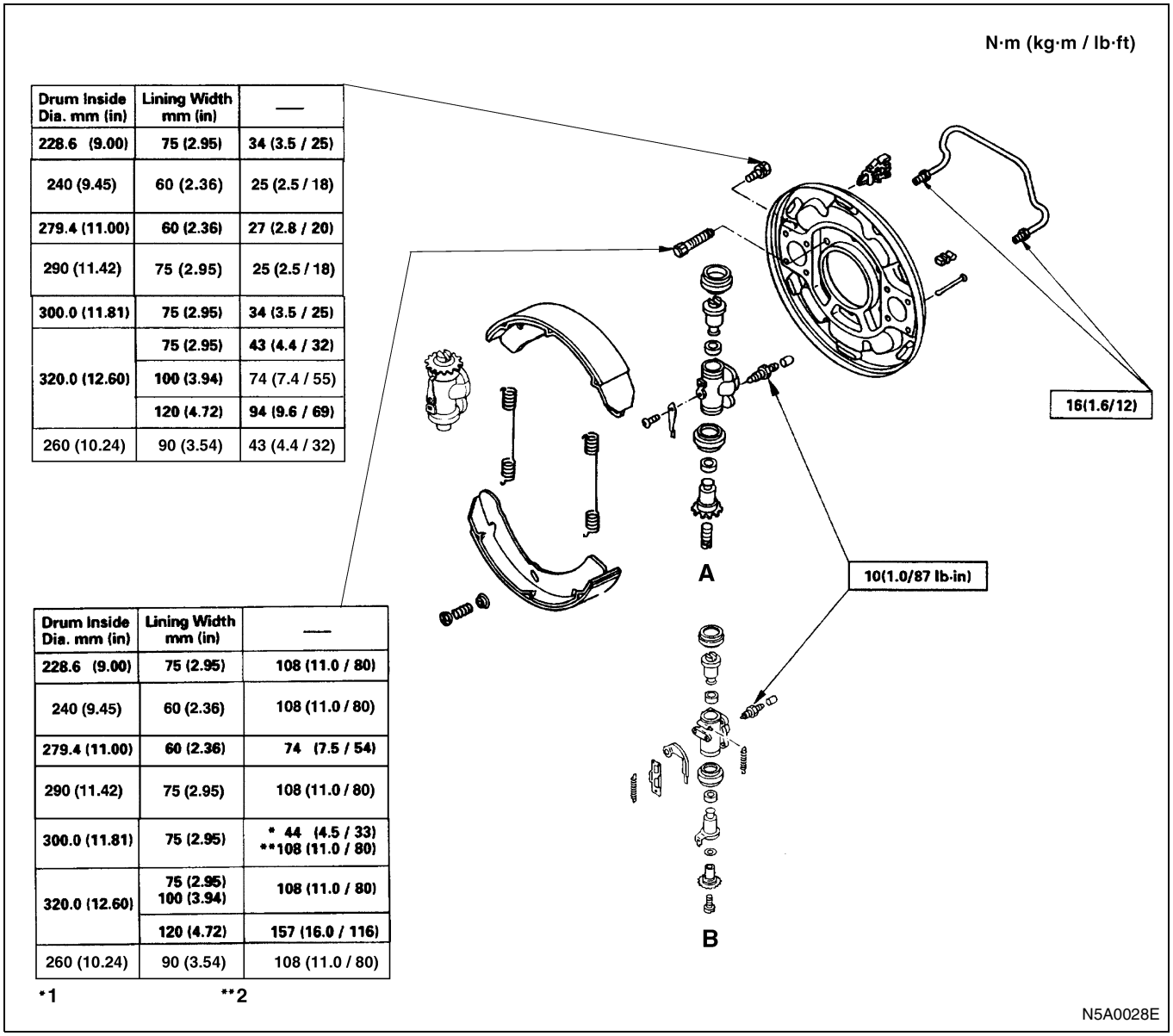
Front Wheel Brake (NPS)



Rear Wheel Brake (Except Drum Inside Diameter 370 mm)



Drum Inside Dia. mm (in)	Lining Width mm (in)	—
228.6 (9.00)	75 (2.95)	34 (3.5 / 25)
240 (9.45)	60 (2.36)	25 (2.5 / 18)
279.4 (11.00)	60 (2.36)	27 (2.8 / 20)
290 (11.42)	75 (2.95)	25 (2.5 / 18)
300.0 (11.81)	75 (2.95)	34 (3.5 / 25)
320.0 (12.60)	75 (2.95)	43 (4.4 / 32)
	100 (3.94)	74 (7.4 / 55)
	120 (4.72)	94 (9.6 / 69)
260 (10.24)	90 (3.54)	43 (4.4 / 32)

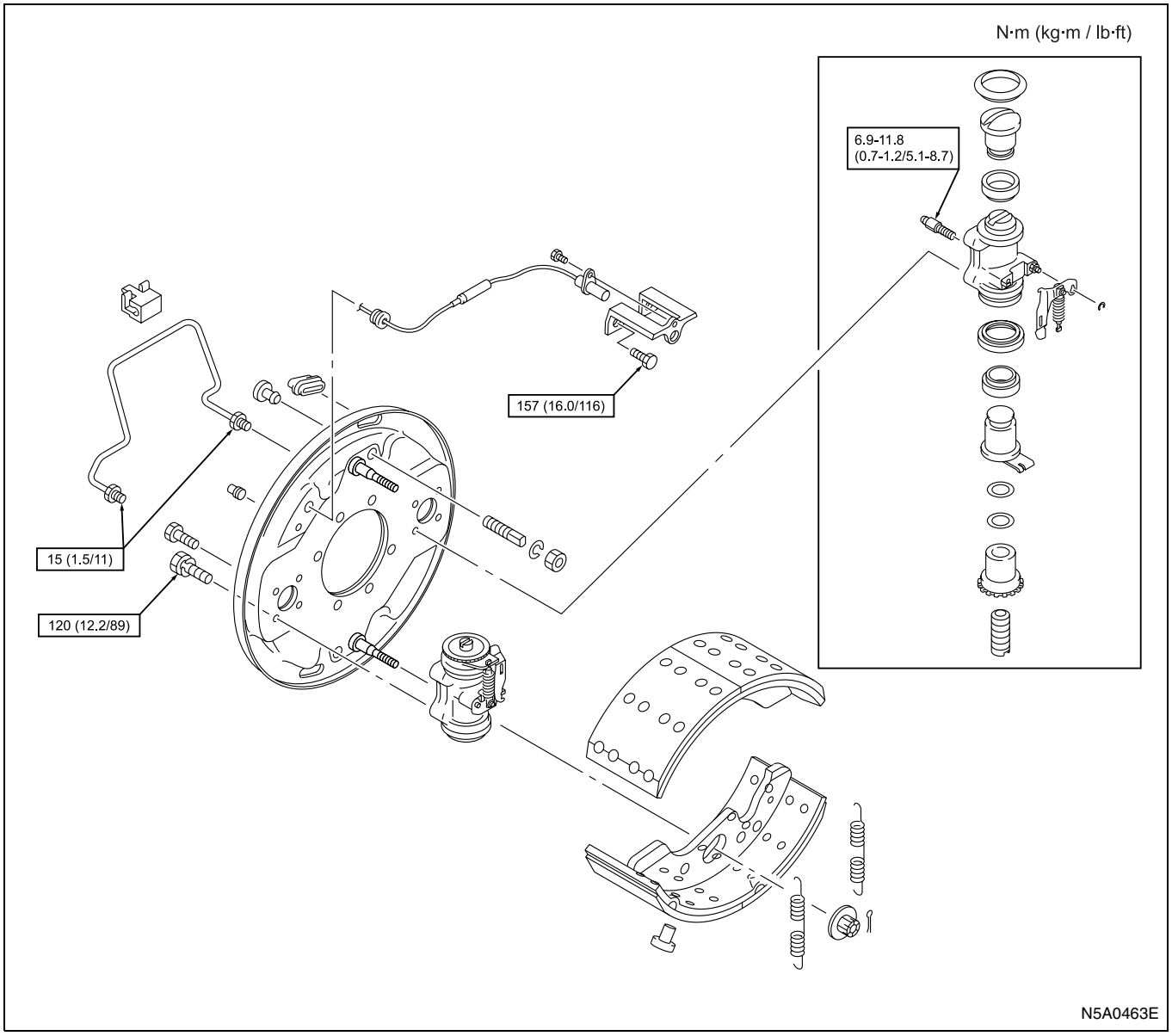
Drum Inside Dia. mm (in)	Lining Width mm (in)	—
228.6 (9.00)	75 (2.95)	108 (11.0 / 80)
240 (9.45)	60 (2.36)	108 (11.0 / 80)
279.4 (11.00)	60 (2.36)	74 (7.5 / 54)
290 (11.42)	75 (2.95)	108 (11.0 / 80)
300.0 (11.81)	75 (2.95)	* 44 (4.5 / 33) **108 (11.0 / 80)
320.0 (12.60)	75 (2.95) 100 (3.94)	108 (11.0 / 80)
	120 (4.72)	157 (16.0 / 116)
260 (10.24)	90 (3.54)	108 (11.0 / 80)

*1 **2

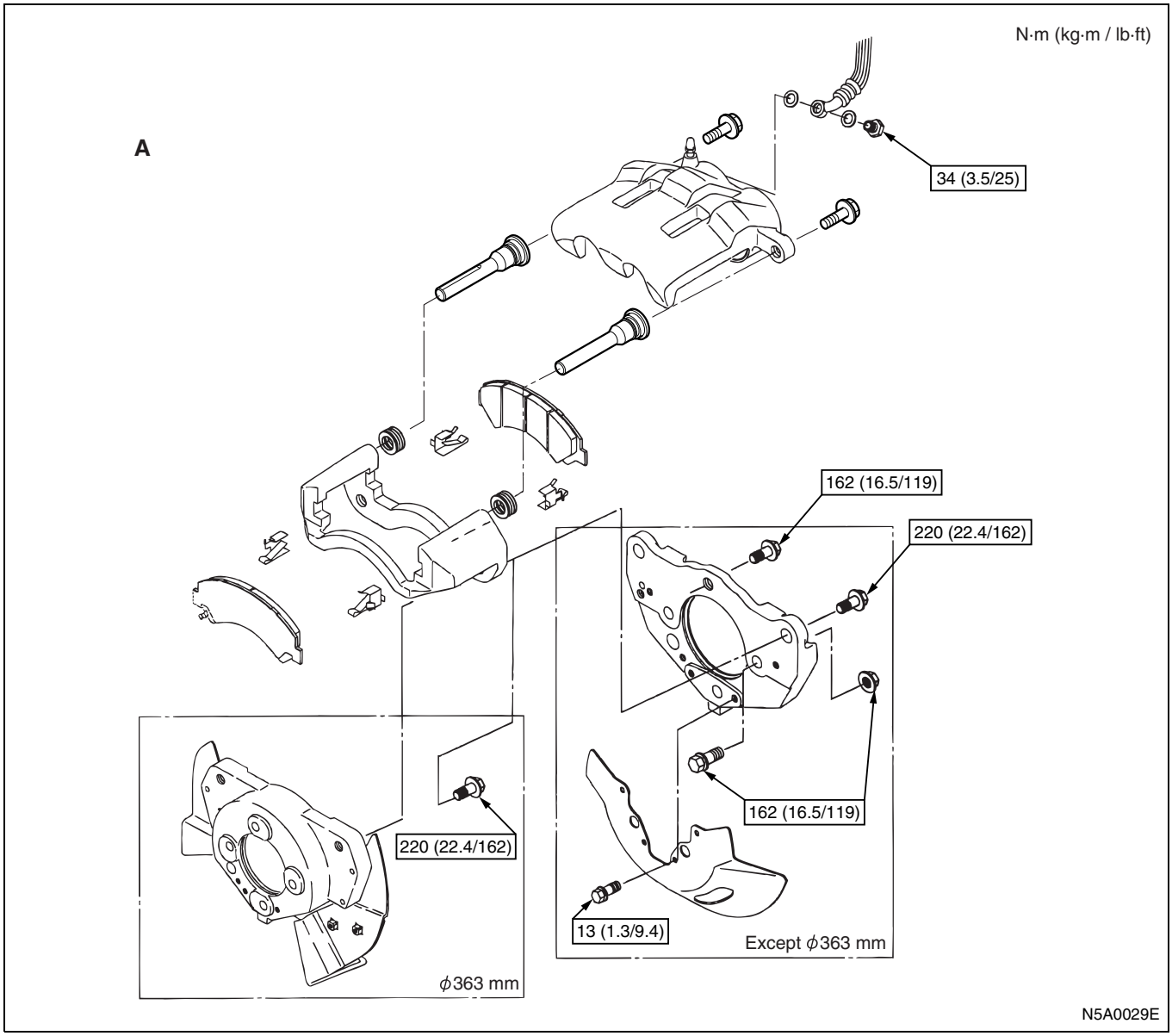
Legend

A. Without auto-adjuster
B. With auto-adjuster
1. Single tire models
2. Dual tire models

Rear Wheel Brake (Drum Inside Diameter 370 mm)



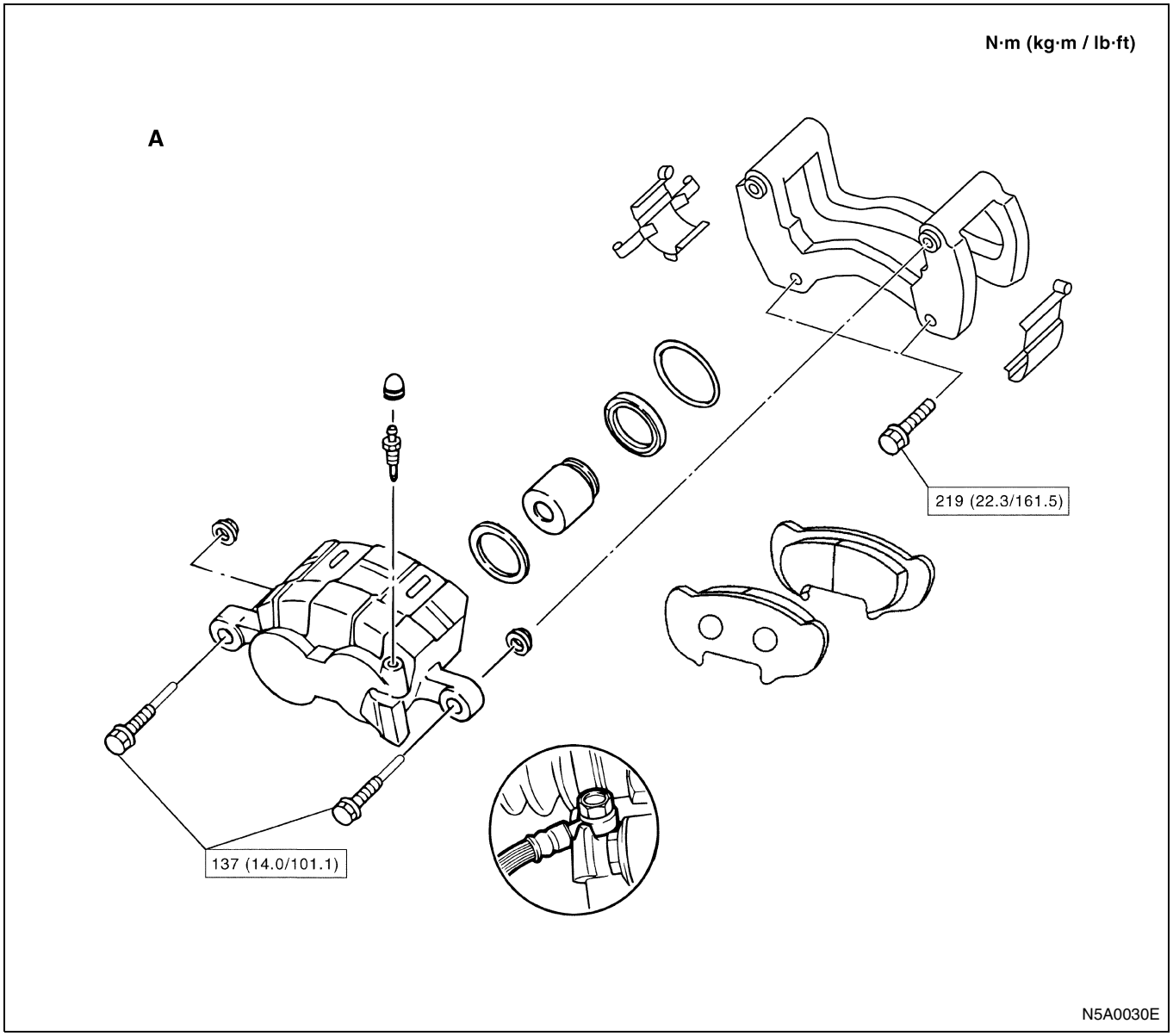
Front Disc Brake (NKR / NPR / NQR)



Legend

A. Leaf spring suspension models (Rigid axle type)

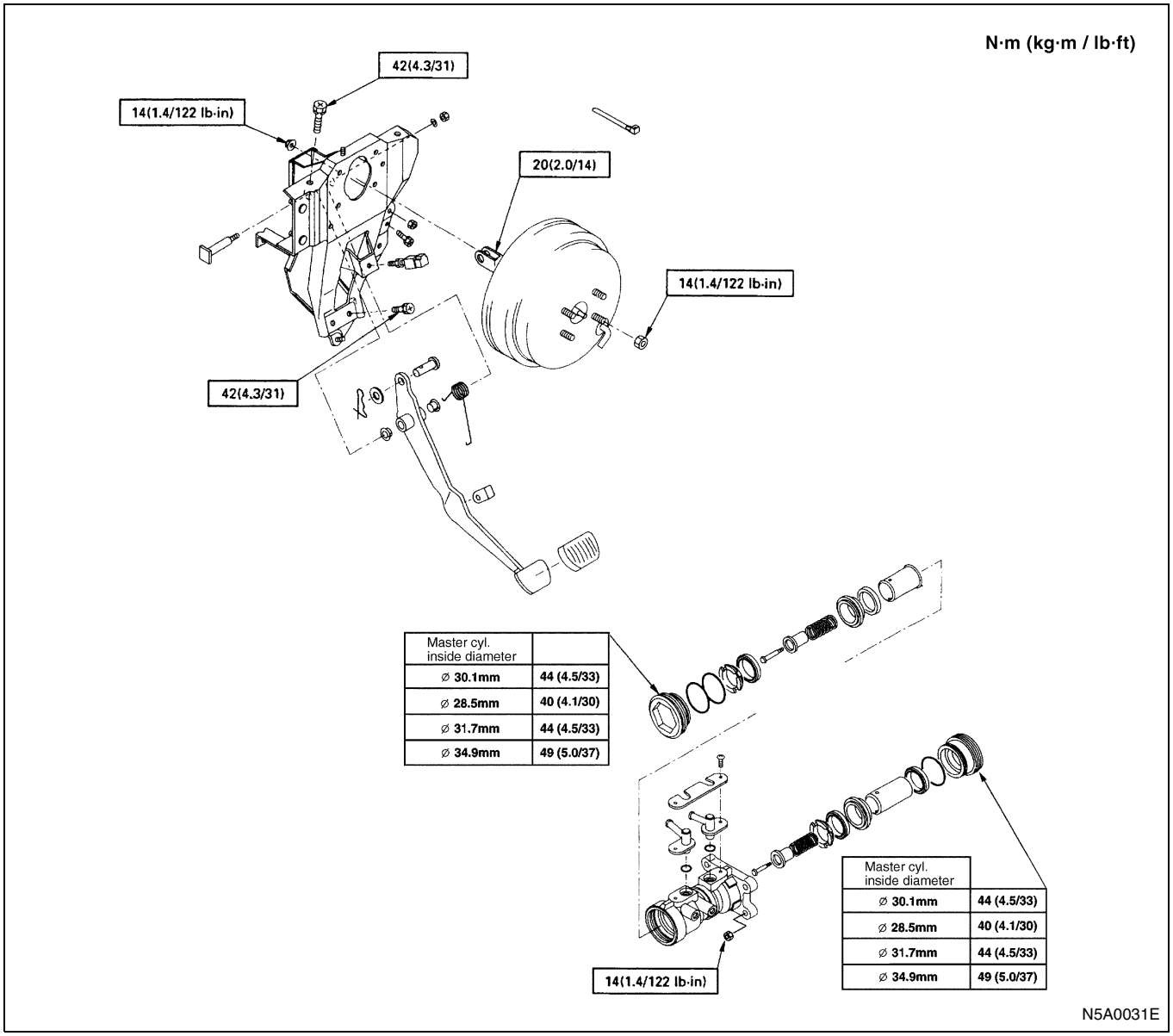
Front Disc Brake (NKR)



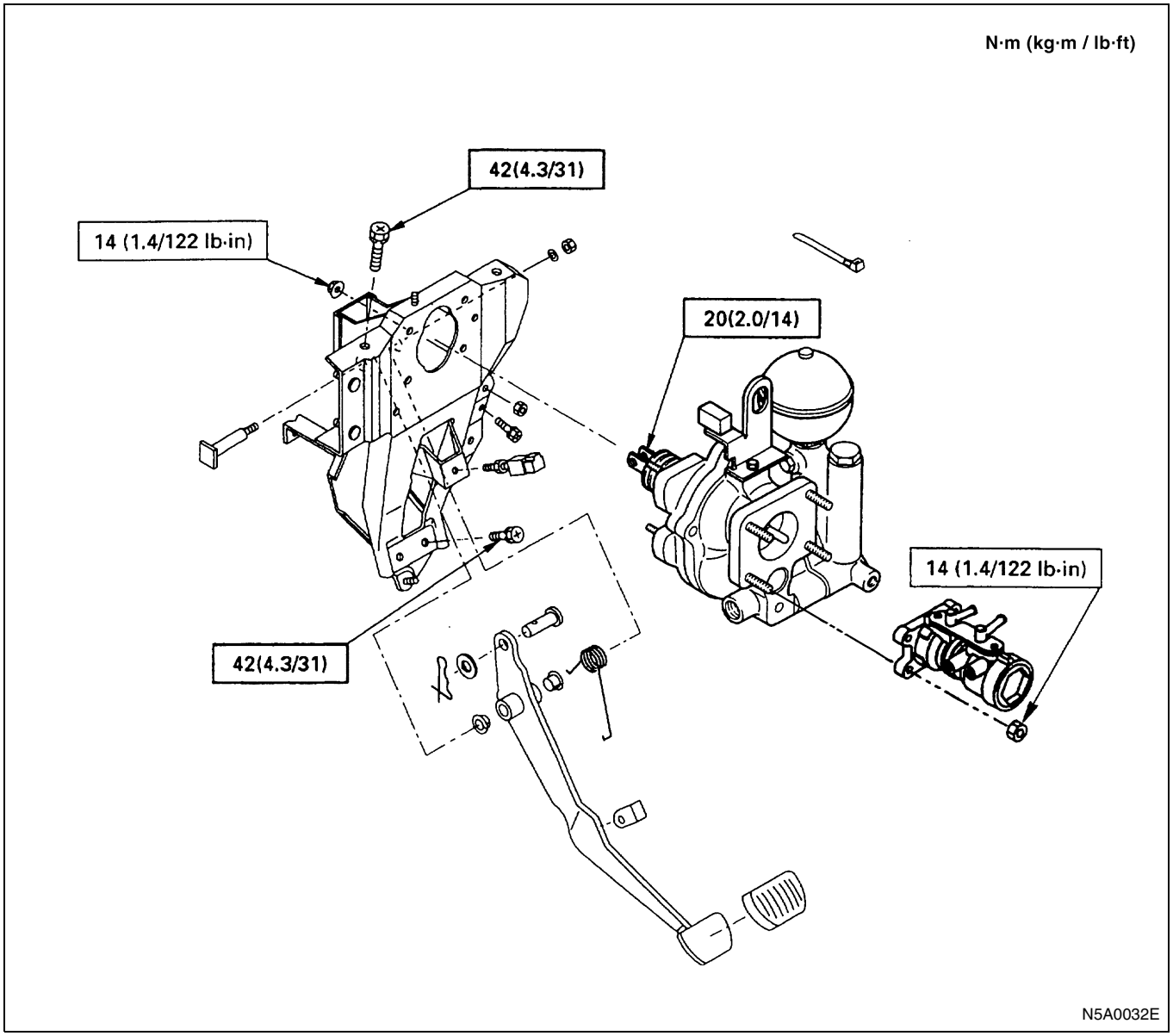
Legend

A. Independent suspension models

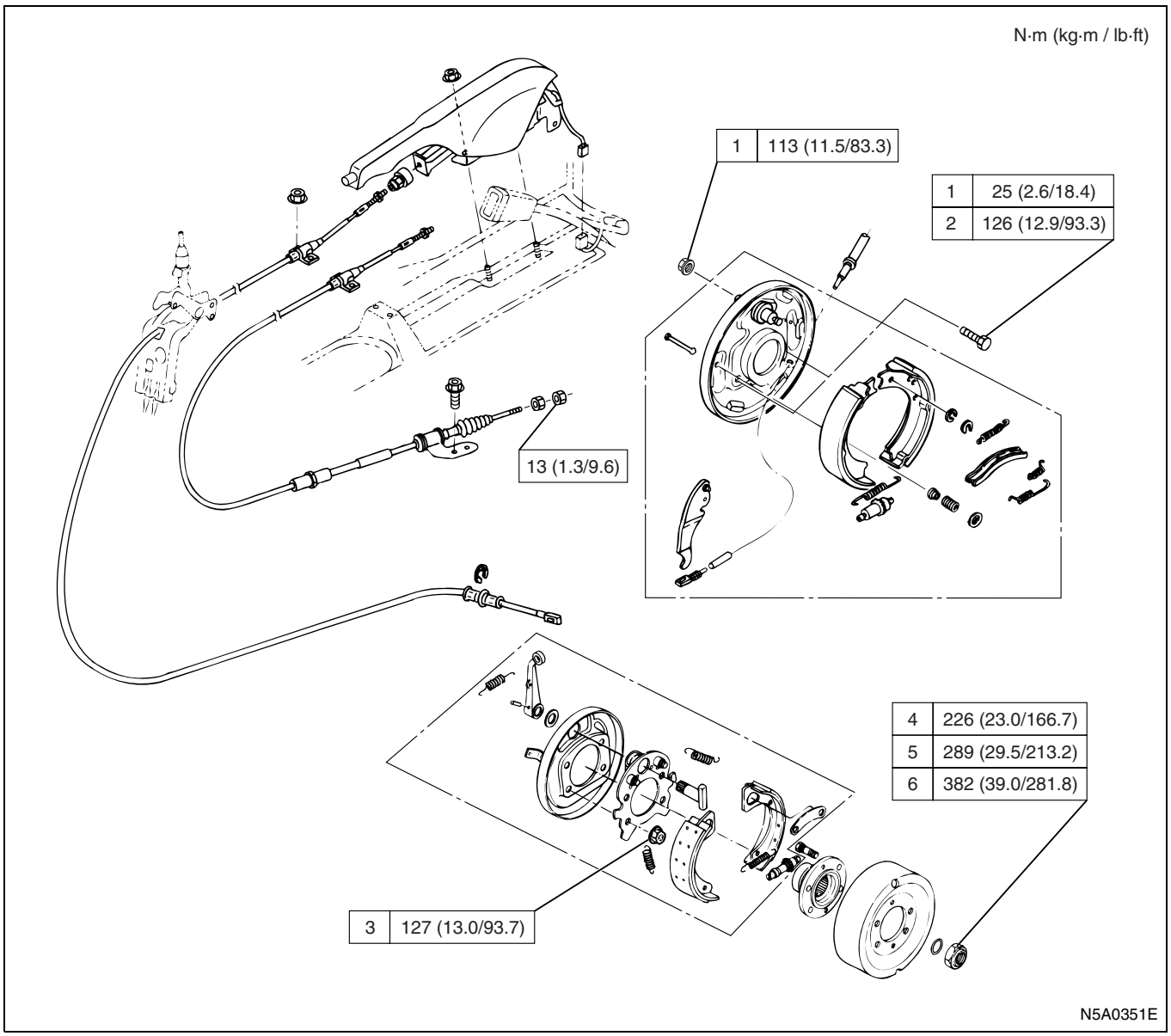
Brake Pedal and Control (Vacuum Booster Type)



Brake Pedal and Control (Hydraulic Booster Type)



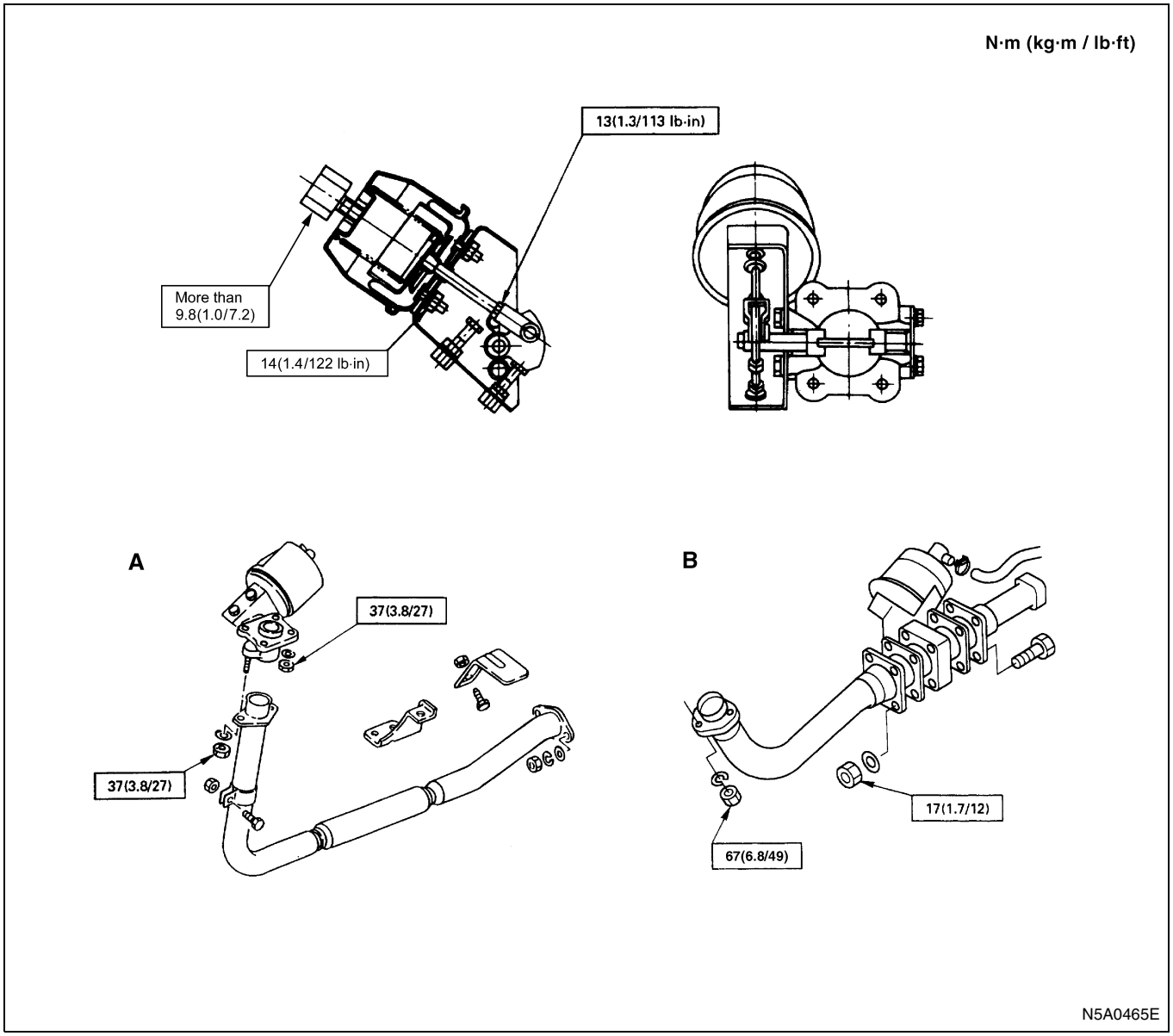
Parking Brake



Legend

1. ϕ 178 mm parking brake
2. ϕ 190 mm parking brake
3. ϕ 203 mm parking brake
4. MSB type transmission
5. MYY type transmission
6. MZZ type transmission

Exhaust Brake



Legend

A. 4J engine without turbocharger

B. 4J engine with turbocharger and 4H engine

SPECIAL TOOLS

Hydraulic Brakes

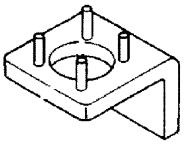
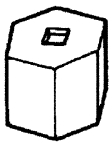
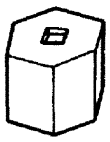
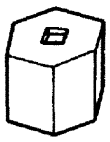
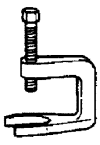
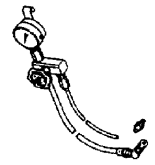
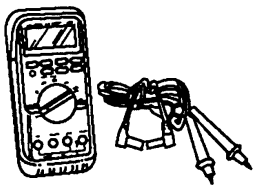
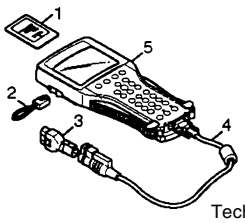
Illustration	Tool Number / Description / Remarks
 5884023710	5-8840-2371-0 / Master cylinder support plate
 5884023700	5-8840-2370-0 / Wrench (Cylinder inside diameter 30.1 mm, 31.7 mm)
 5884023690	5-8840-2369-0 / Wrench (Cylinder inside diameter 28.5 mm)
 5884028050	5-8840-2805-0 / Wrench (Cylinder inside diameter 34.9 mm)
 5884022150	5-8840-2215-0 / Remover: steering wheel
9852200260	9-8522-0026-0 / Return spring plier

Illustration	Tool Number / Description / Remarks
 5884021900	5-8840-2190-0 / Pressure gauge: brake fluid

Anti-lock Brake System (ABS)

Illustration	Tool Number / Description / Remarks
 5884002850	5-8840-0285-0 (J-39200) / High impedance multimeter
 Tech 2	1. PCMCIA Card 2. RS232 Loop Back Connector 3. SAE 16/19 Adapter 4. DLC Cable 5. Tech 2

Parking Brakes

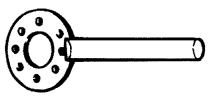
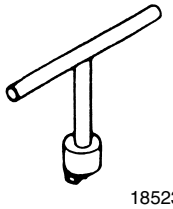
Illustration	Tool Number / Description / Remarks
 5884020430	5-8840-2043-0 / Flange holder
 1852370020	1-8523-7002-0 / Return spring remover

Illustration	Tool Number / Description / Remarks
9852212310	9-8522-1231-0 / Return spring setting tool

BRAKES

SECTION 5A
HYDRAULIC BRAKES

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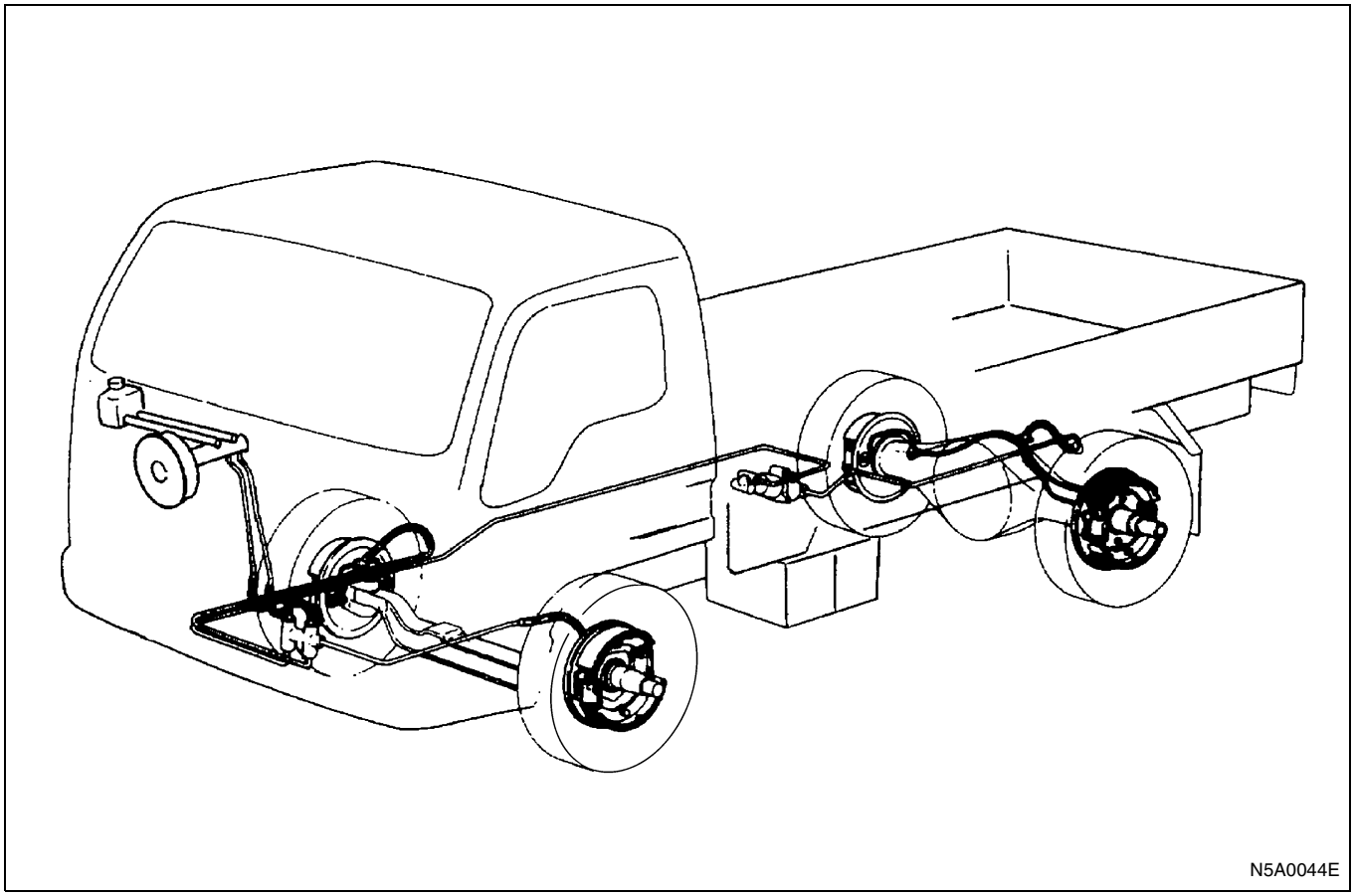
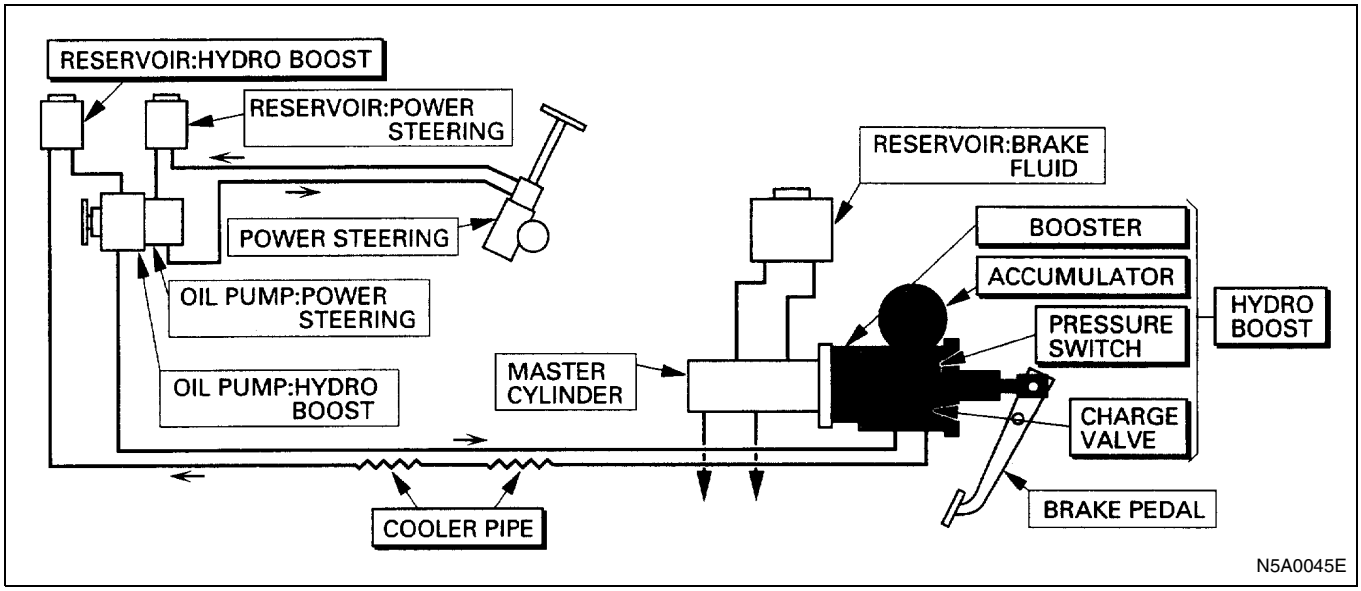
GENERAL DESCRIPTION

Hydraulic Brake System



The brake system has dual hydraulic circuit with vacuum booster (Master-vac).
The master cylinders and the wheel cylinders at the front and rear of the vehicle are connected by steel piping and flexible hoses.
The vacuum booster is connected to the vacuum pump through the vacuum tank. This provides the most effective vacuum assist.

Hydraulic Booster Brake system



The hydro boost system, which functions as a brake force boosting device that allows the brake to be operated with less force than otherwise, includes the hydro boost, which has the booster, accumulator, charge valve, and pressure switch in an integrated structure, a reservoir, and a cooler pipe.

Functions of the Main Constituent Parts

Booster:
Controls the hydraulic oil ejected from the oil pump and amplifies the force on the pedal.
Accumulator:
Accumulates the hydraulic oil under pressure for the boosting operation after the pump stops.
Charge valve:
Performs switching operation and feeds the hydraulic oil to the accumulator when the accumulator oil pressure declines.
Pressure switch:
Detects that the accumulator oil pressure has declined to the warning set pressure and operates the warning buzzer.
Oil pump:
Is driven by the engine rotation and feeds the hydraulic oil to the hydro boost through the piping.
Reservoir:
The pump stores the hydraulic oil for doing suction and expulsion.
Cooler pipe:
Located before the radiator, facilitates heat radiation of the hydraulic oil in the system piping, and inhibits an increase in the temperature of the oil.

Other units relating to this system include, as shown in the figure, the power steering, the pump and reservoir for the power steering, the master cylinder, which receives the output of the hydro boost and activates the brake, the reservoir for the master cylinder, and the brake pedal that activates the booster.
The master cylinder is integrally bolted to the booster of the hydro boost. The pump for the power steering is integrated as a tandem pump that shares the hydro boost pump and the drive unit. But as systems, the hydro boost and the power steering are independent of each other, and their reservoirs are separate as well.

Booster Assembly

The hydraulic booster is a device that applies force to the master cylinder when the brake pedal is applied. The fluid flowing through the booster head is controlled by brake pedal movement.
The hydraulic booster cylinder rod attaches to a piston that connects with the spool valve. This assembly moves when brake pedal pressure is applied. The spool valve restricts fluid flow and builds pressure on one side of the piston. The pressure overcomes the return spring and moves the piston to a balanced position. As the piston moves, it pushes the cylinder rod and applies pressure to the master cylinder.
A relief valve inside the pump limits the pressure to 11,770 kPa (120 kg/cm^2 / 1707 psi). This pressure level provides good braking without damaging the brake pipes or hoses. When actuated, the relief valve allows fluid to bypass the piston.

Fluid and Fluid Handling

This system uses no special fluids. However, care must be taken to use the correct fluids. The master cylinder and brake system uses brake fluid, while the hydraulic brake booster pump uses power steering fluid.

Substandard or Contaminated Fluid

Notice:
Hydraulic brake systems use two distinct and incompatible fluids. Power steering fluid is used in the hydraulic booster brake system. Brake fluid is used in the master cylinder and brake pipes to the wheels. Be extremely careful when selecting brake system fluids or seal damage can result. Refer to Section 0B MAINTENANCE AND LUBRICATION to select the correct fluid.

Notice:
Do not reuse brake system fluids. Do not mix power steering fluid with brake fluid. Swelling and deterioration of rubber parts can result from fluid contamination. This can lead to reduced brake performance and the eventual loss of braking capability.

Contaminated fluid causes swelling and deterioration of rubber parts that can lead to reduced brake performance and the eventual loss of braking capability. Check the condition of the fluid at regular intervals and note any unusual consistency, color, and signs of contaminants in the fluid. Do not reuse brake system fluids. Always discard used fluids. Do not mix power steering fluid with hydraulic brake fluid. If contamination occurs, flush the hydraulic booster system with clean power steering fluid.
Booster components bench servicing should be done in a clean work area separated from the brake servicing area. Wash hands before changing between brake or booster work areas. Do not use the same containers for fluids.

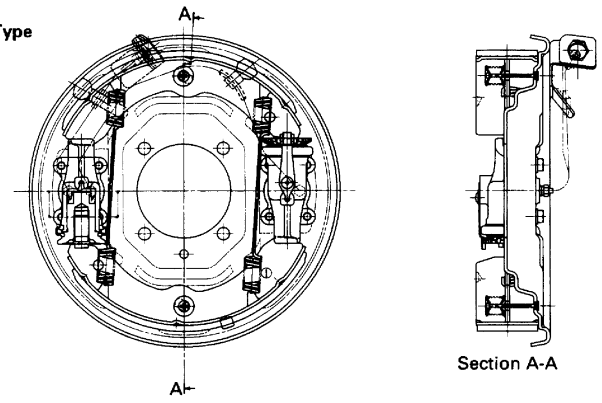
Flushing the Hydraulic Booster System

Flushing is required when dirt, sludge, or water is found in the system. Flushing involves running clean fluid through the system until the draining fluid appears the same as clean fluid.
Contaminated fluid in the booster system can cause rubber parts to deteriorate.
The hydraulic booster system should be cleaned and flushed when the hydraulic pump is replaced.
Metal shavings from a worn hydraulic pump often contaminate the system. Pipes and hoses should be removed and blown clean of all metal shavings.

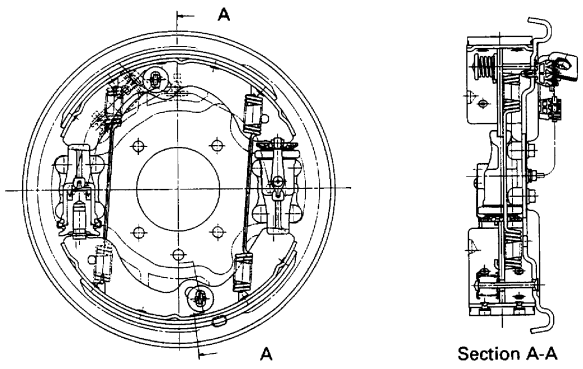
Front Drum Brake

Drum Inside Diameter

279.4 & 300 mm – 2L Type



320 mm – 2L Type



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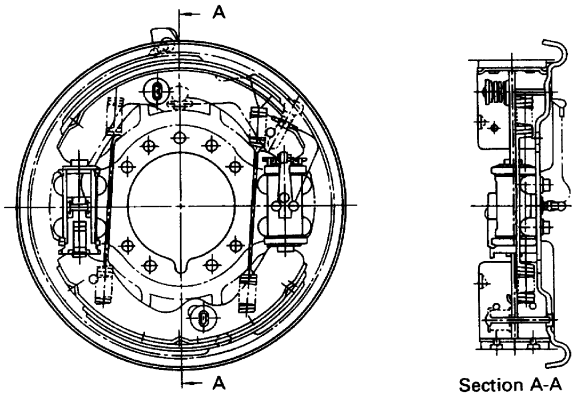
NPS



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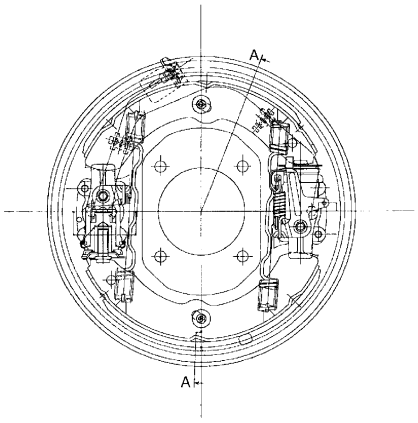
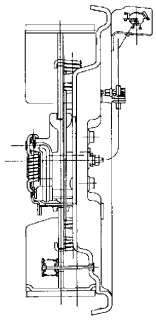
Front Drum Brake (Auto-adjuster Type)

Drum Inside Diameter

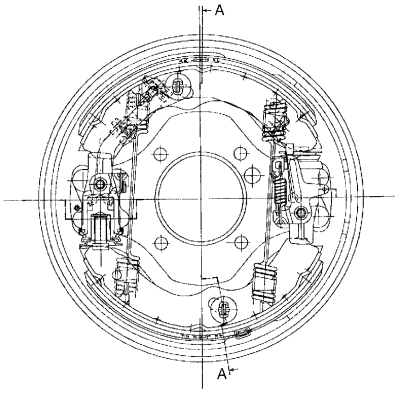
300mm - 2L Type

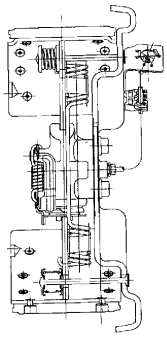




Section A-A

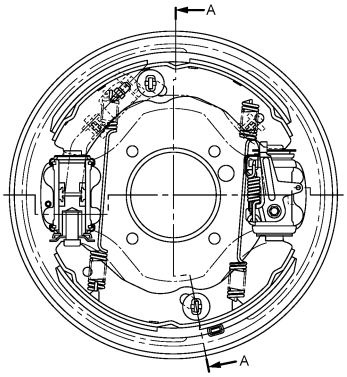
320mm - 2L Type

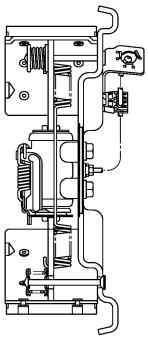




Section A-A

320mm - D2L Type





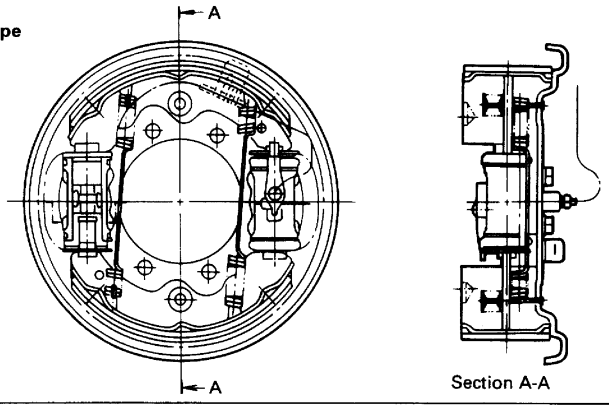
Section A-A

N5A0049E

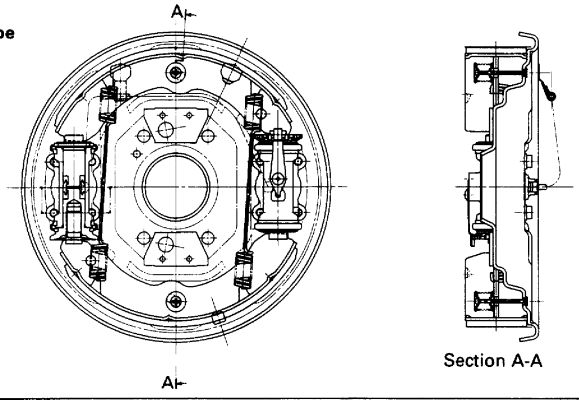
Rear Drum Brake (Manual Adjuster Type)

Drum Inside Diameter

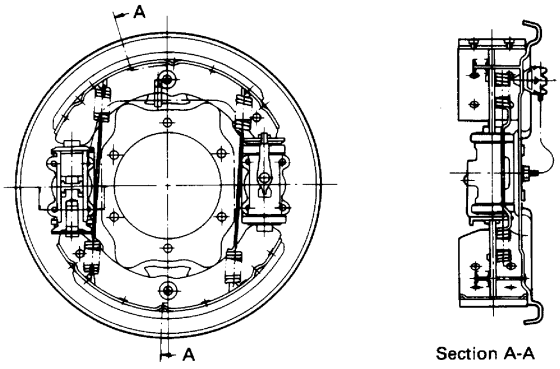
228.6 mm – D2L Type



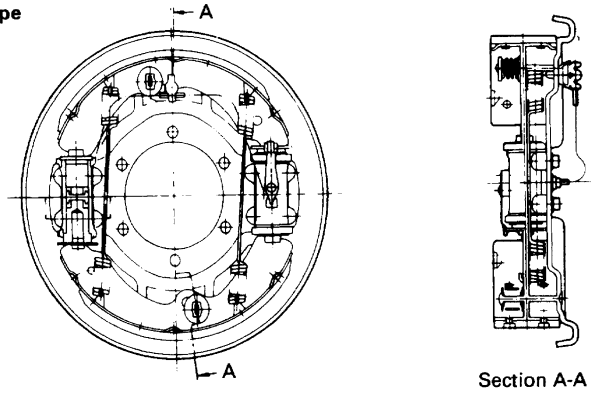
279.4 mm – D2L Type



300 mm – D2L Type



320 mm – D2L Type



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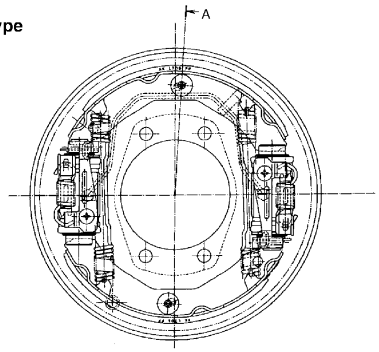
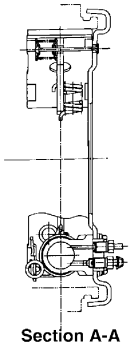
Rear Drum Brake (Auto-Adjuster Type)

Drum Inside Diameter

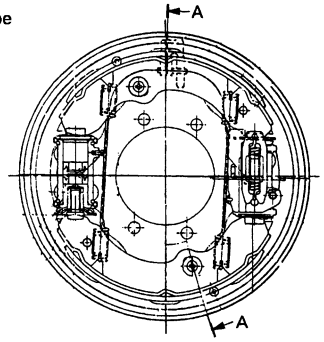
240mm - D2L Type

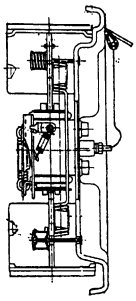




Section A-A

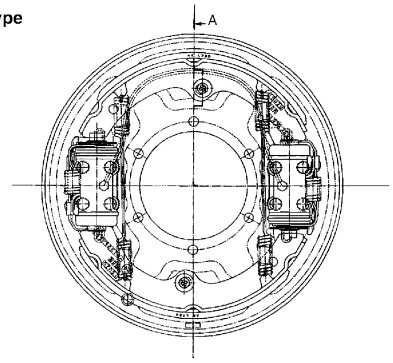
260mm - D2L Type

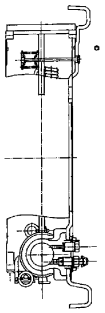




Section A-A

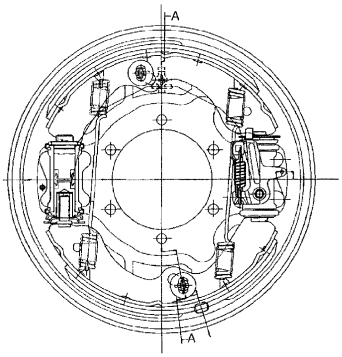
290mm - D2L Type

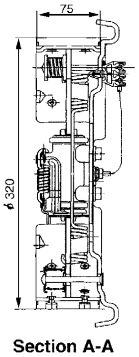




Section A-A

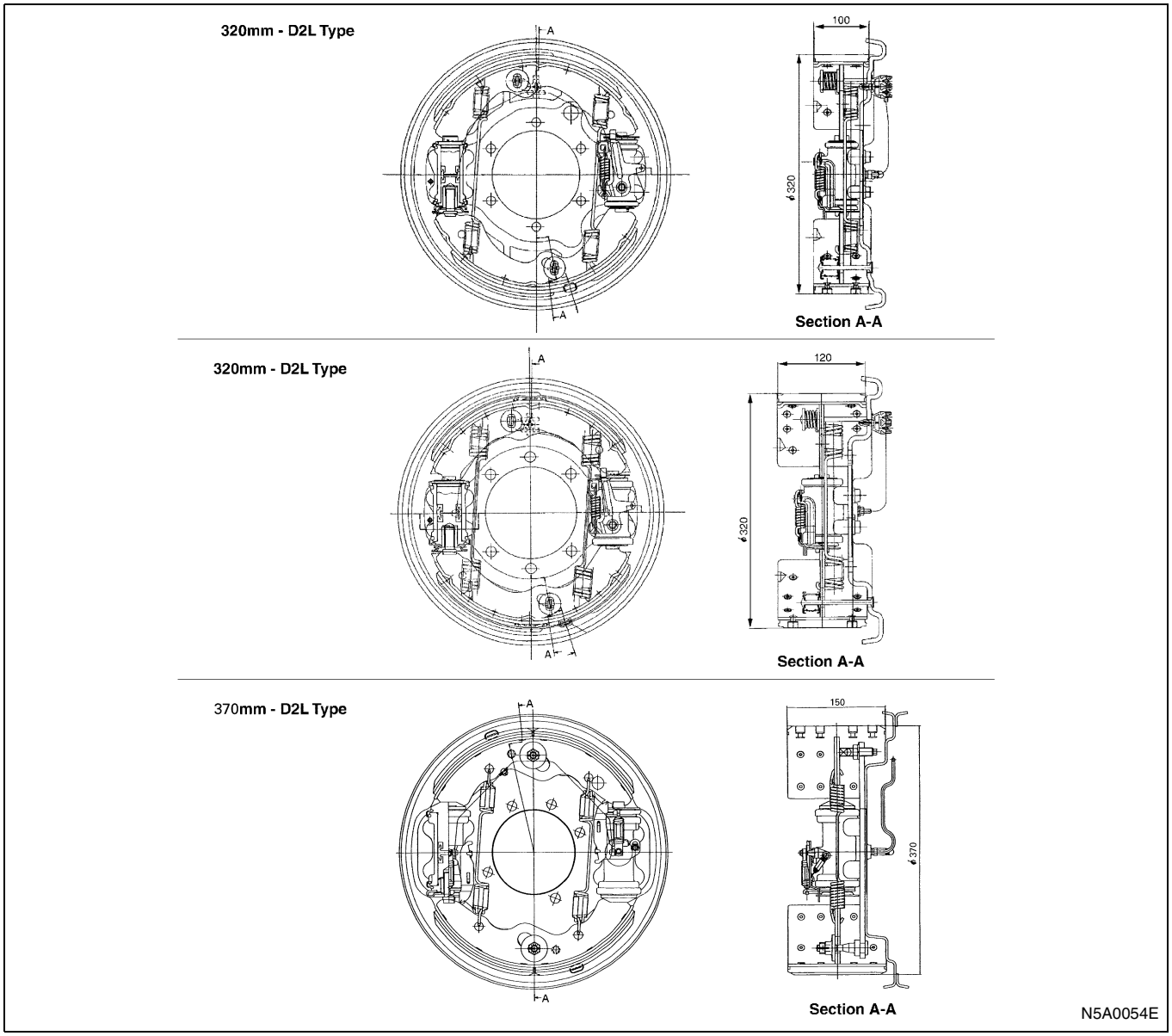
320mm - D2L Type





Section A-A

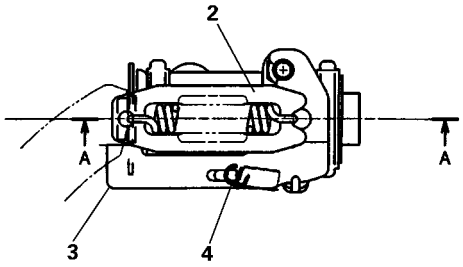
N5A0053E

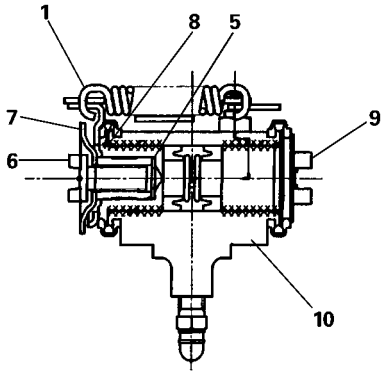


The dual two leading shoe type brake eliminates the problem of weaker braking force on reverse stops common to two leading shoe type brakes while maintaining the many advantages of this type of brake.
This combination of two leading shoes provides nearly equal braking force. This prevents an uneven load distribution on the wheel hub bearings.
This type of brakes is widely used on the rear wheels of many vehicles.

Auto-Adjuster

Drum Inside Diameter 260 mm





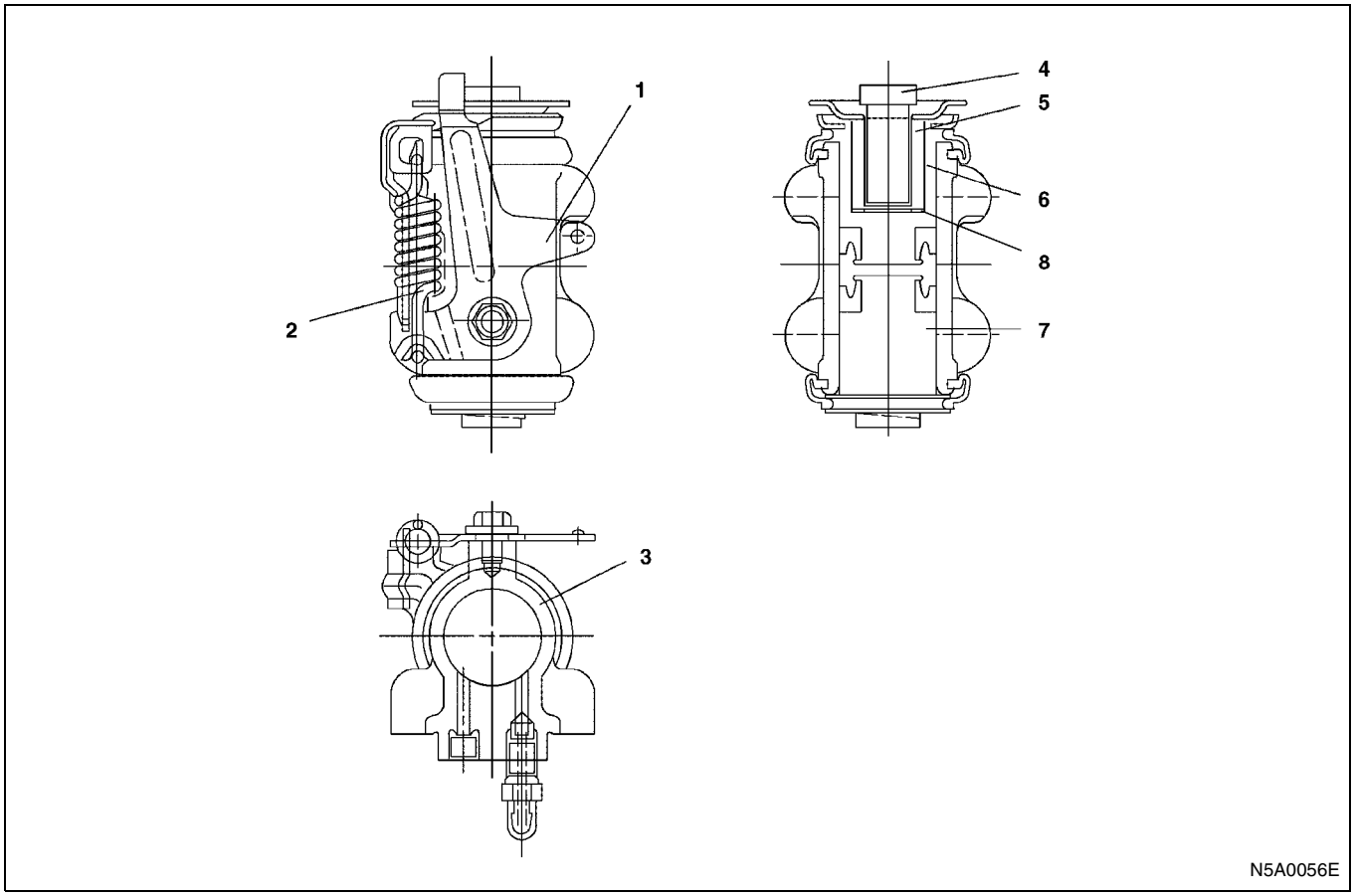
Section A-A

N5A0055E

Legend

1. Over-travel spring
2. Fitting
3. Adjust lever
4. Lever return spring
5. Washer
6. Adjust screw
7. Adjust gear and nut assembly
8. Piston and bracket assembly
9. Anchor piston
10. Body

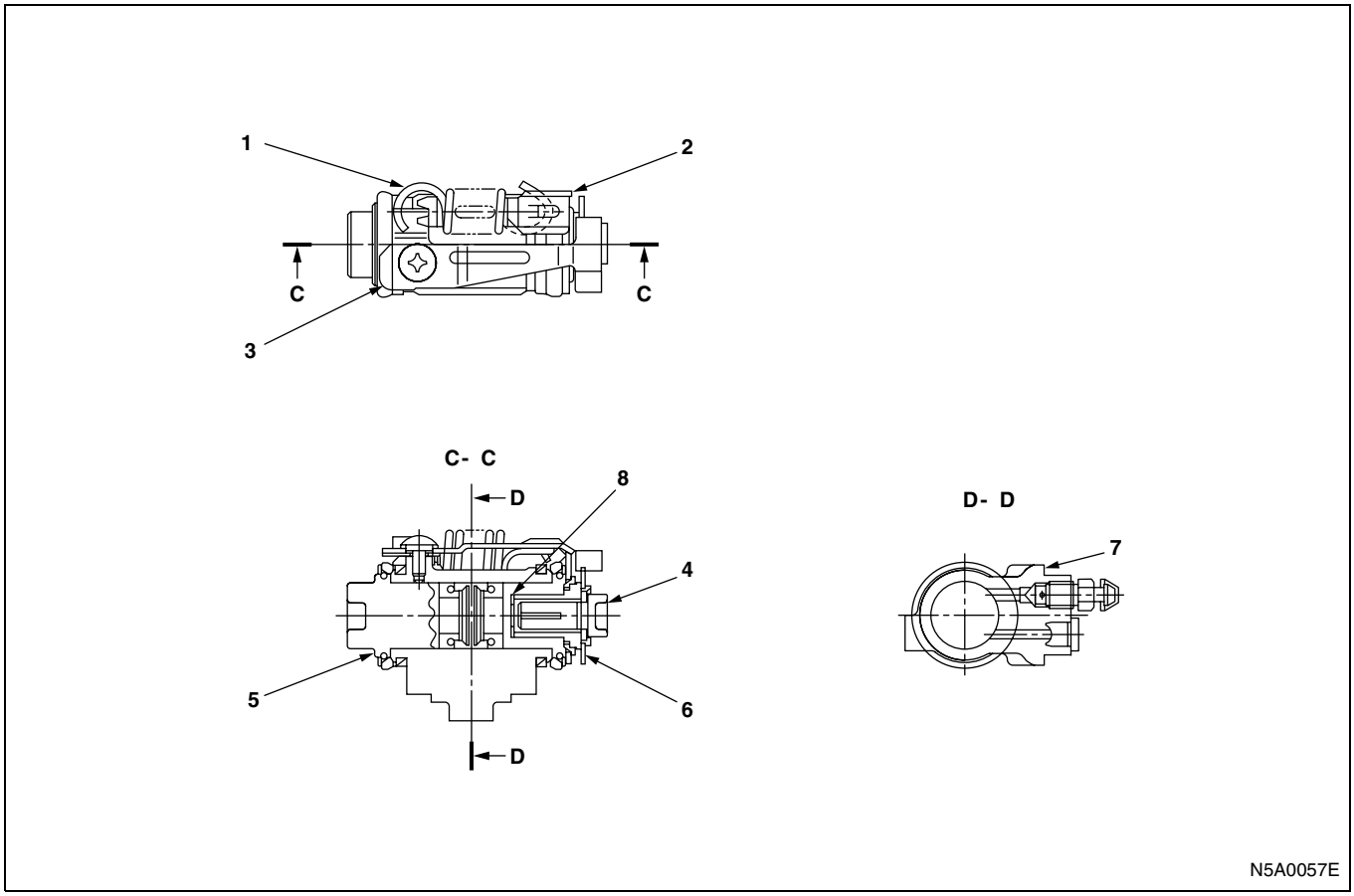
Drum Inside Diameter 300 mm, 320 mm



Legend

1. Adjust lever
2. Over-travel spring and fitting (Bracket) (including: lever return spring)
3. Body
4. Adjust screw
5. Adjust gear and nut assembly
6. Piston and bracket assembly
7. Anchor piston
8. Washer

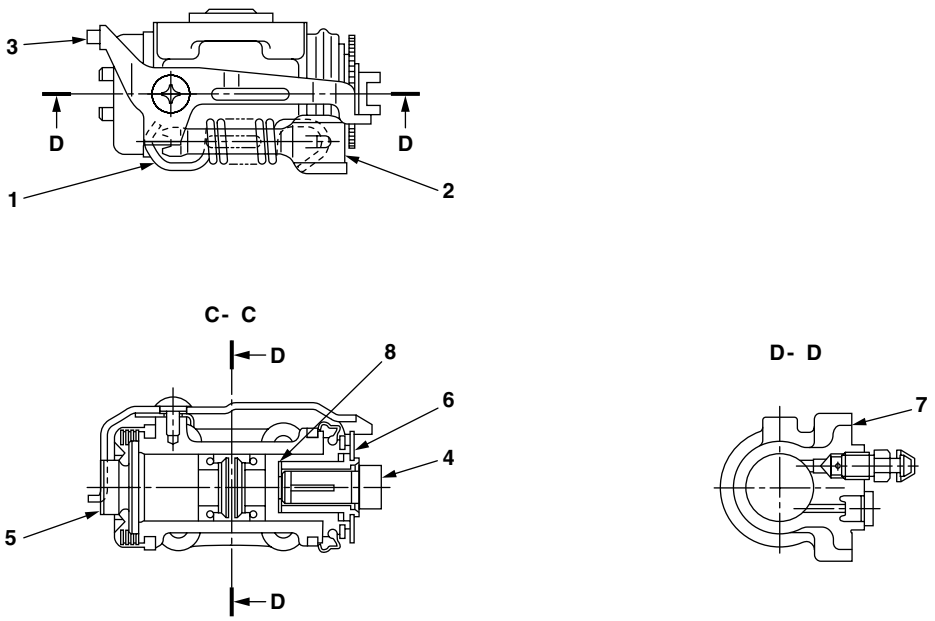
Drum Inside Diameter 240 mm



Legend

1. Overtravel spring
2. Piston and bracket assembly
3. Adjust lever
4. Adjust screw
5. Anchor piston
6. Adjust gear and nut assembly
7. Body
8. Washer

Drum Inside Diameter 290 mm

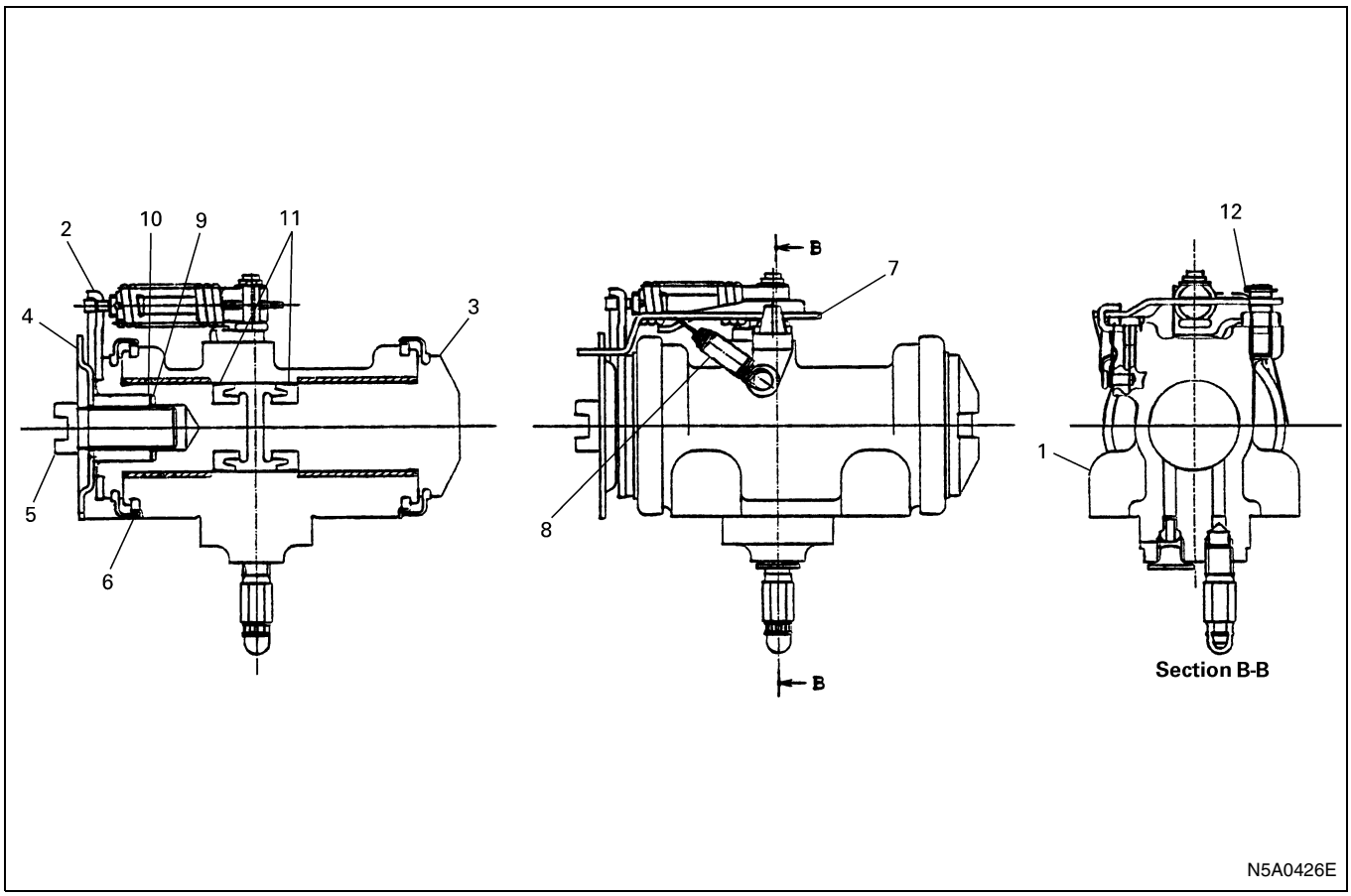


N5A0058E

Legend

1. Overtravel spring
2. Piston and bracket assembly
3. Adjust lever
4. Adjust screw
5. Anchor piston
6. Adjust gear and nut assembly
7. Body
8. Washer

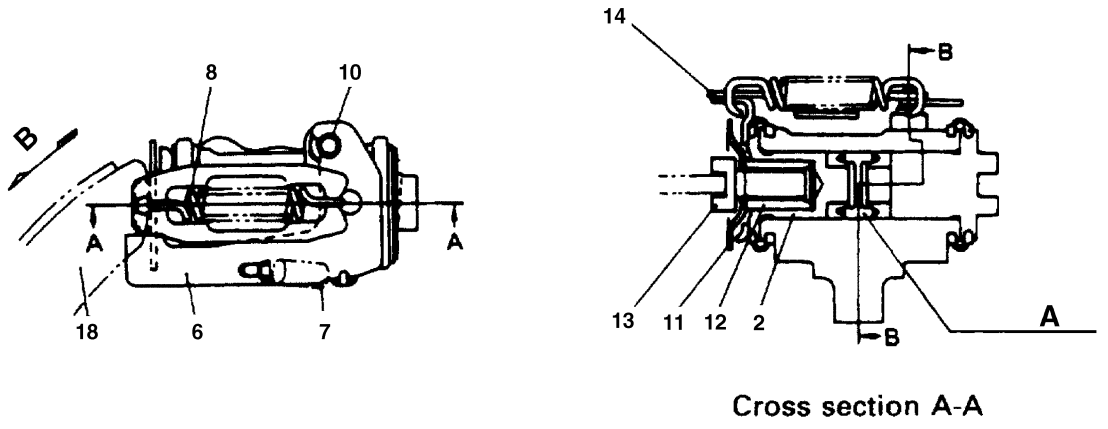
Drum Inside Diameter 370 mm



Legend

1. Body
2. Piston and bracket assembly
3. Anchor piston
4. Gear and nut assembly
5. Adjust screw
6. Boot
7. Lever assembly
8. Spring
9. Plain washer
10. Plain washer
11. Cup
12. Snap ring-E type

Operation of Auto-adjuster



Legend

A. Oil chamber

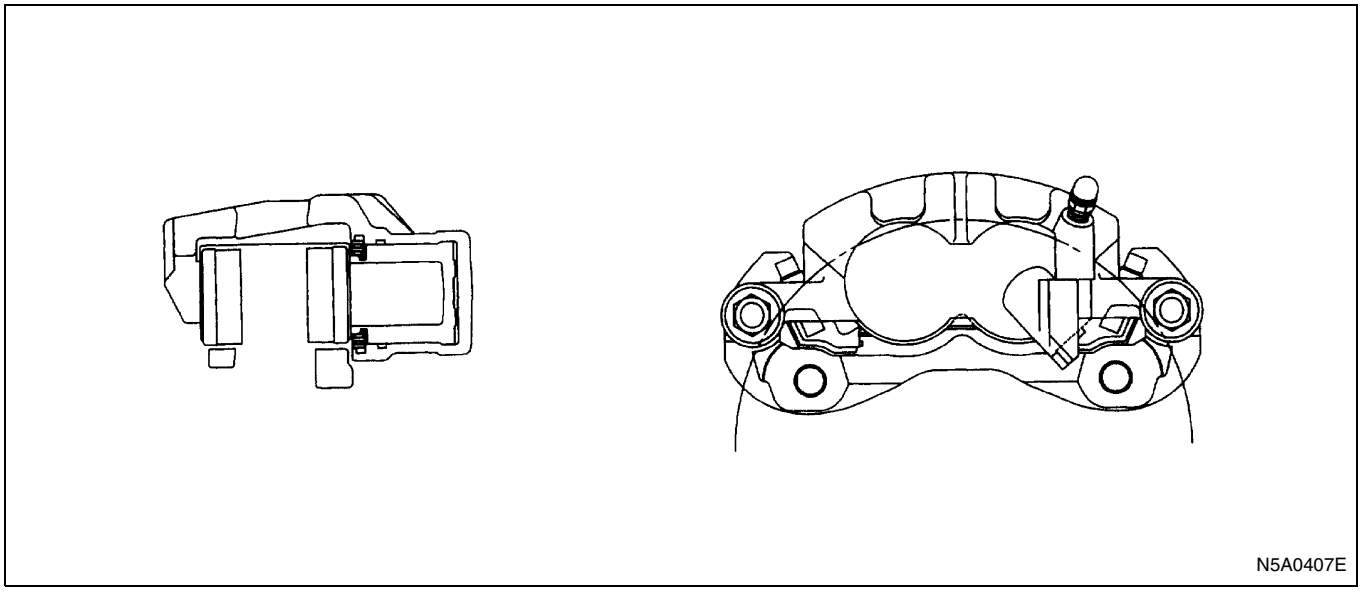
B. Rotational direction of the drum (forward)

The entire auto-adjust mechanism is incorporated into the wheel cylinder assembly, and the adjust operation is carried out only when in the forward movement.
The operation of the auto-adjuster is as follows:

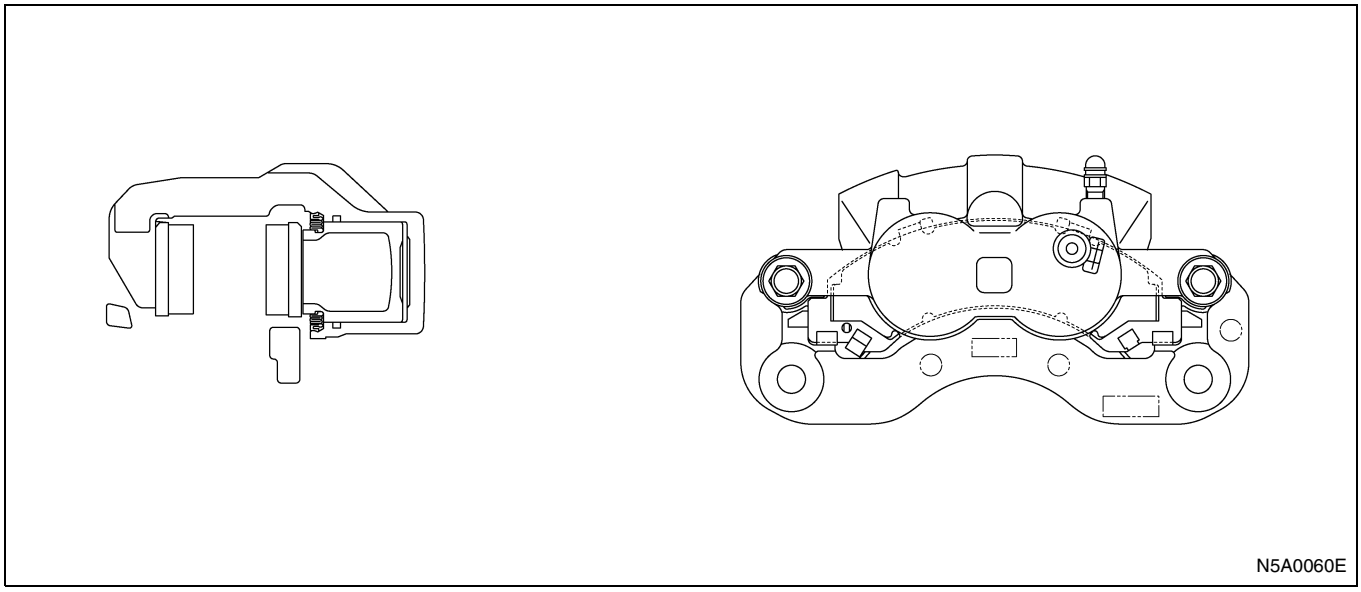
- When fluid pressure is applied to the oil chamber (A), the piston, which is resistant to the over-travel spring installed between the bracket (14) and the adjust lever (6), is forced out to the brake shoe (18) side. (The piston and bracket are welded into a monolithic construction.)
- When force delivered by the over-travel spring (18) is intensified as the piston (2) moves, the balance maintained with the lever return spring (7) installed between the adjust lever (6) and lever pin (10) is destroyed, and the adjust lever (6) with the lever pin (10) as a pivot, rotates the adjust gear (11) in the rotational direction.
- When the shoe clearance (clearance between the brake shoe and the brake drum) gets to the specified value, the adjust lever (6) adjusts the shoe clearance by driving one gear tooth or more of the adjust gear (11) in the rotational direction through the force of the over-travel spring (8).
- When the brake shoe (18) comes into contact with the brake drum, the frictional force generated between the adjust screw (13) and the adjust nut (12) gets larger, and the adjust gear (11) cannot be rotated by the force of the over-travel spring (8). (The adjust gear and the adjust nut are welded into a monolithic construction.) That is, the automatic adjustment of the shoe clearance is carried out until the brake shoe comes in touch with brake drum. However, over adjust can be avoided since this automatic adjustment will not be performed for the increased amount of the piston shift caused by the deformation of the drum and shoe after their contact.
- When the fluid pressure is released from the oil chamber (A), the force by which the lever return spring (7) rotates the adjust gear (6) adversely gets weaker than the frictional force generated between the adjust screw (13) and the adjust nut (12),therefore, the adjust lever (6) slides on the adjust gear (11) to get back to its former state before operation and this operation is completed with the adjust gear (11) left in the state in the rotational direction into which its has been driven.

Front Disc Brake

Independent Suspension Models

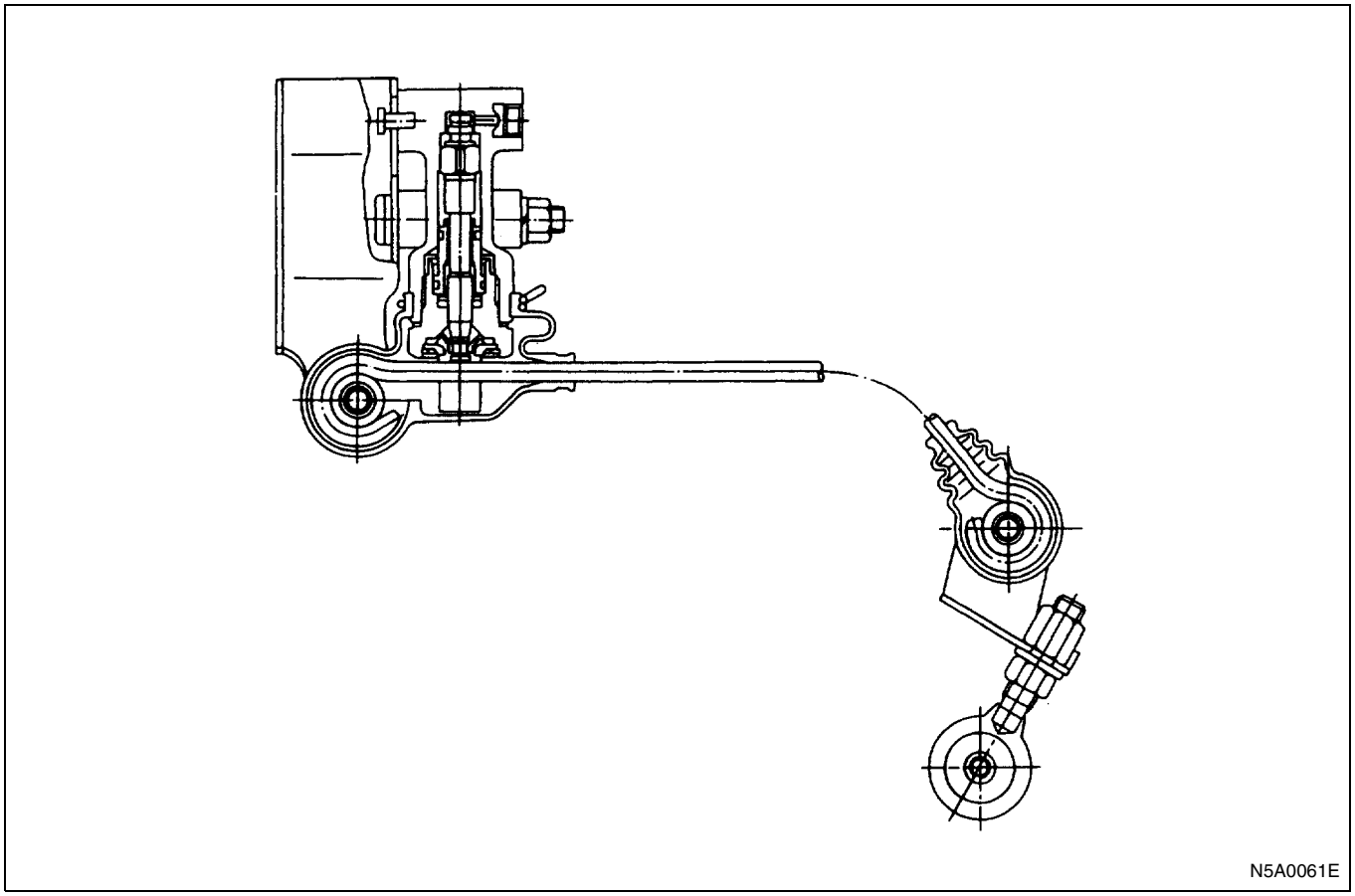


Leaf Spring Suspension Models (Rigid Axle Type)

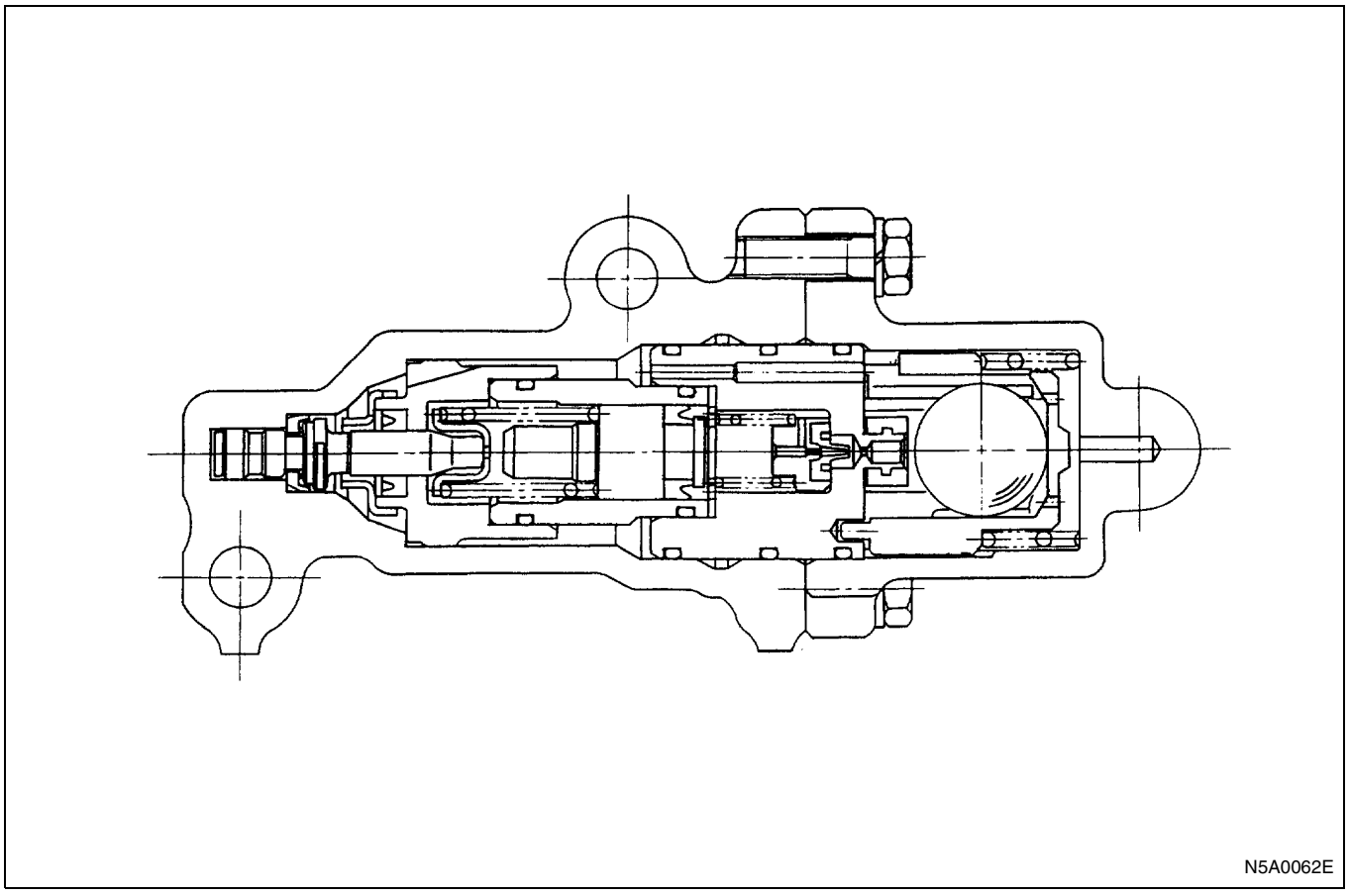


The disc brake assembly consists of a caliper, piston, disc, pad assembly and support bracket.
The caliper assembly has two bores and is mounted to the support bracket with 2 mounting bolts. The support bracket allows the caliper to move laterally against the disc. The caliper is a one-piece casting with the inboard side containing the piston bore. A square cut rubber seal is located in a groove in the piston bore which provides the hydraulic seal between the piston and the cylinder wall.

Load Sensing Proportioning Valve (LSPV)



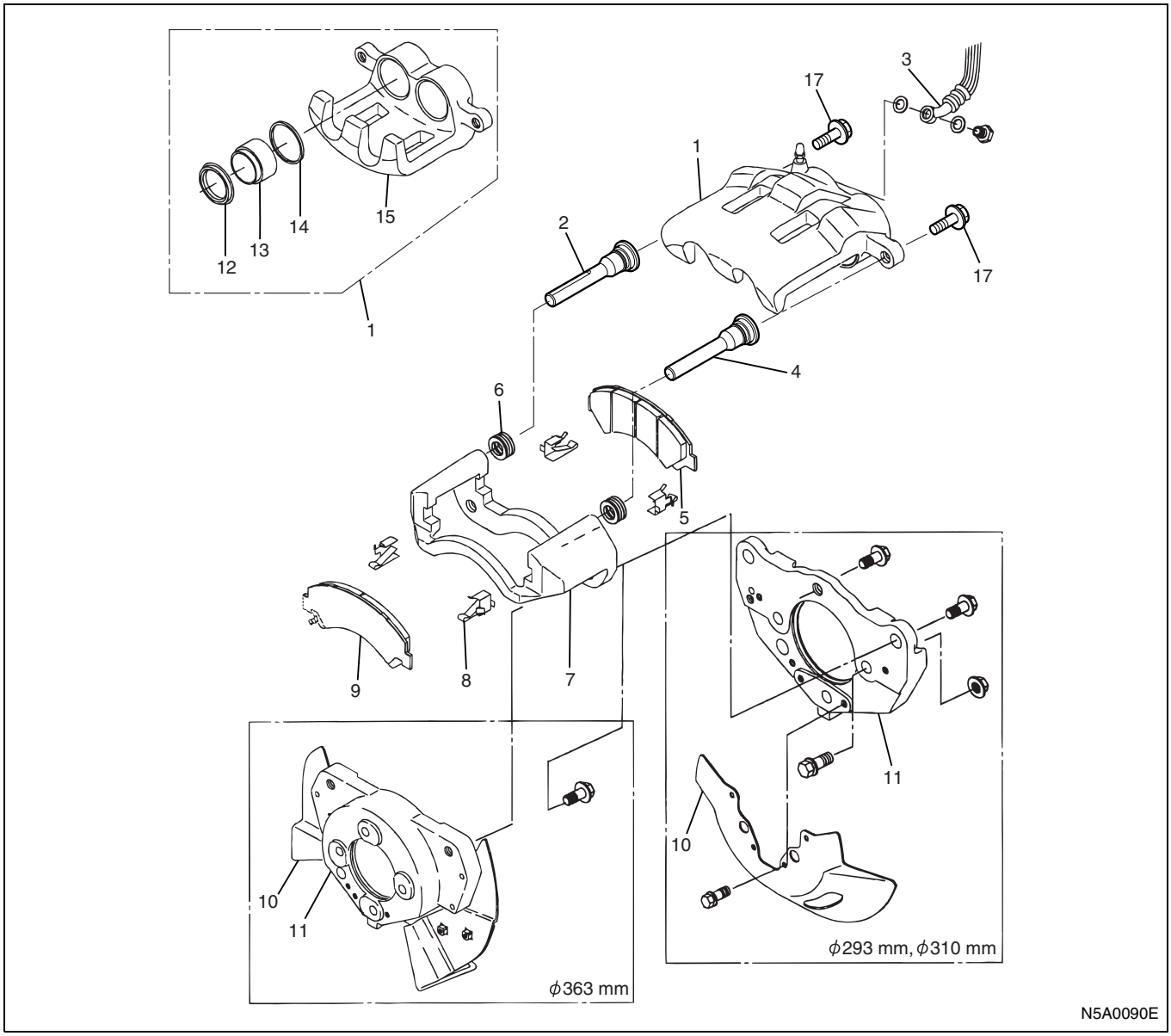
Deceleration Sensing Proportioning Valve (DSPV)



ON-VEHICLE SERVICE

Front Disc Brake Assembly

Leaf Spring Suspension Models (ø293, ø310 and ø363 mm)



Legend

1. Caliper assembly
2. Guide pin (Green)
3. Flexible hose
4. Lock pin (Yellow)
5. Inner pad (Pad Kit)
6. Pin boot (Seal Kit)
7. Support assembly
8. Pad clip
9. Outer pad (Pad Kit)
10. Wind guide
11. Adapter
12. Piston boot (Seal Kit)
13. Piston
14. Piston seal (Seal Kit)
15. Body assembly
16. Pin bolt

Removal

Notice:

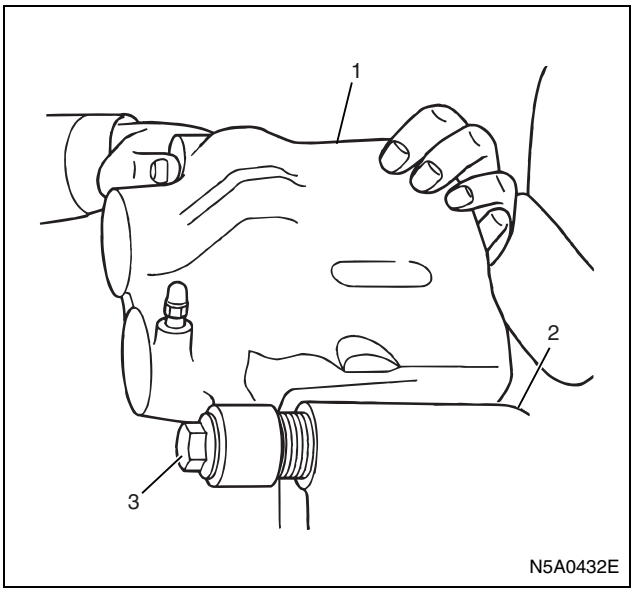
- Block vehicle wheels and apply the parking brake.
- Rise the axle to clear the tire from the ground.

Position jack stands under vehicle.

- Remove the wheel.

Notice:
Seal parts cannot be reused. When reassembling, be sure to replace with a new seal kit.

1. Flexible hose
2. Pin bolt (Lock pin side)
3. Caliper assembly
   - Slide the caliper assembly free from the inside.

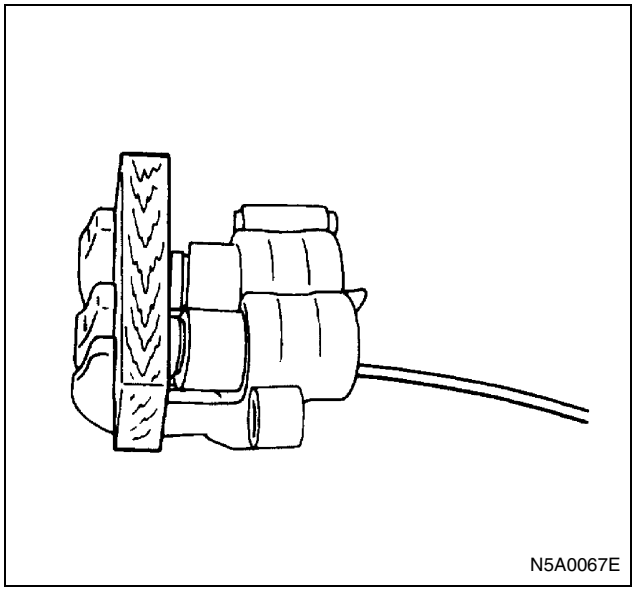


Legend
1. Caliper Assembly
2. Support Assembly
3. Pin Bolt

4. Outer pad
5. Inner pad
6. Pad clips
7. Support assembly
   - Remove the hub and disc before removing the support assembly.
8. Wind guide
   - Remove the hub and disc before removing the wind guide.
9. Adapter

Disassembly

1. Place a piece of wood across the body assembly to prevent piston damage.
2. Apply approximately 196 kPa (2.0 kg/cm^2 / 28.4 psi) of compressed air to the body assembly oil port to remove the pistons.

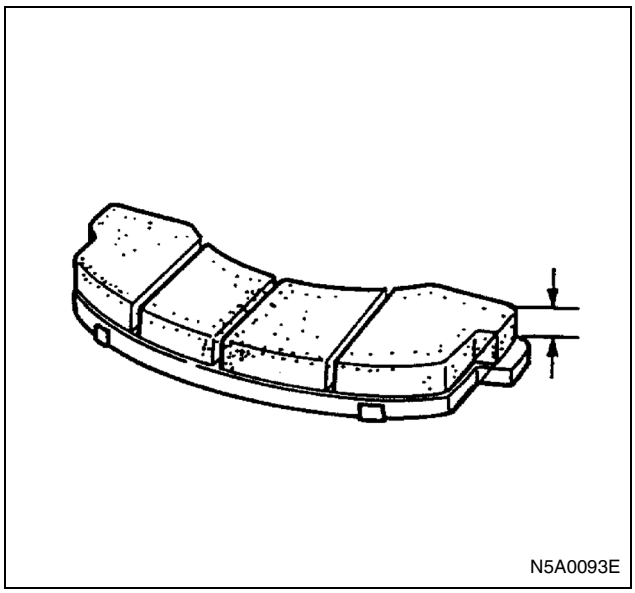


Inspection

1. All parts for wear distortion or other conditions and replace as needed.
2. Inner and outer pads.
   - Use a vernier caliper to measure the inner pad and outer pad thickness.

Pad Thickness	mm (in)
Standard	Limit
13 (0.51)	1 (0.04)

   - If the measured value is less than the specified limit, the pads must be replaced with the repair pad kit.

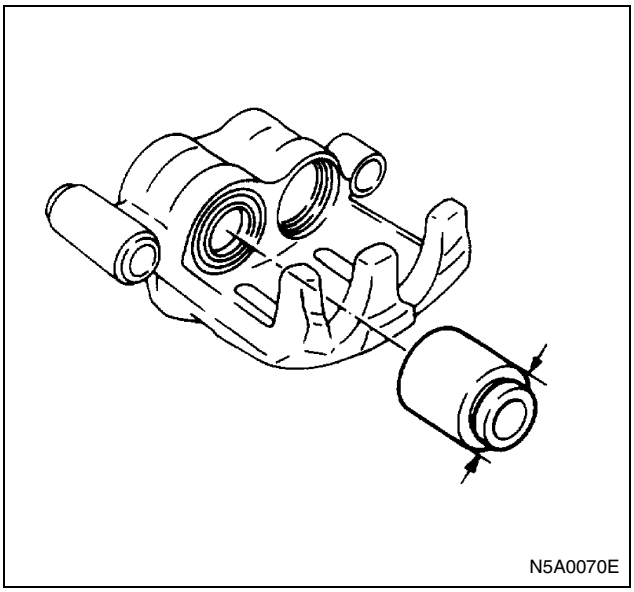


3. Piston and Cylinder Clearance.
   - Use a micrometer to measure the piston diameter.
   - Use an inside dial indicator to measure the cylinder bore.

- Calculate the piston and cylinder bore clearance.

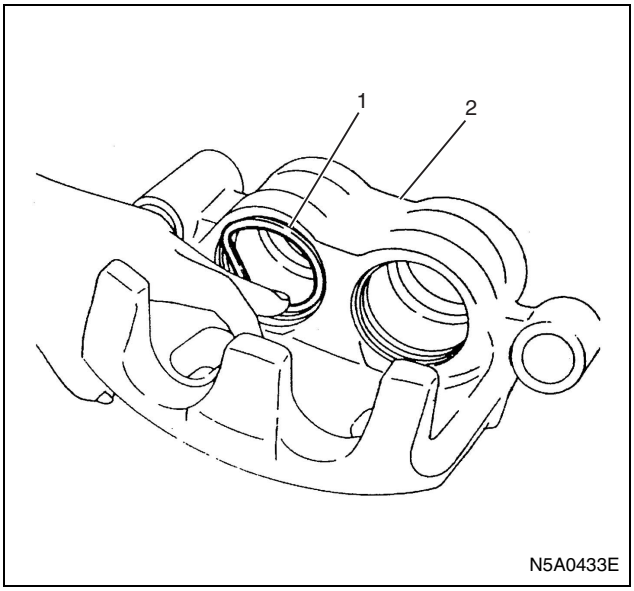
Piston and cylinder bore clearance mm (in)	
Standard	Limit
0.08 — 0.18 (0.003 — 0.007)	0.23 (0.009)

- If the clearance exceeds the specified limit, the piston and/or the body assembly must be replaced along with the repair seal kit.


N5A0070E

Reassembly

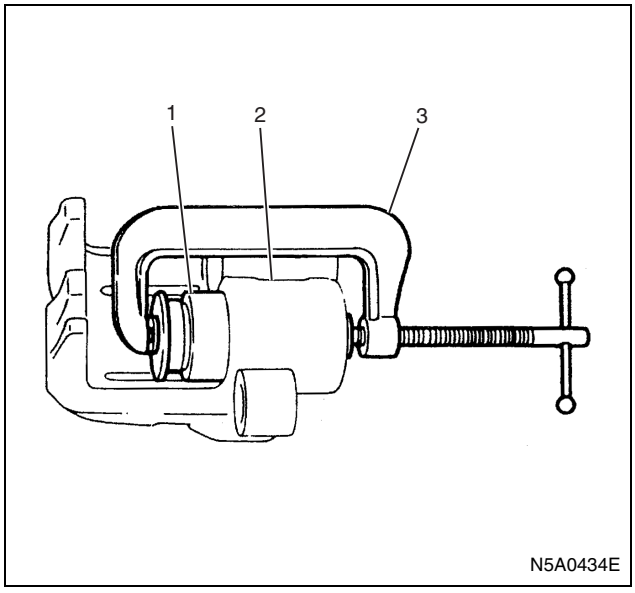
1. Piston Seal
   - Be sure to use a new seal ring.
   - Apply rubber grease to the piston seal. The rubber grease is included in the seal kit.
   - Install the piston seal to the cylinder bore groove.



N5A0433E

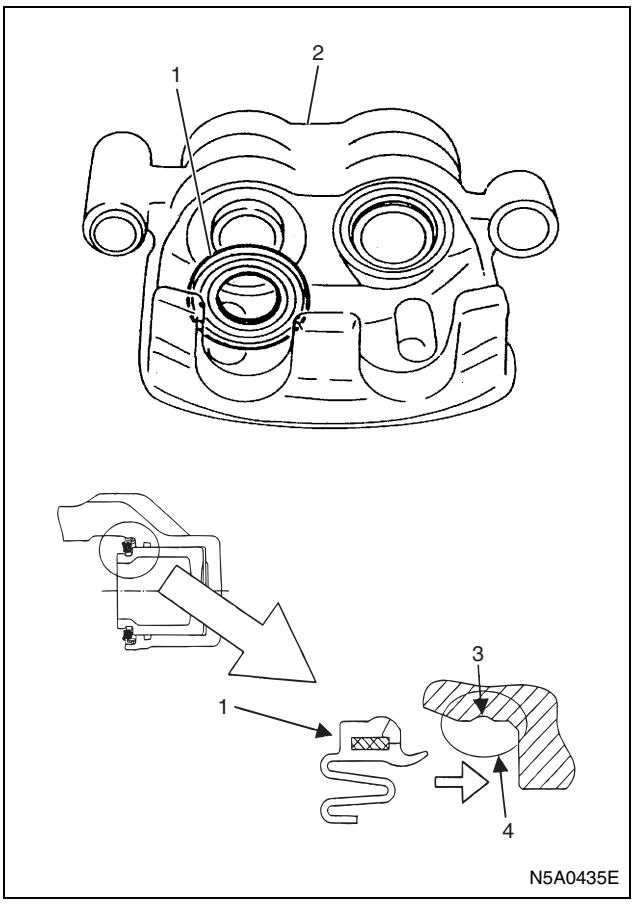
Legend
1. Piston Seal
2. Body Assembly

2. Piston and Piston Boot
   - Apply brake oil to the piston outer circumference.
   - Use a hand vise to install the pistons to the cylinder.
   - Apply special grease to the piston.
     This will prevent cylinder and piston corrosion.
   - Use a new piston boot.
     Do not confuse the front and rear sides of the boot.
     Carefully press the insert portion of the boot into the cylinder body groove. Be sure that the insertion depth is uniform.
   - Install the piston boot inner lip to the piston groove.
     Handle the piston boot carefully.



N5A0434E

Legend
1. Piston
2. Body Assembly
3. Hand Vise

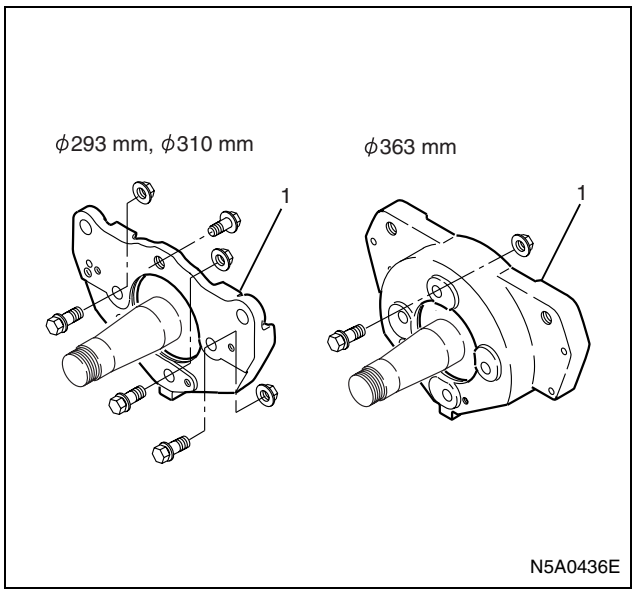


Legend
1. Piston Boot
2. Body Assembly
3. Cylinder Body Groove
4. Boot Insert Portion

Installation

1. Adapter
   - Install the adapter to the knuckle.
   - Tighten the fixing bolts and nuts to the specified torque.

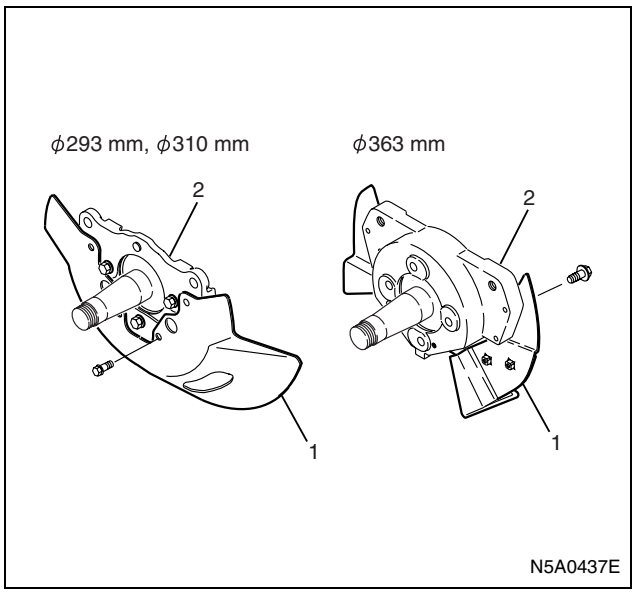
Tighten:
Fixing bolts and nuts to 162 N·m (16.5 kg·m / 119 lb·ft).



Legend
1. Adapter

2. Wind Guide
   - Tighten the fixing bolts to the specified torque.

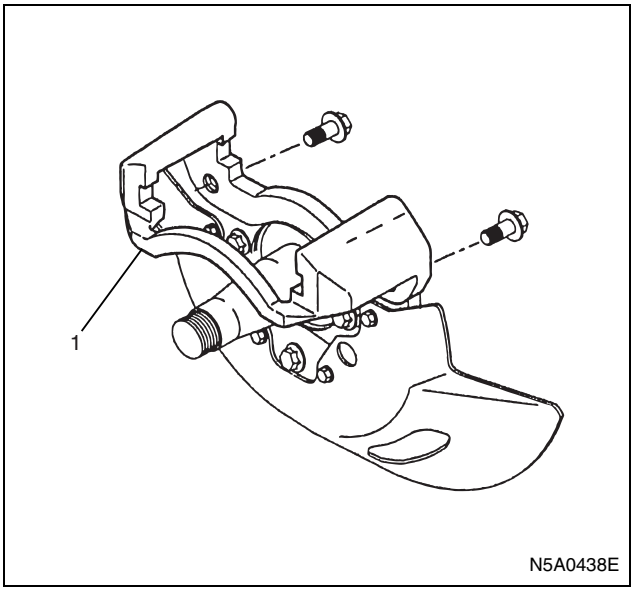
Tighten:
Fixing bolts to 13 N·m (1.3 kg·m / 113 lb·in).



Legend
1. Wind Guide
2. Adapter

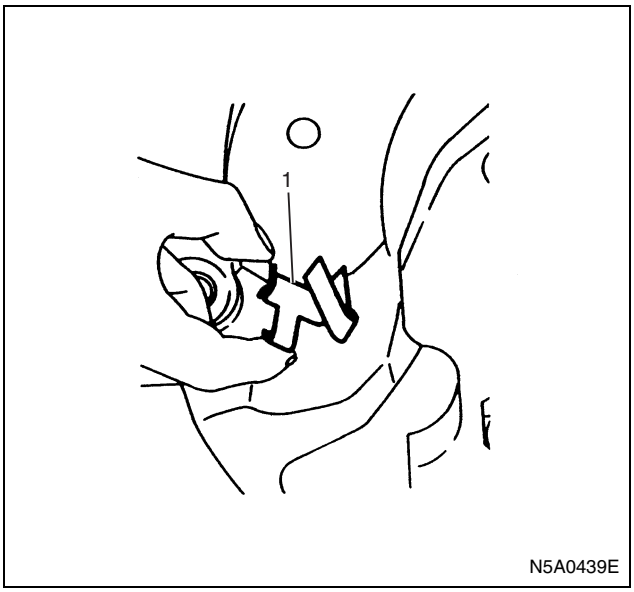
3. Support Assembly
   - Tighten the fixing bolts to the specified torque.

Tighten:
Fixing nuts to 221 N·m (22.5 kg·m / 163 lb·ft).



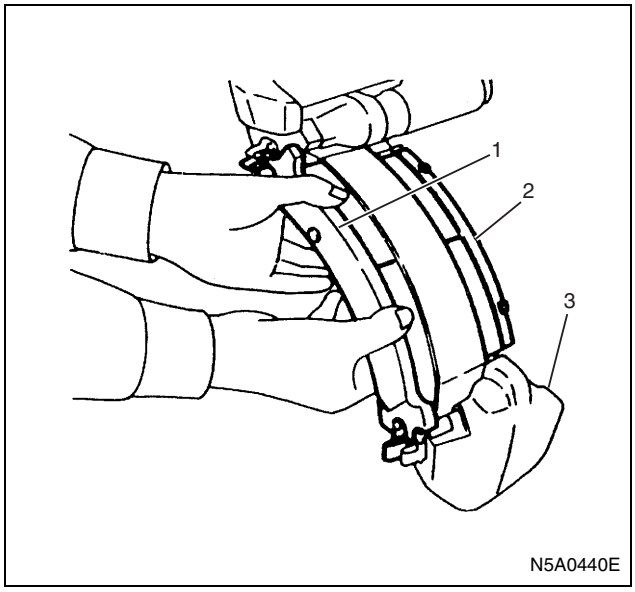
Legend
1. Support Assembly

4. Pad Clips
   - Be sure that the clips are completely installed to the support assembly.



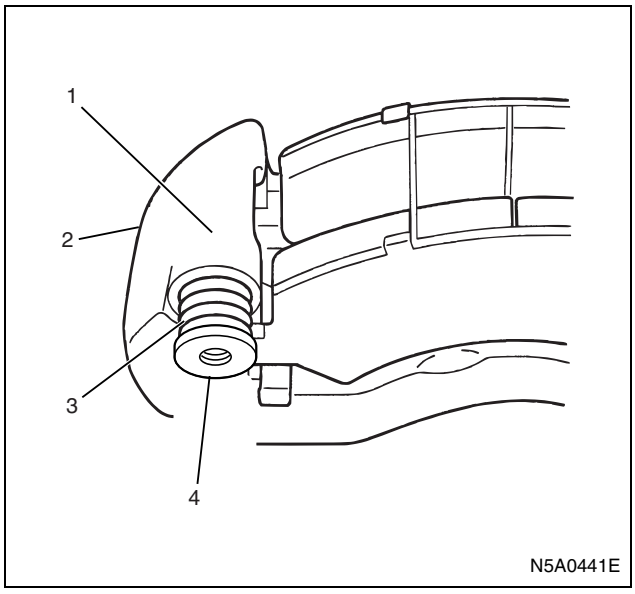
Legend
1. Pad Clip

5. Pads
   - Install the inner pad and the outer pad to the support assembly.



Legend
1. Outer Pad (WEAR INDICATOR....ø310 / ø363)
2. Inner Pad (WEAR INDICATOR....ø293)
3. Support Assembly

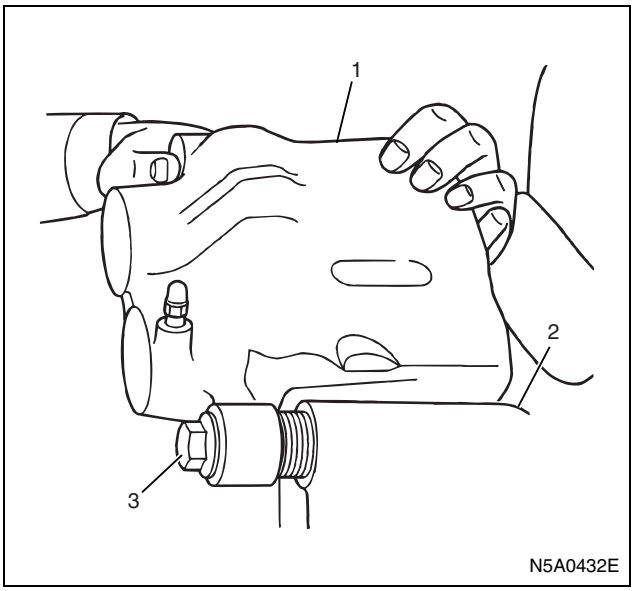
6. Pin Boot
   - Under normal conditions, there is no need to remove the pin boot.
   - Apply approximately 1g (0.035 oz) of special grease to the pin boot bore and pin boss bore of support.
     This will prevent pin corrosion.
     The special grease is included in the seal kit.
   - Install the pin boot to the support assembly.
   - Check that the pin boot is securely inserted to the groove.



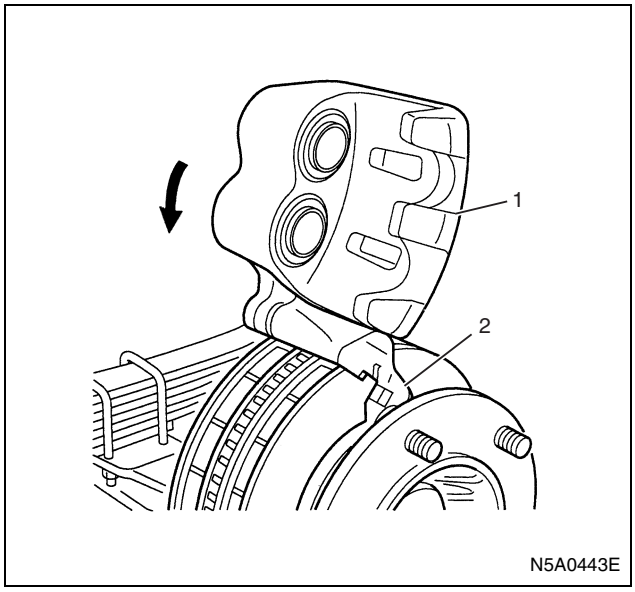
Legend
1. Pin Boss of Support
2. Support Assembly
3. Pin Boot
4. Pin

7. Caliper Assembly and Bolt (Lock pin side)
   - Install the caliper assembly to the support assembly guide pin from the inside.
   - Return the caliper assembly to its original position.
   - Tighten the bolt (lock pin side) to the specified torque.

Tighten:
Bolt (Lock pin side) to 125 N·m (12.7 kg·m / 92 lb·ft).



Legend
1. Caliper Assembly
2. Support Assembly
3. Pin Bolt



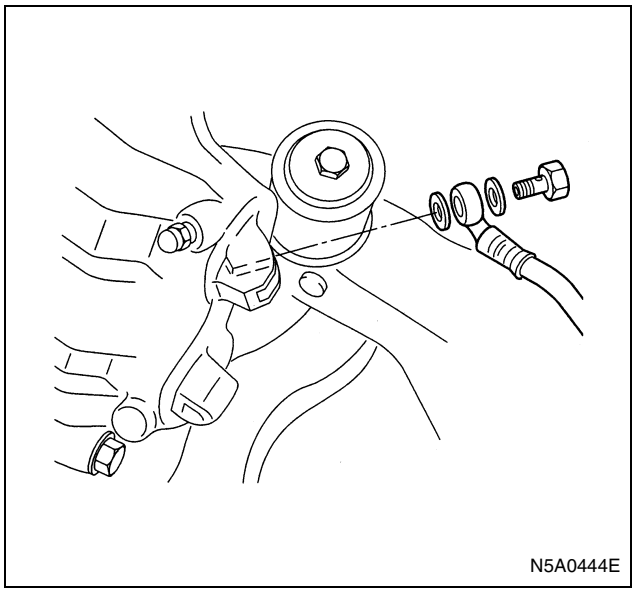
Legend
1. Caliper Assembly
2. Support Assembly

8. Flexible Hose
   - Tighten the flexible hose bolt to the specified torque.

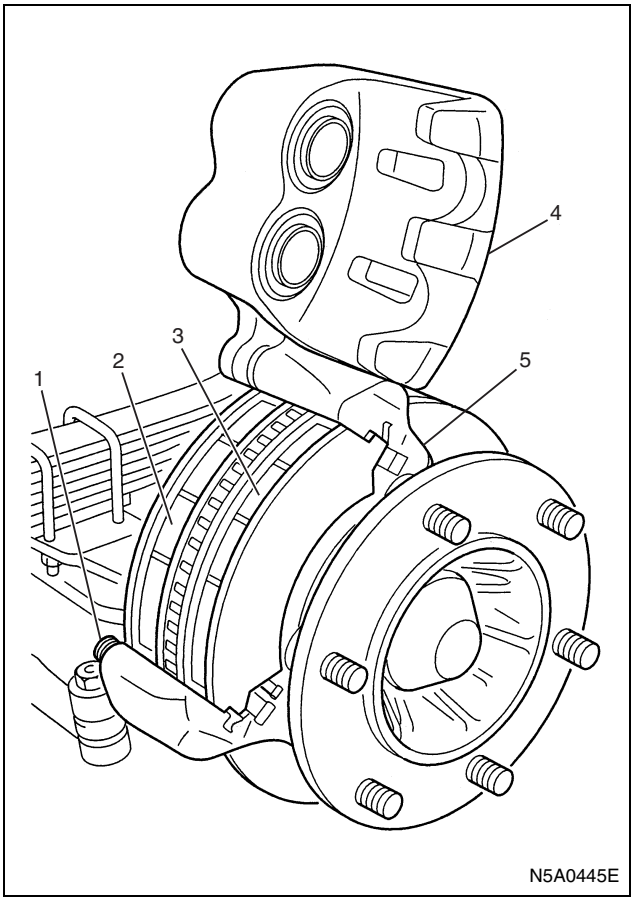
Tighten:
Hose bolt to 34 N·m (3.5 kg·m / 25 lb·ft).

Air Bleeding

Refer to “Brake Bleeding” in Section 00 of section.



Front Disc Brake Pad



Legend

1. Lock Pin
2. Inner Pad
3. Outer Pad
4. Caliper Assembly
5. Support Assembly

Removal

Notice:

- Block vehicle wheels and apply the parking brake.
- Rise the axle to clear the tire from the ground.

  Position jack stands under vehicle.
- Remove the wheel.

1. Loosen and remove the lock pin bolt from the lower side of the caliper.
2. Turn the caliper assembly up and wire it to the frame firmly so that the hose is not stretched.

Notice:

- Do not disconnect the brake hose.

3. Remove the pad assembly with clips.
4. Conduct disc wear check, and resurface or replace it as required.
5. When removing brake disc, slide caliper assembly inside of the vehicle, and take out brake disc from support assembly.

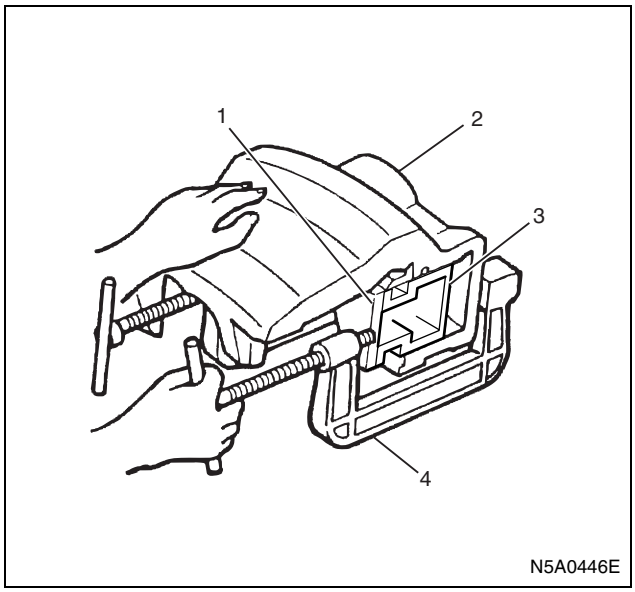
   Take care not to wipe the special grease from guide pin, and prevent from sticking dust or any foreign material to guide pin.
6. Refer to Section 4C FRONT AXLE and Section 3C FRONT SUSPENSION for disc wear check and replacement procedures.

Installation

1. Keep the rotor face away from the brake oil or grease.
2. Use a hand vise to push the piston backward until it reaches the cylinder bottom, as the piston was pushed forward by the distance where the pad worn.

Notice:

- When using a hand vise, push the piston at its center.



Legend

1. Steel Plate
2. Caliper Assembly
3. Piston
4. Hand Vise

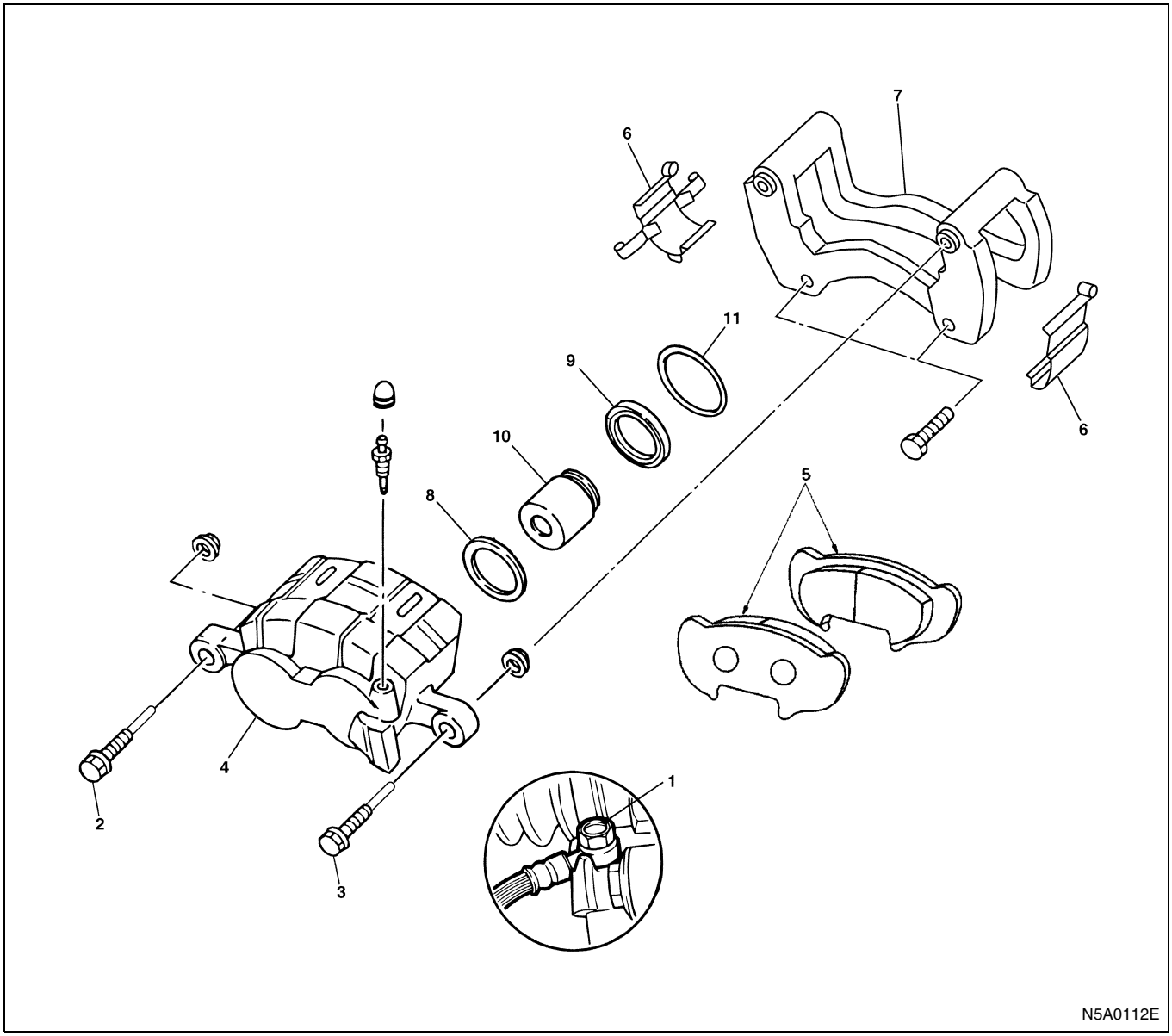
3. Remove hand vise and install the new pads along with new clips.

Notice:

- Be careful not to assemble the inner and outer pad reversely.

4. Install the bolt (Lock pin side) into the lock pin by turning the caliper carefully so that the piston boot and pin boot may not be wedged.
   After assembling the caliper assembly, make sure that the piston boot and pin boot fitted correctly, and not damaged.

Independent Suspension Models (NKR)

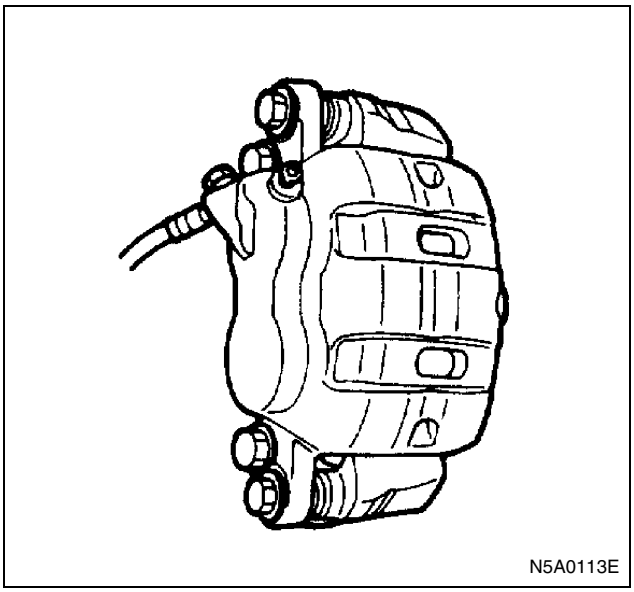


Legend

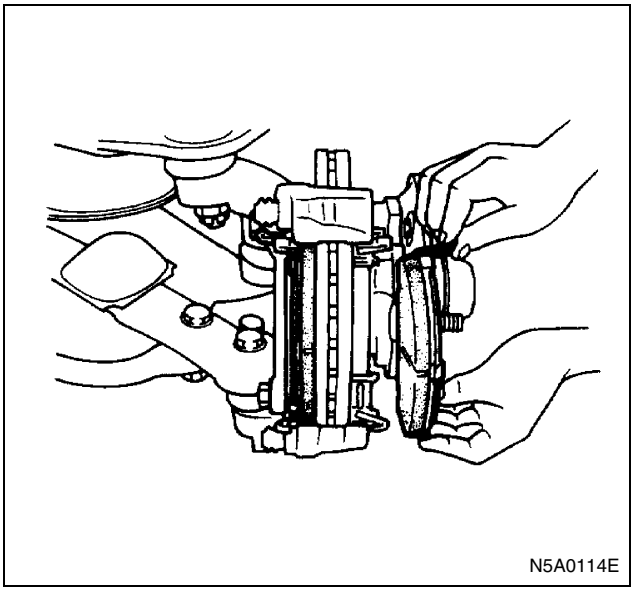
1. Joint bolt and flexible hose
2. Lock pin bolt
3. Guide pin bolt
4. Caliper assembly
5. Pad
6. Pad clip
7. Support assembly
8. Boot ring
9. Piston boot
10. Piston
11. Piston seal

Removal

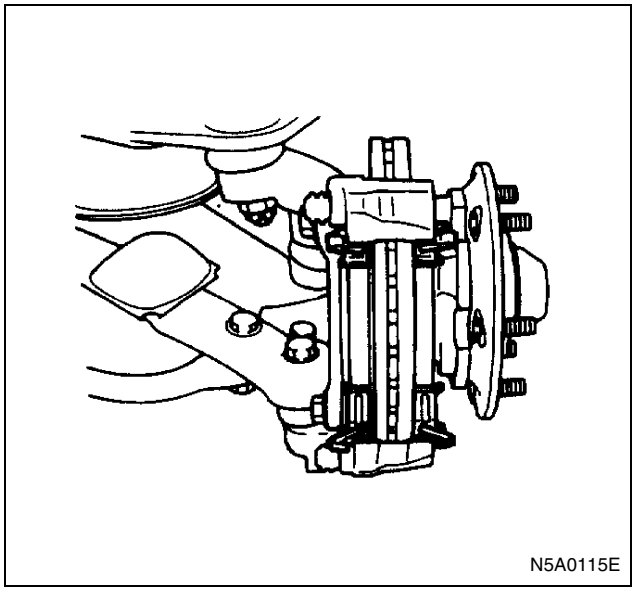
1. Joint bolt and Flexible Hose
2. Lock Pin Bolt
3. Guide Pin Bolt
4. Caliper Assembly


N5A0113E

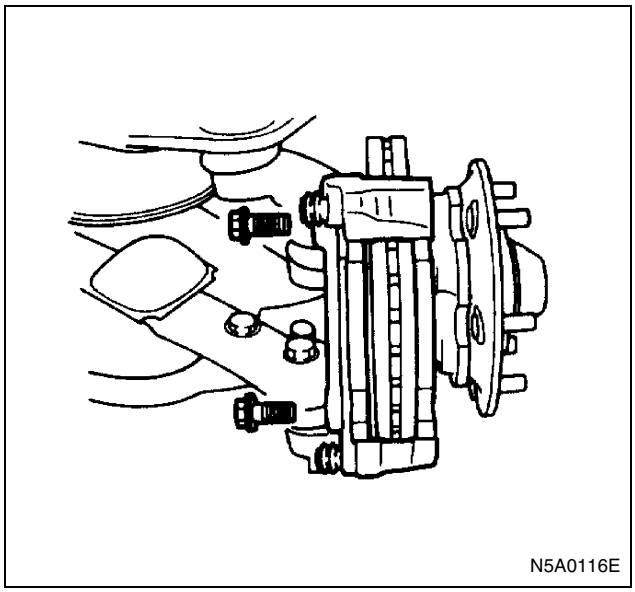
5. Pad


N5A0114E

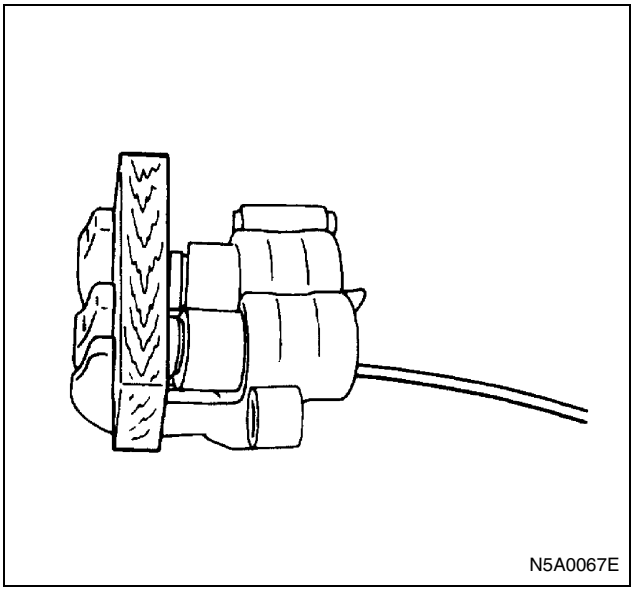
6. Pad Clip


N5A0115E

7. Support Assembly


N5A0116E

8. Boot Ring
9. Piston Boot
10. Piston
    1) Place a piece of wood across the body assembly to prevent piston damage.
    2) Apply approximately 196 kPa (2 kg/cm^2 / 28.4 psi) of compressed air to the body assembly oil port to remove the pistons.



11. Piston Seal

Inspection and Repair

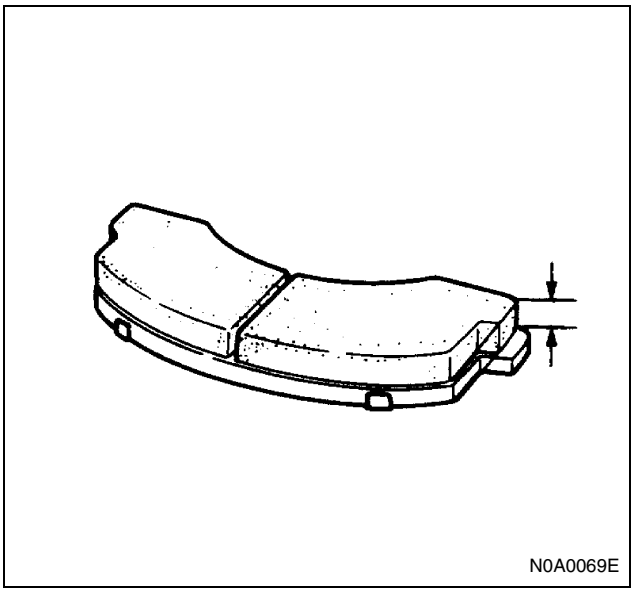
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Pad

Use a vernier caliper to measure the pad thickness.

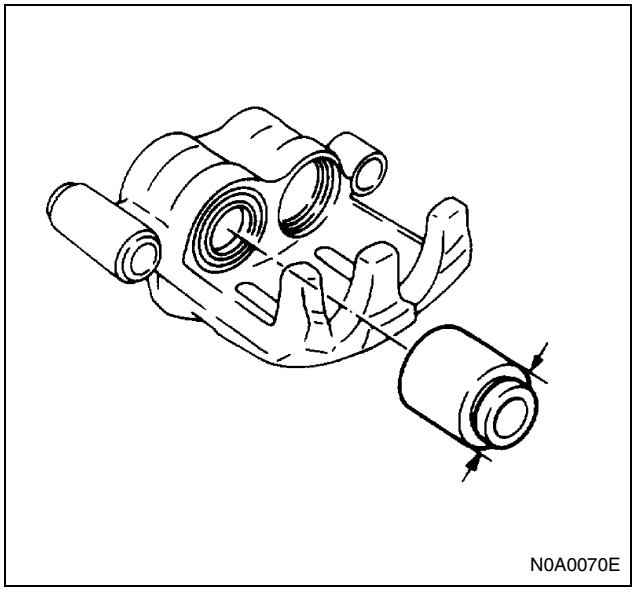
Pad Thickness	mm (in)
Standard	Limit
14 (0.551)	1 (0.039)

If the measured value is less than the specified limit, the pads must be replaced with the repair pad kit.



Piston and Cylinder Clearance

1. Use a micrometer to measure the piston diameter.



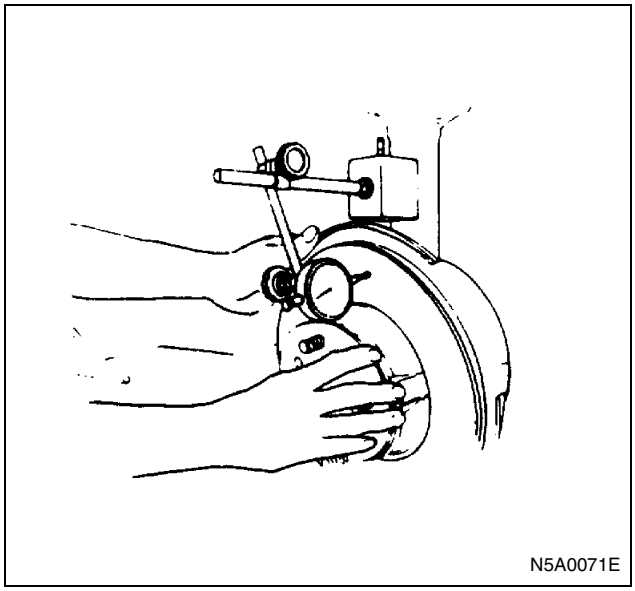
2. Use an inside dial indicator to measure the cylinder bore.
3. Calculate the piston and cylinder clearance.

Piston and cylinder Clearance	mm (in)
Standard	Limit
0.08 — 0.18 (0.0031 — 0.0071)	0.23 (0.0091)

If the clearance exceeds the specified limit, the piston and/or the body assembly must be replaced along with the repair seal kit.

Lateral Runout

1. Adjust the wheel bearing correctly.
   Refer to Section 4C FRONT AXLE.
2. Attach a dial indicator to some portion of the suspension so that the stem contacts the disc face about 29 mm (1.14 in) from the disc edge.



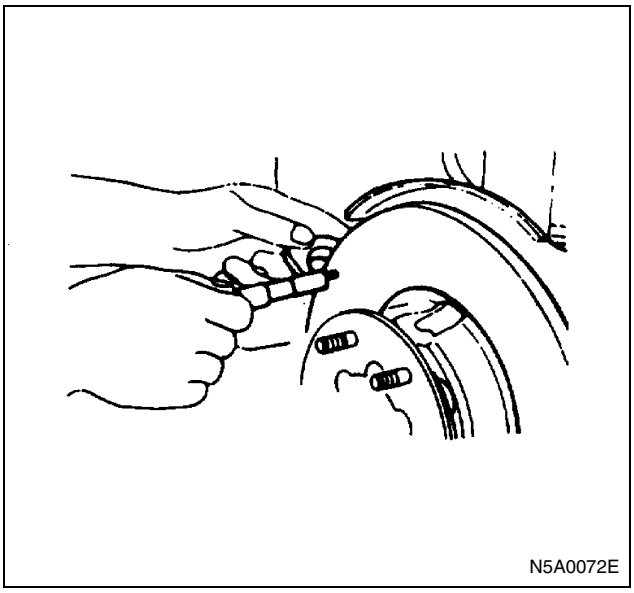
3. Move the disc one complete rotation.
   The lateral runout should not exceed 0.13 mm (0.005 in).

Maximum runout mm (in)	0.13 (0.005)

Parallelism and thickness
Parallelism is the measurement of the thickness of the disc at four or more points around the circumference of the disc. All measurement must be made at 29 mm (1.14 in) from the edge of the disc.
The disc thickness must not vary more than 0.010 mm (0.0004 in) from the point to point.

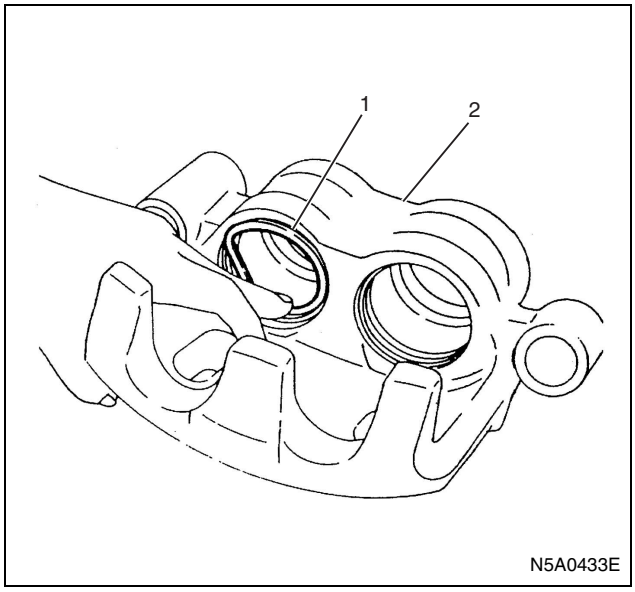
Maximum parallelism mm (in)	0.02 (0.0008)

Disc Thickness	mm (in)
Standard	Limit
35.0 (1.378)	32.0 (1.260)


N5A0072E

Installation

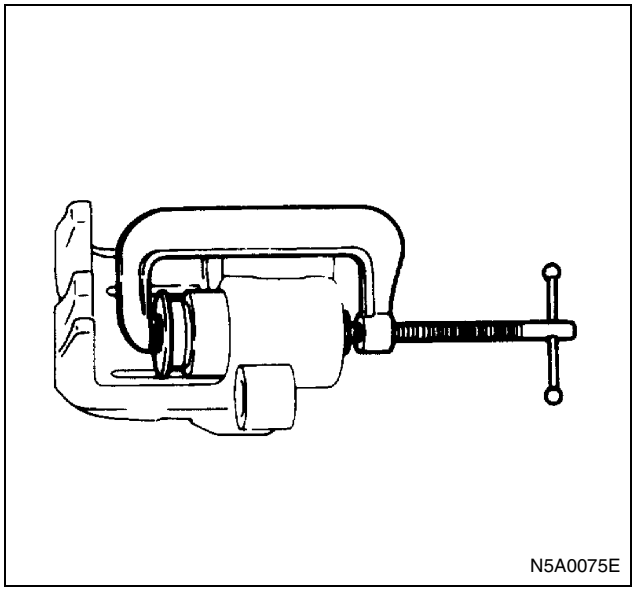
1. Piston Seal
   1) Apply rubber grease to the piston seal.
      The rubber grease is included in the seal kit.
   2) Install the piston seal to the cylinder bore groove.



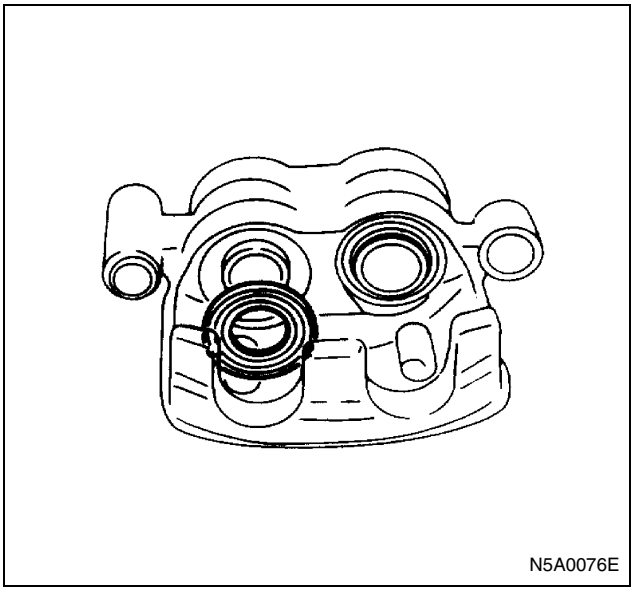
N5A0433E

Legend
1. Piston Seal
2. Body Assembly

2. Piston
3. Piston Boot
4. Boot Ring
   1) Apply brake oil to the piston outer circumference.
   2) Use a hand vise to install the pistons to the cylinder.


N5A0075E

   3) Apply special grease to the piston.
      This will prevent cylinder and piston corrosion.
   4) Install the piston boot outer lip to the cylinder bore groove.
      Install the piston boot inner lip to the piston groove.
      Handle the piston boot carefully.



5) Install the boot ring to the cylinder bore groove. The boot ring must be completely installed to the groove.

5. Support Assembly

Tighten:
Support assembly bolt to 226 N·m (23.0 kg·m / 116 lb·ft)

6. Pad Clip
7. Pad
8. Caliper Assembly
9. Guide Pin Bolt
10. Lock Pin Bolt

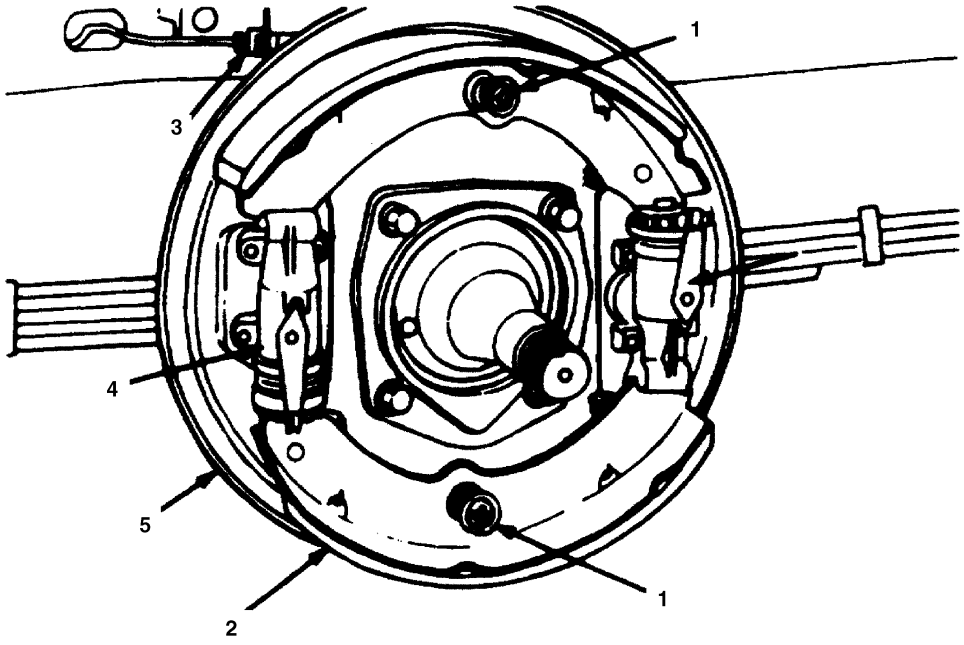
Tighten:
Guide pin and lock pin bolt to 137 N·m (14.0 kg·m / 101 lb·ft)

11. Joint Bolt and Flexible Hose

Tighten:
Joint bolt to 34 N·m (3.5 kg·m / 25 lb·ft)

Front Drum Brake Assembly (Two Leading and Dual Two Leading)

Two Leading Type (2L Type)

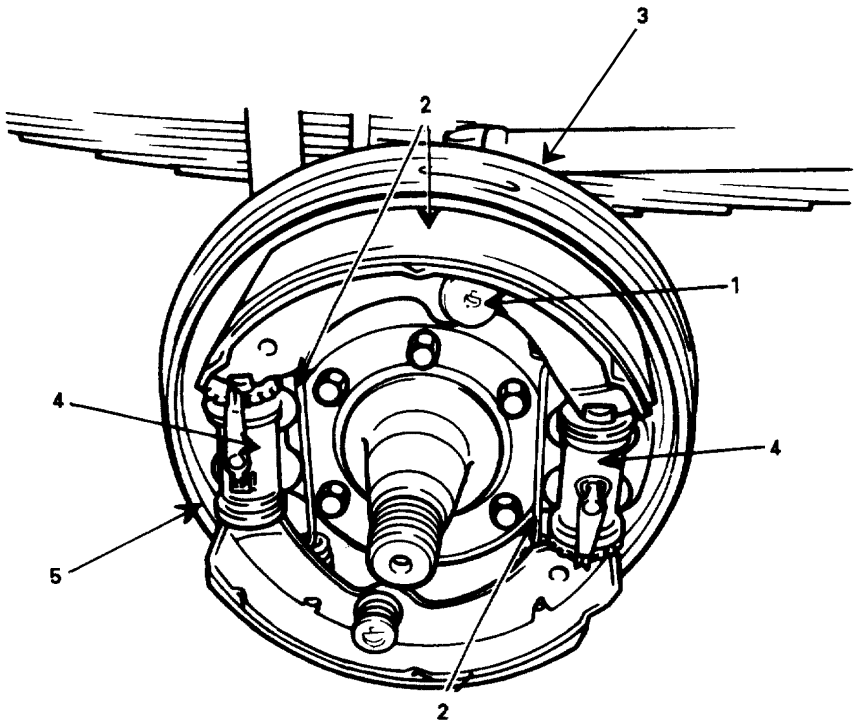


N5A0126E

Legend

1. Shoe holding spring, cup and pin
2. Brake shoe and return spring
3. Brake flexible hose and pipe
4. Wheel cylinder assembly
5. Back plate and oil shield cover

Dual Two Leading Type (D2L Type)



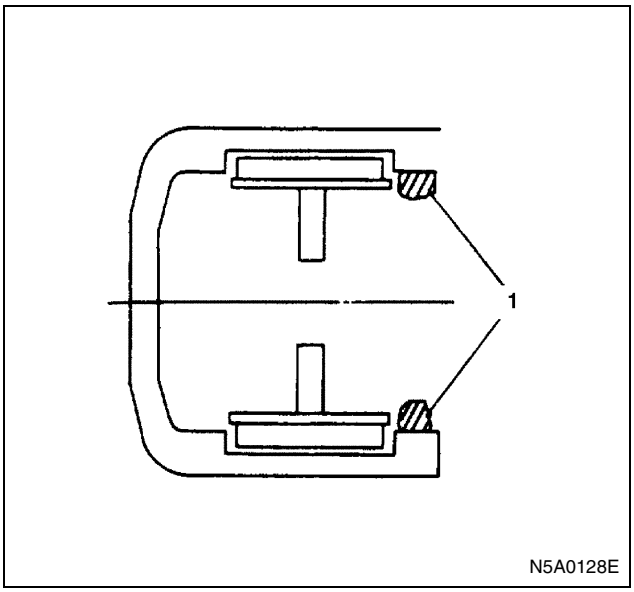
N5A0127E

Legend

1. Shoe holding spring, cup and pin
2. Brake shoe and return spring
3. Brake flexible hose and pipe
4. Wheel cylinder assembly
5. Back plate and oil shield cover

Removal

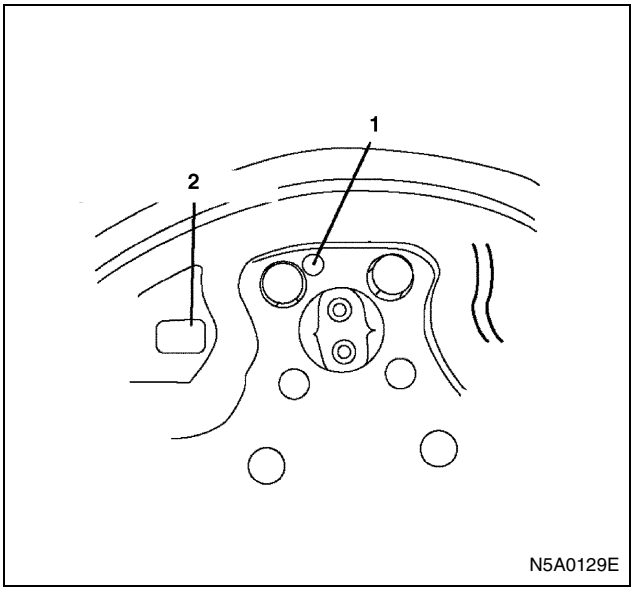
If the brake drum has step wear or the brake drum edge is corroded, it will be difficult to remove the brake drum. The following procedure will make brake drum removal easier.



Legend

1. Corroded portion

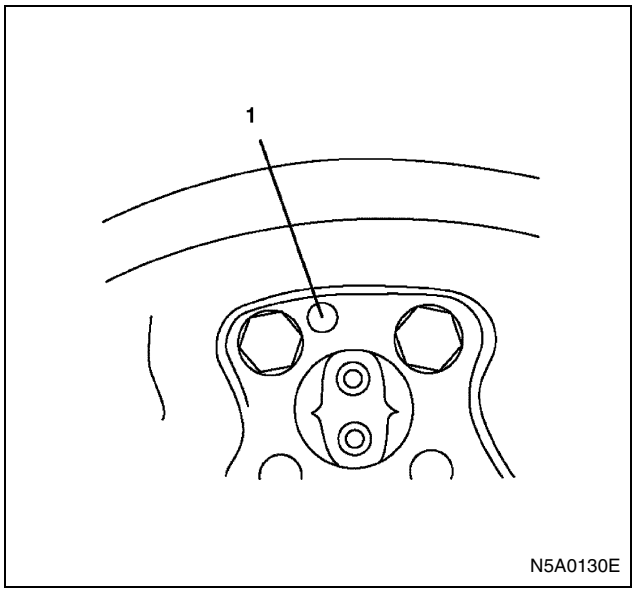
1. Remove the rubber cover from the brake lining clearance adjusting hole and auto-adjuster lever release hole.
2. Remove the adjust hole cover and adjuster lever release hole cover.



Legend

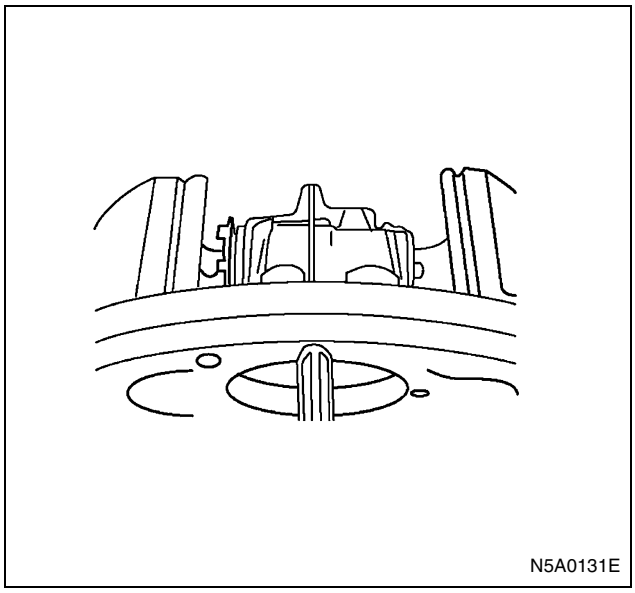
1. Adjuster lever release hole cover
2. Adjust hole cover

3. Using ϕ5 mm plus driver put it into the adjuster lever release hole and then push up the adjuster lever.

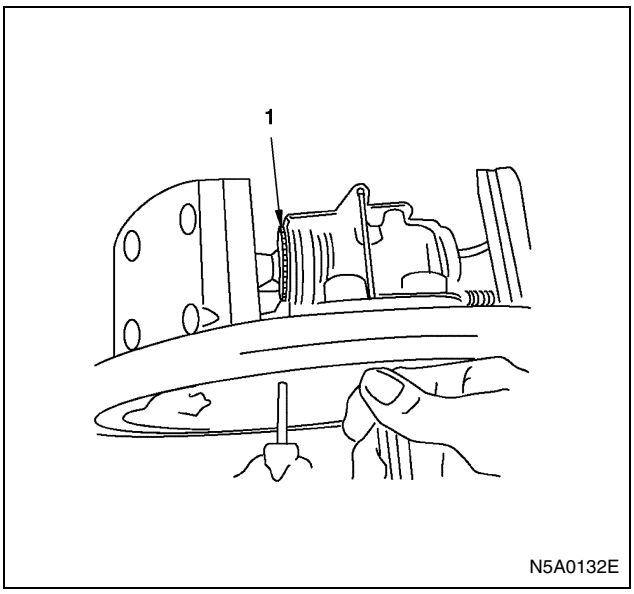


Legend

1. Adjuster lever release hole

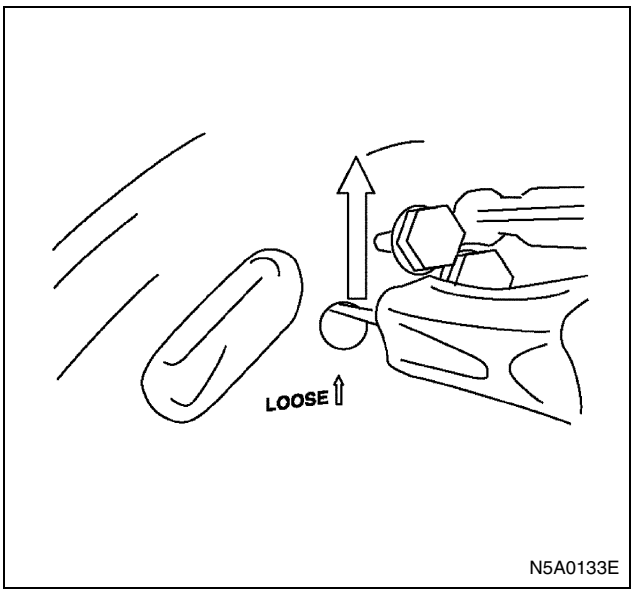


4. Put the slotted screwdriver into the adjuster hole while push up the adjuster lever.

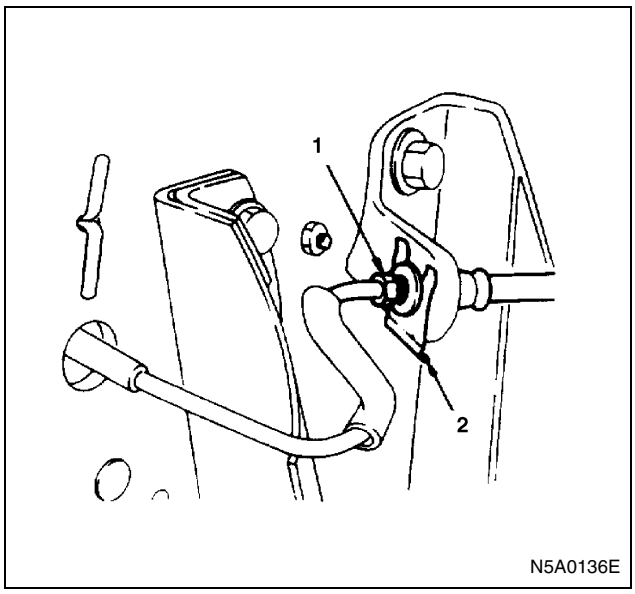


Legend
1. Adjuster gear

5. Turn the adjuster gear to the marked arrow “LOOSE” on the backing plate.

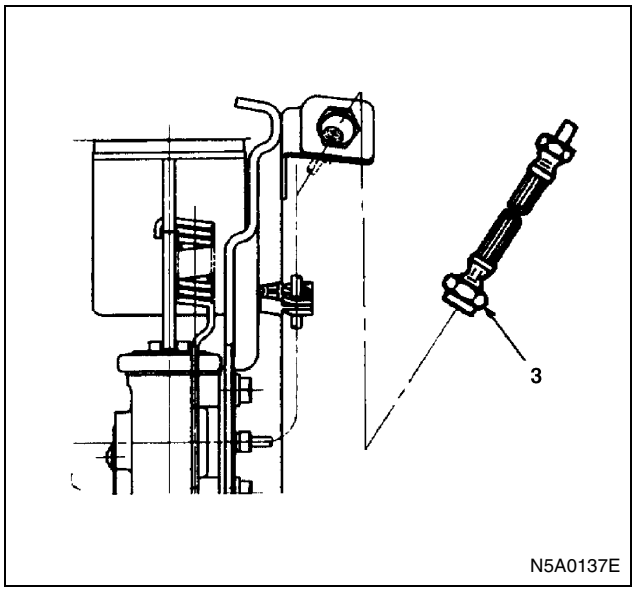


6. Shoe Holding Spring, Cup and Pin
7. Brake Shoe and Return Spring
8. Brake flexible Hose and Pipe
   1) Place a tray beneath the flexible hose to receive the brake fluid.
   2) Loosen the union nut (1).



   3) Remove the clip (2) and loosen the hose end (3) from the pipe to remove the flexible hose.

Notice:
Take care not to twist the piping and the flexible hose.



9. Wheel Cylinder Assembly
10. Back Plate and Oil Shield Cover
    Store all of the removed parts in a clean part tray.

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

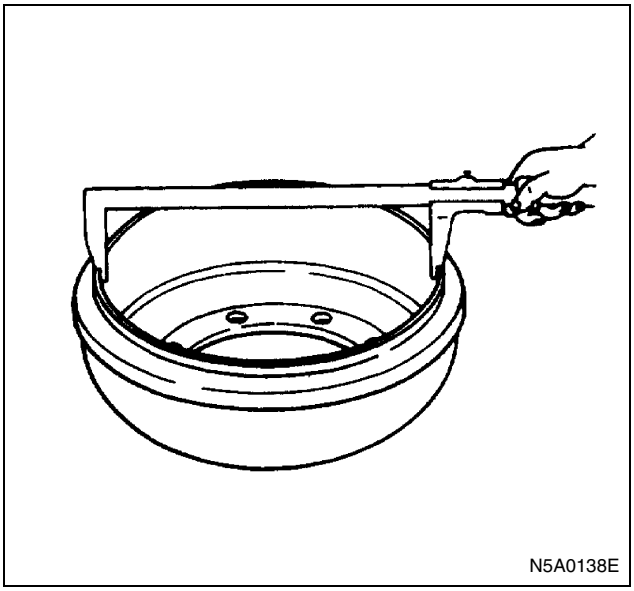
Brake Drum Inside Diameter

Visually inspect the brake drum for excessive wear and scoring.

If the brake drum is scored or worn, lathed to the specified limit.

Use a vernier caliper to measure the brake drum inside diameter.

Brake Drum Inside Diameter		mm (in)
Drum size	Standard	Limit
279.4 300.0 320.0	279.4 (11.00) 300.0 (11.81) 320.0 (12.60)	281.0 (11.06) 301.5 (11.87) 321.5 (12.66)
Out of round: • Limit: 0.13 mm (0.005 in)		

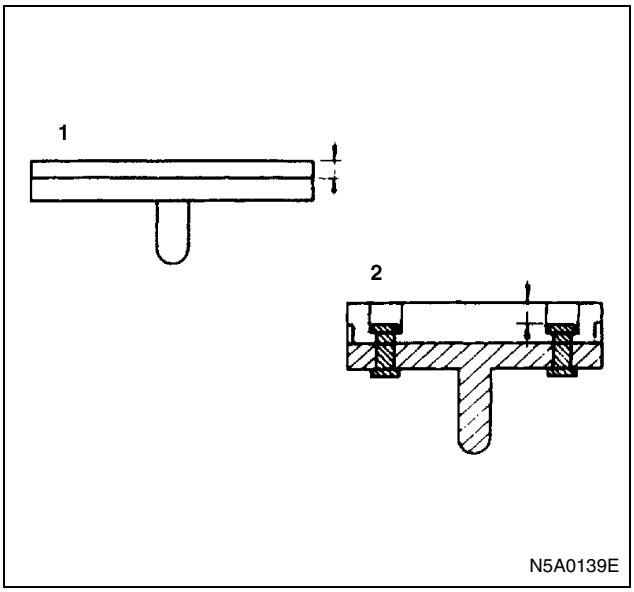

N5A0138E

Brake Lining Thickness Measurement

Use a vernier caliper to measure the brake lining thickness or the rivet depth.

If the measured value is less than the specified limit, the brake shoe assembly and/or the lining must be replaced.

Brake Lining Thickness or Rivet Depth	mm (in)
Limit	1.0 (0.039)



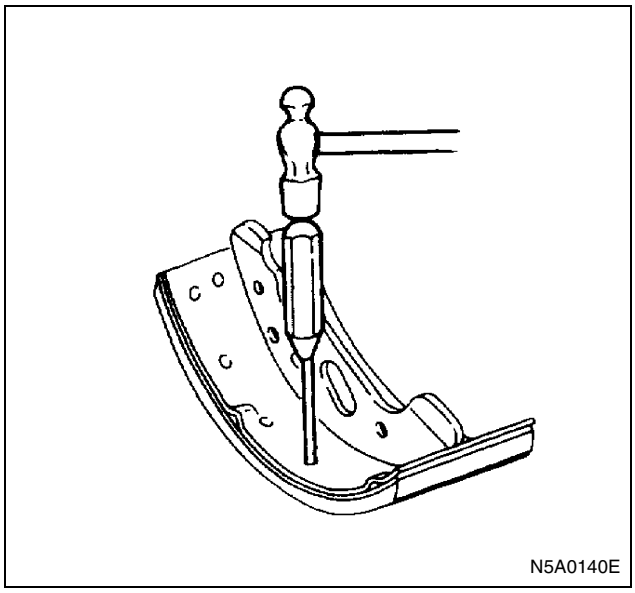
N5A0139E

Legend

1. Adhesion type
2. Riveted type

Brake Lining Removal (Riveted Type Only)

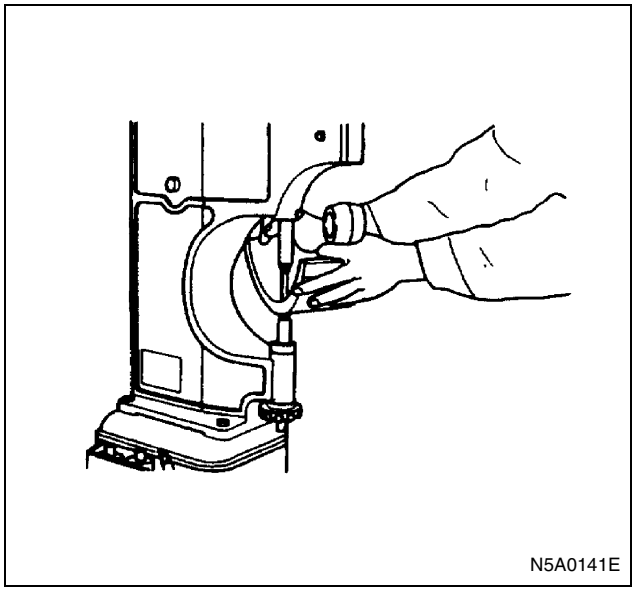
1. Remove the rivet caulking portions with a hammer and chisel.
2. Remove the rivets with a hammer and punch.


N5A0140E

3. Inspect the brake shoe for cracking.

Brake Lining Installation (Riveted Type Only)

1. Install the brake lining the rivets to the brake shoe.
2. Place the brake shoe assembly in the air hydraulic riveter.
3. Use the air hydraulic riveter to set and caulk each of the rivets.

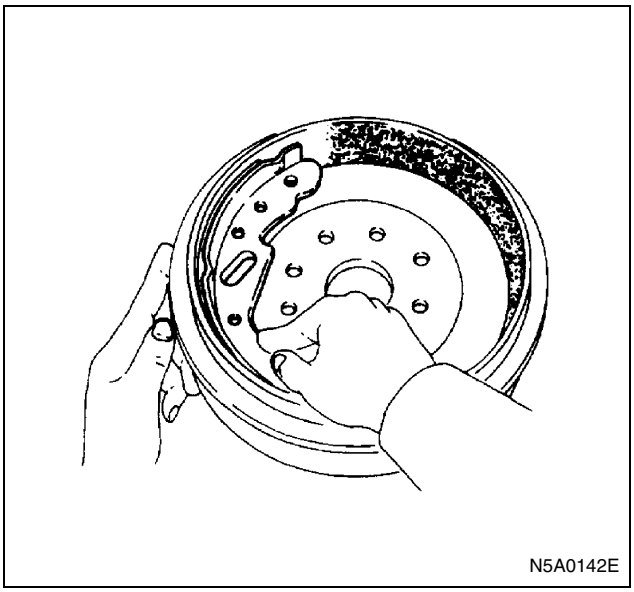

N5A0141E

4. Start riveting at the center of lining and work towards the ends.

Brake Lining and Drum Contact

1. Apply chalk powder to the entire inside brake drum surface.

2. Place the brake shoe assembly in the inside brake drum.
3. Move the brake shoe assembly around the inside brake drum.
   Check for uniform contact between the brake lining and the brake drum.


N5A0142E

4. Correct any areas having poor contact with sandpaper.
5. Repeat Steps 1 through 4 until the contact between the brake lining and the brake drum is perfect.

Installation

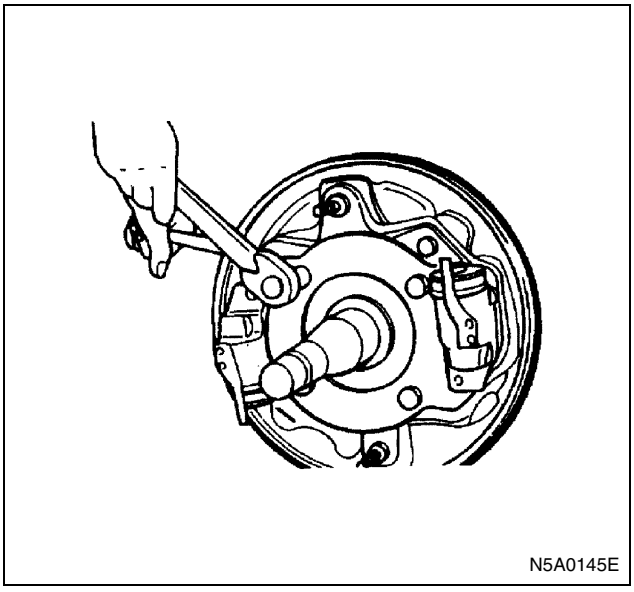
1. Back Plate and Oil Shield cover
   Tighten the back plate and oil shield cover bolts to the specified torque.

Tighten:
Back plate and oil shield cover bolts to

NPS model: 98 N·m (10.0 kg·m / 72 lb·ft)

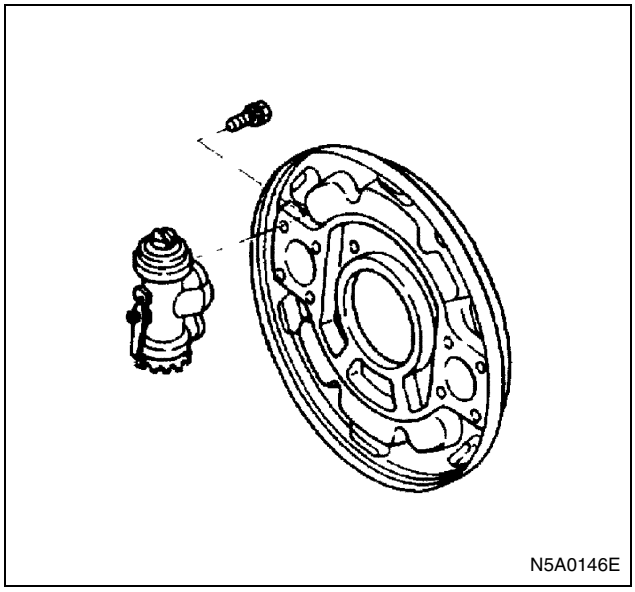
NQR model: 157 N·m (16.0 kg·m / 116 lb·ft)

Others: 88 N·m (9.0 kg·m / 65 lb·ft)


N5A0145E

2. Wheel Cylinder Assembly
   Tighten the wheel cylinder assembly bolts to the specified torque.

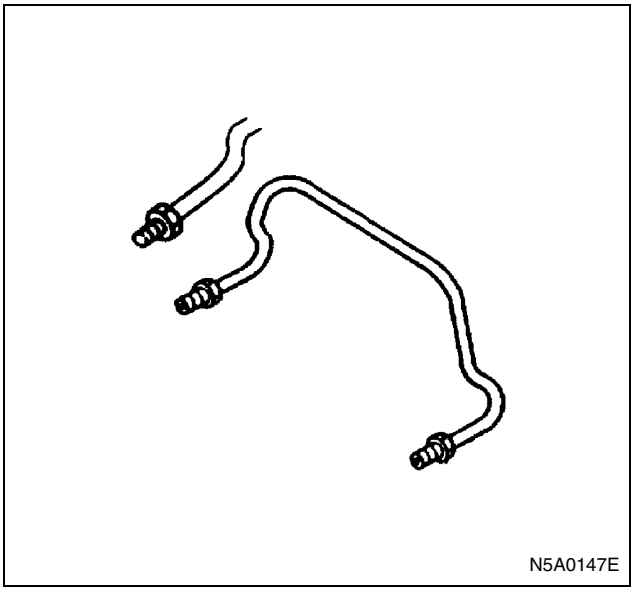
Wheel Cylinder Assembly Bolt Torque N·m (kg·m/lb·ft)		
Drum Inside Dia. mm (in)	Lining Width mm (in)	—
279.4 (11.00)	60 (2.36)	27 (2.8/20)
300.0 (11.81)	75 (2.95)	34 (3.5/25)
320.0 (12.60)		43 (4.4/32)
320.0 (12.60)	100 (3.94)	74 (7.5/54)
320.0 (12.60)	120 (4.72)	94 (9.6/69)


N5A0146E

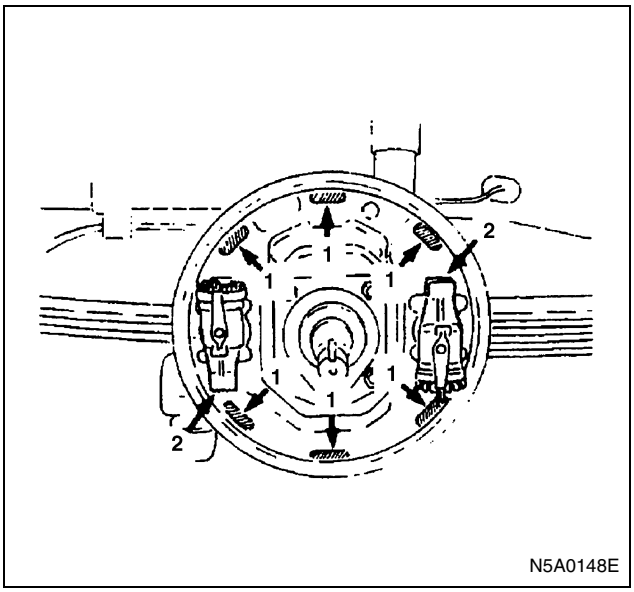
3. Brake Flexible Hose and Pipe
   Tighten the brake pipe flare nuts to the specified torque.

Tighten:
Brake pipe flare nuts to 16 N·m (1.6 kg·m / 12 lb·ft)

Notice:
Take care not to twist the piping and the flexible hose.

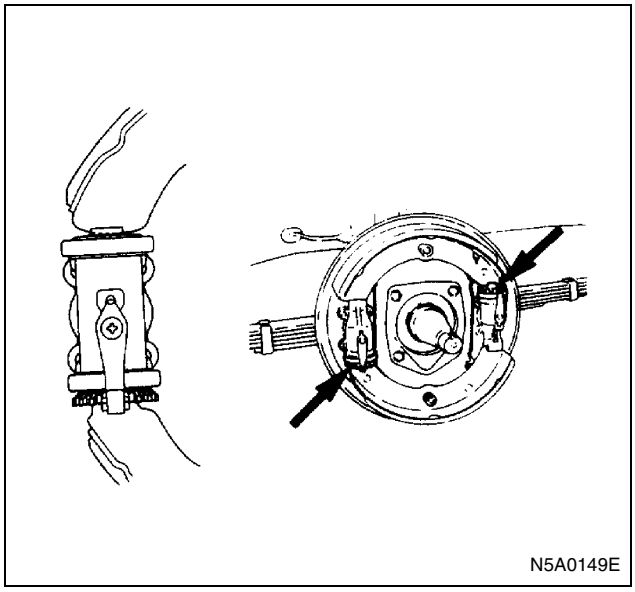

N5A0147E

4. Brake Shoe and Return Spring (Two Leading Type)
   1) Before setting the brake shoes, apply a thin coat of molybdenum disulfide grease to the back plate portions (1) contacting the brake shoe edge as shown in the illustrations.
   2) Apply a coat of molybdenum disulfide grease to the wheel cylinder parts contacting the shoe (2).

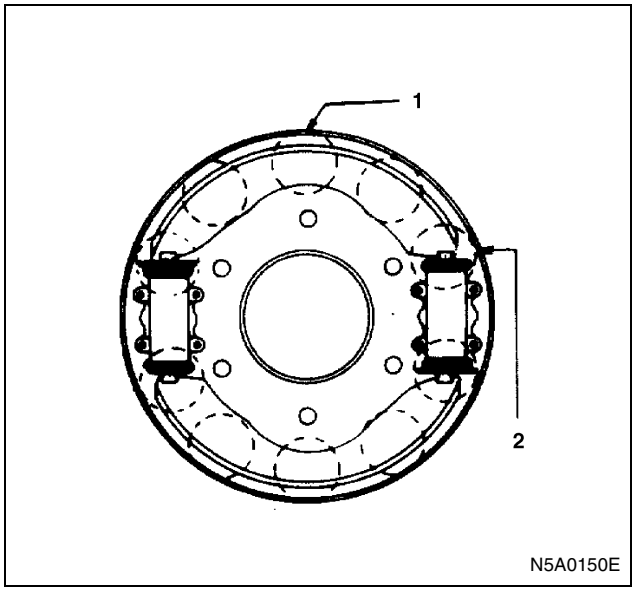


N5A0148E

   3) Set the brake shoe assembly to the cylinder adjusting screw at the brake shoe small angle end.
      Do not install it at the round end to the adjusting screw.

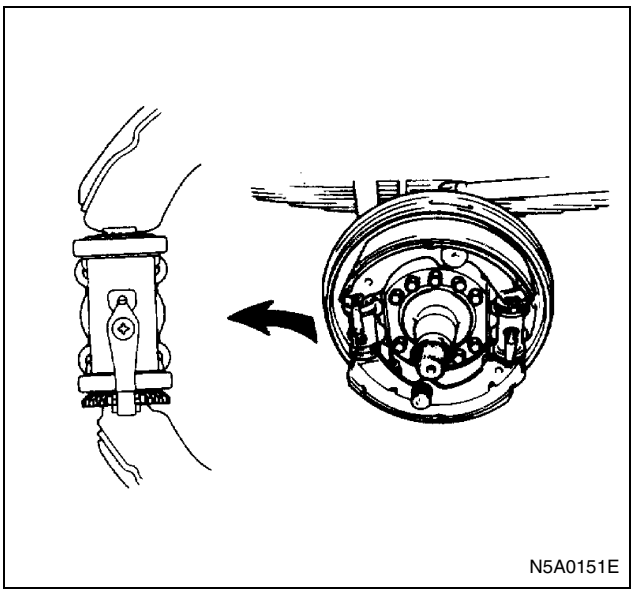

N5A0149E

   4) Install the brake shoes and the return springs to the wheel cylinders.
      Keep the lining surface clean.
5. Brake Shoe and Return Spring (Dual Two Leading Type)
   1) Before setting the brake shoes, apply a thin coat of molybdenum disulfide grease to the back plate portions (1) contacting the brake shoe edge as shown in the illustrations.
   2) Apply a coat of molybdenum disulfide grease to the wheel cylinder parts contacting the brake shoe (2).



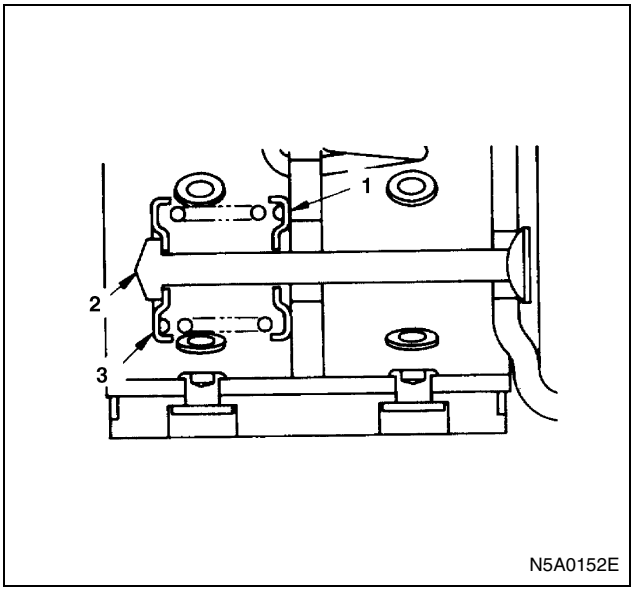
N5A0150E

   3) Set the brake shoe assembly to the cylinder adjusting screw at the brake shoe small angle end.
      Do not install it at the round end to the adjusting screw.


N5A0151E

4) Install the brake shoes and the return springs to the wheel cylinders.
Keep the brake lining clean.

6. Shoe Holding Spring, Cup and Pin
   1) Before installing the holding pin, apply a coat of molybdenum disulfide grease to the holding cup seating faces (1) contacting the brake shoe.



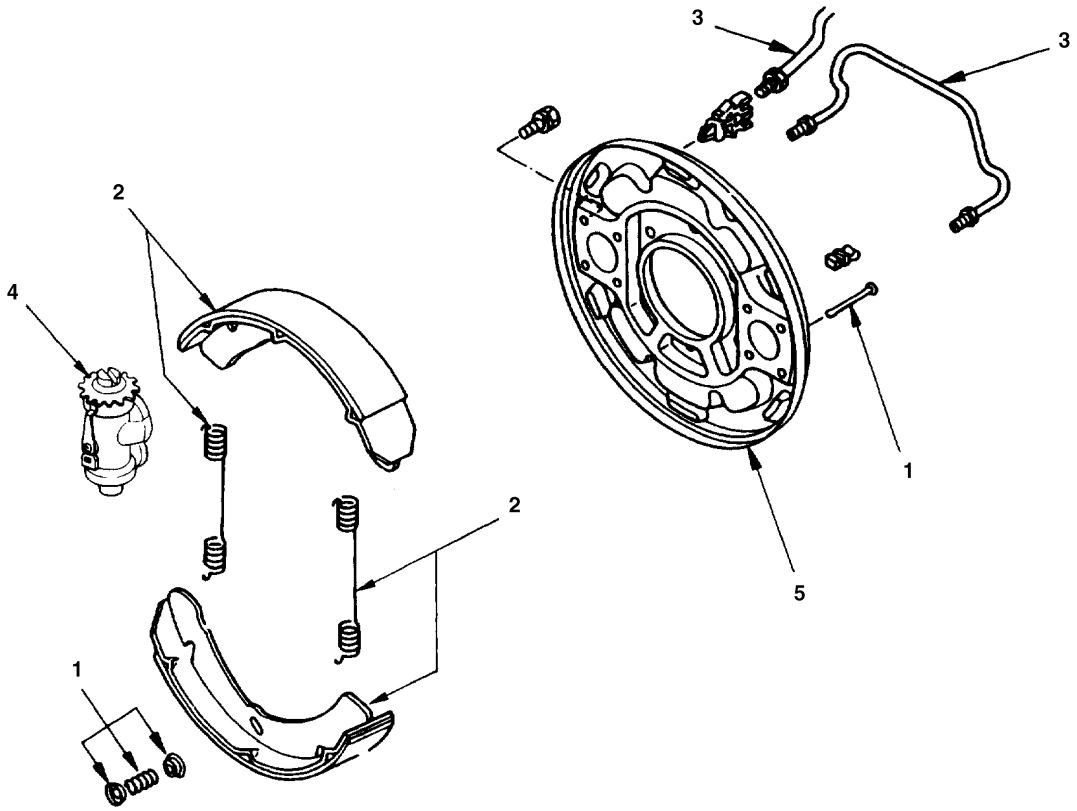
N5A0152E

   2) After installation of the pins, cups and the springs, make sure the pin (2) seats to the cup (3) properly.

After assembly, adjust the lining clearance and air bleeding the brake, referring to “SERVING” in Section 00 of this section.

Rear Drum Brake Assembly (Except Drum Inside Diameter 370 mm)

These removal steps are based on the without auto-adjuster type brake.



N5A0153E

Legend

1. Shoe holding spring, cup and pin
2. Brake shoe and return spring
3. Brake pipe
4. Wheel cylinder assembly
5. Back plate

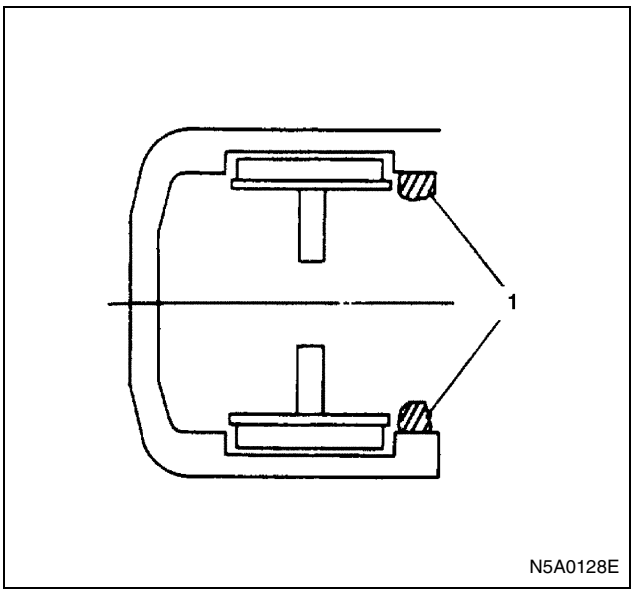
Removal

1. Shoe Holding Spring, Cup and Pin
2. Brake Shoe Return Spring
3. Brake Pipe
4. Wheel Cylinder Assembly
5. Back Plate

   Store all of the removed parts in a clean part tray.

With Auto-adjuster

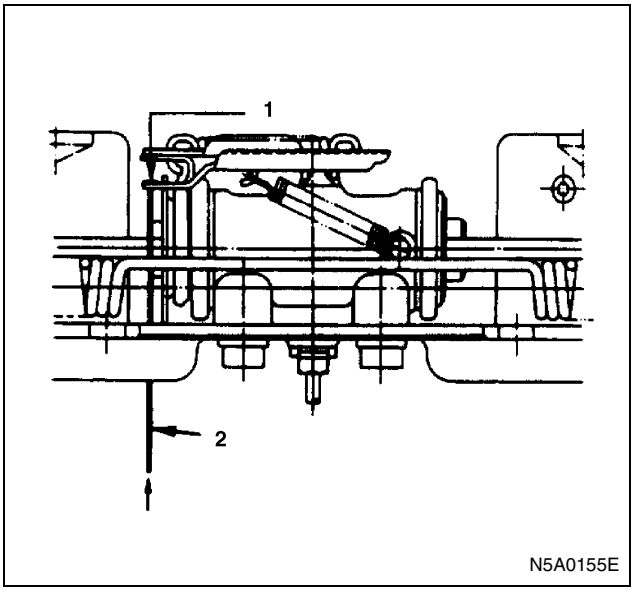
If the brake drum has step wear or the brake drum edge is corroded, it will be difficult to remove the brake drum. The following procedure will make brake drum removal easier.



Legend
1. Corroded portion

Drum Inside Diameter 260 mm

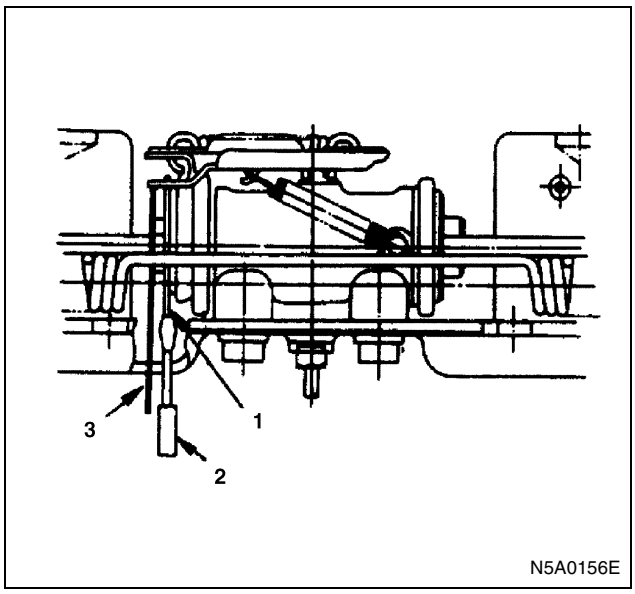
1. Remove the rubber covers from the brake lining clearance adjusting hole and auto-adjuster lever release hole.
2. Push up the auto-adjuster lever with a long drift or a suitable rod.
   (Outside diameter: 4 mm (0.15 in) length: 80 mm (3.1 in))



Legend
1. Auto-adjuster lever
2. Rod

3. Hold the auto-adjuster lever stationary.
   Use a screwdriver to rotate adjusters at back of the brake to provide clearance between lining and drum.

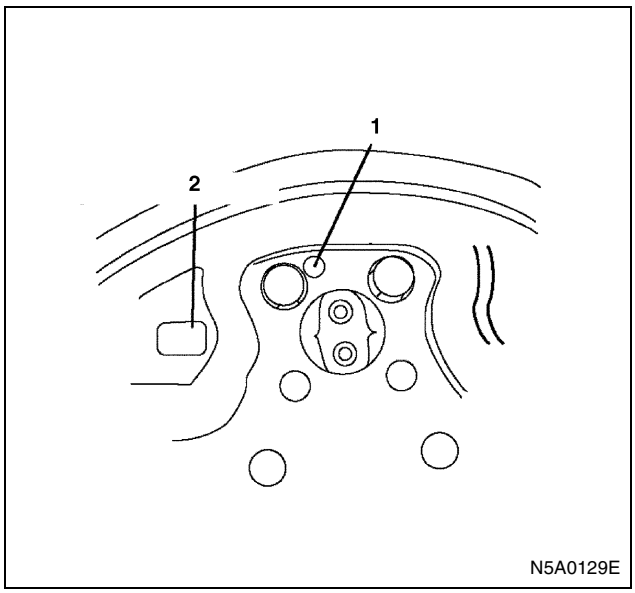
Notice:
Be sure to push up the auto-adjuster lever (Step 2).
Failure to do so will result in damage to the teeth of the auto-adjuster lever.
Take care not to damage the rubber boot with the bar or the screwdriver.



Legend
1. Adjuster
2. Screw driver
3. Rod

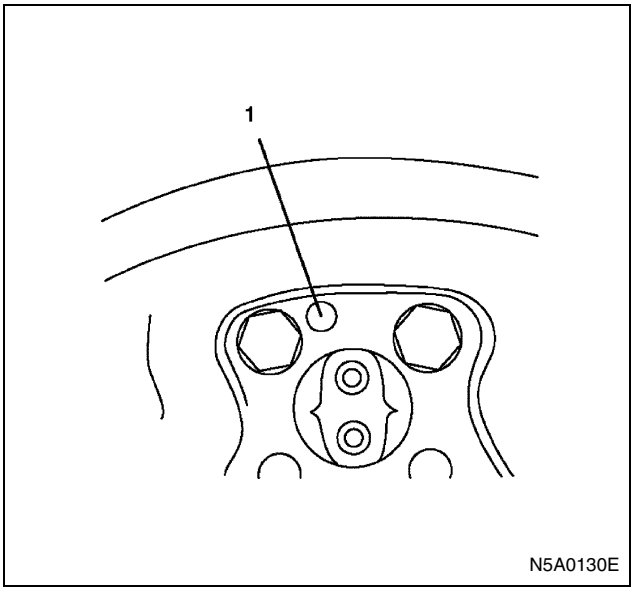
Drum Inside Diameter 320 mm

1. Remove the rubber cover from the brake lining clearance adjusting hole and auto-adjuster lever release hole.
2. Remove the adjust hole cover and adjuster lever release hole cover.

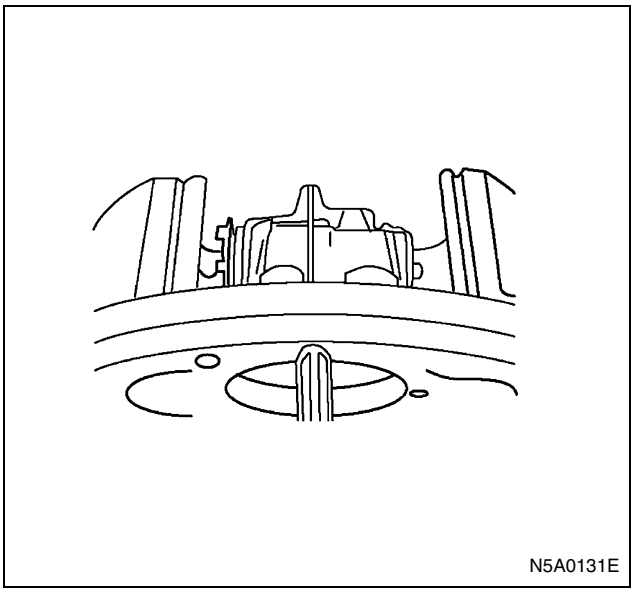


Legend
1. Adjuster lever release hole cover
2. Adjuster hole cover

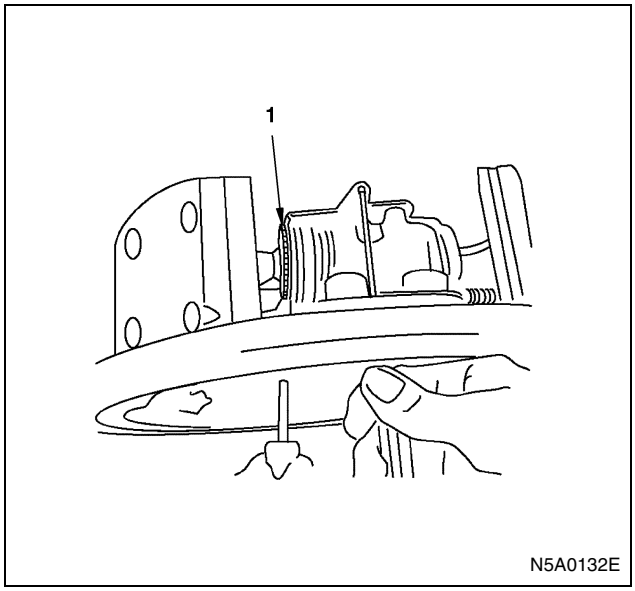
3. Using ϕ5 mm Phillips screwdriver put it into the adjuster lever release hole and then push up the adjuster lever.



Legend
1. Adjuster lever release hole

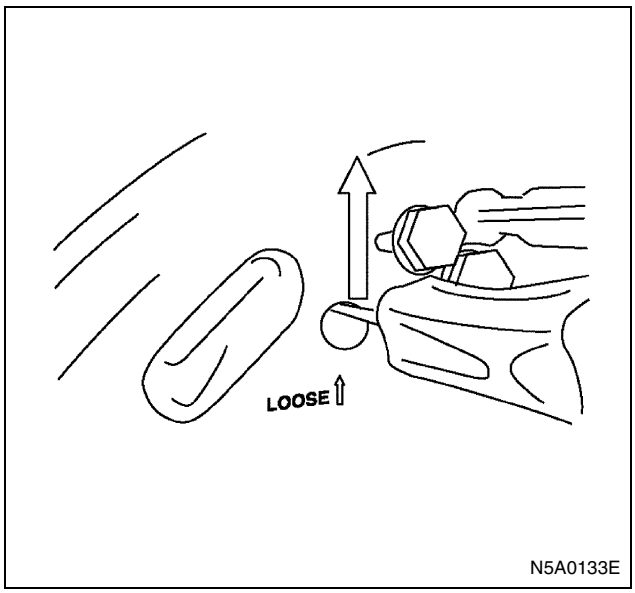


4. Put the flathead screwdriver into the adjuster hole while push up the adjuster lever.



Legend
1. Adjuster gear

5. Turn the adjuster gear to the marked arrow “LOOSE” on the backing plate.

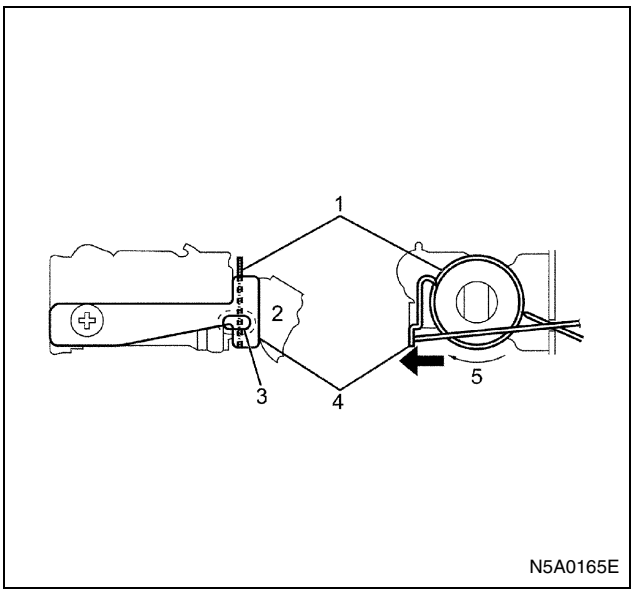


Drum Inside Diameter 240 mm

1. Remove the rubber cover from the brake lining clearance adjusting hole/auto-adjuster lever release hole in the back plate.
2. Insert a thin, suitable rod in the hole, and push up the auto-adjuster lever (4).
3. With the auto-adjuster lever (4) pushed up, insert a keystone tip screwdriver in the adjusting hole, and turn the adjuster gear (1) to increase the gap between the gear and the brake shoe (the outside diameter of the shoe will decrease).

Notice:
Do not fail to push up the auto-adjuster lever before turning the gear. Failure to do so will result in damage to the teeth of the gear because it is locked with the lever.

Exercise care not to damage the boot of the wheel cylinder and other parts when turning the gear and pushing up the lever.



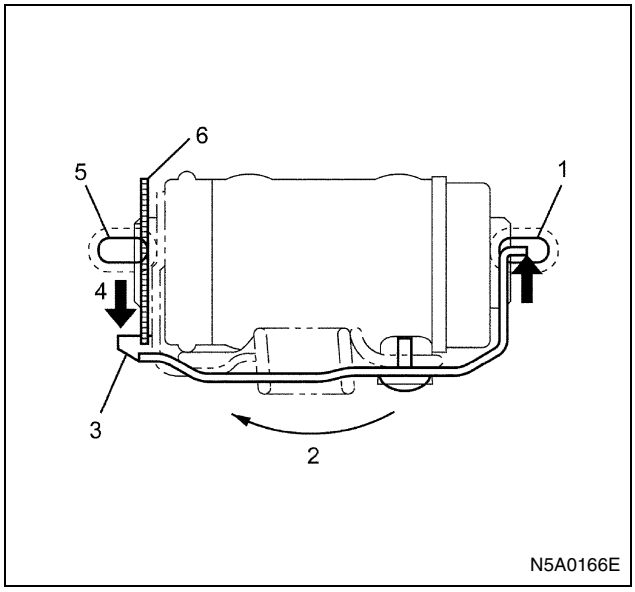
Legend
1. Adjuster gear
2. Brake shoe
3. Plug hole
4. Auto-adjuster lever
5. Loosening direction

Drum Inside Diameter 290 mm

1. Remove the rubber cover from the brake lining clearance adjusting hole/auto-adjuster lever release hole in the back plate.
2. Insert a thin, suitable rod in the auto-adjuster lever release hole, and push the end of the auto-adjuster lever (3) in the direction of the arrow (4).
3. With the auto-adjuster lever (3) pushed up, insert a keystone tip screwdriver in the adjusting hole, and turn the adjuster gear (6) to increase the gap between the gear and the brake shoe (the outside diameter of the shoe will decrease).

Notice:
Do not fail to push up the auto-adjuster lever before turning the gear. Failure to do so will result in damage to the teeth of the gear because it is locked with the lever.

Exercise care not to damage the boot of the wheel cylinder and other parts when turning the gear and pushing up the lever.



Legend
1. Plug hole
2. Rotating direction of tire (forward)
3. Auto-adjuster lever
4. Loosening direction
5. Plug hole
6. Adjuster gear

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

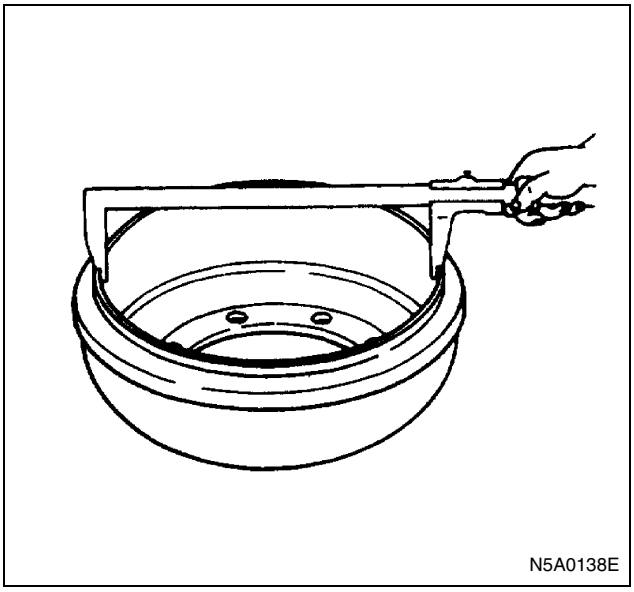
Brake Drum Inside Diameter

Visually inspect the brake drum for excessive wear and scoring.

If the brake drum is scored or worn, lathed to the specified limit.

Use a vernier caliper to measure the brake drum inside diameter.

Brake Drum Inside Diameter		mm (in)
Drum size	Standard	Limit
228.6	228.6 (9.00)	230.0 (9.06)
240	240.0 (9.45)	241.5 (9.51)
260	260.0 (10.24)	261.5 (10.30)
279.4	279.4 (11.00)	281.0 (11.06)
290	290.0 (11.42)	291.5 (11.48)
300	300.0 (11.81)	301.5 (11.87)
320	320.0 (12.60)	321.5 (12.66)
Out of round • Limit: 0.13 mm (0.005 in)		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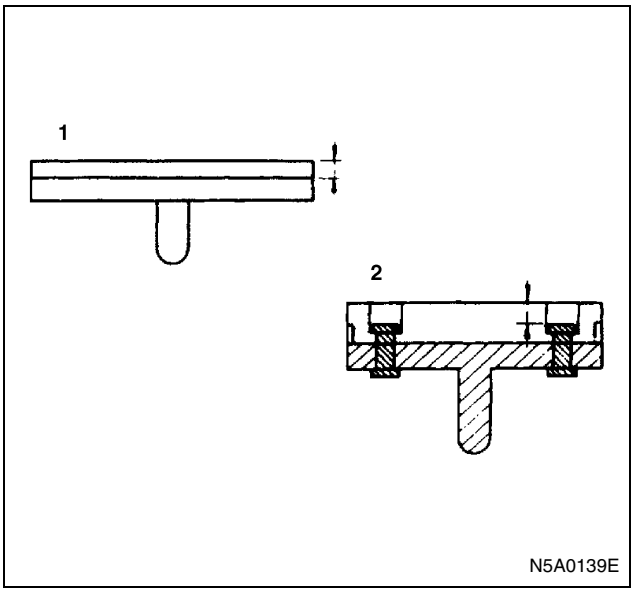
Brake Lining Thickness Measurement
Use a vernier caliper to measure the brake lining thickness or the rivet depth.
If the measured value is less than the specified limit, the brake shoe assembly and/or the lining must be replaced.

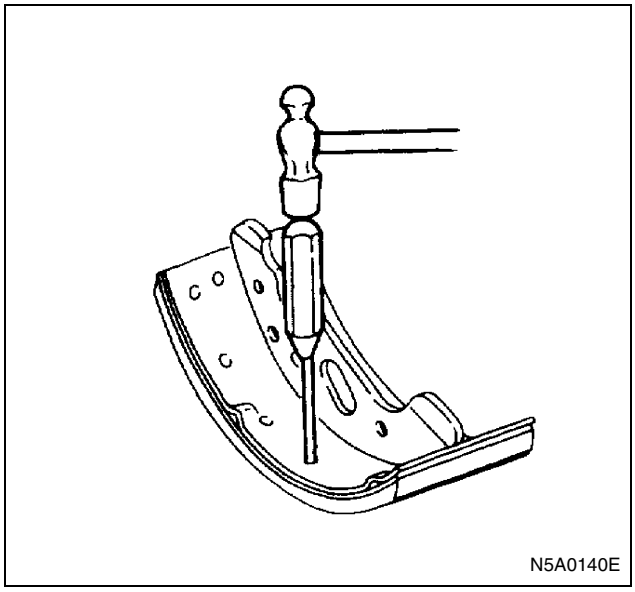
Brake Lining Thickness or Rivet Depth	mm (in)
Limit	1.0 (0.039)



N5A0139E

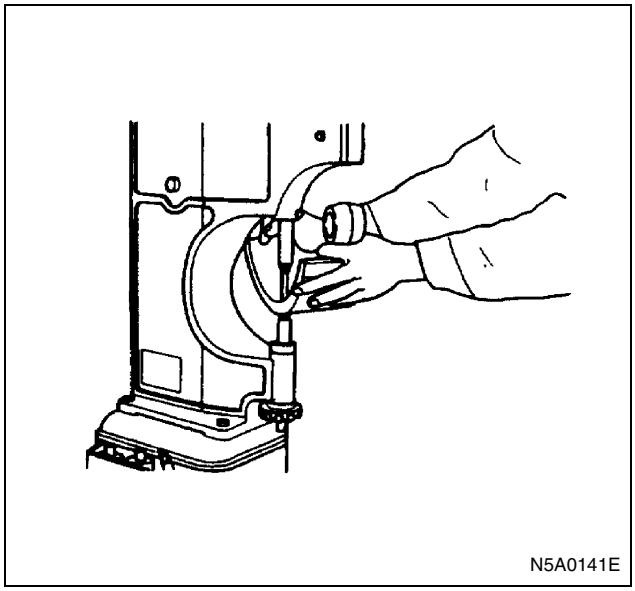
Legend
1. Adhesion type
2. Riveted type

Brake Lining Removal (Riveted Type Only)
1. Remove the rivet caulking portions with a hammer and chisel.
2. Remove the rivets with a hammer and punch.


N5A0140E

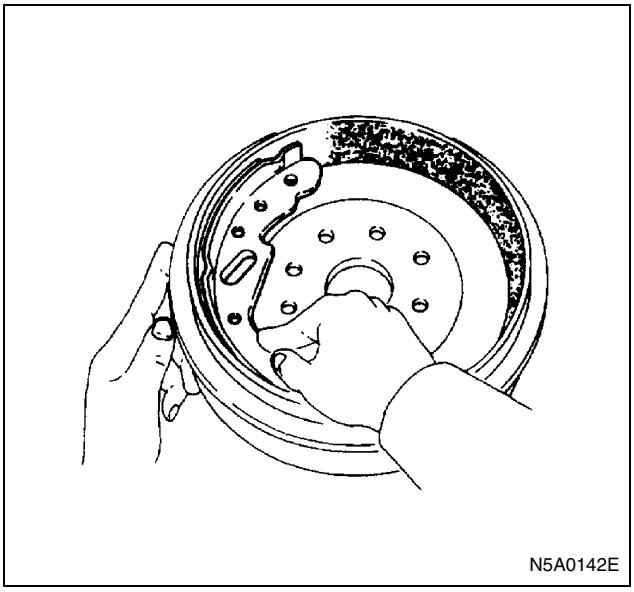
3. Inspect the brake shoe for cracking.

Brake Lining Installation (Riveted Type Only)
1. Install the brake lining and the rivets to the brake shoe.
2. Place the brake shoe assembly in the air hydraulic riveter.
3. Use the air hydraulic riveter to set and caulk each of the rivets.


N5A0141E

4. Start riveting at the center of lining and work towards the ends.

Brake Lining and Drum Contact
1. Apply chalk powder to the entire inside brake drum surface.
2. Place the brake shoe assembly in the inside brake drum.
3. Move the brake shoe assembly around the inside brake drum.
   Check for uniform contact between the brake lining and the brake drum.


N5A0142E

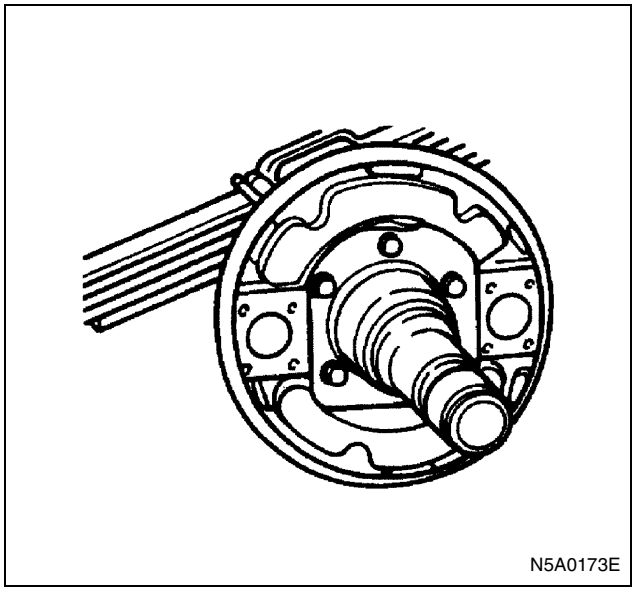
4. Correct any areas having poor contact with sandpaper.
5. Repeat Steps 1 through 4 until the contact between the brake lining and the brake drum is perfect.

Installation

1. Back Plate
   Tighten the back plate bolts to the specified torque.

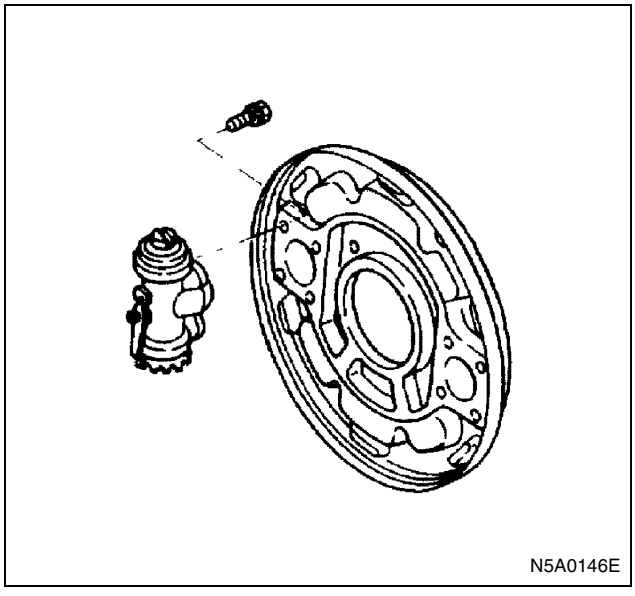
Back Plate Bolt Torque		N·m (kg·m/lb·ft)
Drum Inside Dia. mm (in)	Lining Width mm (in)	—
228.6 (9.00)	75 (2.95)	108 (11.0/80)
240.0 (9.45)	60 (2.36)	108 (11.0/80)
260.0 (10.24)	90 (3.54)	108 (11.0/80)
279.4 (11.00)	60 (2.36)	74 (7.5/54)
290.0 (11.42)	75 (2.95)	108 (11.0/80)
300.0 (11.81)	75 (2.95)	* 44 (4.5/33)
		** 108 (11.0/80)
320.0 (12.60)	75 (2.95)	108 (11.0/80)
	100 (3.94)	108 (11.0/80)
	120 (4.72)	157 (16.0/116)

* Single Tire models
** Dual Tire models


N5A0173E

2. Wheel Cylinder Assembly
   Tighten the wheel cylinder assembly bolts to the specified torque.

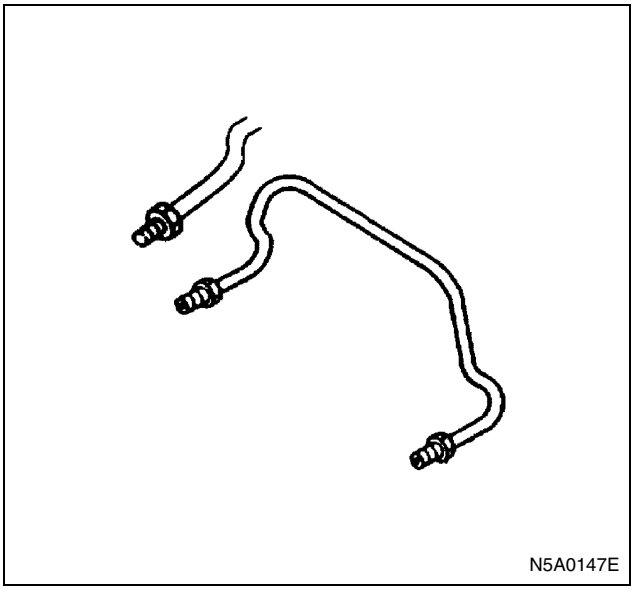
Wheel Cylinder Assembly Bolt Torque		N·m (kg·m/lb·ft)
Drum Inside Dia. mm (in)	Lining Width mm (in)	—
228.6 (9.00)	75 (2.95)	34 (3.5/25)
240.0 (9.45)	60 (2.36)	25 (2.5/18)
260.0 (10.24)	90 (3.54)	43 (4.4/32)
279.4 (11.00)	60 (2.36)	27 (2.8/20)
290.0 (11.42)	75 (2.95)	25 (2.5/18)
300.0 (11.81)	75 (2.95)	34 (3.5/25)
320.0 (12.60)	75 (2.95)	43 (4.4/32)
	100 (3.94)	74 (7.5/55)
	120 (4.72)	94 (9.6/69)


N5A0146E

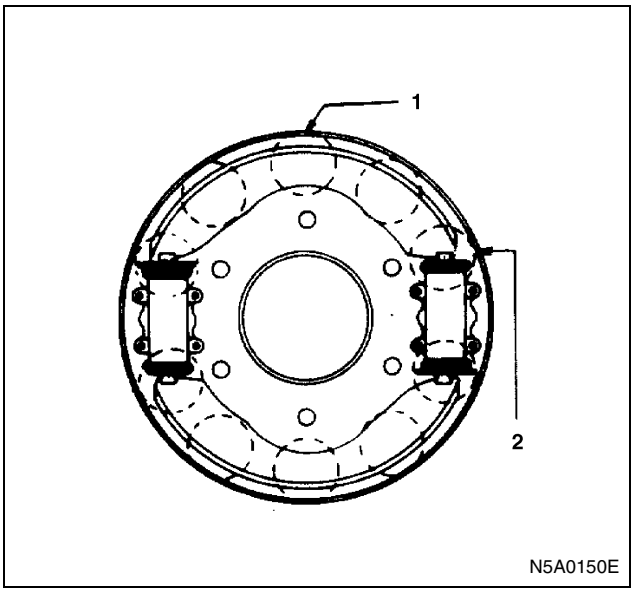
3. Brake Pipe
   Tighten the brake pipe flare nuts to the specified torque.

Tighten:
Brake pipe flare nuts to 16 N·m (1.6 kg·m / 12 lb·ft)

Notice:
Take care not to twist the piping.

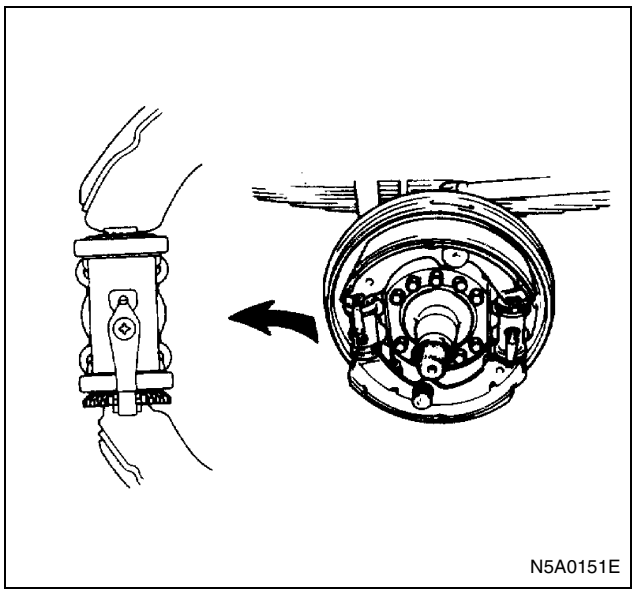

N5A0147E

4. Brake Shoe and Return Spring
   1) Before setting the brake shoes, apply a thin coat of molybdenum disulfide grease to the back plate portions (1) contacting the brake shoe edge as shown in the illustrations.
   2) Apply a coat of molybdenum disulfide grease to the wheel cylinder parts contacting the brake shoe (2).

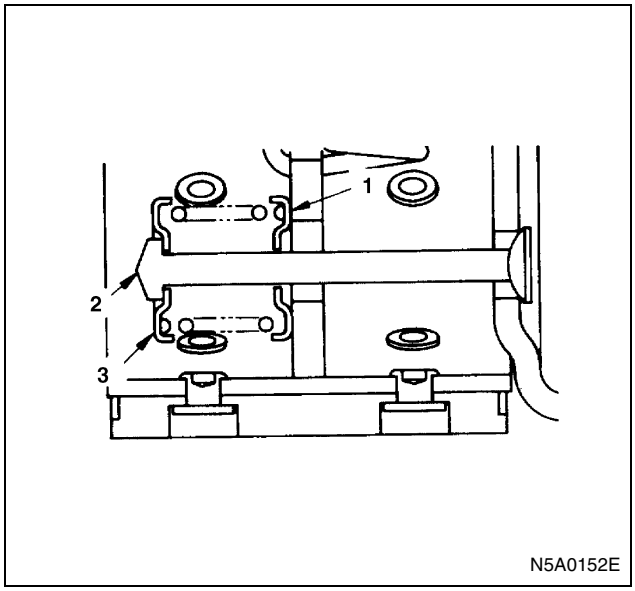


N5A0150E

   3) Set the brake shoe assembly to the cylinder adjusting screw at the brake shoe small angle end.
      Do not install it at the round end.


N5A0151E

   4) Install the brake shoes and the return springs to the wheel cylinders.
      Keep the brake lining clean.
5. Shoe Holding Spring, Cup and Pin
   1) Before installing the holding pin.
      Apply a coat of molybdenum disulfide grease to the holding cup seating faces (1) contacting the brake shoe.
   2) After installation of the pins, cups and the springs, make sure the pin (2) seats to the cup (3) properly.



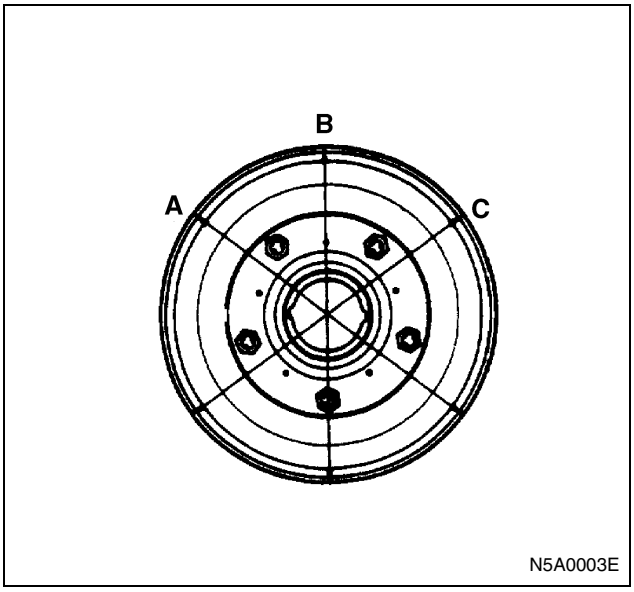
N5A0152E

6. After installation of brake drum, be sure to perform the preload adjustment of hub bearing.
7. Bleed the air from brake.

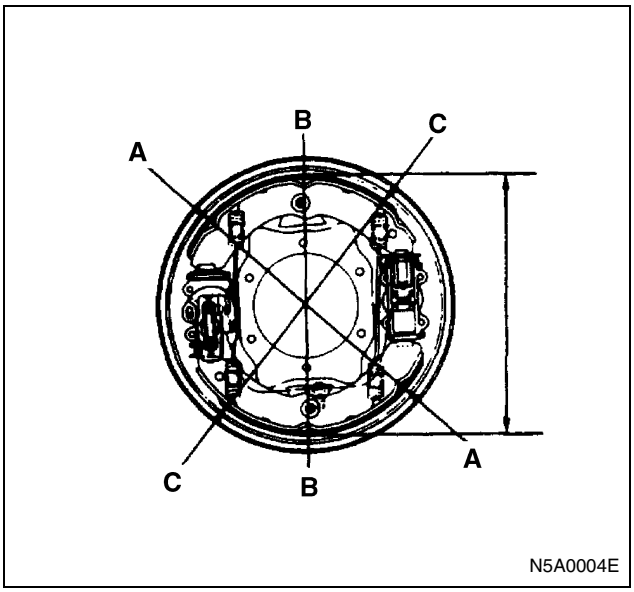
With Auto-adjuster

For the drum brake with auto-adjuster, perform the following procedure before Step 6 and 7.

1. Measure the internal diameter of the brake drum.
   - Take measurement of the distance at (A), (B) and (C) points.



2. Measure the external diameter of the brake shoe.
   - Take measurement of the distance at (A), (B) and (C) points.



3. Turn the adjuster gear so that the difference between the internal diameter of the brake drum and the internal diameter of the brake shoe becomes 0.6 mm (0.024 in).
4. Install the brake drum.

Adjustment

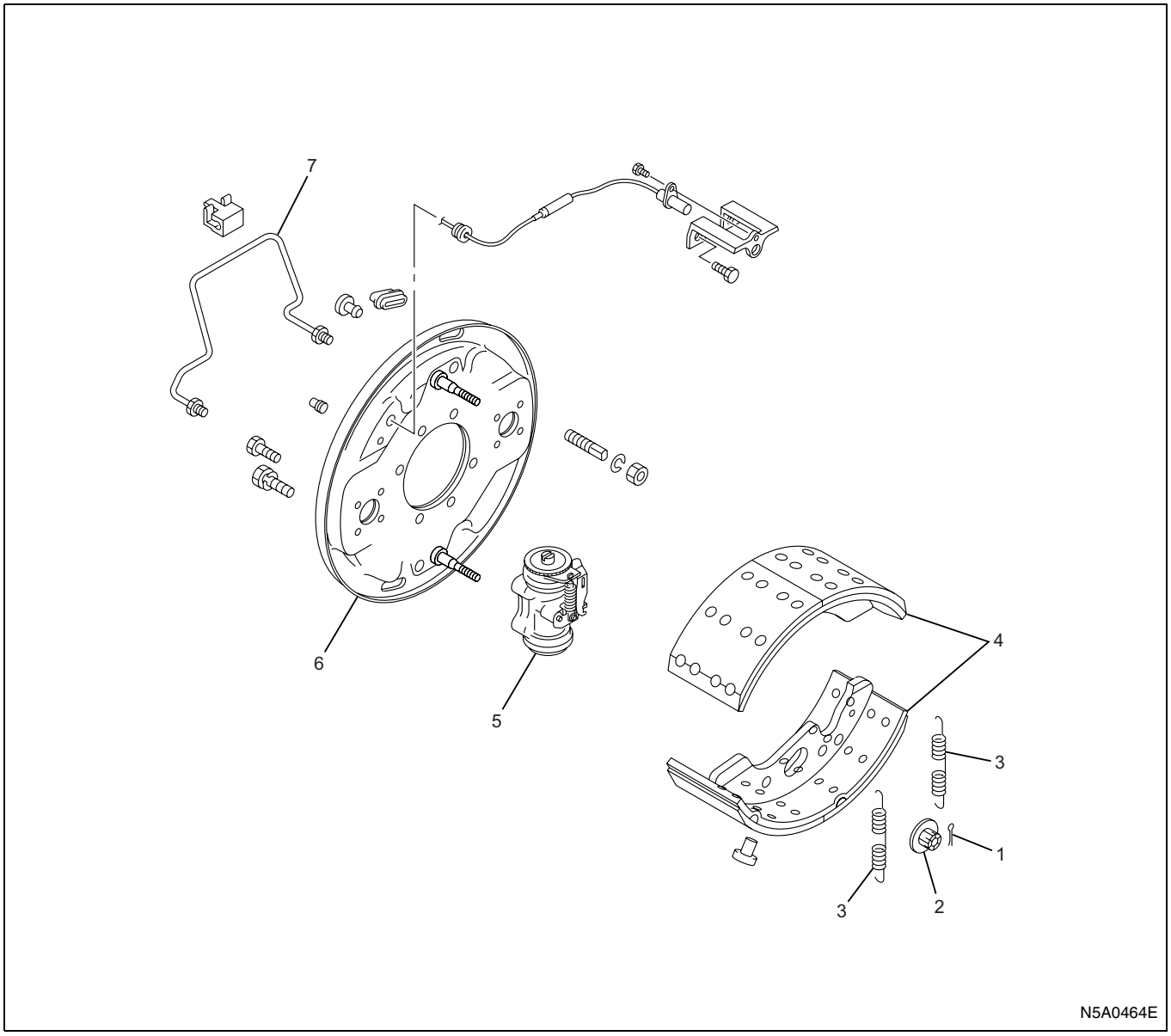
Without Auto-adjuster

Turn the adjuster until the brake drum stops rotating. Depress the brake pedal several times and turn the adjuster furthermore. When the brake drum stops rotating completely, turn the adjuster back for 5 to 6 notches.

With Auto-adjuster

Strongly depress the brake pedal several times while rotating the brake drum in the direction of moving forward or driving the vehicle forward. This adjusts the brake drum clearance automatically.

Rear Drum Brake Assembly (Drum Inside Diameter 370 mm)



Legend

1. Cotter pin
2. Shoe hold nut
3. Brake shoe return spring
4. Brake shoe assembly
5. Wheel cylinder assembly
6. Back plate
7. Brake pipe

Removal

- Block vehicle wheels and apply the parking brake.
- Raise the axle to clear the tire from the ground. Position jack stands under vehicle.

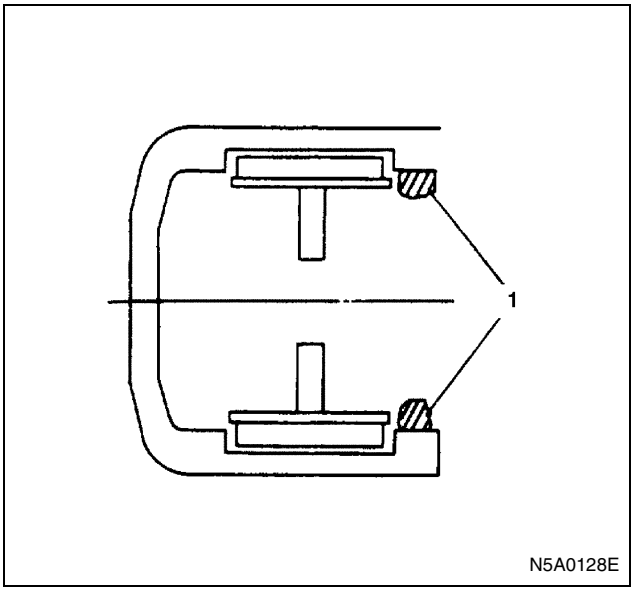
1. Wheel and tire assembly and brake drum and hub assembly.
   - Refer to Section 3E WHEELS AND TIRES.
   - Refer to Section 4C FRONT AXLE and Section 3C FRONT SUSPENSION.
   - Refer to Section 4B REAR AXLE.
2. Holder nuts.
3. Shoe return springs using a return spring plier. Return spring plier: 9-8522-0026-0
4. Shoe and lining assemblies.
5. Brake pipes.

Notice:
The brake pipes to the wheel cylinders must be removed before the wheel cylinders can be removed.

6. Brake hose.
7. Back plate.
8. Wheel cylinders.

Drum Inside Diameter 370.0 mm (14.57 in)

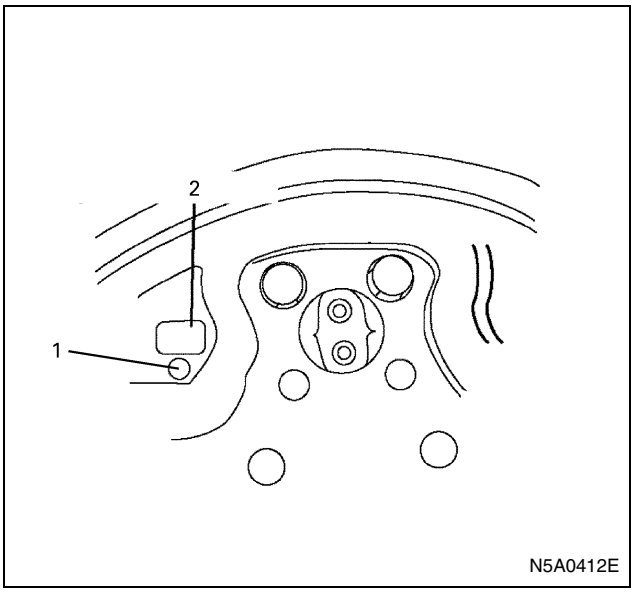
If the brake drum has step wear or the brake drum edge is corroded, it will be difficult to remove the brake drum. The following procedure will make brake drum removal easier.



Legend

1. Corroded portion

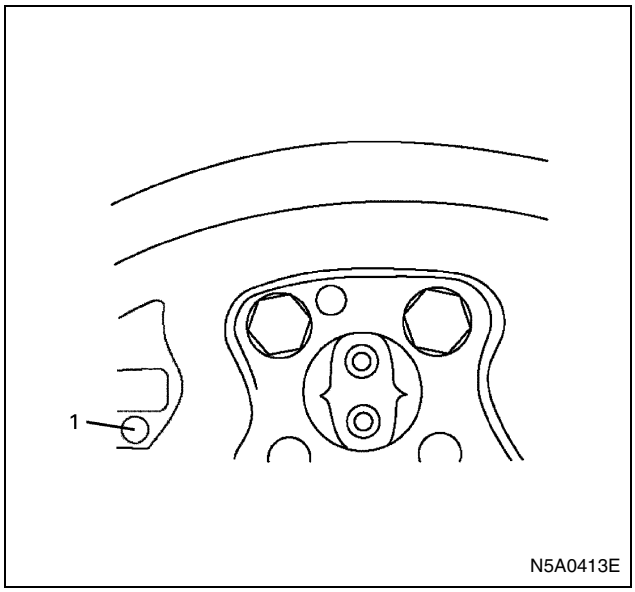
1. Remove the rubber cover from the brake lining clearance adjusting hole and auto-adjuster lever release hole.
2. Remove the adjust hole cover and adjuster lever release hole cover.



Legend

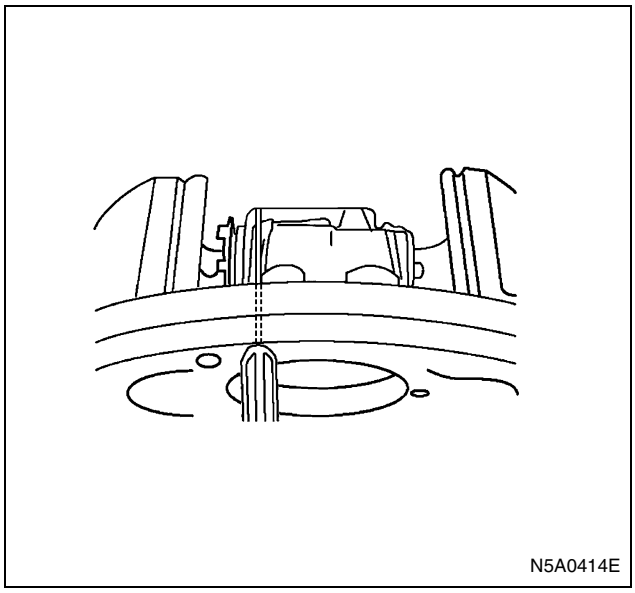
1. Adjuster lever release hole cover
2. Adjuster hole cover

3. Using ϕ5 mm Phillips screwdriver put it into the adjuster lever release hole and then push up the adjuster lever.

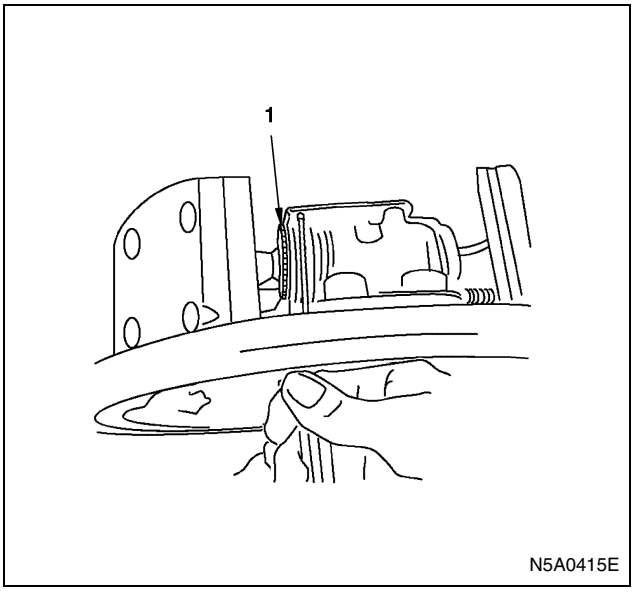


Legend

1. Adjuster lever release hole



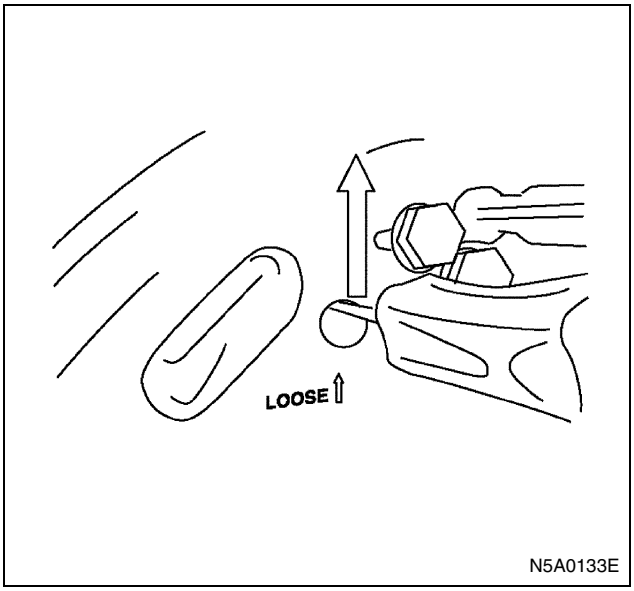
4. Put the flathead screwdriver into the adjuster hole while push up the adjuster lever.



Legend

1. Adjuster gear

5. Turn the adjuster gear to the marked arrow “LOOSE” on the backing plate.

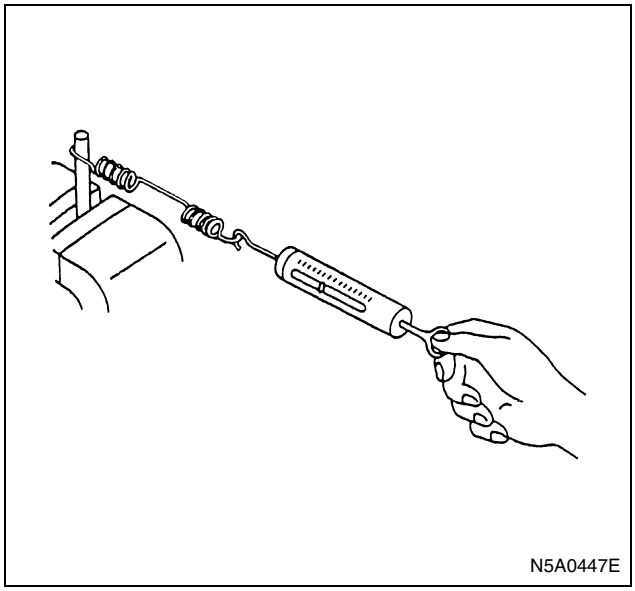


Inspection

- All components for wear or damage. Replace as necessary.

Measurement

Set the return spring as it is installed, and measure the tension.



- Return spring tension.

Free Length mm (in)	209.3 (8.24)
Set Length mm (in)	226 (8.90)
Set Load N (kg/lb)	292.2 — 357 (29.8 — 36.4 / 65.7 — 80.2)

Installation

1. Wheel cylinder assemblies.

Tighten:
Wheel cylinder mounting bolts to 120 N·m (12.2 kg·m / 89 lb·ft)

2. Back Plate.

Tighten:
Mounting plate bolts to 157 N·m (16.0 kg·m / 116 lb·ft)

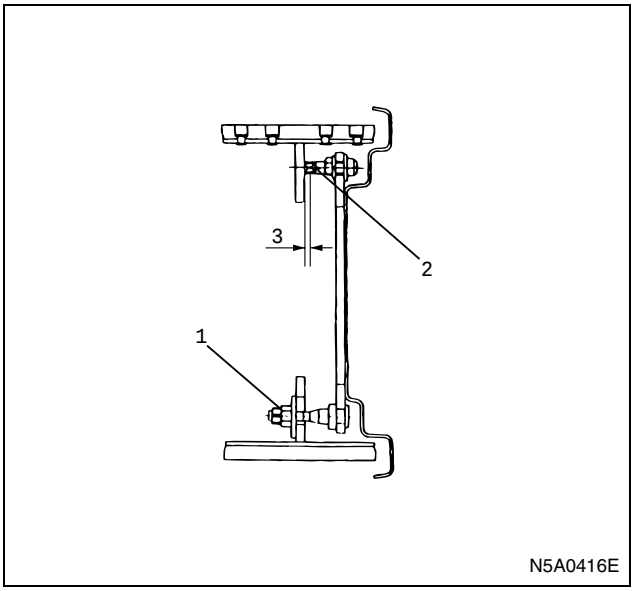
3. Brake pipes and hoses.

Tighten:
Brake pipe nuts to 15 N·m (1.5 kg·m / 11 lb·ft)

4. Shoe and lining assemblies.
5. Shoe return spring using a return spring plier.
   Return spring plier: 9-8522-0026-0
6. Holder nuts.
   - Brake holder nut clearance.
     – Turn nut (1) clockwise until shoe comes into contact with the bolts (2).
     – Turn nut (1) counterclockwise 1/3 turn. Back off the nut until the hole in the holding pin lines up with the nearest slot in the nut within 1/6 turn, and install split pin.
     – Check to see if clearance between bolt and shoe in 0.3 — 0.5 mm (0.012 — 0.020 in). If

clearance is not specified, it should be readjusted.

Caution:
Do not loosen the nuts on the shoe hold bolts during the operation.



Legend
1. Nut
2. Bolt
3. Clearance 0.3 — 0.5 mm (0.012 — 0.020 in)

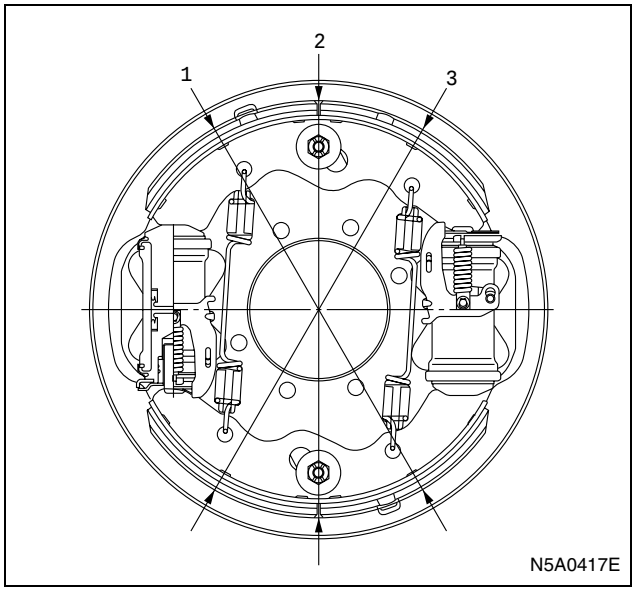
7. Cotter pin.
   Use a new cotter pin. Be sure to bend back the legs of the pin.
8. Hub and drum assembly and wheel and tire assembly. Adjust wheel bearings.
   - Refer to Section 3E WHEELS AND TIRES.
   - Refer to Section 4C FRONT AXLE and Section 3C FRONT SUSPENSION.
   - Refer to Section 4B REAR AXLE.

Adjustment

1. After reassembling the brake assembly, adjust the brake lining external diameter to 369.3 — 369.8 mm (14.54 — 14.56 in) by turning the wheel cylinder adjuster gear.
   If the measurement at 1, 2 and 3 point are within the range of specified value, brake drum can be installed easily.

Notice:
Be sure to push up the auto-adjuster lever. Failure to do so will result in damage to the teeth of auto-adjuster-gear.

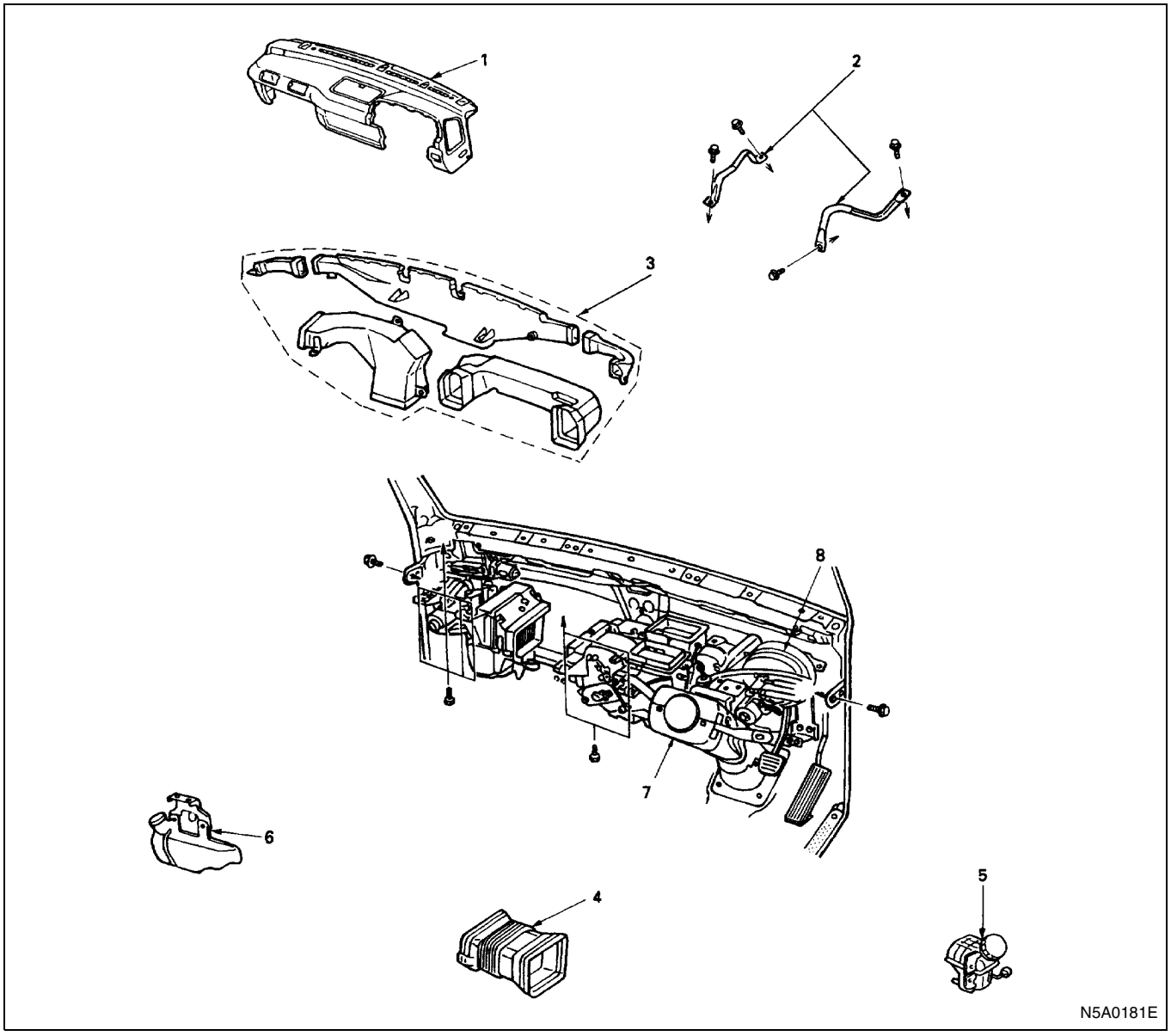
Take care not to damage the rubber boot with the screw driver.



2. Install the brake drum.
3. Rotate the brake drum and depress the brake pedal as far as possible.

Brake Pedal and Control

Brake Vacuum Booster and Brake Pedal Assembly

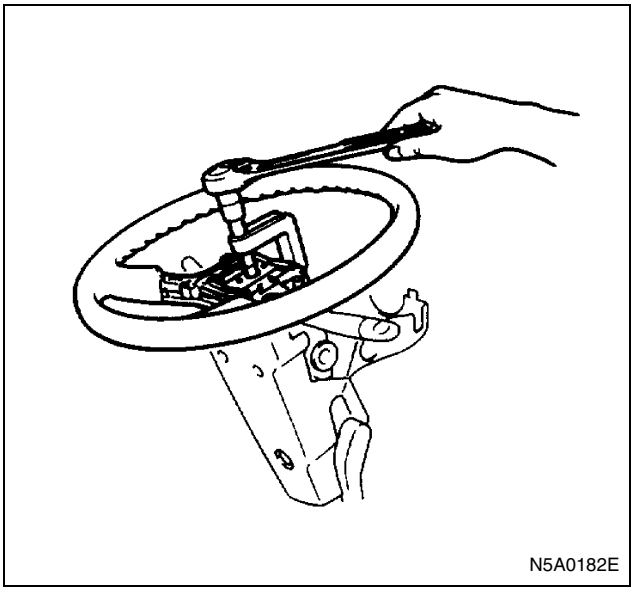


Legend

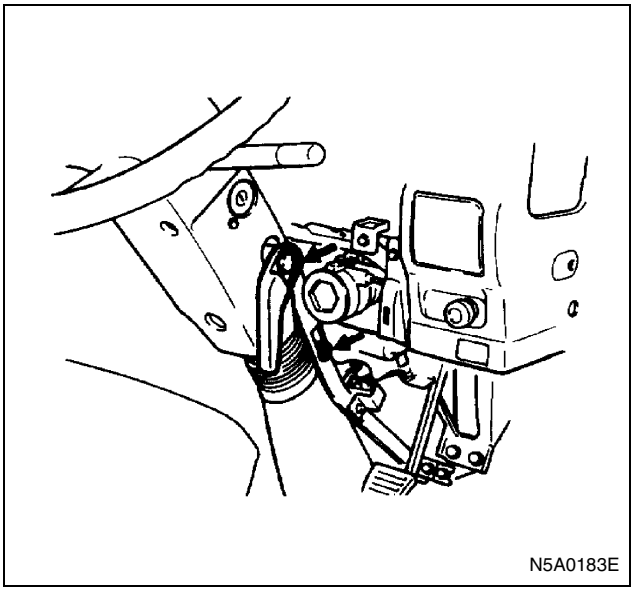
1. Instrument panel
2. Stay
3. Defroster nozzle and vent duct
4. Center duct (NPR model only)
5. Brake and clutch fluid reservoir
6. Windshield washer tank
7. Steering cowl assembly
8. Vacuum booster and brake pedal assembly

Removal

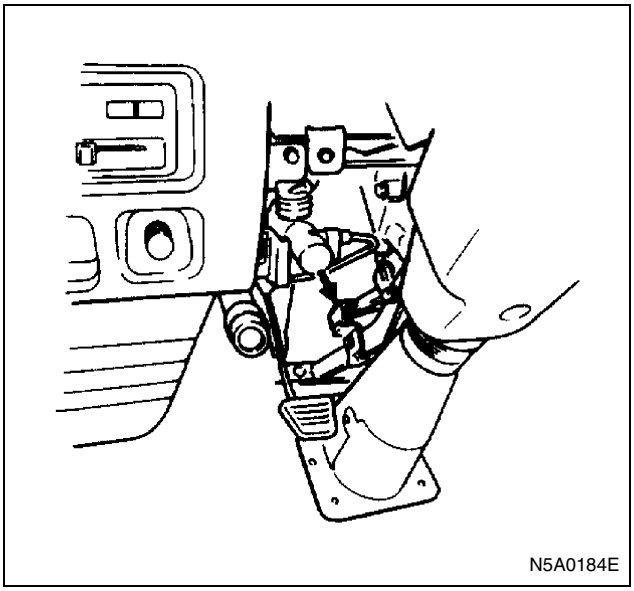
1. Instrument Panel
2. Stay
3. Defroster Nozzle and Vent Duct
4. Center Duct (NPR model only)
5. Brake and Clutch Fluid Reservoir
6. Windshield Washer Tank
   For the removal procedure for above, refer to Section 2 CAB AND FRAME.
7. Steering Cowl Assembly
   Wheel remover: 5-8840-2215-0


N5A0182E

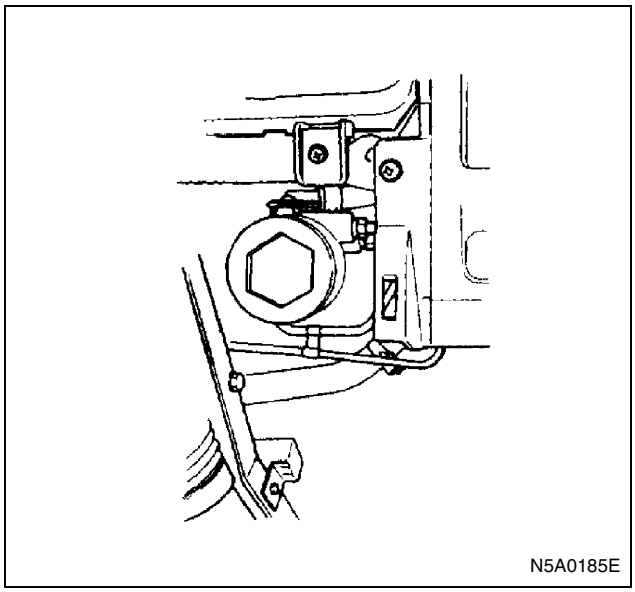
Remove the tilt lever and steering cowl.


N5A0183E

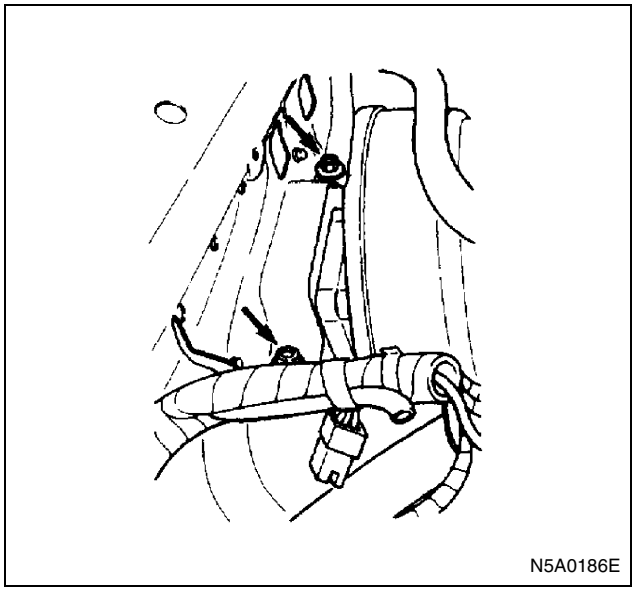
Disconnect the wire harness connectors.


N5A0184E

8. Vacuum Booster and Brake Pedal Assembly
   1) Disconnect the brake pipes and hoses.


N5A0185E

   2) Plug or cover the brake rubber hoses, pipes and the master cylinder brake fluid ports to prevent brake fluid spillage.
      If brake fluid spillage occurs, wipe it up immediately.
   3) Remove the brake pedal bracket fixing bolts and vacuum booster and brake pedal assembly.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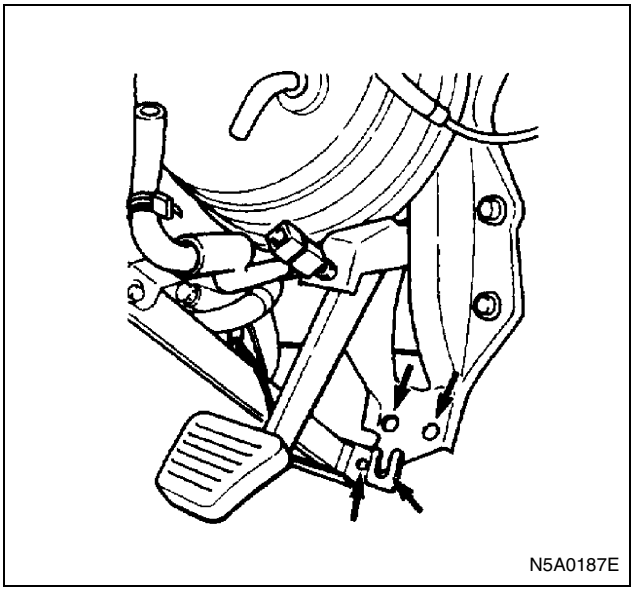
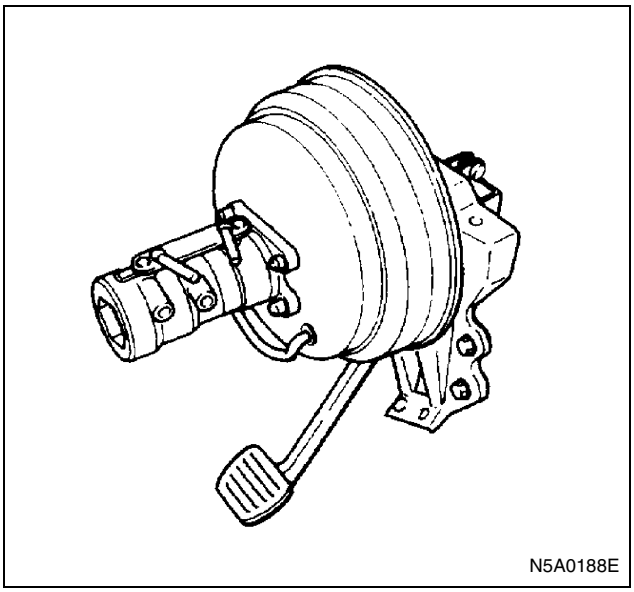
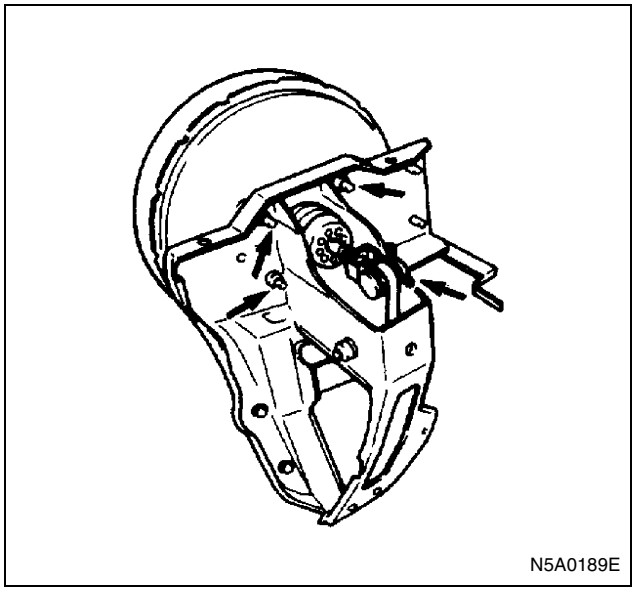

N5A0187E

4) Remove the brake pedal and master cylinder.

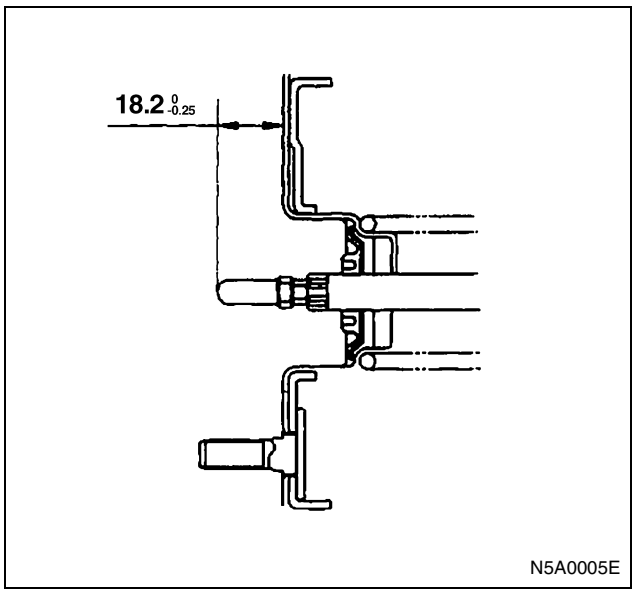

N5A0188E

5) Remove the vacuum booster assembly from brake pedal assembly.


N5A0189E

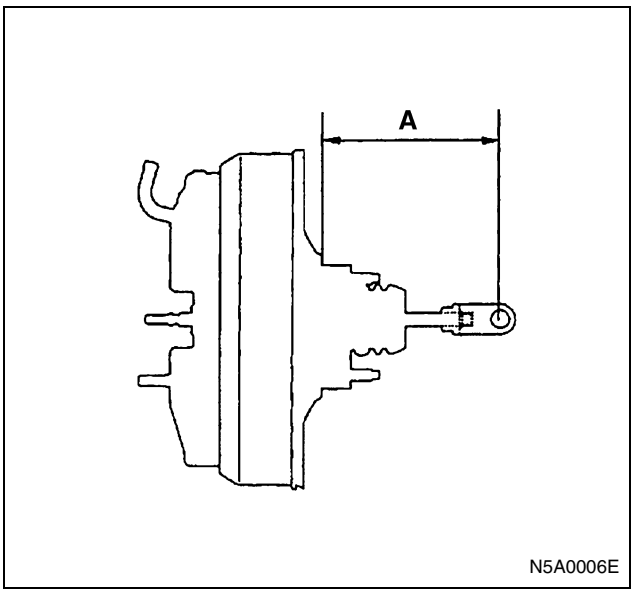
Installation

1. Vacuum Booster and Brake Pedal Assembly
   1) Vacuum booster cannot be overhauled. If it is found faulty, replace its assembly with a new one.
   2) Make necessary adjustment, so that distance between end of push rod and flange face is adjusted to 18.2 mm (0.717 in) in condition of vacuum applying.



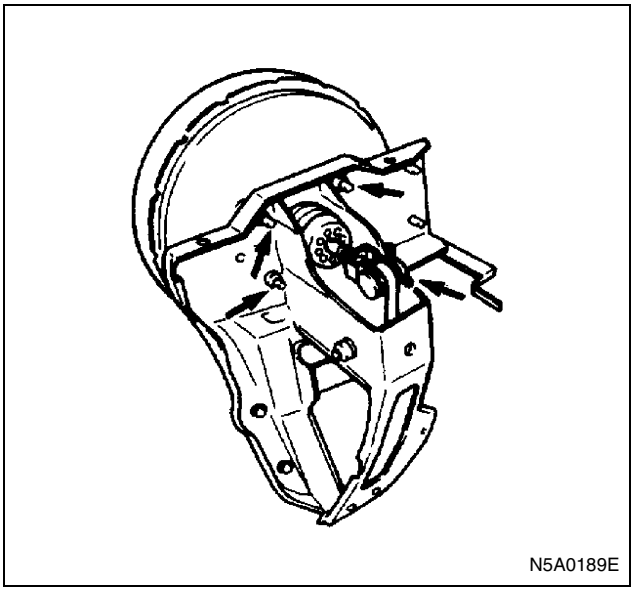
N5A0005E

   3) Push rod length (A) is measured from the center of the clevis pin hole to the mounting surface of the brake pedal bracket. Adjusted to 109 mm (4.291 in); without spacer, 129 mm (5.079 in); with spacer and tighten the lock nut. When fixed under this condition, there is no need to adjust the height of brake pedal from floor and free play.



4) Install the vacuum booster to brake pedal assembly.

- Adjust the clearance between the tip of threaded portion of the stop light switch and the pedal arm to 0.5 — 1.0 mm (0.02 — 0.04 in).

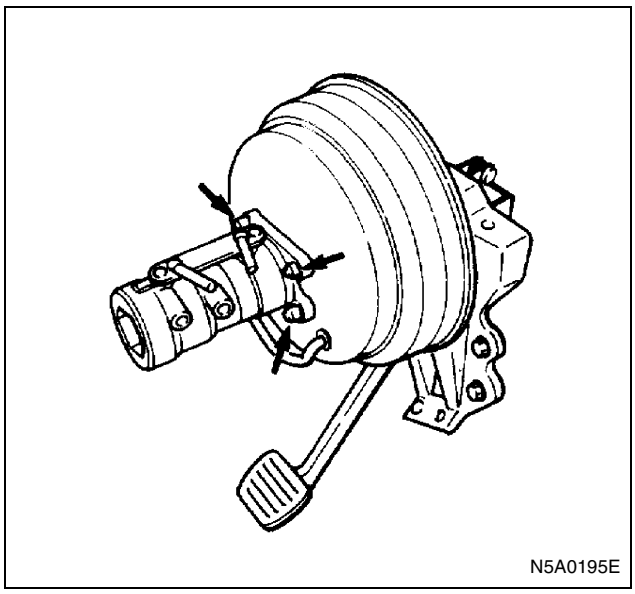


5) Tighten the vacuum booster bolts to the specified torque.

Tighten:
Vacuum booster bolts to 14 N·m (1.4 kg·m / 122 lb·in)

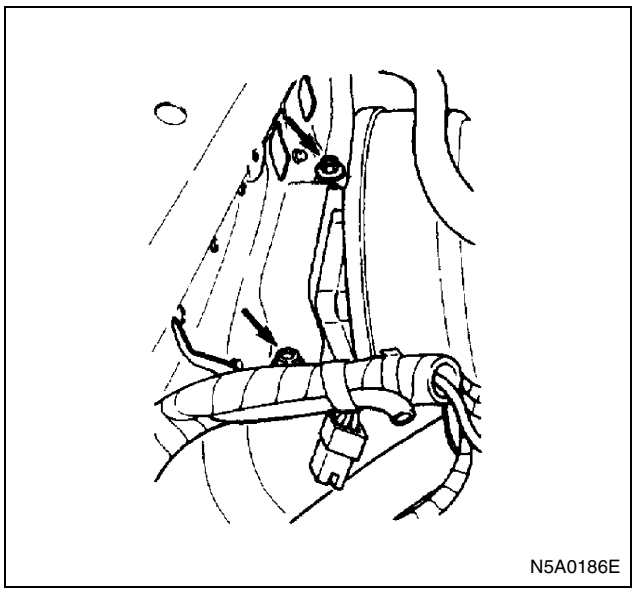
6) Install the master cylinder assembly to vacuum booster or brake pedal assembly.
7) Tighten the master cylinder nut to the specified torque.

Tighten:
Master cylinder nut to 14 N·m (1.4 kg·m / 122 lb·in)

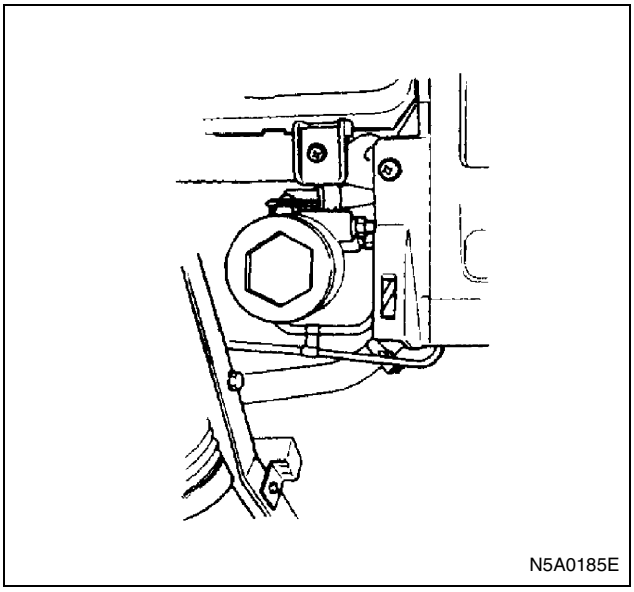


8) Install the vacuum booster and brake pedal assembly.

Tighten:
Vacuum booster and brake pedal assembly bolts to 42 N·m (4.3 kg·m / 32 lb·ft)

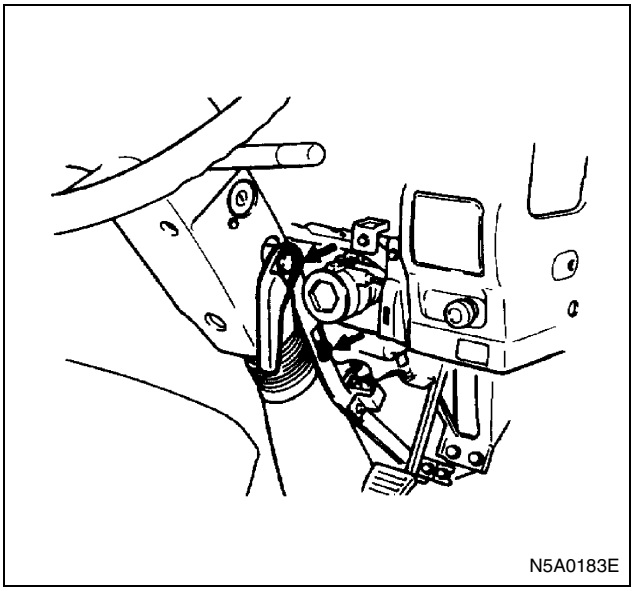


9) Connect the brake hoses and pipes.


N5A0185E

2. Steering Cowl Assembly
   1) Connect the wire harness connectors.
   2) Install the steering cowl.

Tighten:
Steering cowl bolt to 14 N·m (1.4 kg·m / 122 lb·in)

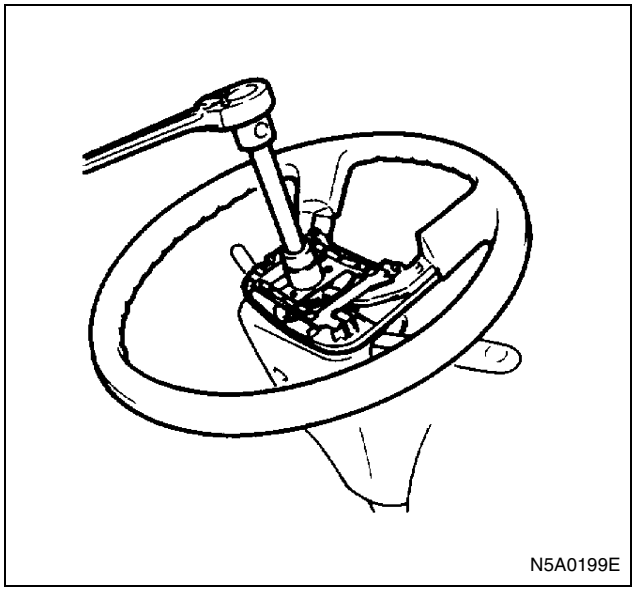

N5A0183E

   3) Install the tilt lever.

Tighten:
Tilt lever bolt to 45 N·m (4.6 kg·m / 33 lb·ft)

   4) Install the steering wheel.

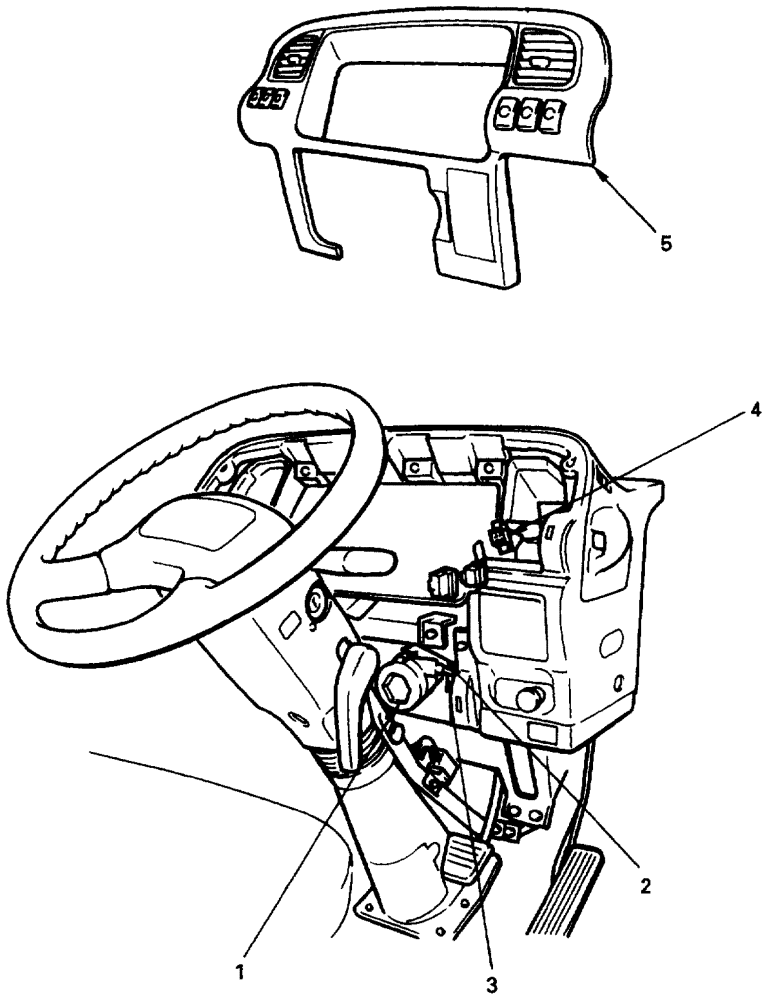
Tighten:
Steering wheel nut to 49 N·m (5.0 kg·m / 36 lb·ft)


N5A0199E

3. Windshield Washer Tank
4. Brake and Clutch Fluid Reservoir
5. Center Duct (NPR model only)
6. Defroster Nozzle and Vent Duct
7. Stay
8. Instrument Panel
   For the installation procedure for above, refer to Section 2 CAB AND FRAME.

Master Cylinder Assembly

This illustration is based on RHD.



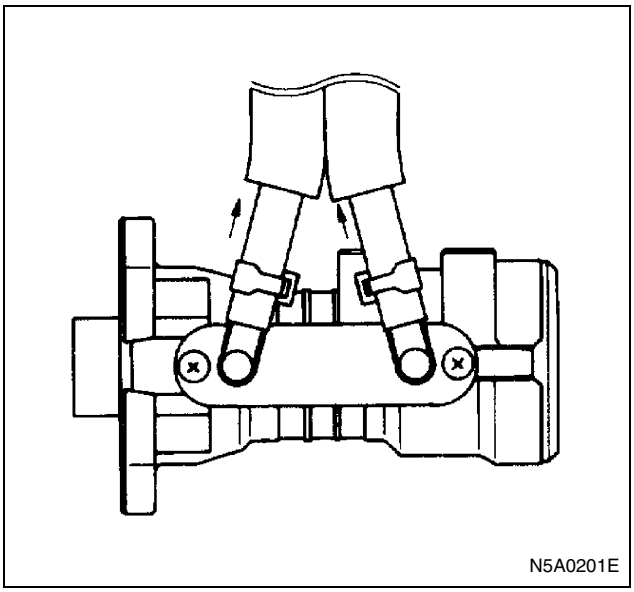
N5A0200E

Legend

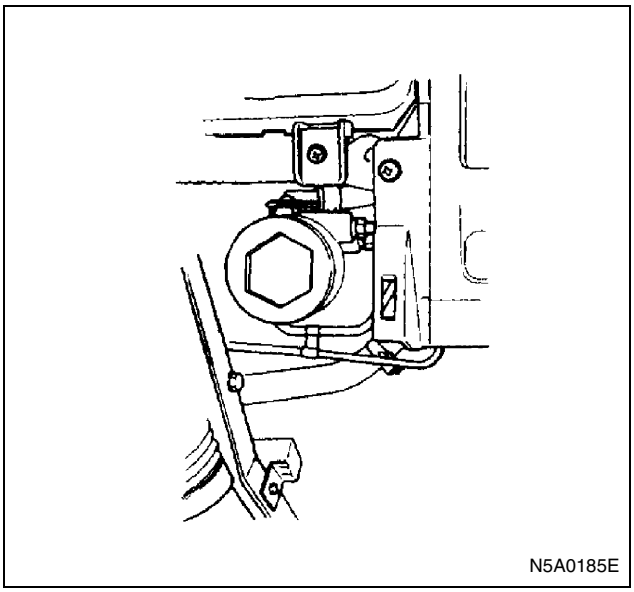
1. Meter cluster
2. Switch connector
3. Brake pipe
4. Brake hose
5. Master cylinder

Removal

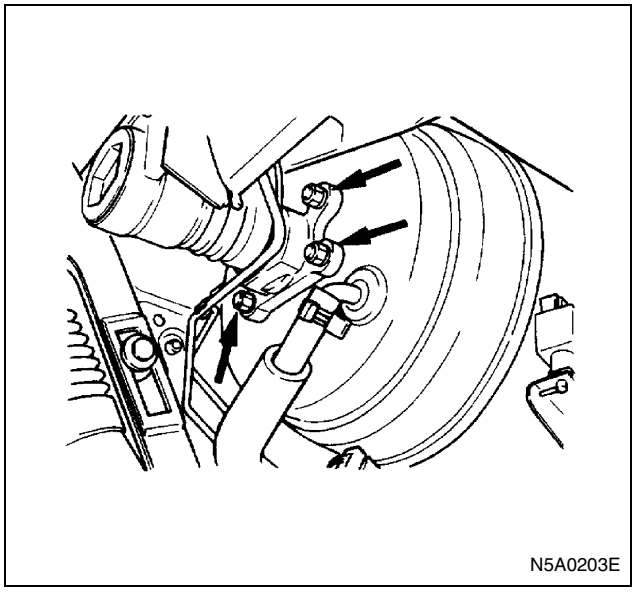
1. Meter Cluster
2. Switch connector
   For the removal procedure for above, refer to Section 2 CAB AND FRAME.
3. Brake Pipe


N5A0201E

4. Brake Hose
   1) Disconnect the brake pipes and hoses.
   2) Plug or cover the brake rubber hoses, pipes and the master cylinder brake fluid ports to prevent brake fluid spillage.
      If brake fluid spillage occurs, wipe it up immediately.

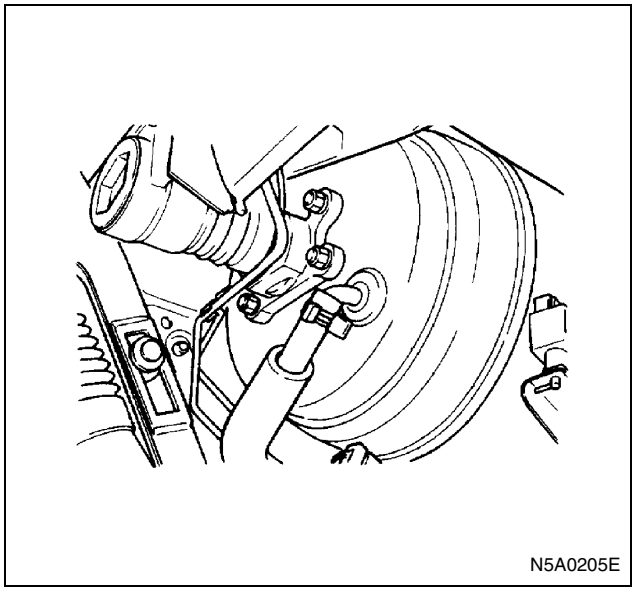

N5A0185E

5. Master Cylinder


N5A0203E

Installation

1. Master Cylinder
   1) Install the master cylinder assembly to the vacuum booster or brake pedal assembly.

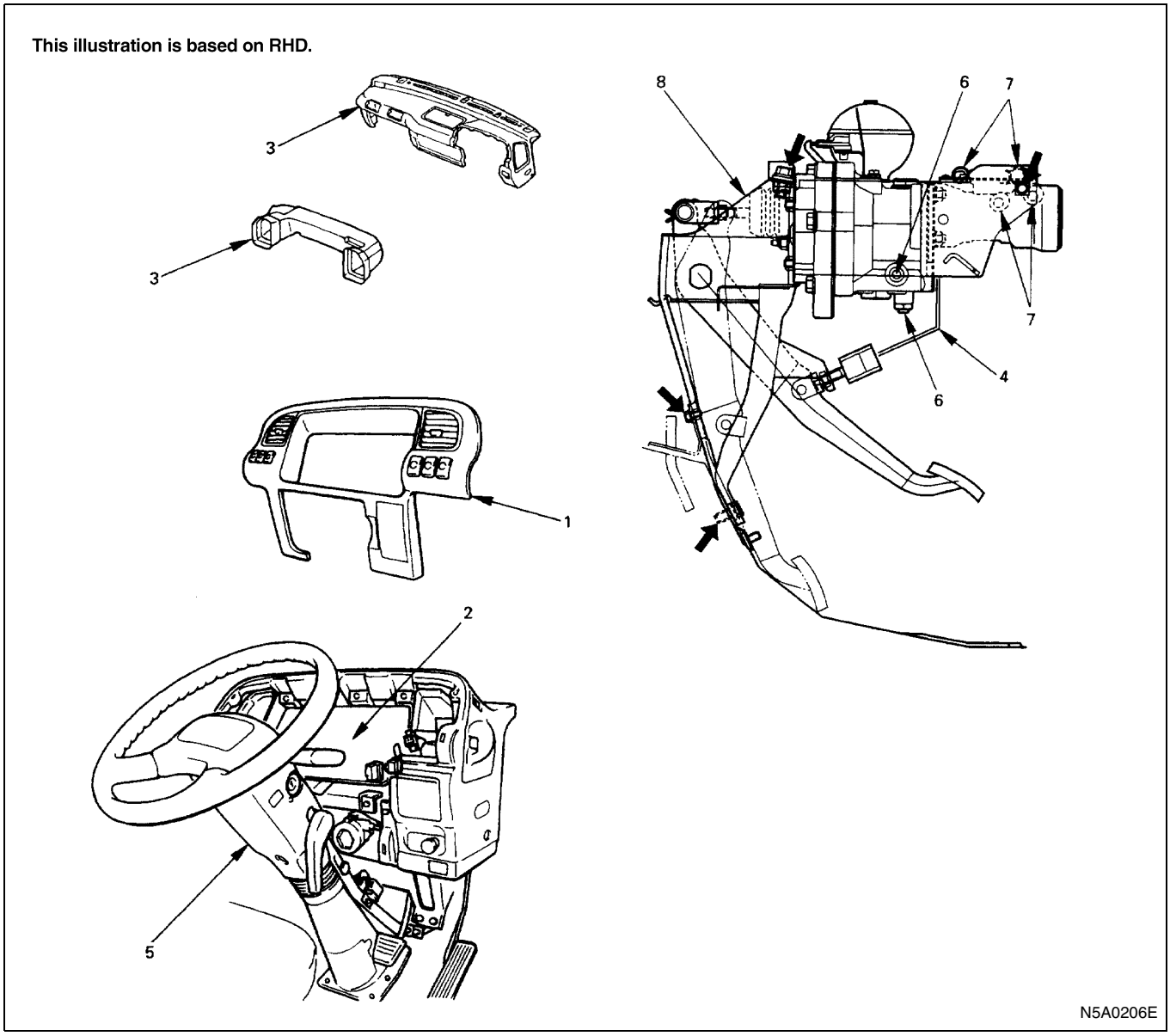

N5A0205E

   2) Tighten the nuts to the specified torque.

Tighten:
Master cylinder assembly nuts to 14 N·m (1.4 kg·m / 122 lb·in)

2. Brake Hose
3. Brake Pipe
4. Switch Connector
5. Meter Cluster

Hydraulic Booster and Brake Pedal Assembly



Legend

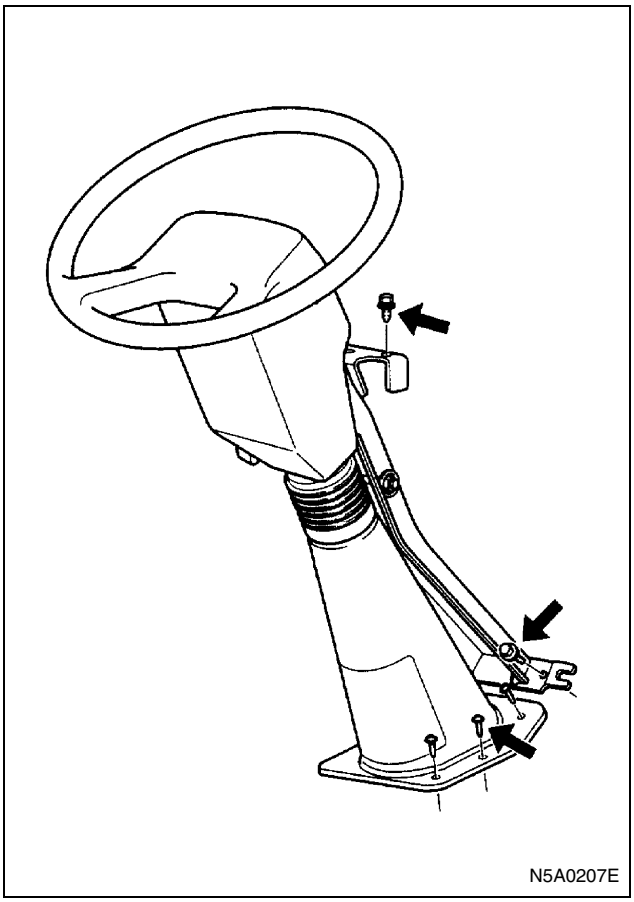
1. Meter cluster
2. Meter
3. Instrument panel and duct
4. Heat protector
5. Steering wheel and column assembly
6. ATF pipe
7. Brake pipe and hose
8. Brake pedal assembly with master cylinder and hydraulic booster

Removal

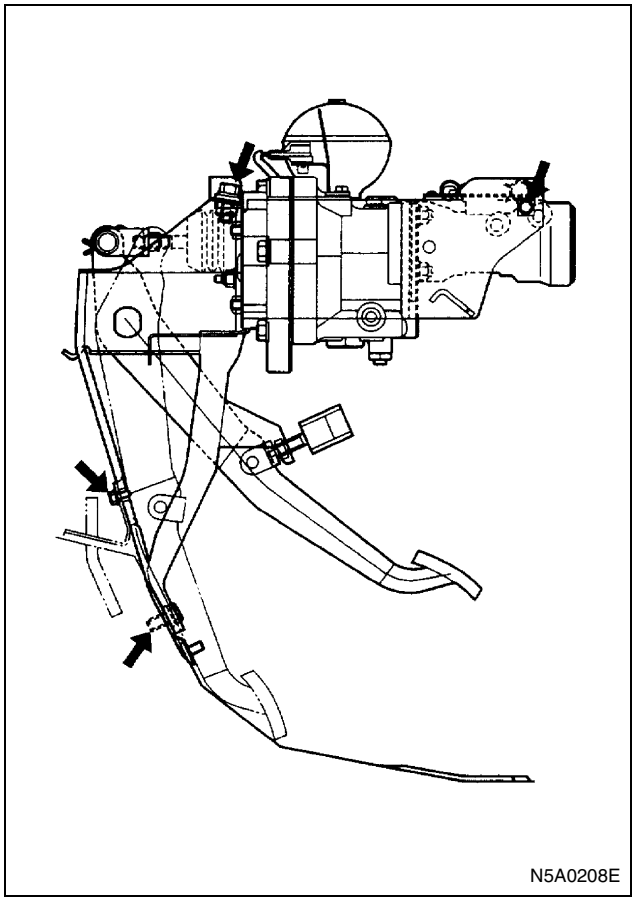
- Block the vehicle wheels and apply the parking brake.
- Disconnect the battery ground cable.
- By brake pedal operation with the engine off, reduce the pressure of the hydraulic oil in the accumulator, and after confirming that the temperature of the hydro boost assembly has been reduced, remove the hydro boost assembly from the vehicle.

1. Remove meter cluster.
2. Remove meter assembly and harness connector.
3. Remove instrument panel assembly and ventilation duct.
4. Remove heat protector under the hydraulic booster.
5. Steering wheel and column assembly.
   - Remove inspection window and mark steering worm shaft and U-joint yoke.
     Remove key bolt and nut.
   - Remove screws: boots to floor.

- Remove bolts and nuts: support bracket to floor.
- Remove bolts: steering column bracket to instrument reinforcement assembly.
- Remove bolts: steering column bracket to brake pedal bracket.


N5A0207E

6. ATF pipe: inlet and outlet.
   - Disconnect pipes from the booster.
7. Brake pipe and hose: front and rear.
   - Disconnect pipes and hoses from the brake master cylinder.
8. Brake pedal assembly with master cylinder and hydraulic booster.
   - Remove accelerator pedal bracket.
   - Remove brake pedal assembly mounting bolts.
   - Remove radiator grille and disconnect ATF inlet pipe from flexible hose in front of the radiator.
     Remove ATF inlet pipe.
   - Remove brake pedal assembly.

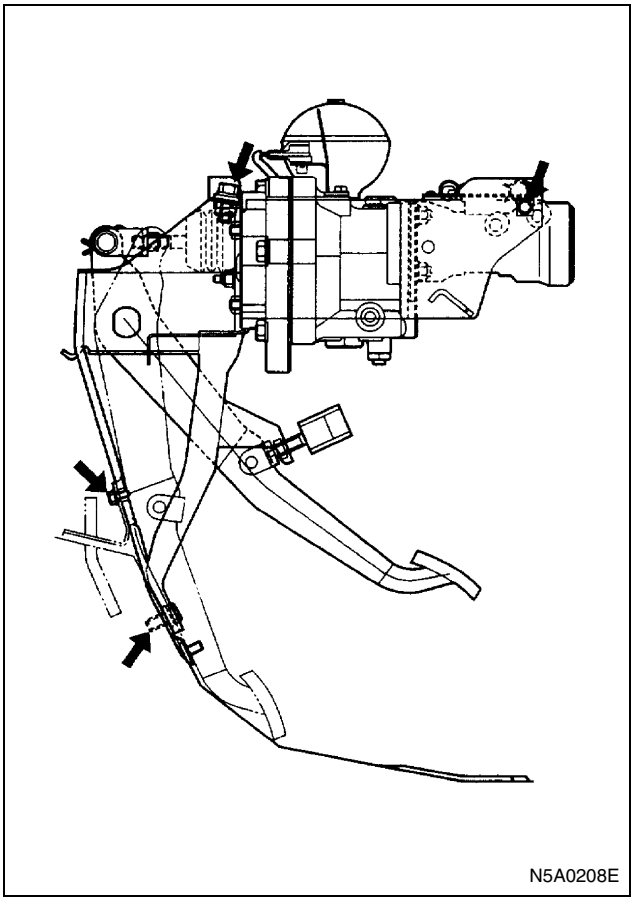

N5A0208E

Installation

1. Brake Pedal Assembly with Master Cylinder and Hydraulic Booster
   - Set ATF inlet pipe and install brake pedal assembly.

Tighten:
M10 mounting bolts to 42 N·m (4.3 kg·m / 32 lb·ft)

- Connect ATF inlet pipe with flexible hose.
- Install accelerator pedal bracket.
- Install radiator grille.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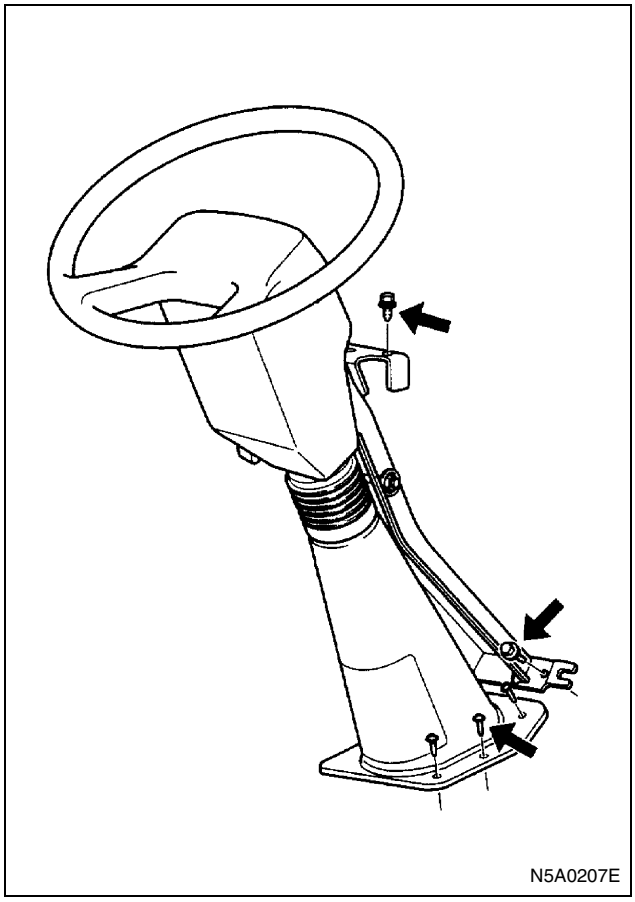
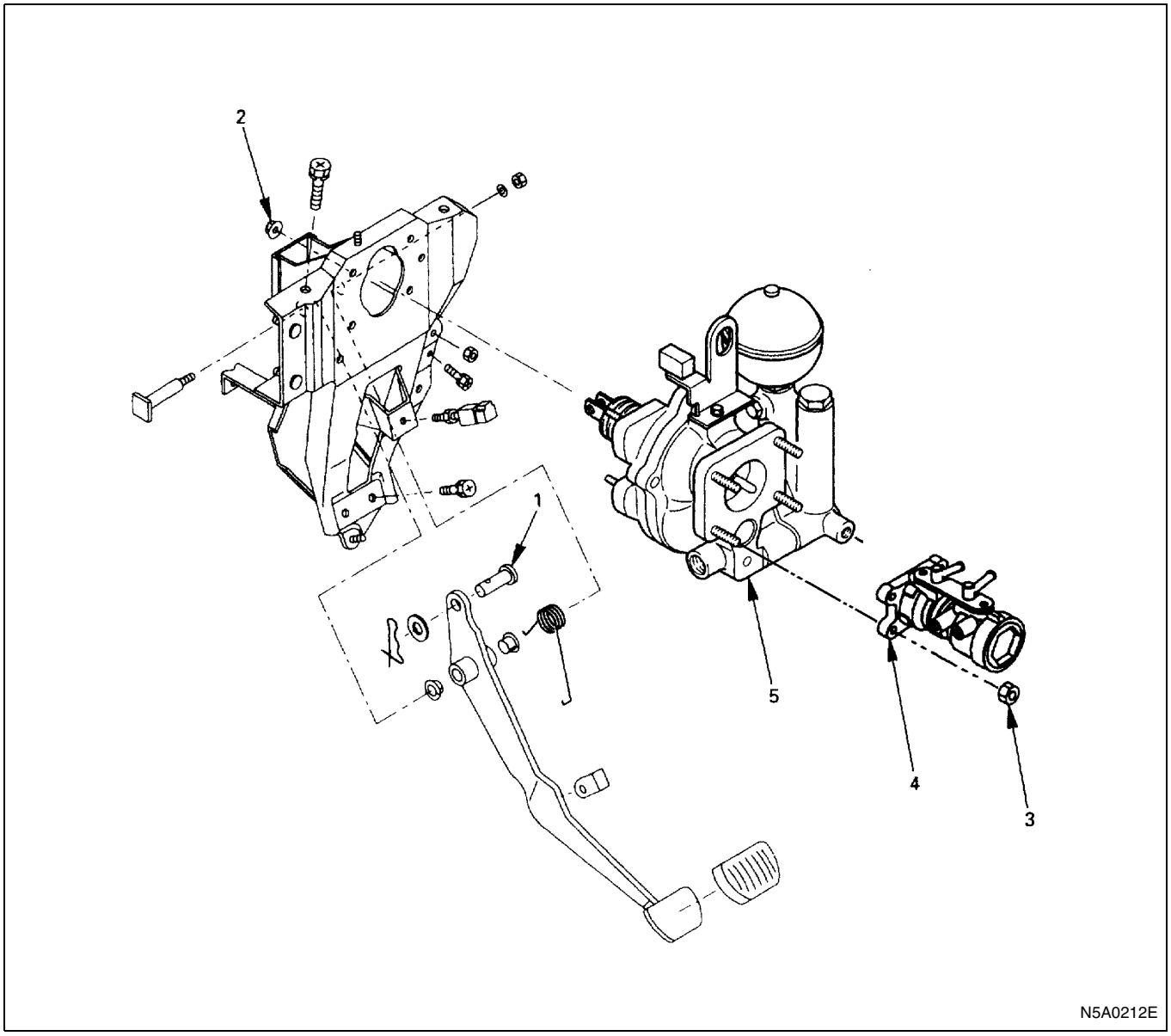

N5A0207E

2. ATF Pipe
   - Install ATF pipes to hydraulic booster.
3. Brake Pipe and Hose
   - Install master cylinder hydraulic lines to master cylinder.
4. Steering Wheel and Column Assembly
   - Set steering wheel and column assembly.
   - Install mounting bolts, nuts and screws to body.
   - Install key bolt and nut.

Tighten:
Key bolt to 38 N·m (3.9 kg·m / 28 lb·ft)

   - Install inspection window.
5. Heat Protector
   - Install hydraulic booster heat protector.
6. Instrument Panel and Duct
   - Install ventilation duct and instrument panel assembly.
7. Meter
   - Install meter assembly and harness connector.
8. Meter Cluster
   - Install meter cluster.
9. Battery ground cable.
10. After attaching it to the vehicle, always replenish with new hydraulic oil (Besco ATF III), and completely release the air from the hydro boost.
11. Bleed brake lines.
12. Release the parking brake and remove the wheel blocks.

Hydraulic Booster

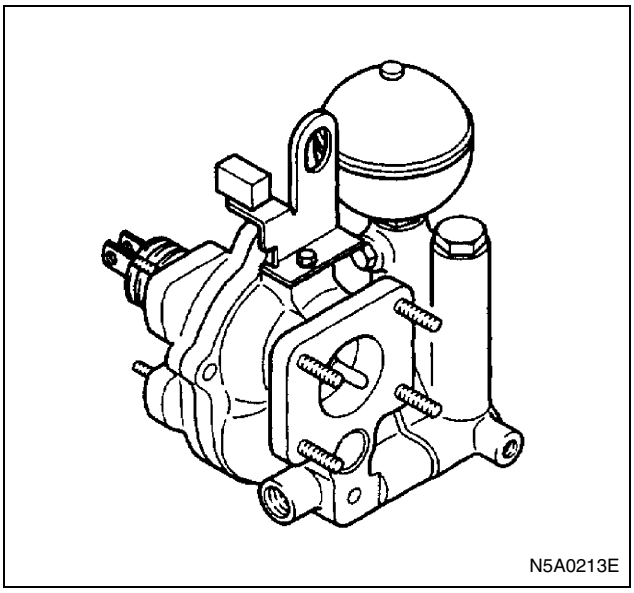


Legend

1. Clevis pin
2. Hydraulic booster nut
3. Master cylinder nut
4. Master cylinder
5. Hydraulic booster

Removal

1. Clevis Pin
2. Hydraulic Booster Nut
   - Four hydraulic booster mounting nuts at pedal bracket.
   - Remove master cylinder with hydraulic booster.
3. Mastcr Cylinder Nut
   - Four nuts retaining master cylinder to hydraulic booster.
4. Master Cylinder
5. Hydraulic Booster



Installation

1. Hydraulic Booster
2. Master Cylinder Assembly
3. Master Cylinder Nut

Tighten:
Master cylinder nut to 14 N·m (1.4 kg·m / 122 lb·in)

4. Hydraulic Booster Nut
   - Four hydraulic booster mounting nuts to pedal bracket.

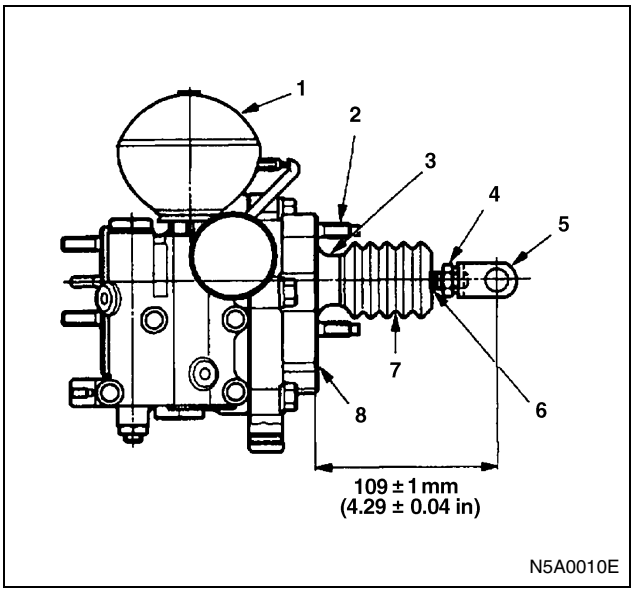
Tighten:
Hydraulic booster nut to 14 N·m (1.4 kg·m / 122 lb·in)

5. Clevis Pin
   - Connect hydraulic booster clevis to brake pedal and install clevis pin.

Accumulator and O-ring Replacement

Removal

- Block the vehicle and apply the parking brake.
- Disconnect the battery ground cable.
- Reduce the pressure of the hydraulic oil in the accumulator by brake pedal operation with the engine off, and after confirming that the temperature of the hydro boost assembly has been reduced, remove the hydro boost assembly from the vehicle.
  1) Remove meter cluster.
  2) Remove meter assembly and harness connector.
  3) Remove ventilation duct.
  4) Using an oil filter wrench, remove accumulator and O-ring.



Legend

1. Accumulator
2. Stud bolt
3. Cover boss
4. Lock nut
5. Clevis
6. Operating rod
7. Guard
8. Flange

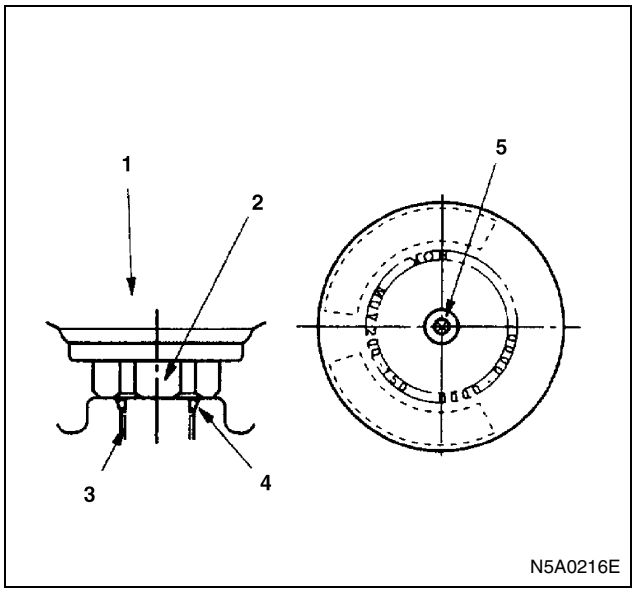
Installation

1. Verify that there is no foreign matter adhering to the screw part of the accumulator or to the attachment part on the booster side.
2. Put an O-ring coated with new hydraulic oil (ATF DEXRON®-III) into the screw part of the accumulator, being careful not to damage it.
   Always use a new O-ring.
3. Using an oil filter wrench, hold the accumulator shell fixed, and tighten it via the wrench to the specified torque.

Tighten:
Accumulator to 29 N·m (3.0 kg·m / 22 lb·ft)

4. Install ventilation duct.
5. Connect harness connector and install meter assembly.
6. Install meter cluster.
7. Connect the battery ground cable.
8. After attaching it to the vehicle, always replenish with new hydraulic oil (ATF DEXRON®-III), and completely release the air from the hydro boost.
9. Release the parking brake and remove the wheel blocks.

Notice:
How to dispose of the accumulator
To dispose of the accumulator, drill a hole in the position shown in the diagram according to the indications printed on the accumulator, completely release the nitrogen gas scaled inside the accumulator, then dispose of the accumulator.
Concerning disposal with the hydro boost assembly as well, dispose of it after first letting out all the nitrogen gas inside the accumulator, by the above method.



Legend

1. Accumulator
2. HEX25
3. Thread
4. O-ring
5. Drilling point for gas releasing

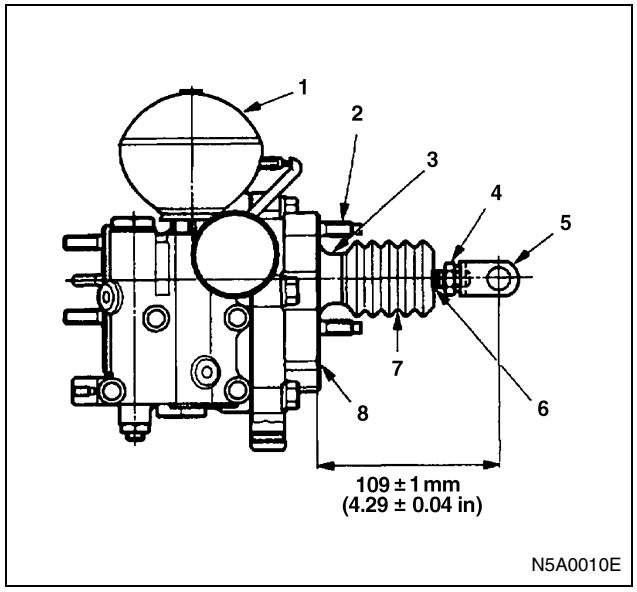
Clevis and Lock Nut Replacement

Removal

1. Remove hydraulic booster assembly.
   Refer to “Removal” of Hydraulic Booster in this section.
2. Secure the hydro boost assembly to the jig using the four stud bolts on the surface of the flange for attachment to the vehicle.
3. Being careful not to exert any off-center load on the operating rod, loosen the lock nut and remove the clevis and lock nut.

Installation

1. Screw the lock nut and then the clevis onto the operating rod.



Legend

1. Accumulator
2. Stud bolt
3. Cover boss
4. Lock nut
5. Clevis
6. Operating rod
7. Guard
8. Flange

2. Adjust so that the booster clevis position dimension (the distance to the center of the clevis hole from the surface of the flange for attachment to the vehicle) is 109 ± 1 mm (4.29 ± 0.04 in), and tighten the lock nut with the prescribed torque.
   When tightening the lock nut, be careful not to deform the clevis.

Tighten:
Lock nut to 20 N·m (2.0 kg·m / 14 lb·ft)

3. Attach the hydro boost assembly to the vehicle. Refer to “Installation” of Hydraulic Booster in this section.

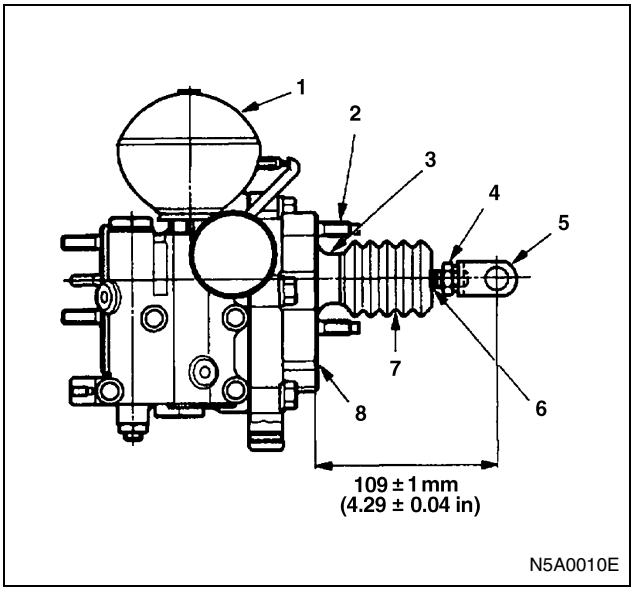
Guard Replacement

Removal

1. Remove hydraulic booster assembly.
   Refer to “Removal” of Hydraulic Booster in this section.
2. Secure the hydro boost assembly to the jig using the four stud bolts on the surface of the flange for attachment to the vehicle.
3. Being careful not to exert any off-center load on the operating rod, loosen the lock nut and remove the clevis and lock nut.
4. Remove the guard from the cover boss anchoring groove and from the operating rod anchoring groove, and pull it out.

Installation

1. With a dry cloth, clean well the cover boss anchoring groove and the operating rod anchoring groove, and verify that no foreign matter is present.
2. Insert from the large diameter hole side of the guard end-face into the operating rod outside diameter part, assemble the small diameter hole part of the guard end-face into the anchoring groove of the operating rod, then assemble the large diameter hole part securely into the anchoring groove of the boss of the cover.
3. Screw the lock nut and then the clevis onto the operating rod.



Legend

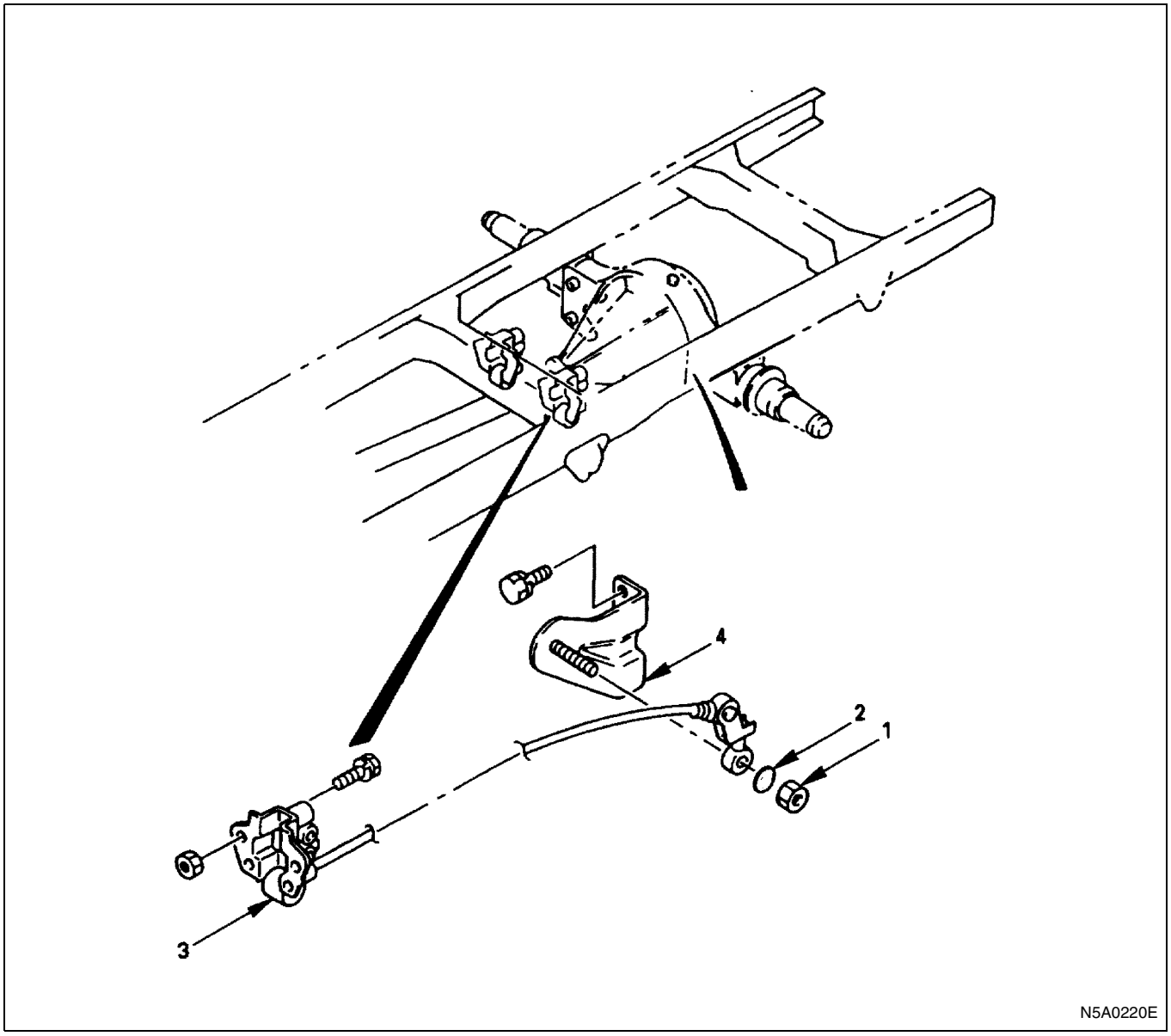
1. Accumulator
2. Stud bolt
3. Cover boss
4. Lock nut
5. Clevis
6. Operating rod
7. Guard
8. Flange

4. Adjust so that the booster clevis position dimension (the distance to the center of the clevis hole from the surface of the flange for attachment to the vehicle) is 109±1 mm (4.29 ± 0.04 in), and tighten the lock nut with the prescribed torque. When tightening the lock nut, be careful not to deform the clevis.

Tighten:
Lock nut to 20 N·m (2.0 kg·m / 14 lb·ft)

5. Attach the hydro boost assembly to the vehicle. Refer to “Installation” of Hydraulic Booster in this section.

Load Sensing Proportioning Valve



Legend

1. Nut
2. Washer
3. Load sensing proportioning valve
4. Bracket

Removal

1. Nut
2. Washer
3. Load sensing Proportioning Valve
4. Bracket

Installation

To install, follow the removal steps in the reverse order.

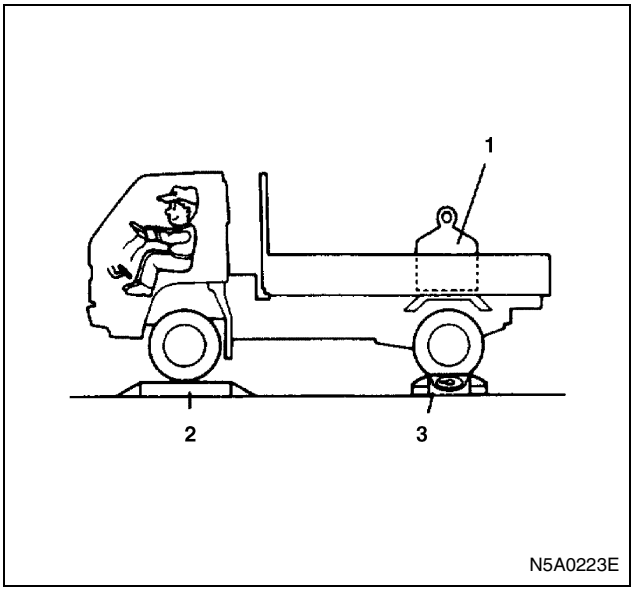
Adjustment

1. Fluid Pressure Measurement
   1) Rear axle weight adjustment

With an axle weight meter, adjust the rear axle weight with a person sitting in the driver's seat and a weight loaded in the rear body.

	N (kg/lb)
Adjustment value	(A)

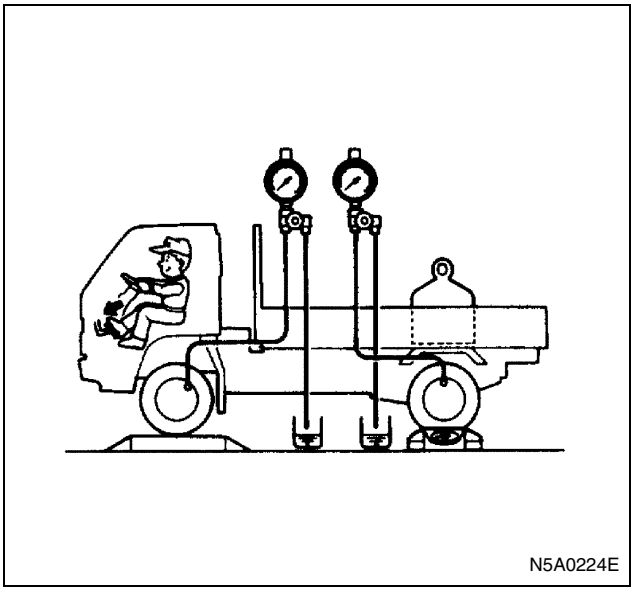
For (A), refer to the adjustment standard table.



Legend
1. Weight
2. Platform (which is the same height as the axle weight meter)
3. Axle weight meter

2) Installation of a fluid pressure gauge
Remove the air bleeder of the left hand wheel front and rear brakes. Bleed air out of the fluid pressure gauge with the measurement hose of the fluid pressure gauge installed.

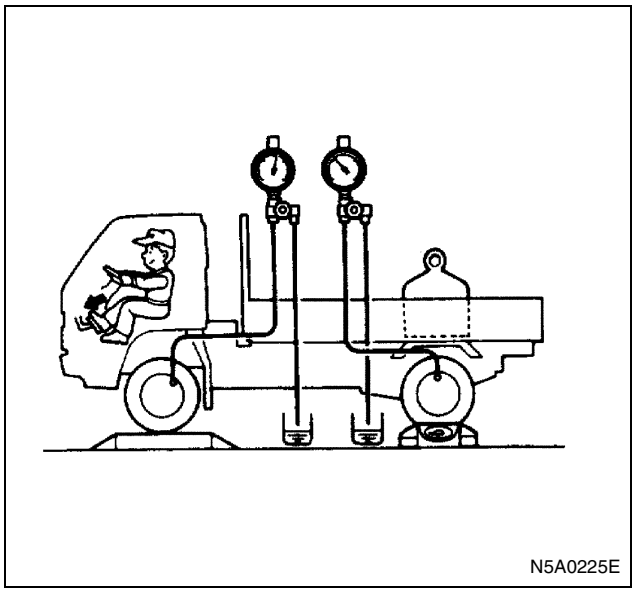
Pressure Tester: Brake oil (Fluid pressure gauge) 5-8840-2190-0



3) Rear wheel cylinder fluid pressure measurement
Step on the brake pedal until the fluid pressure of the front wheel cylinder gets to 7845 kPa (80 kg/cm^2 / 1138 psi), and check the rear wheel cylinder fluid pressure. (Read the value of the front wheel cylinder fluid pressure 2 seconds after the measurement. When measuring the L.S.V fluid pressure, keep the brake pedal pressed down without stepping it down twice or releasing it.)

Rear Wheel Cylinder Fluid Pressure	kPa (kg/cm^2/ psi)
Standard	(B)

For (B), refer to the adjustment standard table.

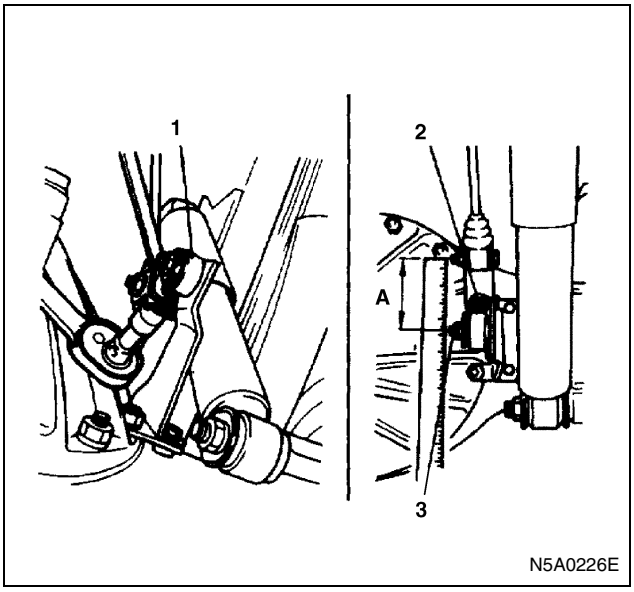


2. Oil Pressure Adjustment
1) L.S.V spring shackle adjustment
Loosen the adjust nut of the L.S.V spring shackle, and adjust the length of the L.S.V spring shackle.
When the oil pressure is insufficient, turn the adjust nut clockwise to extend the span “A”. When the oil pressure is too high, turn the adjust nut counterclockwise to reduce the span “A”.

	mm (in)
Item	Span adjusted
Standard of span “A”	78 (3.07)
Range adjustable	72 — 84 (2.83 — 3.31)

After adjustment, tighten the lock nut securely and install the cotter pin.

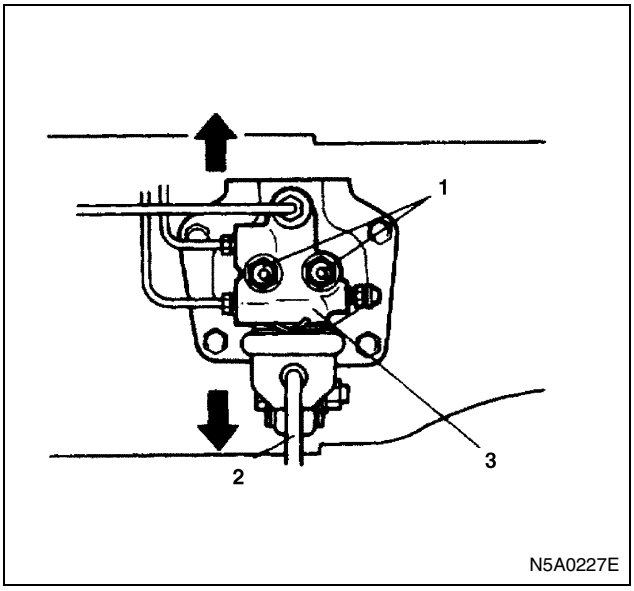
Tighten:
Lock nut to Max. 10 N·m (1.0 kg·m / 87 lb·in)



Legend
1. L.S.V spring shackle
2. Adjust nut
3. Lock nut

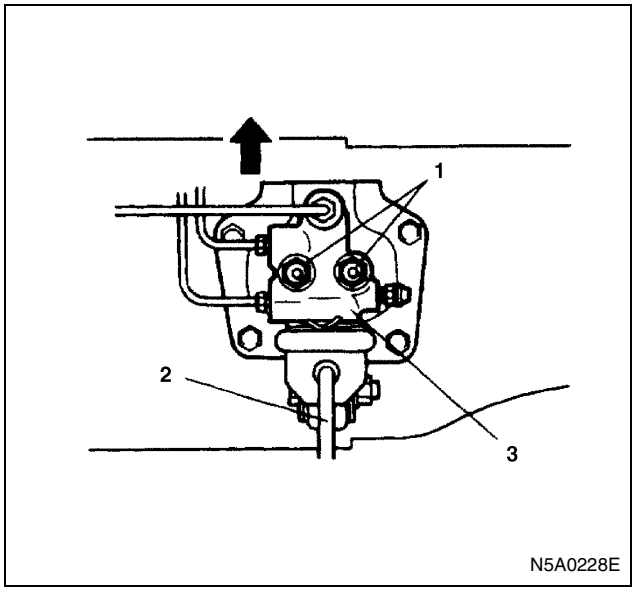
2) L.S.V adjustment
When the adjustment cannot be done with the L.S.V spring shackle, loosen the L.S.V adjust nut (2 pcs.) and adjust the oil pressure to the standard value by sliding the L.S.V up and down. After the L.S.V adjustment, readjust the length of the L.S.V spring shackle.

Tighten:
L.S.V adjust nut to 13 N·m (1.3 kg·m / 113 lb·in)



Legend
1. L.S.V adjust nut
2. L.S.V spring
3. L.S.V

3. Unit Inspection of L.S.V
1) Loosen the L.S.V adjust nut (2 pcs.). And then lift the L.S.V up fully and tighten it up tentatively so that the L.S.V spring will not move.

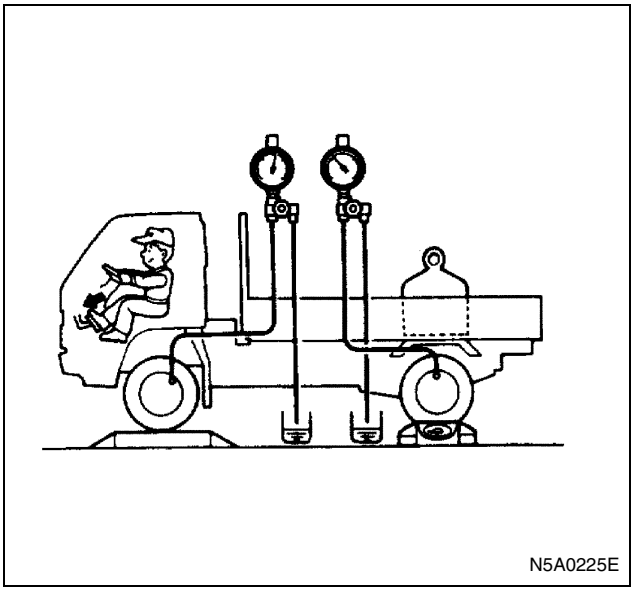


Legend
1. L.S.V adjust nut
2. L.S.V spring
3. L.S.V

2) Under the same conditions as 1) above, check the rear wheel cylinder fluid pressure.

Standard	
Master cylinder fluid pressure kPa (kg/cm^2/psi)	Rear fluid pressure kPa (kg/cm^2/psi)
2942 (30 / 427)	(C)
7845 (80 / 1138)	(D)

For (C) and (D), refer to the adjustment standard table.



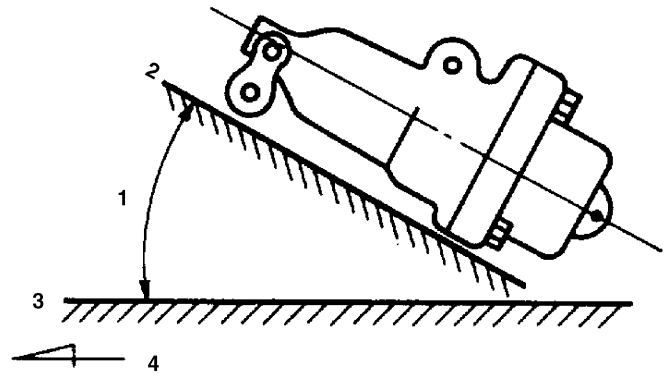
Adjustment Standard Table

Models	(A) N (kg/lb)	(B) kPa (kg/cm^2/psi)	(C) kPa (kg/cm^2/ psi)	(D) kPa (kg/cm^2/ psi)
NHR55-1C	5884(600/1323)	3687±588 (37.6±6/535±85)	1442±196 (14.7±2/209±28)	1932±343 (19.7±3.5/280±50)
NHR55-3C	8826(900/1984)			
NKR77-1D	12258(1250/2756)			
NKR77-5D	11768(1200/2646)			
NKR77-3E	6865(700/1543)			
NKR77-5E	8826(900/1984)			
NKR77-5H	8826(900/1984)			
NKR55-1E	6865(700/1543)			
NKR55-3E	6865(700/1543)			
NKR55-5H	9807(1000/2205)	5031±588 (51.3±6/730±85)	1697±196 (17.3±2/246±28)	2922±343 (29.8±3.5/424±50)
NKR77-3EXY (Taiwan)	6865(700/1543)	3687±588 (37.6±6/535±85)	1442±196 (14.7±2/209±28)	1932±343 (19.7±3.5/280±50)
NKR77-3EXA (Taiwan)	7845(800/1764)			
NKR77-5E (Taiwan)	9807(1000/2205)			
NKR77-5H (Taiwan)	9807(1000/2205)	5031±588 (51.3±6/730±85)	1697±196 (17.3±2/246±28)	2922±343 (29.8±3.5/424±50)
NPR77-5D/5CW	11768(1200/2646)	3687±588 (37.6±6/535±85)	1442±196 (14.7±2/209±28)	1932±343 (19.7±3.5/280±50)

Models	(A) N (kg/lb)	(B) kPa (kg/cm^2/psi)	(C) kPa (kg/cm^2/psi)	(D) kPa (kg/cm^2/psi)
NPR75-5E	8826(900/1984)	5031±588 (51.3±6/730±85)	1697±196 (17.3±2/246±28)	2922±343 (29.8±3.5/424±50)
NPR77-5H	8826(900/1984)			
NPR70/75-5J/5HW	14710(1500/3307)			
NPR75-5J/5HW	14710(1500/3307)			
NPR70/75-5L/5KW	16671(1700/3748)			
NQR75-5L/5KW	14710(1500/3307)			
NQR75-5N (Australia)	12749(1300/2866)			
NPR66-5J	8826(900/1984)			
NPR66-5E	15691(1600/3527)			
NPR66-5L (South Africa)	12749(1300/2866)			
NPR66-5L (GCC)	13729(1400/3086)			
NPR71 / NQR70-5L	13729(1400/3086)			
NQR71-5N	13729(1400/3086)			
NQR75-5N (South Africa)	14710(1500/3307)			
NPS71/75-5J	17652(1800/3968)			

Deceleration Sensing Proportioning Valve

DSPV Mounting Angle



N5A0230E

Legend

1. Mounting angle
2. Mounting surface
3. Ground surface
4. Front

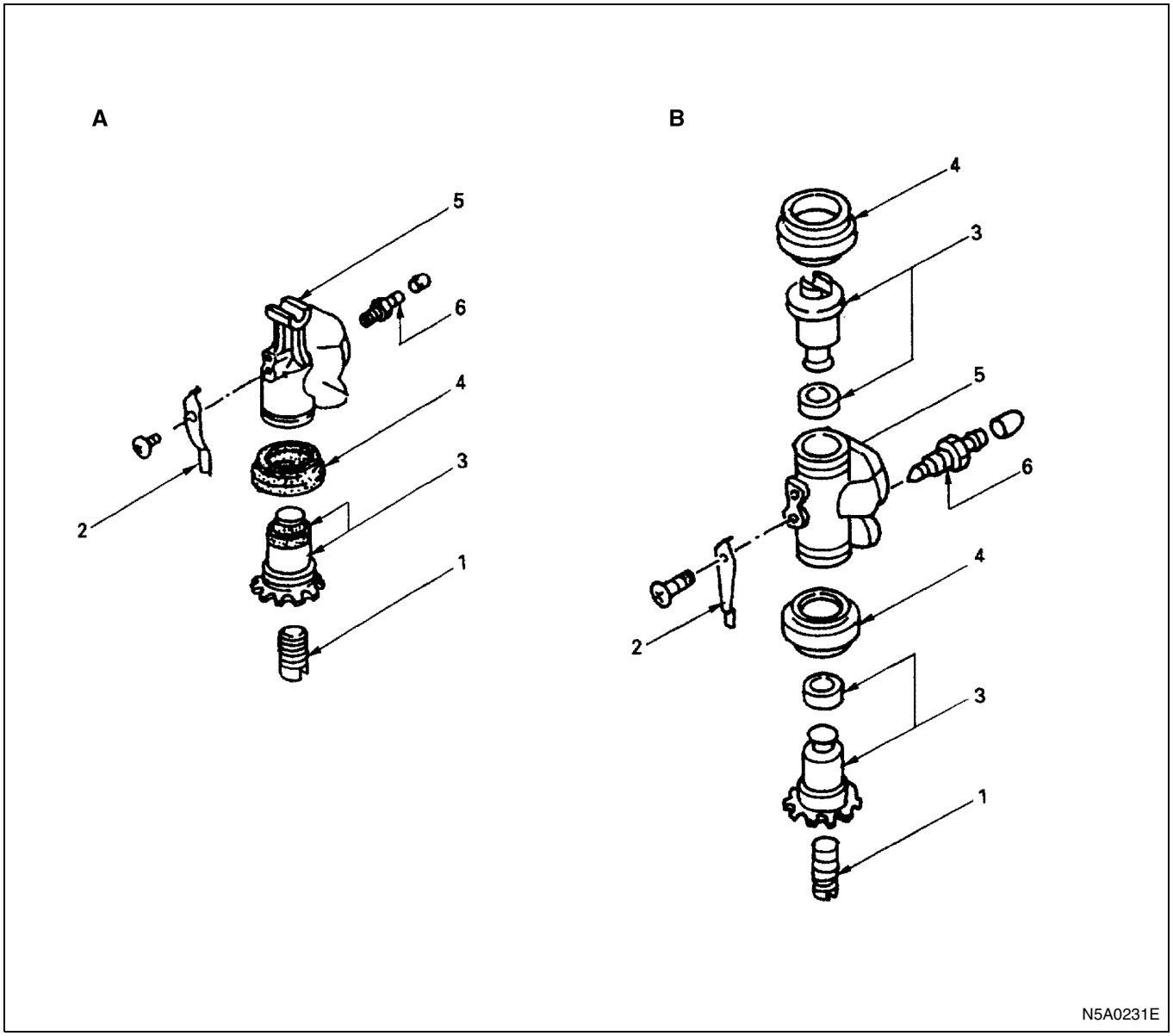
Models	Mounting Angle
NHR	12°00′±45′
NKR	12°30′±45′

Conduct the following inspections, and if any abnormality is found, replace.

Condition	Procedure	Judgement
As installed in the vehicle	Measure braking force to make sure of normality.	If no braking force, adherence of ball (deceleration sensing) to seal is suspected.
	Bleed air also from the DSPV side of breather.	If no brake fluid does not come out, the same trouble as above is suspected.
	Check fluid leakage.	No problem, if there is no leak.
	Check mounting angle. (Refer to the table.)	If installed at an abnormal angle, though rare, specified braking force is unobtainable or DSPV does not work.
As not installed in the vehicle	Incline DSPV back and forth to see if the ball moves insides.	No problem, if a ball sound is heard from within.

UNIT REPAIR

Wheel Cylinder Assembly (without Auto-adjuster)

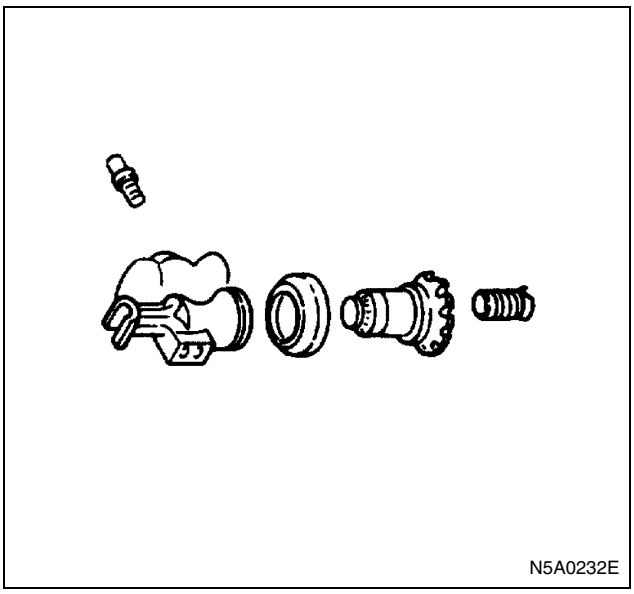


Legend

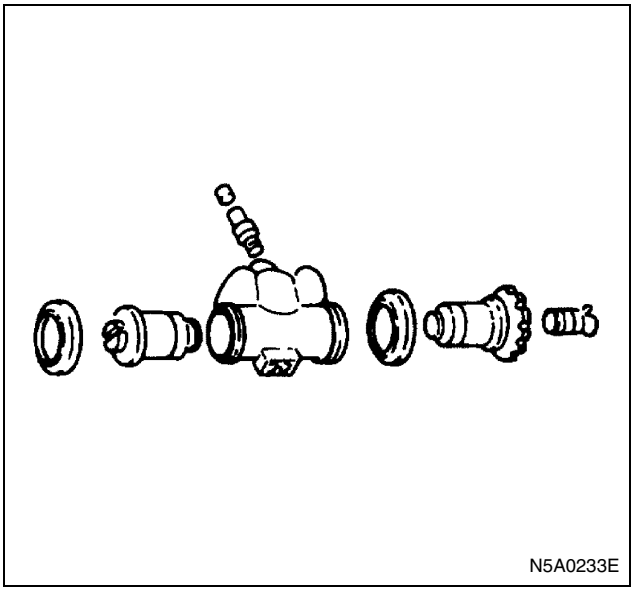
A. 2L type
B. D2L type
1. Adjusting screw
2. Lock plate
3. Piston and cup assembly
4. Boot
5. Wheel cylinder body
6. Bleeder screw

Disassembly

2L Type



D2L Type



1. Adjusting Screw
2. Lock Plate
3. Piston and cup Assembly
4. Boot
5. Wheel Cylinder Body
6. Bleeder Screw

Store all of the removed parts in a clean part tray.

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

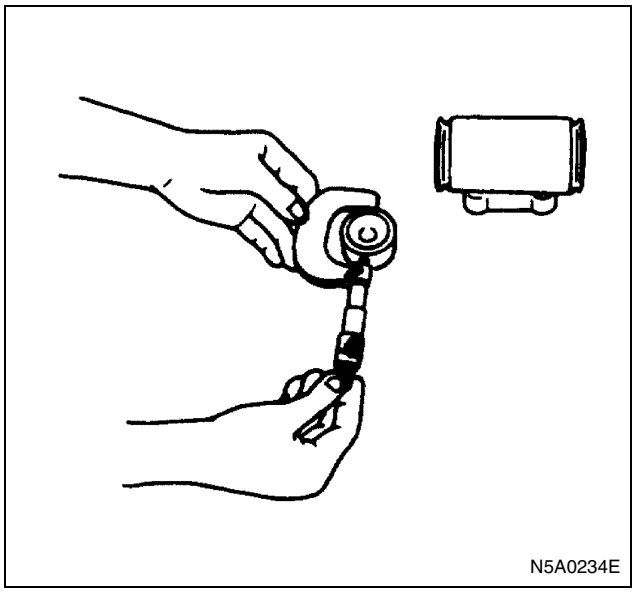
Wheel Cylinder Assembly

Wheel Cylinder and Piston Clearance

1. Use a micrometer to measure the piston diameter.
2. Use an inside dial indicator to measure the cylinder bore.
3. Calculate the clearance between the wheel cylinder and the piston.
   If the clearance exceeds the specified limit, the piston and/or wheel cylinder body must be replaced.

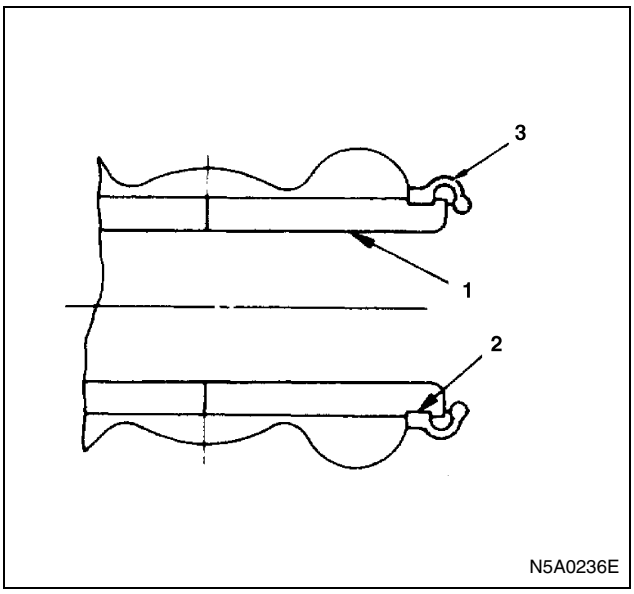
Wheel Cylinder and Piston Clearance mm (in)	
Wheel Cylinder size	Limit
22.22 (0.875) 25.40 (1.000) 28.57 (1.125) 30.16 (1.188) 33.33 (1.312) 34.93 (1.375)	0.15 (0.006)

When the wheel cylinder disassembled, the repair kit (piston cup and boot) must be replaced.



Reassembly

1. Bleeder Screw
2. Wheel Cylinder Body
   1) Apply a coat of rubber grease to the cylinder body bore (1) and the grooves for the boots (2).
   2) Fit the boot edge securely into the mating groove of the cylinder body.



Legend
1. Cylinder body bore
2. Groove
3. Boot

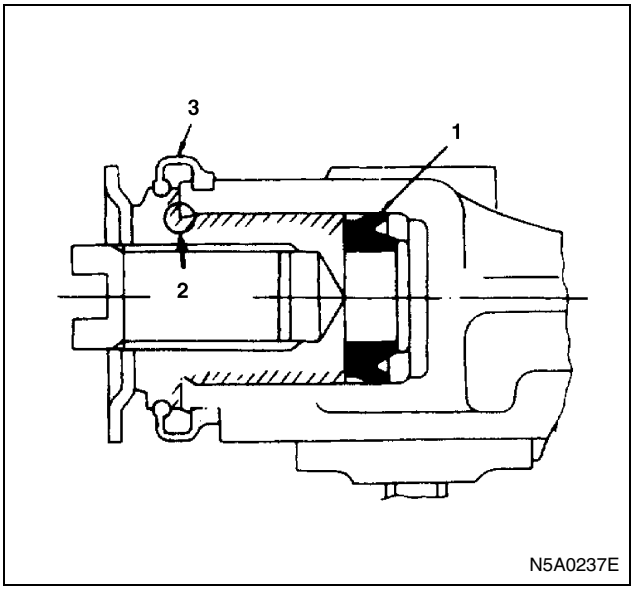
3. Boot
4. Piston Assembly
   1) Apply a coat of rubber grease to the piston cups and the pistons.
      Be sure to lubricate the entire cylinder body bore with the rubber grease.
   2) Install the piston assembly to the cylinder.

Notice:
After installation of the piston assembly into the cylinder body bore, fit the boot edge securely into the mating groove of the piston.

Make sure that the two boot edges firmly sealed into the grooves.

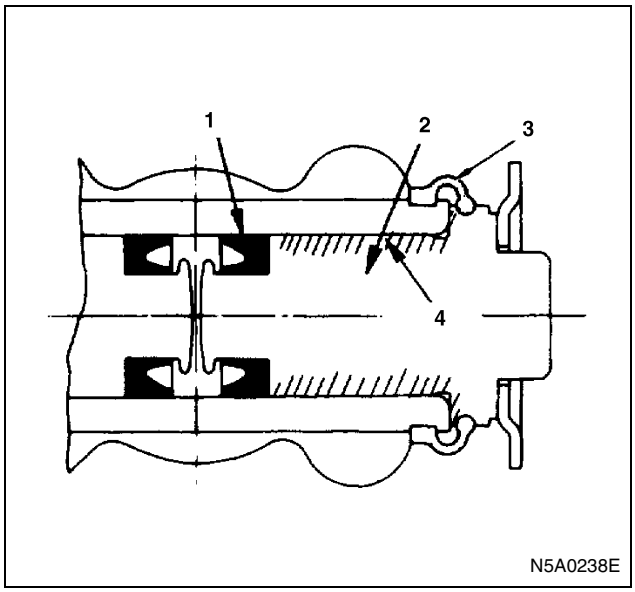
Be careful not to damage the piston cups and the boots.

2L Type



Legend
1. Piston cup
2. Edge
3. Boot

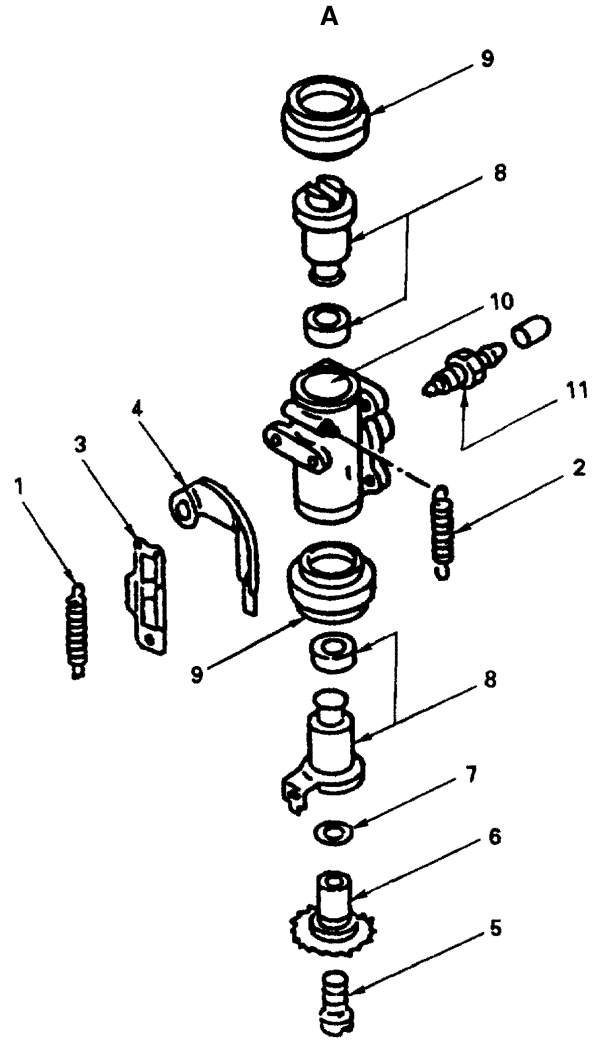
D2L Type



Legend
1. Piston cup
2. Piston
3. Boot
4. Grease

1. Lock Plate
2. Adjusting Screw
   Apply a coat of molybdenum disulfide grease to the adjusting screw slit and threads.

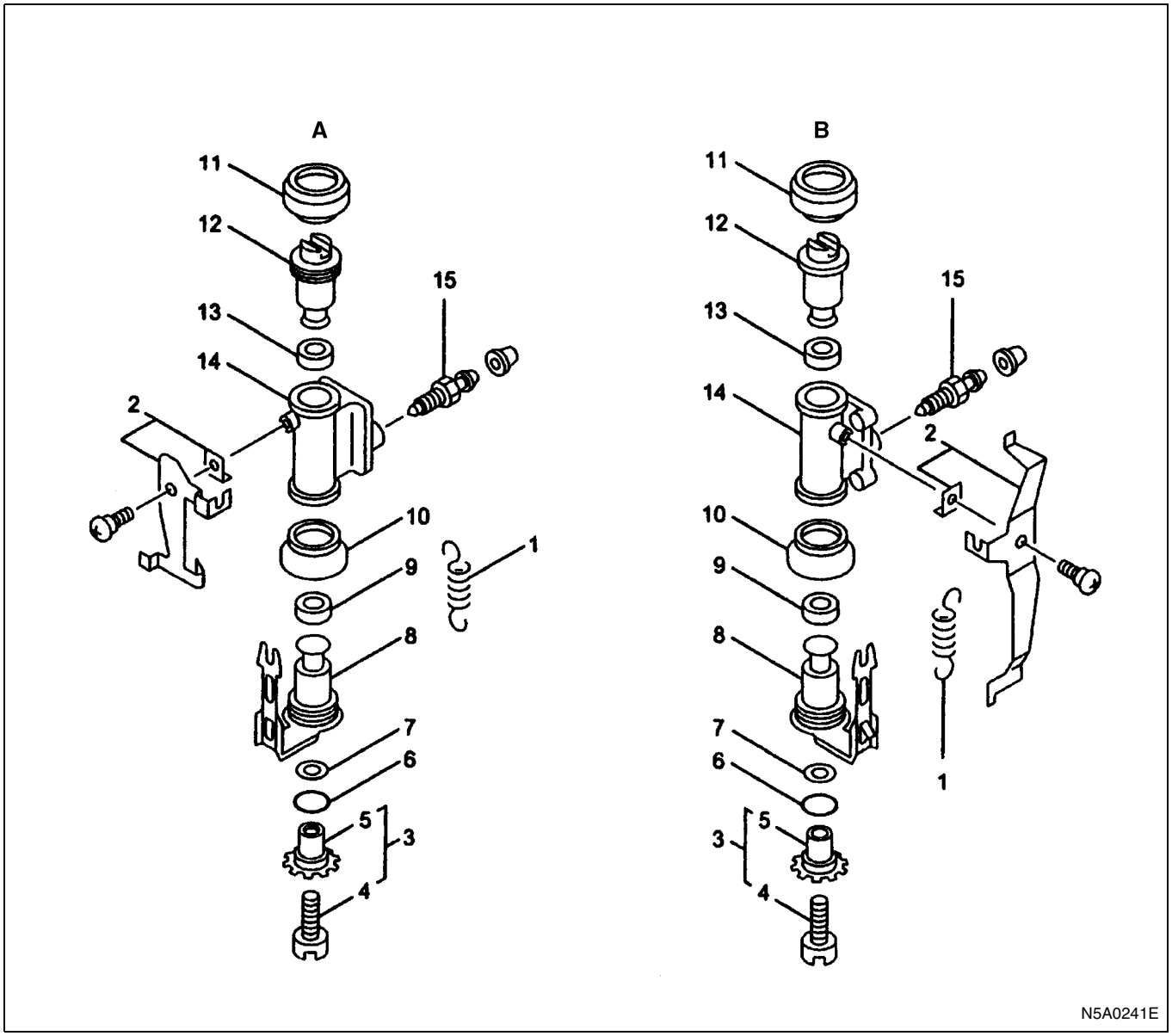
Wheel Cylinder Assembly (with Auto-adjuster)



N5A0240E

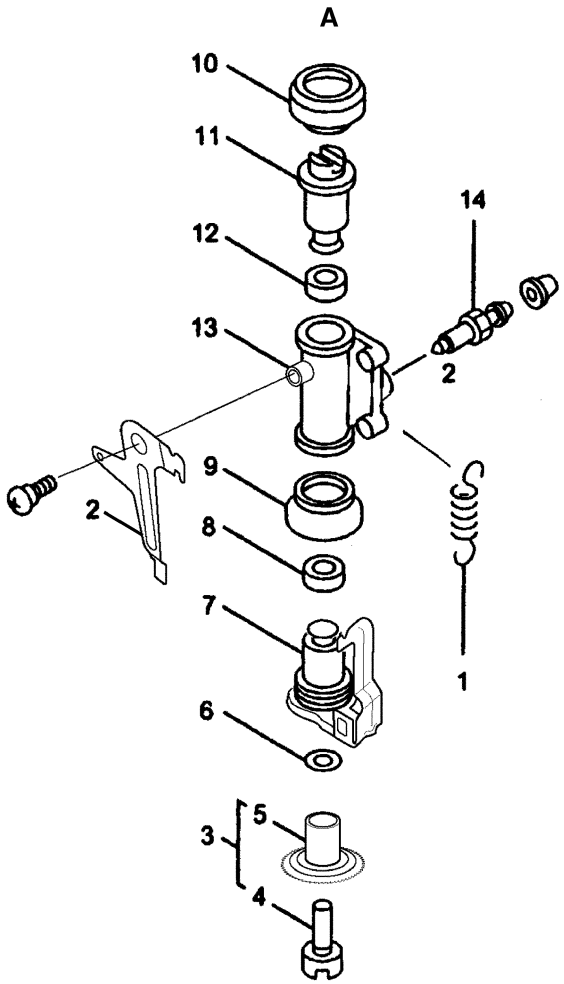
Legend

A. Drum inside diameter 260 mm
1. Overtravel spring
2. Return spring
3. Fitting
4. Adjuster lever
5. Adjusting screw
6. Adjuster gear and nut assembly
7. Washer
8. Piston and cup assembly
9. Boot
10. Wheel cylinder body
11. Bleeder screw



Legend

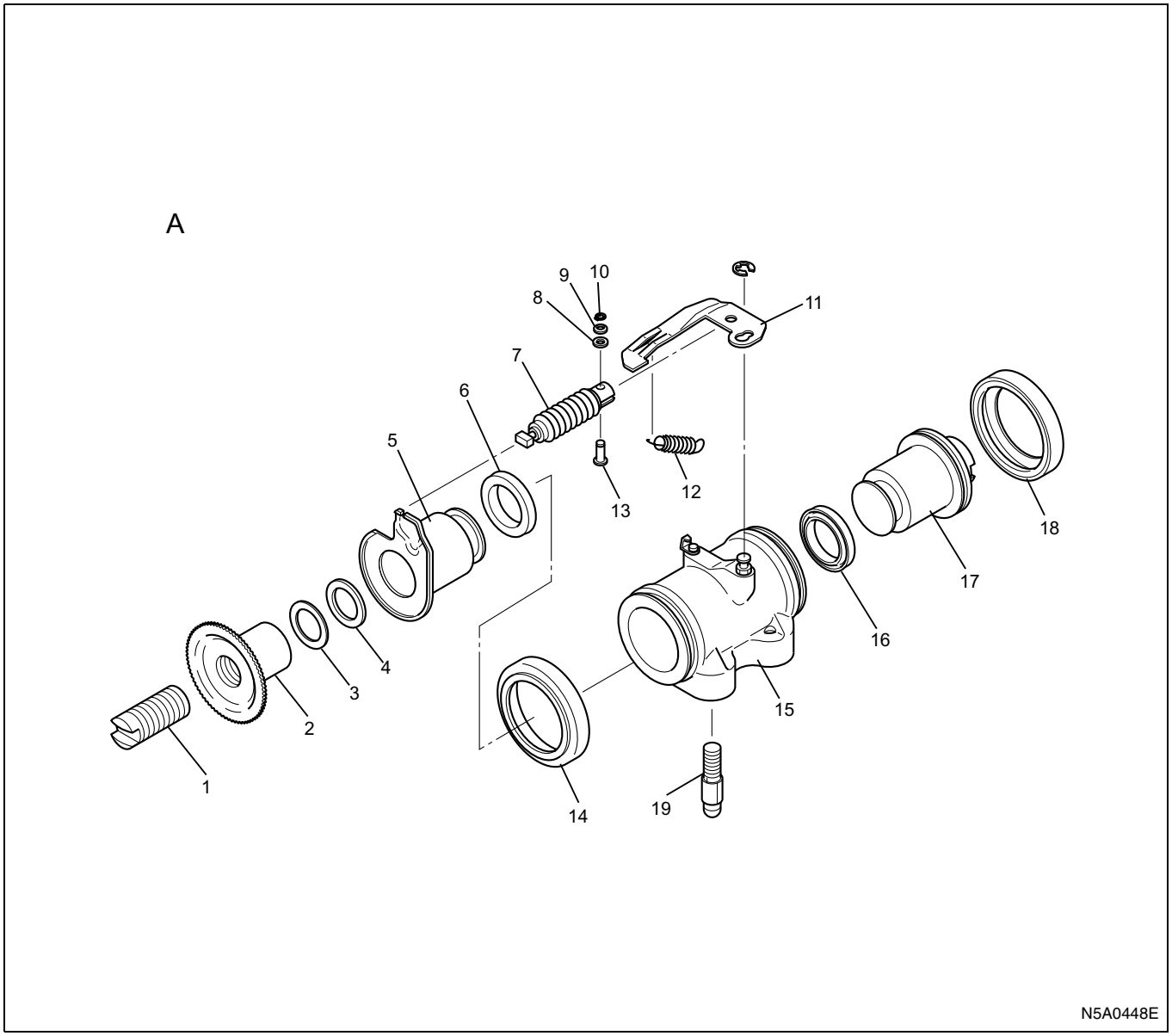
A. Drum inside diameter 240 mm
B. Drum inside diameter 290 mm
1. Overtravel spring
2. Adjuster lever
3. Adjusting screw and gear
4. Adjusting screw
5. Adjuster gear and nut assembly
6. Seal
7. Seat (washer)
8. Piston and bracket assembly
9. Piston cup
10. Boot
11. Boot
12. Anchor piston
13. Piston cup
14. Cylinder body
15. Bleeder



N5A0242E

Legend

A. Drum inside diameter 300 mm, 320 mm
1. Overtravel spring
2. Adjuster lever
3. Adjusting screw and gear
4. Adjusting screw
5. Adjuster gear and nut assembly
6. Seat (Washer)
7. Piston
8. Piston cup
9. Boot
10. Boot
11. Anchor piston
12. Piston cup
13. Cylinder body
14. Bleeder

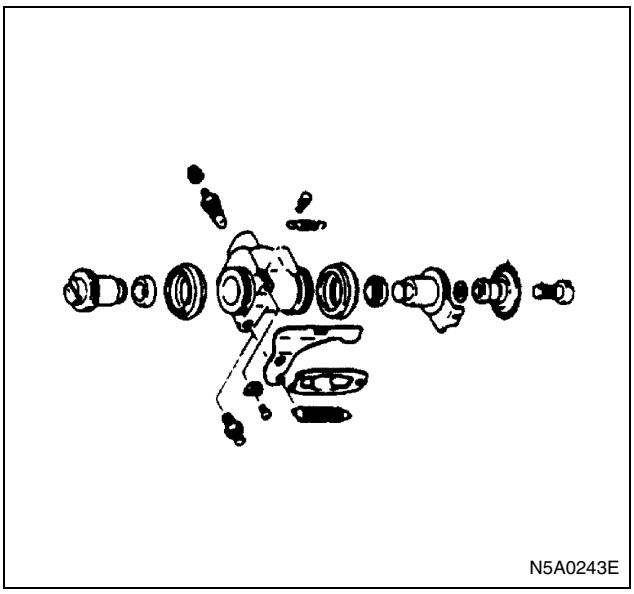


Legend

A. Drum inside diameter 370 mm
1. Adjusting screw
2. Adjuster gear and nut assembly
3. Washer (SUS)
4. Washer (OIL LESS)
5. Piston
6. Piston cup
7. Spring assembly
8. Washer
9. Wave washer
10. Snap ring
11. Lever
12. Return spring
13. Pin
14. Boot
15. Cylinder assembly
16. Piston cup
17. Piston
18. Boot
19. Bleeder

Disassembly

Drum inside diameter 260 mm



1. Overtravel Spring
2. Return Spring
3. Fitting
4. Adjuster Lever
5. Adjusting Screw
6. Adjuster Gear
7. Piston and cup Assembly
8. Boot
9. Wheel Cylinder Body
10. Bleeder Screw

Store all of the removed parts in a clean part tray.

Drum inside diameter 240, 290 mm

Inspect the wheel cylinder.
Remove the parts of the brakes with a drum inside diameter of 240 mm and 290 mm in the order shown below.

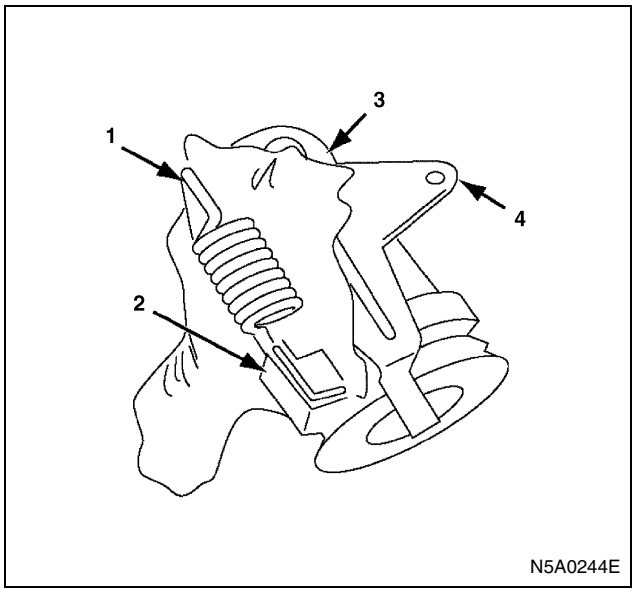
1. Overtravel spring
2. Auto-adjuster lever
3. Adjusting screw and gear assembly
4. Adjusting screw
5. Adjuster gear
6. Seal
7. Seat (washer)
8. Piston
9. Piston cup
10. Boot
11. Boot
12. Piston
13. Piston cup
14. Cylinder
15. Bleeder

Drum inside diameter 300, 320 mm

1. Auto-adjuster
2. Boot
3. Piston
4. Adjusting screw
5. Adjuster gear
6. Washer
7. Piston cup
8. Piston
9. Bleeder screw and cap
10. Cylinder body

Disassembly of piston on adjust side (Drum inside diameter 300, 320 mm)

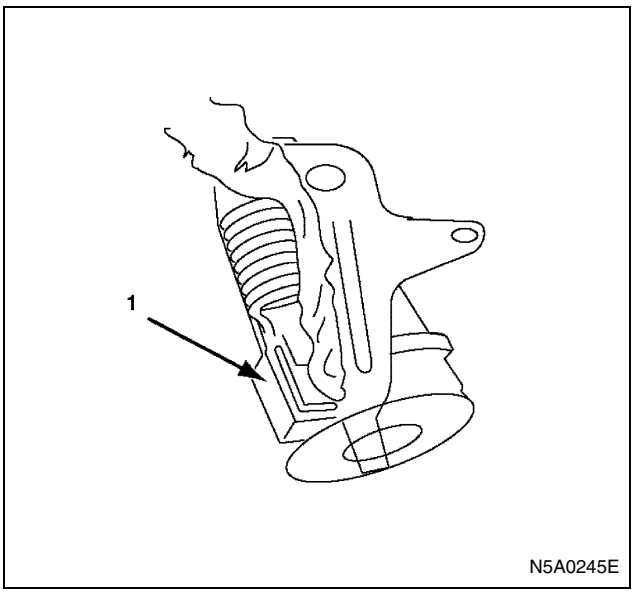
1. Fit the waste cloth between the lever and spring not to damage each parts.



Legend

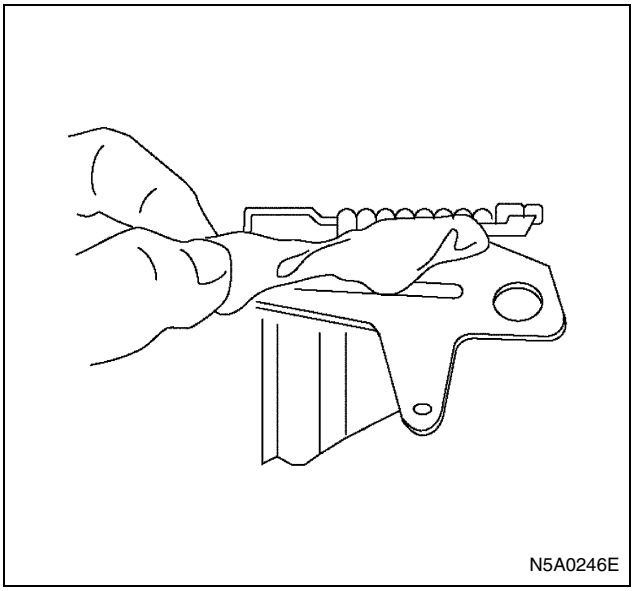
1. Spring
2. Bracket
3. Lever fixing bolt
4. Lever

2. Disassemble the lever fixing bolt.
3. Remove the piston assembly to hold the lever to fit the bracket.



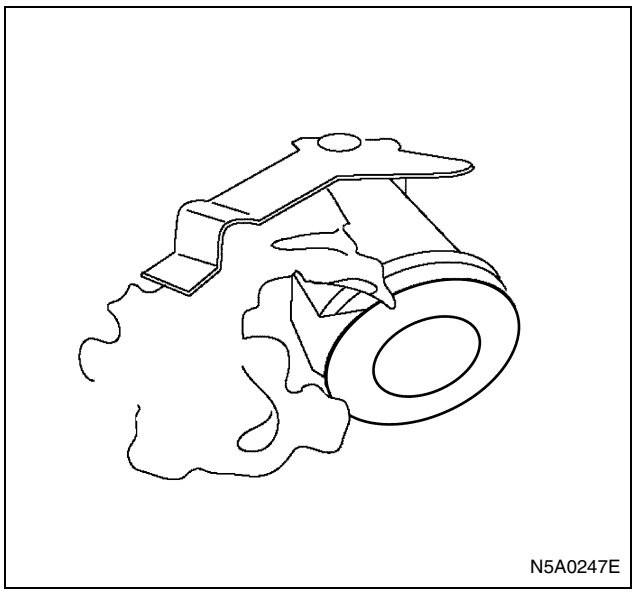
Legend

1. Attach the lever to the bracket

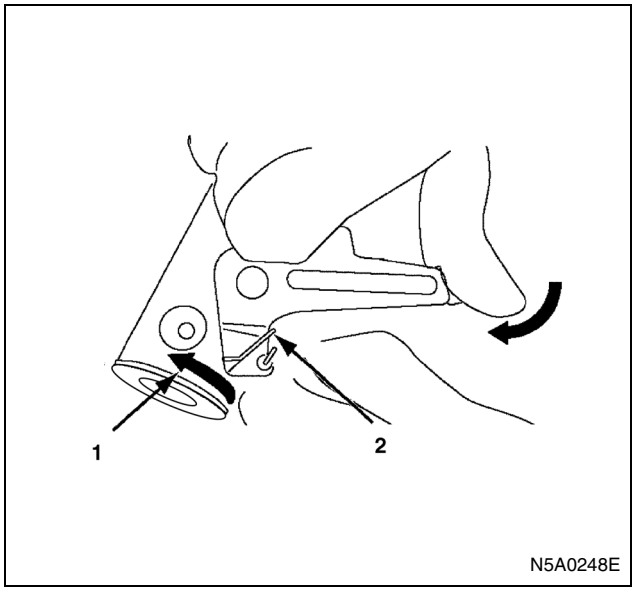


Disassembly of lever spring

1. Fit the waste cloth between the lever and spring not to damage each parts.



2. After running the lever up on the bracket, turn the lever to the direction at the connecting point of lever and spring.



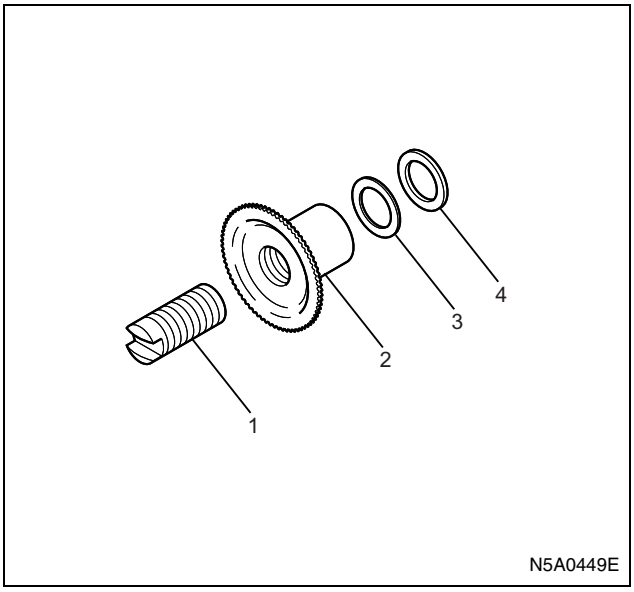
Legend

1. Reassemble the lever from the direction
2. Connecting point of lever and spring

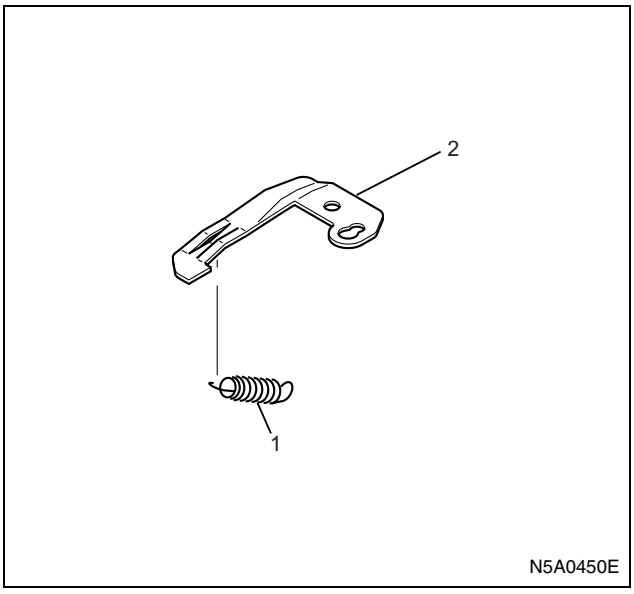
3. Disassemble the lever from the bracket.

Drum inside diameter 370 mm

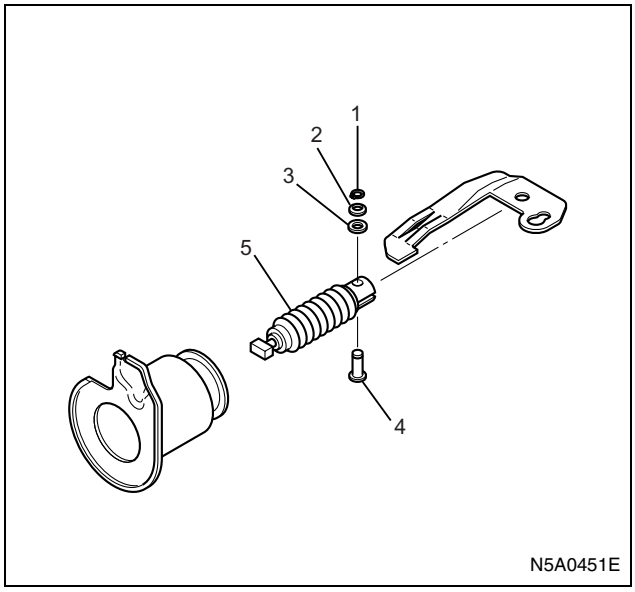
1. Remove the adjusting screw (1).
2. Remove the adjuster gear and nut assembly (2).
3. Remove the washer (SUS) (3).
4. Remove the washer (OIL LESS) (4).



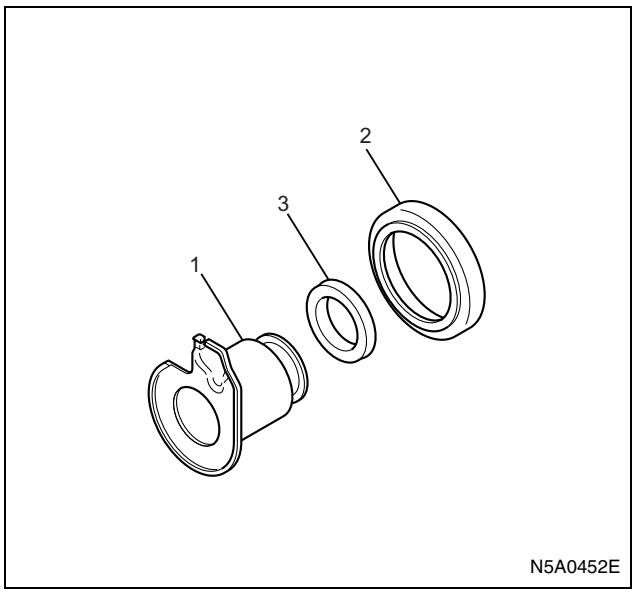
5. Remove the return spring (1).
   Remove the spring from lever side and cylinder side.
6. Remove the lever (2).



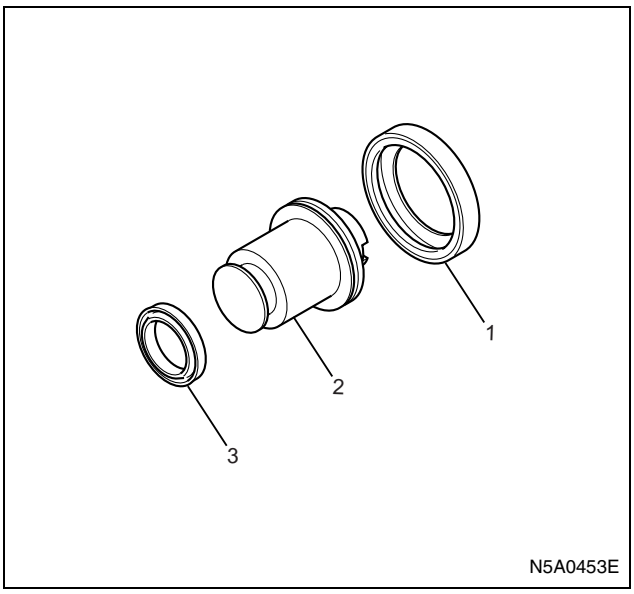
7. Remove the snap ring (1).
8. Remove the wave washer (2).
9. Remove the washer (3).
10. Remove the pin (4).
11. Remove the spring assembly (5).
    Pull out the pin from lever and separate the spring.
    For piston side, remove it from flange groove of piston.



12. Remove the piston (1).
    Remove the boot from cylinder and pull out the piston.
13. Remove the boot (2).
14. Remove the piston cup (3).
15. Remove the cylinder assembly.



16. Remove the boot (1).
17. Remove the piston (2).
18. Remove the piston cup (3).



19. Remove the bleeder.

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

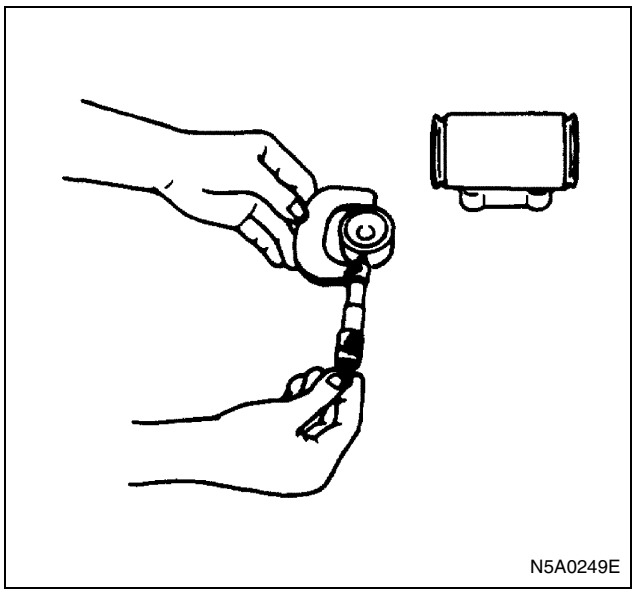
Wheel cylinder assembly

Wheel Cylinder and Piston Clearance

1. Use a micrometer to measure the piston diameter.
2. Use an inside dial indicator to measure the cylinder bore.
3. Calculate the clearance between the wheel cylinder and the piston.
   If the clearance exceeds the specified limit, the piston and/or wheel cylinder body must be replaced.

Wheel Cylinder and Piston Clearance mm (in)	
Wheel Cylinder size	Limit
28.6 (1.125) 30.2 (1.188) 25.4 (1.000) 33.3 (1.313)	0.15 (0.006)

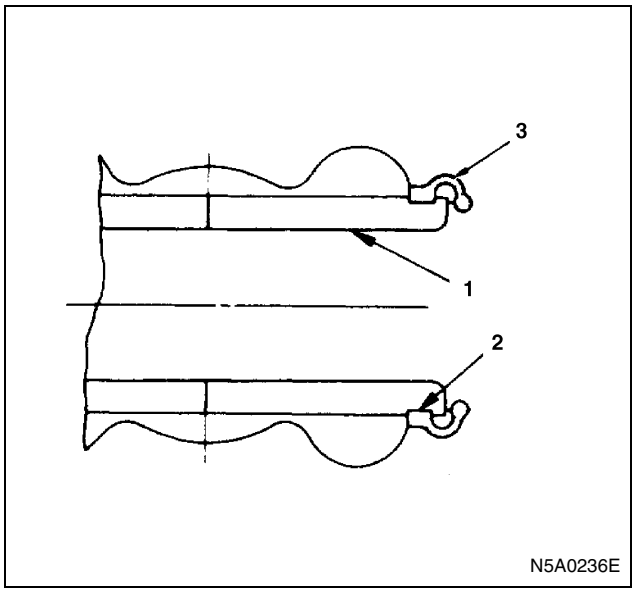
When the wheel cylinder disassembled, the repair kit (piston cup and boot) must be replaced.



Reassembly

Drum Inside Diameter 260 mm

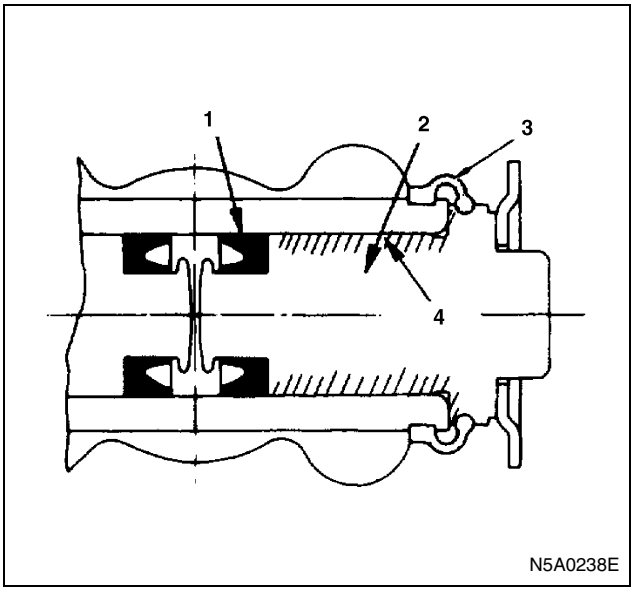
1. Bleeder Screw
2. Wheel Cylinder Body
   1) Apply a coat of rubber grease to the cylinder body bore (1) and the grooves for the boots (2).



Legend

1. Cylinder body bore
2. Groove
3. Boot

   2) Fit the boot edge securely into the mating groove of the cylinder body.
3. Boot
4. Piston Assembly



Legend

1. Piston cup
2. Piston
3. Boot
4. Grease

1) Apply a coat of rubber grease to the piston cups and the pistons.
   Be sure to lubricate the entire cylinder body bore with the rubber grease.
2) Install the piston assembly to the cylinder.

Notice:

After installation of the piston assembly into the cylinder body bore, fit the boot edge securely into the mating groove of the piston.

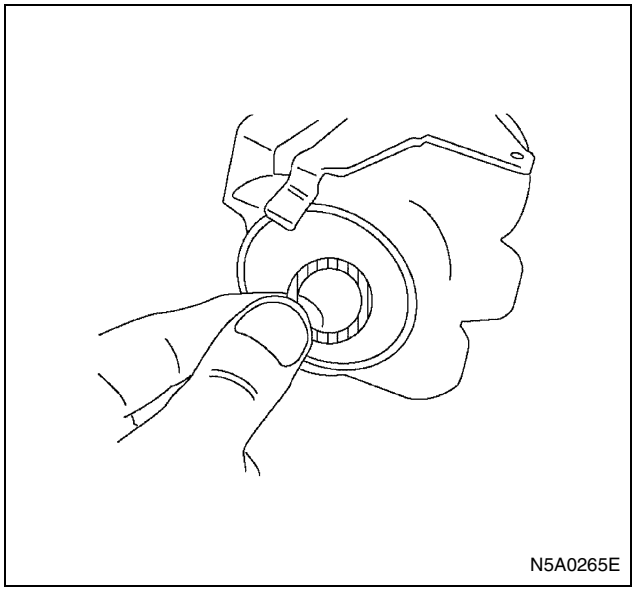
Make sure that the two boot edges firmly sealed into the grooves.

Be careful not to damage the piston cups and the boots.

5. Adjuster Gear
6. Adjusting Screw
   Apply a coat of molybdenum disulfide grease to the adjusting screw slit and threads.

Plain washer

Make sure to assemble the plain washer of coating side to the adjust side.

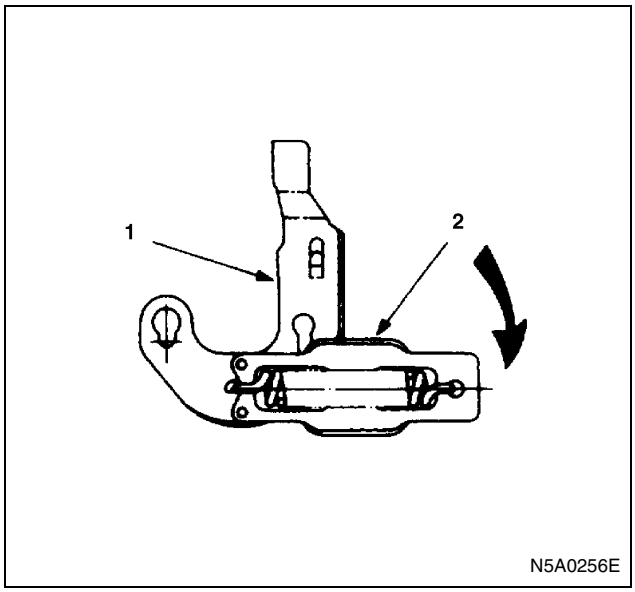


Assemble the plain washer with the copper-colored surface facing inward and the coating (black) surface facing outward.

Notice:

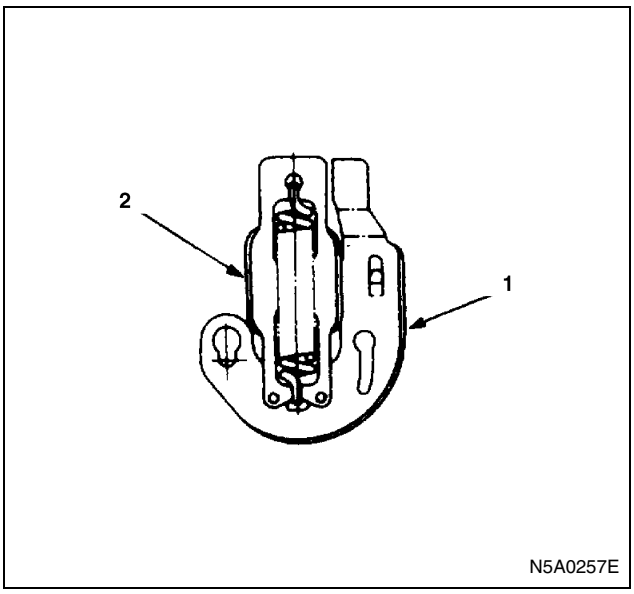
Failure to assemble the plain washer or assembling it inside out causes auto adjuster not to operate properly. Be sure to assemble it correctly.

7. Adjuster Lever
8. Fitting
9. Overtravel Spring



Legend

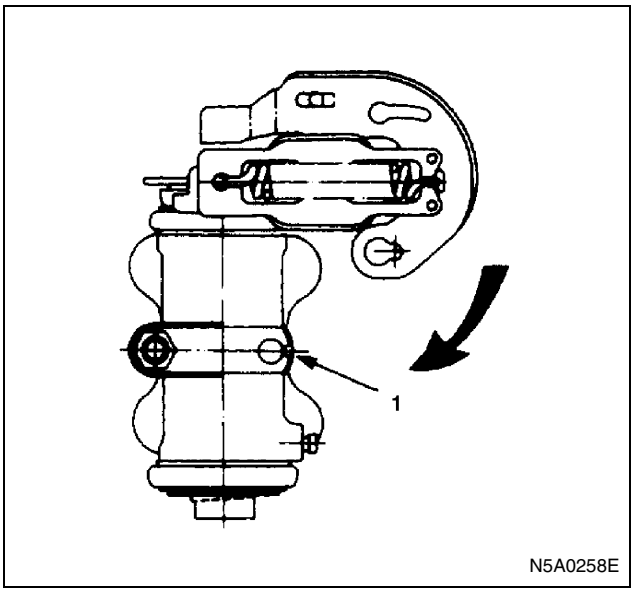
1. Adjuster lever
2. Overtravel spring



Legend
1. Adjuster lever
2. Overtravel spring

1) Hook one end of the overtravel spring to the adjuster lever hole as shown in the illustration.
2) Hook the other end of the overtravel spring to the fitting slot.
3) Turn the overtravel spring 90 degrees counterclockwise as shown in the illustrations.

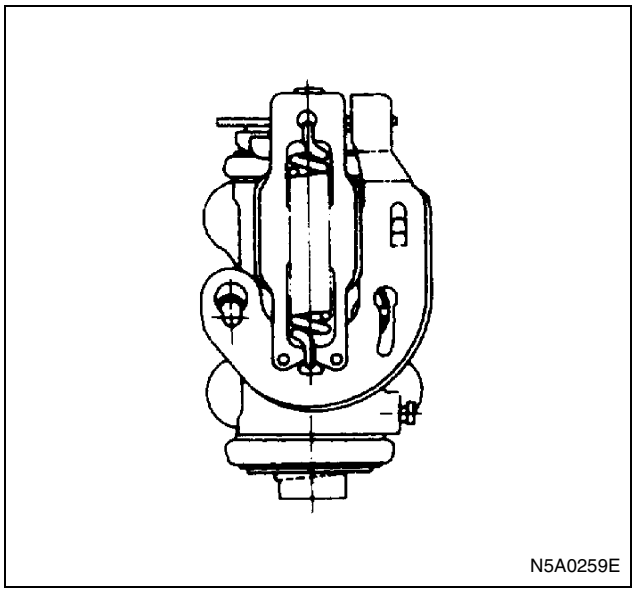
(Wheel Cylinder Body)



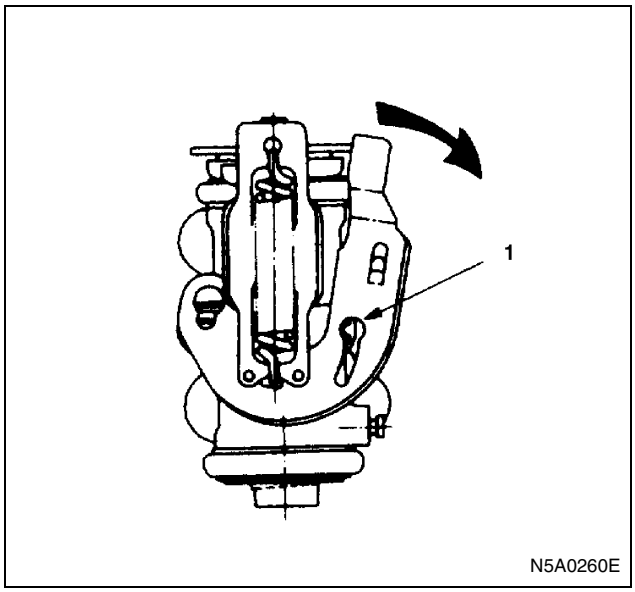
Legend
1. Wheel cylinder

Install the adjuster lever and the overtravel spring to the wheel cylinder body.

1) Hook the overtravel spring fitting slot side to the wheel cylinder body bracket hole.
2) Turn the adjuster lever and the overtravel spring 90 degrees clockwise as shown in the illustration.

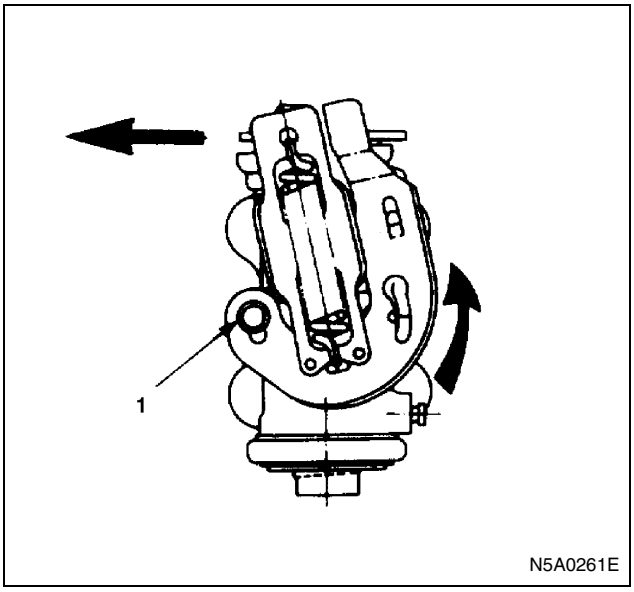


3) Turn the adjuster lever slightly clockwise to attach the adjuster lever hole to the wheel cylinder body hook.



Legend
1. Cylinder body hook

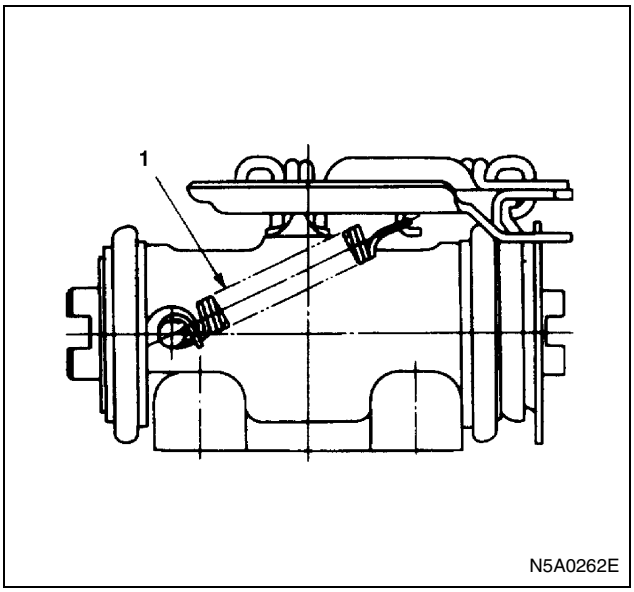
4) Push the wheel cylinder body and bracket to the left as shown in the illustration.



Legend
1. Pin head

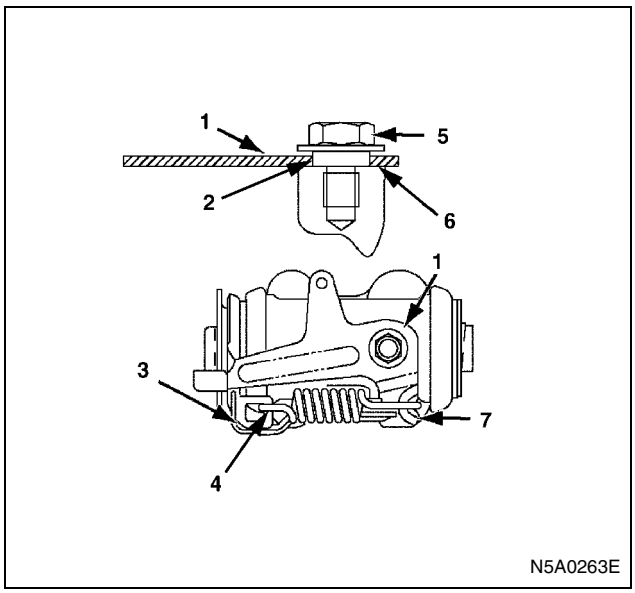
5) Turn the adjuster lever counterclockwise to install the pin head through the adjuster lever hole.

10. Return Spring
Hook the return spring to the wheel cylinder body pin.



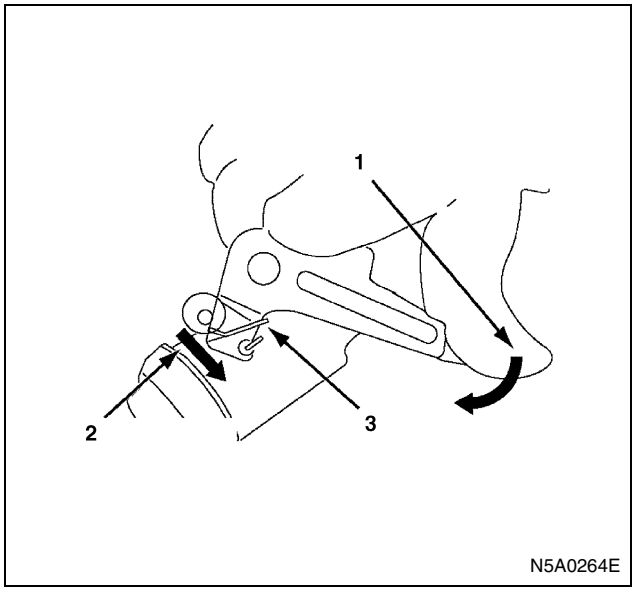
Legend
1. Return spring

Drum Inside Diameter 300, 320 mm



Legend
1. Lever
2. Bolt sleeve
3. Bracket
4. Spring hook (short): Hook to the bracket square hole
5. Lever fixing bolt
Torque: 7.85 — 11.77 N·m (0.80 — 1.20 kg·m/ 5.79 — 8.68 lb·ft)
6. Body surface
7. Spring hook (Long): Hook the lever

1. Reassemble the spring hook (short) to the bracket square hole and spring hook (long) to the lever.
2. Turn the lever to the direction at the connecting point of lever and spring and reassemble the lever to the bracket.



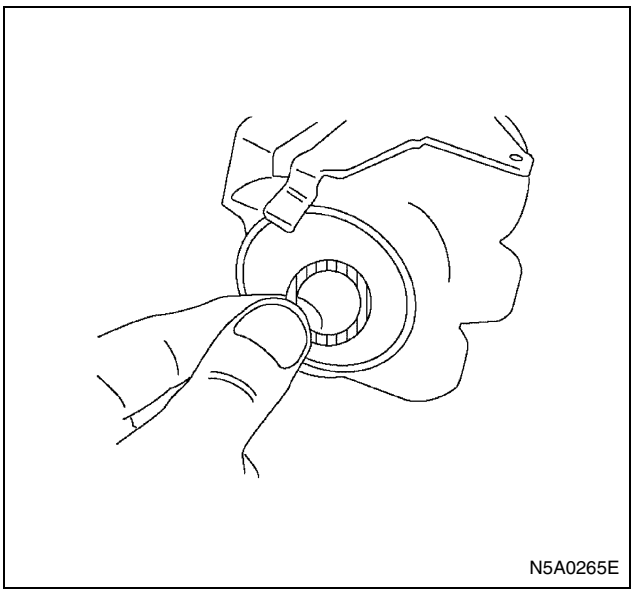
Legend

1. Turn the lever to the arrow, and extend the spring
2. Assemble the lever from the direction
3. Connecting point of lever and spring

3. Install the lever fixing bolt to the specified torque.
4. Make sure not to bite the lever between the bolt sleeve and body surface.
5. Make sure fit the lever to the gear properly after fixing the bolt.

Plain washer

Make sure to assemble the plain washer of coating side to the adjust side.



Assemble the plain washer with the copper-colored surface facing inward and the coating (black) surface facing outward.

Notice:

Failure to assemble the plain washer or assembling it inside out causes auto adjuster not to operate properly. Be sure to assemble it correctly.

Drum Inside Diameter 370 mm

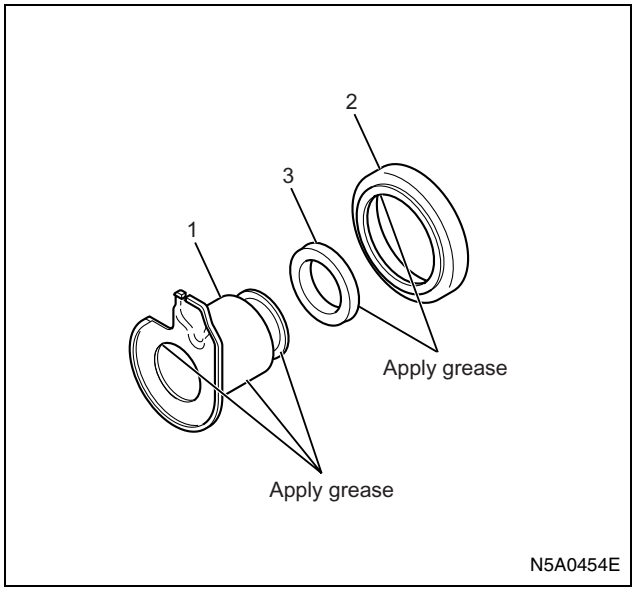
1. Assemble the piston.
   1) Apply grease to the outer circumference of piston (1) and installation groove of boot. Install the boot (2) and apply grease to the insertion groove of cup.

Notice:

After installation of boot, make sure that there are still enough grease in boot.

   2) Assemble the grease-applied piston cup (3) to piston.

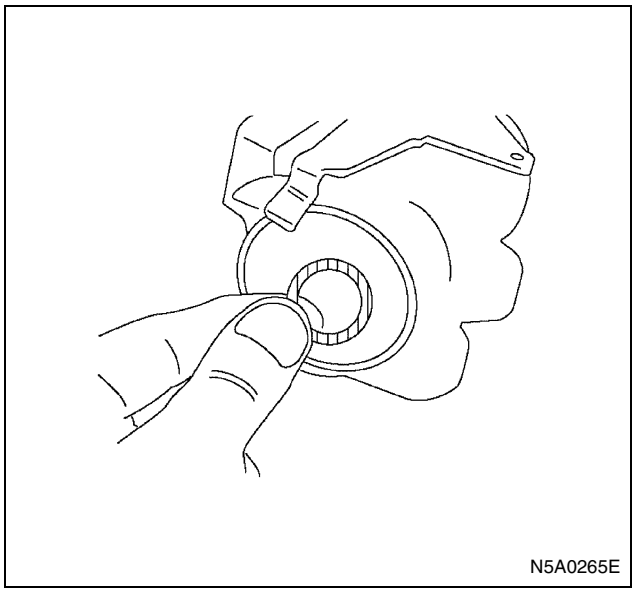
Grease: NIGLUBE RX-2



2. Install the washer (OIL LESS) (1).
   Apply grease to both sides.

Plain washer

Make sure to assemble the plain washer of coating side to the adjust side.



Assemble the plain washer with the copper-colored surface facing inward and the coating (black) surface facing outward.

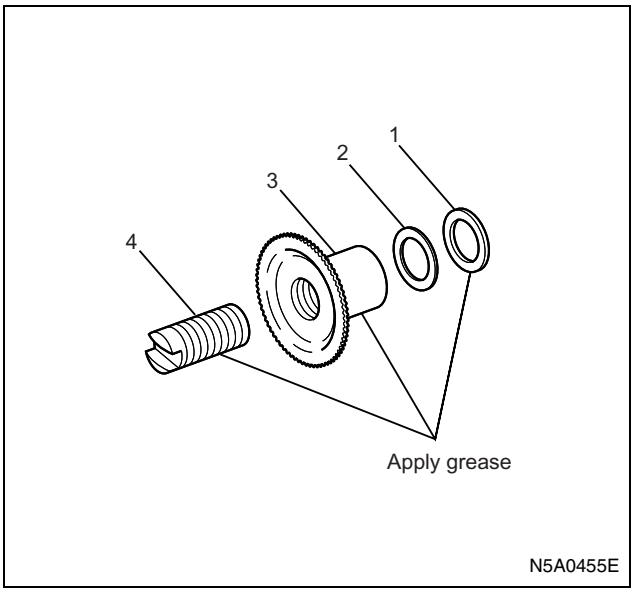
Notice:

Failure to assemble the plain washer or assembling it inside out causes auto adjuster not to operate properly. Be sure to assemble it correctly.

3. Install the washer (SUS) (2).
4. Install the adjuster gear and nut assembly (3).
   Apply grease to the inner surface of piston and adjuster gear and nut assembly, and assemble it to piston.

Grease: NIGLUBE RX-2

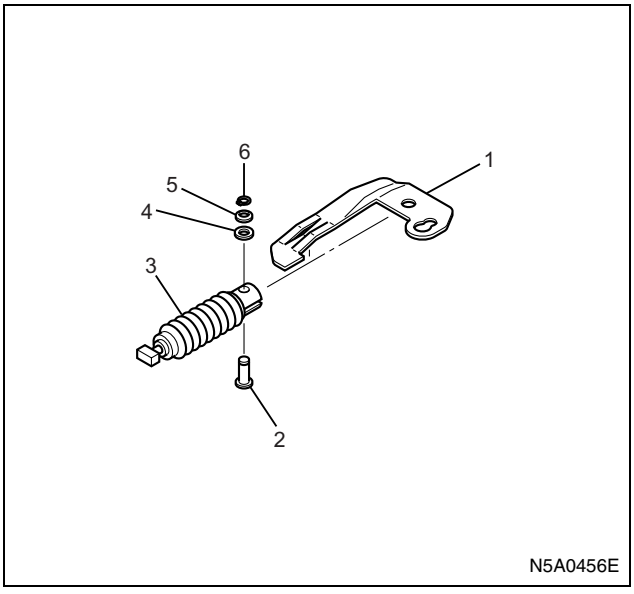
5. Install the adjusting screw (4).
   Apply grease and screw it in to adjuster gear and nut assembly.



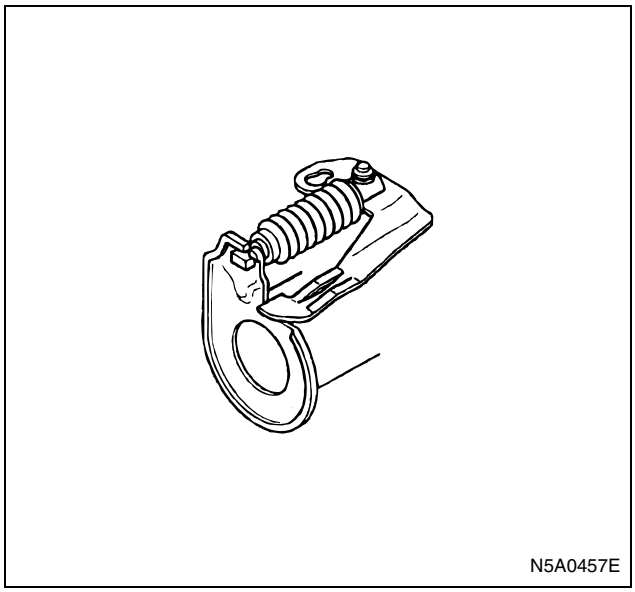
6. Install the cylinder assembly.
   Apply grease to the sliding part of piston. Assemble the piston and install the boot.

Grease: NIGLUBE RX-2

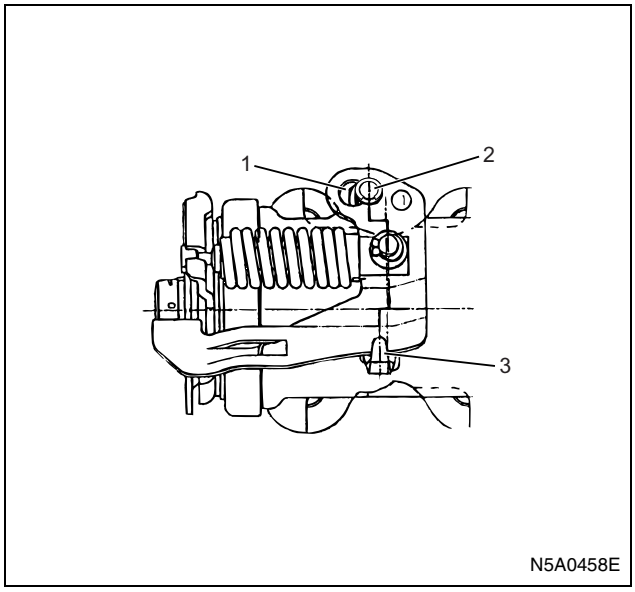
7. Assemble the lever assembly.
   Install the pin (2), spring assembly (3), washer (4), wave washer (5) and snap ring (6) to lever (1).



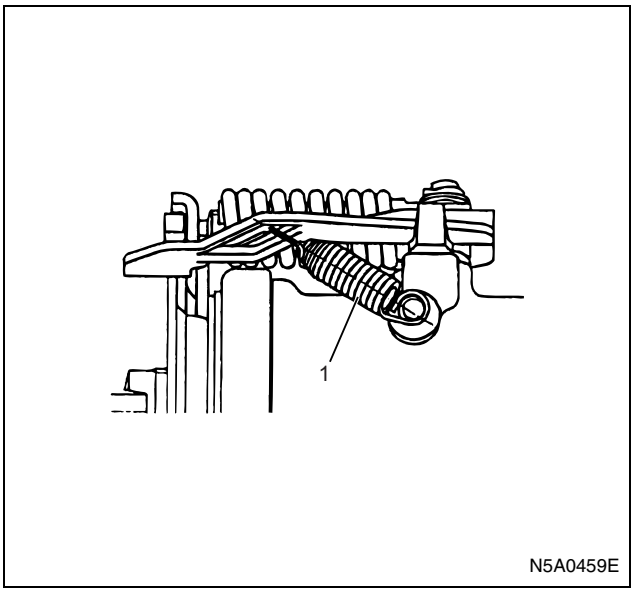
8. Fix the cylinder assembly in a vise and assemble the tip of spring assembly to cutout groove of piston flange.



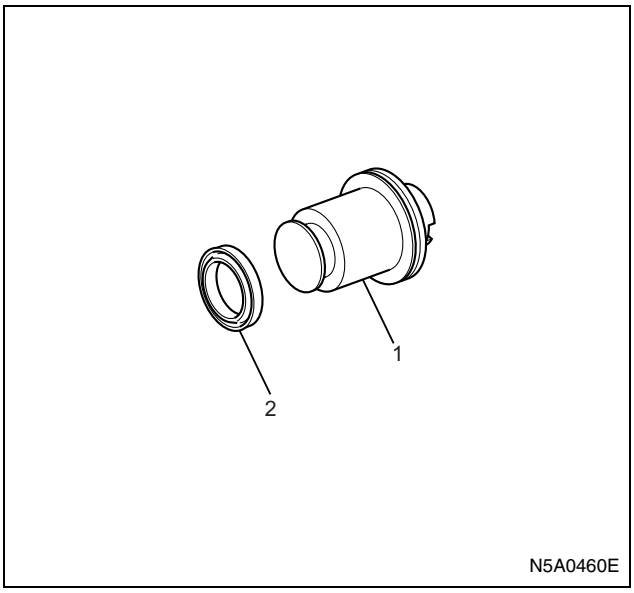
9. While matching the lever to cylinder's hook (3) and stretching the spring assembly, fix the lever to cylinder pin (2) through the double hole (1) of lever.



10. Install the return spring (1).
    Install the closed hook of return spring to pin side.

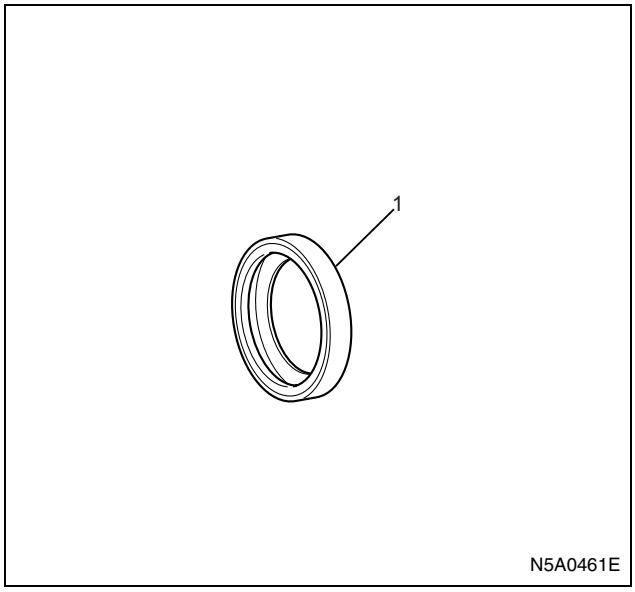


11. Install the piston (1).
    Apply grease to the outer circumference of piston and groove of piston cup (2), and install the grease-applied piston cup.



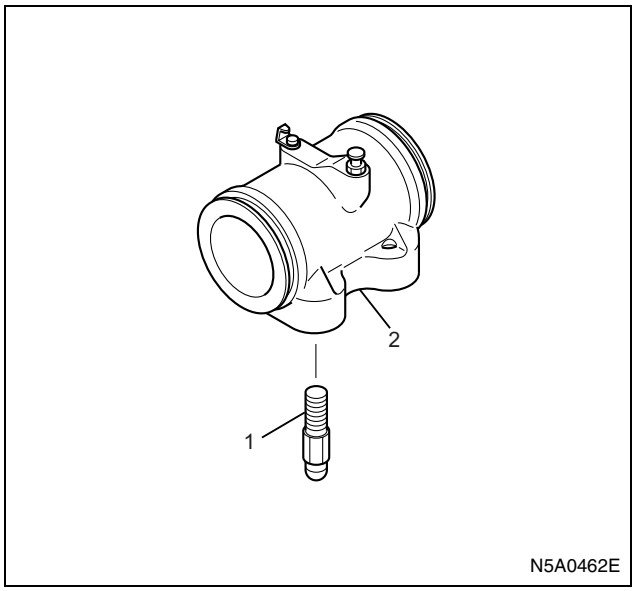
12. Install the boot (1).
    Apply grease to the boot installation groove of cylinder, fill the grease to inside of boot and install it.

Grease: BESCO rubber grease

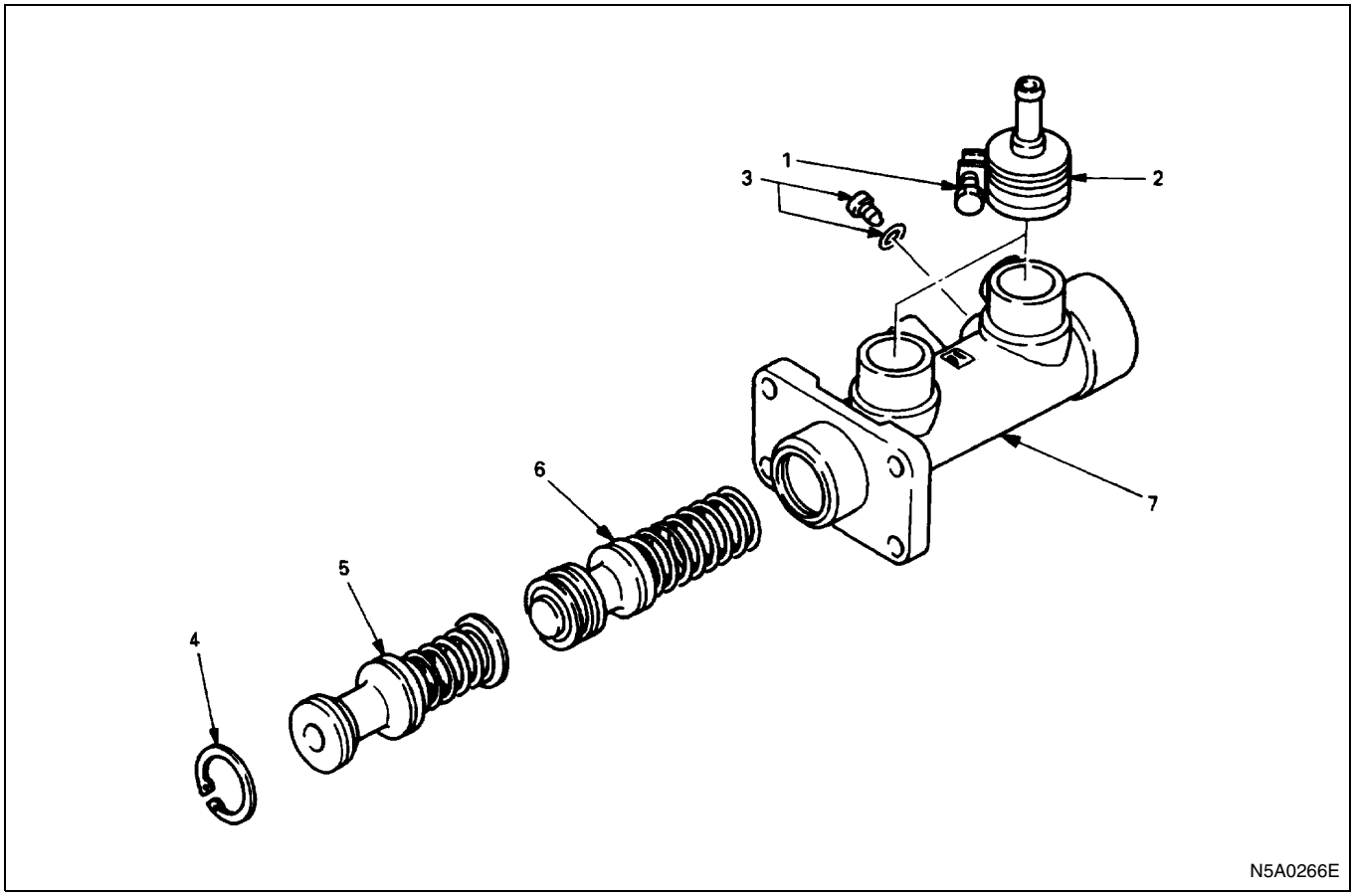


13. Install the bleeder (1) to cylinder assembly (2).

Tighten:
Bleeder to 6.9 — 11.8 N·m (0.7 — 1.2 kg·m / 5.1 — 8.7 lb·ft)



Master Cylinder Assembly (NHR)

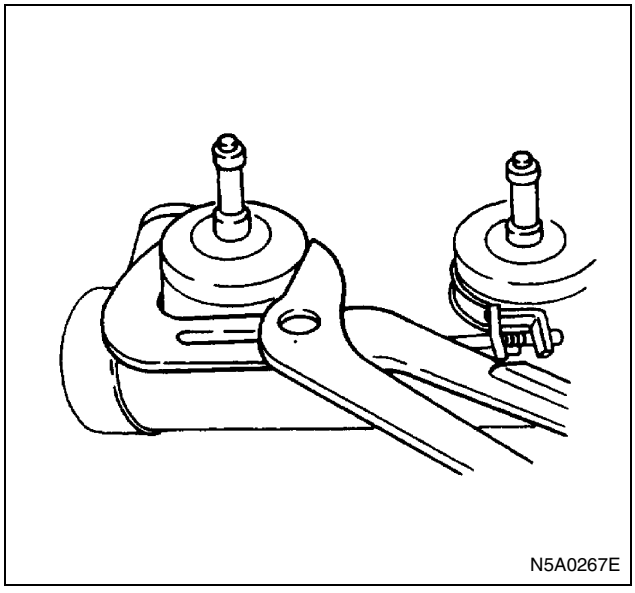


Legend

1. Hose clamp
2. Hose joint
3. Stopper screw and gasket
4. Snap ring
5. Primary piston assembly
6. Secondary piston assembly
7. Cylinder body

Disassembly

1. Hose Clamp
2. Hose Joint
   Use a pair of pliers to remove the hose joint.
   Take care not to damage the hose joint and the cylinder body.



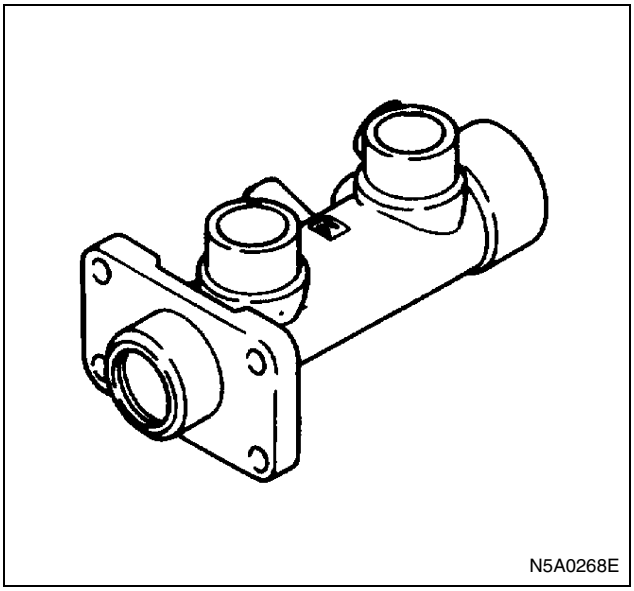
3. Stopper Screw and Gasket
4. Snap Ring
5. Primary Piston Assembly

6. Secondary Piston Assembly
7. Cylinder Body

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Cylinder Body

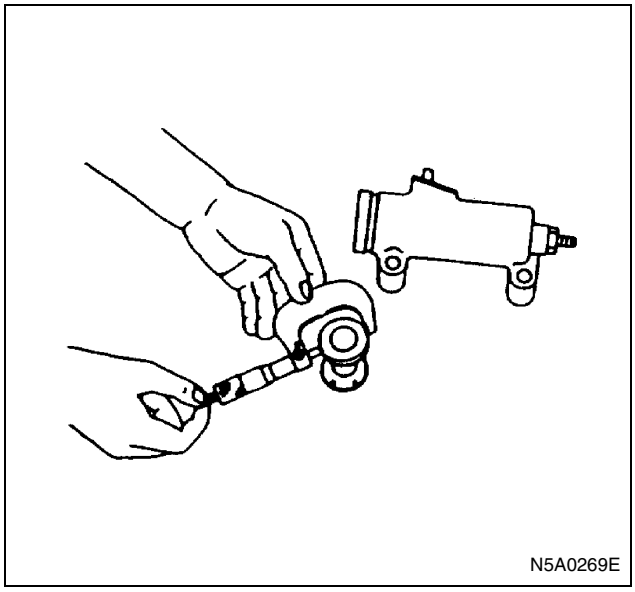

N5A0268E

Visually check that the master cylinder bore, for scuff or scratch, if these conditions are presented, the cylinder body must be replaced.

Piston and Master Cylinder Clearance

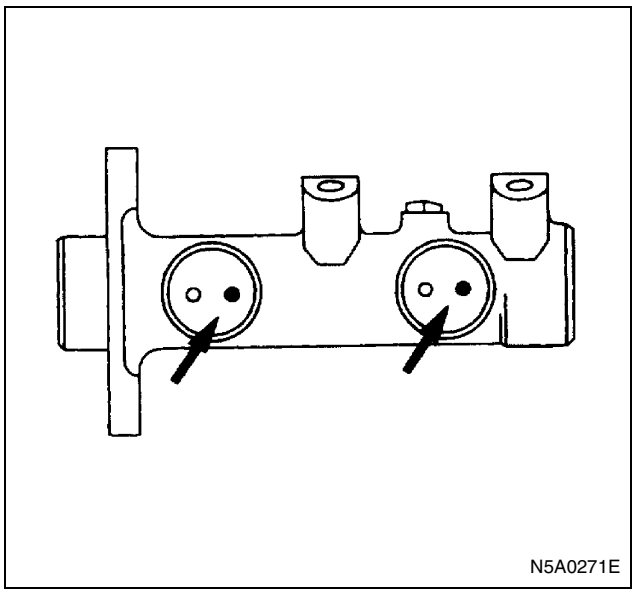
1. Use a micrometer to measure the piston diameter.
2. Use an inside dial indicator to measure the cylinder bore.
3. Calculate the clearance between the wheel cylinder and the piston.
   If the clearance exceeds the specified limit, the piston assembly must be replaced.

Piston and Master Cylinder Clearance mm (in)	
Standard	Limit
0.11 — 0.195 (0.004 — 0.008)	0.22 (0.009)

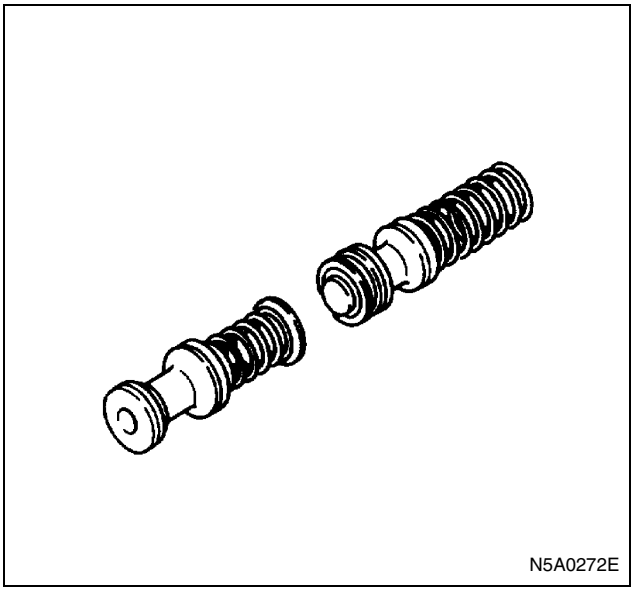

N5A0269E

Reassembly

1. Cylinder Body
   Clean the cylinder body and blow the return ports with compressed air.
   Do not allow the return ports clogged with any foreign material.


N5A0271E

2. Secondary Piston Assembly

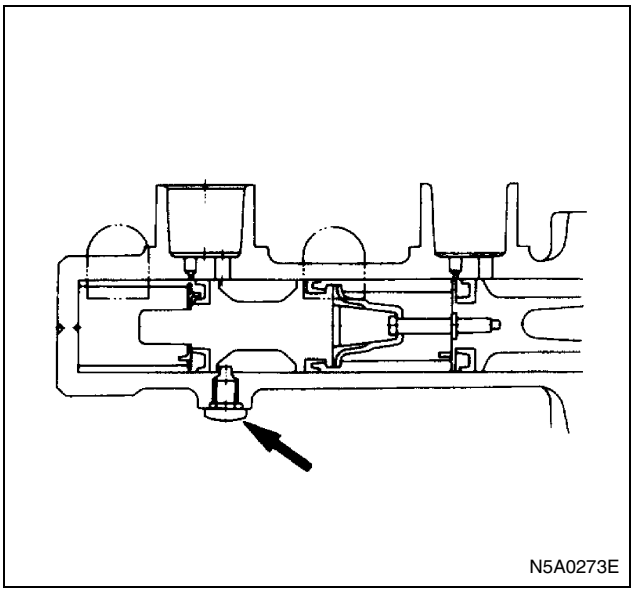

N5A0272E

3. Primary Piston Assembly
   1) Rinse the piston assembly in clean brake fluid.
   2) Install the piston assembly to the master cylinder.

Notice:
Take care not to scratch the primary and secondary cups when installing the piston assembly.

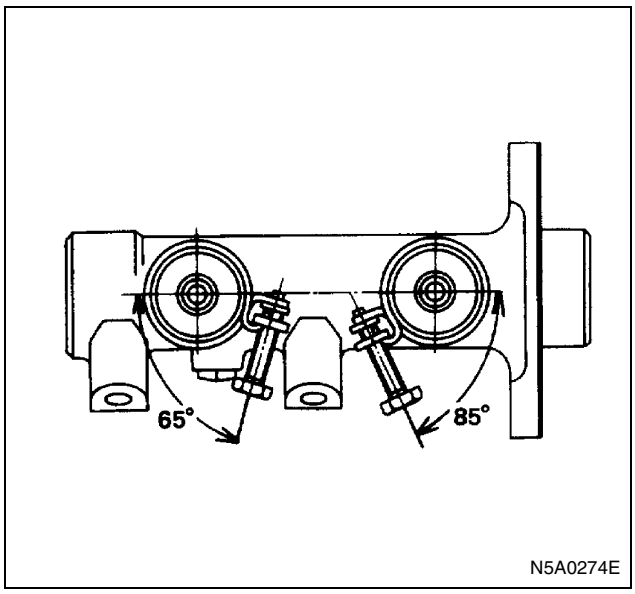
4. Snap Ring
5. Stopper Screw and Gasket
   1) Slide the piston until the oil cavity of the secondary piston dears the stopper bolt hole.
   2) Install the stopper screw and tighten it to the specified torque.

Tighten:
Stopper screw to 27 N·m (2.8 kg·m / 20 lb·ft)


N5A0273E

6. Hose Joint
7. Hose Clamp
   1) Set the clamp in position.
   2) Dip the hose joint in hot water (60 — 80°C / 140 — 176°F) for several minutes.
   3) Take out of the hose joint and blow off water immediately and completely.
   4) Fit the hose joint to the cylinder body.
   5) Align the position of the clamp screw as shown in the illustration.
   6) Tighten the clamp screw to the specified torque.

Tighten:
Clamp screw to 2 N·m (0.2 kg·m / 17 lb·in)



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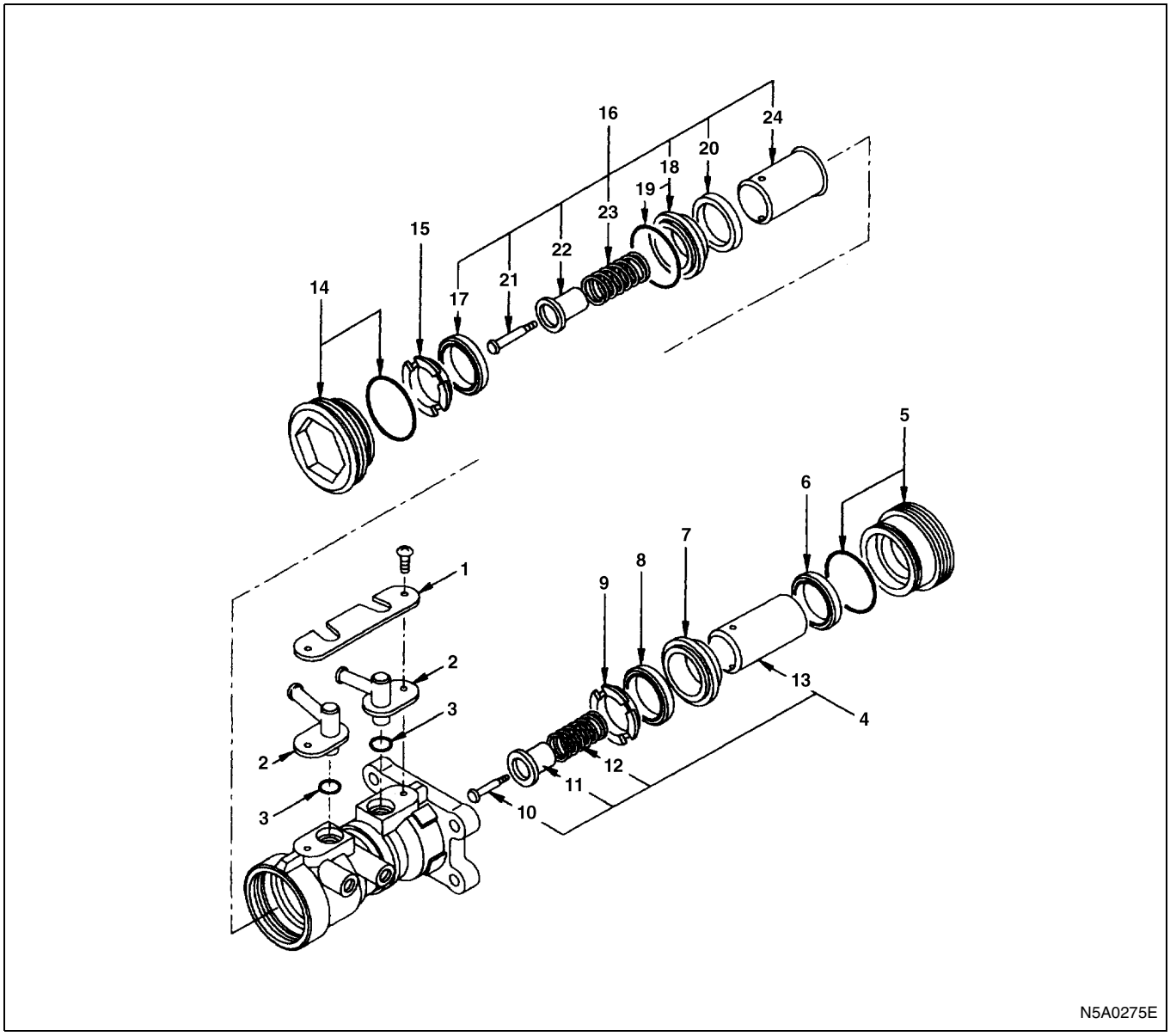
Master Cylinder Assembly (NKR / NPR / NQR / NPS)

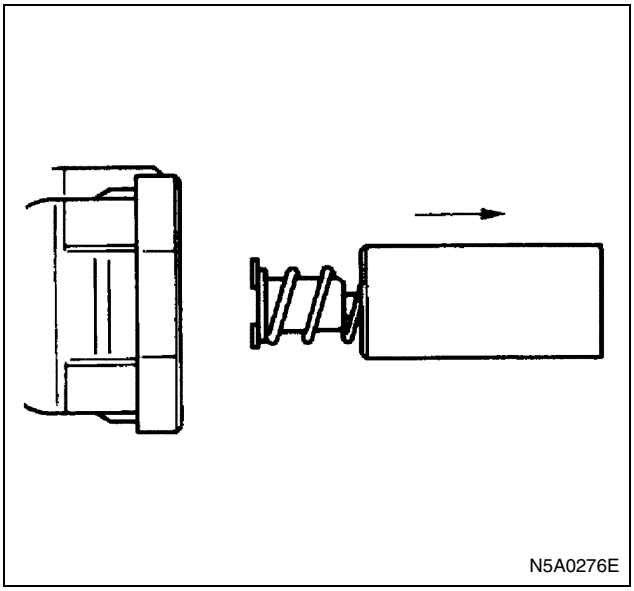


Legend

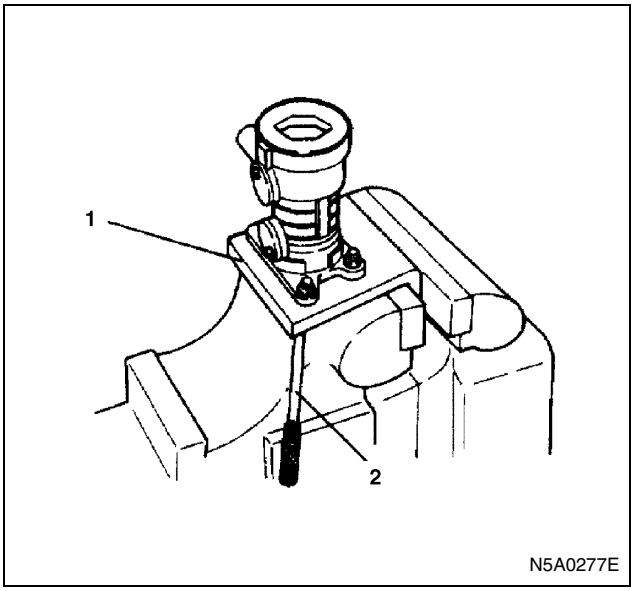
1. Holder plate
2. Hose joint
3. O-ring
4. Primary piston assembly
5. Plug and O-ring
6. Secondary cup
7. Bushing
8. Primary cup
9. Supporter
10. Screw
11. Spring retainer
12. Primary piston spring
13. Primary piston
14. Plug and O-ring
15. Supporter
16. Secondary piston assembly
17. Primary cup
18. Bushing
19. O-ring
20. Secondary cup
21. Screw
22. Spring retainer
23. Secondary piston spring
24. Secondary piston

Disassembly

1. Holder Plate
2. Hose Joint
3. O-ring
4. Primary Piston Assembly
   Draw out Piston by hand so that it may not be damaged.

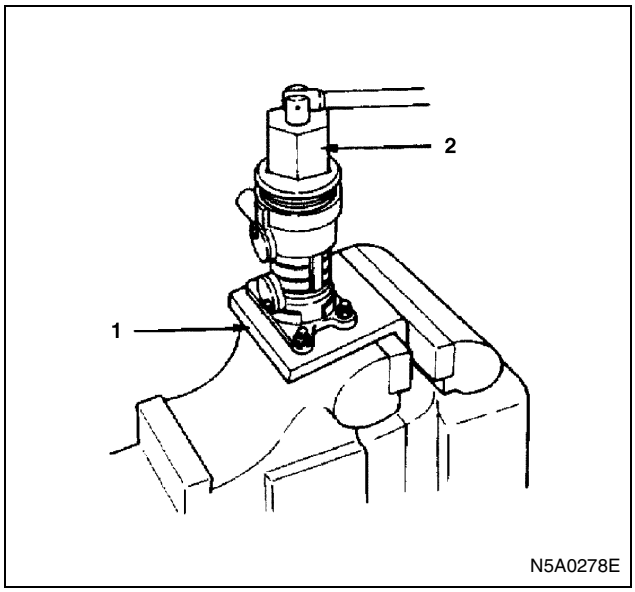

N5A0276E

5. Plug and O-ring
   Install master cylinder on a support plate (1), fix the support in a vice, and loosen plug using a wrench (2).
   Support plate : 5-8840-2371-0
   Wrench : 5-8840-2370-0
   (Master cylinder inside diameter 31.7 mm, 30.1 mm)
   Wrench : 5-8840-2369-0
   (Master cylinder inside diameter 28.5 mm)
   Wrench : 5-8840-2805-0
   (Master cylinder inside diameter 34.9 mm)



N5A0277E

6. Secondary Cup
7. Bushing
8. Primary Cup
9. Supporter
10. Screw
11. Spring Retainer
12. Primary Piston Spring
13. Primary Piston
14. Plug and O-ring
    Install master cylinder on a support plate (1), fix the support in a vice, and loosen plug using a wrench (2).
    Support plate : 5-8840-2371-0
    Wrench : 5-8840-2370-0
    (Master cylinder inside diameter 31.7 mm, 30.1 mm)
    Wrench : 5-8840-2369-0
    (Master cylinder inside diameter 28.5 mm)
    Wrench : 5-8840-2805-0
    (Master cylinder inside diameter 34.9 mm)



N5A0278E

15. Supporter
16. Secondary Piston Assembly
17. Primary Cup
18. Bushing
19. O-ring
20. Secondary Cup
21. Screw
22. Spring Retainer
23. Secondary Piston Spring
24. Secondary Piston

Inspection and Repair

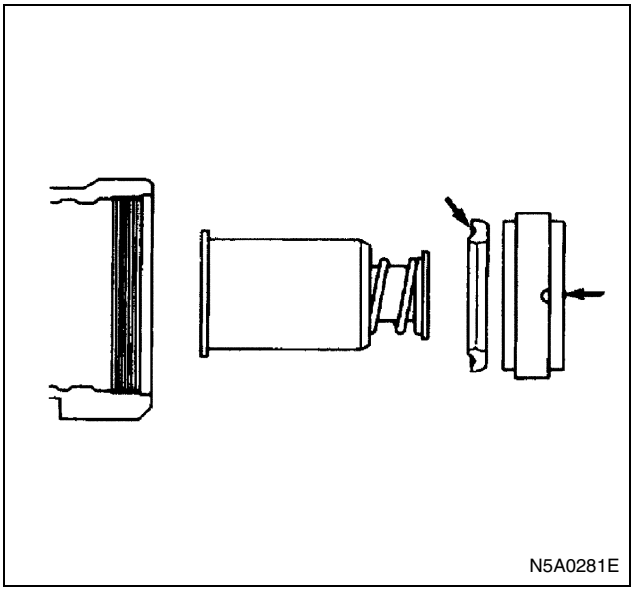
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Cup and O-ring

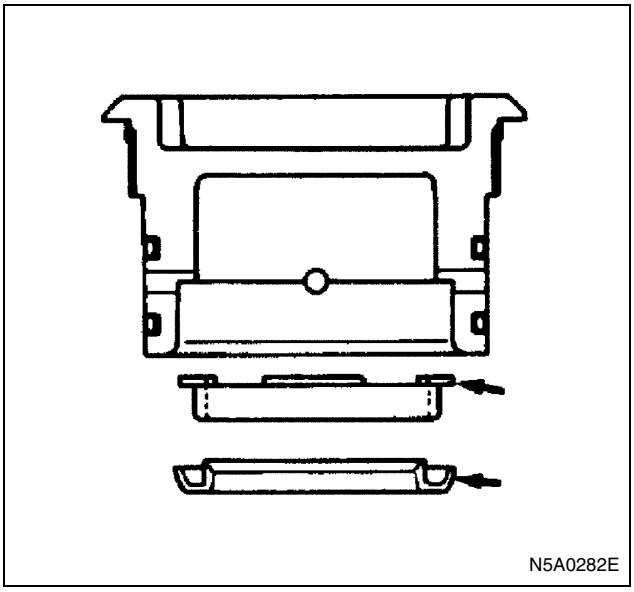
1. Wash each part with brake oil and check for wear, deterioration, and damage.
2. Replace the cups and O-rings.

Reassembly

1. Secondary Piston
2. Secondary Piston Spring
3. Spring Retainer
4. Screw
5. Secondary Cup
6. Bushing
   Combine secondary cup and bushing with secondary piston as indicated as arrows, and push the assembly in until bushing comes into contact with cylinder body step.
7. O-ring
   Install the O-ring to the bushing.



8. Primary Cup
9. Supporter
10. Plug and O-ring
    Combine primary cup and supporter with plug as indicated by arrows.



Then tighten plug to specified tightening torque.

Plug Torque		N·m (kg·m/lb·ft)
Master Cylinder Inside diameter (mm)	28.5	40 (4.1/30)
	30.1	44 (4.5/33)
	31.7	
	34.9	49 (5.0/37)

Support plate : 5-8840-2371-0

Wrench : 5-8840-2370-0

(Master cylinder inside diameter 31.7 mm, 30.1 mm)

Wrench : 5-8840-2369-0

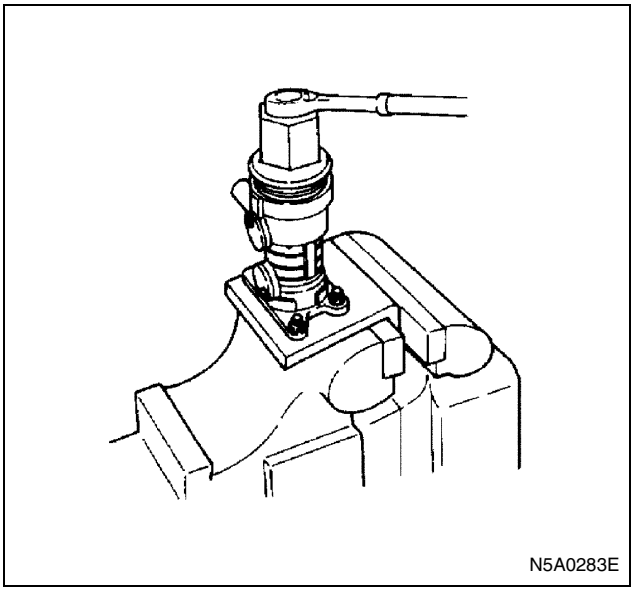
(Master cylinder inside diameter 28.5 mm)

Wrench : 5-8840-2805-0

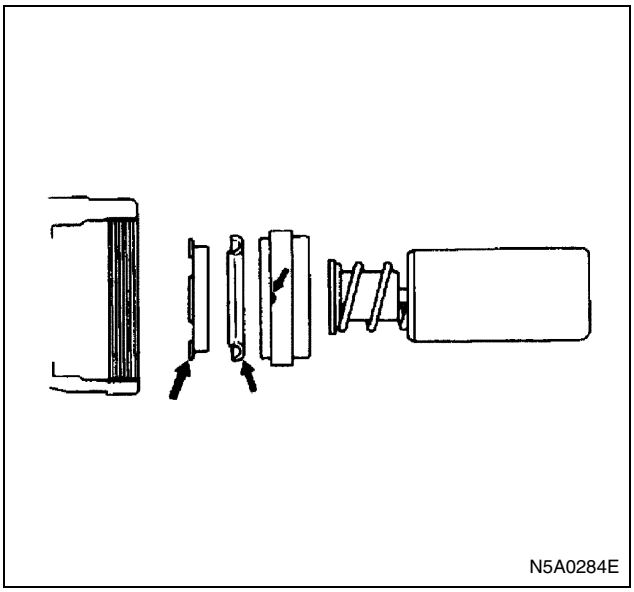
(Master cylinder inside diameter 34.9 mm)

Notice:

If plug tightened to specified torque is found floating from cylinder body, plug should be disassembled again and check for abnormal parts fitting. Then reassemble.


N5A0283E

11. Primary Piston
12. Primary Piston Spring
13. Spring Retainer
14. Screw
15. Supporter
16. Primary Cup
17. Bushing
    1) Combined the parts of primary piston as indicated by arrows.
       Then push the assembly in until bushing comes into contact with the step in cylinder body.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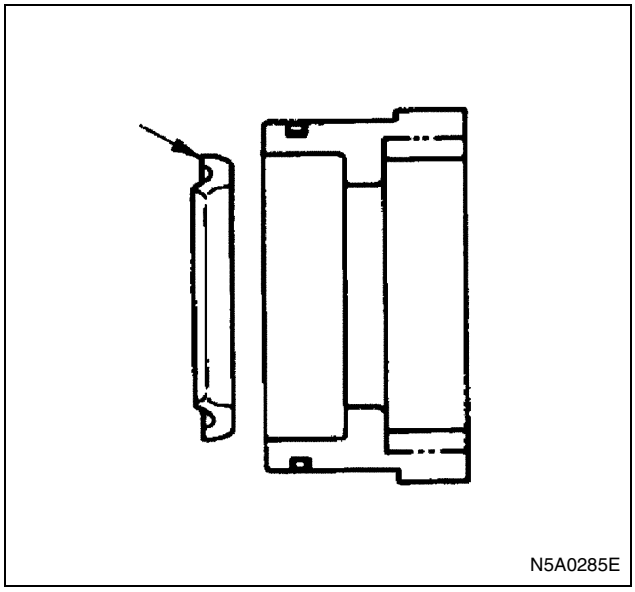
    2) Draw out primary piston alone taking care not to be let bushing get out of the step.
18. Secondary Cup
19. Plug and O-ring
    Combine secondary cup with plug as indicated by arrow, and tighten to specified tightening torque.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Plug Torque		N·m (kg·m/lb·ft)
Master Cylinder Inside diameter (mm)	28.5	40 (4.1/30)
	30.1	44 (4.5/33)
	31.7	
	34.9	49 (5.0/37)

Support plate : 5-8840-2371-0
Wrench : 5-8840-2370-0
(Master cylinder inside diameter 31.7 mm, 30.1 mm)
Wrench : 5-8840-2369-0
(Master cylinder inside diameter 28.5 mm)
Wrench : 5-8840-2805-0
(Master cylinder inside diameter 34.9 mm)

Notice:
If plug tightened to specified torque is found floating from cylinder body, plug should be disassembled again and check for abnormal parts fitting. Then reassemble.

20. O-ring
21. Hose Joint
22. Holder Plate

BRAKES

SECTION 5A4

ANTI-LOCK BRAKE SYSTEM (ABS)

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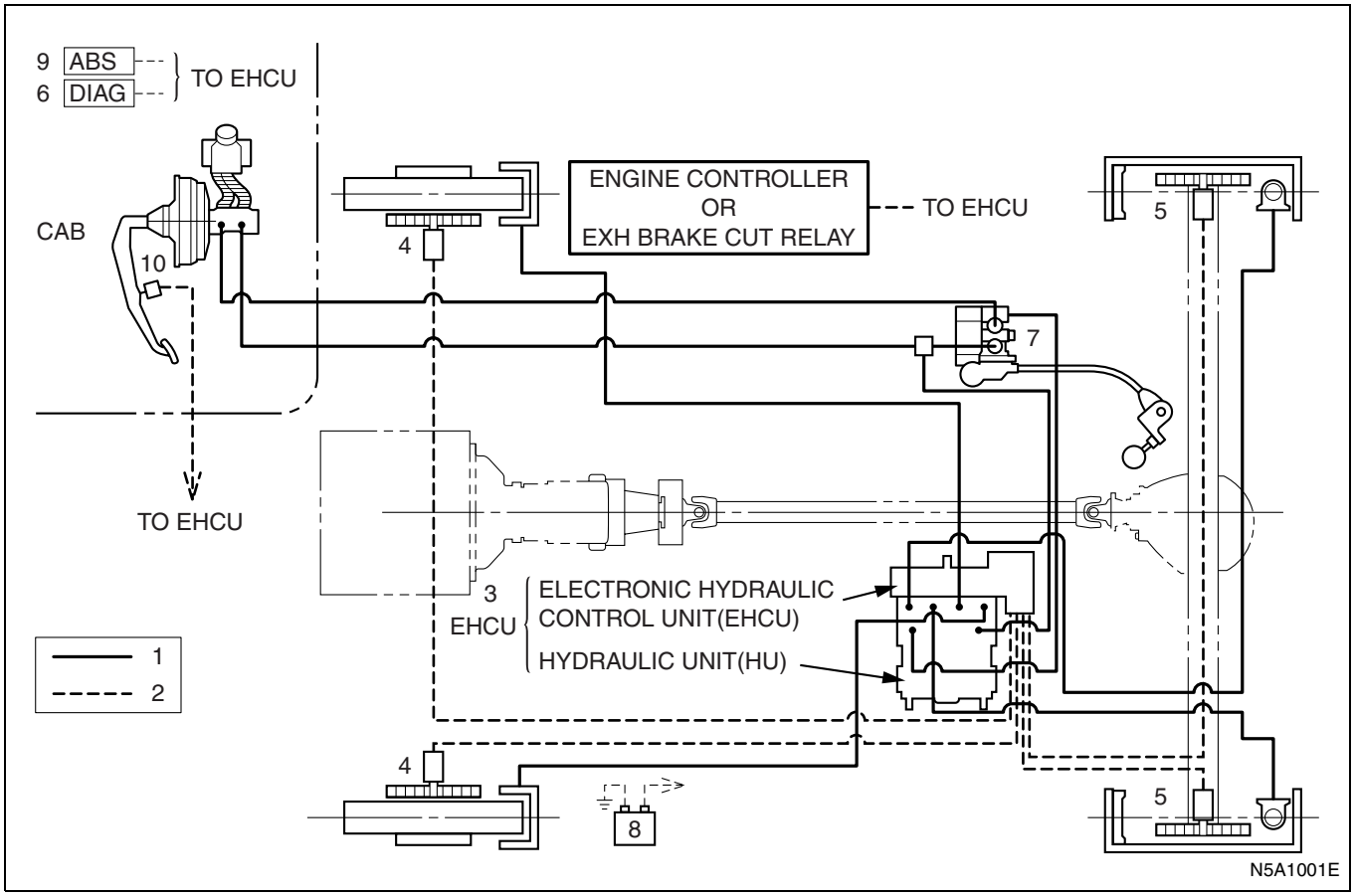
GENERAL DESCRIPTION

Service Precaution

Caution:
Always use the correct fastener in the proper location. When you replace a fastener, use ONLY the exact part number for that application. ISUZU will call out those fasteners that require a replacement after removal. ISUZU will also call out the fasteners that require thread lockers or thread sealant. UNLESS OTHERWISE SPECIFIED, do not use supplemental coatings (Paints, greases, or other corrosion inhibitors) on threaded fasteners or fastener joint interfaces. Generally, such coatings adversely affect the fastener torque and the joint clamping force, and may damage the fastener. When you install fasteners, use the correct tightening sequence and specifications. Following these instructions can help you avoid damage to parts and systems.

General Description

The Anti-lock Brake System (ABS) works on all four wheels. A combination of wheel speed sensor and Electronic Hydraulic Control Unit (EHCU) can determine when a wheel is about to stop turning and adjust brake pressure to maintain best braking.
This system helps the drive maintain greater control of the vehicle under heavy braking conditions.



Legend

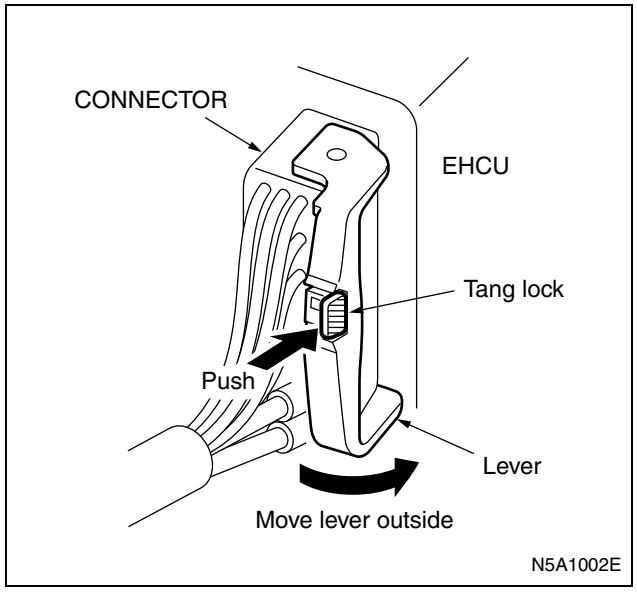
1. Hydraulic Line
2. Electronic Line
3. Electronic Hydraulic Control Unit (EHCU)
4. Front Wheel Speed Sensor
5. Rear Wheel Speed Sensor
6. Diagnosis Connector
7. Load Sensing Proportioning Valve (LSPV)
8. Battery
9. ABS Warning Light
10. Brake Switch

System Components

The Anti-lock Brake System consists of a Electronic Hydraulic Control Unit (EHCU), four Wheel Speed Sensors and Warning Light.

Electronic Hydraulic Control Unit (EHCU)

The EHCU consists of Electronic Brake Control Module (EBCM) and Hydraulic Unit (HU).
The EHCU is located at the frame side, in front of rear spring bracket.
The EHCU consists of ABS control circuits, fault detector, and a fail-safe. It drives the hydraulic unit according to the signal from each sensor, cancelling ABS to return to normal braking when a malfunction has occurred in the ABS.
The EHCU is self-diagnosing function which can indicate faulty circuits during diagnosis.

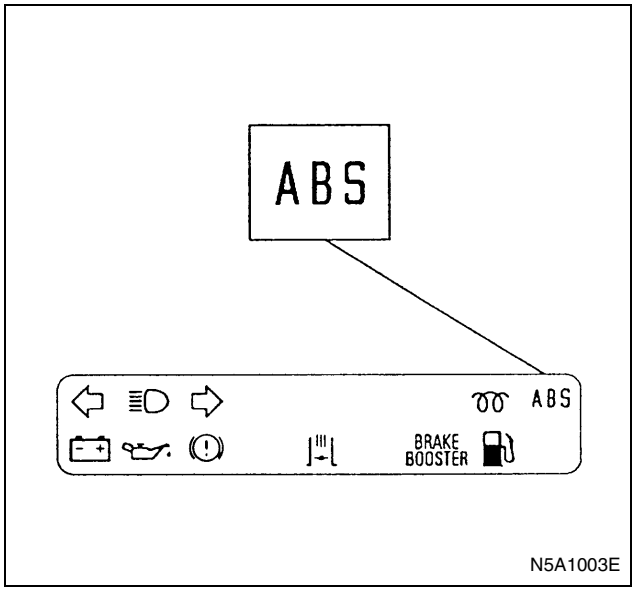


Notice:
When disconnecting harness connector from EHCU, push the tang lock of the connector and release the tang lock. Then move the lever.

Hydraulic Unit (HU)

It consists of a Motor, Plunger Pump, Solenoid Valves and Check Valve.
Solenoid Valves: Reduces or holds the caliper fluid pressure for each front brake or both rear brakes according to the signal sent from the EHCU.
Reservoir: Temporarily holds the brake fluid that returns from the front and rear wheel brake so that pressure of front wheel brake can be reduced smoothly.
Plunger Pump: Feeds the brake fluid held in the reservoir to the master cylinder.
Motor: Drives the pump according to the signal from EHCU. Check Valve: Controls the brake fluid flow.

ABS Warning Light



Vehicles equipped with the Anti-lock Brake System has an amber “ABS” warning light in the instrument panel. The “ABS” warning light will illuminate if a malfunction in the Anti-lock Brake System is detected by the Electronic Hydraulic Control Unit (EHCU). In case of an electronic malfunction, the EHCU will turn “ON” the “ABS” warning light and disable the Anti-lock braking function.
The “ABS” light will turn “ON” for 2 seconds after the ignition switch is to the “ON” position, and then will go out. If the “ABS” light comes “ON” and stays “ON” while driving, the Anti-lock Brake System should be inspected for a malfunction according to the diagnosis procedure.

Wheel Speed Sensor

It consists of a sensor and a rotor. The sensor is attached to the knuckle on the front wheels and to the bracket on the brake back plate on the rear wheels.
The front speed sensor is coil type and rear is Hall IC type.
The sensor rotors press-fitted to front and rear wheel hubs output pulse frequency depending on wheel rotation.
The speed sensors find vehicle speed from its frequency.

Normal and Anti-lock Braking

Under normal driving conditions, the Anti-lock Brake System functions the same as a standard power assisted brake system. However, with the detection of wheel lock-up, a slight bump or kick-back will be felt in the brake pedal. This pedal “bump” will be followed by a series of short pedal pulsations which occurs in rapid succession. The brake pedal pulsation will continue ANTI-LOCK BRAKE SYSTEM (ABS) 5A4-7 until there is no longer a need for the anti-lock function or until the vehicle is stopped. A slight ticking or popping noise may be heard during brake applications when the Anti-lock features is being used.

When the Anti-lock feature is being used, the brake pedal may rise even as the brakes are being applied.
This is also normal. Maintaining a consist force on the pedal will provide the shortest stopping distance.

Brake Pedal Travel

Vehicles equipped with the Anti-lock Brake System may be stopped by applying normal force to the brake pedal. Although there is no need to push the pedal beyond the point where it stops or holds the vehicle, by applying more force the pedal will continue to travel toward the floor.
This extra brake pedal travel is normal.

Acronyms and Abbreviations

Several acronyms and abbreviations are commonly used throughout this section:

ABS
Anti-lock Brake System
CKT
Circuit
DLC
Data Link Connector
DTC
Diagnostic Trouble Code
DVM
Digital Volt Meter (High Impedance Multimeter)
EHCU
Electronic Hydraulic Control Unit
FL
Front Left
FR
Front Right
GEN
Generator
HU
Hydraulic Unit
MV
Millivolts
RL
Rear Left
RR
Rear Right
RPS
Revolution per Second
SW
Switch
VDC
Volts DC
VAC
Volts AC
W/L
Warning Light
WSS
Wheel Speed Sensor

GENERAL DIAGNOSIS

General Information

ABS malfunction can be classified into two types, those which can be detected by the ABS warning light and those which can be detected as a vehicle abnormality by the driver.
In either case, locate the fault in accordance with the "BASIC DIAGNOSTIC FLOWCHART" and repair.
Please refer to Section 5A HYDRAULIC BRAKES for the diagnosis of mechanical troubles such as brake noise, brake judder (brake pedal or vehicle vibration felt when braking), uneven braking, and parking brake trouble.

ABS Service Precautions

Required Tools and Items:

- Box Wrench
- Brake Fluid
- Special Tool

Some diagnosis procedures in this section require the installation of a special tool.
High Impedance Multimeter: 5-8840-0285-0 (J-39200)
When circuit measurements are requested, use a circuit tester with high impedance.

Computer System Service Precautions

The Anti-lock Brake System interfaces directly with the Electronic Hydraulic Control Unit (EHCU) which is a control computer that is similar in some regards to the Engine Control Module. These modules are designed to withstand normal current draws associated with vehicle operation. However, care must be taken to avoid overloading any of the EHCU circuits. In testing for opens or shorts, do not ground or apply voltage to any of the circuits unless instructed to do so by the appropriate diagnostic procedure. These circuits should only be tested with a high impedance multimeter 5-8840-0285-0 (J-39200) or special tools as described in this section. Power should never be removed or applied to any control module with the ignition in the "ON" position. Before removing or connecting battery cables, fuses or connectors, always turn the ignition switch to the "OFF" position.

General Service Precautions

The following are general precautions which should be observed when servicing and diagnosing the Anti-lock Brake System and/or other vehicle systems. Failure to observe these precautions may result in Anti-lock Brake System damage.

- If welding work is to be performed on the vehicle using an electric arc welder, the EHCU connector should be disconnected before the welding operation begins.
- The EHCU connector should never be connected or disconnected with the ignition "ON".
- The EHCU is not separately serviceable and must be replaced as assemblies. Do not disassemble any component which is designated as non-serviceable in this Section.
- If only rear wheels are rotated using jacks or drum tester, the system will diagnose a speed sensor malfunction and the "ABS" warning light will illuminate. But actually no trouble exists. After inspection stop the engine once and re-start it, then make sure that the "ABS" warning light does not illuminate.

Note on Intermittents

As with virtually any electronic system, it is difficult to identify an intermittent failure. In such a case duplicating the system malfunction during a test drive or a good description of vehicle behavior from the customer may be helpful in locating a "most likely" failed component or circuit. The symptom diagnosis chart may also be useful in isolating the failure. Most intermittent problems are caused by faulty electrical connections or wiring. When an intermittent failure is encountered, check suspect circuits for:

- Suspected harness damage.
- Poor mating of connector halves or terminals not fully seated in the connector body (backed out).
- Improperly formed or damaged terminals.

Test Driving ABS Complaint Vehicles

In case that there has been an malfunction in the lighting pattern of "ABS" warning light, the fault can be located in accordance with the "DIAGNOSIS BY "ABS" WARNING LIGHT ILLUMINATION PATTERN". In case of such trouble as can be detected by the driver as a vehicle symptom, however, it is necessary to give a test drive following the test procedure mentioned below, thereby reproducing the symptom for trouble diagnosis on a symptom basis:

1. Start the engine and make sure that the "ABS" W/L goes OFF. If the W/L remains ON, it means that the Diagnostic Trouble Code (DTC) is stored. Therefore, read the code and locate the fault.
2. Start the vehicle and accelerate to about 30 km/h (19 mph) or more.
3. Slowly brake and stop the vehicle completely.
4. Then restart the vehicle and accelerate to about 40 km/h (25 mph) or more.
5. Brake at a time so as to actuate the ABS and stop the vehicle.
6. Be cautious of abnormality during the test. If the W/L is actuated while driving, read the DTC and locate the fault.
7. If the abnormality is not reproduced by the test, make best efforts to reproduce the situation reported by the customer.

8. If the abnormality has been detected, repair in accordance with the “SYMPTOM DIAGNOSIS”.

Notice:

- Be sure to give a test drive on a wide, even road with little traffic.
- If an abnormality is detected, be sure to suspend the test and start trouble diagnosis at once.

“ABS” Warning Light

When ABS trouble occurs and actuates when possible the “ABS” warning light, the trouble code corresponding to the trouble is stored in the EHCU.
Only the ordinary brake system is available when the ABS is turned OFF. When the “ABS” warning light is actuated, if the starter switch is set ON after setting it OFF once, the EHCU checks up on the entire system and, if there is no abnormality, judges ABS to work currently and the warning light works normally even though the trouble code is stored.

Notice:
Illumination of the “ABS” warning light indicates that anti-lock braking is no longer available. Power assisted braking without anti-lock control is still available.

Normal Operation

“ABS” Warning Light

When the ignition is first moved from “OFF” to “ON”, the amber “ABS” warning light will turn “ON” for 2 seconds and will turn “OFF”.

Basic Diagnostic Flow Chart

Step	Action	Value(s)	YES	NO
1	1. Customer complaint. 2. Questioning to customer. 3. Basic inspection (Refer to “Basic inspection procedure”). Using Tech 2?	—	Go to Step 2	Go to Step 3
2	Make sure of DTC by TROUBLE CODE. Is EHCU including DTC?	—	Go to Step 5	Go to Step 4
3	Check if the DTC is stored. Is EHCU including DTC?	—	Go to Step 5	Go to Step 4
4	Test drive. Is W/L lit?	—	Go to Step 5	Trouble diagnosis based on symptom (Refer to “SYMPTOM DIAGNOSIS”) Go to Step 5
5	1. Repair of faulty part. 2. Elimination of DTC. 3. Inspection of “ABS” W/L illumination pattern with ignition SW “ON”. 4. Test drive. Does the DTC repeat?	—	Repeat the diagnosis of the symptom or DTC appears again Go to Step 1	Go to Step 6
6	1. Reconnect all components and ensure all components are properly mounted. 2. Clear diagnostic trouble code. Was this step finished?	—	Finished	—

Basic Inspection Procedure

1. Basic Inspection of Service Brake

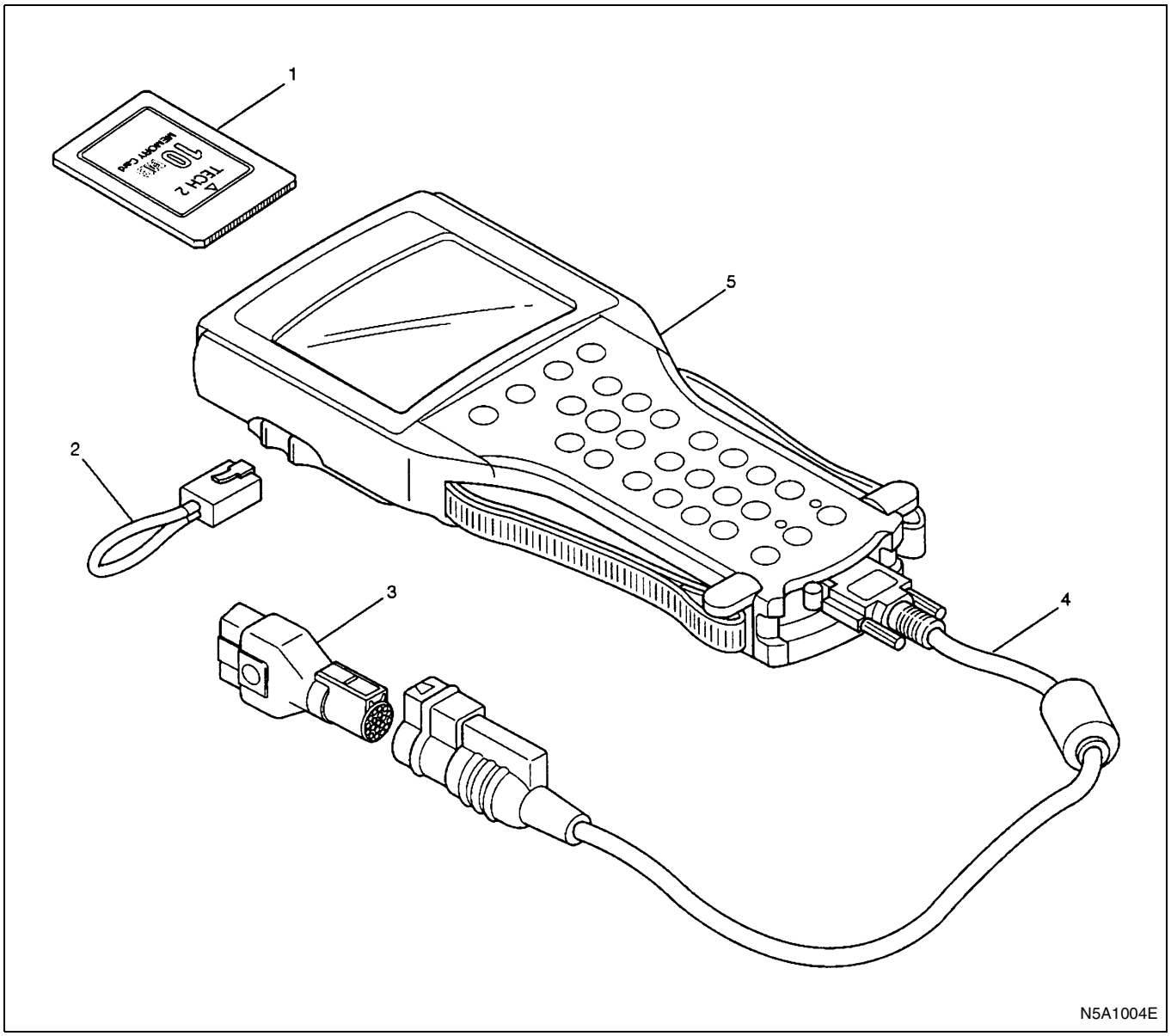
Step	Action	Value(s)	YES	NO
1	Is the fluid level normal?	—	Go to Step 2	Replenish with fluid. Go to Step 2
2	Does brake fluid leak from brake parts?	—	Repair. Go to Step 3	Go to Step 3
3	Is the booster functioning normal?	—	Go to Step 4	Repair. Go to Step 4
4	Is the pad and rotor normal?	—	Go to Step 5	Repair. Go to Step 5
5	Reconnect all components and ensure all components are properly mounted. Was this step finished?	—	Finished	—

2. Ground Inspection

Step	Action	Value(s)	YES	NO
1	Are ABS-related ground points ok?	—	Go to Step 2	Repair. Go to Step 2
2	Reconnect all components and ensure all components are properly mounted. Was this step finished?	—	Finished	—

Tech 2 Scan Tool

From 98 MY, Isuzu dealer service departments are recommended to use Tech 2. Please refer to Tech 2 scan tool user guide.



Legend

1. PCMCIA Card
2. RS 232 Loop Back Connector
3. SAE 16/19 Adapter
4. DLC Cable
5. Tech 2

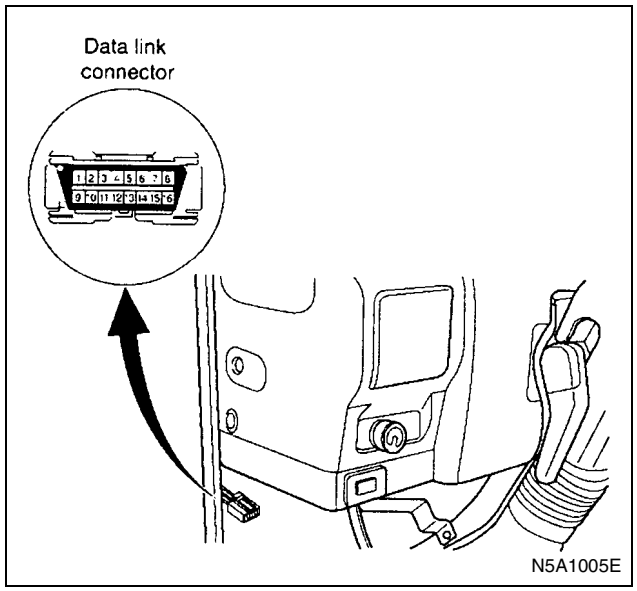
Tech 2 Features

1. Tech 2 is a 12 volt system. Do not apply 24 volt.
2. After connecting and/or installing the Vehicle Communications Interface (VCI) module, PCMCIA card and DLC connector to the Tech 2, connect the tool to the vehicle DLC.
3. Make sure the Tech 2 is powered OFF when removing or installing the PCMCIA card.
4. The PCMCIA card has a capacity of 10 Megabytes which is 10 times greater than the memory of the Tech 1 Mass Storage Cartridge. (except 2003 year model)
5. The Tech 2 has the capability of two snapshots.
6. The PCMCIA card is sensitive to magnetism and static electricity, so care should be taken in the handling of the card.
7. The Tech 2 can plot a graph when replaying a snapshot.
8. Always return to the Main Menu by pressing the EXIT key several times before shutting down.
9. To clear Diagnostic Trouble Codes (DTCs), open Application Menu and press “F1: Clear DTC Info”.

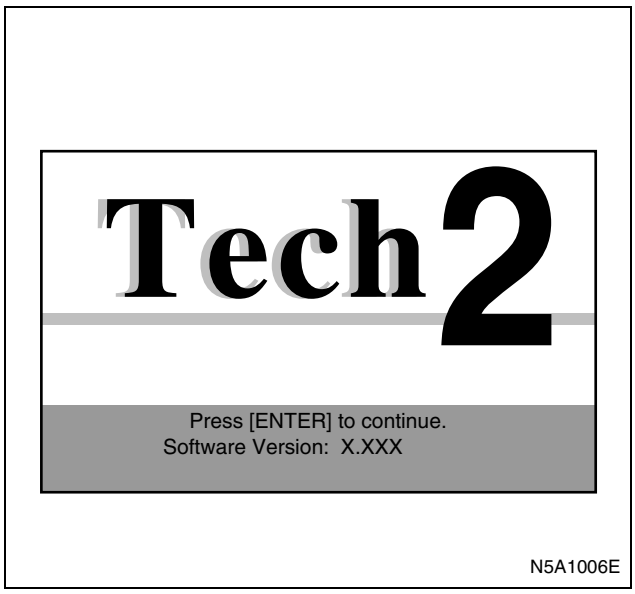
Getting Started

- Before operating the Isuzu PCMCIA card with the Tech 2, the following steps must be performed:

1. The Isuzu System PCMCIA card (1) inserts into the Tech 2 (5).
2. Connect the SAE 16/19 adapter (3) to the DLC cable (4).
3. Connect the DLC cable to the Tech 2 (5).
4. Make sure the vehicle ignition is off.
5. Connect the Tech 2 SAE 16/19 adapter to the vehicle DLC.



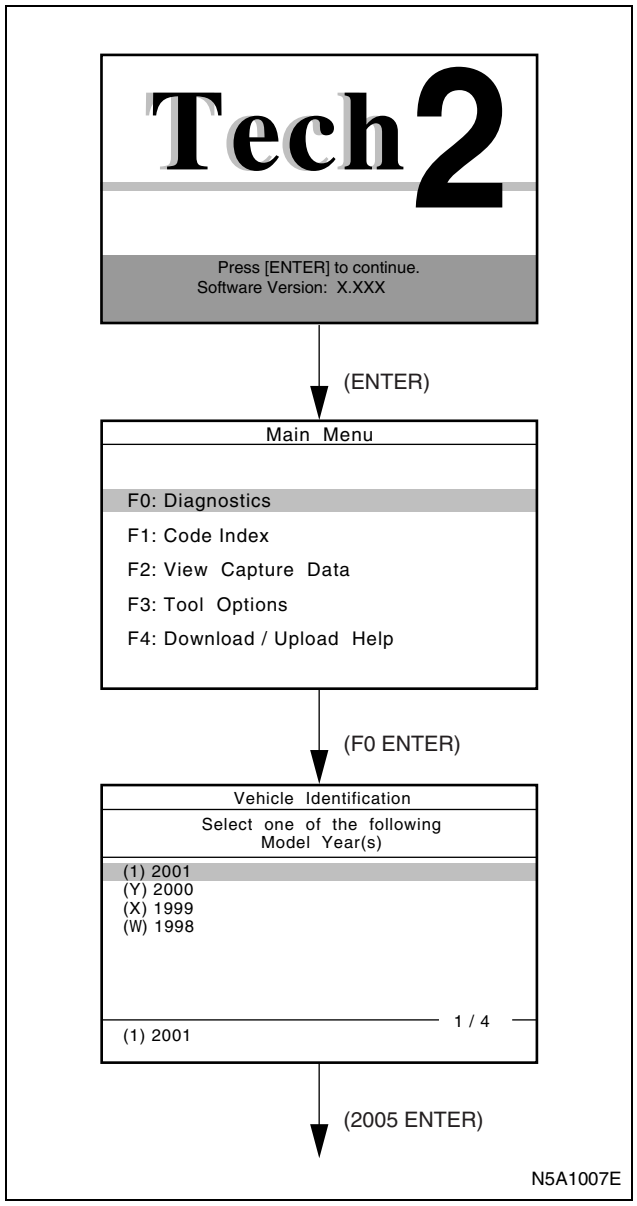
6. Turn on the vehicle ignition.
7. Power the Tech 2 ON and verify the Tech 2 power up display.

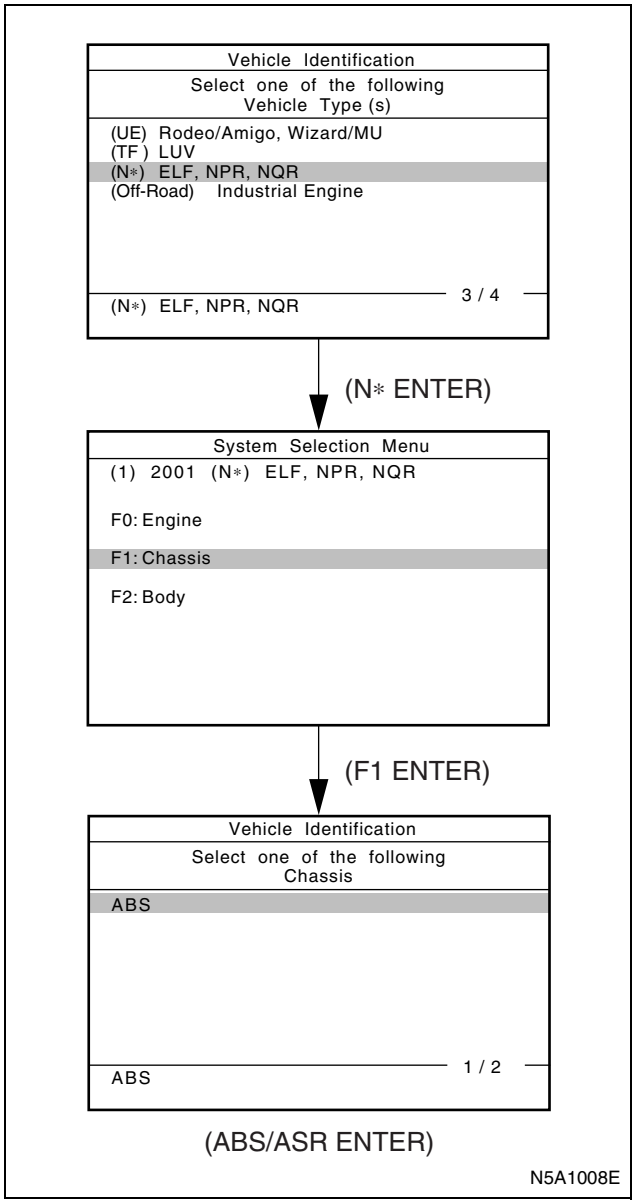


Notice:
The RS232 Loop back connector is only to use for diagnosis of Tech 2. Refer to user guide of the Tech 2.

Operating Procedure (For Example)

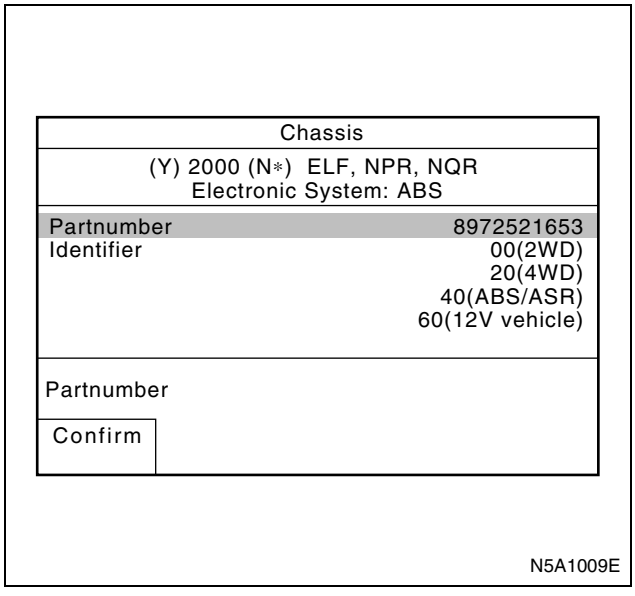
The power up screen is displayed when you power up the tester with the Isuzu systems PCMCIA card. Follow the operating procedure below.



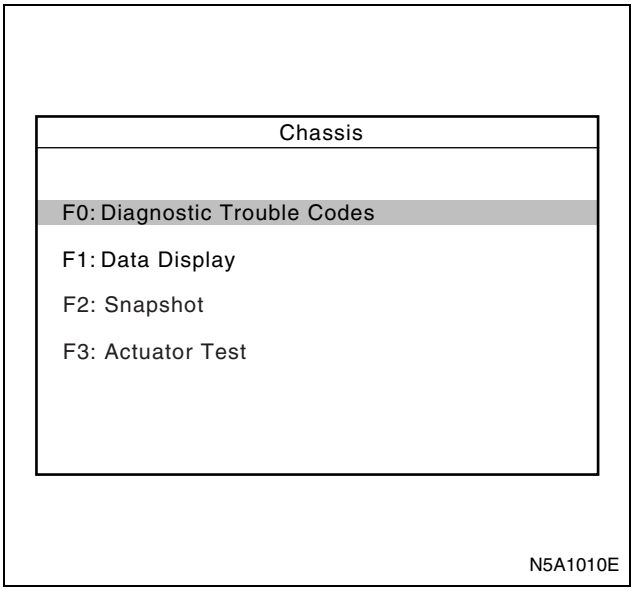


Menu

- The following table shows which functions are used for the available equipment versions.

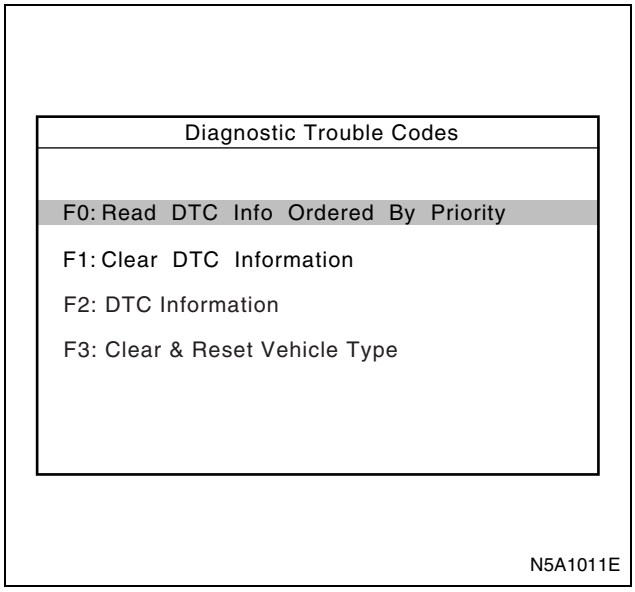


DTC Modes



There are two options available in Tech 2 DTC mode to display the enhanced information available. After selecting DTC, the following menu appears.

- DTC Info
- Clear Info



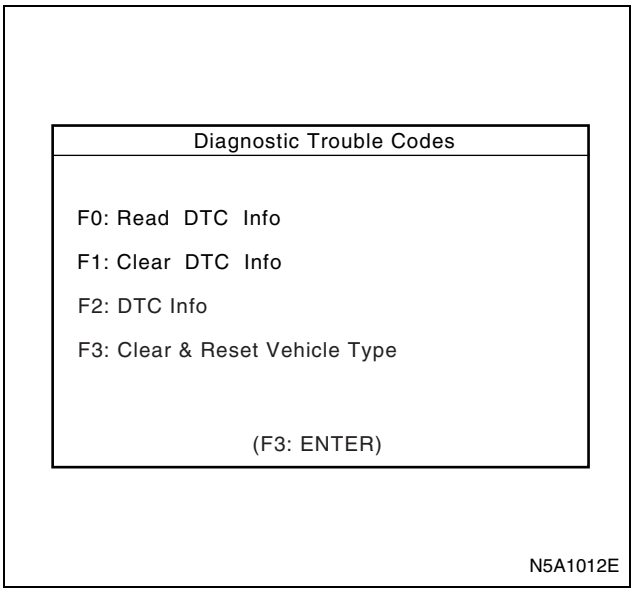
The following is a brief description of each of the sub menus in DTC Info and DTC. The order in which they appear here is alphabetical and not necessarily the way they will appear on the Tech 2.

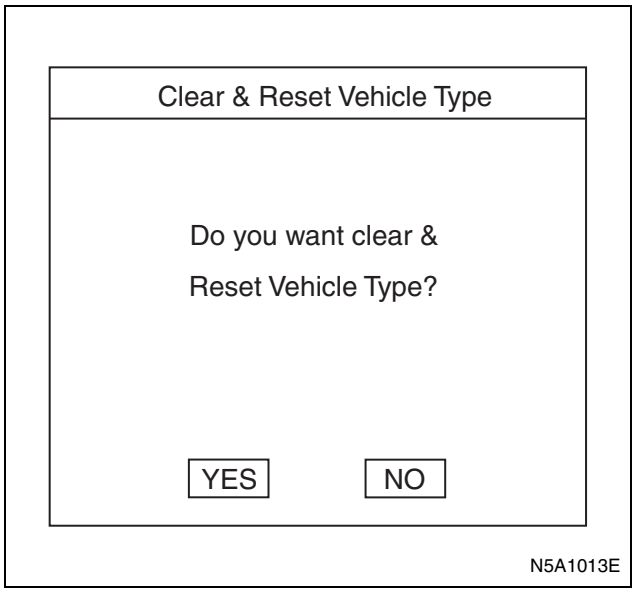
DTC Information Mode

Use the DTC info mode to search for a specific type of stored DTC information. There are two choices. The service manual may instruct the technician to test for DTCs in a certain manner. Always follow published service procedures.

When CODE "13" is Displayed (Vehicle Type Error)

Step	Action	Value(s)	YES	NO
1	Check harness. Is it okay?	—	Erase vehicle type with Tech 2 and reread harness information.	Replace the harness.





YES: Clear vehicle type and reread vehicle harness information.
NO: Return

DTC Status

Current Diagnostic Trouble Codes

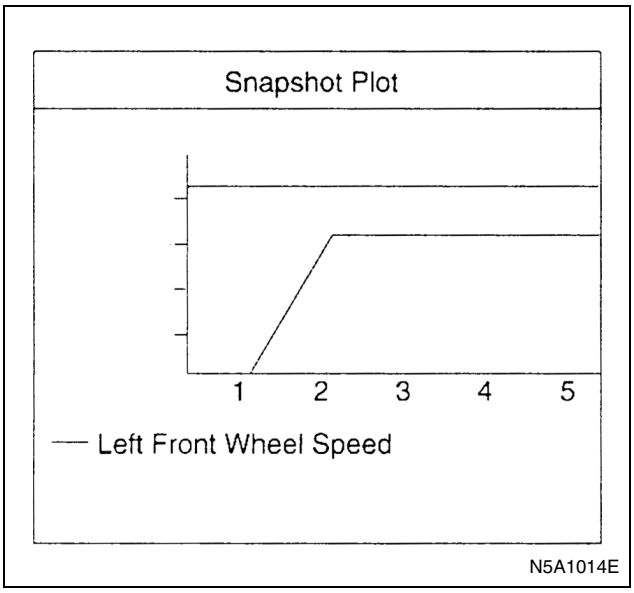
This selection will display all DTCs that have failed during the present ignition cycle.

History Diagnostic Trouble Codes

This selection will display only DTCs that are stored in the EHCU's history memory.

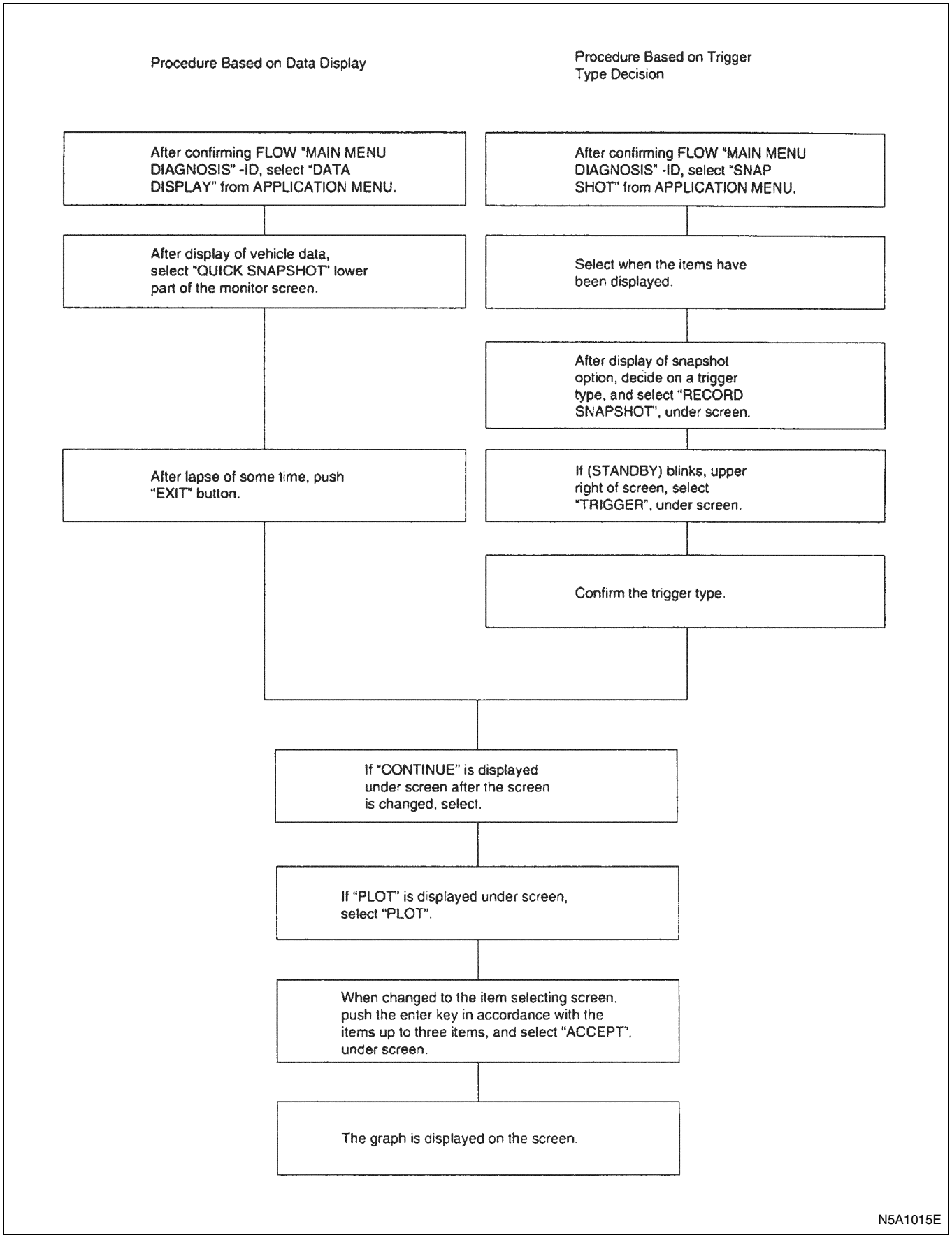
Plotting Snapshot Graph

This test selects several necessary items from the data list to plot graphs and makes data comparison on a long term basis. This test can check ABS performance and defect by graphing wheel speed differences between right and left sides, and front and rear sides obtained from the ABS data list menu.

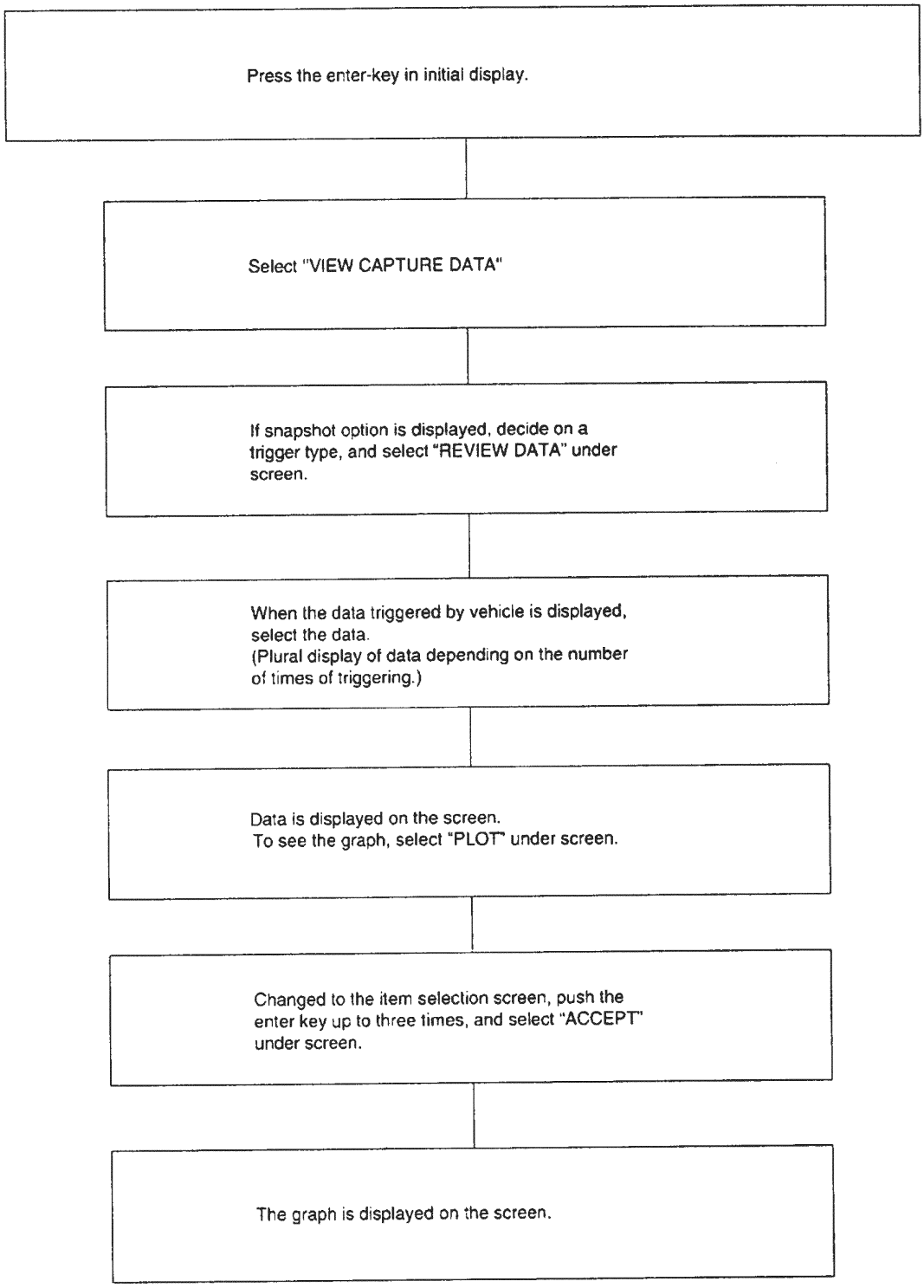


For trouble diagnosis, you can collect graphic data (snap shot) directly from the vehicle.
You can replay the snapshot data as needed.
Therefore, accurate diagnosis is possible, even though the vehicle is not available.

Plotting Graph Flow Chart (Plotting Graph after Obtaining Vehicle Information)



Flow Chart for Snapshot Replay (Plotting Graph)



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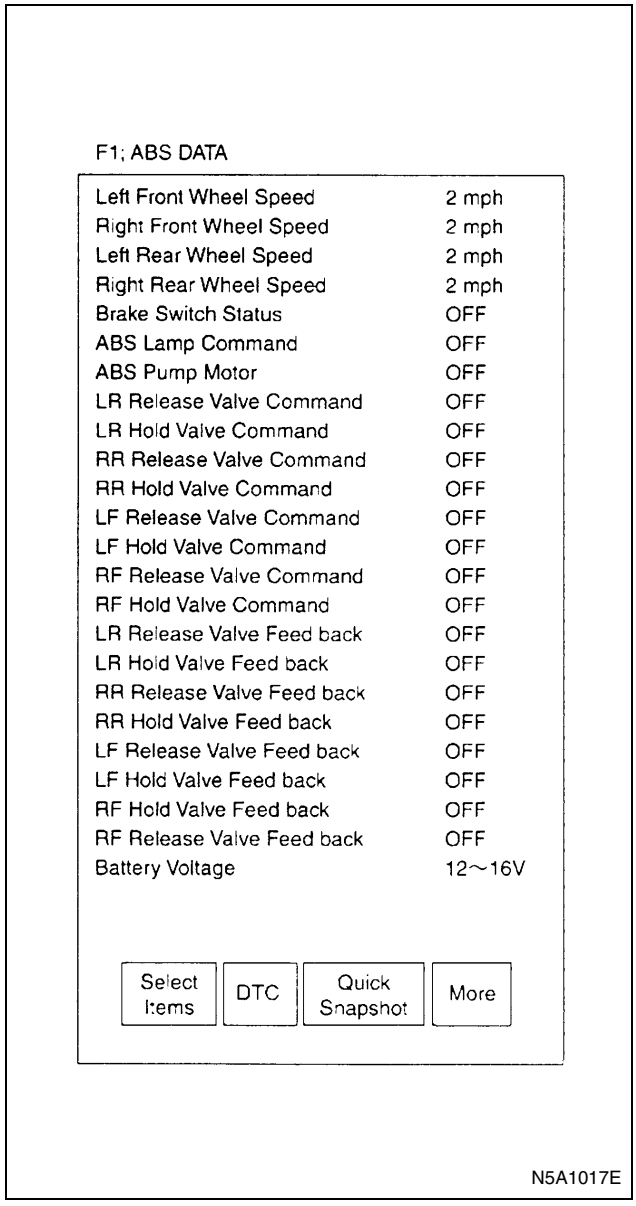
Tech 2 Data Display

Use the Tech 2 data Values only after the ABS Diagnostic System Check has been completed, no DTC(s) were noted, and you have determined that the on-board diagnostics are functioning properly. Tech 2 values from a properly-running engine may be used for comparison with the engine you are diagnosing.

ABS Data

Ignition SW is “ON” position.

(For example)



Special Function

There are 12 different menus available for this test.

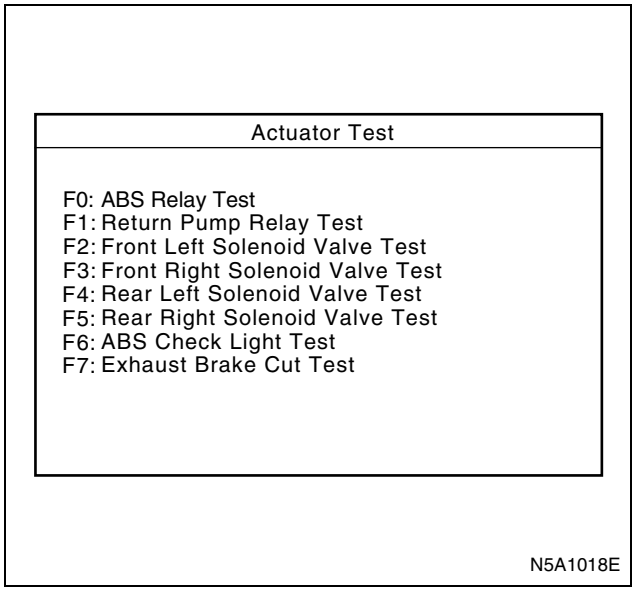
The state of each circuit can be tested by using these menus. Especially when DTC cannot be detected, a faulty circuit can be diagnosed by testing each circuit by means of these menus.

Even when DTC has been detected, the circuit tests using these menus could help discriminate between a mechanical trouble and an electrical trouble.

In all cases test condition; Engine stops with the key turned to the “ON” position. To be more specific, the test is conducted with the brake pedal stepped on after stepping once and releasing.

- Engine: Stop
- Ignition SW: ON
- Brake Pedal: ON-OFF-ON

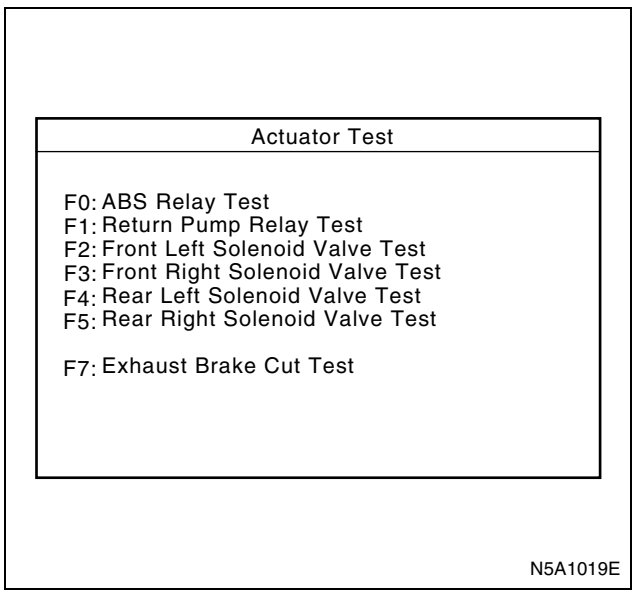
If the Ignition SW was turned OFF or communication was lost, make sure to apply the brake pedal ON-OFF-ON once again and then continue the test.



ABS Warning Lamp

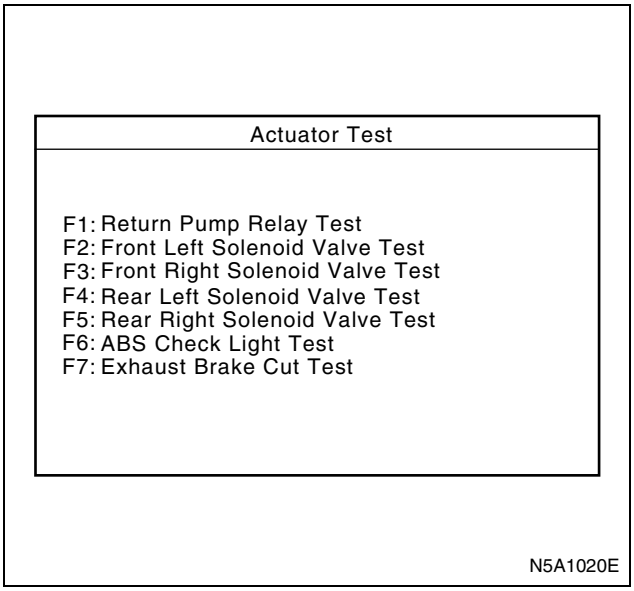
Test condition: Engine stops with the key turned to the “ON” position. To be more specific, the test is conducted with the brake pedal stepped on after stepping once and releasing.

- The circuit is normal if the warning light in the meter panel comes on and goes out in accordance with Tech 2’s instruction.



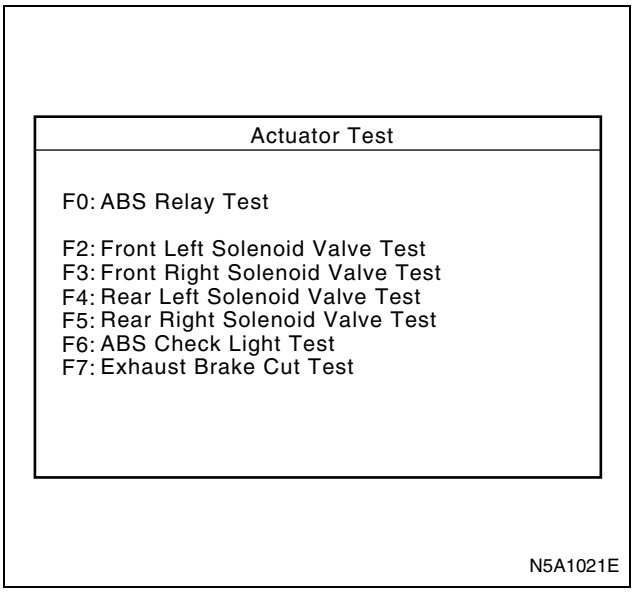
ABS Relay

Test condition: Engine stops with the key turned to the "ON" position. To be more specific, the test is conducted with the brake pedal stepped on after stepping once and releasing.
Make sure of the working sound of the ABS relay.
The circuit is normal if the working sound of the ABS relay is made in accordance with Tech 2's instruction.



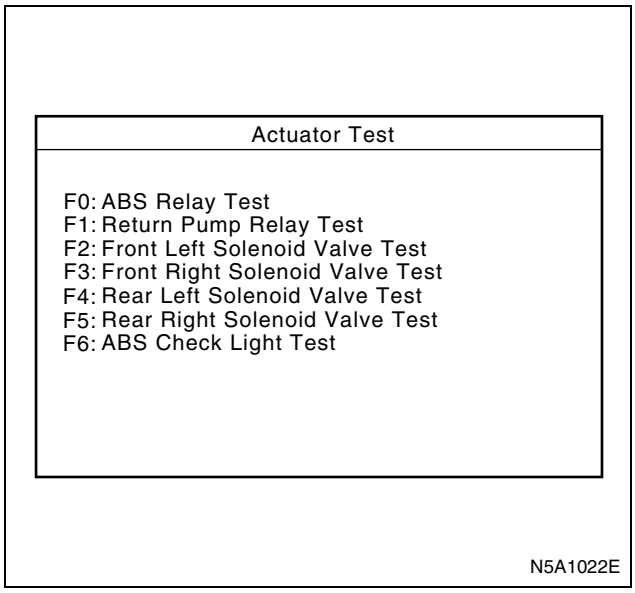
ABS Motor

Test condition: Engine stops with the key turned to the "ON" position. To be more specific, the test is conducted with the brake pedal stepped on after stepping once and releasing.
Make sure of the working sound of the ABS motor.
The circuit is normal if the working sound of the ABS motor is made in accordance with Tech 2's instruction.



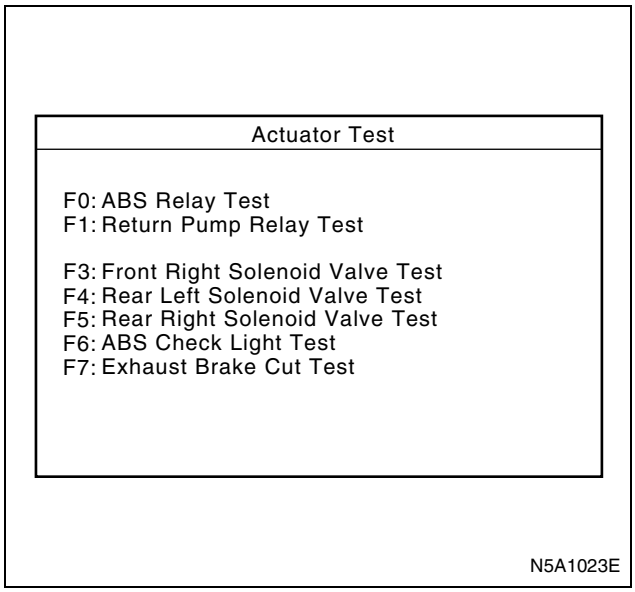
Exhaust Brake Cut Relay

Test condition: Engine stops with the key turned to the "ON" position. To be more specific, the test is conducted with the brake pedal stepped on after stepping once and releasing.
Make sure of the working sound of the exhaust brake cut relay.
The circuit is normal if the working sound of the exhaust brake cut relay is made in accordance with Tech 2's instruction.



Hold Valve Test

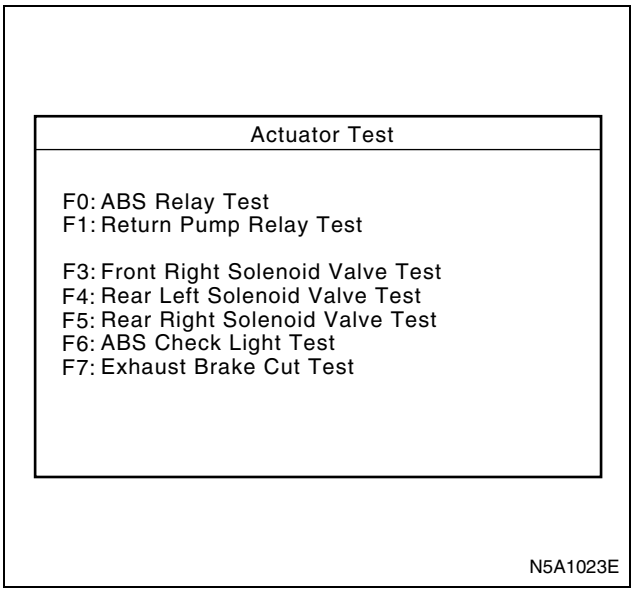
Purpose: The purpose of this test is to detect brake pipe and valve line harness wire wrong connections and valve trouble.
This test will help you confirm the result of your repair service including the removal/reinstallation of brake pipe, valve line harness and valve.



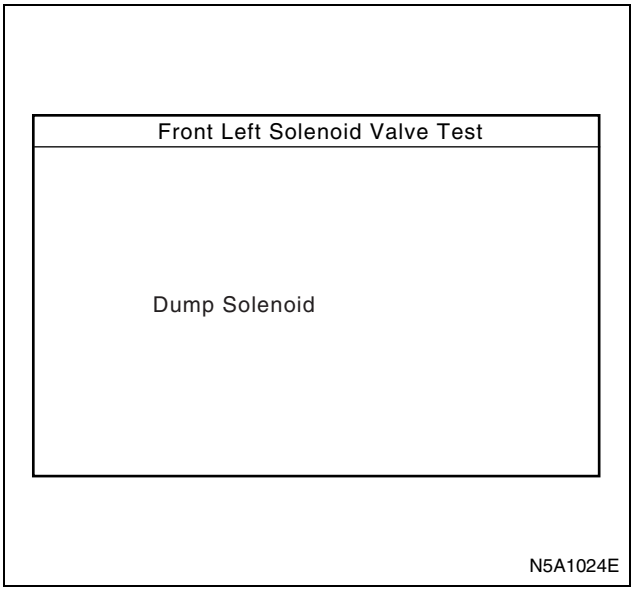
Test conditions: The ignition key is the “ON” position with the four wheels lifted up. The brake pedal is stepped on, released and stepped on again with the parking brake released.

Test procedure:

1. Connect Tech 2 with the vehicle, and select Special Function from the menus.
2. Select a Hold Valve Menu from the Special Function Menus.



Select a ISO Solenoid from the Front Left Solenoid Valve Test Function Menus.



3. Press the Hold Valve “ON” Soft Key with the brake pedal stepped on.
4. Release the brake pedal.
5. Make sure that the Hold Valve “ON” aimed at by Tech 2 and the wheel locked position are the same. If different, check brake pipe, valve line harness wiring and H/UNIT. Repair is needed if abnormality is found.
6. Conduct Step 2 through Step 5 above on all the four wheels.

Caution:

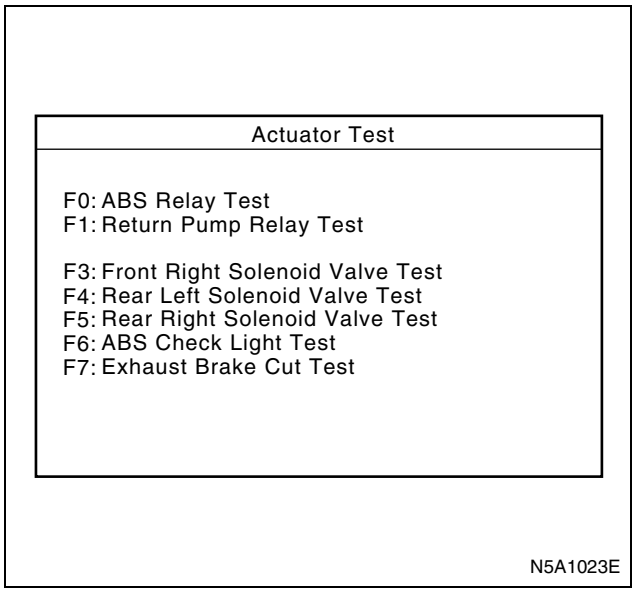
When conducting this test, please observe the following cautions.

1. Do not start the engine without fail.
2. Lift up the vehicle at the level floor.
   - Secure a clearance from the floor surface enough to allow the lifted tire to rotate.
3. Maintain the lift up.
4. Wipe the floor surface to remove water and oil so that the surface may become unslippery.
5. Do not load the vehicle.
   - When lifting up the vehicle, be sure to observe the lifting up points. Refer to vehicle lifting points in Section 0A GENERAL INFORMATION.

Release Valve Test

Purpose: The purpose of this test is to detect brake pipe and valve line harness wire wrong connections and valve trouble.

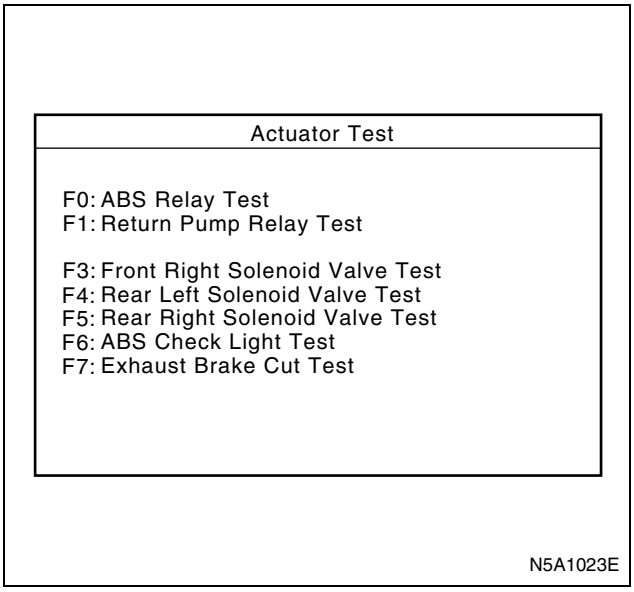
This test will help you confirm the result of your repair service including the removal/reinstallation of brake pipe, valve line harness and valve.



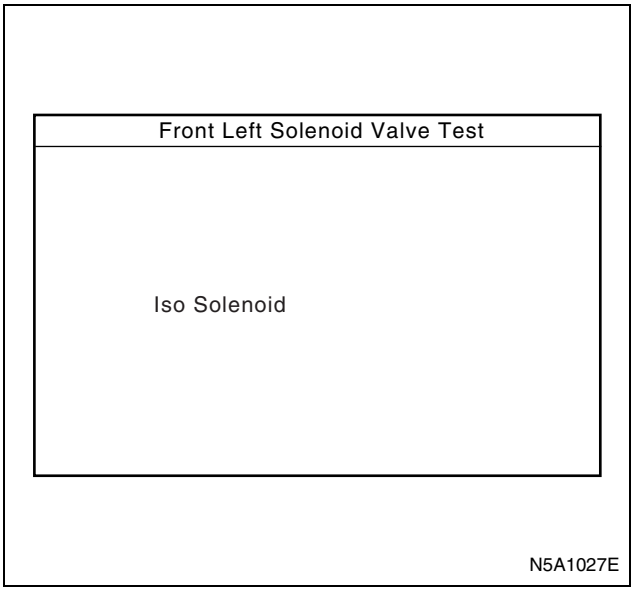
Test conditions: The ignition key is in the “ON” position with the four wheels lifted up. The brake pedal is stepped on, released and stepped on again with the parking brake released.

Test procedure:

1. Connect Tech 2 with the vehicle, and select Special Function from the menus.
2. Select a Release Valve Menu from the Special Function Menus.



Select a Dump Solenoid from the Front Left Solenoid Valve Test Function Menus.



3. Press the Release Valve “ON” Soft Key with the brake pedal stepped on.
4. Make sure that the Release Valve “ON” aimed at by Tech 2 and the wheel released position are the same. If different, check brake pipe, valve line harness wiring and H/UNIT. Repair is needed if abnormality is found.
5. Conduct Step 2 through Step 4 above on all the four wheels.

Caution:
When conducting this test, please observe the following cautions.

1. Do not start the engine without fail.
2. Lift up the vehicle at the level floor.
   - Secure a clearance from the floor surface enough to allow the lifted tire to rotate.
3. Maintain the lift up.
4. Wipe the floor surface to remove water and oil so that the surface may become unslippery.
5. Do not load the vehicle.
   - When lifting up the vehicle, be sure to observe the lifting up points. Refer to vehicle lifting points in Section 0A GENERAL INFORMATION.

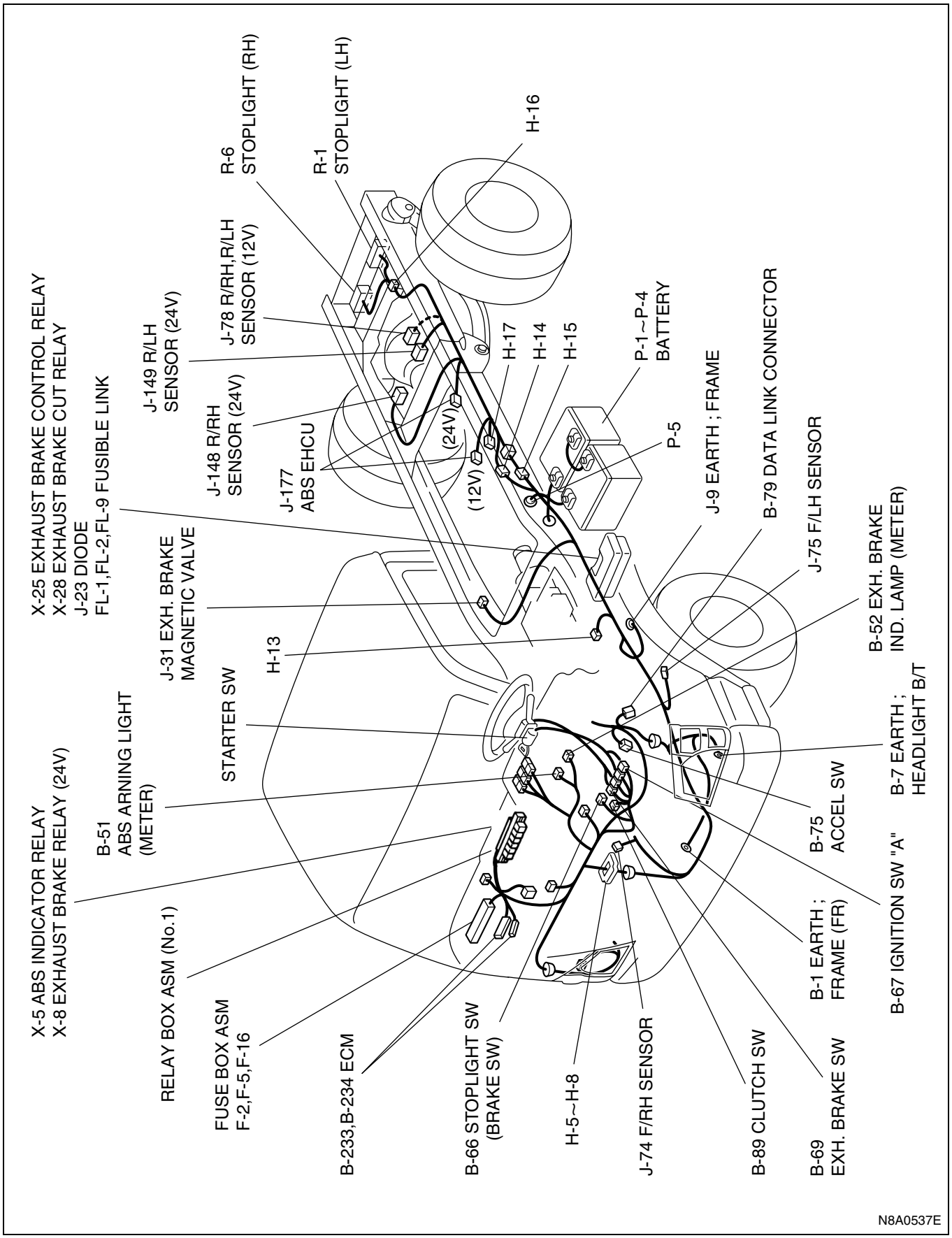
EHCU Connector Pin-out Checks

- Disconnect EHCU.
- Perform checks with high impedance digital multimeter 5-8840-0285-0 (J-39200) or equivalent.

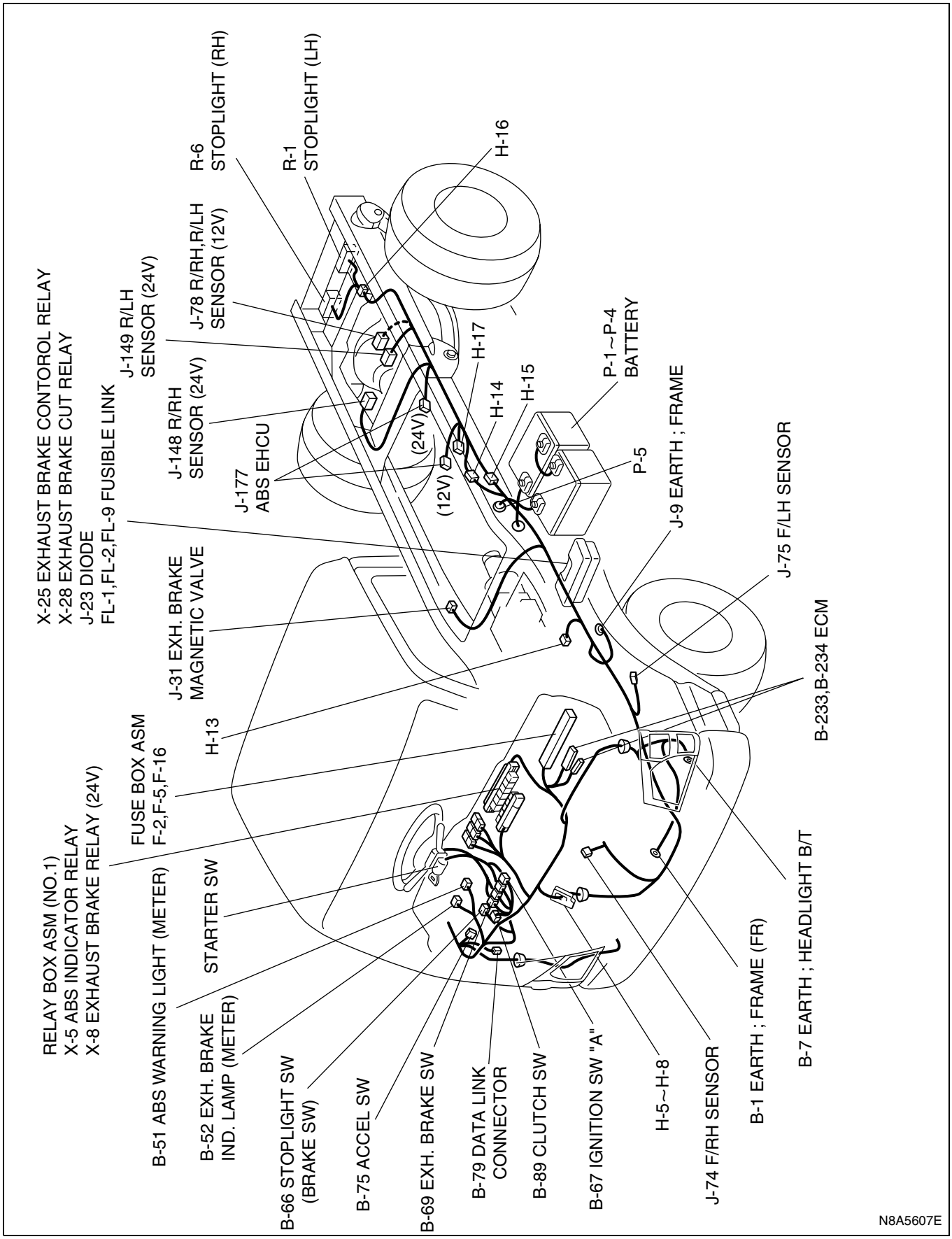
No.	Circuit to be Tested	Key Switch Position	Multimeter Scale/Range	Measure between Pin	Nominal Value (24 V Battery Vehicle)	Note
1	EHCU Power Circuit	OFF	VDC	3(+) — 1(–)	0 — 0.3 V	
		ON	VDC	3(+) — 1(–)	9.5 — 16.5 V (16.5 — 34 V)	
		OFF	VDC	2(+) — 1(–)	9.5 — 16.5 V (16.5 — 34 V)	
		OFF	VDC	24(+) — 1(–)	9.5 — 16.5 V (16.5 — 34 V)	
2	EHCU Ground Circuit	OFF	Ω	1(+) — GND	Less than 0.01 Ω	
		OFF	Ω	23(+) — GND	Less than 0.01 Ω	
3	EXHIN Circuit	ON	VDC	7(+) — 1(–)	9.5 — 16.5 V (16.5 — 34 V)	Engine Run
4	EXHOUT Circuit	ON	VDC	8(+) — 1(–)	9.5 — 16.5 V (16.5 — 34 V)	
		OFF	VDC	8(+) — 1(–)	0 — 0.3 V	
5	Brake Switch Signal Circuit	OFF	VDC	16(+) — 1(–)	0 — 0.3 V	
		OFF	VDC	16(+) — 1(–)	9.5 — 16.5 V (16.5 — 34 V)	Apply Brake Pedal
6	ABS W/L Circuit	ON	VDC	6(+) — 1(–)	9.5 — 16.5V (16.5 — 34 V)	
		OFF	VDC	6(+) — 1(–)	0 — 0.3 V	
7	FL Speed Sensor	OFF	kΩ	10(+) — 11(–)	1 — 2 kΩ	
		OFF	kΩ	10(+) — 1(–)	More than 1000 kΩ	
		OFF	VDC	10(+) — 11(–)	More than 200 mV	Turn Wheel at 0.5 RPS
8	FR Speed Sensor	OFF	kΩ	32(+) — 33(–)	1 — 2 kΩ	
		OFF	kΩ	32(+) — 1(–)	More than 1000 kΩ	
		OFF	VDC	32(+) — 33(–)	More than 200 mV	Turn Wheel at 0.5 RPS

Parts Location

For LHD Model

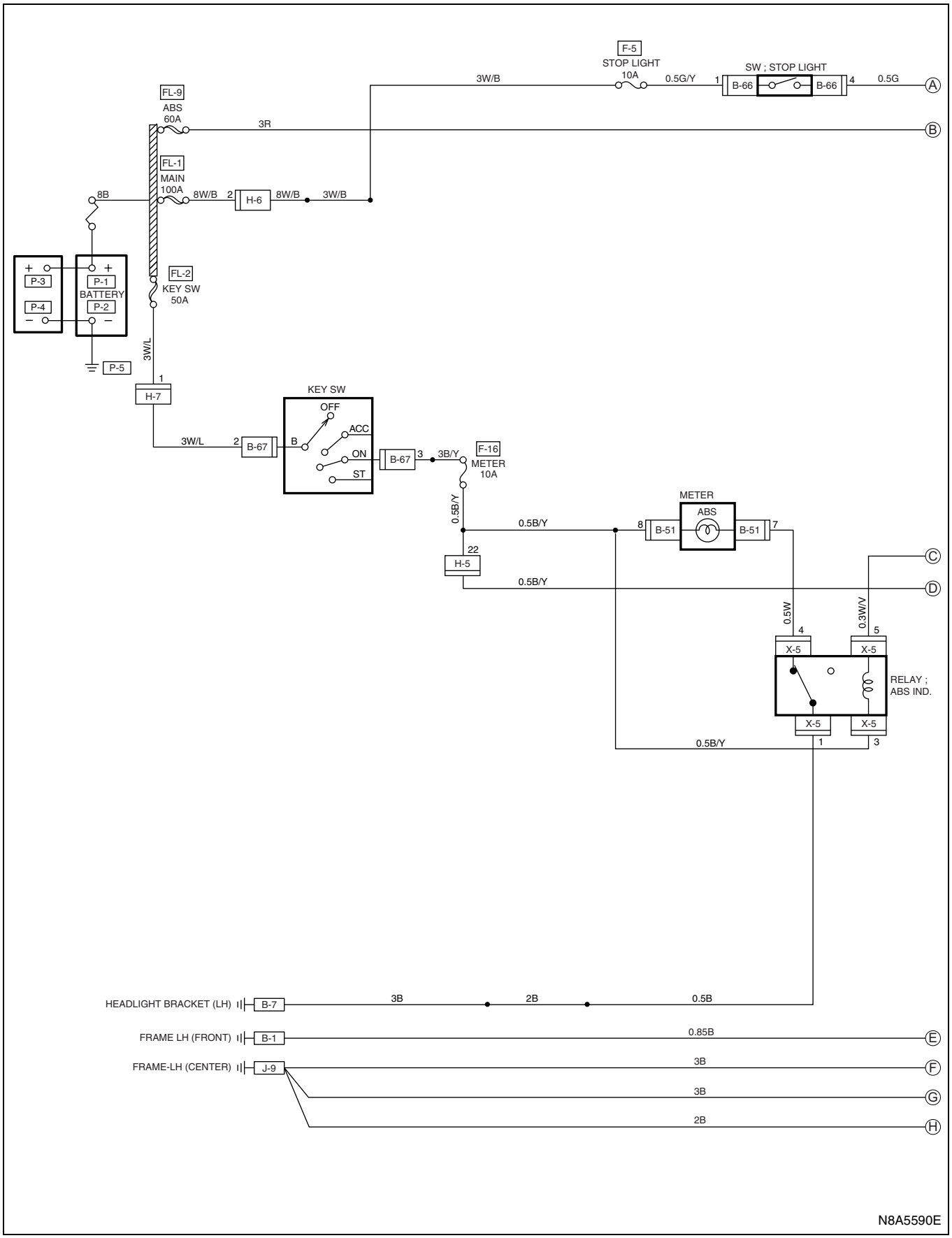


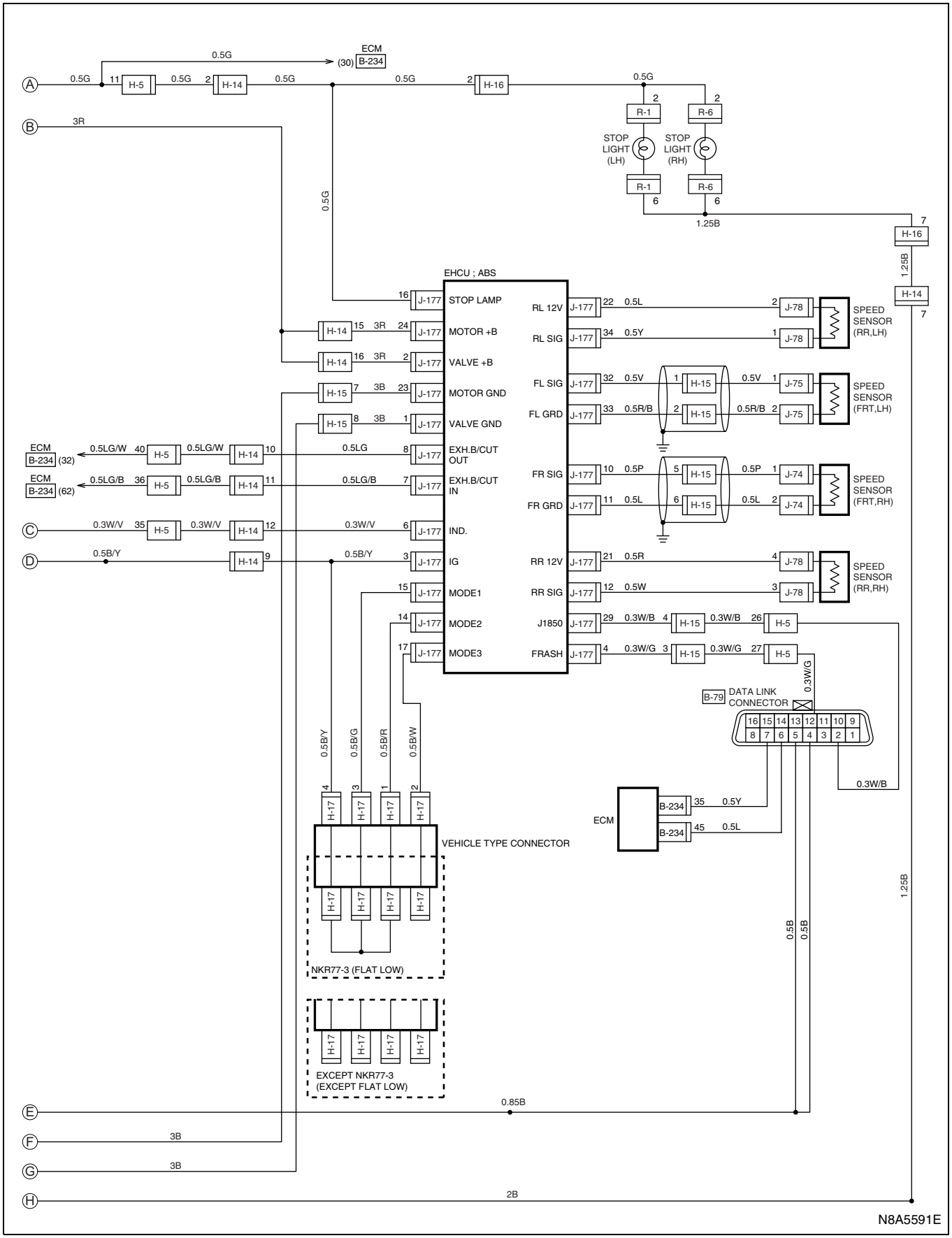
For RHD Model



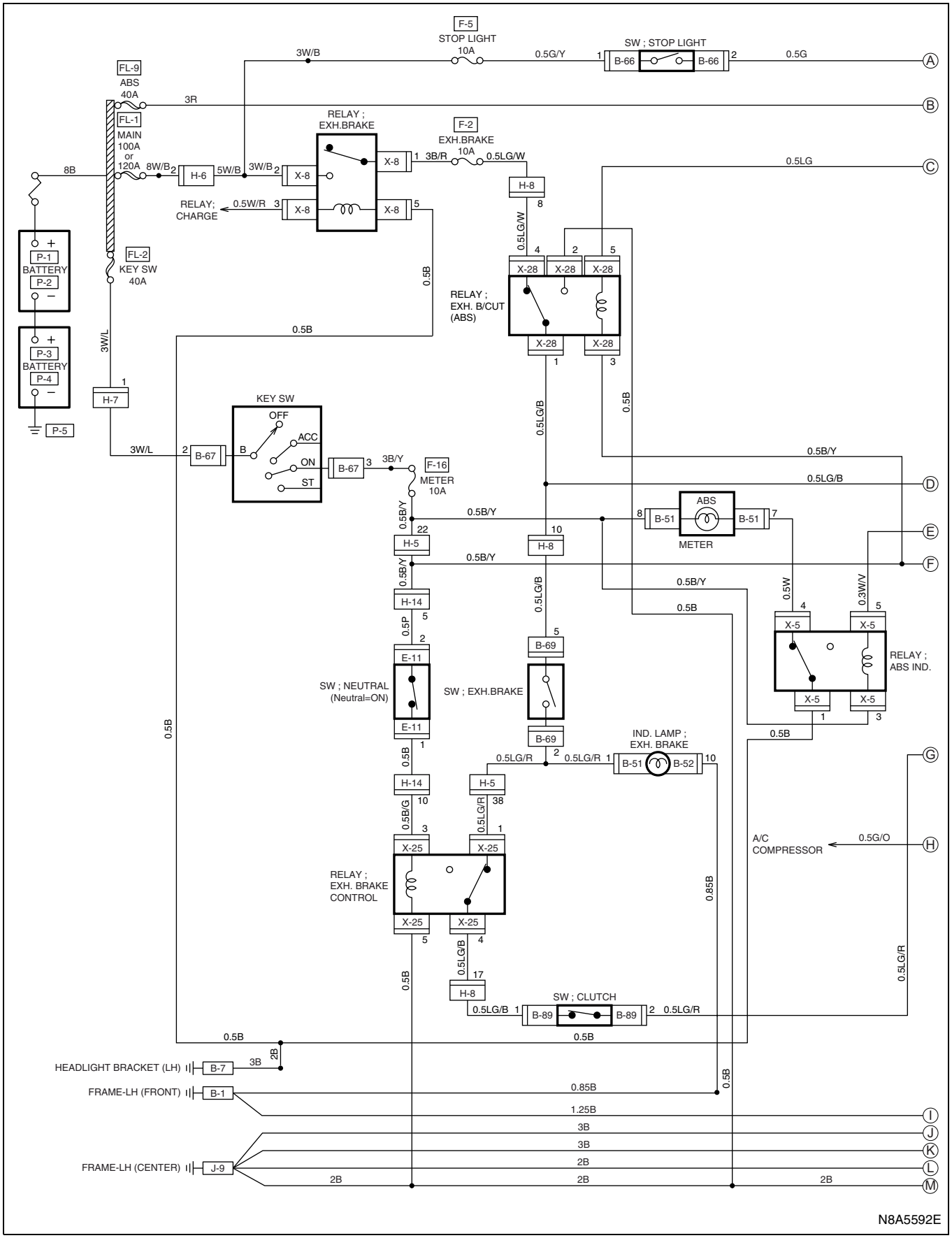
Circuit Diagram

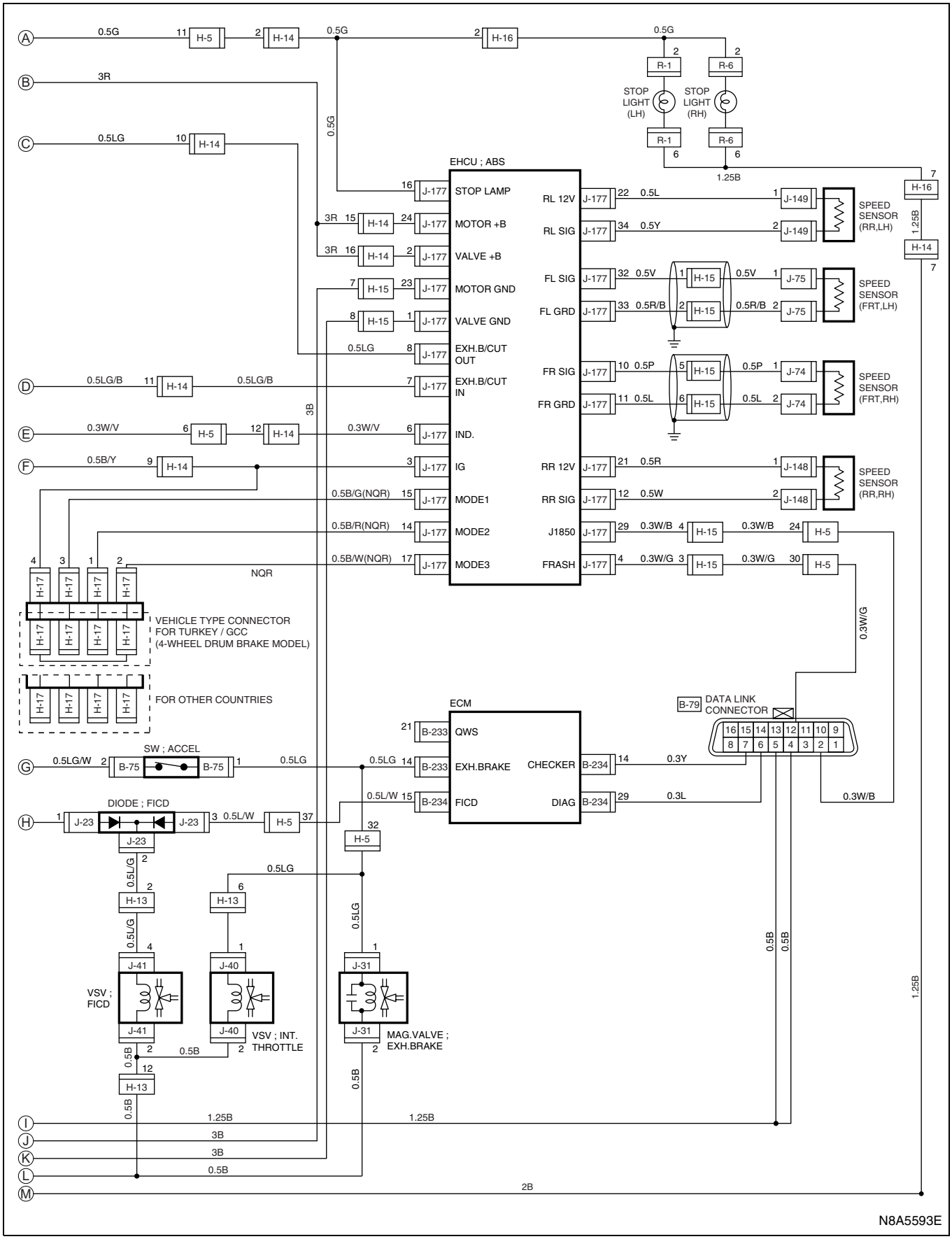
12 Volt (4JH1 Engine)



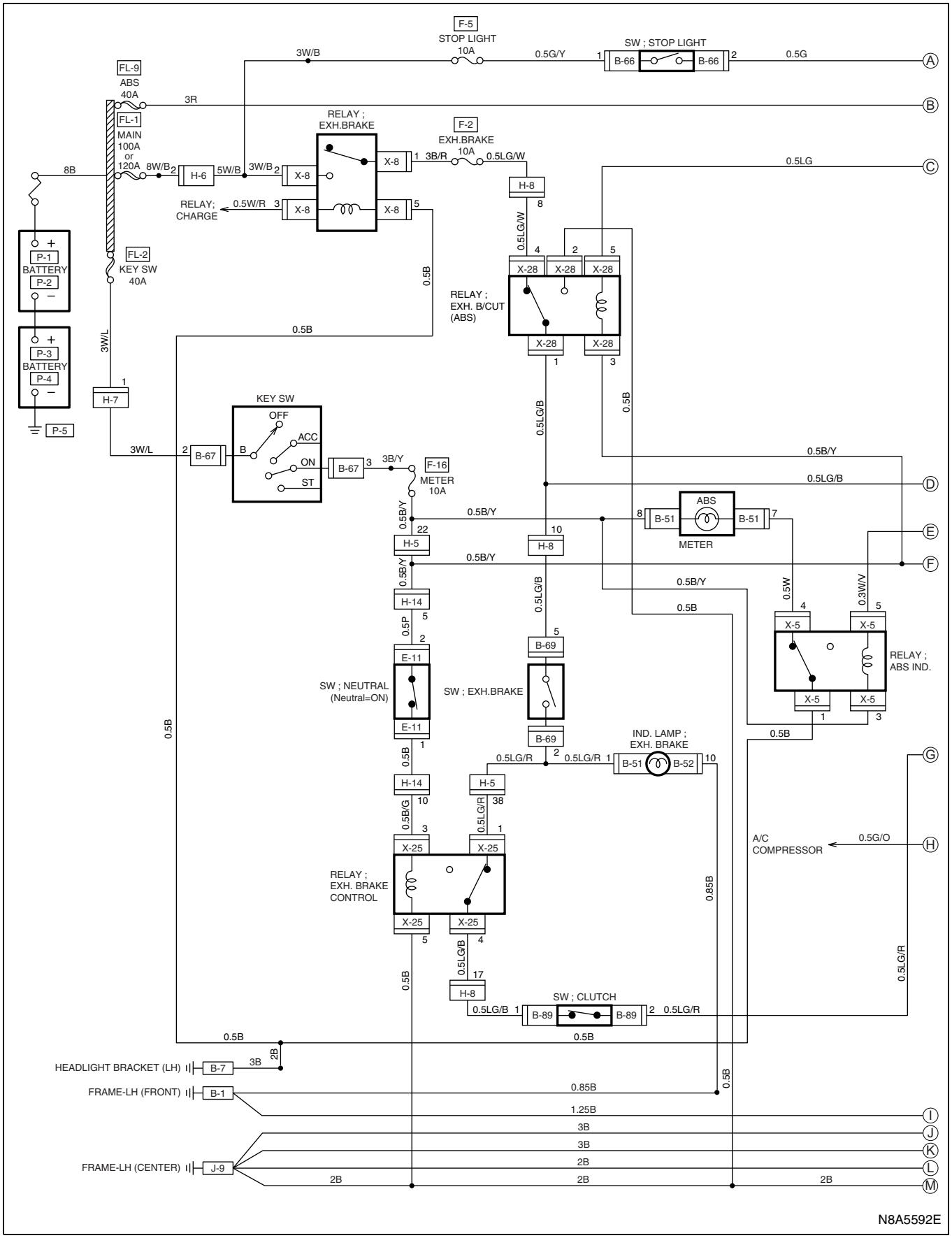

ECM
B-234
(30)
0.5G
A
B
C
D
E
F
G
H
H-5
H-14
H-16
R-1
R-6
STOP LIGHT (LH)
STOP LIGHT (RH)
3R
1.25B
EHCU ; ABS
J-177
STOP LAMP
MOTOR +B
VALVE +B
MOTOR GND
VALVE GND
EXH.B/CUT OUT
EXH.B/CUT IN
IND.
IG
MODE1
MODE2
MODE3
RL 12V
RL SIG
FL SIG
FL GRD
FR SIG
FR GRD
RR 12V
RR SIG
J1850
FRASH
J-78
J-75
J-74
SPEED SENSOR (RR,LH)
SPEED SENSOR (FRT,LH)
SPEED SENSOR (FRT,RH)
SPEED SENSOR (RR,RH)
H-15
0.5L
0.5Y
0.5V
0.5R/B
0.5P
0.5R
0.5W
0.3W/B
0.3W/G
B-79
DATA LINK CONNECTOR
16 15 14 13 12 11 10 9
8 7 6 5 4 3 2 1
0.5LG/W
0.5LG/B
0.3W/V
0.5B/Y
0.5LG
0.3B
0.5B/G
0.5B/R
0.5B/W
0.5B
0.85B
2B
H-17
VEHICLE TYPE CONNECTOR
NKR77-3 (FLAT LOW)
EXCEPT NKR77-3
(EXCEPT FLAT LOW)
N8A5591E

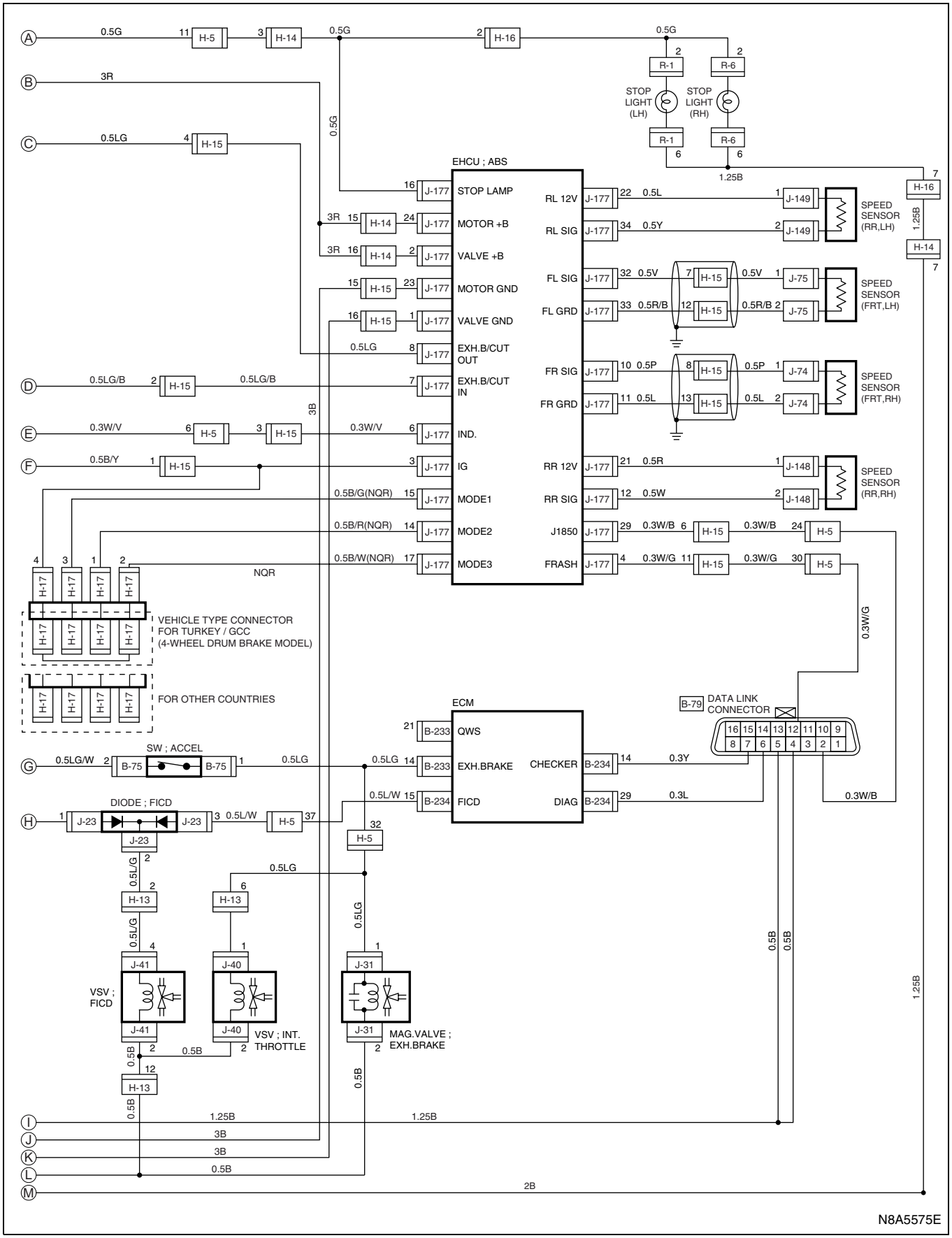
24 Volt (4HE1 Engine, Single Cab Model)




EHCU ; ABS
STOP LAMP
MOTOR +B
VALVE +B
MOTOR GND
VALVE GND
EXH.B/CUT OUT
EXH.B/CUT IN
IND.
IG
MODE1
MODE2
MODE3
RL 12V
RL SIG
FL SIG
FL GRD
FR SIG
FR GRD
RR 12V
RR SIG
J1850
FRASH
SPEED SENSOR (RR,LH)
SPEED SENSOR (FRT,LH)
SPEED SENSOR (FRT,RH)
SPEED SENSOR (RR,RH)
STOP LIGHT (LH)
STOP LIGHT (RH)
VEHICLE TYPE CONNECTOR FOR TURKEY / GCC (4-WHEEL DRUM BRAKE MODEL)
FOR OTHER COUNTRIES
NQR
ECM
QWS
EXH.BRAKE
FICD
CHECKER
DIAG
B-79 DATA LINK CONNECTOR
SW ; ACCEL
DIODE ; FICD
VSV ; FICD
VSV ; INT. THROTTLE
MAG.VALVE ; EXH.BRAKE
N8A5593E

24 Volt (4HE1 Engine, Crew Cab Model)




EHCU ; ABS
STOP LAMP
MOTOR +B
VALVE +B
MOTOR GND
VALVE GND
EXH.B/CUT OUT
EXH.B/CUT IN
IND.
IG
MODE1
MODE2
MODE3
RL 12V
RL SIG
FL SIG
FL GRD
FR SIG
FR GRD
RR 12V
RR SIG
J1850
FRASH
SPEED SENSOR (RR,LH)
SPEED SENSOR (FRT,LH)
SPEED SENSOR (FRT,RH)
SPEED SENSOR (RR,RH)
STOP LIGHT (LH)
STOP LIGHT (RH)
VEHICLE TYPE CONNECTOR FOR TURKEY / GCC (4-WHEEL DRUM BRAKE MODEL)
FOR OTHER COUNTRIES
NQR
ECM
QWS
EXH.BRAKE
FICD
CHECKER
DIAG
DATA LINK CONNECTOR
SW ; ACCEL
DIODE ; FICD
VSV ; FICD
VSV ; INT. THROTTLE
MAG.VALVE ; EXH.BRAKE
N8A5575E

Connector List

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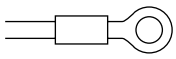
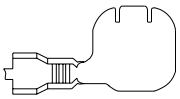
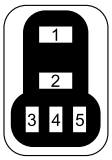
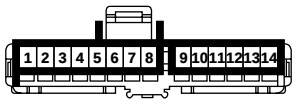
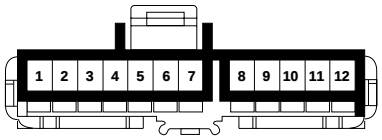
B-1	 000-001
B-7	 000-012
X-5	 005-006
B-51	 014-001
B-52	 012-005
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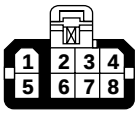
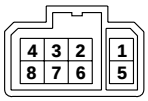
B-67	004-001
B-67	004-002
B-69	 008-001
B-69	 008-002
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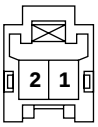
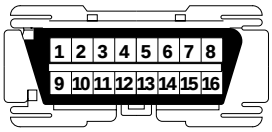
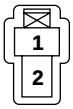
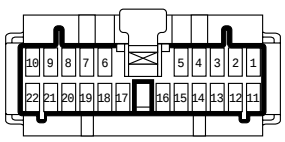
B-75	 002-023
B-79	 016-005
B-89	002-009
B-89	 002-010
B-233 (24 V)	 022-002

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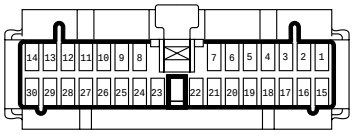
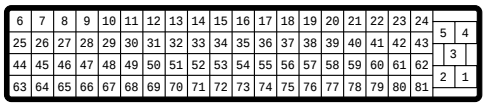
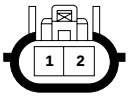
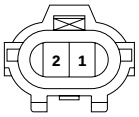
B-234 (24 V)	 030-002
B-234 (12 V)	 121-001
E-11	 002-001
E-11	 002-002
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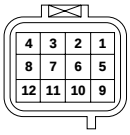
H-13	 012-002
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H-14 (12 V)	014-005

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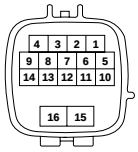
H-14 (24 V)	 016-004
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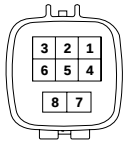
H-15 (12 V)	 008-024
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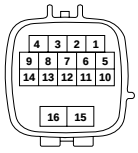
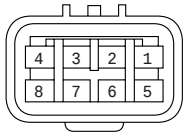
H-15 (24 V)	 016-004
H-16	008-003
H-16	 008-004

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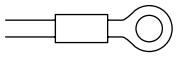
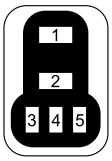
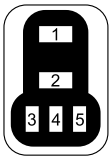
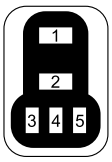
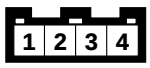
J-9	 000-001
X-8 (24 V)	 005-006
X-25 (24 V)	 005-006
X-28	 005-006
J-23	 004-009
J-31	002-011
J-31	002-012

No.	Connector Face
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J-41	002-015
J-74	002-011
J-74	002-012
J-75	002-011
J-75	002-012
J-148	002-011
J-148	002-012

No.	Connector Face
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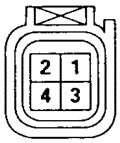
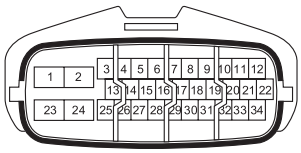
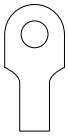
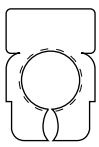
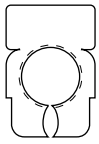
J-149 (24 V)	002-012
J-78 (12 V)	 004-018
J-78 (12 V)	004-011
J-177	 034-001
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004

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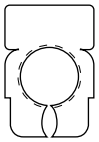
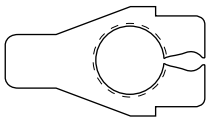
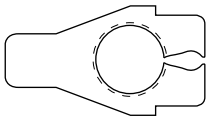
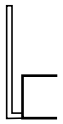
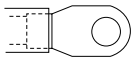
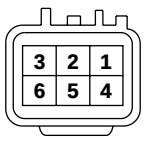
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
P-5 (12 V)	 000-007
P-5 (24 V)	 000-002
R-1	006-004
R-1	 006-005
R-6	006-004

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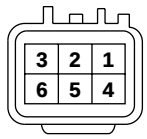
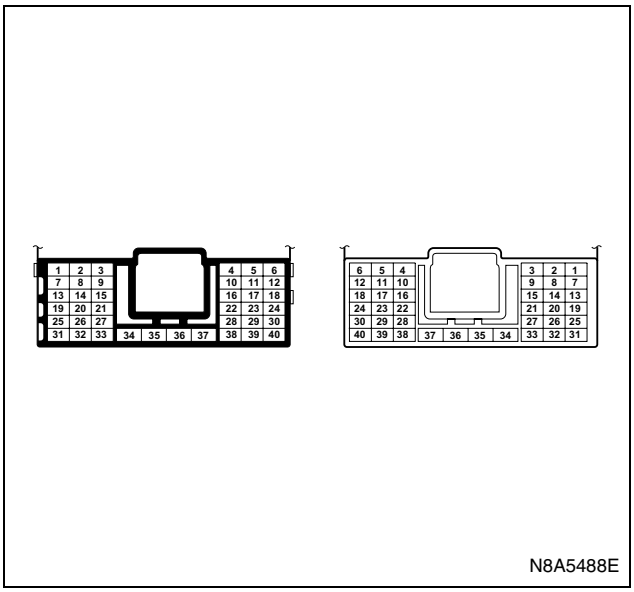
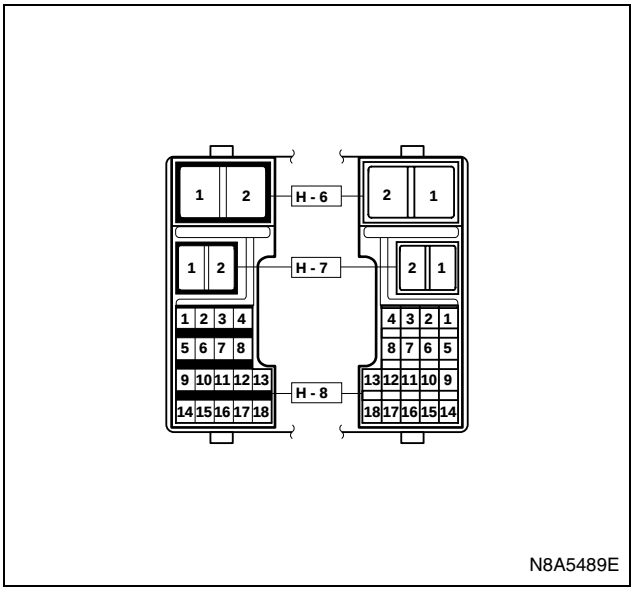
R-6	 006-005

H-5



N8A5488E

H-6, H-7, H-8



N8A5489E

SYMPTOM DIAGNOSIS

Symptom Diagnosis

The symptoms that cannot be indicated by the warning light can be divided in the following five categories:

1. ABS works frequently but vehicle does not decelerate.
2. Uneven braking occurs while ABS works.
3. The wheels lock during braking.
4. Brake pedal feel is abnormal.
5. ABS operating sound (from Hydraulic Unit) is heard while not braking.

These are all attributable to problems which cannot be detected by EHCU self-diagnosis. Use the customer complaint and a test to determine which symptom is present. Then follow the appropriate flow chart listed below.

No.	Symptom	Diagnostic Flow Charts	
		Without Tech 2	With Tech 2
1	ABS works frequently but vehicle does not decelerate.	Chart A-1	Chart TA-1
2	Uneven braking occurs while ABS works.	Chart A-2	Chart TA-2
3	The wheels are locked.	Chart A-3	Chart TA-3
4	ABS operating sound (from Hydraulic Unit) is heard while not braking.	Chart A-4	Chart TA-4

Chart A-1 ABS Works Frequently But Vehicle Does Not Decelerate

Step	Action	Value(s)	YES	NO
1	Inspect the tires. Are tire sizes as specified? Isn't there any abnormal wear?	—	Go to Step 2	Repair tires. Go to Step 2
2	Is braking force distribution normal between the front and rear of the vehicle?	—	Go to Step 3	Repair brake parts. Go to Step 7
3	Are axle parts installed normally?	—	Go to Step 4	Repair axle parts. Go to Step 7
4	Is there play in each wheel speed sensor?	—	Go to Step 5	Repair wheel speed sensor. Go to Step 7
5	Is there damage, or powdered iron sticking to each wheel speed sensor/sensor rotor?	—	Go to Step 6	Replace sensor or sensor rotor. Go to Step 7
6	Is the output of each wheel speed sensor normal? (Refer to chart C-1-1 to C-1-4 or TC-1)	—	Replace EHCU. Go to Step 7	Replace wheel speed sensor or repair harness. Go to Step 7
7	Reconnect all components and ensure all components are properly mounted. Was this step finished?	—	Repeat the "Basic diagnostic flow chart".	—

Chart TA-1 ABS Works Frequently But Vehicle Does Not Decelerate (Use Tech 2)

Step	Action	Value(s)	YES	NO
1	Return to Chart A-1. Was the Chart A-1 from Step 1 to Step 4 finished?	—	Go to Step 2	Repair tires. Go to Step 1
2	1. Connect Tech 2. 2. Confirm the output from each wheel sensor on DATA DISPLAY. Is the minimum vehicle speed output from each sensor stable at 4 km/h (3 mph) or less?	—	Go to Step 3	Replace wheel speed sensor. Go to Step 4
3	Return to Chart A-1. Was the Chart A-1 finished?	—	Go to Step 4	Go to Step 3
4	Reconnect all components, ensure all components are properly mounted. Was this step finished?	—	Repeat the “Basic diagnostic flow chart”.	—

Chart A-2 Uneven Braking Occurs While ABS Works

Step	Action	Value(s)	YES	NO
1	Is there play in each sensor?	—	Go to Step 2	Repair. Go to Step 5
2	Damage or powdered iron sticking to each sensor/sensor rotor?	—	Go to Step 3	Repair. Go to Step 5
3	Is the output of each sensor normal? (Refer to chart C-1-1 to C-1-4 or TC-1)	—	Go to Step 4	Replace sensor or repair harness. Go to Step 5
4	Is brake pipe connecting order correct?	—	Replace EHCU. Go to Step 5	Reconnect brake pipe correctly. Go to Step 5
5	Reconnect all components, ensure all components are properly mounted. Was this step finished?	—	Repeat the “Basic diagnostic flow chart”.	—

Chart TA-2 Uneven Braking Occurs While ABS Works (Use Tech 2)

Step	Action	Value(s)	YES	NO
1	1. Connect Tech 2. 2. WHEEL SENSORS make sure of the output conditions of each sensor. Is the output of each sensor normal?	—	Go to Step 2	Replace wheel speed sensor. Go to Step 3
2	Check the brake pipe connecting. Is brake pipe connecting order correct?	—	Replace EHCU. Go to Step 4	Repair brake pipe. Go to Step 4
3	Check the wheel speed sensor and repair if necessary (Refer to chart C-1-1 to C-1-4 or TC-1). Is each chart complete?	—	Go to Step 4	Go to Step 3
4	Reconnect all components, ensure all components are properly mounted. Was this step finished?	—	Repeat the “Basic diagnostic flow chart”.	—

Chart A-3, TA-3 The Wheels Are Locked

Step	Action	Value(s)	YES	NO
1	Is ABS working?	—	Go to Step 2	Go to Step 4
2	Is vehicle speed under 10 km/h (6 mph)?	—	Go to Step 3	Normal.
3	Is sensor output normal? (Chart C-1-1 to C-1-4 or TC-1)	—	Go to Step 4	Replace sensor or repair harness. Go to Step 5
4	Is hydraulic unit grounded properly?	—	Replace hydraulic unit. Go to Step 5	Correct. Go to Step 5
5	Reconnect all components, ensure all components are properly mounted. Was this step finished?	—	Repeat the “Basic diagnostic flow chart”.	—

Chart A-4, TA-4 Braking Sound (from Hydraulic Unit) Is Heard While Not Braking

Step	Action	Value(s)	YES	NO
1	Is this the first time the vehicle is being driven after starting the engine?	—	It is self checking sound. Normal.	Go to Step 2
2	Is vehicle speed under 10 km/h (6 mph)?	—	It is self checking sound. Normal.	Go to Step 3
3	Check for the following condition: • At the time of shift down or clutch operation. • At the time of low μ drive (ice or snow road) or rough road drive. • At the time of high-speed turn. • At the time of passing curb. • At the time of operating electrical equipment switches. • At the time of racing the engine. Did it occur under any one condition above?	—	ABS may sometime be actuated even when brake pedal is not applied.	Go to Step 4
4	Is there play in each sensor/wheel speed sensor rotor?	—	Go to Step 5	Repair. Go to Step 7
5	Damage or powdered iron sticking to each sensor/wheel speed sensor rotor?	—	Repair. Go to Step 7	Go to Step 6
6	Is each sensor output normal? (Refer to chart C-1-1 to C-1-4 or TC-1).	—	Check harness/ connector for suspected disconnection. If no disconnection is found, replace EHCU. Go to Step 7	Repair. Go to Step 7
7	Reconnect all components, ensure all components are properly mounted. Was this step finished?	—	Repeat the “Basic diagnostic flow chart”.	—

DIAGNOSTIC TROUBLE CODES

Diagnostic Trouble Codes

Choose and trace an appropriate flowchart by the numbers listed below to find fault and repair.

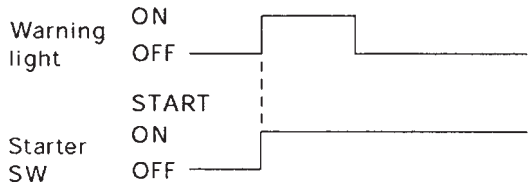
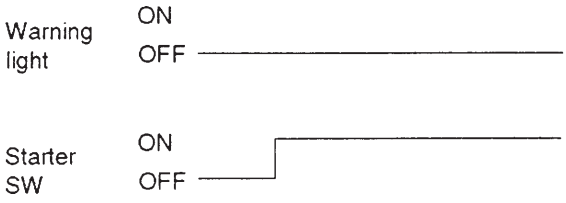
Code		Diagnosis	Item (except Wiring)	Chart No.
Flash out	Serial Communications			
12	—	Normal	—	—
13	C0213	Vehicle Type Error	EHCU	1
14	C0214	EHCU Abnormality	EHCU	2
15	C0215	Low Power Voltage	EHCU	3
25	C0225	Exhaust Brake Cut Circuit Abnormality	Relay or EHCU	4
33	C0233	Motor Drive Circuit Abnormality	EHCU	5
34	C0234	Abnormal Motor Rotation	EHCU	6
41	C0241	Solenoid Valve Power Supply Abnormality	EHCU	7
43	C0243	Solenoid Valve Circuit Abnormality	EHCU	8
45	C0245	Solenoid Valve Circuit Abnormality		
51	C0251	FL Speed Sensor Circuit Abnormality	Sensor, EHCU	9
52	C0252	FR Speed Sensor Circuit Abnormality		10
53	C0253	RL Speed Sensor Circuit Abnormality		11
54	C0254	RR Speed Sensor Circuit Abnormality		12
61	C0261	Abnormal FL Speed Sensor Signal		13
62	C0262	Abnormal FR Speed Sensor Signal		14
63	C0263	Abnormal RL Speed Sensor Signal		15
64	C0264	Abnormal RR Speed Sensor Signal		16

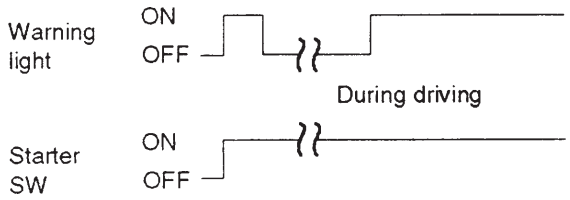
* Important: DTC 20 (Reference Voltage High) cannot be indicated by Tech 2. DTC 20 can be indicated and confirmed by flashing using Diagnosis Switch.

DIAGNOSIS BY “ABS” WARNING LIGHT ILLUMINATION PATTERN

Diagnosis by “ABS” Warning Light Illumination Pattern

In the event that there is abnormality in the “ABS” warning light illumination pattern while the key is in the ON position or if the warning light is actuated during driving, trouble should be diagnosed on a illumination pattern basis as follows:

No.	Condition	“ABS” Warning Light Illumination Pattern	Diagnostic
1	Warning light is actuated normally	 N5A1061E	Normal
2	Warning light is not lit	 N5A1062E	Warning light lighting circuit trouble → Go to Chart B-1

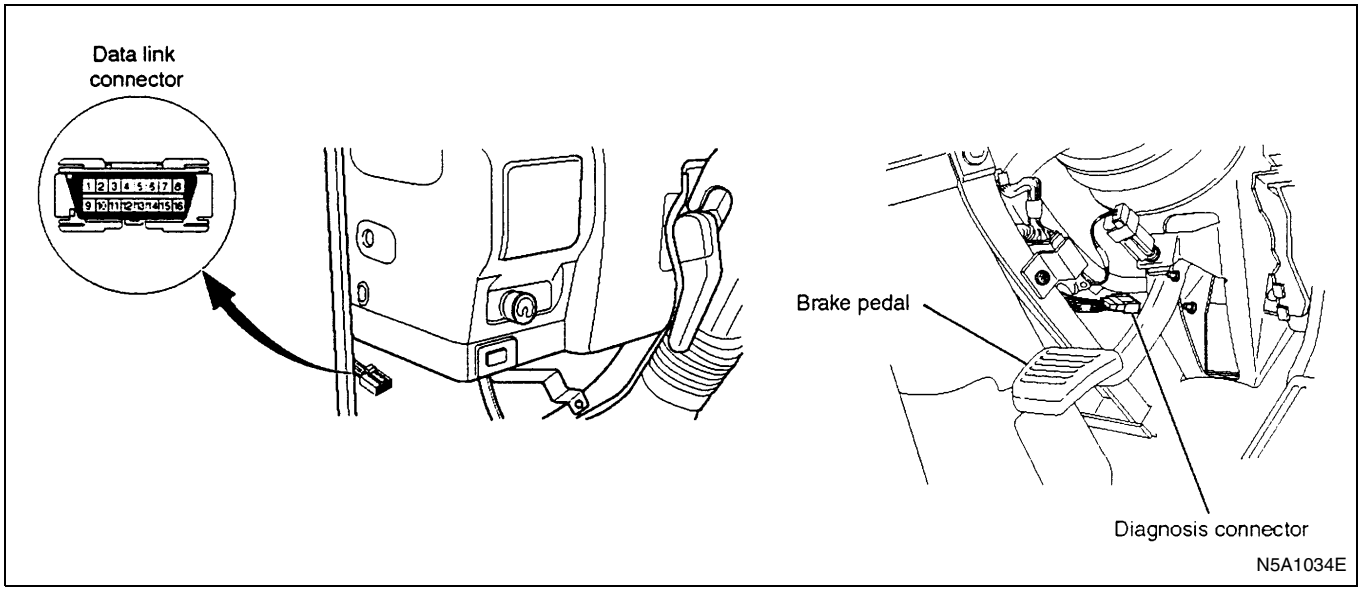
No.	Condition	"ABS" Warning Light Illumination Pattern	Diagnostic
3	Warning light is actuated while driving	 N5A1063E	Diagnostic trouble codes are stored. Display diagnostic trouble codes and diagnose on a code basis according to the flow charts.

Diagnostic Trouble Codes (DTCs)

When the warning light in the meter remains ON, the EHCU stores the fault identification and disables the ABS.

1. How to start DTC display:
   - Confirm that the vehicle has come to a complete stop (with the wheels standing still) and that the brake pedal is not depressed.
     (Unless these two conditions are satisfied, DTC display cannot be started.)
   - With the key switch OFF and short B-79 diagnosis connector terminal 12 to ground.
     Then turn the key switch ON.
   - DTCs can be displayed also by Tech 2.

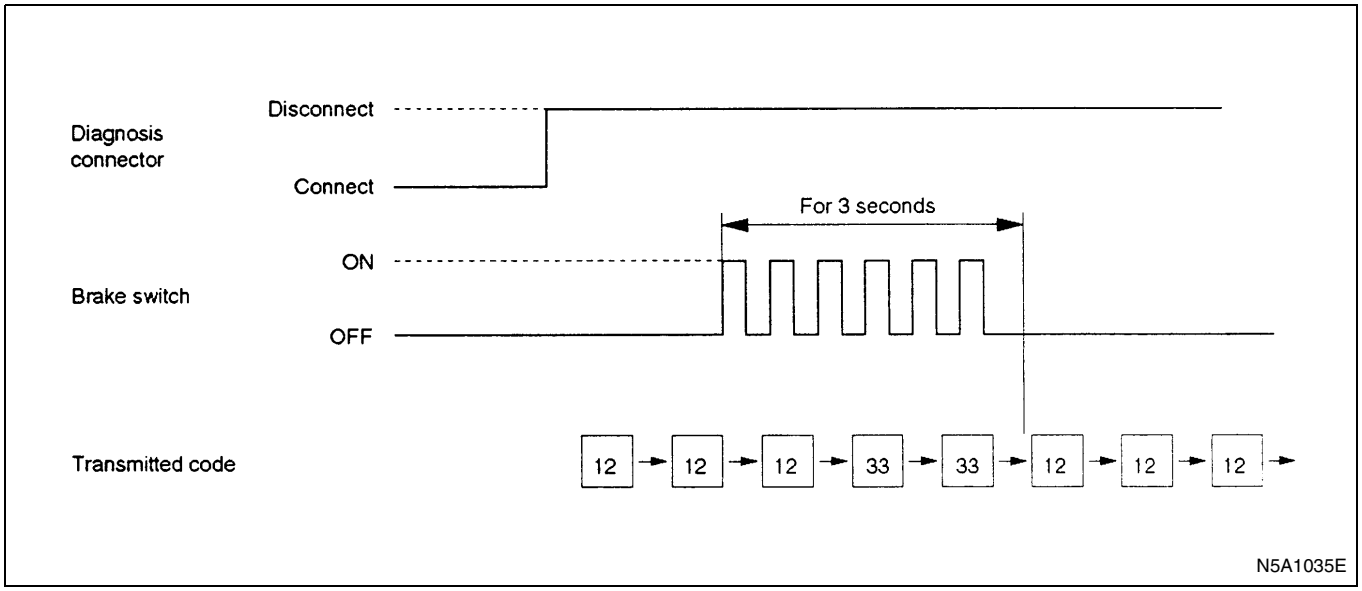
The DLC (for Tech 2) Is Located Behind The Driver Side Lower Cluster Panel



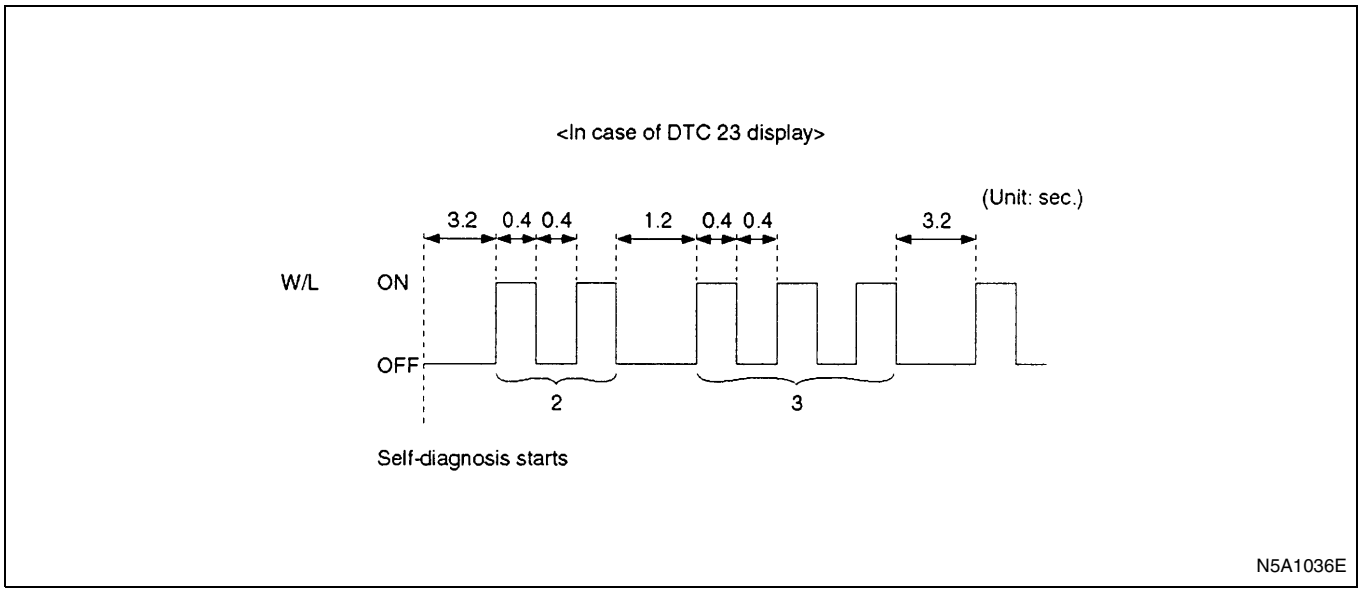
N5A1034E

2. DTC display:
   - DTC is displayed by blinking warning light.
   - Double-digit display.
   - First, normal DTC 12 is displayed three times and then any other DTCs are displayed three times. (If no other DTCs have been stored, the display of DTC 12 will be repeated.)

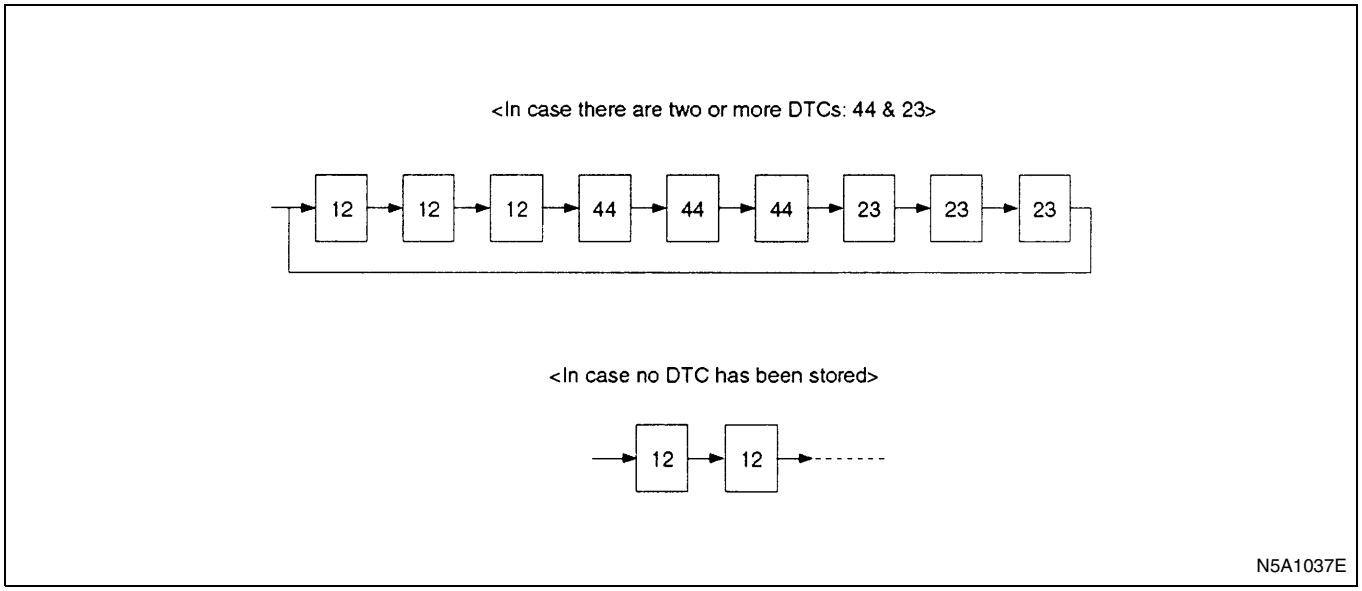
3. How to erase code:
   - Conduct brake switch ON/OFF operation 6 or more times within 3 seconds of self-diagnosis startup.
   - The code cannot be erased if more than 3 seconds have passed since self-diagnosis startup, or if self-diagnosis has started with brake switched on (brake pedal depressed).
   - DTCs can be erased also by Tech 2.



4. An example of DTC display
   Display of DTC 23



After displaying DTC 12 three times, one DTC after another is displayed, starting with the most recent one. (However, display is discontinued after about 5 minutes.)
The DTC 12 is displayed repeatedly. (display is discontinued after about 5 minutes)



5. How to display vehicle model:
   1) Turn the key switch OFF.
   2) Short the diagnosis connector terminal 12 to ground.
   3) Slightly push the brake pedal.
   4) Turn the key switch ON.
   5) ABS warning light illuminates.
   6) Illuminating number of times indicates the vehicle model.

Vehicle model	Illuminating number of times
NKR, NPR FRONT DISC BRAKE	1
NQR	8
NPR FRONT DRUM BRAKE	5

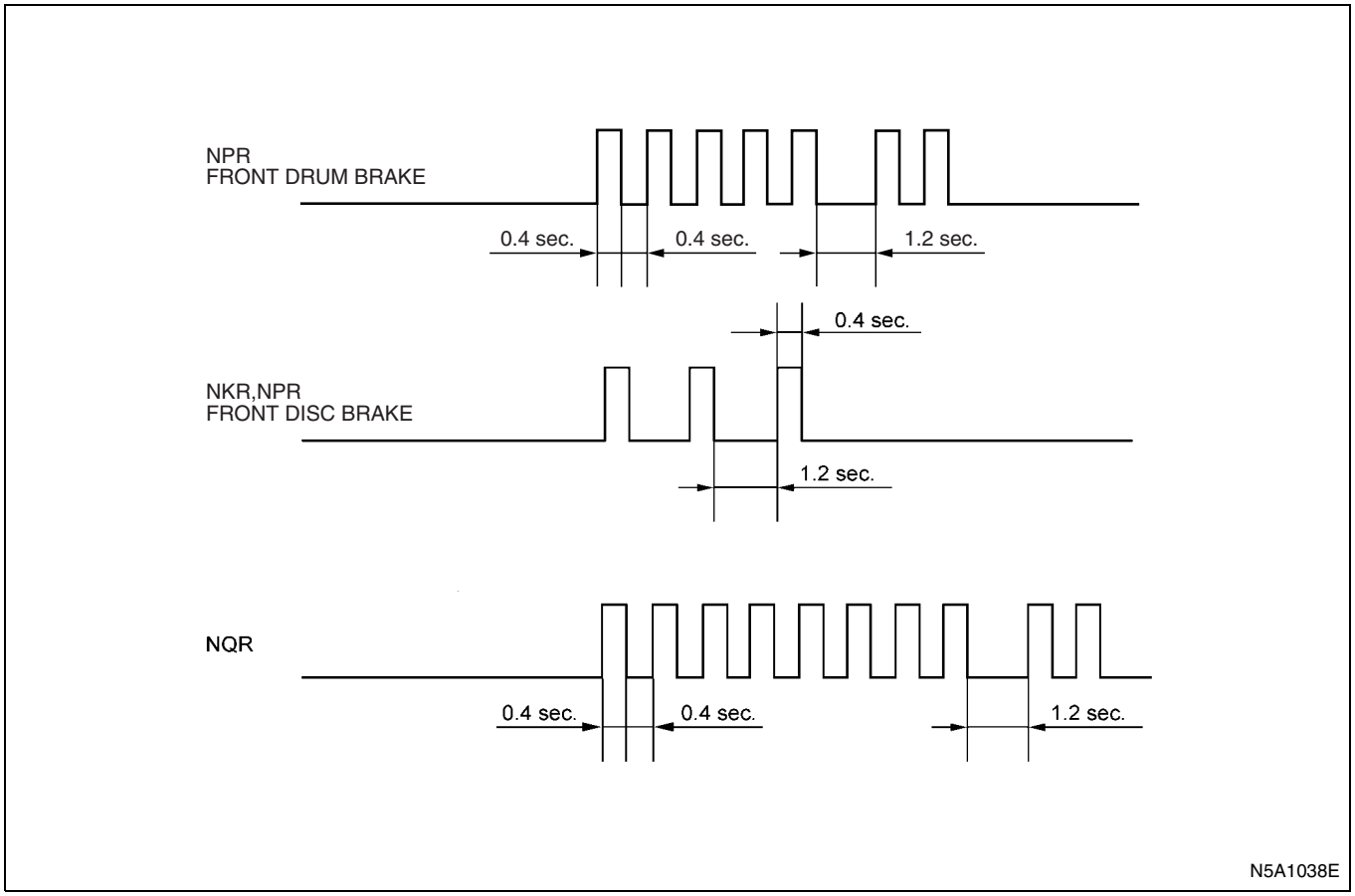


Chart B-1-1 With the key in the ON position (Before starting the engine). Warning light (W/L) is not activated.

Step	Action	Value(s)	YES	NO
1	Is W/L fuse F-16 blown out?	—	Go to Step 5	Go to Step 2
2	Is W/L bulb burnt out?	—	Go to Step 6	Go to Step 3
3	1. Turn the key off. 2. Disconnect EHCU connectors. 3. Turn the key on. 4. Using DVM, measure the voltage between J-177 EHCU connector terminals 6 and 1. Does the DVM display a voltage within the specified value?	12V: 9.5 — 16.5 V 24V: 16.5 — 34 V	Go to Step 4	Go to Step 7
4	Check the continuity between J-177 EHCU connector terminal 1 and body ground. Is there continuity?	—	Go to Step 9	Go to Step 8
5	Replace the fuse. Is action complete?	—	Go to Step 10	—
6	Replace the W/L bulb. Is action complete?	—	Go to Step 10	—
7	Locate and repair open circuit, poor connection or short circuit in the ignition feed circuit. Is action complete?	—	Go to Step 10	—
8	Locate and repair open circuit, poor connection or short circuit in the ground circuit. Is action complete?	—	Go to Step 10	—
9	1. Check the harness for suspected disconnection. 2. If no fault found, replace the EHCU. Is action complete?	—	Go to Step 10	—
10	1. Reconnect all components, ensure all components are properly mounted. 2. Clear diagnostic trouble code. Was this step finished?	—	Go to “Basic diagnostic flow chart”.	—

Chart 1 (DTC13/C0213) Vehicle Type Error

Step	Action	Value(s)	YES	NO
1	1. Disconnect EHCU connector. 2. Turn the key on. 3. Measure the voltage at terminal 14, 15, and 17.	NQR: All terminal battery voltage NKR, NPR FRONT DISC BRAKE: All terminal 0 V NPR FRONT DRUM BRAKE: Terminal 14, 15: 0 V Terminal 17: battery voltage	Go to Step 2	Go to Step 5
2	1. Turn the key off and connect EHCU. 2. Connect the Tech 2. 3. Clear the vehicle type. 4. Does the warning light turn off?	—	Go to Step 3	Replace the EHCU. Go to Step 3
3	Confirm the vehicle type. Is the vehicle type okay?	—	Go to Step 4	Replace the EHCU. Go to Step 3
4	Clear the DTC.	—	Troubleshooting completed.	—
5	Repair harness. Does the warning light turn off?	—	Go to Step 3	Replace the EHCU. Go to Step 3

Chart 2 (DTC14/C0214) EHCU Abnormality

Step	Action	Value(s)	YES	NO
1	1. Turn the key off. 2. Disconnect the EHCU connector. 3. Measure continuity between the body ground and J-177 connector terminal 1, 23. Is there continuity?	—	Go to Step 2	Go to Step 3
2	1. Connect the EHCU connector. 2. Clear DTC. 3. Turn the key from off to on and perform diagnosis procedure. Does the DTC repeat?	—	Go to Step 4	Go to Step 5
3	Repair the open/short circuit or malfunction at connection of connector. Is this step completed?	—	Go to Step 5	—
4	Replace the EHCU. Is this step completed?	—	Go to Step 5	—
5	1. Install all parts. Verify each part is properly installed. 2. Clear DTC. Is this step completed?	—	Go to “Basic diagnostic flow chart”.	—

Chart 3 (DTC15/C0215) EHCU Voltage Out of Range

Step	Action	Value(s)	YES	NO
1	Is the battery voltage okay?	—	Go to Step 2	Go to Step 5
2	1. Turn the key off. 2. Disconnect the EHCU connector. 3. Start the engine. 4. Measure voltage between J-177 connector terminal 2 and J-177 connector terminal 1, 23. Is the voltage within the specified value? 5. Measure voltage between J-177 connector terminal 24 and J-177 connector terminal 1, 23.	12 V vehicle: 10 — 16 V 24 V vehicle: 17 — 33.5 V	Go to Step 3	Go to Step 6
3	Locate the malfunction of connection in the circuit. Is the circuit malfunction specified?	—	Go to Step 4	Go to Step 8
4	Repair the malfunction and perform diagnosis procedure. Does the DTC repeat?	—	Go to Step 7	Go to Step 8
5	Charge or replace the battery. Is this step completed?	—	Go to Step 8	—
6	Repair open/short circuit or malfunction at connection of connector between J-177 connector terminal 2 or 24 and fusible link FL- 9. Is this step completed?	—	Go to Step 8	—
7	Replace the EHCU. Is this step completed?	—	Go to Step 8	—
8	1. Install all parts. Verify each part is properly installed. 2. Clear DTC. Is this step completed?	—	Go to “Basic diagnostic flow chart”.	—

Chart 4 (DTC25/C0225) Exhaust Brake Cut Circuit Abnormality

Step	Action	Value(s)	YES	NO
1	1. Disconnect EHCU connector. 2. Start the engine. 3. Measure voltage between EHCU terminals 8 and 1. Is the voltage within the specified value?	12 V vehicle: More than 5 V 24 V vehicle: More than 10 V	Go to Step 2	Go to Step 4
2	Measure voltage between EHCU terminals 7 and 1. Is the voltage within the specified value?	12 V vehicle: More than 5 V 24 V vehicle: More than 10 V	Go to Step 3	Go to Step 6
3	Short EHCU terminal 8 to 1. Is the voltage at EHCU terminal 7 less than 1.5 V?	—	Replace the EHCU.	Replace the exhaust brake cut relay.
4	Measure resistance of the exhaust brake cut relay coil.	12 V vehicle: 60 — 120 ohms 24 V vehicle: 210 — 310 ohms	Go to Step 5	Replace the exhaust brake cut relay.
5	Measure voltage at coil power side of relay box connector. (key at on position) Is the voltage within the specified value?	12 V vehicle: 10 — 16 V 24 V vehicle: 20 — 32 V	Check harness between EHCU terminal 8 and exhaust brake cut relay. Repair as necessary.	Repair harness and/or power line.
6	Turn the exhaust brake switch on. Does the exhaust brake indicator light turn on?	—	Repair harness of EHCU terminal 7.	Go to exhaust brake diagnosis procedure.

Chart 5 (DTC33/C0233) Motor Drive Circuit Abnormality

Step	Action	Value(s)	YES	NO
1	1. Disconnect EHCU connector. 2. Measure voltage between EHCU terminals 24 and 23. Is the voltage within the specified value?	12 V vehicle: 10 — 16 V 24 V vehicle: 20 — 32 V	Go to Step 2	Go to Step 3
2	Measure continuity between EHCU terminals 23 and 1. Is there continuity?	—	Replace the EHCU.	Repair the harness.
3	Check the ABS fusible link (12 V: 60 A, 24 V: 40 A). Is it okay?	—	Repair the harness.	Replace the ABS fusible link (12 V: 60 A, 24 V: 40 A)

Chart 6 (DTC 34/C0234) Abnormal Motor Rotation

- Replace EHCU.

Chart 7 (DTC41/C0241) Solenoid Valve Power Supply Abnormality

Step	Action	Value(s)	YES	NO
1	1. Disconnect EHCU connector. 2. Measure voltage between EHCU terminals 2 and 1. Is the voltage within the specified value?	12 V vehicle: 10 — 16 V 24 V vehicle: 20 — 32 V	Replace the EHCU.	Go to Step 2
2	Check the ABS fusible link (12 V: 60 A, 24 V: 40 A). Is it okay?	—	Repair the harness.	Replace the ABS fusible link (12 V: 60 A, 24 V: 40 A).

Chart 8 (DTC 43, 45/C0243, C0245) Solenoid Valve Circuit Abnormality

- Replace EHCU.

Chart 9 (DTC51/C0251) FL Speed Sensor Circuit Abnormality

Step	Action	Value(s)	YES	NO
1	1. Disconnect EHCU connector. 2. Measure resistance between EHCU terminals 32 and 33. Is the resistance within the specified value?	1 — 2 k ohms	Replace the EHCU.	Go to Step 2
2	1. Disconnect the FL speed sensor connector. 2. Measure the FL speed sensor resistance. Is the resistance within the specified value?	1 — 2 k ohms	Repair the harness.	Replace the FL speed sensor.

Chart 10 (DTC52/C0252) FR Speed Sensor Circuit Abnormality

Step	Action	Value(s)	YES	NO
1	1. Disconnect EHCU connector. 2. Measure resistance between EHCU terminals 10 and 11. Is the resistance within the specified value?	1 — 2 k ohms	Replace the EHCU.	Go to Step 2
2	1. Disconnect the FR speed sensor connector. 2. Measure the FR speed sensor resistance. Is the resistance within the specified value?	1 — 2 k ohms	Repair the harness.	Replace the FR speed sensor.

Chart 11 (DTC53/C0253) RL Speed Sensor Circuit Abnormality

Step	Action	Value(s)	YES	NO
1	1. Turn the key off. 2. Disconnect EHCU connector J-177 and RL speed sensor connector J-149 (J-78). 3. Check the continuity between connector J-177 terminal 34 and sensor connector J-149 (J-78) terminal 2 (1). Is there continuity?	—	Go to Step 2	Go to Step 7
2	Check the continuity between connector J-177 terminal 34 and connector J-177 terminal 1. Is there continuity?	—	Go to Step 7	Go to Step 3
3	Check the continuity between connector J-177 terminal 22 and sensor connector J-149 (J-78) terminal 1 (2). Is there continuity?	—	Go to Step 4	Go to Step 7
4	Check the continuity between connector J-177 terminal 22 and connector J-177 terminal 1. Is there continuity?	—	Go to Step 7	Go to Step 5
5	1. Connect the connector J-177 with EHCU. 2. Turn the key on. 3. Using DVM, measure the voltage between connector J-149 (J-78) terminal 1 (2) (vehicle side) and ground. Does the DVM display a voltage within the specified value?	9 — 16 V	Go to Step 6	Go to Step 7
6	Check the RL sensor output. (Refer to Chart C-1-3) Does the DTC repeat?	—	Go to Step 8	Go to Step 9
7	Repair open circuit, poor connection and/or short circuit between the EHCU connectors and speed sensor connectors. Is this step complete?	—	Go to Step 9	—
8	Replace EHCU. Is this step complete?	—	Go to Step 9	—
9	1. Reconnect all components, ensure all components are properly mounted. 2. Clear diagnostic trouble code. Was this step finished?	—	Go to “Basic diagnostic flow chart”.	—

Chart 12 (DTC54/C0254) RR Speed Sensor Circuit Abnormality

Step	Action	Value(s)	YES	NO
1	1. Turn the key off. 2. Disconnect EHCU connector J-177 and RL speed sensor connector J-148 (J-78). 3. Check the continuity between connector J-177 terminal 12 and sensor connector J-148 (J-78) terminal 1 (3). Is there continuity?	—	Go to Step 2	Go to Step 7
2	Check the continuity between connector J-177 terminal 12 and connector J-177 terminal 1. Is there continuity?	—	Go to Step 7	Go to Step 3
3	Check the continuity between connector J-177 terminal 21 and sensor connector J-148 (J-78) terminal 2 (4). Is there continuity?	—	Go to Step 4	Go to Step 7
4	Check the continuity between connector J-177 terminal 21 and connector J-177 terminal 1. Is there continuity?	—	Go to Step 7	Go to Step 5
5	1. Connect the connector J-177 with EHCU. 2. Turn the key on. 3. Using DVM, measure the voltage between connector J-148 (J-78) terminal 2 (4) (vehicle side) and ground. Does the DVM display a voltage within the specified value?	9 — 16 V	Go to Step 6	Go to Step 7
6	Check the RL sensor output. (Refer to Chart C-1-4) Does the DTC repeat?	—	Go to Step 8	Go to Step 9
7	Repair open circuit, poor connection and/or short circuit between the EHCU connectors and speed sensor connectors. Is this step complete?	—	Go to Step 9	—
8	Replace EHCU. Is this step complete?	—	Go to Step 9	—
9	1. Reconnect all components, ensure all components are properly mounted. 2. Clear diagnostic trouble code. Was this step finished?	—	Go to “Basic diagnostic flow chart”.	—

Chart 13 (DTC61/C0261) Abnormal FL Speed Sensor Signal

Step	Action	Value(s)	YES	NO
1	Have the vehicle been jacked up? Have two or three wheels been turned on the brake tester intentionally?	—	Be careful that the system may fail if two or three wheels are turned forcibly. The flow is now complete.	Repair tires. Go to Step 2
2	Are tire pressures, sizes and wear normal?	—	Go to Step 3	Repair tires. Go to Step 2
3	Is there play in the FL wheel bearing?	—	Go to Step 12	Go to Step 4
4	Is there play in the FL speed sensor/sensor rotor?	—	Go to Step 13	Go to Step 5
5	Is there powdered iron sticking to FL speed sensor/sensor rotor?	—	Go to Step 14	Go to Step 6
6	Check the FL speed sensor. (Refer to Chart C-1-1 or TC-1) Is the FL sensor output normal?	—	Go to Step 7	Go to Step 10
7	Is there a broken tooth or indentation in the sensor rotor?	—	Go to Step 15	Go to Step 8
8	Using DVM, measure the resistance between J-177 EHCU connector terminal 33 and ground. Does the DVM display a resistance within the specified value?	1000 k ohms or more	Go to Step 9	Go to Step 11
9	1. Clear diagnostic trouble code. 2. Test drive and perform system self-check. Does the DTC repeat?	—	Go to Step 20	Go to Step 18
10	Is there damage or indentation in the speed sensor?	—	Go to Step 16	Go to Step 17
11	1. Disconnect FL sensor connector. 2. Using DVM, measure the resistance between J-75 sensor connector terminal 2 and ground. Does the DVM display a resistance within the specified value?	1000 k ohms or more	Go to Step 19	Go to Step 16
12	Adjust wheel bearing preload. Is action complete?	—	Go to Step 21	—
13	Repair or replace speed sensor/sensor rotor. Is action complete?	—	Go to Step 21	—
14	Repair speed sensor/sensor rotor. Is action complete?	—	Go to Step 21	—
15	Replace sensor rotor. Is action complete?	—	Go to Step 21	—

Step	Action	Value(s)	YES	NO
16	Replace FL speed sensor. Is action complete?	—	Go to Step 21	—
17	Check the FL speed sensor circuit. Refer to Chart 9. Is action complete?	—	Verify repair	—
18	Check for a poor connection and an open circuit on the harness between EHCU and sensor connectors. Refer to “Note on Intermittents” described in earlier this section. Is action complete?	—	Go to Step 21	—
19	1. Locate open circuit, poor connection or short circuit on the harness between EHCU and sensor connectors. 2. Repair the harness. Is action complete?	—	Go to Step 21	Go to Step 21
20	Replace EHCU. Is action complete?	—	Go to Step 21	—
21	1. Reconnect all components, ensure all components are properly mounted. 2. Clear diagnostic trouble code. Was this step finished?	—	Go to “Basic diagnostic flow chart”.	—

Chart 14 (DTC62/C0262) Abnormal FR Speed Sensor Signal

Step	Action	Value(s)	YES	NO
1	Have the vehicle been jacked up? Have two or three wheels been turned on the brake tester intentionally?	—	Be careful that the system may fail if two or three wheels are turned forcibly. The flow is now complete.	Repair tires. Go to Step 2
2	Are tire pressures, sizes and wear normal?	—	Go to Step 3	Repair tires. Go to Step 2
3	Is there play in the FR wheel bearing?	—	Go to Step 12	Go to Step 4
4	Is there play in the FR speed sensor/sensor rotor?	—	Go to Step 13	Go to Step 5
5	Is there powdered iron sticking to FR speed sensor/sensor rotor?	—	Go to Step 14	Go to Step 6
6	Check the FR speed sensor. (Refer to Chart C-1-2 or TC-1) Is the FR sensor output normal?	—	Go to Step 7	Go to Step 10
7	Is there a broken tooth or indentation in the sensor rotor?	—	Go to Step 15	Go to Step 8

Step	Action	Value(s)	YES	NO
8	Using DVM, measure the resistance between J-177 EHCU connector terminal 11 and ground. Does the DVM display a resistance within the specified value?	1000 k ohms or more	Go to Step 9	Go to Step 11
9	1. Clear diagnostic trouble code. 2. Test drive and perform system self-check. Does the DTC repeat?	—	Go to Step 20	Go to Step 18
10	Is there damage or indentation in the speed sensor?	—	Go to Step 16	Go to Step 17
11	1. Disconnect FR sensor connector. 2. Using DVM, measure the resistance between J-74 sensor connector terminal 2 and ground. Does the DVM display a resistance within the specified value?	1000 k ohms or more	Go to Step 19	Go to Step 16
12	Adjust wheel bearing preload. Is action complete?	—	Go to Step 21	—
13	Repair or replace speed sensor/sensor rotor. Is action complete?	—	Go to Step 21	—
14	Repair speed sensor/sensor rotor. Is action complete?	—	Go to Step 21	—
15	Replace sensor rotor. Is action complete?	—	Go to Step 21	—
16	Replace FR speed sensor. Is action complete?	—	Go to Step 21	—
17	Check the FR speed sensor circuit. Refer to Chart 10. Is action complete?	—	Verify repair	—
18	Check for a poor connection and an open circuit on the harness between EHCU and sensor connectors. Refer to “Note on Intermittents” described in earlier this section. Is action complete?	—	Go to Step 21	—
19	1. Locate open circuit, poor connection or short circuit on the harness between EHCU and sensor connectors. 2. Repair the harness. Is action complete?	—	Go to Step 21	Go to Step 21
20	Replace EHCU. Is action complete?	—	Go to Step 21	—

Step	Action	Value(s)	YES	NO
21	1. Reconnect all components, ensure all components are properly mounted. 2. Clear diagnostic trouble code. Was this step finished?	—	Go to “Basic diagnostic flow chart”.	—

Chart 15 (DTC63/C0263) Abnormal RL Speed Sensor Signal

Step	Action	Value(s)	YES	NO
1	Have the vehicle been jacked up? Have two or three wheels been turned on the brake tester intentionally?	—	Be careful that the system may fail if two or three wheels are turned forcibly. The flow is now complete.	Repair tires. Go to Step 2
2	Are tire pressures, sizes and wear normal?	—	Go to Step 3	Repair tires. Go to Step 2
3	Is there play in the RL wheel bearing?	—	Go to Step 10	Go to Step 4
4	Is there play in the RL speed sensor/sensor rotor?	—	Go to Step 11	Go to Step 5
5	Is there powdered iron sticking to RL speed sensor/sensor rotor?	—	Go to Step 12	Go to Step 6
6	Check the RL speed sensor. (Refer to Chart C-1-3 or TC-1) Is the RL sensor output normal?	—	Go to Step 7	Go to Step 9
7	Is there a broken tooth or indentation in the sensor rotor?	—	Go to Step 13	Go to Step 8
8	1. Clear diagnostic trouble code. 2. Test drive and perform system self-check. Does the DTC repeat?	—	Go to Step 17	Go to Step 16
9	Is there damage or indentation in the speed sensor?	—	Go to Step 14	Go to Step 15
10	Adjust wheel bearing preload. Is action complete?	—	Go to Step 18	—
11	Repair or replace speed sensor/sensor rotor. Is action complete?	—	Go to Step 18	—
12	Repair speed sensor/sensor rotor. Is action complete?	—	Go to Step 18	—
13	Replace sensor rotor. Is action complete?	—	Go to Step 18	—
14	Replace RL speed sensor. Is action complete?	—	Go to Step 18	—
15	Check the RL speed sensor circuit. Refer to Chart 11. Is action complete?	—	Verify repair	—

Step	Action	Value(s)	YES	NO
16	Check for a poor connection and an open circuit on the harness between EHCU and sensor connectors. Refer to “Note on Intermittents” described in earlier this section. Is action complete?	—	Go to Step 18	—
17	Replace EHCU. Is action complete?	—	Go to Step 18	—
18	1. Reconnect all components, ensure all components are properly mounted. 2. Clear diagnostic trouble code. Was this step finished?	—	Go to “Basic diagnostic flow chart”.	—

Chart 16 (DTC64/C0264) Abnormal RR Speed Sensor Signal

Step	Action	Value(s)	YES	NO
1	Have the vehicle been jacked up? Have two or three wheels been turned on the brake tester intentionally?	—	Be careful that the system may fail if two or three wheels are turned forcibly. The flow is now complete.	Repair tires. Go to Step 2
2	Are tire pressures, sizes and wear normal?	—	Go to Step 3	Repair tires. Go to Step 2
3	Is there play in the RR wheel bearing?	—	Go to Step 10	Go to Step 4
4	Is there play in the RR speed sensor/sensor rotor?	—	Go to Step 11	Go to Step 5
5	Is there powdered iron sticking to RR speed sensor/sensor rotor?	—	Go to Step 12	Go to Step 6
6	Check the RR speed sensor. (Refer to Chart C-1-4 or TC-1) Is the RR sensor output normal?	—	Go to Step 7	Go to Step 9
7	Is there a broken tooth or indentation in the sensor rotor?	—	Go to Step 13	Go to Step 8
8	1. Clear diagnostic trouble code. 2. Test drive and perform system self-check. Does the DTC repeat?	—	Go to Step 17	Go to Step 16
9	Is there damage or indentation in the speed sensor?	—	Go to Step 14	Go to Step 15
10	Adjust wheel bearing preload. Is action complete?	—	Go to Step 18	—
11	Repair or replace speed sensor/sensor rotor. Is action complete?	—	Go to Step 18	—
12	Repair speed sensor/sensor rotor. Is action complete?	—	Go to Step 18	—

Step	Action	Value(s)	YES	NO
13	Replace sensor rotor. Is action complete?	—	Go to Step 18	—
14	Replace RR speed sensor. Is action complete?	—	Go to Step 18	—
15	Check the RR speed sensor circuit. Refer to Chart 12. Is action complete?	—	Verify repair	—
16	Check for a poor connection and an open circuit on the harness between EHCU and sensor connectors. Refer to “Note on Intermittents” described in earlier this section. Is action complete?	—	Go to Step 18	—
17	Replace EHCU. Is action complete?	—	Go to Step 18	—
18	1. Reconnect all components, ensure all components are properly mounted. 2. Clear diagnostic trouble code. Was this step finished?	—	Go to “Basic diagnostic flow chart”.	—

UNIT INSPECTION PROCEDURE

Unit Inspection Procedure

This section describes the following inspection procedures referred to during “SYMPTOM DIAGNOSIS” and “DIAGNOSS BY ‘ABS’ WARNING LIGHT ILLUMINATION PATTERN”:

	without Tech 2	with Tech 2
Speed Sensor Output Inspection	Chart C-1-1 to C-1-4	Chart TC-1

Chart C-1-1 FL Speed Sensor Output Inspection Procedure

Step	Action	Value(s)	YES	NO
1	1. Turn the key off. 2. Disconnect EHCU connector. 3. Jack up the vehicle, with all wheels off the ground. 4. Measure the AC voltage between J-177 EHCU connector terminals 32 and 33 while turning FL wheel at a speed of 0.5 RPS. Does the DVM display a voltage within the specified value?	200 mV or more	Go to Step 5	Go to Step 2
2	1. Disconnect FL sensor connector. 2. Using DVM, measure the resistance between J-75 sensor connector terminals 1 and 2. Does the DVM display a resistance within the specified value?	1.0 — 2.0 k ohms	Go to Step 4	Go to Step 3
3	1. Locate open circuit, poor connection or short circuit on the harness between EHCU and sensor connectors. 2. Repair the harness. Is action complete?	—	Go to Step 5	—
4	Replace FL sensor. Is action complete?	—	Go to Step 5	—
5	1. Reconnect all components, ensure all components are properly mounted. 2. Clear diagnostic trouble code. Was this step finished?	—	Go to “Basic diagnostic flow chart”.	—

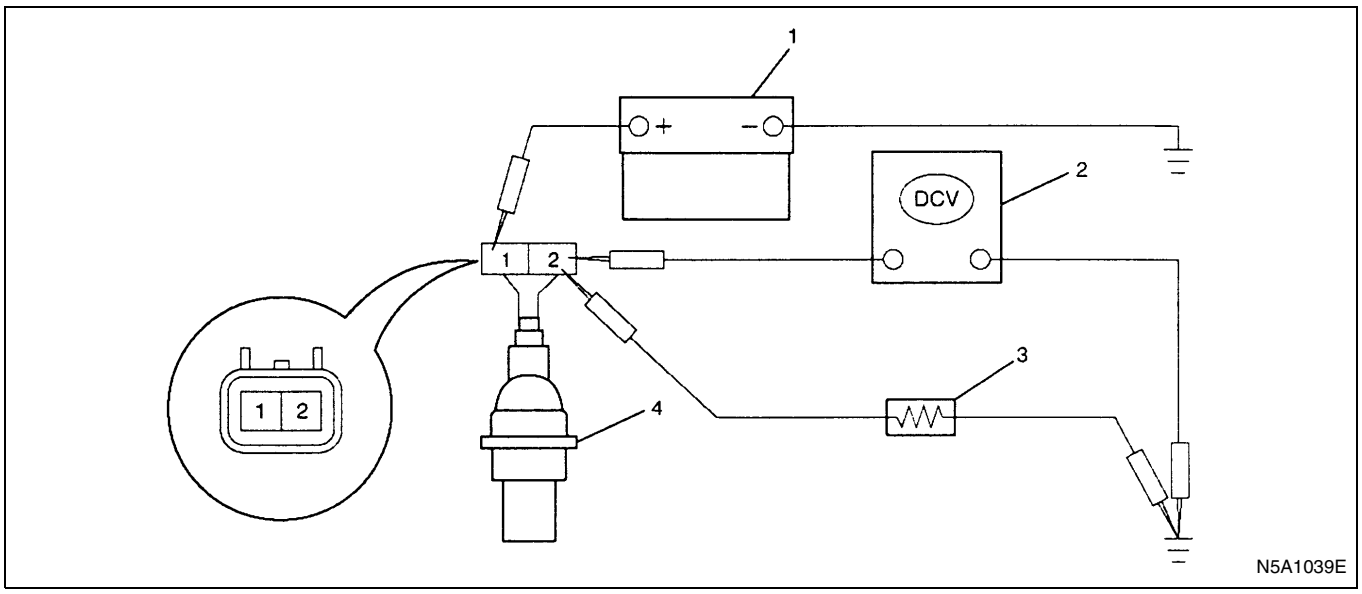
Chart C-1-2 FR Speed Sensor Output Inspection Procedure

Step	Action	Value(s)	YES	NO
1	1. Turn the key off. 2. Disconnect EHCU connector. 3. Jack up the vehicle, with all wheels off the ground. 4. Measure the AC voltage between J-177 EHCU connector terminals 10 and 11 while turning FR wheel at a speed of 0.5 RPS. Does the DVM display a voltage within the specified value?	200 mV or more	Go to Step 5	Go to Step 2
2	1. Disconnect FR sensor connector. 2. Using DVM, measure the resistance between J-74 sensor connector terminals 1 and 2. Does the DVM display a resistance within the specified value?	1.0 — 2.0 k ohms	Go to Step 4	Go to Step 3
3	1. Locate open circuit, poor connection or short circuit on the harness between EHCU and sensor connectors. 2. Repair the harness. Is action complete?	—	Go to Step 5	—
4	Replace FR sensor. Is action complete?	—	Go to Step 5	—
5	1. Reconnect all components, ensure all components are properly mounted. 2. Clear diagnostic trouble code. Was this step finished?	—	Go to “Basic diagnostic flow chart”.	—

Chart C-1-3 RL Speed Sensor Output Inspection Procedure

Step	Action	Value(s)	YES	NO
1	1. Turn the key off. 2. Disconnect EHCU connector. 3. Jack up the vehicle, with all wheels off the ground. 4. Connect a 120 ohms resistor between J-177 EHCU connector terminal 22 and ground. Apply voltage of 12 V to EHCU connector terminal 22. 5. Using DVM, measure the DC voltage between J-177 connector terminal 22 and ground while turning RL wheel at a speed of 0.5 RPS. Does the DVM display a voltage within the specified value?	0.2 — 4.5 V	Go to Step 5	Go to Step 2

Step	Action	Value(s)	YES	NO
2	1. Turn the key off. 2. Disconnect RL sensor connector. 3. Connect a 120 ohms resistor between sensor connector terminal 2 (sensor side) and ground. 4. Apply 12 V voltage at sensor connector terminal 1 (sensor side). 5. Using DVM, measure the DC voltage between sensor connector terminal 2 (sensor side) and ground while turning RL wheel at a speed of 0.5 RPS. Does the DVM display a voltage within the specified value?	0.2 — 4.5 V	Go to Step 3	Go to Step 4
3	1. Locate open circuit, poor connection short circuit on the harness between EHCU and sensor connectors. 2. Repair the harness. Is action complete?	—	Go to Step 5	—
4	Replace RL sensor. Is action complete?	—	Go to Step 5	—
5	1. Reconnect all components, ensure all components are properly mounted. 2. Clear diagnostic trouble code. Was this step finished?	—	Go to “Basic diagnostic flow chart”.	—

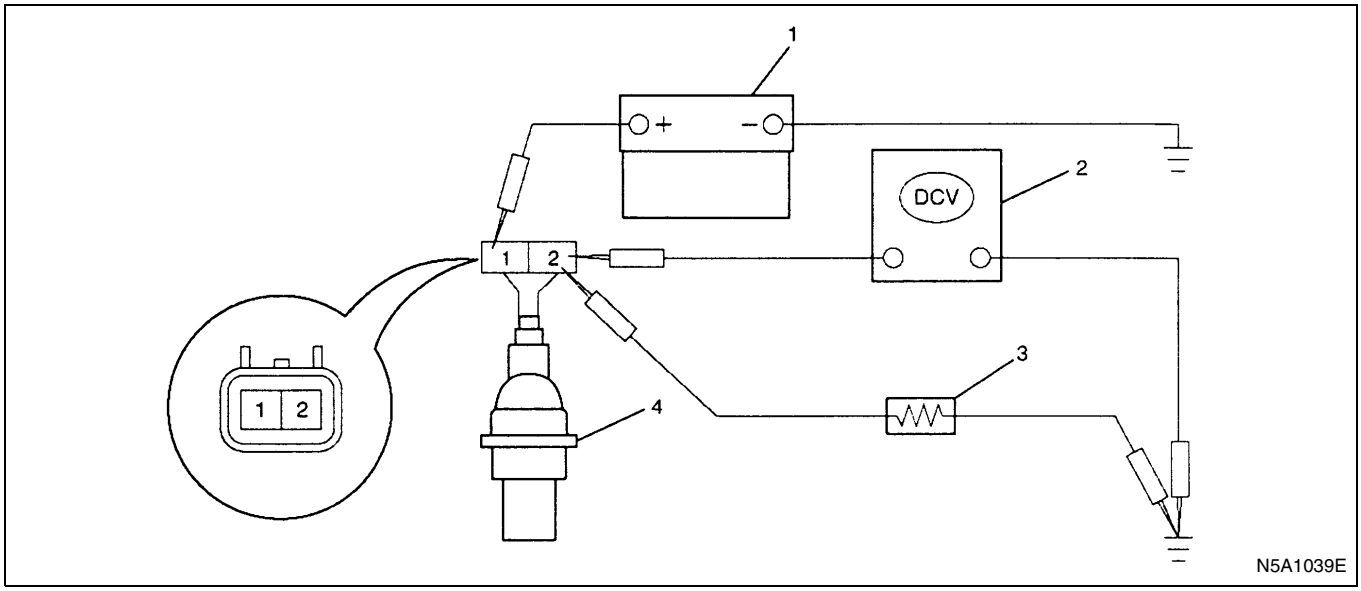


Legend

1. Battery
2. DVM
3. Resistor
4. Speed Sensor

Chart C-1-4 RR Speed Sensor Output Inspection Procedure

Step	Action	Value(s)	YES	NO
1	1. Turn the key off. 2. Disconnect EHCU connector. 3. Jack up the vehicle, with all wheels off the ground. 4. Connect a 120 ohms resistor between J-177 EHCU connector terminal 21 and ground. 5. Using DVM, measure the DC voltage between J-177 connector terminal 21 and ground while turning RR wheel at a speed of 0.5 RPS. Does the DVM display a voltage within the specified value?	0.2 — 4.5 V	Go to Step 5	Go to Step 2
2	1. Turn the key off. 2. Disconnect RR sensor connector. 3. Connect a 120 ohms resistor between sensor connector terminal 2 (sensor side) and ground. 4. Apply 12 V voltage at sensor connector terminal 1 (sensor side). 5. Using DVM, measure the DC voltage between sensor connector terminal 2 (sensor side) and ground while turning RR wheel at a speed of 0.5 RPS. Does the DVM display a voltage within the specified value?	0.2 — 4.5 V	Go to Step 3	Go to Step 4
3	1. Locate open circuit, poor connection short circuit on the harness between EHCU and sensor connectors. 2. Repair the harness. Is action complete?	—	Go to Step 5	—
4	Replace RR sensor. Is action complete?	—	Go to Step 5	—
5	1. Reconnect all components, ensure all components are properly mounted. 2. Clear diagnostic trouble code. Was this step finished?	—	Go to “Basic diagnostic flow chart”.	—



Legend

1. Battery
2. DVM
3. Resistor
4. Speed Sensor

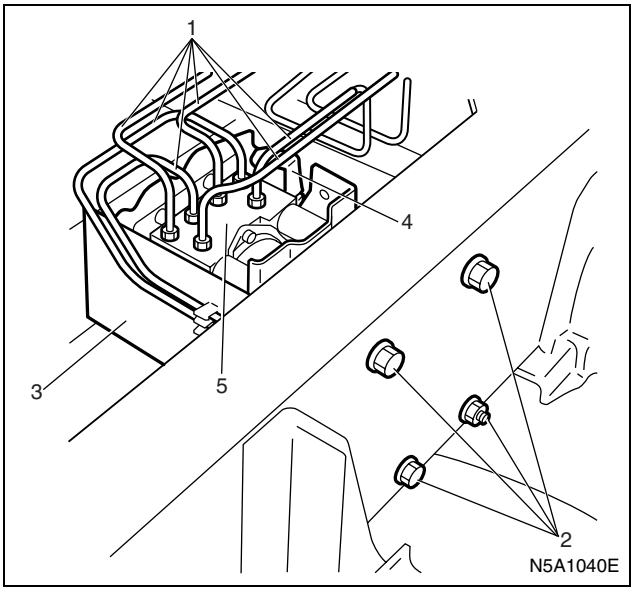
Chart TC-1 Sensor Output Inspection Procedure (Use Tech 2)

Step	Action	Value(s)	YES	NO
1	1. Connect Tech 2. 2. Check the minimum speed of each sensor by WHEEL SENSORS. Is sensor speed within the specified value?	More than 4 km/h (3 mph)	Go to Step 2	Go to Step 6
2	Check the sensor harness for suspected disconnection (check while shaking harness/connector). Is the sensor harness connection normal?	—	Replace speed sensor. Go to Step 3	Repair. Go to Step 2
3	Check the minimum speed of each sensor by WHEEL SENSORS. Is sensor speed within the specified value?	More than 4 km/h (3 mph)	Go to Step 4	Go to Step 6
4	Check the sensor rotor. Is the sensor rotor normal?	—	Go to Step 5	Replace sensor rotor. Go to Step 5
5	Check the minimum speed of each sensor by WHEEL SENSORS. Is sensor speed within the specified value?	More than 4 km/h (3 mph)	Repair harness or connector between EHCU and speed sensor. Go to Step 6	Go to Step 6
6	Reconnect all components, ensure all components are properly mounted. Was this step finished?	—	Repeat the “Basic diagnostic flow chart”.	—

ON-VEHICLE SERVICE

Electronic Hydraulic Control Unit (EHCU)

Removal



Legend

1. Brake Pipe
2. EHCU Bracket Fix Bolt & Nut
3. EHCU Bracket
4. Harness Connector
5. EHCU

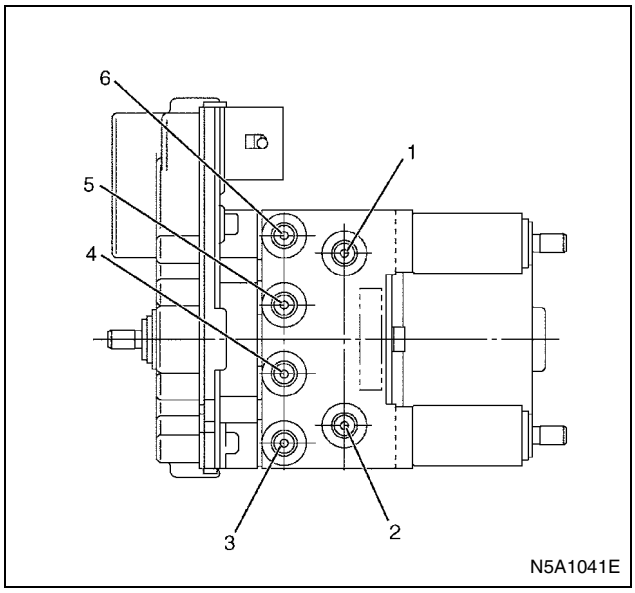
1. Disconnect battery ground cable.
2. Disconnect brake pipes.
3. Remove EHCU bracket fix bolts & nut.
4. Remove EHCU bracket.
5. Remove EHCU.

Installation

To install, follow the removal steps in the reverse order, noting the following points.

Notice:

- If welding work is to be performed on the vehicle using an electric arc welder, the EHCU should be removed from the vehicle before the welding operation begins.
- Do not put a radio equipment etc, that emits strong radio wave near the EHCU.
- Do not wet the control unit. If wetted, wipe off water immediately and dry it fully.
- Never loosen any screw on the control unit.
- Do not paint the control unit.
- Prevent possible electrostatic discharge damage.
- Do not touch the control unit pin type terminal with a metallic tip of a screwdriver or tester.
- Do not apply voltage to the terminal.

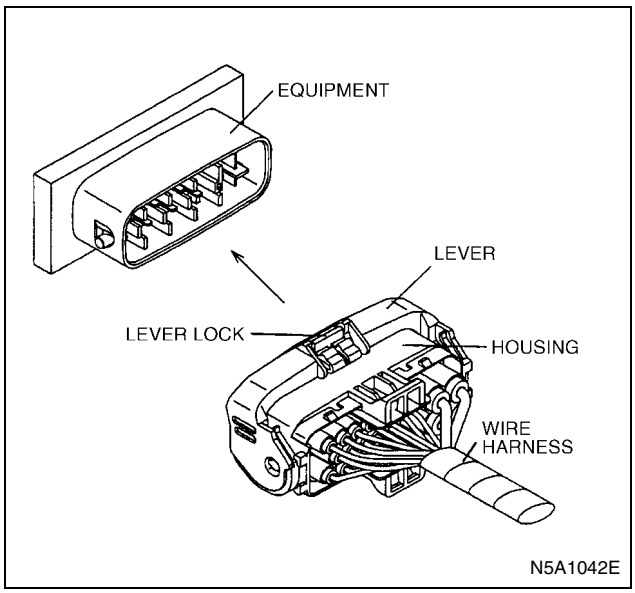


Legend

1. Master Cylinder (front)
2. Master Cylinder (rear)
3. Rear Right Wheel Cylinder
4. Rear Left Wheel Cylinder
5. Front Right Wheel Cylinder
6. Front Left Wheel Cylinder

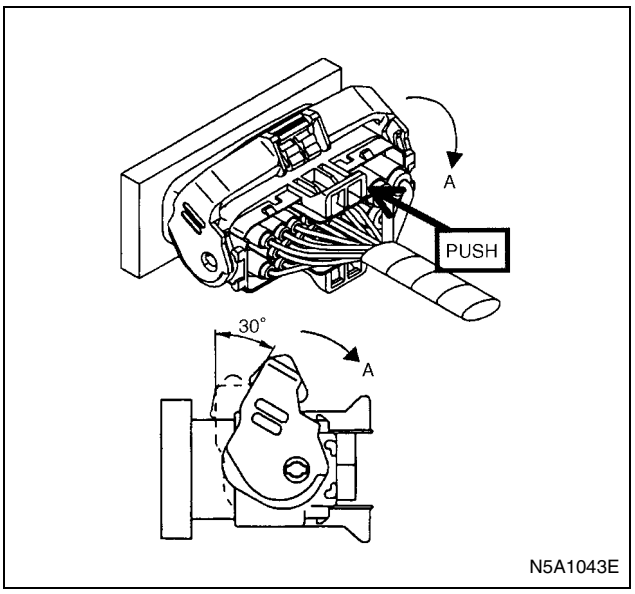
Methods of Matching and Taking Off Connectors

Before Matching



Semi Matching

Wire harness side connector should be inserted to equipment side, then lever folds up about 30°.

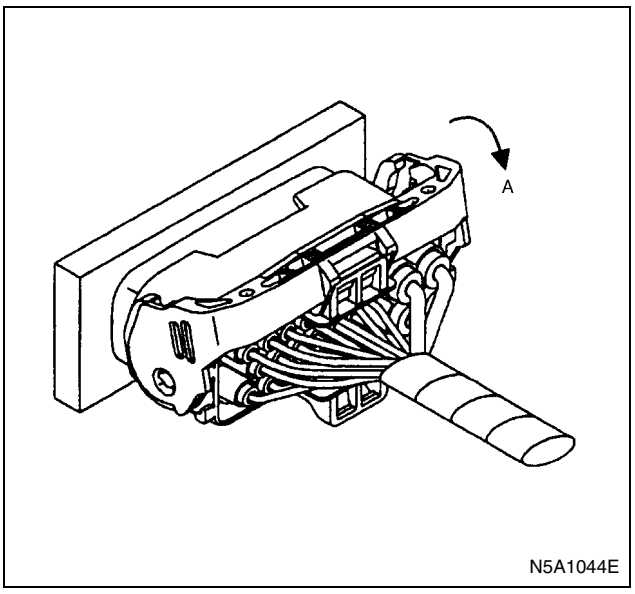


Notice:

Check the lever folding up.

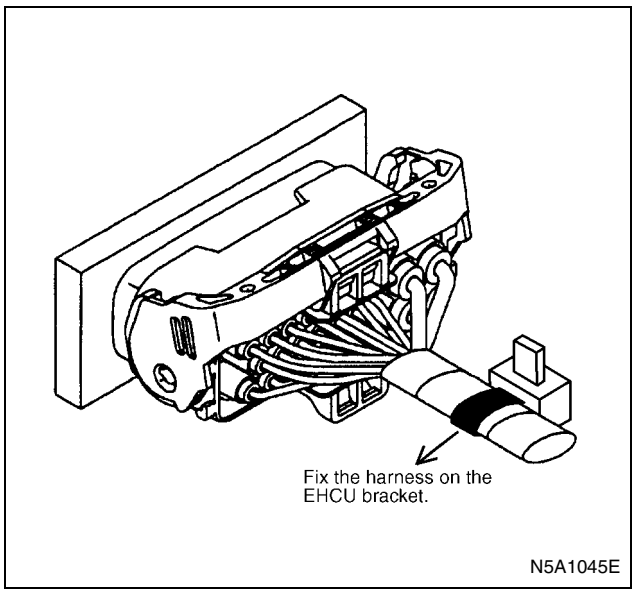
Matching

Turn the lever to direction A and fix the lever lock to the housing.



Finished Matching

On a vehicle in which the harness is clamped onto the EHCU bracket, clamp the harness after matching the connectors.

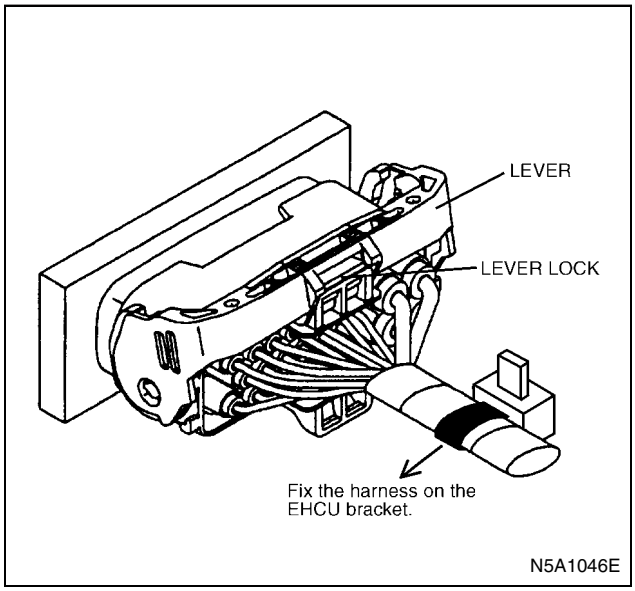


Notice:

Check the lever lock is fixed to housing certainly. The lever or housing can be broken by turned to direction A without the lever folding up (30°).

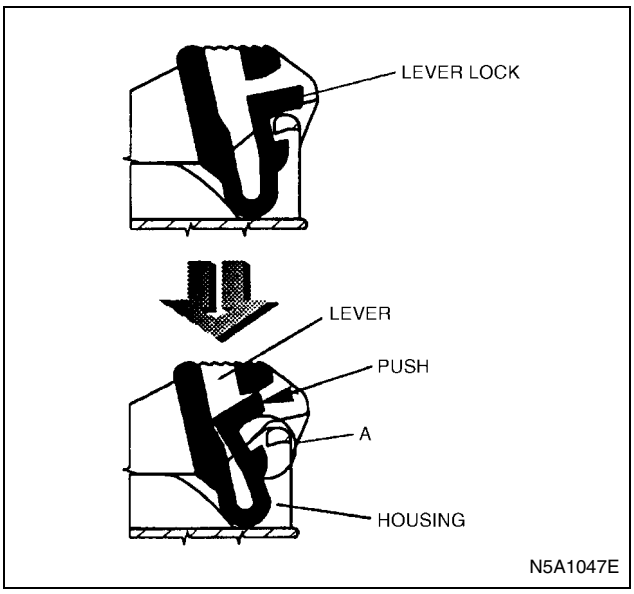
Condition of Matching

On a vehicle in which the harness is clamped onto the EHCU bracket, loosen the before taking off the connectors.



Release of Lock

Push lever lock down until the condition it can be released.



Notice:

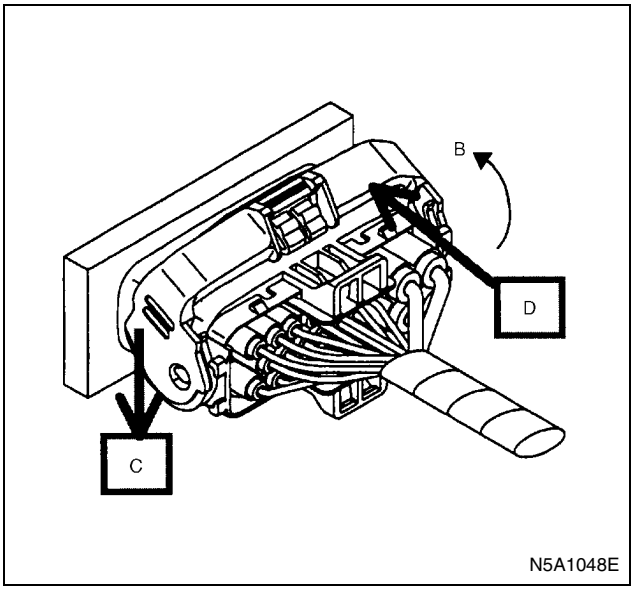
Check division A can be released.

Taking Off

Turn the lever to direction B.

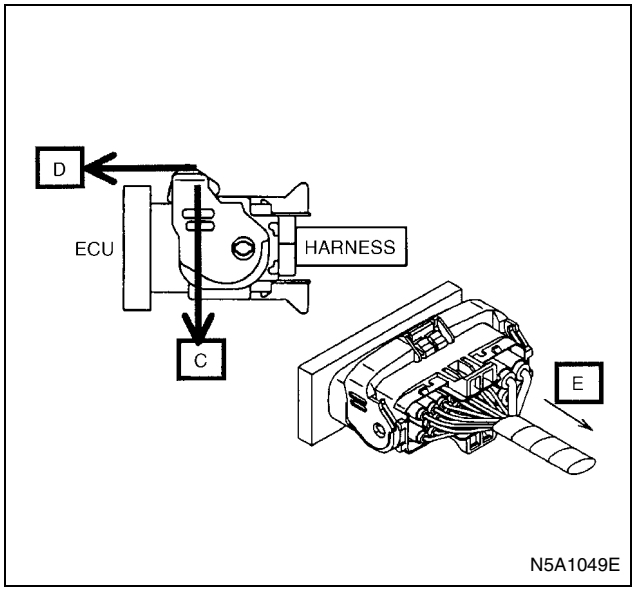
When you feel the lever heavy in your hand (after turning about 40 degrees), turn the lever in the direction of C.

The lever will not turn and the connector may fail if force is applied in the direction of D.



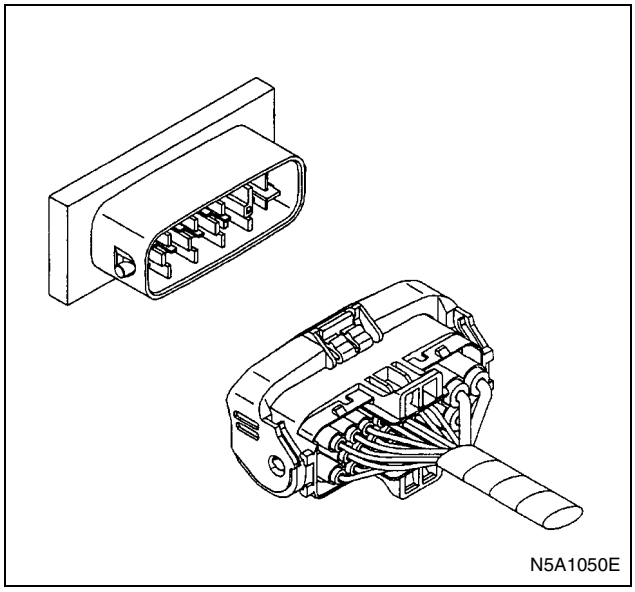
Notice:

The lockarm can be broken by being turned to direction B in case of incomplete locking.



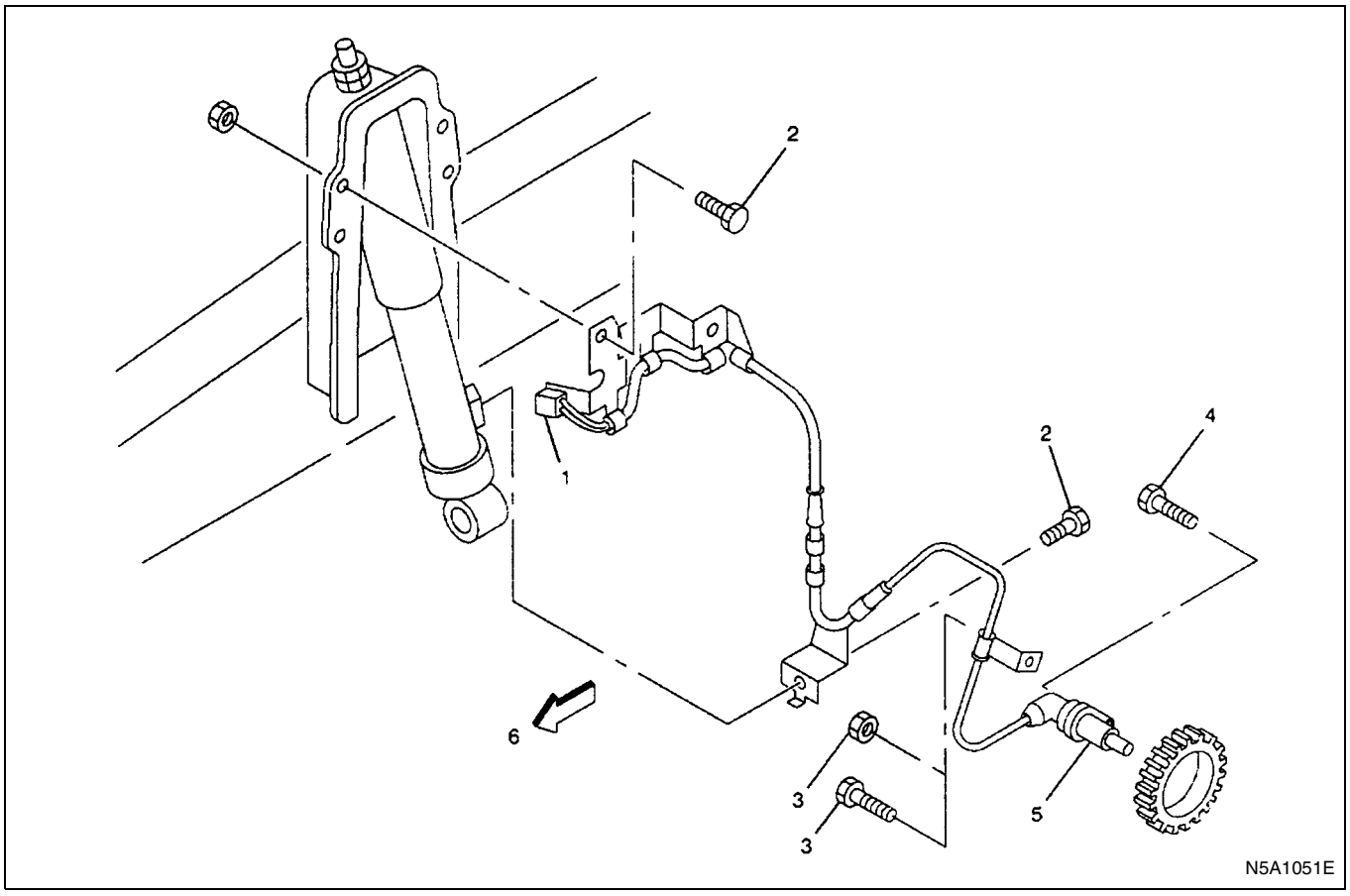
Check the lever is turned certainly and take connector off to direction E.

Finished Taking Off



Front Speed Sensor

Components



Legend

1. Speed Sensor Connector
2. Sensor Cable Fixing Bolt
3. Sensor Cable Fixing Bolt (Front Disc Brake model)
   Sensor Cable Fixing Nut (Front Drum Brake model)
4. Sensor Fixing Bolt
5. Speed Sensor
6. Front

Removal

1. Remove speed sensor connector.
2. Remove sensor cable fixing bolts and/or nut.
3. Remove the speed sensor fixing bolt.
4. Remove speed sensor.

Inspection and Repair

1. Check the speed sensor pole piece for presence of foreign materials; remove any dirt, etc.
2. Check the pole piece for damage; replace speed sensor if necessary.
3. Check the speed sensor cable for short or open circuit, and replace with a new one if necessary.
   To check for cable short or open, bend or stretch the cable while checking for continuity.

Installation

1. Install speed sensor and take care not to hit the speed sensor pole piece during installation.
2. Install speed sensor fixing bolt and tighten the fixing bolt to the specified torque.

Tighten:
Bolt to 22 N·m (2.2 kg·m/16 lb·ft)

3. Install speed sensor cable fixing bolts and tighten the fixing bolt to the specified torque.

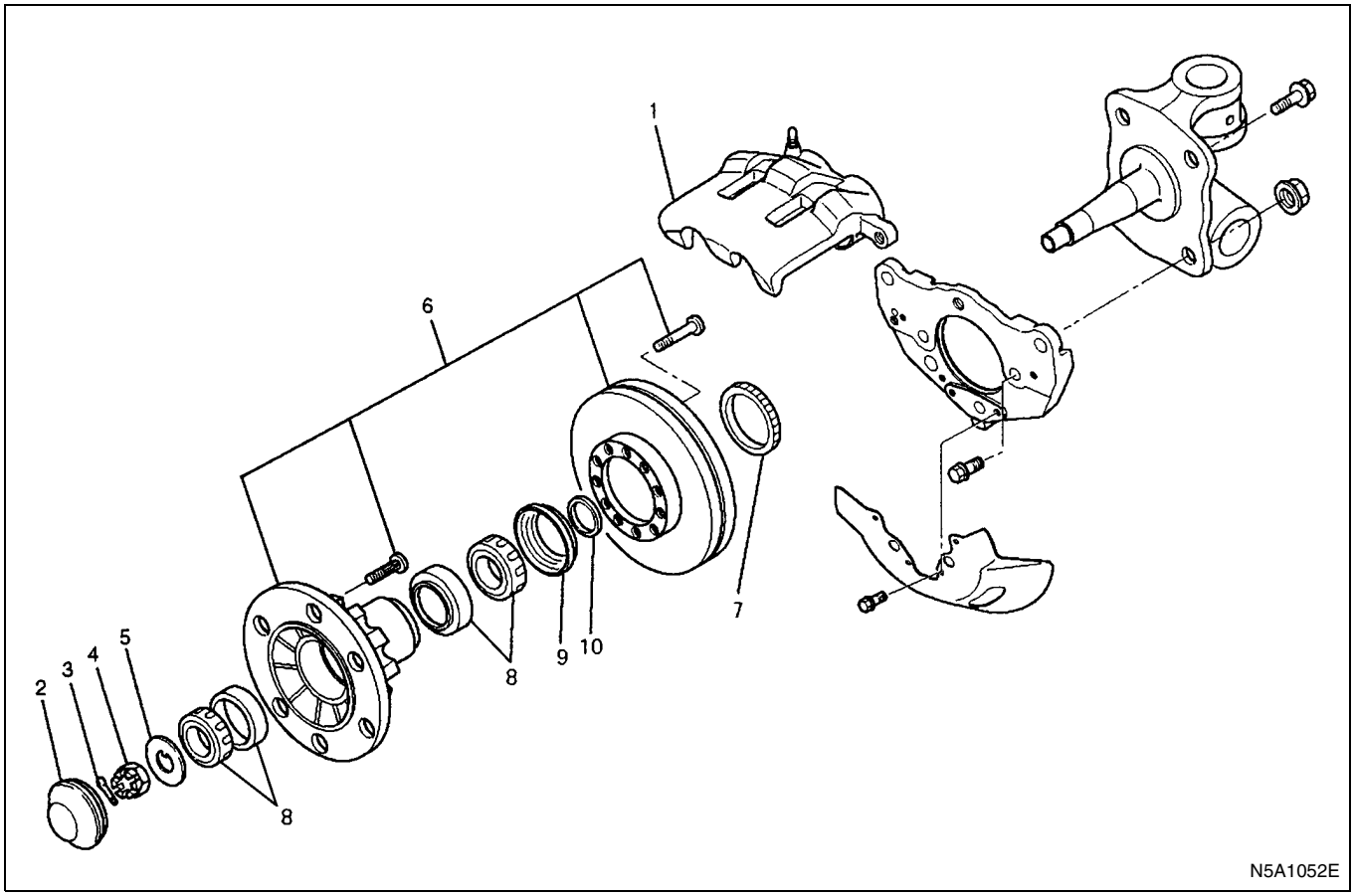
Tighten:
Bolts (2) to 22 N·m (2.2 kg·m/16 lb·ft)
Bolts (3) to 45 N·m (4.6 kg·m/33 lb·ft)
Nut (3) to 15 N·m (1.5 kg·m/11 lb·ft)

Notice:
Confirm that a white or yellow line marked on the cable is not twisted when connecting the speed sensor cable.

4. Connect speed sensor connector.

Front Speed Sensor Rotor

Components

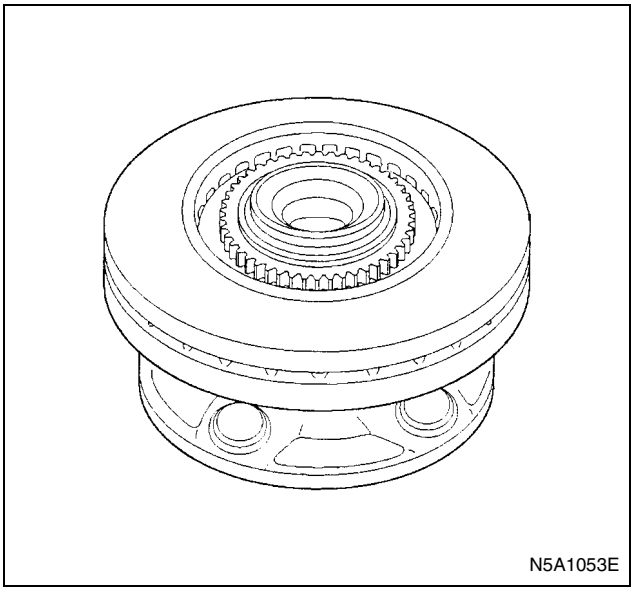


Legend

1. Disc Brake Assembly
2. Hub Cap
3. Cotter Pin
4. Hub Nut
5. Washer
6. Hub and Disc Assembly
7. Speed Sensor Rotor
8. Inner Bearing and Outer Bearing
9. Oil Seal
10. Spacer

Removal

1. Remove disc brake assembly and support the caliper assembly so that the brake hose is not stretched or damaged.
2. Remove hub cap.
3. Remove cotter pin and hub nut.
4. Remove washer.
5. Remove hub and disc assembly.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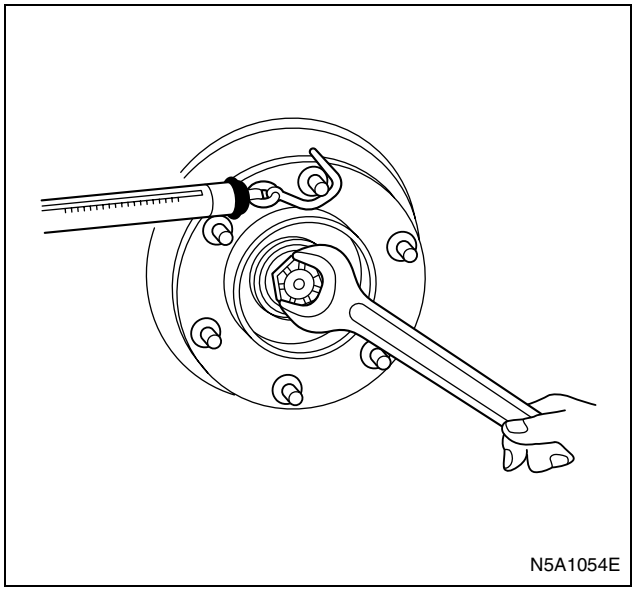
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6. Remove speed sensor rotor.
7. Remove inner bearing, oil seal spacer.

Inspection and Repair

1. Check the speed sensor rotor for damage including tooth chipping, and if damaged, replace the speed sensor rotor.

Installation

1. Using a bench press, install speed sensor rotor.
2. Install spacer onto the knuckle spindle.
3. Apply grease into the outer and inner bearings and install bearings in the hub.
4. Install oil seal into hub and disc assembly and install hub and disc assembly on to the knuckle spindle.

Preload Adjustment

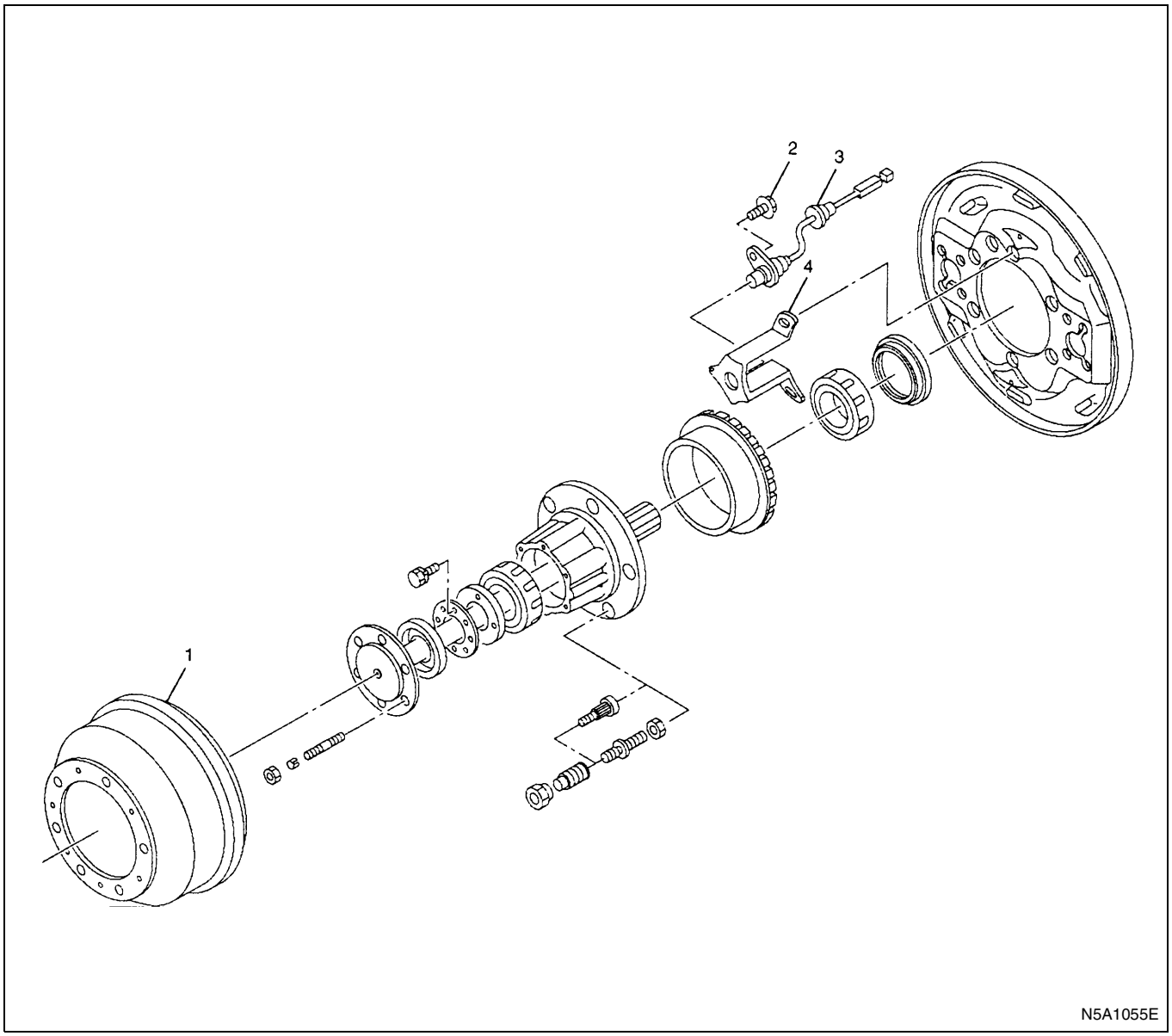
Adjust the wheel bearing as follows:

1. Tighten the nut until you are unable to manually rotate the hub and disc assembly.
2. Loosen the nut.
3. Attach a spring balancer to one stud. Gradually retighten the nut until the hub and disc assembly bearing is adjusted to the specified preload.
   - Hub bearing preload
     New Hub Bearing: 9.8 — 24.5 N (1 — 2.5 kg/ 2.2 — 5.5 lb)
     Reused Hub Bearing: 4.9 — 19.6 N (0.5 — 2 kg/1.1 — 4.4 lb)
4. Install a cotter pin through the nut and knuckle and bend it over.
   - If the notch in the nut does not line up with the cotter pin hole in the knuckle, tighten the nut until it does. Do not loosen the nut to line up a notch and the knuckle hole.
5. Apply grease into the hub cap and install it.
   - 0.4 N (40 g/0.09 lb)
6. Install the disc brake assembly and tighten two bolts to the specified torque.

Tighten:
Bolts to 221 N·m (22.5 kg·m/163 lb·ft)

Rear Speed Sensor

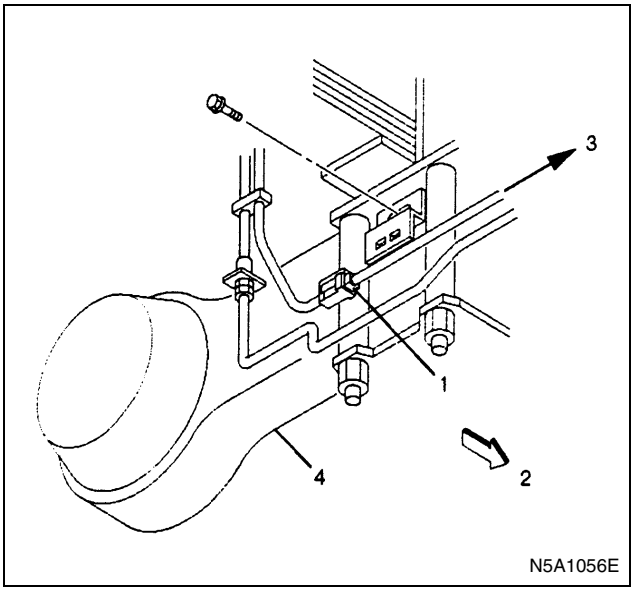
Components



Legend

1. Brake Drum
2. Speed Sensor Fixing Bolt
3. Speed Sensor
4. Speed Sensor Bracket

Removal



Legend

1. Speed Sensor Connector
2. Front
3. Speed Sensor
4. Rear Axle

1. Disconnect speed sensor connector.
2. Remove brake drum.
3. Remove speed sensor fixing bolt.
4. Remove speed sensor.
5. Remove speed sensor bracket.

Inspection and Repair

1. Check the speed sensor for presence of foreign materials; remove any dirt, etc.
2. Check the speed sensor for damage, and replace the speed sensor if necessary.
3. Check the speed sensor harness for a short or an open, and replace with a new one if necessary. To check for harness short or open, bend or stretch the cable while checking for continuity.

Installation

1. Install speed sensor bracket and tighten the nut to the specified torque.

Tighten:
Nut to
GVW Range 12,000 lbs. and 14,500 lbs. model:
108 N·m (11 kg·m/80 lb·ft)
GVW Range 17,950 lbs. model:
157 N·m (16 kg·m/116 lb·ft)

2. Install the speed sensor and take care not to hit the speed sensor during installation.
3. Install the speed sensor fixing bolt and tighten it to the specified torque.

Tighten:
Bolt to 18 N·m (1.8 kg·m/13 lb·ft)

4. Install brake drum and tighten bolts to the specified torque.

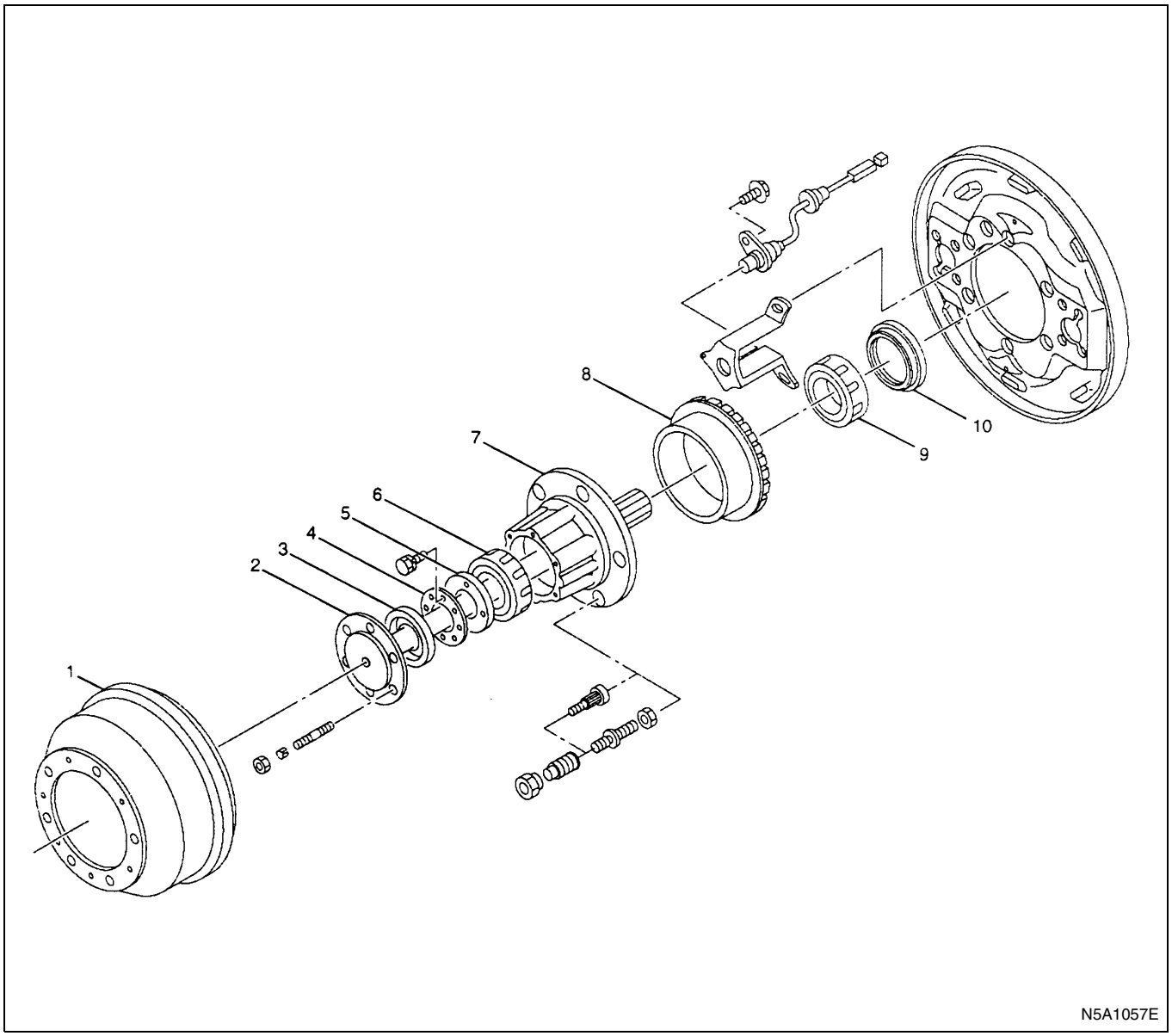
Tighten:
Bolts to 13 N·m (1.3 kg·m/9.5 lb·ft)

5. Connect speed sensor connector.

Notice:
Confirm that the harness is not twisted when connecting the speed sensor connector.

Rear Speed Sensor Rotor

Components



Legend

1. Brake Drum
2. Axle Shaft
3. Outer Oil Seal
4. Lock Washer
5. Bearing Nut
6. Outer Bearing
7. Rear Hub
8. Speed Sensor Rotor
9. Inner Bearing
10. Inner Oil Seal

Removal

1. Remove brake drum.
2. Remove axle shaft.
3. Remove outer oil seal, using a screwdriver.
4. Remove lock washer.
5. Remove bearing nut with a hub bearing nut wrench.
6. Remove hub assembly from axle case.
7. Remove outer bearing from hub assembly.
8. Remove speed sensor rotor from hub assembly.
9. Remove inner bearing and inner oil seal from axle case.

Inspection and Repair

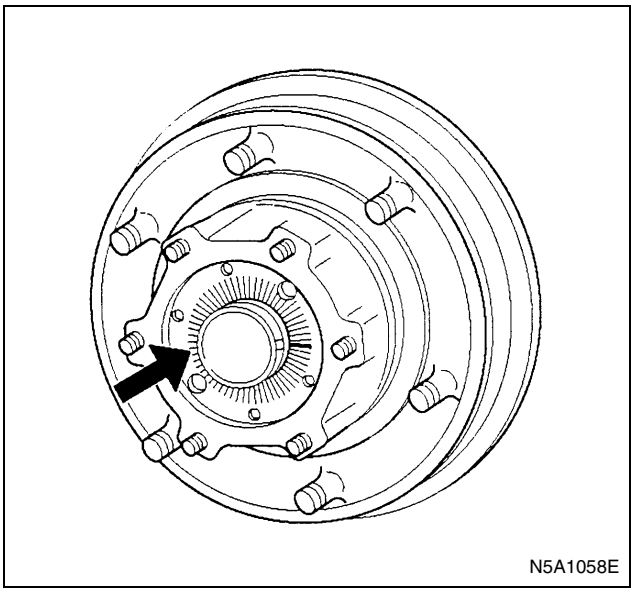
1. Check the speed sensor rotor for damage including tooth chipping. If damaged, replace speed sensor rotor.

Installation

1. Using a bench press, install speed sensor rotor.

Notice:
Do not reuse the sensor rotor.

2. Install spacer on to the axle case.
3. Apply grease into the outer and inner bearings and install bearings in the hub.
4. Install outer oil seal into hub.
5. Install hub assembly onto the axle case.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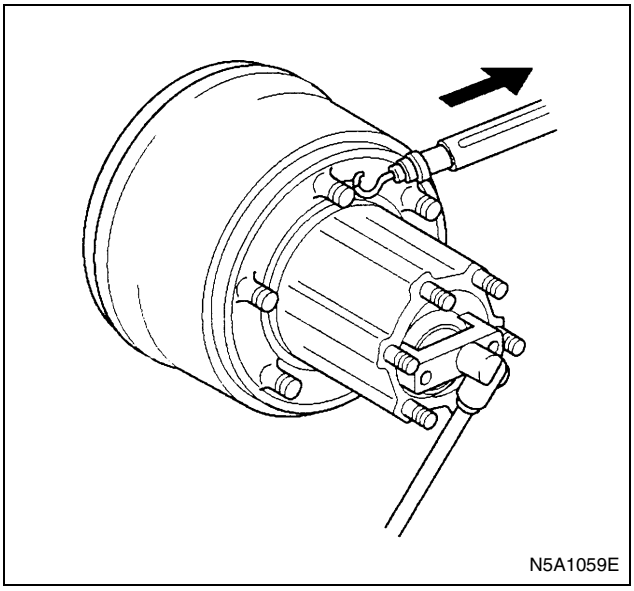
6. Set the lock nut with the notched line facing out.

Preload Adjustment

1) Turn the hub to the left and right several times to establish bearing conformity.
2) Use the bearing nut wrench to tighten the bearing nut until the hub can not be manually rotated.
3) Loosen the bearing nut until hub rotates easily.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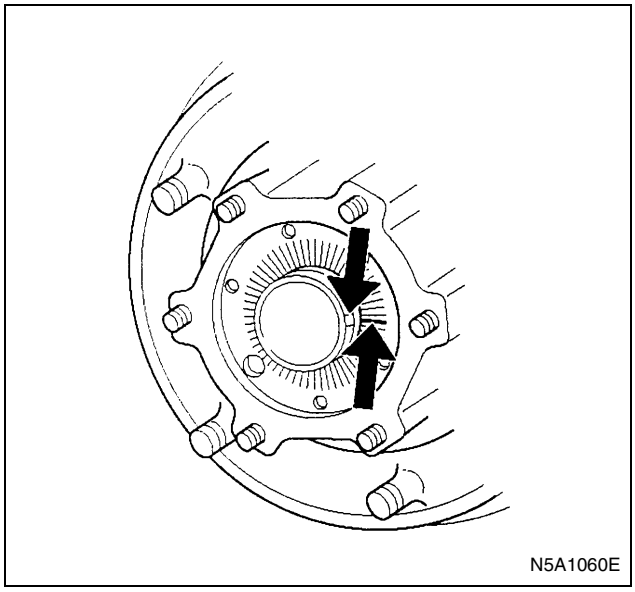
4) Set the spring balancer to the wheel pin in the position shown in the illustration.
5) Measure the hub bearing preload by carefully pulling on the spring balancer and noting the indicator reading.
   Hub Bearing Preload (At Wheel Pin):
   42 — 52 N (4.3 — 5.3 kg/9.4 — 11.6 lb)
6) Rotate the hub several times to the right and left.
7) Measure the bearing preload a second time.


N5A1060E

8) Align the axle case groove with the closest bearing nut slit.

Notice:
If it is difficult to align the axle case and bearing nut, slightly tighten the bearing nut.

7. Install the lock washer with the lock washer tabs inserted to the axle case grooves.
   Install the lock bolts to prevent the bearing nut from loosening.
   Check that the lock washer tabs are inserted to the axle case grooves.
8. Apply grease to the outer oil seal lip inner and outer circumferences and install outer oil seal.
9. Clean the axle shaft.
   Apply gear oil to the axle shaft spline.
   Insert the axle shaft into the axle case.
   Take care not to damage the oil seal.
10. Tighten the axle shaft nuts to the specified torque a little at a time.

Tighten:
Nuts to 46 N·m (4.7 kg·m/34 lb·ft)

11. Install brake drum.

BRAKES

SECTION 5C

PARKING BRAKES

Contents

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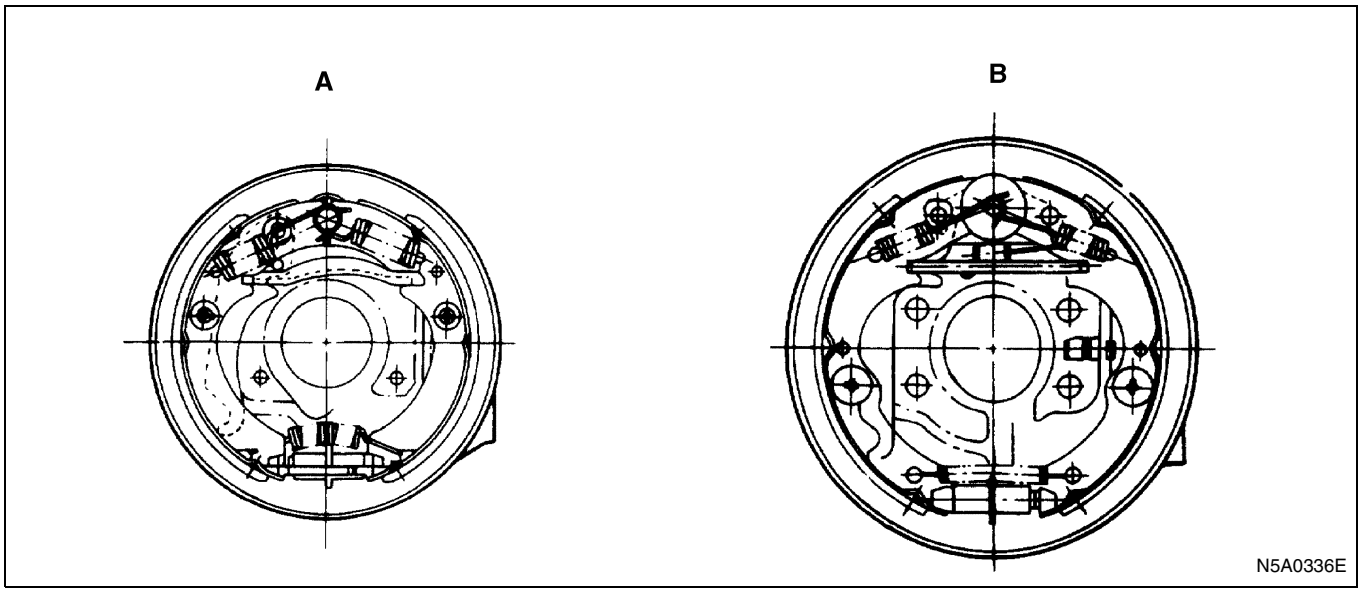
PARKING BRAKE ASSEMBLY, PARKING BRAKE LEVER.....5C-3
UNIT REPAIR [178 mm, 190 mm TYPE].....5C-8
UNIT REPAIR [203 mm TYPE].....5C-11

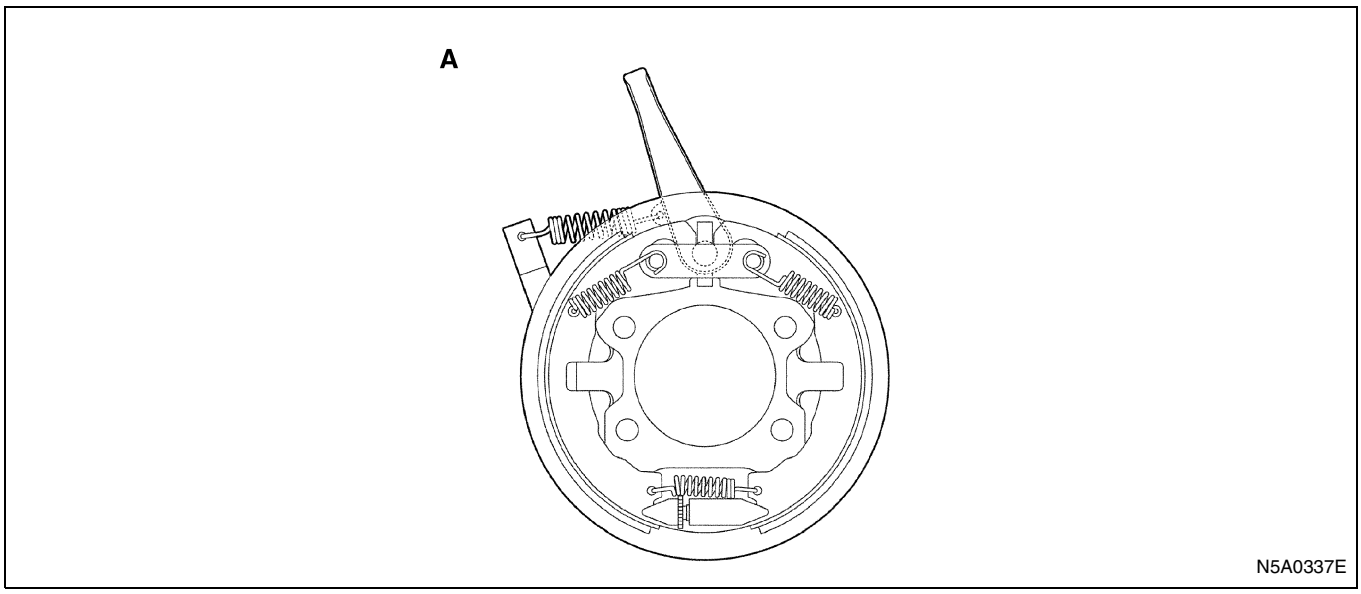
GENERAL DESCRIPTION

Parking Brake Assembly



Legend

A. 178 mm type
B. 190 mm type



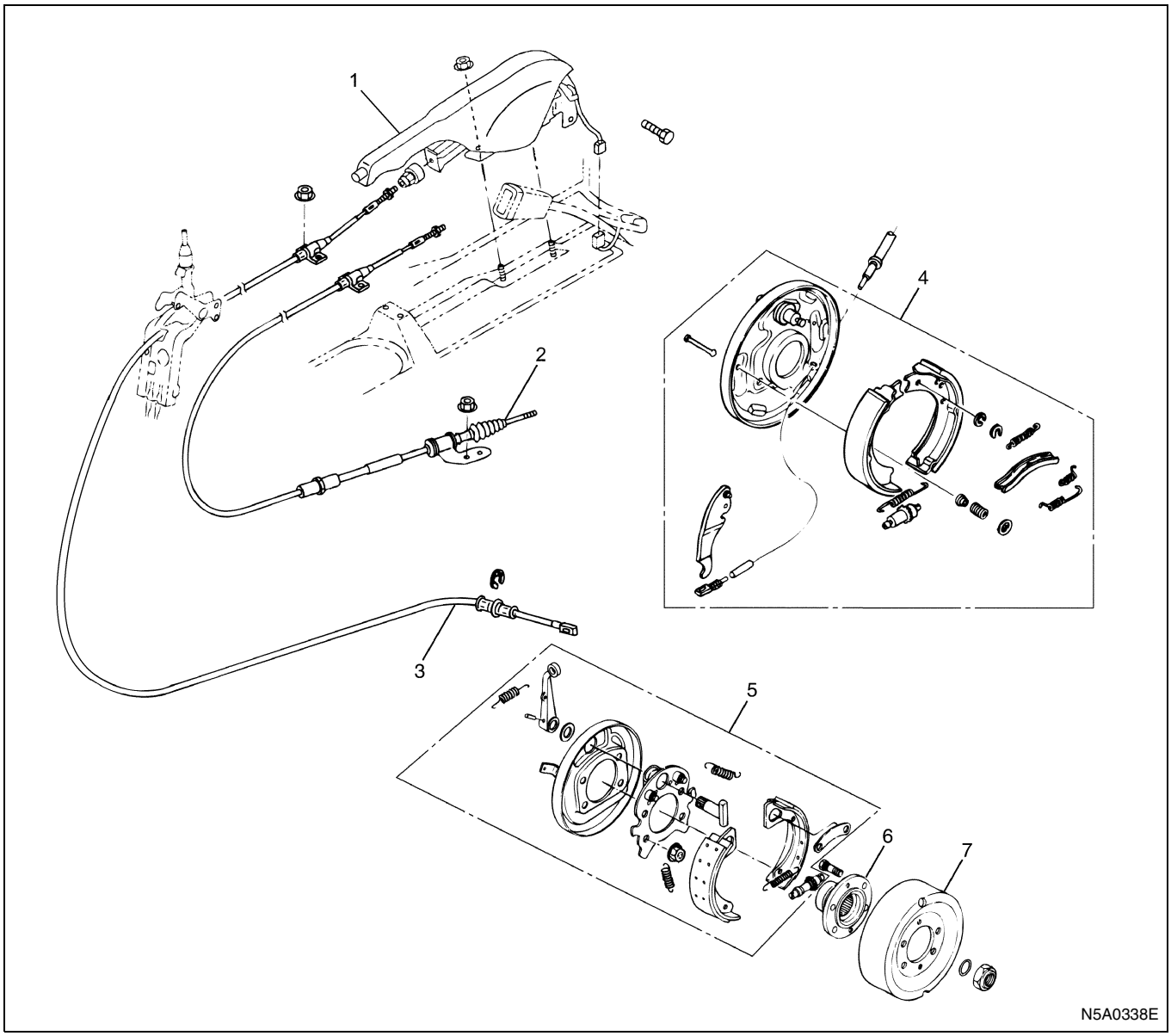
Legend

A. 203 mm type

The parking brake is a mechanically operated internal-expanding type drum brake. It is mounted on the rear of the transmission case.
The control cable is routed into the vehicle cab where it is connected to the parking brake lever.

PARKING BRAKE ASSEMBLY, PARKING BRAKE LEVER

Components



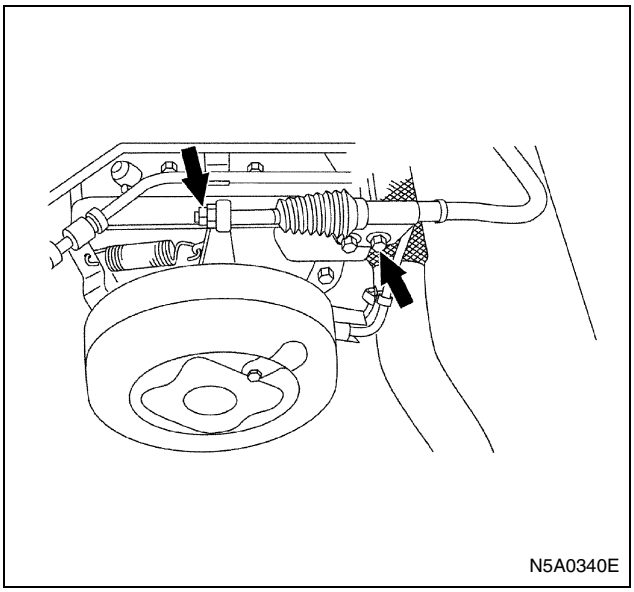
Legend

1. Parking brake lever assembly
2. Parking brake cable (203 mm TYPE)
3. Parking brake cable (178, 190 mm TYPE)
4. Parking brake assembly (178, 190 mm TYPE)
5. Parking brake assembly (203 mm TYPE)
6. Coupling driver
7. Parking brake drum

Removal

1. Jack up the body, and support the frame with the stand.
   Refer to “LIFTING INSTRUCTION” in Section 0A GENERAL INFORMATION.
2. Remove the rear propeller shaft.
   - Disconnect the propeller shaft from the transmission.
   - Remove the center bearing bracket as well in the case of the long type.
3. Loosen the coupling driver lock nut.
   - Apply the parking brake, completely raise the latch of the lock nut for the coupling driver, and loosen the lock nut. Then, release the parking brake.
4. Disconnect the parking brake cable.
   - 203 mm TYPE
     – Remove the lock nut from the lever of the parking brake assembly.

– Remove the mounting bolt from the cable bracket, and disconnect the parking brake cable from the transmission.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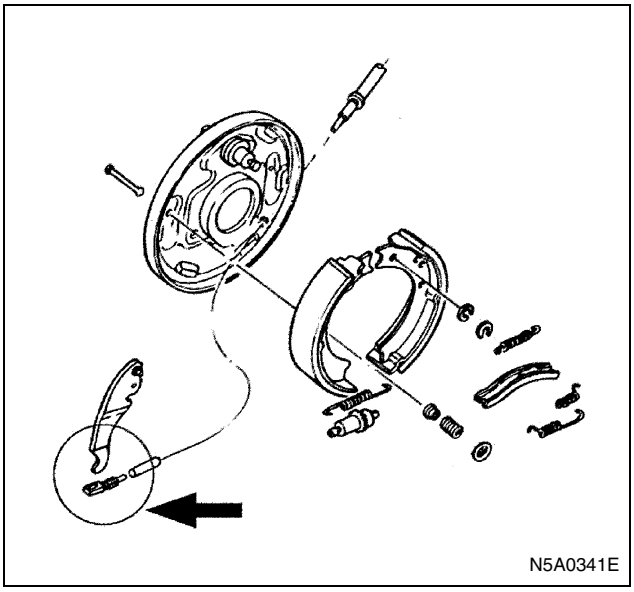
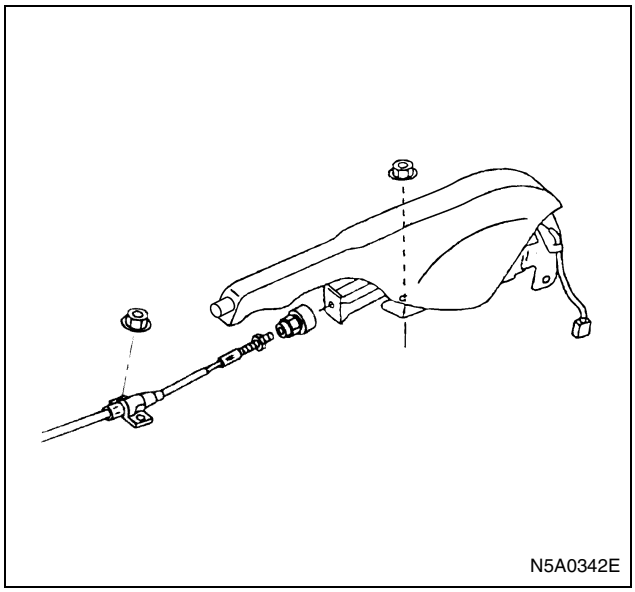
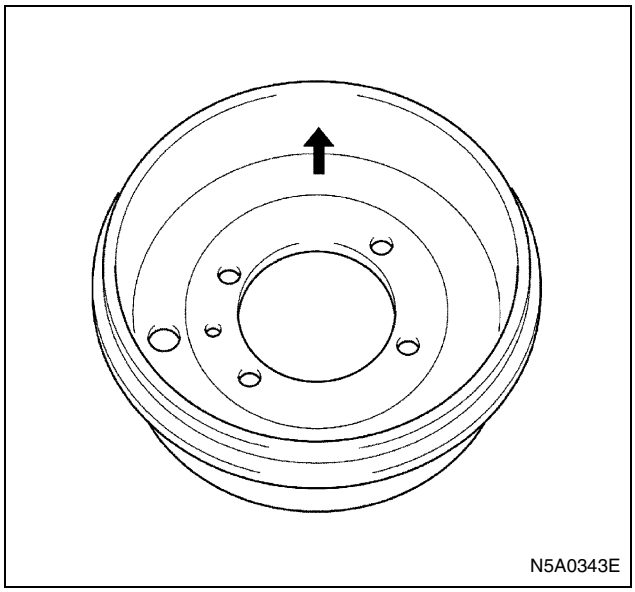
• 178, 190 mm TYPE
  – Remove the parking brake drum.
  – Disconnect the cable from the lever of the parking brake assembly.


N5A0341E

5. Remove the parking brake drum.
  • Remove the adjusting hole cover and the parking brake drum.
6. Remove the coupling driver.
  • Remove the lock nut that was loosened in step 3, and remove the coupling driver using a universal puller.
7. Remove the parking brake assembly.
8. Remove the parking brake lever assembly.
  • Loosen the adjusting nut, and disconnect the parking brake cable from the lever.
  • Disconnect the connector.
  • Loosen the retaining nut, and remove the parking brake lever assembly.


N5A0342E

9. Inspect the parking brake drum.
  • Inspect the parking brake drum for damage, wear, step wear, or cracking. If any defect is found, correct or replace the parking brake drum with a new one.
  • Measure the inside diameter of the parking brake drum.

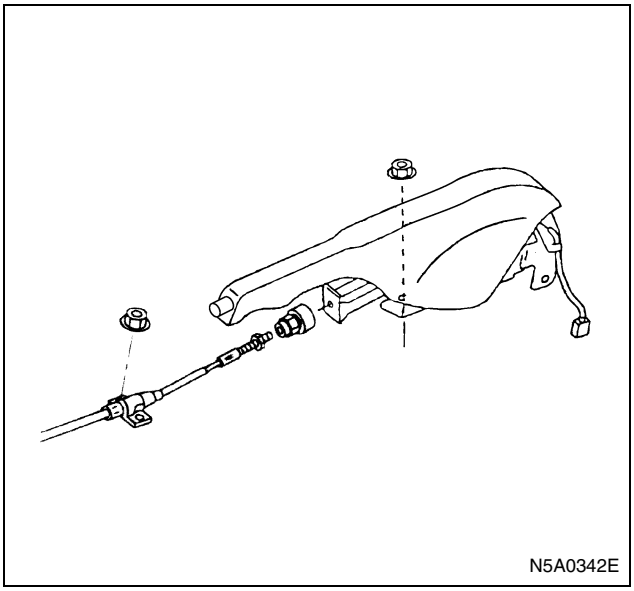

N5A0343E

Drum inside diameter
178 mm (7.00 in) type parking brake
Standard value = 178 mm (7.00 in), limit = 179 mm (7.05 in)
190 mm (7.48 in) type parking brake
Standard value = 190 mm (7.48 in), limit = 191 mm (7.52 in)
203 mm (7.99 in) type parking brake
Standard value = 203 mm (7.99 in), limit = 204 mm (8.03 in)

Notice:
Correct the drum inside diameter by grinding to the appropriate limit.

Installation

1. Mount the parking brake lever assembly.
   - Mount the parking brake lever assembly, connect the parking brake cable, and properly tighten the adjusting nut.


N5A0342E

2. Mount the parking brake assembly.
   - 178 mm type parking brake

Tighten:
M12 nut to 113 N·m (11.5 kg·m/83.3 lb·ft)
M8 bolt to 25 N·m (2.6 kg·m/18.4 lb·ft)

- 190 mm type parking brake
  - Wash the stud bolt and the bolt hole with volatile oil (thinner, alcohol, etc.).
  - Apply Loctite #638 to the embedded side (guide side) of the stud bolt and the bolt hole.
  - Attach the stud bolt (M12).

Tighten:
Stud bolt to 49 N·m (5.0 kg·m/36.1 lb·ft)

  - Mount the parking brake assembly, and fasten it with the caulking nut (M12).

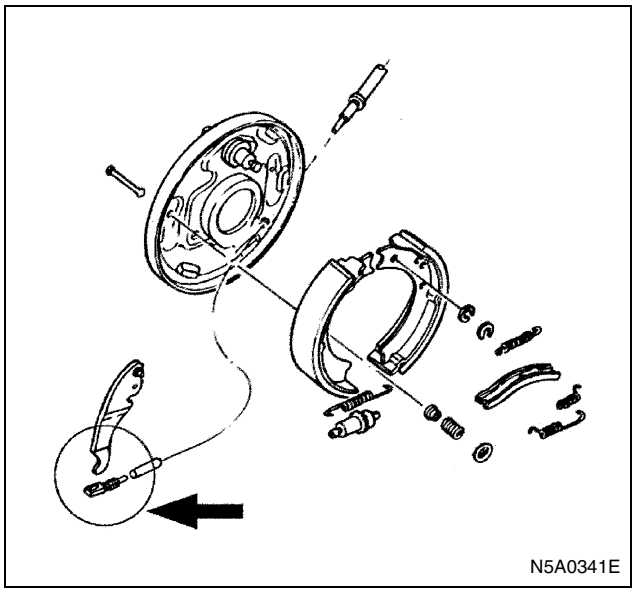
Tighten:
Caulking nut to 126.5 N·m (12.9 kg·m/93.3 lb·ft)

- 203 mm type parking brake

Tighten:
127 N·m (13.0 kg·m/93.7 lb·ft)

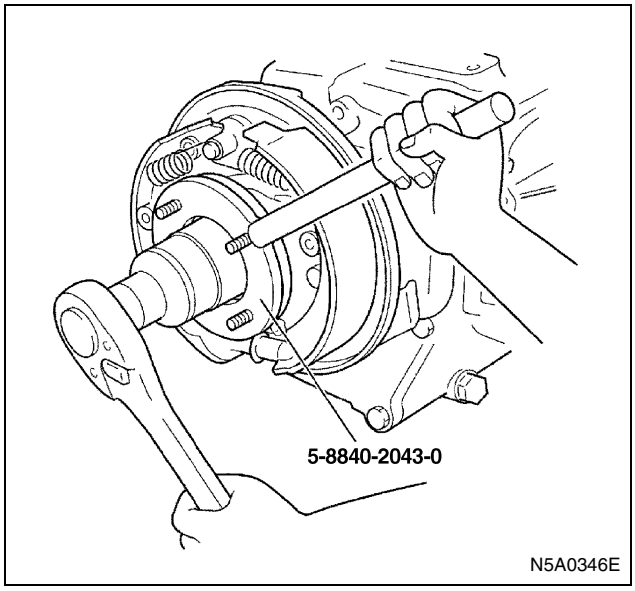
3. Connect the parking brake cable.
   - Connect the parking brake cable to the lever of the parking brake assembly (178, 190 mm TYPE).

Notice:
Confirm that the portion indicated by the arrow is properly connected.


N5A0341E

4. Mount the coupling driver.
   - Attach the coupling driver to the main shaft, and fasten it with an O-ring, a conical washer (MSB only), and a lock nut.
     Tighten the lock nut while holding the coupling driver with a handle 5-8840-2043-0.

Tightening torque	N·m (kg·m/lb·ft)
MSB type transmission	226 (23.0/166.7)
MYY type transmission	289 (29.5/213.2)
MZZ type transmission	382 (39.0/281.8)

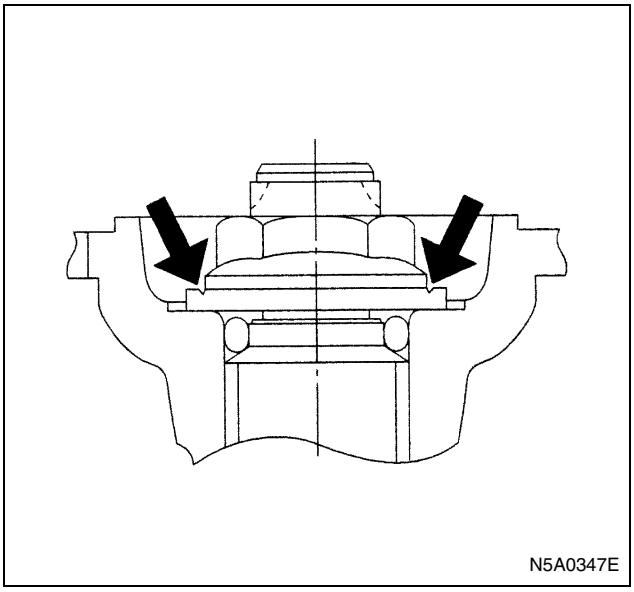


N5A0346E

Notice:

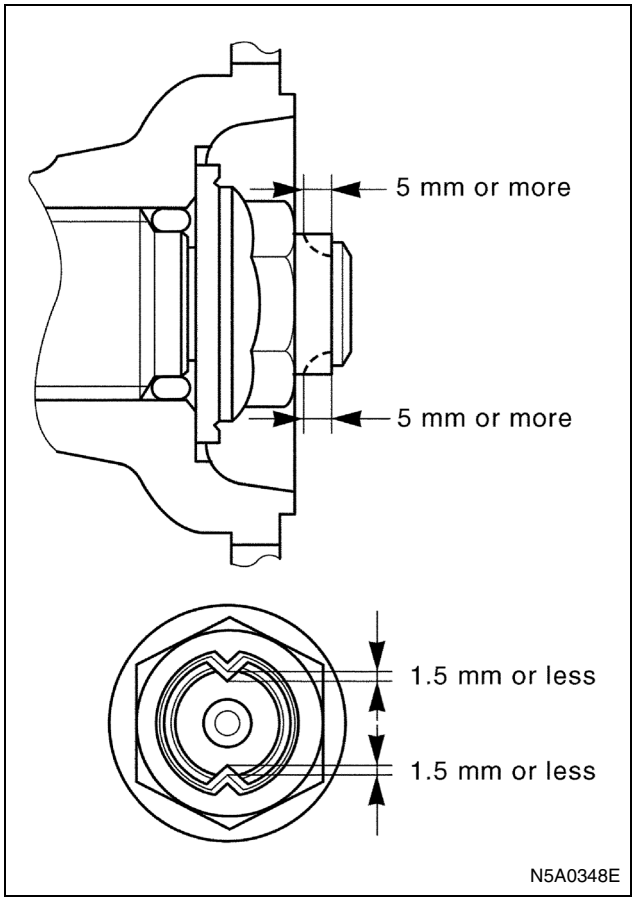
- Use a new lock nut because it is a caulking type. Apply oil to the seating face before attaching the lock nut.

- Use a new O-ring. Apply a thin coat of lubricating oil to the O-ring before attaching it.
- Attach the conical washer (MSB only) with the identification groove facing the lock nut (rear side).

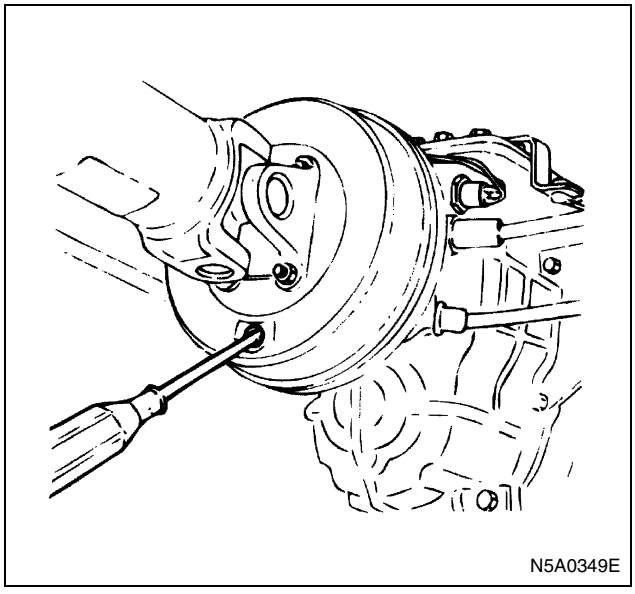


5. Caulk the lock nut.
   - Align the lip of the lock nut with the V-grooves cut in the tip of the main shaft, and securely caulk the lock nut at two points so that the caulking length will be 5 mm (0.2 in) or more and the clearance between the lower V-groove in the main shaft and the lock nut lip will be 1.5 mm (0.06 in) or less.

Notice:
After the caulking of the lock nut, check the caulked points for cracking. If there is any crack, replace the lock nut with a new one, and caulk it.



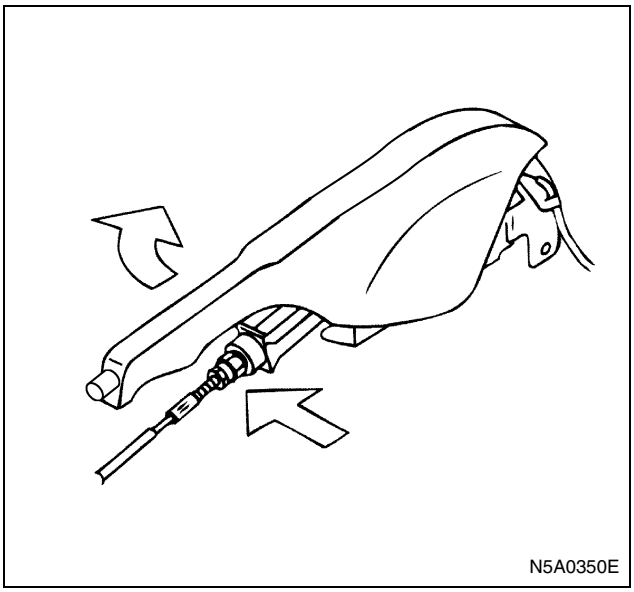
6. Mount the parking brake drum.
7. Adjust the pulling allowance of the parking brake.
   - Turn the adjuster until the parking brake drum stops turning. (Turn the parking brake drum downward in the case of vehicles with a 203 mm type or upward in the case of vehicles other than 203 mm type.)
   - Turn back the adjuster by the specified number of notches.



Number of notches by which the adjuster must be turned back

All vehicles equipped with other than 203 mm type = 30 notches

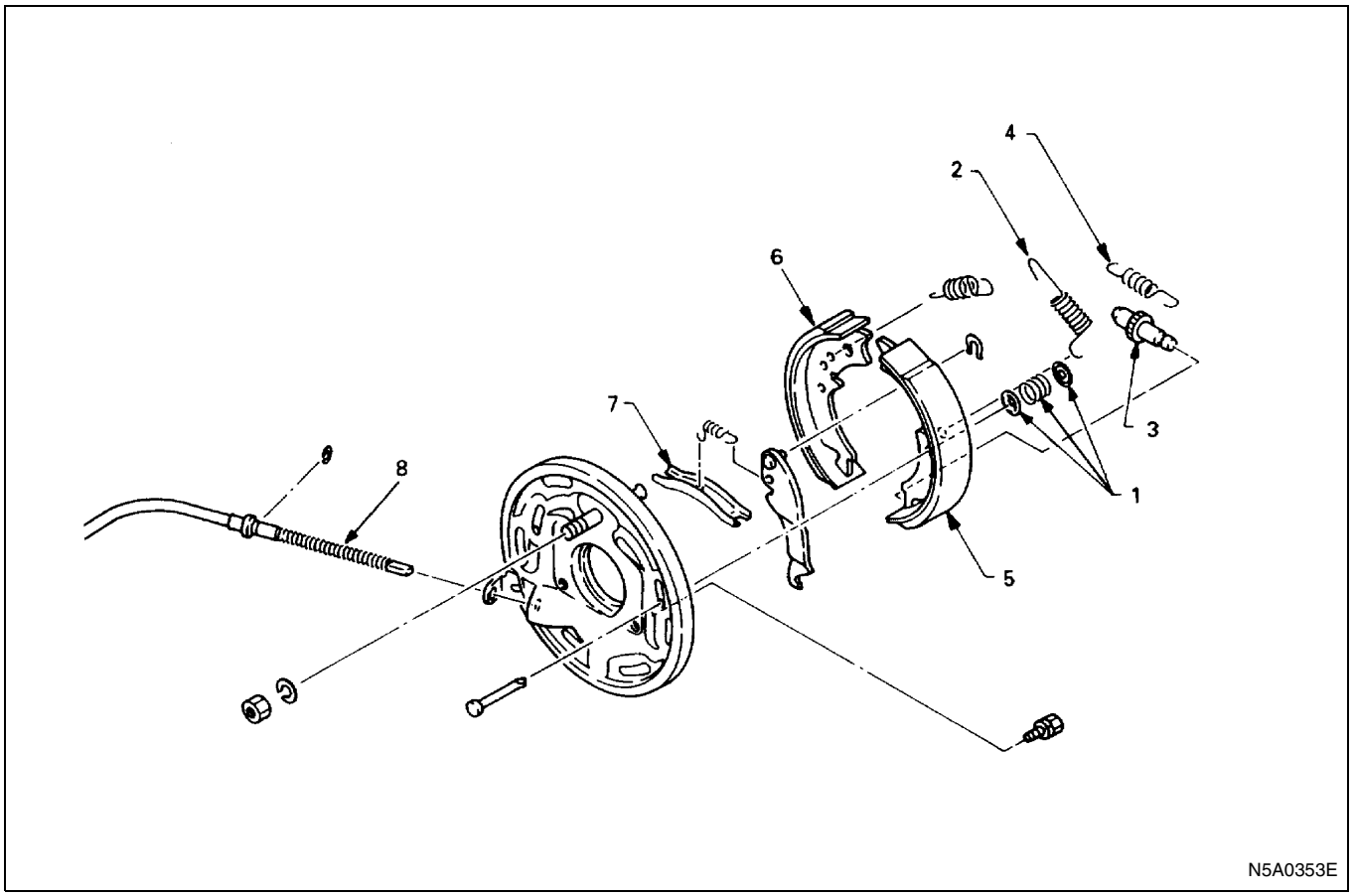
Vehicles equipped with a 203 mm type = 8 notches



- Adjust the pulling allowance of the parking brake lever by tightening the adjusting nut so that the allowance at a handle operating force of 147 N (15.0 kg / 33 lb) will be six to eight notches.
- Confirm that the brake does not drag.
- Mount the adjusting cover over the parking brake drum.

UNIT REPAIR [178 mm, 190 mm TYPE]

Parking Brake Assembly



Legend

1. Holding spring
2. Return spring
3. Adjuster assembly
4. Spring; adjuster
5. Secondary brake shoe assembly with lever
6. Primary brake shoe assembly
7. Strut
8. Parking cable

Disassembly

1. Holding Spring
2. Return Spring
3. Adjuster Assembly
4. Spring; Adjuster
5. Secondary Brake Shoe Assembly
6. Primary Brake Shoe Assembly
7. Strut
8. Parking Cable

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Visual Check

Inspect the following parts for wear, corrosion, scuffs, scratches, deterioration or other abnormal conditions.

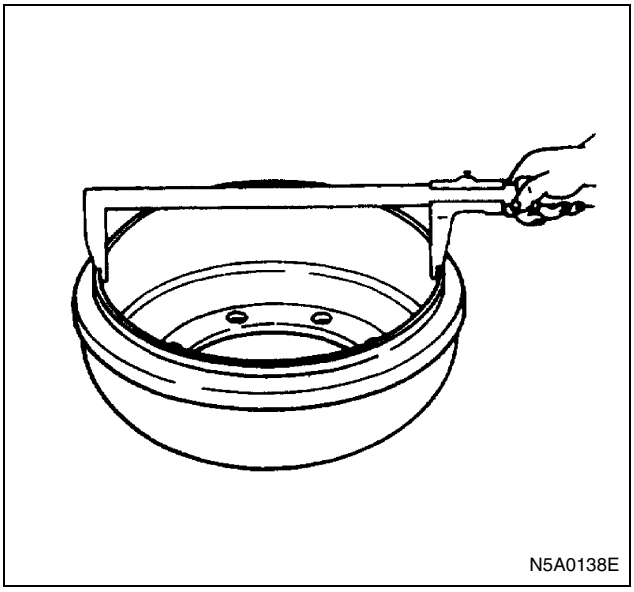
- Brake drum
- Brake lining
- Return spring
- Parking brake lever assembly
- Parking brake inner cable

Brake Drum

Use a vernier caliper to measure the brake drum inside diameter.

If the measured value exceeds the specified limit, the brake drum must be replaced.

Brake Drum Inside Diameter		mm (in)
	Standard	Limit
Inside diameter	178 (7.01) 190 (7.48)	179 (7.05) 191 (7.52)
Out of round: • Limit: 0.05 mm (0.0020 in) or less		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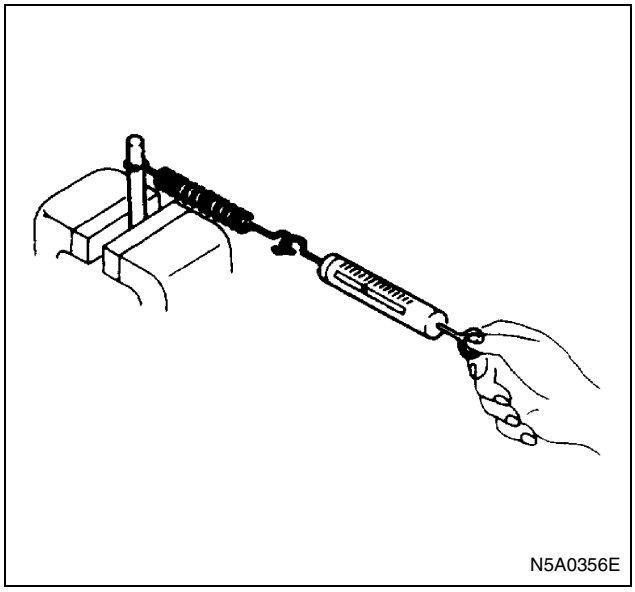
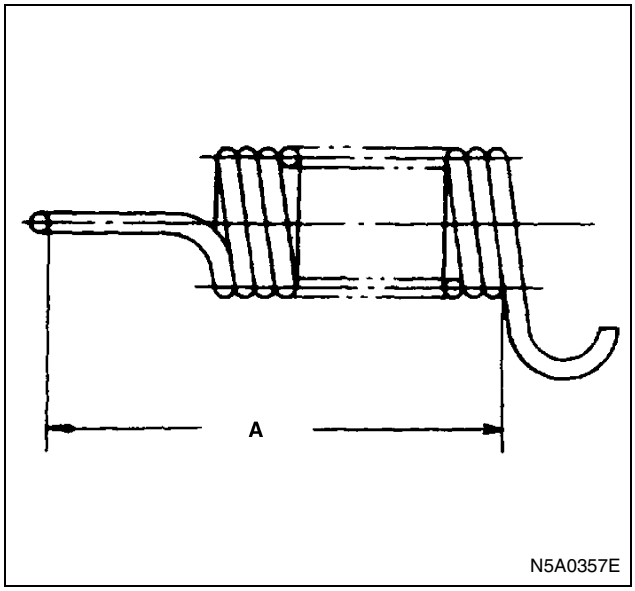

N5A0356E

Return Spring

Use a spring balancer to measure the return spring set load.

If the variation exceeds 10% of the specified value, the return spring must be replaced.

		Drum inside dia. mm (in)	
		178 (7.01)	190 (7.48)
Free length: mm (in)	Primary	62 (2.44)	62.1 (2.44)
	Secondary	49 (1.93)	
Set length: mm (in)	Primary	70 (2.76)	67.1 (2.64)
	Secondary	57 (2.24)	
Set load; N (kg/lb)	Primary	105.9 — 129.5 (10.8 — 13.2/23.8 — 29.1)	53 — 65.7 (5.4 — 6.6/ 11.9 — 14.6)
	Secondary	88.3 — 107.8 (9.0 — 11.0/19.8 — 24.3)	



N5A0357E

Legend

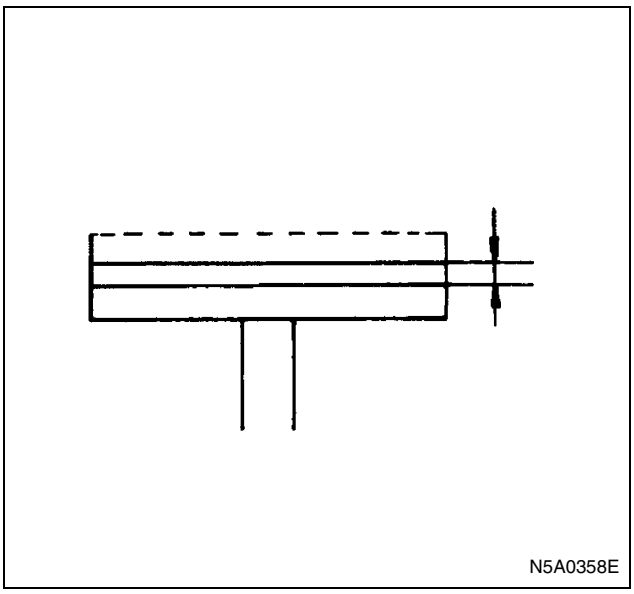
A. Length

Brake Lining Thickness

Use a vernier caliper to measure the brake lining thickness.

If the measured value is less than the specified limit, the brake shoe assembly must be replaced.

Brake Lining Thickness	mm (in)
Limit	1.0 (0.039)

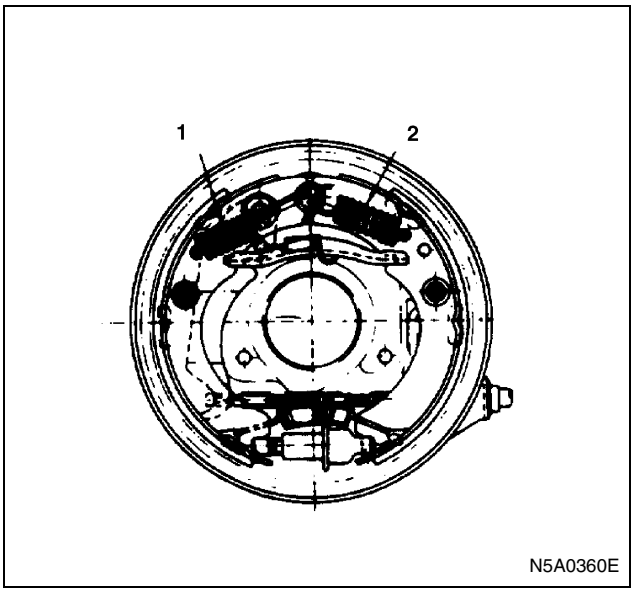


Reassembly

1. Parking Cable Rear
2. Strut
3. Primary Brake Shoe Assembly
4. Secondary Brake Shoe Assembly
   Install the brake shoes by fitting them properly into slot in the adjuster and strut.
5. Spring; Adjuster
6. Adjuster Assembly
7. Return Spring

Drum inside diameter 178 mm only

Attach the return spring bauing fewer windings at the primary side as illustrated.



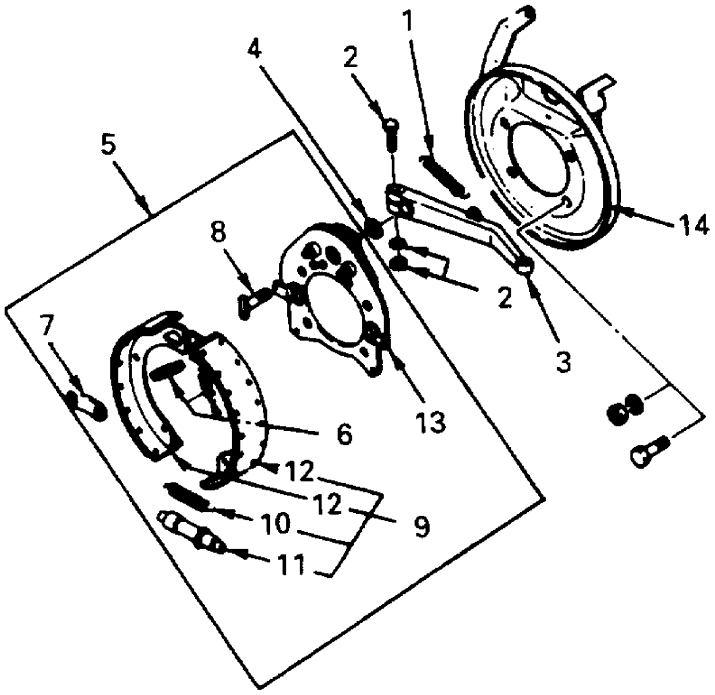
Legend

1. Fewer windings
2. Much windings

8. Holding Spring

UNIT REPAIR [203 mm TYPE]

Parking Brake Assembly



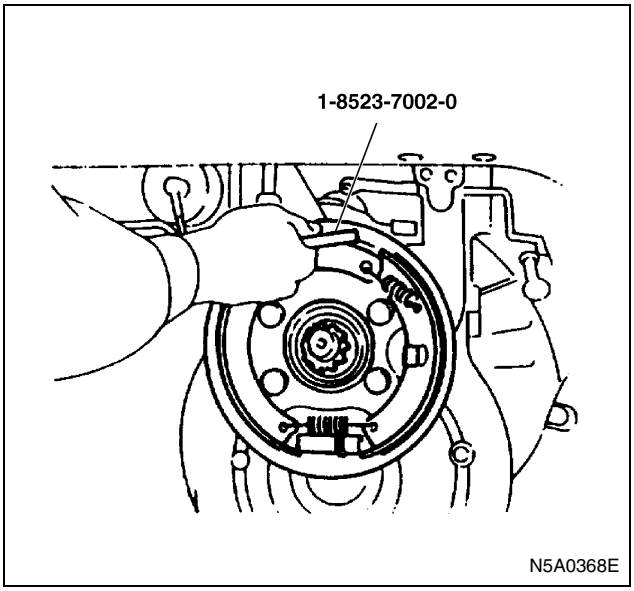
N5A0361E

Legend

1. Spring
2. Nut, spring washer and bolt
3. Lever
4. Washer
5. Brake shoe and support plate
6. Return spring
7. Anchor pin brace
8. Camshaft
9. Brake shoe assembly
10. Spring: adjuster
11. Adjusting screw
12. Brake shoe
13. Support plate
14. Dust cover

Disassembly

1. Spring
2. Nut, Spring Washer and Bolt
3. Lever
4. Washer
5. Brake Shoe and Support Plate
6. Return Spring
   Remover: 1-8523-7002-0



7. Anchor Pin Brace
8. Camshaft
9. Brake Shoe Assembly
10. Spring: adjuster
11. Adjusting Screw
12. Brake Shoe
13. Support Plate
14. Dust Cover

Inspection and Repair

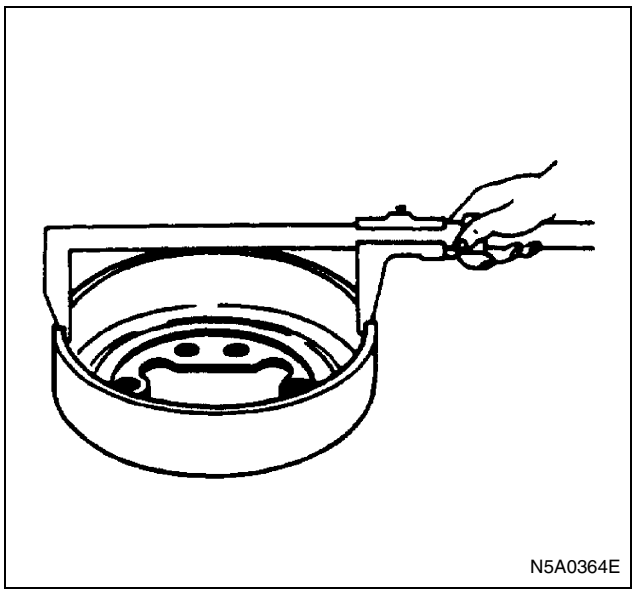
Make the necessary adjustments, repairs, and part replacernents if excessive wear or damage is discovered during inspection.

Visual Check

Inspect the following parts for wear, corrosion, scuffs, scratches, deterioration or other abnormal conditions.

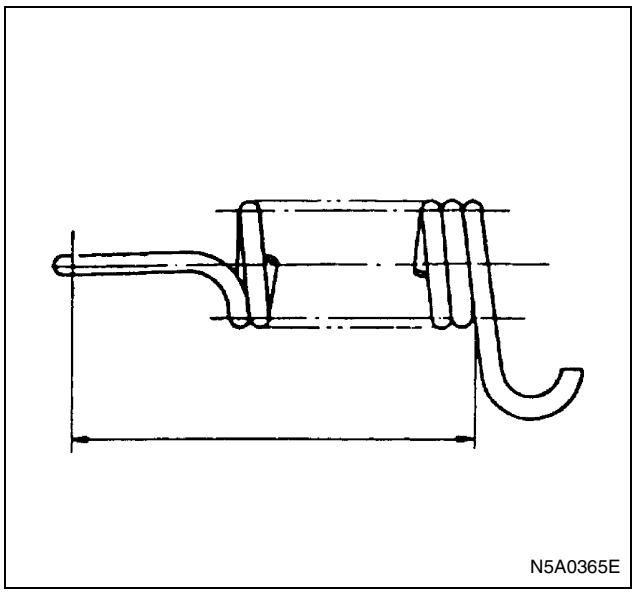
- Brake drum
- Brake lining
- Return spring
- Parking brake lever assembly
- Parking brake inner cable

Brake Drum



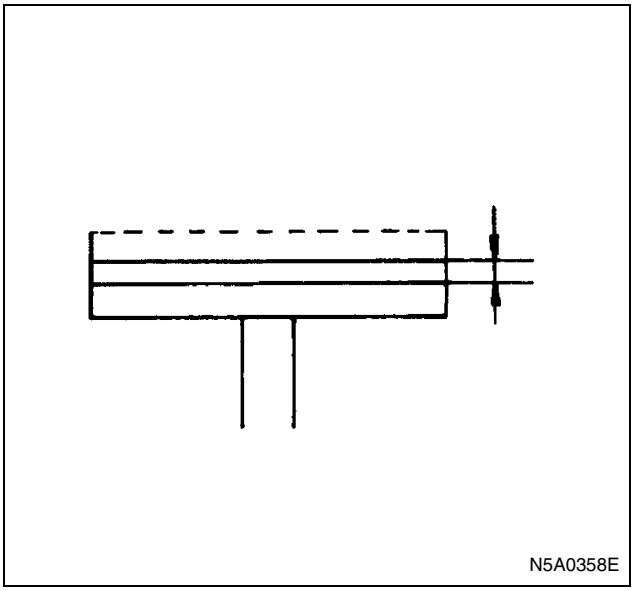
		mm (in)
	Standard	Limit
Brake drum size inside diameter	203 (8.00)	205 (8.07)
Uneven wear and/or score	Run out 0.05 (0.002) or less	

Return Spring



		mm (in)
Free length		49.9 (1.965)
Set load	N (kg/lb)	147 (15/33.07)
Set length		57.5 (2.264)

Brake Lining



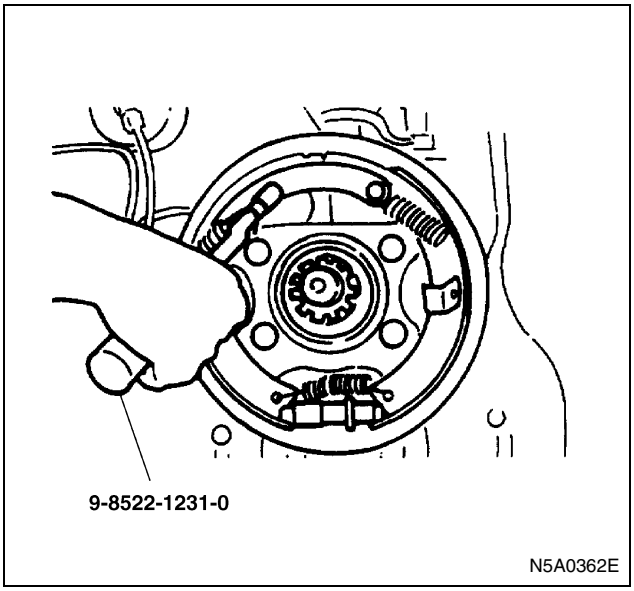
Brake Lining Thickness	mm (in)
Limit	1.0 (0.039)

Reassembly

1. Duct Cover
2. Support Plate

Tighten:
Bolt to 123 N·m (12.5kg·m / 90 lb·ft)

3. Brake Shoe
4. Adjusting Screw
5. Spring: adjuster
6. Brake Shoe Assembly
7. Camshaft
8. Anchor Pin Brace
9. Spring
   Spring installer: 9-8522-1231-0



10. Brake Shoe and Support Plate
11. Washer
12. Lever
13. Bolt, Spring Washer and Nut
14. Spring

BRAKES

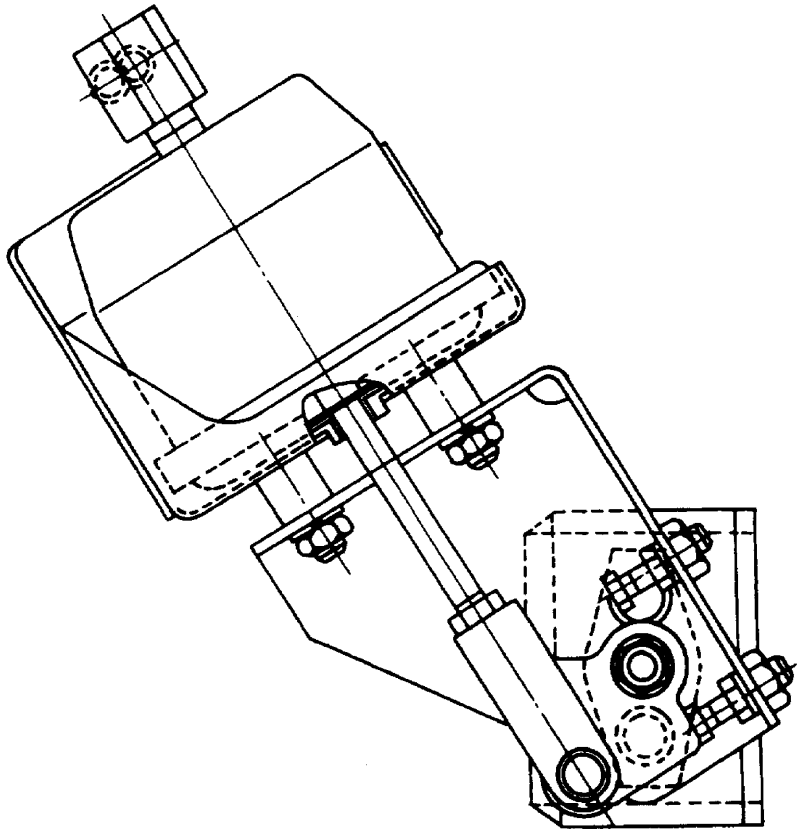
SECTION 5E

EXHAUST BRAKE

Contents

GENERAL DESCRIPTION 5E-2
ON-VEHICLE SERVICE 5E-3
UNIT REPAIR 5E-5

GENERAL DESCRIPTION



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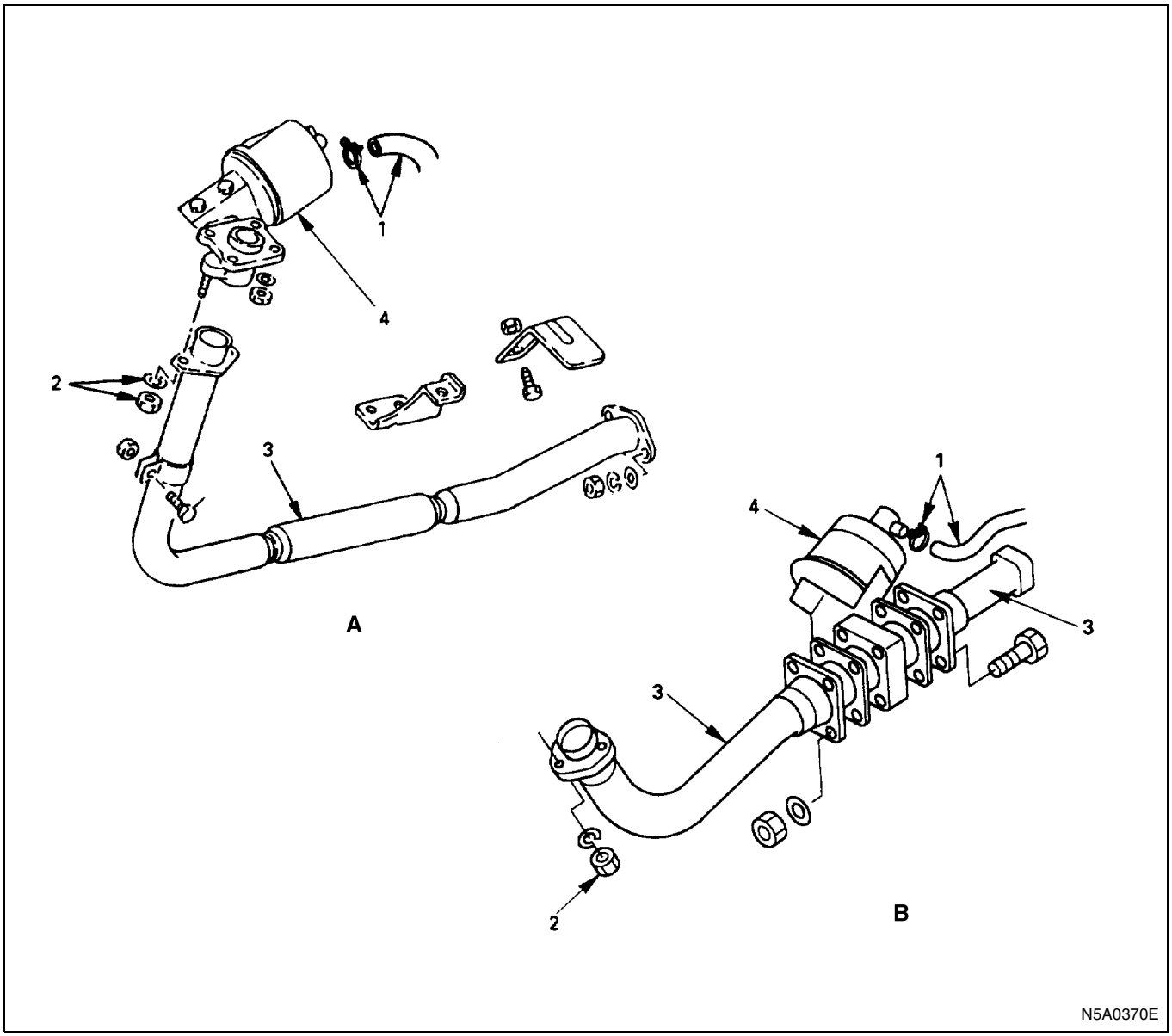
ON-VEHICLE SERVICE

Exhaust Brake Assembly



Legend

A. 4J engine without turbocharger
B. 4J engine with turbocharger and 4H engine
1. Vacuum hose and clip
2. Flange nut
3. Exhaust pipe
4. Exhaust brake unit

Removal

1. Vacuum Hose and Clip
2. Nut
3. Exhaust Pipe
4. Exhaust Brake Unit

Installation

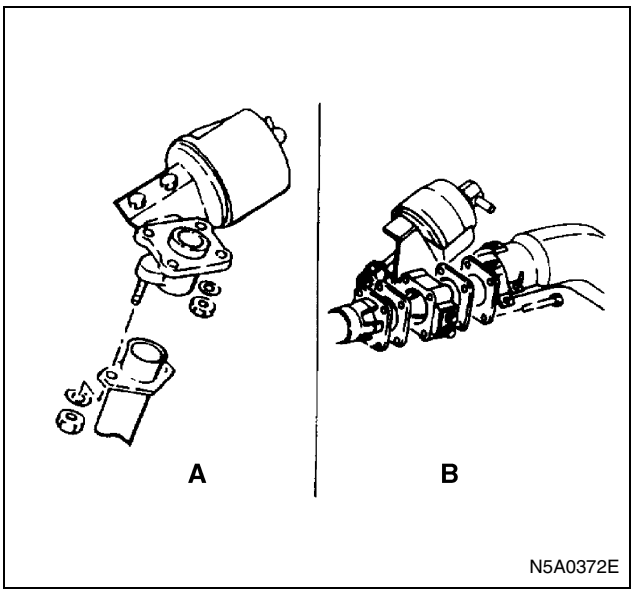
1. Exhaust Brake Unit
   Tighten the brake unit fixing nuts and/or bolts to the specified torque.

Tighten:

Exhaust brake unit fixing nuts and bolts to

4J engine without turbocharger: 37 N·m (3.8 kg·m / 27 lb·ft)

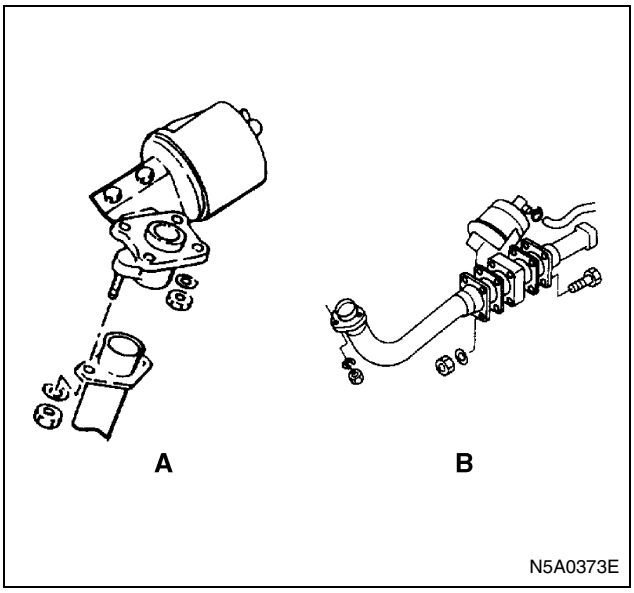
4J engine with turbocharger and 4H engine: 17 N·m (1.7 kg·m / 12 lb·ft)



Legend
A. 4J engine without turbocharger
B. 4J engine with turbocharger and 4H engine

2. Exhaust Pipe
3. Flange Nut
   Tighten the exhaust pipe flange nuts for the exhaust manifold to the specified torque.

Tighten:
Flange nuts to
4J engine without turbocharger: 37 N·m (3.8 kg·m / 27 lb·ft)
4J engine with turbocharger and 4H engine: 67 N·m (6.8 kg·m / 49 lb·ft)

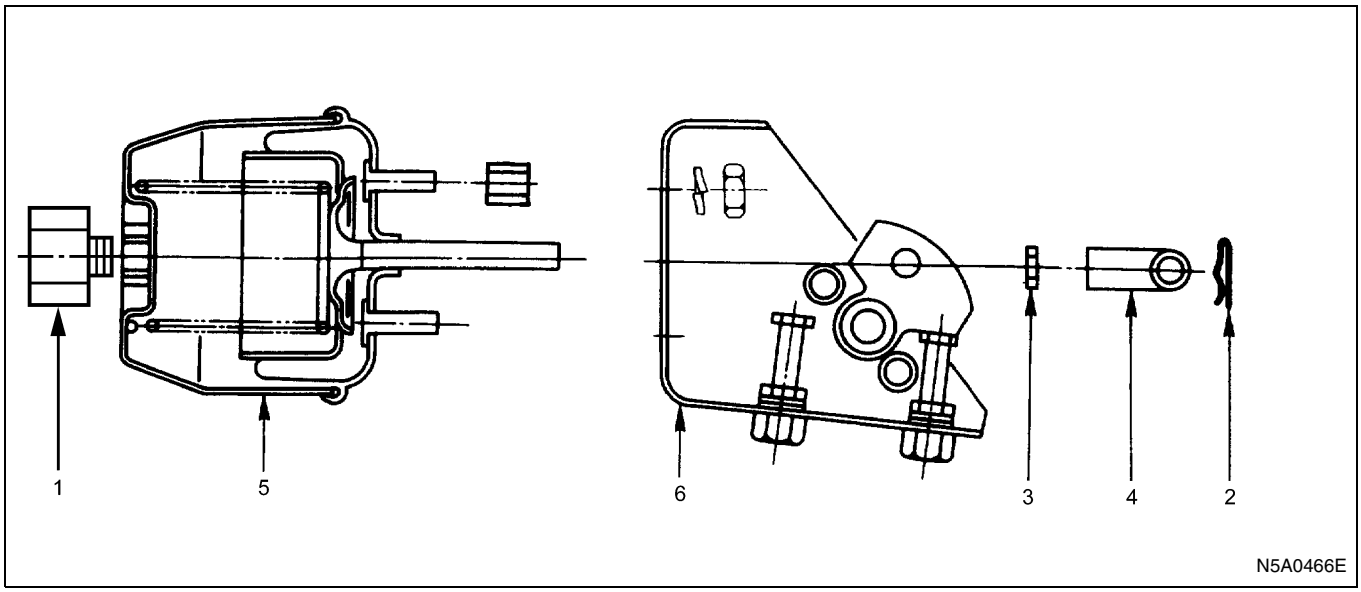


Legend
A. 4J engine without turbocharger
B. 4J engine with turbocharger and 4H engine

4. Vacuum Hose and Clip

UNIT REPAIR

Exhaust Brake Unit



Legend

1. Exhaust brake valve connector
2. Cotter pin
3. Lock nut
4. Clevis joint
5. Power chamber
6. Exhaust valve assembly

Disassembly

1. Exhaust Brake Valve Connector
2. Cotter Pin
3. Lock Nut
4. Clevis Joint
5. Power Chamber
6. Exhaust Valve Assembly

Inspection and Repair

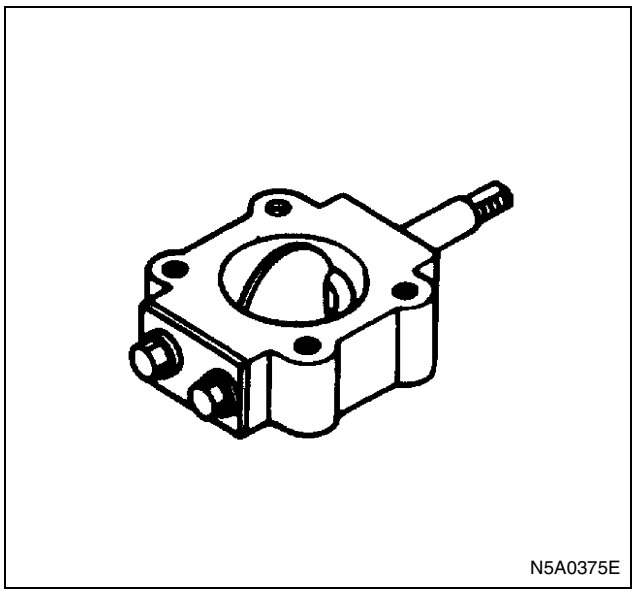
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Visual Inspection

Visually inspect the following parts for excessive wear and damage.

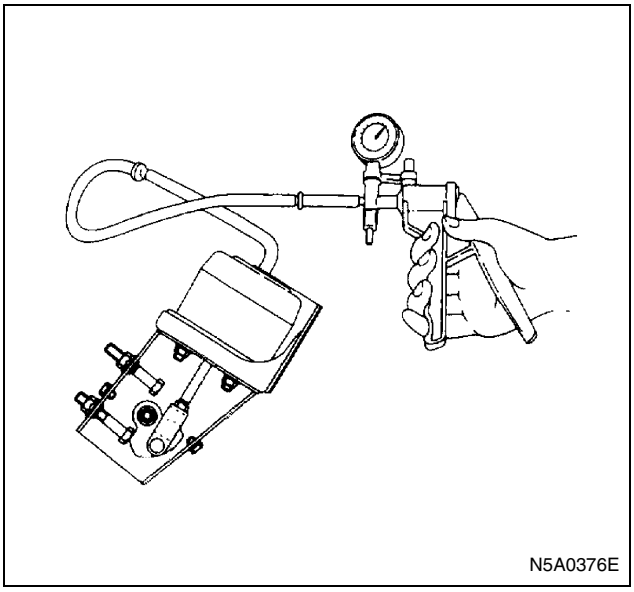
If excessive wear or damage is discovered during inspection, the part(s) must be replaced.

- Exhaust brake valve
- Exhaust brake shaft
- Butterfly valve
- Bushings
- Power chamber



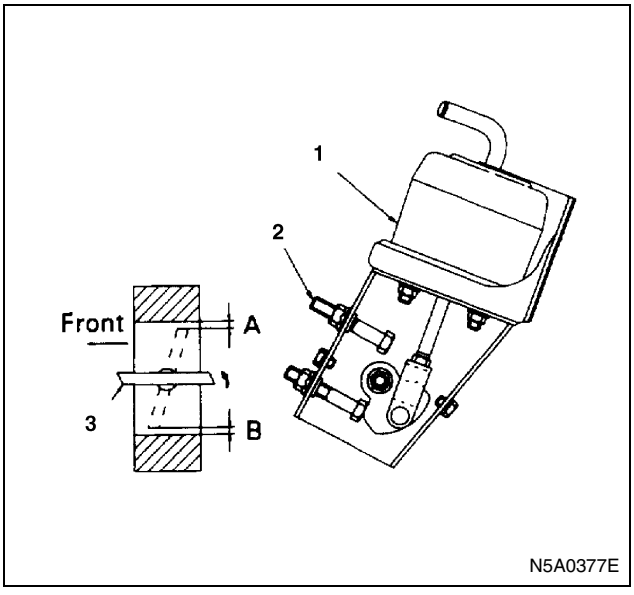
Power Chamber

(1) The exhaust brake valve should operate smoothly when the negative pressure (400 mmHg to 700 mmHg) is applied to the power chamber via the vacuum pump.


N5A0376E

(2) At the points (A) and (B), the average clearance between the valve and the vehicle body should be as mentioned in the following table when the negative pressure (650 mmHg to 700 mmHg) is applied to the power chamber via the vacuum pump.

Clearance Between Valve And Body	mm (in)
	Standard
4HF1 Engine	0.4 — 0.6 (0.016 — 0.024)
Others	0.1 — 0.2 (0.004 — 0.008)



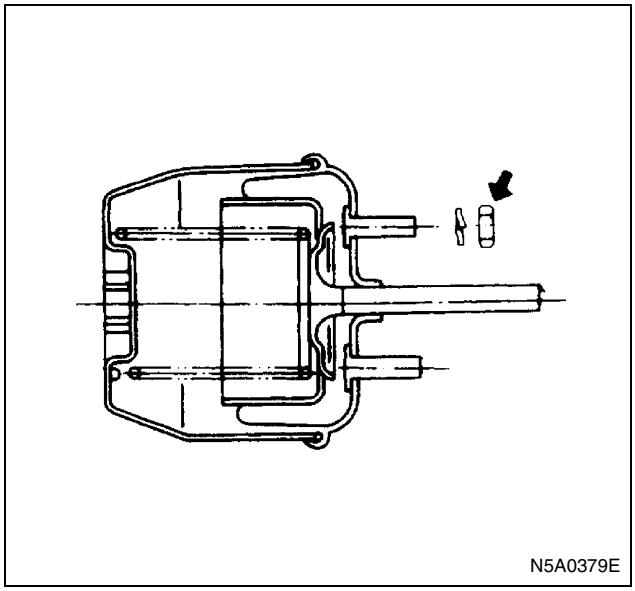
N5A0377E

Legend
1. Power chamber
2. Adjust bolt
3. Valve

Reassembly

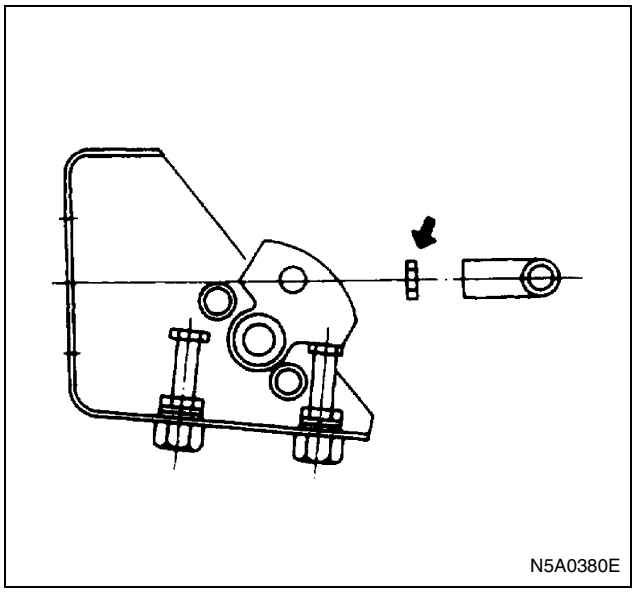
1. Exhaust Valve Assembly
2. Power Chamber

Tighten:
Power chamber fixing nut to 14 N·m (1.4 kg·m / 122 lb·in)


N5A0379E

3. Lock Nut

Tighten:
Lock nut to 13 N·m (1.3 kg·m / 113 lb·in)


N5A0380E

4. Clevis Joint
5. Cotter Pin
6. Exhaust Brake Valve Connector

Tighten:
More than 9.8 N·m (1.0 kg·m / 7.2 lb·ft)

LGBRA-WE-0552

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LGBRA-WE-0552 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

BRAKES

SECTION 5

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

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5A4	ANTI-LOCK BRAKE SYSTEM (ABS)
5B	—
5C	PARKING BRAKES
5D	—
5E	EXHAUST BRAKE

ABS/ASR

SECTION 5A4
ABS/ASR

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ABS/ASR System

Description of Function and Operation

Description of ABS/ASR

ABS (Anti-lock Brake System) and ASR (Anti-Slip Regulator) are the system to prevent the wheels from locking and wheel spin, and to assure stability and steering ability of the vehicle.
When a malfunction occurs in the system, fail-safe deactivate the ABS and ASR, and the warning lamp comes on. Also, the self-diagnosis function is equipped to improve serviceability.

Contents of ABS Control

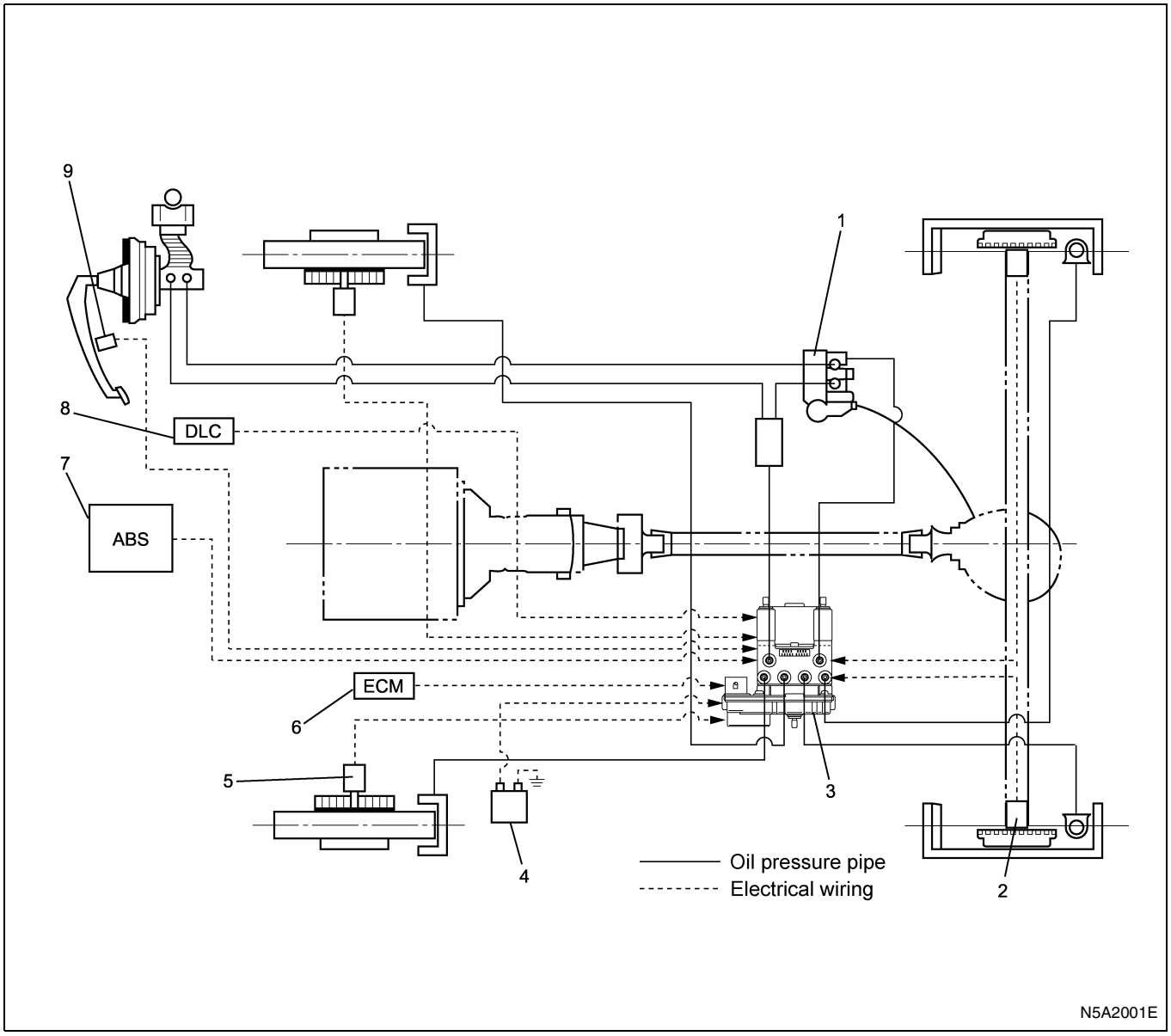
The ABS controls the brake fluid pressure in the way that the electronic hydraulic control unit (EHCU) hold/decrease/increase the brake fluid pressure during brake operation, based on the signal transmitted from the wheel speed sensor.
The EHCU calculate the wheel speed, the wheel acceleration speed, and the vehicle speed based on the signal transmitted from the wheel speed sensor. When brake is applied while the vehicle is running, the wheel speed abruptly goes down, and the difference from the vehicle speed becomes more than specified; the EHCU judges that the wheel turns toward being locked, and it performs holding of the brake fluid pressure.
When the vehicle speed further goes down, the system judges that the wheel is about to be locked, and it performs decreasing of the brake fluid pressure. Consequently, when the system judges that wheel lock is avoided, it performs holding and increasing of the brake fluid pressure repeatedly.

Contents of ASR Control

The ASR controls the engine torque to prevent wheel spin of the drive wheel during sudden start/acceleration. The ABS/ASR control unit calculates the engine control speed (average of the drive wheel RH and LH speed) and the vehicle speed (driven wheel speed) based on the signal transmitted from each wheel speed sensor.

When the drive wheel spins and the speed difference between the engine control speed and the vehicle speed reaches the specified value, the ABS/ASR control unit send a signal to the engine control unit to operate the throttle closing direction to adjust the slip amount appropriately.

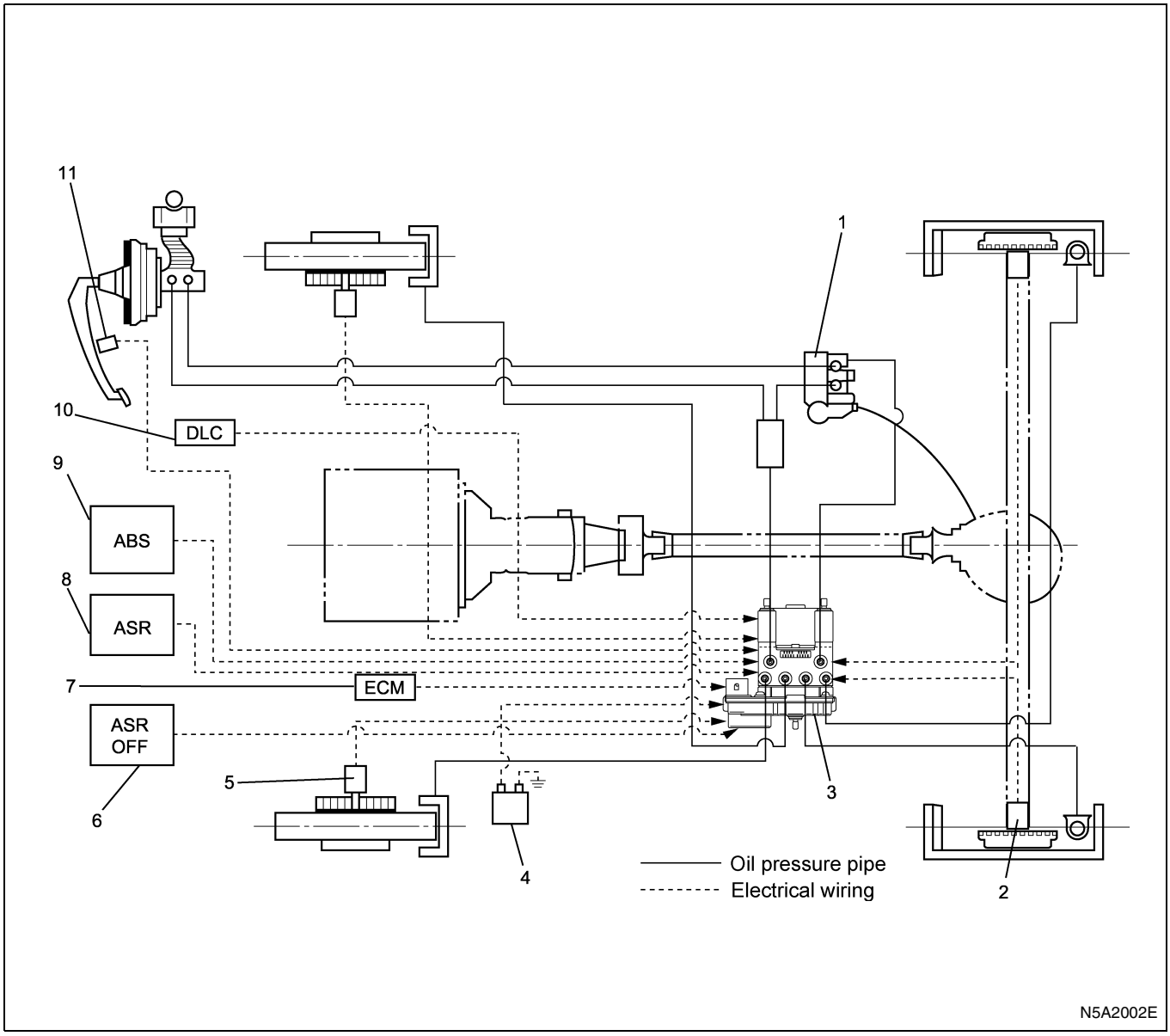
2WD ABS



Legend

1. LSPV
2. Speed sensor (rear wheel)
3. Electronic hydraulic control unit (EHCU)
4. Battery
5. Speed sensor (front wheel)
6. Engine control unit
7. ABS warning lamp
8. Self-diagnosis connector
9. Brake switch

ABS/ASR



Legend

1. LSPV
2. Speed sensor (rear wheel)
3. Electronic hydraulic control unit (EHCU)
4. Battery
5. Speed sensor (front wheel)
6. ASR OFF switch
7. Engine control unit
8. ASR warning lamp
9. ABS warning lamp
10. Self-diagnosis connector
11. Brake switch

Symptom Specific to the Model with ABS

The vehicle equipped with ABS may develop the following symptoms, but those are inherent to the system and not malfunction.

1. Kickback or vibration in the break pedal, vibration in the steering wheel and vehicle are felt during abrupt braking or braking on a slippery surface.
2. Noise is generated around the brake pedal or from the vehicle rearward while ABS is in operation.
3. Motor operation noise is generated for short time immediately after engine starting.

Abbreviation

Abbreviations are used in this section. Followings are list of abbreviations for your convenience.

ABS

Anti-lock brake system

ASR
Anti-slip regulator

CKT
Circuit

DLC
Data link connector

DTC
Diagnostic trouble code

ECM
Engine control module

ECU
Electronic control unit

EHCU
Electronic hydraulic control unit

FL
Front left

FR
Front right

GEN
Generator

HU
Hydraulic unit

LSPV
Load sensing proportioning valve

MV
Millivolt

RR
Rear right

RPS
Revolution per second

VDC
Volts, direct current

VAC
Volts, alternating current

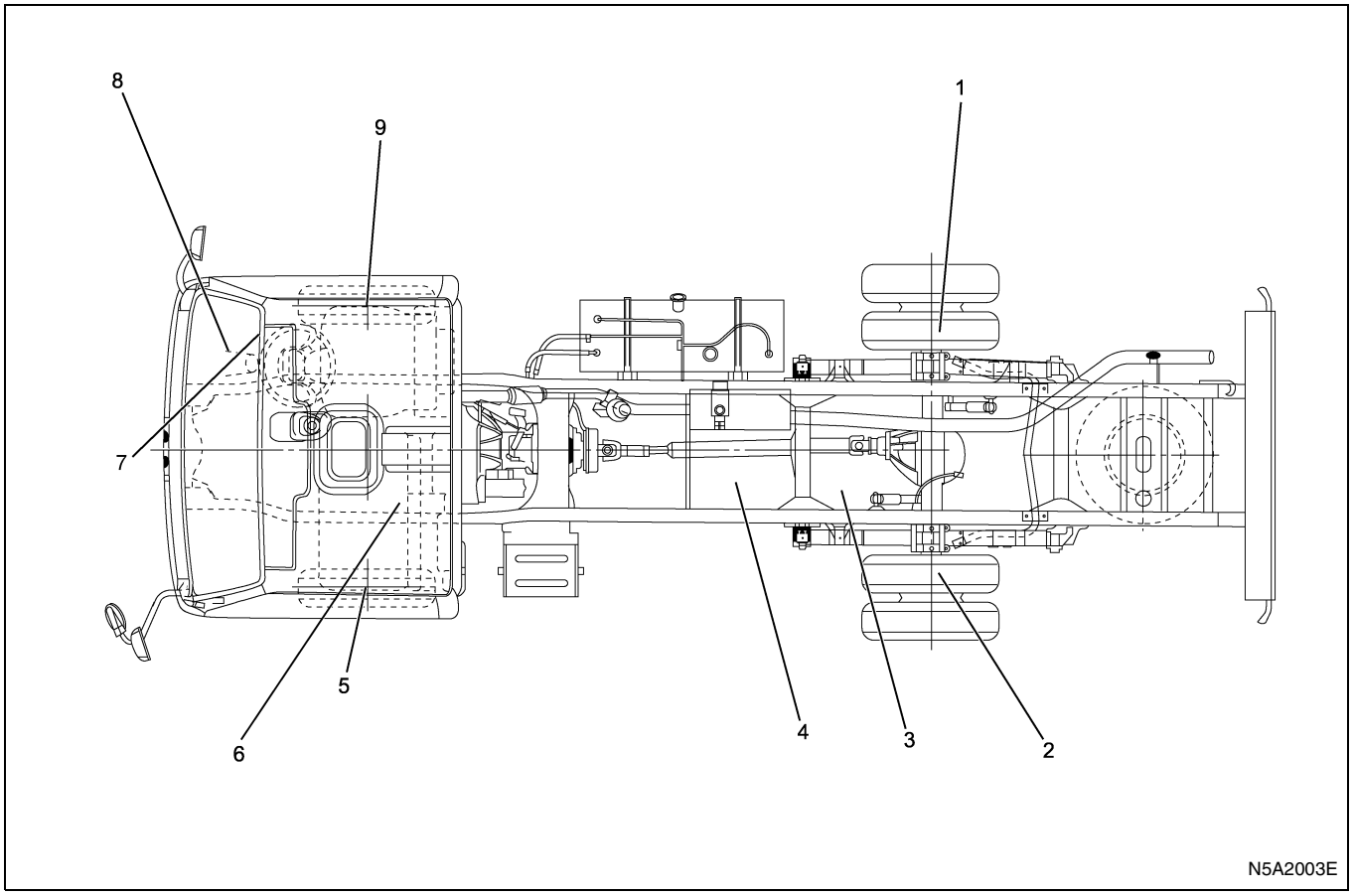
VIM
Vehicle interface module

W/L
Warning light

WSS
Wheel speed sensor

System Component

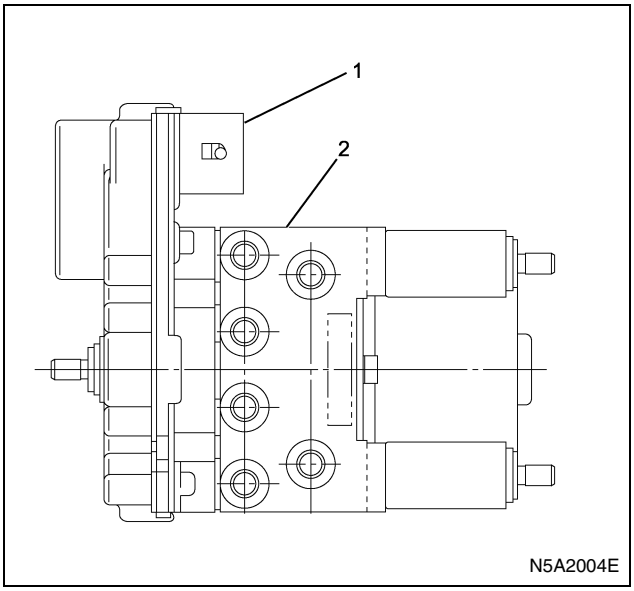
Component location



Legend

1. Rear speed sensor RH
2. Rear speed sensor LH
3. LSPV
4. EHCU
5. Front speed sensor LH
6. Engine control unit
7. Self-diagnosis connector
8. ABS/ASR warning lamp
9. Front speed sensor RH

Electronic Hydraulic Control Unit (EHCU)



Legend

1. Electronic control unit part
2. Hydraulic control unit part

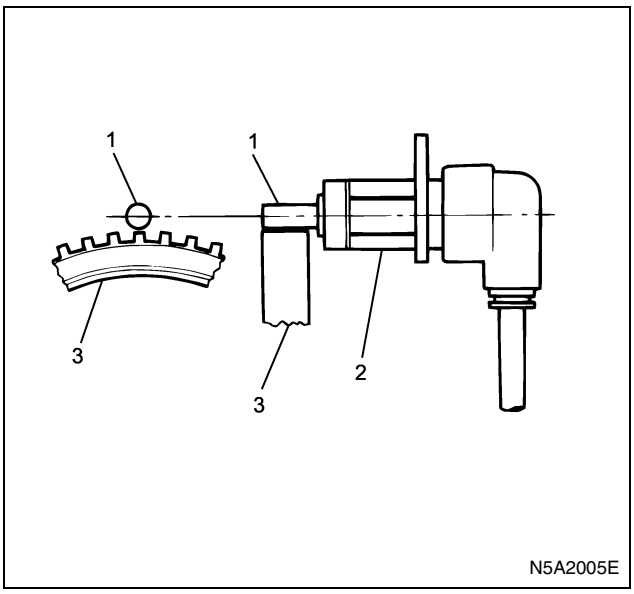
EHCU consists of ECU and HU. The ECU consists of the ABS/ASR control part, the fault detecting part, and the fail-safe part. It drives the hydraulic unit etc. based on the signal transmitted from each sensor. In case of system failure, it stops the fail-safe and returns to the normal brake. Also, the self-diagnosis function is equipped to indicate the trouble part during diagnosis.

The HU consists of the motor, the plunger pump, and the solenoid valve.
Solenoid valve: Decrease, hold, increase the brake fluid pressure based on the signal transmitted from the ECU.
Reservoir: Temporarily store the brake fluid from each caliper to lower the fluid pressure smoothly.
Plunger pump: Send the brake fluid stored in the reservoir to the master cylinder.
Motor: Drive the plunger pump based on the signal from ECU.
Check valve: Control the brake fluid flow.

CAUTION:
Turning the key ON with the harness disconnected from the EHCU means that the CAN communication line is not connected at this moment. Therefore, the systems which perform CAN communication such as engine and Smoother are judged as faulty. After replacing the EHCU, clear the DTCs of the systems which perform CAN communication. Also, do not drive the vehicle with the EHCU removed.

Wheel Speed Sensor

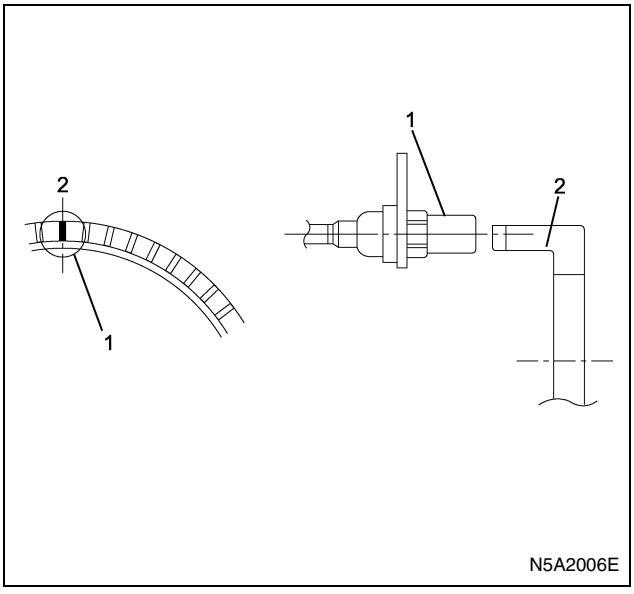
Front speed sensor



Legend

1. Electrode
2. Sensor
3. Sensor rotor

Rear speed sensor

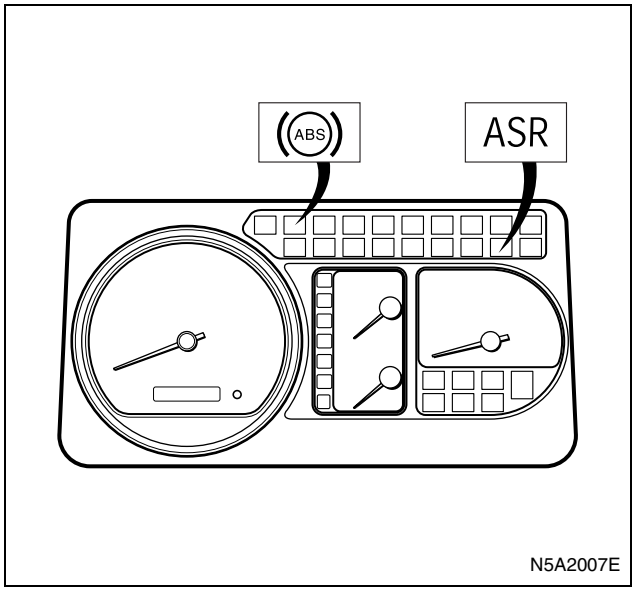


Legend

1. Sensor
2. Sensor rotor

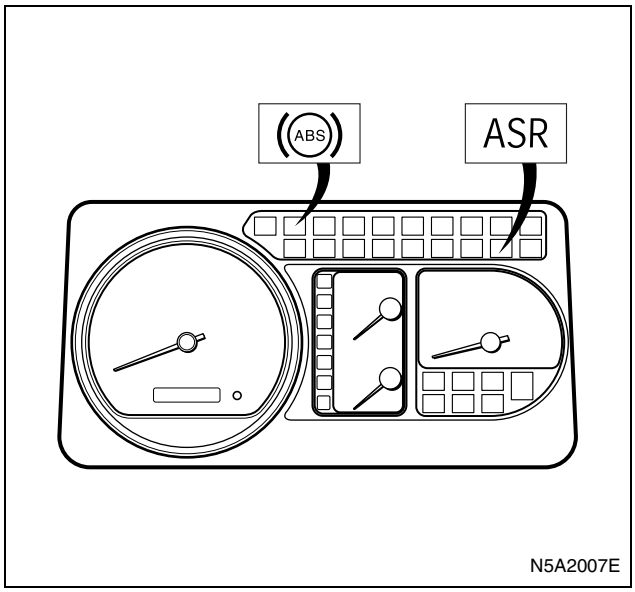
The front speed sensor consists of permanent magnet and coil, and the rear speed sensor is the 2 wire system hall IC type and is installed to the knuckle for front wheels, and to the brake back plate for rear wheels. Sensor rotors inserted in front/rear wheel hubs rotate to generate voltage in the sensor. Frequency of this voltage varies in relation to the rotor revolution speed; therefore this allows the sensor to detect the vehicle speed.

ABS Warning Lamp



The ABS warning lamp comes on with the starter switch ON, and then goes off if the ABS is normal.
It also comes on in case of ABS malfunction, and indicates the trouble code with blinking pattern upon change of the EHCU to diagnosis mode.

ASR Indicator/Off Lamp

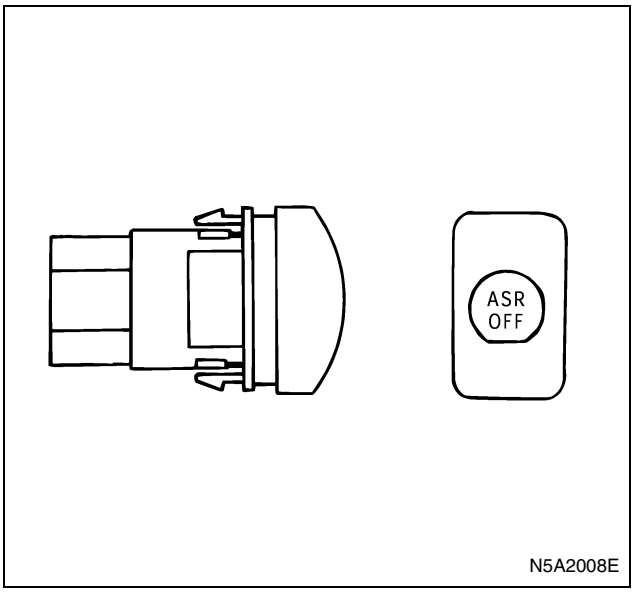


The ASR warning lamp comes on with the starter switch ON, and then goes off if the ASR is normal.
It blinks while the ASR is in operation.
It comes on in case of ASR malfunction and when the ASR off switch is pressed to deactivate the system.
It indicates the trouble code with blinking pattern upon changing to the diagnosis mode.

CAUTION:
When either of the ABS or ASR is faulty (which does not affect the other), the warning lamp of the affected sys-

tem only comes on and prohibit the system operation.
In this case, the other system is still workable if normal.

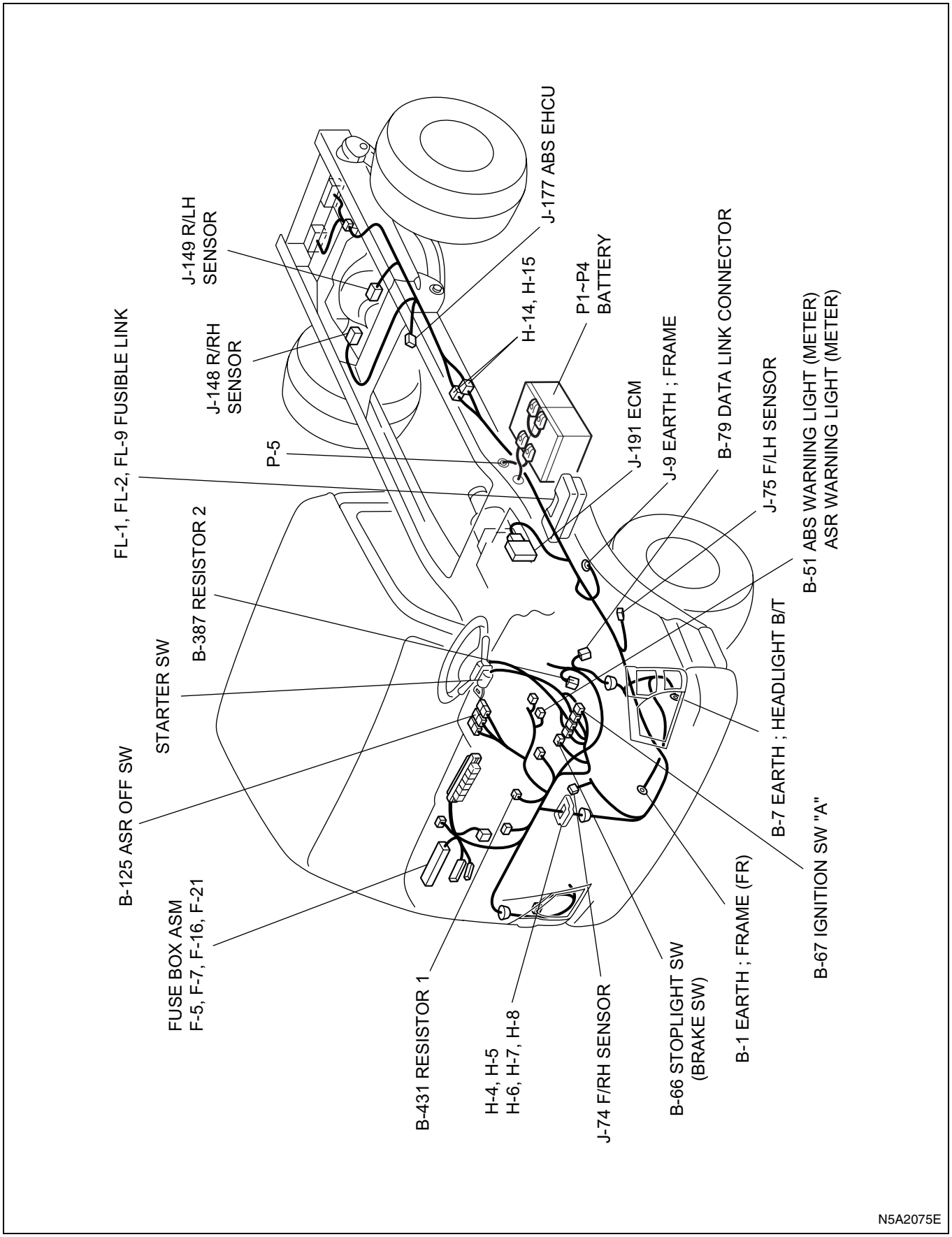
ASR Off Switch



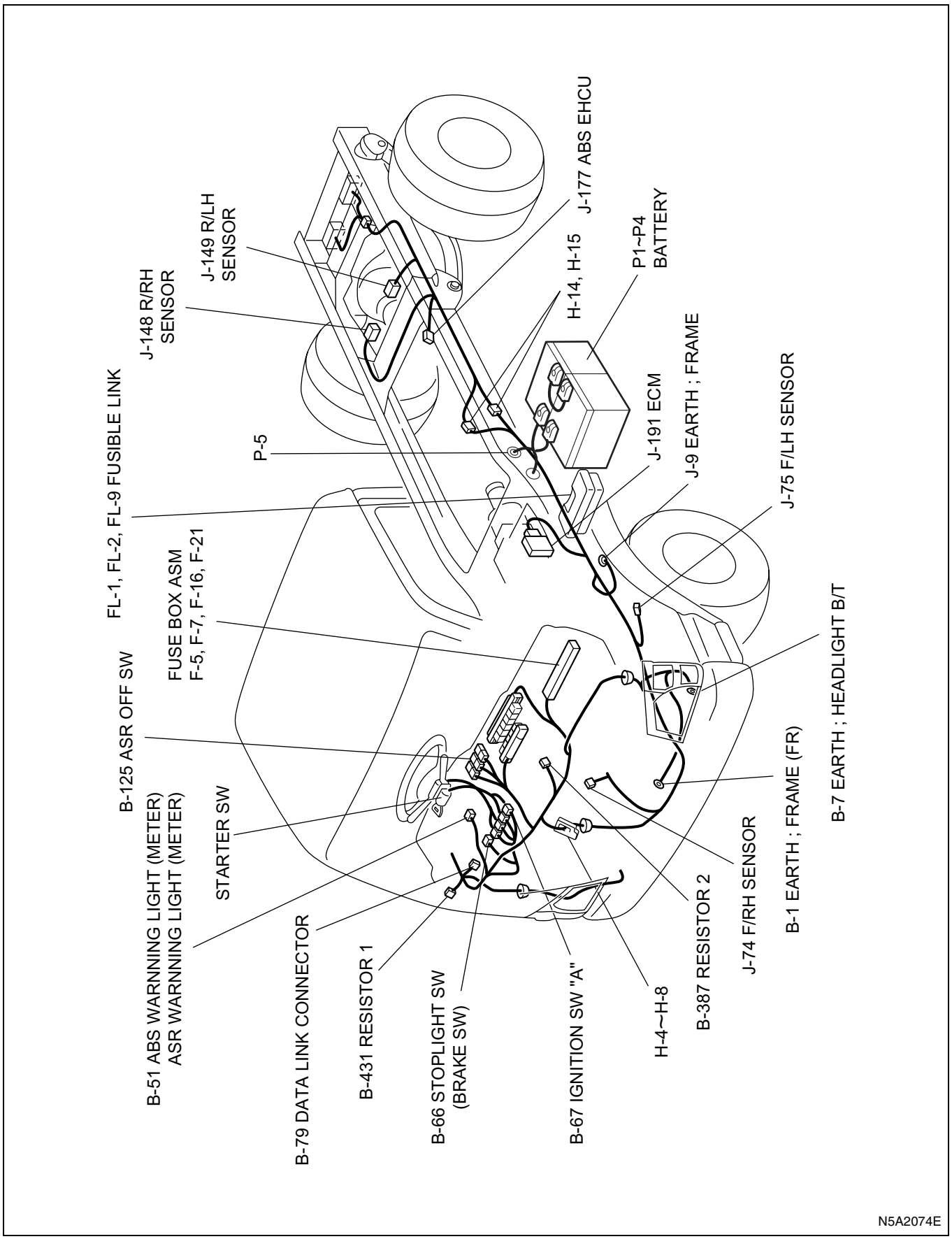
Pressing the ASR off switch after starting the engine deactivates the ASR, and pressing again bring the system to stand-by condition. The ASR is set stand-by condition whenever the engine is started regardless of switch condition.

Parts Location

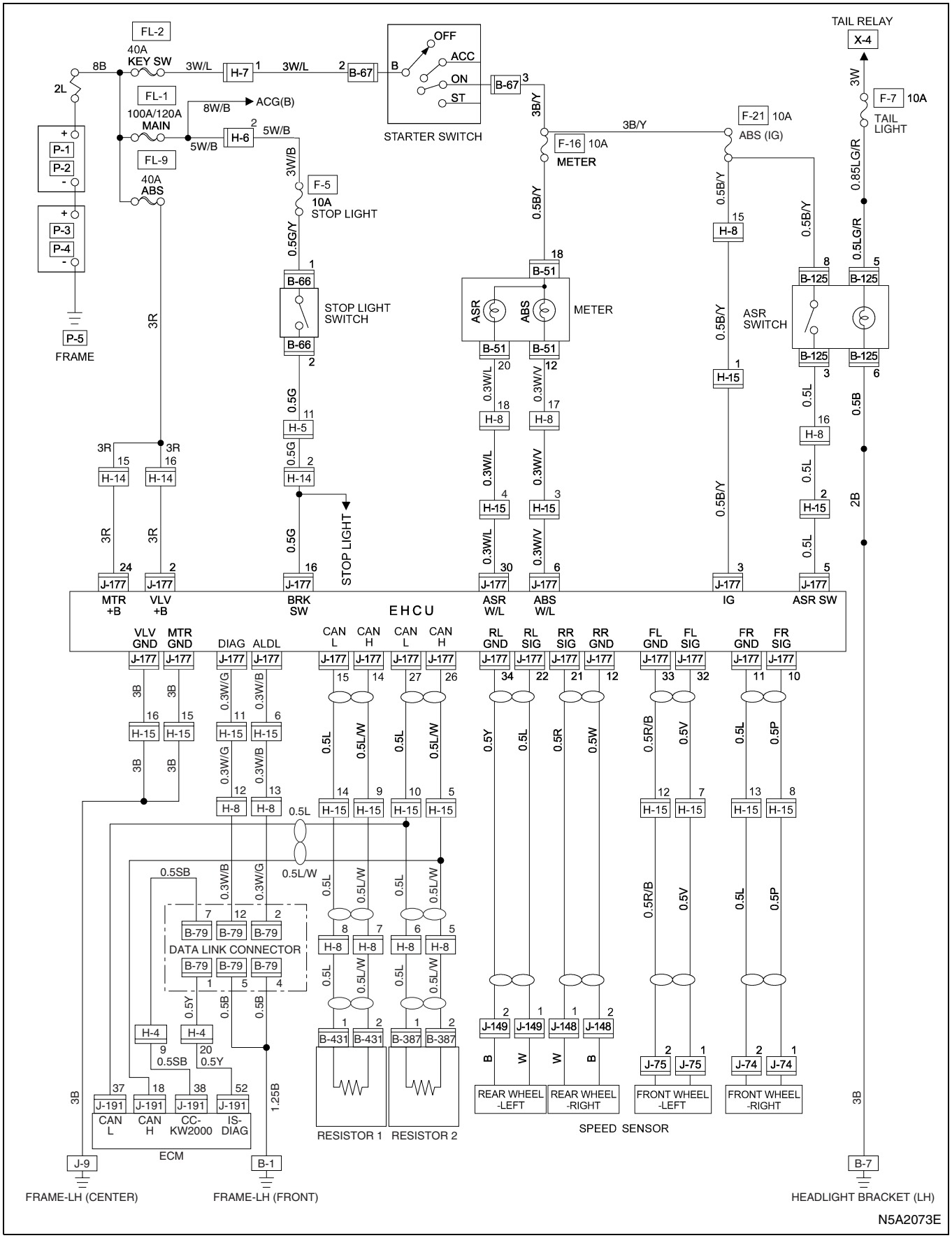
LHD Model



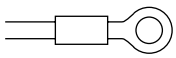
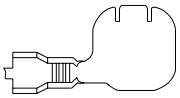
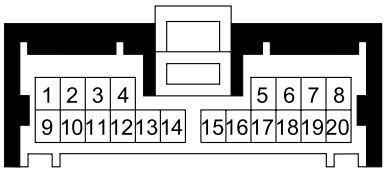
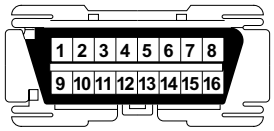
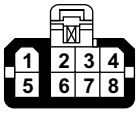
RHD Model

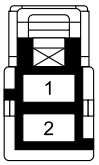
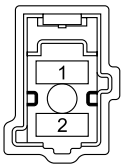
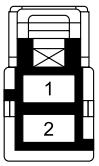
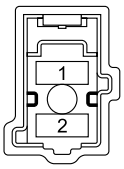
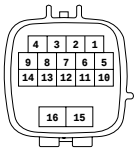
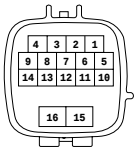

J-149 R/LH SENSOR
J-148 R/RH SENSOR
J-177 ABS EHCU
H-14, H-15
P1~P4 BATTERY
P-5
J-191 ECM
J-9 EARTH ; FRAME
FL-1, FL-2, FL-9 FUSIBLE LINK
J-75 F/LH SENSOR
B-125 ASR OFF SW
FUSE BOX ASM F-5, F-7, F-16, F-21
B-51 ABS WARNNING LIGHT (METER) ASR WARNNING LIGHT (METER)
STARTER SW
B-7 EARTH ; HEADLIGHT B/T
B-79 DATA LINK CONNECTOR
B-431 RESISTOR 1
B-66 STOPLIGHT SW (BRAKE SW)
B-67 IGNITION SW "A"
H-4~H-8
B-387 RESISTOR 2
J-74 F/RH SENSOR
B-1 EARTH ; FRAME (FR)
N5A2074E

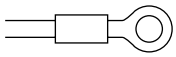
Circuit Diagram

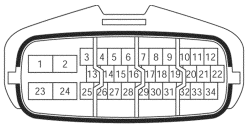
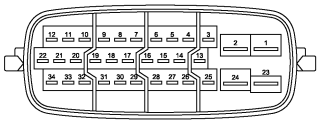
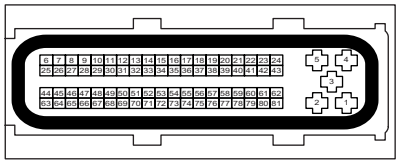
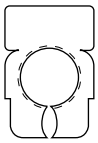
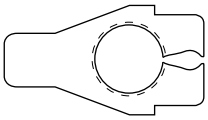
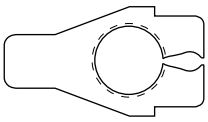
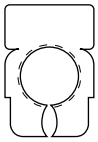


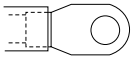
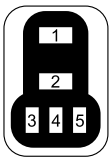
Connector List

No.	Connector Face
B-1	 000-001
B-7	 000-012
B-51	 020-004
B-66	002-031
B-67	004-002
B-67	004-001
B-79	 016-005
B-125	 008-001

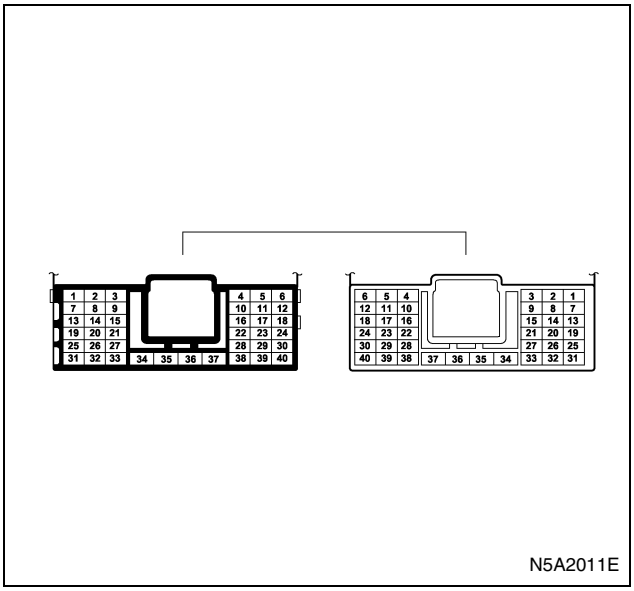
No.	Connector Face
B-387	 002-038
B-387	 002-039
B-431	 002-038
B-431	 002-039
H-14	 016-004
H-14	016-003
H-15	016-003
H-15	 016-004

No.	Connector Face
J-9	 000-001
J-74	002-012
J-74	002-011
J-75	002-012
J-75	002-011
J-148	002-012
J-148	002-011
J-149	002-012

No.	Connector Face
J-149	002-011
J-177	 034-001
J-177	 034-002
J-191	 081-001
P-1	 000-004
P-2	 000-006
P-3	 000-006
P-4	 000-004

No.	Connector Face
P-5	 000-002
X-4	 005-006

H-5



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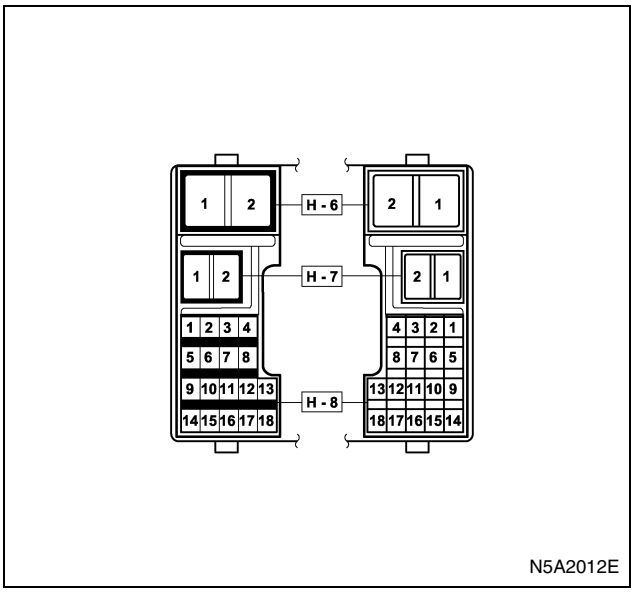
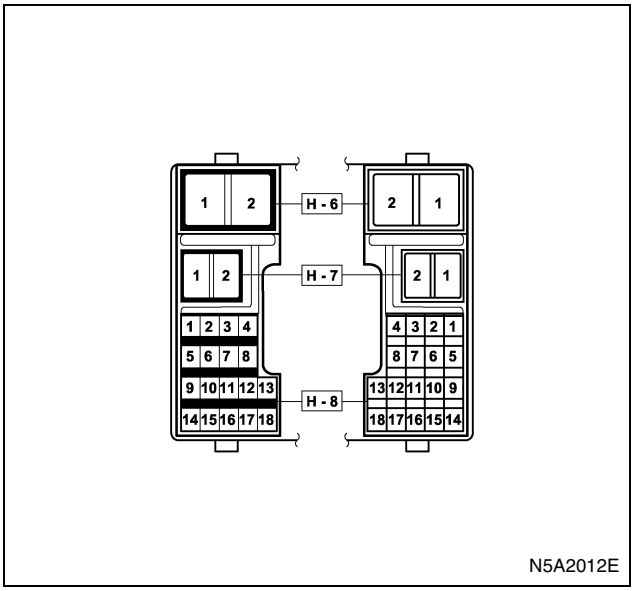
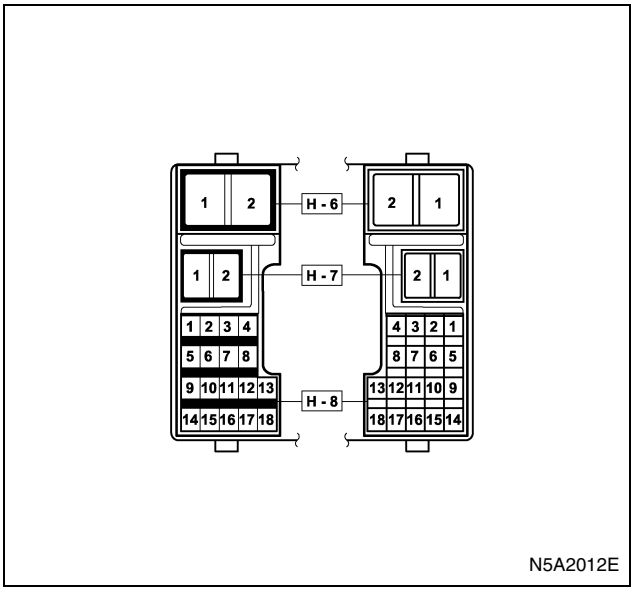


H-7



H-8



Procedure of Trouble Diagnosis

Description of Diagnosis

Trouble symptom related to ABS and ASR can be classified into two kinds; one is with ABS/ASR warning lamp illumination pattern, the other is from the trouble symptoms noticeable by the driver.
Refer to “Diagnosis with illumination pattern” in the first case, and “List of trouble symptoms” in the latter case for diagnostic procedures. Also, diagnostics with Tech 2 is available. Refer to sections 5A and 5C for the diagnosis of mechanical trouble, including brake noise, brake judder (vibration of pedal or vehicle body during normal brake operation), break pulling to one side, parking brake fault.

About Self-Diagnosis

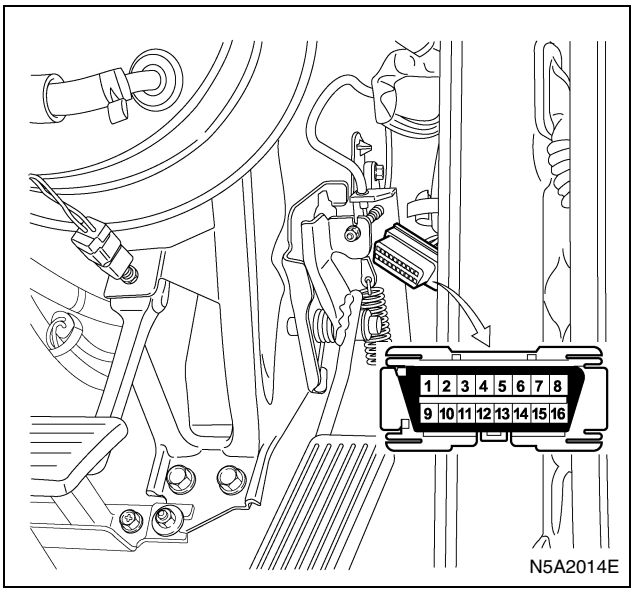
Self-diagnosis function is equipped with the EHCU, it performs the checks as shown in the illustration below to

examine the system for fault and identify the trouble part every time the system starts. If it found to be faulty, the system illuminates the ABS/ASR warning lamp to notify the fault, and stores the diagnostic trouble code (DTC). Illumination pattern differ depending on the fault condition; refer to “Diagnostic procedure with illumination pattern” described in later, and check and repair according to the relevant flow chart.

CAUTION:
Lamp illumination is reset every time the starter switch is OFF (system OFF), however the diagnosis code will not be erased unless it is compulsory erased. In case of faults while driving and intermittent fault, the control unit may judge it as normal at the time of diagnosis and indicate the normal code. Therefore perform the check and repair according to the diagnosis flow.

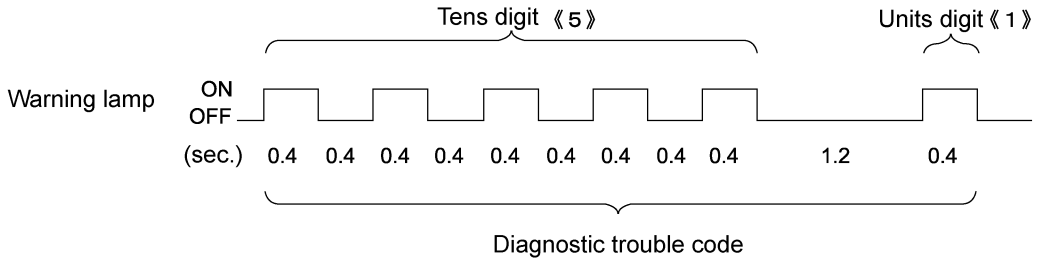
How to Indicate Trouble Codes

The vehicle must be parked (vehicle speed 3.3km/h (2 mph) or less). Short the terminal No. 12 with No. 4 or 5 (ground) of the self-diagnosis connector, and turn the starter switch to ON. The ABS/ASR warning lamp will blink to indicate the diagnosis trouble code.

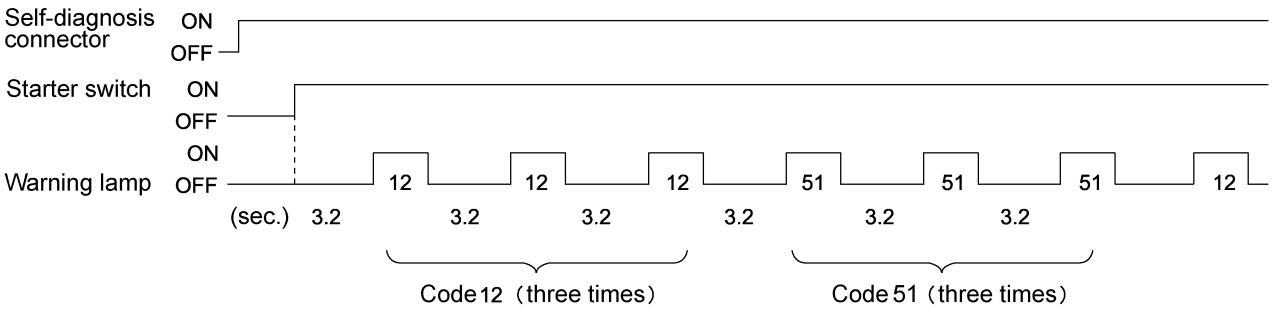


The normal code 12 is repeatedly displayed if normal.
If faulty, after displaying the normal code 12 for three times, the stored diagnosis trouble code (DTC) is displayed for three times. Then back to the normal code again and repeats this display order. Maximum 6 codes are stored, and these are displayed in the reverse chronological order.
For details concerning DTCs, refer to “List of Diagnostic Trouble Code (DTC)” described later.

How to read diagnostic trouble code ; for code 51



Indication sample of diagnostic trouble code ; for code 51



* Warning lamp : ABS/ASR warning lamp

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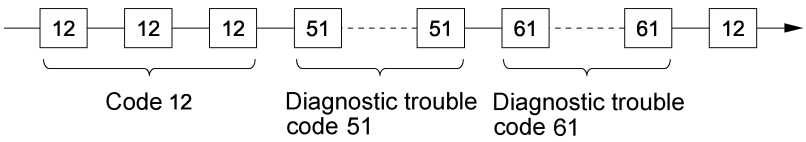
Indication sample of multiple diagnostic trouble code ; for code 51,61



N5A2016E

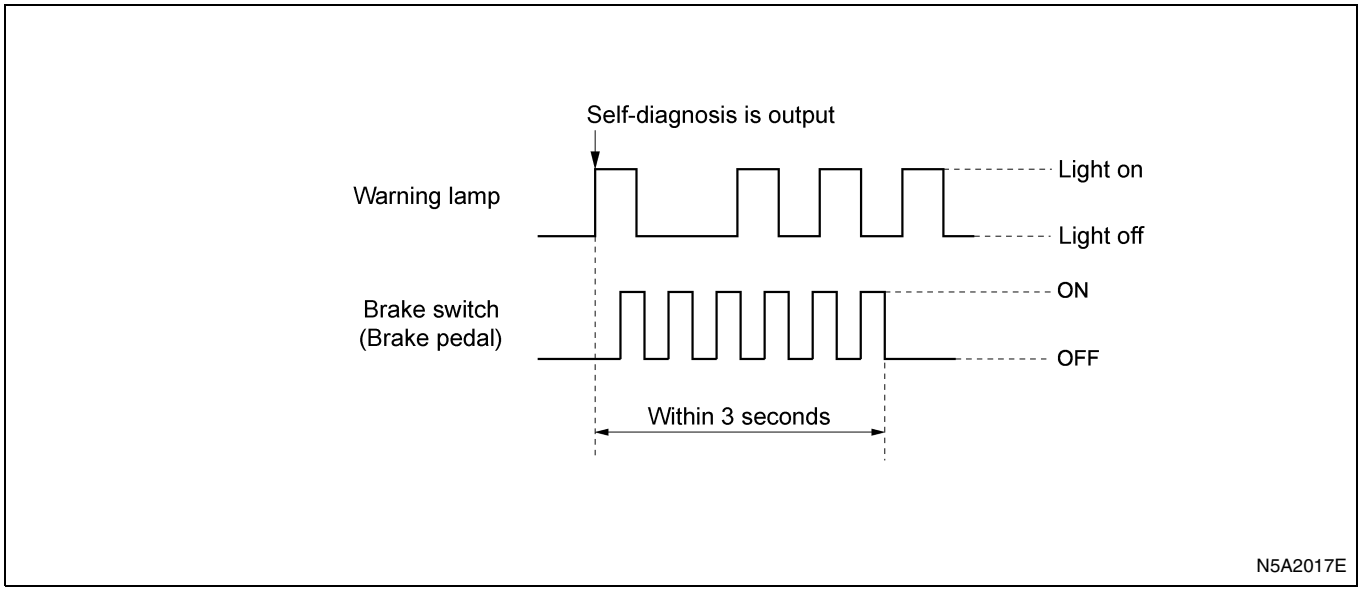
How to Clear Diagnosis Trouble Code (DTC)

DTCs stored in the EHCU will not be erased automatically upon repair. Clear the DTCs using either of the following procedure:

1. Input the brake switch ON/OFF signal for six times within three seconds while self-diagnosis result is being output.
2. Use Tech 2 to clear.

CAUTION:

- After performing the DTC clear procedure, ensure that it is cleared.
- If the step 1 does not work, perform with the step2.



Precautions During Diagnosis

At general baintenance

Adhere the following precautions when servicing and diagnosing of the ABS/ASR and other vehicle control systems.

- When performing electric-arc welding on the vehicle, disconnect the EHCU connector before starting welding work.
- Do not connect/disconnect the EHCU connector when the starter switch is ON.
- The EHCU is a non-disassembled part. Do not loosen the bolts and plugs of the EHCU.
- Be especially careful not to allow dirt, dust or metallic powder to get into the hydraulic circuit during checking and servicing the brake components.
- When only rear wheels are rotated using dram tester or jack-upped for inspection, the ABS judges it as sensor fault and illuminates the ABS warning lamp. This indicates no fault in the system. Erase the ABS diagnosis code after repair. Turn the starter switch to ON again, to make sure that the ABS warning lamp does not come on.

When servicing computer system

Extreme care is required to avoid overcurrent to the EHCU circuit. Do not ground to or apply voltage to the EHCU without careful consideration while checking open/short circuit. Use only the circuit tester having high internal resistance or the special tool described in this section to check those circuit. Do not connect/disconnect the power supply to the EHCU when the starter switch is ON. Be sure to turn the starter switch to OFF before disconnecting/connecting the battery cable, the fuse, or the connector.

When replacing EHCU

The EHCU body fault rarely occurs, but more cases are falsely identified as EHCU trouble, as it happened to be corrected when replacing the EHCU but the fact is mostly secondary failure caused by the harness-side trouble (such as short circuit) or undetectable cause due to intermittent trouble. Therefore, before replacing the EHCU, check if overcurrent is applied to the EHCU as well as improper connection of the connectors.

Intermittent trouble

Intermittent troubles are mostly caused by temporally disconnection of the harnesses and connectors. If a trouble occurs, check the related circuit in the following procedure.

1. Check for misconnection of the connector. Also check for improper connection of the connector terminal.
2. Check for deformation and damage of the terminal. If deformed or damaged, correct and reconnect it securely.
3. Simulated open circuit is also suspected. Check the circuit by shaking the harness in a degree that does not damage the harness.

Test run of vehicle with ABS problem

Trouble cause of the problem appeared as ABS warning lamp illumination, can be identified with “Diagnostic procedure with illumination pattern”. However for the problem that can solely be identified by the driver as trouble

symptoms, the following procedure is necessary to identify the trouble cause by reproducing the trouble symptom with test run the vehicle.

1. Start the engine, and make sure that the ABS warning lamp goes off. (If the lamp does not go off, read the DTC and identify the trouble part.)
2. Slowly start the vehicle and run at 30 km/h (19 mph) or more for three minutes, then apply the brake to stop the vehicle completely. Start the vehicle again and accelerate to 30 km/h (19 mph) or more. Repeat this operation a least three times.
3. Next, start the vehicle and accelerate to 40 km/h (25 mph) or more, and then abruptly apply the brake to activate the ABS, till stop the vehicle.
4. If the warning lamp comes on during the test run, check the DTC and inspect the vehicle according to the DTC. If no DTC appeared, or the warning light does not come on, reproduce the condition of the trouble occurrence claimed by the customer as much as possible.
5. If DTC appeared or trouble symptom is found, perform the appropriate inspection according to the diagnostic procedure.

Check after repair

Upon completion of repair, turn the starter switch to OFF and then start the engine to make sure each lamp goes off. Next, run the vehicle at 30 km/h (19 mph) or more for 1 minute, and check that the lamp does not come on.

Brake basic inspection

Step	Action	Value	YES	NO
1	Is the brake fluid level correct?	—	Go to Step2	Replenish fluid. Go to Step2
2	Is fluid leaked?	—	Go to Step3	Repair. Go to Step3
3	Does the vacuum booster operate normally?	—	Go to Step4	Repair. Go to Step4
4	Is the brake pad and rotor normal?	—	Go to Step5	Repair. Go to Step5
5	Install all the components, and check that those are installed properly. Is this step completed?	—	End.	Go to Step5

Ground check

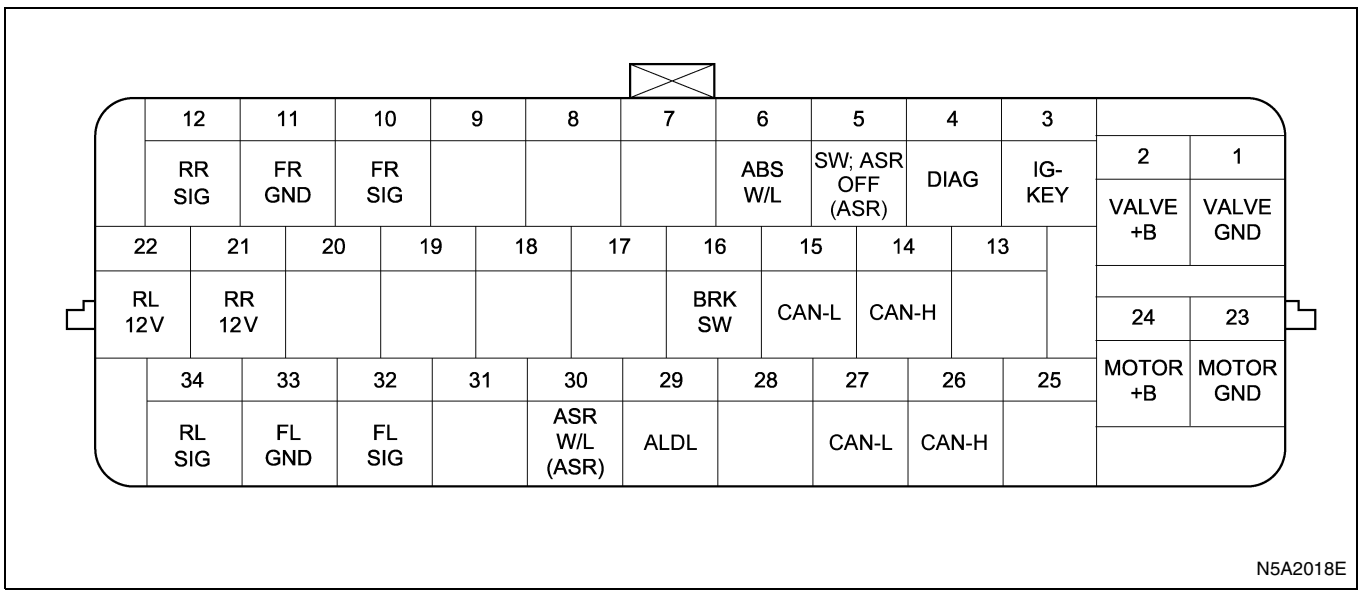
Step	Action	Value	YES	NO
1	Are all the ground point related to ABS OK?	—	Go to Step2	Repair. Go to Step2
2	Install all the components, and check that those are installed properly. Is this step completed?	—	End.	Go to Step2

Diagnostic basic flow

Step	Action	Value	YES	NO
1	1. Complaint from the customer 2. Interview to the customer. 3. Perform the basic inspection. (Refer to “Brake basic inspection”.) Is Tech 2 required?	—	Go to Step2	Go to Step3
2	Check DTC. Is DTC appeared?	—	Go to Step5	Go to Step4
3	Check DTC (with warning lamp illumination pattern). Is DTC appeared?	—	Go to Step5	Go to Step4
4	Test run the vehicle. Does the warning lamp come on?	—	Go to Step5	Refer to “List of trouble symptom”.Go to Step5
5	1. Repair the trouble part. 2. Clear the DTC. 3. Check the ABS warning lamp for illumination pattern with the ignition switch ON. 4. Test run the vehicle. Is the trouble appeared again?	—	Repeat the “Diagnostic basic flow” if the trouble appeared again (with trouble symptom or DTC). Go to Step1	Go to Step6
6	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	End.	Go to Step6

Function Check

EHCU Connector Pin Arrangement



Terminal	Mark	Signal name	Wire color
1	VALVE GND	ECU system ground (body ground 0V)	BLK
2	VALVE+B	Solenoid valve power supply	RED
3	IG-KEY	ECU system power supply	BLK/YEL
4	DIAG	Diagnosis entry	WHT/GRN
5	SW; ASR OFF	ASR cut switch (ASR only)	BLU
6	ABS W/L	ABS warning lamp output	WHT/VIOLET
7	NC	Not available	—
8	NC	Not available	—
9	NC	Not available	—
10	FR SIG	FR wheel speed signal (magnetic pickup sensor)	PNK
11	FR GND	FR wheel speed signal GND	BLU
12	RR GND	RR wheel speed signal GND	WHT
13	NC	Not available	—
14	CAN-H	CAN Hi input	BLU/WHT
15	CAN-L	CAN Lo input	BLU
16	BRK SW	Brake switch input signal	GRN
17	NC	Not available	—
18	NC	Not available	—
19	NC	Not available	—
20	NC	Not available	—
21	RR SIG	RR wheel speed signal	RED
22	RL SIG	RL wheel speed signal	BLU
23	MOTOR GND	Motor ground (body ground 0V)	BLK
24	MOTOR+B	Motor power supply	RED
25	NC	Not available	—
26	CAN-H	CAN Hi input	BLU/WHT
27	CAN-L	CAN Lo input	BLU
28	NC	Not available	—
29	ALDL	J1850 Class 2 communication	WHT/BLK
30	ASR W/L	ASR warning lamp output (ASR only)	WHT/BLU
31	NC	Not available	—
32	FL SIG	FL wheel speed signal (magnetic pickup sensor)	VIOLET
33	FL GND	FL wheel speed signal GND	RED/BLK
34	RL GND	RL wheel speed signal GND	YEL

Check List of EHCU Connector Terminal

1. EHCU power supply

Starter Switch	Tester scale/ range	Connector terminal No. to be measured	Standard value	Remarks
OFF	VDC	J-177,3(+)–J-177,1(–)	0–0.3V	
ON	VDC	J-177,3(+)–J-177,1(–)	16.5–34V	
OFF	VDC	J-177,2(+)–J-177,1(–)	16.5–34V	
OFF	VDC	J-177,24(+)–J-177,1(–)	16.5–34V	

2. EHCU ground

Starter Switch	Tester scale/ range	Connector terminal No. to be measured	Standard value	Remarks
OFF	Ω	J-177,1(+)–GND	0–1Ω	
OFF	Ω	J-177,23(+)–GND	0–1Ω	

3. Brake switch signal circuit

Starter Switch	Tester scale/ range	Connector terminal No. to be measured	Standard value	Remarks
OFF	VDC	J-177,16(+)–J-177,1(–)	0–0.3V	
OFF	VDC	J-177,16(+)–J-177,1(–)	16.5–34V	Brake pedal depressed

4. ABS warning lamp

Starter Switch	Tester scale/ range	Connector terminal No. to be measured	Standard value	Remarks
ON	VDC	J-177,6(+)–J-177,1(–)	16.5–34V	
OFF	VDC	J-177,6(+)–J-177,1(–)	0–0.3V	

5. Front LH speed sensor

Starter Switch	Tester scale/ range	Connector terminal No. to be measured	Standard value	Remarks
OFF	kΩ	J-177,32(+)–J-177,33(–)	1–2kΩ	
OFF	kΩ	J-177,32(+)–J-177,1(–)	1000kΩ or more	
OFF	VDC	J-177,32(+)–J-177,33(–)	200mV or more	Tire half-turn/sec

6. Front RH speed sensor

Starter Switch	Tester scale/ range	Connector terminal No. to be measured	Standard value	Remarks
OFF	kΩ	J-177,10(+)–J-177,11(–)	1–2kΩ	
OFF	kΩ	J-177,10(+)–J-177,1(–)	1000kΩ or more	
OFF	VDC	J-177,10(+)–J-177,11(–)	200mV or more	Tire half-turn/sec

7. Rear LH speed sensor

Starter Switch	Tester scale/ range	Connector terminal No. to be measured	Standard value	Remarks
ON	VDC	J-177,22(+)–J-177,34(–)	0.2–4.5V	Tire half-turn/sec

8. Rear RH speed sensor

Starter Switch	Tester scale/ range	Connector terminal No. to be measured	Standard value	Remarks
ON	VDC	J-177,21(+)–J-177,12(–)	0.2–4.5V	Tire half-turn/sec

9. ASR cut switch (ASR only)

Starter Switch	Tester scale/ range	Connector terminal No. to be measured	Standard value	Remarks
ON	VDC	J-177,5(+)–J-177,1(–)	16.5–34V (switch pressed) 0–0.3V (switch released)	

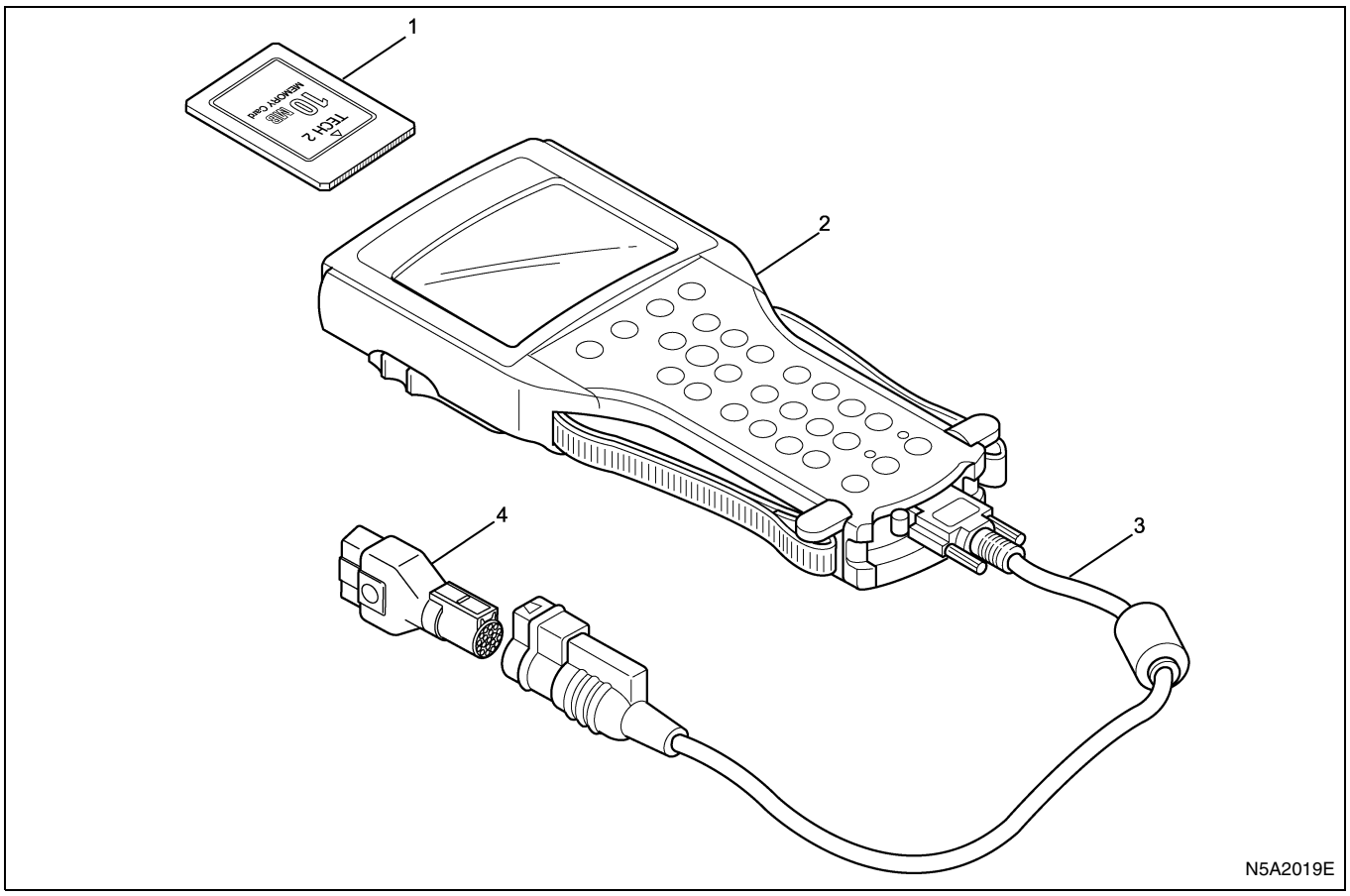
10. ASR warning lamp (ASR only)

Starter Switch	Tester scale/ range	Connector terminal No. to be measured	Standard value	Remarks
ON	VDC	J-177,30(+)–J-177,1(–)	16.5–34V	
OFF	VDC	J-177,30(+)–J-177,1(–)	0–0.3V	

Trouble Diagnosis with Scan Tool

Tech 2

Tech 2 is useful to diagnose the electric fault and the system check of the ABS control system. The Tech 2 is small and light tester. It can communicate with the ECM to perform various types of the diagnosis and the test by connecting the self-diagnosis connector equipped to the vehicle.



Legend

1. PCMCIA card
2. TECH 2
3. DLC cable
4. SAE16/19 pin adapter

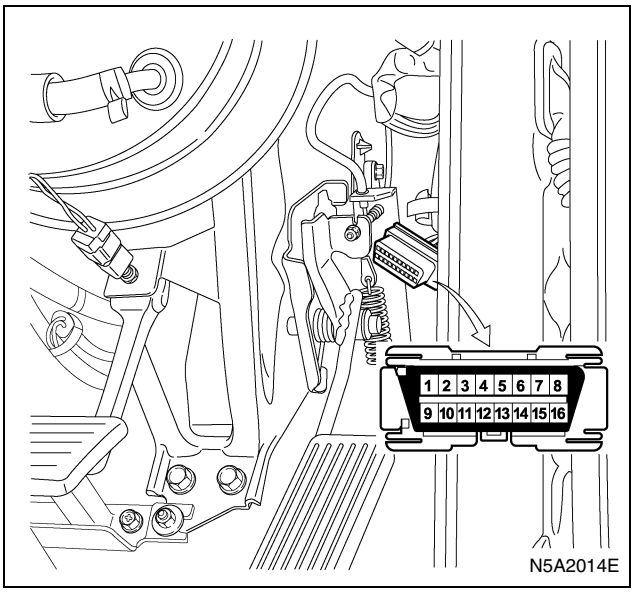
Feature of Tech 2

1. Tech 2 (2) is a 12-V power supply system. Do not use a 24-V power supply. If the vehicle system is equipped with a 24-V power supply, use a 12-V battery with an adapter for power distribution. Power distribution is not available from the cigar lighter.
2. Set the PCMCIA card (1) to the Tech 2 (2), and attach the VCI (Vehicle Communication Interface) (3)(4), and connect to the DLC in the vehicle.
3. Turn the power switch off before installing/removing the PCMCIA card.
4. The capacity of the PCMCIA card for Tech 2 is 10MB. It is ten times as large as Tech1 (1) mass storage.
5. Tech 2 has a capacity of equivalent to two snapshots.
6. The PCNCIA card is sensitive to magnetic and electrostatic. Please handle it with care.
7. Tech 2 can plot a graph of snapshots.
8. Pressing the EXIT key can bring back to the main menu anytime.
9. Open the application menu and press the “F1:Clear DTCInfo” or the DTC clear to erase the diagnosis trouble codes (DTCs).

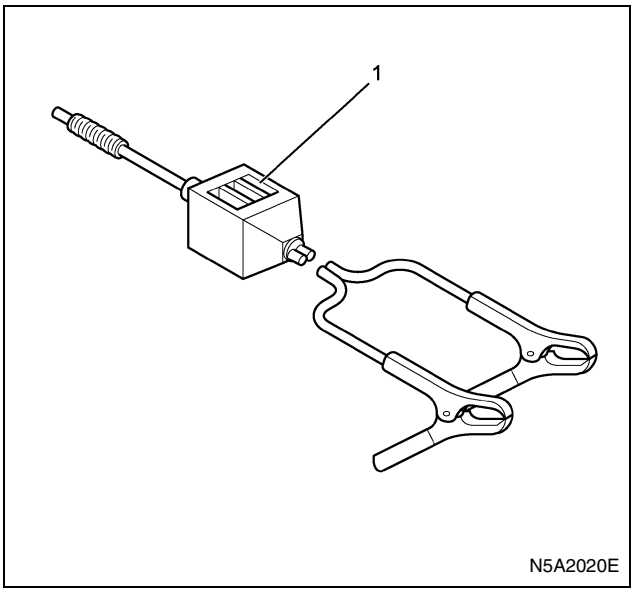
How to Connect Tech 2

1. Insert the PCMCIA card for ISUZU system to the Tech 2 body.
2. Install the SAE 16/19 adapter to the DLC cable.
3. Install the DLC cable to the Tech 2 body.
4. Make sure that the ignition is “OFF”.

5. Connect the SAE-16/19 adapter of the Tech 2 to the self-diagnosis cord (black) in the body side.



Connect an adapter cable between the Tech 2 and 12-V battery. (When connecting the adapter cable, start with the negative side.)



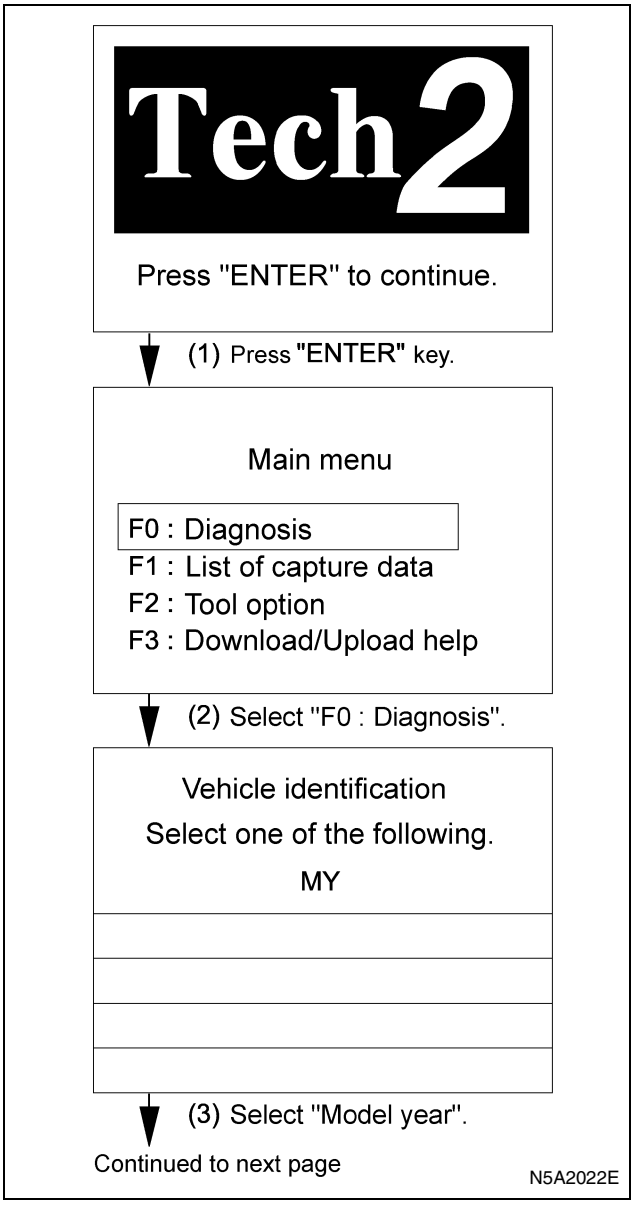
Legend

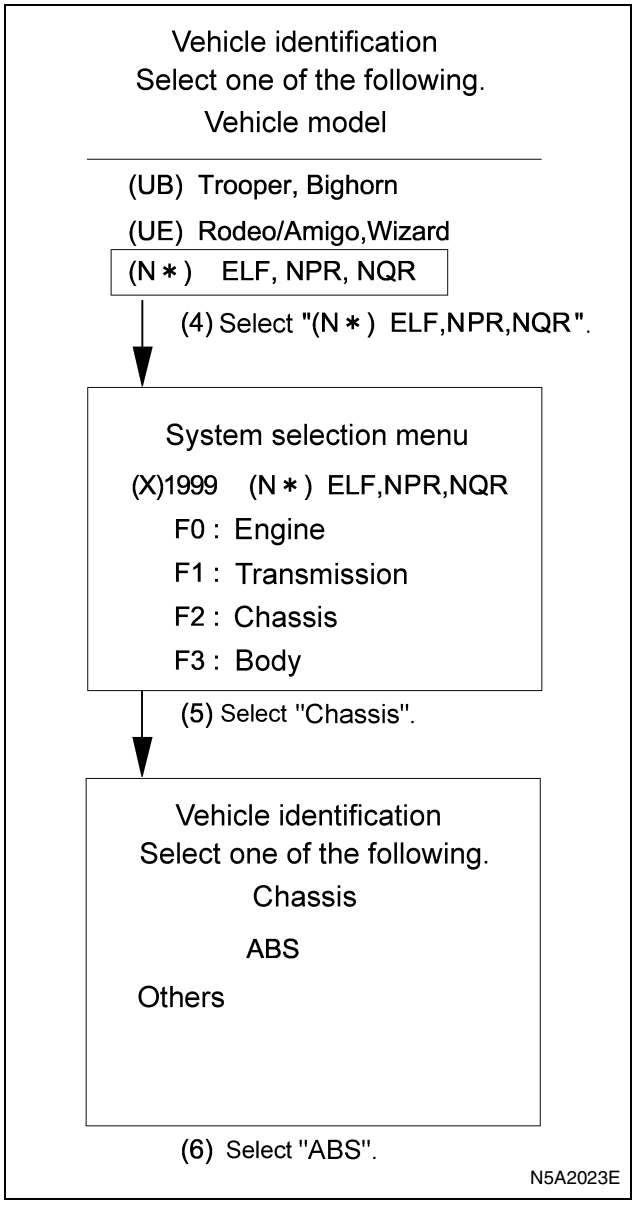
1. 3A-fuse

6. Turn the ignition switch to “ON” and press the “PWR” key of the Tech 2.
7. Check the display of the Tech 2.

CAUTION:
Make sure that no power is supplied to the Tech 2 when installing/removing the PCMCIA card.

Tech 2 Operation Procedure





The following chart shows the functions used by the current Tech 2 software.

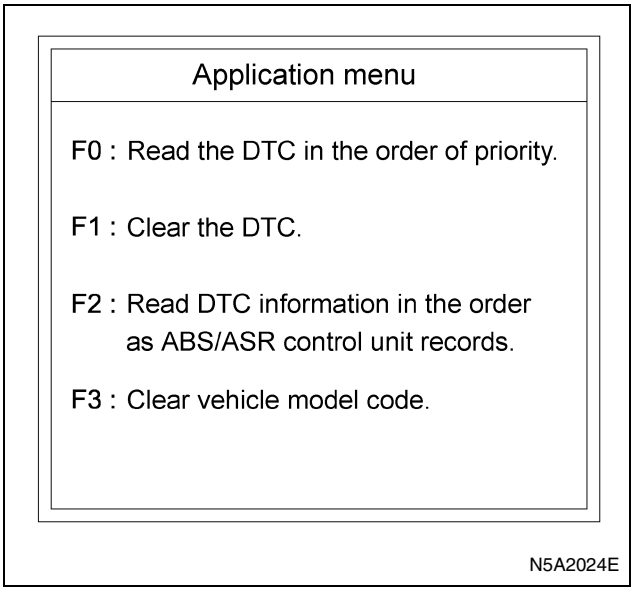
Menu

F0:	Diagnostic trouble code
	F0: Read the DTC in the order of priority. F1: Clear the DTC.
F1:	Data display
F2:	Snapshot
F3:	Actuator test

DTC (diagnostic trouble code) mode

Two options are available for Tech 2 DTC mode. After selecting the DTC, the following menu is displayed.

- DTC Info (DTC information)
- Clear Info (DTC clear)

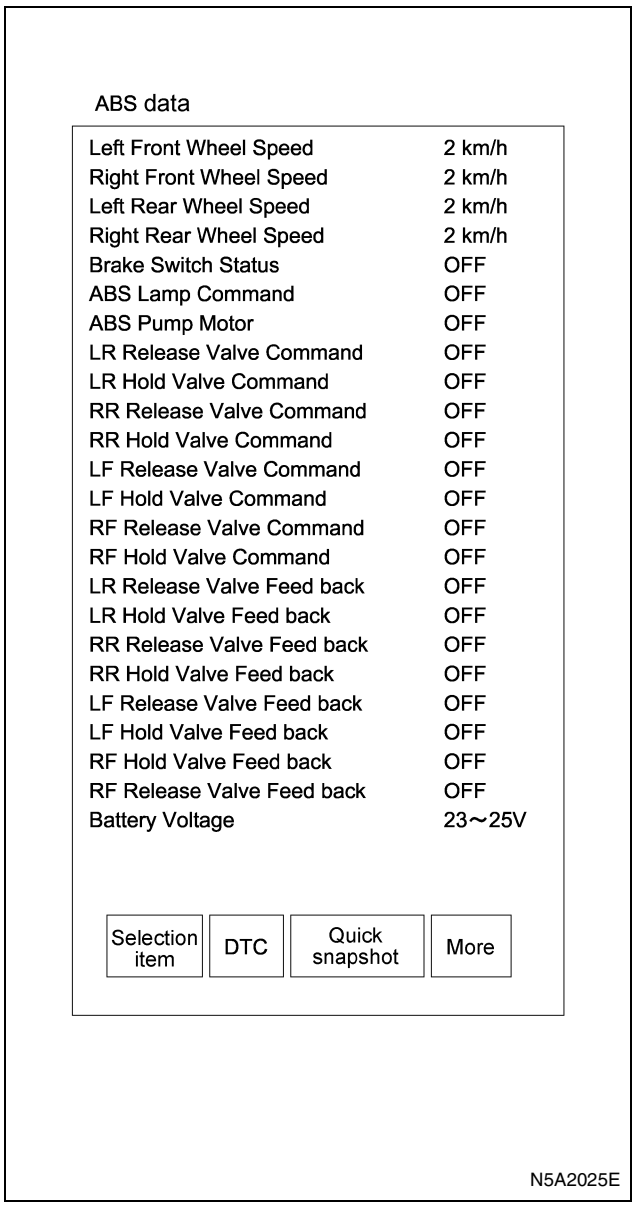


DTC is the language for technicians to communicate with the ECM on the vehicle.
DTC can roughly be classified into past DTC and current DTC.

- Current DTC: Trouble (fault) occurred current ignition cycle
- Past DTC: Trouble (fault) occurred previous ignition cycle or that in the past
- Multiple DTC: More than one DTC may be displayed in a time. It is called as multiple DTC. This happens when multiple troubles (faults) occurred in a time. Further this happens to the sensors and switches sharing same power source or ground. When such power source or ground is open or shorted, the DTCs of relevant sensors or switches are displayed.
  In this case, the power source or ground shared must be checked for open/short circuit.
  Use of DTC clear mode can erase the DTC memory stored in the vehicle.

Data display

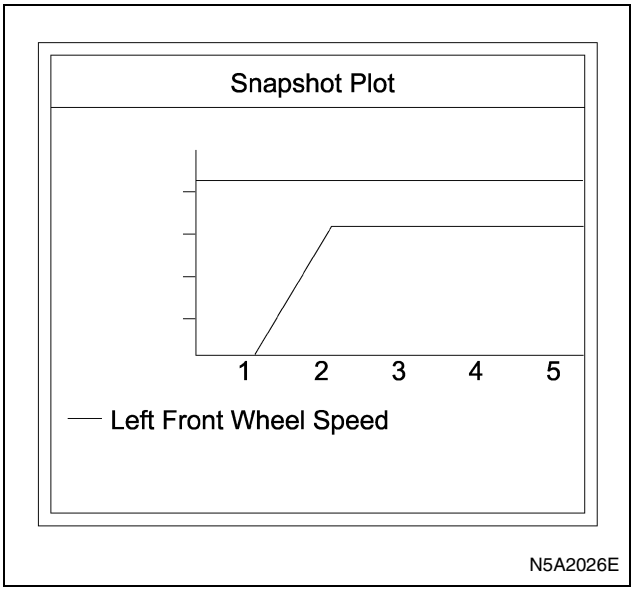
Example



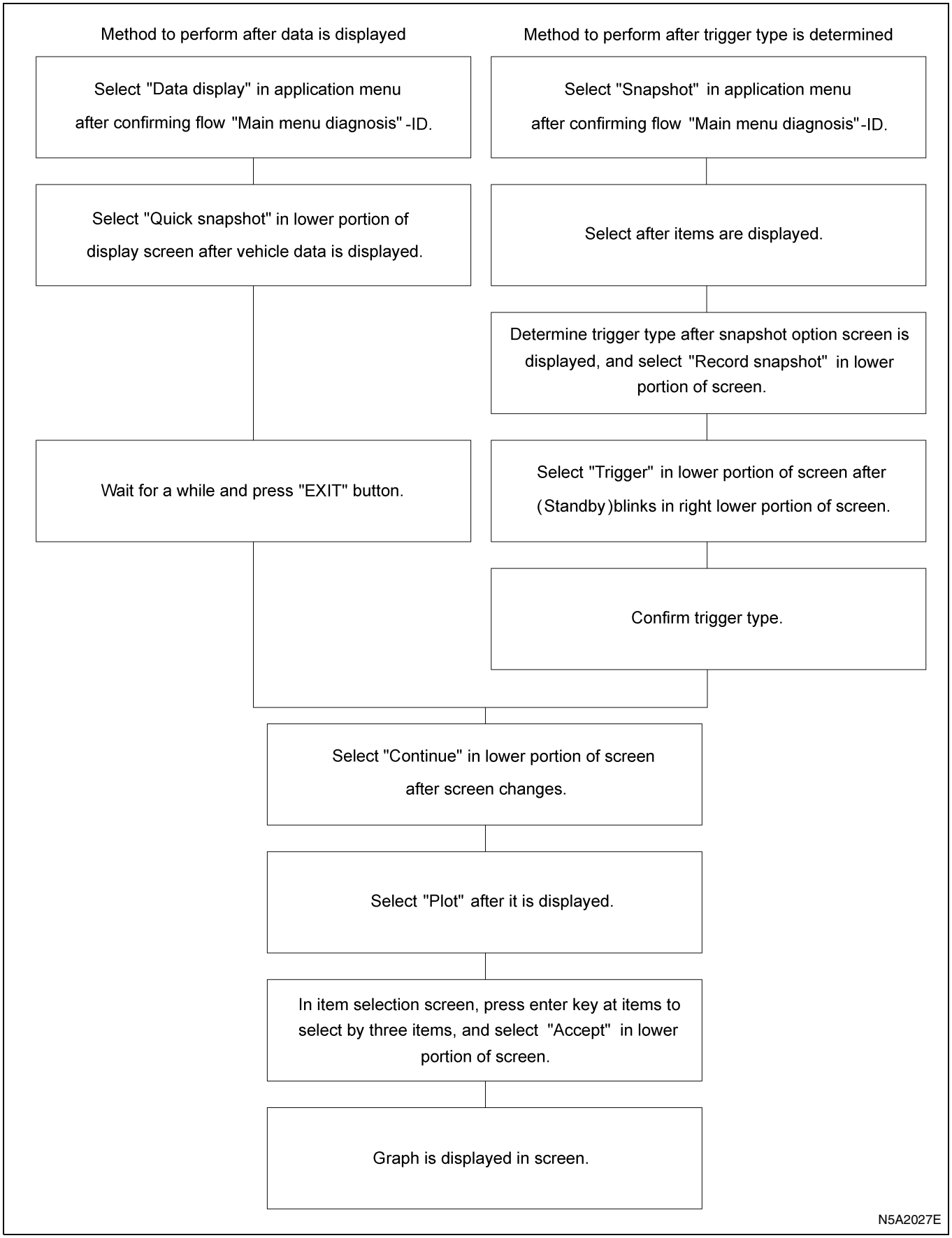
Use of this menu can display the current data.
Note that menu is subject to change.

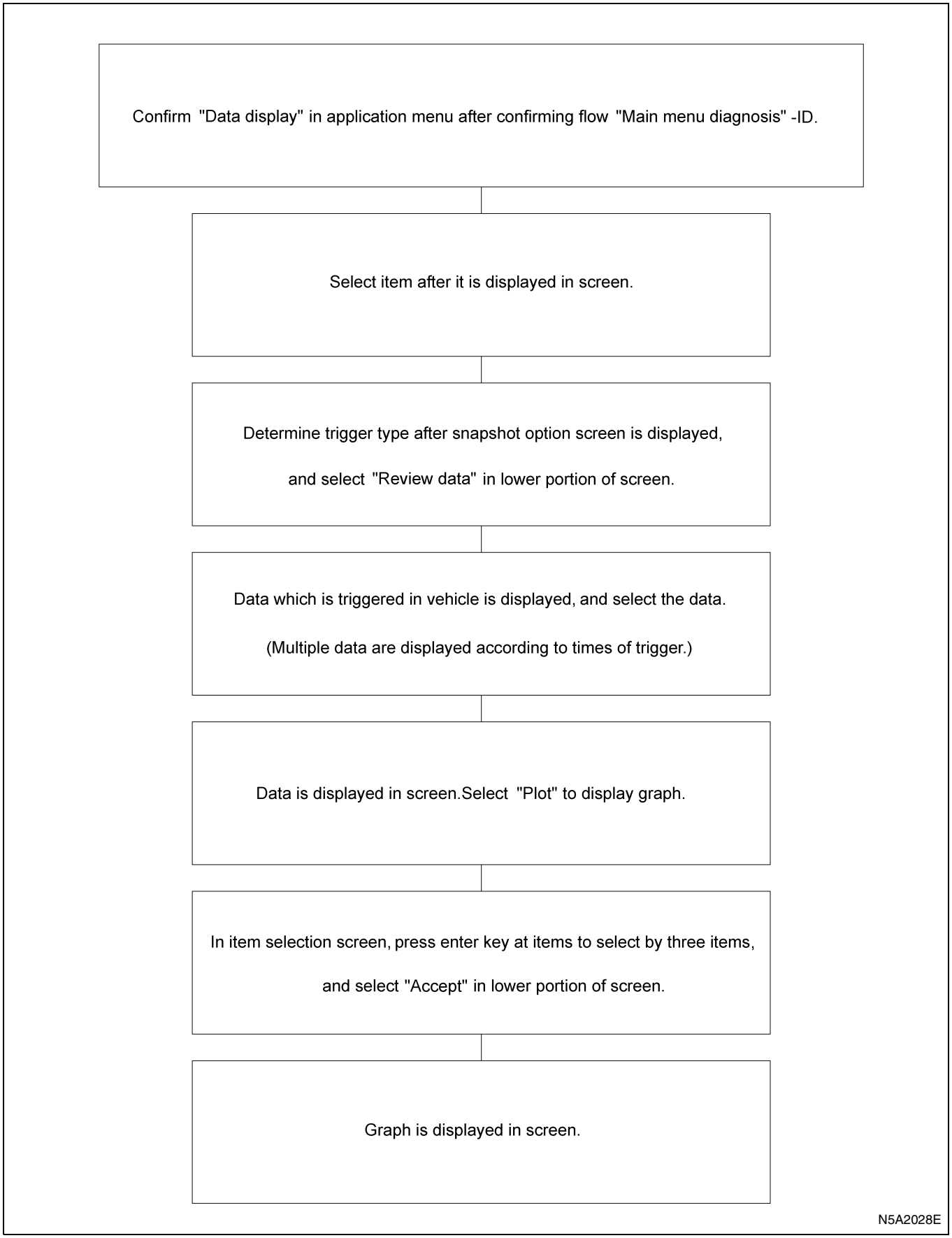
CAUTION:
On the vehicle that the rear tires have smaller diameter, the rear wheel speed may be indicated a little higher than the front wheel speed. Check the speed after driving a while at a constant speed.

Snapshot (graph plotting)



- The snapshot can record the data list menu and plot a graph.
- Utilizing this mode, reproduce and record the conditions claimed by the customer to identify the engine data fault.
- The stored data can be replayed with a domestic power supply.


Method to perform after data is displayed
Select "Data display" in application menu after confirming flow "Main menu diagnosis" -ID.
Select "Quick snapshot" in lower portion of display screen after vehicle data is displayed.
Wait for a while and press "EXIT" button.
Method to perform after trigger type is determined
Select "Snapshot" in application menu after confirming flow "Main menu diagnosis" -ID.
Select after items are displayed.
Determine trigger type after snapshot option screen is displayed, and select "Record snapshot" in lower portion of screen.
Select "Trigger" in lower portion of screen after (Standby) blinks in right lower portion of screen.
Confirm trigger type.
Select "Continue" in lower portion of screen after screen changes.
Select "Plot" after it is displayed.
In item selection screen, press enter key at items to select by three items, and select "Accept" in lower portion of screen.
Graph is displayed in screen.
N5A2027E

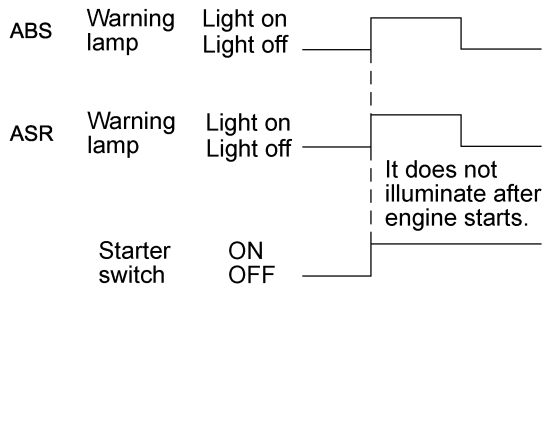
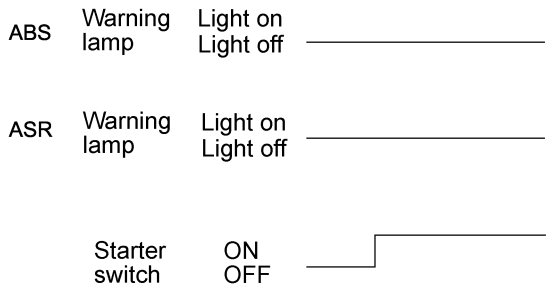

Confirm "Data display" in application menu after confirming flow "Main menu diagnosis" -ID.
Select item after it is displayed in screen.
Determine trigger type after snapshot option screen is displayed,
and select "Review data" in lower portion of screen.
Data which is triggered in vehicle is displayed, and select the data.
(Multiple data are displayed according to times of trigger.)
Data is displayed in screen.Select "Plot" to display graph.
In item selection screen, press enter key at items to select by three items,
and select "Accept" in lower portion of screen.
Graph is displayed in screen.
N5A2028E

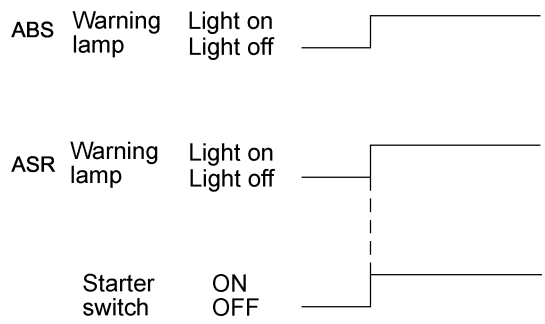
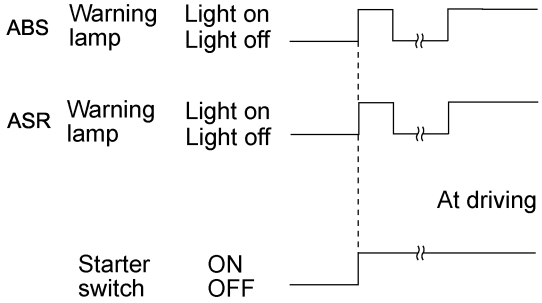
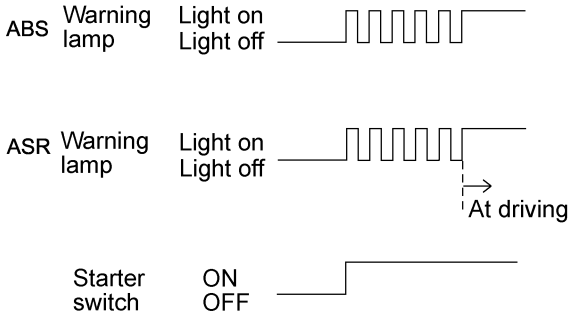
List of Diagnostic Trouble Code

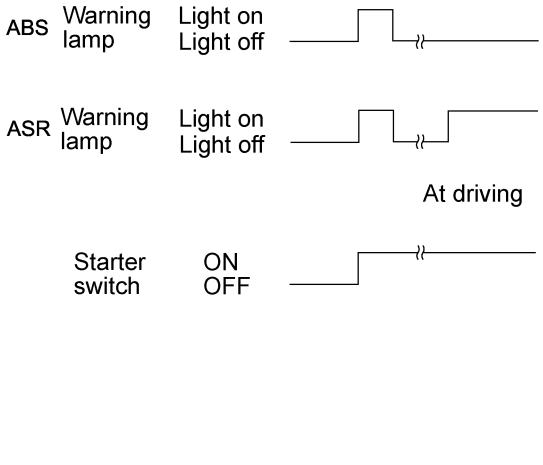
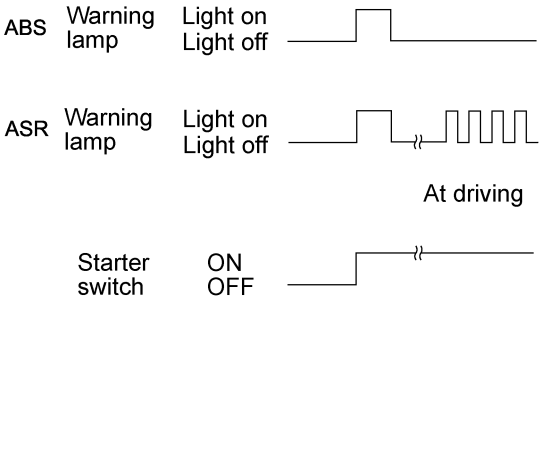
DTC		Description	Check flow
Flash out code (warning lamp blinking pattern)	Tech 2 code		
12	C0212	Normal	—
13	C0213	Model type identification fault due to wrong assembly of control unit	B-2
14	C0214	EHCU fault	B-3
15	C0215	ECU power supply fault	B-4
16	C0216	CAN Communication fault	B-5
26	C0226	ECM Communication fault	B-6
33	C0233	Motor drive circuit fault	B-7
34	C0234	Motor rotation fault	B-8
35	C0235	ASR communication fault (ASR only) ASR continuous operation	B-9
41	C0241	Fail-safe relay fault	B-10
43	C0243	Solenoid drive circuit fault	B-11
45	C0245	Solenoid monitor circuit fault	B-12
51	C0251	Speed sensor open/short circuit; FL	B-13
52	C0252	Speed sensor open/short circuit; FR	B-14
53	C0253	Speed sensor open/short circuit; RL	B-15
54	C0254	Speed sensor open/short circuit; RR	B-16
61	C0261	Speed sensor signal fault/wrong tire size; FL	B-17
62	C0262	Speed sensor signal fault/wrong tire size; FR	B-18
63	C0263	Speed sensor signal fault/wrong tire size; RL	B-19
64	C0264	Speed sensor signal fault/wrong tire size; RR	B-20

Diagnosis with Blinking Pattern

If the ABS/ASR warning lamp blinking pattern is found to be faulty with the ignition switch ON, or when the warning lamp comes on during the test run, perform the diagnosis according to the chart shown below depending on the blinking pattern.

No.	Lamp condition	Warning lamp illumination pattern	Diagnostic flow
1	Warning lamp shows normal.	 N5A2029E	Normal
2	Warning lamp remains off.	 ※Non illumination may occur for “ABS” or “ASR” each. N5A2030E	ABS ABS warning lamp illumination circuit is faulty. Go to check flow B-1-1. ASR ASR warning lamp illumination circuit is faulty.

No.	Lamp condition	Warning lamp illumination pattern	Diagnostic flow
3	Warning lamp remains on.	 N5A2031E	DTC is stored. Display the DTC and perform the diagnosis for each code according to the diagnostic flow. If DTC is not stored, warning lamp illumination circuit or meter may be faulty. Check the meter itself or harness between the meter and EHCU connector terminal 6.
4	Warning lamp comes on when driving.	 ※ Either “ABS” or “ASR” is faulty,one of two illuminates.System without faulty can operate. N5A2032E	DTC is stored. Display the DTC and perform the diagnosis for each code according to the diagnostic flow.
5	Warning lamp repeats blinking after turning the starter switch ON, and then turns on when driving the vehicle.	 N5A2033E	Self-diagnosis circuit is faulty. Go to check flow B-1-2.

No.	Lamp condition	Warning lamp illumination pattern	Diagnostic flow
6	ASR lamp only comes on when driving.	 N5A2034E	Normal if ASR off switch has been operated. If not, the ASR off switch circuit is faulty. Check the ASR off switch itself, and the harness between the ASR off switch and the EHCU connector terminal 5.
7	ASR lamp only blinks when driving.	 N5A2035E	ASR is in operation. It is normal.

ABS Warning Lamp does not Come on with the Starter Switch ON.

Check flow B-1-1

Step	Action	Value	YES	NO
1	Is the F-16 meter backup lamp fuse blown?	—	Go to Step5	Go to Step2
2	Is the warning lamp bulb blown?	—	Go to Step6	Go to Step3
3	1. Turn the starter switch OFF. 2. Disconnect the connector of the EHCU. 3. Turn the starter switch ON. 4. Measure the voltage between the B-51 connector terminal 18 and the J-177 connector terminal 1,23. Is the voltage within specified value?	16.5 — 34V	Go to Step4	Go to Step7
4	Check for continuity between the J-177 connector terminal 1,23 and the body ground. Is there continuity?	—	Go to Step9	Go to Step8
5	Replace the fuse. Is this step completed?	—	Go to Step10	—
6	Replace the warning lamp. Is this step completed?	—	Go to Step10	—
7	Repair the circuit for open/short circuit, and the connector for improper connection. Is this step completed?	—	Go to Step10	—
8	Repair the circuit for open/short circuit, and the connector for improper connection. Is this step completed?	—	Go to Step10	—
9	1. Check the suspicious circuit for improper connection. 2. If the connection is normal, replace the EHCU. Is this step completed?	—	Go to Step10	—
10	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	—

ABS Warning Lamp Repeats Blinking After Turning the Starter Switch to ON.

Check flow B-1-2

Step	Action	Value	YES	NO
1	Is anything connected to the self-diagnosis connector?	—	Go to Step2	Go to Step3
2	Disconnect the connection. Is this step completed?	—	Go to Step7	—
3	1. Turn the starter switch OFF. 2. Disconnect the connector of the EHCU. Check for continuity between the J-177 connector terminal 4 and the J-177 connector terminal 1,23. Is there continuity?	—	Go to Step4	Go to Step5
4	Repair the circuit of the diagnosis connector J-177 terminal 4 and the B-79 connector terminal 12. Is this step completed?	—	Go to Step7	—
5	Is there any other trouble symptom?	—	Check according to the check flow of such symptom.	Go to Step6
6	Replace the EHCU. Is this step completed?	—	Go to Step7	—
7	Install all the components, and check that those are installed properly. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step7

ABS Warning Lamp Repeats Blinking After Turning the Starter Switch to ON.

Check flow B-1-3

Step	Action	Value	YES	NO
1	Is anything connected to the self-diagnosis connector?	—	Go to Step2	Go to Step3
2	Disconnect the connection. Is this step completed?	—	Go to Step7	—
3	1. Turn the starter switch OFF. 2. Disconnect the connector of the EHCU. Is there continuity between the J-177 connector terminal 4 and the J-177 connector terminal 1, 23?	—	Go to Step4	Go to Step5
4	Repair the circuit between the diagnosis connector J-177 terminal 4 and the B-79 connector terminal 12. Is this step completed?	—	Go to Step7	—
5	Is there any other trouble symptom?	—	Check according to the check flow of such symptom.	Go to Step6
6	Replace the EHCU. Is this step completed?	—	Go to Step7	—
7	Install all the components, and check that those are installed properly. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step7

DTC:C0213 (Flash Code 13) Model Type Identification Fault Due to Wrong Assembly of Control Unit

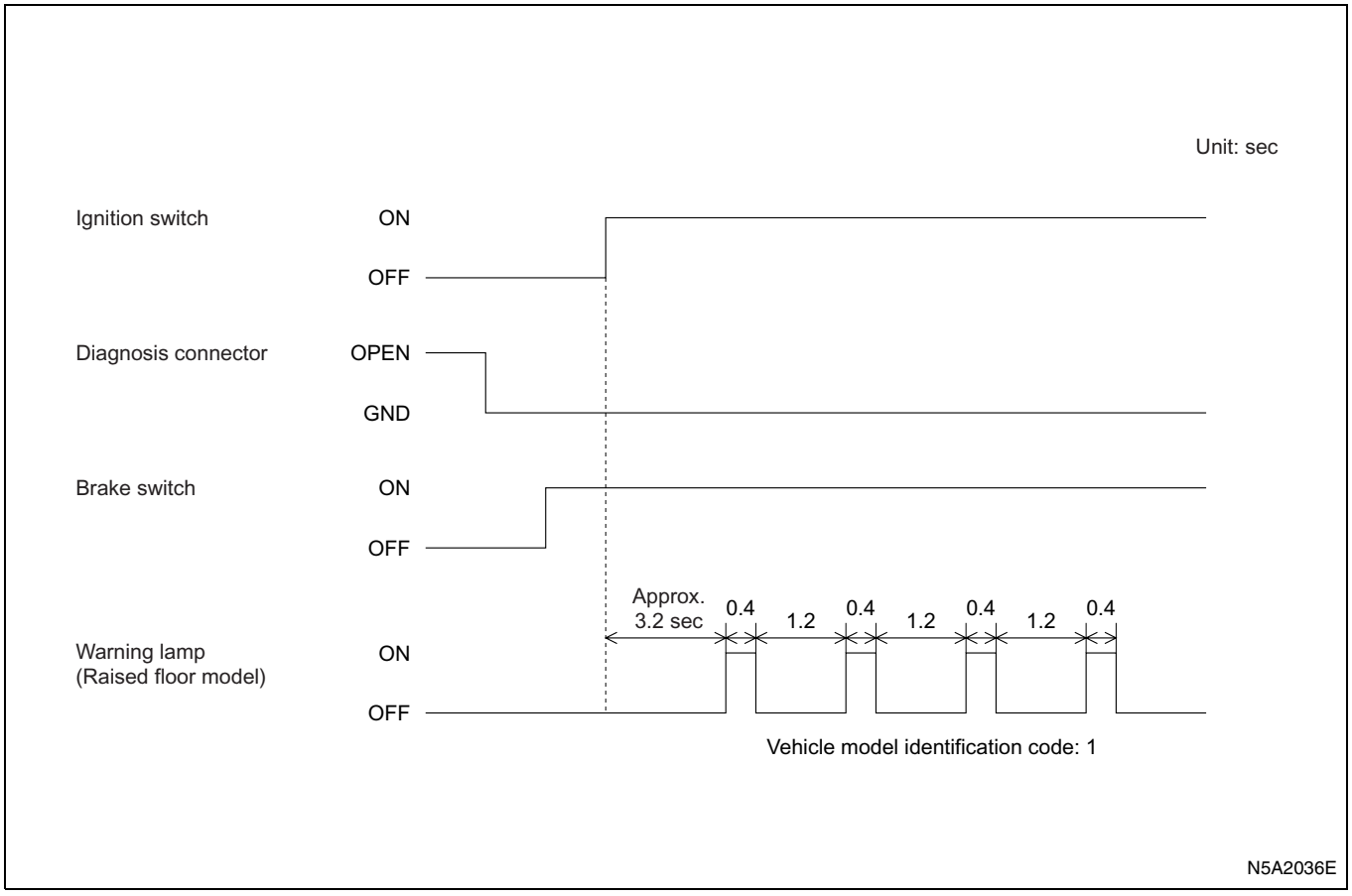
Step	Action	Value	YES	NO
1	1. Turn the starter switch OFF. 2. Disconnect the J-177 connector of the EHCU. 3. Turn the starter switch ON. Measure the voltage between the J-177 connector terminal 18 and the 1,23. Is the voltage within the specified value?	0.5 — 4.5V	Go to Step2	Go to Step3
2	Repair the short circuit and improper connection in J-177 connector terminal 18. Measure the voltage between the J-177 connector terminal 18 and 1,23. Is the voltage within the specified value?	0.5 — 4.5V	Go to Step3	Go to Step4
3	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. 3. With Tech 2: • Connect the J-177 connector of the EHCU. Check the model type code. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step4
4	Replace the EHCU with a new one. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step3

Model Type Identification by Control Unit

EHCU (ABS control unit) is exclusively installed for each vehicle type, based the drive system, brake type, tire, etc. Also, you can use the warning lamp blinking pattern to identify the type of control unit (for which vehicle type).

How to Indicate Model Type Identification Result

With the ignition switch OFF, short the terminal 12 with the terminal 4 or 5 (ground) of the self-diagnosis connector, and depress the brake pedal and then turn the starter switch to ON. The ABS warning lamp will blink to indicate the result.



Model type identification code	2WD ABS
1	Raised floor model with front wheel disc brake
2	Flat low model with front wheel disc brake
3	Raised floor model with four wheel drum brake
7	NQR model for EC
8	NQR model for Australia

DTC:C0214 (Flash Code 14) EHCU Fault

Check flow B-3

Step	Action	Value	YES	NO
1	1. Turn the starter switch OFF. 2. Disconnect the connector of the EHCU. 3. Check for continuity between the J-177 connector terminal 1,23 and the body ground. Is there continuity?	—	Go to Step2	Go to Step3
2	1. Connect the connector of the EHCU. 2. Clear the DTC. 3. Perform the self-diagnosis after turning the starter switch from OFF to ON. Is DTC displayed repeatedly?	—	Go to Step4	Go to Step5
3	Repair the circuit for open/short circuit, and the connector for improper connection. Is this step completed?	—	Go to Step5	—
4	Replace the EHCU. Is this step completed?	—	Go to Step5	—
5	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step5

DTC:C0215 (Flash Code 15) ECU Power Supply Fault

Check flow B-4

Step	Action	Value	YES	NO
1	Is the battery voltage normal?	—	Go to Step2	Go to Step5
2	1. Turn the starter switch OFF. 2. Disconnect the connector of the EHCU. 3. Start the engine. 4. Measure the voltage between the J-177 connector terminal 2 and the J-177 connector terminal 1,23. Is the value within specified value?	17 — 33.5V	Go to Step3	Go to Step6
3	Look for the circuit with improper connection. Is improper connection found?	—	Go to Step4	Go to Step8
4	Repair and perform the self-diagnosis. Is DTC displayed repeatedly?	—	Go to Step7	Go to Step8
5	Charge or replace the battery. Is this step completed?	—	Go to Step8	—
6	Repair the circuit for open/short circuit, and the connector for improper connection between the J-177 connector terminal 2 and the fusible link FL-9. Is this step completed?	—	Go to Step8	—
7	Replace the control unit. Is this step completed?	—	Go to Step8	—
8	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step8

DTC:C0216 (Flash Code 16) CAN Communication Fault

Check flow B-5

Step	Action	Value	YES	NO
1	1. Turn the starter switch OFF. 2. Remove the harnesses from all the control units (engine, ABS, Smoother, etc.) connected to the CAN communication circuit. 3. Check for short circuit (shorts with ground, power supply, lines, and circuits) in the CAN communication circuit harnesses. Is the harness normal?	—	Go to Step3	Go to Step2
2	Repair the CAN communication circuit. Is the procedure completed?	—	Go to Step3	—
3	1. Turn the starter switch OFF. 2. Remove the harness from the EHCU. 3. Measure the circuit resistance between the terminals 14 and 15, and between terminals 26 and 27 in EHCU harness-side connector. Is the resistance within specified value?	100 —140Ω	Go to Step5	Go to Step4
4	Inspect the CAN communication circuit, terminating resistor, and connectors for faulty contact, the pin terminals for looseness, etc., and repair as necessary. Is the procedure completed?	—	Go to Step5	—
5	1. Turn the starter switch OFF. 2. Check the CAN communication (engine, ABS, Smoother, etc.) circuit harnesses for open circuit. Is the harness normal?	—	Go to Step7	Go to Step6
6	Repair the CAN communication circuit. Is the procedure completed?	—	Go to Step7	—
7	1. Turn the starter switch OFF. 2. Install the harnesses to all the control units connected to the CAN communication circuit. 3. Turn the starter switch ON. 4. Check each system (engine, Smoother, etc) for DTC. 5. If any DTC is detected in any system, repair it. Is the procedure completed?	—	Go to Step8	—
8	1. Clear the DTC. 2. Perform the test drive. 3. Check for DTC. Was DTC C0216 detected?	—	Go to Step9	Go to Step10

Step	Action	Value	YES	NO
9	Replace the EHCU. Is this step completed?	—	Go to Step10	—
10	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step10

DTC:C0226 (Flash Code 26) ECM Communication Fault

Check flow B-6

Step	Action	Value	YES	NO
1	Inspect the engine control, and repair or replace any faulty parts. Is this step completed?	—	Go to Step2	Go to Step1
2	Perform the check flow B-5. Is this step completed?	—	Go to Step3	Go to Step2
3	1. Clear the DTC. 2. Perform the test drive. 3. Check for DTC. Was DTC C0226 detected?	—	Go to Step4	Go to Step5
4	Replace the EHCU. Is this step completed?	—	Go to Step5	—
5	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step5

DTC:C0233 (Flash Code 33) Motor Drive Circuit Fault

Check flow B-7

Step	Action	Value	YES	NO
1	1. Turn the starter switch OFF. 2. Disconnect the connector of the EHCU. 3. Turn the starter switch ON. 4. Measure the voltage between the J-177 connector terminal 24 and the J-177 connector terminal 23. Is the value within specified value?	20 — 32V	Go to Step5	Go to Step2
2	Repair the circuit between the J-177 connector terminal 24 and the FL-9, or replace the FL-9. Is this step completed?	—	Go to Step3	Go to Step2
3	Measure the voltage between the J-177 connector terminals 24 and 23. Is the value within specified value?	20 — 32V	Go to Step6	Go to Step4
4	Repair the harness between the J-177 connector terminal 23 and the chassis ground. Is this step completed?	—	Go to Step6	Go to Step4
5	Replace the EHCU. Is this step completed?	—	Go to Step6	Go to Step5
6	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. 3. Test run the vehicle. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step6

DTC:C0234 (Flash Code 34) Motor Rotation Fault

Check flow B-8

Step	Action	Value	YES	NO
1	Replace the EHCU. Is this step completed?	—	Go to Step2	Go to Step1
2	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. 3. Test run the vehicle. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step2

DTC:C0235 (Flash Code 35) ASR Communication Line Fault/ASR Continuous Operation

Check flow B-9

Step	Action	Value	YES	NO
1	1. Check the tire. 2. Check if specified tires are attached. 3. Check for abnormal wear on the tire outer surface. Are the tires normal?	—	Go to Step2	Replace with the specified tire, and Go to Step2
2	Check the speed sensor. (Check the sensor output by referring to the check flow C-1-1-C-1-4, or TC-1.) Is the sensor output normal?	100 — 140Ω	Go to Step3	Repair the faulty speed sensor, and Go to Step5
3	Check the engine control. Is the engine control normal?	"Diagnosis with Blinking Pattern" No.1	Go to Step4	Repair the engine control, and Go to Step5
4	Replace the EHCU. Is this step completed?	—	Go to Step5	Go to Step4
5	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to "Diagnostic basic flow".	Go to Step5

DTC:C0241 (Flash Code 41) Fail-Safe Relay Fault

Check flow B-10

Step	Action	Value	YES	NO
1	1. Turn the starter switch OFF. 2. Disconnect the connector of the EHCU. 3. Turn the starter switch ON. 4. Measure the voltage between the J-177 connector terminal 2 and the J-177 connector terminal 1. Is the value within specified value?	16.5 — 34V	Go to Step6	Go to Step2
2	Repair the circuit between the J-177 connector terminal 2 and the FL-9. Is this step completed?	—	Go to Step3	Go to Step2
3	Measure the voltage between the J-177 connector terminals 2 and 1. Is the value within specified value?	16.5 — 34V	Go to Step7	Go to Step4
4	Repair the harness between the J-177 connector terminal 1 and the chassis ground. Is this step completed?	—	Go to Step5	Go to Step4
5	Measure the voltage between the J-177 connector terminals 2 and 1. Is the value within specified value?	16.5 — 34V	Go to Step7	Go to Step5
6	Replace the EHCU. Is this step completed?	—	Go to Step7	Go to Step6
7	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. 3. Test run the vehicle. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step7

DTC:C0243 (Flash Code 43) Solenoid Drive Circuit Fault

Check flow B-11

Step	Action	Value	YES	NO
1	Replace the EHCU. Is this step completed?	—	Go to Step2	Go to Step1
2	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. 3. Test run the vehicle. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step2

DTC:C0245 (Flash Code 45) Solenoid Monitor Circuit Fault

Check flow B-12

Step	Action	Value	YES	NO
1	Replace the EHCU. Is this step completed?	—	Go to Step2	Go to Step1
2	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. 3. Test run the vehicle. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step2

DTC:C0251 (Flash Code 51) Speed Sensor Open/Short Circuit; FL

Check flow B-13

Step	Action	Value	YES	NO
1	1. Turn the starter switch OFF. 2. Disconnect the connector of the EHCU. 3. Measure the resistance between the J-177 connector terminals 32 and 33. Is the value within specified value?	1 — 2kΩ	Go to Step2	Go to Step3
2	Measure the resistance between the J-177 connector terminals 32 and the ground. Is the value within specified value?	1000kΩ or more	Go to Step7	Go to Step4
3	1. Disconnect the FL wheel speed sensor connector. 2. Measure the resistance between the J-75 connector terminals 1 and 2 (sensor side). Is the value within specified value?	1 — 2Ω	Go to Step5	Go to Step6
4	1. Disconnect the FL wheel speed sensor connector. 2. Measure the resistance between the J-75 connector terminal 1 (sensor side) and the ground. Is the value within specified value?	1000kΩ or more	Go to Step5	Go to Step6
5	Repair the circuit for open/short circuit between the control unit connector and the sensor connector. Is this step completed?	—	Go to Step8	—
6	Replace the FL wheel speed sensor. Is this step completed?	—	Go to Step8	—
7	Replace the control unit. Is this step completed?	—	Go to Step8	—
8	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step8

DTC:C0252 (Flash Code 52) Speed Sensor Open/Short Circuit; FR

Check flow B-14

Step	Action	Value	YES	NO
1	1. Turn the starter switch OFF. 2. Disconnect the connector of the EHCU. 3. Measure the resistance between the J-177 connector terminals 10 and 11. Is the value within specified value?	1 — 2kΩ	Go to Step2	Go to Step3
2	Measure the resistance between the J-177 connector terminals 10 and the ground. Is the value within specified value?	1000kΩ or more	Go to Step7	Go to Step4
3	1. Disconnect the FR wheel speed sensor connector. 2. Measure the resistance between the J-74 connector terminals 1 and 2 (sensor side). Is the value within specified value?	1 — 2kΩ	Go to Step5	Go to Step6
4	1. Disconnect the FR wheel speed sensor connector. 2. Measure the resistance between the J-74 connector terminal 1 (sensor side) and the ground. Is the value within specified value?	1000kΩ or more	Go to Step5	Go to Step6
5	Repair the circuit for open/short circuit between the control unit connector and the sensor connector. Is this step completed?	—	Go to Step8	—
6	Replace the FR control unit. Is this step completed?	—	Go to Step8	—
7	Replace the control unit. Is this step completed?	—	Go to Step8	—
8	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step8

DTC:C0253 (Flash Code 53) Speed Sensor Open/Short Circuit; RL

Check flow B-15

Step	Action	Value	YES	NO
1	1. Turn the starter switch OFF. 2. Disconnect the connector of the EHCU and the RL wheel speed sensor connector J-149. 3. Check for continuity between the J-177 connector terminal 34 and the J-149 sensor connector terminal 2. Is there continuity?	—	Go to Step2	Go to Step7
2	Check for continuity between the J-177 connector terminals 34 and 1. Is there continuity?	—	Go to Step7	Go to Step3
3	Check for continuity between the J-177 connector terminal 22 and the J-149 sensor connector terminal 1. Is there continuity?	—	Go to Step4	Go to Step7
4	Check for continuity between the J-177 connector terminals 22 and 1. Is there continuity?	—	Go to Step7	Go to Step5
5	1. Connect the connector of the EHCU. 2. Turn the starter switch ON. 3. Measure the voltage between the J-149 sensor connector terminal 1 and the ground. Is the value within specified value?	9 — 16V	Go to Step6	Go to Step7
6	Check the RL wheel speed sensor output. (Refer to the check flow C-1-3.) Is the fail corrected?	—	Go to Step9	Go to Step8
7	Repair the circuit for open/short circuit, and the connector for improper connection between the connector of EHCU and the speed sensor connector. Is this step completed?	—	Go to Step9	Go to Step7
8	Replace the control unit. Is this step completed?	—	Go to Step9	Go to Step8
9	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step9

DTC:C0254 (Flash Code 54) Speed Sensor Open/Short Circuit; RR

Check flow B-16

Step	Action	Value	YES	NO
1	1. Turn the starter switch OFF. 2. Disconnect the connector of EHCU and the RR wheel speed sensor connector J-148. 3. Check for continuity between the J-177 connector terminal 12 and the J-148 sensor connector terminal 2. Is there continuity?	—	Go to Step2	Go to Step7
2	Check for continuity between the J-177 connector terminals 12 and 1. Is there continuity?	—	Go to Step7	Go to Step3
3	Check for continuity between the J-177 connector terminal 21 and the J-148 sensor connector terminal 1. Is there continuity?	—	Go to Step4	Go to Step7
4	Check for continuity between the J-177 connector terminals 21 and 1. Is there continuity?	—	Go to Step7	Go to Step5
5	1. Connect the connector of the EHCU. 2. Turn the starter switch ON. 3. Measure the voltage between the J-148 sensor connector terminal 1 and the ground. Is the value within specified value?	9 — 16V	Go to Step6	Go to Step7
6	Check the RR wheel speed sensor output. (Refer to the check flow C-1-4.) Is the fail corrected?	—	Go to Step8	Go to Step8
7	Repair the circuit for open/short circuit, and the connector for improper connection between the connector of EHCU and the speed sensor connector. Is this step completed?	—	Go to Step9	Go to Step7
8	Replace the control unit. Is this step completed?	—	Go to Step9	Go to Step8
9	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step9

DTC:C0261 (Flash Code 61) Speed Sensor Signal Fault/Wrong Tire Size; FL

Check flow B-17

Step	Action	Value	YES	NO
1	Check the tire. Is the tire specification correct? Is abnormal wear found in the outer surface?	—	Go to Step2	Replace with the specified tire without wear.Go to Step21
2	Has certain tire been rotated alone by perfuming for jack-up or roller tester?	—	DTC may be set if certain tire is rotated alone. Go to Step21	Go to Step3
3	Is the FL wheel bearing rattling?	—	Go to Step12	Go to Step4
4	Is the FL wheel speed sensor/sensor rotor rattling?	—	Go to Step13	Go to Step5
5	Is iron powder attached to the FL wheel speed sensor/sensor rotor?	—	Go to Step14	Go to Step6
6	Check the FL wheel speed sensor. (Refer to the check flow C-1-1 or TC-1.) Is the FL sensor output normal?	—	Go to Step7	Go to Step10
7	Does the sensor rotor have missing tooth or saw-toothed?	—	Go to Step15	Go to Step8
8	Measure the resistance between the B-177 connector terminals 33 and the ground. Is the value within specified value?	1000kΩ or more	Go to Step9	Go to Step11
9	1. Clear the DTC. 2. Test run the vehicle, and perform the self-diagnosis. Is DTC displayed repeatedly?	—	Go to Step20	Go to Step18
10	Is the speed sensor damaged or saw-toothed?	—	Go to Step16	Go to Step17
11	1. Disconnect the FL sensor connector. 2. Measure the resistance between the J-75 connector terminal 2 (sensor side) and the ground. Is the value within specified value?	1000kΩ or more	Go to Step19	Go to Step16
12	Adjust the preload of the wheel bearing. Is this step completed?	—	Go to Step21	—
13	Repair or replace the speed sensor/sensor rotor. Is this step completed?	—	Go to Step21	—
14	Repair the speed sensor/sensor rotor. Is this step completed?	—	Go to Step21	—
15	Replace the sensor rotor. Is this step completed?	—	Go to Step21	—
16	Replace the FL wheel speed sensor. Is this step completed?	—	Go to Step21	—

Step	Action	Value	YES	NO
17	Check the FL wheel speed sensor circuit. (Refer to the check flow B-13.) Is this step completed?	—	Check the repair.	—
18	Check the circuit for open circuit, and the connector for improper connection between the EHCU and the speed sensor connector. Refer to “Intermittent trouble”. Is this step completed?	—	Go to Step21	—
19	Repair the circuit for open/short circuit, and the connector for improper connection between the EHCU connector and the speed sensor connector. Is this step completed?	—	Go to Step21	Go to Step21
20	Replace the EHCU. Is this step completed?	—	Go to Step21	—
21	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step21

DTC:C0262 (Flash Code 62) Speed Sensor Signal Fault/Wrong Tire Size; FR

Check flow B-18

Step	Action	Value	YES	NO
1	Check the tire. Is the tire specification correct? Is abnormal wear found in the outer surface?	—	Go to Step2	Replace with the specified tire without wear.Go to Step21
2	Has certain tire been rotated alone by perfuming for jack-up or roller tester?	—	DTC may be set if certain tire is rotated alone. Go to Step21	Go to Step3
3	Is the FR wheel bearing rattling?	—	Go to Step12	Go to Step4
4	Is the FR wheel speed sensor/sensor rotor rattling?	—	Go to Step13	Go to Step5
5	Is iron powder attached to the FR wheel speed sensor/sensor rotor?	—	Go to Step14	Go to Step6
6	Check the FR wheel speed sensor. (Refer to the check flow C-1-2 or TC-1.) Is the FR sensor output normal?	—	Go to Step7	Go to Step10
7	Does the sensor rotor have missing tooth or saw-toothed?	—	Go to Step15	Go to Step8
8	Measure the resistance between the B-177 connector terminal 11 and the ground. Is the value within specified value?	1000kΩ or more	Go to Step9	Go to Step11
9	1. Clear the DTC. 2. Test run the vehicle, and perform the self-diagnosis. Is DTC displayed repeatedly?	—	Go to Step20	Go to Step18
10	Is the speed sensor damaged or saw-toothed?	—	Go to Step16	Go to Step17
11	1. Disconnect the FR sensor connector. 2. Measure the resistance between the J-74 connector terminal 2 (sensor side) and the ground. Is the value within specified value?	1000kΩ or more	Go to Step19	Go to Step16
12	Adjust the preload of the wheel bearing. Is this step completed?	—	Go to Step21	—
13	Repair or replace the speed sensor/sensor rotor. Is this step completed?	—	Go to Step21	—
14	Repair the speed sensor/sensor rotor. Is this step completed?	—	Go to Step21	—
15	Replace the sensor rotor. Is this step completed?	—	Go to Step21	—
16	Replace the FR wheel speed sensor. Is this step completed?	—	Go to Step21	—

Step	Action	Value	YES	NO
17	Check the FR wheel speed sensor circuit. (Refer to the check flow B-14.) Is this step completed?	—	Check the repair.	—
18	Check the circuit for open circuit, and the connector for improper connection between the EHCU and the speed sensor connector. Refer to “Intermittent trouble”. Is this step completed?	—	Go to Step21	—
19	Repair the circuit for open/short circuit, and the connector for improper connection between the EHCU connector and the speed sensor connector. Is this step completed?	—	Go to Step21	Go to Step21
20	Replace the EHCU. Is this step completed?	—	Go to Step21	—
21	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step21

DTC:C0263 (Flash Code 63) Speed Sensor Signal Fault/Wrong Tire Size; RL

Check flow B-19

Step	Action	Value	YES	NO
1	Check the tire. Is the tire specification correct? Is abnormal wear found in the outer surface?	—	Go to Step2	Replace with the specified tire without wear.Go to Step18
2	Has certain tire been rotated alone by perfuming for jack-up or roller tester?	—	DTC may be set if certain tire is rotated alone. Go to Step18	Go to Step3
3	Is the FL wheel bearing rattling?	—	Go to Step10	Go to Step4
4	Is the FL wheel speed sensor/sensor rotor rattling?	—	Go to Step11	Go to Step5
5	Is iron powder attached to the FL wheel speed sensor/sensor rotor?	—	Go to Step12	Go to Step6
6	Check the RL wheel speed sensor. (Refer to the check flow C-1-3.) Is the RL sensor output normal?	—	Go to Step7	Go to Step9
7	Does the sensor rotor have missing tooth or saw-toothed?	—	Go to Step13	Go to Step8
8	1. Clear the DTC. 2. Test run the vehicle, and perform the self-diagnosis. Is DTC displayed repeatedly?	—	Go to Step17	Go to Step16
9	Is the speed sensor damaged or saw-toothed?	—	Go to Step14	Go to Step15
10	Adjust the preload of the wheel bearing. Is this step completed?	—	Go to Step18	—
11	Repair or replace the speed sensor/sensor rotor. Is this step completed?	—	Go to Step18	—
12	Repair the speed sensor/sensor rotor. Is this step completed?	—	Go to Step18	—
13	Replace the sensor rotor. Is this step completed?	—	Go to Step18	—
14	Replace the RL wheel speed sensor. Is this step completed?	—	Go to Step18	—
15	Check the RL wheel speed sensor circuit. (Refer to the check flow B-15.) Is this step completed?	—	Check the repair.	—
16	Check the circuit for open circuit, and the connector for improper connection the EHCU connector and the speed sensor connector. Refer to “Intermittent trouble”. Is this step completed?	—	Go to Step18	—

Step	Action	Value	YES	NO
17	Replace the EHCU. Is this step completed?	—	Go to Step18	—
18	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step18

DTC:C0264 (Flash Code 64) Speed Sensor Signal Fault/Wrong Tire Size; RR

Check flow B-20

Step	Action	Value	YES	NO
1	Check the tire. Is the tire specification correct? Is abnormal wear found in the outer surface?	—	Go to Step2	Replace with the specified tire without wear.Go to Step18
2	Has certain tire been rotated alone by perfuming for jack-up or roller tester?		DTC may be set if certain tire is rotated alone. Go to Step18	Go to Step3
3	Is the RR wheel bearing rattling?	—	Go to Step10	Go to Step4
4	Is the RR wheel speed sensor/sensor rotor rattling?	—	Go to Step11	Go to Step5
5	Is iron powder attached to the RR wheel speed sensor/sensor rotor?	—	Go to Step12	Go to Step6
6	Check the RR wheel speed sensor. (Refer to the check flow C-1-4.) Is the RR sensor output normal?	—	Go to Step7	Go to Step9
7	Does the sensor rotor have missing tooth or saw-toothed?	—	Go to Step13	Go to Step8
8	1. Clear the DTC. 2. Test run the vehicle, and perform the self-diagnosis. Is DTC displayed repeatedly?	—	Go to Step17	Go to Step16
9	Is the speed sensor damaged or saw-toothed?	—	Go to Step14	Go to Step15
10	Adjust the preload of the wheel bearing. Is this step completed?	—	Go to Step18	—
11	Repair or replace the speed sensor/sensor rotor. Is this step completed?	—	Go to Step18	—
12	Repair the speed sensor/sensor rotor. Is this step completed?	—	Go to Step18	—
13	Replace the sensor rotor. Is this step completed?	—	Go to Step18	—
14	Replace the RR wheel speed sensor. Is this step completed?	—	Go to Step18	—
15	Check the RR wheel speed sensor circuit. (Refer to the check flow B-16.) Is this step completed?	—	Check the repair.	—
16	Check the circuit for open circuit, and the connector for improper connection the EHCU connector and the speed sensor connector. Refer to “Intermittent trouble”. Is this step completed?	—	Go to Step18	—

Step	Action	Value	YES	NO
17	Replace the EHCU. Is this step completed?	—	Go to Step18	—
18	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step18

List of Trouble Symptom

Troubles not appeared as warning lamp indication can be classified into the following five categories.

1. The ABS operates frequently but brake force is insufficient, or the ASR operates frequently.
2. The ABS operates but pulling to one side.
3. Wheels are locked during brake operation.
4. Feeling of brake pedal is faulty.
5. Brake operating noise comes from the EHCU though the brake pedal is not depressed.

Self-diagnosis function is unable to detect these symptoms.

Check the trouble symptom by reproducing the condition through interviewing customer with the test run, and perform the diagnosis according to each trouble symptom.

No.	Trouble symptom	Diagnostic check flow	
		Without Tech 2	With Tech 2
1	The ABS operates frequently but brake force is insufficient, or the ASR operates frequently.	Check flow A-1	Check flow TA-1
2	The ABS operates but pulling to one side.	Check flow A-2	Check flow TA-2
3	Wheels are locked during brake operation.	Check flow A-3	Check flow TA-3
4	Feeling of brake pedal is faulty.	Check flow A-4	—
5	Brake operating noise comes from the hydraulic unit though the brake pedal is not depressed.	Check flow A-5	Check flow TA-5

Symptom: [The ABS Operates Frequently but Brake Force is Insufficient, or the ASR Operates Frequently.] (Check Flow A-1)

Check flow A-1

Step	Action	Value	YES	NO
1	Check the tire. Is the tire specification correct? Is abnormal wear found in the outer surface?	—	Go to Step2	Replace with the specified tire without wear.Go to Step7
2	Is the brake balance between front and rear wheels correct?	—	Go to Step3	Repair the brake components.Go to Step7
3	Are the axle-related parts correctly assembled?	—	Go to Step4	Repair the parts.Go to Step7
4	Is the speed sensor installation normal?	—	Go to Step5	Repair the wheel speed sensor.Go to Step7
5	Is the speed sensor/sensor rotor damaged? Or iron powder attached?	—	Go to Step6	Replace the sensor or sensor rotor. Go to Step7
6	Are all the wheel speed sensor outputs normal?	—	Replace the control unit.Go to Step7	Replace the wheel speed sensor, or repair the circuit. Go to Step7
7	Install all the components, and check that those are installed properly. Is this step completed?	—	Repeat “Diagnostic basic flow”.	Go to Step7

Symptom: [The ABS Operates Frequently but Brake Force is Insufficient, or the ASR Operates Frequently.] (Check Flow TA-1)

Check flow TA-1

Step	Action	Value	YES	NO
1	1. Connect the Tech 2. 2. Check each sensor output from the “Wheel sensor”. Is the lowest value of each wheel sensor reading 4 km/h (2 mph) or less? And is the value stable?	—	Go to Step2	Replace the wheel speed sensor.Go to Step3
2	Go back to the check flow A-1. Is the check flow A-1 completed?	—	Go to Step3	Go to Step2
3	Assemble all the components, and check that those are installed properly. Is this step completed?	—	Repeat “Diagnostic basic flow”.	Go to Step3

CAUTION:
On the vehicle that the rear tires have smaller diameter, the rear wheel speed may be indicated a little higher than the front wheel speed. Check the speed after driving a while at a constant speed.

Symptom: [The ABS Operates but Pulling to One Side.] (Check Flow A-2)

Check flow A-2

Step	Action	Value	YES	NO
1	Is the speed sensor installation normal?	—	Go to Step2	Repair.Go to Step5
2	Is the wheel speed sensor/sensor rotor damaged? Or iron powder attached?	—	Go to Step3	Repair or replace it.Go to Step5
3	Are the wheel speed sensor outputs normal? (Refer to the check flow C-1 or TC-1)	—	Go to Step4	Replace the sensor or repair the circuit. Go to Step5
4	Is the brake pipe connection correct?	—	Replace the control unit.Go to Step5	Correct the connection.Go to Step5
5	Assemble all the components, and check that those are installed properly. Is this step completed?	—	Repeat “Diagnostic basic flow”.	Go to Step5

Symptom: [The ABS Operates but Pulling to One Side.] (Check Flow TA-2)

Check flow TA-2

Step	Action	Value	YES	NO
1	1. Connect the Tech 2. 2. Check each wheel speed sensor output. Is each sensor output normal?	—	Go to Step2	Go to Step3
2	Check the brake pipe. Is the pipe normal?	—	Replace the EHCU.Go to Step4	Repair the pipe.Go to Step4
3	Repair and check the wheel speed sensor. (Refer to the check flow C-1 or TC-1.) Is this step completed?	—	Go to Step4	Go to Step3
4	Assemble all the components, and check that those are installed properly. Is this step completed?	—	Repeat “Diagnostic basic flow”.	Go to Step4

CAUTION:
On the vehicle that the rear tires have smaller diameter, the rear wheel speed may be indicated a little higher than the front wheel speed. Check the speed after driving a while at a constant speed.

Symptom: [Wheels are Locked During Brake Operation.] (Check Flow A-3, TA-3)

Check flow A-3, TA-3

Step	Action	Value	YES	NO
1	Does the ABS operate?	—	Go to Step2	Go to Step4
2	Is the vehicle speed 10km/h (6 mph) or less?	—	Go to Step3	Normal
3	Are the wheel speed sensor outputs normal? (Refer to the check flow C-1 or TC-1)	—	Go to Step4	Replace the sensor or repair the circuit. Go to Step5
4	Is the EHCU grounded properly?	—	Replace the EHCU.Go to Step5	Repair.Go to Step5
5	Assemble all the components, and check that those are installed properly. Is this step completed?	—	Repeat “Diagnostic basic flow”.	Go to Step5

Symptom: [Feeling of Brake Pedal is Faulty.] (Check Flow A-4)

Check flow A-4

Step	Action	Value	YES	NO
1	Does the stop lamp come on when depressing the brake pedal?	—	Go to Step2	Go to Step3
2	1. Turn the starter switch OFF. 2. Disconnect the connector of the EHCU. 3. Measure the voltage between the J-177 connector terminal 16 and the J-177 connector terminal 1,23 with the brake pedal depressed. Is the power supply voltage supplied to it?	—	Go to Step4	Repair the circuit between the stop lamp switch and the control unit.Go to Step7
3	Is the stop lamp fuse F-5 normal?	—	Go to Step5	Replace the fuse.Go to Step7
4	Check for continuity between the J-177 connector terminal 1,23 and the body ground. Is there continuity?	—	Go to Step6	Repair the body ground circuit.Go to Step7
5	Is the stop lamp switch normal?	—	Repair the stop lamp circuit.Go to Step7	Replace the stop lamp switch.Go to Step7
6	Check the suspicious circuit/connector for improper connection. Is there improper connection?	—	Brake fluid line is leaked or air mixed. (Refer to Section 5A.)Go to Step7	Repair the circuit.Go to Step7
7	Assemble all the components, and check that those are assembled properly. Is this step completed?	—	Repeat “Diagnostic basic flow”.	Go to Step7

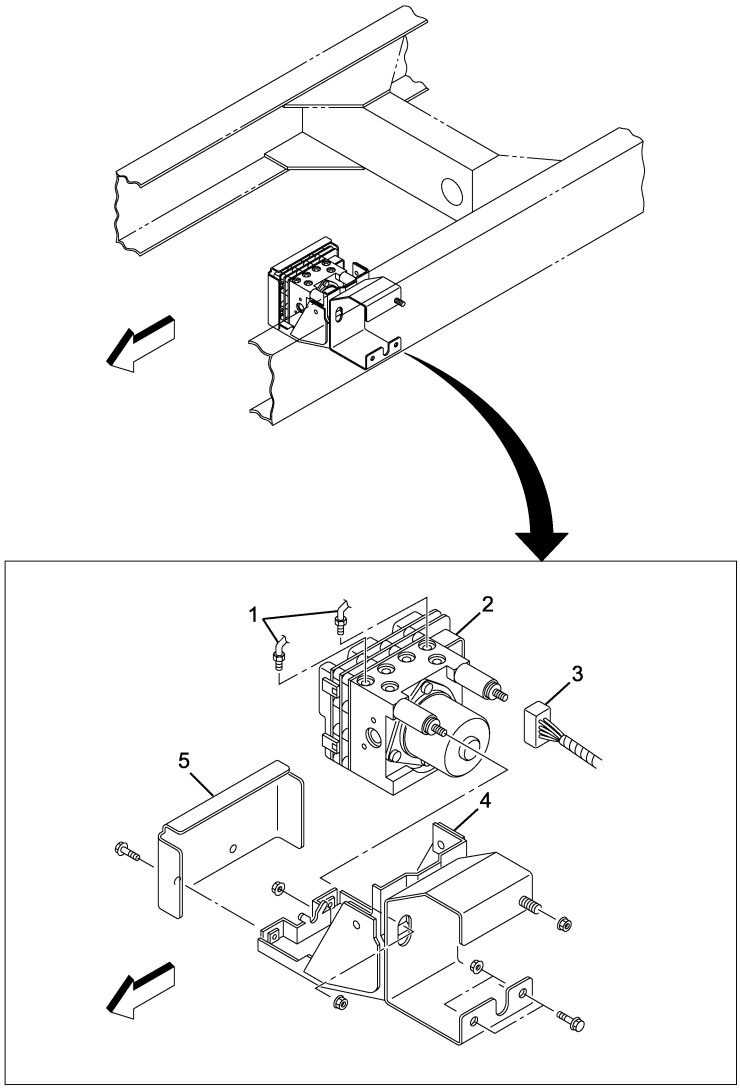
Symptom: [Brake Operating Noise Comes from the Hydraulic Unit Though the Brake Pedal is not Depressed.] (Check Flow A-5, TA-5)

Check flow A-5, TA-5

Step	Action	Value	YES	NO
1	Is this the first time operation since the engine is started?	—	Normal (It is a motor check operation noise of self-diagnosis function.)	Go to Step2
2	Is the vehicle speed 10km/h (6 mph) or less?	—	Normal (It is a motor check operation noise of self-diagnosis function.)	Go to Step3
3	Check for noise in the following conditions: • When shifting down, or when operating the clutch • When driving a slippery low-temperature road (iced or snow-covered), or when driving a rough road • While turning with high speed • When driving over a bump (such as curbstone) • When operating electrical switches • When running the engine high speed Is noise generated in any of the above conditions?	—	Normal (ABS may operate without depressing the brake pedal.)	Go to Step4
4	Do all the speed sensor/sensor rotor operate normally?	—	Go to Step5	Repair.Go to Step7
5	Is the wheel speed sensor/sensor rotor damaged? Or iron powder attached?	—	Go to Step7	Repair or replace it.Go to Step6
6	Are all the sensor outputs normal? (Refer to the check flow C-1 or TC-1)	—	Check the suspicious circuit/connector for improper connection. If the connection is normal, replace the EHCU.Go to Step7	Repair.Go to Step7
7	Assemble all the components, and check that those are installed properly. Is this step completed?	—	Repeat “Diagnostic basic flow”.	Go to Step7

Electronic Hydraulic Control Unit (EHCU)

Components



N5A2039E

Legend

1. Pipe
2. EHCU
3. Connector
4. Bracket
5. Cover

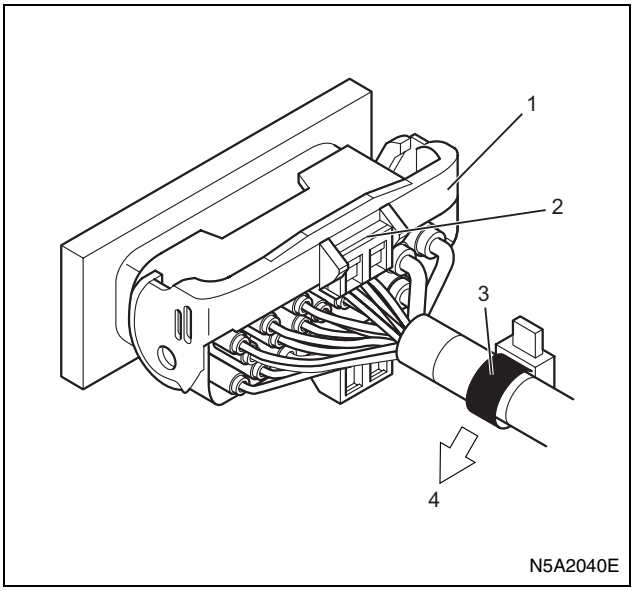
Removal

CAUTION:

- When performing electric-arc welding on the vehicle, remove the EHCU before starting welding work.
- When removing the EHCU from the vehicle, disconnect the battery cable first, and then disconnect the connector. Connect in the reverse order of disconnection.
- Do not place intense radio emission equipment such as radio device near the EHCU.
- Do not pour water to the EHCU directly.
- Never loosen the screw of the EHCU body. Nor apply paint to the EHCU body.
- Do not let metal products directly contact with the connector pin terminals, including screwdriver and or tester probe.
- Use special care for electrostatic.
- Do not directly apply external voltage to the terminals.

- When handling, do not hold the pipe of the upper EHCU.
- Never loosen the bolts and nuts of the EHCU body. If loosened, that EHCU must not be used anymore.

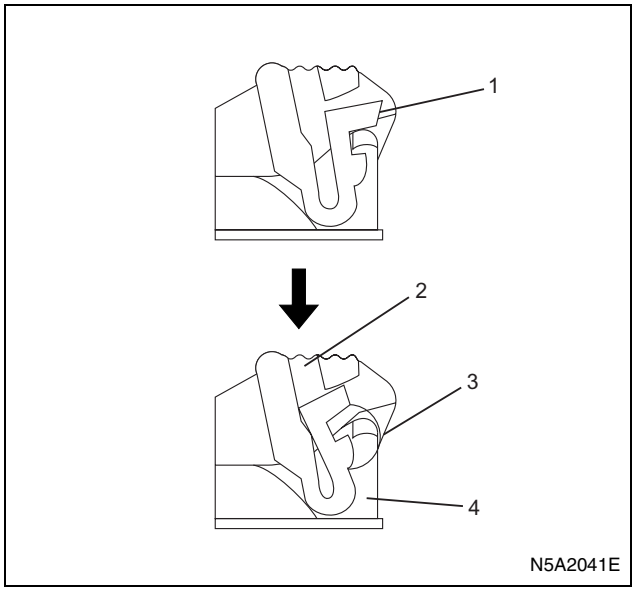
1. Cover
   - Remove the cover.
2. Harness connector
   - If the harness is fixed to the EHCU bracket, loosen the fixing clip.



Legend
1. Lever
2. Lever lock
3. Clip
4. Fixed to EHCU bracket.

- Unlock the connector. Pull down the lever lock to the unlock position.

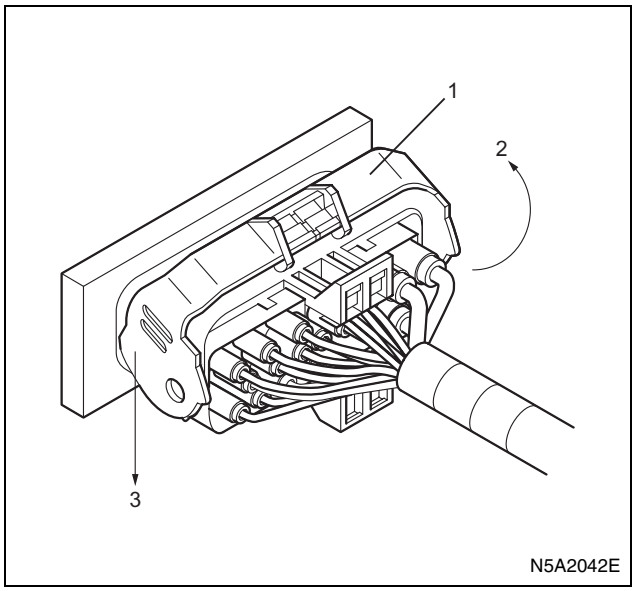
Notice:
Make sure the lock portion (A portion) is in the unlock position.



Legend
1. Lever lock
2. Lever
3. Lock portion (A portion)
4. Housing

- Operate the lever.

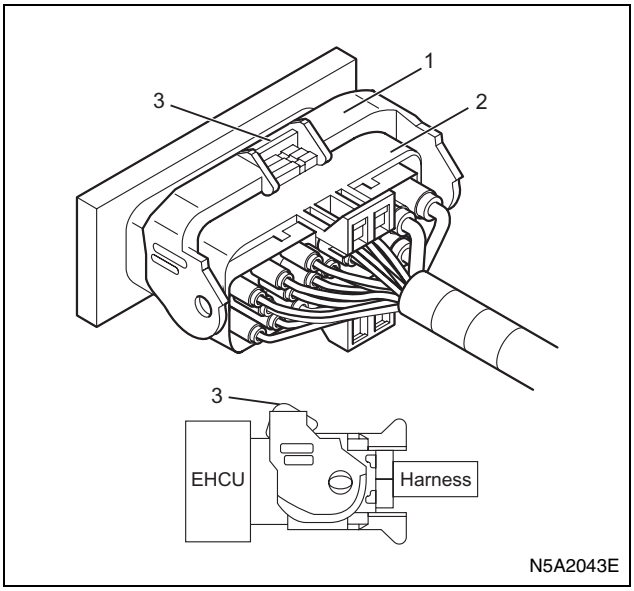
Notice:
Operate the lever till the lever becomes heavy. Then change the force direction to the downward of the connector. (See illustration.) Applying force to the EHCU-side may damage the connector.



Legend
1. Lever
2. Lever operation (rotation direction)
3. Force applied direction when operating lever

- Move the connector to the opposite side of the EHCU to remove.

Notice:
With the lever in stop position, make sure that the lever surface (lock portion side) is almost perpendicular to the connector before removing the connector.



Legend
1. Lever
2. Connector
3. Lever lock

3. Brake pipe
   - Disconnect the six brake pipes.
4. EHCU fixing nut
   - Disconnect the three nuts fixing the EHCU.
5. EHCU
   - Remove the EHCU.
6. Bracket
   - Remove the bracket.

Installation

CAUTION:
- Be sure to use ground bolt to install the ground.
- Make sure there is no dust or foreign materials in and around the pipe connection.
- Be careful that the pipe is connect to correctly.
- After EHCU installation, bleed air from the brake system completely. Remove the fuse (FL-9 (40A)) of ABS to deactivate the ABS before air bleeding operation.
- Be sure to use fresh specified brake fluid.

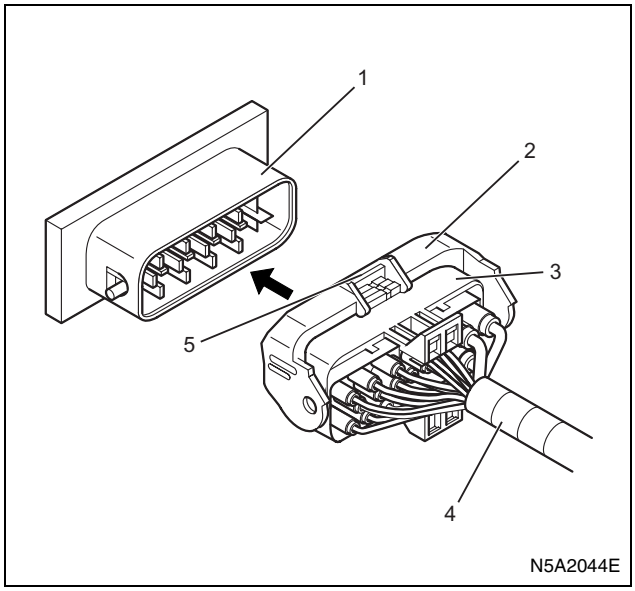
1. Bracket
   - Install the bracket to the frame if it has been removed.
2. EHCU
   - Install the EHCU to the bracket.
3. EHCU fixing nut
   - Install the EHCU fixing nuts.

Tighten:
Nut to 22 N·m (2.2 kg·m / 16.2 lb·ft)

4. Brake pipe
   - Install the brake pipe.

Tighten:
Brake pipe to 16 N·m (1.6 kg·m / 11.8 lb·ft)

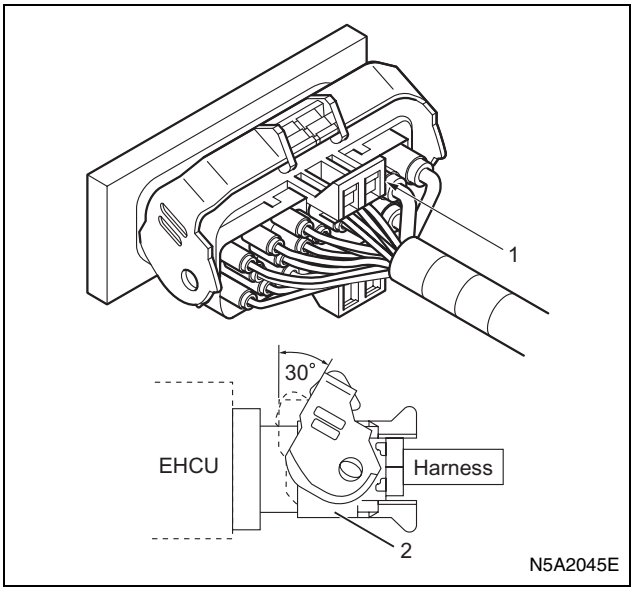
5. Harness connector
   - Align the harness-side connector with the EHCU-side connector.



Legend
1. EHCU-side connector
2. Lever
3. Housing
4. Harness
5. Lever lock

   - Insert the harness-side connector to the EHCU-side connector.

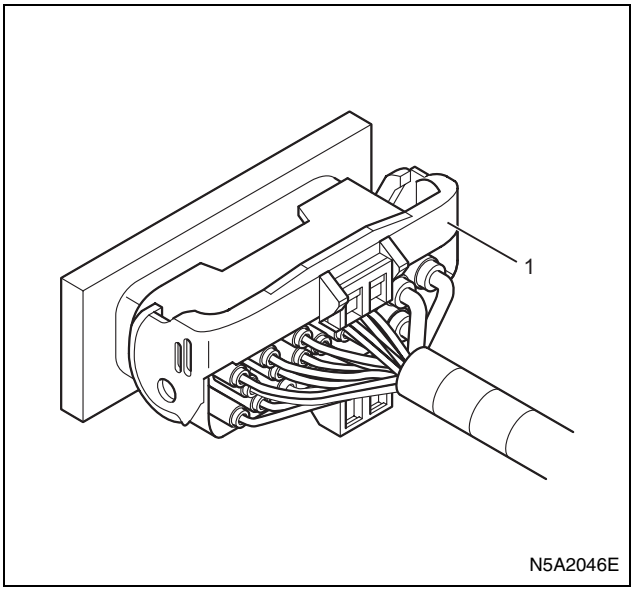
Notice:
The lever moves approx. 30° when the connector is inserted.



Legend

1. Pushing direction
2. Harness-side connector

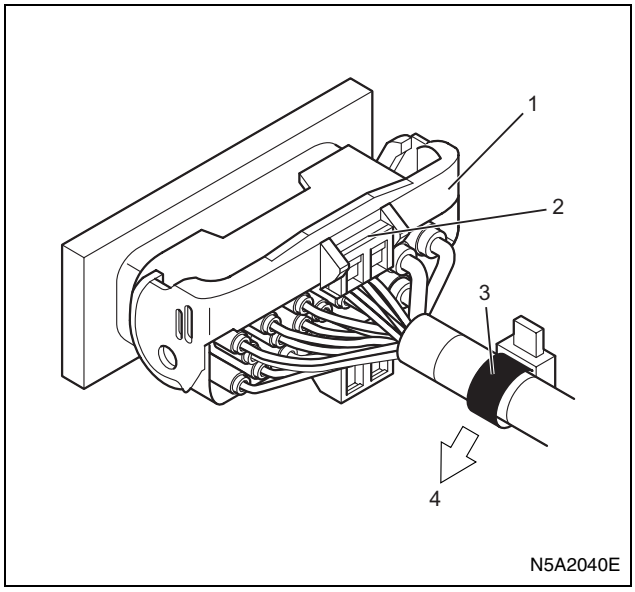
- Operate the lever to lock the lever lock to the housing.



Legend

1. Lever

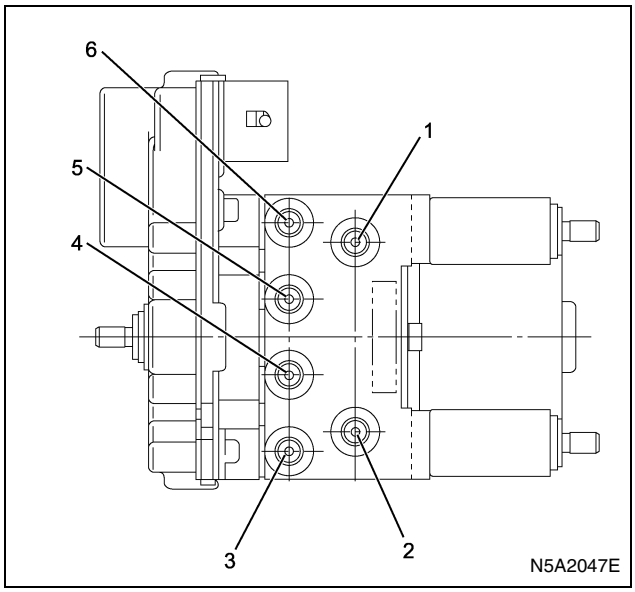
- If the harness was fixed to the EHCU bracket, fix the harness with the fixing clip.



Legend

1. Lever
2. Lever lock
3. Clip
4. Fixed to EHCU bracket.

6. Cover
   - Install the cover.

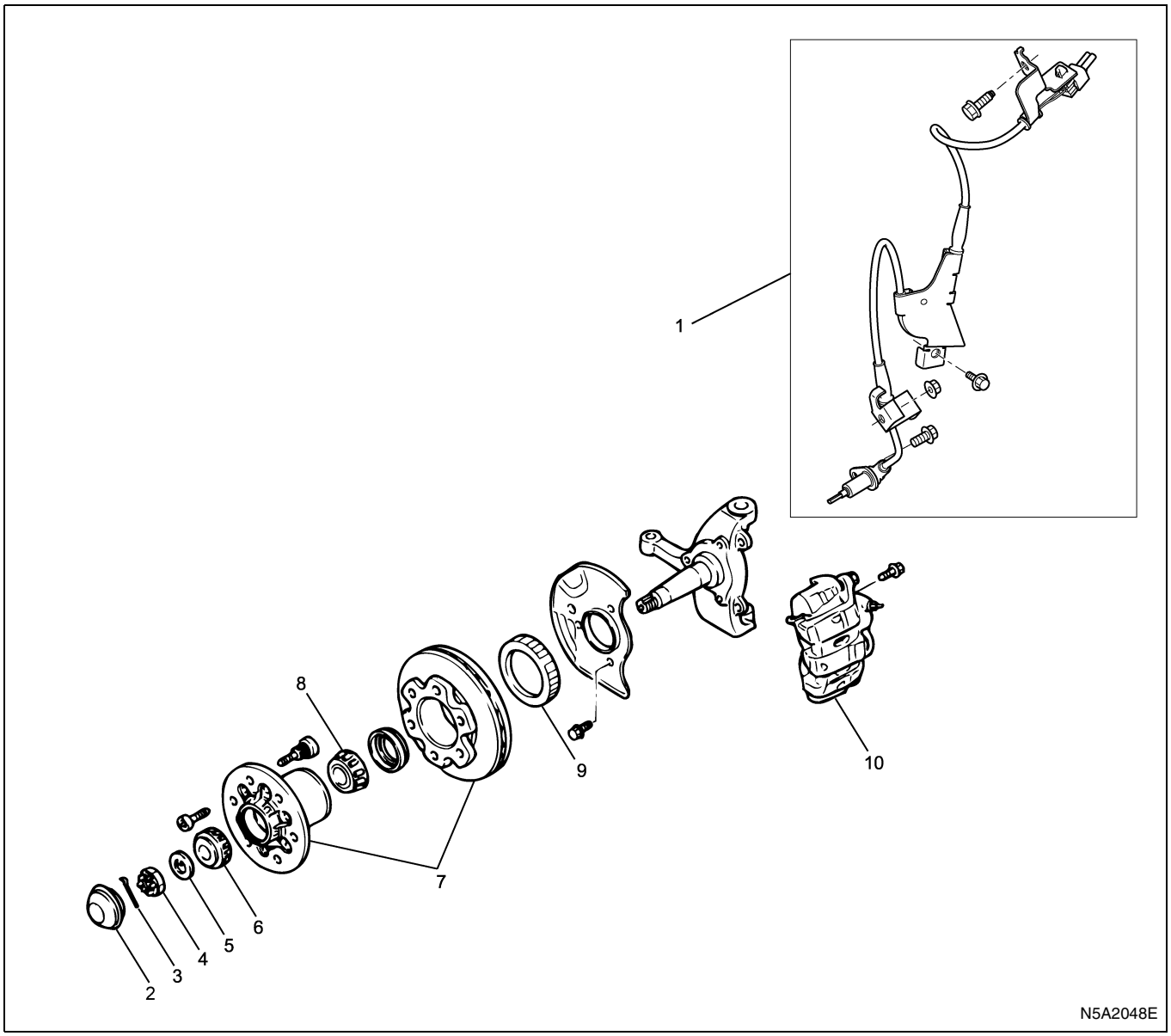


Legend

1. Master cylinder (front wheel)
2. Master cylinder (rear wheel)
3. RR wheel master cylinder
4. RL wheel master cylinder
5. FR wheel master cylinder
6. FL wheel master cylinder

Speed Sensor (Front)

Components



Legend

1. Speed sensor (model with rigid suspension)
2. Hub cap
3. Cotter pin
4. Hub nut
5. Thrust washer
6. Outer bearing
7. Hub & rotor assembly
8. Inner bearing
9. Sensor rotor
10. Disc caliper assembly

Removal

1. Harness connector
   - Disconnect the harness connector.
2. Harness fixing bolt
   - Remove the harness fixing bolt.
3. Sensor fixing bolt
   - Remove the sensor fixing bolt.
4. Speed sensor (front)

Installation

CAUTION:

- Do not let the speed sensor body contact with the sensor rotor during hub assembly. Otherwise the parts will be damaged.
- The speed sensor body has a built-in magnet. Be careful not to allow metallic materials attached to it.

- Remove the speed sensor before removing the hub & rotor assembly or the hub & drum assembly.
- Remove the speed sensor before hammering to remove the knuckle etc.
- Use the harness line as a reference to avoid the harness from twisting, when installing the sensor harness.
- To install the sensor, press-fit the sensor until the sensor flange contacts closely with the installing surface by your hand, and then tighten with the bolt.

1. Speed sensor (front)
   - Install the speed sensor.
2. Sensor fixing bolt
   - Install the sensor fixing bolt.

Tighten:
Bolt to 22 N·m (2.2 kg·m / 16.2 lb·ft)

3. Harness fixing bolt
   - Install the harness fixing bolt.

   Frame side

Tighten:
Bolt to 22 N·m (2.2 kg·m / 16.2 lb·ft)

Tighten together with the dust cover
(model with dram brake)

Tighten:
Bolt to 15 N·m (1.5 kg·m / 11.1 lb·ft)

Tighten together with the brake support
(model with rigid disc brake)

Tighten:
Bolt to 45 N·m (4.6 kg·m / 33.2 lb·ft)

4. Harness connector
   - Connect the harness connector.

Inspection

This section explores inspection procedures as the reference to perform “Diagnostics with symptom” and “Diagnosis with illumination pattern”.

	Without Tech 2	With Tech 2
Speed sensor output check	Check flow C-1-1 — C-1-4	Check flow TC-1

FL Wheel Speed Sensor Output Check Procedure
Check flow C-1-1

Step	Action	Value	YES	NO
1	1. Turn the starter switch OFF. 2. Disconnect the EHCU connector. 3. Jack-up the vehicle to lift the front wheels off the floor. 4. Measure the AC voltage between the J-177 connector terminals 32 and 33 while turning the FL wheel half turn/sec. Is the value within specified value?	200mV or more	Go to Step5	Go to Step2
2	1. Disconnect the FL sensor connector J-75. 2. Measure the resistance between the J-75 connector terminals 1 and 2 (sensor side). Is the value within specified value?	1 — 2kΩ	Go to Step4	Go to Step3
3	Replace the FL sensor. Is this step completed?	—	Go to Step5	—
4	Repair the circuit for open/short circuit, and the connector for improper connection between the connector of EHCU and the sensor connector. Is this step completed?	—	Go to Step5	—

Step	Action	Value	YES	NO
5	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step5

FR Wheel Speed Sensor Output Check Procedure
Check flow C-1-2

Step	Action	Value	YES	NO
1	1. Turn the starter switch OFF. 2. Disconnect the EHCU connector. 3. Jack-up the vehicle to lift the front wheels off the floor. 4. Measure the AC voltage between the J177 connector terminals 10 and 11 while turning the FR wheel half turn/sec. Is the value within specified value?	200mV or more	Go to Step5	Go to Step2
2	1. Disconnect the FR sensor connector J-74. 2. Measure the resistance between the J-74 connector terminals 1 and 2 (sensor side). Is the value within specified value?	1 — 2kΩ	Go to Step4	Go to Step3
3	Replace the FR sensor. Is this step completed?	—	Go to Step5	—
4	Repair the circuit for open/short circuit, and the connector for improper connection between the connector of EHCU and the sensor connector. Is this step completed?	—	Go to Step5	—
5	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step5

Speed Sensor Output Check Procedure (With Tech 2)
Check flow TC-1

Step	Action	Value	YES	NO
1	1. Connect the Tech 2. 2. Check each sensor lowest speed from the “Wheel sensor”. Is the sensor speed 4km/h (2mph) or more?	—	Go to Step2	Go to Step6
2	Check the suspicious sensor circuit for open circuit. (Check with shaking the wire and the connector.) Is the sensor circuit connection normal?	—	Replace the speed sensor.Go to Step3	Repair.Go to Step3

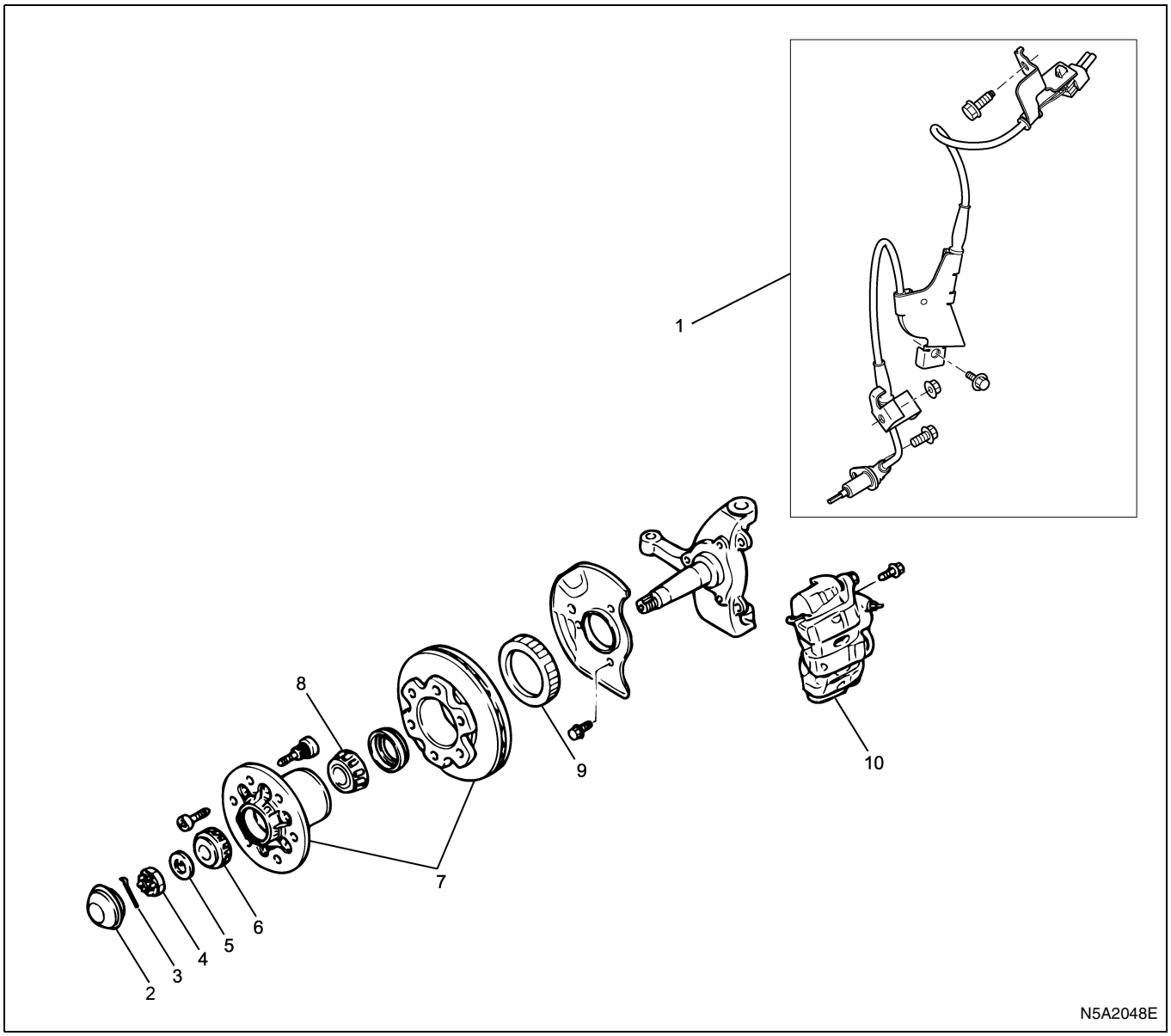
Step	Action	Value	YES	NO
3	Check each sensor lowest speed from the “Wheel sensor”. Is the sensor speed 4km/h (2mph) or more?	—	Go to Step4	Go to Step6
4	Check the sensor rotor. Is the sensor rotor normal?	—	Go to Step5	Replace the sensor rotor.Go to Step5
5	Check each sensor lowest speed from the “Wheel sensor”. Is the sensor speed 4km/h (2mph) or more?	—	Repair the circuit or circuit between the EHCU and the speed sensor. Go to Step6	Go to Step6
6	Install all the components, and check that those are installed properly. Is this step completed?	—	Repeat “Diagnostic basic flow”.	Go to Step6

Used for checking the front speed sensor, or the rear speed sensor when no DTC is set.

CAUTION:
On the vehicle that the rear tires have smaller diameter, the rear wheel speed may be indicated a little higher than the front wheel speed. Check the speed after driving a while at a constant speed.

Sensor Rotor (Front Wheel)

Components



Legend

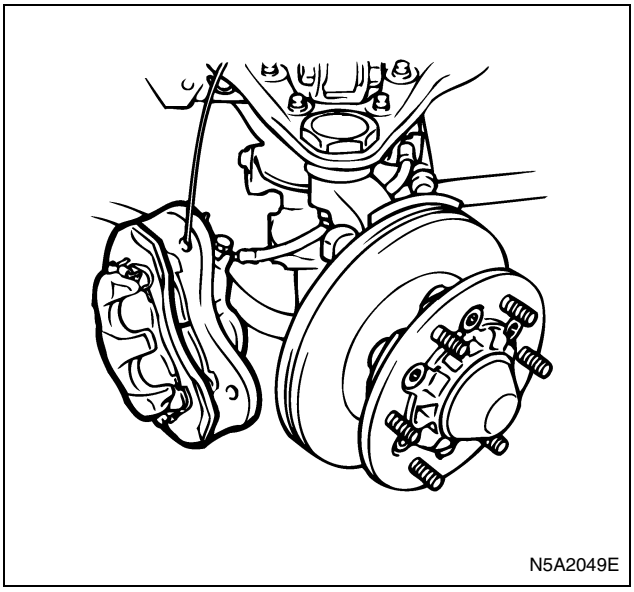
1. Speed sensor (model with rigid suspension)
2. Hub cap
3. Cotter pin
4. Hub nut
5. Thrust washer
6. Outer bearing
7. Hub & rotor assembly
8. Inner bearing
9. Sensor rotor
10. Disc caliper assembly

Removal

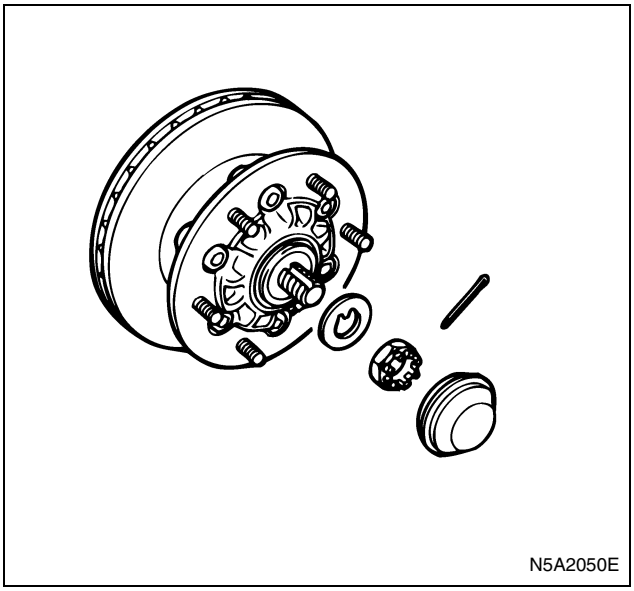
CAUTION:

- Hold the brake hose and the caliper assembly with wire or the like to prevent them from dropping, to stand clear from the service work. Do not bend the hose sharply or stretch it to the limit.
- Remove the brake hose if necessary. If to be removed, be careful to prevent the brake fluid from flowing out and protect it from intrusion of foreign materials.

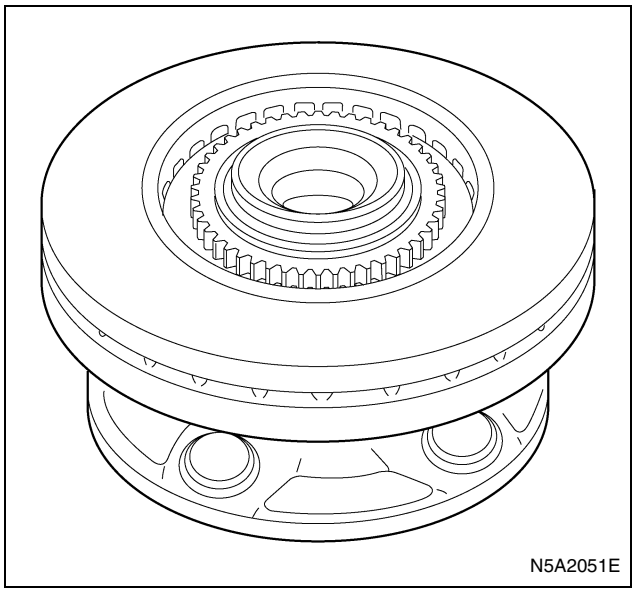
1. Remove the disc brake caliper. (Model with disc brake)


N5A2049E

2. Guard (NPR with disc brake)
   - Remove the guard.
3. Speed sensor (NPS)
   - Remove the head section of the speed sensor from the knuckle.
4. Hub cap (NPR)
   - Remove the hub cap.
5. Free wheel hub assembly (NPS)
   - Remove the free wheel hub assembly.
6. Cotter pin (NPR)
   - Remove the cotter pin.
7. Lock washer (NPS)
   - Remove the lock washer and the fixing screw.
8. Hub nut
   - Remove the hub nut.
9. Trust washer (NPR)
   - Remove the thrust washer.
10. Hub & rotor assembly


N5A2050E

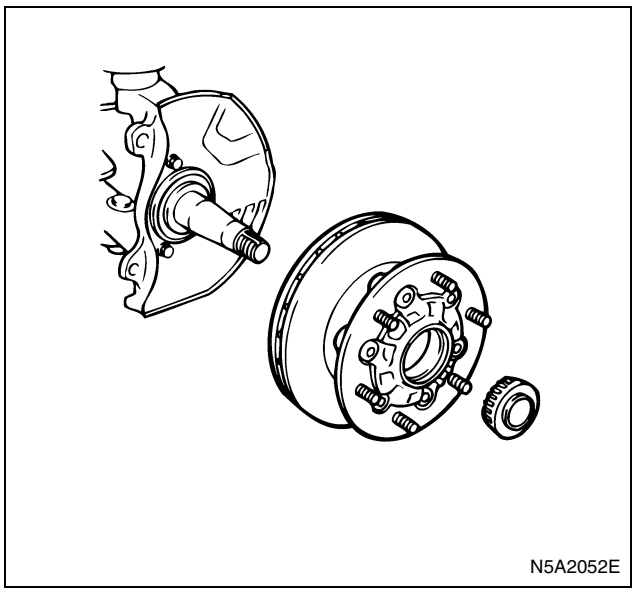
11. Outer bearing inner race
12. Sensor rotor (front wheel)
    - Use a puller to take out the sensor rotor.


N5A2051E

Installation

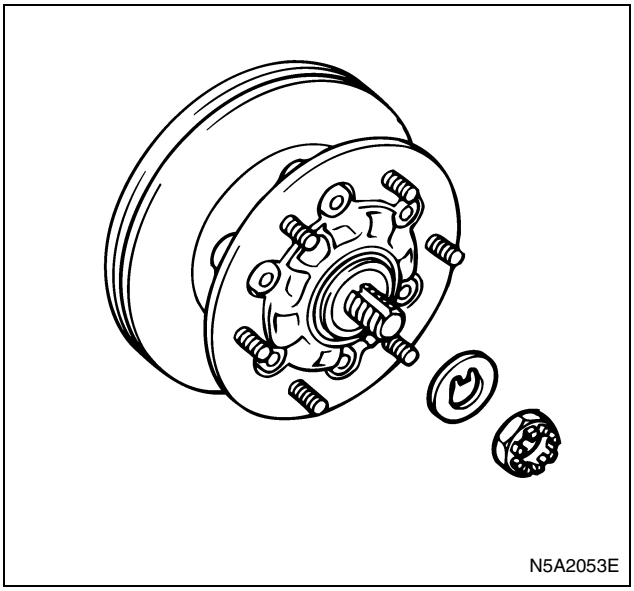
1. Sensor rotor (front wheel)
   - Press-fit the new sensor rotor with a bench press around the circumference until it contacts.
2. Hub & rotor assembly
   - Fill the outer bearing with grease (Besco L-2), and install it to the hub.

CAUTION:
Use new oil seal.


N5A2052E

3. Outer bearing inner race
4. Trust washer (NPR)
   - Install the thrust washer.
5. Hub nut
   - Install the hub nut.

CAUTION:
After installing the thrust washer and the hub nut, adjust the hub bearing preload.

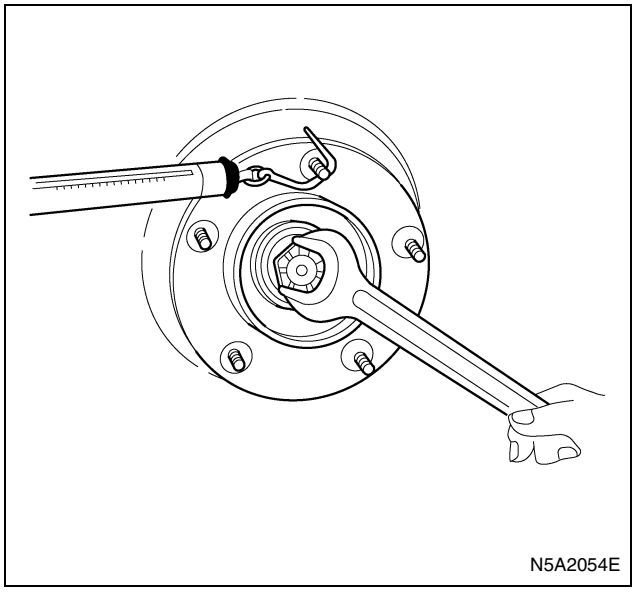

N5A2053E

Hub bearing preload adjustment

- Tighten the hub nut till the hub no longer be turned, and then loosen it completely.
- Turn the hub to make the bearing seated.
- Attach a spring balance to the wheel pin. While pulling the it tangentially, tighten the hub nut so that the hub rotates with the specified value.
- For hub bearing preload, refer to “FRONT AXLE” in Section 4C.

6. Cotter pin (NPR)
   - After preload adjustment, install the cotter pin. If the pin hole does not match the groove on the nut, adjust them by turning minimum to the tightening direction.
7. Lock washer (NPS)
   - Install the pawl to the cutout of the spindle securely, and tighten with the screw.

Tighten:
Lock washer to 10 N·m (1.0 kg·m / 7.4 lb·ft)


N5A2054E

8. Hub cap
   - Fill the hub cap with grease (Besco L-2), and drive it in to the hub.

9. Free wheel hub assembly (NPS)
   - Install the free wheel hub assembly.

CAUTION:
Be sure to adjust the drive shaft axial play.

10. Speed sensor (NPS)
    - Install the head section of the speed sensor to the knuckle and tighten the bolt to the specified torque.

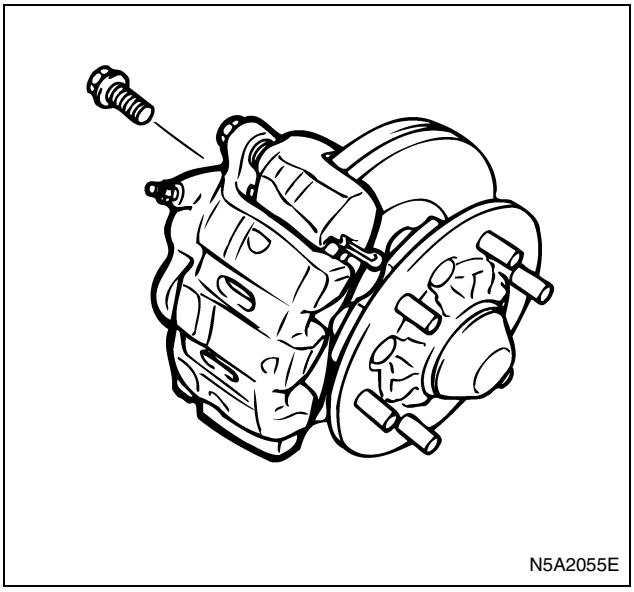
Tighten:
Speed sensor to 22 N·m (2.2 kg·m / 16.2 lb·ft)

11. Guard (NPR with disc brake)
    - Install the guard.

Tighten:
Guard to 37 N·m (3.7 kg·m / 27.3 lb·ft)

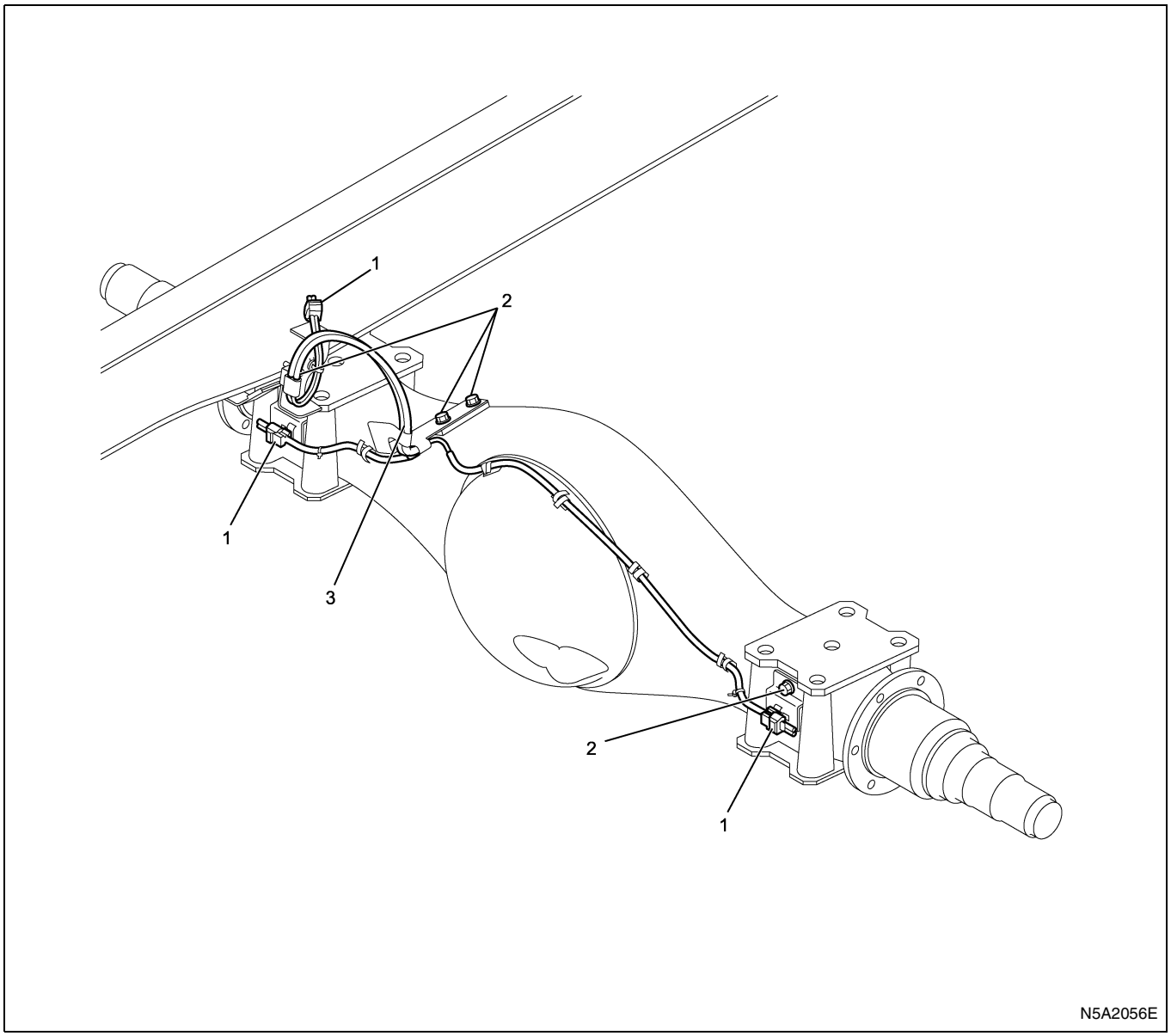
12. Disc brake caliper assembly (Model with disc brake)
    - Install the disc brake caliper assembly.

Tighten:
Disc brake calper to 220 N·m (22.5 kg·m / 162.3 lb·ft)


N5A2055E

Sensor Harness (Rear Axle)

Components



Legend

1. Harness connector
2. Harness bracket fixing bolt
3. Sensor harness

Removal

1. Harness connector
   - Disconnect the harness connector.
2. Harness bracket fixing bolt
   - Remove the harness bracket fixing bolt.
3. Sensor harness
   - Remove the sensor harness.

Installation

CAUTION:
Take care not to twist the harness during installation.

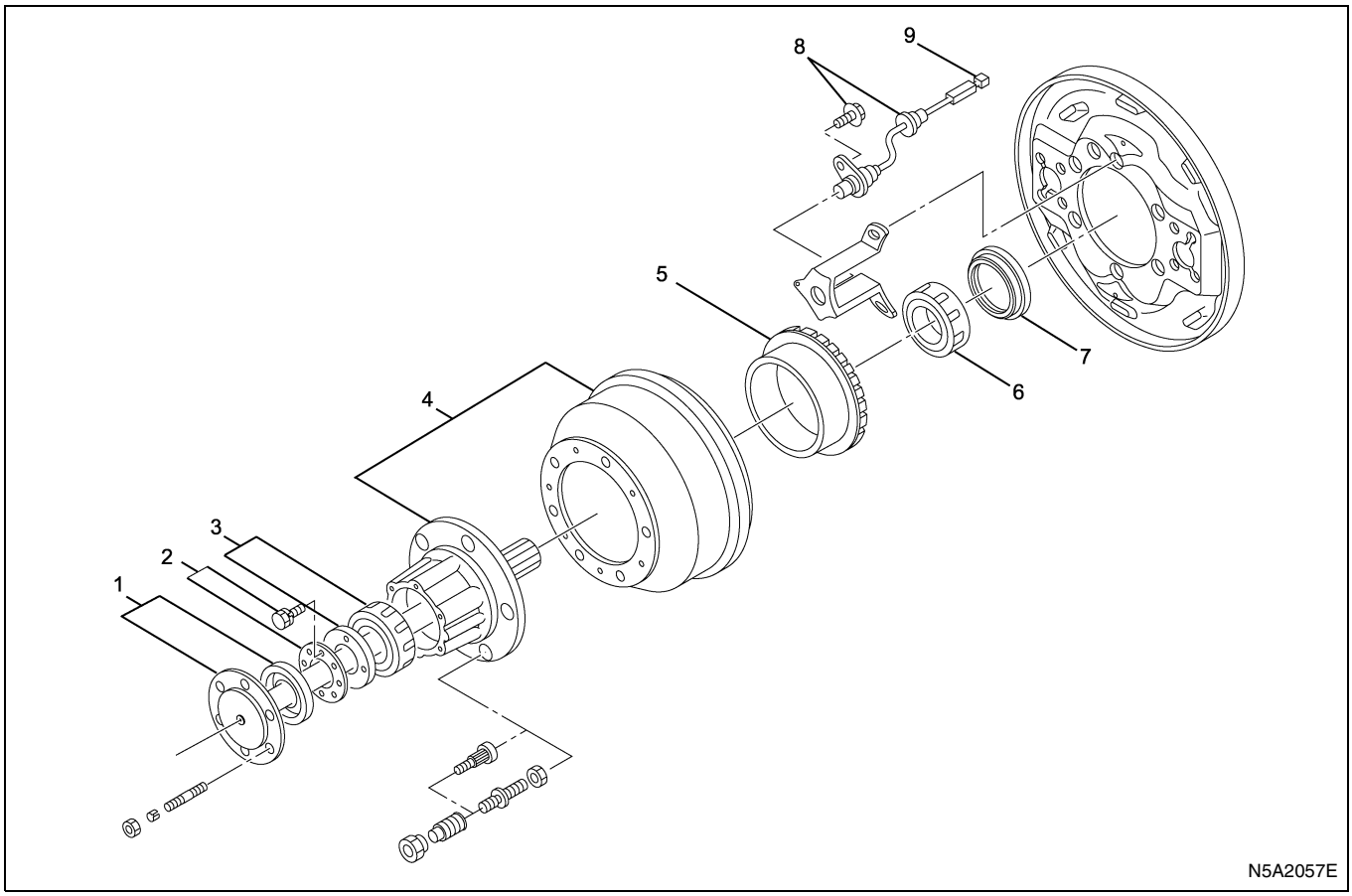
1. Sensor harness
   - Install the sensor harness.
2. Harness bracket fixing bolt
   - Install the harness bracket fixing bolt.

Tighten:
- Flange bolt (except below) to 22 N·m (2.2 kg·m / 16.2 lb·ft)
- SEMS bolt (2 points on the axle case upper face) to 13 N·m (1.3 kg·m / 9.6 lb·ft)

3. Harness connector
   - Connect the harness connector.

Rear Speed Sensor

Components



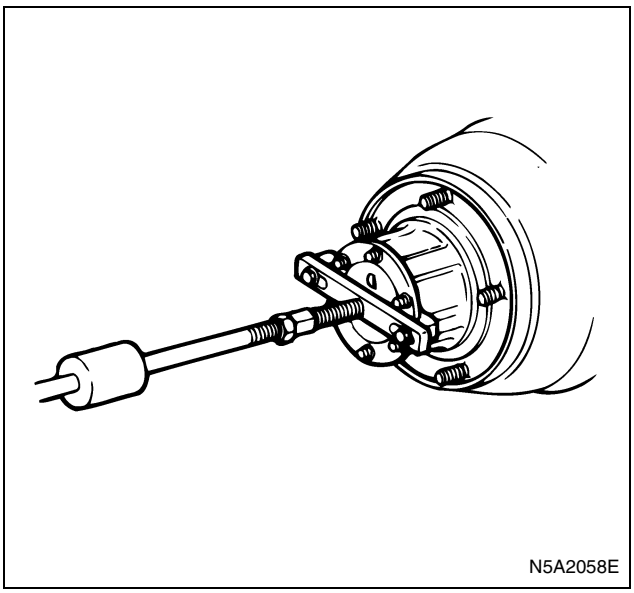
Legend

1. Axle shaft, outer oil seal
2. Bearing lock washer, lock nut
3. Outer bearing, bearing lock nut
4. Hub and drum
5. Sensor rotor
6. Inner bearing
7. Inner oil seal
8. Rear speed sensor
9. Harness connector

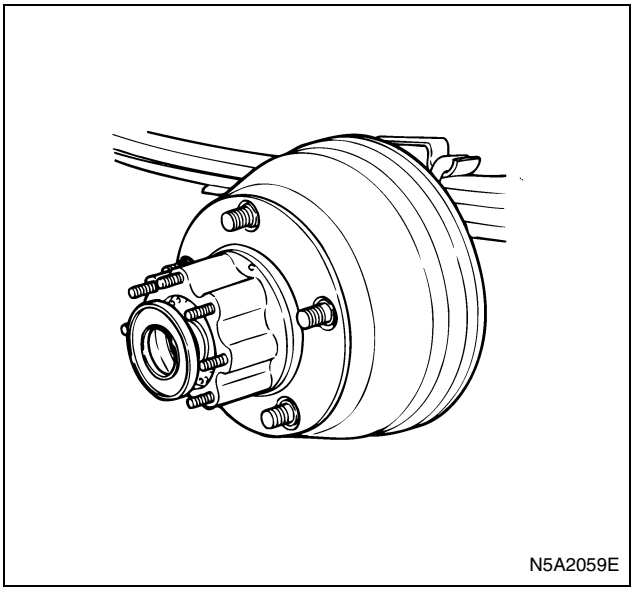
Removal

1. Rear axle shaft, outer oil seal, lock washer
   - Remove the axle shaft installing nut, and remove the rear axle shaft.

Special tool:
Universal puller: 5-8840-2027-0
Slide hammer: 5-8840-0084-0



- Remove the outer oil seal.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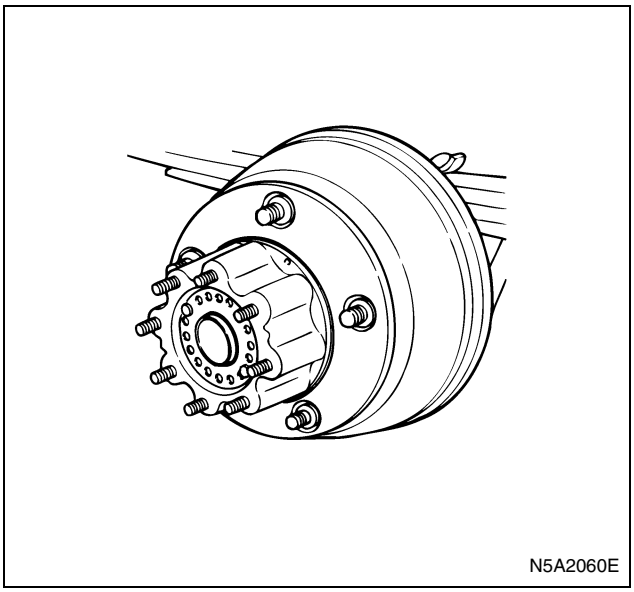
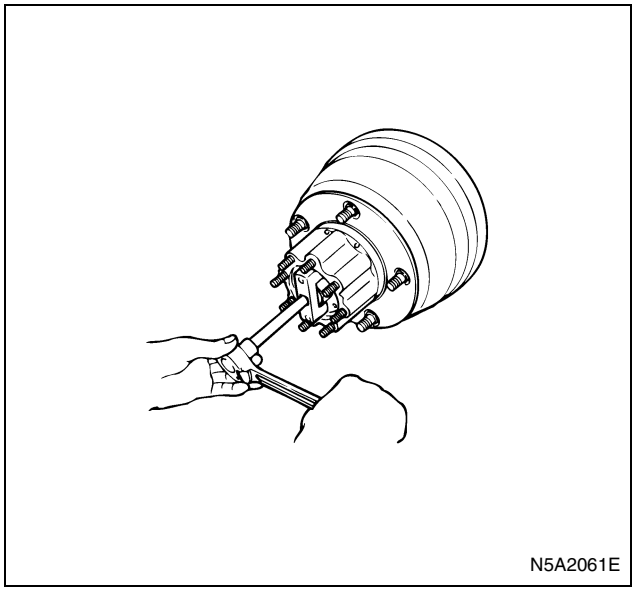
- Remove the lock washer installing bolt.


N5A2060E

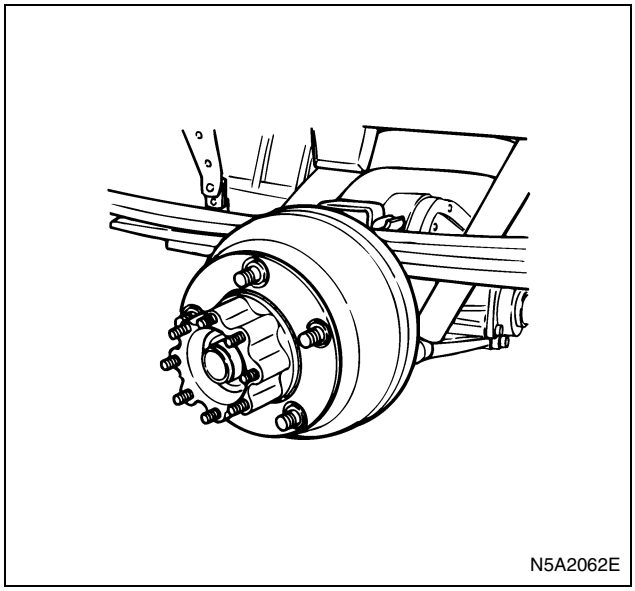
2. Bearing lock nut, outer bearing, hub
   - Remove the bearing nut.

Special tool:
Wrench: 9-8522-1188-0

   - Remove the outer bearing.


N5A2061E

3. Hub and drum assembly
   - Remove the hub and drum assembly.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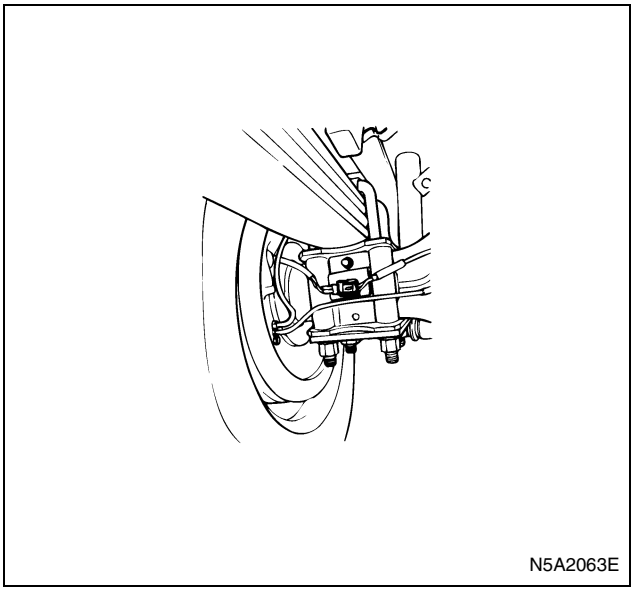
4. Inner oil seal
   - Remove the inner oil seal.
5. Inner bearing
   - Remove the inner bearing.
6. Harness connector
   - Disconnect the connection of the harness connector.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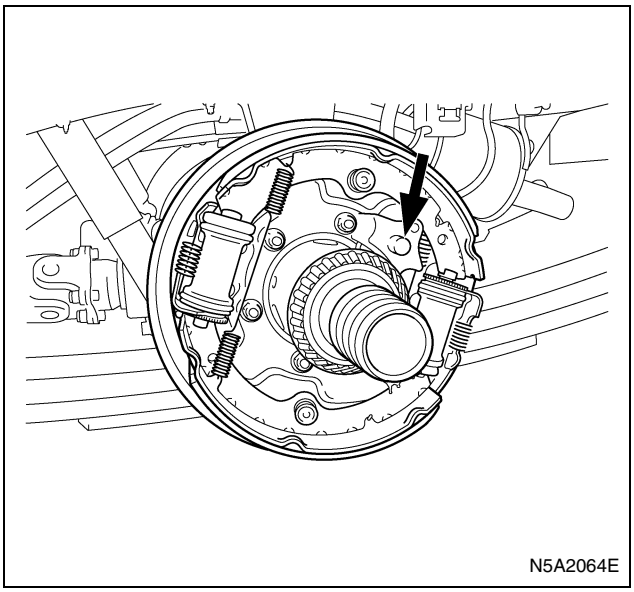
7. Rear speed sensor
   - Remove the speed sensor installing bolt, and take out from the sensor bracket.


N5A2064E

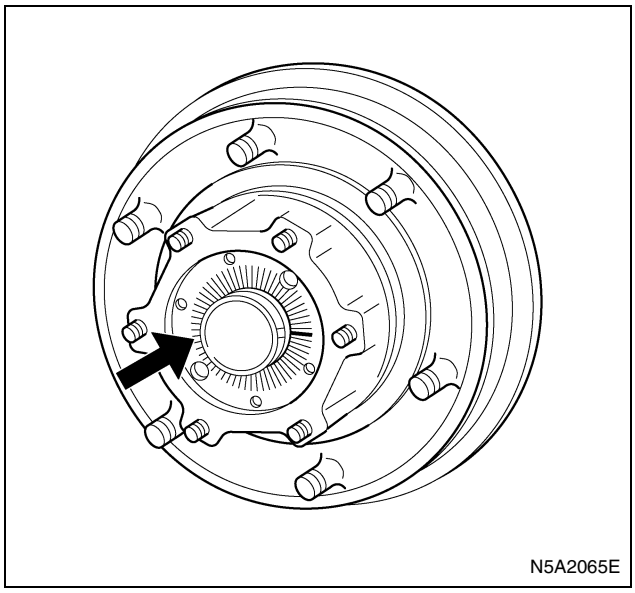
Installation

CAUTION:
- Grommet in the back plate must be installed securely.
- Bearing lock nut must be installed with its slit surface facing outside.

1. Rear speed sensor
   - Tighten the speed sensor installing bolt.

Tighten:
Bolt to 22 N·m (2.2 kg·m / 16.2 lb·ft)

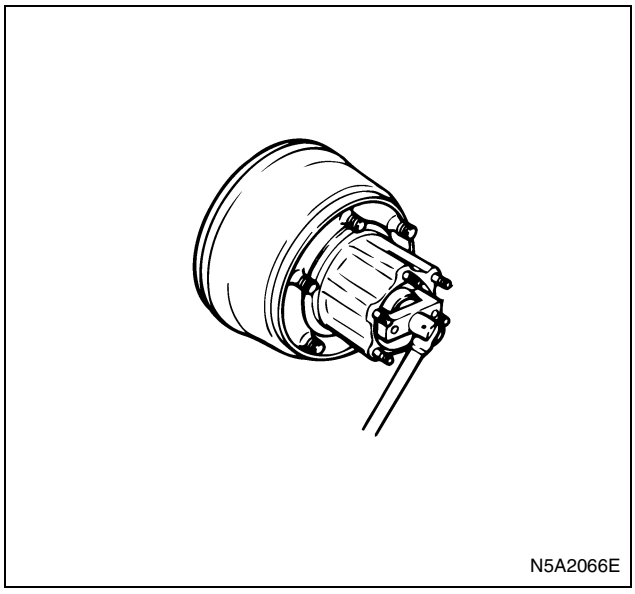
2. Harness connector
   - Connect the harness connector.
3. Inner bearing
   - Install the inner bearing.
4. Inner oil seal
   - Install the inner oil seal.
5. Hub and drum assembly
   - Install the hub and drum assembly.
6. Outer bearing, hub, bearing lock nut
   - Install the outer bearing, hub, and bearing lock nut.


N5A2065E

Rear hub bearing preload adjustment

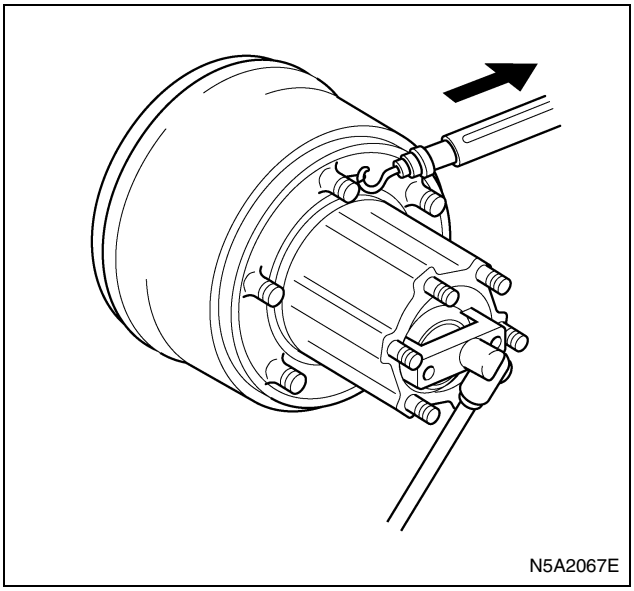
- Rotate the hub to the left and right several times to make it seated.
- Tighten the bearing lock nut till the hub no longer be turned. Then, back off to a degree that the hub rotates easily.

Special tool:
Wrench: 9-8522-1180-0

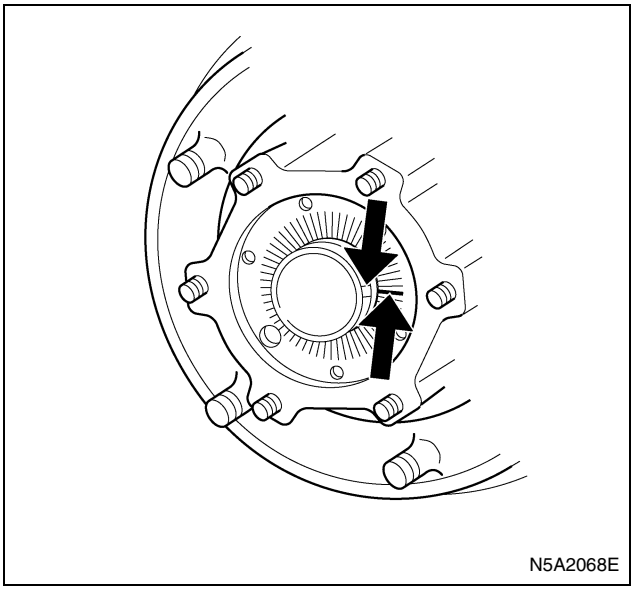

N5A2066E

- Attach a spring balance to the wheel pin. While pulling it tangentially, tighten the bearing nut so that the spring balance reading shows the specified value when the hub starts rotation.

Tighten:
Starting to 42 — 52 N (4.3 — 5.3 kg / 9.4 — 11.7 lb)

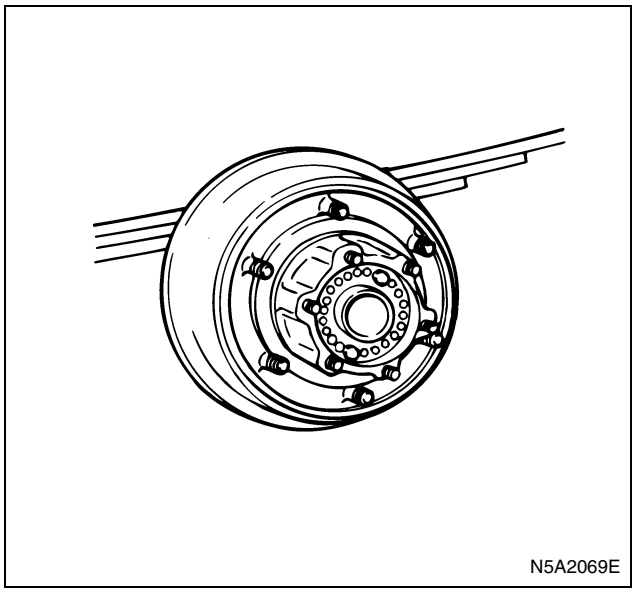

N5A2067E

- After adjusting the starting torque, move the hub to the right and left side several times to make sure the value is correct.
- With the preload adjusted, match the lock cut-out center point of the axle case screw part with nearest ruling of the bearing lock nut. If it does not, rotate the nut in the tightening direction to match.


N5A2068E

7. Lock washer, outer oil seal, axle shaft
   - Install the pawl of the lock washer to the lock cutout of the axle case screw part securely, and tighten the bearing nut and the lock washer with the lock bolt.
   - Apply grease to the circumference of the outer oil seal inner lip, and install the outer oil seal.
   - Install the axle shaft.
     Install to the rear hub stud part through the special washer with the flange nut.

Tighten:
Flarge nut to 49 N·m (5.0 kg·m / 36.1 lb·ft)

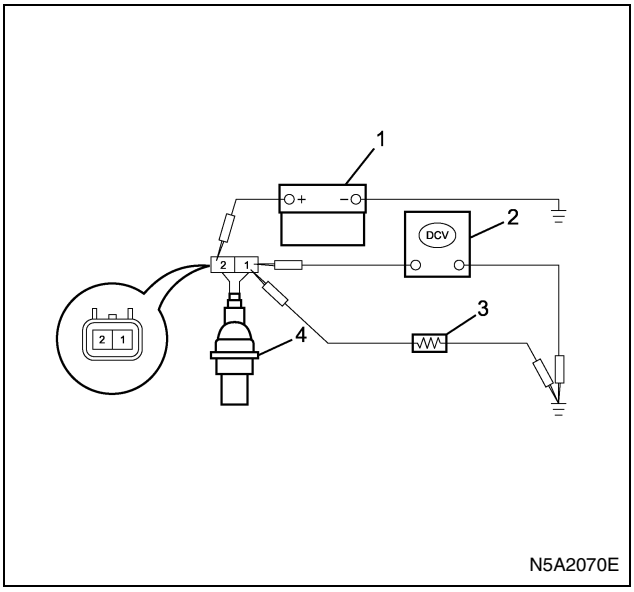

N5A2069E

Inspection

RL Wheel Speed Sensor Output Check Procedure

Check flow C-1-3

Step	Action	Value	YES	NO
1	1. Turn the starter switch OFF. 2. Disconnect the connector of the EHCU. 3. Jack-up the vehicle to lift the front wheels off the floor. 4. Connect a 120Ω resistance between the J-177 connector terminal 34 and the ground. 5. Apply a 9 — 16V voltage to the J-177 connector terminal 22. 6. Measure the DC voltage between the B-177 connector terminal 34 and the ground while turning the RL wheel half turn/sec. Is the value within specified value?	0.2 — 4.5V	Go to Step5	Go to Step2
2	1. Turn the starter switch OFF. 2. Disconnect the RL wheel speed sensor connector J-149. 3. Connect a 120Ω resistance between the J-149 connector terminal 2 and the ground. 4. Apply a 9 — 16V voltage to the J-149 connector terminal 1 (sensor side). 5. Measure the DC voltage between the J-149 connector terminal 2 and the ground while turning the RL wheel half turn/sec. Is the value within specified value?	0.2 — 4.5V	Go to Step3	Go to Step4
3	Repair the circuit for open/short circuit, and the connector for improper connection between the connector of EHCU and the sensor connector. Is this step completed?	—	Go to Step5	—
4	Replace the RL wheel speed sensor. Is this step completed?	—	Go to Step5	—
5	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step5



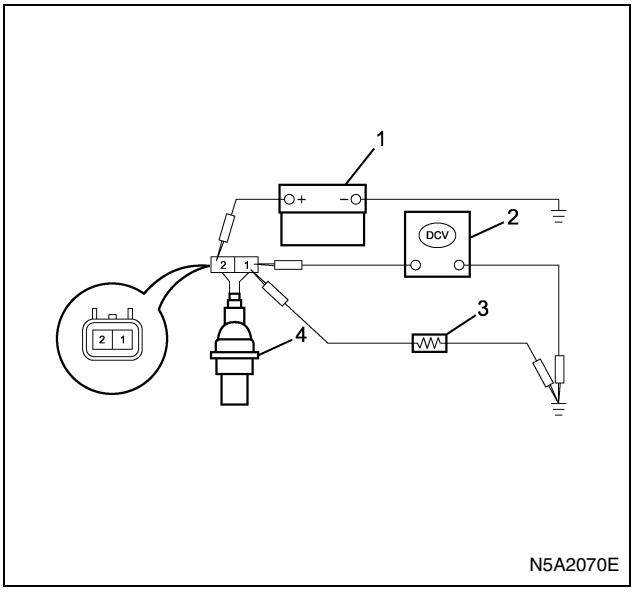
Legend

1. Battery (12V)
2. Tester
3. Resistance
4. Speed sensor

RR Wheel Speed Sensor Output Check Procedure

Check flow C-1-4

Step	Action	Value	YES	NO
1	1. Turn the starter switch OFF. 2. Disconnect the connector of the EHCU. 3. Jack-up the vehicle to lift the front wheels off the floor. 4. Connect a 120Ω resistance between the J-177 connector terminal 12 and the ground. 5. Apply a 9 — 16V voltage to the J-177 connector terminal 21. 6. Measure the DC voltage between the J-177 connector terminal 1 and the ground while turning the RR wheel half turn/sec. Is the value within specified value?	0.2 — 4.5V	Go to Step5	Go to Step2
2	1. Turn the starter switch OFF. 2. Disconnect the RR wheel speed sensor connector J-148. 3. Connect a 120Ω resistance between the J-148 connector terminal 2 and the ground. 4. Apply a 9 — 16V voltage to the J-148 connector terminal 1 (sensor side). 5. Measure the DC voltage between the J-148 connector terminal 2 and the ground while turning the RR wheel half turn/sec. Is the value within specified value?	0.2 — 4.5V	Go to Step3	Go to Step4
3	Repair the circuit for open/short circuit, and the connector for improper connection between the connector of EHCU and the sensor connector. Is this step completed?	—	Go to Step5	—
4	Replace the RR wheel speed sensor. Is this step completed?	—	Go to Step5	—
5	1. Install all the components, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Go to “Diagnostic basic flow”.	Go to Step5



Legend

1. Battery (12V)
2. Tester
3. Resistance
4. Speed sensor

Speed Sensor Output Check Procedure

Check flow TC-1

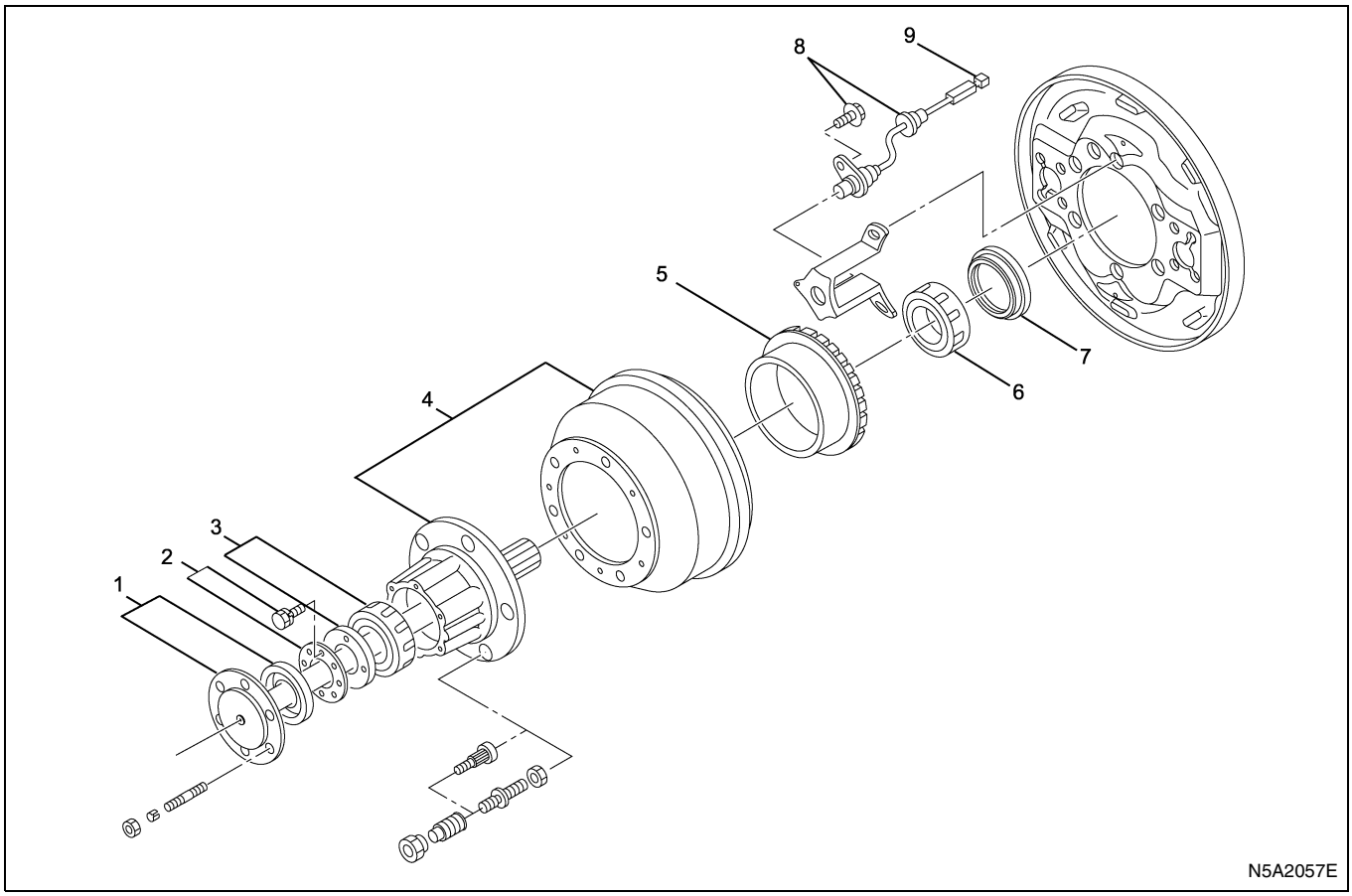
Step	Action	Value	YES	NO
1	1. Connect the Tech 2. 2. Check each sensor lowest speed from the “Wheel sensor”. Is the sensor speed 4km/h (2 mph) or more?	—	Go to Step2	Go to Step6
2	Check the suspicious sensor circuit for open circuit. (Check with shaking the wire and the connector.) Is the sensor circuit connection normal?	—	Replace the speed sensor.Go to Step3	Repair.Go to Step2
3	Check each sensor lowest speed from the “Wheel sensor”. Is the sensor speed 4km/h (2 mph) or more?	—	Go to Step4	Go to Step6
4	Check the sensor rotor. Is the sensor rotor normal?	—	Go to Step5	Replace the sensor rotor. Go to Step5
5	Check each sensor lowest speed from the “Wheel sensor”. Is the sensor speed 4km/h (2 mph) or more?	—	Repair the circuit or connector between the EHCU and the speed sensor. Go to Step6	Go to Step6
6	Install all the components, and check that those are installed properly. Is this step completed?	—	Repeat “Diagnostic basic flow”.	Go to Step6

Used for checking the front speed sensor, or the rear speed sensor when no DTC is set.

CAUTION:
On the vehicle that the rear tires have smaller diameter, the rear wheel speed may be indicated a little higher than the front wheel speed. Check the speed after driving a while at a constant speed.

Rear Sensor Rotor

Components



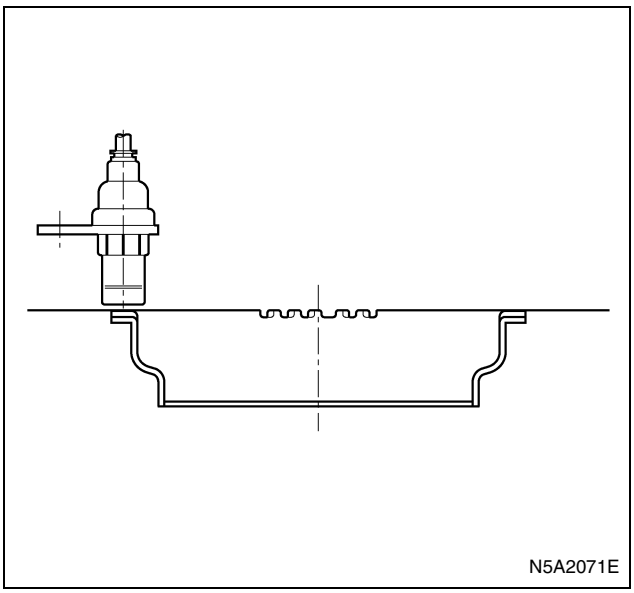
Legend

1. Axle shaft, outer oil seal
2. Bearing lock washer, lock nut
3. Outer bearing, bearing lock nut
4. Hub and drum
5. Sensor rotor
6. Inner bearing
7. Inner oil seal
8. Rear speed sensor
9. Harness connector

Removal

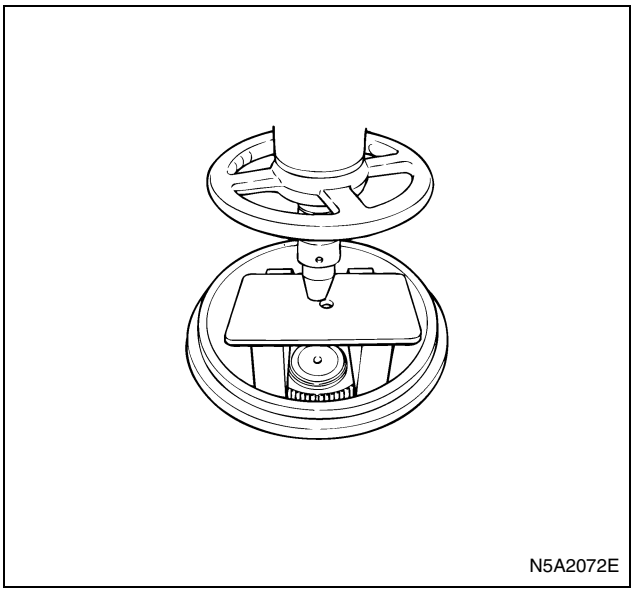
- Refer to the rear speed sensor removal procedure.

1. Rear sensor rotor
   - Use a puller to take out the sensor rotor.
2. Inner oil seal
   - Remove the inner oil seal.
3. Inner bearing
   - Remove the inner bearing.
   - Rotor runout must be ±0.1 mm (0.004 in) or less with the rotor installed.



Installation

1. Install the inner bearing to the hub.
2. Install the inner oil seal to the hub.
3. Install the new rear sensor rotor to the hub.
   - Press-fit with a bench press around the circumference until it contacts.
   - Refer to the rear speed sensor installation procedure step. 5 — 7.



N5A2072E

LGBRK-WE-0551

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ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LGBRK-WE-0551 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

ABS/ASR

SECTION 5A4

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International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
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Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

SECTION No.	CONTENTS
5A4	ABS/ASR

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WORKSHOP MANUAL

N-SERIES

HSA (HILL START AID)

SECTION 5A5

ISUZU

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N-Series

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HSA (HILL START AID)

SECTION 5A5

HSA (HILL START AID)

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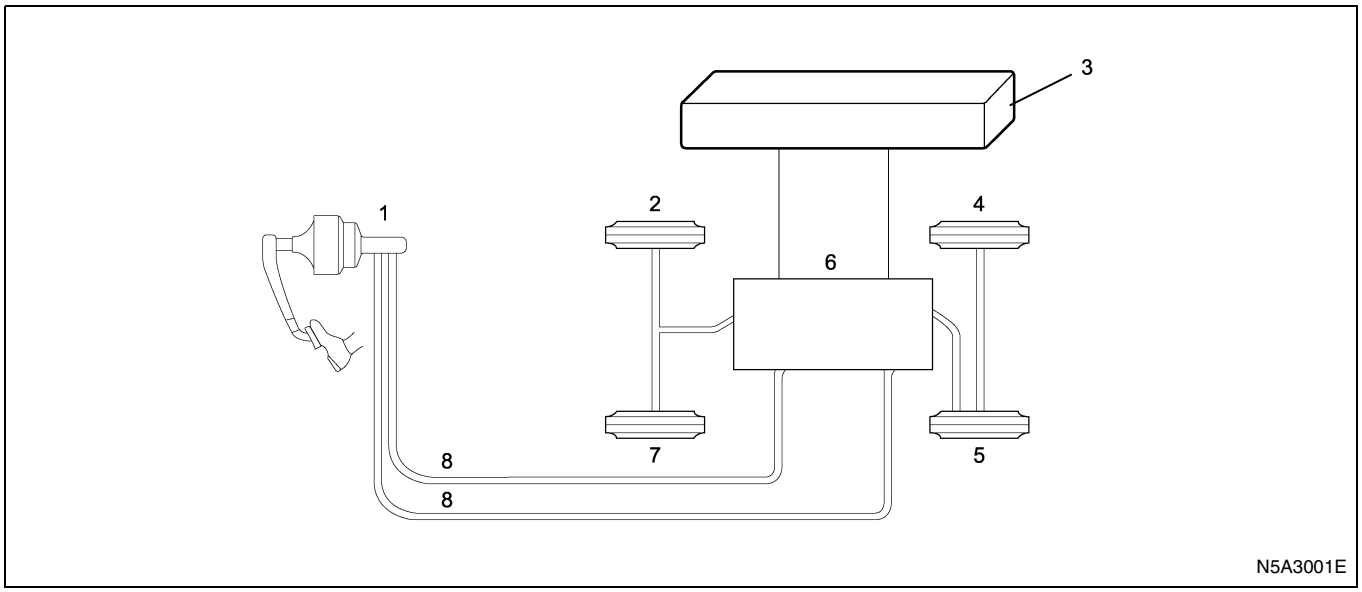
HSA System

Description of Function and Operation

The HSA (hill start aid) is the system to retain the brake force with brake pedal not depressed when the vehicle is parked, and to automatically release the brake force when starting the vehicle.

The HSA control unit drives the HSA valve located in the pipe route between the master cylinder and the wheel cylinder, to hold/release the brake fluid pressure. Also, alarm function (activates when the door opened with HSA operating, when the HSA system has running long time, when the HSA pressure goes down) and self-diagnosis function are equipped with the HSA control unit.



Legend

1. Servo unit master ring
2. FR wheel cylinder
3. HSA control unit
4. RR wheel cylinder
5. RL wheel cylinder
6. HSA valve
7. FL wheel cylinder
8. Oil

Contents of HSA Control

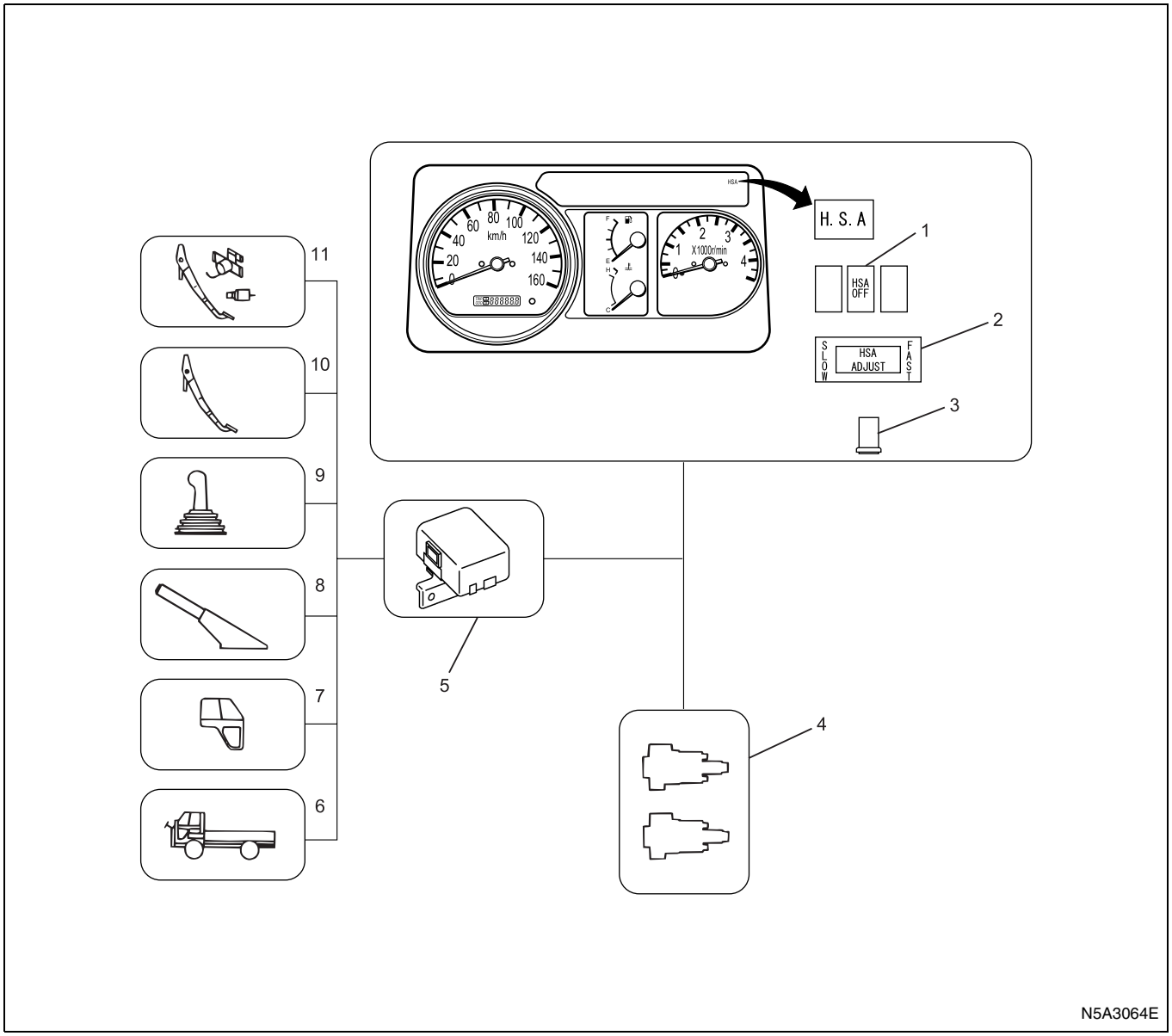
The HSA operates when all the following conditions are completed.

1. Brake pedal depressed
2. Parking brake released
3. Vehicle standstill

Notice:
The HSA can operate wherever the gearshift lever is set.

The HSA is released when any of the following is completed.

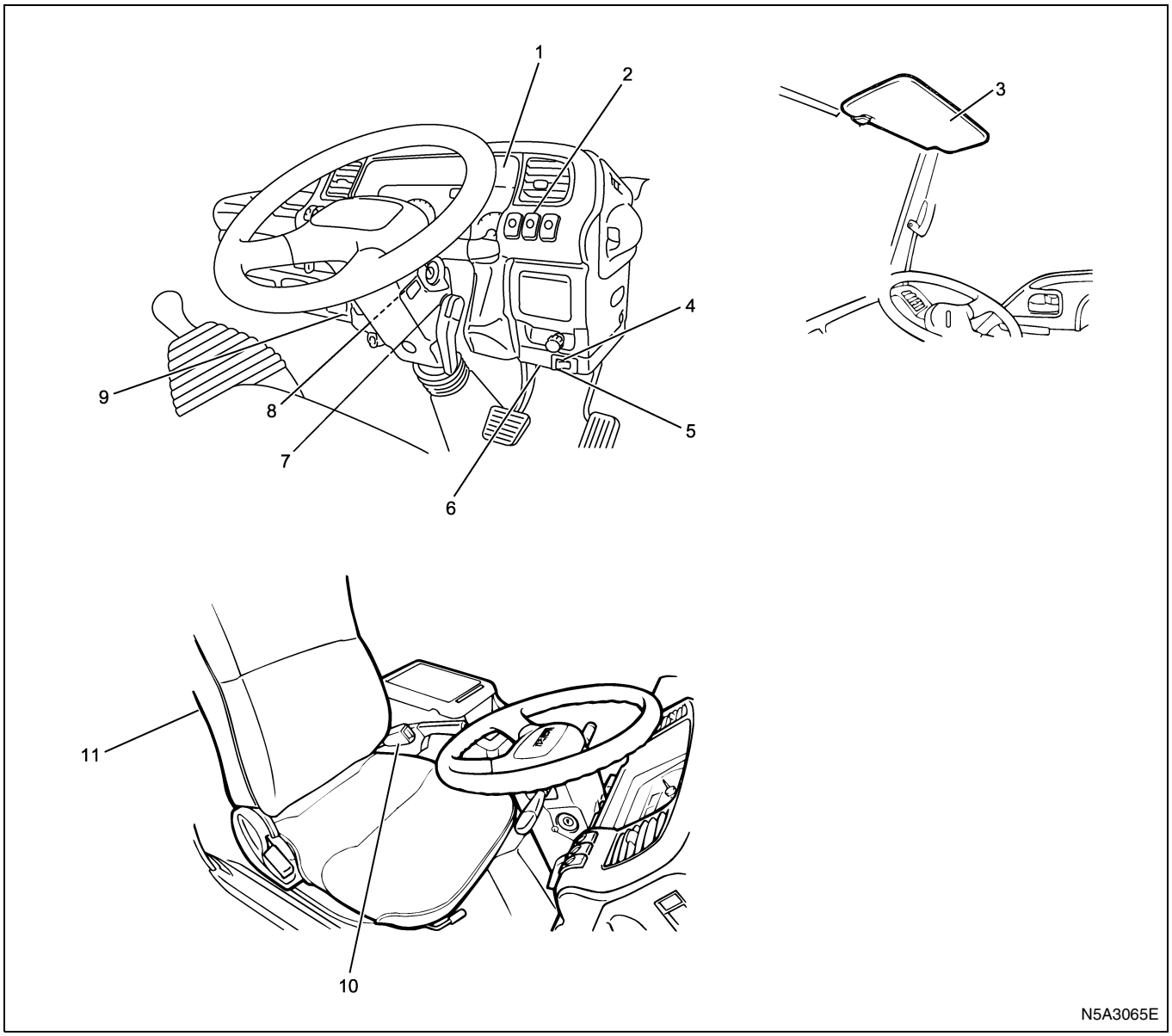
1. Gear except in neutral and clutch engaged more than half
2. Parking brake applied
3. HSA off switch depressed
4. Starter switch in ACC or OFF



Legend

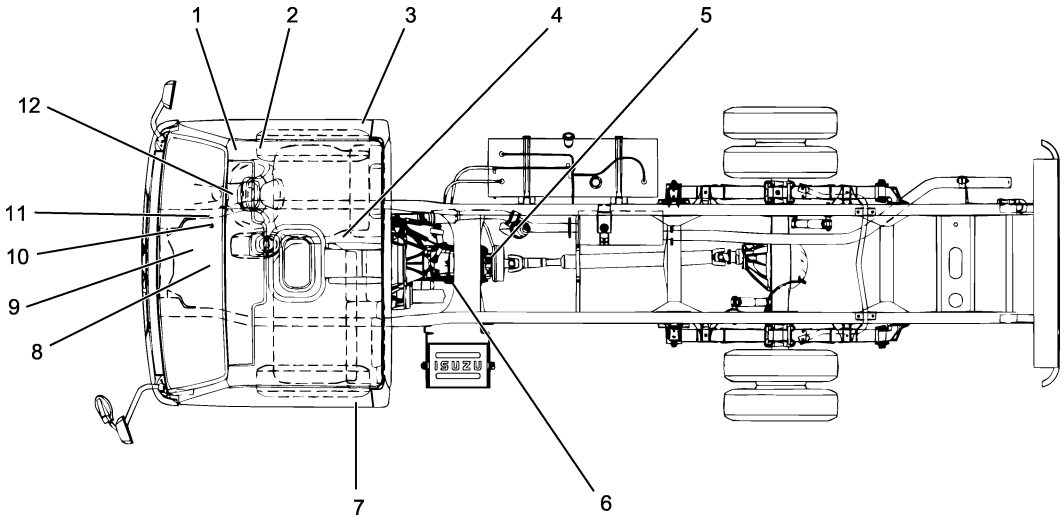
1. HSA off switch
2. HSA adjust switch
3. HSA reset switch
4. HSA valve
5. Control unit buzzer built-in
6. Speed sensor
7. Door switch
8. Parking brake switch
9. Neutral switch
10. Stop lamp switch
11. Clutch stroke sensor/clutch fluid pressure sensor

Part Location Diagram



Legend

1. HSA indicator lamp
2. HSA off switch
3. HSA caution plate
4. HSA adjust switch
5. HSA reset switch
6. Stop lamp switch
7. Clutch stroke sensor
8. Clutch fluid pressure switch
9. HSA control unit
10. Parking switch
11. Door switch



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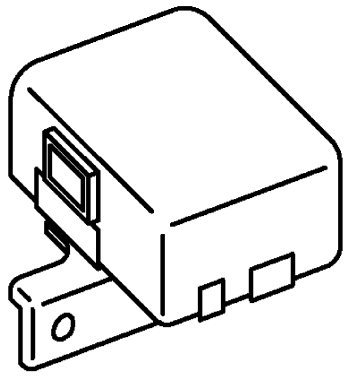
Legend

1. HSA off switch
2. HSA reset switch, HSA adjust switch
3. Door switch (RH)
4. Parking brake switch
5. Speed sensor
6. Neutral switch
7. Door switch (LH)
8. HSA control unit
9. HSA valve
10. Clutch sensor/clutch fluid pressure switch
11. HSA indicator lamp
12. Stop lamp switch

HSA Control Unit



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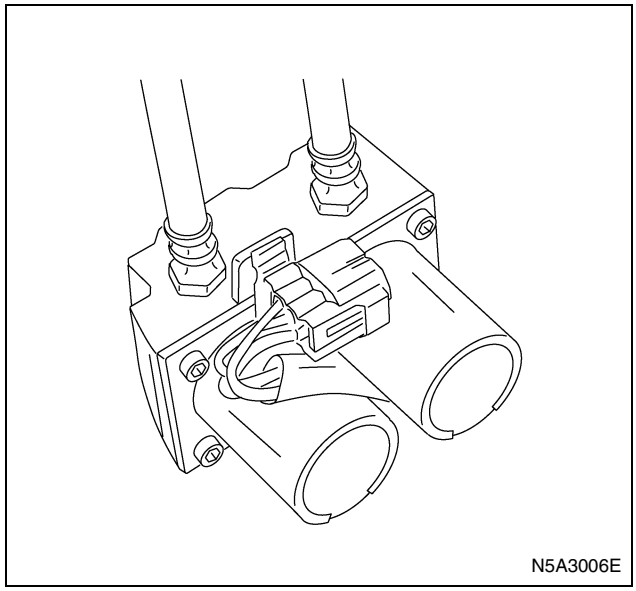
The HSA control unit activates the HSA valve to hold/release the brake fluid pressure based on the input signal from each switch and sensor. When a malfunction occurs in the system, it activates the built-in buzzer and blinks the HSA indicator lamp to indicate the trouble code.

Also the system has the alarm functions as follows:

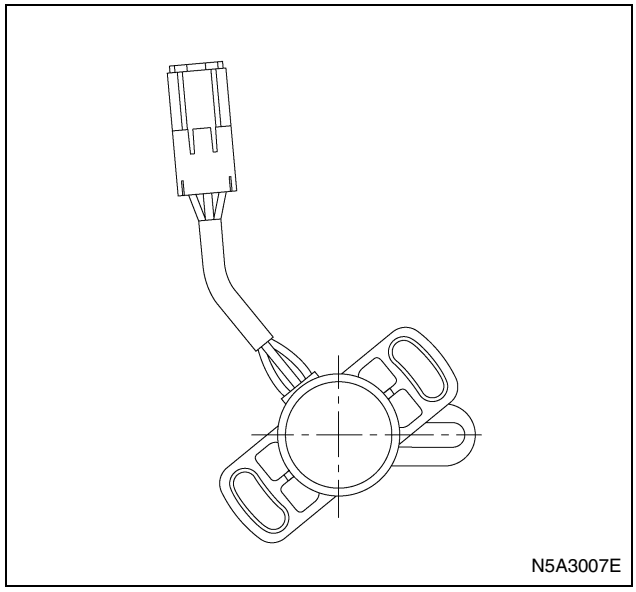
1. Door open alarm when HSA operating
   When the door is opened while the HSA is operating; it triggers the built-in buzzer and blink the HSA indicator lamp.
2. HSA long-time operation alarm
   When the HSA have operated for more than 8 minutes; it triggers the built-in buzzer and blink the HSA indicator lamp.
3. Vehicle motion alarm
   When the vehicle speed reaches aprrox. 1.5km/h (1 mph) while HSA operating; it triggers the built-in buzzer and blink the HSA indicator lamp. (However, the HSA is released when the vehicle speed reaches 5km/h (3 mph).)

HSA Valve



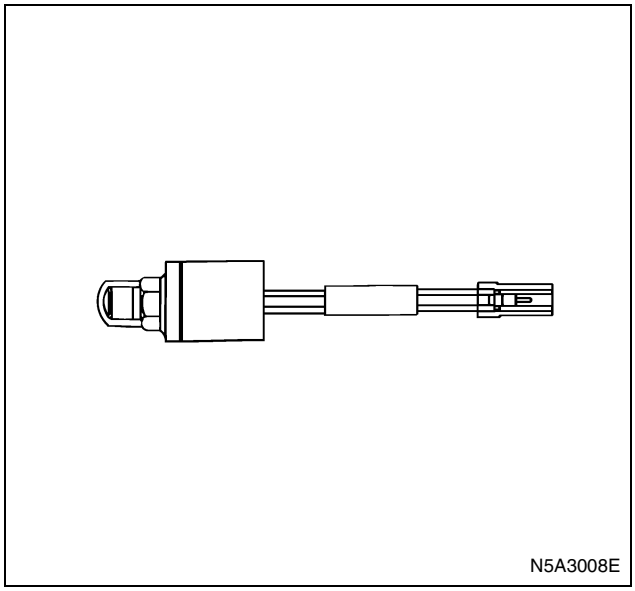
The HSA valve is located in the pipe route between the master cylinder and the wheel cylinder, and it is driven by the HSA control unit output (ON/OFF).

Clutch Sensor



The clutch sensor is installed to the clutch pedal bracket and changes the voltage being input to the HSA control unit by sensing the amount of clutch pedal depressed. This voltage is one of the signals to control the HSA operation/release.

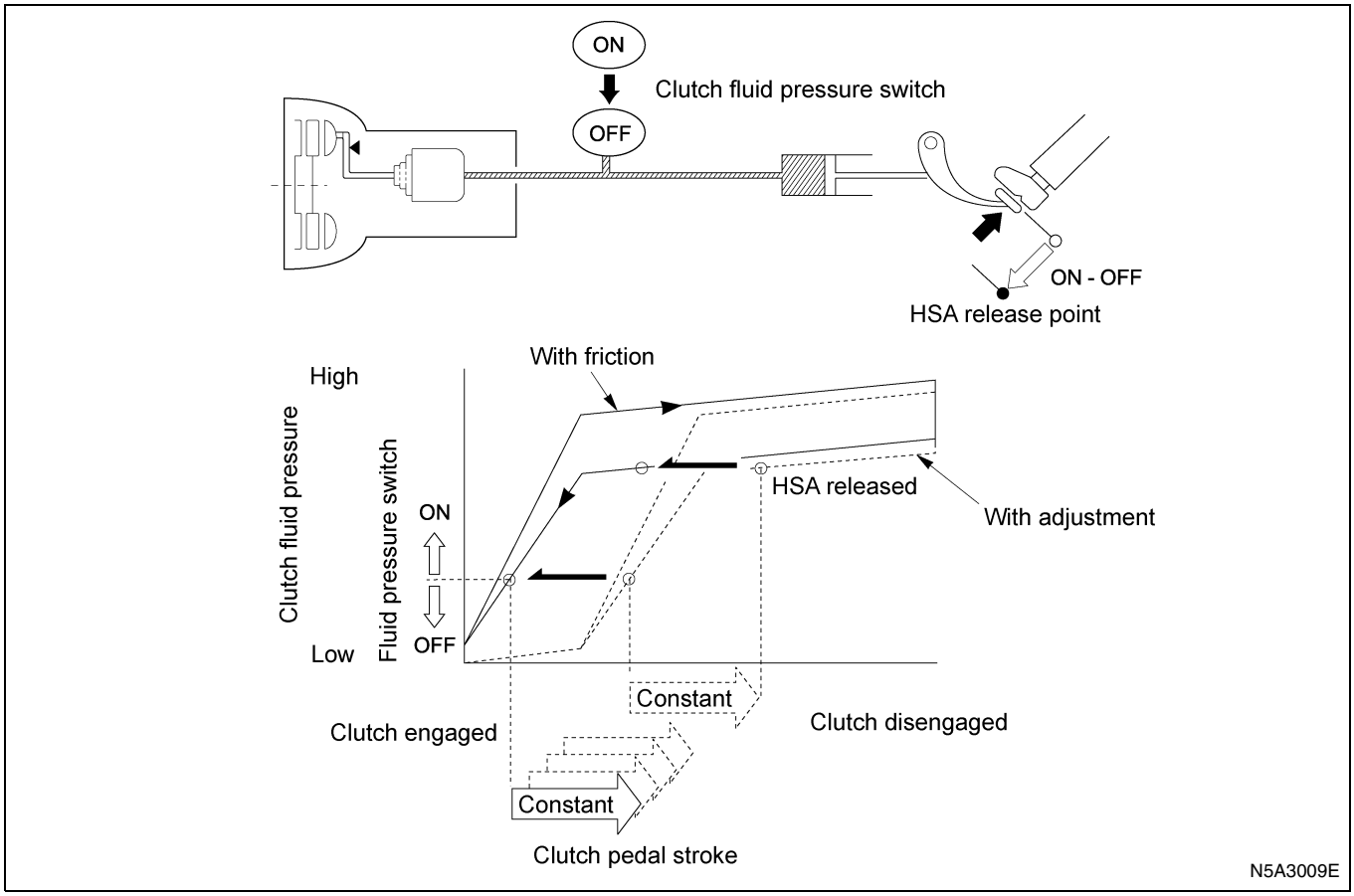
Clutch Fluid Pressure Switch



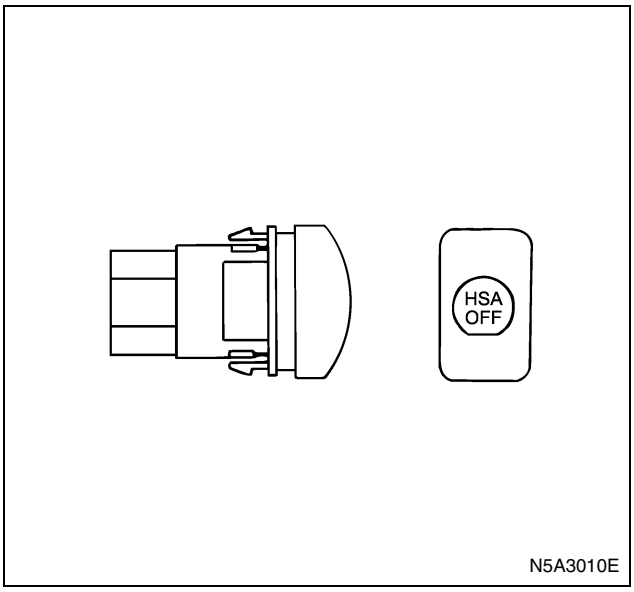
The clutch fluid pressure switch is off the contact with the clutch pedal fully engaged, and it contacts the point with the clutch pedal depressed (clutch disengaged).
The HSA system memorizes the clutch meeting point (engaging point) to release the brake force at that point. However, the meeting point is gradually raised as the driven plate wears, resulting the brake force be released before the clutch engages.
To prevent this, the HSA has a follow-up function automatically to co-op with the clutch wear.

Clutch-wear Automatic Follow-up Mechanism

The clutch fluid pressure switch is installed to the clutch master cylinder, and it turns ON with the clutch pedal depressed, and turns OFF with the clutch pedal released.
Positional relationship between the stroke point where the HSA is released and this clutch fluid pressure switch OFF position is constant regardless the degree of clutch disc wear.
Utilizing this characteristic, the HSA can follow-up the release point automatically even when the fluid pressure switch OFF point is shifted.

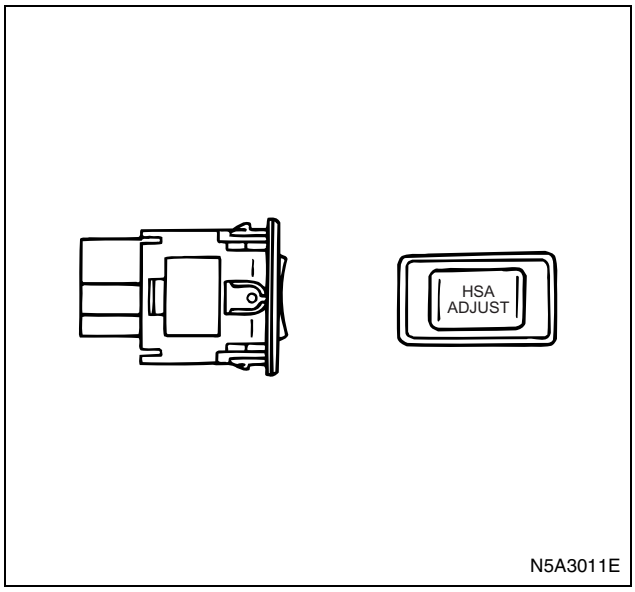


HSA Off Switch



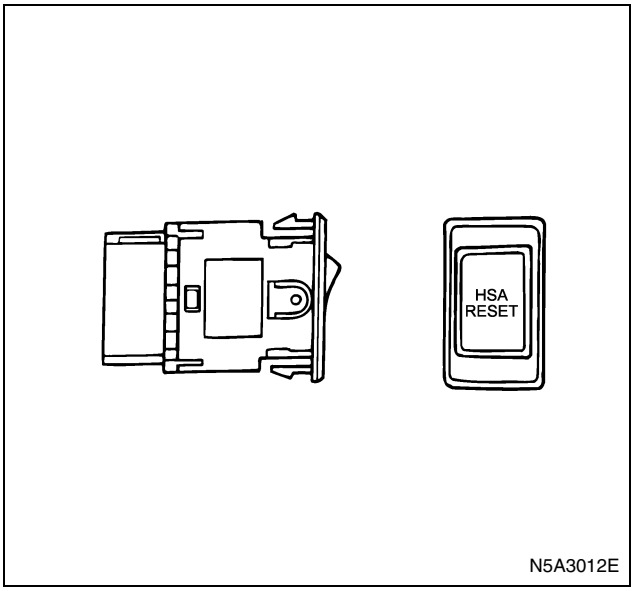
The HSA is released with this switch depressed. (HSA off warning light comes on at this time.)

HSA Adjust Switch



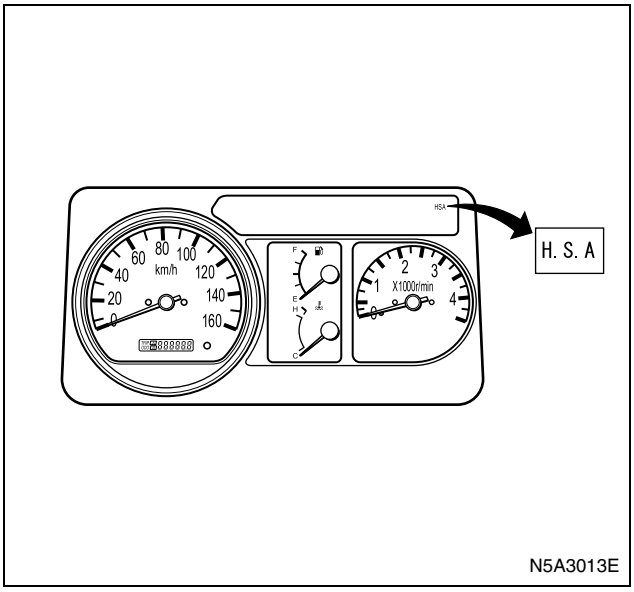
Used for fine adjustment of the clutch pedal position to release the HSA brake force when operating to start the vehicle. Also, used for initial adjustment.

HSA Reset Switch



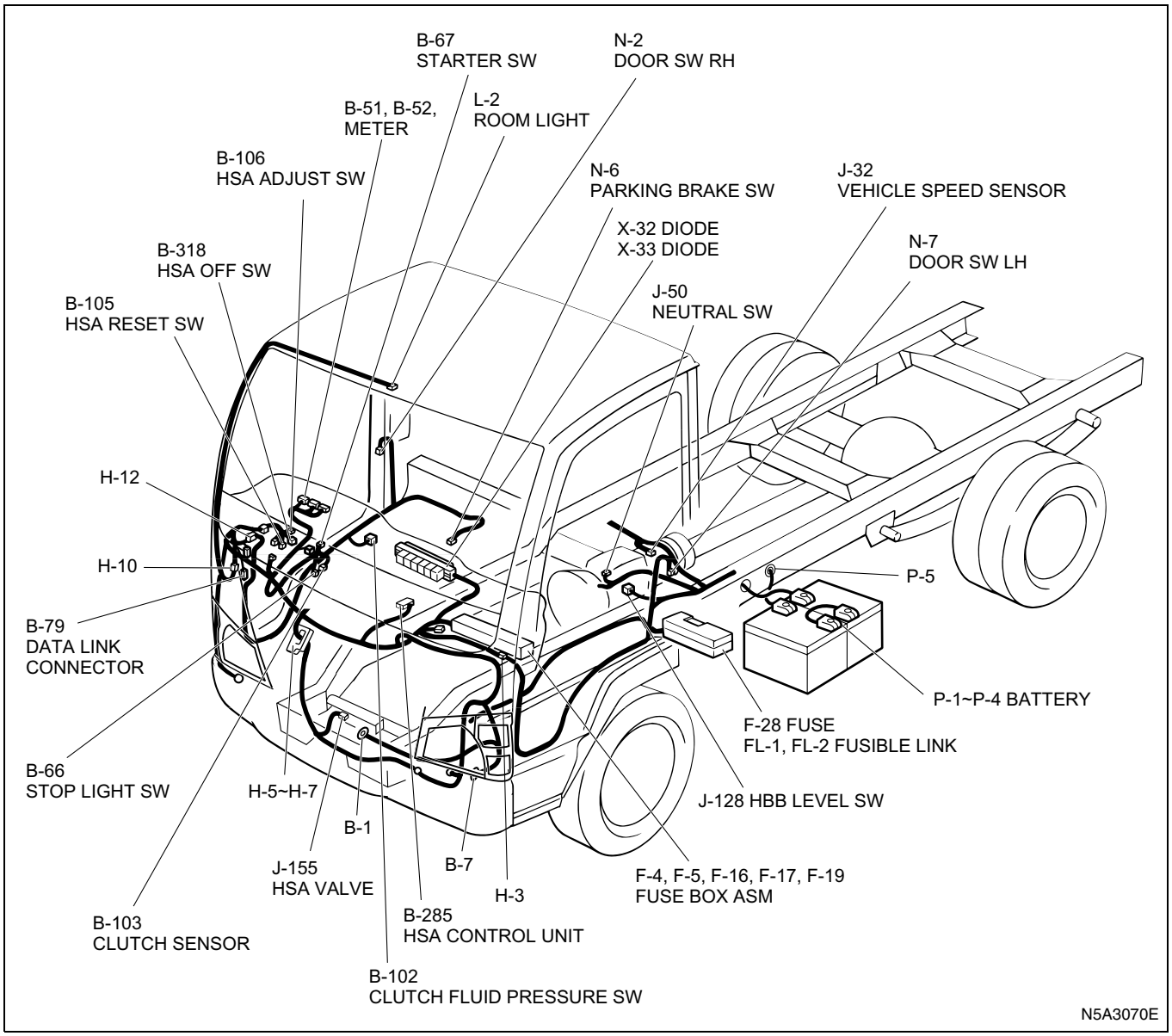
Used when the timing to release the HSA brake force is shifted considerably when operating to start the vehicle after clutch replacement or clutch play adjustment.

HSA Indicator Lamp

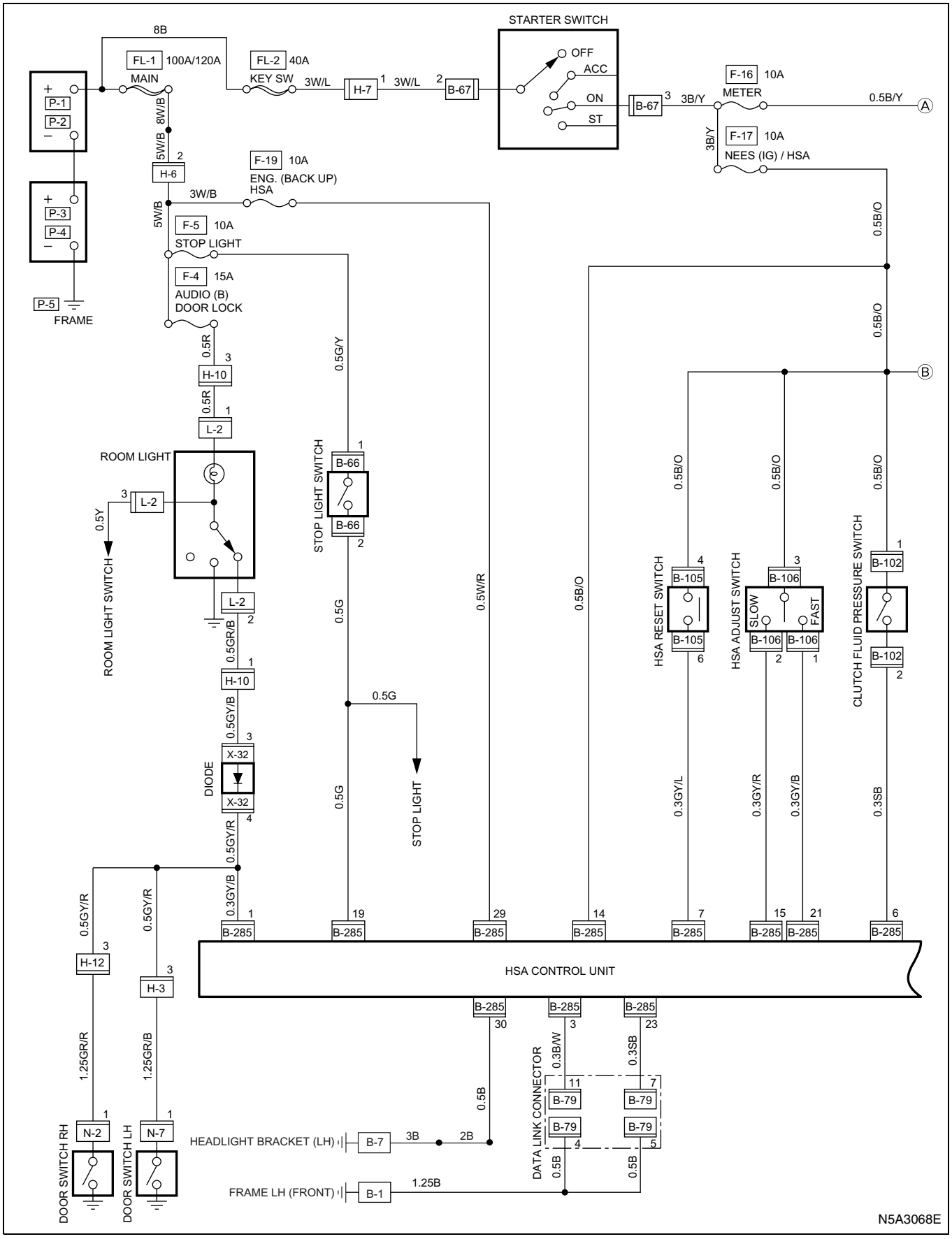


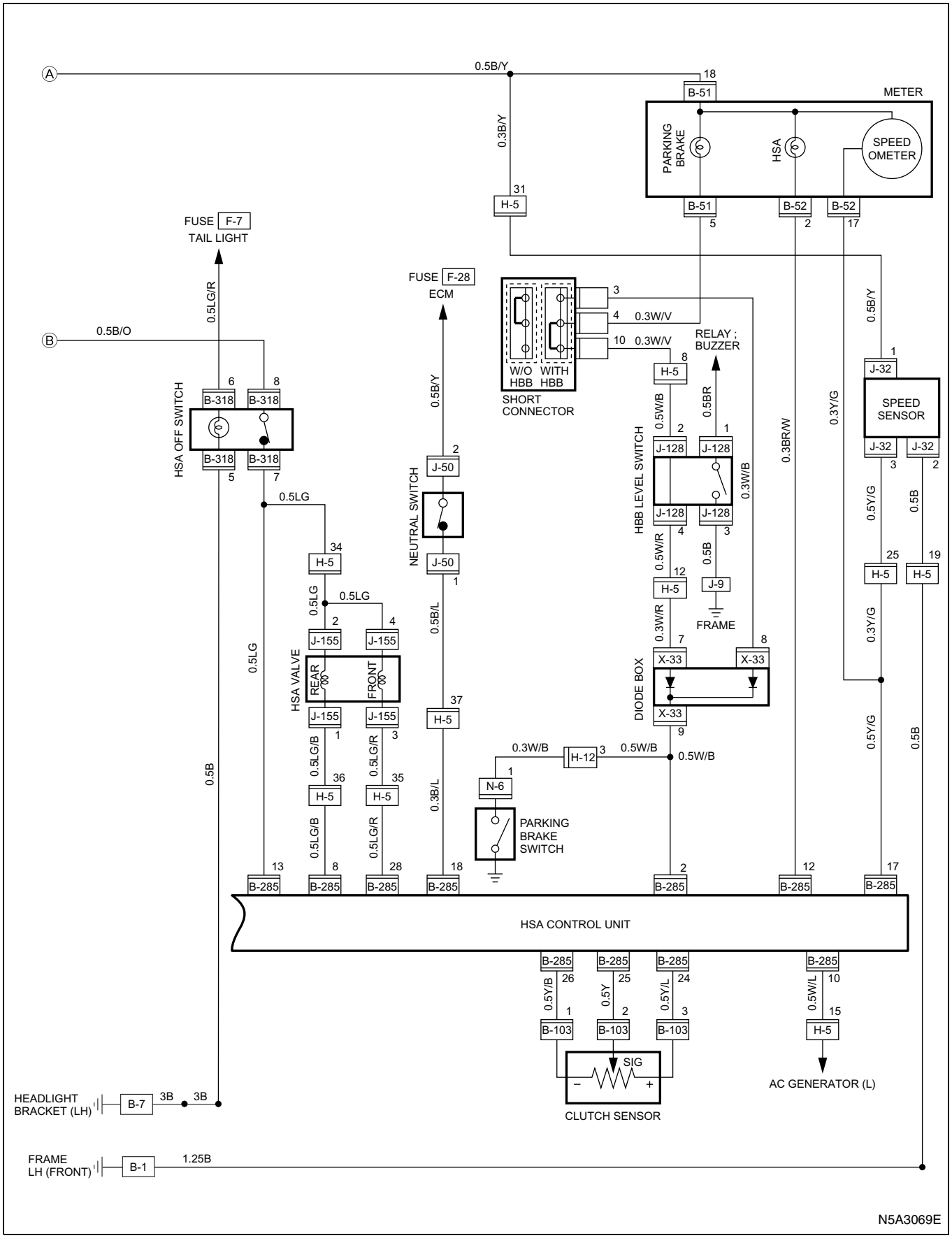
The HSA indicator lamp comes ON when HSA operating, and OFF when not operating. Also, it blinks sycronized with alarm. It blinks or illuminates when a malfunction occurs. Also used for while diagnosing.

Parts Location

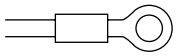
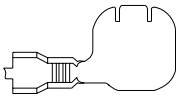
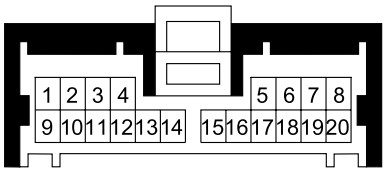
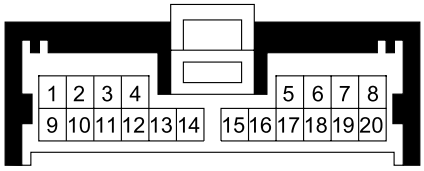
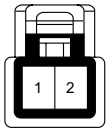
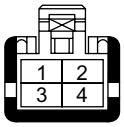
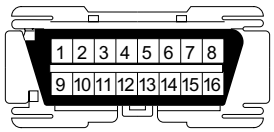


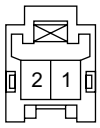
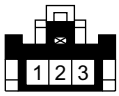
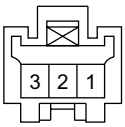
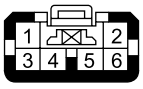
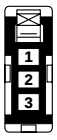
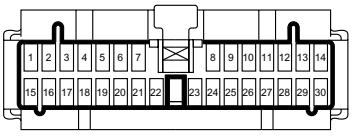
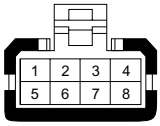
Circuit Diagram

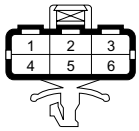
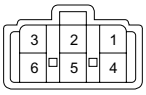
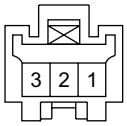
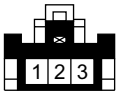
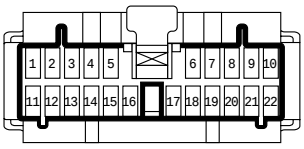
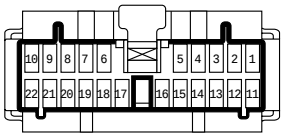
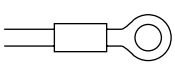


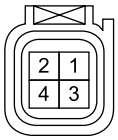
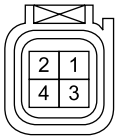
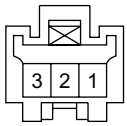
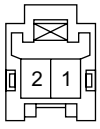

A
0.5B/Y
18
B-51
METER
PARKING BRAKE
HSA
SPEED OMETER
0.3B/Y
31
H-5
B-51
5
B-52
2
B-52
17
FUSE F-7
TAIL LIGHT
0.5LG/R
FUSE F-28
ECM
B
0.5B/O
3
4
0.3W/V
10
0.3W/V
RELAY ; BUZZER
W/O HBB
WITH HBB
SHORT CONNECTOR
8
H-5
0.5B/Y
1
J-32
SPEED SENSOR
J-32
J-32
3
2
0.5B/Y
0.5W/B
0.5BR
2
1
J-128
J-128
HBB LEVEL SWITCH
0.3W/B
0.3BR/W
0.3Y/G
0.5Y/G
0.5B
6
8
B-318
B-318
HSA OFF SWITCH
B-318
B-318
5
7
0.5LG
34
H-5
0.5LG
0.5LG
2
4
J-155
J-155
HSA VALVE
REAR
FRONT
J-155
J-155
1
3
0.5LG/B
0.5LG/R
36
35
H-5
H-5
0.5LG/B
0.5LG/R
13
8
28
B-285
B-285
B-285
0.5LG
0.5B
2
J-50
NEUTRAL SWITCH
J-50
1
0.5B/L
37
H-5
0.3B/L
18
B-285
0.5W/R
12
H-5
0.5B
J-9
FRAME
0.3W/R
7
8
X-33
X-33
DIODE BOX
X-33
9
0.3W/B
H-12
3
0.5W/B
0.5W/B
1
N-6
PARKING BRAKE SWITCH
2
B-285
12
B-285
25
19
H-5
H-5
0.3Y/G
0.5Y/G
0.5B
17
B-285
HSA CONTROL UNIT
B-285
B-285
B-285
B-285
0.5Y/B
26
0.5Y
25
0.5Y/L
24
0.5W/L
10
1
2
3
15
B-103
B-103
B-103
H-5
SIG
CLUTCH SENSOR
AC GENERATOR (L)
HEADLIGHT BRACKET (LH)
B-7
3B
3B
FRAME LH (FRONT)
B-1
1.25B
N5A3069E

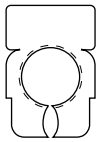
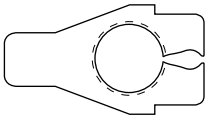
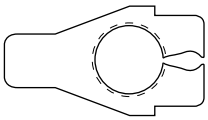
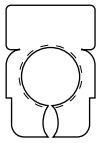
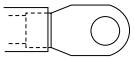
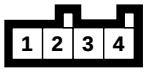
Connector List

No.	Connector Face
B-1	 000-001
B-7	 000-012
B-51	 020-004
B-52	 020-005
B-66	 002-031
B-67	004-002
B-67	 004-001
B-79	 016-005

No.	Connector Face
B-102	002-022
B-102	 002-023
B-103	 003-009
B-103	 003-010
B-105	 006-021
B-106	 003-014
B-285	 030-001
B-318	 008-005

No.	Connector Face
H-3	 006-014
H-3	 006-015
H-10	 003-010
H-10	 003-009
H-12	 022-001
H-12	 022-002
J-9	 000-001
J-32	003-018

No.	Connector Face
J-50	002-035
J-128	 004-018
J-155	 004-018
J-155	004-011
L-2	 003-010
L-2	003-009
N-2	001-020
N-6	 002-023

No.	Connector Face
N-6	002-022
N-7	001-020
P-1	 000-004
P-2	 000-006
P-3	 000-006
P-4	 000-004
P-5	 000-002
X-32	 004-004

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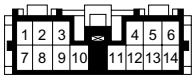
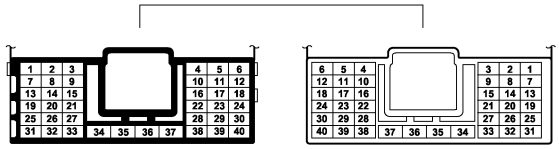
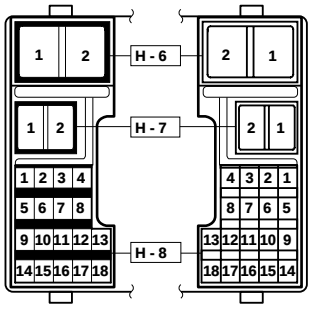
X-33	 014-002

H-5



N5A2011E

H-6, H-7



N8A5489E

Procedure of Trouble Diagnosis

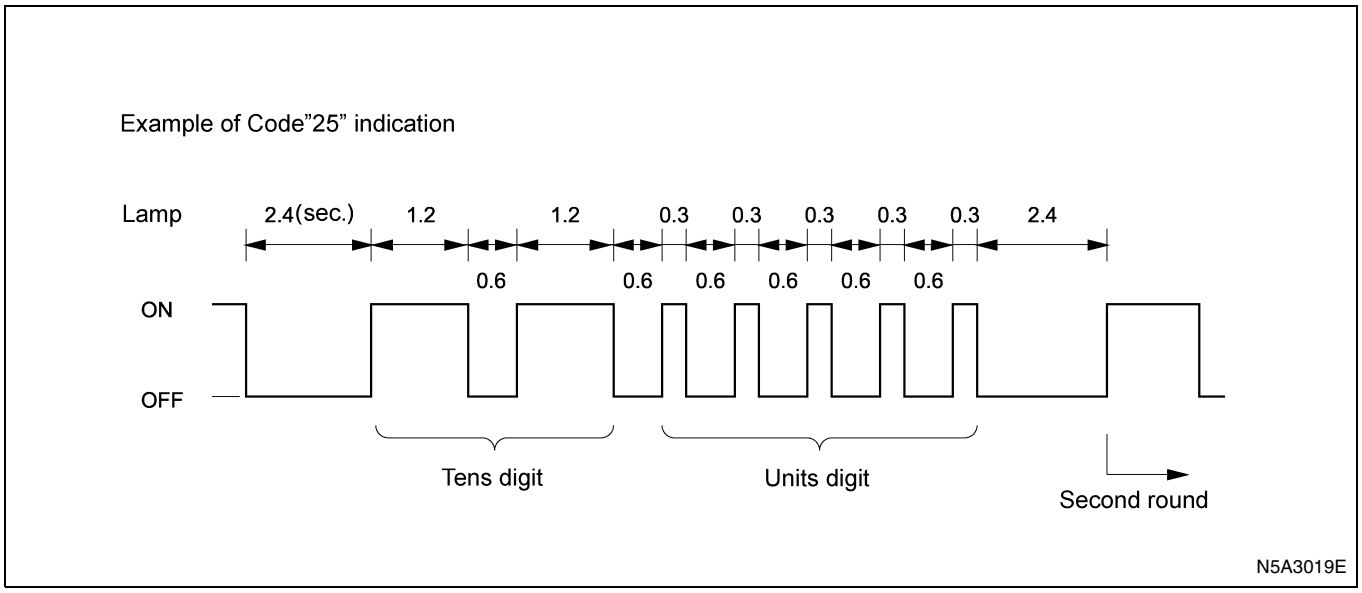
Description of Diagnosis

HSA diagnostic procedure is classified into two kinds; one is with diagnostic trouble codes indicated by blinking pattern of the HSA indicator lamp, and the other is from trouble symptoms. Refer to “Diagnostics with diagnostic trouble code” in the first case, and “Diagnostics with Phenomenon” in the latter case for diagnostic procedures.

Self-diagnosis

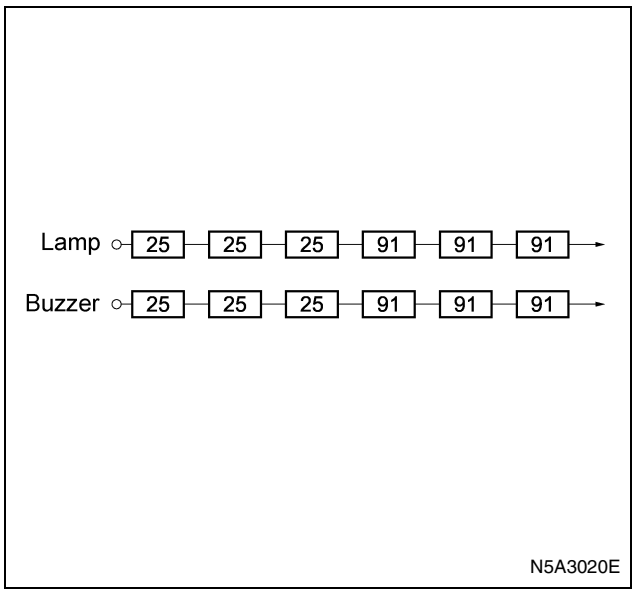
The HSA can perform the self-diagnosis when a malfunction occurs in the system.
Perform the self-diagnosis in the following procedure. HSA indicates the result in the lamp blinking pattern and the buzzer.

1. Park the vehicle and apply the parking brake.
2. Press the adjust switch “FAST” or “SLOW” and hold it. Self-diagnosis display continues while the switch is pressed.
3. While pressing the switch, diagnostic trouble codes (DTC) are displayed with the HSA indicator lamp blinking pattern. Buzzer beeps in synchronization with lamp while displaying the trouble code.



Caution:
DTCs are displayed for three times each in turn. After taking a round, the DTCs are displayed in the same order repeatedly.

- When multiple number of trouble code stored; Code 25/Code 91



Basic Diagnostic Procedure

Step	Action	Value	YES	NO
1	Turn the HSA off switch OFF. Does the HSA lamp blink?	—	 Go to Step2	 Go to Step3
2	Is there any trouble code?	—	Go to Step6, 7	Go to Step4, 5
3	Is the trouble reappeared?	—	Go to Step4, 5	Go to Step4, 5
4	What is the trouble symptom?	—	Go to Step5	Go to Step4
5	Has “Diagnostics with phenomenon” been performed?	—	Go to Step8	Go to Step5
6	Take notes all the trouble code appeared. What is the trouble code?	—	 Go to Step7	 Go to Step6
7	Has “Diagnostics with diagnostic trouble code” been performed?	—	Go to Step8	Go to Step7
8	Has the trouble part corrected?	—	End.	Go to Step8

Caution:
- Always perform the diagnosis in a predetermined sequence before performing the HSA system repair.
- After repair, make sure the HSA system operate/stop normally, and the trouble code does not appear again.
- Use the harness side (body side) connector to check for continuity (resistance) and voltage unless specified. Also, be especially careful not to damage the connector terminals with the tester etc.
- Check for continuity (resistance) with the starter switch OFF, and voltage with the starter switch ON.
- HSA control unit, HSA valve, clutch sensor, and speed sensor are non-disassembled parts; do not loosen the bolts and nuts.
- Do not directly apply external voltage to the HSA control unit, the clutch sensor, and the speed sensor. Use special care for electrostatic.

No.	Circuit to be checked	Power switch position	Tester scale/ range	Terminal No.	Standard value	Remarks
1	Door switch circuit	—	DCV	1 (+) — 30 (–)	0 V	Door open *Note
		—	DCV	1 (+) — 30 (–)	Approx. 24 V	Door closed *Note
2	Stop lamp switch circuit	—	DCV	19 (+) — 30 (–)	0 V	
		—	DCV	19 (+) — 30 (–)	Approx. 24 V	Brake pedal depressed
3	Power supply circuit	—	DCV	29 (+) — 30 (–)	Approx. 24 V	
		OFF	DCV	14 (+) — 30 (–)	0 V	
		ON	DCV	14 (+) — 30 (–)	Approx. 24 V	
4	Clutch fluid pressure switch circuit	ON	DCV	6 (+) — 30 (–)	0 V	
		ON	DCV	6 (+) — 30 (–)	Approx. 24 V	Clutch pedal depressed
5	HSA reset switch circuit	ON	DCV	7 (+) — 30 (–)	0 V	
		ON	DCV	7 (+) — 30 (–)	Approx. 24 V	Switch ON
6	HSA adjust switch circuit	ON	DCV	15 (+) — 30 (–)	0 V	
		ON	DCV	21 (+) — 30 (–)	0 V	
		ON	DCV	15 (+) — 30 (–)	Approx. 24 V	Switch “SLOW” side
		ON	DCV	21 (+) — 30 (–)	Approx. 24 V	Switch “FAST” side
7	HSA off switch circuit	ON	DCV	13 (+) — 30 (–)	Approx. 24 V	Switch OFF
		ON	DCV	13 (+) — 30 (–)	0 V	Switch ON

No.	Circuit to be checked	Power switch position	Tester scale/ range	Terminal No.	Standard value	Remarks
8	HSA valve circuit	OFF	Ω	8 — 28	111.6±10%	HSA off switch depressed, Control unit removed
9	Neutral switch circuit	ON	DCV	18 (+) — 30 (–)	0 V	Gear except in “Neutral”
		ON	DCV	18 (+) — 30 (–)	Approx. 24 V	Gear in “Neutral”
10	Parking brake switch circuit	ON	DCV	2 (+) — 30 (–)	Approx. 24 V	Parking brake released
		ON	DCV	2 (+) — 30 (–)	0 V	Parking brake applied
11	HSA indicator lamp circuit	ON	DCV	12 (+) — 30 (–)	Approx. 24 V	With indicator lamp OFF
		ON	DCV	12 (+) — 30 (–)	0 V	With indicator lamp ON
12	Clutch sensor circuit	OFF	Ω	24 — 26	2kΩ±400Ω	
		OFF	Ω	25 — 26	400Ω — 2.8kΩ	Clutch pedal operated
		ON	DCV	24 (+) — 30 (–)	4.5 V or more	
		ON	DCV	25 (+) — 30 (–)	0.5V±0.2V	Clutch pedal released (clutch fully engaged)
13	Speed sensor circuit	ON	DCV	17 (+) — 30 (–)	2V or 14V	
14	Generator L terminal circuit	ON	DCV	10 (+) — 30 (–)	0 V	Engine stopping
		ON	DCV	10 (+) — 30 (–)	Approx. 24 V	Engine running

*Note: Position the room lamp switch at door interlock.

Function Check

HSA Adjustment

The HSA memorize the clutch meeting point to release the brake force. Therefore, releasing point must be adjusted after clutch replacement or clutch play adjustment. Adjustment contains the “Initial adjustment” to memorize the clutch pedal position to release the HSA brake force, and the “Brake release adjustment” to fine adjustment of the clutch pedal position to release the brake for smooth starting of the vehicle.

Vehicle condition when adjustment is needed	Necessary adjustment
When the clutch-related parts are replaced, or clutch pedal play is adjusted. When the brake release timing is considerably fast/slow. When the brake drags at vehicle starting.	Initial adjustment
When the brake drags at vehicle starting. When the vehicle moves back at starting on a graded road. When the brake release timing does not match with the feeling.	Brake release adjustment (FAST) (SLOW) (FAST OR SLOW)

Initial Adjustment

1. Start the engine.
2. Make sure that the HSA off switch is not pressed (HSA in operation).
3. Apply the parking brake.
4. Disengage the clutch, move the gear position to 2nd, and press the HSA reset switch. (Buzzer (bleep*) continues at this time.)
5. Slowly release the clutch pedal, and press the “SLOW” or “FAST” of the HSA adjust switch when the engine speed goes down to 30 — 50 rpm lower than the idle speed. (Buzzer (bleep*) stops at this time.)
6. Move the gear back to neutral and slowly engage the clutch. In case when the buzzer goes off while in operation or when the HSA adjust switch is pressed by accident, retry the procedure from step 3.

Brake Release Adjustment

1. Start the engine.
2. Make sure that the HSA off switch is not pressed (HSA in operation).
3. Depress the brake, make sure the gear is in neutral, and release the parking brake lever.

4. Check that the HSA indicator lamp is ON, disengage the clutch, and move the gear except in neutral position.
5. When the brake release is too slow that the brake drags at vehicle starting, press the “FAST” of the adjust switch.
   When the brake release is too fast that the vehicle moves back at starting on a graded road, press the “SLOW” of the adjust switch.

Caution:
Each time pressing the switch, the buzzer bleeps. The number of times pressing the switch increase to the degree of change where to release the brake force at higher/lower clutch pedal position.

Number of times pressing the switch	
1 — 2 times	Fine adjustment “FAST” “SLOW”
2 — 3 times	When brake drags “FAST” When the vehicle on a graded road moves back. “SLOW”
3 — 5 times	When brake drags. “FAST” When the vehicle on a graded road moves back. “SLOW”

6. When the brake release timing does not match with the feeling, retry the procedure from step 3.
   (Start over from the initial adjustment if messed up.)

List of Diagnostic Trouble Code

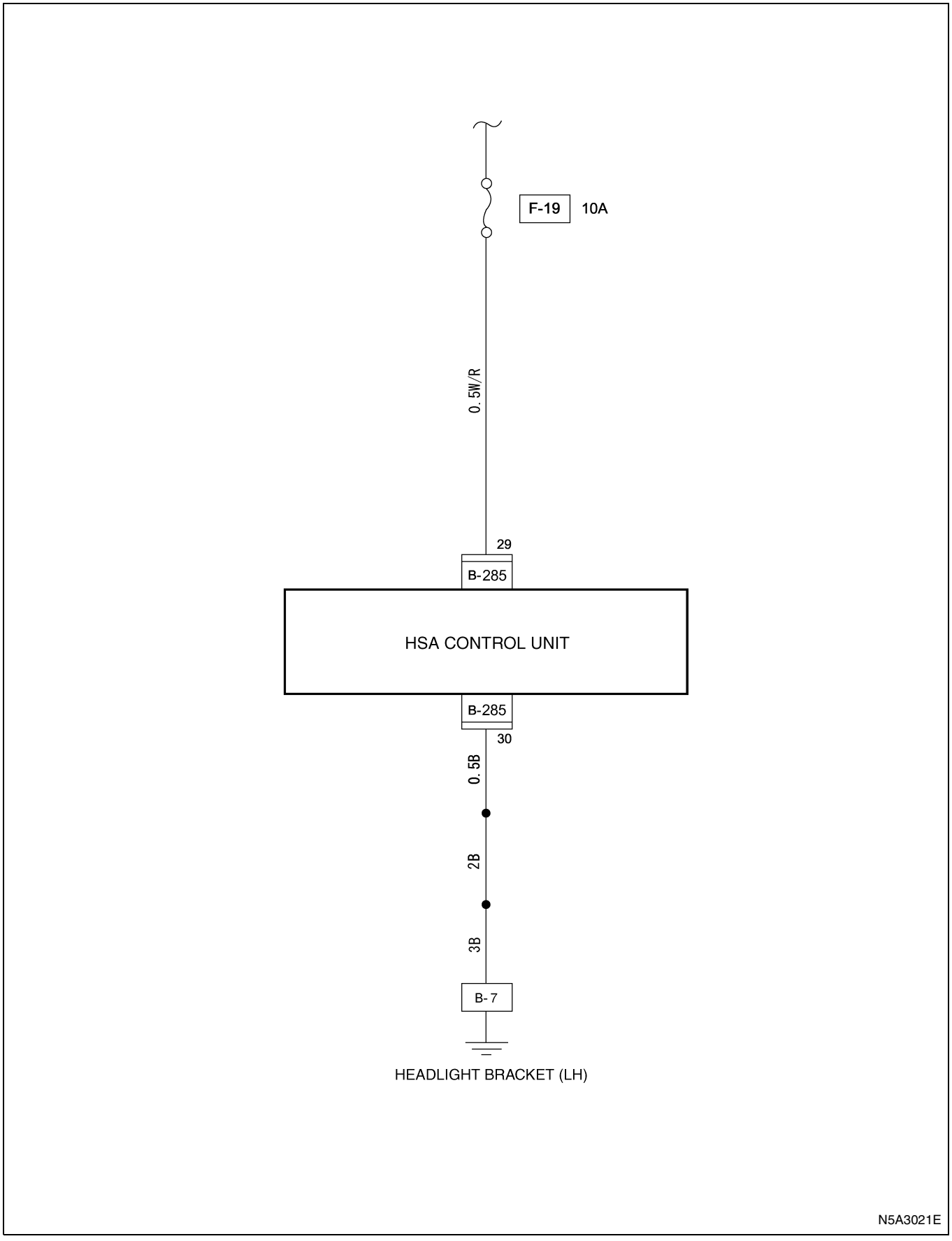
Code	Diagnosis item
01	Normal code
03	Back-up fuse open
08	Clutch sensor output voltage fault
19	Adjust switch “FAST” or “SLOW” is ON even when out of the adjustment limit, or adjust switch “FAST” or “SLOW” is ON when the vehicle speed 5 km/h (3 mph) or more.
25	Vehicle speed sensor output voltage fault
33	Control unit fault
36	Generator L terminal output does not exist even when the clutch is engaged and the gear is shifted with vehicle running.
86	Clutch fluid pressure switch does not turn ON with clutch pedal depressed, and it turns ON with the clutch engaged. (Clutch fluid pressure switch fault)
91	Solenoid valve drive signal and solenoid valve monitor conditions are erratic. (HSA valve fault)
Vehicle motion alarm	Detects vehicle speed 1.5km/h (1 mph) or more with solenoid valve operated and gear in neutral.
Longtime alarm	Solenoid valve has operated for more than 8 minutes continuously with brake not depressed.

About Diagnostic Trouble Code

The control unit clears the fault code when the fault part is judged to be normal.

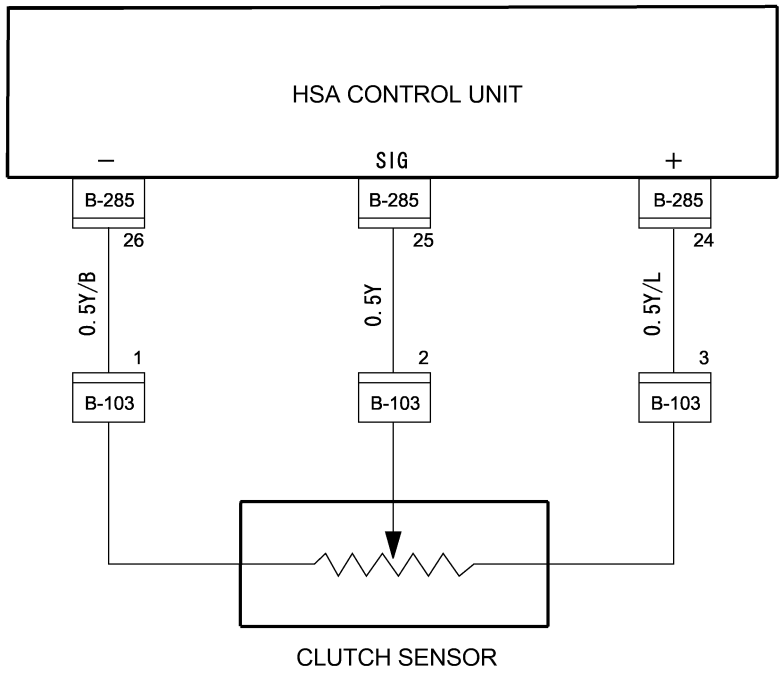
DTC 03 Back-up Fuse Open

Step	Action	Value	YES	NO
1	Check the fuse “F-19”. Is the fuse “F-19” normal?	—	Go to Step2	Go to Step3
2	Check for battery voltage between the HSA control unit connector terminal 29 “B-285” and the body ground. Does it have the battery voltage?	20 V or more	Go to Step6	Go to Step7
3	Repair the short circuit in the circuit and the parts connected to the fuse “F-19”. Is the repair completed?	—	Go to Step4	Go to Step3
4	Install a new fuse with the HSA control unit connector “B-285” disconnected. Is the fuse blown?	—	Go to Step2	Go to Step5
5	Connect the connector of the HSA control unit. Is the fuse blown?	—	Go to Step8	Go to Step10
6	Check the connector. Is the connector of the HSA control unit normal?	—	Go to Step8	Go to Step9
7	Repair the open circuit between the fuse “F-19” and 29 “B-285”. Is the repair completed?	—	Go to Step10	Go to Step7
8	Replace the HSA control unit. Is the replacement completed?	—	Go to Step10	Go to Step8
9	Repair the connector. Is the repair completed?	—	Go to Step10	Go to Step9
10	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step10

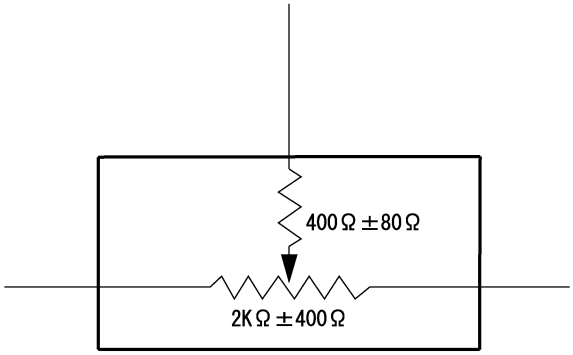

F-19
10A
0.5W/R
29
B-285
HSA CONTROL UNIT
B-285
30
0.5B
2B
3B
B-7
HEADLIGHT BRACKET (LH)
N5A3021E

DTC 08 Clutch Sensor Output Voltage Fault

Step	Action	Value	YES	NO
1	Check the clutch sensor. Is the clutch sensor normal?	—	Go to Step2	Go to Step3
2	Measure the resistances between the HSA control unit and the clutch sensor connector terminals 24 “B-285” and 3 “B-103”, 25 “B-285” and 2 “B-103”, 26 “B-285” and 1 “B-103”. Are all the resistances less than 5Ω?	Less than 5Ω	Go to Step4	Go to Step5
3	Replace the clutch sensor. Is the replacement completed?	2kΩ±400	Go to Step4	Go to Step3
4	Replace the HSA control unit. Is the replacement completed?	—	Go to Step6	Go to Step4
5	Repair the open circuit of the circuit that has resistance of 5Ω or more. Is the repair completed?	—	Go to Step6	Go to Step5
6	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step6



CLUTCH SENSOR

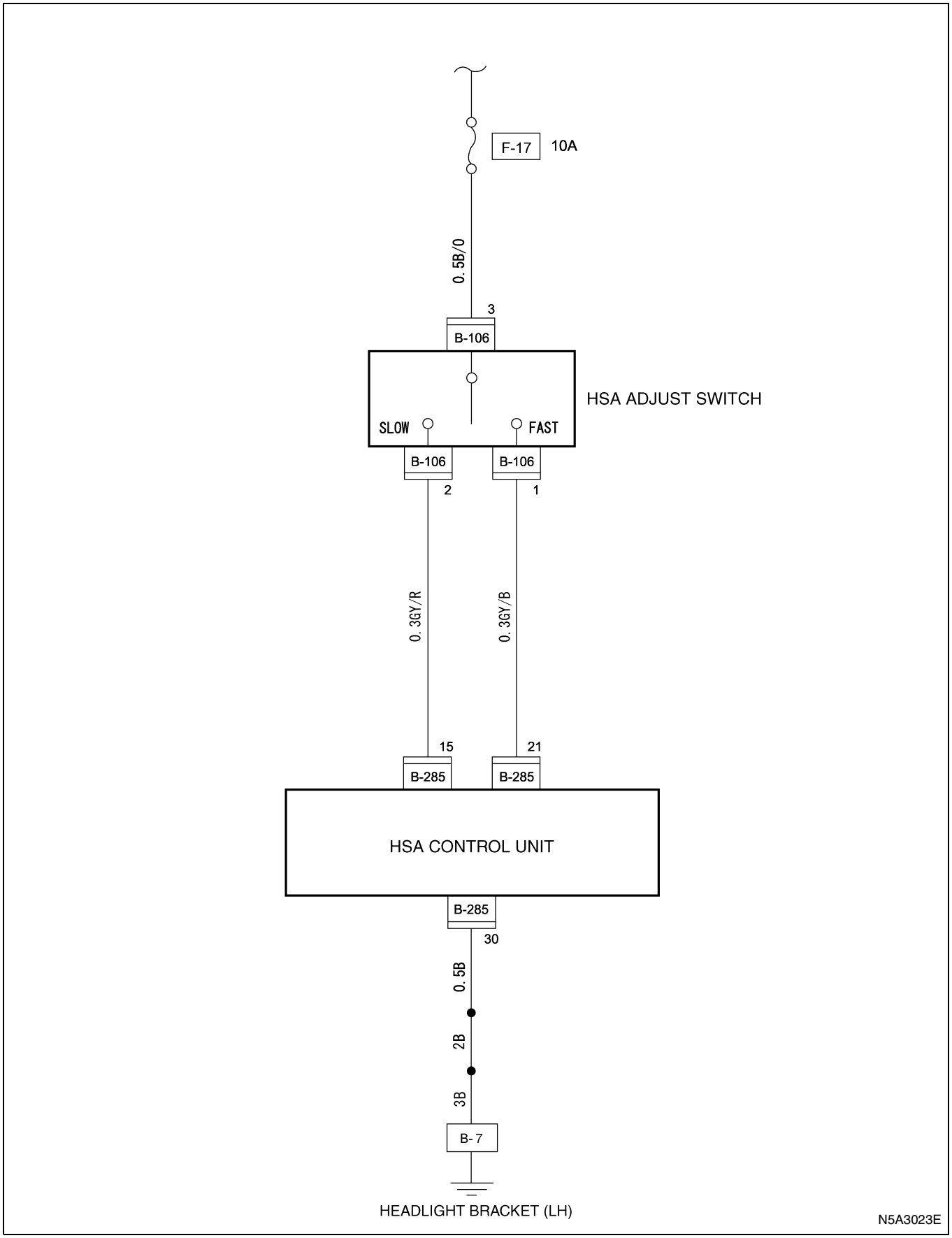


CLUTCH SENSOR

N5A3022E

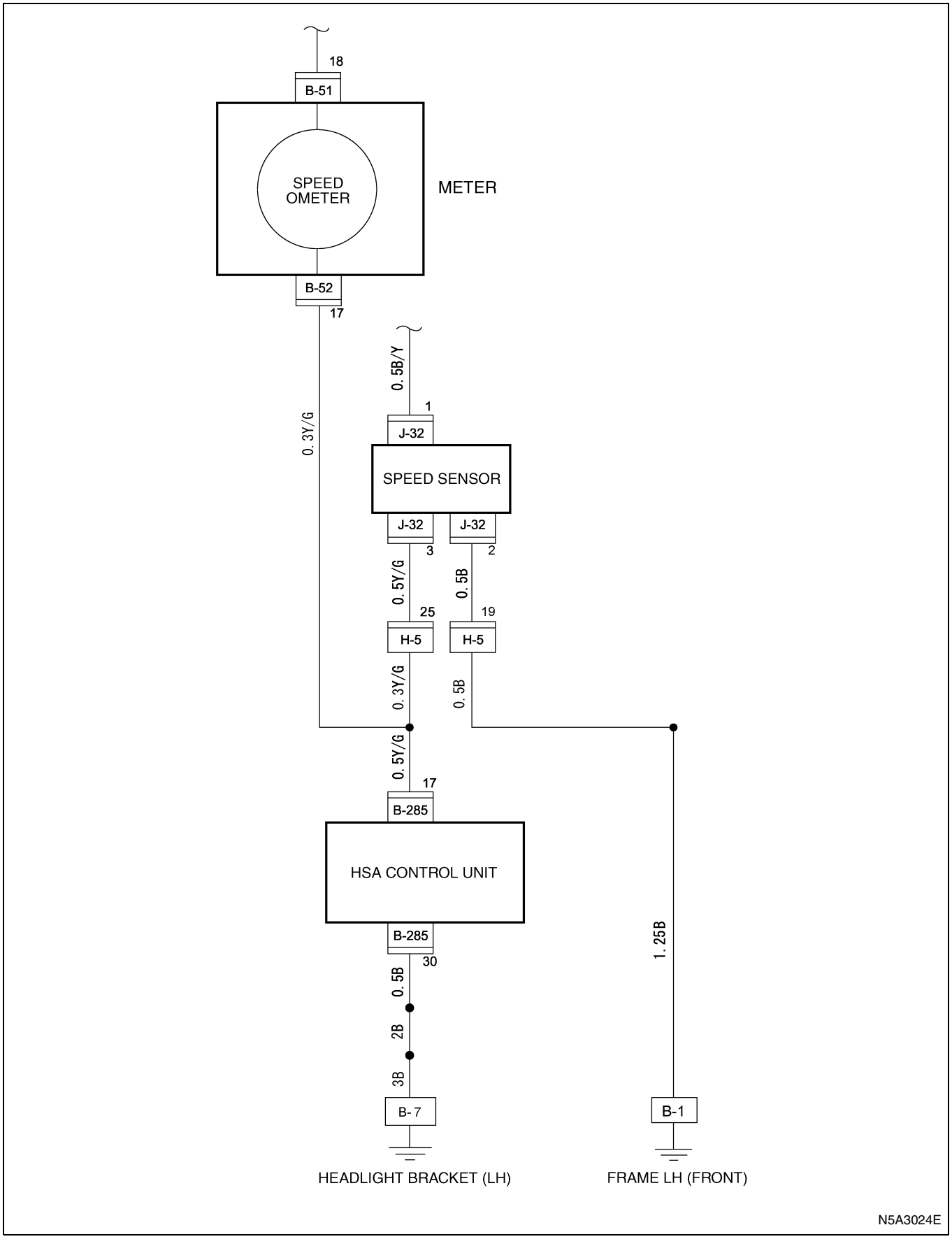
DTC 19 Adjust Switch “FAST” or “SLOW” Remain ON

Step	Action	Value	YES	NO
1	Is the battery voltage applied between the HSA adjust switch connector terminal 3 “B-106” and the body ground (connector disconnected)?	20 V or more	Go to Step2	Go to Step3
2	Is the continuity (resistance) of the HSA adjust switch normal?	—	Go to Step4	Go to Step5
3	Repair the open circuit between the fuse “F-17” and 3 “B-106”. Has the open circuit corrected?	—	Go to Step4	Go to Step3
4	Connect the connector of the HSA adjust switch. Measure the voltages between the HSA control unit connector terminals 15 “B-285”, 21 “B-285” and the body ground. Are the voltages 20V or more with adjust switch operating, and 0V not operating (with the HSA control unit connector disconnected)?	20V with switch operated 0V with not operated	Go to Step6	Go to Step7
5	Repair or replace the switch. Is the repair completed?	—	Go to Step6	Go to Step5
6	Replace the HSA control unit. Is the replacement completed?	—	Go to Step7	Go to Step6
7	Repair the open circuit between the HSA adjust switch connector terminals and the HSA control unit connector terminals 2 “B-106” — 15 “B-285”, 1 “B-106” — 21 “B-285”. Is the repair completed?	—	Go to Step8	Go to Step7
8	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step8


F-17
10A
0.5B/O
3
B-106
HSA ADJUST SWITCH
SLOW
FAST
B-106
B-106
2
1
0.3GY/R
0.3GY/B
15
21
B-285
B-285
HSA CONTROL UNIT
B-285
30
0.5B
2B
3B
B-7
HEADLIGHT BRACKET (LH)
N5A3023E

DTC 25 Vehicle Speed Sensor Output Voltage Fault

Step	Action	Value	YES	NO
1	Is there damage or improper connection in the HSA control unit and the speed sensor connector?	—	Go to Step2	Go to Step3
2	Measure the resistance between the speed sensor connector terminal 3 “J-32” and the control unit connector terminal 17 “B-285” (with the connector disconnected). Is the measurement completed?	Less than 5Ω	Go to Step4	Go to Step5
3	Repair the connector. Is the repair completed?	—	Go to Step4	Go to Step3
4	Measure the resistances between the speed sensor connector terminal 2 “J-32” and the body ground (with the connector disconnected). Is the measurement completed?	Less than 5Ω	Go to Step6	Go to Step7
5	Repair the open circuit, connector disconnection, etc. between 3 “J-32” and 17 “B-285” (with the connector disconnected). Is the repair completed?	—	Go to Step6	Go to Step5
6	Check for battery voltage between the speed sensor connector terminal 1 “J-32” and 2 “J-32” (with the connector disconnected). Is the measurement completed?	10V or more	Go to Step8	Go to Step9
7	Repair the open circuit, improper grounding, etc. between 2 “J-32” and “B-1” (with the connector disconnected). Is the repair completed?	—	Go to Step8	Go to Step7
8	Measure the sensor output voltage between the speed sensor connector terminal 3 “J-32” and 2 “J-32”. Is the measurement completed?	2V±1V — 14V+1V — 2V	Go to Step10	Go to Step11
9	Repair the open circuit, connector disconnection, etc. between 11 “B-53” (meter) and 1 “J-32” (with the connector disconnected). Is the repair completed?	—	Go to Step10	Go to Step9
10	Measure the resistance between the meter connector terminals 14 “B-52” and 11 “B-53”. Is the value 390 Ω± 5% (with the connector disconnected)?	390Ω±5%	Go to Step12	Go to Step13
11	Replace the speed sensor. Is the repair completed?	—	Go to Step14	Go to Step11
12	Replace the HSA control unit. Is the repair completed?	—	Go to Step14	Go to Step12
13	Replace the flexible substrate (printed circuit board) of the meter. Is the repair completed?	—	Go to Step14	Go to Step13
14	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step14

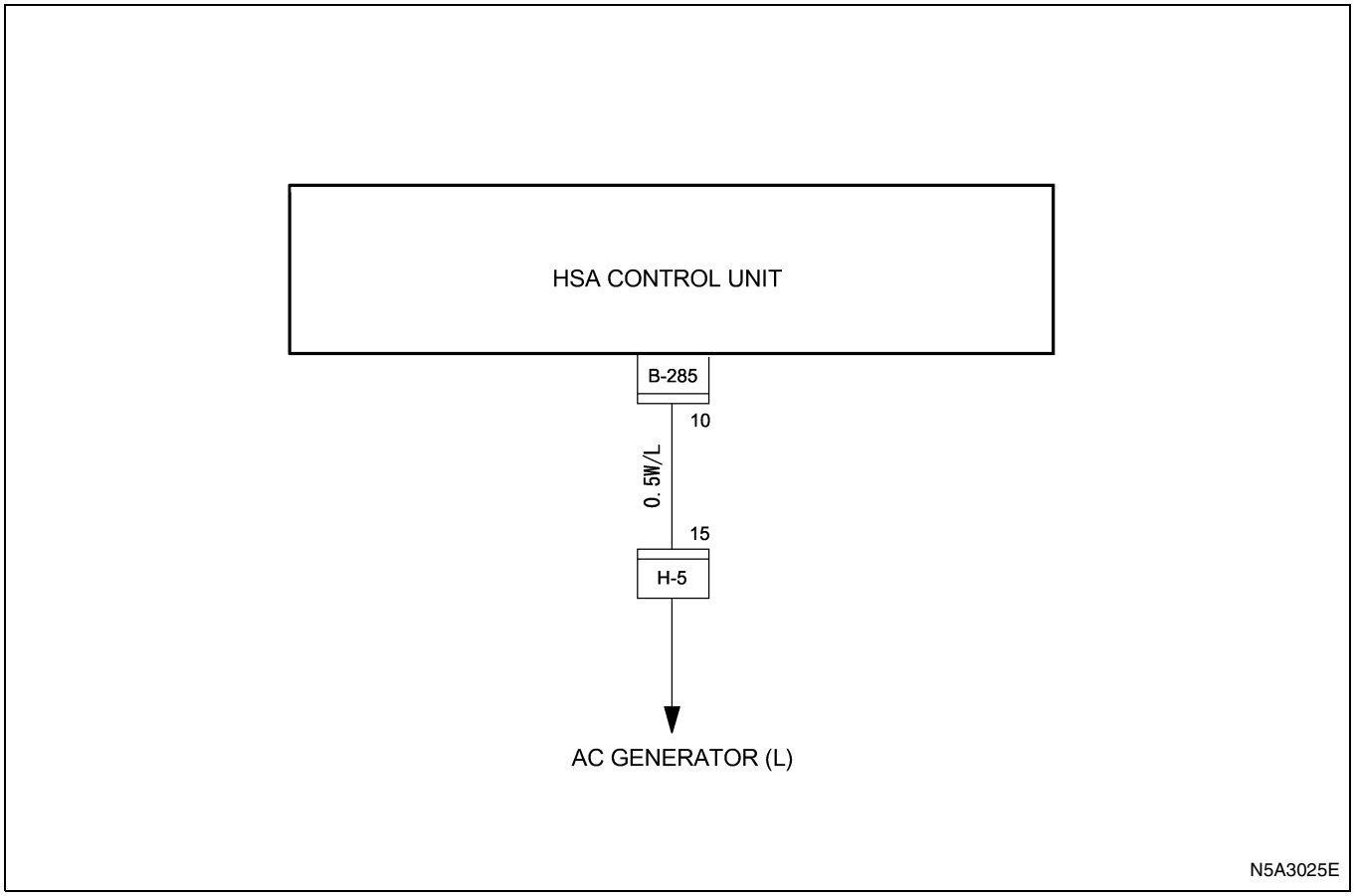

18
B-51
SPEED OMETER
METER
B-52
17
0.5B/Y
1
J-32
SPEED SENSOR
J-32
3
J-32
2
0.3Y/G
0.5Y/G
0.5B
25
19
H-5
H-5
0.3Y/G
0.5B
0.5Y/G
17
B-285
HSA CONTROL UNIT
B-285
30
1.25B
0.5B
2B
3B
B-7
B-1
HEADLIGHT BRACKET (LH)
FRAME LH (FRONT)
N5A3024E

DTC 33 Control Unit Fault

Step	Action	Value	YES	NO
1	Disconnect the connector of the HSA control unit, and then reconnect it. When the trouble code “33” appears again, replace the HSA control unit. Is the repair completed?	—	Go to Step2	Go to Step1
2	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step2

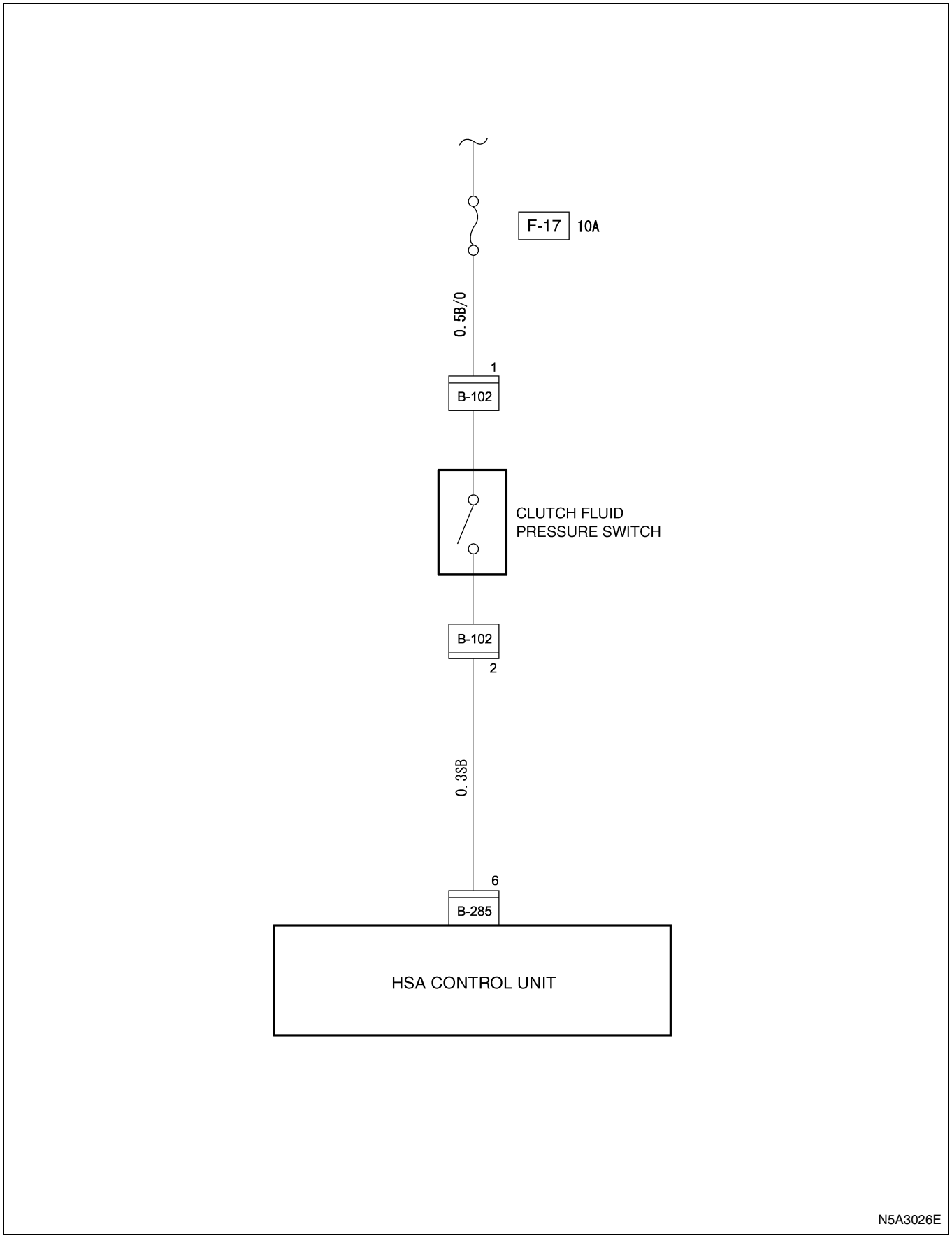
DTC 36 Generator Terminal Output Does not Exist With the Clutch Engaged and Vehicle Running

Step	Action	Value	YES	NO
1	Disconnect the HSA control unit connector “B-285”, and start the engine. Is the voltage of approx. 24V applied between the connector terminal 10 “B-285” and the body ground?	Approx. 24V	Go to Step2	Go to Step3
2	Replace the HSA control unit. Is the repair completed?	—	Go to Step4	Go to Step2
3	Repair the open circuit between the AC generator “L” terminal and 10 “B-285”. Is the repair completed?	—	Go to Step4	Go to Step3
4	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step4



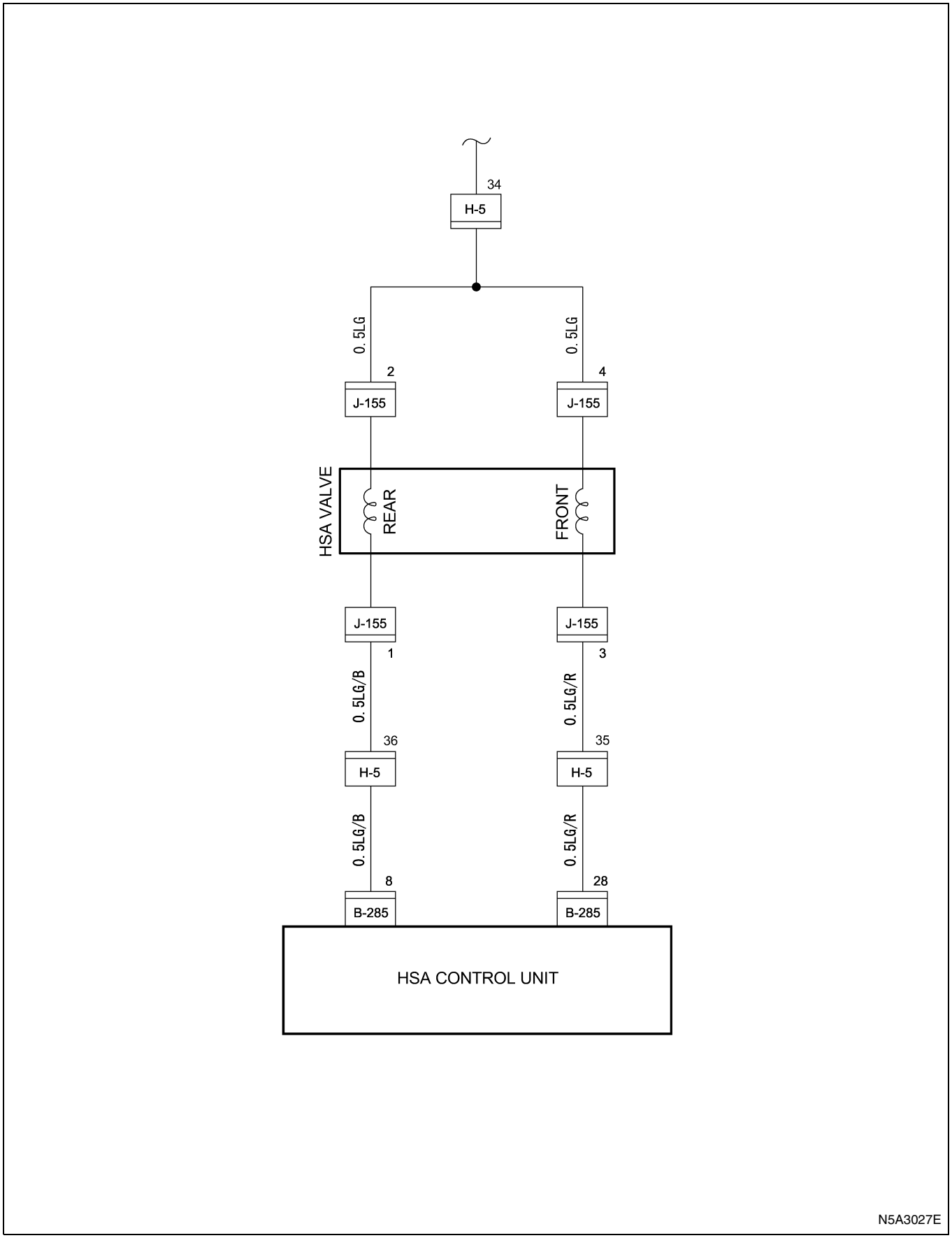
DTC 86 Clutch Switch Does not Turn ON With Clutch Pedal Depressed

Step	Action	Value	YES	NO
1	Is the clutch pedal play normal?	—	Go to Step2	Go to Step3
2	Is there improper connection or damage in the clutch fluid pressure switch connector?	—	Go to Step4	Go to Step5
3	Adjust the clutch play. Is the repair completed?	—	Go to Step4	Go to Step3
4	Measure the resistance of the clutch fluid pressure switch (at the switch side connector) (with the connector disconnected). Is the measurement completed?	5Ω or more with clutch pedal released, less than 5Ω with clutch pedal depressed	Go to Step6	Go to Step7
5	Repair the connector. Is the repair completed?	—	Go to Step6	Go to Step5
6	Measure the battery voltage between the clutch fluid pressure switch connector terminal 1 “B-102” and the body ground (with connector disconnected). Is the measurement completed?	20 V or more	Go to Step8	Go to Step9
7	Replace the clutch fluid pressure switch. Is the repair completed?	—	Go to Step8	Go to Step7
8	Measure the resistance between the clutch fluid pressure switch connector terminal 2 “B-102” and the HSA control unit connector terminal 6 “B-285” (with connector disconnected). Is the measurement completed?	Less than 5Ω	Go to Step10	Go to Step11
9	Repair the open circuit between the fuse “F-17” and 1 “B-102”. Is the repair completed?	—	Go to Step10	Go to Step9
10	Connect all the connectors, turn the starter switch to ON, engage the clutch then disengage the clutch for 5 seconds or more, and engage the clutch for 1 minute. Does the trouble code “86” appear again?	—	Go to Step12	Go to Step13
11	Repair the wire between 2 “B-102” and 6 “B-285”. Is the repair completed?	—	Go to Step13	Go to Step11
12	Replace the HSA control unit. Is the repair completed?	—	Go to Step13	Go to Step12
13	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step13


F-17
10A
0.5B/O
1
B-102
CLUTCH FLUID
PRESSURE SWITCH
B-102
2
0.3SB
6
B-285
HSA CONTROL UNIT
N5A3026E

DTC 91 Solenoid Valve Drive Signal and Solenoid Valve Monitor Conditions Are Erratic

Step	Action	Value	YES	NO
1	Is the connector of the HSA valve normal?	—	Go to Step2	Go to Step3
2	Disconnect the connector of HSA valve. Measure the resistance in HSA valve. Is the measurement completed?	55.8Ω±10%	Go to Step4	Go to Step5
3	Repair the connector. Is the repair completed?	—	Go to Step4	Go to Step3
4	Measure the resistances between the HSA valve connector terminals and the HSA control unit connector terminals 3 “J-155” and 28 “B-285” (front side), and 1 “J-155” and 8 “B-285” (rear side) (with the connector disconnected). Is the measurement completed?	Less than 5Ω	Go to Step6	Go to Step7
5	Replace the HSA valve. Is the repair completed?	—	Go to Step6	Go to Step5
6	Is the battery voltage applied between the HSA valve connector terminals 2 “J-155”, 4 “J-155” and the body ground (with connector disconnected)?	20 V or more	Go to Step8	Go to Step9
7	Repair the open circuit of the circuit that has resistance of 5Ω or more. Is the repair completed?	—	Go to Step8	Go to Step7
8	Replace the HSA control unit. Is the repair completed?	—	Go to Step10	Go to Step8
9	Repair the open circuit of the circuit that has resistance of less than 20V. Is the repair completed?	—	Go to Step10	Go to Step9
10	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step10


34
H-5
0.5LG
0.5LG
2
4
J-155
J-155
HSA VALVE
REAR
FRONT
J-155
J-155
1
3
0.5LG/B
0.5LG/R
36
35
H-5
H-5
0.5LG/B
0.5LG/R
8
28
B-285
B-285
HSA CONTROL UNIT
N5A3027E

List of Trouble Phenomenon

For the troubles which are not appeared as trouble code, interview the customer and the test run the vehicle to check for trouble symptom, and perform the diagnosis according the symptom.

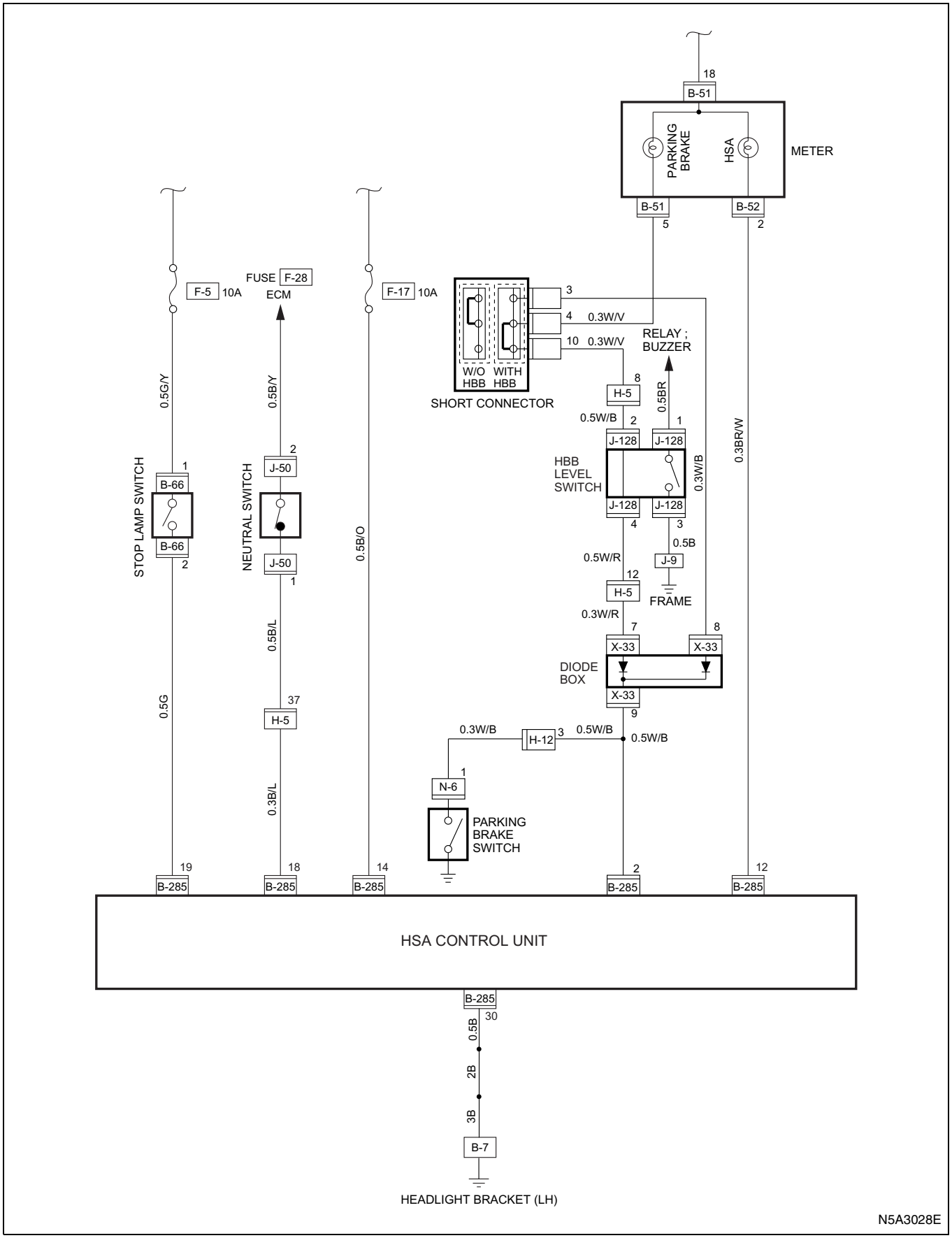
	Possible cause															
Trouble symptom	Door switch	Parking brake switch	Clutch fluid pressure switch	HSA reset switch	HSA valve, pipe	ACG	HSA lamp (including meter)	HSA off switch	HSA adjust switch	Speed sensor	Neutral switch	Stop lamp switch	Clutch sensor	Back-up lamp switch	Diode box	Action to be taken
HSA does not operate.		❍			❍	❍					❍	❍				Refer to the trouble symptom.
HSA does not release though the HSA off switch is depressed.					❍			❍								Refer to the trouble symptom.
HSA does not release though the vehicle is operated to start. (HSA indicator lamp remains ON.)											❍		❍			Refer to the trouble symptom.
HSA does not release though the parking brake is applied.		❍														Refer to the trouble symptom.
HSA indicator lamp does not come on. (HSA does not operate.)		❍			❍	❍					❍	❍				Refer to the trouble symptom.
HSA indicator lamp does not come on. (HSA does operate.)							❍									Refer to the trouble symptom.
HSA indicator lamp does not go off. (HSA released.)							❍									Refer to the trouble symptom.
Buzzer does not sound though the door is opened while HSA operating.	❍														❍	Refer to the trouble symptom.
HSA indicator lamp blinks abnormally and does not output the trouble cord during self-diagnosis.		❍					❍									Refer to the trouble symptom.
Buzzer beeps continuously during self-diagnosis (trouble code output impossible)									❍					❍		Refer to the trouble symptom.

Symptom: HSA Does not Operate

Step	Action	Value	YES	NO
1	Does the HSA indicator lamp not illuminate?	—	Go to Step2	Go to Step3
2	Is the fuse “F-17” normal?	—	Go to Step4	Go to Step5
3	Check the HSA valve and the pipe, and repair or replace. Is the repair completed?	—	Go to Step5	Go to Step3
4	Measure the battery voltage between the HSA control unit connector terminal 14 “B-285” and the body ground (with connector disconnected). Is the measurement completed?	20 V or more	Go to Step6	Go to Step7
5	Repair the short circuit in the circuit and the parts (clutch fluid pressure switch, HSA valve, etc.) connected to the fuse “F-17”, and then replace the fuse. Is the repair completed?	—	Go to Step6	Go to Step5
6	Measure the resistance between the HSA control unit connector terminal 30 “B-285” and the body ground (with connector disconnected). Is the measurement completed?	Less than 5Ω	Go to Step8	Go to Step9
7	Repair the open circuit between the fuse “F-17” and 14 “B-285”. Is the repair completed?	—	Go to Step8	Go to Step7
8	Measure the battery voltage between the HSA control unit connector terminal 2 “B-285” and the body ground (with connector disconnected) with the parking brake not applied. Is the measurement completed?	20 V or more	Go to Step10	Go to Step11
9	Repair the open circuit or improper grounding between 30 “B-285” and the ground terminal “B-7” (in front of the frame LH) (with the connector disconnected). Is the repair completed?	—	Go to Step10	Go to Step9
10	Is the fuse “F-5” normal?	—	Go to Step12	Go to Step13
11	Is the continuity (resistance) of the parking brake switch normal?	—	Go to Step28	Go to Step29
12	Measure the continuity (resistance) in the switch side terminal of the stop lamp switch. Does the resistance exist when the brake pedal depressed, and no resistance when the brake pedal released (with the connector disconnected)?	—	Go to Step14	Go to Step15
13	Check and repair the short circuit in the stop lamp circuit, and then replace the fuse. Is the repair completed?	—	Go to Step14	Go to Step13
14	Measure the battery voltage between the stop lamp switch connector terminal 1 “B-66” and the body ground (with connector disconnected). Is the measurement completed?	20V or more	Go to Step16	Go to Step17

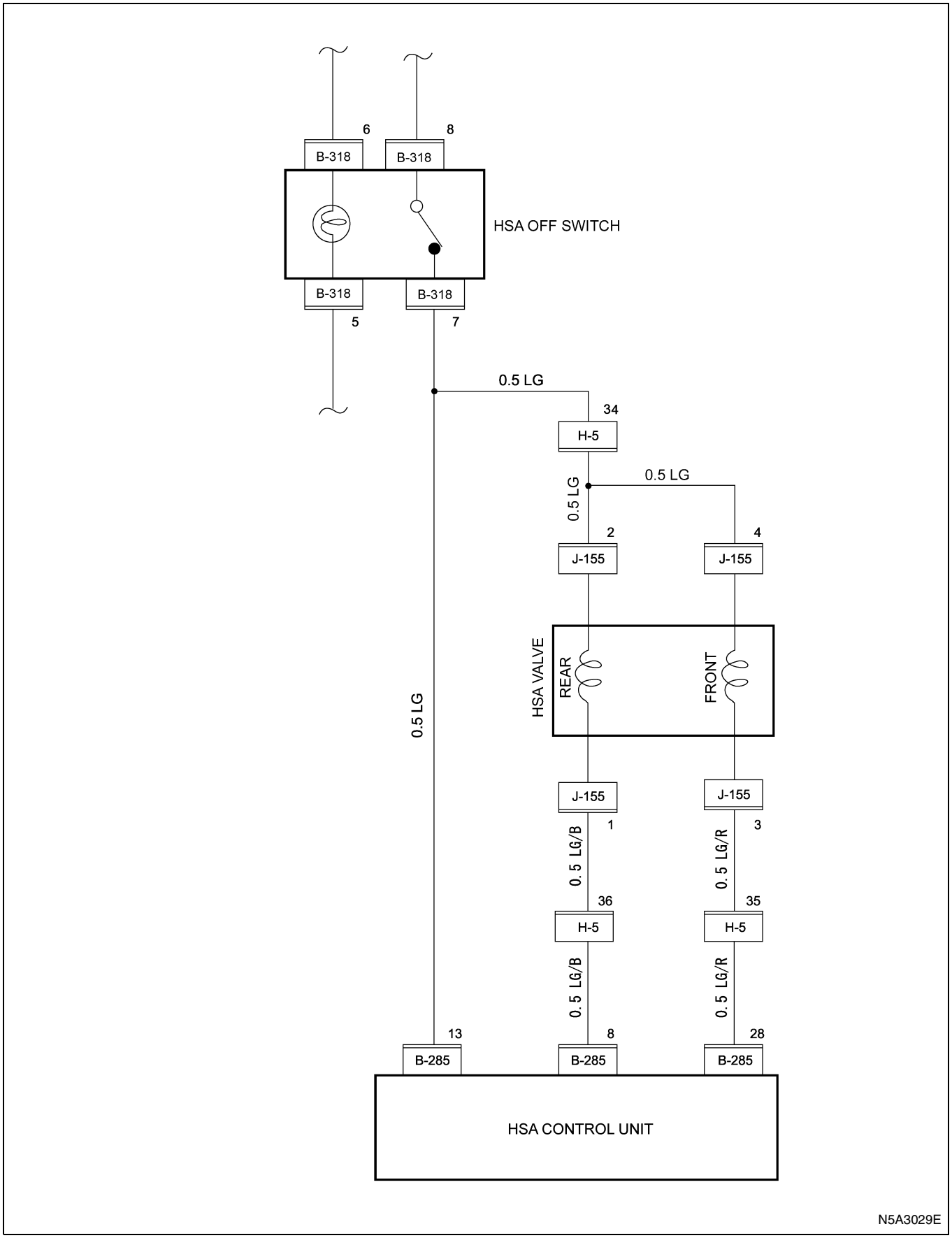
Step	Action	Value	YES	NO
15	Repair or replace the stop lamp switch. Is the repair completed?	—	Go to Step15	Go to Step15
16	Connect the connector of the stop lamp switch. Measure the battery voltage between the HSA control unit connector terminal 19 “B-285” and the body ground (with connector disconnected) with the brake pedal depressed. Is the measurement completed?	20V or more	Go to Step18	Go to Step19
17	Repair the open circuit between the fuse “F-5” and 1 “B-66” (stop lamp switch). Is the repair completed?	—	Go to Step18	Go to Step17
18	Is the continuity (resistance) of neutral switch normal?	—	Go to Step20	Go to Step21
19	Repair the open circuit between 2 “B-66” and 19 “B-285”. Is the repair completed?	—	Go to Step20	Go to Step19
20	Measure the battery voltage between the neutral switch connector terminal 2 “J-50” and the body ground (with the connector disconnected). Is the measurement completed?	20V or more	Go to Step22	Go to Step23
21	Repair or replace the neutral switch. Is the repair completed?	—	Go to Step22	Go to Step21
22	Connect the connector “J-50” of the neutral switch. Measure the battery voltage between the HSA control unit connector terminal 18 “B-285” and the body ground (with connector disconnected) with the gear in neutral. Is the measurement completed?	20V or more with gear in neutral, 0V with gear except in neutral	Go to Step24	Go to Step25
23	Repair the open circuit between the fuse “F-28” and 2 “J-50”. Is the repair completed?	—	Go to Step24	Go to Step23
24	Measure the voltage between the HSA control unit connector terminal 10 “B-285” and the body ground (connector disconnected) with engine running. Is the measurement completed?	Approx. 24 V	Go to Step26	Go to Step27
25	Repair the open circuit between 1 “J-50” and 18 “B-285”. Is the repair completed?	—	Go to Step26	Go to Step25
26	Replace the HSA control unit. Is the repair completed?	—	Go to Step28	Go to Step29
27	Repair the open circuit between the AC generator “L” terminal and 10 “B-285”. Is the repair completed?	—	Go to Step30	Go to Step27
28	Replace the HSA control unit. Is the repair completed?	—	Go to Step30	Go to Step28

Step	Action	Value	YES	NO
29	Repair or replace the parking brake switch. Is the repair completed?	—	Go to Step30	Go to Step29
30	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step30


18
B-51
METER
PARKING BRAKE
HSA
B-51
5
B-52
2
FUSE F-28
F-5 10A
ECM
F-17 10A
3
4 0.3W/V
10 0.3W/V
RELAY ; BUZZER
W/O HBB
WITH HBB
SHORT CONNECTOR
8
H-5
0.5BR
0.5W/B
2
1
J-128
J-128
HBB LEVEL SWITCH
0.3W/B
J-128
J-128
4
3
0.5B
0.5W/R
12
J-9
H-5
FRAME
0.3W/R
7
8
X-33
X-33
DIODE BOX
X-33
9
0.3W/B
H-12
3
0.5W/B
0.5W/B
1
N-6
PARKING BRAKE SWITCH
0.5G/Y
0.5B/Y
0.5B/O
0.3BR/W
STOP LAMP SWITCH
1
B-66
B-66
2
NEUTRAL SWITCH
2
J-50
J-50
1
0.5B/L
37
H-5
0.3B/L
0.5G
19
18
14
2
12
B-285
B-285
B-285
B-285
B-285
HSA CONTROL UNIT
B-285
30
0.5B
2B
3B
B-7
HEADLIGHT BRACKET (LH)
N5A3028E

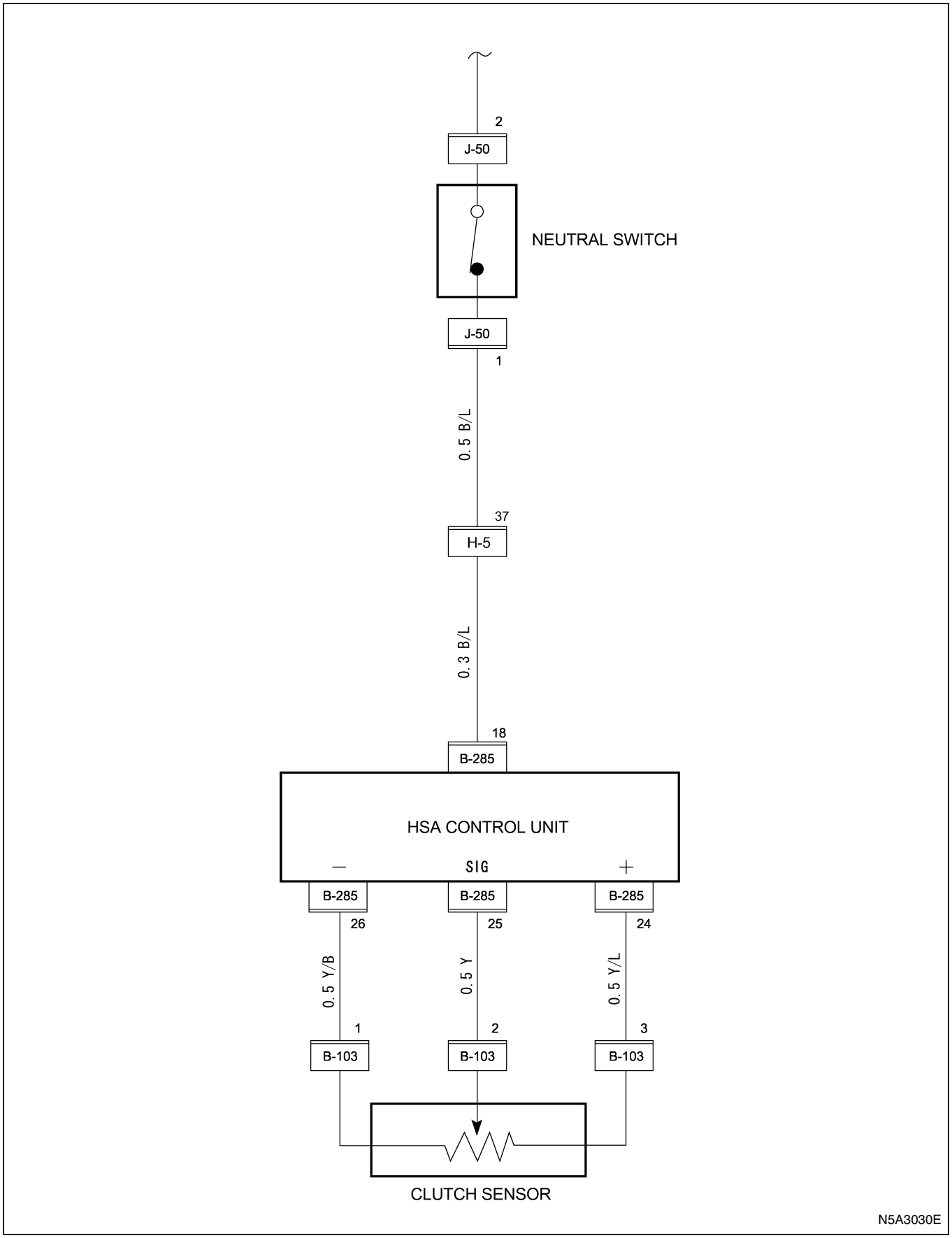
Symptom: HSA Does not Release Though the HSA Off Switch Is Depressed

Step	Action	Value	YES	NO
1	Is the continuity (resistance) of the HSA off switch normal?	—	Go to Step2	Go to Step3
2	Replace the HSA valve. Is the repair completed?	—	Go to Step4	Go to Step2
3	Replace the HSA off switch. Is the repair completed?	—	Go to Step4	Go to Step3
4	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step4


6
8
B-318
B-318
HSA OFF SWITCH
B-318
B-318
5
7
0.5 LG
34
H-5
0.5 LG
0.5 LG
2
4
J-155
J-155
HSA VALVE
REAR
FRONT
0.5 LG
J-155
J-155
1
3
0. 5 LG/B
0. 5 LG/R
36
35
H-5
H-5
0. 5 LG/B
0. 5 LG/R
13
8
28
B-285
B-285
B-285
HSA CONTROL UNIT
N5A3029E

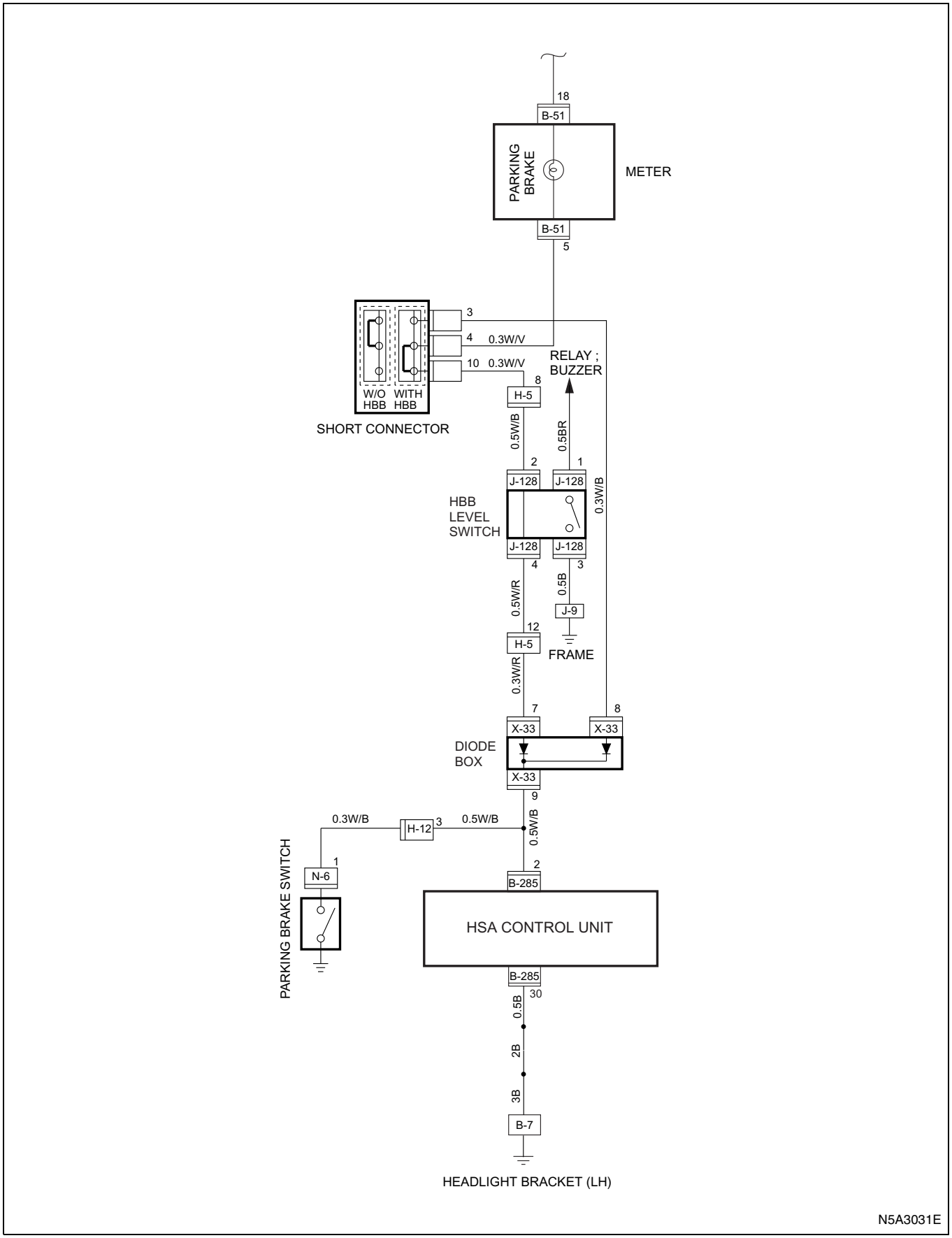
Symptom: HSA Does not Release Though the Vehicle Is Operated to Start (HSA Indicator Lamp Remains ON)

Step	Action	Value	YES	NO
1	Is the continuity (resistance) of neutral switch normal?	—	Go to Step2	Go to Step3
2	Is the clutch sensor properly installed (check the trouble code “08”)?	—	Go to Step4	Go to Step5
3	Repair or replace the neutral switch. Is the repair completed?	—	Go to Step4	Go to Step3
4	Is the resistance between the clutch sensor terminals within the specified range?	—	Go to Step6	Go to Step7
5	After installation, perform the initial adjustment. Is the repair completed?	—	Go to Step8	Go to Step8
6	Replace the HSA control unit. Is the repair completed?	—	Go to Step8	Go to Step6
7	Replace the clutch sensor. Is the repair completed?	—	Go to Step8	Go to Step7
8	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step8


2
J-50
NEUTRAL SWITCH
J-50
1
0.5 B/L
37
H-5
0.3 B/L
18
B-285
HSA CONTROL UNIT
–
SIG
+
B-285
B-285
B-285
26
25
24
0.5 Y/B
0.5 Y
0.5 Y/L
1
2
3
B-103
B-103
B-103
CLUTCH SENSOR
N5A3030E

Symptom: HSA Does not Release Though the Parking Brake Is Applied

Step	Action	Value	YES	NO
1	Is the continuity (resistance) of the parking brake switch normal?	—	Go to Step2	Go to Step3
2	Measure the battery voltage between the parking brake switch connector terminal 1 “N-6” and the body ground (with the connector disconnected). Is the measurement completed?	20V or more	Go to Step4	Go to Step5
3	Repair or replace the parking brake switch. Is the repair completed?	—	Go to Step4	Go to Step3
4	Measure the battery voltage between the HSA control unit connector terminal 2 “B-285” and the body ground (with connector disconnected). Is the measurement completed?	20V or more	Go to Step6	Go to Step7
5	Repair the improper connection or open circuit between 5 “B-51” (meter) and 1 “N-6”. Is the repair completed?	—	Go to Step7	Go to Step5
6	Replace the HSA control unit. Is the repair completed?	—	Go to Step8	Go to Step6
7	Repair the open circuit between 5 “B-51” (meter) and 2 “B-285”. Is the repair completed?	—	Go to Step8	Go to Step7
8	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step8

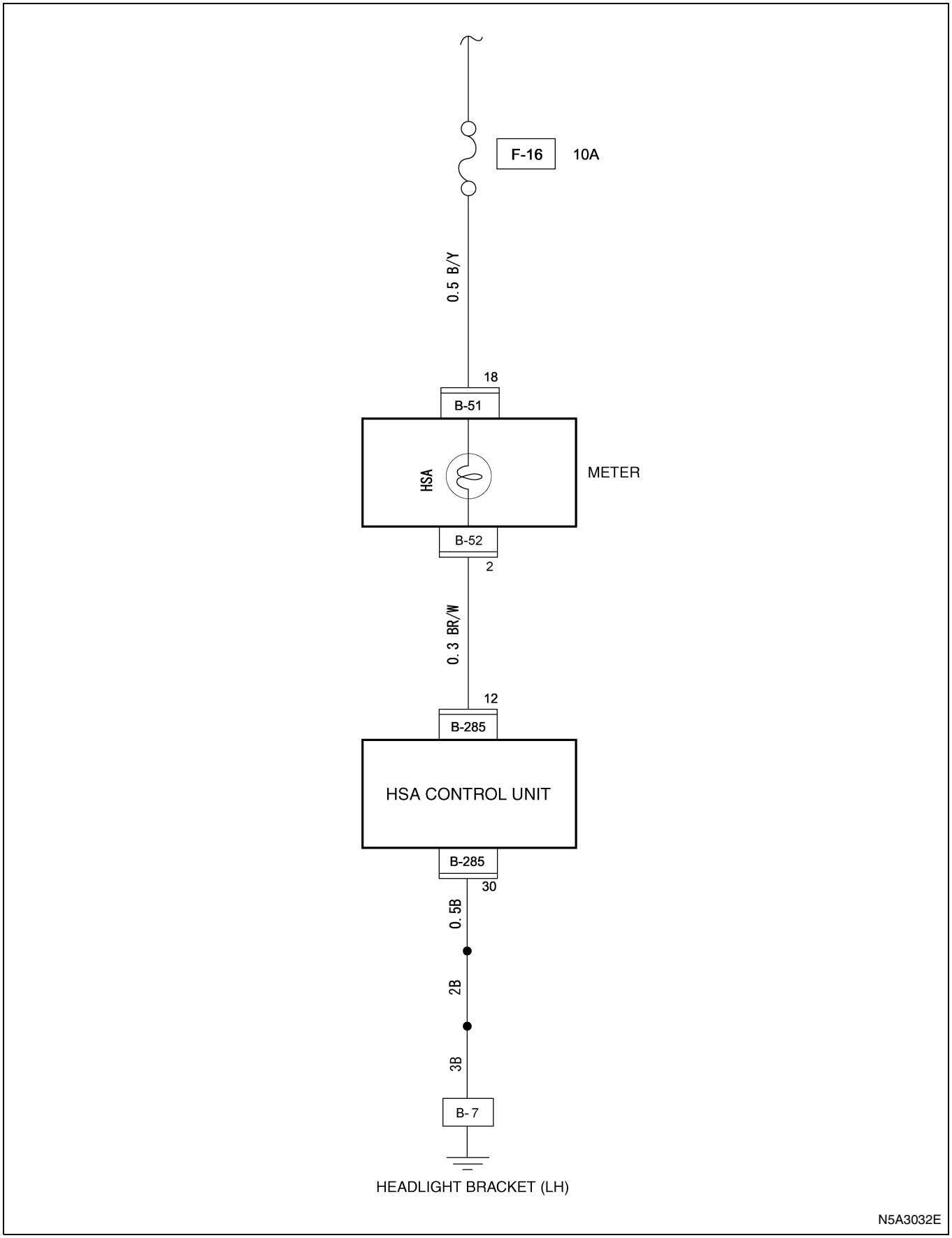

18
B-51
PARKING BRAKE
METER
B-51
5
3
4
0.3W/V
10
0.3W/V
RELAY ; BUZZER
8
H-5
W/O HBB
WITH HBB
SHORT CONNECTOR
0.5W/B
0.5BR
2
1
J-128
J-128
HBB LEVEL SWITCH
0.3W/B
J-128
J-128
4
3
0.5W/R
0.5B
J-9
12
H-5
FRAME
0.3W/R
7
8
X-33
X-33
DIODE BOX
X-33
9
0.3W/B
H-12
3
0.5W/B
0.5W/B
1
N-6
2
B-285
PARKING BRAKE SWITCH
HSA CONTROL UNIT
B-285
30
0.5B
2B
3B
B-7
HEADLIGHT BRACKET (LH)
N5A3031E

Symptom: HSA Indicator Lamp Does not Come On (HSA Does not Operate)

Step	Action	Value	YES	NO
1	Refer to “Symptom: HSA does not operate”. Is this step completed?	—	—	Go to Step1

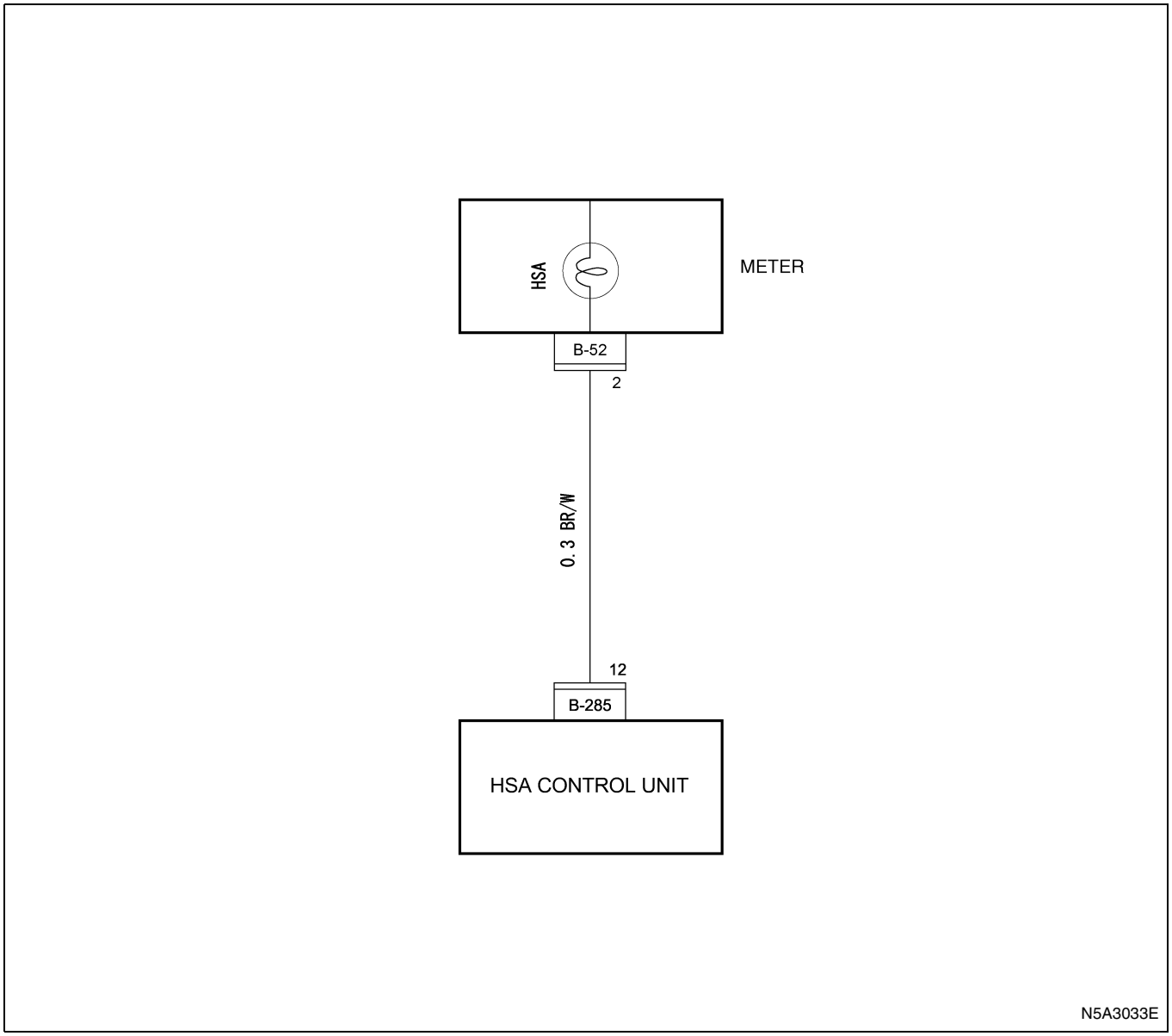
Symptom: HSA Indicator Lamp Does not Come On (HSA Does Operate)

Step	Action	Value	YES	NO
1	Does the meter operate normally?	—	Go to Step2	Go to Step3
2	Is the HSA indicator lamp normal?	—	Go to Step6	Go to Step7
3	Is the fuse “F-16” normal?	—	Go to Step4	Go to Step5
4	Repair the open circuit between the fuse “F-16” and 18 “B-51” (meter). Is the repair completed?	—	Go to Step5	Go to Step4
5	Replace the fuse. Is the repair completed?	—	Go to Step6	Go to Step5
6	Measure the battery voltage between the HSA control unit connector terminal 12 “B-285” and the body ground (with connector disconnected). Is the measurement completed?	20V or more	Go to Step8	Go to Step9
7	Replace the bulb. Is the repair completed?	—	Go to Step8	Go to Step7
8	Replace the HSA control unit. Is the repair completed?	—	Go to Step10	Go to Step8
9	Repair the open circuit between 2 “B-52” (meter) and 12 “B-285”. Is the repair completed?	—	Go to Step10	Go to Step9
10	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step10


F-16
10A
0.5 B/Y
18
B-51
HSA
METER
B-52
2
0.3 BR/W
12
B-285
HSA CONTROL UNIT
B-285
30
0.5B
2B
3B
B-7
HEADLIGHT BRACKET (LH)
N5A3032E

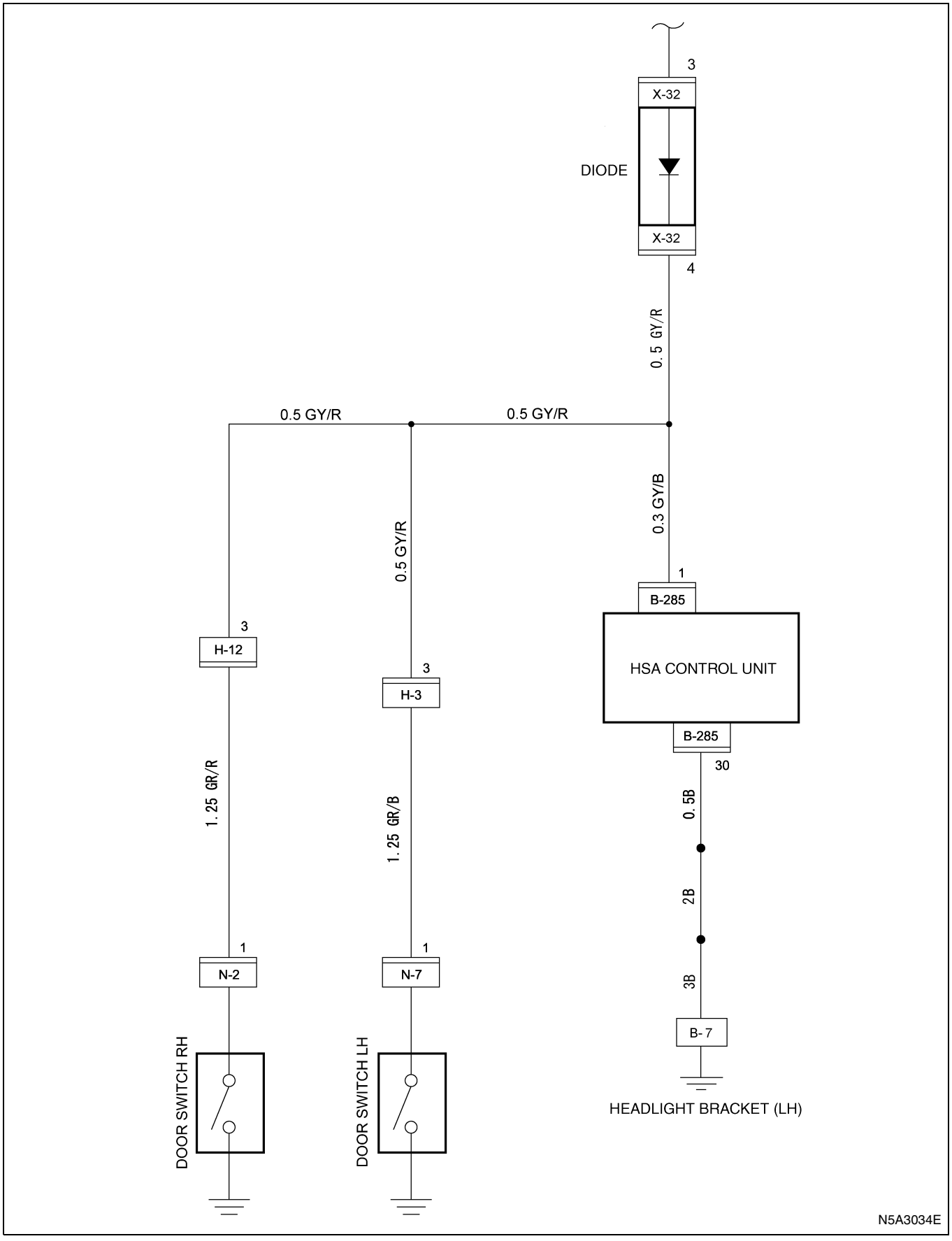
Symptom: HSA Indicator Lamp Does not Go Off (HSA Released)

Step	Action	Value	YES	NO
1	Does the HSA indicator lamp go off, when the connector of the HSA control unit is disconnected?	—	Go to Step2	Go to Step3
2	Replace the HSA control unit. Is the repair completed?	—	Go to Step4	Go to Step2
3	Repair the short circuit in the harness between 2 “B-52” (meter) and 12 “B-285” (control unit). Is the repair completed?	—	Go to Step4	Go to Step3
4	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	—



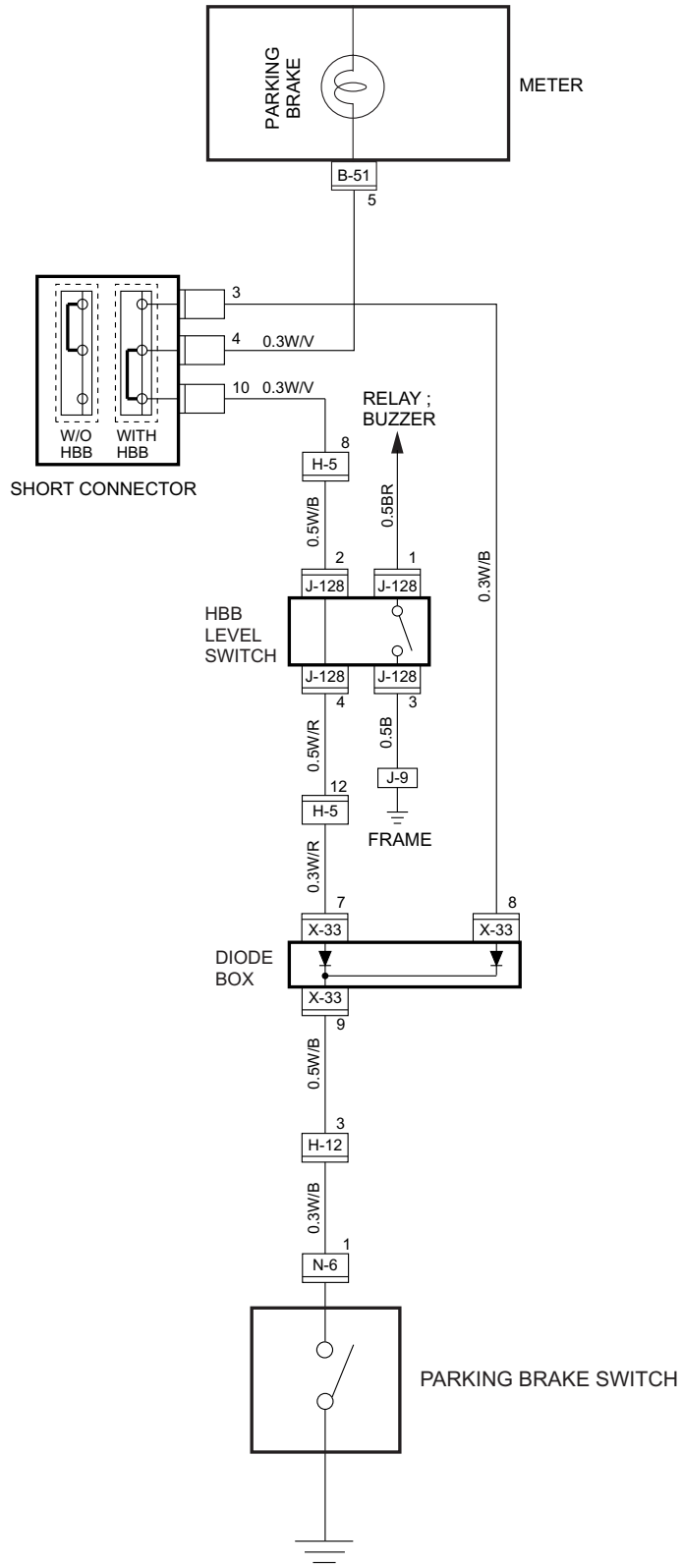
Symptom: Buzzer Does not Operate Though the Door Is Opened While HSA Operating

Step	Action	Value	YES	NO
1	Is the continuity (resistance) of the diode box normal?	—	Go to Step2	Go to Step3
2	Measure the voltage between the HSA control unit connector terminal 1 “B-285” and the body ground (connector disconnected) when the door opened. Also, measure the battery voltage when the door closed. Are the measurements completed?	Body ground voltage less than 3V Battery voltage 20 V or more	Go to Step4	Go to Step5
3	Replace the diode box. Is the repair completed?	—	Go to Step4	Go to Step3
4	Replace the HSA control unit. Is the repair completed?	—	Go to Step8	Go to Step4
5	Is the continuity (resistance) of the door switch normal?	—	Go to Step6	Go to Step6
6	Check the door switch circuit for open circuit, and the connector for improper connection. Is the repair completed?	—	Go to Step8	Go to Step6
7	Repair or replace the door switch. Is the repair completed?	—	Go to Step8	Go to Step6
8	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step8


3
X-32
DIODE
X-32
4
0.5 GY/R
0.5 GY/R
0.5 GY/R
0.3 GY/B
1
B-285
HSA CONTROL UNIT
B-285
30
0.5B
2B
3B
B-7
HEADLIGHT BRACKET (LH)
3
H-12
1.25 GR/R
1
N-2
DOOR SWITCH RH
0.5 GY/R
3
H-3
1.25 GR/B
1
N-7
DOOR SWITCH LH
N5A3034E

Symptom: HSA Indicator Lamp Blinks Abnormally and Does not Output the Trouble Cord During Self-diagnosis

Step	Action	Value	YES	NO
1	Does the parking brake lamp (meter) come on when the parking brake is applied?	—	Go to Step2	Go to Step3
2	Replace the HSA control unit. Is the repair completed?	—	Go to Step6	Go to Step2
3	Is the continuity (resistance) of the parking brake switch normal?	—	Go to Step4	Go to Step5
4	Repair the improper connection or open circuit between 5 “B-51” (meter) and 1 “N-6”. Is the repair completed?	—	Go to Step6	Go to Step4
5	Repair or replace the parking brake switch. Is the repair completed?	—	Go to Step6	Go to Step5
6	After HSA repair, make sure no trouble is found during self-diagnosis. Is this step completed?	—	—	Go to Step6


PARKING BRAKE
METER
B-51
5
3
4
0.3W/V
10
0.3W/V
W/O HBB
WITH HBB
SHORT CONNECTOR
RELAY ; BUZZER
8
H-5
0.5W/B
0.5BR
0.3W/B
2
1
J-128
J-128
HBB LEVEL SWITCH
J-128
J-128
4
3
0.5W/R
0.5B
J-9
12
H-5
FRAME
0.3W/R
7
8
X-33
X-33
DIODE BOX
X-33
9
0.5W/B
3
H-12
0.3W/B
1
N-6
PARKING BRAKE SWITCH

N5A3035E

Symptom: Buzzer Beeps Continuously During Self-diagnosis (Trouble Code Output Impossible)

Step	Action	Value	YES	NO
1	Refer to “Symptom: HSA indicator lamp blinks abnormally”. Is this step completed?	—	—	Go to Step1

Symptom: HSA Warning Lamp Had Blinked or Buzzer Had Beeped In the Past (Currently the System Is Normal)

Symptom	Possible cause	Action to be taken
HSA warning lamp had blinked in the past.	The warning lamp blinked when the back-up fuse “F-19” was disconnected.	The warning lamp blinked when the adjusted value was extremely off the point, or when the clutch play adjustment was not completed.
	This indicates no malfunction.	Properly adjust according to the adjustment procedure.
	The warning lamp blinked when the HSA had been operated for 7 — 8 minutes.	Longtime alarm. This indicates no malfunction.
	The warning lamp blinked when the vehicle had moved while the HSA operating. (The warning lamp blinked when the vehicle was started with brake dragged, or when the vehicle moved back because the brake pedal was depressed insufficiently.)	Vehicle motion alarm This indicates no malfunction.
	The warning lamp blinked when the adjust switch “FAST” or “SLOW” was depressed while the vehicle running.	Fault in adjust switch (code 19) was detected but not a malfunction. (When turning the adjust switch to OFF, the diagnosis stops and the lamp goes off.)
HSA warning buzzer had beeped in the past.	The warning buzzer beeped when the HSA had been operated for 7 — 8 minutes.	Longtime alarm. This indicates no malfunction.
	The warning buzzer beeped when the vehicle had moved while the HSA operating. (The warning lamp blinked when the vehicle was started with brake dragged, or when the vehicle moved back because the brake pedal was depressed insufficiently.)	Vehicle motion alarm. This indicates no malfunction.
	The warning buzzer beeped when the starter switch was turned ON with the back-up fuse “F-19” disconnected.	It was caused by the control unit being reset, and not a malfunction.

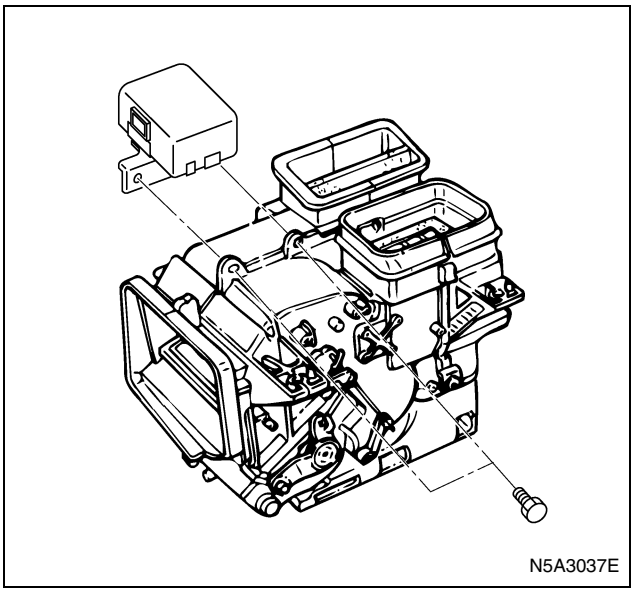
Caution:
The trouble code 03 is displayed when diagnosing with the fuse removed.
The warning lamp blinks when the HSA release adjustment is set-up fully to the FAST side or SLOW side with the HSA adjust switch depressed. With this condition, the vehicle will move back when starting or brake dragging. To prevent this, correctly adjust it.
Never operate the adjust switch while driving. Otherwise, it will lower the driver performance.

HSA Control Unit

Removal

1. Remove the instrument panel ASM.
   - Refer to the item regarding the instrument panel in the chapter 2 body section.
2. Remove the ventilation duct.
3. Remove the HSA control unit.
   - Remove the two installing bolts and nuts.

     Disconnect the two connectors.



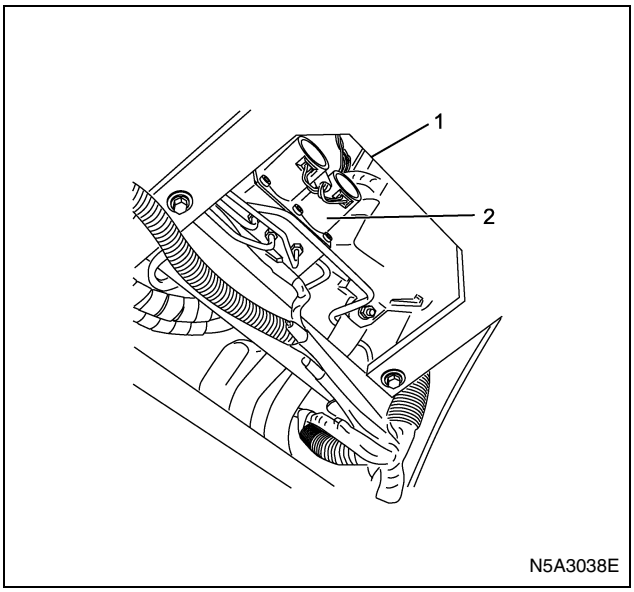
Installation

Install in the reverse order of removal.

HSA Valve

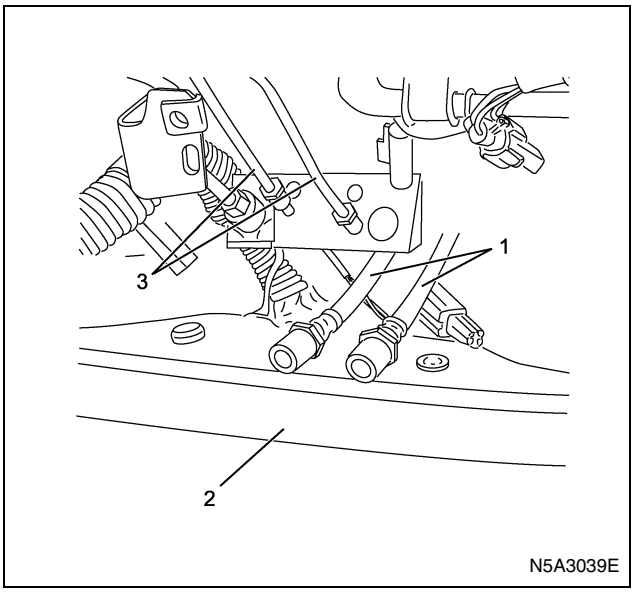
Removal

1. Remove the undercover.



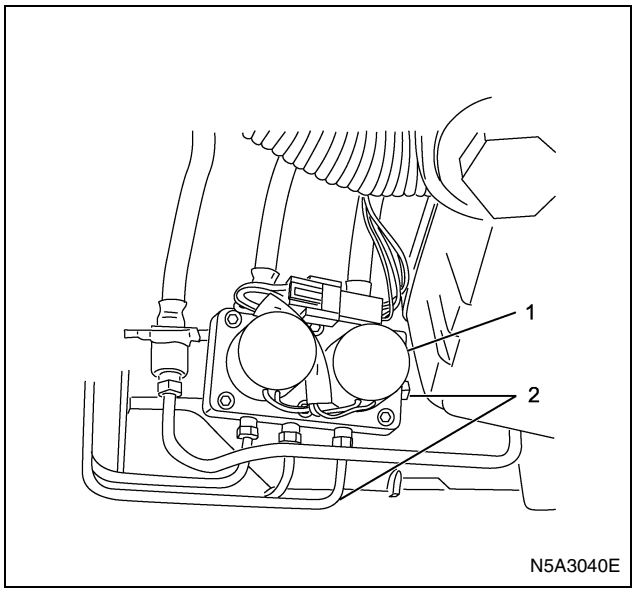
Legend
1. Undercover
2. HSA valve

2. Disconnect the HSA valve connector.



Legend
1. Hose
2. Bumper
3. Brake pipe

3. Remove the radiator grille.
4. Disconnect the connection of the brake pipe and the hose.



Legend
1. HSA valve
2. Pipe

5. Disconnect the pipe.
6. Disconnect the HSA valve.

Installation

1. Install the two installing bolts of HSA valve.

Tighten:
Bolts to 21 N·m (2.1 kg·m/15.5 lb·ft)

2. Install the brake pipe.

Tighten:
Brake pipe to 16 N·m (1.6 kg·m/11.8 lb·ft)

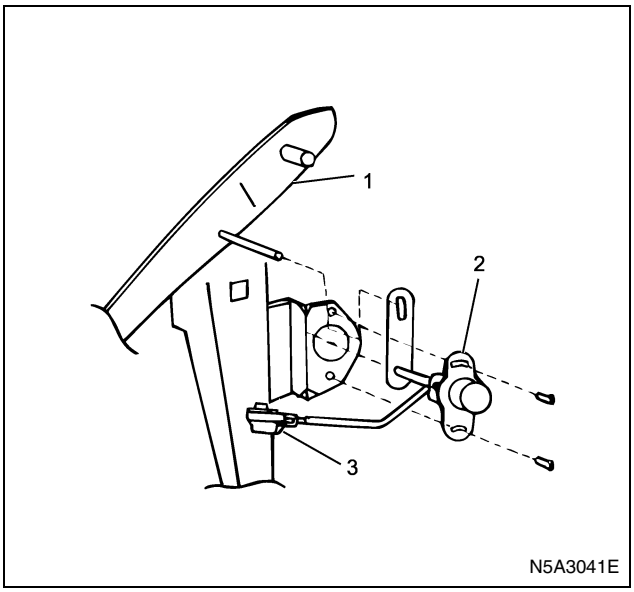
3. Connect the connector.

Caution:
- Make sure there is no dust or foreign materials in and around the pipe connection.
- Be careful to correctly connect the pipe.
- After installation, bleed air from the brake system completely.
- Be sure to use fresh specified brake fluid.

Clutch Sensor

Removal

1. Disconnect the connection of the connector.
2. Remove the two installing bolts of the clutch sensor.



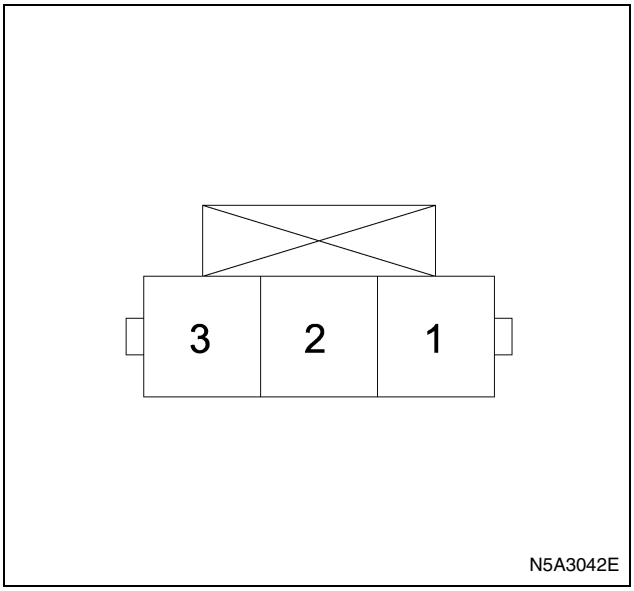
Legend

1. Clutch pedal
2. Clutch sensor
3. Connector

Inspection

Disconnect the connector of the clutch sensor, and measure the resistance between terminals.

1. Terminal 1 — Terminal 3 — 2kΩ±400Ω
2. Clutch pedal operated
   - Terminal 2 — Terminal 1 — Approx. 400Ω — 2.8kΩ

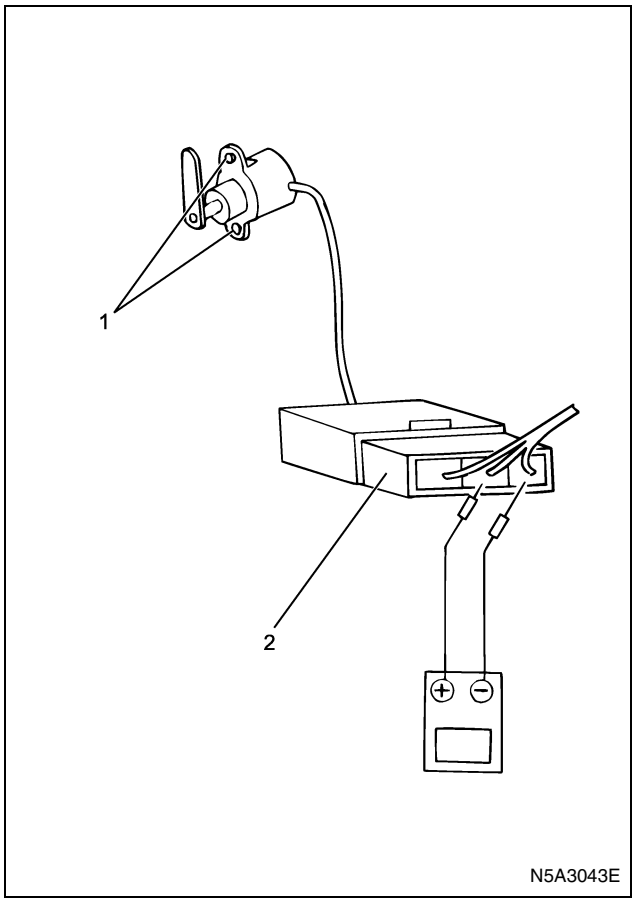


Adjustment

1. Loosen the installing bolts of the clutch sensor.
2. Turn the starter switch to “ON”.
3. Adjust the sensor installing position so that the voltage between the clutch sensor connector terminals 2 (SIG) — terminal 1 (GND) is 0.5±0.2V when the clutch pedal is fully released (clutch fully engaged).

Caution:

- Adjust with the clutch sensor connector connected to the body side harness connector.
- For voltage check, connect the tester from the backside of the body side connector.



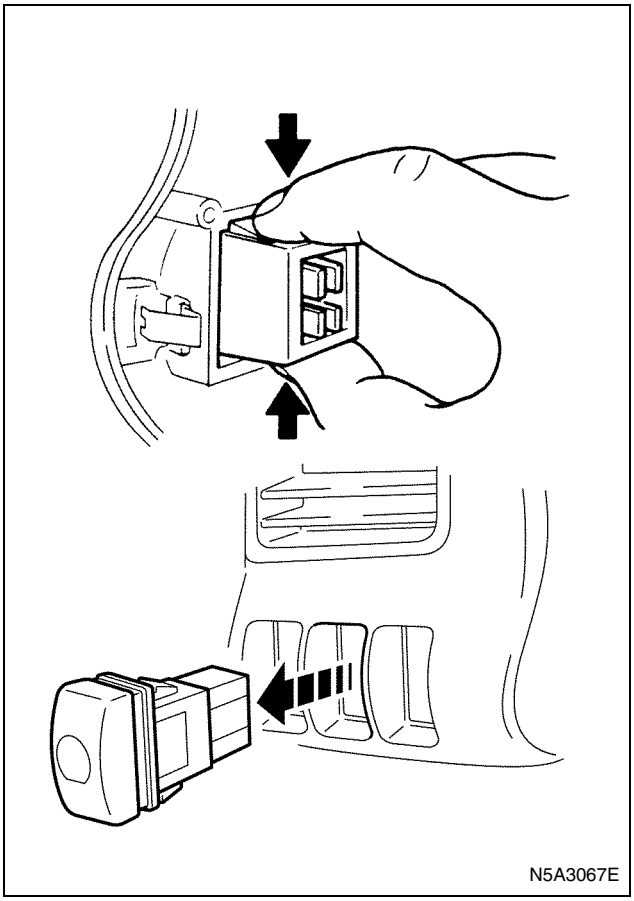
Legend

1. Clutch sensor installing nut
2. Body side connector

HSA Off Switch

Removal

1. Remove the meter clutster.
2. Disconnect the connector.
3. Remove the HSA off switch.
   - Remove it while pressing the switch claw from the backside of the instrument panel.

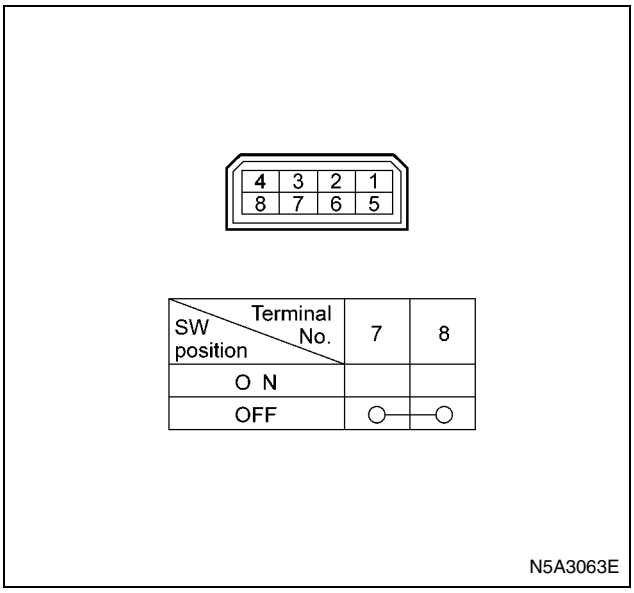


Installation

Install in the reverse order of removal.

Inspection

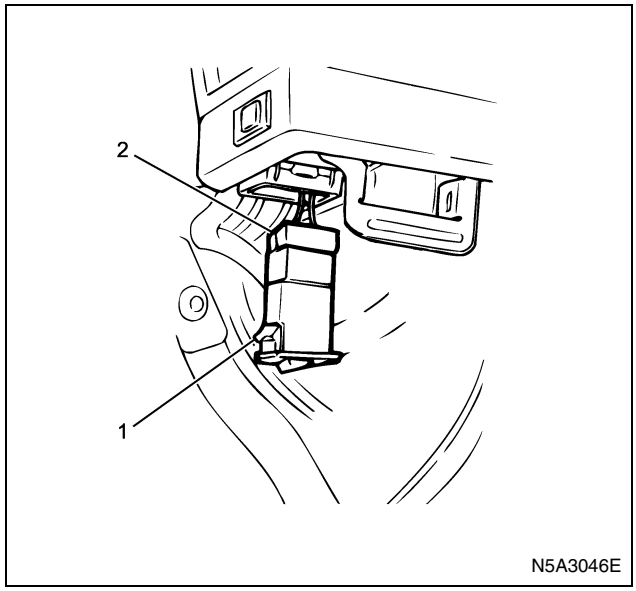
Check for continuity between the switch terminals.



HSA Reset Switch

Removal

1. Remove the HSA reset switch.
2. Disconnect the connector.

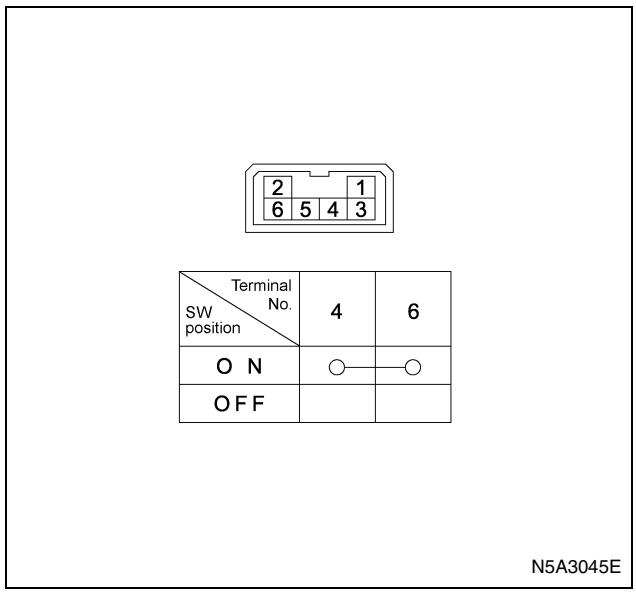


Legend

1. HSA reset switch
2. Connector

Inspection

Check for continuity between the switch terminals.



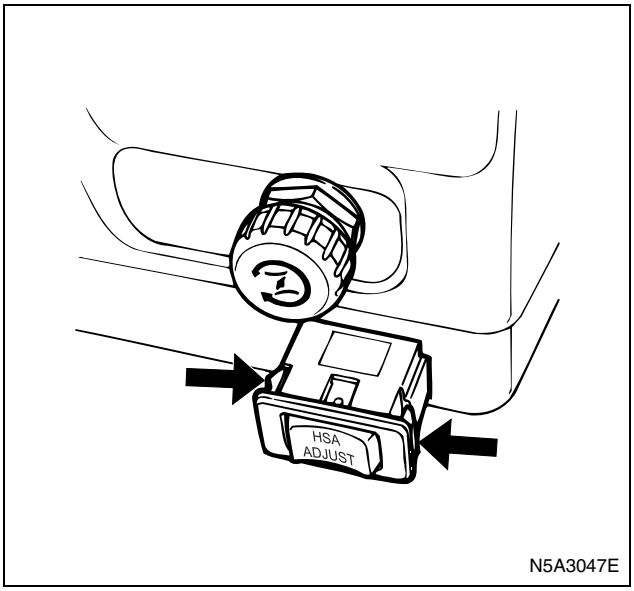
Installation

Install in the reverse order of removal.

HSA Adjust Switch

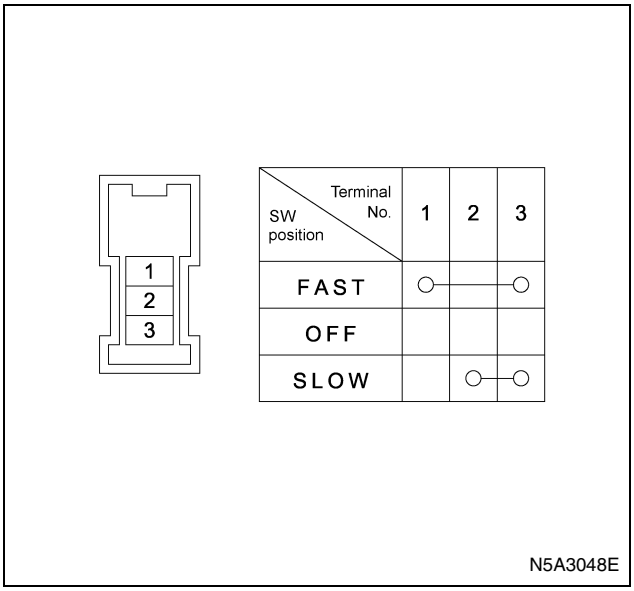
Removal

1. Disconnect the connector.
2. Remove the HSA adjust switch.
   - Remove it while pressing the switch claw from the backside of the instrument panel.



Inspection

Check for continuity between the switch terminals.



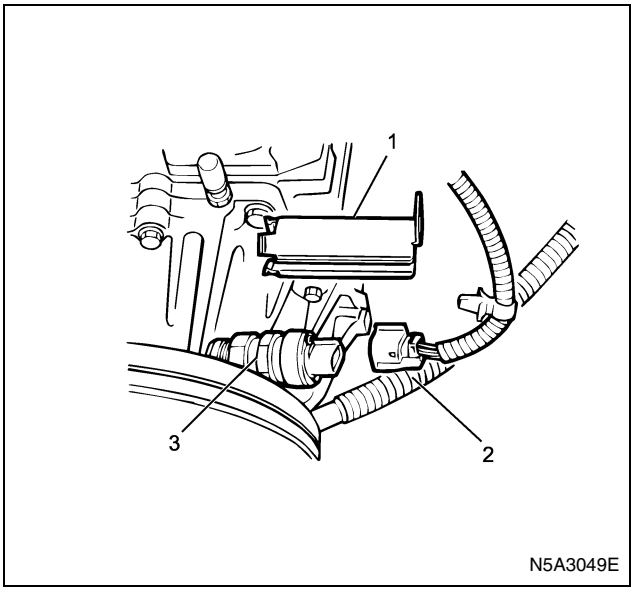
Installation

Install in the reverse order of removal.

Speed Sensor

Removal

1. Remove the protector.
2. Disconnect the connection of the connector.
3. Remove the speed sensor.



Legend

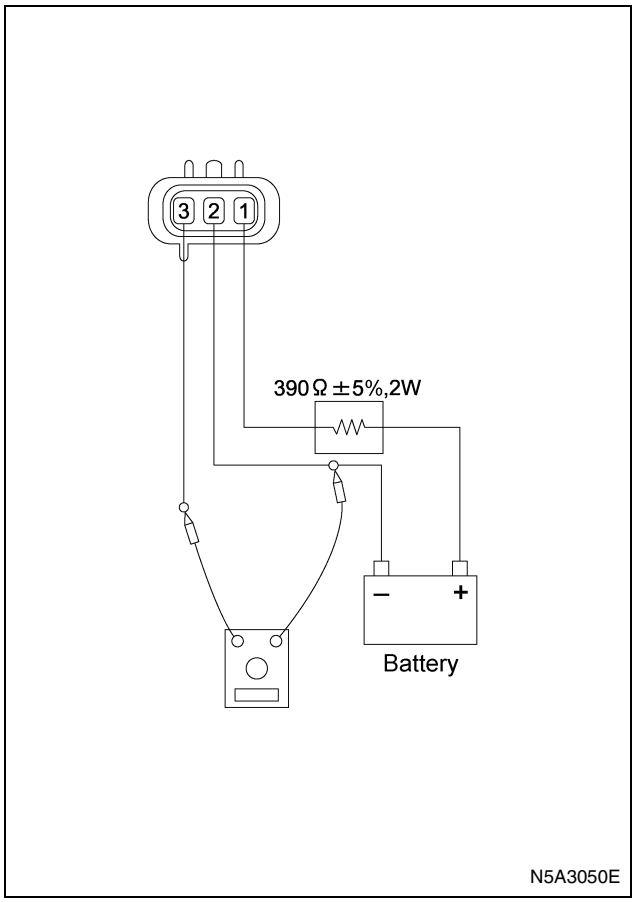
1. Protector
2. Connector
3. Speed sensor

Inspection

1. Connect a resistance of 390Ω±5%, 2W between the speed sensor connector terminal 1 “J-32” and the battery (+) terminal, and connect 2 “J-32” to the battery (−) terminal.

Caution:
Never connect the battery (+) terminal to the connector 3 “J-32”. It may cause the speed sensor failure.

2. Measure the voltage between 3 “J-32” and 2 “J-32” using a digital tester while slowly rotating the speed sensor shaft.
   The voltage shows 2V±1V and 14V (+1V, −2V) repeatedly for 8 times per one rotation of the shaft.
   If the result of the inspection is unsatisfactory, replace with a new part.



Installation

1. Install the speed sensor.

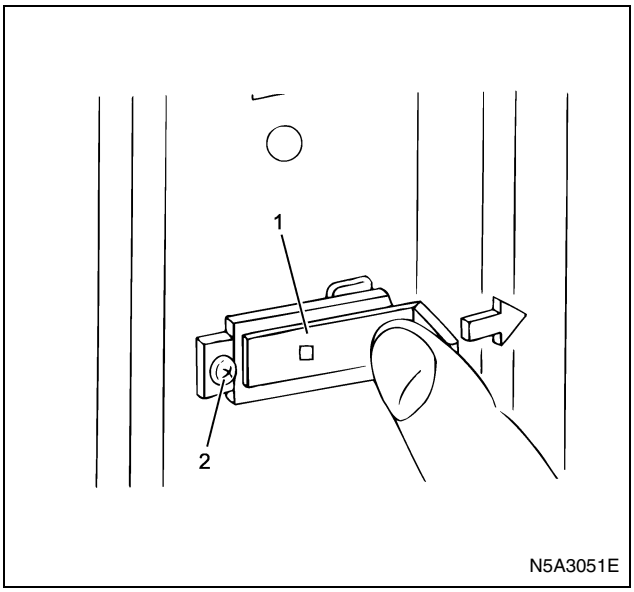
Tighten:
Speed sensor to 25 N·m (2.5 kg·m/18.4 lb·ft)

2. Install the protector.
3. Connect the connector.

Door Switch

Removal

1. Remove the installing screw while pressing the sliding part of the door switch.
   - Disconnect the connector.

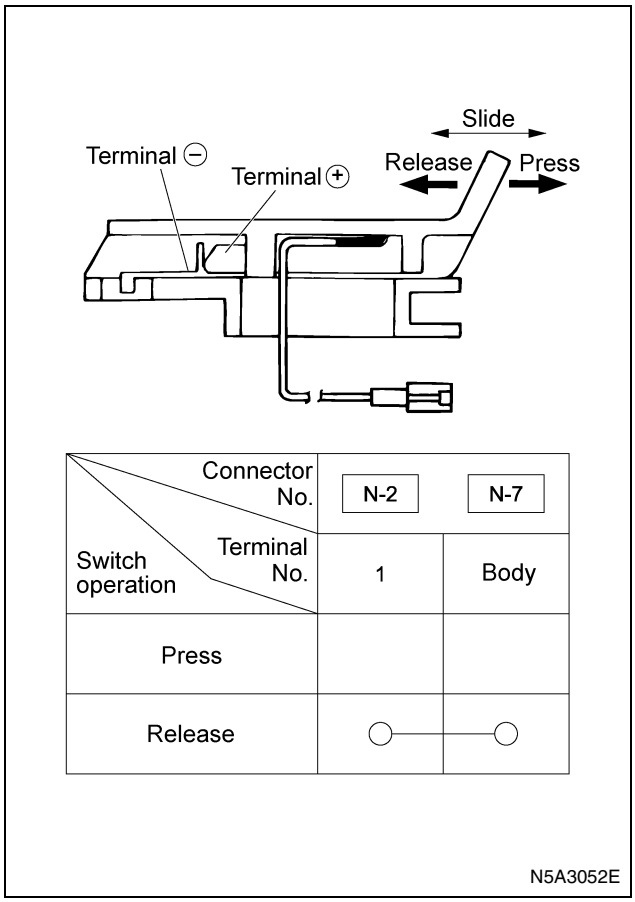


Legend

1. Sliding part
2. Screw

Inspection

Move the sliding part to check for continuity between the terminal and the body.



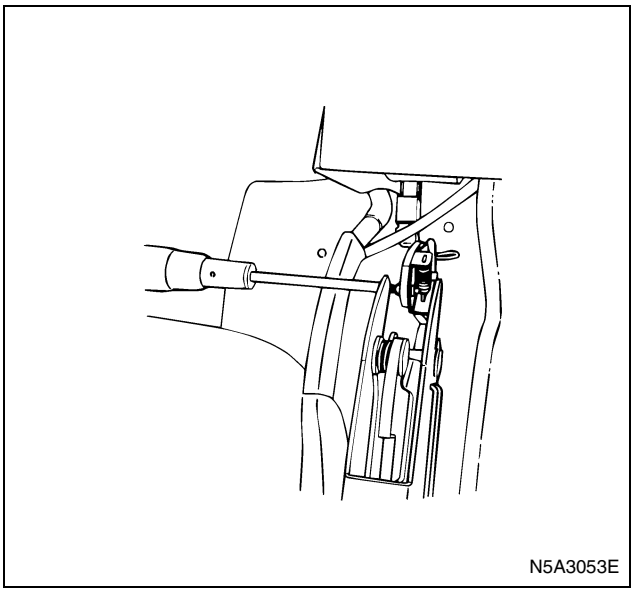
Installation

Install in the reverse order of removal.

Parking Brake Switch

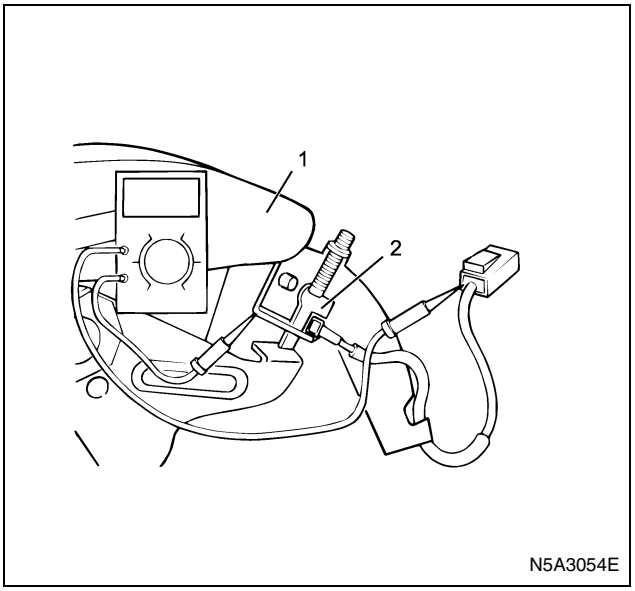
Removal

1. Remove the parking brake rear cover.
   - Disconnect the two clips.
2. Remove the parking brake switch.
   - Remove the one installing screw.
   - Disconnect the connector.



Inspection

1. Disconnect the parking brake switch connector.
2. Connect the circuit between the switch terminal and the body to check for continuity.
   With parking brake applied = Continuity exists
   With parking brake released = No continuity
   If the result of the inspection is unsatisfactory, repair or replace with a new part.



Legend

1. Parking brake lever
2. Parking brake switch

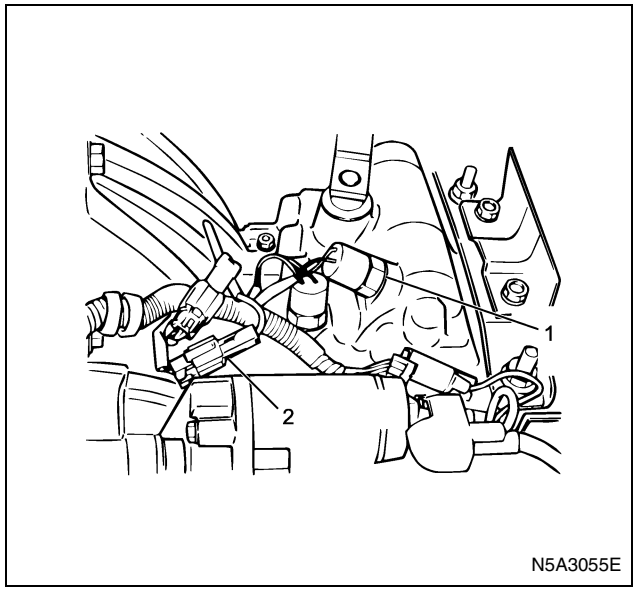
Installation

Install in the reverse order of removal.

Neutral Switch

Removal

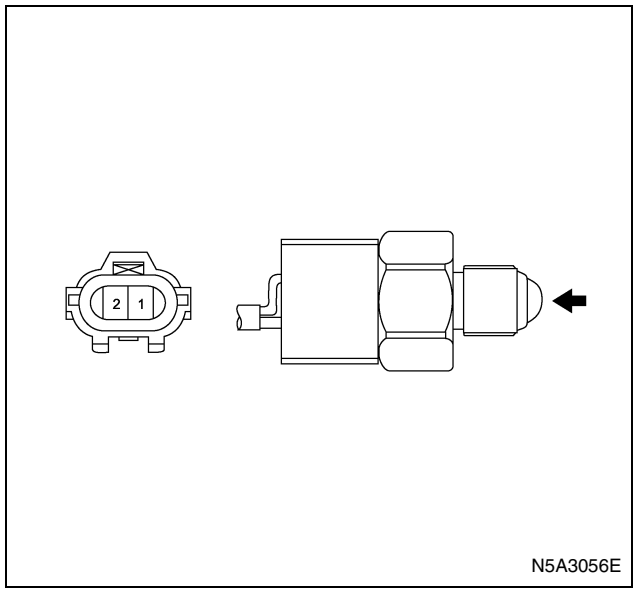
1. Remove the neutral switch.
   - Disconnect the connector.
   - Twist off the switch to remove.



Legend
1. Neutral switch
2. Connector (gray)

Inspection

Press the switch to check the continuity between the connector terminals.
With switch released = Continuity exists
With switch pressed = No continuity



Installation

1. Apply liquid gasket to the threaded portion of the neutral switch to install.

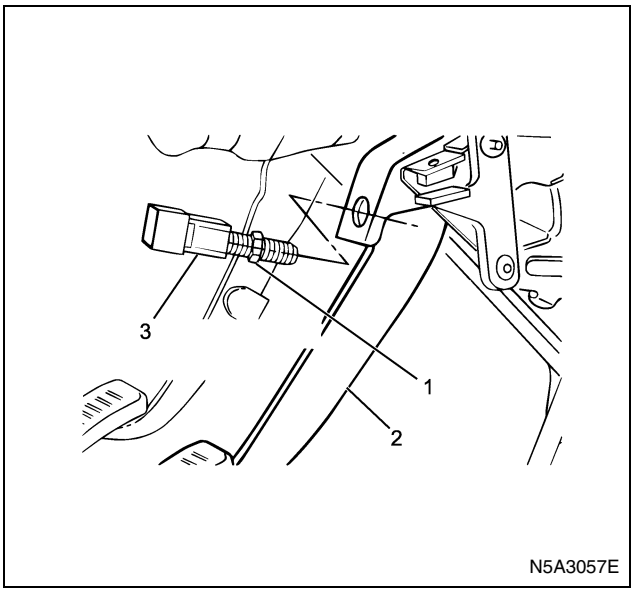
Liquid gasket: THREE BOND 1141

Tighten:
Neutral switch to 34 N·m (3.5 kg·m/25.1 lb·ft)

Stop Lamp Switch

Removal

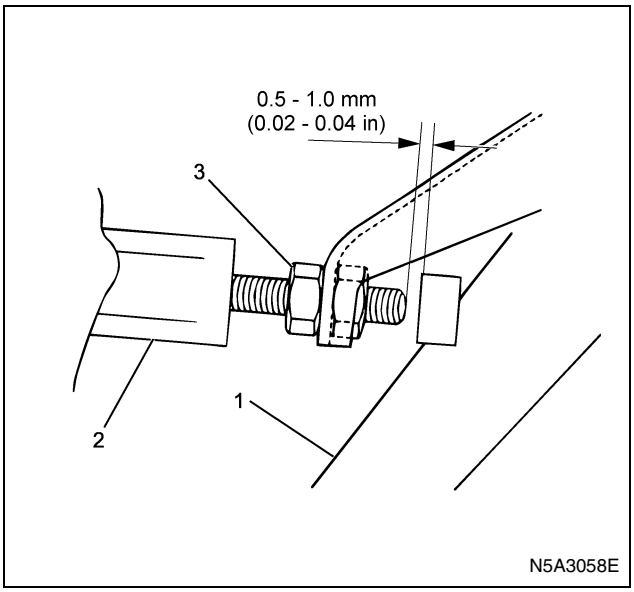
1. Remove the stop lamp switch.
   - Disconnect the connector of the stop lamp switch.
   - Loosen the lock nut.
   - Turn the switch body to remove from the bracket.



Legend
1. Lock nut
2. Brake pedal
3. Stop lamp switch

Installation

1. Install the stop lamp switch.
   - Screw in until the thread end of the stop lamp switch contacts the brake pedal.



Legend
1. Brake pedal
2. Stop lamp switch
3. Lock nut

Caution:
Screw in until the thread end of the stop lamp switch contacts the brake pedal.

- After contacting with the pedal, back off the switch to make clearance between 0.5 — 1.0 mm (0.02 — 0.04 in), and then tighten the lock nut.

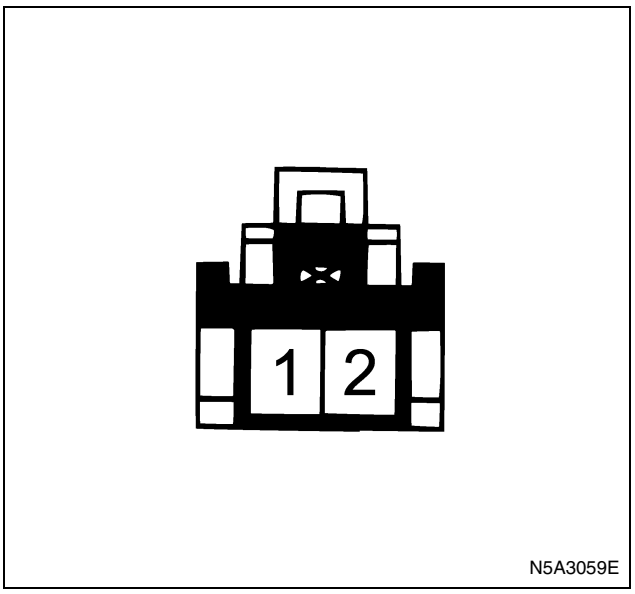
Clutch Fluid Pressure Switch

Removal

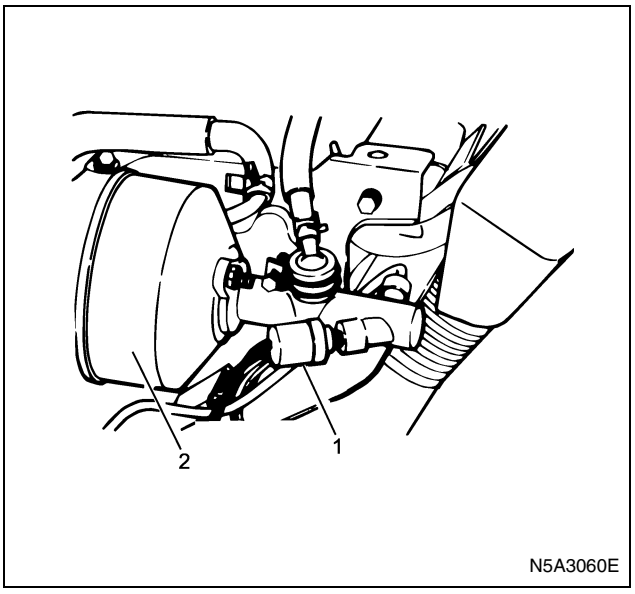
1. Check the clutch fluid pressure switch.
   - Disconnect the clutch fluid pressure switch connector, and check for continuity between the connector terminals with the clutch pedal fully depressed/released.

     With clutch pedal depressed = Continuity exists

     With clutch pedal released = No continuity



2. Remove the clutch fluid pressure switch.
   - Disconnect the connector, and twist off the hexagon nut portion of the switch.



Legend
1. Clutch fluid pressure switch
2. Clutch booster

Installation

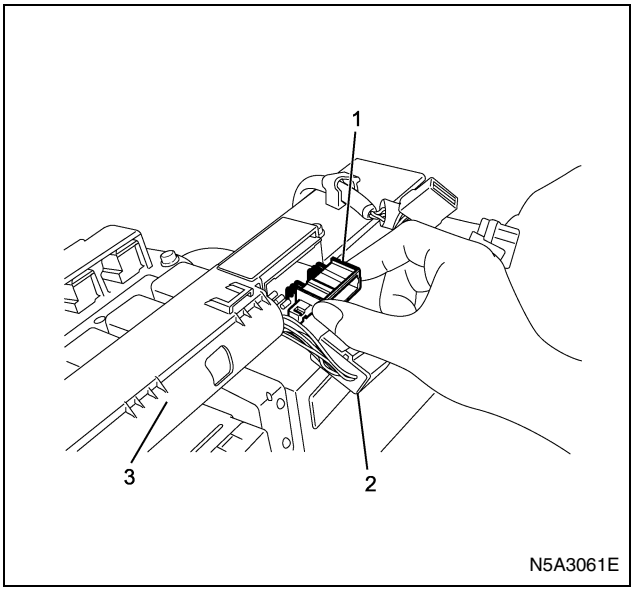
1. Install the clutch fluid pressure switch.

Tighten:
Clutch fluid pressure switch to 15 N·m (1.5 kg·m/11.1 lb·ft)

Diode Box

Removal

1. Remove the instrument panel.
2. Disconnect the connector.
3. Remove the diode box.

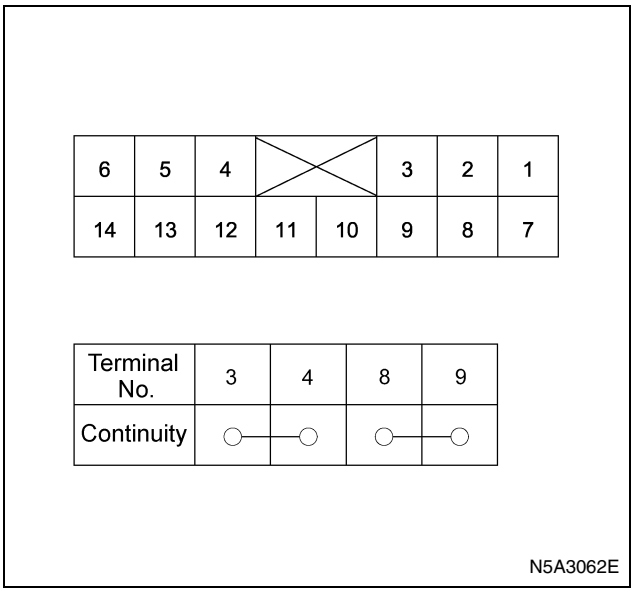


Legend

1. Diode box
2. Connector
3. Relay box

Inspection

Check for continuity between the unit terminals.



Installation

Install in the reverse order of removal.

ENGINE 4H SERIES

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SERVICE INFORMATION

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TROUBLESHOOTING

Hard Starting

1. Starter Inoperative

Checkpoint	Possible cause	Correction
Battery	Loose battery cable terminal Poor connections due to rusting	Clean and/or retighten the battery cable terminal
	Battery discharged or weak	Recharge or replace the battery
	Fan belt loose or broken	Adjust or replace the fan belt
Fusible link	Fusible link shorted	Replace the fusible link
Starter switch	Defective starter switch or starter relay	Replace the starter switch or the starter relay
Starter motor	Defective magnetic switch or starter relay	Repair or replace the magnetic switch
	Defective starter motor	Repair or replace the starter motor

2. Starter Motor Operates But Engine Does Not Turn Over

Checkpoint	Possible cause	Correction
Battery	Loose battery cable terminal Poor connections due to rusting	Clean and/or retighten the battery cable terminal
	Battery discharged or weak	Recharge or replace the battery
	Fan belt loose or broken	Adjust or replace the fan belt
Starter motor	Defective pinion gear	Replace the pinion gear
	Defective magnetic switch	Repair or replace the magnetic switch
	Brush wear, Weak brush spring	Replace the brush and/or the brush spring
Engine	Piston, crank bearing seizure, or other damage	Repair or replace the related parts

3. Engine Turns Over But Does Not Start

Checkpoint	Possible cause	Correction
Engine stop mechanism	Defective fuel cut solenoid valve	Replace the fuel cut solenoid valve

Fuel is Not Being Delivered to The Injection Pump

Fuel	Fuel tank is empty	Fill the fuel tank
Fuel piping	Clogged or damaged fuel lines Loose fuel line connection	Repair or replace the fuel lines Retighten the fuel line connection
Fuel filter	Fuel filter overflow valve does not close	Repair or replace the fuel filter overflow valve
	Clogged fuel filter element	Replace the fuel filter element or the filter cartridge
Fuel system	Air in the fuel system	Bleed the air from the fuel system
Fuel feed pump	Defective feed pump	Repair or replace the feed pump

Fuel is Being Delivered to The Injection Pump

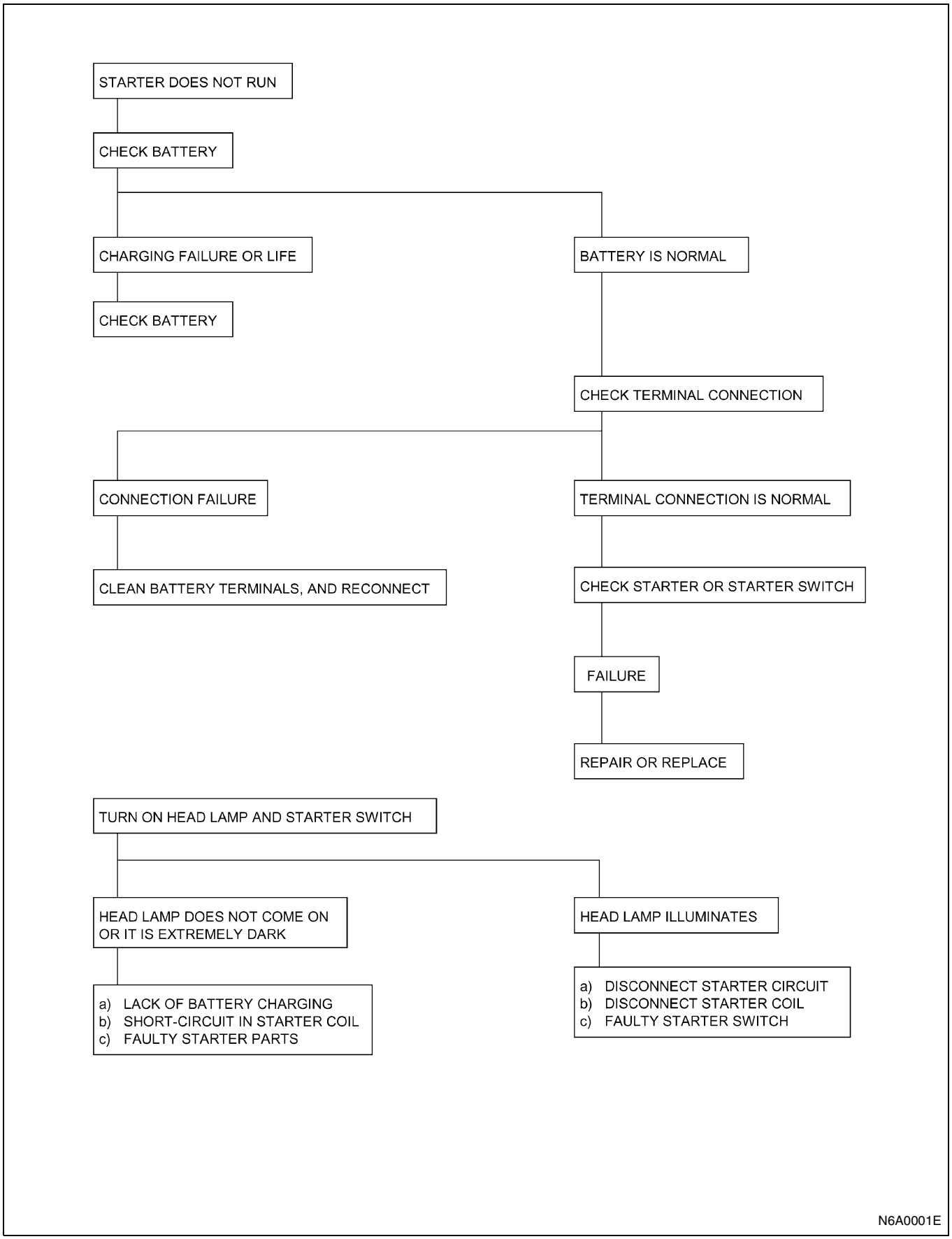
Fuel	Use of the wrong fuel	Use the correct fuel
	Water particles in the fuel	Charge the fuel
Fuel system	Air in the injection pump	Bleed the air from the fuel system

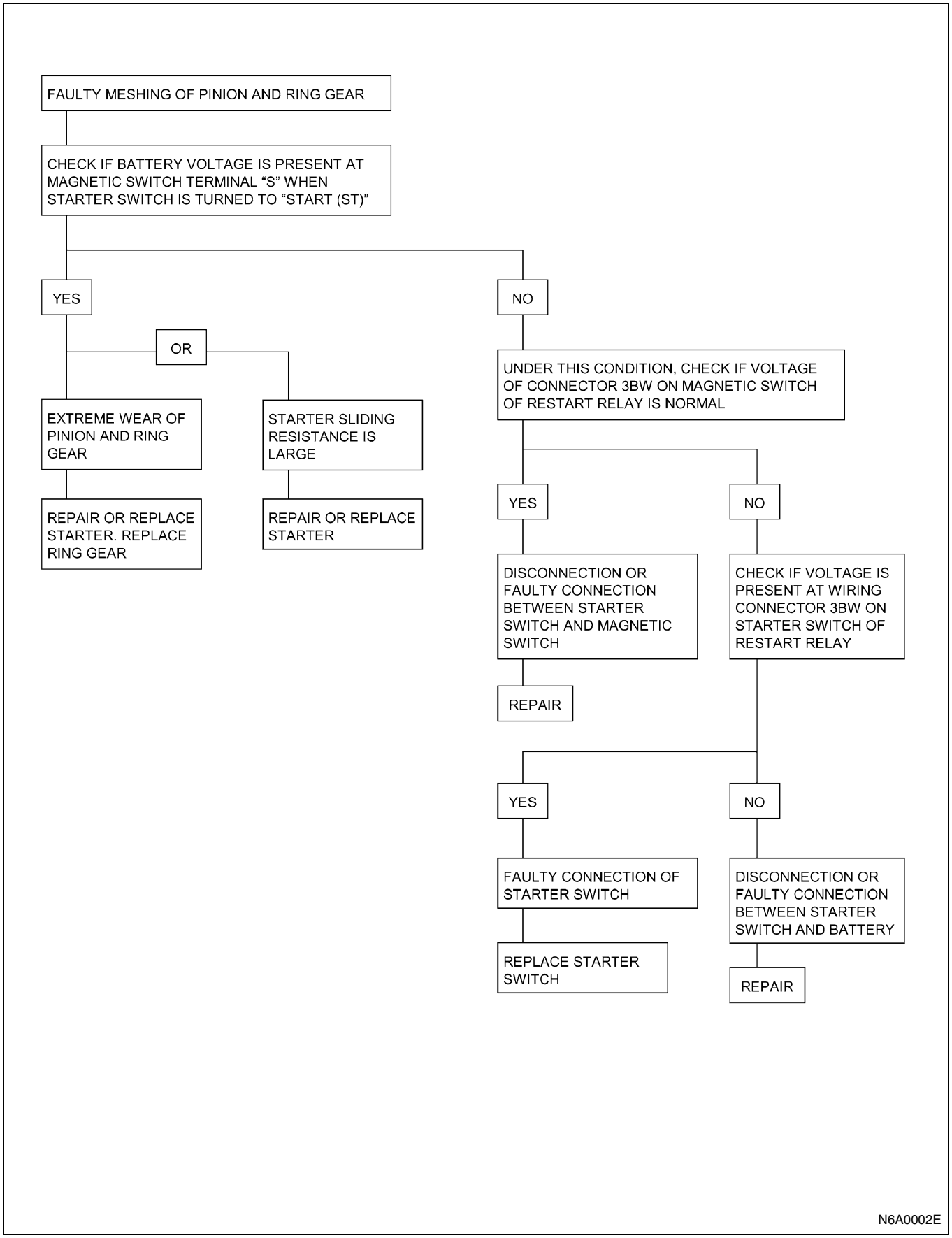
Checkpoint	Possible cause	Correction
Injection nozzle	Injection nozzle sticking	Replace the injection nozzle
	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
Injection pump	Defective fuel injection nozzle resulting in the fuel drippage after fuel injection	Replace the delivery valve
	Defective injection pump control rack operation	Repair or replace the injection pump control rack
	Injection pump plunger worn or stuck	Replace the injection pump plunger assembly
	Injection pump drive shaft seizure or other damage	Replace the injection drive shaft
	Injection pump governor spring seizure	Replace the injection pump governor spring

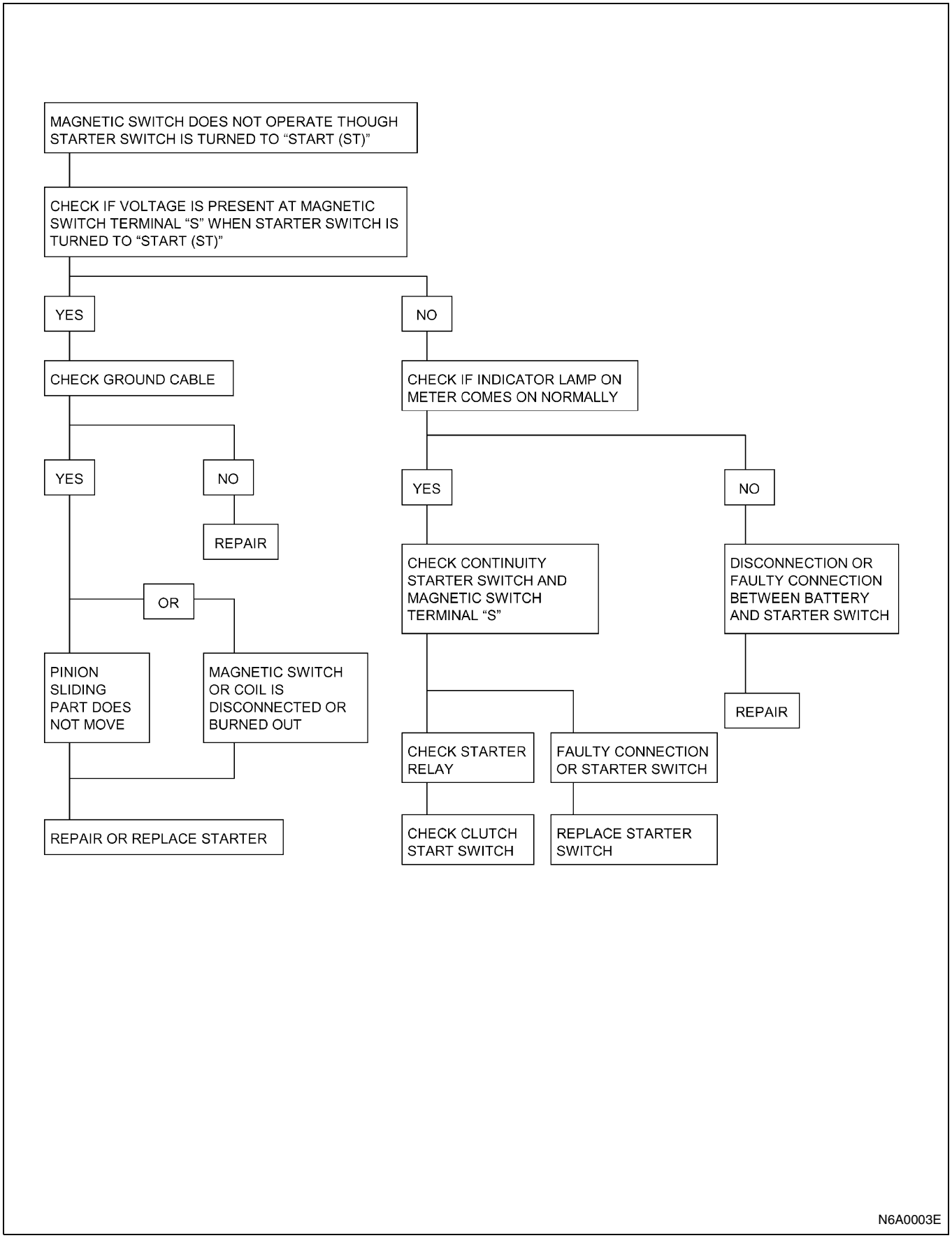
4. Quick-on Start System

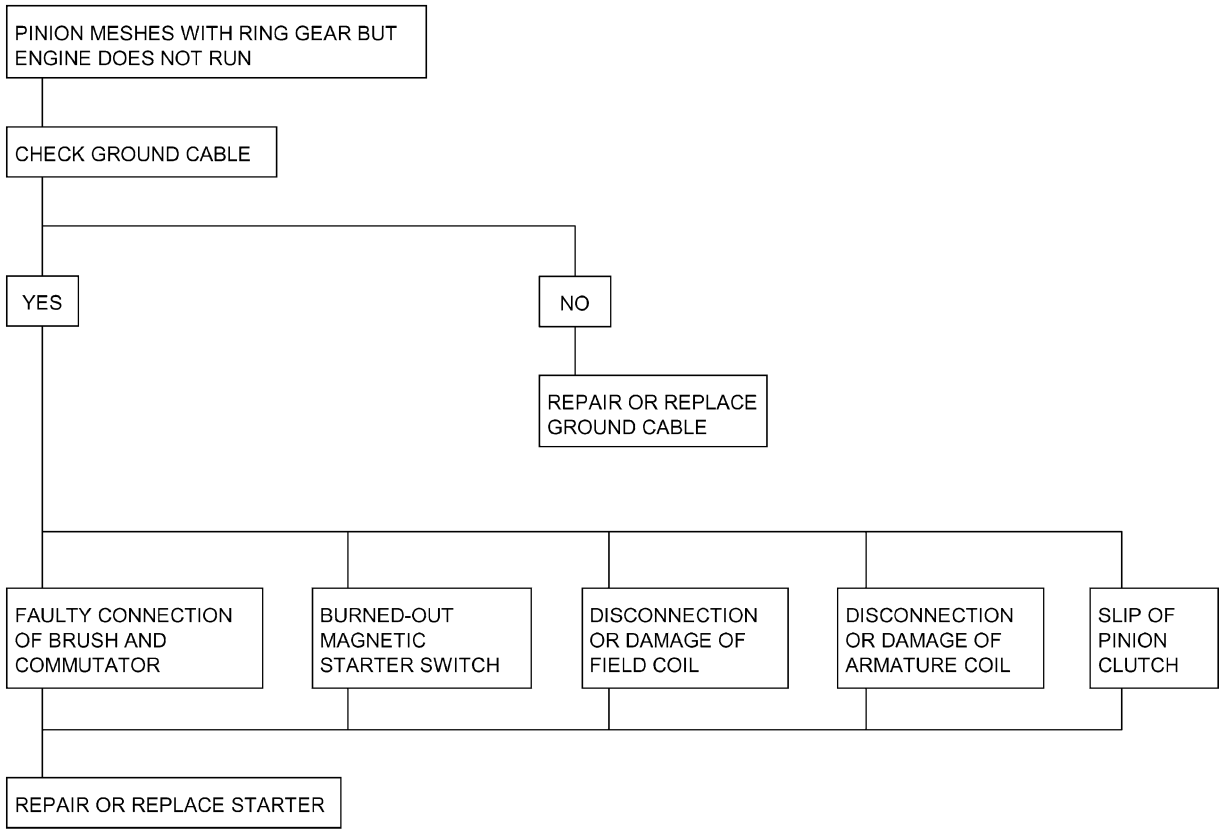
Check point	Possible cause	Correction
Glow plug indicator light does not turn on	1. Defective Fusible link wire	Replace the fusible link wire
	2. Broken indicator light fuse	Replace the indicator light fuse
	3. Defective indicator bulb	Replace the indicator light bulb
Preheating system dose not work	1. Defective fusible link wire shorted	Replace the fusible link wire
	2. Defective glow plug relay connector	Replace or Repair glow plug relay connector
	3. Defective glow plug connector	Replace or Repair glow plug connector
	4. Defective quick-on start timer connector	Replace or Repair quick-on start timer connector
Preheating time to long or to short	1. Defective thermo switch include defective wiring harness	Replace thermo switch
	2. Defective glow plug	Replace glow plug
	3. Defective timer unit	Replace timer unit

Check if battery is normal, then perform the following diagnosis.




FAULTY MESHING OF PINION AND RING GEAR
CHECK IF BATTERY VOLTAGE IS PRESENT AT MAGNETIC SWITCH TERMINAL “S” WHEN STARTER SWITCH IS TURNED TO “START (ST)”
YES
OR
EXTREME WEAR OF PINION AND RING GEAR
REPAIR OR REPLACE STARTER. REPLACE RING GEAR
STARTER SLIDING RESISTANCE IS LARGE
REPAIR OR REPLACE STARTER
NO
UNDER THIS CONDITION, CHECK IF VOLTAGE OF CONNECTOR 3BW ON MAGNETIC SWITCH OF RESTART RELAY IS NORMAL
YES
DISCONNECTION OR FAULTY CONNECTION BETWEEN STARTER SWITCH AND MAGNETIC SWITCH
REPAIR
NO
CHECK IF VOLTAGE IS PRESENT AT WIRING CONNECTOR 3BW ON STARTER SWITCH OF RESTART RELAY
YES
FAULTY CONNECTION OF STARTER SWITCH
REPLACE STARTER SWITCH
NO
DISCONNECTION OR FAULTY CONNECTION BETWEEN STARTER SWITCH AND BATTERY
REPAIR
N6A0002E


MAGNETIC SWITCH DOES NOT OPERATE THOUGH STARTER SWITCH IS TURNED TO “START (ST)”
CHECK IF VOLTAGE IS PRESENT AT MAGNETIC SWITCH TERMINAL “S” WHEN STARTER SWITCH IS TURNED TO “START (ST)”
YES
NO
CHECK GROUND CABLE
CHECK IF INDICATOR LAMP ON METER COMES ON NORMALLY
YES
NO
REPAIR
YES
NO
OR
CHECK CONTINUITY STARTER SWITCH AND MAGNETIC SWITCH TERMINAL “S”
DISCONNECTION OR FAULTY CONNECTION BETWEEN BATTERY AND STARTER SWITCH
PINION SLIDING PART DOES NOT MOVE
MAGNETIC SWITCH OR COIL IS DISCONNECTED OR BURNED OUT
REPAIR
CHECK STARTER RELAY
FAULTY CONNECTION OR STARTER SWITCH
CHECK CLUTCH START SWITCH
REPLACE STARTER SWITCH
REPAIR OR REPLACE STARTER
N6A0003E


PINION MESHES WITH RING GEAR BUT ENGINE DOES NOT RUN
CHECK GROUND CABLE
YES
NO
REPAIR OR REPLACE GROUND CABLE
FAULTY CONNECTION OF BRUSH AND COMMUTATOR
BURNED-OUT MAGNETIC STARTER SWITCH
DISCONNECTION OR DAMAGE OF FIELD COIL
DISCONNECTION OR DAMAGE OF ARMATURE COIL
SLIP OF PINION CLUTCH
REPAIR OR REPLACE STARTER

N6A0004E

Unstable Idling

Check point	Possible cause	Correction
Idling system	Idling improperly adjusted	Adjust the idling
Fast idling speed control device	Defective fast idling speed control device	Repair or replace the fast idling speed control device
Accelerator control system	Accelerator control system improperly adjusted	Adjust the accelerator control system
Fuel system	Fuel system leakage or blockage	Repair or replace the fuel system
	Air in the fuel system	Bleed the air from the fuel system
	Water particles in the fuel system	Change the fuel
Fuel filter	Clogged fuel filter element	Replace the fuel filter element or the fuel filter cartridge
Fuel feed pump	Defective fuel feed pump	Repair or replace the fuel feed pump
Injection nozzle	Injection nozzle sticking	Replace the injection nozzle
	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
Injection pump	Defective delivery valve resulting in fuel drippage after fuel injection	Replace the delivery valve
	Injection timing improperly adjusted	Adjust the injection timing
	Insufficient injection volume	Adjust the injection volume
	Defective idle spring	Replace the idle spring
	Defective governor lever operation	Repair or replace the governor lever
	Regulator valve improperly adjustment	Adjust or replace the regulator valve
	Broken plunger spring	Replace the plunger spring
	Worn plunger	Replace the plunger assembly
	Worn cam disc	Replace the cam disc
Valve clearance	Valve clearance improperly adjusted	Adjust the valve clearance
Compression pressure	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking between the valve and the valve seat	Replace the related parts

Insufficient Power

Check point	Possible cause	Correction
Air cleaner	Clogged air cleaner element	Clean or replace the air cleaner element
Fuel	Water particle in the fuel	Replace fuel
Fuel filter	Clogged fuel filter element	Replace the fuel filter element or the fuel filter cartridge
Fuel feed pump	Defective fuel feed pump	Repair or replace the fuel feed pump
Injection nozzle	Injection nozzle sticking	Replace the injection nozzle
	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
Fuel injection pipes	Fuel injection pipes damaged or obstructed	Replace the fuel injection pipes
Injection pump	Defective regulating valve	Repair or replace the regulating valve
	Defective delivery valve	Replace the delivery valve
	Defective timer	Repair or replace the timer
	Worn cam disk	Replace the cam disk
	Improper control lever operation	Adjust or replace the control lever
	Defective injection timing	Adjust the injection timing Repair or replace the injection pump timer
	Weak governor spring	Replace the governor spring
	Worn plunger	Replace the plunger assembly
Compression pressure	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking	Replace the related parts
Valve clearance	Valve clearance improperly adjusted	Adjust the valve clearance
Valve spring	Valve spring weak or broken	Replace the valve spring
Exhaust system	Exhaust pipe clogged	Clean the exhaust pipe
Full load adjusting screw seal	Open and improperly set adjusting screw seal	Adjust and reseal the adjusting screw

Excessive Fuel Consumption

Check point	Possible cause	Correction
Fuel system	Fuel leakage	Repair or replace the fuel system related parts
Air cleaner	Clogged air cleaner element	Clean or replace the air cleaner element
Idling speed	Poorly adjusted idling speed	Adjust the idling speed
Injection nozzle	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
Fuel injection timing	Fuel injection timing improperly	Adjust the fuel injection timing
Injection pump	Defective delivery valve resulting is fuel drippage after fuel injection	Replace the delivery valve
Valve clearance	Valve clearance improperly adjusted	Adjust the valve clearance
Compression pressure	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking	Replace the related parts
Valve spring	Valve spring weak or broken	Replace the valve spring

Excessive Oil Consumption

Check point	Possible cause	Correction
Engine oil	Engine oil unsuitable Too much engine oil	Replace the engine oil Correct the engine oil level
Oil seal and gasket	Oil leakage from the oil seal and/or the gasket	Replace the oil seal and/or the gasket
Air breather	Clogged air breather	Clean the air breather
Intake and exhaust valve	Worn valve stems and valve guides	Replace the intake and exhaust valves and the valve guides

Overheating

Check point	Possible cause	Correction
Cooling water	Insufficient cooling water	Replenish the cooling water
Fan clutch	Oil leakage from the fan clutch	Replace the fan clutch
Fan belt	Fan belt loose or cracked causing slippage	Replace the fan belt
Radiator	Defective radiator cap or clogged radiator core	Replace the radiator cap or clean the radiator core
Water pump	Defective water pump	Repair or replace the water pump
Cylinder head and cylinder body sealing cap	Defective sealing cap resulting in water leakage	Replace the sealing cap
Thermostat	Defective thermostat	Replace the thermostat
Cooling system	Cooling system clogged by foreign material	Clean the foreign material from the cooling system
Fuel injection timing	Fuel injection timing improperly adjusted	Adjust the fuel injection timing

White Exhaust Smoke

Check point	Possible cause	Correction
Fuel	Water particles in the fuel	Replace the fuel
Fuel injection timing	Delayed fuel injection timing	Adjust the fuel injection timing
Compression pressure	Blown out cylinder head gasket Worn cylinder liner Piston ring sticking	Replace the related parts
Inlet and exhaust valves Valves seals	Defective valve seales Worn valves stems and valve guides	Replace the valve seales, the valves, and the valve guides

Dark Exhaust Smoke

Check point	Possible cause	Correction
Air cleaner	Clogged air cleaner element	Clean or replace the air cleaner element
Injection nozzle	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
Fuel injection timing	Fuel injection timing improperly adjusted	Adjust the fuel injection timing
Injection pump	Defective delivery valve resulting in fuel drippage after fuel injection	Replace the delivery valve
	Excessive injection volume	Adjust the injection volume

Oil Pressure Does Not Rise

Check point	Possible cause	Correction
Engine oil	Improper viscosity engine oil Insufficient engine oil	Replace the engine oil Correct the engine oil volume
Oil pressure gauge or unit Oil pressure indicator light	Defective oil pressure gauge or unit Defective indicator light	Repair or replace the oil pressure gauge or unit Replace the indicator light
Oil filter	Clogged oil filter element	Replace the oil filter element or the oil filter cartridge
Relief valve and by-pass valve	Relief valve sticking and/or weak by-pass valve spring	Replace the relief valve and/or the by-pass valve spring
Oil pump	Clogged oil pump strainer	Clean the oil pump strainer
	Worn oil pump related parts	Replace the oil pump related parts
Rocker arm shaft	Worn rocker arm bushing	Replace the rocker arm bushing
Camshaft	Worn camshaft and camshaft bearing	Replace the camshaft and the camshaft bearing
Crankshaft and bearings	Worn crankshaft and bearings	Replace the crankshaft and/or the bearings

Abnormal Engine Noise

1. Engine Knocking
   Check to see that the engine has been thoroughly warmed up before beginning the troubleshooting procedure.

Check point	Possible cause	Correction
Fuel	Fuel unsuitable	Replace the fuel
Fuel injection timing	Fuel injection timing improperly adjusted	Adjust the fuel injection timing
Injection nozzle	Improper injection nozzle starting pressure and spray condition	Adjust or replace the injection nozzle
Compression pressure	Blown out head gasket	Broken piston ring Replace the head gasket or the piston ring

2. Gas Leakage Noise

Check point	Possible cause	Correction
Exhaust pipes	Loosely connected exhaust pipes Broken exhaust pipes	Tighten the exhaust pipe connections Replace the exhaust pipes
Injection nozzles and/ or glow plugs	Loose injection nozzles and /or glow plugs	Replace the washers Tighten the injection nozzles and/or the glow plugs
Exhaust manifold	Loosely connected exhaust manifold and/ or glow plugs	Tighten the exhaust manifold connections
Cylinder head gasket	Damaged cylinder head gasket	Replace the cylinder head gasket

3. Continuous Noise

Check point	Possible cause	Correction
Fan belt	Loose fan belt	Readjust the fan belt tension
Cooling fan	Loose cooling fan	Retighten the cooling fan
Water pump bearing	Worn or damaged water pump bearing	Replace the water pump bearing
Alternator or vacuum pump	Defective alternator or vacuum pump	Repair or replace the alternator or the vacuum pump
Valve clearance	Clearance improperly adjust	Adjust the valve clearance

4. Slapping Noise

Check point	Possible cause	Correction
Valve clearance	Valve clearance improperly adjusted	Adjust the valve clearance
Rocker arm	Damaged rocker arm	Replace the rocker arm
Flywheel	Loose flywheel bolts	Retighten the flywheel bolts
Crankshaft and thrust bearings	Worn or damaged crankshaft and/or thrust bearings	Replace the crankshaft and/or the thrust bearings
Crankshaft and connecting rod bearings	Worn or damaged crankshaft and/or connecting rod bearings	Replace the crankshaft and/or the connecting rod bearings
Connecting rod bushing and piston pin	Worn or damaged connecting rod bushing and piston pin	Replace the connecting rod bushing and/ or the piston pin
Piston and cylinder liner	Worn or damaged piston and cylinder liner Foreign material in the cylinder	Replace the piston and the cylinder liner

Engine Cooling Trouble

Condition	Possible cause	Correction
Engine overheating	Low coolant level	Replenish
	Thermo unit faulty	Replace
	Faulty thermostat	Replace
	Faulty coolant unit	Repair or replace
	Clogged radiator	Clean or replace
	Faulty radiator cap	Replace
	Low engine oil level or use of improper engine oil	Replenish or change oil Replenish
	Damaged cylinder head gasket	Replace
	Clogged exhaust system	Clean exhaust system or replace faulty parts
	Loose fan belt	Adjust
	Excessive fuel injected	Adjust
	Improper injection timing	Adjust
Engine overcooling	Faulty thermostat	Replace
Too long engine warm-up time	Faulty thermostat	Replace
	Thermo unit faulty	Replace

Starter Motor Does Not Stop

STARTER DOES NOT STOP THOUGH STARTER SWITCH IS RETURNED TO “ON”

DISCONNECTED STARTER SWITCH WIRING CONNECTOR, AND CHECK STARTER SWITCH OPERATION.

STARTER SWITCH KEY POSITION	Connector No.	B-67				B-68				
	Terminal No.	1	2	3	4	1	2	4	5	6
	Terminal No.	ACC	B	ON	ST	B_1	P_1	P_2	W	W
OFF	LOCK					○—○				
ON	ACC	○—○							○—○	
	ON	○—○—○				○—○				
	START		○—○—○			○—○				

THERE MUST BE NO CONTINUITY EXCEPT ABOVE LINES.

YES

MAGNETIC SWITCH CONTACTS ARE FUSED AND NOT MOVED, OR A RETURN SPRING IS BROKEN OR DETERIORATED

REPLACE MAGNETIC SWITCH

NO

REPLACE STARTER SWITCH

N6A0005E

MAIN DATA AND SPECIFICATIONS

Main Data and Specifications

Item				Engine Model	
				4HF1	4HF1-2
Item	Engine type			Four-cycle, overhead camshaft, water cooled	
	Combustion chamber type			Direct injection	
	Cylinder liner type			Dry liner, special compound metal	
	Timing drive system			Gear drive	
	No. of cylinders — Bore × stroke		mm (in)	4 — 112 × 110 (4 — 4.41 × 4.33)	
	No. of piston rings			Compression rings: 2, Oil ring: 1	
	Total piston displacement		cm^3 (in^3)	4334 (264.5)	
	Compression ratio		to : 1	19	
	Compression pressure kPa (kg / cm^2 / psi) — rpm			3,040 (31/441) — 200	3,226 (32.9/468) — 200
	Fuel injection order			1 — 3 — 4 — 2	
	Fuel injection timing (BTDC)		deg	8	12
	Specified fuel type			SAE No. 2 diesel fuel	
	Idling speed rpm			550 — 600	575 — 625
	Valve system				
	Valve clearances (At cold):	Intake	mm (in)	0.4 (0.016)	
		Exhaust	mm (in)	0.4 (0.016)	
	Valve timing (At valve clearances 0.4 mm (0.016 in))				
	Intake valves	Open at (BTDC)	deg	18	
		Close at (ABDC)	deg	50	
	Exhaust valves	Open at (BBDC)	deg	51	
		Close at (ATDC)	deg	17	
	Fuel system				
	Injection pump type			Bosch in-line type with automatic timer	Bosch “VE” distributor with automatic timer
	Plunger outside diameter		mm (in)	9.5 (0.374)	12 (0.472)
	Plunger lift		mm (in)	11.0 (0.433)	2.8 (0.110)
	Governor type			RLD-F mechanical (Variable speed)	Half all speed governor
	Automatic timer type			SCDM, centrifugal, flyweight	Hydraulic speed sensing type
	Fuel feed pump type			Piston	Vane

			Engine Model	
			4HF1	4HF1-2
Item	**Injection nozzle type**			
	Injection nozzle type		Hole type (with 5 orifices)	
	Pressure	MPa (kg / cm^2 / psi)	18.1 (185 / 2,631)	
	Pressure adjustment		Shim adjusted	
	Main fuel filter type		Disposal spin-on cartridge and remote mounted water separator	
	Lubricating system			
	Lubrication method		Full flow pressure circulation	
	Specified engine oil (API grade)		CD or above	
	Oil pressure	kPa (kg /cm^2 / psi) — rpm	147 (1.5 / 21) — 700 (SAE 10W-30 API CD grade engine oil at 80°C (176°F))	
	Oil pump type		Gear type	
	Oil filter type		Spin-on cartridge	
	Oil capacity	lit (US / UK gal)	10.5 (2.77 / 2.31)	
	Oil cooler type		Water cooled	
	Cooling system			
	Radiator type		Corrugated fin with reserve tank	
	Coolant capacity	lit (US / UK gal)	12 (3.17 / 2.64)	
	Water pump type		Centrifugal impeller, V-belt drive	
	Pump to crankshaft speed ratio	to : 1	1.16 (175 / 151)	
	Delivery volume	lit (US / UK gal)/min	200 (52.8 / 44.0) (Pump speed at 3,300 rpm Water temperature at 82°C (180°F))	
	Pump bearing type		Double row shaft	
	Thermostat type		Wax pellet	
	Valve initial opening temperature	°C (°F)	With jiggle valve: 85±1.5 (182 — 188) Without jiggle valve: 82±1.5 (177 — 182)	
	Valve lift	mm (in)	With jiggle valve: 8 (0.3) or more at 100°C (212°F) Without jiggle valve: 8 (0.3) or more at 95°C (203°F)	
	Air cleaner type		Dry paper element	
	Battery type	Volt-amp.hr.	55D23R / 12 — 60 : 2 pcs	
	Generator			
	Type		AC brush with IC regulator and vacuum pump	
	Voltage	V	24	
	Drive and rotation		V-belt, clockwise viewed from the drive pulley	
	Ground polarity		Negative	
	Maximum output	A	60 at 5,000 rpm	50 at 5,000 rpm (For Indonesian) 80 at 5,000 rpm
	Maximum speed	rpm	7,500 — 10,000	

			Engine Model	
			4HF1	4HF1-2
	Regulator			
	Type		IC	
	Regulating voltage	V	28 — 29	
	Vacuum pump			
	-66.7 kPa (-500 mmHg / -9.67 psi) build-up time		13 seconds or less at 1,000 rpm 4 seconds or less at 5,000 rpm	
	Maximum vacuum		-90.7 kPa (-680 mmHg / -13.1 psi) or more at 5,000 rpm	
	Starter motor			
	Type		Magnetic solenoid-controlled	
	Model		S25-168	
	Rated voltage	V	24	
	Rated output	kW	4.0	
Item	Load characteristics			
	Terminal voltage	V	18.55	
	Load current	A	250	
	Torque	N·m (kg·m / lb·ft)	14.22 (1.45 / 10.49) at 1,500 rpm or more	
	Preheating system		Quick-On-Start System II	
	Exhaust system			
	Pipe outside diameter × thickness			
	Front pipe	mm (in)	60.5 × 2.0 (2.38 × 0.079)	
	Middle pipe	mm (in)	60.5 × 2.0 (2.38 × 0.079)	
	Rear pipe	mm (in)	60.5 × 1.6 (2.38 × 0.063)	
	Silencer Type		Circular section-shell construction of triple skin and end plates, internal construction of baffles and perforated tubes	
	Inside diameter	mm (in)	Approximately 200 (7.87)	

				Engine Model	
				4HG1	4HG1-T
	Engine type			Four-cycle, overhead camshaft, water cooled	
	Combustion chamber type			Direct injection	
	Cylinder liner type			Dry liner, special compound metal	
	Timing drive system			Gear drive	
	No. of cylinders — Bore × stroke		mm (in)	4 — 115 × 110 (4 — 4.53 × 4.33)	
	No. of piston rings			Compression rings: 2, Oil ring: 1	
	Total piston displacement		cm^3 (in^3)	4570 (278.9)	
	Compression ratio		to : 1	19	
	Compression pressure		kPa (kg / cm^2 / psi) — rpm	3,226 (32.9/468) — 200	
	Fuel injection order			1 — 3 — 4 — 2	
	Fuel injection timing (BTDC)		deg	9	7 (Except Colombia) 9 (For Colombia)
	Specified fuel type			SAE No. 2 diesel fuel	
	Idling speed rpm			550 — 600	600 — 650
	Valve system				
Item	Valve clearances (At cold):	Intake	mm (in)	0.4 (0.016)	
		Exhaust	mm (in)	0.4 (0.016)	
	Valve timing (At valve clearances 0.4 mm (0.016 in))				
	Intake valves	Open at (BTDC)	deg	18	
		Close at (ABDC)	deg	50	
	Exhaust valves	Open at (BBDC)	deg	51	
		Close at (ATDC)	deg	17	
	Fuel system				
	Injection pump type			Bosch in-line type with automatic timer	
	Plunger outside diameter		mm (in)	9.5 (0.374)	10.5 (0.413)
	Plunger lift		mm (in)	11.0 (0.433)	
	Governor type			RLD-F mechanical (Variable speed)	
	Automatic timer type			SCDM, centrifugal, flyweight	
	Fuel feed pump type			Piston	

			Engine Model	
			4HG1	4HG1-T
Item	Injection nozzle opening			
	Injection nozzle type		Hole type (with 5 orifices)	
	Pressure	MPa (kg / cm^2 / psi)	18.1 (185 / 2,631)	1st 18.1 (185 / 2,631) 2nd 21.1 (215 / 3,057)
	Pressure adjustment		Shim adjusted	
	Main fuel filter type		Disposal spin-on cartridge and remote mounted water separator	
	Lubricating system			
	Lubrication method		Full flow pressure circulation	
	Specified engine oil (API grade)		CD or above	
	Oil pressure	kPa (kg /cm^2 / psi) — rpm	147 (1.5 / 21) — 700 (SAE 10W-30 API CD grade engine oil at 80°C (176°F))	
	Oil pump type		Gear type	
	Oil filter type		Spin-on cartridge	
	Oil capacity	lit (US / UK gal)	10.5 (2.77 / 2.31)	
	Oil cooler type		Water cooled	
	Cooling system			
	Radiator type		Corrugated fin with reserve tank	
	Coolant capacity	lit (US / UK gal)	12 (3.17 / 2.64)	
	Water pump type		Centrifugal impeller, V-belt drive	
	Pump to crankshaft speed ratio	to : 1	1.19 (175 / 147)	
	Delivery volume	lit (US / UK gal)/min	200 (52.8 / 44.0) (Pump speed at 3,300 rpm Water temperature at 82°C (180°F))	
	Pump bearing type		Double row shaft	
	Thermostat type		Wax pellet	
	Valve initial opening temperature	°C (°F)	With jiggle valve: 85±1.5 (182 — 188) Without jiggle valve: 82±1.5 (177 — 182)	
	Valve lift	mm (in)	With jiggle valve: 8 (0.3) or more at 100°C (212°F) Without jiggle valve: 8 (0.3) or more at 95°C (203°F)	
	Air cleaner type		Dry paper element or oil bath	
	Battery type	Volt-amp.hr.	75D23R / 12-65 : 2 pcs	
	Generator			
	Type		AC brush with IC regulator and vacuum pump	
	Voltage	V	24	12 or 24
	Drive and rotation		V-belt, clockwise viewed from the drive pulley	
	Ground polarity		Negative	
	Maximum output	A	35 at 5,000 rpm 60 at 5,000 rpm	50 at 5,000 rpm 80 (12V) at 5,000 rpm
	Maximum speed	rpm	7,500 — 10,000	

			Engine Model		
			4HG1	4HG1-T	
Item	**Regulator**				
	Type		IC		
	Regulating voltage	V	28 — 29	14.4±0.3	28 — 29
	Vacuum pump				
	-66.7kPa (-500 mmHg / -9.67 psi) build-up time		13 seconds or less at 1,000 rpm 4 seconds or less at 5,000 rpm		
	Maximum vacuum		-90.7 kPa (-680 mmHg / -13.1 psi) or more at 5,000 rpm		
	Starter motor				
	Type		Magnetic solenoid-controlled		
	Model		S25-168	R3.0	S25-168
	Rated voltage	V	24	12	24
	Rated output	kW	4	3	4
	Load characteristics				
	Terminal voltage	V	18.55	14	18.55
	Load current	A	250	890 (MAX)	250
	Torque	N·m (kg·m / lb·ft)	14.22 (1.45 / 10.49) at 1,500 rpm or more	29.4 (2.99 / 21.63) at 860 rpm or more	14.22 (1.45 / 10.49) at 1,500 rpm or more
	Preheating system		Quick-On-Start System II		
	Exhaust system				
	Pipe outside diameter × thickness				
	Front pipe	mm (in)	60.5 × 2.0 (2.38 × 0.079)		
	Middle pipe	mm (in)	60.5 × 2.0 (2.38 × 0.079)		
	Rear pipe	mm (in)	60.5 × 1.6 (2.38 × 0.063)		
	Silencer type		Circular section-shell construction of triple skin and end plates, internal construction of baffles and perforated tubes		
	Inside diameter	mm (in)	Approximately 200 (7.87)		

				Engine Model	
				4HE1-TC (4HE1-XS, XN) 98EPA	4HE1-TC (4HE1-XS) SPEC. EURO3
Item	Engine type			Four-cycle, overhead camshaft, water cooled	
	Combustion chamber type			Direct injection	
	Cylinder liner type			Dry liner, special compound metal	
	Timing drive system			Gear drive	
	No. of cylinders — Bore × stroke		mm (in)	4 — 110 × 125 (4 — 4.33 × 4.92)	
	No. of piston rings			Compression rings 3, oil ring 1	
	Total piston displacement		cm^3 (in^3)	4751(289.9)	
	Compression ratio		to : 1	17.3	
	Compression pressure		kPa (kg / cm^2 / psi) — rpm	3,040 (31/441) — 200	
	Fuel injection order			1— 3 — 4 — 2	
	Fuel injection timing (BTDC)		deg	8	9
	Specified fuel type			SAE No. 2 diesel fuel	
	Idling speed		rpm	775 — 825	
	Valve system				
	Valve clearances (At cold):	Intake	mm (in)	0.4 (0.016)	
		Exhaust	mm (in)	0.4 (0.016)	
	Valve timing (At valve clearances 0.4 mm (0.016 in))				
	Intake valves	Open at (BTDC)	deg	14	
		Close at (ABDC)	deg	51	
	Exhaust valves	Open at (BBDC)	deg	49	
		Close at (ATDC)	deg	16	

			Engine Model	
			4HE1-TC (4HE1-XS, XN) 98EPA	4HE1-TC (4HE1-XS) SPEC. EURO3
Item	**Fuel system**			
	Injection pump type		Bosch in-line MI-TICS Different injection fuel quantity between 98EPA and EURO3, or XS and XN	
	Plunger outside diameter	mm (in)	11 (0.433)	
	Plunger lift	mm (in)	12 (0.472)	
	Governor type		RLD-M mechanical (Variable speed)	
	Automatic timer type		Electronic control	
	Fuel feed pump type		Piston	
	Injection nozzle opening			
	Injection nozzle type		Hole type	
			(with 6 × 0.22ϕ orifices)	(with 6 × 0.21ϕ orifices)
	Pressure	MPa (kg / cm^2 / psi)	21.6 (220 / 3,128)	
	Pressure adjustment		Shim adjusted	
	Main fuel filter type		Disposal spin-on cartridge and remote mounted water separator	
	Lubricating system			
	Lubrication method		Full flow pressure circulation	
	Specified engine oil (API grade)		CD or above	
	Oil pressure	kPa (kg /cm^2 / psi) — rpm	147 (1.5 / 21) — 700 (SAE 10W-30 API CD grade engine oil at 80°C (176°F))	
	Oil pump type		Gear type	
	Oil filter type		Spin-on cartridge	
	Oil capacity	lit (US / UK gal)	13 (3.43 / 2.86)	
	Oil cooler type		Water cooled	
	Cooling system			
	Radiator type		Corrugated fin with reserve tank	
	Coolant capacity	lit (US / UK gal)	11 (3.70 / 3.08)	
	Water pump type		Centrifugal impeller, V-belt drive	
	Pump to crankshaft speed ratio	to : 1	1.19	
	Delivery volume	lit (US / UK gal)/min	200 (52.8 / 44.0) (Pump speed at 3,300 rpm Water temperature at 82°C (180°F))	
	Pump bearing type		Double row shaft	
	Thermostat type		Wax pellet	
	Valve initial opening temperature	°C (°F)	With jiggle valve: 85 ± 1.5 (182 — 188) Without jiggle valve Primary: 82 ± 2 (176 — 183) Secondary: 85 ± 2 (181 — 189)	
	Valve lift	mm (in)	With jiggle valve: 8 (0.3) or more at 100°C (212°F) Without jiggle valve: 8 (0.3) or more at 95°C (203°F)	

			Engine Model	
			4HE1-TC (4HE1-XS, XN) 98EPA	4HE1-TC (4HE1-XS) SPEC. EURO3
Item	**Air cleaner type**		Dry paper element or wet paper element	
	Battery type	Model / Volt-amp.hr.	80D26R / 12-65 : 2 pcs	
	Generator			
	Type		AC brush with IC regulator and vacuum pump	
	Voltage	V	12 (For Venezuela) 24 (Except Venezuela)	
	Drive and rotation		V-belt, clockwise viewed from the drive pulley	
	Ground polarity		Negative	
	Maximum output	V / A / rpm	12 / 80 at 5,000 (Hitachi) (For Venezuela) 24 / 50 at 5,000, 24 / 60 at 5,000 (Hitachi) 24 / 80 at 5,000 (Hitachi) (Except Venezuela)	
	Maximum speed	rpm	7,500 — 10,000	
	Regulator			
	Type		IC	
	Regulating voltage	V	28 — 29 (Except Venezuela)	
	Vacuum pump			
	-66.7 kPa (-500 mmHg / -9.67 psi) build-up time		13 seconds or less at 1,000 rpm 4 seconds or less at 5,000 rpm	
	Maximum vacuum	kPa (mmHg / psi)	-90.7 (-680 / -13.1) or more at 5,000 rpm	
	Starter motor			
	Type		Magnetic solenoid-controlled	
	Model		R3.0 (For Venezuela) S25-505D (Except Venezuela)	
	Rated voltage	V	12 (For Venezuela) 24 (Except Venezuela)	
	Rated output	kW	3 (For Venezuela) 4.5 (Except Venezuela)	
	Load characteristics			
	Terminal voltage	V	14.3 (Except Venezuela)	
	Load current	A	890 (MAX) (For Venezuela) 400 (Except Venezuela)	
	Torque	N·m (kg·m / lb·ft)	29.4 (2.99 / 21.63) at 860 rpm or more (For Venezuela) 25.0 (2.55 / 18.4) at 1,000 rpm or more (Except Venezuela)	

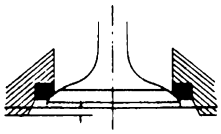
			Engine Model	
			4HE1-TC (4HE1-XS, XN) 98EPA	4HE1-TC (4HE1-XS) SPEC. EURO3
Item	**Preheating system**		Quick-On-Start System II	
	Exhaust system			
	Pipe outside diameter × Thickness			
	Front pipe	mm (in)	60.5 × 2.0 (2.38 × 0.079)	
	Middle pipe	mm (in)	60.5 × 2.0 (2.38 × 0.079)	
	Rear pipe	mm (in)	60.5 × 1.6 (2.38 × 0.063)	
	Silencer type		Silencer with built-in catalytic converter (platinum)	Silencer with built-in catalytic converter (iron oxide)
	Inside diameter	mm (in)	Approximately 200 (7.87)	
	Exhaust gas recirculation system (EGR)		Equipped	Equipped (cooled)

SERVICE STANDARD

Engine

Item	Service Standard	Service Limit
Compression Pressure KPa (kg / cm^2 / psi) / rpm	3040 (31 / 441) or more Variance in pressure between the cylinders: less than 294 (3 / 43) / 200	2,157 (22 / 312)

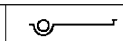
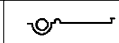
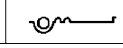
Cylinder Head

Item	Service Standard	Service Limit
Inlet and Exhaust Valve Seat Depression mm (in)  N6A1400E	0.7 — 1.2 (0.028 — 0.047) Measurement should be taken by using a new valve.	2.5 (0.098)
Cylinder Head Lower Face Warpage mm (in)	0.05 (0.002) or less Do not regrind the cylinder head lower face.	0.2 (0.008)
Manifold Fitting Face Warpage mm (in)	0.05 (0.002) or less	0.2 (0.008)
Water Leak Test kPa (kg / cm^2 / psi)	490 (5 / 71) — 3 minutes	Repair or replace those having water leak.

Cylinder Head Gasket Selection
Remarks:
The grade mark of the cylinder head gasket is shown by semicircular notches on the left side of the front portion of the gasket.

4HF1/4HF1-2/4HG1-T
Cylinder Head Gasket Selection

mm (in)

Gasket Grade		Ti max	Gasket Thickness (Reference)
A		0.579 - 0.659 (0.0228 - 0.0259)	1.70 (0.0669)
B		0.659 - 0.739 (0.0259 - 0.0291)	1.75 (0.0689)
C		0.739 – 0.819 (0.0291 – 0.0322)	1.80 (0.0708)

N6A1401E

4HE1-TC

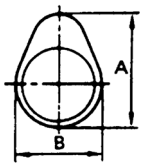
Cylinder Head Gasket Selection

mm (in)

Gasket Grade		Ti max	Gasket Thickness (Reference)
A		0.529 - 0.609 (0.0208 - 0.0240)	1.70 (0.0669)
B		0.609 - 0.679 (0.0240 - 0.0267)	1.75 (0.0689)
C		0.679 – 0.759 (0.0267 – 0.0300)	1.80 (0.0708)

N6A1404E

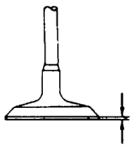
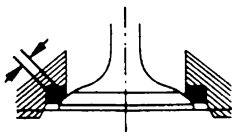
Camshaft

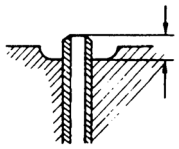
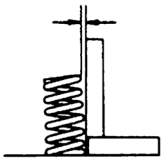
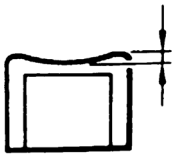
Item		Service Standard	Service Limit
Cam Height	mm (in)	52.75 — 52.91 (2.076 — 2.083)	51.8 (2.039)
 N6A1407E			
Camshaft Journal Uneven Wear	mm (in)	0.015 (0.0006) or less	0.05 (0.002)
Camshaft Journal Wear	mm (in)	39.950 — 39.975 (1.5728 — 1.5738)	39.850 (1.569)
Camshaft Journal and Bearing Clearance	mm (in)	0.025 — 0.087 (0.00098 — 0.00343)	0.15 (0.0059)
Camshaft Run-Out	mm (in)	0.04 (0.0016) or less against the adjacent journal	0.05 (0.002)

Rocker Arm and Rocker Arm Shaft

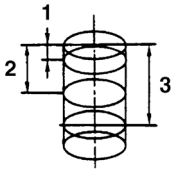
Item		Service Standard	Service Limit
Rocker Arm Shaft Wear	mm (in)	21.979 — 22.000 (0.8653 — 0.8661)	21.85 (0.860)
Rocker Arm Bushing Wear	mm (in)	22.010 — 22.035 (0.8665 — 0.8675)	22.15 (0.872)
Rocker Arm and Rocker Arm Shaft Clearance	mm (in)	0.010 — 0.056 (0.0004 — 0.0022)	0.2 (0.008)
Rocker Arm Shaft Run-Out	mm (in)		0.3 (0.012)
Rocker Arm Roller and Pin Clearnace	mm (in)	0.040 — 0.084 (0.0016 — 0.0033)	0.5 (0.020)
Roller Surface			When there is an excessive wear or deformation found, replace it. When it is damaged only slightly, correct it with an oil stone.

Valve

Item		Service Standard		Service Limit
Valve Stem Wear	mm (in)	Inlet	8.946 — 8.961 (0.3522 — 0.3528)	8.88 (0.35)
		Exhaust	8.921 — 8.936 (0.3512 — 0.3529)	8.80 (0.34)
Valve Stem and Valve Guide Clearance	mm (in)	Inlet	0.038 — 0.071 (0.0015 — 0.0028)	0.20 (0.0079)
		Exhaust	0.064 — 0.096 (0.0025 — 0.0038)	0.25 (0.0098)
Valve Guide and Cylinder Head Interference	mm (in)	0.005 — 0.040 (0.0002 — 0.0016) Press it in with the valve guide applied with engine oil.		
Valve Thickness	mm (in)	Inlet	Nominal size 1.80 (0.071)	1.3 (0.051)
 N6A1408E		Exhaust	Nominal size 1.75 (0.069)	1.3 (0.051)
Valve Contact Width	mm (in)	Inlet	Nominal size 2.5 (0.098)	3.0 (0.118)
 N6A1409E		Exhaust	Nominal size 2.0 (0.079)	2.5 (0.098)

Item		Service Standard	Service Limit
Valve Guide Upper End Height  N6A1410E	mm (in)	14.1±0.2 (0.555±0.008)	
Valve Stem Seal Lip Wear	mm (in)	8.3 — 8.7 (0.3268 — 0.3425)	8.8 (0.346)
Valve Spring Tension	N (kg / lb)	414 — 477 (42.2 — 48.6 / 93 — 107) Set length 47.0 mm (1.85 in)	40.9 (98 / 401)
Valve Spring Free Height	mm (in)	Nominal size 62.5 (2.46)	59.4 (2.34)
Valve Spring Squareness  N6A1411E	mm (in)		1.0 (0.04)
Valve Clearance (At cold)	mm (in)	0.4 (0.016)	
Valve Stem Cap Wear  N6A1412E	mm (in)		0.5 (0.02) Replace it when worn or deformed excessively.

Cylinder Body

Item		Service Standard	Service Limit
Cylinder Liner Bore Wear  N6A1413E 1. 20 mm (0.79 in) 2. 90 mm (3.54 in) 3. 160 mm (6.30 in)	mm (in)	4HF1: 4HF12: 112.021 — 112.050 (4.4103 — 4.4114) 4HG1: 4HG1-T: 115.021 — 115.050 (4.5284 — 4.5295) 4HE1-TC: 110.041 — 110.080 (4.3323 — 4.3338)	112.20 (4.417) 115.20 (4.535) 115.20 (4.535)
Cylinder Liner Projection	mm (in)	0.10 — 0.14 (0.0039 — 0.0055) The difference in the cylinder liner projection height between any two adjacent cylinders must not exceed 0.03 (0.0012)	There must be a projection on the cylinder liner.
Cylinder Body Upper Face Warpage	mm (in)	0.05 (0.002) or less Do not regrind the cylinder body upper face.	0.02 (0.008)

Item	Service Standard	Service Limit
Water Leak Test kPa (kg / cm^2 / psi)	490 (5 / 71) — 3 minutes	Repair or replace those having water leak.

Cylinder Liner Grade Selection
Remarks:
Cylinder Bore Grade Mark Position
The grade mark (1, 2 or 3) of the cylinder bore is stamped on the position just beside each cylinder on the upper left side (the upper portion of the oil cooler installation face) of the cylinder body.

Cylinder Liner Grade Mark Position
The outside diameter grade mark (1, 2 or 3) of the cylinder liner is stamped on the position approximately 160mm from the top face of the liner.

4HF1/4HF1-2

Line Grade	Cylinder Bore Diameter mm (in)	Service Grade	Liner Outside Diameter mm (in)
1	115.001 — 115.010 (4.5276 — 4.5279)	1X	114.991 — 115.000 (4.5272 — 4.5276)
2	115.011 — 115.020 (4.5280 — 4.5283)	3X	115.001 — 115.010 (4.5276 — 4.5279)
3	115.021 — 115.030 (4.5284 — 4.5287)		

4HG1 / 4HG1-T

Line Grade	Cylinder Bore Diameter mm (in)	Service Grade	Liner Outside Diameter mm (in)
1	118.001 — 118.010 (4.6457 — 4.6461)	1X	117.991 — 118.000 (4.6453 — 4.6457)
2	118.011 — 118.020 (4.6461 — 4.6464)	3X	118.001 — 118.010 (4.6457 — 4.6461)
3	118.021 — 118.030 (4.6465 — 4.6468)		

4HE1-TC

Line Grade	Cylinder Bore Diameter mm (in)	Service Grade	Liner Outside Diameter mm (in)
1	115.001 — 115.010 (4.5276 — 4.5279)	1X	115.021 — 115.030 (4.5284 — 4.5287)
2	115.011 — 115.020 (4.5280 — 4.5283)	3X	115.031 — 115.040 (4.5289 — 4.5291)
3	115.021 — 115.030 (4.5284 — 4.5287)		

Crankshaft

Item		Service Standard	Service Limit
Crankshaft Journal and Crankpin Uneven Wear mm (in)			0.05 (0.002)
Crankshaft Journal Wear mm (in)	No. 1, 2, 4 and 5	81.905 — 81.925 (3.2246 — 3.2254)	81.85 (3.2224)
	No. 3	81.890 — 81.910 (3.2240 — 3.2248)	81.85 (3.2224)
Crankshaft Journal and Bearing Clearance mm (in)	No. 1, 2, 4 and 5	0.037 — 0.072 (0.0015 — 0.0028)	0.11 (0.0043)
	No. 3	0.051 — 0.086 (0.0020 — 0.0034)	0.11 (0.0043)
Crankpin Wear		4HF1, 4HG1, 4HG1-T: 65.902 — 65.992 (2.5946 — 2.5954)	65.85 (2.5925)
		4HE1-TC: 72.920 — 72.922 (2.8709 — 2.8433)	72.850 (2.8681)
Crankshaft Journal Bearing Spread mm (in)			87 (3.43)
Crankshaft End Play mm (in)		0.104 — 0.205 (0.0041 — 0.0081)	0.35 (0.014)
Crankshaft Run-Out mm (in)		0.05 (0.002) or less	0.3 (0.012)
Crankshaft Front and Rear Oil Seal and Slinger Wear			When there is an oil leak found, the oil seal and slinger must be replaced as a set. Insert it securely with a special tool.

Crankshaft Journal Bearing Selection
Remarks:
Crankshaft Bearing Housing Grade Mark Position
The crankshaft bearing housing grade marks (1 or 2) are stamped collectively for all cylinders on the underside of the left front portion of the cylinder body.

Crankshaft Journal Grade Mark Position
The crankshaft journal grade marks (1 or 2) are stamped collectively for all cylinders on the front side of the crankshaft No. 1 balancer

Crankshaft Bearing Grade Mark Position
The identification color code (black, brown or blue) of the crankshaft journal bearing grade mark is applied on the side of each bearing.

Crankshaft Journal No. 1, 2, 4 and 5

Bearing Housing		Crankshaft Journal		Crankshaft Bearing Color Code
Grade Mark	(Reference) Inside Diameter mm (in)	Grade Mark	(Reference) Outside Diameter mm (in)	
1	87.000 — 87.009 (3.4252 — 3.4255)	1	81.905 — 81.915 (3.2246 — 3.2250)	Black
		2	81.916 — 81.925 (3.2250 — 3.2254)	Brown
2	87.010 — 87.019 (3.4256 — 3.4259)	1	81.905 — 81.915 (3.2246 — 3.2250)	Blue
		2	81.916 — 81.925 (3.2250 — 3.2254)	Black

Crankshaft Journal No. 3

Bearing Housing		Crankshaft Journal		Crankshaft Bearing Color Code
Grade Mark	(Reference) Inside Diameter mm (in)	Grade Mark	(Reference) Outside Diameter mm (in)	
1	87.000 — 87.009 (3.4252 — 3.4255)	1	81.890 — 81.900 (3.2240 — 3.2244)	Black
		2	81.901 — 81.910 (3.2244 — 3.2248)	Brown
2	87.010 — 87.019 (3.4256 — 3.4259)	1	81.890 — 81.900 (3.2240 — 3.2244)	Blue
		2	81.901 — 81.910 (3.2244 — 3.2248)	Black

Piston

Item	Service Standard	Service Limit
Piston and Cylinder Liner Clearance mm (in)	4HG1: 0.081 — 0.116 (0.0032 — 0.0044)	
	4HF1: 0.081 — 0.113 (0.0032 — 0.0044)	
	4HE1-TC: 0.091 — 0.131 (0.0036 — 0.0052)	

Piston Grade Selection
Remarks:
Piston Grade Mark Position
The piston grade marks (i.e. A, B, C) are stamped on the piston upper face.

Piston Outside Diameter Measuring Position
Take measurement of the Piston at the position 82mm (3.23 in) from the top in the direction of the longer diameter.
Piston Grade

Engine model	Cylinder Liner Bore Diameter mm (in)	Piston Service Grade	Piston Outside Diameter mm (in)
4HF1 4HF1-2	112.041 — 112.060 (4.4111 — 4.4118)	—	111.947 — 111.960 (4.4074 — 4.4079)
4HG1 4HG1-T	115.040 — 115.060 (4.5291 — 4.5299)	—	114.944 — 114.959 (4.5253 — 4.5259)
4HE1-TC	110.066 — 110.075 (4.3333 — 4.3337)	AX	109.944 — 109.959 (4.3285 — 4.3291)
	110.076 — 110.085 (4.3337 — 4.3340)	CX	109.960 — 109.975 (4.3291 — 4.3297)

Piston Pin

Item	Service Standard		Service Limit
Piston Pin Wear mm (in)	4HF1 4HF1-2 4HG1 4HG1-T	35.995 — 36.000 (1.4171 — 1.4173)	35.970 (1.4161)
	4HE1-TC	39.995 — 40.000 (1.5746 — 1.5748)	39.970 (1.5736)

Item	Service Standard	Service Limit
Piston and Piston Pin Clearance mm (in)	0.004 — 0.017 (0.0002 — 0.0007) Clearance should be wide enough for the piston pin to be inserted under the condition where the piston is heated to the temperature of 80°C to 100°C (176°F to 212°F).	0.04 (0.0016) When an abnormal striking sound is heard, replace the piston and the piston pin.

Piston Ring

Item			Service Standard	Service Limit
Piston Ring Gap (Inside the cylinder) mm (in)	4HF1 4HF1-2	1st Compression Ring	0.24 — 0.39 (0.0094 — 0.0153)	1.50 (0.0591)
		2nd Compression Ring	0.35 — 0.50 (0.0138 — 0.0197)	1.50 (0.0591)
		Oil Ring	0.02 — 0.40 (0.0008 — 0.0157)	1.50 (0.0591)
	4HG1 4HG1-T	1st Compression Ring	0.24 — 0.39 (0.0094 — 0.0153)	1.50 (0.0591)
		2nd Compression Ring	0.35 — 0.50 (0.0138 — 0.0197)	1.50 (0.0591)
		Oil Ring	0.15 — 0.35 (0.00591 — 0.0138)	1.50 (0.0591)
	4HE1-TC	1st Compression Ring	0.24 — 0.40 (0.0094 — 0.0157)	1.50 (0.0591)
		2nd Compression Ring	0.30 — 0.40 (0.0118 — 0.0157)	1.50 (0.0591)
		3rd Compression Ring	0.30 — 0.40 (0.0118 — 0.0157)	1.50 (0.0591)
		Oil Ring	0.02 — 0.40 (0.0008 — 0.0157)	1.50 (0.0591)
Piston Ring & Piston Ring Groove Clearance mm (in)	4HF1 4HF1-2	1st Compression Ring	0.062 — 0.092 (0.0024 — 0.0036)	0.2 (0.0078)
		2nd Compression Ring	0.04 — 0.08 (0.0015 — 0.0031)	0.15 (0.0059)
		Oil Ring	0.02 — 0.06 (0.0008 — 0.0024)	0.15 (0.0059)
	4HG1 4HG1-T	1st Compression Ring	0.062 — 0.092 (0.0024 — 0.0036)	0.2 (0.0078)
		2nd Compression Ring	0.04 — 0.08 (0.0015 — 0.0031)	0.15 (0.0059)
		Oil Ring	0.02 — 0.06 (0.0008 — 0.0024)	0.15 (0.0059)
	4HE1-TC	1st Compression Ring	0.09 — 0.13 (0.0035 — 0.0051)	0.2 (0.0078)
		2nd Compression Ring	0.09 — 0.13 (0.0035 — 0.0051)	0.2 (0.0078)
		3rd Compression Ring	0.09 — 0.13 (0.0035 — 0.0051)	0.2 (0.0078)
		Oil Ring	0.03 — 0.07 (0.0012 — 0.0028)	0.15 (0.0059)
The direction of the piston ring connecting end			Alternately at 180°. Don't position the connecting end in the side pressure direction. Place the connecting end of the oil ring and that of the expander coil at 180° alternately.	

Connecting Rod

Item		Service Standard	Service Limit
Connecting Rod Alignment mm (in)	Distortion	0.05 (0.002) or less	0.20 (0.008)
	Parallelism	0.05 (0.002) or less	0.20 (0.008)
Connecting Rod Small End Bushing and Piston Pin Clearance mm (in)		0.012 — 0.027 (0.0005 — 0.0011) There must be clearance enough to rotate the piston pin while holding it lightly with its large end fixed.	0.05 (0.002)
Connecting Rod Bearing Spread mm (in)			70 (2.77) or more

Item		Service Standard	Service Limit
Connecting Rod Bearing and Crankpin Clearance	mm (in)	0.036 — 0.077 (0.0014 — 0.0030)	0.10 (0.004)
The difference in weight between the connecting rod and the piston when assembled.	N (gr / lb)		0.2 (20 / 0.28)

Connecting Rod Bearing Selection
Remarks:
The connecting rod big end inside diameter grade marks (A or B) are stamped on top of the cylinder number align marks of the big end.

4HF1 / 4HF1-2 / 4HG1 / 4HG1-T

Connecting Rod Big End		Crankpin	Big End Bearing Color Code
Grade Mark	(Reference) Inside Diameter mm (in)	(Reference) Outside Diameter mm (in)	
A	69.985 — 69.992 (2.7553 — 2.7556)	65.902 — 65.922 (2.5946 — 2.5954)	Green
B	69.993 — 70.000 (2.7556 — 2.7559)	65.902 — 65.922 (2.5946 — 2.5954)	Yellow

4HE1-TC

Connecting Rod Big End		Crankpin	Big End Bearing Color Code
Grade Mark	(Reference) Inside Diameter mm (in)	(Reference) Outside Diameter mm (in)	
A	77.985 — 77.992 (3.0702 — 3.0705)	72.902 — 72.922 (2.8702 — 2.8709)	Green
B	77.993 — 78.000 (3.0706 — 3.0709)	72.902 — 72.922 (2.8702 — 2.8709)	Yellow

Flywheel

Item		Service Standard	Service Limit
Flywheel Thickness	mm (in)	31.4 — 31.6 (1.236 — 1.244) (Flywheel friction surface — crankshaft setting face)	31.0 (1.22)
Friction Surface Run-Out	mm (in)		0.2 (0.008)
Friction Surface Roughness	mm (in)	0.006 (0.0002) or less	
Ring Gear			The tooth face burr must be chamfered. Replace ones when damaged excessively.

Gear Train

Item	Service Standard	Service Limit
Timing Gear Backlash Gear to Gear (In the direction of a normal line) mm (in)	0.10 — 0.17 (0.0039 — 0.0067) Hold both the gear to be checked and the adjoining gear stationary.	0.30 (0.012)
Crankshaft Gear and Crankshaft Interference mm (in)	0.03 — 0.093 (0.0012 — 0.0037)	
Camshaft Gear and Camshaft Interference mm (in)	0.015 — 0.023 (0.0006 — 0.0009)	
Idle Gear Shaft Wear mm (in)	29.959 — 29.980 (1.1795 — 1.1803)	29.80 (1.1732)
Idle Gear Bushing Wear mm (in)	30.000 — 30.021 (1.1811 — 1.1819)	30.1 (1.185)
Idle Gear Bushing and Idle Gear Shaft Clearance mm (in)	0.020 — 0.062 (0.0008 — 0.0024)	0.2 (0.008)
Idle Gear End Play mm (in)	0.058 — 0.115 (0.0002 — 0.005)	0.2 (0.008)

Lubrication System

Item			Service Standard	Service Limit
Oil Pump	Gear Teeth and Inner Wall Clearance mm (in)		0.125 — 0.220 (0.0049 — 0.0087)	0.3 (0.012)
	Gear and Pump Cover Clearance mm (in)		0.064 — 0.109 (0.0018 — 0.0043)	0.2 (0.008)
	Gear Shaft Wear mm (in)		15.989 — 16.000 (0.6295 — 0.6299)	15.9 (0.626)
	Gear Shaft and Bushing Clearance mm (in)		0.04 — 0.07 (0.0016 — 0.0028)	0.2 (0.012)
	Delivery Volume cc (cu·in)/rev		16.54 (1.0) Delivery Pressure: 392kPa (4 kg/cm^2 / 56.9 psi) Oil Temperature: 50 ± 2°C (122 ± 3.6°F) Oil Viscosity: SAE 30	
Relief Valve Opening Pressure kPa (kg/cm^2 / psi)		Oil Gallery	441.3 (4.5 / 64.0)	(Reference)
		Oil Pump	784.5 (8.0 / 113.8)	(Reference)

Cooling System

Item		Service Standard	Service Limit
Water Pump	External appearance	Check the following: • Cracks and damages of the pump body • Cracks and corrosion of the impeller • Water leak from the seal unit When an abnormal condition is found, replace the water pump as an assembly.	
	Seal Unit	Push the fan center in the radial direction while rotating it and check the seal unit for any excessive play or abnormal sound. When there is any abnormal condition found, replace the water pump as an assembly.	
	Delivery Volume lit (US / UK gal) / min	200 or more Water Pump Speed: 3,300 rpm Water Temperature: 80 ± 2°C (176 ± 3.6°F)	
Fan Drive Belt Tension mm (in)		8 — 12 (0.31 — 0.47) ... New belt 10 — 14 (0.39 — 0.55) ... Reuse belt Depress the drive belt mid-portion with a 98N (10kg / 22lb) force	
Thermostat With Jiggle Valve	Valve Initial Opening Temperature °C (°F)	85 ± 1.5 (185 ± 2.7)	
	Valve Lift At 100°C (212°F) mm (in)	8 (0.31) or more	
Thermostat With-Out Jiggle Valve	Valve Initial Opening Temperature °C (°F)	82 ± 1.5 (177 — 182)	
	Valve Lift At 95°C (203°F) mm (in)	8 (0.31) or more	
Radiator	External appearance	• Check the radiator for any corrosion, water leak, fin damage, or clogging. When there is any abnormal condition found, correct the radiator or replace it. • When deterioration, cracking or water leak is found in the rubber hose, replace the rubber hose.	
	Pressure Valve Opening Pressure kPa (kg/cm^2/ psi)	103.0 ± 14.7 (1.05 ± 0.15 / 14.9 ± 2.1)	
	Vacuum Valve Opening Pressure kPa (kg/cm^2/ psi)	1.0 — 4.9 (0.01 — 0.05 / 0.14 — 0.71)	
Cooling Fan	Cooling Fan Pulley Speed rpm	3,900	Rotate the fan by hand, and when it doesn't rotate smoothly, or when there is oil leak from the fan clutch, replace the fan clutch.
	Cold Condition (Bimetal lower than 40°C (104°F) rpm	900 or lower	
	Hot Condition (Bimetal higher than 70°C (158°F) rpm	3,300 ± 150	
	Pulley Ratio (Crankshaft/Fan)	175 / 151	

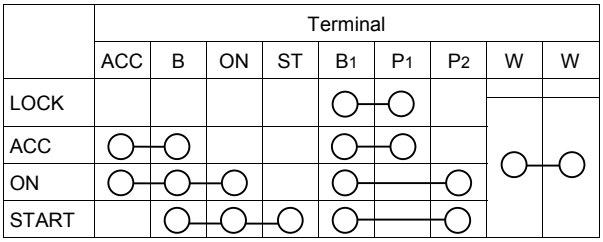
Fuel System

Item		Service Standard	Service Limit
Fuel Feed Pump	Suction capacity	The suction must be completed in 25 times or less. Priming Pump Speed: 60 — 100 times/minute Pipe Inside Diameter: 8mm (0.31in) Suction Pipe Length: 2,000mm (78.7 in) Suction Height: 1,000mm (39.4in)	
Injection Nozzle	Spray Condition	• The spray must be fine and uniform. • The injection must be directed in the center direction with no stray spray. • The spray from each nozzle hole must be uniform	

Engine Electrical

Item			Service Standard	Service Limit
Generator	Ball bearing			When it doesn't rotate smoothly or is giving out an abnormal sound, or when there is an oil leak from the seal, replace it.
	Slip Ring Diameter mm (in)		Nominal size 31.6 (1.244)	30.6
	Rotor	Coil Resistance Ω	Nominal resistance 12.6	When the resistance differs largely from the standard value, or when a poor insulation is found, replace it.
		Coil Insulation Resistance MΩ	1 or more (500 volt megger tester)	
	Stator	Coil Resistance Ω	Nominal resistance 0.17 (Between coil end and each coil end)	
		Coil Insulation Resistance MΩ	1 or more (500 volt megger tester)	
	Brush Length mm (in)		Nominal size 20 (0.79)	6 (0.24)
IC Voltage Regulator	Rectifier		The rectifier is normal when there is continuity with the tester - terminal connected to "B" (battery) terminal and the + terminal to the rectifier holder, and when there is no continuity with their connections reversed.	When there is continuity in both directions, or when there is no continuity in both directions, replace the rectifier.
	Battery Power V		<4HF1 / 4HF1-2 / 4HG1 / 4HG1-T>	
			LR 250 — 504 (24V - 60A)	28 — 29
			LR 250 — 508B (24V - 50A)	28 — 29
			DENSO (12V - 35A)	27.8 — 28.8
			<4HE1-TC>	
			LR 250 — 510 (24V - 50A)	28 — 29
			LR 180 — 510 (12V - 80A)	14.1 — 14.7

Item		Service Standard	Service Limit
IC Voltage Regulator	Output Current A	1300 rpm / 2000 rpm / 4000 rpm <4HF1 / 4HF1-2 / 4HG1 / 4HG1-T> LR 250 — 504: 18 / 35 / 53 LR 250 — 508B: 15 / 32 / 46 DENSO: 12 / 18 / 37 <4HE1-TC> LR 250 — 510: 15 / 32 / 43 LR 180 — 510: 25 / 58 / 82	
	Pulley Ratio (Crankshaft/Generator)	175 / 82	
Vacuum Pump	Pump Housing Inside Diameter mm (in)	60.0 — 60.1 (2.362)	(Reference)
	Vane Length mm (in)	14.2 — 15.2 (0.559 — 0.598)	(Reference)
	Performances Time required for the pressure to get to -66.7kPa (-500mmHg / -9.7psi).	1,000 rpm 13 sec or less 1,000 rpm 35 sec or less (LR 180 — 510 only) 5,000 rpm 4 sec or less 5,000 rpm 10 sec or less (LR 180 — 510 only) Oil Viscosity: SAE 30 Oil Temperature: 70 ± 5°C (158 ± 9°F) Oil Pressure: 441kPa (4.5 kg / cm^2 / 64psi) Tank Capacity: 7,000cc (427 cu·in)	
	Check Valve	• Apply 98 — 490 kPa (1 — 5 kg/cm^2 14-71 psi) compressed air to pump side of the check valve. • Check for air leakage from the check valve. • If there is air leakage, the check valve must be replaced.	
Starter	Commutator Run-Out mm (in)	0.05 (0.002) or less	0.2 (0.008)
	Commutator Outside Diameter mm (in)	36.5 (1.437)	35.5 (1.398)
	Mica Segment Depth mm (in)	0.5 — 0.8 (0.020 — 0.031)	0.2 (0.008)
	Brush Length mm (in)	15.0 (0.591)	10.5 (0.413)
	Brush Spring Tension N (kg / lb)	24.5 — 34.3 (2.5 — 3.5 / 5.5 — 7.7)	

Item			Service Standard	Service Limit
Starter	Load Characteristics			
	Terminal Voltage	V	18.55	
	Load Current	A	250	
	Torque	N·m (kg·m / lb·ft)	14.2 (1.45 / 10.5) or more	
	Speed	rpm	860	
			 N6A1414E	
Preheating system (QOSII)	Time required for the glow indicator to light up	sec	3.5 After the key switch is turned to ON position without engine turned.	
	Time required for the source voltage to be supplied to the glow plug	sec	18 After the key switch is turned to ON position without engine turned.	
	Glow Relay Coil Resistance	Ω	Nominal resistance 51.5	
	Thermo Switch Operating Temperature	°C (°F)	OFF → ON: 7 — 13 (44.6 — 55.4) ON → OFF: Less 3 (37.4)	
	Glow Plug Continuity			If no continuity exists, must be replaced.

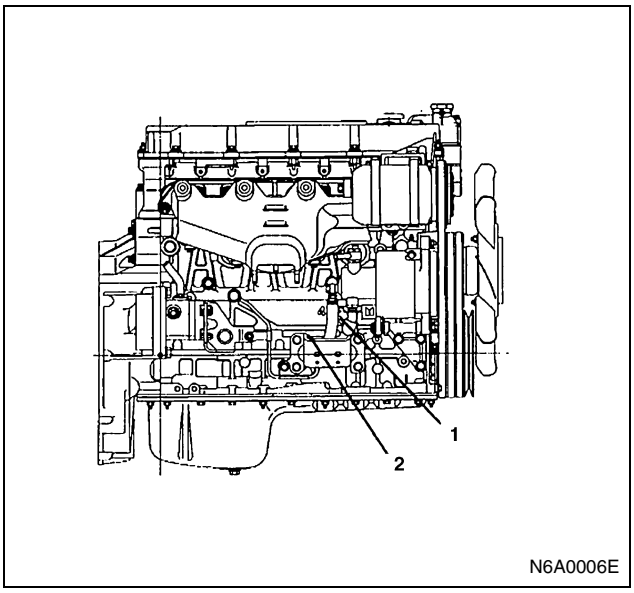
SERVICING

Servicing refers to general maintenance procedures to be performed by qualified service personnel.

Model Identification

Engine Serial Number

The engine number is stamped on the front left hand side of the cylinder body.



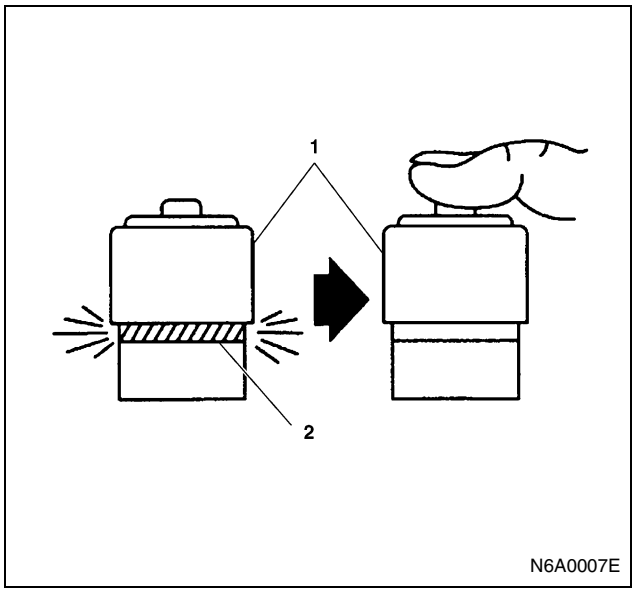
Legend

1. Engine type
2. Engine number

Air Cleaner

Dust Indicator

1. The dust indicator is installed to the air cleaner. (for Australia and GCC)
   Inspect the dust indicator. If the indicator plate is red, the air cleaner element must be cleaned or replaced.
2. Clean the air cleaner element once and reinstall it.
   Press the dust indicator button to clear the dust indicator.

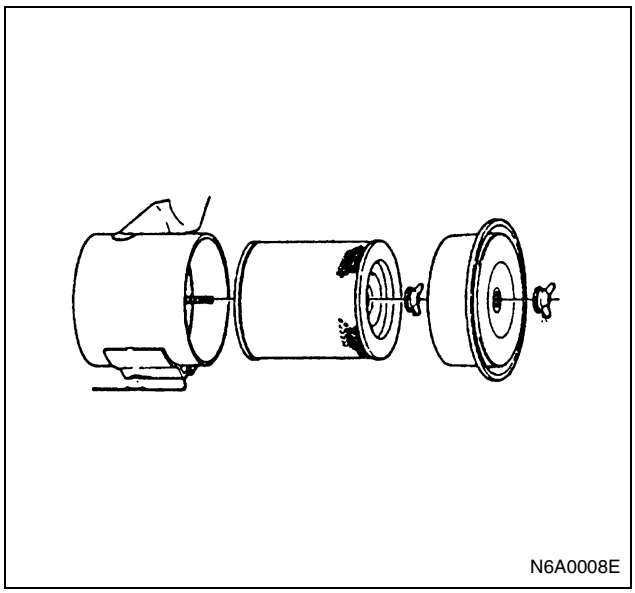


Legend

1. Dust indicator
2. Red color

Dry Type Washable Paper Element

Element cleaning procedures will vary according to the condition of the element.



Dust Fouled Element

Rotate the element with your hand while applying compressed air to the inside of the element. This will blow the dust free.
Compressed air pressure must not exceed 686 kPa (7 kg/cm^2 / 99.6 psi).

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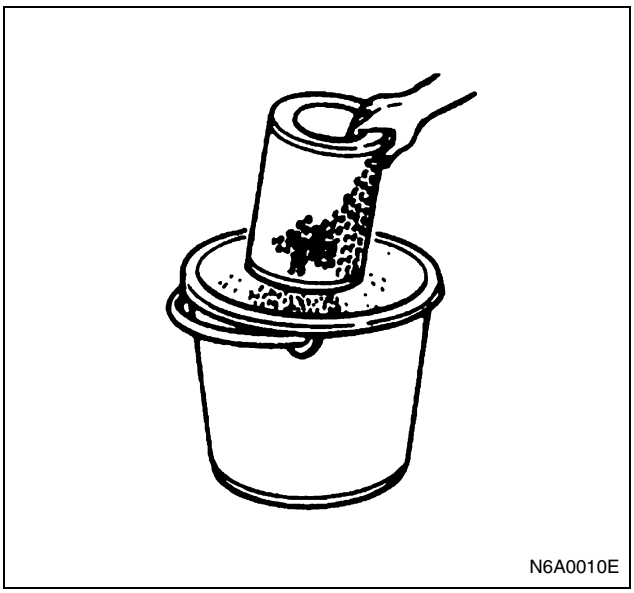
Carbon and Dust Fouled Element

1. Prepare a cleaning solution of Isuzu Genuine Element Cleaner (Donaldson D1400) diluted with water.
2. Immerse the element in the solution for twenty minutes.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3. Remove the element from the solution and rinse it well with running water.
   Water pressure must not exceed 274 kPa (2.8 kg/cm^2 / 39.8 psi).

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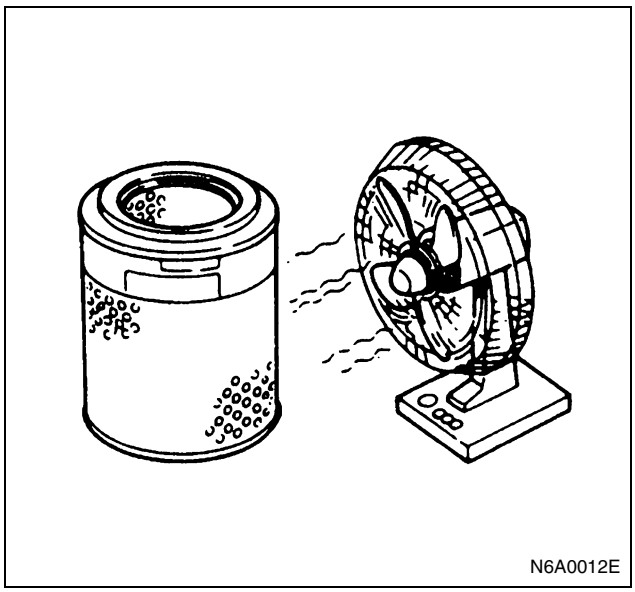
4. Dry the element in a well ventilated area.
   An electric fan will hasten drying.

Caution:
Do not use compressed air or an open flame to dry the element quickly. Damage to the element will result.

It will usually take two or three days for the element to dry completely. Therefore, it is a good idea to have a spare on hand to use in the interim.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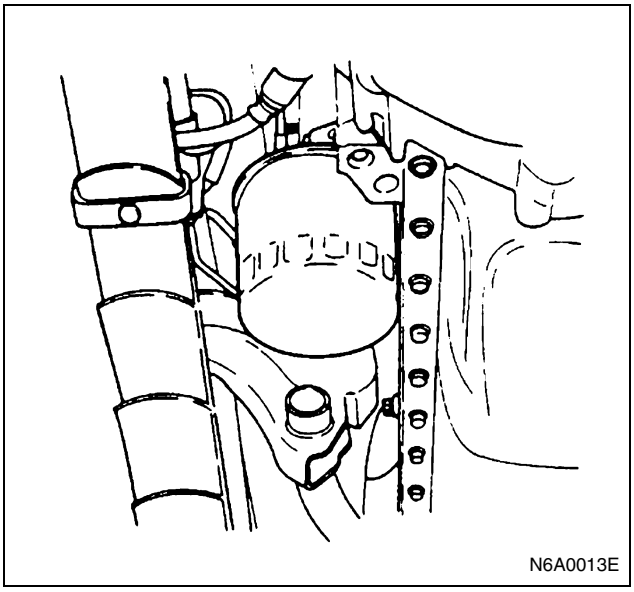
Lubricating System

Main Oil Filter (Disposable Spin-On Cartridge Element)

Replacement Procedure

1. Loosen the used oil filter by turning it counterclockwise with the filter wrench.
   Filter Wrench: 1-85221-097-0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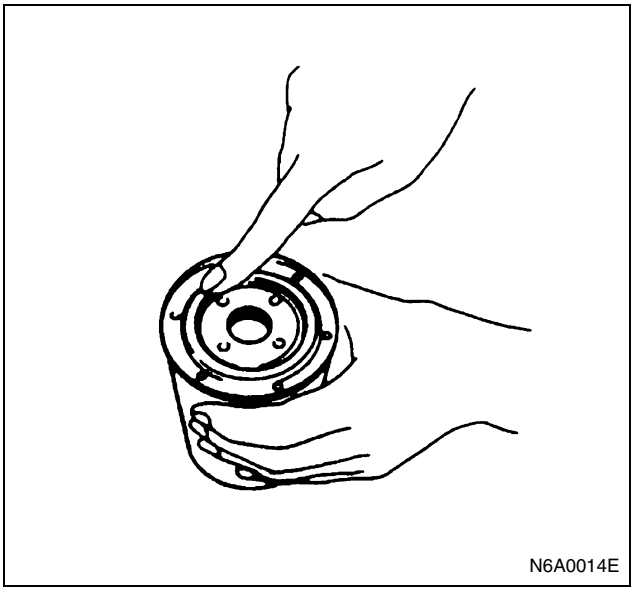
2. Clean the oil filter fitting face.
   This will allow the new oil filter to seat properly.
3. Apply a light coat of engine oil to the O-ring.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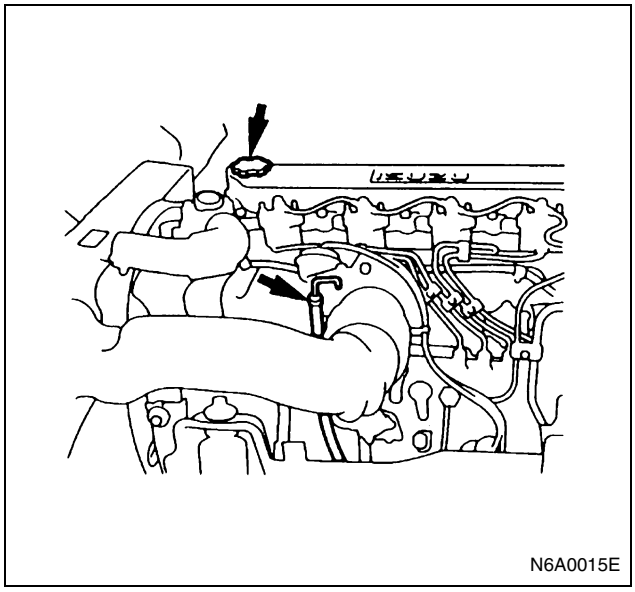
4. Turn in the new oil filter until the filter O-ring is fitted against the sealing face.
5. Use the filter wrench to turn in the filter an additional one full turn.
6. Check the engine oil level and replenish to the specified level if required.

Engine Oil Replenishment	lit (US/UK gal)
0.7 (0.19/0.15)	

7. Start the engine and check for oil leakage from the main oil filter.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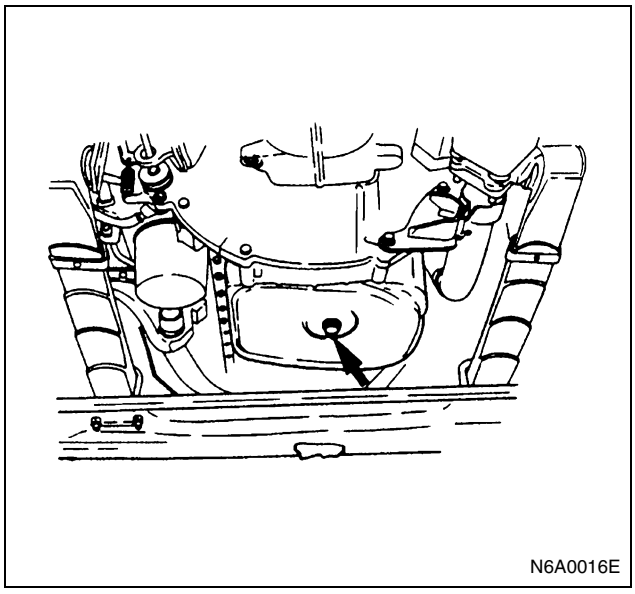
Engine Oil Replacement

Draining

1. Remove the drain plug to completely drain the engine oil.
   Do this while the engine is hot.
2. Replace the drain plug.
3. Tighten the drain plug to the specified torque.

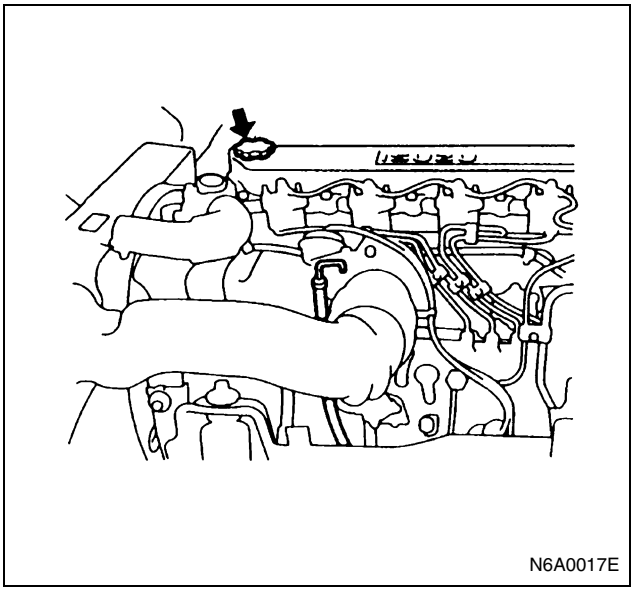
Tighten:
Drain plug to 78 N·m (8.0 kg·m/58 lb·ft)


N6A0016E

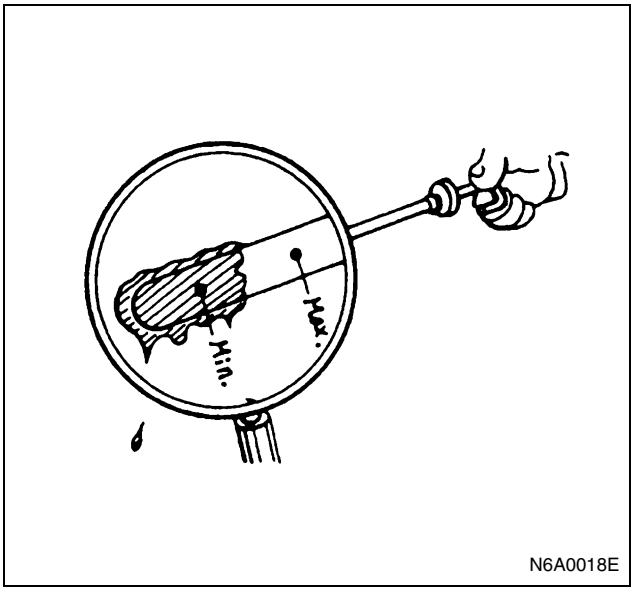
Replenishment

1. Remove the filler cap.
2. Pour the specified engine oil into the crankcase through the oil filler.
3. Replace the filler cap.

Crankcase and Filter Oil Capacity	lit (US/UK gal)
10.5 (2.8/2.3)	


N6A0017E

4. Start the engine and allow it to idle for a few minutes.
5. Stop the engine.
6. Use the dipstick to check the oil level.
   If the oil level is below the “MIN” line, add oil through the oil filler.
   If the oil level is above the “MAX” line, drain off the excess oil through the drain plug.



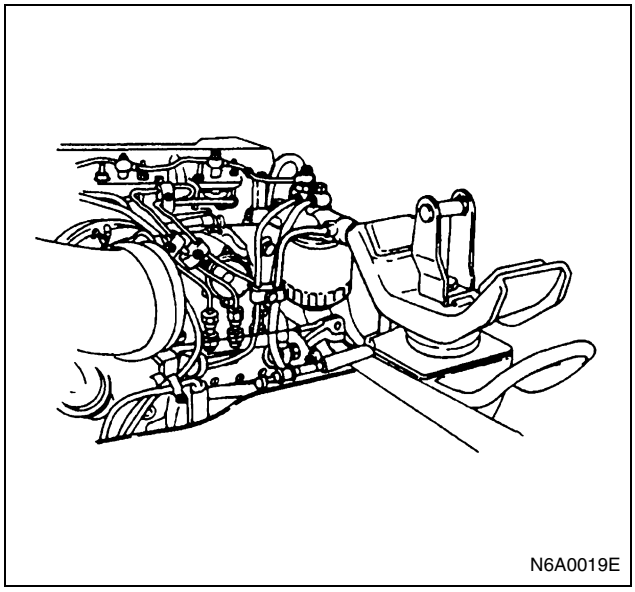
N6A0018E

Fuel System

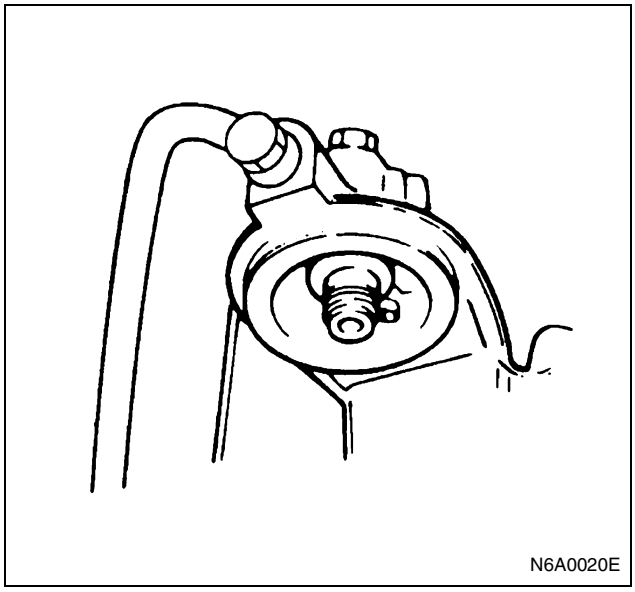
Fuel Filter

Replacement Procedure

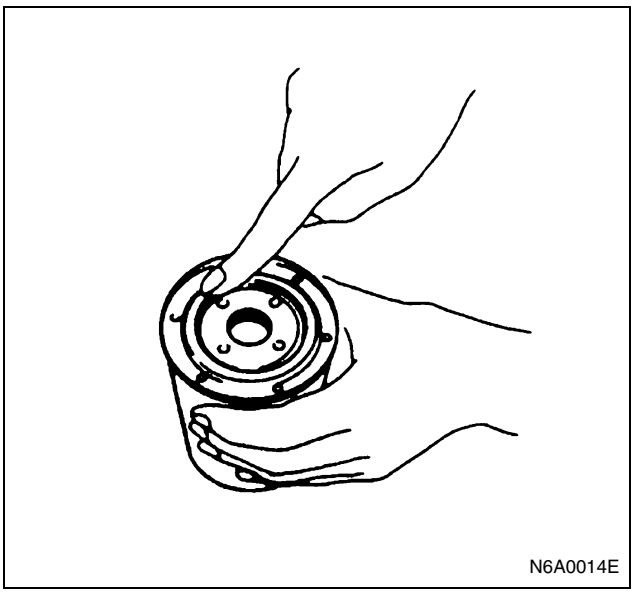
1. Loosen the used fuel filter by turning it counterclockwise with the universal filter wrench.


N6A0019E

2. Clean the upper cover fitting face.
   This will allow the new fuel filter to seat properly.

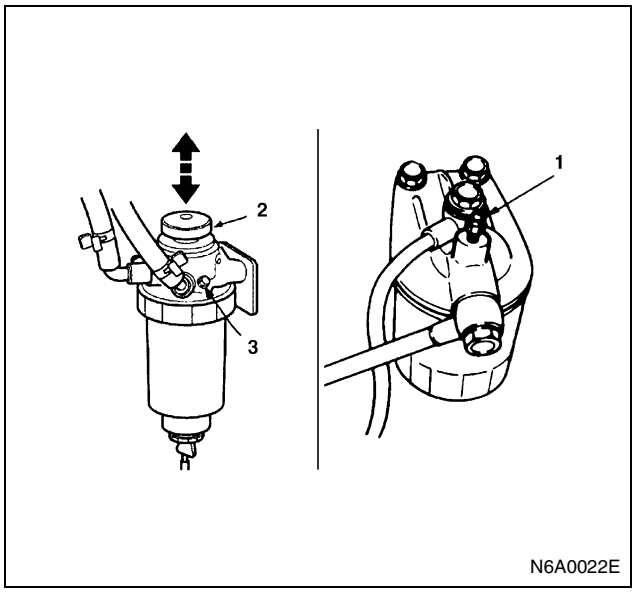

N6A0020E

3. Apply a light coat of engine oil to the O-ring.

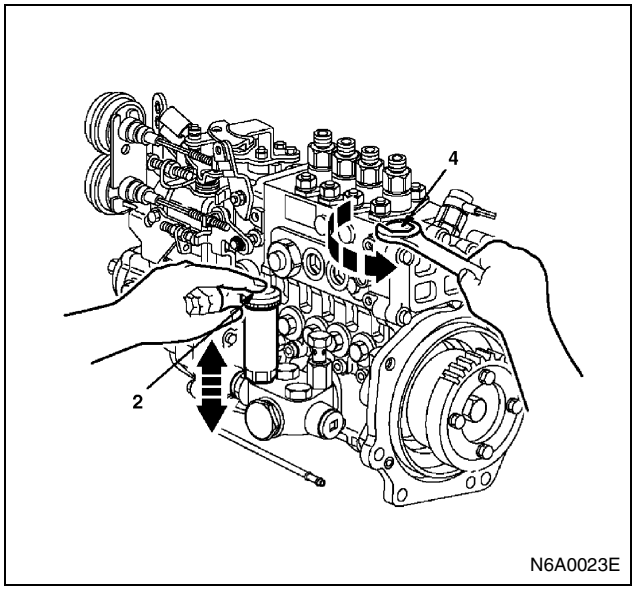

N6A0014E

4. Supply fuel to the new fuel filter to facilitate bleeding.
5. Turn in the new fuel filter until the filter O-ring is fitted against the sealing face.
   Be very careful to avoid fuel spillage.
6. Use the filter wrench to turn in the fuel filter an additional 1/3 to 2/3 of a turn.
7. Operate the priming pump to bleed the air from the fuel line in the following procedures.
   - Loosen the priming pump cap (2).
   - Loosen the air bleeding plug (3).
     (4HG1-T model only)
   - Operate the priming pump.
     Pump the primer pump until fuel flow is free of air bubbles.
     (Except 4HG1-T model)
   - Tighten the air bleeding plug (3).
     (4HG1-T model only)
   - Loosen the bleeding plug (1).
   - Operate the priming pump.
     Pump the primer pump until fuel flow is free of air bubbles.
   - Tighten the bleeder plug (1).
   - Operate the priming pump.
     Pump the primer pump until fuel flow is free of air bubbles.
     (Except 4HE1-TC model)
   - Loosen the bleeding plug on the injection pump (4).
     (4HE1-TC model only)
   - Operate the priming pump.
     Pump the primer pump until fuel flow is free of air bubbles.
     (4HE1-TC model only)
   - Tighten the bleeding plug on the injection pump (4).
     (4HE1-TC model only)
   - Lock the priming pump cap (2).

Notice:
Check for fuel leakage from around the injection pump and the fuel filter.



N6A0022E



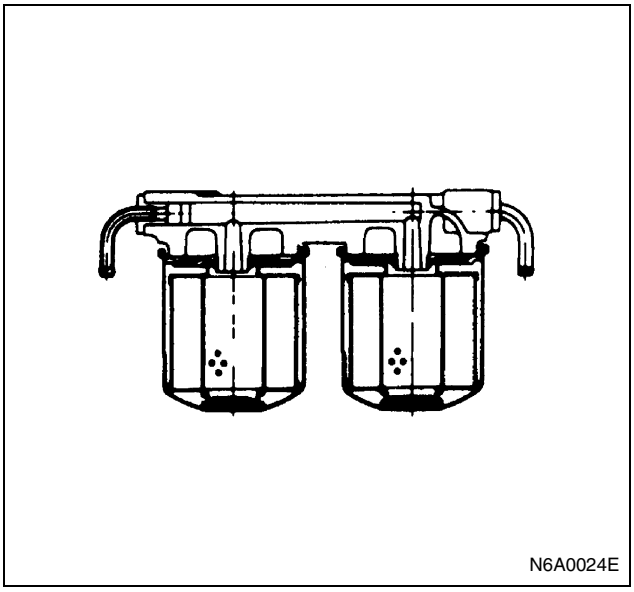
N6A0023E

8. Start the engine.
   Crank the engine for ten seconds or until it starts.
   If the engine does not start after ten seconds, repeat Step 7.

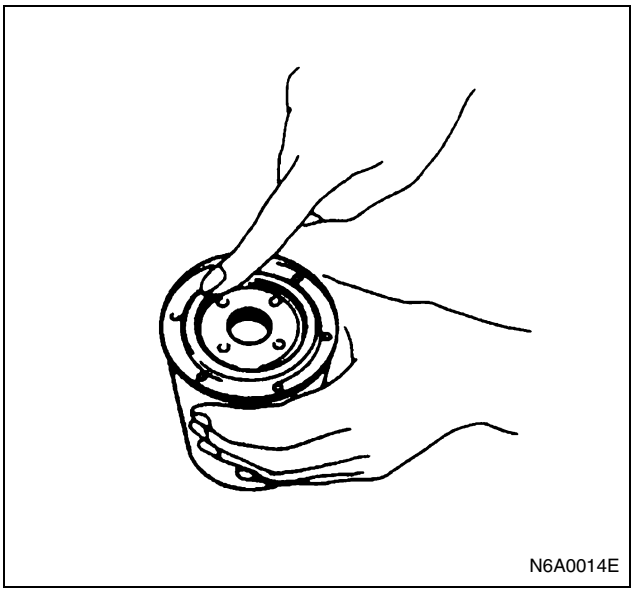
Sub Fuel Filter (Dual Type)

Replacement Procedure

1. Loosen the fuel filters by turning them counterclockwise with the universal filter wrench.
2. Clean the upper cover fitting faces.
   This will allow the new fuel filters to seat properly.


N6A0024E

3. Apply a thin coat of engine oil to the O-rings.

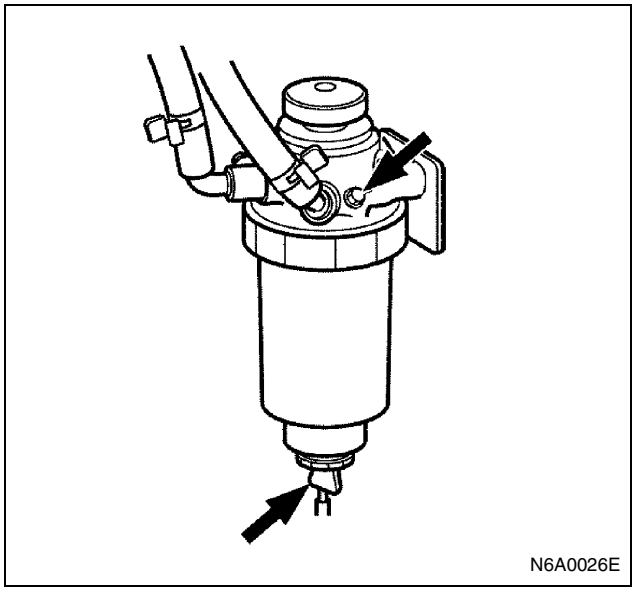

N6A0014E

4. Install the filter assemblies.
   Carefully turn each assembly clockwise until the O-ring is fitted against the filter cover sealing face.
5. Use the filter wrench to turn in each filter assembly an additional 1/3 to 2/3 of turn.
6. Operate the priming pump on the fuel filter to bleed the fuel system.
   Refer to “AIR BLEEDING” for more detailed information.

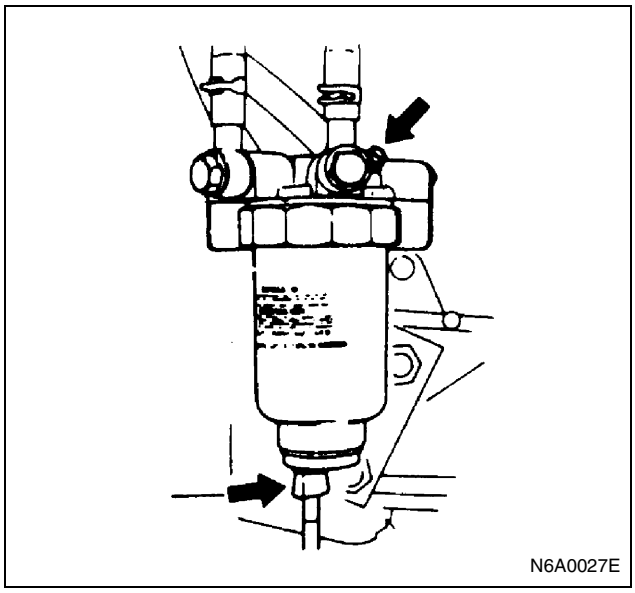
Pre-fuel Filter Water Draining Procedure

The indicator light will come on when the water level in the water separator exceeds the specified level.
Drain the water and foreign material from the water separator with the following procedure.

1. Place the end of a vinyl hose (beneath the drain plug) in a container.
2. Loosen the air intake plug and drain plug, then drain water.


N6A0026E

3. After draining, securely tighten the drain plug and air intake plug.


N6A0027E

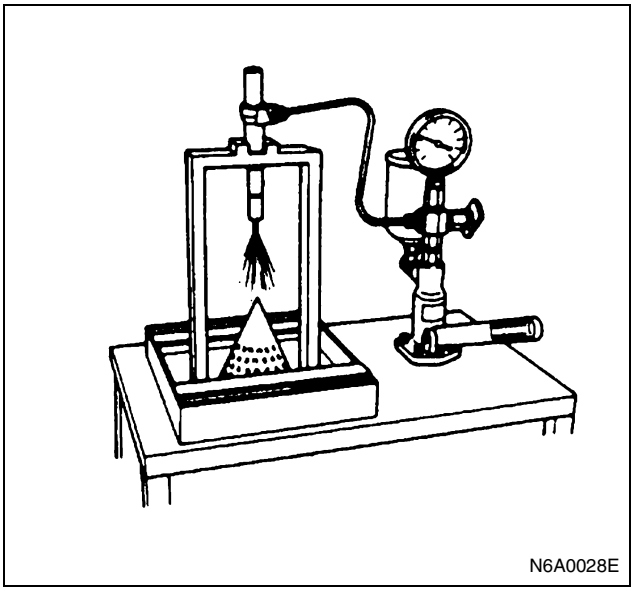
4. Then, operate the priming pump on the injection pump to bleed the fuel system.
5. After starting the engine, check to see that no fuel leaks from the drain plug.

Injection Nozzle

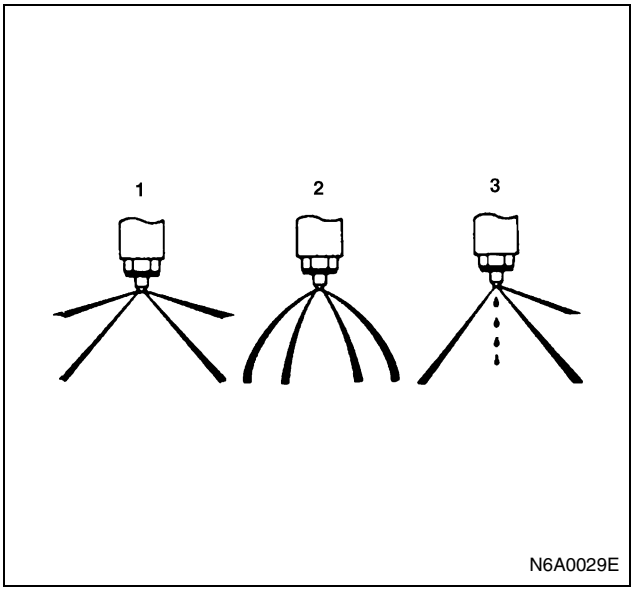
Pressure and Spray Condition Check

1. Use a nozzle tester to check the injection nozzle opening pressure.
   If the opening pressure is above or below the specified value, the injection nozzle must be replaced or adjusted.
   Refer to “Adjustment.”

Injection Nozzle Opening Pressure	Mpa (kg/cm^2/psi)
4HF1/4HF1-2/4HG1	18.14 (185/2,631)
4HE1-TC	21.57 (220/3,128)
4HG1-T	1st: 18.1 (185/2,631) 2nd: 21.1 (215/3,057)


N6A0028E

2. Check the spray condition.
   Refer to the illustration.
   Spray Condition



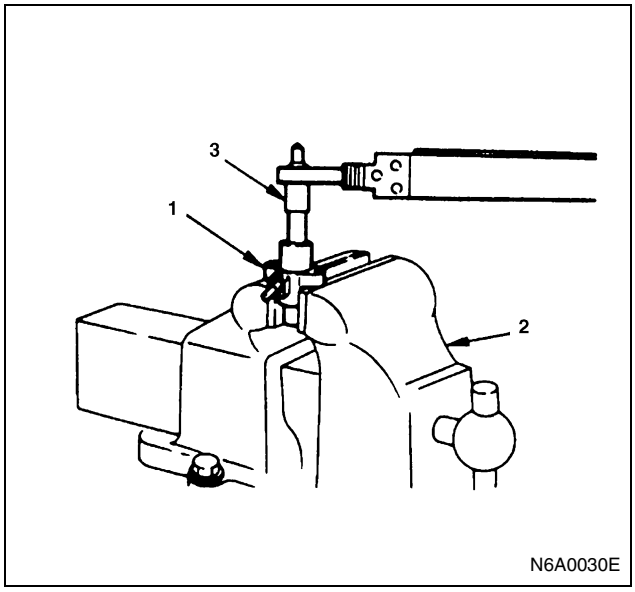
N6A0029E

1) Correct
2) Incorrect (Restrictions in orifice)
3) Incorrect (Dripping)

If the spray condition is bad, the injection nozzle must be replaced or adjusted.
Refer to “6C FUEL SYSTEM”.

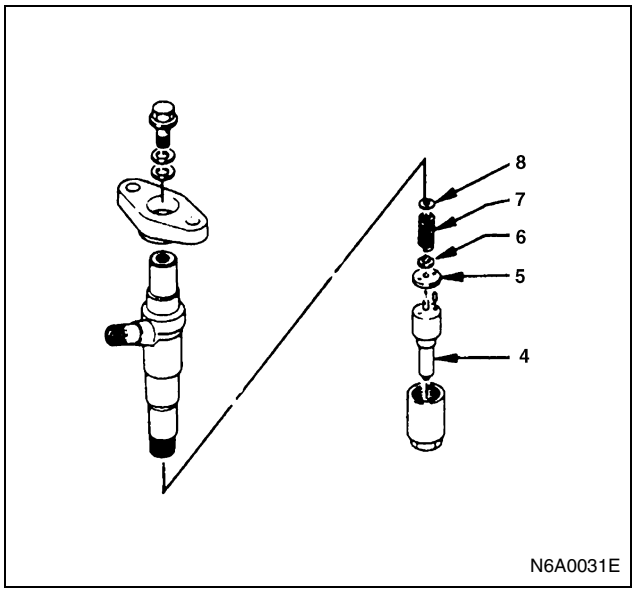
Adjustment

1. Clamp the injection nozzle holder (1) in a vise (2).
2. Use a wrench to remove the injection nozzle retaining nut (3).



N6A0030E

3. Remove the injection nozzle holder from the vise.
4. Remove the injection nozzle (4), the spacer (5), the spring seat (6) the spring (7) and the adjusting shim (8).



N6A0031E

5. Install the new adjusting shim, the spring, the spring seat, the spacer, the injection nozzle, and the retaining nut.
6. Clamp the injection nozzle holder in the vise.
7. Tighten the injection nozzle holder retaining nut to the specified torque.

Tighten:
Injection nozzle holder retaining nut to 34 N·m (3.5 kg·m/ 25 lb·ft)

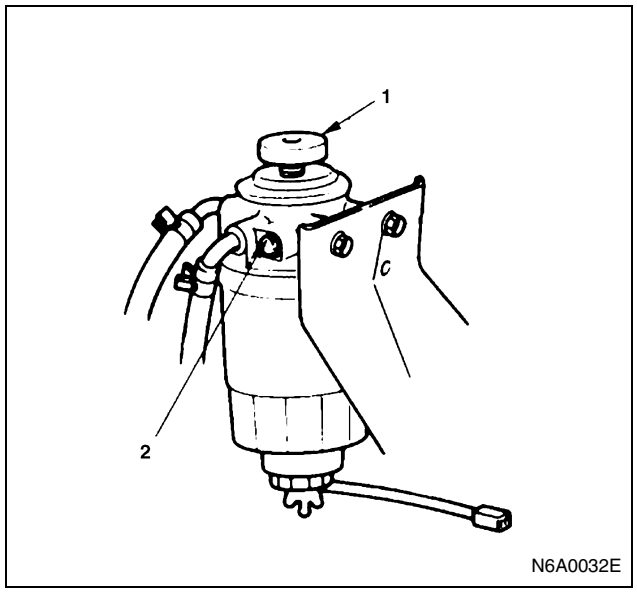
8. Remove the injection nozzle holder from the vise.

9. Attach the injection nozzle holder to the injection nozzle tester.
10. Apply pressure to the nozzle tester to check that the injection nozzle opens at the specified pressure.
    If the injection nozzle does not open at the specified pressure, install or remove the appropriate number or adjusting shims to adjust it.
    Removing or installing one shim will increase or decrease the nozzle opening pressure approximately 370 kPa (3.77 kg/cm^2 / 53.6 psi).

Adjust Shim Arailability	mm (in)
Range	0.5 — 1.5 (0.02 — 0.06)
Increment	0.025 (0.001)
Total Number of Shims	41

Air Bleeding (Except 4HF1-2 model only)
Above works refer to “FUEL SYSTEM” in this section.
Air Bleeding (4HF1-2 model only)

1. Actuate the priming pump (1) to send the air in the fuel system to the injection pump.
2. Loosen the sedimenter air bleeding plug (2) and operate the priming pump until no bubbles appear.
3. Tighten the air bleeding plug (2) completely.



4. Try to start the engine. If the engine is not started within 10 seconds, air bleeding should be conducted once again.
5. Check that there is no fuel leak, and then tighten the priming pump completely.

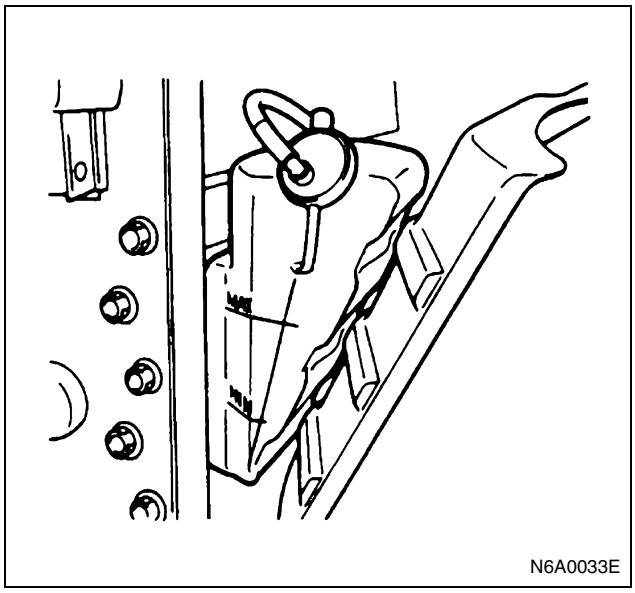
Water Drain
If more water than specified has collected, the warning light is lit. Under this condition, follow the following water drain procedure:

1. Place a container (Approximately 0.2 liters capacity) beneath the drain plug on the separator.
2. Loosen the drain plug and air bleeding plug.
3. After draining, tighten the drain plug.
4. Operate the priming pump several times again and check for fuel leak.
5. Tighten the air bleeding plug.
6. Make sure that the warning light in the instrument panel is off. (Except 4HE1-TC model)

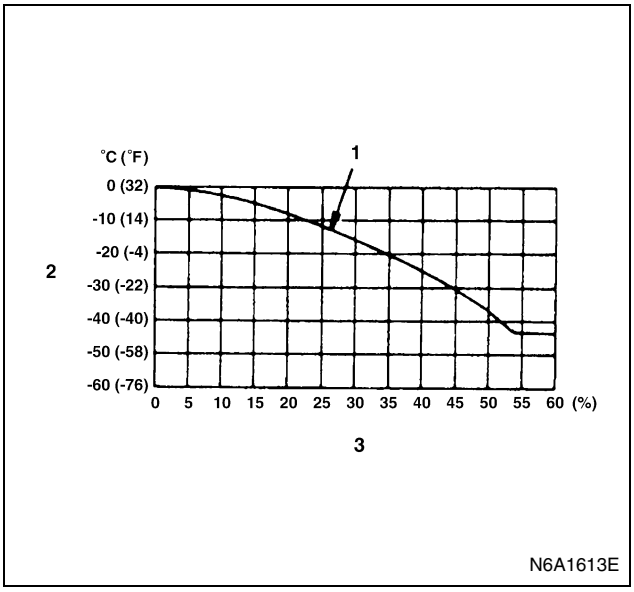
Cooling System

Coolant Level

Check the coolant level and replenish the radiator reserve tank if necessary.
If the coolant level falls below the “MIN” line, carefully check the cooling system for leakage. Then add enough coolant to bring the level up to the “MAX” line.



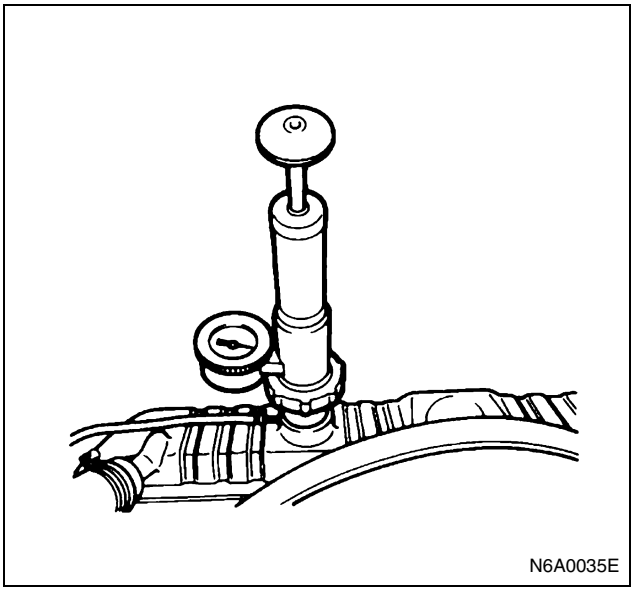
Notice:
Do not overfill the reserve tank.
Remove the radiator filler cap only when absolutely necessary.
Always check the coolant level when the engine is cold.
Always refer to the chart at the left to determine the correct cooling water to antifreeze solution mixing ratio.



Legend
1. Good quality ethylene glycol anti-freeze
2. Freezing point
3. Mixing ratio

Cooling System Leakage Inspection

Clog up the reserver tank hose carefully and check the cooling system for leakage with a radiator cap tester by applying an air pressure of 196 kPa (2 kg/cm^2/28 psi) from filler neck to inside the radiator.
As the radiator upper tank is provided with a valve, the pressure fails to rise higher than the valve opening pressure unless the hose is clogged up.



Radiator Valve Inspection

Apply air pressure from filler neck using radiator cap tester and check the opening pressure of radiator valve. If the valve opening pressure is out of the standard value range, replace with a new radiator valve.

Radiator valve opening pressure kPa (kg/cm^2/psi)
93 — 123 (0.95 — 1.25/13.5 — 17.8)

Remove the radiator valve and check a negative pressure valve as the center of the valve seat side. If the negative pressure valve does not work smoothly, clean or replace the radiator valve.

Tighten:
Radiator valve fixing to 6 N·m (0.6 kg·m/4 lb·ft)

Conduct cooling system leakage check after reinstalling the radiator valve.

Thermostat Operating Test
1. Completely submerge the thermostat in water.
2. Heat the water.

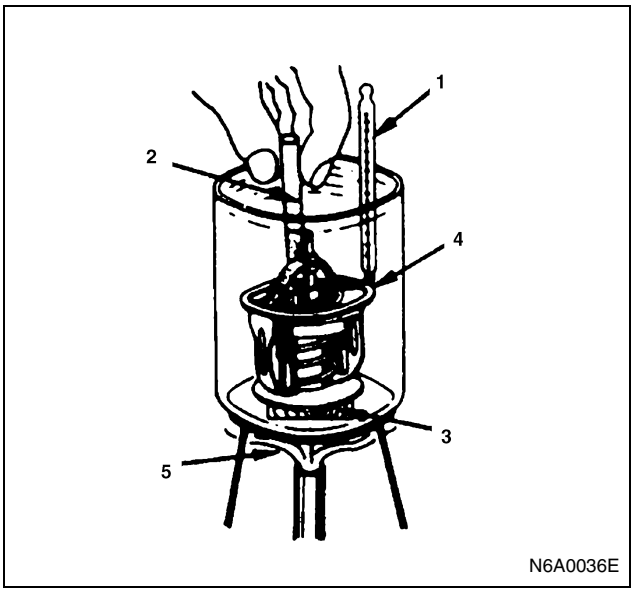
Stir the water constantly to avoid direct heat being applied to the thermostat.

3. Check the valve initial opening temperature.

Valve Initial Opening Temperature °C (°F)		
		Standard
without jiggle valve	Primary valve	83 — 87 (181 — 189)
	Secondary valve	80 — 84 (176 — 183)
with jiggle valve		83.5 — 86.5 (182 — 188)

4. Check the valve lift full opening temperature.

Valve Lift Full Opening Temperature °C (°F)	
	Standard
without jiggle valve	95 (203)
with jiggle valve	100 (212)



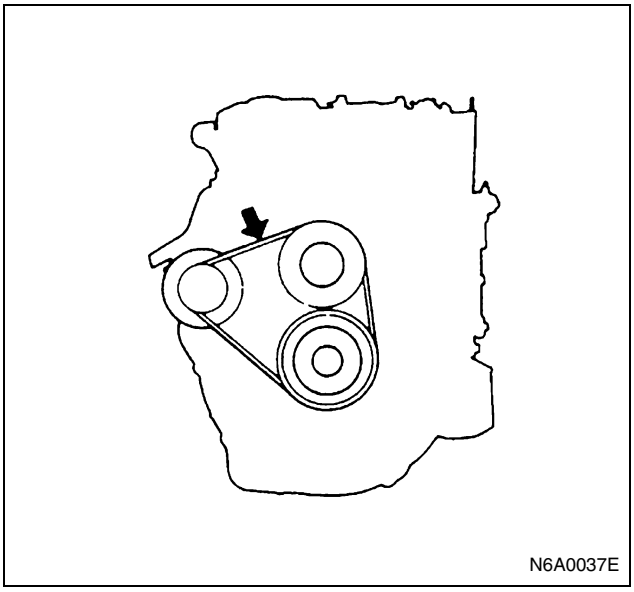
Legend
1. Thermometer
2. Aditating rod
3. Wooden piece
4. Thermostat
5. Heat

Fan Belt

Check the drive belt tension.
Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

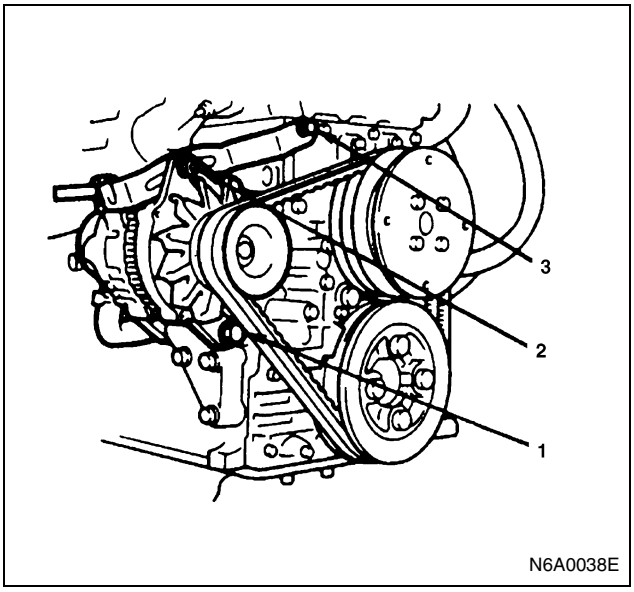
Drive Belt Deflection	mm (in)
8 — 12 (0.31 — 0.47) ... New belt 10 — 14 (0.39 — 0.55) ... Reuse belt	

Check the drive belt for cracking and other damage.
- Crankshaft damper pulley
- Generator pulley
- Cooling fan pulley


N6A0037E

Fan Belt Adjustment
Fan belt tension is adjusted by moving the generator.

Tighten:
Bolt 1 to 40 N·m (4.1 kg·m/30 lb·ft)
Bolt 2 to 24 N·m (2.4 kg·m/17 lb·ft)
Bolt 3 to 46 N·m (4.7 kg·m/34 lb·ft)



N6A0038E

If equipped with A/C compressor, loosen the A/C drive belt tension pulley adjust bolt and lock nut. Then free the A/C drive belt. When finishing the fan belt adjustment, adjust the A/C drive belt and check the belt tension.

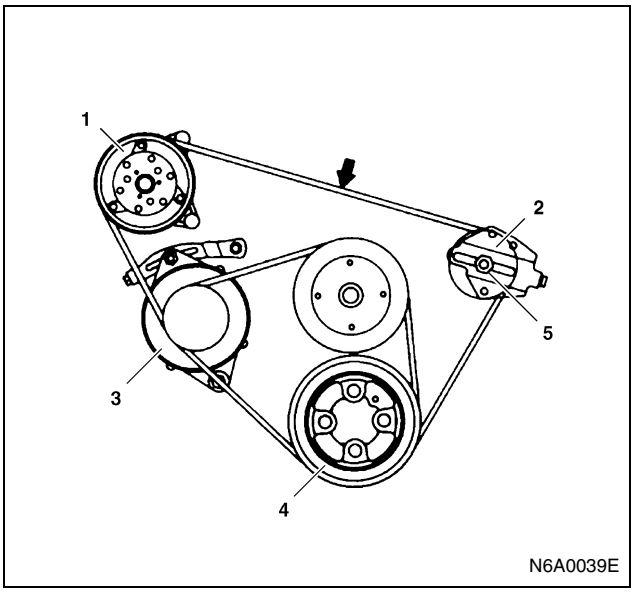
Air Conditioning (A/C) Compressor Drive Belt

Check the drive belt tension.
- Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

Drive Belt Deflection	mm (in)
16 — 20 (0.63 — 0.79) ... New belt 18 — 22 (0.71 — 0.87) ... Reuse belt	

Check the drive belt for cracking and other damage.
A/C compressor drive belt tension is adjusted by moving the tension pulley.
When finishing the fan drive belt, then adjust the A/C drive belt.

Tighten:
Locking nut to 27 N·m (2.8 kg·m/20 lb·ft)



N6A0039E

Legend

1. A/C compressor pulley
2. Tension pulley
3. Generator pulley
4. Crankshaft damper pulley
5. Tension pulley lock nut

Engine Control

Idling Speed Inspection

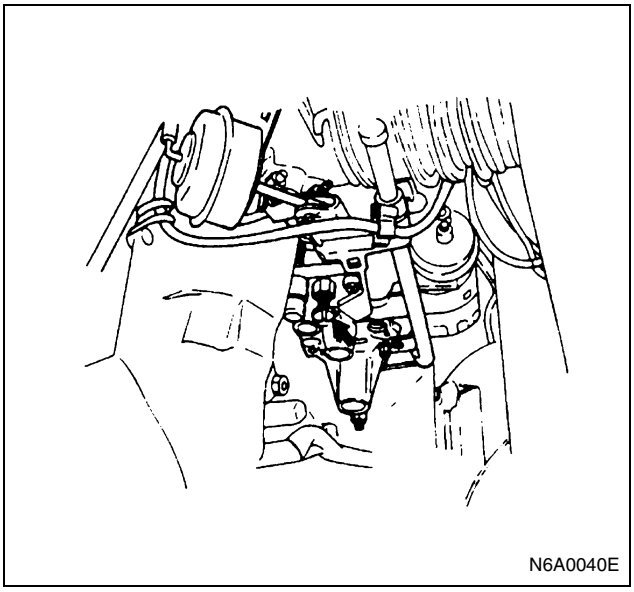
1. Set the vehicle parking brake and chock the drive wheels.
2. Place the transmission in neutral.
3. Start the engine and allow it to warm up.
4. Check that the idling control knob is in the engine idling position.
5. Set a tachometer to the engine.
6. Check the engine idling speed.
   Engine idling speed should be as below.

Engine Idling Speed		rpm
4HF1	M/T	550 — 625
4HF1-2	M/T	575 — 625
4HG1	M/T	550 — 600
4HG1-T	M/T	600 — 650
4HE1-TC (4HE1-TC-XS, XN) 98EPA	M/T	775 — 825
4HE1-TC (4HE1-TC-XS, XN) SPEC. EURO3	M/T	775 — 825

If the engine idling speed is outside the specified range, it must be adjusted.

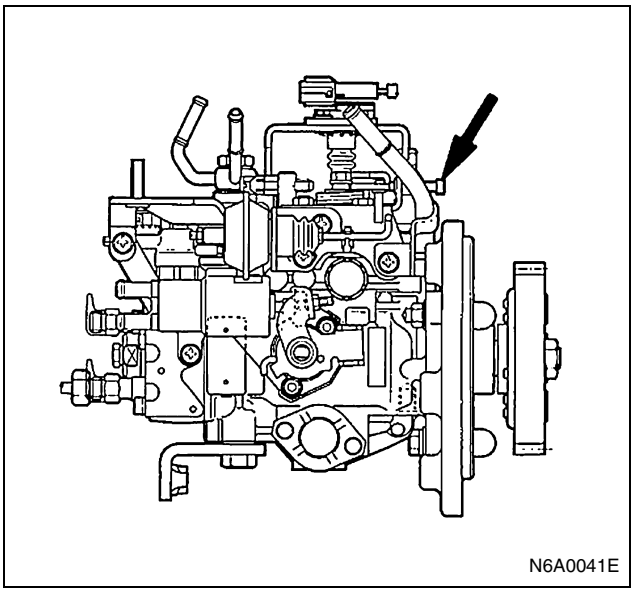
Idling Speed Adjustment

1. Loosen the idling set bolt lock nut on the injection pump.
2. Adjust the idling speed with the idling set bolt.
3. Tighten the lock nut.


N6A0040E

Idling Speed Check & Adjustment (4HF1-2 model only)

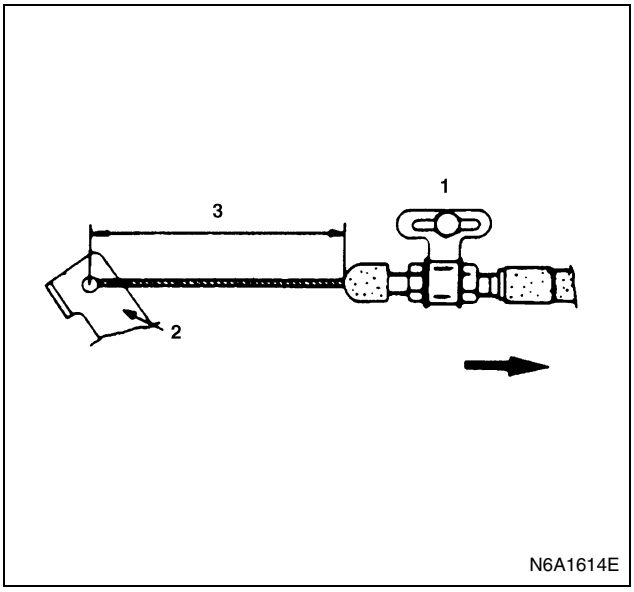
1. Warm up the engine.
2. Measure idling speed by means of tachometer.
3. If idling speed is out of the standard, adjust with an idling adjust bolt (indicated by an arrow mark).
   Idling speed: 575 — 625 rpm


N6A0041E

Accelerator Control

Accelerator Control Cable Adjustment

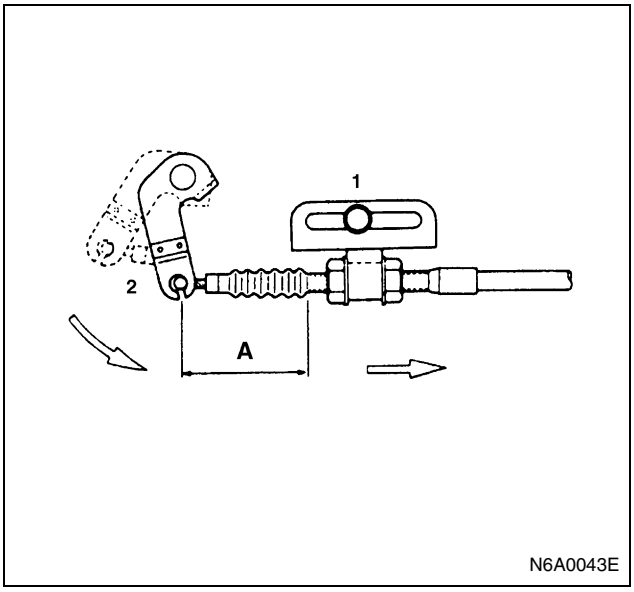
1. Loosen the accelerator cable clamp bolt (1).
2. Check that the idling control knob is in the engine idling position.
3. Hold the accelerator lever (2) in the fully closed position and stretch the control cable (3) in the direction indicated by the arrow to remove any slack.



Engine Stop Control

Adjustment

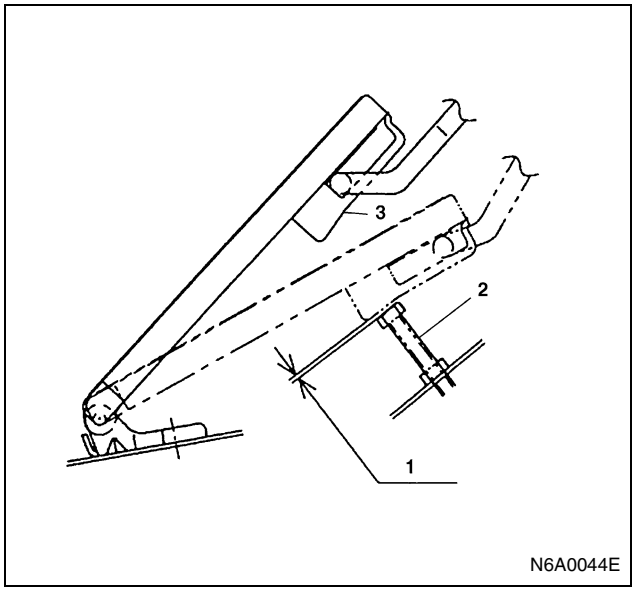
1. Check that the key switch is either in the “LOCK” position or removed from the engine.
2. Loosen the bolt (1).
3. Pull the fuel cut lever (2) as far as possible and hold it.
4. Remove cable slackness (A) by pulling the cable in the direction of the arrow in the illustration.
5. Tighten the bolt (1).



Accelerator Pedal Adjustment

1. Press the accelerator pedal to the floorboard and hold it.
2. Use the stopper bolt (2) to adjust the clearance between the stopper bolt end and the accelerator pedal (3) lower face.

Accelerator Pedal Clearance	mm (in)
0 — 2 (0 — 0.079)	



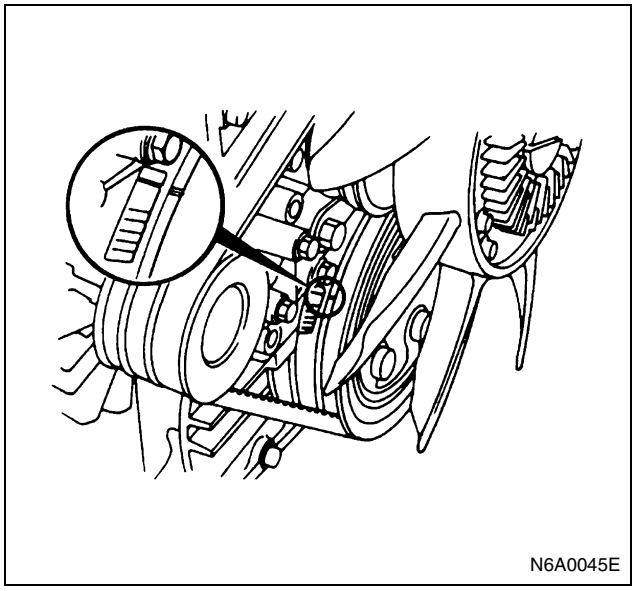
Legend

1. Full stroke 0 — 2 mm (0 — 0.079 in)
2. Stopper bolt
3. Accelerator pedal

Valve Clearance Adjustment

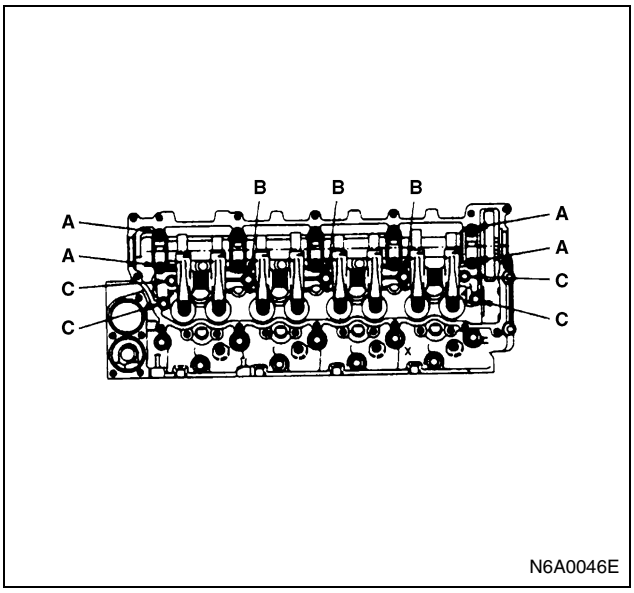
1. Bring the piston in either the No.1 cylinder or the No.4 cylinder to TDC on the compression stroke by turning the crankshaft until the crankshaft damper pulley timing mark is aligned with the TDC notched line.

Notice:
If there are two marks on the crank pulley, the front side of mark is for setting BTDC 49° and the rear side of mark is for setting TDC.



2. Tighten the rocker arm shaft bracket nuts and bolts to the specified torque in numerical order a little at a time as shown in the illustration.

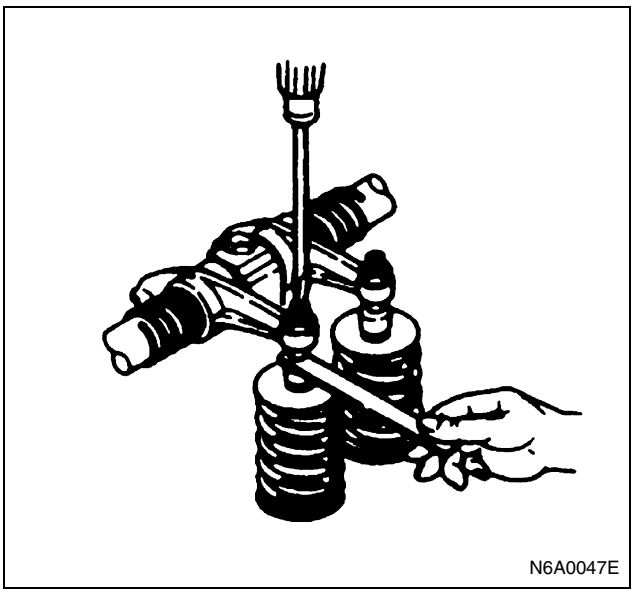
Tighten:
Rocker arm shaft bracket nut and bolt to
- Nut (A) 27 N·m (2.8 kg·m/20 lb·ft)
- Bolt (B) 56 N·m (5.7 kg·m/41 lb·ft)
- Bolt (C) 27 N·m (2.8 kg·m/20 lb·ft)



N6A0046E

- Apply engine oil to the threaded portion of the nuts marked with “A” and the bolts with “B”shown in the illustration, and then tighten them to the specified torque.

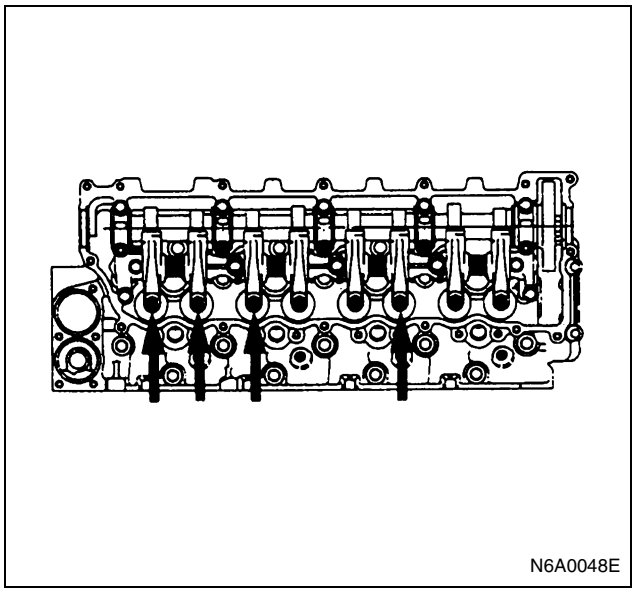
3. Check for play in the No.1 intake and exhaust valve rocker arms.
   If the No.1 cylinder intake and exhaust valve rocker arms have play, the No.1 piston is at TDC on the compression stroke.
   If the No.1 cylinder intake and exhaust valve rocker arms are depressed, the No.4 piston is at TDC on the compression stroke.


N6A0047E

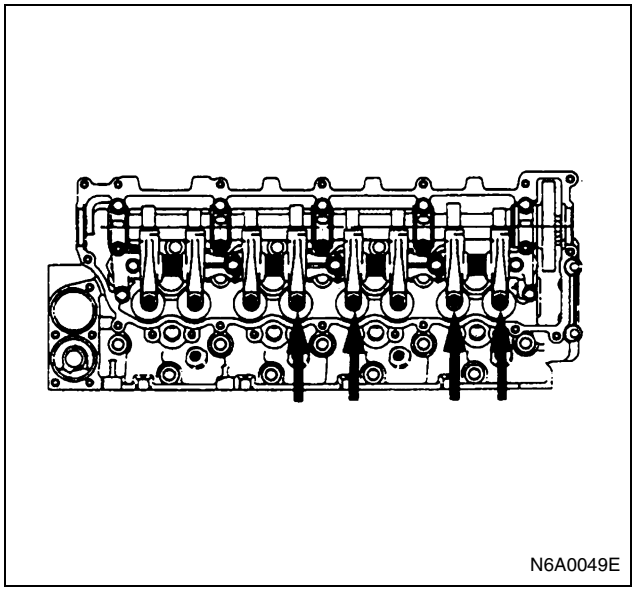
Adjust the No.1 or the No.4 cylinder valve clearance while their respective cylinders are at TDC on the compression stroke.

Valve Clearance	mm (in)
At cold	0.40 (0.016)

4. Loosen each valve clearance adjusting screw as shown in the illustration.


N6A0048E

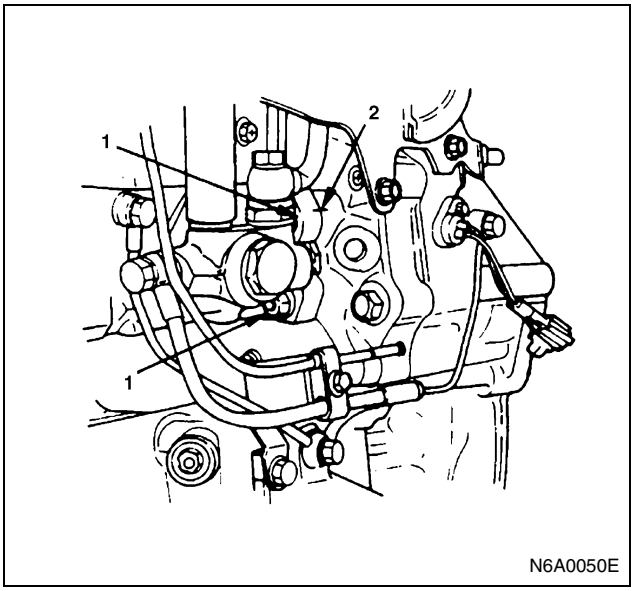
5. Insert a feeler gauge of the appropriate thickness between the rocker arm and the valve stem end.
6. Turn the valve clearance adjusting screw until a slight drag can be felt on the feeler gauge.
7. Tighten the lock nut securely.
8. Rotate the crankshaft 360 degrees.
9. Realign the crankshaft damper pulley timing mark with the TDC notched line.
10. Adjust the clearance for the remaining valves as shown in the illustration.


N6A0049E

Injection Timing Adjustment

Injection Pump Notched Line Inspection

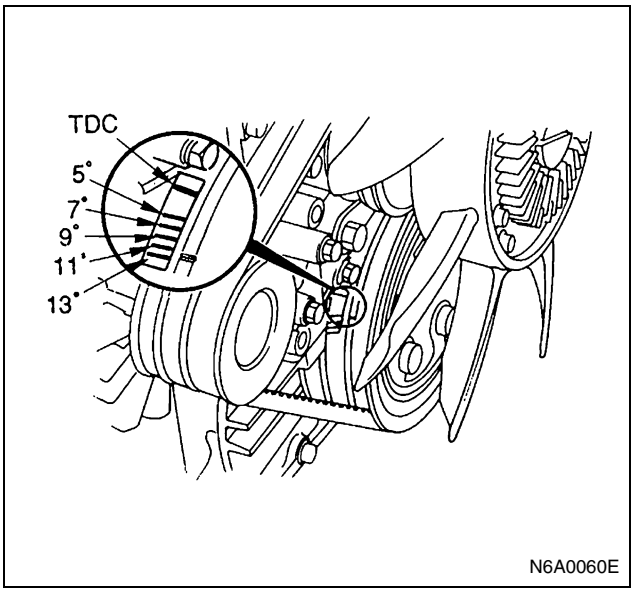
1. Check the injection pump bracket nuts (1) for looseness.
   Tighten as required.
2. Check that the notched lines (2) on the injection pump bracket and the timing gear case are aligned.
   If the notched lines are not aligned, the injection timing must be checked.



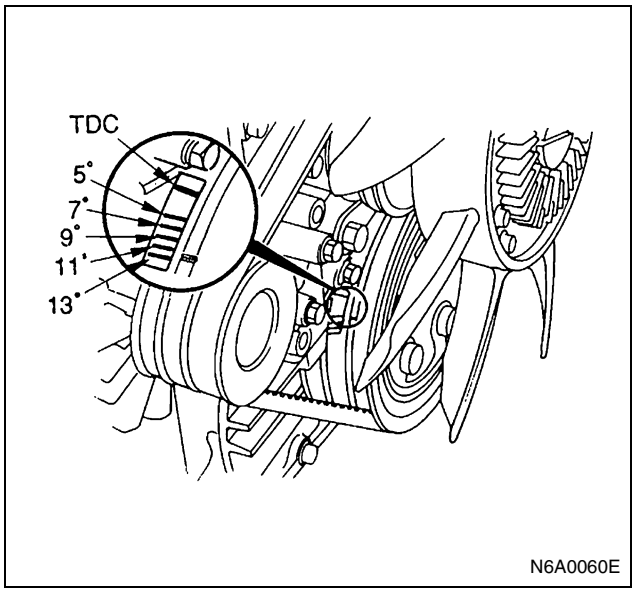
3. Some time, check injection timing on the crank damper pulley.
   If the injection timing aligned with in correct, the injection timing must be readjusted.

Injection Timing Adjustment

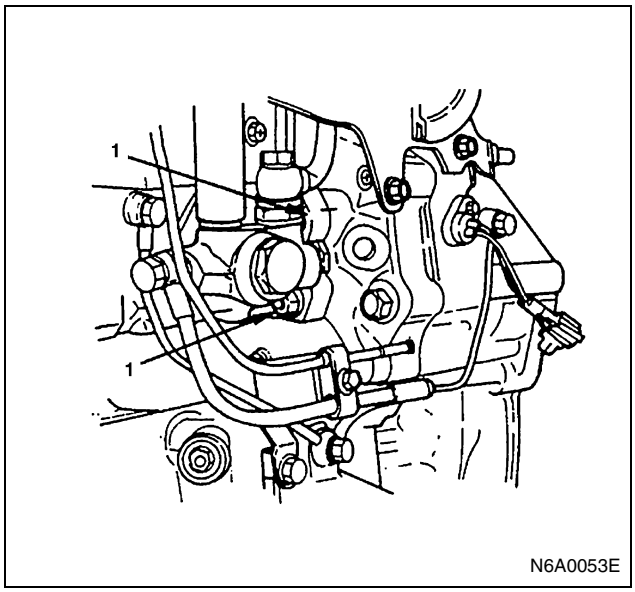
1. Turn the crankshaft until the timing mark on the crankshaft damper pulley is aligned with the BTDC (injection timing of each engine model) mark in the illustration.



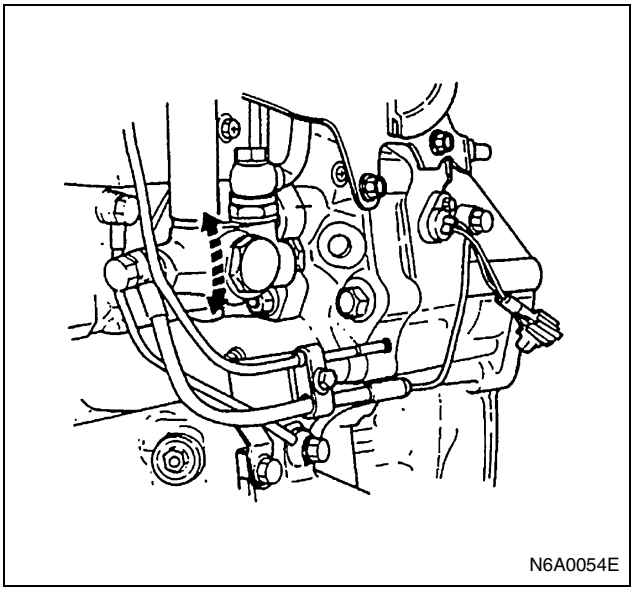
Injection Timing	deg
4HF1 4HE1-TC (4HE1-XS, XN)	BTDC 8
4HG1	BTDC 9
4HEI-T	BTDC 7
4HE1-TC (4HE1-XS)	BTDC 9 (Spec EURO3)



2. Remove the two foam rubbers.
3. Loosen the four injection pump fixing nuts (1).
   This will allow the pump to pivot.
   Do not bend or scratch the fuel pipe.

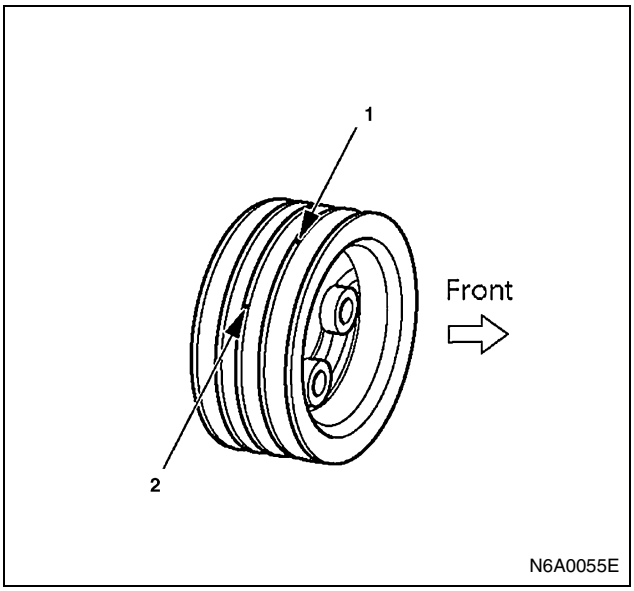


4. Align the notched line between the injection pump bracket and the timing gear case.
   Make sure that the timing mark on the crank damper pulley is aligned with correct injection timing.


N6A0054E

Notice:
In case the crank pulley has two marks as illustrated, (1) BTDC 49° mark on the second crest and (2) TDC mark on the third crest (as viewed from the front side), be sure to set at the mark (2). (If there are two different marks on one and same crest, set at the mark which comes second when rotated in the normal direction.)

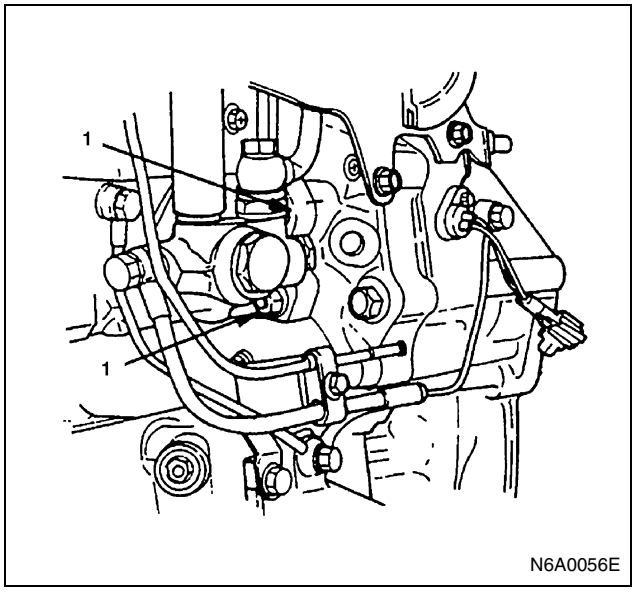
The mark (1) is used when installing the injection pump for 4HF1-2.



N6A0055E

5. Tighten the injection pump fixing nuts (1) to the specified torque.

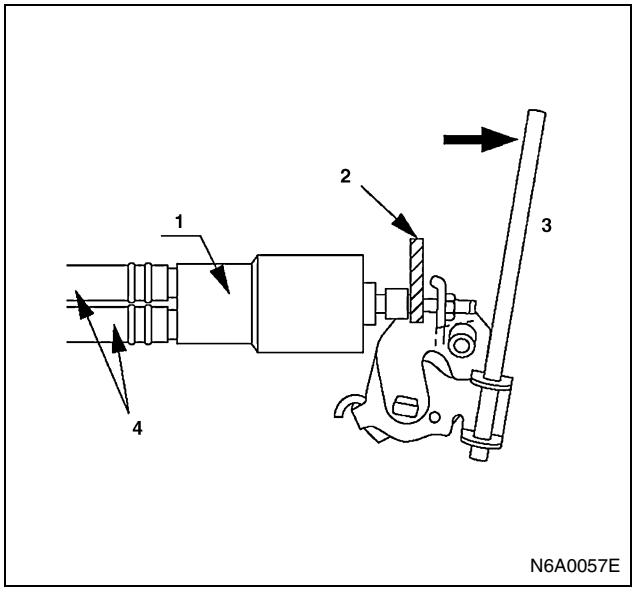
Tighten:
Injection pump fixing nut to 25 N·m (2.6 kg·m/19 lb·ft)



N6A0056E

Injection Timing Check (4HF1-2 model only)

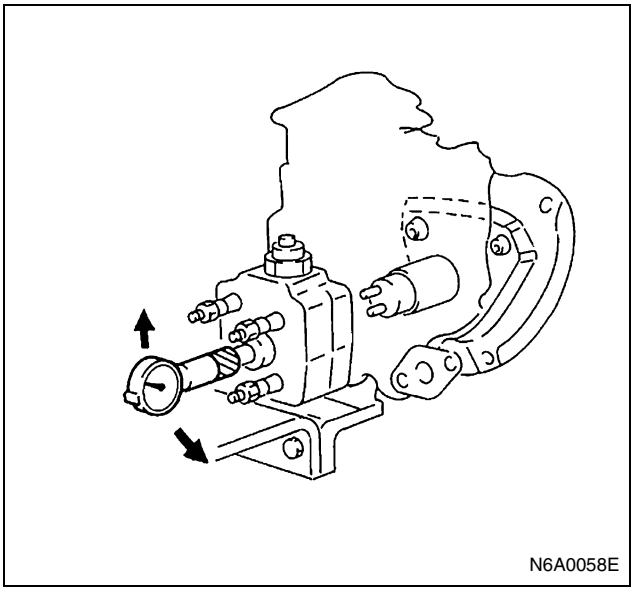
1. Set No. 1 Cylinder to the TDC in the compression stroke.
2. Disconnect Injection Pipe.
3. Put down Wax CSD lever, insert a spacer 10 — 20 mm (0.39 — 0.47 in) thick between the plunger and adjust bolt, and cancel the Wax CSD.



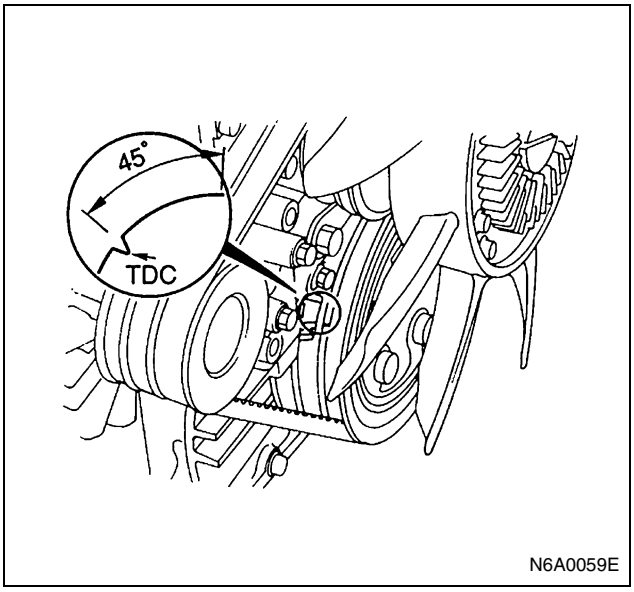
N6A0057E

Legend
1. Wax CSD
2. Spacer
3. Lever
4. Water hose

4. Remove the pump rear plug, connect a dial gage and set the lift at 1 mm (0.039 in).
   Special Tool
   Measuring device: 5-8840-0145-0


N6A0058E

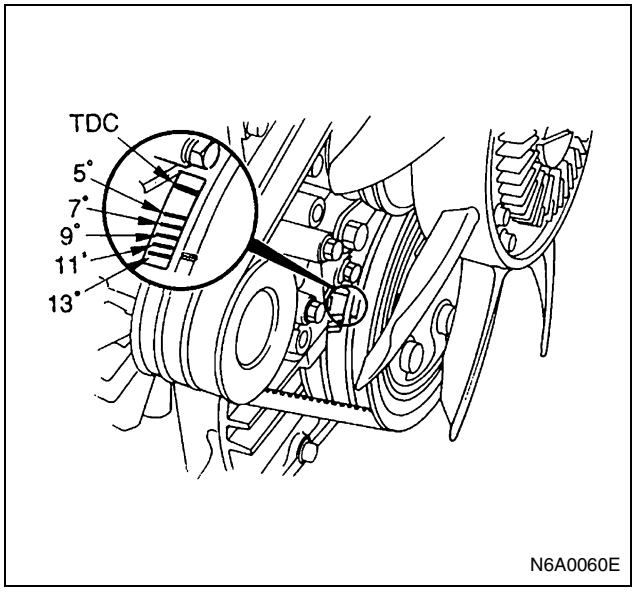
5. Set the crankshaft damper pulley TDC mark to the pointer or 45° before TDC.



N6A0059E

6. Set the dial gage to the “0” position.
7. Turn the crankshaft leftwise and rightwise a little and make sure that the needle stays in the “0” position.
8. Turn the crankshaft in the normal direction and read the measuring device’s indication at the 12° before TDC position.

Notice:
As there is no 12° mark, set midway between the 11° and 13° marks.
Standard value: 0.5 mm (0.0197 in)



N6A0060E

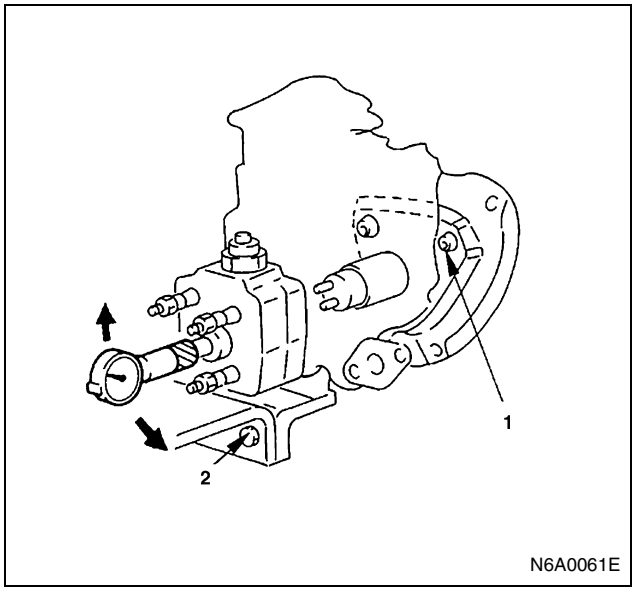
Injection Timing Adjustment (4HF1-2 model only)

If injection timing is out of the specified range, follow the following procedure for adjustment:

1. Loosen injection pump fixing nuts (1) and bracket bolt (2).
2. Adjust the mounting angle of injection pump:
   - If injection timing is too fast, bring the injection pump closer to the engine.
   - If injection timing is too slow, put the injection pump more distant from the engine.
3. When the dial gage has indicated the specified value, tighten the fixing nuts (1) and bolt (2) to specified torque:

Tighten:
Fixing nut to 24 N·m (2.4 kg·m/17 lb·ft)

Tighten:
Bracket bolt to 48 N·m (4.9 kg·m/35 lb·ft)



N6A0061E

4. Disconnect the dial gage, install and tighten the plug to specified torque. (Make sure of a copper washer being attached to the plug)

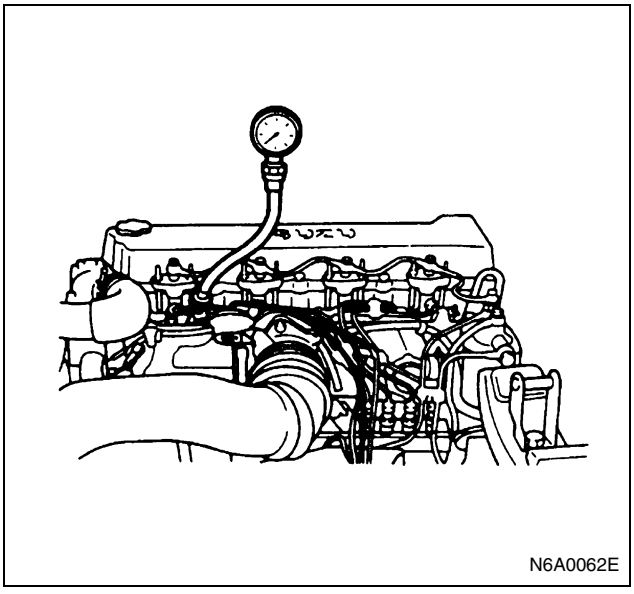
Tighten:
Pump rear plug to 17 N·m (1.7 kg·m/12 lb·ft)

5. Release the wax CSD and connect the injection pipe.

Tighten:
Pipe sleeve nut to 29 N·m (3.0 kg·m/22 lb·ft)

Compression Pressure Measurement

1. Start the engine and allow it to warm up.
   Engine Coolant Temperature: Above 80°C (176°F)
2. Stop the engine.
3. Remove the following parts.
   - Glow plugs.
   - In case VE pump;
     Fuel cut solenoid connector.
   - In case line pump;
     F-9 fuse in fuse box.
4. Set the adapter and the compression gauge to the No.1 cylinder glow plug hole.
   Compression Gauge: 5-8840-2675-0
   Adapter; Compression Gauge: 5-8531-7001-0


N6A0062E

5. Connect a tachometer and check that engine cranking speed is 200 rpm or higher.
6. Turn the engine over with the starter motor and take the compression gauge reading.
7. Repeat the procedure (steps 4,5 and 6) for the remaining cylinders.

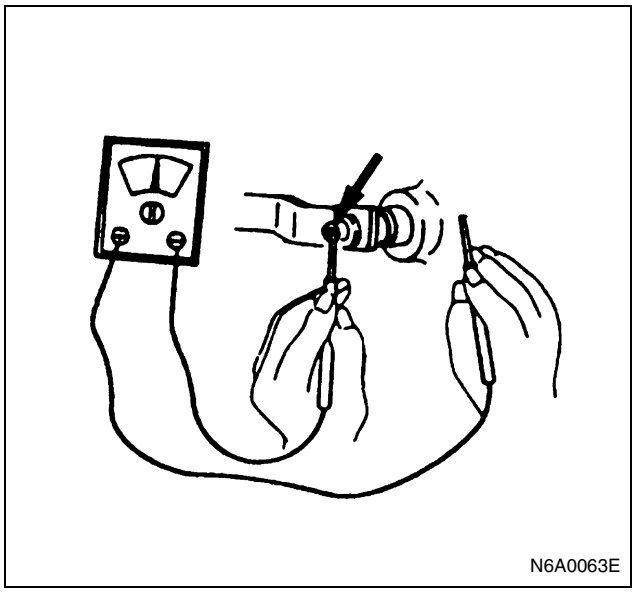
Compression Pressure kPa (kg/cm^2/psi) at 200 rpm	
Standard	More than 2,942 (30/426)
Limit for use	2,157(22/312)
Variance in pressure between cylinders	Less than 294 (3/43)

If the measured valve is less than the specified limit, above works refer to “TROUBLESHOOTING” Section in this manual.

Quick-On-Start II System

Inspection Procedure

1. Disconnect the thermoswitch connection on the thermostat outlet pipe.
2. Turn the key switch to the “ON” position.
   If the Quick-ON-Start II system is operating properly, the flow relay will make a clicking sound within three seconds.
3. Measure the glow plug terminal voltage with a circuit tester as soon as possible after turning the key switch to the “ON” position.


N6A0063E

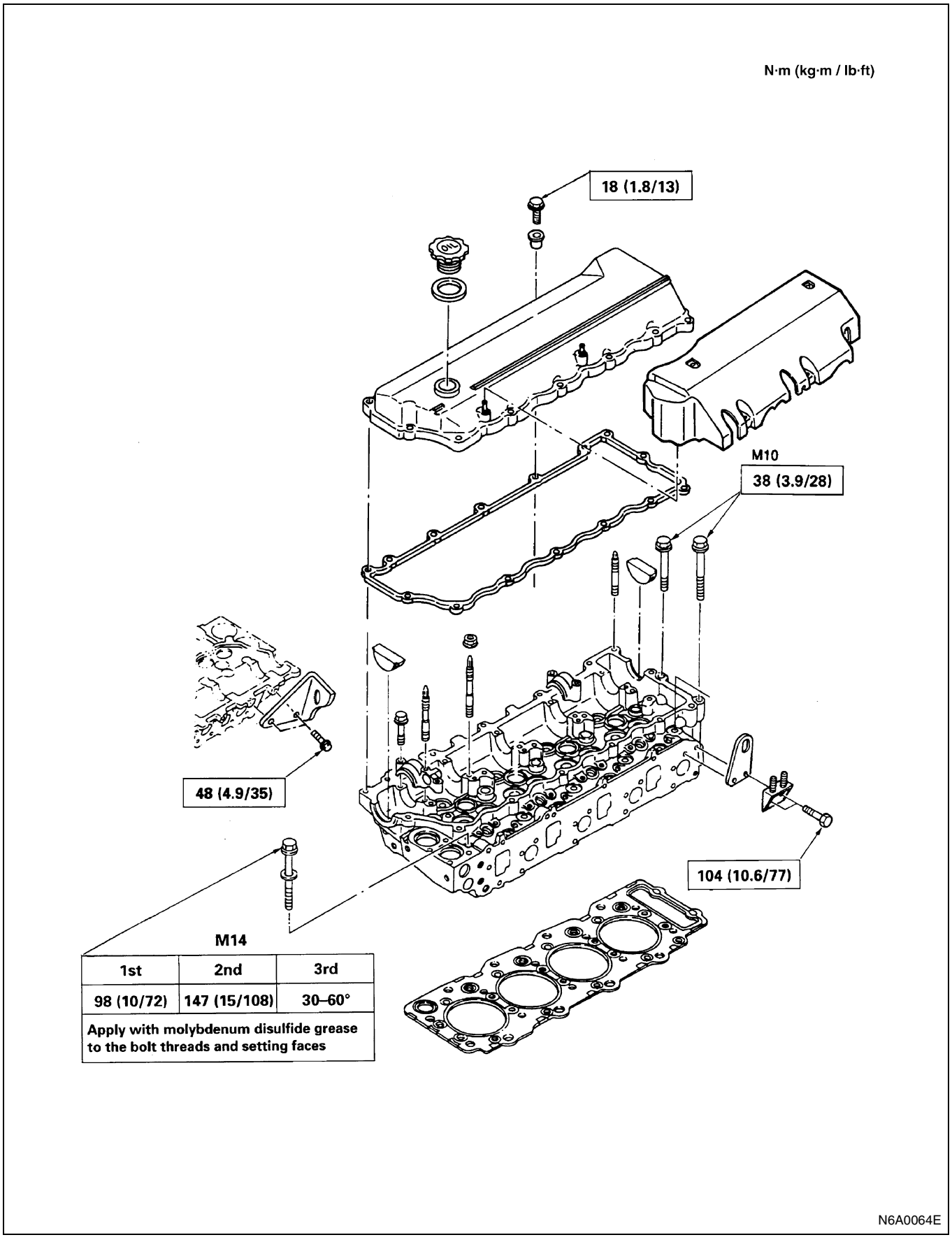
4. Check the glow plug heating time.

Approximate Glow Plug Heating Time	sec
18	

FIXING TORQUE

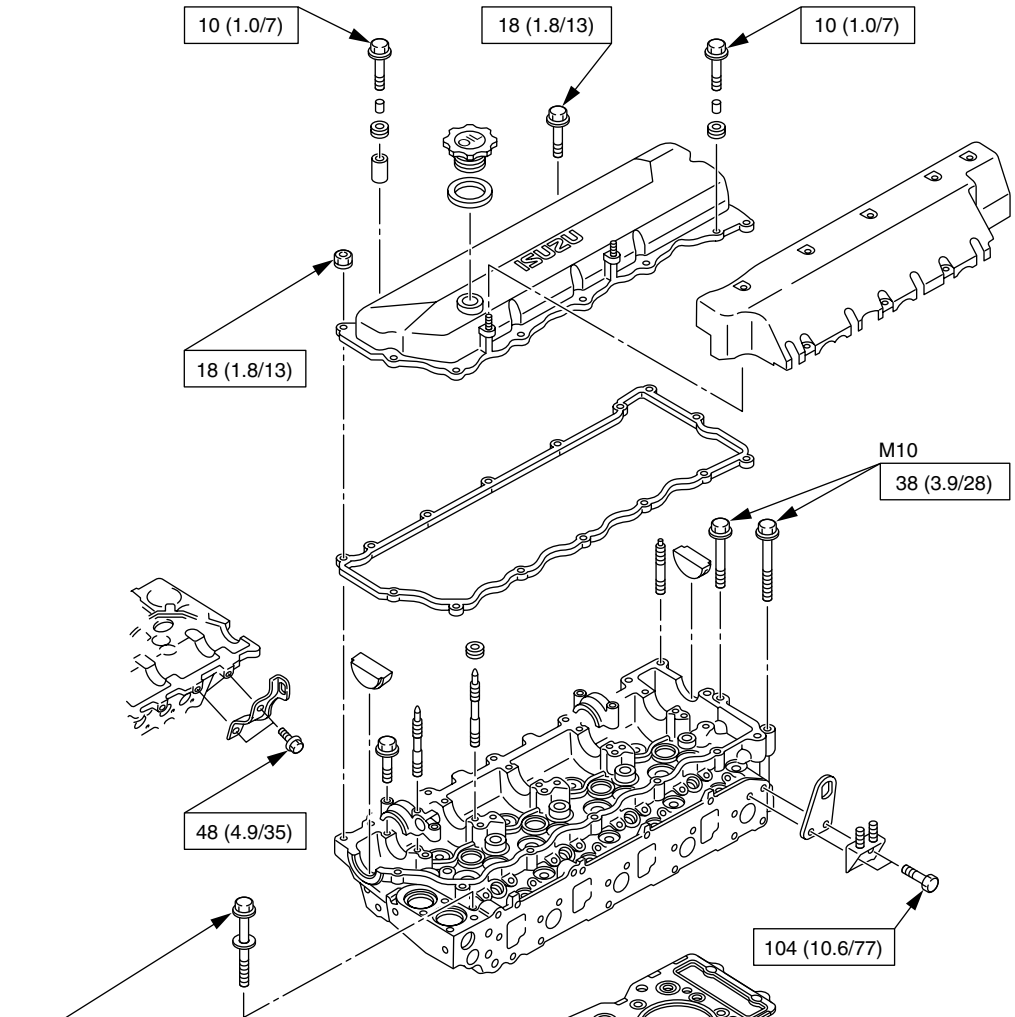
Cylinder Head, Head Gasket and Head Cover

Except for 4HE1-TC (Engine)



4HE1-TC (Engine)

N·m (kg·m / lb·ft)

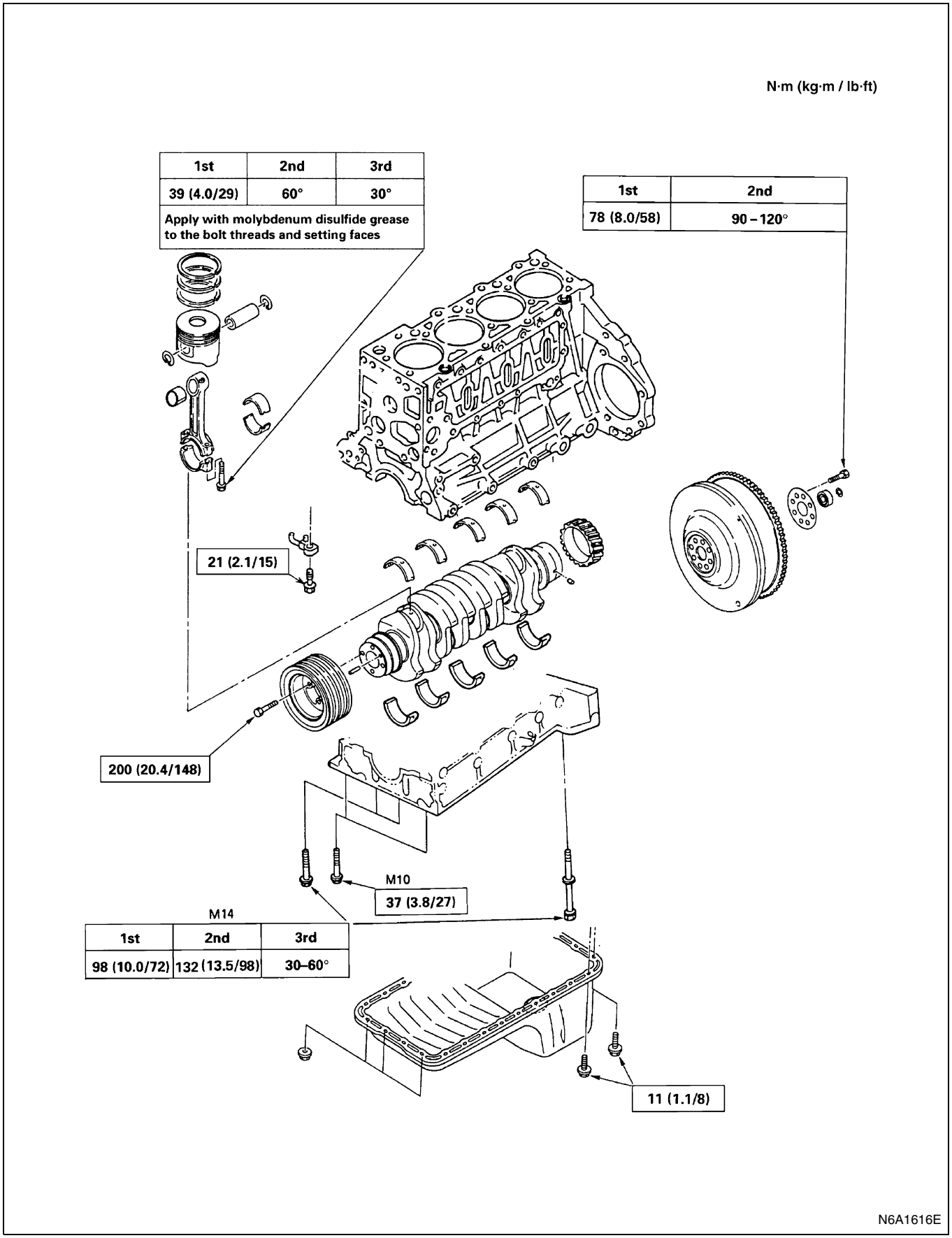


M14

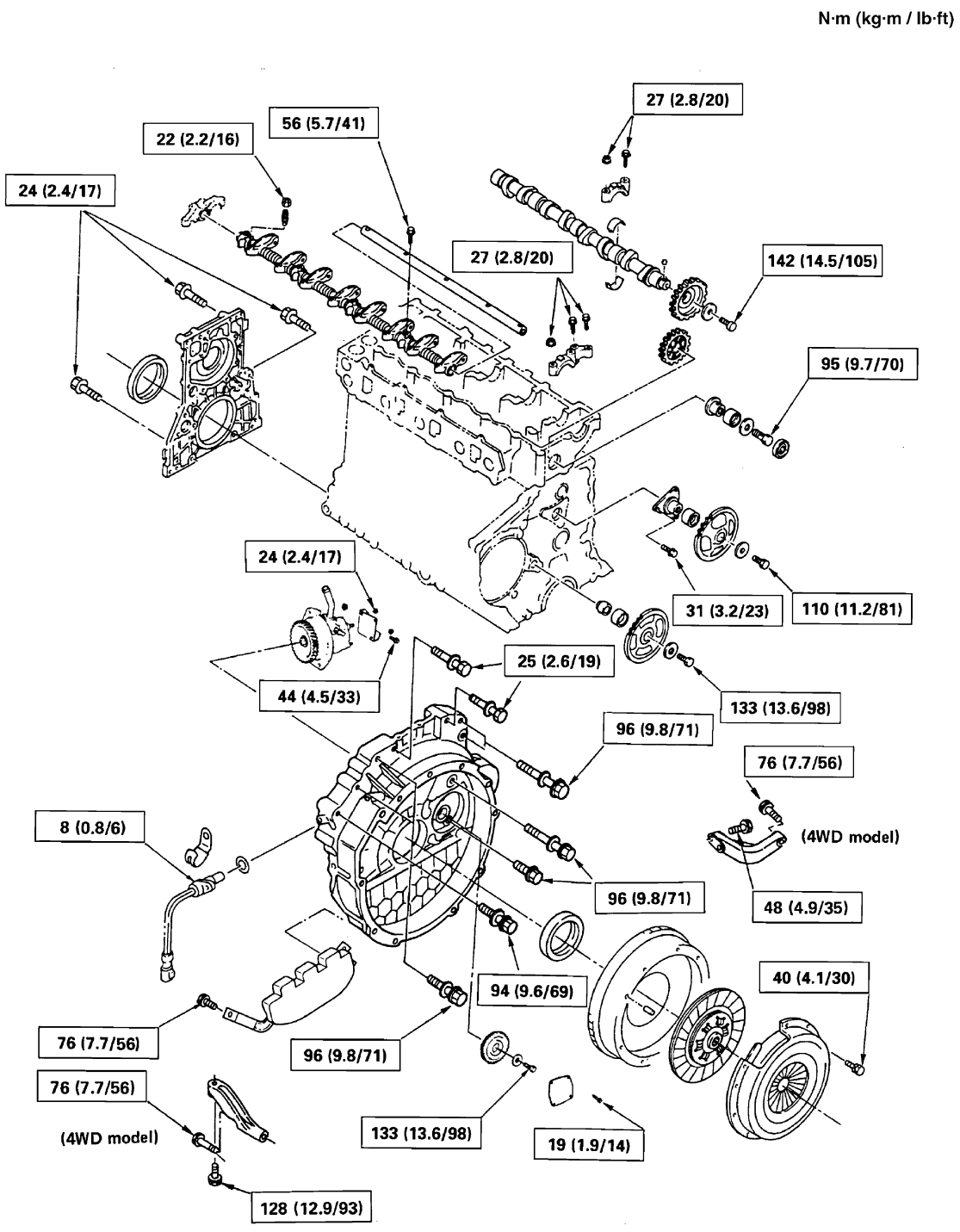
1st	2nd	3rd
90 (10/72)	147 (15/108)	30-60°
Apply with molybdenum disulfide grease to the bolt threads and setting faces		

N6A1615E

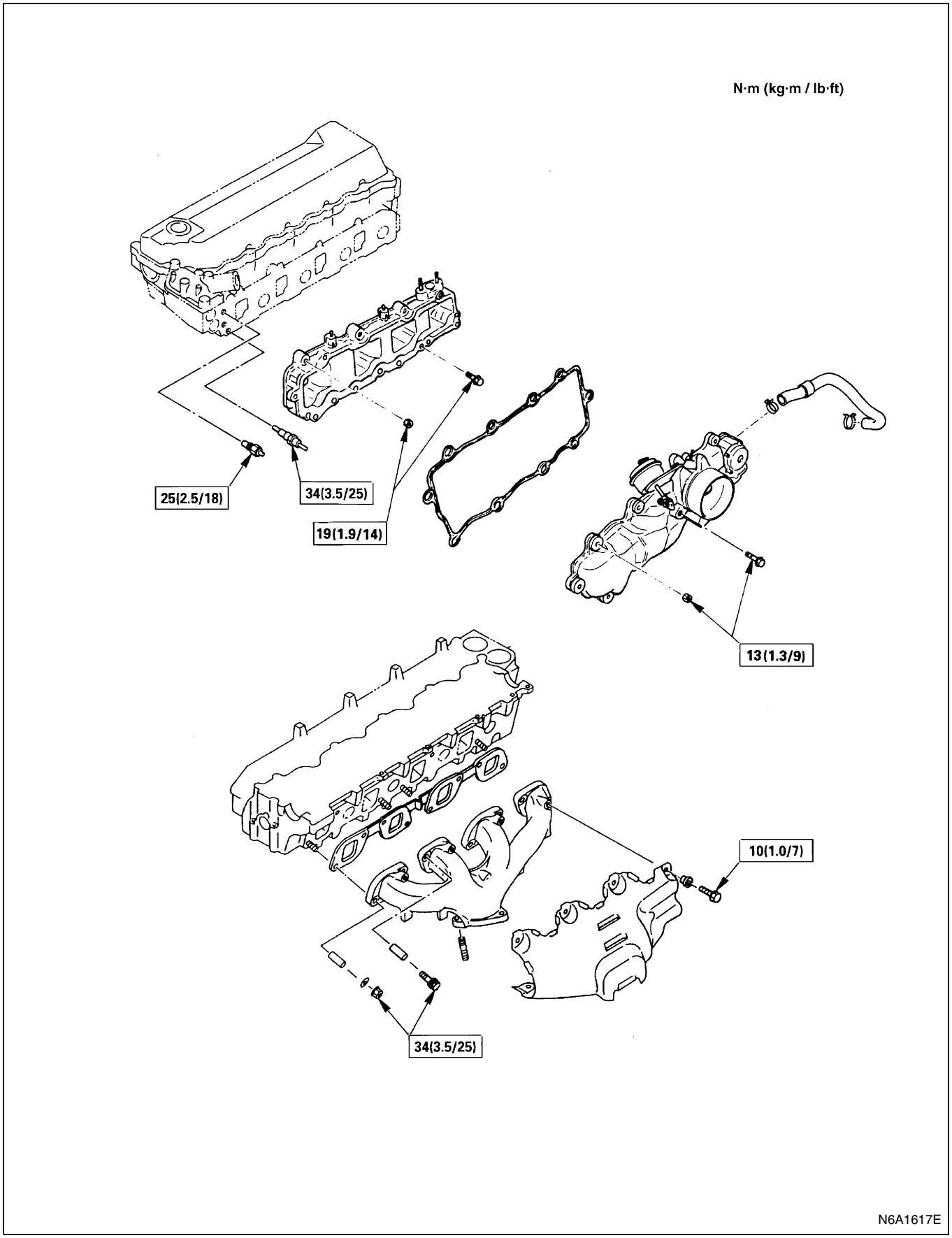
Crankshaft, Flywheel, Damper Pulley, Connecting Rod and Oil Pan



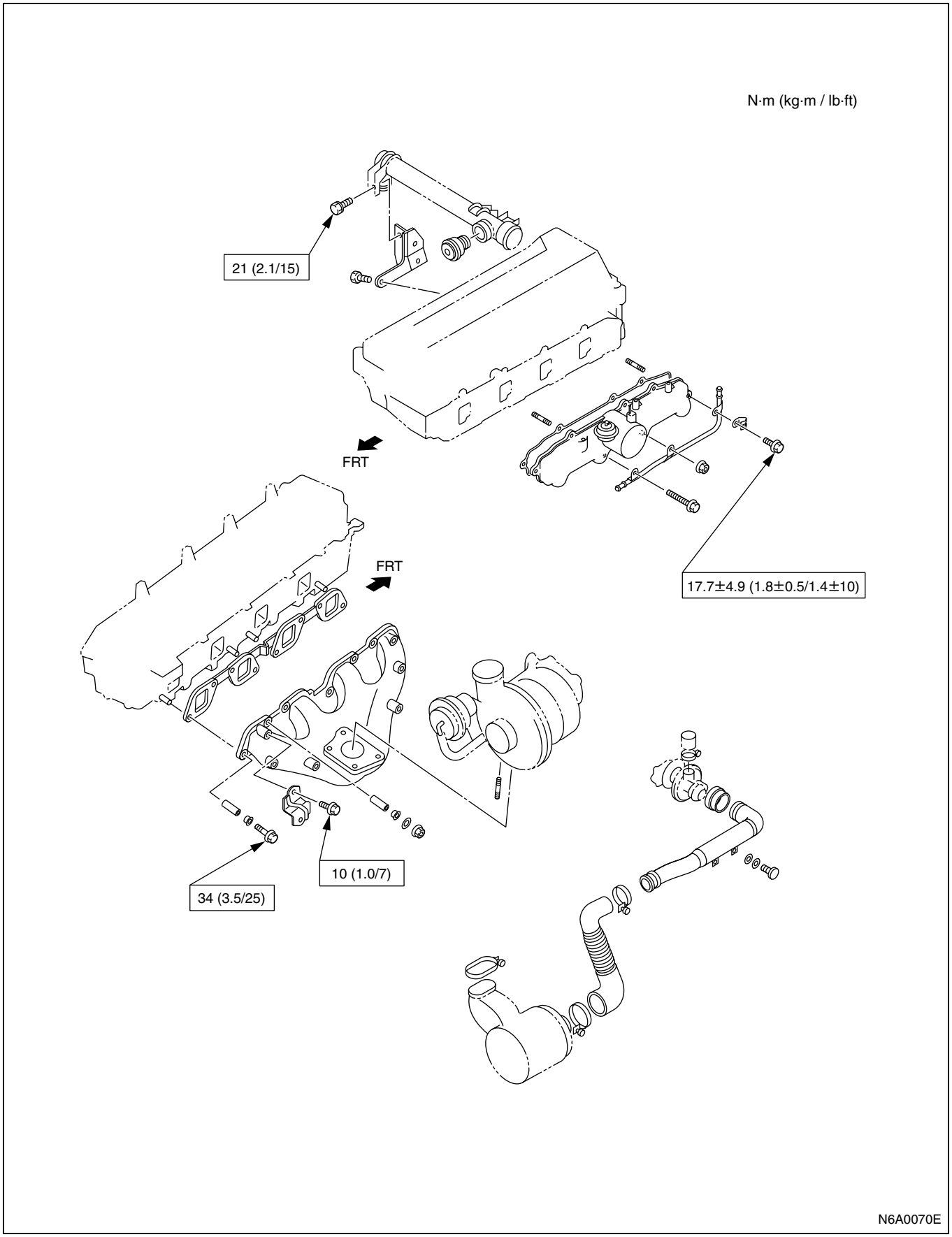
Gear Train, Camshaft, Rocker Arm Shaft, Front Retainer, Flywheel Housing



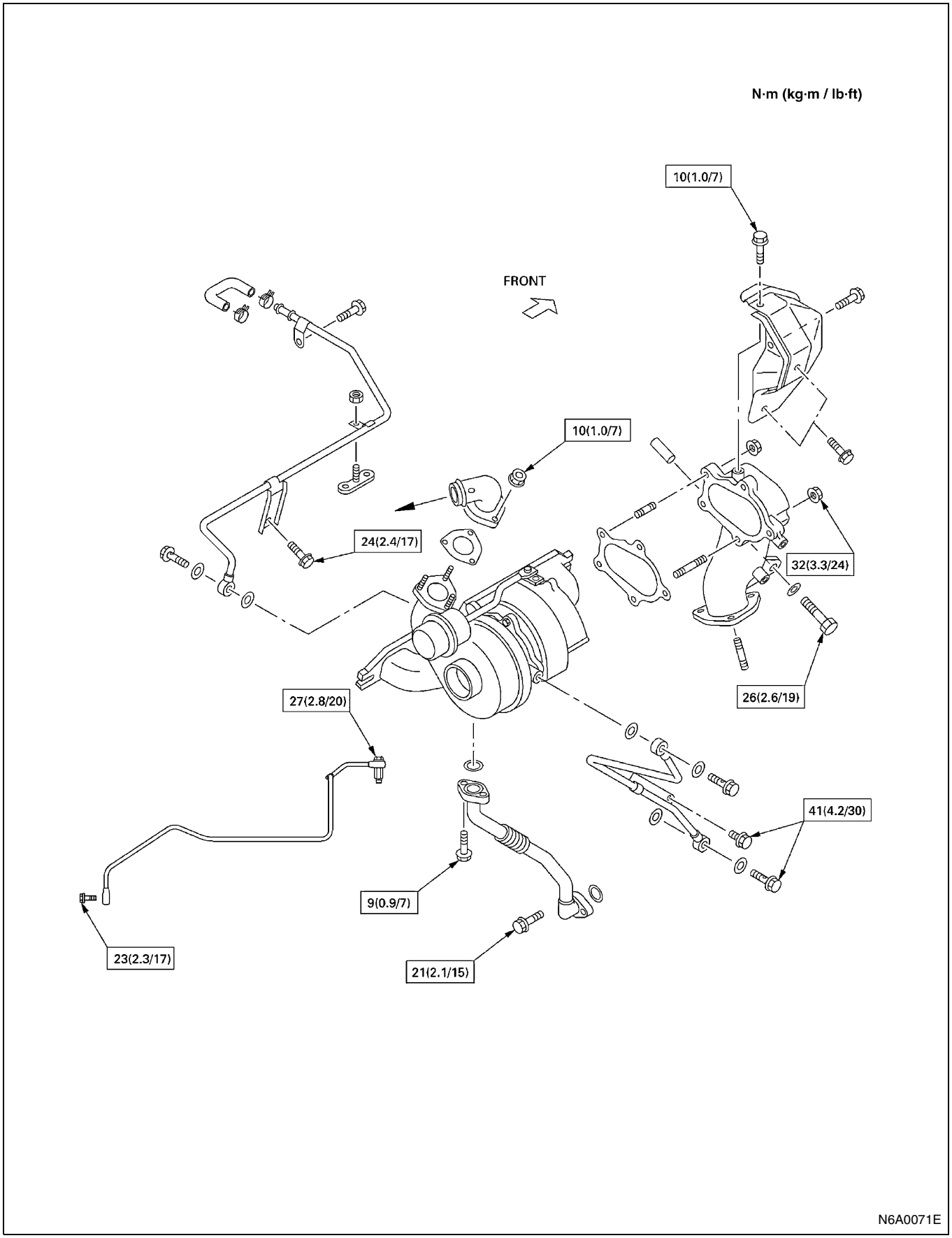
Inlet Cover and Exhaust Manifold



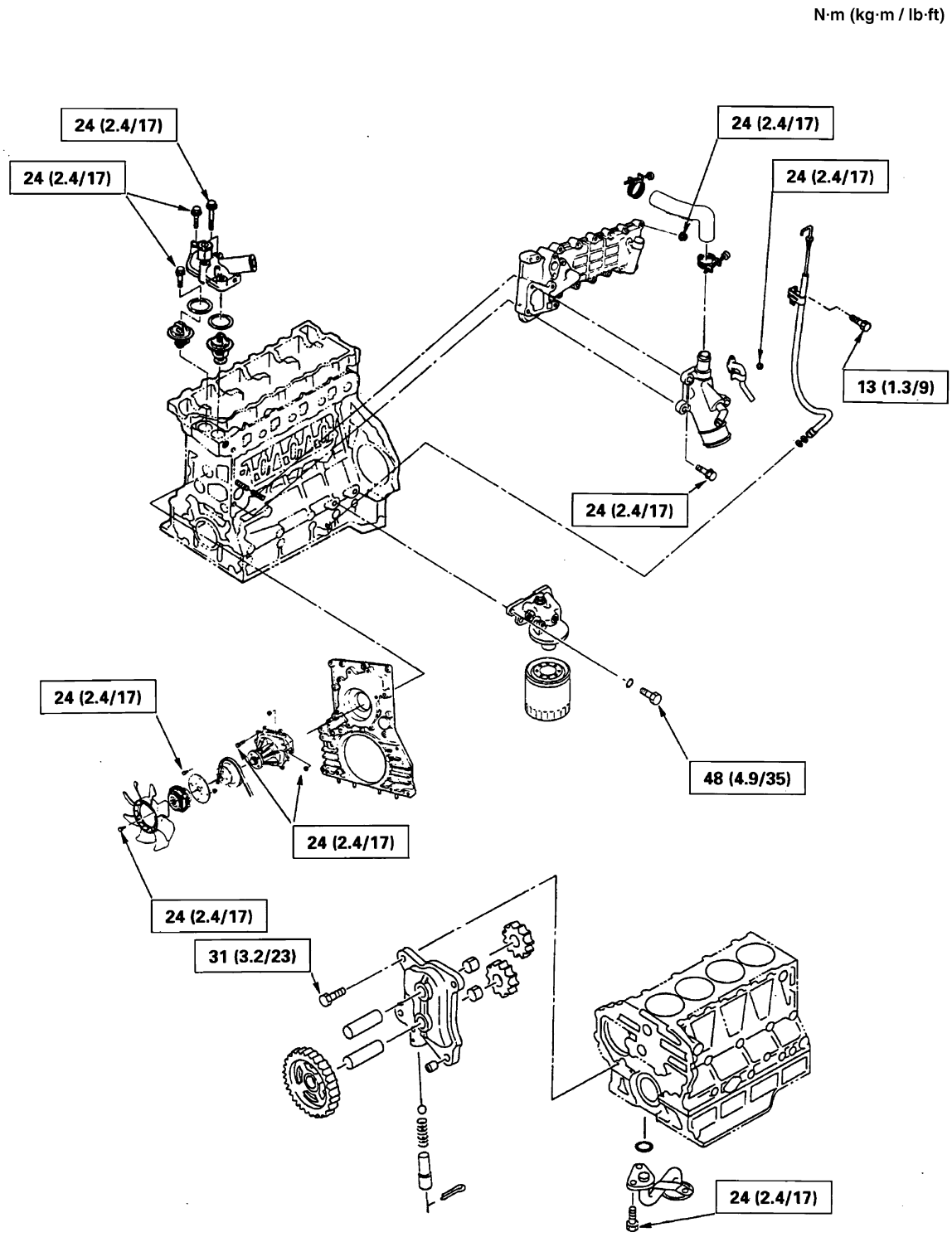
4HE1-TC Engine



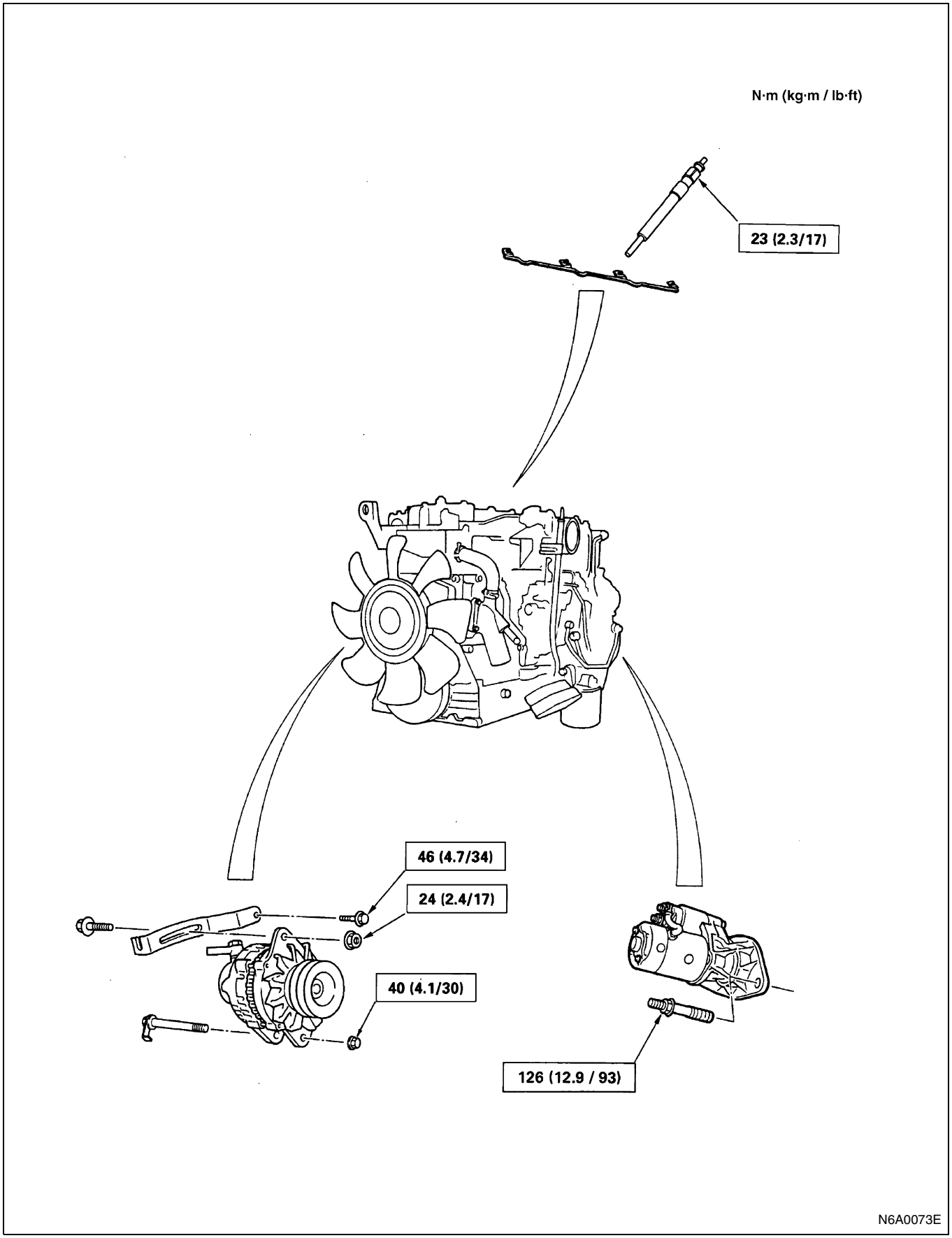
Turbocharger, Water Pipe and Oil Pipe



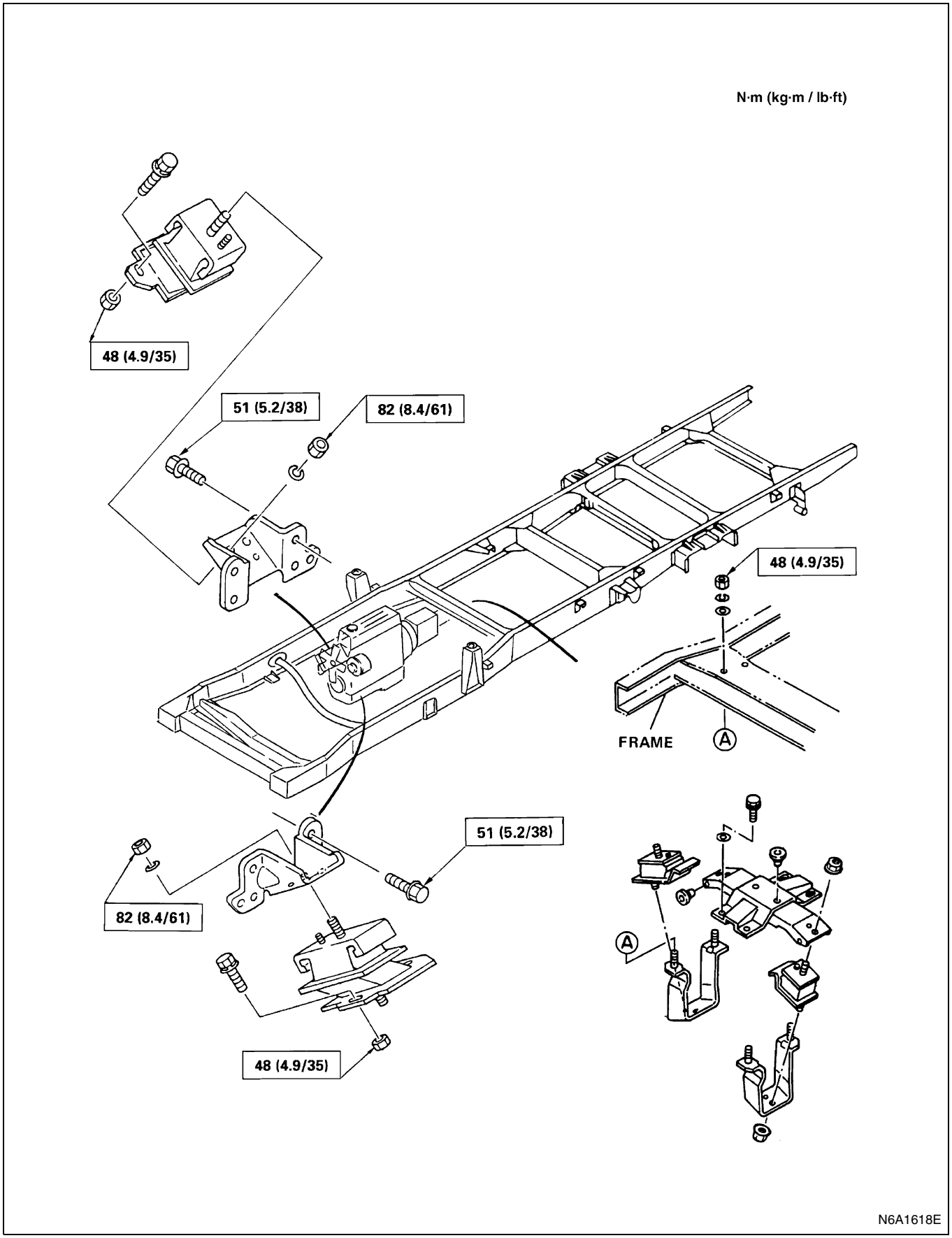
Water Pump, Water Outlet Pipe, Oil Pump, Oil Cooler and Oil Filter



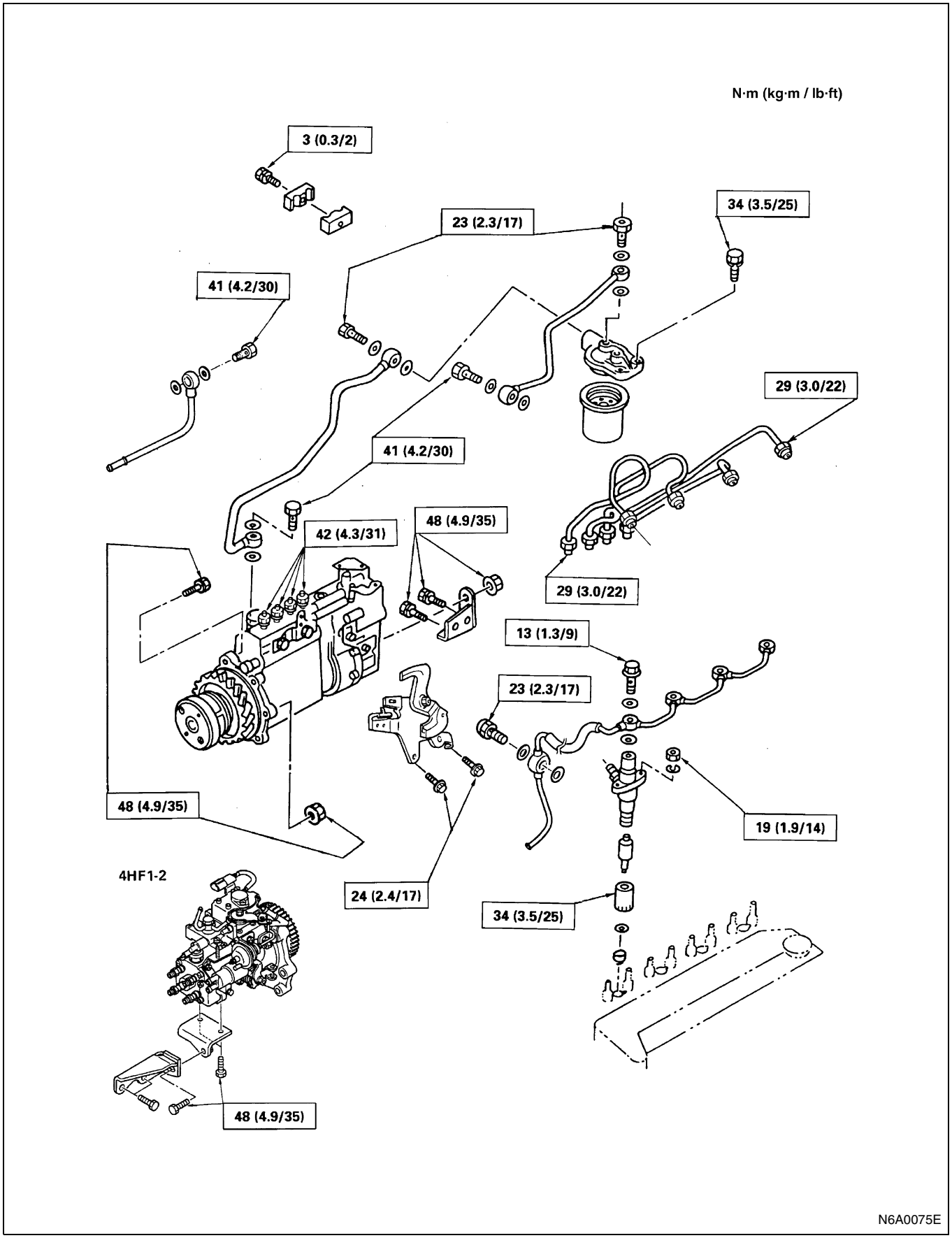
Generator, Starter and Glow Plug



Engine Mounting



Injection Pump, Injection Pipe and Fuel Pipe



SPECIAL TOOLS

Special Tools

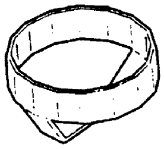
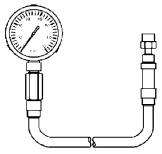
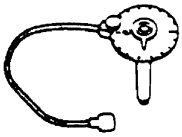
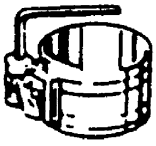
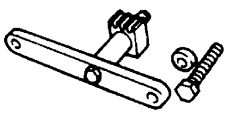
Illustration	Tool Number / Description / Remarks
 1852210970	1-8522-1097-0 / Oil filter wrench
 5884026750	5-8840-2675-0 / Compression gauge
5853170010	5-8531-7001-0 / Adapter; Compression gauge
 5884002660	5-8840-0266-0 / Angle gauge / For angular bolt and nut tightening
 5884090180	5-8840-9018-0 / Piston installer
 5884022300	5-8840-2230-0 / Crankshaft stopper

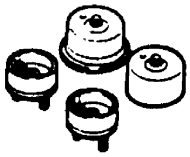
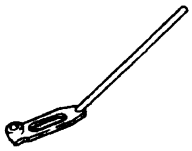
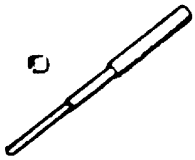
Illustration	Tool Number / Description / Remarks
5884023600	5-8840-2360-0 / Slinger puller / For crankshaft front and rear slinger remove
 5884024310	5-8840-2431-0 / Oil seal setting tool kit / For crankshaft front and rear oil seal and slinger install
5884022400	5-8840-2240-0 / Clutch pilot aligner
 5884022280	5-8840-2228-0 / Valve spring compressor
 5884022270	5-8840-2227-0 / Valve guide replacer
8943968150	8-9439-6815-0 / Valve guide seal installer

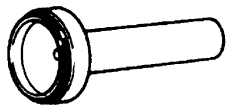
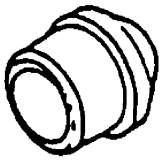
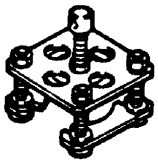
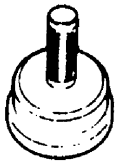
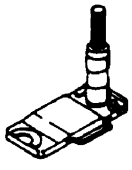
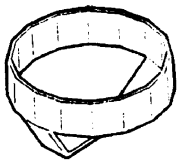
Illustration	Tool Number / Description / Remarks
 5884022220	5-8840-2222-0 / Sealing cup installer
9852311690	9-8523-1169-0 / Cylinder liner remover
5884022200 5884023970	5-8840-2220-0 5-8840-2397-0 (4HG1) / Cylinder liner remover ankle
 5884023370	5-8840-2337-0 / Cylinder Liner Installer (4HE1-TC only)
 8943968180	8-9439-6818-0 / Crankshaft gear remover
 8943968190	8-9439-6819-0 / Crankshaft gear installer
 5884023400	5-8840-2340-0 / Conrod bush replacer

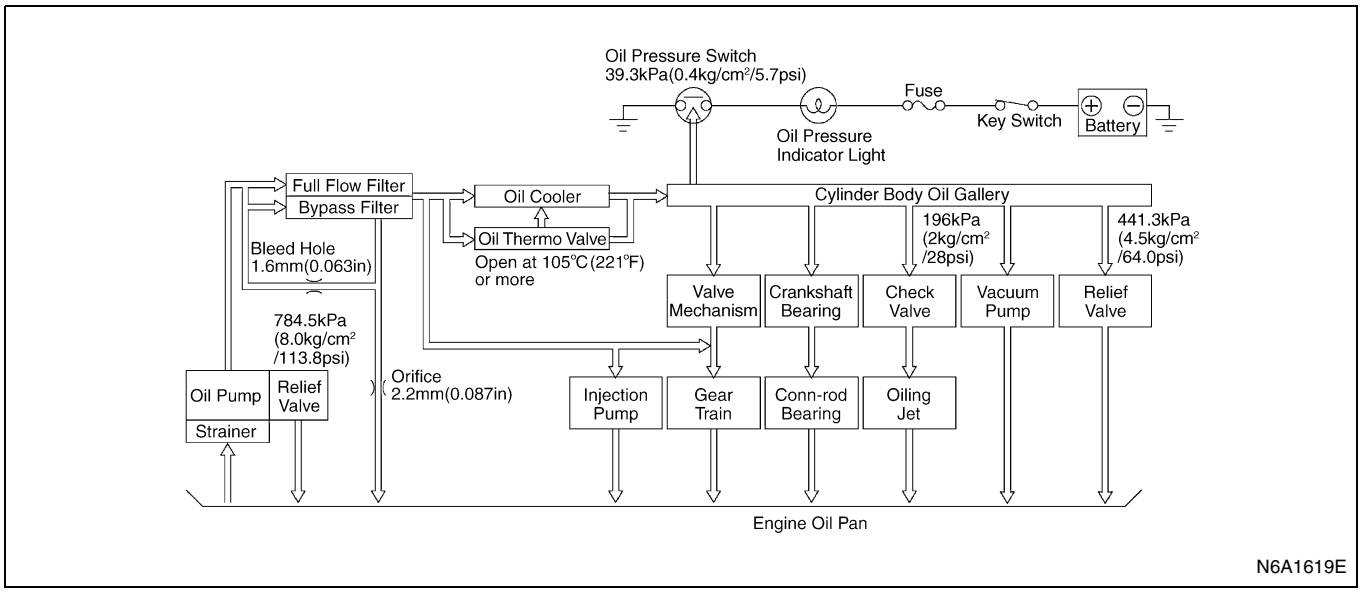
Illustration	Tool Number / Description / Remarks
 5884020940	5-8840-2094-0 / Oil filter wrench / 4WD model

LUBRICATING SYSTEM

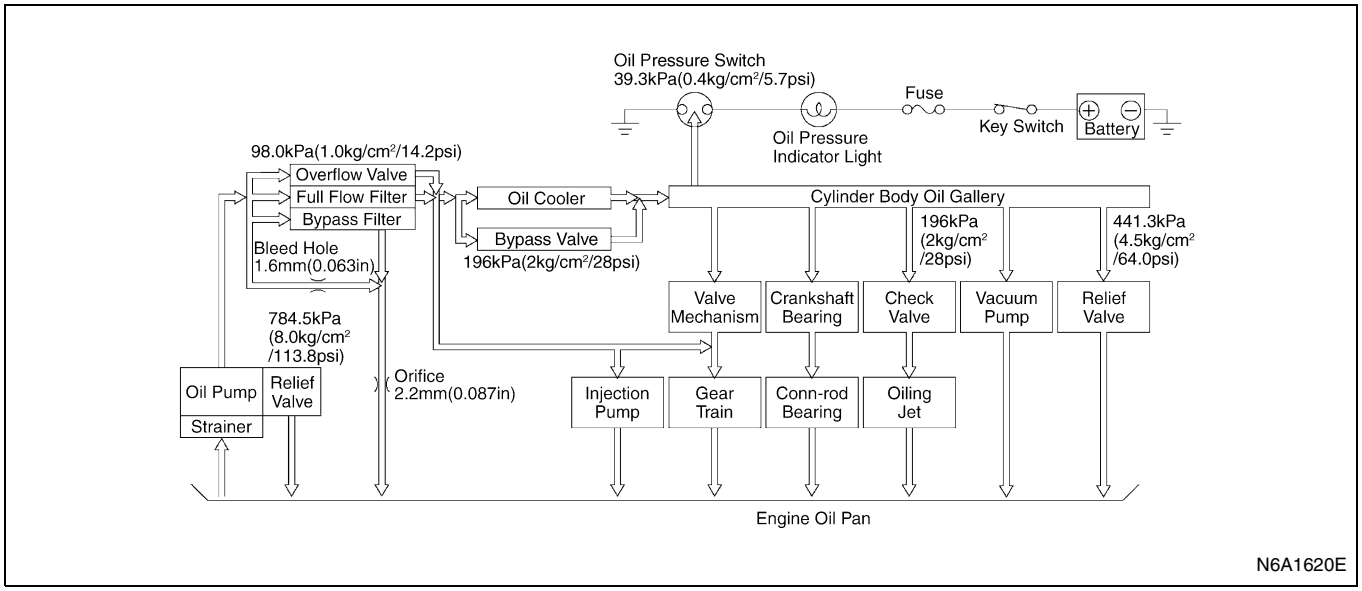
General Description

Lubricating Oil Flow

4HF1, 4HF1-2, 4HG1-T Model



4HE1-TC Model



The engine lubricating system is a full flow type.
Lubricating oil is pumped from the oil pump to the cylinder body oil gallery through the oil filter and the oil cooler. It is then delivered to the vital parts of the engine from the cylinder body oil gallery.
Oil jets installed on the cylinder body spray engine oil to the piston inside faces to achieve maximum cooling effect.

ENGINE 4H SERIES

SECTION 6A
ENGINE MECHANICAL

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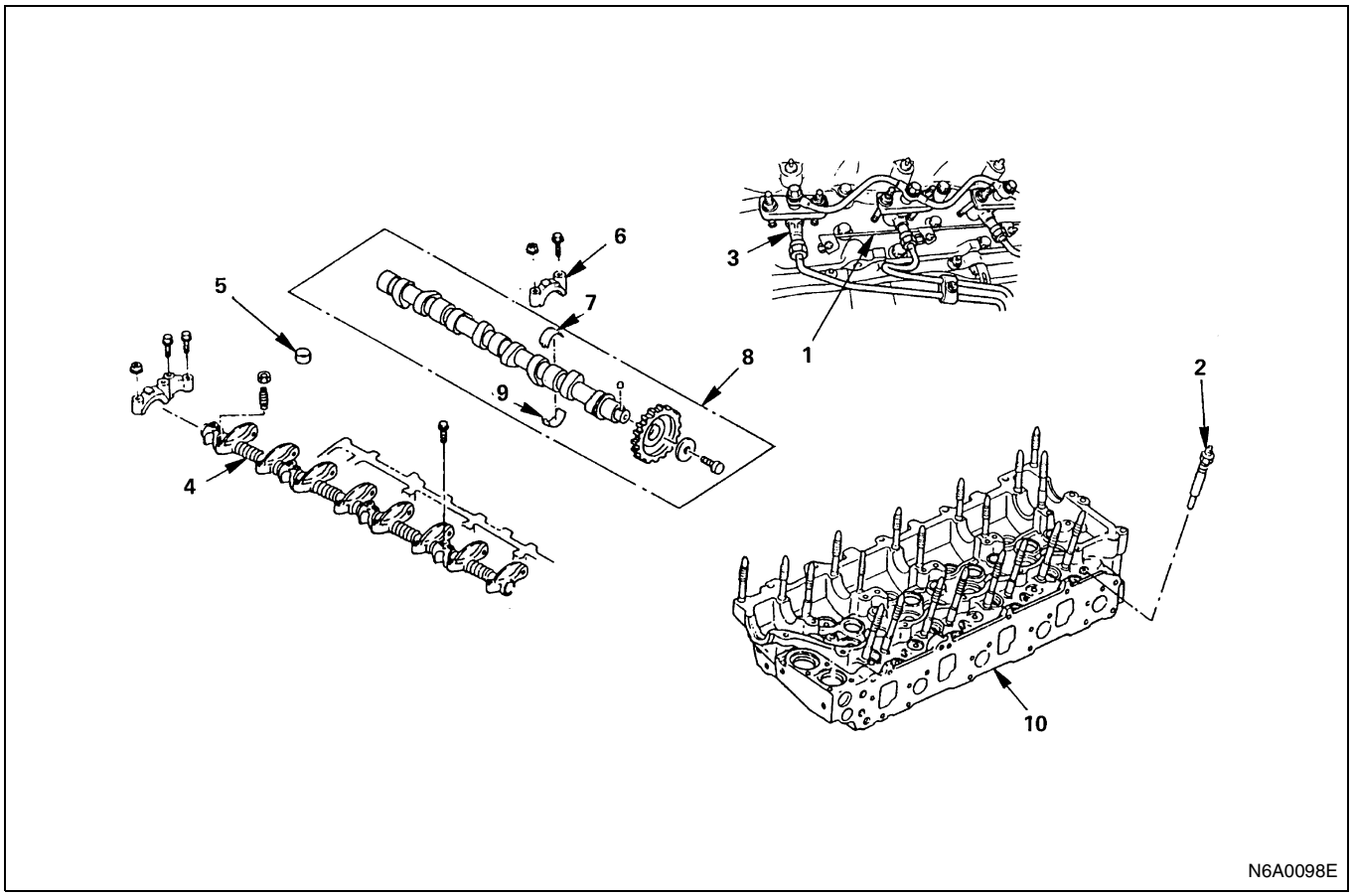
CYLINDER HEAD

Component



Legend

1. Glow plug connector
2. Glow plug
3. Injection nozzle holder assembly
4. Rocker arm shaft assembly
5. Valve cap
6. Camshaft bearing cap
7. Camshaft bearing upper
8. Camshaft assembly
9. Camshaft bearing lower
10. Cylinder head

Notice:

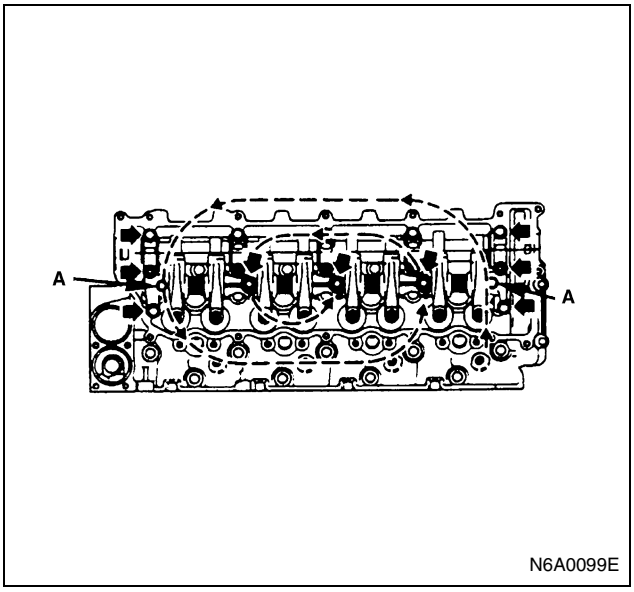
- During disassembly, be sure that the valve train components are kept together and identified so that they can be re-installed in their original locations.
- Before removing the cylinder head from the engine and before disassembling the valve mechanism, make a compression test and note the results.

Disassembly

1. Glow Plug Connector
2. Glow Plug
3. Injection Nozzle Holder Assembly
   Mark the nozzle holder assemblies fitting positions by tagging each nozzle holder assembly with the cylinder number from which it was removed.
4. Rocker Arm Shaft Assembly
   1) Loosen the rocker arm shaft bracket nuts and bolts in numerical order a little at a time and remove the rocker arm shaft assembly with the camshaft brackets.
   2) Leave the (A) indicated bolt unremoved on this occasion, since it is the rocker arm fixing bolt.

Caution:

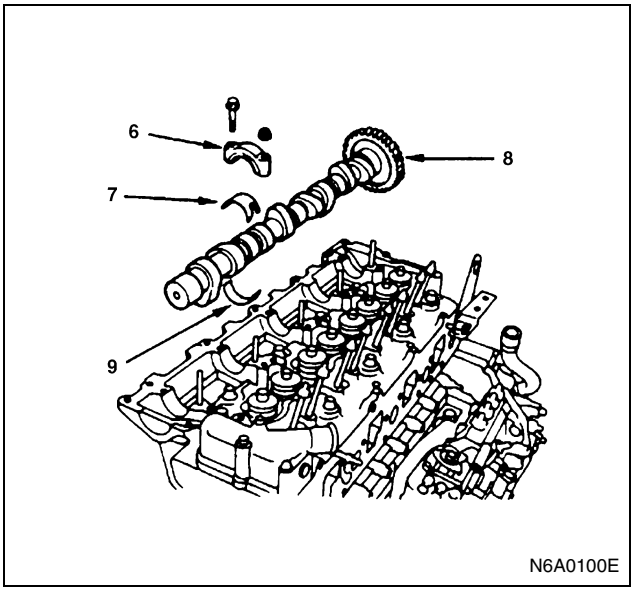
Failure to loosen the rocker arm shaft bracket nuts and bolts in numerical order a little at a time will adversely affect the rocker arm shaft.



5. Valve Cap

Caution:
Take sufficient care not to let valve caps fall into the gear case or oil return hole.

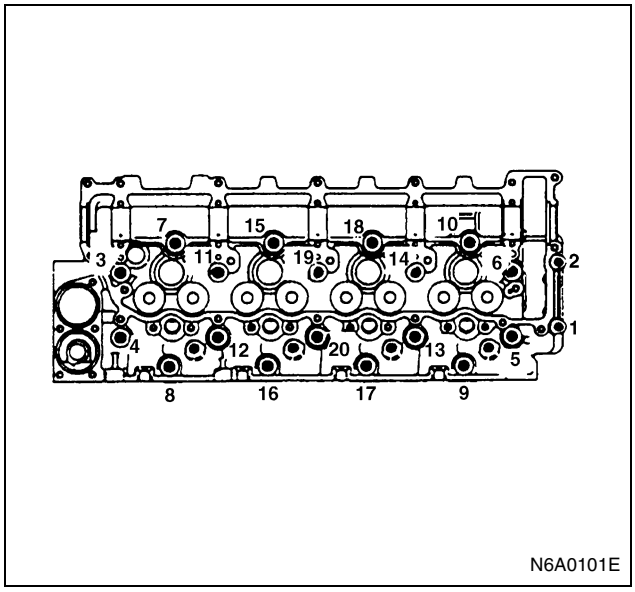
6. Camshaft Bearing Cap
7. Camshaft Bearing Upper
8. Camshaft Assembly
9. Camshaft Bearing Lower
   If the camshaft bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



10. Cylinder Head
    Loosen the cylinder head bolts in numerical order a little at a time.

Caution:
Failure to loosen the cylinder head bolts in numerical order a little at a time will adversely affect the cylinder head lower surface.

- Refer to Section 6A3 “CYLINDER HEAD”.



Clean

- Cylinder head bolts
- Cylinder head
  Carefully remove all varnish, soot and carbon to the bare metal. Do not use a motorized wire brush on any gasket sealing surface.

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

- Cylinder head gasket and mating surfaces for leaks, corrosion and blow-by. If the gasket has failed, determine the cause;
  - Improper installation
  - Loose or warped cylinder head
  - Insufficient torque on head bolts
  - Warped case surface

1. Cylinder head bolts for damaged threads or stretching and damaged heads caused by improper use of tools.

Caution:
Suspected bolts must be replaced.

2. Cylinder head for cracks, especially between valve seats and in the exhaust ports.
3. Cylinder head deck for corrosion, sand particles in head and porosity.

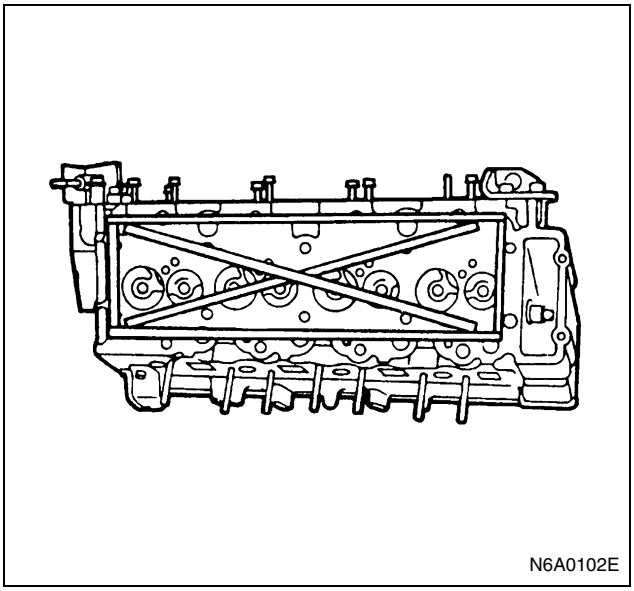
Caution:
Do not attempt to weld the cylinder head. Replace it.

Cylinder Head Lower Face Warpage

1. Use a straight edge and a feeler gauge to measure the four sides and the two diagonals of the cylinder head face.
2. If the measured values exceed the specified limit, the cylinder head must be replaced.

Notice:
Do not regrind the cylinder head lower face.

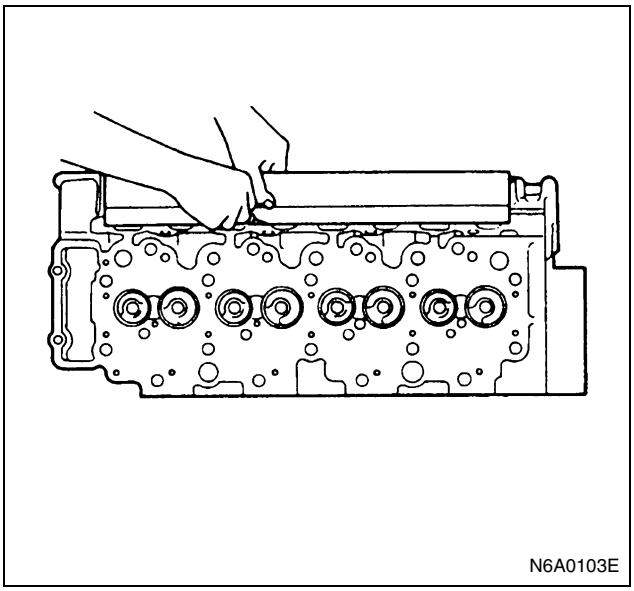
Cylinder Head Lower Face Warpage	mm (in)
Standard	Limit
0.05 (0.002) or less	0.2 (0.008)


N6A0102E

Manifold Fitting Face Warpage

Use a straight edge and a feeler gauge to measure the manifold cylinder head fitting face warpage.
Regrind the manifold cylinder head fitting faces if the measured value is greater than the specified limit.

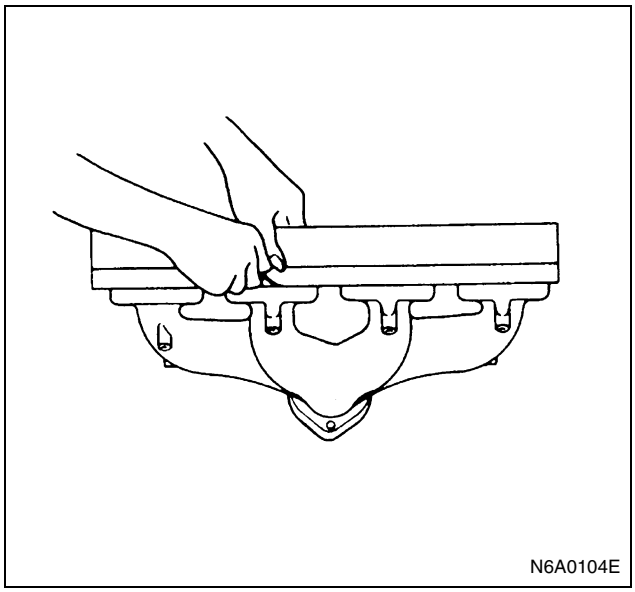
Manifold Fitting Face Warpage	mm (in)
Standard	Limit
0.05 (0.002) or less	0.2 (0.008)


N6A0103E

Exhaust Manifold Warpage

Use a straight edge and a feeler gauge to measure the manifold cylinder head fitting face warpage.
If the measured values exceed the specified limit, the manifold must be replaced.

Exhaust Manifold Warpage	mm (in)
Standard	Limit
0.05 (0.002) or less	0.24 (0.008)

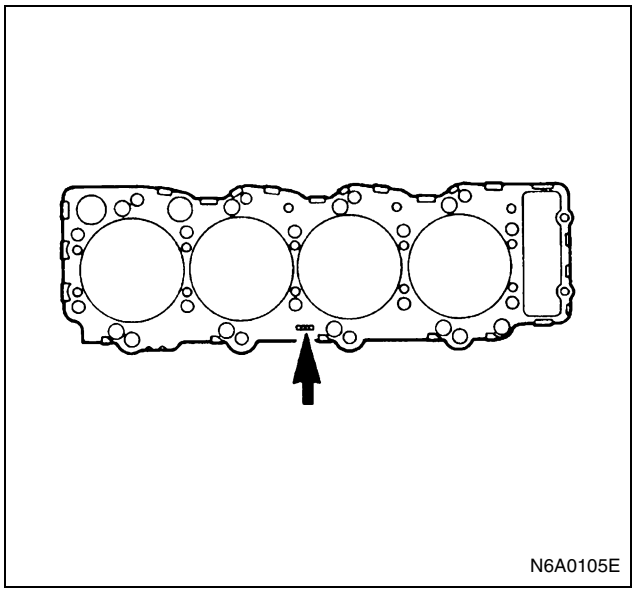

N6A0104E

Reassembly

Install the cylinder head gasket with its “PART NUMBER” mark facing up and toward the left of the engine.

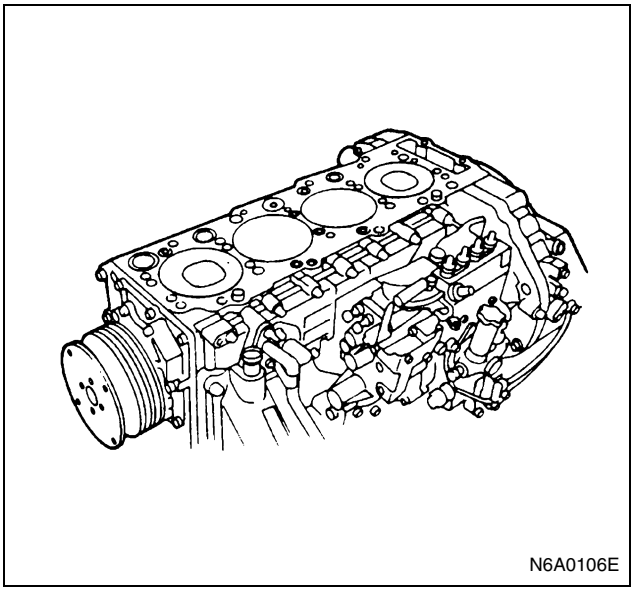
Caution:
Do not reuse the cylinder head gasket.

Above works refer to “CYLINDER BLOCK” section in this manual.


N6A0105E

1. Cylinder Head

1) Align the cylinder body dowels and the cylinder head dowel holes.
2) Carefully place the cylinder head on the cylinder head gasket.

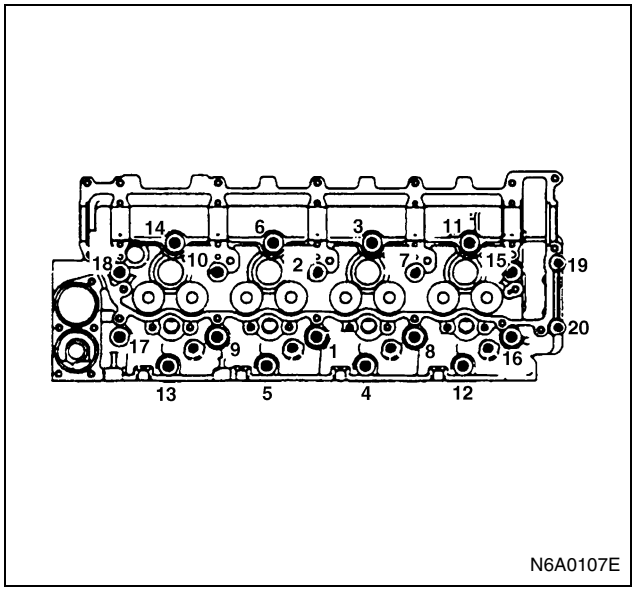

N6A0106E

3) Apply a coat of molybdenum disulfide grease to the M14 cylinder head bolt threads and setting faces and apply a coat of engine oil to the M10 cylinder head bolt threads and setting faces.
4) Use the angular tightening method to tighten the bolts (M14) to the specified torque in three steps following the numerical order shown in the illustration.

Tighten:
Cylinder head bolt (M14: (1) — (18)) to
- 1st step: 98 N·m (10 kg·m / 72 lb·ft)
- 2nd step: 147 N·m (15 kg·m / 108 lb·ft)
- 3rd step: 30 — 60°

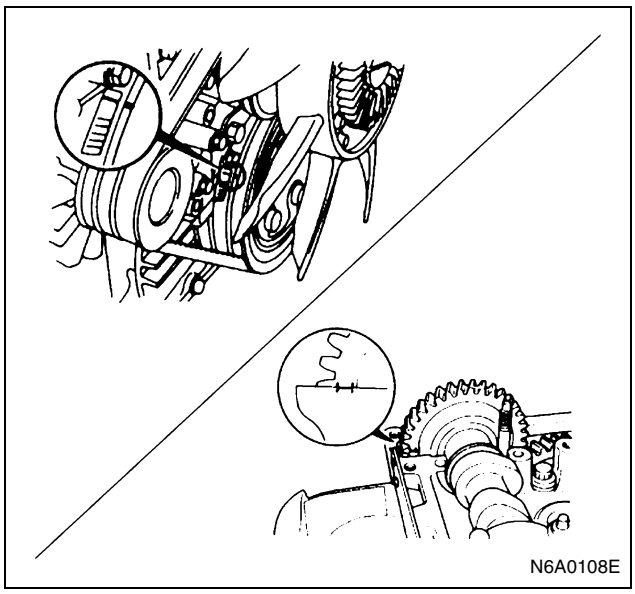
5) Tighten the cylinder head to the flywheel housing bolts (M10) to the specified torque.

Tighten:
Cylinder head bolt to (M10: (19) — (20)) to 38 N·m (3.9 kg·m / 28 lb·ft)

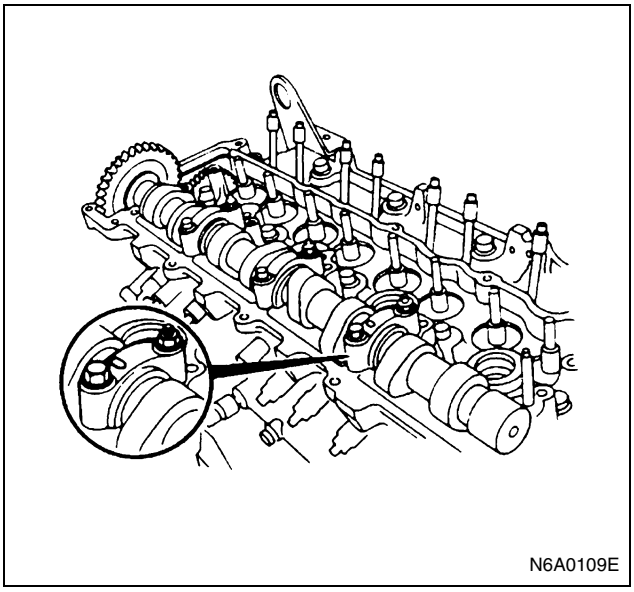


N6A0107E

2. Camshaft Bearing Lower
3. Camshaft Assembly
   1) Turn the crankshaft in the direction of normal rotation until the timing mark on the crankshaft damper pulley is aligned with the TDC notched line. (Confirm that the No. 1 cylinder piston comes to the compression top dead center.)

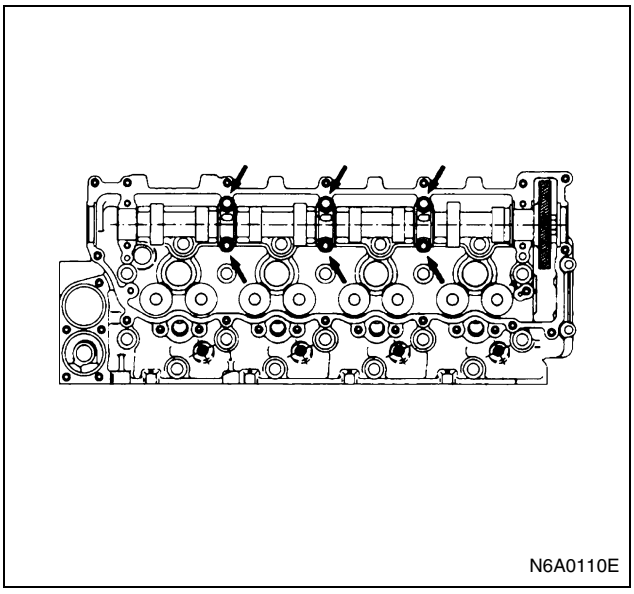

N6A0108E

   2) Apply engine oil to the camshaft journal and the camshaft bearing surfaces before installation.
   3) Carefully align the camshaft gear “I” mark and the cylinder head upper face shown in the illustration.
4. Camshaft Bearing Upper
5. Camshaft Bearing Cap
   1) Install the bearing caps with the bearing cap head mark (arrow) facing forward.


N6A0109E

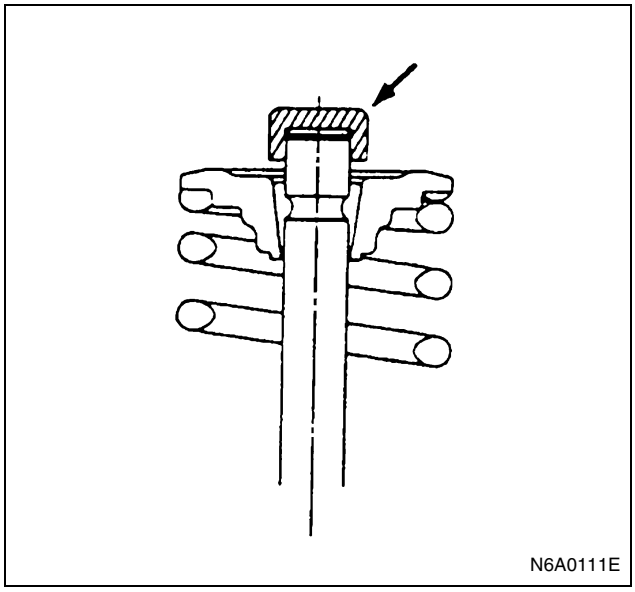
2) Apply a coat of engine oil to the bearing cap bolt and stud threads.
3) Tighten the bearing cap bolts and studs to the specified torque.

Tighten:
Camshaft bearing cap nut and bolt to 27 N·m (2.8 kg·m / 20 lb·ft)

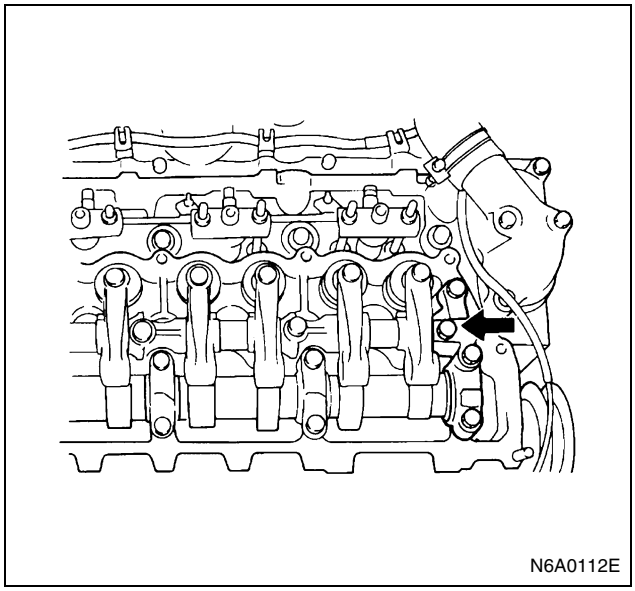

N6A0110E

6. Valve Cap
Apply engine oil to the inside of the valve caps and install them to the valve stem end.

Caution:
Take sufficient care not to let valve caps fall into the gear.

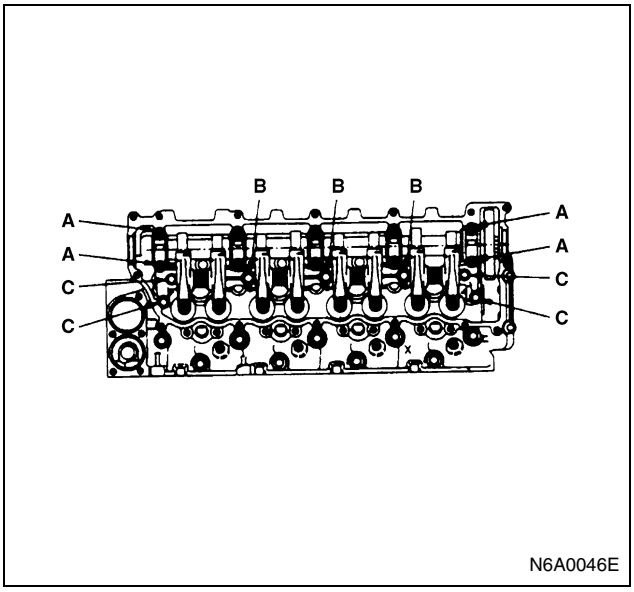

N6A0111E

7. Rocker Arm Shaft Assembly
1) Temporarily tighten the bolts marked with the arrow in the illustration.


N6A0112E

2) Loosen the rocker arm adjust screws and apply engine oil to the rocker arm roller portions.
3) Install the rocker arm assembly on the cylinder head.
4) Tighten the rocker arm shaft bracket nuts and bolts to the specified torque in numerical order a little at a time as shown in the illustration.

Tighten:
Rocker arm shaft bracket nut and bolt to
- Nut (A): 27 N·m (2.8 kg·m / 20 lb·ft)
- Bolt (B): 56 N·m (5.7 kg·m / 41 lb·ft)
- Bolt (C): 27 N·m (2.8 kg·m / 20 lb·ft)

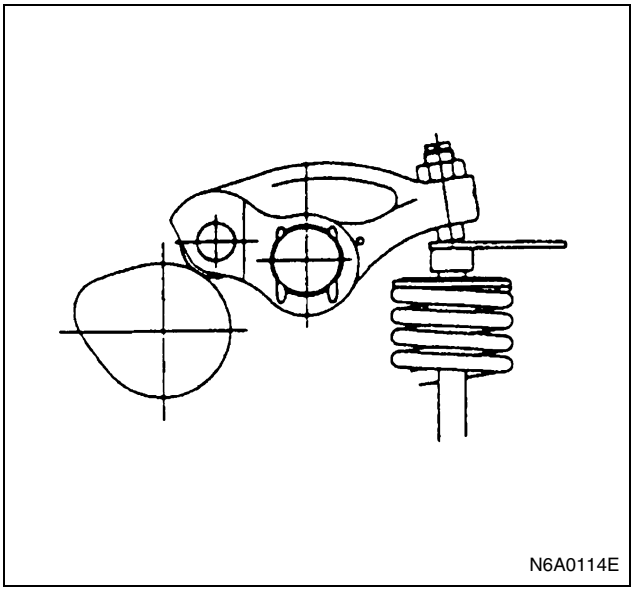


5) Apply engine oil to the threaded portion of the nuts marked with “A” and the bolts with “B” shown in the illustration left, and tighten them to the specified torque.

Adjust the valve clearance.

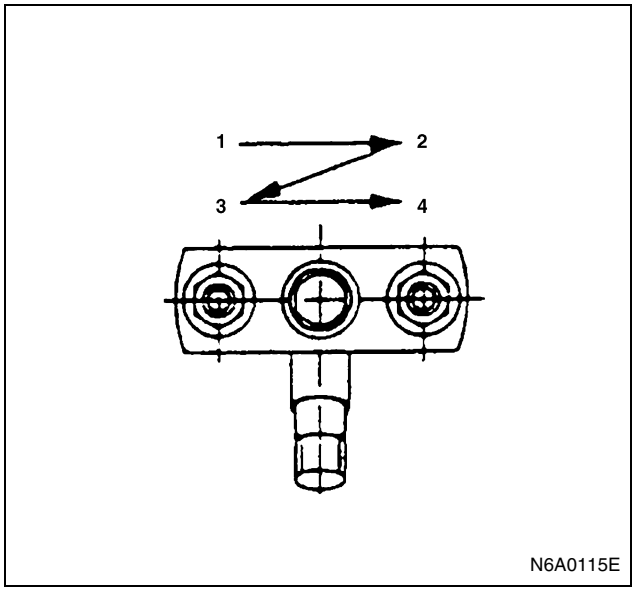
Valve Clearance	mm (in)
At cold	0.4 (0.016)

Above works refer to “SERVICING” “VALVE CLEARANCE ADJUSTMENT” previously section in this manual.



8. Injection Nozzle Holder Assembly
   Tighten the nozzle holder flange nuts to the specified torque in the numerical order shown in the illustration.

Tighten:
Nozzle holder flange nut to 19 N·m (1.9 kg·m / 14 lb·ft)



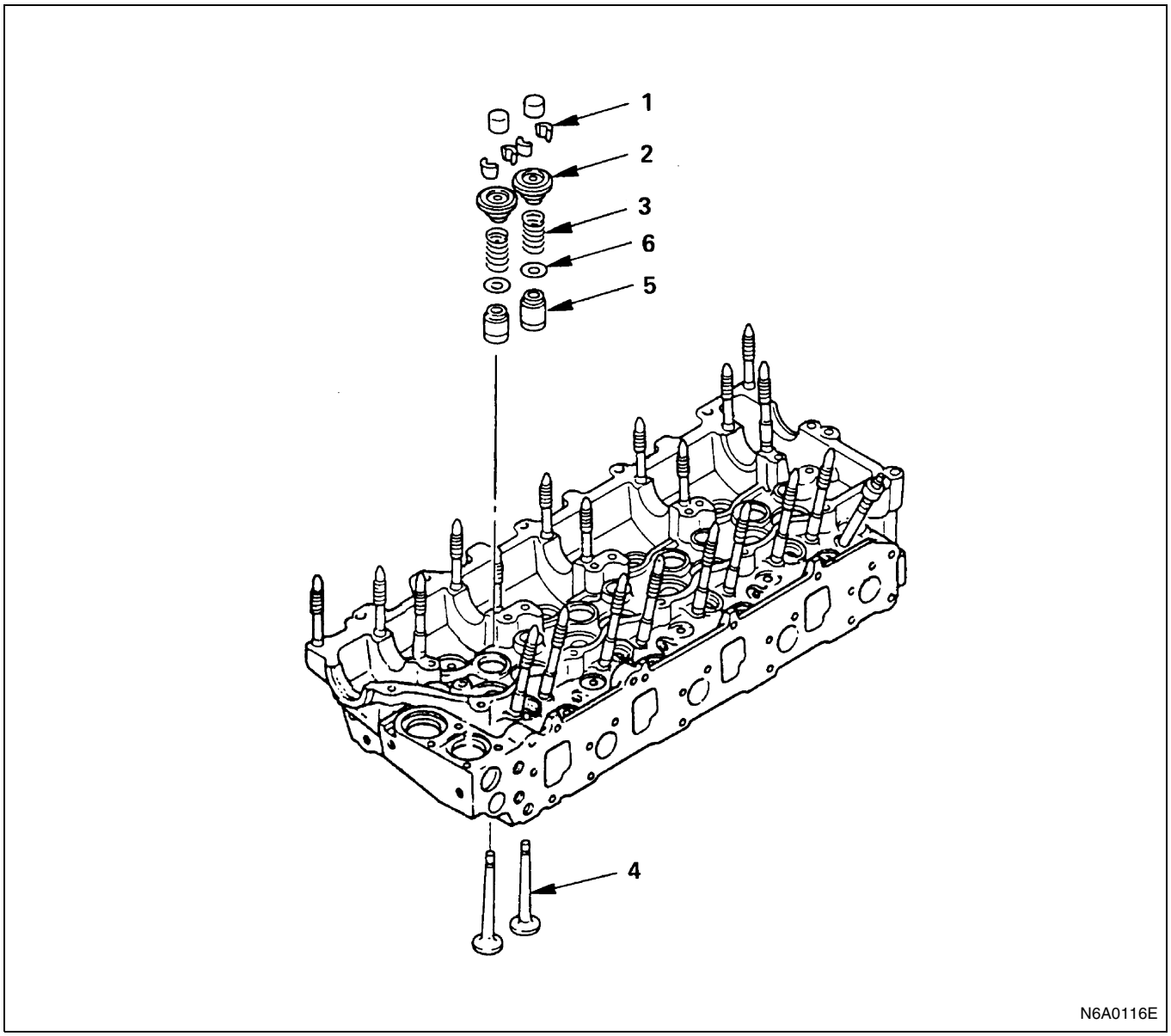
9. Glow Plug

Tighten:
Glow Plug to 23 N·m (2.3 kg·m / 17 lb·ft)

10. Glow Plug Connector

VALVE SPRING, VALVE GUIDE OIL SEAL, VALVE, VALVE GUIDE

Component



Legend

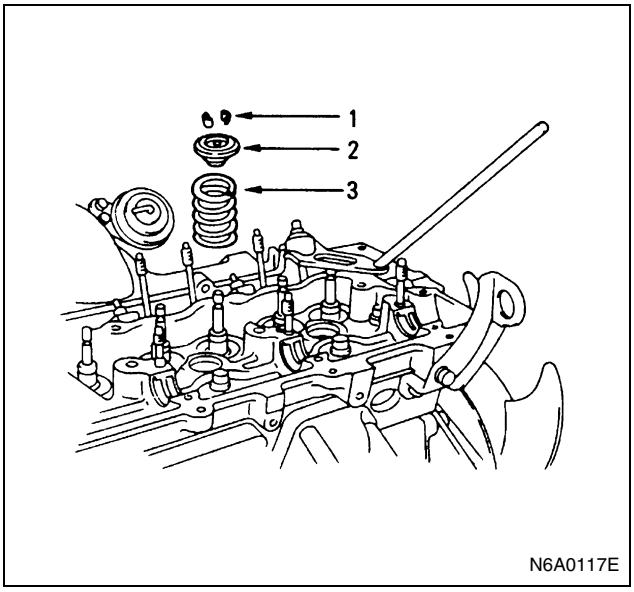
1. Split collar
2. Spring upper seat
3. Valve spring
4. Intake and exhaust valve
5. Valve guide seal
6. Spring lower seat

Disassembly

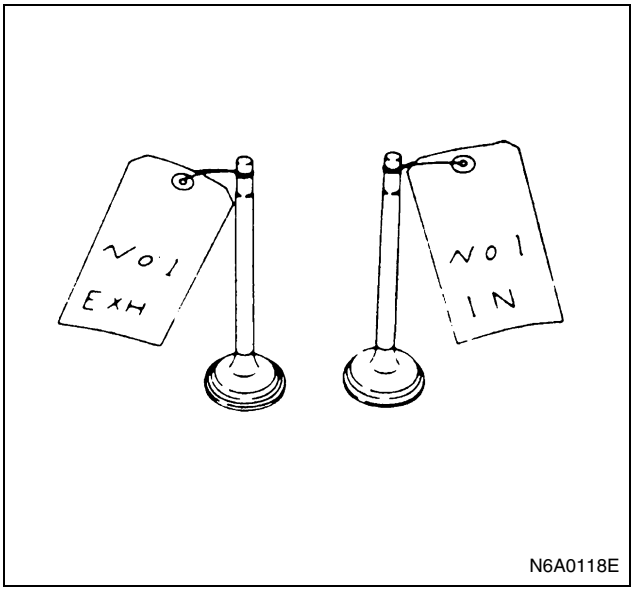
Preparation

- Remove all the parts only with the cylinder head assembly left.
  (Above works refer to “CYLINDER HEAD GASKET” section 6A3 in this manual.)

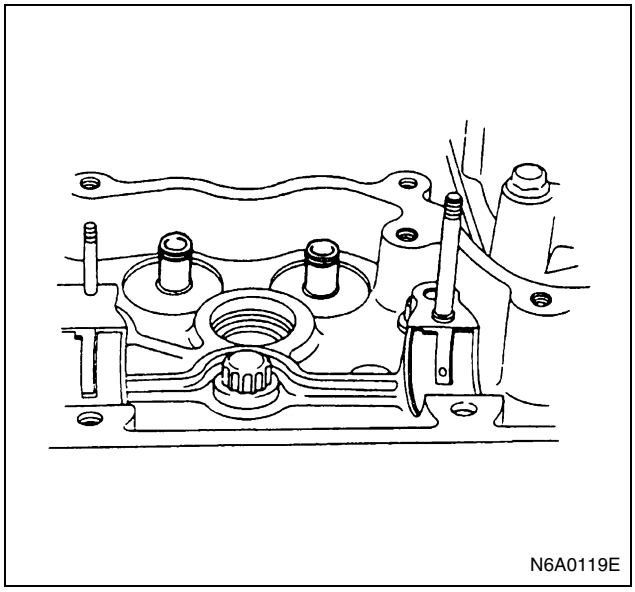
1. Cotter Collar
   1) Place the cylinder head on a flat wooden surface.
   2) Use the valve spring compressor to remove the cotter collar.
      Do not allow the valve to fall from the cylinder head.
      Valve Spring Compressor: 5-8840-2228-0
2. Spring Upper Seat
3. Valve Spring



4. Intake and Exhaust Valve
   If the intake and exhaust valves are to be reinstalled, mark their installation positions by tagging each valve with the cylinder number from which it was removed.
   If the intake and exhaust valves are to be replaced, the valve guides must also be replaced.



5. Valve Guide Seal
6. Spring Lower Seat



Inspection and Repair

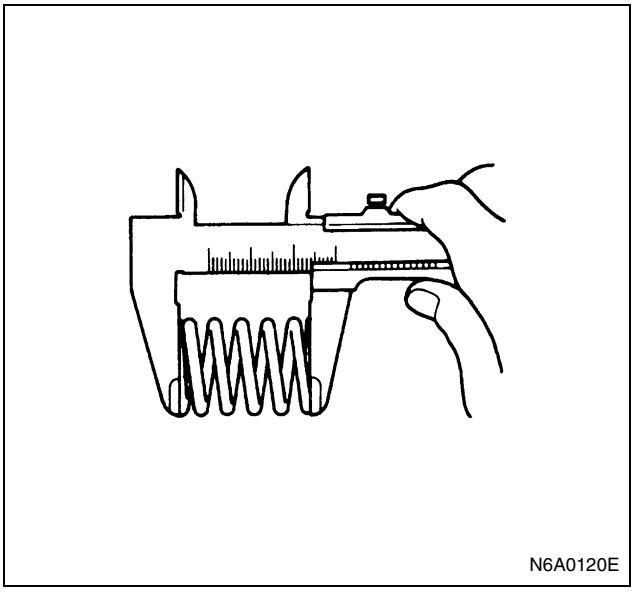
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Valve Spring Free Height

Use a vernier caliper to measure the valve spring free height.
If the measured valve is less than the specified limit, the valve spring must be replaced.

Valve Spring Free Height 4HF1: 4HF1-2: 4HG1: 4HG1-T	mm (in)
Nominal Size	Limit
62.5 (2.46)	59.4 (2.34)

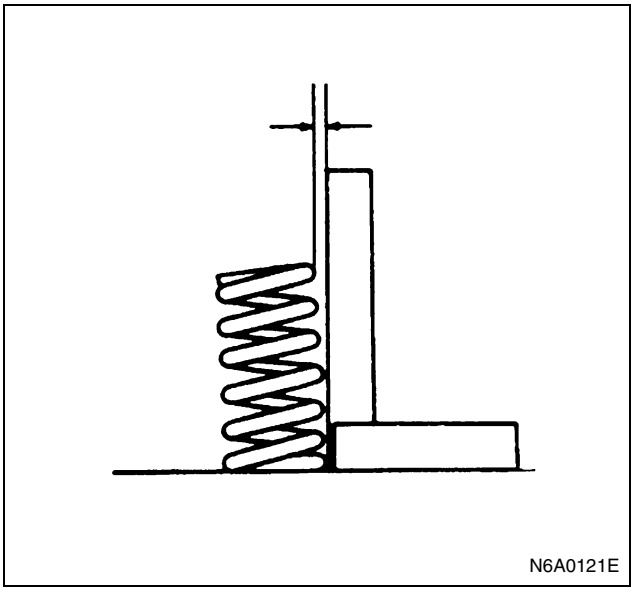
4HE1-TC:		mm (in)
	Nominal size	Limit
Intake Inner	53.2 (2.094)	50.1 (1.972)
Intake Outer	55.6 (2.189)	52.5 (2.067)
Exhaust Inner	58.6 (2.307)	55.5 (2.185)
Exhaust Outer	62.0 (2.441)	58.9 (2.319)


N6A0120E

Valve Spring Squareness

Use a surface plate and a square to measure the valve spring squareness.
If the measured value exceeds the specified limit, the valve spring must be replaced.

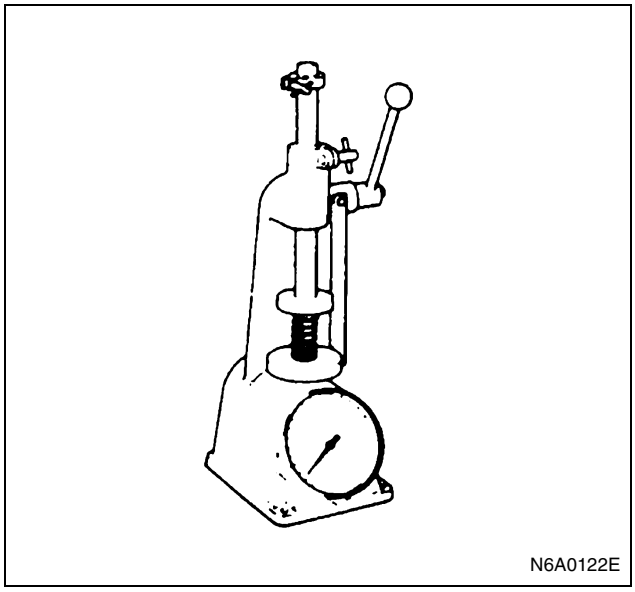
Valve Spring Squareness	mm (in)
Limit	1.0 (0.04)


N6A0121E

Valve Spring Tension

Use spring tester to measure the valve spring tension.
If the measured valve is less than the specified limit, the valve spring must be replaced.

Valve Spring Tension		N (kg/lb)
Set Length mm (in)	Standard	Limit
47.0 (1.85)	414 — 477 (42.2 — 48.6/93 — 107)	401 (40.9/98)


N6A0122E

Valve Guide

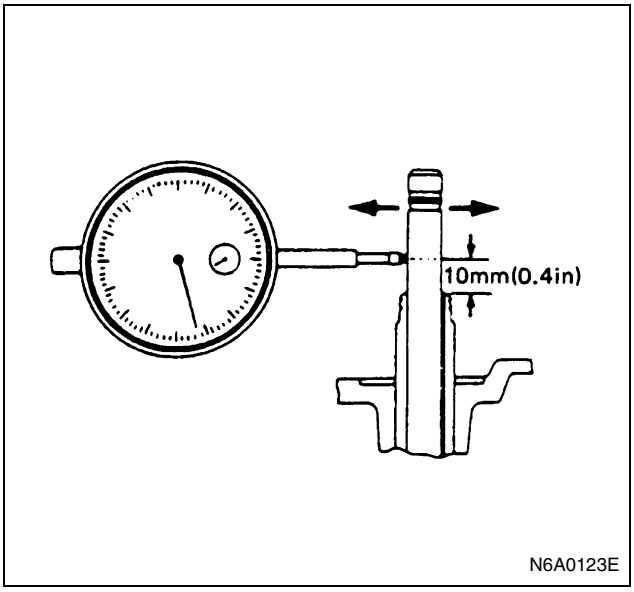
Caution:
Taking care not to damage the valve seat contact surface, when removing carbon adhering to the valve head.
Carefully inspect the valve stem for scratching or abnormal wear. If these conditions are present, the valve and the valve guide must be replaced as a set.

Valve Stem and Valve Guide Clearance

(Measuring Method-I)

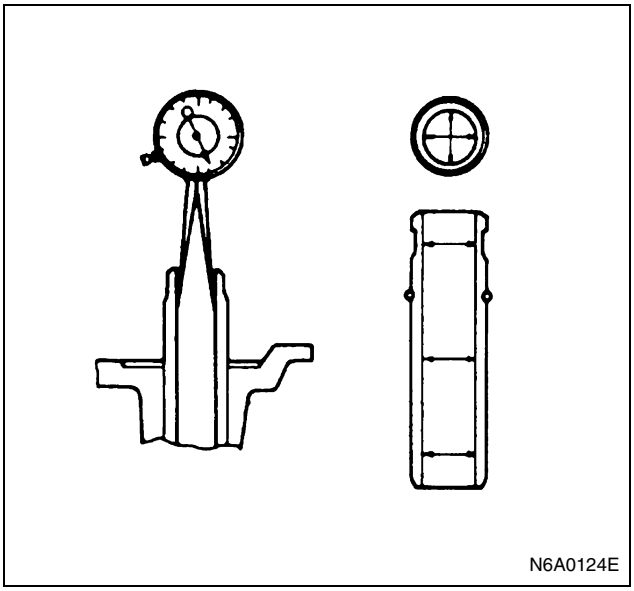
1. Set the dial indicator to the valve stem measuring point.
2. Move the valve stem end from side to side.
   Read the dial indicator.
   Note the total indicator reading.
   If the measured values exceed the specified limit, the valve and the valve guide must be replaced as a set.

Total Dial Indicator Reading (Valve Stem and Valve Guide Clearance)		mm (in)
Valve	Standard	Limit
Intake Valve	0.038 — 0.071 (0.0015 — 0.0028)	0.20 (0.0079)
Exhaust Valve	0.064 — 0.096 (0.0025 — 0.0038)	0.25 (0.0098)



(Measuring Method-II)

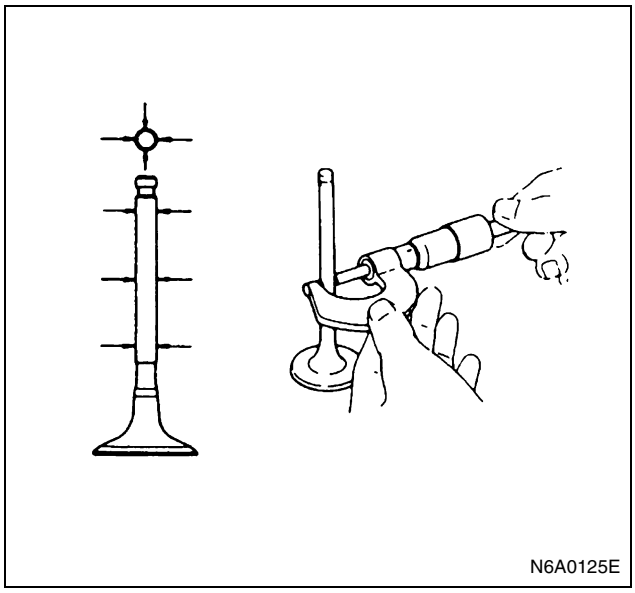
1. Measure the valve stem outside diameter.
   Refer to the “Valve Stem Outside Diameter”.
2. Use a caliper calibrator or a telescoping gauge to measure the valve guide inside diameter.
3. Calculate the clearance between the valve guide inside diameter and the valve stem outside diameter.
   If the clearance exceeds the specified limit, the valve and the valve guide must be replaced as a set.



Valve Stem Outside Diameter

Measure the valve stem diameter at three points.
If the measured valve is less than the specified limit, the valve and the valve guide must be replaced as a set.

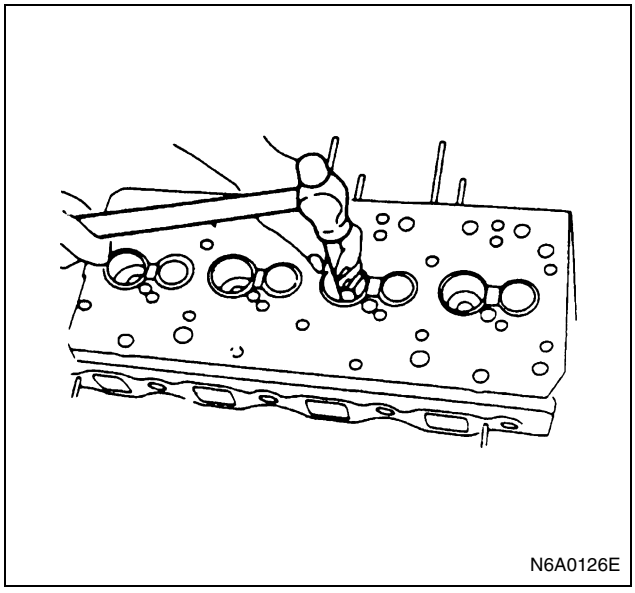
Valve Stem Outside Diameter		mm (in)
Valve	Standard	Limit
Intake Valve	8.946 — 8.962 (0.3522 — 0.3528)	8.88 (0.350)
Exhaust Valve	8.921 — 8.936 (0.3512 — 0.3529)	8.80 (0.346)



Valve Guide Replacement

Valve Guide Removal

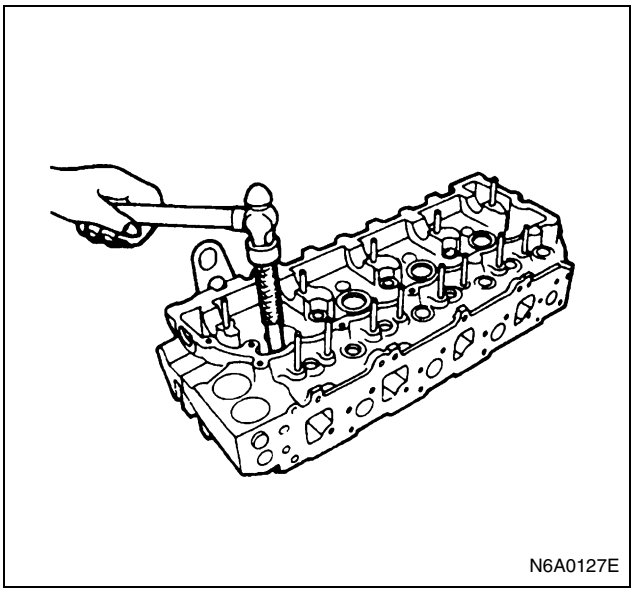
Use a hammer and the valve guide replacer to drive out the valve guide from the cylinder head lower face.
Valve Guide Replacer: 5-8840-2227-0



Valve Guide Installation

1. Apply engine oil to the valve guide outer circumference.
2. Attach the valve guide installer to the valve guide.
   Valve Guide Replacer: 5-8840-2227-0

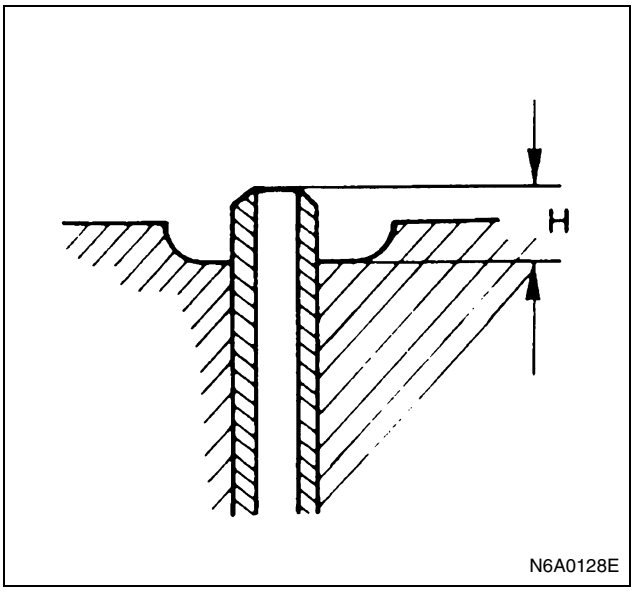
3. Use a hammer to drive the valve guide into position from the cylinder head upper face.



4. Measure the height (H) of the valve guide upper end from the cylinder head upper face.

Valve Guide Upper End Height (H)	mm (in)
14.1 ± 0.2 (0.555 ± 0.008)	

Notice:
If the valve guide has been removed, both the valve and the valve guide must be replaced as a set.

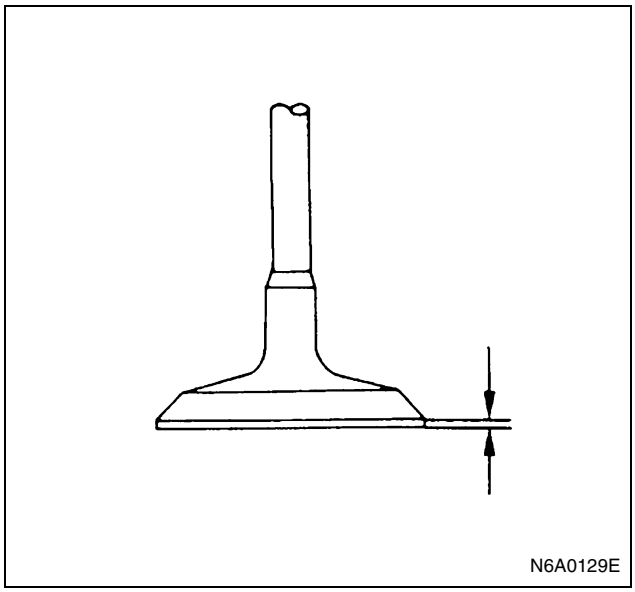


Valve and Valve Seat Insert

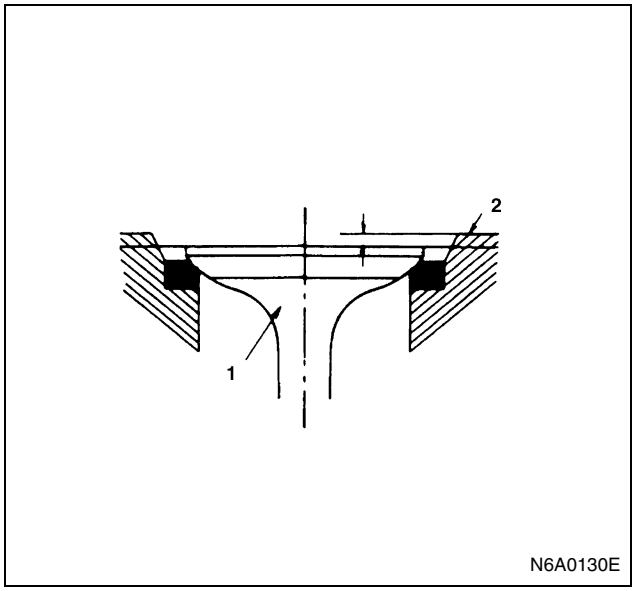
Valve Thickness and Depression

1. Measure the valve thickness.
   If the measured value is less than the specified limit, the valve and the valve seat insert must be replaced as a set.

Intake and Exhaust Valve Thickness		mm (in)
Valve	Nominal Size	Limit
Inlet	1.8 (0.071)	1.3 (0.051)
Exhaust	1.75 (0.069)	1.3 (0.051)



2. Install the new valve (1) to the cylinder head (2).



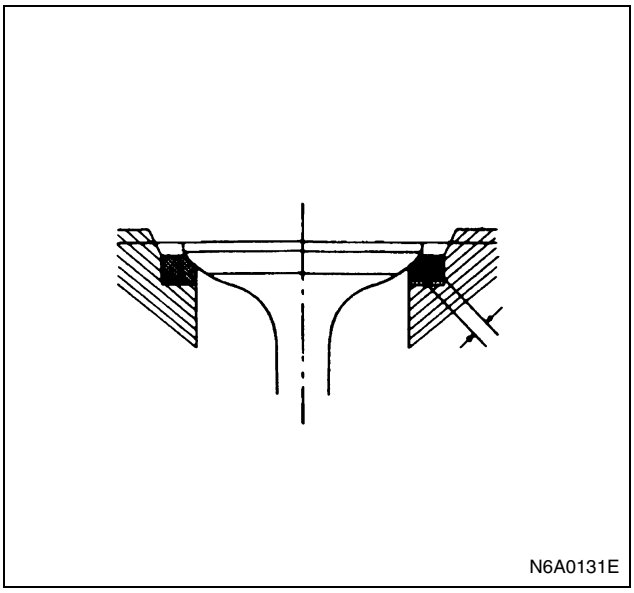
3. Use a depth gauge or a straight edge with steel rule to measure the valve depression from the cylinder head lower surface.
   If the measured value exceeds the specified limit, the valve seat insert and/or the valve must be replaced.

Intake and Exhaust Valve Depression	mm (in)
Standard	Limit
0.7 — 1.2 (0.028 — 0.047)	2.5(0.098)

Valve Contact Width

1. Check the valve contact faces for roughness and unevenness.
   Make smooth the valve contact surfaces.
2. Measure the valve contact width.
   If the measured value exceeds the specified limit, the valve seat insert must be corrected or replaced.

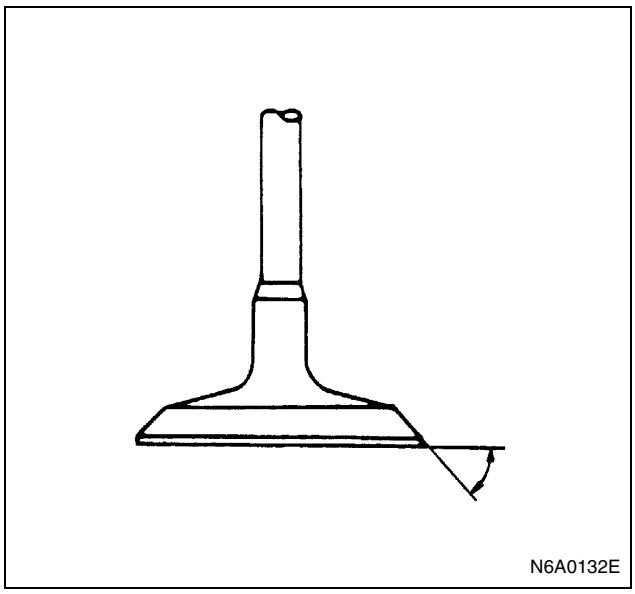
Valve Contact Width		mm (in)
Valve	Nominal Size	Limit
Intake	2.5 (0.098)	3.0 (0.118)
Exhaust	2.0 (0.079)	2.5 (0.098)



Contact Surface Angle on Valve Seat on Valve

1. Measure contact surface angle on valve seat.
2. If the measured value exceeds the limit, replace valve, valve guide and valve seat as a set.

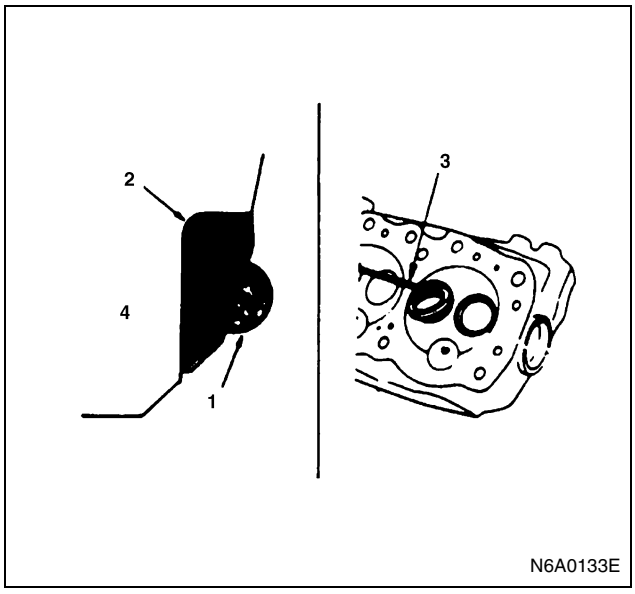
Standard	Degrees
45°	



Valve Seat Insert Replacement

Valve Seat Insert Removal

1. Arc weld the entire inside circumference (1) of the valve seat insert (2).
2. Allow the valve seat insert to cool for a few minutes. This will invite contraction and make removal of the valve seat insert easier.
3. Use a screwdriver (3) to pry the valve seat insert free. Take care not to damage the cylinder head (4).
4. Carefully remove carbon and other foreign material from the cylinder head insert bore.



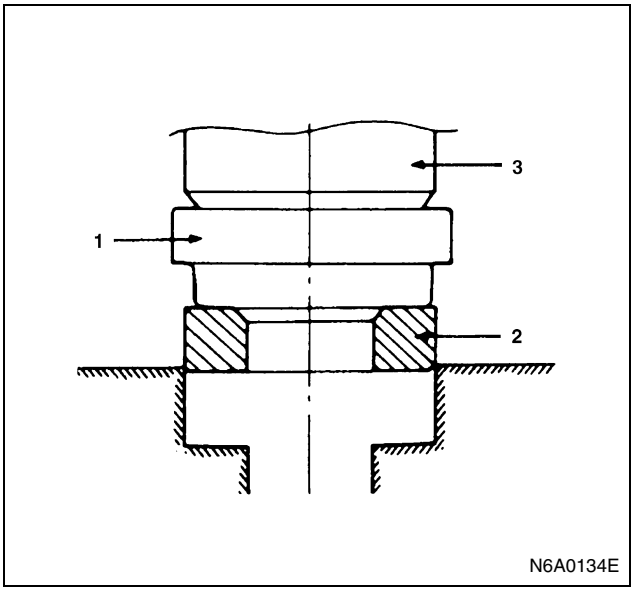
Valve Seat Insert Installation

1. Carefully place the attachment (1) (having a smaller outside diameter than the valve seat insert) on the valve seat insert (2).

Notice:
The smooth side of the attachment must contact the valve seat insert.

2. Use a bench press (3) to gradually apply pressure to the attachment and press the valve seat insert into place.

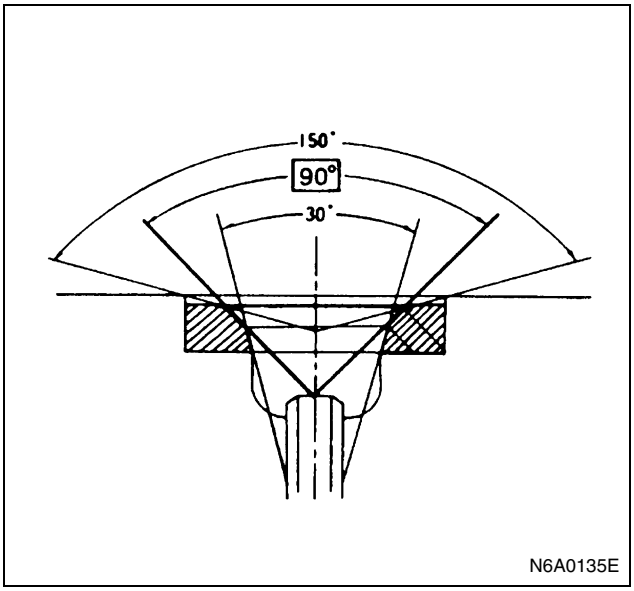
Caution:
Do not apply an excessive amount of pressure with the bench press. Damage to the valve seat insert will result.



3. The valve should be lapped before final assembly to ensure a good valve seal.
   Above works refer to “Valve Seat Insert Correction” section in this manual.

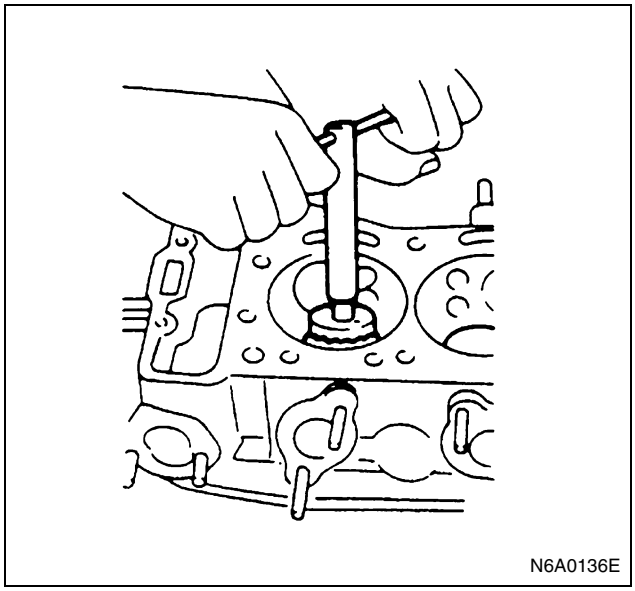
Valve Seat Insert Correction

1. Remove the carbon from the valve seat insert surface.
2. Use a valve cutter (15°, 45°, and 75° blades) to minimize scratches and other rough areas. This will bring the contact width back to the standard value. Remove only the scratches and rough areas. Do not cut away too much. Take care not to cut away unblemished areas of the valve seat surface.

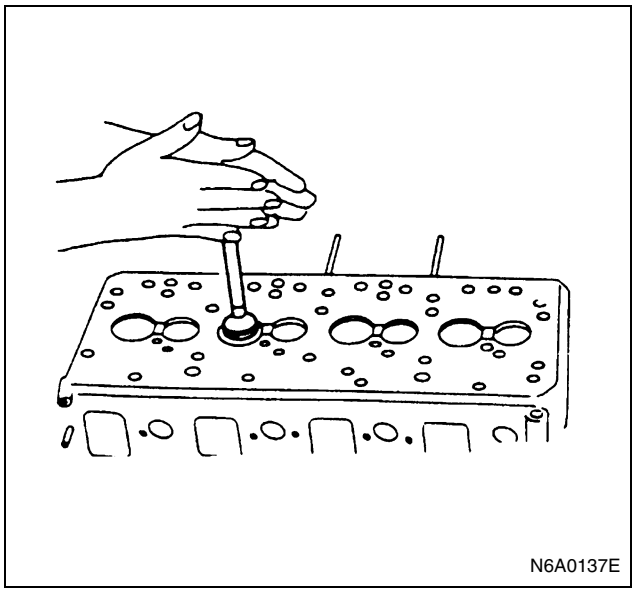


Valve Seat Angle	Degrees
45°	

Notice:
Use an adjustable valve cutter pilot.
Do not allow the valve cutter pilot to wobble inside the valve guide.



3. Apply abrasive compound to the valve seat insert surface.
4. Insert the valve into the valve guide.
5. Turn the valve while tapping it to fit the valve seat insert.

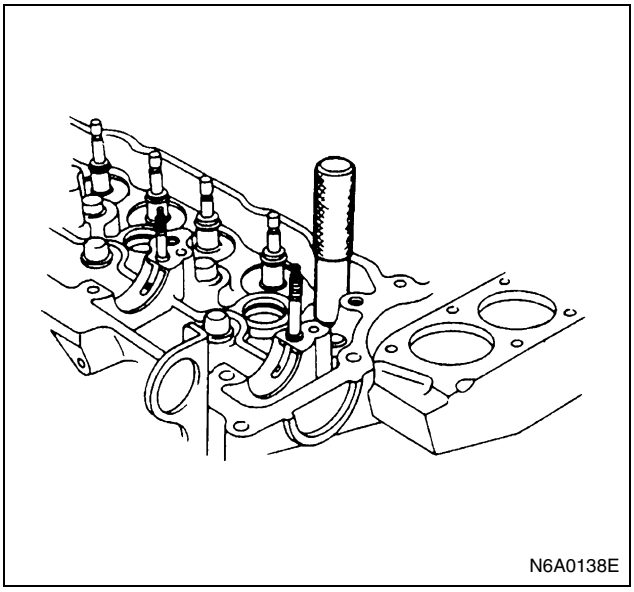


6. Check to see if the valve contact width is correct.
7. Check to see if the valve seat insert surface is in contact with the entire circumference of the valve.

Reassembly

1. Spring Lower Seat

2. Valve Guide Seal
   1) Apply a coat of engine oil to the valve guide seal inner face.
   2) Use a valve guide seal installer to install the valve guide seal to the valve guide
      Valve Guide Seal Installer: 8-9439-6815-0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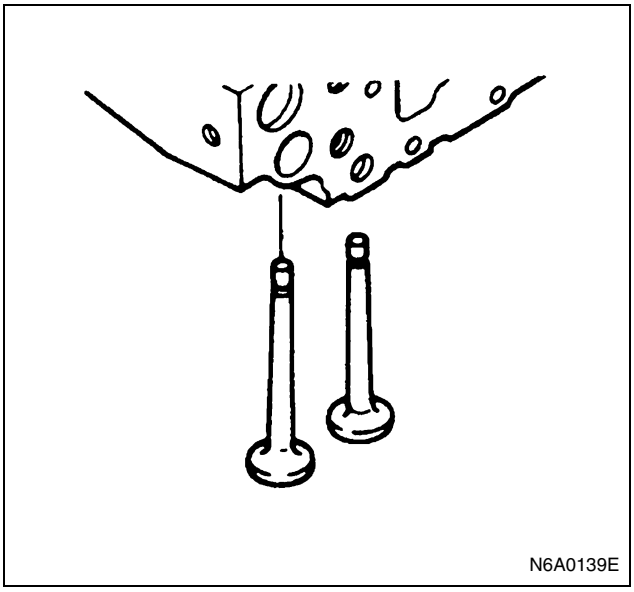
3. Intake and Exhaust Valve
   1) Apply a coat of engine oil to each valve stem before installation.
   2) Install the intake and exhaust valve.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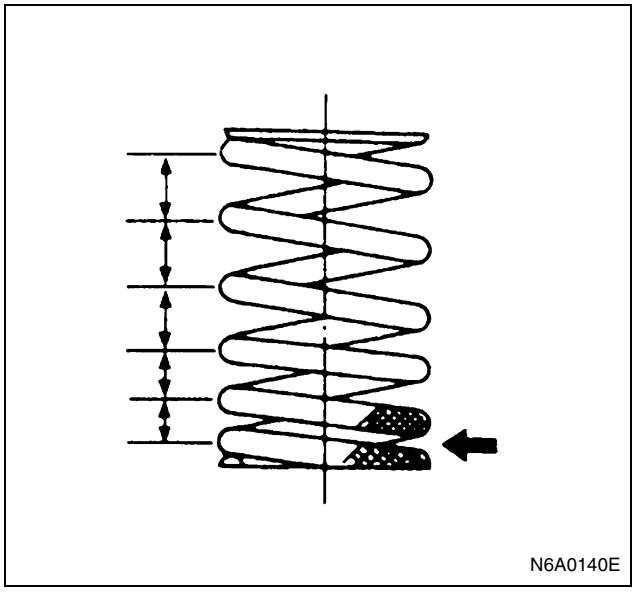
   3) Turn the cylinder head up to install the valve spring. Take care not to allow the installed valves to fall free.
4. Valve Spring
   Install the valve spring with its fine pitched (or painted) end side down.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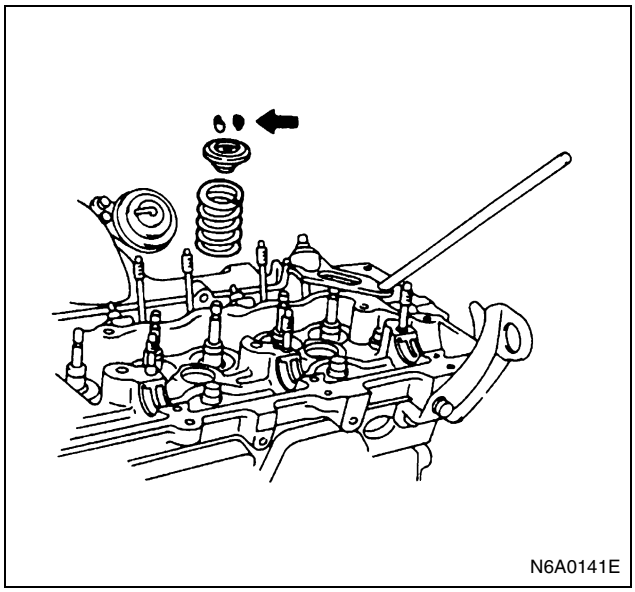
5. Spring Upper Seat
6. Cotter Collar
   1) Use the valve spring compressor to push the valve spring into position.
      Valve Spring Compressor: 5-8840-2228-0
   2) Install the cotter collar to the valve stem.
   3) Set the cotter collar by tapping around the head of the collar with a rubber hammer.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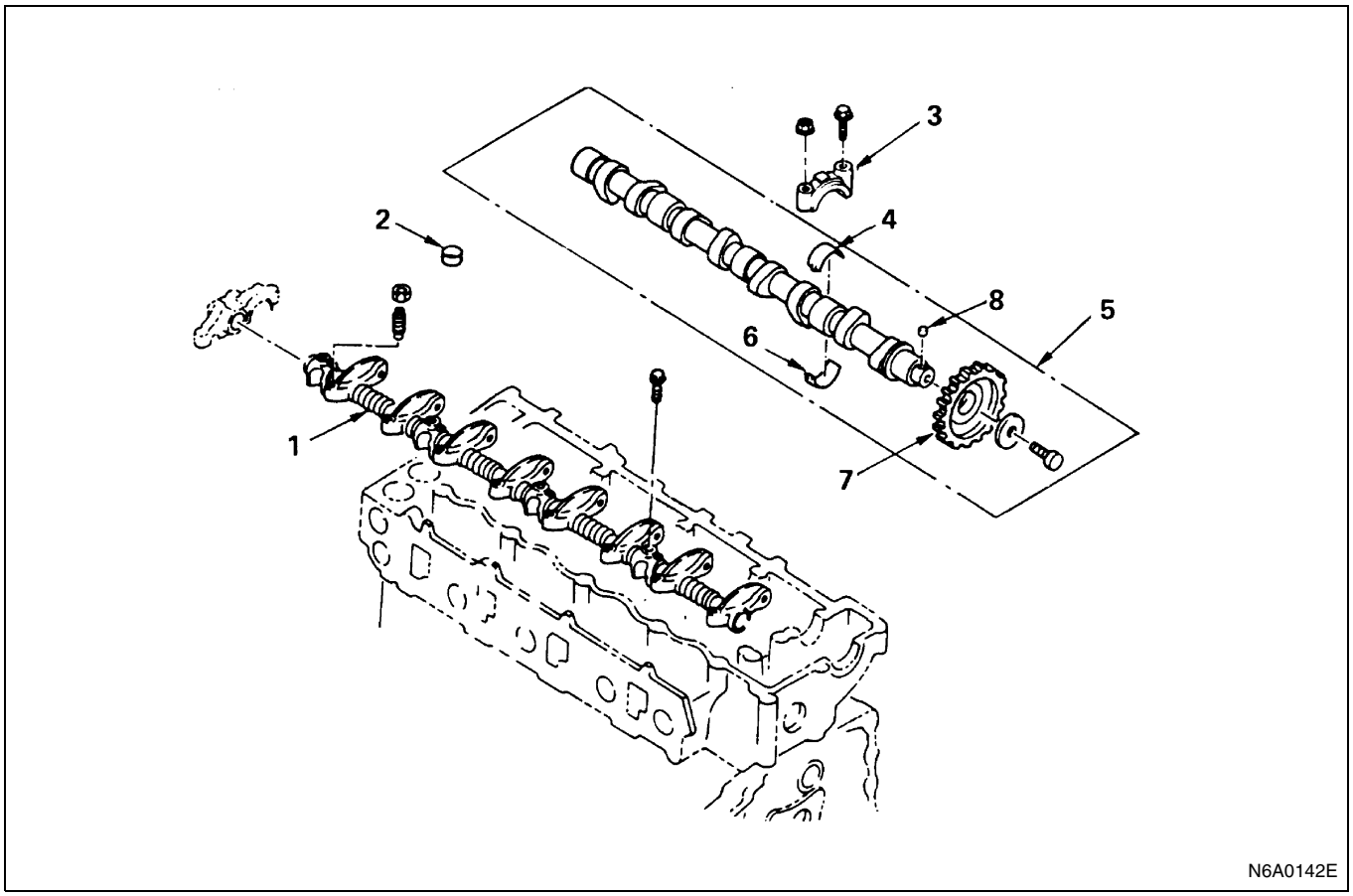
CAMSHAFT

Component

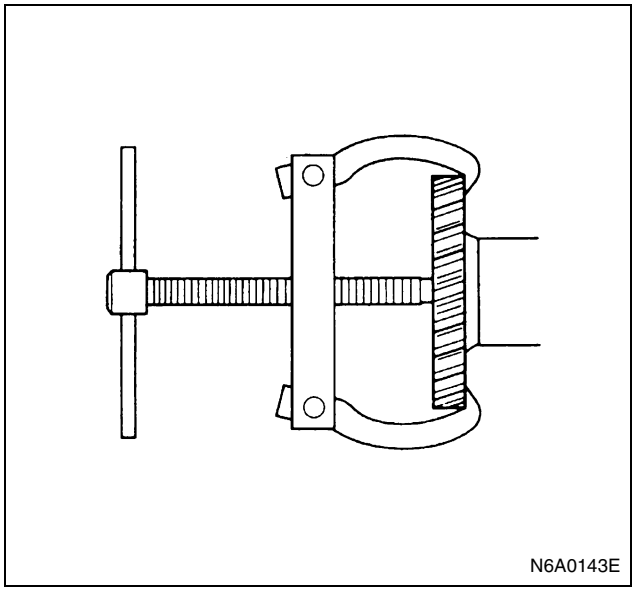


Legend

1. Rocker arm shaft assembly
2. Valve cap
3. Camshaft bearing cap
4. Camshaft bearing upper
5. Camshaft assembly
6. Camshaft bearing lower
7. Camshaft gear
8. Key

Disassembly

1. Rocker Arm Shaft Assembly
2. Valve Cap
3. Camshaft Bearing Cap
4. Camshaft Bearing Upper
5. Camshaft Assembly
6. Camshaft Bearing Lower
   Above works refer to “CYLINDER HEAD” section in this manual.
7. Camshaft Gear
   Use the universal puller to pull out the camshaft gear.
   Universal puller: 5-8840-2027-0/5-8840-0086-0
8. Key



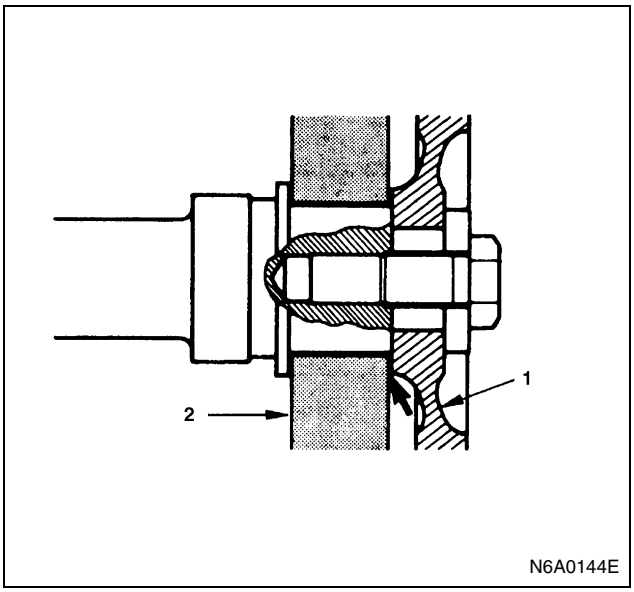
Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Camshaft End Play

Use a thickness gauge to measure the clearance between the camshaft gear (1) and the camshaft bracket (2).
If the measured value exceeds the specified limit, the camshaft gear or the camshaft must be replaced.

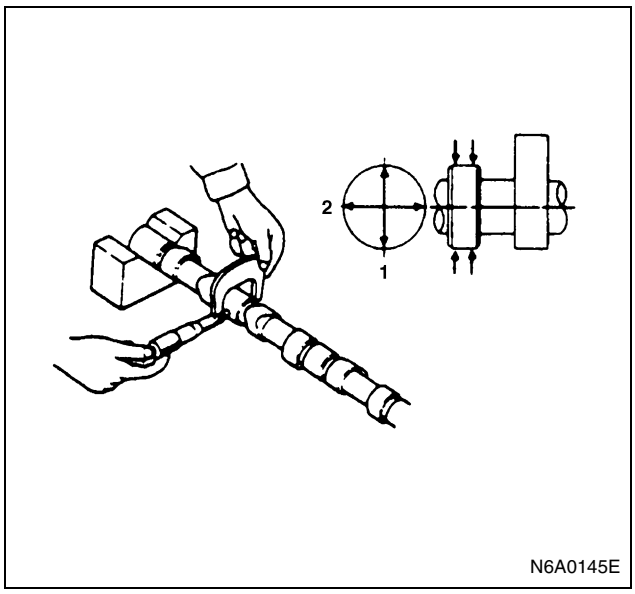
Camshaft End Play	mm (in)
Standard	Limit
0.085 — 0.205 (0.0033 — 0.0081)	0.25 (0.0098)



Camshaft Journal Diameter

Use a micrometer to measure each camshaft journal diameter in two directions ((1) and (2)). If the measured value is less than the specified limit, the camshaft must be replaced.

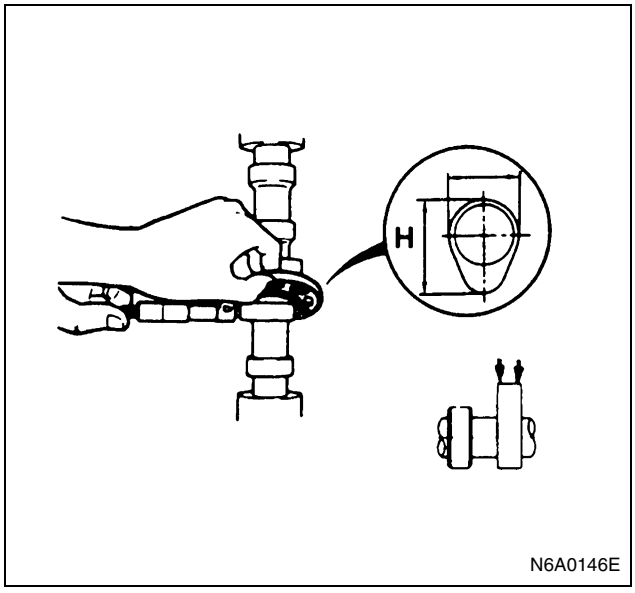
Camshaft Journal Diameter	mm (in)
Standard	Limit
39.950 — 39.975 (1.5728 — 1.5738)	39.850 (1.569)



Cam Height

Measure the cam height “H” with a micrometer. If the measured value is less than the specified limit, the camshaft must be replaced.

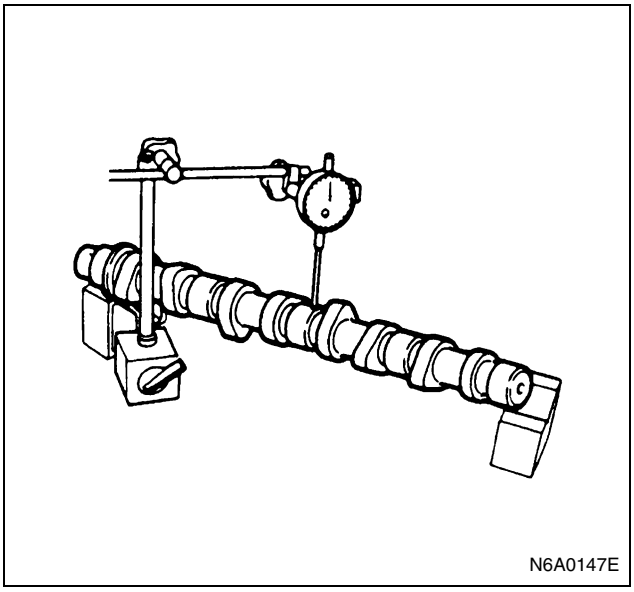
Cam Height “H”		mm (in)
Engine model	Standard	Limit
Except 4HE1-TC	52.8 (2.078)	51.8 (2.039)
4HE1-TC	53.6 (2.110)	52.6 (2.071)



Camshaft Run-Out

1. Mount the camshaft on V-blocks.
2. Measure the run-out with a dial indicator.
   If the measured value exceeds the specified limit, the camshaft must be replaced.

Camshaft Run-Out	mm (in)
Limit	0.05 (0.002)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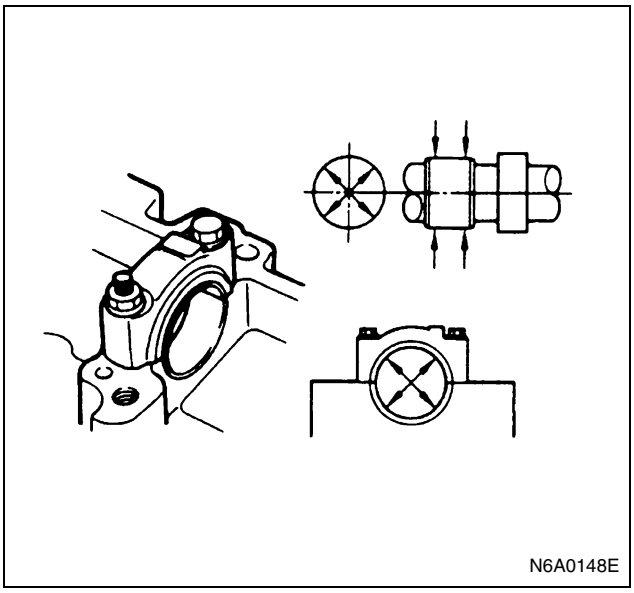
Camshaft and Camshaft Bearing Clearance

Use an inside dial indicator to measure the camshaft bearing inside diameter.

Camshaft Bearing Inside Diameter	mm (in)
Standard	40.000 — 40.037 (1.5748 — 1.5763)

If the clearance between the camshaft bearing inside diameter and the journal exceeds the specified limit, the camshaft bearing must be replaced.

Camshaft Bearing Clearance	mm (in)
Standard	Limit
0.025 — 0.087 (0.00098 — 0.00343)	0.15 (0.0059)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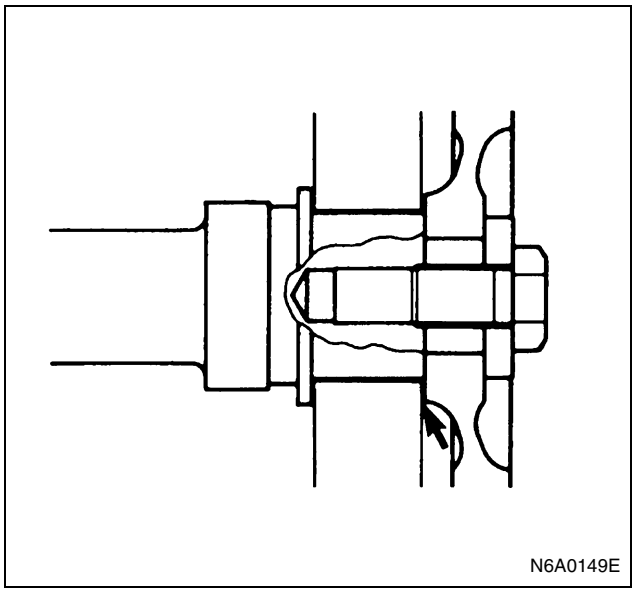
Reassembly

1. Key
2. Camshaft Gear
   - With the projection of the camshaft gear center boss turned to the camshaft side, set it to the knock pin and install the camshaft gear.

Tighten:
Camshaft gear bolt to 142 N·m (14.5 kg·m / 105 lb·ft)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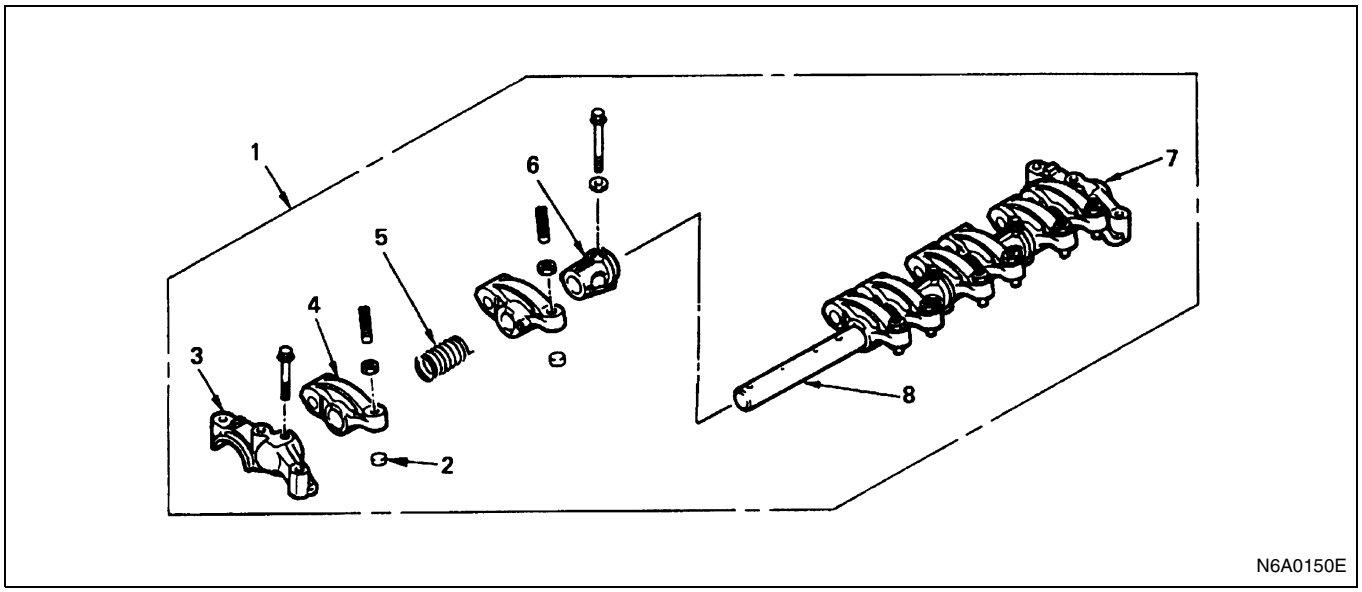
3. Camshaft Bearing Lower
4. Camshaft Assembly
5. Camshaft Bearing Upper
6. Camshaft Bearing Cap
7. Valve Cap
8. Rocker Arm Shaft Assembly
   Above works refer to “CYLINDER HEAD” section in this manual.

ROCKER ARM ASSEMBLY

Component



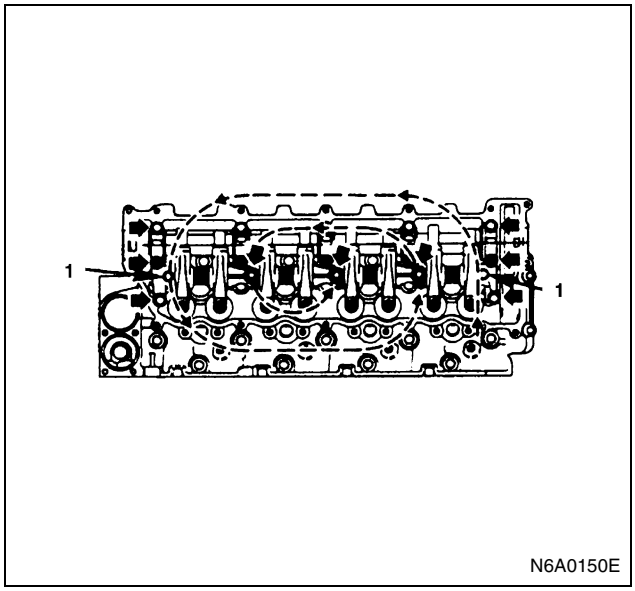
Legend

1. Rocker arm shaft assembly
2. Valve cap
3. Camshaft bracket
4. Rocker arm
5. Spring
6. Rocker arm bracket
7. Camshaft bracket
8. Rocker arm shaft

Disassembly

1. Rocker Arm Shaft Assembly
   1) Loosen the rocker arm shaft bracket nuts and bolts in numerical order a little at a time and remove the rocker arm shaft assembly with the camshaft brackets.
   2) Leave the (1) indicated bolt unremoved on this occasion, since it is the rocker arm fixing bolt.

Caution:
Failure to loosen the rocker arm shaft bracket nuts and bolts in numerical order a little at a time will adversely affect the rocker arm shaft.



2. Valve Cap

Caution:
Take sufficient care not to let the valve caps fall into the gear case or oil return hole.

3. Camshaft Bracket
4. Rocker Arm
5. Spring
6. Rocker Arm Bracket
7. Camshaft Bracket

8. Rocker Arm Shaft

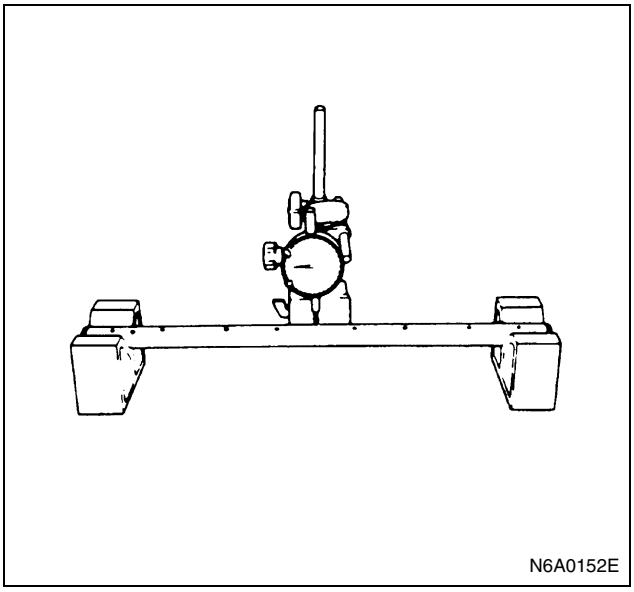
Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Rocker Arm Shaft Run-Out

1) Place the rocker arm shaft on V-blocks.
2) Use a dial indicator to measure the rocker arm shaft central portion run-out.
   If the run-out is very slight, correct the rocker arm shaft run-out with a bench press. The rocker arm must be at cold condition.
   If the measured rocker arm shaft run-out exceeds the specified limit, the rocker arm shaft must be replaced.

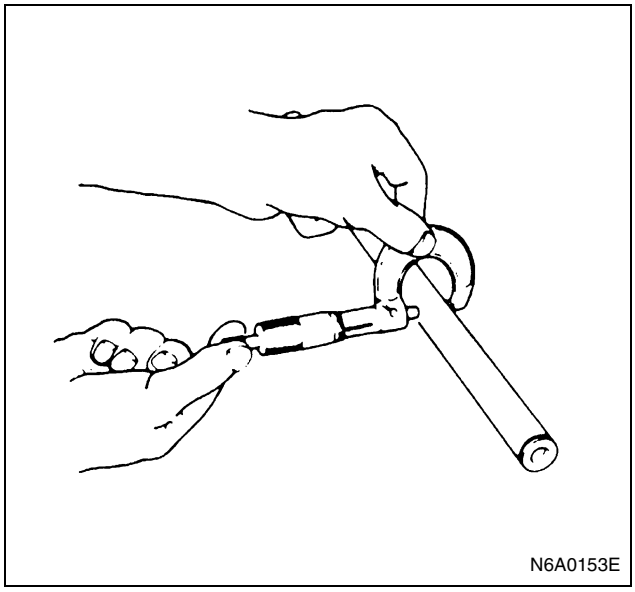
Rocker Arm Shaft Run-Out	mm (in)
Limit	0.3 (0.012)



Rocker Arm Shaft Outside Diameter

Use a micrometer to measure the rocker arm fitting portion outside diameter.
If the measured value is less than the specified limit, the rocker arm shaft must be replaced.

Rocker Arm Shaft Outside Diameter		mm (in)
Standard	Limit	
21.979 — 22.000 (0.8653 — 0.8661)	21.85 (0.8602)	

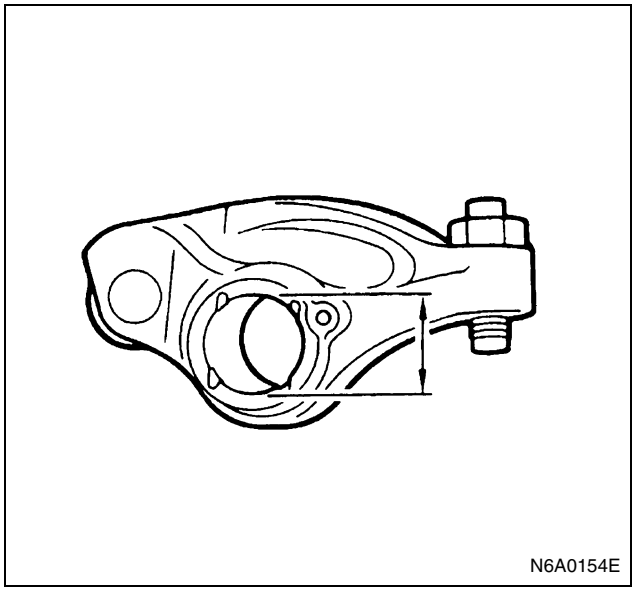


Rocker Arm Bushing Inside Diameter

Use either a vernier caliper or a dial indicator to measure the rocker arm bushing inside diameter.

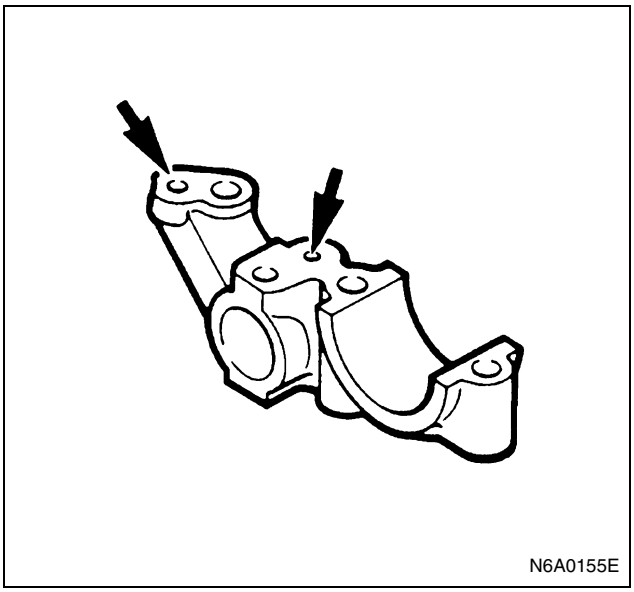
Rocker Arm Bushing Inside Diameter		mm (in)
Standard	Limit	
22.010 — 22.035 (0.8665 — 0.8675)	22.15 (0.8720)	

Rocker Arm and Rocker Arm Shaft Clearance		mm (in)
Standard	Limit	
0.010 — 0.056 (0.0004 — 0.0022)	0.2 (0.0079)	



Check to see if the rocker arm oil port is free of obstructions.

If necessary, use compressed air to clean the rocker arm oil port.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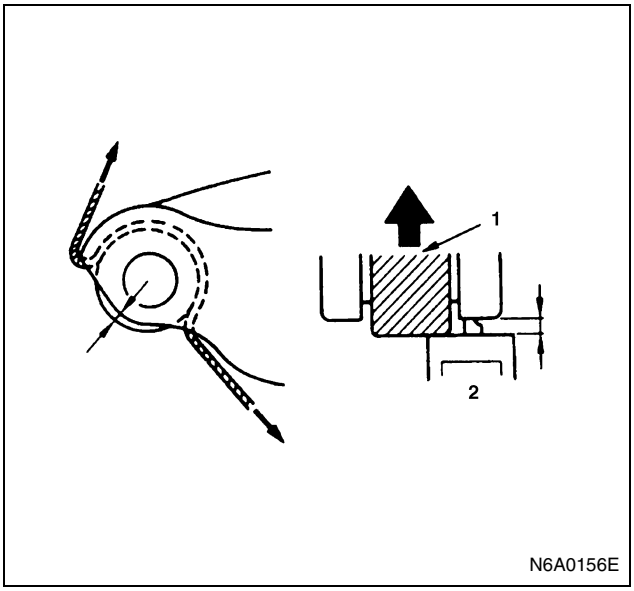
Rocker Arm Roller and Rocker Arm Pin

1. Pass a string through the rocker arm-roller clearance and measure the roller protrusion while pulling both ends of the string in the arrow-indicated directions to push out the roller.
2. Mark the measuring point and draw out the string. Measure the roller protrusion again while the roller is pushed in.
3. Note the difference in the above measurements is the standard roller-rocker arm pin clearance. Should the clearance exceed the limit, replace the rocker arm.

Rocker Arm Roller and Pin Clearance	mm (in)
Standard	Limit
0.040 — 0.084 (0.0016 — 0.0033)	0.5 (0.02)



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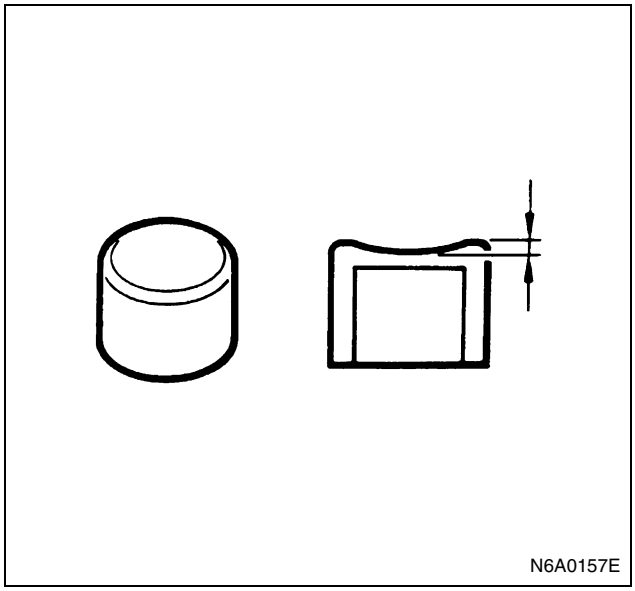
Legend
1. Roller
2. Depth gauge

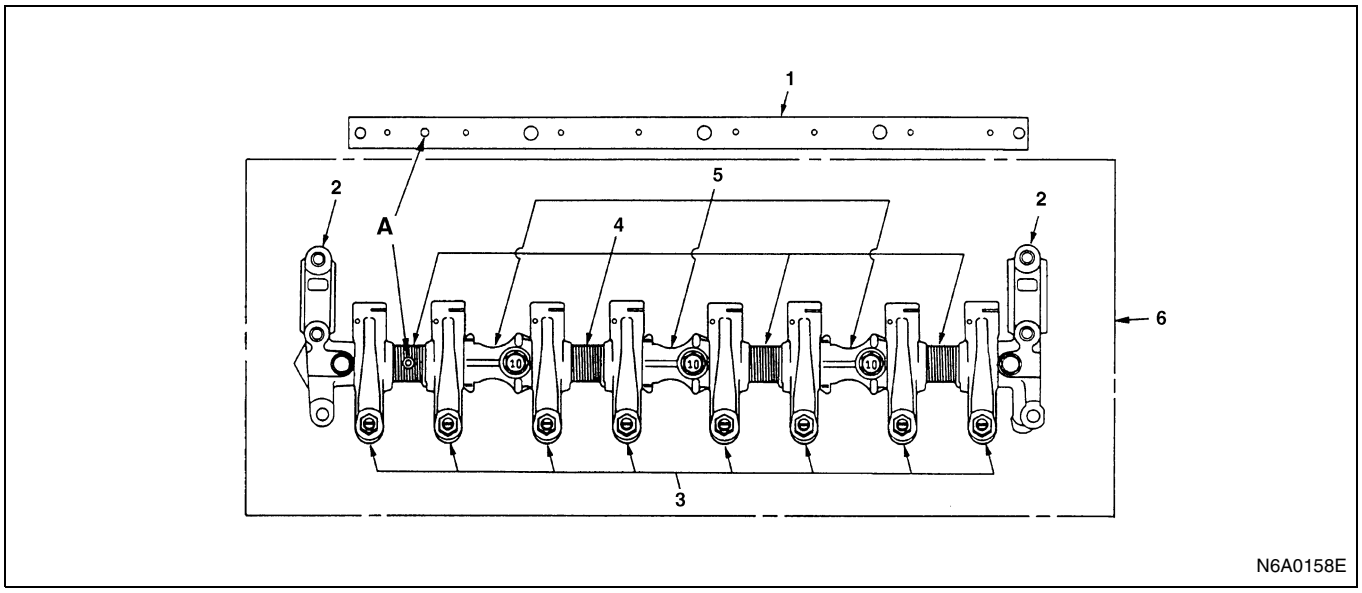
Valve Cap Wear

Inspect the valve cap surface contacting the rocker arm using a dial gauge.
If wear exceeds the limit, replace the valve cap with a new one.

Valve Cap Worn	mm (in)
Limit	0.1 (0.004)


N6A0157E

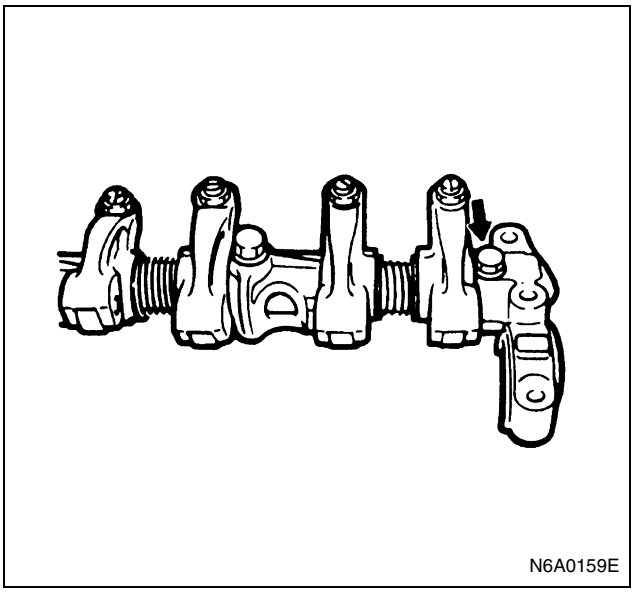
Reassembly



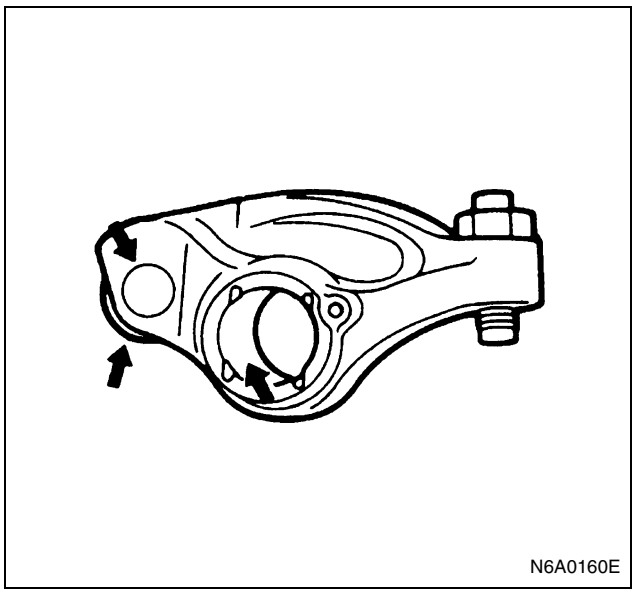
Legend

A. Front mark
1. Rocker arm shaft
2. Camshaft bracket
3. Rocker arm
4. Spring
5. Rocker arm bracket
6. Valve cap

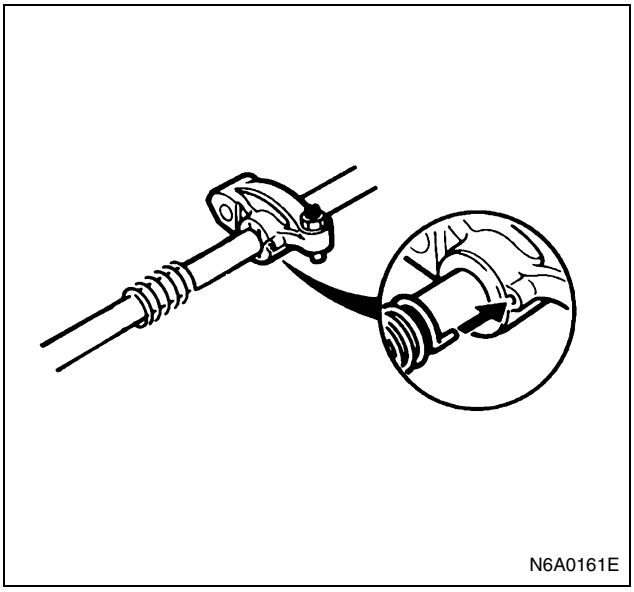
1. Rocker Arm Shaft
   1) Use compressed air to thoroughly clean the rocker arm shaft oil holes.
   2) Apply a coat of engine oil to the rocker arm shaft.
   3) Install the rocker arm shaft with the “Front” mark facing up and toward the front of the engine.
2. Camshaft Bracket
   Install the camshaft bracket to the rocker arm shaft and temporarily tighten the camshaft bracket fixing bolt as shown in the illustration.



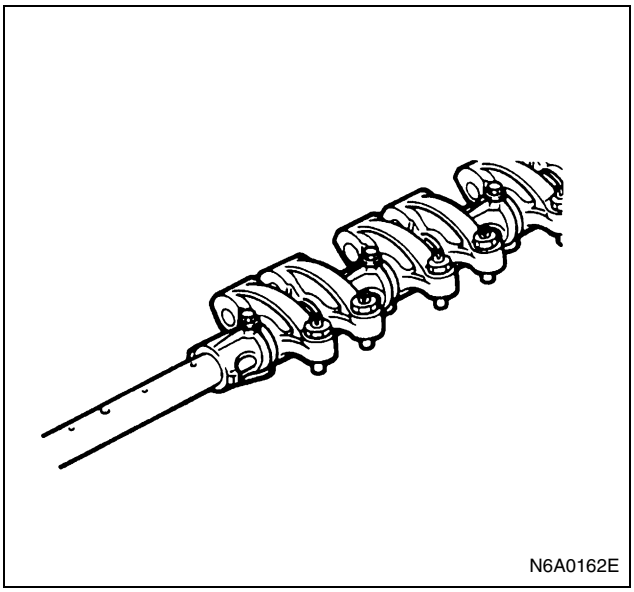
3. Rocker Arm
   Apply engine oil to the rocker arm bushing and the roller pin and then install it to the rocker arm shaft.



4. Spring
   Insert the spring end into the rocker arm.


N6A0161E

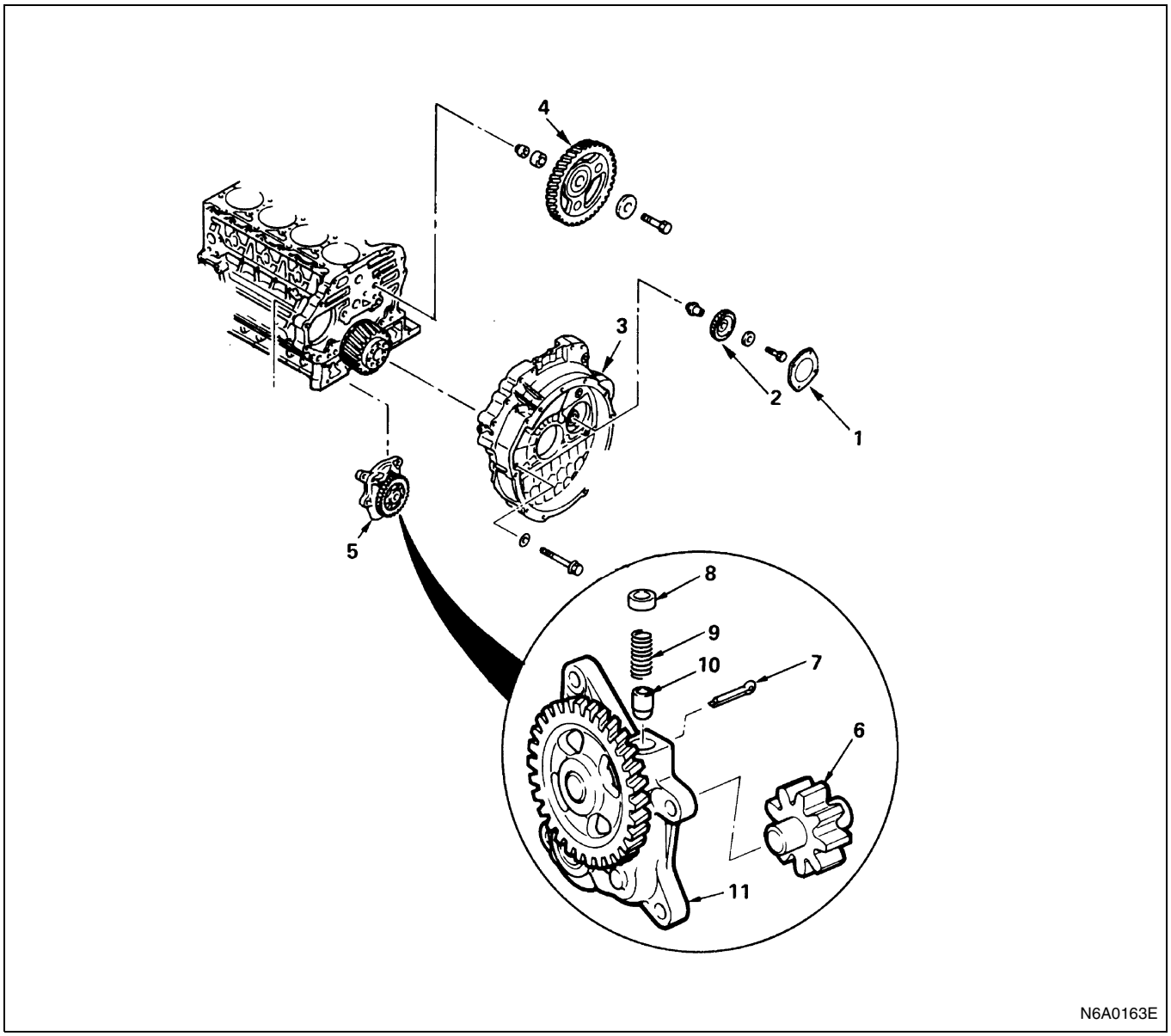
5. Rocker Arm Bracket


N6A0162E

6. Camshaft Bracket
   Temporarily tighten the camshaft bracket fixing bolt.
7. Valve Cap
8. Rocker Arm Shaft Assembly
   Above works refer to “CYLINDER HEAD” section in this manual.

OIL PUMP

Component

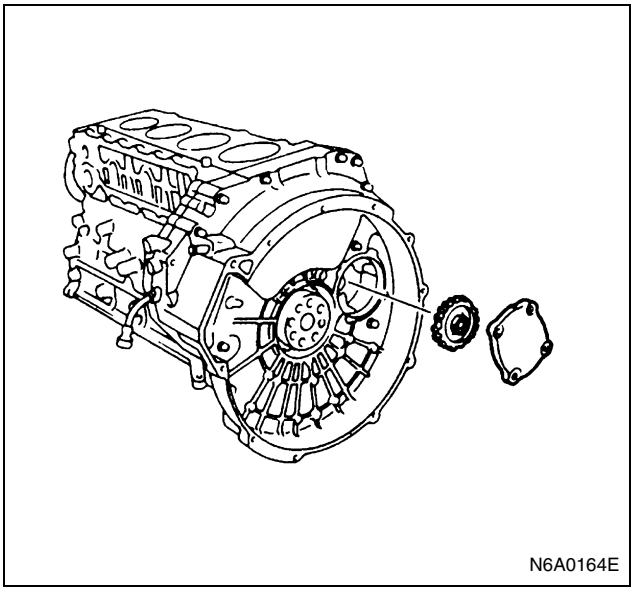


Legend

1. Power steering pump idle gear cover
2. Power steering pump idle gear
3. Flywheel housing
4. Idle gear A
5. Oil pump assembly
6. Driven gear and shaft
7. Cotter pin
8. Spring seat
9. Oil relief valve spring
10. Oil relief valve
11. Pump cover

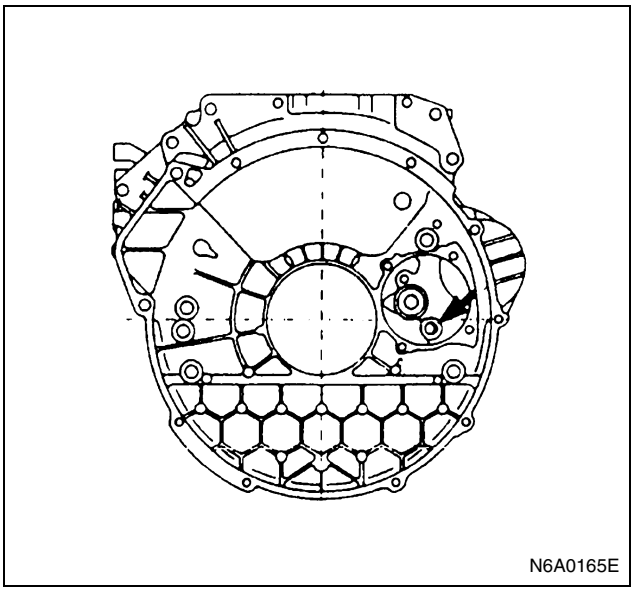
Disassembly

1. Power Steering Pump Idle Gear Cover
2. Power Steering Pump Idle Gear

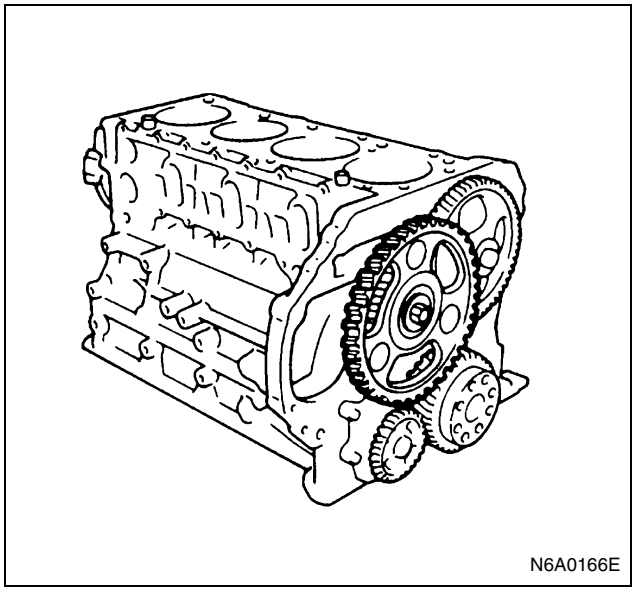

N6A0164E

3. Flywheel Housing

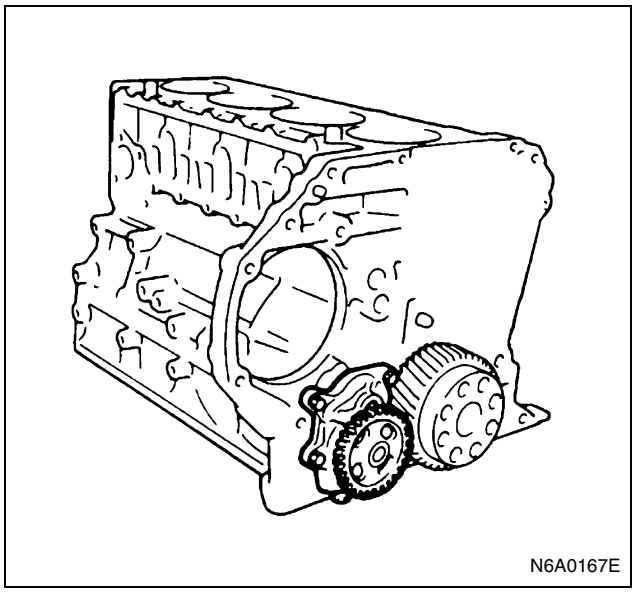
Notice:
Be careful not to fail to remove the bolts shown in the illustration.


N6A0165E

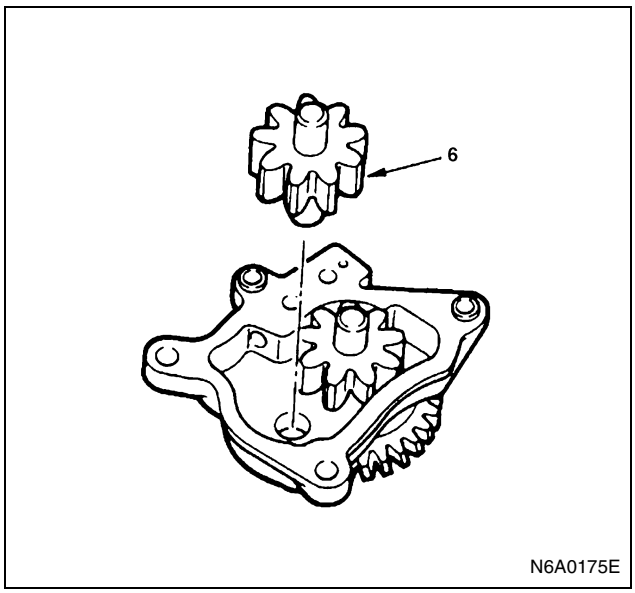
4. Idle Gear A


N6A0166E

5. Oil Pump Assembly

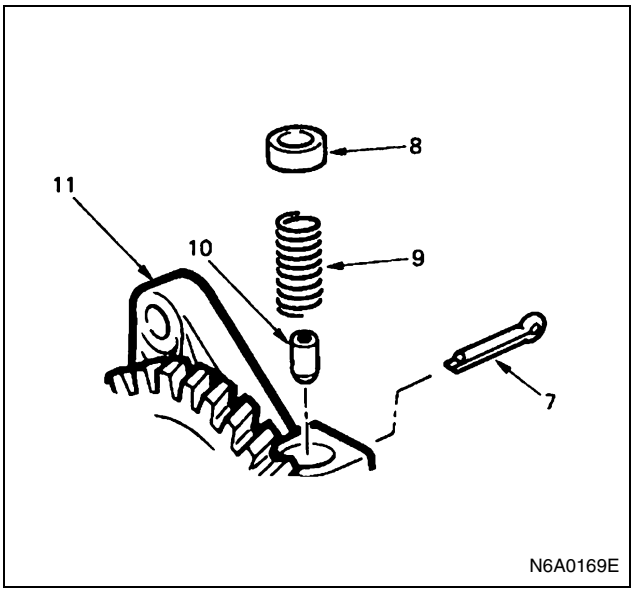

N6A0167E

6. Driven Gear and Shaft



N6A0175E

7. Cotter Pin
8. Spring Seat
9. Oil Relief Valve Spring
10. Oil Relief Valve
11. Pump Cover



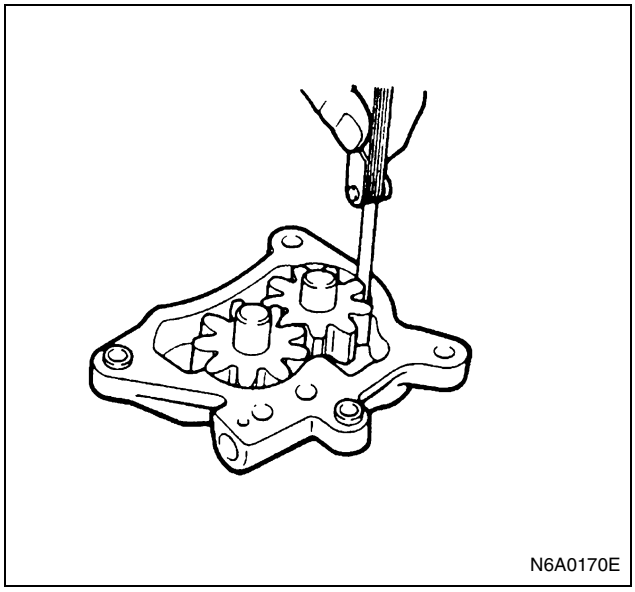
Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Gear Teeth and Cover Inner Wall Clearance

Use a feeler gauge to measure the clearance between the gear teeth and the cover inner wall.
If the clearance between the gear teeth and the cover inner wall exceeds the specified limit, the oil pump assembly must be replaced.

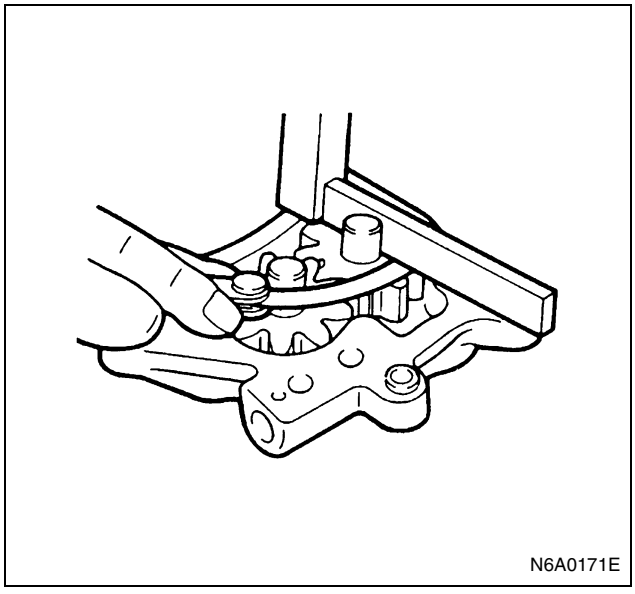
Gear Teeth and Cover Inner Wall Clearance	mm (in)
Standard	Limit
0.125 — 0.220 (0.0049 — 0.0087)	0.3 (0.012)



Gear and Cover Clearance

Use a feeler gauge to measure the clearance between the cover and the gear.
If the clearance between the gear and the cover exceeds the specified limit, the oil pump assembly must be replaced.

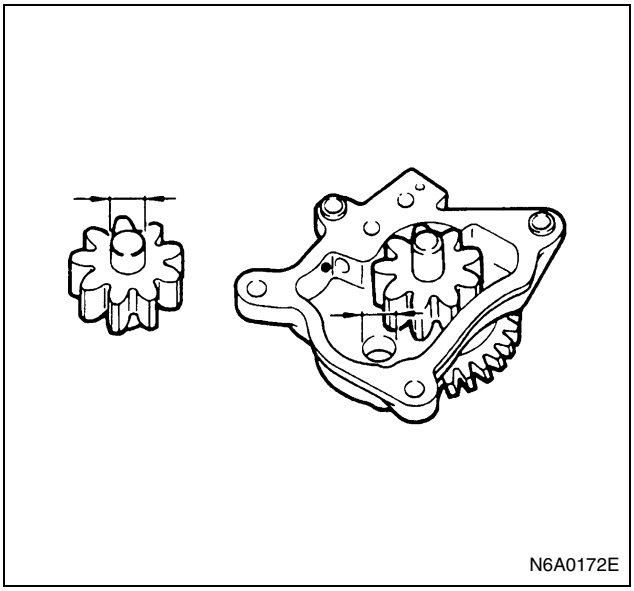
Gear and Cover Clearance	mm (in)
Standard	Limit
0.064 — 0.109 (0.0025 — 0.0043)	0.2 (0.008)



Driven Gear Shaft and Bushing Clearance

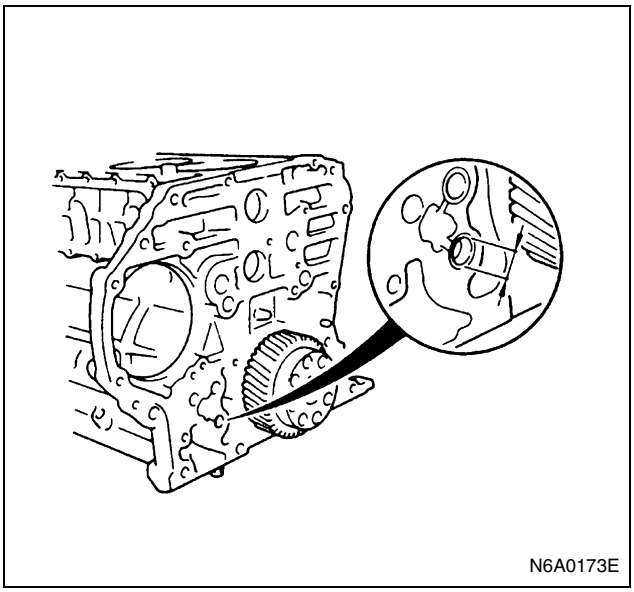
1. Use a micrometer to measure the gear shafts outside diameter.

Gear Shaft Outside Diameter	mm (in)
Standard	Limit
15.989 —16.000 (0.6295 — 0.6299)	15.9 (0.626)


N6A0172E

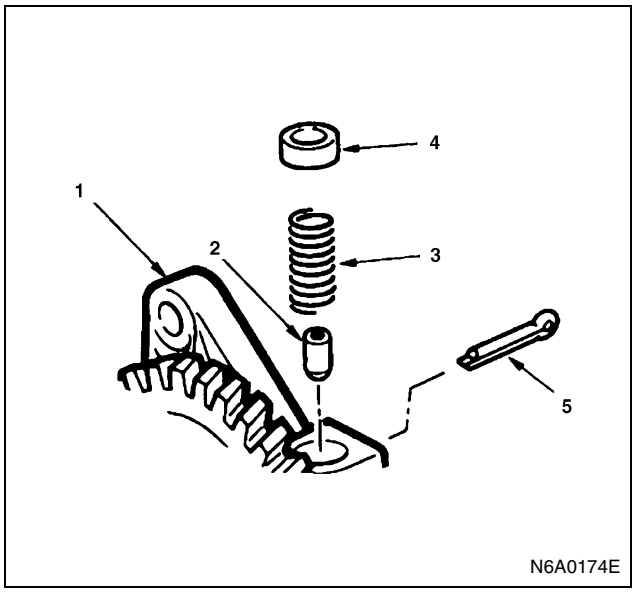
2. Use an inside dial indicator or inside micrometer to measure the pump cover bushing inside diameter and the cylinder body inside diameter.
   If clearance between the gear shaft and the bushing exceeds the specified limit, the oil pump assembly must be replaced.

Gear Shaft and Bushing Clearance	mm (in)
Standard	Limit
0.04 — 0.07 (0.0016 — 0.0028)	0.2 (0.012)


N6A0173E

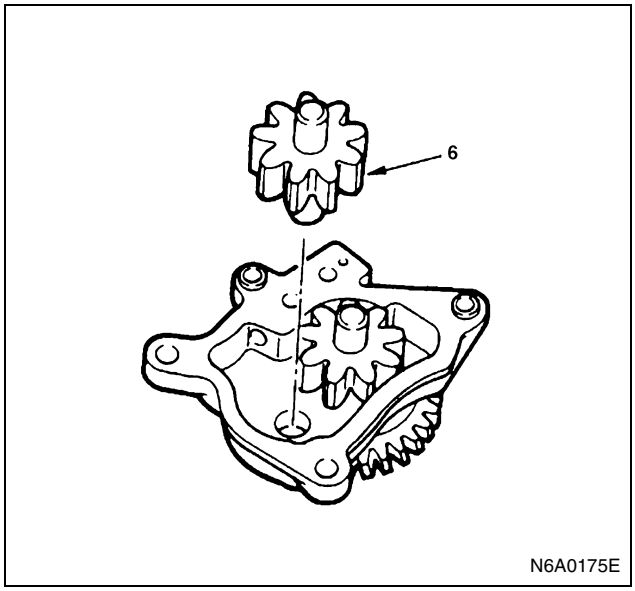
Reassembly

1. Pump Cover
2. Oil Relief Valve
3. Oil Relief Valve Spring
4. Sprig Seat
5. Cotter Pin



N6A0174E

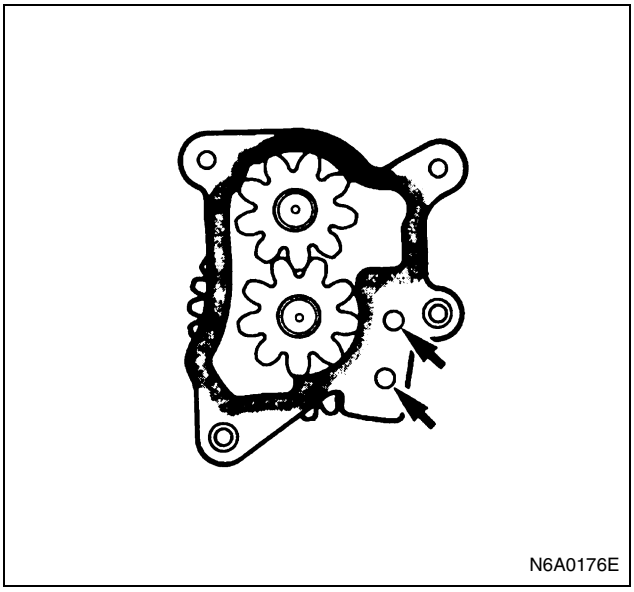
6. Driven Gear and Shaft
   Apply the engine oil to the driven gear shaft.



N6A0175E

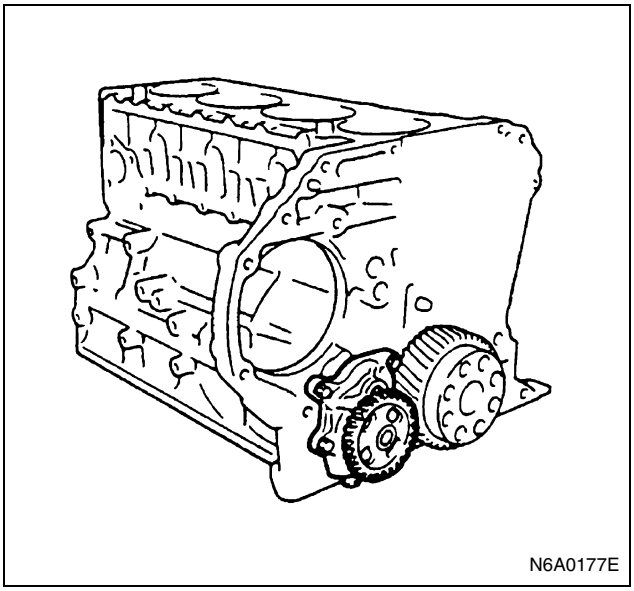
7. Oil Pump Assembly
   1) Carefully wipe any foreign material from cylinder body rear surface.
   2) Apply the recommended liquid gasket (Three Bond 1141E) or its equivalent to the shaded areas shown in the illustration.

Caution:
Be careful that no liquid gasket gets into the holes in the arrow-marked portion in the illustration and the inside of the oil pump cover.

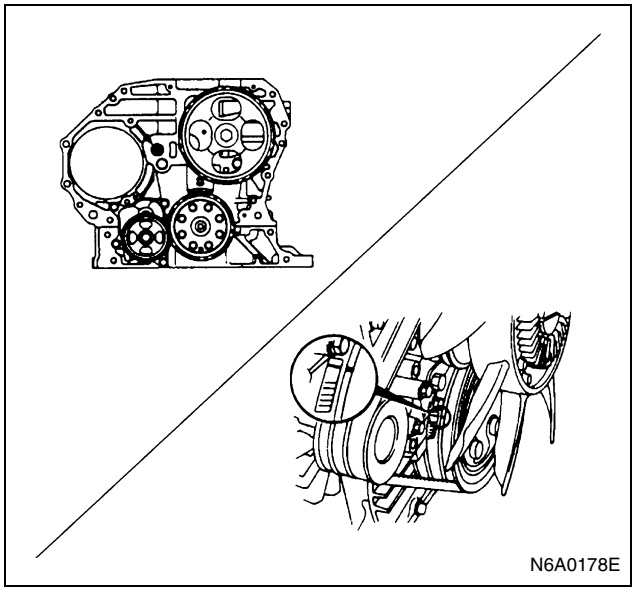

N6A0176E

3) Install the oil pump to the cylinder body.
4) Tighten the oil pump to the specified torque.

Tighten:
Oil pump bolt to 31 N·m (3.2 kg·m / 23 lb·ft)

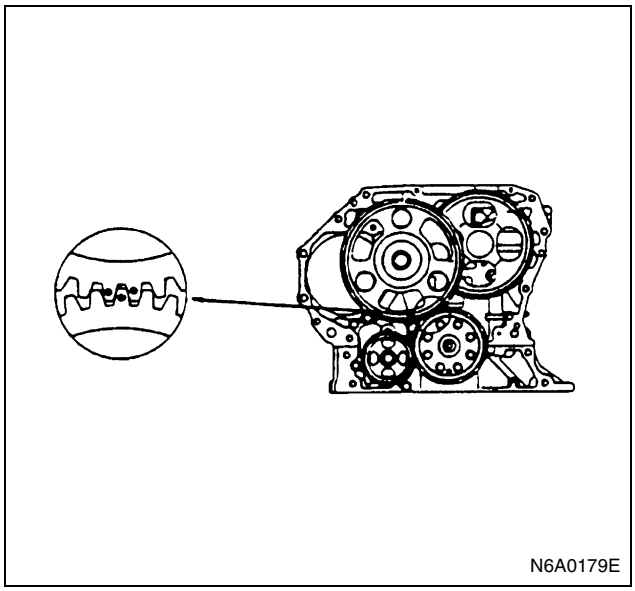

N6A0177E

8. Idle Gear A
   1) Turn the crankshaft clockwise so that the engagement mark of the crankshaft gear faces to the shaft center of the idle gear A and the No.1 cylinder piston comes to the top dead center.

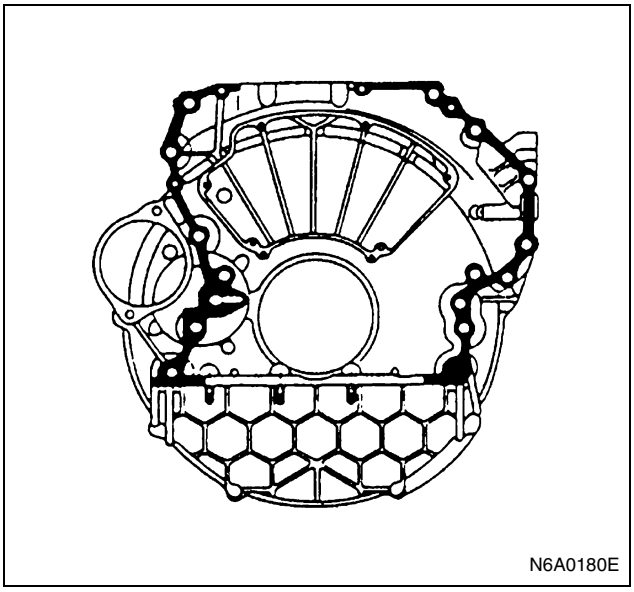

N6A0178E

2) Align the crankshaft gear with the engagement mark of the idle gear and install the idle gear A.

Tighten:
Idle gear A bolt to 133 N·m (13.6 kg·m / 98 lb·ft)

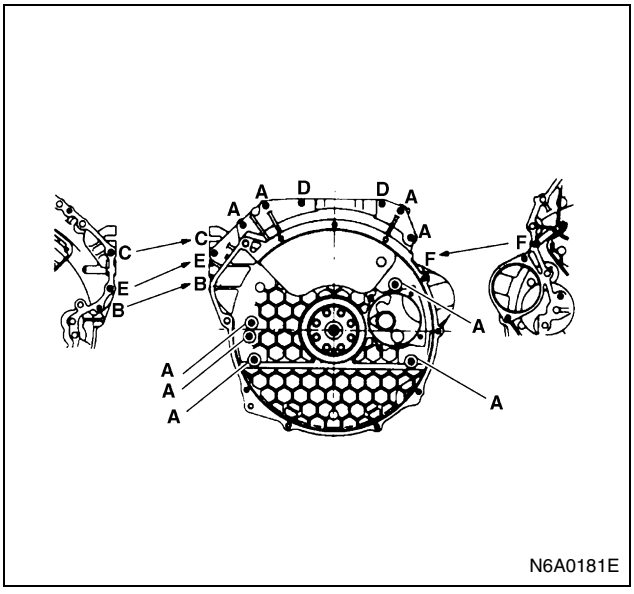

N6A0179E

9. Flywheel Housing
   1) Carefully wipe any foreign material from the cylinder body rear face.
   2) Apply the recommended liquid gasket (Three Bond 1207C) or its equivalent to the shaded areas shown in the illustration.


N6A0180E

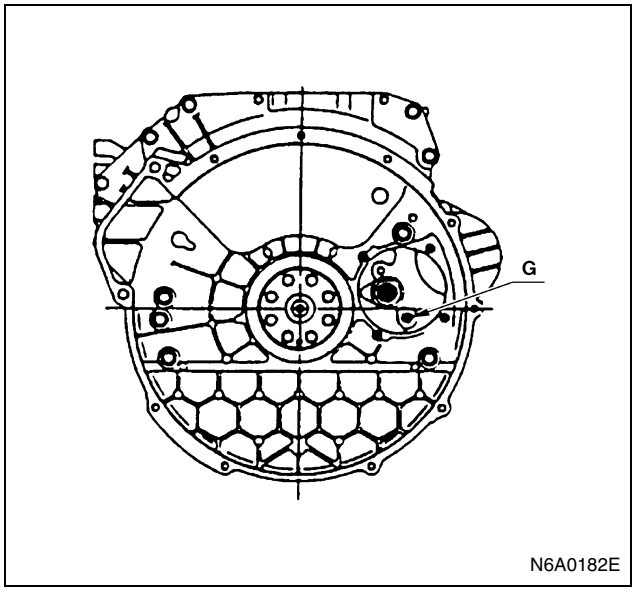
3) Align the cylinder body knock pins with the flywheel housing knock pin holes.
4) Tighten the flywheel housing bolts to the specified torque shown in the illustration.

Tighten:
Flywheel housing bolt to
- A: 96 N·m (9.8 kg·m / 71 lb·ft)
- B: 48 N·m (4.9 kg·m / 35 lb·ft)
- C: 94 N·m (9.6 kg·m / 69 lb·ft)
- D: 25 N·m (2.6 kg·m / 19 lb·ft)
- E: 76 N·m (7.7 kg·m / 56 lb·ft)
- F: 38 N·m (3.9 kg·m / 28 lb·ft)
    - Tighten the bolts marked with “E” or “B” from the injection pump side, and those with “F” from the cylinder body side.



N6A0181E

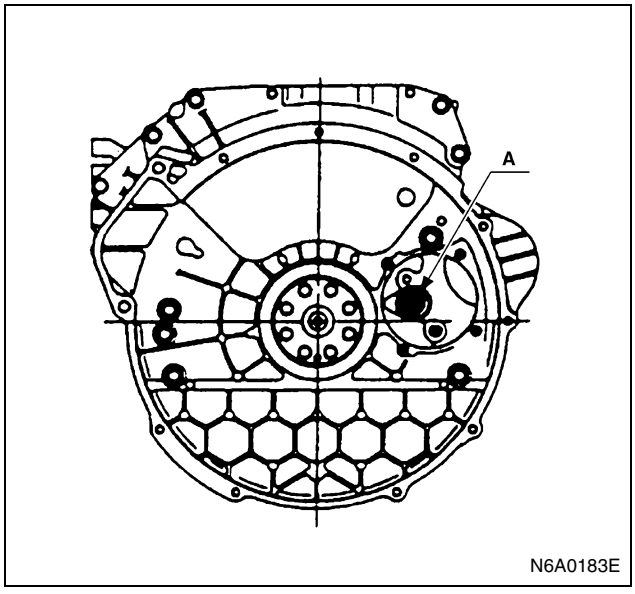
Tighten:
Flywheel housing bolt (G) to 96 N·m (9.8 kg·m / 71 lb·ft)



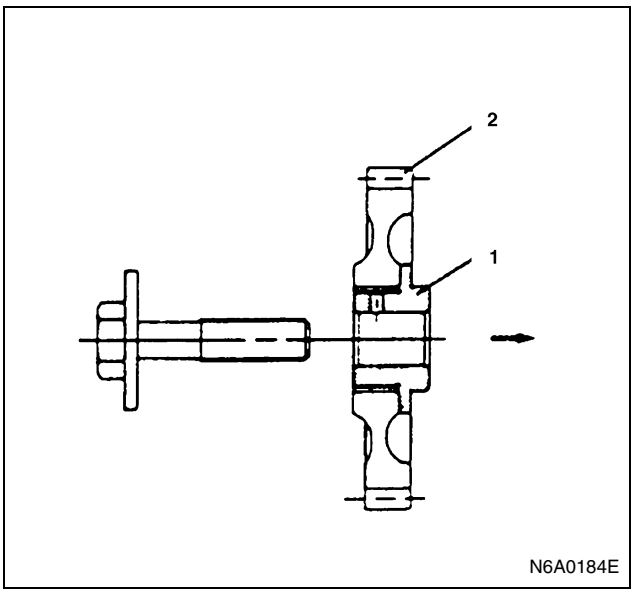
N6A0182E

10. Power Steering Pump Idle Gear
    1) Apply the engine oil to the idle gear shaft.
    2) Install the idle gear shaft (1) with the idle gear (2) to the cylinder body “A” portion as shown in the illustration.

Tighten:
Idle gear shaft bolt to 133 N·m (13.6 kg·m / 98 lb·ft)

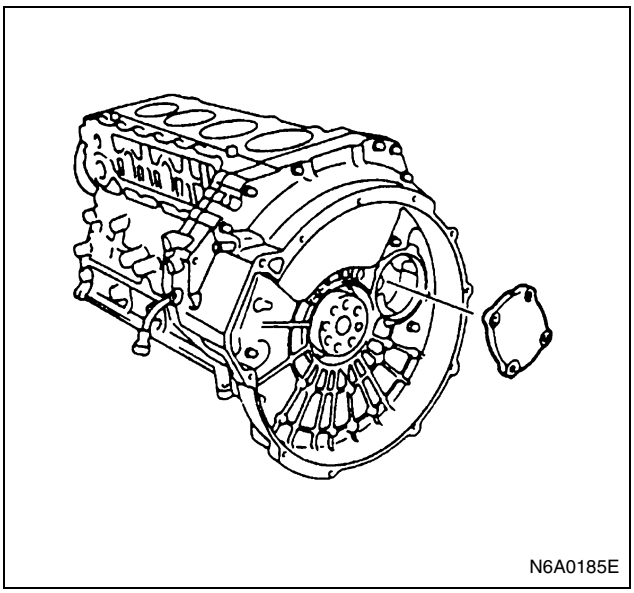


N6A0183E



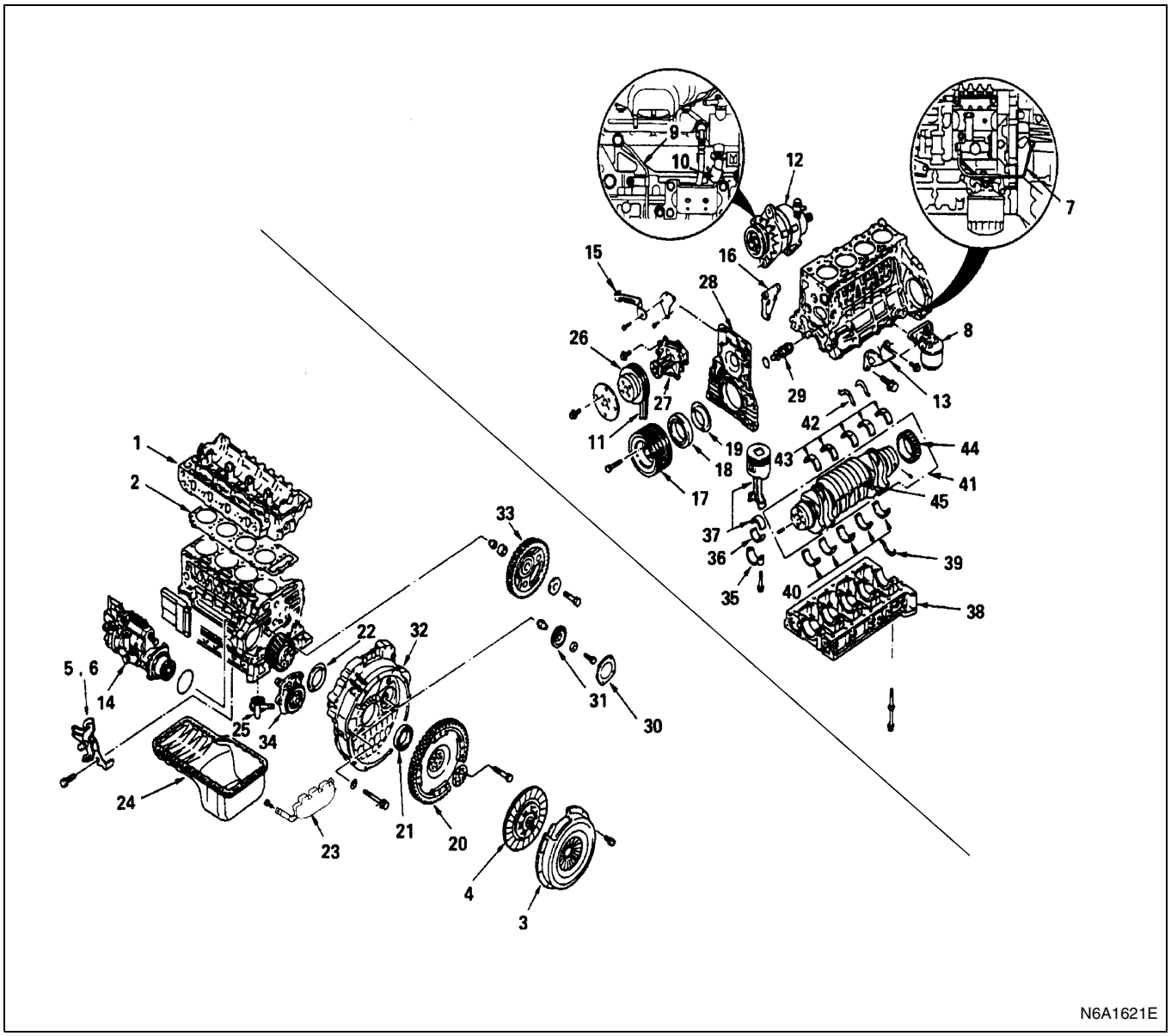
11. Power Steering Pump Idle Gear Cover
    Install the gear cover with the O-ring.

Tighten:
Gear cover bolt to 19 N·m (1.9 kg·m / 14 lb·ft)



CRANKSHAFT

Component



Legend

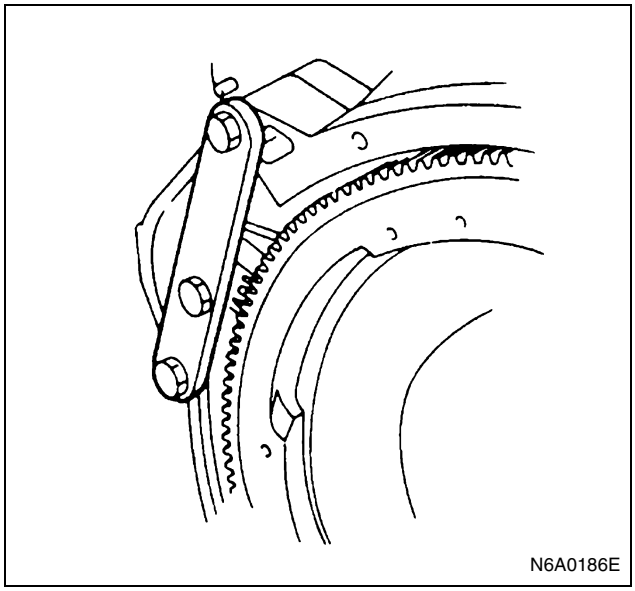
1. Cylinder head assembly
2. Cylinder head gasket
3. Clutch pressure plate assembly
4. Driven plate
5. Engine control wire
6. Engine control lever assembly
7. Oil pipe
8. Oil filter assembly
9. Vacuum pump oil pipe
10. Vacuum pump rubber hose
11. Fan belt
12. Generator
13. Engine foot
14. Injection pump assembly
15. Fan belt adjust plate
16. Generator bracket
17. Crankshaft damper pulley
18. Crankshaft front oil seal
19. Crankshaft front slinger
20. Flywheel
21. Crankshaft rear oil seal
22. Crankshaft rear slinger
23. Spacer rubber
24. Oil pan
25. Oil pump strainer
26. Water pump pulley
27. Water pump
28. Front retainer
29. Oil thermo valve
30. Power steering pump idle gear cover
31. Power steering pump idle gear
32. Flywheel housing
33. Idle gear A
34. Oil pump assembly
35. Connecting rod cap assembly
36. Connecting rod lower bearing
37. Piston and connecting rod assembly
38. Crankcase
39. Thrust bearing lower
40. Crankshaft bearing lower
41. Crankshaft assembly
42. Thrust bearing upper
43. Crankshaft bearing upper
44. Crankshaft gear
45. Crankshaft

Disassembly

1. Cylinder Head Assembly
   Above works refer to “CYLINDER HEAD” section in this manual.
2. Cylinder Head Gasket

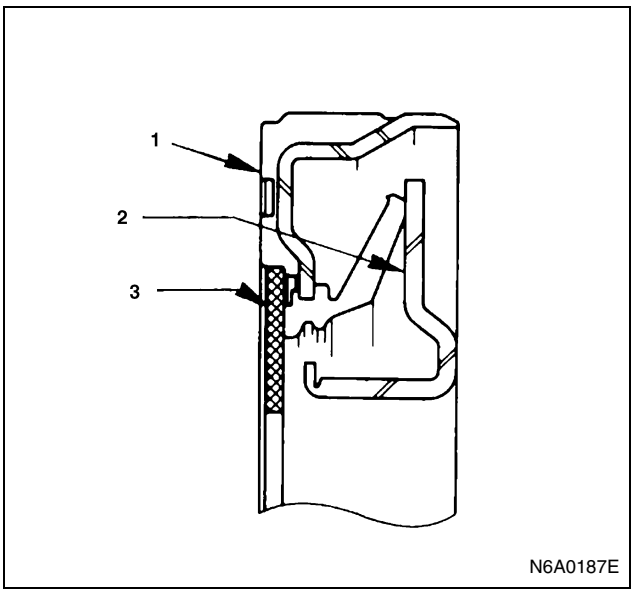
Caution:
Do not reuse the cylinder head gasket.

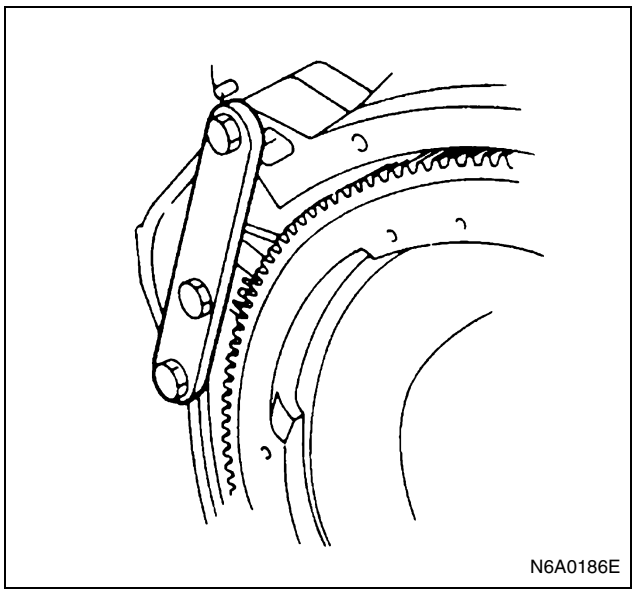
3. Clutch Pressure Plate Assembly
4. Driven Plate
5. Engine Control Wire
6. Engine Control Lever Assembly
7. Oil Pipe
8. Oil Filter Assembly
9. Vacuum Pump Oil Pipe
10. Vacuum Pump Rubber Hose
11. Fan Belt
12. Generator
13. Engine Foot
14. Injection Pump Assembly
15. Fan Belt Adjust Plate
16. Generator Bracket
    Above works refer to “CYLINDER BLOCK” section in this manual.
17. Crankshaft Damper Pulley
    1) Use the crankshaft stopper to prevent the crankshaft from turning.
       Crankshaft Stopper: 5-8840-2230-0
    2) Loosen the damper pulley bolts and remove the damper pulley.



18. Crankshaft Front Oil Seal

Caution:
Be careful not to damage the crankshaft oil seal contact surface during the removal procedure.

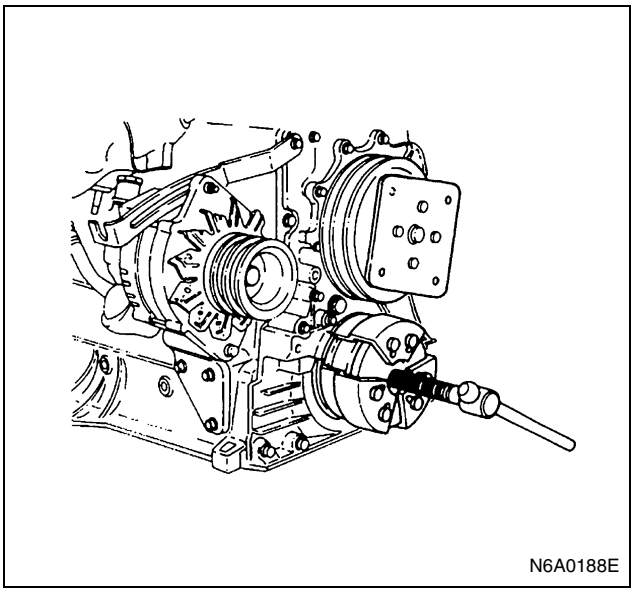




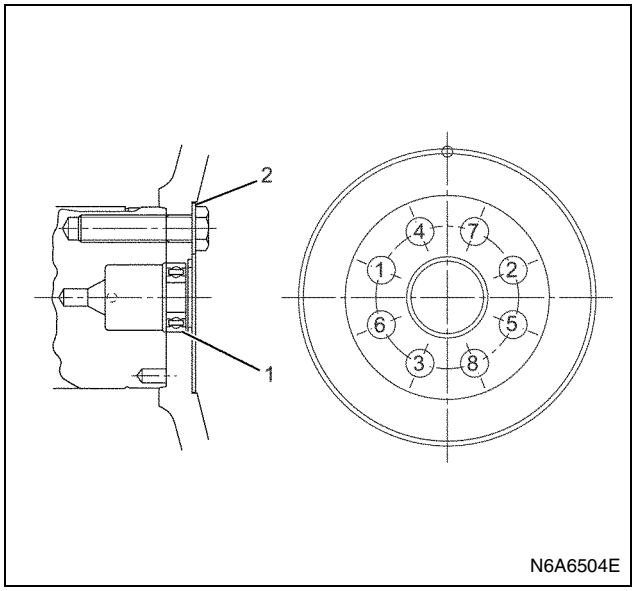
Legend
1. Oil seal
2. Slinger
3. Felt

19. Crankshaft Front Slinger
    Use the slinger puller to pull out the slinger.
    Slinger Puller: 5-8840-2360-0

Notice:
If the oil seal has been removed, both the oil seal and slinger must be replaced as a set.



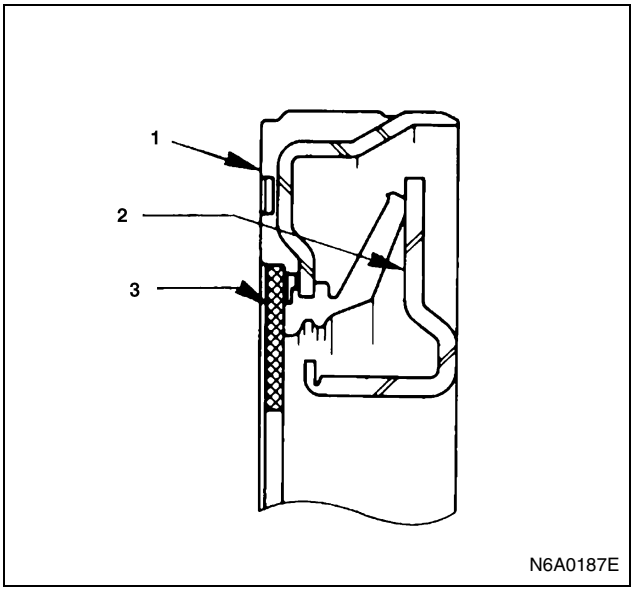
20. Flywheel Assembly
    1) Use the crankshaft stopper to prevent the crankshaft from turning
       Crankshaft Stopper: 5-8840-2230-0
    2) Loosen the flywheel bolts in numerical order a little at a time as shown in the illustration.
    3) Remove the flywheel stopper and the flywheel assembly.



Legend
1. Washer
2. Pilot bearing

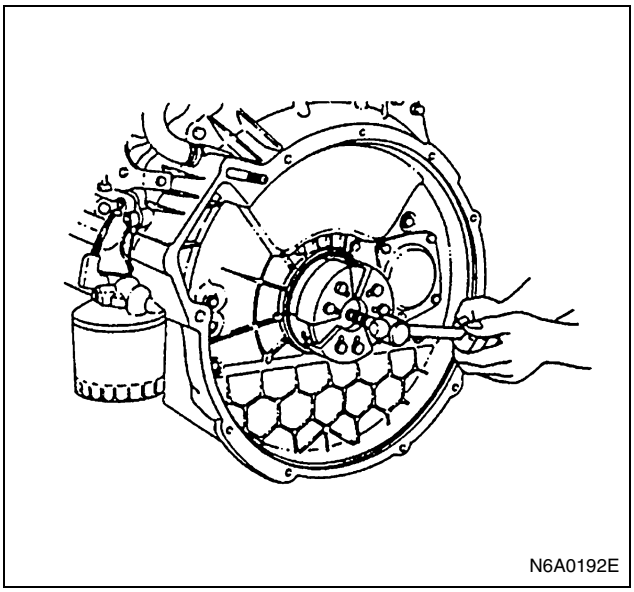
21. Crankshaft Rear Oil Seal

Caution:
Be careful not to damage the crankshaft oil seal contact surface during the removal procedure.

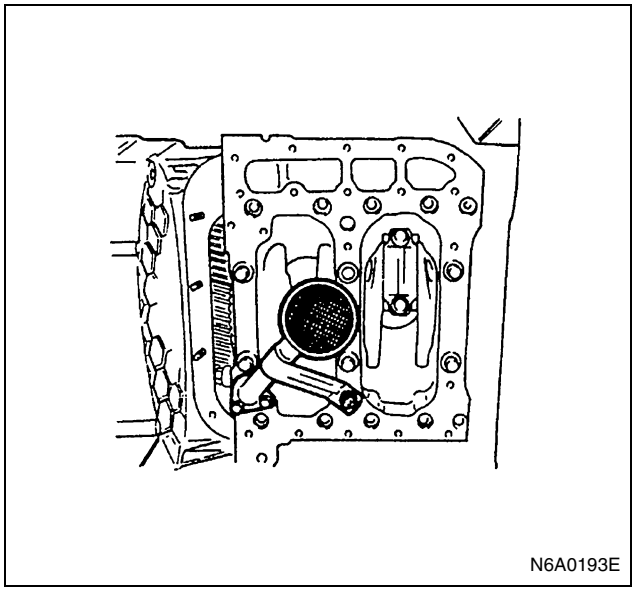


Legend
1. Oil seal
2. Slinger
3. Felt

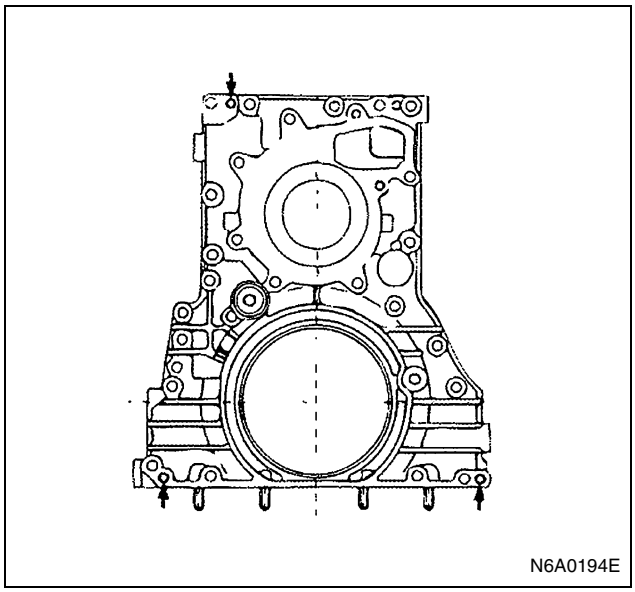
22. Crankshaft Rear Slinger
    Use the slinger puller to pull out the slinger.
    Slinger Puller: 5-8840-2360-0



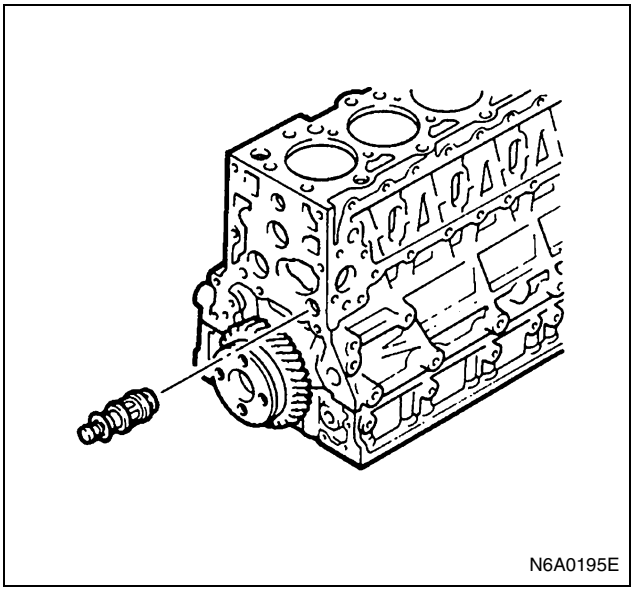
23. Spacer Rubber
24. Oil Pan
25. Oil Pump Strainer
26. Water Pump Pulley
27. Water Pump



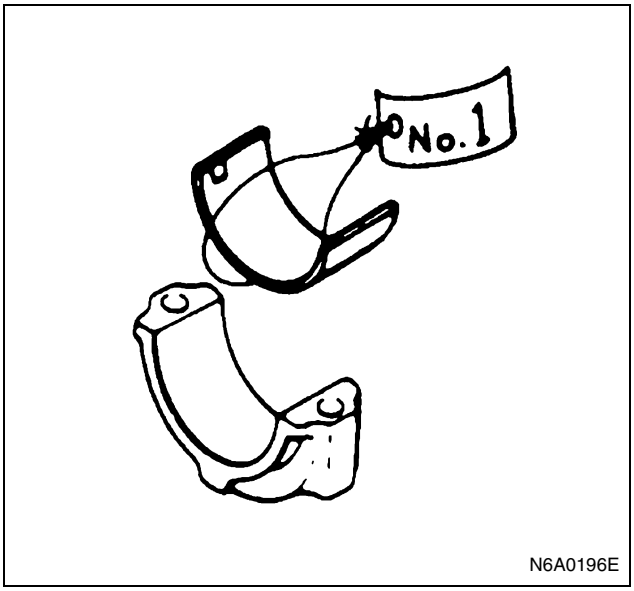
28. Front Retainer
    Install the three front retainer fixing bolts to the front retainer replacer holes as shown in the illustration, and tighten the bolts alternately a little at a time.



29. Oil Thermo Valve (4HF1, 4HF1-2, 4HG1, 4HG1-T)
    Pull out the thermo valve from the cylinder body.


N6A0195E

30. Bypass Valve (4HE1-TC)
    Pull out the bypass valve from the cylinder body.
31. Power Steering Pump Idle Gear Cover
32. Power Steering Pump Idle Gear
33. Flywheel Housing
34. Idle Gear A
35. Oil Pump Assembly
    Above works refer to “OIL PUMP” section in this manual.
36. Connecting Rod Cap Assembly
37. Connecting Rod Lower Bearing
    1) Take out the connecting rod bearing cap bolts and remove the bearing cap with the lower bearing.
    2) If the connecting rod lower bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



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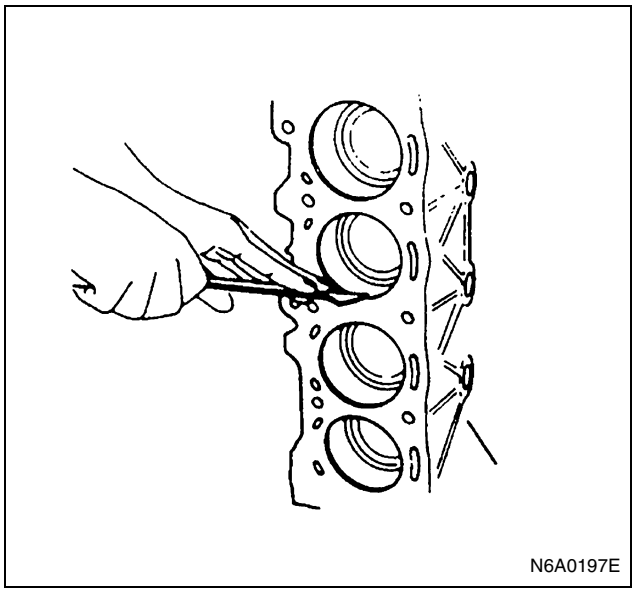
38. Piston and Connecting Rod Assembly
    1) To facilitate smooth removal of piston, remove carbon from the upper part of the cylinder wall using a scraper or equivalent.


N6A0197E

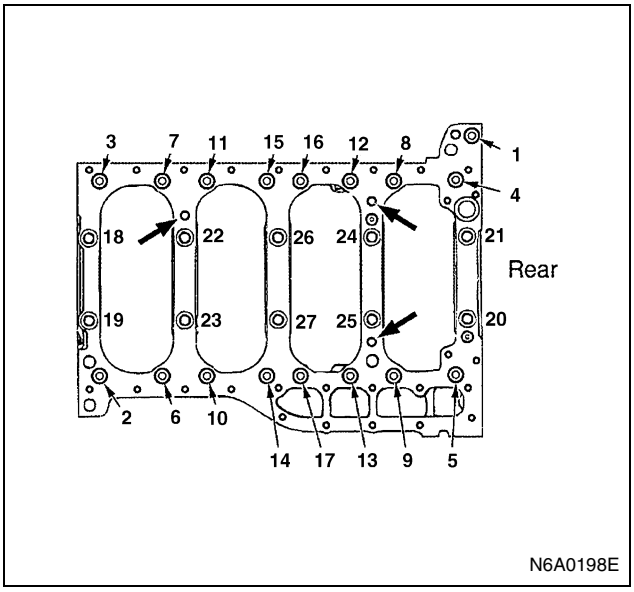
    2) Remove the piston and connecting rod assembly upward by pushing on the edge of the connecting rod with a hammer handle or equivalent.
    3) If the connecting rod bearing are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.

Caution:
Do not bend or damage the oiling jet.

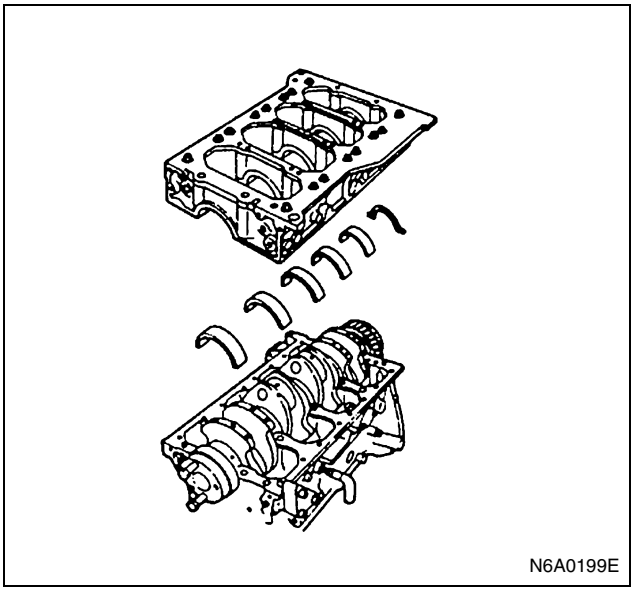
Notice:
When removing the piston and connecting rod assembly, pull the connecting rod in parallel with the cylinder bore.

39. Crankcase
    1) Loosen the crankcase bolts in numerical order a little at a time.
    2) Install the three crankcase fixing bolts (See left arrow marks) to the crankcase replacer holes as shown in the illustration, and tighten the bolts alternate a little at a time.

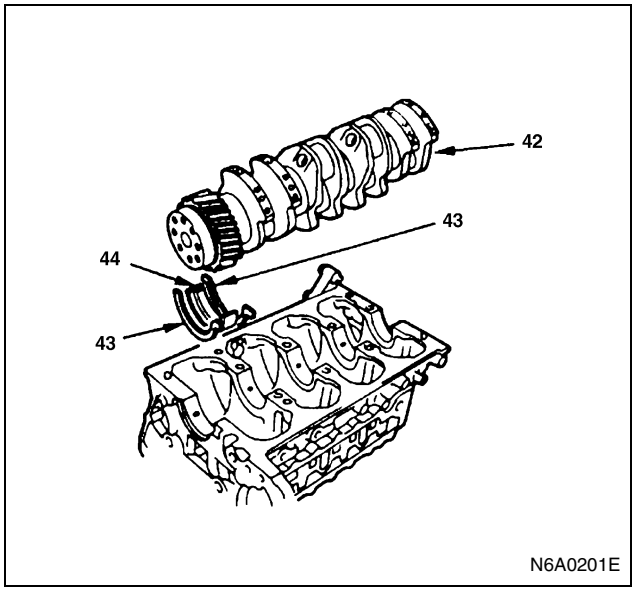
Notice:
When removing the crankcase, be sure to remove the oil pump and the generator bracket before that.



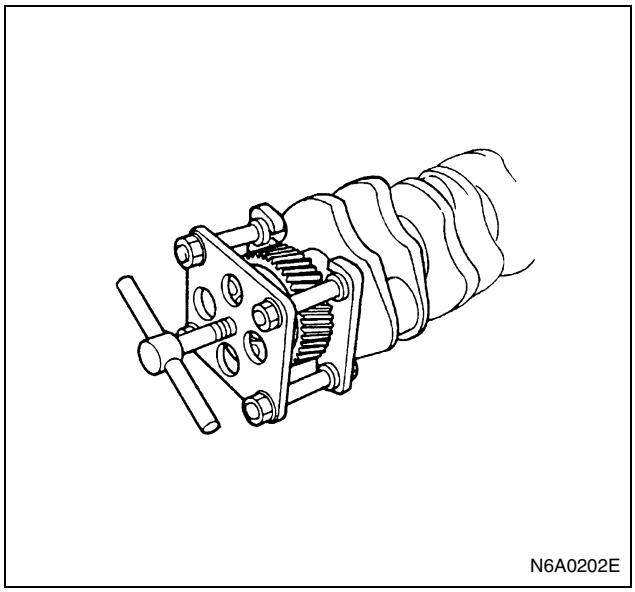
40. Thrust Bearing Lower
41. Crankshaft Bearing Lower



42. Crankshaft Assembly
43. Thrust Bearing Upper
44. Crankshaft Bearing Upper



45. Crankshaft Gear
    1) Use the crankshaft gear remover to remove the crankshaft gear.
       Crankshaft Gear Remover: 8-9439-6818-0
    2) Remove the crankshaft feather key.



46. Crankshaft

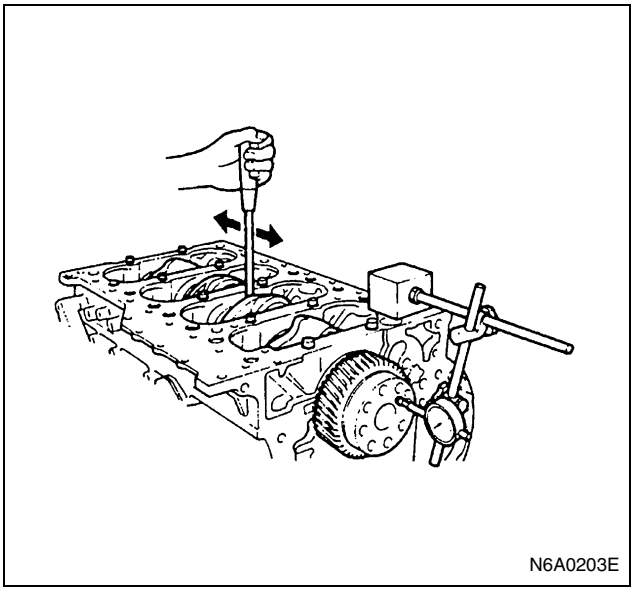
Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Crankshaft End Play

1. Set the dial indicator to the crankshaft end and measure the end play.
2. If the measured value exceeds the specified limit, the thrust bearings must be replaced.

Crankshaft End Play	mm (in)
Standard	Limit
0.104 — 0.205 (0.0041 — 0.0081)	0.35 (0.014)


N6A0203E

Crankshaft and Bearing

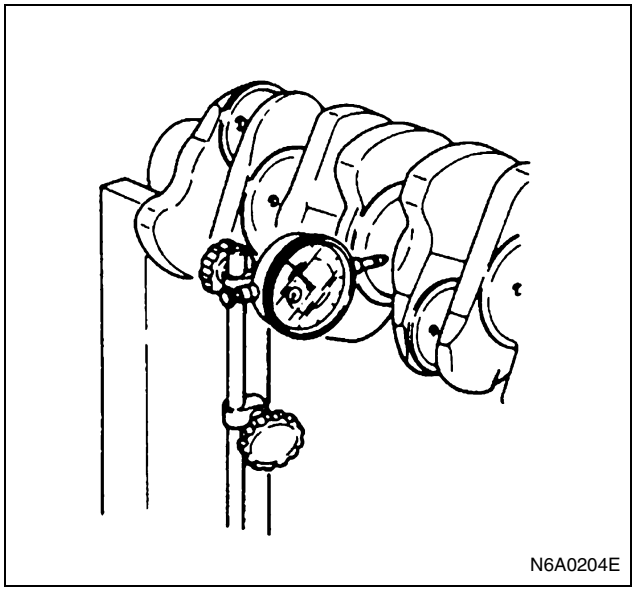
Inspect the surface of the crankshaft journals and crankpins for excessive wear and damage.
Inspect the oil seal fitting surfaces for excessive wear and damage.
Inspect the oil ports for obstructions.

Crankshaft Run-Out

1. Set a dial indicator to the center of the crankshaft journal.
2. Gently turn the crankshaft in the normal direction of rotation.

Read the dial indicator as you turn the crankshaft.
If the measured value exceeds the specified limit, the crankshaft must be replaced.

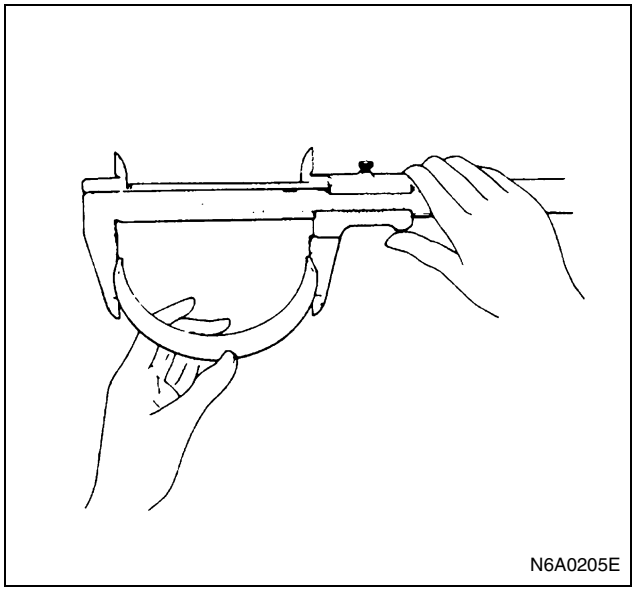
Crankshaft Run-Out	mm (in)
Standard	Limit
0.05 (0.002) or less	0.30 (0.012)


N6A0204E

Bearing Spread

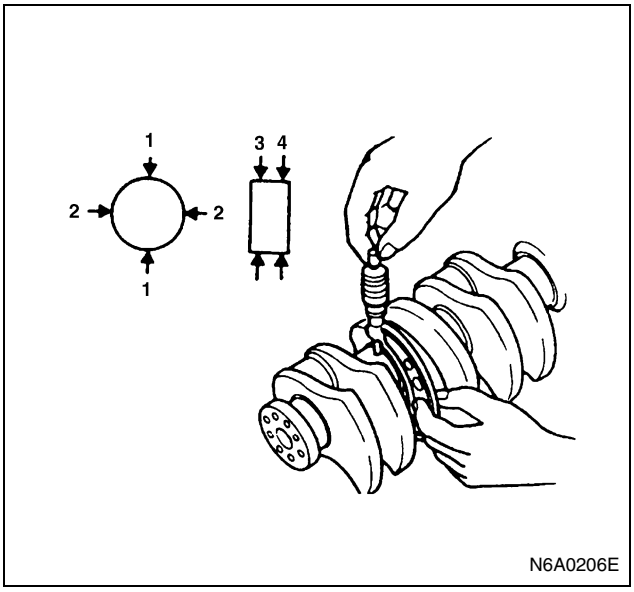
Use a vernier caliper to measure the bearing spread.
If the measured value is less than the specified limit, the bearing must be replaced.

Bearing Spread	mm (in)
Limit	87 (3.43)


N6A0205E

Crankshaft Journal and Crankpin Diameter

1. Use a micrometer to measure the crankshaft journal diameter across points (1) — (1) and (2) — (2).
2. Use the micrometer to measure the crankshaft journal diameter at the two points (3) and (4).



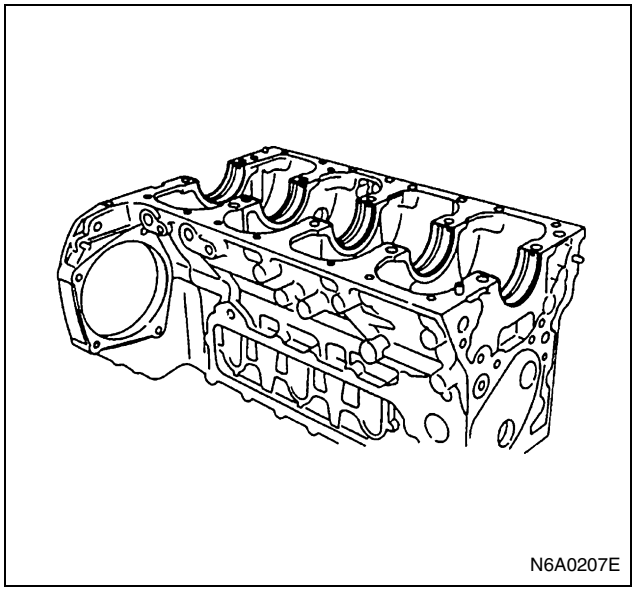
3. Repeat Steps 1 and 2 to measure the crankpin diameter.
   If the measured values are less than the limit, the crankshaft must be reground or replaced.

Crankshaft Journal and Crankpin Diameter			mm (in)
Engine model		Standard	Limit
ALL	No.1,2,4 and 5 Journal	81.905 — 81.925 (3.2246 — 3.2254)	81.85 (3.2224)
ALL	No.3 Journal	81.891 — 81.911 (3.2240 — 3.2248)	81.85 (3.2224)
Except 4HE1-TC	Crankpin	65.902 — 65.922 (2.5946 — 2.5954)	65.85 (2.5925)
4HE1-TC	Crankpin	72.902 — 72.922 (2.8702 — 2.8433)	72.85 (2.8681)

Crankshaft Journal and Crankpin Diameter Uneven Wear		mm (in)
Except 4HE1-TC	Limit	0.050 (0.002)
4HE1-TC		0.0050 (0.0002)

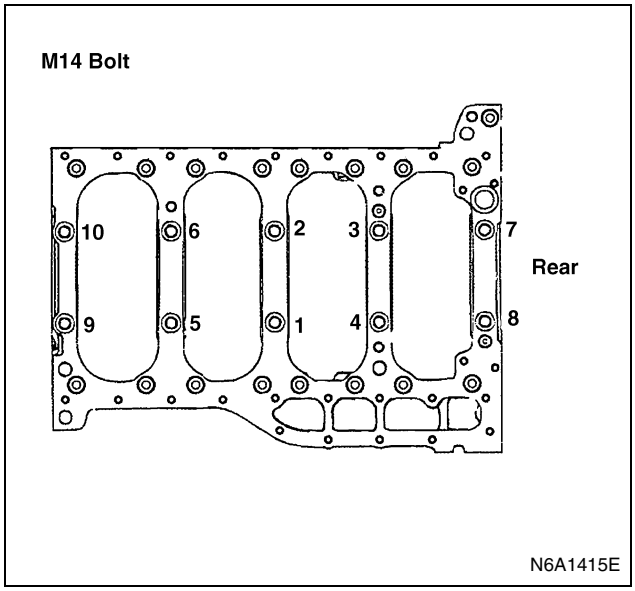
Crankshaft Journal and Bearing Clearance

1. Clean the cylinder body and crankcase, the journal bearing fitting surface, and the journal bearings.
2. Install the bearings to the cylinder body and crankcase.
3. Install the crankcase to the cylinder body.

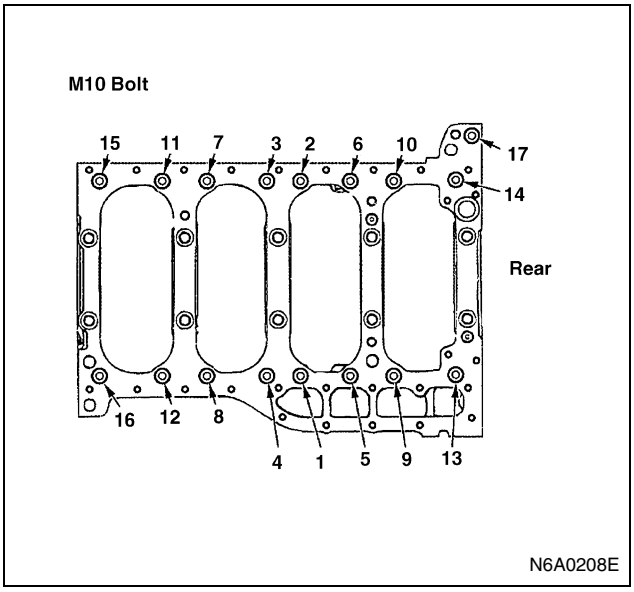


4. Tighten the crankcase to the specified torque in the numerical order shown in the illustration.

Tighten:
Crankcase bolt (M14: (1) — (10)) to
- 1st step: 98 N·m (10 kg·m / 72 lb·ft)
- 2nd step: 132 N·m (13.5 kg·m / 98 lb·ft)
- 3rd step: 30 — 60°



Tighten:
Crankcase bolt (M10: (1) — (17)) to 37 N·m (3.8 kg·m / 27 lb·ft)



5. Use a dial indicator to measure the crankshaft journal inside diameter.
6. If the clearance between the crankshaft journal and the bearing exceeds the specified limit, the crankshaft must be either reground or replaced.

Crankshaft Journal and Bearing Clearance		mm (in)
	Standard	Limit
No.1, 2, 4 and 5 Journal	0.037 — 0.072 (0.0015 — 0.0028)	0.11 (0.0043)
No.3 Journal	0.051 — 0.086 (0.0020 — 0.0034)	0.11 (0.0043)

7. Remove the crankcase and the bearings.

Undersized Crankshaft Journal Bearing Availability (Except 4HE1-TC)	mm (in)
0.25 (0.01)	0.50 (0.02)

Crankshaft Bearing Selection

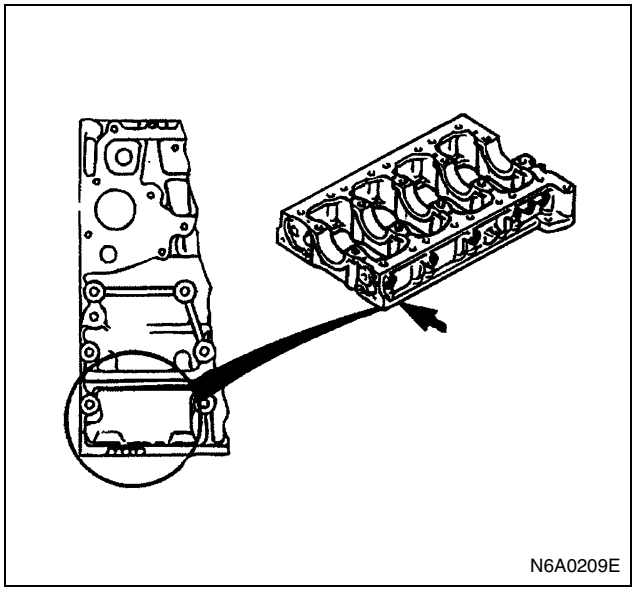
Refer to the following table when replacing the crankshaft and/or the crankshaft bearings.
Crankshaft bearing selection is based on the measured diameters of the crankshaft journals and the bearing housing.
Match the crankshaft bearing housing grade marks and the crankshaft journal grade marks in the table below to determine the correct crankshaft bearing size.

Crankshaft Bearing Insert Grade Mark Position

The crankshaft bearing housing grade marks (1 or 2) are stamped collectively for all cylinders on the underside of the left front portion of the crankcase.

Example:

1	2	1	1	2
↑	↑	↑	↑	↑
No.1 Bearing Housing	No. 2 Bearing Housing	No. 3 Bearing Housing	No. 4 Bearing Housing	No. 5 Bearing Housing

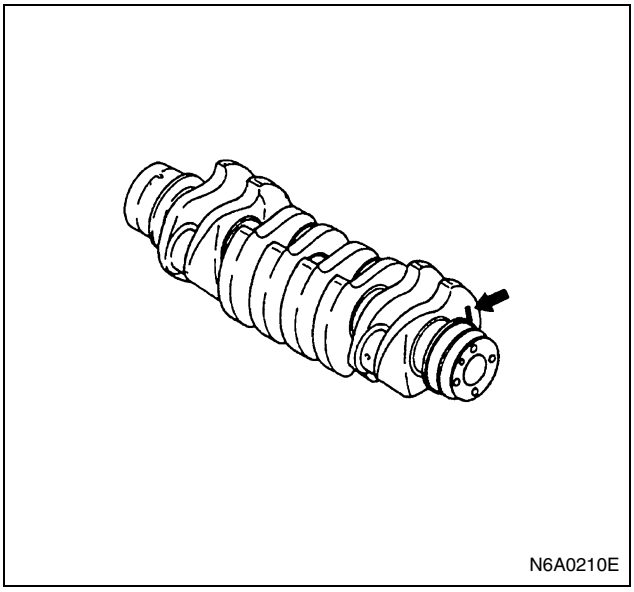


Crankshaft Journal Grade Mark Position

The crankshaft journal grade marks (1 or 2) are stamped collectively for all cylinders on the front side of the crankshaft No.1 balancer.
The clearance between the crankshaft journal and the bearing must be the same for each position after installation of the crankshaft and the crankshaft bearings.

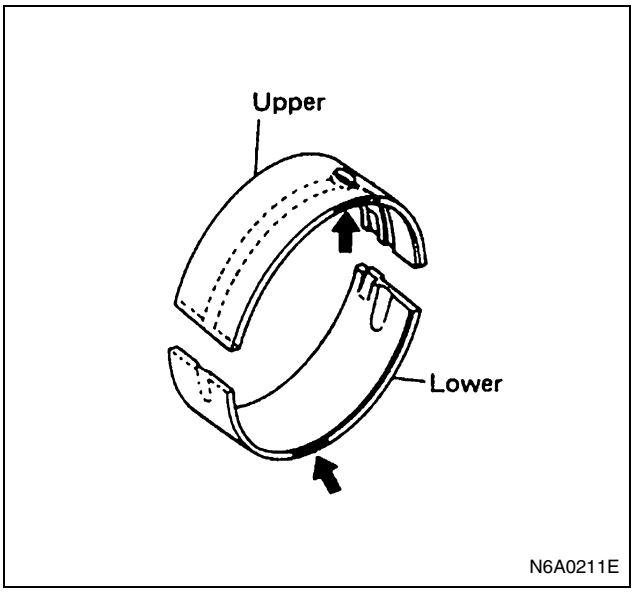
Example:

2	1	2	2	1
↑	↑	↑	↑	↑
No.1 Journal	No.2 Journal	No.3 Journal	No.4 Journal	No.5 Journal


N6A0210E

Crankshaft Bearing Combination (Reference) mm (in)

Bearing Housing		Crankshaft Journal No.1, 2, 4, 5		Crankshaft Bearing	Oil Clearance
Grade Mark	Diameter	Grade Mark	Diameter	Color Code	
1	87.000 — 87.009 (3.4252 — 3.4255)	1	81.905 — 81.915 (3.2246 — 3.2250)	Black	0.039 — 0.070 (0.0015 — 0.0028)
		2	81.916 — 81.925 (3.2250 — 3.2254)	Brown	0.037 — 0.068 (0.0015 — 0.0027)
2	87.010 — 87.019 (3.4256 — 3.4259)	1	81.905 — 81.915 (3.2246 — 3.2250)	Blue	0.041 — 0.072 (0.0016 — 0.0028)
		2	81.916 — 81.925 (3.2250 — 3.2254)	Black	0.039 — 0.070 (0.0015 — 0.0028)



N6A0211E

Crankshaft Bearing Combination (Reference)					mm (in)
Bearing Housing		Crankshaft Journal No.3		Crankshaft Bearing	Oil Clearance
Grade Mark	Diameter	Grade Mark	Diameter	Color Code	
1	87.000 — 87.009 (3.4252 — 3.4255)	1	81.890 — 81.900 (3.2240 — 3.2244)	Black	0.053 — 0.084 (0.0021 — 0.0033)
		2	81.901 — 81.910 (3.2244 — 3.2248)	Brown	0.051 — 0.082 (0.0020 — 0.0032)
2	87.010 — 87.019 (3.4256 — 3.4259)	1	81.890 — 81.900 (3.2240 — 3.2244)	Blue	0.055 — 0.086 (0.0022 — 0.0034)
		2	81.901 — 81.910 (3.2244 — 3.2248)	Black	0.053 — 0.084 (0.0021 — 0.0033)

Crankpin and Connecting Rod Bearing Clearance

1. Clean the crankshaft, the connecting rod, the bearing cap, and the bearings.
2. Install the bearing to the connecting rod and the bearing cap.
3. Apply a coat of molybdenum disulfide grease to the bearing cap bolt threads and setting faces.
4. Prevent the connecting rod from moving.
5. Tighten the bearing cap to the specified torque.

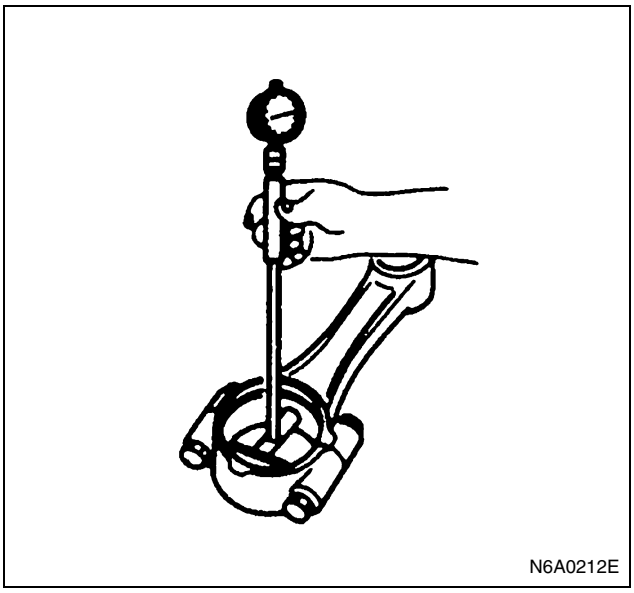
Tighten:

Connecting rod bearing cap bolt to

- 1st step: 39 N·m (4.0 kg·m / 29 lb·ft)
- 2nd step: 60°
- 3rd step: 30°

6. Use the dial indicator to measure the connecting rod bearing inside diameter.

Crankpin and Connecting Rod Bearing Clearance	mm (in)
Standard	Limit
0.036 — 0.077 (0.0014 — 0.0030)	0.10 (0.004)



N6A0212E

7. If the clearance between the measured bearing inside diameter and the crankpin exceeds the specified limit, the bearing and/or the crankshaft must be replace or reground. (Except 4HE1-TC)
8. Remove the bearing cap and the bearings.

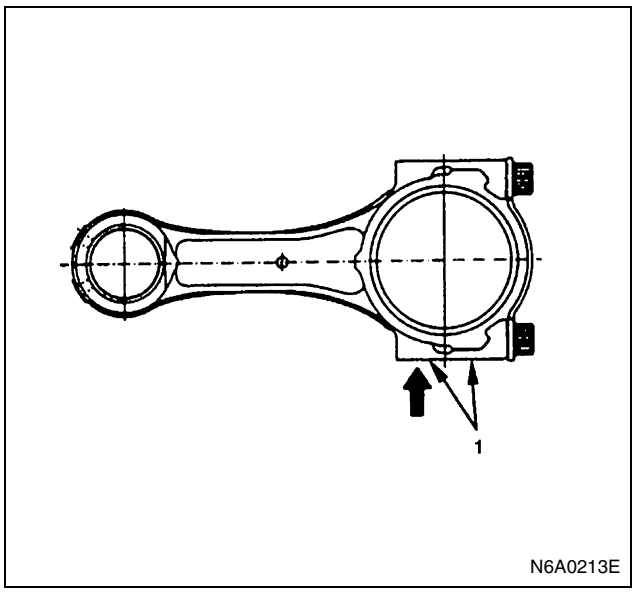
Undersized Connecting Rod Bearing Availability	mm (in)
0.25 (0.01)	0.50 (0.02)

Connecting Rod Bearing Selection

Refer to the following table when installing or replacing the connecting rod bearings.

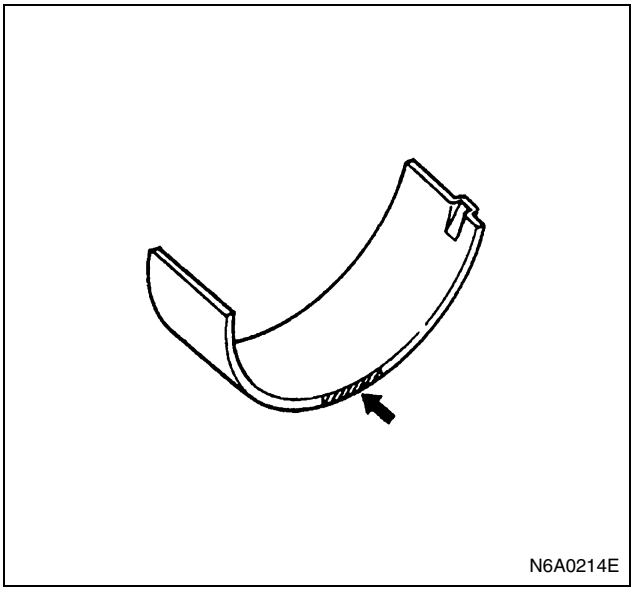
Pay close attention to the size mark on the big end of the connecting rod.

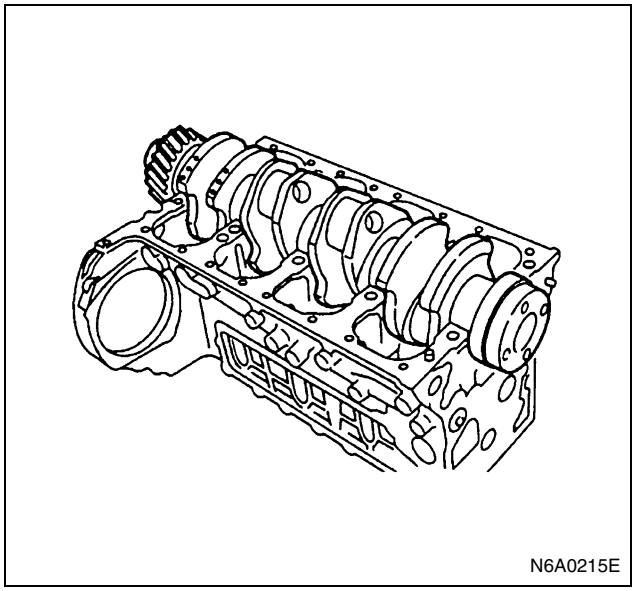
Do not confuse the size mark on the big end of connecting rod with the alignment cylinder No. (1) mark.



N6A0213E

Connecting Rod Bearing Combination					mm (in)
Engine Model	Connecting Rod Big End		Crankpin	Connecting Rod Bearing	Oil Clearance
	Grade Mark	Diameter	Diameter	Color Code	
4HF1 4HF1-2 4HG1 4HG1-T	A	69.985 — 69.992 (2.7553 — 2.7556)	65.902 — 65.992 (2.5946 — 2.5954)	Green	0.036 — 0.077 (0.0014 — 0.0030)
	B	69.993 — 70.000 (2.7556 — 2.7559)	65.902 — 65.922 (2.5946 — 2.5954)	Yellow	0.036 — 0.070 (0.0014 - 0.0030)
4HE1-TC	A	77.985 — 77.992 (3.0703 — 3.0705)	72.902 — 72.922 (2.8702 — 2.8709)	Green	0.037 — 0.077 (0.0015 — 0.0030)
	B	77.993 — 78.000 (3.0706 — 3.0709)		Yellow	

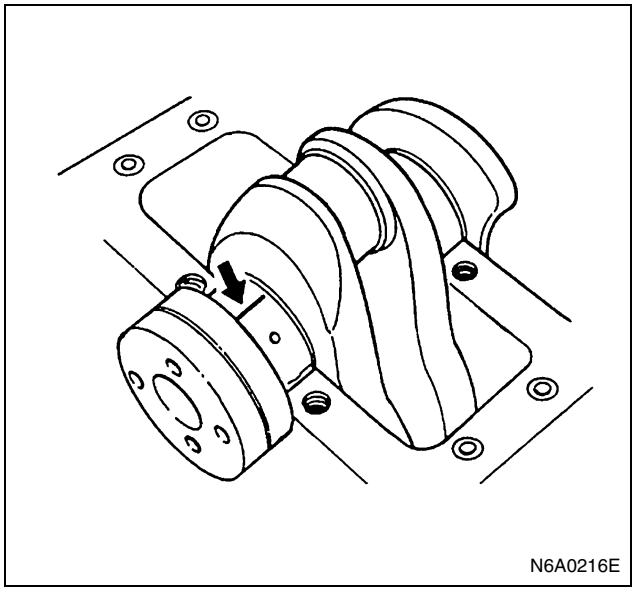




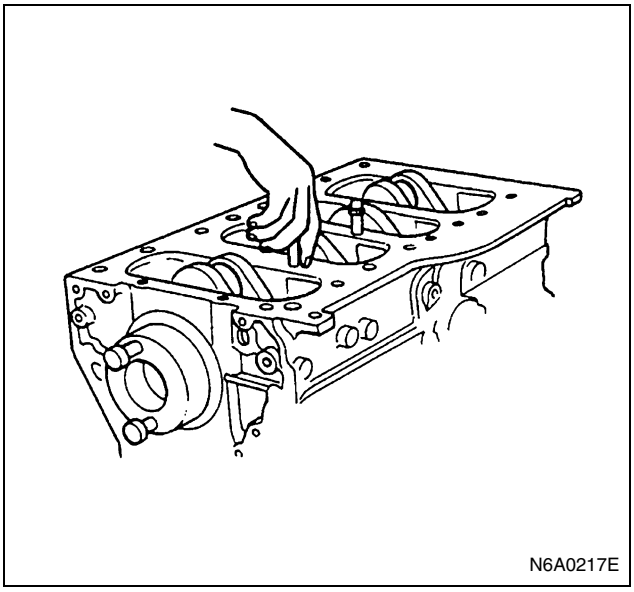
Clearance Measurements (With Plastigage)

Crankshaft Journal and Bearing Clearance

1. Clean the cylinder body and crankcase, the journal bearing fitting surface, and the journal bearings.
2. Install the bearings to the cylinder body and crankcase.
3. Carefully place the crankshaft on the bearings.
4. Rotate the crankshaft approximately 30 degrees to seat the bearing.
5. Place the Plastigage (arrow) over the crankshaft journal across the full width of the bearing.

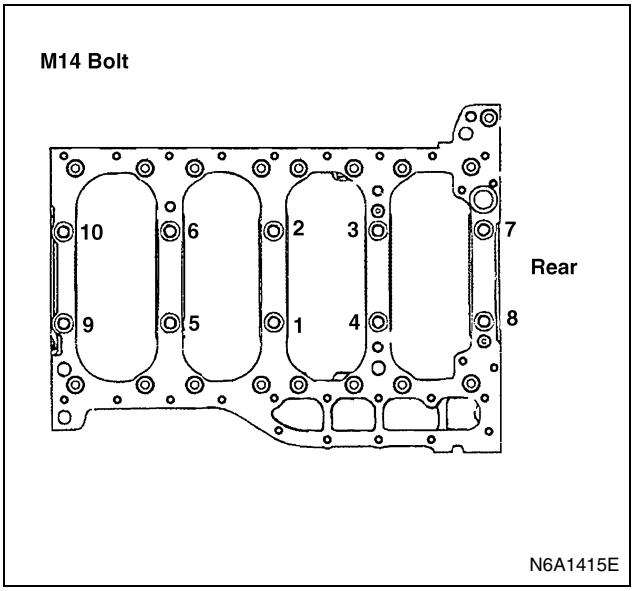


6. Install the crankcase to the cylinder body.


N6A0217E

7. Tighten the crankcase to the specified torque in the numerical order shown in the illustration.

Tighten:
Crankcase bolt (M14: (1) — (10)) to
- 1st step: 98 N·m (10 kg·m / 72 lb·ft)
- 2nd step: 132 N·m (13.5 kg·m / 98 lb·ft)
- 3rd step: 30 — 60°



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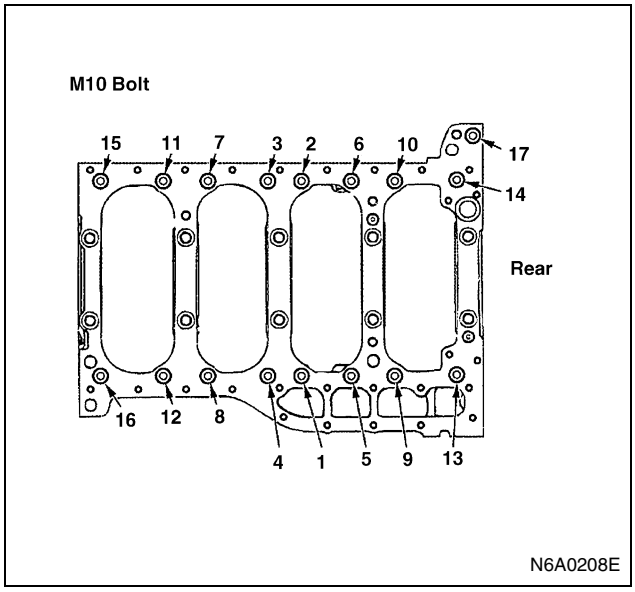
Tighten:
Crankcase bolt (M10: (1) — (17)) to 3.9±0.7 N·m (28±5 kg·m / 38±7 lb·ft)

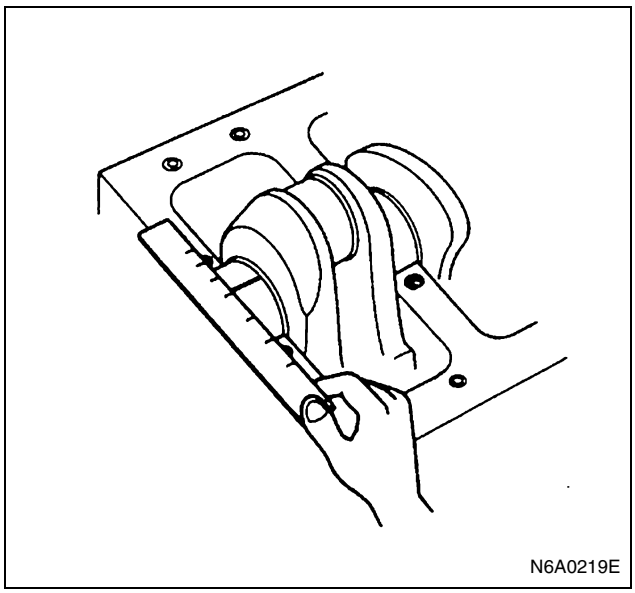


N6A0208E

Do not allow the crankshaft to turn during bearing cap installation and tightening.

8. Remove the bearing beam and the crankcase with bearings.
9. Compare the width of the Plastigage attached to either the crankshaft or the bearing with the scale printed on the Plastigage container.

Crankshaft Journal and Bearing Clearance		mm (in)
	Standard	Limit
No.1, 2, 4 and 5 Journal	0.037 — 0.072 (0.0015 — 0.0028)	0.11 (0.0043)
No.3 Journal	0.051 — 0.086 (0.0020 — 0.0034)	0.11 (0.0043)


N6A0219E

10. If the measured value exceeds the limit, perform the following additional steps.

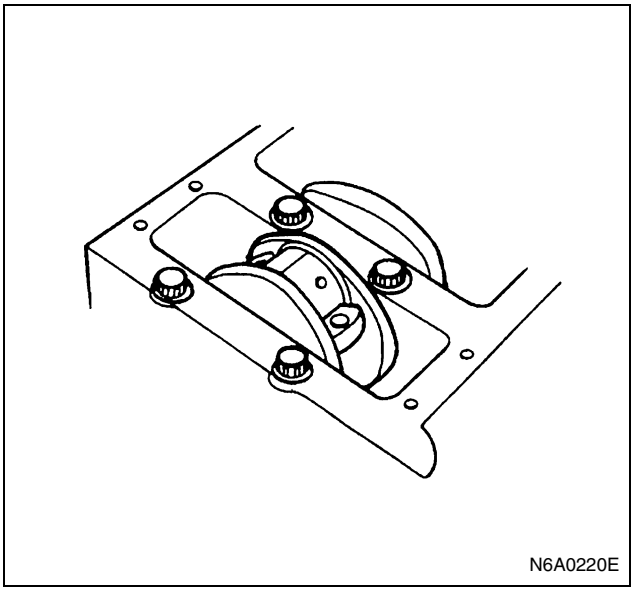
- Use a micrometer to measure the crankshaft outside diameter.
- Use an inside dial indicator to measure the bearing inside diameter.
  If the crankshaft journal and bearing clearance exceeds the limit, the crankshaft and/or the bearing must be reground (Except 4HE1-TC) or replaced.

Undersized Crankshaft Journal Bearing Availability (Except 4HE1-TC)	mm (in)
0.25 (0.01)	0.50 (0.02)

11. Remove the crankshaft and bearings.

Crankpin and Connecting Rod Bearing Clearance

1. Clean the crankshaft, the connecting rod, the bearing cap, and the bearings.
2. Install the bearing to the connecting rod and the bearing cap.
   Do not allow the crankshaft to move when installing the bearing cap.
3. Prevent the connecting rod from moving.
4. Attach the Plastigate to the crankpin.
   Apply engine oil to the Plastigate to keep it from falling.


N6A0220E

5. Apply a coat of molybdenum disulfide grease to the bearing cap bolt threads and setting faces.
6. Install the bearing cap and tighten it to the specified torque.
   Do not allow the connecting rod to move when installing and tightening the bearing cap.

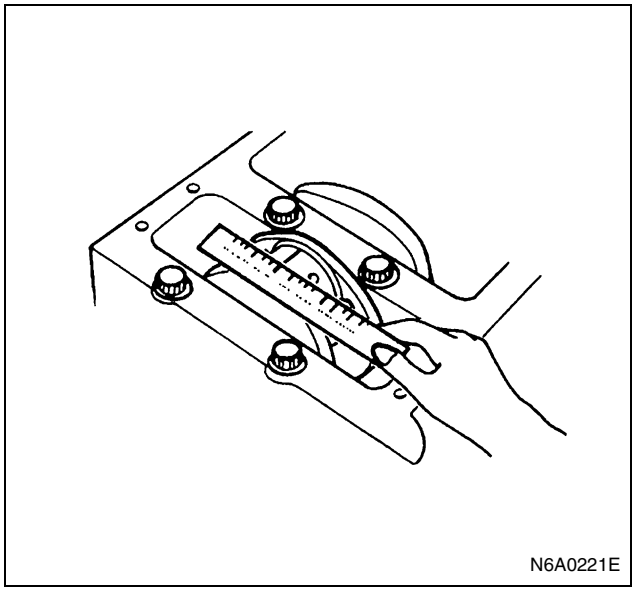
Tighten:

Connecting rod bearing cap bolt to

- 1st step: 39 N·m (4.0 kg·m / 29 lb·ft)
- 2nd step: 60°
- 3rd step: 30°

7. Remove the bearing cap.
8. Compare the width of the Plastigate attached to either the crankshaft or the bearing against the scale printed on the Plastigage container.

Crankpin and Connecting Rod Bearing Clearance	mm (in)
Standard	Limit
0.036 — 0.077 (0.0014 — 0.0030)	0.10 (0.004)


N6A0221E

9. If the measured value exceeds the specified limit, perform the following additional steps.
   - Use a micrometer to measure the crankpin outside diameter.
   - Use an inside dial indicator to measure the bearing inside diameter.
     If the clearance between the crankpin and the bearing exceeds the specified limit, the crankshaft and / or the bearing must be reground (except 4HE1-TC) or replaced.

Undersized Connecting Rod Bearing Availability (Except 4HE1-TC)	mm (in)
0.25 (0.01)	0.50 (0.02)

Crankshaft Regrinding (Except 4HE1-TC)

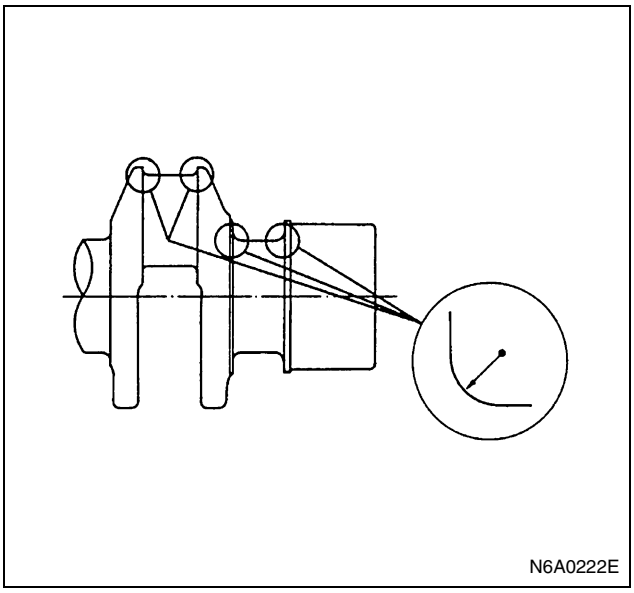
To ensure crankshaft reliability, pay close attention to the following items during and after the crankshaft journal and crankpin regrinding procedure.

Undersized Bearing Availability	mm (in)
0.25 (0.01)	0.50 (0.02)

Crankshaft Journal and Crankpin Grinding Limit (Reference)		mm (in)
Journal	No.1, 2, 4, 5	81.405 (3.2049)
	No.3	81.390 (3.2043)
Crankpin		65.402 (2.5749)

Crankshaft Regrinding Procedure (Except 4HE1-TC)

1. Regrind the crankshaft journals and the crankpins.
2. Fillet the crankshaft journals and the crankpin radiuses to a minimum of R 4.8±0.2 mm (0.189±0.0078 in).
   There must be no stepping around the fillet area.



3. Finish the crankshaft journals, the crankpins, and the oil port corners to a smooth surface having a chamfer radius of 1 mm (0.04 in).

Crankshaft Journal and Crankpin Roughness
0.4 μm or less

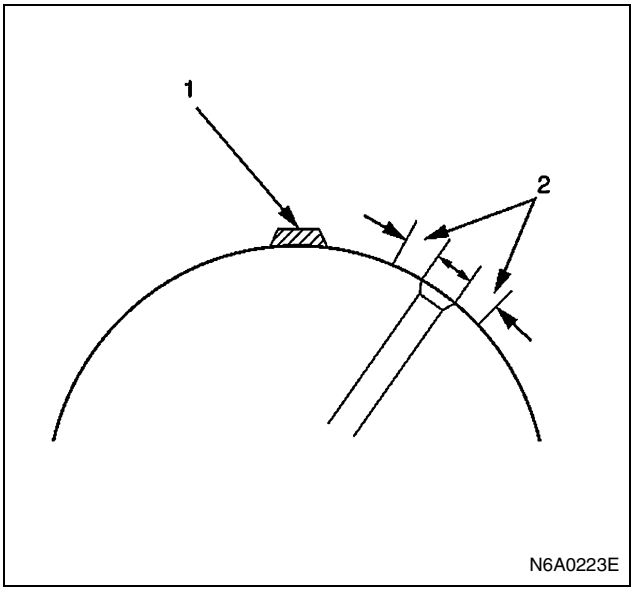
4. Check the crankshaft journal and crankpin clearance.
   Refer to the “Crankshaft Journal and Bearing Clearance” and “Crankpin and Connecting Rod Bearing Clearance”.
5. Check the crankshaft run-out.
   Refer to the “Crankshaft Run-Out”.

Caution:
The crankshaft for 4HE1-TC is applied soft nitrided surface (Taftriding). Therefore, the crankshaft for 4HE1-TC not could be ground.

Inspection Procedure for Soft Nitrided (Taftriding) Crankshaft (For 4HE1-TC)

1. Inspect the crankshaft following points.
   - Excessive wear and damage on the surface of crankshaft journals.
   - Excessive wear and damage on the surface of crankpin.
   - Excessive wear and damage on the oil seal fitting surface.
   - Inspect the oil ports foe obstructions.
2. Inspect the crankshaft soft nitrided surface (Taftriding). The soft nitrided crankshaft has been applied to increase crankshaft strength.
   Because of this, it is not possible to regrind the crankshaft surfaces.
   1) Inspection conditions.
      - Remove the oil and other material on the crankshaft inspection area.
      - The portion to be tested must be held horizontally so as not let the test solution flow.
      - Test liquid should not be applied to the approximately 10 mm (0.39 in) area around the oil port (2).
   2) Inspection method
      - Use an organic cleaner to thoroughly clean the crankshaft. There must be no traces of oil the surfaces to be inspected.
      - Prepare a 5 — 10 percent solution of ammonium cupric chloride (dissolved in distilled water).
      - Use a syringe to apply the solution (1) to the surface to be inspected. Hold the surface to be inspected perfectly horizontal to prevent the solution from running.
   3) Judgement
      - Wait for thirty to forty seconds. If there is no discoloration after thirty to forty seconds, the crankshaft is usable. If discoloration appears (the surface being tested will become the color copper), the crankshaft must be replaced.
      - Steam clean the crankshaft surface immediately after completing the inspection.

Notice:
The ammonium cupric chloride solution is highly corrosive. Because of this, it is imperative that the surfaces being inspected be cleaned immediately after completing the inspection.

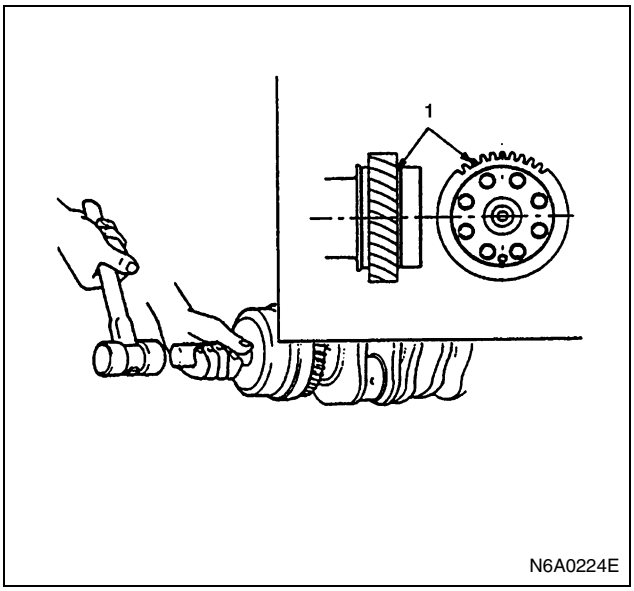


Reassembly

1. Crankshaft
2. Crankshaft Gear
   1) Use a piston heater to heat the crankshaft gear to 170 — 250°C (338 — 482°F).
   2) With the alignment mark “S” on the side of the crankshaft gear turned outward, align the groove on the gear side with the crankshaft pin position and hammer it in with a crankshaft gear installer until it hits the bottom.

Caution:
When hammered in with the gear slanted, the crankshaft gear may be caught in the middle and cannot be hammered in fully. Hammer it inquickly enough not to allow a shaft line along the gear and the crankshaft to slant.

Crankshaft Gear Installer: 8-9439-6819-0

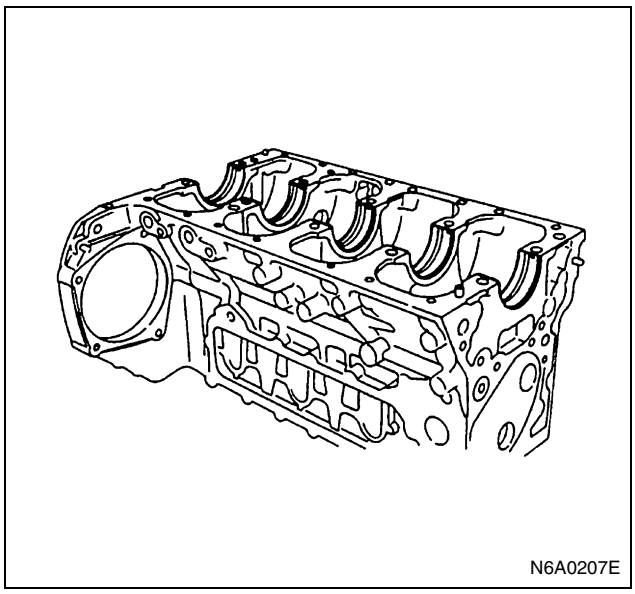


Legend
1. Alignment mark

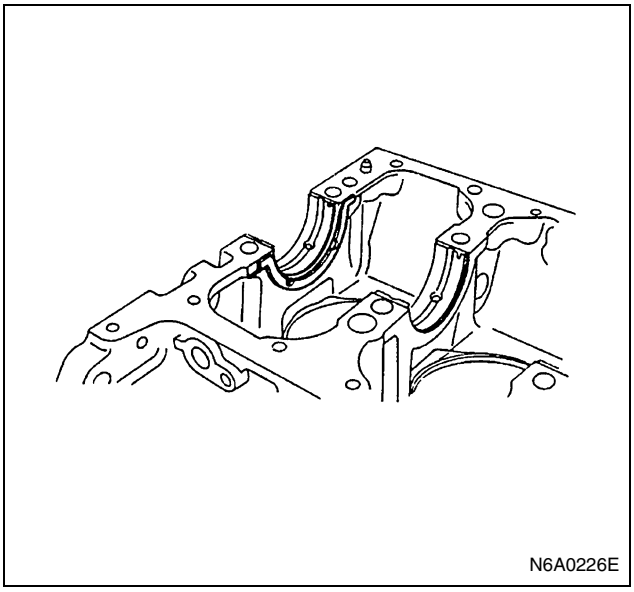
3. Crankshaft Bearing Upper
   When replacing the crankshaft or the crankshaft bearing with a new one, select the crankshaft bearing according to the respective grades stamped on the crankshaft and the cylinder body.
   Above works refer to “CRANKSHAFT” section in this manual.
   All upper bearings have oil grooves.
   1) Carefully wipe any foreign material from the upper bearing.

Caution:
Do not apply engine oil to the bearing back faces and the cylinder body bearing fitting surfaces.

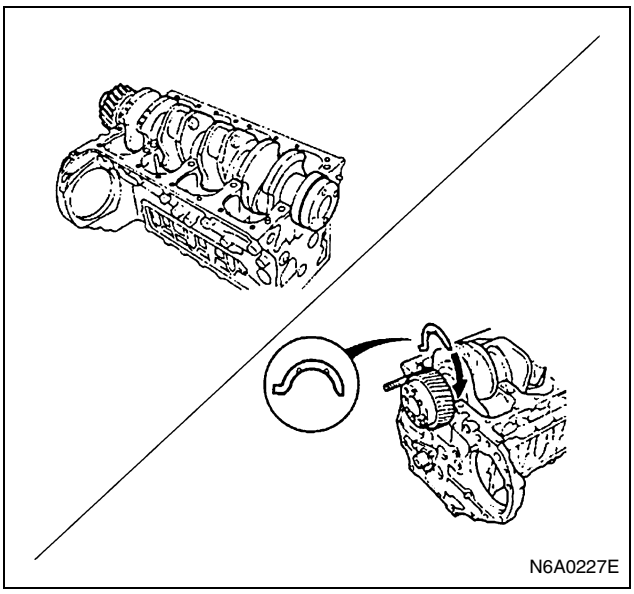
   2) Locate the position mark applied at disassembly if the removed upper bearings are to be reused.



4. Thrust Bearing Upper
   1) Install the thrust bearing upper to the front side of the cylinder body No.5 journal. At this time, the thrust bearing upper may be pasted to the cylinder body with grease. However, wipe off any excessive grease clean.
   2) The thrust bearing oil grooves must be facing the sliding faces.


N6A0226E

5. Crankshaft Assembly
   1) Apply an ample coat of the engine oil to the crankshaft journals and the crankshaft bearing surfaces before installing the crankshaft with timing gear.
   2) With the installed crankshaft pressed on to the rear side, install the thrust bearing upper to the rear side of the cylinder body No.5 journal.
   3) The thrust bearing oil grooves must be facing the sliding faces.

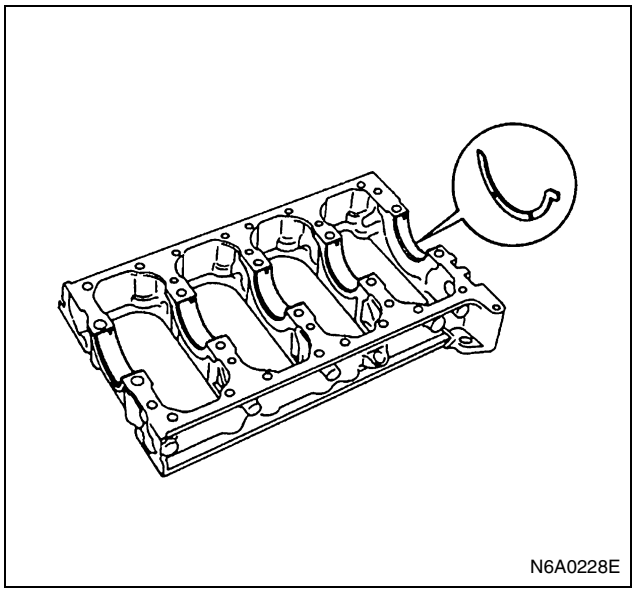

N6A0227E

6. Crankshaft Bearing Lower
   All lower bearings does not have oil grooves.
   1) Carefully wipe any foreign material from the lower bearing.

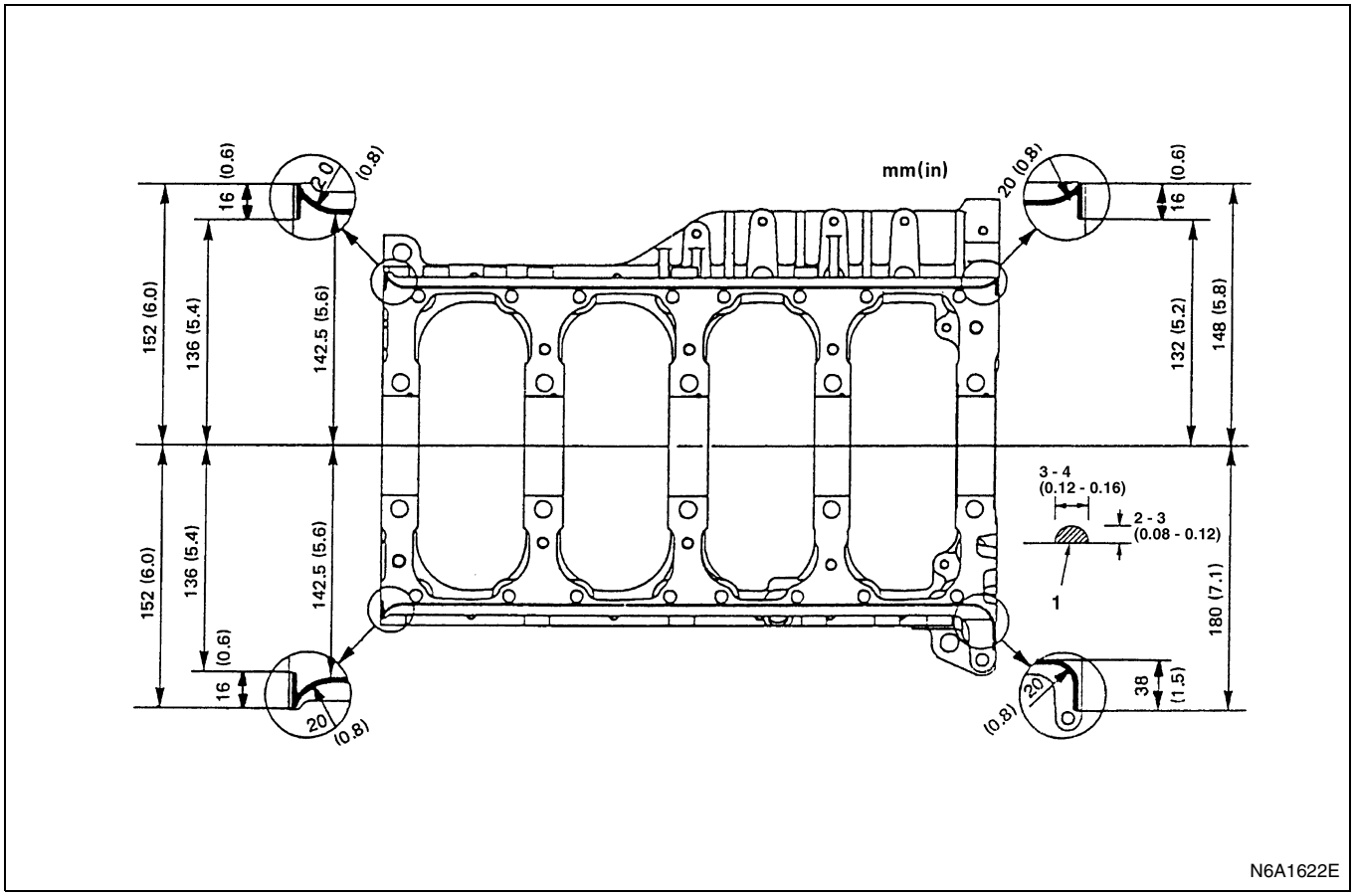
Caution:
Do not apply engine oil to the bearing back faces and the crankcase bearing fitting surfaces.

   2) Locate the position mark applied at disassembly if the removed lower bearings are to be reused.

7. Thrust Bearing Lower
   1) Install the thrust bearing lower to the rear side of the crankcase No.5 journal.
   2) The thrust bearing oil grooves must be facing the sliding faces.


N6A0228E

8. Crankcase
   1) Apply a 3 mm (0.12 in) bead of recommended liquid gasket (Three Bond 1207C) or its equivalent to the crankcase upper surface as shown in the illustration.
   2) Carefully place the crankcase on the cylinder body.
   • Install the crankcase within 20 minutes after application of liquid gasket.



Legend

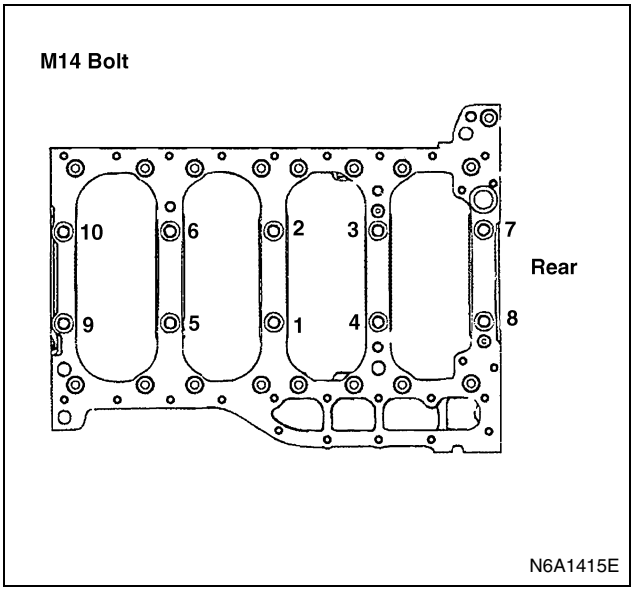
1. Liquid gasket

3) Tighten the crankcase to the specified torque in the numerical order shown in the illustration.

Tighten:

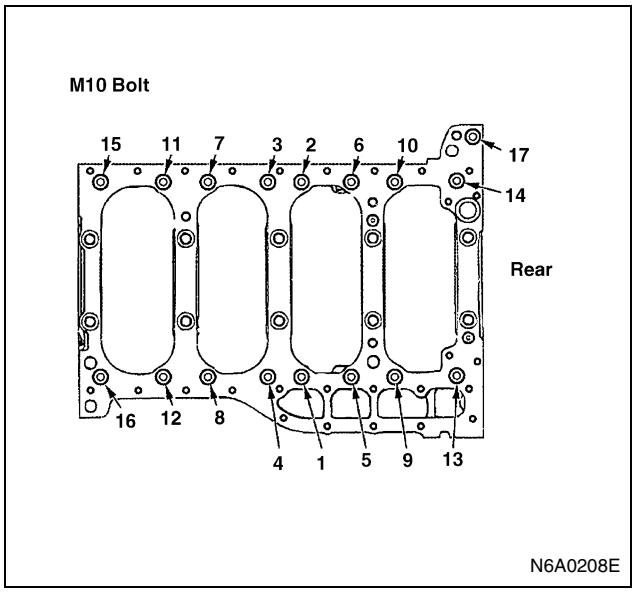
Crankcase bolt (M14: (1) — (10)) to

- 1st step: 98 N·m (10 kg·m / 72 lb·ft)
- 2nd step: 132 N·m (13.5 kg·m / 98 lb·ft)
- 3rd step: 30 — 60°



Tighten:

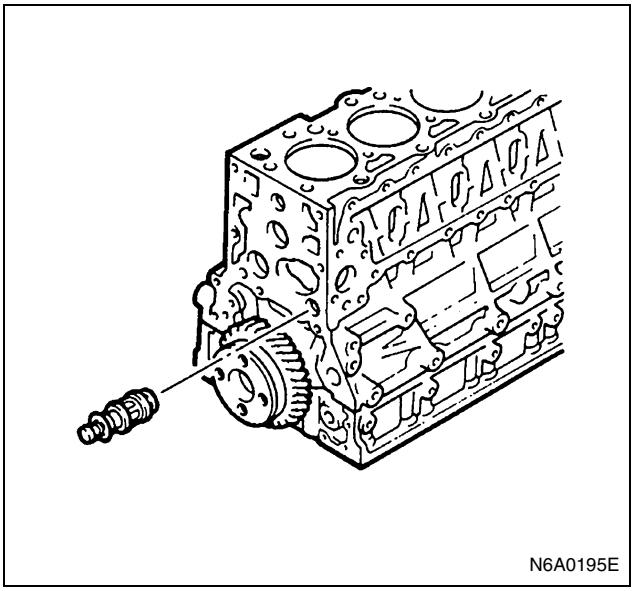
Crankcase bolt (M10: (1) — (17)) to 37 N·m (3.8 kg·m / 27 lb·ft)



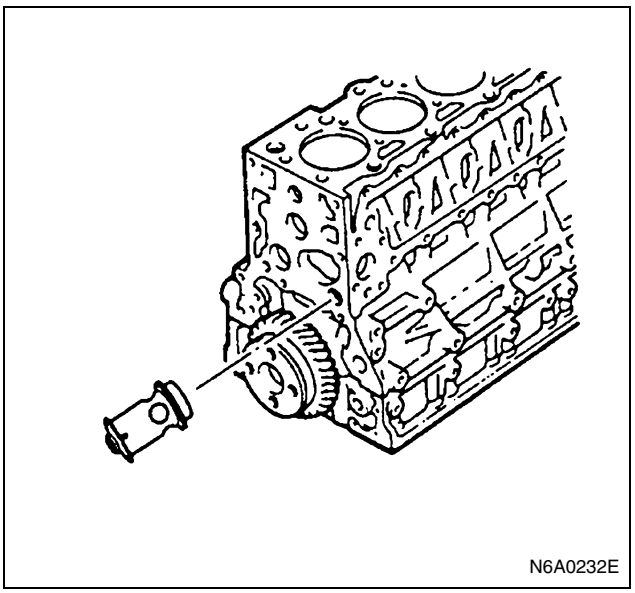
Angle gauge: 5-8840-0266-0

9. Piston and Connecting Rod Assembly
10. Connecting Rod Lower Bearing

11. Connecting Rod Cap Assembly
    Above works refer to “PISTON AND CONNECTING ROD” section in this manual.
12. Oil Pump Assembly
13. Idle Gear A
14. Flywheel Housing
15. Power Steering Pump Idle Gear
16. Power Steering Pump Idle Gear Cover
    Above works refer to O”IL PUMP” section in this manual.
17. Oil Thermo Valve (4HF1, 4HF1-2, 4HG1, 4HG1-T)
    Insert the oil thermo valve into the cylinder body.

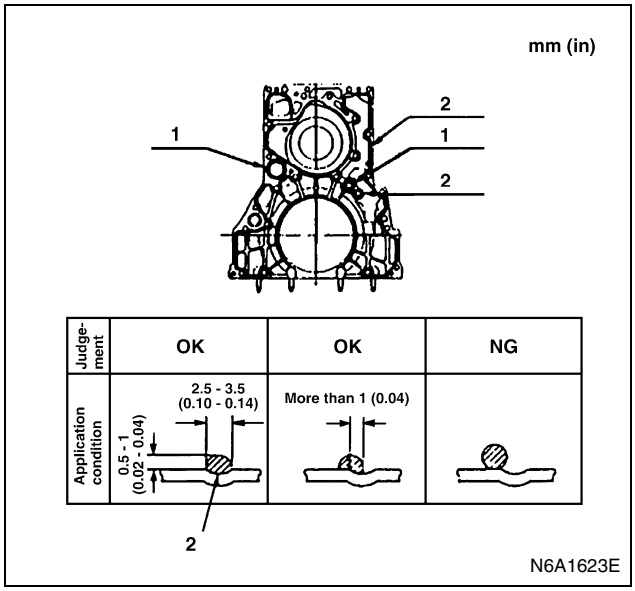

N6A0195E

18. Bypass Valve (4HE1-TC)
    Insert the bypass valve into the cylinder body.


N6A0232E

19. Front Retainer
    1) Carefully wipe any foreign material from the cylinder body front face.
    2) Apply 2.5 — 3.5 mm (0.10 — 0.14 in) bead of the recommended liquid gasket (Three Bond 1207C) or its equivalent on the groove of the front retainer fitting surface shown in the illustration.
    3) Install the O-rings (2 pieces) to the front retainer.

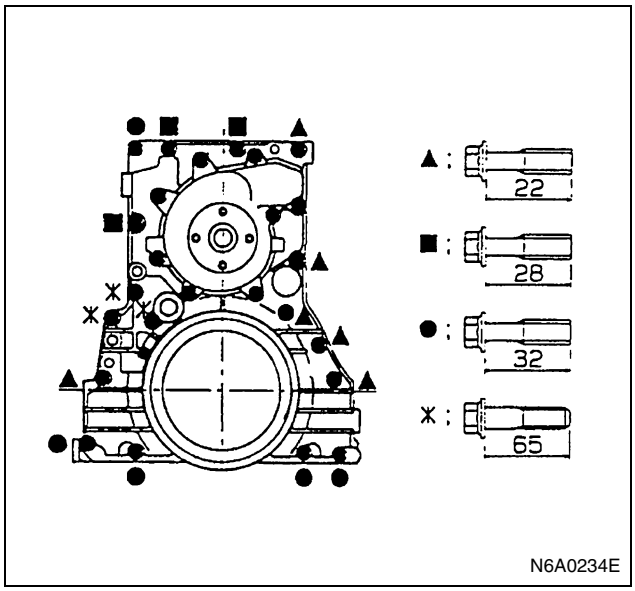
    • Install the front retainer within 7 minutes after application of liquid gasket.
    • For the dislocation of liquid gasket, refer to the illustration.



Legend
1. O-ring
2. Liquid gasket

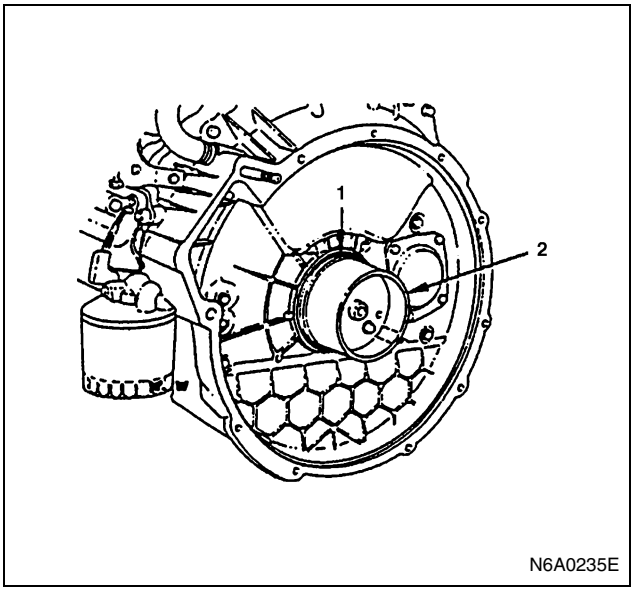
    4) Align the cylinder body knock pins with the front retainer knock pin holes.

Tighten:
Front retainer bolt to 24 N·m (2.4 kg·m / 17 lb·ft)

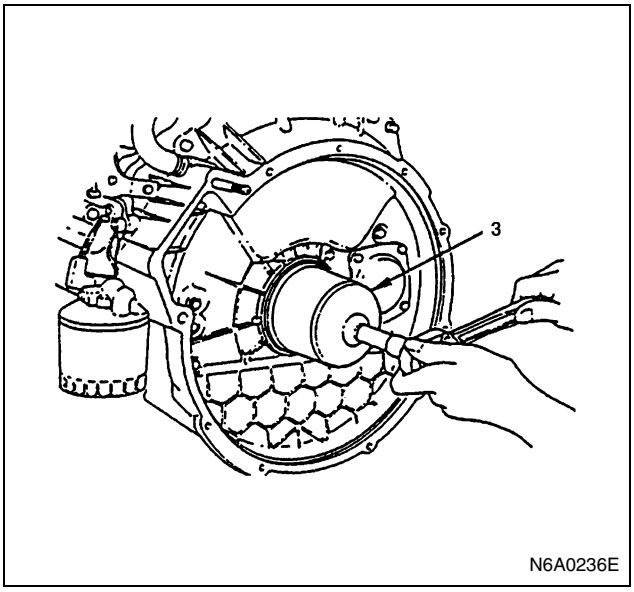


20. Water Pump Assembly
21. Water Pump Pulley
22. Oil Pump Strainer

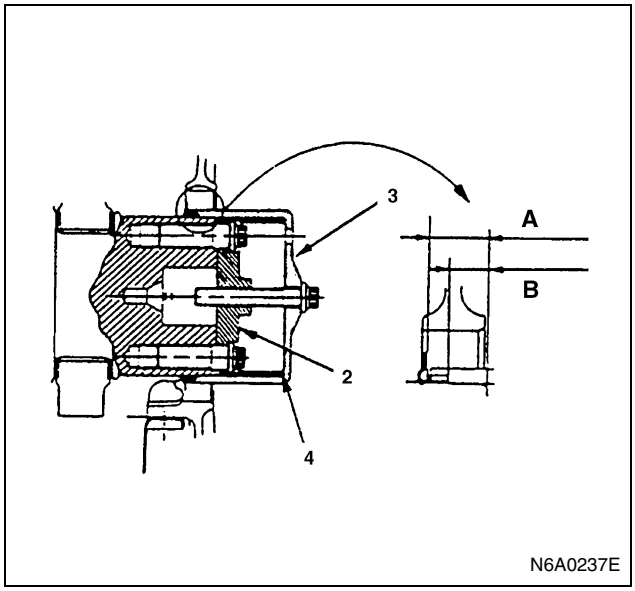
23. Oil Pan
24. Spacer Rubber
    Above works refer to “CYLINDER BLOCK” section in this manual.
25. Crankshaft Rear Slinger
    Press in the slinger using oil seal setting tool kit.
    1) Insert the slinger (1) into the end of the adapter (2) and install the adapter on the crankshaft.



    2) Cover the sleeve (3) and tighten the bolt until the sleeve comes to contact the adapter stopper (4).



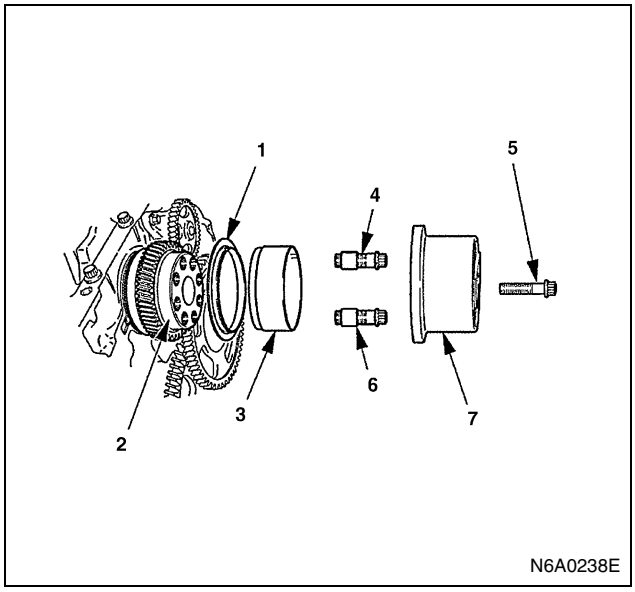
    3) Make sure of measurements specified in the illustration as well as of slinger deflection.
    (A): 17.3 ± 0.3 mm (0.681 ± 0.012 in)
    (B): 10.8 ± 0.1 mm (0.425 ± 0.004 in)



Notice:
Be sure to replace the slinger and oil seal as a set.

Oil Seal Setting Tool Kit: 5-8840-2431-0

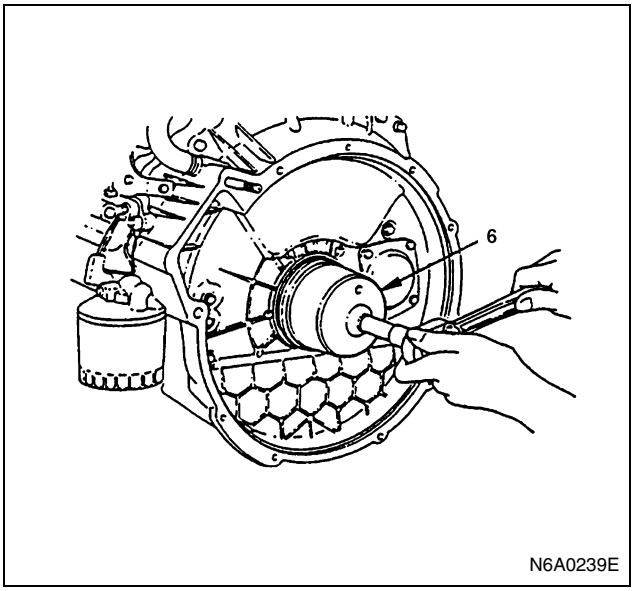
Rear slinger and oil seal setting tools			
Part Name	Stamp	Slinger	Oil Seal
Adapter	RR	❍	❍
Sleeve	RR	❍	❍
Oil seal adapter ring	RR		❍
Center bolt	—	❍	❍
Adapter bolt	—	❍	❍
Adapter bolt collar	RR	❍	❍



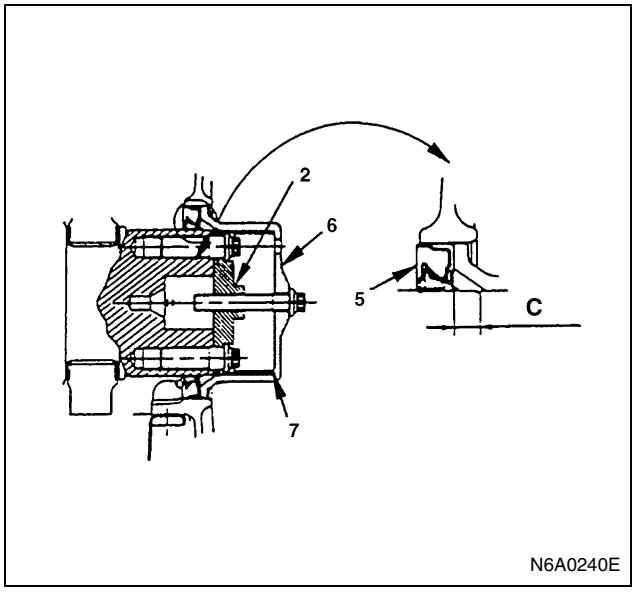
Legend

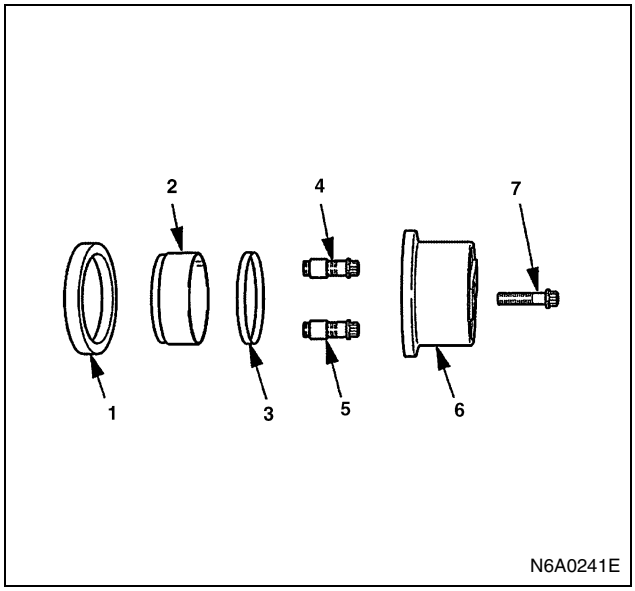
1. Slinger
2. Crankshaft
3. Adapter
4. Adapter bolt
5. Center bolt
6. Collar
7. Sleeve

26. Crankshaft Rear Oil Seal
    1) Apply engine oil to the lip of the oil seal.
    2) Press in the oil seal using rear oil seal setting tool kit.
    3) Remove the slinger sleeve and insert the oil seal (5) into the adapter (2).
    4) Install the adapter ring into the sleeve.
    5) Install the oil seal sleeve (6) to the adapter (2) and tighten the center bolt until the sleeve comes to contact the adapter stopper (7).



    6) With the oil seal pressed in, make sure of the measurements specified in the illustration.
    (C): 7.8 ± 0.3 mm (0.307 ± 0.012 in)



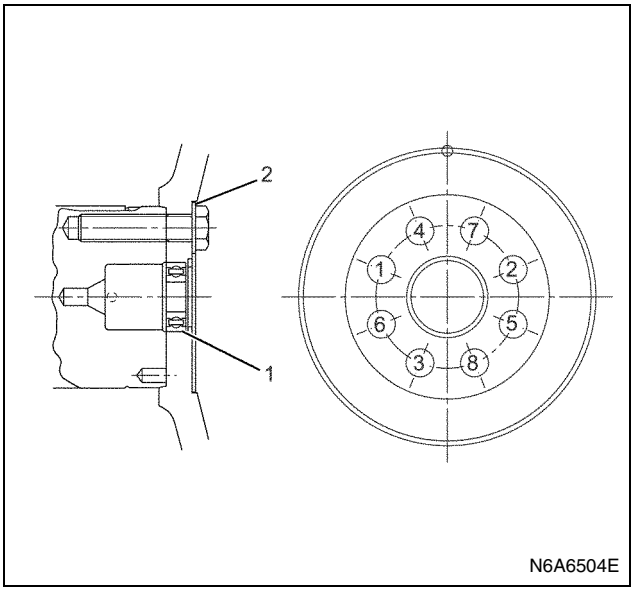


Legend

1. Oil seal
2. Adapter
3. Ring
4. Adapter bolt
5. Collar
6. Sleeve
7. Center bolt

27. Flywheel Assembly
    1) Apply molybdenum disulfide grease to the flywheel bolt threads and setting faces.
    2) Align the flywheel with the crankshaft knock pin and temporarily tighten the flywheel bolts.
    3) Use the crankshaft stopper to prevent the crankshaft from turning.
    Crankshaft Stopper: 5-8840-2230-0
    4) Install the washer and the flywheel bolts and tighten to the specified torque in numerical order show in the illustration.

Tighten:
Flywheel bolt to
- 1st step: 78 N·m (8.0 kg·m / 58 lb·ft)
- 2nd step: 90 — 120°

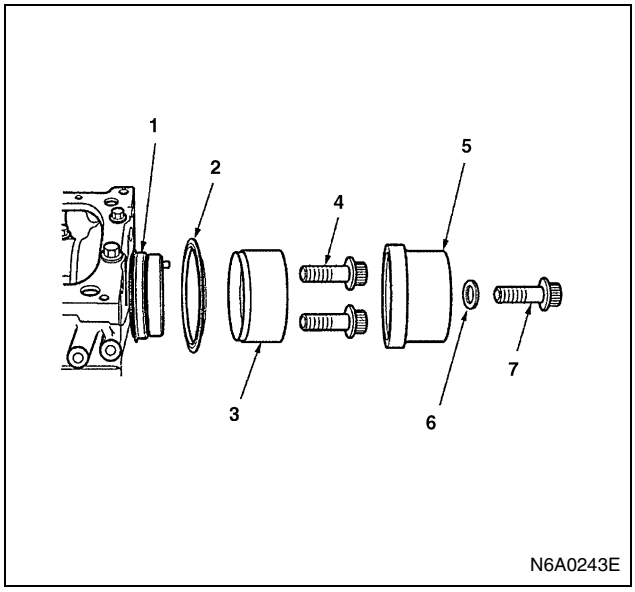


Legend
1. Washer
2. Pilot bearing

5) Remove the crankshaft stopper.

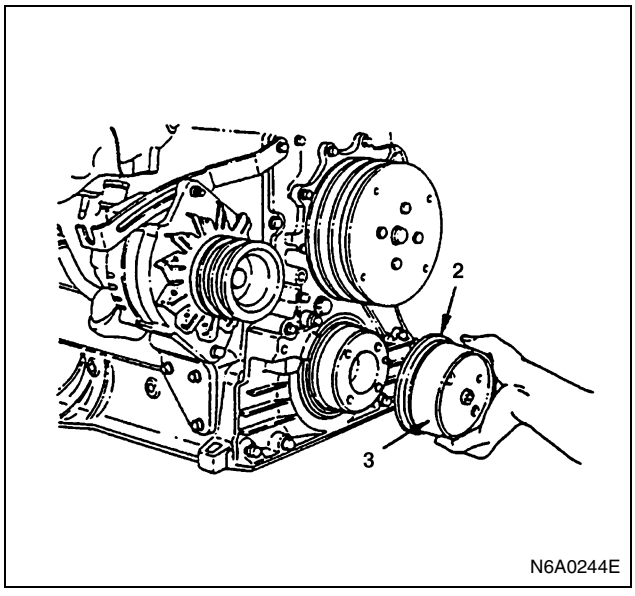
28. Crankshaft Front Slinger
Press in the slinger using the oil seal setting tool kit.
Oil Seal Setting Tool Kit: 5-8840-2431-0

Front slinger and oil seal setting tools			
Part Name	Stamp	Slinger	Oil Seal
Adapter	FT	❍	❍
Sleeve	FT	❍	❍
Oil seal adapter ring	FT		❍
Center bolt	—	❍	❍
Adapter bolt	—	❍	❍

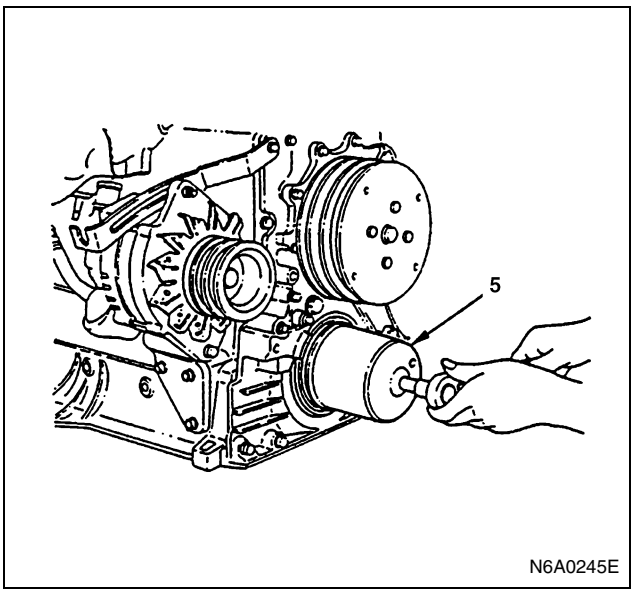


Legend
1. Crankshaft
2. Slinger
3. Adapter
4. Adapter bolt
5. Sleeve
6. Washer (5 mm (0.20 in))
7. Center bolt

1) Insert the slinger (2) into the end of the adapter (3) and install the adapter on the crankshaft.

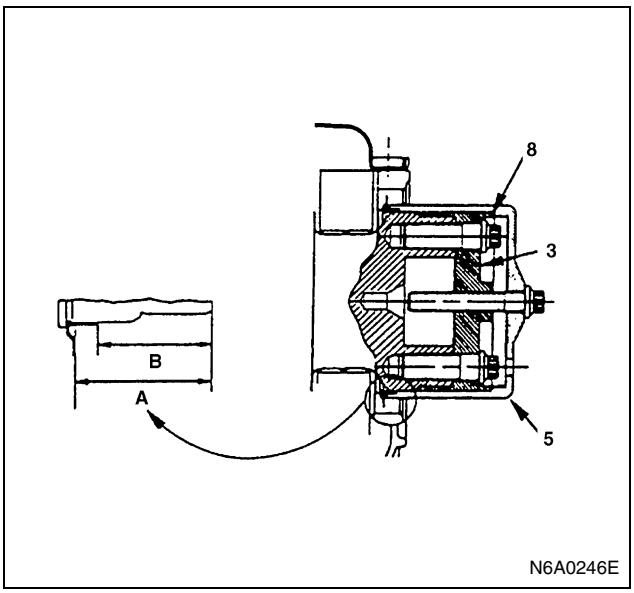


2) Cover the sleeve (5)and tighten the bolt until the sleeve comes to contact the adapter stopper (8).

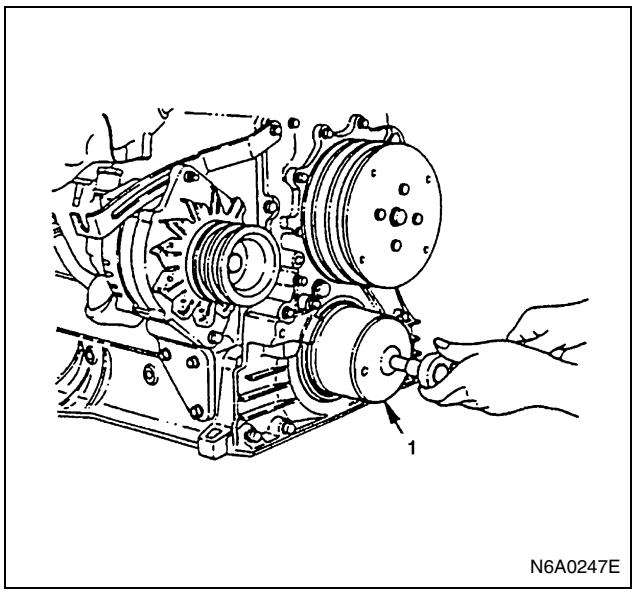


3) Make sure of measurements specified in the illustration as well as of slinger deflection.
(A): 40.5 ± 0.3 mm (1.594 ± 0.012 in)
(B): 34.0 ± 0.1 mm (1.339 ± 0.004 in)

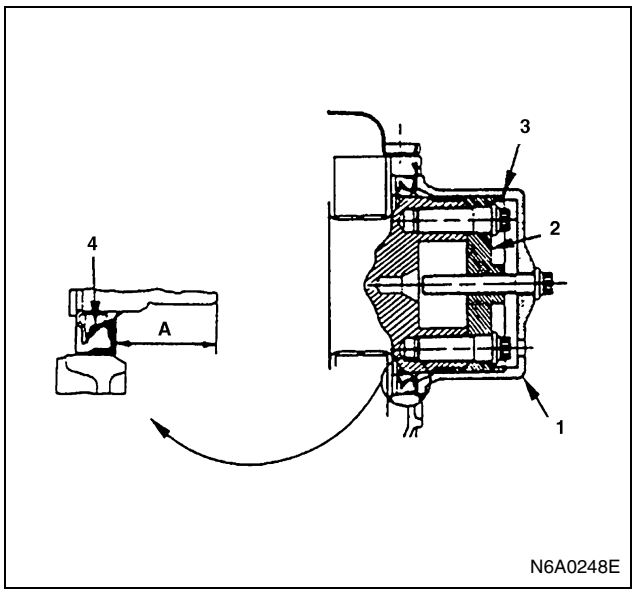
Notice:
Be sure to replace the slinger and the oil seal as a set. Use about 5mm (0.20 in) thickness plain washer on the center bolt.

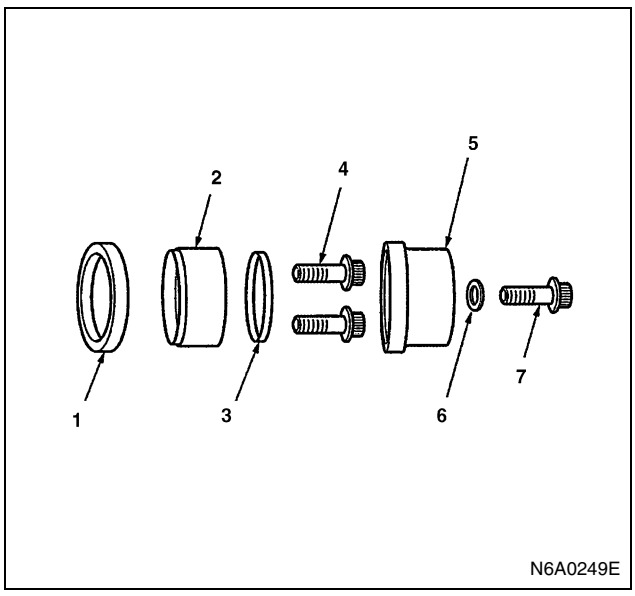


29. Crankshaft Front Oil Seal
    1) Apply engine oil to the lip of the oil seal.
    2) Press in the oil seal using the front oil seal setting tool kit.
    3) Remove the slinger sleeve and insert the oil seal (4) into the adapter (2).
    4) Install the adapter ring into the sleeve.
    5) Install the oil seal sleeve (1) to the adapter (2) and tighten the center bolt until the sleeve comes to contact the adapter stopper (3).



6) Make sure of the measurements specified in the illustration.
(A): 31 ± 0.3 mm (1.220 ± 0.012 in)



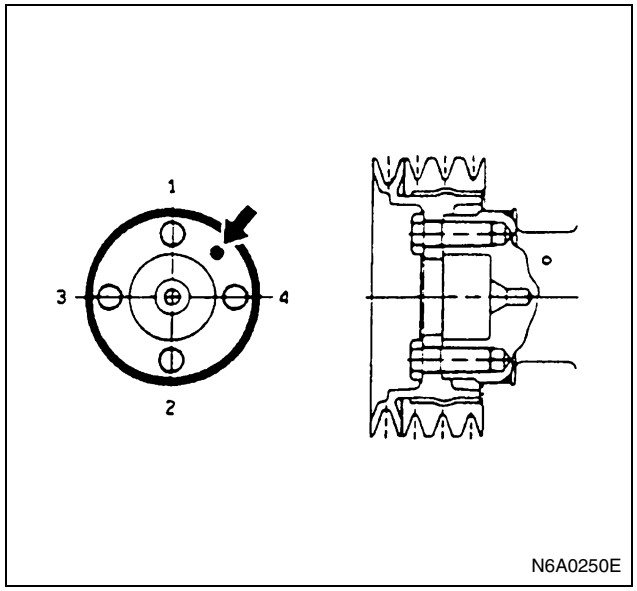


Legend

1. Oil seal
2. Adapter
3. Ring
4. Adapter bolt
5. Sleeve
6. Washer (5 mm (0.20 in))
7. Center bolt

30. Crankshaft Damper Pulley
    1) Apply a coat of engine oil to the threads of the bolts.
    2) Align the damper pulley with the crankshaft knock pin and tighten the bolts to the specified torque in numerical order.

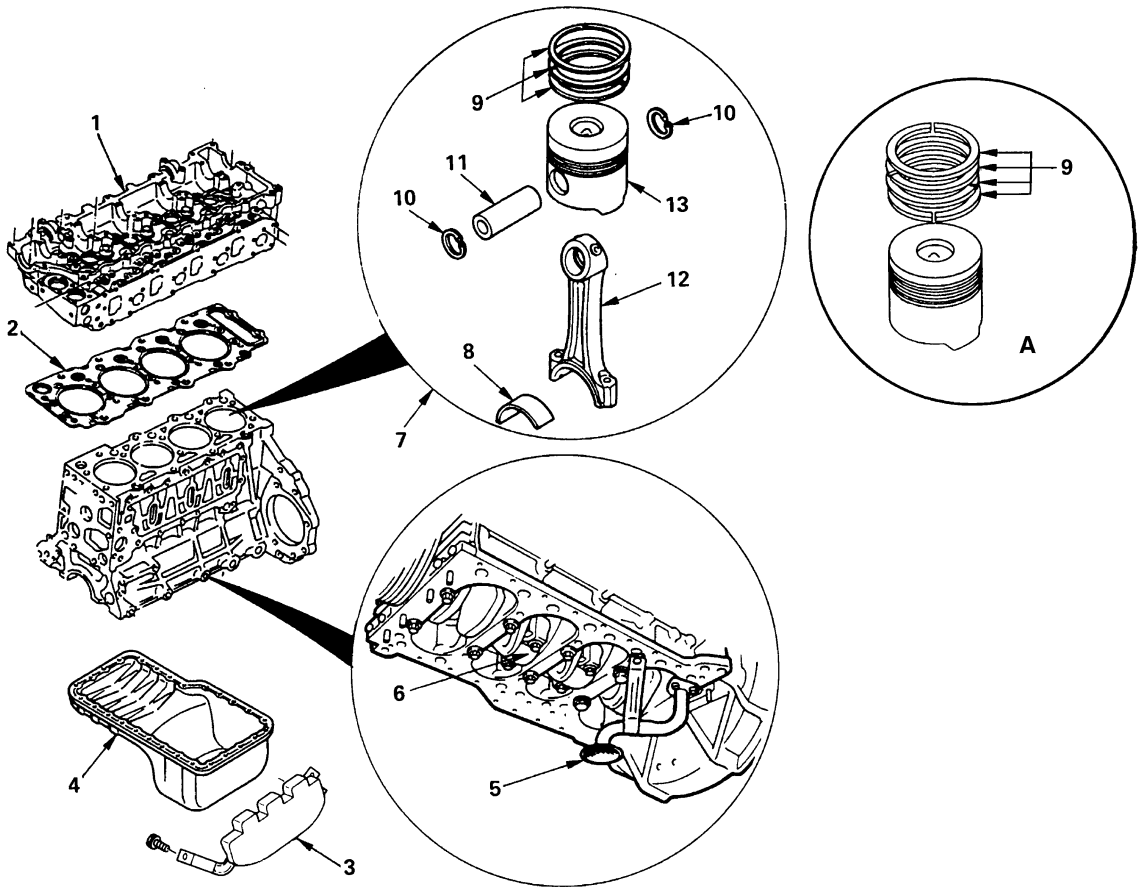
Tighten:
Damper pulley bolt to 200 N·m (20.4 kg·m / 147 lb·ft)



31. Generator Bracket
32. Fan Belt Adjust Plate
33. Injection Pump Assembly
34. Engine Foot
35. Generator
36. Fan Belt
37. Fan Belt Adjustment
38. Vacuum Pump Rubber Hose
39. Vacuum Pump Oil Pipe
40. Oil Filter Assembly
41. Oil Pipe
42. Engine Control Lever Assembly
43. Engine Control Wire
44. Driven Plate
45. Clutch Pressure Plate Assembly
46. Cylinder Head Gasket
    Above works refer to “CYLINDER BLOCK” section in this manual.
47. Cylinder Head Assembly
    Above works refer to “CYLINDER HEAD” section in this manual.

PISTON AND CONNECTING ROD

Component



Legend

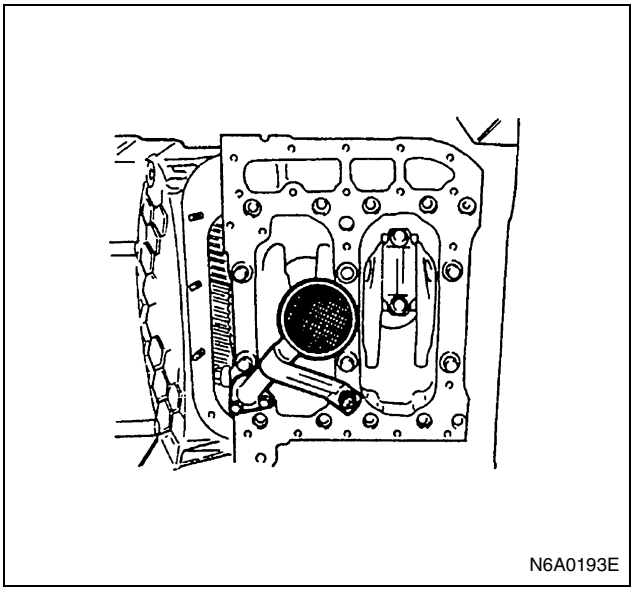
A. For 4HE1-TC
1. Cylinder head assembly
2. Cylinder head gasket
3. Spacer rubber
4. Oil pan
5. Oil pump strainer
6. Connecting rod cap
7. Piston and connecting rod
8. Connecting rod bearing
9. Piston ring
10. Piston pin snap ring
11. Piston pin
12. Connecting rod
13. Piston

Disassembly

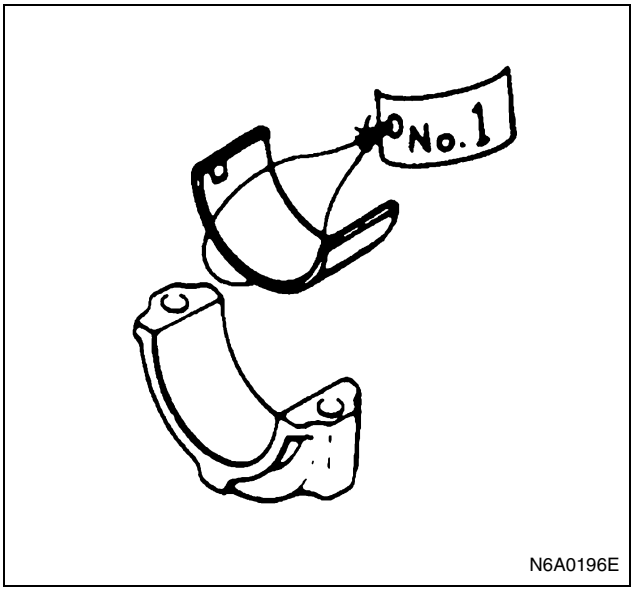
1. Cylinder Head Assembly
   Above works refer to “CYLINDER HEAD” section in this manual.
2. Cylinder Head Gasket

Caution:
Do not reuse the cylinder head gasket.

3. Spacer Rubber
4. Oil Pan
5. Oil Pump Strainer

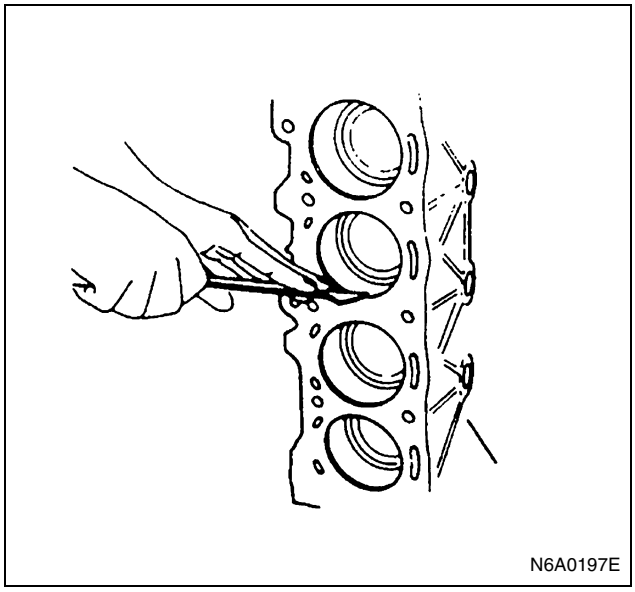

N6A0193E

6. Connecting Rod Cap
   1) Take out the connecting rod bearing cap bolts and remove the bearing cap with the lower bearing.
   2) If the connecting rod lower bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



N6A0196E

7. Piston and Connecting Rod Assembly
   1) To facilitate smooth removal of piston, remove carbon from the upper part of the cylinder wall using a scraper or equivalent.

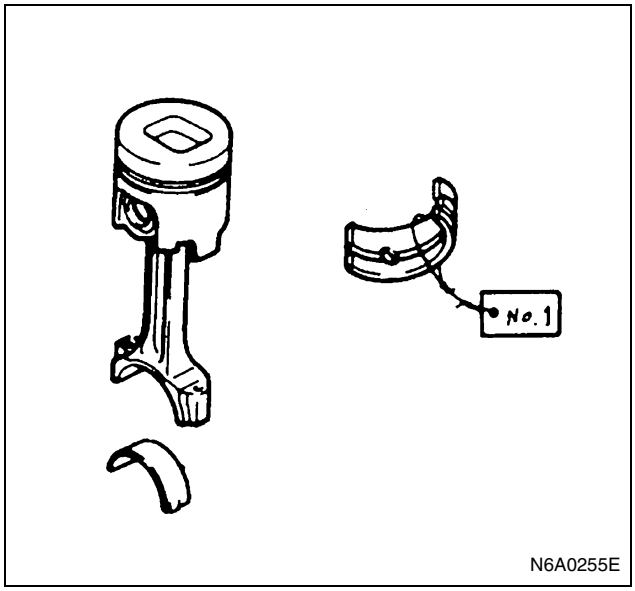

N6A0197E

   2) Remove the piston and connecting rod assembly upward by pushing on the edge of the connecting rod with a hammer handle or equivalent.
   3) If the connecting rod bearing are to be reinstalled, mark their fitting positions by taggfing each bearing with the cylinder number from which it was removed.

Caution:
Do not bend or damage the oiling jet.

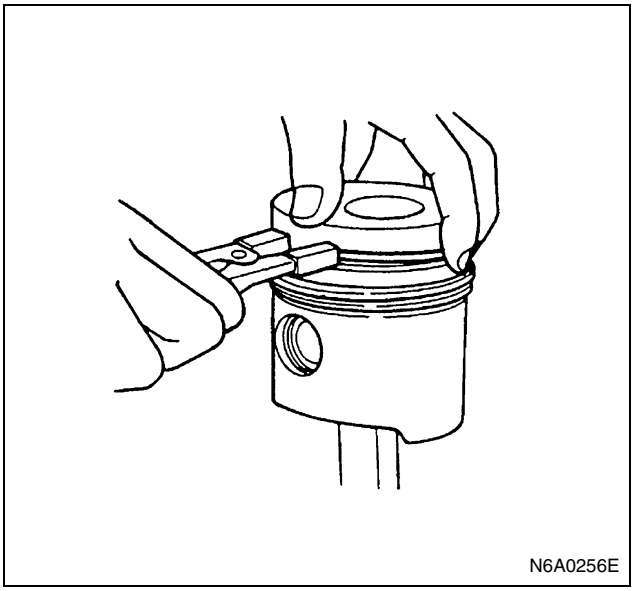
Notice:
When removing the piston and connecting rod assembly, pull the connecting rod in parallel with the cylinder bore.

8. Connecting Rod Bearing
   If the connecting rod bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.

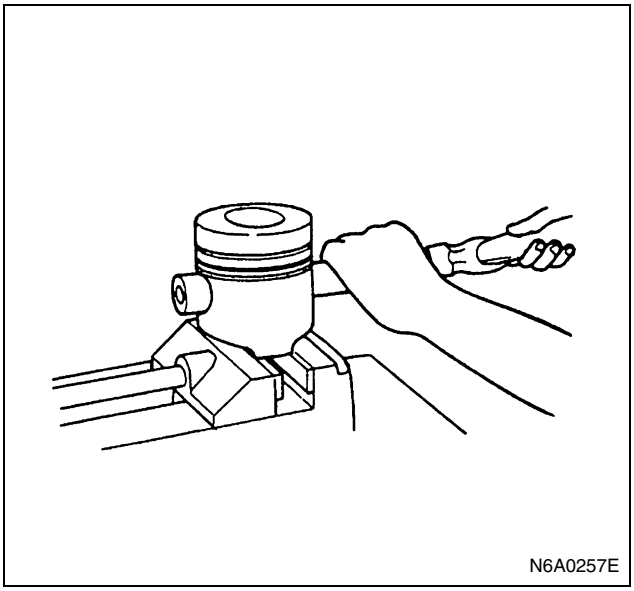


N6A0255E

9. Piston Ring
   1) Clamp the connecting rod in a vise.
      Take care not to damage the connecting rod.
   2) Use piston ring replacer to remove the piston rings.
      Do not attempt to use some other tool to remove the piston rings. Piston ring stretching will result in reduced piston ring tension.


N6A0256E

10. Piston Pin Snap Ring
    Use a pair of snap ring pliers to remove the piston pin snap rings.
11. Piston Pin
12. Connecting Rod
13. Piston
    Tap the piston pin out with a hammer and a brass bar. If the pistons are to be reinstalled, mark their installation positions by tagging each piston with the cylinder number from which it was removed.


N6A0257E

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

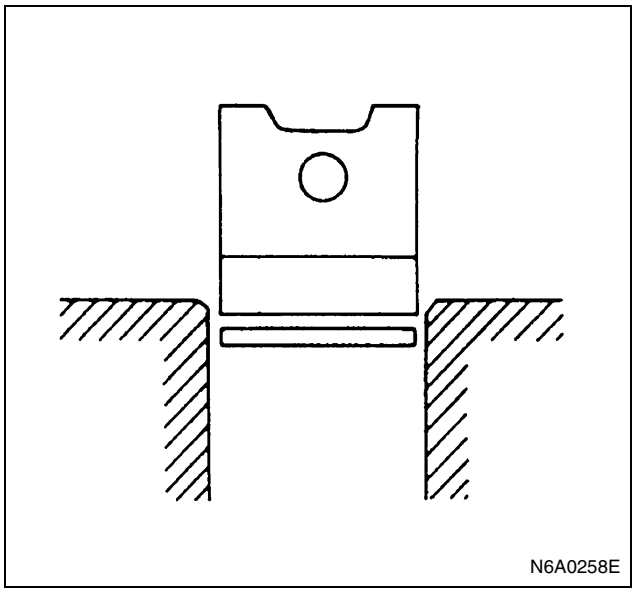
Piston Grade Selection and Cylinder Bore Measurement

Refer to the Section “CYLINDER BLOCK”, Item “Cylinder Liner Bore Measurement” for details on piston grade selection and cylinder liner bore measurement.

Piston Ring

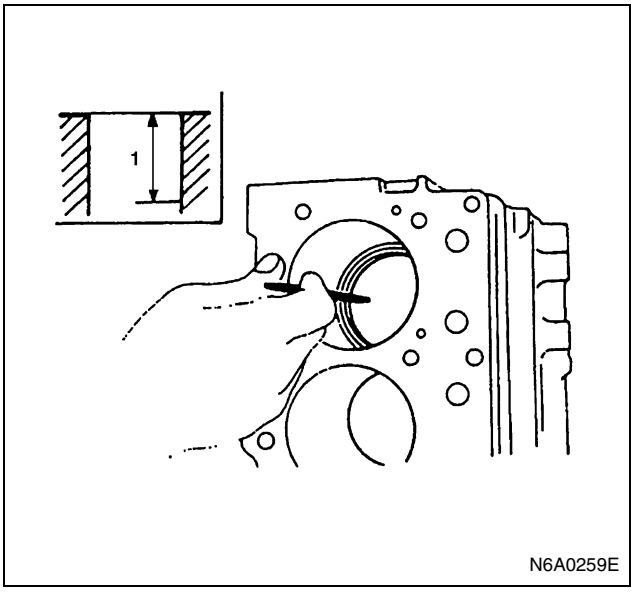
Piston Ring Gap

1. Insert the piston ring horizontally (in the position it would assume if it were installed to the piston) into the cylinder liner bore.


N6A0258E

2. Push the piston ring into the cylinder liner bore until it reaches the point (1) where the cylinder liner bore is the smallest.
   Do not allow the piston ring to slant to one side or the other. It must be perfectly horizontal.

Measuring Point	mm (in)
Approx. 150 (6)	



3. Use a feeler gauge to measure the piston ring gap. If the measured valve exceeds the specified limit, the piston ring must be replaced.

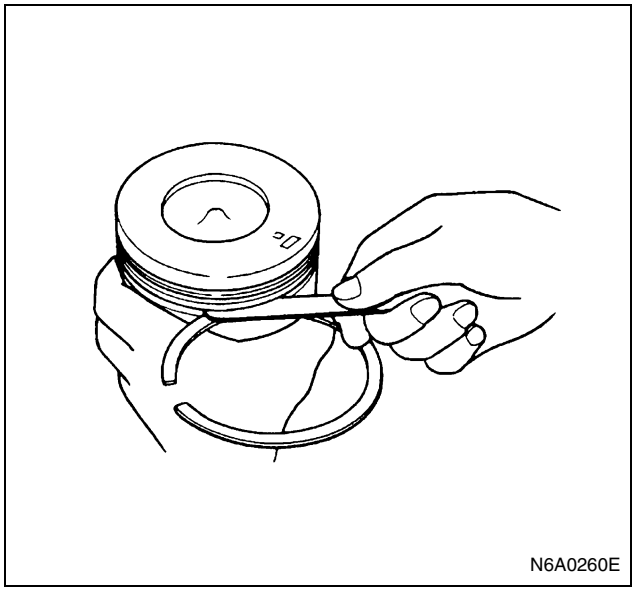
Piston Ring Gap / 4HF1 / 4HF1-2		mm (in)
	Standard	Limit
1st compression ring gap	0.24 — 0.39 (0.0094 — 0.0153)	1.50 (0.0591)
2nd compression ring gap	0.35 — 0.50 (0.0138 — 0.0197)	
Oil ring gap	0.02 — 0.40 (0.0008 — 0.0157)	

Piston Ring Gap / 4HG1 / 4HG1-T		mm (in)
	Standard	Limit
1st compression ring gap	0.24 — 0.39 (0.0094 — 0.0153)	1.50 (0.0591)
2nd compression ring gap	0.35 — 0.50 (0.0138 — 0.0197)	
Oil ring gap	0.15 — 0.35 (0.00591 — 0.0138)	

Piston Ring Gap / 4HE1-TC		mm (in)
	Standard	Limit
1st compression ring gap	0.24 — 0.40 (0.0094 — 0.0157)	1.50 (0.0591)
2nd and 3rd compression ring gap	0.30 — 0.450 (0.0118 — 0.0177)	
Oil ring gap	0.20 — 0.40 (0.0078 — 0.0157)	

Piston Ring and Piston Ring Groove Clearance

1. Use a feeler gauge to measure the clearance between the piston ring and the piston ring groove at several points around the piston.



Piston Ring and Piston Ring Groove Clearance / 4HF1, 4HF1-2, 4HG1, 4HG1-T		mm (in)
	Standard	Limit
1st Compression Ring	0.062 — 0.092 (0.0024 — 0.0036)	0.20 (0.0079)
2nd Compression Ring	0.04 — 0.08 (0.0015 — 0.0031)	0.15 (0.0059)
Oil ring gap	0.02 — 0.06 (0.0008 — 0.0024)	

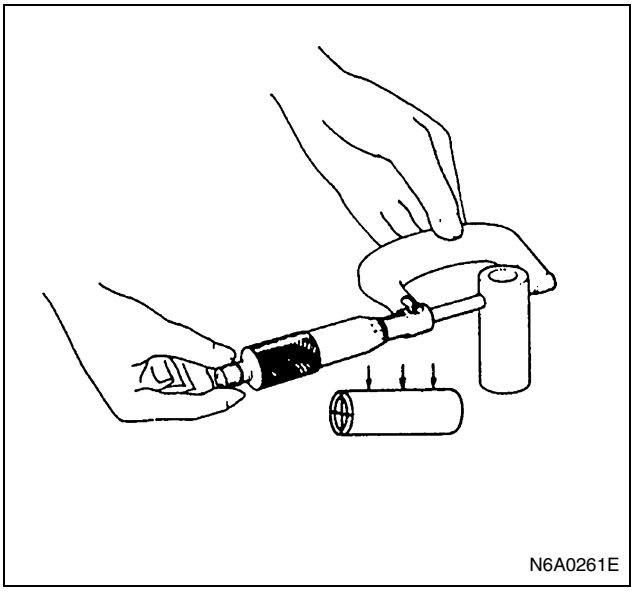
Groove Clearance / 4HE1-TC		mm (in)
	Standard	Limit
1st Compression Ring	0.09 — 0.13 (0.0035 — 0.0051)	0.20 (0.0078)
2nd and 3rd Compression Ring	0.09 — 0.13 (0.0035 — 0.0051)	
Oil ring gap	0.03 — 0.07 (0.0012 — 0.0028)	0.15 (0.0059)

2. Visually inspect the piston ring grooves. If a piston ring groove is damaged or distorted, the piston must be replaced.

Piston Pin

Piston Pin Diameter

Use a micrometer to measure the piston pin outside diameter at several points.
If the measured value is less than the specified limit, the piston pin must be replaced.

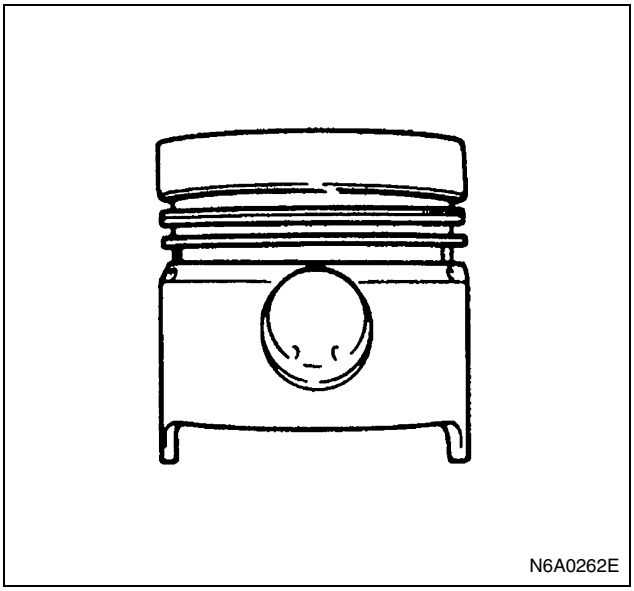

N6A0261E

Piston Pin Diameter		mm (in)
Engine model	Standard	Limit
Except 4HE1-TC	35.995 — 36.000 (1.4171 — 1.4173)	35.970 (1.4161)
4HE1-TC	39.995 — 40.000 (1.5746 — 1.5748)	39.970 (1.5736)

Piston Pin Hole and Piston Pin Clearance

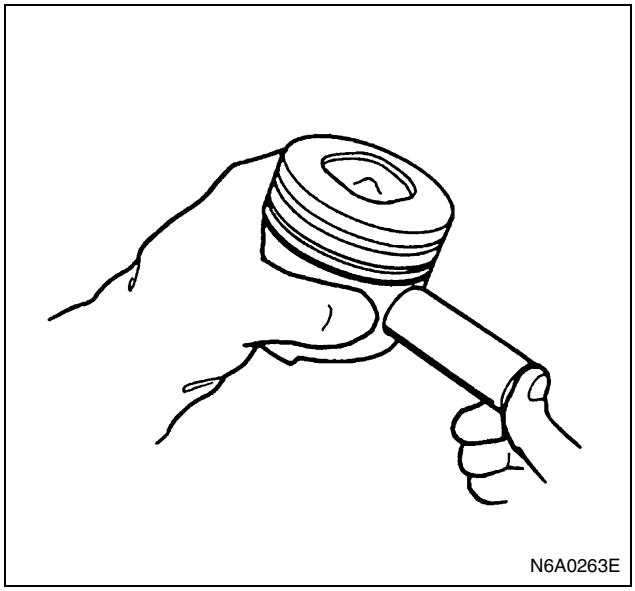
Use an inside dial indicator to measure the piston pin hole (in the piston).

Piston Pin Hole and Piston Pin Clearance	mm (in)
Standard	Limit
0.004 — 0.017 (0.00016 — 0.00067)	0.04 (0.0016)


N6A0262E

If an inside dial indicator is not available, use the following procedure to check the piston pin clearance.

1. Use a piston heater to heat the piston to approximately 80 — 100°C (176 — 212°F)
2. Push strongly against the piston pin with your thumbs. The piston pin should move smoothly with little or no resistance.


N6A0263E

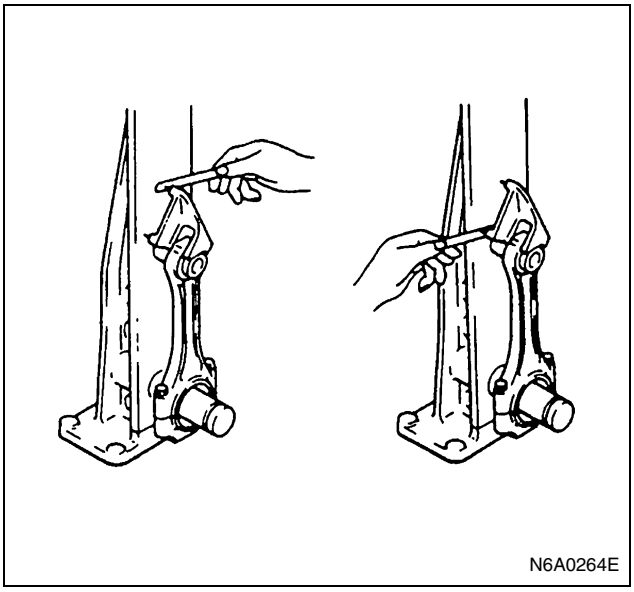
Connecting Rod

Connecting Rod Alignment

Use a connecting rod aligner to measure the distortion and the parallelism between the connecting rod big end hole and the connecting rod small end hole.

If either the measured distortion or parallelism exceeds the specified limit, the connecting rod must be replaced.

Connecting Rod Alignment		mm (in)
Per Length of 100 (3.94)		
	Standard	Limit
Distortion	0.05 (0.002) or less	0.20 (0.008)
Parallelism		

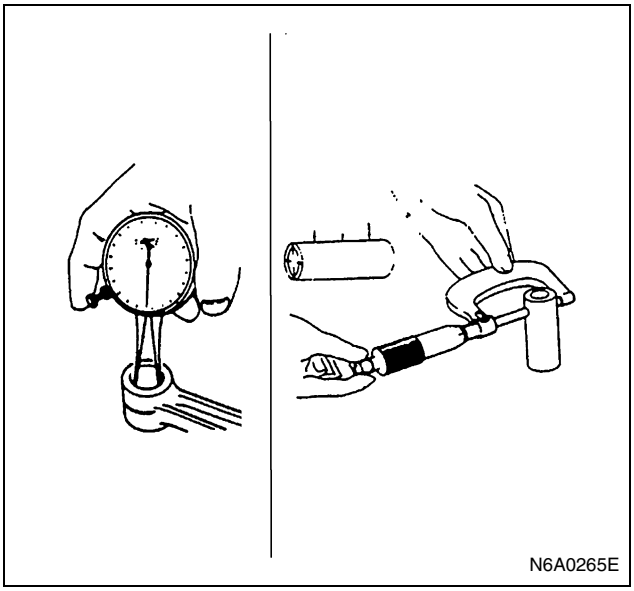

N6A0264E

Piston Pin and Connecting rod Small End Bushing Clearance

Use a caliper calibrator and a dial indicator to measure the clearance between the piston pin and connecting rod small end bushing.

If the clearance between the piston pin and the connecting rod small end bushing exceeds the specified limit, replace the piston pin and/or the connecting rod bushing.

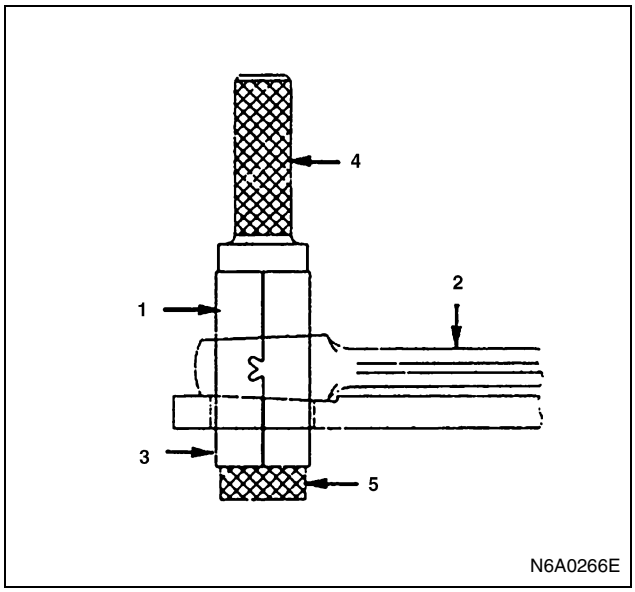
Piston Pin and Connecting Rod Small End Bushing Clearance	mm (in)
Standard	Limit
0.012 — 0.027 (0.0005 — 0.0011)	0.05 (0.002)


N6A0265E

Connecting Rod Bushing Replacement

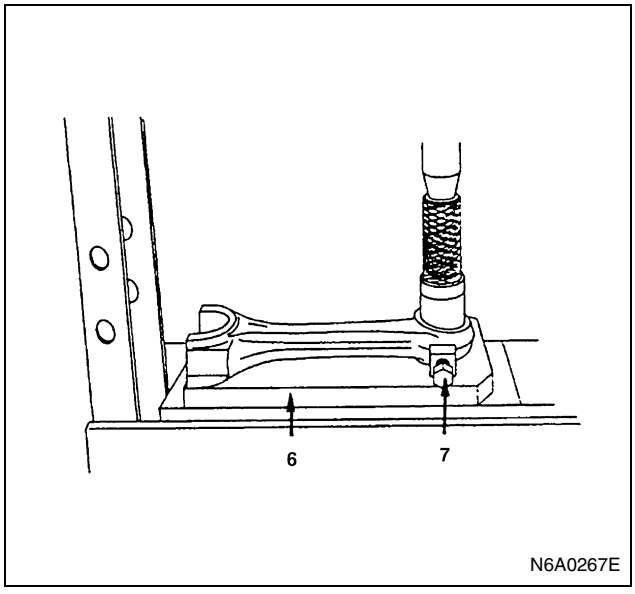
Connecting Rod Bushing Removal

1. Set the collar (1), the connecting rod (2), and the collar (3) to the setting bar (4).
   Connecting Rod Bushing Replacer: 5-8840-2340-0
2. Hand-tighten the nut (5) until there is no more gap.



N6A0266E

3. Set the connecting rod bushing replacer base (6) to the bench press.
4. Set the connecting rod to the connecting rod bushing replacer base.
5. Tighten the bolt (7).

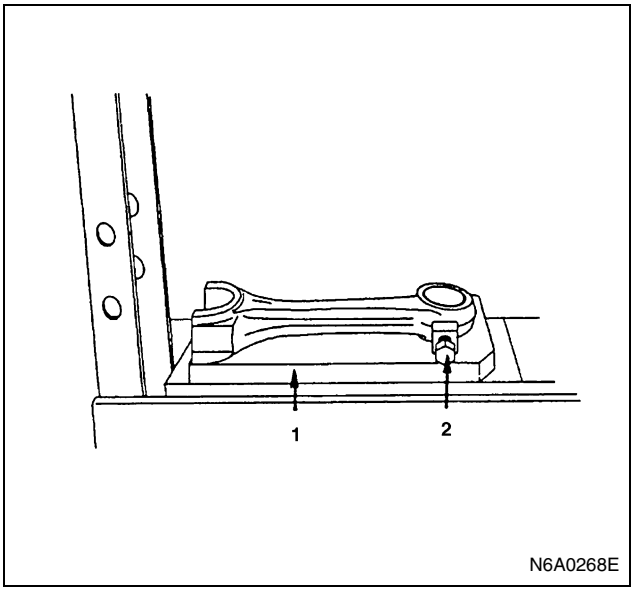


N6A0267E

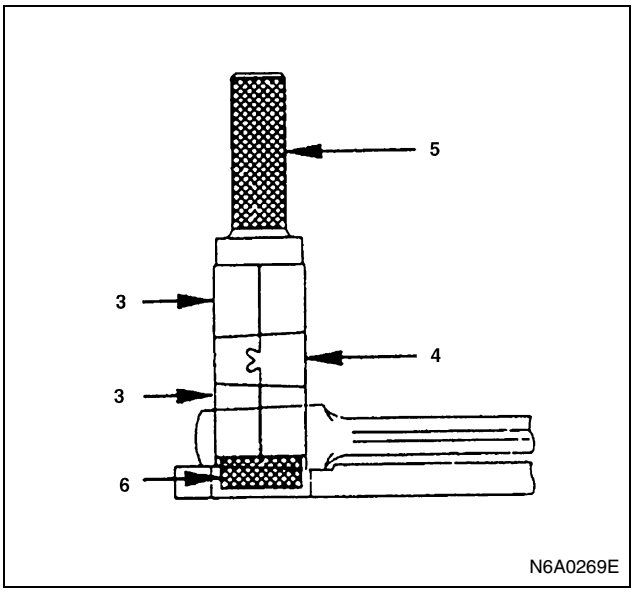
6. Use the bench press to force the bushing from the connecting rod.

Connecting Rod Bushing Installation

1. Set the connecting rod bushing replacer base (1) to the bench press.
   Connecting Rod Bushing Replacer: 5-8840-2340-0
2. Set the connecting rod to the connecting rod replacer base.
   The connecting rod must be perfectly horizontal.
3. Tighten the bolt (2) to hold the connecting rod small end in place.

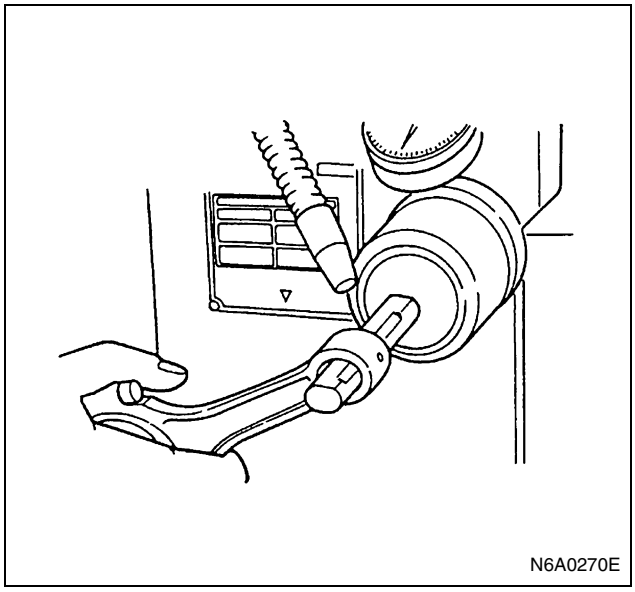


4. Install the two collars (3) and the new bushing (4) to the setting bar (5).
   Align the bushing clinch line and the collar setting marks.
   Tighten the nut (6).



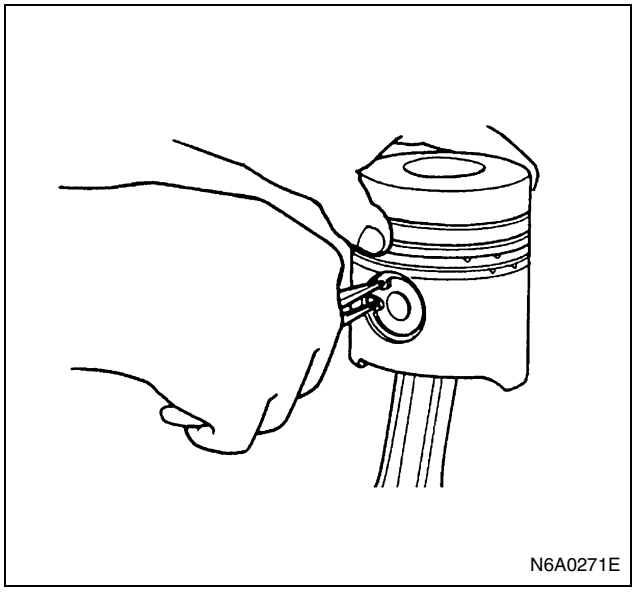
5. Use the bench press to press the new bushing into position inside the connecting rod.
   Check that the bushing oil holes and the connecting rod oil holes are aligned.
6. Use a pinhole grinder to finish the new bushing.

Connecting Rod Small End Bushing Inside Diameter	mm (in)
Except 4HE1-TC	36.012 — 36.022 (1.4178 — 1.4182)
4HE1-TC	40.012 — 40.022 (1.5753 — 1.5767)

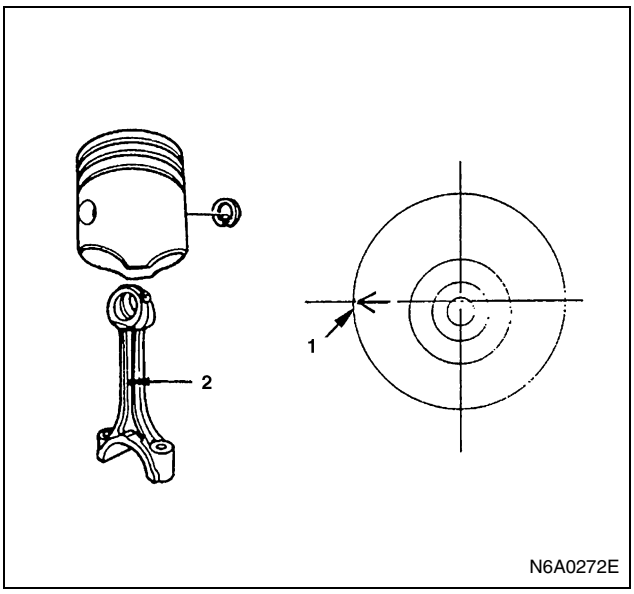


Reassembly

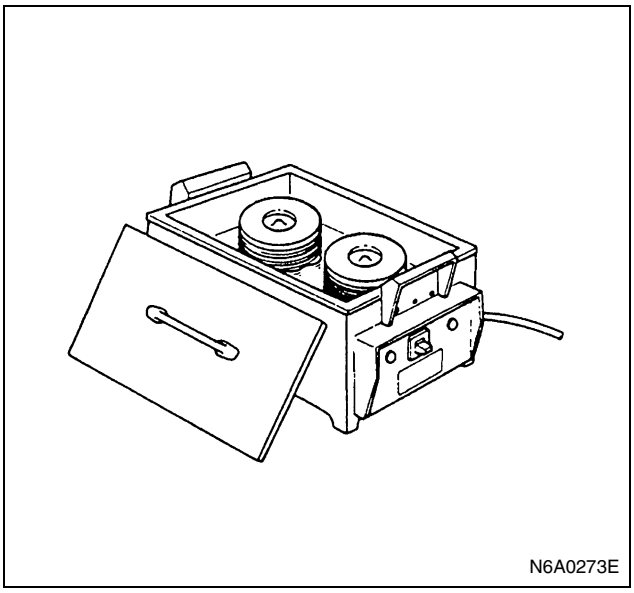
1. Piston
2. Piston Pin Snap Ring
   Use a pair of snap ring pliers to install the piston pin snap ring to the piston.



3. Connecting Rod
   1) Clamp the connecting rod in a vise.
      Take care not to damage the connecting rod.
   2) Install the connecting rod so that the piston head front mark (1) and the connecting rod forging mark (projecting) (2) are set in the same direction.

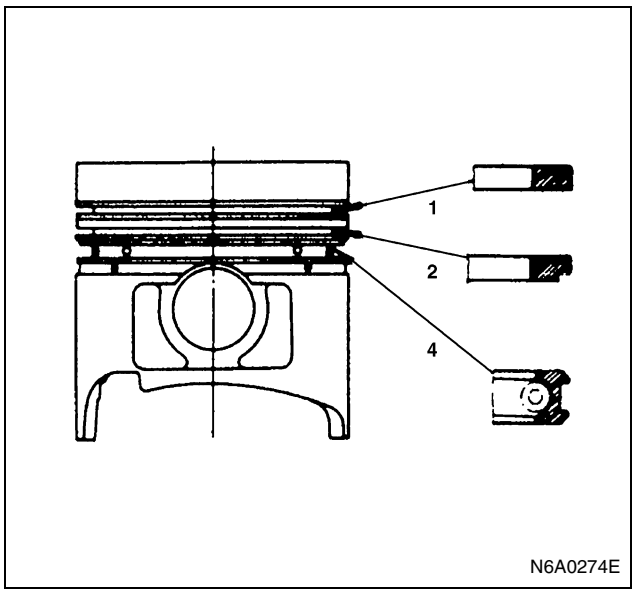


4. Piston Pin
   If could not be installed piston pin, it is recommended to remove it by following procedure.
   1) Use a piston heater to heat the piston to 80 — 100°C (176 — 212°F).

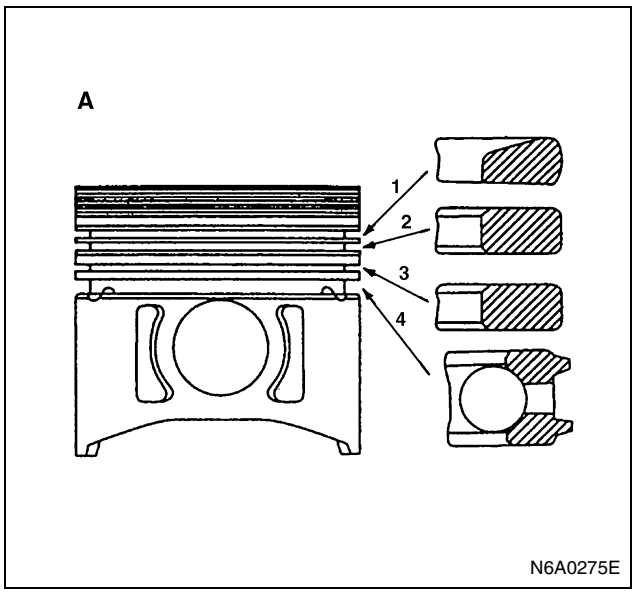


   2) Apply a coat of the engine oil to the piston pin.
   3) Use your fingers to force the piston pin into the piston until it makes contact with the snap ring.
   4) Check to see if the connecting rod moves smoothly on the piston pin.
5. Snap Ring
6. Piston Ring
   1) Use a piston ring replacer to install the three piston rings.

   Install the piston rings in the order shown in the illustration.



Legend
1. 1st compression ring
2. 2nd compression ring
4. Oil ring



Legend
A. For 4HE1-TC
1. 1st compression ring
2. 2nd compression ring
3. 3rd compression ring (For 4HE1-TC)
4. Oil ring

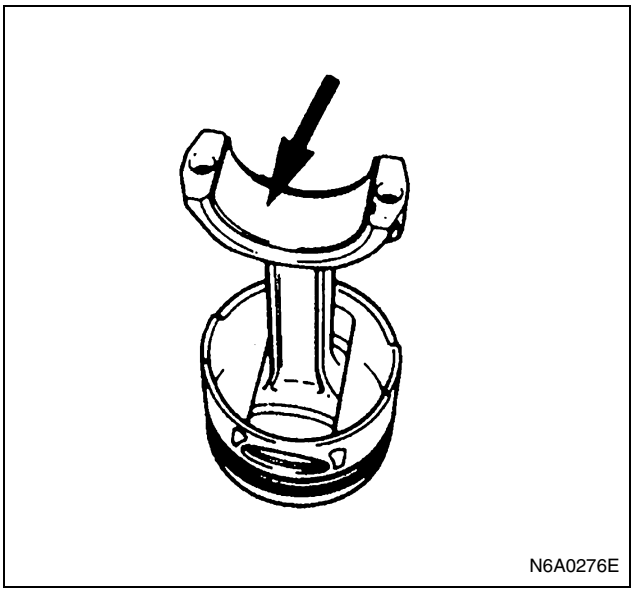
Notice:
Insert the expander coil into the oil ring groove so that there is no gap on either side of the expander coil before installing the oil ring.

Install the compression rings with the stamped side facing up.

   2) Apply engine oil to the piston ring surfaces.

3) Check to see if the piston rings rotate smoothly in the piston ring grooves.

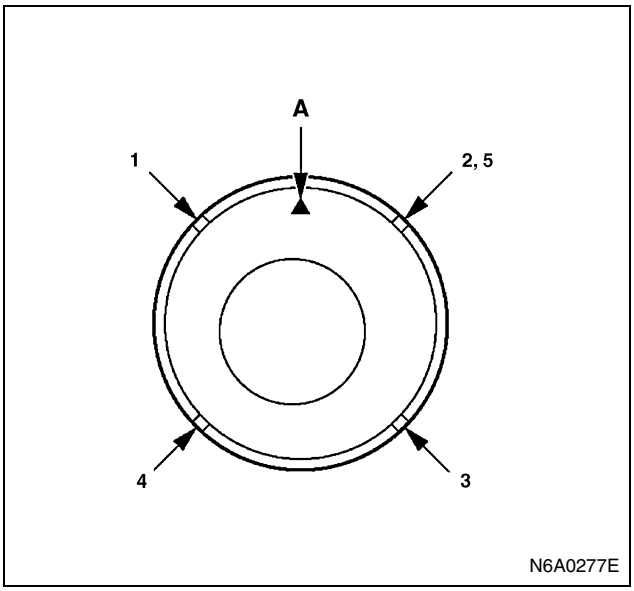
7. Connecting Rod Bearing
Carefully wipe any oil or other foreign material from the connecting rod bearing back face and the connecting rod bearing fitting surface.


N6A0276E

8. Piston and Connecting Rod Assembly

Notice:
When installing new connecting rod and/or connecting rod bearings, refer to the selection table. Above works refer to “CRANKSHAFT” section in this manual.

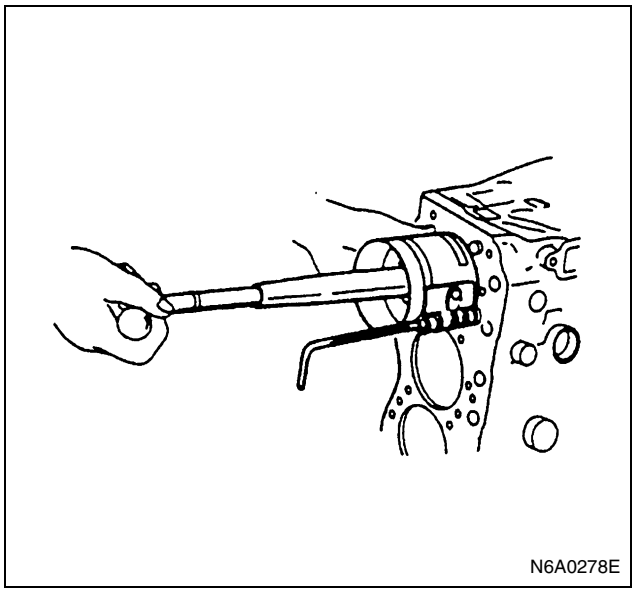
1) Apply a coat of the engine oil to the circumference of each piston ring and piston.
2) Position the piston ring gaps as shown in the illustration.



N6A0277E

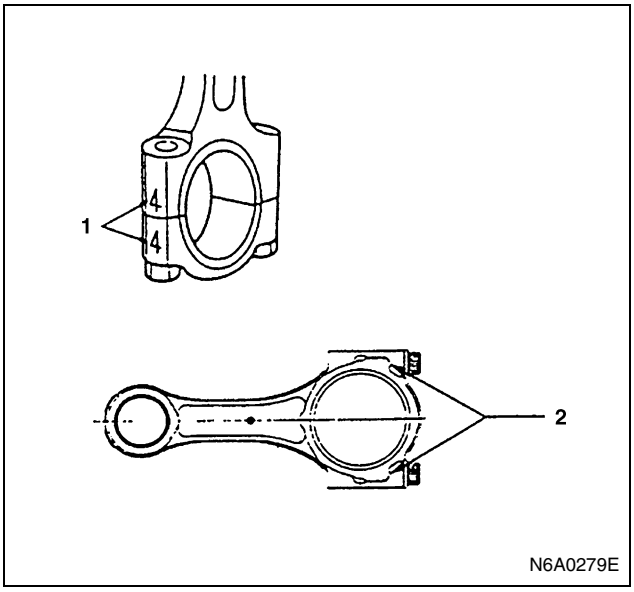
Legend
A. Front mark
1. 1st compression ring
2. 2nd compression ring
3. 3rd compression ring (For 4HE1-TC only)
4. Oil ring
5. Coil expander

3) Apply a coat of molybdenum disulfide grease to the two piston skirts.
This will facilitate smooth break-in when the engine is first started after reassembly.
4) Apply a coat of the engine oil to the upper bearing surfaces.
5) Apply a coat of the engine oil to the cylinder wall.
6) Position the piston head front mark so that it is facing the front of the engine.
7) Use the piston ring compressor to compress the piston rings.
Piston Ring Compressor: 5-8840-9018-0
8) Use a hammer grip to push the piston in until the connecting rod makes contact with the crankpin.
At the same time, rotate the crankshaft until the crankpin is at bottom dead center.


N6A0278E

Caution:
Do not bend or damage the oiling jet.

9. Connecting Rod Cap
1) Install the connecting rod bearing caps.
2) Align the bearing cap cylinder number marks (1) and the connecting rod cylinder number marks (1).
3) Apply a coat of molybdenum disulfide grease to the threads and setting faces of each connecting rod cap bolts.

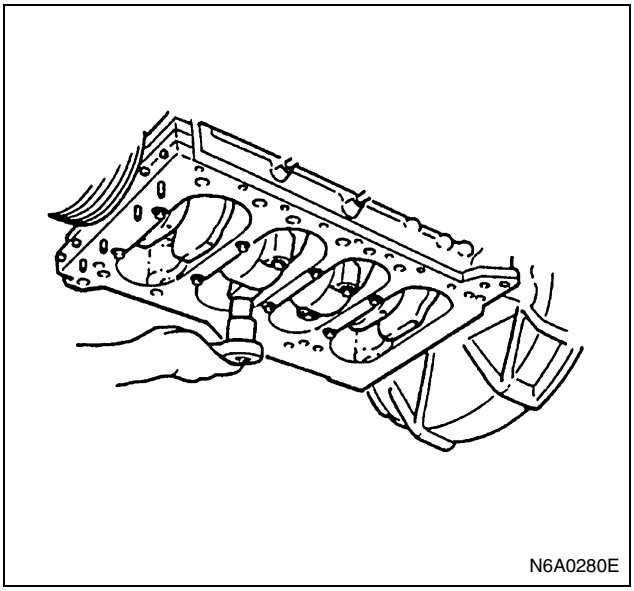


Legend
1. Alignment
2. Boss discriminating the front from the rear

4) Tighten the connecting rod caps to the specified torque.

Tighten:
Connecting rod bearing cap bolt to
- 1st step: 39 N·m (4.0 kg·m / 29 lb·ft)
- 2nd step: 60°
- 3rd step: 30°

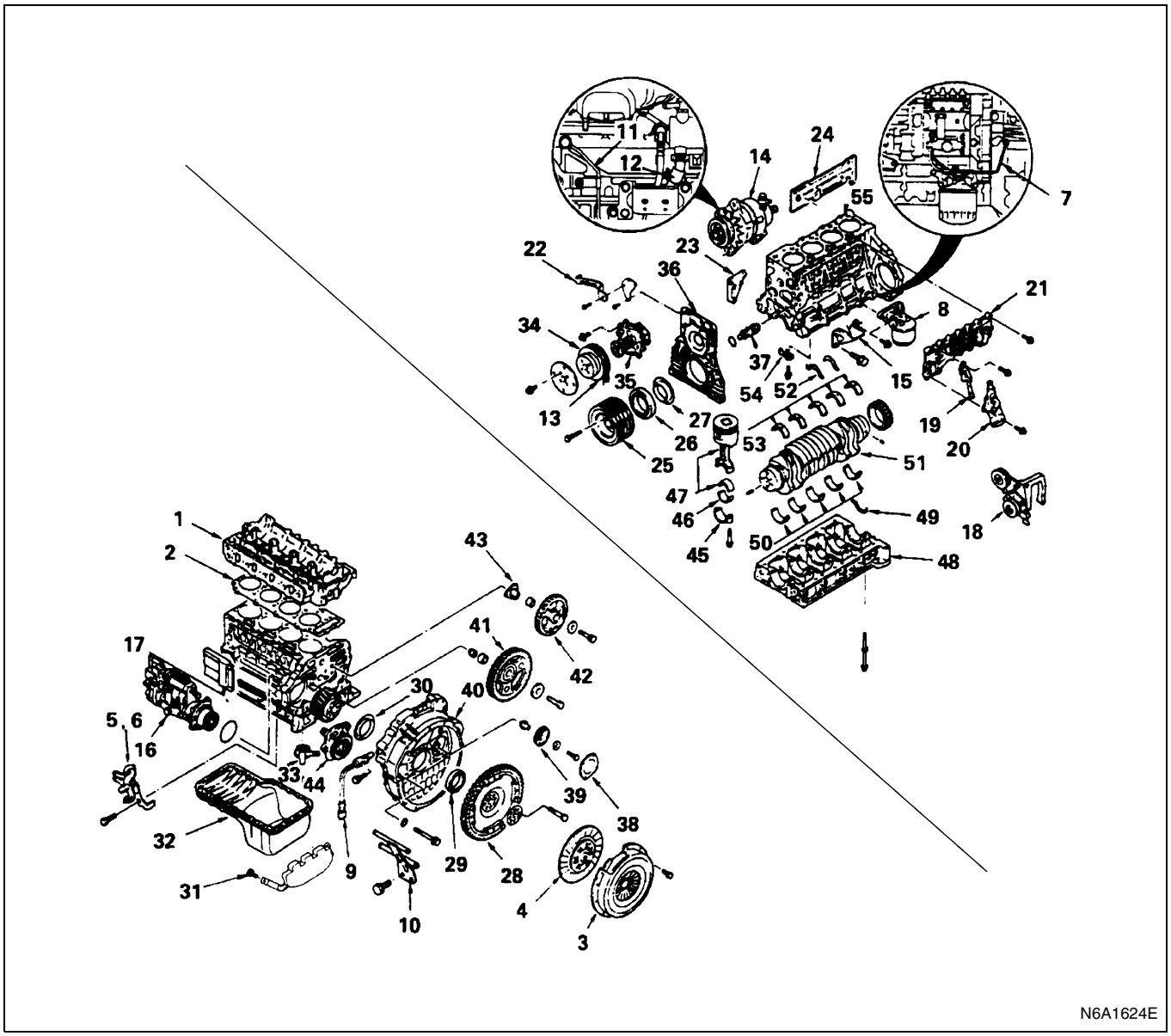
Angle gauge: 5-8840-0266-0



10. Oil Pump Strainer
11. Oil Pan
12. Spacer Rubber
13. Cylinder Head Gasket
    Above works refer to “CYLINDER BLOCK” section in this manual.
14. Cylinder Head Assembly
    Above works refer to “CYLINDER HEAD” section in this manual.

CYLINDER BLOCK

Component



Legend

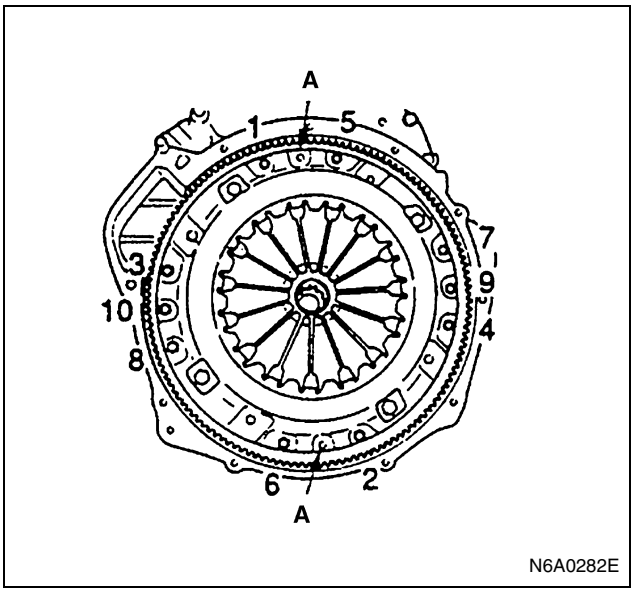
1. Cylinder head assembly
2. Cylinder head gasket
3. Clutch pressure plate assembly
4. Driven plate
5. Engine control wire
6. Engine control lever assembly
7. Oil pipe
8. Oil filter assembly
9. Tachometer sensor
10. Fuel pipe bracket
11. Vacuum pump oil pipe
12. Vacuum pump rubber hose
13. Fan belt
14. Generator
15. Engine foot
16. Injection pump assembly
17. Injection pump rubber spacer
18. Idle pulley bracket
19. Heater pipe
20. Water suction pipe
21. Oil cooler assembly
22. Fan belt adjust plate
23. Generator bracket
24. Cover
25. Crankshaft pulley
26. Crankshaft front oil seal
27. Crankshaft front slinger
28. Flywheel assembly
29. Crankshaft rear oil seal
30. Crankshaft rear slinger
31. Spacer rubber
32. Oil pan
33. Oil pump strainer
34. Water pump pulley
35. Water pump
36. Front retainer
37. Oil thermo valve
38. Power steering pump idle gear cover
39. Power steering pump idle gear
40. Flywheel housing
41. Idle gear A
42. Idle gear B
43. Idle gear B shaft
44. Oil pump assembly
45. Connecting rod cap
46. Connecting rod lower bearing
47. Piston and connecting
48. Crankcase
49. Thrust bearing lower
50. Crankshaft bearing lower
51. Crankshaft assembly
52. Thrust bearing upper
53. Crankshaft bearing upper
54. Piston oil jet
55. Cylinder block

Disassembly

1. Cylinder Head Assembly
   Above works refer to CYLINDER HEAD" section in this manual.
2. Cylinder Head Gasket

Caution:
Do not reuse the cylinder head gasket.

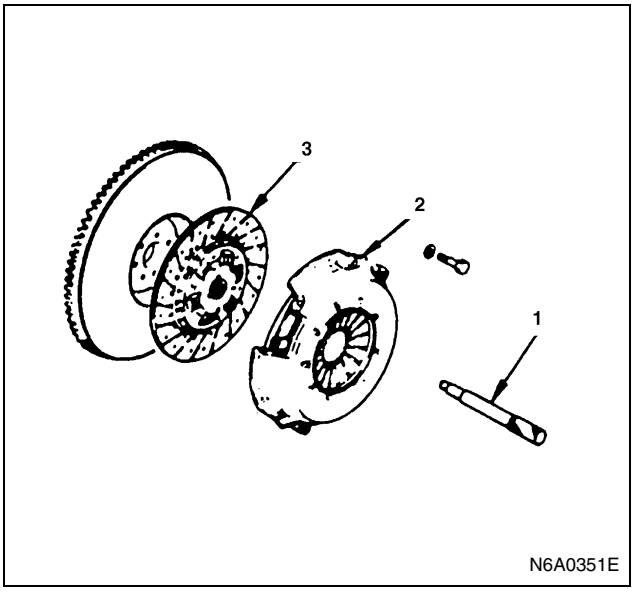
3. Clutch Pressure Plate Assembly
   1) Insert the clutch pilot a slinger to the clutch assembly.
      Clutch Pilot Aligner: 5-8840-2240-0
   2) Loosen the pressure plate bolts in numerical order a little at a time as shown in the illustration.



Legend

A. Knock pin

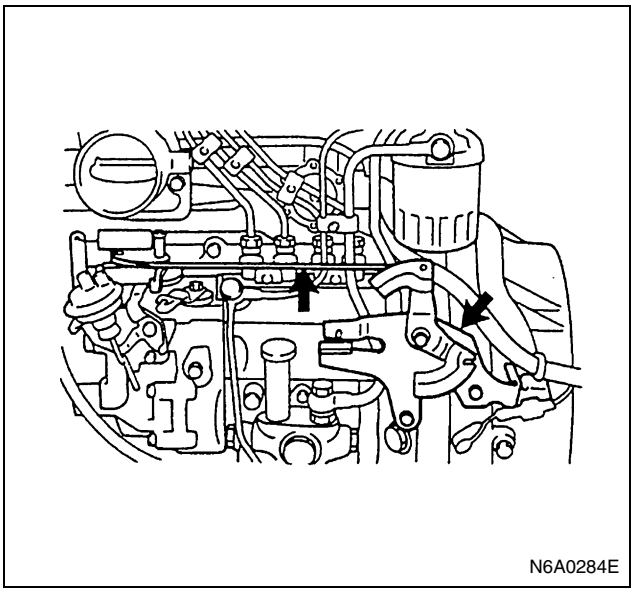
   3) Remove the pressure plate assembly.
4. Driven Plate
   Remove the driven plate with the clutch pilot aligner.



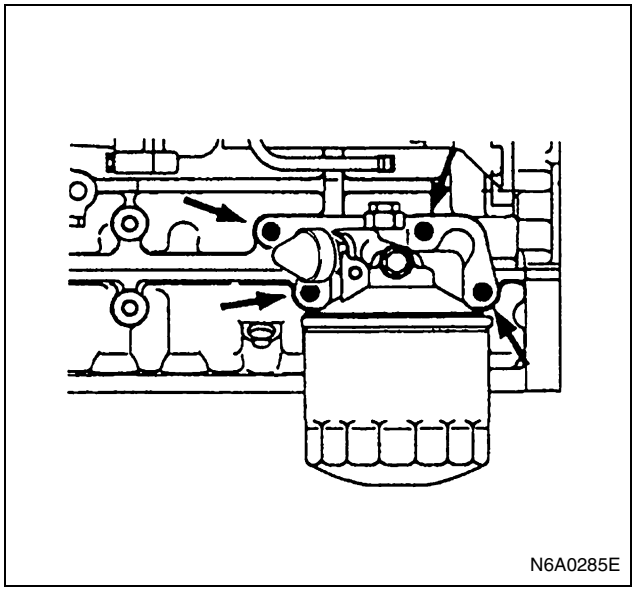
Legend

1. Clutch pilot aligner
2. Clutch pressure plate assembly
3. Driven plate

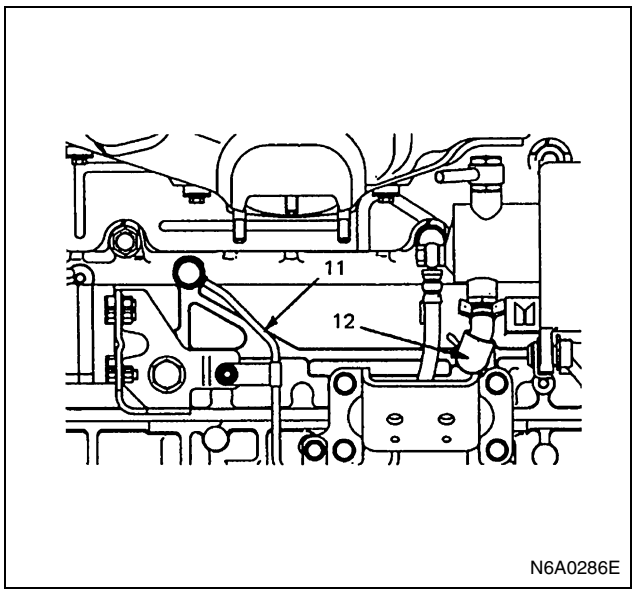
5. Engine Control Wire
6. Engine Control Lever Assembly
7. Oil Pipe



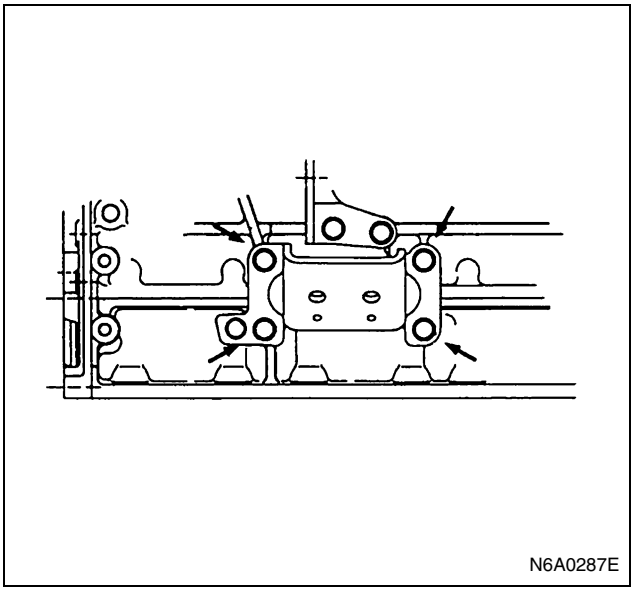
8. Oil Filter Assembly
9. Tachometer Sensor
10. Fuel Pipe Bracket



11. Vacuum Pump Oil Pipe (11)
12. Vacuum Pump Rubber Hose (12)



13. Fan Belt
14. Generator
15. Engine Foot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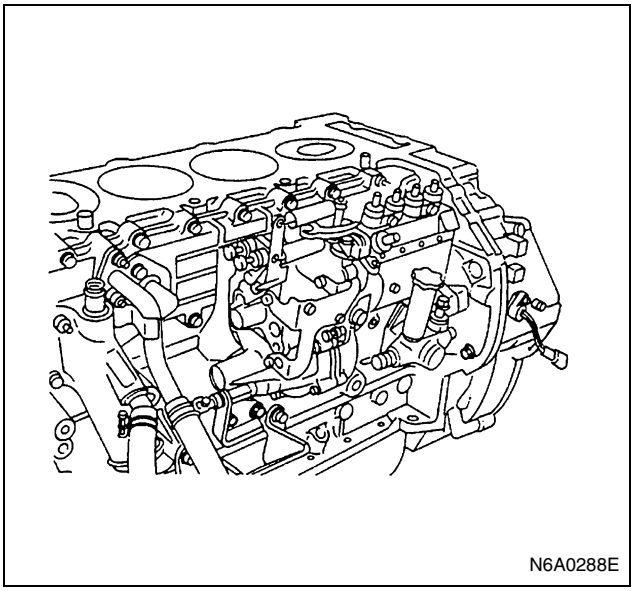
16. Injection Pump Assembly
    1) Remove the injection pump bracket bolts and the injection pump rear bracket bolts.
    2) Then remove the injection pump assembly.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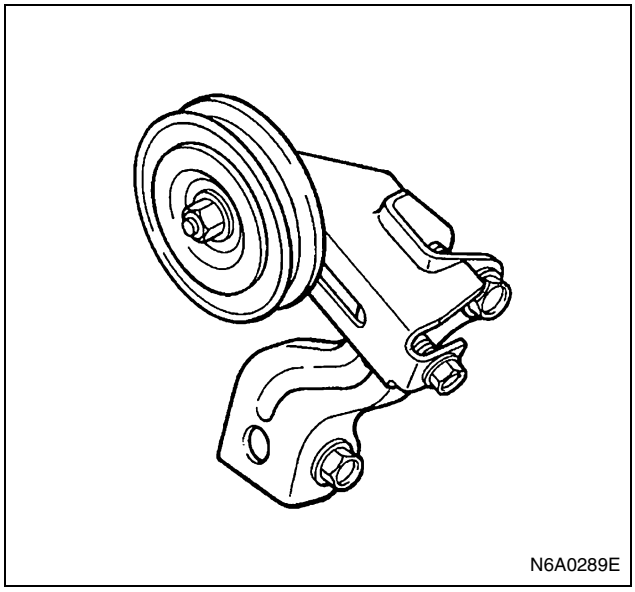
17. Injection Pump Rubber Spacer
18. Idle Pulley Bracket (If equipped with A/C)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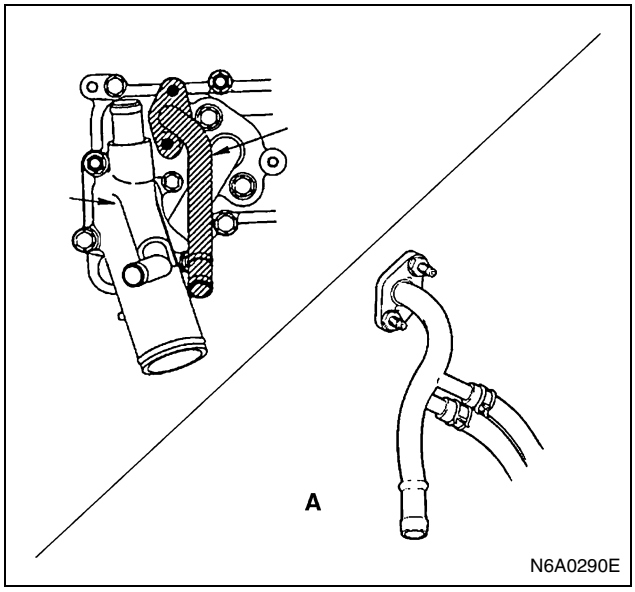
19. Heater Pipe
20. Water Suction Pipe



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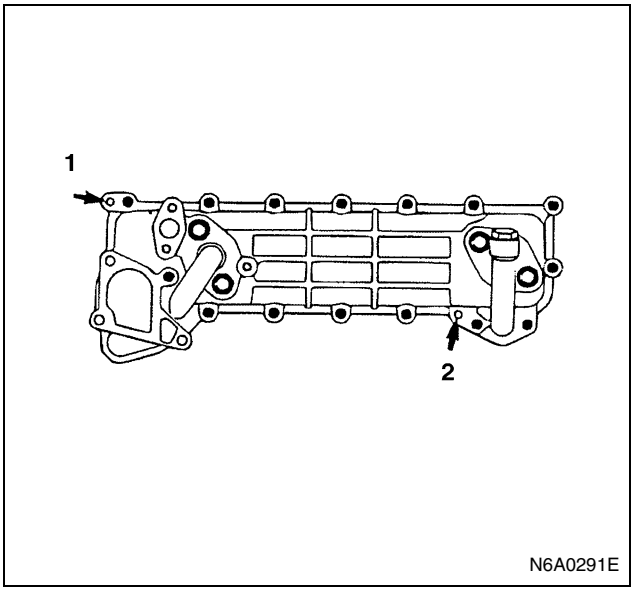
Legend
A. 4HF1-2

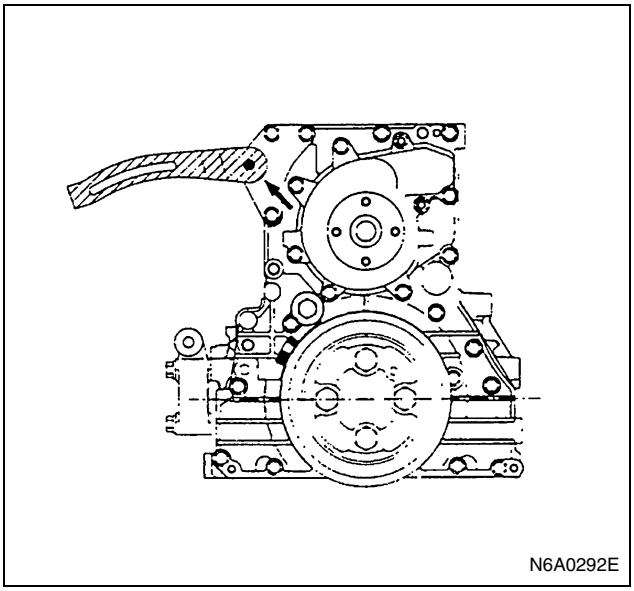
21. Oil Cooler Assembly
    1) Remove the oil cooler bolts.
    2) Install a oil cooler fixing bolt to the oil cooler replacer hole as shown in the illustration, and tighten the bolt alternately a little at a time.



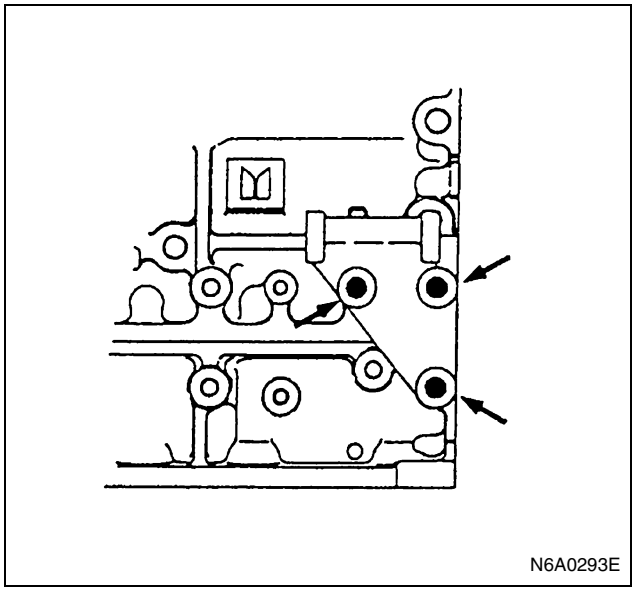
Legend

1. 4HE1-TC
2. 4HF1, 4HG1-T

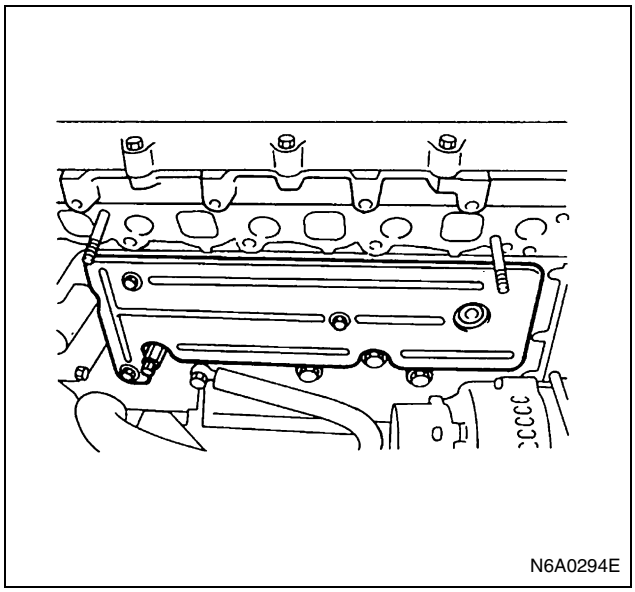
22. Fan Belt Adjust Plate

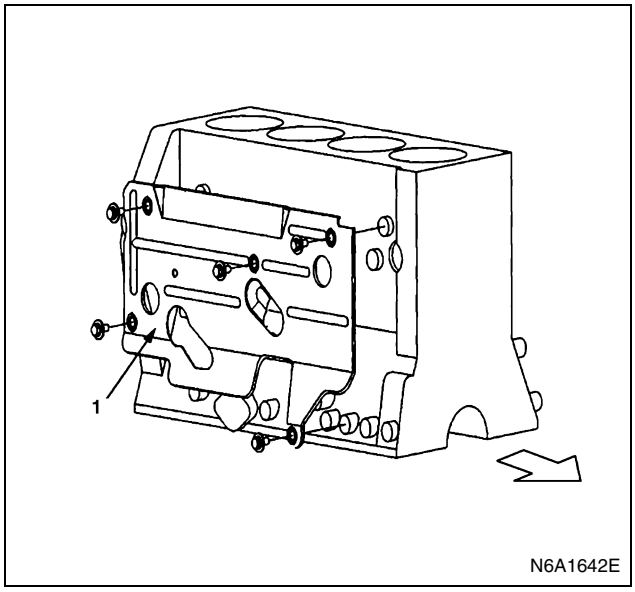


23. Generator Bracket



24. Cover

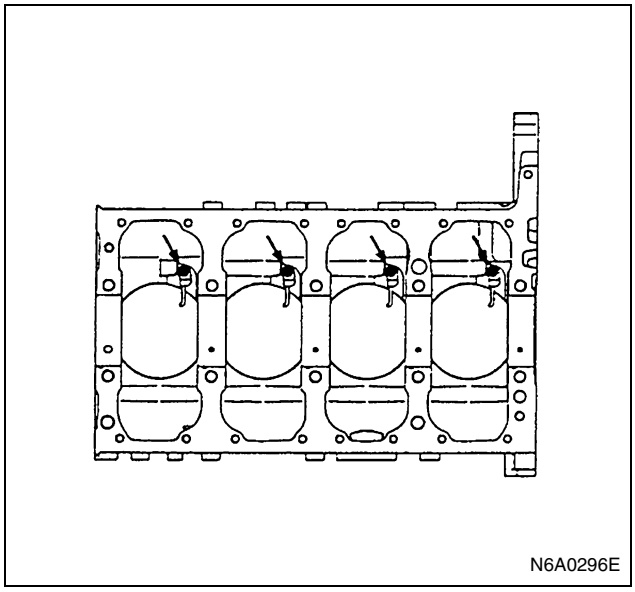




Legend

1. Cover

25. Crankshaft Damper Pulley
26. Crankshaft Front Oil Seal
27. Crankshaft Front Slinger
28. Flywheel Assembly
29. Crankshaft Rear Oil Seal
30. Crankshaft Rear Slinger
31. Space Rubber (NKR model only)
32. Oil Pan
33. Oil Pump Strainer
34. Water Pump Pulley
35. Water Pump
36. Front Retainer
37. Oil Thermo Valve
38. Power Steering Pump Idle Gear Cover
39. Power Steering Pump Idle Gear
40. Flywheel Housing
41. Idle Gear A
42. Idle Gear B
43. Idle Gear B Shaft
44. Oil Pump Assembly
45. Connecting Rod Cap
46. Connecting Rod Lower Bearing
47. Piston and Connecting Rod Assembly
48. Crankcase
49. Thrust Bearing Lower
50. Crankshaft Bearing Lower
51. Crankshaft Assembly
52. Thrust Bearing Upper
53. Crankshaft Bearing Upper
    Above works refer to “CRANKSHAFT” section in this manual.
54. Piston Oiling Jet
    Loosen the check valves to remove both the check valves and the oiling jets.
    Take care not to bend or damage the oiling jets.



55. Cylinder Block

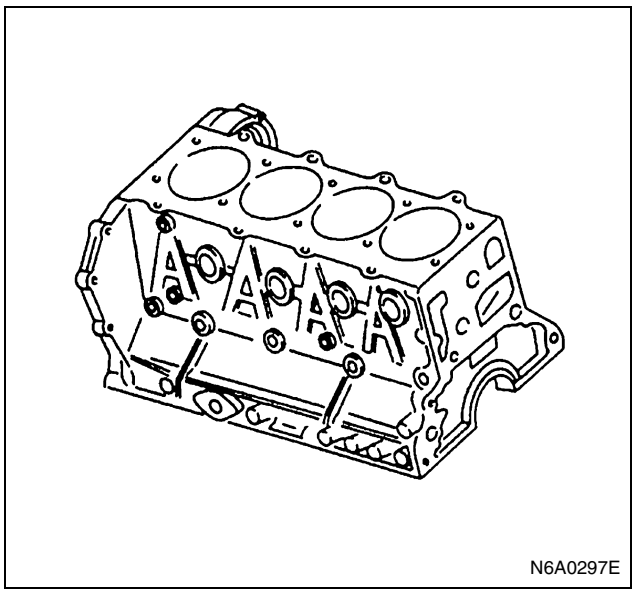
Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

1. Remove the gasket and any other material adhering to the upper surface of the cylinder block.
   Be very careful not to allow any material to accidentally drop into the cylinder block.
   Be very careful not to scratch the cylinder block.
2. Carefully remove the oil pump, rear oil seal, and oil pan installation surface seal.
3. Wipe the cylinder block clean.

Cylinder Body Upper Face Warpage

1. Remove the cylinder body dowel.
2. Remove the cylinder liner.
   Refer to “Cylinder Liner Replacement”.

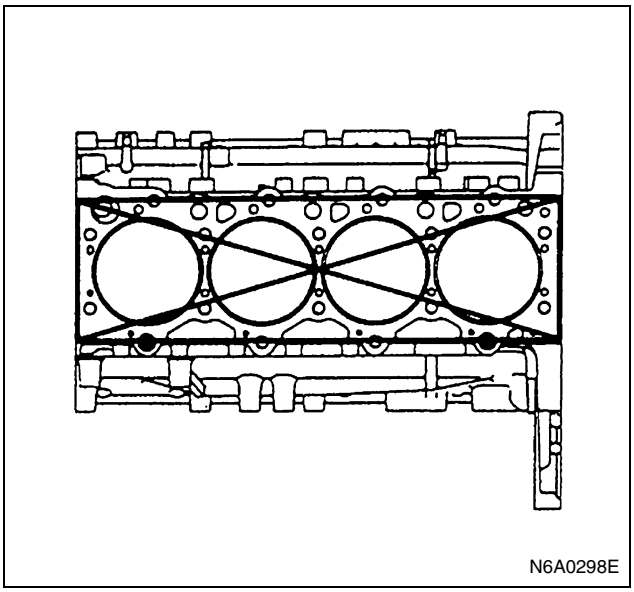


3. Use a straight edge and a feeler gauge to measure the four sides and the two diagonals of the cylinder body upper face.
4. If the measured values exceed the specified limit, the cylinder body must be replaced.

Caution:
Do not regrind the cylinder body upper face.

Cylinder Body Upper Face Warpage	mm (in)
Standard	Limit
0.05 (0.002) or less	0.20(0.008)

Cylinder Body Height (H) (Reference)	mm (in)
Standard	
279.965 — 280.035 (11.022 — 11.025)	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5. Reinstall the cylinder liner.
   Refer to the “Cylinder Body Bore Measurement”.
6. Reinstall the cylinder body dowel.

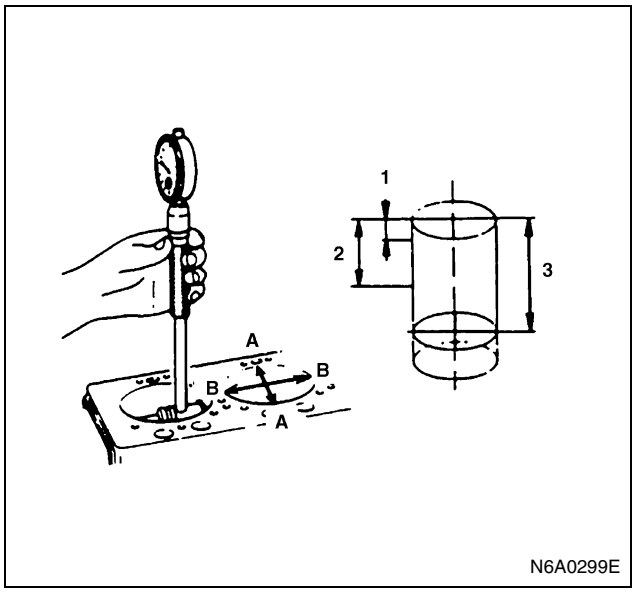
Cylinder Liner Bore Measurement

Use a cylinder indicator to measure the cylinder bore at measuring points (1), (2) and (3) in the A — A and B — B directions of the crankshaft.
Measuring points:

1. 20 mm (0.79 in)
2. 90 mm (3.54 in)
3. 160 mm (6.30 in)

If the measured value exceeds the specified limit, the cylinder liner must be replaced.

Cylinder Liner Bore		mm (in)
	Standard	Limit
4HF1 4HF1-2	112.021 — 112.050 (4.4103 — 4.4114)	112.20 (4.417)
4HG1 4HG1-T	115.021 — 115.050 (4.5284 — 4.5295)	115.20 (4.535)
4HE1-TC	110.041 — 110.080 (4.3323 — 4.3338)	110.23 (4.340)



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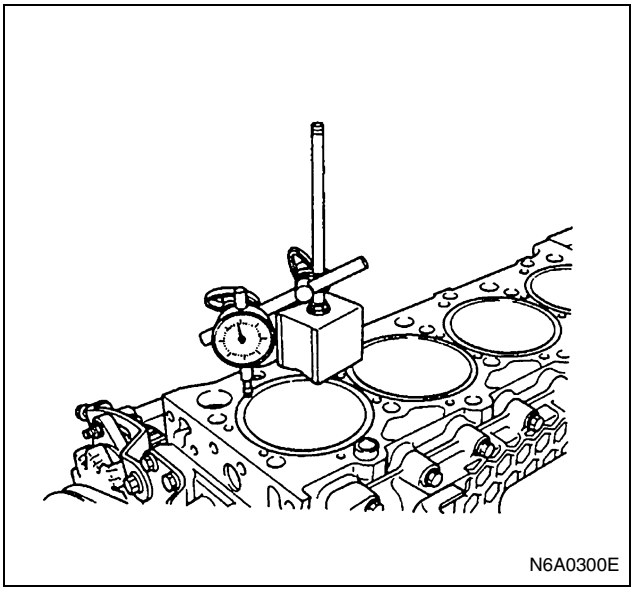
Notice:
The inside of the dry type cylinder liner is made of thin cast iron. It cannot be rebored or honed.
If the inside of the cylinder liner is scored or scorched, the cylinder liner must be replaced.

Cylinder Liner Projection Inspection
Use a dial gauge to measure the projection of each cylinder.

Cylinder Liner Projection	mm (in)
Standard	
0.09 — 0.14 (0.0035 — 0.0055)	

The difference in the cylinder liner projection height between any two adjacent cylinders must not exceed 0.03 mm (0.0012 in).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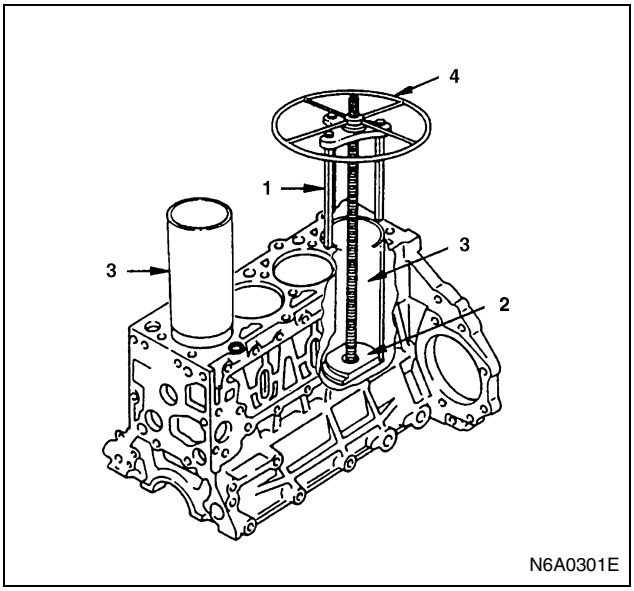
Cylinder Liner Replacement

Cylinder Liner Removal

If could not be removed cylinder liner, it is recommended to remove it by following procedure.

1. Set the cylinder liner remover (1) to the cylinder liner (3).
2. Check to see if the remover shaft ankle (2) is firmly gripping the cylinder liner bottom edge.
3. Slowly turn the remover shaft handle (4) clockwise to pull the cylinder liner free.
   Cylinder Liner Remover:
   9-8523-1169-0
   Cylinder Liner Remover Ankle:
   5-8840-2220-0
   Ankle:
   5-8840-2397-0 (4HG1)



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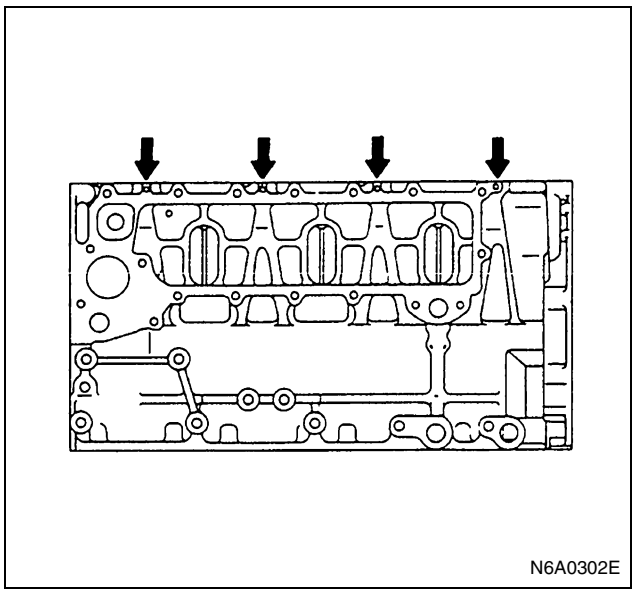
Caution:
Take care not to damage the cylinder body upper face during the cylinder liner removal procedure.

Cylinder Liner Grade Selection and Standard Fitting Interference

Accurately measured fitting interference and proper cylinder liner grade selection are extremely important.
If the cylinder liner fitting interference is too small, engine cooling efficiency will be adversely affected.
If the cylinder liner fitting interference is too large, it will be difficult to insert the cylinder liner into the cylinder body.
A mark was stamped on the left side of the cylinder block during production to indicate the correct liner. The liner grade (i.e.1, 2, 3) is indicated in metal stamp.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Cylinder Liner Grade

- 4HF1 / 4HF1-2

Line Grade	Cylinder Bore Diameter mm (in.)	Service Grade	Liner Outside Diameter mm (in.)
1	115.001 — 115.010 (4.5276 — 4.5279)	1X	114.991 — 115.000 (4.5272 — 4.5276)
2	115.011 — 115.020 (4.5280 — 4.5283)	3X	115.001 — 115.010 (4.5276 — 4.5279)
3	115.021 — 115.030 (4.5284 — 4.5287)		

• 4HG1 / 4HG1-T

Line Grade	Cylinder Bore Diameter mm (in.)	Service Grade	Liner Outside Diameter mm (in.)
1	118.001 — 118.010 (4.6457 — 4.6461)	1X	117.991 — 118.000 (4.6453 — 4.6457)
2	118.011 — 118.020 (4.6461 — 4.6464)	3X	118.001 — 118.010 (4.6457 — 4.6461)
3	118.021 — 118.030 (4.6465 — 4.6468)		

• 4HE1-TC

Line Grade	Cylinder Bore Diameter mm (in.)	Service Grade	Liner Outside Diameter mm (in.)
1	115.001 — 115.010 (4.5276 — 4.5279)	1X	115.021 — 115.030 (4.5284 — 4.5287)
2	115.011 — 115.020 (4.5280 — 4.5283)	3X	115.031 — 115.040 (4.5289 — 4.5291)
3	115.021 — 115.030 (4.5284 — 4.5287)		

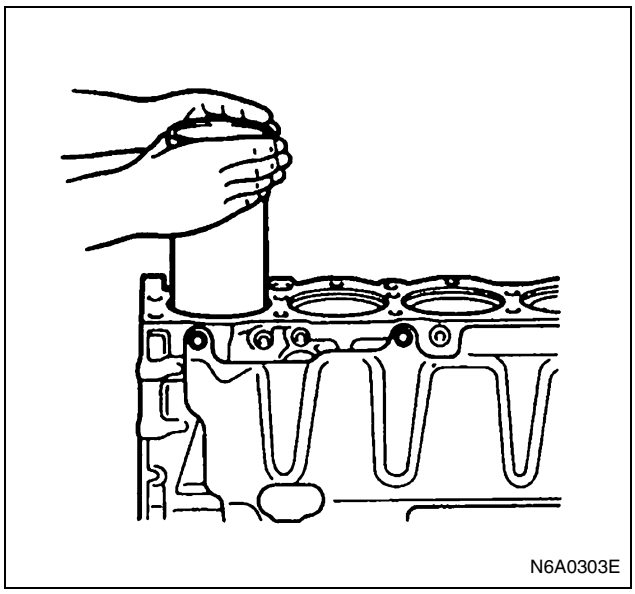
The cylinder liner grade is stamped on the outside of the cylinder liner.

Cylinder Liner Installation (For 4HF1, 4HF1-2, 4HG1 and 4HG1-T Engine)

1. Use new kerosene or diesel oil to thoroughly clean the cylinder liners and bores.
2. Use compressed air to blow dry the cylinder liner and bore surfaces.

Caution:
All foreign material must be carefully removed from the cylinder liner and the cylinder bore before installation.

3. Install the cylinder liner perpendicularly to the cylinder bore. Do not give any excessive force such as knocking while inserting cylinder liner into the cylinder bore.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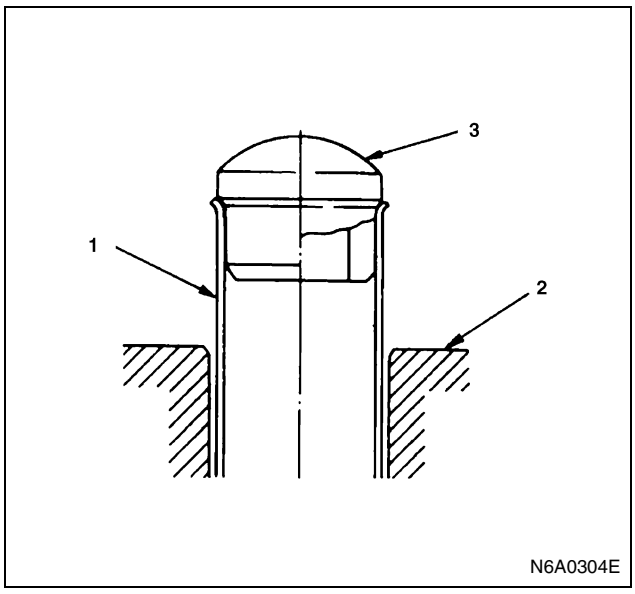
Cylinder Liner Installation (For 4HE1-TC Engine)

1. Cylinder Liner Installation Using The Special Tool
   - Use new kerosene or diesel oil to thoroughly clean the cylinder liners and bores.
   - Use compressed air to blow-dry the cylinder liner and bore surfaces.

Caution:
All foreign material must be carefully removed from the cylinder liner and the cylinder bore before installation.

- Insert the cylinder liner (1) into the cylinder body (2) from the top of the cylinder body.
- Set the cylinder liner installer (3) to the top of the cylinder liner.
  Cylinder Liner Installer: 5-8840-2337-0



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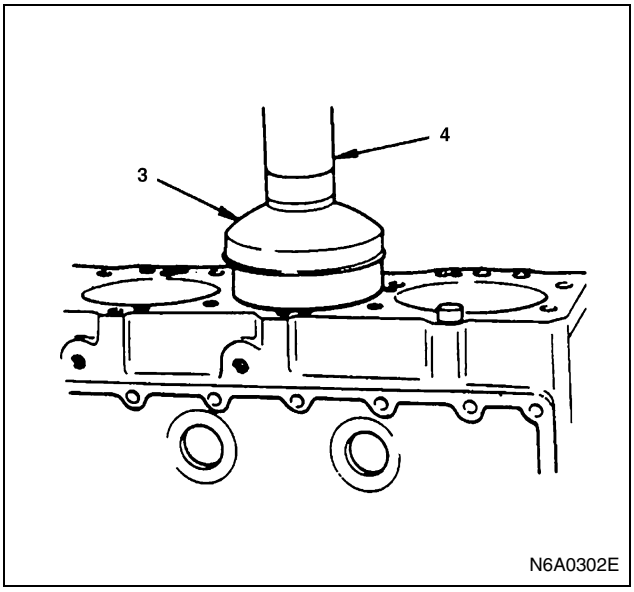
- (3) is directly beneath the bench press shaft center (4).



Caution:
Check that the cylinder liner is set perpendicular to the bench press and that there is no wobble.

- Use the bench press to apply a seating force of 4,900 N (500 kg / 1,102.5 lb) to the cylinder liner.
- Apply a force of 24,500 N (2,500 kg / 5,512.5 lb) to fully seat the cylinder liner.
- After installing the cylinder liner, measure the cylinder liner projection.
  Refer to “Cylinder Liner Projection Inspection”.

2. Cylinder Liner Installation Using Dry Ice
   If the cylinder liner is a chrome plated dry type, it is advisable to use dry ice during the installation procedure.
   Cooling the cylinder liner with dry ice will cause the cylinder liner to contract, thus making installation easier.

Caution:
It is important that the cylinder liner be inserted to the cylinder body immediately after it has been cooled.

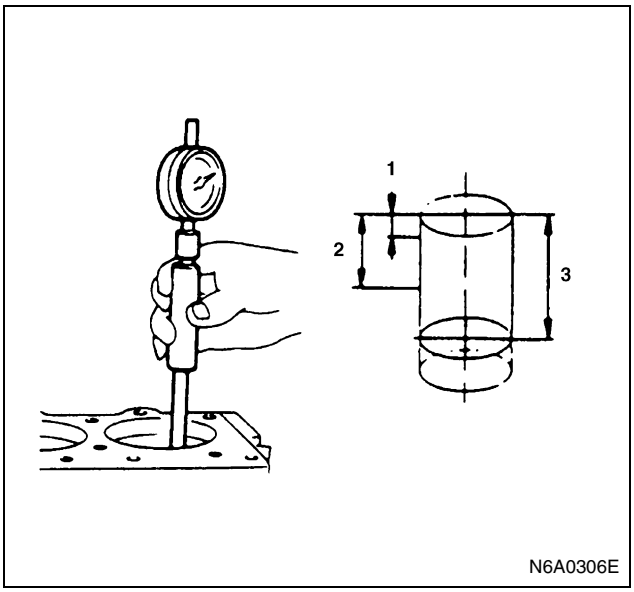
WARNING:
DRY ICE MUST BE USED WITH GREAT CARE. CARELESS HANDLING OF DRY ICE CAN RESULT IN SEVERE FROSTBITE.

Piston Grade Selection

Measure the cylinder liner bore after installing the cylinder liner. Then select the appropriate piston grade for the installed cylinder liner.

1. Measure the cylinder liner bore.
   Refer to the “Cylinder Liner Bore Measurement”.
   Measuring Point (1) 20 mm (0.79 in)
   Measuring Point (2) 90 mm (3.54 in)
   Measuring Point (3) 160 mm (6.30 in)

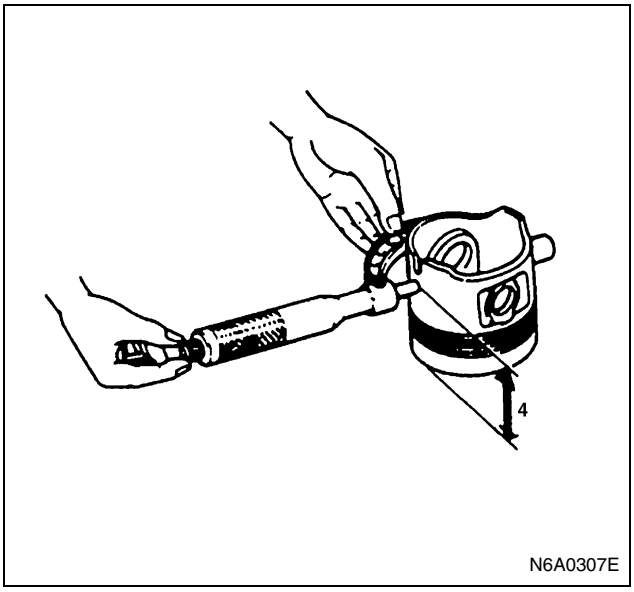
Cylinder Liner Bore		mm (in)
	Standard	Limit
4HF1 4HF1-2	112.021 — 112.050 (4.4103 — 4.4114)	112.20 (4.417)
4HG1 4HG1-T	115.021 — 115.050 (4.5284 — 4.5295)	115.20 (4.535)
4HE1-TC	110.041 — 110.080 (4.3323 — 4.3338)	110.23 (4.340)



Caution:
It is most important that the correct piston grade be used. Failure to select the correct piston grade will result in engine failure. Always measure the cylinder bore and select the correct piston grade.

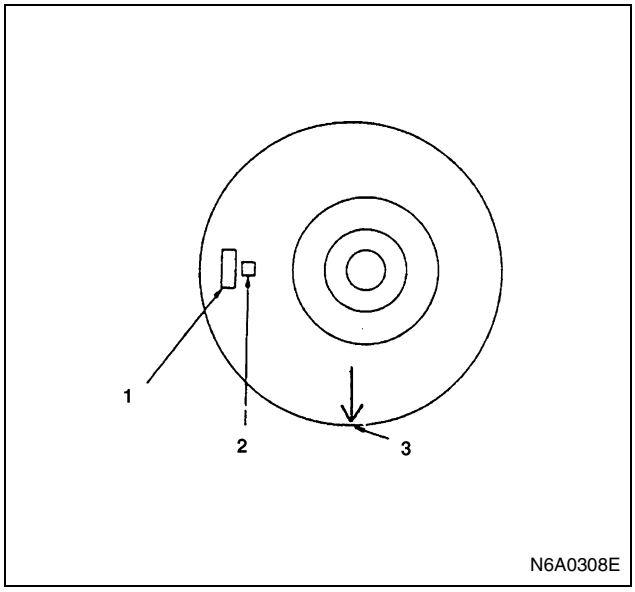
2. Measure the piston outside diameter (Reference).
   Piston Measuring Point (4): 82 mm (3.23 in)

Cylinder Liner and Piston Clearance mm (in)
4HF1 / 4HF1-2: 0.081 — 0.113 (0.0032 — 0.0044)
4HG1 / 4HG1-T: 0.081 — 0.116 (0.0032 — 0.0046)
4HE1-TC: 0.091 — 0.131 (0.0036 — 0.0052)



The piston grade (i.e. A, B, C) is indicated in metal stamp on the piston upper face.

Piston Grade			
Engine Model	Cylinder Liner Bore Diameter mm (in)	Piston Service Grade	Piston Outside Diameter mm (in)
4HF1 4HF1-2	112.041 — 112.060 (4.4111 — 4.4118)	—	111.944 — 111.959 (4.4072 — 4.4078)
4HG1 4HG1-T	115.041 — 115.060 (4.5292 — 4.5299)	—	114.944 — 114.959 (4.5253 — 4.5259)
4HE1-TC	110.066 — 110.075 (4.3333 — 4.3337)	AX	109.944 — 109.959 (4.3285 — 4.3291)
	110.076 — 110.085 (4.3337 — 4.3340)	CX	109.960 — 109.975 (4.3291 — 4.3297)



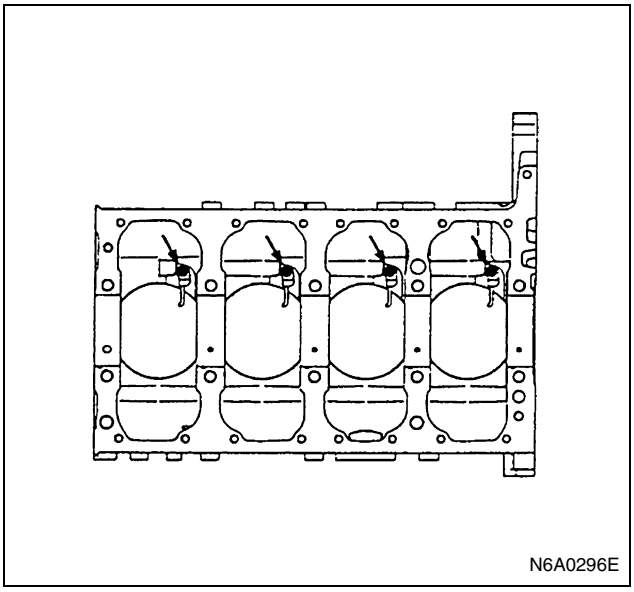
Legend
1. Part No.
2. Grade
3. Front mark

Caution:
Cylinder liner kit clearances are preset. However, the cylinder liner installation procedure may result in slight decreases in cylinder liner clearances. Always measure the cylinder liner clearance after installation to be sure that it is correct.

Reassembly

1. Cylinder Block
   Use compressed air to thoroughly clean the inside and outside surfaces of the cylinder body, the oil holes, and the water jackets.
2. Piston Oiling Jet
   1) Install the oiling jets together with the check valves. Take care not to damage the oiling jet nozzles.
   2) Tighten the check valves and oiling jets to the specified torque.

Tighten:
Check valve and oiling jet to 21 N·m (2.1 kg·m / 15 lb·ft)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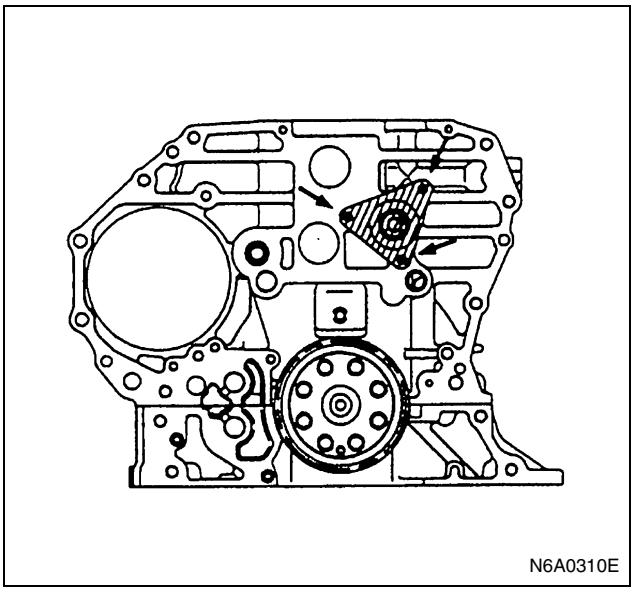
3. Crankshaft Bearing Upper
4. Thrust Bearing Upper
5. Crankshaft Assembly
6. Crankshaft Bearing Lower
7. Thrust Bearing Lower
8. Crankcase
   Above works refer to “CRANKSHAFT” section in this manual.
9. Piston and Connecting Rod Assembly
10. Connecting Rod Lower Bearing
11. Connecting Rod Cap
    Above works refer to “PISTON AND CONNECTING ROD” section in this manual.
12. Oil Pump Assembly
13. Idle Gear B Shaft

Tighten:
Idle gear B shaft bolt to 31 N·m (3.2 kg·m / 23 lb·ft)

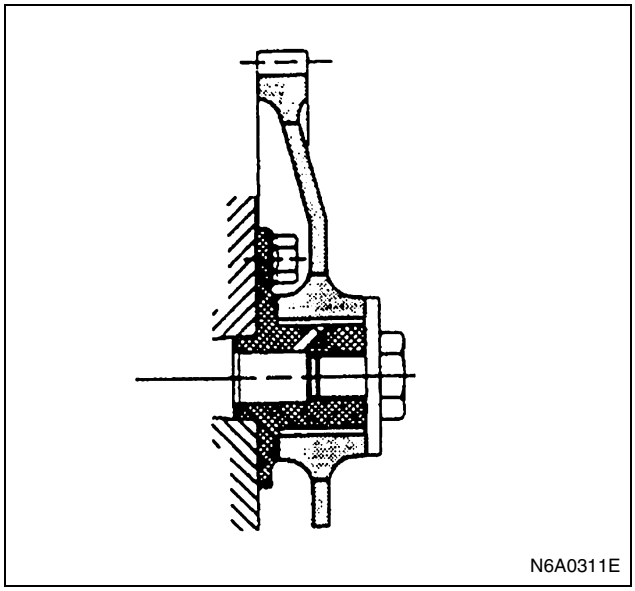
Apply the engine oil to the idle gear shaft after installation.


N6A0310E

14. Idle Gear B

The face of the idle gear B with longer boss should be positioned toward the rear side shown in the illustration.

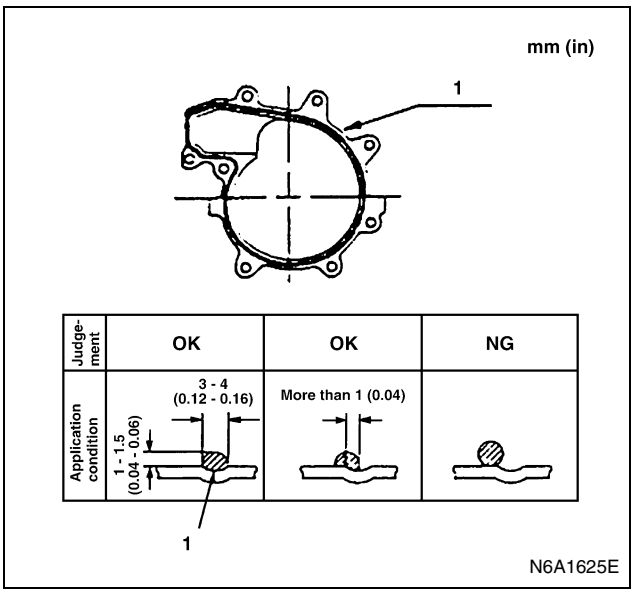
Tighten:
Idle gear B bolt to 110 N·m (11.2 kg·m / 81 lb·ft)


N6A0311E

15. Idle Gear A
16. Flywheel Housing
17. Power Steering Pump Idle Gear
18. Power Steering Pump Idle Gear Cover
    Above works refer to “OIL PUMP” section in this manual.
19. Oil Thermo Valve
20. Front Retainer
    Above works refer to “CRANKSHAFT” section in this manual.
21. Water Pump Assembly
    1) Apply 3 — 4 mm (0.12 — 0.16 in) bead of the recommended liquid gasket (Three Bond 1207C) or its equivalent on the water pump fitting surface.
    2) Install the water pump to the front retainer.

Tighten:
Water pump bolt to 24 N·m (2.4 kg·m / 17 lb·ft)

- Install the water pump within 7 minutes after application of liquid gasket.
- For the dislocation of liquid gasket, refer to the illustration.

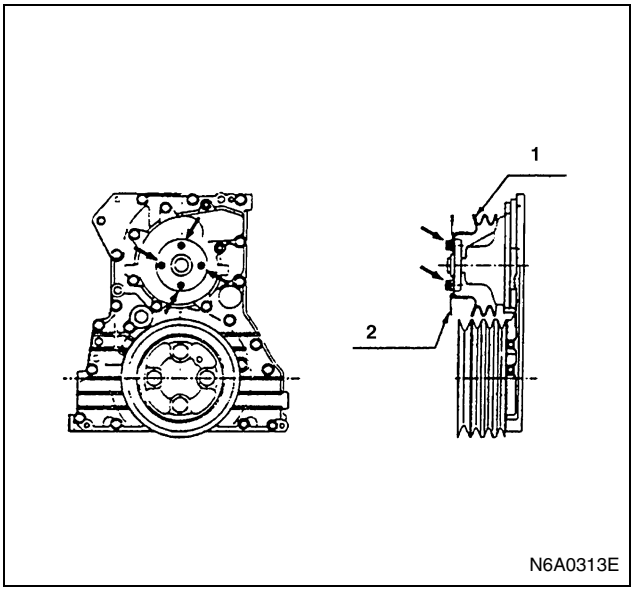


Legend
1. Liquid gasket

Caution:
The water pump clamping bolt is also used to tighten the front retainer. So, install the water pump before liquid gasket gets dry immediately after installation of the front retainer.

22. Water Pump Pulley

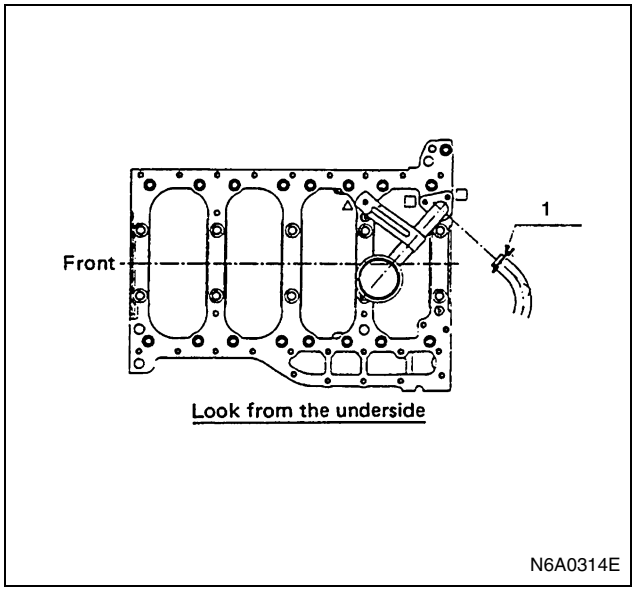
Tighten:
Water pump pulley bolt to 24 N·m (2.4 kg·m / 17 lb·ft)



Legend
1. Pulley
2. Set plate

23. Oil Pump Strainer
    Install the O-ring (1) to the oil pump strainer pipe and install the oil pump strainer to the cylinder body shown in the illustration.

Tighten:
Oil pump strainer bolt to 24 N·m (2.4 kg·m / 17 lb·ft)

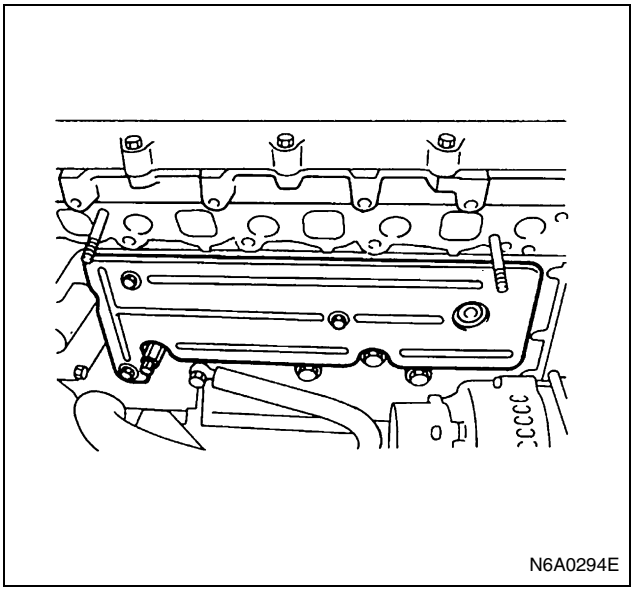


24. Oil Pan
    Above works refer to “OIL PAN” section in this manual.
25. Spacer Rubber

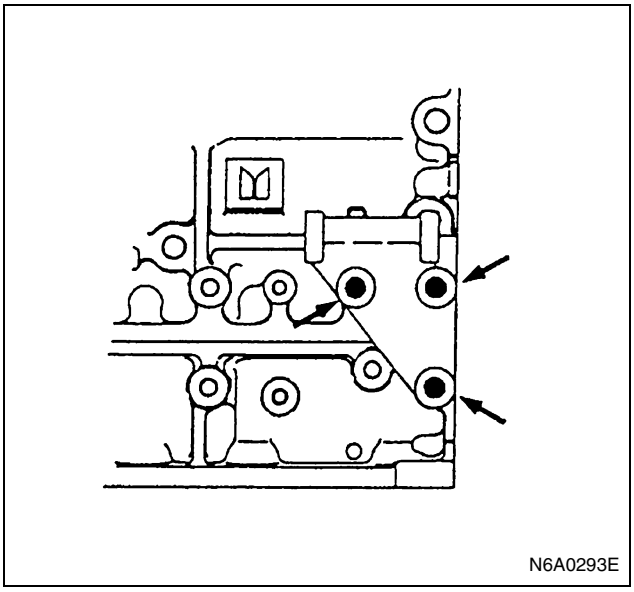
Tighten:
Spacer rubber bolt to 76 N·m (7.7 kg·m / 56 lb·ft)

26. Crankshaft Rear Slinger
27. Crankshaft Rear Oil Seal
28. Flywheel Assembly
29. Crankshaft Front Slinger
30. Crankshaft Front Oil Seal
31. Crankshaft Damper Pulley
    Above works refer to “CRANKSHAFT” section in this manual.
32. Cover

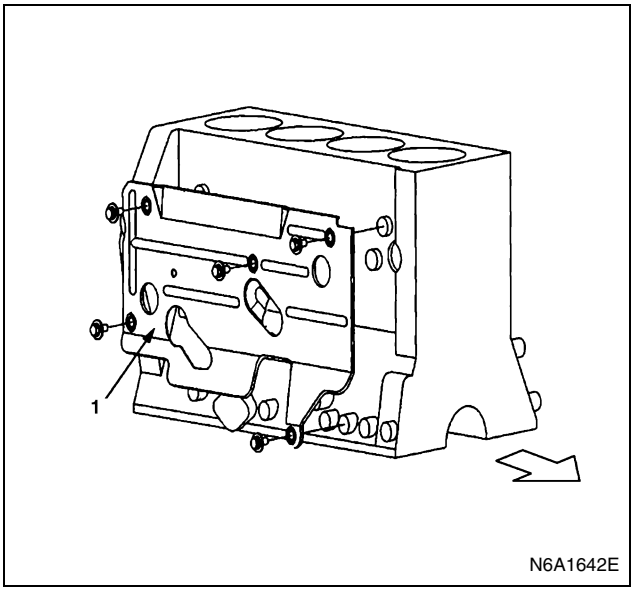
Tighten:
Cover Bolt to 13 N·m (1.3 kg·m / 9 lb·ft)


N6A0294E

4HE1-TC
4HE1-TC engines use a larger rubber spacer than other engines.


N6A0293E

34. Fan Belt Adjust Plate
    Install the adjust plate and temporarily tighten the adjust plate bolt.

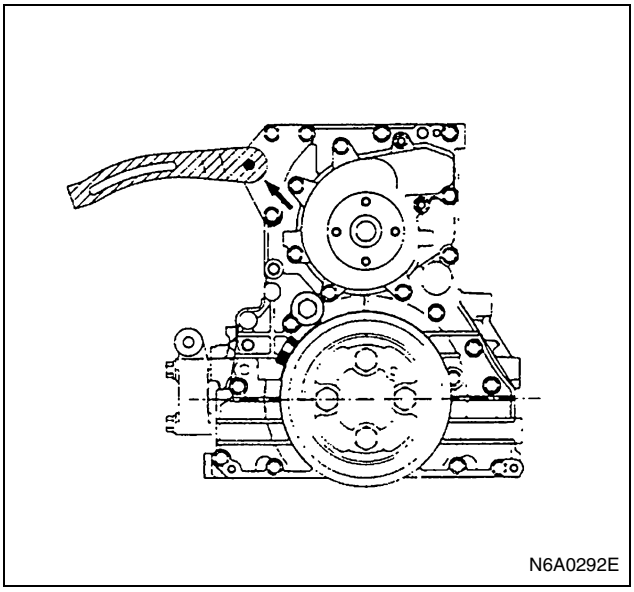


N6A1642E

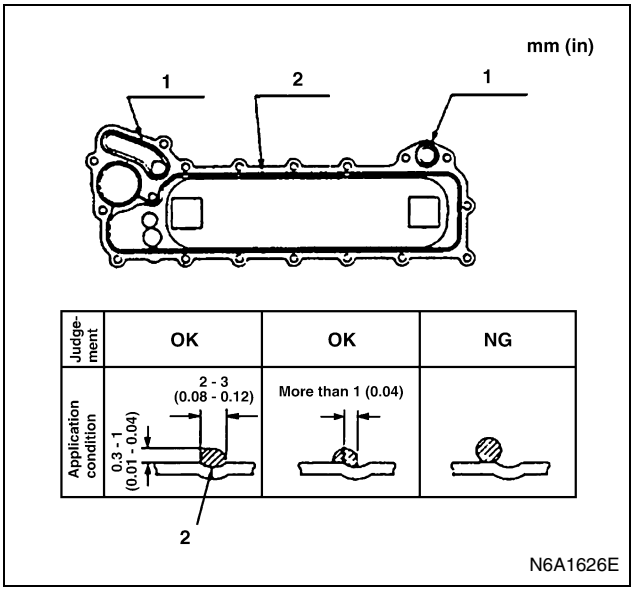
Legend
1. Cover

33. Generator Bracket

Tighten:
Generator bracket bolt to 48 N·m (4.9 kg·m / 35 lb·ft)


N6A0292E

35. Oil Cooler Assembly
    1) Apply 2 — 3 mm (0.08 — 0.12 in) bead of the recommended liquid gasket (Three Bond 1207C) or its equivalent on the oil cooler fitting surface.
    2) Apply a coat of engine oil to the O-rings (2 pieces) and install the O-rings to the oil cooler.



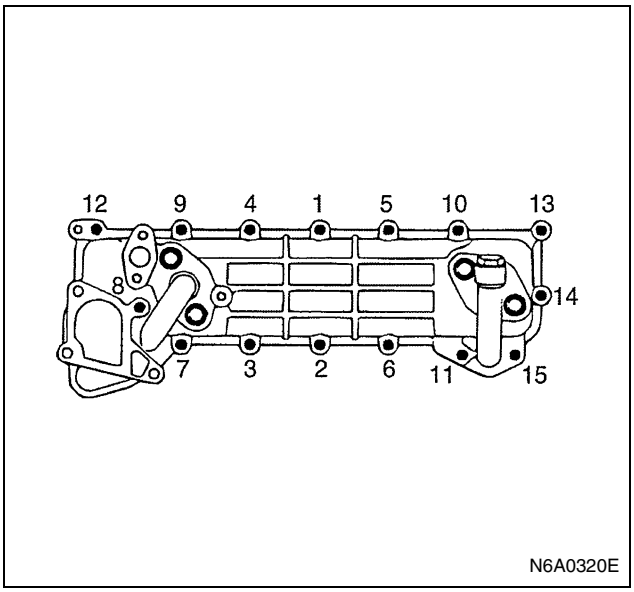
Legend
1. O-ring
2. Liquid gasket

Notice:
Take care that the O-ring is not smeared with liquid gasket.

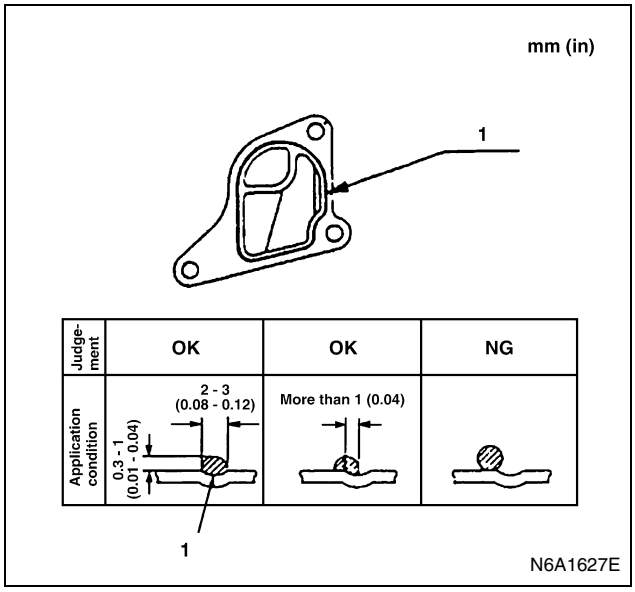
- Install it within 7 minutes after application of liquid gasket.
- For the dislocation of liquid gasket, refer to the illustration.

3) Tighten the oil cooler bolts and nut to the specified torque a little at a time in the sequence shown in the illustration.

Tighten:
Oil cooler bolt and nut to 24 N·m (2.4 kg·m / 17 lb·ft)



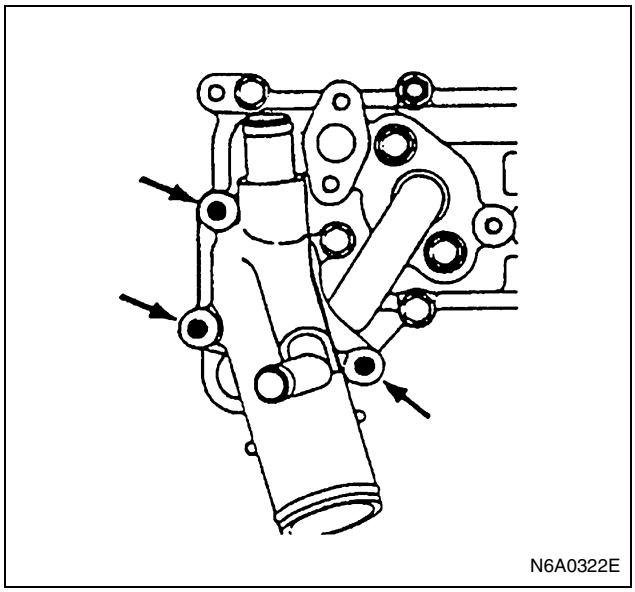
36. Water Suction Pipe
    1) Apply 2 — 3 mm (0.08 — 0.12 in) bead of the recommended liquid gasket (Three Bond 1207C) or its equivalent on the groove of the water suction pipe fitting surface.
    2) Install the water suction pipe to the oil cooler.
    - For the dislocation of liquid gasket, refer to the illustration.



Legend
1. Liquid gasket

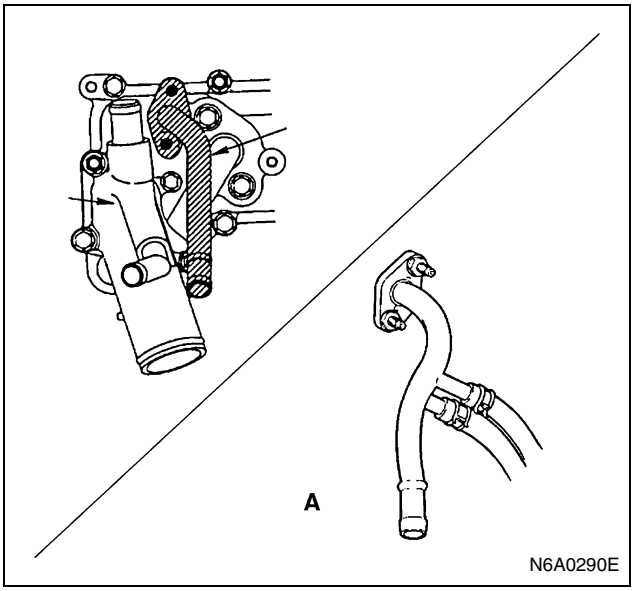
Tighten:
Water suction pipe bolt and nuts to 24 N·m (2.4 kg·m / 17 lb·ft)

Notice:
Install the water suction pipe immediately after the installation of the oil cooler.



37. Heater Pipe
    1) Install the O-ring to the heater pipe.
    2) Install the heater pipe to the oil cooler.

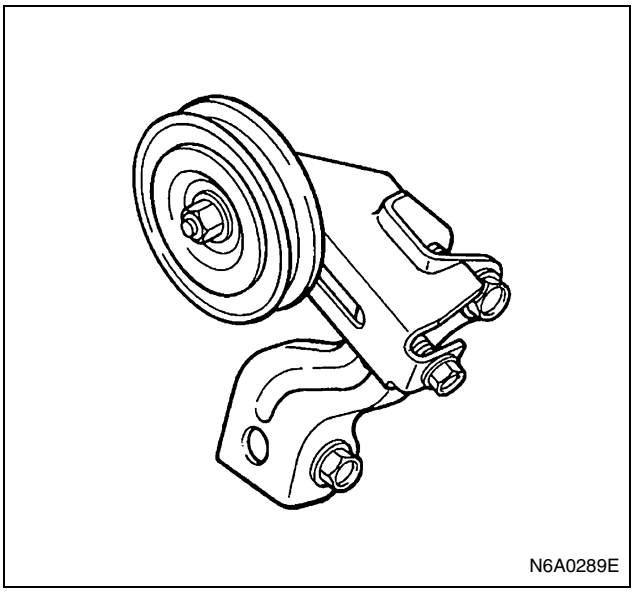
Tighten:
Heater pipe bolt to 24 N·m (2.4 kg·m / 17 lb·ft)



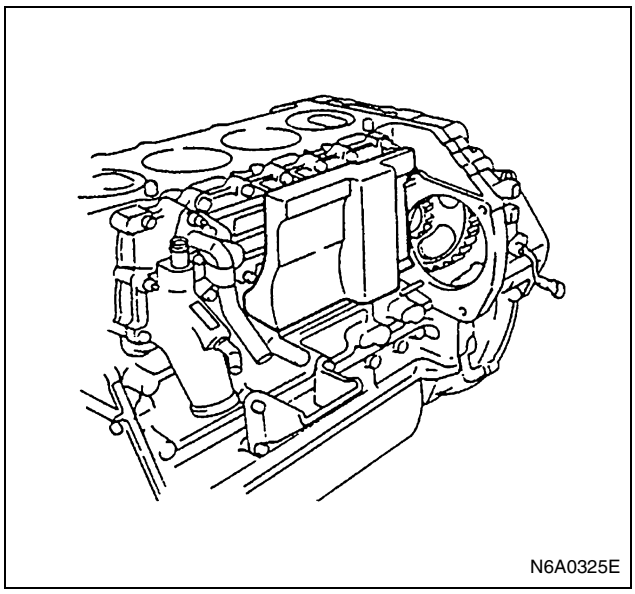
Legend
A. 4HF1-2

38. Idle Pulley Bracket (If equipped with A/C)

Tighten:
Idle pulley bracket bolt to 48 N·m (4.9 kg·m / 35 lb·ft)

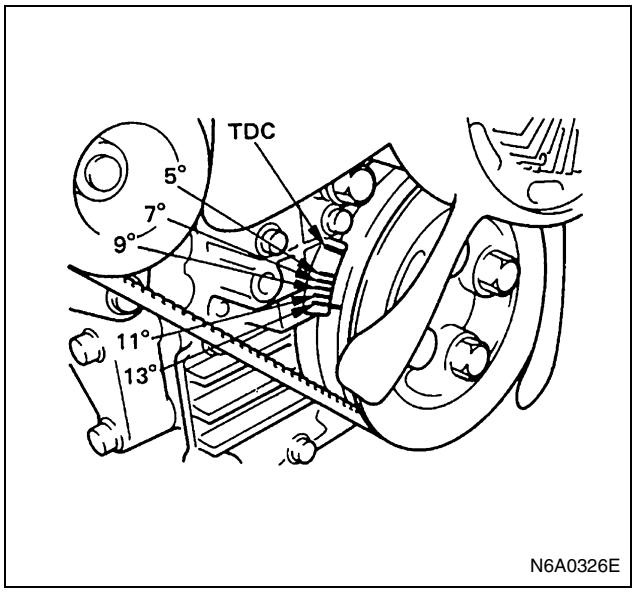


39. Injection Pump Rubber Spacer
    Stick the rubber spacer to the location indicated in the illustration with pressure sensitive adhesive double coated tape.



40. Injection Pump Assembly (Except 4HF1-2)
    1) Turn the crankshaft until the timing mark on the crankshaft damper pulley is aligned with “13°” line.

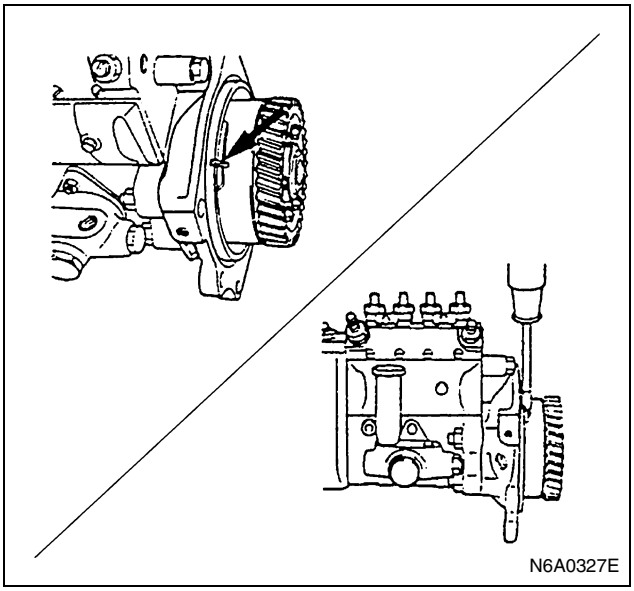
Notice:
BTDC 13° to be aligned with here is an angle at which the injection pump is installed, and has nothing to do with the injection timing.



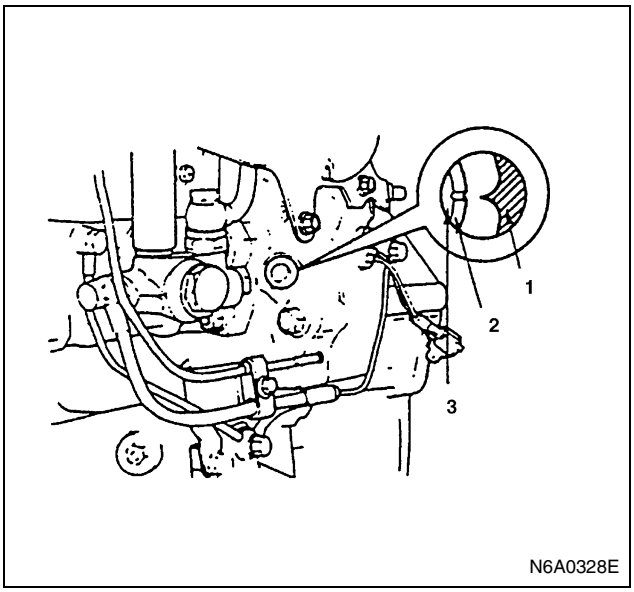
    2) Remove the inspection hole plug from the cylinder body.
    3) Install the O-ring to the injection pump bracket.
    4) Align the injection pump bracket slit with the timer slit.
    5) Install the injection pump assembly to the cylinder body.

Notice:
When the injection pump has a poor gear engagement while installing the assembly to the cylinder body, insert a screwdriver into the slit on the timer peripheral with the

pump bracket slit used as a guide, and move it up and down to get it into forcibly.


N6A0327E

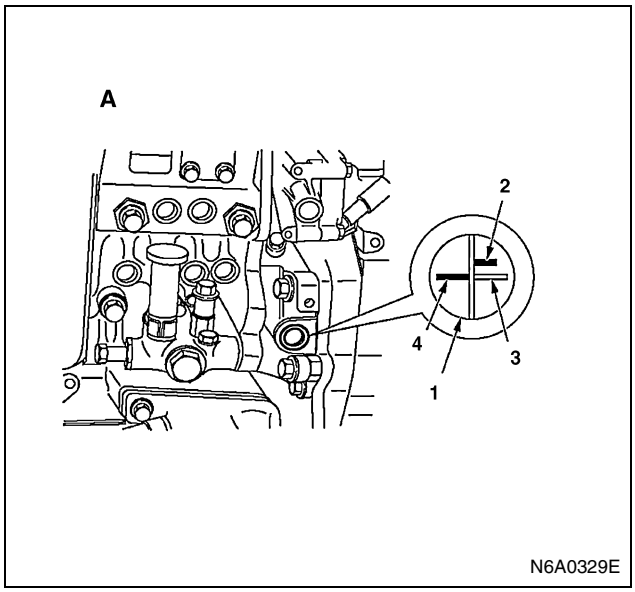
6) After installation of the injection pump, the injection timing can be checked through the timing check hole provided to the injection pump bracket.
Set the No.1 cylinder to BTDC (Injection timing of each engine model) on the compression stroke. When the pointer of the timing check hole comes in line with the mark on the timer periphery of the injection pump as shown in the illustration, the injection timing is normal. After completion of the injection timing check, tighten the check hole plug to the specified torque.



N6A0328E

Legend
1. Pointer
2. Timer outside mark
3. Timing check hole

Injection Timing	deg
4HF1 4HE1-TC (4HE1-XS, XN)	BTDC 8
4HG1	BTDC 9
4HG1-T	BTDC 7 (Except Colombia) BTDC 9 (For Colombia)
4HE1-TC (4HE1-XS)	BTDC 9 (Spec EURO3)

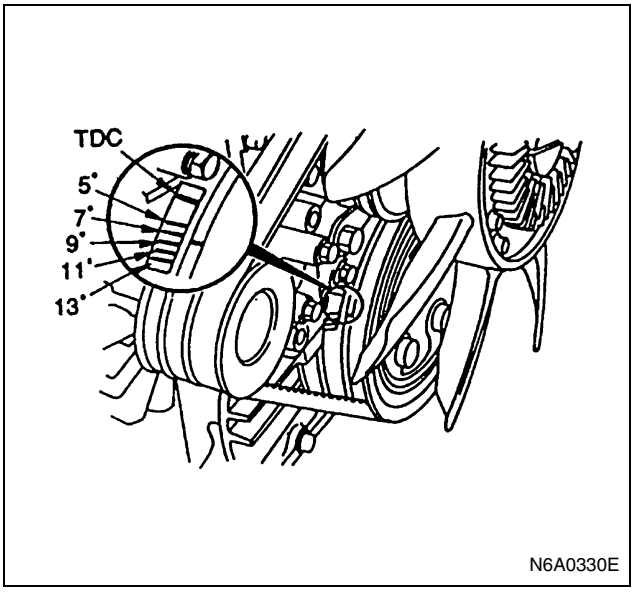


N6A0329E

Legend
A. For 4HF1-TC
1. Timing check hole
2. 8° Mark
3. 13° Mark
4. Pointer

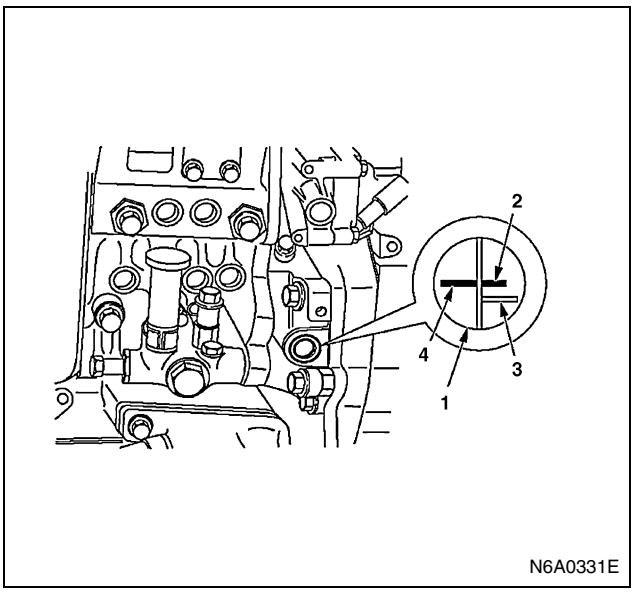
7) Turn the crankshaft until the timing mark on the crankshaft damper pulley is aligned with “8°” (98EPA) or “9°” (Spec EURO3) line.

Notice:
Position in its normal rotating direction. (for 4HE1-TC only)



8) Adjust injection pump downward so that the "8°" (98EPA) or "9°" (Spec EURO3) comes to position in the timing check hole. (for 4HE1-TC only)

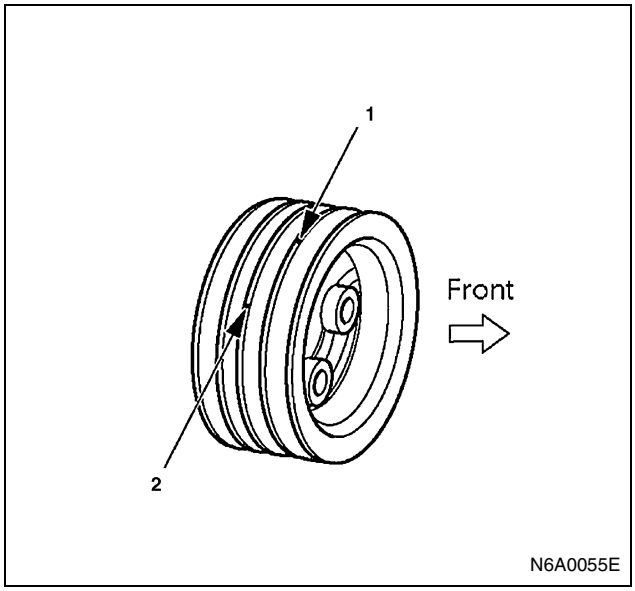
Notice:
When ever the injection pump is replaced, be sure to adjust the injection timing for the details of the adjustment, refer to the "SECTION 00 SERVICING: INJECTION TIMING INSPECTION AND ADJUSTMENT."



Legend
1. Timing check hole
2. 8° Mark
3. 13° Mark
4. Pointer

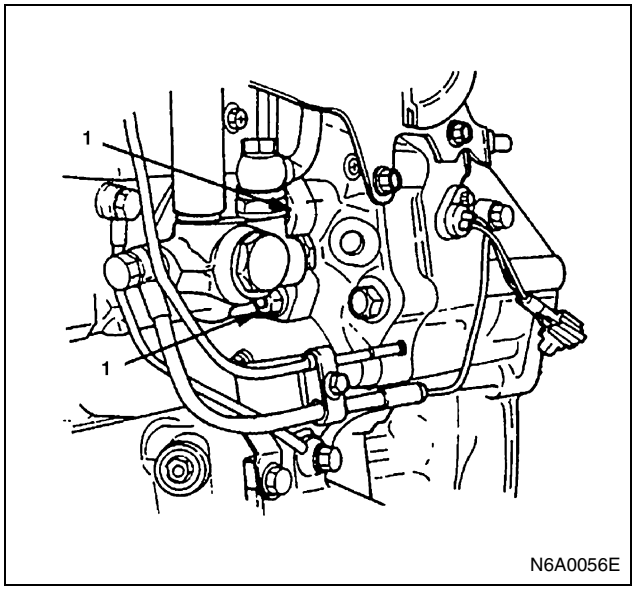
Notice:
In case the crank pulley has two marks as illustrated, (1) BTDC 49° mark on the second crest and (2) TDC mark on the third crest (as viewed from the front side), be sure to set at the mark (2). (If there are two different marks on one and same crest, set at the mark which comes second when rotated in the normal direction.)

The mark (1) is used when installing the injection pump for 4HF1-2.



9) Tighten the injection pump bracket nuts and bolts to the specified torque.

Tighten:
Injection pump bracket nut and bolt (1) to 48 N·m (4.9 kg·m / 35 lb·ft)



10) Install the injection pump rear bracket.

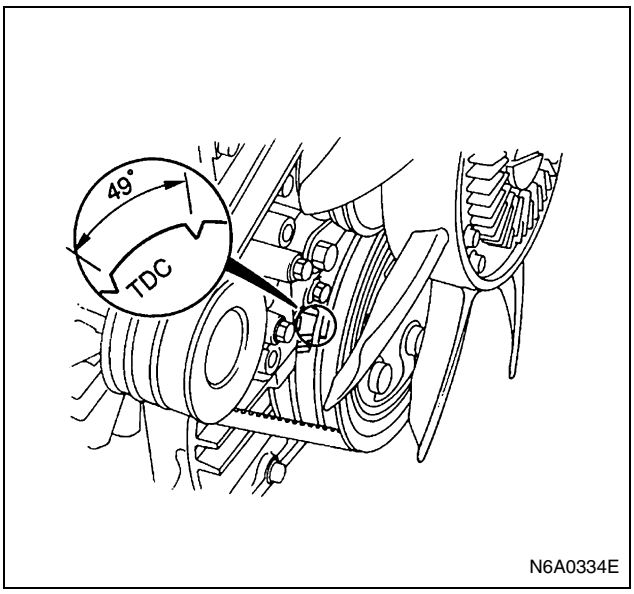
Tighten:
Injection pump rear bracket bolt to 48 N·m (4.9 kg·m / 35 lb·ft)

11) Install the inspection hole plug.

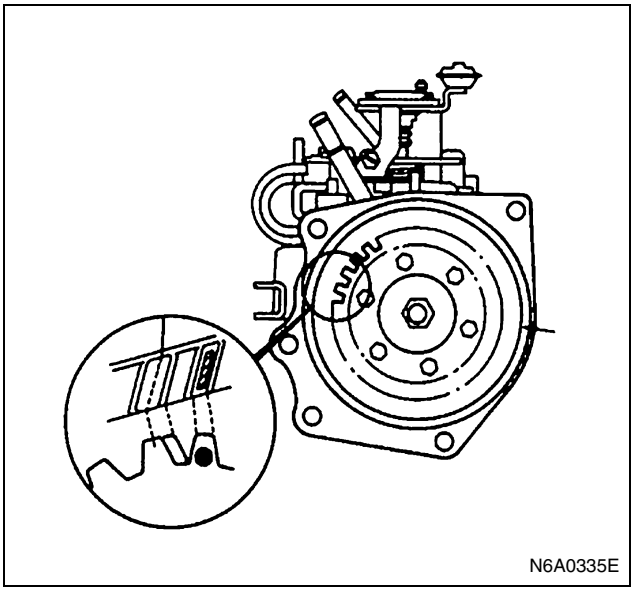
Tighten:
Inspection hole plug to 48 N·m (4.9 kg·m / 35 lb·ft)

41. Injection Pump Assembly (4HF1-2 model only)

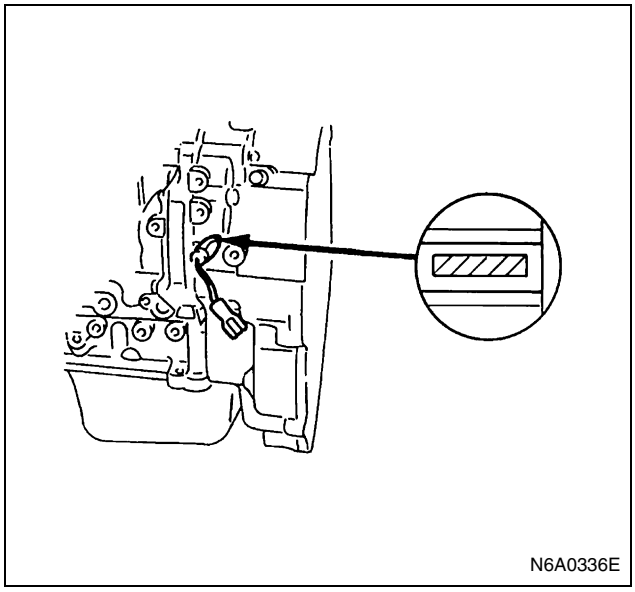
1) Turn the crankshaft to set No.1 cylinder to 49° before TDC in its compression stroke.
(49° is a pump installing alignment angle, not related to injection timing.)



2) Install O-ring to the injection pump.
3) Apply paint on the • (Z) marked side of the injection pump gear.
4) Align the pump bracket mark with the tooth (under side of the pump) just before the • (Z) marked tooth.



5) Insert the pump using the block side of stud bolt as a guide.
6) After installing the injection pump, remove the tachometer sensor from the housing, and make sure that the painted gear is at the center of the sensor mounting hole.



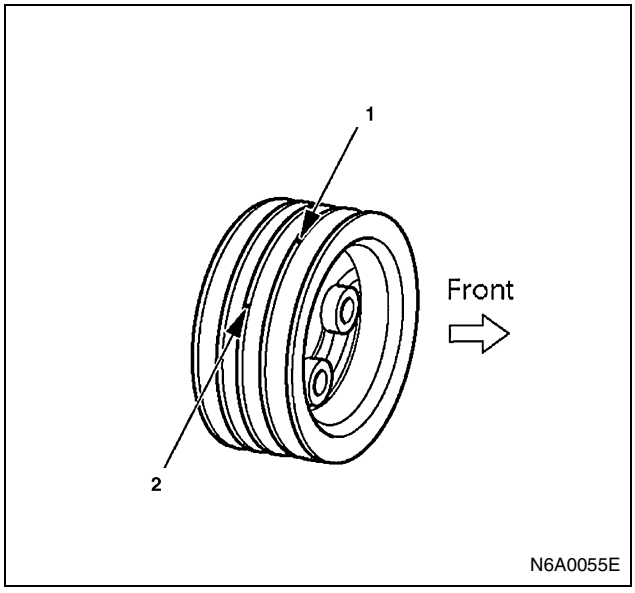
7) Tighten injection pump clamping bolt and nut to specified torque:

Tighten:
Bolt to 48 N·m (4.9 kg·m / 35 lb·ft)

Tighten:
Nut to 24 N·m (2.4 kg·m / 17 lb·ft)

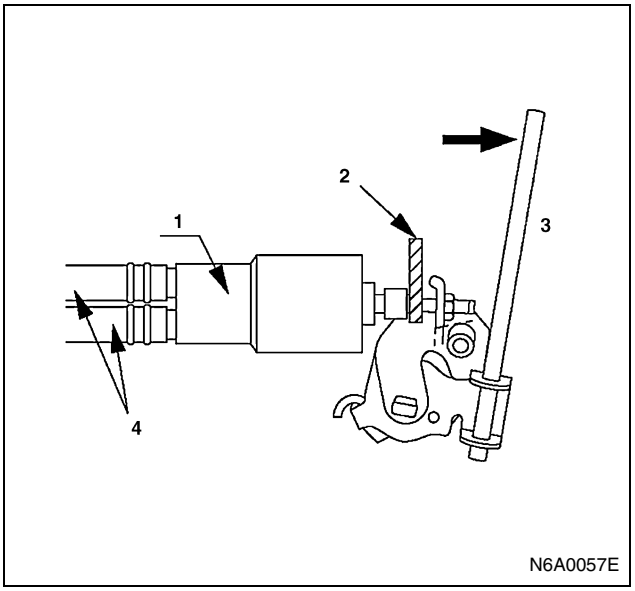
8) With reference to Injection Timing Check & Adjustment, set No. 1 Cylinder to 12° before its TDC.

Notice:
In case the crank pulley has two marks as illustrated (1), BTDC 49° mark on the second crest and (2) TDC mark on the third crest (as viewed from the front side), be sure to set at the mark (2). (If there are two different marks on one and same crest, set at the mark which comes second when rotated in the normal direction.)



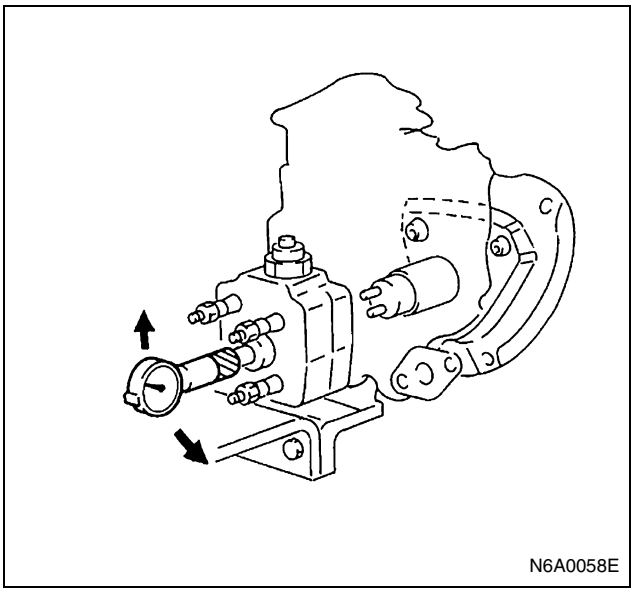
42. Injection Timing Check (4HF1-2 model only)
1) Set No. 1 Cylinder to the TDC in the compression stroke.

2) Disconnect Injection Pipe.
3) Put down Wax CSD lever, insert a spacer 10 — 20 mm (0.39 — 0.47 in) thick between the plunger and adjust bolt, and cancel the Wax CSD.

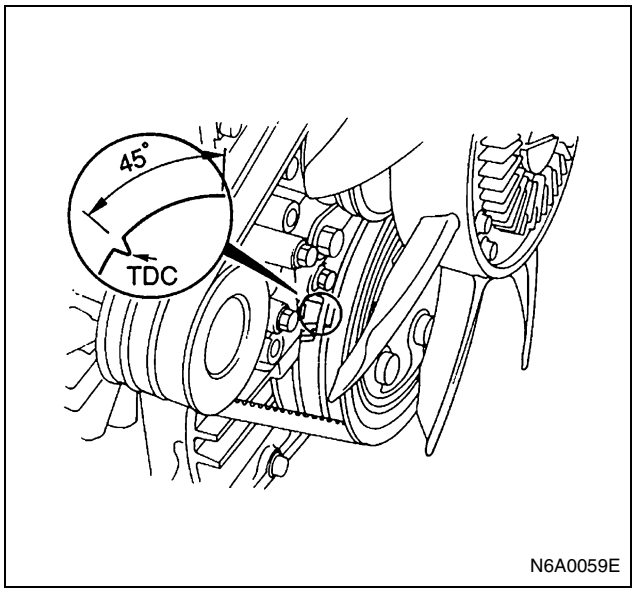


Legend
1. Water house
2. Wax CSD
3. Spacer
4. Lever

4) Remove the pump rear plug, connect a dial gage and set the lift at 1 mm (0.039 in).
Special Tool
Measuring device: 5-8840-0145-0

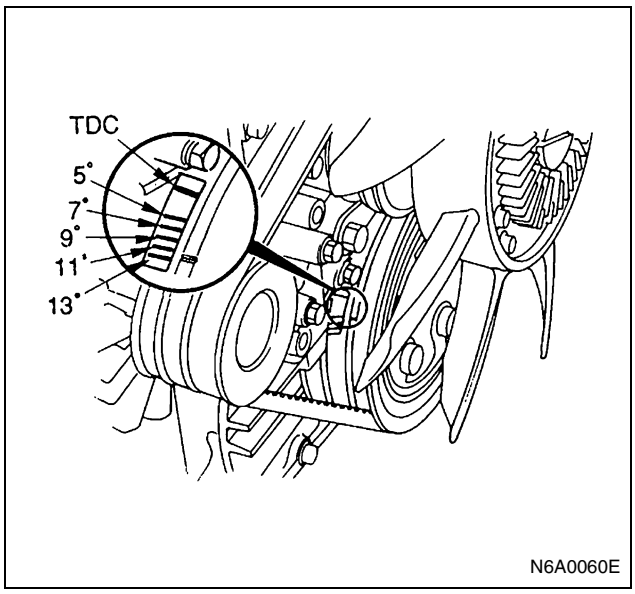


5) Set the crankshaft damper pulley TDC mark to the pointer or 45° before TDC.
6) Set the dial gage to the “0” position.
7) Turn the crankshaft leftwise and rightwise a little and make sure that the needle stays in the “0” position.



8) Turn the crankshaft in the normal direction and read the measuring device’s indication at the 12° before TDC position.

Notice:
As there is no 12° mark, set midway between the 11° and 13 marks.
Standard value: 0.5 mm (0.0197 in)



43. Injection Timing Adjustment (4HF1-2 model only)
If injection timing is out of the specified range, follow the following procedure for adjustment:
1) Loosen injection pump fixing nuts and bracket bolt.
2) Adjust the mounting angle of injection pump:
   - If injection timing is too fast, bring the injection pump closer to the engine.
   - If injection timing is too slow, put the injection pump more distant from the engine.

3) When the dial gage has indicated the specified value, tighten the fixing nuts and bolt to specified torque:

Tighten:
Nut to 24 N·m (2.4 kg·m / 17 lb·ft)

Tighten:
Bolt to 48 N·m (4.9 kg·m / 35 lb·ft)

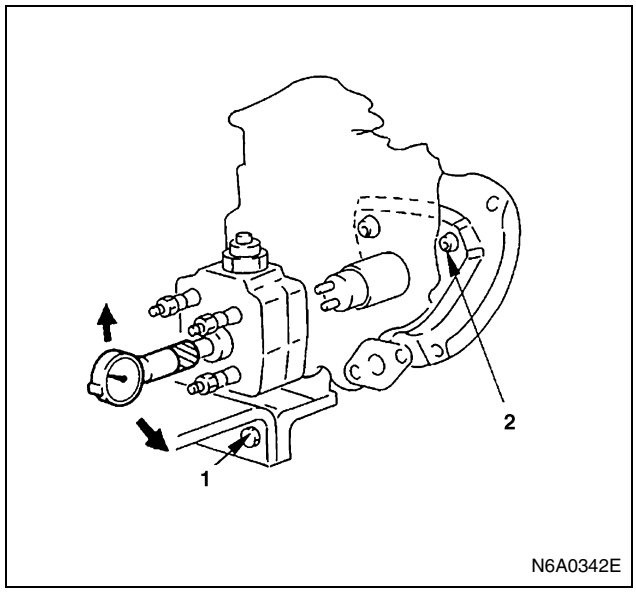
4) Disconnect the dial gage, install and tighten the plug to specified torque. (Make sure of a copper washer being attached to the plug)

Tighten:
Pump rear plug to 17 N·m (1.7 kg·m / 12 lb·ft)

5) Release the wax CSD and connect the injection pipe.

Tighten:
Pipe sleeve to 29 N·m (3.0 kg·m / 22 lb·ft)

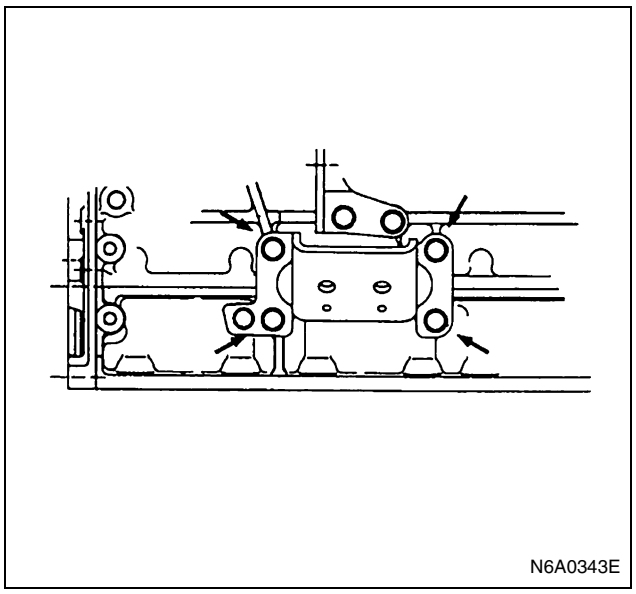
Notice:
If there are two marks on the crank pulley, the front side of mark is for setting BTDC 49° and the rear side of mark is for setting TDC.



Legend
1. Bolts
2. Nuts

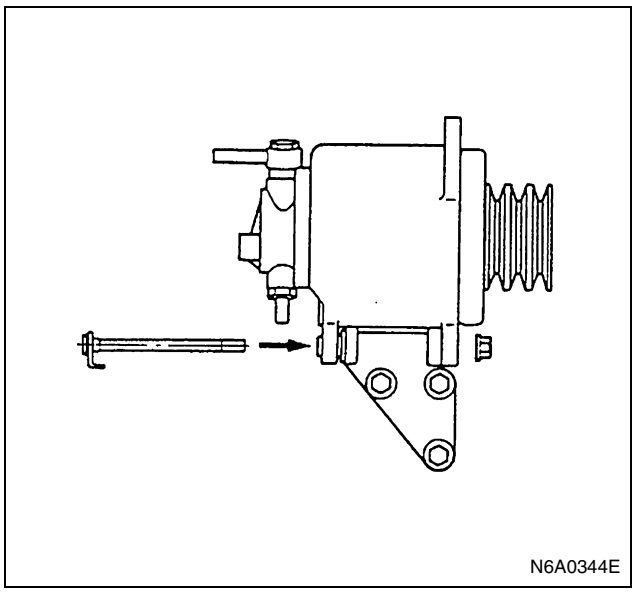
44. Engine Foot

Tighten:
Engine foot bolt to 51 N·m (5.2 kg·m / 38 lb·ft)



45. Generator

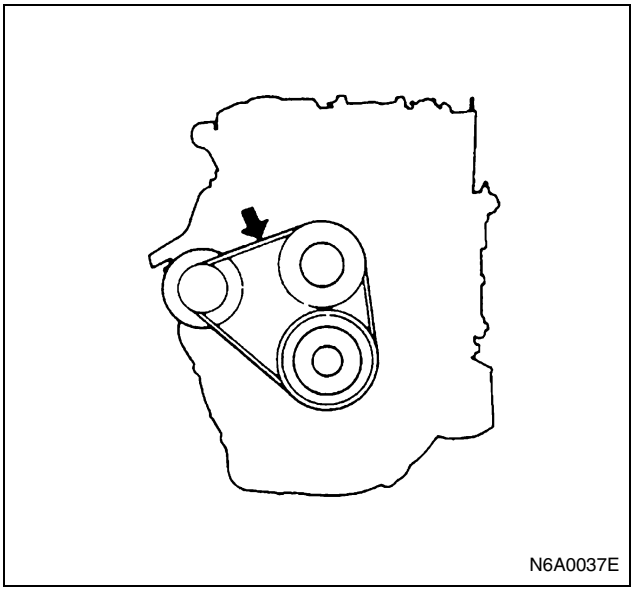
Notice:
Before tightening the generator securely, tighten it temporarily in advance after adjusting the fan belt. Put the lower fixing bolt through from the rear side and tighten it with the nut on the front side as shown in the illustration.



46. Fan Belt
Check the drive belt tension.
Depress the drive belt mid-portion with a 10 kg (22 lb / 98 N) force.

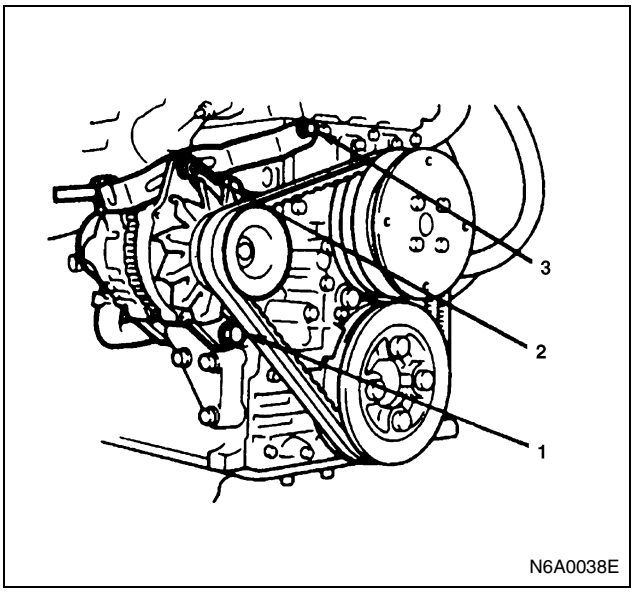
Drive Belt Deflection	mm (in)
New belt	8 — 12 (0.31 — 0.47)
Reuse belt	10 — 14 (0.39 — 0.55)

Check the drive belt for cranking and other damage.


N6A0037E

47. Fan Belt Adjustment
    Fan belt tension is adjusted by moving the alternator.

Tighten:
Bolt to
- (1): 40 N·m (4.1 kg·m / 30 lb·ft)
- (2): 24 N·m (2.4 kg·m / 17 lb·ft)
- (3): 46 N·m (4.7 kg·m / 34 lb·ft)

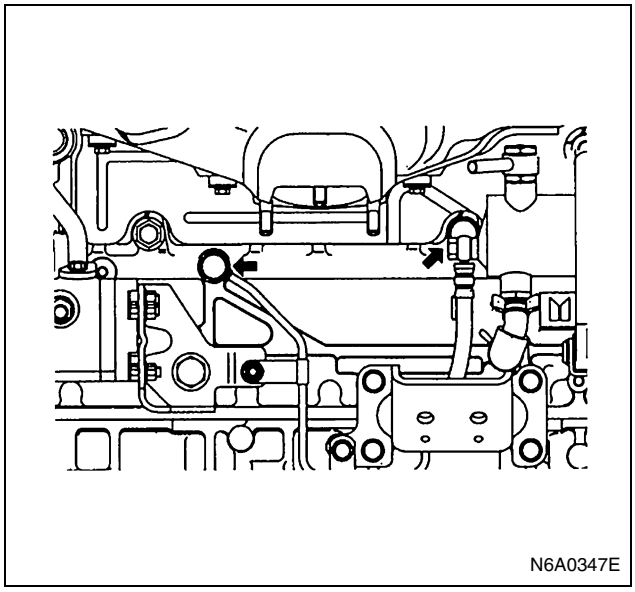


N6A0038E

48. Vacuum Pump Rubber Hose
49. Vacuum Pump Oil Pipe

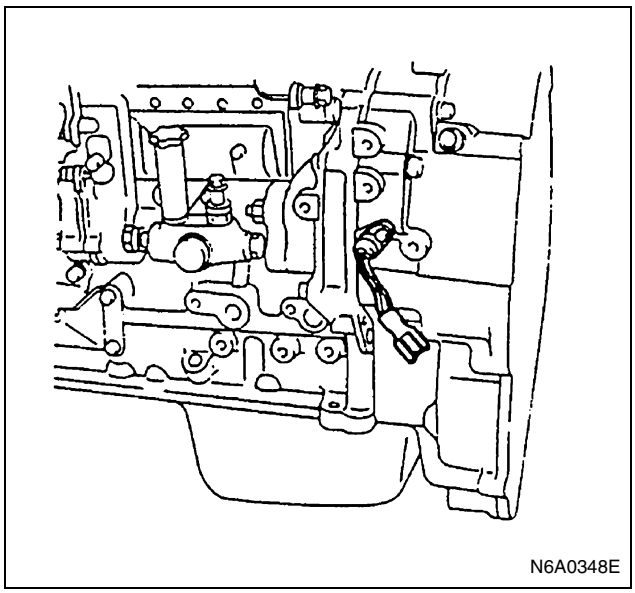
Tighten:
Cylinder body side pipe to 41 N·m (4.2 kg·m / 30 lb·ft)

Tighten:
Generator side pipe to 23 N·m (2.3 kg·m / 17 lb·ft)


N6A0347E

50. Fuel Pipe Bracket
51. Tachometer Sensor

Tighten:
Tachometer bolt to 8 N·m (0.8 kg·m / 6 lb·ft)

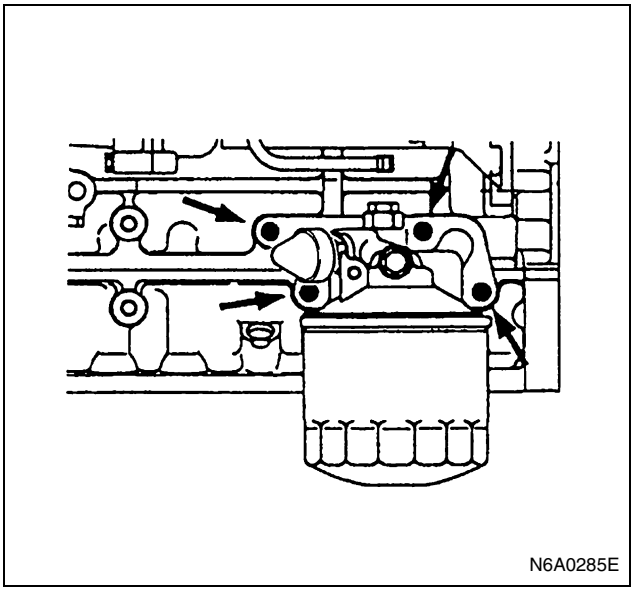

N6A0348E

52. Oil Filter Assembly

Tighten:
Oil filter bolt to 48 N·m (4.9 kg·m / 35 lb·ft)

53. Oil Pipe

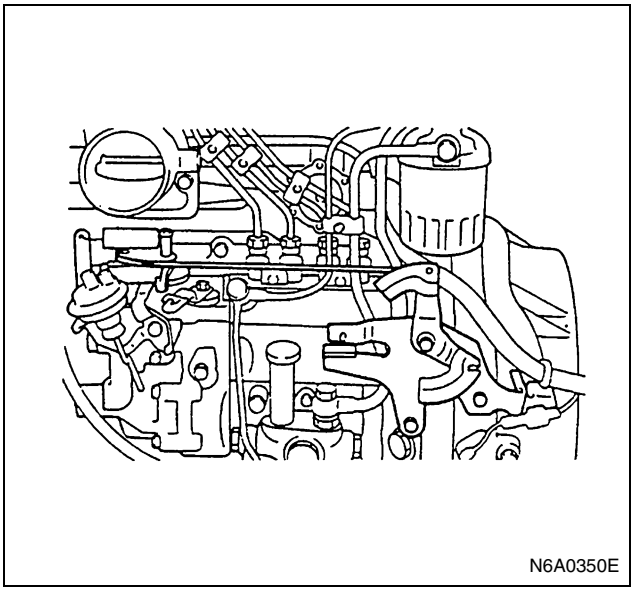
Tighten:
Oil pipe joint bolt to 17 N·m (1.7 kg·m / 12 lb·ft)



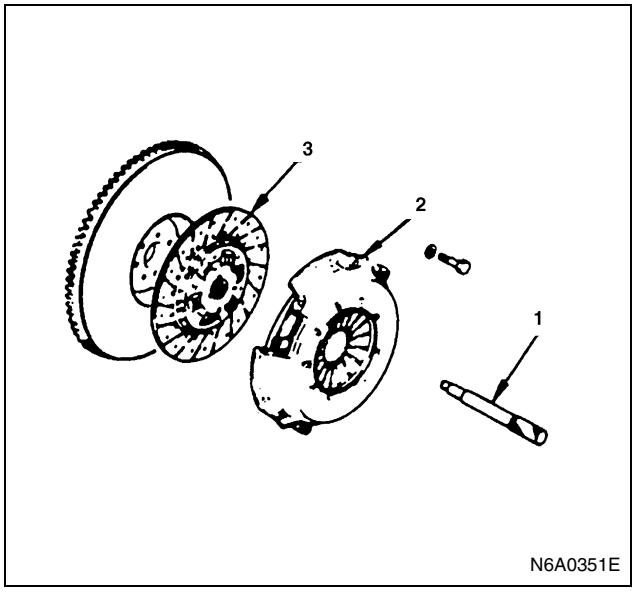
54. Engine Control Lever Assembly

Tighten:
Engine control lever bolt to 24 N·m (2.4 kg·m / 17 lb·ft)

55. Engine Control Wire



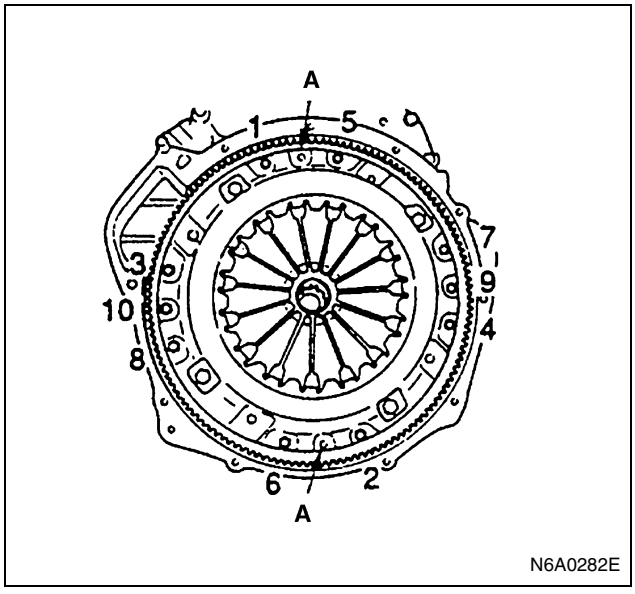
56. Driven Plate
    Use the clutch pilot aligner to install the driven plate.
    Clutch Pilot Aligner: 5-8840-2240-0



Legend
1. Clutch pilot aligner
2. Clutch pressure plate assembly
3. Driven plate

57. Clutch Pressure Plate Assembly
    1) Align the clutch pressure plate with the flywheel knock pin.
    2) Tighten the pressure plate bolts to the specified torque in numerical order.

Tighten:
Clutch pressure plate bolt to 40 N·m (4.1 kg·m / 30 lb·ft)



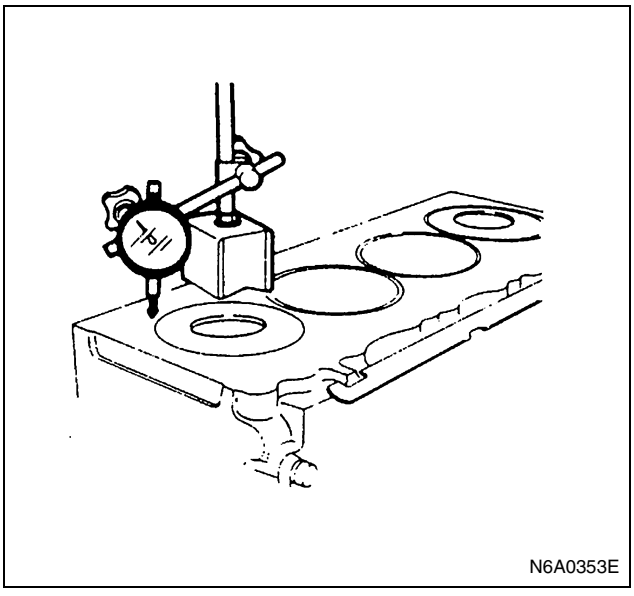
Legend
A. Knock pin

58. Cylinder Head Gasket

1) When any of the cylinder block, crankshaft, crankshaft bearing, connecting rod, connecting rod bearing, and piston is replaced with a new one, cylinder head gasket thickness should be determined newly.
2) When replacing the cylinder head gasket alone without replacing any of the parts mentioned in 1) above, the gasket to be used should be the same grade as the one used before.
3) Correct the cylinder head gasket thickness is important. Installing the wrong thickness gasket can result in greatly reduced engine performance.
4) There are three cylinder head gaskets available.

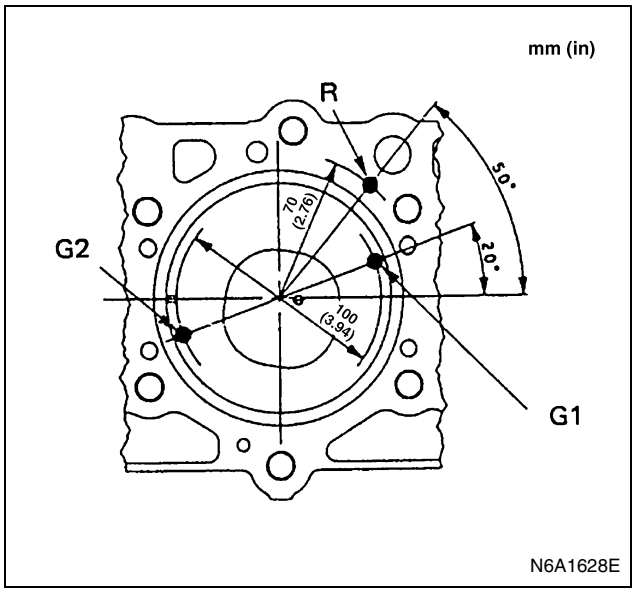
59. Piston Head Projection Measurement

- Select a cylinder head gasket.
- Clean thoroughly the top faces of the piston head and the cylinder body.
- Use the dial gauge to measure the piston head projection. Take measurements at two locations for each cylinder.
- The measurement points of the piston head and the reference point of the cylinder body are shown in the illustration.
  Measurement points: Points G1 and G2 of the piston head
  Reference point: Point R on the top face of the cylinder body


N6A0353E

Notice:
Note that there are three types of a cylinder head gasket available as shown in the table following, according to the piston projection.

- For each cylinder, calculate the average value (Ti) of the piston projection.
- Find the maximum value (Timax) of the average value (Ti) of each cylinder.
- Based on the Timax obtained, select a gasket of the appropriate grade.



4HF1/4HF1-2/4HG1-T
Cylinder Head Gasket Selection

mm (in)

Gasket Grade	Ti max	Gasket Thickness (Reference)
A	0.579 - 0.659 (0.0228 - 0.0259)	1.70 (0.0669)
B	0.659 - 0.739 (0.0259 - 0.0291)	1.75 (0.0689)
C	0.739 - 0.819 (0.0291 - 0.0322)	1.80 (0.0708)

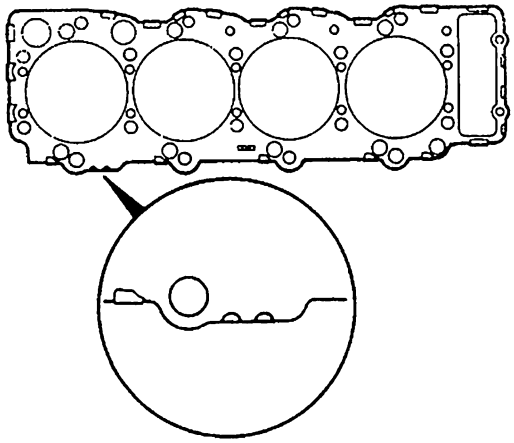
N6A1396E

4HE1-TC
Cylinder Head Gasket Selection

mm (in)

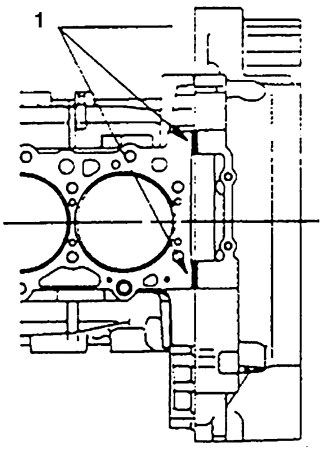
Gasket Grade	Ti max	Gasket Thickness (Reference)
A	0.529 - 0.609 (0.0208 - 0.0240)	1.70 (0.0669)
B	0.609 - 0.679 (0.0240 - 0.0267)	1.75 (0.0689)
C	0.679 - 0.759 (0.0267 - 0.0300)	1.80 (0.0708)

N6A1397E



N6A0353E

- Apply a 3 mm (0.12 in) bead or recommended liquid gasket or its equivalent to the shaded areas shown in the illustration.



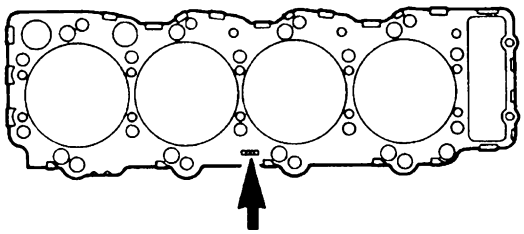
N6A0356E

Legend
1. Bead width ϕ3

- Install the cylinder head gasket with its “PART NUMBER” mark facing up and toward the left of the engine.

Caution:
Do not reuse the cylinder head gasket.

60. Cylinder Head Assembly
    Above works refer to “CYLINDER HEAD” section 6A3 in this manual.



N6A0105E

ENGINE 4H SERIES

SECTION 6A3

ENGINE
(4HF1 / 4HF1-2 / 4HE1-TC / 4HG1 / 4HG1-T)

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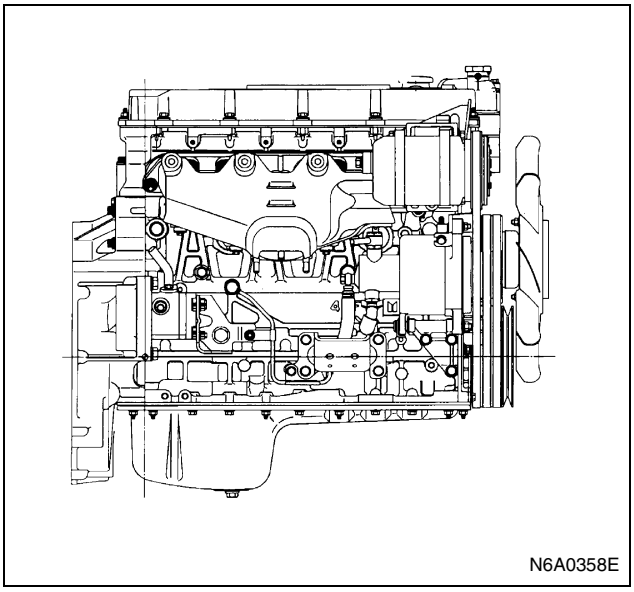
GENERAL DESCRIPTION

The engine is a four-cycle, four-cylinder, in-line, direct fuel injection type diesel engine with the piston displacement of 4,334 cc. It features a gear driven OHC (overhead camshaft) timing train and the unique mechanisms and systems designed for outstanding cleanness, economy and durability. Its torque characteristics promise dynamic ride at high speed, high power at low speed, and smooth and continuous torque at medium to high ranges.

For 4HF1



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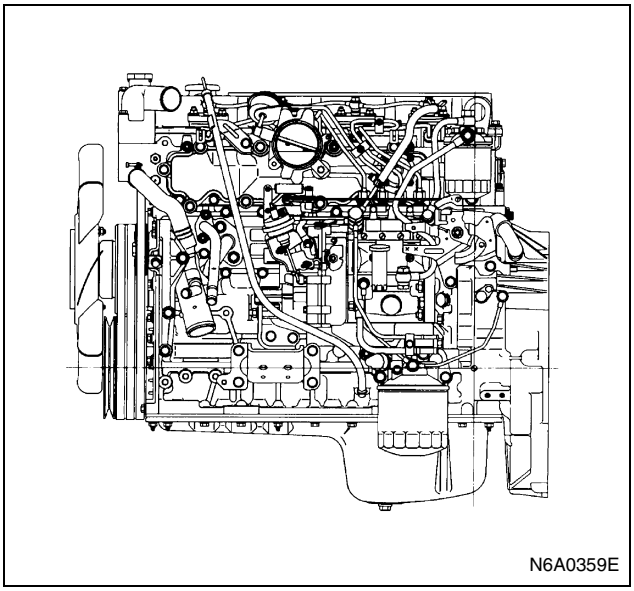
For 4HF1



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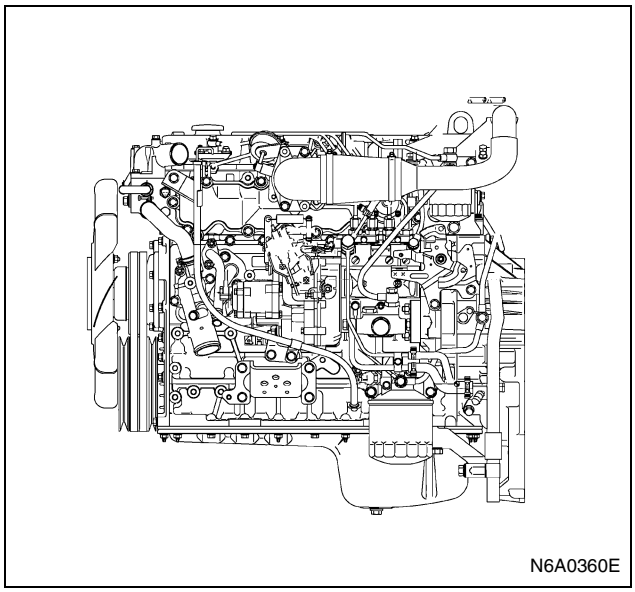
For 4HG1-T



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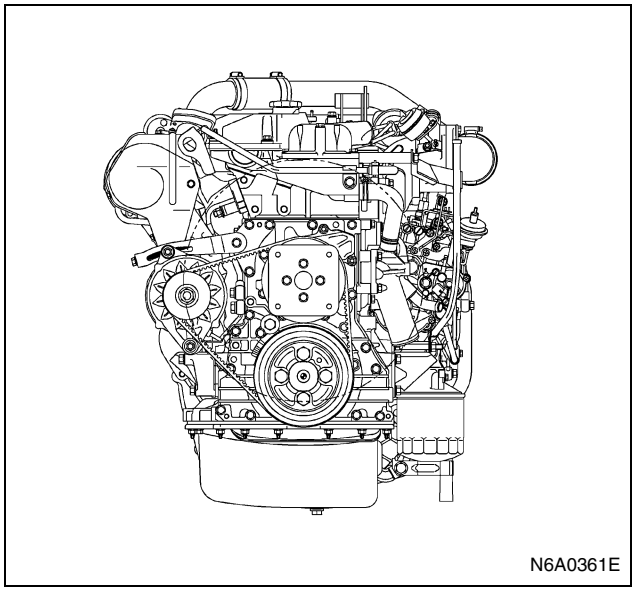
For 4HG1-T



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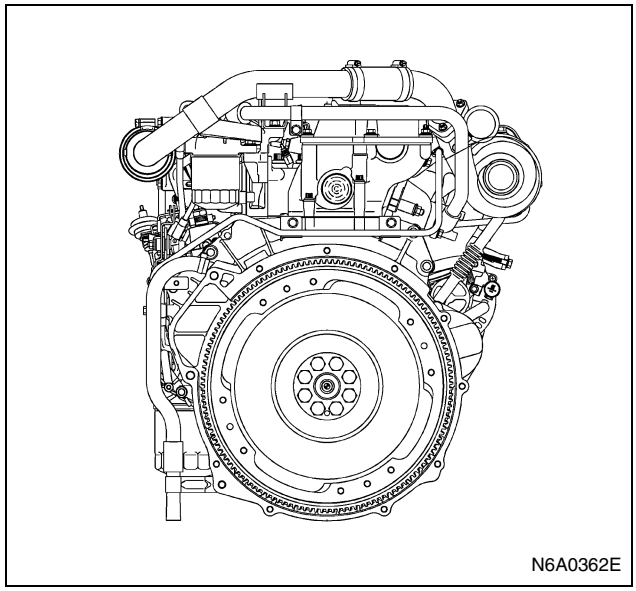
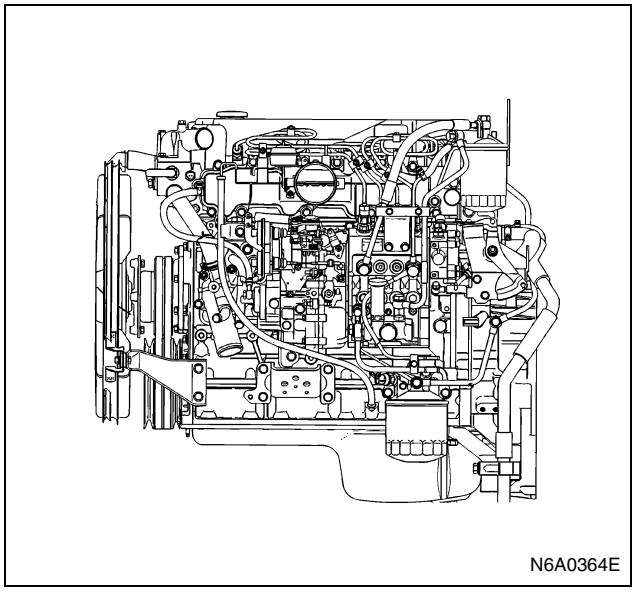
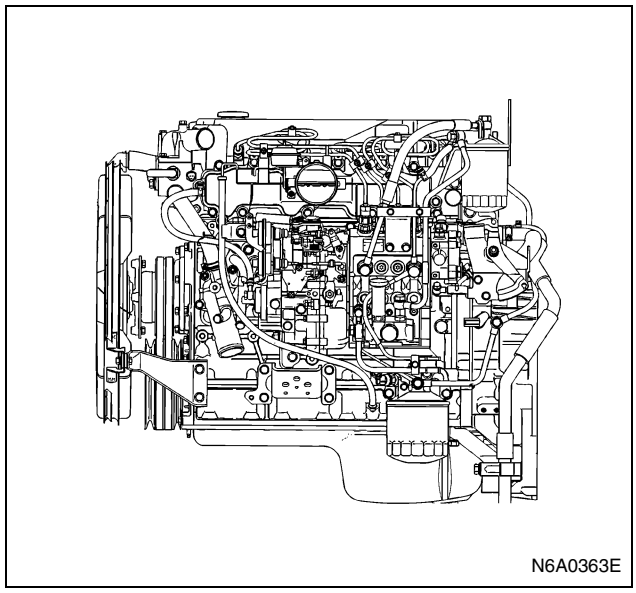
For 4HG1-T



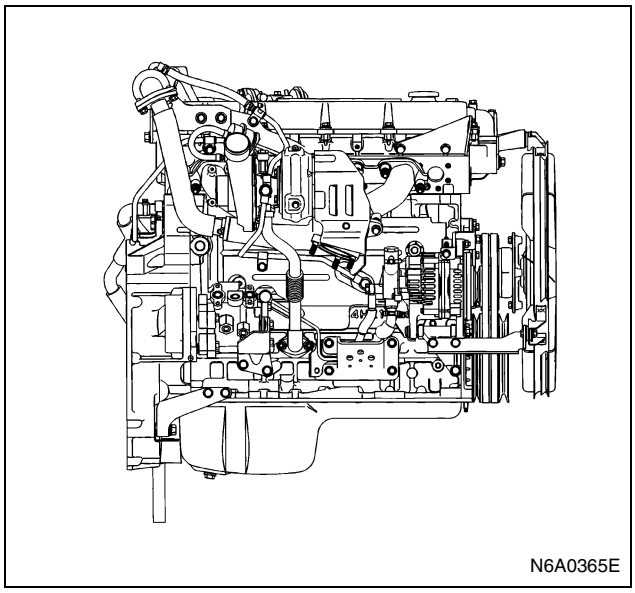
For 4HE1-TC (4HE1-XS) 98EPA



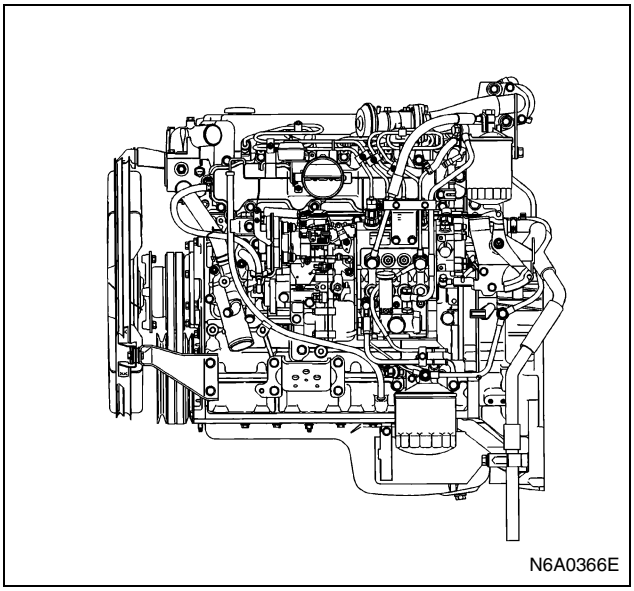
For 4HE1-TC (4HE1-XS) 98EPA



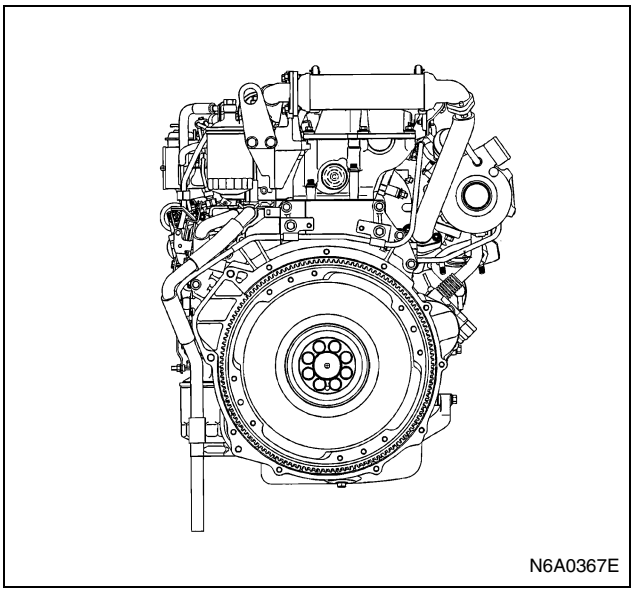
For 4HE1-TC (4HE1-XS) SPEC. EURO3



For 4HE1-TC (4HE1-XS) SPEC. EURO3

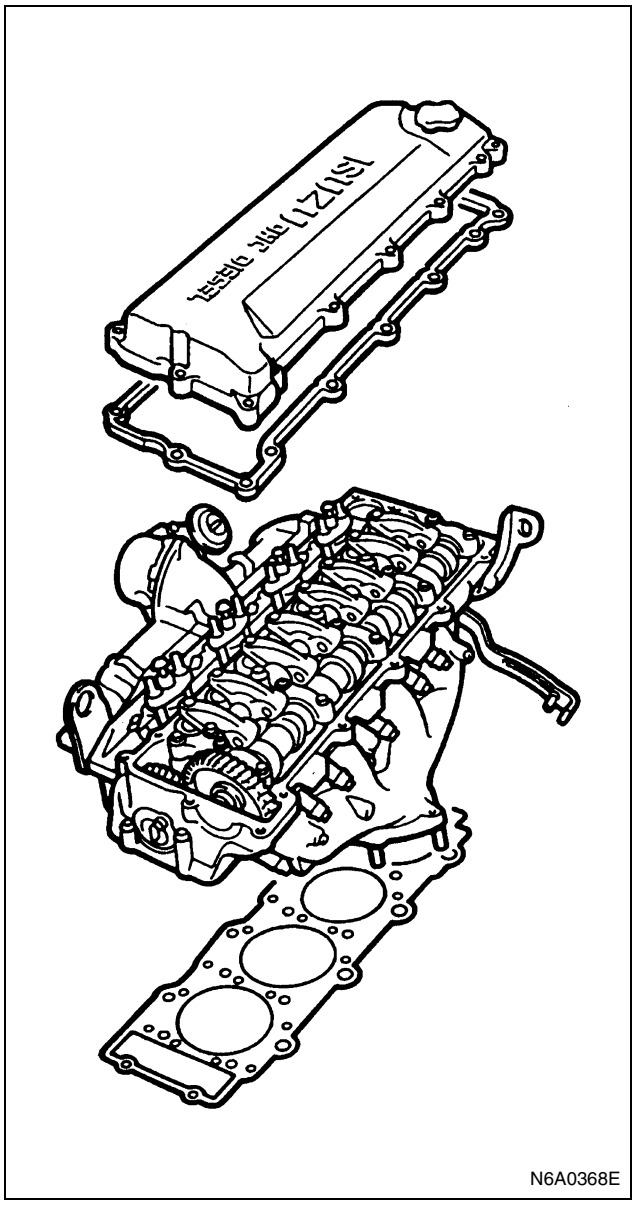

N6A0366E

For 4HE1-TC (4HE1-XS) SPEC. EURO3


N6A0367E

Cylinder Head

- The cylinder head is made of cast iron and has a crossflow layout with the intake system in the left side and the exhaust system in the right side, designed to reduce resistance in the intake and exhaust systems.
- The valve diameter is increased to offset the mass of the valve operating system reduced by the introduction of the OHC mechanism.
  In addition, the intake and exhaust ports are put in a smoother and less resistant layout to enhance intake and exhaust efficiency.
- The cylinder head gasket is of the laminated steel of least fatigue in combination with the angular cylinder head bolt tightening method, equally designed to increase reliability against gas and water leakage, in addition, selective assembly of gaskets of various thicknesses minimizes the wasted space between the piston and the cylinder head to maintain performance at a high level.
- The cylinder head cover is made of aluminum to reduce noise.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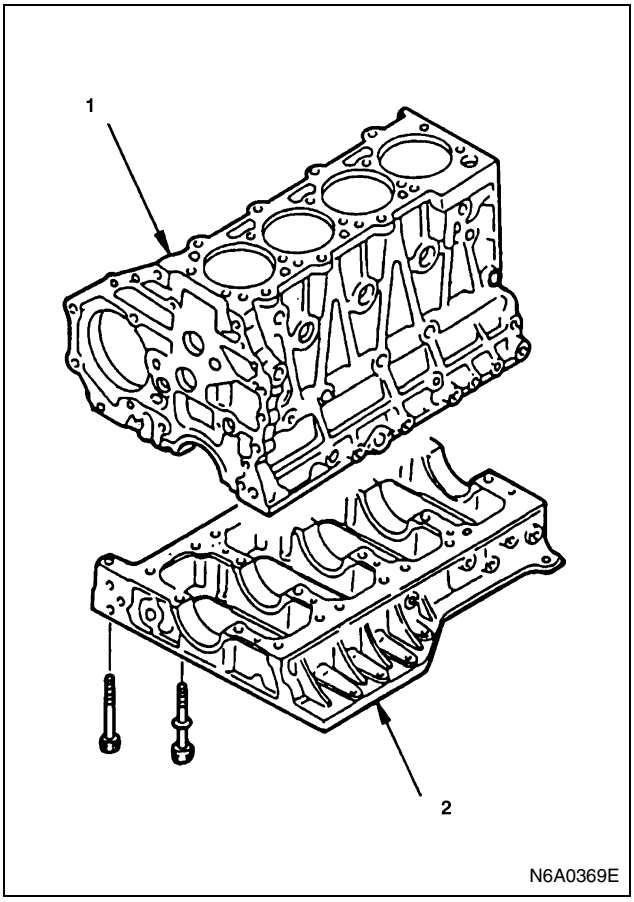
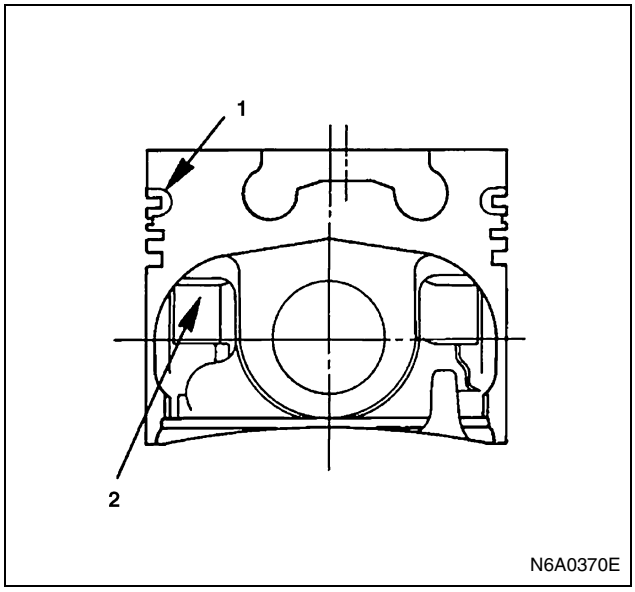
Cylinder Block

- The cylinder block (1) is made of cast iron having dry cylinder liner and five bearings.
  The bearing cap has a ladder frame (2) construction integrating the crankcase to increase rigidity.
- The cylinder liner is made of thin iron plus special alloys and is combined with the chrome-plated piston ring to ensure good resistance against wear.
- The oil pan is made of vibration-damping steel to reduce noise.



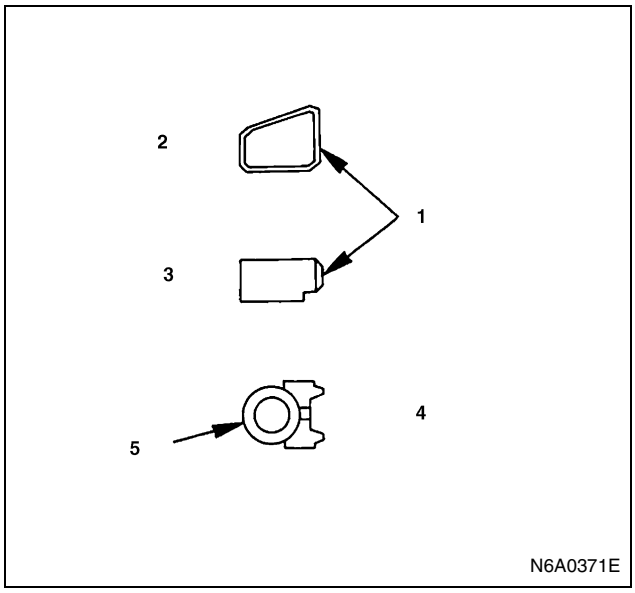
Piston, Connecting Rod and Crankshaft

- The piston is made of aluminum alloy. A ring trigger is cast into the top ring groove and chrome plating is applied to four sides of the top ring to ensure sufficient strength and wear resistance of the ring and the ring groove. The piston bottom has a thermal flow shape to increase cooling efficiency of the oiling jet. This design reduces thermal load while increasing rigidity (see figure).
- The combustion chamber has a square shelf of proven performance to ensure outstanding stability in exhaust gas control (see figure).
- The autothermatic piston and offset piston pin reduces piston flapping and other noise.



Legend

1. Ring trigger
2. Strut

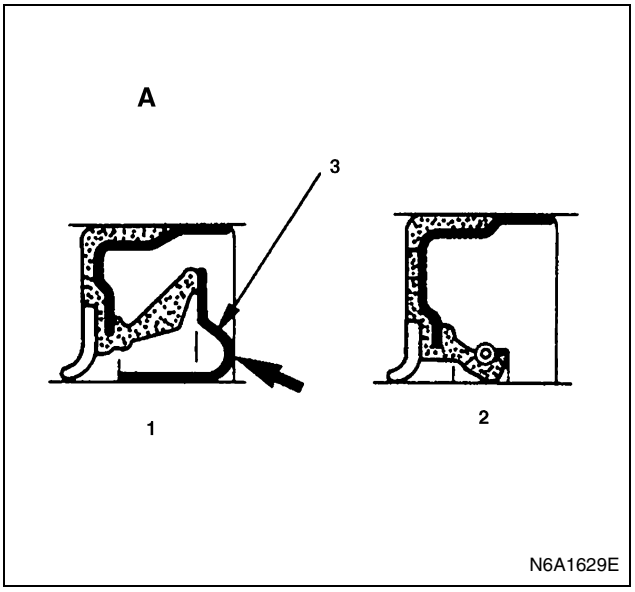


Legend

1. Chrome plated
2. Top ring
3. 2nd ring
4. Nitriding
5. Oil ring expander

- The crankshaft is made of cast carbon steel with five bearings and eight counterweights to reduce revolution load to the bearing. The ladder frame design that integrates the bearing cap and the crankcase increases bearing rigidity. The angular tightening method of the bearing bolt further increases reliability and durability.

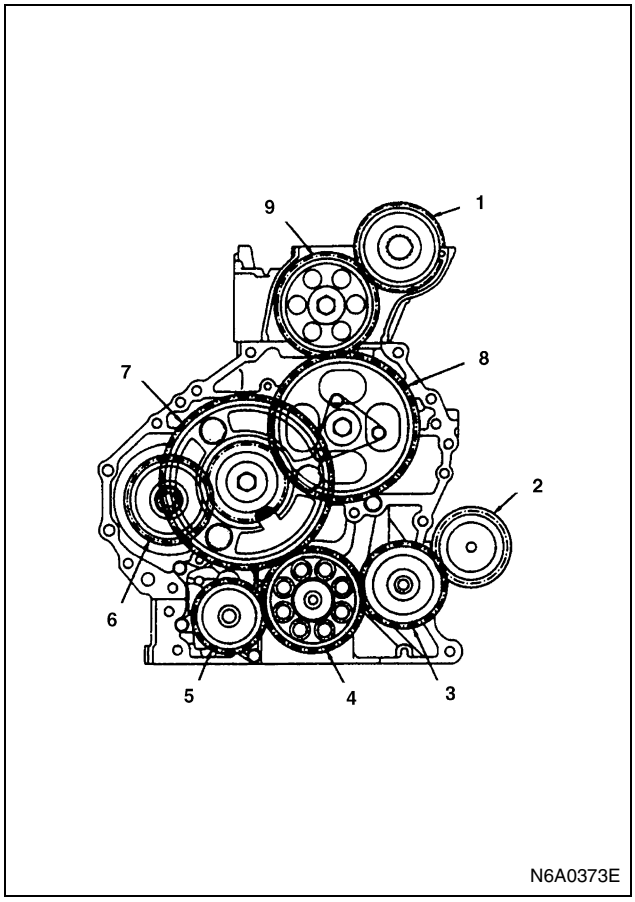
- The connecting rod is made of cast carbon steel and the cap is bolted by angular tightening method to maintain reliability.
- The bearing, as well as the crank journal and crank pin bearings, are made of Kelmet metal.
  Oil clearance is controlled accurately through selective assembly by thickness to reduce noise and increase reliability.
- The crankshaft has the axial type oil seal that drastically improves durability and reliability.
  Compared with the conventional radial type (lips in a radial orientation), the axial type oil seal has lips in an axial orientation to minimize lip wear. It also precludes lip peeling and damage, spring dislocation and other problems associated with the radial type oil seal (see figure).



Legend
A. Crankshaft oil seal
1. Axial type
2. Radial type
3. Slinger

Valve Train

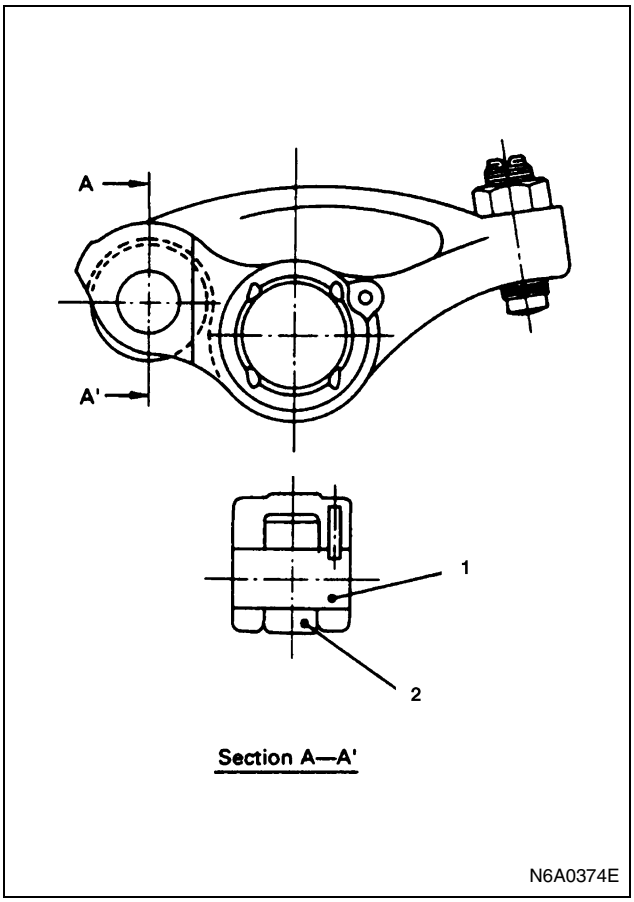
- The gear train is located at the end of the cylinder block to minimize influence of the torsional vibration of the crankshaft and the radiant sound. Noise is further reduced, to the same level as a timing belt driven system, by integrating the crank gear with the crankshaft by shrink fit and by careful turning of the gear precision, teeth contact ratio of gear, backlash, bearing rigidity, neutral frequency, etc. (See figure).



Legend
1. Camshaft gear
2. Power steering pump gear
3. Power steering pump idle gear
4. Crankshaft gear
5. Oil pump drive gear
6. Injection pump gear
7. Idle gear A
8. Idle gear B
9. Idle gear C

- Gears are of the forged type. Gears are tufftrided to secure sufficient durability.
- The camshaft is made of carbon steel with five bearings. The cam's nose and the journal are induction-hardened to secure sufficient durability.
- The cam has a Fourier-dyne profile to maximize the intake and exhaust valve lifts and the valve opening and closing timing is optimized to increase intake and exhaust efficiency.
- The valve spring is a single spring having an egg-shaped cross section to reduce weight while reducing stress. Coupled with the unique cam profile, the spring increases the jump-and bounce-free limit at high-speed operation to provide reserve characteristics.
- The rocker arm is made of diecast aluminum and is of the center pivot type having a roller. This increases reliability while reducing friction and con-

tributes to increased power output and fuel efficiency (See figure).



Legend
1. Pin
2. Roller

- The rocker shaft is chrome plated to secure sufficient durability.

Fuel System

LINE Pump

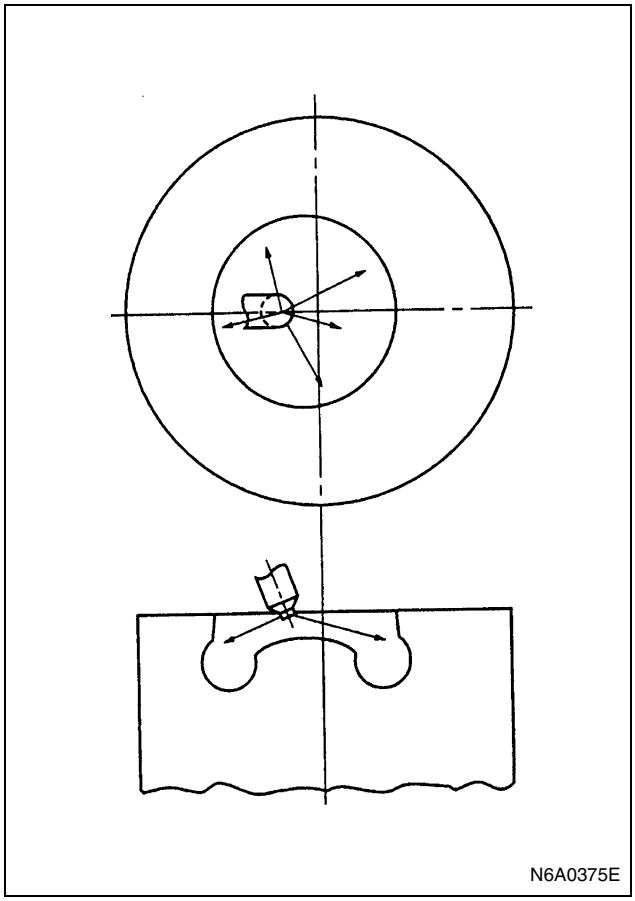
- The injection pump is of Bosch A type with the plunger outside diameter of 9.5 mm (0.37 in) and cam lift of 9 mm (0.35 in).
  The plunger has a special notch for advancing the timing at starting.
- The governor is of a mechanical RLD type to ensure sustained power at high speed.
- The timer is of the SCDM (eccentric) type.

VE Pump

- A Bosch Distributor Type injection Pump is used.
  A single reciprocating / revolving plunger delivers the fuel uniformly to the injection nozzles, regardless of the number of cylinders.
- The governor, the injection timer, and the feed pump are all contained in the injection pump housing. The injection pump is compact, light weight, and provides reliable high-speed operation.
  An android compensator is available as an option for vehicles to be operated at high altitudes. It adjusts the fuel and air mixing ratio.

Injection Nozzle

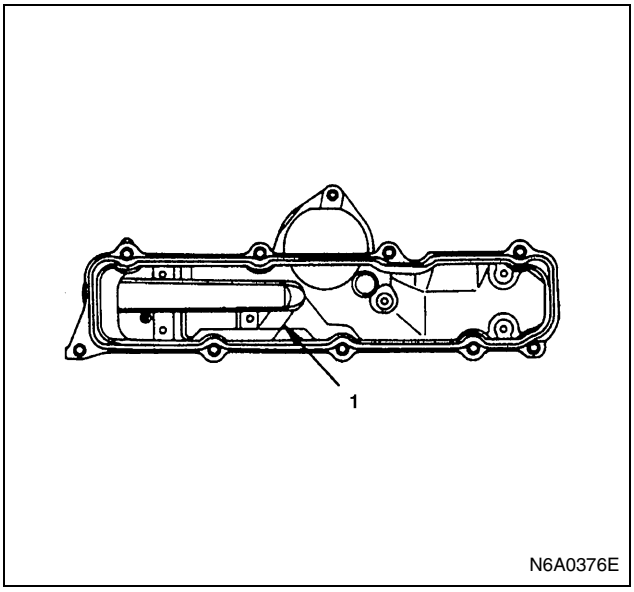
- The injection nozzle is of the P type to bring it as technically close as possible to the center of the combustion chamber. The nozzle inclination is also reduced to minimum to increase combustion efficiency.
  The nozzle has five jets and the valve opening pressure is set at 185 kg/cm^2 (2,630 psi, 18,142 kPa) (See figure).



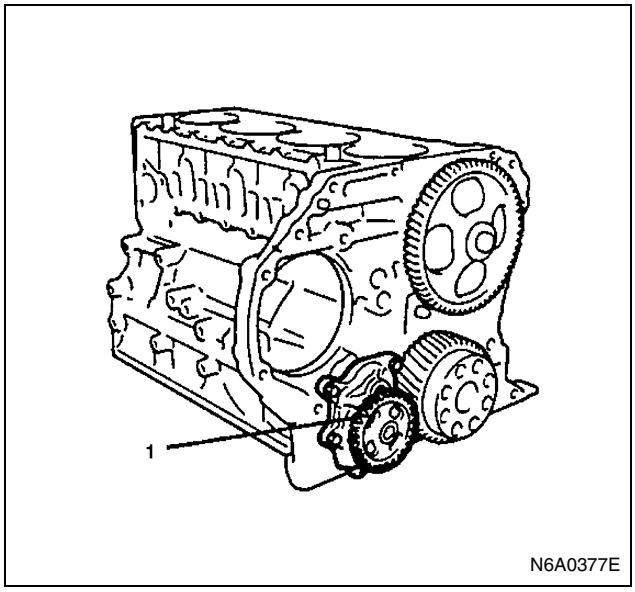
- The injection pipe is laid in such a way that the overall length is minimized to enhance performance.

Intake and Exhaust Systems

- The resin-made intake manifold is of the cover type having an inner cover made of rubber and steel. This design effectively reduces radiant sound and transmitted sound.
- The intake manifold has a straightening vane inside to stabilize swirl and improve performance. It also contains a built-in Positive Crankcase Ventilation (PCV) valve to minimize the overall size (See figure).
- The exhaust manifold is mode of cast iron and heatresisting alloys. Ports are shaped carefully to minimize exhaust resistance.



Legend
1. Straightening wall



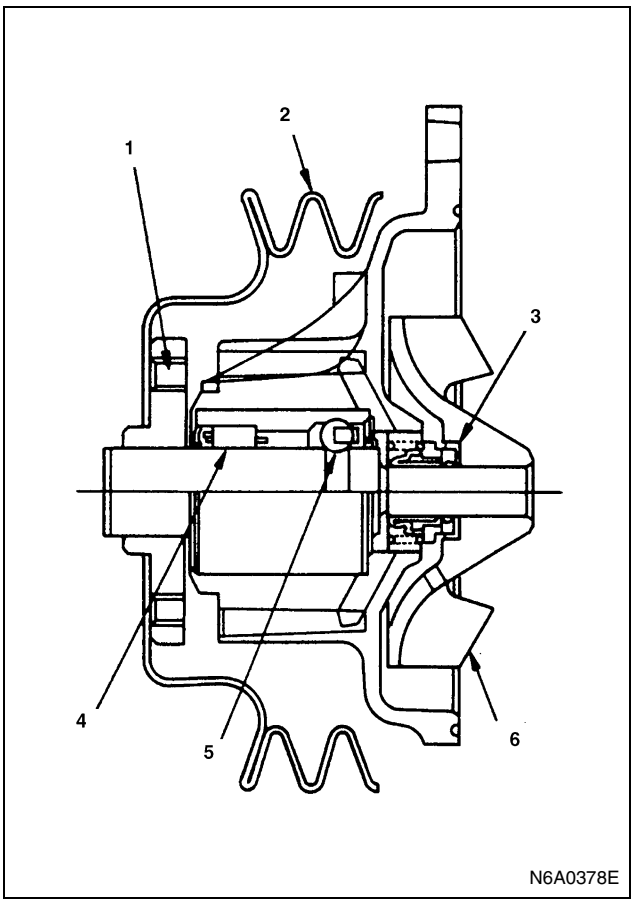
Legend
1. Oil pump gear

Lubrication System

- The oil pump is driven by the crank gear directly to increase durability while maintaining sufficient delivery.
  The pump body is partially integrated with the cylinder block to reduce the overall size and weight (See figure)
- The oil filter is of the cartridge type integrating the full flow filter and bypass filter as a single unit. This presents several advantages such as an extended interval between oil exchanges and greater ease of maintenance resulting in cost reduction. The bypass valve is fitted to the body itself to avoid flow of foreign matter due to bypassing of oil thereby maintaining sufficient reliability.
- The oil cooler is of a large-capacity, water-cooled and multiple-partition type built into the side of the cylinder block. This design maintains necessary stability in oil temperature. It also has a bypass valve to minimize delay of the oil gallery pressure build-up for cold starting.

Cooling System

- The water pump is driven by a V-belt and the pump body is made of diecast aluminum. Part of the swirl chamber is built into the engine front cover to reduce the overall size and weight.
  A sintered carbon type seal unit is chosen to secure reliability. The shaft bearing combines roller bearing and ball bearing to maintain necessary durability. The outlet for draining is located behind the pulley to prevent dust from entering the system as much as possible. (See figure)
- The cooling fan operation is regulated by a temperature-sensitive clutch to enhance fuel efficiency while reducing noise.



Legend

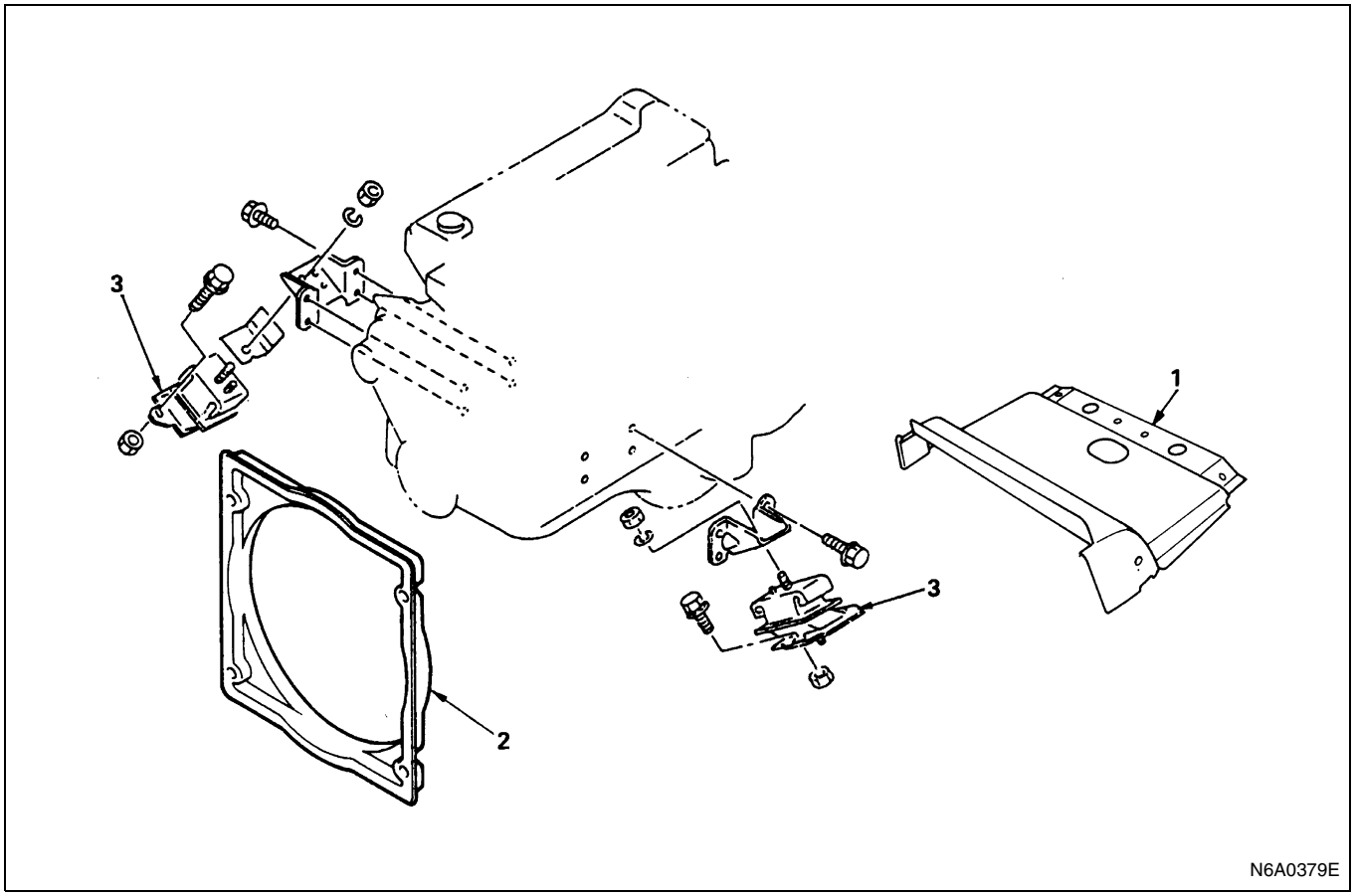
1. Fan center
2. Fan pulley
3. Seal unit
4. Roller bearing
5. Ball bearing
6. Impeller

Important Operations

1. **Axial Type Oil Seal**
   - As crankshaft front and rear oil seals are both axial type, attention must be paid to the following: when replacing, replace oil seal and slinger as a set.
   - Be sure to use the special tool correctly since oil seal and slinger must be set accurately in their longitudinal direction.
2. **Valve Cap**
   - As intake and exhaust valves have caps, take sufficient care not to let them fall into the gear case or oil return hole during disassembly or reassembly.
3. **Application of Liquid Gasket**
   - Oil pan, crankcase, oil cooler, retainer front, and water pump are not sealed with sheet gasket but with liquid gasket only.
   - Prior to application, be sure to remove old hardened liquid gasket or oil from those surfaces to which new gasket will be applied. Further, if the old gasket can hardly be removed, mask such surfaces with gasket remover (Three Bond PANDO-391D; ISUZU Genuine Parts No. 1-8844-0542-0) or equivalent in accordance with the instructions manual.
   - Liquid gasket should be applied evenly so that no breaks and omissions may be made. Further, were O-ring is used should not be exposed to liquid gasket.
4. **Plastic-Region Angular Bolt Tightening Method**
   - Clamping bolts of connecting rod and cylinder head (M14 only) are tightened by plastic region angular bolt tightening method. This method is applied with bolt threads and setting faces coated with molybdenum disulfide grease.

ENGINE MOUNT (RH,LH)

Component



Legend

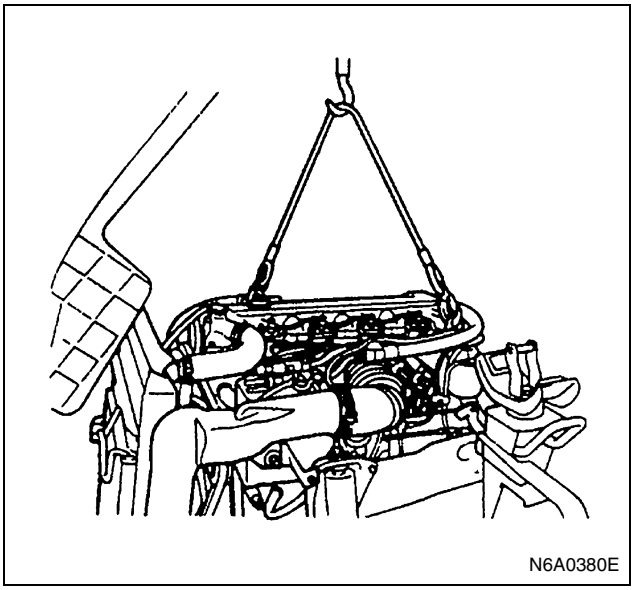
1. Transmission panel
2. Fan guide
3. Engine mount

Removal

Preparation

- Disconnect battery ground cable.
- Tilt the cab.

1. Transmission Panel
2. Fan Guide
   Remove the fan guide and hang it on the fan side.
3. Engine Mount
   1) Hang the engine by the hoist before dismounting the engine mount.
   2) Remove the nuts that fix the engine foot and the engine mount.
   3) Remove the fixing bolts on the chassis frame side of the engine mount.
   4) Hoist the engine assembly a little, and dismount the engine mount.



Installation

1. Engine Mount
   Tighten the fixing bolts to the specified torque.

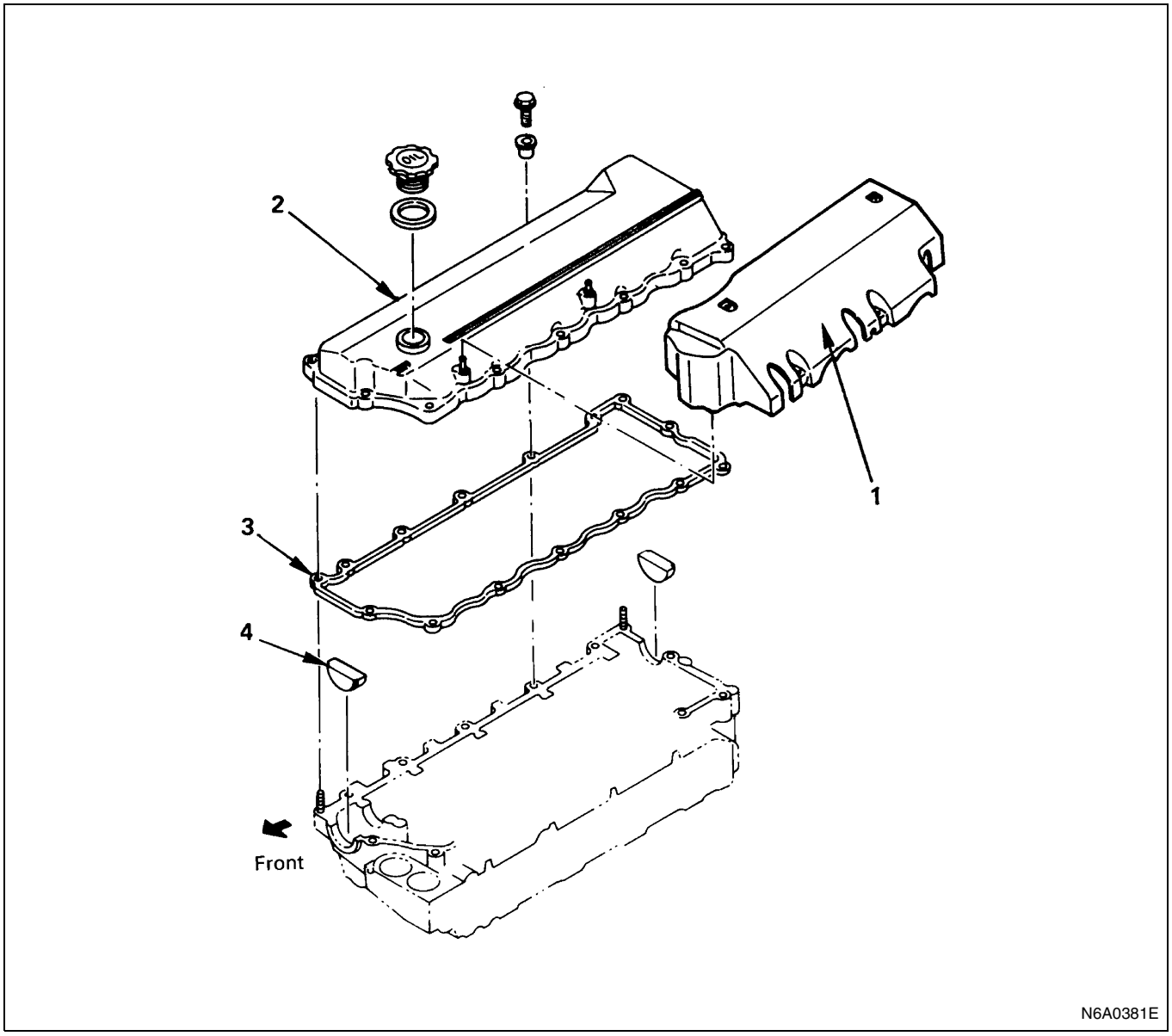
Tighten:
Chassis frame side bolt to 48 N·m (4.9 kg·m/35 lb·ft)

Tighten:
Engine foot side nut to 82 N·m (8.4 kg·m/61 lb·ft)

2. Fan Guide
3. Transmission Panel
   1) Connect the negative battery cable.
   2) Lower the cab
   3) Start the engine, and check for any abnormal conditions with the engine mount.

CYLINDER HEAD COVER

Component



Legend

1. Nozzle cover
2. Cylinder head cover
3. Cylinder head cover gasket
4. Rubber plug

Removal

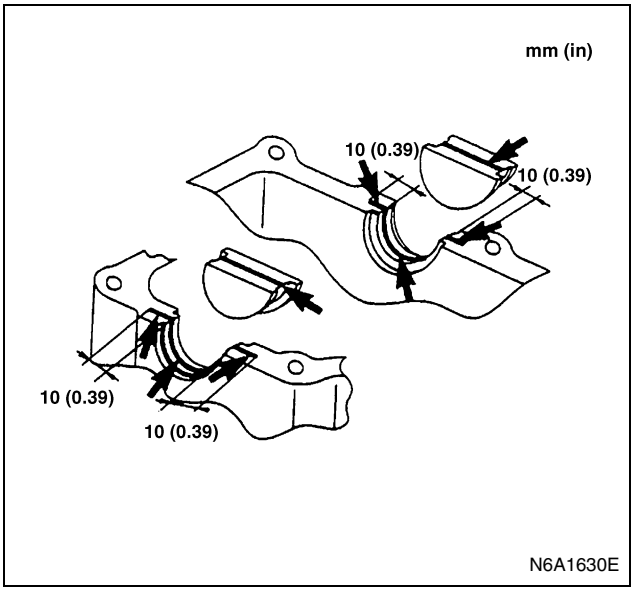
Preparation

- Disconnect battery ground cable.
- Tilt the cab.

1. Nozzle Cover
2. Cylinder Head Cover
3. Cylinder Head Cover Gasket
4. Rubber Plug

Installation

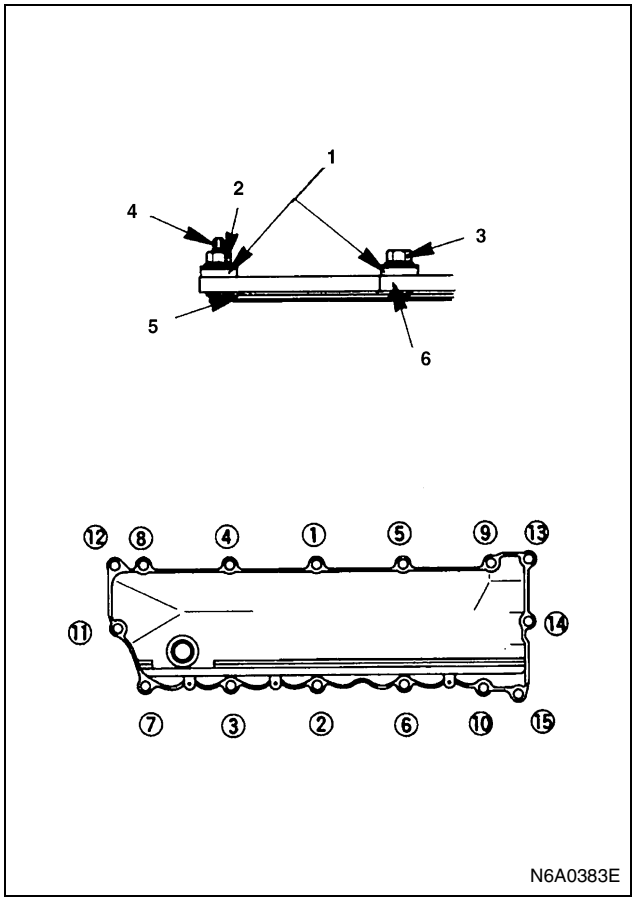
1. Rubber Plug
   1) Apply a 3 — 4 mm (0.12 — 0.16 in) bead of the recommended liquid gasket (Three Bond 1207B) or its equivalent to the cylinder head front and rear plug arch.
   2) Install the rubber plugs to the cylinder head upper faces.
   3) Apply a 3 — 4 mm (0.12 — 0.16 in) bead of the recommended liquid gasket (Three Bond 1207B) or its equivalent to the rubber plugs and cylinder head upper faces. Refer to arrows in the illustration.



Install the cylinder head cover within 7 minutes after application of liquid gasket.

2. Cylinder Head Cover Gasket
   Install the gasket to the cylinder head cover.
3. Cylinder Head Cover
   1) Install the cylinder head cover.
   2) Tighten the cylinder head cover nuts and bolts to the specified torque in the numerical order shown in the illustration.

Tighten:
Cylinder head cover nut and bolt to 18 N·m (1.8 kg·m/13 lb·ft)



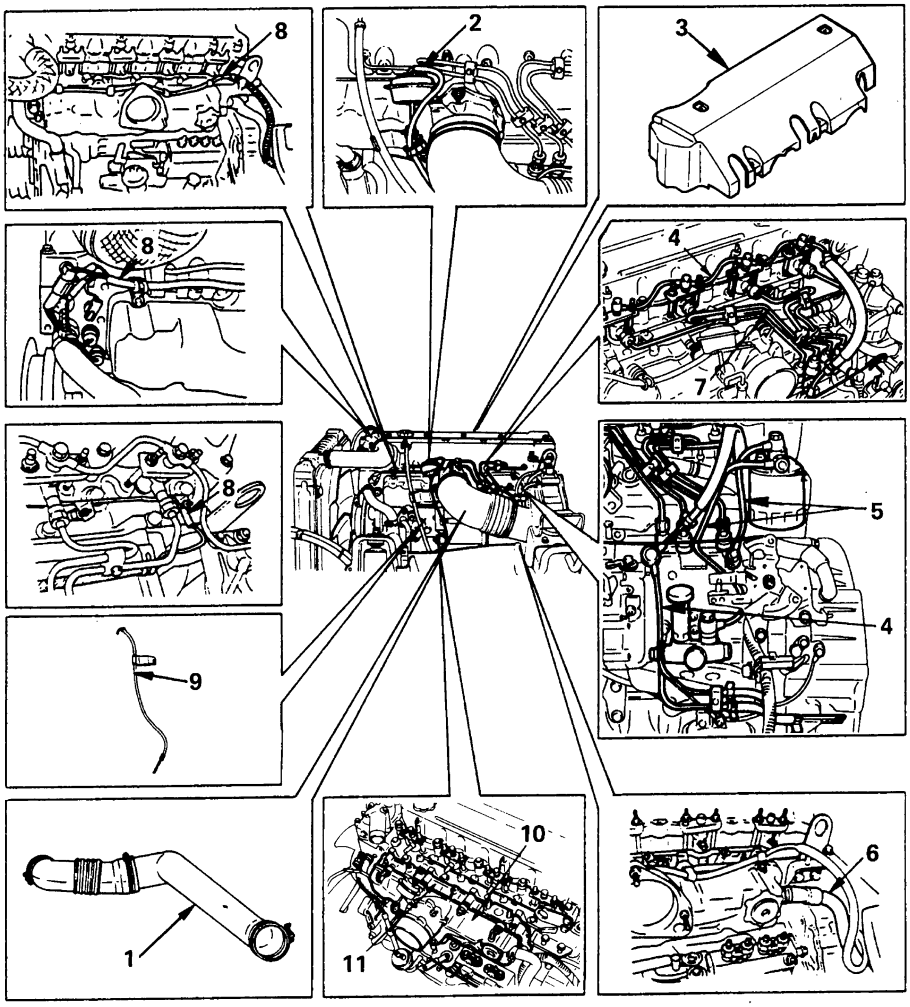
Legend
1. Mounting rubber
2. Nut
3. Bolt
4. Stud
5. Gasket
6. Head cover

4. Nozzle Cover
   - Connect the negative battery cable.
   - Lower the cab.
   - Start engine and check for oil leakage carefully.

INLET COVER / INLET CASE

Component

For 4HF1



N6A0384E

Legend

1. Intake air duct
2. Vacuum hose
3. Nozzle cover
4. Leak off pipe
5. Fuel pipe
6. PCV hose
7. Injection pipe
8. Engine harness
9. Oil level guide tube
10. Inlet cover
11. Inlet case

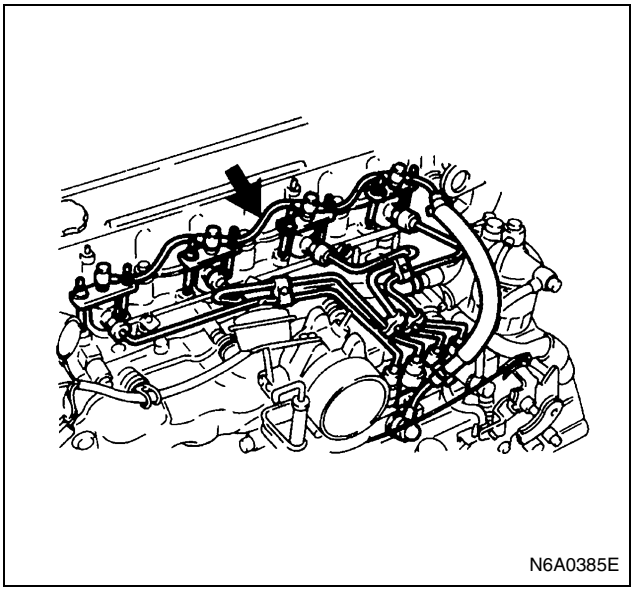
Removal

Preparation

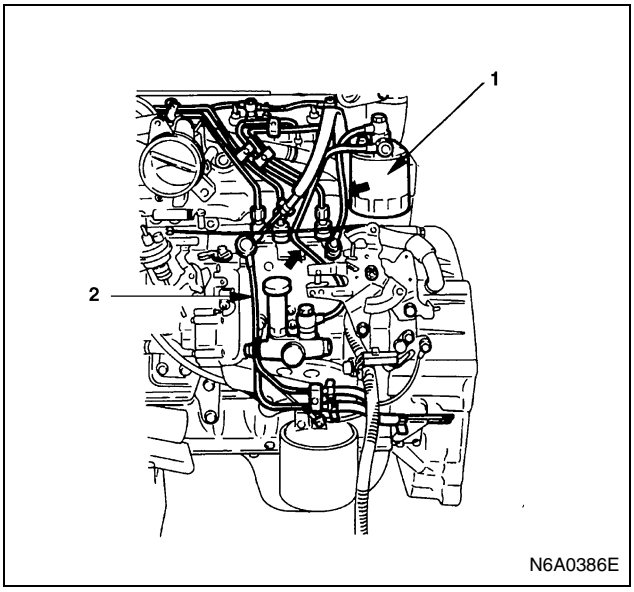
- Disconnect battery ground cable.
- Tilt the cab.

1. Intake Air Duct
   1) Remove the clips at the connections with the inlet cover and with the air cleaner.
   2) Remove the intake air duct with the connector hose attached.
2. Vacuum Hose
3. Nozzle Cover

4. Leak off Pipe


N6A0385E

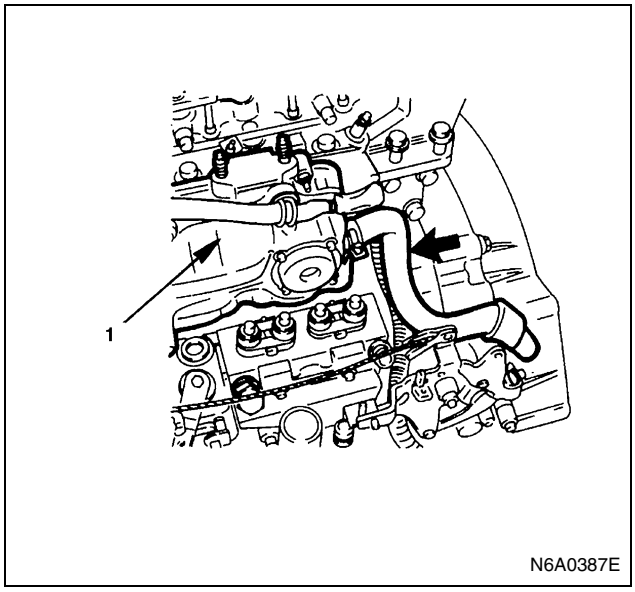
5. Fuel Pipe
   Do not apply excessive force to the fuel pipes.



N6A0386E

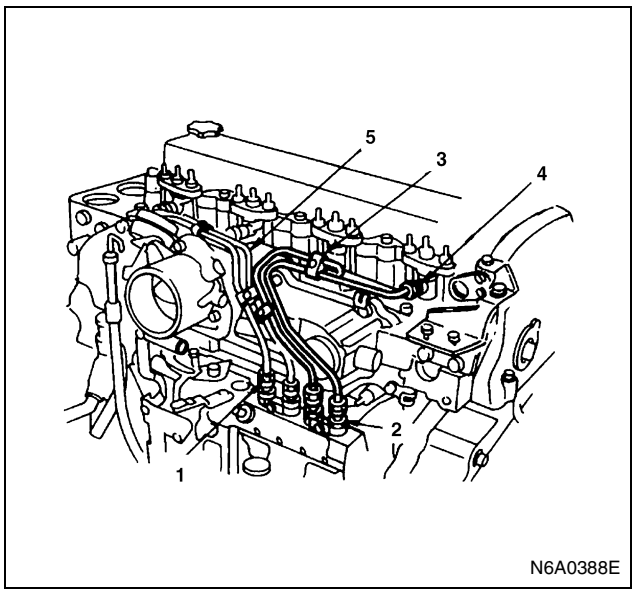
Legend
1. Fuel filter
2. Leak off

6. Positive Crankcase Ventilation (PCV) Hose
   Disconnect the PCV hose from inlet cover (1).



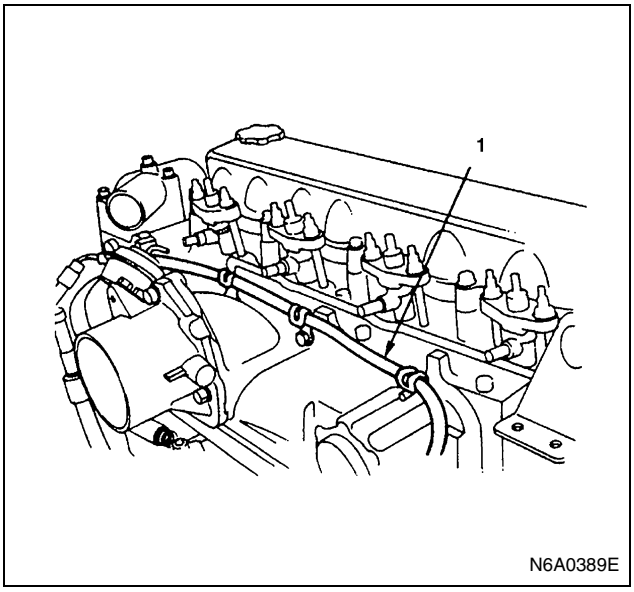
N6A0387E

7. Fuel Injection Pipe
   1) Loosen the injection pipe sleeve nuts (1).
   2) Do not apply excessive force to the injection pipes (5).
   3) Loosen the injection pipes clips (3).
   4) Remove the injection pipe assembly.
      Plug the delivery valve holder (2) ports and nozzle holder (4) ports with caps to prevent the entry of foreign material.



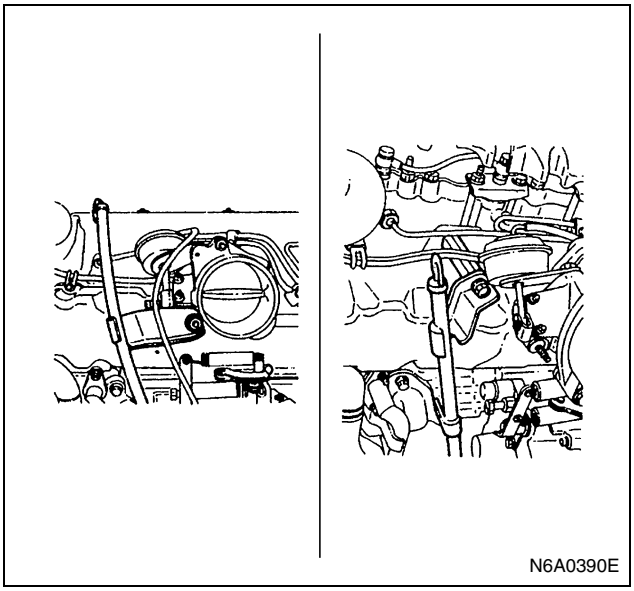
N6A0388E

8. Engine Harness
   Disconnect thermometer unit, thermo switch, tachometer sensor and glow plug harness connectors and separate harness from clips.

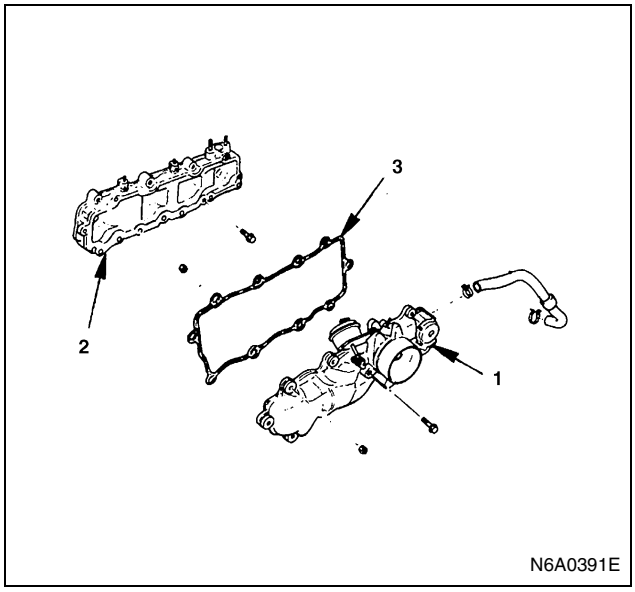


Legend
1. Engine harness

9. Oil Level Guide Tube
   Remove the guide tube fixing bolt and pull out the guide tube.



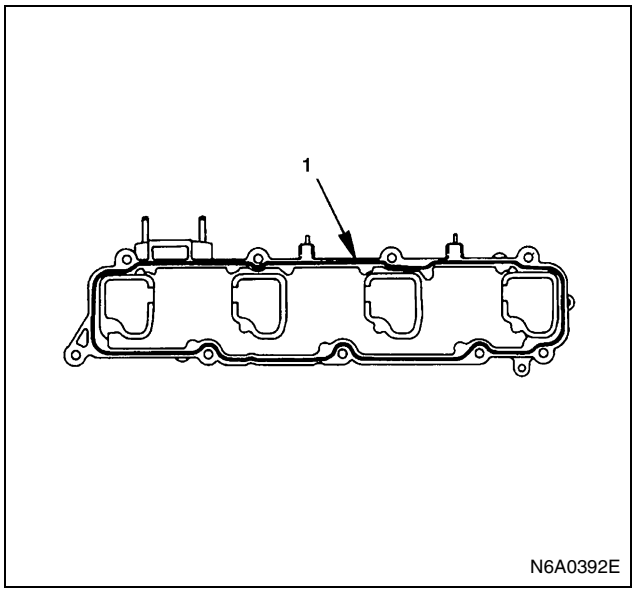
10. Inlet Cover
11. Inlet Case
    Remove the inlet case while removing the liquid gasket.



Legend
1. Inlet cover
2. Inlet case
3. Gasket

Installation

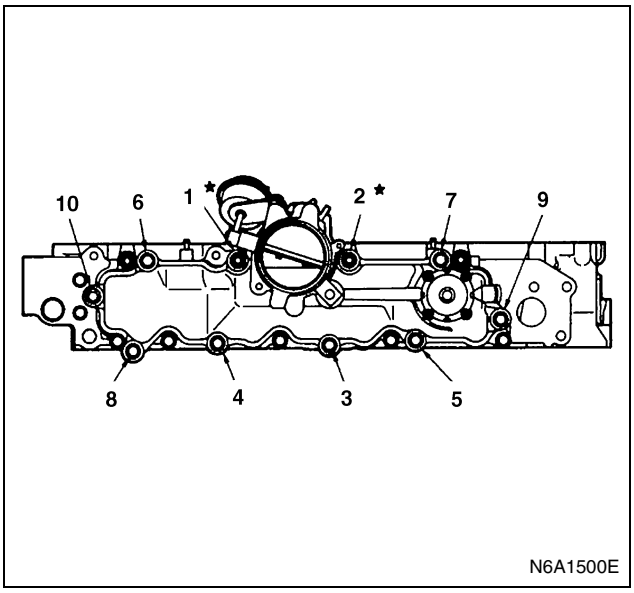
1. Inlet Case
   1) Apply 2 — 3 mm (0.08 — 0.12 in) bead of the recommended liquid gasket (Three Bond 1207C) or its equivalent on the groove (1) of the inlet case fitting surfaces shown in the illustration.
   - Clean the inlet case fitting surface of the cylinder head.



   2) Install the inlet case to the cylinder head.
   - Install the inlet case within 7 minutes after application of liquid gasket.
   3) Tighten the inlet case to the specified torque.

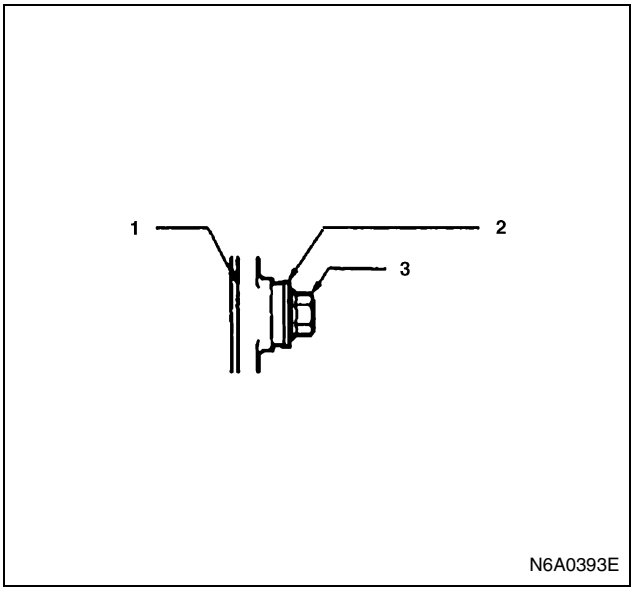
Tighten:
Inlet case nuts and bolts to 19 N·m (1.9 kg·m/ 14 lb·ft)

2. Inlet Cover
   1) Attach harness clips ((1), (6) and (7)) and tighten the inlet cover bolts and nuts to the specified torque in the numerical order shown in the illustration.



   2) ★ marks are located on the nut positions.

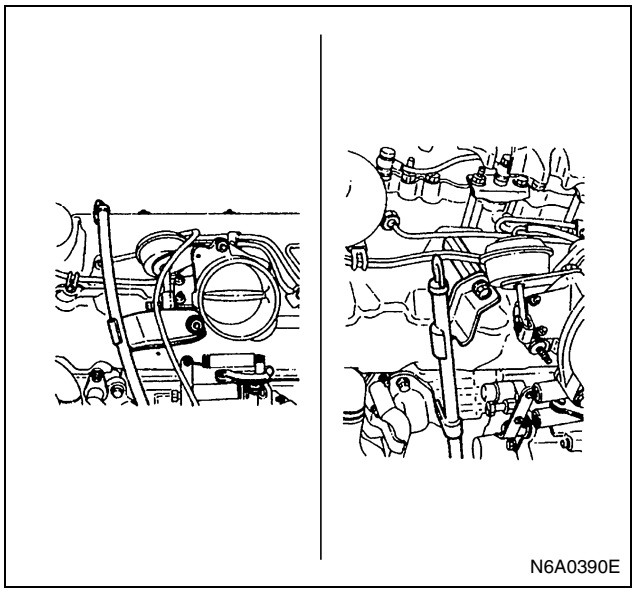
Tighten:
Inlet cover bolt and nut to 13 N·m (1.3 kg·m/9 lb·ft)



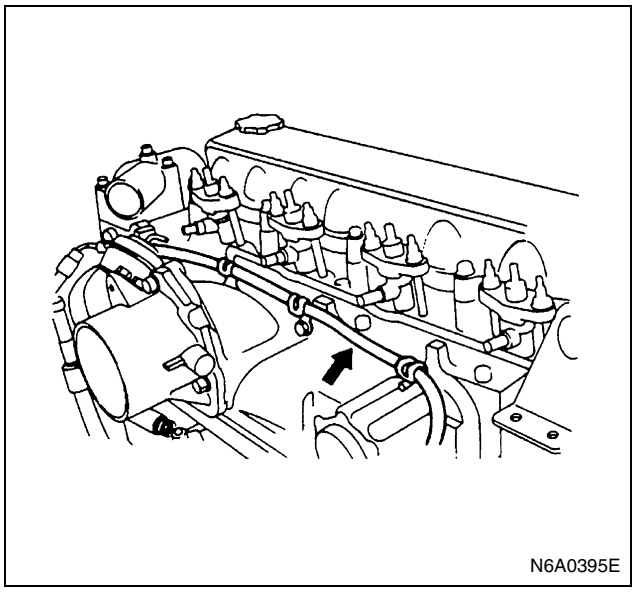
Legend
1. Inlet cover
2. Mounting rubber
3. Bolt

3. Oil Level Guide Tube
   1) Install the O-rings to the guide tube lower portion and insert the guide tube completely to the cylinder body.
   2) Tighten the guide tube bolt to the specified torque.

Tighten:
Guide tube bolt to 13 N·m (1.3 kg·m/9.4 lb·ft)



4. Engine Harness
   Connect thermometer unit, thermo switch, tachometer sensor and glow plug harness connector and fasten the engine harness with clips.

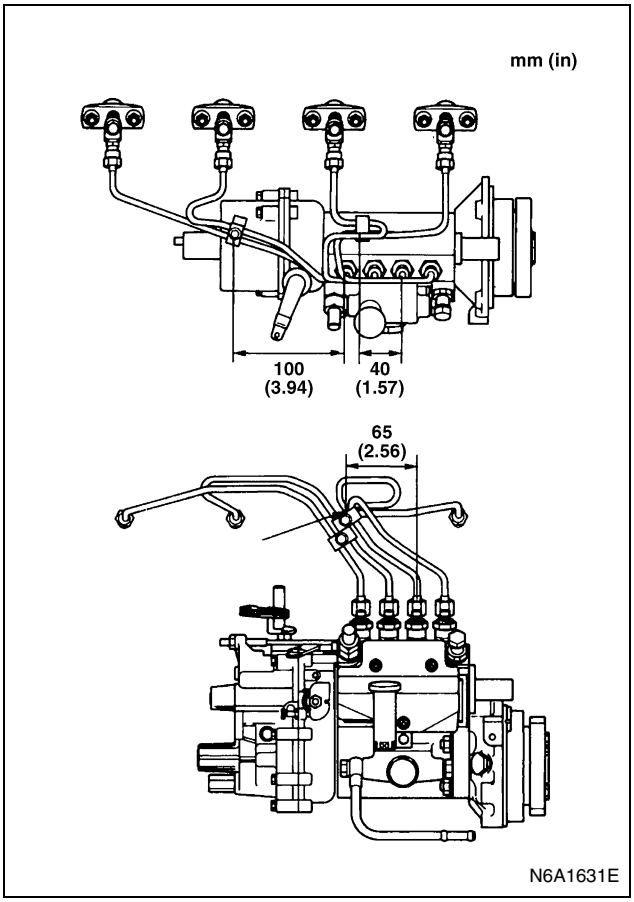


5. Injection Pipe
   1) Install the injection pipe assembly and temporarily tighten the injection pipe sleeve nuts.
   2) Set the clips in the prescribed position shown in the illustration.

Caution:
Make absolutely sure that the clip is correctly positioned.

An improperly positioned clip will result in injection pipe breakage and fuel pulsing noise.

Tighten:
Clip screw to 3 N·m (0.3 kg·m/26 lb·in)



3) Tighten the injection pipe sleeve nuts to the specified torque.

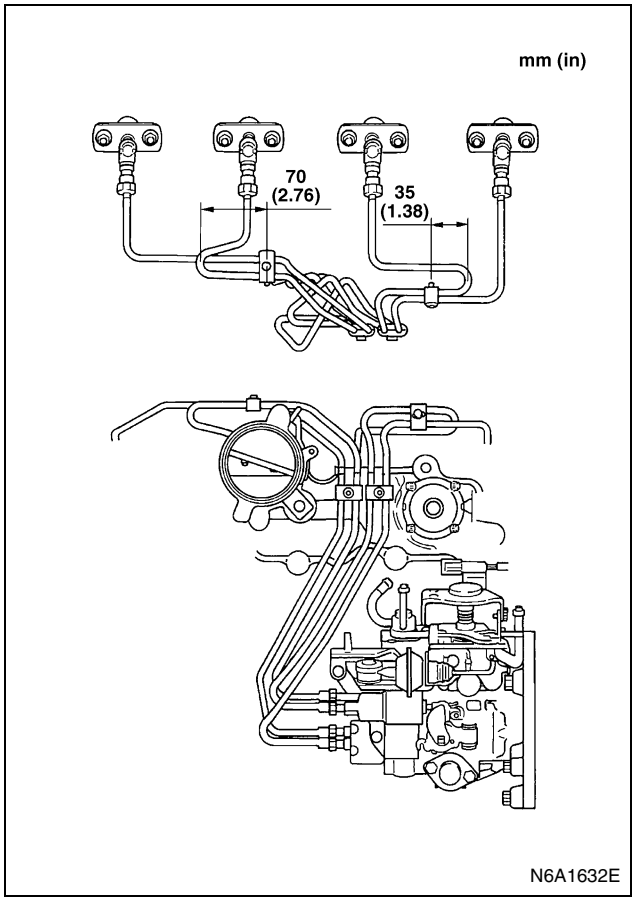
Tighten:
Injection pipe sleeve nut to 29 N·m (3 kg·m/22 lb·ft)

Injection Pipe (4HF1-2 model only)

1) Install the injection pipe assembly and temporarily tighten the injection pipe sleeve nuts.
2) Set the clips in the prescribed position shown in the illustration.

Caution:
Make absolutely sure that the clip is correctly positioned.
An improperly positioned clip will result in injection pipe breakage and fuel pulsing noise.

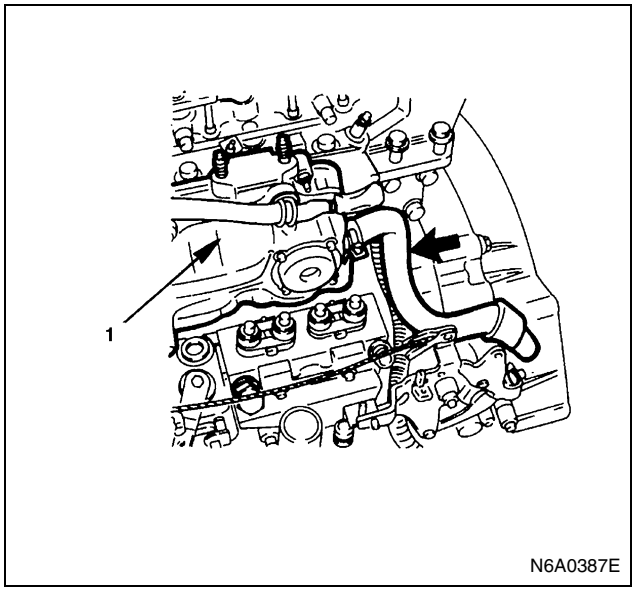
Tighten:
Clip screw to 3 N·m (0.3 kg·m/26 lb·in)



3) Tighten the injection pipe sleeve nuts to the specified torque.

Tighten:
Injection pipe sleeve nut to 29 N·m (3 kg·m/22 lb·ft)

6. Positive Crankcase Ventilation (PCV) Hose



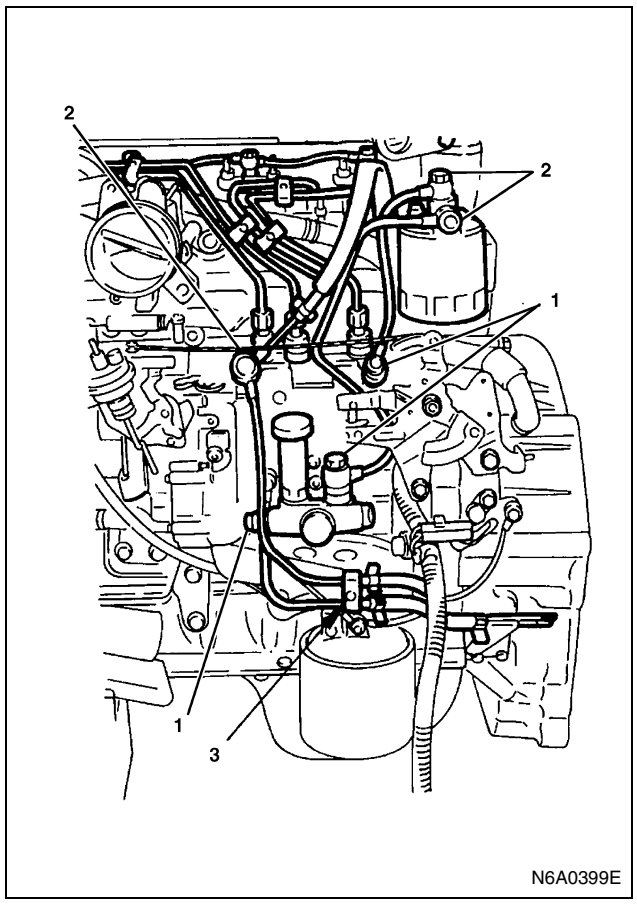
Legend
1. Inlet cover

7. Fuel Pipe
   Do not apply excessive force to the fuel pipe.

Tighten:
Fuel pipe joint bolt (1) to 41 N·m (4.2 kg·m/30 lb·ft)

Tighten:
Fuel pipe joint bolt (2) to 23 N·m (2.3 kg·m/17 lb·ft)

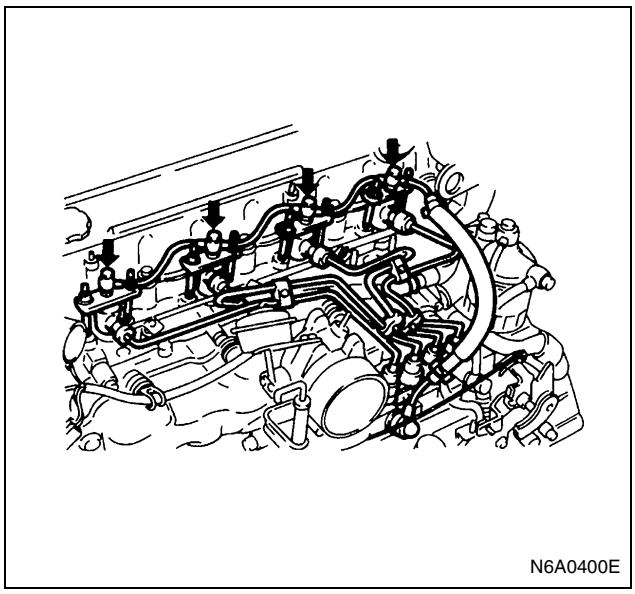
Tighten:
Clip screw to 4 N·m (0.4 kg·m/35 lb·in)



Legend
1. Fuel pipe joint bolt
2. Fuel pipe joint bolt
3. Clip

8. Leak Off Pipe

Tighten:
Leak-Off pipe joint bolt to 13 N·m (1.3 kg·m/113 lb·in)

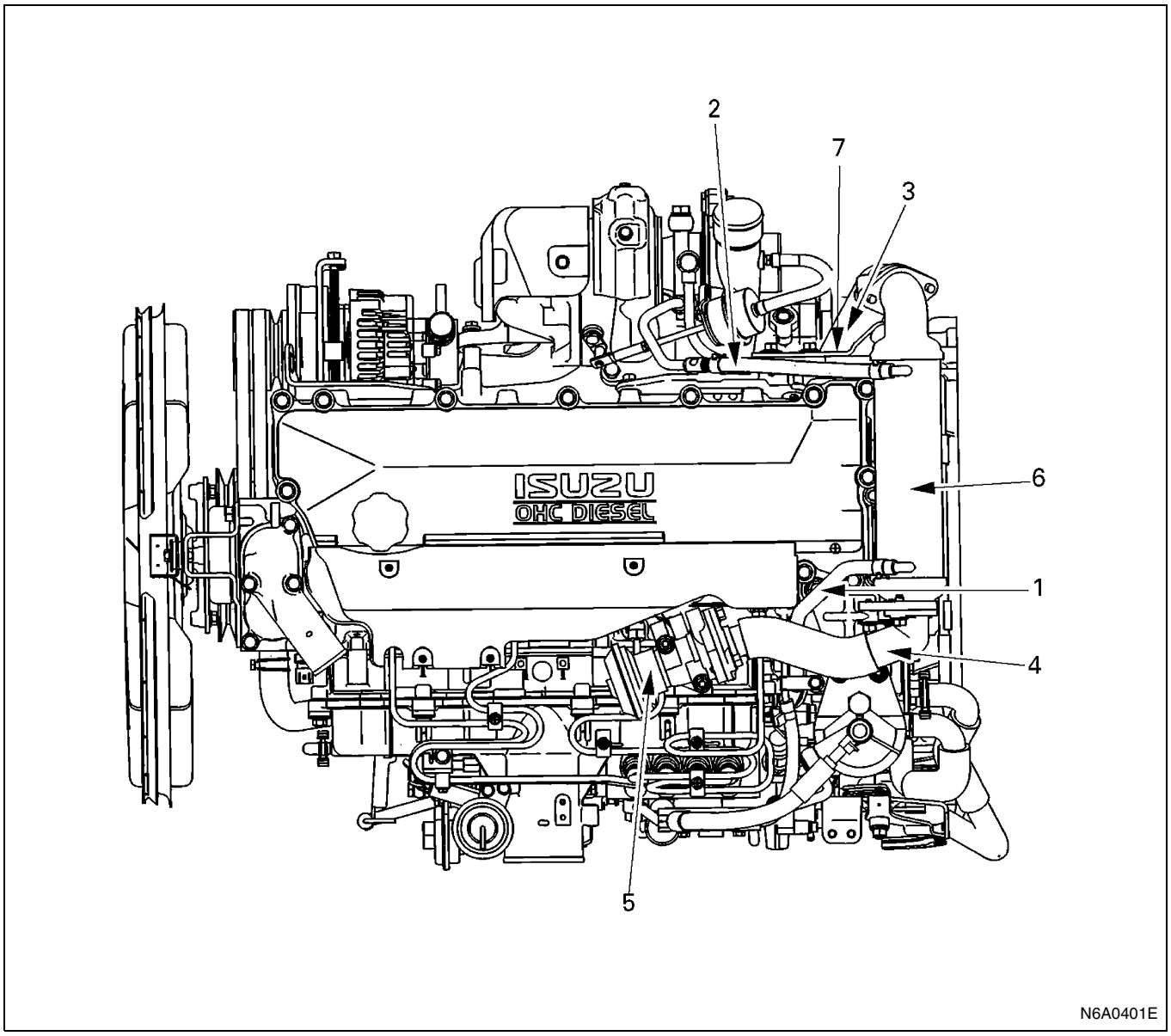


9. Nozzle Cover
10. Vacuum Hose
11. Intake Air Duct
    - Connect the negative battery cable.
    - Lower the cab.
    - Start engine and check for fuel leakage carefully.

4HE1-TC (4HE1-XS) for EURO3

EXHAUST GAS RECIRCULATION SYSTEM (EGR)

Component



Legend

1. Water hose (out)
2. Water hose (in)
3. EGR pipe (right side)
4. EGR pipe (left side)
5. EGR valve
6. EGR cooler
7. EGR cooler bracket

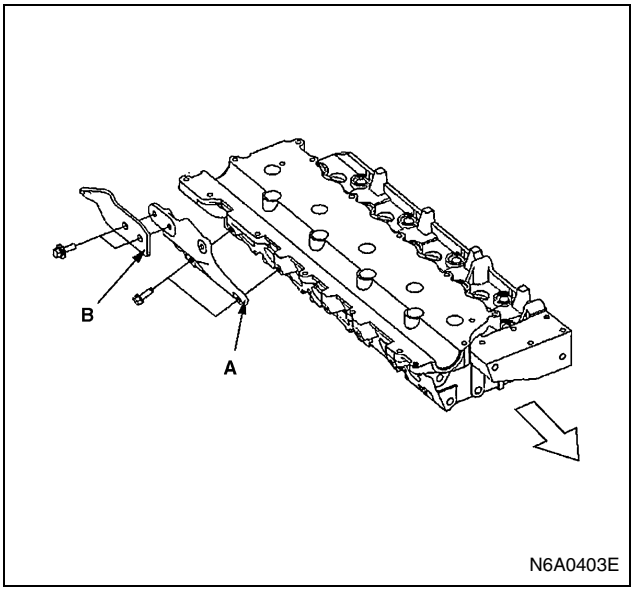
Removal

1. Water hose (out)
2. Water hose (in)
3. EGR pipe (right side)
4. EGR pipe (left side)
5. EGR valve
6. EGR cooler
7. EGR cooler bracket

Installation

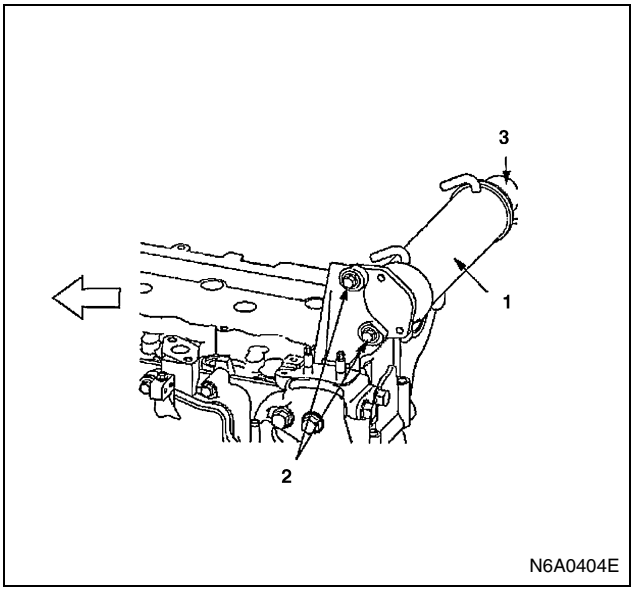
1. EGR Cooler Bracket
   Temporarily tighten the EGR cooler bracket (B) to the EGR cooler bracket (A).

Tighten:
EGR cooler bracket bolt (A) to 31 N·m (3.2 kg·m/23 lb·ft)



2. EGR Cooler
   1) Temporarily tighten the EGR cooler bolts left side.
   2) Tighten the EGR cooler bolt right side.

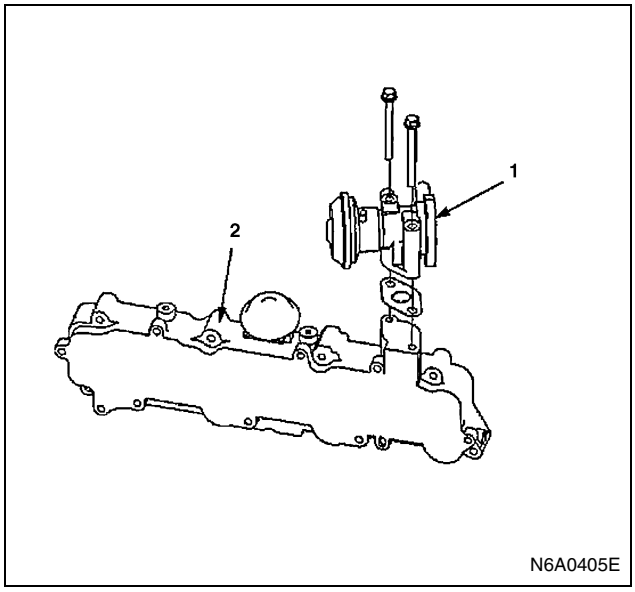
Tighten:
EGR cooler bracket bolt (right side) to 33 N·m (3.4 kg·m/ 25 lb·ft)



Legend
1. EGR cooler
2. Left side
3. Right side

3. EGR Valve
   Insert the gasket and install the EGR valve to the intake manifold.

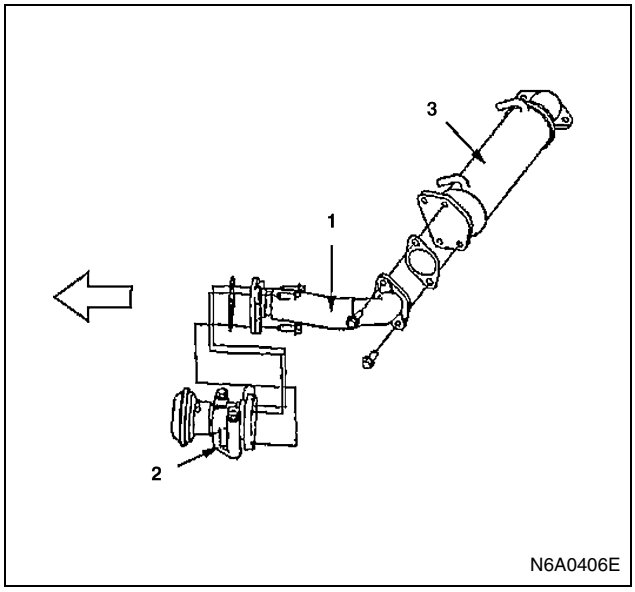
Tighten:
EGR valve bolt to 24 N·m (2.4 kg·m/17 lb·ft)



Legend
1. EGR valve
2. Inlet case

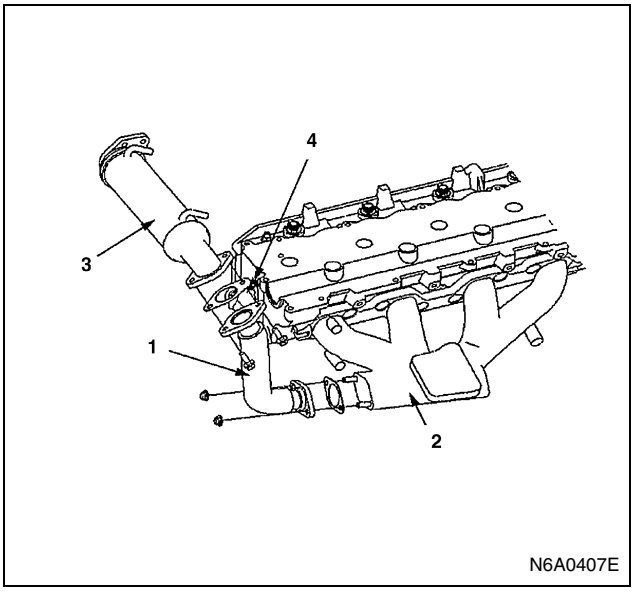
4. EGR Pipe (left side)
   Insert the gasket into the left-hand EGR pipe (1). Install the pipe between the EGR valve (2) and the EGR cooler (3).

Tighten:
EGR pipe (left side) bolt to 24 N·m (2.4 kg·m/17 lb·ft)



5. EGR Pipe (right side)
   1) Insert the gasket into the right-hand EGR pipe (refer to the illustration). Install the pipe between the exhaust manifold and the EGR cooler.

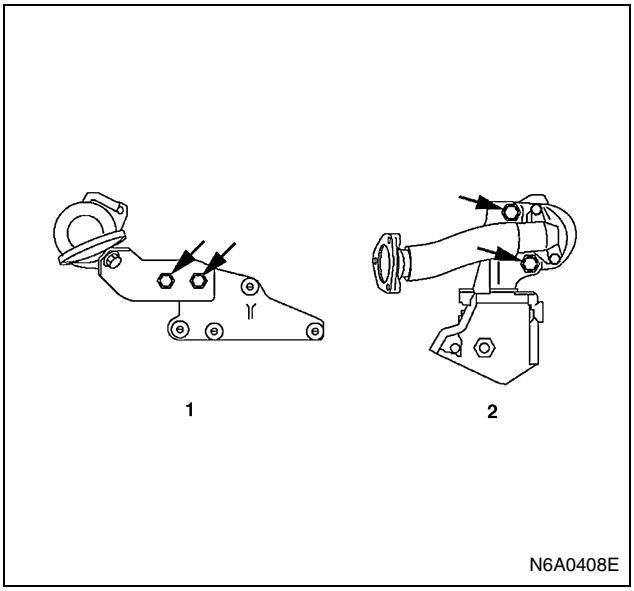
Tighten:
EGR pipe nut and bolt to 28 N·m (2.9 kg·m/21 lb·ft)



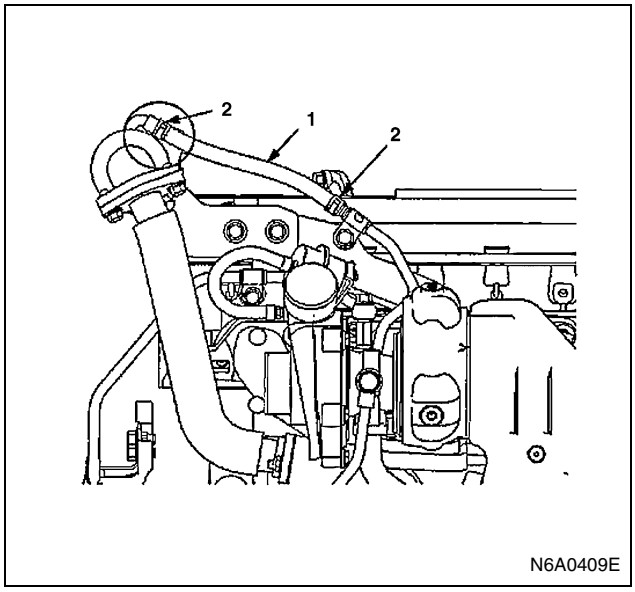
Legend
1. EGR pipe
2. Exhaust manifold
3. EGR cooler
4. TAB

2) Adjust bracket position to eliminate any play using the bracket adjustment holes. Tighten the bolts as shown by the arrows in the illustration.

Tighten:
EGR cooler bracket bolt to
- Right side (1): 26 N·m (2.7 kg·m/20 lb·ft)
- Left side (2): 24 N·m (2.4 kg·m/17 lb·ft)

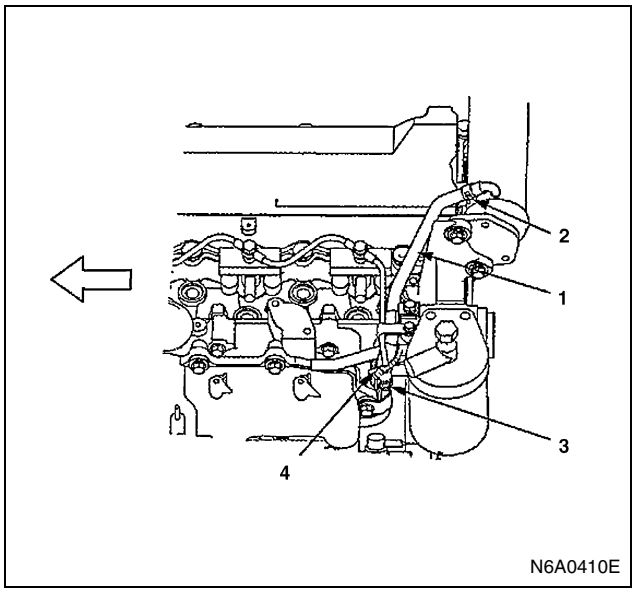


6. Water Hose (in)
Arrange the clips so that the jaws face the side of the engine.



Legend
1. Water hose (in)
2. Clip

7. Water Hose (out)
Insert clip (2) so that the jaws face the side of the engine.
Install clip (3) so that the jaws face away from the engine.

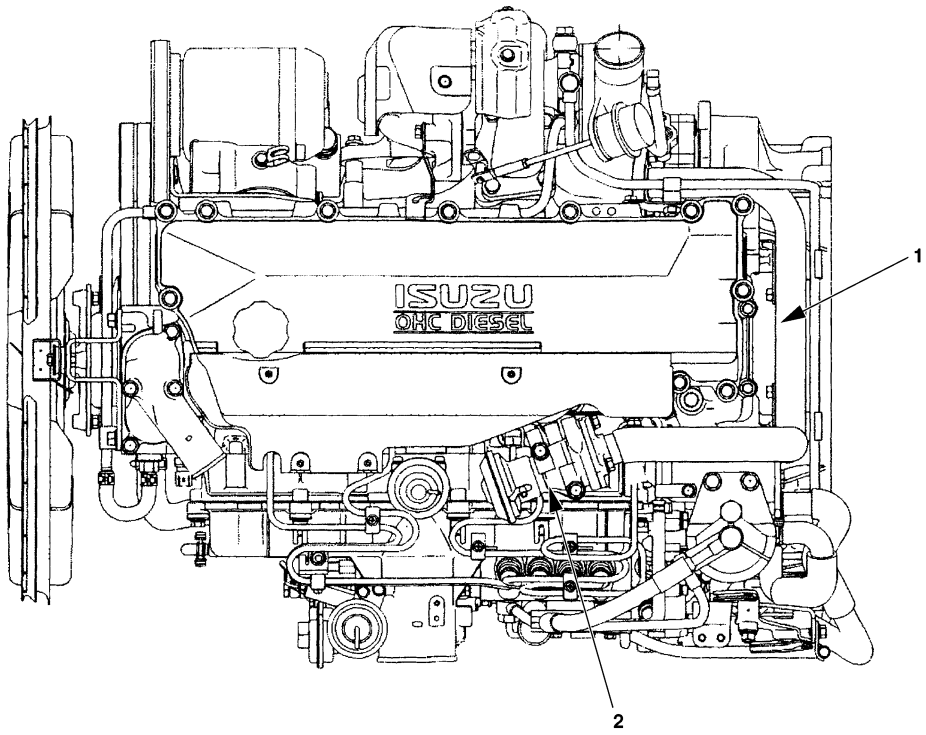


Legend
1. Water hose (out)
2. Clip
3. Clip
4. Band clip

4HE1-TC (98EPA)

EXHAUST GAS RECIRCULATION SYSTEM (EGR)

Component



N6A1601E

Legend

1. EGR pipe assembly
2. EGR valve

Removal

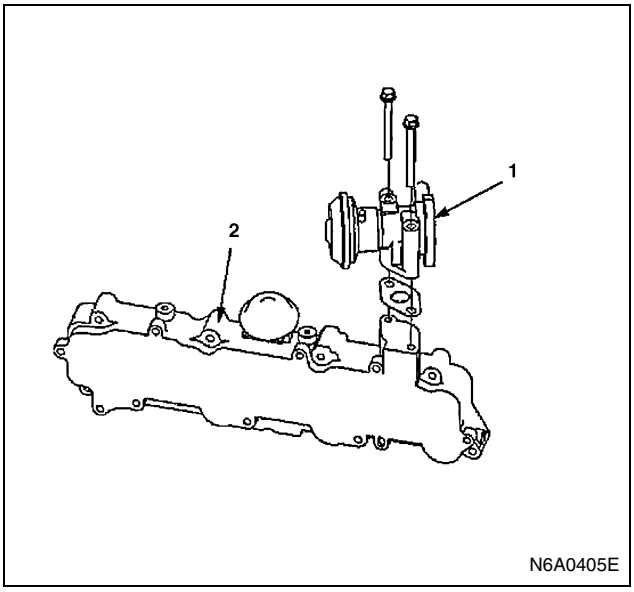
1. EGR pipe assembly
2. EGR valve

Installation

1. EGR valve
   Insert the gasket and install the EGR valve to the intake manifold.

Notice:
The gasket of 4HE1-XS and 4HE1-XN are dirrerent.

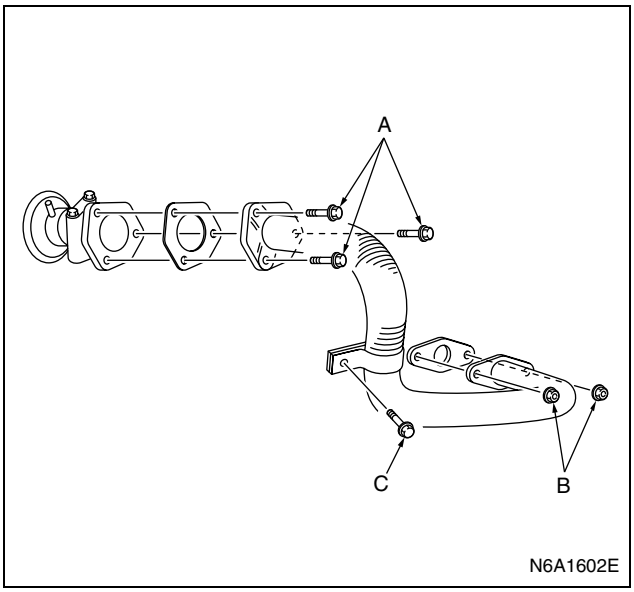
Tighten:
EGR valve bolt to 23.5 ± 5 N·m (2.4 ± 0.5 kg·m/17 ± 3.7 lb·ft)



Legend
1. EGR valve
2. Inlet case

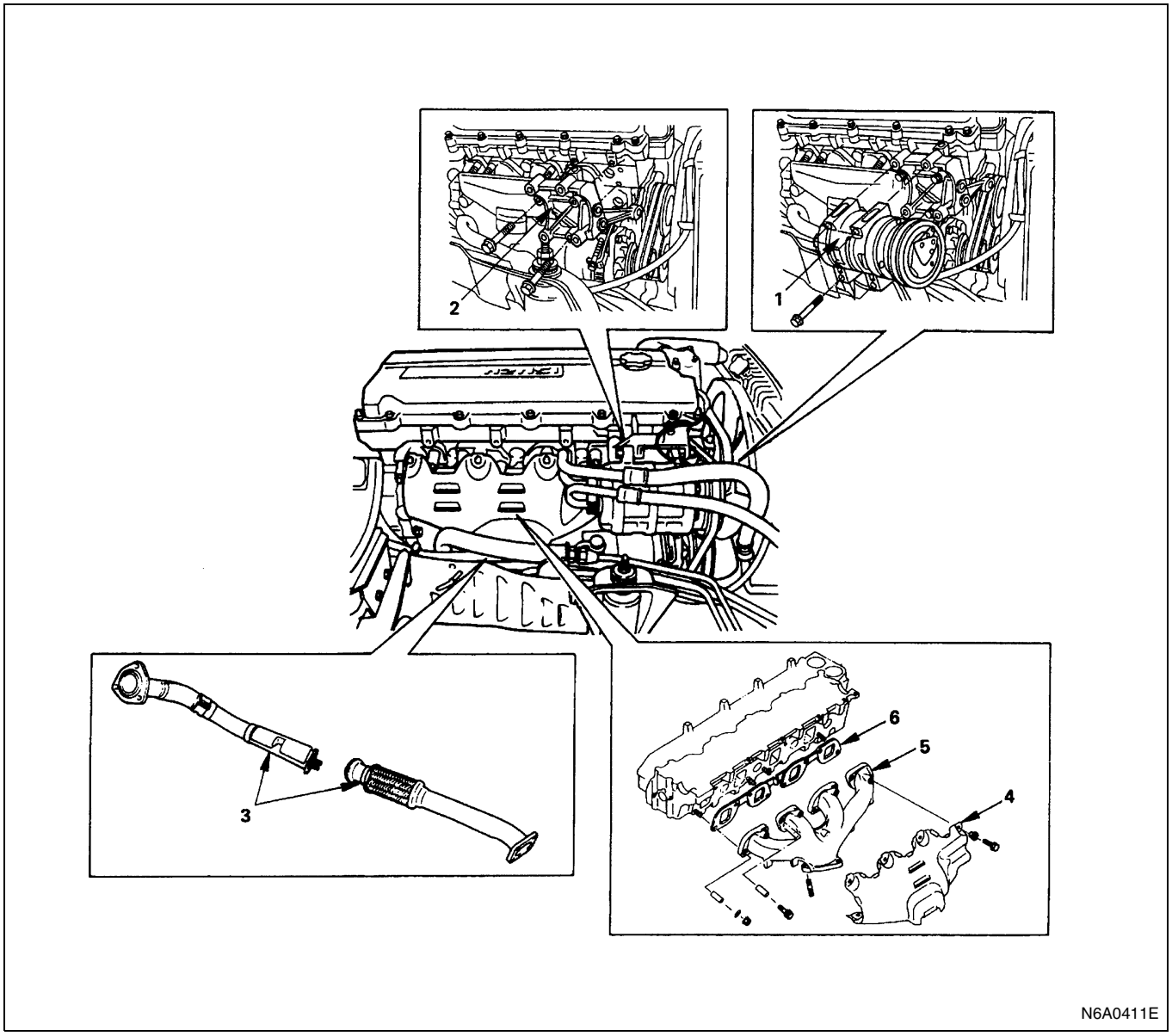
2. EGR Pipe assembly
   Install the EGR pipe assembly to the exhaust manifold and the EGR valve with gasket.

Tighten:
A: Bolt to 23.5 ± 5 N·m (2.4 ± 0.5 kg·m/17 ± 3.7 lb·ft)
B: Nut to 28.4 ± 4 N·m (2.9 ± 0.4 kg·m/21 ± 3.1 lb·ft)
C: Bolt to 23.5 ± 5 N·m (2.4 ± 0.5 kg·m/17 ± 3.7 lb·ft)



EXHAUST MANIFOLD

Component



Legend

1. A/C compressor (If equipped with A/C)
2. A/C compressor bracket (If equipped with A/C)
3. Front exhaust Pipe
4. Heat protector
5. Exhaust manifold
6. Exhaust gasket

Removal

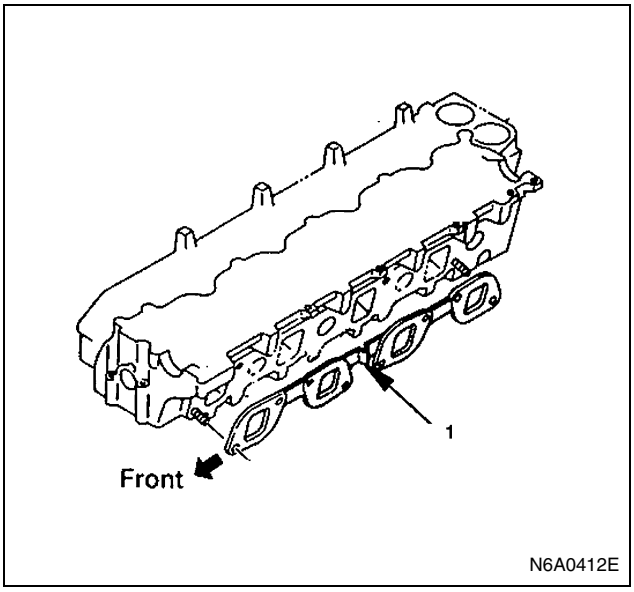
Preparation

- Disconnect battery ground cable.
- Tilt the cab.

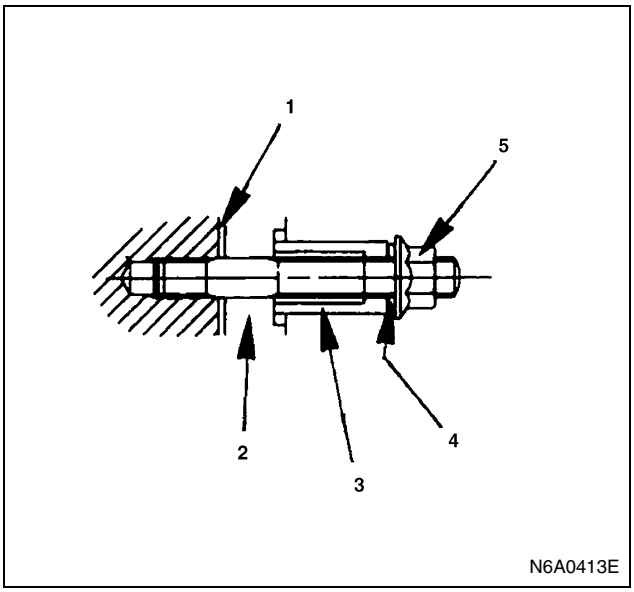
1. Air Conditioning (A/C) Compressor (If equipped with A/C)
   1) Disconnect magnetic clutch harness connector.
   2) Dismount the compressor together with the hoses from the A/C compressor bracket, and fasten it to the appropriate location with a wire.
2. A/C Compressor Bracket (If equipped with A/C)
3. Front Exhaust Pipe
4. Heat Protector
5. Exhaust Manifold
6. Exhaust Gasket

Installation

1. Exhaust Gasket
   Insert the gasket into the stud provided to the cylinder head (with the projection (1) of the gasket on this side).

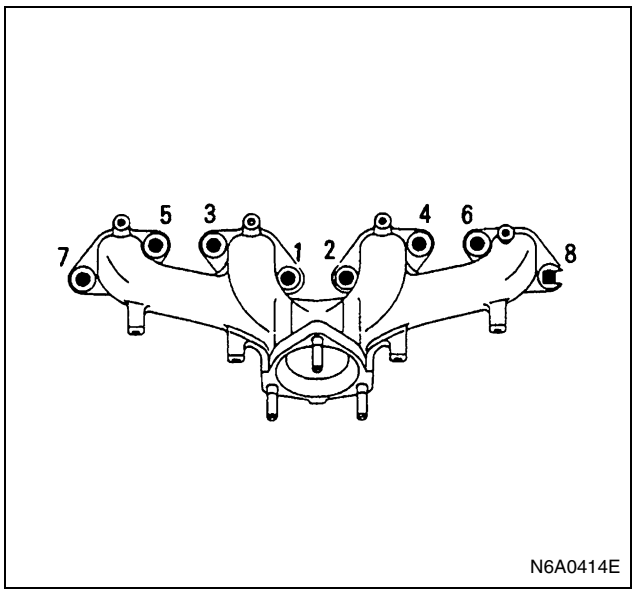


2. Exhaust Manifold
   1) Install exhaust manifold gaskets (1), exhaust manifold (2), distance pieces (3), dish washers (4) and nuts (5) to the stud bolts shown in the illustration.



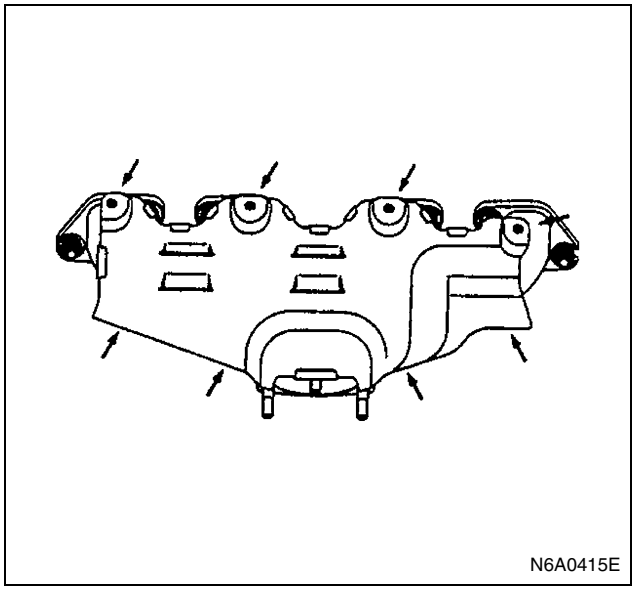
   2) Tighten the nuts to the specified torque in the numerical order shown in the illustration.

Tighten:
Exhaust manifold nut to 34 N·m (3.5 kg·m/25 lb·ft)



3. Heat Protector

Tighten:
Heat protector bolt to 10 N·m (1.0 kg·m/7 lb·ft)

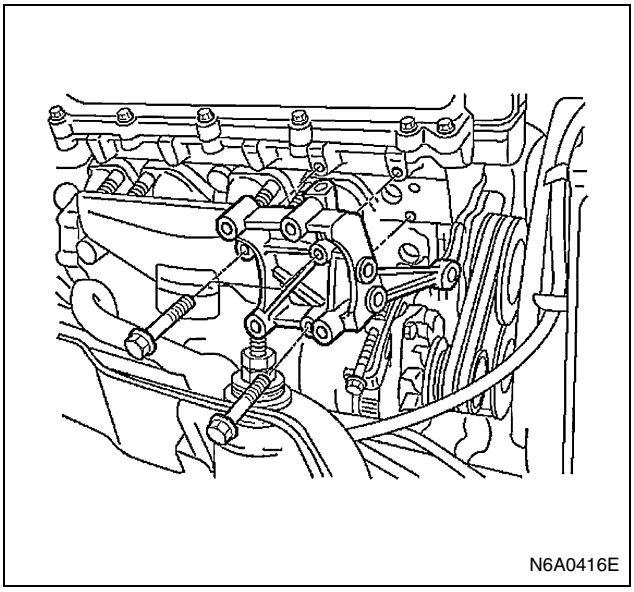


4. Front Exhaust Pipe

Tighten:
Front exhaust pipe to
- Exhaust manifold side: 67 N·m (6.8 kg·m/49 lb·ft)
- Exhaust brake side: 17 N·m (1.7 kg·m/12 lb·ft)

5. Air Conditioning (A/C) Compressor Bracket (If equipped with A/C)
   Tighten fixing bolts to the specified torque.

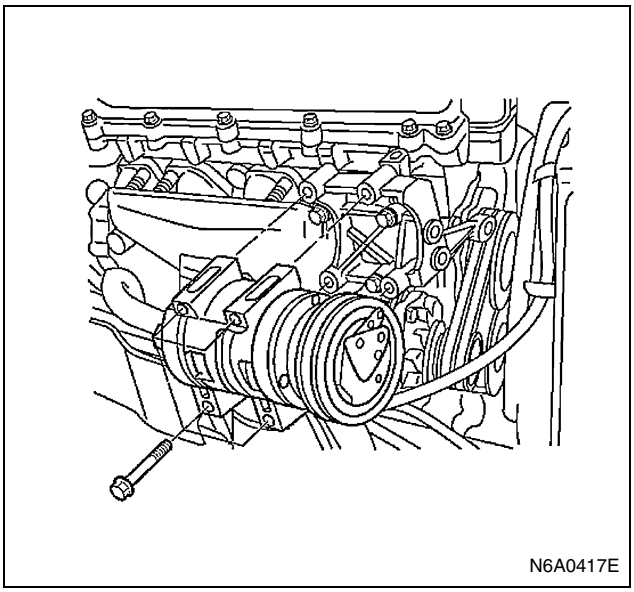
Tighten:
A/C compressor bracket bolt to 48 N·m (4.9 kg·m/35 lb·ft)


N6A0416E

6. A/C Compressor (If equipped with A/C)
   1) Tighten fixing bolts to the specified torque.

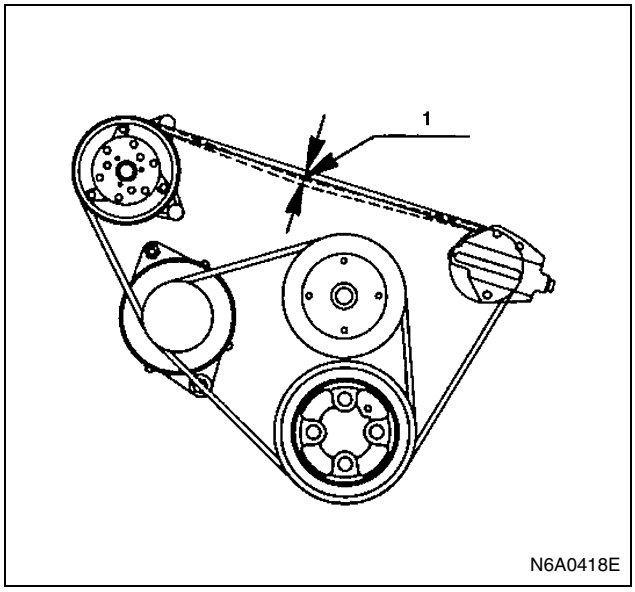
Tighten:
A/C compressor bolt to 48 N·m (4.9 kg·m/35 lb·ft)

Notice:
When tightening the compressor fixing bolts, tighten first the 2 bolts on the rear side, and then the remaining 2 on the front.


N6A0417E

   2) Install drive belt adjust belt tension by adjusting bolt and tighten locking nut to the specified torque.
   3) Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

Drive Belt Deflection	mm (in)
16 — 20 (0.63 — 0.79) ... New belt 18 — 22 (0.71 — 0.87) ... Reuse belt	



N6A0418E

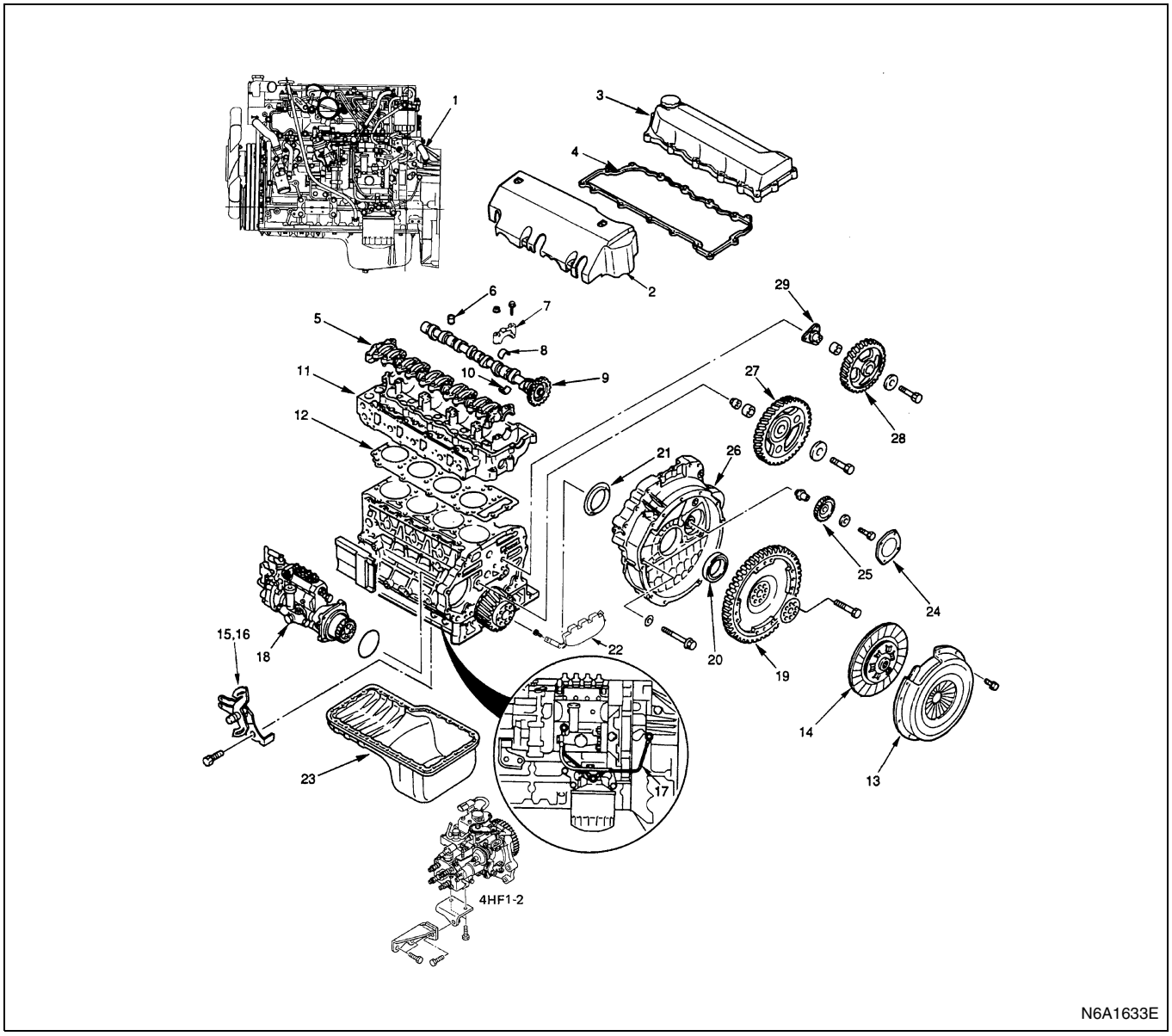
Legend
1. Belt deflection

Tighten:
Locking nut to 27 N·m (2.8 kg·m/20 lb·ft)

- Connect the negative battery cable.
- Lower the cab.
- Start engine and check for gas leakage carefully.

TIMING GEAR REPLACEMENT

Component



Legend

1. Engine assembly
2. Nozzle cover
3. Cylinder head cover
4. Head cover gasket
5. Rocker arm shaft assembly
6. Valve cap
7. Camshaft bearing cap
8. Camshaft bearing upper
9. Camshaft assembly
10. Camshaft bearing lower
11. Cylinder head assembly
12. Cylinder head gasket
13. Clutch pressure plate assembly
14. Driven plate
15. Engine control wire
16. Engine control lever assembly
17. Oil pipe
18. Injection pump assembly
19. Flywheel
20. Rear oil seal
21. Slinger
22. Spacer rubber
23. Oil pan
24. Power steering pump idle gear cover
25. Power steering pump idle gear
26. Flywheel housing
27. Idle gear A
28. Idle gear B
29. Idle gear B shaft

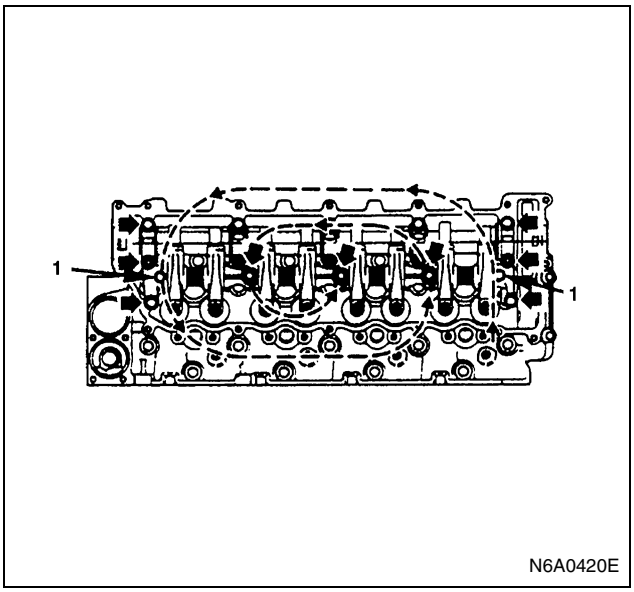
Removal

Preparation

- Disconnect battery ground cable.
- Tilt the cab.
- Drain coolant and engine oil.

1. Engine Assembly
   Above works refer to “ENGINE ASSEMBLY” section in this manual.
2. Nozzle Cover
3. Cylinder Head Cover
4. Head Cover Gasket
5. Rocker Arm Shaft Assembly
   1) Loosen the rocker arm shaft bracket nuts and bolts in numerical order a little at a time and remove the rocker arm shaft assembly with the camshaft brackets.
   2) Leave the (1) indicated bolt unremoved on this occasion, since it is the rocker arm fixing bolt.

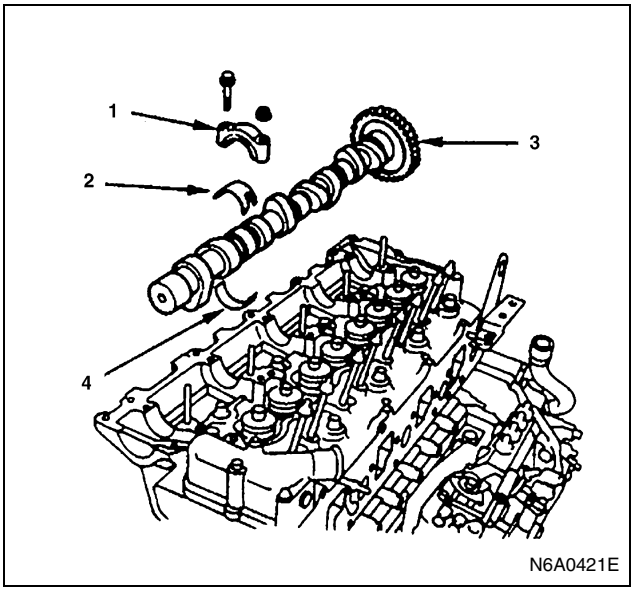
Caution:
Failure to loosen the rocker arm shaft bracket nuts and bolts in numerical order a little at a time will adversely affect the rocker arm shaft.



6. Valve Cap

Caution:
Take sufficient care not to let valve caps fall into the gear case or oil return hole.

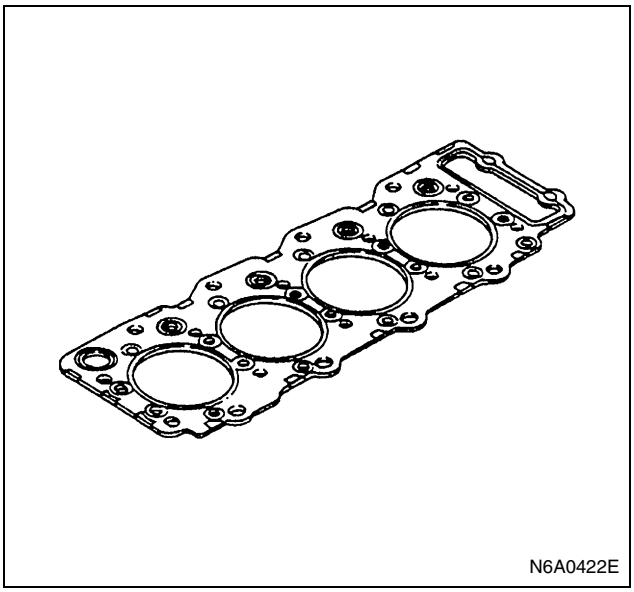
7. Camshaft Bearing Cap
8. Camshaft Bearing Upper
9. Camshaft Assembly
10. Camshaft Bearing Lower
    If the camshaft bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



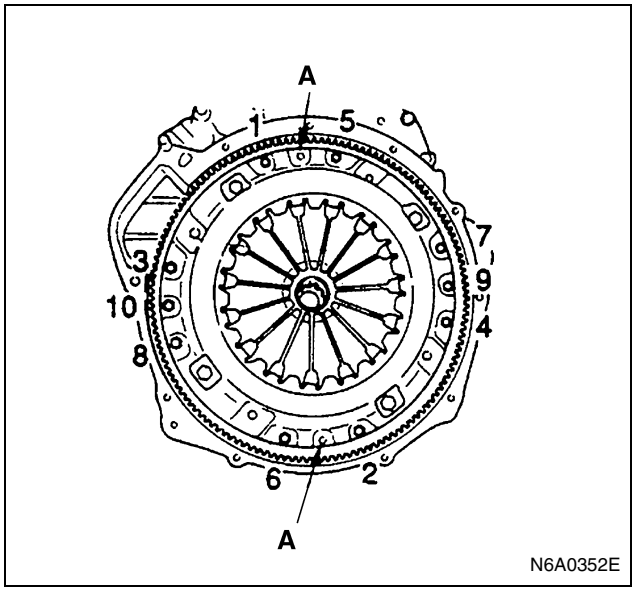
Legend
1. Camshaft bearing cap
2. Camshaft bearing upper
3. Camshaft assembly
4. Camshaft bearing lower

11. Cylinder Head Assembly
    Above works refer to “CYLINDER HEAD” section in this manual.
12. Cylinder Head Gasket

Caution:
Do not reuse the cylinder head gasket.

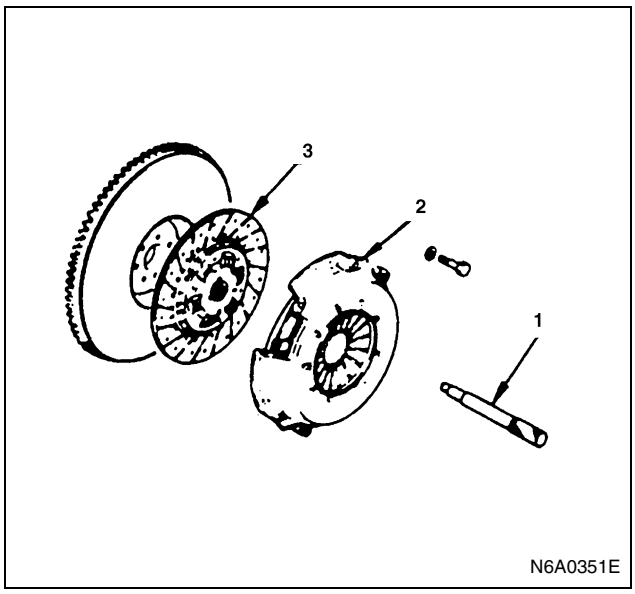


13. Clutch Pressure Plate Assembly
    1) Insert the clutch pilot aligner to the clutch assembly.
       Clutch Pilot Aligner: 5-8840-2240-0
    2) Loosen the pressure plate bolts in numerical order a little at a time as shown in the illustration.



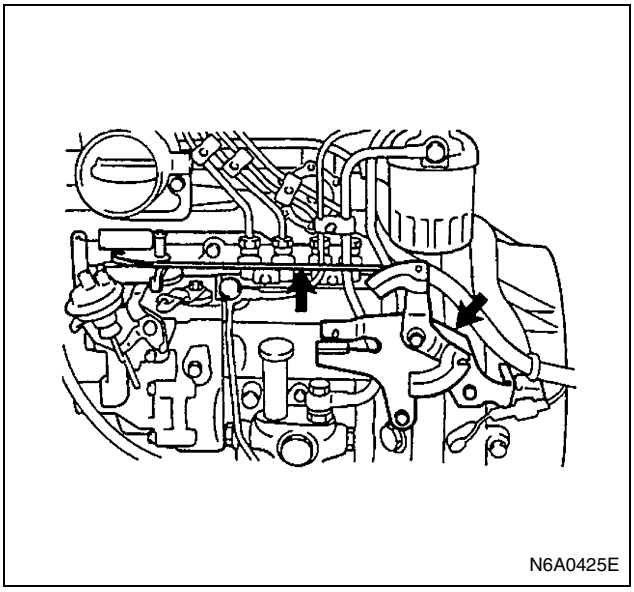
Legend
A. Knock pin

    3) Remove the pressure plate assembly.
14. Driven Plate
    Remove the driven plate with the clutch pilot aligner.

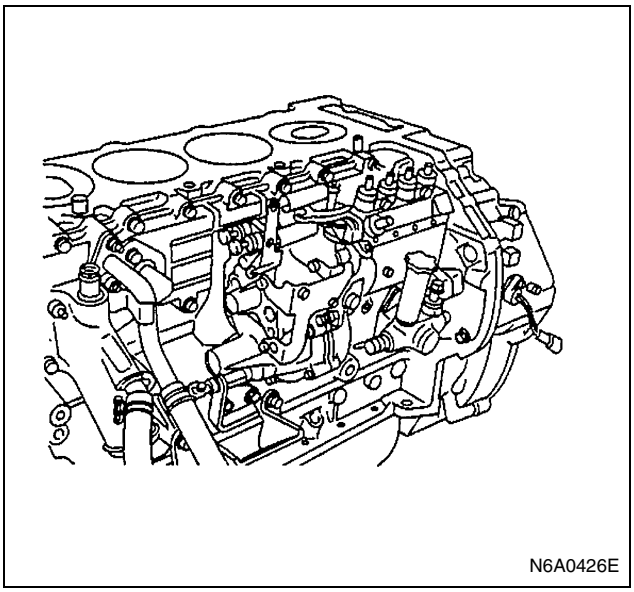


Legend
1. Clutch pilot aligner
2. Clutch pressure plate assembly
3. Driven plate

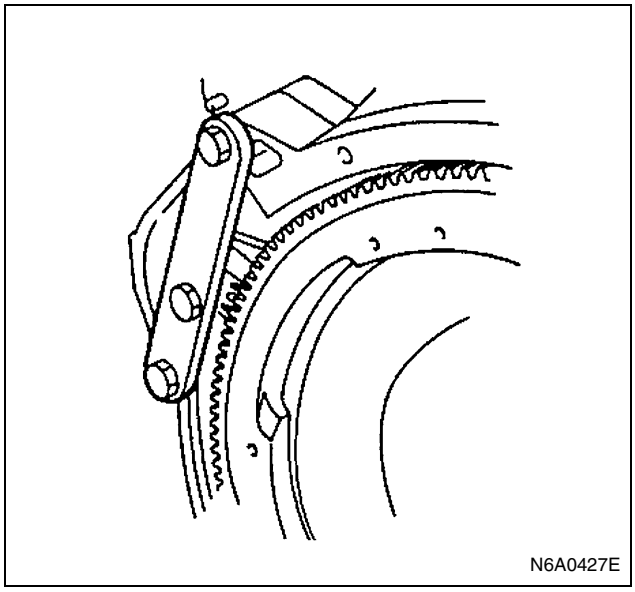
15. Engine Control Wire
16. Engine Control Lever Assembly


N6A0425E

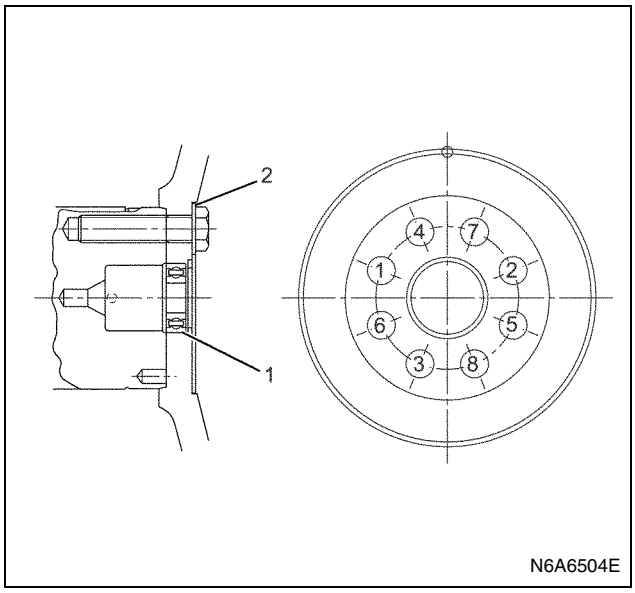
17. Oil Pipe
18. Injection Pump Assembly
    1) Remove the injection pump bracket bolts and the injection pump rear bracket bolts.
    2) Then remove the injection pump assembly.


N6A0426E

19. Flywheel
    1) Use the crankshaft stopper to prevent the crankshaft from turning.
       Crankshaft Stopper: 5-8840-2230-0


N6A0427E

    2) Loosen the flywheel bolts in numerical order a little at a time as shown in the illustration.

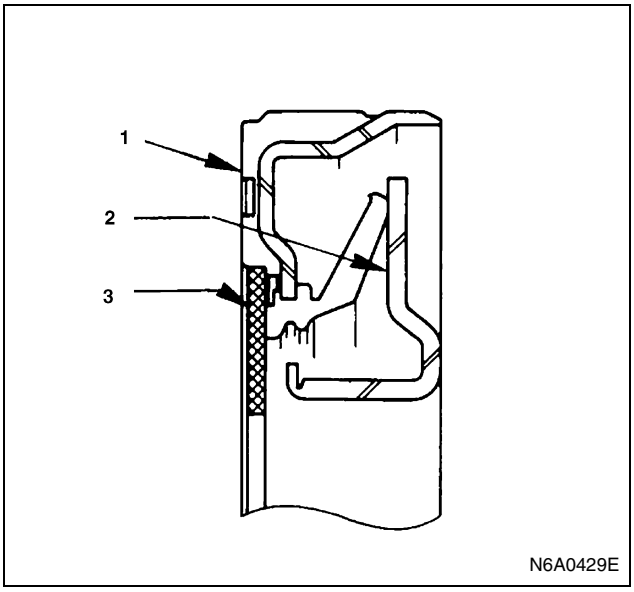


N6A6504E

Legend
1. Washer
2. Pilot bearing

    3) Remove the flywheel stopper and the flywheel assembly.
20. Crankshaft Rear Oil Seal

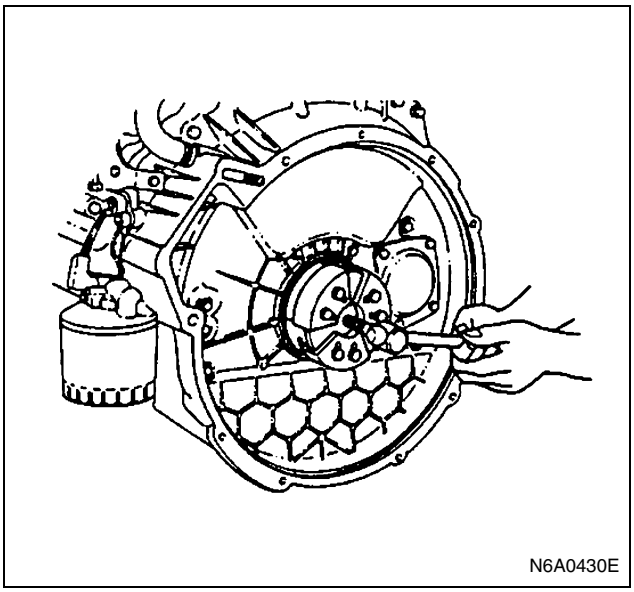
Caution:
Be careful not to damage the crankshaft oil seal contact surface during the removal procedure.



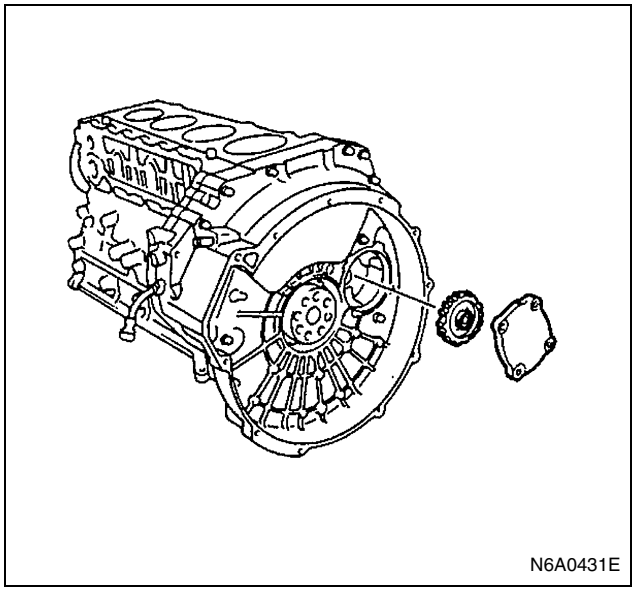
Legend

1. Oil seal
2. Slinger
3. Felt

21. Crankshaft Rear Slinger
    Use the slinger puller to pull out the slinger.
    Slinger Puller: 5-8840-2360-0

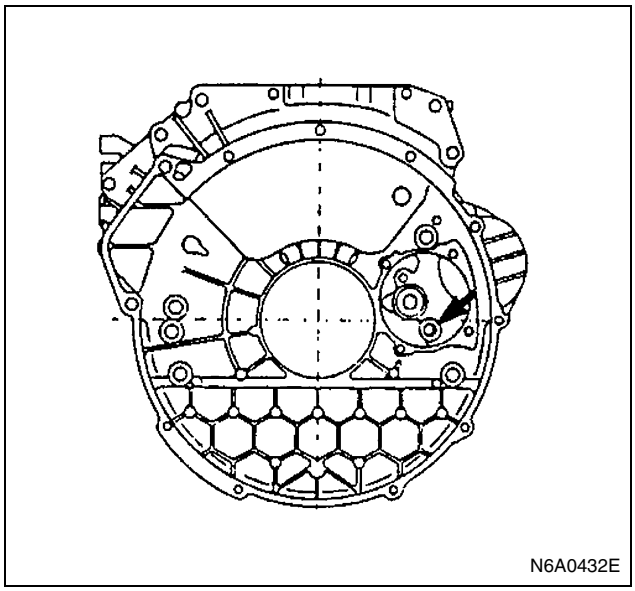


22. Spacer Rubber
    (Remove the stiffener before removing the spacer rubber.)
23. Oil Pan
24. Power Steering Pump Idle Gear Cover
25. Power Steering Pump Idle Gear

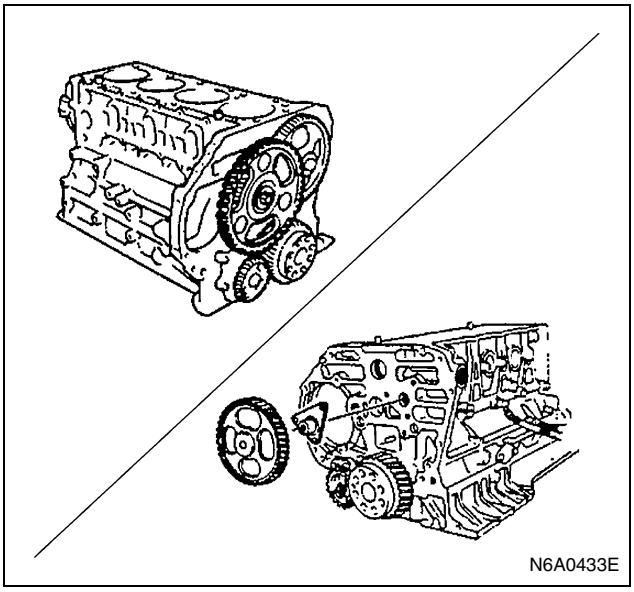


26. Flywheel Housing

Notice:
Be careful not to fail to remove the bolts shown in the illustration.



27. Idle Gear A
28. Idle Gear B
29. Idle Gear B shaft

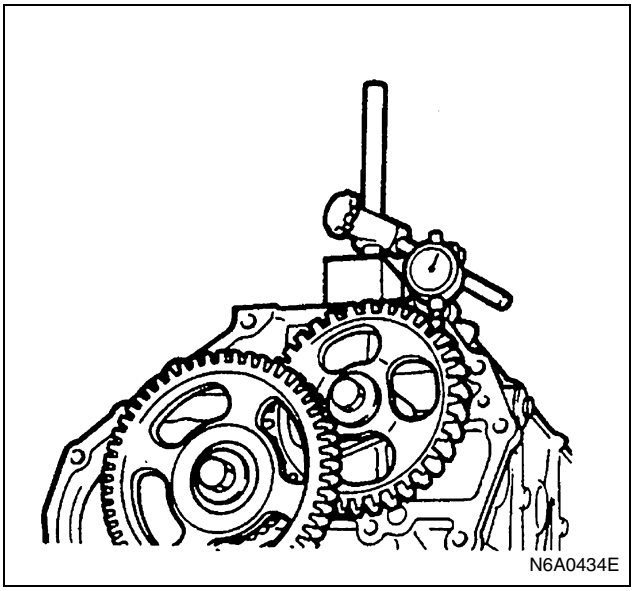

N6A0433E

Inspection

Idle Gear Backlash Measurement

1. Set a dial indicator to the timing gear to be measured.
   Hold both the gear to be checked and the adjoining gear stationary.
2. Move the gear to be checked right and left as far as possible. Take the dial indicator reading.

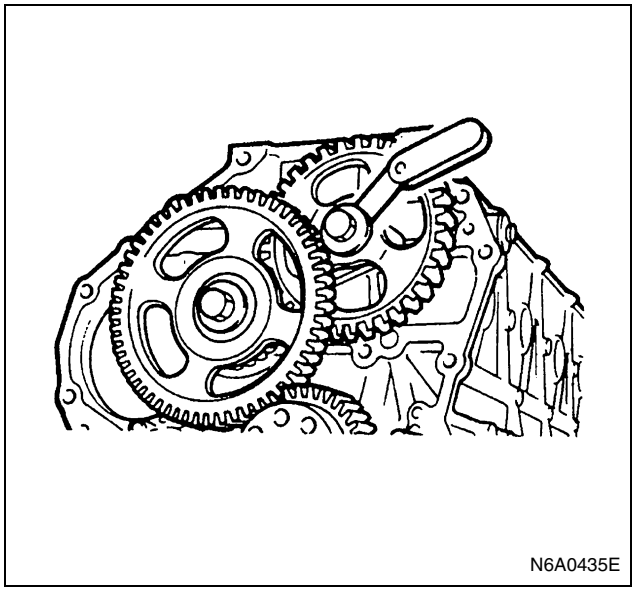
Timing Gear Backlash Gear to Gear	mm (in)
Standard	Limit
0.10 — 0.17 (0.0039 — 0.0067)	0.30 (0.012)


N6A0434E

Idler Gear End Play Measurement

Insert a feeler gauge between the idler gear and the thrust collar to measure the gap and determine the idler gear end play.
If the measured value exceeds the specified limit, the thrust collar must be replaced.

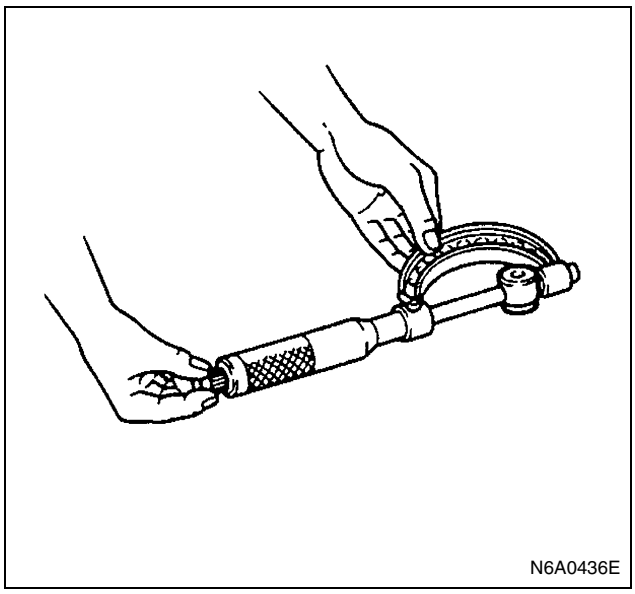
Idler Gear End Play	mm (in)
Standard	Limit
0.058 — 0.115 (0.002 — 0.005)	0.2 (0.008)


N6A0435E

Idler Gear Shaft Outside Diameter

Use a micrometer to measure the idler gear shaft outside diameter.
If the measured value is less than the specified limit, the idler gear must be replaced.

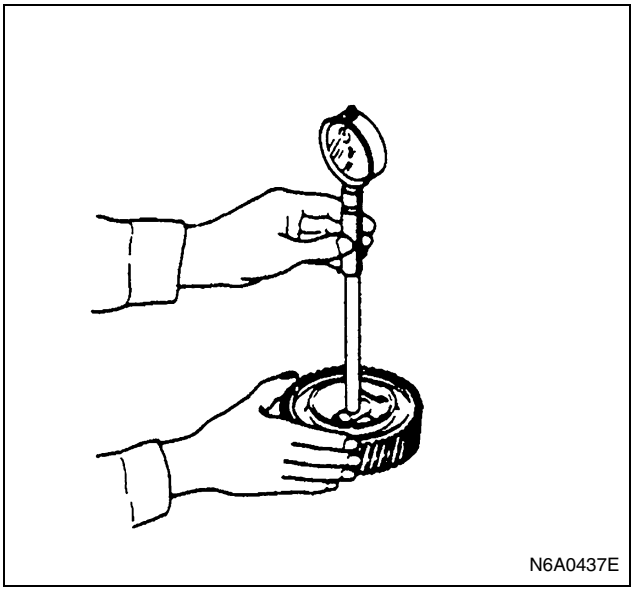
Idler Gear Shaft Outside Diameter	mm (in)
Standard	Limit
29.959 — 29.980 (1.1795 — 1.1803)	29.80 (1.1732)


N6A0436E

Idler Gear Inside Diameter

Use an inside dial indicator or an inside micrometer to measure the idler gear inside diameter.

Idler Gear Inside diameter	mm (in)
Standard	Limit
30.000 — 30.021 (1.1811 — 1.1819)	30.100 (1.1850)


N6A0437E

If the clearance between the idler gear shaft outside diameter and the idler gear inside diameter exceeds the limit, the idler gear must be replaced.

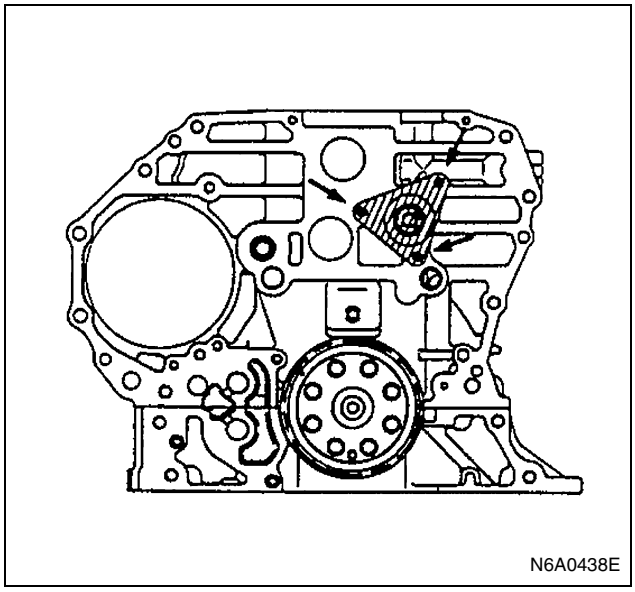
Idler Gear Shaft and Idler Gear clearance mm (in)	
Standard	Limit
0.020 — 0.062 (0.0008 — 0.0024)	0.200 (0.0079)

Installation

1. Idler Gear B Shaft

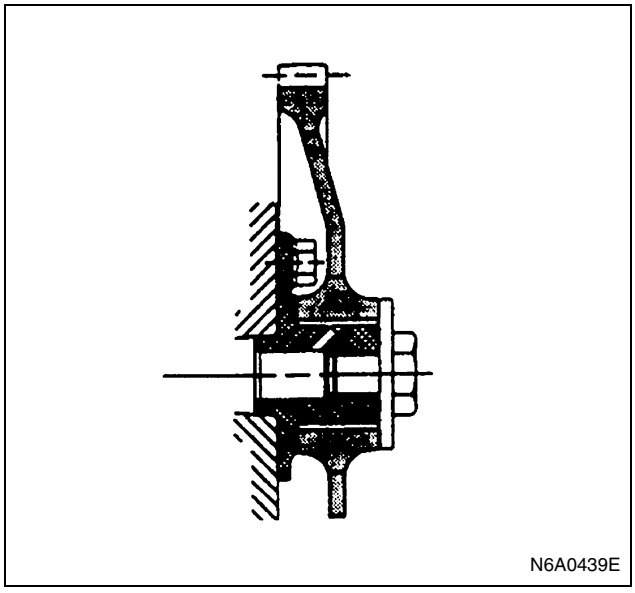
Tighten:
Idle gear B shaft bolt to 31 N·m (3.2 kg·m/23 lb·ft)

Apply the engine oil to the idle gear shaft after installation.


N6A0438E

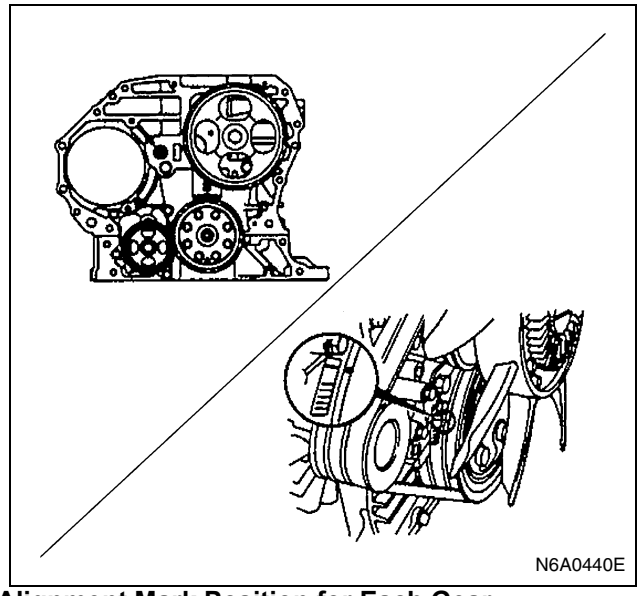
2. Idle Gear B
   The face of the idle gear B with longer boss should be positioned toward the rear side shown in the illustration.

Tighten:
Idle gear B bolt to 110 N·m (11.2 kg·m/81 lb·ft)

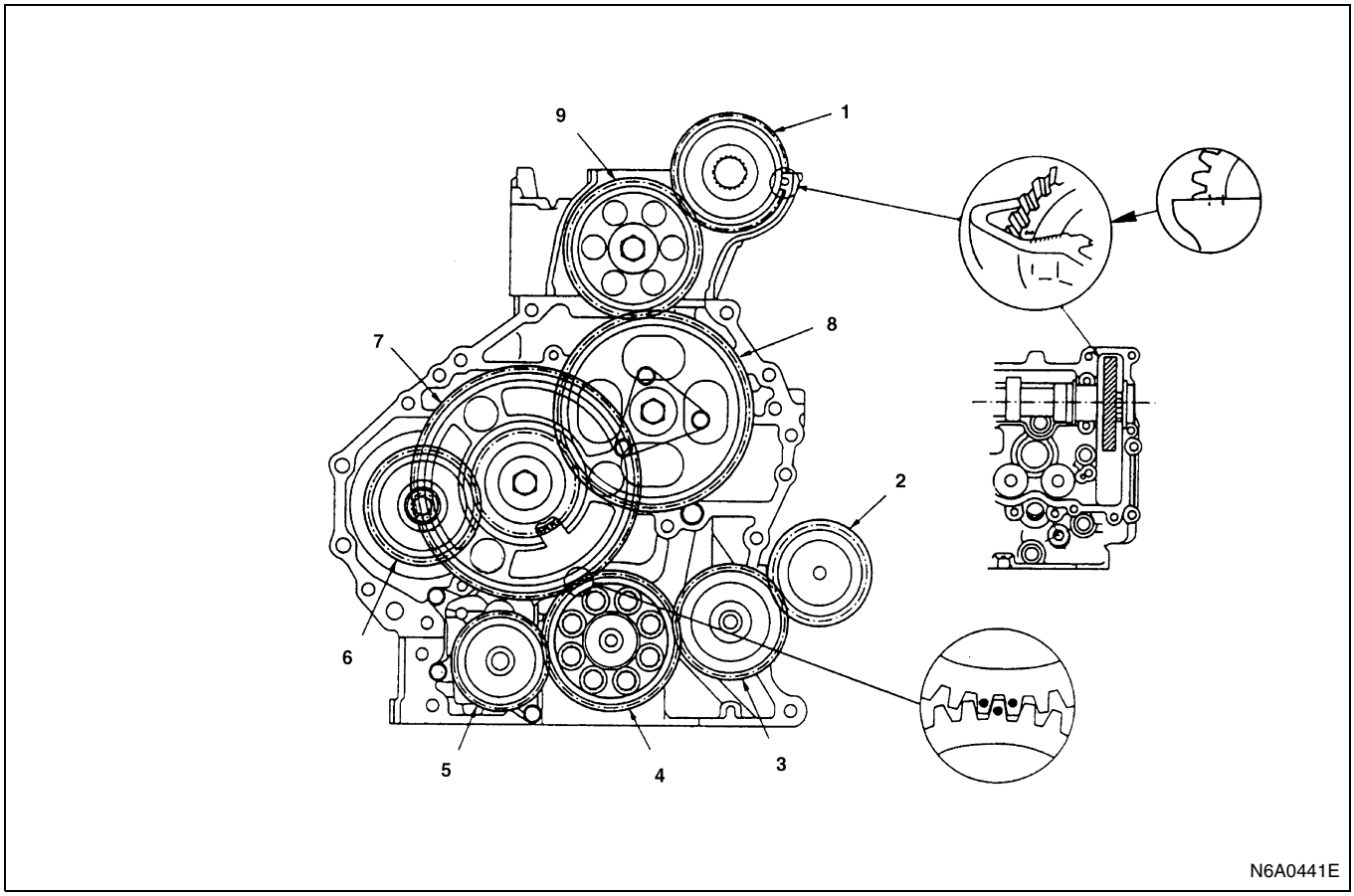

N6A0439E

3. Idle Gear A
   1) Turn the crankshaft clockwise so that the engagement mark of the crankshaft gear faces to the shaft center of the idle gear A and the No.1 cylinder piston comes to the top dead center.
   2) Align the crankshaft gear with the engagement mark of the idle gear and install the idle gear A.

Tighten:
Idle gear A bolt to 133 N·m (13.6 kg·m/98 lb·ft)



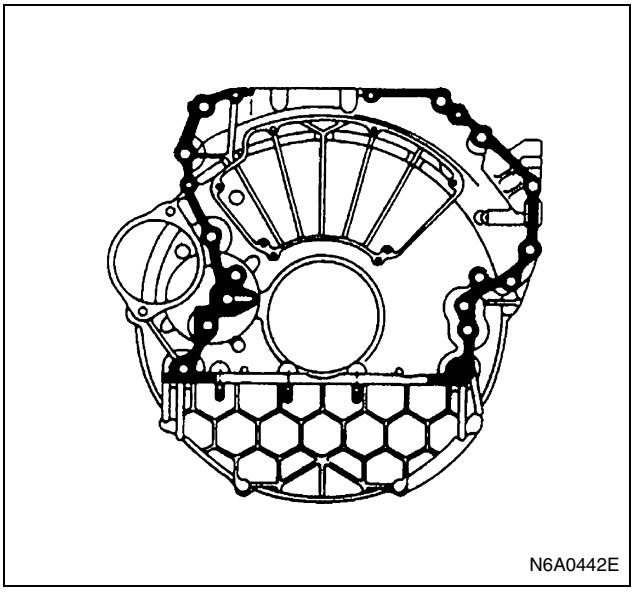
Alignment Mark Position for Each Gear



Legend

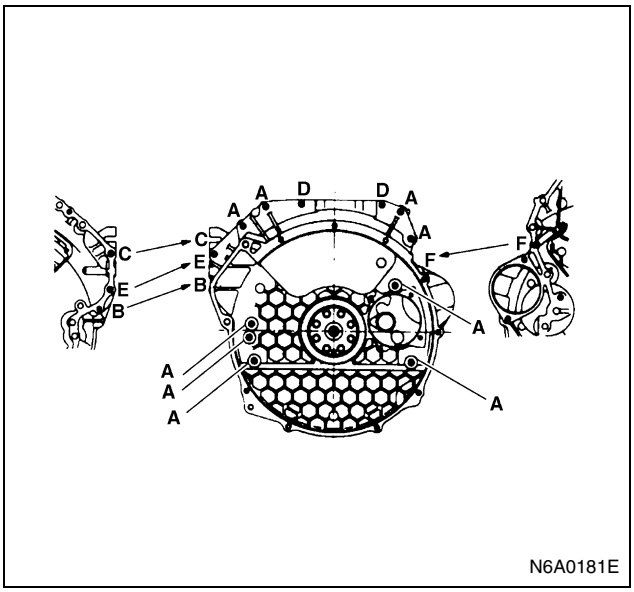
1. Camshaft gear
2. Power steering pump gear
3. Power steering pump idle gear
4. Crankshaft gear
5. Oil pump drive
6. Injection pump gear
7. Idle gear A
8. Idle gear B
9. Idle gear C

4. Flywheel Housing
   1) Carefully wipe any foreign material from the cylinder body rear face.
   2) Apply the recommended liquid gasket (Three Bond 1207C) or its equivalent to the shaded areas shown in the illustration.


N6A0442E

3) Align the cylinder body knock pins with the flywheel housing knock pin holes.
4) Tighten the flywheel housing bolts to the specified torque shown in the illustration.

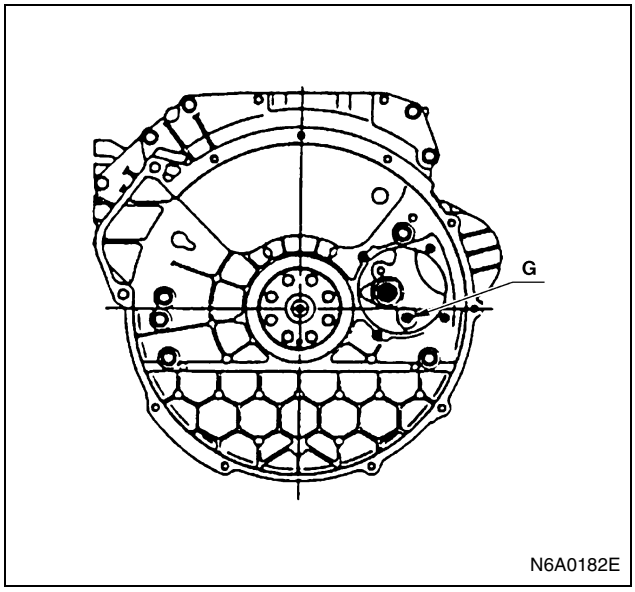
Tighten:
Flywheel housing bolt to
- (A): 96 N·m (9.8 kg·m/71 lb·ft)
- (B): 48 N·m (4.9 kg·m/35 lb·ft)
- (C): 94 N·m (9.6 kg·m/69 lb·ft)
- (D): 25 N·m (2.6 kg·m/19 lb·ft)
- (E): 76 N·m (7.7 kg·m/56 lb·ft)
- (F): 48 N·m (4.9 kg·m/35 lb·ft)



N6A0181E

- Tighten the bolts marked with “E” or “B” from the injection pump side, and those with “F” from the cylinder body side.

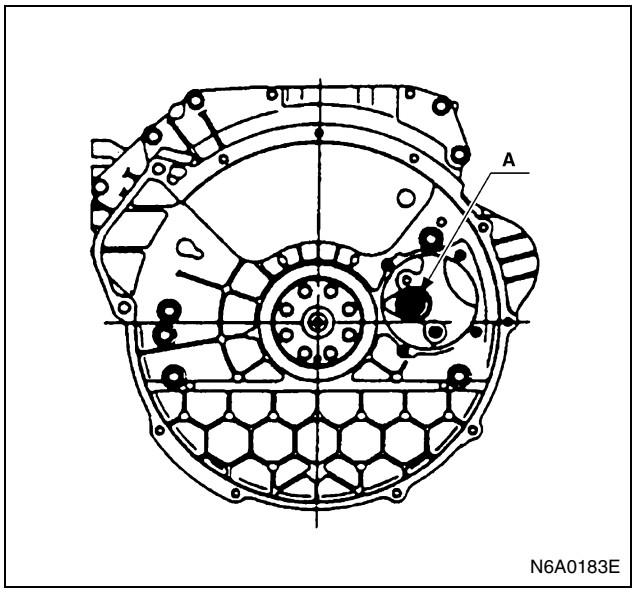
Tighten:
Flywheel housing bolt (G) to 96 N·m (9.8 kg·m/71 lb·ft)



N6A0182E

5. Power Steering Pump Idle Gear
   1) Apply the engine oil to the idle gear shaft.
   2) Install the idle gear shaft (1) with the idle gear (2) to the cylinder body A portion as shown in the illustration.

Tighten:
Idle gear shaft bolt to 135 N·m (13.6 kg·m/98 lb·ft)



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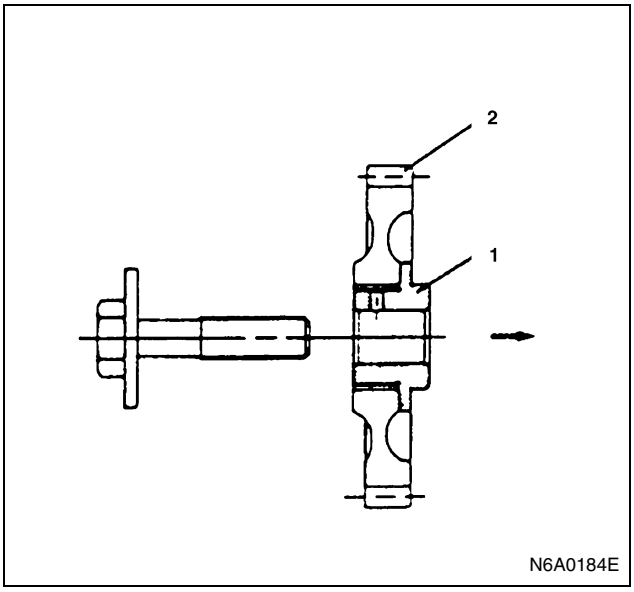
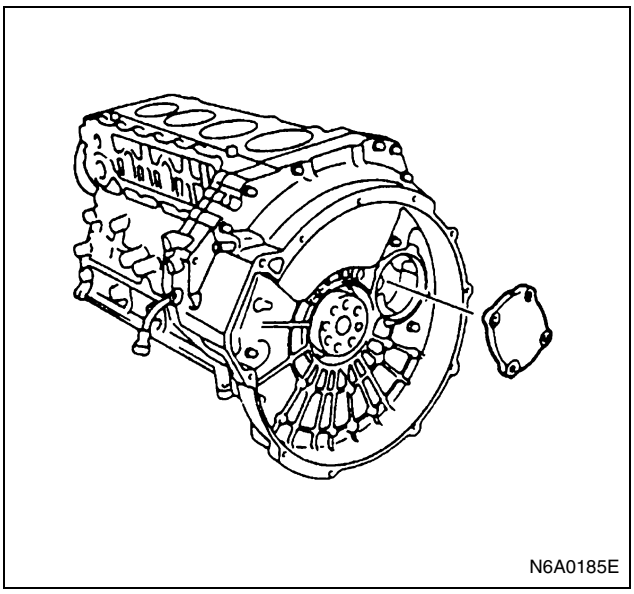


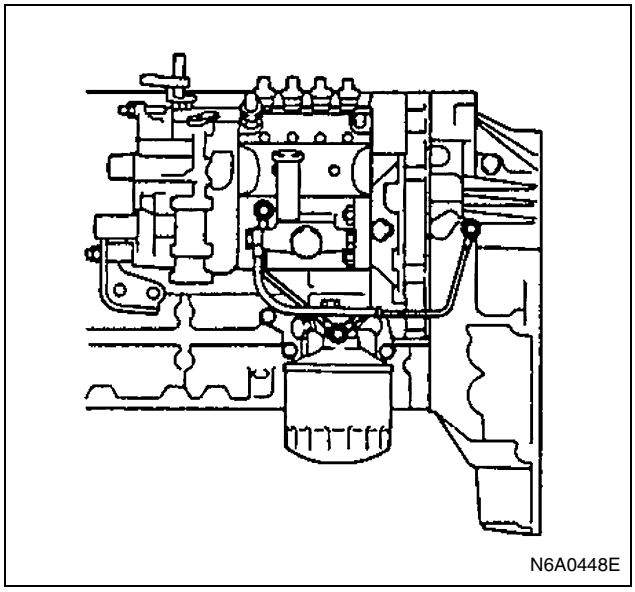
6. Power steering Pump Idle Gear Cover
   Install the gear cover with the O-ring.

Tighten:
Gear cover bolt to 19 N·m (1.9 kg·m/14 lb·ft)



7. Oil Pan
8. Spacer Rubber
   Above works refer to “OIL PAN” section in this manual.
9. Crankshaft Rear Slinger
10. Crankshaft Rear Oil Seal
11. Flywheel
    Above works refer to “CRANKSHAFT REAR OIL SEAL” section in this manual.
12. Injection Pump Assembly
    Above works refer to “INJECTION PUMP ASSEMBLY” section in this manual.
13. Oil Pipe

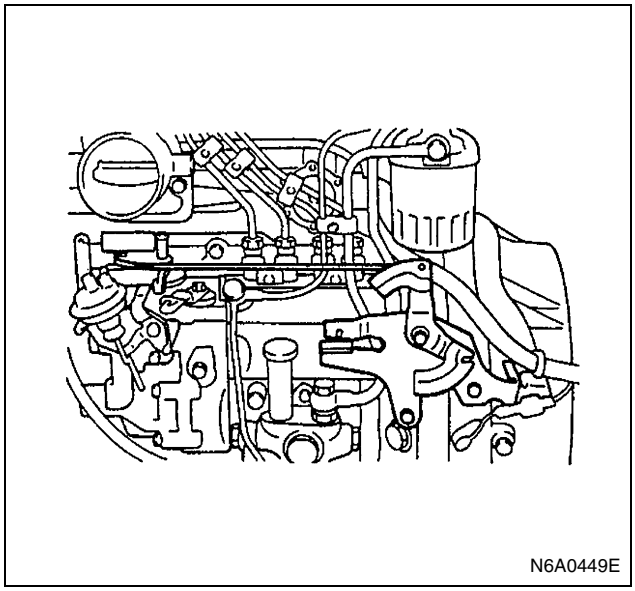
Tighten:
Oil pipe joint bolt to 17 N·m (1.7 kg·m/12 lb·ft)



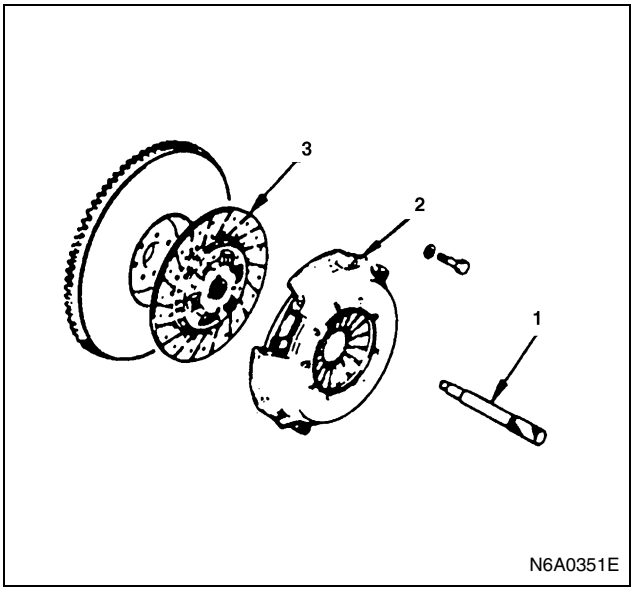
14. Engine Control Lever Assembly

Tighten:
Engine control lever bolt to 24 N·m (2.4 kg·m/17 lb·ft)

15. Engine Control Wire



16. Driven Plate
    Use the clutch pilot aligner to install the driven plate.
    Clutch Pilot Aligner: 5-8840-2240-0

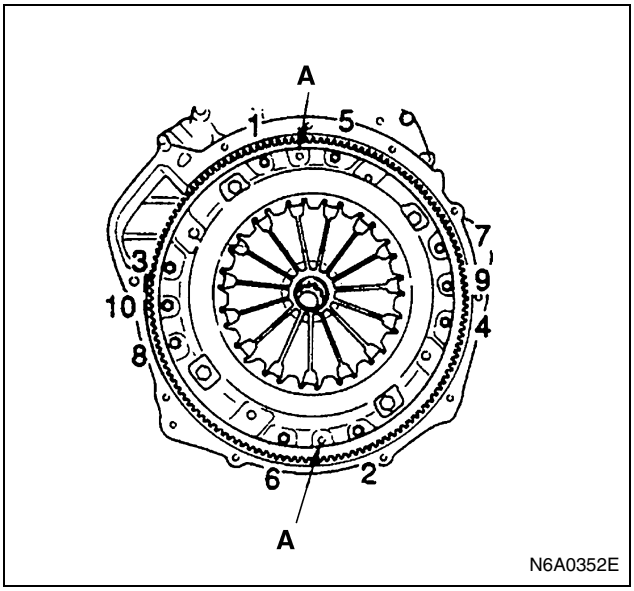


Legend

1. Clutch pilot aligner
2. Clutch pressure plate assembly
3. Driven plate

17. Clutch Pressure Plate Assembly
    1) Align the clutch pressure plate with the flywheel knock pin.
    2) Tighten the pressure plate bolts to the specified torque in numerical order.

Tighten:
Clutch pressure plate bolt to 40 N·m (4.1 kg·m/30 lb·ft)



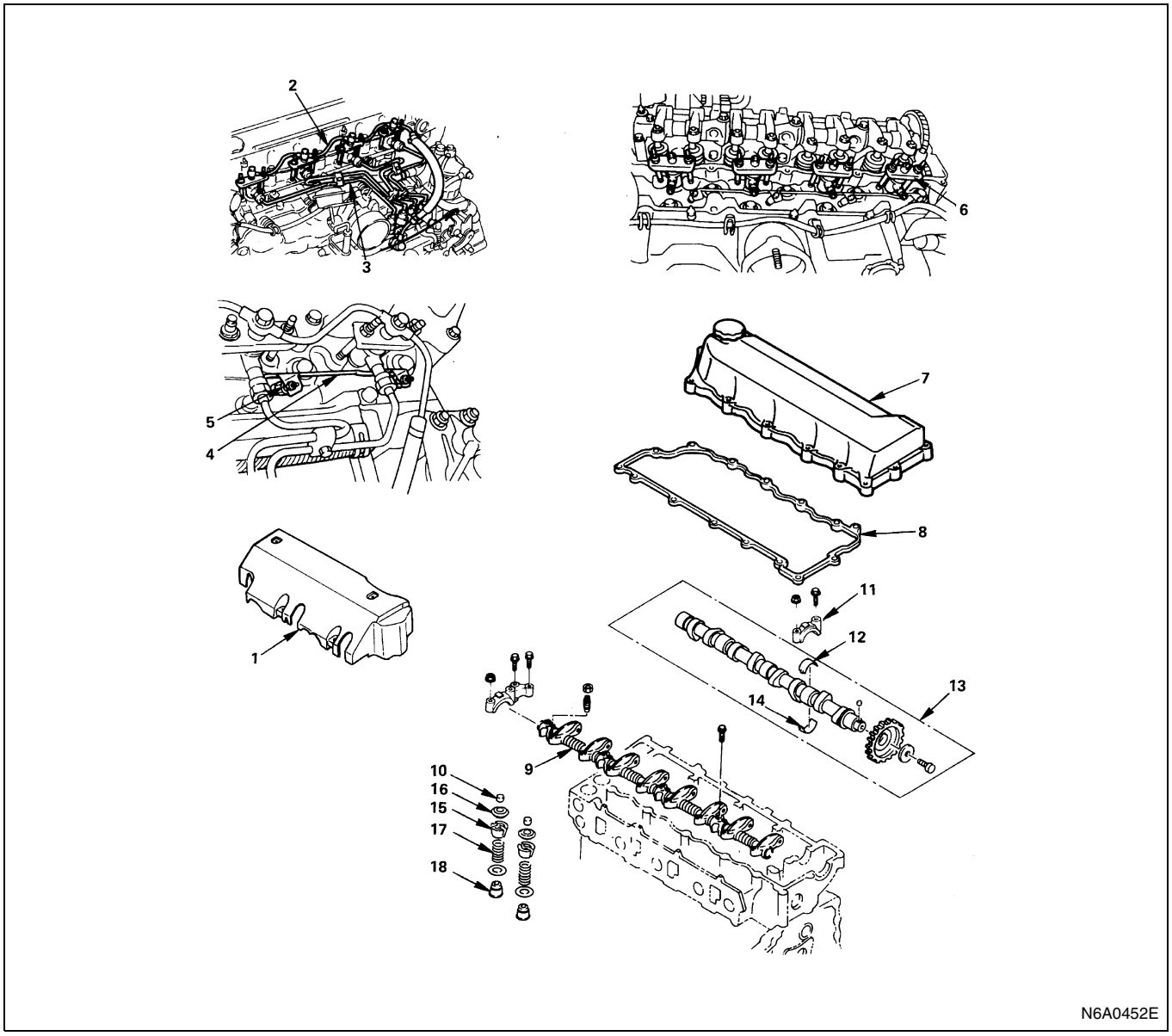
Legend

A. Knock pin

18. Cylinder Head Gasket
    Above works refer to “CYLINDER HEAD GASKET” section in this manual.
19. Cylinder Head Assembly
    Above works refer to “CYLINDER HEAD GASKET” section in this manual.
20. Camshaft Bearing Lower
21. Camshaft Assembly
22. Camshaft Bearing Upper
23. Camshaft Bearing Cap
24. Valve Cap
25. Rocker Arm Shaft Assembly
    Above works refer to “CAMSHAFT ASSEMBLY” section in this manual.
26. Head Cover Gasket
27. Cylinder Head Cover
    Above works refer to “CYLINDER HEAD COVER” section in this manual.
28. Nozzle Cover
29. Engine Assembly
    Above works refer to “ENGINE ASSEMBLY” section in this manual.

VALVE GUIDE SEAL & VALVE SPRING

Component



Legend

1. Nozzle cover
2. Leak off pipe
3. Injection pipe
4. Glow plug connector
5. Glow plug
6. Injection nozzle holder assembly
7. Cylinder head cover
8. Cylinder head cover gasket
9. Rocker arm shaft assembly
10. Valve cap
11. Camshaft bearing cap
12. Camshaft bearing upper
13. Camshaft assembly
14. Camshaft bearing lower
15. Cotter collar
16. Spring upper seat
17. Valve spring
18. Valve guide seal

Removal

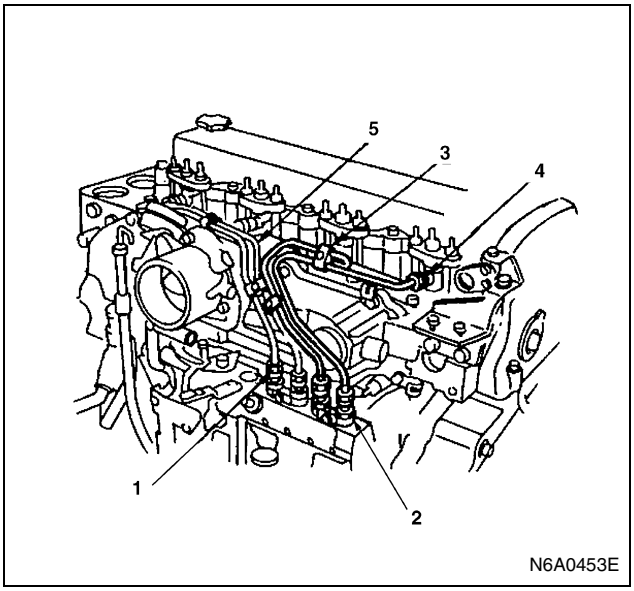
Preparation

- Disconnect battery ground cable.
- Tilt the cab.

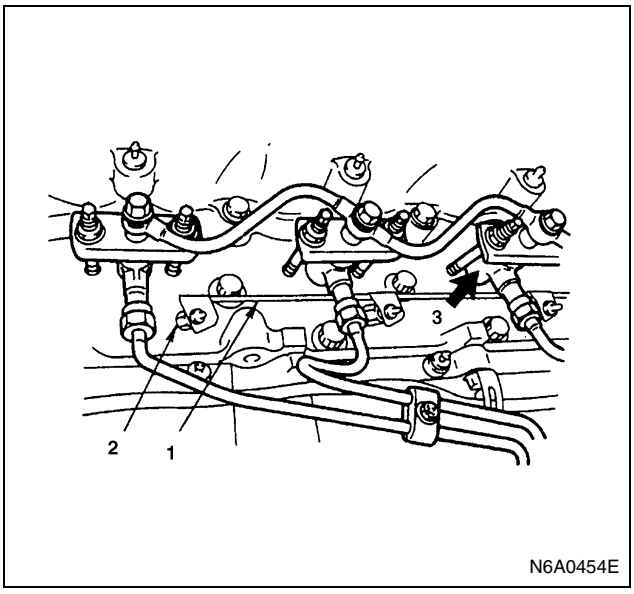
1. Nozzle Cover
2. Leak Off Pipe
3. Injection Pipe
   - Loosen the injection pipe sleeve nuts (1).

Do not apply excessive force to the injection pipes (5).

- Loosen the injection pipes clips (3).
  Remove the injection pipe assembly.
  Plug the delivery valve holder (2) ports and nozzle holder (4) ports with caps to prevent the entry of foreign material.



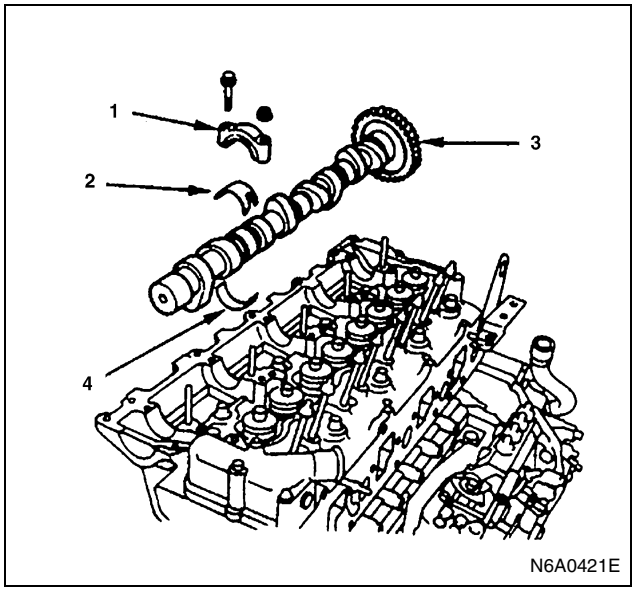
4. Glow Plug Connector
5. Glow Plug
6. Injection Nozzle Holder Assembly
   Mark the nozzle holder assemblies fitting positions by tagging each nozzle holder assembly with the cylinder number from which it was removed.



Legend

1. Glow plug connector
2. Glow plug
3. Injection nozzle holder assembly

7. Cylinder Head Cover
8. Cylinder Head Cover Gasket
9. Rocker Arm Shaft Assembly
   Above works refer to “ROCKER ARM SHAFT ASSEMBLY” section in this manual.
10. Valve Cap
11. Camshaft Bearing Cap
12. Camshaft Bearing Upper
13. Camshaft Assembly
14. Camshaft Bearing Lower
    - If the camshaft bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.

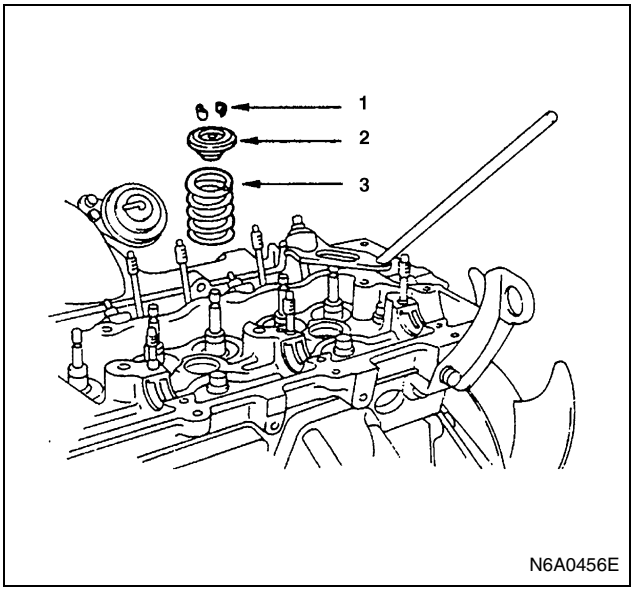


Legend

1. Camshaft bearing cap
2. Camshaft bearing upper
3. Camshaft assembly
4. Camshaft bearing lower

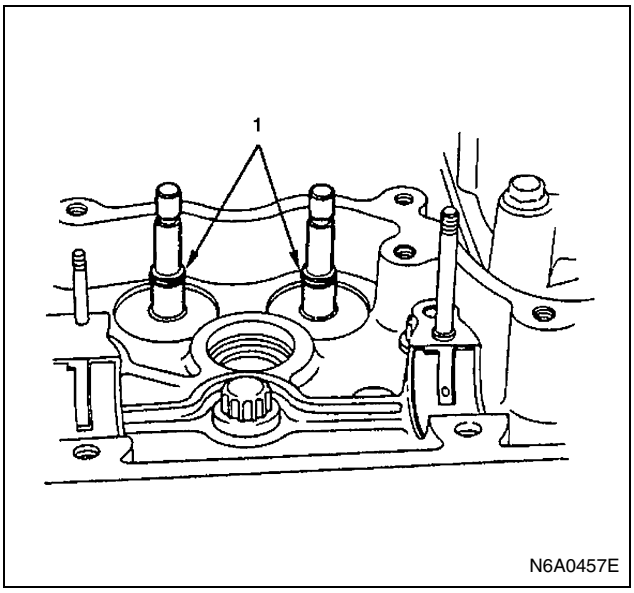
15. Cotter Collar
16. Spring Upper Seat
17. Valve Spring
    - Apply compressed air to cylinder from the glow plug hole to hold the valve in place.
    - Using special tool, compress valve spring and remove cotter collar.

    Valve Spring Compressor: 5-8840-2228-0



Legend
1. Cotter collar
2. Spring upper seat
3. Valve spring

18. Valve Guide Seal

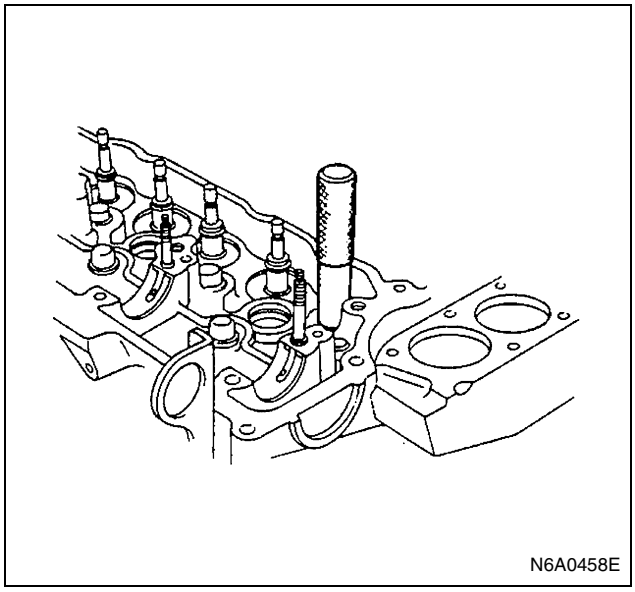


Legend
1. Oil seal

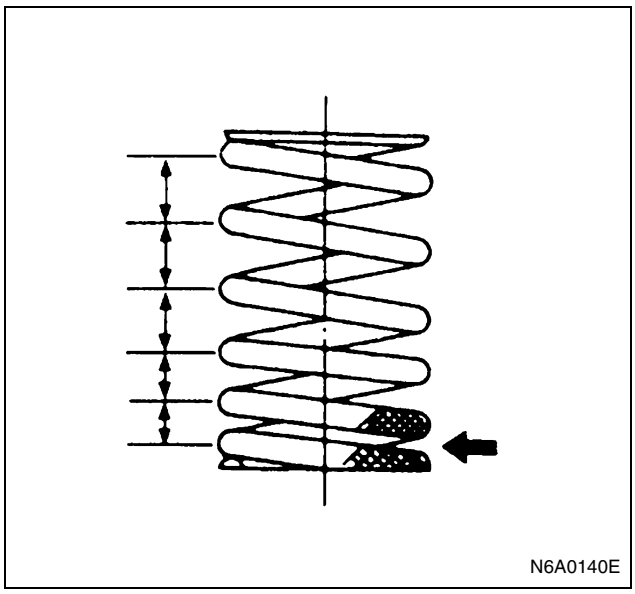
Installation

1. Valve Guide Seal
   - Apply a coat of engine oil to the valve guide seal inner face.
   - Use a valve guide seal installer to install the valve guide seal to the valve guide

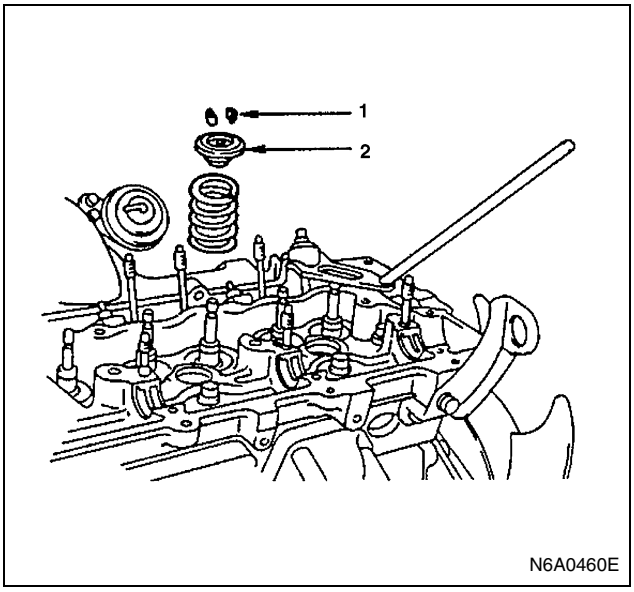
   Valve Guide Seal Installer: 8-9439-6815-0



2. Valve Spring
   Install the valve spring with its fine pitched (or painted) end side down.



3. Spring Upper Seat
4. Cotter Collar
   1) Use the valve spring compressor to push the valve spring into position.
      Valve Spring Compressor: 5-8840-2228-0
   2) Install the cotter collar to the valve stem.
   3) Set the cotter collar by tapping around the head of the collar with a rubber hammer.

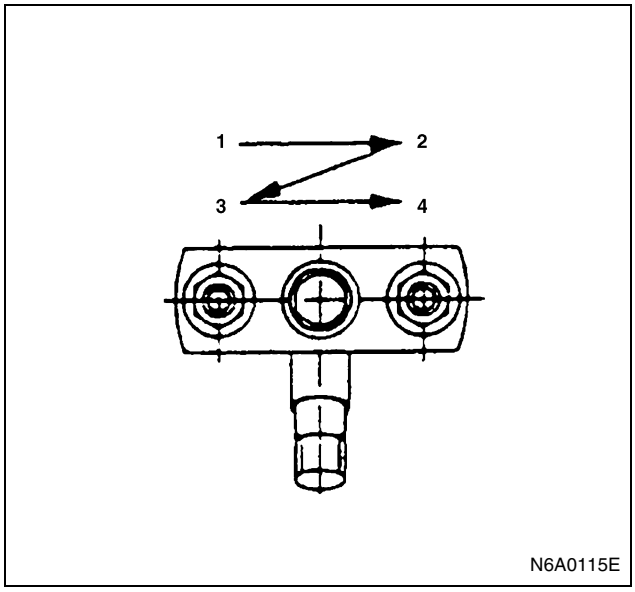


Legend

1. Cotter collar
2. Spring upper seat

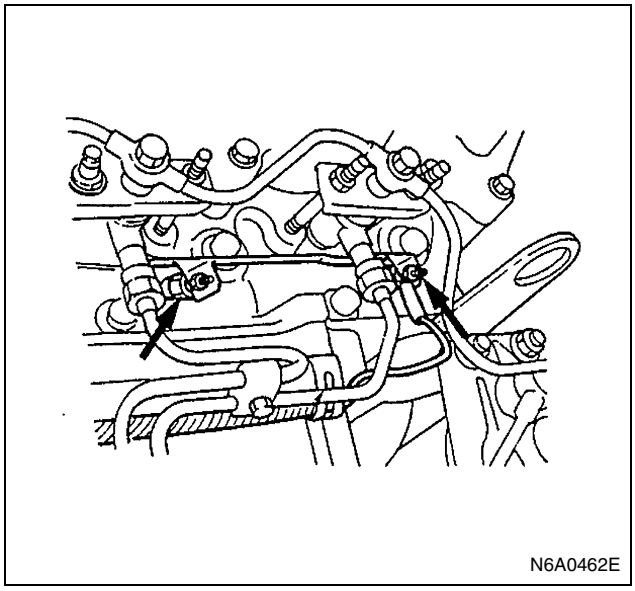
5. Camshaft Bearing Lower
6. Camshaft Assembly
7. Camshaft Bearing Upper
8. Camshaft Bearing Cap
9. Valve Cap
   Above works refer to “CAMSHAFT ASSEMBLY” section in this manual.
10. Rocker Arm shaft Assembly
    Above works refer to “ROCKER ARM SHAFT ASSEMBLY” section in this manual.
11. Cylinder Head Cover Gasket
12. Cylinder Head Cover
    Above works refer to “CYLINDER HEAD COVER” section in this manual.
13. Injection Nozzle Holder Assembly
    Tighten the nozzle holder flange nuts to the specified torque in the numerical order shown in the illustration.

Tighten:
Nozzle holder flange nut to 19 N·m (1.9 kg·m/14 lb·ft)

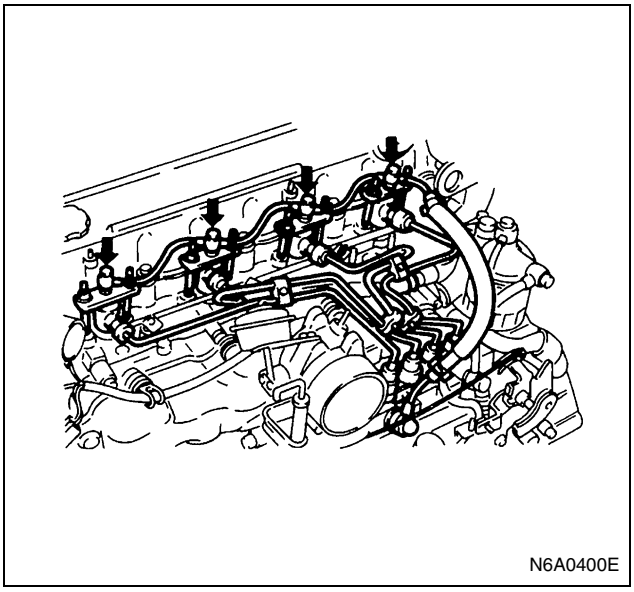


14. Glow Plug

Tighten:
Glow plug to 23 N·m (2.3 kg·m/17 lb·ft)



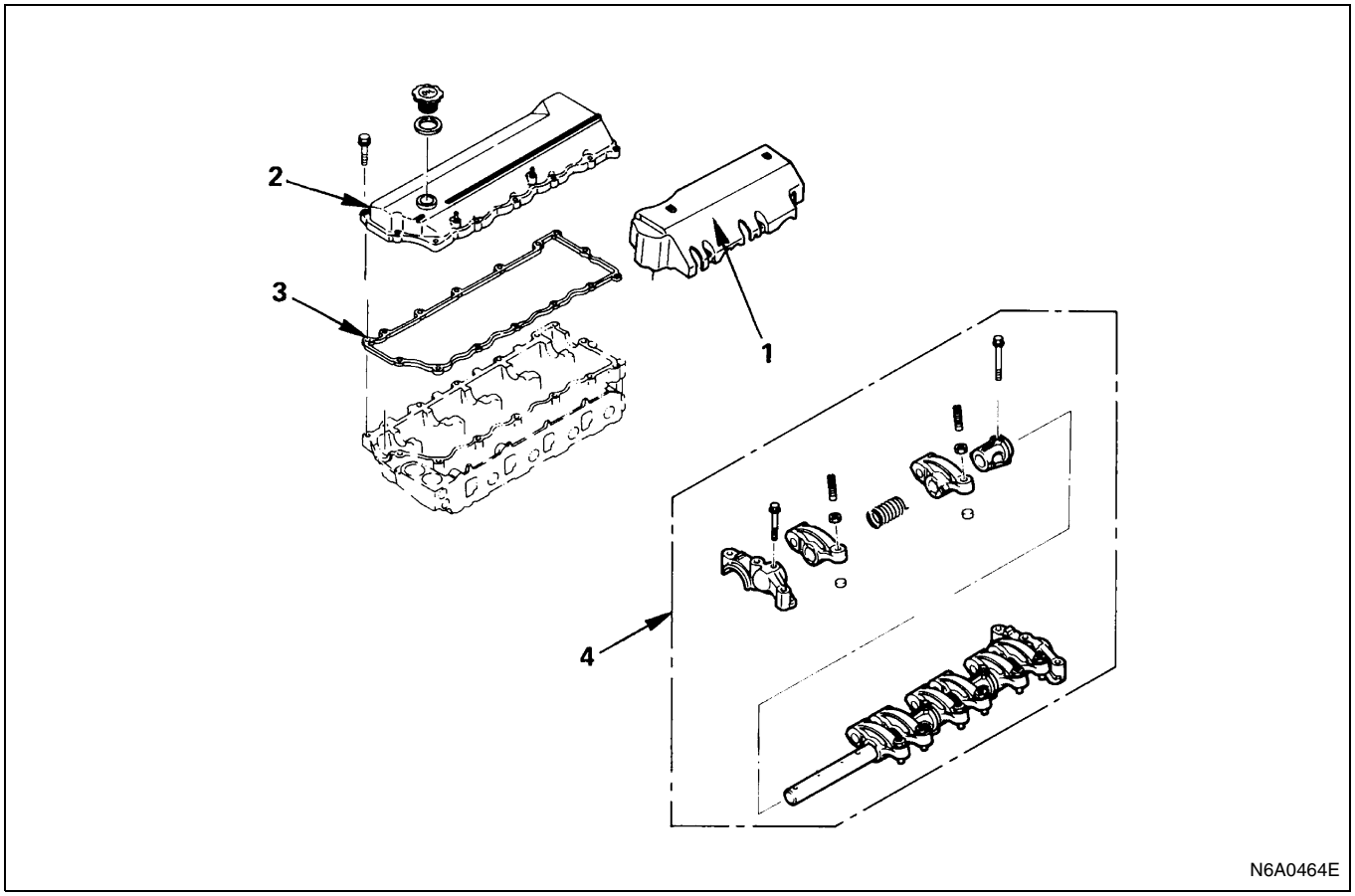
15. Glow Plug Connector
16. Injection Pipe
17. Leak Off Pipe
    Above works refer to “INJECTION PUMP ASSEMBLY” section in this manual.



18. Nozzle Cover
    - Connect the negative battery cable
    - Lower the cab
    - Start engine and check for fuel leakage carefully.

ROCKER ARM SHAFT ASSEMBLY

Component



Legend

1. Nozzle cover
2. Cylinder head cover
3. Cylinder head cover gasket
4. Rocker arm shaft assembly

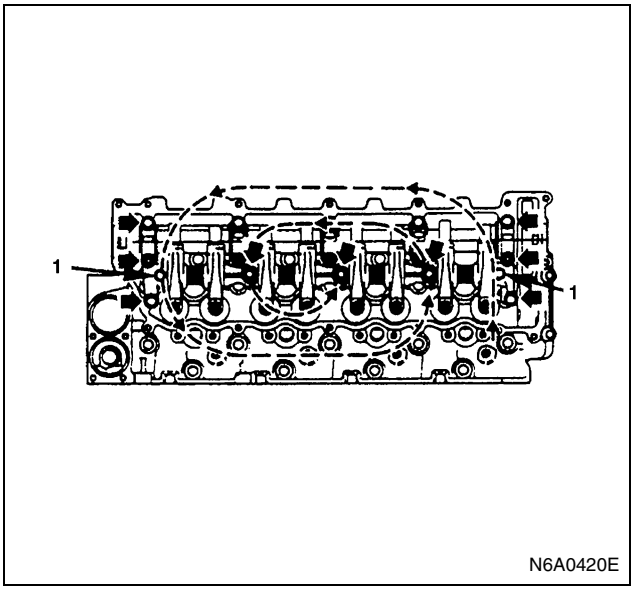
Removal

Preparation

- Disconnect battery ground cable.
- Tilt the cab.

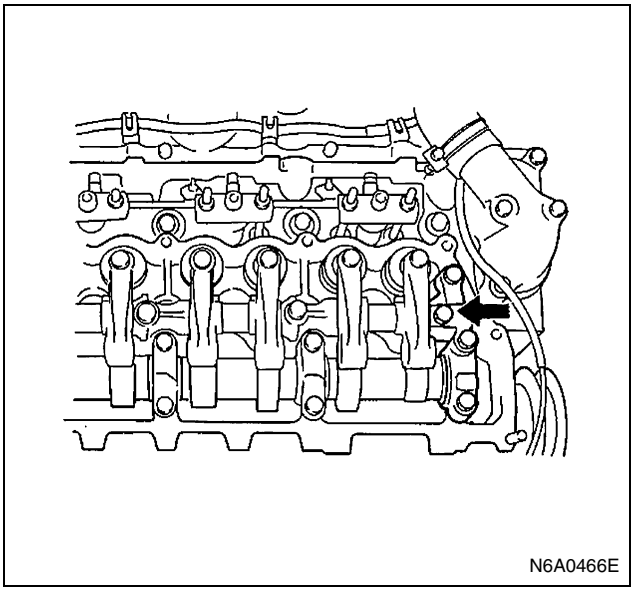
1. Nozzle Cover
2. Cylinder Head Cover
3. Cylinder Head Cover Gasket
4. Rocker Arm Shaft Assembly
   1) Loosen the rocker arm shaft bracket nuts and bolts in numerical order a little at a time and remove the rocker arm shaft assembly with the camshaft brackets.
   2) Leave the (1) indicated bolt unremoved on this occasion, since it is the rocker arm fixing bolt.

Caution:
Failure to loosen the rocker arm shaft bracket nuts and bolts in numerical order a little at a time will adversely affect the rocker arm shaft.



Installation

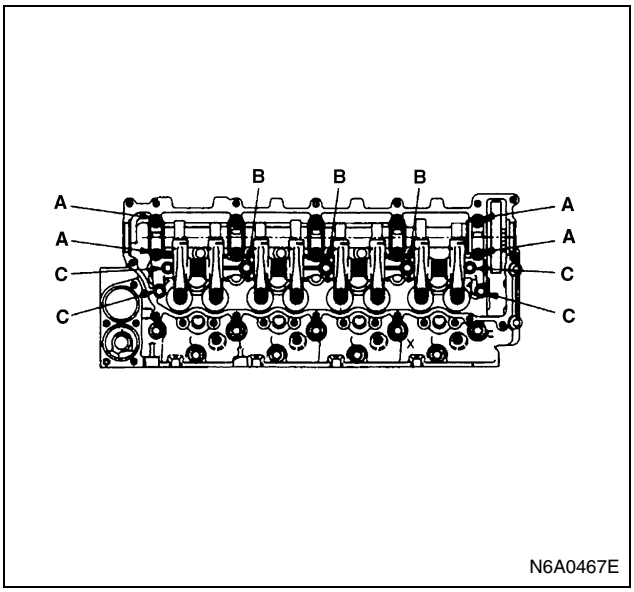
1. Rocker Arm Shaft Assembly
   1) Slightly loosen the bolts marked with the arrow in the illustration.


N6A0466E

   2) Loosen the rocker arm adjust screws and apply engine oil to the rocker arm roller portions.
   3) Install the rocker arm assembly on the cylinder head.
   4) Tighten the rocker arm shaft breaker nuts and bolts to the specified torque in numerical order a little at a time as shown in the illustration.

Tighten:
Rocker arm shaft bracket nut and bolt to
- Nut (A): 27 N·m (2.8 kg·m/20 lb·ft)
- Bolt (B): 56 N·m (5.7 kg·m/41 lb·ft)
- Bolt (C): 27 N·m (2.8 kg·m/20 lb·ft)

   5) Apply engine oil to the threaded portion of the nuts marked with “A” and the bolts with “B” shown in the illustration left, and then tighten them to the specified torque.



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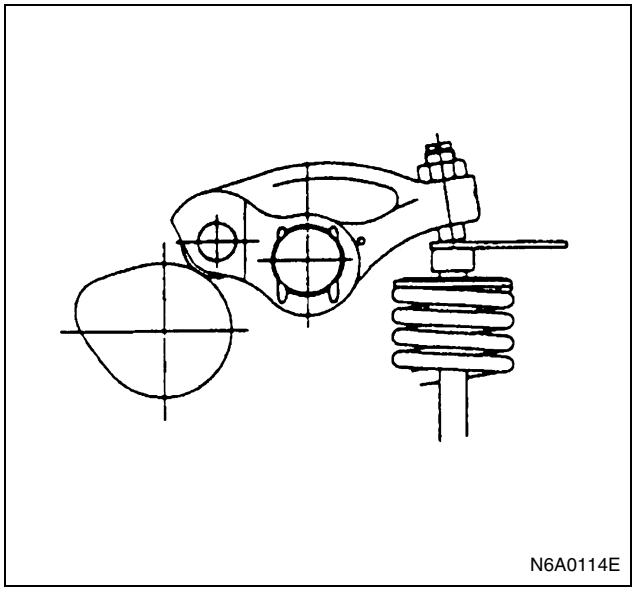
Adjust the valve clearance.

Valve Clearance	mm (in)
At cold	0.4 (0.016)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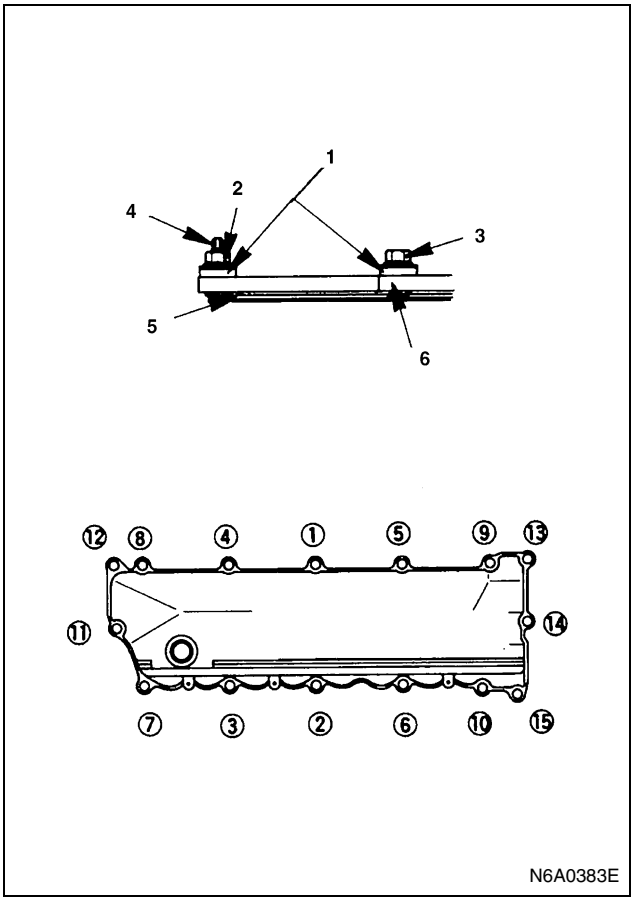
Above works refer to “SERVICING” VALVE CLEARANCE ADJUSTMENT” previously section in this manual.

2. Cylinder Head Cover Gasket
   Install the gasket to the cylinder head cover.
3. Cylinder Head Cover
   1) Install the cylinder head cover.
   2) Tighten the cylinder head cover nuts and bolts to the specified torque in the numerical order shown in the illustration.

Tighten:
Cylinder head cover nut and bolt to 18 N·m (1.8 kg·m/13 lb·ft)



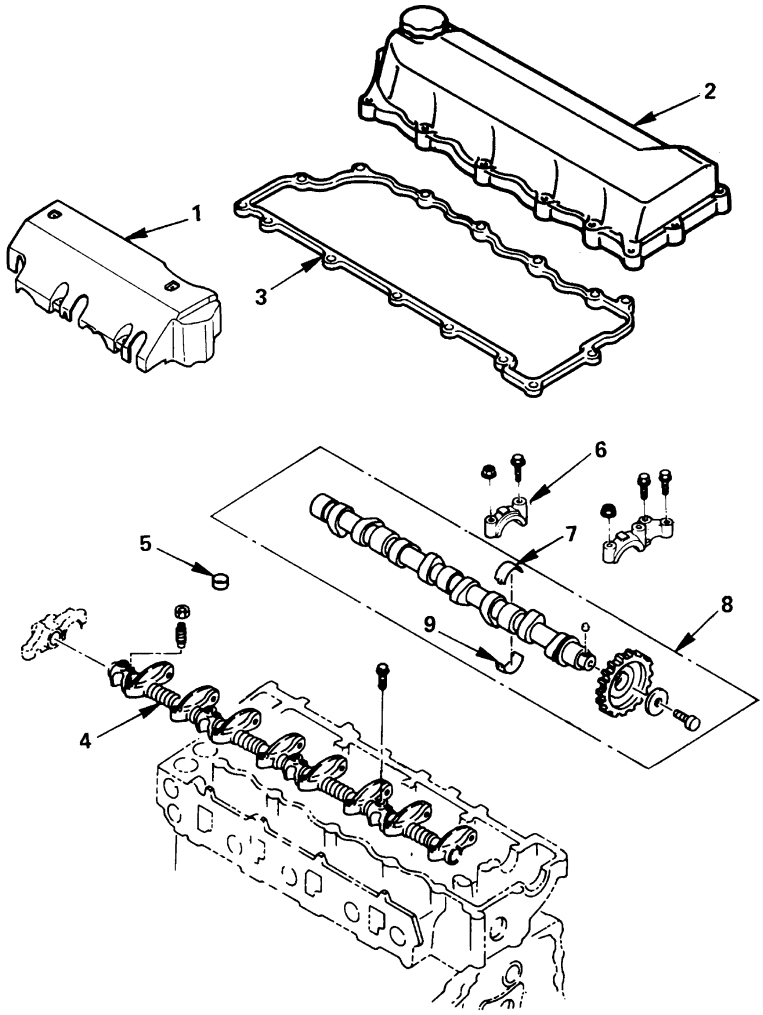
Legend

1. Mounting rubber
2. Nut
3. Bolt
4. Stud
5. Gasket
6. Head cover

4. Nozzle Cover
   - Connect the battery ground cable.
   - Lower the cab.
   - Start the engine and check for the oil leakage carefully.

CAMSHAFT ASSEMBLY

Component



N6A0470E

Legend

1. Nozzle cover
2. Cylinder head cover
3. Cylinder head cover gasket
4. Rocker arm shaft assembly
5. Valve cap
6. Camshaft bearing cap
7. Camshaft bearing upper
8. Camshaft assembly
9. Camshaft bearing lower

Removal

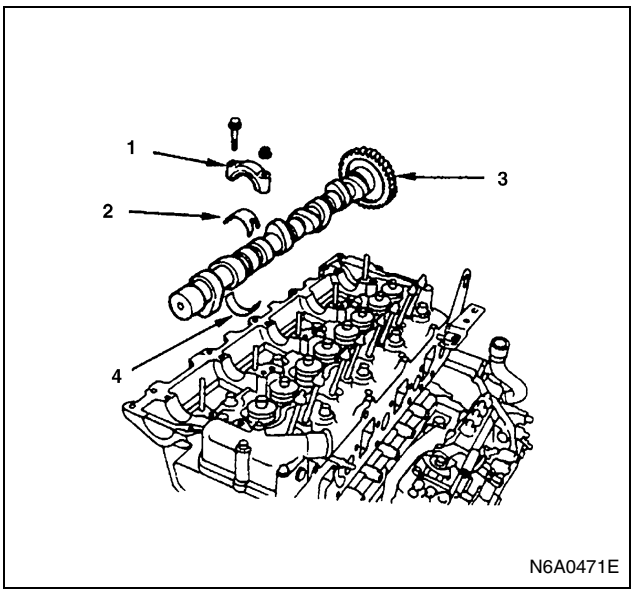
Preparation

- Disconnect battery ground cable.
- Tilt the cab.

1. Nozzle Cover
2. Cylinder Head Cover
3. Cylinder Head Cover Gasket
4. Rocker Arm Shaft Assembly

   Above works refer to “ROCKER ARM SHAFT ASSEMBLY” section in this manual.
5. Valve Cap
6. Camshaft Bearing Cap
7. Camshaft Bearing Upper
8. Camshaft Assembly
9. Camshaft Bearing Lower

- If the camshaft bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.

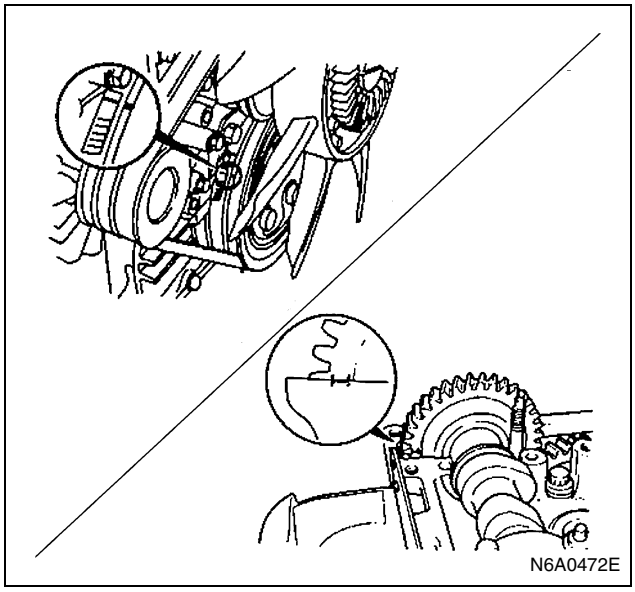


Legend

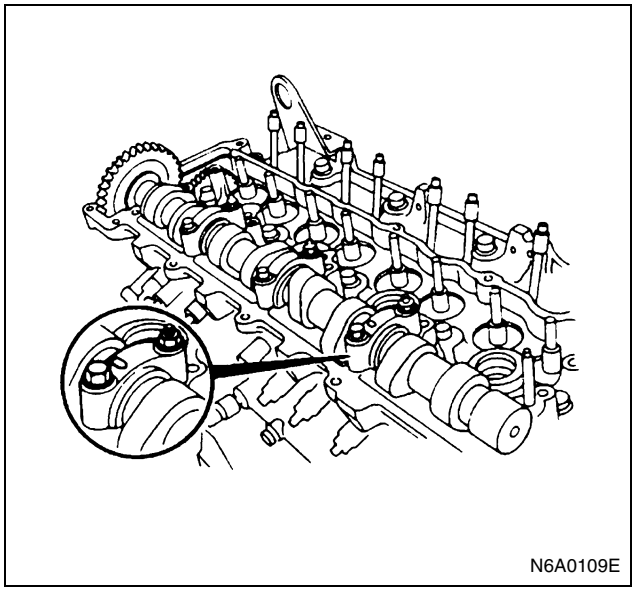
1. Camshaft bearing cap
2. Camshaft bearing upper
3. Camshaft assembly
4. Camshaft bearing lower

Installation

1. Camshaft Bearing Lower
2. Camshaft Assembly
   1) Turn the crankshaft in the direction of normal rotation until the timing mark on the crankshaft damper pulley is aligned with the TDC notched line.
   2) Apply engine oil to the camshaft journal and the camshaft bearing surfaces before installation.
   3) Carefully align the camshaft gear "I" mark and the cylinder head upper face shown in the illustration.

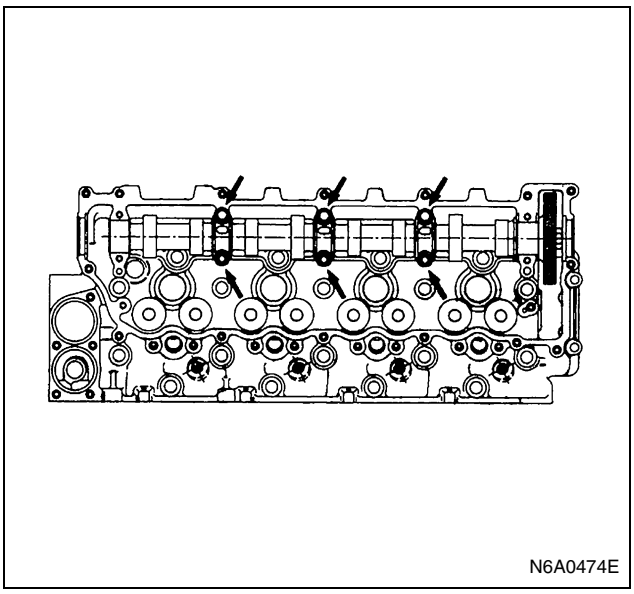


3. Camshaft Bearing Upper
4. Camshaft Bearing Cap
   - Install the bearing caps with the bearing cap head mark (arrow) facing forward.
   - Apply a coat of engine oil to the bearing cap bolt and stud threads.



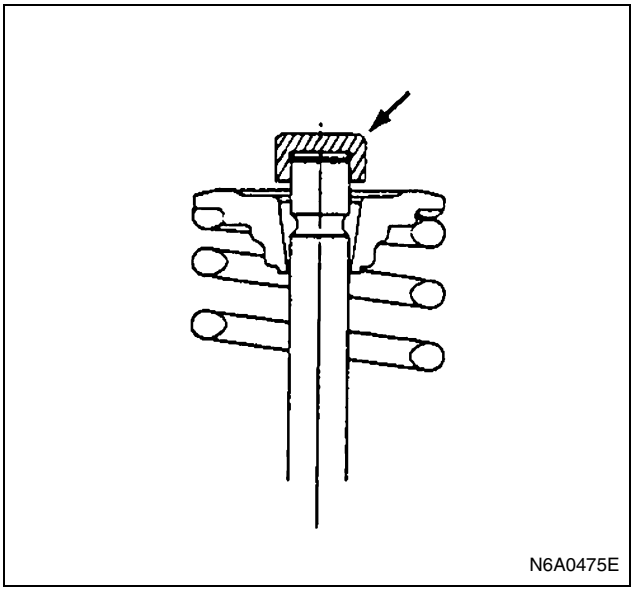
- Tighten the bearing cap bolts and studs to the specified torque.

Tighten:
Camshaft bearing cap nut and bolt to 27 N·m (2.8 kg·m/ 20 lb·ft)


N6A0474E

5. Valve Cap
   Apply engine oil to the inside of the valve caps and install them to the valve stem end.

Caution:
Take sufficient care not to let the valve caps fall into the gear.

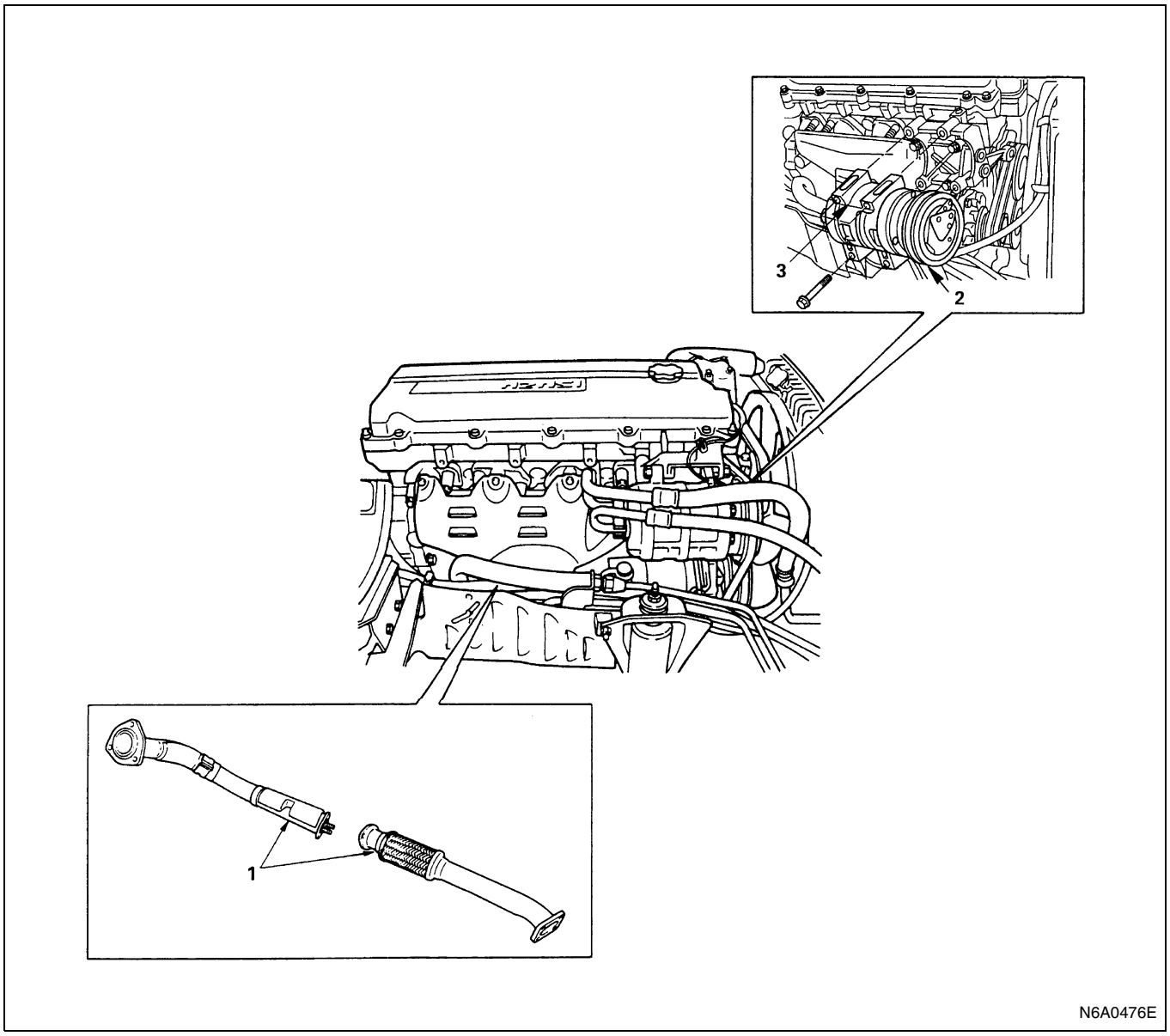

N6A0475E

6. Rocker Arm Shaft Assembly
   Above works refer to “ROCKER ARM SHAFT ASSEMBLY” section in this manual.
7. Cylinder Head Cover Gasket
8. Cylinder Head Cover
   Above works refer to “CYLINDER HEAD COVER” section in this manual.
9. Nozzle Cover
   - Connect the battery ground cable.
   - Lower the cab.
   - Start engine and check for oil leakage carefully.

CYLINDER HEAD

Component

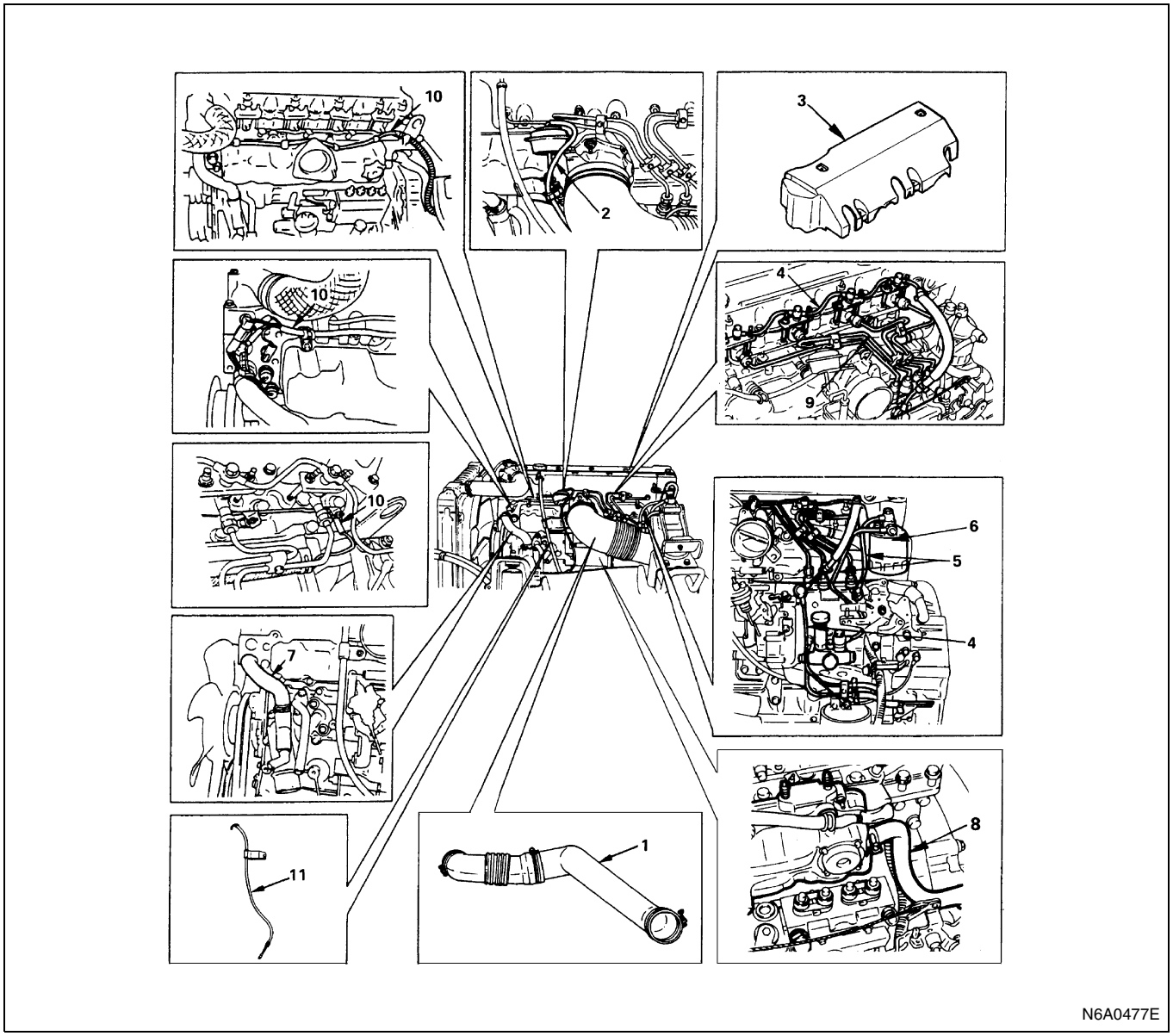
Engine Right Side



Legend

1. Front exhaust pipe
2. A/C compressor drive belt (If equipped with A/C)
3. A/C compressor (If equipped with A/C)

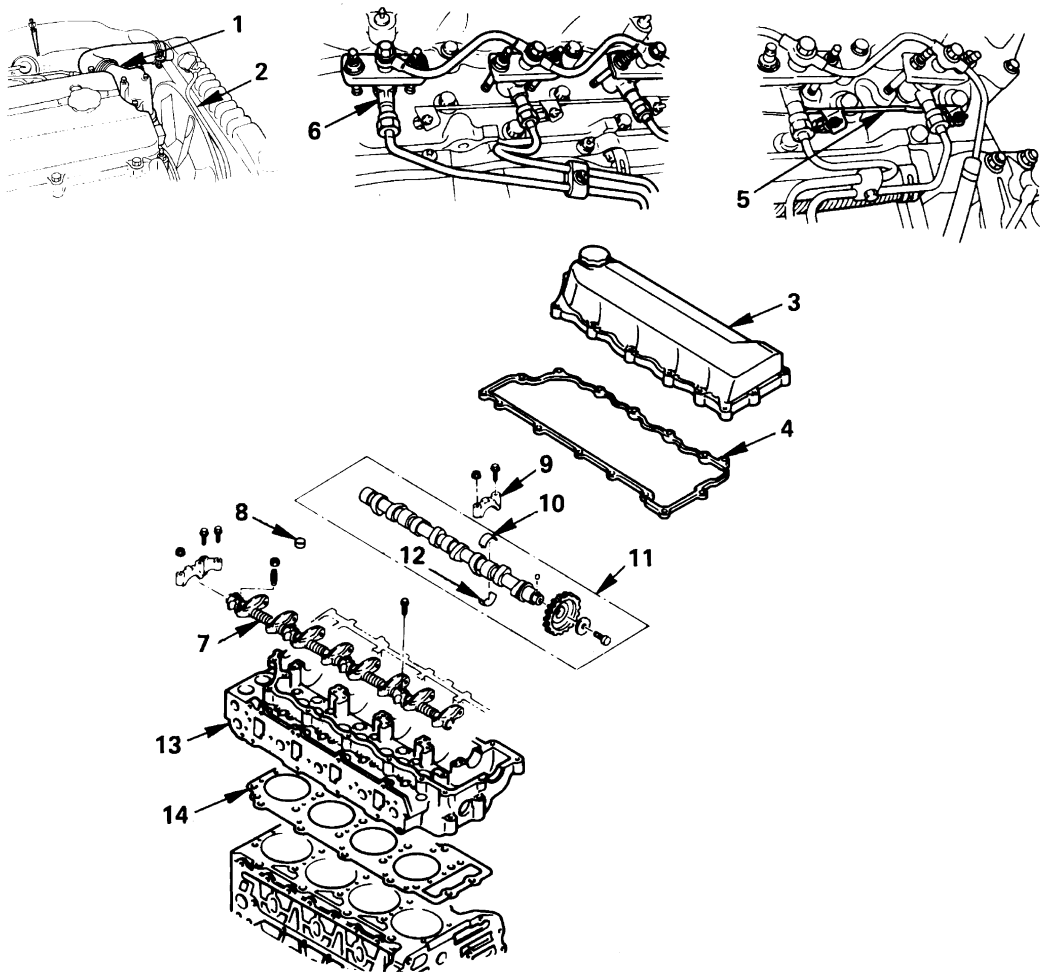
Engine Left Side



Legend

1. Intake air duct
2. Vacuum hose
3. Nozzle cover
4. Leak off pipe
5. Fuel pipe
6. Fuel filter and bracket
7. Water bypass hose
8. PCV hose
9. Injection pipe
10. Engine harness
11. Oil level gauge guide tube

Cylinder Head Side



N6A0482E

Legend

1. Radiator upper hose
2. Coolant reserve tank hose/bypass hose
3. Cylinder head cover
4. Cylinder head cover gasket
5. Glow plug connector
6. Injection nozzle holder assembly
7. Rocker arm shaft assembly
8. Valve cap
9. Camshaft bearing cap
10. Camshaft bearing upper
11. Camshaft assembly
12. Camshaft bearing lower
13. Cylinder head assembly
14. Cylinder head gasket

Removal

Preparation

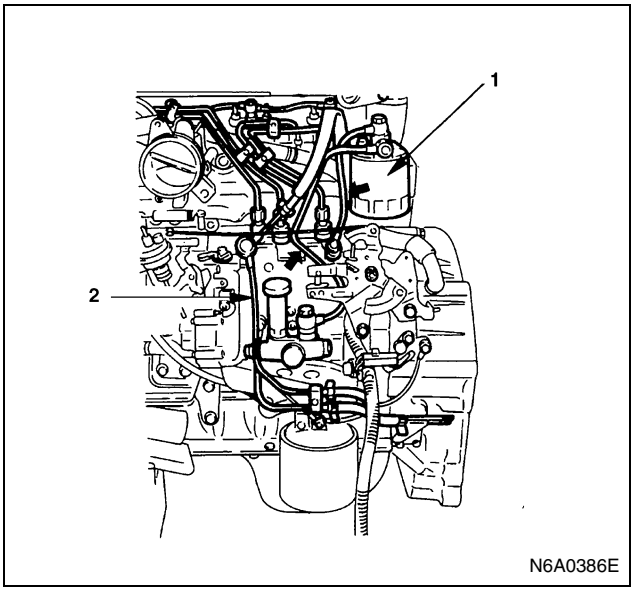
- Disconnect battery ground cable
- Tilt the cab.
- Drain coolant

Engine Right Side

1. Front Exhaust Pipe
2. Air Conditioning (A/C) Compressor Drive Belt (If equipped with A/C)
3. A/C Compressor (If equipped with A/C)
   1) Disconnect magnetic clutch harness connector.
   2) Dismount the compressor together with the hoses from the A/C compressor bracket, and fasten it with a wire to the appropriate location.

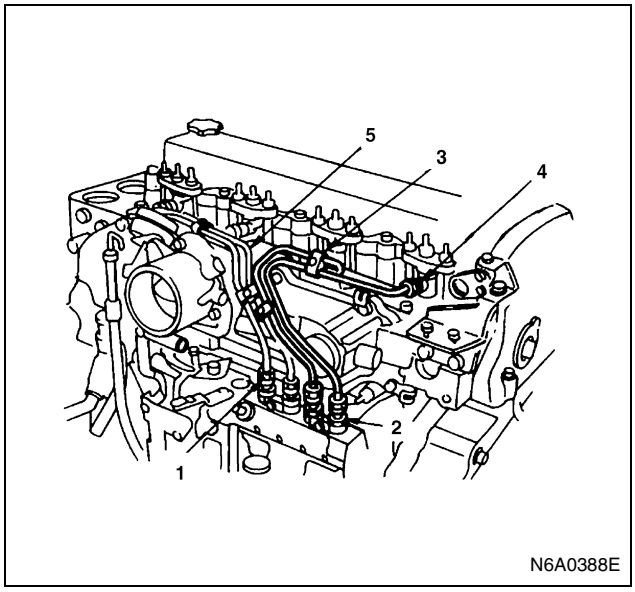
Engine Left Side

1. Intake Air Duct
   1) Remove the clips at the connections with the inlet cover and with the air cleaner.
   2) Remove the intake air duct with the connecting hoses attached.
2. Vacuum Hose
3. Nozzle Cover
4. Leak Off Pipe
5. Fuel Pipe

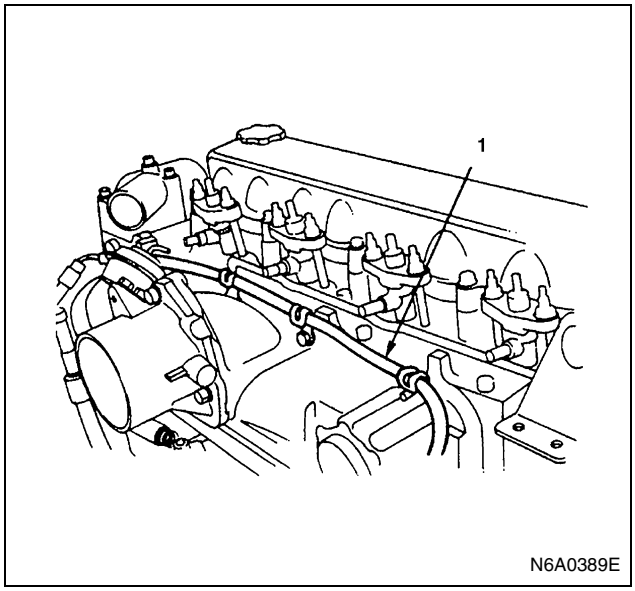


Legend
1. Fuel filter
2. Leak off

6. Fuel filter & Bracket
7. Water Bypass Hose
8. Positive Crankcase Ventilation (PCV) Hose
9. Injection Pipe
   1) Loosen the injection pipe sleeve nuts (1).
   Do not apply excessive force to the injection pipes (5).
   2) Loosen the injection pipes clips (3).
   3) Remove the injection pipe assembly.
   Plug the delivery valve holder (2) ports and nozzle holder (4) ports with caps to prevent the entry of foreign material.

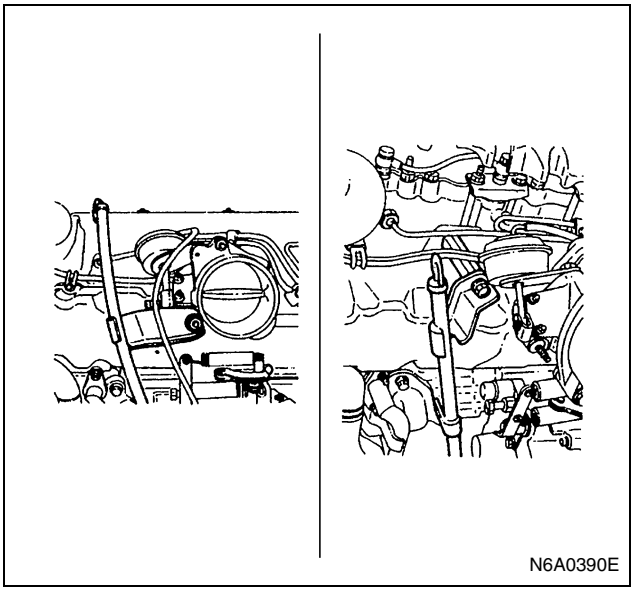


10. Engine Harness
    Disconnect thermometer unit, thermo switch, tachometer sensor and glow plug harness connectors an separate harness from clips.



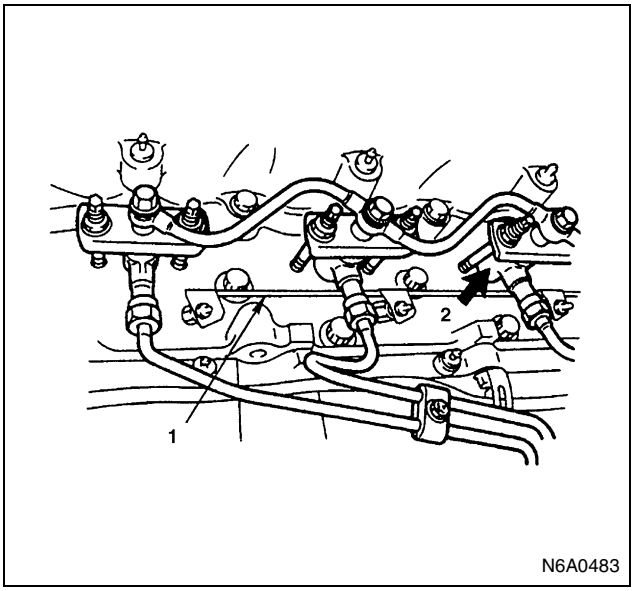
Legend
1. Engine harness

11. Oil Level Gauge Guide Tube
    Remove the guide tube fixing bolt and pull out the guide tube.


N6A0390E

Cylinder Head Side

1. Radiator Upper Hose
2. Coolant Reserve Tank Hose/Bypass Hose
3. Cylinder Head Cover
4. Cylinder Head Cover Gasket
5. Glow Plug Connector
6. Injection Nozzle Holder Assembly
   Mark the nozzle holder assemblies fitting positions by tagging each nozzle holder assembly with the cylinder number from which it was removed.



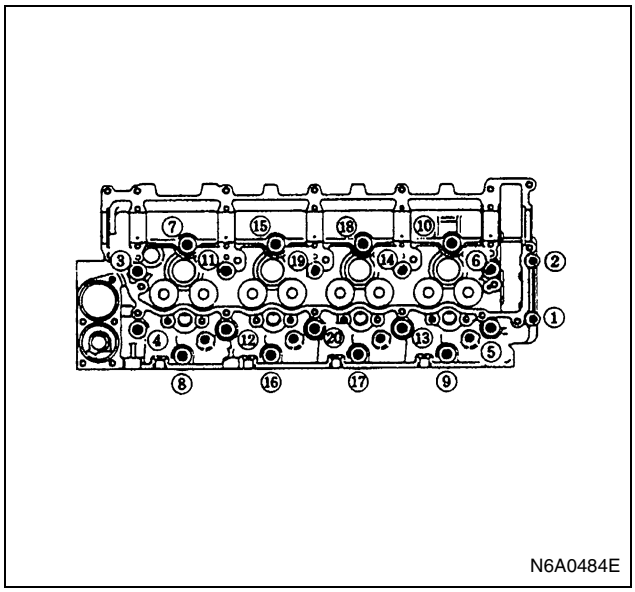
N6A0483

Legend

1. Glow plug connector
2. Injection nozzle holder assembly

7. Rocker Arm Shaft Assembly
8. Valve Cap
9. Camshaft Bearing Cap
10. Camshaft Bearing Upper
11. Camshaft Assembly
12. Camshaft Bearing Lower
    Above works refer to “ROCKER ARM SHAFT ASSEMBLY AND CAMSHAFT ASSEMBLY” section in this manual.
13. Cylinder Head Assembly
    Loosen the cylinder head bolts in numerical order a little at a time.

Caution:
Failure to loosen the cylinder head bolts in numerical order a little at a time will adversely affect the cylinder head lower surface.



N6A0484E

14. Cylinder Head Gasket

Caution:
Do not reuse the cylinder head gasket.

Installation

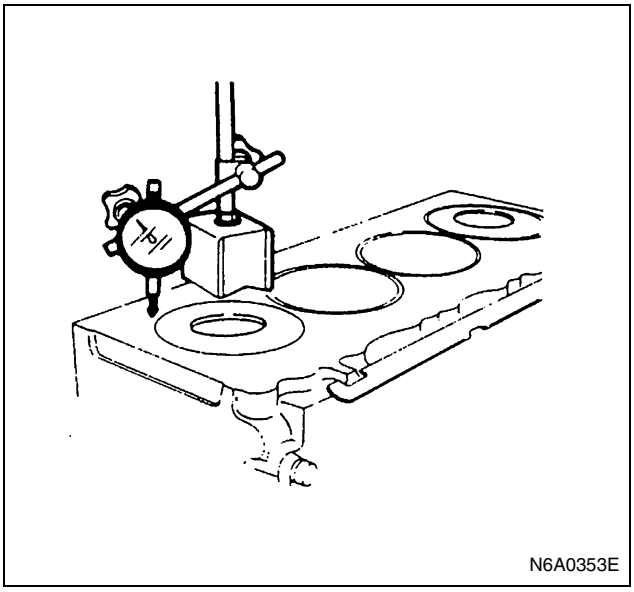
Cylinder Head Side

1. Cylinder Head Gasket
   1) When any of the cylinder block, crankshaft, crankshaft bearing, connecting rod, connecting rod bearing, and piston is replaced with a new one, cylinder head gasket thickness ahold be determined newly.
   2) When replacing the cylinder head gasket alone without replacing any of the parts mentioned in 1) above, the gasket to be used should be the same grade as the one used before.
   3) Correct cylinder head gasket thickness is important.
      Installing the wrong thickness gasket can result in greatly reduced engine performance.
   4) There are three cylinder head gaskets available.

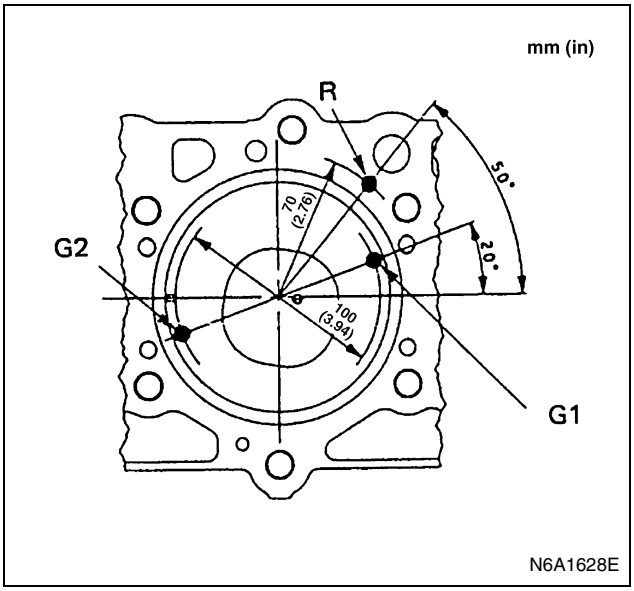
Piston Head Projection Measurement

- Select a cylinder head gasket.
- Clean thoroughly the top faces of the piston head and the cylinder body.

- Use the dial gauge to measure the piston head projection. Take measurements at two location for each cylinder.
- The measurement points of the piston head and the reference point of the cylinder body are shown in the illustration.


N6A0353E

Measurement points: Points G1 and G2 of the piston head
Reference point: Point R on the top face of the cylinder body



N6A1628E

Notice:
Note that there are three types of a cylinder head gasket available as below, according to the piston projection.

- For each cylinder, calculate the average value (Ti) of the piston projection.
- Find the maximum value (Ti max) of the average of each cylinder.
- Based on the Timax obtained, select a gasket of the appropriate grade.

4HF1/4HF1-2/4HG1-T
Cylinder Head Gasket Selection

mm (in)

Gasket Grade	Ti max	Gasket Thickness (Reference)
A	0.579 - 0.659 (0.0228 - 0.0259)	1.70 (0.0669)
B	0.659 - 0.739 (0.0259 - 0.0291)	1.75 (0.0689)
C	0.739 - 0.819 (0.0291 - 0.0322)	1.80 (0.0708)

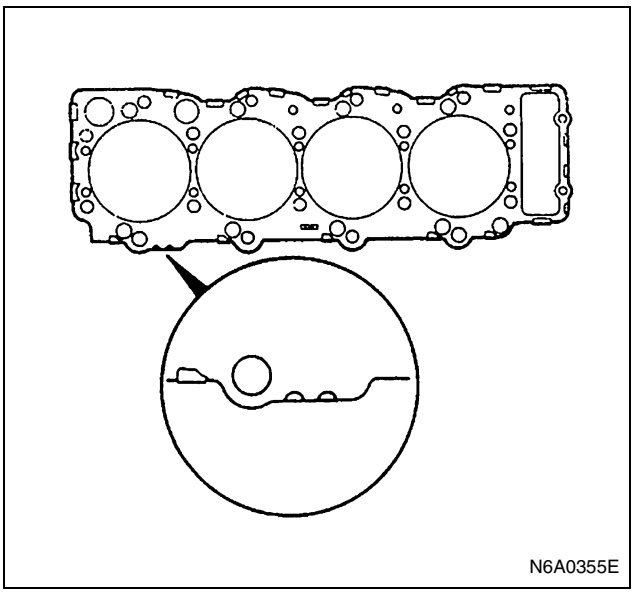
N6A1396E

4HE1-TC
Cylinder Head Gasket Selection

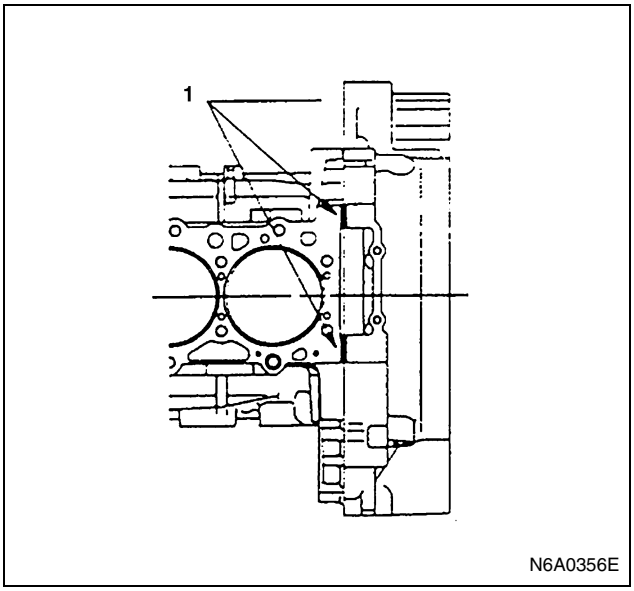
mm (in)

Gasket Grade	Ti max	Gasket Thickness (Reference)
A	0.529 - 0.609 (0.0208 - 0.0240)	1.70 (0.0669)
B	0.609 - 0.679 (0.0240 - 0.0267)	1.75 (0.0689)
C	0.679 - 0.759 (0.0267 - 0.0300)	1.80 (0.0708)

N6A1397E


N6A0355E

5) Apply a 3 mm (0.12 in) bead or recommended liquid gasket (Three Bond 1207C) or its equivalent to the shaded areas shown in the illustration.

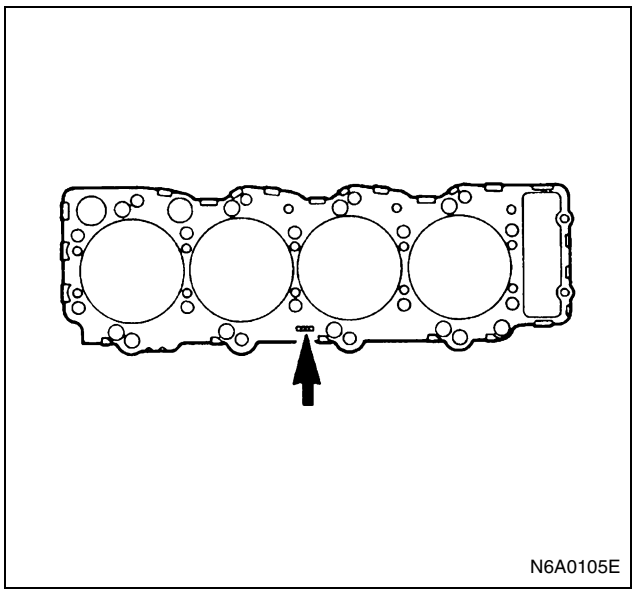


N6A0356E

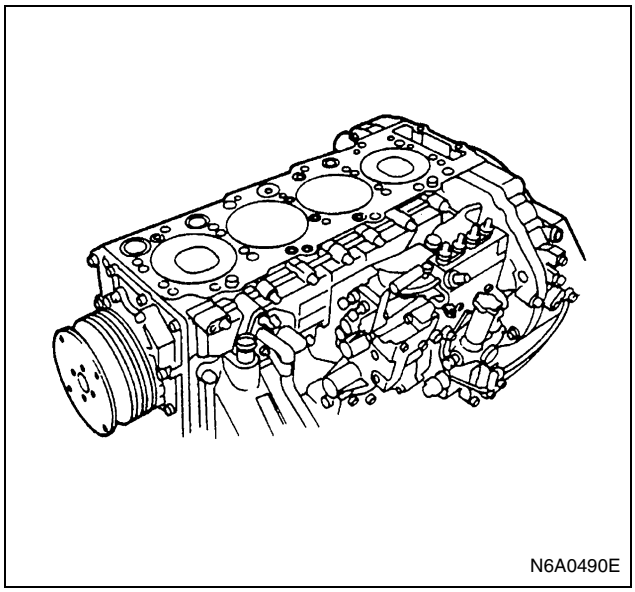
Legend
1. Bead width ϕ3

6) Install the cylinder head gasket with its "PART NUMBER" mark facing up and toward the left of the engine.

Caution:
Do not reuse the cylinder head gasket.

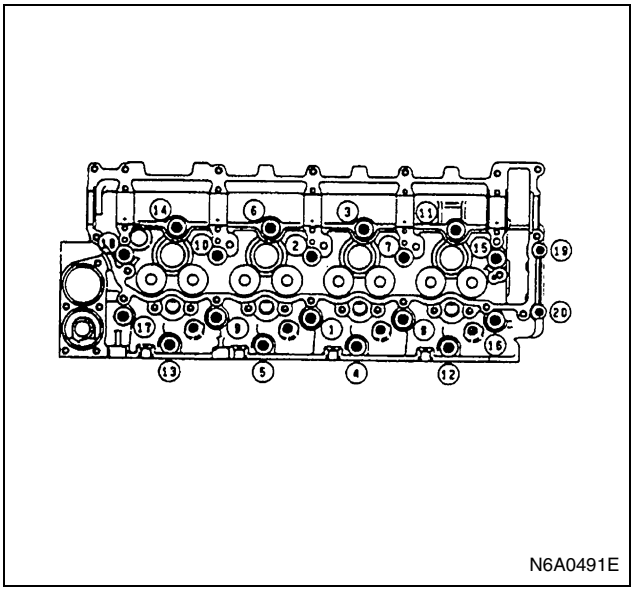

N6A0105E

2. Cylinder Head Assembly
   1) Align the cylinder body dowels and the cylinder head dowel holes.
   2) Carefully place the cylinder head on the cylinder head gasket.


N6A0490E

   3) Apply a coat of molybdenum disulfide grease to the M14 cylinder head bolt threads and setting faces and apply a coat of engine oil to the M10 cylinder head bolt threads and setting faces.
   4) Use the angular tightening method to tighten the bolts (M14) to the specified torque in three steps following the numerical order shown in the illustration.

Tighten:
Cylinder head bolt (M14: (1) — (18)) to
- 1st step: 98 N·m (10 kg·m/72 lb·ft)
- 2nd step: 147 N·m (15 kg·m/108 lb·ft)
- 3rd step: 30 — 60°

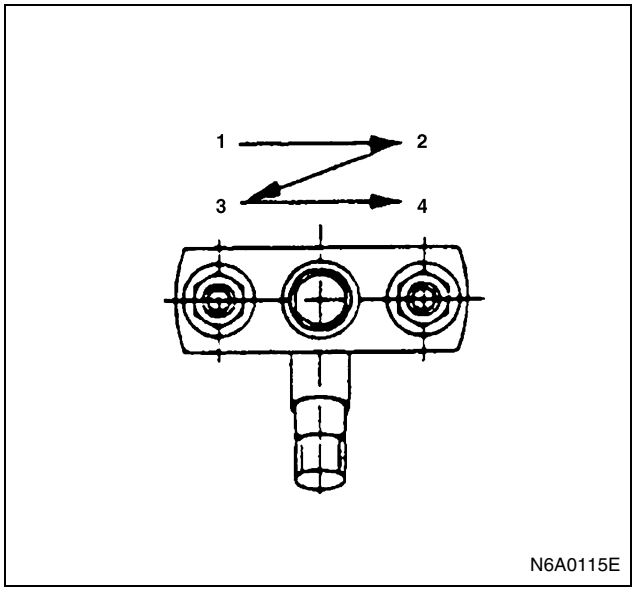


5) Tighten the cylinder head to the flywheel housing bolts (M10) to the specified torque.

Tighten:
Cylinder head bolt (M10: (19), (20)) to 38 N·m (3.9 kg·m/ 28 lb·ft)

3. Camshaft Bearing Lower
4. Camshaft Assembly
5. Camshaft Bearing Upper
6. Camshaft Bearing Cap
7. Valve Cap
   Above works refer to “CAMSHAFT ASSEMBLY” section in this manual.
8. Rocker Arm Shaft Assembly
   Above works refer to “ROCKER ARM SHAFT ASSEMBLY” section in this manual.
9. Injection Nozzle Holder Assembly
   Tighten the nozzle holder flange nuts to the specified torque in the numerical order shown in the illustration.

Tighten:
Nozzle holder flange nut to 19 N·m (1.9 kg·m/14 lb·ft)

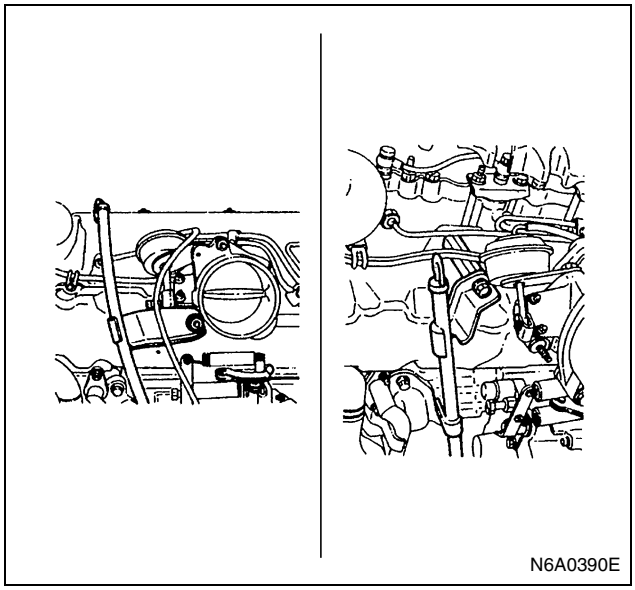


10. Glow Plug Connector
11. Head Cover Gasket
    Install the gasket to the cylinder head cover.
12. Cylinder Head Cover
    Above works refer to “CYLINDER HEAD COVER” section in this manual.
13. Coolant Reserve Tank Hose/Bypass Hose
14. Radiator Upper Hose

Engine Left Side

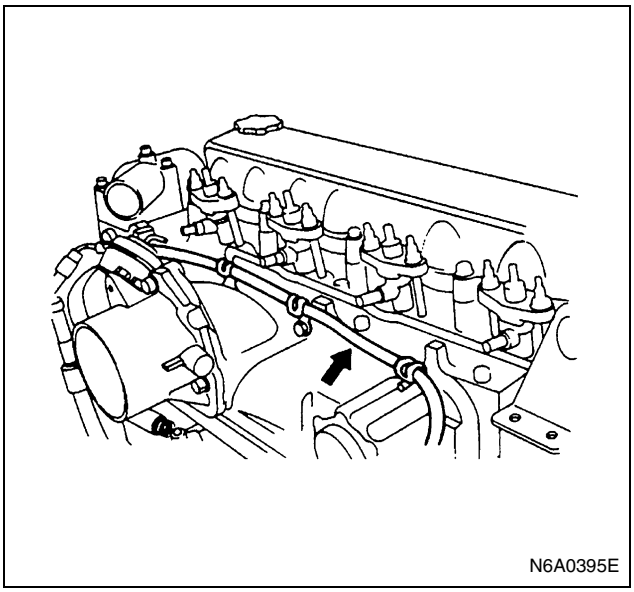
1. Oil Level Gauge Guide Tube
   1) Install the O-rings to the guide tube lower portion and insert the guide tube completely to the cylinder body.
   2) Tighten the guide tube bolt to the specified torque.

Tighten:
Guide tube bolt to 13 N·m (1.3 kg·m/113 lb·in)



2. Engine Harness

Connect thermometer unit, thermo switch, tachometer sensor and glow plug harness connector and fasten the engine harness with clips.


N6A0395E

3. Fuel Injection Pipe Assembly
   Above works refer to “INJECTION PUMP ASSEMBLY” section in this manual.
4. Positive Crankcase Ventilation (PCV) Hose
5. Water Bypass Hose
6. Fuel Filter & Bracket

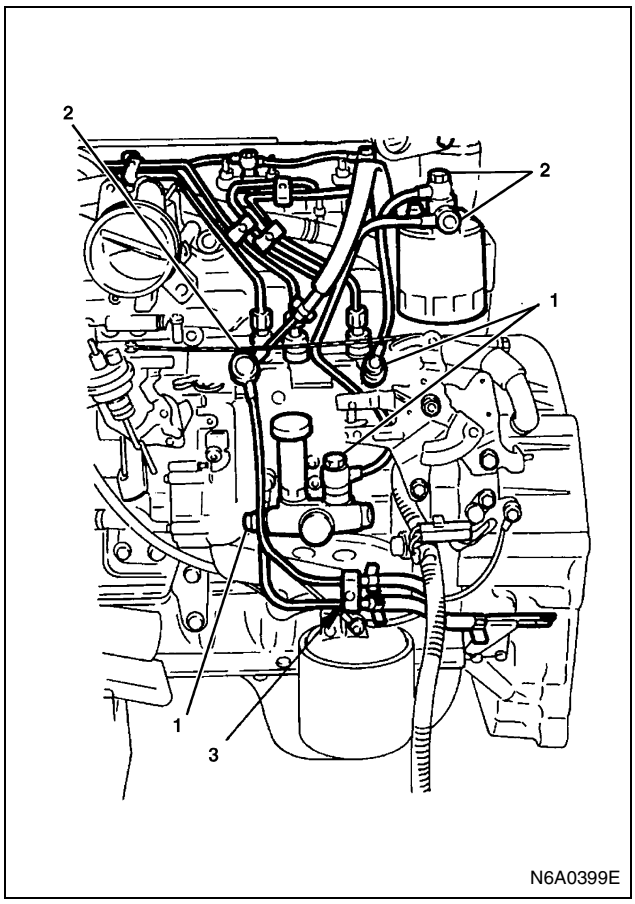
Tighten:
Fuel filter bracket to 34 N·m (3.5 kg·m/25 lb·ft)

7. Fuel Pipe
   Do not apply excessive force to the fuel pipe.

Tighten:
Fuel pipe joint bolt (1) to 41 N·m (4.2 kg·m/30 lb·ft)

Tighten:
Fuel pipe joint bolt (2) to 23 N·m (2.3 kg·m/17 lb·ft)

Tighten:
Clip screw to 4 N·m (0.4 kg·m/35 lb·in)

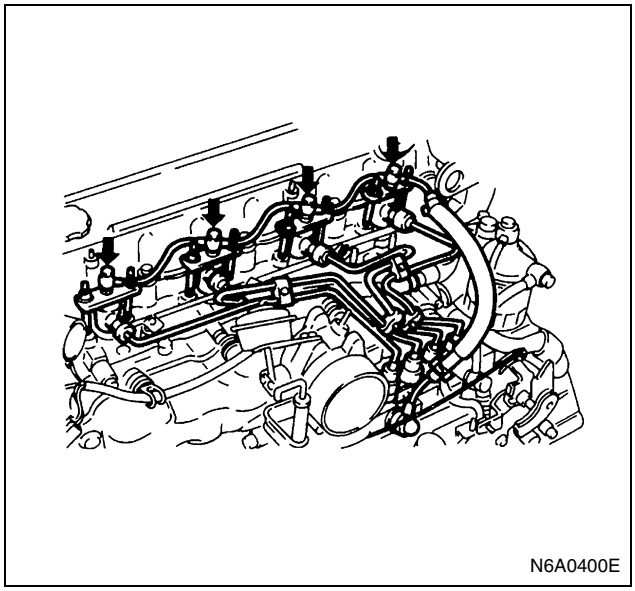


N6A0399E

Legend
1. Fuel pipe joint bolt
2. Fuel pipe joint bolt
3. Clip

8. Leak Off Pipe

Tighten:
Leak-off pipe joint bolt to 13 N·m (1.3 kg·m/113 lb·in)


N6A0400E

9. Nozzle Cover
10. Vacuum Hose

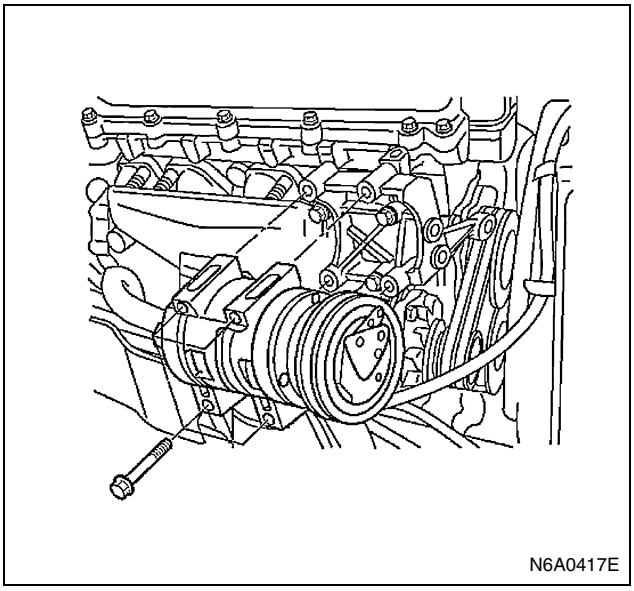
11. Intake Air Duct

Engine Right Side

1. Air Conditioning (A/C) Compressor (If equipped with A/C)
   Tighten fixing bolts to the specified to torque.

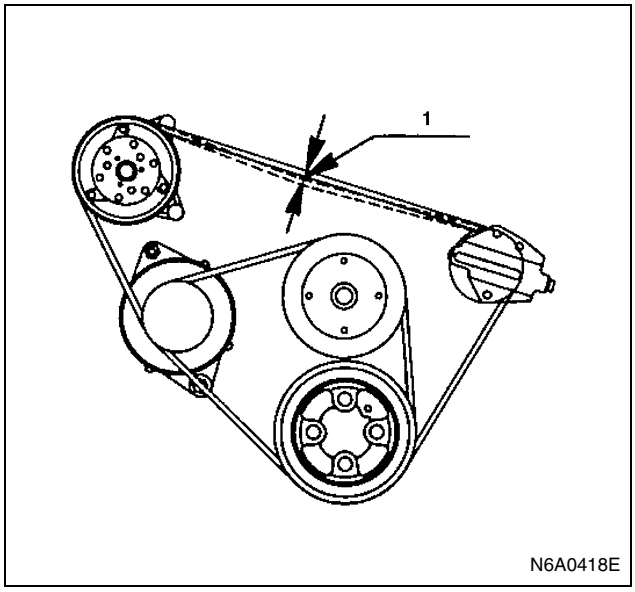
Tighten:
A/C compressor bolt to 48 N·m (4.9 kg·m/35 lb·ft)

Notice:
When tightening the compressor fixing bolts, tighten first the 2 bolts on the rear side, and then the remaining 2 on the front side.


N6A0417E

2. A/C Compressor Drive Belt (If equipped with A/C)
   1) Install drive belt adjust belt tension by adjusting bolt and tighten locking nut to the specified torque.
   2) Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

Drive Belt Deflection	mm (in)
16 — 20 (0.63 — 0.79) ... New belt 18 — 22 (0.71 — 0.87) ... Reuse belt	



N6A0418E

Legend
1. Belt deflection

Tighten:
Locking nut to 27 N·m (2.8 kg·m/20 lb·ft)

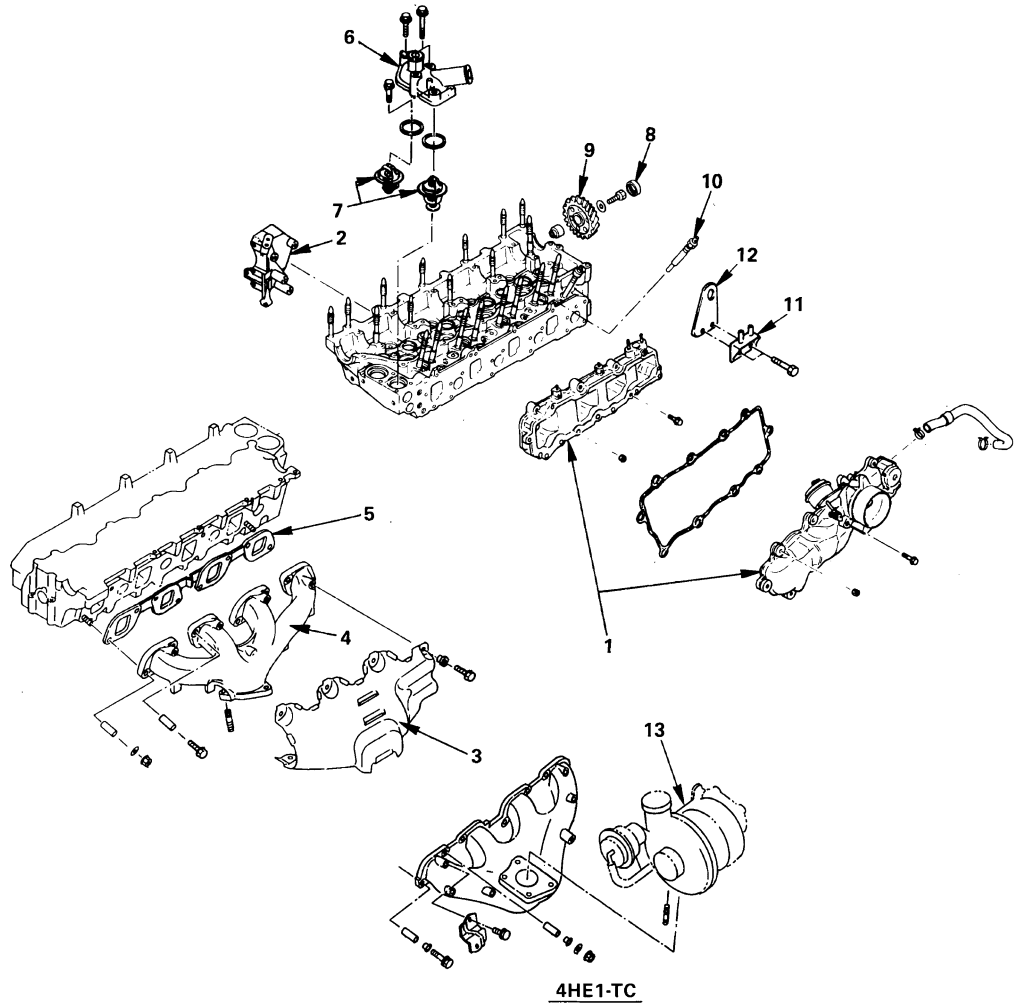
3. Front Exhaust Pipe

Tighten:
Front exhaust pipe to
- Exhaust manifold side: 67 N·m (6.8 kg·m/49 lb·ft)
- Exhaust brake side: 17 N·m (1.7 kg·m/12 lb·ft)

  - Connect the negative battery cable.
  - Lower the cab.
  - Start engine and check for oil, fuel and water leakage carefully.

CIRCUMFERENCE PARTS OF CYLINDER HEAD

Component



N6A0499E

Legend

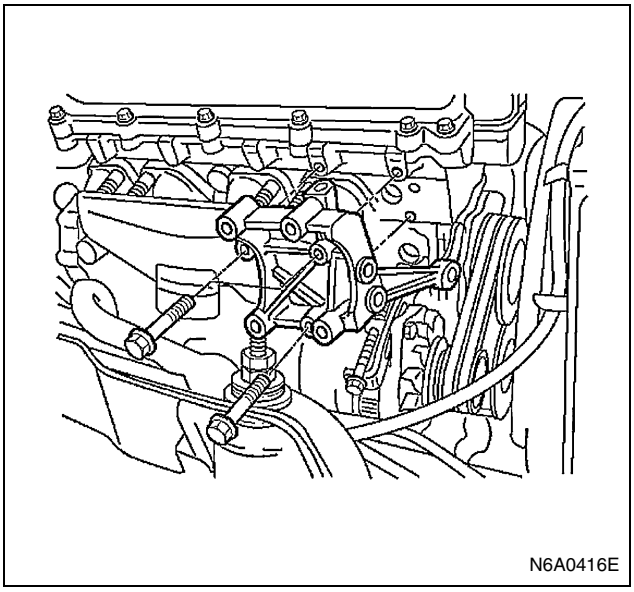
1. Inlet cover/inlet case
2. A/C compressor bracket (If equipped with A/C)
3. Heat protector
4. Exhaust manifold
5. Exhaust gasket
6. Water outlet pipe
7. Idle gear C cover
8. Idle gear C cover
9. Idle gear C
10. Glow plug
11. Fuel filter bracket
12. Engine hanger
13. Turbocharger

Removal

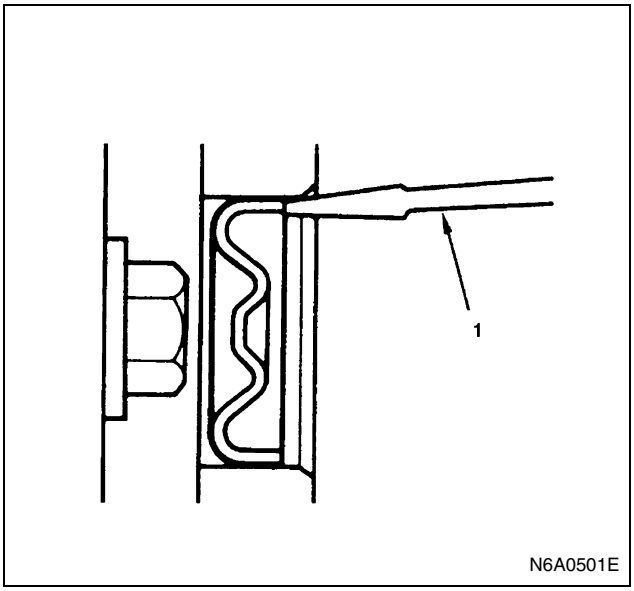
Preparation

- Disconnect battery ground cable
- Tilt the cab
- Drain coolant
- Remove each part from the cylinder head assembly.
  For details, refer to the “CYLINDER HEAD” in this section.

1. Inlet Cover/Inlet Case
2. Air Conditioning (A/C) Compressor Bracket (If equipped with A/C)

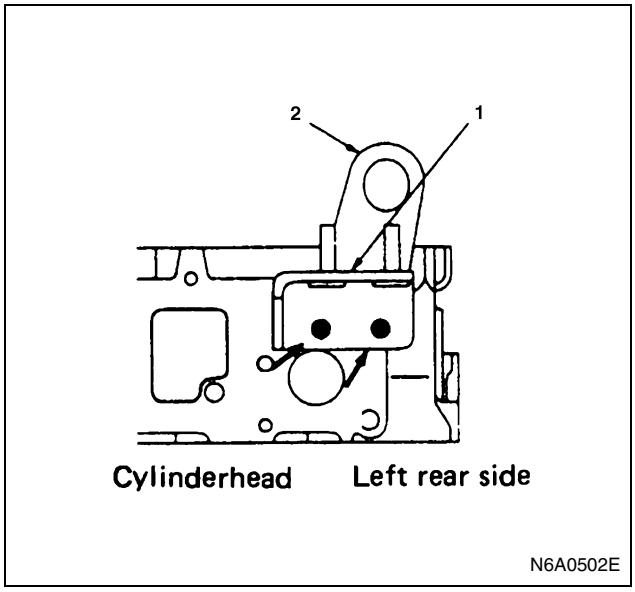

N6A0416E

3. Heat Protector
4. Exhaust Manifold
5. Exhaust Gasket
6. Water Outlet Pipe
7. Thermostat
8. Idle Gear C Cover
   Tap the outside of the sealing cup with a screwdriver (1) to deform one end of it and draw it out with pliers.



N6A0501E

9. Idle Gear C
10. Glow Plug
11. Fuel Filter Bracket
12. Engine Hanger



N6A0502E

Legend
1. Fuel filter bracket
2. Engine hanger

Installation

1. Engine Hanger
2. Fuel Filter Bracket

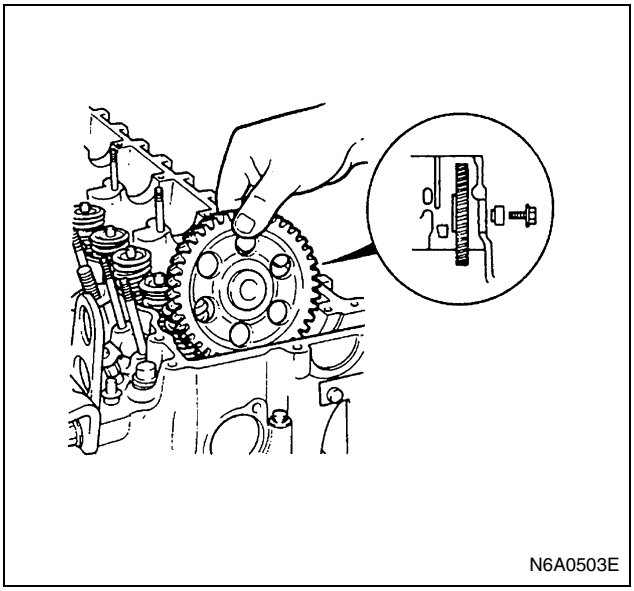
Tighten:
Fuel filter bracket bolt to 104 N·m (10.6 kg·m/77 lb·ft)

3. Glow Plug

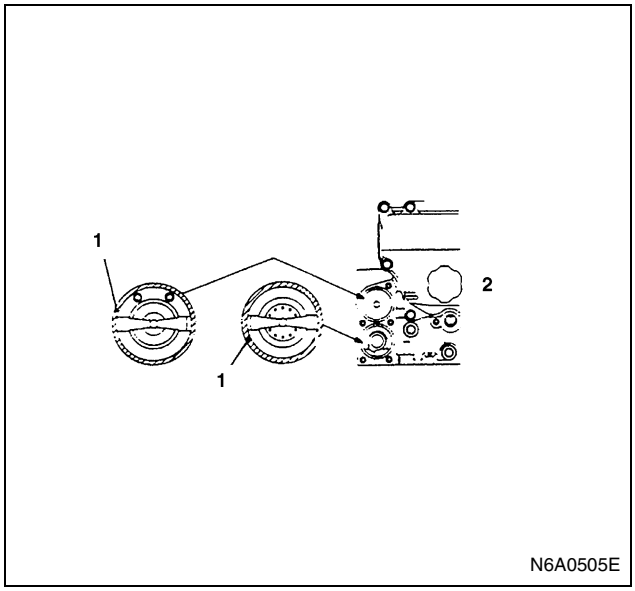
Tighten:
Glow plug to 23 N·m (2.3 kg·m/17 lb·ft)

4. Idle Gear C
   1) Apply engine oil to the idle gear shaft, bushing and idle gear before installation.
   2) Install the idle gear with the boss side facing to the camshaft as shown in the illustration.

Tighten:
Idle gear C bolt to 95 N·m (9.7 kg·m/70 lb·ft)


N6A0503E

5. Idle Gear C Cover
   1) Apply the recommended liquid gasket (LOCTITE 262) or its equivalent to the outside of the sealing cup and install it to the cylinder head.
   2) Use the sealing cup installer and a hammer to drive the sealing cup into position from the cylinder head side as shown in the illustration.
      Sealing Cup Installer: 5-8840-2222-0

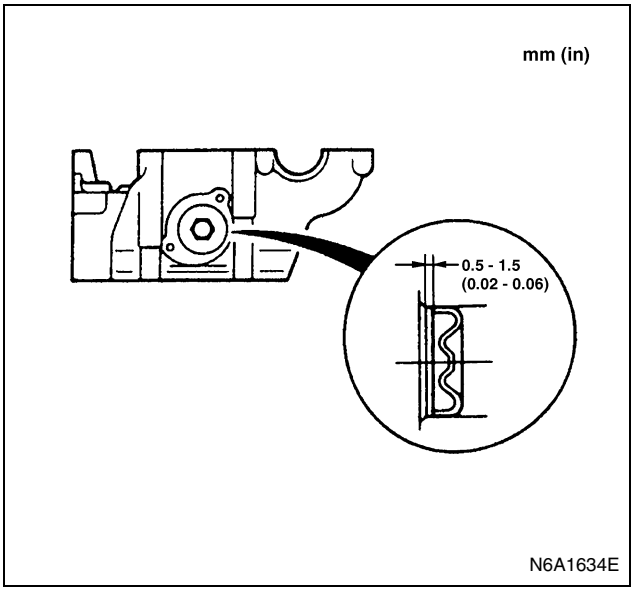


N6A0505E

Legend
1. Gasket
2. Top face of the head

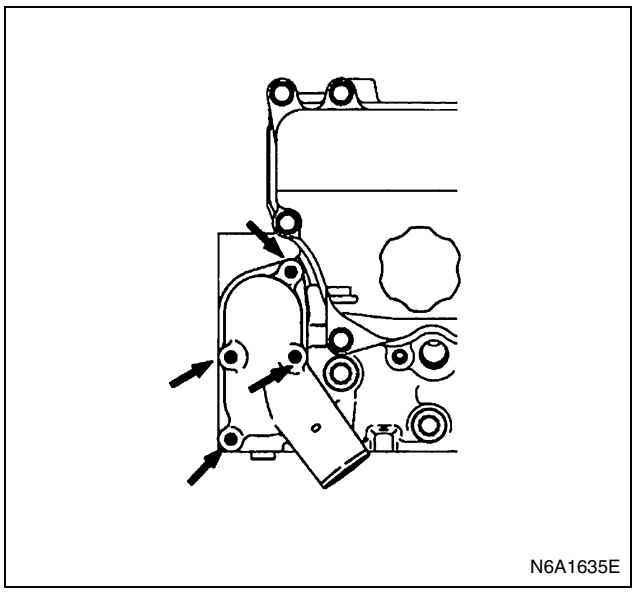
7. Water Outlet Pipe

Tighten:
Water outlet pipe bolt to 24 N·m (2.4 kg·m/17 lb·ft)

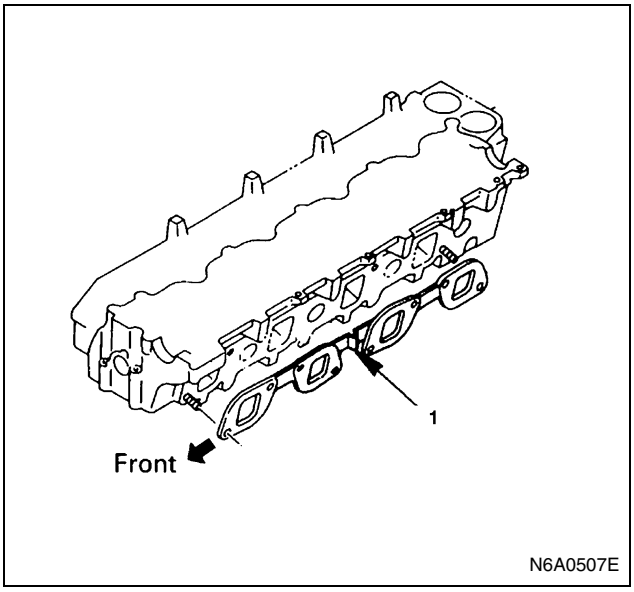


N6A1634E

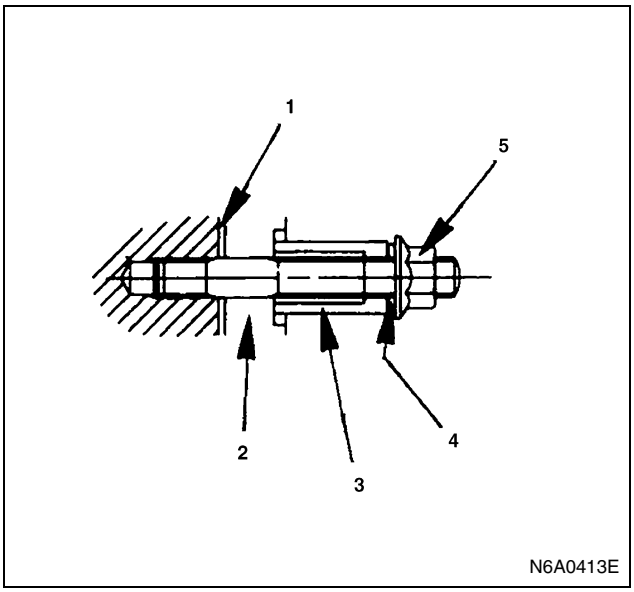
6. Thermostat
   Install the gaskets to the thermostat and install them to the cylinder head as shown in the illustration.


N6A1635E

8. Exhaust Gasket
   Insert the gasket into the stud provided to the cylinder head (with the projection (1) of the gasket on this side).

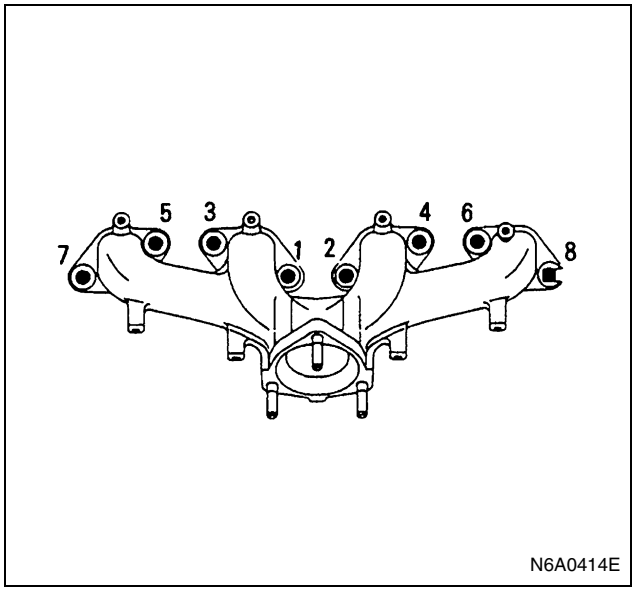


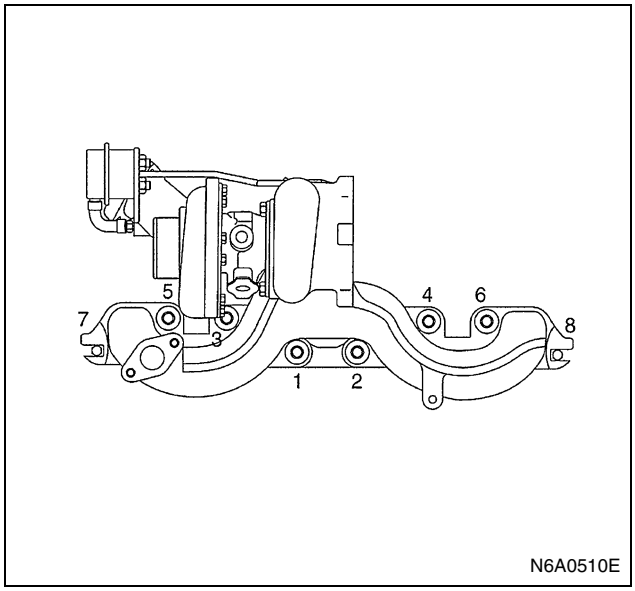
9. Exhaust Manifold
   1) Install exhaust manifold gaskets (1), exhaust manifold (2), distance pieces (3), dish washers (4) and nuts (5) to the stud bolts shown in the illustration.



   2) Tighten the nuts to the specified torque in the numerical order shown in the illustration.

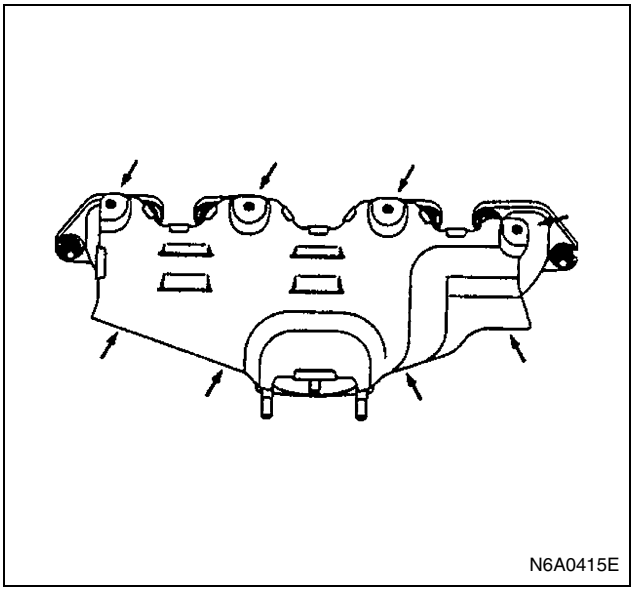
Tighten:
Exhaust manifold nut to 34 N·m (3.5 kg·m/25 lb·ft)





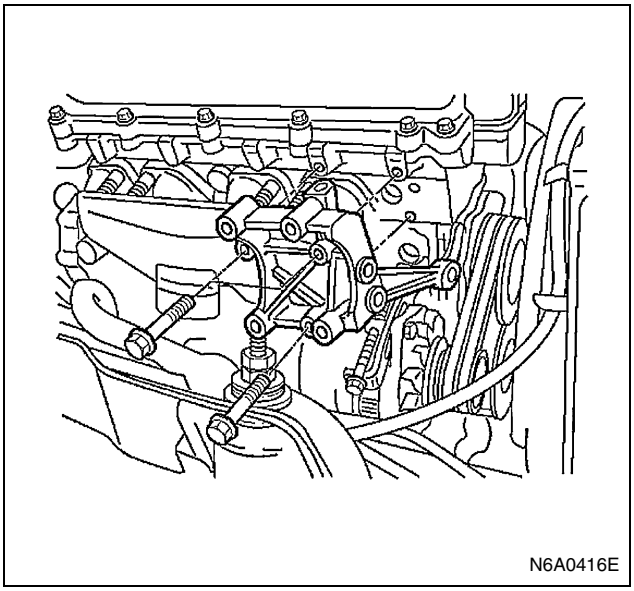
10. Heat Protector

Tighten:
Heat protector bolt to 10 N·m (1.0 kg·m/87 lb·in)

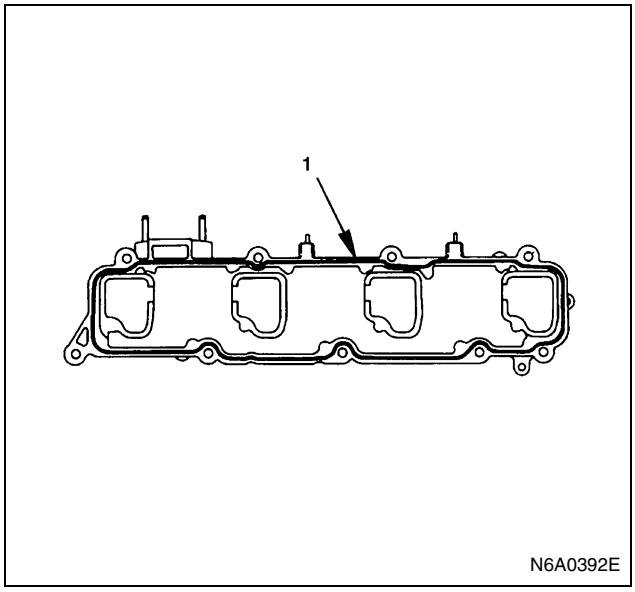

N6A0415E

11. Air Conditioning (A/C) Compressor Bracket (If equipped with A/C)
    Tighten fixing bolts to the specified torque.

Tighten:
A/C compressor bracket bolt to 48 N·m (4.9 kg·m/35 lb·ft)

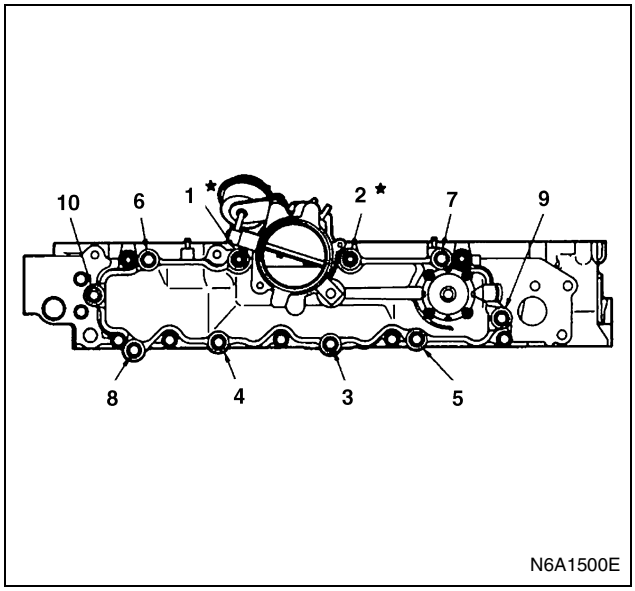

N6A0416E

12. Inlet Cover/Inlet Case
    1) Apply 2 — 3 mm (0.08 — 0.12 in) bead of the recommended liquid gasket (Three Bond 1207C) or its equivalent on the groove (1) of the inlet case fitting surfaces shown in the illustration.
    - Clean the inlet case fitting surface of the cylinder head.



N6A0392E

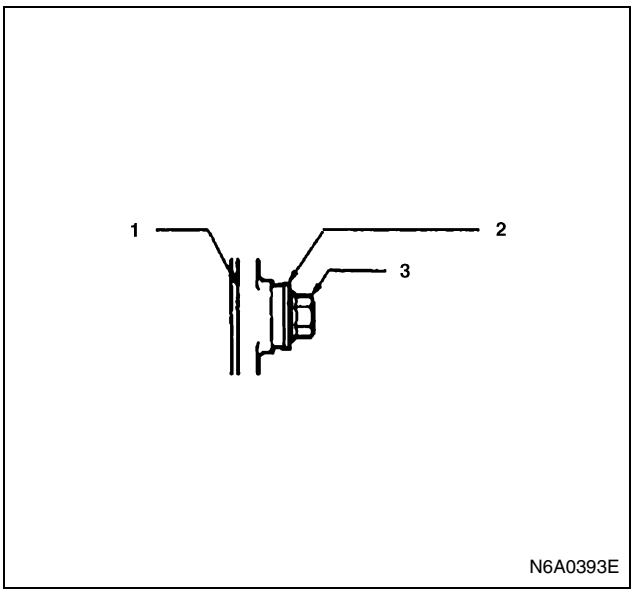
    2) Install the inlet case to the cylinder head.
    - Install the inlet case within 7 minutes after application of liquid gasket.
    - Attach harness clips ((1), (6) and (7)) and tighten the inlet cover bolts and nuts to the specified torque in the numerical order shown in the illustration.



N6A1500E

    - ★ marks are located on nut positions.

Tighten:
Inlet cover bolt and nut to 13 N·m (1.3 kg·m/9 lb·ft)



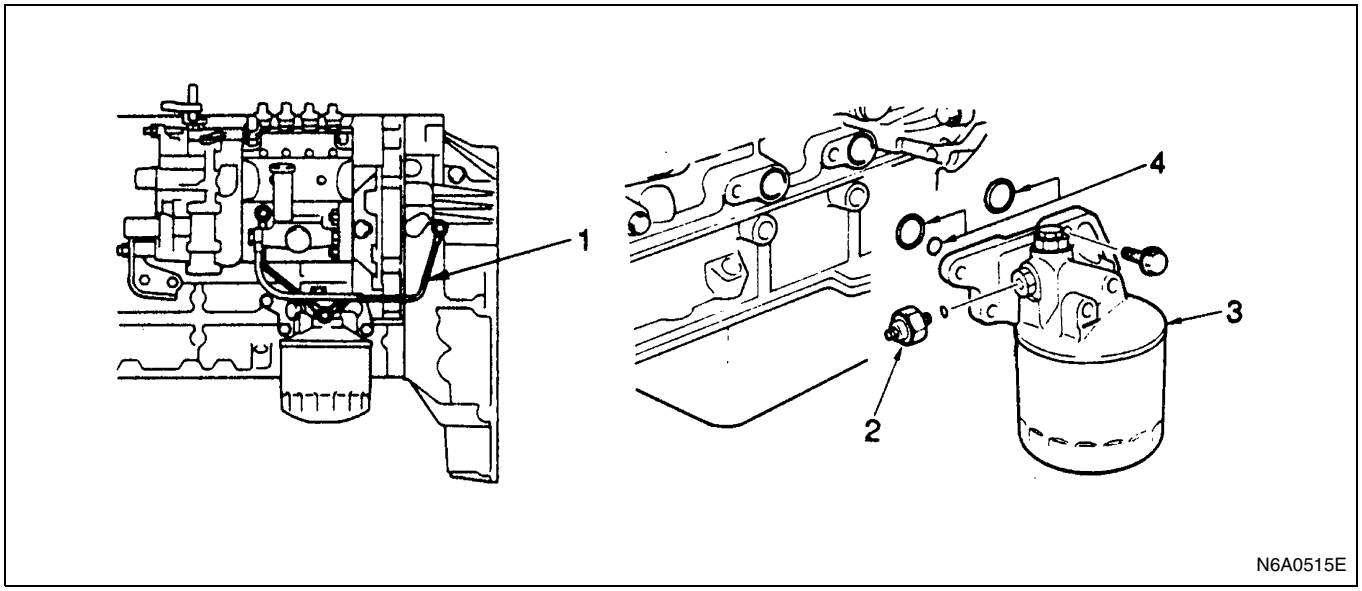
Legend

1. Inlet cover
2. Mounting rubber
3. Bolt

Refer to “CYLINDER HEAD” in this section, install the remaining parts.

OIL FILTER ASSEMBLY

Component



Legend

1. Oil pipe
2. Oil pressure switch
3. Oil filter
4. O-ring

Removal

Preparation

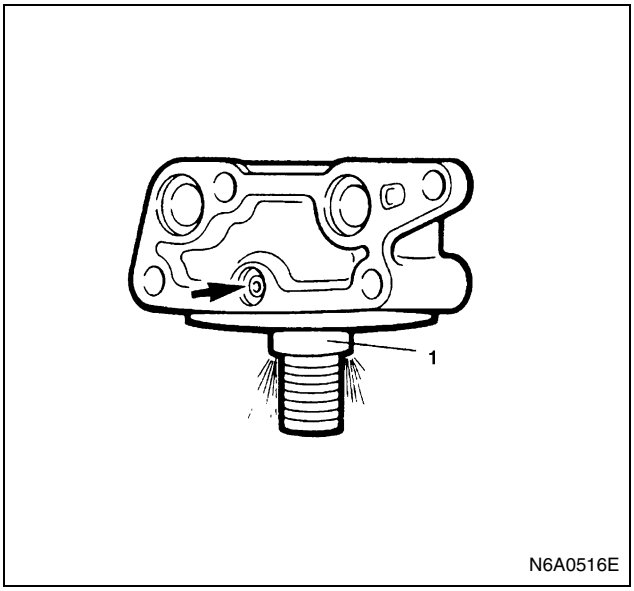
- Disconnect battery ground cable.
- Place a receptacle beneath the oil filter to contain the drained oil.

1. Oil Pipe
2. Oil Pressure Switch
3. Oil Filter
4. O-ring

Inspection

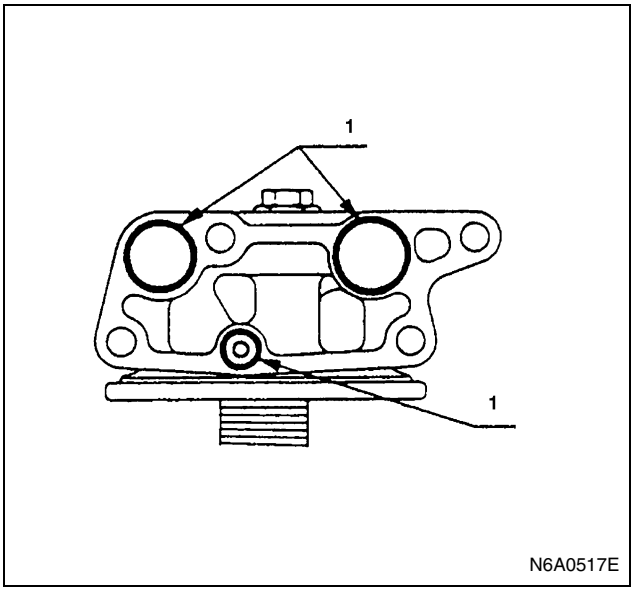
Oil Filter Cover

1. Check the partial filter orifice for any clogging.
2. Send air into the arrow-marked hole in the illustration, and check to see if the air blows out from the small holes in the center sleeve (1).



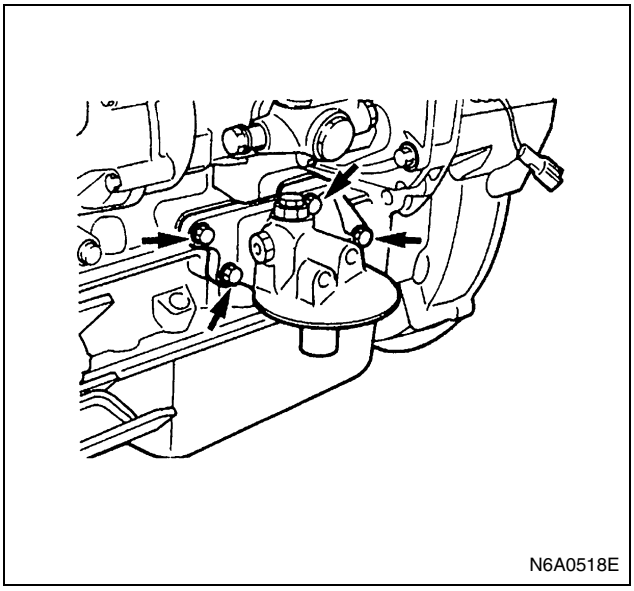
Installation

1. O-Ring
   Apply a coat of engine oil to the O-rings (1) and install them to the cylinder body.



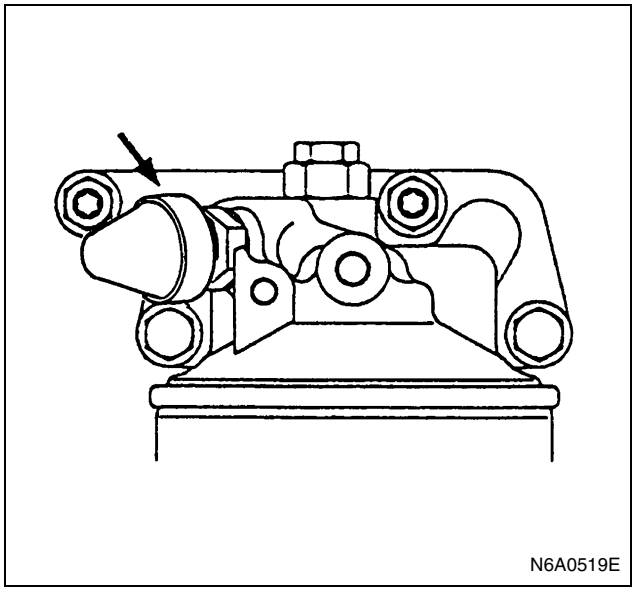
2. Oil Filter

Tighten:
Oil filter cover bolt to 48 N·m (4.9 kg·m/35 lb·ft)



3. Oil Pressure Switch
   1) Apply the recommended liquid gasket (LOCTITE 262) or its equivalent to at least 2 — 3 of the oil pressure switch threaded areas.
   2) Install the oil pressure switch to the oil filter cover.

Tighten:
Oil pressure switch to 13 N·m (1.3 kg·m/113 lb·in)



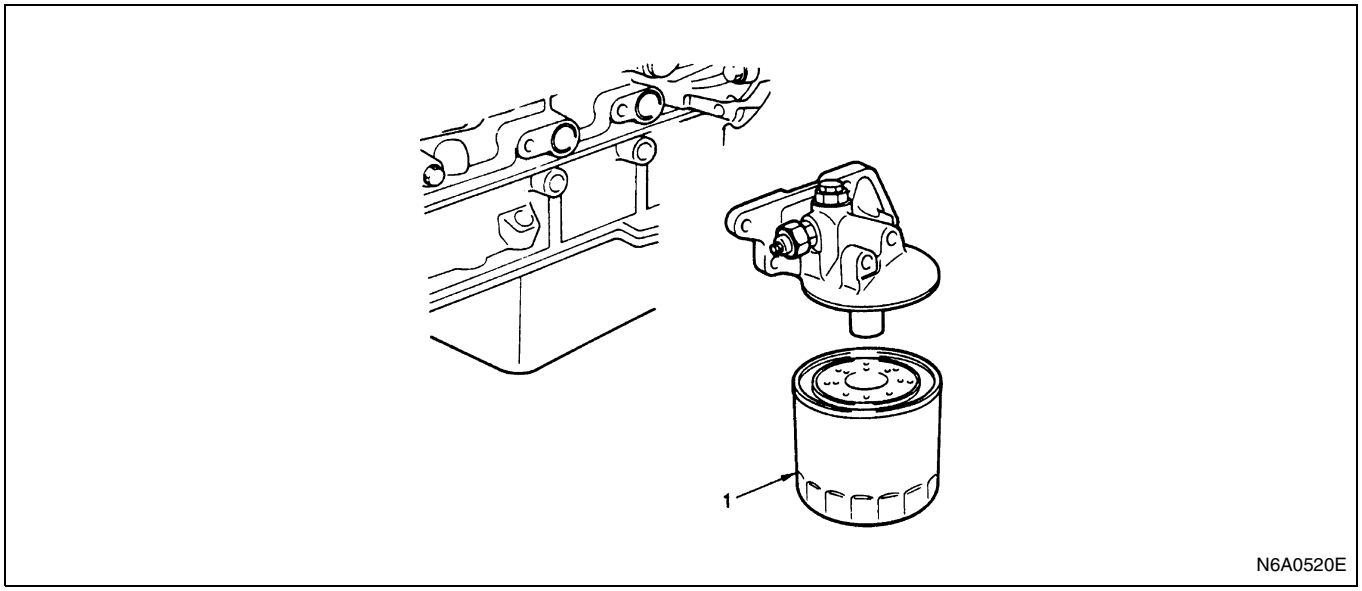
4. Oil Pipe

Tighten:
Oil pipe joint bolt to 17 N·m (1.7 kg·m/12 lb·ft)

- Connect battery ground cable.
- Start engine and check for oil leakage carefully.

OIL FILTER CARTRIDGE

Component

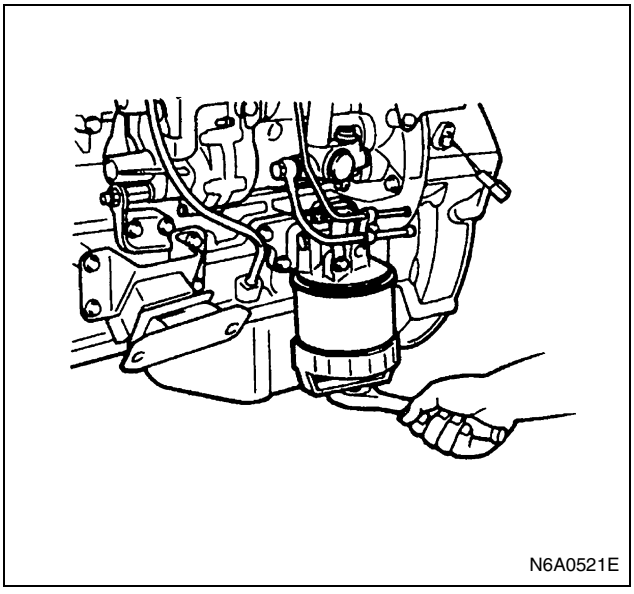


Legend
1. Oil filter cartridge

Removal

Preparation
- Disconnect battery ground cable.
- Place a receptacle beneath the oil filter to contain the drained oil.

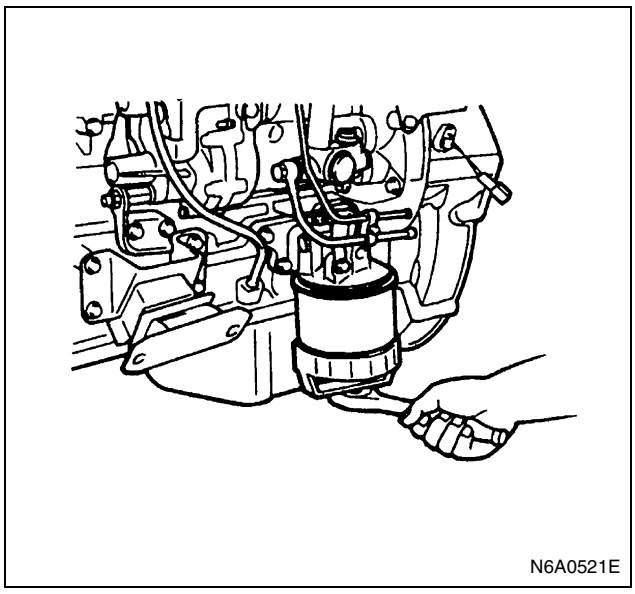
1. Oil Filter Cartridge
   Use an oil filter wrench to remove the oil filter cartridge.
   Oil Filter Wrench: 1-8522-1097-0
   5-8840-2094-0 (4WD model)



Installation

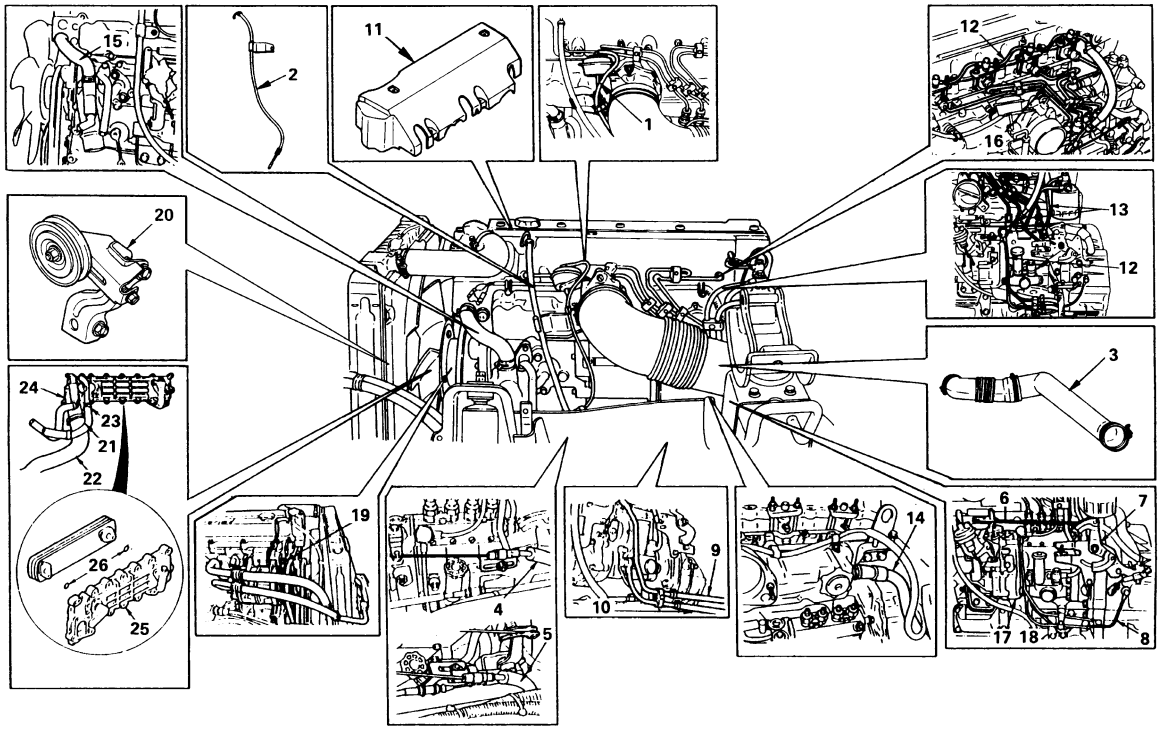
1. Oil Filter Cartridge
   1) Clean the oil filter fitting face.
   2) Apply a light coat of engine oil to the O-ring.
   3) Turn in the new oil filter until the filter O-ring is fitted against the sealing face.
   4) Use an oil filter wrench to install the new oil filter cartridge.
      Oil Filter Wrench: 1-8522-1097-0
      5-8840-2094-0 (4WD model)

Tighten:
Oil filter to 64 N·m (6.5 kg·m/47 lb·ft)



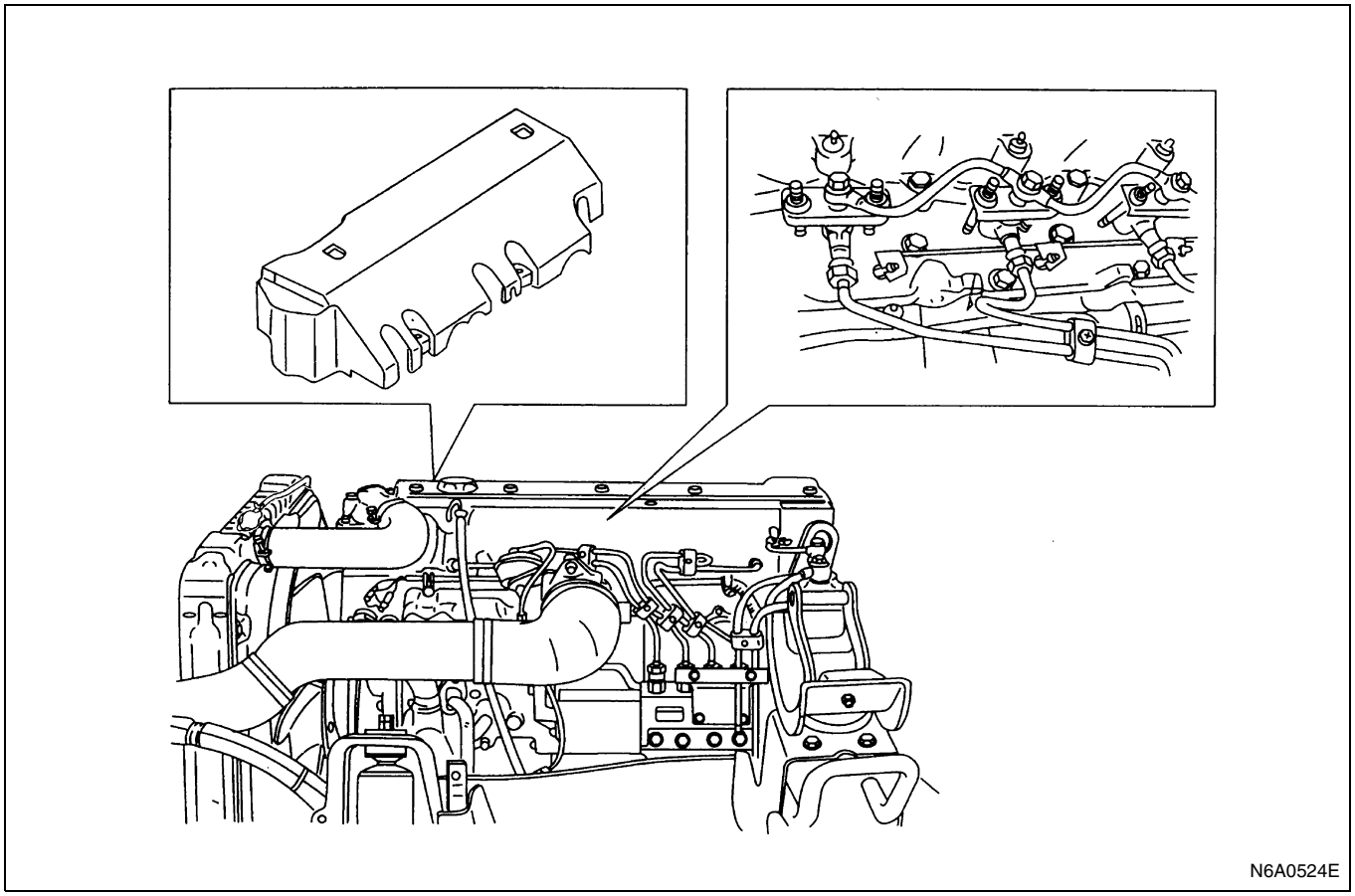
OIL COOLER

Component



Legend

1. Vacuum hose
2. Oil level guide tube
3. Intake air duct
4. Engine stop cable
5. Accelerator control cable
6. Engine control cable
7. Engine control lever assembly
8. Oil pipe
9. Fuel return hose
10. Fuel feed hose
11. Nozzle cover
12. Leak off pipe
13. Fuel pipe
14. PCV hose
15. Water bypass hose
16. Injection pipe
17. Injection pump assembly
18. Injection pump rubber spacer
19. A/C drive belt (If equipped with A/C)
20. Idle pulley bracket (If equipped with A/C)
21. Heater hose
22. Radiator lower hose
23. Heater pipe
24. Water suction pipe
25. Oil cooler assembly
26. O-ring

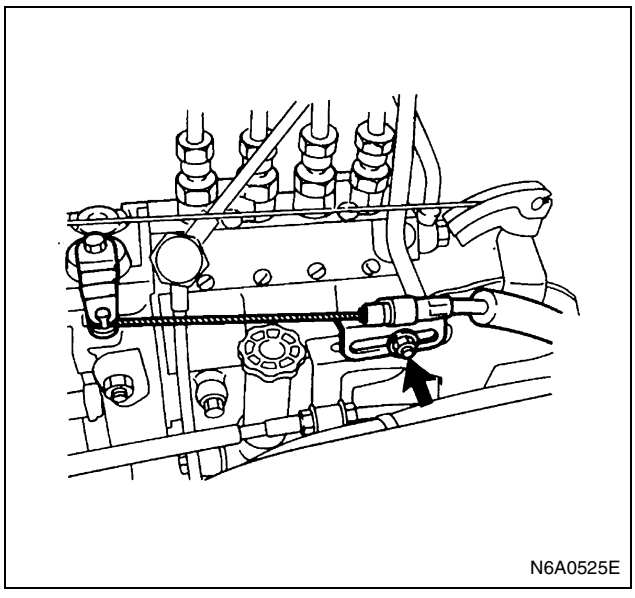


Removal

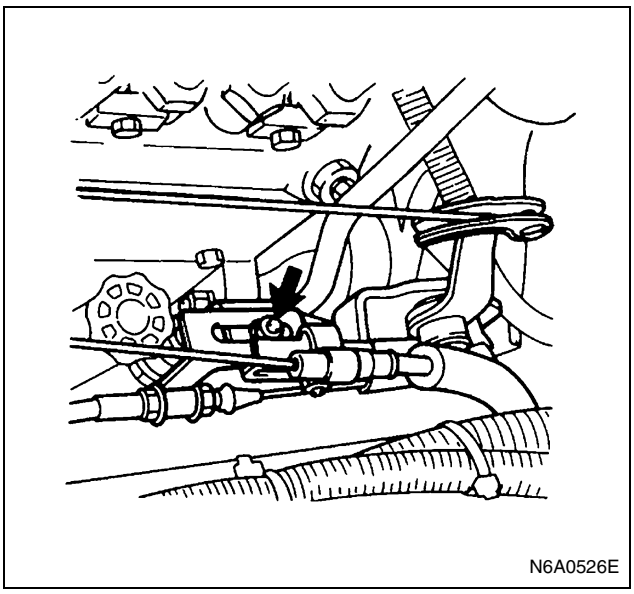
Preparation

- Disconnect the battery ground cable
- Drain coolant

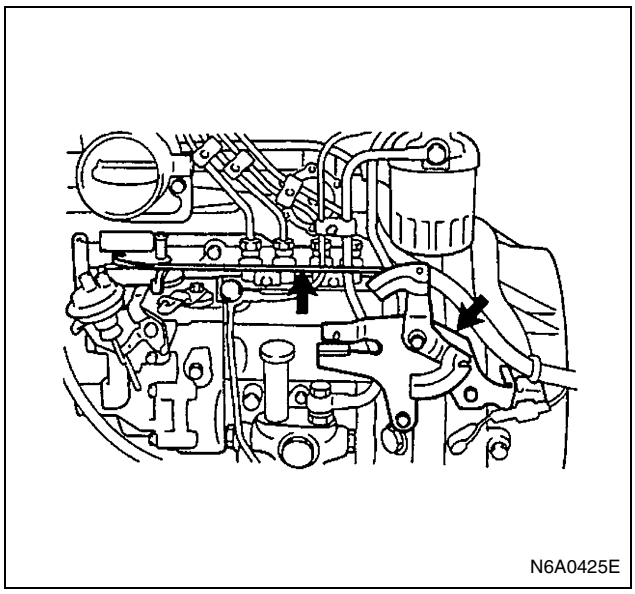
1. Vacuum Hose
2. Oil Level Guide Tube
   Remove the guide tube fixing bolt and pull out the guide tube.
3. Intake Air Duct
4. Engine Stop Cable
   Loosen the locking nut at the bracket and disconnect engine stop cable from injection pump stop lever.



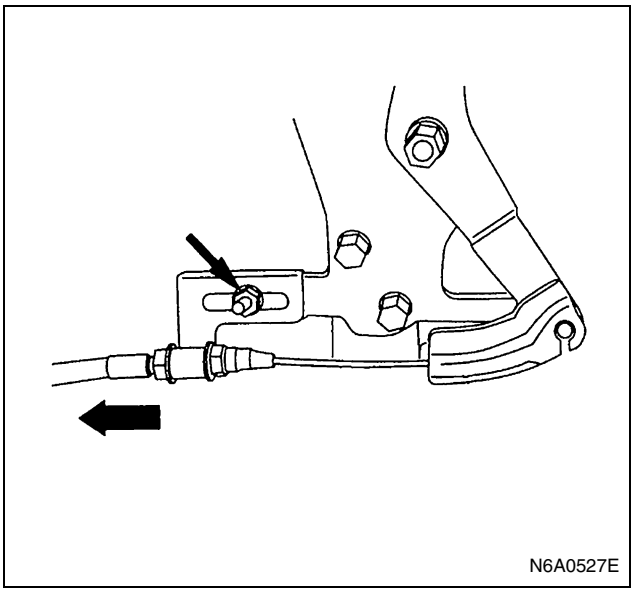
5. Accelerator Control Cable
   Loosen the locking nut at the bracket and disconnect accelerator control cable from injection pump control lever.



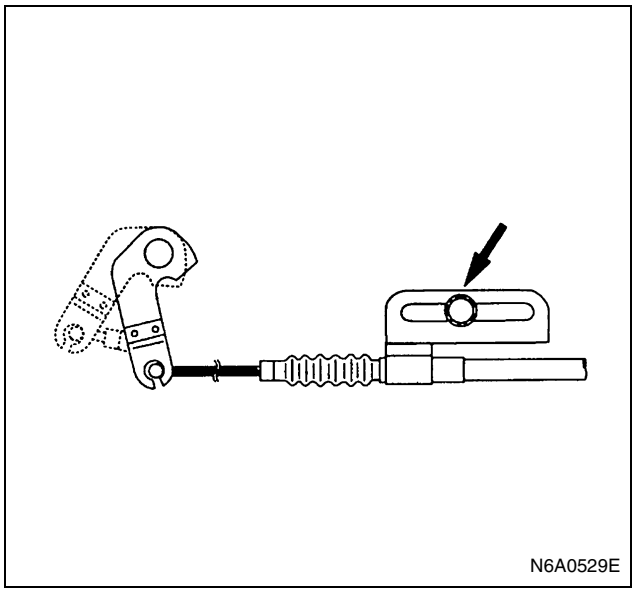
For 4HE1-TC



For 4HE1-TC

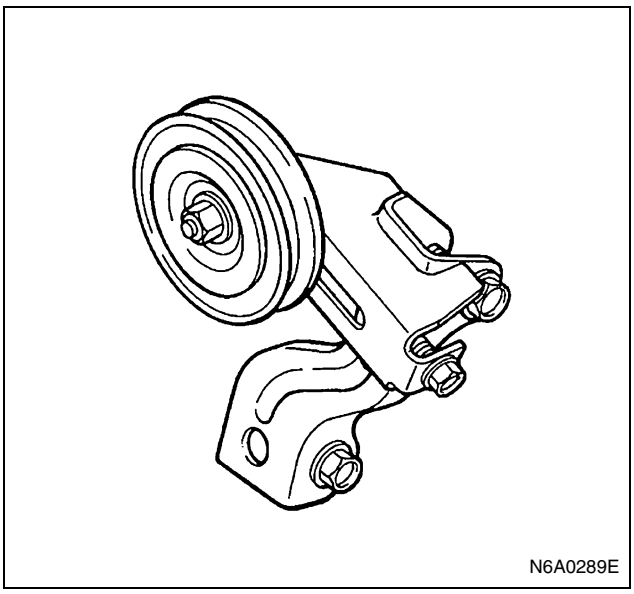


6. Engine Control Cable
7. Engine Control Lever Assembly

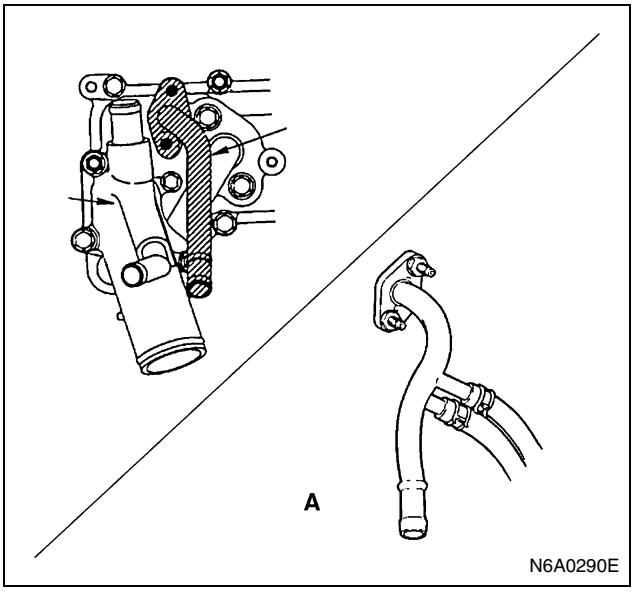


8. Oil Pipe
9. Fuel Return Hose
10. Fuel Feed Hose
    Disconnect fuel hose from injection pump side and take care not to spill and enter dust.
11. Nozzle Cover
12. Leak Off Pipe
13. Fuel Pipe
14. Positive Crankcase Ventilation (PCV) Hose
15. Water Bypass Hose
16. Injection Pipe
17. Injection Pump Assembly
    Above works refer to “INJECTION PUMP ASSEMBLY” section in this manual.
18. Injection Pump Rubber Spacer (for 4HF1/4HG1-T)
19. Air Conditioning (A/C) Drive Belt (If equipped with A/C)

20. Idle Pulley Bracket (If equipped with A/C)
    After removal of the A/C drive belt, remove the 3 bracket fixing bolts. Then, remove the bracket with the tensioner and the idler attached.


N6A0289E

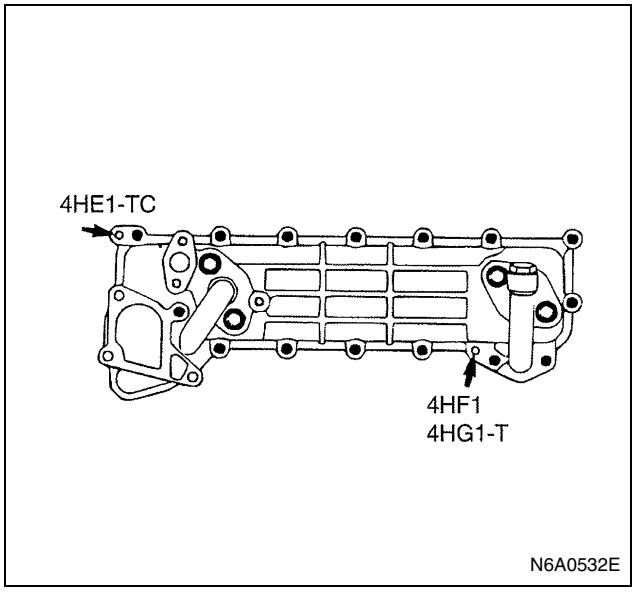
21. Heater Hose
22. Radiator Lower Hose
23. Heater Pipe



N6A0290E

Legend
A. 4HF1-2

24. Water Suction Pipe
25. Oil Cooler Assembly
    1) Remove the oil cooler bolts.
    2) Install a oil cooler fixing bolt to the oil cooler replace hole as shown in the illustration, and tighten the bolt alternately a little at a time.



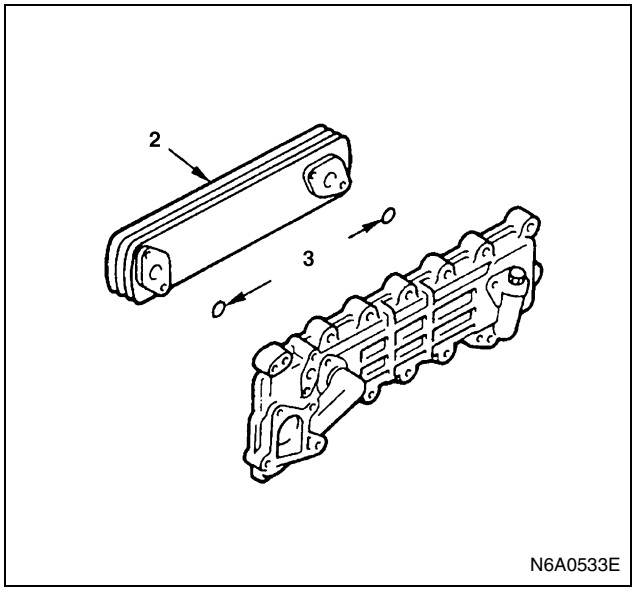
N6A0532E

26. O-Ring

Disassembly

(Oil Cooler Assembly)

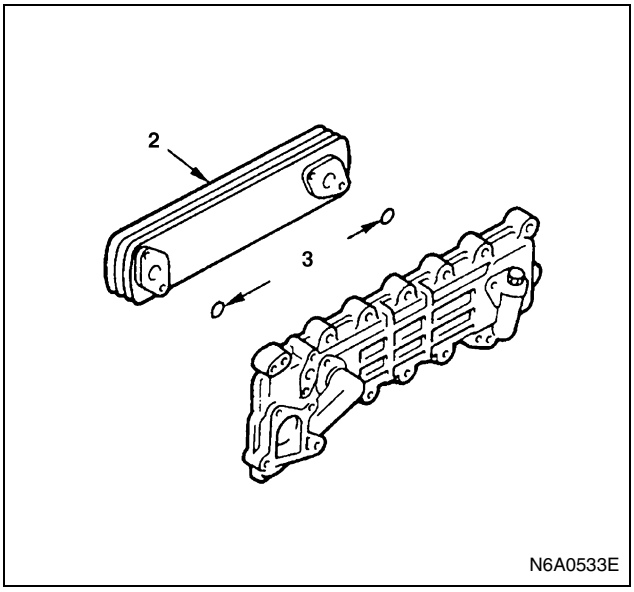
1. Element fixing bolts
2. Element
3. O-Ring



N6A0533E

Reassembly

1. O-Ring
   Apply a coat of engine oil to the O-rings and install the O-rings the oil cooler.
2. Element



Legend
2. Element
3. O-ring

3. Element fixing bolts

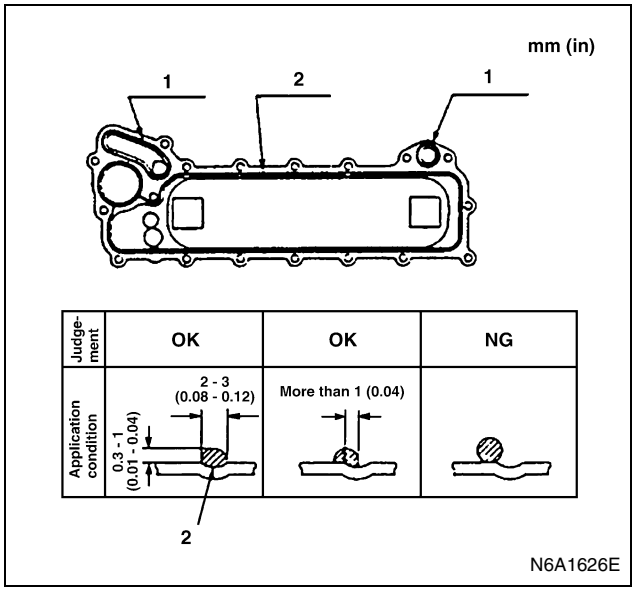
Tighten:
Element fixing bolts to 20 N·m (2.0 kg·m/14 lb·ft)

Installation

1. O-Ring
2. Oil Cooler Assembly
   1) Apply 2 — 3 mm (0.08 — 0.12 in) bead of the recommended liquid gasket (Three Bond 1207C) or its equivalent on the oil cooler fitting surface.
   2) Apply a coat of engine oil to the O-rings (2 pieces) and install the O-rings to the oil cooler.

Notice:
Take care that the O-ring is not smeared with liquid gasket.

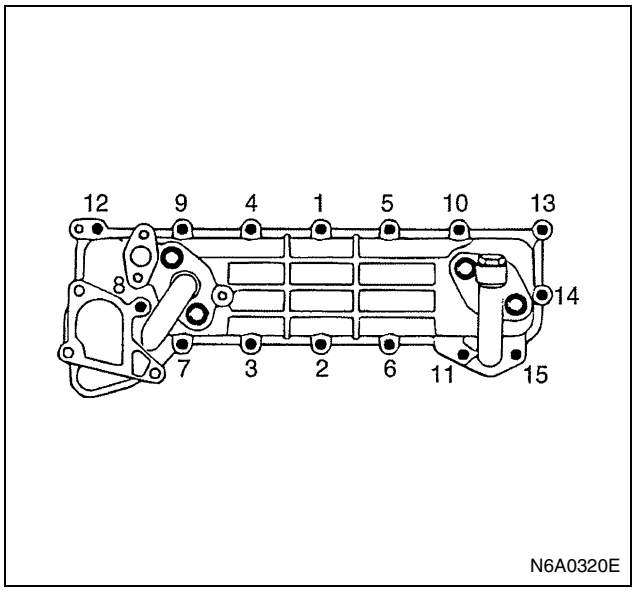
- Install the oil cooler within 7 minutes after application of liquid gasket.
- For the dislocation of liquid gasket, refer to the illustration.



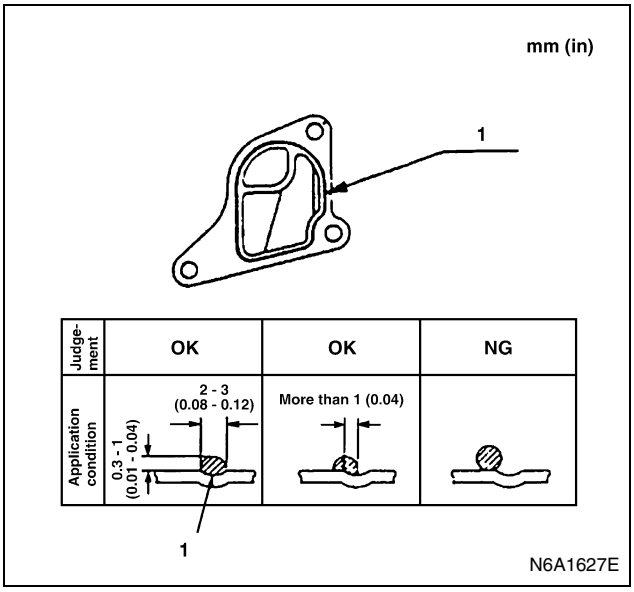
Legend
1. O-ring
2. Liquid gasket

3) Tighten the oil cooler bolts and nut to the specified torque a little at a time in the sequence shown in the illustration.

Tighten:
Oil cooler bolt and nut to 24 N·m (2.4 kg·m/17 lb·ft)



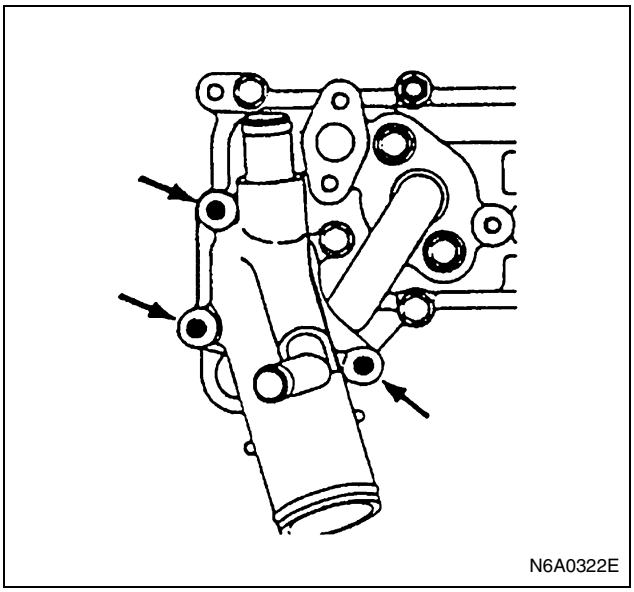
3. Water Suction Pipe
   1) Apply 2 — 3 mm (0.08 — 0.12 in) bead of the recommended liquid gasket (Three Bond 1207C) or its equivalent on the groove of the water suction pipe fitting surface.
   2) Install the water suction pipe to the oil cooler.
   - For the dislocation of liquid gasket, refer to the illustration.



Legend
1. Liquid gasket

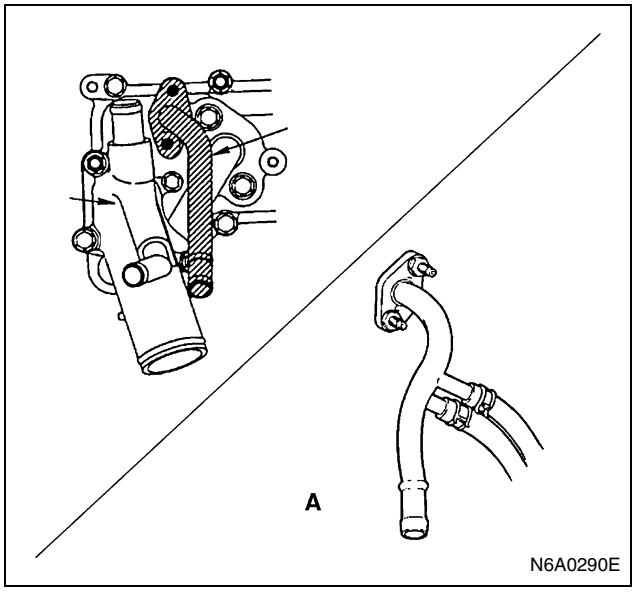
Tighten:
Water suction pipe bolt to 24 N·m (2.4 kg·m/17 lb·ft)

Notice:
Install the water suction pipe immediately after the installation of the oil cooler.



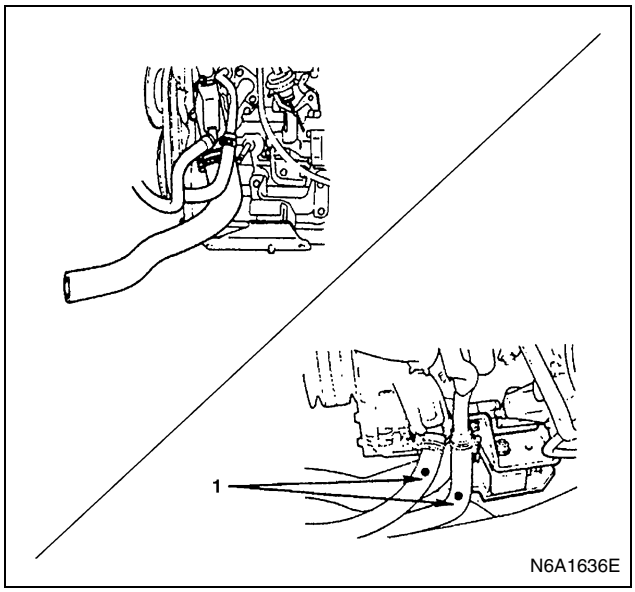
4. Heater Pipe
   1) Install the O-ring to the heater pipe.
   2) Install the heater pipe to the oil cooler.

Tighten:
Heater pipe bolt to 24 N·m (2.4 kg·m/17 lb·ft)



Legend
A. 4HF1-2

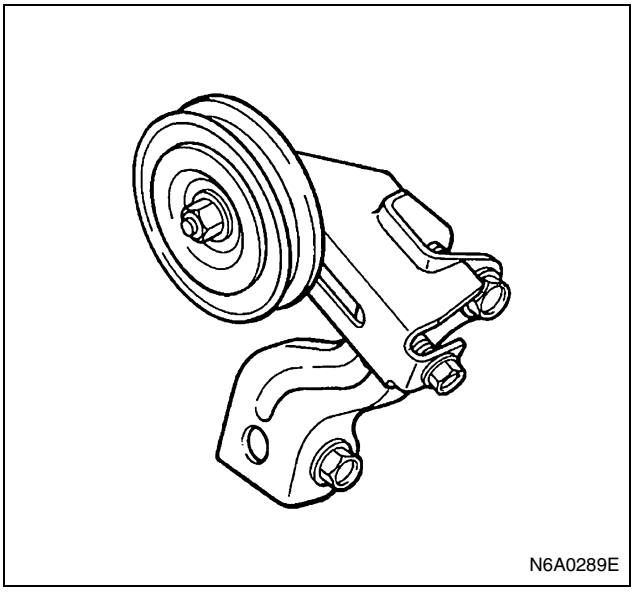
5. Radiator Lower Hose
6. Heater Hose



Legend
1. Mark

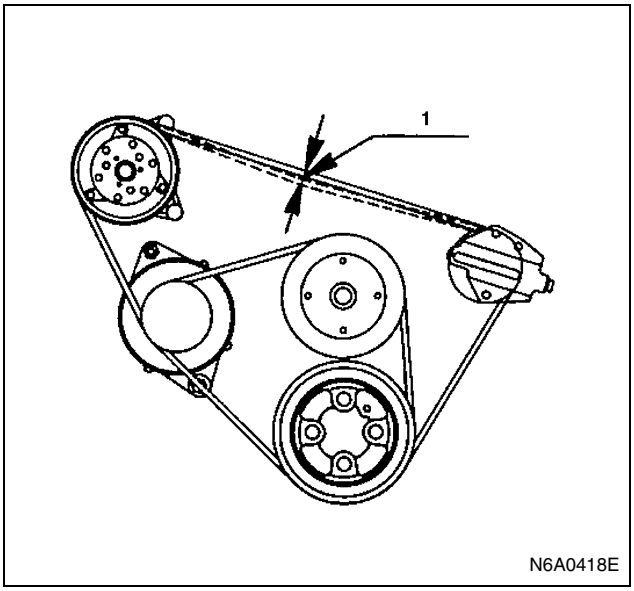
7. Idle Pulley Bracket (If equipped with A/C)

Tighten:
Idle pulley bracket bolt to 48 N·m (4.9 kg·m/35 lb·ft)


N6A0289E

8. Air Conditioning (A/C) Drive Belt (If equipped with A/C)
   - Install drive belt adjust belt tension by adjusting bolt and tighten locking nut to the specified torque.
   - Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

Drive Belt Deflection	mm (in)
16 — 20 (0.63 — 0.79) ... New belt 18 — 22 (0.71 — 0.87) ... Reuse belt	



N6A0418E

Legend
1. Belt deflection

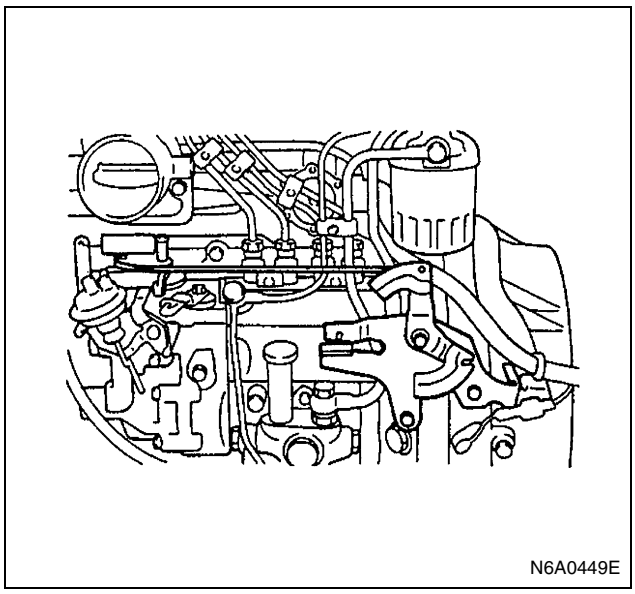
Tighten:
Locking nut to 27 N·m (2.8 kg·m/20 lb·ft)

9. Injection Pump Rubber Spacer (4HF1/4HG1-T)
10. Injection Pump Assembly
11. Injection Pipe
12. Water Bypass Hose
13. Positive Crankcase Ventilation (PCV) Hose
14. Fuel Pipe
15. Leak Off Pipe
16. Nozzle Cover
17. Fuel Feed Hose
18. Fuel Return Hose

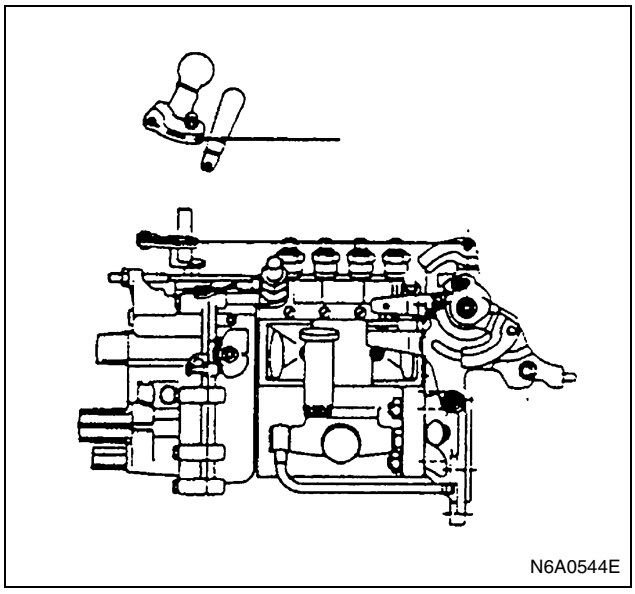
Air Bleeding
Above works refer to “INJECTION PUMP ASSEMBLY” section in this manual.

19. Oil Pipe
20. Engine Control Lever Assembly

Tighten:
Engine control lever bolt to 24 N·m (2.4 kg·m/17 lb·ft)

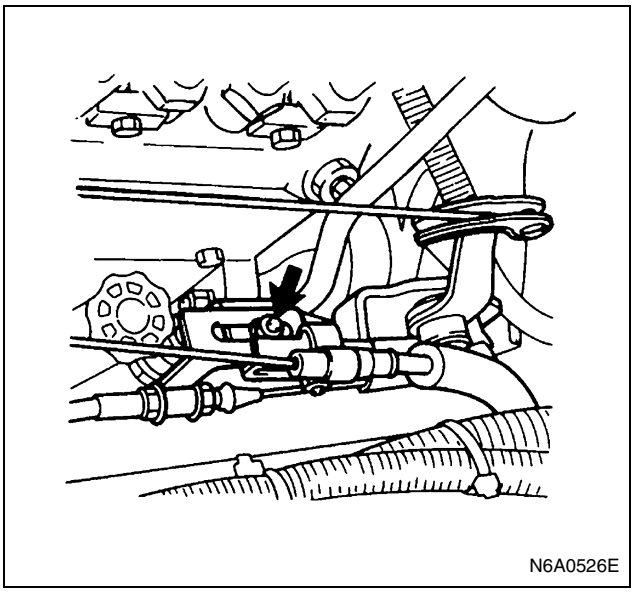

N6A0449E

21. Engine Control Cable

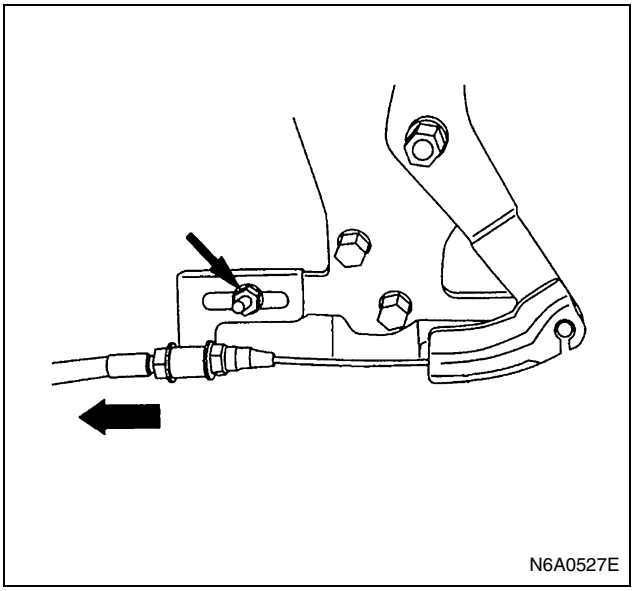

N6A0544E

22. Accelerator Control Cable
    1) Check to see if the idling control knob is turned to the utmost limit to the left.

2) Install the end tip of the cable to the engine control lever.
3) With the outer cable pulled toward the front of the vehicle, provide the engine control wire and the inner cable with the appropriate play. Then, fasten the clamp with a nut.

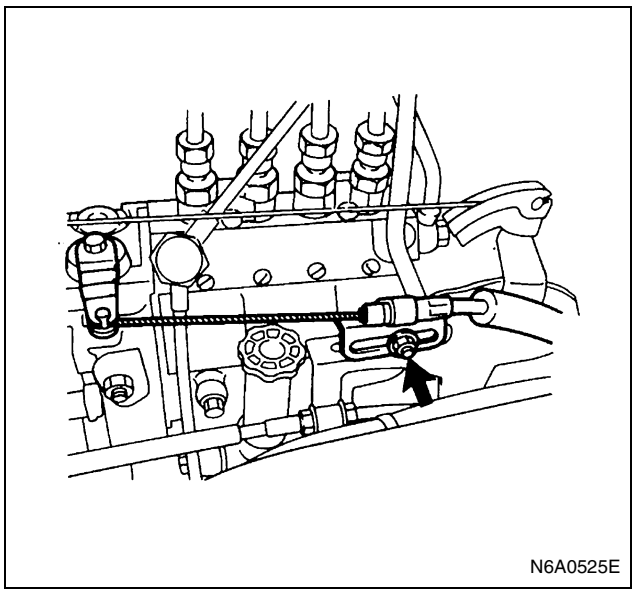

N6A0526E

For 4HE1-TC

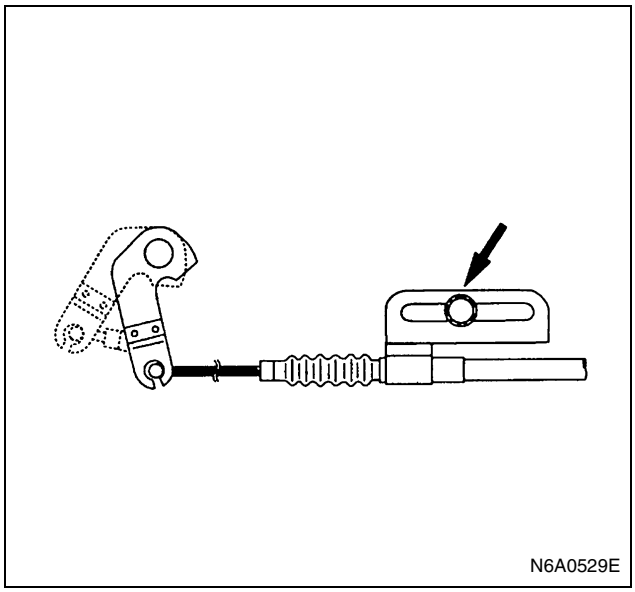

N6A0527E

4) Check to see if the control lever of the injection pump is set at the idling position (with the lever attached to the stopper bolt).

23. Engine Stop Cable
    1) Install the end tip of the cable to the engine stop lever.
    2) Pull the cable toward the rear of the vehicle, and fasten the clamp with a nut at the position where the lever stops.

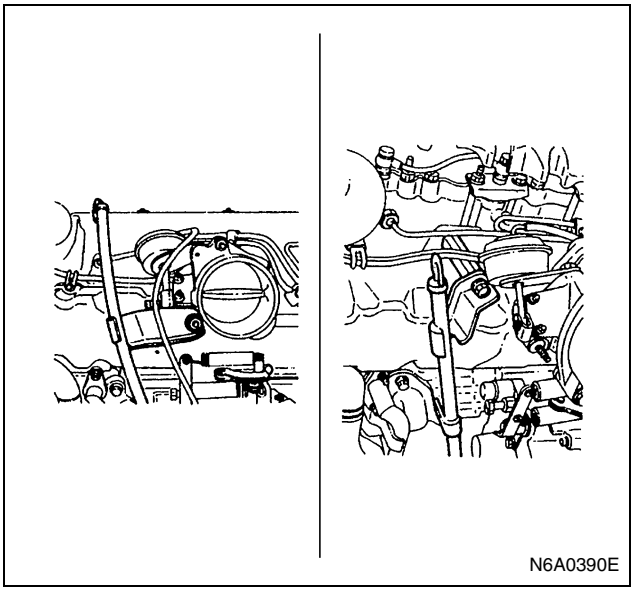

N6A0525E

For 4HE1-TC


N6A0529E

24. Intake Air Duct
25. Oil Level Gauge Guide Tube
    1) Install the O-rings to the guide tube lower portion and insert the guide tube completely to the cylinder body.
    2) Tighten the guide tube bolt to the specified torque.

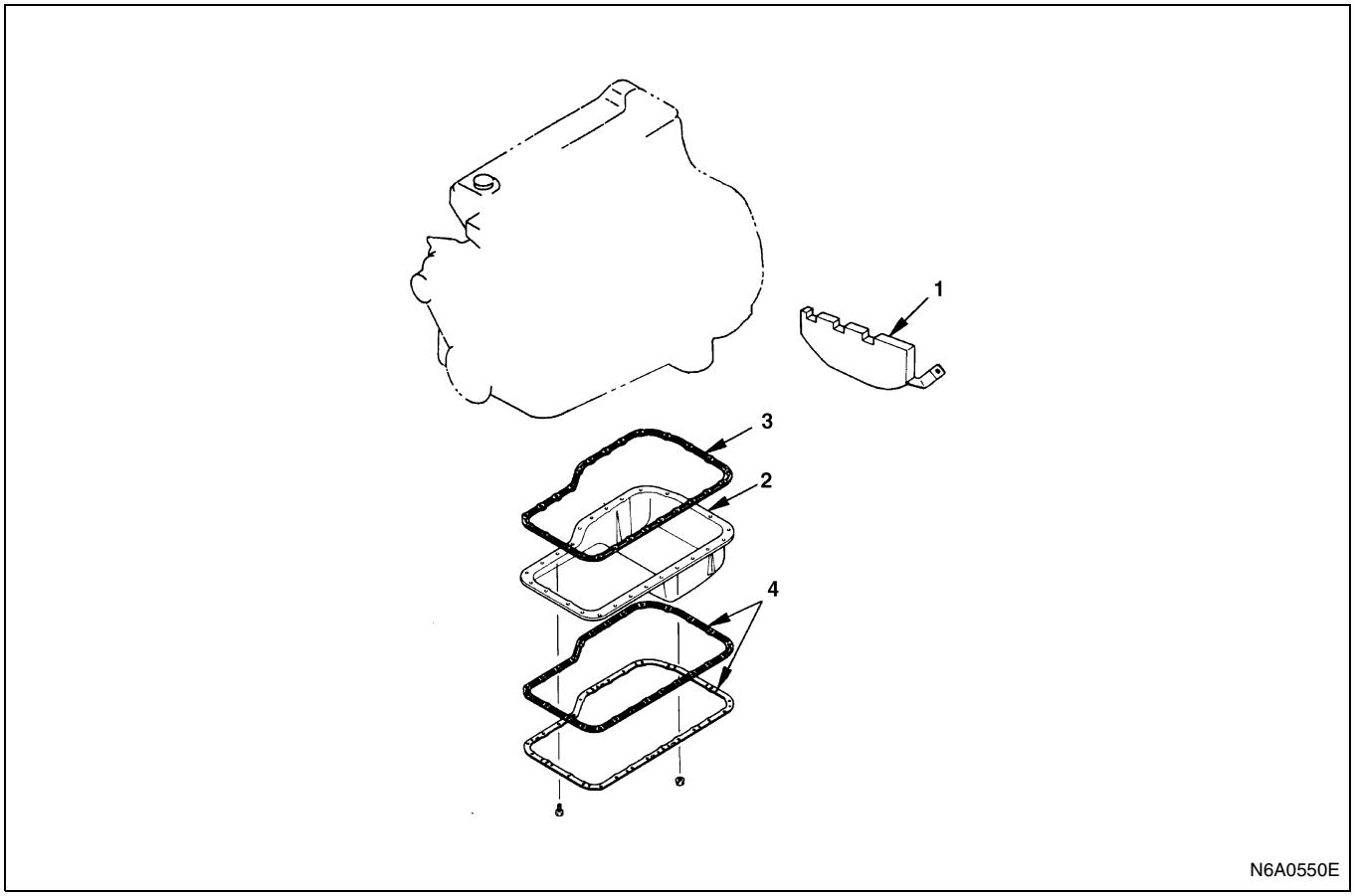
Tighten:
Guide tube bolt to 13 N·m (1.3 kg·m/113 lb·in)



26. Vacuum Hose
    - Pour coolant into radiator.
    - Connect battery ground cable.
    - Start engine and check for oil and water leakage carefully.

OIL PAN

Component



Legend

1. Spacer rubber
2. Oil pan
3. Gasket
4. Rubber assembly

Removal

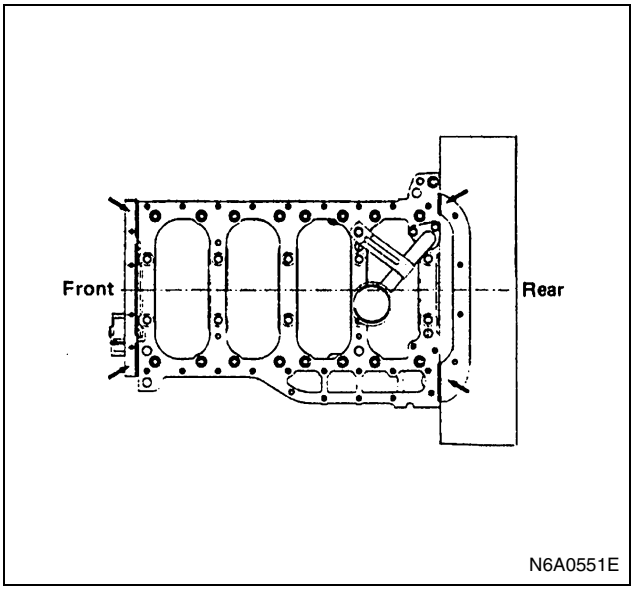
Preparation

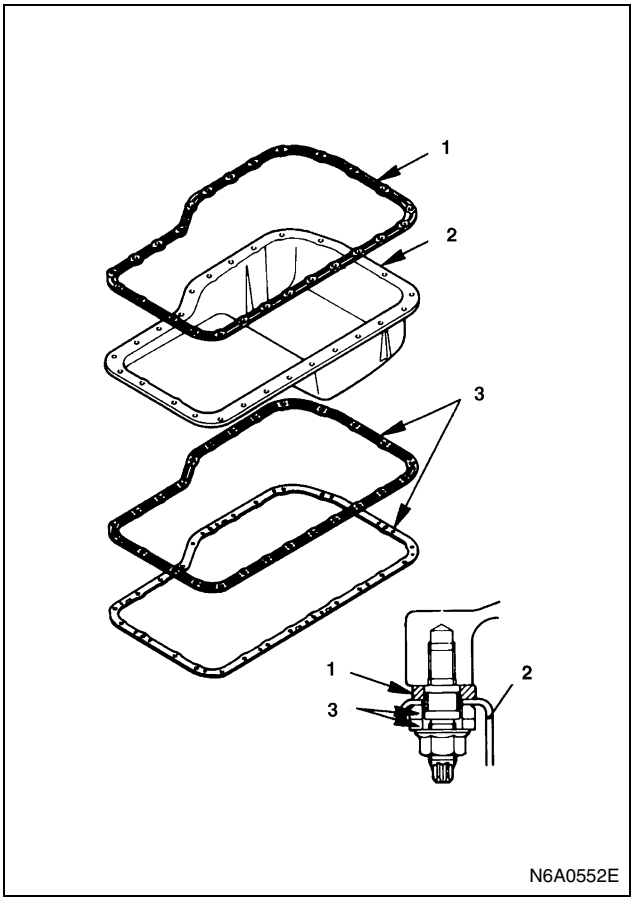
- Disconnect battery ground cable
- Lift up car
- Drain engine oil

1. Spacer Rubber
   - Remove the stiffener before removing the spacer rubber.
2. Oil Pan

Installation

1. Oil Pan
   1) Apply a 3 mm (0.12 in) bead of recommended liquid gasket (Three Bond 1207C) or its equivalent to the shaded areas shown in the illustration.



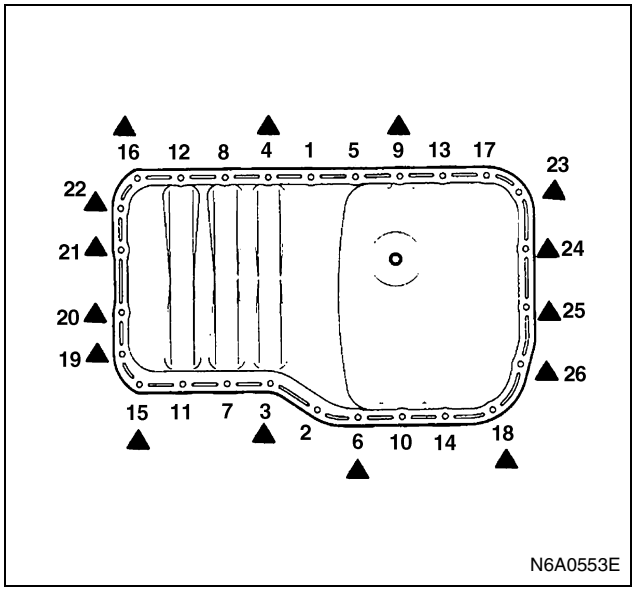


Legend
1. Gasket
2. Oil pan
3. Rubber assembly

2) Tighten the oil pan nuts and bolts to the specified torque in the numerical order as shown in the illustration.
▲marks are located on nut positions.

Tighten:
Oil Pan nuts and bolts to 11 N·m (1.1 kg·m/8 lb·ft)

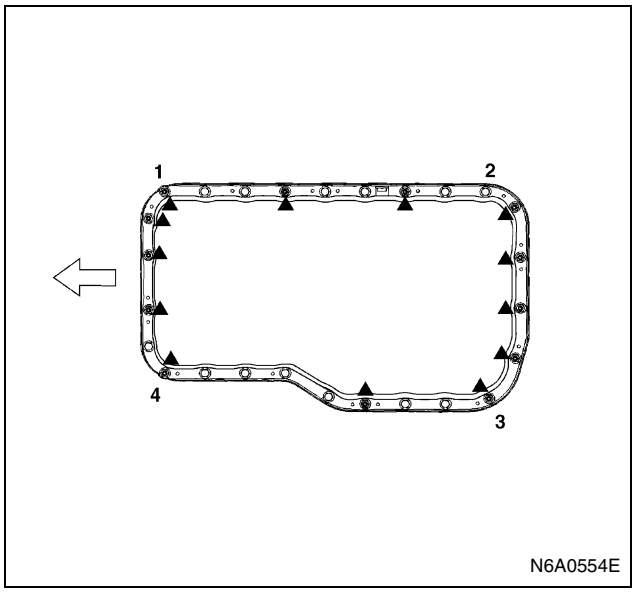
Except 4HE1-TC



- Tighten bolts (1), (2), (3), and (4) in numerical order.
- Tighten the remaining bolts (numerical order is not requred).

Tighten:
Oil pan nuts and bolts to 11 N·m (1.1 kg·m/8 lb·ft)

For 4HE1-TC

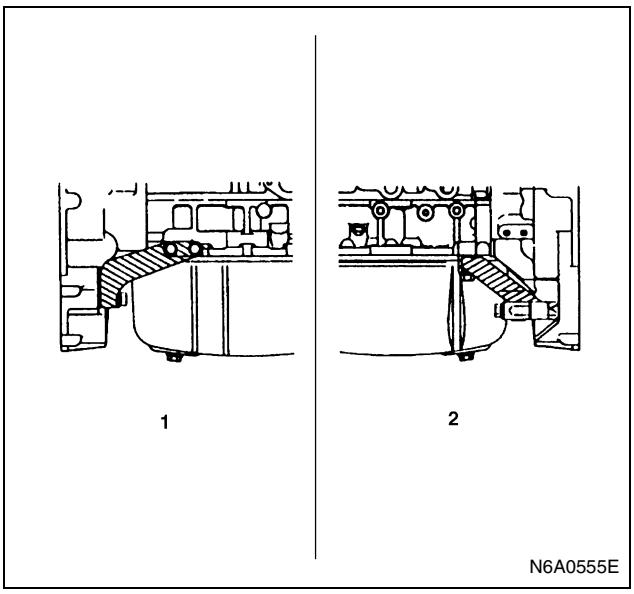


2. Spacer Rubber

Tighten:
Spacer rubber bolts to 76 N·m (7.7 kg·m/56 lb·ft)

- Tighten the spacer rubber together with the stiffener.

Tighten:
Spacer rubber bolts to
- Cylinder body RH side: 48 N·m (4.9 kg·m/35 lb·ft)
- Cylinder body LH side: 128 N·m (12.9 kg·m/93 lb·ft)
- Flywheel housing side: 76 N·m (7.7 kg·m/56 lb·ft)



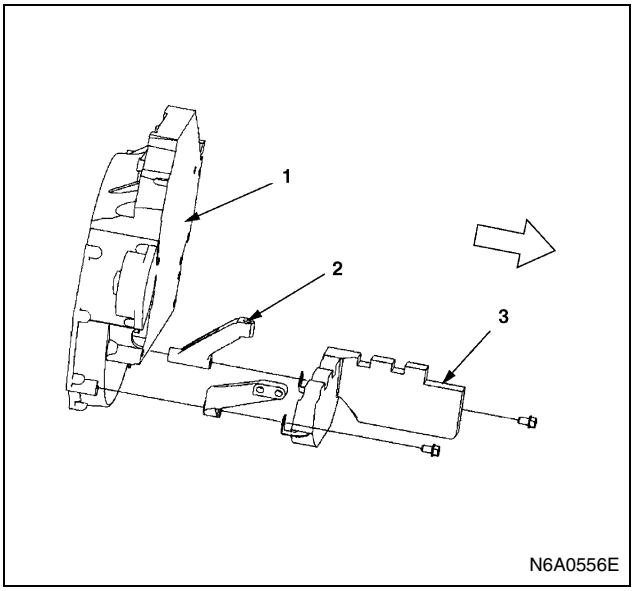
Legend
1. Right side
2. Left side

- 4HE1-TC engines use a larger rubber spacer than other engines.

Tighten:
Space rubber bolts to 76 N·m (7.7 kg·m/56 lb·ft)

- Install the rubber spacer to the bracket from the outside of the spacer. Tighten the stiffener together with the rubber spacer.

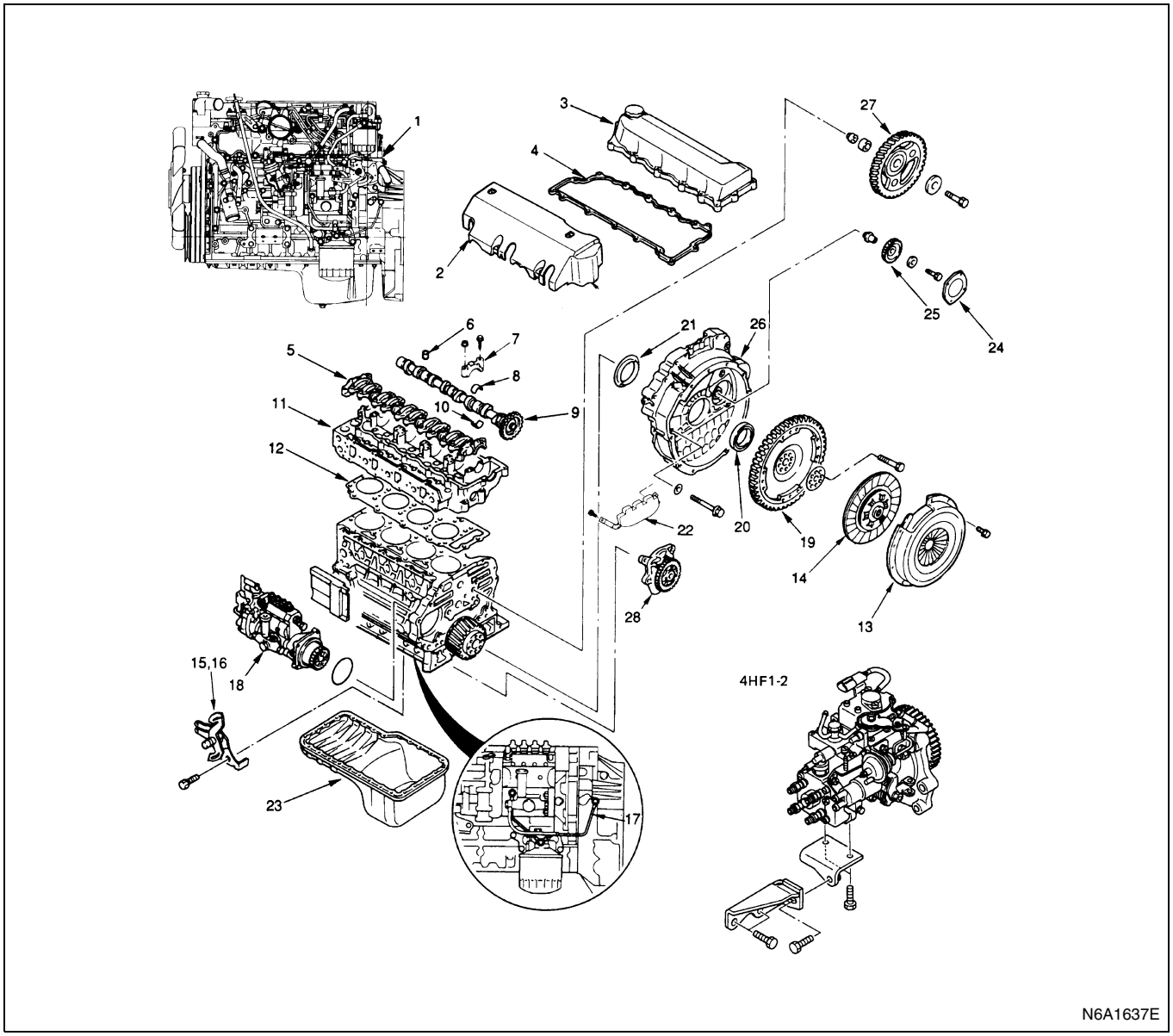
For 4HE1-TC



Legend
1. Flywheel housing
2. Stiffener
3. Space rubber

OIL PUMP ASSEMBLY

Component



Legend

1. Engine assembly
2. Nozzle cover
3. Cylinder head cover
4. Head cover gasket
5. Rocker arm shaft assembly
6. Valve cap
7. Camshaft bearing cap
8. Camshaft bearing upper
9. Camshaft assembly
10. Camshaft bearing lower
11. Cylinder head assembly
12. Cylinder head gasket
13. Clutch pressure plate assembly
14. Driven plate
15. Engine control wire
16. Engine control lever assembly
17. Oil pipe
18. Injection pump assembly
19. Flywheel
20. Rear oil seal
21. Slinger
22. Spacer rubber
23. Oil pan
24. Power steering pump idle gear cover
25. Power steering pump idle gear
26. Flywheel housing
27. Idle gear A
28. Oil pump assembly

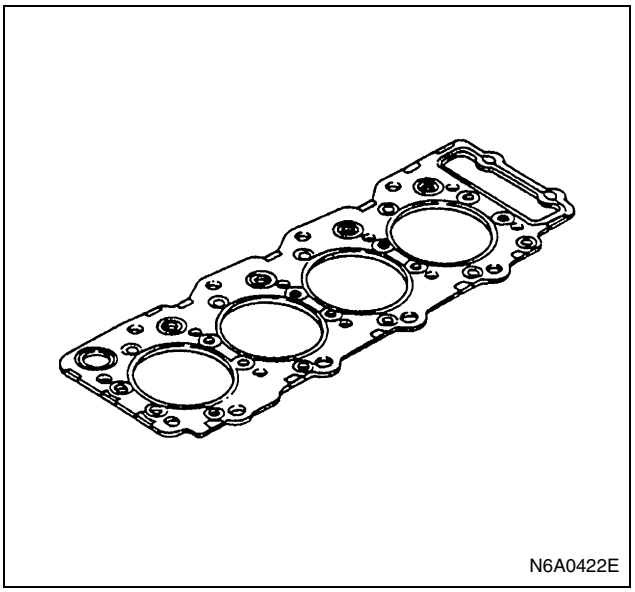
Removal

Preparation

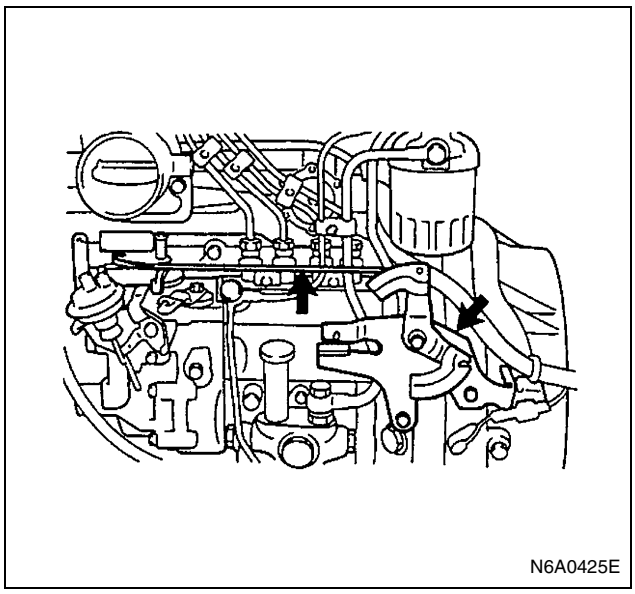
- Disconnect battery ground cable.
- Tilt the cab.
- Drain coolant and engine oil

1. Engine Assembly
   Above works refer to “ENGINE ASSEMBLY” section in this manual.
2. Nozzle Cover
3. Cylinder Head Cover
4. Head Cover Gasket
5. Rocker Arm Shaft Assembly
6. Valve Cap
7. Camshaft Bearing Cap
8. Camshaft Bearing Upper
9. Camshaft Assembly
10. Camshaft Bearing Lower
    Above works refer to “ROCKER ARM SHAFT ASSEMBLY AND CAMSHAFT ASSEMBLY” section in this manual.
11. Cylinder Head Assembly
    Above works refer to “CYLINDER HEAD” section in this manual.
12. Cylinder Head Gasket

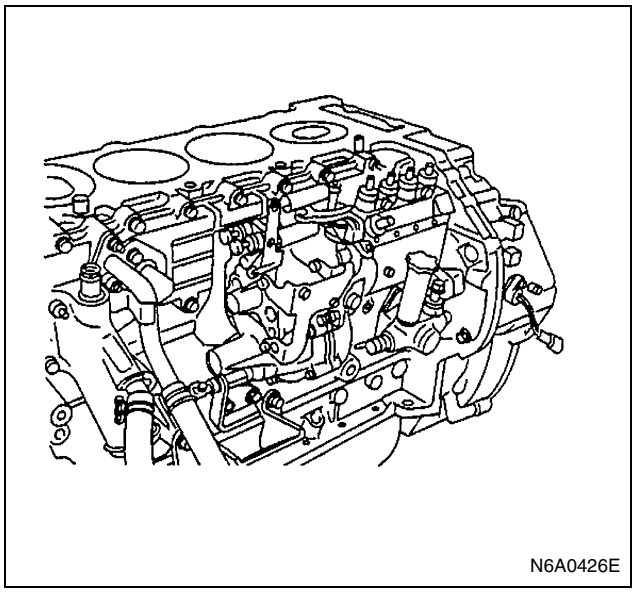
Caution:
Do not reuse the cylinder head gasket.


N6A0422E

13. Clutch Pressure Plate Assembly
14. Driven Plate
    Above works refer to “TIMING GEAR REPLACEMENT” section in this manual.
15. Engine Control Wire
16. Engine Control Lever Assembly

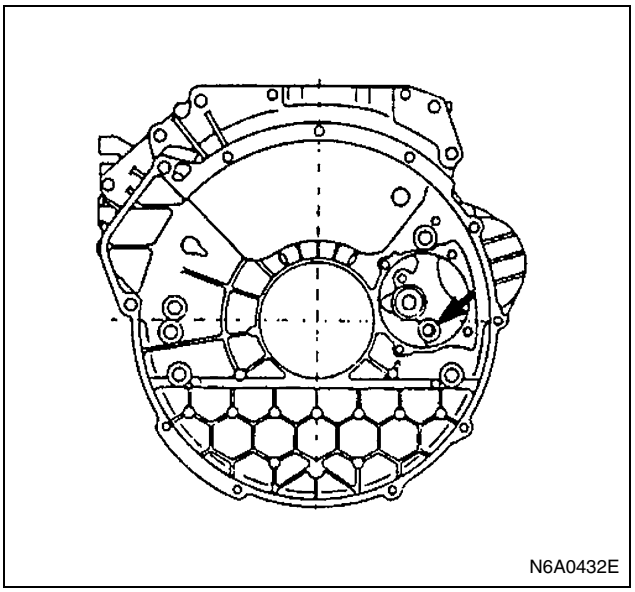

N6A0425E

17. Oil Pipe
18. Injection Pump Assembly
    1) Remove the injection pump bracket bolts and the injection pump rear bracket bolts.
    2) Then remove the injection pump assembly.

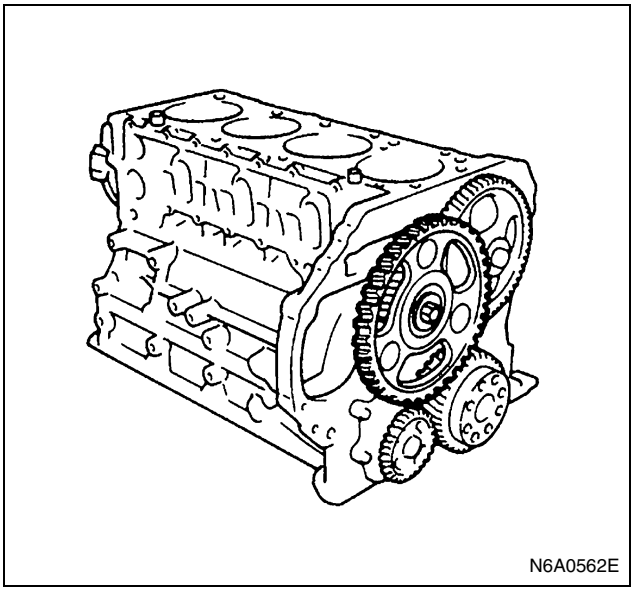

N6A0426E

19. Flywheel
20. Crankshaft Rear Oil Seal
21. Crankshaft Rear Slinger
    Above works refer to “CRANKSHAFT REAR OIL SEAL” section in this manual.
22. Spacer Rubber
    Remove the stiffener before removing the spacer rubber.
23. Oil Pan
24. Power Steering Pump Idle Gear Cover
25. Power Steering Pump Idle Gear
26. Flywheel Housing

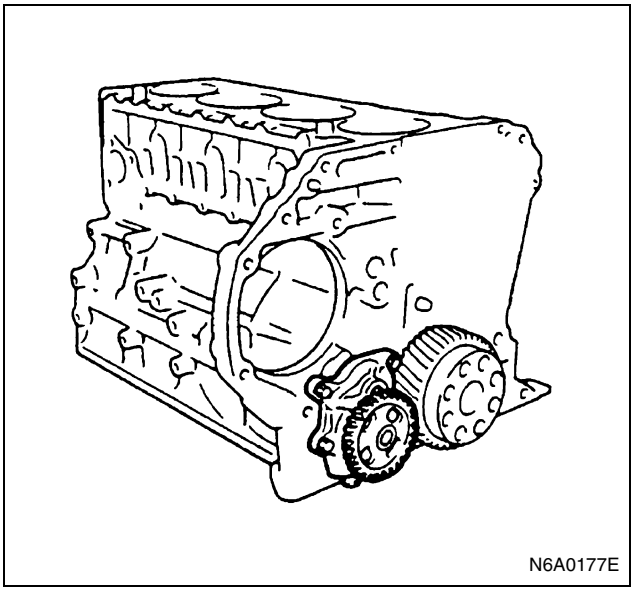
Notice:
Be careful not to fail to remove the bolts shown in the illustration.


N6A0432E

27. Idle Gear A


N6A0562E

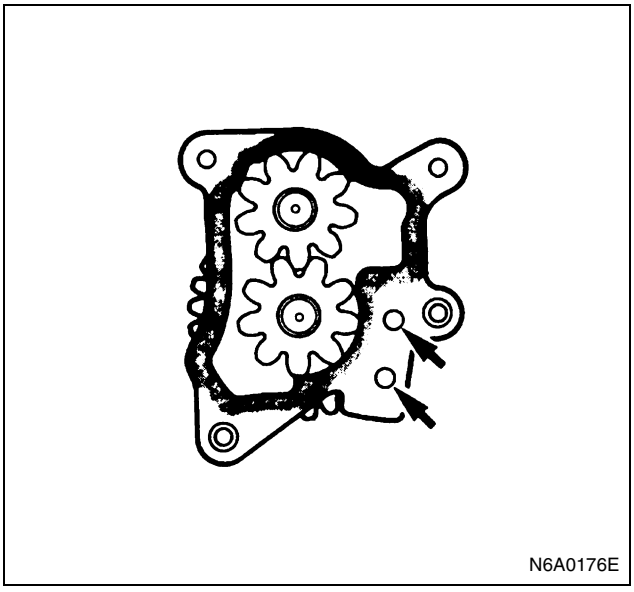
28. Oil Pump Assembly


N6A0177E

Installation

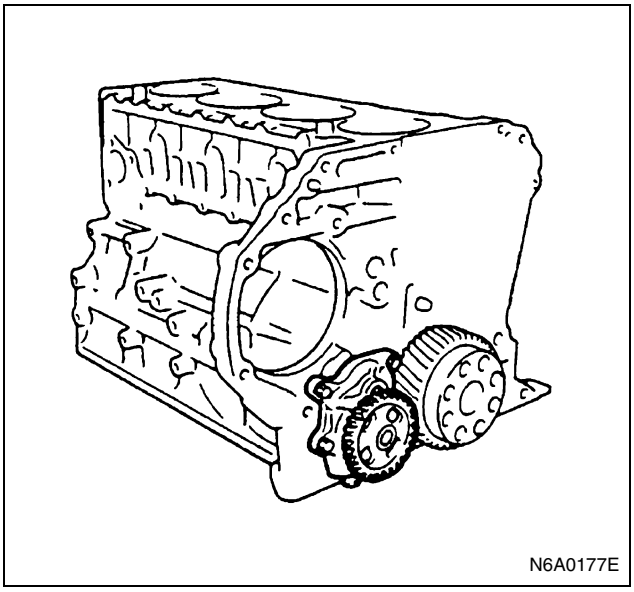
1. Oil Pump Assembly
   1) Carefully wipe any foreign material from the cylinder body rear surface.
   2) Apply the recommended liquid gasket (Three Bond 1141E) or its equivalent to the shaded areas shown in the illustration.

Caution:
Be careful that no liquid gasket gets into the holes in the arrow-marked portion in the illustration and the inside of the oil pump cover.

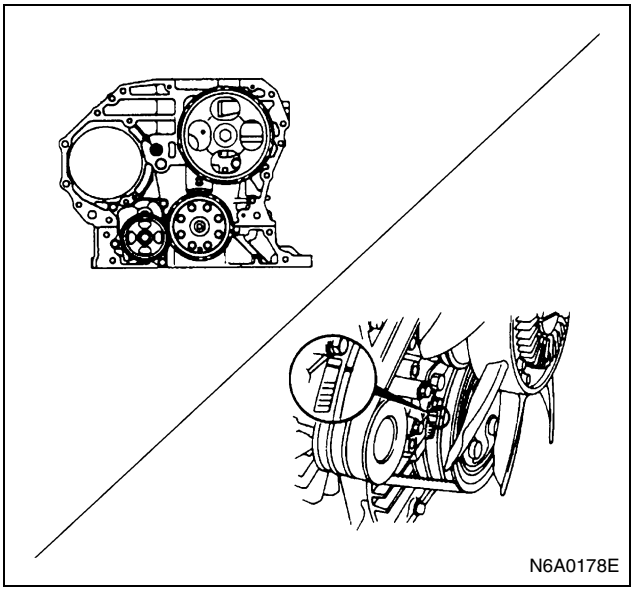

N6A0176E

   3) Install the oil pump to the cylinder body.
   4) Tighten the oil pump to the specified torque.

Tighten:
Oil pump bolt to 31 N·m (3.2 kg·m/23 lb·ft)

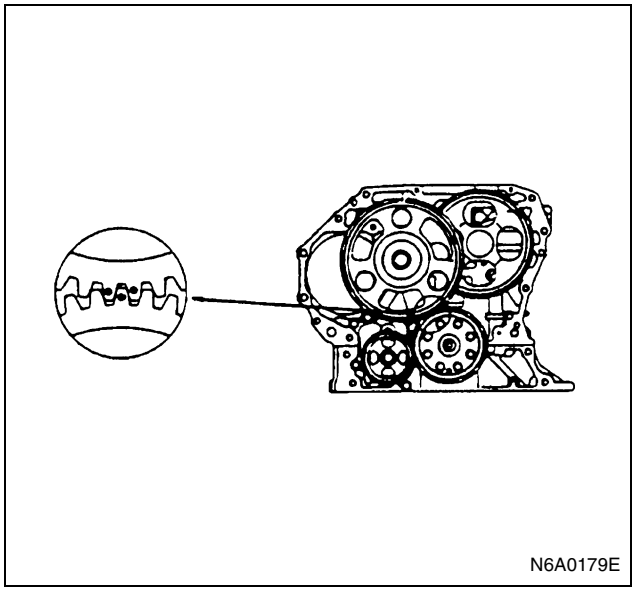

N6A0177E

2. Idle Gear A
   1) Turn the crankshaft clockwise so that the engagement mark of the crankshaft gear faces to the shaft center of the idle gear A and the No.1 cylinder piston comes to the top dead center.


N6A0178E

   2) Align the crankshaft gear with the engagement mark of the idle gear and install the idle gear A.

Tighten:
Idle gear A bolt to 133 N·m (13.6 kg·m/98 lb·ft)


N6A0179E

3. Flywheel Housing
4. Power Steering Pump Idle Gear
5. Power Steering Pump Idle Gear Cover
   Above works refer to “TIMING GEAR REPLACEMENT” section in this manual.
6. Oil Pan
7. Spacer Rubber
   Above works refer to “OIL PAN” section in this manual.
8. Crankshaft Rear Slinger
9. Crankshaft Rear Oil Seal
10. Flywheel
    Above works refer to “CRANKSHAFT REAR OIL SEAL” section in this manual.
11. Injection Pump Assembly
    Above works refer to “INJECTION PUMP ASSEMBLY” section in this manual.
12. Oil Pipe
13. Engine Control Lever Assembly
14. Engine Control Wire
    Above works refer to “INJECTION PUMP ASSEMBLY” section in this manual.
15. Driven Plate
16. Clutch Pressure Plate Assembly
    Above works refer to “TIMING GEAR REPLACEMENT” section in this manual.
17. Cylinder Head Gasket
    Above works refer to “CYLINDER HEAD” section in this manual.
18. Cylinder Head Assembly
    Above works refer to “CYLINDER HEAD” section in this manual.
19. Camshaft Bearing Lower
20. Camshaft Assembly
21. Camshaft Bearing Upper
22. Camshaft Bearing Cap
23. Valve Cap

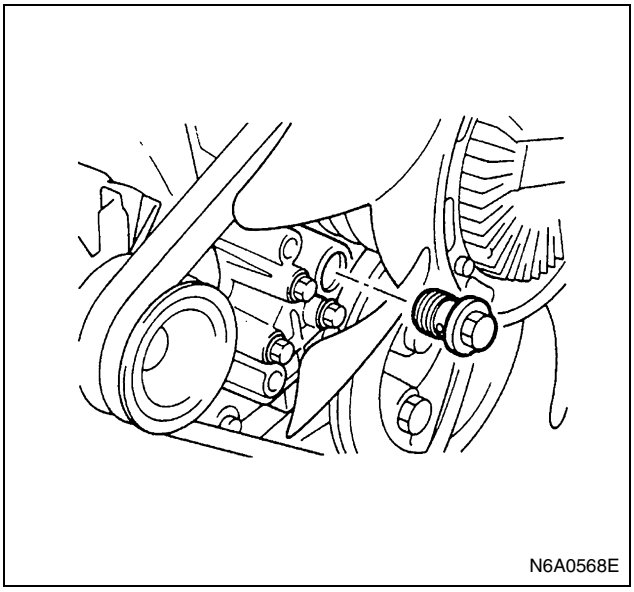
Above works refer to “CAMSHAFT ASSEMBLY” section in this manual.

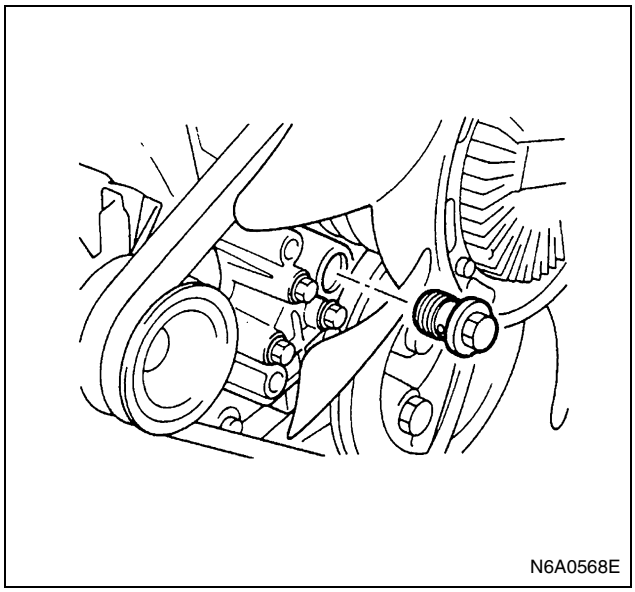
24. Rocker Arm Shaft Assembly
    Above works refer to “ROCKER ARM SHAFT ASSEMBLY” section in this manual.
25. Head Cover Gasket
26. Cylinder Head Cover
    Above works refer to “CYLINDER HEAD COVER” section in this manual.
27. Nozzle Cover
28. Engine Assembly
    Above works refer to “ENGINE ASSEMBLY” section in this manual.

OIL RELIEF VALVE

Removal

1. Oil Relief Valve





Inspection and Repair

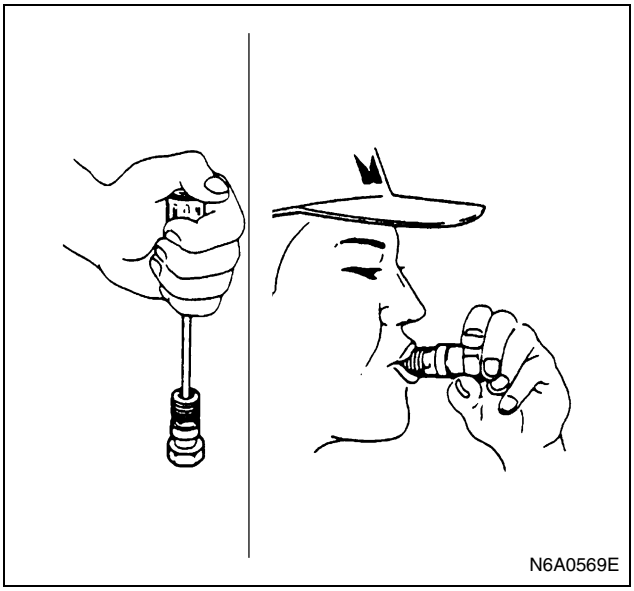
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Valve

Push the valve with a screwdriver to check it for binding. When the valve is binding, replace the relief valve with a new one.

Spring

Blow the valve and check it for air leak. When there is any air leak in the valve, replace it with a new one.



Installation

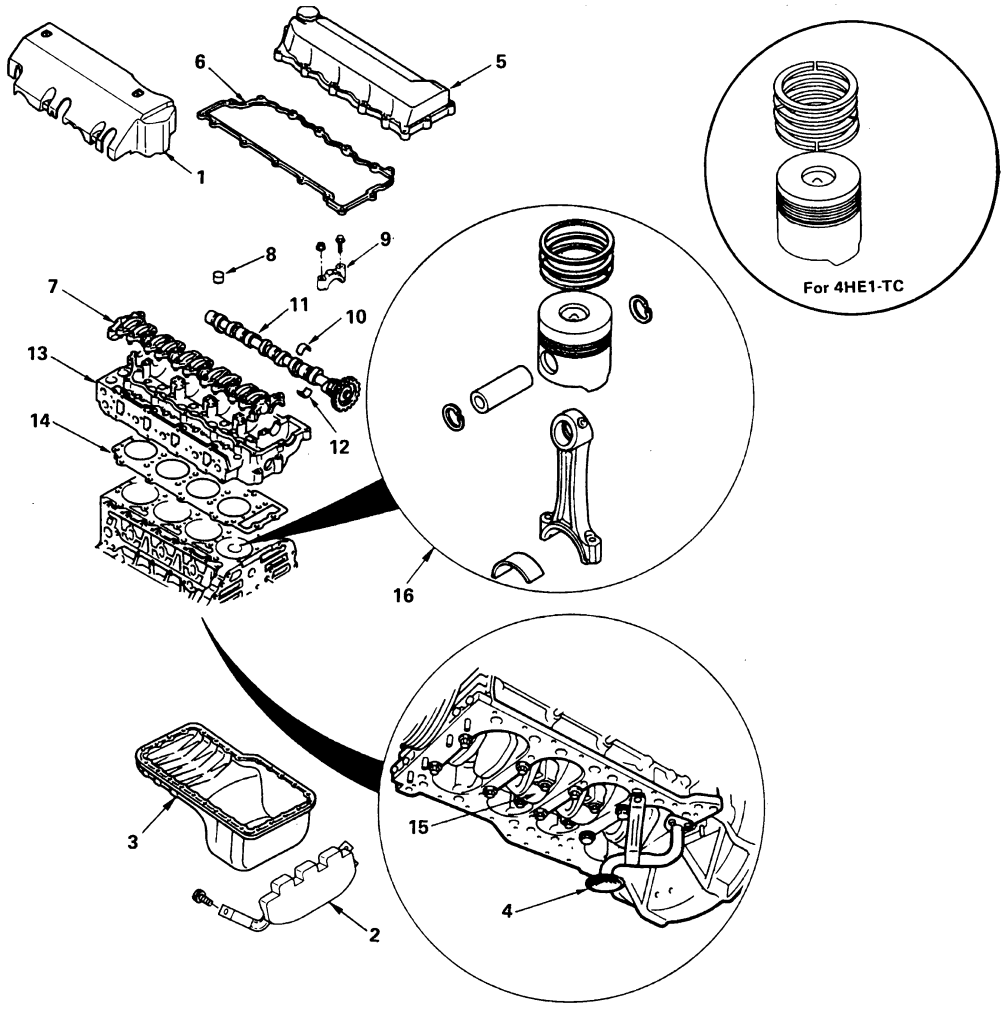
1. Oil Relief Valve

Tighten:

Oil relief valve to 39 N·m (4.0 kg·m/29 lb·ft)

PISTON, PISTON RING, PISTON PIN AND CONNECTING ROD

Component



Legend

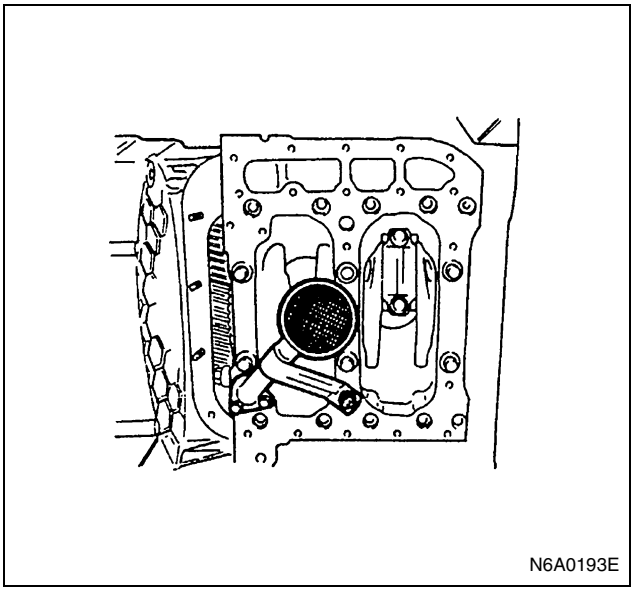
1. Nozzle cover
2. Spacer rubber
3. Oil pan
4. Oil pump strainer
5. Cylinder head cover
6. Cylinder head cover gasket
7. Rocker arm shaft assembly
8. Valve cap
9. Camshaft bearing cap
10. Camshaft bearing upper
11. Camshaft assembly
12. Camshaft bearing lower
13. Cylinder head assembly
14. Cylinder head gasket
15. Connecting rod cap
16. Piston and connecting rod assembly

Removal

Preparation

- Disconnect battery ground cable.
- Tilt the cab.
- Drain coolant and engine oil.

1. Nozzle Cover
2. Spacer Rubber
   Remove the stiffener before removing the spacer rubber.
3. Oil Pan
4. Oil Pump Strainer

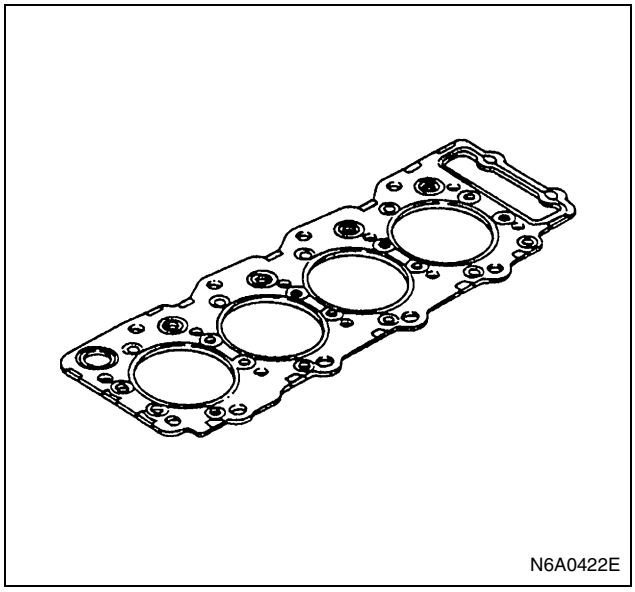

N6A0193E

5. Cylinder Head Cover
6. Cylinder Head Cover Gasket
7. Rocker Arm Shaft Assembly
   Above works refer to “ROCKER ARM SHAFT ASSEMBLY” section in this manual.
8. Valve Cap

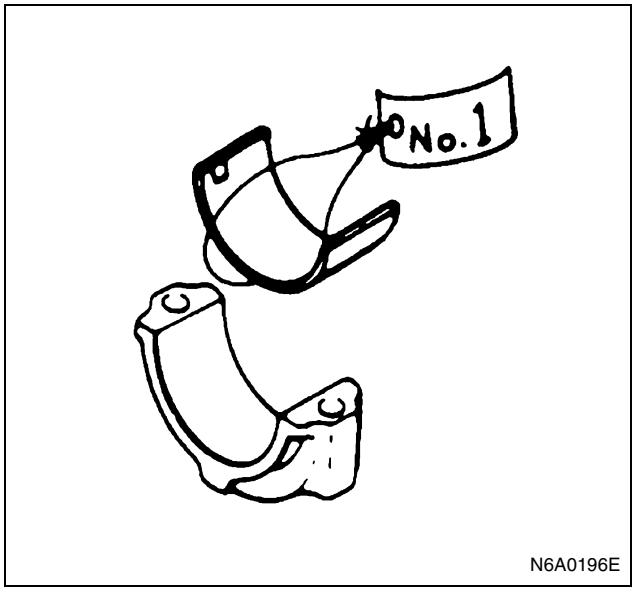
Caution:
Take sufficient care not to let valve caps fall into the gear case or oil return hole.

9. Camshaft Bearing Cap
10. Camshaft Bearing Upper
11. Camshaft Assembly
12. Camshaft Bearing Lower
    Above works refer to “CAMSHAFT ASSEMBLY” section in this manual.
13. Cylinder Head Assembly
    Above works refer to “CYLINDER HEAD” section in this manual.
14. Cylinder Head Gasket

Caution:
Do not reuse the cylinder head gasket.

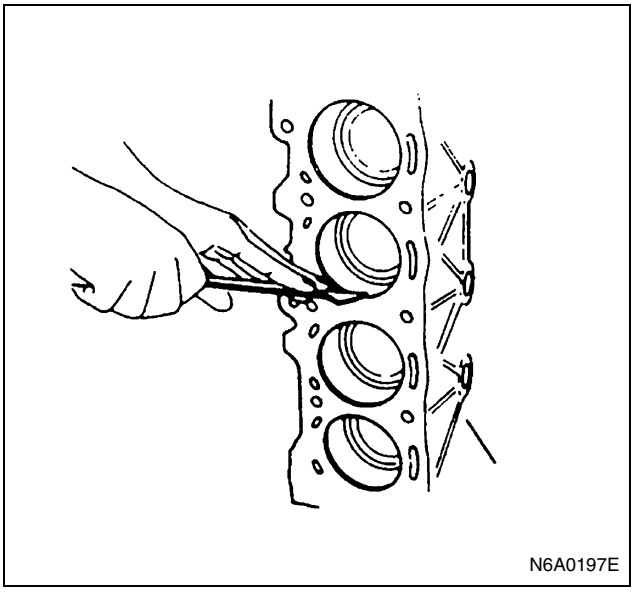

N6A0422E

15. Connecting Rod Cap
    1) Take out the connecting rod bearing cap bolts and remove the bearing cap with the lower bearing.
    2) If the connecting rod lower bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



N6A0196E

16. Piston and Connecting Rod Assembly
    1) To facilitate smooth removal of piston, remove carbon from the upper part of the cylinder wall using a scraper or equivalent.


N6A0197E

2) Remove the piston and connecting rod assembly upward by pushing on the edge of the connecting rod with a hammer handle or equivalent.
3) If the connecting rod bearing are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.

Caution:
Do not bend or damage the oiling jet.

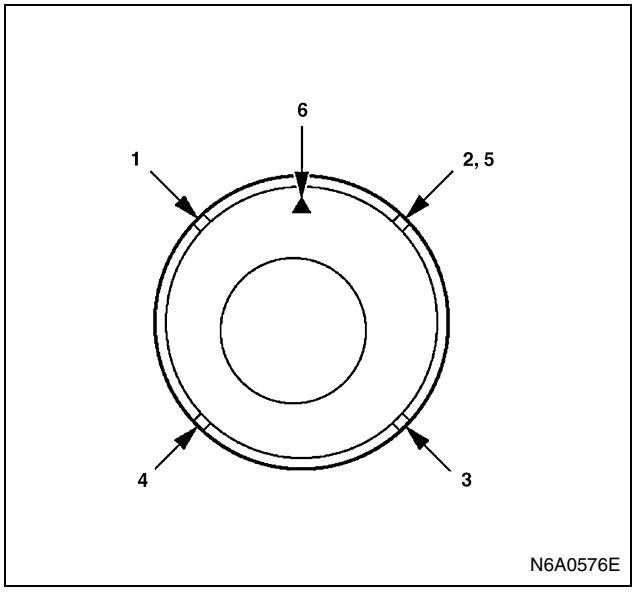
Notice:
When removing the piston and connecting rod assembly, pull the connecting rod in parallel with the cylinder bore.

Installation

1. Piston and Connecting Rod Assembly

Notice:
When installing new connecting rod and/or connecting rod bearings, refer to the selection table. Above works refer to “CRANKSHAFT” section 6A in this manual.

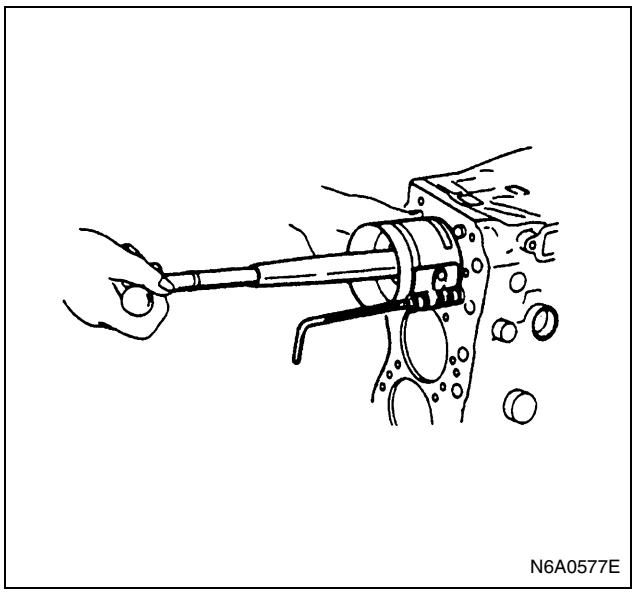
1) Apply a coat of engine oil to the circumference of each piston ring and piston.
2) Position the piston ring gaps as shown in the illustration.



N6A0576E

Legend
1. 1st compression ring
2. 2nd compression ring
3. 3rd compression ring (4HE1-TC only)
4. Oil ring
5. Coil expander
6. Front mark

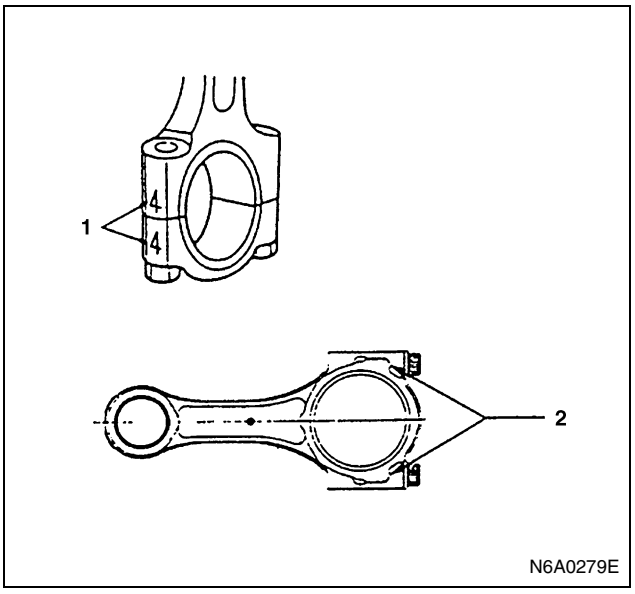
3) Apply a coat of molybdenum disulfide grease to the two piston skirts.
This will facilitate smooth break-in when the engine is first started after reassembly.
4) Apply a coat of engine oil to the upper bearing surfaces.
5) Apply a coat of engine oil to the cylinder wall.
6) Position the piston head front mark so that it is facing the front of the engine.
7) Use the piston ring compressor to compress the piston rings.
Piston Ring Compressor: 5-8840-9018-0


N6A0577E

8) Use a hammer grip to push the piston in until the connecting rod makes contact with the crankpin.
At the same time, rotate the crankshaft until the crankpin is at bottom dead center.

Caution:
Do not bend or damage the oiling jet.

2. Connecting Rod Cap
   1) Install the connecting rod bearing caps.
   2) Align the bearing cap cylinder number marks and the connecting rod cylinder number marks.
   3) Apply a coat of molybdenum disulfide grease to the threads and setting faces of each connecting rod cap bolts.

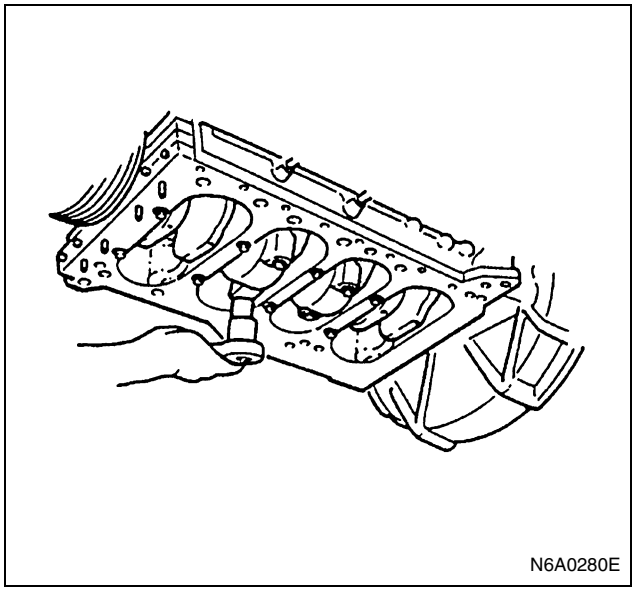


Legend
1. Alighment
2. Boss discriminating the front from rear

   4) Tighten the connecting rod caps to the specified torque.

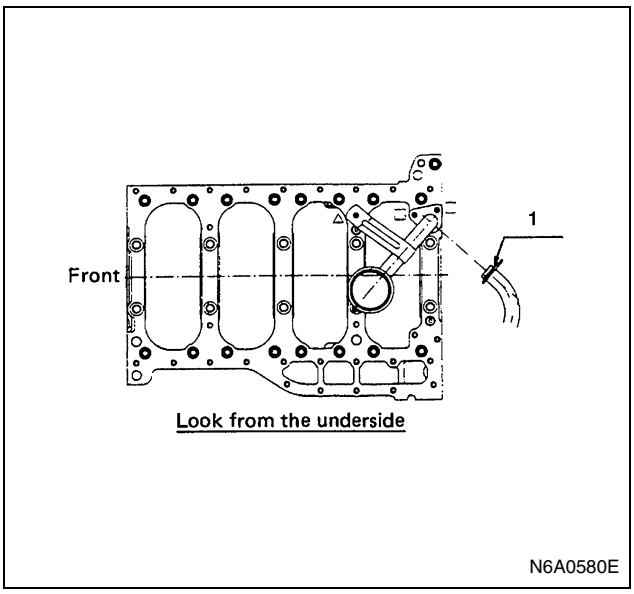
Tighten:
Connecting rod bearing cap bolt to
- 1st step: 39 N·m (4.0 kg·m/29 lb·ft)
- 2nd step: 60°
- 3rd step: 30°

Angle gauge: 5-8840-0266-0



3. Cylinder Head Gasket
   Above works refer to “CYLINDER HEAD” section in this manual.
4. Cylinder Head Assembly
   Above works refer to “CYLINDER HEAD” section in this manual.
5. Camshaft Bearing Lower
6. Camshaft Assembly
7. Camshaft Bearing Upper
8. Camshaft Bearing Cap
9. Valve Cap
   Above works refer to “CAMSHAFT ASSEMBLY” section in this manual.
10. Rocker Arm Shaft Assembly
    Above works refer to “ROCKER ARM SHAFT ASSEMBLY” section in this manual.
11. Cylinder Head Cover Gasket
    Above works refer to “CYLINDER HEAD” section in this manual.
12. Cylinder Head Cover
    Above works refer to “CYLINDER HEAD COVER” section in this manual.
13. Oil Pump Strainer
    Install the O-ring (1) to the oil pump strainer pipe and install the oil pump strainer to the cylinder body shown in the illustration.

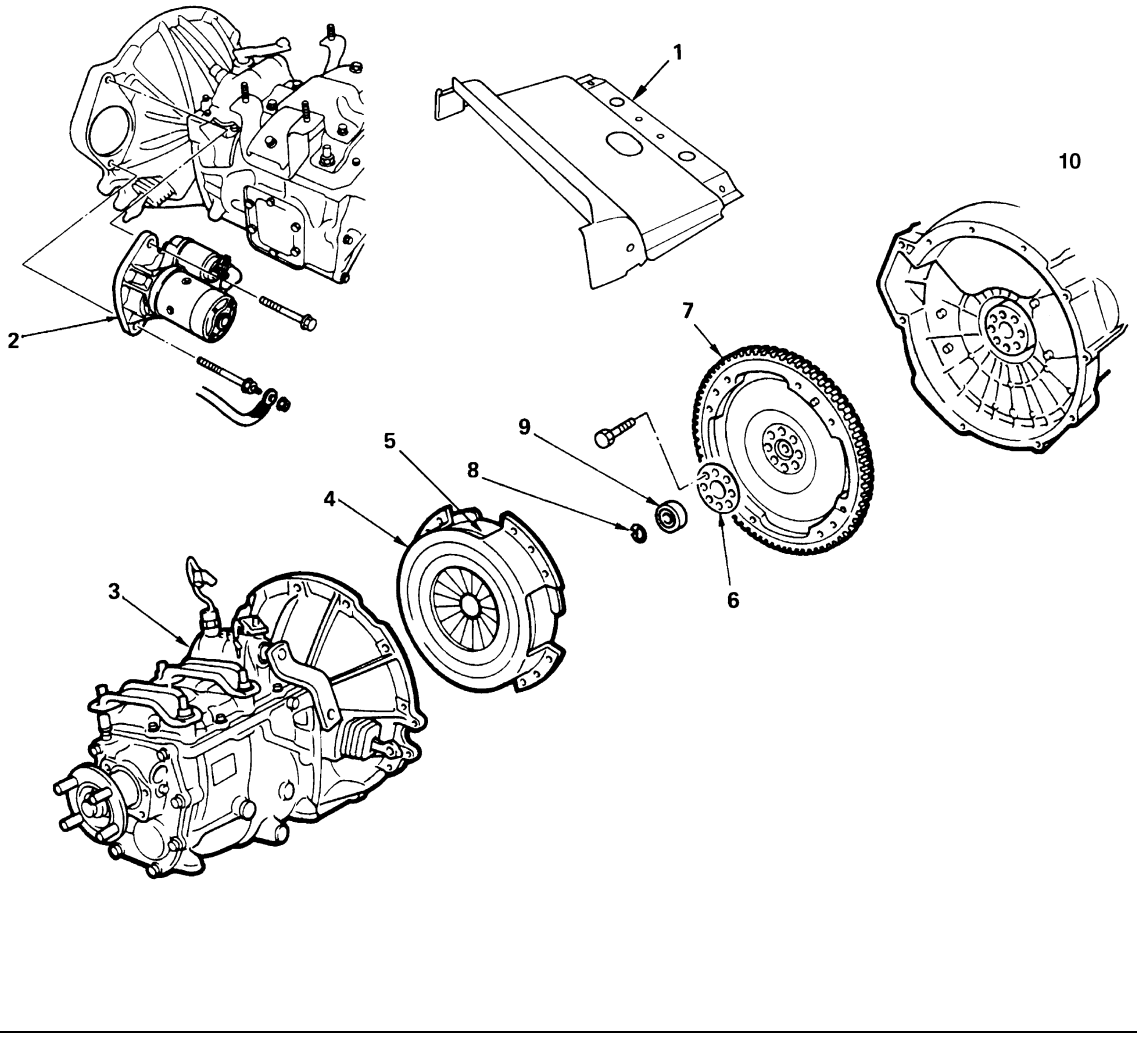
Tighten:
Oil pump strainer bolt to 24 N·m (2.4 kg·m/17 lb·ft)



14. Oil Pan
15. Spacer Rubber
    Above works refer to “OIL PAN” section in this manual.
16. Nozzle Cover
    - Pour engine oil and coolant into the engine
    - Connect battery ground cable
    - Start the engine and check for coolant and oil leakage

FLYWHEEL AND PILOT BEARING

Component



Legend

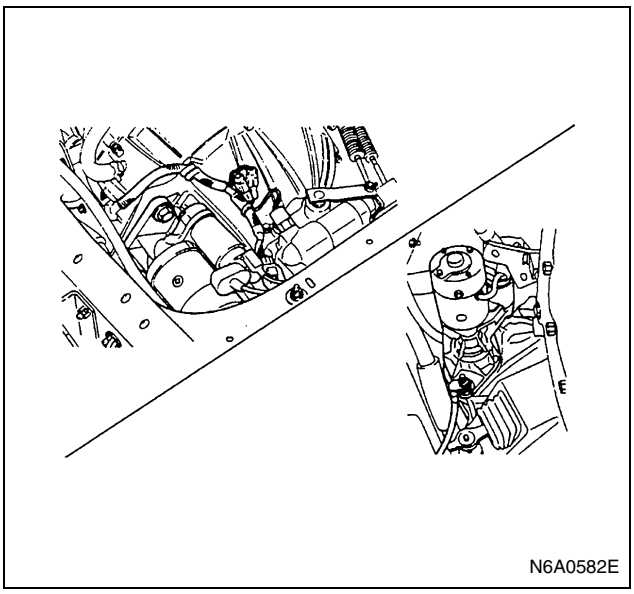
1. Transmission panel
2. Starter
3. Transmission assembly
4. Clutch pressure plate assembly
5. Driven plate
6. Washer
7. Flywheel assembly
8. Snap ring
9. Pilot bearing
10. Engine side

Removal

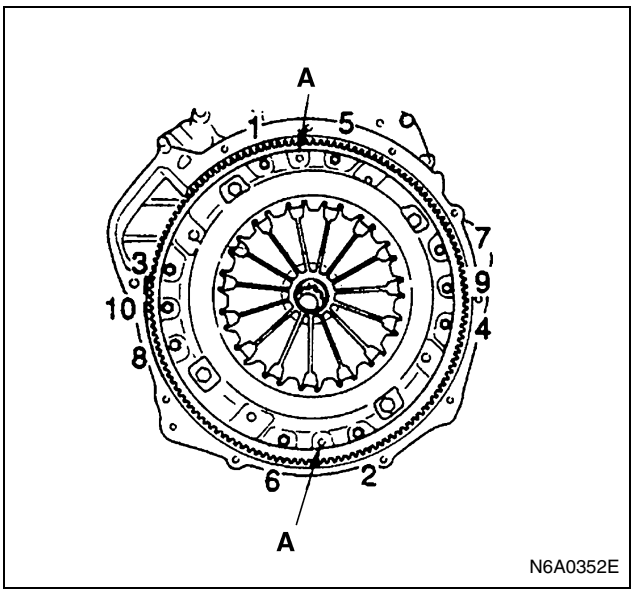
Preparation

- Disconnect battery ground cable.

1. Transmission Panel
2. Starter
   1) Disconnect the battery cable at the starter motor.
   2) Remove the starter assembly from flywheel housing.


N6A0582E

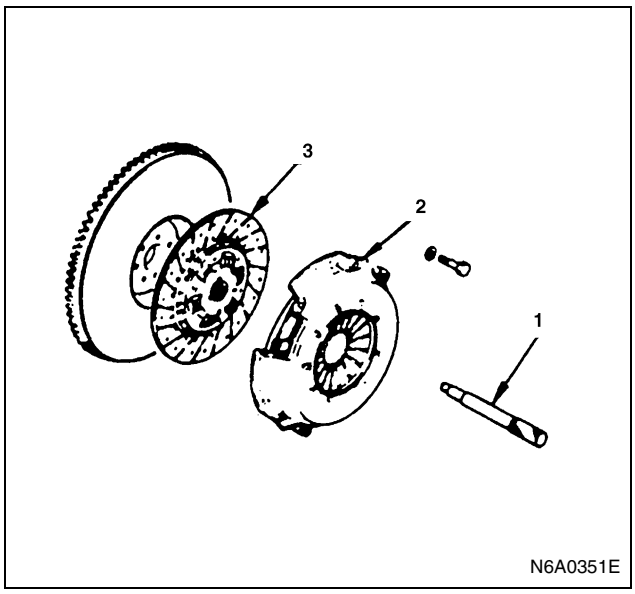
3. Transmission Assembly
   Above works refer to “ENGINE ASSEMBLY” section in this manual.
4. Clutch Pressure Plate Assembly
   1) Insert the clutch pilot aligner to the clutch assembly.
      Clutch Pilot Aligner: 5-8840-2240-0
   2) Loosen the pressure plate bolts in numerical order a little at a time as shown in the illustration.



N6A0352E

Legend
A. Knock pin

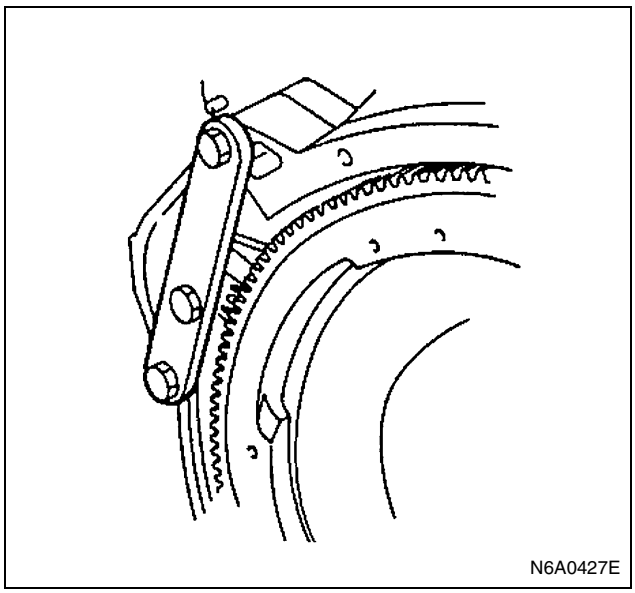
   3) Remove the pressure plate assembly.
5. Driven Plate
   Remove the driven plate with the clutch pilot aligner.



N6A0351E

Legend
1. Clutch pilot aligner
2. Clutch pressure plate assembly
3. Driven plate

6. Washer
7. Flywheel Assembly
   1) Use the crankshaft stopper to prevent the crankshaft from turning.
      Crankshaft Stopper: 5-8840-2230-0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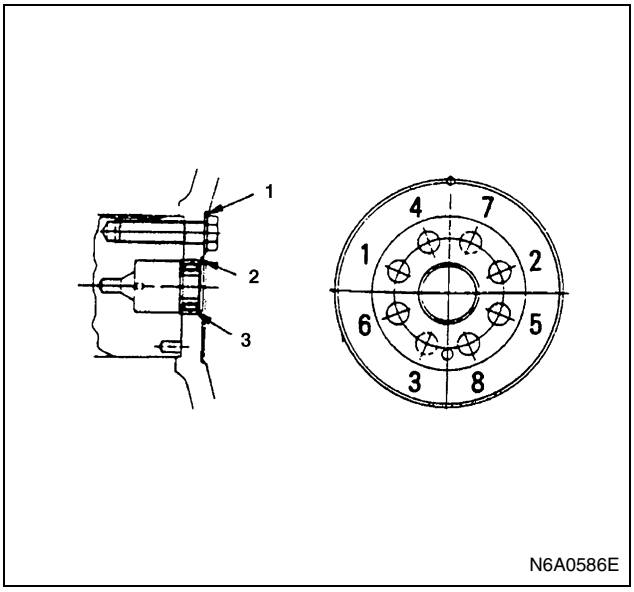
   2) Loosen the flywheel bolts in numerical order a little at a time as shown in the illustration.



N6A0586E

Legend
1. Washer
2. Snap ring
3. Pilot bearing

3) Remove the flywheel stopper and the flywheel assembly.

8. Snap Ring
   Use a snap ring pliers to remove the snap ring from the flywheel.
9. Pilot Bearing

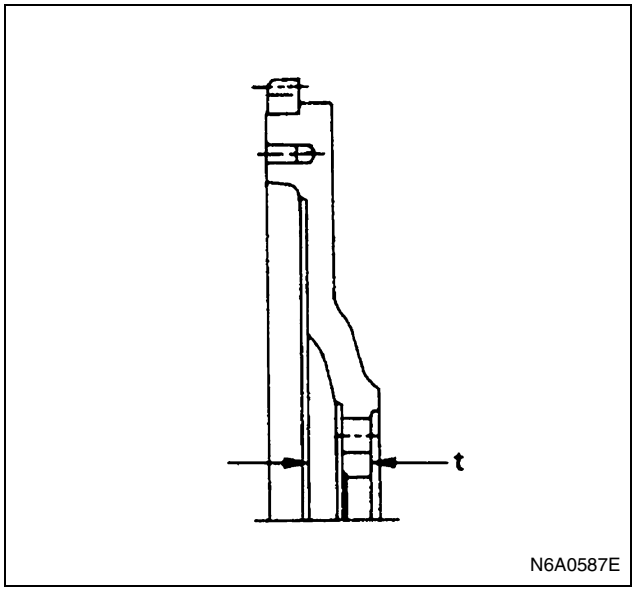
Inspection and Repair

Flywheel

1. Inspect the flywheel friction surface for excessive wear and heat cracks.
2. Measure the flywheel thickness (t) between the flywheel friction surface and crankshaft setting face.
   If the measured value is between the standard and the specified limit, the flywheel may be reground.
   If the measured value exceeds the specified limit, the flywheel must be replaced.

Flywheel Thickness (t) mm (in)		
Engine model	Standard	Limit
Others	31.4 — 31.6 (1.236 — 1.244)	31.0 (1.220)
4HG1-TC	37.4 — 37.6 (1.472 — 1.480)	37.0 (1.457)

Flywheel Friction Surface Roughness mm (in)
Less than 0.006 (0.00024)

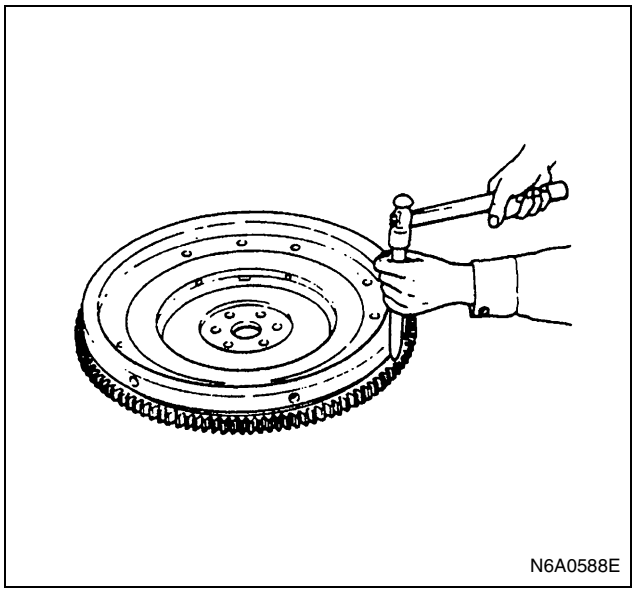


N6A0587E

Ring Gear
Inspect the ring gear
If the ring gear teeth are broken or excessively worn, the ring gear must be replaced.

Ring Gear Replacement

REMOVAL
Strike around the edges of the ring gear with a hammer and chisel to remove it.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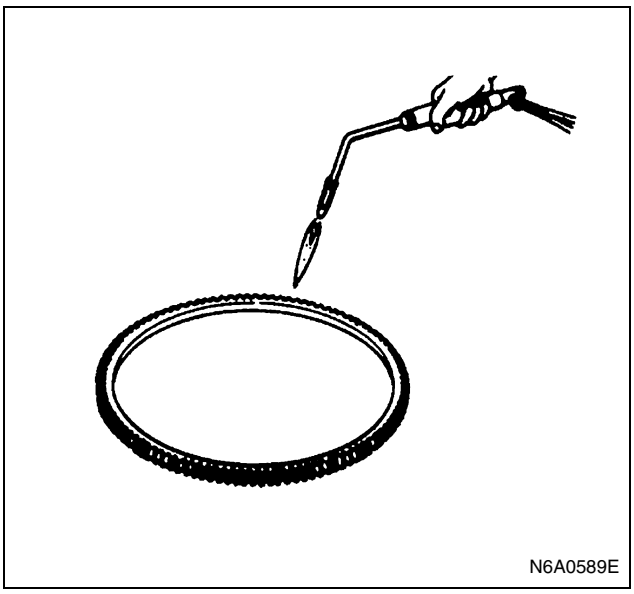
INSTALLATION

1. Heat the ring gear evenly with a gas burner to invite thermal expansion.


N6A0589E

2. Install the ring gear when it is sufficiently heated. The ring gear must be installed with the chamfer facing the clutch.

Pilot Bearing

Check the pilot bearing for wear or damage and replace with a new one if any abnormal condition is noticeable.

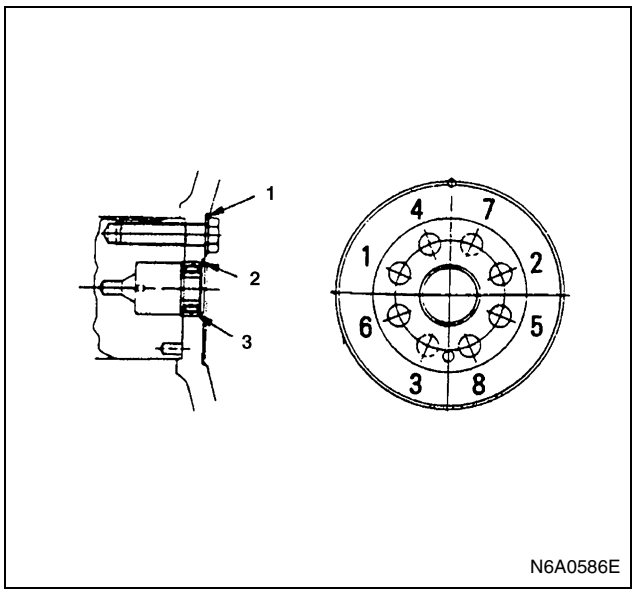
Installation

1. Pilot Bearing
2. Snap Ring
3. Flywheel Assembly
4. Washer
   1) Align the flywheel with the crankshaft knock pin and temporarily tighten the flywheel bolts.
   2) Use the crankshaft stopper to prevent the crankshaft from turning.
      Crankshaft stopper: 5-8840-2230-0
   3) Install the washer and the flywheel bolts and tighten to the specified torque in numerical order show in the illustration.

Tighten:

Flywheel bolt to

- 1st step: 78 N·m (8.0 kg·m/58 lb·ft)
- 2nd step: 90 — 120°



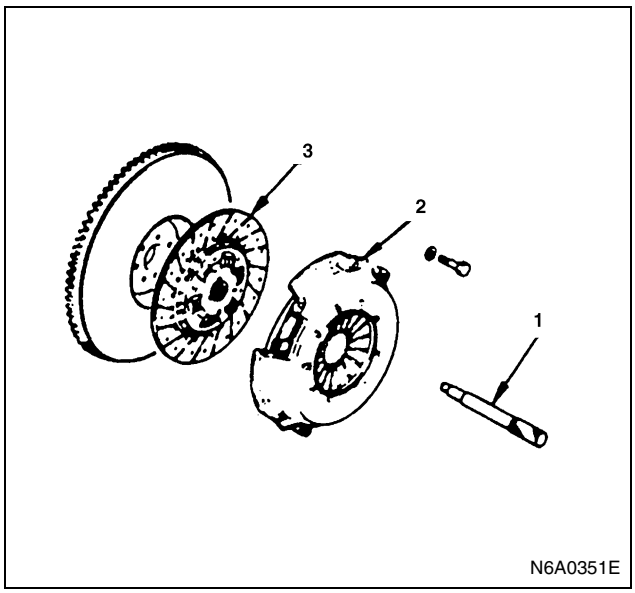
N6A0586E

Legend

1. Washer
2. Snap ring
3. Pilot bearing

   4) Remove the crankshaft stopper.

5. Driven Plate
   Use the clutch pilot aligner to install the driven plate.
   Clutch Pilot Aligner: 5-8840-2240-0



N6A0351E

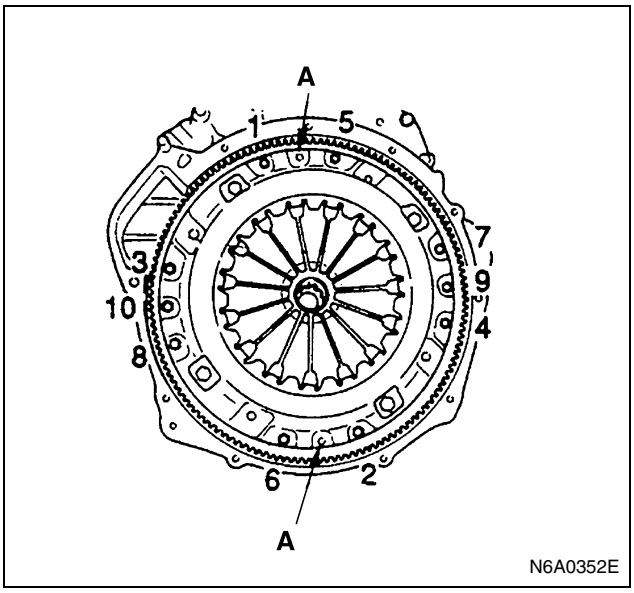
Legend

1. Clutch pilot aligner
2. Clutch pressure plate assembly
3. Driven plate

6. Clutch Pressure Plate Assembly
   1) Align the clutch pressure plate with the flywheel knock pin.

2) Tighten the pressure plate bolts to the specified torque in numerical order.

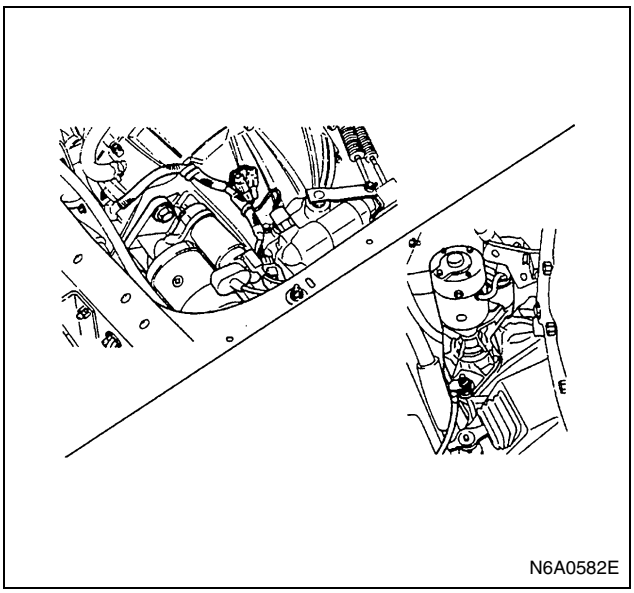
Tighten:
Clutch pressure plate bolt to 40 N·m (4.1 kg·m/30 lb·ft)



Legend
A. Knock pin

7. Transmission Assembly
   Above works refer to “ENGINE ASSEMBLY” section in this manual.
8. Starter

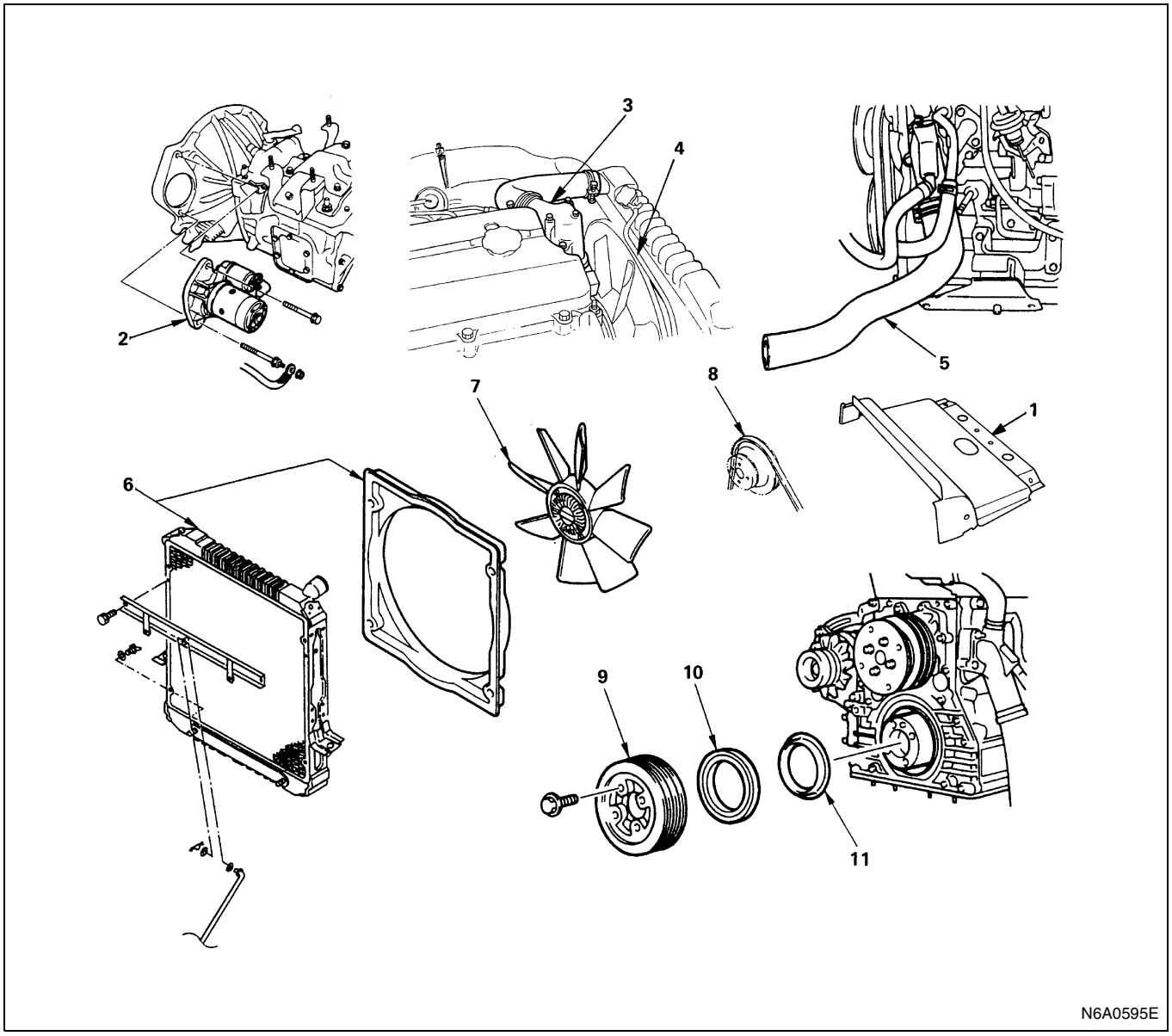
Tighten:
Starter bolt to 76 N·m (7.7 kg·m/56 lb·ft)



9. Transmission Panel
   - Connect the battery ground cable.

CRANKSHAFT FRONT OIL SEAL

Component



Legend

1. Transmission panel (Australia only)
2. Starter
3. Radiator upper hose
4. Coolant reserve tank hose/Bypass hose
5. Radiator lower hose
6. Radiator (with guide)
7. Fan assembly
8. Fan belt
9. Crankshaft damper pulley
10. Crankshaft front oil seal
11. Crankshaft front slinger

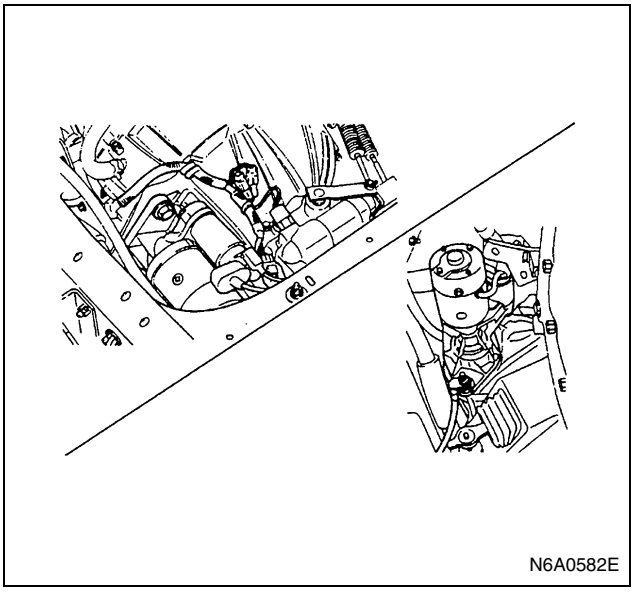
Removal

Preparation

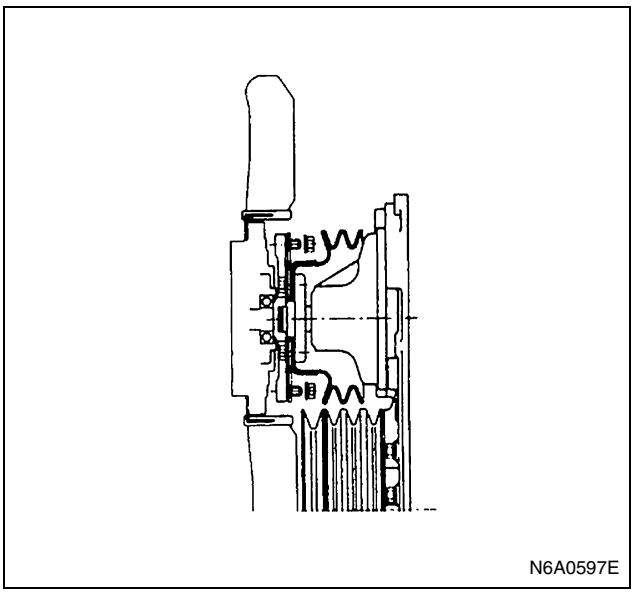
- Disconnect battery ground cable.
- Tilt the cab.
- Drain coolant

1. Transmission Panel
2. Starter

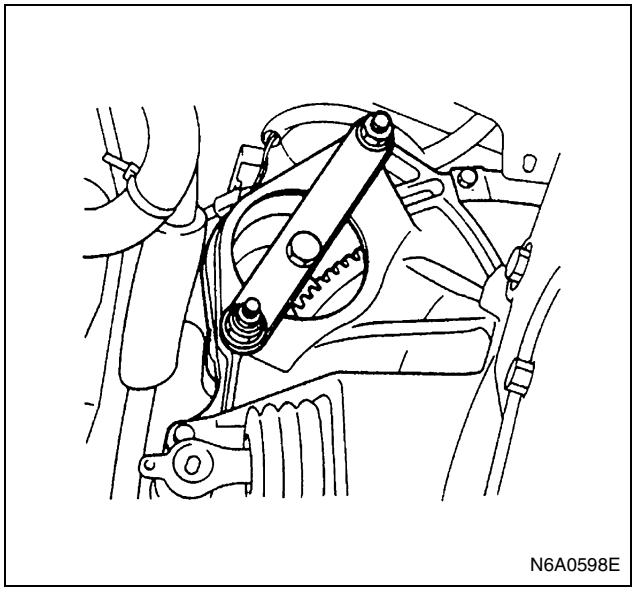
- Disconnect the battery cable at the starter motor.
- Remove the starter assembly from flywheel housing.


N6A0582E

3. Radiator Upper Hose
4. Coolant Reserve Tank Hose/Bypass Hose
5. Radiator Lower Hose
6. Radiator (with Guide)
7. Fan Assembly

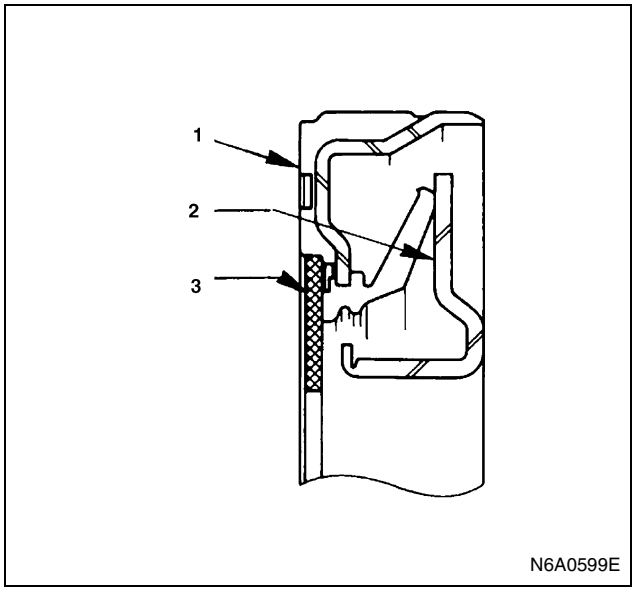

N6A0597E

8. Fan Belt
9. Crankshaft Damper Pulley
   1) Use the crankshaft stopper to prevent the crankshaft from turning.
      Crankshaft Stopper: 5-8840-2230-0


N6A0598E

   2) Loosen the damper pulley bolts and remove the damper pulley.
10. Crankshaft Front Oil Seal

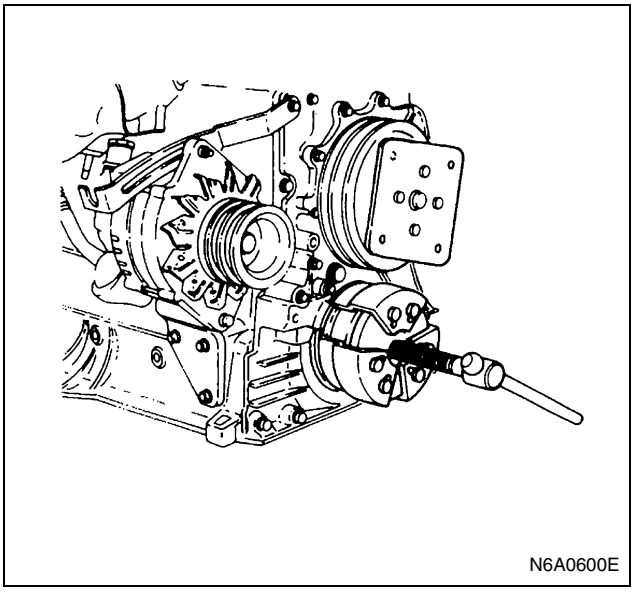
Caution:
Be careful not to damage the crankshaft oil seal contact surface during the removal procedure.



N6A0599E

Legend
1. Oil seal
2. Slinger
3. Felt

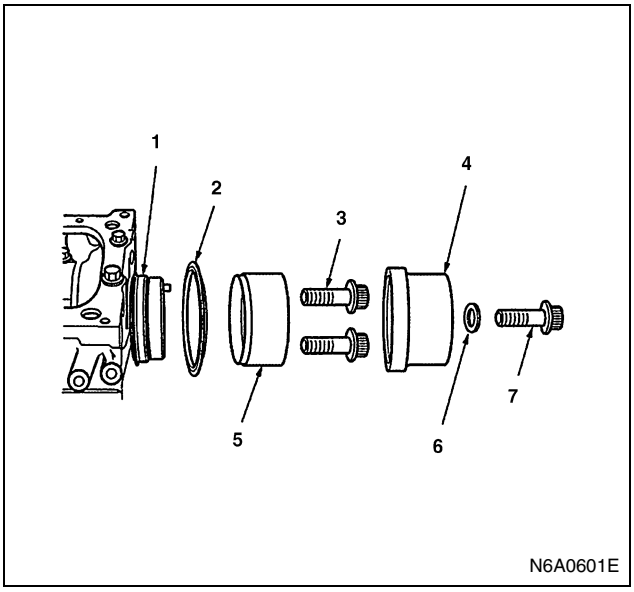
11. Crankshaft Front Slinger
    Use the slinger puller to pull out the slinger.
    Slinger Puller: 5-8840-2360-0


N6A0600E

Installation

1. Crankshaft Front Slinger
   Press in the slinger using the oil seal setting tool kit.
   Oil Seal Setting Tool Kit: 5-8840-2431-0
   Front slinger and oil seal setting tools

Part Name	Stamp	Slinger	Oil Seal
Adapter	FT	❍	❍
Sleeve	FT	❍	❍
Oil seal adapter ring	FT		❍
Center bolt	—	❍	❍
Adapter bolt	—	❍	❍

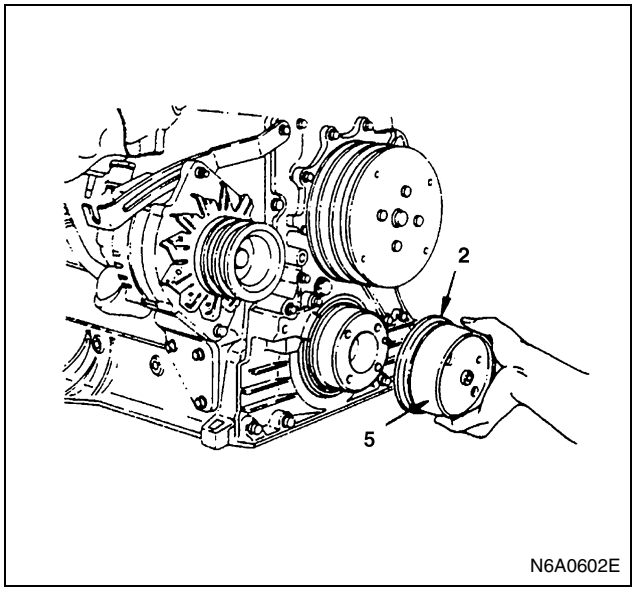


N6A0601E

Legend

1. Crankshaft
2. Slinger
3. Adapter bolt
4. Sleeve
5. Adapter
6. Washer (5 mm (0.20 in))
7. Center bolt

1) Insert the slinger (2) into the end of adapter (5) and install the adapter on the crankshaft.



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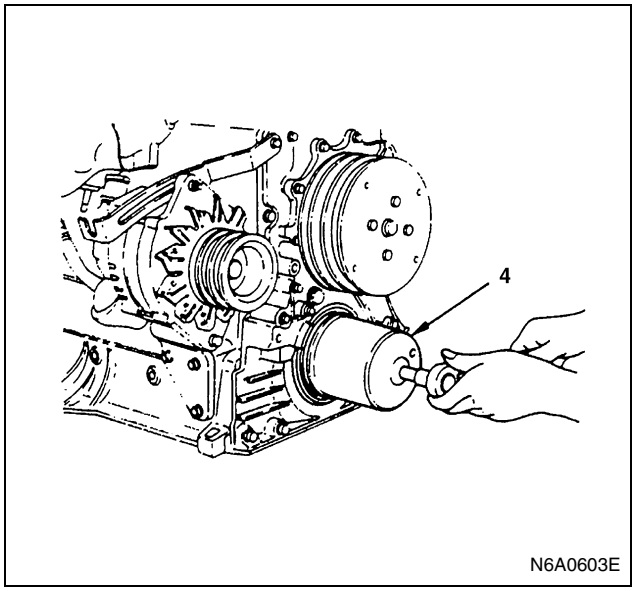
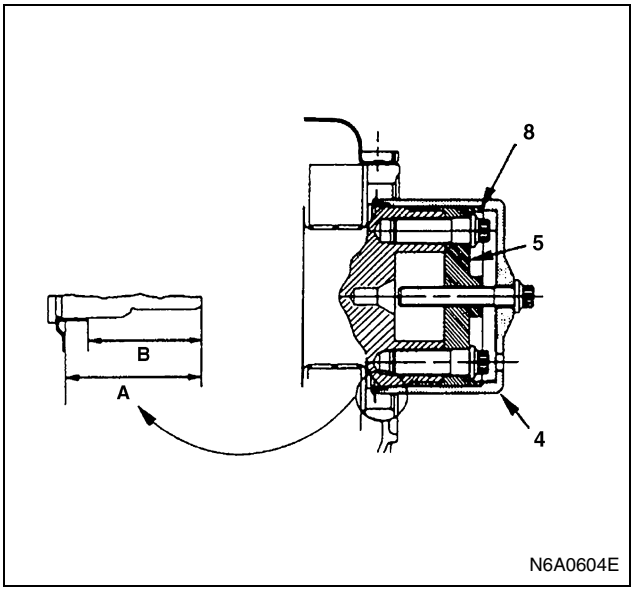
2) Cover the sleeve (4) and tighten the bolt until the sleeve comes to contact the adapter stopper (8).



N6A0603E



3) With the slinger pressed in, make sure of measurements specified in the illustration as well as of slinger deflection.
(A): 40.5 ± 0.3 mm (1.594 ± 0.012 in)
(B): 34.0 ± 0.1 mm (1.339 ± 0.004 in)

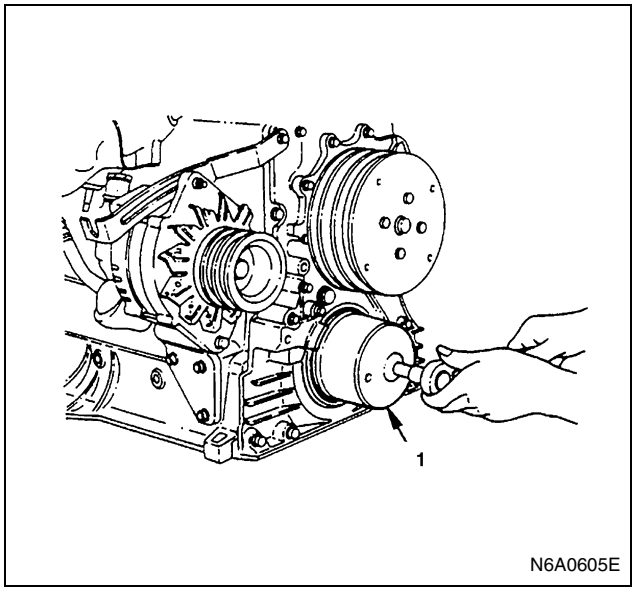
Notice:
Be sure to replace the slinger and oil seal as a set.

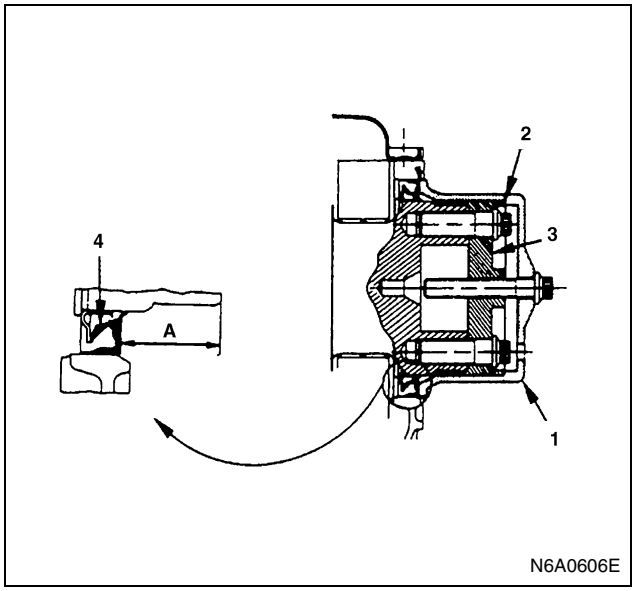
Use about 5 mm (0.20 in) thickness plain washer on the center bolt.

2. Crankshaft Front Oil Seal
   1) Apply engine oil to the lip of the oil seal.
   2) Press in the oil seal using the front oil seal setting tool kit.
   - Remove the slinger sleeve and insert the oil seal (4) into the adapter (3).
   - Install the oil seal sleeve (1) to the adapter (3) and tighten the center bolt until the sleeve comes to contact the adapter stopper (2).
   - With the oil seal pressed in, make sure of the measurements specified in the illustration.
     (A): 31 ± 0.3 mm (1.220 ± 0.012 in)

Notice:
Be sure to replace the slinger and oil seal as a set.

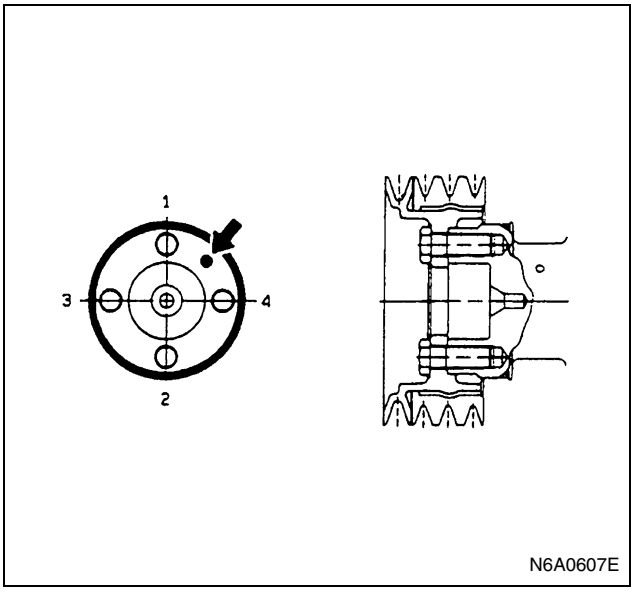
Use about 5 mm (0.20 in) thickness plain washer on the center bolt.





3. Crankshaft Damper Pulley
   1) Apply a coat of engine oil to the threads of the bolts.
   2) Align the damper pulley with the crankshaft knock pin and tighten the bolts to the specified torque in numerical order.

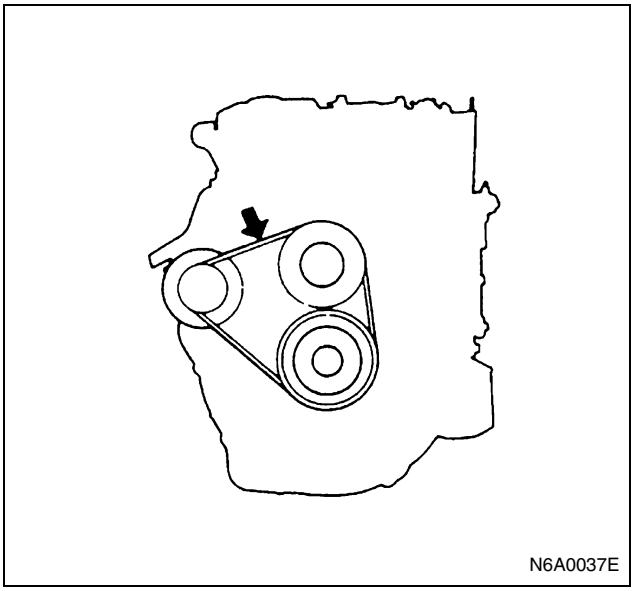
Tighten:
Damper pulley bolt to 200 N·m (20.4 kg·m/147 lb·ft)



4. Fan Belt
   Check the drive belt tension.
   Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

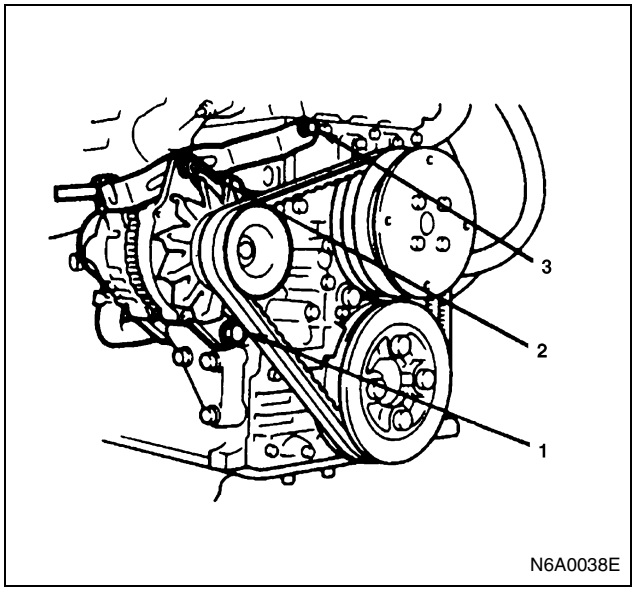
Drive Belt Deflection	mm (in)
8 — 12 (0.31 — 0.47) ... New belt 10 — 14 (0.39 — 0.55) ... Reuse belt	

   Check the drive belt for cranking and other damage.



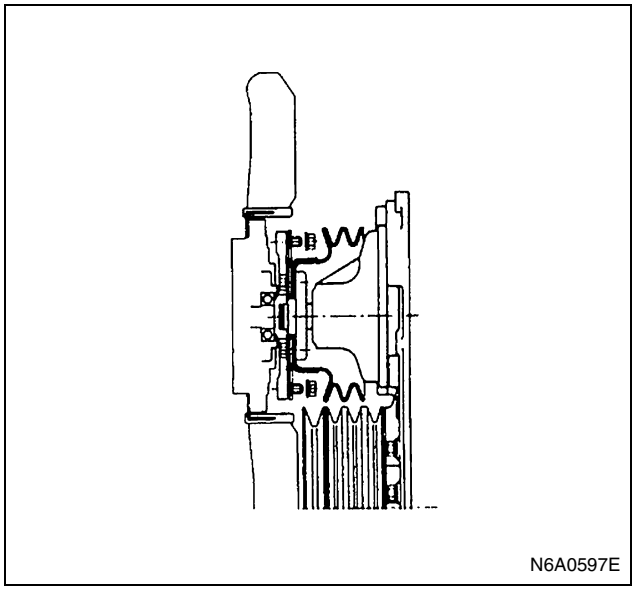
Fan Belt Adjustment
Fan belt tension is adjusted by moving the generator.

Tighten:
Belt to
- (1): 40 N·m (4.1 kg·m/30 lb·ft)
- (2): 24 N·m (2.4 kg·m/17 lb·ft)
- (3): 46 N·m (4.7 kg·m/34 lb·ft)



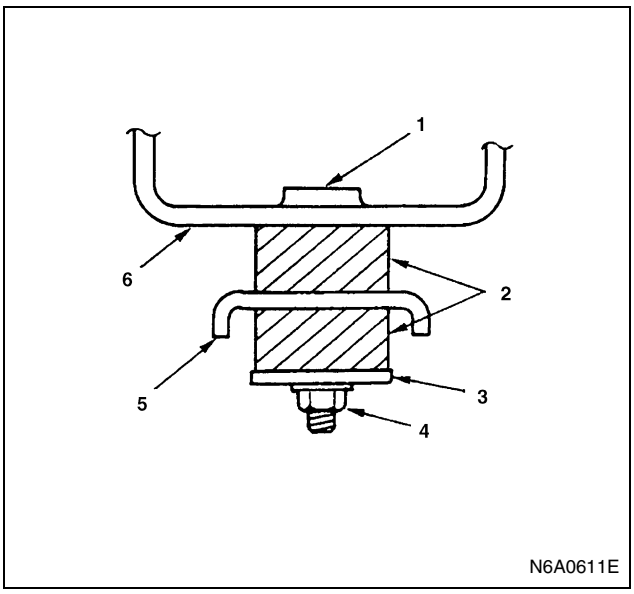
5. Fan Assembly

Tighten:
Fan bolt to 24 N·m (2.4 kg·m/17 lb·ft)



6. Radiator (with Guide)

Tighten:
Radiator bolt to 55 N·m (5.6 kg·m/41 lb·ft)

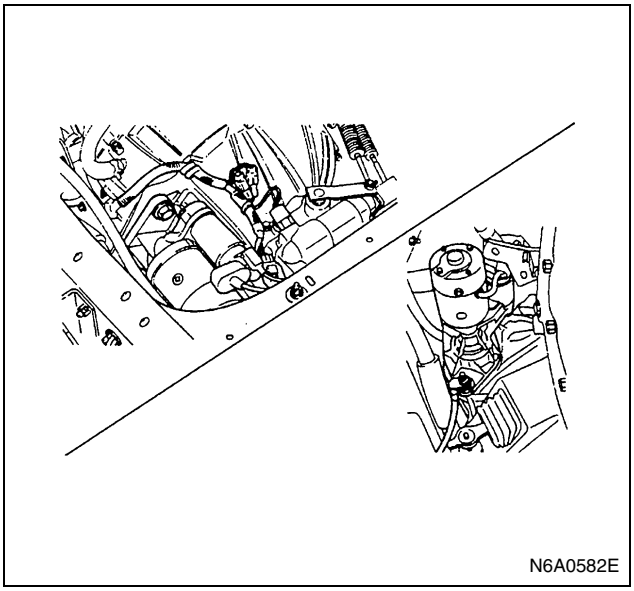


Legend

1. Stud bolt
2. Rubber
3. Washer
4. Flange nut
5. Flame side bracket
6. Radiator side bracket

7. Radiator Lower Hose
8. Coolant reserve Tank Hose/Bypass Hose
9. Radiator Upper Hose
10. Starter

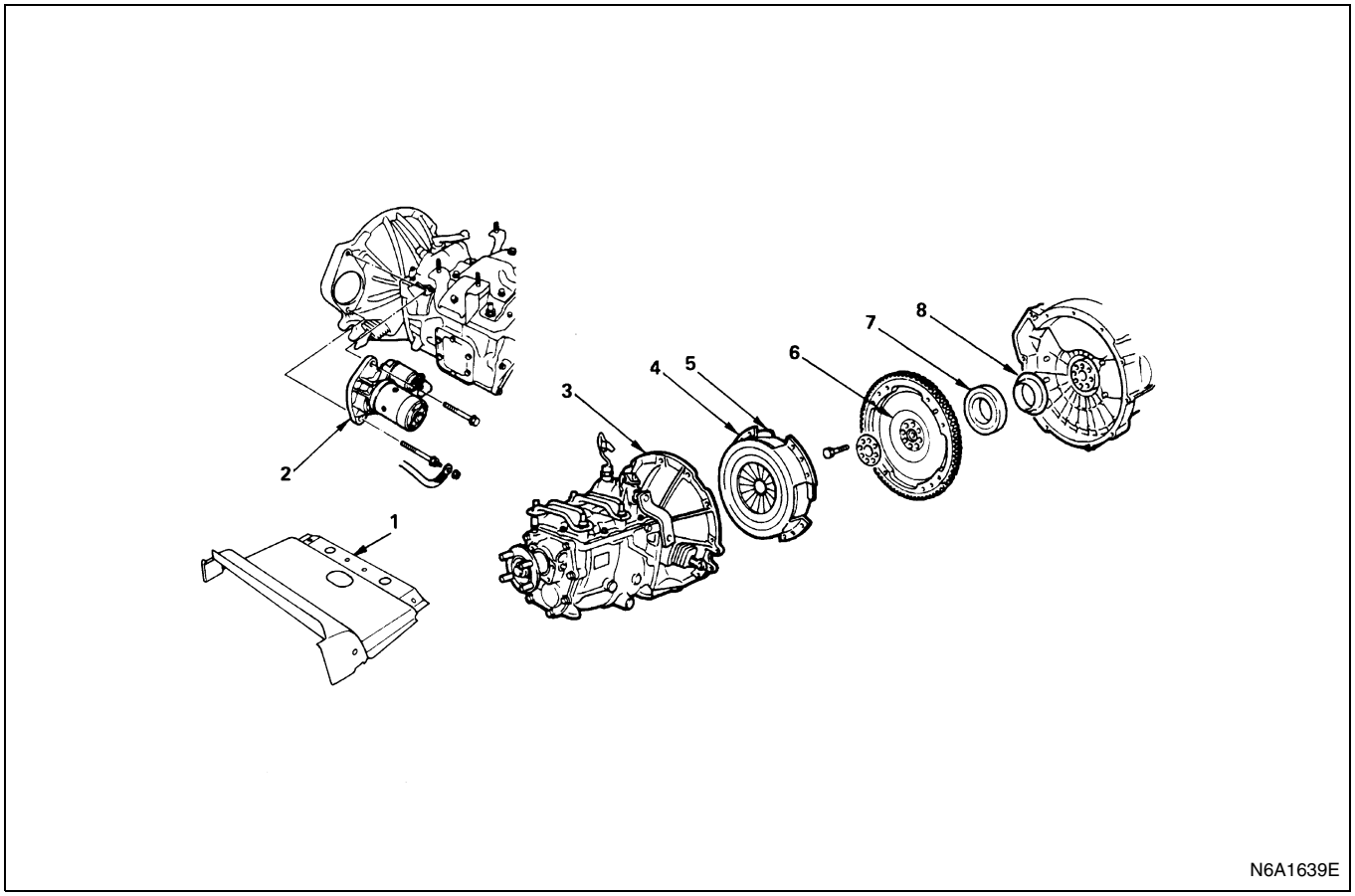
Tighten:
Starter bolt to 76 N·m (7.7 kg·m/56 lb·ft)



11. Transmission Panel
    - Connect battery ground cable.
    - Pour engine coolant into engine.

CRANKSHAFT REAR OIL SEAL

Component



Legend

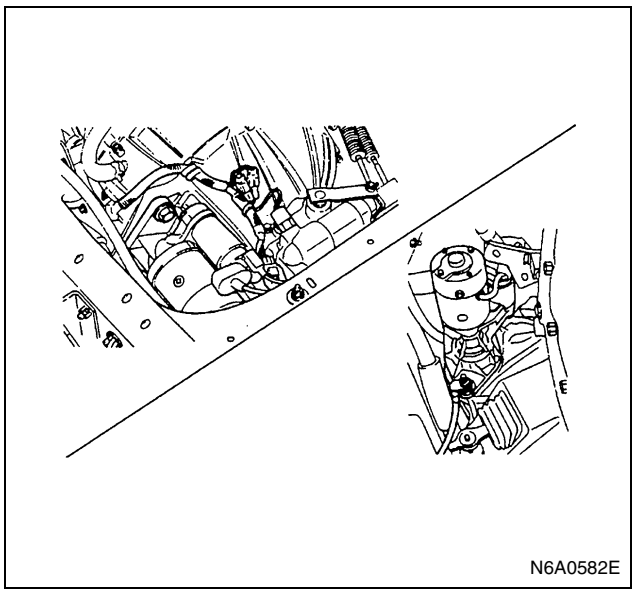
1. Transmission panel
2. Starter
3. Transmission assembly
4. Clutch pressure plate assembly
5. Driven plate
6. Flywheel assembly
7. Crankshaft rear oil seal
8. Crankshaft rear slinger

Removal

Preparation

- Disconnect battery ground cable.

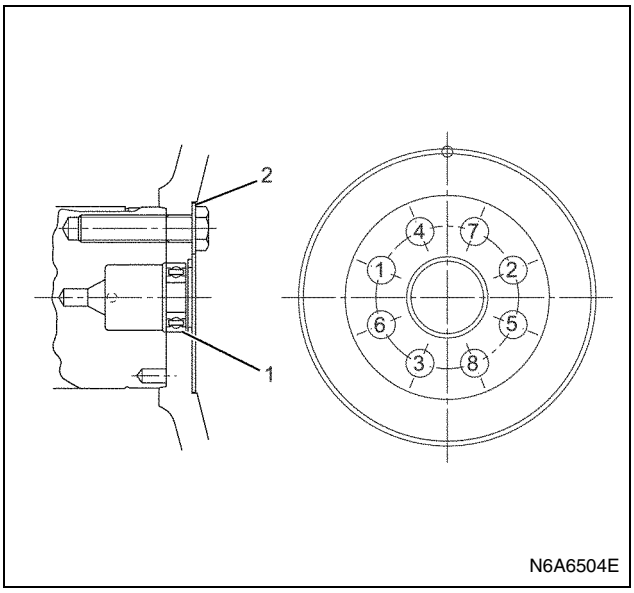
1. Transmission Panel
2. Starter
   1) Disconnect the battery cable at the starter motor.
   2) Remove the starter assembly from flywheel housing.



3. Transmission Assembly

Above works refer to “ENGINE ASSEMBLY” section in this manual.

4. Clutch Pressure Plate Assembly
5. Driven Plate
6. Flywheel Assembly
   Above works refer to “FLYWHEEL AND PILOT BEARING” section in this manual.



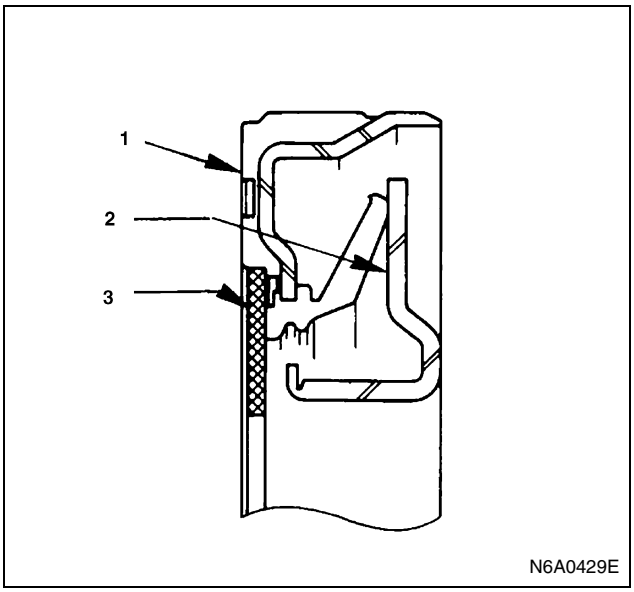
N6A6504E

Legend

1. Washer
2. Pilot bearing

7. Crankshaft Rear Oil Seal

Caution:
Be careful not to damage the crankshaft oil seal contact surface during the removal procedure.

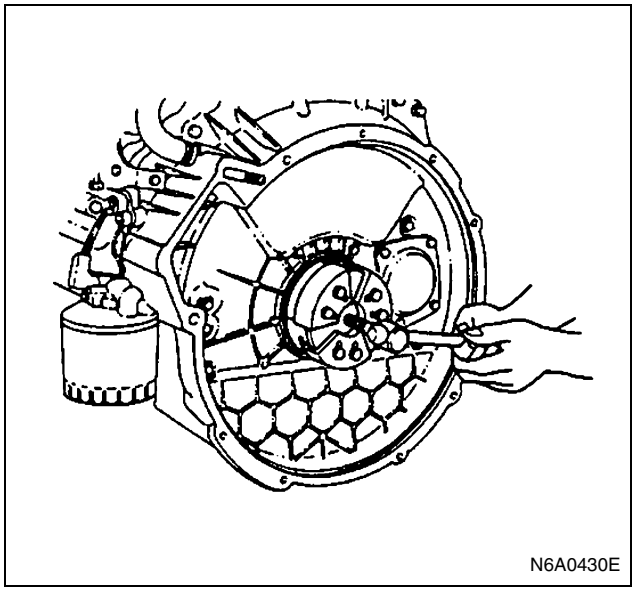


N6A0429E

Legend

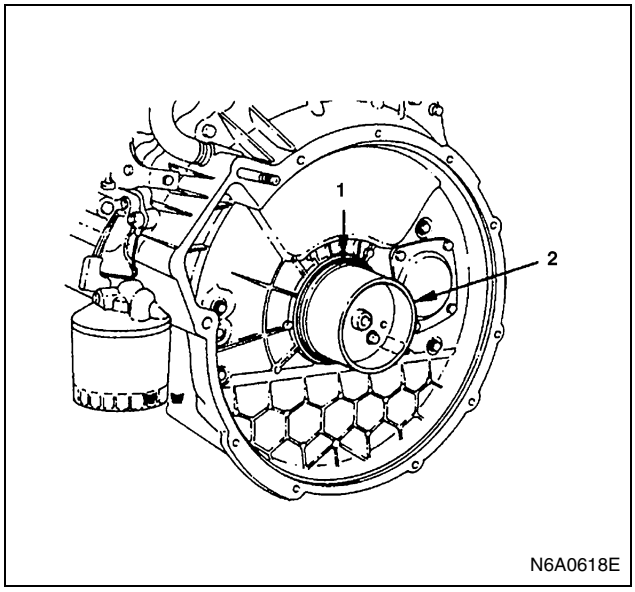
1. Oil seal
2. Slinger
3. Felt

8. Crankshaft Rear Slinger
   Use the slinger puller to pull out the slinger.
   Slinger Puller: 5-8840-2360-0


N6A0430E

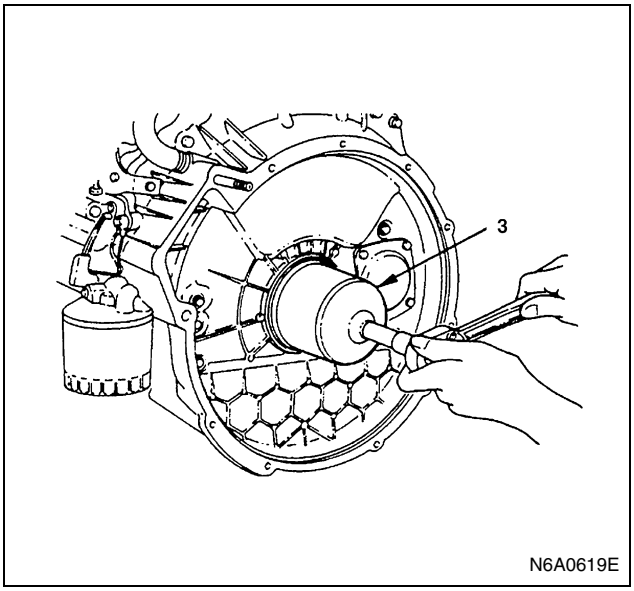
Installation

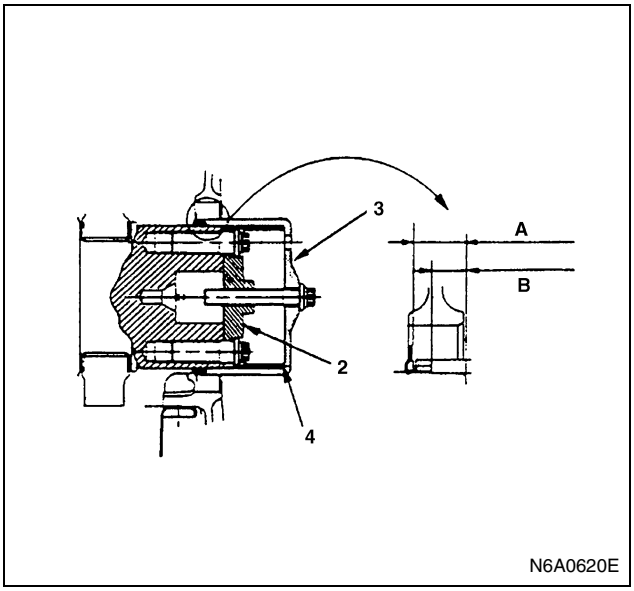
1. Crankshaft Rear Slinger
   Press in the slinger using oil seal setting tool kit.
   - Insert the slinger (1) into the end of adapter (2) and install the adapter on the crankshaft.



N6A0618E

   - Cover the sleeve (3) and tighten the bolt until the sleeve comes to contact the adapter stopper (4).



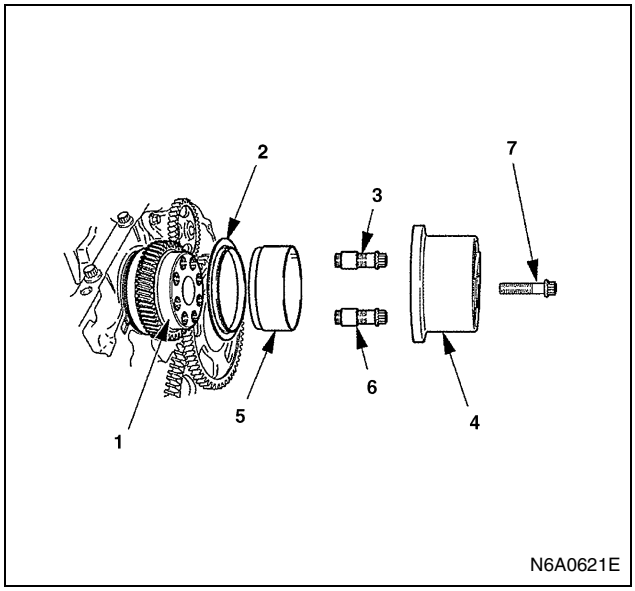


- Make sure of measurements specified in the illustration as well as of slinger deflection.
  (A): 17.3 ± 0.3 mm (0.681 ± 0.012 in)
  (B): 10.8 ± 0.1 mm (0.425 ± 0.004 in)

Notice:
Be sure to replace the slinger and oil seal as a set.

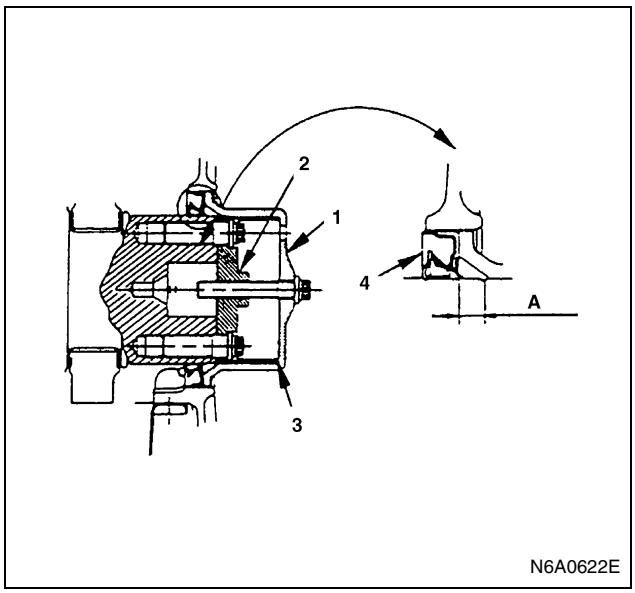
Oil Seal Setting Tool Kit: 5-8840-2431-0
Rear slinger and oil seal setting tools

Part Name	Stamp	Slinger	Oil Seal
Adapter	RR	❍	❍
Sleeve	RR	❍	❍
Oil seal adapter ring	RR		❍
Center bolt	—	❍	❍
Adapter bolt	—	❍	❍
Adapter bolt collar	RR	❍	❍

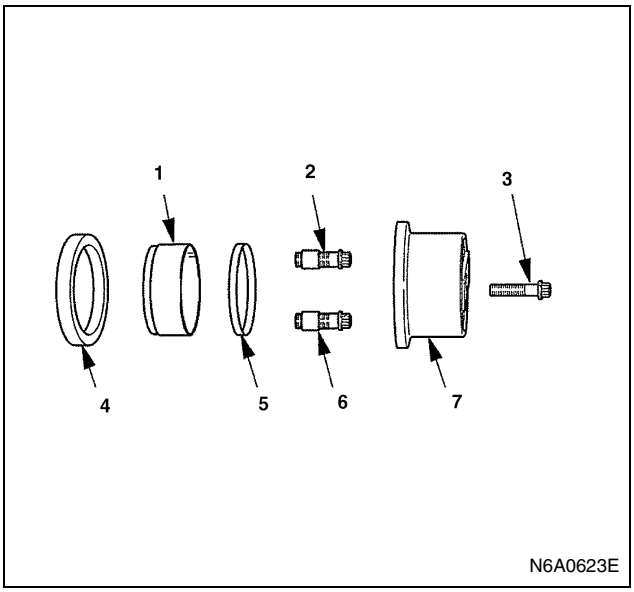


Legend
1. Crankshaft
2. Slinger
3. Adapter bolt
4. Sleeve
5. Adapter
6. Collar
7. Center bolt

2. Crankshaft Rear Oil Seal
   1) Apply engine oil to the lip of the oil seal.
   2) Press in the oil seal using rear oil seal setting tool kit.
   - Remove the slinger sleeve and insert the oil seal (4) into the adapter (2).
   - Install the adapter ring into the sleeve.
   - Install the oil seal sleeve (1) to the adapter (2) and tighten the center bolt until the sleeve comes to contact the adapter stopper (3).



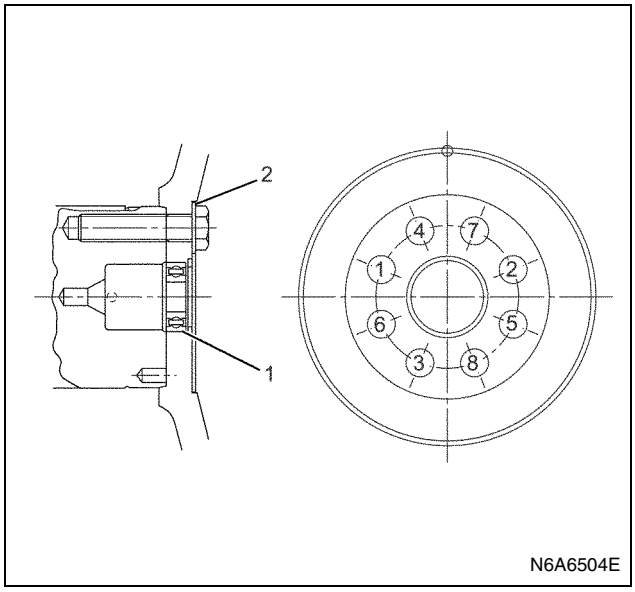
- Make sure of the measurements specified in the illustration.
  (A): 7.8 ± 0.3 mm (0.307 ± 0.012 in)



Legend
1. Adapter
2. Adapter bolt
3. Center bolt
4. Oil seal
5. Ring
6. Collar
7. Sleeve

3. Flywheel Assembly
   1) Apply a coat of molybdenum disulfide grease to the flywheel bolt threads and setting faces.
   2) Align the flywheel with the crankshaft knock pin and temporarily tighten the flywheel bolts.
   3) Use the crankshaft stopper to prevent the crankshaft from turning.
      Crankshaft Stopper: 5-8840-2230-0
   4) Install the washer and the flywheel bolts and tighten to the specified torque in numerical order show in the illustration.

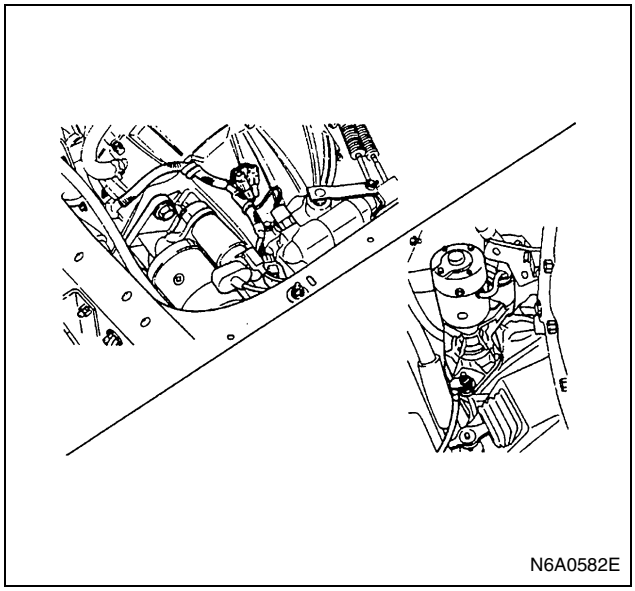
Tighten:
Flywheel bolt to
- 1st step: 78 N·m (8.0 kg·m/58 lb·ft)
- 2nd step: 90 — 120°



Legend
1. Washer
2. Pilot bearing

   5) Remove the crankshaft stopper.
4. Driven Plate
5. Clutch Pressure Plate Assembly
   Above works refer to “FLYWHEEL AND PILOT BEARING” section in this manual.
6. Transmission Assembly
   Above works refer to “ENGINE ASSEMBLY” section in this manual.
7. Starter

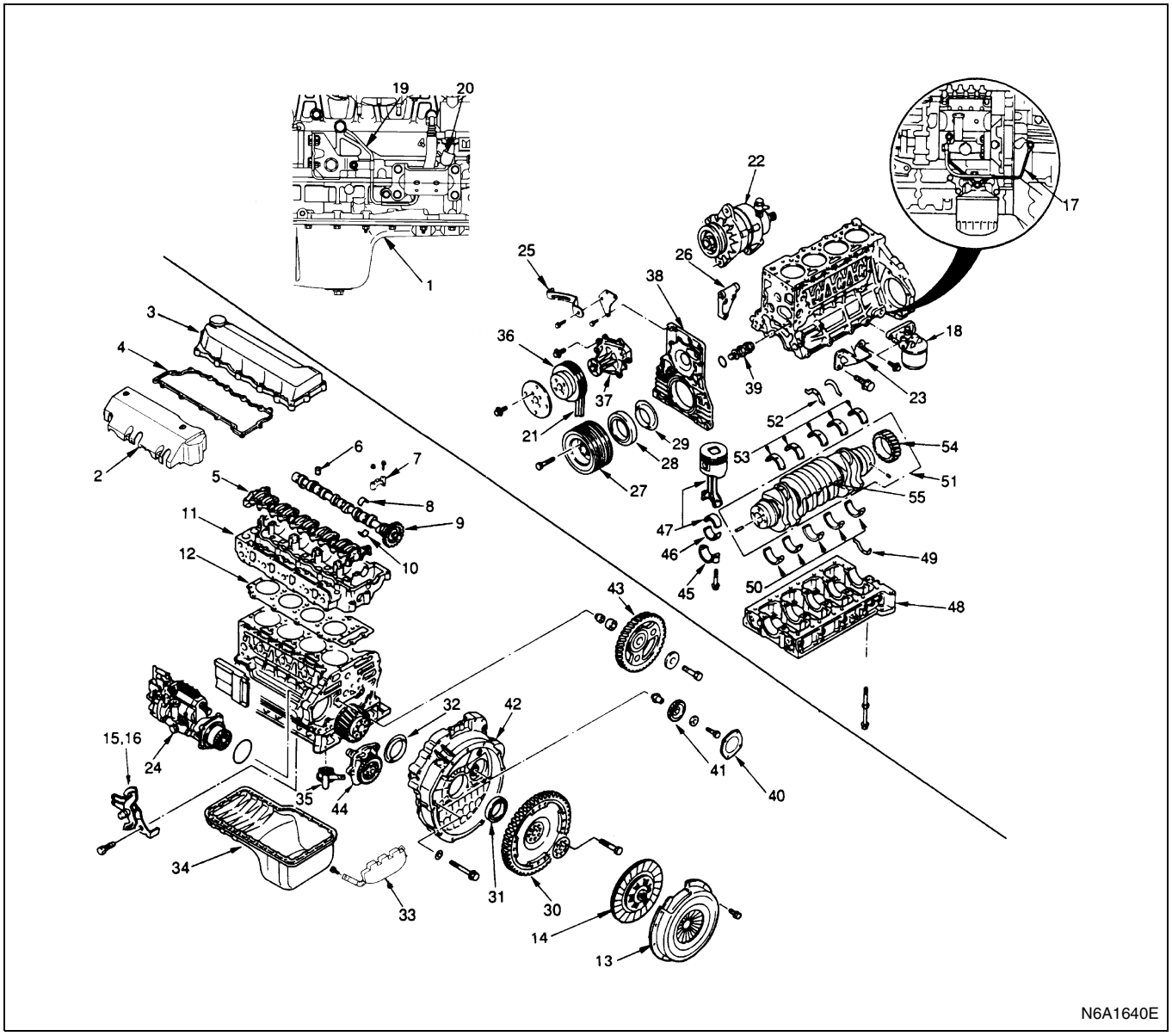
Tighten:
Starter bolt to 76 N·m (7.7 kg·m/56 lb·ft)



8. Transmission Panel
   - Connect the battery ground cable.

CRANKSHAFT

Component



Legend

1. Engine cover
2. Nozzle cover
3. Cylinder head cover
4. Cylinder head cover gasket
5. Rocker arm shaft assembly
6. Valve cap
7. Camshaft bearing cap
8. Camshaft bearing upper
9. Camshaft assembly
10. Camshaft bearing lower
11. Cylinder head assembly
12. Cylinder head gasket
13. Clutch pressure plate assembly
14. Driven plate
15. Engine control wire
16. Engine control lever assembly
17. Oil pipe
18. Oil filter assembly
19. Vacuum pump oil pipe
20. Vacuum pump rubber hose
21. Fan belt
22. Generator
23. Engine foot
24. Injection pump assembly
25. Fan belt adjust plate
26. Generator bracket
27. Crankshaft pulley
28. Crankshaft front oil seal
29. Crankshaft front slinger
30. Flywheel
31. Crankshaft rear oil seal
32. Crankshaft rear slinger
33. Spacer rubber
34. Oil pan
35. Oil pump strainer
36. Water pump pulley
37. Water pump
38. Front retainer
39. Oil thermo valve
40. Power steering pump idle gear cover
41. Power steering pump idle gear
42. Flywheel housing
43. Idle gear A
44. Oil pump assembly
45. Connecting rod cap assembly
46. Connecting rod lower bearing
47. Piston and connecting rod assembly
48. Crankcase
49. Thrust bearing lower
50. Crankshaft bearing lower
51. Crankshaft assembly
52. Thrust bearing upper
53. Crankshaft bearing upper
54. Crankshaft gear
55. Crankshaft

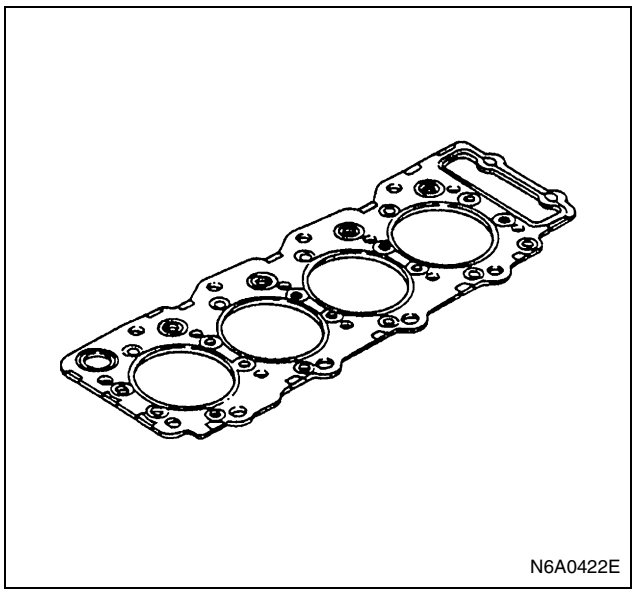
Removal

Preparation

- Disconnect battery ground cable.
- Tilt the cab
- Drain coolant and engine oil

1. Engine Assembly
   Above works refer to “ENGINE ASSEMBLY” section in this manual.
2. Nozzle Cover
3. Cylinder Head Cover
4. Cylinder Head Cover Gasket
5. Rocker Arm Shaft Assembly
   Above works refer to “ROCKER ARM SHAFT ASSEMBLY” section in this manual.
6. Valve Cap
7. Camshaft Bearing Cap
8. Camshaft Bearing Upper
9. Camshaft Assembly
10. Camshaft Bearing Lower
    Above works refer to “CAMSHAFT ASSEMBLY” section in this manual.
11. Cylinder Head Assembly
    Above works refer to “CYLINDER HEAD” section in this manual.
12. Cylinder Head Gasket

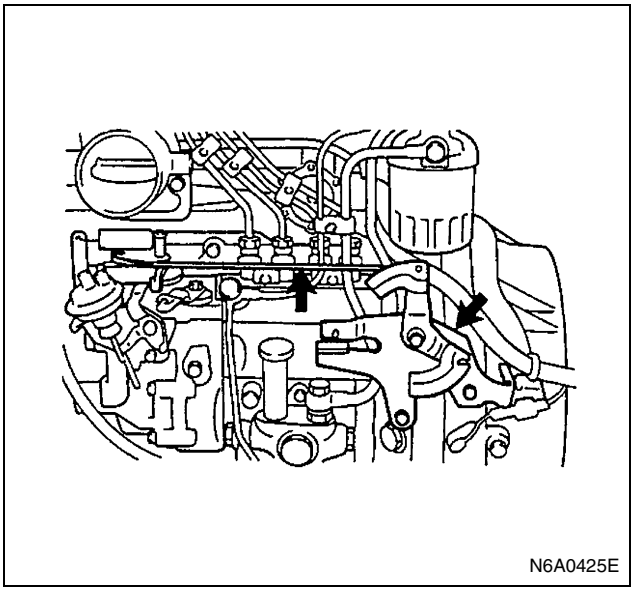
Caution:
Do not reuse the cylinder head gasket.



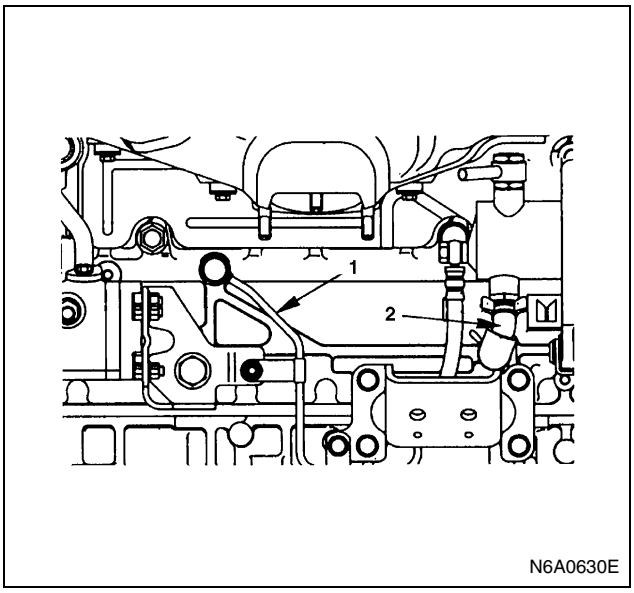
13. Clutch Pressure Plate Assembly
14. Driven Plate

Above works refer to “FLYWHEEL AND PILOT BEARING” section in this manual.

15. Engine Control Wire
16. Engine Control Lever Assembly


N6A0425E

17. Oil Pipe
18. Oil Filter Assembly
19. Vacuum Pump Oil Pipe
20. Vacuum Pump Rubber Hose

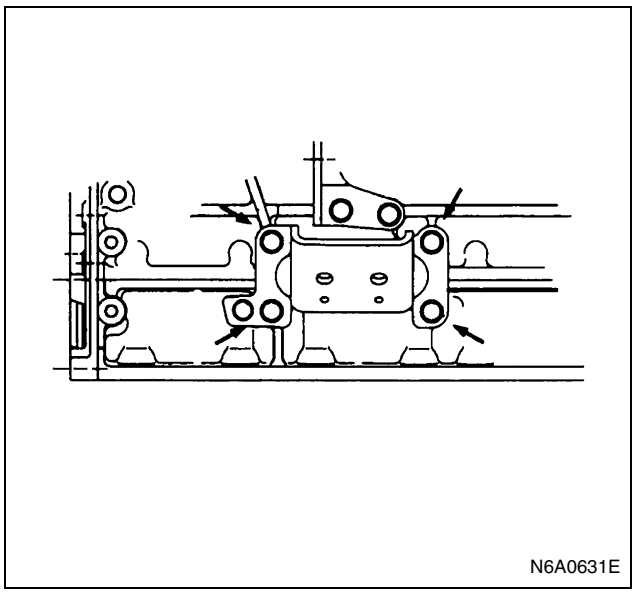


N6A0630E

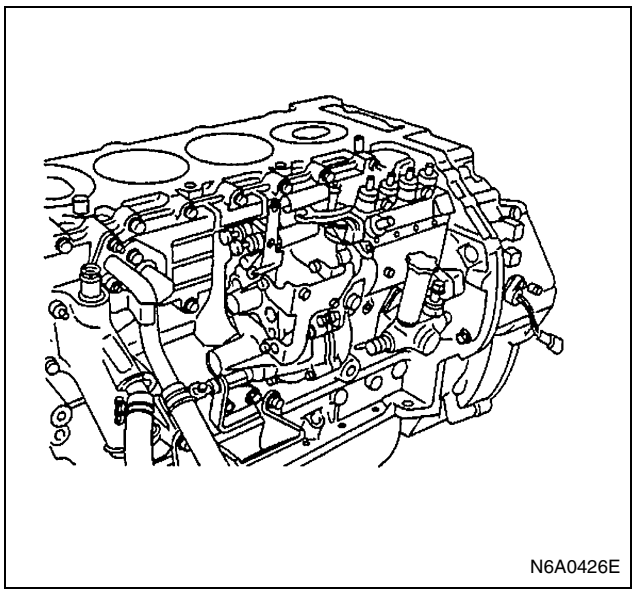
Legend

1. Vacuum pump oil pipe
2. Vacuum pump rubber hose

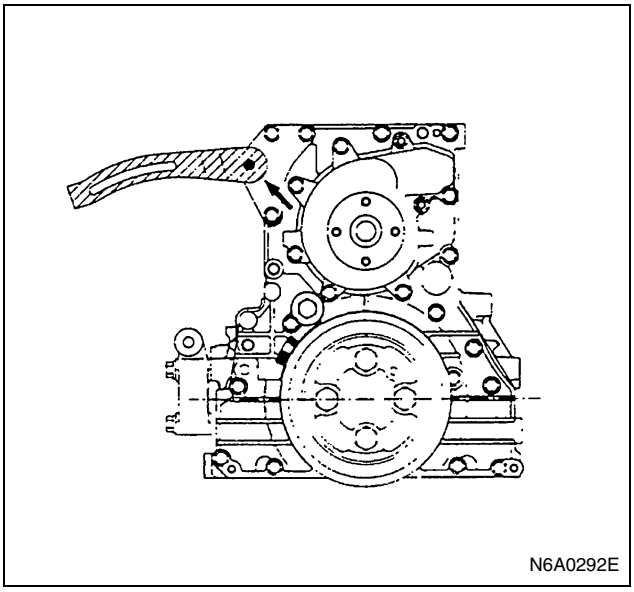
21. Fan Belt
22. Generator
23. Engine Foot


N6A0631E

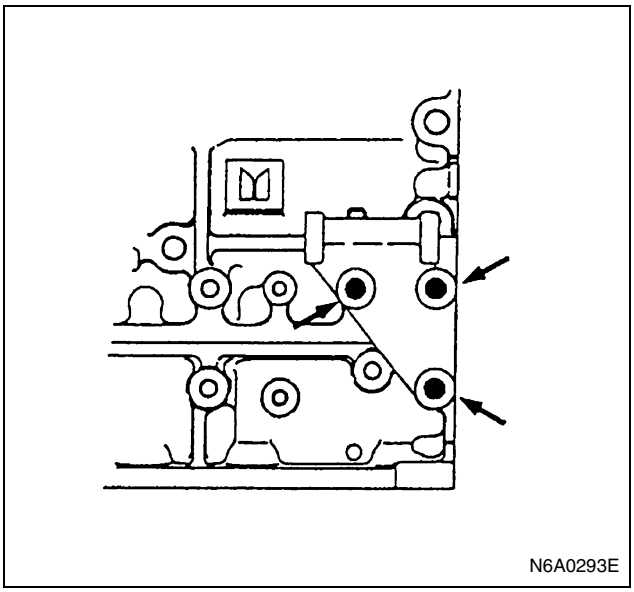
24. Injection Pump Assembly
    1) Remove the injection pump bracket bolts and the injection pump rear bracket bolts.
    2) Then remove the injection pump assembly.


N6A0426E

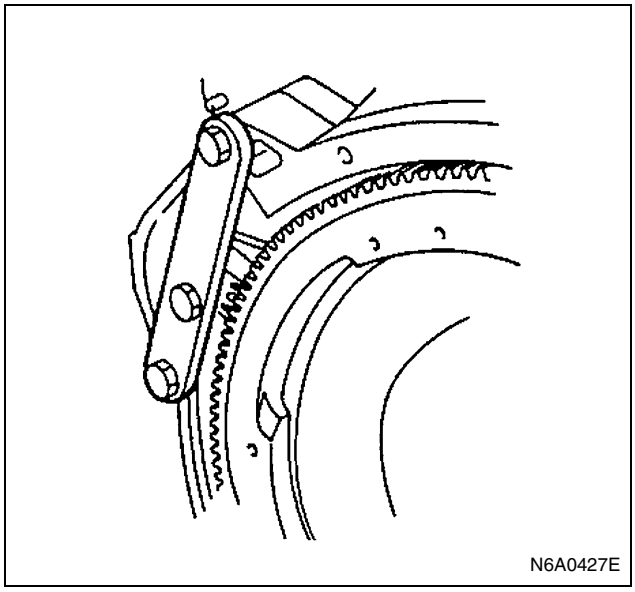
25. Fan Belt Adjust Plate


N6A0292E

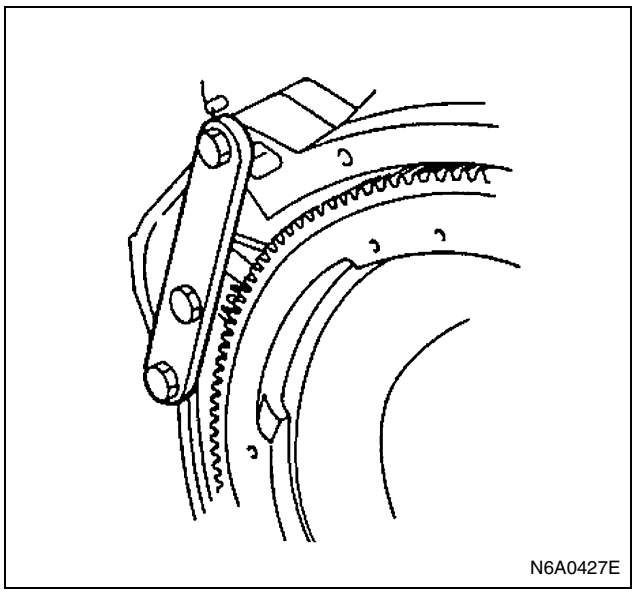
26. Generator Bracket


N6A0293E

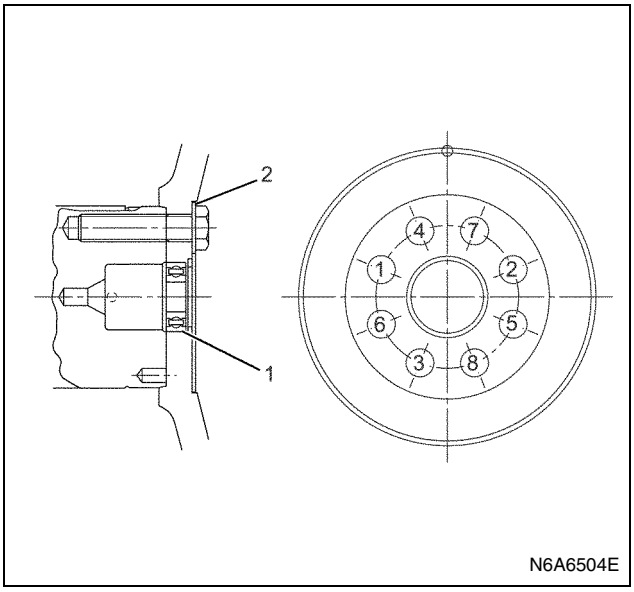
27. Crankshaft Damper Pulley
    1) Use the crankshaft stopper to prevent the crankshaft from turning.
       Crankshaft Stopper: 5-8840-2230-0


N6A0427E

    2) Loosen the damper pulley bolts and remove the damper pulley.
28. Crankshaft Front Oil Seal
29. Crankshaft Front Slinger
    Above works refer to ""CRANKSHAFT FRONT OIL SEAL" section in this manual.
30. Flywheel
    1) Use the crankshaft stopper to prevent the crankshaft from turning
       Crankshaft Stopper: 5-8840-2230-0


N6A0427E

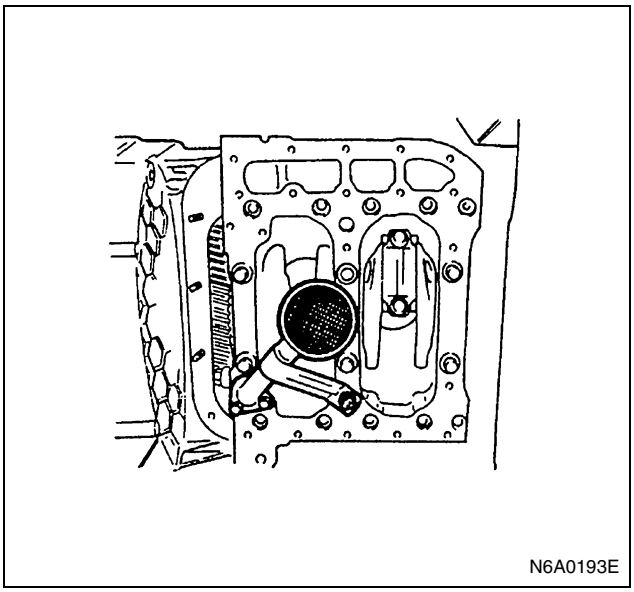
    2) Loosen the flywheel bolts in numerical order a little at a time as shown in the illustration.
    3) Remove the flywheel stopper and the flywheel assembly.



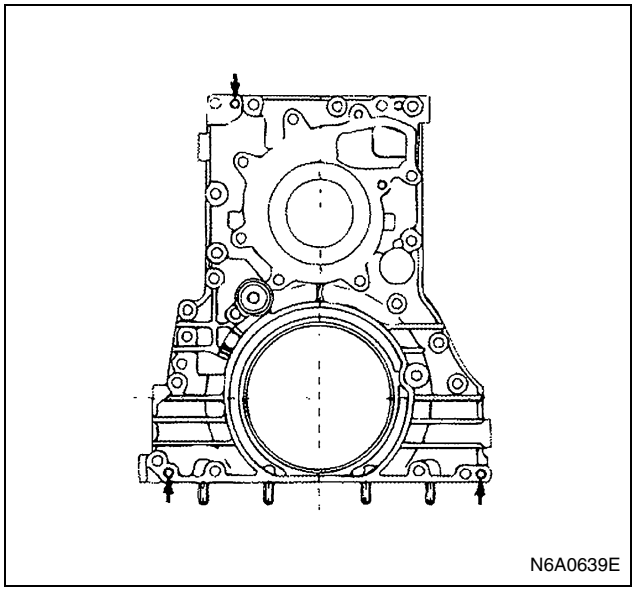
N6A6504E

Legend
1. Washer
2. Pilot bearing

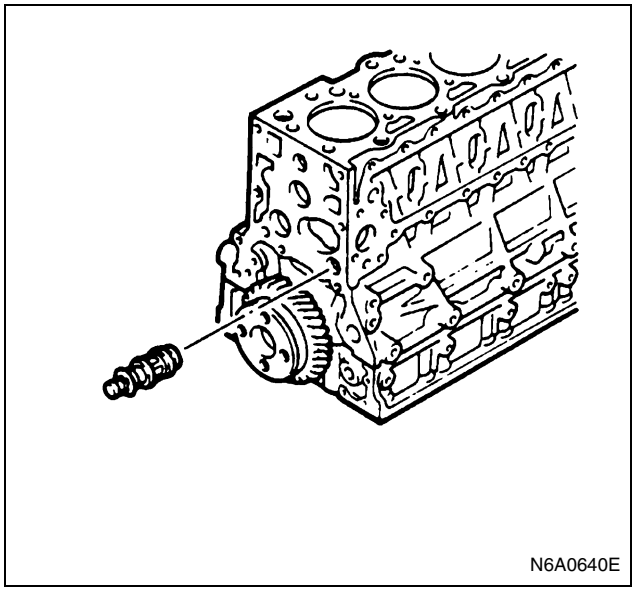
31. Crankshaft Rear Oil Seal
32. Crankshaft Rear Slinger
    Above works refer to “CRANKSHAFT REAR OIL SEAL” section in this manual.
33. Spacer Rubber
    Remove the stiffener before removing the spacer rubber.
34. Oil Pan
35. Oil Pump Strainer


N6A0193E

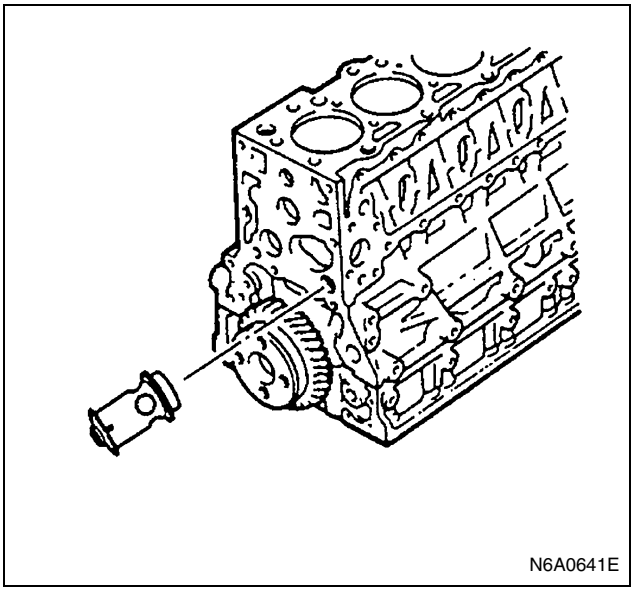
36. Water Pump Pulley
37. Water Pump
38. Front Retainer
    Install the three front retainer fixing bolts to the front retainer replacer holes as shown in the illustration, and tighten the bolts alternately a little at a time.

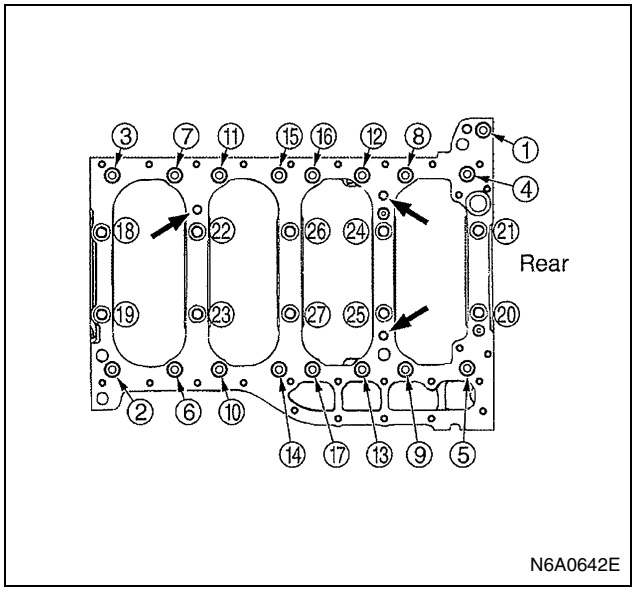

N6A0639E

39. Oil Thermo Valve (4HF1, 4HF1-2, 4HG1, 4HG1-T)
    Pull out the thermo valve from the cylinder body.


N6A0640E

40. Bypass Valve (4HE1-TC)
    Pull out the bypass valve from the cylinder body.


N6A0641E

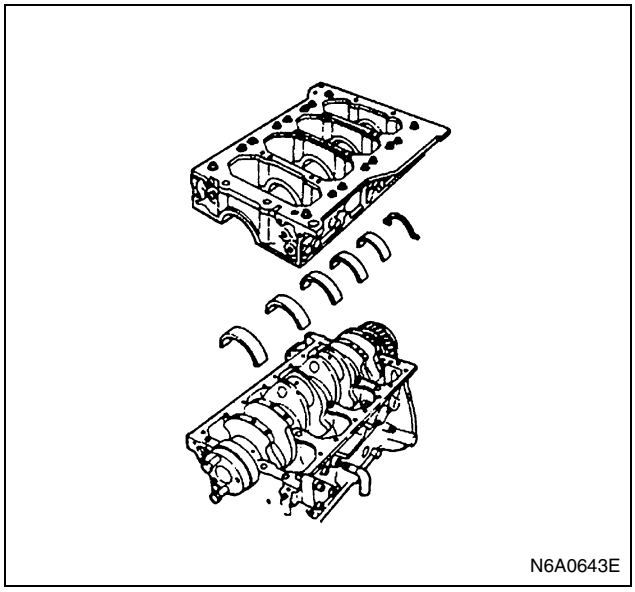


N6A0642E

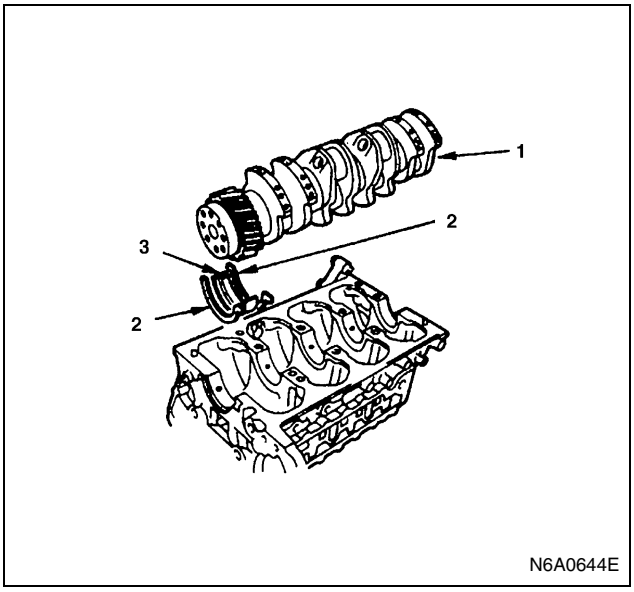
41. Power Steering Pump Idle Gear Cover
42. Power Steering Pump Idle Gear
43. Flywheel Housing
44. Idle Gear A
45. Oil Pump Assembly
    Above works refer to “TIMING GEAR REPLACEMENT” section in this manual.
46. Connecting Rod Cap Assembly
47. Connecting Rod Lower Bearing
48. Piston and Connecting Rod Assembly
    Above works refer to “PISTON AND CONNECTING ROD” section in this manual.
49. Crankcase
    1) Loosen the crankcase bolts in numerical order a little at a time.
    2) Install the three crankcase fixing bolts (See arrow marks) to the crankcase replacer holes as shown in the illustration, and tighten the bolts alternate a little at a time.

Notice:
When removing the crankcase, be sure to remove the oil pump and the generator bracket before that.

50. Thrust Bearing Lower
51. Crankshaft Bearing Lower

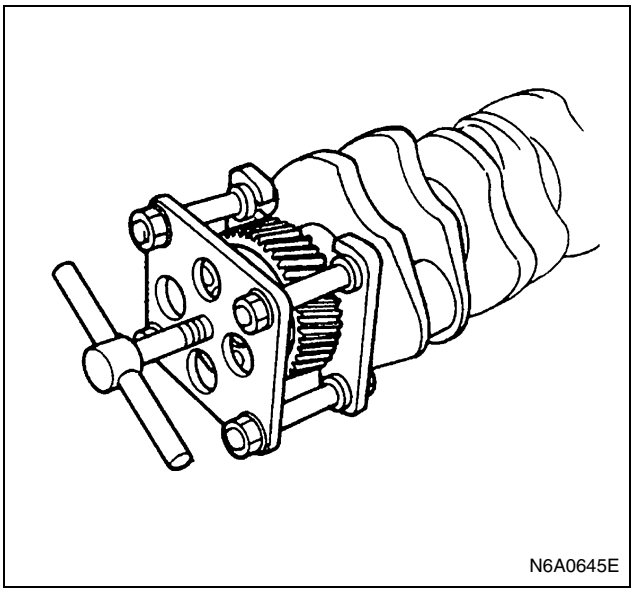

N6A0643E

52. Crankshaft Assembly
53. Thrust Bearing Upper
54. Crankshaft Bearing Upper



Legend
1. Crankshaft assembly
2. Thrust bearing upper
3. Crankshaft bearing upper

55. Crankshaft Gear
    1) Use the crankshaft gear remover to remove the crankshaft gear.
       Crankshaft Gear Remover: 8-9439-6818-0



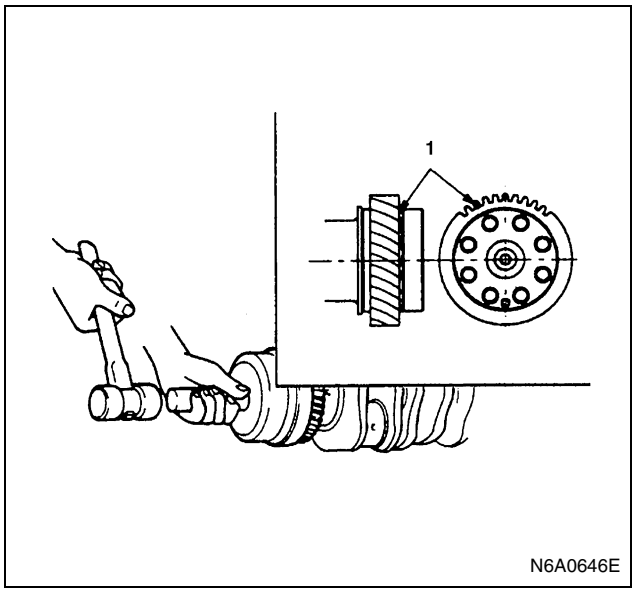
    2) Remove the crankshaft feather key.
56. Crankshaft

Installation

1. Crankshaft
2. Crankshaft Gear
    1) Use a piston heater to heat the crankshaft gear to 170 — 250°C (338 — 482°F).
    2) With the alignment mark “S” on the side of the crankshaft gear turned outward, align the groove on the gear side with the crankshaft pin position and hammer it in with a crankshaft gear installer until it hits the bottom.

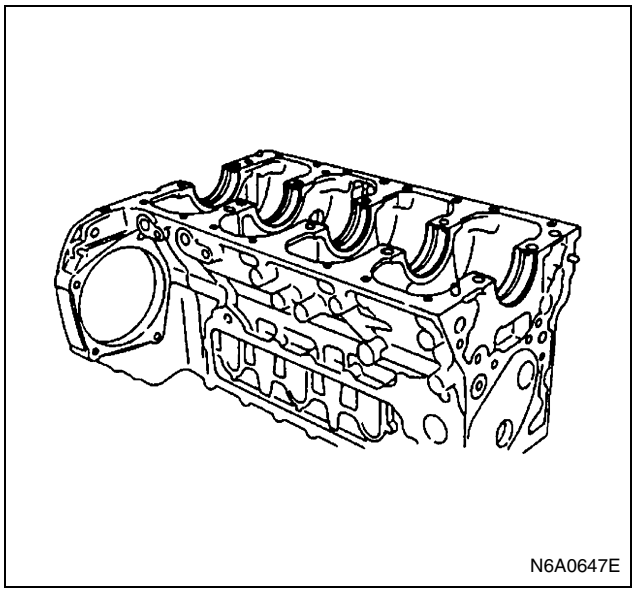
Caution:
When hammered in with the gear slanted, the crankshaft gear may be caught in the middle and cannot be hammered in fully. Gear it in quickly enough not to allow a shaft line along the gear and the crankshaft to slant.

Crankshaft Gear Installer: 8-9439-6819-0



Legend
1. Alighment mark

3. Crankshaft Bearing Upper
   When replacing the crankshaft or the crankshaft bearing with a new one, select the crankshaft bearing according to the respective grades stamped on the crankshaft and the cylinder body.
   Refer to the “CRANKSHAFT”.
   All upper bearings have oil grooves.



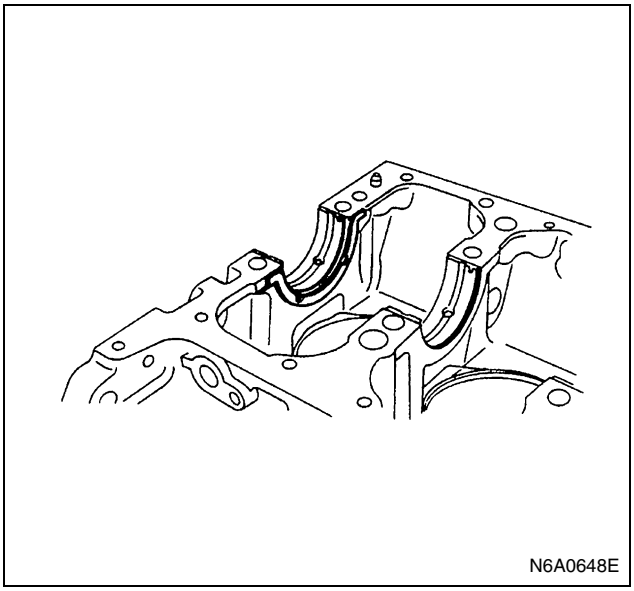
1) Carefully wipe any foreign material from the upper bearing.

Caution:
Do not apply engine oil to the bearing back faces and the cylinder body bearing fitting surfaces.

2) Locate the position mark applied at disassembly if the removed upper bearings are to be reused.

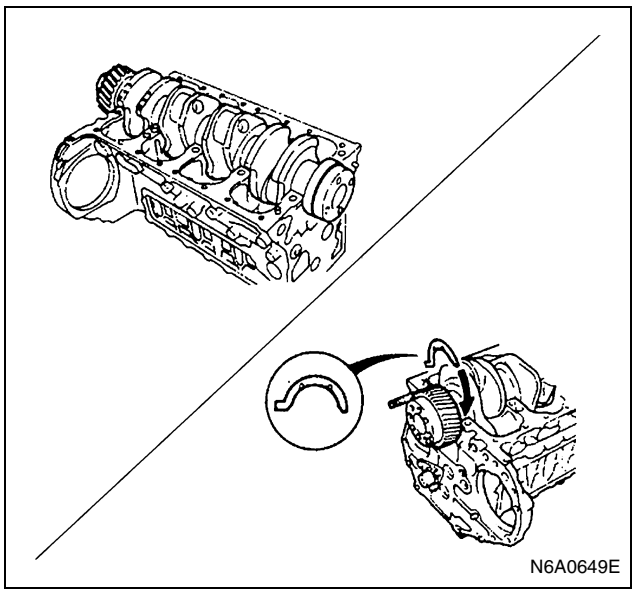
4. Thrust Bearing Upper
Install the thrust bearing upper to the front side of the cylinder body No.5 journal. At this time, the thrust bearing upper may be pasted to the cylinder body with grease.
However, be sure to wipe off any excessive grease.

Caution:
The thrust bearing oil grooves must be facing the sliding faces.


N6A0648E

5. Crankshaft Assembly
Apply an ample coat of engine oil to the crankshaft journals and the crankshaft bearing surfaces before installing the crankshaft with timing gear.
   - While pressing on the installed crankshaft toward the rear side, insert the thrust bearing upper into the rear side of the cylinder body No.5 journal.

Caution:
The thrust bearing oil grooves must be facing the sliding faces.


N6A0649E

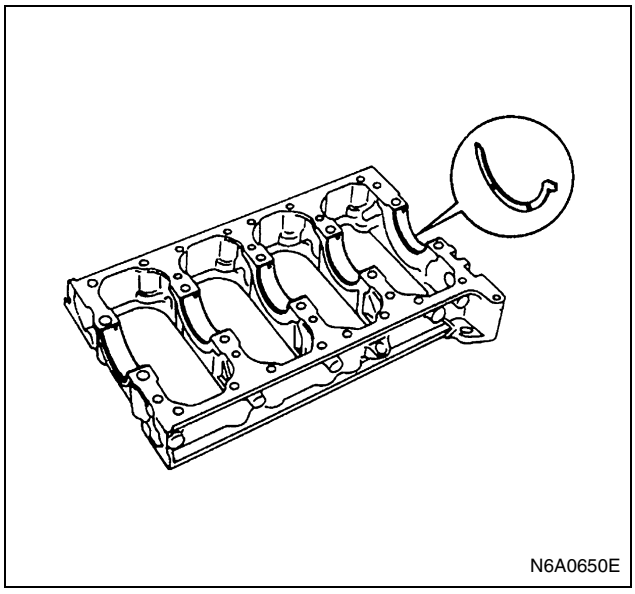
6. Crankshaft Bearing Lower
All lower bearings does not have oil grooves.
   1) Carefully wipe any foreign material from the lower bearing.

Caution:
Do not apply engine oil to the bearing back faces and the crankcase bearing fitting surfaces.

2) Locate the position mark applied at disassembly if the removed lower bearings are to be reused.

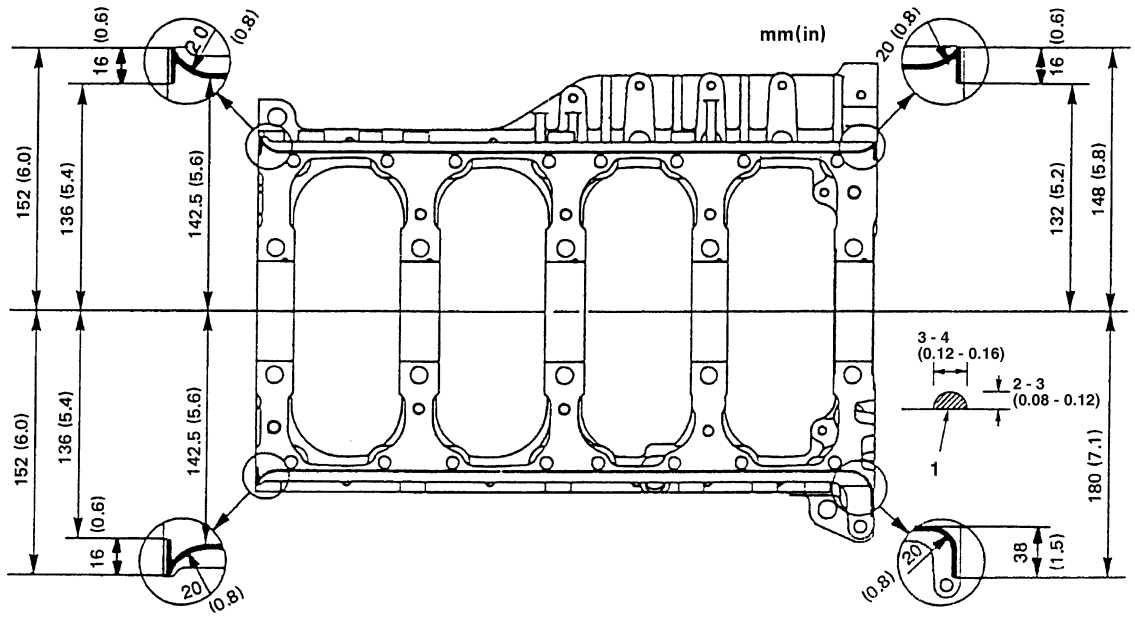
7. Thrust Bearing Lower
Install the thrust bearing lower to the rear side of the crankcase No.5 journal.

Caution:
The thrust bearing oil grooves must be facing the sliding faces.


N6A0650E

8. Crankcase
   1) Apply a 3 mm (0.12 in) bead of recommended liquid gasket (Three Bond 1207C) or its equivalent to the crankcase upper surface as shown in the illustration.
   2) Carefully place the crankcase on the cylinder body.

   • Install the crankcase within 20 minutes after application of liquid gasket.



N6A1622E

Legend

1. Liquid gasket

   3) Tighten the crankcase to the specified torque in the numerical order shown in the illustration.

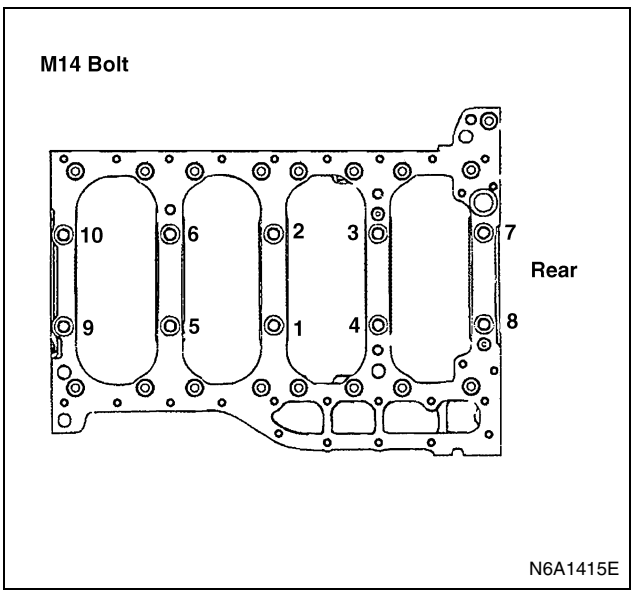
Tighten:

Crankcase bolt (M14: (1) — (10)) to

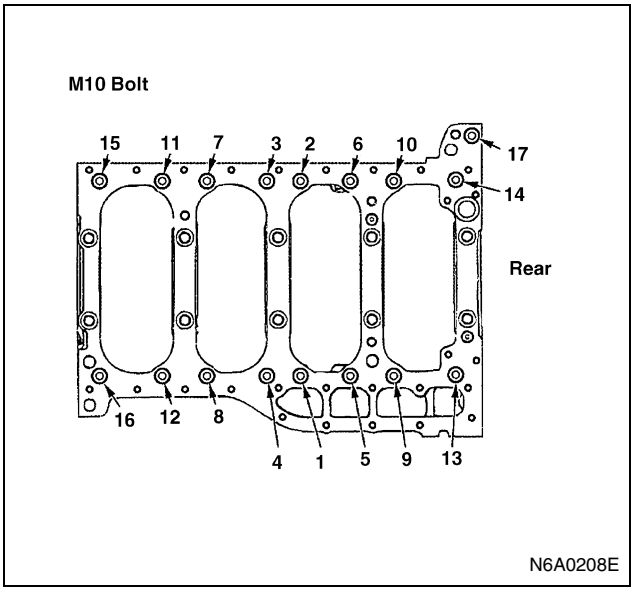
- 1st step: 98 N·m (10 kg·m/72 lb·ft)
- 2nd step: 132 N·m (13.5 kg·m/98 lb·ft)
- 3rd step: 30 — 60°

Crankcase bolt (M10:(1) — (17)) to 37 N·m (3.8 kg·m/27 lb·ft)

Angle gauge: 5-8840-0266-0

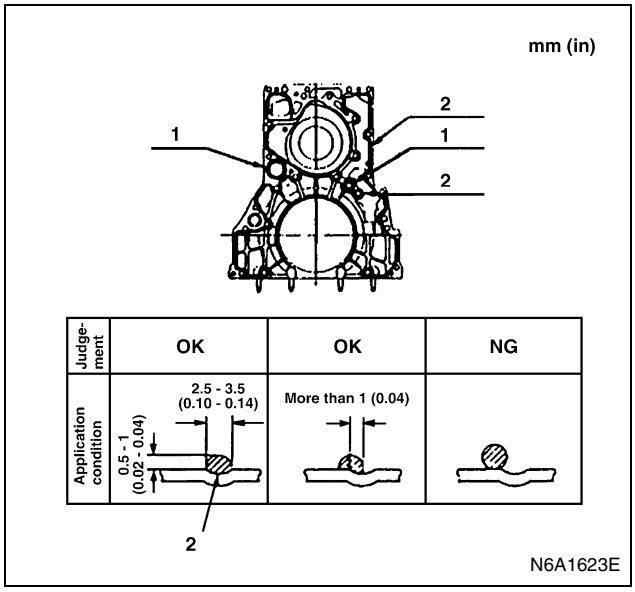


N6A1415E

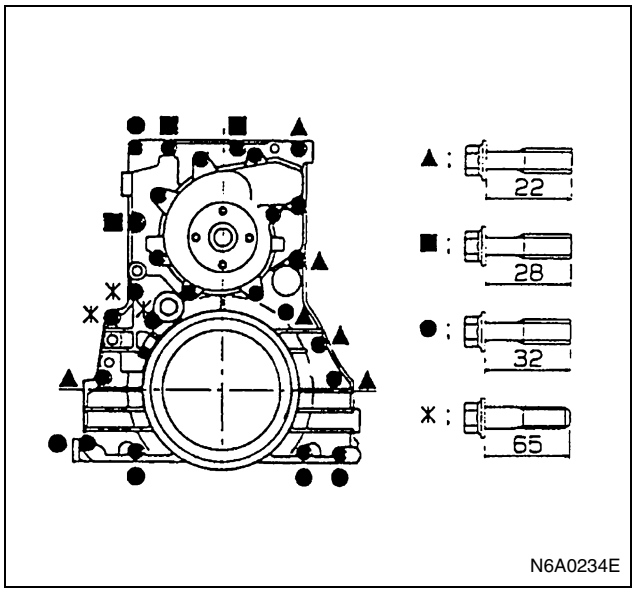


9. Piston and Connecting Rod Assembly
10. Connecting Rod Lower Bearing
11. Connecting Rod Cap Assembly
    Above works refer to “PISTON AND CONNECTING ROD” section in this manual.
12. Oil Pump Assembly
13. Idle Gear A
    Above works refer to “OIL PUMP ASSEMBLY” section in this manual.
14. Flywheel Houisng
15. Power Steering Pump Idle Gear
16. Power Steering Pump Idle Gear Cover
17. Oil Thermo Valve
    Above works refer to “TIMING GEAR REPLACEMENT” section in this manual.
18. Front Retainer
    1) Carefully wipe any foreign material from the cylinder body front face.
    2) Apply 2.5 — 3.5 mm (0.10 — 0.14 in) bead of the recommended liquid gasket (Three Bond 1207C) or its equivalent on the groove of the front retainer fitting surface shown in the illustration.
    3) Install the O-rings (2 pieces) to the front retainer.
    - Install the front retainer within 7 minutes after application of liquid gasket.
    - For the dislocation of liquid gasket, refer to the illustration.
    4) Align the cylinder body knock pins with the front retainer knock pin holes.

Tighten:
Front retainer bolt to 24 N·m (2.4 kg·m/17 lb·ft)



Legend
1. O-ring
2. Liquid gasket



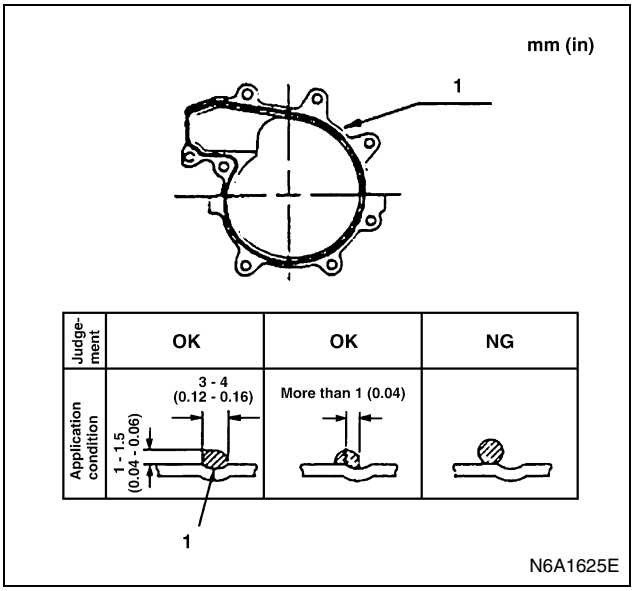
19. Water Pump Assembly
    1) Apply 3 — 4 mm (0.12 — 0.16 in) bead of the recommended liquid gasket (Three Bond 1207C) or its equivalent on the water pump fitting surface.
    2) Install the water pump to the front retainer.

Tighten:
Water pump bolt to 24 N·m (2.4 kg·m/17 lb·ft)

- Install the water pump within 7 minutes after application of liquid gasket.
- For the dislocation of liquid gasket, refer to the illustration.

Caution:
The water pump clamping bolt is also used to tighten the front retainer. So, install the water pump before liquid

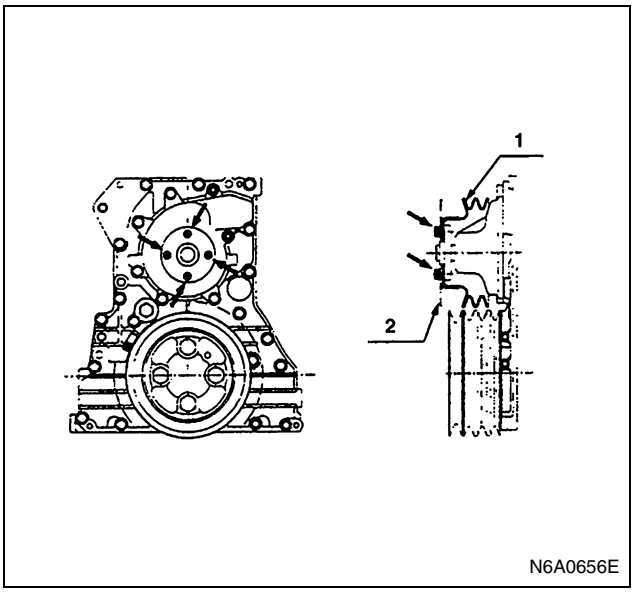
gasket gets dry immediately after installation of the front retainer.



Legend
1. Liquid gasket

20. Water Pump Pulley

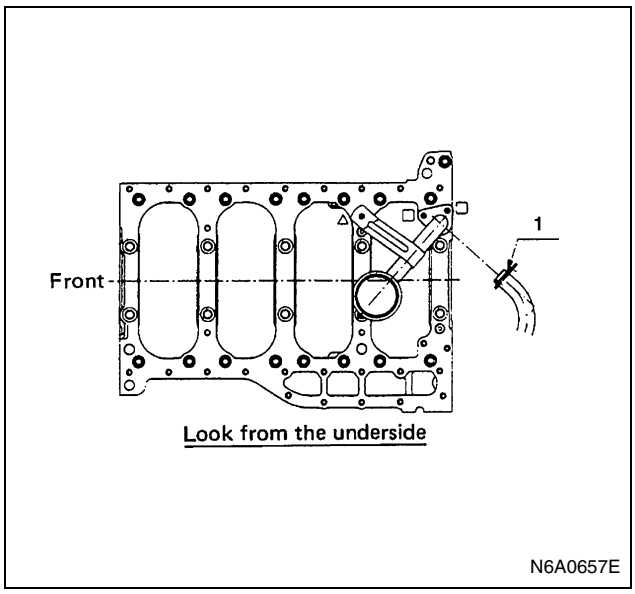
Tighten:
Water pump pulley bolt to 24 N·m (2.4 kg·m/17 lb·ft)



Legend
1. Pulley
2. Set plate

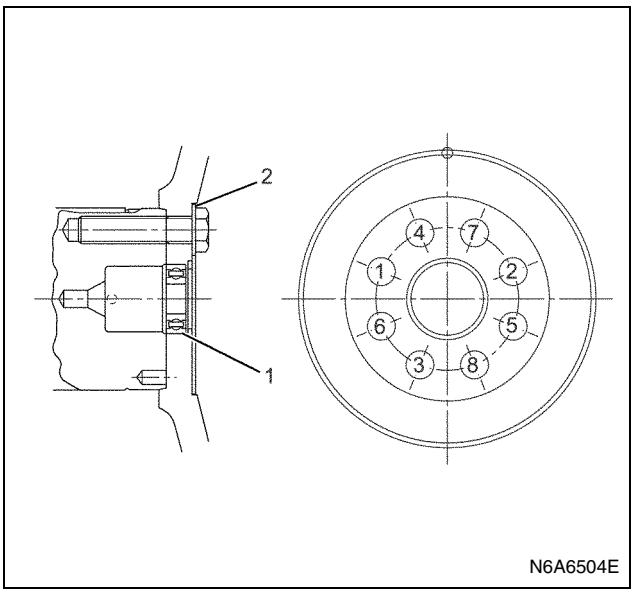
21. Oil Pump Strainer
    Install the O-ring (1) to the oil pump strainer pipe and install the oil pump strainer to the cylinder body shown in the illustration.

Tighten:
Oil pump strainer bolt to 24 N·m (2.4 kg·m/17 lb·ft)



22. Oil Pan
23. Spacer Rubber
    Above works refer to “OIL PAN” section in this manual.
24. Crankshaft Rear Slinger
25. Crankshaft Rear Oil Seal
    Above works refer to “CRANKSHAFT REAR OIL SEAL” section in this manual.
26. Flywheel
    1) Align the flywheel with the crankshaft knock pin and temporarily tighten the flywheel bolts.
    2) Use the crankshaft stopper to prevent the crankshaft from turning.
       Crankshaft Stopper: 5-8840-2230-0
    3) Install the washer and the flywheel bolts and tighten to the specified torque in numerical order show in the illustration.

Tighten:
Flywheel bolt to
- 1st step: 78 N·m (8.0 kg·m/58 lb·ft)
- 2nd step: 90 — 120°

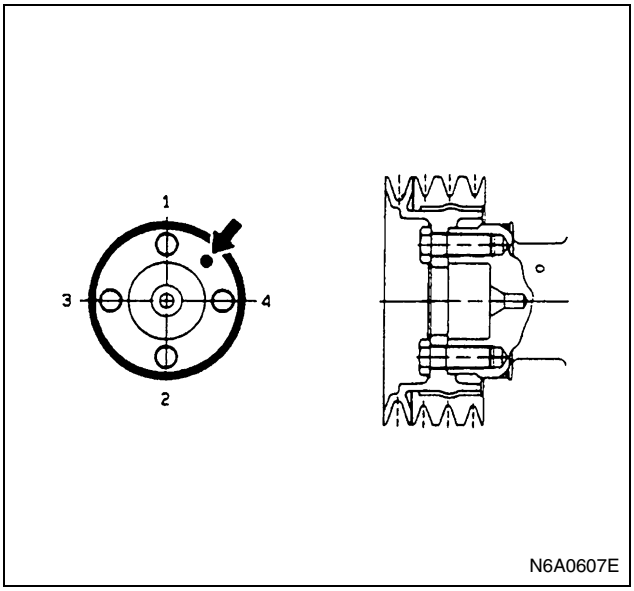


Legend
1. Washer
2. Pilot bearing

4) Remove the crankshaft stopper.

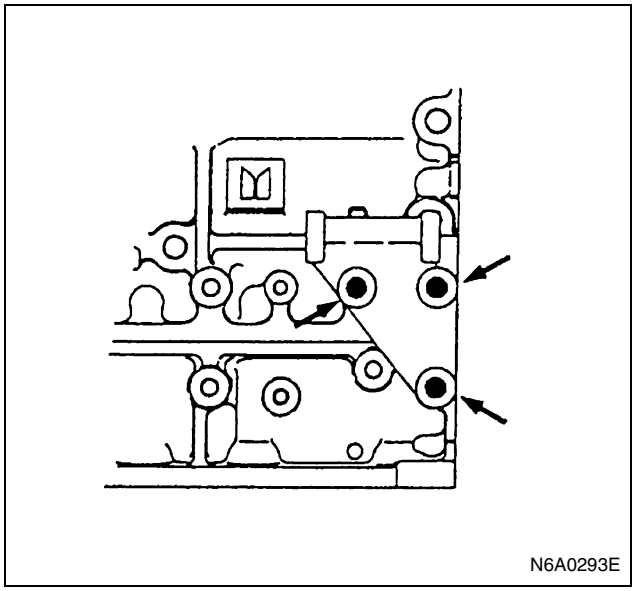
27. Crankshaft Front Slinger
28. Crankshaft Front Oil Seal
    Above works refer to “CRANKSHAFT FRONT OIL SEAL” section in this manual.
29. Crankshaft Damper Pulley
    1) Apply a coat of engine oil to the threads of the bolts.
    2) Align the damper pulley with the crankshaft knock pin and tighten the bolts to the specified torque in numerical order.

Tighten:
Damper pulley bolt to 200 N·m (20.4 kg·m/147 lb·ft)

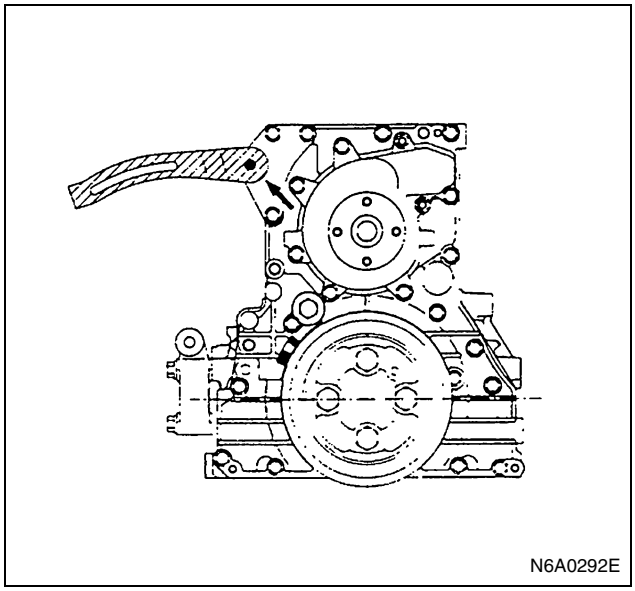


30. Generator Bracket

Tighten:
Generator bracket bolt to 48 N·m (4.9 kg·m/35 lb·ft)

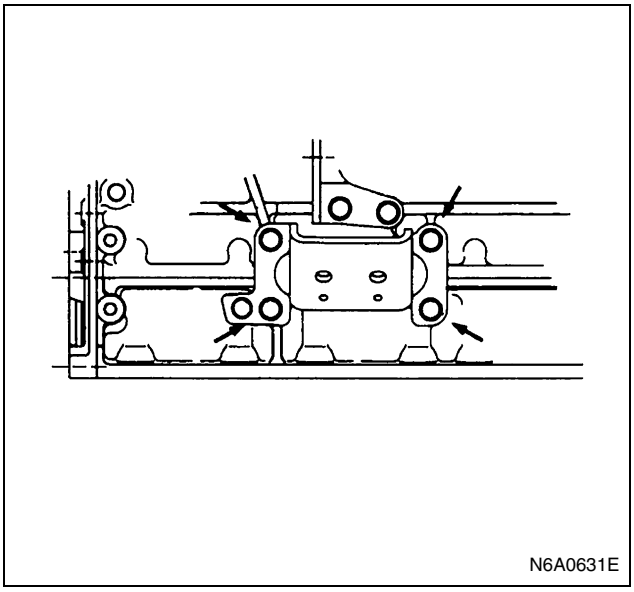


31. Fan Belt Adjust Plate
    Install the adjust plate and temporarily tighten the adjust plate bolt.



32. Injection Pump Assembly
    Above works refer to “INJECTION PUMP ASSEMBLY” section 6C in this manual.
33. Engine Foot

Tighten:
Engine foot bolt to 51 N·m (5.2 kg·m/38 lb·ft)


N6A0631E

34. Generator

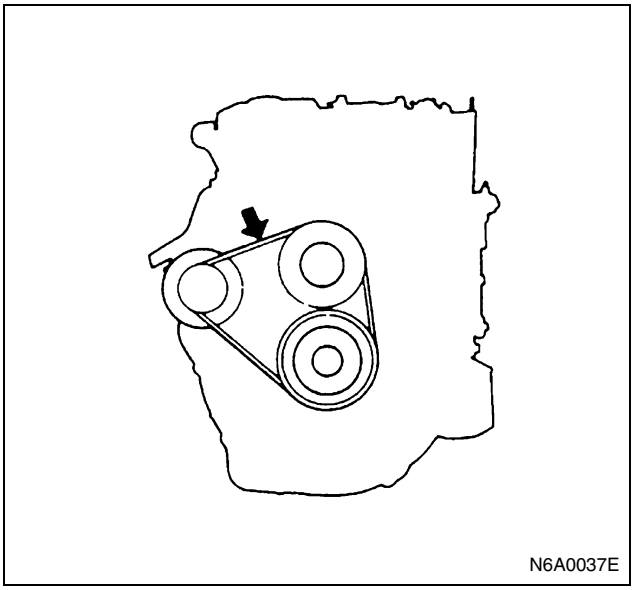
Notice:
When tightening the generator, tighten in advance the fan belt temporarily after its adjustment.

- Insert through the lower fixing bolt from the rear side as shown in the illustration, and tighten it with a nut on the front side.

35. Fan Belt
Check the drive belt tension.
Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

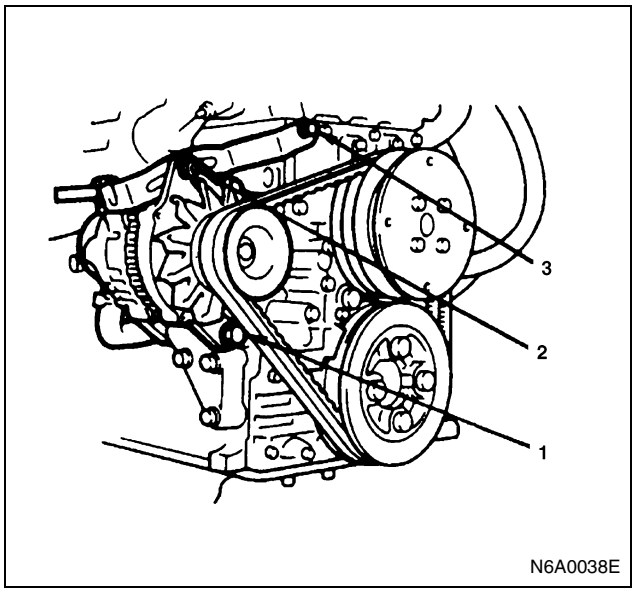
Drive Belt Deflection	mm (in)
8 — 12 (0.31 — 0.47) ... New belt 10 — 14 (0.39 — 0.55) ... Reuse belt	

Check the drive belt for cranking and other damage.


N6A0037E

Fan Belt Adjustment
Fan belt tension is adjusted by moving the generator.

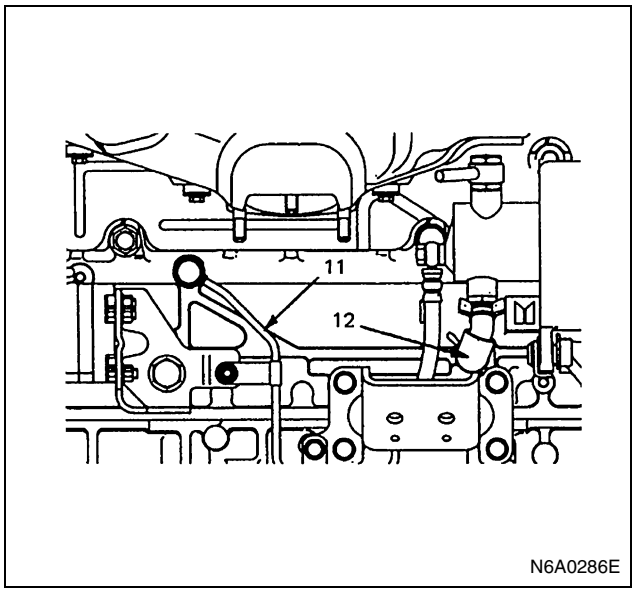
Tighten:
Bolt to
- (1): 40 N·m (4.1 kg·m/30 lb·ft)
- (2): 24 N·m (2.4 kg·m/17 lb·ft)
- (3): 46 N·m (4.7 kg·m/34 lb·ft)



N6A0038E

36. Vacuum Pump Rubber Hose (12)
37. Vacuum Pump Oil Pipe (11)

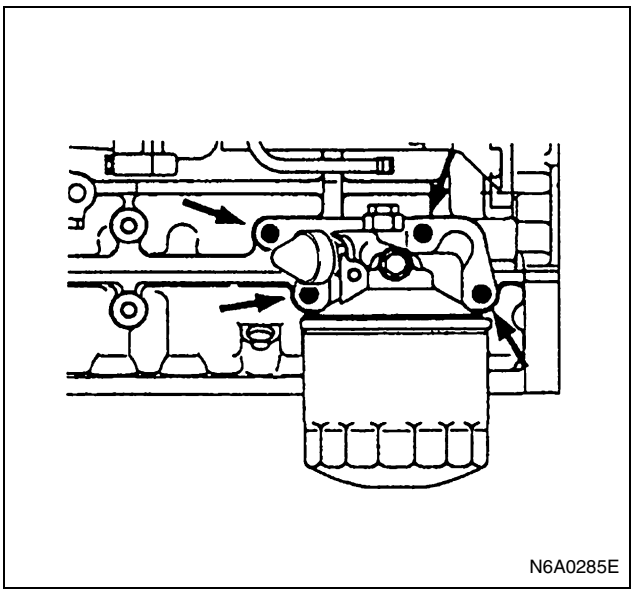
Tighten:
Vacuum pump oil pipe to
- Cylinder body side: 41 N·m (4.2 kg·m/30 lb·ft)
- Generator side: 23 N·m (2.3 kg·m/17 lb·ft)



N6A0286E

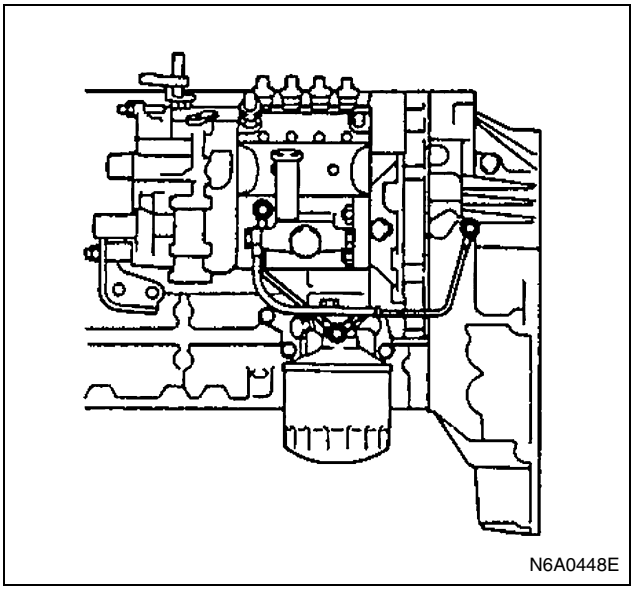
38. Oil Filter Assembly

Tighten:
Oil filter bolt to 48 N·m (4.9 kg·m/35 lb·ft)


N6A0285E

39. Oil Pipe

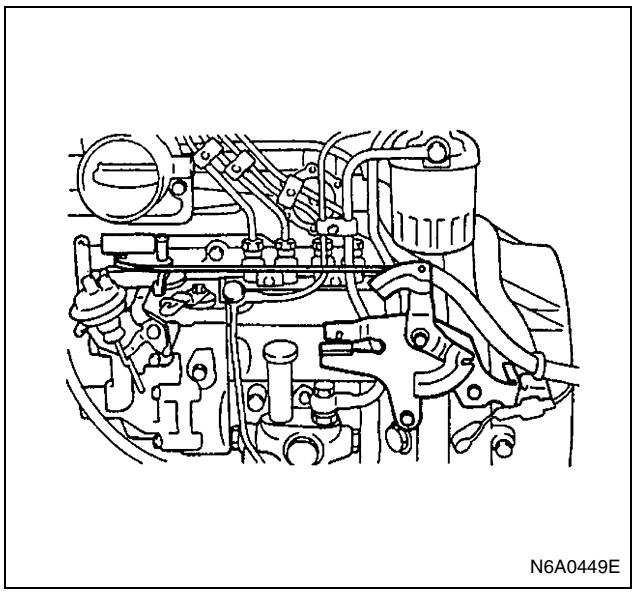
Tighten:
Oil pipe joint bolt to 17 N·m (1.7 kg·m/12 lb·ft)


N6A0448E

40. Engine Control Lever Assembly

Tighten:
Engine control lever bolt to 24 N·m (2.4 kg·m/17 lb·ft)

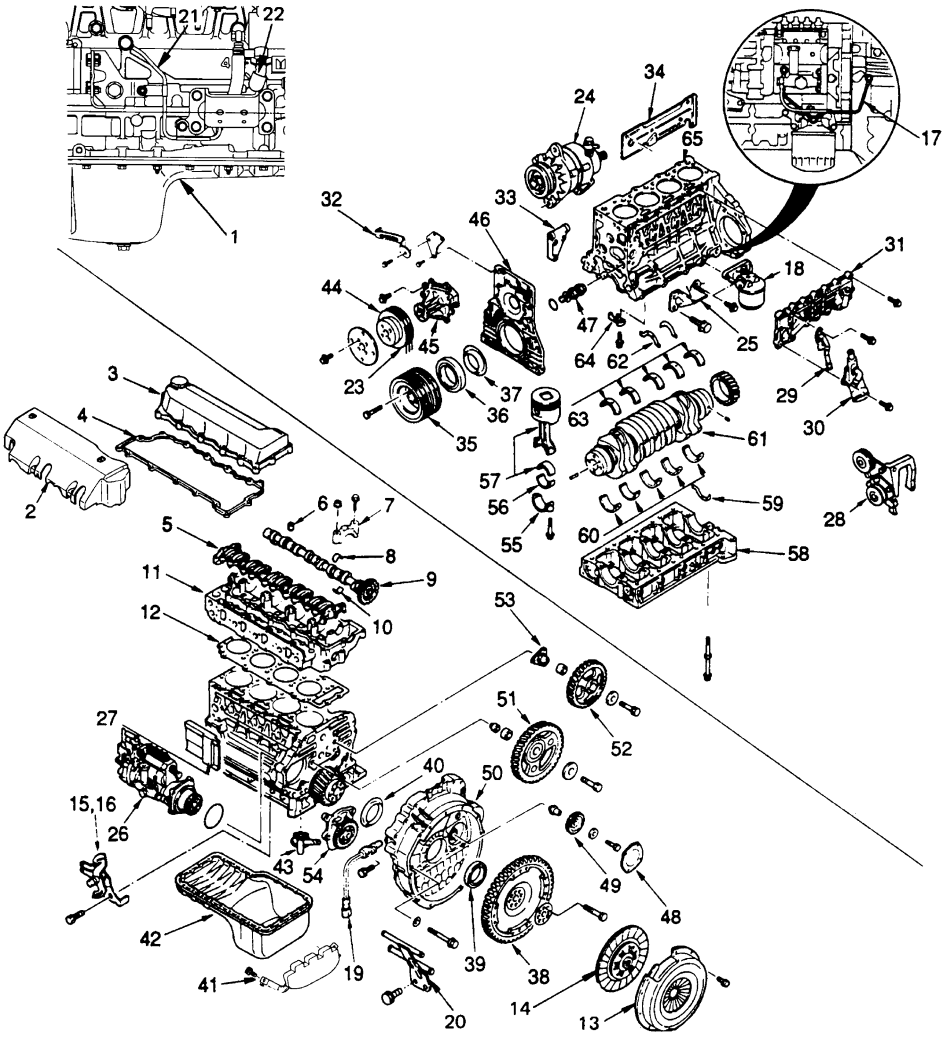
41. Engine Control Wire


N6A0449E

42. Driven Plate
43. Clutch Pressure Plate Assembly
    Above works refer to “FLYWHEEL AND PILOT BEARING” section in this manual.
44. Cylinder Head Gasket
    Above works refer to “CYLINDER HEAD” section in this manual.
45. Cylinder Head Assembly
    Above works refer to “CYLINDER HEAD” section in this manual.
46. Camshaft Bearing Lower
47. Camshaft Assembly
48. Camshaft Bearing Upper
49. Camshaft Bearing Cap
50. Valve Cap
    Above works refer to “CAMSHAFT ASSEMBLY” section in this manual.
51. Rocker Arm Shaft Assembly
    Above works refer to “ROCKER ARM SHAFT ASSEMBLY” section in this manual.
52. Cylinder Head Cover Gasket
    Above works refer to “CYLINDER HEAD” section in this manual.
53. Cylinder Head Cover
    Above works refer to “ROCKER ARM SHAFT ASSEMBLY” section in this manual.
54. Nozzle Cover
55. Engine Assembly
    Above works refer to “ENGINE ASSEMBLY” section in this manual.

CYLINDER BLOCK

Component



N6A1641E

Legend

1. Engine assembly
2. Nozzle cover
3. Cylinder head cover
4. Cylinder head cover gasket
5. Rocker arm shaft assembly
6. Valve cap
7. Camshaft bearing cap
8. Camshaft bearing upper
9. Camshaft assembly
10. Camshaft bearing lower
11. Cylinder head assembly
12. Cylinder head gasket
13. Clutch pressure plate assembly
14. Driven plate
15. Engine control wire
16. Engine control lever assembly
17. Oil pipe
18. Oil filter assembly
19. Tachometer sensor
20. Fuel pipe bracket
21. Vacuum pump oil pipe
22. Vacuum pump rubber hose
23. Fan belt
24. Generator
25. Engine foot
26. Injection pump assembly
27. Injection pump rubber spacer
28. Idle pulley bracket
29. Heater pipe
30. Water suction pipe
31. Oil cooler assembly
32. Fan belt adjust plate
33. Generator bracket
34. Cover
35. Crankshaft pulley
36. Crankshaft front oil seal
37. Crankshaft front slinger
38. Flywheel assembly
39. Crankshaft rear oil seal
40. Crankshaft rear slinger
41. Spacer rubber
42. Oil pan
43. Oil pump strainer
44. Water pump pulley
45. Water pump
46. Front retainer
47. Oil thermo valve
48. Power steering pump idle gear cover
49. Power steering pump idle gear
50. Flywheel housing
51. Idle gear A
52. Idle gear B
53. Idle gear B shaft
54. Oil pump assembly
55. Connecting rod cap
56. Connecting rod lower bearing
57. Piston and connecting
58. Crankcase
59. Thrust bearing lower
60. Crankshaft bearing lower
61. Crankshaft assembly
62. Thrust bearing upper
63. Crankshaft bearing upper
64. Piston oil jet
65. Cylinder block

Removal

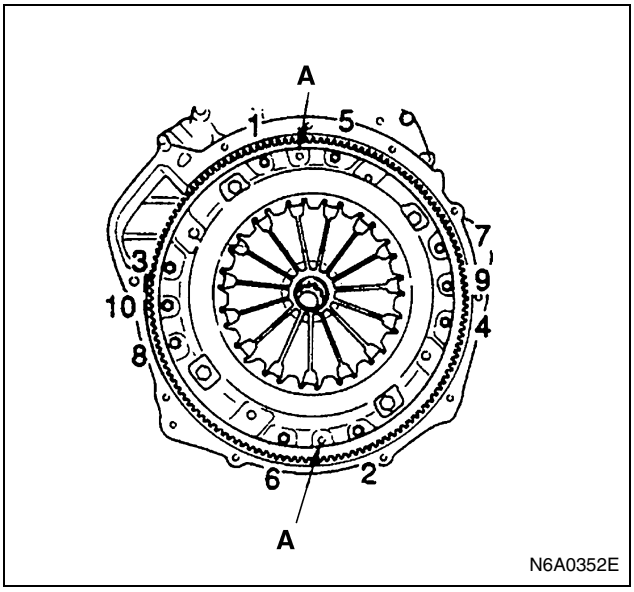
Preparation

- Disconnect battery ground cable.
- Tilt the cab
- Drain coolant and engine oil

1. Engine Assembly
   Above works refer to “ENGINE ASSEMBLY” section in this manual.
2. Nozzle Cover
3. Cylinder Head Cover
4. Cylinder Head Cover Gasket
5. Rocker Arm shaft Assembly
   Above works refer to “ROCKER ARM SHAFT ASSEMBLY” section in this manual.
6. Valve Cap

Caution:
Take sufficient care not to let valve caps fall into the gear case or oil return hole.

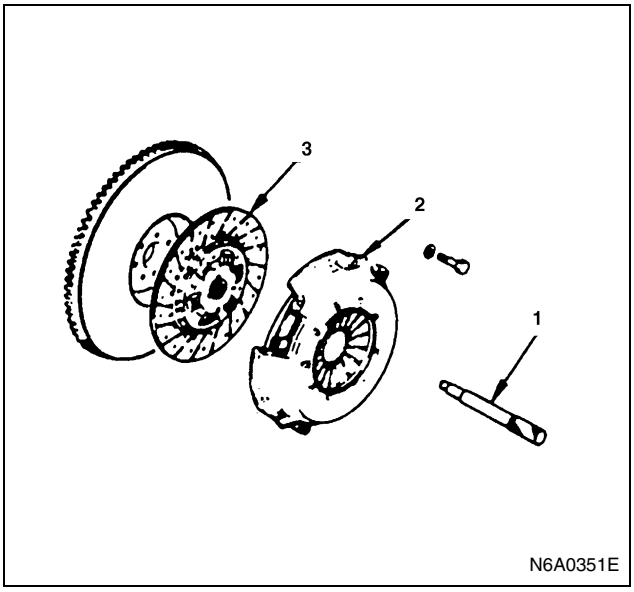
7. Camshaft Bearing Cap
8. Camshaft Bearing Upper
9. Camshaft Assembly
10. Camshaft Bearing Lower
    Above works refer to “CAMSHAFT ASSEMBLY” section in this manual.
11. Cylinder Head Assembly
    Above works refer to “CYLINDER HEAD” section in this manual.
12. Cylinder Head Gasket
13. Clutch Pressure Plate Assembly
    1) Insert the clutch pilot aligner to the clutch assembly.
       Clutch Pilot Aligner: 5-8840-2240-0
    2) Loosen the pressure plate bolts in numerical order a little at a time as shown in the illustration.



Legend
A. Knock pin

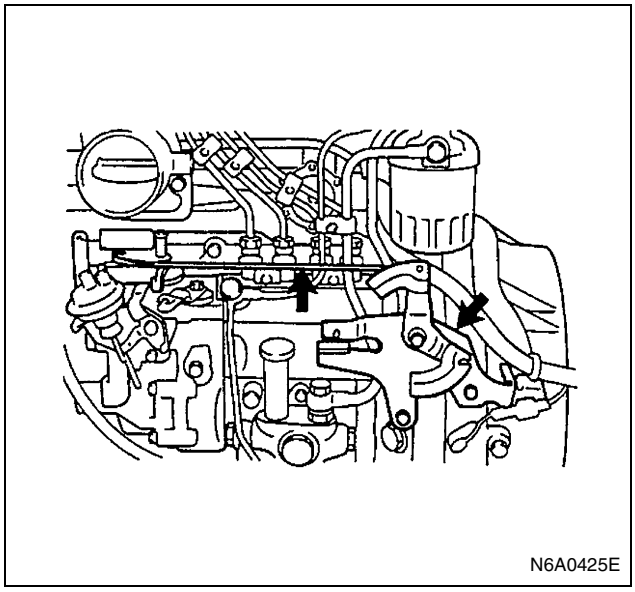
3) Remove the pressure plate assembly.

14. Driven Plate
Remove the driven plate with the clutch pilot aligner.

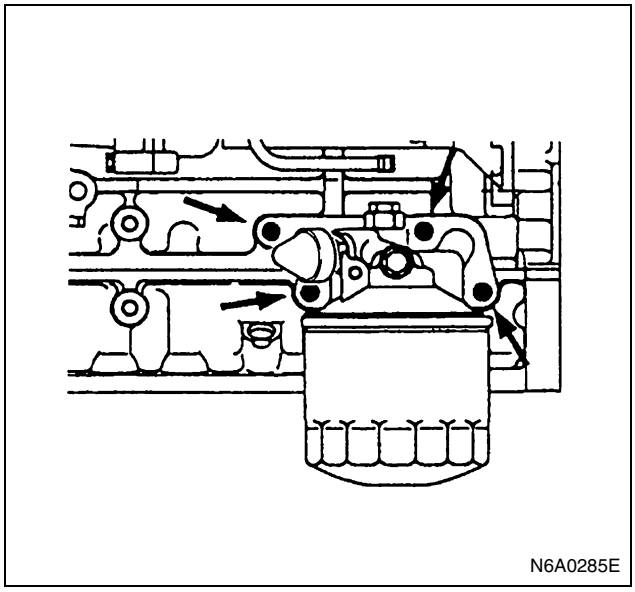


Legend
1. Clutch pilot aligner
2. Clutch pressure plate assembly
3. Driven plate

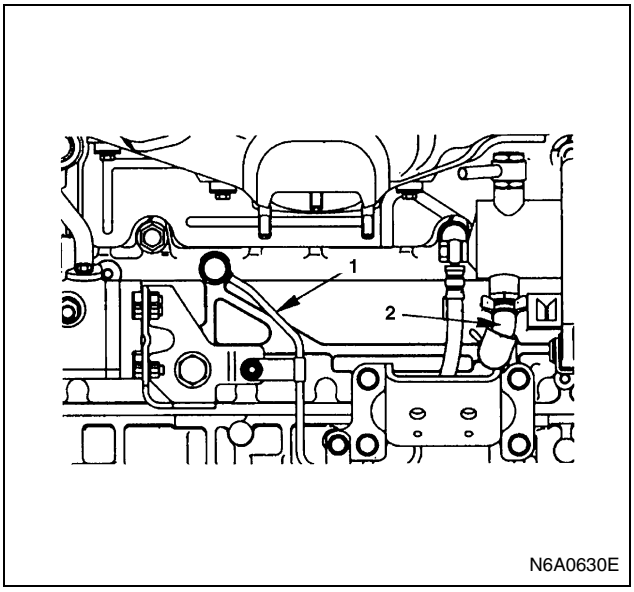
15. Engine Control Wire
16. Engine Control Lever Assembly



17. Oil Pipe
18. Oil Filter Assembly



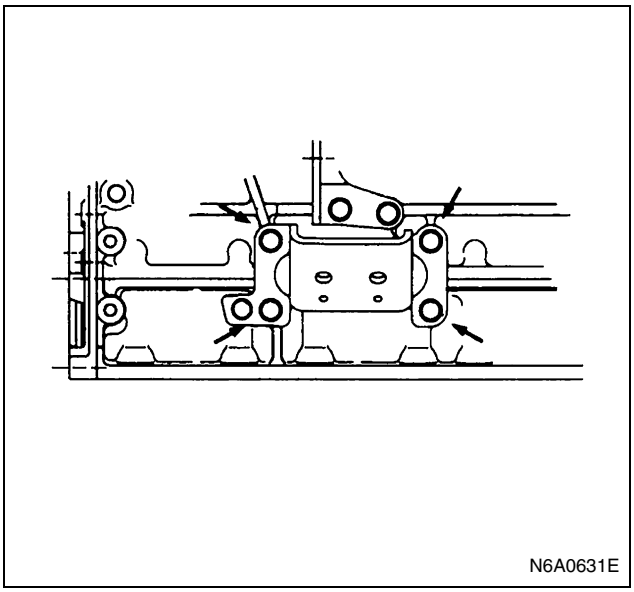
19. Tachometer Sensor
20. Fuel Pipe Bracket
21. Vacuum Pump Oil Pipe
22. Vacuum Pump Rubber Hose



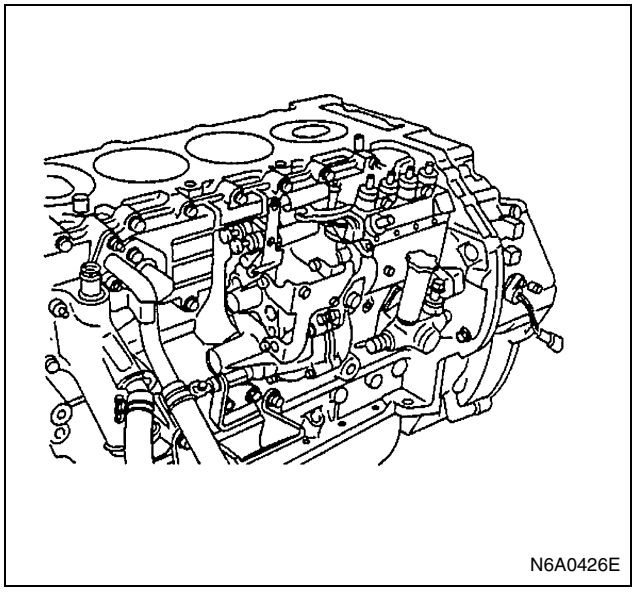
Legend

1. Vacuum pump oil pipe
2. Vacuum pump rubber hose

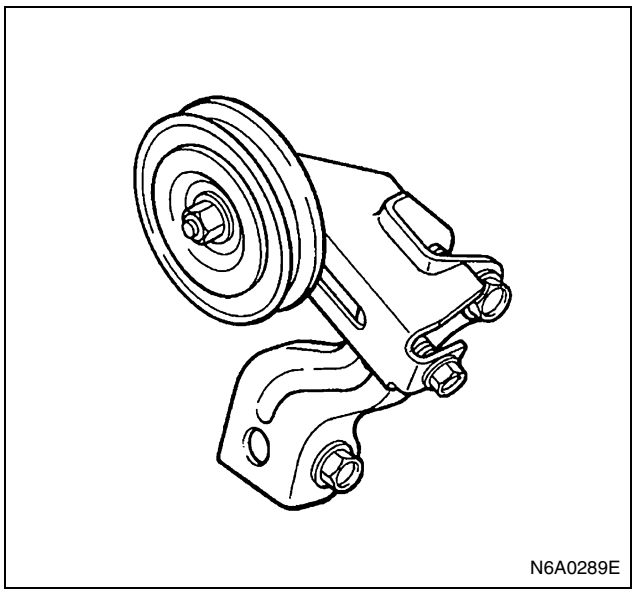
23. Fan Belt
24. Generator
25. Engine Foot



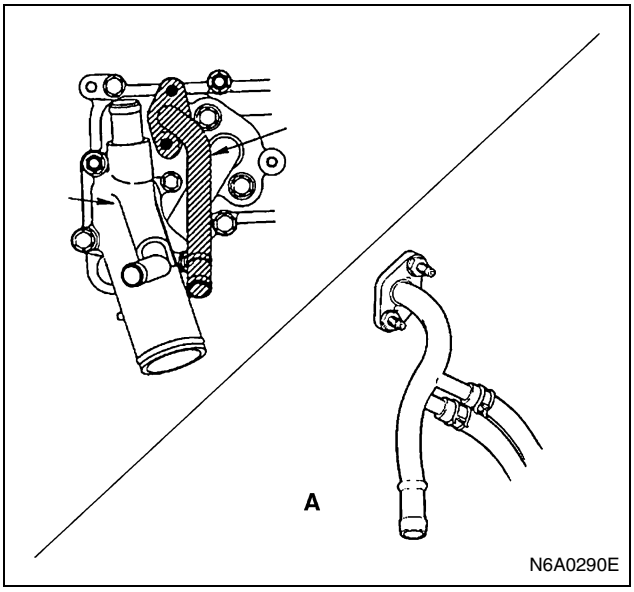
26. Injection Pump Assembly
    1) Remove the injection pump bracket bolts and the injection pump rear bracket bolts.
    2) Then remove the injection pump assembly.



27. Injection Pump Rubber Spacer
28. Idle Pulley Bracket (If equipped with A/C)

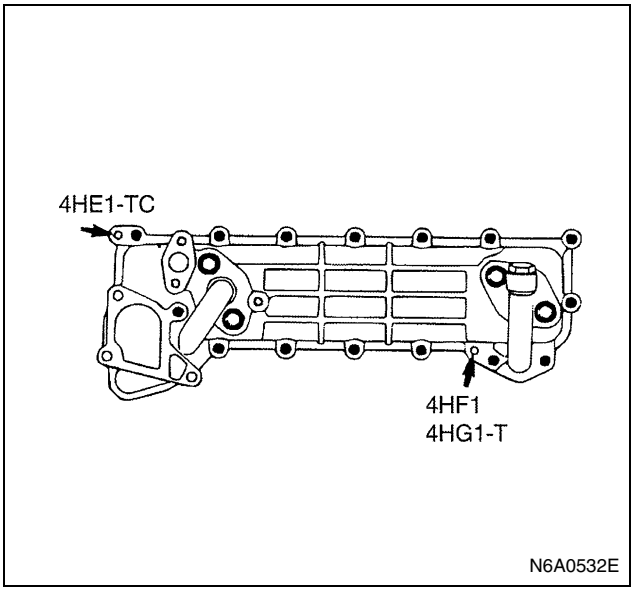


29. Heater Pipe

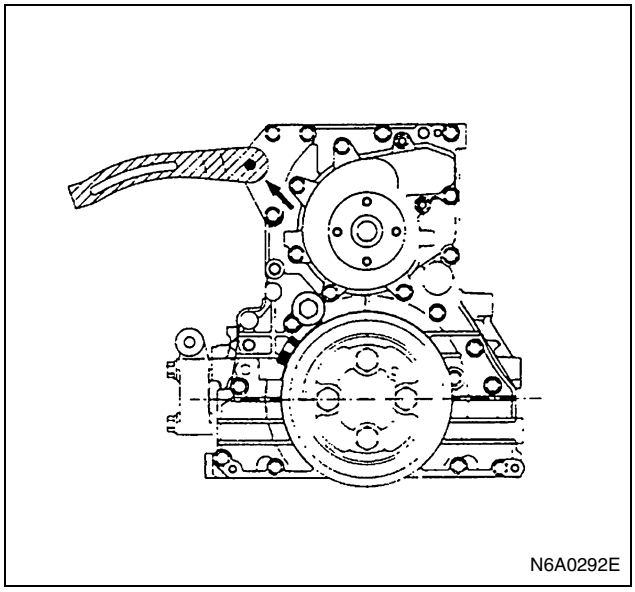


Legend
A. 4HF1-2

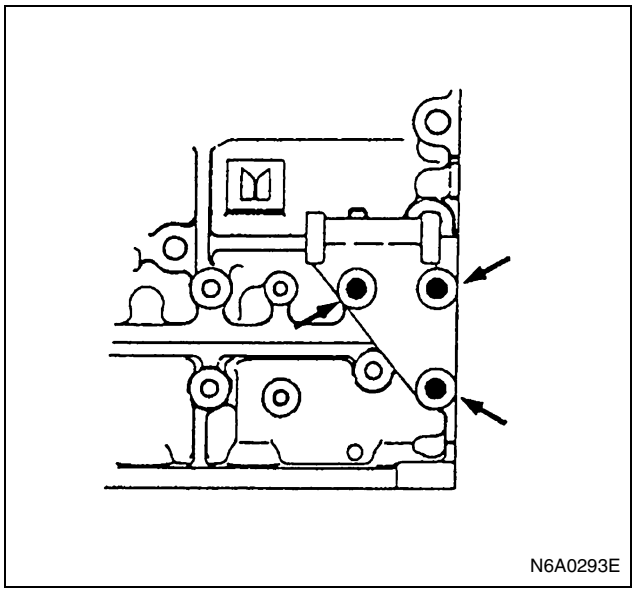
30. Water Suction Pipe
31. Oil Cooler Assembly
    1) Remove the oil cooler bolts.
    2) Install a oil cooler fixing bolt to the oil cooler replacer hole as shown in the illustration, and tighten the bolt alternately a little at a time.



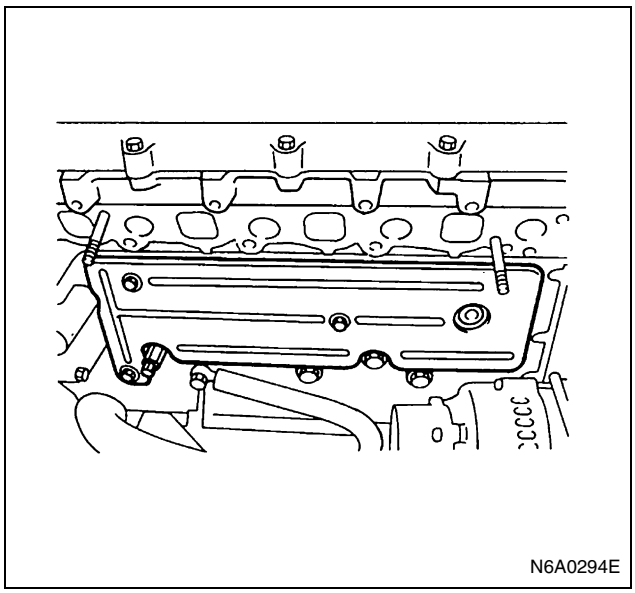
32. Fan Belt Adjust Plate



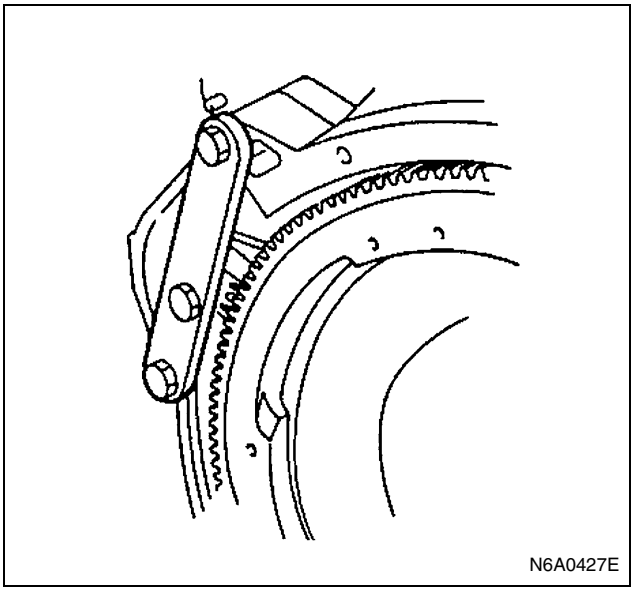
33. Generator Bracket



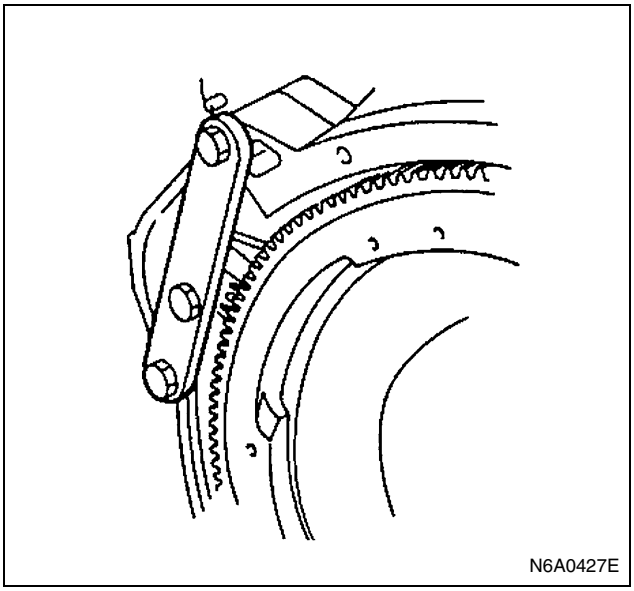
34. Cover



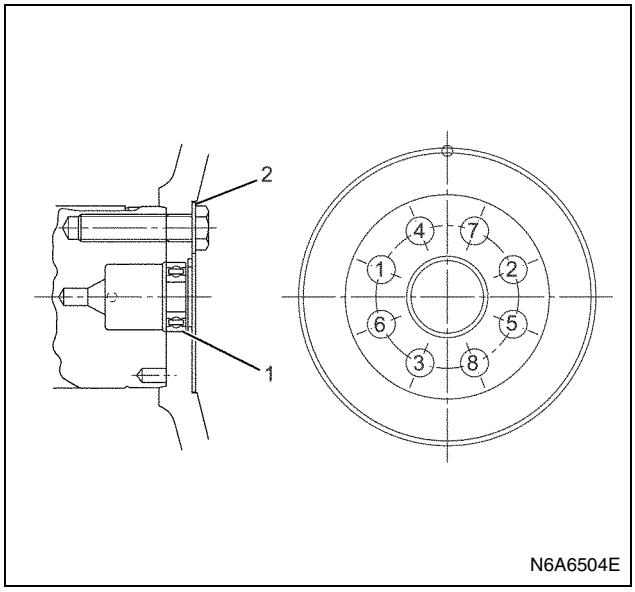
35. Crankshaft Damper Pulley
    1) Use the crankshaft stopper to prevent the crankshaft from turning.
       Crankshaft Stopper: 5-8840-2230-0



    2) Loosen the damper pulley bolts and remove the damper pulley.
36. Crankshaft Front Oil Seal
37. Crankshaft Front Slinger
    Above works refer to “CRANKSHAFT FRONT OIL SEAL” section in this manual.
38. Flywheel Assembly
    1) Use the crankshaft stopper to prevent the crankshaft from turning
       Crankshaft Stopper: 5-8840-2230-0

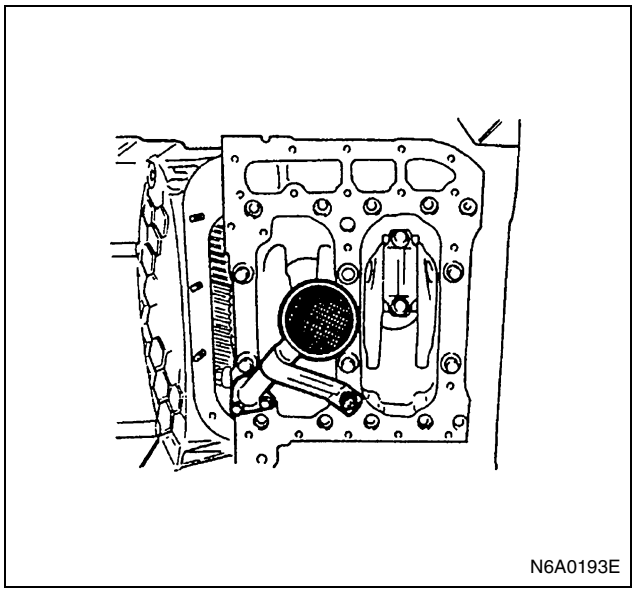


    2) Loosen the flywheel bolts in numerical order a little at a time as shown in the illustration.
    3) Remove the flywheel stopper and the flywheel assembly.

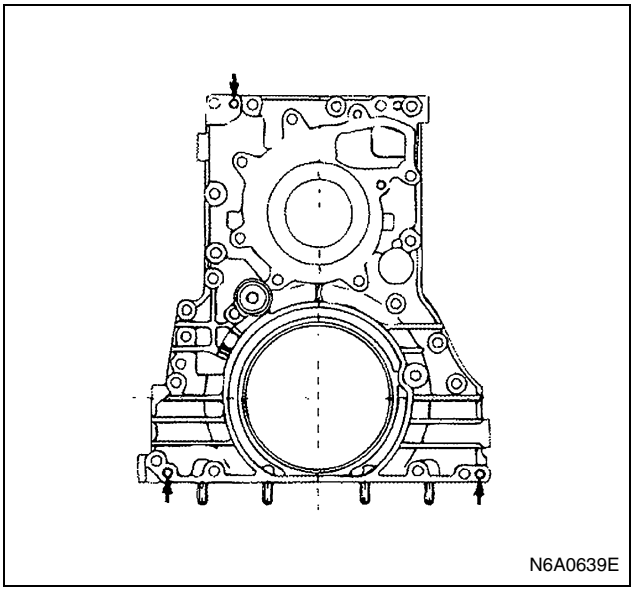


Legend
1. Washer
2. Pilot bearing

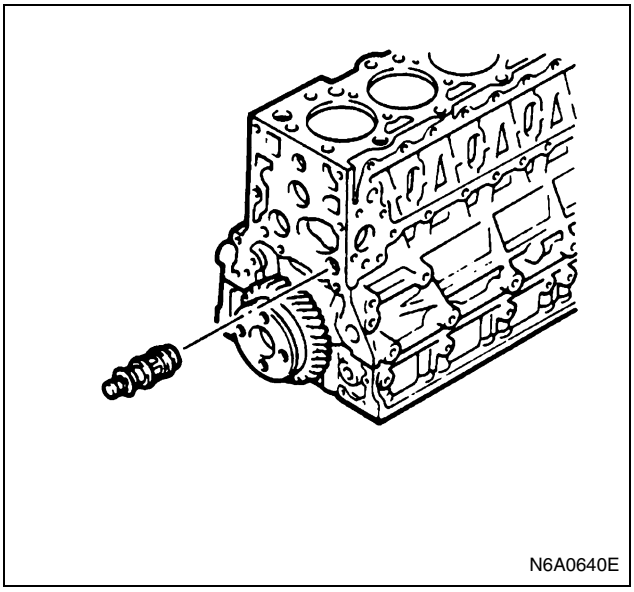
39. Crankshaft Rear Seal
40. Crankshaft Rear Slinger
    Above works refer to “CRANKSHAFT REAR OIL SEAL” section in this manual.
41. Spacer Rubber
    Remove the stiffener before removing the spacer rubber.
42. Oil Pan
43. Oil Pump Strainer



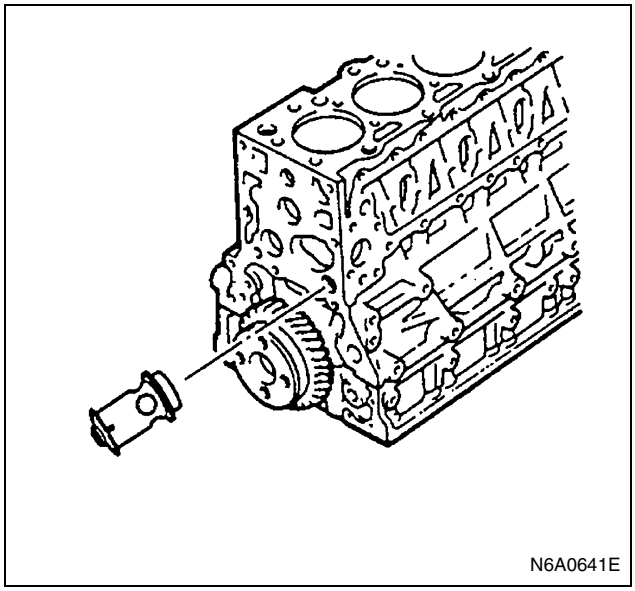
44. Water Pump Pulley
45. Water Pump
46. Front Retainer
    Install the three front retainer fixing bolts to the front retainer replacer holes as shown in the illustration, and tighten the bolts alternately a little at a time.



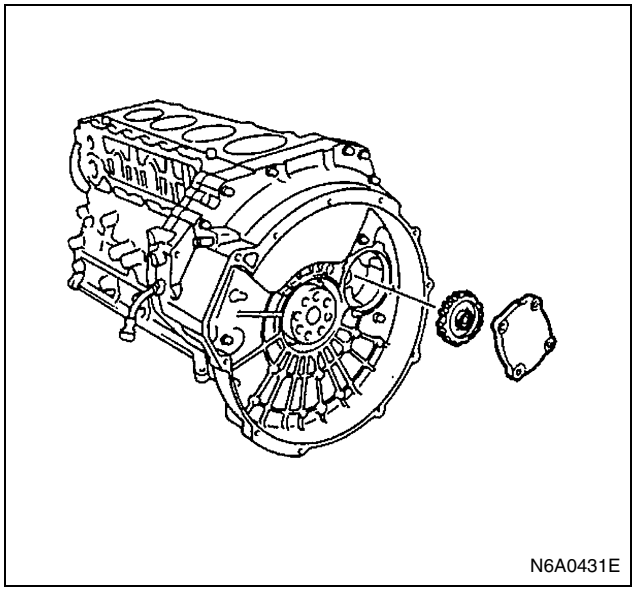
47. Oil Thermo Valve (4HF1, 4HF1-2, 4HG1, 4HG1-T)
Pull out the thermo valve from the cylinder body.



48. Bypass Valve (4HE1-TC)
Pull out the bypass valve from the cylinder body.

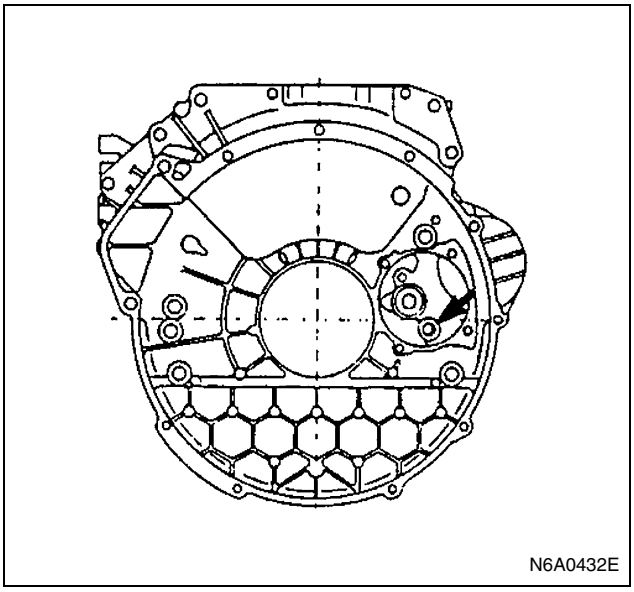


49. Power Steering Pump Idle Gear Cover
50. Power Steering Pump Idle Gear

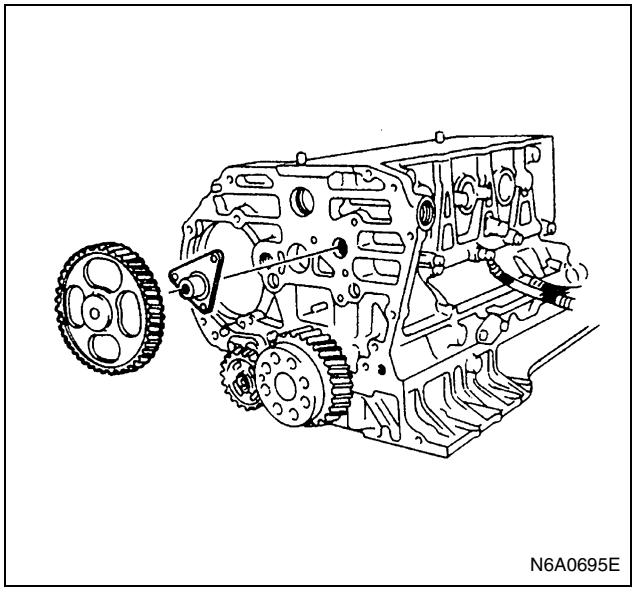


51. Flywheel Housing

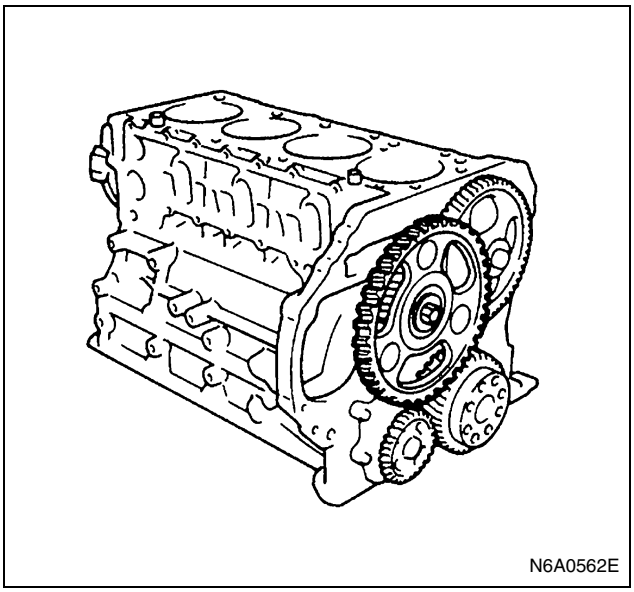
Notice:
Be careful not to fail to remove the bolts shown in the illustration.



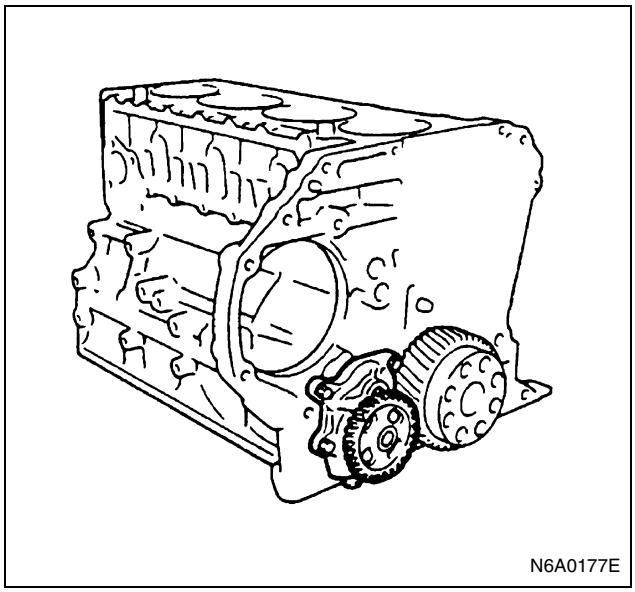
52. Idle Gear A



55. Oil Pump Assembly

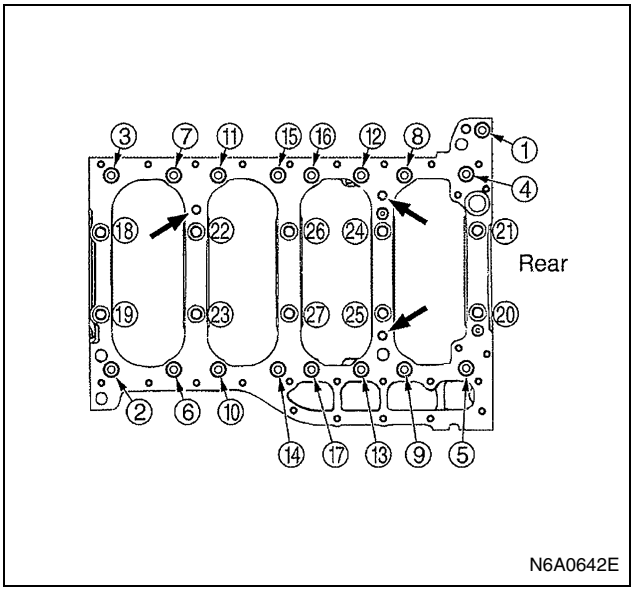


53. Idle Gear B
54. Idle Gear B Shaft

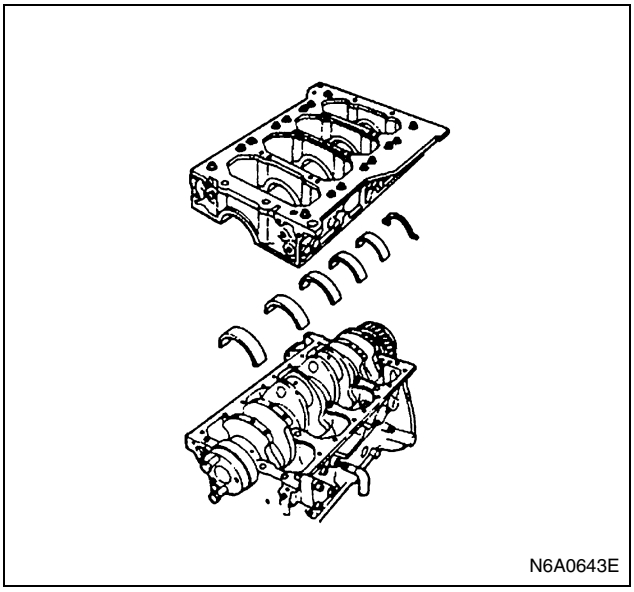


56. Connecting Rod Cap
57. Connecting Rod Lower Bearing
58. Piston and Connecting Rod Assembly
    Above works refer to “PISTON AND CONNECTING ROD” section in this manual.
59. Crankcase
    1) Loosen the crankcase bolts in numerical order a little at a time.
    2) Install the three crankcase fixing bolts (See arrow marks) to the crankcase replacer holes as shown in the illustration, and tighten the bolts alternate a little at a time.

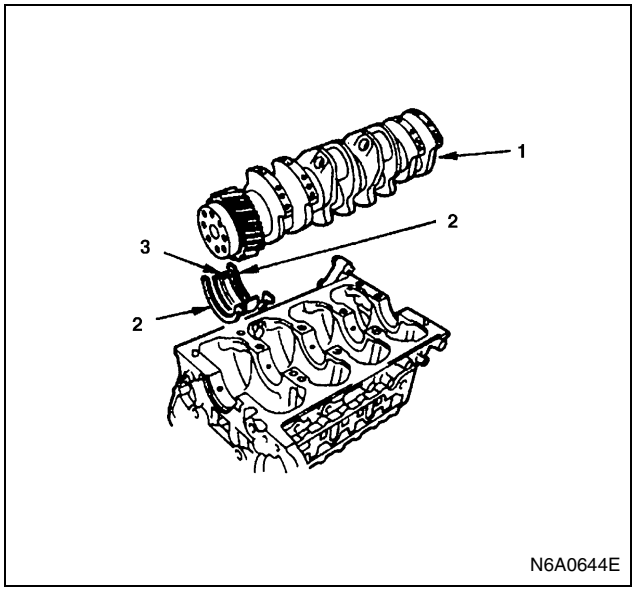
Notice:
When removing the crankcase, be sure to remove the oil pump and the generator bracket before that.



60. Thrust Bearing Lower
61. Crankshaft Bearing Lower



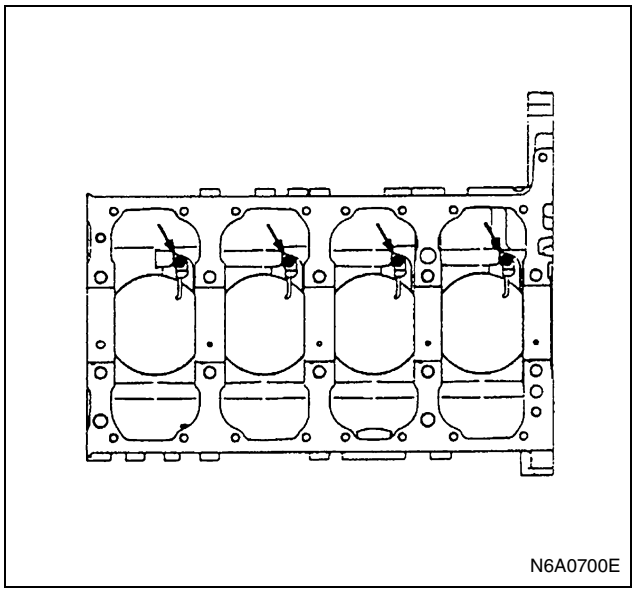
62. Crankshaft Assembly
63. Thrust Bearing Upper
64. Crankshaft Bearing Upper



Legend

1. Crankshaft assembly
2. Thrust bearing upper
3. Crankshaft bearing upper

65. Oiling Jet
    Loosen the check valves to remove both the check valves and the oiling jets.
    Take care not to bend or damage the oiling jets.



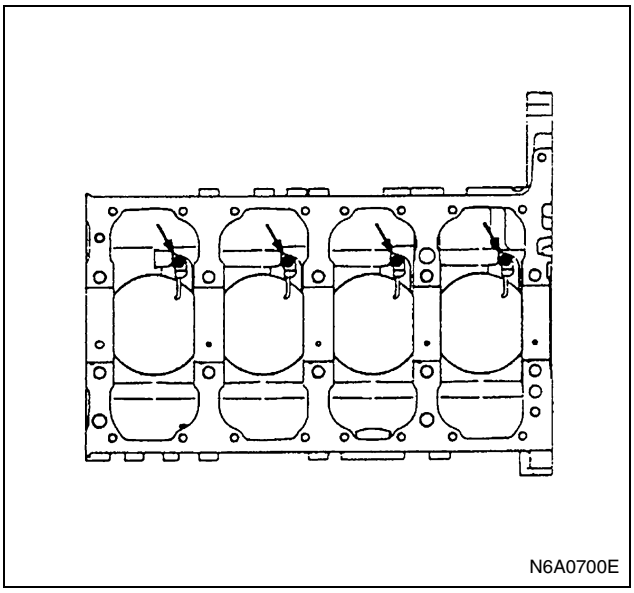
66. Cylinder Block

Installation

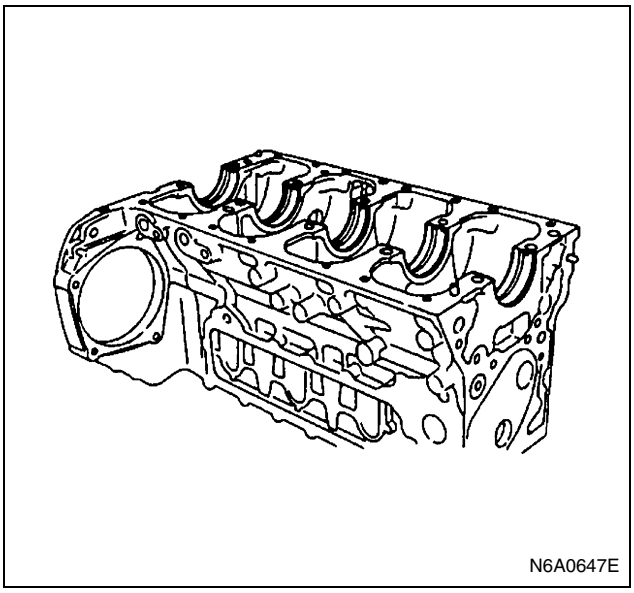
1. Cylinder Block
   Use compressed air to thoroughly clean the inside and outside surfaces of the cylinder body, the oil holes, and the water jackets.
2. Oiling Jet
   1) Install the oiling jets together with the check valves.
      Take care not to damage the oiling jet nozzles.

2) Tighten the check valves and oiling jets to the specified torque.

Tighten:
Check valve and oiling jet to 21 N·m (2.1 kg·m/15 lb·ft)


N6A0700E

3. Crankshaft Bearing Upper
When replacing the crankshaft or the crankshaft bearing with a new one, select the crankshaft bearing according to the respective grades stamped on the crankshaft and the cylinder body.
Refer to the “CRANKSHAFT” in section 6A.
All upper bearings have oil grooves.


N6A0647E

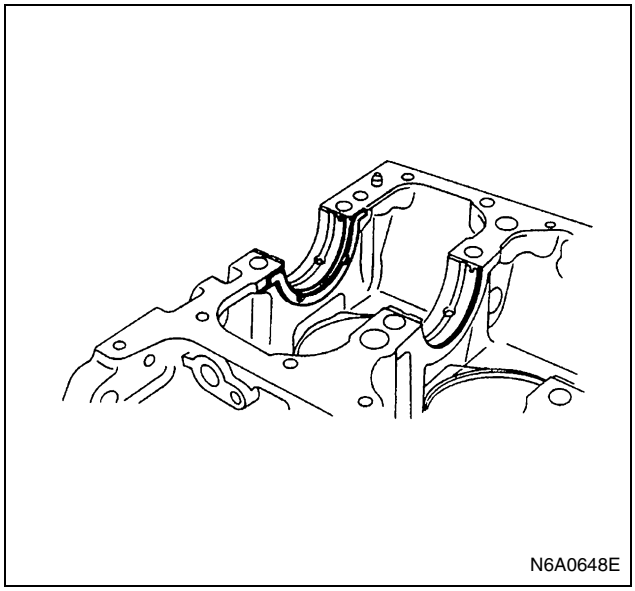
1) Carefully wipe any foreign material from the upper bearing.

Caution:
Do not apply engine oil to the bearing back faces and the cylinder body bearing fitting surface.

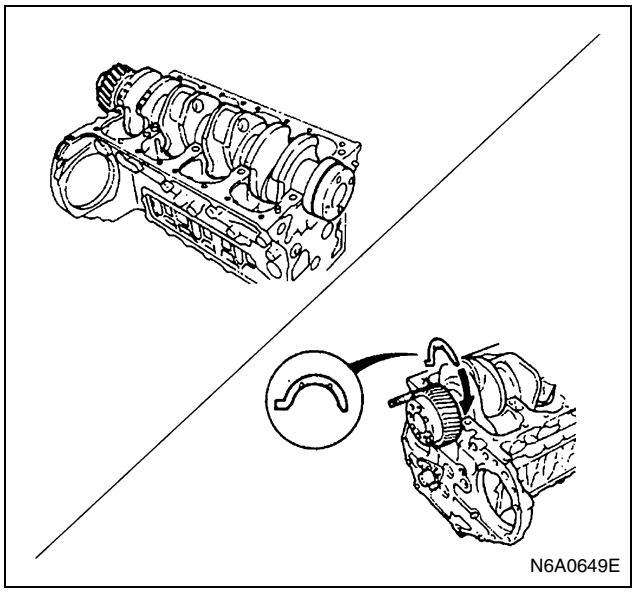
2) Locate the position mark applied at disassembly if the removed upper bearings are to be reused.

4. Thrust Bearing Upper
Install the thrust bearing upper to the front side of the cylinder body No.5 journal. At this time, the thrust bearing upper may be pasted to the cylinder body with grease.
However, be sure to wipe off nay excessive grease.

Caution:
The thrust bearing oil grooves must be facing the sliding faces.


N6A0648E

5. Crankshaft Assembly
Apply an ample coat of engine oil to the crankshaft journals and the crankshaft bearing surfaces before installing the crankshaft with timing gear.


N6A0649E

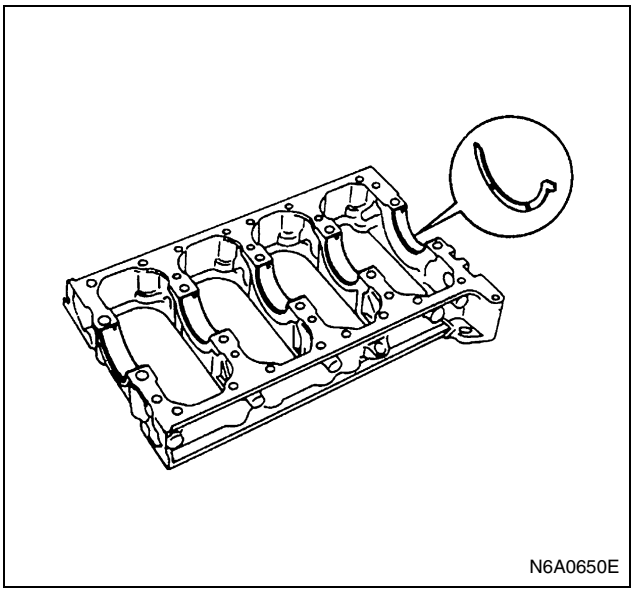
6. Crankshaft Bearing Lower
All lower bearings does not have oil grooves.
1) Carefully wipe any foreign material from the lower bearing.

Caution:
Do not apply engine oil to the bearing back faces and the crankcase bearing fitting surfaces.

2) Locate the position mark applied at disassembly if the removed lower bearings are to be reused.

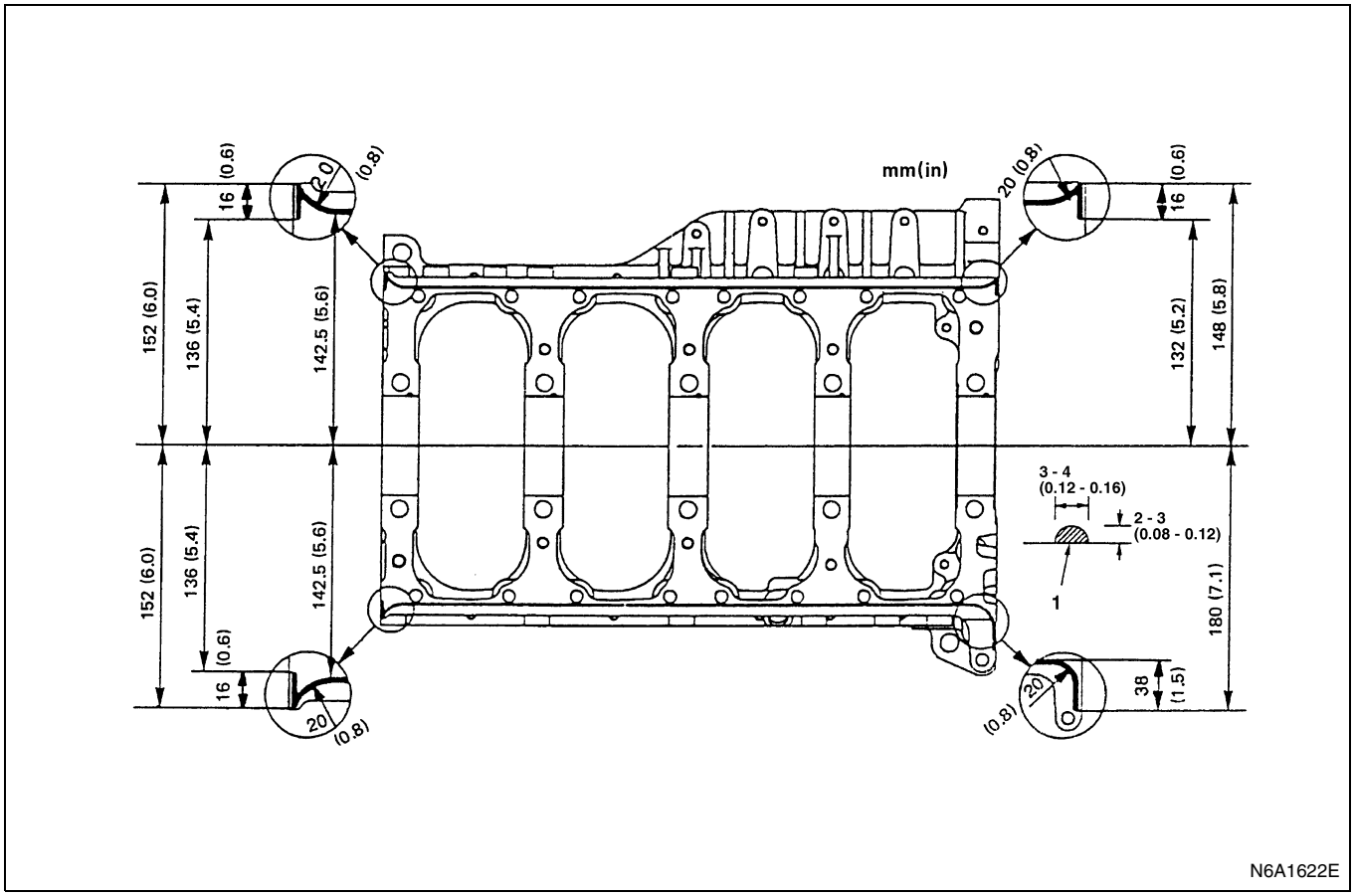
7. Thrust Bearing Lower
   Install the thrust bearing lower to the rear side of the crankcase No.5 journal.

Caution:
The thrust bearing oil grooves must be facing the sliding faces.


N6A0650E

8. Crankcase
   1) Apply a 3 mm (0.12 in) bead of recommended liquid gasket (Three Bond 1207C) or its equivalent to the crankcase upper surface as shown in the illustration.
   2) Carefully place the crankcase on the cylinder body.

   • Install the crankcase within 20 minutes after application of liquid gasket.



Legend

1. Liquid gasket

3) Tighten the crankcase to the specified torque in the numerical order shown in the illustration.

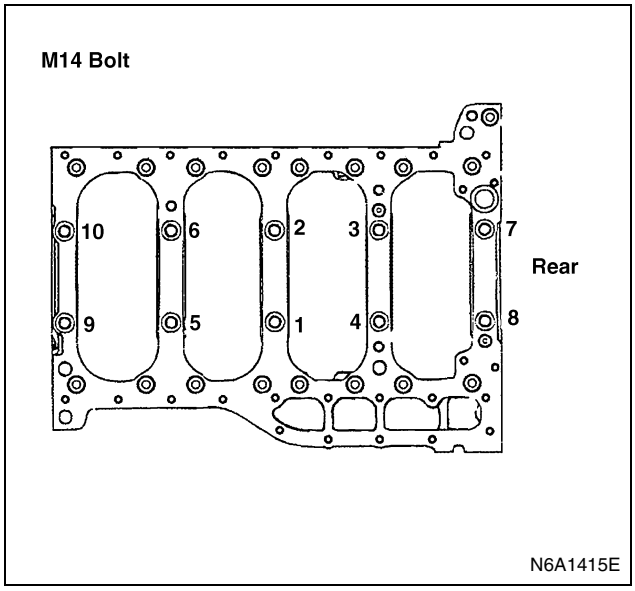
Tighten:

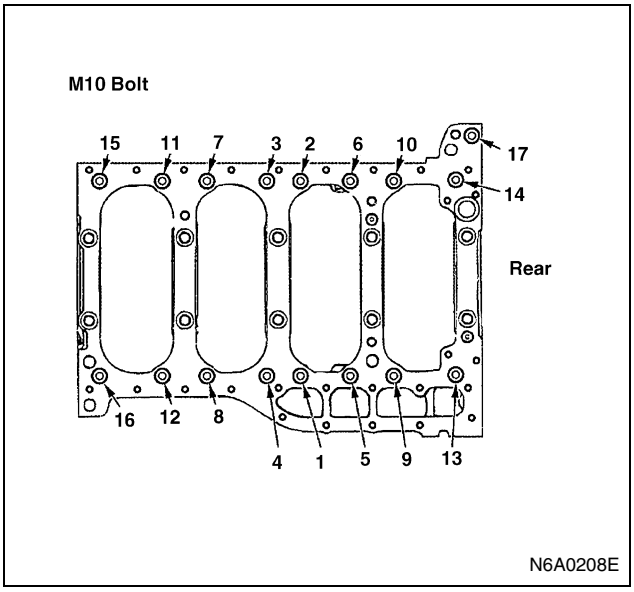
Crankcase bolt (M14: (1) — (10)) to

- 1st step: 98 N·m (10 kg·m/72 lb·ft)
- 2nd step: 132 N·m (13.5 kg·m/98 lb·ft)
- 3rd step: 30 — 60°

Crankcase bolt (M10: (1) — (17)) to 37 N·m (3.8 kg·m/ 27 lb·ft)

Angle gauge: 5-8840-0266-0

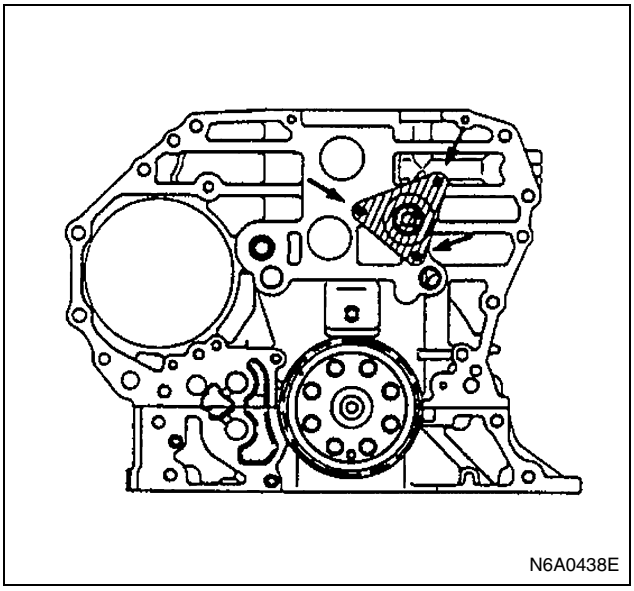




9. Piston and Connecting Rod Assembly
10. Connecting Rod Bearing
11. Connecting Rod Cap
    Above works refer to “PISTON AND CONNECTING ROD” section in this manual.
12. Oil Pump Assembly
    Above works refer to “OIL PUMP ASSEMBLY” section in this manual.
13. Idle Gear B Shaft

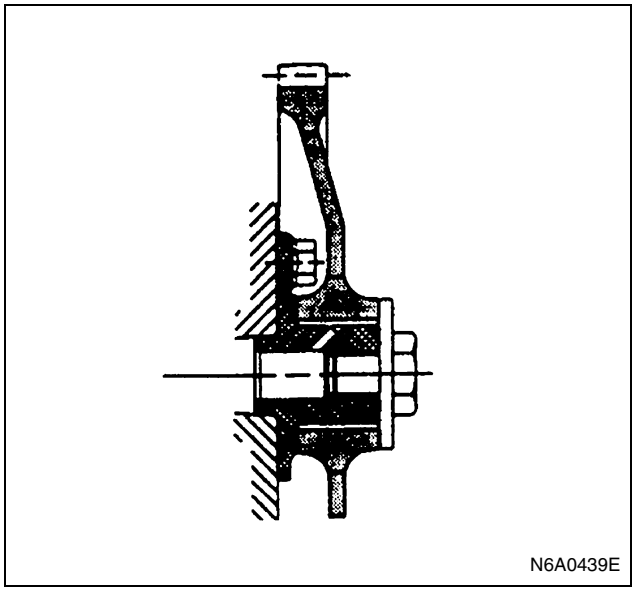
Tighten:
Idle gear B shaft bolt to 31 N·m (3.2 kg·m/23 lb·ft)

Apply the engine oil to the idle gear shaft after installation.



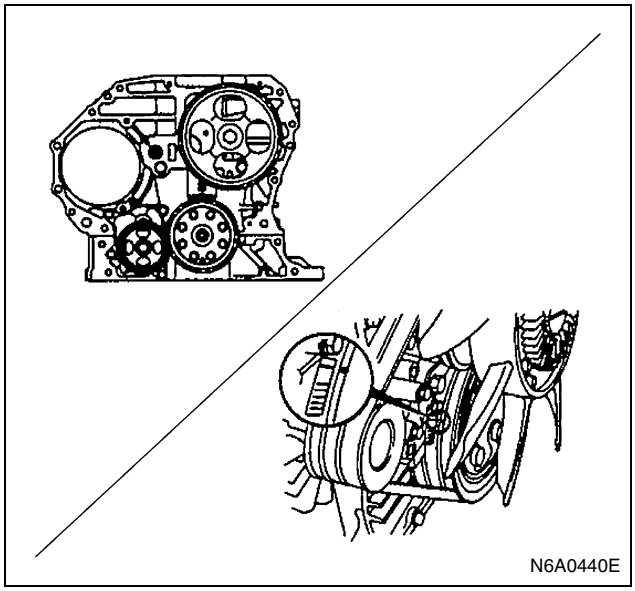
14. Idle Gear B
    The face of the idle gear B with longer boss should be positioned toward the rear side shown in the illustration

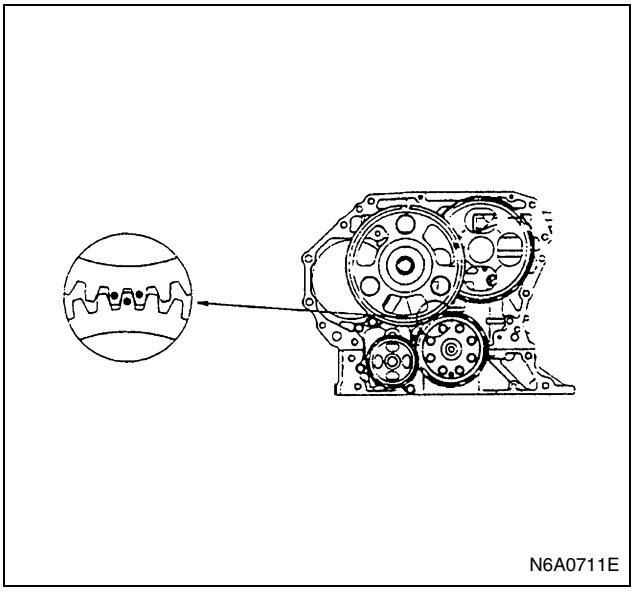
Tighten:
Idle gear B bolt to 110 N·m (11.2 kg·m/81 lb·ft)



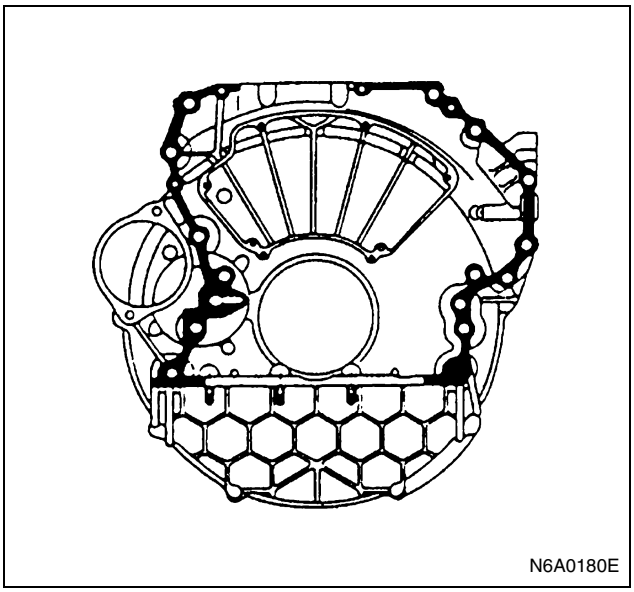
15. Idle Gear A
    1) Turn the crankshaft clockwise so that the engagement mark of the crankshaft gear faces to the shaft center of the idle gear A and the No.1 cylinder piston comes to the top dead center.
    2) Align the crankshaft gear with the engagement mark of the idle gear and install the idle gear A.

Tighten:
Idle gear A bolt to 133 N·m (13.6 kg·m/98 lb·ft)



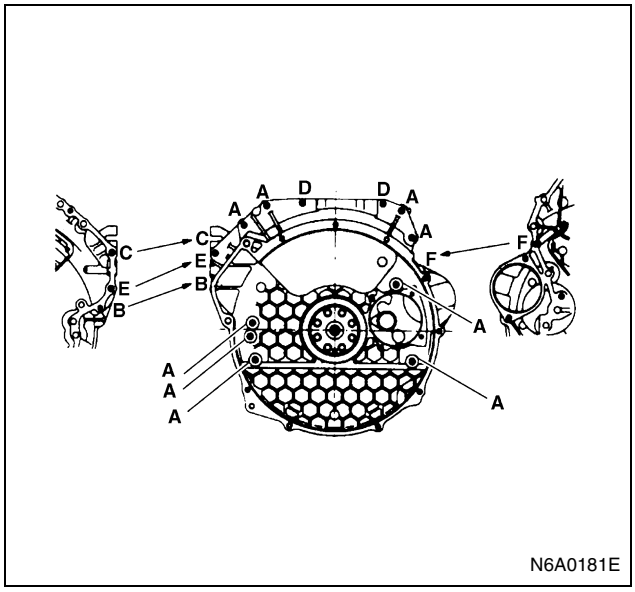


16. Flywheel Housing
    1) Carefully wipe any foreign material from the cylinder body rear face.
    2) Apply the recommended liquid gasket (Three Bond 1207C) or its equivalent to the shaded areas shown in the illustration.



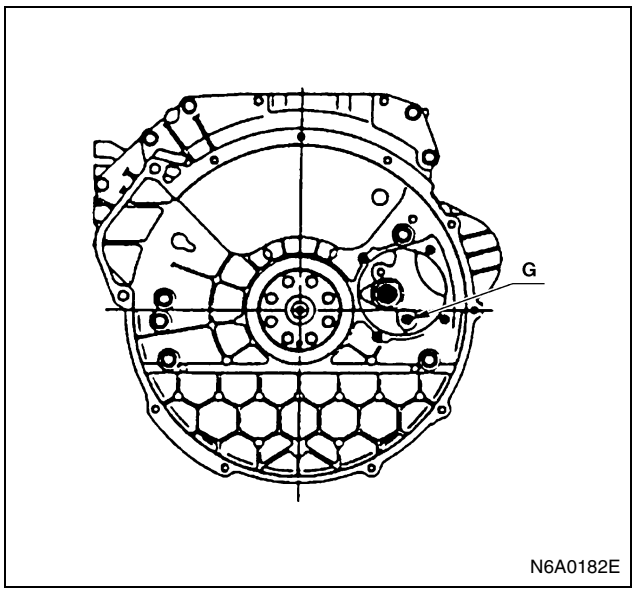
    3) Align the cylinder body knock pins with the flywheel housing knock pin holes.
    4) Tighten the flywheel housing bolts to the specified torque shown in the illustration.

Tighten:
Flywheel housing bolt to
- (A): 96 N·m (9.8 kg·m/71 lb·ft)
- (B): 48 N·m (4.9 kg·m/35 lb·ft)
- (C): 94 N·m (9.6 kg·m/69 lb·ft)
- (D): 25 N·m (2.6 kg·m/19 lb·ft)
- (E): 76 N·m (7.7 kg·m/56 lb·ft)
- (F): 48 N·m (4.9 kg·m/35 lb·ft)



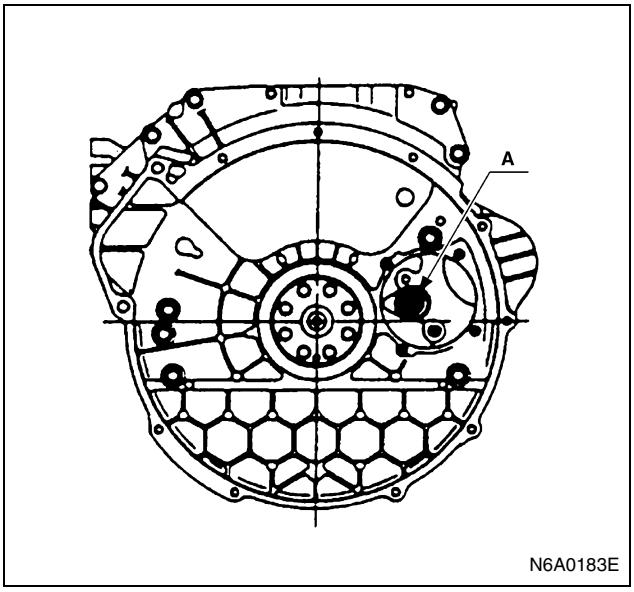
- Tighten the bolts marked with “E” or “B” from the injection pump side, and those with “F” from the cylinder body side.

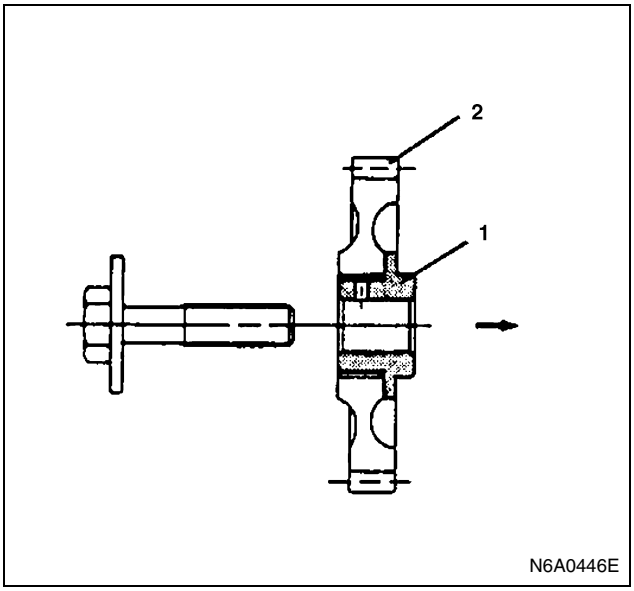
Tighten:
Flywheel housing bolt (G) to 96 N·m (9.8 kg·m/71 lb·ft)



17. Power Steering Pump Idle Gear
    1) Apply the engine oil to the idle gear shaft.
    2) Install the idle gear shaft (1) with the idle gear (2) to the cylinder body A portion as shown in the illustration.

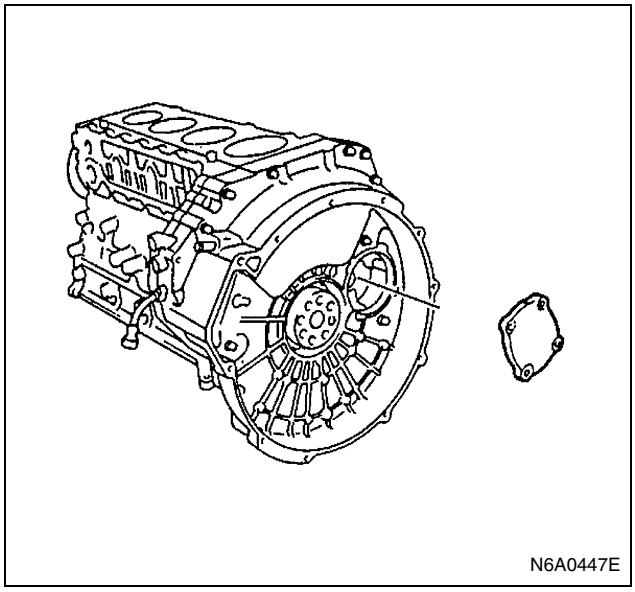
Tighten:
Idle gear shaft bolt to 133 N·m (13.6 kg·m/98 lb·ft)



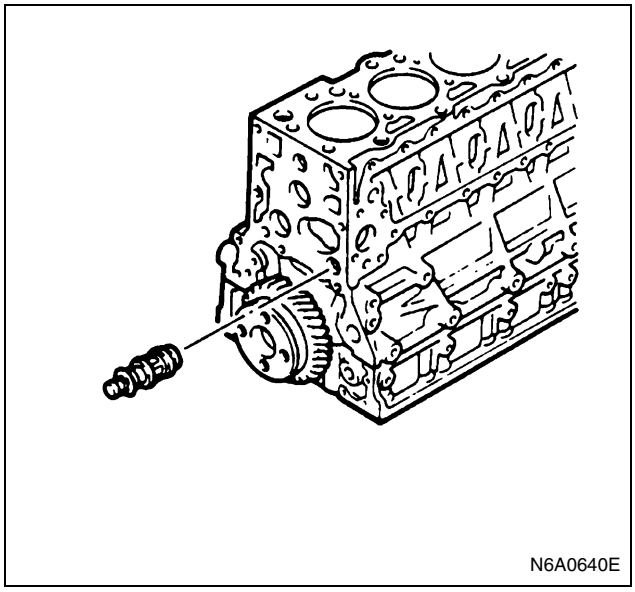


18. Power Steering Pump Idle Gear Cover
    Install the gear cover with the O-ring.

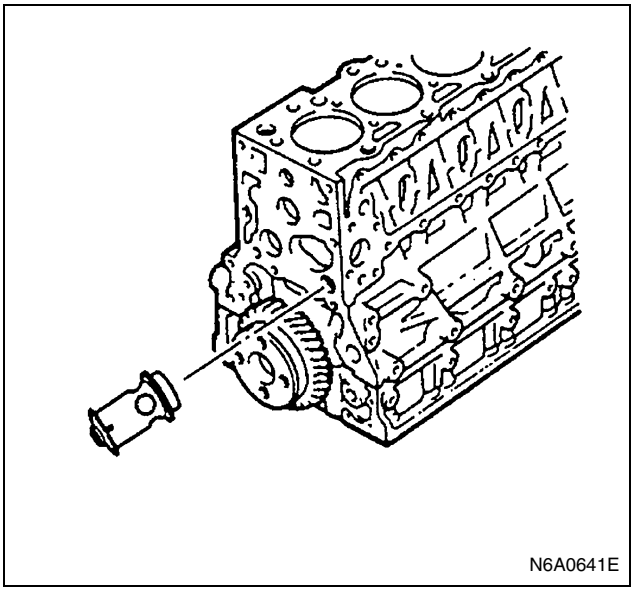
Tighten:
Gear cover bolt to 19 N·m (1.9 kg·m/14 lb·ft)



19. Oil Thermo Valve (4HF1, 4HF1-2, 4HG1, 4HG1-T)
    Insert the oil thermo valve into the cylinder body.

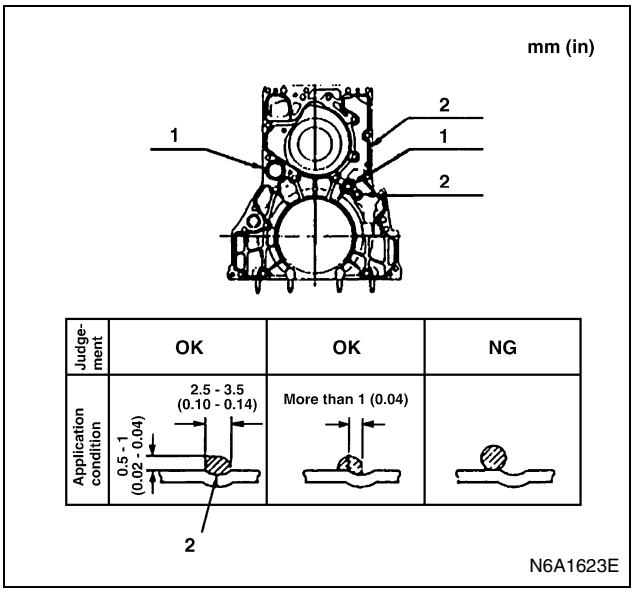


20. Bypass Valve (4HE1-TC)
    Insert the bypass valve into the cylinder body.

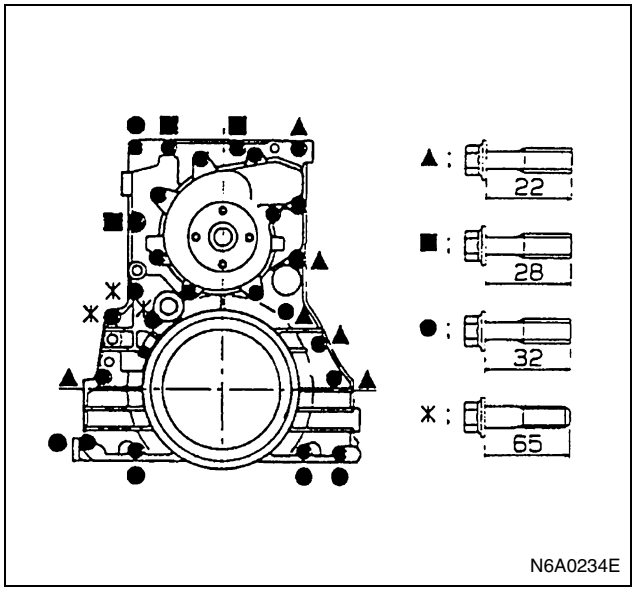


21. Front Retainer
    1) Carefully wipe any foreign material from the cylinder body front face.
    2) Apply a 2.5 — 3.5 mm (0.10 — 0.14 in) bead of the recommended liquid gasket (Three Bond 1207C) or its equivalent on the groove of the front retainer fitting surface shown in the illustration.
    3) Install the O-rings (2 pieces) to the front retainer.
    - Install the front retainer within 7 minutes after application of the liquid gasket.
    - For the dislocation of liquid gasket, refer to the illustration.
    4) Align the cylinder body knock pins with the front retainer knock pin holes.

Tighten:
Front retainer bolt to 24 N·m (2.4 kg·m/17 lb·ft)



Legend
1. O-ring
2. Liquid gasket

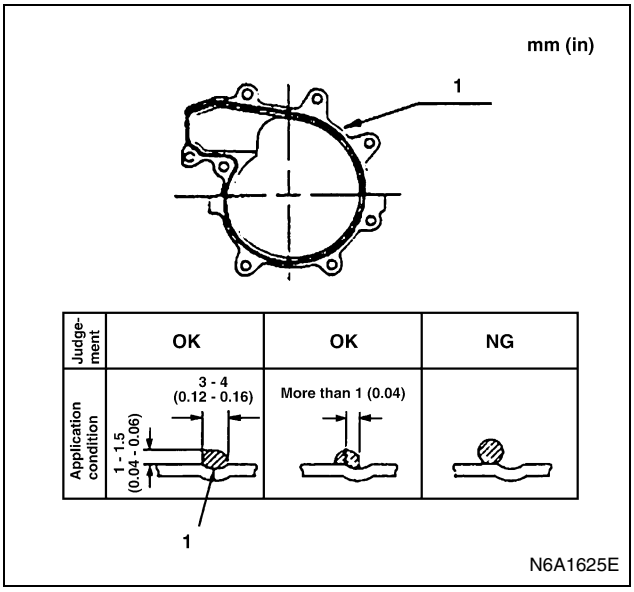


22. Water Pump Assembly
    1) Apply 3 — 4 mm (0.12 — 0.16 in) bead of the recommended liquid gasket (Three Bond 1207C) or its equivalent on the water pump fitting surface.
    2) Install the water pump to the front retainer.

Tighten:
Water pump bolt to 24 N·m (2.4 kg·m/17 lb·ft)

- Install the water pump within 7 minutes after application of liquid gasket.
- For the dislocation of liquid gasket, refer to the illustration.

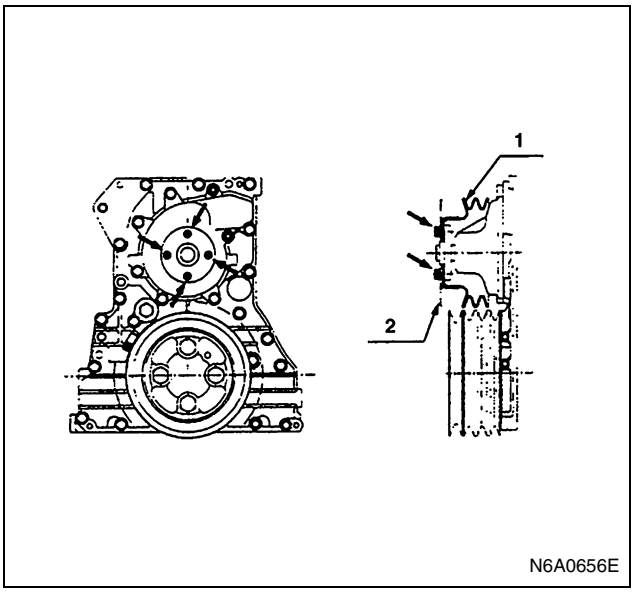
Caution:
The water pump clamping bolt is also used to tighten the front retainer. So, install the water pump before liquid gasket gets dry immediately after installation of the front retainer.



Legend
1. Liquid gasket

23. Water Pump Pulley

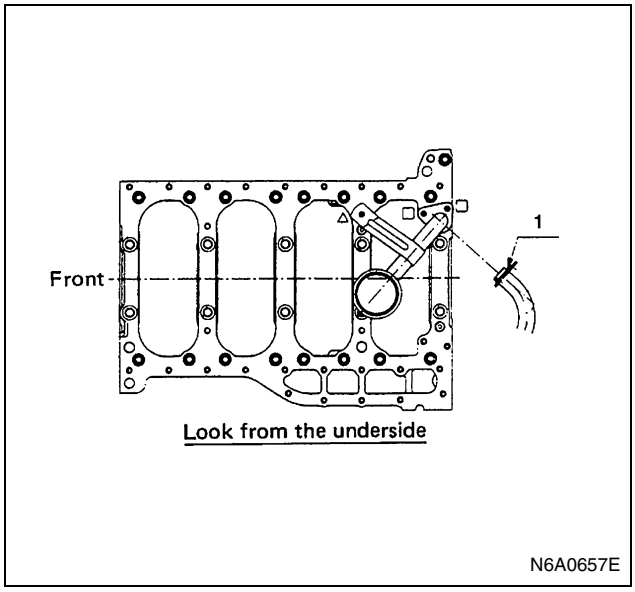
Tighten:
Water pump pulley bolt to 24 N·m (2.4 kg·m/17 lb·ft)



Legend
1. Pulley
2. Set plate

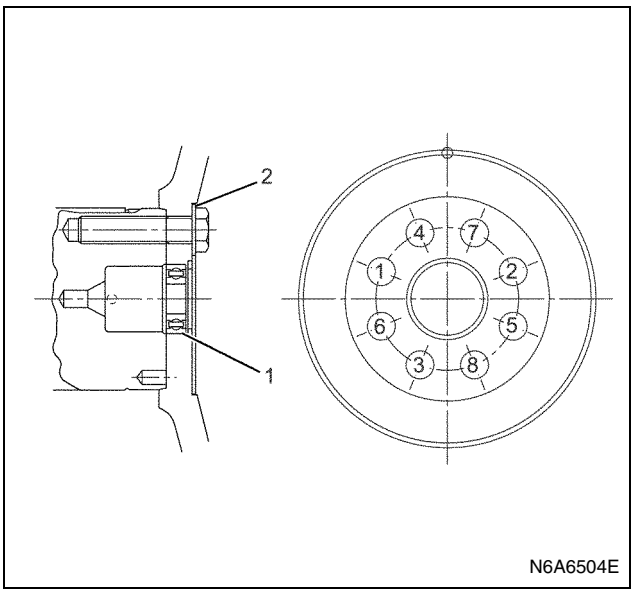
24. Oil Pump Strainer
    Install the O-ring (1) to the oil pump strainer pipe and install the oil pump strainer to the cylinder body shown in the illustration.

Tighten:
Oil pump strainer bolt to 24 N·m (2.4 kg·m/17 lb·ft)



25. Oil Pan
    Above works refer to “OIL PAN” section in this manual.
26. Spacer Rubber
    Above works refer to “OIL PAN” section in this manual.
27. Crankshaft Rear Slinger
28. Crankshaft Rear Oil Seal
    Above works refer to “CRANKSHAFT REAR OIL SEAL” section in this manual.
29. Flywheel Assembly
    1) Align the flywheel with the crankshaft knock pin and temporarily tighten the flywheel bolts.
    2) Use the crankshaft stopper to prevent the crankshaft from turning.
       Crankshaft Stopper: 5-8840-2230-0
    3) Install the washer and the flywheel bolts and tighten to the specified torque in the numerical order show in the illustration.

Tighten:
Flywheel bolt to
- 1st step: 78 N·m (8.0 kg·m/58 lb·ft)
- 2nd step: 90 — 120°

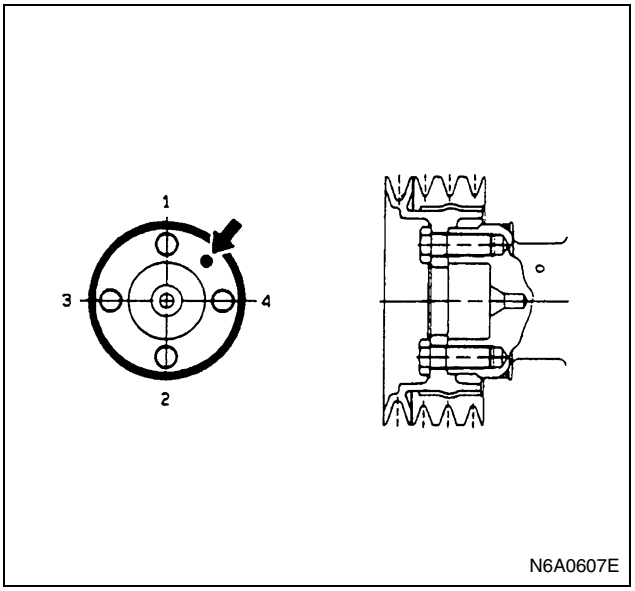


Legend
1. Washer
2. Pilot bearing

4) Remove the crankshaft stopper.

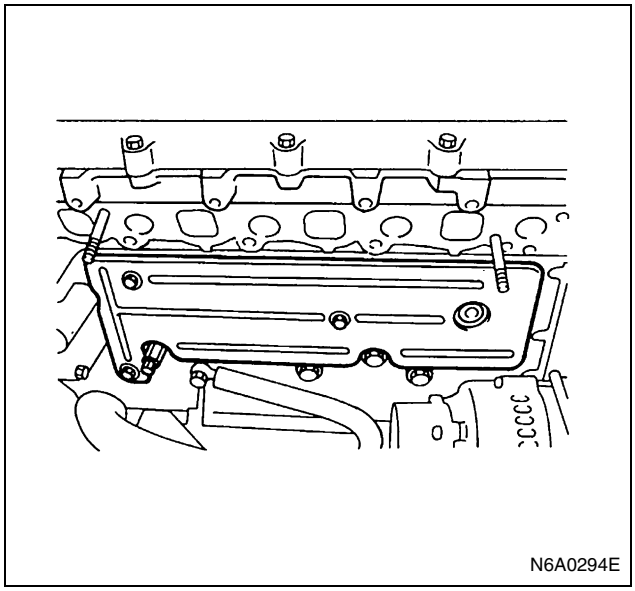
30. Crankshaft Front Slinger
31. Crankshaft Front Oil Seal
    Above works refer to “CRANKSHAFT FRONT OIL SEAL” section in this manual.
32. Crankshaft Damper Pulley
    1) Apply a coat of the engine oil to the threads of the bolts.
    2) Align the damper pulley with the crankshaft knock pin and tighten the bolts to the specified torque in the numerical order.

Tighten:
Damper pulley bolt to 200 N·m (20.4 kg·m/147 lb·ft)

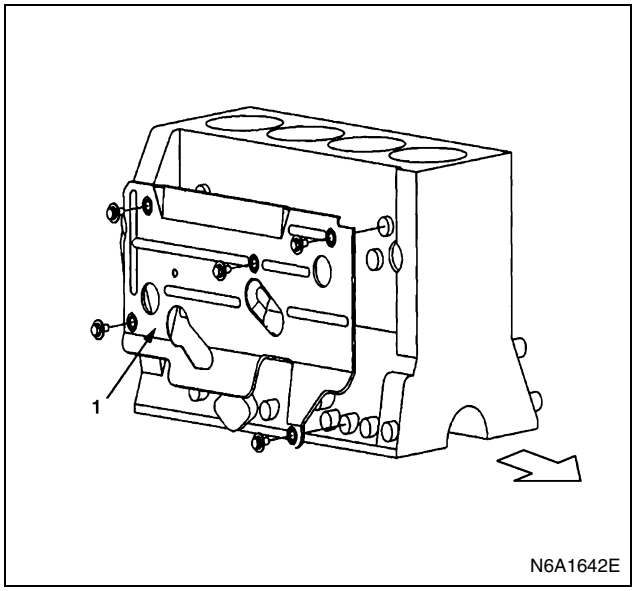


33. Cover

Tighten:
Cover Bolt to 13 N·m (1.3 kg·m/113 lb·in)



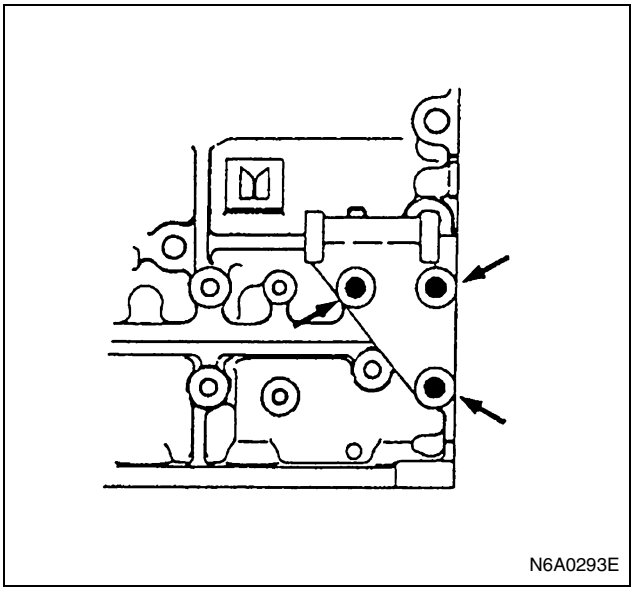
4HE1-TC
4HE1-TC engines use a larger rubber spacer than other engines.



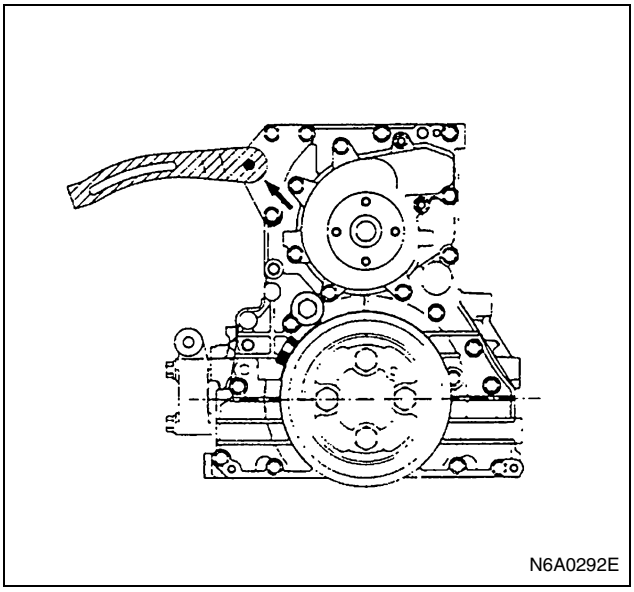
Legend
1. Cover

34. Generator Bracket

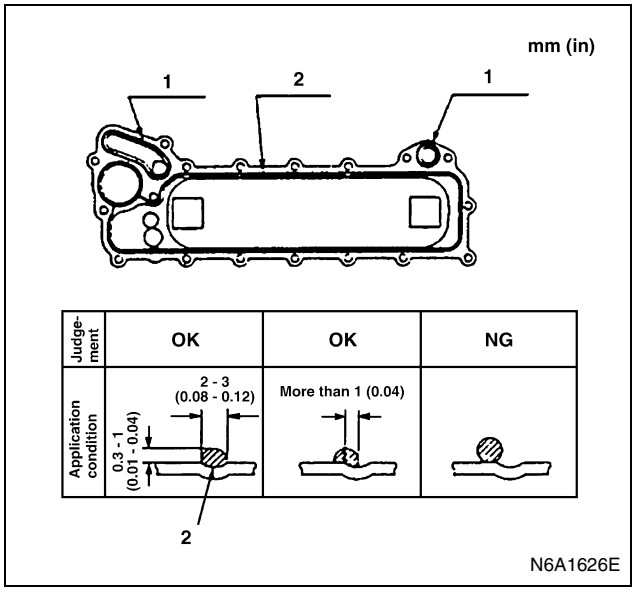
Tighten:
Generator bracket bolt to 48 N·m (4.9 kg·m/35 lb·ft)


N6A0293E

35. Fan Belt Adjust Plate
    Install the adjust plate and temporarily tighten the adjust plate bolt.


N6A0292E

36. Oil Cooler Assembly
    1) Apply 2 — 3 mm (0.08 — 0.12 in) bead of the recommended liquid gasket (Three Bond 1207C) or its equivalent on the oil cooler fitting surface.
    2) Apply a coat of engine oil to the O-rings (2 pieces) and install the O-rings to the oil cooler.



N6A1626E

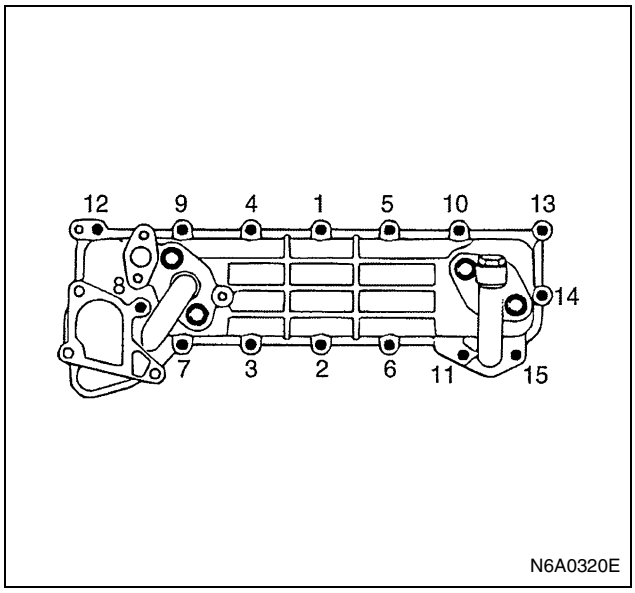
Legend
1. O-ring
2. Liquid gasket

Notice:
Take care that the O-ring does not get smeared with liquid gasket.

- Install the oil cooler within 7 minutes after application of the liquid gasket.
- For the dislocation of the liquid gasket, refer to the illustration.

3) Tighten the oil cooler bolts and nut to the specified torque a little at a time in the sequence shown in the illustration.

Tighten:
Oil cooler bolt and nut to 24 N·m (2.4 kg·m/17 lb·ft)



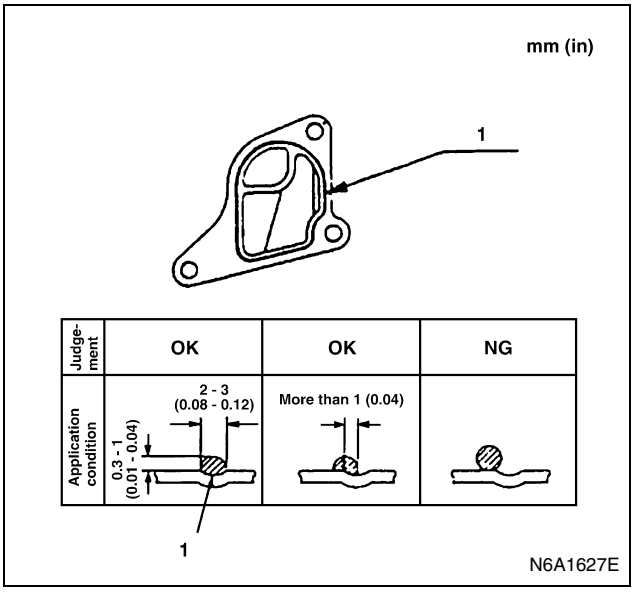
N6A0320E

37. Water Suction Pipe
    1) Apply a 2 — 3 mm (0.12 — 0.16 in) bead of the recommended liquid gasket (Three Bond

1207C) or its equivalent on the groove of the water suction pipe fitting surface.

2) Install the water suction pipe to the oil cooler.

- For the dislocation of liquid gasket, refer to the illustration.



Legend

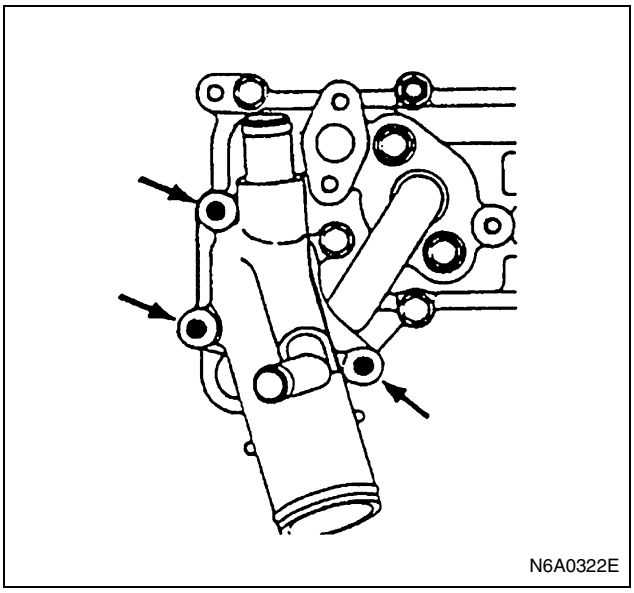
1. Liquid gasket

Tighten:

Water suction pipe bolt and nuts to 24 N·m (2.4 kg·m/17 lb·ft)

Notice:

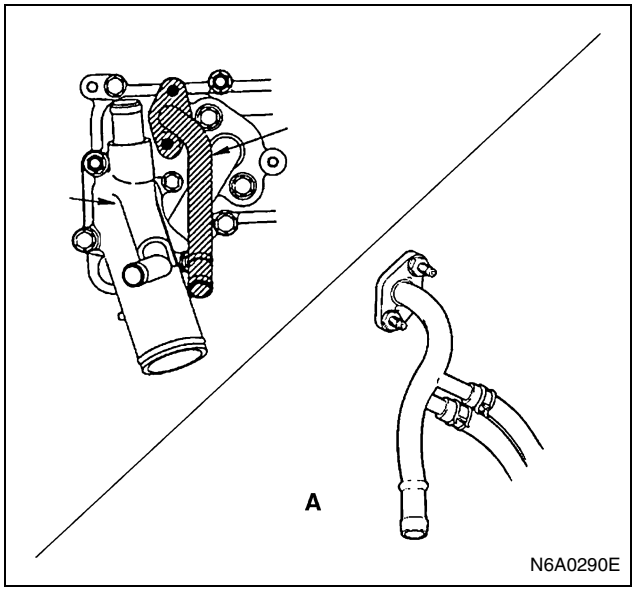
Install the water suction pipe immediately after the installation of the oil cooler.



38. Heater Pipe
    1) Install the O-ring to the heater pipe.
    2) Install the heater pipe to the oil cooler.

Tighten:

Heater pipe bolt to 24 N·m (2.4 kg·m/17 lb·ft)



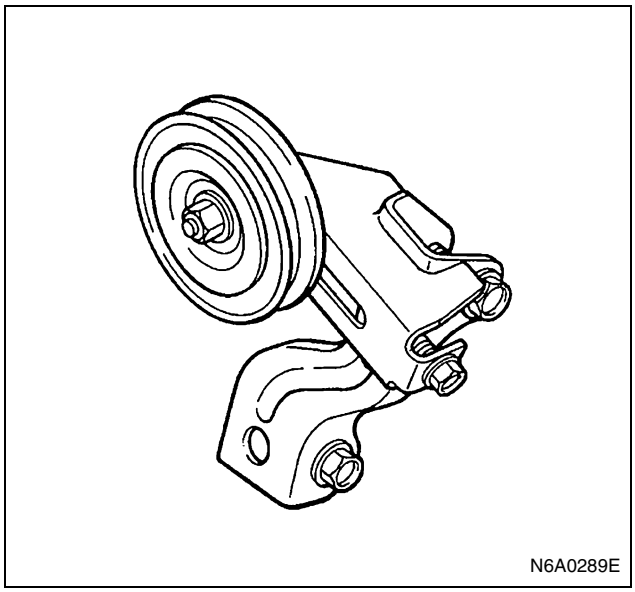
Legend

A. 4HF1-2

39. Idle Pulley Bracket (If equipped with A/C)

Tighten:

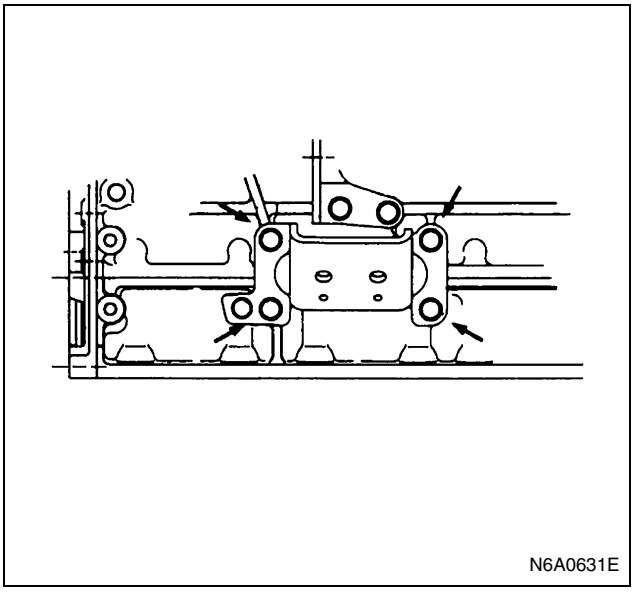
Idle pulley bracket bolt to 48 N·m (4.9 kg·m/35 lb·ft)



40. Injection Pump Rubber Spacer
41. Injection Pump Assembly
    Above works refer to “INJECTION PUMP ASSEMBLY” section in this manual.
42. Engine Foot

Tighten:

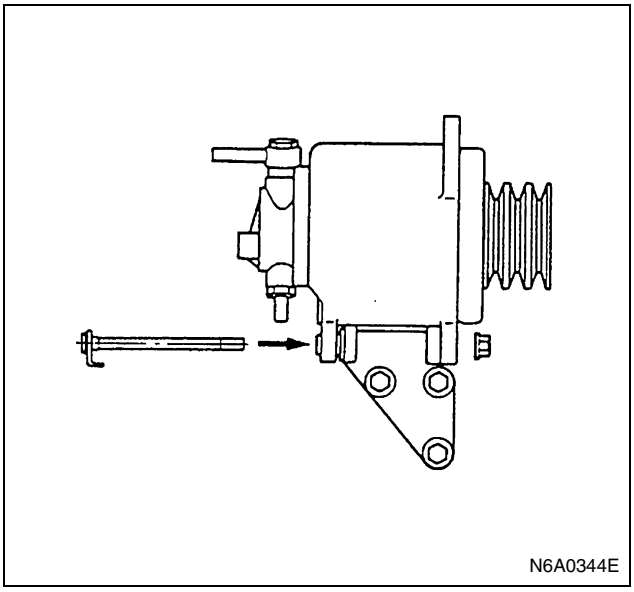
Engine foot bolt to 51 N·m (5.2 kg·m/38 lb·ft)


N6A0631E

43. Generator

Notice:
When tightening the generator, tighten in advance the fan belt temporarily after its adjustment.

- Insert through the lower fixing bolt from the rear side as shown in the illustration, and tighten it with a nut on the front side.

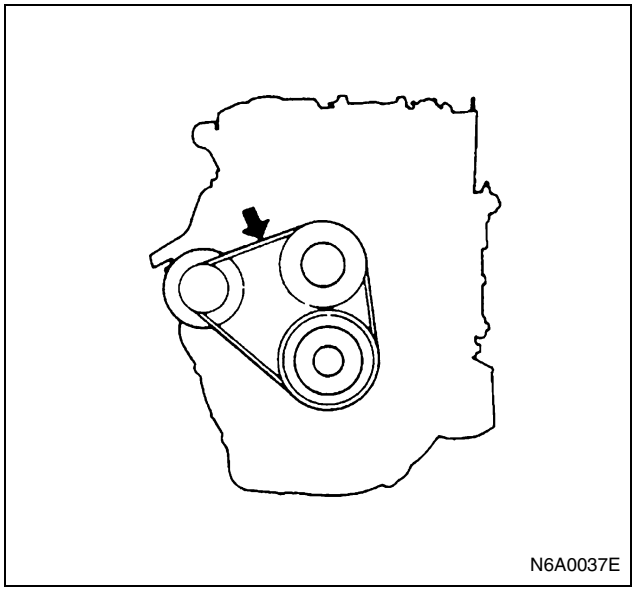

N6A0344E

44. Fan Belt
Check the drive belt tension.

Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

Drive Belt Deflection	mm (in)
8 — 12 (0.31 — 0.47) ... New belt 10 — 14 (0.39 — 0.55) ... Reuse belt	

Check the drive belt for cranking and other damage.

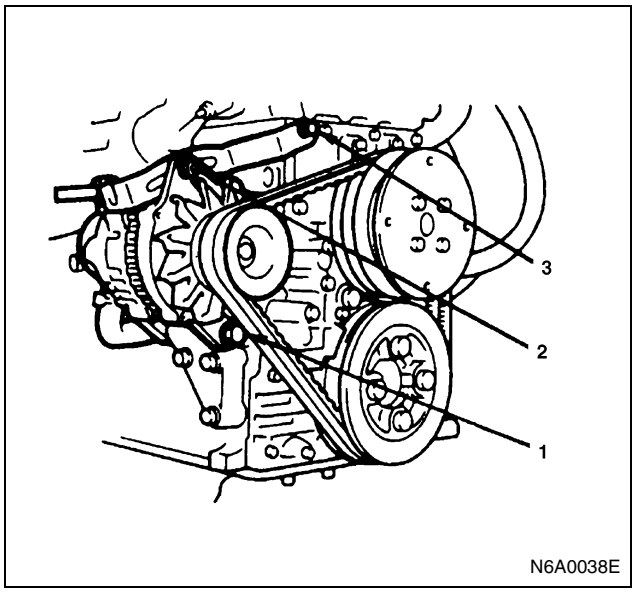

N6A0037E

Fan Belt Adjustment

Fan belt tension is adjusted by moving the generator.

Tighten:
Bolt to

- (1): 40 N·m (4.1 kg·m/30 lb·ft)
- (2): 24 N·m (2.4 kg·m/17 lb·ft)
- (3): 46 N·m (4.7 kg·m/34 lb·ft)

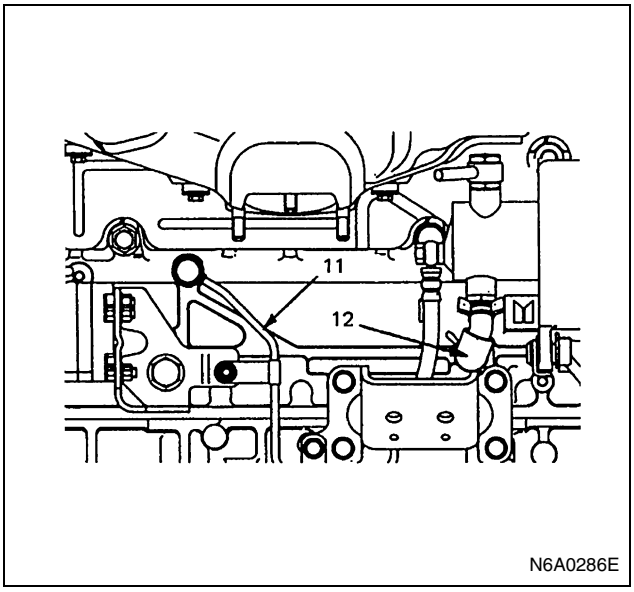


N6A0038E

45. Vacuum Pump Rubber Hose (12)
46. Vacuum Pump Oil Pipe (11)

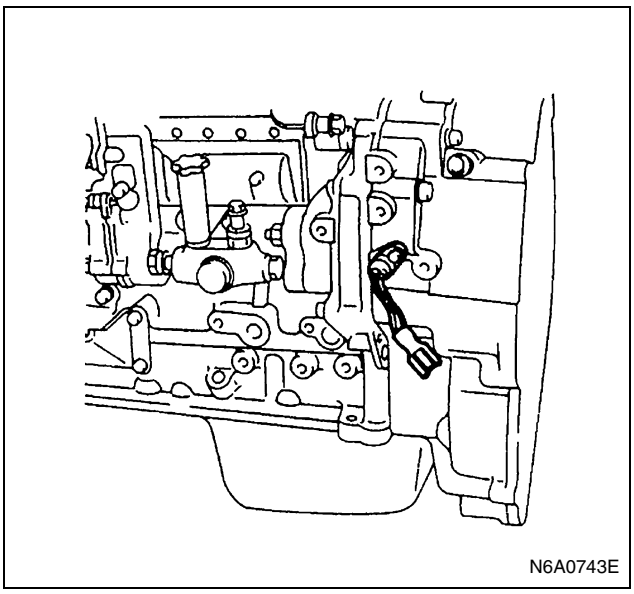
Tighten:
Vacuum pump oil pipe to

- Cylinder body side: 41 N·m (4.2 kg·m/30 lb·ft)
- Generator side: 23 N·m (2.3 kg·m/17 lb·ft)



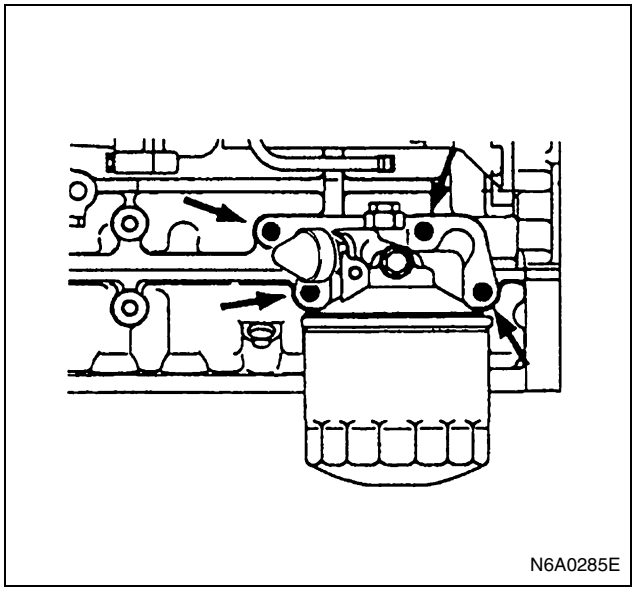
47. Fuel Pipe Bracket
48. Tachometer Sensor

Tighten:
Tachometer bolt to 8 N·m (0.8 kg·m/69 lb·in)



49. Oil Filter Assembly

Tighten:
Oil filter bolt to 8 N·m (4.9 kg·m/35 lb·ft)



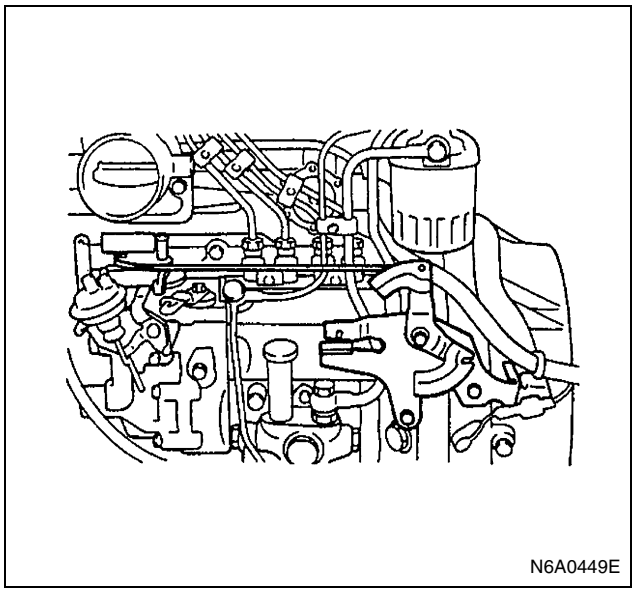
50. Oil Pipe

Tighten:
Oil pipe joint bolt to 17 N·m (1.7 kg·m/12 lb·ft)

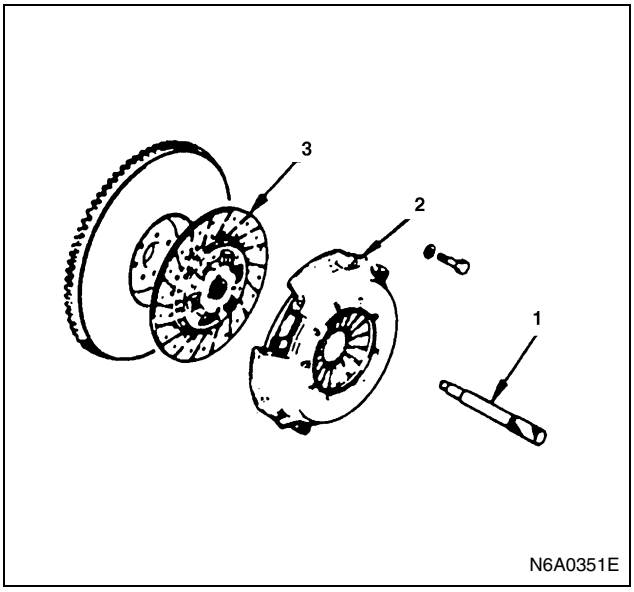
51. Engine Control Lever Assembly

Tighten:
Engine control lever bolt to 24 N·m (2.4 kg·m/17 lb·ft)

52. Engine Control Wire



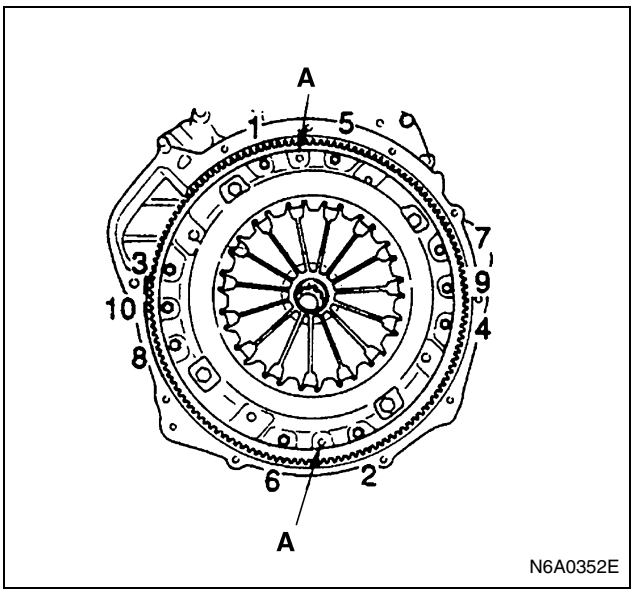
53. Driven Plate
    Use the clutch pilot aligner to install the driven plate.
    Clutch Pilot Aligner: 5-8840-2240-0



Legend
1. Clutch pilot aligner
2. Clutch pressure plate assembly
3. Driven plate

54. Clutch Pressure Plate Assembly
    1) Align the clutch pressure plate with the flywheel knock pin.
    2) Tighten the pressure plate bolts to the specified torque in numerical order.

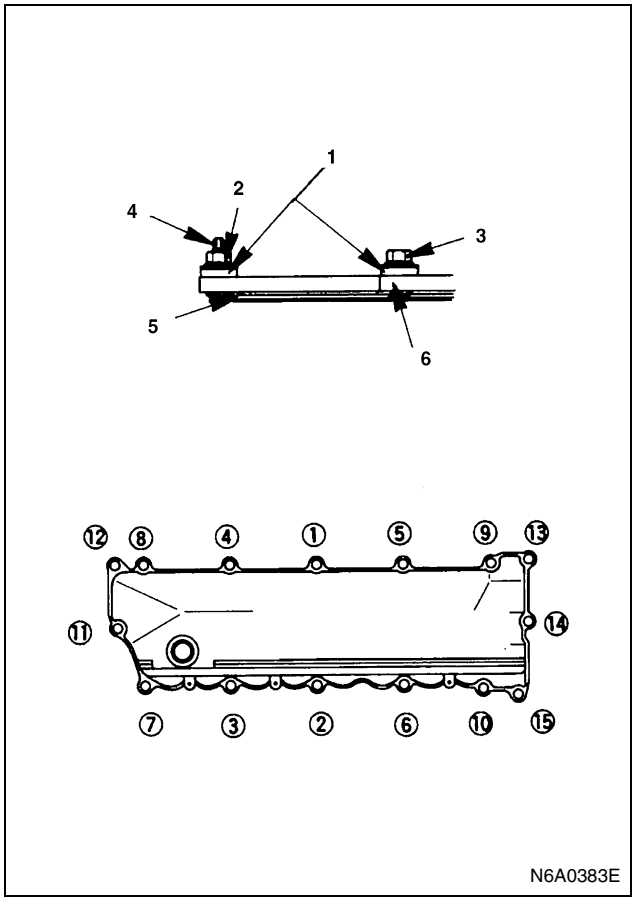
Tighten:
Clutch pressure plate bolt to 40 N·m (4.1 kg·m/30 lb·ft)



Legend
A. Knock pin

55. Cylinder Head Gasket
56. Cylinder Head Assembly
    Above works refer to “CYLINDER HEAD” section in this manual.
57. Camshaft Bearing Lower
58. Camshaft Assembly
59. Camshaft Bearing Upper
60. Camshaft Bearing Cap
61. Valve Cap
    Above works refer to “CAMSHAFT ASSEMBLY” section in this manual.
62. Rocker Arm Shaft Assembly
    Above works refer to “ROCKER ARM SHAFT ASSEMBLY” section in this manual.
63. Head Cover Gasket
    Above works refer to “CYLINDER HEAD” section in this manual.
64. Cylinder Head Cover
    1) Install the cylinder head cover.
    2) Tighten the cylinder head cover nuts and bolts to the specified torque in the numerical order shown in the illustration.

Tighten:
Cylinder head cover nut and bolt to 18 N·m (1.8 kg·m/13 lb·ft)



Legend

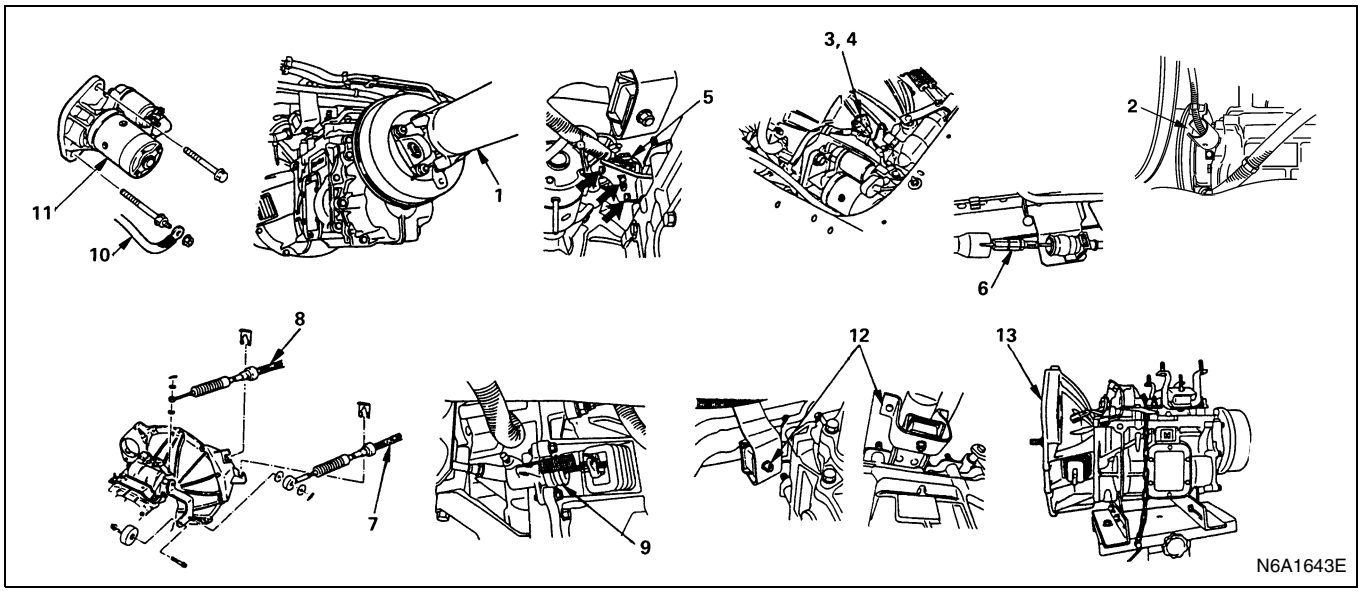
1. Mounting rubber
2. Nut
3. Bolt
4. Stud bolt
5. Gasket
6. Head cover

65. Nozzle Cover
66. Engine Assembly
    Above works refer to “ENGINE ASSEMBLY” section in this manual.

ENGINE ASSEMBLY

Component

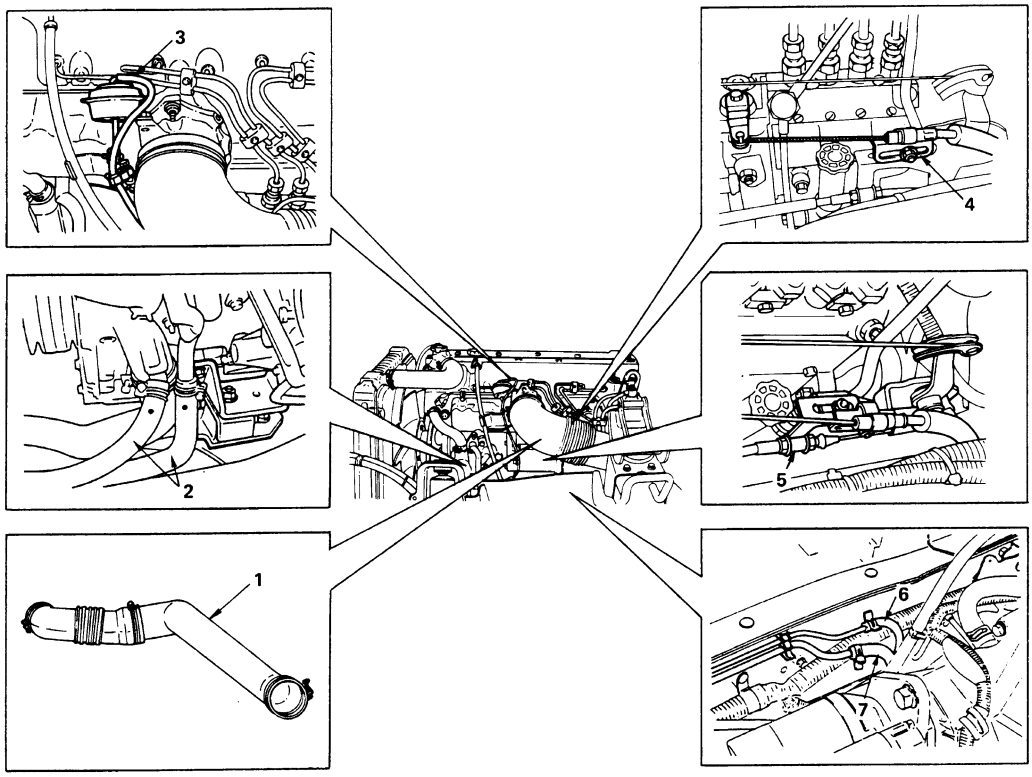
Transmission Side



Legend

1. Propeller shaft assembly
2. Car speed sensor connector
3. Neutral switch connector
4. Back-up lamp connector
5. Harness connector
6. Parking brake cable
7. Shift cable
8. Select cable
9. Clutch slave cylinder
10. Starter earth cable
11. Starter
12. Transmission mounting nut
13. Transmission assembly

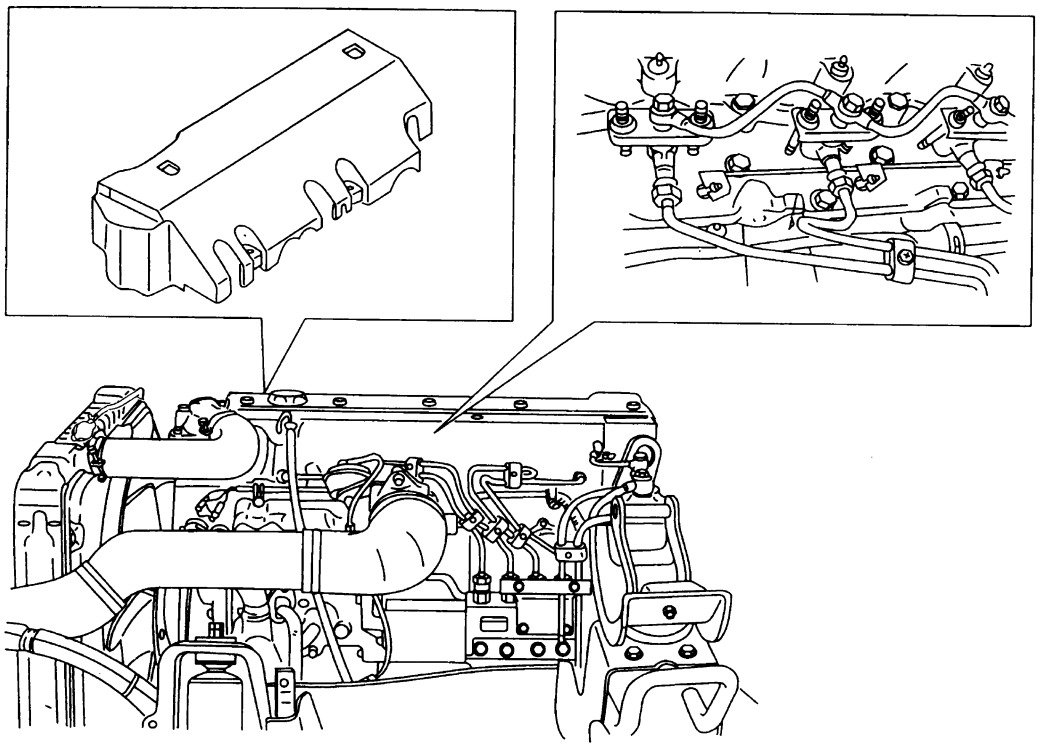
Engine Left Side



Legend

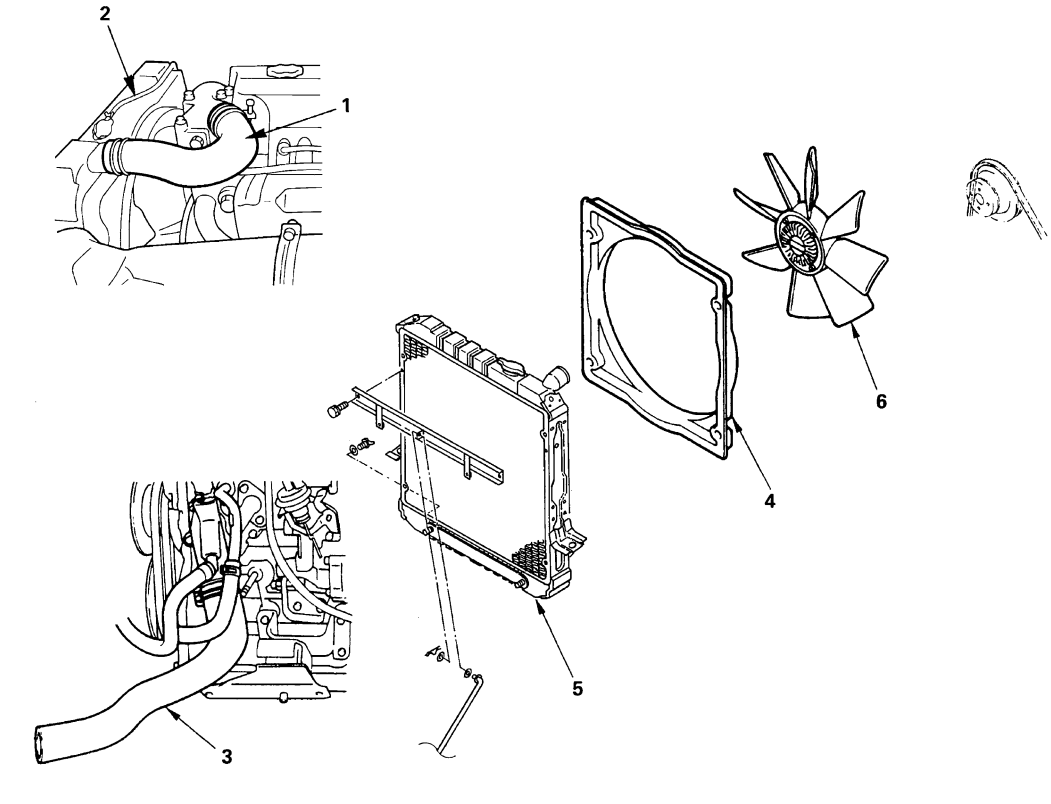
1. Intake air duct
2. Heater hose
3. Vacuum hose
4. Engine stop cable
5. Accelerator control cable
6. Fuel return hose
7. Fuel feed hose

Engine Upper Side



N6A0762E

Engine Front Side

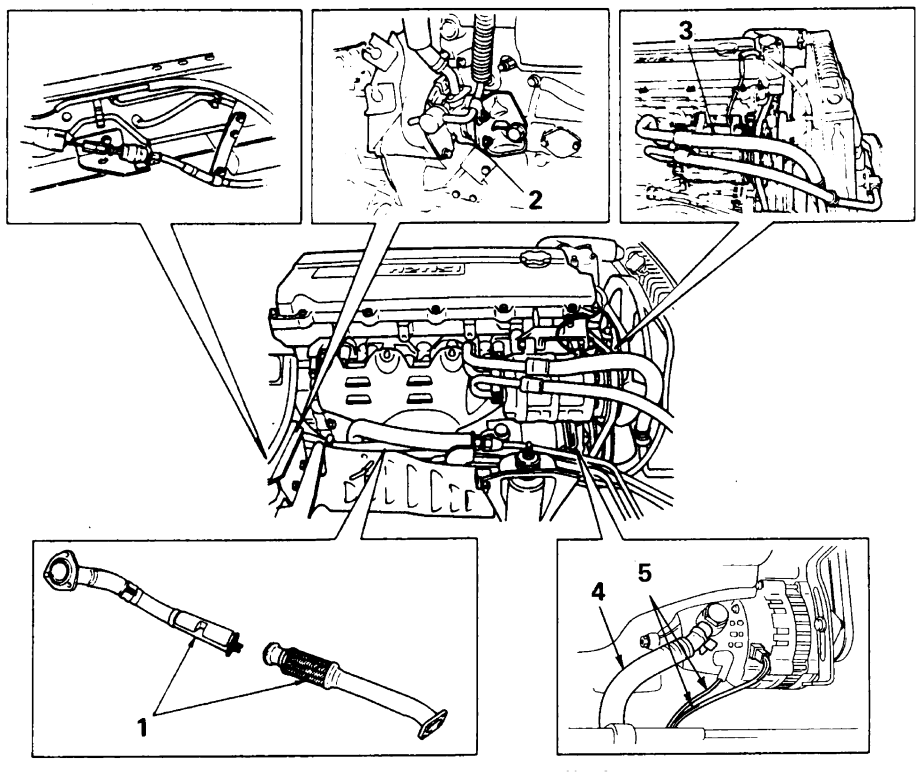


N6A1644E

Legend

1. Radiator upper hose
2. Coolant reserve tank hose/Bypass hose
3. Radiator lower hose
4. Fan guide
5. Radiator
6. Fan

Engine Right Side

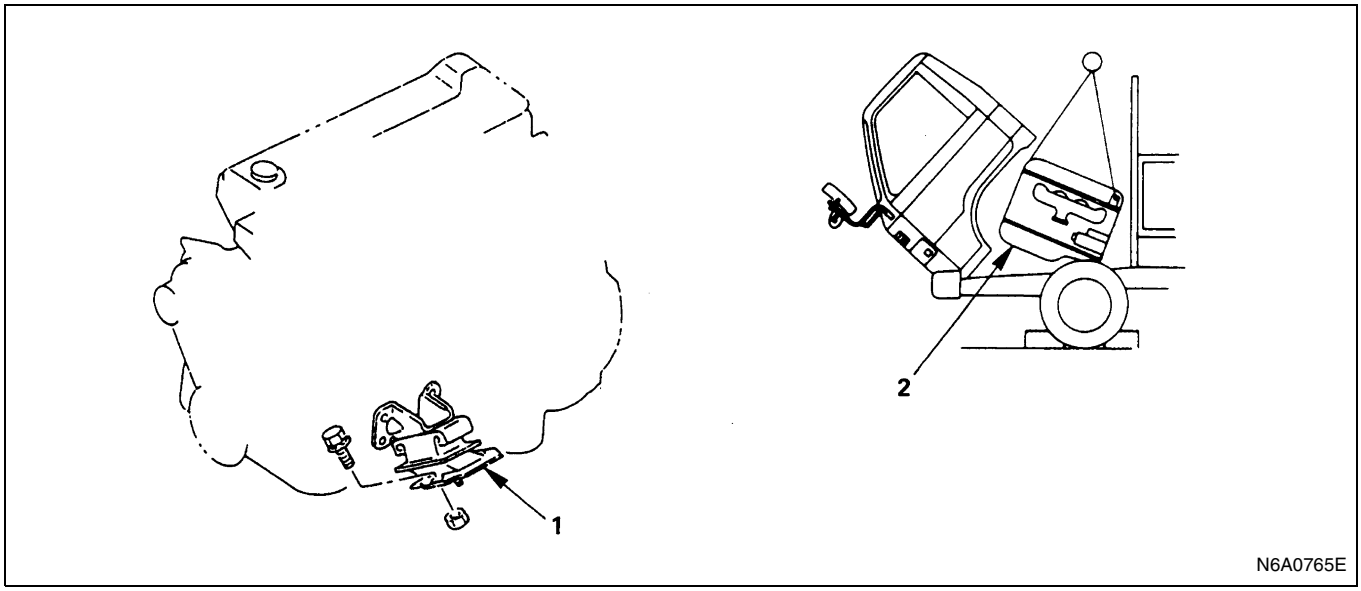


N6A0764E

Legend

1. Front exhaust pipe
2. Power steering pump
3. A/C compressor
4. ACG vacuum hose
5. ACG harness

Engine Mounting Side



Legend

1. Engine mount
2. Engine assembly

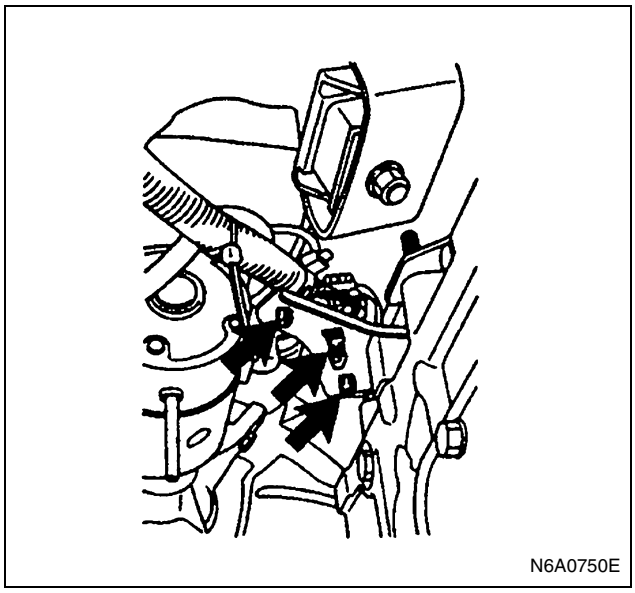
Removal

Preparation

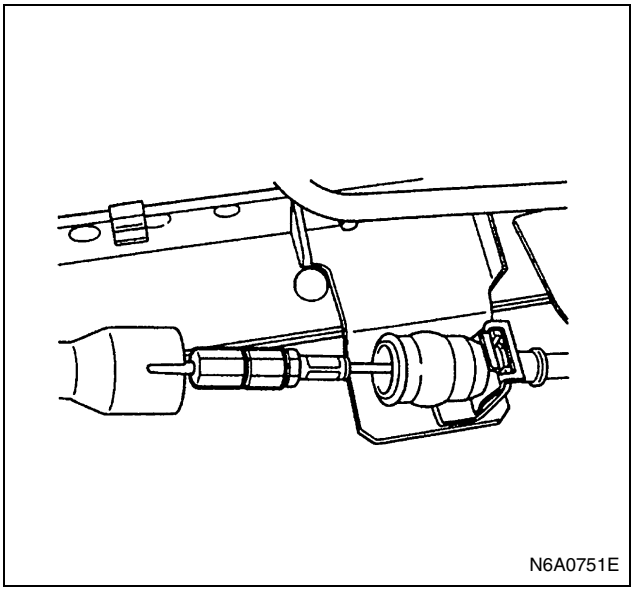
- Disconnect battery ground cable
- Tilt the cab
- Remove the transmission panel
- Drain coolant

Transmission Side

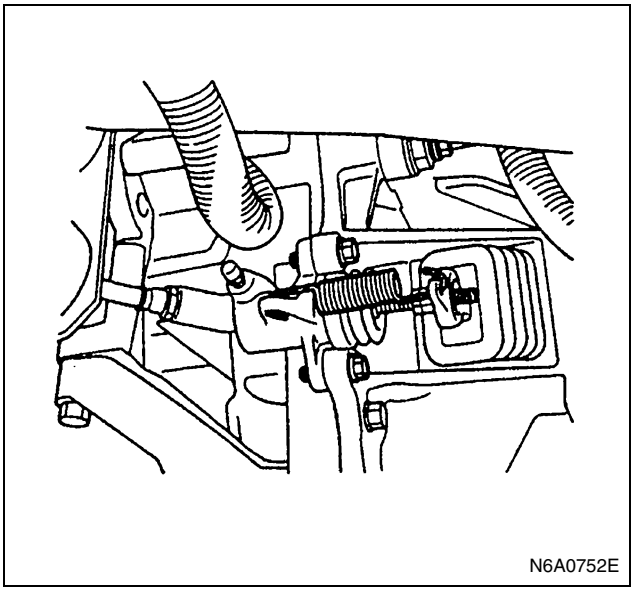
1. Propeller shaft Assembly
   1) Put in advance an alignment mark to the drum and the flange yoke.
   2) Put the drum and the flange yoke aside and hang them with a wire so that they do not interfere with servicing work.
2. Car Speed Sensor Connector
3. Neutral Switch Connector
4. Back-up Lamp Connector
5. Harness Connector
   Remove the connectors from the harness bracket. At that time, take care not to cause any damages to the clips.



6. Parking Brake Cable
   Remove the clip and slide the cover provided in the middle of the cable. Then, loosen the longer nut on the front side of the vehicle to disconnect the parking brake cable.


N6A0751E

7. Shift Cable
8. Select Cable
9. Clutch Slave Cylinder
   1) Disconnect the clutch return spring from the clutch slave cylinder.
   2) Remove the slave cylinder from the clutch shift fork.


N6A0752E

10. Starter Earth Cable
11. Starter
    1) Disconnect the battery cable at the starter motor.
    2) Remove the starter assembly from flywheel housing.
12. Transmission Mounting Nut
    1) Check that the engine lifting is securely supporting the engine.
    2) Remove the engine rear mounting bracket nuts from the No.3 crossmember.
13. Transmission Assembly

    Remove the transmission nuts and bolts from the flywheel housing.

    • Remove the transmission by pulling it toward the rear of the vehicle while slowly lowering the transmission jack.

Engine Left Side

1. Intake Air Duct
2. Heater Hose
3. Vacuum Hose
4. Engine Stop Cable
   Loosen locking nut at bracket and disconnect engine stop cable from injection pump stop lever.
5. Accelerator Control Cable
   Loosen locking nut at bracket and disconnect accelerator control cable from injection pump control lever.
6. Fuel Return Hose
7. Fuel Feed Hose
   Disconnect fuel hose from injection pump side and take care not to spill and enter dust.

Engine Front Side

1. Radiator Upper Hose
2. Coolant Reserve Tank Hose/Bypass Hose
3. Radiator Lower Hose
4. Fan Guide
5. Radiator
6. Fan

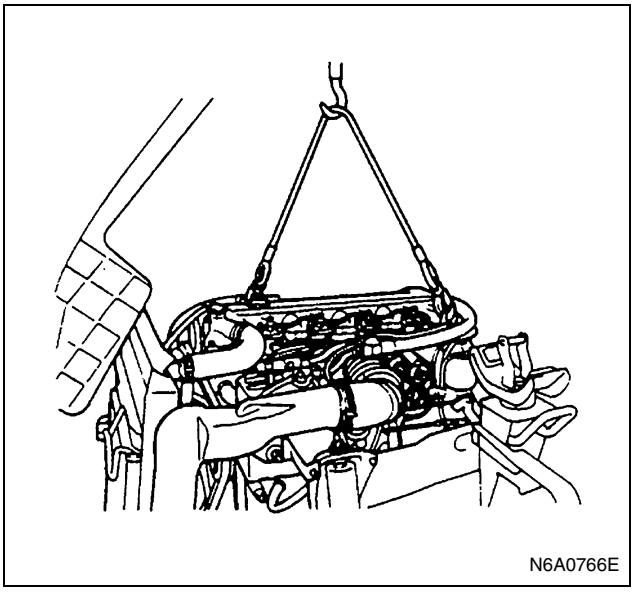
Engine Right Side

1. Front Exhaust Pipe
2. Power Steering Pump
   Remove the power steering pump from the engine side with the bracket attached, and fasten it with a wire to the appropriate location, together with the hoses.
3. Air Conditioning (A/C) Compressor (If equipped with A/C)
   1) Remove the A/C compressor drive belt.
   2) Dismount the compressor from the A/C compressor bracket, and fasten it with a wire to the appropriate location, together with the hoses.
4. ACG Vacuum Hose
   Disconnect the vacuum hoses from vacuum pump side.
5. ACG Harness
   Disconnect the B terminal cable and harness connector from generator.

Engine Mounting Side

1. Engine Mount
   Attach lifting wires to the engine lifting hangers and slightly raise the engine.

   Remove the engine mounting rubber nuts attaching the engine mounting crossmembers.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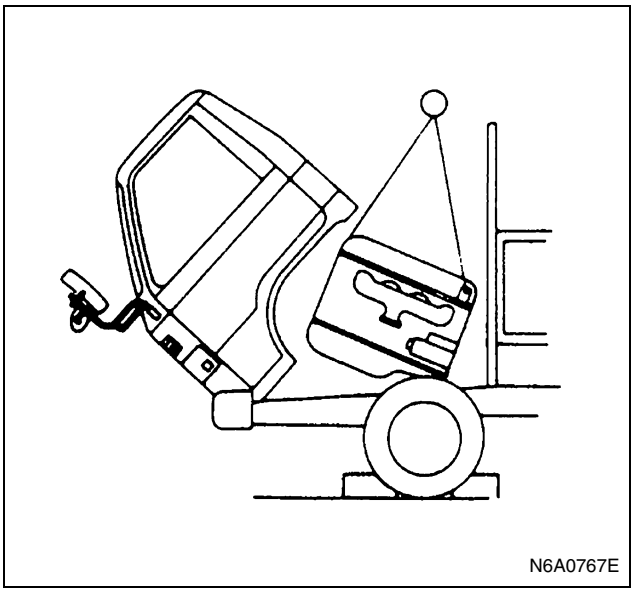
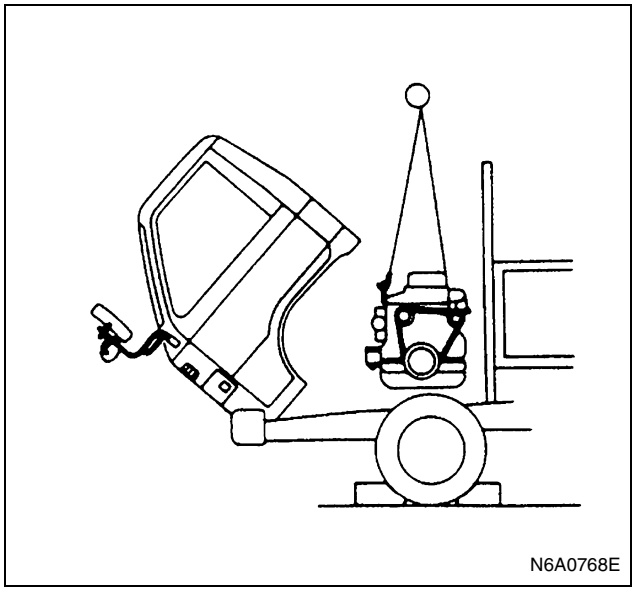
2. Engine Assembly
   1) Make sure that the connecting pipes, hoses, and cables have all been removed from the engine.
   2) Operate the hoist to slowly raise the engine until it is clear of the chassis frame.


N6A0767E

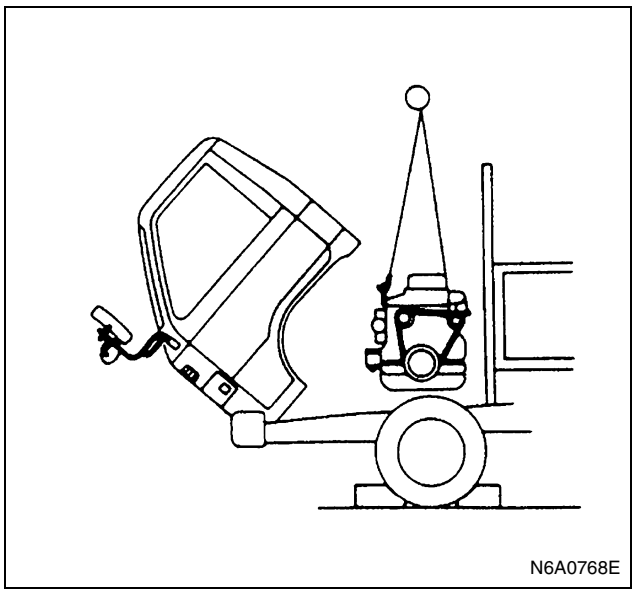
   3) Rotate the engine 90 degrees.
   4) Continue to lift the engine from the chassis.
   5) Carefully move the hoist and engine.
   6) Set the engine on an engine stand.


N6A0768E

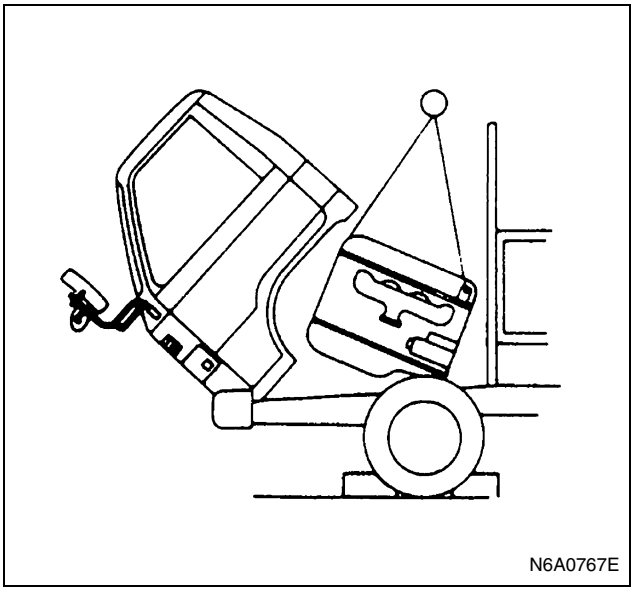
Installation

Engine Mounting Side

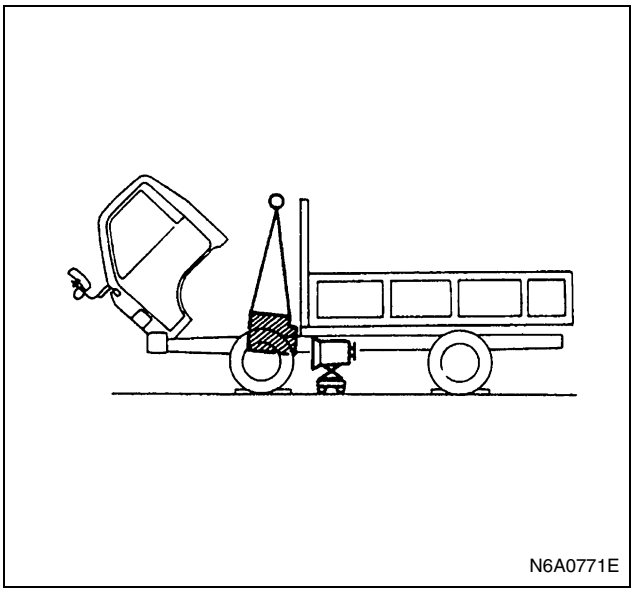
1. Engine Assembly
   1) Attach a lifting wire to the engine lifting hangers.
   2) Operate the hoist to position the engine above the chassis frame.
   3) Carefully lower the engine until it is just above the chassis frame.


N6A0768E

   4) Rotate the engine 90° to position it for final installation.
   5) Carefully set the engine to the chassis.
      The front of the engine should be held higher than the rear at this time.
      Be careful not to damage the exposed parts.


N6A0767E

6) Lower the engine until it contacts the engine mounting crossmember.
7) Set the engine mounting rubbers to the engine mounting crossmember.
8) Temporarily tighten the engine mounting rubber bolts.
The bolts will be finally tightened after the transmission has been installed to the engine and the engine rear mounting bracket and the No.3 crossmember connected.


N6A0771E

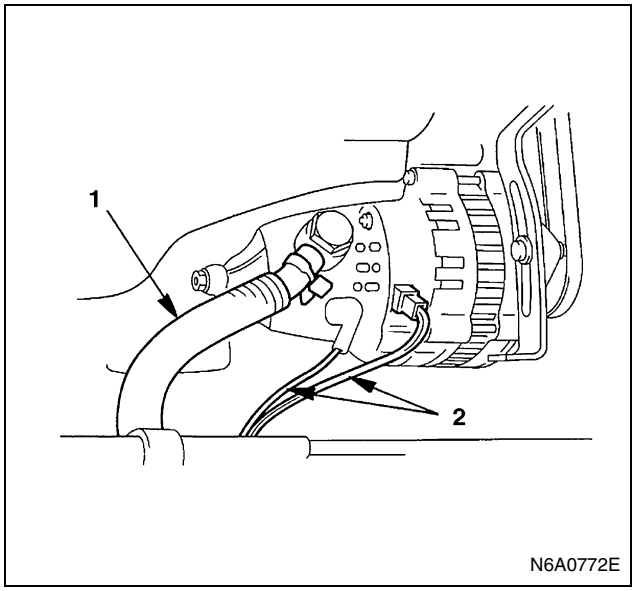
2. Engine Mount
Install the engine mount with it set to the holes of the engine mount crossmember. Then tighten it to the specified torque.

Tighten:
Mounting rubber nut to 48 N·m (4.9 kg·m/35 lb·ft)

Engine Right Side

1. ACG Harness
2. ACG Vacuum Hose

1) Connect the B terminal cable and the harness connector.
2) Connect the vacuum hoses to the vacuum pump.



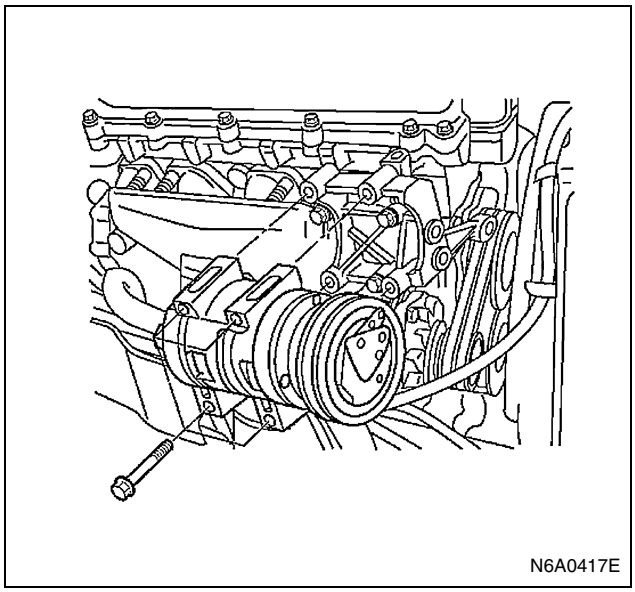
N6A0772E

Legend
1. ACG vacuum hose
2. ACG harness

3. Air Conditioning (A/C) Compressor
   • Tighten the fixing bolts to the specified torque.

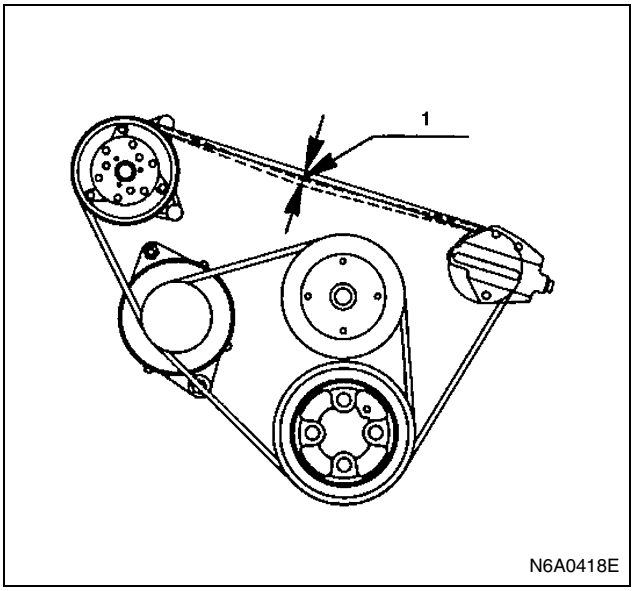
Tighten:
A/C compressor bolt to 48 N·m (4.9 kg·m/35 lb·ft)

Notice:
When tightening the compressor fixing bolts, tighten the first 2 bolts on the rear side, and then the remaining 2 on the front.


N6A0417E

- Install the drive belt adjust belt tension by adjusting bolt and tighten the locking nut to the specified torque.
- Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

Drive Belt Deflection	mm (in)
16 — 20 (0.63 — 0.79) ... New belt 18 — 22 (0.71 — 0.87) ... Reuse belt	



Legend

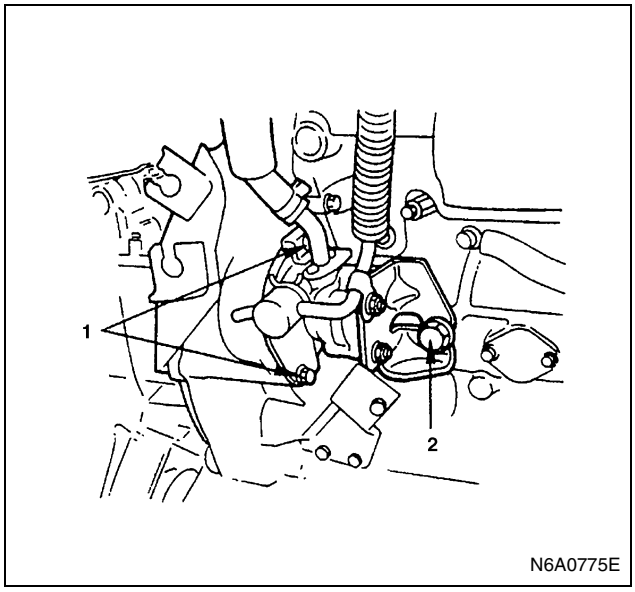
1. Belt deflection

Tighten:
Locking nut to 27 N·m (2.8 kg·m/20 lb·ft)

4. Power Steering Pump

Tighten:
Bolt to

- (1): 43 N·m (4.4 kg·m/32 lb·ft)
- (2): 44 N·m (4.5 kg·m/33 lb·ft)



5. Front Exhaust Pipe

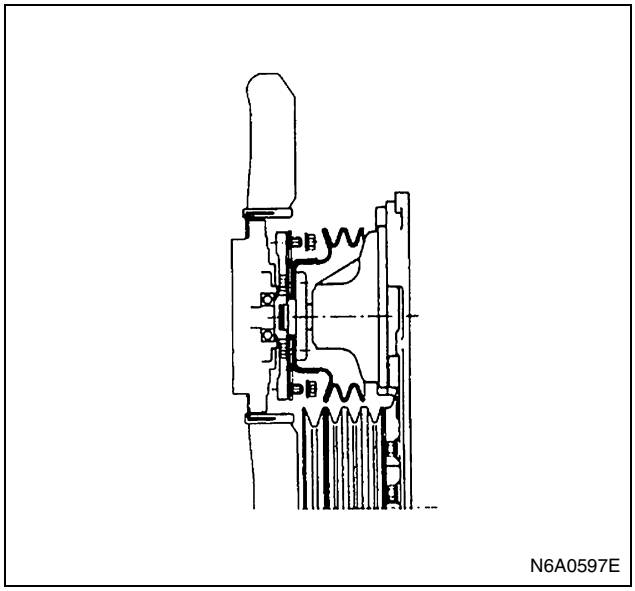
Tighten:
Front exhaust pipe to

- Exhaust manifold side: 67 N·m (6.8 kg·m/49 lb·ft)
- Exhaust brake side: 17 N·m (1.7 kg·m/12 lb·ft)
- Cylinder body side: 17 N·m (1.7 kg·m/12 lb·ft)

Engine Front Side

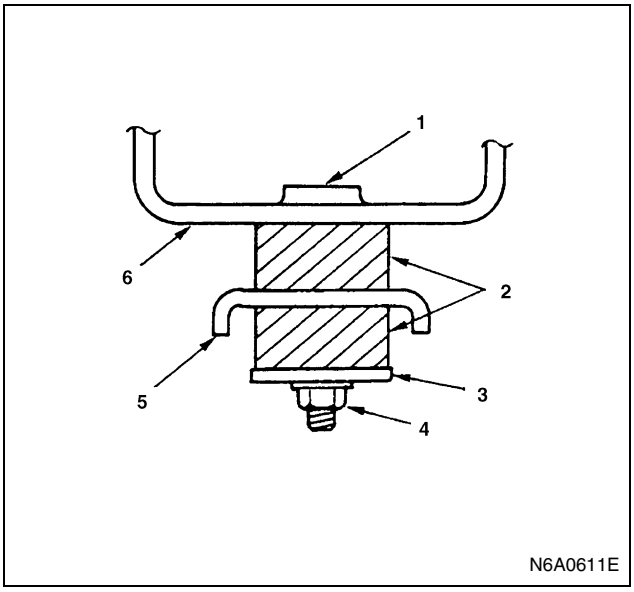
1. Fan

Tighten:
Fan bolt to 24 N·m (2.4 kg·m/17 lb·ft)



2. Radiator

Tighten:
Radiator bracket bolt to 55 N·m (5.6 kg·m/41 lb·ft)



Legend

1. Stud bolt
2. Rubber
3. Washer
4. Flange nut
5. Flame side bracket
6. Radiator side bracket

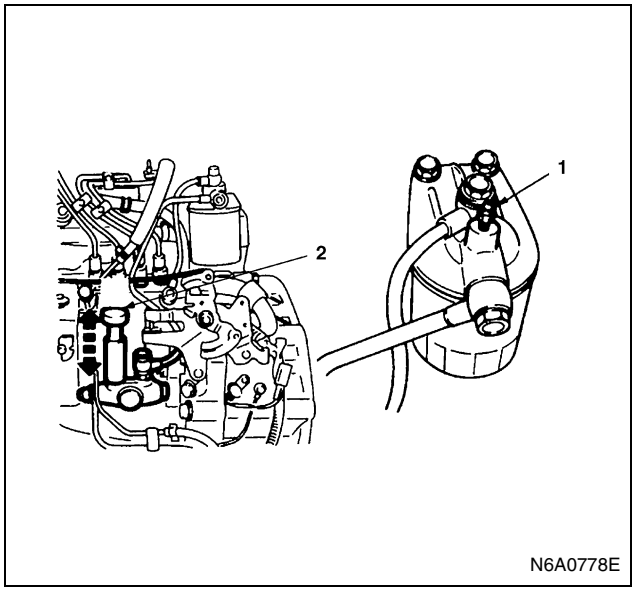
3. Fan Guide
4. Radiator Lower Hose
5. Coolant Reserve Tank Hose/Bypass Hose
6. Radiator Upper Hose

Engine Left Side

1. Fuel Feed Hose
2. Fuel Return Hose

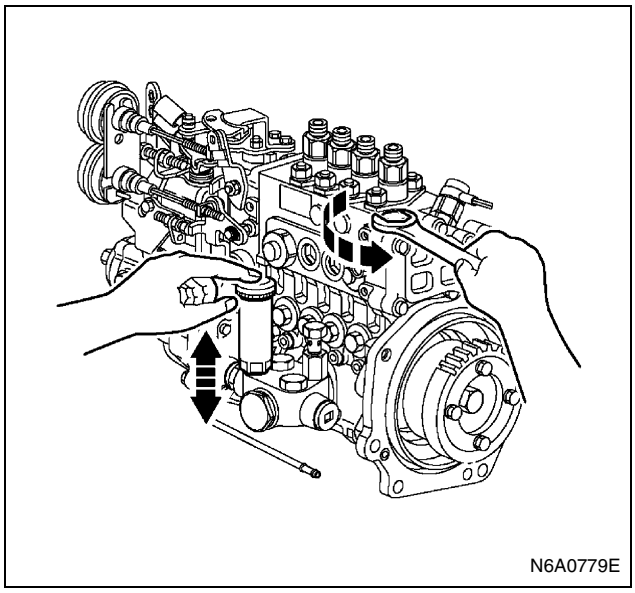
Air Bleeding

1) Loosen the priming pump cap (2) at the side of the injection pump.
2) Loosen the bleeder valve (1) (4HF1) at the top of the fuel filter.

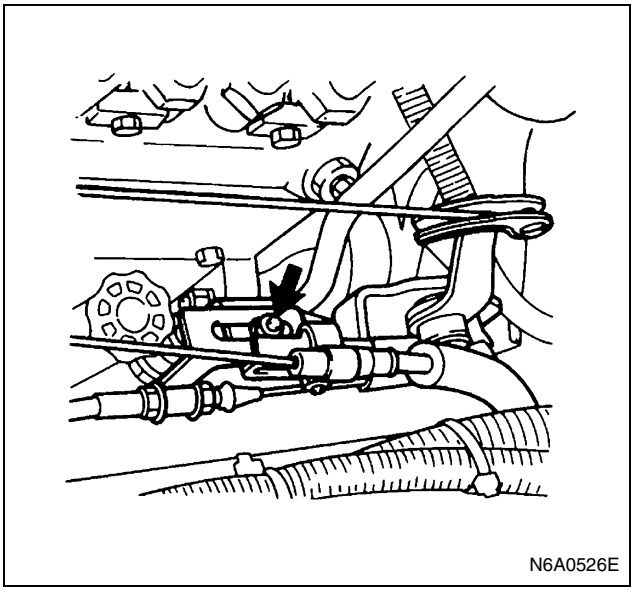


3) Operate the priming pump to bleed the air from the injection pump.
4) Retighten the bleeder valve.
5) Operate the priming pump.
   Check for fuel leakage from around the injection pump and the fuel filter.
6) Lock the priming pump cap to the injection pump.

For 4HE1-TC



3. Accelerator Control Cable
   1) Check to see if the idling control knob is turned to the extreme left.
   2) Attach the end tip of the cable to the engine control lever.
   3) Pull the outer cable toward the front of the vehicle, and provide the engine control wire and the inner cable with an appropriate play before fastening the clamp with a nut.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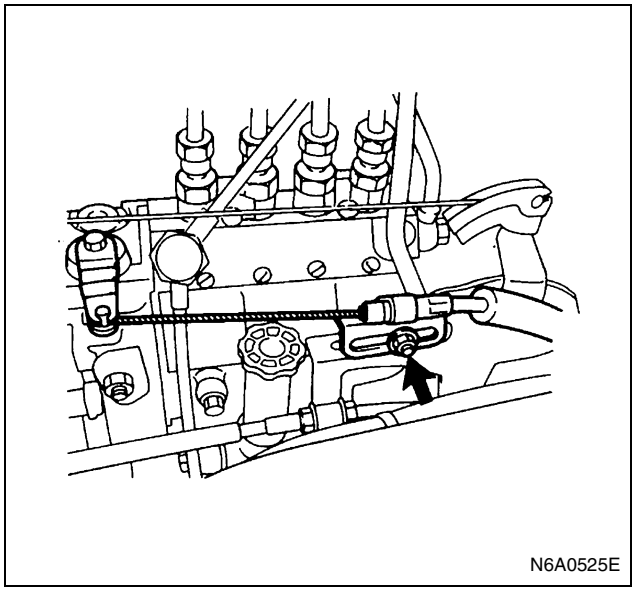
For 4HE1-TC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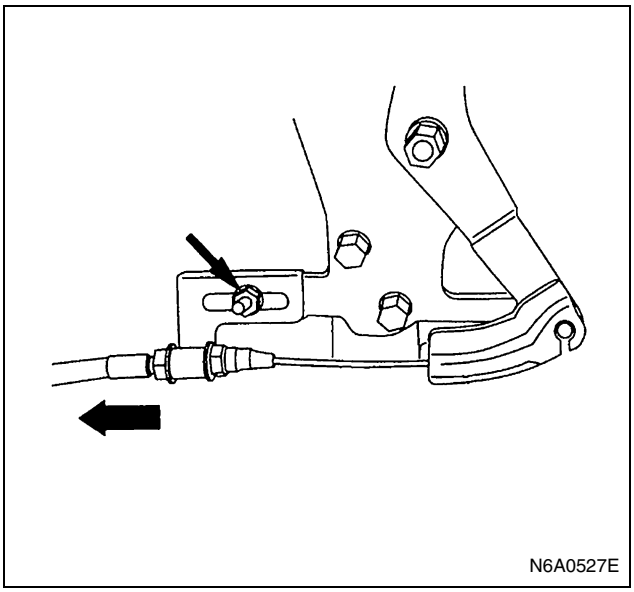
For 4HE1-TC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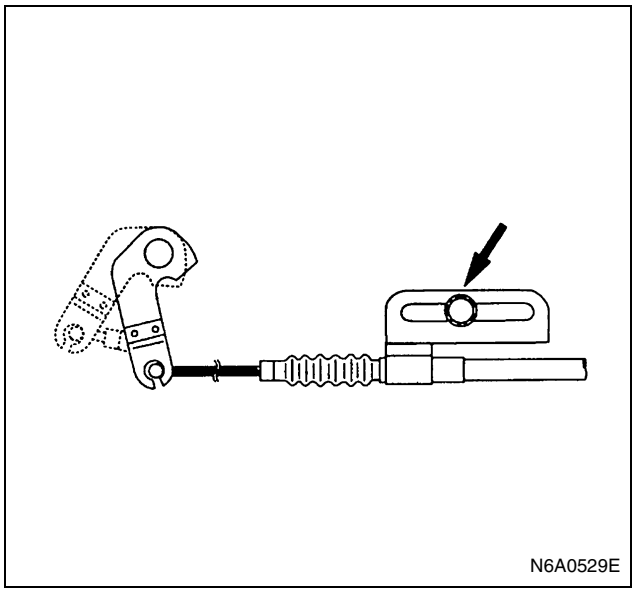
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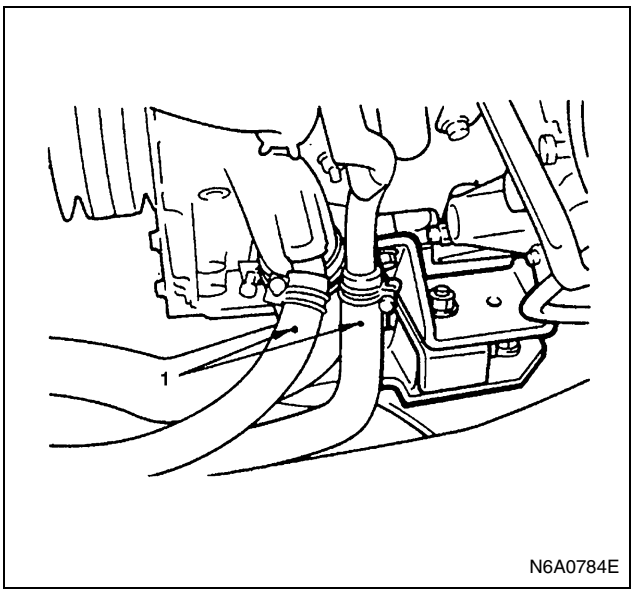
4) Check to see if the control lever of the injection pump is at the idle position (with the lever in touch with the stopper bolt).

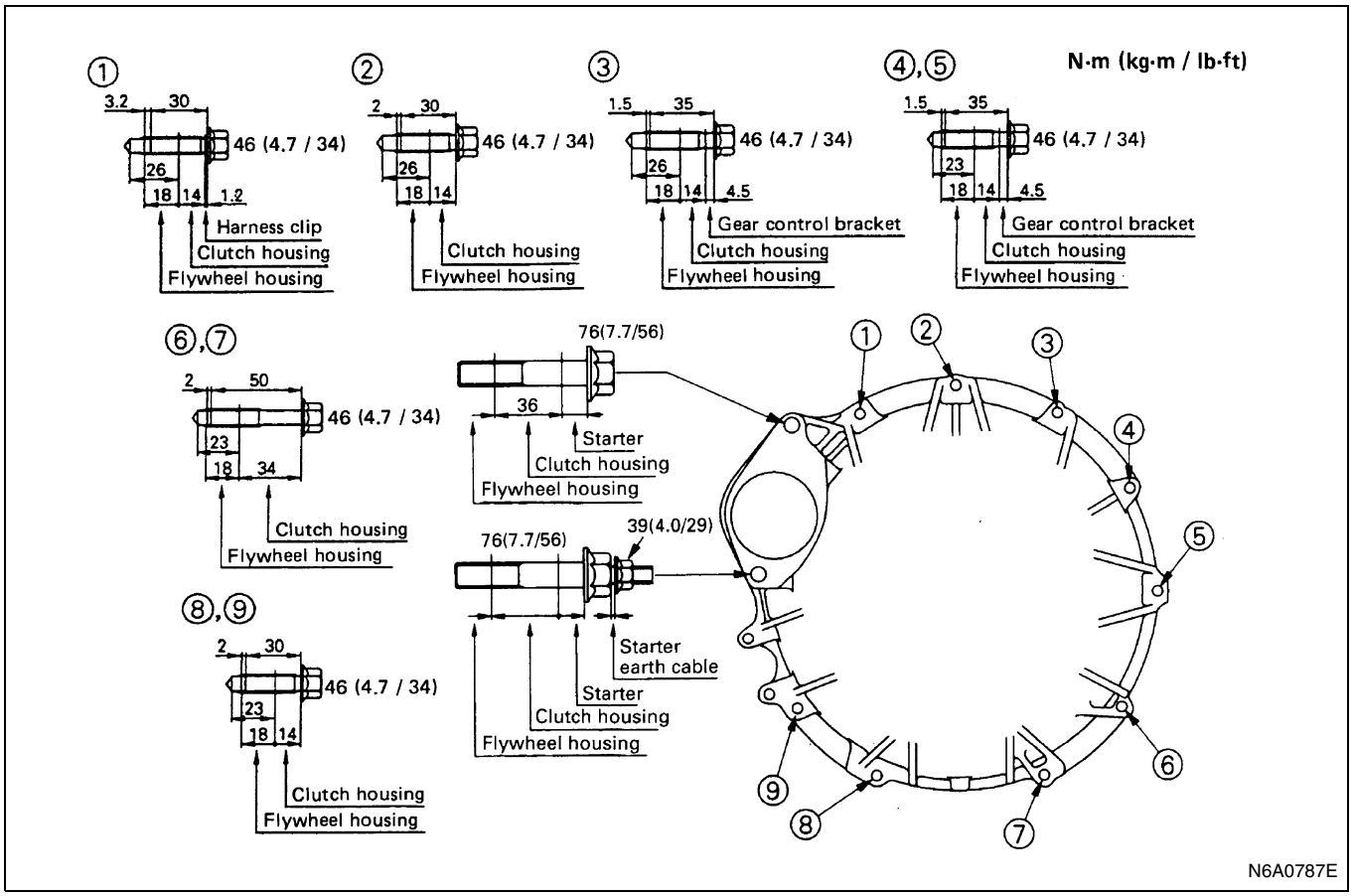
4. Engine Stop Cable
   1) Attach the end tip of the cable to the engine stopper lever.
   2) Pull the cable toward the rear side of the vehicle, and fasten the clamp with a nut at the position where the lever stops.
5. Vacuum Hose
6. Heater Hose
   Install the hose with its mark (1) turned up.



7. Intake Air Duct

Transmission Side

1. Transmission Assembly
   Fasten the transmission to the transmission jack with a chain in the same manner as when dismounting it, and tighten the clutch housing clamping bolt to the specified torque.
   (Refer to the illustration below.)



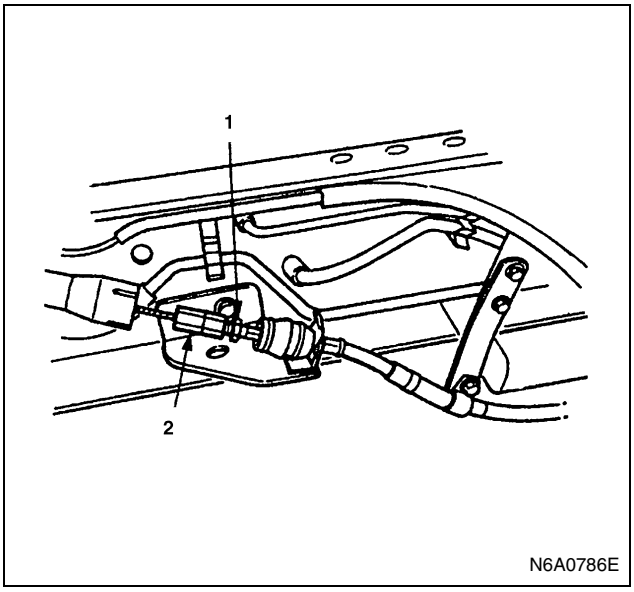
2. Transmission Mounting Nut

Tighten:
Transmission mounting nut to 40 N·m (4.1 kg·m/30 lb·ft)

3. Starter
4. Starter Earth Cable
   Refer to the preceding page.
5. Clutch Slave Cylinder
   1) Install the clutch slave cylinder.

Tighten:
Slave cylinder bolts to 16 N·m (1.6 kg·m/12 lb·ft)

   2) Install the clutch return spring to the clutch shift fork.
6. Select Cable
7. Shift Cable
8. Parking Brake Cable
   1) With the lock nut (1) of the parking brake side cable tightened to the limit, rotate the nut (2) to connect it with the front side cable.
   2) After tightening the front side nut (2) to the limit, fasten the parking brake cable with the lock nut (1).



3) Pull the parking brake lever to the limit (with the operating force of about 147 N (15 kg/33 lb) at the hand), adjust the lever with the lever adjusting nut so that the number of notches becomes 6 to 8 notches.

9. Harness Connector
10. Back-up Lamp Connector
11. Neutral Switch Connector
12. Car Speed Sensor Connector
13. Propeller Shaft Assembly

Tighten:
Propeller shaft bolt to 103 N·m (10.5 kg·m/76 lb·ft)

Engine Warm-Up
After completing the required maintenance procedures, start the engine and allow it to warm up. Then check the following:

1) Engine idling speed
   Refer to “Servicing” for the idling speed adjustment procedure.
2) Engine noise level
3) Engine oil, coolant and fuel leakage
4) Engine control cable operation
5) Clutch engagement
6) Indicator warning light operation

ENGINE 4H SERIES

SECTION 6B

ENGINE COOLING

Contents

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Removal 6B-6
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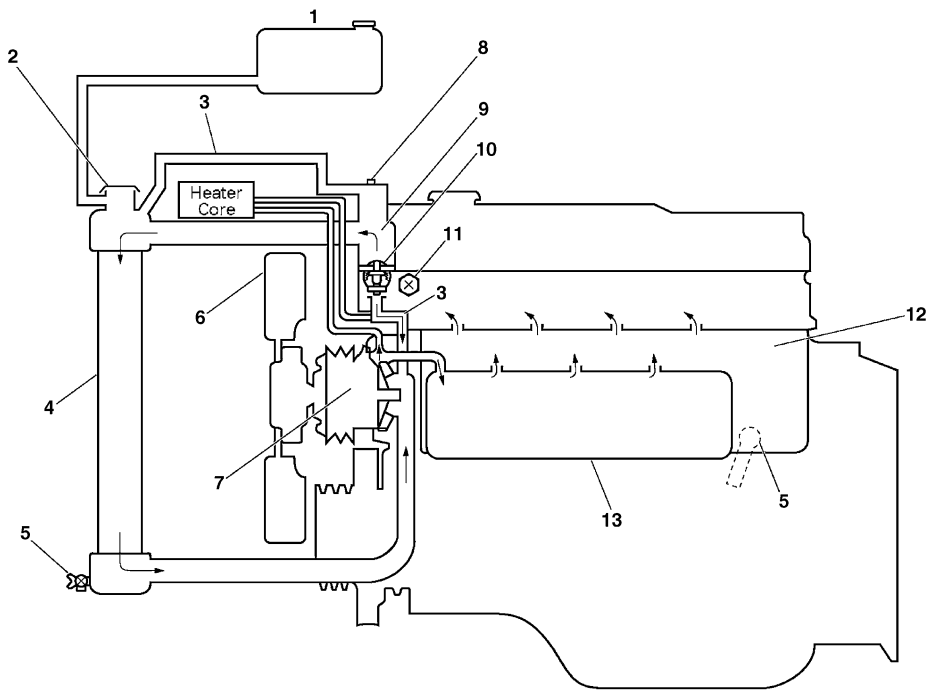
Component 6B-11
Removal 6B-11
Inspection 6B-12
Installation 6B-12
DRIVE BELT ADJUSTMENT 6B-14
Component 6B-14
Inspection 6B-14

GENERAL DESCRIPTION



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Legend

1. Reservoir tank
2. Radiator cap
3. Bypass hose
4. Radiator
5. Drain cock
6. Cooling fan
7. Water pump
8. Air bleeding
9. Water outlet pipe
10. Thermostat
11. Thermometer unit
12. Water jacket
13. Oil cooler

The engine cooling system consists of the radiator, the water pump, the cooling fan, and the thermostats.

To quickly increase cold engine coolant temperature for smooth engine operation, the coolant is circulated by the water pump and thermostats through the by-pass hose and back to the cylinder body. The coolant does not circulate through the radiator.

When the coolant temperature reaches 82°C (180°F), the thermostat will begin to open and a gradually increasing amount of coolant will circulate through the radiator.

The thermostats will be fully open when the coolant temperature reaches 100°C (212°F). All of the coolant is now circulating through the radiator for effective engine cooling.

Engine coolant change procedure.

1. To change engine coolant, make sure that the engine is cool.

WARNING:
WHEN THE COOLANT IS HEATED TO A HIGH TEMPERATURE, BE SURE NOT TO LOOSEN OR REMOVE THE RADIATOR CAP. OTHERWISE YOU MIGHT GET SCALDED BY HOT VAPOR OR BOILING WATER. TO OPEN THE RADIATOR CAP, PUT A PIECE OF THICK CLOTH ON THE CAP AND LOOSEN THE CAP SLOWLY TO REDUCE THE PRESSURE WHEN THE COOLANT HAS BECOME COOLER.

2. Open radiator cap and drain the cooling system by loosening the drain valve on the radiator and on the cylinder body.

Notice:
For best result it is suggested that the engine cooling system be flushed at least once a year.

It is advisable to flash the interior of the cooling system including the radiator before using anti-freeze (ethylene-glycol based).

Replace damaged rubber hoses as the engine anti-freeze coolant is liable to leak out even minor cracks.

Isuzu recommends to use Isuzu genuine anti-freeze (ethylene-glycol based) or equivalent, for the cooling system and not add any inhibitors or additives.

Caution:
A failure to correctly fill the engine cooling system in changing or topping up coolant may sometimes cause the coolant to overflow from the filler neck even before the engine and radiator are completely full.

If the engine runs under this condition, shortage of coolant may possibly result in engine overheating. To avoid such trouble, the following precautions should be taken in filling the system.

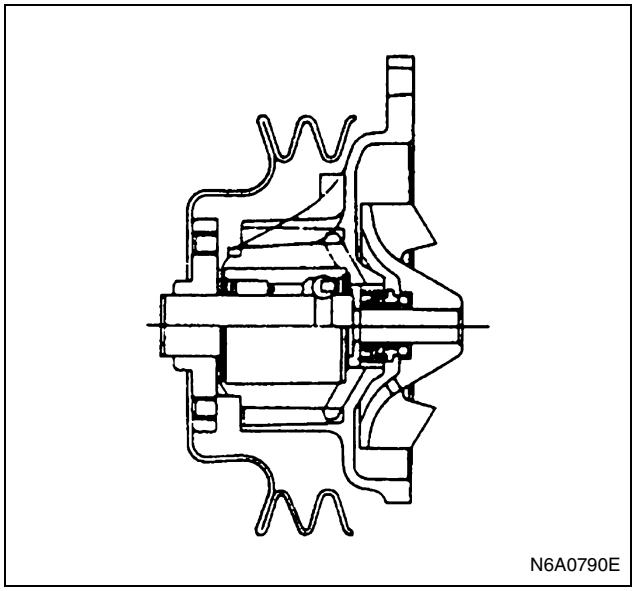
3. To refill engine coolant, pour coolant up to filler neck using a filling hose which is smaller in outside diameter of the filler neck. Otherwise air between the filler neck and the filling hose will block entry, preventing the system from completely filling up.
4. Keep a filling rate of 9 liter/min or less. Filling over this maximum rate may force air inside the engine and radiator.
   And also, the coolant overflow will increase, making it difficult to determine, whether or not the system is completely full.
5. After filling the system to the full, pull out the filling hose and check to see if air trapped in the system is dislodged and the coolant level goes down.
   Should the coolant level go down, repeat topping-up until there is no more drop in the coolant level.
6. After directly filling the radiator, fill the reservoir to the maximum level.
7. Install and tighten radiator cap and start the engine. After idling for 2 to 3 minutes, stop the engine and reopen radiator cap. If the water level is lower, replenish.

WARNING:
WHEN THE COOLANT IS HEATED TO A HIGH TEMPERATURE, BE SURE NOT TO LOOSEN OR REMOVE THE RADIATOR CAP. OTHERWISE YOU MIGHT GET SCALDED BY HOT VAPOR OR BOILING WATER. TO OPEN THE RADIATOR CAP, PUT A PIECE OF THICK CLOTH ON THE CAP AND LOOSEN THE CAP SLOWLY TO REDUCE THE PRESSURE WHEN THE COOLANT HAS BECOME COOLER.

8. After tightening radiator cap, warm up the engine at about 2,000 rpm.
   Set heater adjustment to the highest temperature position, and let the coolant circulate also into heater water system.
9. Check to see the thermostat has opened through the needle position of water thermometer, conduct a 5-minute idling again and stop the engine.
10. When the engine has been cooled, check filler neck for water level and replenish if required.
    Should extreme shortage of coolant is found, check the coolant system and reservoir tank hose for leakage.
11. Fill the coolant into the reservoir tank up to “MAX” line.

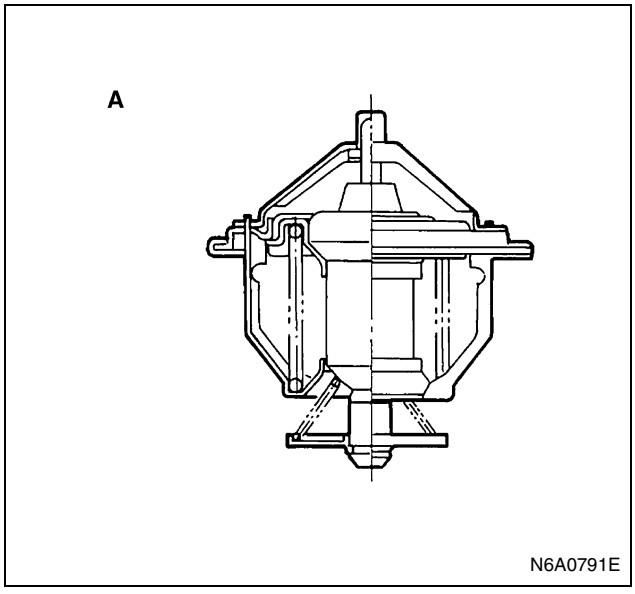
Water Pump

The coolant pump is a centrifugal impeller type and is driven by V type drive belt.

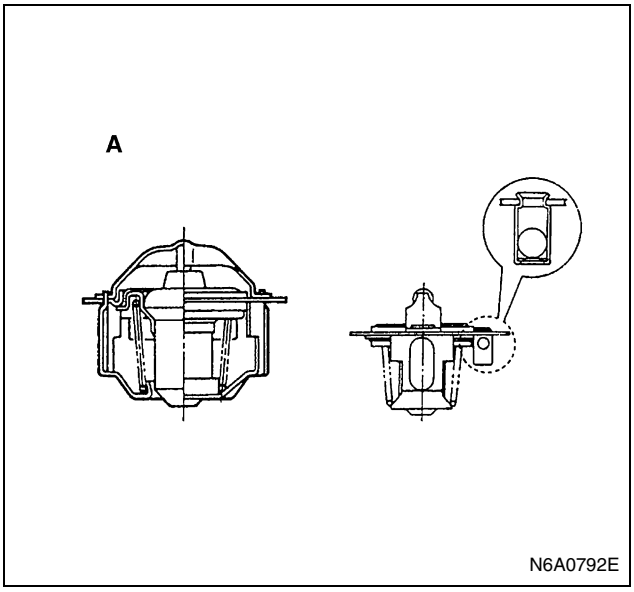


Thermostat

The thermostat is a wax pellet type with a jiggle valve and is installed in the outlet pipe.



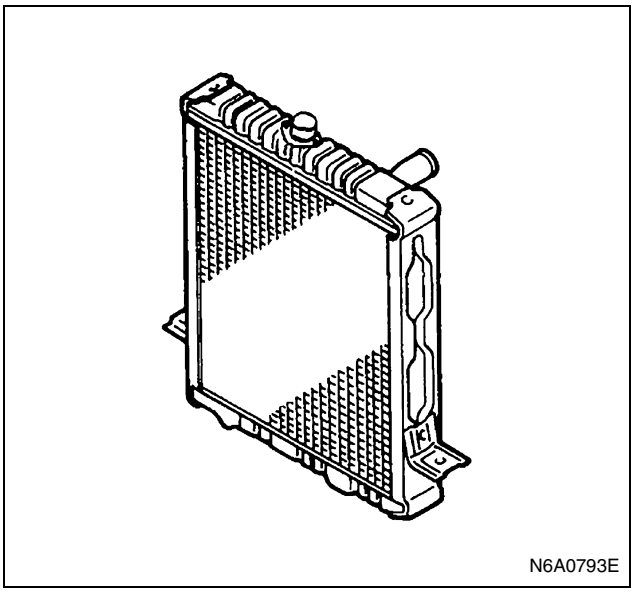
Legend
A. Without jiggle valve



Legend
A. With jiggle valve

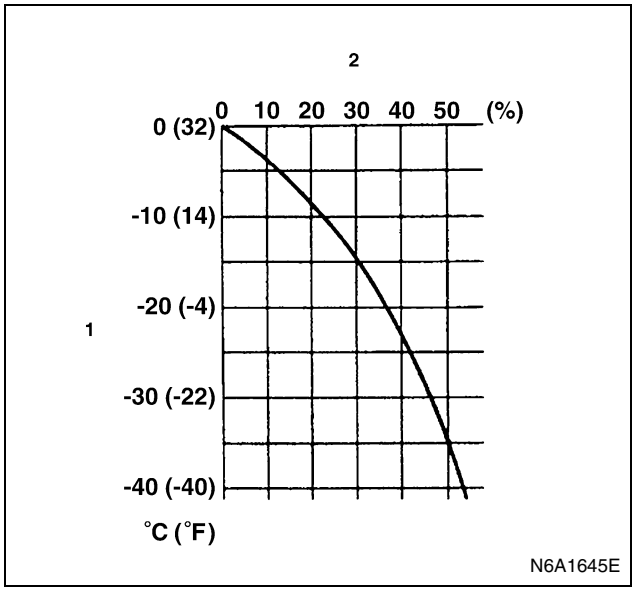
Radiator

The radiator is a tube type with corrugated fins. In order to raise the boiling point of coolant, the radiator is adjusted through a valve fitted to the upper tank to a pressure range of 93 — 123 kPa (0.95 — 1.25 kg/cm^2). The cap fitted to the cylinder head thermostat housing has only a water supply function.



Anti-freeze Solution

- Relation between Mixing ratio and Freezing point
  Freezing temperature of the engine coolant varies with the ratio of anti-freeze solution in water.
  Proper mixing ratio can be determined by referring to the chart. Supplemental inhibitors or additives claiming to increase cooling capability that have not been specifically approved by Isuzu are not recommended for addition to the cooling system.



Legend
1. Freezing point
2. Mixing ratio

- Calculation of mixing ratio

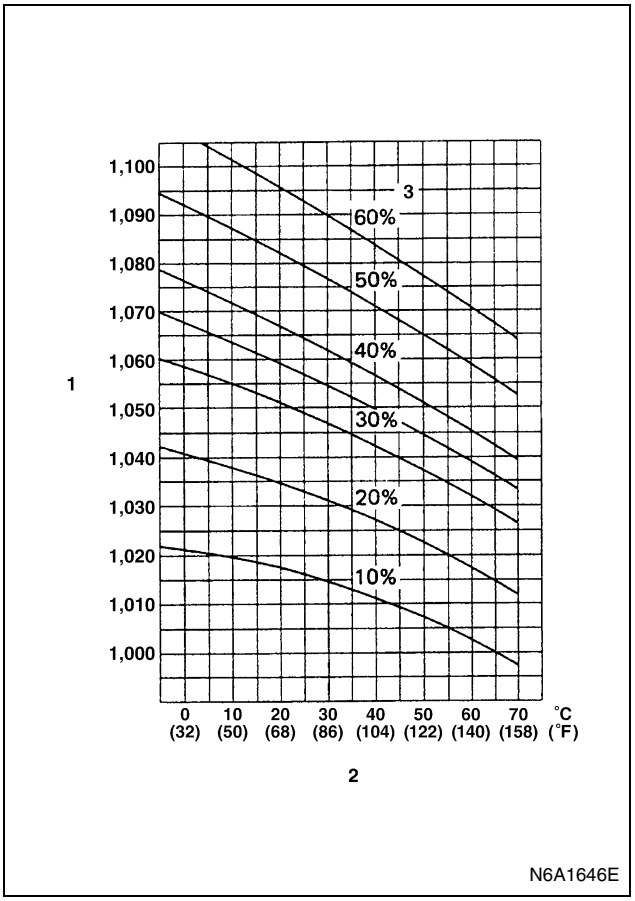
$$\text{Mixing ratio} = \frac{\text{Anti-freeze solution (Lit/qt.)}}{\text{Anti-freeze solution (Lit/qt.) + water (Lit/qt.)}}$$

Notice:
Anti-freeze solution + Water = Total cooling system capacity.

In case of 12 lit (3.17 US gal/2.64 UK gal) total cooling system capacity

Freezing point: °C (°F)	Mixing ratio: %	Anti-freeze solution: L (Imp.qt./U.S.qt)	Water: L (Imp.qt/U.S. qt)
-18 (4)	35	4.2 (4.44/3.70)	7.8 (8.24/6.86)
-25 (-13)	42	5.0 (5.29/4.40)	7.0 (7.40/6.16)
-35 (-31)	50	6.0 (6.34/5.28)	6.0 (6.34/5.28)
-40 (-40)	53	6.4 (6.76/5.63)	5.6 (5.92/4.93)

- Mixing ratio
  Check the specific gravity of engine coolant in the cooling system in temperature ranges from 0 — 50°C (32 — 122°F) using a suction type hydrometer, then determine the mixing ratio of the coolant by referring to the table.

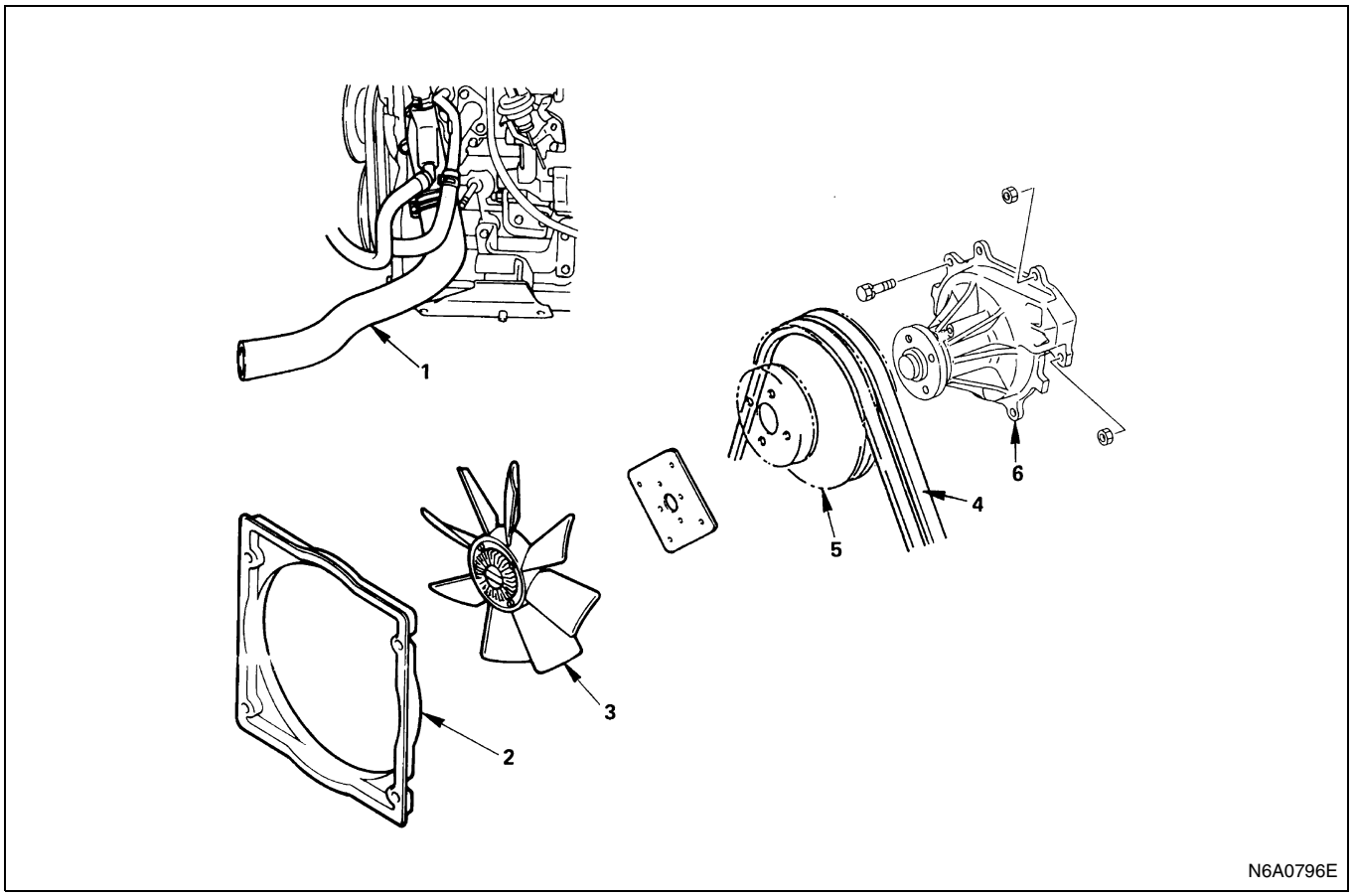


Legend

1. Specific gravity
2. Coolant temperature
3. Mixing ratio

WATER PUMP

Component



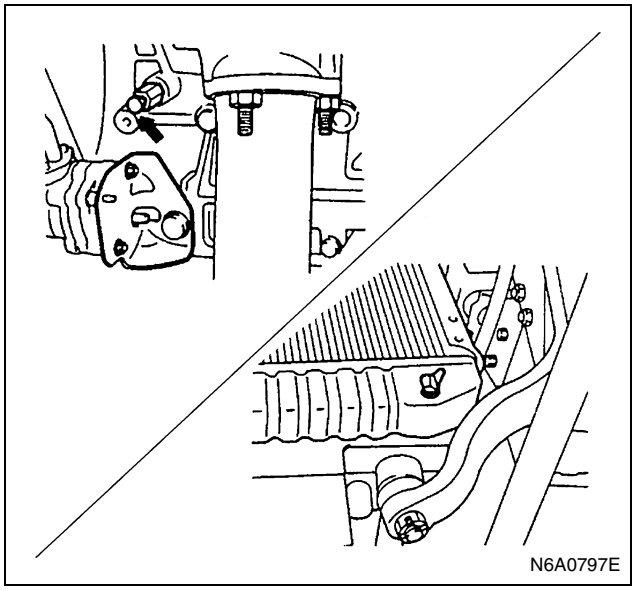
Legend

1. Radiator lower hose
2. Fan guide
3. Fan
4. Fan belt
5. Water pump pulley
6. Water pump assembly

Removal

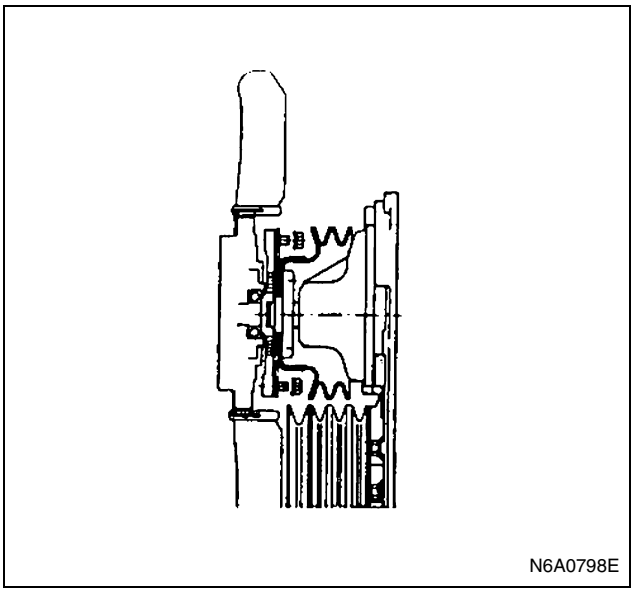
Preparation

- Disconnect battery ground cable.
- Drain coolant.
- Tilt the cab.



1. Radiator Lower Hose
   Disconnect radiator Lower hose from radiator.

2. Fan Guide
3. Fan


N6A0798E

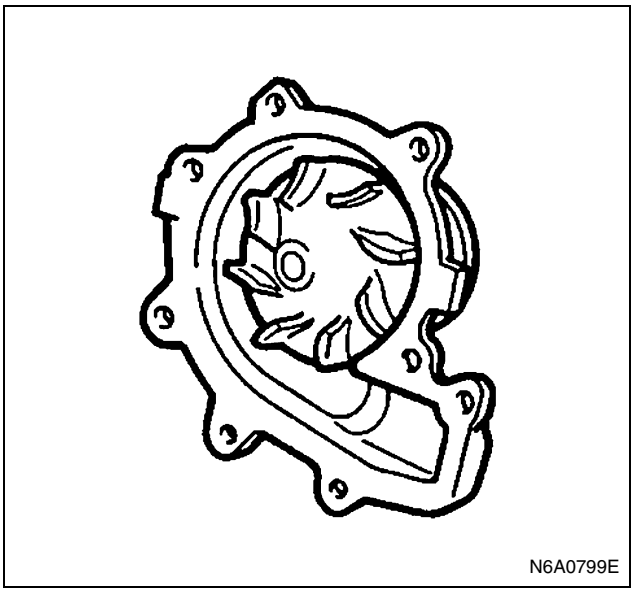
4. Fan Belt
5. Water Pump Pulley
6. Water Pump Assembly

Inspection

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

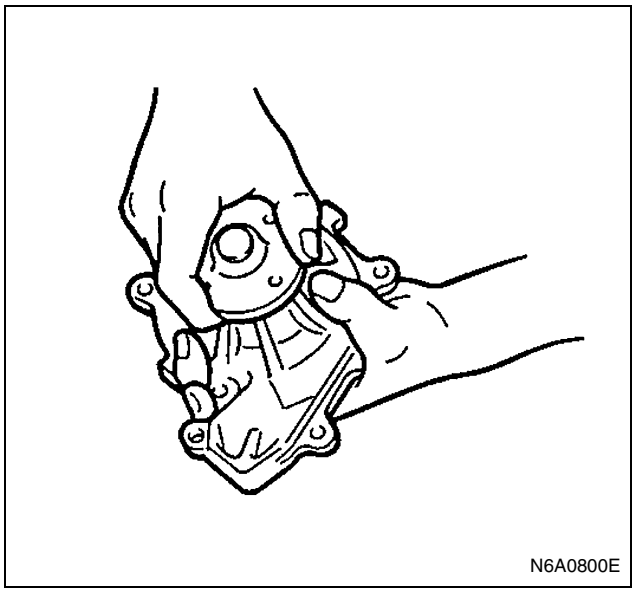
Water Pump Assembly

1. Check the pump body for crack and damage.
2. Check the impeller for crack and corrosion.
3. Check the seal unit leakage.
4. If there is any abnormal condition, replace the water pump as an assembly.


N6A0799E

Bearing Unit

1. Rotate the fan center while pushing it toward the radius, and check to see if there is any excessive play or noise.
2. When there is any excessive play or noise found, replace it as a water pump assembly.

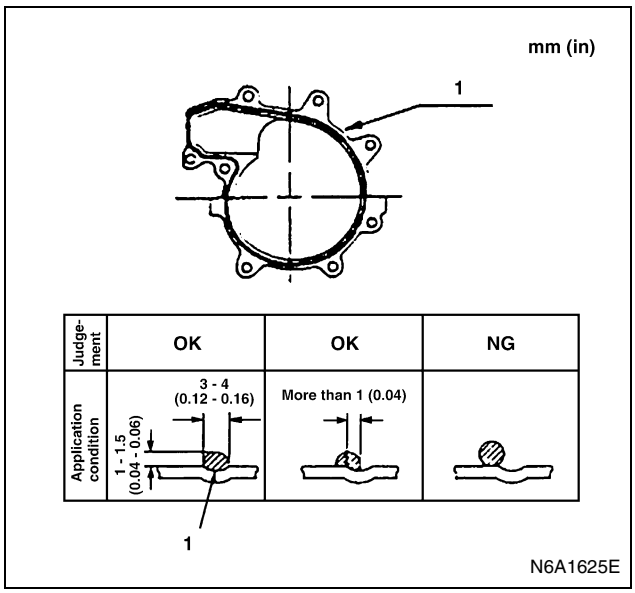

N6A0800E

Installation

1. Water Pump Assembly
   1) Apply 3 — 4 mm (0.12 — 0.16 in) bead of the recommended liquid gasket (Three Bond 1207C) or its equivalent on the water pump fitting surface.
   2) Install the water pump to the front retainer.

Tighten:
Water pump bolt to 24 N·m (2.4 kg·m / 17 lb·ft)

- Install the water pump within 7 minutes after application of liquid gasket.
- For the dislocation of liquid gasket, refer to the illustration.



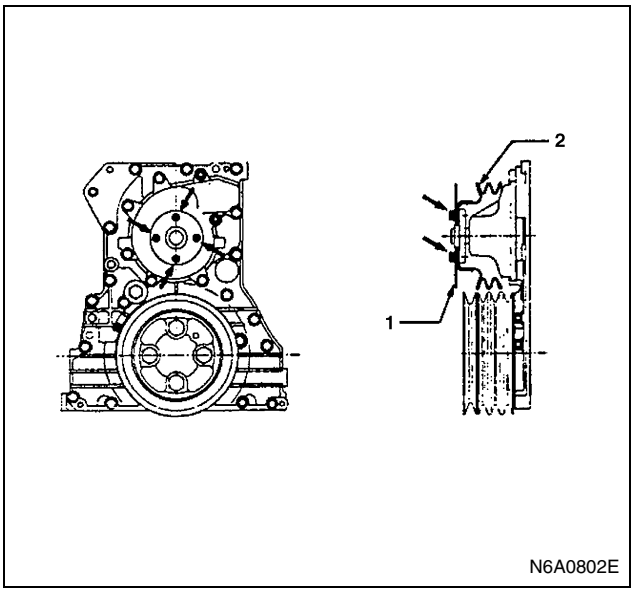
N6A1625E

Legend
1. Liquid gasket

Caution:
The water pump clamping bolt is also used to tighten the front retainer. So, install the water pump before liquid gasket gets dry immediately after installation of the front retainer.

2. Water Pump Pulley

Tighten:
Water pump pulley bolt to 24 N·m (2.4 kg·m / 17 lb·ft)

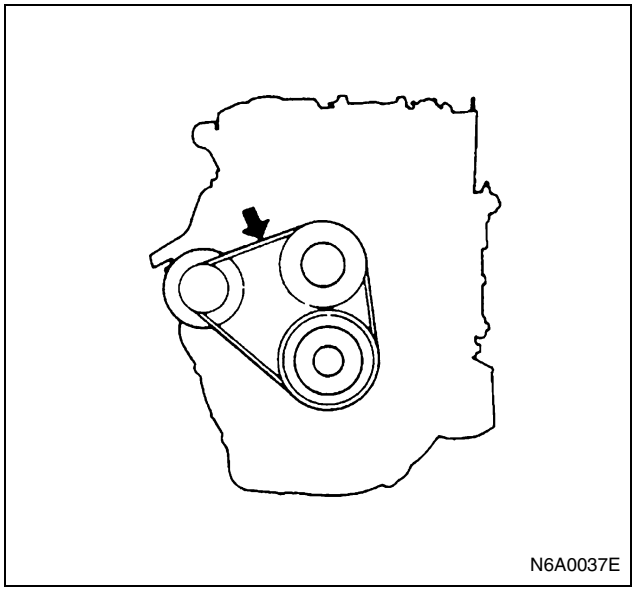


Legend
1. Set plate
2. Pulley

3. Fan Belt
   Check the drive belt tension.
   Depress the drive belt mid-portion with a 98 N (10 kg / 22 lb) force.

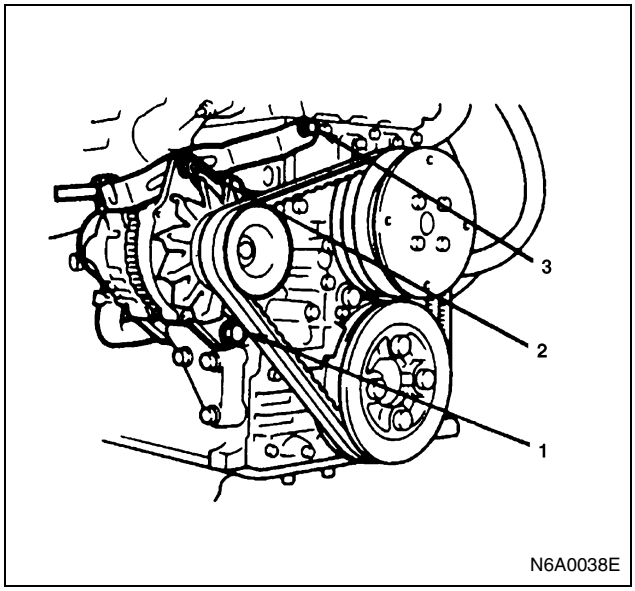
Drive Belt Deflection	mm (in)
New belt	8 — 12 (0.31 — 0.47)
Reuse belt	10 — 14 (0.39 — 0.55)

   Check the drive belt for cranking and other damage.



Fan Belt Adjustment
Fan belt tension is adjusted by moving the generator.

Tighten:
Bolt to
- (1): 40 N·m (4.1 kg·m / 30 lb·ft)
- (2): 24 N·m (2.4 kg·m / 17 lb·ft)
- (3): 46 N·m (4.7 kg·m / 34 lb·ft)



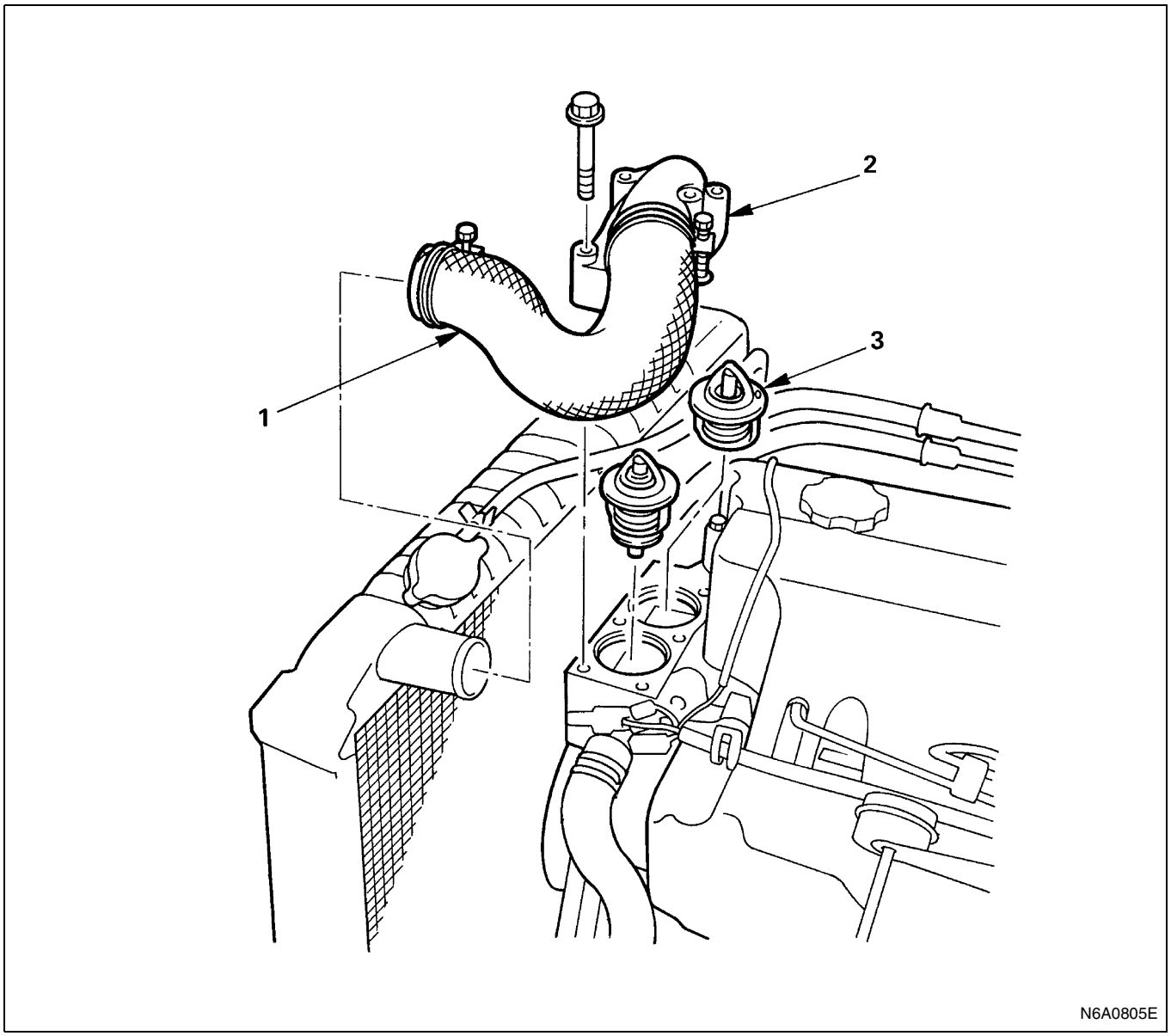
4. Fan

Tighten:
Fan bolt to 24 N·m (2.4 kg·m / 17 lb·ft)

5. Fan Guide
6. Radiator Lower Hose
   - Pour coolant into radiator.
   - Connect battery ground cable.
   - Start engine and check for water leakage carefully.

THERMOSTAT

Component



Legend

1. Radiator upper hose
2. Water outlet pipe
3. Thermostat

Removal

Preparation

- Disconnect battery ground cable
- Drain coolant

1. Radiator Upper Hose
   Disconnect radiator upper hose from radiator.
2. Water Outlet Pipe
   Remove mounting bolt and remove outlet pipe together with radiator upper hose.
3. Thermostat

Inspection

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

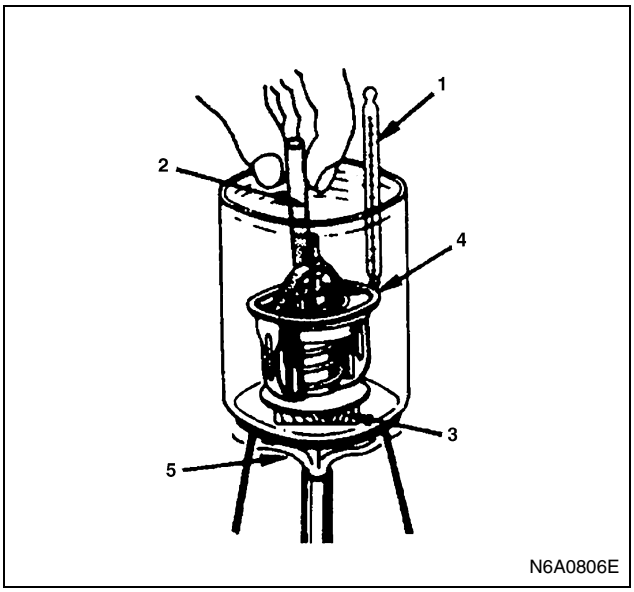
Operating Test

1. Completely submerge the thermostat in water.
2. Heat the water.
   Stir the water constantly to avoid direct heat being applied to the thermostat.
3. Check the valve initial opening temperature.

Valve Initial Opening Temperature		°C (°F)
		Standard
without jiggle valve	Primary valve	80 — 84 (176 — 183)
	Secondary valve	83 — 87 (181 — 189)
with jiggle valve		83.5 — 86.5 (182 — 188)

4. Check the valve lift full opening temperature.

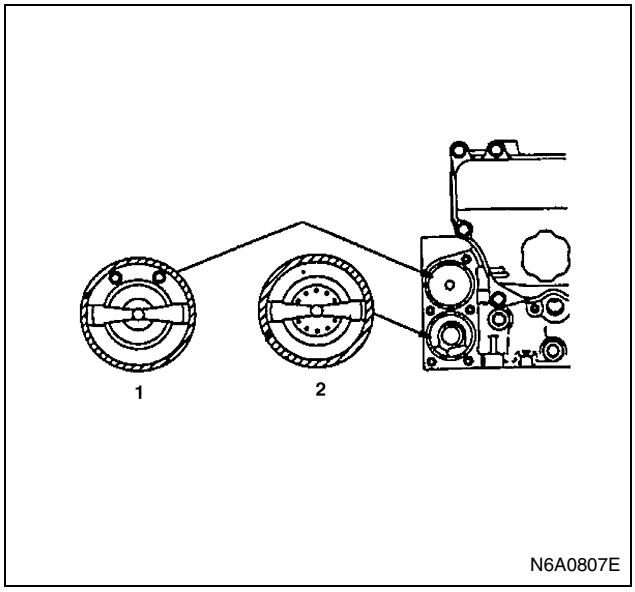
Valve Lift Full Opening Temperature	°C (°F)
	Standard
without jiggle valve	95 (203)
with jiggle valve	100 (212)



Legend
1. Thermometer
2. Agitating rod
3. Wooden piece
4. Thermostat
5. Heat

Installation

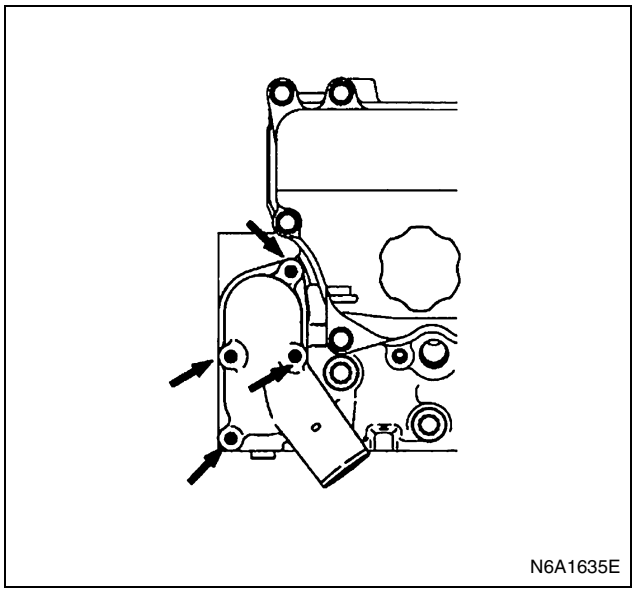
1. Thermostat
   Install the gaskets to the thermostats and the thermostats to the cylinder head as shown in the illustration.



Legend
1. With jiggle valve
2. Without jiggle valve

2. Water Outlet Pipe
   Install the water outlet pipe with thermostat to the cylinder head.
   Tighten the water outlet pipe bolts to the specified torque.

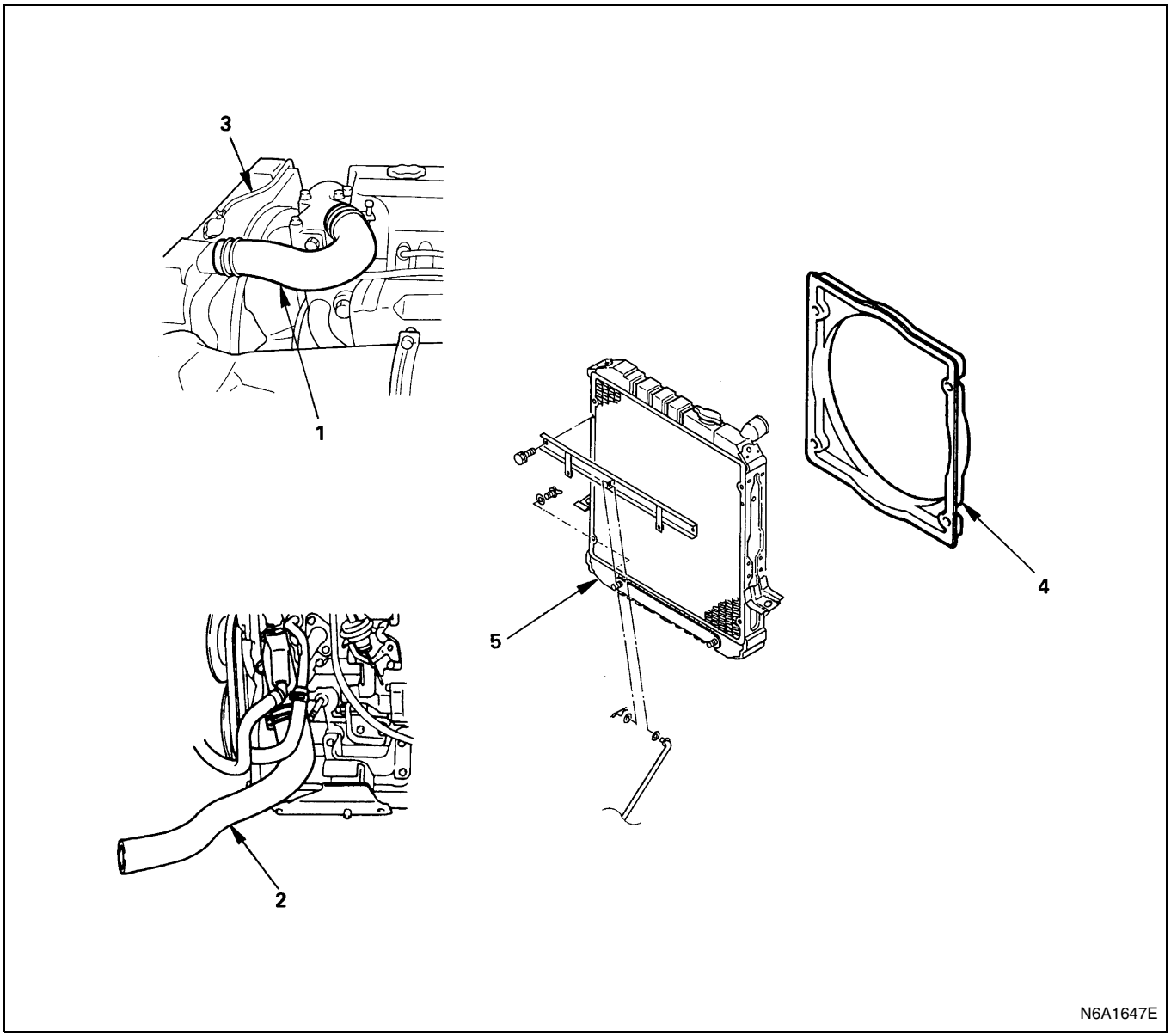
Tighten:
Water outlet pipe bolt to 24 N·m (2.4 kg·m / 17 lb·ft)



3. Radiator Upper
   - Connect battery ground cable.
   - Pour coolant
   - Start the engine and check coolant leakage.

RADIATOR

Component

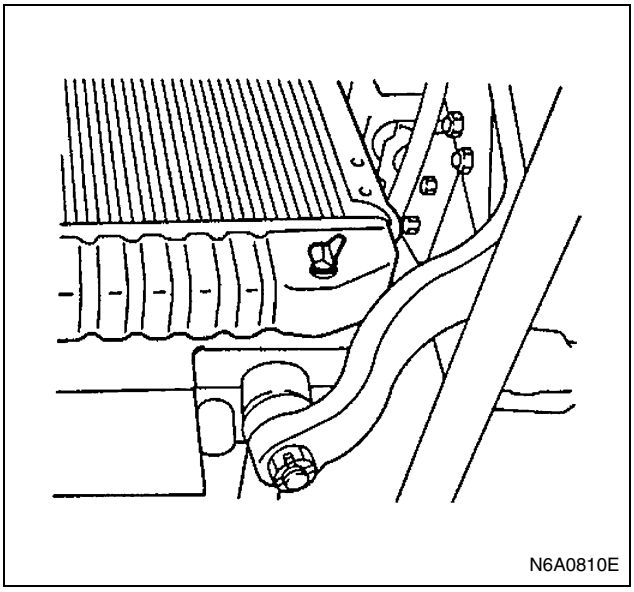


Legend

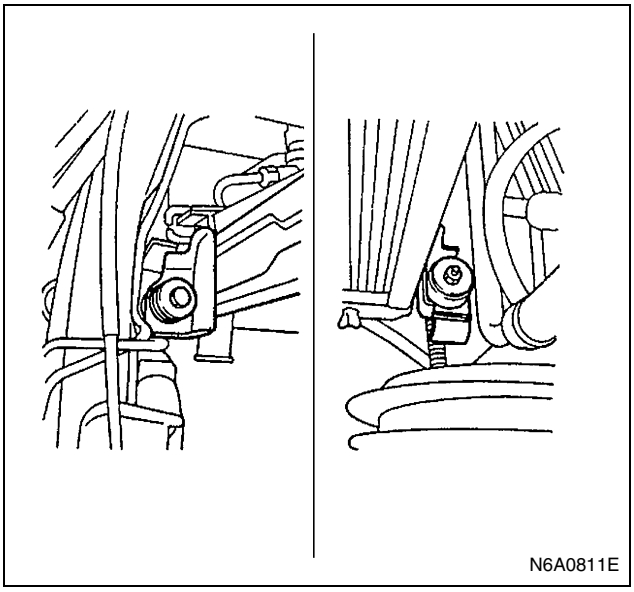
1. Radiator upper hose
2. Radiator lower hose
3. Coolant reserve tank hose
4. Fan guide
5. Radiator

Removal

- Disconnect battery ground cable.
- Tilt the cab.
- Loosen drain plug to drain coolant.


N6A0810E

1. Radiator Upper Hose
2. Radiator Lower Hose
   Disconnect upper hose and lower hose from the radiator.
3. Coolant Reserve Tank Hose
4. Fan Guide
5. Radiator
   1) Remove upward the radiator assembly with hose, taking care not to damage the radiator core by fan blade.


N6A0811E

Inspection

Radiator Valve Check

1. Apply air pressure from filler neck using radiator cap tester and check the opening pressure of radiator valve. If the valve opening pressure is out of the standard value range, replace with a new radiator valve.

Radiator Valve Opening Pressure kPa (kg/cm^2/psi)
93 — 123 (0.95 — 1.25/13.5 — 17.8)

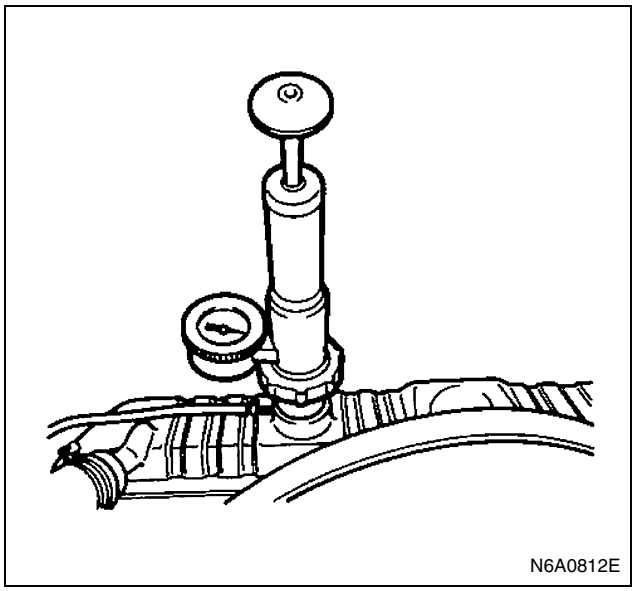
2. Remove the radiator valve and check a negative pressure valve as the center of the valve seat side. If the negative pressure valve does not work smoothly, clean or replace the radiator valve.

Tighten:
Radiator valve fixing to 6 N·m (0.6 kg·m / 4 lb·ft)

3. Conduct cooling system leakage check after reinstalling the radiator valve.

Cooling System Leakage Check

1. Clog up the reservoir tank hose carefully and check the cooling system for leakage with a radiator cap tester by applying an air pressure of 196 kPa (2 kg/cm^2/28 psi) from filler neck to inside the radiator.
2. As the radiator upper tank is provided with a valve, the pressure fails to rise higher than the valve opening pressure unless the hose is clogged up.


N6A0812E

Radiator Core

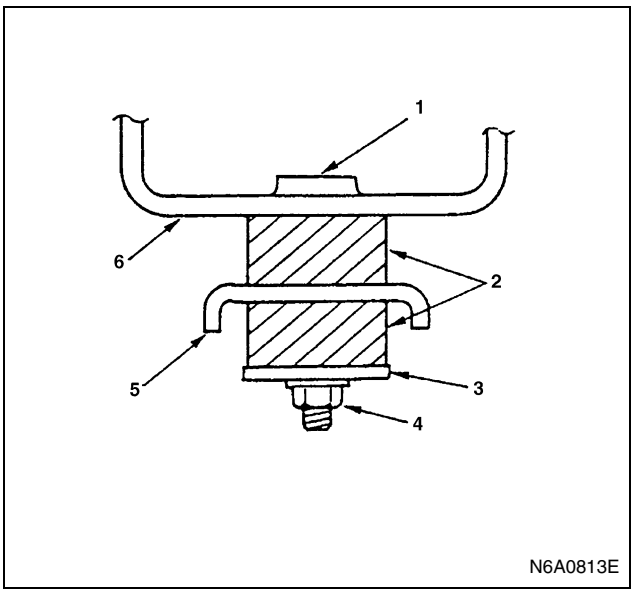
1. Deformed radiator fins could reduce radiation effects, resulting in overheat. Straighten the fins. In such a case, take care not to damage the fin roots.
2. Remove dust and other foreign materials.

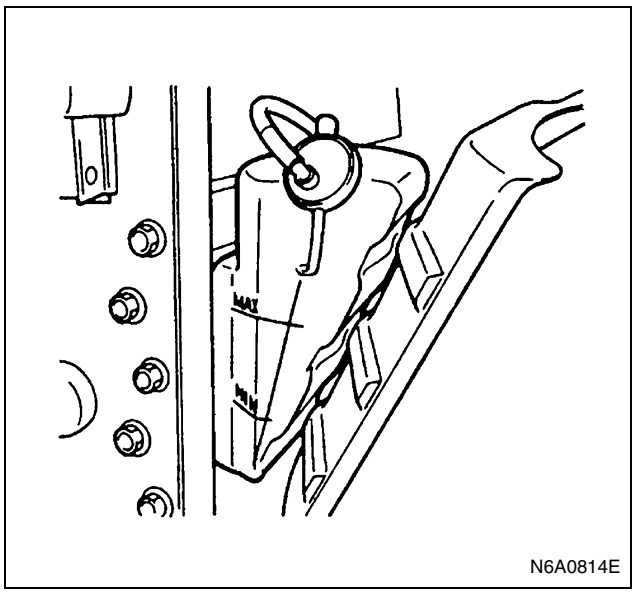
Flushing the Radiator

Wash the inside of radiator and the coolant passage with water and neutral detergent. Remove all scales and rust.

Installation

1. Radiator
   With due attention paid not to damage the radiator core by the fan blades, install the both brackets of the radiator to the brackets on the frame as shown in the illustration.





Legend

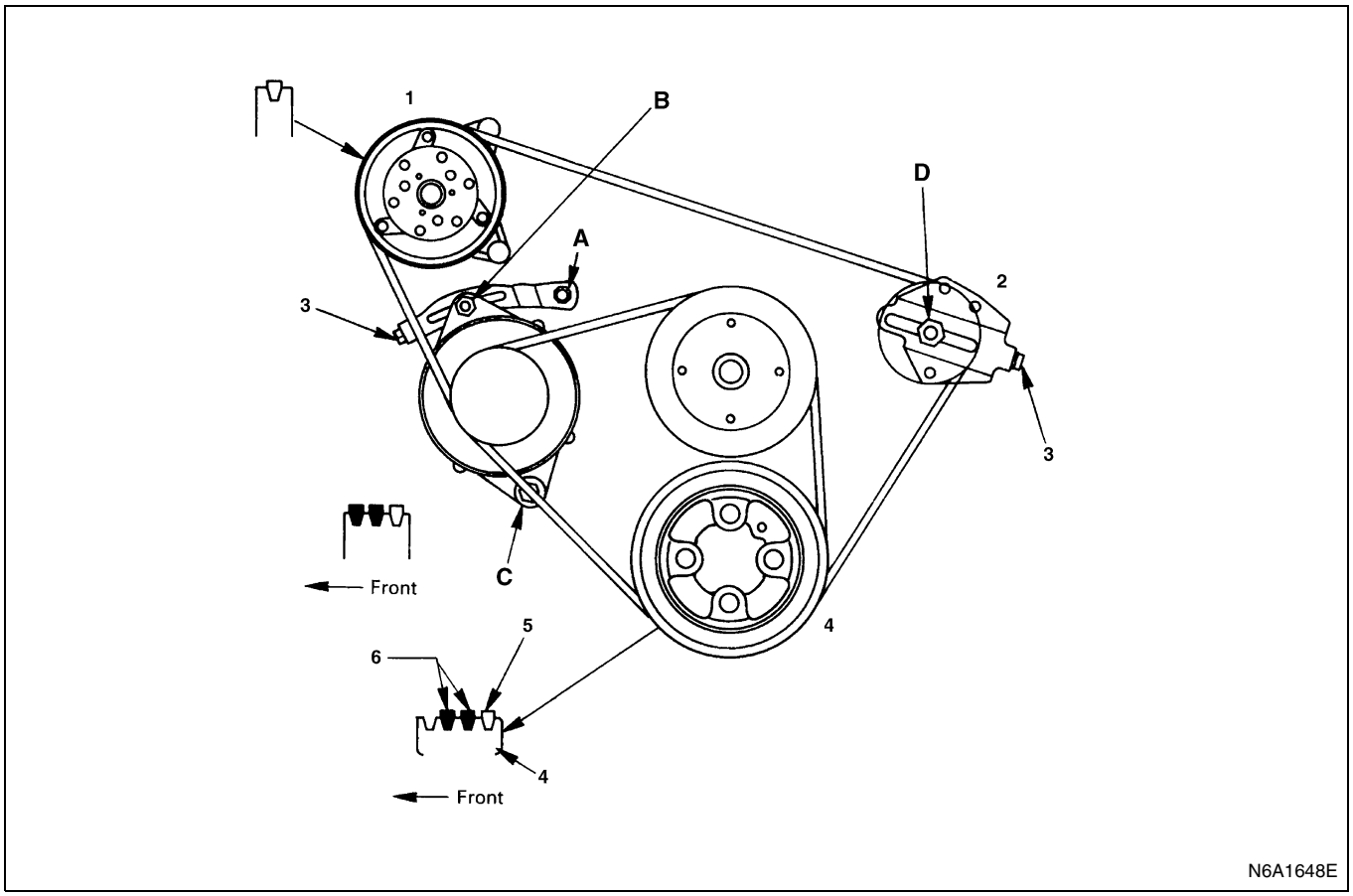
1. Stud bolt
2. Rubber
3. Washer
4. Flange nut
5. Flame side bracket
6. Radiator side bracket

---

2. Fan Guide
3. Coolant Reserve Tank Hose
4. Radiator Lower Hose
5. Radiator Upper Hose
   - Connect battery ground cable.
   - Pour coolant
   - Pour coolant up to filler neck of outlet pipe, and up to MAX mark of reserve tank.
   - Start engine to warm up, and check for coolant level.
     Replenish coolant if it does not reach the outlet pipe filler neck, and tighten the cap completely.

DRIVE BELT ADJUSTMENT

Component



Legend

1. A/C compressor
2. Tension pulley
3. Adjust bolt
4. Crank pulley
5. Compressor drive belt
6. Generator drive belt

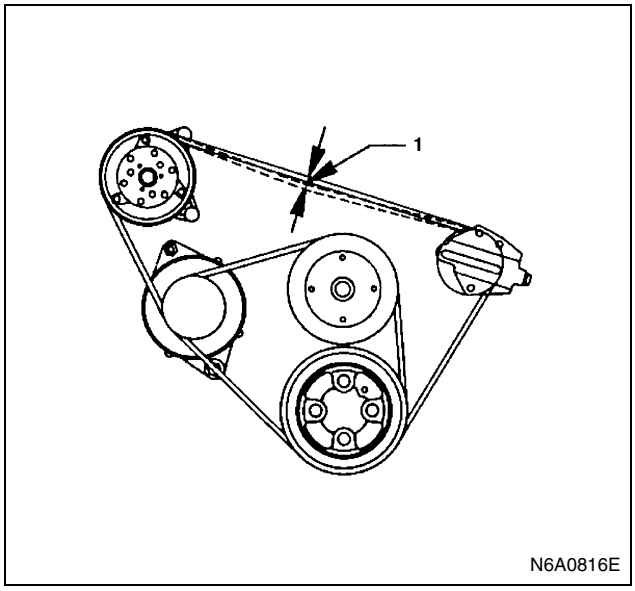
Inspection

Check drive belts for wear or damage, and replace with new ones as necessary. Check belts for tension, and adjust as necessary.

1. Check drive belts tension
2. Push the middle of belts with a force of 98 N (10 kg / 22 lb) and check each belt for deflection.
3. Standard deflection

Fan Drive Belt Deflection	mm (in)
New belt	8 — 12 (0.31 — 0.47)
Reuse belt	10 — 14 (0.39 — 0.55)

A/C Drive Belt Deflection	mm (in)
New belt	16 — 20 (0.63 — 0.79)
Reuse belt	18 — 22 (0.71 — 0.87)



Legend
1. Belt deflection

Tension Adjustment

(Refer to the illustration on the previous page.)

1. Generator & Water Pump Pulley Drive Belt
   1) Loosen the Air Conditioning (A/C) drive belt tension pulley adjust bolt and lock nut (D). Then free the A/C drive belt.
   2) Loosen the adjust plate lock nut (B), the fixing bolt (A), and the fixing bolts (C) on the lower side of the generator.
   3) Rotate the adjust bolt to adjust the belt.
   4) After adjustment, tighten each section to the specified torque.

Tighten:
Bolt and nut to
- (A): 46 N·m (4.7 kg·m / 34 lb·ft)
- (B): 24 N·m (2.4 kg·m / 17 lb·ft)
- (C): 40 N·m (4.1 kg·m /30 lb·ft)

   5) Adjust the A/C drive belt tension.

2. A/C Compressor Drive Belt
   1) Loosen the tension pulley lock nut (D), and rotate the adjust bolt to adjust the belt.
      When finishing the fan drive belt adjustment, then adjust the A/C drive belt.
      After adjustment, tighten the lock nut (D) to the specified torque.

Tighten:
Lock nut (D) to 27 N·m (2.8 kg·m / 20 lb·ft).

ENGINE 4H SERIES

SECTION 6C
FUEL SYSTEM

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GENERAL DESCRIPTION

Caution

When working on the fuel system, there are several things to keep in mind:

- Any time the fuel system is being worked on, disconnect the negative battery cable except for those tests where battery voltage is required.
- Always keep a dry chemical (Class B) fire extinguisher near the work area.
- Replace all pipes with the same pipe and fittings that were removed.
- Clean and inspect “O” rings. Replace where required.
- Always relieve the line pressure before servicing any fuel system components.
- Do not attempt repairs on the fuel system until you have read the instructions and checked the pictures relating to that repair.

Description

Fuel Filters

The Purpose of the fuel filters is to clean the fuel of any dirt particles that can cause wear on the fuel injection nozzle’s sliding surface; and to separate any water from the fuel, which is ever-present from the condensation in the fuel tank. The pre-fuel filter (water separator) is located between the fuel tank and the injection pump. The secondary fuel filter is located between the fuel pump and the injection pump.

Pre-Fuel Filter

When the condensed water in the pre-fuel filter (water separator) comes to the warning level indicated on its plastic body, drain the fluid immediately from the drain plug located bottom of water separator.

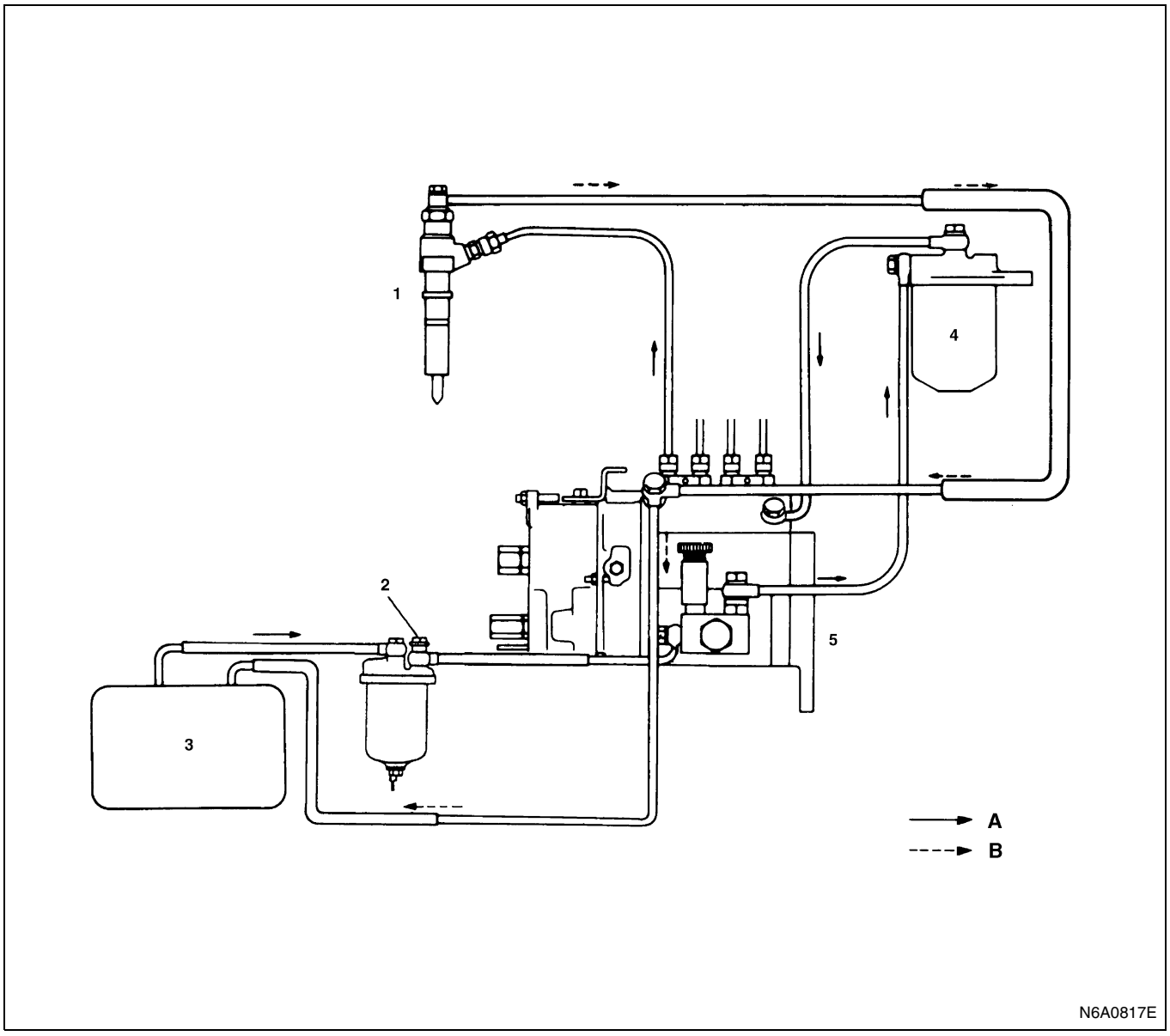
Injection Pump

The fuel injection system includes a fuel tank, fuel hoses and lines, a fuel/water separator, fuel filters, a fuel pump, a Bosch-type in-line fuel injection pump with an internal governor, delivery valves, fuel injection lines and for fuel injection nozzles.

The fuel pump, injection pump and the nozzle are manufactured by Bosch AS corporation, but serviced by Bosch.

Remove the injection pump and governor assembly as a unit to have it services. Do not open or break any seals on the pump or the warranty is void. The injection pump has an identification plate attached to the pump body.

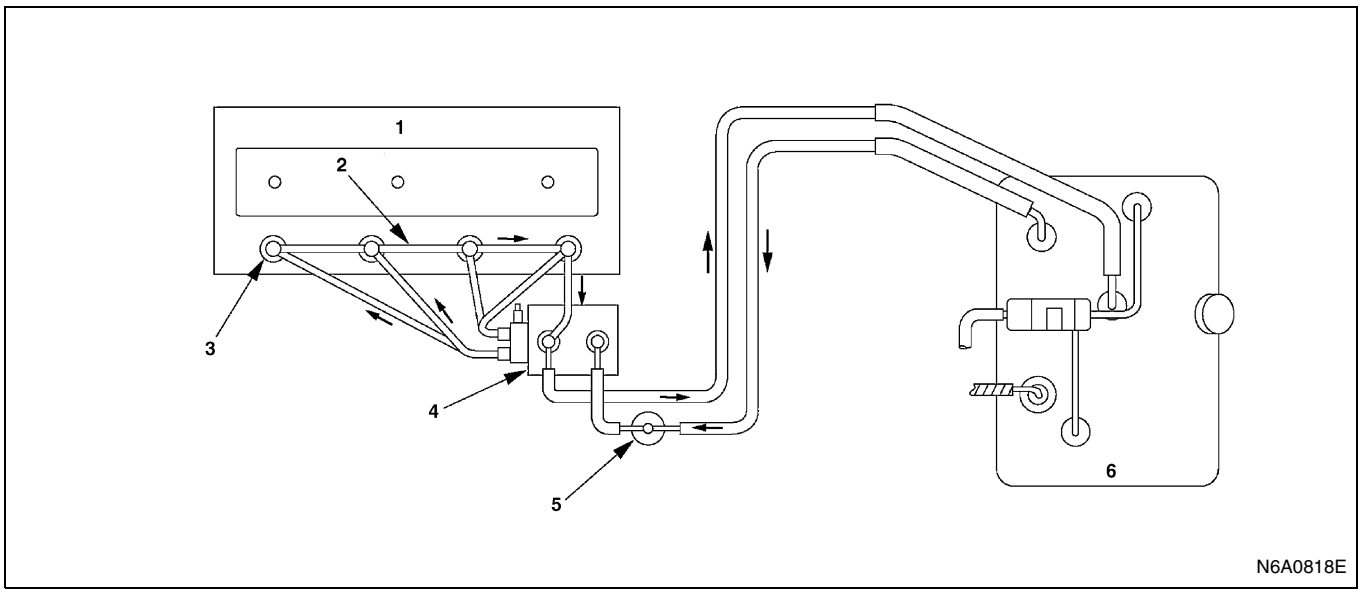
Fuel Flow



Legend

A. Feed
B. Return
1. Nozzle
2. Water separator
3. Fuel tank
4. Fuel filter
5. Injection pump

4HF1-2



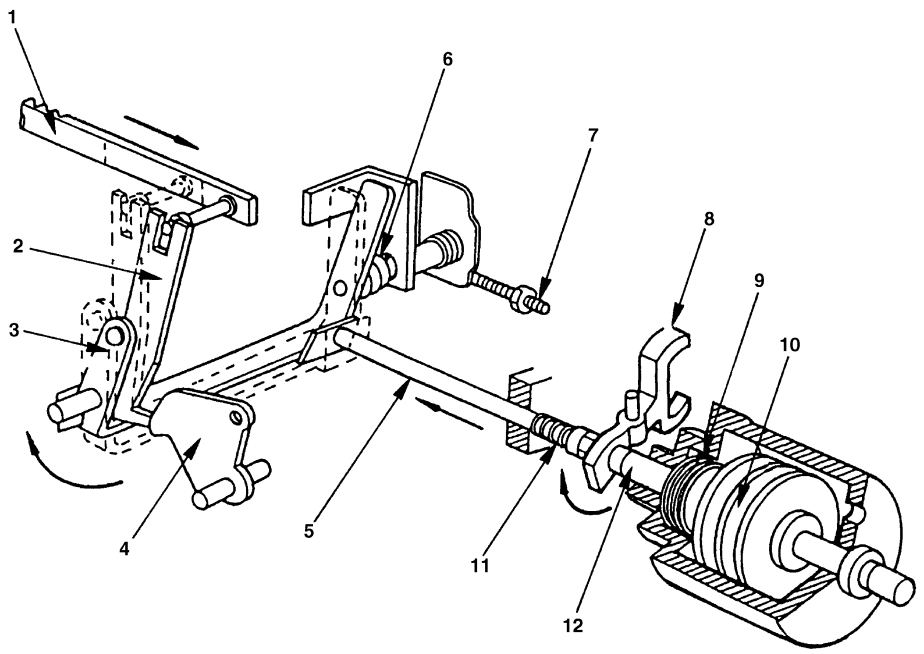
Legend

1. Engine
2. Leak off pipe
3. Nozzle
4. Injection pump
5. Fuel filter (sedimeater)
6. Fuel tank

Aneroid Compensator Function

The bellows in the aneroid compensator is provided with an initial set force by the aneroid compensator spring and is compressed by the push rod C. As the atmospheric pressure drops, the bellows begins to expand against the force of the aneroid compensator spring, which in turn causes the push rod B, through the push rod C and the boost compensator lever F, to move to the left.

Then the push rod B comes into contact with the U-shaped lever and, as the expanding bellows over come the force of the cancel spring installed on the U-shaped lever, causes the U-shaped lever to turn clockwise. Because the bottom of the sensor lever is in touch with the torque cam, the torque cam then works as a pivot on which the top of the sensor lever moves to the right together with the U-shaped lever. At the same time, the control rack, which is hooked on the sensor lever, moves toward the governor to reduce fuel injection.



N6A0819E

Legend

1. Control rack
2. Sensor lever
3. U-shaped lever
4. Torque cam
5. Push rod B
6. Cancel spring
7. Full load set screw
8. Boost compensator lever
9. Aneroid compensator spring
10. Bellows
11. Return spring
12. Push rod C

Brief Explanation of Emission and Electrical Control System

MITICS (Mechanically Integrated Timing and Injection Control System)

4HE1-TC

The Mechanically Integrated Timing and Injection rate Control System (MITICS) utilizes mechanical control, in comparison with TICS systems, which utilize electronic control.

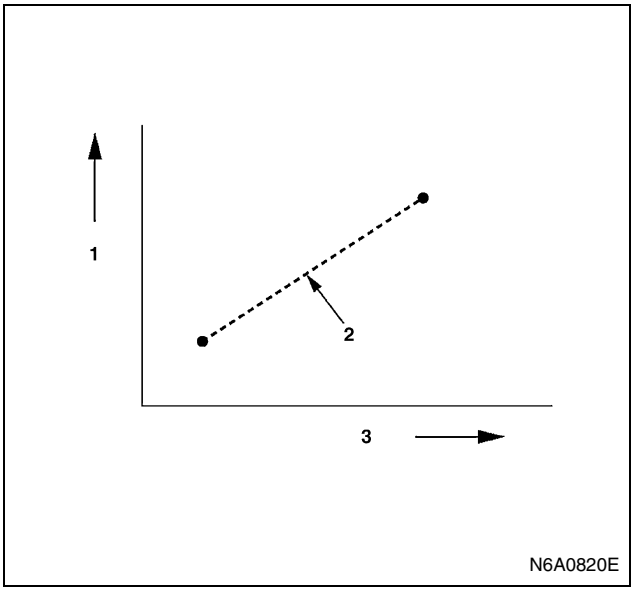
MITICS is equipped with the RLD-M type governor, which contains a pre-stroke control mechanism. With this, pre-stroke position (i.e, beginning of static injection) can be varied to control injection timing and injection rate (i.e., the fuel injection quantity injected from the nozzle per cam angle degree).

This enables high injection rates1 in the low and medium speed ranges through a short injection interval, thus contributing to higher engine torque and cleaner exhaust.

MITICS was developed in response to the demands of medium sized diesel engines for low cost, low fuel consumption, high output and cleaner emissions.

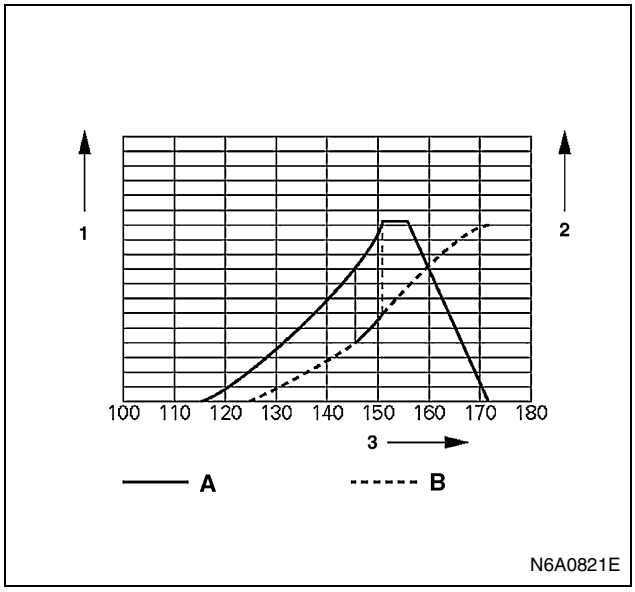
High injection rates using a short injection interval.

- The speed at which the injection pump plunger rises slows as engine speed decreases and the pressure inside the injection pipe decreases. Because of this, the nozzle spray deteriorates and makes it impossible to obtain the proper fuel - air mixture.
  To obtain the proper mixture at low and medium speeds, it is necessary to increase the pressure inside the injection pipes using a short injection interval.



Legend
1. Injection pipe pressure
2. PE-AD type injection pump
3. Engine speed

- The following figure shows plunger speed and cam lift in relation to cam angle. It can be seen from the graph that plunger speed increases together with cam lift.
  MITICS varies the beginning of injection position at low and medium speeds so that injection occurs when the plunger speed increases during the latter half of cam lift (shown by the bold line). At high speeds, injection is performed when the plunger speed decreases during the first half of cam lift to prevent an excessive increase in injection pipe pressure.
  This enables high pressures at low and medium speeds with a fast plunger speed. Thus, a fine fuel oil spray is injected into the cylinder from the nozzles within a short time to provide the proper mixture for combustion, helping to increase torque and keep exhaust emissions clean.



Legend
A. Plunger speed
B. Cam lift
1. Plunger speed (m/sec)
2. Cam lift (mm)
3. Cam angle (degrees)

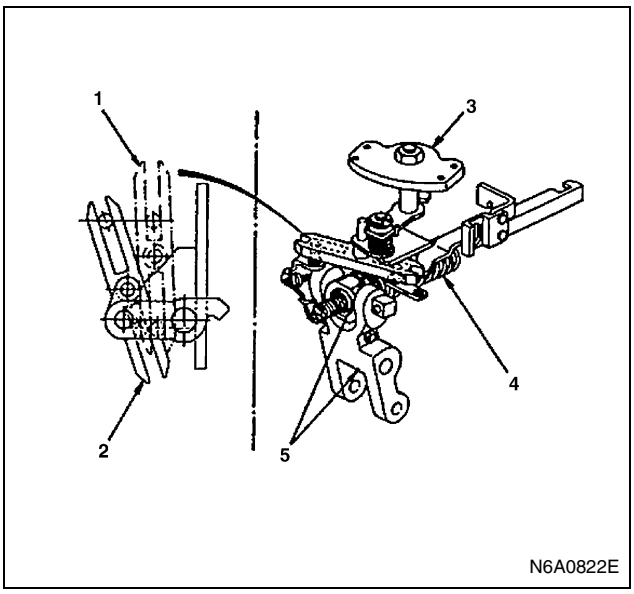
Governor (Model RLD-M)

4HE1-TC

The RLD-J type governor can be used with the MI, MITICS injection pumps, and was designed to have better control and endurance than the previous RLD type governor.
Although the basic construction is identical to that of the RLD type governor, the RLD-M type is larger to match the applicable pumps' larger size.

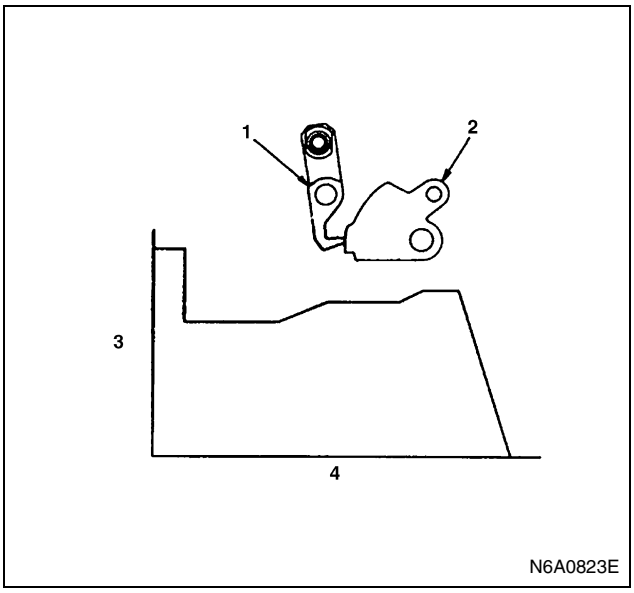
Features

1. Variable speed control governor with decreased lever reaction force
   As with the previous RLD type governor, RLD-M governor control is accomplished using the speed control lever to change the fulcrum of the internal link mechanism.
   Consequently, as the reaction force of the governor spring does not act directly on the speed control lever, only a very small lever reaction force is exerted on the accelerator pedal.



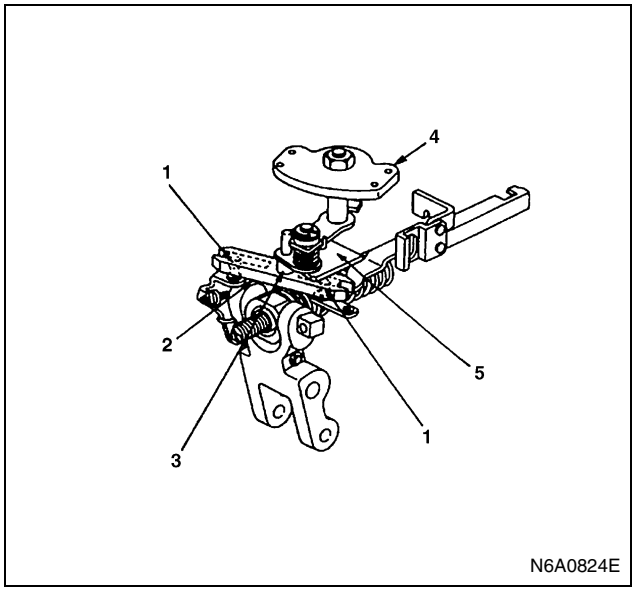
Legend
1. At maximum speed control
2. At idle speed control
3. Speed control lever
4. Governor spring
5. Link mechanism

2. Set torque characteristics through internal torque cam
   At full load, the tip of the sensor lever traces the face of the torque cam to determine the full load rack position and control the full load injection quantity.
   Consequently, the torque characteristics demanded by the engine can be freely set by changing the shape of the torque cam face.



Legend
1. Sensor lever
2. Torque cam
3. Control rack position (mm)
4. Pump speed (r/min)

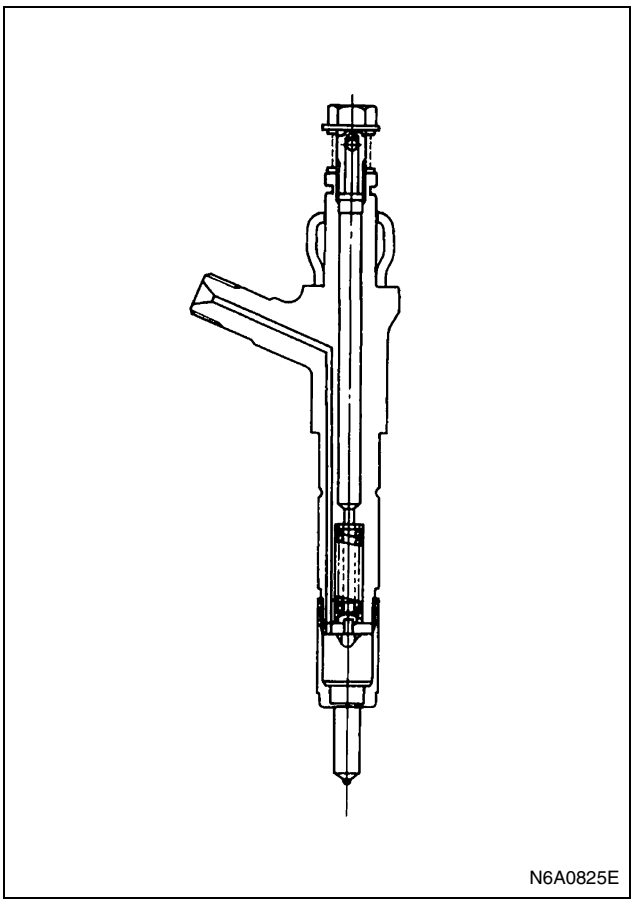
3. Improved control through internal guide plate
   When the speed control lever is operated, the 2nd supporting lever's pin moves along the guide plate. The floating lever connected to the pin thus moves to change the ball joint fulcrum positions. In the intermediate to high speed ranges, the guide plate causes the floating lever to move to increase the lever ratio continuously from 1.1 (idling) — 6 (full speed). This increase in the lever ratio in the intermediate to high speed range improves speed droop.



Legend
1. Ball joint
2. Floating lever
3. 2nd supporting lever pin
4. Speed control lever
5. Guide plate

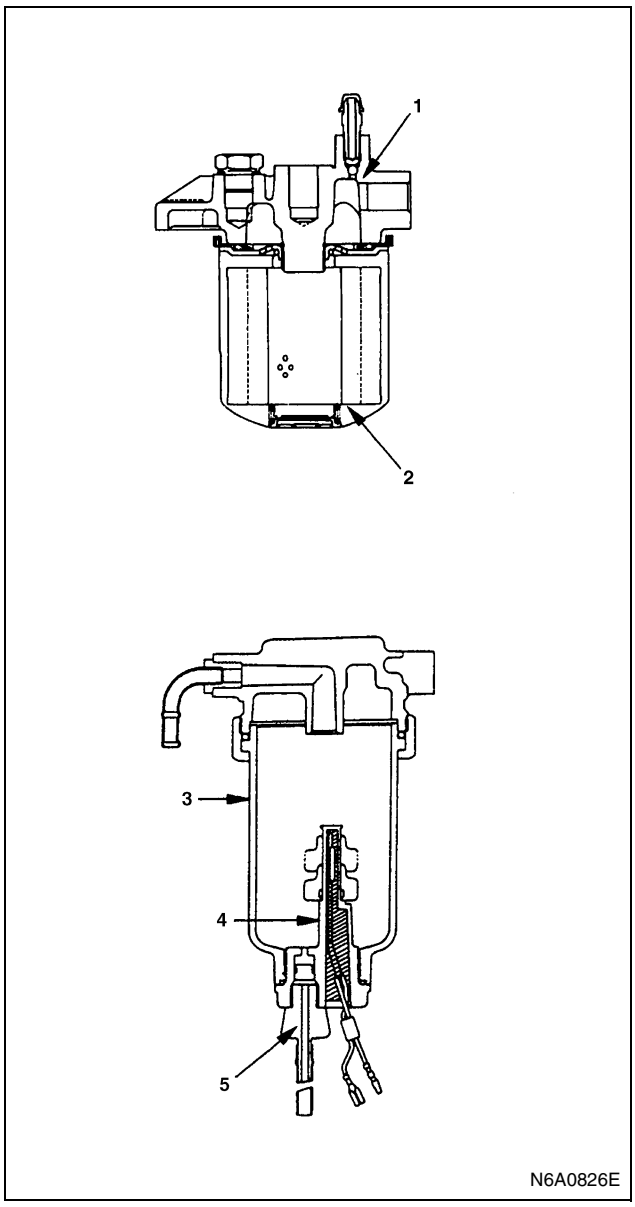
Injection Nozzle

A Bosch hole type injection nozzle is used. It consists of the nozzle body and the needle valve assembly.
The injection nozzle assembly sprays pressurized fuel from the injection pump into the combustion chamber through the nozzle body injection orifice.



Fuel Filter and Water Separator

A cartridge type fuel filter and a water separator are used along with the in-line type injection pump.
As the inside of the injection pump is lubricated by the fuel which it is pumping, the fuel must be perfectly clean. The fuel filter and the water separator remove water particles and other foreign material from the fuel before it reaches the injection pump.
The water separator has an internal float. When the float reaches the specified level, a warning light comes on to remind you to drain the water from the separator.

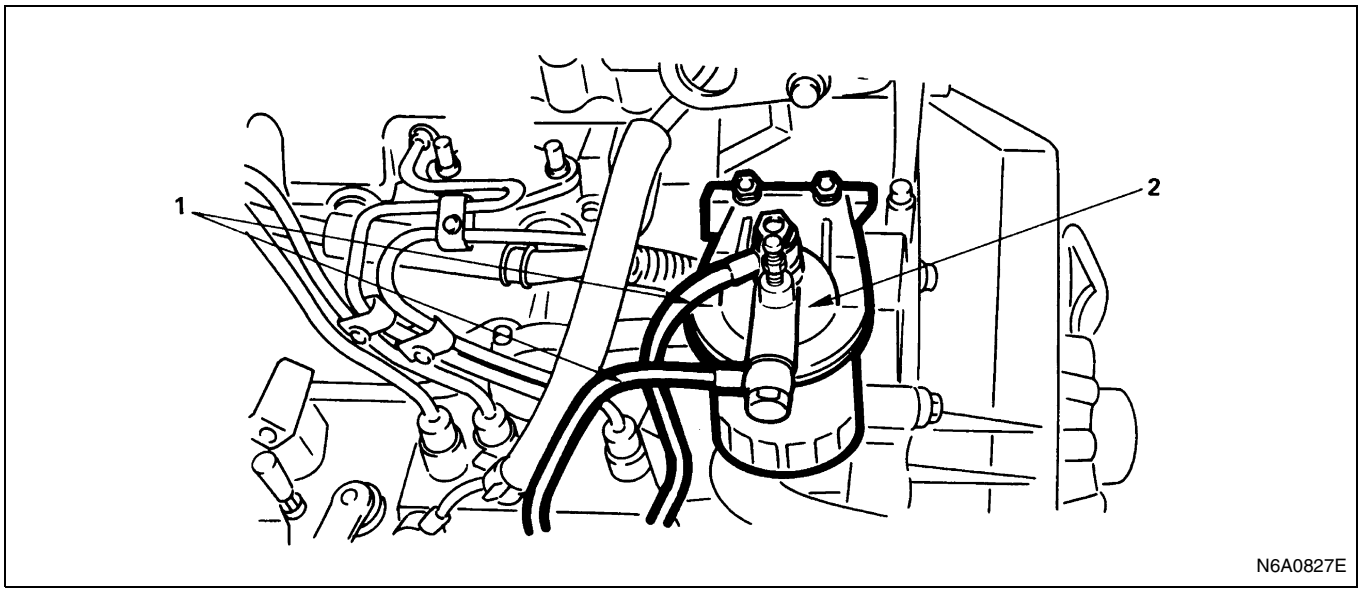


Legend

1. Body assembly
2. Filter cartridge
3. Case
4. Lever sensor
5. Drain plug

FUEL FILTER ASSEMBLY (Except 4HF1-2 model)

Component



Legend

1. Fuel pipe
2. Fuel filter

Removal

Preparation

- Disconnect battery ground cable.
- Tilt the cab

1. Fuel Pipe
2. Fuel Filter Assembly

Installation

1. Fuel Filter Assembly

Tighten:
Fuel filter bracket to 34 N·m (3.5 kg·m / 25 lb·ft)

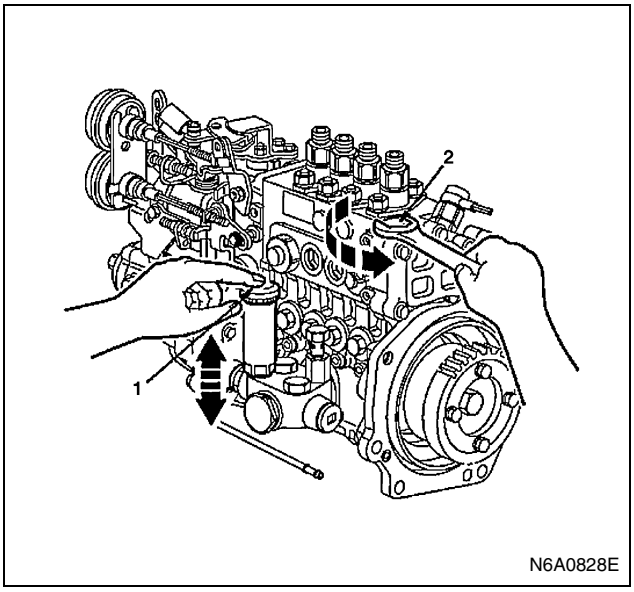
2. Fuel Pipe

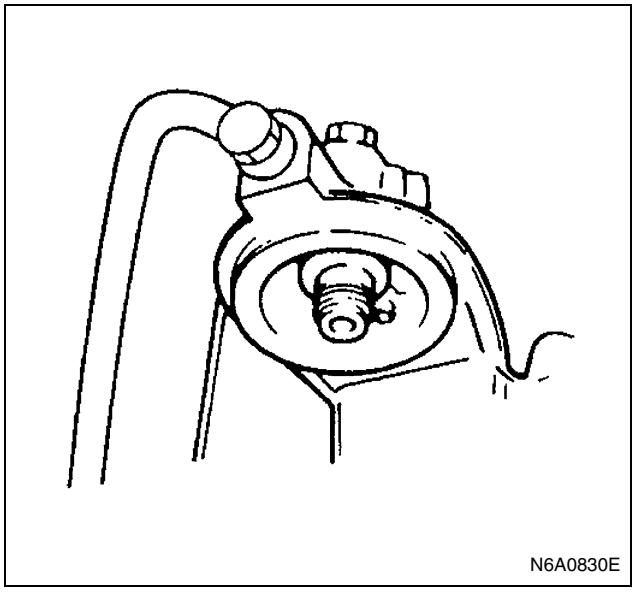
Tighten:
Fuel pipe joint bolt to 23 N·m (2.4 kg·m / 17 lb·ft)

Air Bleeding

- Loosen the priming pump cap (1).
- Loosen the air bleeding plug. (4HG1-T model only)
- Operate the priming pump.
  Pump the primer pump until fuel flow is free of air bubbles. (Except 4HG1-T model)
- Tighten the air bleeding plug. (4HG1-T model only)
- Loosen the bleeding plug.
- Operate the priming pump.
  Pump the primer pump until fuel flow is free of air bubbles.
- Tighten the bleeder plug.
- Operate the priming pump.
  Pump the primer pump until fuel flow is free of air bubbles. (Except 4HE1-TC model)
- Loosen the bleeding plug on the injection pump (2). (4HE1-TC model only)
- Operate the priming pump.
  Pump the primer pump until fuel flow is free of air bubbles. (4HE1-TC model only)
- Tighten the bleeding plug on the injection pump (2). (4HE1-TC model only)
- Lock the priming pump cap (1).

Notice:
Check for fuel leakage from around the injection pump and the fuel filter.



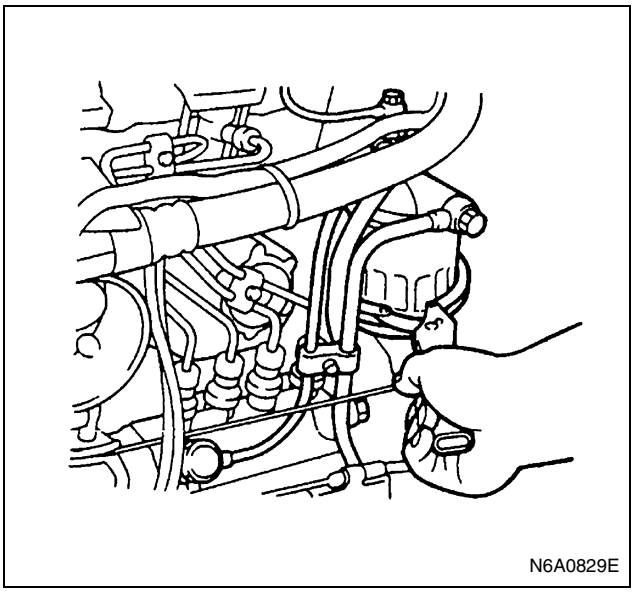


Cartridge Replacement

Removal

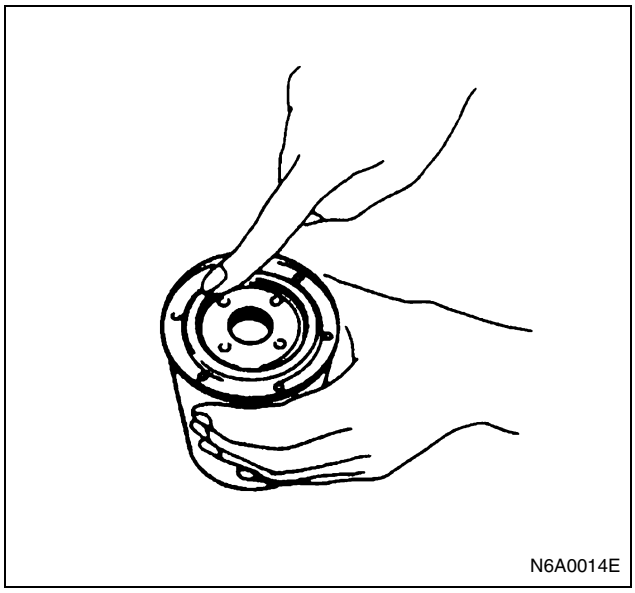
Replacement Procedure

1. Loosen the used fuel filter by turning it counterclockwise with the filter wrench.



Installation

1. Clean the upper cover fitting face.
   This will allow the new fuel filter to seat properly.
2. Apply a light coat of engine oil to the O-ring.
3. Supply fuel to the new fuel filter to facilitate bleeding.
4. Turn in the new fuel filter until the filter O-ring is fitted against the sealing face.
   Be very careful to avoid fuel spillage.

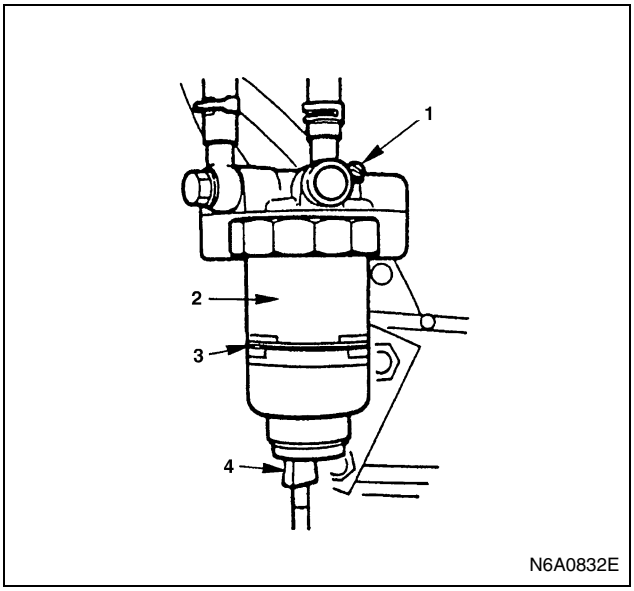


5. Use the filter wrench to turn in the fuel filter an additional 1/3 to 2/3 of a turn.
6. Operate the priming pump to bleed the air from the fuel line.
   Refer to “FUEL FILTER ASSEMBLY” for more detailed information.
7. Start the engine.
   Crank the engine for ten seconds or until it starts.
   If the engine does not start after ten seconds, repeat Step 6.

Draining the Pre-fuel Filter

1. Loosen the air bleeding plug and drain plug by turning them counterclockwise.

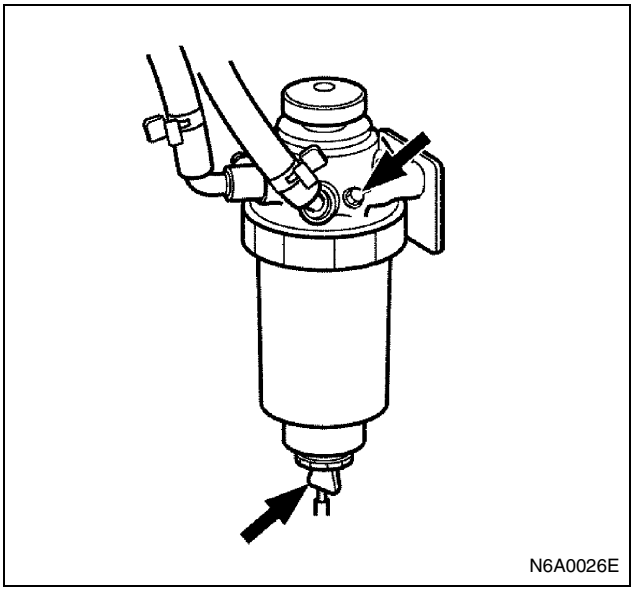
2. Drain approximately 0.1 liters (3.4 oz) of water.
3. Securely tighten the drain plug.
4. Operate the primer pump on the fuel pump to bleed the fuel system.
5. Tighten the air bleeding plug.



Legend

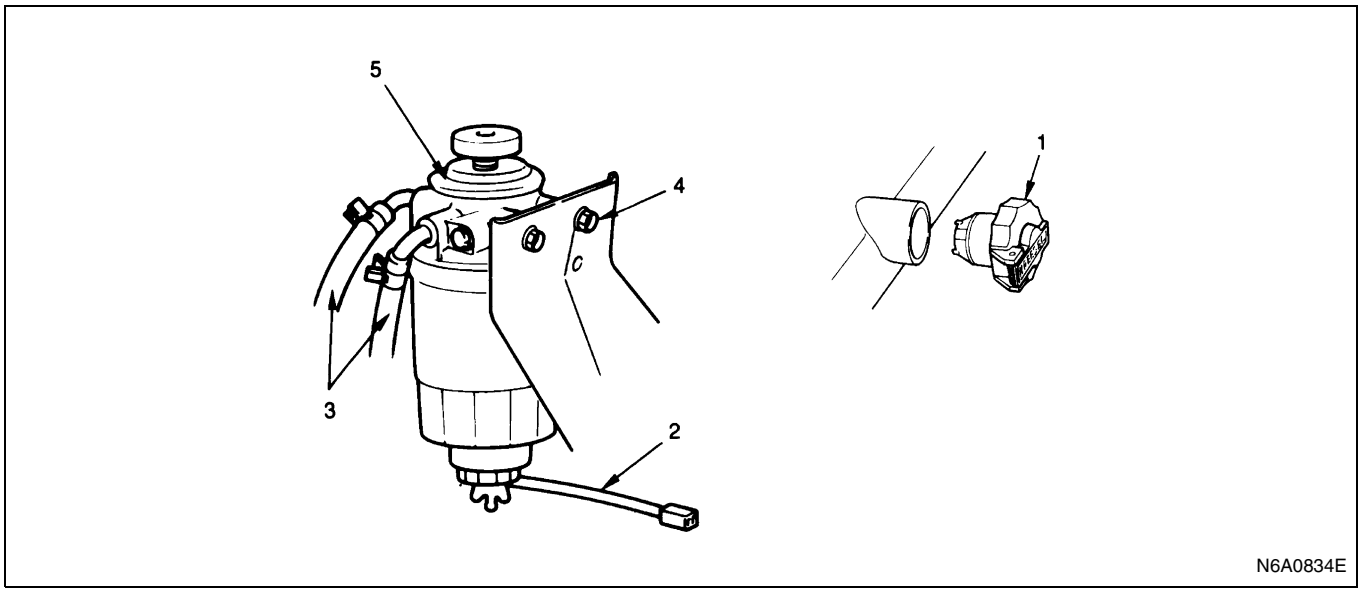
1. Air bleeding plug
2. Pre-fuel filter
3. Drain level
4. Drain plug

6. Start the engine and check to be sure no fuel is leaking from the drain plug.
7. Make sure that the warning light in the instrument panel is off. (Except 4HE1-TC)



FUEL FILTER ASSEMBLY (4HF1-2 model only)

Component



Legend

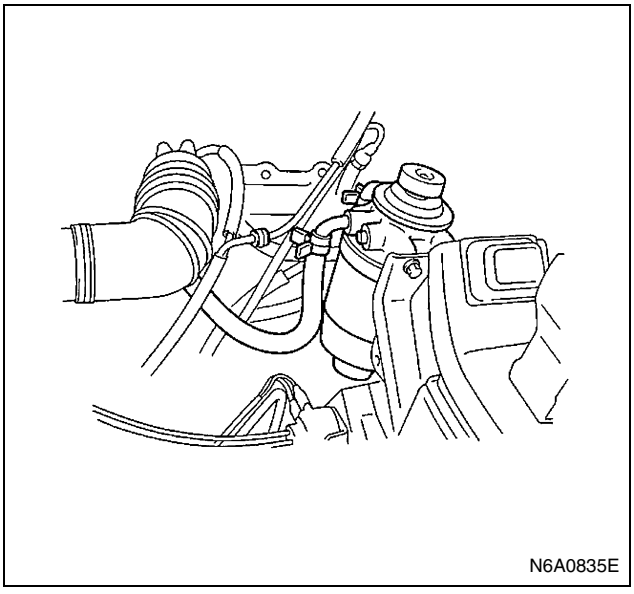
1. Filter cap
2. Lead switch wiring connector
3. Fuel hoses
4. Fuel filter installing bolt
5. Fuel filter assembly

Removal

Preparation

- Disconnect battery ground cable.

1. Filler cap
2. Lead switch wiring connector
3. Fuel hose
   - Draw out inlet and outlet hoses from the fuel filter and cork the hoses to prevent fuel outflow.
4. Fuel filter installing bolt
5. Fuel filter assembly



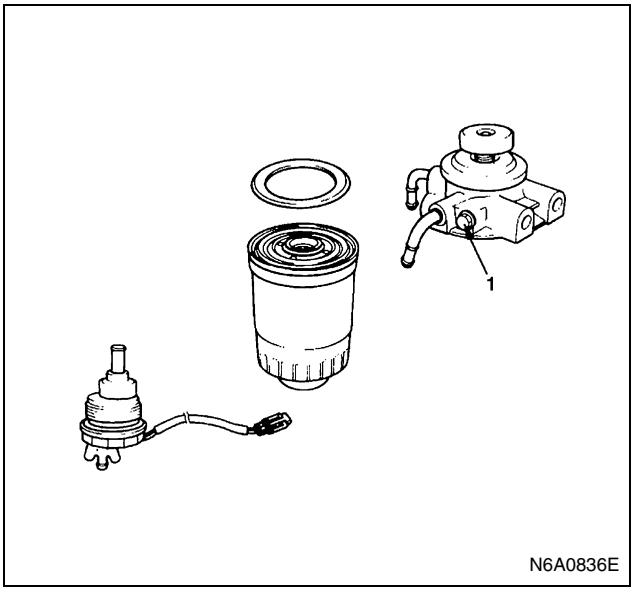
Installation

1. Fuel filter assembly
2. Fuel filter installing bolt
3. Fuel hose
   - Connect the inlet hose and outlet hose.
4. Lead switch wiring connector
5. Filler cap

Cartridge Replacement

Removal

1. Remove the cartridge using a filter wrench.
   Special Tool
   Filter wrench: 5-8840-0253-0
2. Remove the sedimenter/center.

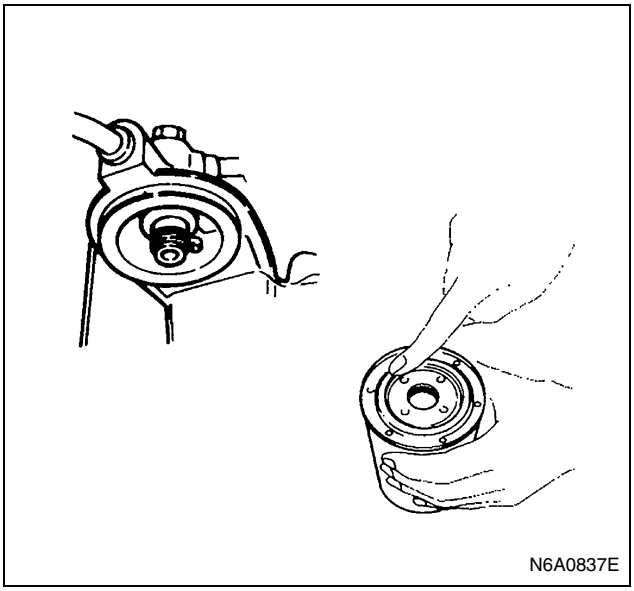


Legend

1. Air bleeding plug

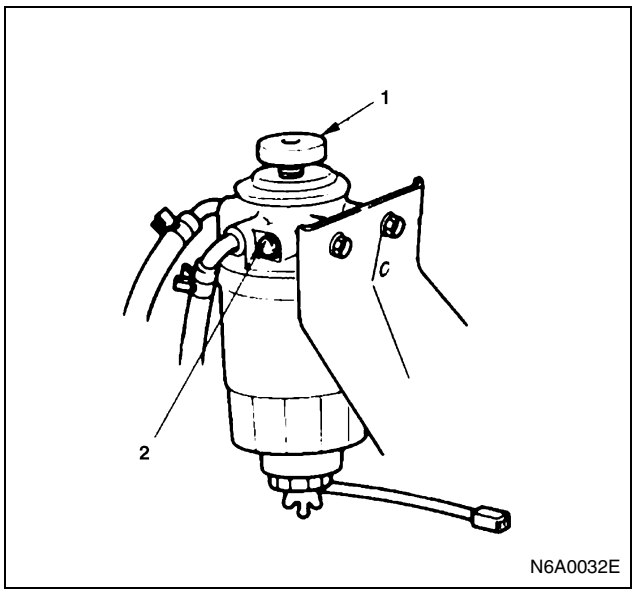
Reassembly

1. Fit the sedimenter/center in a new cartridge.
2. Clean the cartridge mounting surface of the filter body so that the new cartridge can be seated completely.
3. Apply engine oil thinly to the new cartridge O-ring.
4. Fill the new cartridge with light oil to facilitate air bleeding.
5. Tighten the cartridge until the O-ring comes into contact with the sealing surface. Sufficient care should be taken not to spill the light oil.
   Give 1/3 to 2/3 of a turn using a filter wrench.
   Special Tool
   Filter wrench: 5-8840-0253-0



Air Bleeding

1. Actuate the priming pump (1) to send the air in the fuel system to the injection pump.
2. Loosen the sedimenter air bleeding plug (2) and operate the priming pump until no bubbles appear.
3. Tighten the air bleeding plug completely.
4. Try to start the engine. If the engine is not started within 10 seconds, air bleeding should be conducted once again.
5. Check that there is no fuel leak, and then tighten the priming pump completely.



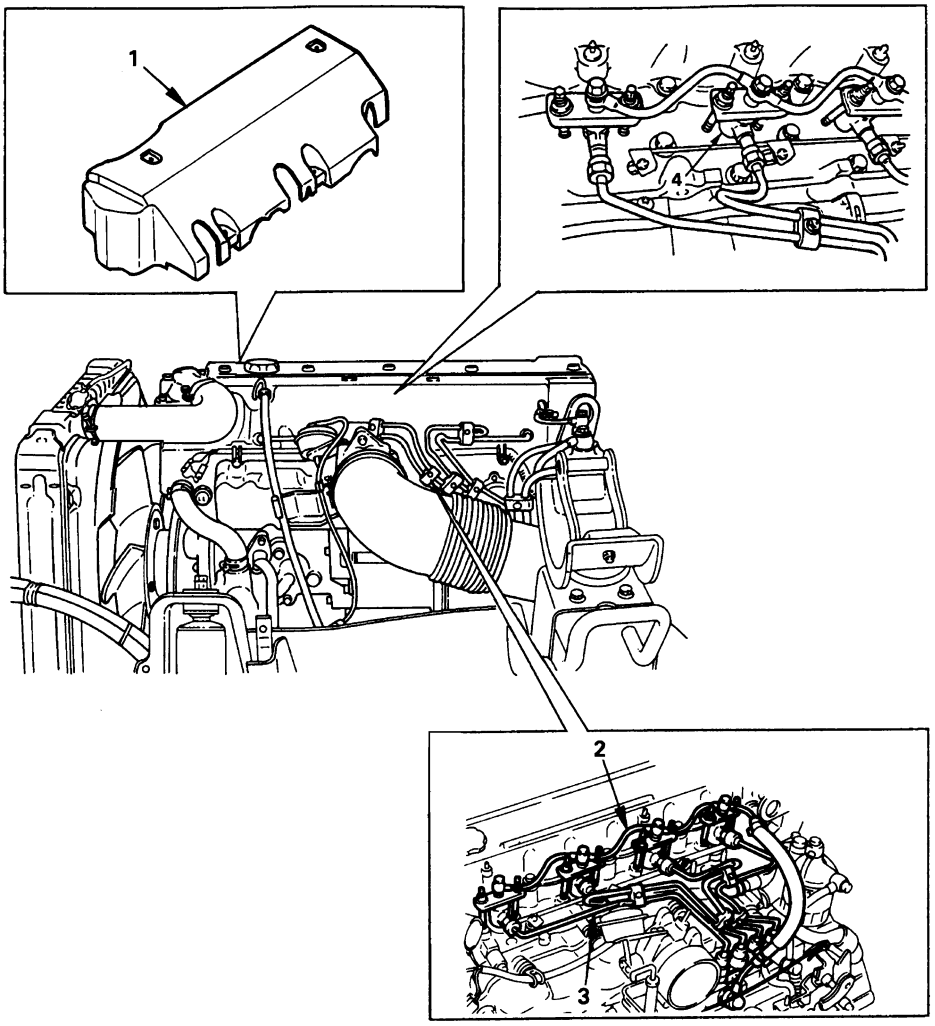
Water Drain

If more than specified has collected, the warning light is lit. Under this condition, follow the following water drain procedure:

1. Place a container (Approximately 0.2 lit (0.18 Imp qt/0.21 US qt) capacity) beneath the drain plug on the separator.
2. Loosen the drain plug and air bleeding plug.
3. After draining, tighten the drain plug.
4. Operate the priming pump several times again and check for fuel leak.
5. Tighten the air bleeding plug.
6. Make sure that the warning light in the instrument panel is off.

INJECTION NOZZLE ASSEMBLY

Component



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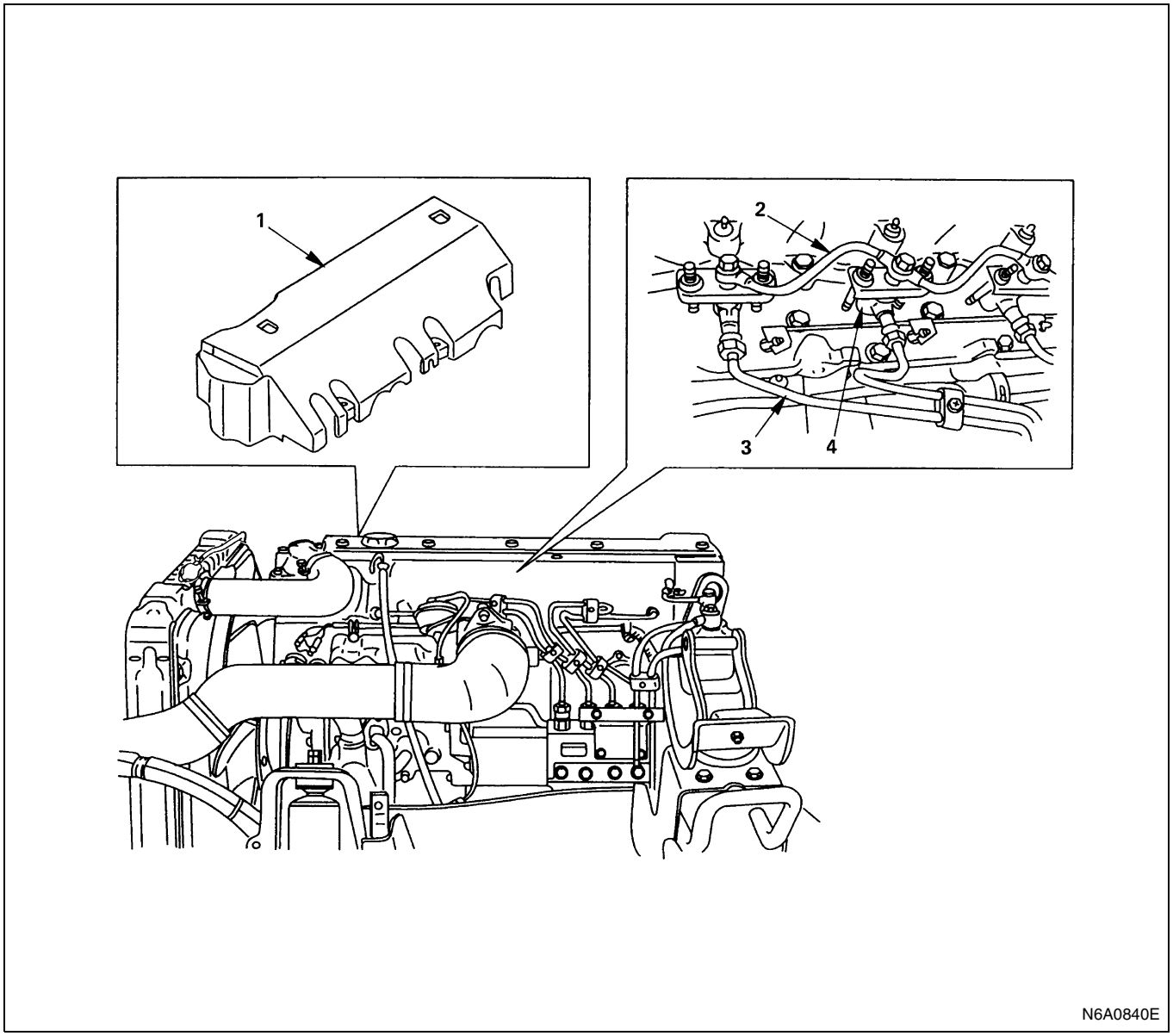
Legend

1. Nozzle cover
2. Leak off pipe
3. Injection pipe
4. Injection nozzle assembly

4HE1-TC (Engine)



Legend

1. Nozzle cover
2. Leak off pipe
3. Injection pipe
4. Injection nozzle assembly

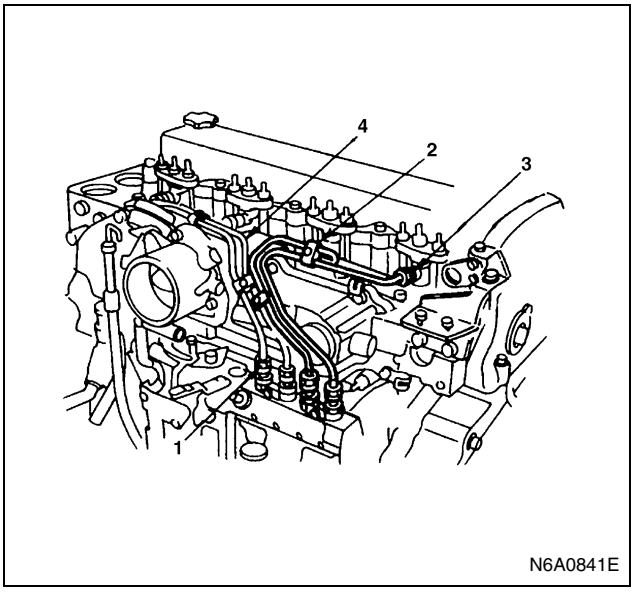
Removal

Preparation

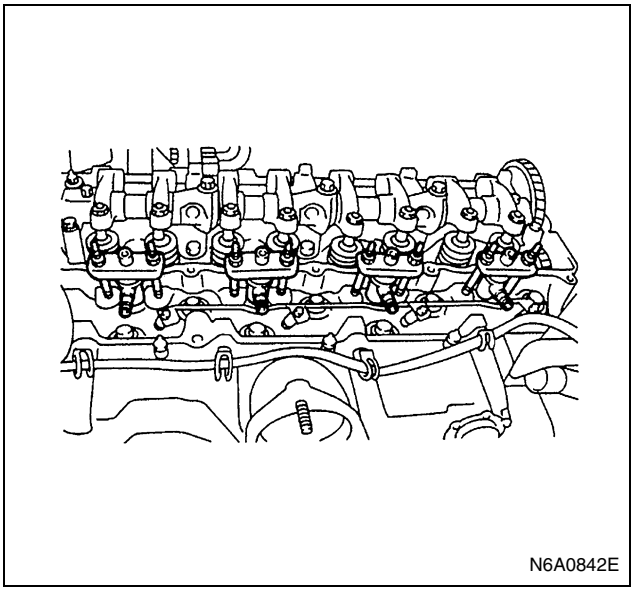
- Disconnect battery ground cable.
- Tilt the cab.

1. Nozzle Cover
2. Leak-Off Pipe
3. Fuel Injection
   1) Loosen the injection pipe sleeve nuts (1). Do not apply excessive force to the injection pipes (4).
   2) Loosen the injection pipes clips (2).
   3) Remove the injection pipe assembly.

Plug the delivery valve holder ports and nozzle holder (3) ports with caps to prevent the entry of foreign material.



4. Injection Nozzle Assembly
   Mark the nozzle holder assemblies fitting positions by tagging each nozzle holder assembly with the cylinder number from which it was removed.



Inspection

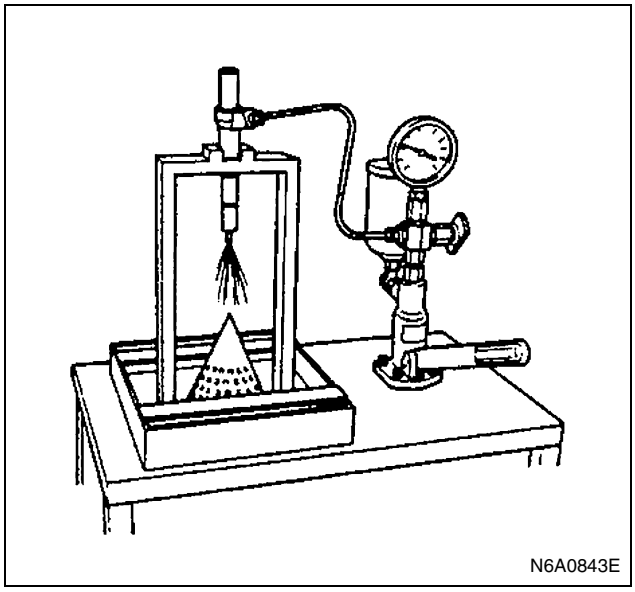
Before disassembling the injection nozzle assembly, check nozzle opening pressure, spray pattern, chatter and oil leakage.

Opening Pressure

Use a nozzle tester to check the injection nozzle opening pressure.

If the opening pressure is above or below the specified value, the injection nozzle must be replaced or adjusted.

Injection Nozzle Opening Pressure		MPa (kg/cm^2/psi)
4HF1/4HF1-2/4HG1		18.1 (185/2,631)
4HE1-TC		21.6 (220/3,128)
4HG1-T	1st	18.1 (185/2,631)
	2nd	21.1 (215/3,057)



Spray Pattern

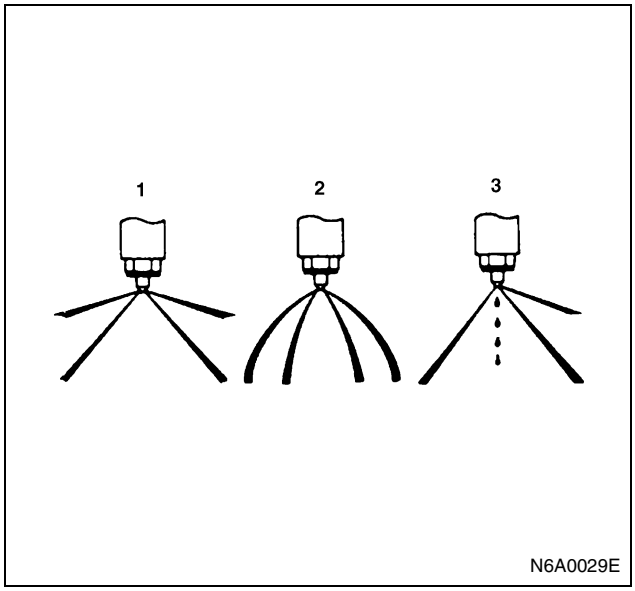
Check the spray pattern

Refer to the illustration.

Spray Condition

- Correct (1)
- Incorrect (Restrictions in orifice) (2)
- Incorrect (Dripping) (3)

If the spray condition is bad, the injection nozzle must be replaced or adjusted.



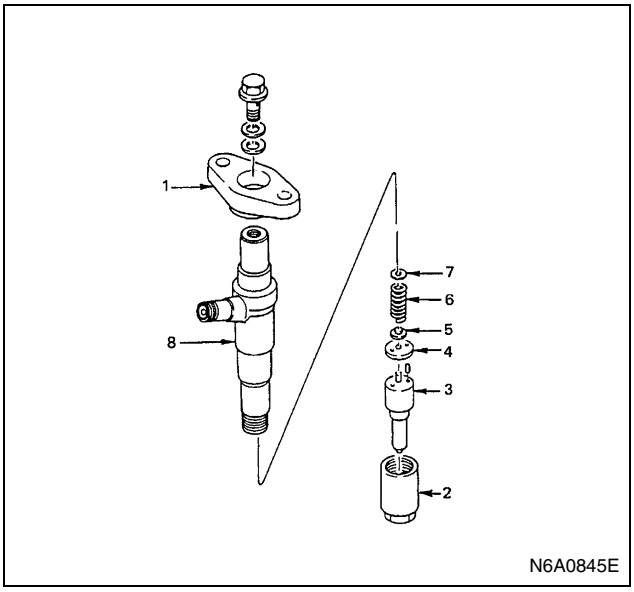
Leakage
Hold the tester handle to about 2,070 kPa (21 kg/cm^2/ 300 psi) below the opening pressure. If no drops of fuel fall from the nozzle tip within 10 seconds, the nozzle is not leaking.

Chatter
An easily audible chatter at all pump lever speeds should be heard.

WARNING:
TEST FLUID FROM THE INJECTION NOZZLE WILL SPRAY OUT UNDER GREAT PRESSURE. IT CAN EASILY PUNCTURE A PERSON'S SKIN. KEEP YOUR HANDS AWAY FROM THE INJECTION NOZZLE TESTER AT ALL TIMES.

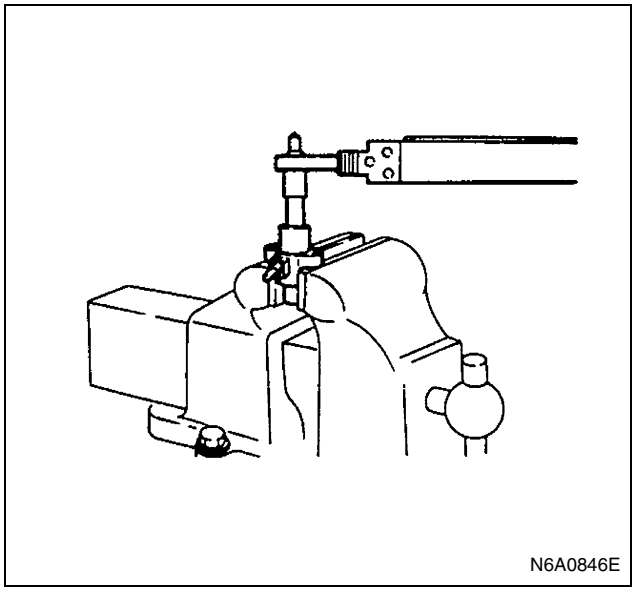
Disassembly

Clamp the injection nozzle holder in a vice.



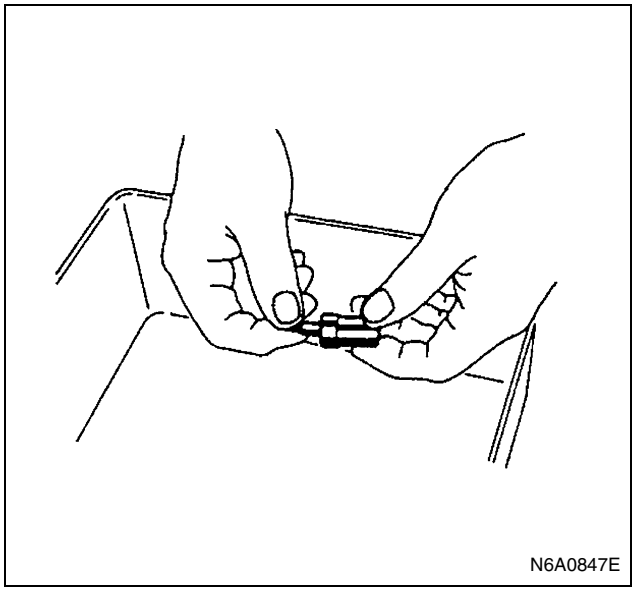
Legend
1. Flange
2. Retaining nut
3. Injection nozzle
4. Spacer
5. Spring seat
6. Nozzle spring
7. Adjusting shim
8. Nozzle holder body

1. Flange
2. Retaining Nut
   Use a wrench to remove the injection nozzle retainer nut.



3. Injection Nozzle
   Keep the nozzle along with the needle valve separately to maintain the original nozzle to needle valve combination.
4. Spacer
5. Spring Seat
6. Nozzle Spring
7. Adjusting Shim
   Keep the adjusting shims in the original groups to hold the initial shim to nozzle spring combination.
8. Nozzle Holder Body

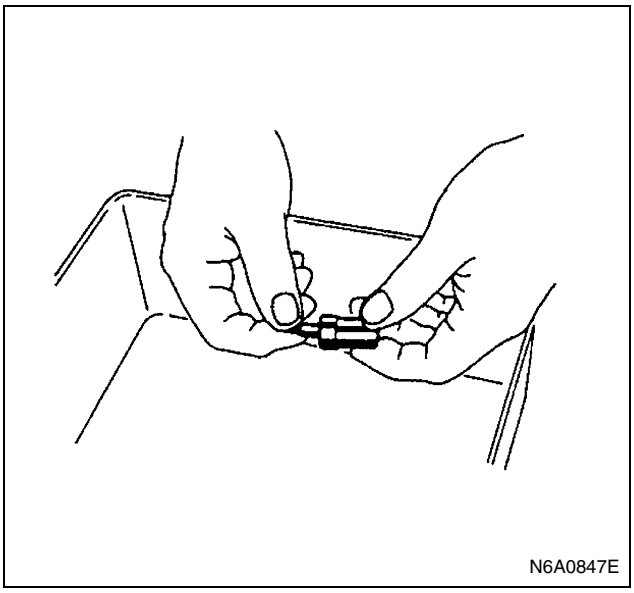
Caution:
- Wash all the parts removed and arrange them on a cylinder basis, care should be taken not to miss any parts.
- Soak the nozzle assembly in a parts receptacle filled with light oil.
- Care should be taken not to miss shim, if used.



Inspection

Injection Nozzle Needle

1. Remove the nozzle from the nozzle body.
2. Carefully wash the nozzle needle and the nozzle body in clean diesel fuel.
3. Check that the nozzle needle moves smoothly inside the injection nozzle body.
   If the nozzle does not move smoothly, it must be repaired (See “Nozzle Lapping Procedure” below).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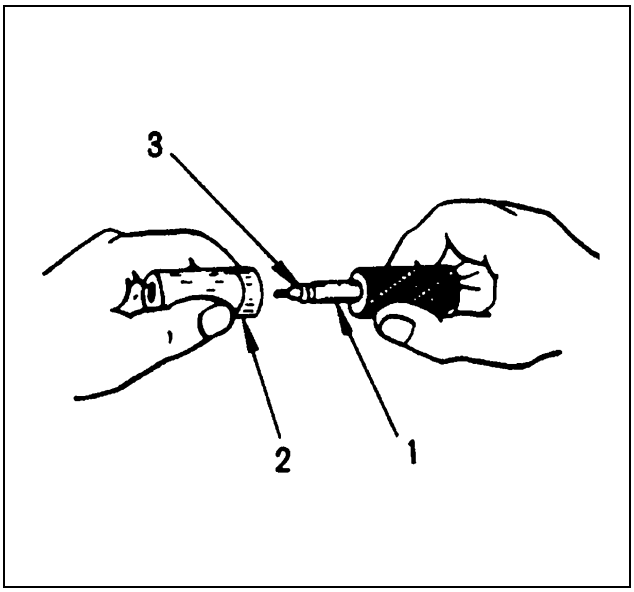
Nozzle Lapping Procedure

1. Lap the nozzle needle (1) and the nozzle body (2) by applying a compound of oxidized chrome and animal oil (3).

Notice:
Do not apply an excessive amount of the oxidized chrome and animal oil compound to the injection needle valve seat area.



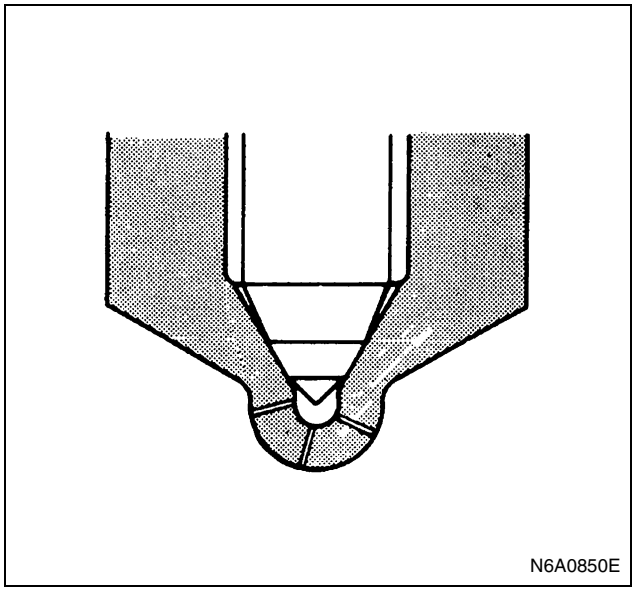
2. Carefully wash the needle valve and the nozzle body in clean diesel fuel after lapping.

Nozzle Body and Needle Valve

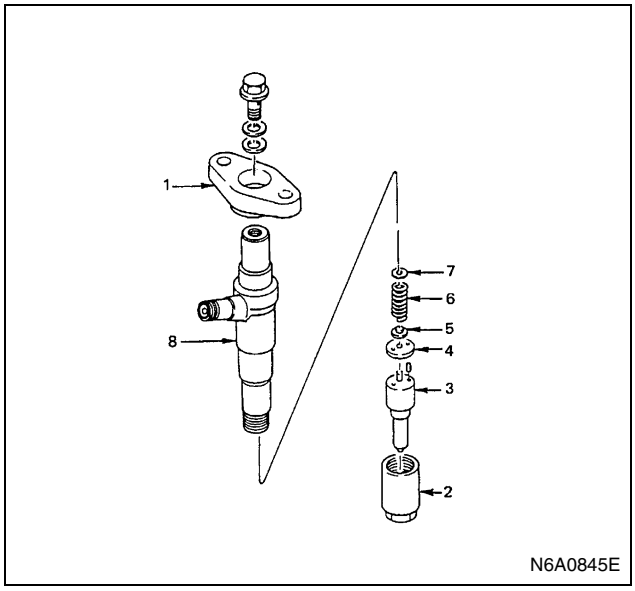
Check the nozzle body and the needle valve for damage and deformation.
The nozzle and body assembly must be replaced if either of these two conditions are discovered during inspection.

Notice:
New nozzles must be cleaned in a solvent to remove protective coating.

The nozzle body and needle must always be replace as an assembly.


N6A0850E

Reassembly

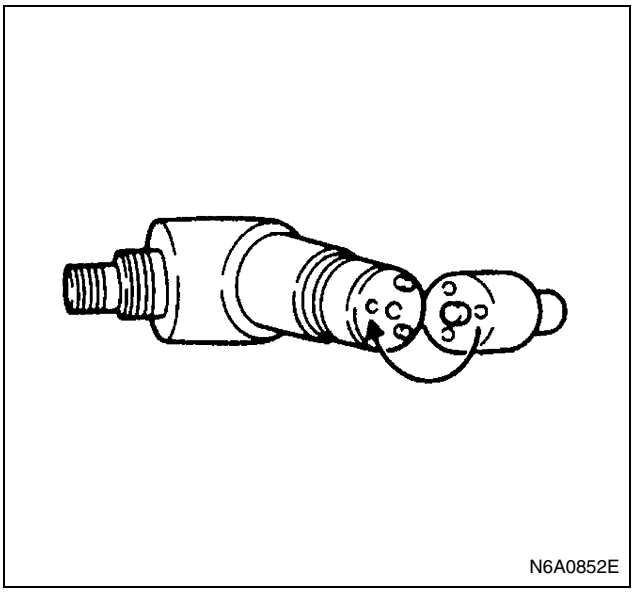


N6A0845E

Legend

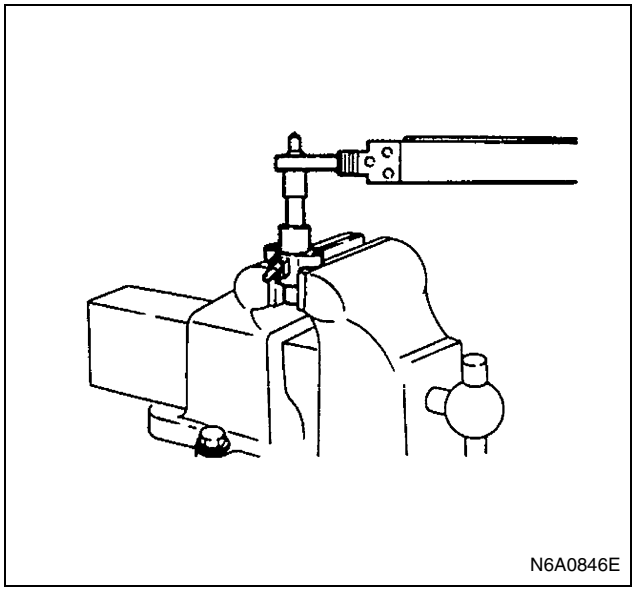
1. Flange
2. Retaining nut
3. Injection nozzle
4. Spacer
5. Spring seat
6. Nozzle spring
7. Adjusting shim
8. Nozzle holder body

1. Nozzle Holder Body
2. Adjusting Shim
3. Nozzle Spring
4. Spring Seat
5. Spacer
6. Injection Nozzle
   Install the nozzle dowel pin with it set to the dowel hose of the nozzle holder body.



7. Retaining Nut
   Clamp the injection nozzle holder in a vice.
   Tighten the injection nozzle holder retaining nut to the specified torque.

Tighten:
Injection nozzle holder retaining nut to 34 N·m (3.5 kg·m / 25 lb·ft)



   Remove the injection nozzle holder from the vice.
8. Flange

Adjustment of Injection Starting Pressure

After reassemble of the injection nozzle, recheck the opening pressure and spray condition.

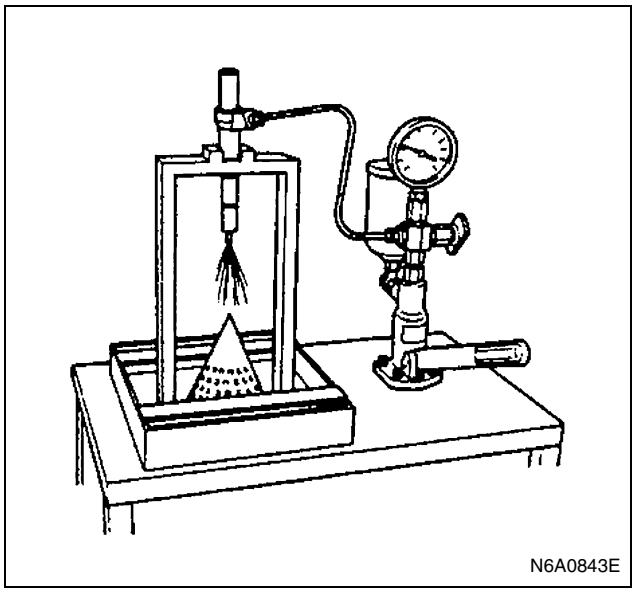
Opening Pressure

Attach the injection nozzle holder to the injection nozzle tester.

Apply pressure to the nozzle tester to check that the injection nozzle opens at the specified pressure.

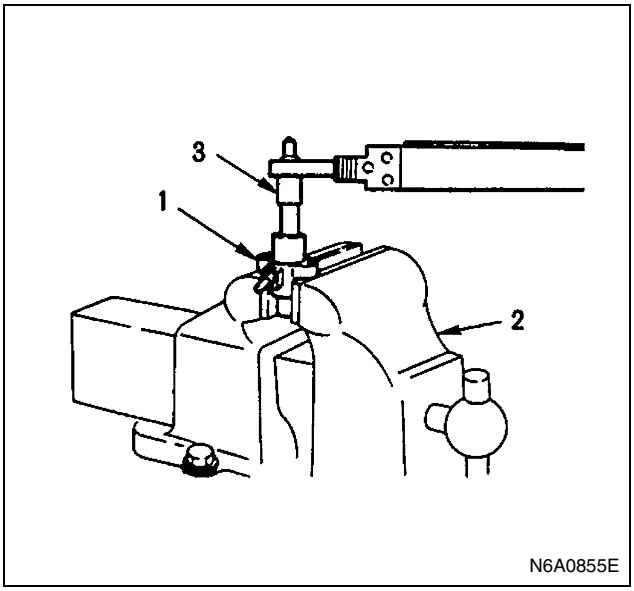
If the injection nozzle does not open at the specified pressure, install or remove the appropriate number of adjusting shims to adjust it.

Injection Nozzle Opening Pressure	MPa (kg/cm^2/psi)
4HF1/4HF1-2/4HG1	18.1 (185/2,631)
4HE1-TC	21.6 (220/3,128)

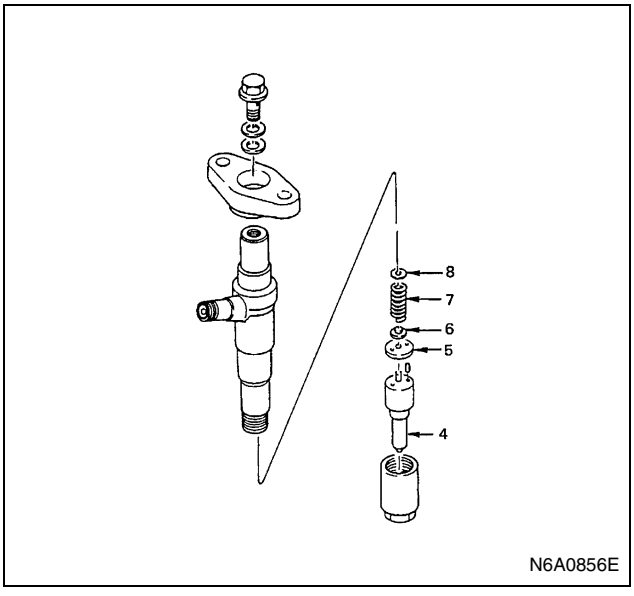


Opening Pressure Adjustment

1. Clamp the injection nozzle holder (1) in a vise (2).
2. Use a wrench to remove the injection nozzle retaining nut (3).



3. Remove the injection nozzle holder from the vise.
4. Remove the injection nozzle (4), the spacer (5), the spring seat (6) the spring (7) and the adjusting shim (8).
5. Install the new adjusting shim, the spring, the sprig seat, the spacer, the injection nozzle, and the retaining nut.



6. Clamp the injection nozzle holder in the vise.
7. Tighten the injection nozzle holder retaining nut to the specified torque.

Tighten:
Injection nozzle holder retaining nut to 34 N·m (3.5 kg·m / 25 lb·ft)

8. Remove the injection nozzle holder from the vise.
9. Attach the injection nozzle holder to the injection nozzle tester.
10. Apply pressure to the nozzle tester to check that the injection nozzle opens at the specified pressure.
    If the injection nozzle does not open at the specified pressure, install or remove the appropriate number or adjusting shims to adjust it.
    Removing or installing one shim will increase or decrease the nozzle opening pressure approximately 370 kPa (3.77 kg/cm^2 / 53.6 psi).

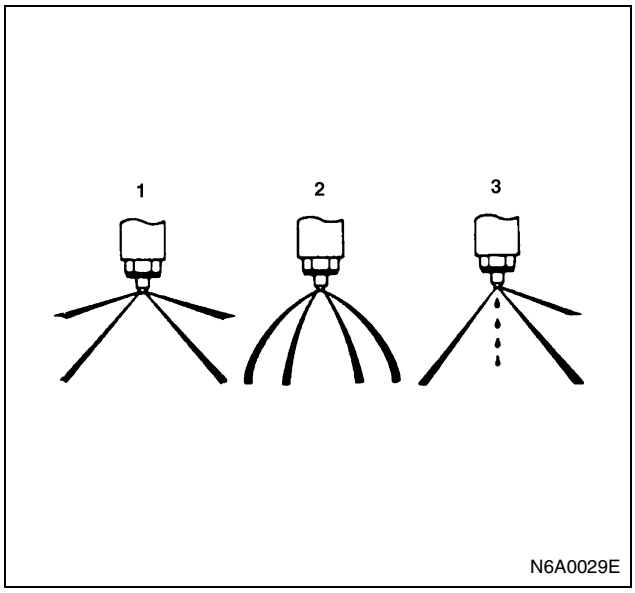
Adjusting Shim Availability	mm (in)
Range	0.5 — 1.5 (0.02 — 0.06)
Increment	0.025 (0.001)
Total Number of Shims	41

Spray Pattern

Check the spray condition.
Refer to the illustration.
Spray Condition

- Correct (1)
- Incorrect (Restrictions in orifice) (2)
- Incorrect (Dripping) (3)

If the spray condition is bad, the injection nozzle must be replaced or adjusted.



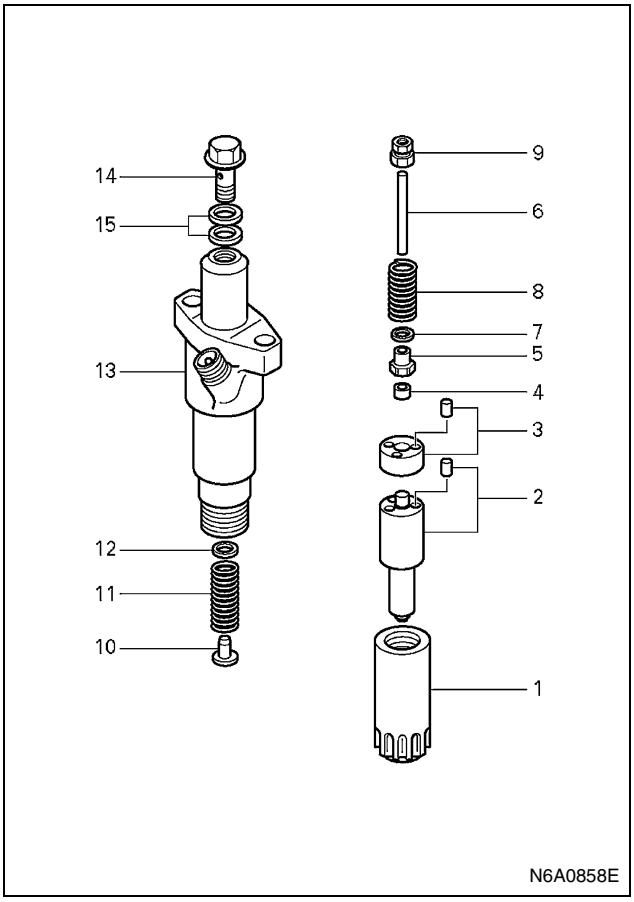
Refer to “Adjustment”.

Notice:
Adjust the nozzle in a well ventilated area. Do not inhale oil or spray injected from the nozzle.

Disassembly

4-1 Injection Nozzle (Two spring nozzle holder) (4HG1-T only)

The two-spring nozzle holder has been developed to reduce NOx (Nitrogen Oxides) and particulates from direct injection diesel engine exhaust.



Legend

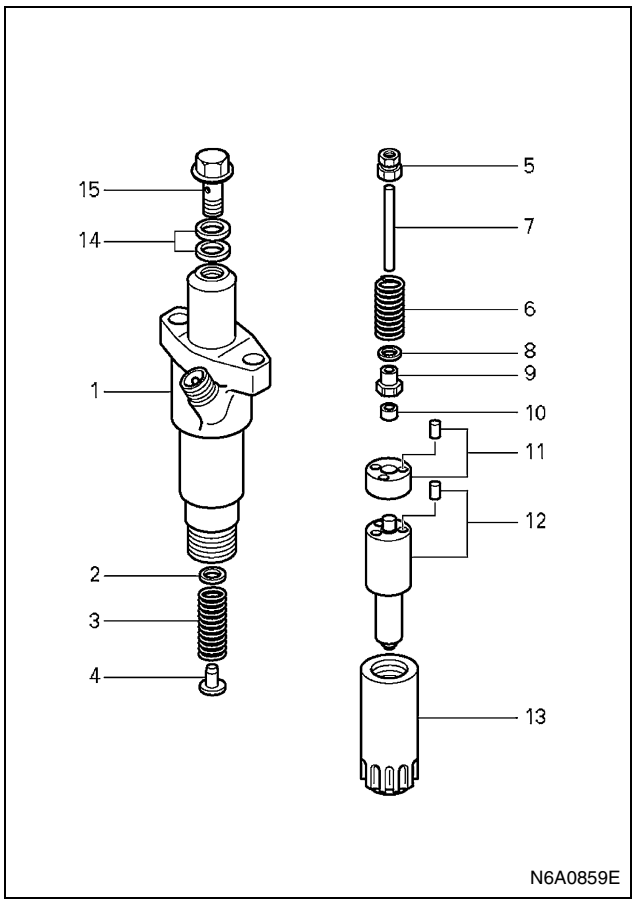
1. Retaining nut
2. Nozzle & pin
3. Spacer & pin
4. Lift piece
5. Spring seat
6. Push rod
7. Shim (Second nozzle opening pressure adjustment)
8. Second spring
9. Collar
10. Spring seat
11. First spring
12. Shim (First nozzle opening pressure adjustment)
13. Nozzle holder body
14. Eye bolt
15. Gasket

1. Before disassembly remove carbon deposit from nozzle and nozzle holder using a wire brush and wash the outside nozzle holder assembly.

Caution:
Do not touch nozzle holes with the wire brush during cleaning it.

2. Disassemble the nozzle holder assembly to numerical order.

Reassembly and Opening Pressure Adjustment



Legend

1. Nozzle holder body
2. Shim (First opening pressure adjustment)
3. First spring
4. Spring seat
5. Collar
6. Second spring
7. Push rod
8. Shim (Second opening pressure adjustment)
9. Spring seat
10. Lift piece
11. Spacer & pin
12. Nozzle & pin
13. Retaining nut
14. Gasket
15. Eye bolt

The nozzle holder is adjusted as the components are reassembled in the sequence above.
As adjustment of the two-spring nozzle holder is made in hundredths of a millimeter, clean the parts thoroughly in light oil to completely remove any dirt or foreign matter.

Reassembly and Adjustment Procedure

1. First nozzle opening pressure adjustment
   - Adjust the first nozzle opening pressure using the shim.

2. Full needle valve lift confirmation
   - Confirm the full needle valve lift in accordance with the closed method.
3. Pre-lift confirmation
   - Confirm pre-lift in accordance with the closed method.

Caution:
If not as specified, replace the nozzle assembly, lift piece, pins and spacer using the nozzle service kit.

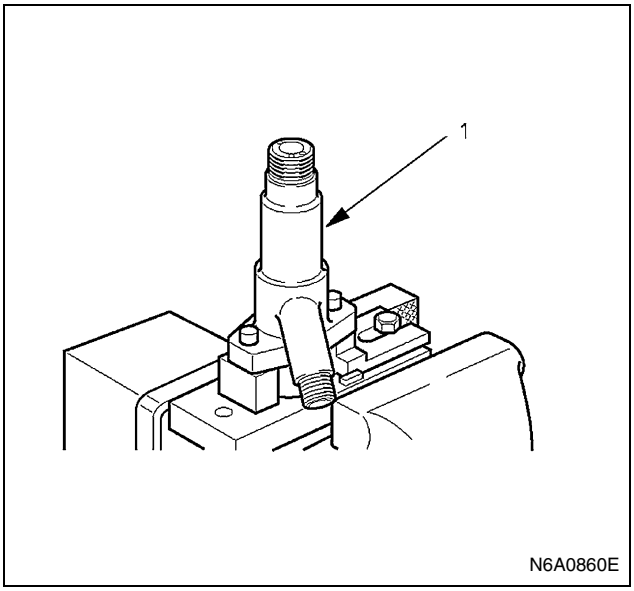
4. Second nozzle opening pressure confirmation
   - Confirm the second nozzle opening pressure in accordance with the closed method.
5. Second nozzle opening pressure adjustment
   - Adjust the second nozzle opening pressure using the shim.
6. Final inspection
   - Confirm the condition of the fuel spray with the nozzle and nozzle holder assembled.

Adjustment Service Data (4HG1-T only)

Nozzle needle valve full-lift		0.30 mm (0.0118 in)
Nozzle needle valve pre-lift		0.04 mm (0.0016 in) at 19.1 MPa (195 kg/cm^2, 2,770 psi)
Nozzle pressure	1st Stage	18.1 MPa (185 kg/cm^2, 2,630 psi)
	2nd Stage	22.1 — 23.0 MPa (225 — 235 kg/cm^2, 3,200 — 3,342 psi) at lift 0.09 mm (0.0035 in) = pre lift + 0.05 mm (0.0020 in)

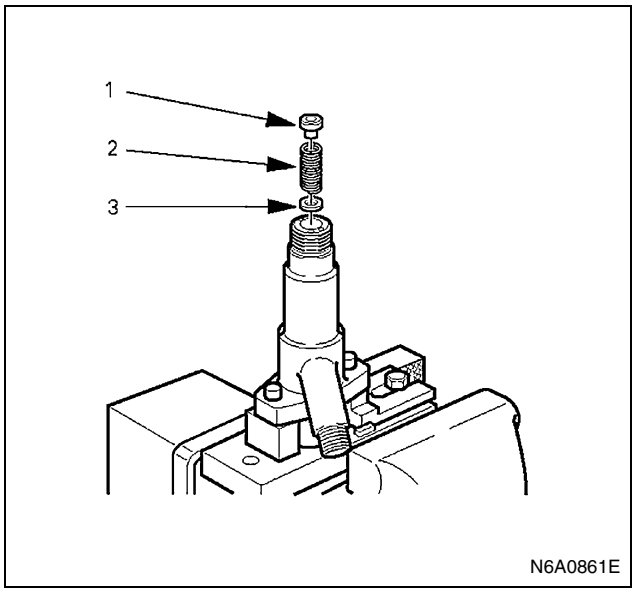
First nozzle opening pressure adjustment

1. Clamp the nozzle holder in a vise.



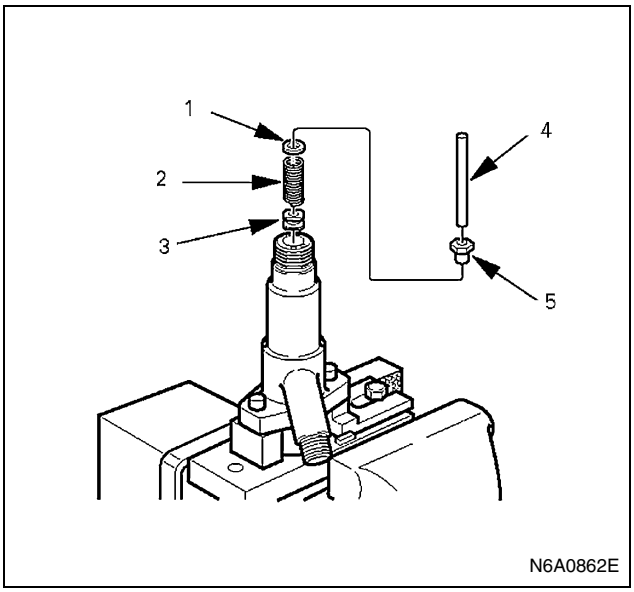
Legend
1. Nozzle holder body

2. Install the shim, first spring and spring seat in the nozzle holder.



Legend
1. Spring seat
2. First spring
3. First nozzle opening pressure adjusting shim

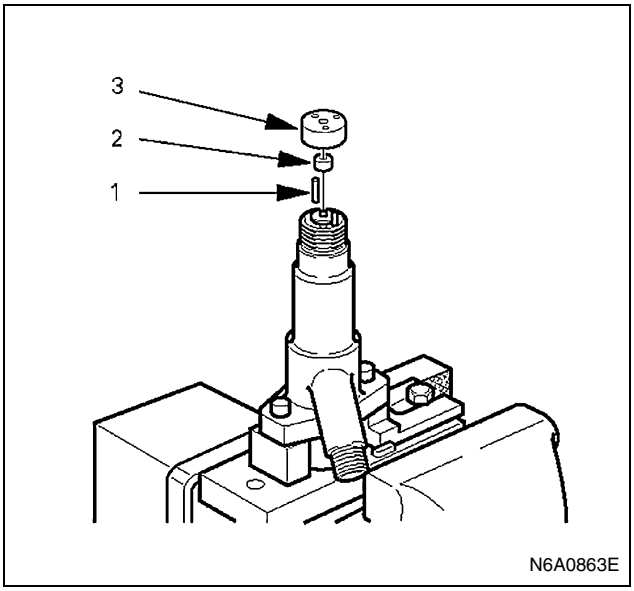
3. Install the collar, second spring, shim, spring seat and push rod in the nozzle holder.



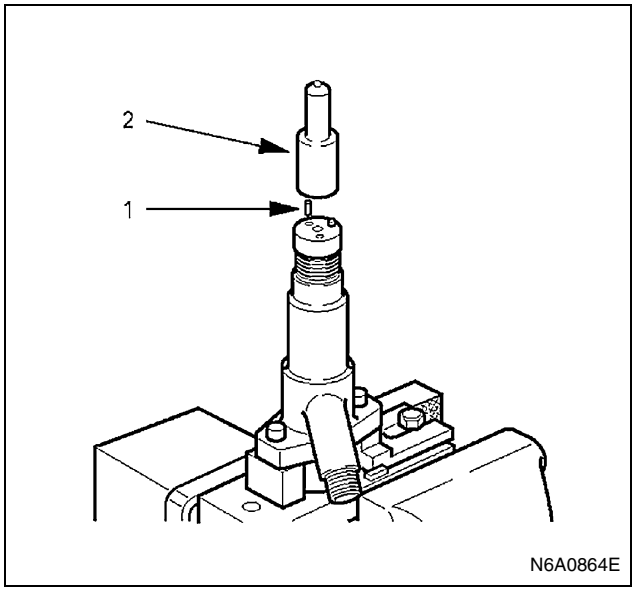
Legend

1. Second nozzle opening pressure adjusting shim
2. Second spring
3. Collar
4. Push rod
5. Spring seat

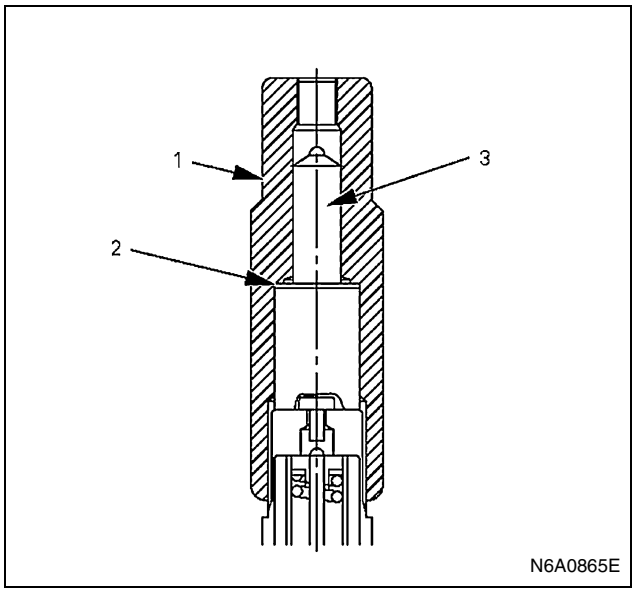
4. Install the pins (1), lift piece (2) and spacer (3) in the nozzle holder.



5. Install the pins (1) in the spacer.
6. Install the nozzle (2) on the spacer.



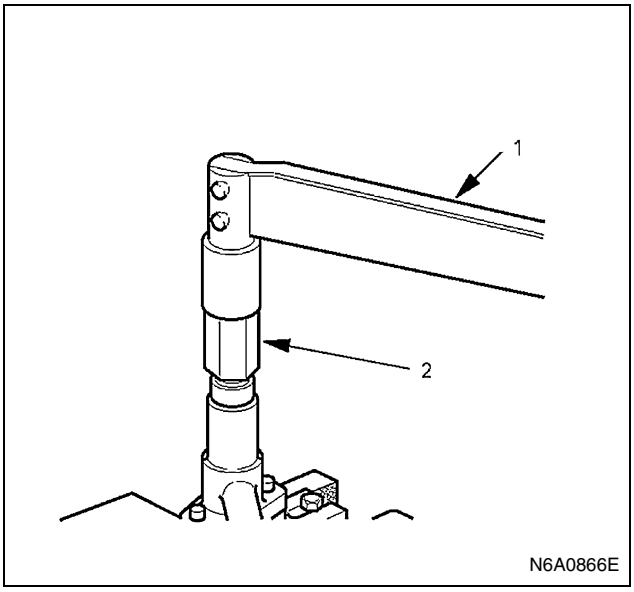
7. Hand-tighten the adjustment retaining nut together with the gasket to the nozzle holder.
   Retaining nut: 157892-3200 (* Bosch AS)
   Gasket: 157892-5100 (* Bosch AS)
   (* Bosch Automotive System Corporation)



Legend

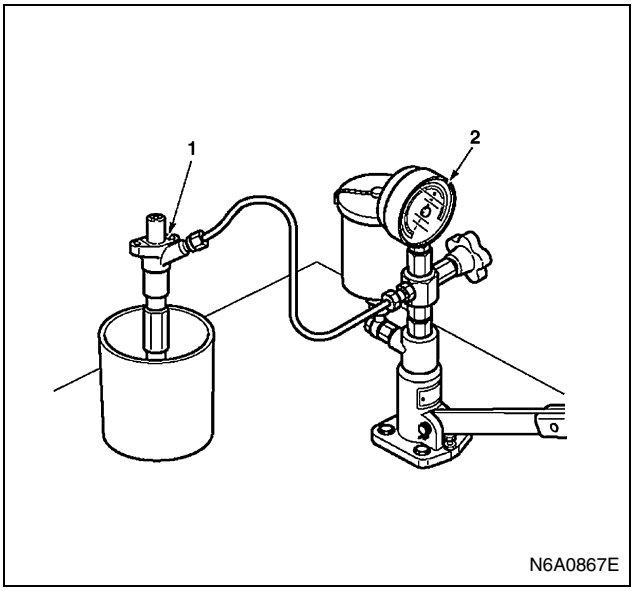
1. Retaining nut (special tool)
2. Gasket
3. Nozzle

8. Tighten the adjustment retaining nut to the specified torque.
   Torque: 29 — 39 N·m (3.0 — 4.0 kg·m/257 — 345 lb·in)



Legend
1. Torque wrench
2. Retaining nut (special tool)

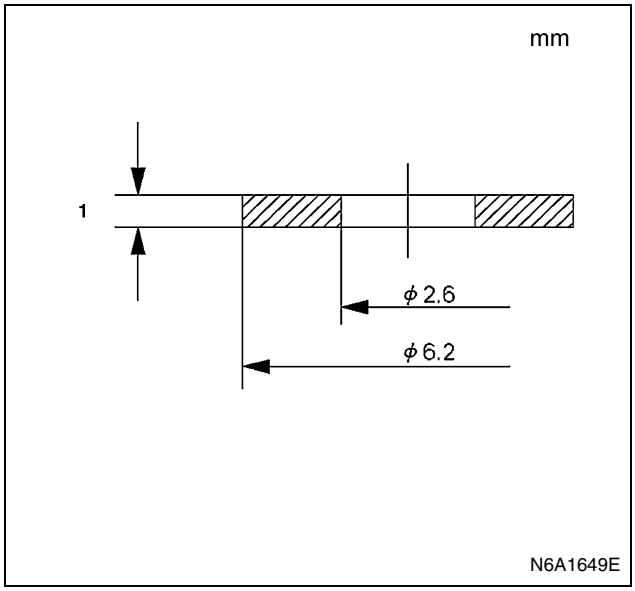
9. Set the nozzle holder (1) to the nozzle tester (2).



10. Operate the nozzle tester and measure the first nozzle opening pressure.
11. If the first nozzle opening pressure is not as specified, disassemble the nozzle holder and replace the shim until the pressure is as specified.

Caution:
- Use a micrometer to measure shim thickness.
- Use some combination of 3 adjusting shims to adjust the pressure.
- First nozzle opening pressure adjusting shims

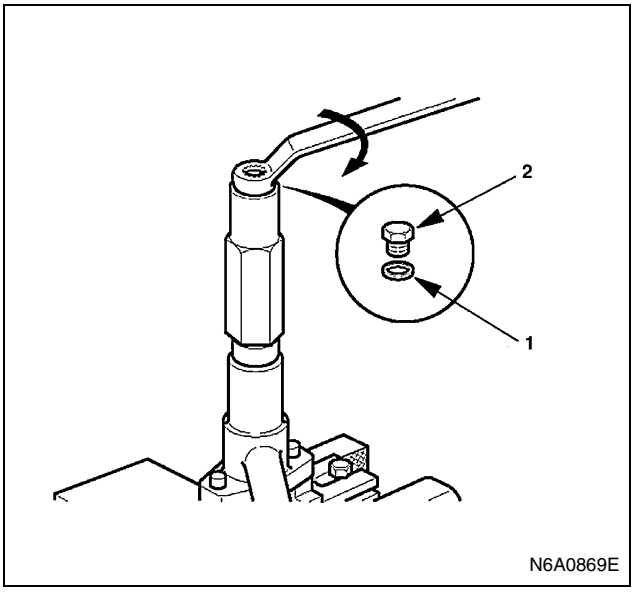
Part No. (ISUZU)	Thickness mm (in)
115349-0420	0.40 (0.0157)
115349-0430	0.50 (0.0197)
115349-0440	0.52 (0.0205)
115349-0450	0.54 (0.0213)
115349-0460	0.56 (0.0220)
115349-0470	0.58 (0.0228)
115349-0480	0.60 (0.0236)
115349-0490	0.70 (0.0276)



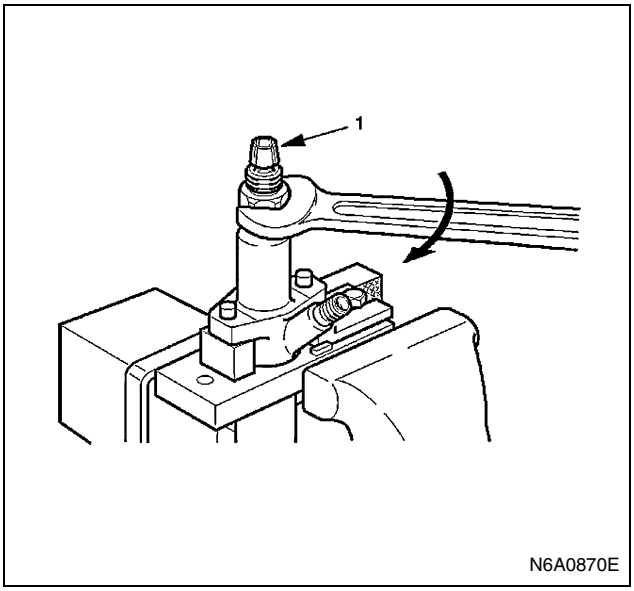
Legend
1. Thickness

Full Needle Valve Lift Confirmation

1. Install the gasket (1) and plug (2) on the adjustment retaining nut.
   Gasket:
   026508-1140 (Bosch AS)
   894227-6020 (ISUZU)
   Plug:
   157892-1600 (Bosch AS)

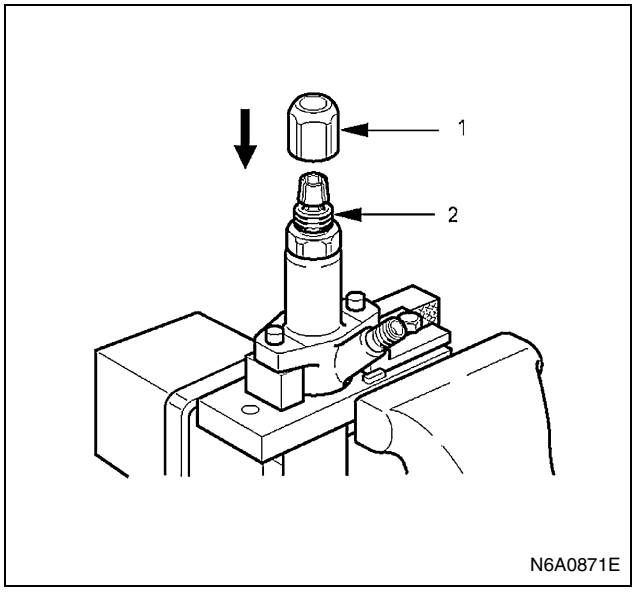


2. Position the nozzle holder with the nozzle facing down and install the dial gauge holder on the nozzle holder.
   Dial gauge holder: 157892-5000 (Bosch AS)



Legend
1. Holder (special tool)

3. Install the nut on the dial gauge holder.
   Nut: 157892-1000 (Bosch AS)

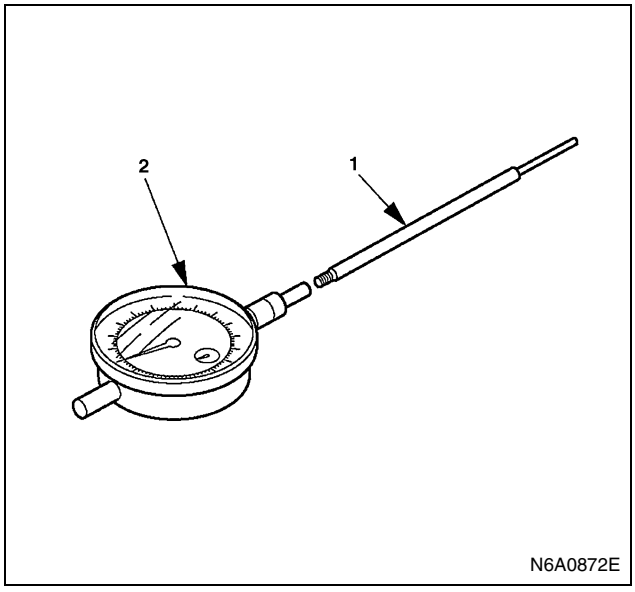


Legend
1. Nut (special tool)
2. Holder (special tool)

4. Install the pin (1) to the dial gauge (2).

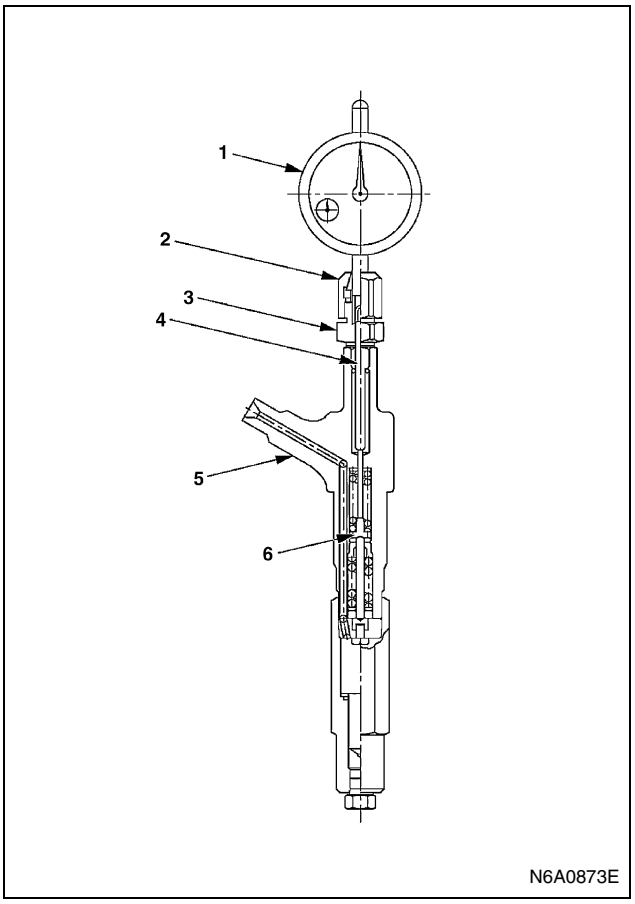
Notice:
The lengths of the pins do not include the threaded portions.

Pin (l=100 mm (3.94 in)):
157892-5200 (Bosch AS)
Dial gauge:
157954-3800 (Bosch AS)
185317-0150 (ISUZU)



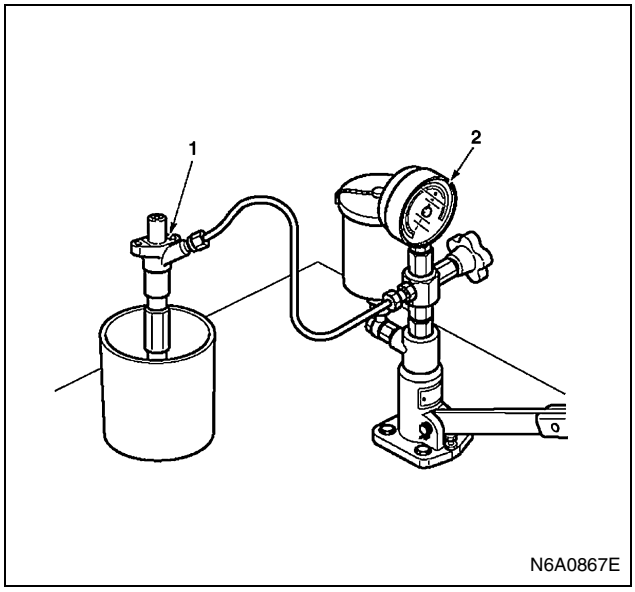
5. Secure the dial gauge to the nozzle holder using the nut so that the pin contacts the tip of the first spring seat.

Caution:
- Secure the dial gauge so that a stroke of 2 mm (0.08 in) can be measured.
- Do not over-tighten the nut as the dial gauge shaft may jam. (Confirm from the dial gauge that the shaft moves smoothly.)



Legend
1. Dial gauge
2. Nut
3. Holder
4. Pin
5. Nozzle holder
6. First spring seat

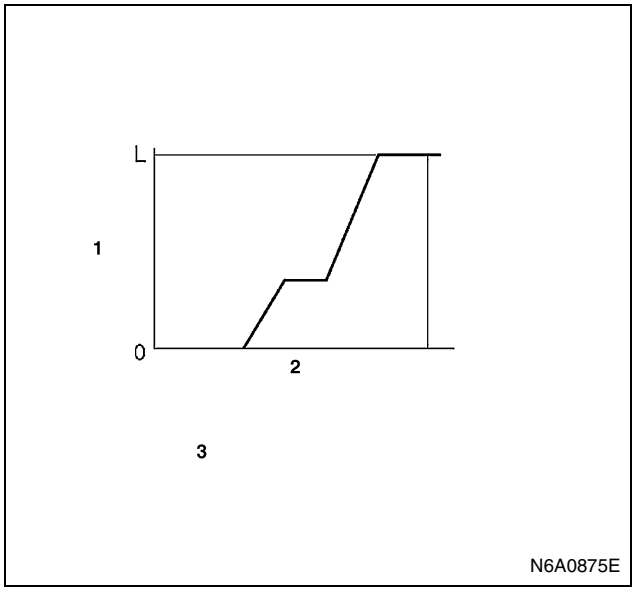
6. Set the nozzle holder (1) to the nozzle tester (2) and put needle to zero on the dial gauge.
7. Operate the nozzle tester to bleed any air from inside the retaining nut and to confirm that no fuel leaks.



8. Operate the nozzle tester and increase the in-line pressure to 34.3 — 44.1 MPa (350 — 450 kg/cm^2 / 4,975 — 6,396 psi) so that the nozzle's needle valve moves through its full lift.
   Record full lift 'L'. (Read dial gauge)

Nozzle Full Lift	mm (in)
0.30 (0.0118)	

Notice:
The above operation is used to determine whether the nozzle seat is worn and whether the nozzle assembly is in good condition.

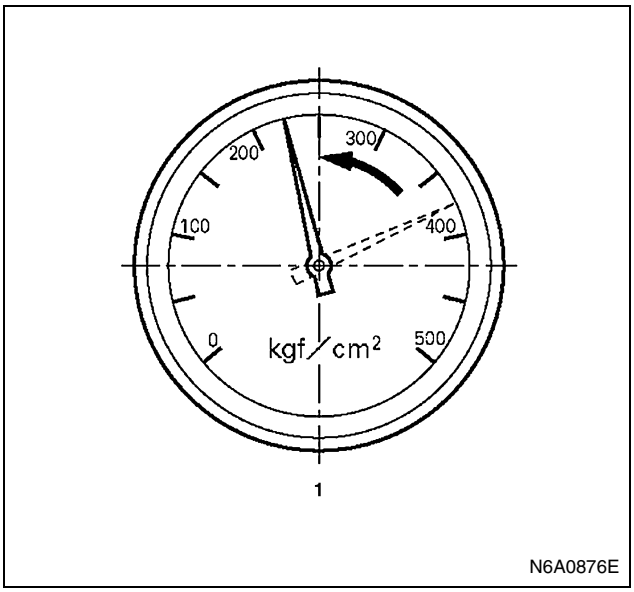


Legend
1. Needle valve
2. First nozzle opening pressure 34.3 — 44.1 MPa (350 — 450 kg/cm^2 / 4,975 — 6,396 psi)
3. In line pressure

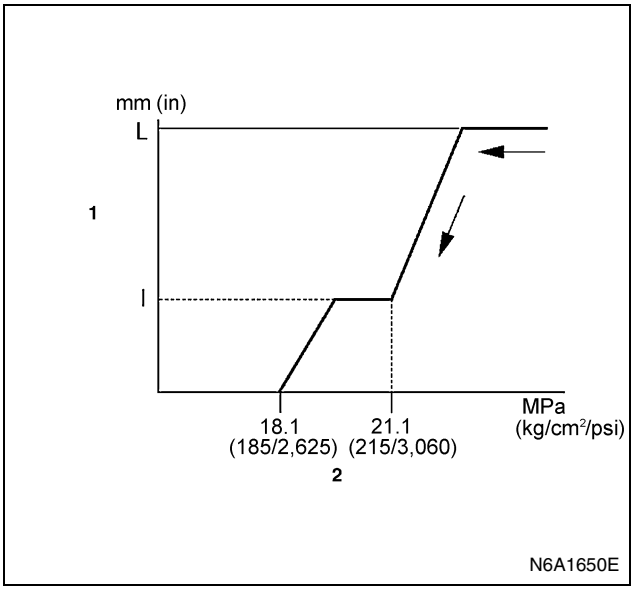
Pre-lift Confirmation

1. With the needle valve at full lift, release the nozzle tester handle.

Notice:
The in-line pressure will decrease and needle valve lift (as indicated on the dial gauge) will also decrease a little.



Legend
1. Pressure gauge



Legend
1. Needle valve lift
2. In line pressure

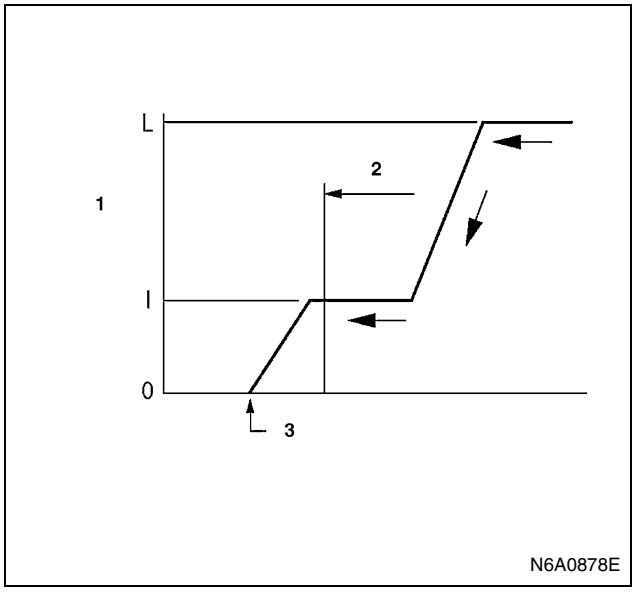
2. Read the needle valve lift 'I' from the dial gauge indication (once the needle valve has descended when the second spring has stopped operating). Refer to the pre-lift measuring point for 'I'.

Pre-lift measuring point:

Read the dial gauge at **first nozzle opening pressure +approx 1 MPa (10 kg/cm^2 / 145 psi)**.

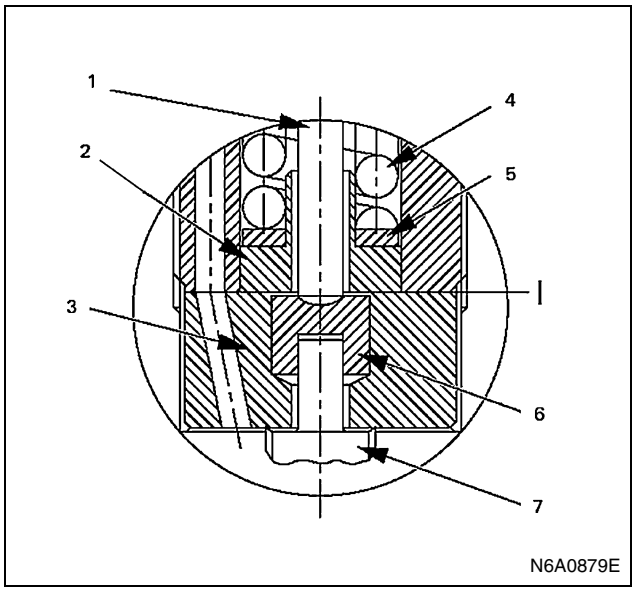
Pre-lift		
Engine	Pressure MPa (kg/cm^2 / psi)	Lift mm (in)
4HG1-T	19.1 (195/2,770)	0.04 (0.0016)

Notice:
This point can be found while the pressure is decreasing.



Legend
1. Needle valve lift
2. Measuring point of prelift
3. First nozzle opening pressure

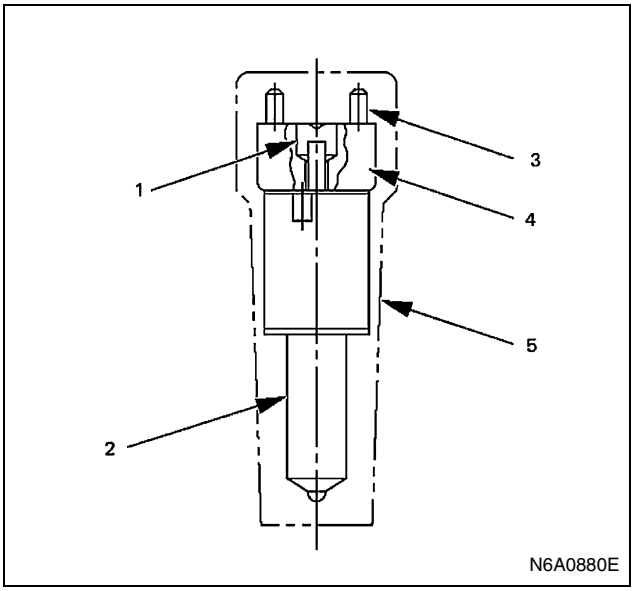
3. Confirm that pre-lift 'I' is as specified.



Legend
1. Push rod
2. Spring seat
3. Spacer
4. Second spring
5. Adjusting shim
6. Lift piece
7. Needle valve

4. If pre-lift is not as specified, replace the pins, lift piece, spacer and nozzle assembly as a set with the service kit.

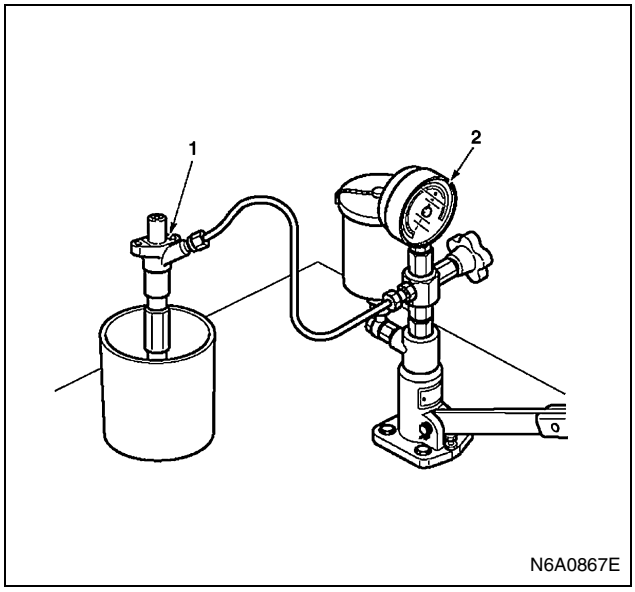
Service kit:	
4HG1-T	897313-8970



Legend
1. Lift piece
2. Nozzle assembly
3. Pin
4. Spacer
5. Capsule

Second Nozzle Opening Pressure Confirmation

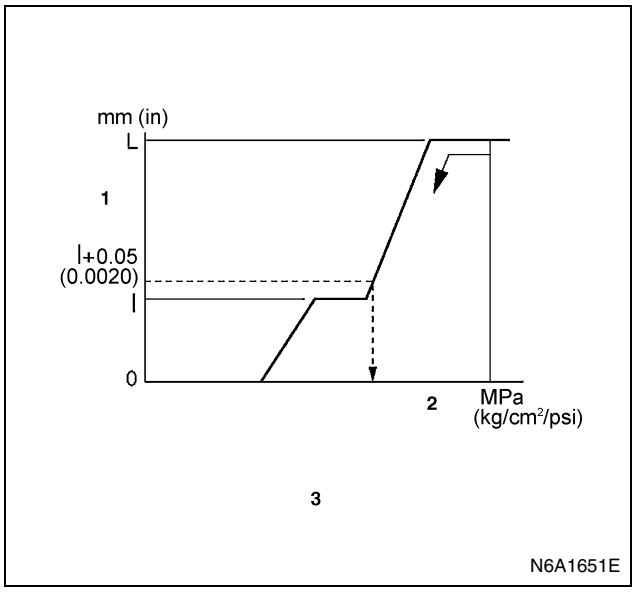
1. After pre-lift confirmation, operate the nozzle tester to increase in-line pressure to 34.3 — 44.1 MPa (350 — 450 kg/cm^2 / 4,975 — 6,396 psi) so that the nozzle's needle valve moves through its full lift.



Legend
1. Nozzle holder
2. Nozzle tester

2. Release the nozzle tester handle so that in-line pressure decreases.

Notice:
The in-line pressure will decrease and needle valve lift (as indicated on the dial gauge) will also decrease a little.

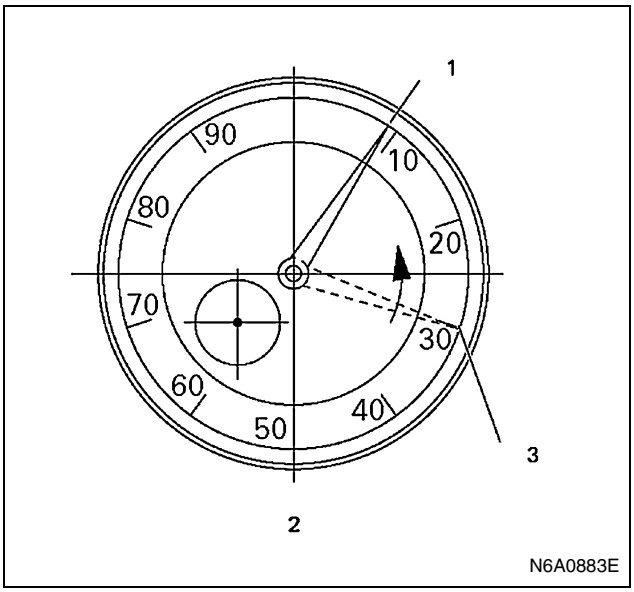


Legend
1. Needle valve lift
2. Second nozzle opening pressure 34.3 — 44.1 MPa (350 — 450 kg/cm^2 / 4,975 — 6,396 psi)
3. In line pressure

3. Then, read the pressure gauge indication (second nozzle opening pressure) the instant that the dial

gauge indicates the specified needle valve lift (usually pre-lift l + 0.05 mm (0.0020 in).

Second Nozzle Opening Pressure		
	Lift mm (in)	Pressure MPa (kg/cm^2/psi)
4HG1-T	0.09 (0.0035)	22.1 — 23.0 (225 — 235/ 3,200 — 3,342)



Legend

1. When needle valve lift is l + 0.05 mm (0.0020 in)
2. Dial gauge
3. Full needle valve lift

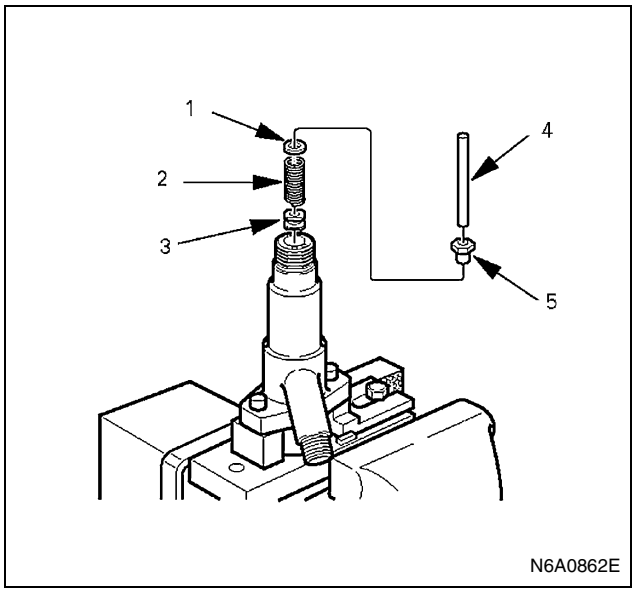
Second Nozzle Opening Pressure Adjustment

If the second nozzle opening pressure is not as specified, disassemble the nozzle from the nozzle holder and replace the shim until the pressure is as specified.

Caution:

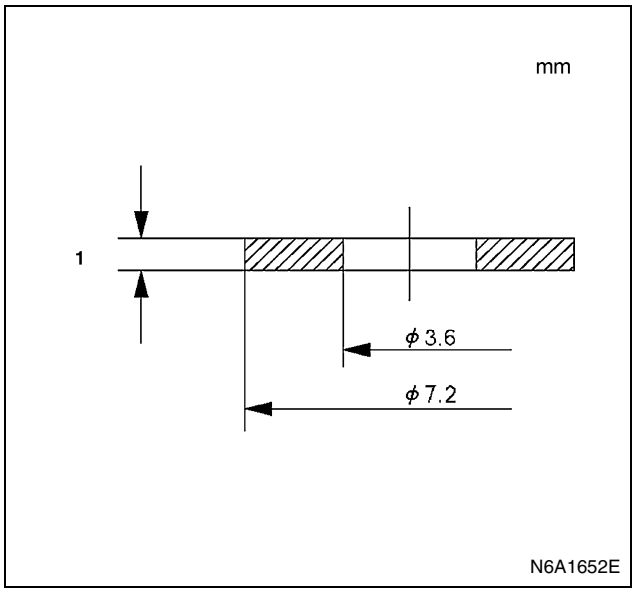
- Because the second opening pressure changes when the first opening pressure changes, the second opening pressure must be adjusted when the first opening pressure changes.
- Use a micrometer to measure shim thickness.
- Use some combination of 3 adjusting shims to adjust the pressure.
- Second nozzle opening pressure adjusting shims

Part No. (ISUZU)	Thickness mm (in)
897116-0290	0.10 (0.0039)
897116-0320	0.20 (0.0079)
897116-0330	0.30 (0.0118)
897116-0340	0.40 (0.0157)
897116-0350	0.50 (0.0197)
897116-0360	0.51 (0.0201)
897116-0370	0.52 (0.0205)
897116-0380	0.53 (0.0209)
897116-0390	0.54 (0.0213)
897116-0400	0.55 (0.0217)
897116-0410	0.56 (0.0220)
897116-0420	0.57 (0.0224)
897116-0430	0.58 (0.0228)
897116-0440	0.59 (0.0232)



Legend

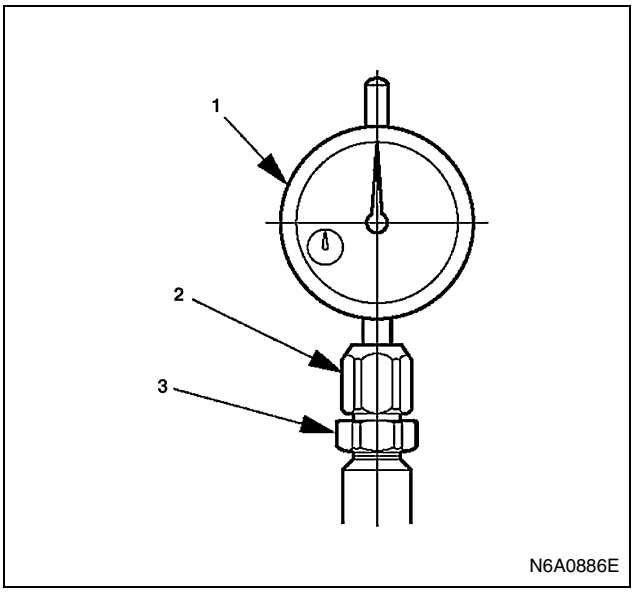
1. Second nozzle opening pressure adjusting shim
2. Second spring
3. Collar
4. Push rod
5. Spring seat



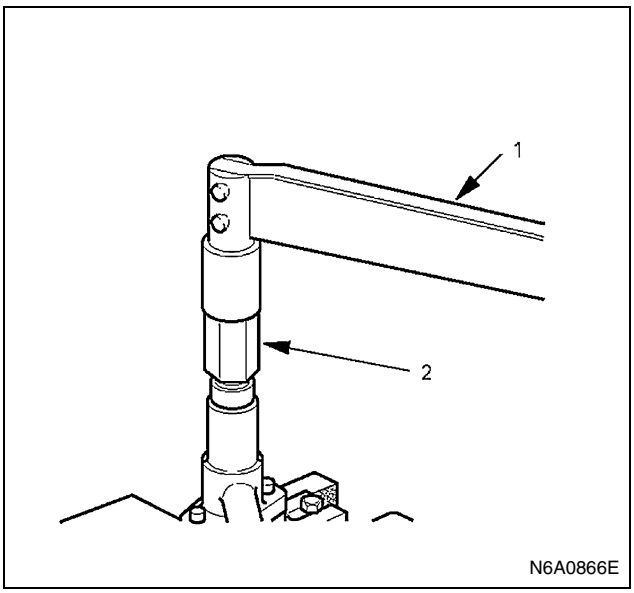
Legend
1. Thickness

Final Inspection

1. Remove the dial gauge (1), nut (2) and dial gauge holder (3).



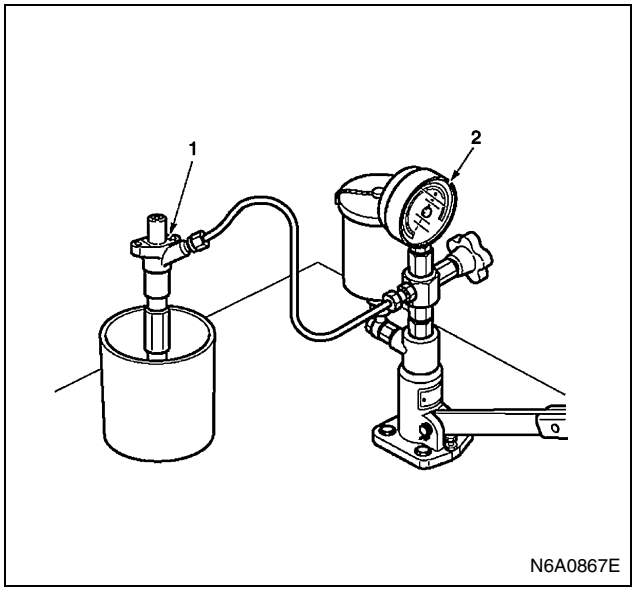
2. Remove the adjustment retaining nut and gasket.
3. Install the original retaining nut, confirm that the pins are inserted fully into the nozzle, and then hand-tighten the retaining nut. Then, tighten the original retaining nut to the specified torque.
   Torque: 29 — 39 N·m (3.0 — 4.0 kg·m / 22 — 29 lb·ft)



Legend
1. Torque wrench
2. Retaining nut (special tool)

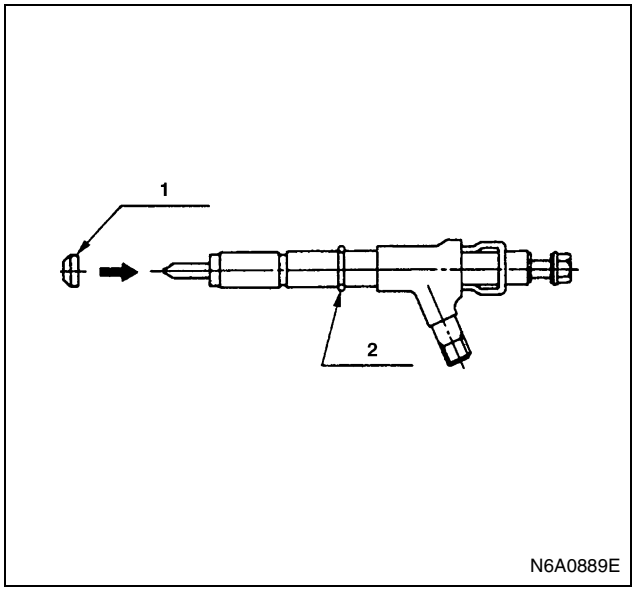
4. Set the nozzle holder (1) to the nozzle tester (2) and check first nozzle opening pressure, spray condition, seat oil tightness and each part for oil leaks.
5. When replacing the nozzle, replace the nozzle, lift piece, pins and spacer as a set with the nozzle service kit.

Caution:
Pre-lift will not be as specified if only the nozzle is replaced.



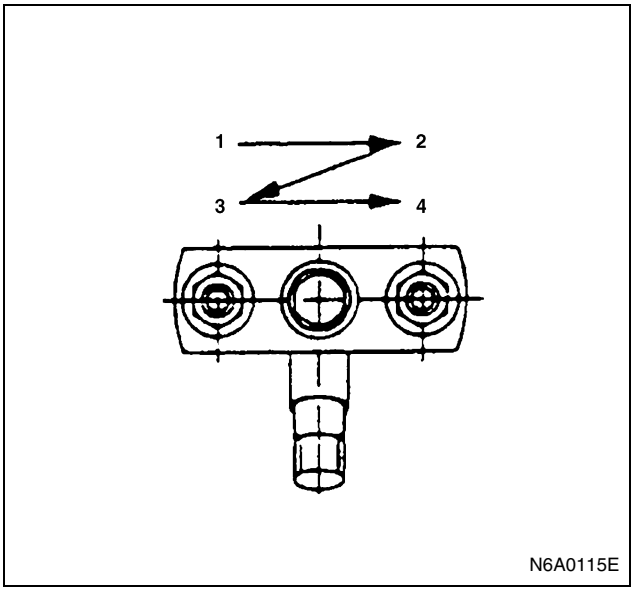
Installation

1. Injection Nozzle Assembly
   1) Install a new injection nozzle (1) gasket and O-ring (2) to the nozzle holder, and then install the nozzle holder to the cylinder head as shown in the illustration.



   2) Tighten the nozzle holder flange nuts to the specified torque in the numerical order.

Tighten:
Nozzle holder flange nuts to 19 N·m (1.9 kg·m / 14 lb·ft)



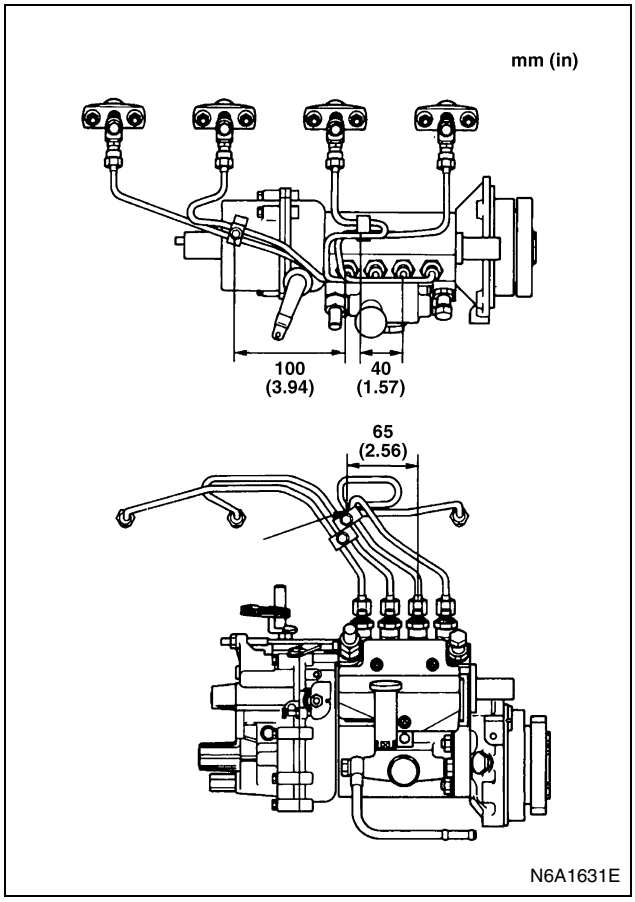
2. Fuel Injection Pipe
   1) Install the injection pipe assembly and temporarily tighten the injection pipe sleeve nuts.
   2) Set the clips in the prescribed position shown in the illustration.

Caution:
Make absolutely sure that the clip is correctly positioned.
An improperly positioned clip will result in injection pipe breakage and fuel pulsing noise.

Tighten:
Clip screw to 3 N·m (0.3 kg·m / 26 lb·in)

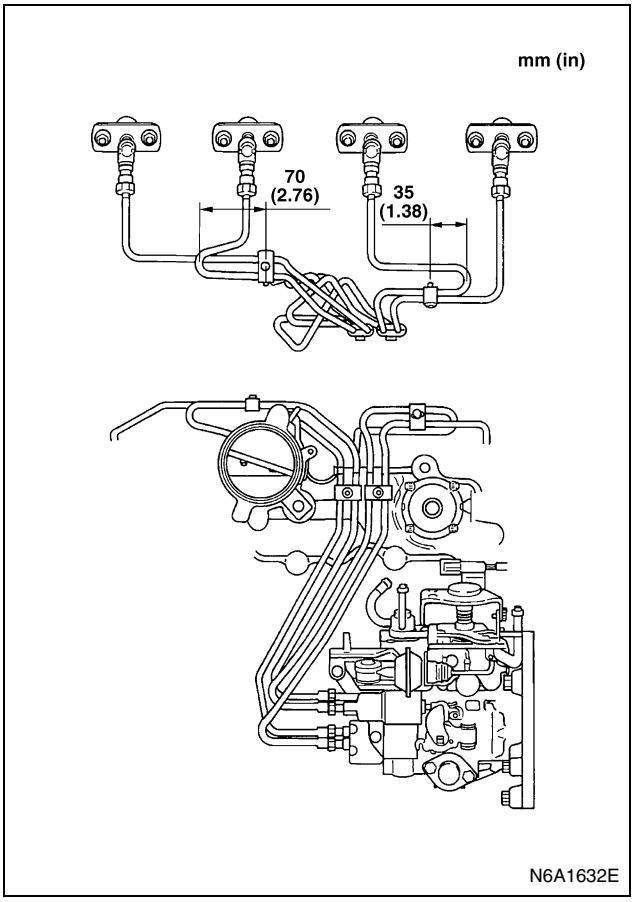
   3) Tighten the injection pipe sleeve nuts to the specified torque.

Tighten:
Injection pipe sleeve nut to 29 N·m (3 kg·m / 22 lb·ft)



3. Fuel Injection Pipe (4HF1-2 model only)
   1) Connect Injection Pipe and fix with clips as illustrated.

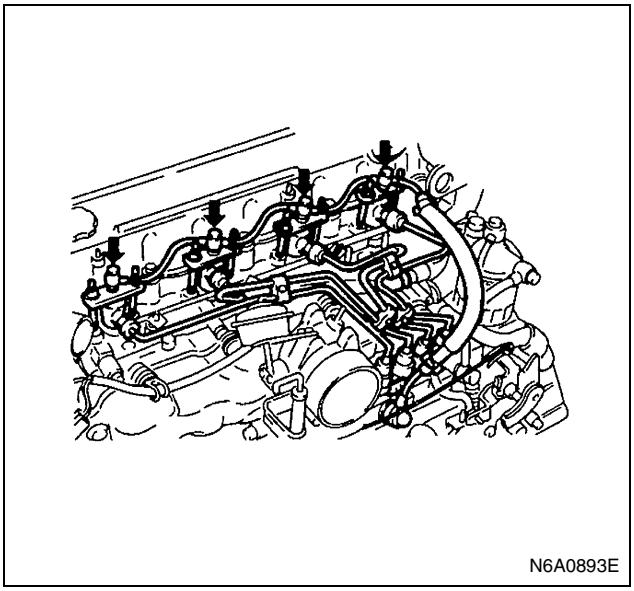
Tighten:
- Injection pipe to 29 N·m (3.0 kg·m / 22 lb·ft)
- Clip to 3 N·m (0.3 kg·m / 26 lb·in)



4. Leak Off Pipe

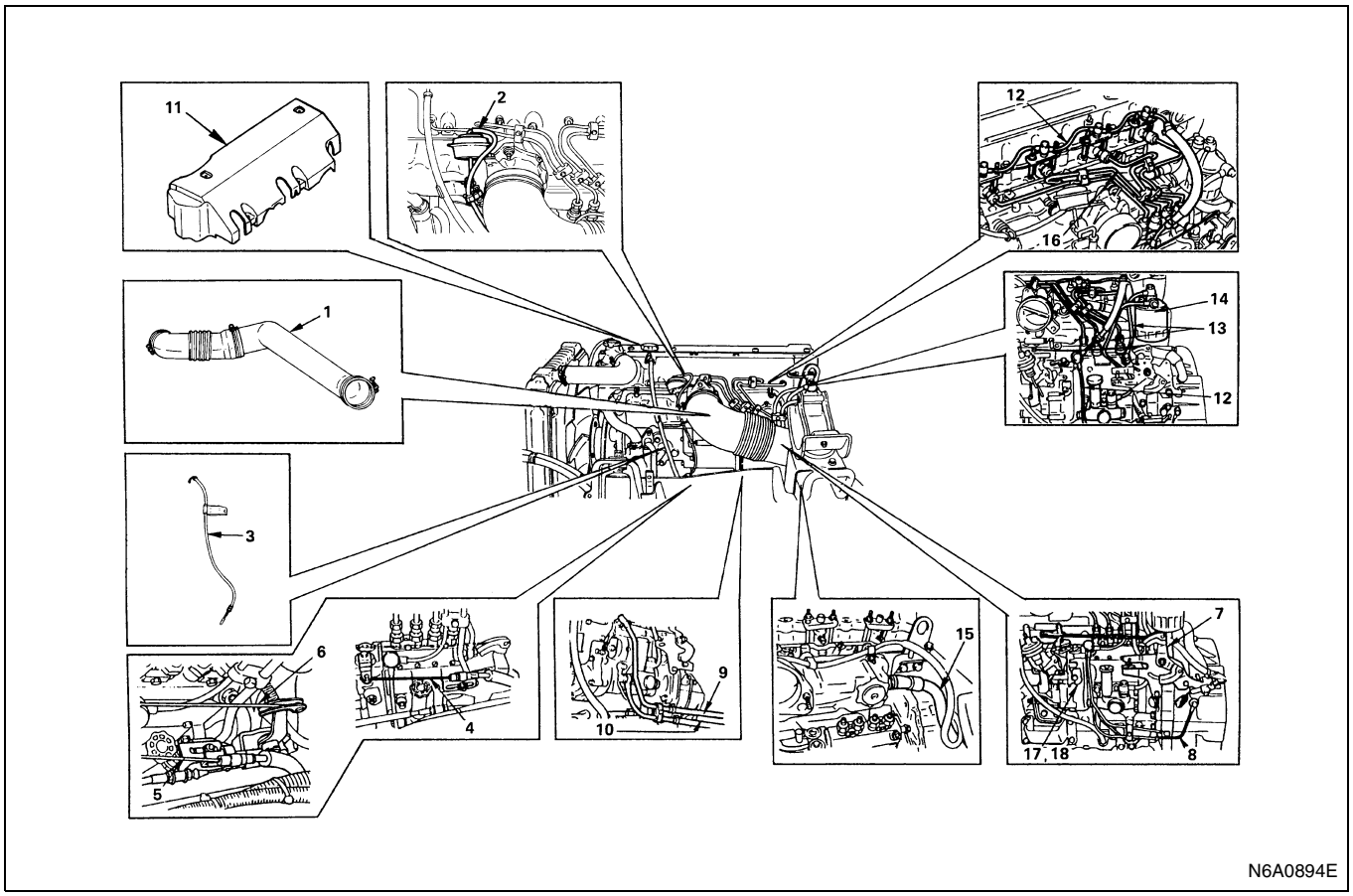
Leak-off pipe joint bolt 13 N·m (1.3 kg·m / 113 lb·in)

5. Nozzle Cover
    - Connect battery ground cable.



INJECTION PUMP ASSEMBLY (Except 4HF1-2 model)

Component



Legend

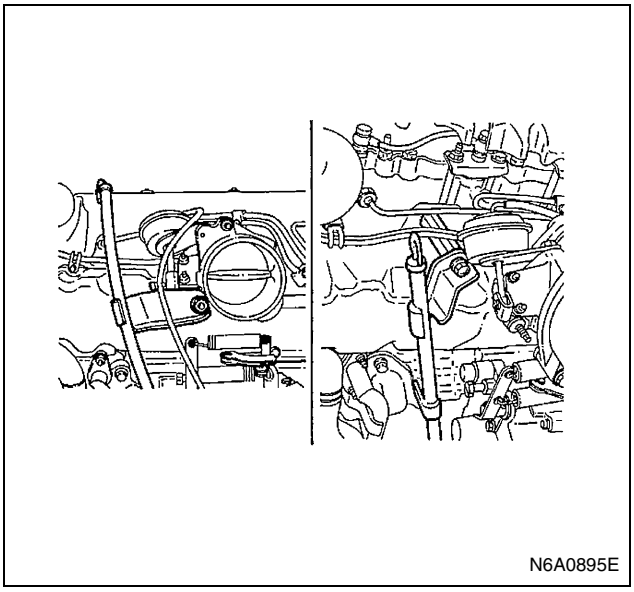
1. Intake air duct
2. Vacuum hose
3. Oil level guide tube
4. Engine stop cable
5. Accelerator control cable
6. Engine control wire
7. Engine control lever
8. Oil pipe
9. Fuel return hose
10. Fuel feed hose
11. Nozzle cover
12. Leak off pipe
13. Fuel pipe
14. Fuel filter assembly
15. PCV hose
16. Injection pipe
17. Injection pump assembly
18. Injection rubber spacer

Removal

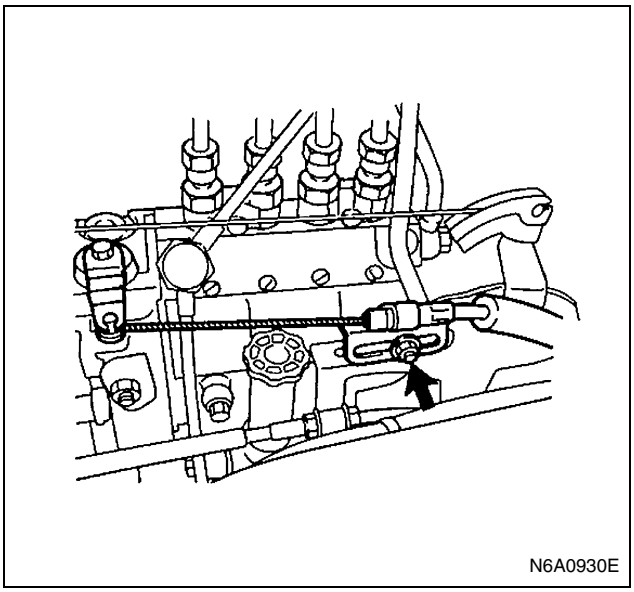
Preparation

- Disconnect the battery ground cable
- Drain coolant

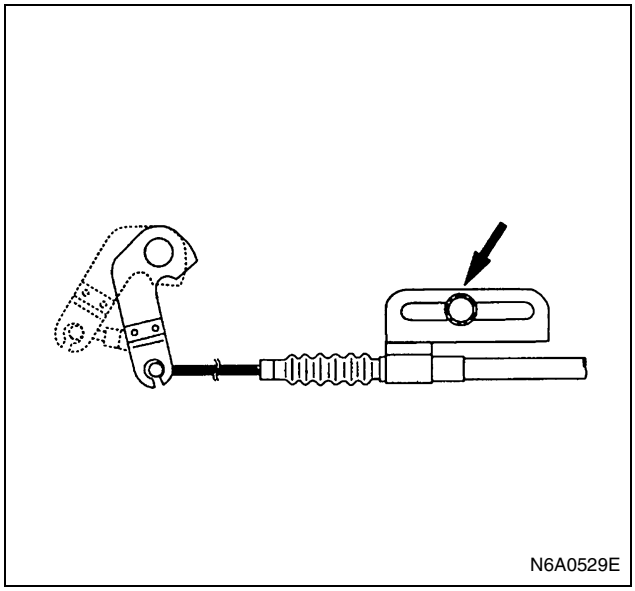
1. Intake Air Duct
2. Vacuum Hose
3. Oil Level Guide Tube
   - Remove the guide tube fixing bolt and pull out the guide tube.


N6A0895E

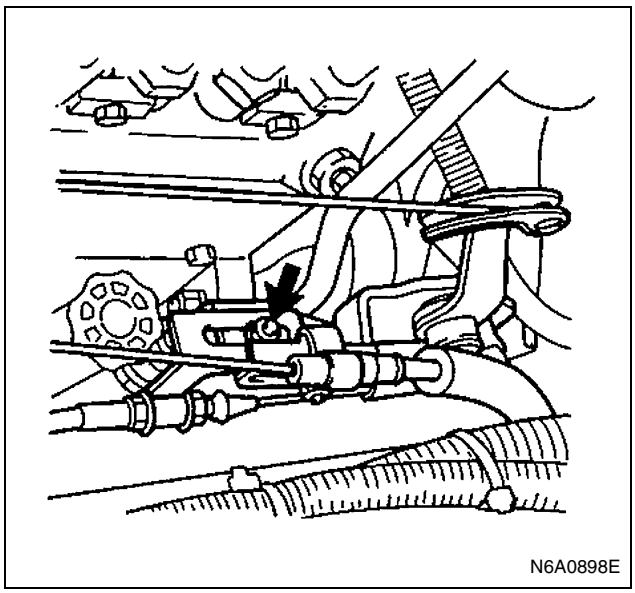
4. Engine Stop Cable
   - Loosen the locking nut at bracket and disconnect engine stop cable from the injection pump stop lever.


N6A0930E

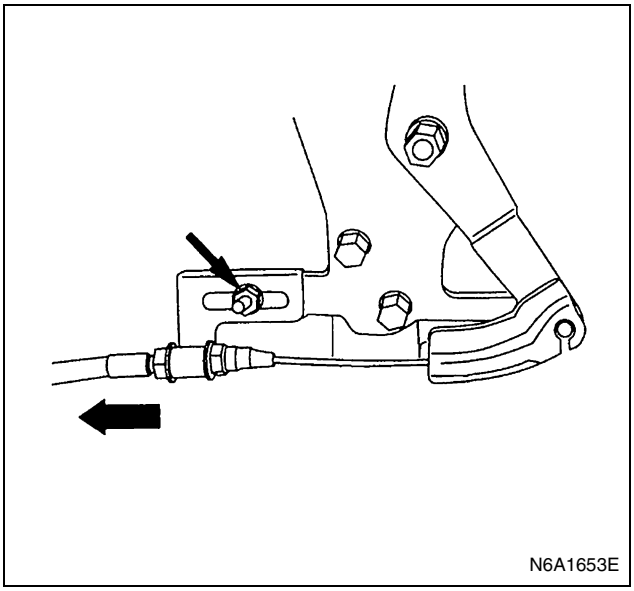
For 4HE1-TC


N6A0529E

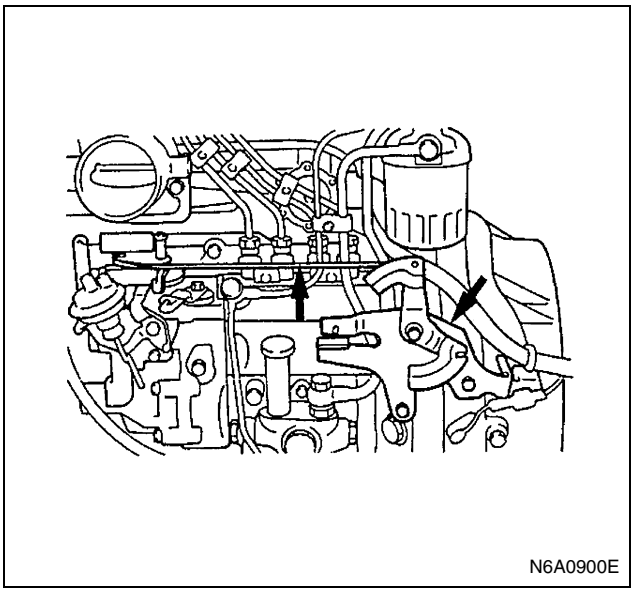
5. Accelerator Control Cable
   - Loosen the locking nut at bracket and disconnect the accelerator control cable from the injection pump control lever.


N6A0898E

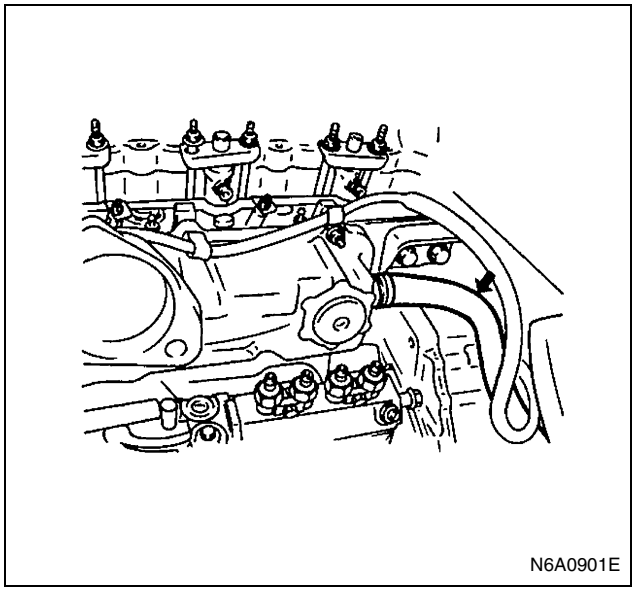
For 4HE1-TC


N6A1653E

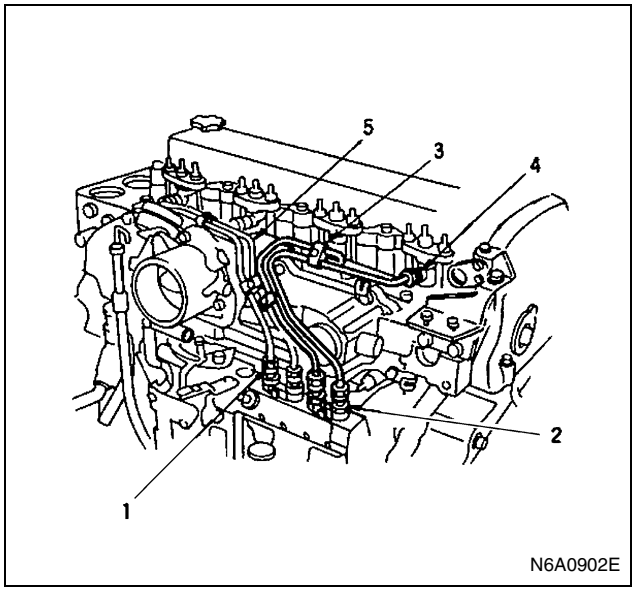
6. Engine Control Wire
7. Engine Control Lever
8. Oil Pipe
9. Fuel Return Hose
10. Fuel Feed Hose
    - Disconnect fuel hose from injection pump side and take care not to spill and enter dust.
11. Nozzle Cover


N6A0900E

12. Leak-Off Pipe
13. Fuel Pipe
14. Fuel Filter Assembly
15. PCV Hose

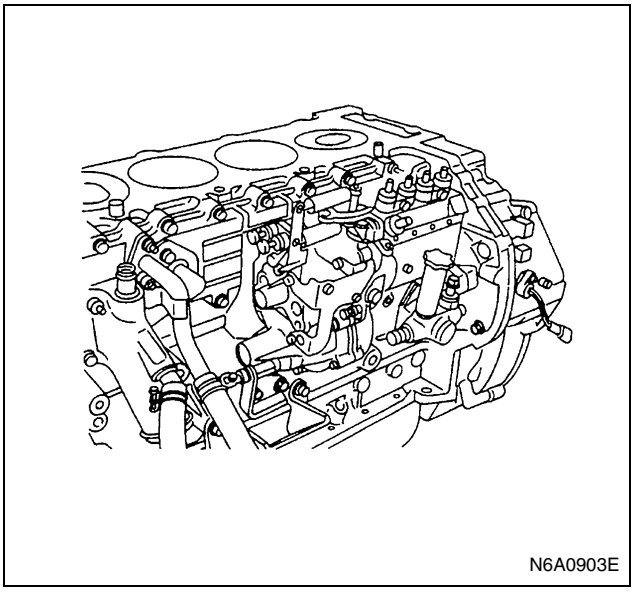

N6A0901E

16. Injection Pipe
    - Loosen the injection pipe sleeve nuts (1). Do not apply excessive force to the injection pipes (5).
    - Loosen the injection pipes clips (3).
    - Remove the injection pipe assembly. Plug the delivery valve holder (2) ports and nozzle holder (4) ports with caps to prevent the entry of foreign material.

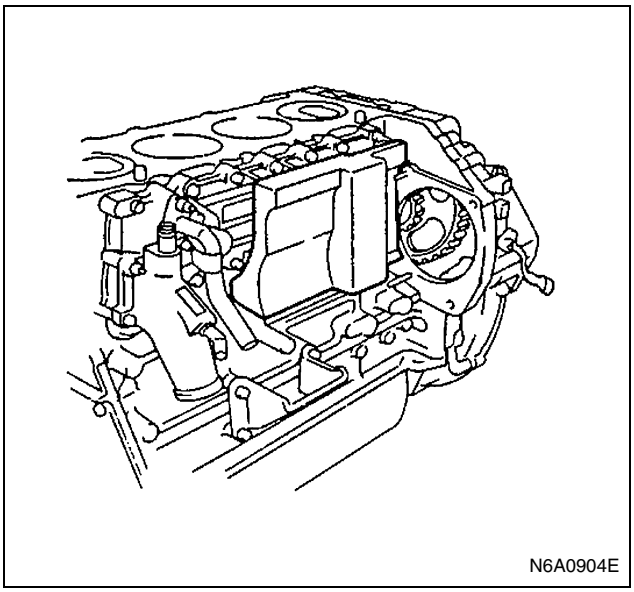


N6A0902E

17. Injection Pump Assembly
    1) Remove the injection pump bracket bolts and the injection pump rear bracket bolts.
    2) Then remove the injection pump assembly.

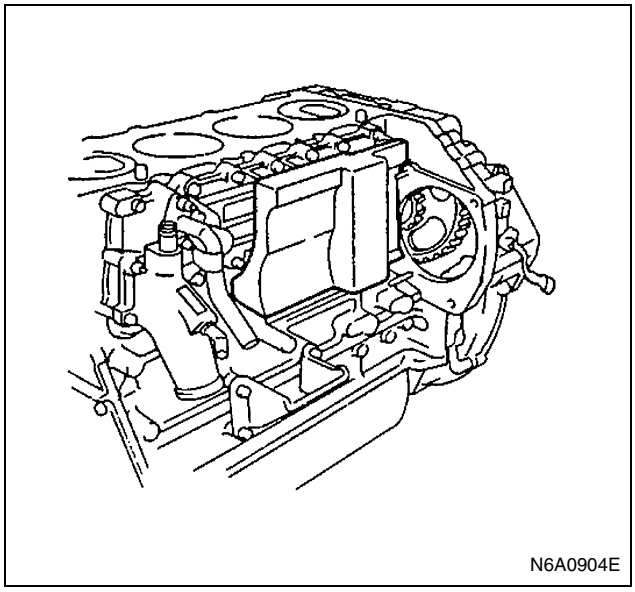

N6A0903E

18. Injection Pump Rubber Spacer (For 4HF1/4HG1)


N6A0904E

Installation

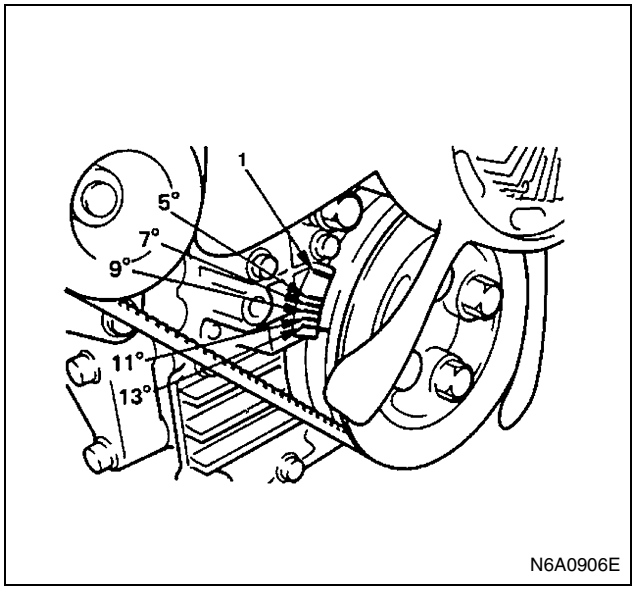
1. Injection Pump Rubber Spacer
   1) Stick the rubber spacer to the location indicated in the illustration with pressure sensitive adhesive double coated tape. (4HF1/4HG1 Engine)
   2) 4HE1-TC (4HE1-XS) EURO-3 engines use a larger rubber spacer than other engines. However, engines destined for Hong Kong do not have a rubber spacer.


N6A0904E

2. Injection Pump Assembly
   1) Turn the crankshaft until the timing mark on the crankshaft damper pulley is aligned with “13°” line.
   2) Check the No.1 cylinder intake and exhaust valve rocker arms for any play.
      If the No.1 cylinder intake and exhaust valve rocker arms are depressed the No.4 piston is at on the compression stroke.
      Rotate the crankshaft one full turn (360 degrees) and realign the crankshaft damper pulley timing mark with the “13°” line.

Notice:
BTDC 13° to be aligned with here is an angle at which the injection pump is installed, and has nothing to do with the injection timing.

- Remove the inspection hole plug from the cylinder body.
- Install the O-ring to the injection pump bracket.

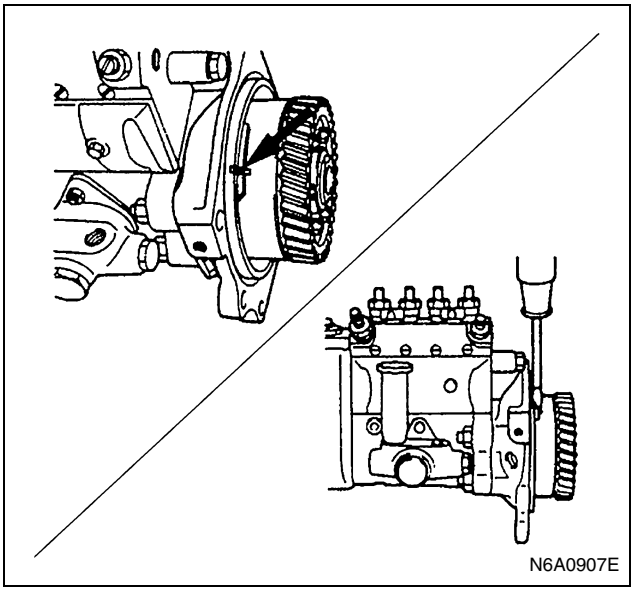


N6A0906E

Legend
1. TDC

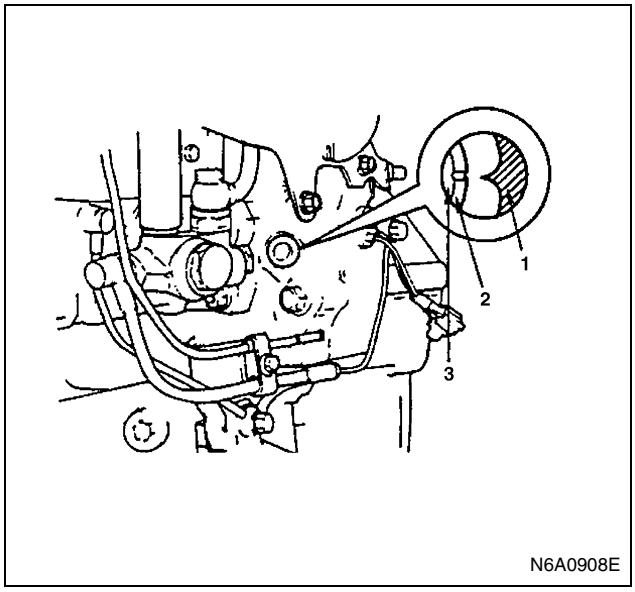
3) Align the injection pump bracket slit with the timer slit.
4) Install the injection pump assembly to the cylinder body.

Notice:
When the injection pump has a poor gear engagement while installing the assembly to the cylinder body, insert a screwdriver into the slit on the time peripheral with the pump bracket slit used as a guide, and move it up and down to get it into forcibly.


N6A0907E

5) After installing the injection pump, the injection timing can be checked through the timing check hole provided at the injection pump bracket.
Set the No.1 cylinder to the BTDC (injection timing of engine mode) on the compression stroke. When the pointer of the timing check hole comes in line with the mark on the timer periphery of the injection pump as shown in the illustration, the injection timing is normal.
After completion of the injection timing check, tighten the check hole plug to the specified torque.

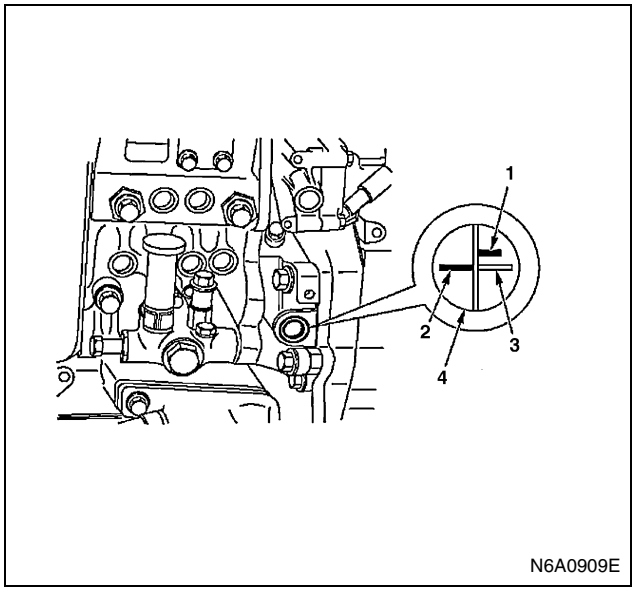
Injection Timing	deg
4HF1: 4HE1-TC (4HE1-XS, XN)	BTDC 8
4HG1	BTDC 9
4HG1-T	BTDC 7 BTDC 9 (For Colombia)
4HE1-TC (4HE1-XS)	BTDC 9 (Spec EURO3)



N6A0908E

Legend
1. Pointer
2. Timer outside mark
3. Timing check hole

For 4HE1-TC

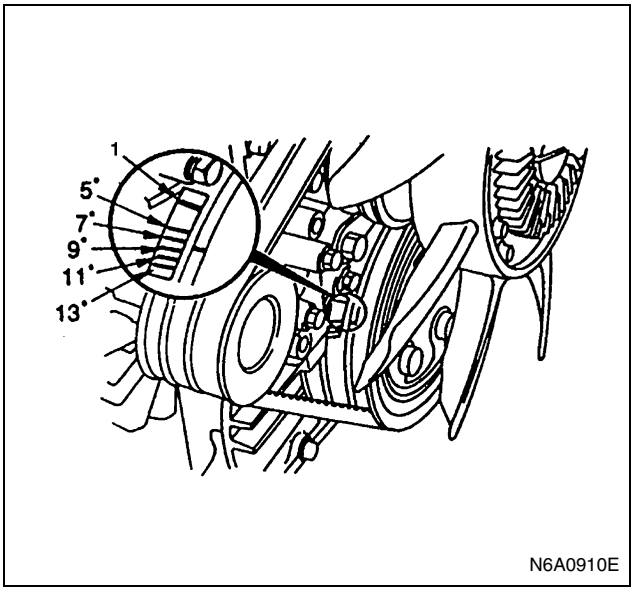


N6A0909E

Legend
1. 8° mark
2. Pointer
3. 13° mark
4. Timing check hole

6) Turn the crankshaft until the timing mark on the crankshaft damper pulley is aligned with “8°” (98EPA) or “9°” (Spec EURO3) line.

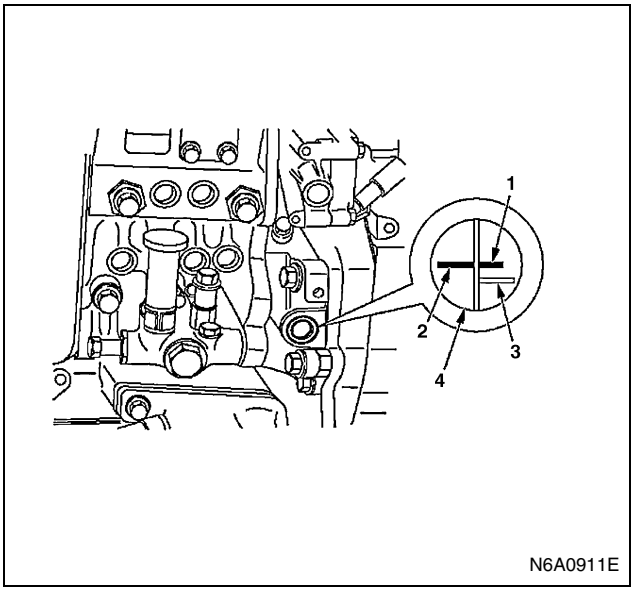
Notice:
Position in its normal rotating direction. (for 4HE1-TC only)



Legend
1. TDC

7) Adjust injection pump downward so that the "8°" (98EPA) or "9°" (Spec EURO3) comes to position in the timing check hole. (for 4HE1-TC only)

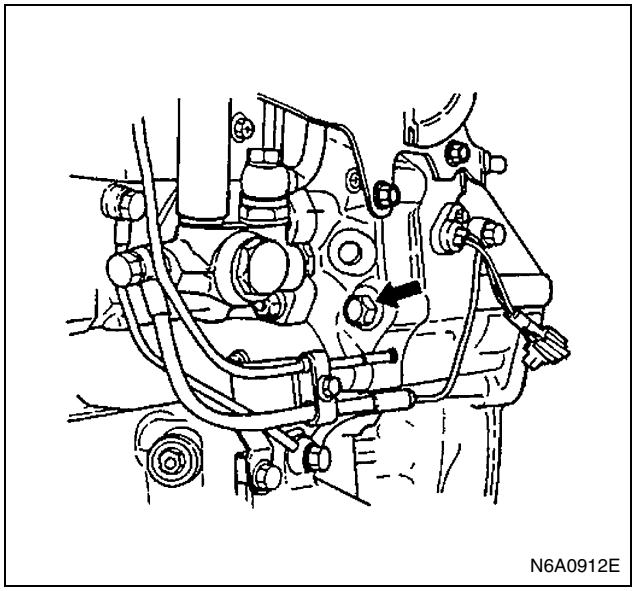
Notice:
Whenever the injection pump is replaced, be sure to adjust the injection timing. For the details of the adjustment, refer to the "SECTION 00 SERVICING: INJECTION TIMING INSPECTION AND ADJUSTMENT".



Legend
1. 8° mark
2. Pointer
3. 13° mark
4. Timing check hole

8) Tighten the injection pump bracket nuts and bolts to the specified torque.

Tighten:
Injection pump bracket nut and bolt to 48 N·m (4.9 kg·m / 35 lb·ft)



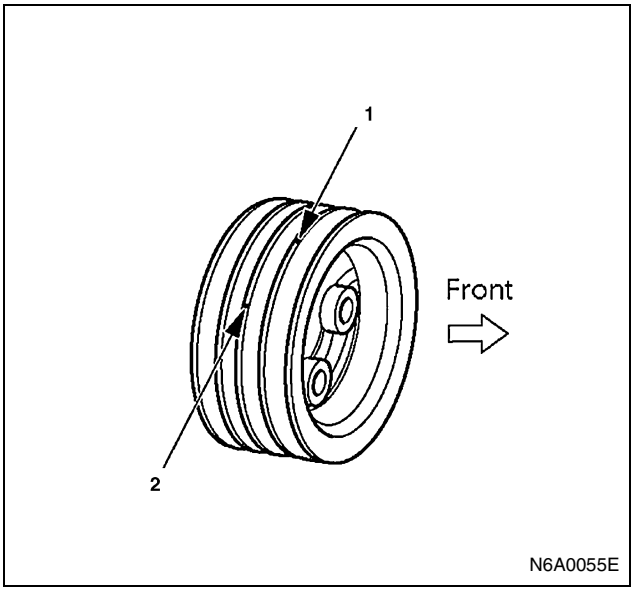
9) Install the injection pump rear bracket.

Tighten:
Injection pump rear bracket bolt to 48 N·m (4.9 kg·m / 35 lb·ft)

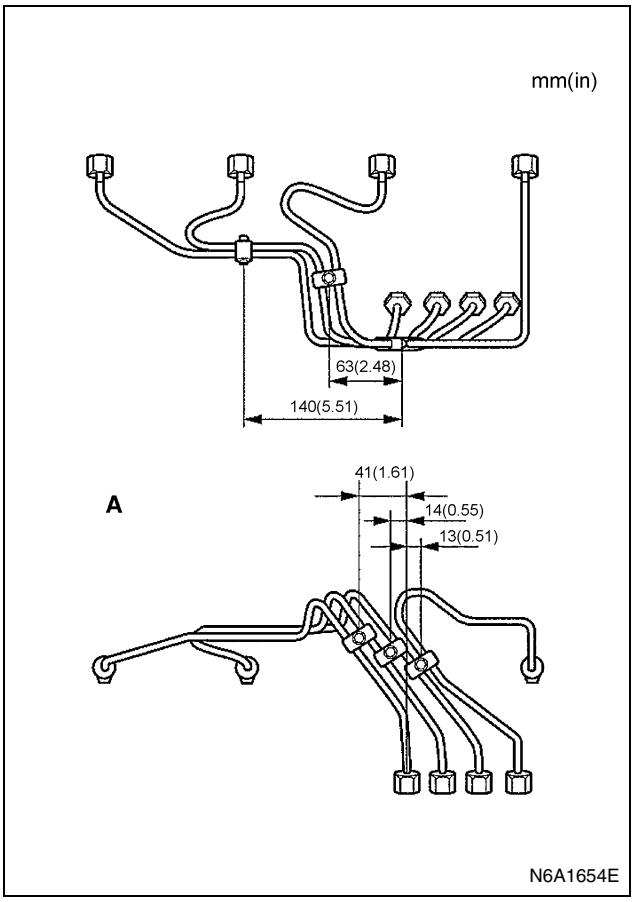
10) Install the inspection hole plug.

Tighten:
Inspection hole plug to 48 N·m (4.9 kg·m / 35 lb·ft)

Notice:
In case the crank pulley has two marks as illustrated, (1) BTDC 49° mark on the second crest and (2) TDC mark on the third crest (as viewed from the front side), be sure to set at the mark (2). (If there are two different marks on one and same crest, set at the mark which comes second when rotated in the normal direction.) The mark (1) is used when installing the injection pump for 4HF1-2.



3. Fuel Injection Pipe
   1) Install the injection pipe assembly and temporarily tighten the injection pipe sleeve nuts.
   2) Set the clips in the prescribed position shown in the illustration.



Legend
A. 4HG1-T

Caution:
Make absolutely sure that the clip is correctly positioned.

An improperly positioned clip will result in injection pipe breakage and fuel pulsing noise.

Tighten:
Clip screw to 3 N·m (0.3 kg·m / 26 lb·in)

   3) Tighten the injection pipe sleeve nuts to the specified torque.

Tighten:
Injection pipe sleeve nut to 29 N·m (3 kg·m / 22 lb·ft)

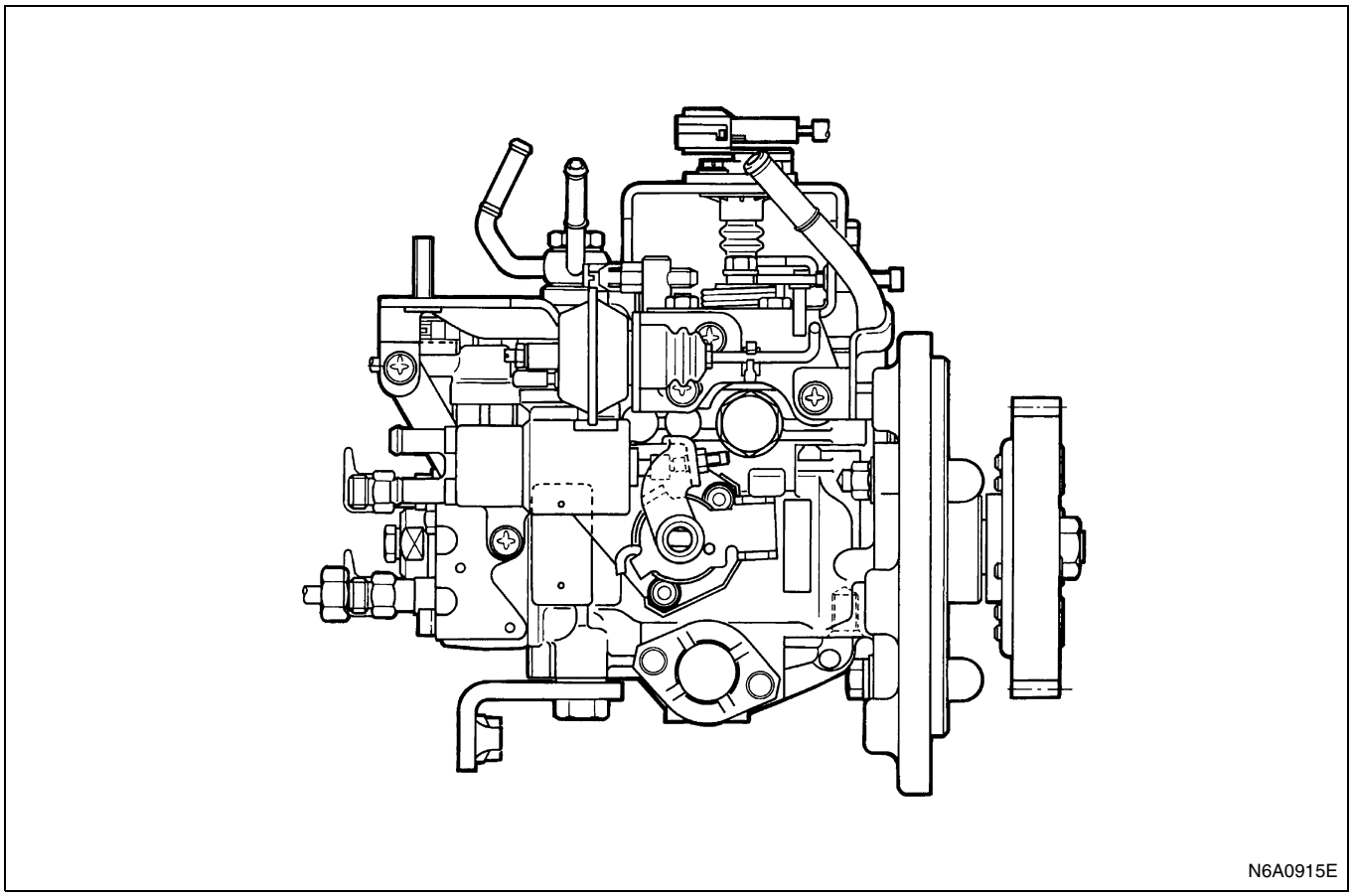
4. PCV Hose
5. Fuel Filter

Tighten:
Fuel filter bracket bolt to 34 N·m (3.5 kg·m / 25 lb·ft)

6. Fuel Pipe
7. Leak Off Pipe
8. Nozzle Cover
9. Fuel Feed Hose
10. Fuel Return Hose
11. Oil Pipe
12. Engine Control Lever
13. Engine Control Wire
14. Accelerator Control Cable
15. Engine Stop Cable
16. Oil Level Guide Tube
17. Vacuum Hose
18. Intake Air Duct

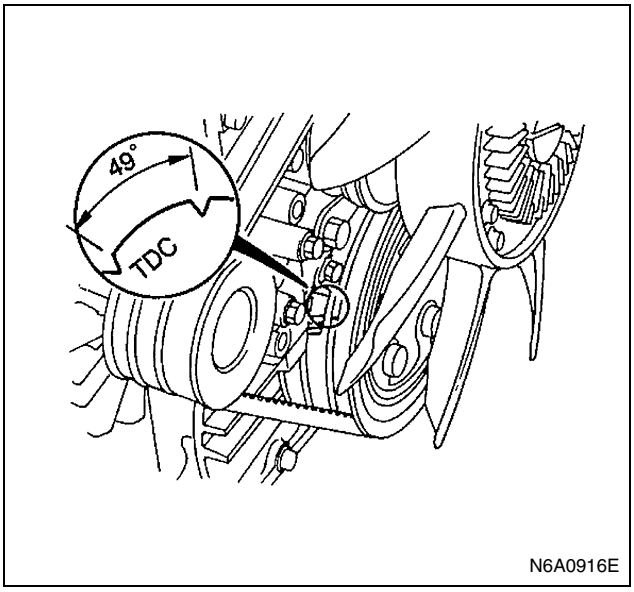
INJECTION PUMP ASSEMBLY (4HF1-2 model only)

Component

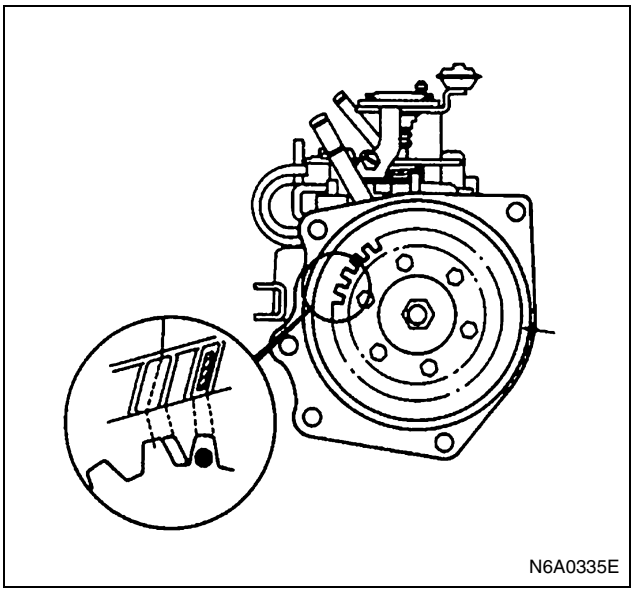


Installation

1. Turn the crankshaft to set No. 1 cylinder to 49° before TDC in its compression stroke. (49° is a pump assembling angle, not related to injection timing.)

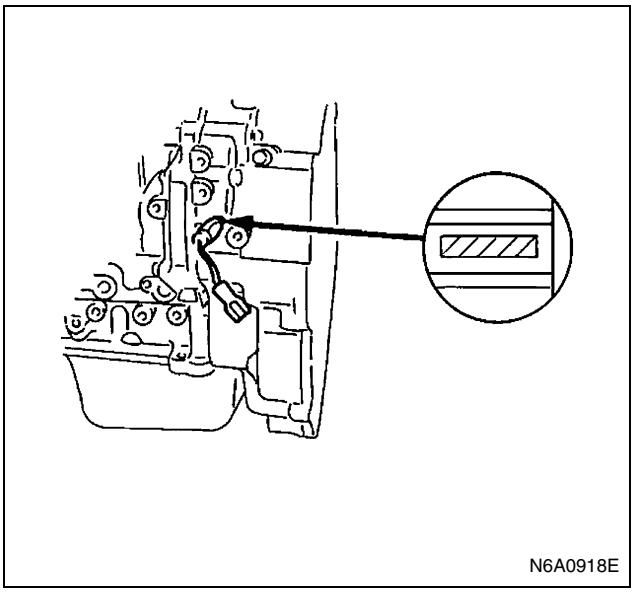


2. Install O-ring to the injection pump.
3. Apply paint on the • (Z) marked side of the injection pump gear.
4. Align the pump bracket mark with the tooth (under side of the pump) just before the • (Z) marked tooth.
5. Insert the pump using the block side of stud bolt as a guide.



6. After installing the injection pump, remove the tachometer sensor from the housing, and make sure

that the painted gear is at the center of the sensor mounting hole.

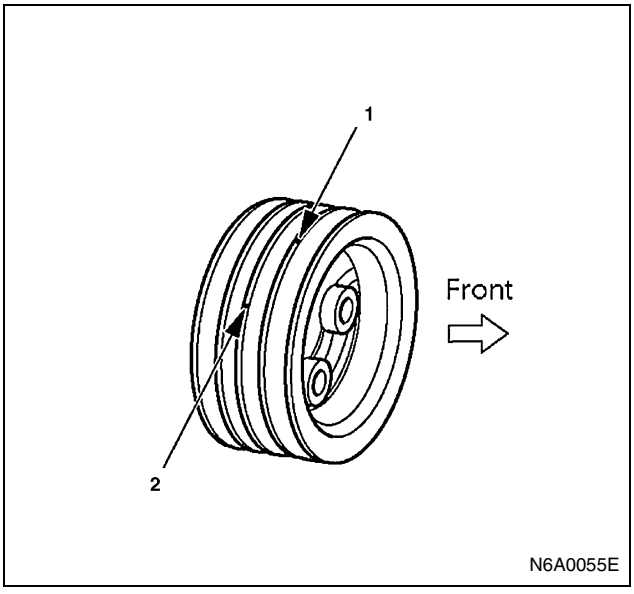


7. Tighten injection pump clamping bolt and nut to specified torque:

Tighten:
- Bolt to 48 N·m (4.9 kg·m / 35 lb·ft)
- Nut to 24 N·m (2.4 kg·m / 17 lb·ft)

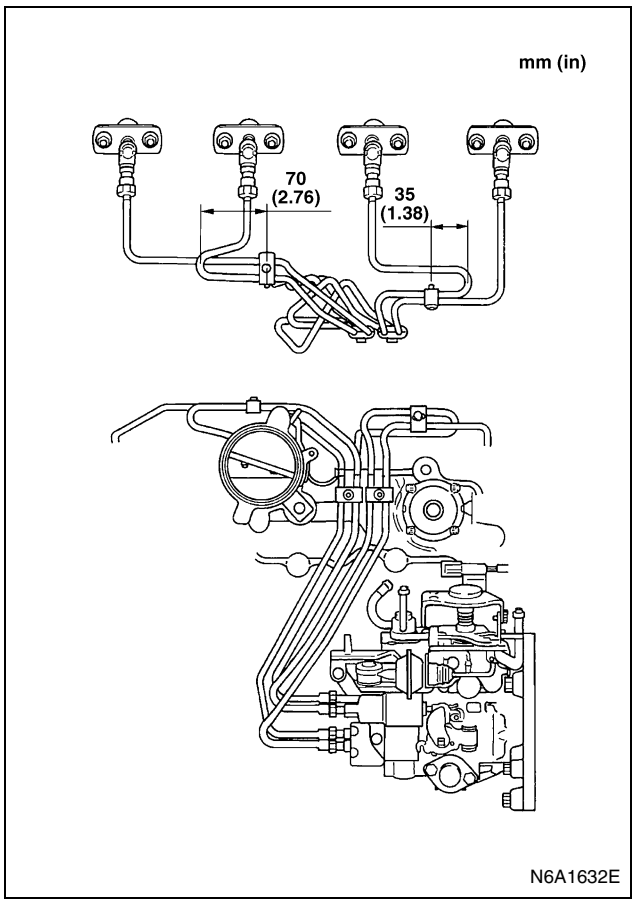
8. With reference to Injection Timing Check & Adjustment, set No. 1 Cylinder to 12° before its TDC.

Notice:
In case the crank pulley has two marks as illustrated, (1) BTDC 49° mark on the second crest and TDC mark on the third crest (as viewed from the front side), be sure to set at the mark (2). (If there are two different marks on one and same crest, set at the mark which comes second when rotated in the normal direction.)



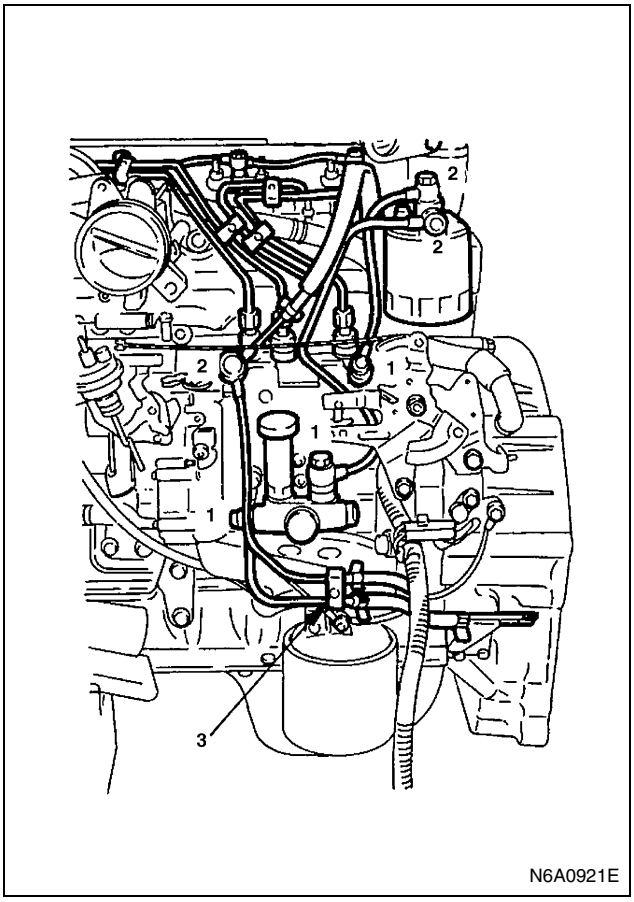
9. Injection Pipe (4HF1-2 model only)
   1) Connect Injection Pipe and fix with clips as illustrated.

Tighten:
- Injection pipe to 29 N·m (3.0 kg·m / 22 lb·ft)
- Clip to 3 N·m (0.3 kg·m / 26 lb·in)



10. Fuel Pipe
    Do not apply excessive force to the fuel pipe.

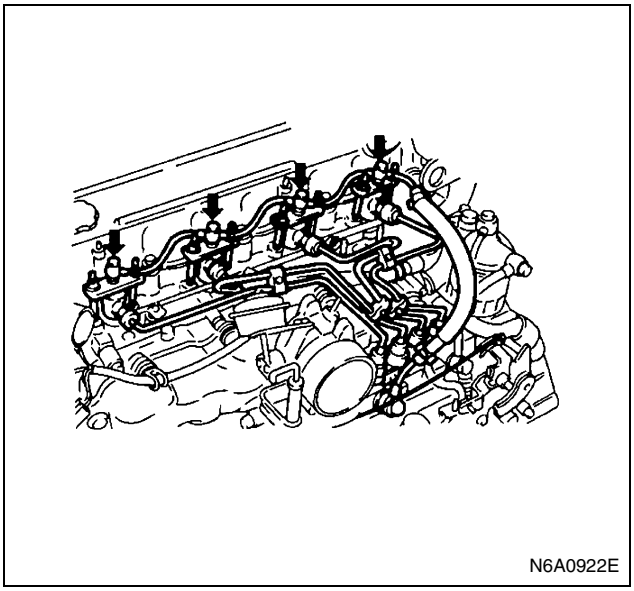
Tighten:
- Fuel pipe joint bolt (1) to 41 N·m (4.2 kg·m / 30 lb·ft)
- Fuel pipe joint bolt (2) to 23 N·m (2.3 kg·m / 17 lb·ft)
- Clip screw to 4 N·m (0.4 kg·m / 35 lb·in)



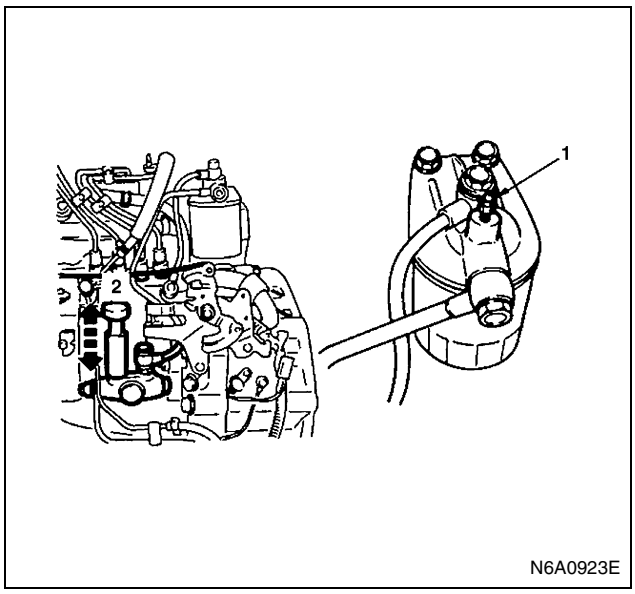
Legend
1. Fuel pipe joint bolt
2. Fuel pipe joint bolt
3. Clip

11. Leak Off Pipe

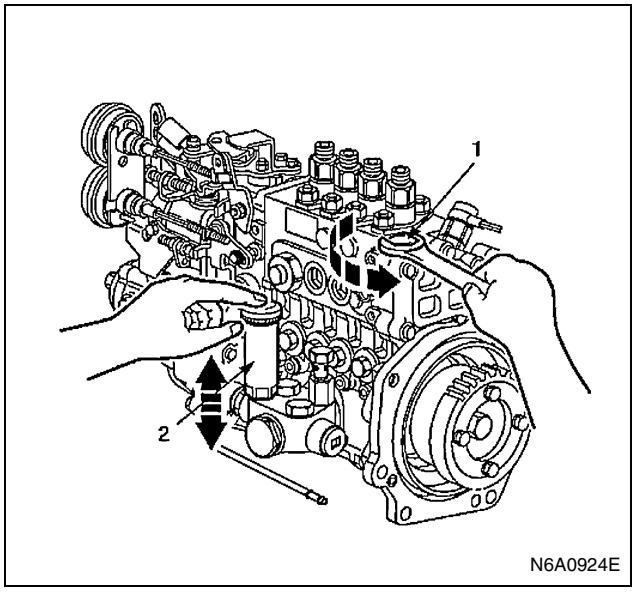
Tighten:
Leak-off pipe joint bolt to 13 N·m (1.3 kg·m / 9.6 lb·ft)



12. Nozzle Cover
13. Fuel Feed Hose
14. Fuel Return Hose
15. Air Bleeding
    1) Loosen the priming pump cap (2) at the side of the injection pump.
    2) Loosen the bleeder valve (1) at the top of the fuel filter.
    3) Operate the priming pump to bleed the air from the injection pump.
    4) Retighten the bleeder valve (1).
    5) Operate the priming pump.
       Check for fuel leakage from around the injection pump and the fuel filter.
    6) Lock the priming pump cap (2) to the injection pump.

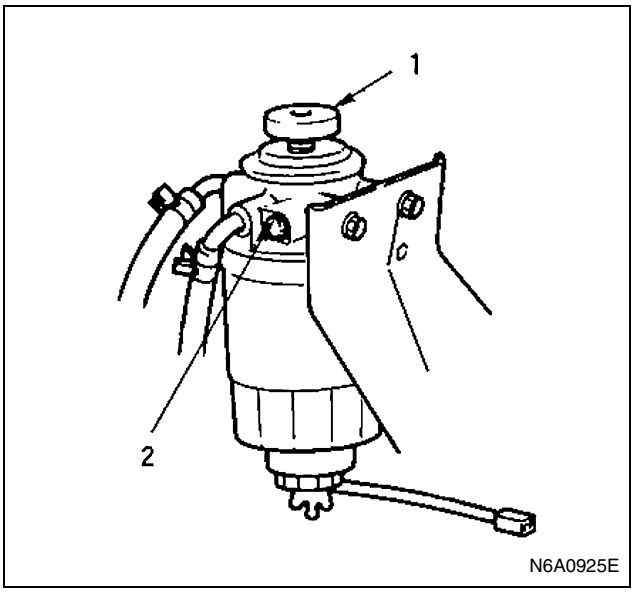


For 4HE1-TC



16. Air Bleeding (4HF1-2 model only)
    1) Actuate the priming pump (1) to send the air in the fuel system to the injection pump.

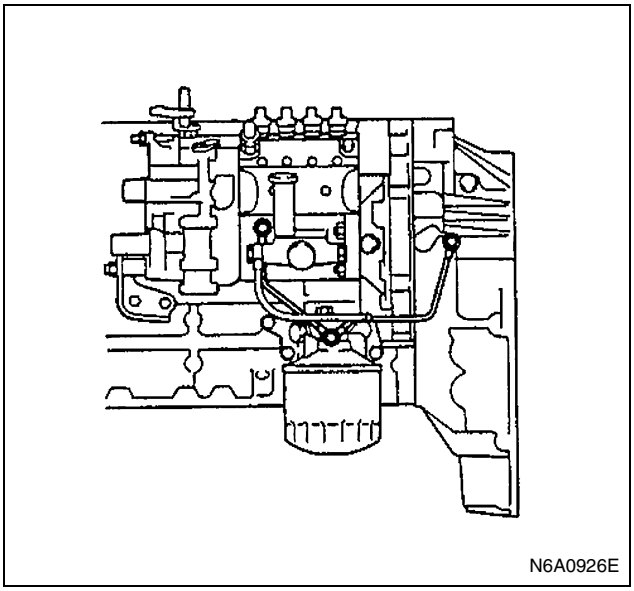
2) Loosen the sedimenter air bleeding plug (2) and operate the priming pump until no bubbles appear.



3) Tighten the air bleeding plug completely.
4) Try to start the engine. If the engine is not started within 10 seconds, air bleeding should be conducted once again.
5) Check that there is not fuel leak, and then tighten the priming pump completely.

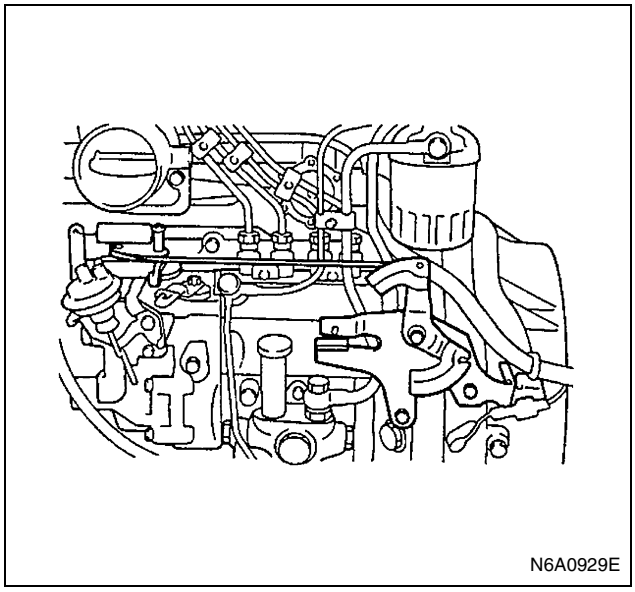
17. Oil Pipe

Tighten:
Oil pipe joint bolt to17 N·m (1.7 kg·m / 12 lb·ft)

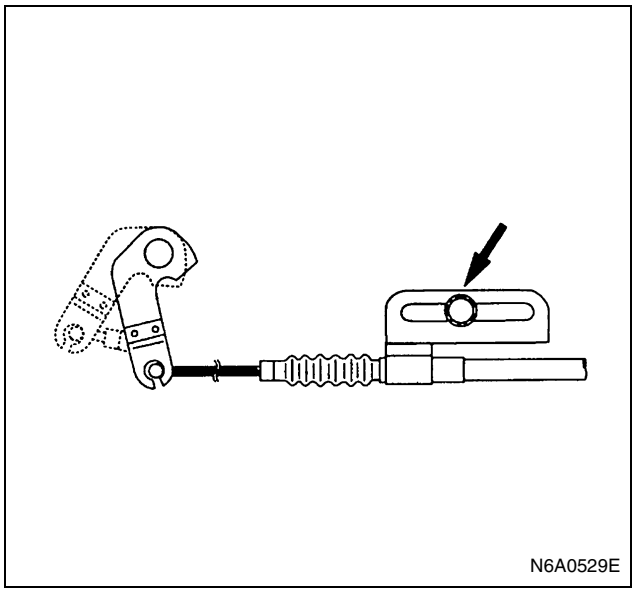


18. Engine Control Lever Assembly

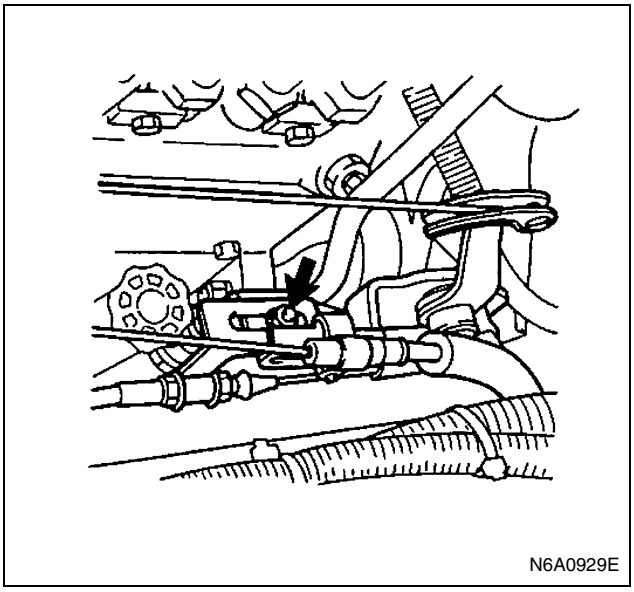
Tighten:
Engine control lever bolt to 24 N·m (2.4 kg·m / 17 lb·ft)



For 4HE1-TC

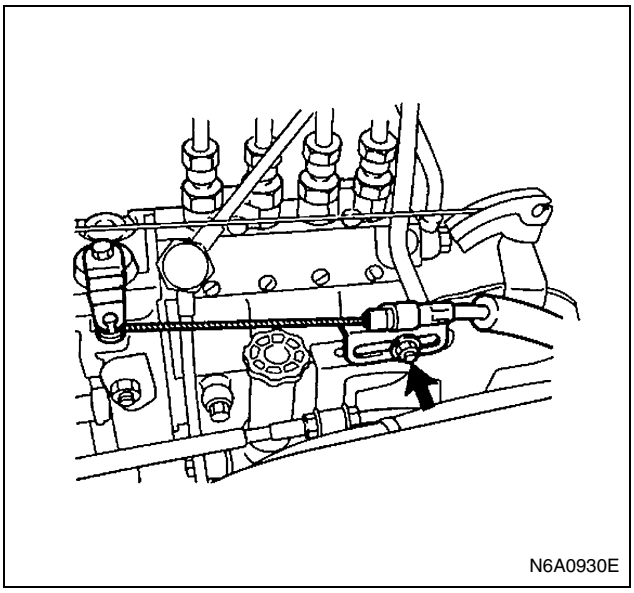


19. Engine Control Wire
20. Accelerator Control Cable
    1) Check to see if the idling control knob is turned to the extreme left.
    2) Attach the tip end of the cable to the engine control lever.
    3) Pull the outer cable toward the front side of the vehicle, and provide the engine control wire and the inner cable with an appropriate play before fastening the clamp with a nut.


N6A0929E

4) Check to see if the injection pump control lever is at the idling position (with the lever in touch with the stopper bolt).

21. Engine Stop Cable
    1) Attach the end tip of the cable to the engine stop lever.
    2) Pull the cable toward the rear side of the vehicle, and fasten the clamp with a nut at the position where the lever stops.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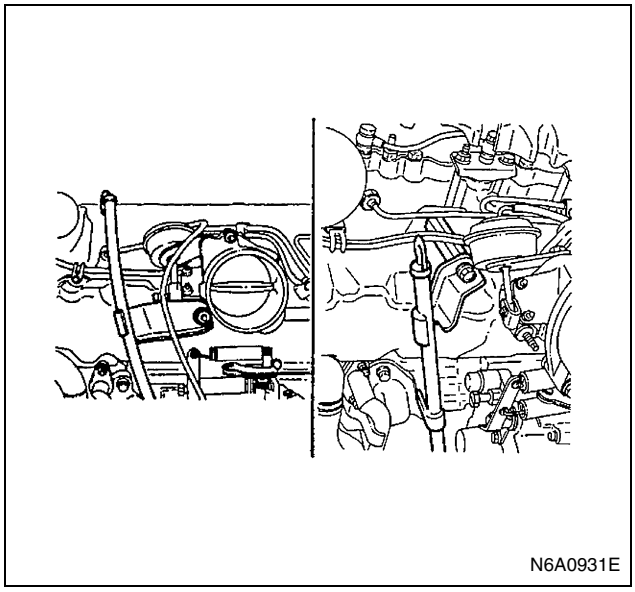
22. Oil Level Gauge Guide Tube
    1) Install the O-rings to the guide tube lower portion and insert the guide tube completely to the cylinder body.
    2) Tighten the guide tube bolt to the specified torque.

Tighten:
Guide tube bolt to 13 N·m (1.3 kg·m / 9.6 lb·ft)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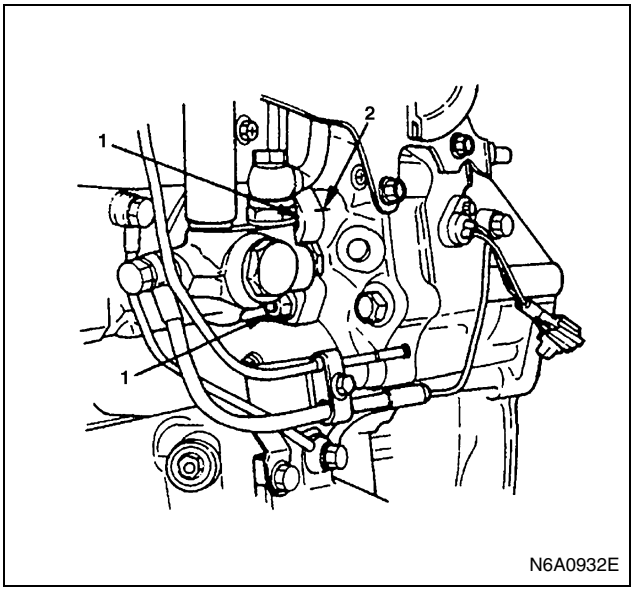
23. Vacuum Hose
24. Intake Air Duct
    - Pour coolant into radiator.
    - Connect battery ground cable.
    - Start engine and check for oil and fuel leakage carefully.

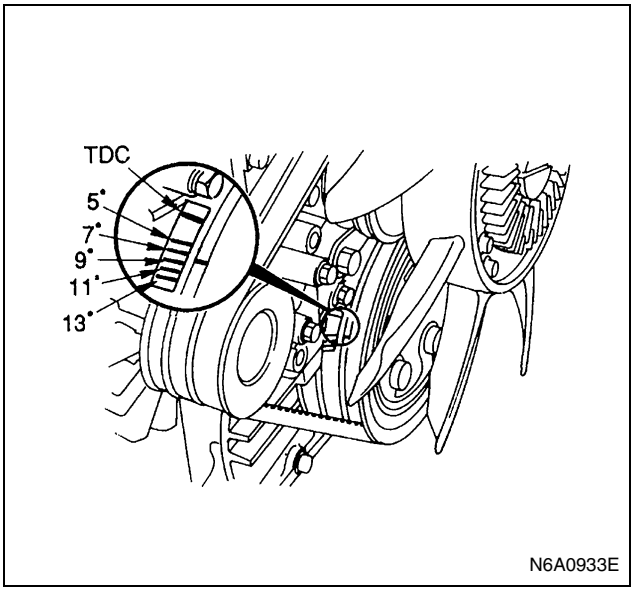
INJECTION TIMING ADJUSTMENT

Injection Pump Notched Line Inspection

1. Check the injection pump bracket nuts (1) for looseness.
   Tighten as required.
2. Check that the notched lines (2) on the injection pump bracket and the timing gear case are aligned.
   If the notched lines are not aligned, the injection timing must be checked.



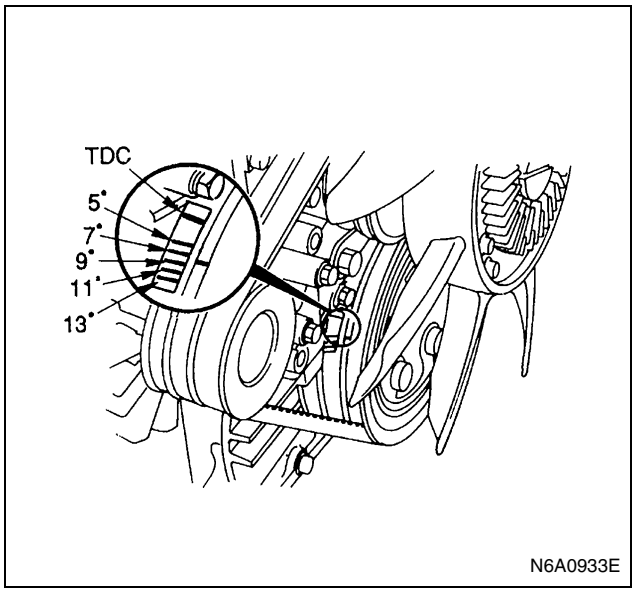
3. Same time, check injection timing on the crank damper pulley. If the injection timing aligned with incorrect, the injection timing must be readjusted.



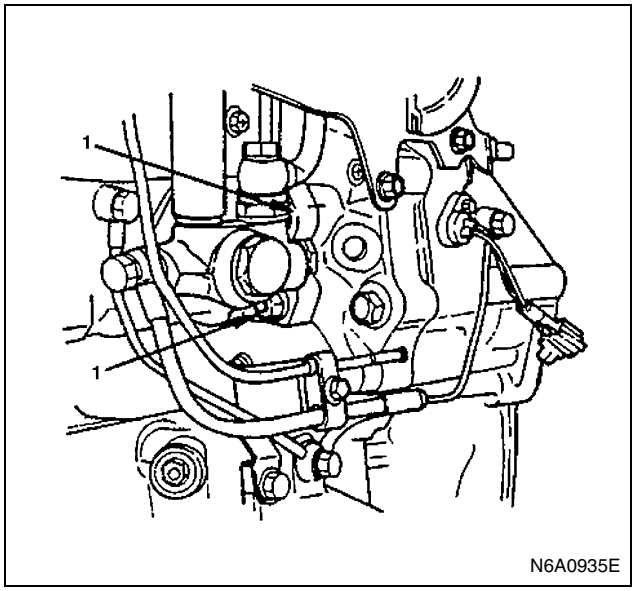
Injection Timing Adjustment (Except 4HF1-2 model)

1. Turn the crankshaft until the timing mark on the crankshaft damper pulley is aligned with the injection timing of each engine mode mark in the illustration.

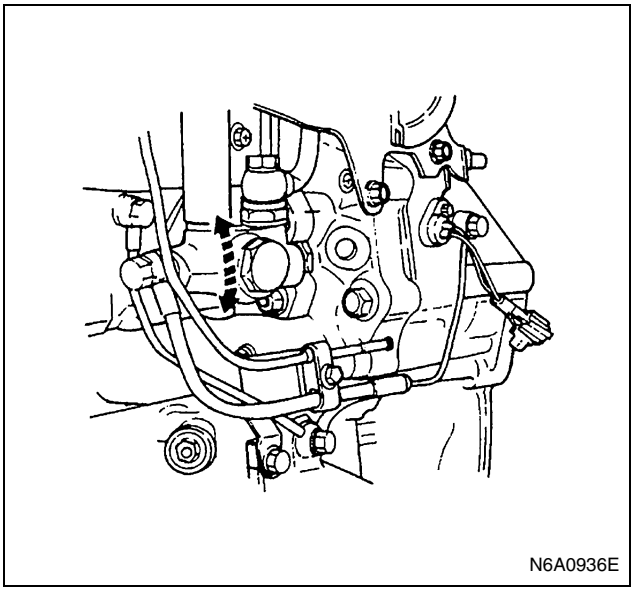
Injection Timing	deg
4HF1 4HE1-TC (4HE1-XS)	BTDC 8
4HG1	BTDC 9
4HG1-T	BTDC 7 BTDC 9 (For Colombia)
4HE1-TC (4HE1-XS)	BTDC 9 (Spec EURO3)



2. Remove the two foam rubbers.
3. Loosen the four injection pump fixing nuts (1). This will allow the pump to pivot.
   Do not bend or scratch the fuel pipe.



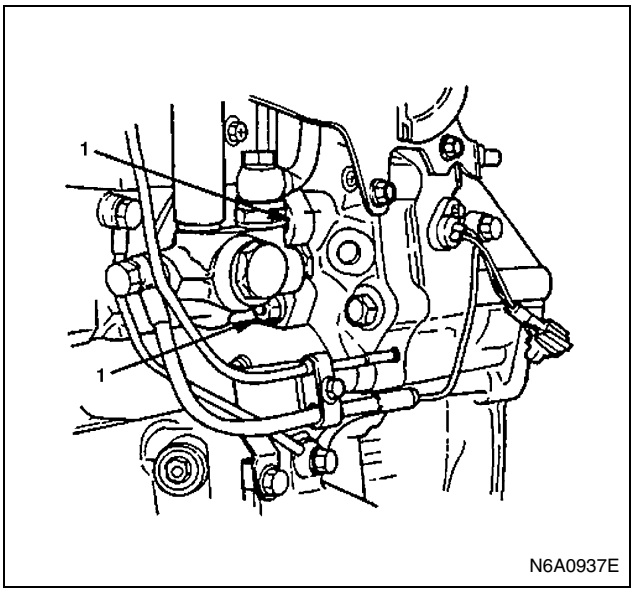
4. Align the notched line between the injection pump bracket and the timing gear case.
   Make sure that the timing mark on the crank damper pulley is aligned with correct injection timing.


N6A0936E

5. Tighten the injection pump fixing nuts (1) to the specified torque.

Tighten:
Injection pump fixing nut to 25 N·m (2.6 kg·m / 19 lb·ft)

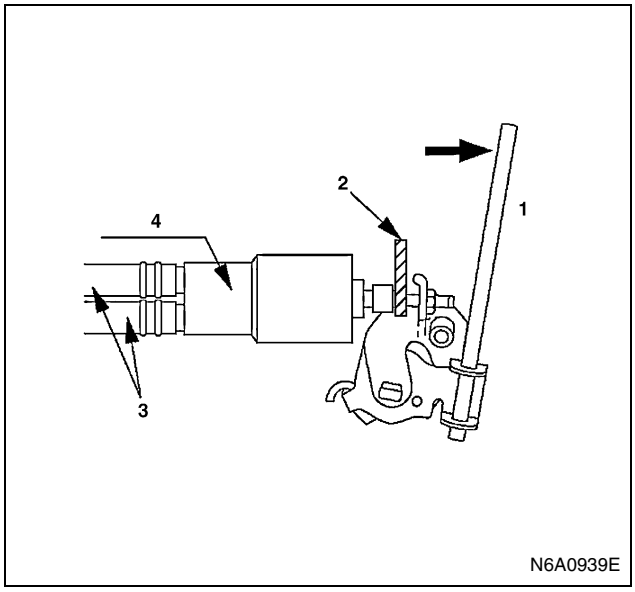
Notice:
If there are two marks on the crank pulley, the front side of mark is for setting BTDC 49° and the rear side of mark is for setting TDC.



N6A0937E

Injection Timing Check (4HF1-2 model only)

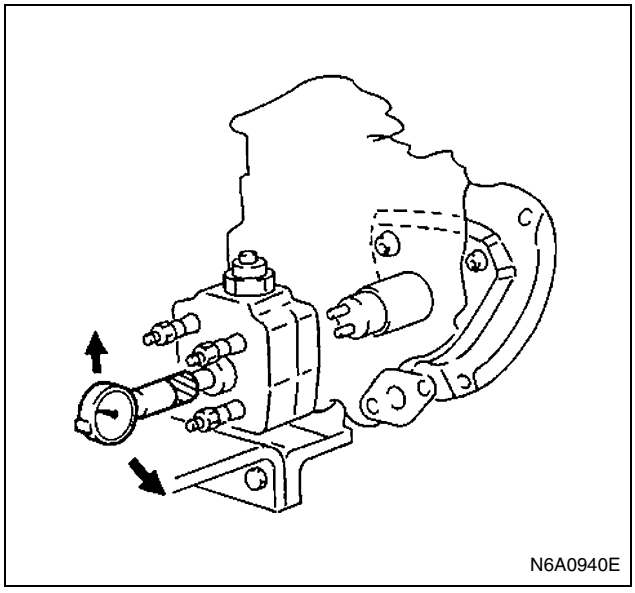
1. Set No. 1 Cylinder to the TDC in the compression stroke.
2. Disconnect Injection Pipe.
3. Put down Wax CSD lever, insert a spacer 10 — 12 mm (0.39 — 0.47 in) thick between the plunger and adjust bolt, and cancel the Wax CSD.



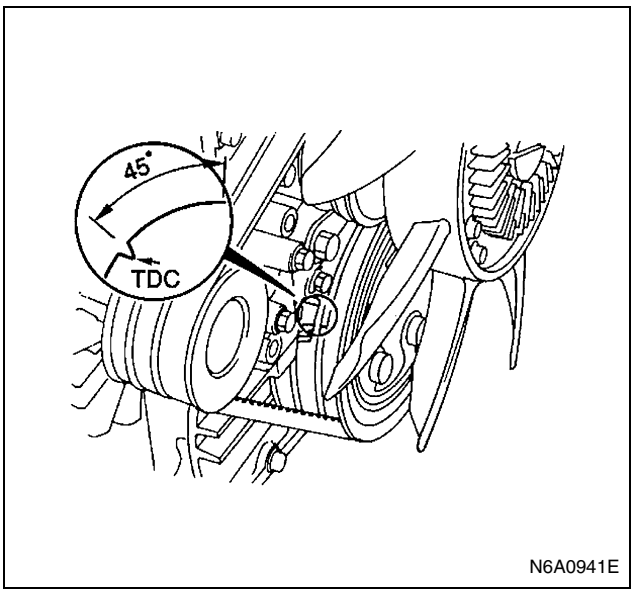
N6A0939E

Legend
1. Lever
2. Spacer
3. Water hose
4. Wax CSD

4. Remove the pump rear plug, connect a dial gage and set the lift at 1 mm (0.039 in).
   Special Tool
   Measuring device: 5-9940-0145-0


N6A0940E

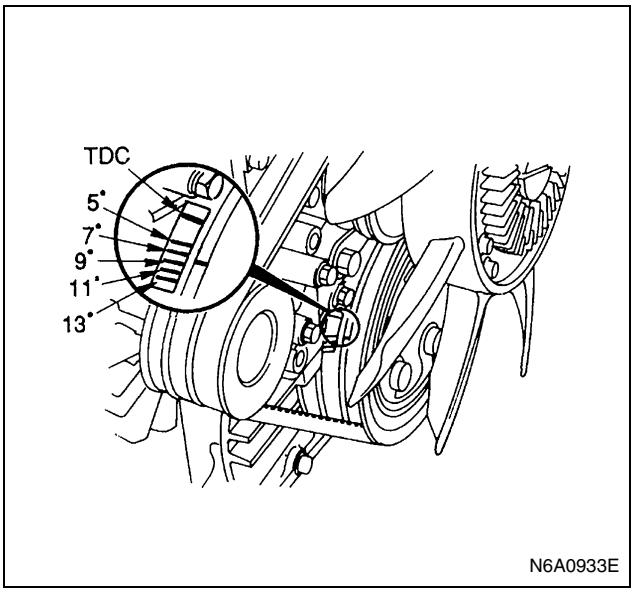
5. Set the crankshaft damper pulley TDC mark to the pointer or 45° before TDC.



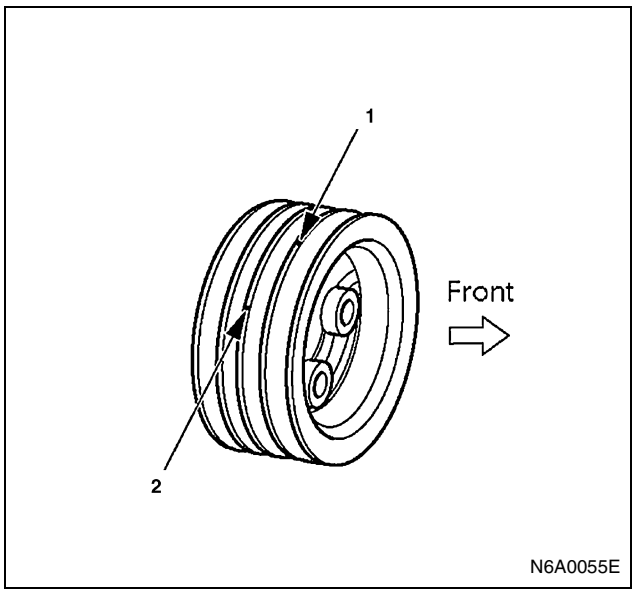
6. Set the dial gage to the “0” position.
7. Turn the crankshaft leftwise and rightwise a little and make sure that the needle stays in the “0” position.
8. Turn the crankshaft in the normal direction and read the measuring device’s indication at the 12° before TDC position.

Notice:
As there is no 12° mark, set midway between the 11° and 13° marks.

Standard value: 0.5 mm (0.0197 in)



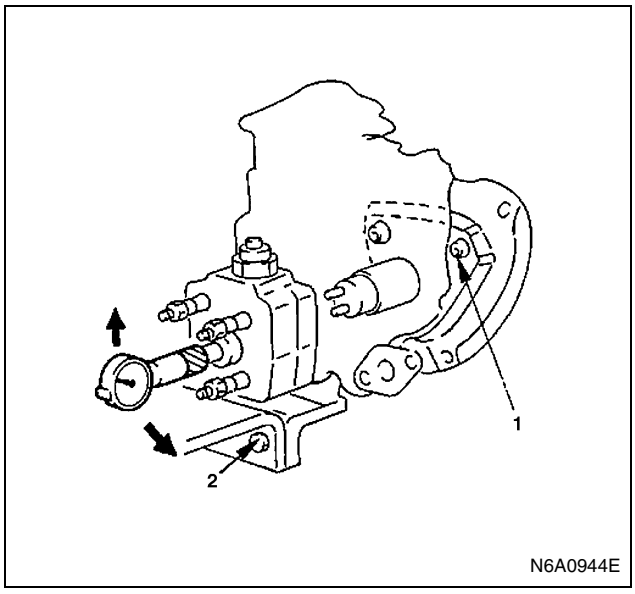
Notice:
In case the crank pulley has two marks as illustrated, (1) BTDC 49° mark on the second crest and (2) TDC mark on the third crest (as viewed from the front side), be sure to set at the mark (2). (If there are two different marks on one and same crest, set at the mark which comes second when rotated in the normal direction.) The mark (1) is used when installing the injection pump for 4HF1-2.



Injection Timing Adjustment (4HF1-2 model only)

If injection timing is out of the specified range, follow the following procedure for adjustment:

1. Loosen injection pump fixing nuts (1) and bracket bolt (2).



2. Adjust the mounting angle of injection pump:
   - If injection timing is too fast, bring the injection pump closer to the engine.
   - If injection timing is too slow, put the injection pump more distant from the engine.
3. When the dial gage has indicated the specified value, tighten the fixing nuts and bolt to specified torque.

Tighten:
- Nut to 24 N·m (2.4 kg·m / 17 lb·ft)
- Bolt to 48 N·m (4.9 kg·m / 35 lb·ft)

4. Disconnect the dial gage, install and tighten the plug to specified torque. (Make sure of a coper washer being attached to the plug)

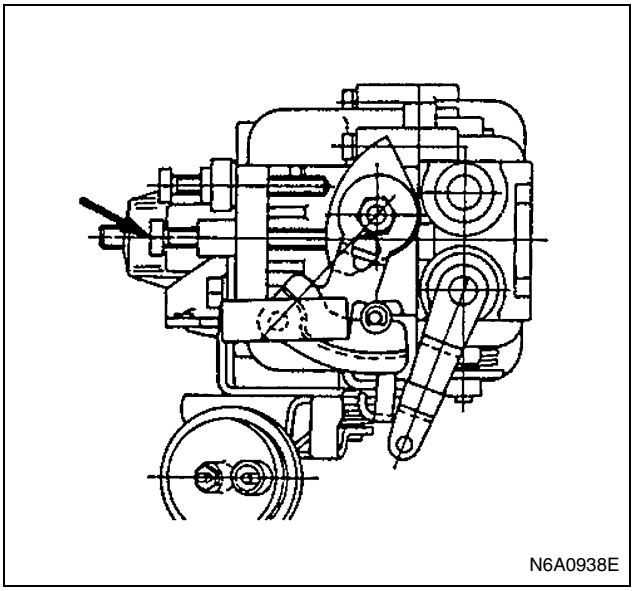
Tighten:
Plug to 17 N·m (1.7 kg·m / 12 lb·ft)

5. Release the wax CSD and connect the injection pipe.

Tighten:
Pipe sleeve nut to 29 N·m (3.0 kg·m / 22 lb·ft)

Idling Speed Adjustment (Except 4HF1-2 model)

1. Idling Rotation Check
   1) Idle the engine.
   2) Measure the number of the idling rotations with a tachometer.
   3) When the number of the idling rotations is outside the specified value, adjust it with the idling adjust bolt (arrow-marked).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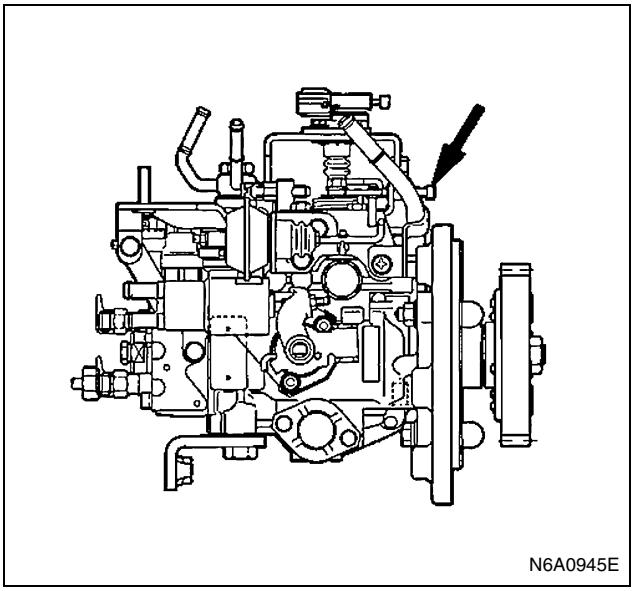
Number of idling rotations:
550 — 600 rpm
(4HE1-TC)
775 — 825 rpm

Idling Speed Check & Adjustment (4HF1-2 model only)

1. Warm up the engine.
2. Measure idling speed by means of tachometer.
3. If idling speed is out of the standard, adjust with an idling adjust bolt (indicated by arrow mark).
   Idling speed: 575 — 625 rpm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INJECTION PUMP DATA

Injection Volume Adjustment (4HF1 Engine)

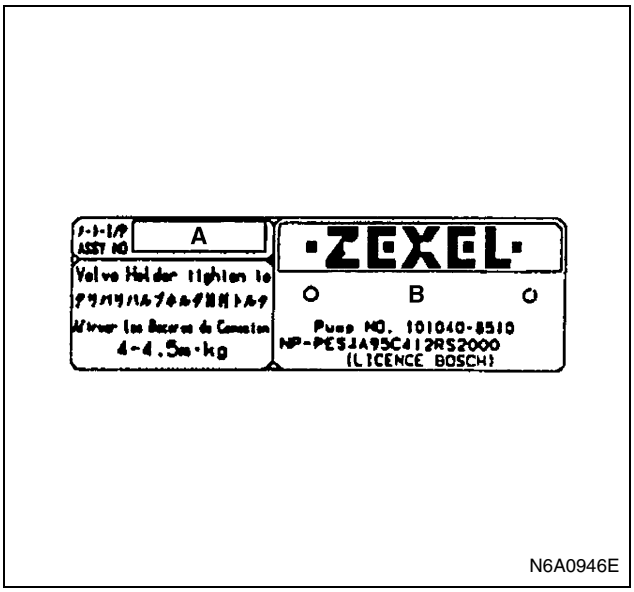
Test Conditions

4HF1 Engine

Item		Condition
Injection nozzle and holder assembly		Bosch AS Part No.: 105118-6051
Injection nozzle		Bosch AS Part No.: 105017-1860
Nozzle holder		Bosch AS Part No.: 105048-3673
Injection nozzle opening pressure	kPa (kg/cm^2 / psi)	18,142 (185 / 2,631)
Injection line dimensions		
Inside diameter	mm (in)	2.0 (0.079)
Outside diameter	mm (in)	6.0 (0.236)
Length	mm (in)	500 (19.7)
Fuel delivery pressure	kPa (kg/cm^2 / psi)	156.9 (1.6 / 22.75)
Test fuel		SAE Standard Test Diesel Fuel (SAE J967d) ISO Standard Test Diesel Fuel (ISO 4113)
Test fuel temperature	°C (°F)	40 — 45 (104 — 113)
Identification numbers		101401-7070 101401-7060 101401-7090 101401-7311

Identification Plate and Number

Use the data following the injection pump identification number to adjust the injection volume.



Legend

A. Isuzu part No. (Pump assembly No.)
B. Bosch pump assembly No.

Injection Volume and Governor Performance Diagram

Identification Numbers : 101401-7070/101401-7060

[4HF1 Engine]

Pre-stroke : No. 1 plunger 4.1±0.05 mm (0.1614±0.0020 in)

Injection order : 1 — 3 — 4 — 2 (interval 90°±30′) Plungers are numbered from the Governor side

Tappet clearance : Bolt adjustment type : More than 0.3 mm (0.0118 in) for all cylinders.

: Shim adjustment type : Manually rotate the camshaft 2 — 3 times and confirm that it rotates smoothly.

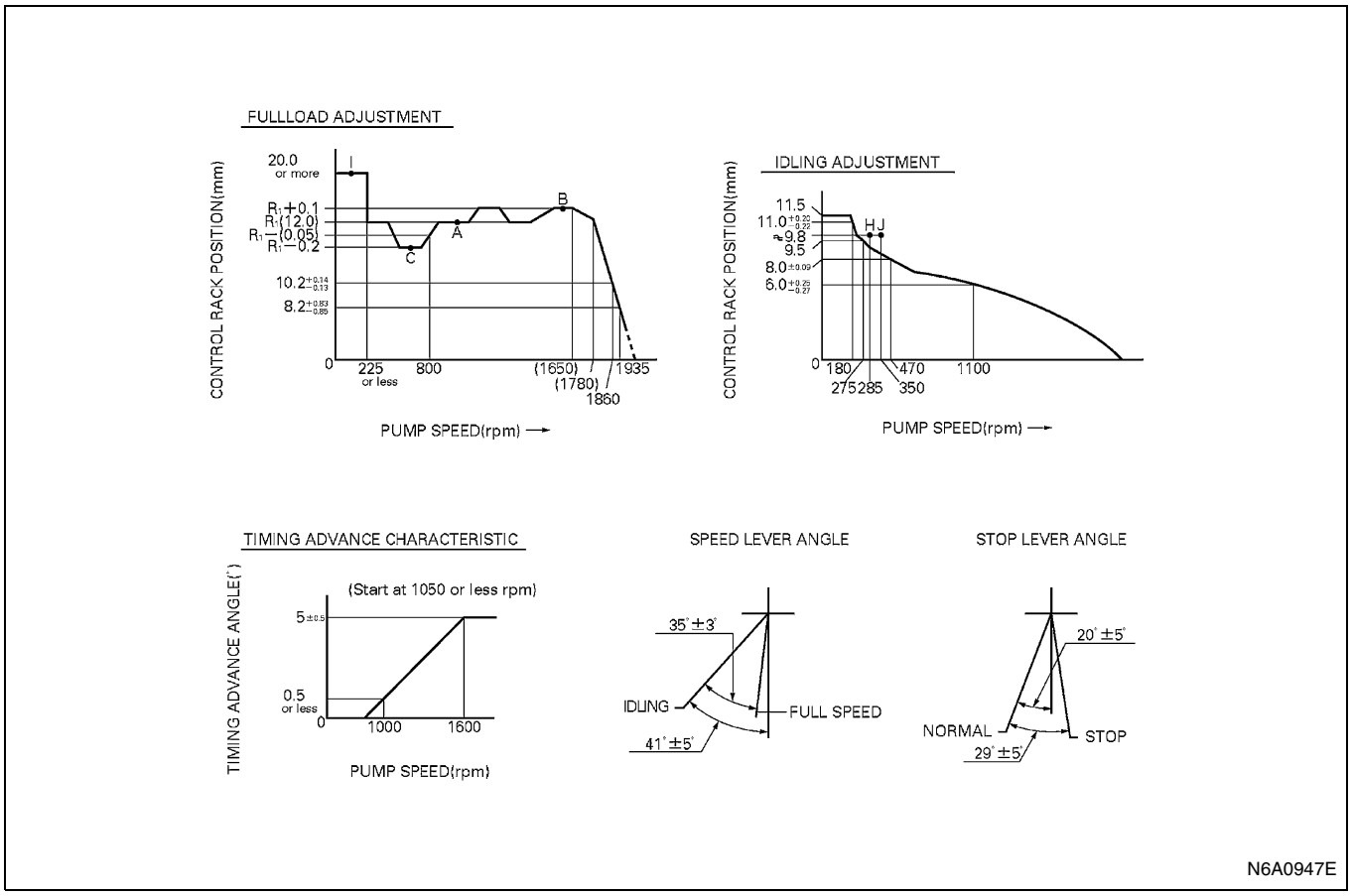
Injection Volume

Adjusting point	Pump speed (r.p.m.)	Injection volume (cc/ 1000 strokes)	Variance (%)	Remarks
	960	61±1.6	±4	Basic
H	285	16±1.3	±10.0	
A	960	61±1	—	Basic
B	1,600	(62)±2	—	
C	500	(60.5)±2	—	
I	150	$(82)^{+16}_{-0}$	—	

Timing Advance Specification

Pump Speed (r.p.m.)	1,050 or less	1,000	1,600 or more
Degree for Angle of Lead (deg.)	Start	0.5 or less	Finish 5±0.5

Governor Adjustment



N6A0947E

Injection Volume and Governor Performance Diagram

Identification Numbers : 101401-7090

[4HF1 Engine]

Pre-stroke : No. 1 plunger 4.1±0.05 mm (0.1614±0.0020 in)

Injection order : 1 — 3 — 4 — 2 (interval 90°±30′) Plungers are numbered from the Governor side

Tappet clearance : Bolt adjustment type : More than 0.3 mm (0.0118 in) for all cylinders.

: Shim adjustment type : Manually rotate the camshaft 2 — 3 times and confirm that it rotates smoothly.

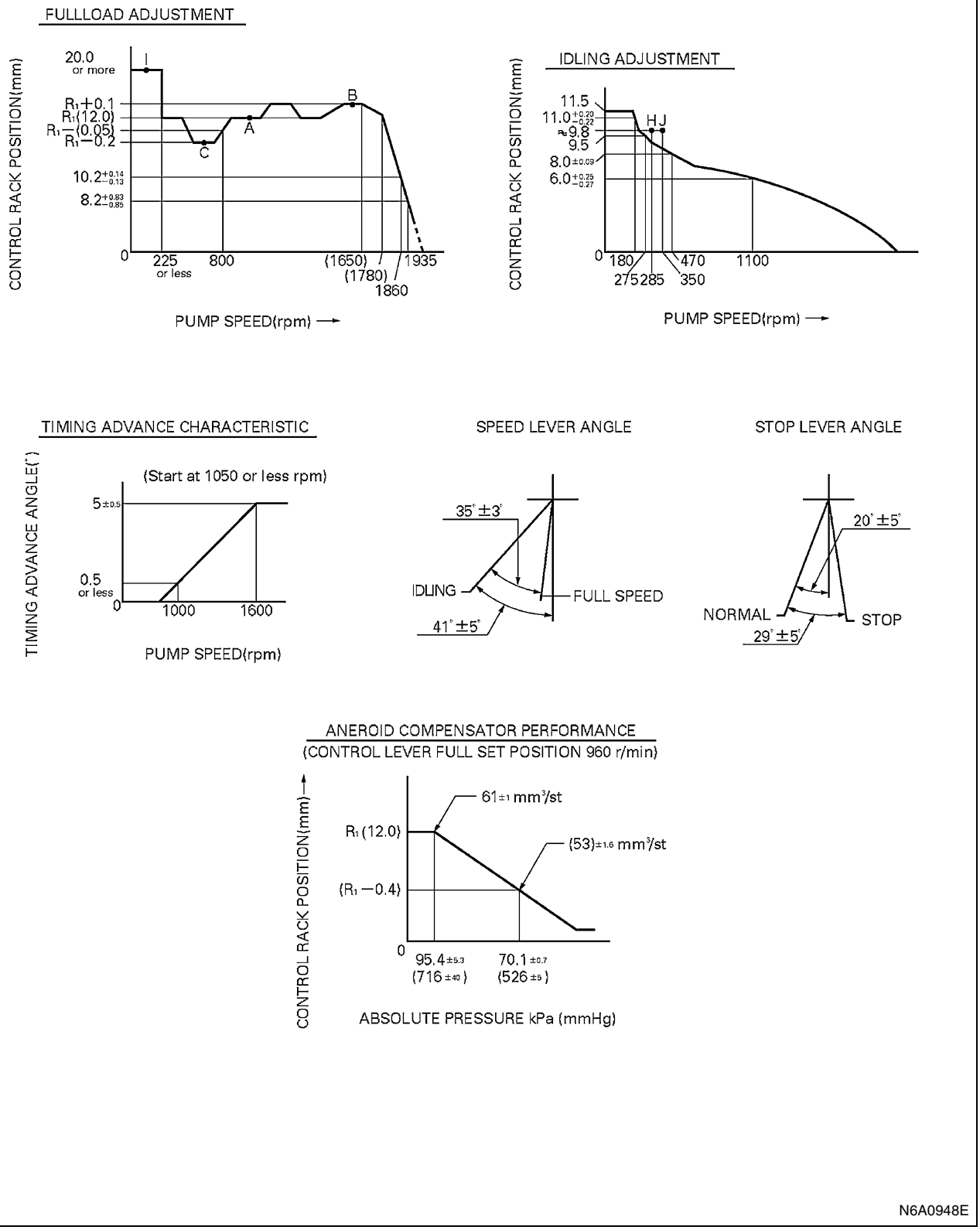
Injection Volume

Adjusting point	Pump speed (r.p.m.)	Injection volume (cc/ 1000 strokes)	Variance (%)	Remarks
	960	61±1.6	±4	Basic
H	285	16±1.3	±10.0	
A	960	61±1	—	Basic
B	1,600	(62)±2	—	
C	500	(60.5)±2	—	
I	150	$(82)^{+16}_{-0}$	—	

Timing Advance Specification

Pump Speed (r.p.m.)	1,050 or less	1,000	1,600 or more
Degree for Angle of Lead (deg.)	Start	0.5 or less	Finish 5±0.5

Governor Adjustment



N6A0948E

Injection Volume and Governor Performance Diagram

Identification Numbers : 101401-7311

[4HF1 Engine]

Pre-stroke : No. 1 plunger 4.1±0.05 mm (0.1614±0.0020 in)

Injection order : 1 — 3 — 4 — 2 (interval 90°±30′) Plungers are numbered from the Governor side

Tappet clearance : Bolt adjustment type : More than 0.3 mm (0.0118 in) for all cylinders.

: Shim adjustment type : Manually rotate the camshaft 2 — 3 times and confirm that it rotates smoothly.

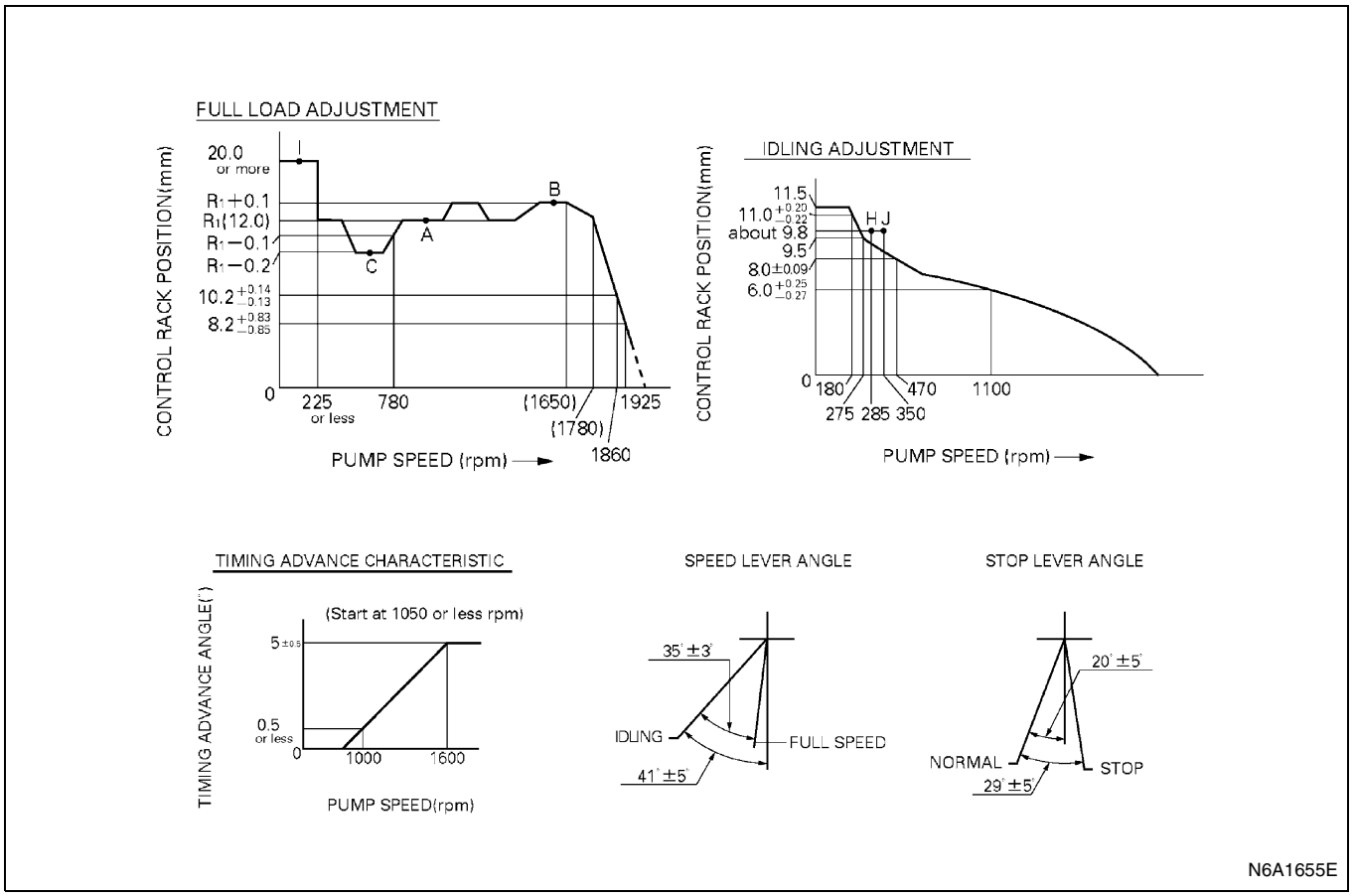
Injection Volume

Adjusting point	Pump speed (r.p.m.)	Injection volume (cc/ 1000 strokes)	Variance (%)	Remarks
	960	61±1.6	±4	Basic
H	285	16±1.3	±10.0	
A	960	65±1	—	Basic
B	1,600	(62)±2	—	
C	500	(63.5)±2	—	
I	150	$(82)^{+16}_{-0}$	—	

Timing Advance Specification

Pump Speed (r.p.m.)	1,000	1,600 or more
Degree for Angle of Lead (deg.)	0.5 or less	Finish 5±0.5

Governor Adjustment



Injection Volume Adjustment (4HF1-2 Engine)

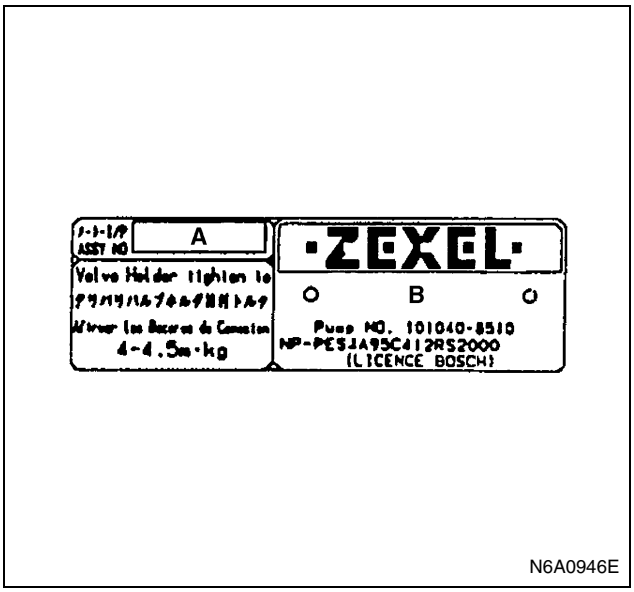
Test Conditions

4HF1-2 (Bosch distributor type)

Item		Condition
Injection nozzle and holder assembly		Bosch AS Part No.: 105118-4680
Injection nozzle		Bosch AS Part No.: 105017-2200
Nozzle holder		Bosch AS Part No.: 105048-3673
Injection nozzle opening pressure	kPa (kg/cm^2 / psi)	13,042 (133 / 1,891)
Injection line dimensions		
Inside diameter	mm (in)	2.0 (0.079)
Outside diameter	mm (in)	6.0 (0.236)
Length	mm (in)	450 (17.7)
Fuel delivery pressure	kPa (kg/cm^2 / psi)	19.6 (0.2 / 2.84)
Test fuel		SAE Standard Test Diesel Fuel (SAE J967d) ISO Standard Test Diesel Fuel (ISO 4113)
Test fuel temperature	°C (°F)	40 — 45 (104 — 113)
Identification numbers		101742-1630

Identification Plate and Number

Use the data following the injection pump identification number to adjust the injection volume.



N6A0946E

Legend

A. Isuzu part No. (Pump assembly No.)
B. Bosch pump assembly No.

Injection Volume and Governor Performance Diagram

Identification Numbers : 104742-1630

[4HF1-2 Engine]

Pre-stroke : No. 1 plunger 0.45±0.05 mm (0.0177±0.0020 in)

Injection order : 1 — 3 — 4 — 2 (interval 90°±30′) Plungers are numbered from the Governor side

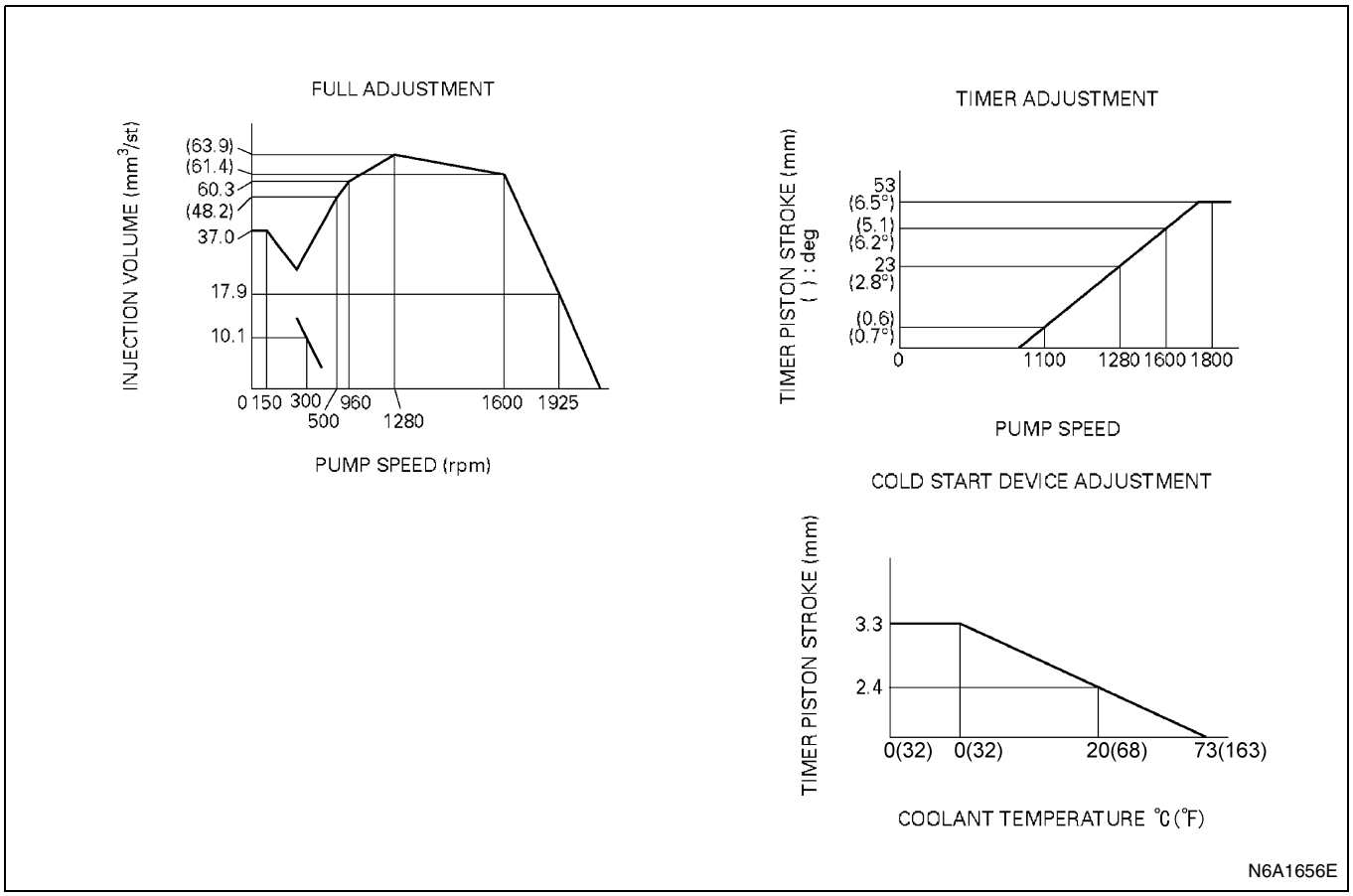
Injection volume

Pump speed (rpm)	Injection volume (mm^3/strokes)	Uneven amplitude (mm^3/strokes)	Oil temperature (°C (°F))	Remarks
500	48.2 ± 4.5	—	48±2 (118±36)	
960	60.3±1.0	5.0	50±2 (122±36)	Basic
1280	63.9±3.5	—	50±2 (122±36)	
1600	61.4±4.5	—	50±2 (122±36)	
1925	17.9±3.0	5.5	50±2 (122±36)	Basic
300	10.1±2.0	2.0	48±2 (118±36)	Basic
150	37.0±10	—	48±2 (118±36)	

Timing Advance Specification

Pump Speed (r.p.m.)	1,100	1,280	1,600	1,800
Degree for Angle of Lead (deg.)	0.7	2.8	6.2	Finish 6.5

Governor Adjustment (4HF1-2)



Injection Volume Adjustment (4HG1 Engine)

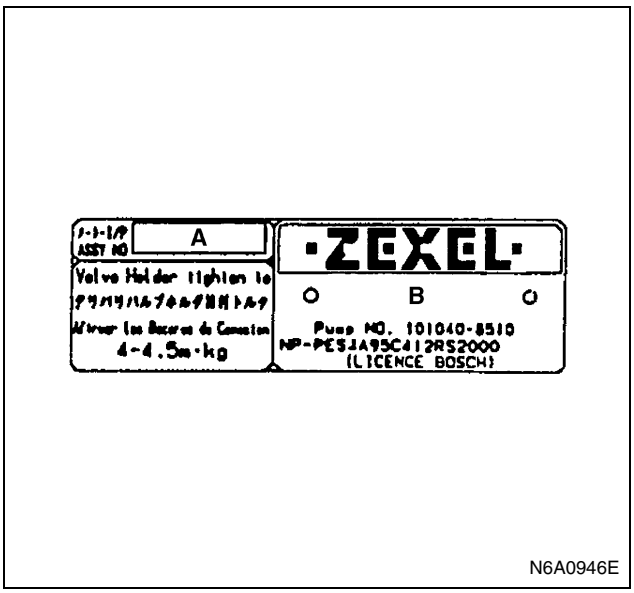
Test Conditions

4HG1 Engine

Item		Condition
Injection nozzle and holder assembly		Bosch AS Part No.: 105118-6041
Injection nozzle		Bosch AS Part No.: 105017-1850
Nozzle holder		Bosch AS Part No.: 105048-3673
Injection nozzle opening pressure	kPa (kg/cm^2 / psi)	18,142 (185 / 2,631)
Injection line dimensions		
Inside diameter	mm (in)	2.0 (0.079)
Outside diameter	mm (in)	6.0 (0.236)
Length	mm (in)	600 (23.6)
Fuel delivery pressure	kPa (kg/cm^2 / psi)	156.9 (1.6 / 22.75)
Test fuel		SAE Standard Test Diesel Fuel (SAE J967d) ISO Standard Test Diesel Fuel (ISO 4113)
Test fuel temperature	°C (°F)	40 — 45 (104 — 113)
Identification numbers		101401-7430 101401-7440

Identification Plate and Number

Use the data following the injection pump identification number to adjust the injection volume.



N6A0946E

Legend

A. Isuzu part No. (Pump assembly No.)
B. Bosch pump assembly No.

Injection Volume and Governor Performance Diagram

Identification Numbers : 101401-7430/101401-7440

[4HG1 Engine]

Pre-stroke : No. 1 plunger 4.1±0.05 mm (0.1614±0.0020 in)

Injection order : 1 — 3 — 4 — 2 (interval 90°±30′) Plungers are numbered from the Governor side

Tappet clearance : Bolt adjustment type : More than 0.3 mm (0.0118 in) for all cylinders.

: Shim adjustment type : Manually rotate the camshaft 2 — 3 times and confirm that it rotates smoothly.

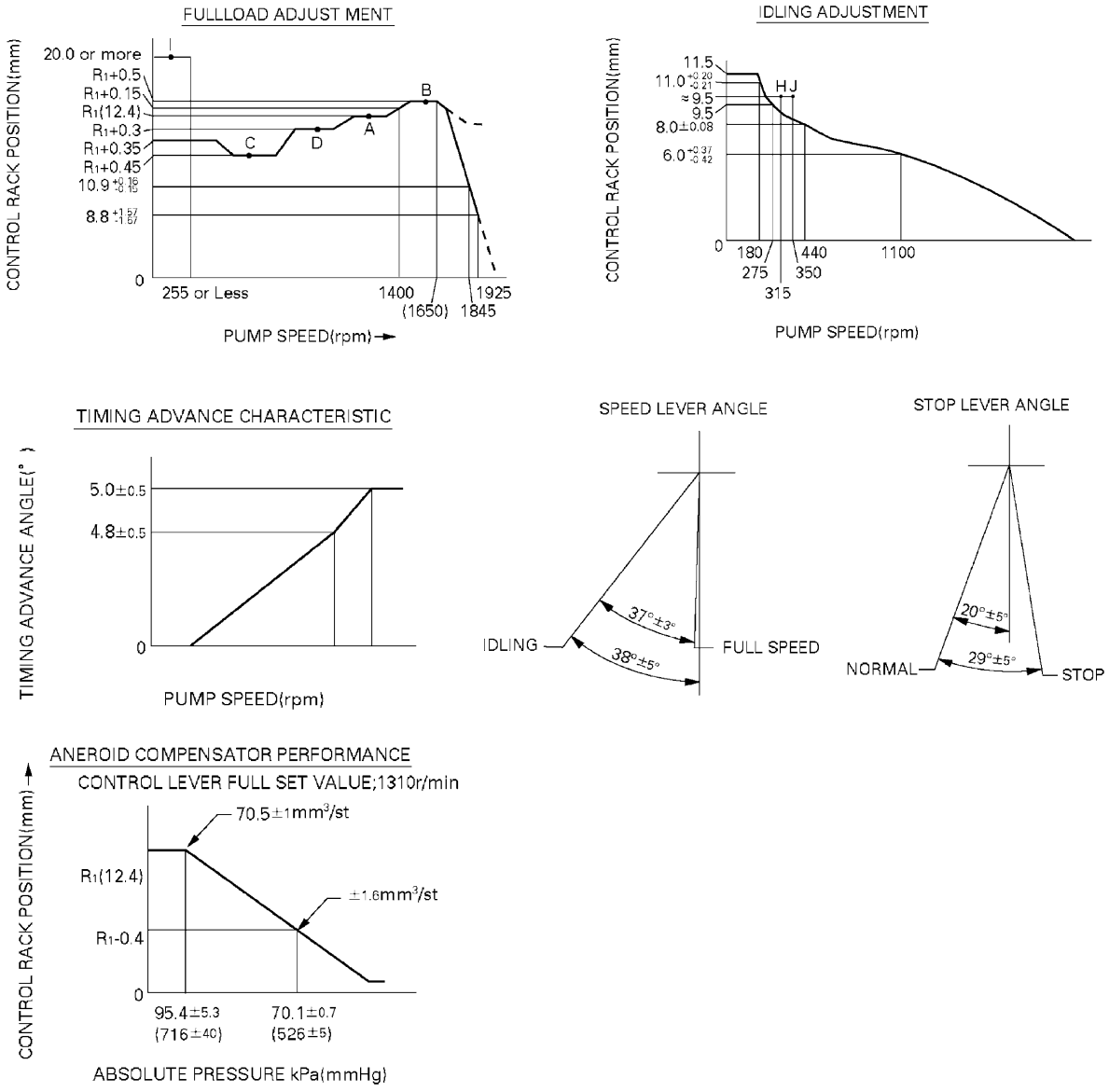
Injection Volume

Adjusting point	Pump speed (r.p.m.)	Injection volume (cc/ 1000 strokes)	Variance (%)	Remarks
	1,310	70.5±1.6	±4	Basic
H	315	10±1.3	±10.0	
A	1,310	70.5±1	—	Basic
B	1,600	(75.5)±2	—	
C	520	(64)±2	—	
D	960	$(70.5)^{+2}_{-0}$	—	
I	150	$(95)^{+16}_{-0}$	—	

Timing Advance Specification

Pump Speed (r.p.m.)	1,050 or less	1,000	1,600 or more
Degree for Angle of Lead (deg.)	Start	0.5 or less	Finish 5±0.5

Governor Adjustment



N6A1657E

Injection Volume Adjustment (4HG1-T Engine)

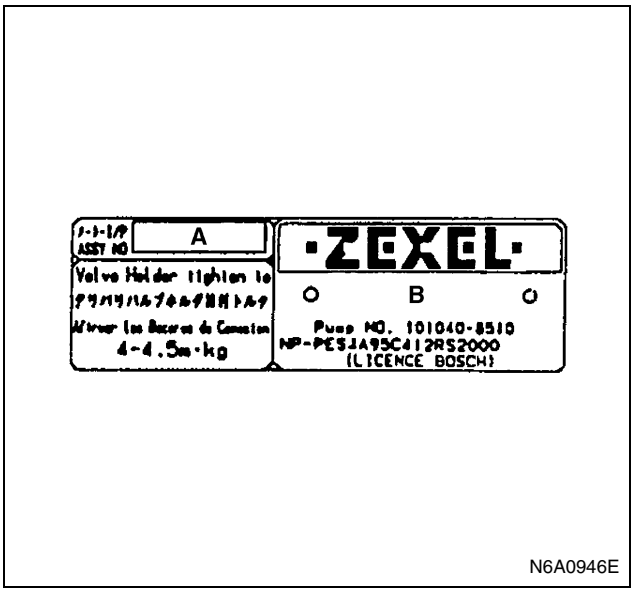
Test Conditions

4HG1-T Engine

Item		Condition
Injection nozzle and holder assembly		Bosch AS Part No.: 105118-7542
Injection nozzle		Bosch AS Part No.: 105019-1470
Nozzle holder		Bosch AS Part No.: 105048-3832
Injection nozzle opening pressure	kPa (kg/cm^2 / psi)	18,044 (184 / 2,616)
Injection line dimensions		
Inside diameter	mm (in)	2.2 (0.079)
Outside diameter	mm (in)	6.0 (0.236)
Length	mm (in)	600 (23.6)
Fuel delivery pressure	kPa (kg/cm^2 / psi)	254.9 (2.6 / 36.97)
Test fuel		SAE Standard Test Diesel Fuel (SAE J967d) ISO Standard Test Diesel Fuel (ISO 4113)
Test fuel temperature	°C (°F)	40 — 45 (104 — 113)
Identification numbers		101401-7452

Identification Plate and Number

Use the data following the injection pump identification number to adjust the injection volume.



Legend

A. Isuzu part No. (Pump assembly No.)
B. Bosch pump assembly No.

Injection Volume and Governor Performance Diagram

Identification Numbers : 101401-7452

[4HG1-T Engine]

Pre-stroke : No. 1 plunger 3.8±0.05 mm (0.1496±0.0020 in)

Injection order : 1 — 3 — 4 — 2 (interval 90°±30′) Plungers are numbered from the Governor side

Tappet clearance : Shim adjustment type : Manually rotate the camshaft 2 — 3 times and confirm that it rotates smoothly.

: Bolt adjustment type : More than 0.3 mm (0.0118 in) for all cylinders.

Injection Volume

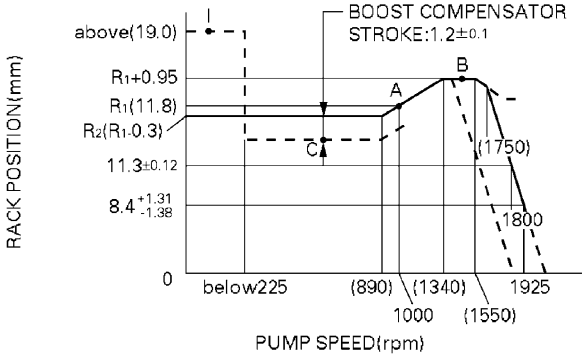
Adjusting point	Rack Position (mm (in))	Pump Speed (rpm)	Injection q'ty (cm^3/ 1000strokes)	Max var bet. cyl. (%)	Fixed	Remarks
	11.5 (0.4528)	1000	73.5±1.6	±4	Rack	Basic
H	Approx. 8.9 (0.3504)	315	(Measure)±1.3	±10	Rack	
A	R1 (11.5 (0.4528))	1000	73.5±1	—	Lever	Basic Boost press. kPa (mmHg/ psi) Above 62.0 (465/8.99)
B	R1 +1.0 (0.0394)	1500	(78.5)±2	—	Lever	Lever Boost press. kPa (mmHg/ psi) Above 62.0 (465/8.99)
C	R2 -0.8 (0.0315)	500	(66.5)±2	—	Lever	Boost press. 0
I	—	150	(Measure)±16	—	Lever	Boost press. 0 Confirm that the timing of is advanced 1°±30′ from A.

Timing Advance Specification

Pump speed (rpm)	Below (N1 + 50)	N1	N3
Advance angle (°)	Start	Below 0.5	Finish 4.0±0.5

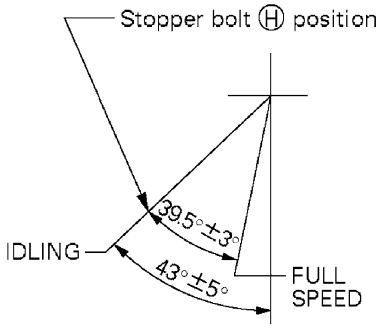
Governor Adjustment (4HG1-T)

FULL LOAD ADJUSTMENT

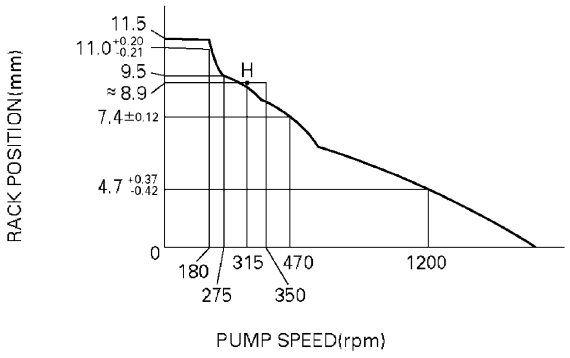


Confirm that Vist=2.97±0.28 at N=1500, R=R+0.95
at rack sensor voltage 5±0.01 V.

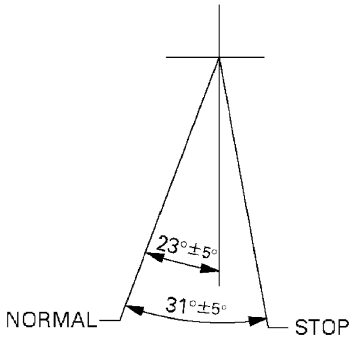
SPEED LEVER ANGLE



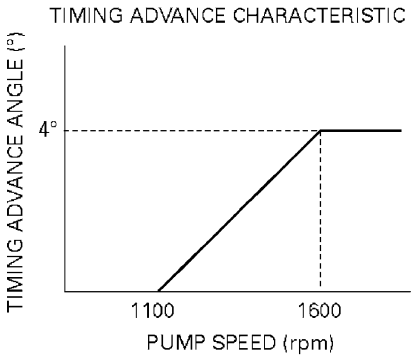
IDLING ADJUSTMENT



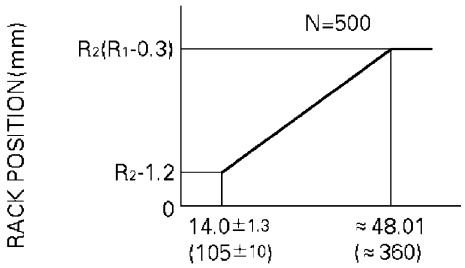
STOP LEVER ANGLE



TIMING ADVANCE CHARACTERISTIC



BOOST COMPENSATOR ADJUSTMENT



N6A0955E

Injection Volume Adjustment (4HE1-TC Engine)

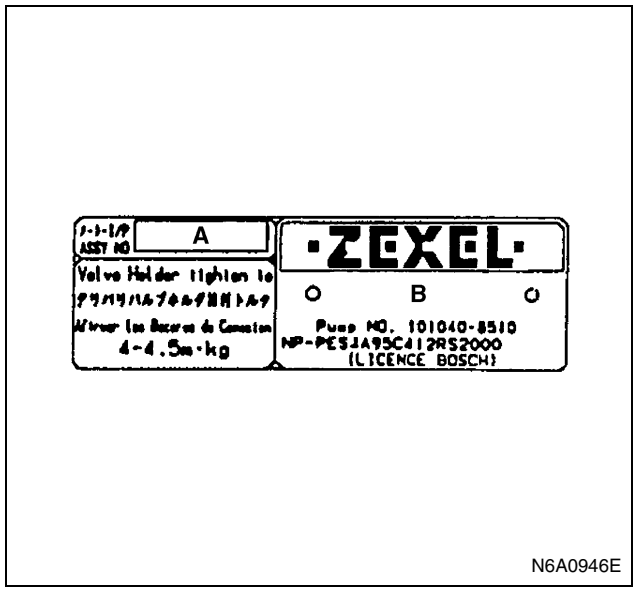
Test Conditions

4HE1-TC Engine

Item		Condition
Injection nozzle and holder assembly		Bosch AS Part No.: 105118-6462
Injection nozzle		Bosch AS Part No.: 105017-2181
Nozzle holder		Bosch AS Part No.: 105048-4510
Injection nozzle opening pressure	kPa (kg/cm^2 / psi)	18,142 (185 / 2,631)
Injection line dimensions		
Inside diameter	mm (in)	3.0 (0.118)
Outside diameter	mm (in)	8.0 (0.315)
Length	mm (in)	600 (23.6)
Fuel delivery pressure	kPa (kg/cm^2 / psi)	254.9 (2.6 / 36.97)
Test fuel		SAE Standard Test Diesel Fuel (SAE J967d) ISO Standard Test Diesel Fuel (ISO 4113)
Test fuel temperature	°C (°F)	40 — 45 (104 — 113)
Identification numbers		107492-1023 107492-1062 107492-1032 107492-1100 107492-1110 107492-1120 107492-1130 897212-9351 (ISUZU NO.)

Identification Plate and Number

Use the data following the injection pump identification number to adjust the injection volume.



Legend

A. Isuzu part No. (Pump assembly No.)
B. Bosch pump assembly No.

Injection Volume and Governor Performance Diagram

Identification Numbers : 107492-1110

[4HE1-TC Engine]

Pre-stroke : No. 1 plunger 4.0±0.03 mm (0.1575±0.0012 in)

Injection order : 1 — 3 — 4 — 2 (interval 90°±15′) Plungers are numbered from the Governor side

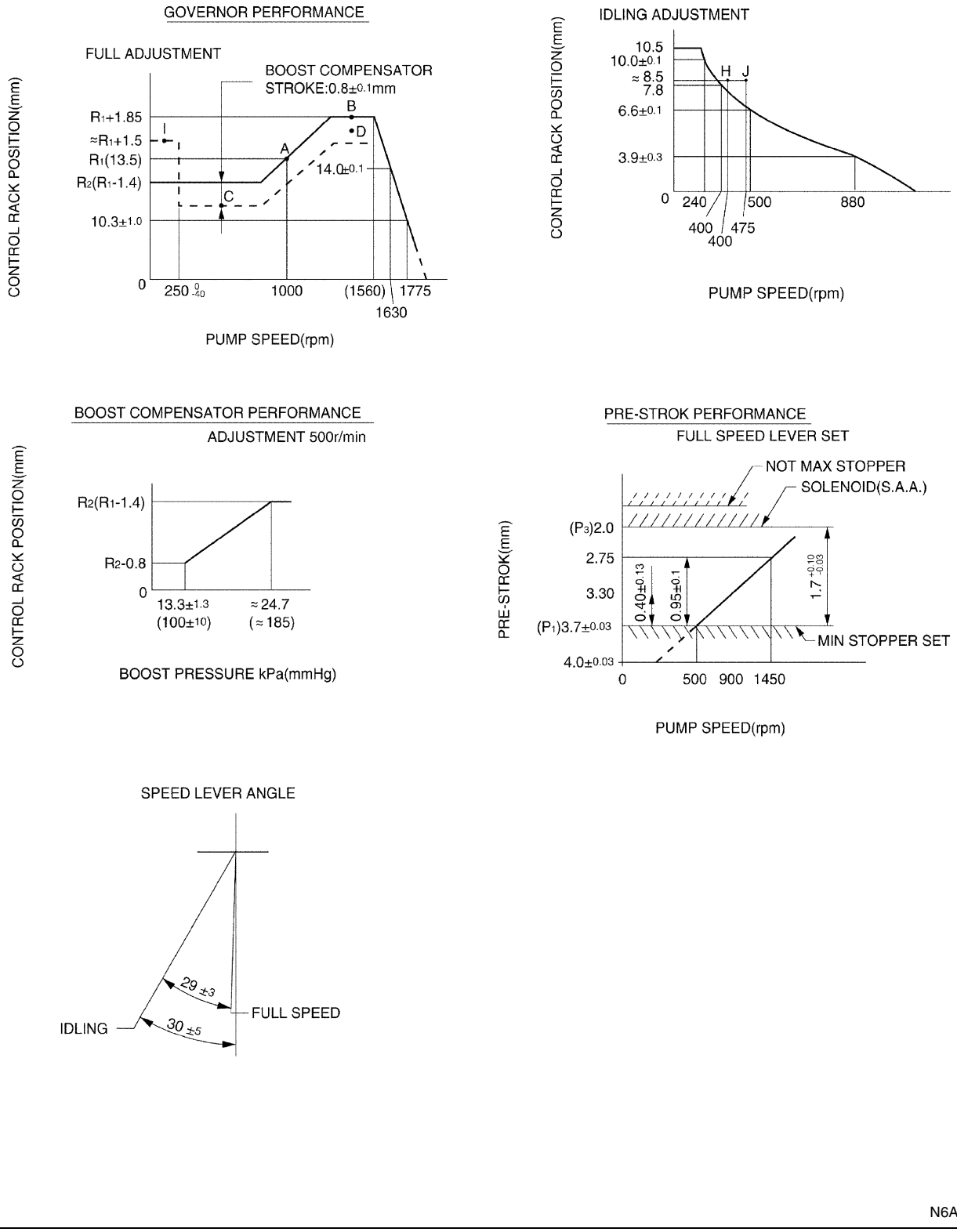
Tappet clearance : Bolt adjustment type : More than 0.3 mm (0.0118 in) for all cylinders.

: Shim adjustment type : Manually rotate the camshaft 2 — 3 times and confirm that it rotates smoothly.

Injection Volume

Adjusting point	Pump speed (r.p.m.)	Injection volume (cc/ 1000 strokes)	Variance (%)	Remarks
	1,000	82.5±1.6	±4	Basic
H	400	19±1.5	±14	
Z	500	—	—	
A	1,000	82.5±1	—	Basic
B	1,450	92.5±2	—	
C	500	67	—	
D	1,450	89.5	—	
I	150	220	—	

Governor Adjustment



Injection Volume and Governor Performance Diagram

Identification Numbers : 107492-1023 / 107492-1100

[4HE1-TC Engine]

Pre-stroke : No. 1 plunger 4.0±0.03 mm (0.1575±0.0012 in)

Injection order : 1 — 3 — 4 — 2 (interval 90°±15′) Plungers are numbered from the Governor side

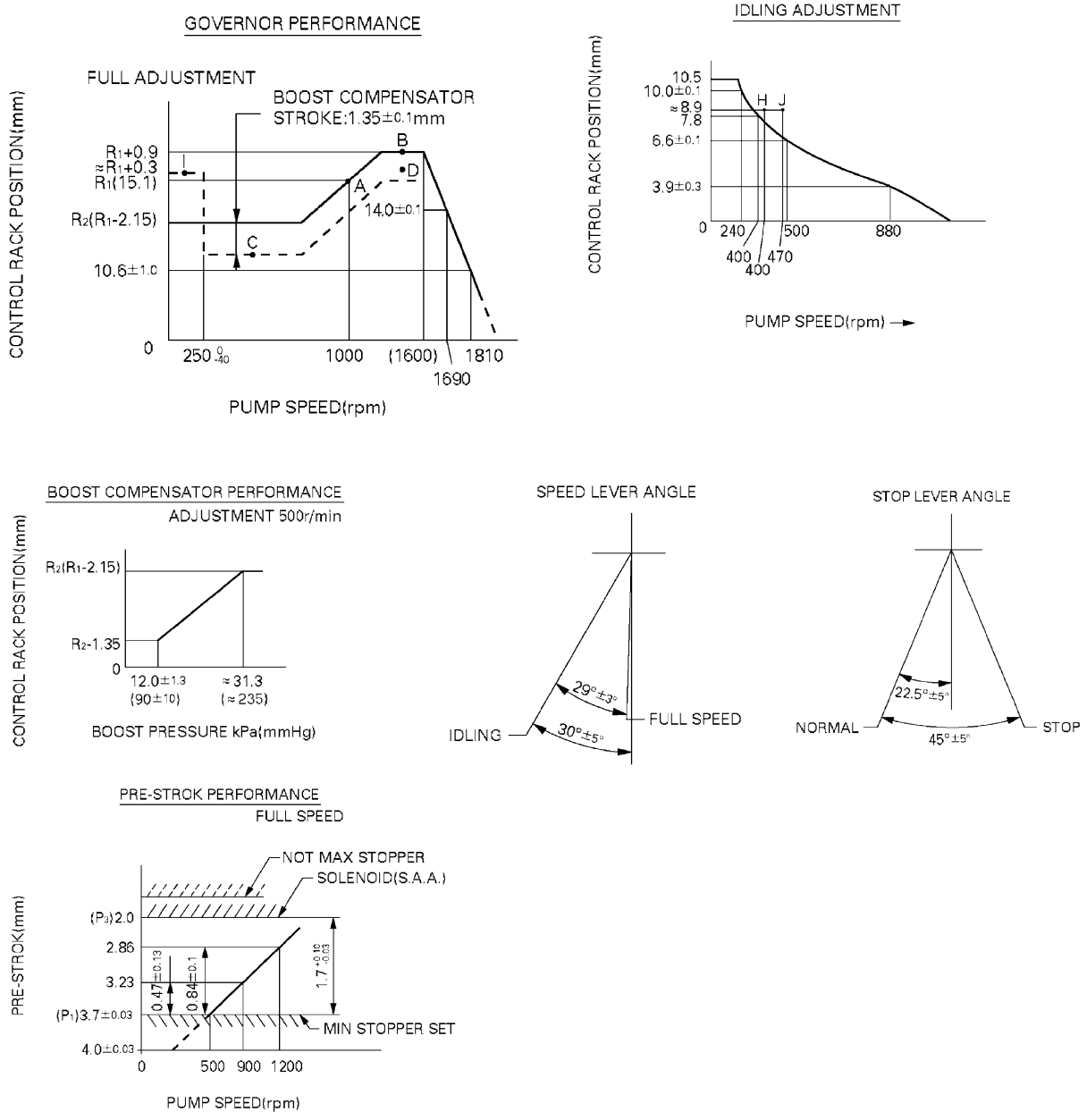
Tappet clearance : Bolt adjustment type : More than 0.3 mm (0.0118 in) for all cylinders.

: Shim adjustment type : Manually rotate the camshaft 2 — 3 times and confirm that it rotates smoothly.

Injection Volume

Adjusting point	Pump speed (r.p.m.)	Injection volume (cc/ 1000 strokes)	Variance (%)	Remarks
	1,000	107.5±1.6	±4	Basic
H	400	22±1.5	±10.0	
Z	510	—	—	Basic
A	1,000	107.5±1	—	
B	1,200	112.5±2	—	
C	500	(78)	—	
D	1,200	(103)	—	
I	150	(235)	—	

Governor Adjustment



N6A1659E

Injection Volume and Governor Performance Diagram

Identification Numbers : 107492-1062 / 107492-1120 / 897212-9350 (ISUZU NO.)

[4HE1-TC Engine]

Pre-stroke : No. 1 plunger 4.0±0.03 mm (0.1575±0.0012 in)

Injection order : 1 — 3 — 4 — 2 (interval 90°±15′) Plungers are numbered from the Governor side

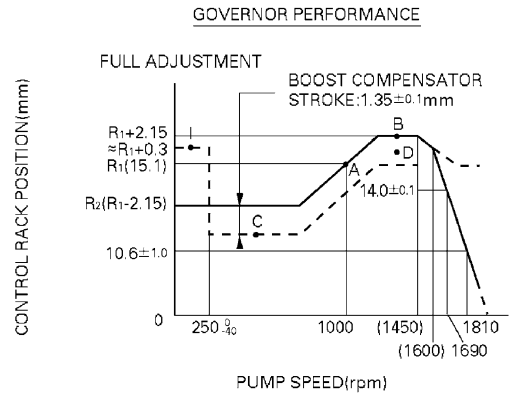
Tappet clearance : Bolt adjustment type : More than 0.3 mm (0.0118 in) for all cylinders.

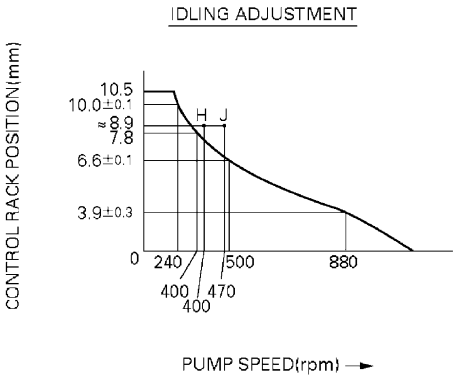
: Shim adjustment type : Manually rotate the camshaft 2 — 3 times and confirm that it rotates smoothly.

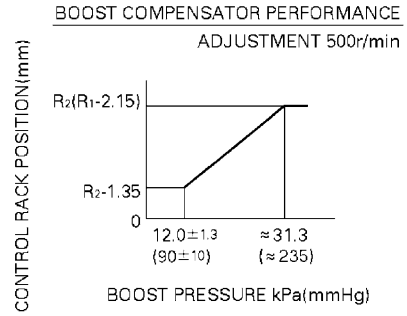
Injection Volume

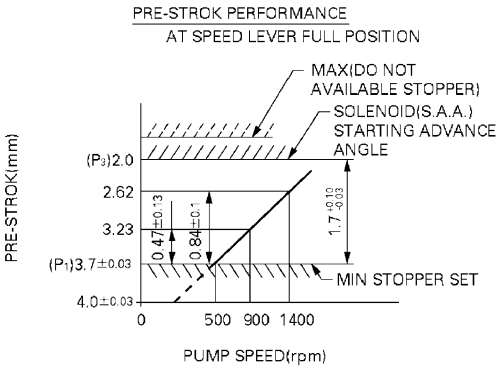
Adjusting point	Pump speed (r.p.m.)	Injection volume (cc/ 1000 strokes)	Variance (%)	Remarks
	1,000	107.5±1.6	±4	Basic
H	400	22±1.5	±14	
Z	510	—	—	Basic
A	1,000	107.5±1	—	
B	1,400	121.5±2	—	
C	500	78	—	
D	1,400	103	—	
I	150	235	—	

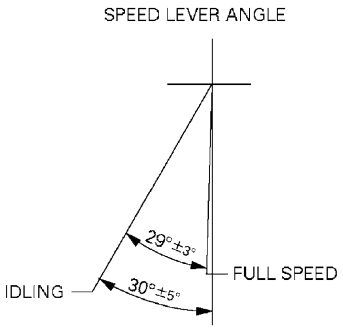
Governor Adjustment











N6A0959E

Injection Volume and Governor Performance Diagram

Identification Numbers : 10749-1032 / 107492-1130

[4HE1-TC Engine]

Pre-stroke : No. 1 plunger 4.0±0.03 mm (0.1575±0.0012 in)

Injection order : 1 — 3 — 4 — 2 (interval 90°±15′) Plungers are numbered from the Governor side

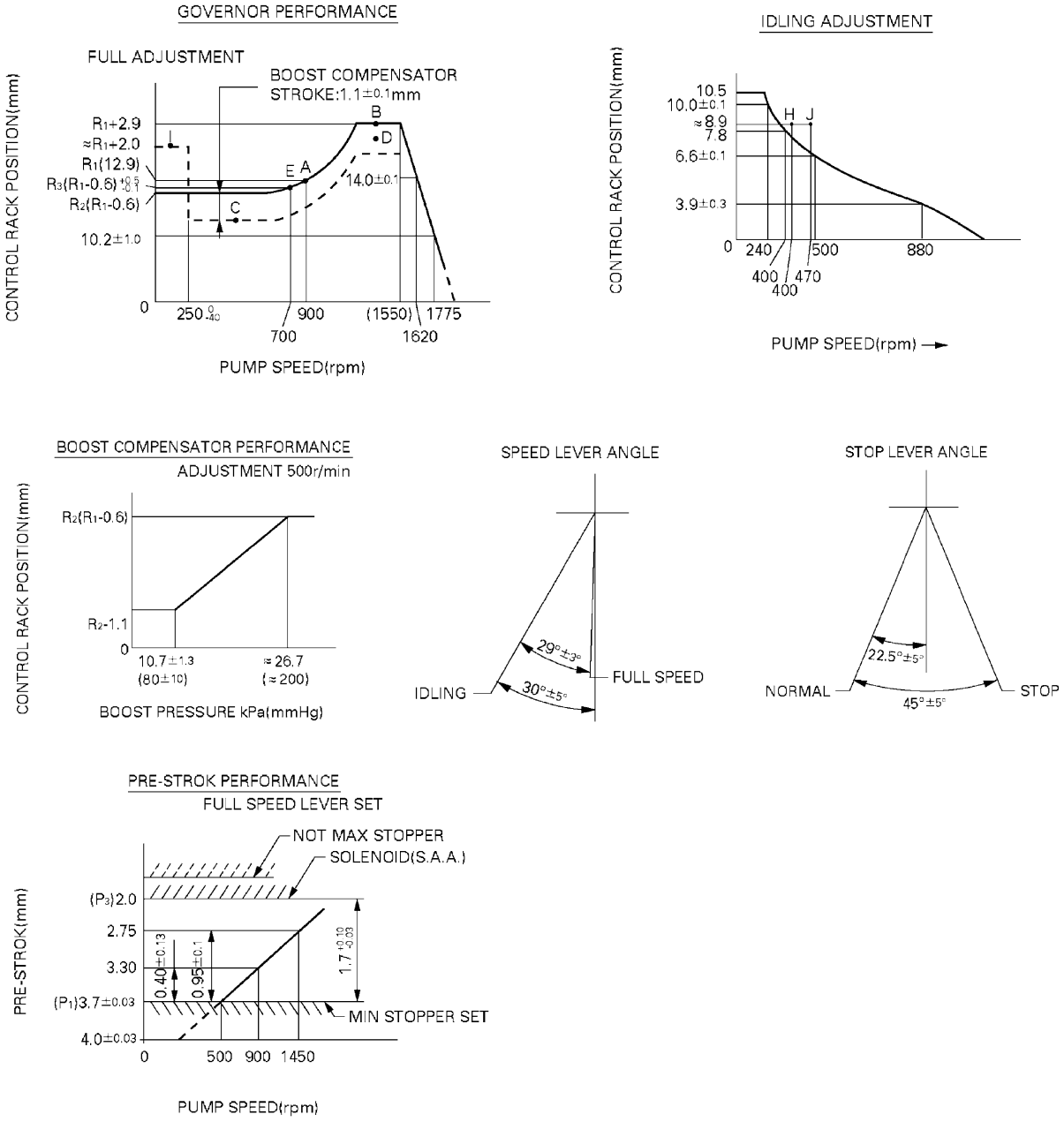
Tappet clearance : Bolt adjustment type : More than 0.3 mm (0.0118 in) for all cylinders.

: Shim adjustment type : Manually rotate the camshaft 2 — 3 times and confirm that it rotates smoothly.

Injection Volume

Adjusting point	Pump speed (r.p.m.)	Injection volume (cc/ 1000 strokes)	Variance (%)	Remarks
	900	78±1.6	±4	Basic
H	400	19±1.5	±14	
Z	500	—	—	Basic
A	900	78±1	—	
B	1,450	89.5±2	—	
C	500	67.5	—	
D	1,450	91.5	—	
E	700	78	—	
I	150	220	—	

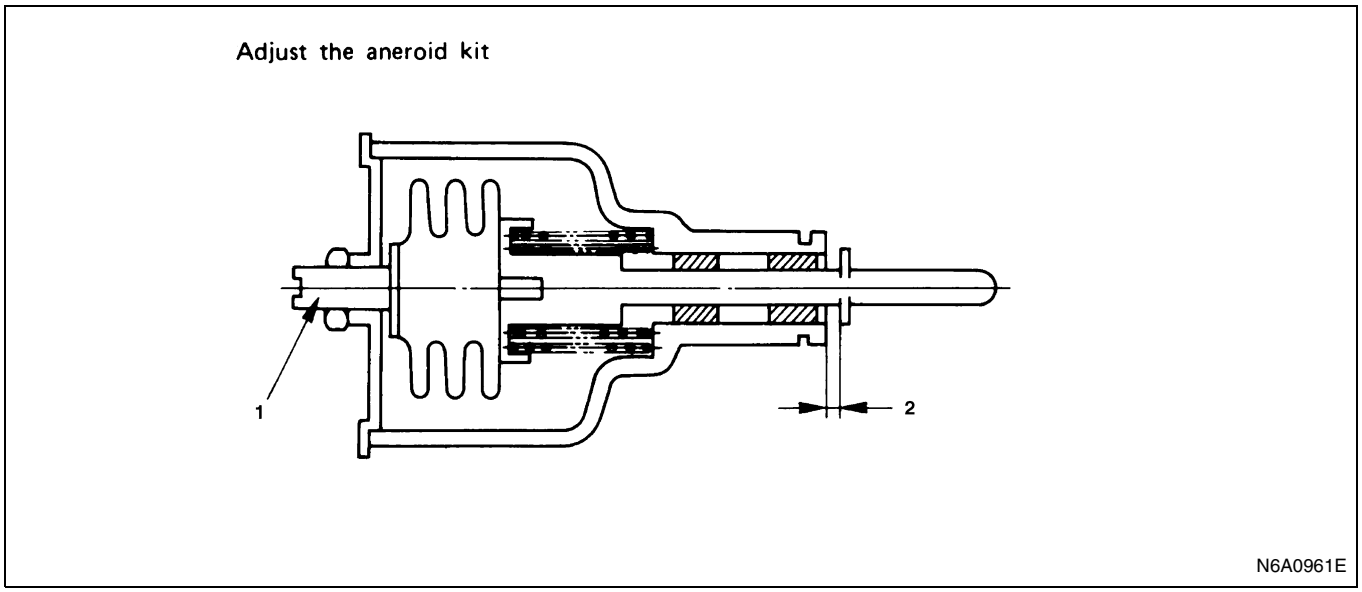
Governor Adjustment



N6A0960E

ANEROID COMPENSATOR ADJUSTMENT

Component



Legend

1. Setting screw
2. Between 1.4 — 1.7 mm (0.055 — 0.067 in) at sea level (adjust by setting screw)

INJECTION VOLUME ADJUSTMENT

4HE1-TC (4HE1-XS) Engine for EURO3

Test Condition

Item		Condition
Injection nozzle and holder assembly		Bosch AS Part No.: 105118-6831
Injection nozzle		Bosch AS Part No.: 105017-2930
Nozzle holder		Bosch AS Part No.: 105048-4430
Injection nozzle opening pressure	MPa (kg/cm^2 / psi)	20.7 (211 / 3,000)
Injection line dimensions		
Inside diameter	mm (in)	3.0 (0.118)
Outside diameter	mm (in)	8.0 (0.315)
Length	mm (in)	600 (23.6)
Fuel delivery pressure	kPa (kg/cm^2 / psi)	254.9 (2.6 / 36.97)
Test fuel		SAE Standard Test Diesel Fuel (SAE J967d) ISO Standard Test Diesel Fuel (ISO 4113)
Test fuel temperature	°C (°F)	40 — 45 (104 — 113)
Identification numbers		107492-1162 897225-4322 (ISUZU No.)

Injection Timing

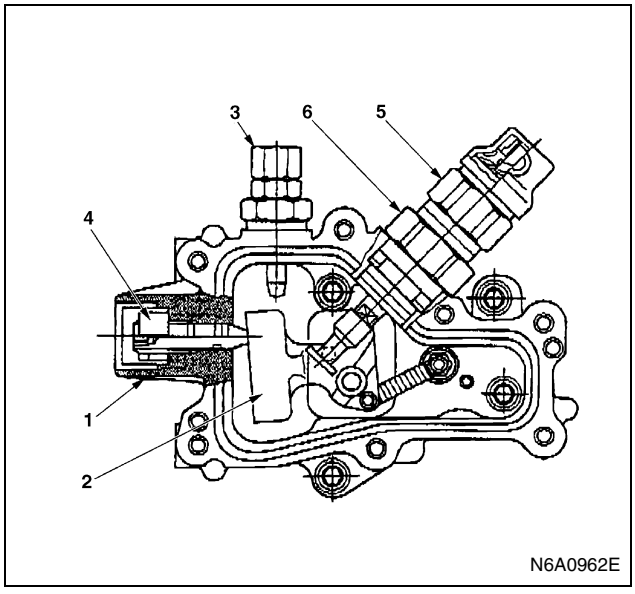
Pre-stroke	: No. 1 plunger 4.0±0.03 mm (0.1575±0.0012 in)	
Injection order	: 1 — 3 — 4 — 2 (interval 90°±15′) Plungers are numbered from the Governor side	
Tappet clearance	: Shim adjustment type	: Manually rotate the camshaft 2 — 3 times and confirm that it rotates smoothly.

Injection Timing Adjustment

(Refer to the MITICS Repair and Maintenance Service Manual for adjustment details.)

Adjustment Preparation

1. Install setscrew (3) (P/N 157927-2820), screw (4) (P/N 157927-3321) and solenoid switch (5) into housing (1).
   1) Screw in setscrew (3) until the counterweight contacts the housing's pressfitted stopper pin.
   2) Tighten screw (4) until clearance between screw (4) and counterweight (2) is 1 — 2 mm (0.04 — 0.08 in).
   3) Tighten solenoid switch (5) until clearance between solenoid switch and counterweight (2)'s pin is 1 — 2 mm (0.04 — 0.08 in), then tighten locknut (6).



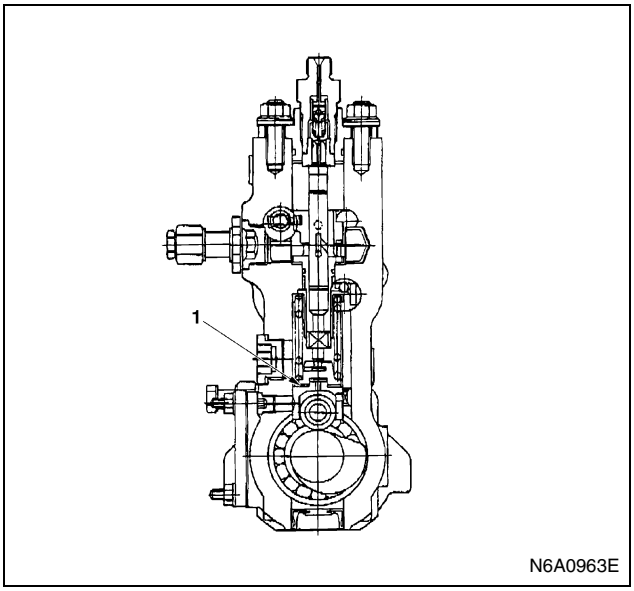
2. Install starting advance mechanism's cover.
3. Position control rack in full position.
4. Set power supply voltage to manual controller at 12V.

Pre-stroke adjustment

Adjust No.1 cylinder's start of static injection using the shim (1).

Individual cylinder's injection order adjustment

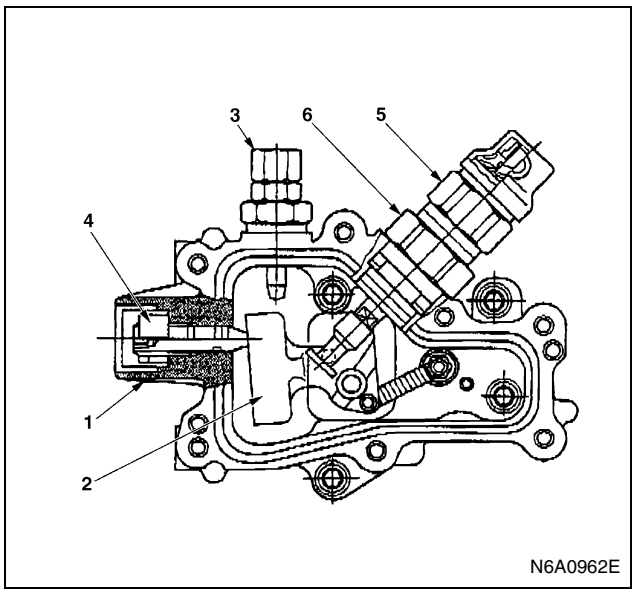
Adjust difference between each cylinder's injection angle based on that of the No.1 cylinder using the shim (1).



Measuring pre-stroke output voltage

1. Install the measuring device (P/N 105782-6420).
2. Remove the setscrew (3) (P/N 157927-2820) and install the air bleeder bolt.
3. Screw in screw (4) (P/N 157927-3321) and measure the No 1 cylinder's output voltage for pre-stroke lift values in the table below.

Adjusting point confirmation point	Pre-stroke (mm (in))	Output voltage (actual)	Remarks
a	3.70 (0.1457)	a1	+ tolerance
	3.44 (0.1354)	a2	– tolerance
b	3.24 (0.1276)	b1	+ tolerance
	3.04 (0.1197)	b2	– tolerance
(calculate form each specification)			



Advice

If measuring device (P/N 105782-6420) is removed, the output voltage (a1, a2) should be remeasured.

Minimum advance angle adjustment stopper adjustment

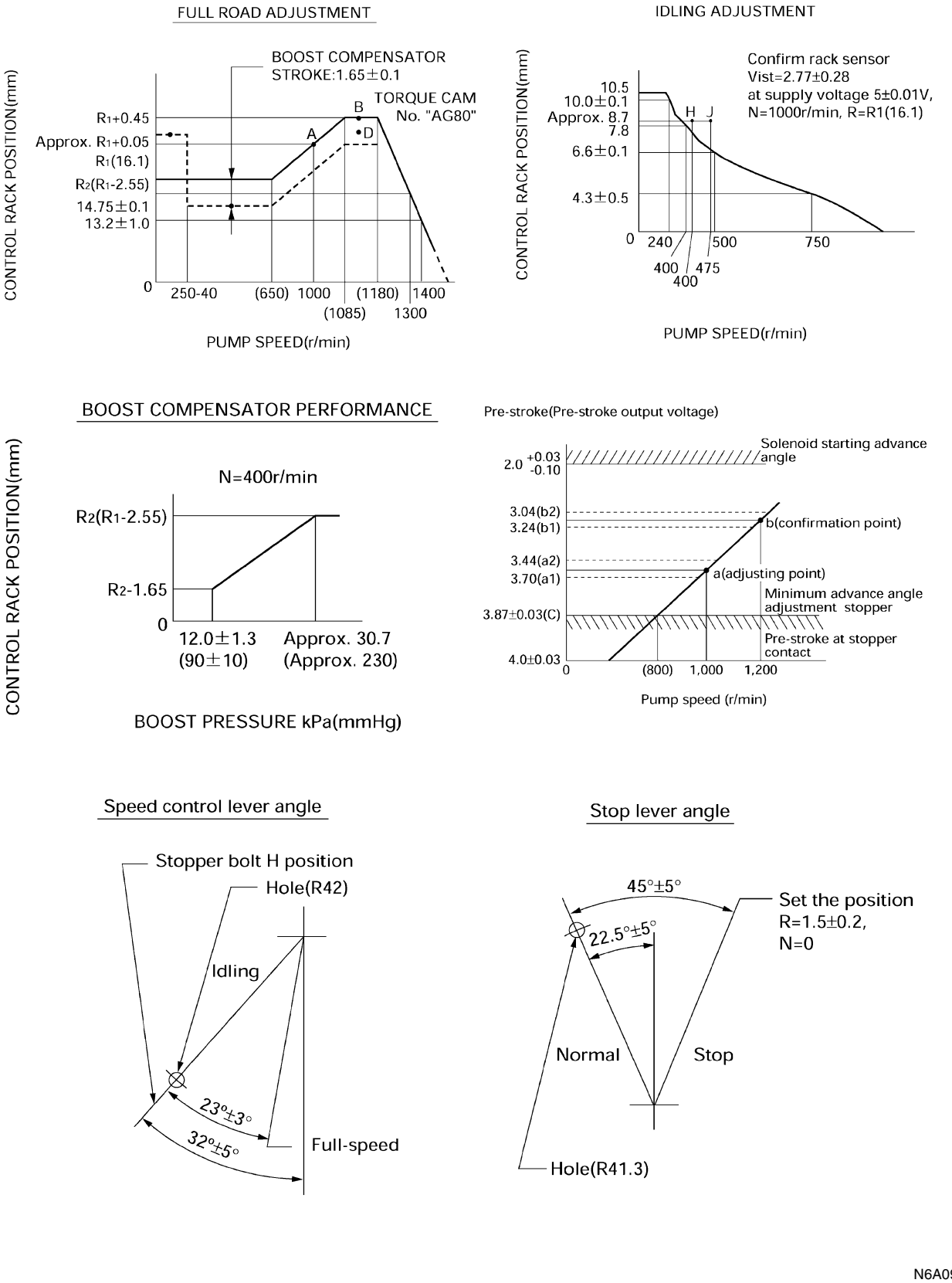
1. Remove the screw (4) (P/N 157927-3321) and install minimum advance angle adjustment stopper.
2. Screw in minimum advance angle adjustment stopper until No 1 cylinder's pre-stroke is 3.84 — 3.90 mm (0.1512 — 0.1535 in).
   Then, tighten locknut to specified torque.
3. Measure the output voltage (c) at this time.

Solenoid switch adjustment

1. Apply 24 V voltage to solenoid switch (5).
2. Loosen solenoid switch (5) until No 1 cylinder's pre-stroke is 1.90 — 2.03 mm (0.0748 — 0.0799 in), then tighten the locknut to the specified torque.
3. Confirm solenoid switch operates at 14.5 — 0.1 V.

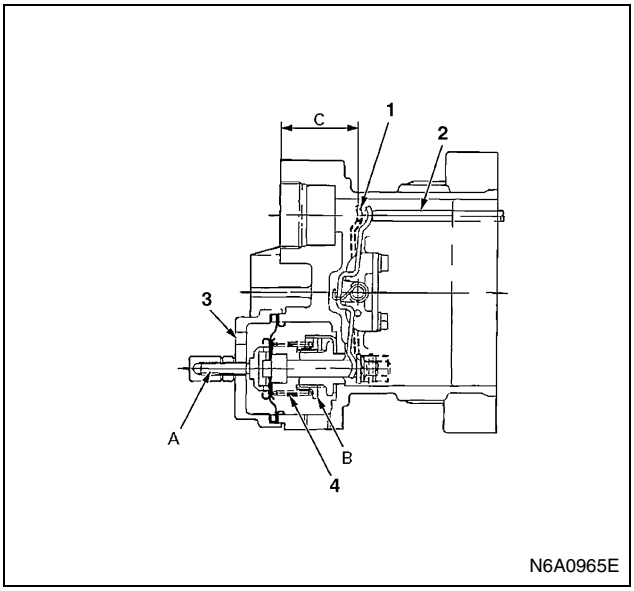
Governor Adjustment

Governor adjustment



Boost compensator adjustment

1. Select a push rod so (C) = 37.5±0.5 mm (1.48±0.02 in) at full boost pressure. ((C) is the distance from the end face of the housing to top of the lever.)
2. Adjust the boost compensator stroke using screw (A). (0 boost pressure position adjustment)
   Adjust the beginning of boost compensator operation by adjusting the notch adjusting nut (B).



Legend

1. Top of lever
2. Push rod
3. Boost pressure inlet
4. Boost compensator spring

Timing cam adjustment (Timing cam No: 510)

1. Hold speed control lever against full speed stopper bolt.
2. Supply boost pressure of at least 44.0 kPa (330 mmHg/6.38 psi)
3. Operate pump at the timing cam adjusting point (point a table below: Np = 1,000 r/min).
4. Perform timing cam adjustment so output voltage is within range of a1 — a2 actually measured for pore-stroke output voltage during injection timing adjustment in 3 — 4.

Adjusting point	Pre-stroke (mm (in))	Output voltage (actual)	Remarks
a	3.70 (0.1457)	a1	+ tolerance
	3.44 (0.1354)	a2	– tolerance

5. Operate the pump at the timing cam confirmation point.
   (point b in table below: Np = 1,200 r/min)
6. Confirm that the pre-stroke output voltage is within the range b1 — b2.

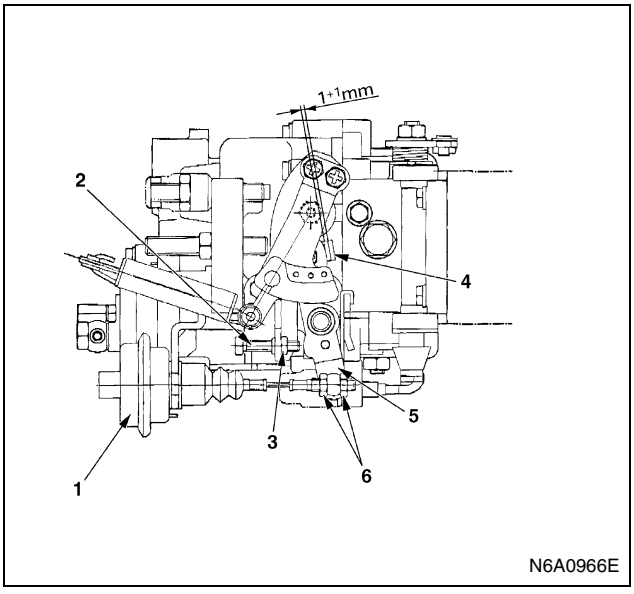
Confirmation point	Pre-stroke (mm (in))	Output voltage (actual)	Remarks
b	3.24 (0.1276)	b1	+ tolerance
	3.04 (0.1197)	b2	– tolerance

Injection Quantity

Adjusting point	Rack position (mm (in))	Pump speed (r/min)	Injection q'ty (cm^3 /1,000 strokes)	Max. variation between cylinders	Fixed	Pre-stroke at adjustment	Remarks	
—	16.1 (0.6339)	1,000	124±1.6	±4	Rack	a1 — a2 (v)	Basic	Cylinder variation adjustment standard
Z	8.7±0.5 (0.3425± 0.0197)	585	14±1.5	±14	Rack	c (v)		Cylinder variation adjustment standard
A	R1 (16.1 (0.6339))	1,000	124±1	—	Lever	a1 — a2 (v)	Basic	Boost press. kPa (mmHg/ psi) Above 44.0 (330/6.38)
B	R1+0.45 (0.0177)	1,150	123.5±2	—	Lever	Measure		Boost press. kPa (mmHg/ psi) Above 44.0 (330/6.38)
D*	16.15±0.1 (0.6358± 0.0039)	1,150	—	—	Lever	Measure		Boost press. kPa (mmHg/ psi) Above 44.0 (330/6.38) Negative press. kPa (mmHg/psi) 53.3 (400/7.73)
D*: Aneroid compensator actuator adjustment point								

FICD Adjustment

1. Stop the injection pump.
2. Hold speed control lever against idling stopper bolt.
3. Adjust clearance between FICD actuator lever and speed control lever to approx. 1+1 mm (0.0394+0.0394 in).
4. Loosen nut (3) and fully tighten FICD set bolt (2).
5. Apply 53.3 kPa (400 mmHg/7.73 psi) negative pressure to the actuator (1) and set the pump speed at 450 r/min.
6. Gradually loosen set bolt (2) then fix bolt using nut when the rack position is 8.1±0.1 mm (0.3189±0.0039 in).
7. Apply above negative pressure several times and confirm FICD actuator is operating properly and clearance between FICD actuator lever and speed control lever.



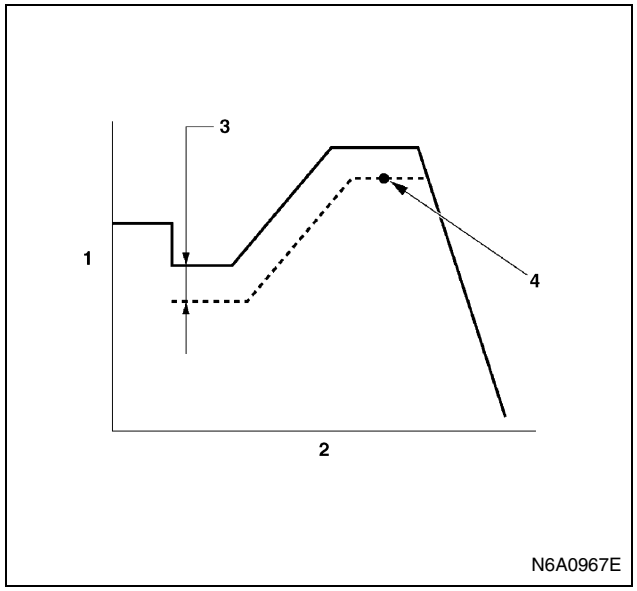
Legend

1. Actuator
2. Set bolt
3. Nut
4. Speed control lever
5. FICD actuator lever
6. Tightening torque 5 — 7 N·m (0.5 — 0.7 kg·m/ 3.7 — 5.2 lb·ft)

Aneroid Compensator Actuator Adjustment (Injection Quantity Decrease)

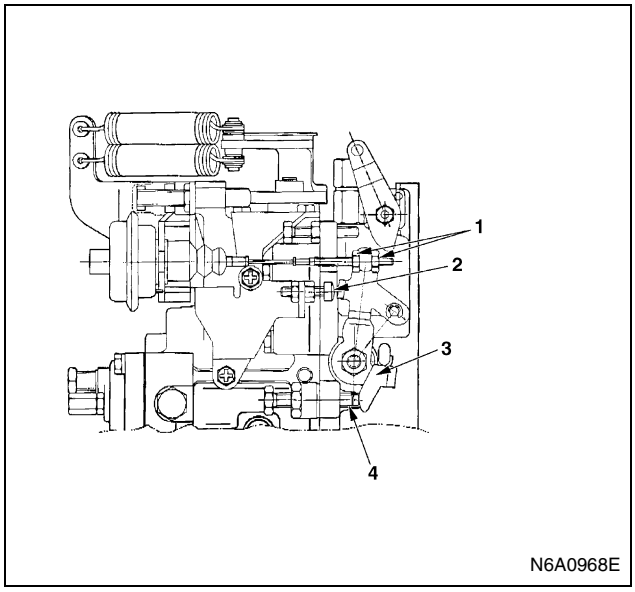
Notice:
Set this actuator after adjusting the full rack position.

1. Stop injection pump.
2. Adjust wire nut so full load set lever contacts full load set bolt and aneroid compensator actuator wire is not loose. Then, fix the nut.
3. Apply 53.3 kPa (400 mmHg/7.73 psi) negative pressure to aneroid compensator, set pump speed at 1,150 r/min.



Legend
1. Rack position (mm)
2. Pump speed (r/min)
3. Stroke
4. Injection quantity decrease adjustment point

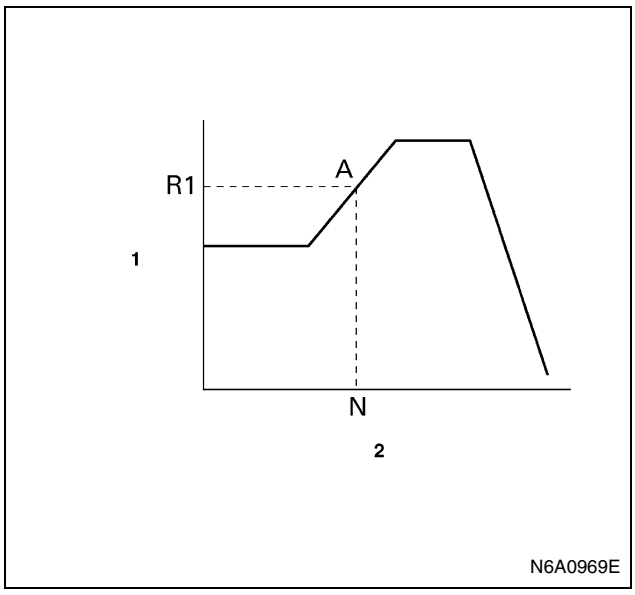
4. Apply at least 44.0 kPa (330 mmHg/6.38 psi) boost pressure to the boost compensator.
5. After operating full load set lever, adjust aneroid compensator set bolt so control rack position is 16.15±0.1 mm (0.6358±0.0039 in) and fuel injection quantity is as specified. Then, fix the set bolt.



Legend
1. Nut
2. Set bolt
3. Full load set lever
4. Full load set bolt

Rack Sensor Adjustment

1. Before removing rack position measuring device, apply at least 44.0 kPa (330 mmHg/6.38 psi) boost pressure and confirm rack position is R1 = 16.1 mm and fuel injection quantity is 124±1 mm^3/st at N = 1,000 r/min.



Legend
1. Rack position (mm)
2. Pump speed (r/min)

2. Remove the rack position measuring device.
3. Attach the rack sensor core to the control rack.

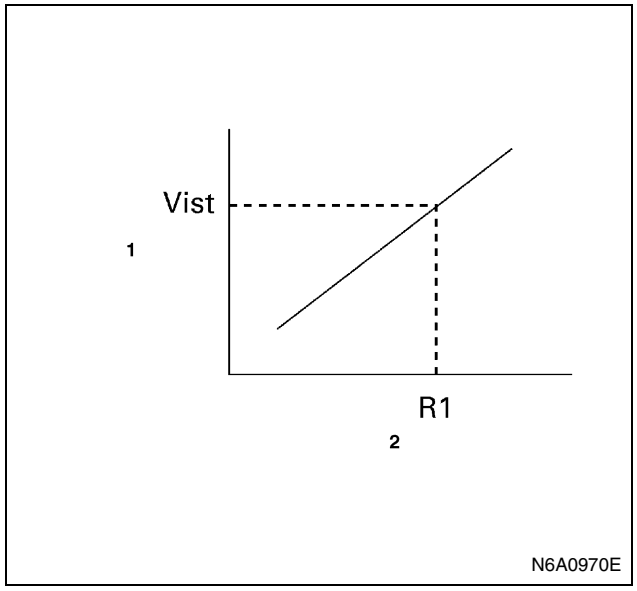
At this time, hold control rack using a spanner (to prevent the rack from bending).

Specified torque: 3.4 — 4.9 N·m (0.35 — 0.5 kg·m/2.5 — 3.6 lb·ft)

4. While pulling stop lever, install rack sensor to rack sensor core.
5. Tighten the two flnge fixing screws.

Specified torque: 6.9 — 8.8 N·m (0.7 — 0.9 kg·m/5.1 — 6.5 lb·ft))

6. Connect the rack sensor wire harness to constant voltage power supply and digital voltmeter.
7. Turn constant voltage power supply power switch ON and set it to DC 5±0.01V.
8. Apply at least 44.0 kPa (330 mmHg/6.38 psi) boost pressure, set pump speed at N = 1,000 r/min, and hold speed control lever against the full speed stopper bolt.
9. Confirm the rack sensor output voltage from the digital voltmeter. (Vist = 2.77±0.28V)
10. Confirm that the voltage changes when the speed control lever is moved to the idle and full sides.

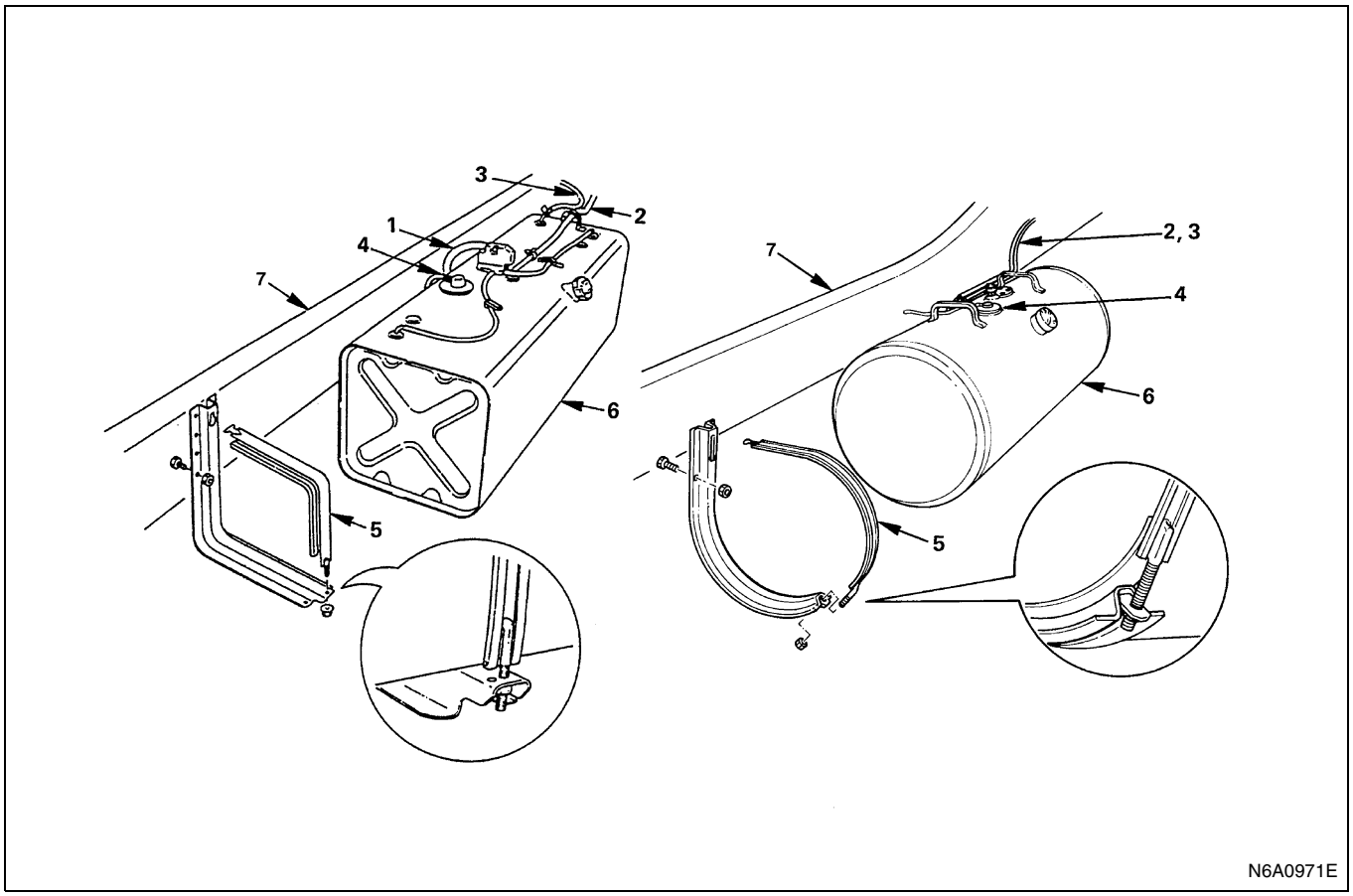


Legend

1. Sensor output voltage (V)
2. Rack position (mm)

FUEL TANK

Component



Legend

1. Evapo fuel hose
2. Fuel feed hose
3. Fuel return hose
4. Fuel gauge unit connector
5. Band
6. Fuel tank
7. Frame

Removal

Preparation

- Disconnect the battery ground cable.
- Loosen the fuel filler cap.
- Drain fuel from drain plug.
- After the drain fuel, tighten the drain plug to the specified torque.

Tighten:
Drain plug to 29 N·m (3 kg·m / 22 lb·ft)

1. Evapo Fuel Hose
2. Fuel Feed Hose
3. Fuel Return Hose
   - Plugging the return hose to prevent fuel from getting spilt, tie it to the fame with the plugged end up.
4. Fuel Gauge Unit Connector
   - Remove the fuel gauge unit connector.
5. Band
   - Remove the nut of the fuel tank fixing band, and then remove the band end on the frame side.
6. Fuel Tank
   - Pull out the fuel tank to the outside.

Notice:
When it is not possible to pull out the fuel tank, remove the bracket and then draw out the fuel tank downward.

Installation

1. Fuel Tank

Notice:
When the bracket was removed to take off the fuel tank, install the bracket to the frame and tighten it to the specified torque.

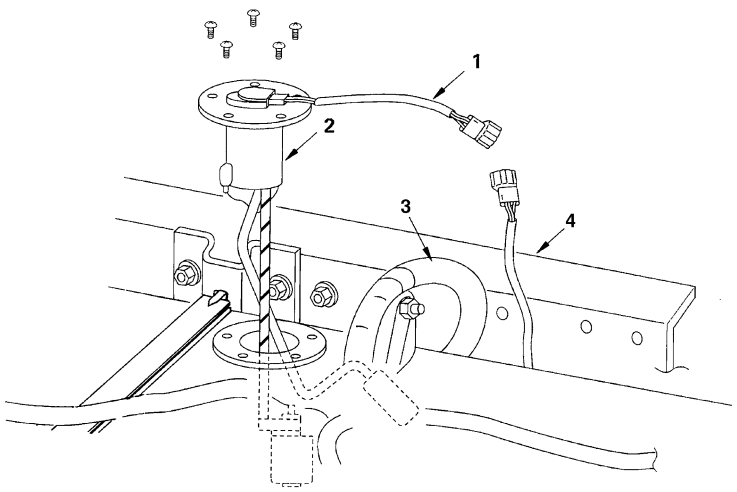
Tighten:
Fuel tank bracket to 55 N·m (5.6 kg·m / 41 lb·ft)

Also, when mounting the fuel tank to the bracket, place the packing section attached to the fuel tank securely on the bracket.

2. Band
   - Tighten the band to 12 N·m (1.2 kg·m /104 lb·in)
3. Fuel Gauge Unit Connector
   - Connect the fuel gauge unit connector.
4. Fuel Return Hose
5. Fuel Feed Hose
   - Set the hose to the pipe more than 25 mm (0.98 in) deep.
6. Evapo Fuel Hose
   - Fill the fuel to the fuel tank.
   - Connect battery ground cable.

FUEL GAUGE UNIT

Component



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Legend

1. Fuel gauge unit connector
2. Fuel gauge unit
3. Evapo fuel hose
4. Frame

Removal

Preparation

Disconnect the Battery ground cable.

1. Fuel Gauge Unit Connector
   - Disconnect the fuel gauge unit connector from the fuel gauge unit.
2. Fuel Gauge Unit
   - Remove the fuel gauge unit fixing screw and fuel gauge unit.

Notice:

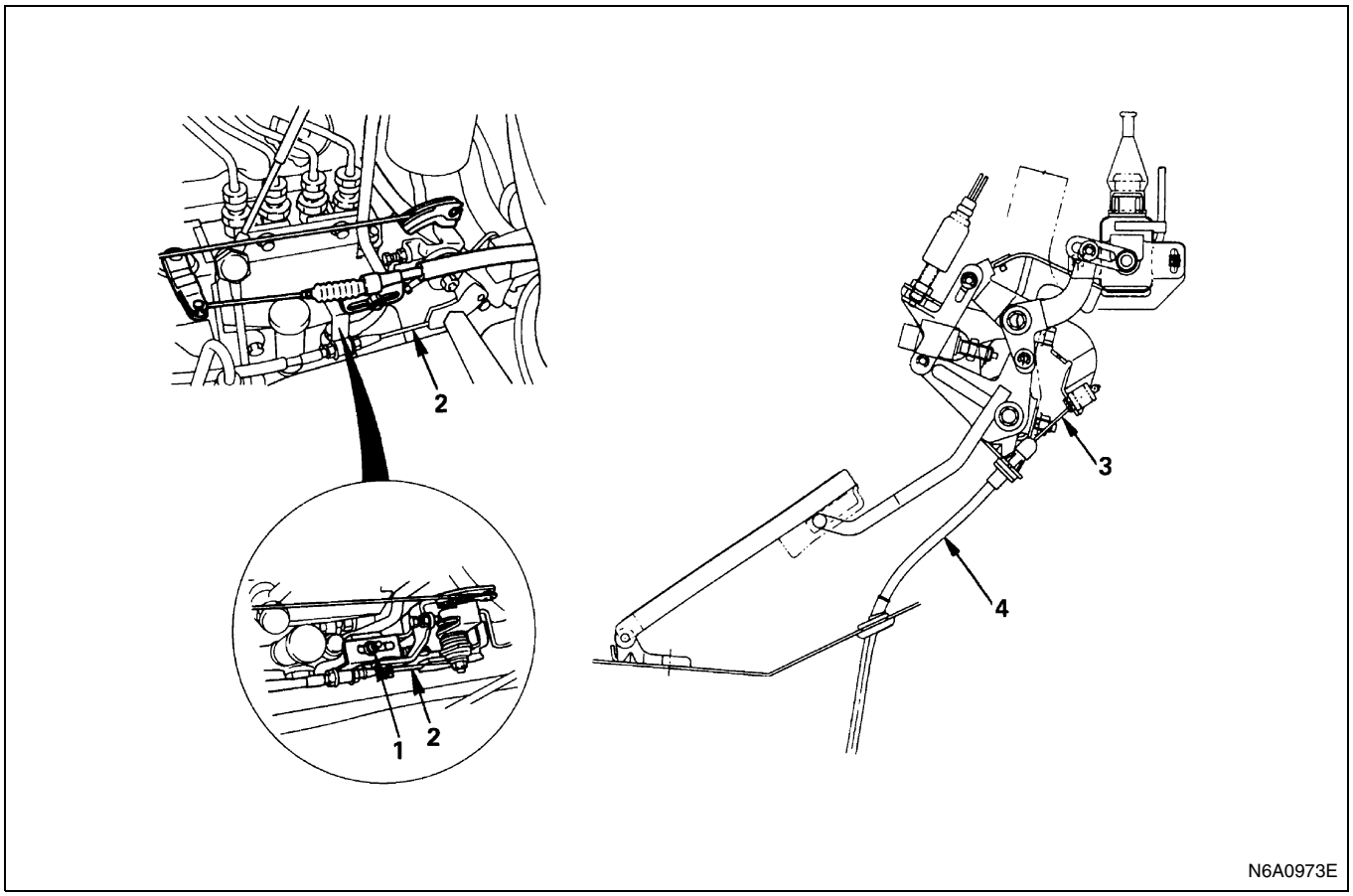
After removing fuel gauge unit, cover fuel tank with waste to prevent any dust entering

Installation

1. Fuel Gauge Unit
2. Fuel Gauge Unit Connector
   - Connect the wiring connector to the fuel gauge unit.

ACCELERATOR CONTROL CABLE

Component



Legend

1. Adjust nut
2. Accelerator control wire (Injection pump side)
3. Accelerator control wire (Accelerator pedal side)
4. Accelerator control cable

Removal

1. Adjust Nut
   - Loosen the adjust nut on the cable bracket mounted.
2. Accelerator Control Wire (Injection pump side)
   - Remove the control wire from injection pump control lever.
3. Accelerator Control Wire (Accelerator pedal side)
   - Remove the Accelerator control wire from accelerator pedal.
4. Accelerator Control Cable
   - Pull out the wire to the chassis side through the grommet hole of the floor board, and remove the control cable.

Inspection

Check the following items, and replace the control cable if any abnormality is found.

- The control cable should move smoothly.
- The control cable should not be bent or kinked.
- The control cable should be free of damage and corrosion.

Installation

1. Accelerator Control Cable
   - Take care that the core wire of the cable does not get damaged or inded.
   - Put the cable through the grommet hole from under the floor.
   - Set the groove of the grommet securely into the floor panel.
2. Accelerator Control Wire (Accelerator Pedal side)
   - Connect the accelerator control wire to Accelerator pedal.
3. Cable Clips
   - Install the cable clip to chassis frame.
   - Tighten the cable clips to 16 N·m (1.6 kg·m / 12 lb·ft)
4. Accelerator Control Wire

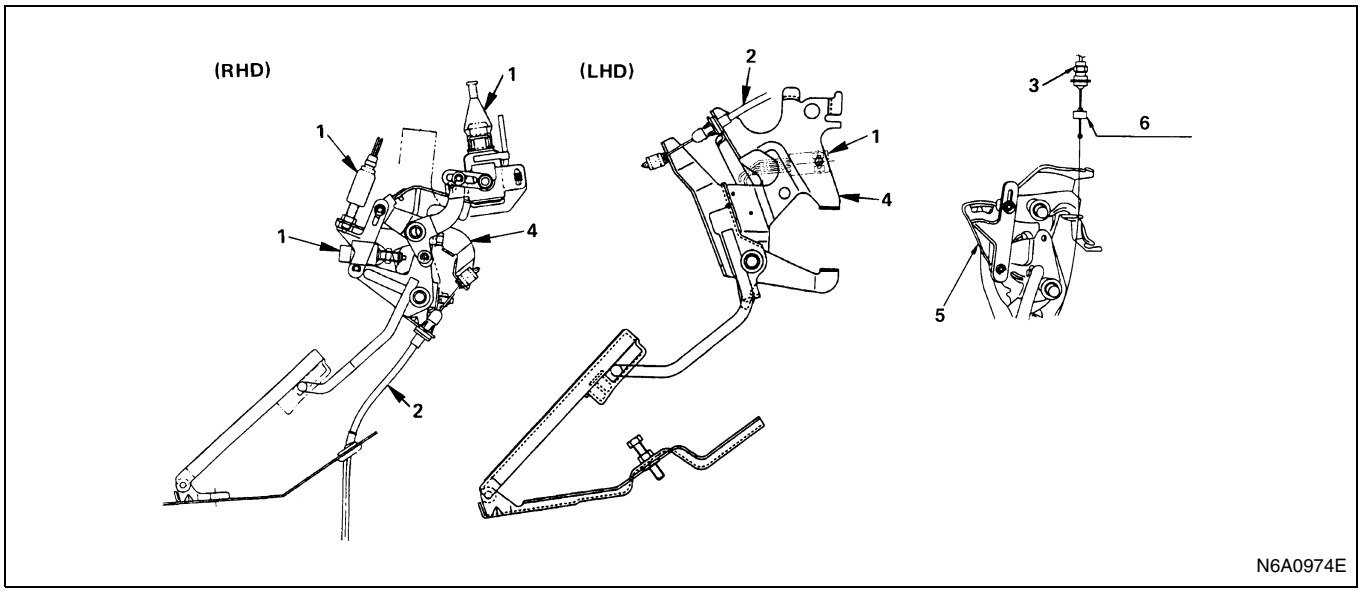
5. Adjust Nut
   - Attach the end tip of the wire to the engine control lever.
   - Pull the outer cable gently toward the front of the vehicle, and provide the engine control wire and the accelerator control wire an appropriate play before fastening the clamp with a nut.

Tighten:
Nut to 8 N·m (0.8 kg·m /69 lb·in)

- Check to see if the injection pump lever is at the idle position (with the lever in touch with the stopper bolt).
- Connect the battery ground cable.
- Check to see if the accelerator pedal fully is in the range of 5 — 10 mm (0.2 — 0.4 in) above the pedal pad.
- Press down on the accelerator pedal fully, and check to see if the engine rotates at the maximum speed with the linkage in the smooth operation.
- In the operating range of the accelerator pedal, check to see if the accelerator pedal and the injection pump lever return without fail to the original positions.

ACCELERATOR PEDAL

Component

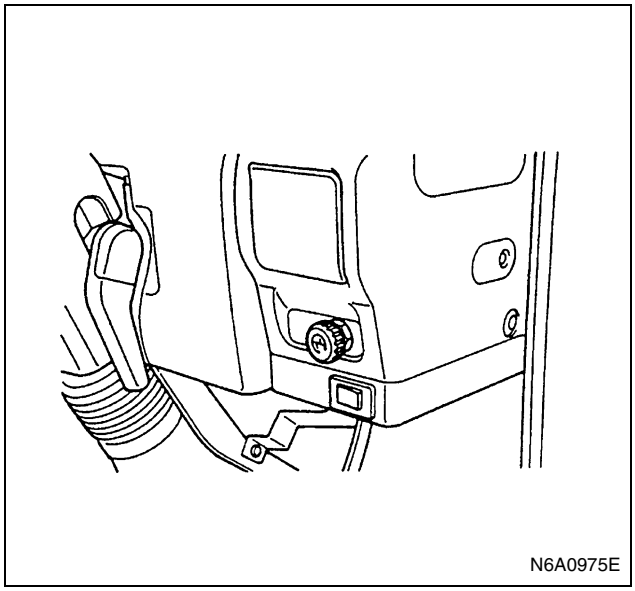


Legend

1. Switch connector
2. Accelerator control cable
3. Idling control cable
4. Accelerator pedal assembly
5. Accele pedal bracket
6. Wire guide

Removal

1. Switch Connector
2. Accelerator Control Cable.
   - Remove control cable from Accelerator pedal bracket.
3. Idling Control Cable
   - Remove control cable from accelerator pedal bracket.
4. Accelerator Pedal Assembly
   - Remove accelerator pedal assembly from brake pedal bracket.

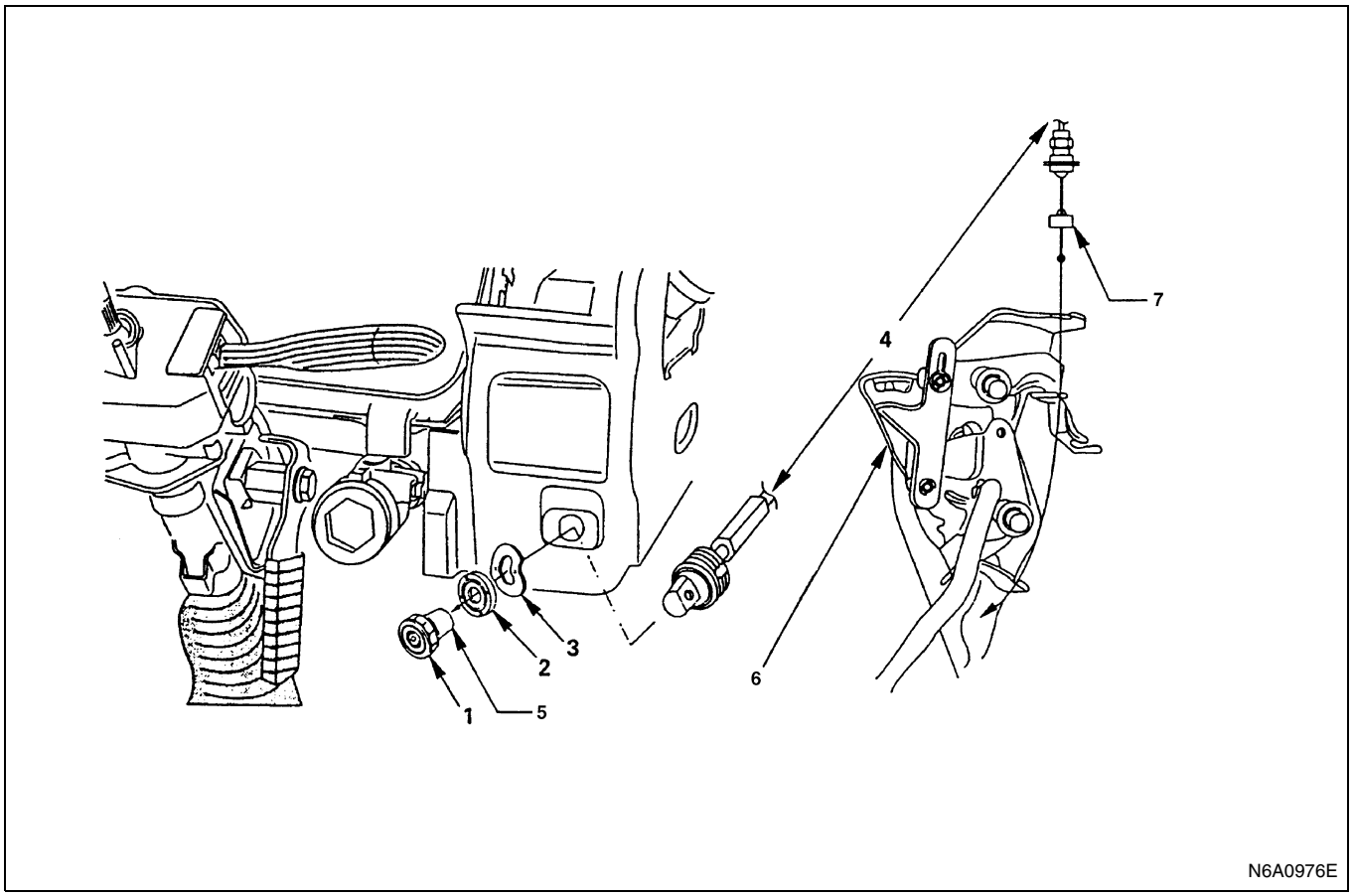


Installation

1. Accelerator Pedal Assembly
   - Apply grease to the sliding portion, and install it to the brake pedal bracket.
2. Idling Control Cable
   - Install the idling control cable to the lever of the accelerator pedal bracket.
3. Accelerator Control Cable
   - After confirming that the idling control knob is turned fully to the left, install the accelerator control cable.
4. Switch Connector

IDLING CONTROL CABLE

Component



Legend

1. Idling control knob
2. Idling control cable nut
3. Wave washer
4. Idling control cable
5. Screw
6. Accelerator pedal bracket
7. Wire guide

Removal

1. Idling Control Knob
   - Loosen the idling control knob screw and remove the knob from cable.
2. Idling Control Cable Nut
3. Wave Washer
4. Idling Control Cable
   - Remove control cable from accelerator pedal bracket.

Installation

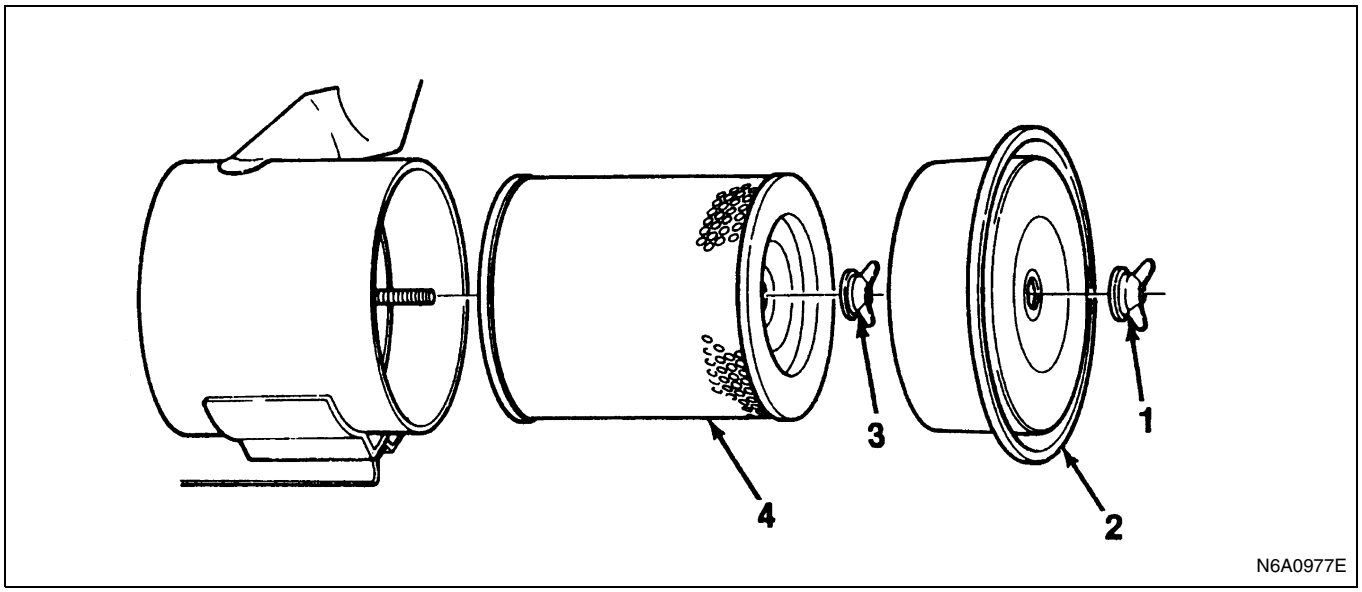
1. Idling Control Cable
   - Install control cable to Accelerator pedal bracket.
2. Wave Washer
3. Idling Control Cable Nut
   - Insert the idling control cable into the specified hole of the instrument panel.
   - Install the washer to the cable, and tighten it with a nut.
4. Idling Control Knob
   - Insert the idling control knob into the cable, and tighten the screw.

Inspection:

- With the idling control knob not in use, check to see if the injection pump lever is at the idle position (with the lever in contact with the stopper bolt).
- With the idling control knob turned fully to the right, check to see if the number of the engine idling rotations gets to 1,500 rpm or more.

AIR CLEANER ELEMENT

Component



Legend

1. Cover wing nut
2. End cover
3. Filter wing nut
4. Air cleaner element

Removal

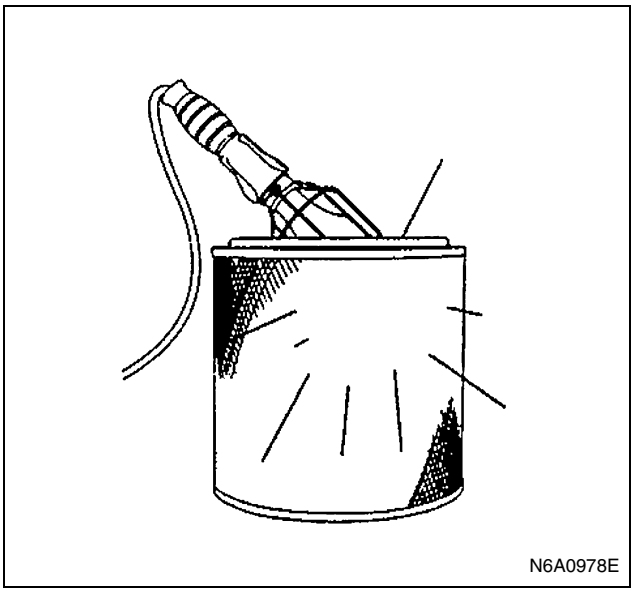
1. Cover Wing Nut
2. End Cover
3. Filter Wing Nut
4. Air Cleaner Element

Clean

- Wipe out the inside of the Air cleaner assembly
- Wipe off the Cover

Inspection

- The air filter with a light for fears or holes.



Cleaning Method

Dust Fouled Element

Rotate the element with your hand while applying compressed air to the inside of the element. This will blow the dust free.

Compressed air pressure	kPa (kg/cm^2/psi)
392 — 490 (4 — 5/57 — 71)	

Caution:
Do not bang the element against another object in an attempt to clean it. Damage to the element will result.

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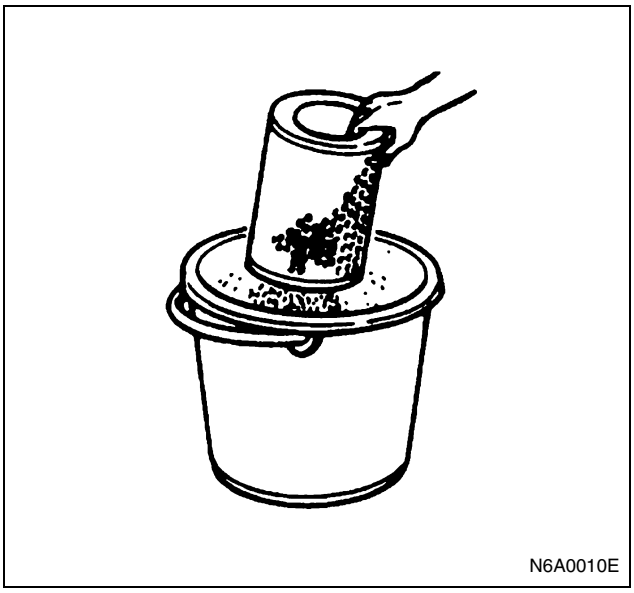
Carbon and Dust Fouled Element

1. Prepare a cleaning solution of Isuzu Genuine Element Cleaner (Donaldson D1400) diluted with water.
2. Submerge the element in the solution for twenty minutes.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3. Remove the element from the solution and rinse it well with running water.
   Water pressure must not exceed 274 kPa (2.8 kg/cm^2/40 psi)

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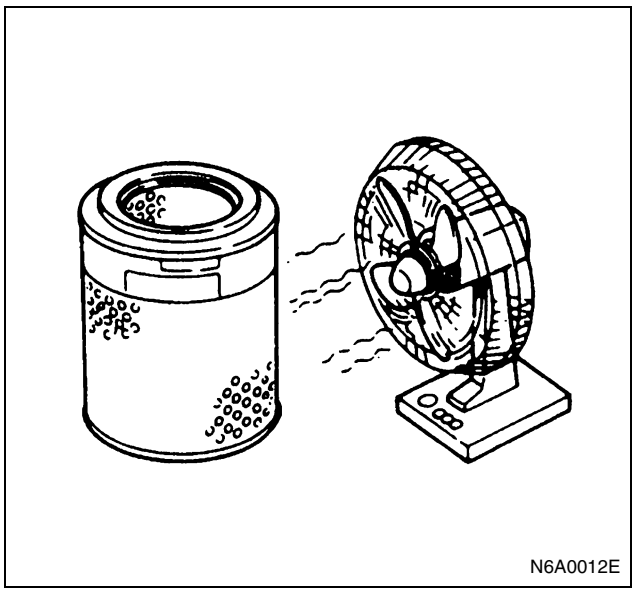
4. Dry the element in a well ventilated area.
   An electric fan will hasten drying.

Notice:
Do not use compressed air or an open flame to dry the element quickly. Damage to the element will result.

It will usually take two or three days for the element to dry completely. Therefore, it is a good idea to have a spare on hand to use in the interim.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Installation

1. Air Cleaner Element
2. Filter Wing Nut
3. End Cover
4. Cover Wing Nut

ENGINE 4H SERIES

SECTION 6D1

ENGINE ELECTRICAL

Contents

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General Description....6D1-2
Diagnosis....6D1-2
On-vehicle Service....6D1-3
Main Data and Specifications....6D1-4

BATTERY

General Description

There are six battery fluid caps at the top of the battery. The battery is completely sealed except for the six small vent holes at the side. These vent holes permit the escape of small amounts of gas generated by the battery. This type of battery has the following advantages over conventional batteries:

1. There is no need to add water during the entire service life of the battery.
2. The battery protects itself against overcharging. The battery will refuse to accept an excessive charge.
   (A conventional battery will accept an excessive charge, resulting in gassing and loss of battery fluid.)
3. The battery is much less vulnerable to self-discharge than a conventional type battery.

Diagnosis

Visual Inspection

Inspect the battery for obvious physical damage, such as a cracked or broken case, which would permit electrolyte loss.
Replace the battery if obvious physical damage is discovered during inspection.
Check for any other physical damage and correct it as necessary. If not, proceed to “Hydrometer check”.

Hydrometer Check

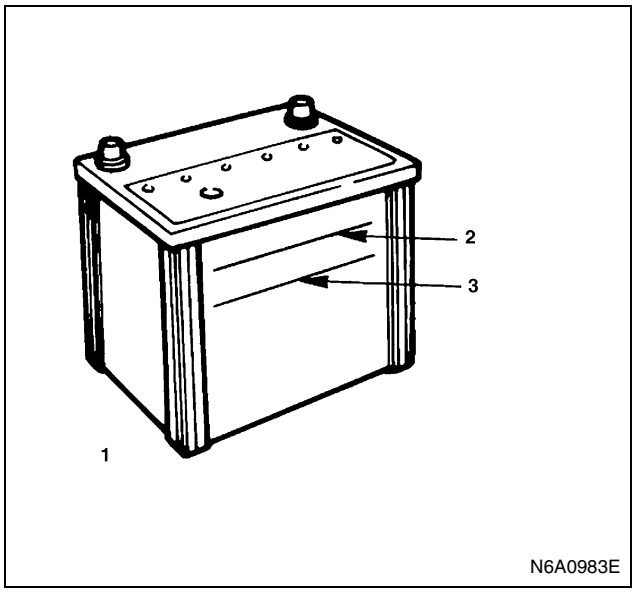
There is a built-in hydrometer (Charge test indicator) at the top of the battery. It is designed to be used during diagnostic procedures.
Before trying to read the hydrometer, carefully clean the upper battery surface.
If your work area is poorly lit, additional light may be necessary to read the hydrometer.

a. BLUE RING OR DOT VISIBLE - Go to “Voltage check”.
b. BLUE RING OR DOT NOT VISIBLE - Go to “Fluid level check”.

Fluid Level Check

The fluid level should be between the upper level line and lower level line on side of the battery.

a. CORRECT FLUID LEVEL - Charge the battery.
b. BELOW LOWER LEVEL - Replace battery.



Legend

1. Battery
2. Upper level
3. Lower level

Voltage Check

1. Put voltmeter test leads to battery terminals.
   a. VOLTAGE IS 12.4V OR ABOVE - Go to “Load test”.
   b. VOLTAGE IS UNDER 12.4V - Go to procedure 2 below.
2. Determine fast charge amperage from specification.
   (See Main Data and Specifications in this section).
   Fast charge battery for 30 minutes at amperage rate no higher than specified value.
   Take voltage and amperage readings after charge.
   a. VOLTAGE IS ABOVE 16V AT BELOW 1/3 OF AMPERAGE RATE - Replace battery.
   b. VOLTAGE IS ABOVE 16V AT ABOVE 1/3 OF AMPERAGE RATE - Drop charging voltage to 15V and charge for 10 — 15 hours.
   Then go to “Load test”.
   c. VOLTAGE IS BETWEEN 12V AND 16V - Continue charging at the same rate for an additional 3-1/2 hours. Then go to “Load test”.
   d. VOLTAGE IS BELOW 12V - Replace battery.

Load Test

1. Connect a voltmeter and a battery load tester across the battery terminals.
2. Apply 300 ampere load for 15 seconds to remove surface charge from the battery.
   Remove load.

3. Wait 15 seconds to let battery recover. Then apply specified load from specifications (See Main Data and Specifications in this section).
   Read voltage after 15 seconds, then remove load.
   1) VOLTAGE DOES NOT DROP BELOW THE MINIMUM LISTED IN FOLLOWING TABLE - The battery is good and should be returned to service.
   2) VOLTAGE IS LESS THAN MINIMUM LISTED -Replace battery.

ESTIMATED TEMPERATURE		MINIMUM VOLTAGE
°F	°C	
70	21	9.6
60	16	9.5
50	10	9.4
40	4	9.3
30	−1	9.1
20	−7	8.9
10	−12	8.7
0	−18	8.5
The battery temperature must be estimated by feel and by the temperature the battery has been exposed to for the preceding few hours.		

On-vehicle Service

Battery Charging

Observe the following safety precautions when charging the battery:

1. Never attempt to charge the battery when the fluid level is below the lower level line on the side of the battery.
   In this case, the battery must be replaced.
2. Pay close attention to the battery during the charging procedure.
   Battery charging should be discontinued or the rate of charge reduced if the battery feels hot to the touch.
   Battery charging should be discontinued or the rate of charge reduced if the battery begins to gas or spew electrolyte from the vent holes.
3. In order to more easily view the hydrometer blue dot or ring, it may be necessary to jiggle or tilt the battery.
4. Battery temperature can have a great effect on battery charging capacity.
5. The sealed battery used on this vehicle may be either quick-charged or slow-charged in the same manner as other batteries.
   Whichever method you decide to use, be sure that you completely charge the battery. Never partially charge the battery.

Jump Starting

Jump Starting With An Auxiliary (Booster) Battery

Caution:

Never push or to the vehicle in an attempt to start it.

Serious damage to the emission system as well as other vehicle parts will result.

Treat both the discharged battery and the booster battery with great care when using jumper cables.

Carefully follow the jump starting procedure, being careful at all times to avoid sparking.

WARNING:

FAILURE TO CAREFULLY FOLLOW THE JUMP STARTING PROCEDURE COULD RESULT IN THE FOLLOWING:

1. **SERIOUS PERSONAL INJURY, PARTICULARLY TO YOUR EYES.**
2. **PROPERTY DAMAGE FROM A BATTERY EXPLOSION, BATTERY ACID, OR AN ELECTRICAL FIRE.**
3. **DAMAGE TO THE ELECTRONIC COMPONENTS OF ONE OR BOTH VEHICLES PARTICULARLY.**

Never expose the battery to an open flame or electrical spark. Gas generated by the battery may catch fire or explode.

Remove any rings, watches, or other jewelry before working around the battery. Protect your eyes by wearing an approved set of goggles.

Never allow battery fluid to come in contact with your eyes or skin.

Never allow battery fluid to come in contact with fabrics or painted surfaces.

Battery fluid is a highly corrosive acid.

Should battery fluid come in contact with your eyes, skin, fabric, or a painted surface, immediately and thoroughly rinse the affected area with clean tap water.

Never allow metal tools or jumper cables to come in contact with the positive battery terminal, or any other metal surface of the vehicle. This will protect against a short circuit.

Always keep batteries out of the reach of young children.

Jump Starting Procedure

1. Set the vehicle parking brake.
   If the vehicle is equipped with an automatic transmission, place the selector lever in the “PARK” position.
   If the vehicle is equipped with a manual transmission, place the shift lever in the “NEUTRAL” position.
   Turn “OFF” the ignition.
   Turn “OFF” all lights and any other accessory requiring electrical power.
2. Look at the built-in hydrometer.
   If the indication area of the built-in hydrometer is completely clear, do not try to jump start.

3. Attach the end of one jumper cable to the positive terminal of the booster battery.
   Attach the other end of the same cable to the positive terminal of the discharged battery.
   Do not allow the vehicles to touch each other.
   This will cause a ground connection, effectively neutralizing the charging procedure.
   Be sure that the booster battery has a 12 volt rating.
4. Attach one end of the remaining cable to the negative terminal of the booster battery.
   Attach the other end of the same cable to a solid engine ground (such as the A/C compressor bracket or the generator mounting bracket) of the vehicle with the discharged battery.
   This ground connection must be at least 450 mm (18 in) from the battery of the vehicle whose battery is being charged.

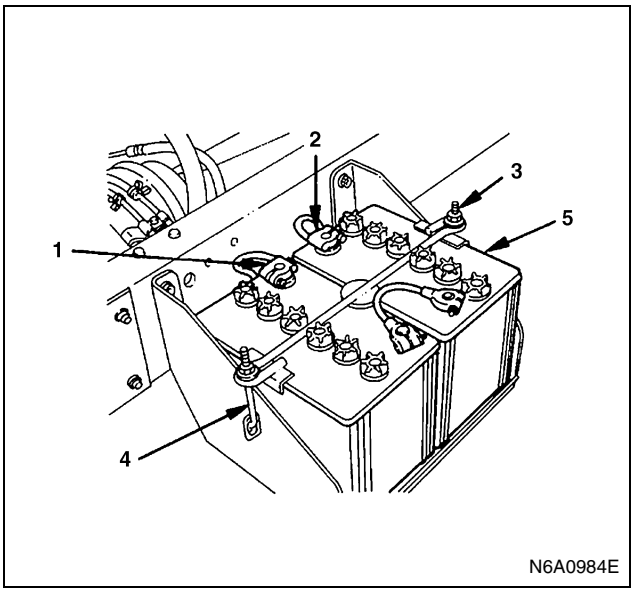
WARNING:
NEVER ATTACH THE END OF THE JUMPER CABLE DIRECTLY TO THE NEGATIVE TERMINAL OF THE DEAD BATTERY.

5. Start the engine of the vehicle with the good battery.
   Make sure that all unnecessary electrical accessories have been turned “OFF”.
6. Start the engine of the vehicle with the dead battery.
7. To remove the jumper cables, follow the above directions in the reverse order.

Be sure to first disconnect the negative cable from the vehicle with the discharged battery.

Removal

1. Negative cable
2. Positive cable
3. Retainer screw and rods
4. Retainer
5. Battery



Installation

To install the battery, follow the removal procedure in the reverse order, noting the following points:

1. Make sure that the rod is hooked on the body side.

Main Data and Specifications

Model	(JIS)	65D23R	75D23R	80D26R	115E41R	DELCO 31-750
Voltage	(V)	12	12	12	12	12
Cold-Cranking Performance	(Amp)		520	356		750
Reserve Capacity	(Min.)		180	133		160

ENGINE 4H SERIES

SECTION 6D2
STARTING SYSTEM

Contents

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ON-VEHICLE SERVICE 6D2-5
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UNIT REPAIR 6D2-7
Component 6D2-7
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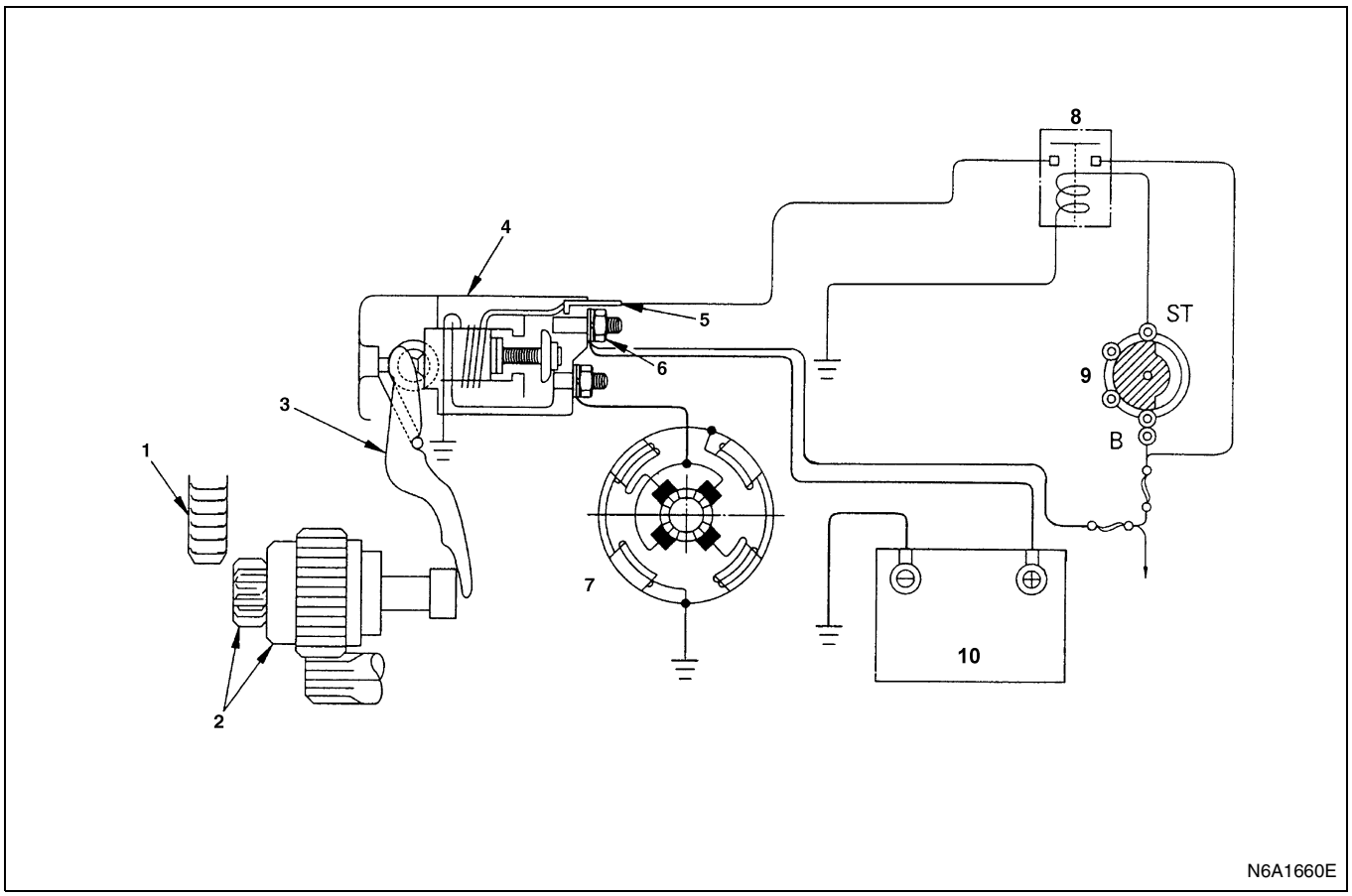
Reassembly 6D2-15

GENERAL DESCRIPTION

Component

Starting Circuit

The cranking system consists of a battery, starter, starter switch, starter relay, etc. and these main components are connected as shown in figure. For details of the starting circuit.



Legend

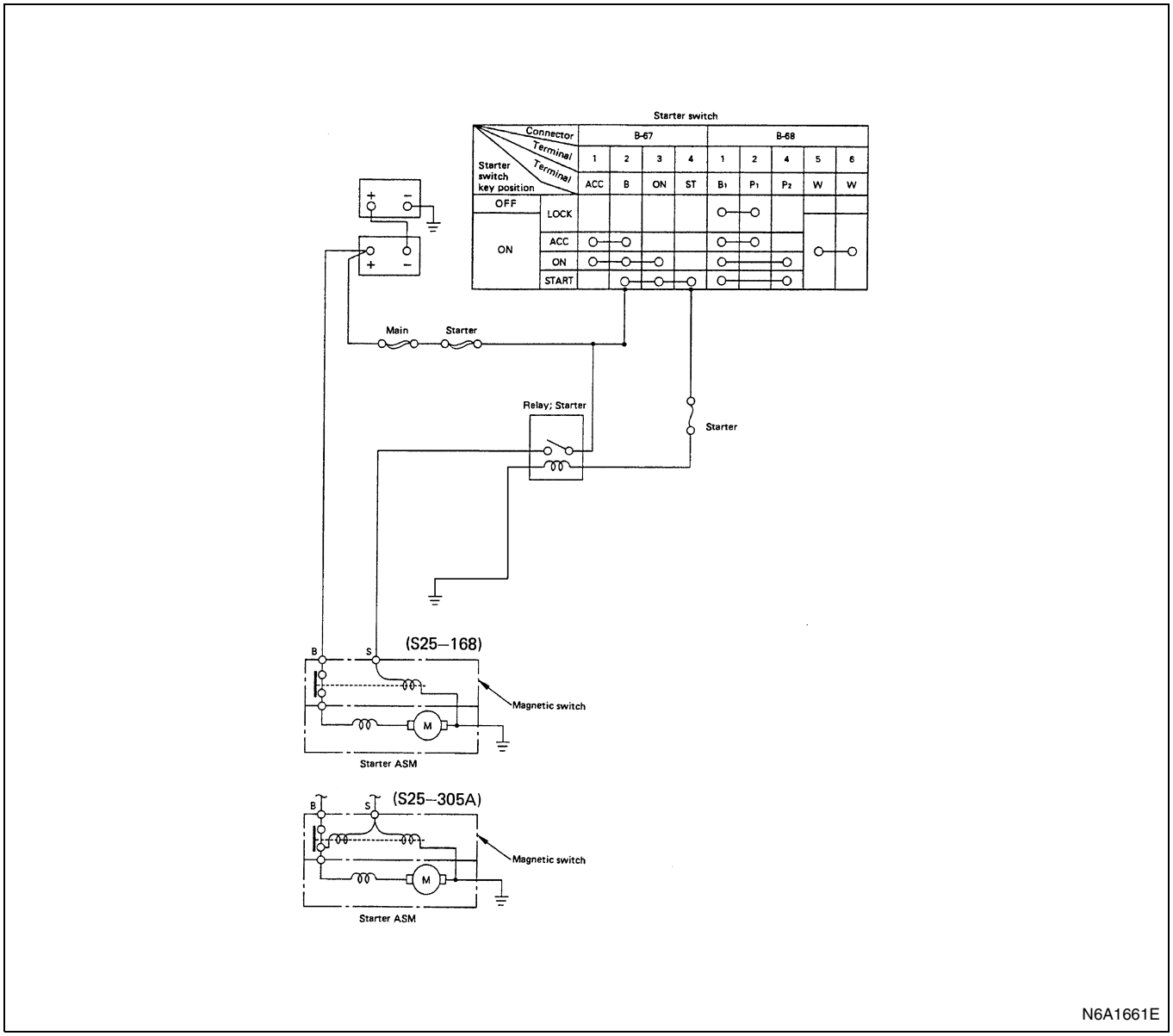
1. Ring gear
2. Pinion clutch
3. Shift lever
4. Magnetic switch
5. “S” terminal
6. “B” terminal
7. Starter
8. Relay; starter
9. Starter switch
10. Battery

Starter

The starting system employs a magnetic type reduction starter in which the motor shaft is also used as a pinion shaft. When the starter switch is turned on, the contacts of magnetic switch are closed, and the armature rotates. At the same time, the plunger is attracted, and the pinion is pushed forward by the shift lever to mesh with ring gear.

Then, the ring gear runs to start the engine. When the engine starts and the starter switch is turned off, the plunger returns, the pinion is disengaged from ring gear, and the armature stops rotation. When the engine speed is higher than the pinion, the pinion idles, so that the armature is not driven.

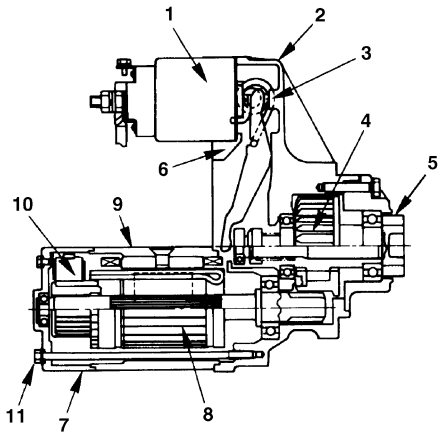
Starting Circuit



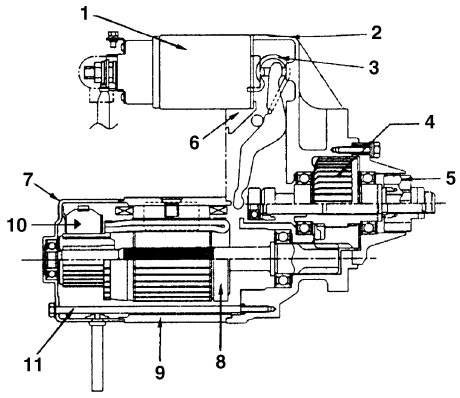
N6A1661E

Starting Motor

S25—168



S25—305A



N6A0987E

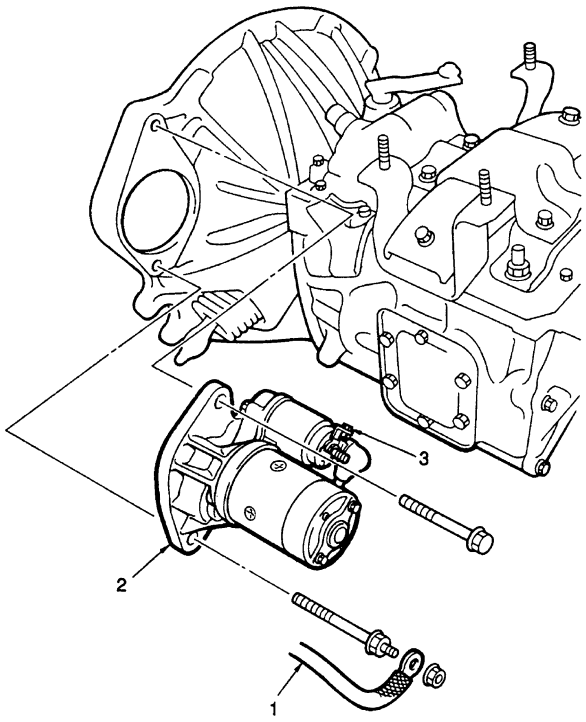
Legend

1. Magnetic switch
2. Gear case
3. Torsion spring
4. Clutch
5. Pinion
6. Dust cover
7. Rear cover
8. Armature
9. Yoke
10. Brush
11. Through bolt

ON-VEHICLE SERVICE

Component

Starter



N6A0988E

Legend

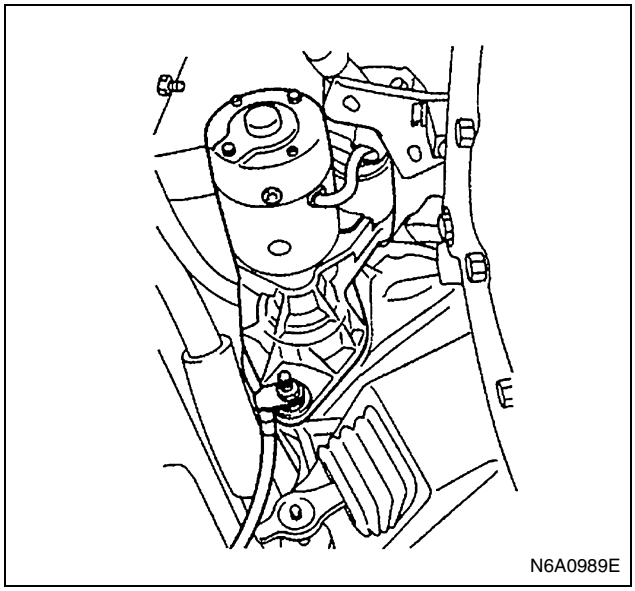
1. Starter earth cable
2. Starter assembly
3. Starter wiring connector

Removal

Preparation

- Disconnect the battery ground cable (both batteries).

1. Starter Earth Cable

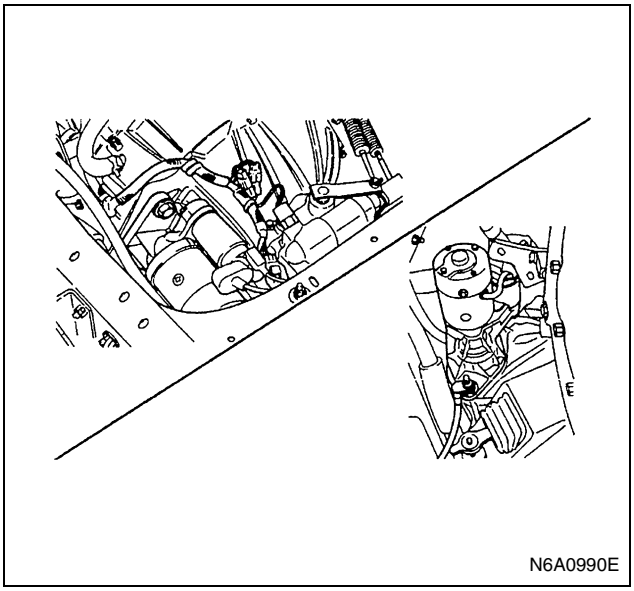


N6A0989E

- Disconnect the starter earth cable at the starter motor.

- Disconnect the front frame harness connector somewhere near the control box of the transmission, remove each clip that fastens the harness.

2. Starter Assembly

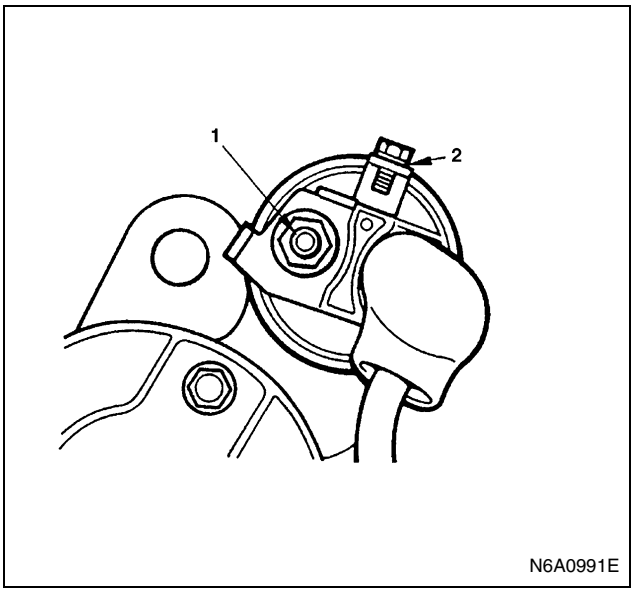


- Remove the starter assembly from flywheel housing.

3. Starter Wiring Connector

Installation

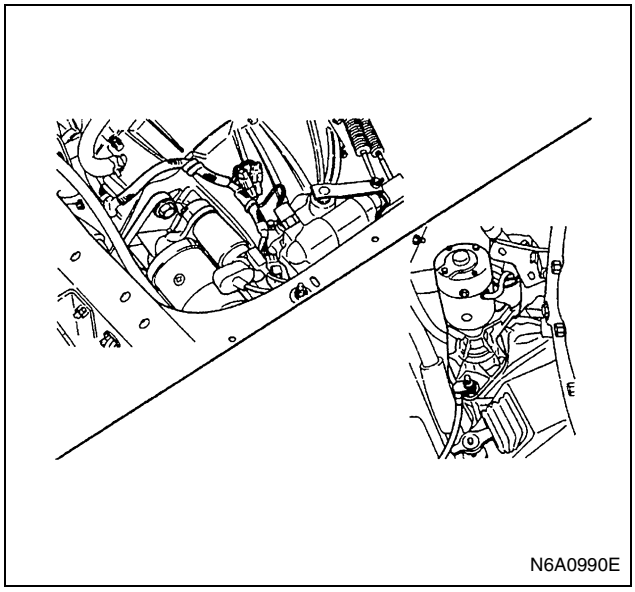
1. Starter Wiring Connector



Legend

1. Terminal B
2. Terminal S

2. Starter Assembly



- Install the starter to the flywheel housing.

Tighten:

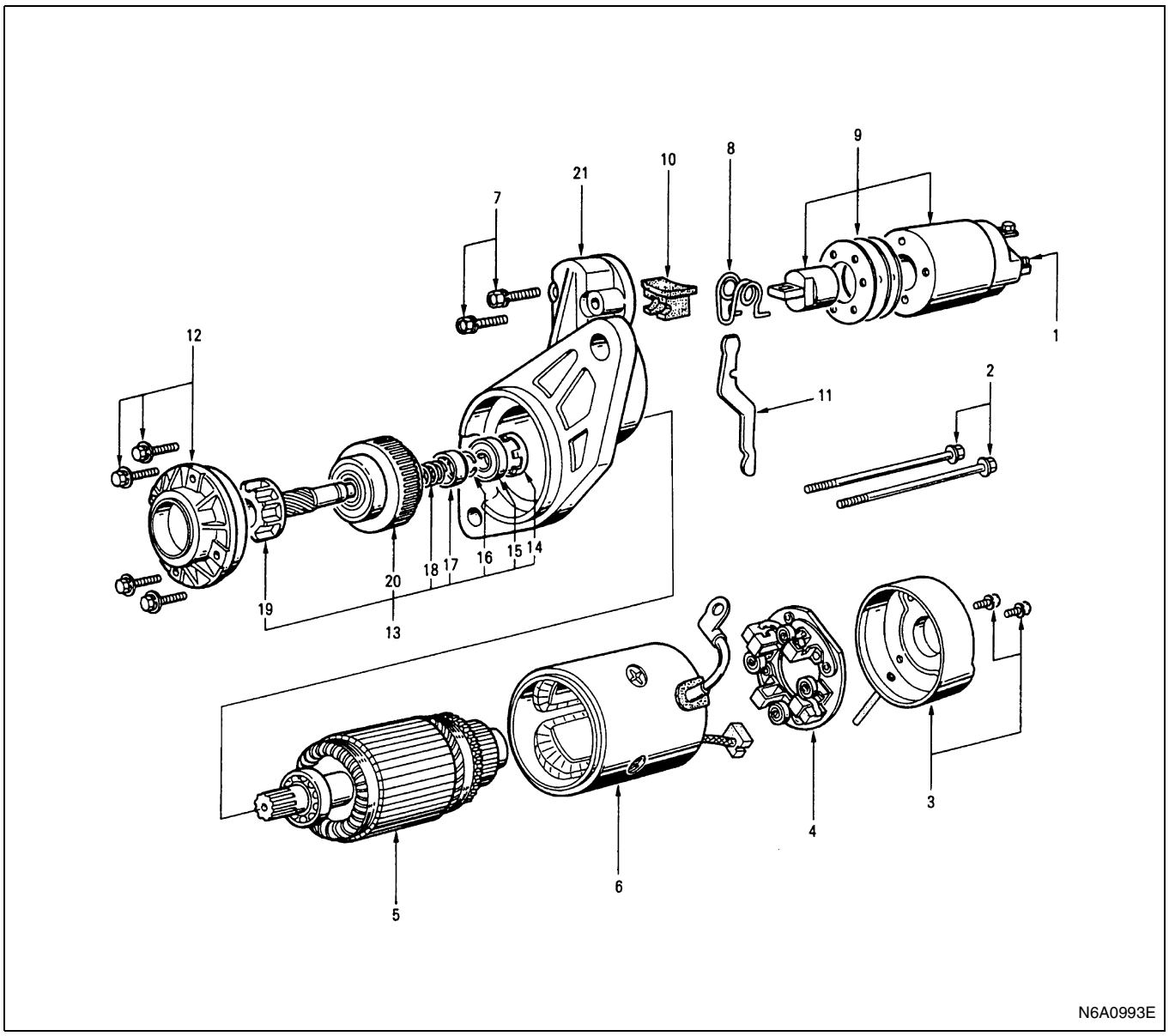
Starter bolt to 126 N·m (12.9 kg·m / 93 lb·ft)

3. Starter Earth Cable
   - Connect the earth cable to the starter motor.
   - Connect the battery ground cable.

UNIT REPAIR

Component

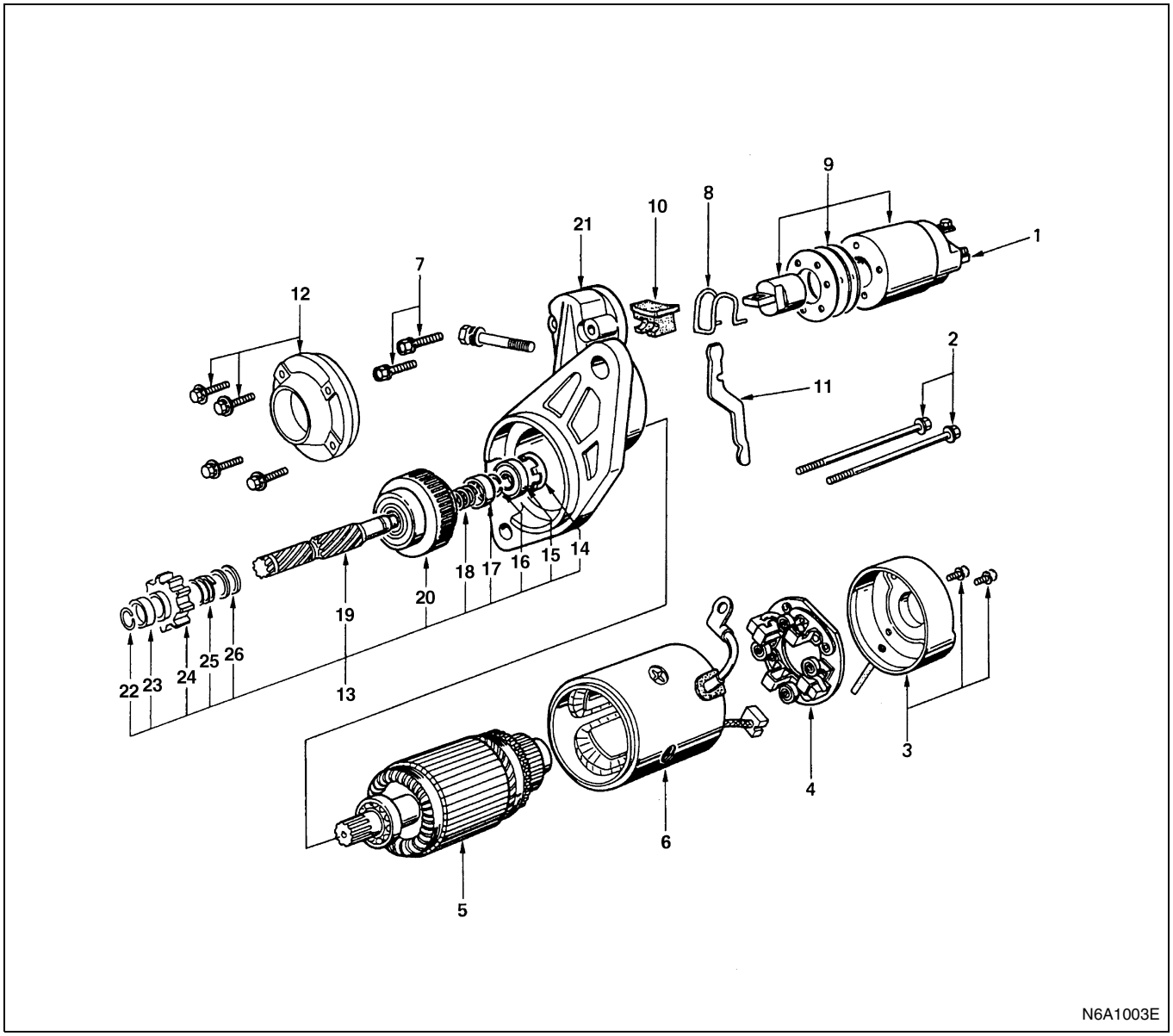
S25-168



Legend

1. Lead wire nut
2. Through bolt
3. Rear cover
4. Brush holder
5. Armature
6. Yoke
7. Bolt
8. Torsion spring
9. Magnetic switch assembly
10. Dust cover
11. Shift lever
12. Bearing retainer
13. Clutch assembly
14. Bearing holder
15. Ball bearing
16. Pinion stopper clip
17. Pinion stopper
18. Return spring
19. Pinion shaft
20. Pinion clutch
21. Gear case

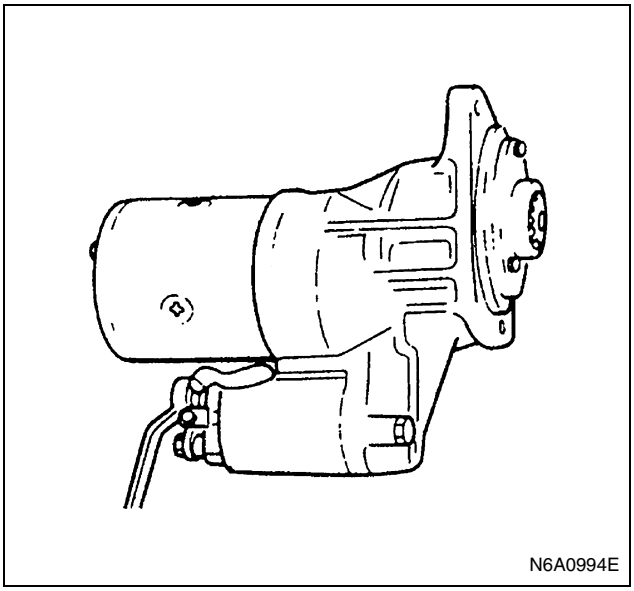
S25-305A



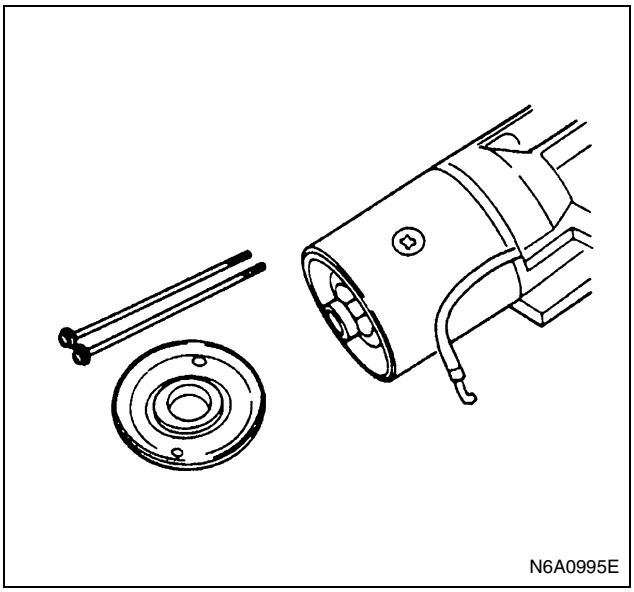
Legend

1. Lead wire nut
2. Through bolt
3. Rear cover
4. Brush holder
5. Armature
6. Yoke
7. Bolt
8. Torsion spring
9. Magnetic switch assembly
10. Dust cover
11. Shift lever
12. Bearing retainer
13. Clutch assembly
14. Bearing holder
15. Ball bearing
16. Pinion stopper clip
17. Pinion stopper
18. Return spring
19. Pinion shaft
20. Pinion clutch
21. Gear case
22. Clip
23. Pinion stopper
24. Pinion
25. Cushion spring
26. Washer

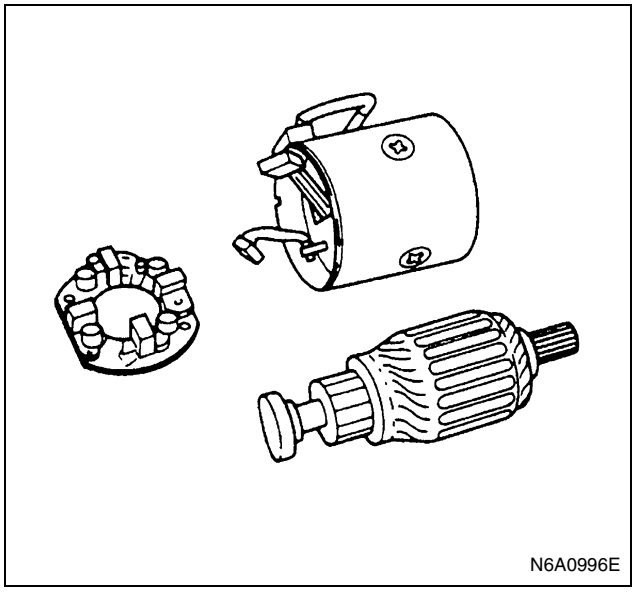
Disassembly


N6A0994E

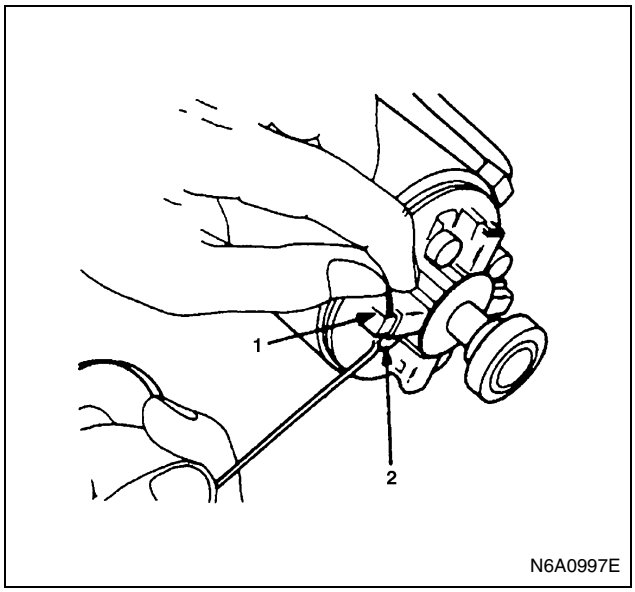
1. Lead Wire Nut
   Disconnect the lead wire at the magnetic switch.
2. Through Bolt


N6A0995E

3. Rear Cover
   Remove the through bolts, then remove the rear cover.
4. Brush Holder


N6A0996E

5. Armature
6. Yoke
   Remove the brush holder and pull the armature assembly from the yoke.
   Remove the four brushes from the brush holders.

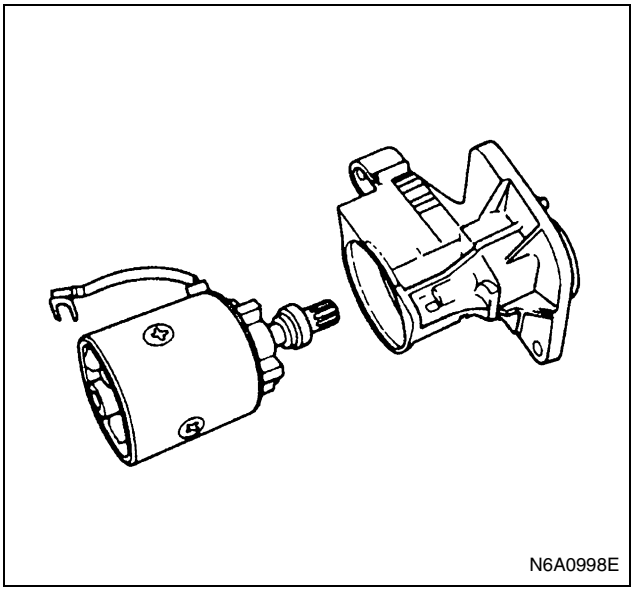


N6A0997E

Legend

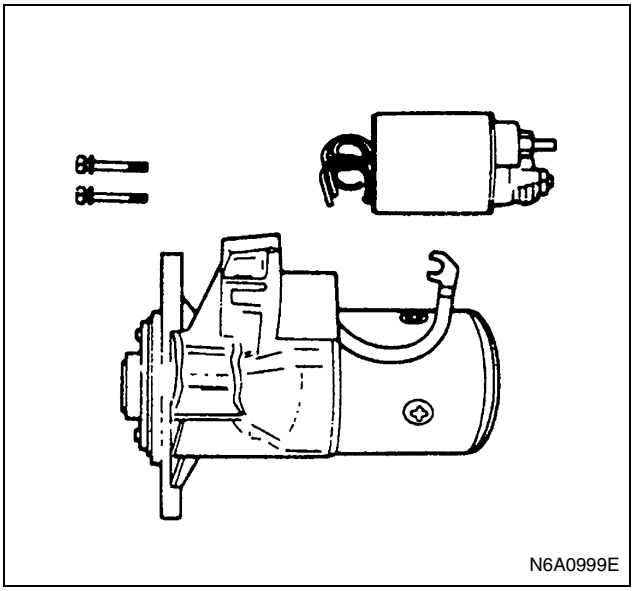
1. Brush
2. Brush spring

Remove the yoke along with the armature and the brush holder from the drive housing.


N6A0998E

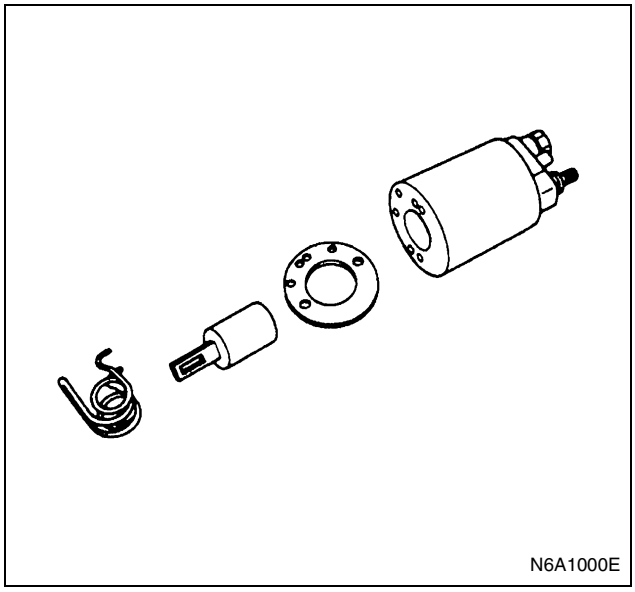
Remove the brushes and commutator carefully so as not to allow them in contact with the adjacent parts.

7. Bolt
8. Torsion Spring
9. Magnetic Switch Assembly

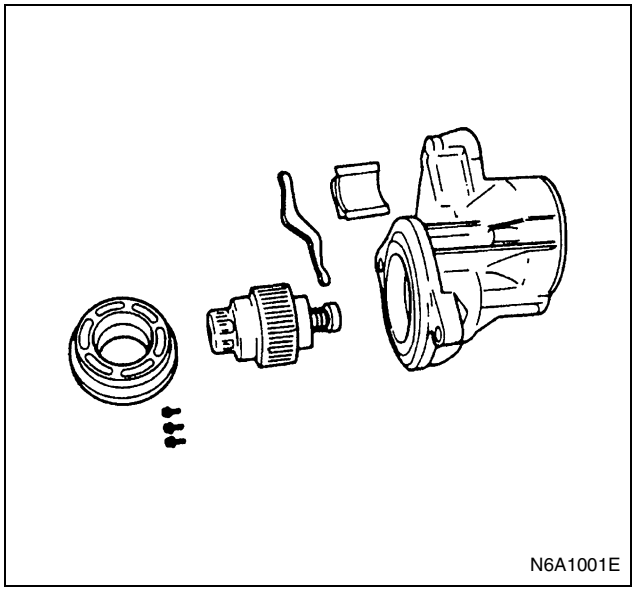

N6A0999E

Remove the magnetic switch bolts, then remove the switch from the shift lever.

Remove the torsion spring from the magnetic switch.


N6A1000E

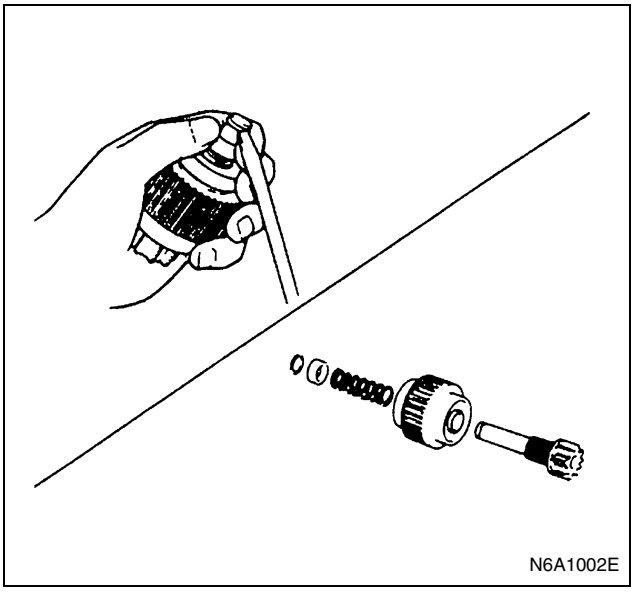
10. Dust Cover
11. Shift Lever
12. Bearing Retainer
13. Clutch Assembly


N6A1001E

1) Remove the bearing retainer.
2) Remove the clutch assembly from the gear case.

14. Bearing Holder
15. Ball Bearing
16. Pinion Stopper Clip
17. Pinion Stopper
18. Return Spring
19. Pinion Shaft
20. Pinion Clutch

Use a screwdriver to remove the stopper clip. Then disassemble the clutch assembly.


N6A1002E

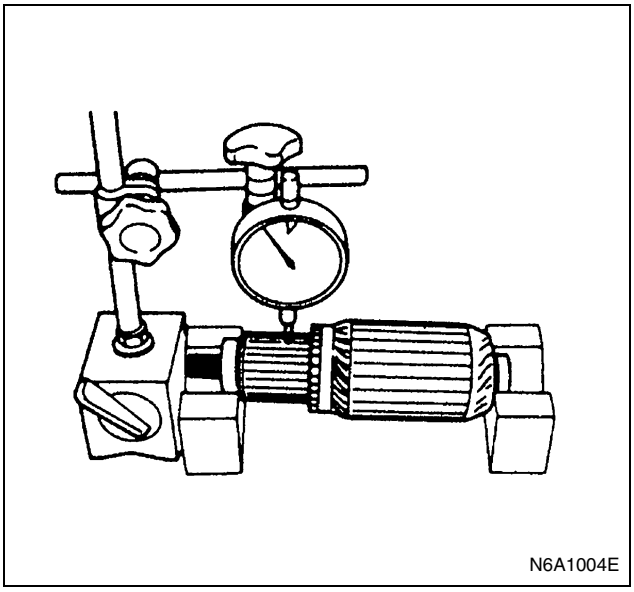
Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Armature

1. Measure the commutator run-out.
   Replace the commutator if the measured run-out exceeds the specified limit.

Commutator Run-Out	mm (in)
Standard	Limit
0.05 (0.002) or less	0.2 (0.008)

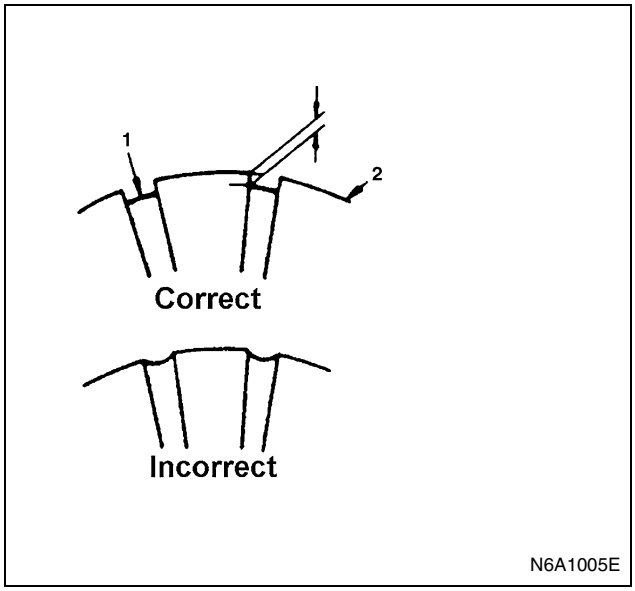

N6A1004E

2. Check the commutator mica segments for excessive wear.
3. Measure the mica segment depth.

Mica Segment Depth	mm (in)
Standard	Limit
0.5 — 0.8 (0.020 — 0.031)	0.2 (0.008)

If the mica segment depth is less than the standard but more than the limit, the commutator may be reground.

If the mica segment depth is less than the limit, the commutator must be replaced.

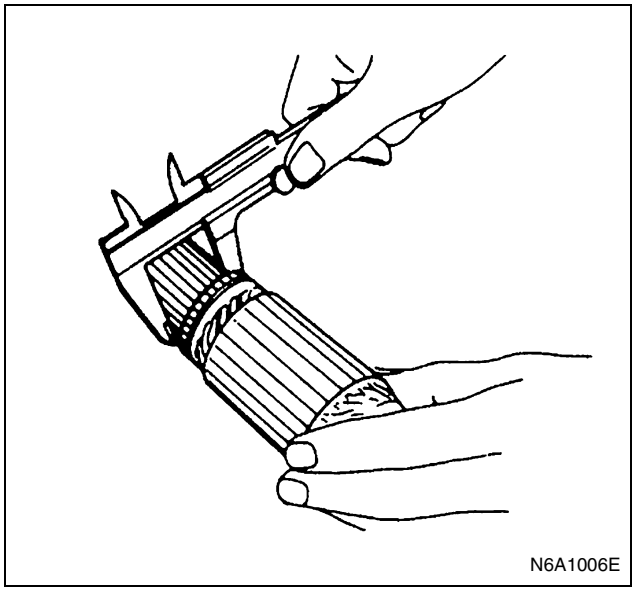


N6A1005E

Legend

1. Insulator
2. Commutator segments

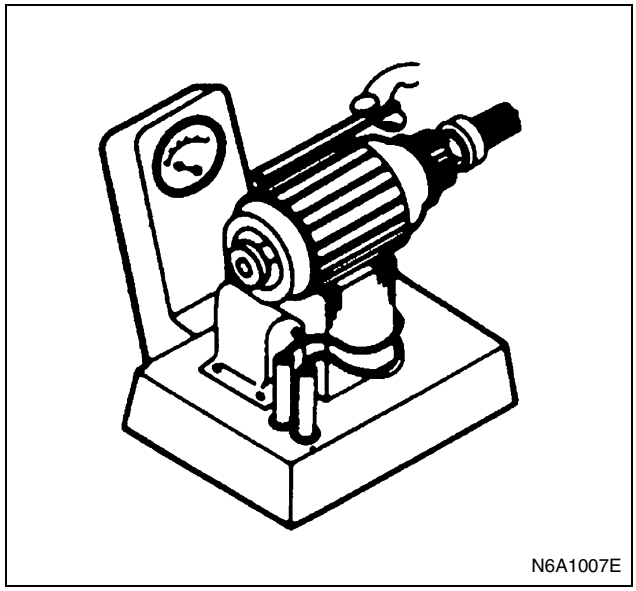
4. Measure the commutator outside diameter.


N6A1006E

Commutator Outside Diameter			mm (in)
Model	Yoke Diameter	Standard	Limit
S25-163C	ϕ80	36.5 (1.437)	35.5 (1.398)
S25-305C	ϕ90	38.0 (1.496)	36.6 (1.441)

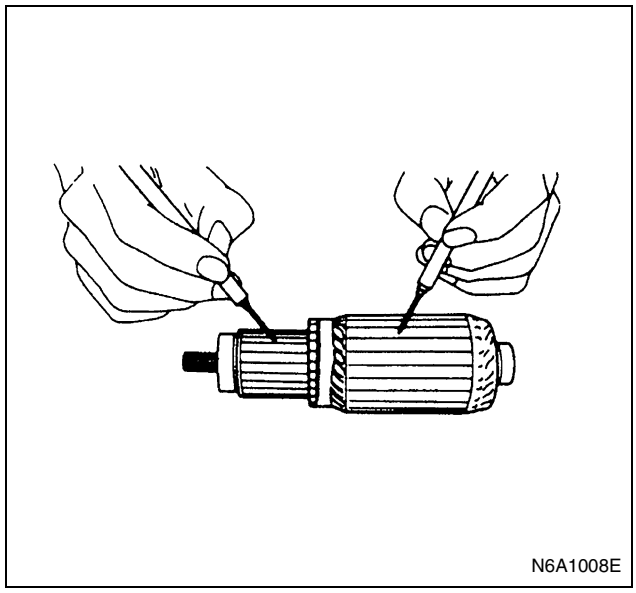
If the measured outside diameter is less than the specified limit, the commutator must be replaced.

5. Test the armature for short circuiting.


N6A1007E

a. Place the armature in a growler tester.
b. Hold a hacksaw blade against the armature core.
   If the armature has a short circuit, the hacksaw blade will vibrate.
   Replace the armature if there is a short circuit.

6. Use a circuit tester to check the armature for grounding.

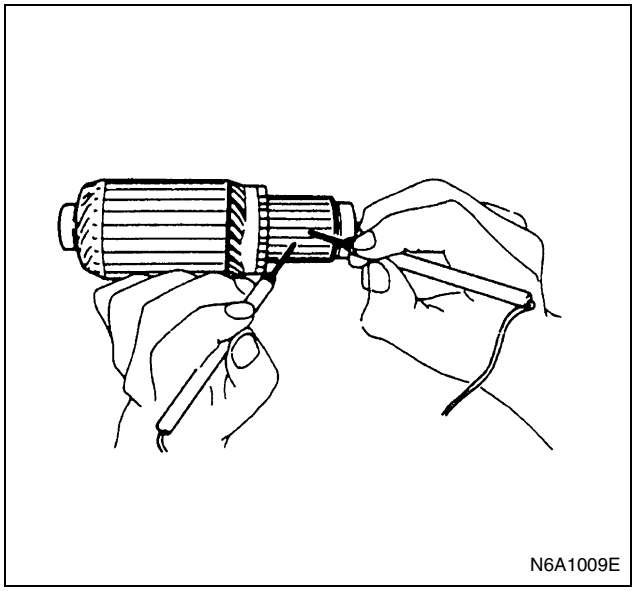

N6A1008E

1) Hold one probe of the circuit tester against the commutator segment.
2) Hold the other circuit tester probe against the armature core.

If the circuit tester indicates continuity, the armature is grounded.

The armature must be replaced.

7. Use the circuit tester to check the armature for continuity.


N6A1009E

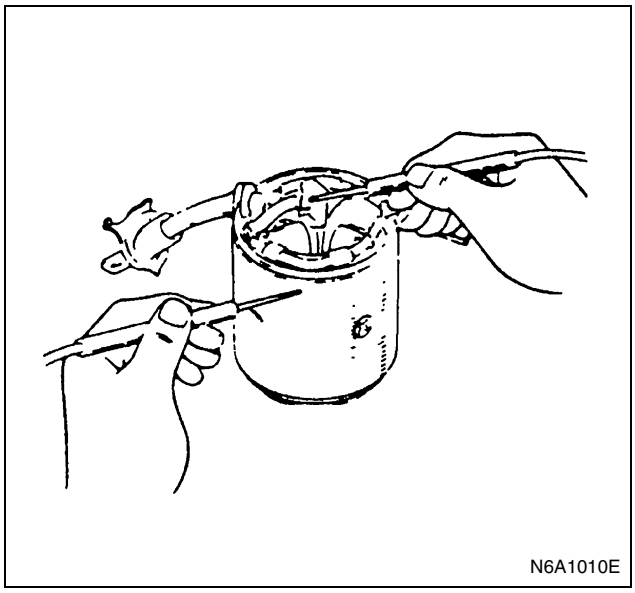
1) Hold the circuit tester probes against two armature core segments.
2) Repeat Step 1 at different segments of the armature core.

There should be continuity between all segments of the armature core.

If there is not, the armature must be replaced.

Yoke

1. Use a circuit tester to check the field winding ground.


N6A1010E

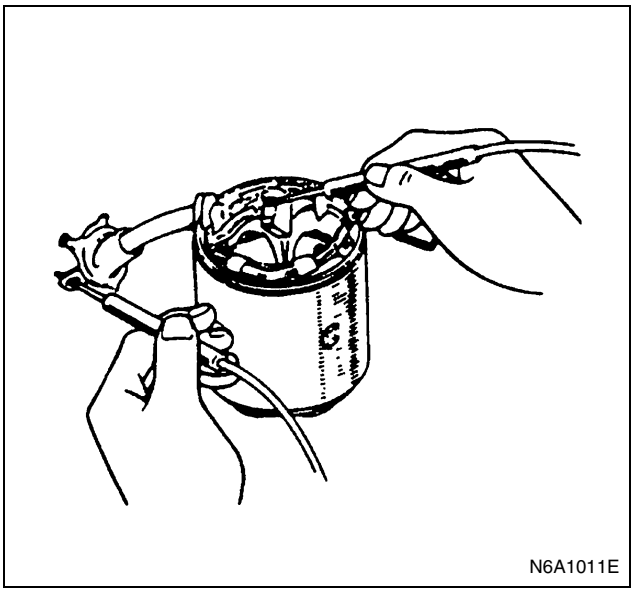
1) Hold one circuit tester probe against the field winding end or brush.
2) Hold the other circuit tester probe against the bare surface of the yoke body.

There should be no continuity.

If there is continuity, the field coil is grounded.

The yoke must be replaced.

2. Use the circuit tester to check the field winding continuity.


N6A1011E

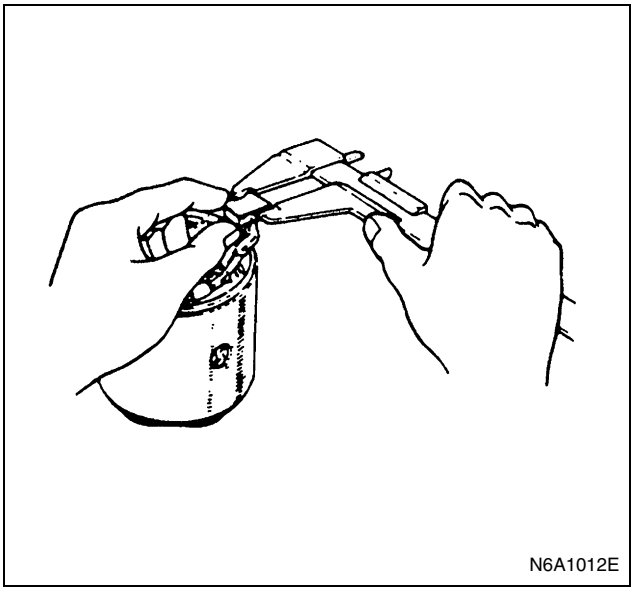
1) Hold one circuit tester probe against the “C” terminal lead wire.
2) Hold the other circuit tester probe against the field winding brush.

There should be continuity.

If there is no continuity, the yoke must be replaced.

Brush and Brush Holder

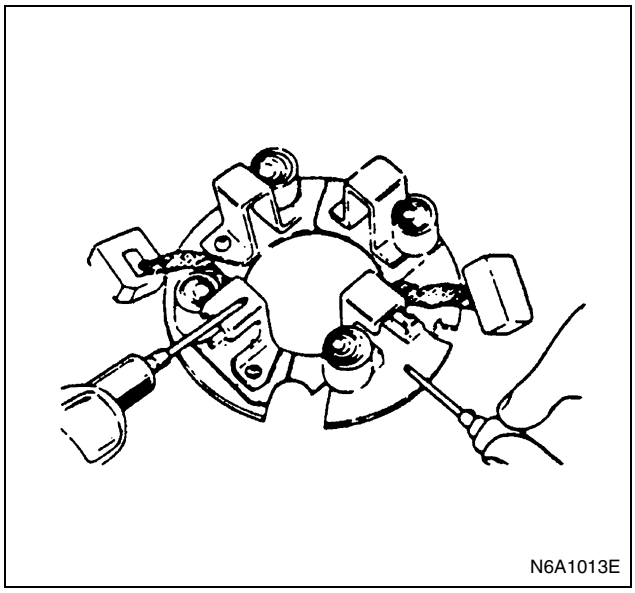
1. Use a vernier caliper to measure the brush length (four brushes).


N6A1012E

Replace the brushes as a set if one or more of the brush length is less than the specified limit.

Brush Length			mm (in)
Model	Yoke Diameter	Standard	Limit
S25-168	ϕ80	15.0 (0.591)	10.5 (0.413)
S25-305	ϕ90	18.0 (0.709)	11.0 (0.433)

2. Use a circuit tester to check the brush holder insulation.


N6A1013E

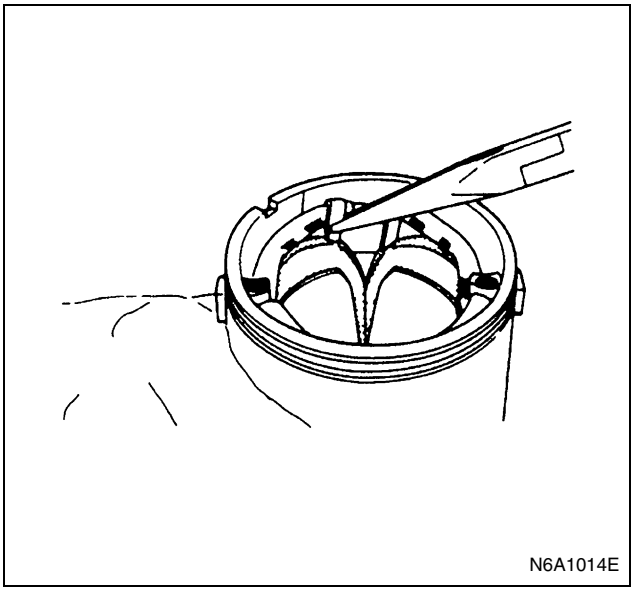
Touch one probe to the holder plate and the other probe to the positive brush holder.

There should be no continuity.

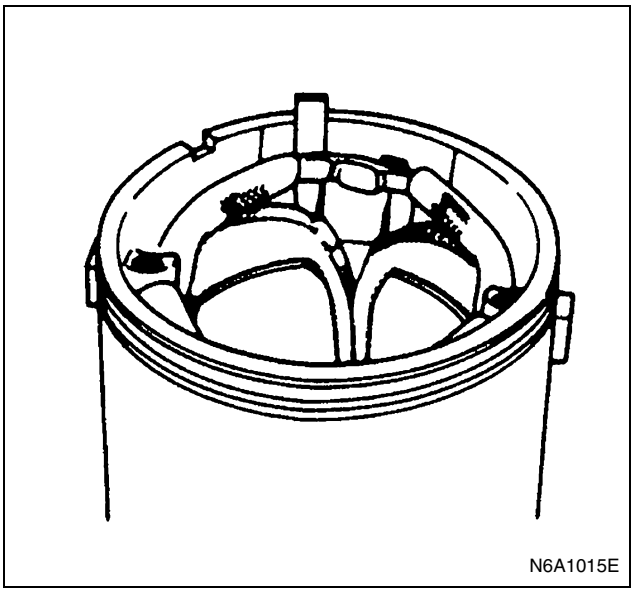
3. Inspect the brushes for excessive wear.
If the negative brushes have excessive wear, the entire brush holder assembly must be replaced.

If the positive brushes have excessive wear, only the brushes must be replaced.

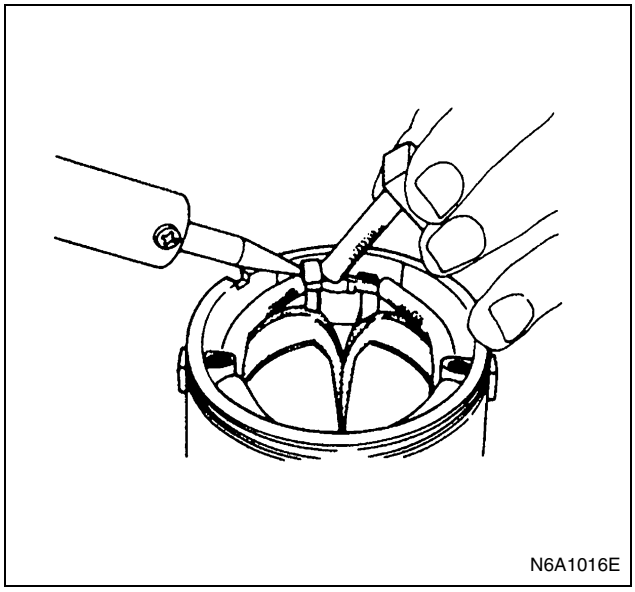
1) Use a pair of side cutters to cut the lead wire from the brush.


N6A1014E

2) File away any foreign material clinging to the edge of the lead wire.
3) Remove the brushes from the brush holder.
4) Install the new brushes.
5) Straighten the bent portion of the clip.


N6A1015E

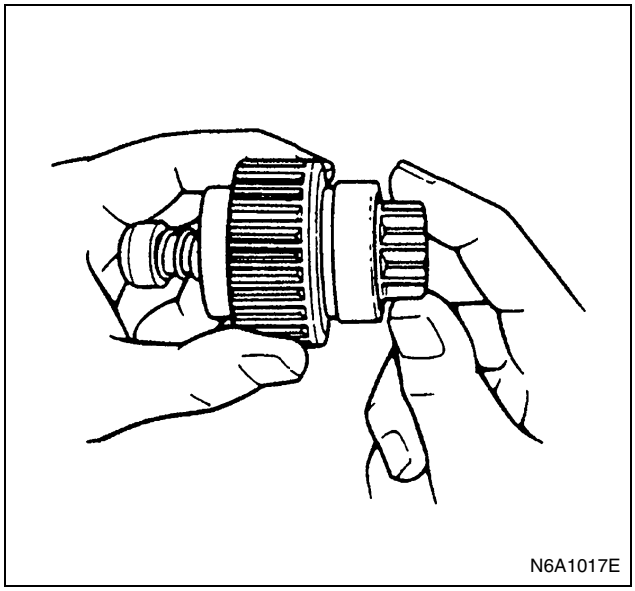
6) File away any foreign material clinging to the clip surface.
7) Place the lead wire in the clip.
8) Bend the clip shut.
9) Solder the brush lead.


N6A1016E

10) Repeat the procedure for each of the brushes.

Overrunning Clutch

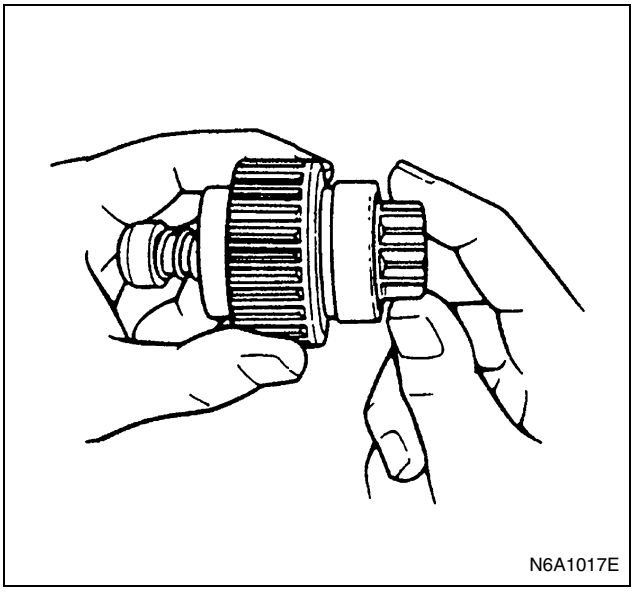
1. Inspect the overrunning clutch gear teeth for excessive wear and damage.
   Replace the overrunning clutch if necessary.
2. Rotate the pinion clockwise.


N6A1017E

   It should turn smoothly.
3. Try to rotate the pinion in the opposite direction.
   The pinion should lock.

Ball Bearing

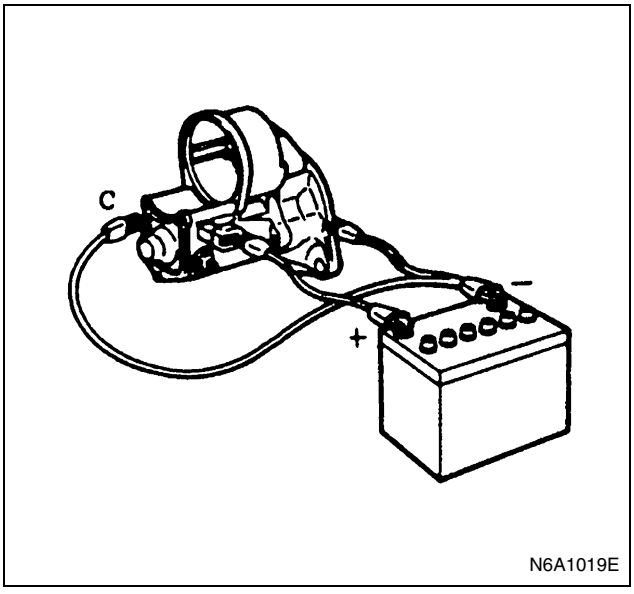
Inspect the bearings for excessive wear and damage.
Replace the bearings if necessary.


N6A1017E

Magnetic Switch

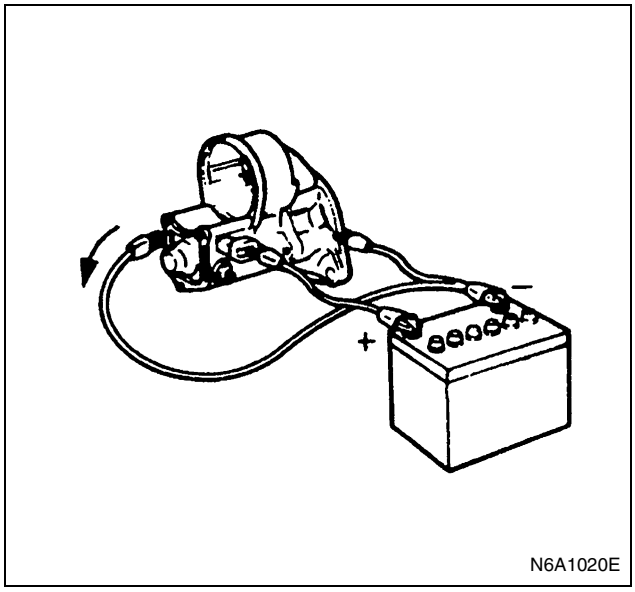
The following tests must be performed with the starter motor fully assembled.
The yoke lead wire must be disconnected from the “C” terminal.
To prevent coil burning, complete each test as quickly as possible (within three to five seconds).
Temporarily connect the magnetic switch between the clutch and the housing and run the following test.
Complete each test within three to five seconds.

1. Pull-Out Test
   Connect the battery negative terminal with the magnetic switch body and the C terminal. When current is applied to the 50 terminal from the battery positive terminal, the pinion should flutter.



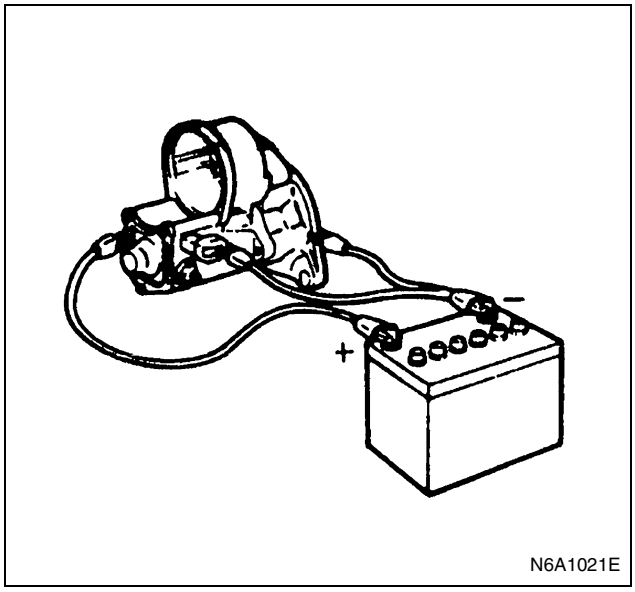
N6A1019E

2. Hold-in Maintenance Test
   Disconnect the lead at the C terminal. The pinion should continue to flutter.



N6A1020E

3. Return Test
   Connect the battery negative leads to the starter body and the 50 terminal.

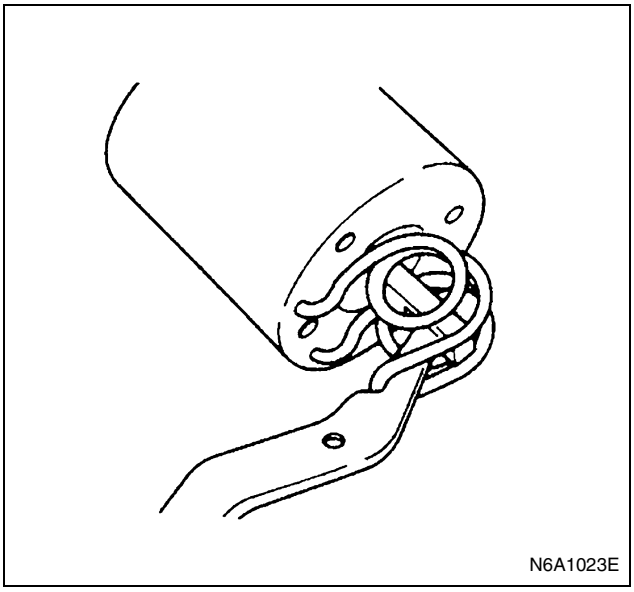


N6A1021E

Connect the battery positive lead at the C terminal.
The pinion should return to its home position.

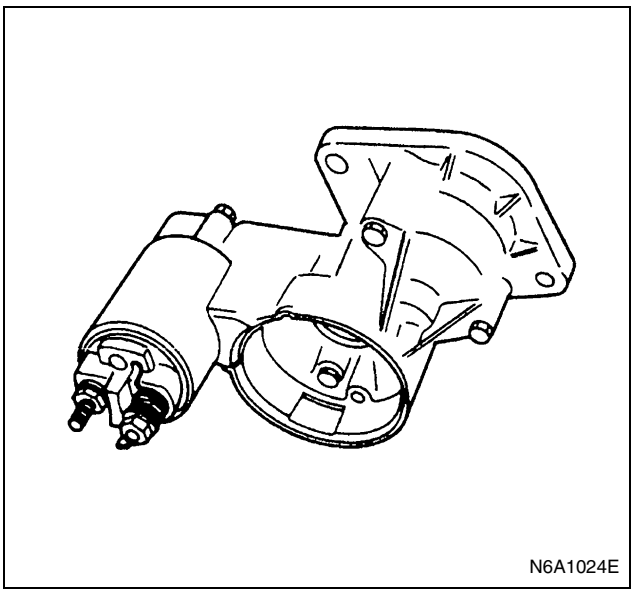
Reassembly

1. Gear Case
2. Magnetic Switch Assembly
3. Torsion Spring
4. Shift Lever
   1) Attach the torsion spring to the hole in the magnetic switch as illustrated.


N6A1023E

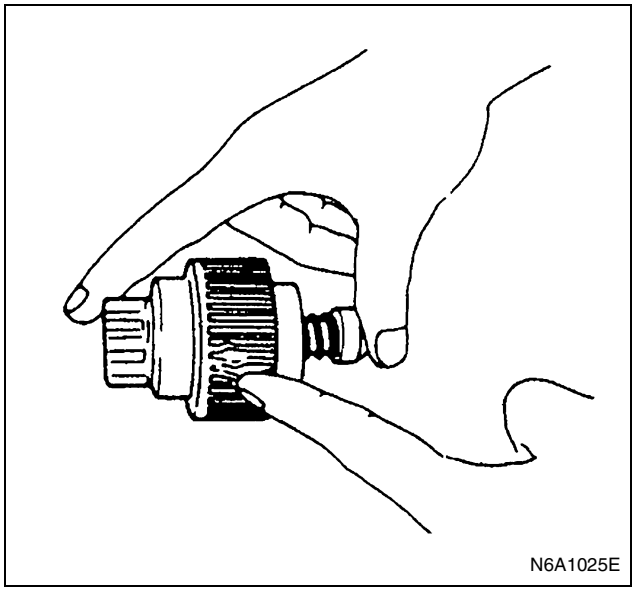
2) Insert the shift lever into the plunger hole of the magnetic switch.

5. Dust Cover
   Install the dust cover.
6. Bolt
   Install the magnetic switch assembly in the gear case and tighten the bolt to the specified torque.

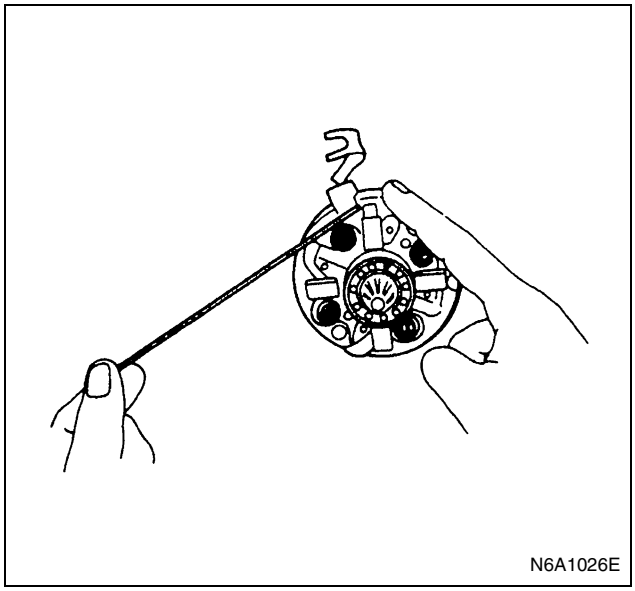

N6A1024E

Tighten:
Gear case bolt to 8 N·m (0.8 kg·m / 69 lb·in)

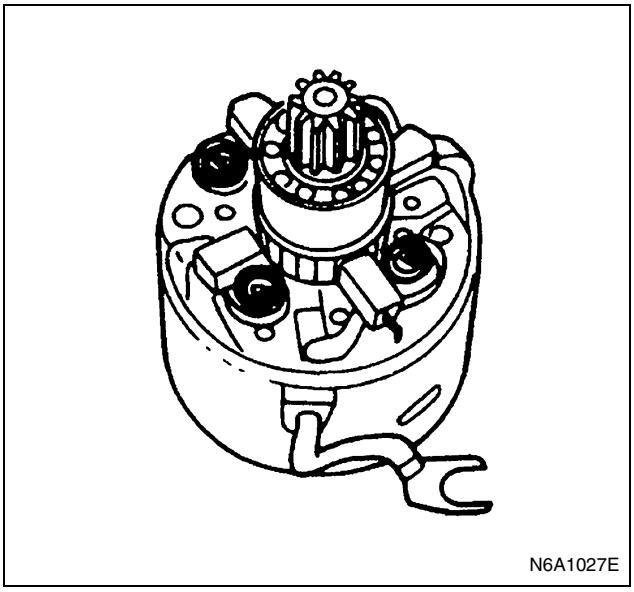
7. Pinion Clutch
8. Pinion Shaft
   Apply a coat of grease to the pinion clutch gear and install the pinion assembly to the armature shaft.


N6A1025E

9. Return Spring
10. Pinion Stopper
11. Pinion Stopper Clip
12. Ball Bearing
13. Bearing Holder
14. Clutch Assembly
15. Bearing Retainer
16. Armature
17. Yoke
18. Brush Holder

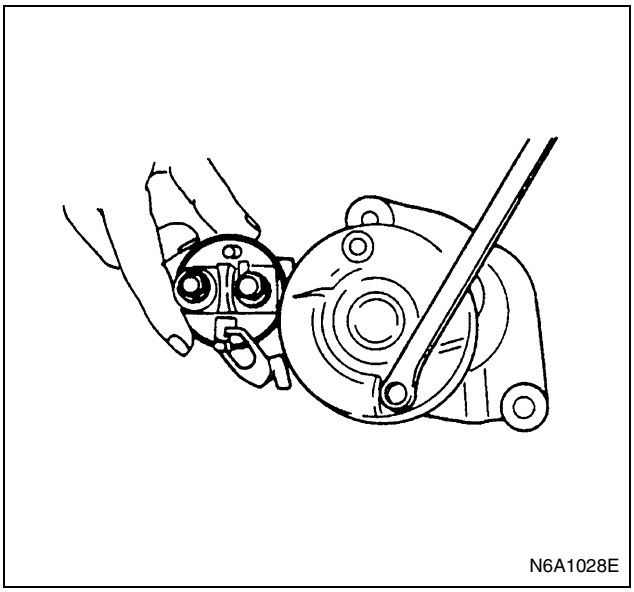

N6A1026E

1) Twist the holder spring and hold it.
2) Install the brush to the brush holder.
3) Repeat step 1 and 2 for the reaming holders.
4) Install the brush holder assembly to the yoke.


N6A1027E

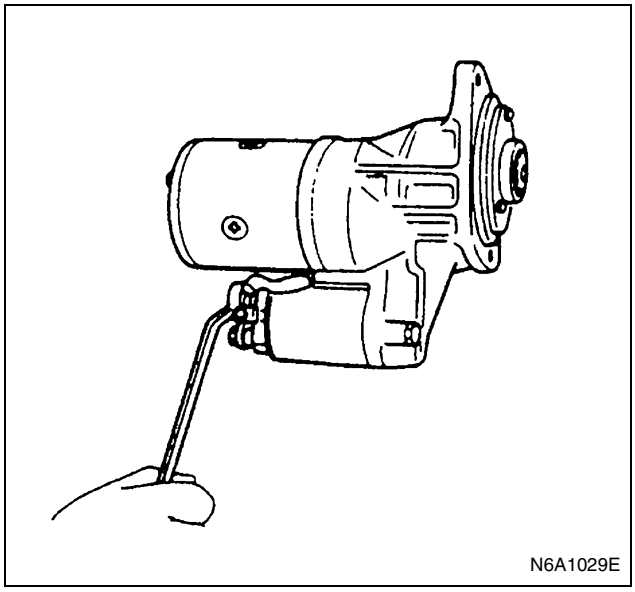
Take care not to damage the commutator face and the brushes.

19. Rear Cover
20. Through Bolt
    Install the through bolts in the rear cover and tighten them to the specified torque.


N6A1028E

Tighten:
Through bolt to 6 N·m (0.6 kg·m / 52 lb·in)

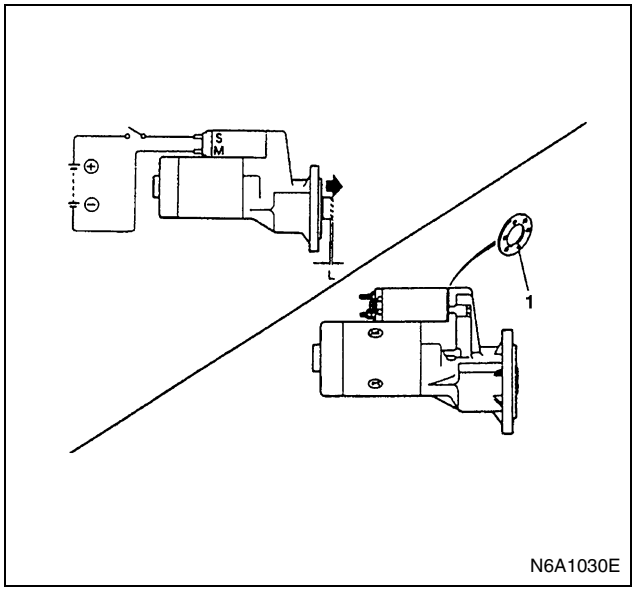
21. Lead Wire Nut
    Connect the lead wire in the magnetic switch and tighten the terminal nut to the specified torque.


N6A1029E

Tighten:
Lead wire terminal nut to 10 N·m (1.0 kg·m / 87 lb·in)

Pinion Jump-out dimension

- Connect the (+) cable of battery to terminal S and the (–) cable to terminal M. Turn the switch on, and measure pinion travel dimension “L” in thrust direction from the jump-out position.



N6A1030E

Legend
1. Spacer

In measuring the dimension, pull the pinion out a little in the arrow direction.

	mm (in)
Dimension	Standard
L	0.3 — 0.1 (0.01 — 0.004)

If the measured value is out of standard, adjust the of shims.

ENGINE 4H SERIES

SECTION 6D3

CHARGING SYSTEM

Contents

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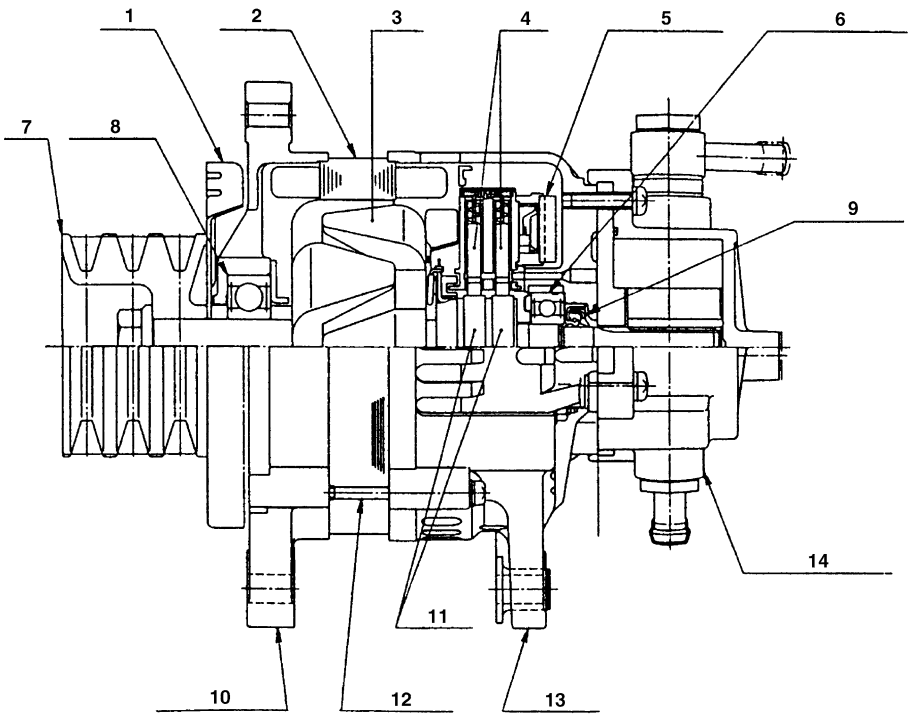
GENERAL DESCRIPTION

The charging system is the IC integral regulator charging system and its main components are connected as shown in figure.
The regulator is a solid state type and it is mounted along with the brush holder assembly inside the generator installed on the rear end cover.
The generator does not require particular maintenance such as voltage adjustment. The rectifier connected to the stator coil has nine diodes to transform A.C. voltage into D.C. voltage. This D.C. voltage is connected to the output terminal of generator.

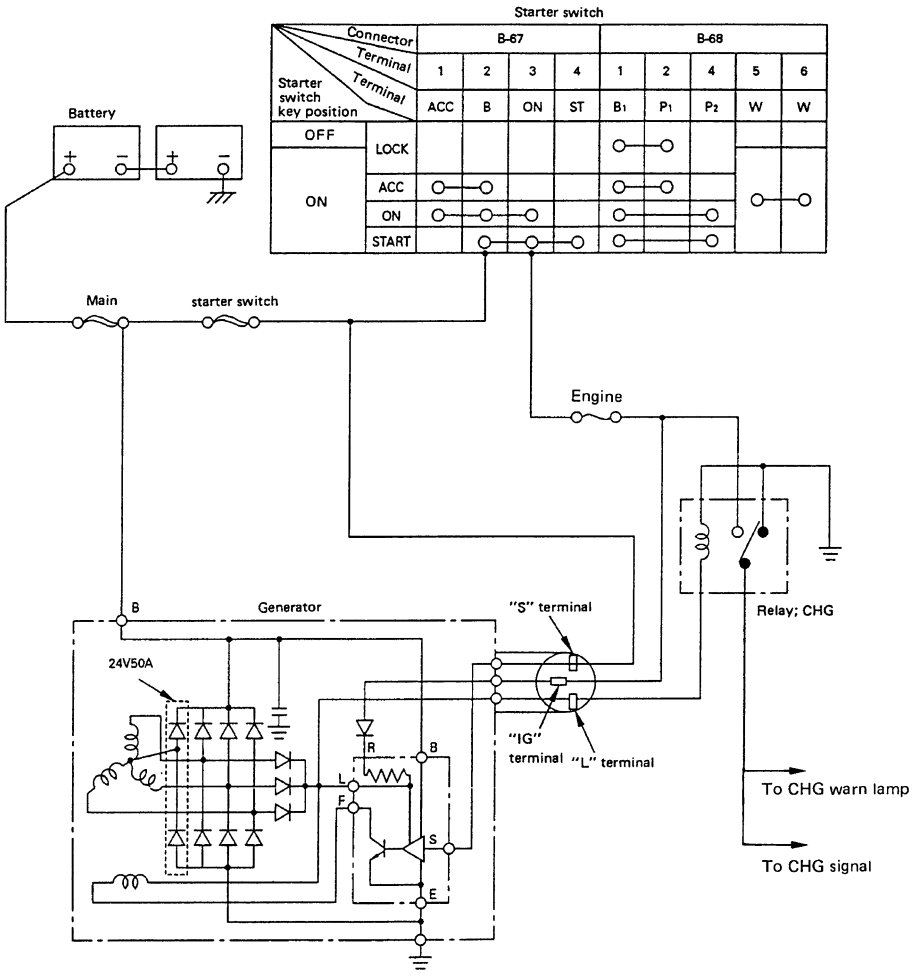
Component



N6A1032E

Legend

1. Fan
2. Stator
3. Rotor
4. Brush
5. IC regulator
6. Ball bearing
7. Pulley
8. Ball bearing
9. Oil seal
10. Front cover
11. Slip ring
12. Through bolt
13. Rear cover
14. Vacuum pump

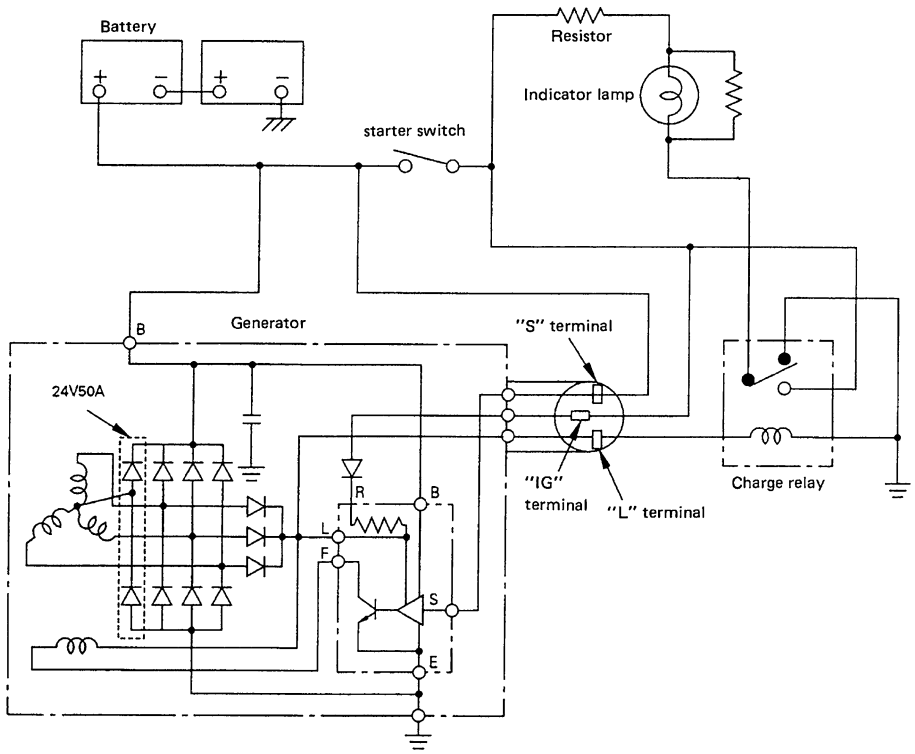

Starter switch
Connector
Terminal
Terminal
Starter switch key position
B-67
B-68
1 2 3 4 1 2 4 5 6
ACC B ON ST B1 P1 P2 W W
OFF
LOCK
ON
ACC
ON
START
Battery
Main
starter switch
Engine
Relay; CHG
B
Generator
"S" terminal
24V50A
R
B
L
F
S
E
"IG" terminal
"L" terminal
To CHG warn lamp
To CHG signal

N6A1033E

DIAGNOSIS

General On-Vehicle Inspection

The operating condition of charging system is indicated by the charge warning lamp. The warning lamp comes on when the starter switch is turned to “ON” position. The charging system operates normally if the lamp goes off when the engine starts. If the warning lamp shows abnormality or if undercharged or overcharged battery condition is suspected, perform diagnosis by checking the charging system as follows:



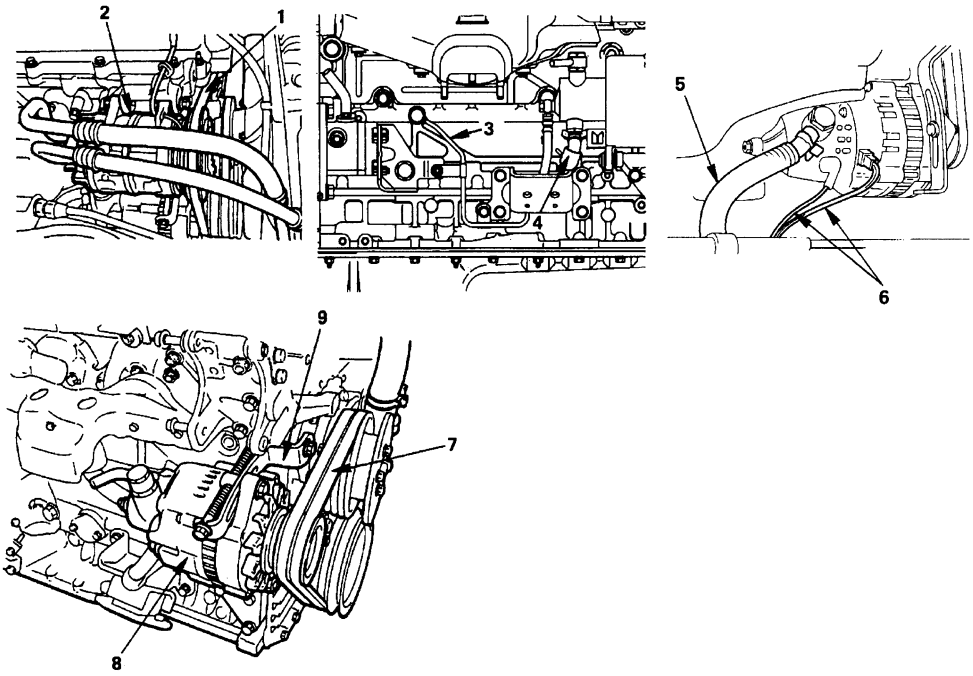
N6A1034E

1. Check visually the belt and wiring connector.
2. With the engine in stop status, turn the starter switch to “ON” position and observe the warning lamp.
   - If lamp does not come on:
     Disconnect wiring connector from generator, and ground the terminal “L” on connector side.
   - If lamp comes on:
     Repair or replace the generator.

ON-VEHICLE SERVICE

Component

Generator



N6A1035E

Legend

1. A/C compressor drive belt
2. A/C compressor
3. Vacuum pump oil pipe
4. Vacuum pump rubber hose
5. Vacuum hose
6. ACG harness
7. Fan belt
8. Generator
9. Adjust plate

Removal

Preparation

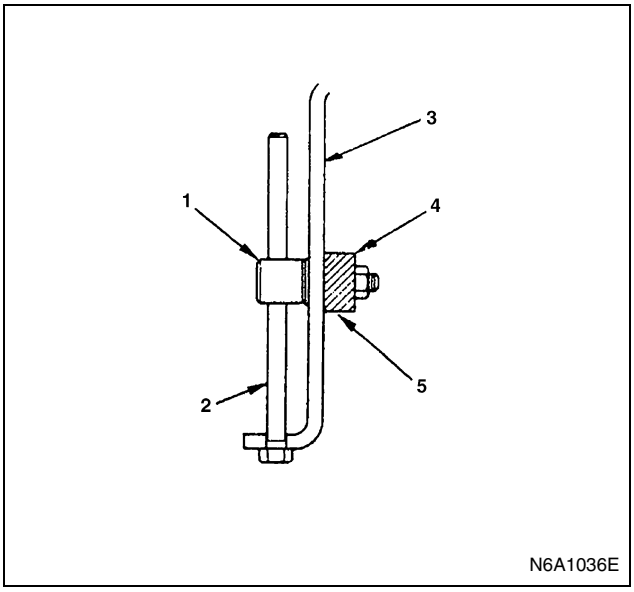
- Disconnector the battery ground cable.
- Tilt the cab.

1. A/C Compressor Drive Belt (If equipped with A/C)
2. A/C Compressor (If equipped with A/C)
   - After disconnecting the A/C compressor harness connector, demount the compressor from the A/C compressor bracket and fasten it with a wire to an appropriate location together with the hoses.
3. Vacuum Pump Oil Pipe
4. Vacuum Pump Rubber Hose
5. Vacuum Hose
6. ACG Harness

   Disconnect the B terminal cable and harness connector from generator.
7. Fan Belt
8. Generator
9. Adjust Plate

Installation

1. Adjust Plate
   Install the adjust plate as shown in the illustration.

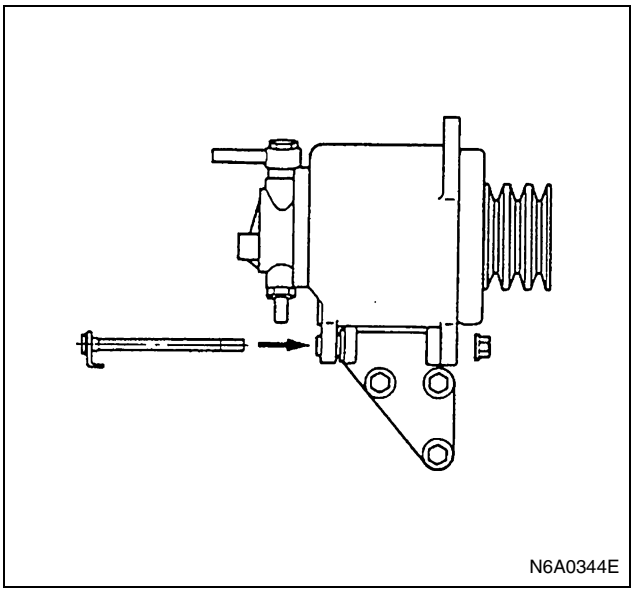


Legend
1. Sliding piece
2. Adjust bolt
3. Adjust plate
4. Nut
5. Generator

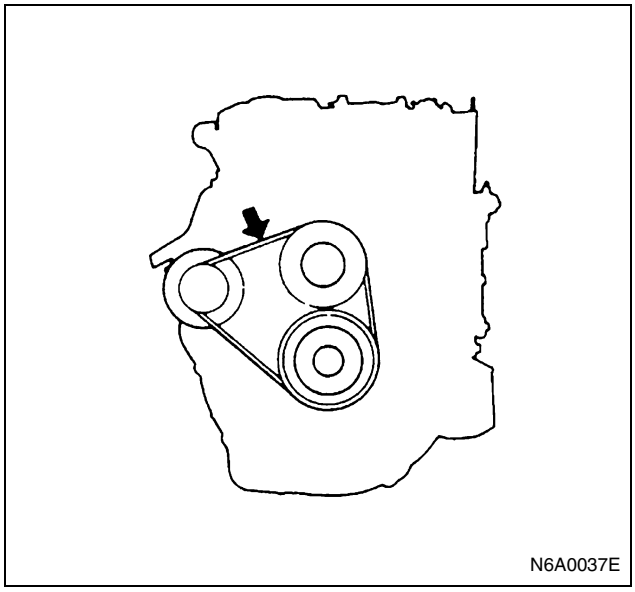
2. Generator

Notice:
Before tightening the generator, tighten in advance the fan belt temporarily after its adjustment.

- Insert the lower fixing bolt from the rear side as shown in the illustration, and tighten it with a nut on the front side.



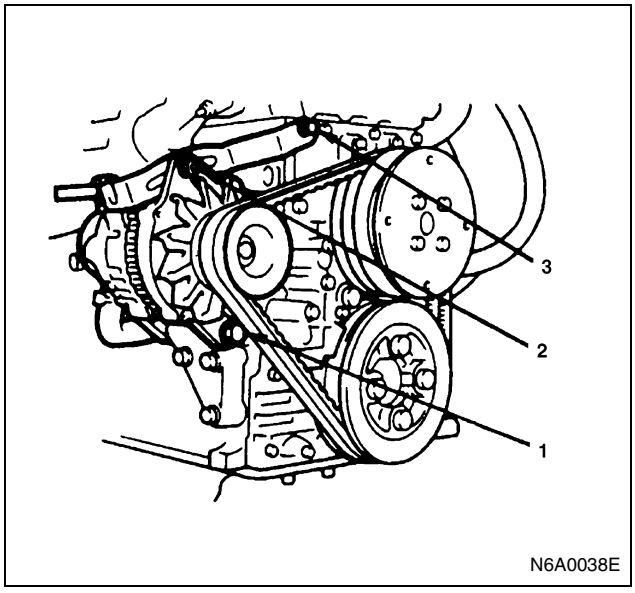
3. Fan Belt
   Check the drive belt tension.
   Depress the drive belt mid-portion with a 98 N (10 kg / 22 lb) force.



Drive Belt Deflection	mm (in)
New belt	8 — 12 (0.31 — 0.47)
Reuse belt	10 — 14 (0.39 — 0.55)

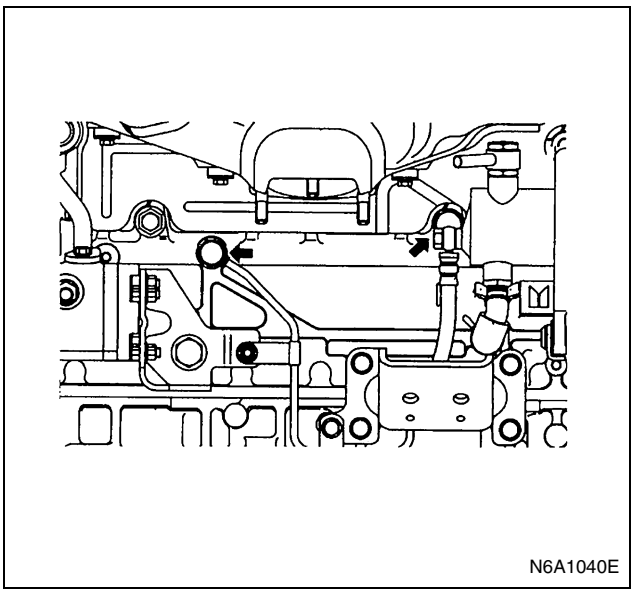
   Check the drive belt for cranking and other damage.

Fan Belt Adjustment
Fan belt tension is adjusted by moving the generator.



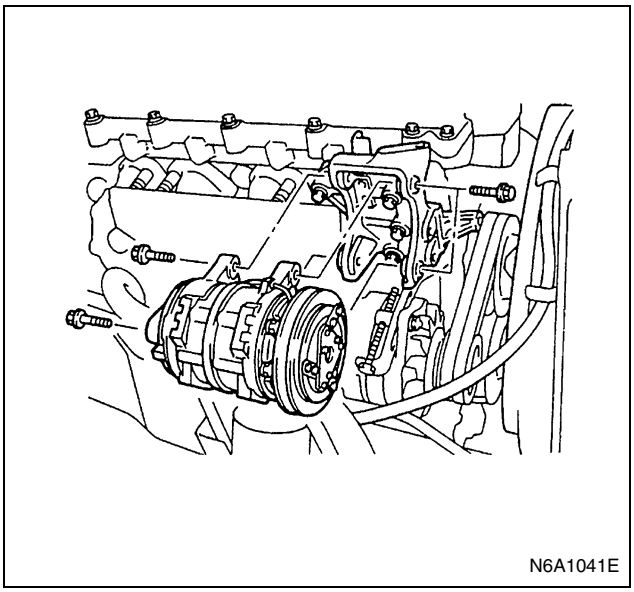
Tighten:
Bolt to
- (1): 40 N·m (4.1 kg·m / 30 lb·ft)
- (2): 24 N·m (2.4 kg·m / 17 lb·ft)
- (3): 46 N·m (4.7 kg·m / 34 lb·ft)

4. ACG Harness
5. Vacuum Hose
6. Vacuum Pump Rubber Hose
7. Vacuum Pump Oil Pipe


N6A1040E

Tighten:
Vacuum pump oil pipe to
- Cylinder body side: 41 N·m (4.2 kg·m / 30 lb·ft)
- Generator side: 23 N·m (2.3 kg·m / 17 lb·ft)

8. A/C Compressor (If equipped with A/C)

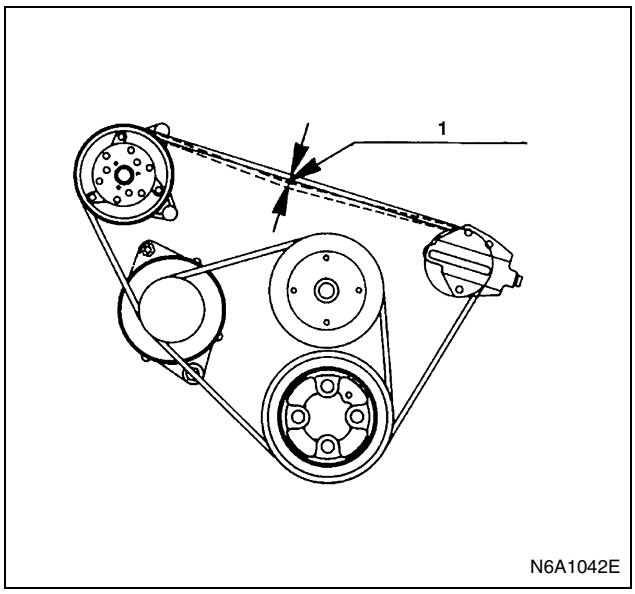

N6A1041E

- Tighten the fixing bolts to the specified torque.

Tighten:
A/C compressor bolt to 48 N·m (4.9 kg·m / 35 lb·ft)

Notice:
When installing the compressor fixing bolts, tighten first the 2 bolts on the rear side, and then the remaining 2 on the front side.

9. A/C Compressor Drive Belt (If equipped with A/C)
   - Install the drive belt adjust belt tension by adjusting bolt and tighten the locking nut to the specified torque.
   - Depress the drive belt mid-portion with a 98 N (10 kg / 22 lb) force.



N6A1042E

Legend
1. Belt deflection

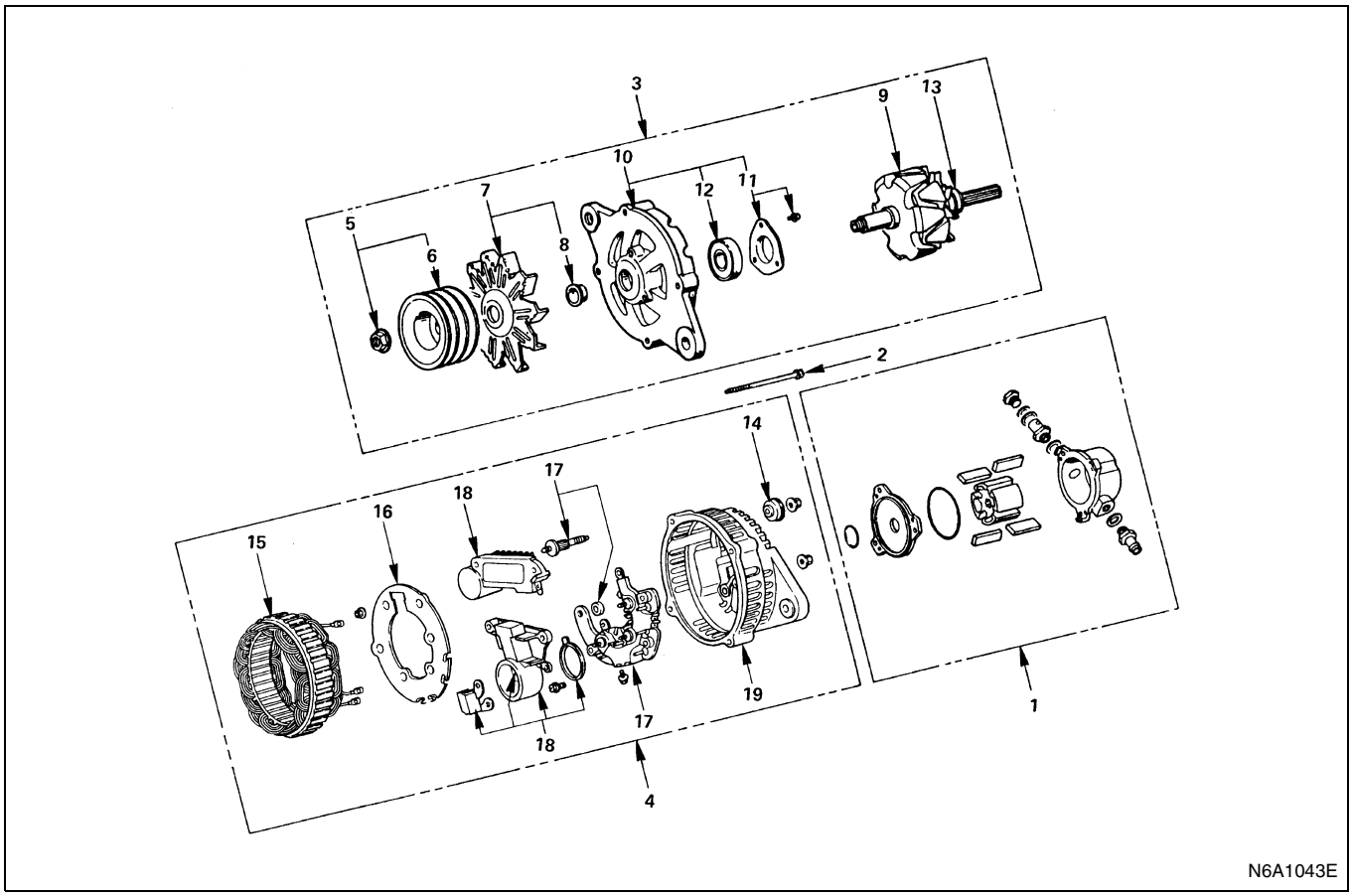
Drive Belt Deflection	mm (in)
New belt	16 — 20 (0.63 — 0.79)
Reuse belt	18 — 22 (0.71 — 0.87)

Tighten:
Locking nut to 27 N·m (2.8 kg·m / 20 lb·ft)

- Connect the negative battery cable.
- Lower the cab.

UNIT REPAIR

Component

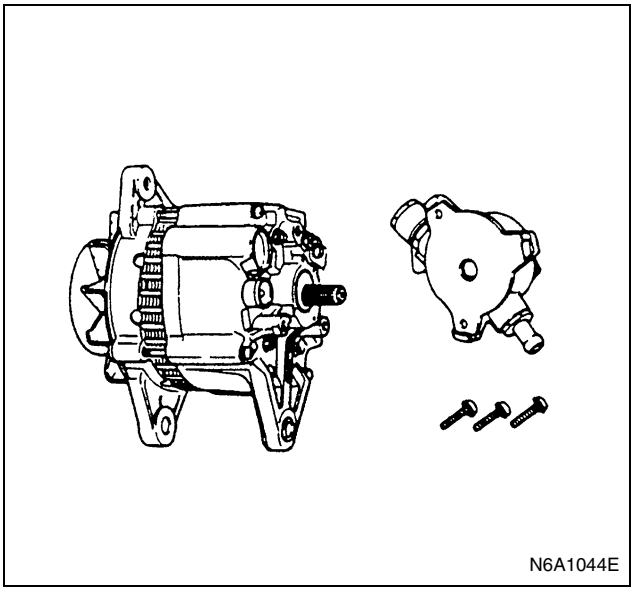


Legend

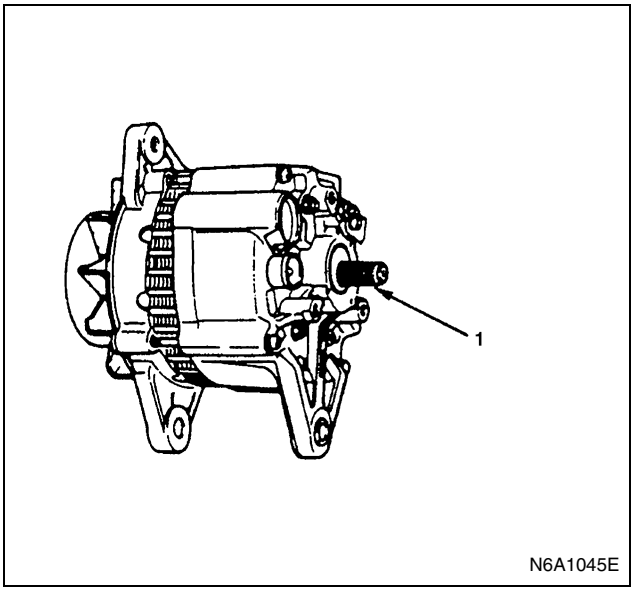
1. Vacuum pump assembly
2. Through bolt
3. Rotor and front cover assembly
4. Stator and rear cover assembly
5. Pulley nut
6. Pulley
7. Fan
8. Spacer
9. Rotor
10. Front cover
11. Bearing retainer
12. Front ball bearing
13. Rear ball bearing
14. Terminal nut and bolt
15. Stator
16. Fan guide
17. Rectifier
18. Brush and IC regulator
19. Rear cover

Disassembly

1. Vacuum Pump Assembly


N6A1044E

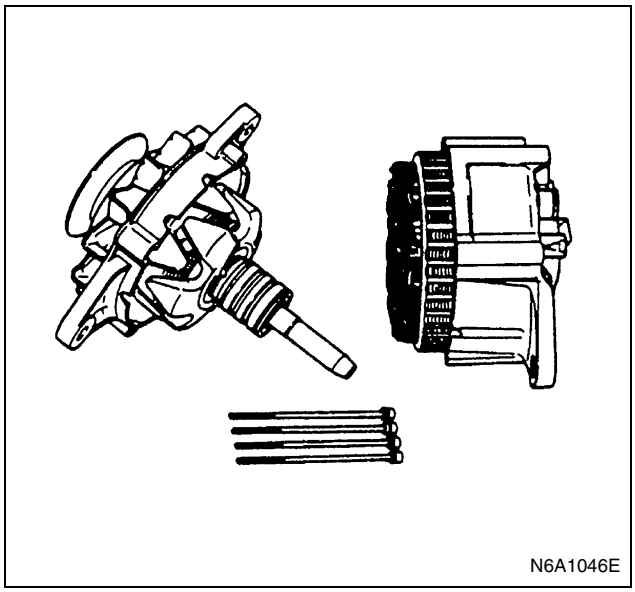
   1) Loosen the vacuum pump fixing bolts.
   2) Support the vacuum pump center plate.
   3) Carefully remove the vacuum pump.
2. Through Bolt
3. Rotor and Front Cover Assembly
4. Stator and Rear Cover Assembly
   1) Loosen the through bolts.
   2) Remove the rotor and front cover assembly from the stator and rear cover assembly.
      Do not allow the stator to separate from the rear cover.
      Take care not to damage the oil seal.
      Tape the rotor splines to protect them from damage.



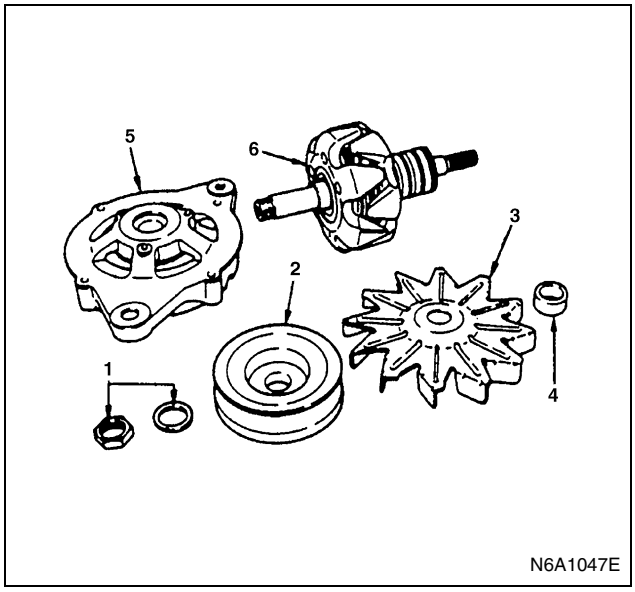
N6A1045E

Legend
1. Taping

5. Pulley Nut
6. Pulley
7. Fan
8. Spacer
9. Rotor

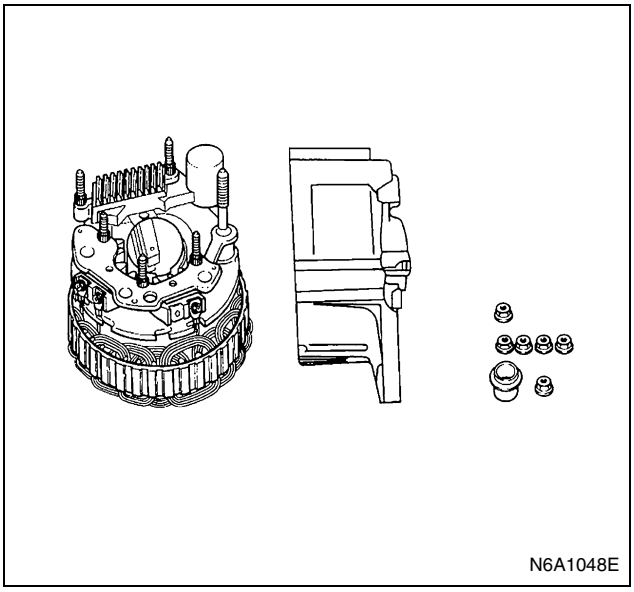

N6A1046E

   1) Carefully clamp the rotor assembly in a vice.



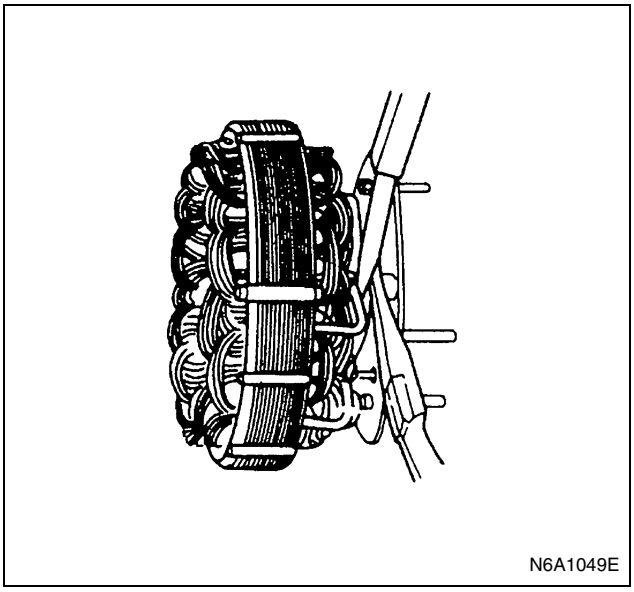
N6A1047E

   2) Loosen the pulley nut (1).
   3) Remove the pulley (2), the fan (3), the spacer (4), the front cover (5) and the rotor (6).
10. Front Cover
11. Bearing Retainer
12. Front Ball Bearing
13. Rear Ball Bearing
14. Terminal Nut and Bolt
15. Stator


N6A1048E

1) Loosen the terminal nuts and bolts.
2) Remove the lead wire, the insulators, and the washers.
3) Remove the stator and the IC regulator assembly from the rear cover.

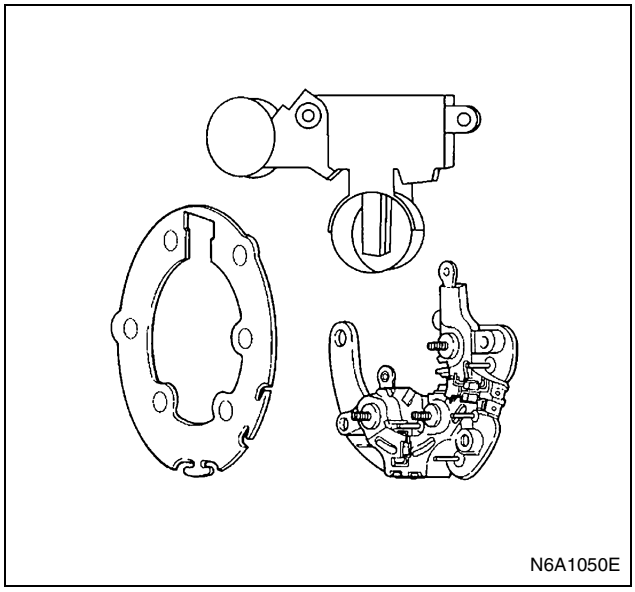
16. Fan guide
17. Rectifier
18. Brush and IC Regulator
    Disconnect the stator coil leads between each rectifier and the N-terminal by melting the solder connection.


N6A1049E

Notice:
Hold the lead wire between the solder and the rectifier with a pair of long nose pliers.

This will prevent heat transfer and resultant damage to the rectifier.

Refer to “INSPECTION AND REPAIR” for the IC regulator, the rectifier, the brush holder, and the condenser replacement procedures.


N6A1050E

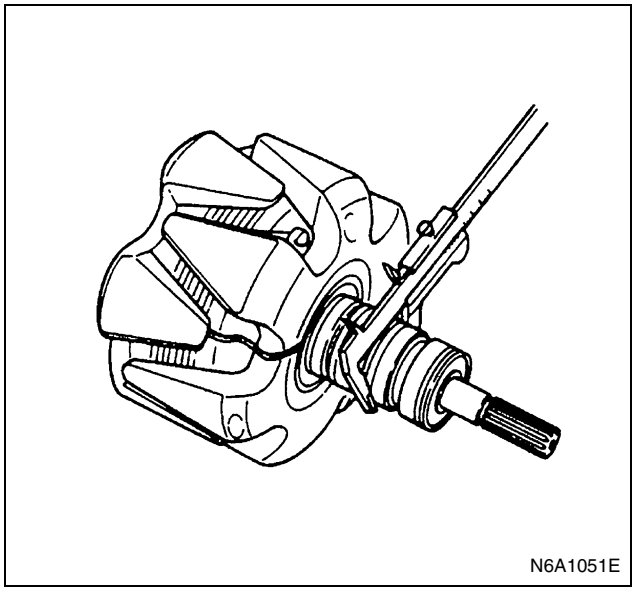
19. Rear Cover

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Rotor

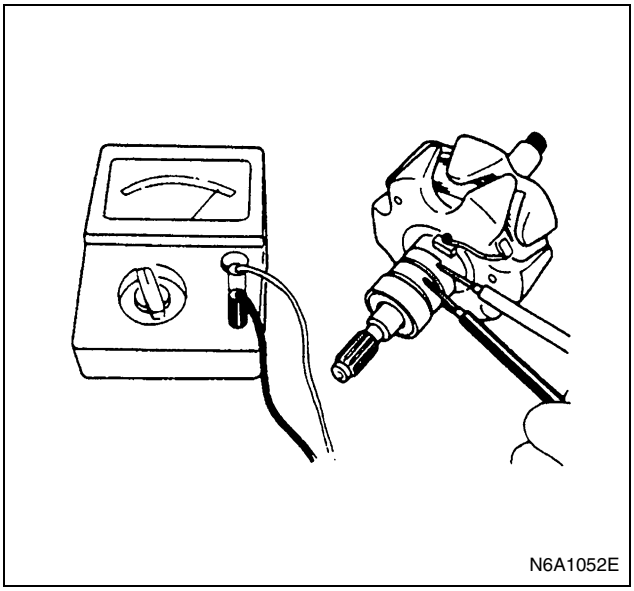
1. Inspect the slip ring faces for dirt and pitting.
   Wipe away any dirt with a clean cloth soaked in alcohol.
   Use a hand grinder to remove pitting.
2. Measure the slip ring diameter.


N6A1051E

Slip Ring Diameter	mm (in)
Standard	Limit
37.6 (1.480)	36.6 (1.441)

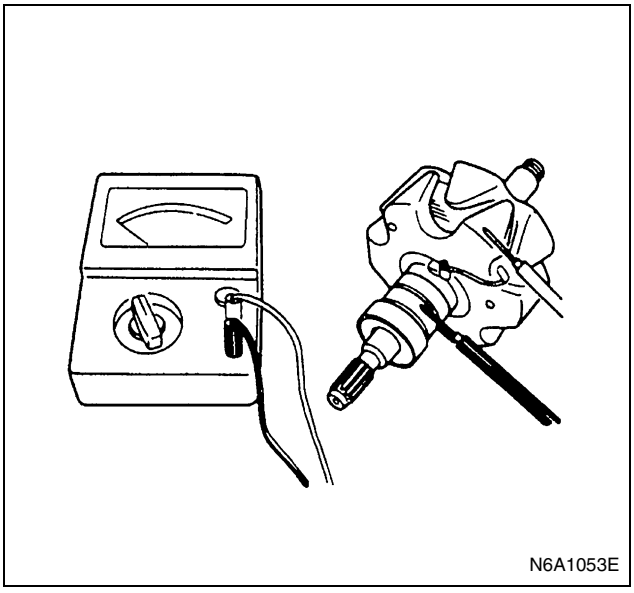
If the slip ring diameter is less than the specified limit, the slip rings must be replaced.

3. Measure the rotor coil resistance.



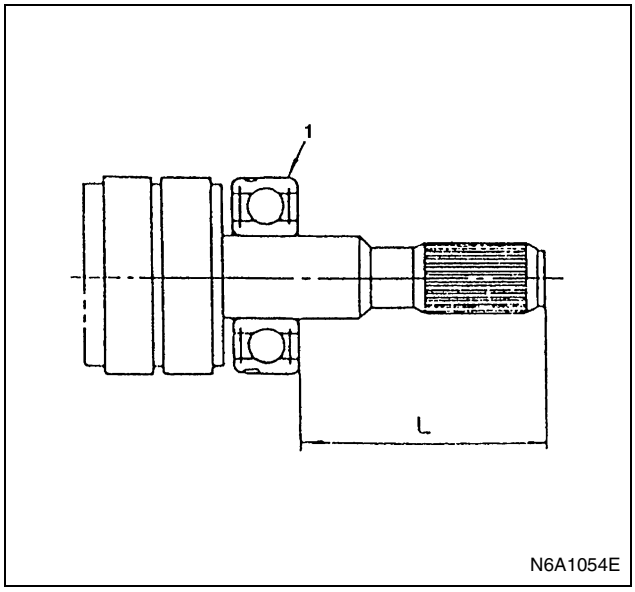
Rotor Coil Resistance at 20°C (68°F)	ohms
Standard	12.6

4. Check for continuity between the slip rings and the rotor core or shaft.



If there is continuity, the entire rotor assembly must be replaced.

5. Rear ball bearing



Legend

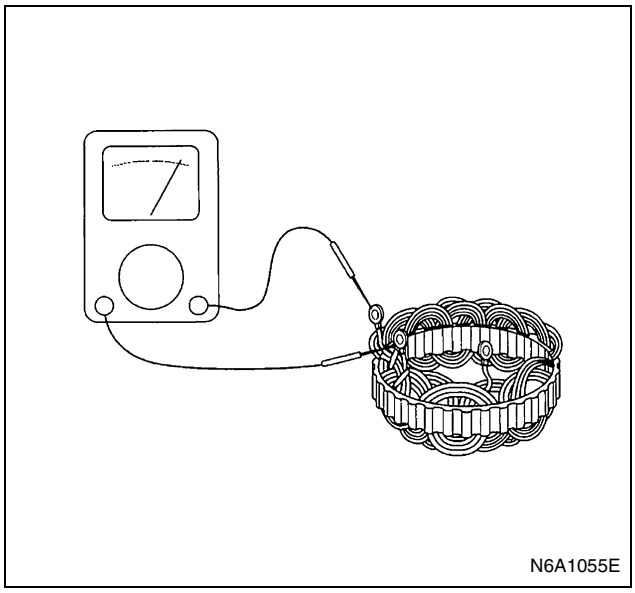
1. Ball bearing

- Check to see if the ball bearings rotate lightly with no noise heard.
- As the result of inspection, it is found that the ball bearing do not rotate lightly or any noises are heard, replace them with new ones.

Press-in measurement (L) when changing bearings	mm (in)
Standard	58.0 — 58.2 (2.283 — 2.291)

Stator

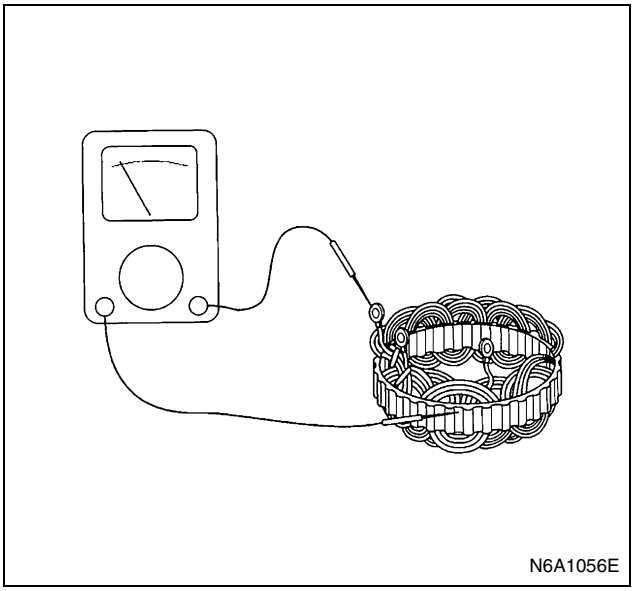
1. Check for continuity across the stator coils.



If there is no continuity, the stator coils must be replaced.

Resistance Between The Coil End “N” And The Each Coil Ends (Reference)	ohms
Standard	0.17

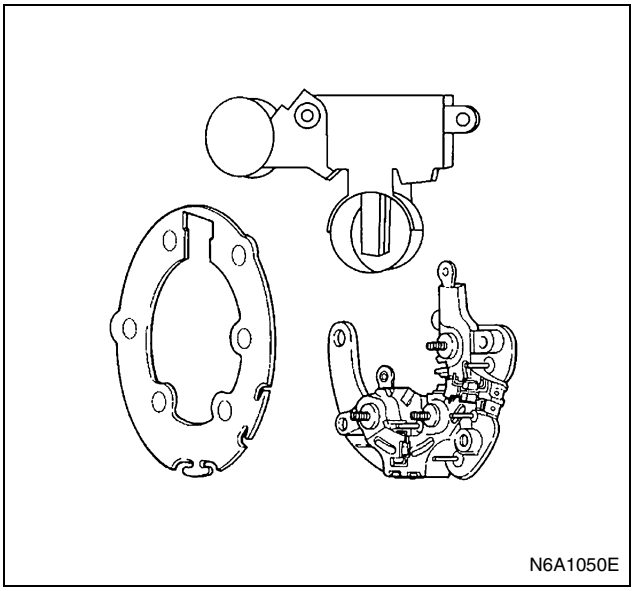
2. Check for continuity between each stator coil and the stator core.



If there is continuity, the stator coils must be replaced.

Rectifier, IC Regulator, and Brush Holder Assembly

Disassembly



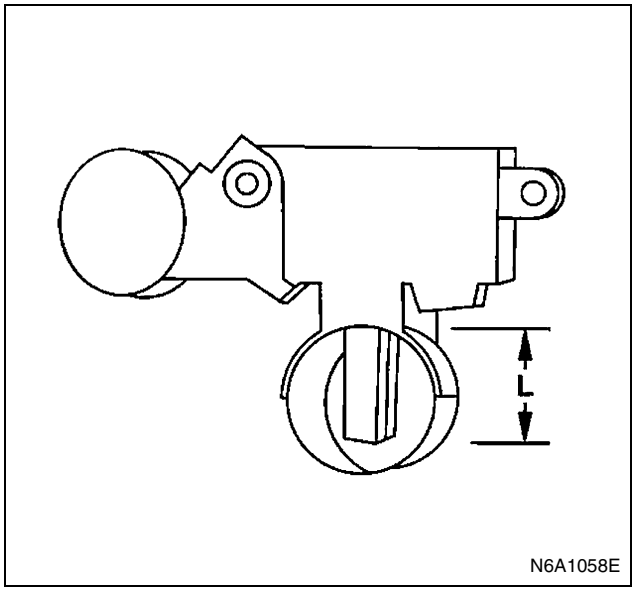
1. Disconnect the IC regulator and the rectifier by melting the solder connections.
2. Loosen the terminal bolt to remove the rectifier.
3. Disconnect the IC regulator, the brush holder, and the condenser by melting the solder connections.
4. Remove the IC regulator from the terminal plates.
5. Remove the stud bolts from the terminal plate.

Notice:
If the brushed, brush holder, and the condenser to be reused, do not remove the stud bolts.

6. Remove the brush holder from the terminal plate.

Inspection

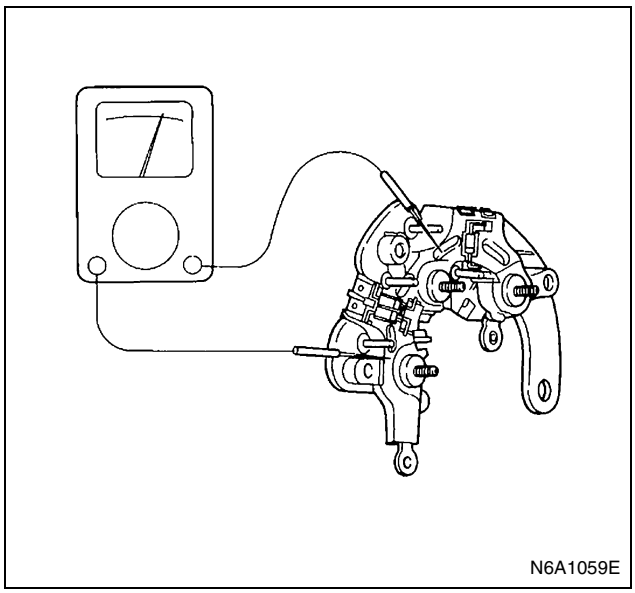
1. Brush
   Each brush has a line to indicate whether or not the brush is serviceable.

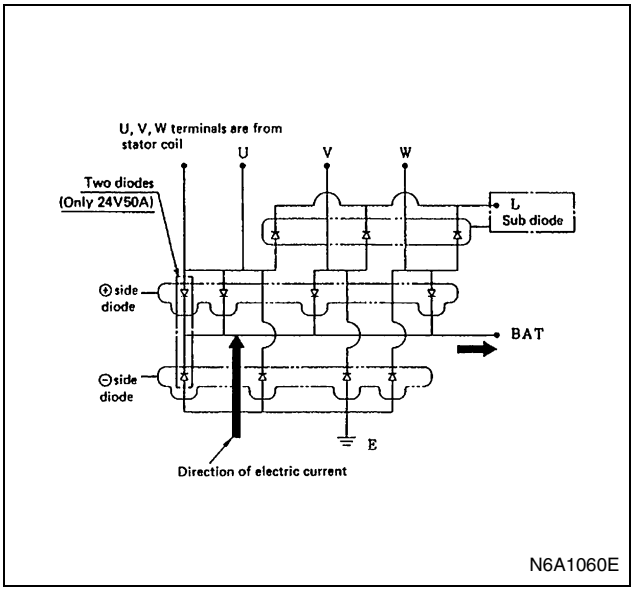


If the line is not visible, the brush must be replaced.

Brush Length (Reference)	mm (in)
Standard	Limit
25 (0.984)	6 (0.236)

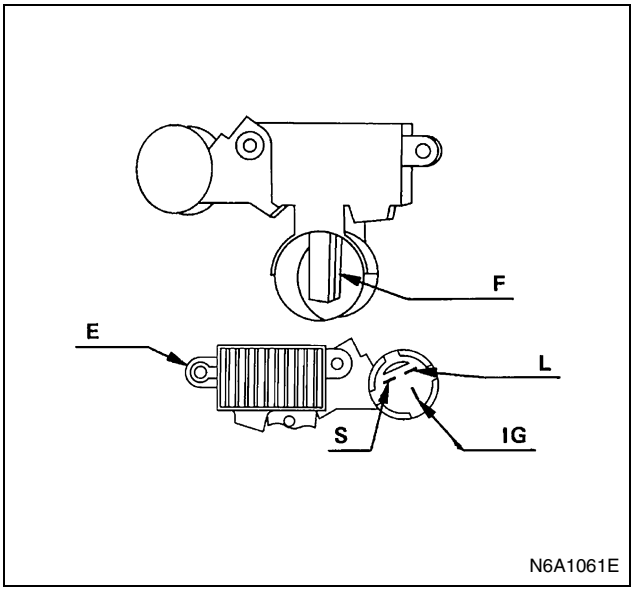
2. Rectifier





1) Check for continuity with a circuit tester between the battery and each of the three stator coil lead terminals.
   If there is continuity from battery to each of the three stator coil lead terminals, the rectifier is normal.
   If there is no continuity, the rectifier must be replaced.
   Check for continuity with a circuit tester between the earth and each of the three stator coil lead terminals.
   If there is continuity from each of the three stator coil lead terminals to earth, the rectifier is normal.
   If there is no continuity, the rectifier must be replaced.
2) Reverse the polarity of the test probes.
   If there is no continuity, the rectifier is normal.
   If there is continuity, the rectifier must be replaced.

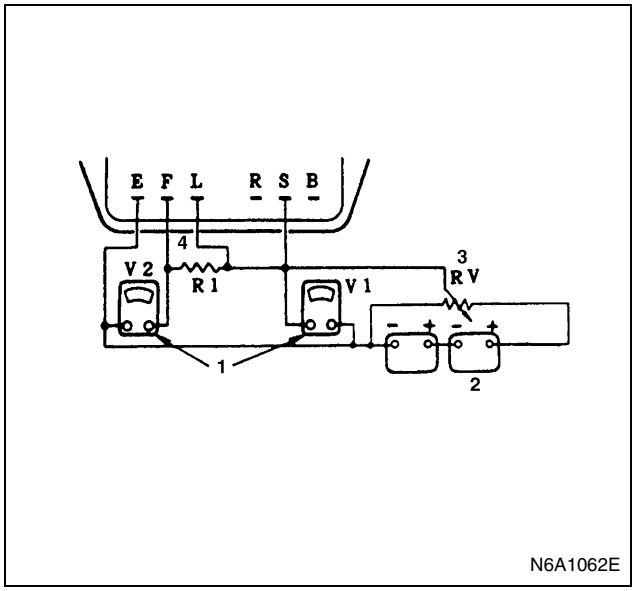
3. IC Regulator



The IC regulator may be tested with either a circuit tester or pair of standard voltmeters.
Refer to the illustration.

1) Circuit tester (or voltmeter) range is from 0 — 50 volts in 0.5 volt increments.
2) Two twelve volt batteries are required.
3) Note the variable resistor.
4) This resistor is rated at 100 watts/3 ohms.

4. Testing the IC Regulator



Refer to the wiring diagram when testing the IC regulator.

1) Connect the batteries in series.
2) Measure the battery power (voltage).

Battery Power	V
28 — 29	

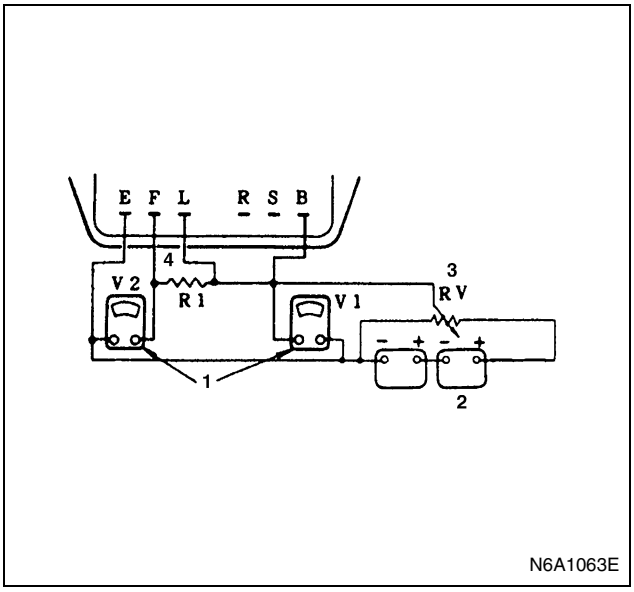
3) Connect the circuit tester (1) (or voltmeter V2) as shown in the illustration.
4) Set the variable resistor (3) to zero.
5) Slowly increase the resistance of the variable resistor toward the build-up point.
   Measure the voltage between E and F.
   As long as the resistance is below the build-up point, the voltage reading should be stable and less than two volts.
   When the resistance exceeds the build-up point, the voltage reading should be two volts or greater.
   If the voltage does not exceed two volts after reaching the build-up point, the IC regulator must be replaced.
6) Return the variable resistor (3) to zero.
7) Connect the circuit tester (or voltmeter V1) as shown in the illustration.
8) Measure the voltage at terminals S, L, and E.
9) Slowly increase the resistance of the variable resistor.

Note the point at which the voltage quickly builds up to between 2 and 6 volts.

This will indicate the point at which the voltage regulator begins to function.

If the measured voltage is outside the specified range, the voltage regulator must be replaced.

10) Repeat Steps 3 through 5 to measure the voltage between terminals B, L, and E.

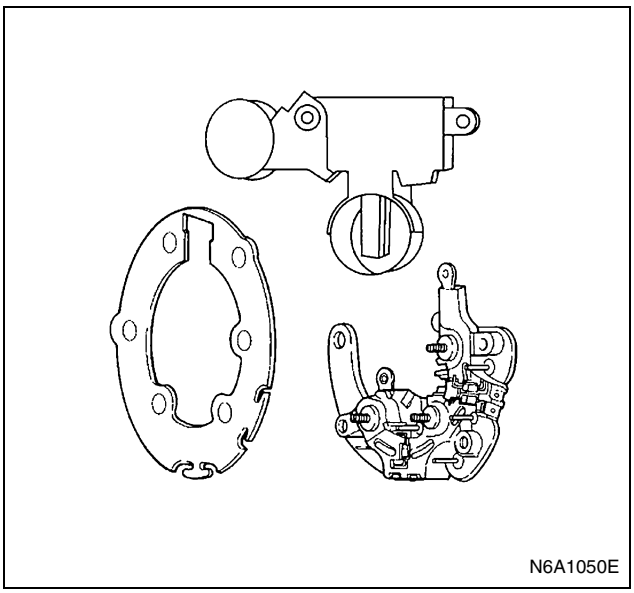


Refer to the wiring diagram.

The regulator voltage should be between 0.5 and 3 volts higher than the measured voltage.

If the regulator voltage is outside this range, the voltage regulator must be replaced.

Reassembly



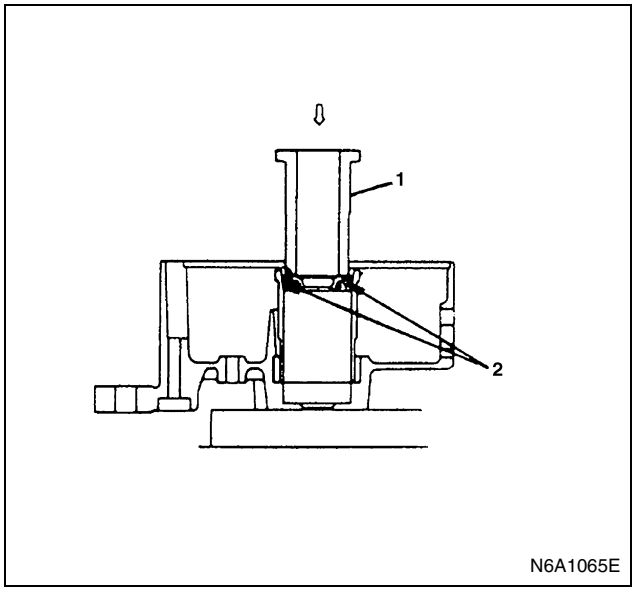
1. Install the brush holder and the stud bolts to the terminal plate.
   Check that the stud bolts fit properly.
2. Attach the IC regulator to the terminal plate.
3. Solder the IC regulator, the brush holder and the condenser.
   Take care not to heat the IC regulator.
   Over-heating will resulting damage to the IC regulator.
4. Set the rectifier to the IC regulator assembly.
5. Solder rectifier and IC regulator.
   Take care not to heat the IC regulator.
   Over-heating will resulting damage to the rectifiers and the IC regulator.
6. Tighten the rectifier terminal bolt.

Oil Seal

Check the rear cover oil seal bore for oil leakage.

Oil Seal Replacement

1. Use a screwdriver to remove the oil seal from the rear cover side.
   Take care not to damage the oil seal bore.
2. Discard the used oil seal.
3. Use the oil seal installer to install the new oil seal.

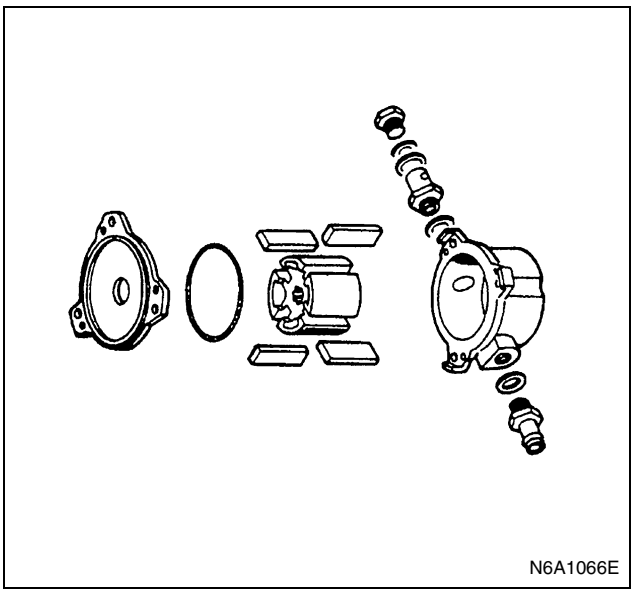


Legend

1. Oil seal installer
2. Oil seal

Vacuum Pump

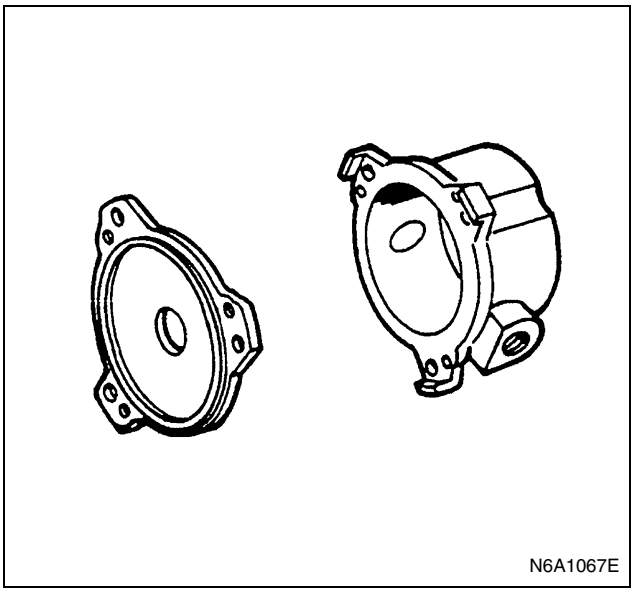
Disassembly



1. Remove the center plate from the vacuum pump housing.
2. Remove the vacuum pump rotor and the vanes from the housing.

Inspection and Repair

1. Vacuum Pump Housing and Center Plate



Inspect the vacuum pump housing and the center plate for excessive wear, abrasion, and scoring.

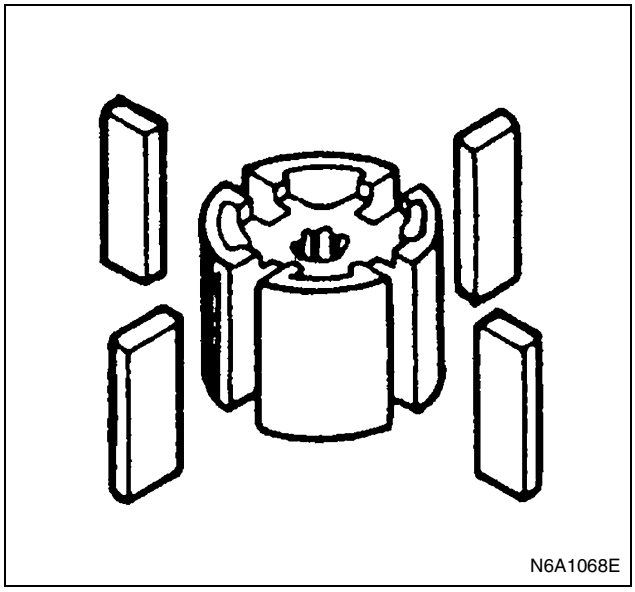
If any of these conditions are present, the vacuum pump housing and center plate must be replaced.

Inspect the vacuum pump housing inside for wear and damage.

If the measured inside diameter is outside the specified range, replace the vacuum pump housing.

Vacuum Pump Housing Inside Diameter (Reference)	mm (in)
Standard	69.5 — 69.6 (2.736 — 2.740)

2. Vane



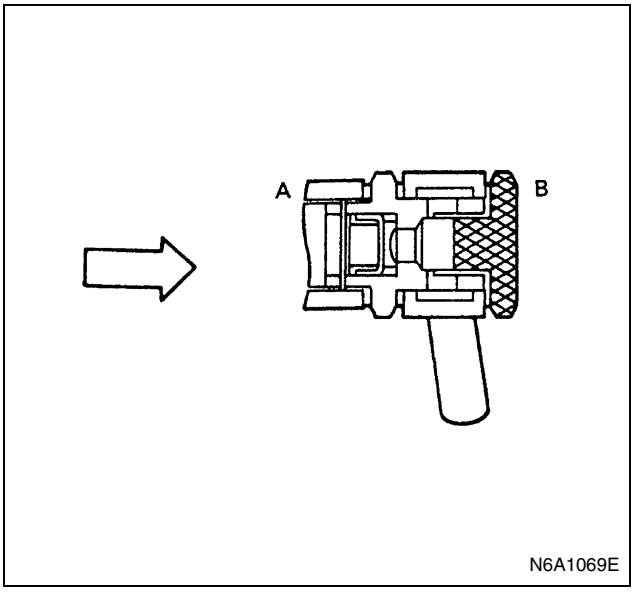
Inspect the vanes for excessive wear and damage.

Replace all four vanes if either of these conditions are present.

Never replace only one vane.

Vane Length (Reference)	mm (in)
Standard	18.0 (0.709)

3. Rotor
   1) Inspect the rotor for excessive wear, abrasion, and scoring.
      Pay particular attention to the internal spline.
      Replace the rotor if any of these conditions are present.
   2) Inspect the generator rotor shaft splines for backlash.
      Replace the rotor if backlash is present.
4. Check Valve
   1) Carefully force the valve from the “B” side as shown in the illustration.



The valve must move smoothly.

If it does not, the check valve must be replaced.

2) Apply compressed air to the “A” side.

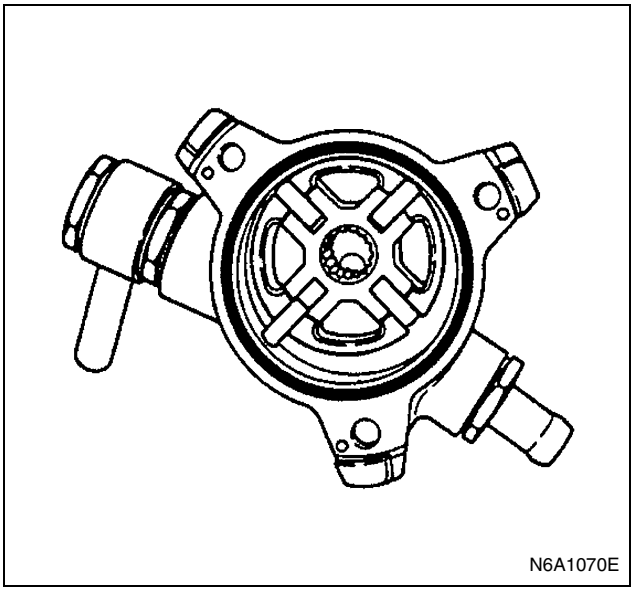
Air Pressure	kPa (kg/cm^2/psi)
98 — 490 (1 — 5/14.22 — 71.10)	

Check for air leakage from the check valve.

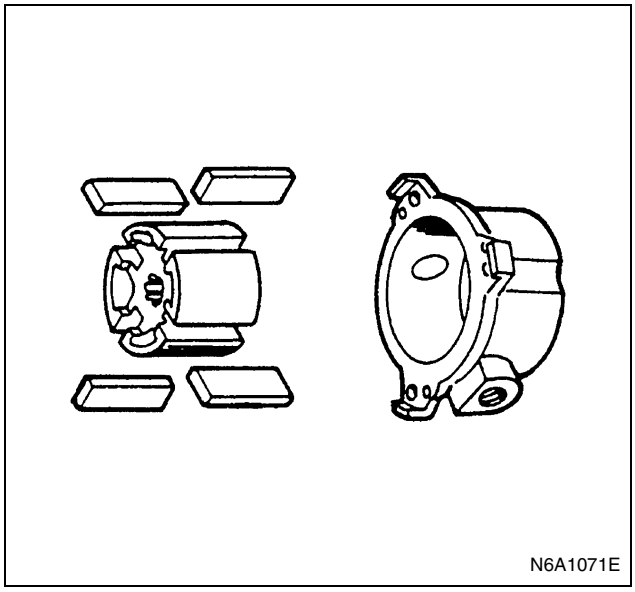
If there is air leakage, the valve must be replaced.

Reassembly

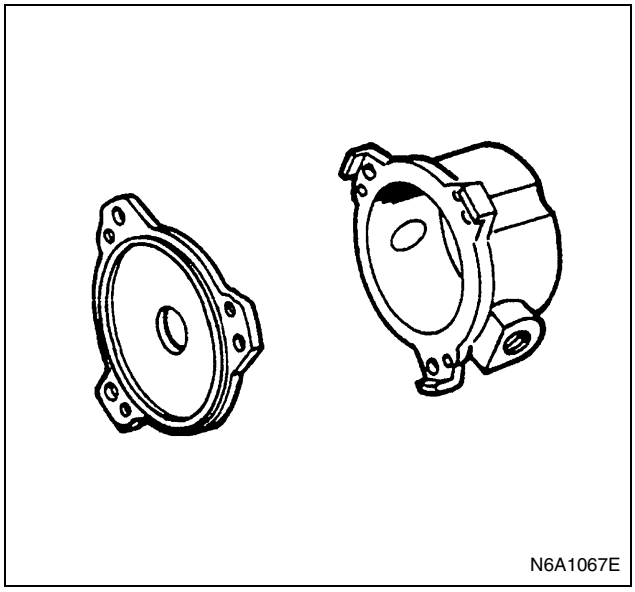
1. Install the vanes to the rotor slits.
   The rounded side of the vanes must be facing the rotor housing.



2. Install the rotor with the concave side facing the center plate.

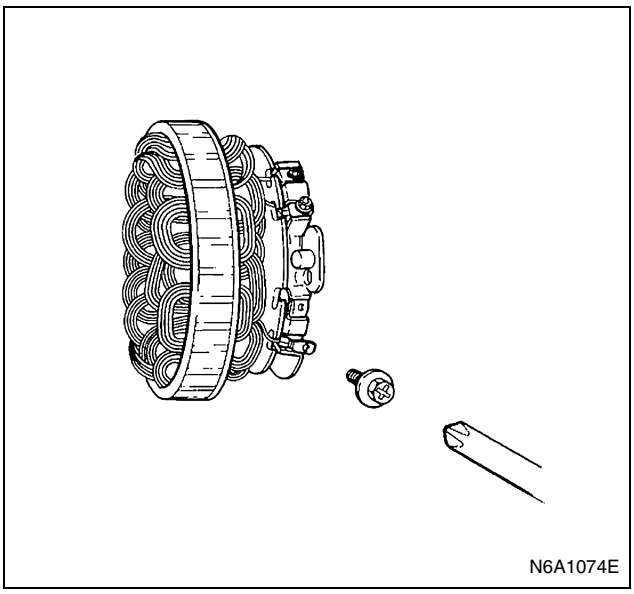


3. Install the center plate to the rotor housing.
   Be sure to use a new O-rings.



Reassembly

1. Rear Cover
2. Brush and IC Regulator
3. Rectifier
4. Fan Guide
5. Stator


N6A1074E

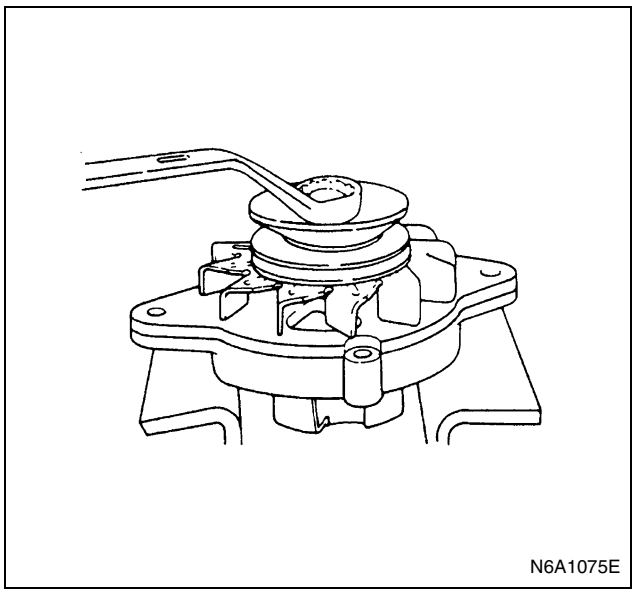
1) Solder together the rectifier and stator leads. Hold the rectifier lead near the rectifier with a pair or long-nose pliers to protect the rectifier from heat.

   Complete the soldering procedure as quickly as possible.

2) Install the IC regulator/stator assemblies to the rear cover.
   Be absolutely sure that the washers and the insulators are reinstalled to their original positions.

   Hold the stator coil against the rear cover.

6. Terminal Nut and Bolt
7. Rotor
8. Rear Ball Bearing
9. Front Cover
10. Front Ball Bearing
11. Bearing Retainer
12. Spacer
13. Fan
14. Pulley
15. Pulley Nut
    1) Carefully clamp the rotor and cover assembly in a vise.
    2) Install the pulley and the pulley nut.

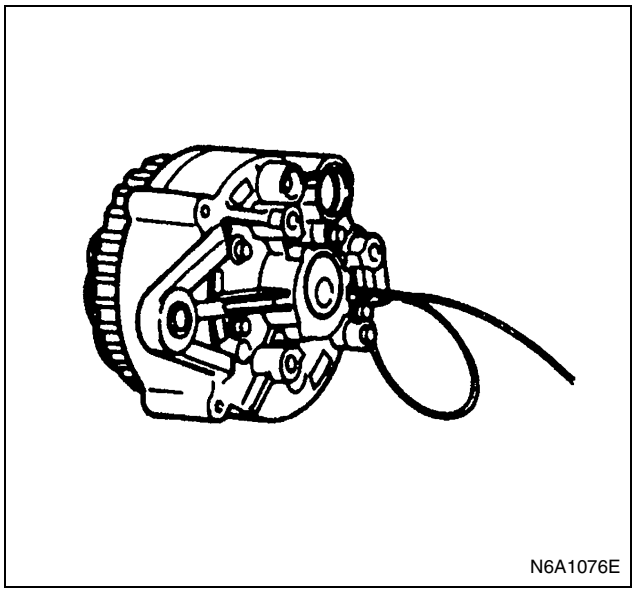

N6A1075E

3) Tighten the pulley to the specified torque.

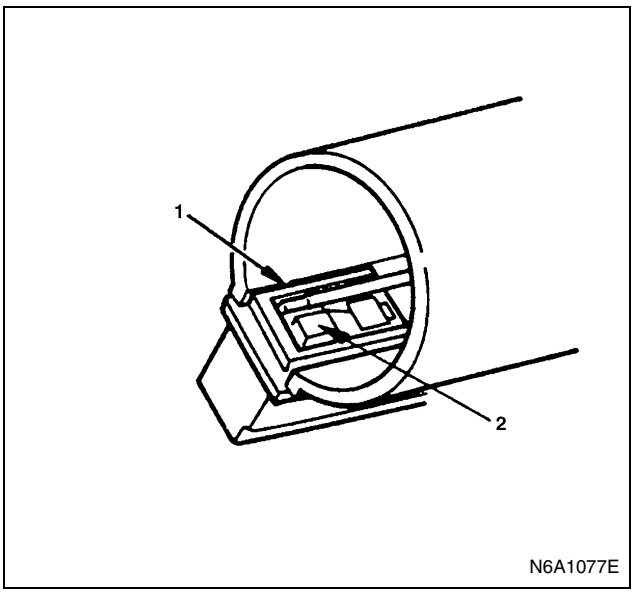
Tighten:
Pulley nut to 98 N·m (10.0 kg·m / 72 lb·ft)

Notice:
Take care not to damage the rotor when clamping it in a vise.

16. Stator and Rear Cover Assembly

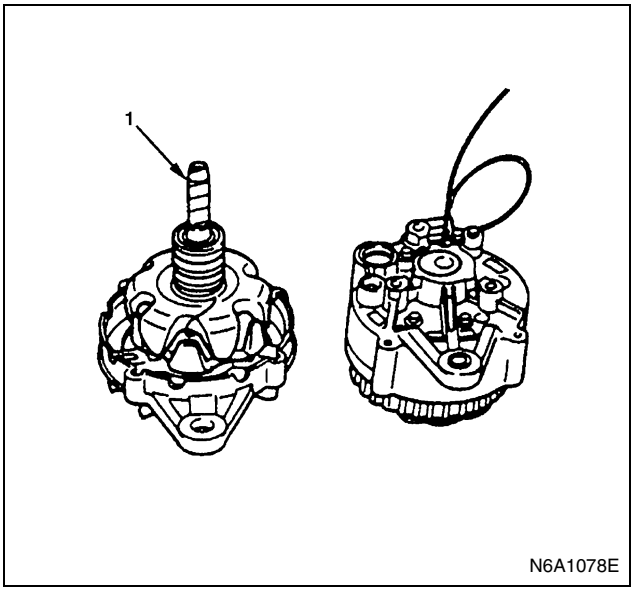

N6A1076E

17. Rotor and Front Cover Assembly
18. Through Bolt
    1) Prepare a brush holding wire or a pin.
    2) Set the holding wire or the pin to the brushes from the vacuum pump side.
    3) Push the brushes into the holder.



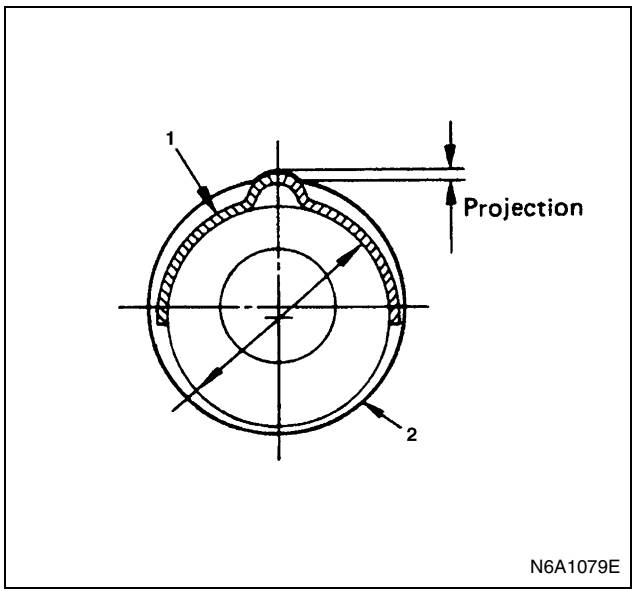
Legend
1. Brush holding wire or pin
2. Brush

4) Bend the wire end to hold the brushes.
   If the holding wire does not hold the brushes properly, the brushes will be damaged.
5) Tape the rotor shaft spline.



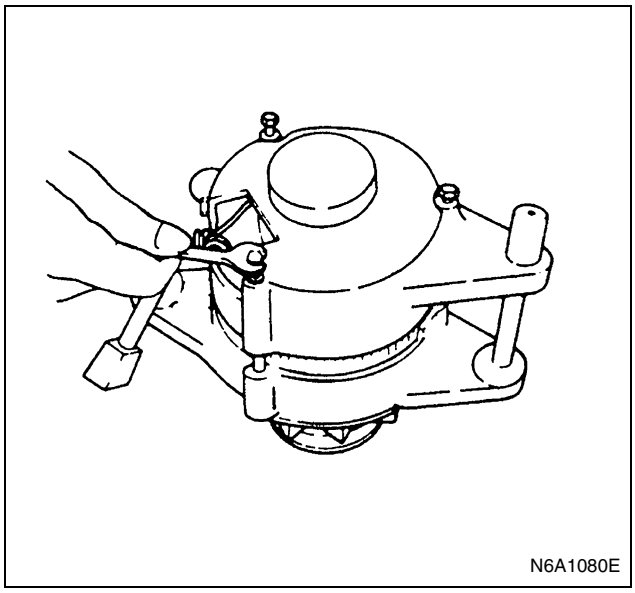
Legend
1. Taping

   This will prevent oil seal damaged.
6) Place the bearing retainer ring.
   Ring projection must be less than 0.65 mm (0.025 in)



Legend
1. Retainer ring
2. Bearing outer race

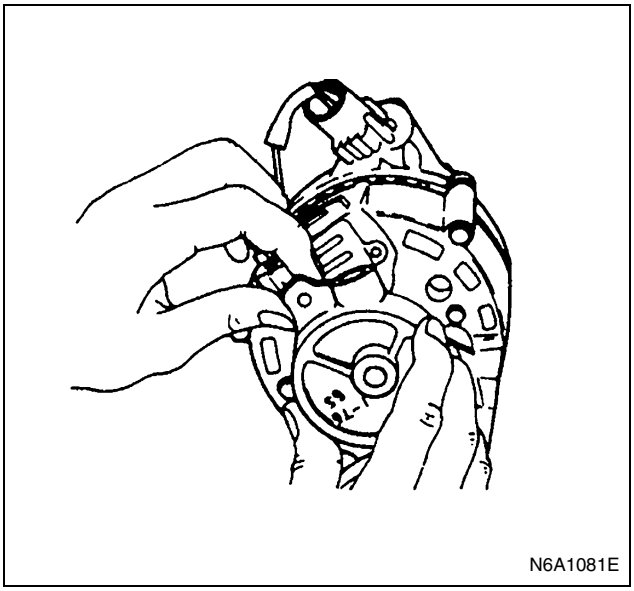
7) Install the front cover and rotor assembly to the rear cover.
   Take care not to damage the rotor, the coil leads, the oil seal lip, and the splines.
8) Place the guide bar into the rear cover bracket hole.
   Align the front cover bracket hole with the guide bar.
9) Install the through bolts.
10) Tighten the through bolts to the specified torque.



Tighten:
Through bolt to 4 N·m (0.4 kg·m / 35 lb·in)

11) Carefully remove the holding wire from the rear cover.

19. Vacuum Pump Assembly
    1) Position the pump rotor together with the pump housing on the center plate.
       The rotor serrated side must be facing up.


N6A1081E

    2) Rotate the rotor to align the rotor bore with the center plate bore.
    3) Install the housing, the rotor, and the center plate.
       The O-ring must not be projecting beyond the center plate slot.
       Take care not to scratch the vanes.
    4) Turn the housing to align it with the center plate.
    5) Tighten the vacuum pump fixing bolts.

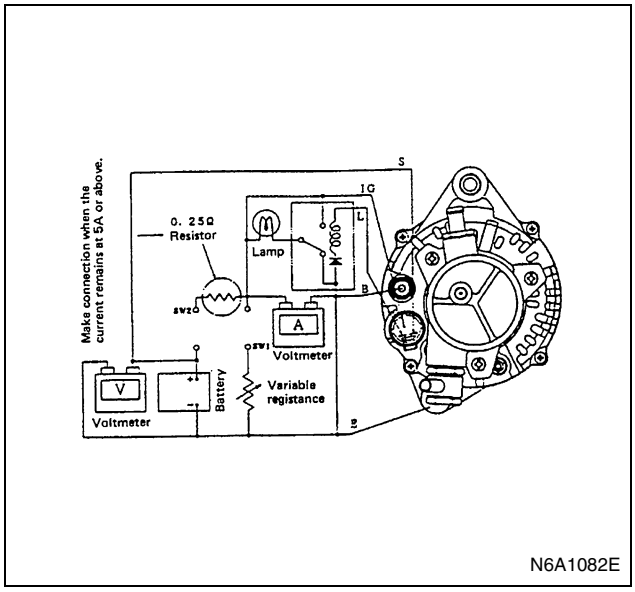
Tighten:
Vacuum pump fixing bolt to 7 N·m (0.7 kg·m / 61 lb·in)

    6) Add 5cc of engine oil through the filler port.
    7) Check that the generator spins smoothly by turning it with your hand.

Inspection

Performance Test

1. Generator
   - Connect the generator as shown in the illustration.

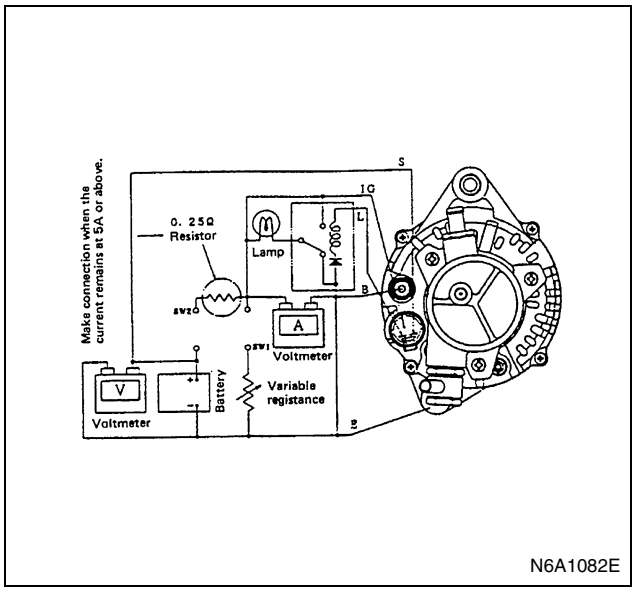


N6A1082E

   - Use a fully charged battery to conduct the measurement with the current outputted from the battery terminals at 5A or less.

Notice:
When conducting the performance test:
For the connection between the generator B terminal and the battery (+) terminal and between the E terminal and the battery (–) terminal, use a lead wire with a cross section of 8 mm^2 and the length of 2.5 m or less.

2. Adjusting voltage measurement



N6A1082E

   - Open SW1 and close SW2.
   - With the number of the generator rotations raised up to its rated rotations of 5,000 rpm, measure the adjusting voltage.

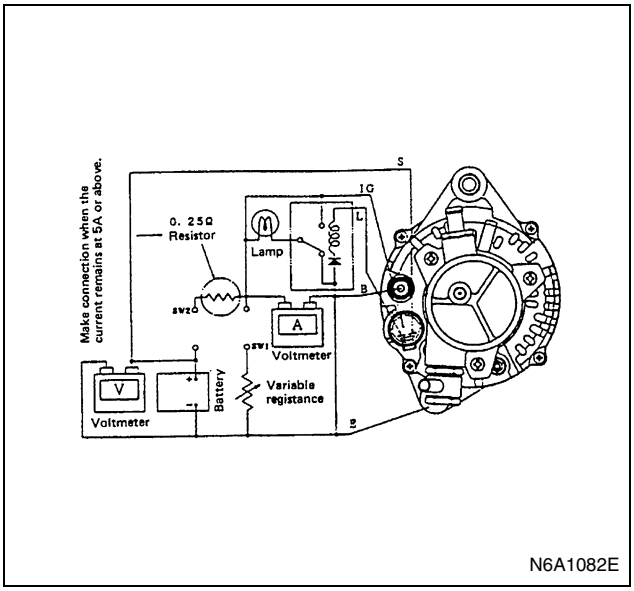
   Adjusting voltage = 28 - 29V

   - Check to see if the fluctuation in the adjusting voltage is not caused by the increased number of rotations.

3. Measurement of the number of rotations at 27V
   - Open SW1 and close SW2.

- Increase the number of the generator rotations gradually until the reading of the voltmeter indicates 27V. Measure the number of rotations at this time.

4. Output current measurement



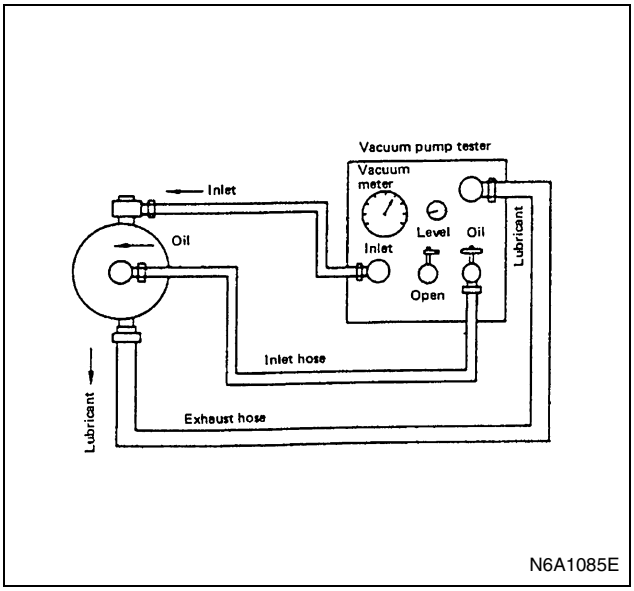
N6A1082E

- Set the resistance of the variable resistor at the minimum, and rotate the generator with SW1 and SW2 closed.
- While keeping the voltage steady at 27V after adjusting the variable resistor, read the indicated value of the ammeter at the generator rotation of 5,000 rpm.

Current at 27V with 5,000 rpm = 35A or more (for 35A specification)

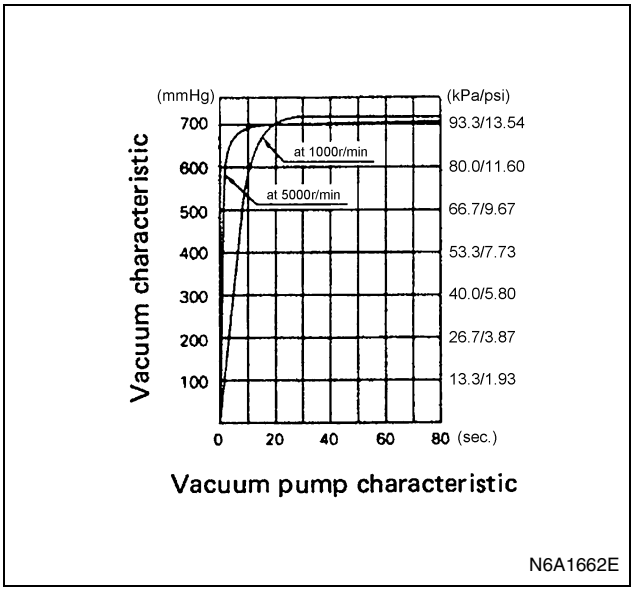
Current at 27V with 5,000 rpm = 45A or more (for 50A specification)

5. Unit test of vacuum pump
   - With a pipe arrangement as shown in the illustration, use the vacuum pump tester to conduct the measurement.

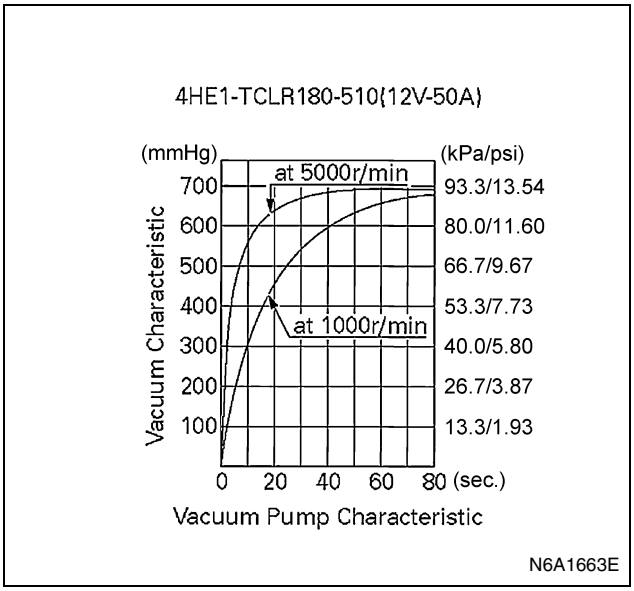


N6A1085E

- Pour about 20 liter (5.28 US gal/4.40 UK gal) of engine oil into the vacuum pump tester.
- Increase the generator rotations gradually, and check to see if the engine oil is fully circulated by discharging oil from the exhaust side of the vacuum pump.
- Close the release valve and measure the “vacuum characteristic” and the “vacuum drop characteristic (air tight characteristic)”. Then check the obtained values based on the following table.



N6A1662E



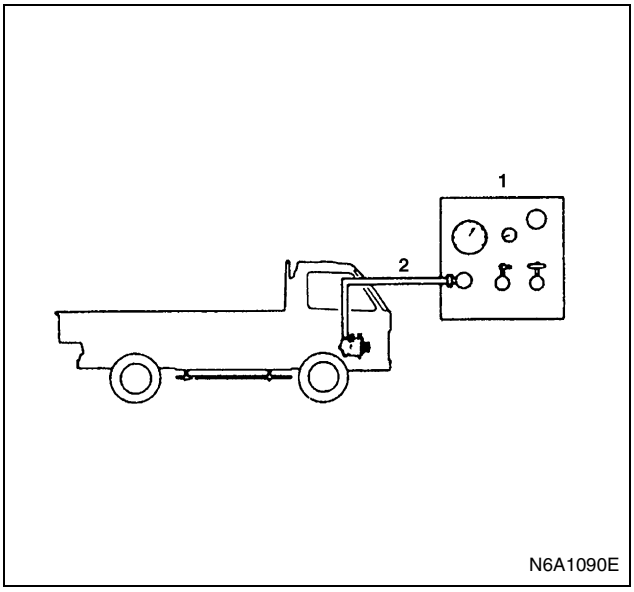
N6A1663E

Item	Performance		Specifications
Vacuum characteristic	5000 rpm — 66.7 kPa (500 mmHg / 9.67 psi)		Less than 4 sec.
	Max. 5000 rpm		More than 90.7 kPa (680 mmHg / 13.15 psi)
Vacuum-down performance	Valve of vacuum-down 15 sec. after the vacuum pump is stopped at 53.3 kPa (400 mmHg / 7.73 psi).		Less than 2.67 kPa (20 mmHg / 0.39 psi)
Test condition	Oil used	Mobil oil #30	
	Oil temperature	75±5°C (167±41°F)	
	Oil pressure	441 kPa (4.5 kg/cm^2 / 63.96 psi)	

- 4HE1-TC LR180-510 (12-50A)

Item	Performance		Specifications
Vacuum characteristic	5000 rpm — 66.7 kPa (500 mmHg / 9.67 psi)		Less than 10 sec.
	Max. 5000 rpm		More than 90.7 kPa (680 mmHg / 13.15 psi)
Vacuum-down performance	Valve of vacuum-down 15 sec. after the vacuum pump is stopped at 53.3 kPa (400 mmHg / 7.73 psi).		Less than 2.67 kPa (20 mmHg / 0.39 psi)
Test condition	Oil used	Mobil oil #30	
	Oil temperature	75±5°C (167±41°F)	
	Oil pressure	441 kPa (4.5 kg/cm^2 / 63.96 psi)	

6. On-vehicle test of the vacuum pump
   - Install the generator to the engine.
   - With the engine idling, check to see if oil is being discharged sufficiently from the exhaust side of the vacuum pump.
   - Idle the engine until the engine oil temperature gets to the range of 70 — 80°C (158 — 176°F).
   - Connect the pipe only to the suction side of the vacuum pump tester, and conduct the test in the same manner as in the unit test. When the resulting value is outside the specified range, re-check the vacuum pump.



Legend
1. Vacuum pump tester
2. Intake

ENGINE 4H SERIES

SECTION 6D6

QOS II PREHEATING SYSTEM

Contents

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Component 6D6-4
Inspection and Repair 6D6-5
TROUBLESHOOTING 6D6-8

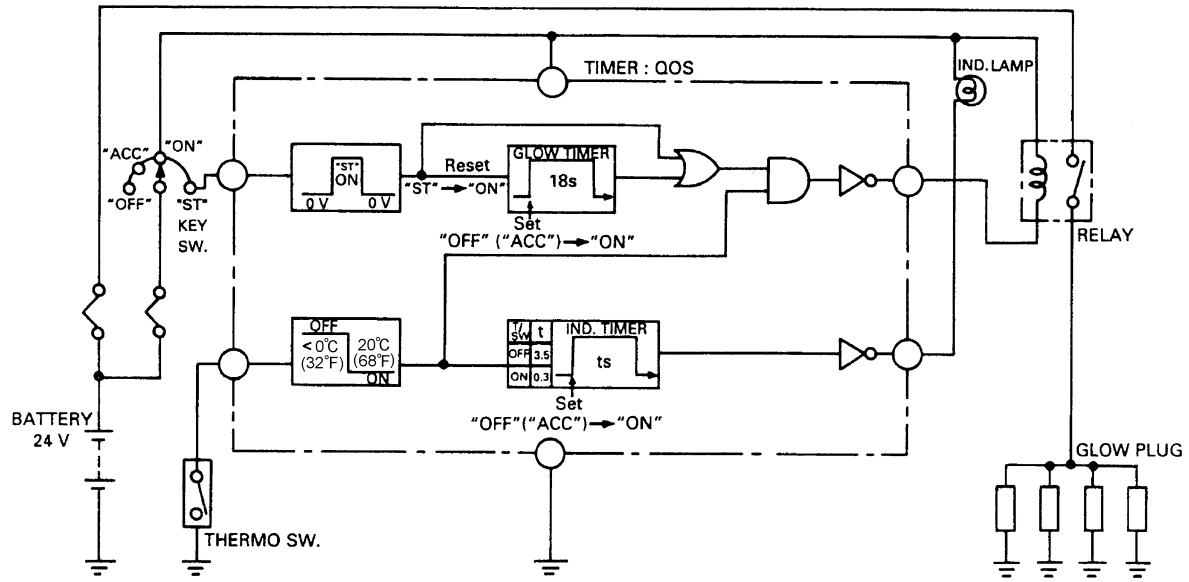
GENERAL DESCRIPTION

QOS II preheating system features a quick-on glow plug with thermometer control of the glowing time and the after-glow time function.
The system consists of a timer, indicator lamp, thermosensor, relay and temperature self-control type glow plug (4 pcs).
With the employment of the thermosensor, the glow time changes according to the engine coolant temperature, thus allowing optimum starting conditions to be obtained.
The afterglow time function is controlled by thermosensor.

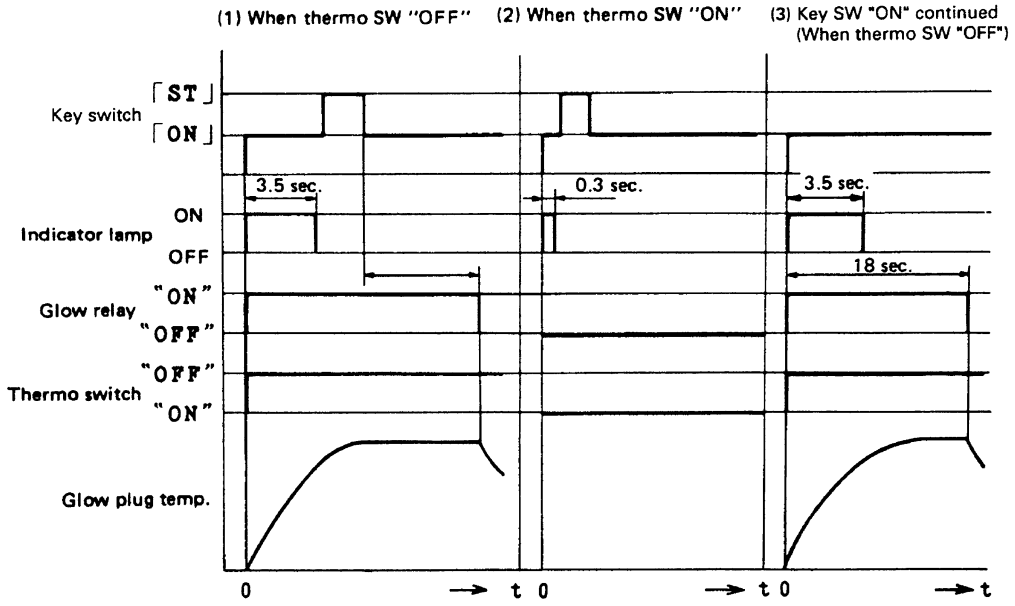
Component

Quick-On-Start II (QOS II)

SYSTEM DIAGRAM



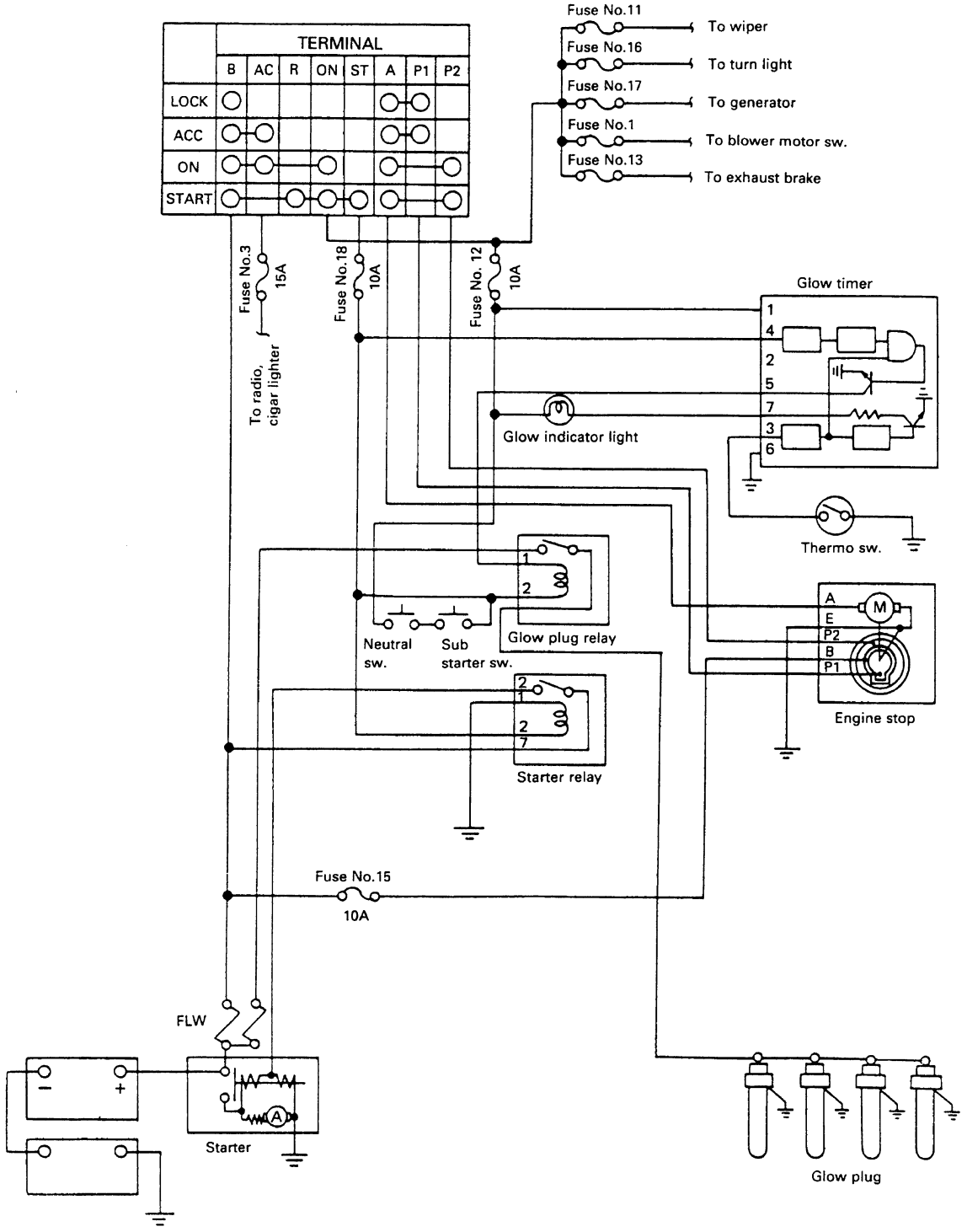
TIMING CHART



N6A1664E

STARTING CIRCUIT DIAGRAM (REFERENCE)

Component



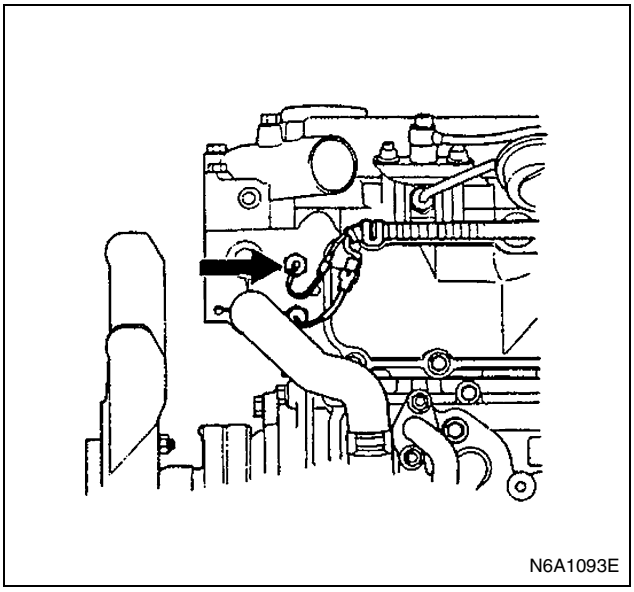
Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Quick-On-Start II (QOS II)

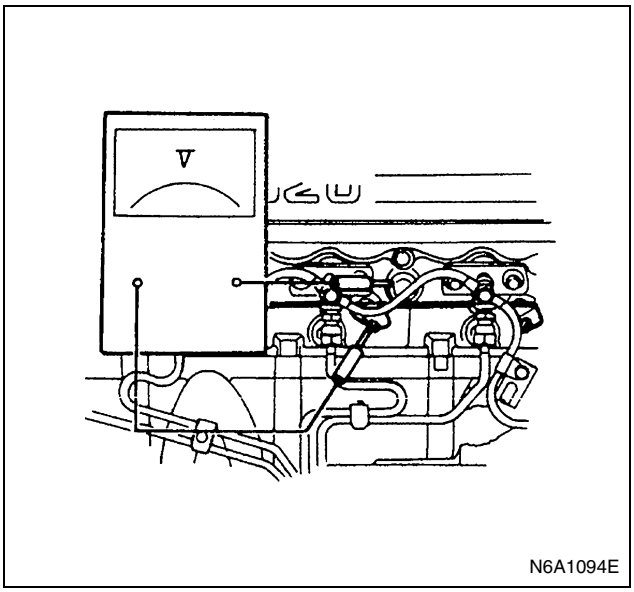
System

1. Disconnect the connector of the thermo switch.



N6A1093E

2. Set the voltage meter in connection as shown in the illustration.



N6A1094E

3. Turn the key switch to “ON” position without engine turned and check the following items.

Glow Indicator Lighting Time	Seconds
Standard	3.5

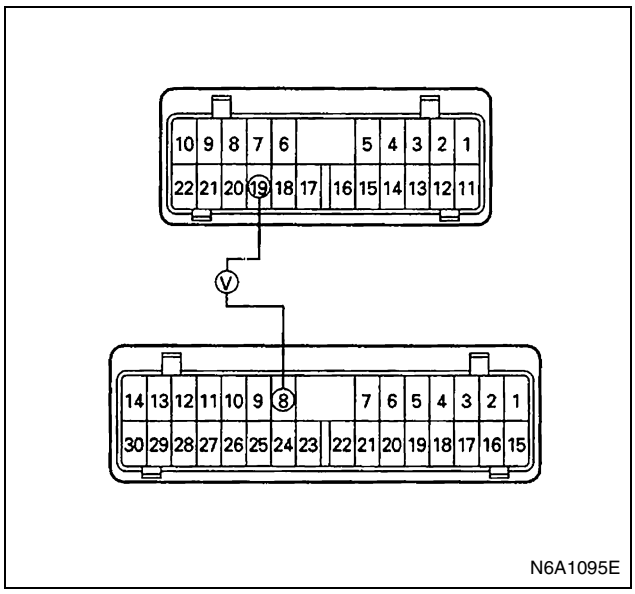
Power Source Voltage Indicating Time	Seconds
Standard	18

When abnormal, check the QOS timer, the glow relay and the thermo switch.

When normal, check the glow plug.

Timer

1. Disconnect the connector of the thermo switch.
2. Set the voltage meter in connection as shown the illustration with connector connected.



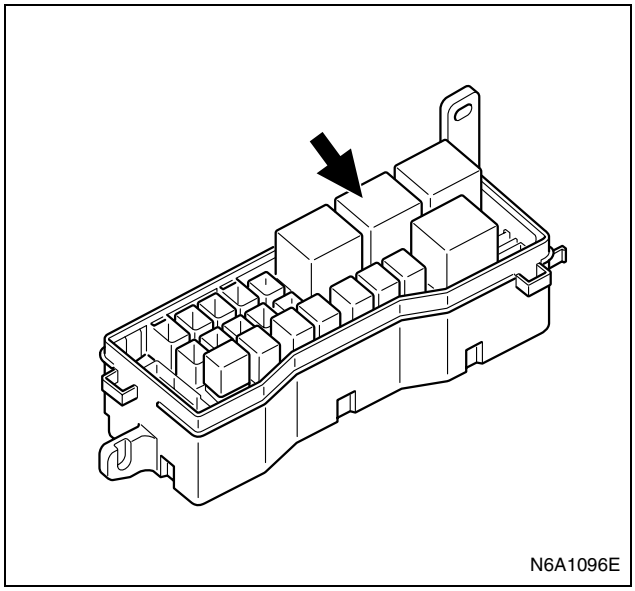
N6A1095E

3. Turn the key switch to “ON” position without engine turned, and check the following.

0 Volts Indicating Time	Seconds
Standard	18

Glow Plug Relay

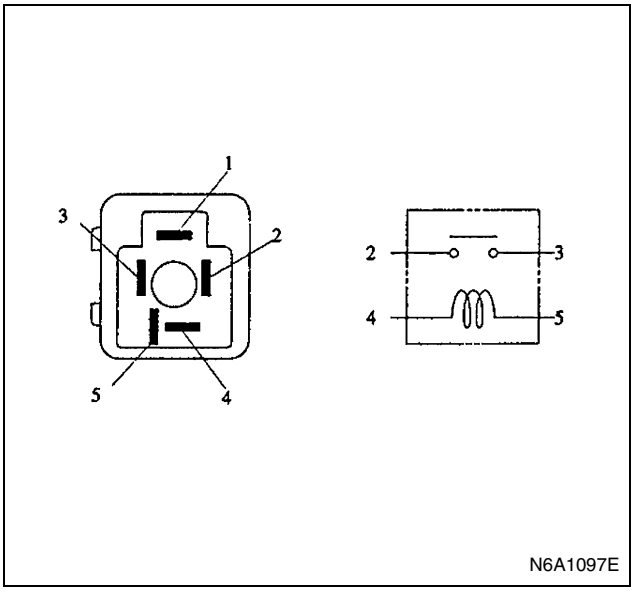
Location



N6A1096E

Specification

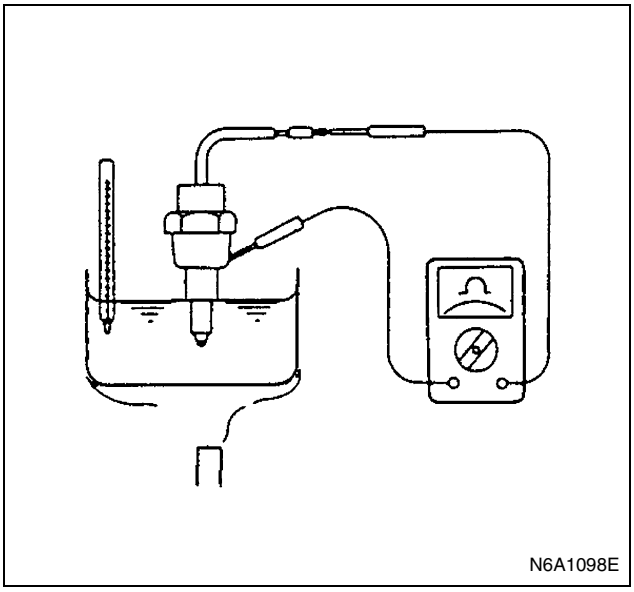
Measure the glow relay resistance between the terminal (4) and the (5) with a circuit tester.



If the measured resistance is outside the specified range, the glow relay must be replaced.

Glow Relay Resistance (Reference)	ohms
Standard	100

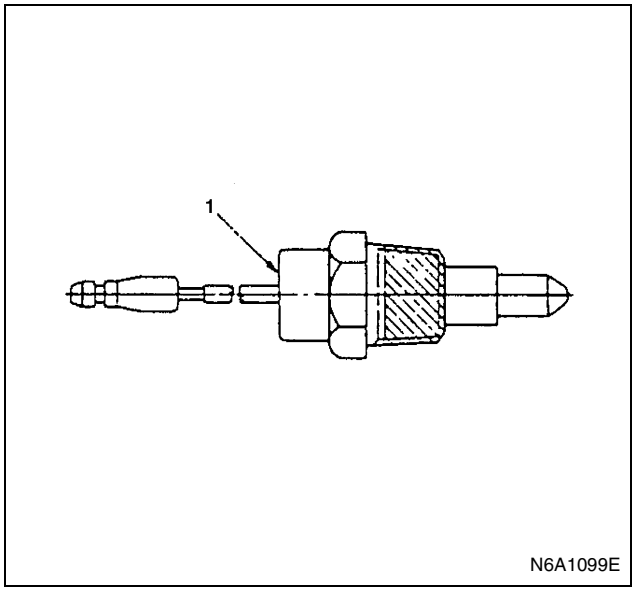
Thermo-Switch



Specification

Operating Temperature	°C (°F)
OFF → ON	7 — 13 (44.6 — 55.4)
ON → OFF	Over 3 (37.4)

- Before installing the thermo-switch, apply LOC-TITE 262 or its equivalent to the portion shown in the illustration.

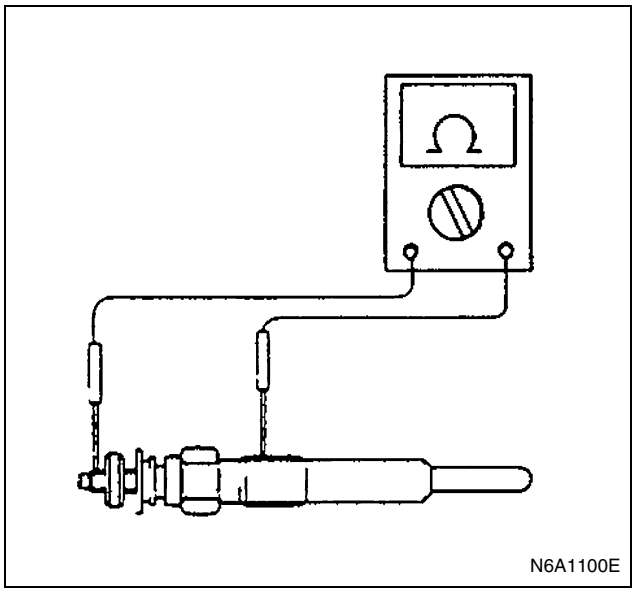


Legend

1. Pink (resin)

Glow plug check

- Use the circuit tester to measure the continuity of the glow plug.

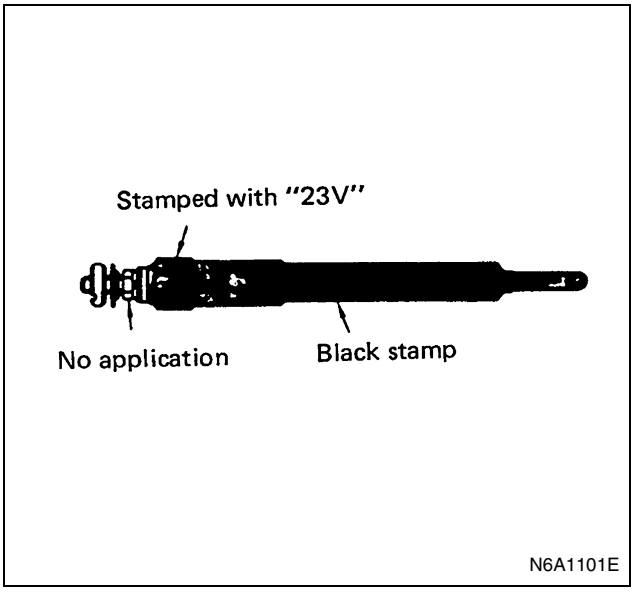


- When the obtained value is outside the specified range, replace the glow plug with a new one.

Glow plug resistance = About 4Ω (at room temperature)

Notice:

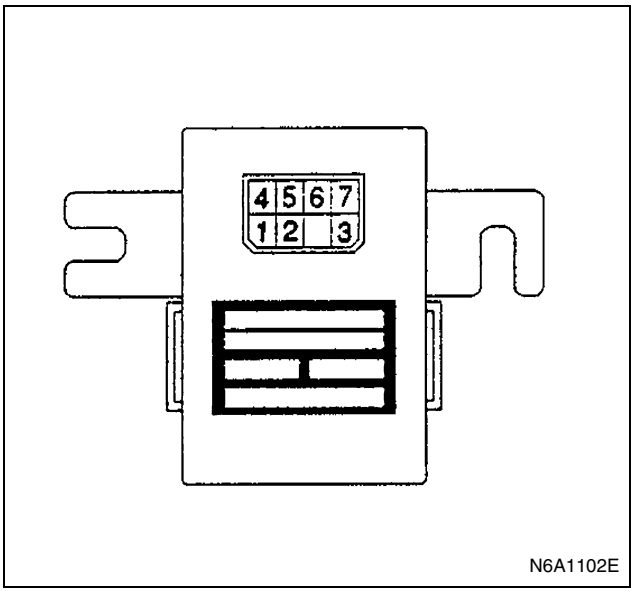
When changing glow plugs, use a set of 4 glow plugs of the same manufacture.



- Note that an identification mark is provided to prevent any possible faulty assembly.

Type	Rated Voltage (V)	Total length mm (in)
Standard	23	141 (5.55)

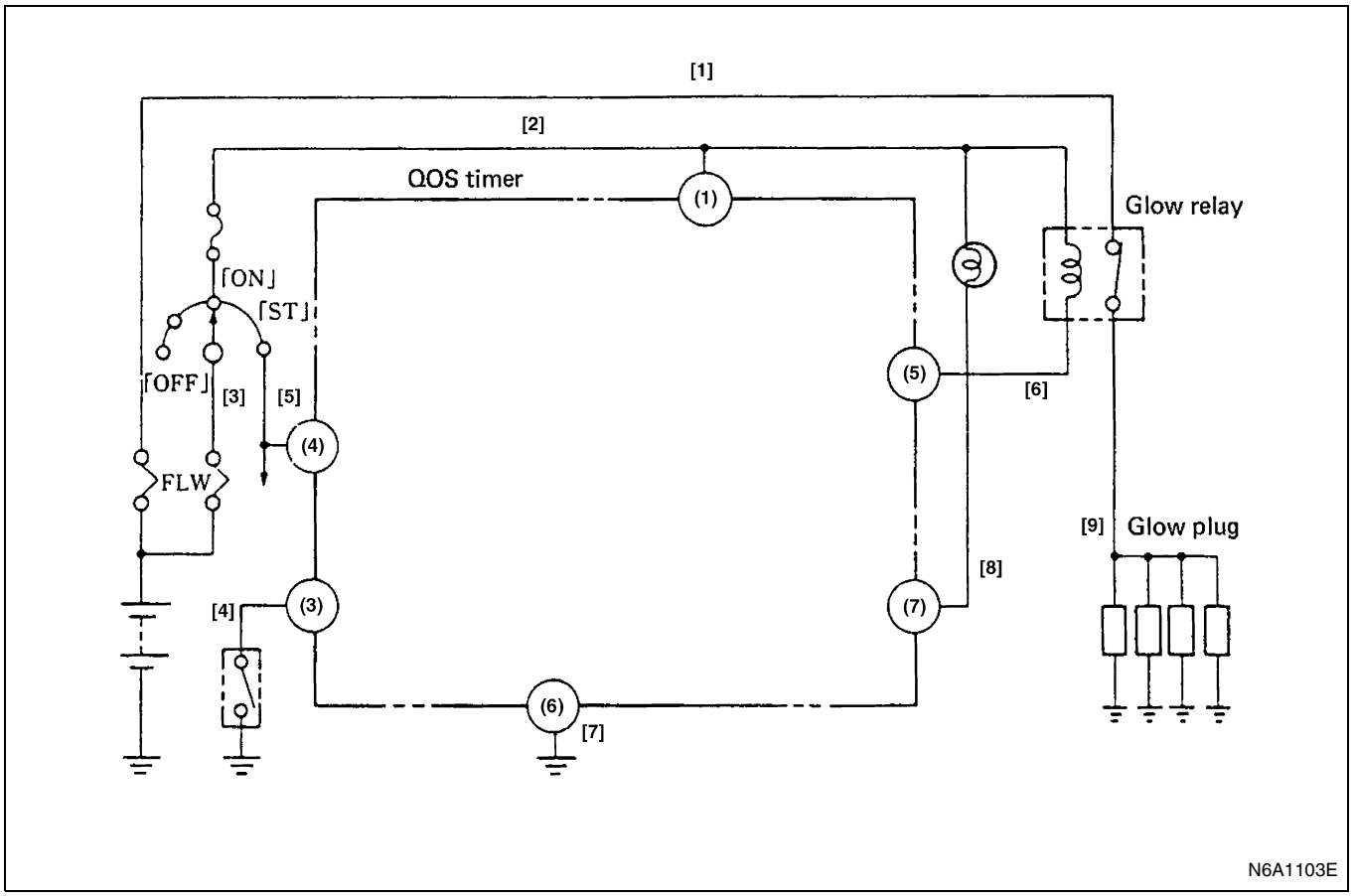
QOS Timer



Timer Specification	
No.	Connection to
1	Starter SW “ON”
2	—
3	Thermo SW
4	Starter SW “ST”
5	Glow relay
6	Earth (ground)
7	Indicator lamp

TROUBLESHOOTING

Circuit diagram



Notice:
A figure in a circle “( )” shows a terminal No.
A figure in a square “[ ]” shows a circuit No.

When the Cooling Water Temperature is Below 0°C (32°F).

Condition	Possible cause	Circuit
The glow relay does not turn on.	1. Defective connection in fusible link between battery and starter switch	[3]
	2. Defective connection or broken wire in starter switch circuit	
	3. Defective connection or broken wire in fuse No.3	[2]
	4. Defective starter switch * Items 3 and 4 above coincide with troubles in other circuits.	
	5. Defective connection of glow relay terminal	[1]
	6. Broken wire in glow relay excitation coil	
	7. Broken wire in the circuit between glow relay and timer	[6]
	8. Defective glow relay (There is no continuity in main connection.)	
	9. Defective connection in QOS timer Defective QOS timer	
	10. Defective ground circuit in QOS timer	[7]
	11. Defective thermo-switch (The thermo-switch does not turn off even when water temperature is below zero.)	
	12. Defective ground circuit in thermo-switch	[7]
Glow relay turns on, but does not get pre-heated.	1. Defective connection of fusible link between battery and start switch	[1]
	2. Defective connection of glow relay main link terminal connector, or broken wire in preheating circuit	
	3. Defective connection of plug connector with preheating circuit	[9]
Glow relay remains on, and does not turn off.	1. Defective QOS timer	
	2. Circuit is shorted to ground between QOS timer terminal (5) and glow relay	[6]
	3. Defective glow relay	
Indicator lamp does not light on.	1. Defective QOS timer	
	2. Broken wire in bulb	[8]
	3. Broken wire in indicator lamp harness	

When the Cooling Water Temperature is Over 0°C (32°F).

Condition	Possible cause	Circuit
Indicator lamp does not light on.	1. Defective QOS timer	
	2. Broken wire in bulb	[8]
Indicator lamp lights on for a long time.	1. Defective thermo-switch, or broken wire in thermo-switch circuit (Indicator lights on for about 3.5 sec.)	[4]
	2. Defective QOS timer	
Glow relay is ready to turn on, or remains on.	1. Circuit is shorted to ground between terminal (5) and glow relay.	[6]

ENGINE 4H SERIES

SECTION 6E (4HE1-TC/4HG1-T Only)

EMISSION AND ELECTRICAL DIAGNOSIS

Caution:
When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength for (stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound, will be called out. The correct torque values must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

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GENERAL DESCRIPTION

The emission and electrical control system operates on a 12 or 24 volt power supply with negative ground polarity. Each wire in the vehicle is of a specific size and has an identifying colored insulation.
These colors are indicated in wiring diagrams and will help in tracing circuits and making proper connections.
Wire size is determined by load capacity and circuit length. Some wires are grouped together and taped.
Such a grouping of wires is called a harness.

The harness use a split corrugated tube to protect the wires from the elements. Each circuit consists of the following:

- Power source - the battery and the alternator.
- Wires - To carry electrical current through the circuit.
- Fuses - To protect the circuit against current overload.
- Relays - To protect voltage drop between the battery and the circuit parts and to protect the switch points against burning.
- Switches - To open and close the circuit.
- Load - Any device, such as a light or a motor, which converts the electrical current into useful work.
- Ground - To allow the current to flow back to the power source.

In this manual, such electrical device is classified by system. For major parts shown on the circuit based on the circuit diagram for each system, inspection and removal and installation procedures are detailed.

Notes for Working on Electrical Items

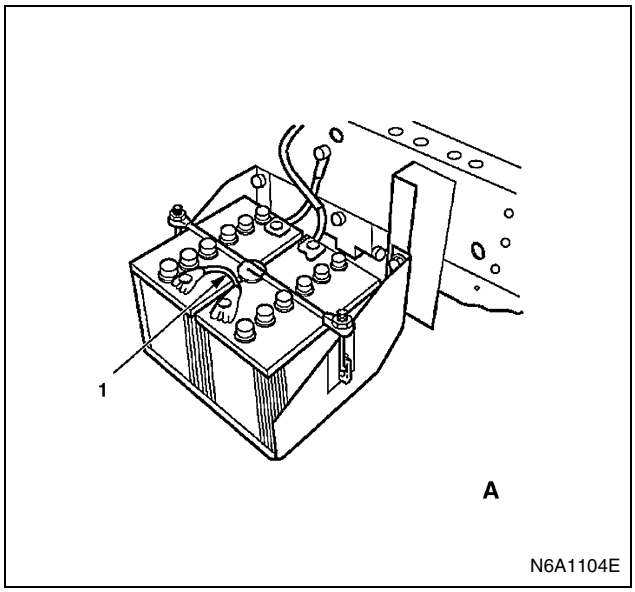
Battery Cable

Disconnecting the Battery Cable

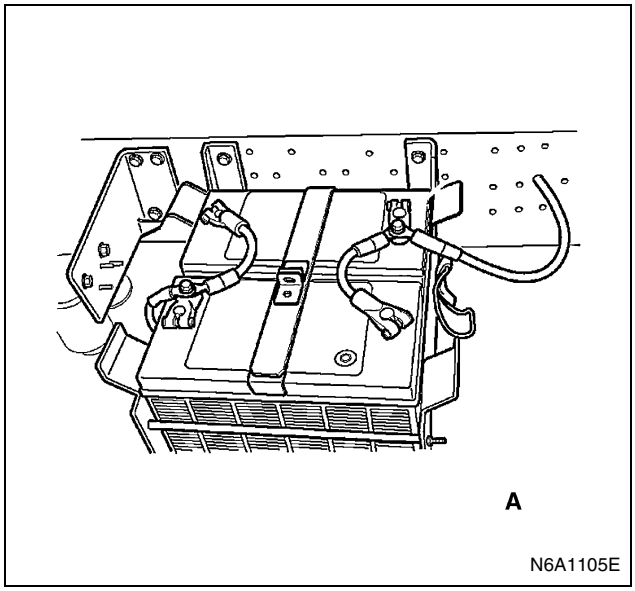
1. All switches should be in the “OFF” position.
2. Disconnect the battery ground cable.
3. Disconnect the battery positive cable
4. Disconnect the battery cable (1).

Caution:
It is important that the battery ground cable be disconnected first.

Disconnecting the battery positive cable first can result in a short circuit.



Legend
A. For 24 volt
1. Cable



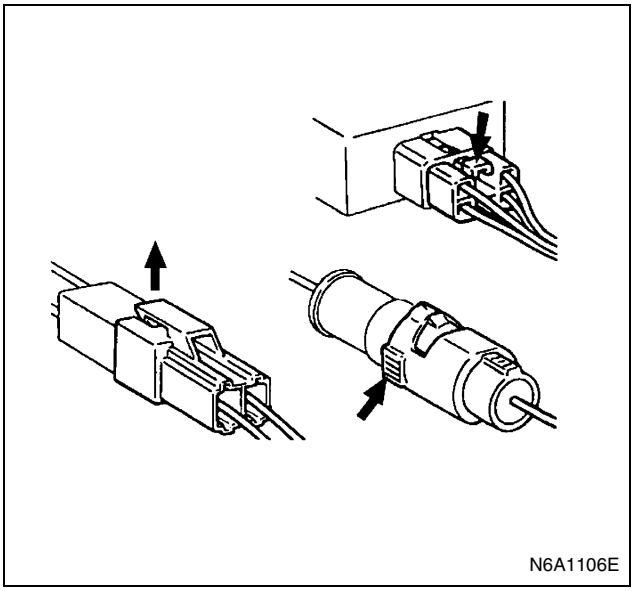
Legend
A. For 12 volt

Connecting the Battery Cable
Follow the disconnecting procedure in the reverse order.

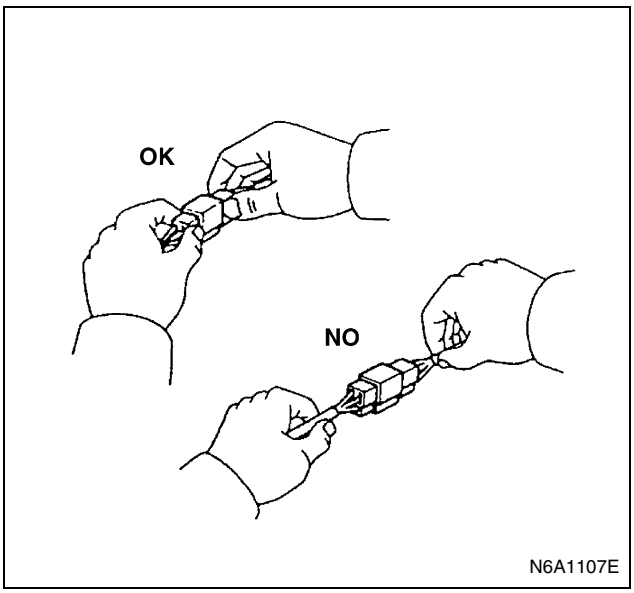
Caution:
Clean the battery terminal and apply a light coat of grease to prevent terminal corrosion.

Connecting Handling
Disconnecting the Connectors
Some connectors have a tang lock to hold the connectors together during vehicle operation.

Some tang locks are released by pulling them towards you.
Other tang locks are released by pressing them forward.
Determine which type of tang lock is on the connector being handled.
Firmly grasp both sides (male and female) of the connector.
Release the tang lock and carefully pull the two halves of the connector apart.


N6A1106E

Never pull on the wires to separate the connectors. This will result in wire breakage.



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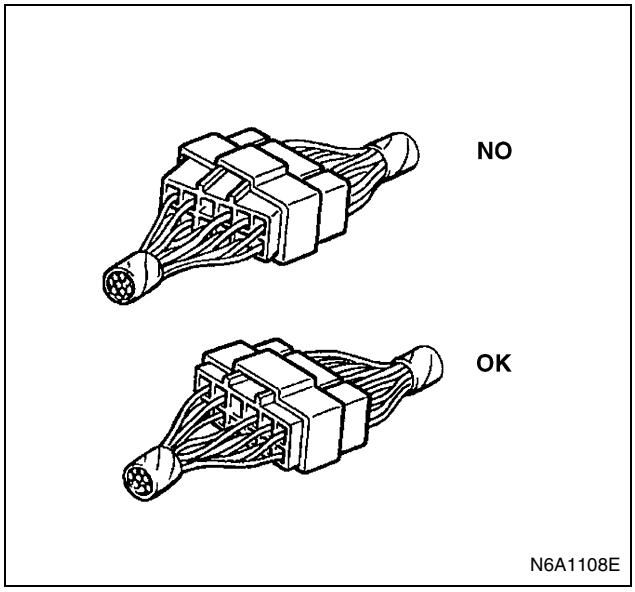
Connecting the Connector
Firmly grasp both sides (male and female) of the connector. Be sure that the connector pins and pin holes match. Be sure that both sides of the connector are aligned with each other. Firmly but carefully push the two sides of the connector together until a distinct click is heard.



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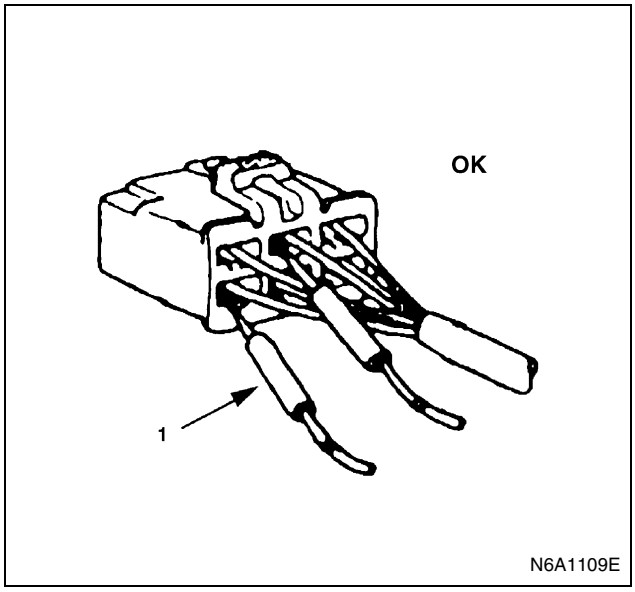
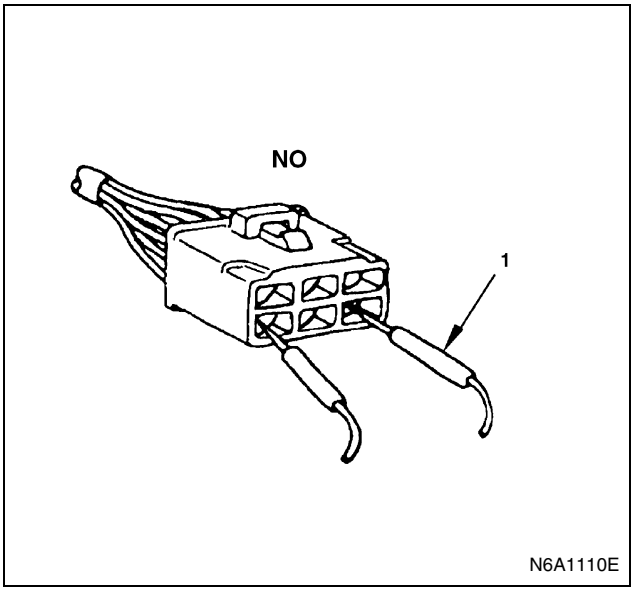
Connector Inspection
Use a circuit tester to check the connector for continuity. Insert the test probes from the connector wire side.



N6A1109E

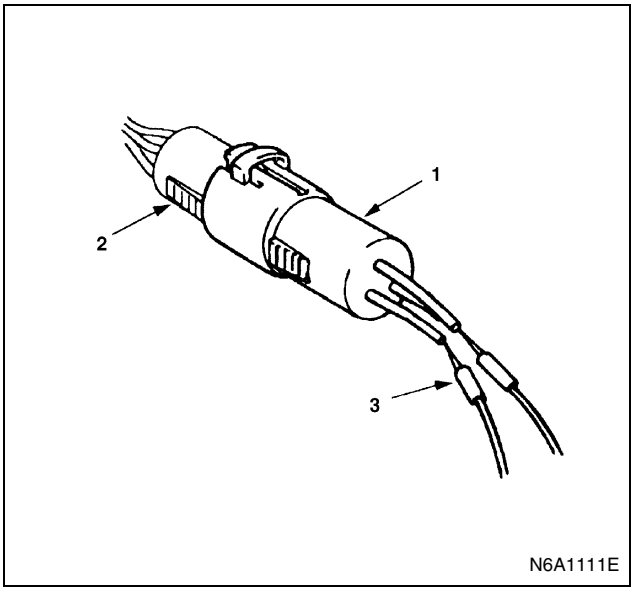
Legend
1. Test probe

Never insert the circuit tester test probes into the connector open end to test the continuity. Broken or open connector terminals will result.



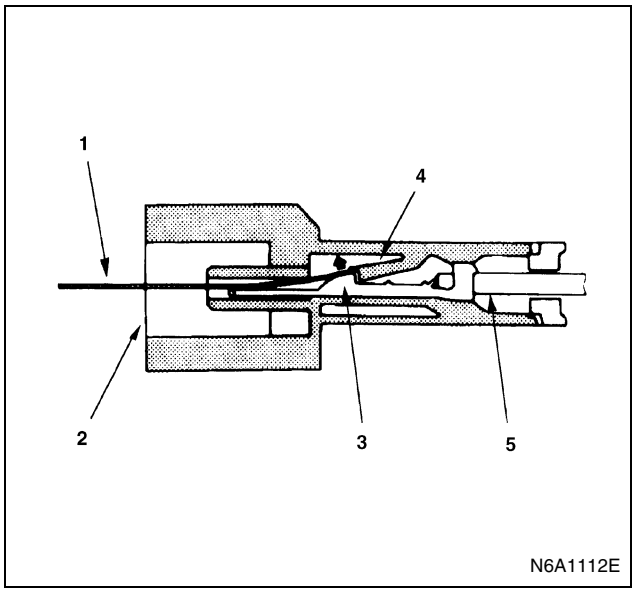
Legend
1. Test probe

Waterproof Connector Inspection
It is not possible to insert the test probes into the connector wire side of a waterproof connector.
Use one side of a connector (1) with its wires cut to make the test. Connect the test connector (2) to the connector to be tested. Connect the test probes to the cut wires to check the connector continuity.



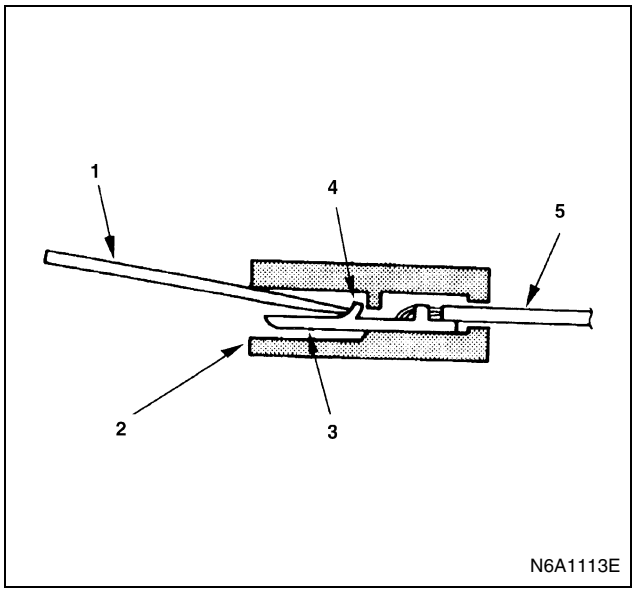
Legend
1. Connector
2. Test connector
3. Test probe

Connector Pin Removal
Connector Housing Tang Lock Type
1. Insert a slender shaft into the connector housing open end.
2. Push the tang lock up (in the direction of the arrow in the illustration). Pull the wire with pin free from the wire side of the connector.



Legend
1. Slender shaft
2. Housing open pad
3. Pin
4. Tang lock
5. Wire

Pin Tang Lock Type
1. Insert a slender shaft into the Connector housing open end.
2. Push the tang lock flat (toward the wire side of the connector). Pull the wire with pin free from the wire side of the connector.

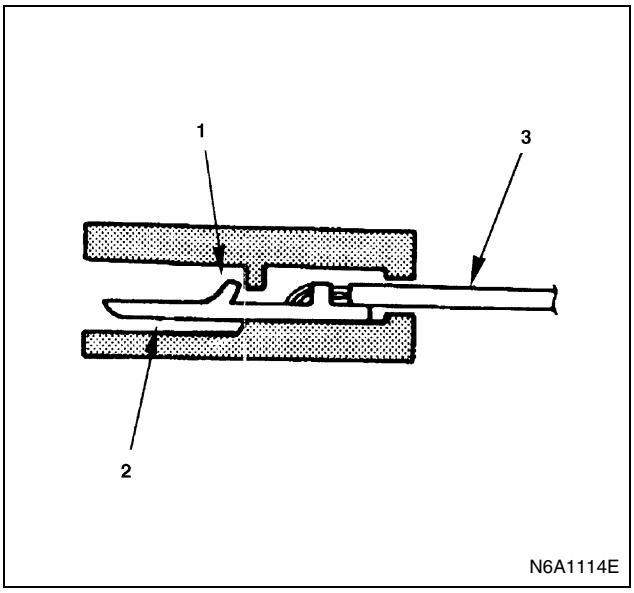


Legend

1. Slender shaft
2. Housing open pad
3. Pin
4. Tang lock
5. Wire

Connector Pin Insertion

1. Check that the tang lock is fully up.
2. Insert the pin from the connector wire side.
   Push the pin in until the tang lock closes firmly.
3. Gently pull on the wires to make sure that the connector pin is firmly set in place.

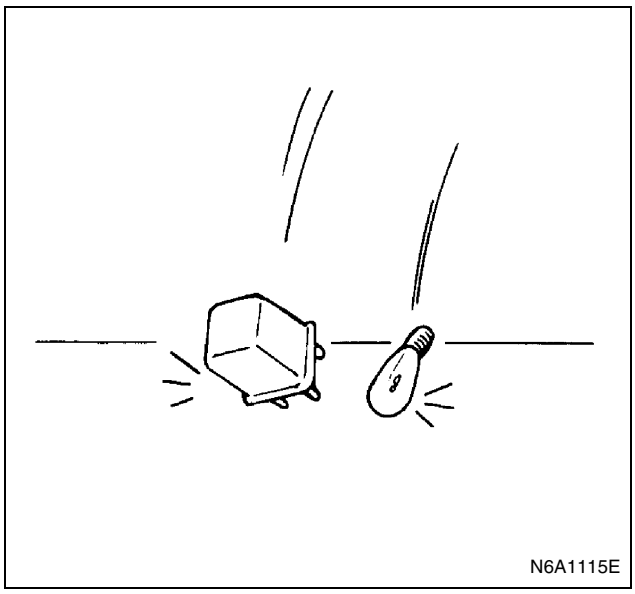


Legend

1. Tang lock
2. Pin
3. Wire

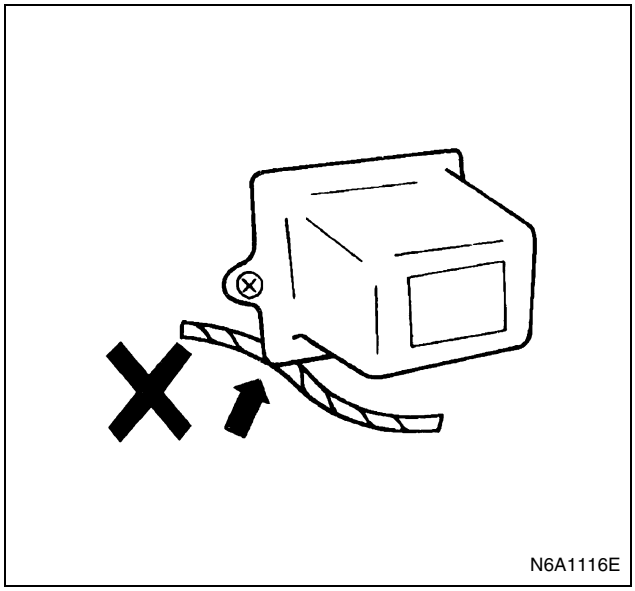
Parts Handling

Be careful when handling electrical parts. They should not be dropped or thrown, because short circuit or other damage may result.



Cable Harness

When installing the parts, be careful not to pinch or wedge the wiring harness.
All electrical connections must be kept clean and tight.

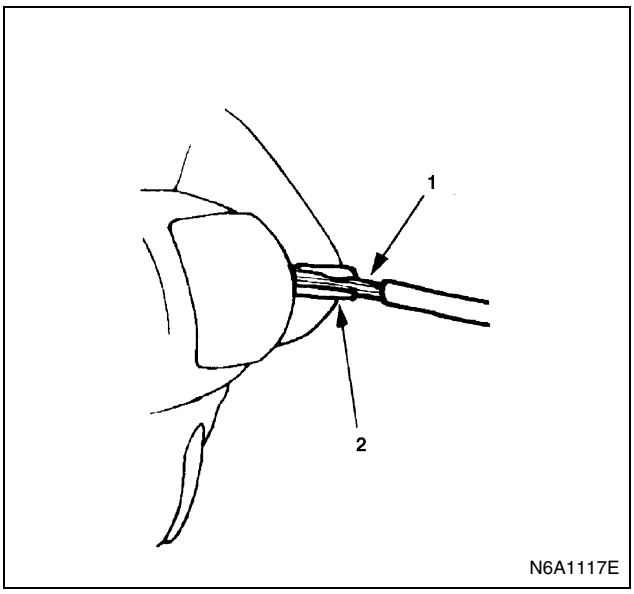


Splicing Wire

1. Open the Harness
   If the harness is taped, remove the tape. To avoid wire insulation damage, use a sewing “seam ripper” (available from sewing supply stores) to cut open the harness.
   If the harness has a block plastic conduit, simply pull out the desired wire.
2. Cut the wire
   Begin by cutting as little wire off the harness as possible. You may need the extra length of wire later if you decide to cut more wire off to change the location of a splice. You may have to adjust splice locations to make certain that each splice is at least 1.5 in (40 mm) away from other splices, harness branches, or connectors.
3. Strip the insulation

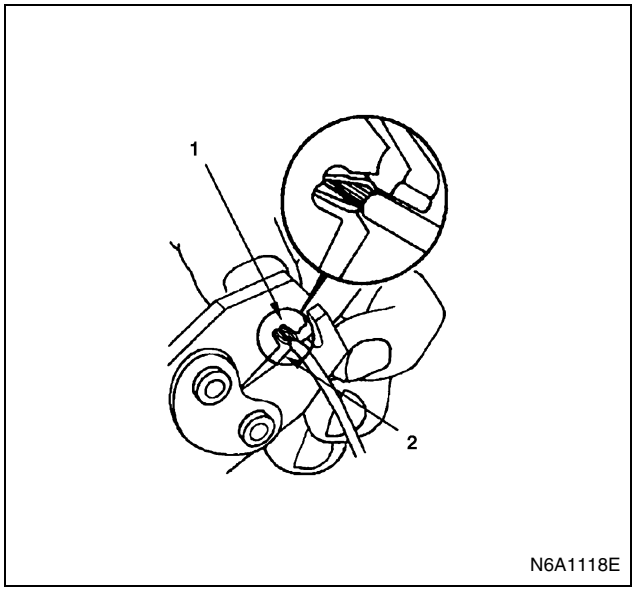
When replacing a wire, use a wire of the same size as the original wire. Check the stripped wire for nicks or cut stands. If the wire is damaged, repeat the procedure on a new section of wire. The two stripped wire ends should be equal in length.

4. Crimp the Wires
   Select the proper clip to secure the splice. To determine the proper clip size for the wire being spliced, follow the directions included with your clips. Select the correct anvil on the crimper. (On most crimpers your choice is limited to either a small or large anvil.) Overlap the two stripped wire ends and hold them between your thumb and forefinger. Then, center the splice clip under the stripped wires and hold it in place.



Legend
1. Over lap bare wires
2. Splice clip

- Open the crimping tool to its full width and rest one handle on a firm flat surface.
- Center the back of the splice clip on the proper anvil and close the crimping tool to the point where the back of the splice clip touches the wings of the clip.
- Make sure that the clip and wires are still in the correct position. then, apply steady pressure until the crimping tool closes.

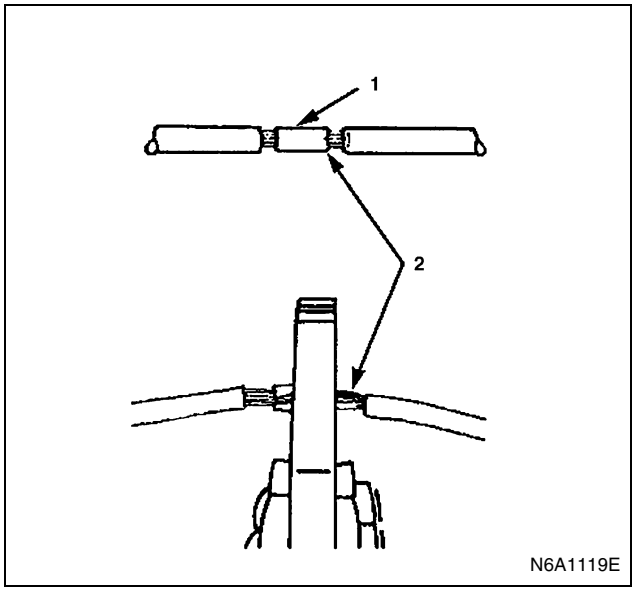


Legend
1. Wings of clip touching former
2. Back of clip centered on anvil

Before crimping the ends of the clip, be sure that:

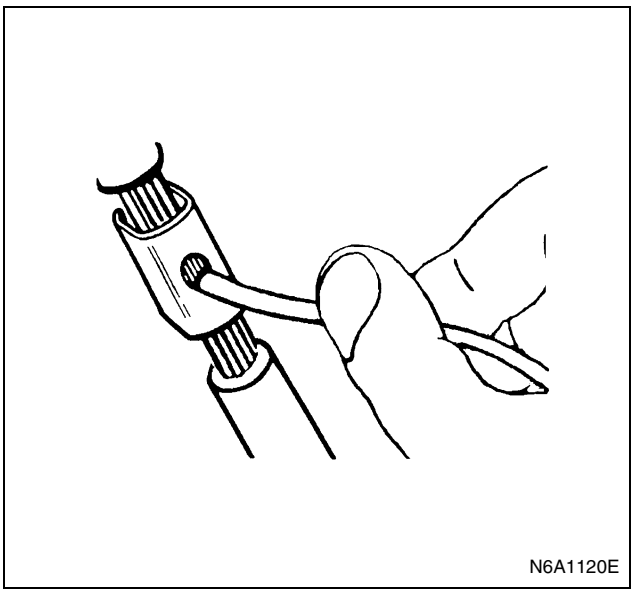
- The wires extend beyond the clip in each direction.
- No stands of wire are cut loose, and
- No insulation is caught under the clip.

Crimp the splice again, once on each end. Do not let the crimping tool extend beyond the edge of the clip or you may damage or nick the wires.

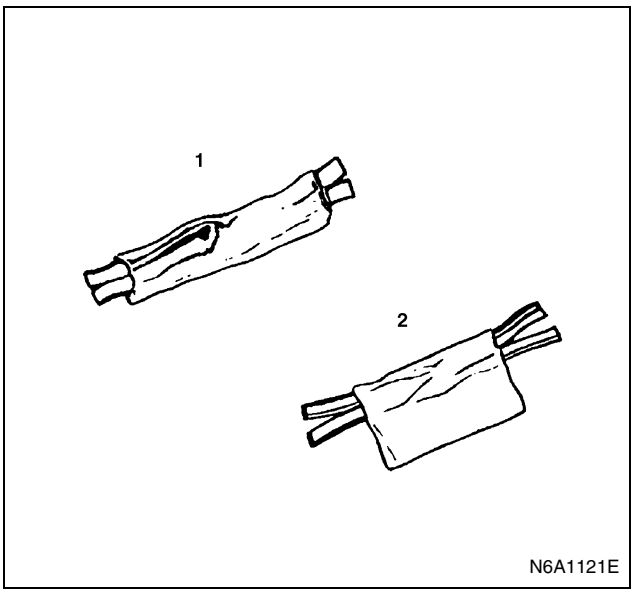


Legend
1. Splice clip
2. Align tool with edge of clip to crimp ends of splice

5. Solder
   Apply 60/40 rosin core colder to the opening in the back of the clip. Follow the manufacturer's instructions for the solder equipment you are using.


N6A1120E

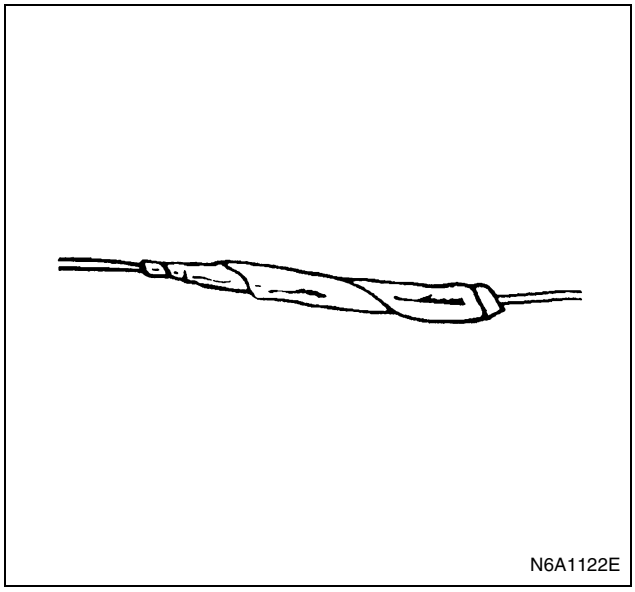
6. Tape the Splice
   Center and roll the splicing tape. The tape should cover the entire splice. Roll on enough tape to duplicate the thickness of the insulation on the existing wires. Do not flag the tape. Flagged tape may not provide enough insulation, and the flagged ends will tangle with the other wires in the harness.



N6A1121E

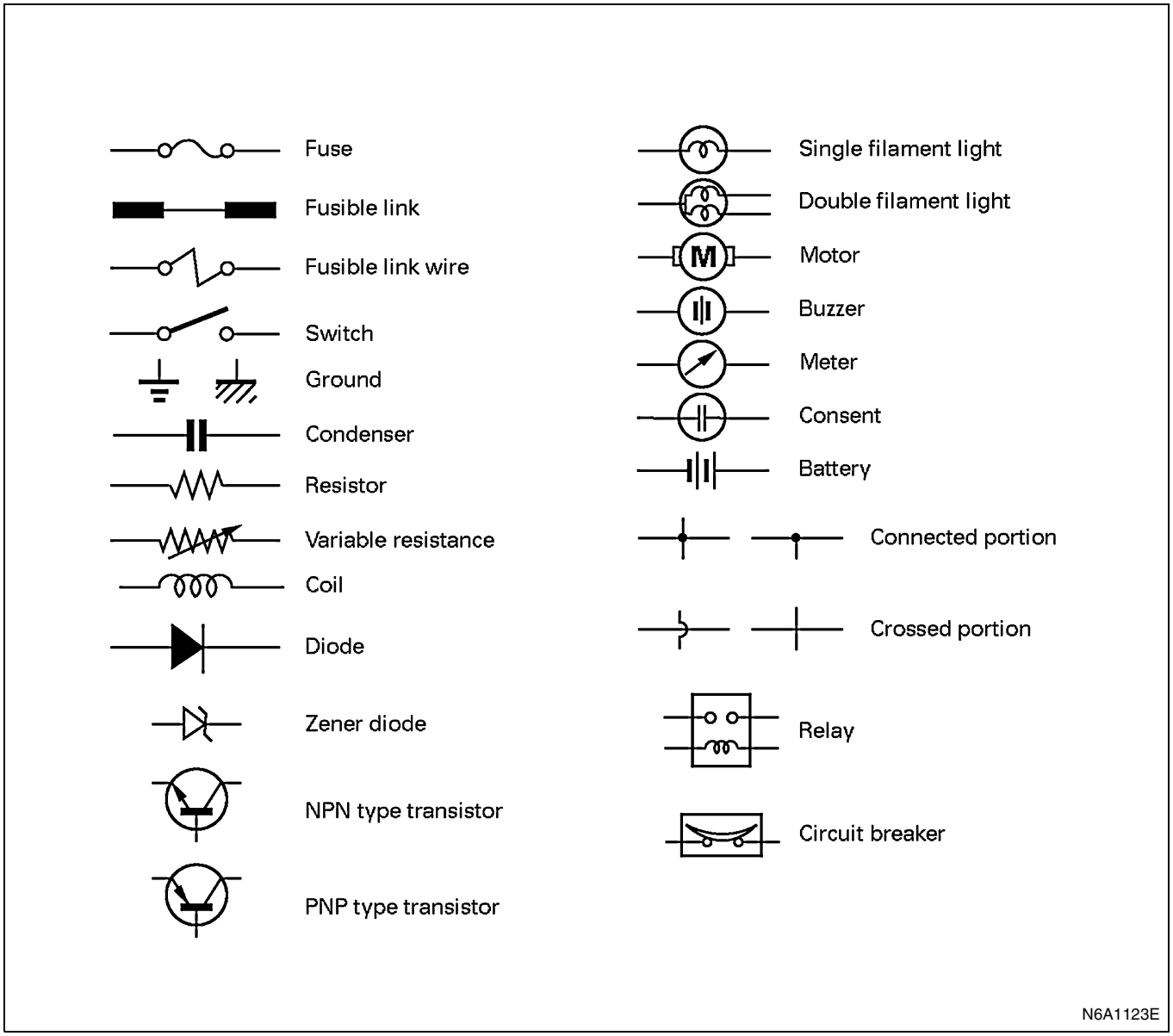
Legend
1. Good (Rolled)
2. Bad (Flaged)

If the wire does not belong in a conduit or other harness covering, tape the wire again. Use a winding motion to cover the first piece of tape.


N6A1122E

Symbols and Abbreviations

Symbols



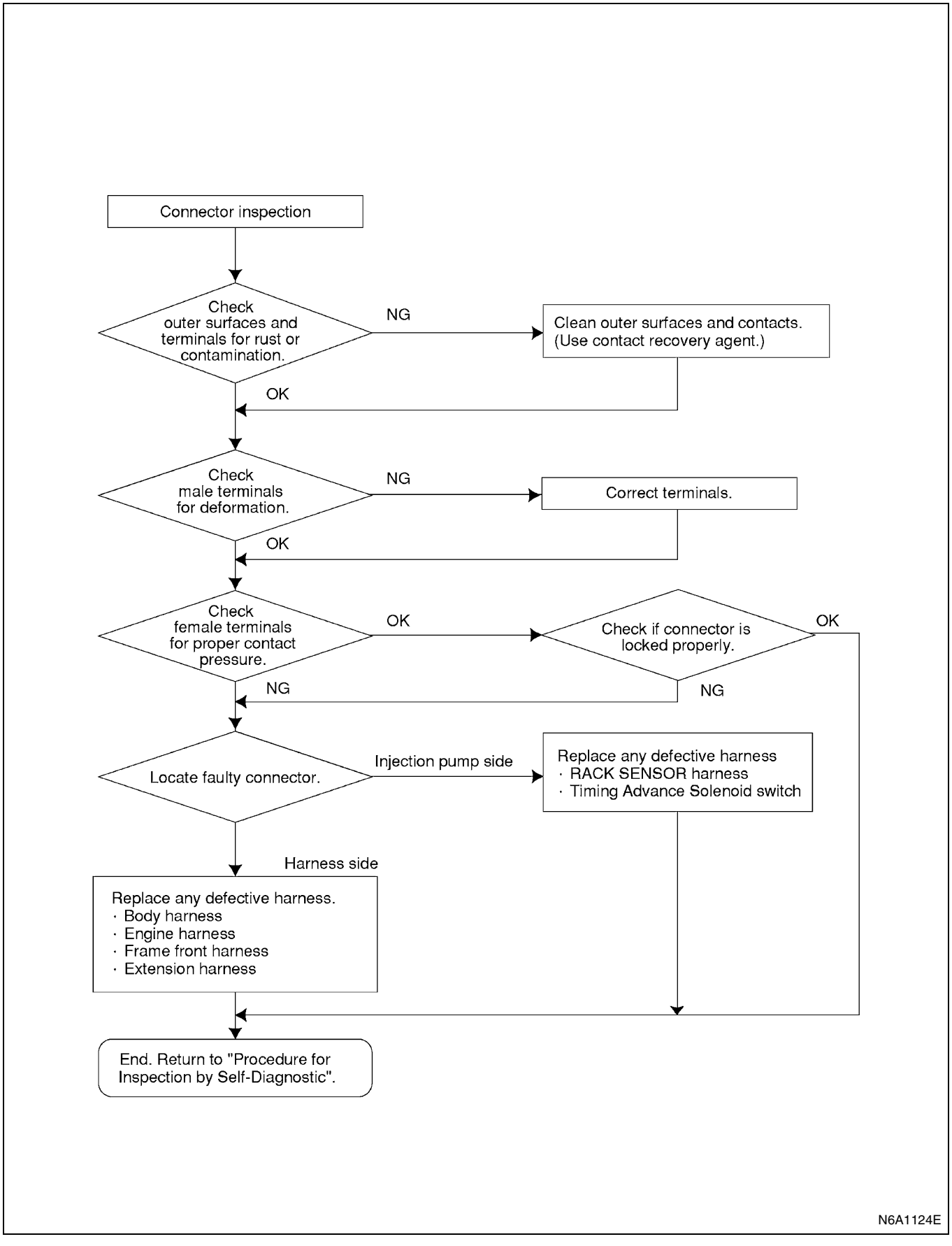
Abbreviations

Abbreviation	Meaning	Abbreviation	Meaning
A/C	Air Conditioner	OBD	BOARD Diagnostic
ACC	Accessory	OFF	Turn Off (Switch/Lamp)
ACT	Actuator	ON	Turn On (Switch/Lamp)
ASSIT	Assistant	OPT	Option
BATT	Battery	P/BRAKE	Parking Brake
		PGND	Power Ground (To Body Earth)
CAS	Cab Air Suspension	PIN	Pin or Terminal
CAS C/U	Cab Air Suspension Control Unit	P/L	Pilot (Warning) Lamp
CCS	Combined Charging System	PRESS	Pressure
CONN	Connector	P/T	Power Train

Abbreviation	Meaning	Abbreviation	Meaning
C/U	Control Unit	PTO	Power Take Off
DC	Direct Current	Q ADJUST-MENT	Injection Quantity Adjustment
D/CONN	Diagnosis Connector		
DTC	Diagnostic Trouble Code	QOS	Quick On Start
		QWS	Quick Warm System
EC	Electrical Control Governor		
ECM	Engine Control Module	RH	Right Hand (Side)
ECT	Engine Coolant Temperature	RHD	Right Hand Drive
EGR	Exhaust Gas Recirculation	R/L	Relay
EH	Electrical and Hydraulic Timer	RR	Rear
EXH	Exhaust		
EVRV	Electronic Vacuum Regulating Valve	S/ASB	Shock Absorber
		SIG	Signal
FICD	Fast Idle Control Device	SS	Speed Sensor
FRT	Front	SS C/U	Speed Sensor Control Unit
		STD	Standard
GND	Ground (Body Earth)	SUSP	Suspension
		SW	Switch
IE	ISUZU Economy System		
IN	Inlet, Intake	TCV	Trailer Cock Valve
IVES	ISUZU Variable Electric and Economy Swirl	TICS	Timing and Injection Rate Control System
LH	Left Hand (Side)	VGS	Variable Geometry Turbocharging System
LHD	Left Hand Drive		
		VSS	Variable Swirl System
MAG	Magnetic	VSV	Vacuum Switching Valve
ME/CONN	Memory Eraser Connector		
MIL	Malfunction Indicator Lamp	W/L	Warning Lamp
M/V	Magnetic Valve	W/	With
		W/O	Without
N	Neutral (Transmission Gear)		
N-TDC	Numbers Top Dead Center		
NR	Noise Reducer		

Connector Inspecting Procedure

Connector Inspecting Procedure

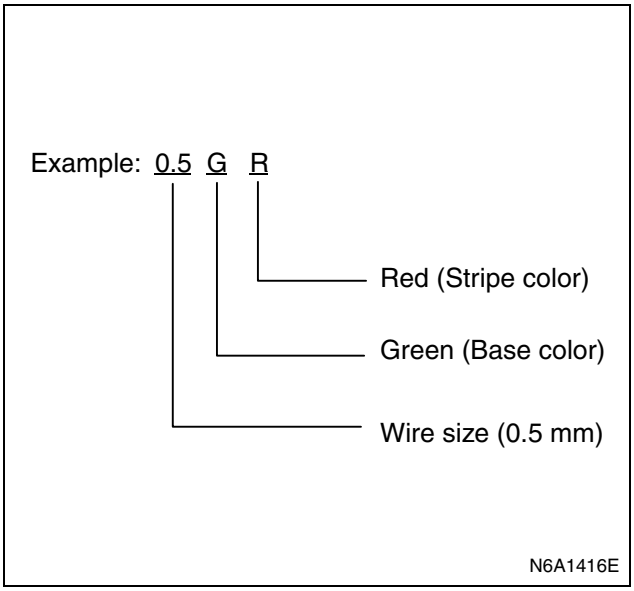


Parts for Electrical Circuit

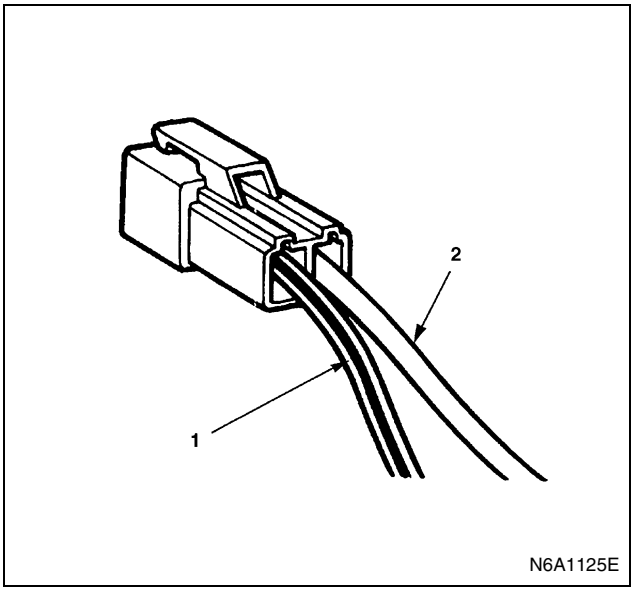
Wiring

Wire Color

All wires have color-coded insulation.
Wires belonging to a system's main harness will have a single color. Wires belonging to a system's sub circuits will have a colored stripe. Striped wires use the following code to show wire size and colors.

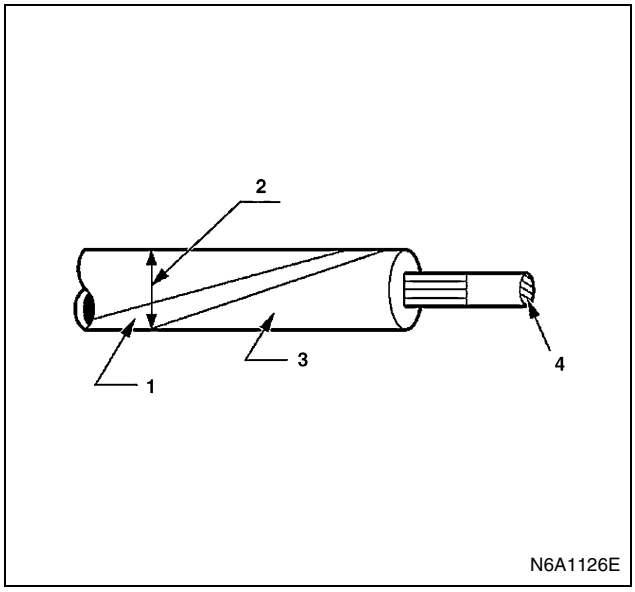


Abbreviations are used to indicate wire color within a circuit diagram.
Refer to the following table.



Legend

1. Colored stripe
2. Single color



Legend

1. Stripe color
2. Outside diameter
3. Base color
4. Cross sectional area

Wire Color Coding

Color-coding	Meaning	Color-coding	Meaning
B	Black	Br	Brown
W	White	Lg	Light green
R	Red	Gr	Gray
G	Green	P	Pink
Y	Yellow	Sb	Sky blue
L	Blue	V	Violet
O	Orange		

Stripe Color Coding

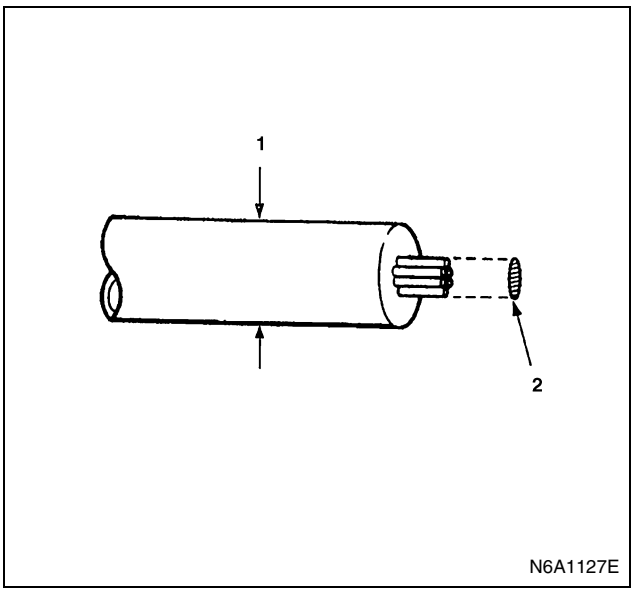
Color-code	Base Color	Stripe Color
LB	Blue	Black
OB	Orange	Black
PB	Pink	Black
PG	Pink	Green
PL	Pink	Blue
RY	Red	Yellow
VR	Violet	Red
VW	Violet	White
YB	Yellow	Black
YB	Yellow	Green
YV	Yellow	Violet

Wire Size

The size of wire, used in a circuit is determined by the amount of current (amperage), the length of the circuit, and the voltage drop allowed. The following wire size and load capacity, shown below, are specified by JIS (Japanese Industrial Standard) (Nominal size means approximate cross sectional area)

Legend

1. Outside diameter
2. Cross sectional area



Nominal size (mm)	Cross sectional area (mm^2)	Outside diameter (mm)	Allowable current (A)
0.3	0.372	1.8	9
0.5	0.563	2	12
0.85	0.885	2.2	16
1.25	1.287	2.5	21
2	2.091	2.9	28
3	3.296	3.6	37.5
5	5.227	4.4	53
8	7.952	5.5	67
15	13.36	7	75
20	20.61	8.2	97

DIAGNOSIS (4HE1-TC Only)

Strategy-based Diagnostics

Strategy-Based Diagnostics

The strategy-based diagnostic is a uniform approach to repair all Electrical/Electronic (E/E) systems. The diagnostic flow can always be used to resolve an E/E system problem and is a starting point when repairs are necessary. The following steps will instruct the technician how to proceed with a diagnosis:

1. Verify the customer complaint.
   - To verify the customer complaint, the technician should know the normal operation of the system.
2. Perform preliminary checks.
   - Conduct a thorough visual inspection.
   - Review the service history.
   - Detect unusual sounds or odors.
   - Gather diagnostic trouble code information to achieve an effective repair.
3. Check bulletins and other service information.
   - This includes videos, newsletters, etc.
4. Refer to service information (manual) system check (s).
   - “System checks” contain information on a system that may not be supported by one or more DTCs.
     System checks verify proper operation of the system. This will lead the technician in an organized approach to diagnostics.
5. Refer to service diagnostics.

Diagnostic Trouble Code (DTC) Stored

Follow the designated DTC chart exactly to make an effective repair.

No DTC

Select the symptom from the symptom tables.

Follow the diagnostic paths or suggestions to complete the repair. You may refer to the applicable component/ system check in the system checks.

No Matchig Symptom

1. Analyze the complaint.
2. Develop a plan for diagnostics.
3. Utilize the wiring diagrams and the theory of operation.

Call technical assistance for similar cases where repair history may be available. Combine technician knowledge with efficient use of the available service information.

Intermittents

Conditions that are not always present are called intermittents. To resolve intermittents, perform the following steps:

1. Observe history DTCs, DTC modes.
2. Evaluate the symptoms and the conditions described by the customer.
3. Use a check sheet or other method to identify the circuit or electrical system component.
4. Follow the suggestions for intermittent diagnosis found in the service documentation.

Most scan tool, such as the Tech II have data-capturing capabilities that can assist in detecting intermittents.

No Trouble Found

This condition exists when the vehicle is found to operate normally. The condition described by the customer may be normal. Verify the customer complaint against another vehicle that is operating normally. The condition may be intermittent. Verify the complaint under the conditions described by the customer before releasing the vehicle.

1. Re-examine the complaint
   When the Complaint cannot be successfully found or isolated, a re-evaluation is necessary.
   The complaint should be re-verified and could be intermittent as defined in Intermittents, or could be normal.
2. Repair and verify.
   After isolating the cause, the repairs should be made.
   Validate for proper operation and verify that the symptom has been corrected. This may involve road testing or other methods to verify that the complaint has been resolved under the following conditions:
   - Conditions noted by the customer.
   - If a DTC was diagnosed, verify a repair by duplicating conditions present according to customer complaint.

Verifying Vehicle Repair

Verification of the vehicle repair will be more comprehensive for vehicles with OBD system diagnostics. Following a repair, the technician should perform the following steps:

Important:

Follow the steps below when you verify repairs on board diagnostic systems. Failure to follow these steps could result in unnecessary repairs.

1. Review and record the Failure Records for the DTC which has been diagnosed.
2. Clear the DTC (S).
3. Operate the vehicle within conditions according to customer complaint.
4. Monitor the Diagnostic Trouble Code (DTC) status information for the specific DTC which has been diagnosed until the diagnostic test associated with that DTC runs.

General Service Information

On Board Diagnostic (OBD) Serviceability Issues

The list of non-vehicle faults that could affect the performance of the OBD system has been complied. These non-vehicle faults vary from environmental conditions to the quality of fuel used.

The illumination of the Malfunction Indicator Lamp (MIL) ("Check Engine" lamp) due to a non-vehicle fault could lead to misdiagnosis of the vehicle, increased warranty expense and customer dissatisfaction. The following list of non-vehicle faults does not include every possible fault and may not apply equally to all product lines.

Poor Vehicle Maintenance

The sensitivity of OBD diagnostics will cause the MIL to turn on if the vehicle is not maintained properly. Restricted air filters, fuel filters, oil filters, and crankcase deposits due to lack of oil changes or improper oil viscosity can trigger actual vehicle faults that were not previously monitored prior to OBD. Poor vehicle maintenance can not be classified as a "non-vehicle fault", but with the sensitivity of OBD diagnostics, vehicle maintenance schedules must be more closely followed.

Maintenance Schedule

Refer to the maintenance Schedule.

Visual/Physical Engine Compartment Inspection

Perform a careful visual and physical engine compartment inspection when performing any diagnostic procedure or diagnosing the cause of an emission test failure. This can often lead to repairing a problem without further steps. Use the following guidelines when performing a visual/physical inspection:

- Inspection all vacuum hoses for punches, cuts, disconnects, and correct rouring.
- Inspect hoses that are difficult to see behind other components.
- Inspect all wires in a engine compartment for proper connections, burned or chafed spots, pinched wires, contact with sharp edges or contact with hot exhaust manifolds or pipes.

Basic Knowledge of Tools Required

Notice:

Lack of basic knowledge of this powertrain when performing diagnostic procedures could result in an incorrect diagnosis or damage to powertrain components. Do not attempt to diagnose a powertrain problem without this basic knowledge.

A basic understanding of hand tools is necessary to effectively use this section of the Service Manual.

On-Board Diagnostic (OBD)

On-Board Diagnostic Tests

A diagnostic test is a series of steps, the result of which is a pass or fail reported to the diagnostic executive. When a diagnostic test reports a pass result, the diagnostic executive records the following data:

- The diagnostic test has been completed since the last ignition cycle.
- The diagnostic test has passed during the current ignition cycle.
- The fault identified by the diagnostic test is not currently active.

When a diagnostic test reports a fail result, the diagnostic executive records the following data:

- The diagnostic test has been completed since the last ignition cycle.
- The fault identified by the diagnostic test is currently active.
- The fault has been active during this ignition cycle.
- The operating conditions at the time of the failure.

Common OBD Terms

Diagnostic

When used as a noun, the word diagnostic refers to any on-board test run by the vehicle's Diagnostic Management System. A diagnostic is simply a test run on a system or component to determine if the system or component is operating according to specification.

Enable Criteria

The term "enable criteria" is engineering language for the conditions necessary for a given diagnostic test to run. Each diagnostic has a specific list of conditions which must be met before the diagnostic will run. "Enable criteria" is another way of saying "conditions required".

Trip

Technically, a trip is a key on-run-key off cycle in which all the enable criteria for a given diagnostic are met, allowing the diagnostic to run. Unfortunately, this concept is not quite that simple. A trip is official when all the enable criteria for a given diagnostic are met. But because the enable criteria vary from one diagnostic to another, the definition of trip varies as well. Some diagnostic are run when the vehicle is at operating temperature, some when the vehicle first start up; some require that the vehicle be cruising at a steady highway speed, some run only when the vehicle is idle.

Some run only immediately following a cold engine start-up.

A trip then, is defined as a key on-run-key off cycle in which the vehicle was operated in such a way as to satisfy the enables criteria for a given diagnostic, and this diagnostic will consider this cycle to be one trip. However, another diagnostic with a different set of enable criteria (which were not met) during this driving event, would not consider it a trip. No trip will occur for that particular diagnostic until the vehicle is driven in such a way as to meet all the enable criteria.

Diagnostic Information
The diagnostic charts and functional checks are designed to locate a faulty circuit or component through a process of logical decisions. The charts are prepared with the requirement that the vehicle functioned correctly at the time of assembly and that there are not multiple faults present.
There is a continuous self-diagnosis on certain control functions. This diagnostic capability is complemented by the diagnostic procedures contained in this manual. The language of communicating the source of the malfunction is a system of diagnostic trouble codes. When a malfunction is detected by the control module, a diagnostic trouble code is set and the Malfunction Indicator Lamp (MIL) is illuminated.
Data Link Connector (DLC)
The provision for communication with the control module is the Data Link Connector (DLC). It is located at near the A post of driver side. The DLC is used to connect to a scan tool. Some common uses of the scan tool are listed below:

- Identifying stored Diagnostic Trouble Codes (DTCs).
- Clearing DTCs.
- Reading serial data.

Decimal/Binary/Hexadecimal Conversions
All scan tool manufacture will display a variety of vehicle information which will aid in repairing the vehicle. Some scan tools will display encoded messages which will aid in determining the nature of the concern. The method of encoding involves the use of a two additional numbering systems: Binary and Hexadecimal.
The binary number system has a base of two numbers. Each digits is either a 0 or a 1. A binary number is an eight digit number and is read from right to left. Each digit has a position number with the farthest right being the 0 position and the farthest left being the 7 position. The 0 position, when displayed by a 1, indicates 1 in decimal. Each position to the left is double the previous position and added to any other position values marked as a 1.
A hexadecimal system is composed of 16 different alpha numeric characters. The alpha numeric characters used are numbers 0 through 9 and letters A through F. The hexadecimal system is the most natural and common approach for scan tool manufactures to display data represented by binary numbers and digital code.
Verifying Vehicle Repair
Verification of vehicle repair will be more comprehensive for vehicle with OBD system diagnostic. Following a repair, the technician should perform the following steps:

1. Review and record the Fail Records for the DTC which has been diagnosed.
2. Clear DTC (s).
3. Operate the vehicle within conditions noted in the Fail Records.
4. Monitor the DTC status information for the specific DTC which has been diagnosed until the diagnostic test associated with that DTC runs.

Following these steps are very important in verifying repairs on OBD systems. Failure to follow these steps could result in unnecessary repairs.
On-Board Diagnostic (OBD) System Check
OBD System should be checked as follows:

1. When Ignition key is turned from the “OFF” to the “ON” position, make sure that MIL is lit for 0.3 — 0.8 sec.
2. Connect Scan Tool and check to see if MIL is always lit.
   If so, OBD System is normal.

Reading Diagnostic Trouble Codes Using a Tech 2 or Other Scan Tool

The procedure for reading diagnostic trouble codes is to be used a diagnostic scan tool. When reading DTCs, follow instructions supplied by tool manufacturer.

Clearing Diagnostic Trouble Codes

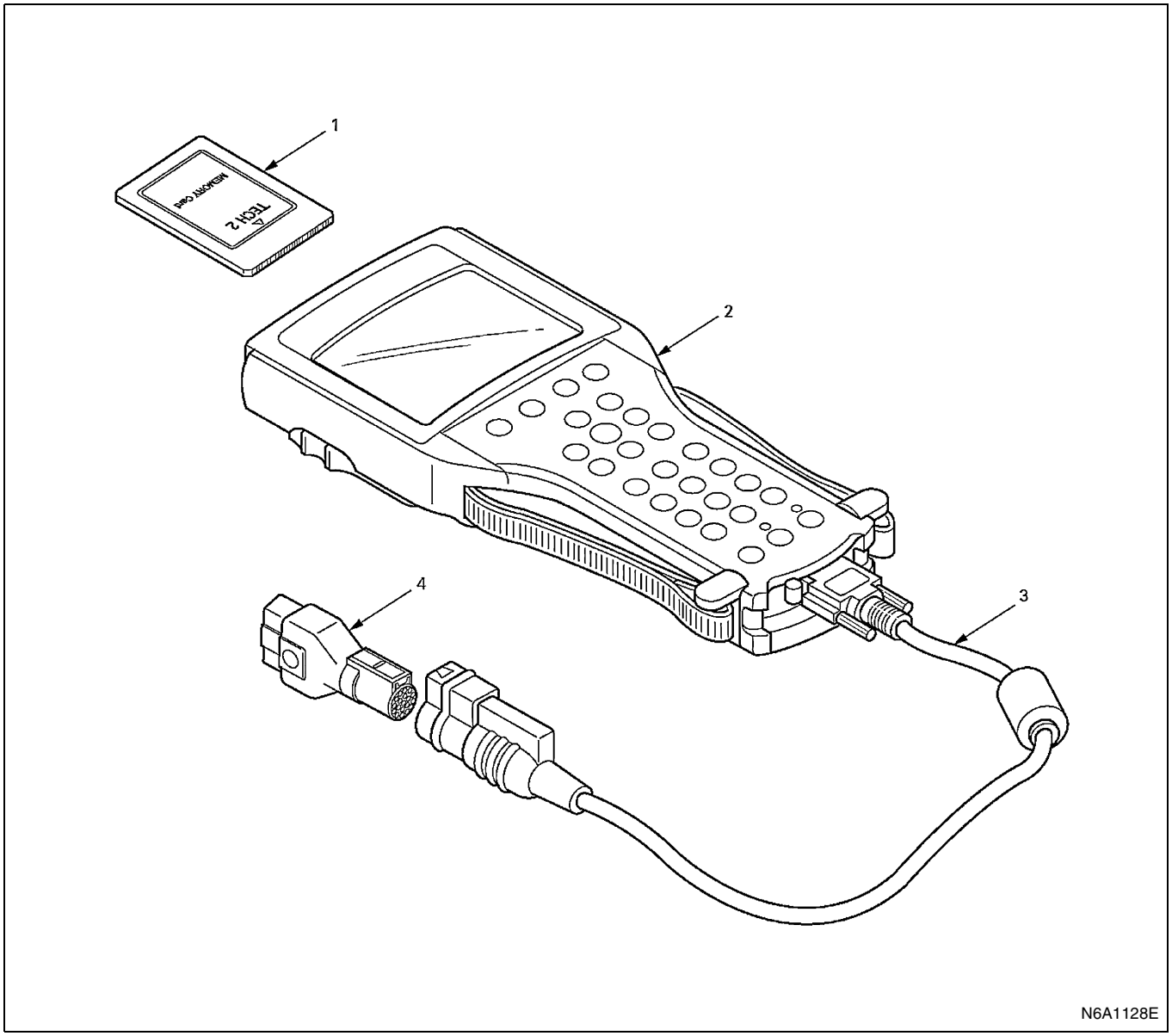
Important:
Do not clear DTCs unless directed to do so by the service information provided for each diagnostic procedure. When DTCs are cleared, the Freeze Frame and Failure Record data which may help diagnose an intermittent fault will also be erased from memory.

If the fault that caused the DTC to be stored into memory has been corrected, the Diagnostic Executive will begin to count the “warm-up” cycles with no further faults detected, the DTC will automatically be cleared from the Engine Control Module (ECM) memory.
To clear Diagnostic Trouble Codes (DTCs), use the diagnostic scan tool “clear DTCs” or “clear Information” function. When clearing DTCs follow instructions supplied by the tool manufacturer.
When a scan tool is not available, DTCs can also be cleared by disconnecting one of the following sources for at least thirty (30) seconds.

Notice:
To prevent system damage, the ignition key must be “OFF” when disconnecting or reconnecting battery power.

- The power source to the control module. Examples: fuse, pigtail at battery ECM connectors etc.
- The negative battery cable. (Disconnecting the negative battery cable will result in the loss of other on-board memory data, such as preset radio tuning).

Tech 2 Scan Tool
From 98 MY, Isuzu Dealer service departments are recommended to use Tech 2. Refer to Tech 2 scan tool user guide.



Legend

1. PCMCIA card
2. SAE 16/19 adapter
3. DLC cable
4. Tech-2

Getting Started

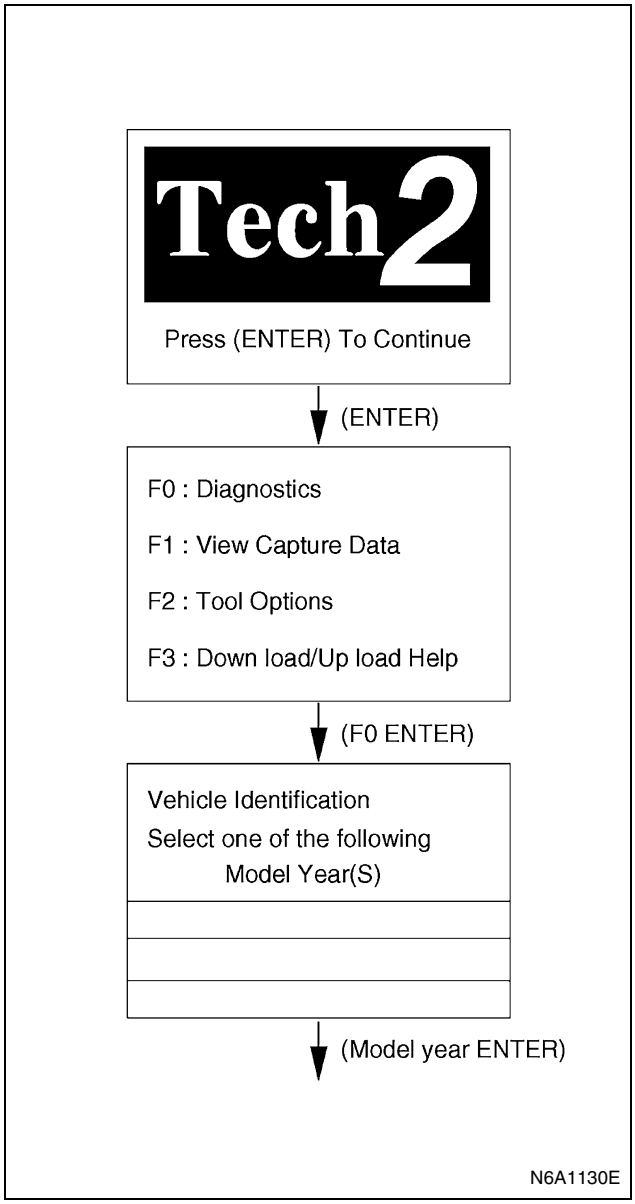
- Before operating the Isuzu PCMCIA card with the Tech 2, the following steps must be performed:

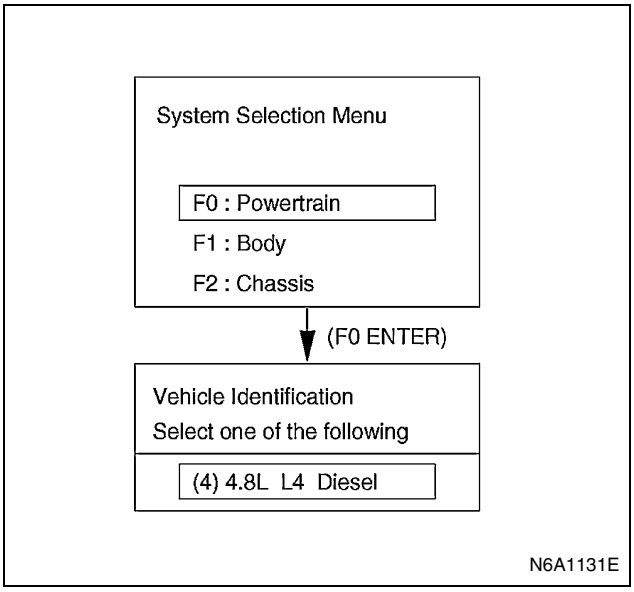
1. The Isuzu 98 System PCMCIA card (1) inserts into the Tech 2 (2).
2. Connect the SAE 16/19 adapter (4) to the DLC cable (3).
3. Connect the DLC cable to the Tech 2 (2).
4. Make sure the vehicle ignition key is off.
5. Connect the Tech 2 SAE 16/19 adapter to the vehicle ALDL/DLC.
6. The vehicle ignition turns on.
7. Verify the Tech 2 power up display.

Notice:
The RS232 Loop back connector is only to use for diagnosis of Tech 2 and refer to user guide of the Tech 2.

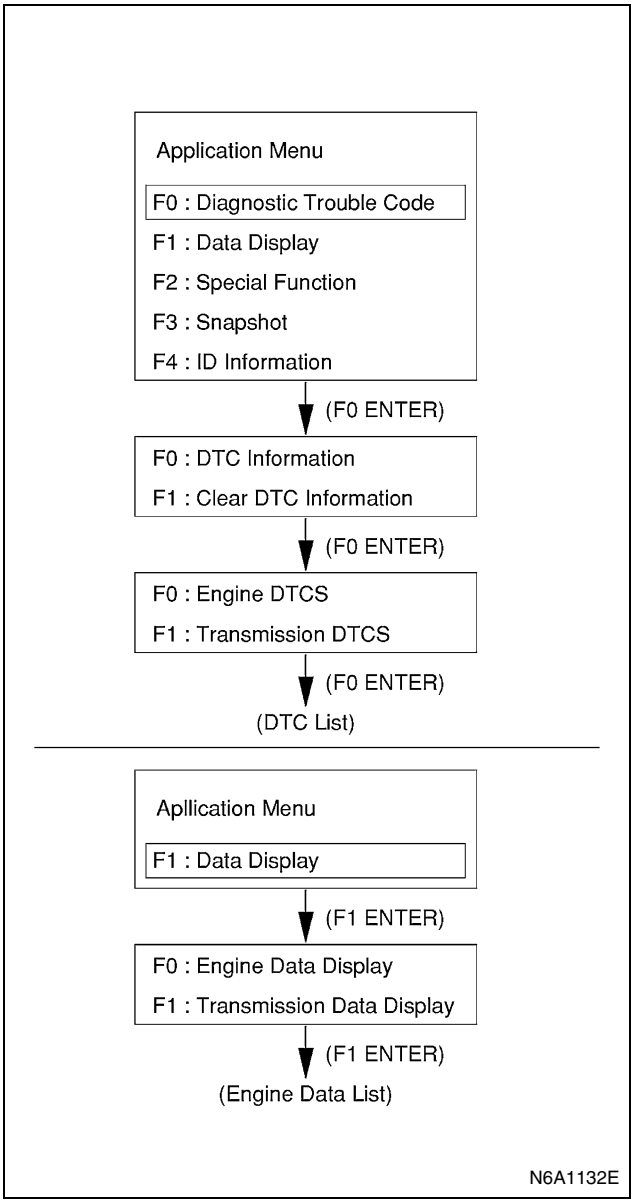
Operating Procedure (For example)

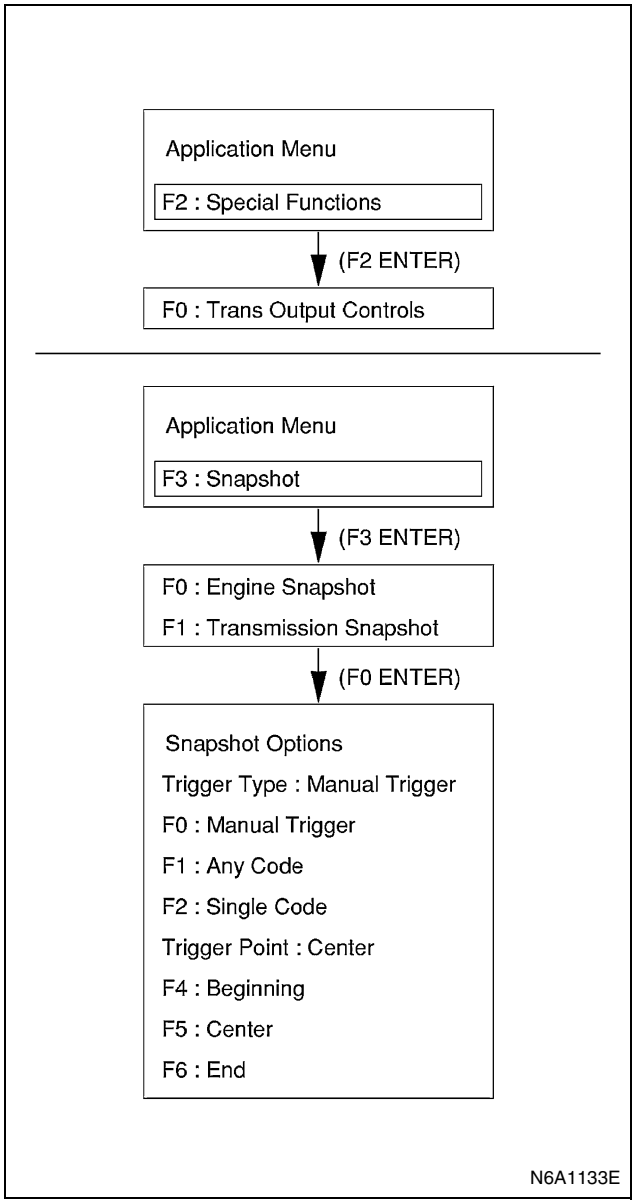
The power up screen is displayed when you power up the tester with the Isuzu systems PCMCIA card. Follow the operating procedure below.

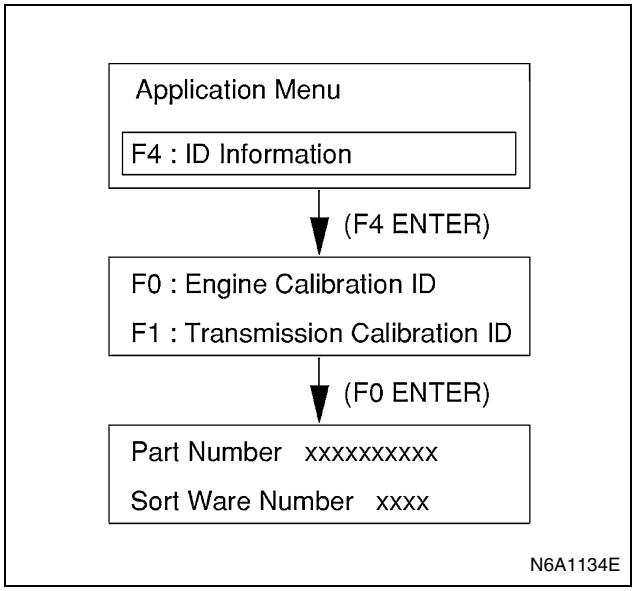




- The following table shows, which functions are used the available equipment versions.







Typical Scan Data Values

Use the Typical Scan Data Values Table only after the On-Board Diagnostic System Check has been completed, no diagnostic trouble codes were noted, and you have determined that the on-board diagnostics are functioning properly. Scan tool values from a properly-running engine may be used for comparison with the engine you are diagnosing. The typical scan data values represent values that would be seen on a normally-running engine.

Notice:
A scan tool that displays faulty data should not be used, and the problem should be reported to the scan tool manufacturer. Use of a faulty scan tool can result in misdiagnosis and unnecessary replacement of parts.

Only the parameters listed below are referred to in this service manual for use in diagnosis. For further information on using the scan tool to diagnose the engine control module and related sensors, refer to the applicable reference section listed below. If all values are within the typical range described below, refer to the symptoms section for diagnosis.

Test Conditions

Engine running, lower radiator hose hot, transmission in park or neutral, closed loop, accessories off, brake not applied and air conditioning off.

Data List (Typical Data)

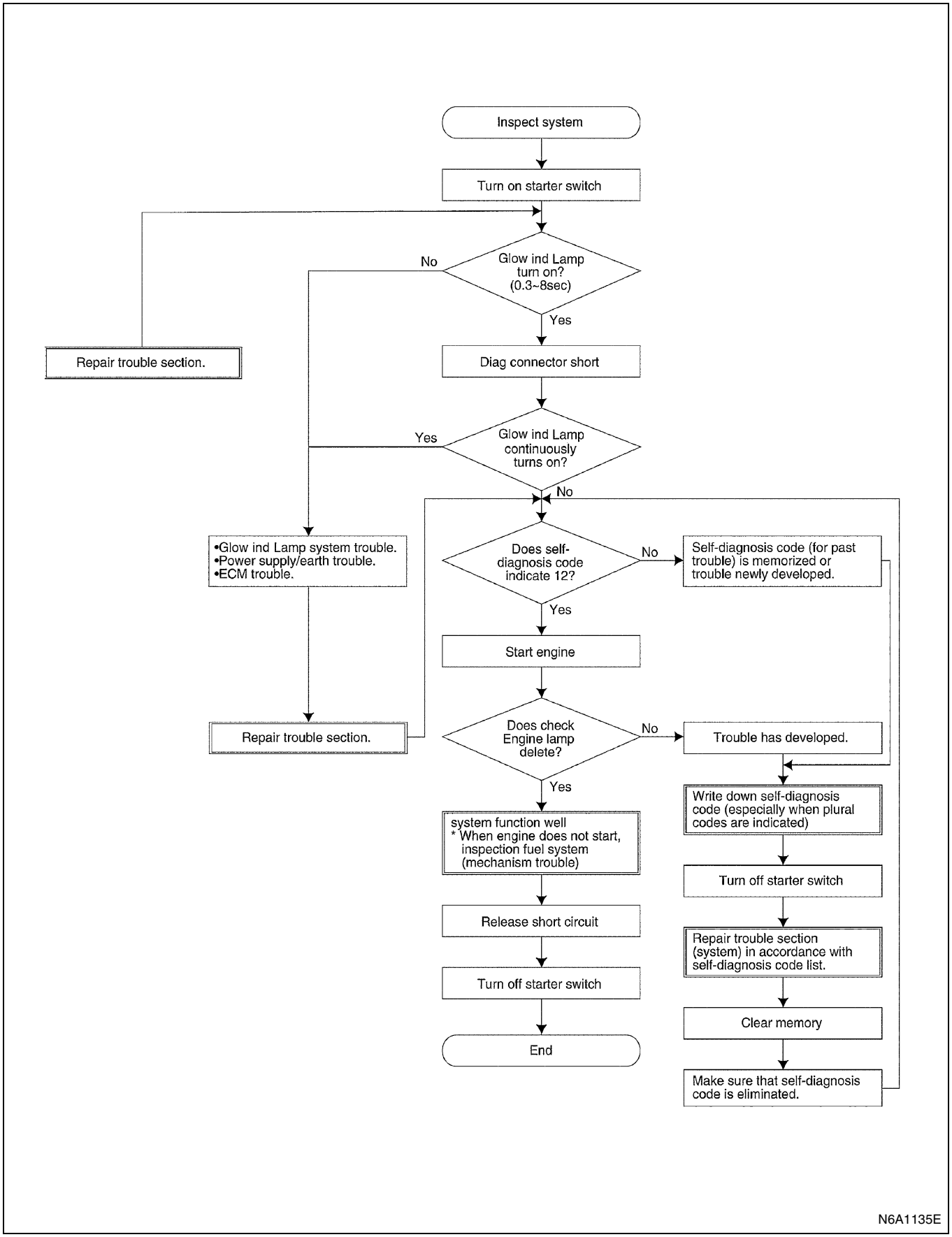
TECH 2 STRING		TYPICAL DATA VALUES (IDLE)
Ignition Switch	(On/Off)	On
Starter Switch	(On/Off)	Off
Exhaust Break Switch	(On/Off)	Off
Transmission Gear Position Switch		N.2.3.4.5.6
Transmission Spec. Select Switch	(AT/MT)	Automatic Trans
Engine Spec. Select Switch	(S/N)	S/N
IAT Switch	(Yes/No and High/Low)	High
EGR/VSS System	(Yes/No)	Yes
Rack Sensor Voltage	(V)	1
Engine Coolant Temperature Sensor Voltage	(V)	1.7 —1.9
Engine Coolant Temperature	°F(°C)	176 (80)
Engine Speed	(rpm)	800
Barometric Voltage	(V)	2.9
Barometric Pressure	(mmHg)	761

Troubleshooting

Caution taken in inspecting

1. In inspecting system, write down self-diagnosis code to be indicated. (especially, when plural self-diagnosis codes are indicated.)
2. Before eliminating the indicated self-diagnosis codes by a memory clear switch, doubly inspect abnormal place as indicated in self-diagnosis code. (Self-diagnosis code means ‘Warning.’ Make sure to inspect abnormal section.)

Inspection Procedure Flowchart



Notice:
Please note that some items of self-diagnosis code may not be generated unless the engine is warmed up or unless the vehicle is driven under load.

Self-diagnosis Functions

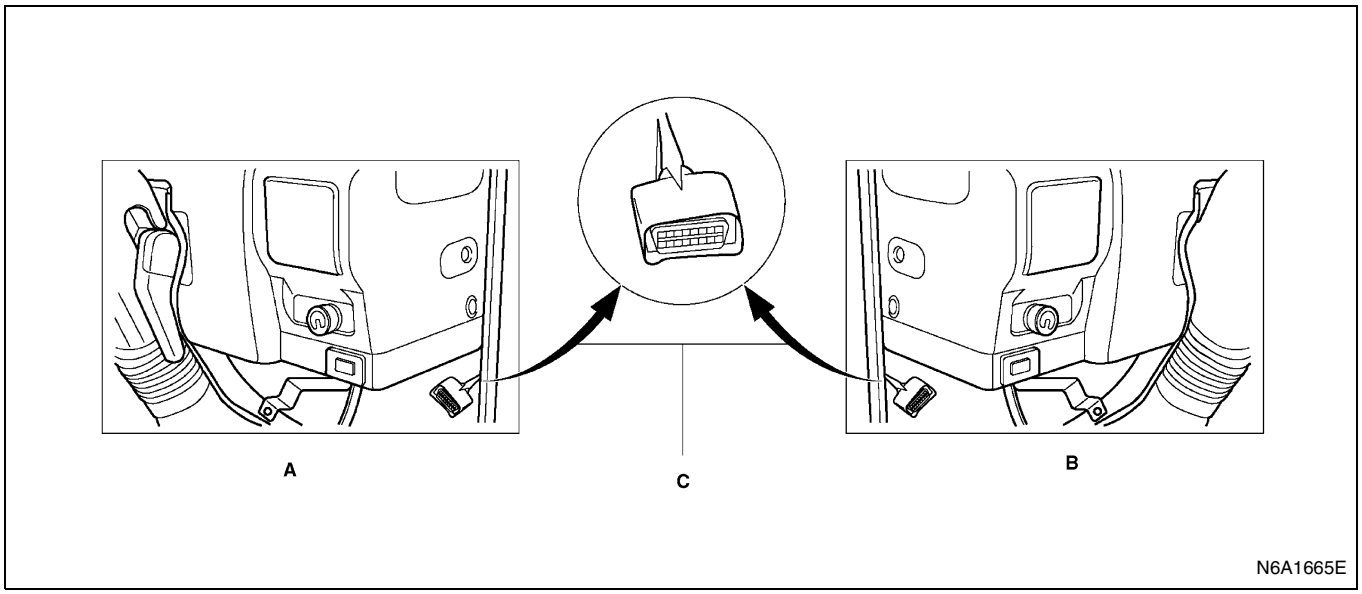
Memorization of self-diagnosis code
The self-diagnosis code indicated will be memorized in Electronically Erasable Programmable Read Only Memory (EEPROM) with in the Engine Control Module (ECM). Accordingly even if the starter switch turns off or the ECM is removed from the vehicle, the memorized self-diagnosis code will not be eliminated.
* Unless an elimination procedure is taken, the self-diagnosis code will remain in memory. (The memory will be eliminated only by a memory clear switch.)

Elimination of self-diagnosis code
The self-diagnosis code memorized in the EEPROM with in the ECM can be eliminated only by Scan Tool or the operation of the memory clear switch.
The elimination method memory clear switch will be described below:

1. Turn OFF ignition switch.
2. Use 4.7kΩ resistance and make short circuit on memory clear switch.
3. Turn ON ignition switch. The indication lamp turn on (lighting) continuously after three seconds flashing the indication lamp.
4. Turn OFF ignition switch.
5. Remove shortage resistance from memory clear switch.

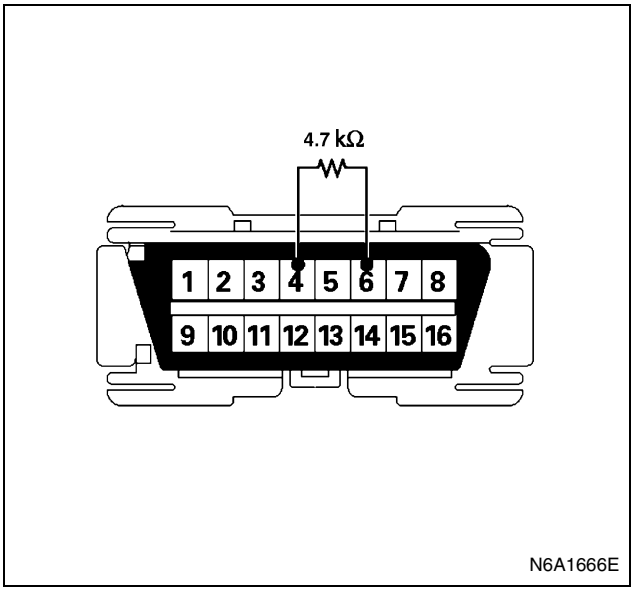
Location of the Memory Clear Switch

Location of the memory clear switch (DATA LINK CONNECTOR)



Legend

A. Right-hand drive
B. Left-hand drive
C. Terminal assignment of data link connector (DLC)

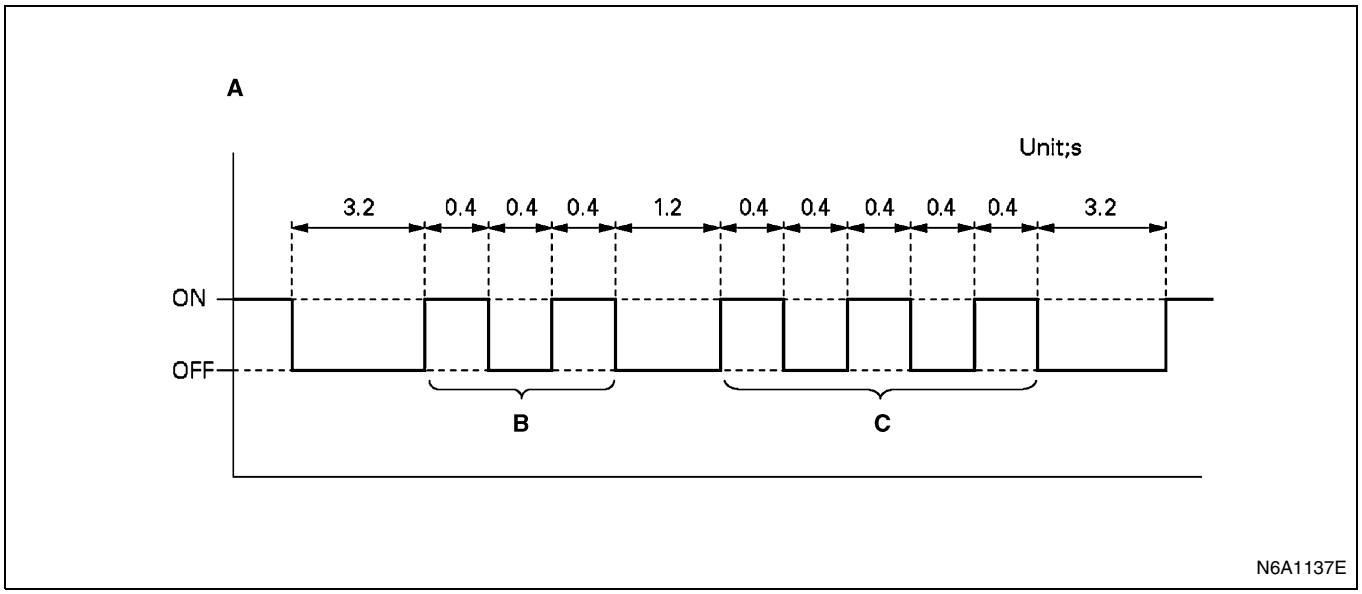


NO	TERMINAL NAME
6	DIAG CONTROL
7	CHECKER SIG
4, 5	CHECKER GND

How to read flashing of the indicator lamp:
The two-digit self-diagnosis code flashes starting from ten's figure to indicate the self-diagnosis code.
Please read the self-diagnosis code from the flashing.
If the plural self-diagnosis codes are indicated, the same self-diagnosis code is flashed repeatedly in steps of three times.
Please read it correctly.

- Diagnostic Trouble Code (DTC) outputting is done in decreasingly order of DTC number.
- Indication is changed over on completion of output DTC indication.
- DTC indicator is stopped with diagnostic switch being off.
- When there is no DTC output, "1" is outputted in normal DTC code.
- After indicating 3 times pear 1 DTC, shift is conducted to the next DTC. (After making a round, the indications are repeated again.)
- In case of the same diagnostic code, it is used 1 DTC (3 times indication.)

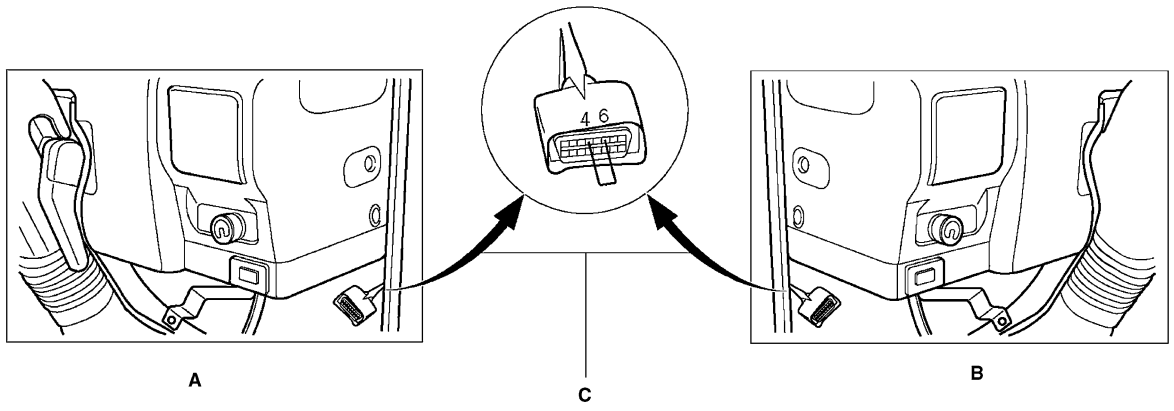
Example Diagnosis Trouble Code Output



Legend

A. (For example) In case of indicate two digits figure "DTC23"
B. Figure of ten
C. Figure of one

Flashing of Indicator Lamp



Legend

A. Right-hand drive
B. Left-hand drive
C. Terminal assignment of data link connector (DLC)

Diagnosis Trouble Code List

DTC#	TECH 2 STRING
P21	Rack Sensor Circuit Low
P22	Rack Sensor Circuit High
P13	Engine Coolant Temperature (ECT) Sensor Circuit High
P14	ECT Sensor Circuit Low
P31 *	Exhaust Gas Recirculation (EGR) Electronic Vacuum Regulating Valve (EVRV) Solenoid Circuit Low
P32 *	EGR EVRV Solenoid Circuit High
P41	Quick On Start (QOS) Relay Control Circuit Low
P42	QOS Relay Control Circuit High
P23	Magnetic Switch Control Circuit Low
P24	Magnetic Switch Control Circuit High
P26	Quick Warm System (QWS) Relay Control Circuit High
P33 *	Variable Swirl System (VSS) Control Circuit Low
P34 *	VSS Control Circuit High
P43	Aneroid Compensator Vacuum Switching Valve (VSV) Control Circuit Low
P35 *	EGR Quick Cut VSV Control Circuit Low
P36 *	EGR Quick Cut VSV Control Circuit High
P44	Aneroid Compensator VSV Control Circuit High
P45	Engine Speed Sensor Circuit Low
P61	Barometric Sensor Circuit Error
P52	Electronically Erasable Programmable Read Only Memory (EEPROM) Error

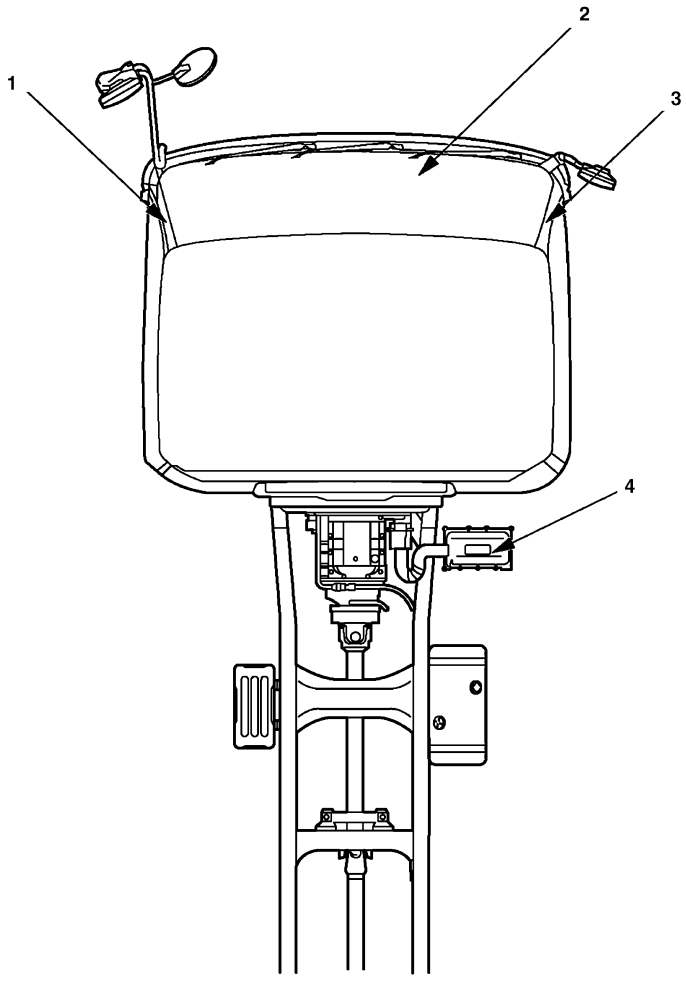
* Equipped with EGR and VSS

Error Classified		Trouble Code	Diagnostic Condition	Return Condition	Back Up	Judging Time
Relay: QWS	+B short	P26	Output TR Monitor	When forward normal	QWS: R/L Non-Continuity.	0.52 sec
VSV: VSS	Harness Open GND short	*P33	Output TR Monitor	When forward normal	VSS: VSV Output stop.	0.52 sec
	+B short	*P34				
VSV: ANECON	Harness Open GND short	P43	Output TR Monitor	When forward normal	ANECON: VSV Output stop.	0.52 sec
	+B short	P44				
VSV: EGR Quick	Harness Open GND short	*P35	Output TR Monitor	When forward normal	EVRV: EGR VSV: EGR Quick Cut The above output stops.	0.52 sec
	+B short	*P36				
Atmospheric Pressure Sensor	Output Abnormal	P61	1.5V (49.9 kPa / 374 mmHg / 7.23 psi) or lower, or 4.5V (160 kPa / 1200 mmHg / 23.2 psi) or higher detected.	When forward normal	EVRV: EGR VSV: EGR Quick Cut The above output stops. ANECON: VSV is actuated.	0.52 sec
	ECM EEPROM error	P52	Check when ECM is started and when Trouble Code is written.	When forward normal	Trouble Code other than 52 (EEPROM error) not indicated.	
Normal		P12	No other trouble code.		No history of this diagnosis recorded	—
Rack Sensor	Harness Open GND short	P21	Rack Voltage 0.3V or lower, Engine speed 600 — 900rpm, and water Temp. 0°C (32°F) or higher are detected for 3 seconds running.	When forward normal	EVRV: EGR VSV: EGR Quick Cut VSV: VSS The above outputs stop. R/L: QWS Non-continuity Idle position output stop. The above outputs stop. Rack Learning valve: 0	3.52 sec
	+5V short Rack Sensor Power Voltage	P22	5V or higher Rack Voltage detected.			0.52 sec
Water Temp Sensor	Harness Open +B short	P13	-79°C/-110°F (390kΩ) or lower, or 120°C/248°F (115kΩ) or higher detected.	When forward normal	EVRV: EGR VSV: EGR Quick Cut VSV: VSS MV: Timing Advance The above outputs stop. VSV: ANECON is actuated QOS: 0°C or lower control	0.52 sec
	GND short	P14				
EVRV: EGR	Harness Open GND short	*P31	Output TR Monitor	When forward normal	EVRV: EGR VSV: EGR Quick Cut The above outputs stop.	1.57 sec
	+B short	*P32				
Relay QOS	Harness Open GND short	P41	Output TR Monitor	When forward normal	QOS: RL Non-continuity	0.52 sec
	+B short	P42				

Error Classified		Trouble Code	Diagnostic Condition	Return Condition	Back Up	Judging Time
Magnetic Volume Timing	Harness Open	P23	Output TR Monitor	When forward normal	Timing Advance: MV output stop.	0.52 sec
	GND short +B short	P24				
	Harness Open GND short	P45	Engine speed 0, Rack Voltage ≥ 0.3V ≤ 0.57 is detected.	When forward normal	EVRV: EGR VSV: EGR Quick Cut VSV: VSS R/L: QWS The above outputs Idling position output stop when T/M POS SW outputted. VSV: ANECON is actuated	1.52 sec

* Equipped with EGR and VSS

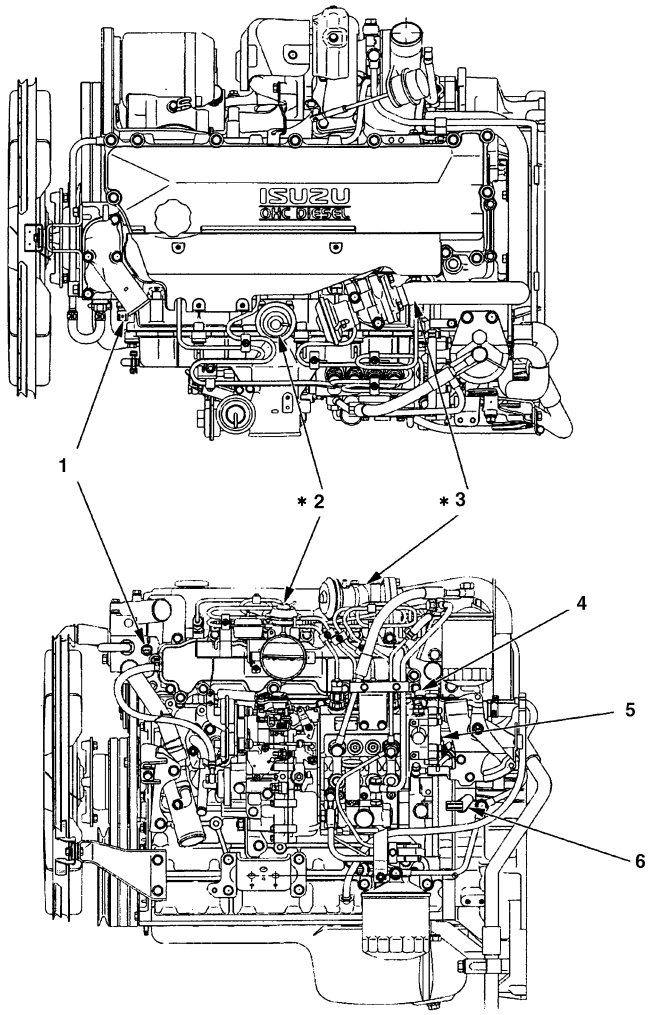
Location of Sensor and Switch



N6A1139E

Legend

1. Data link connector (Left-hand drive)
2. ECM including atmospheric
3. Data link connector (Right-hand drive)
4. Intake air temp switch equipped with EGR and VSS



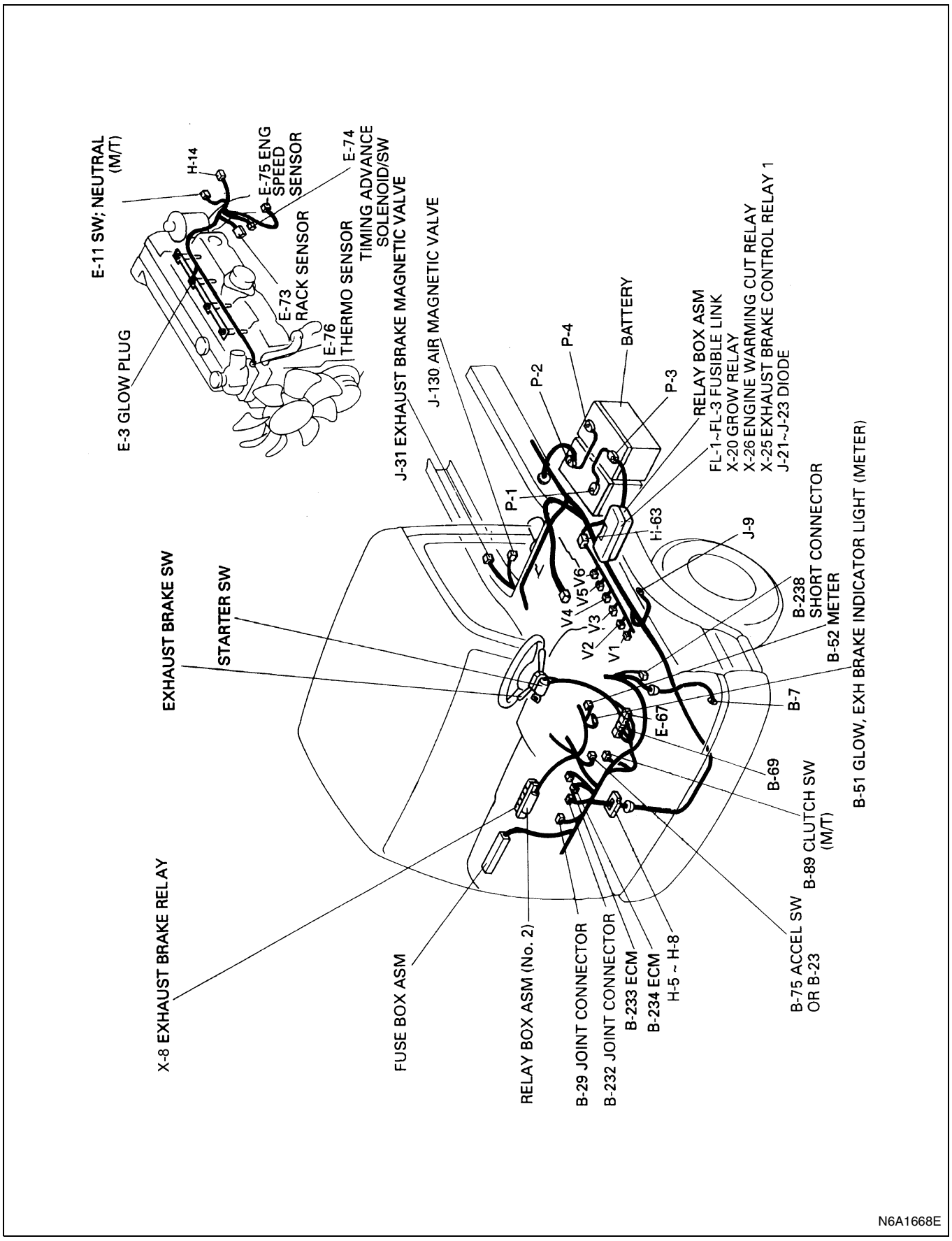
N6A1140E

Legend

1. Engine coolant temperature sensor
2. VSS
3. EGR
4. Timing advance solenoid switch
5. Rock sensor
6. Engine speed sensor

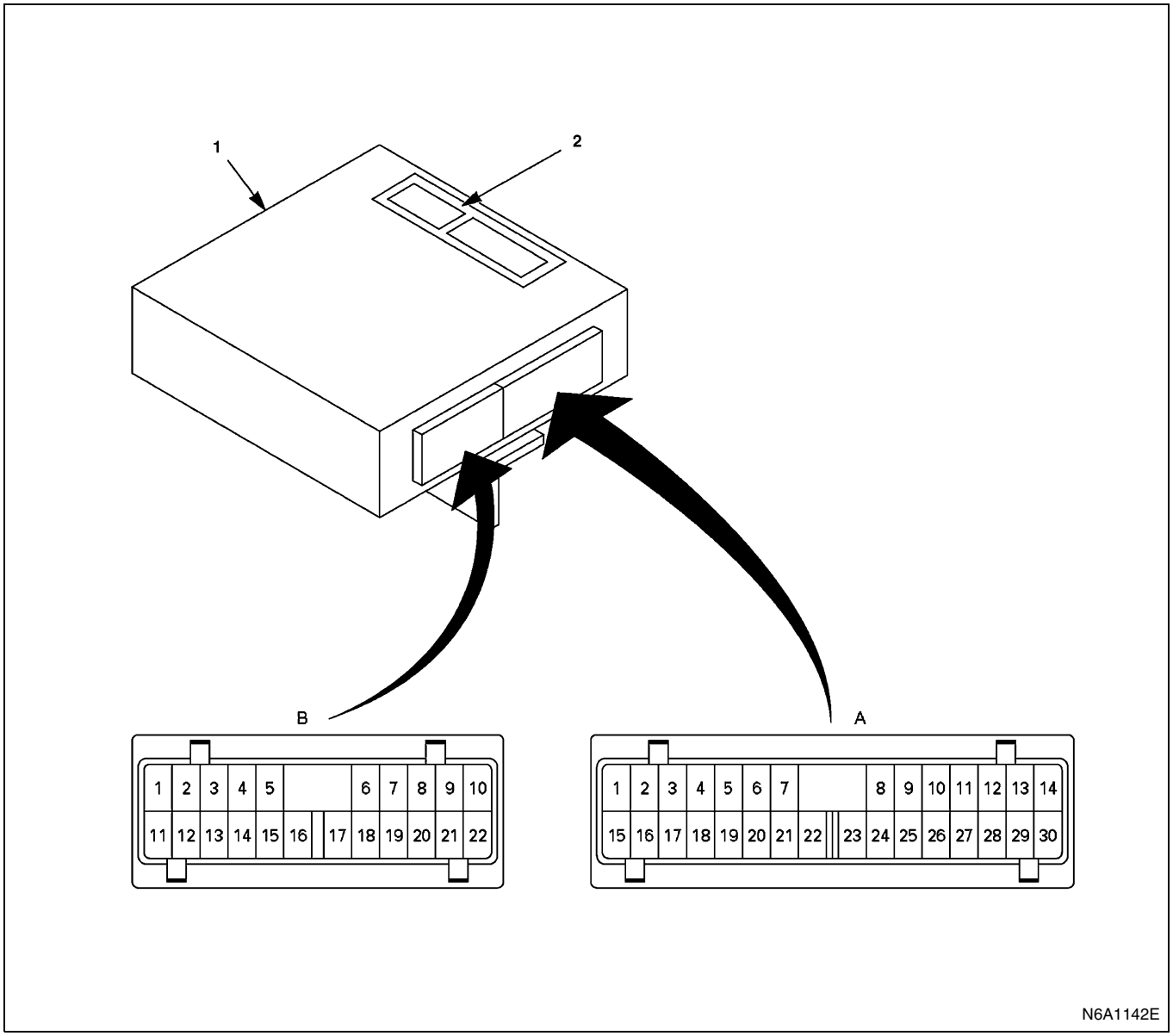
* Equipped with EGR and VSS

Parts Location



Engine Control Module (ECM)

Appearance of ECM



Legend

1. ECM
2. Name plate

A. Detail of 30 pins connector
B. Detail of 22 pins connector

Chart of Engine Control Module (ECM) Input/Output

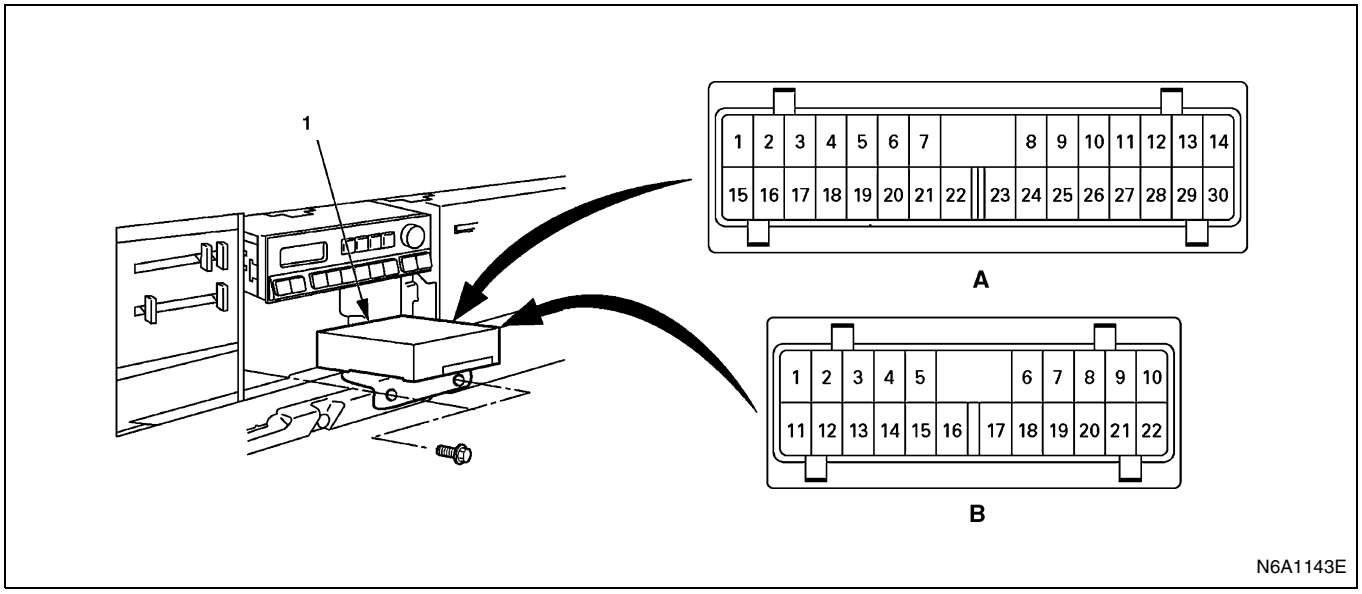
			Equipped without EGR and VSS	Equipped with EGR and VSS	
Connector	Connector number	Connector name	4HE1-XS	4HE1-XN	4HE1-XS
Connector 30 pin	1	Checker SIG (Serial Communication)	❍	❍	❍
	2	Intake Temperature Switch		❍	❍
	3	Engine Type		❍	
	4	Not be used	—	—	—
	5	Transmission Type			
	6	Rack Sensor (+5V)	❍	❍	❍
	7	Rack Sensor SIG	❍	❍	❍
	8	Battery (+)	❍	❍	❍
	9	Ignition Key	❍	❍	❍
	10	Not be used	—	—	—
	11	Timing Advance Solenoid Switch Relay	❍	❍	❍
	12	Not be used	—	—	—
	13	Electric Vacuum Regulating Valve Power Supply	×	❍	❍
	14	Electric Vacuum Regulating Valve GND	×	❍	❍
	15	Checker GND	❍	❍	❍
	16	Diag Control	❍	❍	❍
	17	Not be used	—	—	—
	18	Not be used	—	—	—
	19	Not be used	—	—	—
	20	Not be used	—	—	—
	21	Rack Sensor GND	❍	❍	❍
	22	ECM GND	❍	❍	❍
	23	Not be used	—	—	—
	24	Not be used	—	—	—
	25	Not be used	—	—	—
	26	Not be used	—	—	—
	27	Transmission Position Switch		❍	
	28	Not be used	—	—	—
	29	Not be used	—	—	—
	30	FICD Magnetic Valve Power Supply	❍	❍	❍

			Equipped without EGR and VSS	Equipped with EGR and VSS	
Connector	Connector number	Connector name	4HE1-XS	4HE1-XN	4HE1-XS
Connector 22 pin	1	EGR Cut Magnetic Valve Power Supply	×	❍	❍
	2	Glow Relay	❍	❍	❍
	3	Glow Indicator Lamp	❍	❍	❍
	4	Rack Idle Position Out Put			
	5	Not be used	—	—	—
	6	Not be used	—	—	—
	7	Engine Coolant Temperature Sensor GND	❍	❍	❍
	8	Engine Coolant Temperature Sensor SIG	❍	❍	❍
	9	Engine Revolation Sensor GND	❍	❍	❍
	10	Engine Revolation Sensor SIG	❍	❍	❍
	11	VSS Magnetic Valve Power Supply	×	❍	❍
	12	QWS Relay	❍	❍	❍
	13	Aneroid Compensator Magnetic Valve	❍	❍	❍
	14	Not be used	—	—	—
	15	Not be used	—	—	—
	16	Not be used	—	—	—
	17	Not be used	—	—	—
	18	Starter Switch	❍	❍	❍
	19	Exhaust Brake Status Switch	❍	❍	❍
	20	Not be used	—	—	—
	21	Not be used	—	—	—
	22	Not be used	—	—	—

Notice:
The meaning of symbol marks are:

❍: Connect
BLANK: Not
×: Not Connect

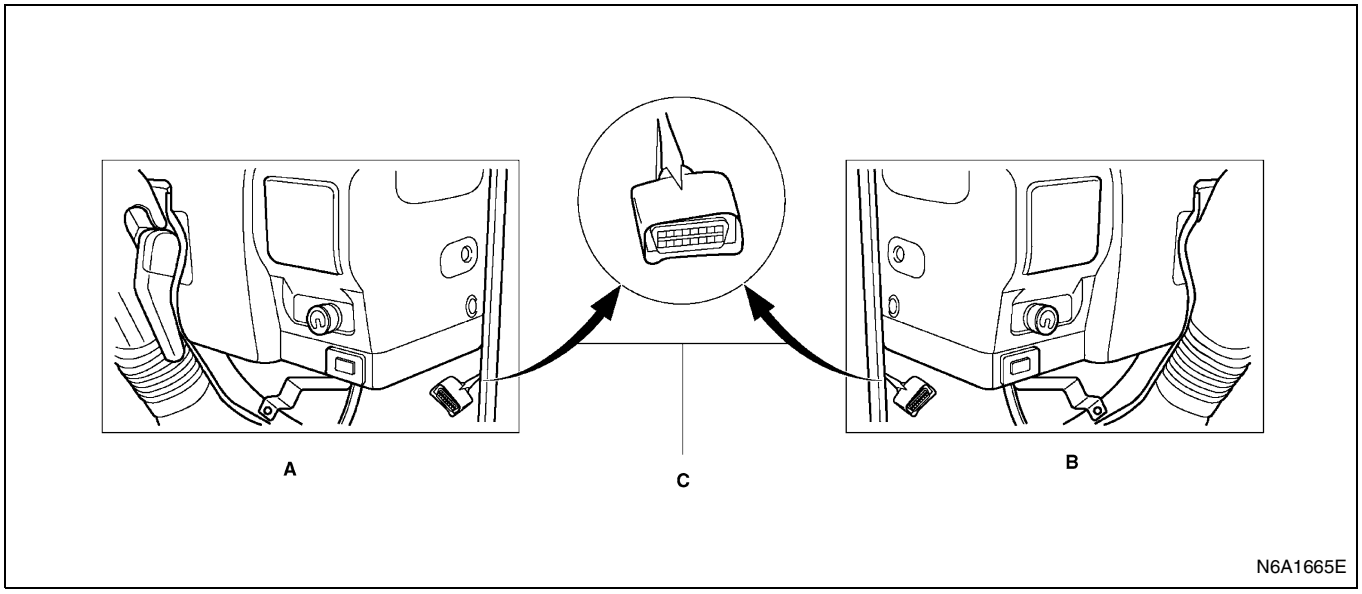
Location of the Engine Control Module (ECM) Connector



Legend

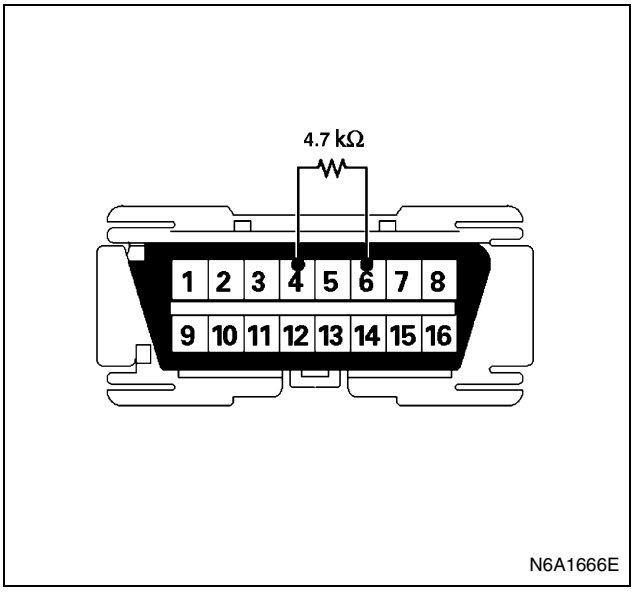
A. 30 pins connector (green)
B. 22 pins connector (green)
1. Engine control module (ECM)

Location of Data Link Connector (DLC)



Legend

A. Right-hand drive
B. Left-hand drive
C. Terminal assignment of data link connector (DLC)



NO	TERMINAL NAME
6	DIAG CONTROL
7	CHECKER SIG
4, 5	CHECKER GND

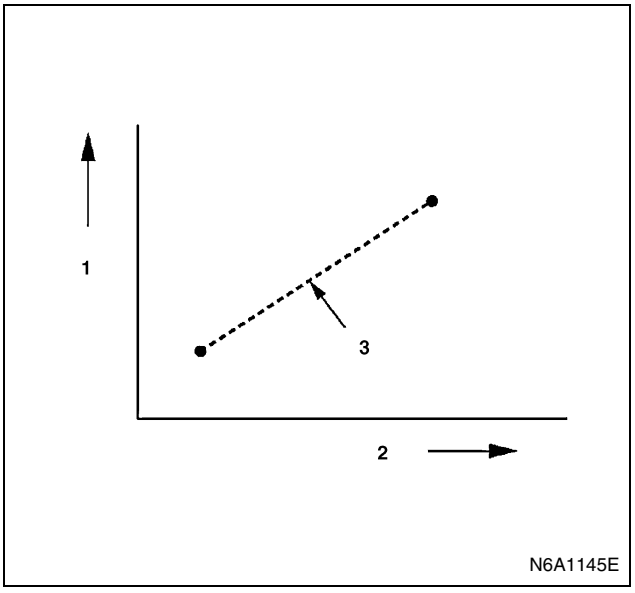
BRIEF EXPLANATION OF EMISSION AND ELECTRICAL CONTROL SYSTEM

MITICS (Mechanically Integrated Timing and Injection Control System)

The Mechanically Integrated Timing and Injection rate Control System (MITICS) utilizes mechanical control, in comparison with TICS systems, which utilize electronic control.
MITICS is equipped with the RLD-M type governor, which contains a pre-stroke control mechanism.
With this, pre-stroke position (i.e., beginning of static injection) can be varied to control injection timing and injection rate (i.e., the fuel injection quantity injected from the nozzle per cam angle degree).
This enables high injection rates1 in the low and medium speed ranges through a short Injection interval, thus contributing to higher engine torque and cleaner exhaust.
MITICS was developed in response to the demands of medium sized diesel engines for low cost, low fuel consumption, high output and cleaner emissions.

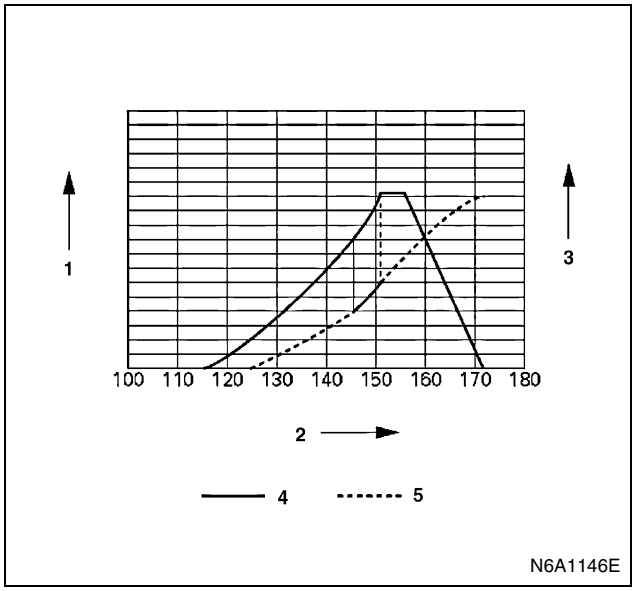
High injection rates using a short injection interval.

- The speed at which the injection pump plunger rises slows as engine speed decreases and the pressure inside the injection pipe decreases.
  Because of this, the nozzle spray deteriorates and makes it impossible to obtain the proper fuel - air mixture.
  To obtain the proper mixture at low and medium speeds, it is necessary to increase the pressure inside the injection pipes using a short injection interval.



Legend
1. Injection pipe pressure
2. Engine speed
3. PE-AD type injection pump

- The left hand figure shows plunger speed and cam lift in relation to cam angle. It can be seen from the graph that plunger speed increases together with cam lift.
  MITICS varies the beginning of injection position at low and medium speeds so that injection occurs when the plunger speed increases during the latter half of cam lift (shown by the bold line).
  At high speeds, injection is performed when the plunger speed decreases during the first half of cam lift to prevent an excessive increase in injection pipe pressure.
  This enables high pressures at low and medium speeds with a fast plunger speed.
  Thus, a fine fuel oil spray is injected into the cylinder from the nozzles within a short time to provide the proper mixture for combustion, helping to increase torque and keep exhaust emissions clean.



Legend
1. Plunger speed (m/sec)
2. Cam angle (degrees)
3. Cam lift (mm)
4. Plunger speed
5. Cam lift

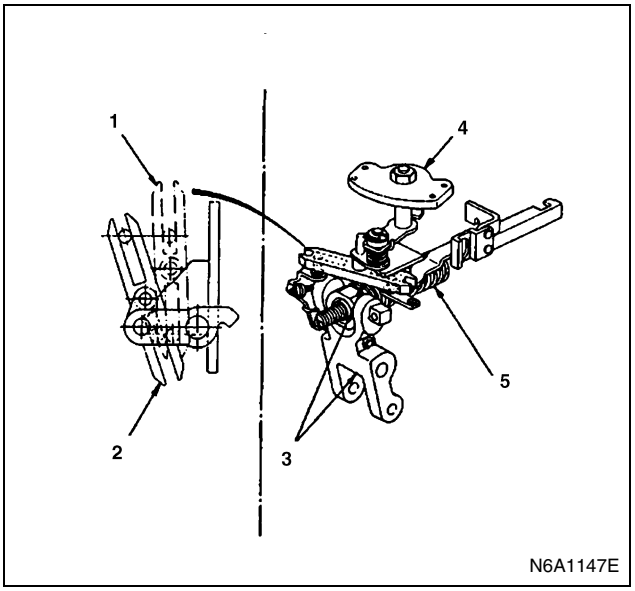
Governor (Model RLD-M)

The RLD-J type governor can be used with the MI, MITICS injection pumps, and was designed to have better control and endurance than the previous RLD type governor.
Although the basic construction is identical to that of the RLD type governor, the RLD-M type is larger to match the applicable pumps' larger size.

Features

Variable speed control governor with decreased lever reaction force

As with the previous RLD type governor, RLD-M governor control is accomplished using the speed control lever to change the fulcrum of the internal link mechanism. Consequently, as the reaction force of the governor spring does not act directly on the speed control lever, only a very small lever reaction force is exerted on the accelerator pedal.

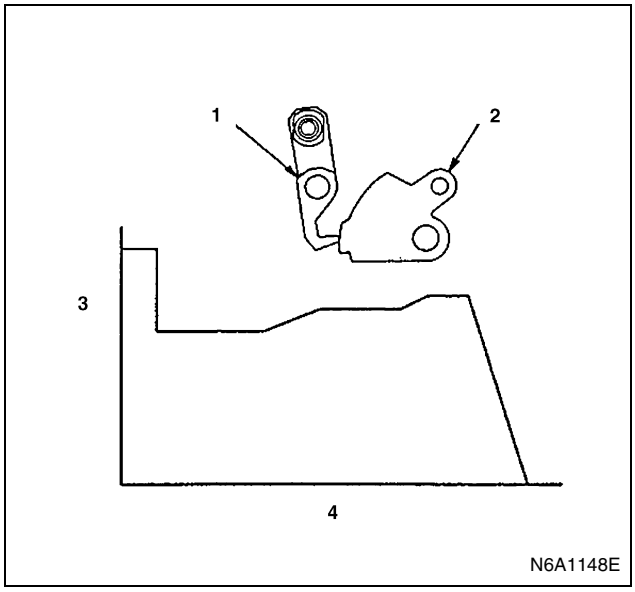


Legend

1. At maximum speed control
2. At idle speed control
3. Link mechanism
4. Speed control lever
5. Governor spring

Set torque characteristics through internal torque cam

At full load, the tip of the sensor lever traces the face of the torque cam to determine the full load rack position and control the full load injection quantity.
Consequently, the torque characteristics demanded by the engine can be freely set by changing the shape of the torque cam face.

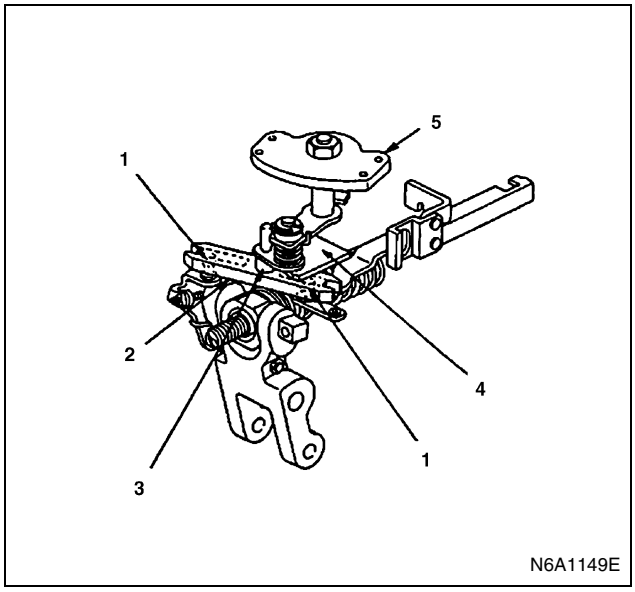


Legend

1. Sensor lever
2. Torque cam
3. Control rack position (mm)
4. Pump speed (r/min)

Improved control through internal guide plate

When the speed control lever is operated, the 2nd supporting lever's pin moves along the guide plate. The floating lever connected to the pin thus moves to change the ball joint fulcrum positions.
In the intermediate to high speed ranges, the guide plate causes the floating lever to move to increase the lever ratio continuously from 1.1 (idling) — 6 (full speed). This increase in the lever ratio in the intermediate to high speed range improves speed droop.



Legend

1. Ball joint
2. Floating lever
3. 2nd supporting lever pin
4. Guide plate
5. Speed control lever

Timing Advance Control

Timing advance control is measuring the ECT to calculate drive current of the solenoid switch for the injection timing advance.

The injection timing is controlled by according to the ECT when engine is started.

Solenoid Switch

The solenoid switch is installed on the top of the injection pump to push the advance lever in the injection pump when 12 or 24 volts is supplied.

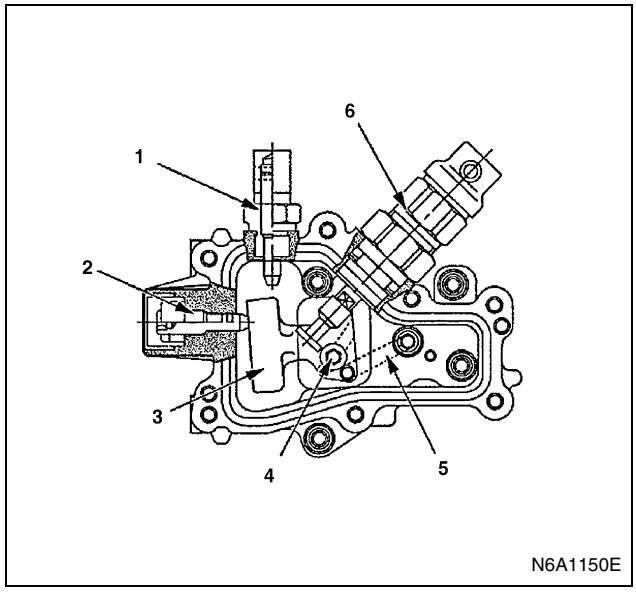
In this condition the injection timing is an additional.

10 degree (BTDC) from normal injection timing.

If there is some trouble for electricity current, it will set the DTC-P23 or P24.

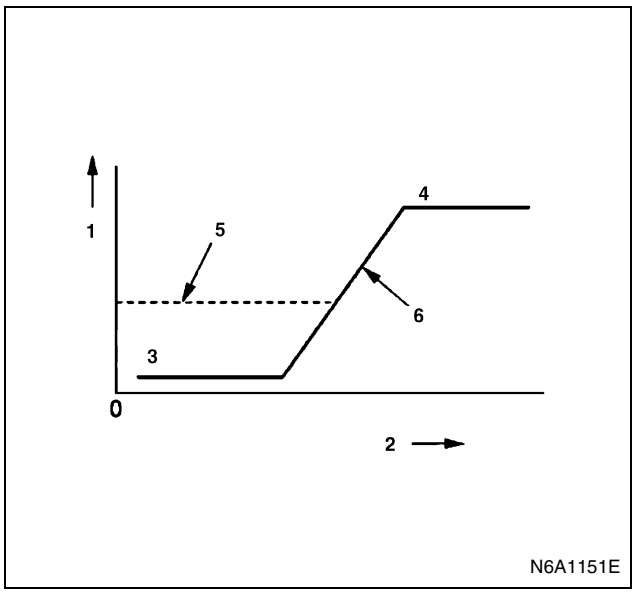
Refer to the DTC chart.

If remove the solenoid switch, it can not be reinstalled because it is necessary to readjust advance value on the injection pump tester.



Legend

1. Adjust screw for maximum advance angle
2. Adjust screw for minimum advance angle
3. Counter weight
4. Timing rod center
5. Return spring
6. Solenoid switch



Legend

1. Advance angle
2. Pump speed
3. Minimum advance angle
4. Maximum advance angle
5. Advance angle by solenoid switch
6. Control character by flyweight

EGR (Exhaust Gas Recirculation) System

EGR Purpose

The exhaust gas recirculation (EGR) system is use to reduce emission levels of the oxides of nitrogen (NOx). The NOx emission levels are caused by a high combustion temperature. The EGR system lowers the NOx emission levels by decreasing the combustion temperature.

EGR Control

The main element of the system is the EGR valve.

The EGR valve feeds small amounts of the exhaust gas back into the intake manifold.

The EGR valve is controlled by the ECM and the ECM uses information from the following sensors to control the EGR valve.

- Engine coolant temperature (ECT) sensor.
- Engine speed sensor.
- Rack sensor
- Exhaust brake switch condition.
- Atmospheric pressure sensor.

EGR Valve Operation and Results of Incorrect Operation

The EGR valve is designed to accurately supply EGR to the engine independent of he intake manifold.

The EGR valve controls EGR flow from the exhaust manifold to the intake manifold through the VSV (Vacu-

um Switching Valve) with a ECM controlled EVRV (Electronic Vacuum Regulating Valve).
The ECM monitors related sensor or switch condition, if EVRV solenoid has incorrect operation, DTC P31 or P32 will be set.
If DTCs P13, P14, P21, P22,P35, P36, P45 or P61 are set, refer to the DTC charts.

Rack Sensor

The rack sensor is engaged with tip of injection pump rack.
The rack sensor signal will send during vehicle operating to the ECM, the ECM calculate together with other sensor's signal, the ECM output activation signal for EVRV.

Atmospheric Pressure Sensor

The atmospheric pressure censor is built-in the ECM.
The EVRV activity will be stopped, when the atmospheric pressure will comes below the setting pressure.

Exhaust Brake Switch

The exhaust brake switch is equipped on the steering column.
The exhaust brake switch is controlled by vehicle operator, when during the vehicle operating the vehicle operator will demand to apply the exhaust brake for assist the main brake system.

EGR Quick Cut Control

During the VSV action, when the EVRV drive current will comes over the setting valve (the drive current will decide relation of the engine load and speed) immediate stop the VSV.
Result of this action will reduce the PM (Particulate Mater).

EVRV Control

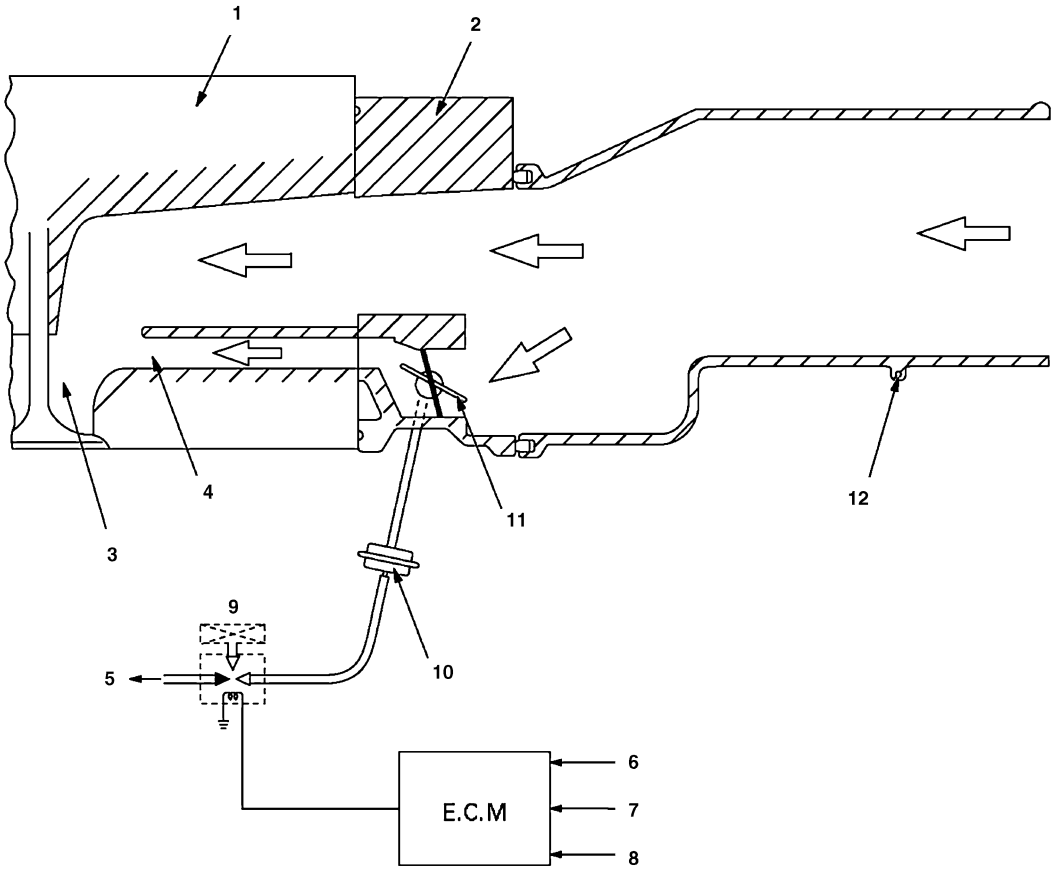
The EGR is controlled under normal temperature with separate stage by the ECT of engine condition.
ECM refer to EGR action map to demand the EVRV drive current, also ECM controls agree EVRV drive current and EVRV actual drive current each other.
Otherwise the ECM transitional stage controls for current of EVRV when EGR is controlled moving OFF area to ON area on the EGR action map.
Also stop the EVRV drive for stop the EGR system under following conditions.
When under low temperature of the ECT.
When acting the QWS system.
When acting the exhaust brake
When the atmospheric pressure comes under setting the pressure valve.

VSS (Variable Swirl System)

The Variable Swirl System (VSS) is designed to adjust the intensity of swirl by allowing or not allowing air to flow through a sub-port (or bypass) the runs in parallel with the intake port for each cylinder. The swirl intensifies when there is no air flow through the sub-port, and vice versa.

The air flow is controlled by the on-off valve at the inlet to the sub-port and the valve in turn is turned on and off by computer signals which are dependent on engine speed, load and coolant temperature. Basically, the air is cut off at low speeds to maintain high swirl and is allowed to flow at high speeds to maintain low swirl.

Variable Swirl System (Equipped with EGR and VSS)

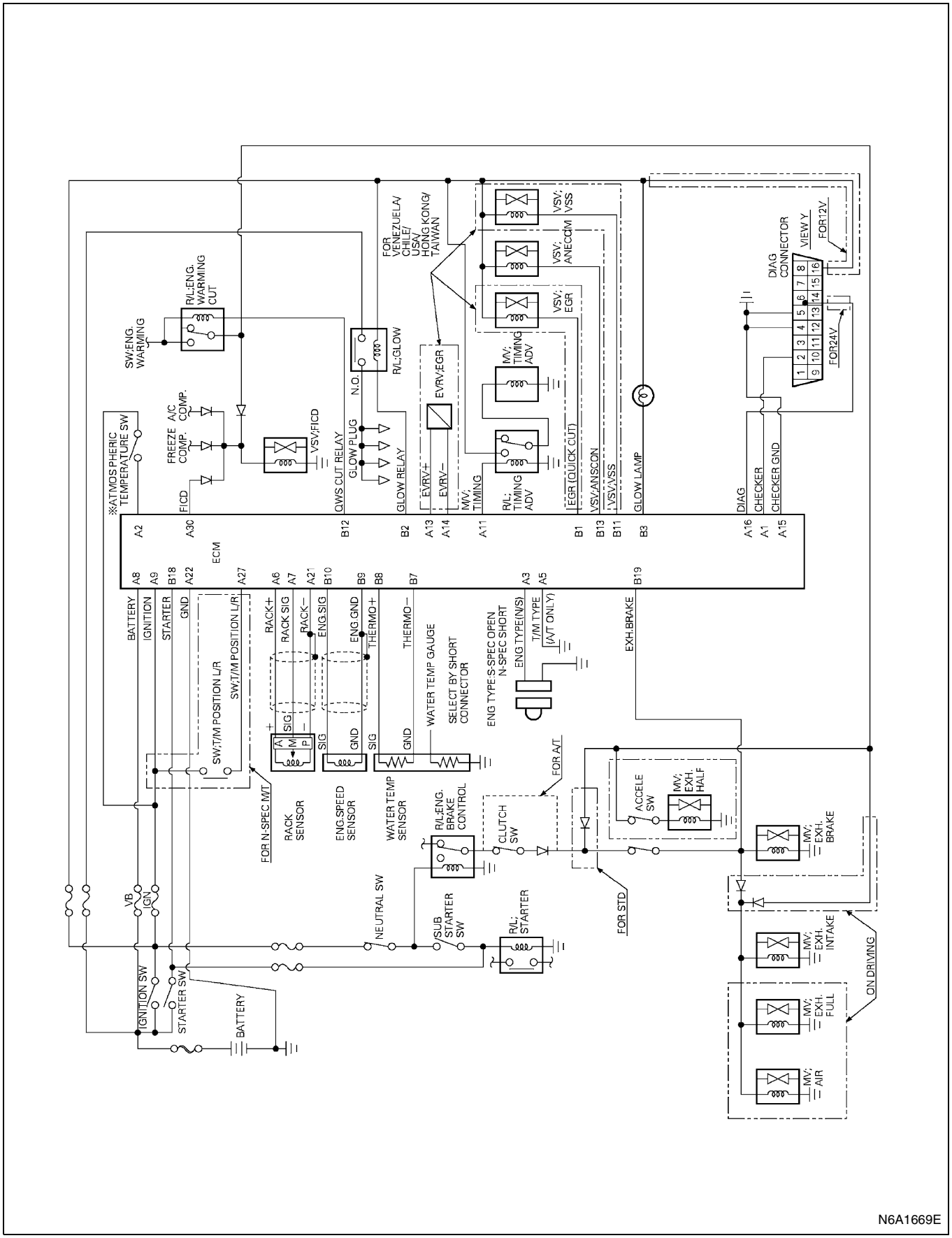


N6A1152E

Legend

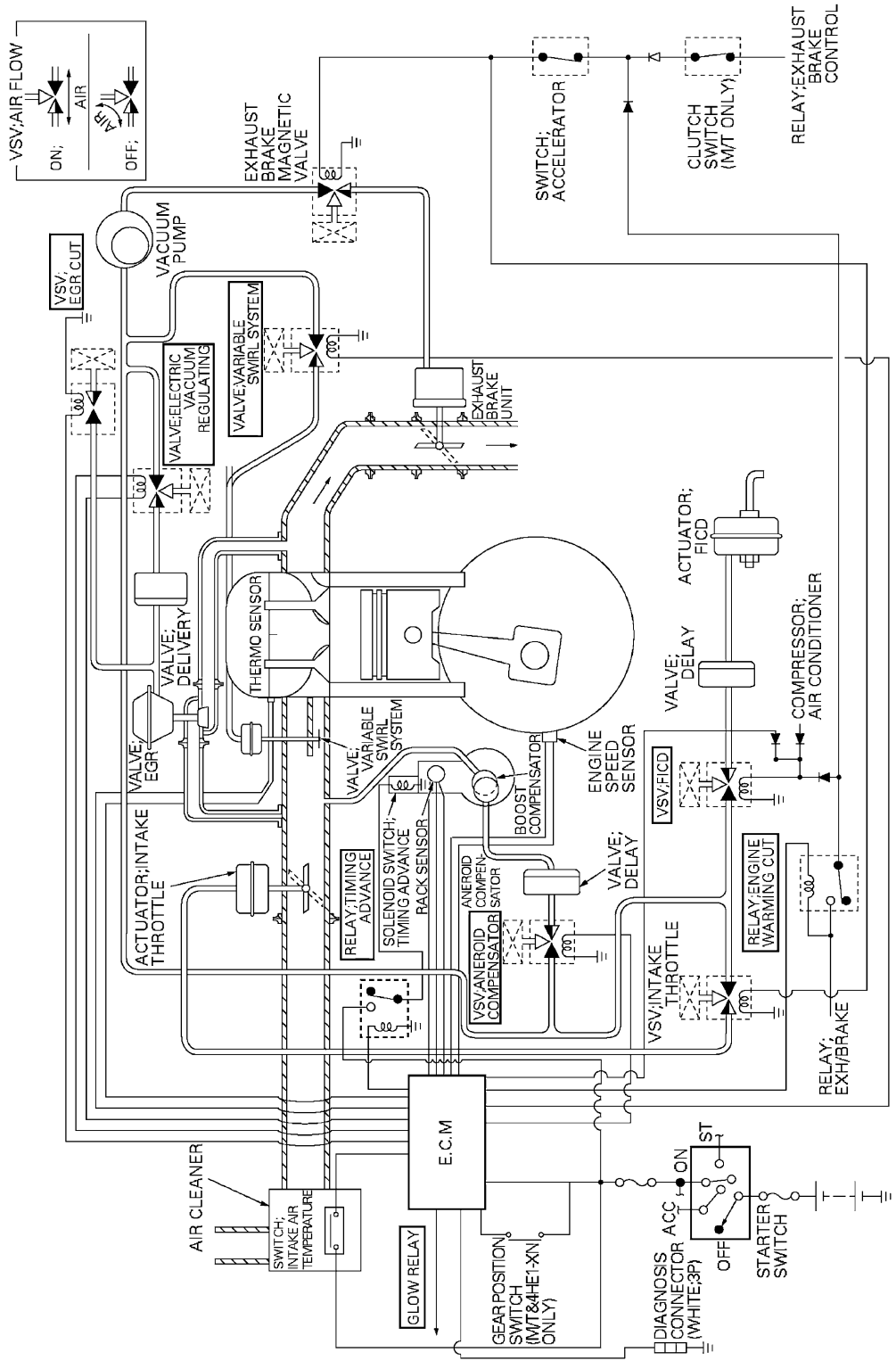
1. Cylinder head
2. VSS case
3. Inlet port
4. Sub-port
5. Vacuum
6. Thermo sensor
7. Engine speed sensor
8. Rack sensor
9. VSV; VSS
10. Actuator
11. Control valve
12. Inlet manifold

Engine Control Module (ECM) System Wiring Diagram

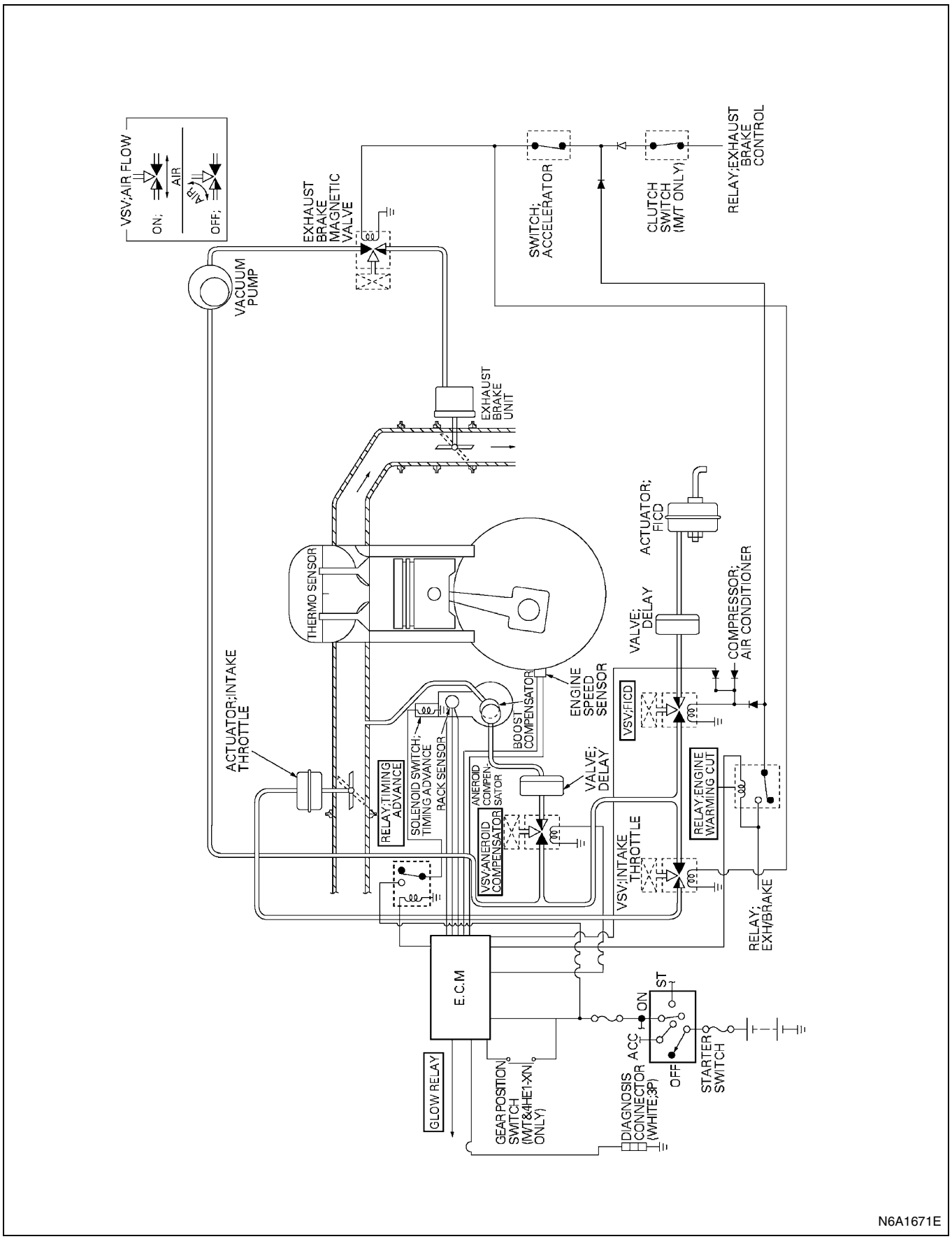


Auxiliary Engine Control System

Equipped with Exhaust Gas Recirculation and Variable Swirl System

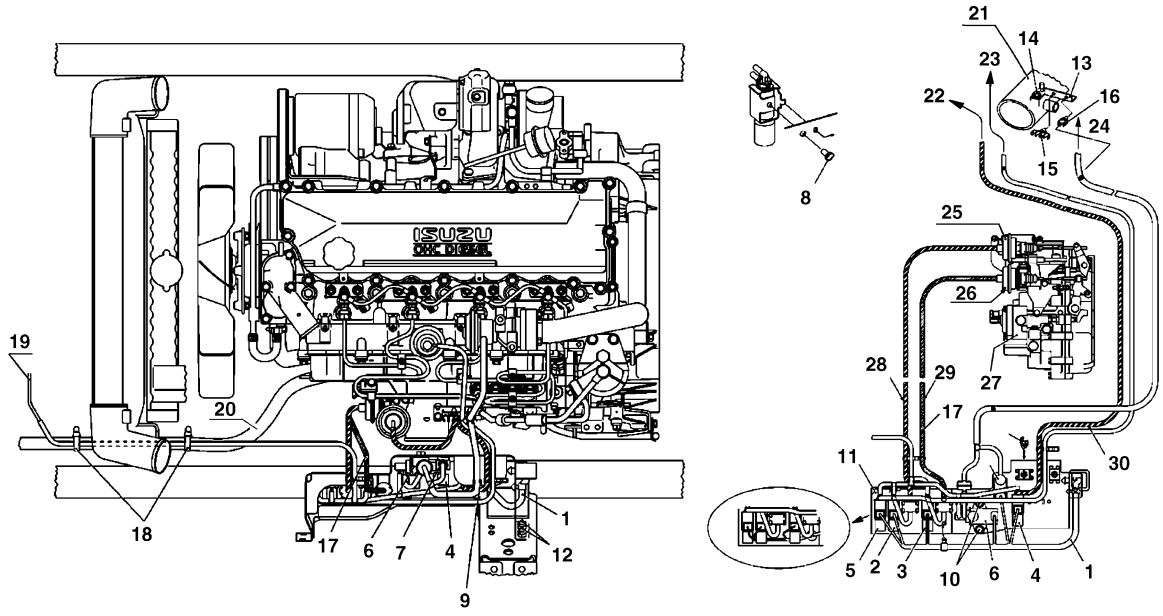


Equipped Without Exhaust Gas Recirculation and Variable Swirl System



Vacuum Switching Valve (VSV) Circuit

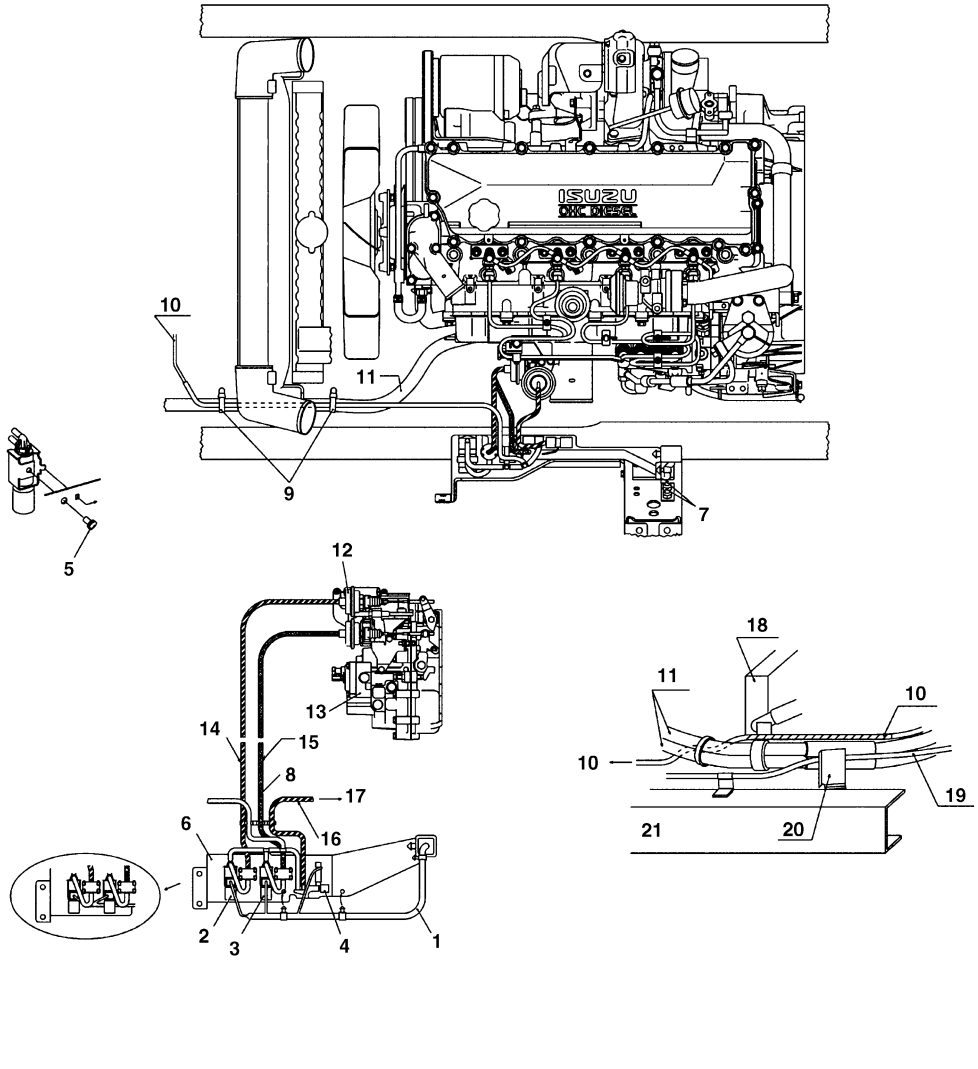
Equipped with Exhaust Gas Recirculation and Variable Swirl System



Legend

1. Extension harness
2. FICD vacuum S/W valve
3. ANECOM vacuum S/W valve
4. I/T throttle vacuum S/W valve
5. VSS vacuum S/W valve
6. Electronic vacuum regulating valve
7. EGR cut vacuum S/W valve
8. VSV fix bolt
9. EGR hose, injection pump clip
10. Valve fix
11. VSV bracket
12. Case fix bolt
13. Rubber hose bracket
14. Bracket fix bolt
15. VSS hose, injection pipe clip
16. EGR hose, injection pipe clip
17. Vacuum hose assembly
18. Vacuum hose clip
19. Vacuum pipe
20. Heater hose
21. Inlet cover
22. Inlet throttle
23. VSS
24. EGR valve
25. FICD diaphragm
26. Aneroid diaphragm
27. Injection pump
28. White stripe
29. Yellow stripe
30. Green stripe

Equipped Without Exhaust Gas Recirculation and Variable Swirl System

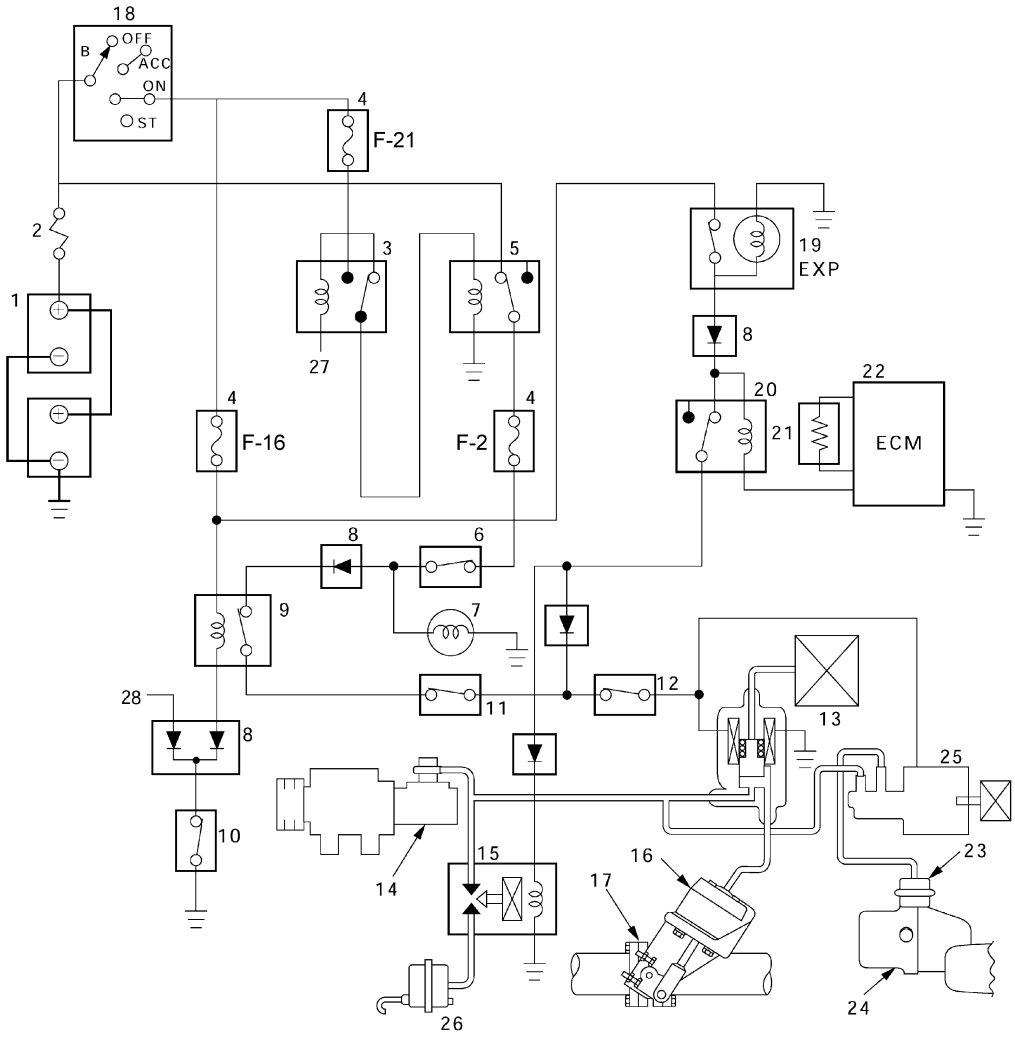


N6A1157E

Legend

1. Extension harness
2. FICD vacuum S/W valve
3. ANECOM vacuum S/W valve
4. I/T throttle vacuum S/W valve
5. VSV fix bolt
6. VSV bracket
7. Case fix bolt
8. Vacuum hose assembly
9. Vacuum hose clip
10. Vacuum pipe
11. Heater hose
12. FICD diaphragm
13. Injection pump
14. White stripe
15. Yellow stripe
16. Green stripe
17. Intake throttle diaphragm
18. Inter cooler
19. Accelerator cable
20. Guide plate
21. Frame

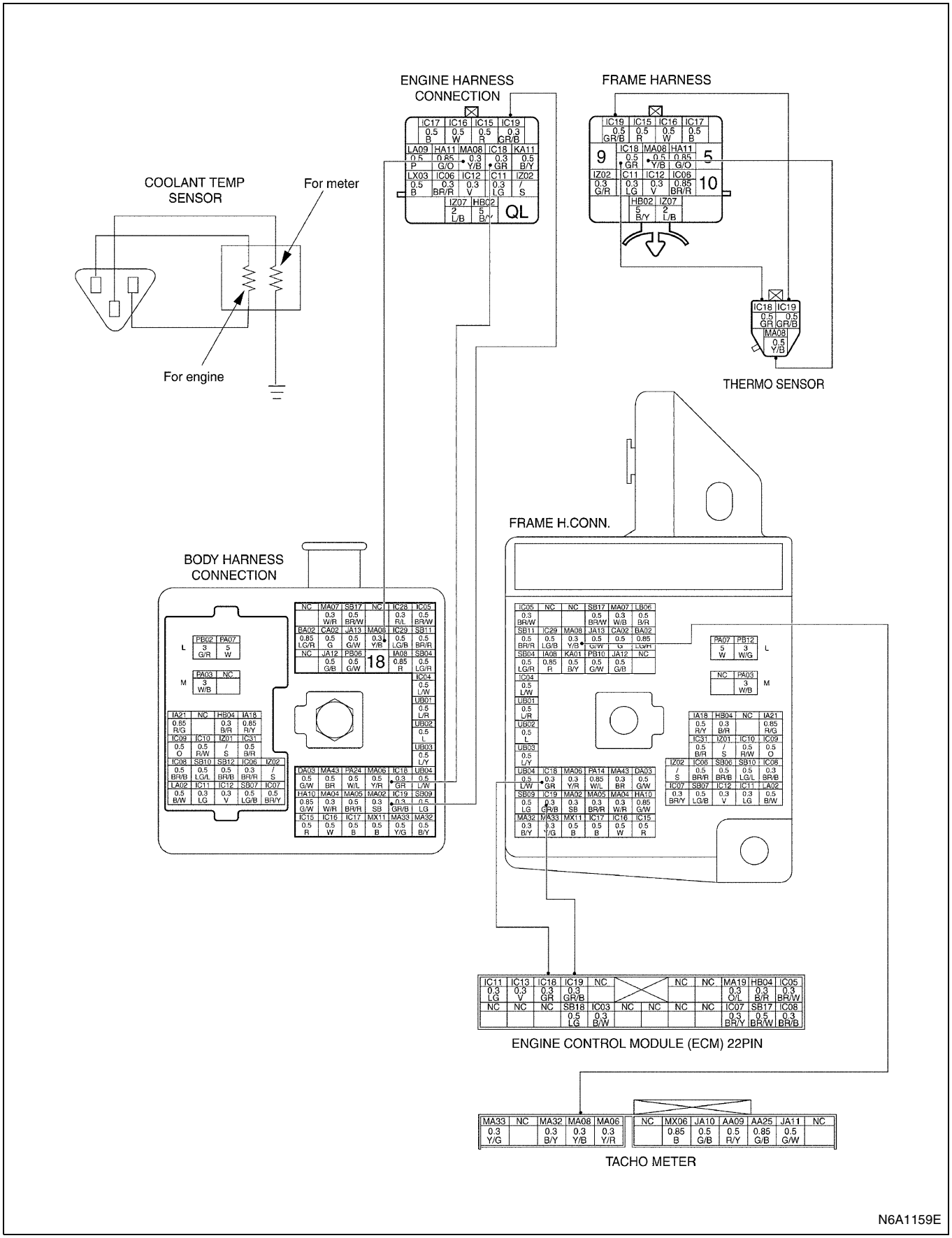
Exhaust Brake and Engine Warm-up Control



Legend

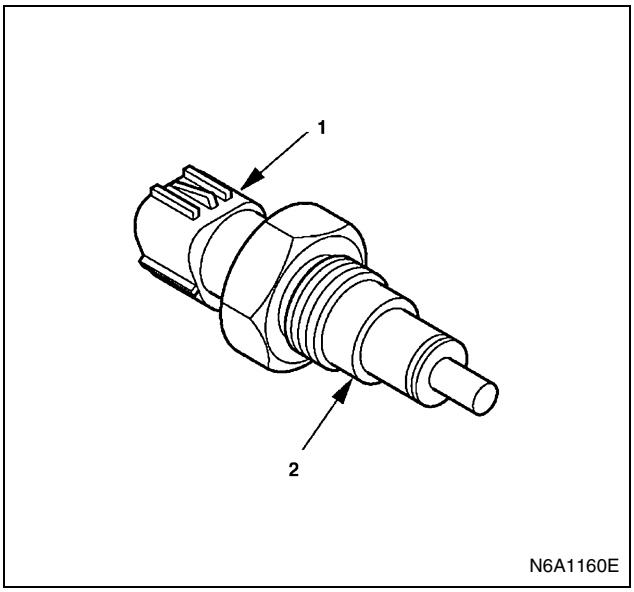
1. Batteries
2. Fusible link wire
3. Charge relay
4. Fuse
5. Exhaust brake relay
6. Exhaust brake switch
7. Indicator light
8. Diode
9. Exhaust brake control relay
10. Neutral switch
11. Clutch switch
12. Accelerator switch
13. Magnetic valve: Exhaust brake
14. Vacuum pump
15. Vacuum switch valve
16. Vacuum chamber: Exhaust brake
17. Exhaust brake valve
18. Key switch
19. Engine warming-up switch
20. Engine warming cut relay
21. Engine coolant temperature sensor
22. ECM
23. Vacuum chamber: Intake throttle
24. Intake throttle
25. Magnetic valve intake throttle
26. Actuator FICD
27. Generator (L)
28. Starter relay coil

DTC-P13 Engine Coolant Temperature (ECT) Sensor Circuit High Voltage



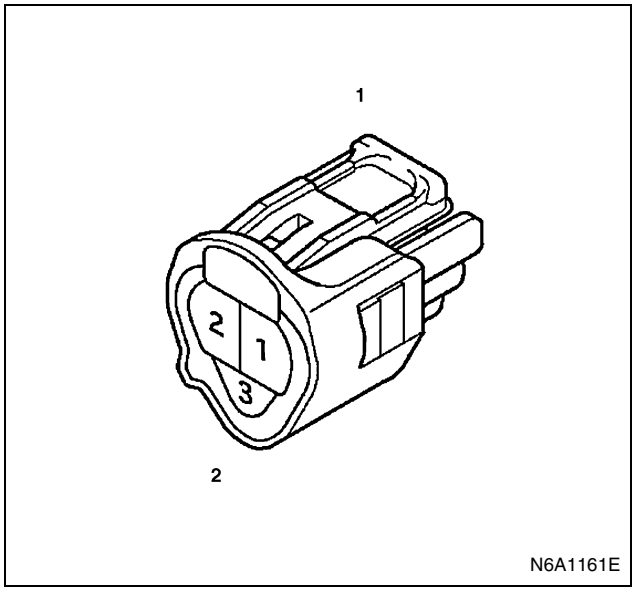
Appearance of Water Temperature Sensor and Connector Pin Assignment

Temperature Sensor



Legend
1. 3 pin connector
2. Engine coolant temperature sensor

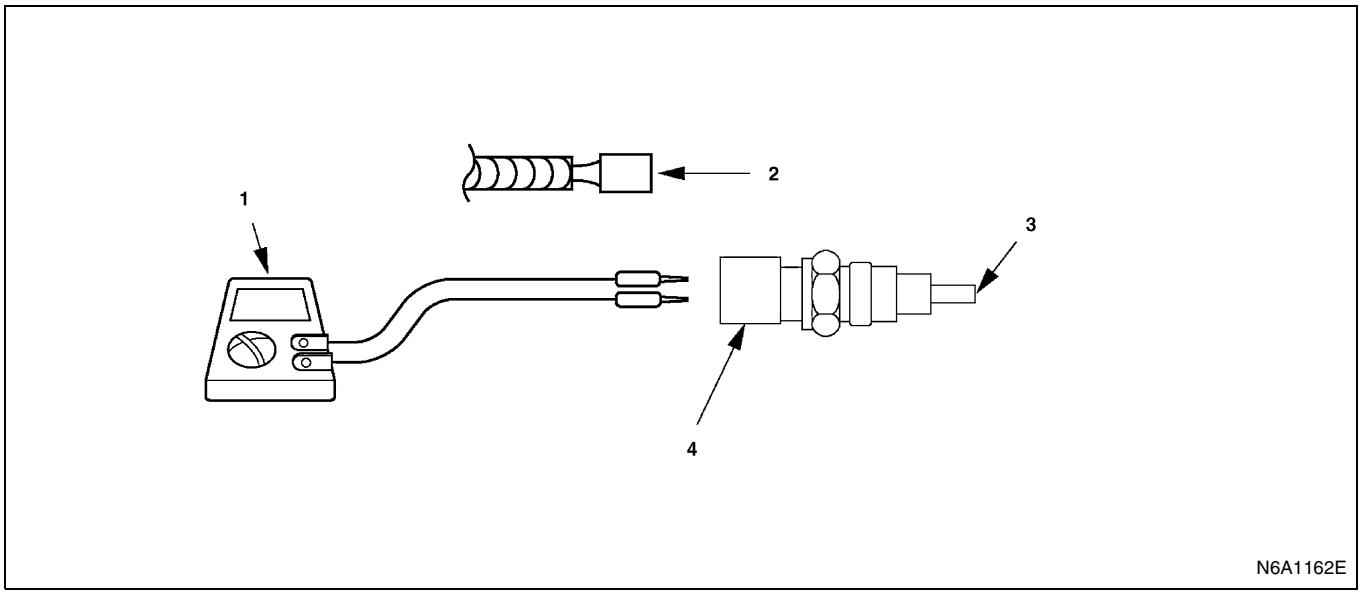
Connector Pin Assignment



Legend
1. To ECT sensor
2. 3 pin gray

Connector No	Signal
1	Thermistor for engine
2	Thermistor for engine
3	Thermistor for meter

Measure Resistance at Engine Coolant Temperature (ECT) Sensor



Legend
1. Circuit tester
2. Remove engine wire harness
3. Engine coolant temperature sensor
4. Measure resistance between connector pin

Caution:
When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

Resistance value

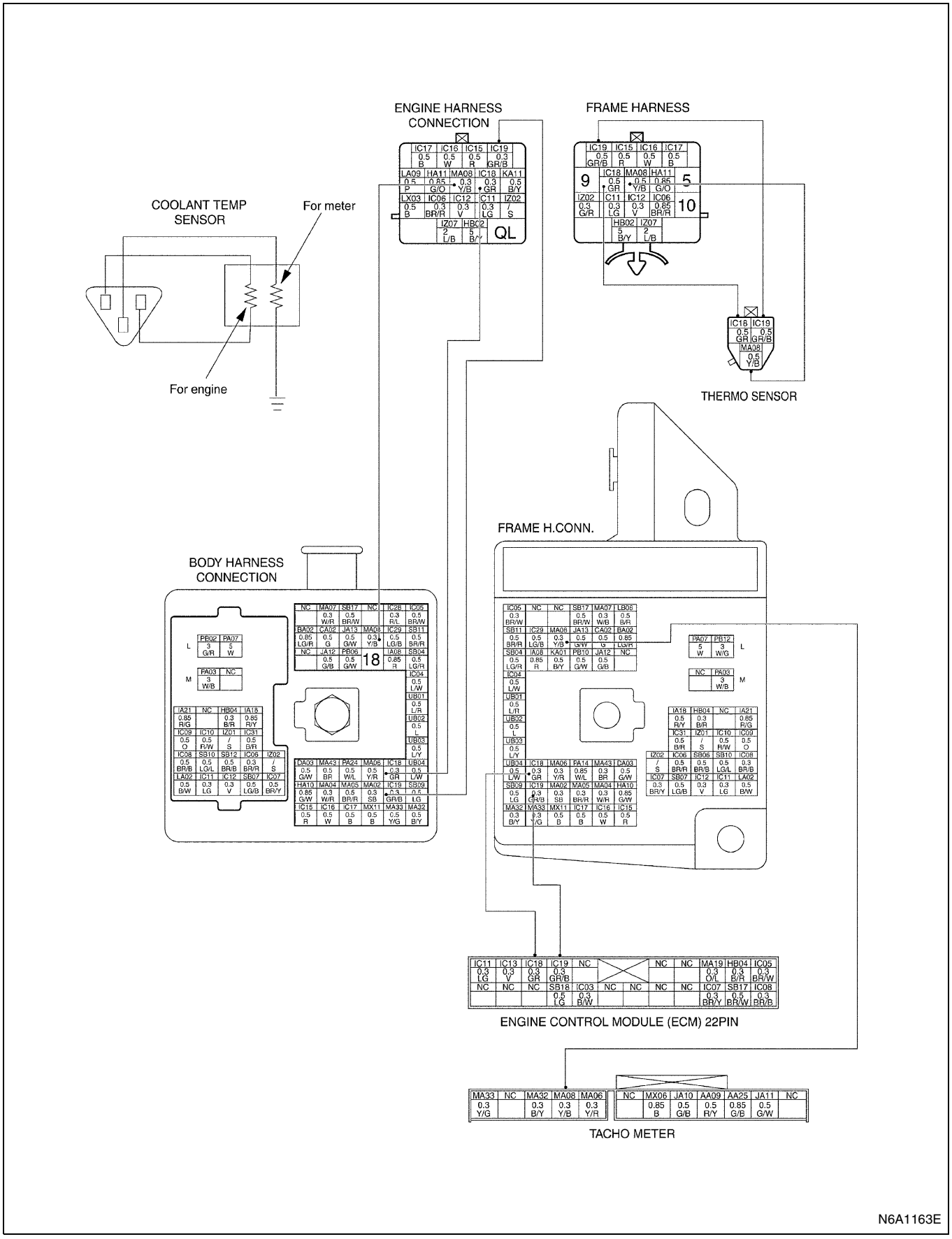
Inspection Point		Resistance Value	Temperature on sensor	Reference
Connector	Pin No.			
3 pin Black	1 ←→ 3	∞	—	Thermistor for ENGINE ←→ Thermistor for meter
	1 ←→ 2	2.5 (kΩ)	20°C (68°F)	Thermistor for ENGINE
		247 (Ω)	90°C (194°F)	
	1 ←→ Body	∞	—	Thermistor for ENGINE ←→ Body
	2 ←→ 3	∞	—	Thermistor for ENGINE ←→ Thermistor for meter
	3 ←→ Body	146.6 (Ω)	60°C (140°F)	Thermistor for meter ENGINE
	2 ←→ Body	∞	—	Thermistor for ECM ←→ Body

Notice:
Resistance value is difference according to the temperature of temperature sensor.

Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	1. Ignition “OFF” 2. Disconnect the ECT sensor electrical connector. 3. Jumper the ECT sensor signal circuit and the ECT sensor ground circuit together at the ECT sensor harness connector. 4. Observe the “Engine cool temp” display on the scan tool. Is the “Engine cool temp” at the specified value?	120°C (248°F)	Go to Step 4	Go to Step 3
3	1. Ignition “OFF” 2. Jumper the ECT signal circuit at the ECT sensor harness connector to chassis ground. 3. Observe the “Engine cool temp” display on the scan tool. Is the “Engine cool temp” at the specified value?	120°C (248°F)	Go to Step 5	Go to Step 6
4	Check for poor connection at the ECT sensor and replace terminals if necessary. Did any terminals require replacement?	—	Go to Step 8	Go to Step 10
5	1. Ignition “OFF”. 2. Disconnect the ECM, and check the ECT sensor ground circuit for an open. 3. If the ECT sensor ground circuit is open, repair it as necessary. Was the ECT sensor ground circuit open?	—	Go to Step 7	Go to Step 10

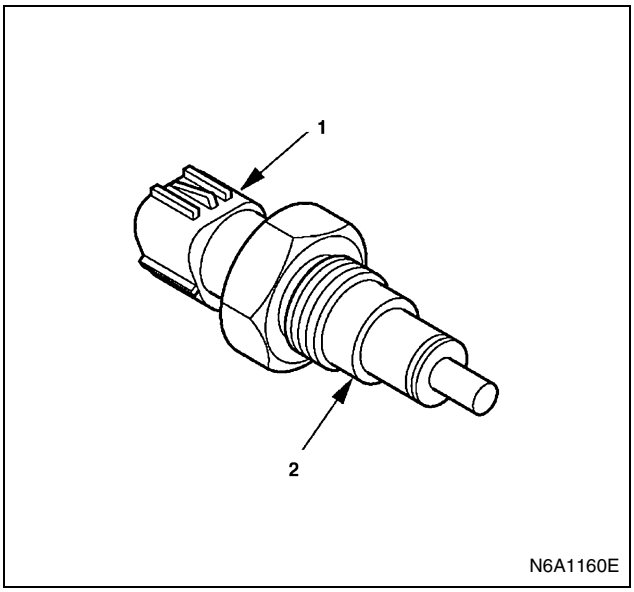
Step	Action	Value	YES	NO
6	1. Ignition “OFF”. 2. Disconnect the ECM, and check the ECT sensor signal circuit for an open. 3. If the ECT signal circuit is open, repair it as necessary. Was the ECT sensor signal circuit open?	—	Go to Step 7	Go to Step 10
7	Check for poor sensor ground or ECT sensor signal circuit terminal connection at the ECU and replace terminal(s) if necessary. Did any of the terminals need to be replaced?	—	Go to Step 9	Go to Step 10
8	1. Ignition “OFF” 2. Replace the ECT Sensor. Is the action complete?	—	Go to Step 10	—
9	1. Replace the ECM. Is the action complete?	—	Go to Step 10	—
10	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC 13 all right under Scan Tool Check?	—	Go to Step 11	Go to Step 2
11	Is any current trouble other than DTC 13 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P14 Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage



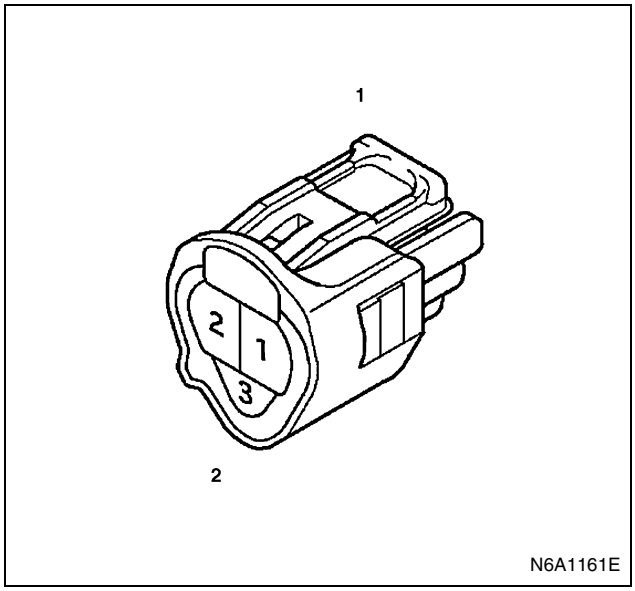
Appearance of Water Temperature Sensor and Connector Pin Assignment

Temperature Sensor



Legend
1. 3 pin connector
2. Engine coolant temperature sensor

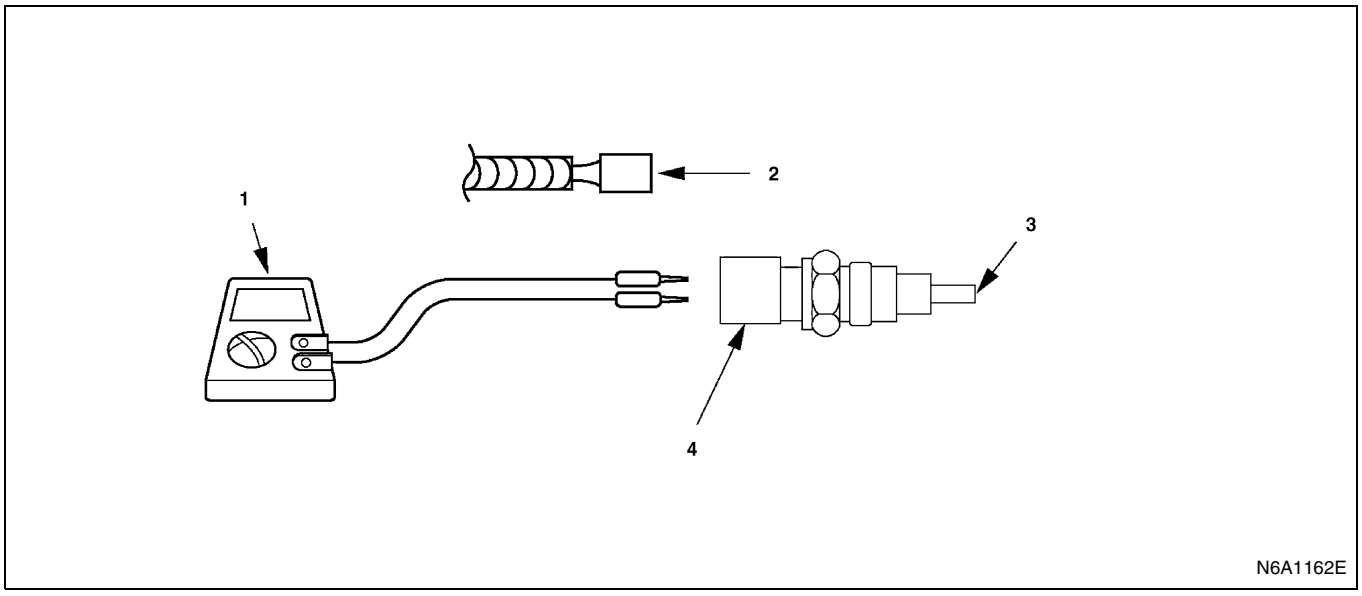
Connector Pin Assignment



Legend
1. To ECT sensor
2. 3 pin gray

Connector No	Signal
1	Thermistor for engine
2	Thermistor for engine
3	Thermistor for meter

Measure Resistance at Engine Coolant Temperature (ECT) Sensor



Legend
1. Circuit tester
2. Remove engine wire harness
3. Engine coolant temperature sensor
4. Measure resistance between connector pin

Caution:
When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

Resistance value

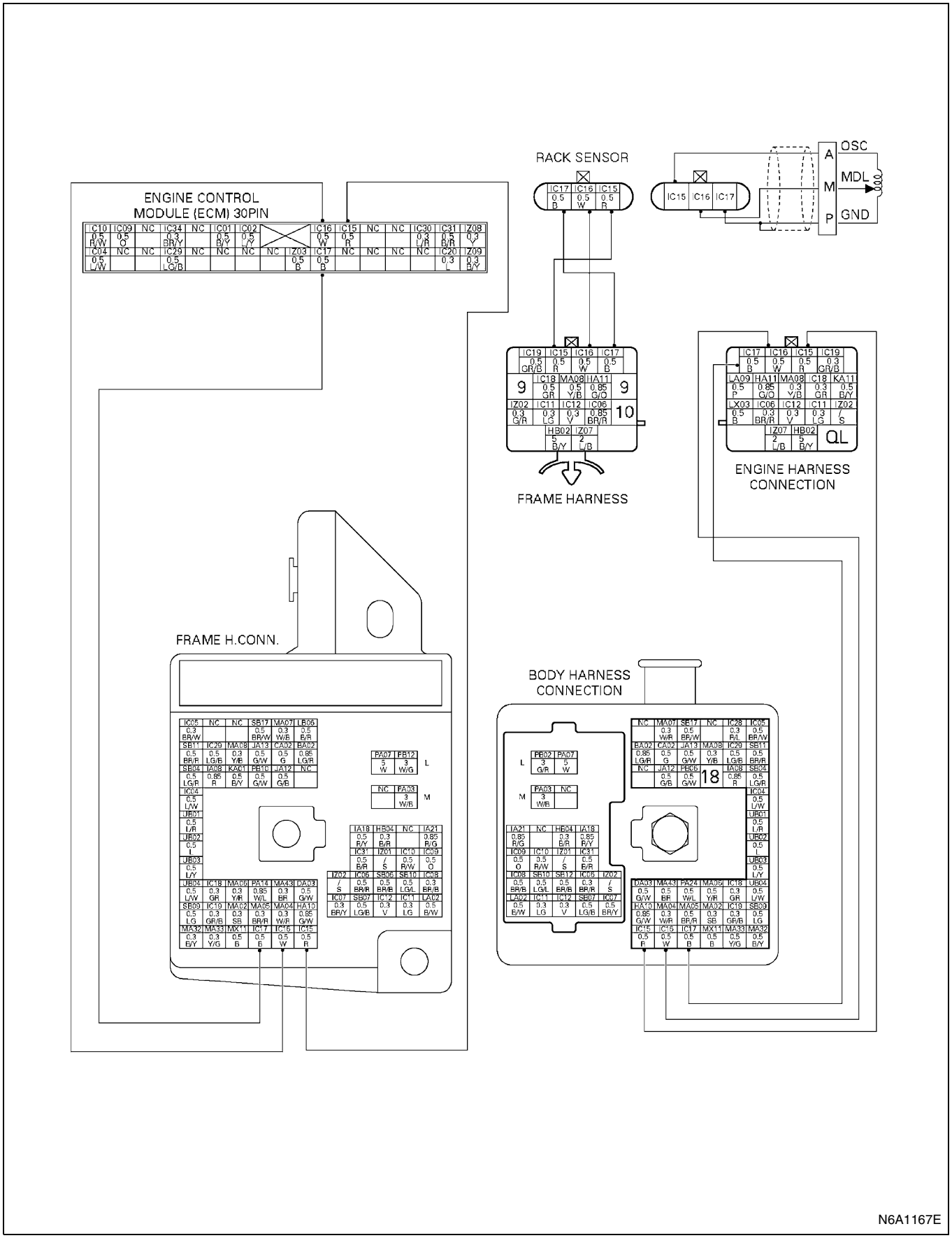
Inspection Point		Resistance Value	Temperature on sensor	Reference
Connector	Pin No.			
3 pin Black	1 ←→ 3	∞	—	Thermistor for ENGINE ←→ Thermistor for meter
	1 ←→ 2	2.5 (kΩ)	20°C (68°F)	Thermistor for ENGINE
		247 (Ω)	90°C (194°F)	
	1 ←→ Body	∞	—	Thermistor for ENGINE ←→ Body
	2 ←→ 3	∞	—	Thermistor for ENGINE ←→ Thermistor for meter
	3 ←→ Body	146.6 (Ω)	60°C (140°F)	Thermistor for meter ENGINE
	2 ←→ Body	∞	—	Thermistor for ECM ←→ Body

Notice:
Resistance value is difference according to the temperature of temperature sensor.

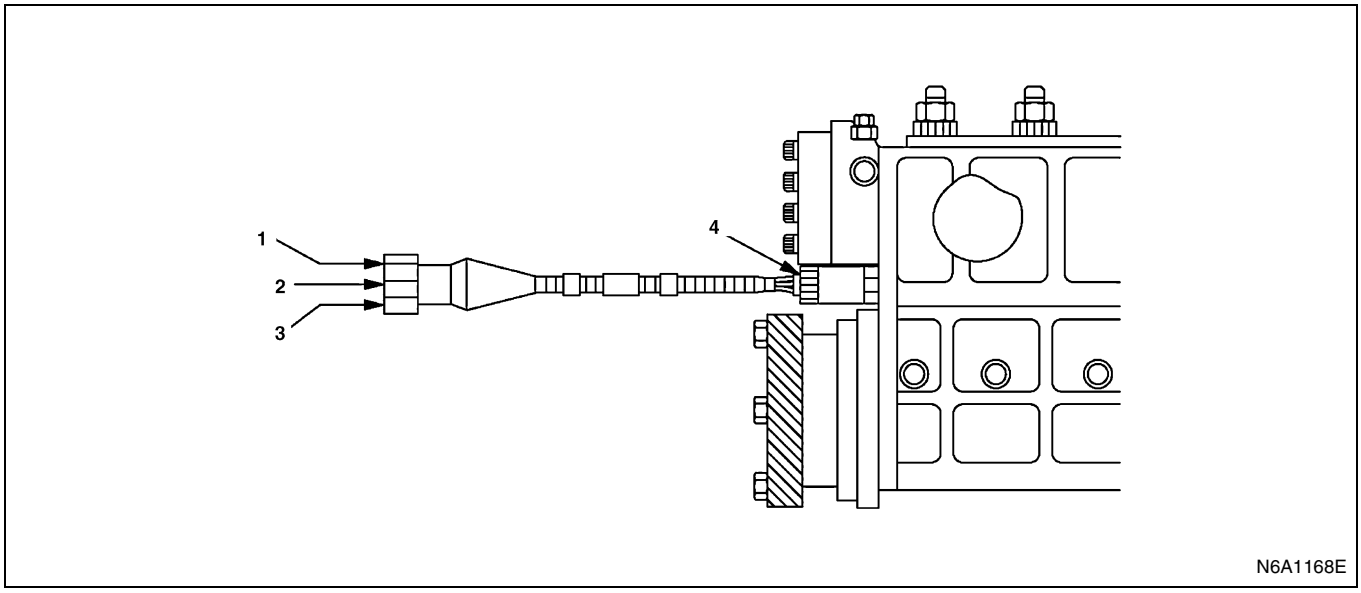
Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	1. Ignition “OFF” 2. Disconnect the ECT sensor. 3. Ignition “ON”, Engine “OFF” 4. See scan Tool Display and Ignore trouble code 13. Does code 14 still remain faulty?	—	Go to Step 3	Go to Step 6
3	1. Ignition “OFF” 2. Check Connector ECT Sensor Harness for interterminal short. 3. Repair if necessary. Was ECT Sensor connector shorted?	—	Go to Step 4	Go to Step 8
4	1. Ignition “OFF” 2. Check the ECM connector terminal short. 3. Repair if necessary. Was ECM terminal shorted?	—	Go to Step 5	Go to Step 8
5	1. Disconnect the ECM. 2. Check if ECT sensor signal circuit for a short to ground or a short to ground circuit. 3. Repair if necessary. Is ECT sensor signal circuit shorted to ground?	—	Go to Step 7	Go to Step 8
6	1. Ignition “OFF” 2. Replace the ECT Sensor. Is the action complete?	—	Go to Step 8	—
7	1. Replace the ECM. Is the action complete?	—	Go to Step 8	—

Step	Action	Value	YES	NO
8	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC 14 all right under Scan Tool Check?	—	Go to Step 9	Go to Step 2
9	Is any current trouble other than DTC 14 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P21 Rack Sensor Circuit Low Voltage



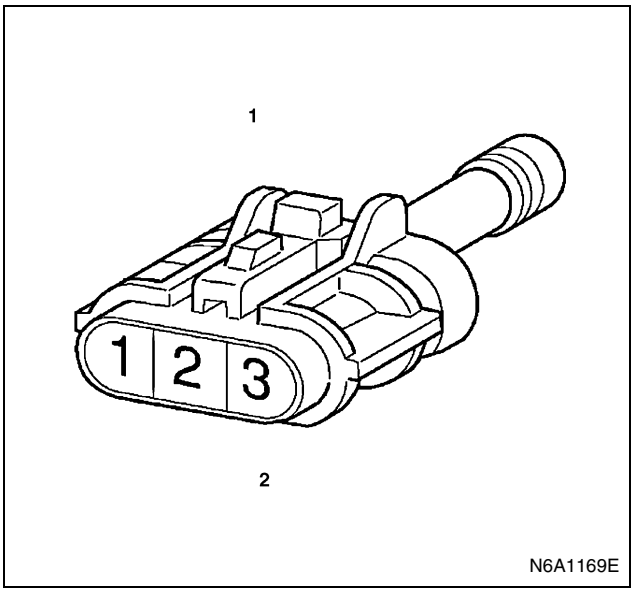
Location of Rack Sensor Connector



Legend

1. OSC (red)
2. MDL (white)
3. GND (black)
4. Rack sensor

Connector Name of Rack Sensor



Legend

1. Rack sensor connector
2. Natural 3 pin

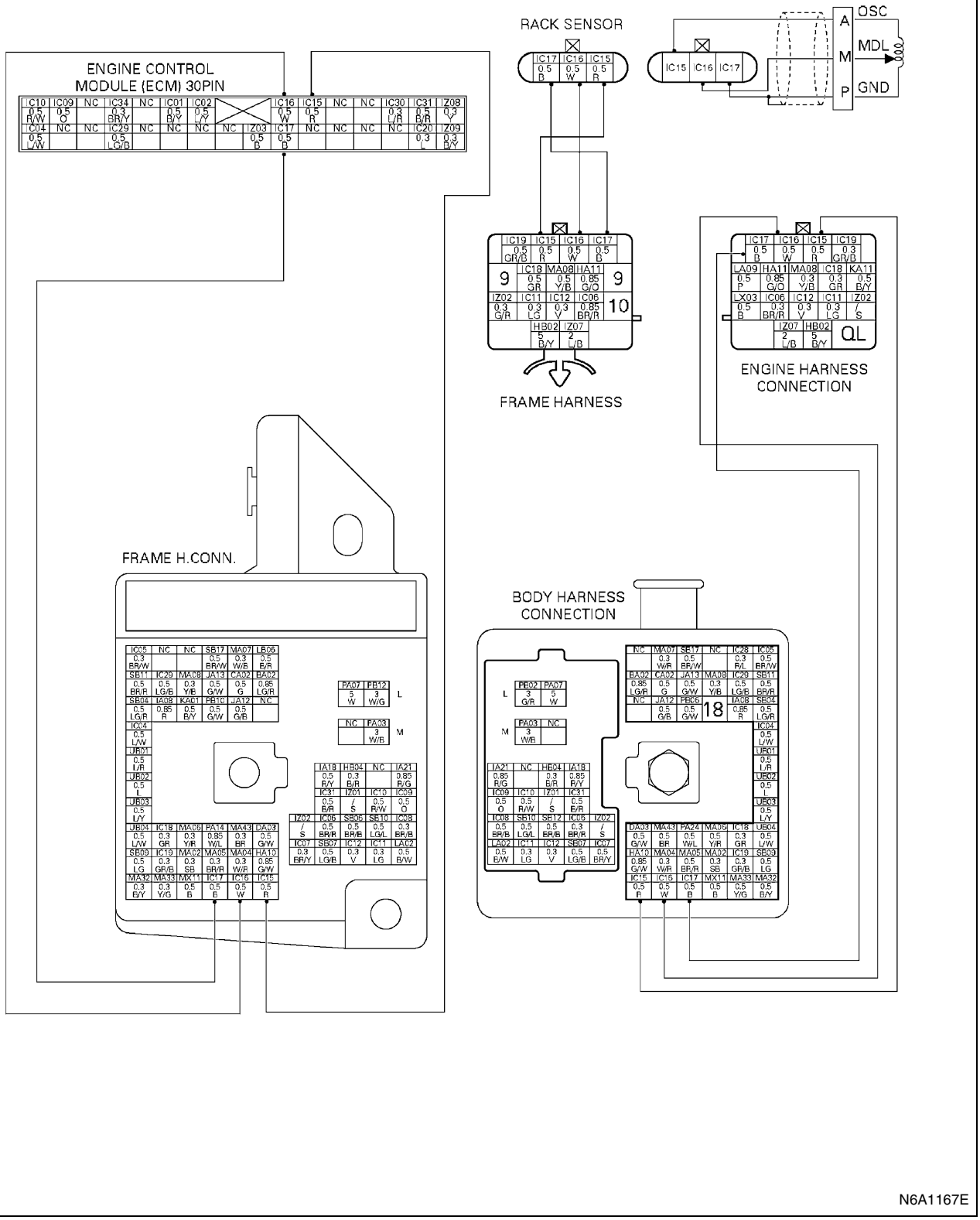
Notice:
Mark "___" on connector which is plugged, therefore, should be confirmed to be played.

Relation Between Connector Number and Signal Name

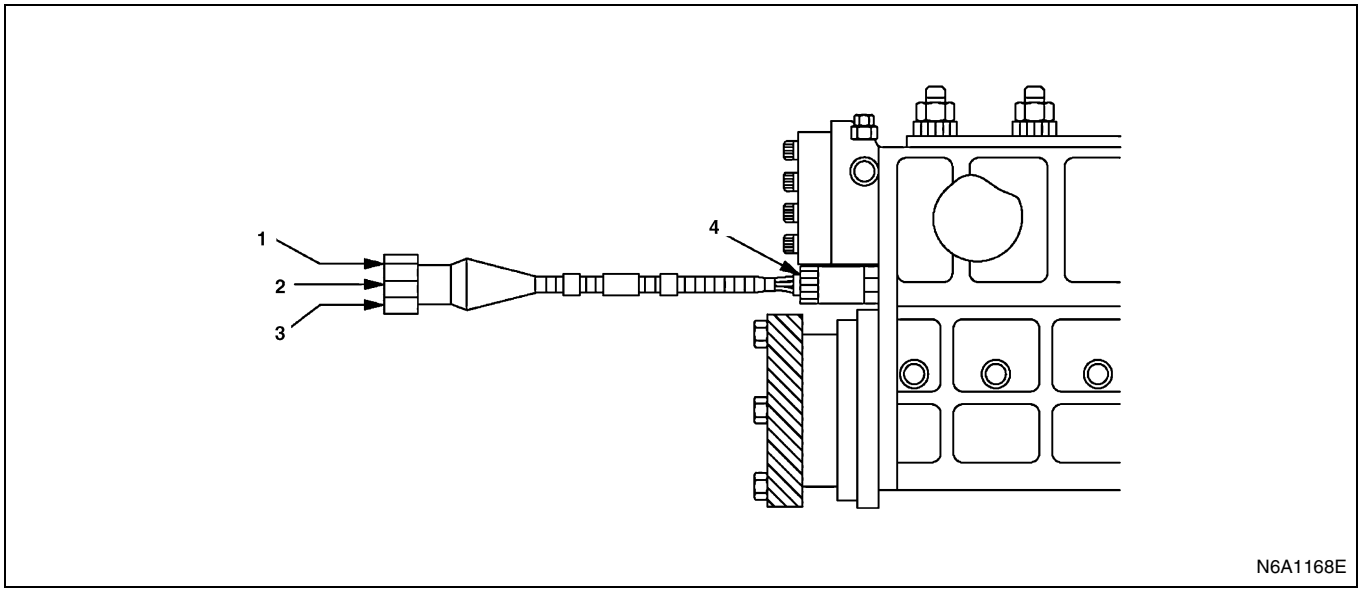
Connector No	Signal	Wire color
1	Rack sensor (OSC)	R
2	Rack sensor (MDL)	W
3	Rack sensor (GND)	B

Step	Action	Value	YES	NO
1	Was the on-board diagnostic (OBD) system check performed?	—	Go to Step 2	Go to self diag system check
2	1. Check harness side power source circuit and signal circuit for GND short. 2. Repair if necessary. Has DTC21 been corrected?	—	Go to Step 10	Go to Step 3
3	Disconnect the Sensor Connector. Jumper RACK+ and RACK signal. Free from trouble now? Ignore code 22.	—	Go to Step 4	Go to Step 6
4	1. Apply 5V to RACK+ TERMINAL. Measure RACK SIG Voltage. Is RACK SIG VOLTAGE as specified?	0.9 — 2.0V (Idling speed)	Go to Step 7	Go to Step 5
5	1. Check Rack Sensor Harness Signal Circuit and power source for GND short. Check signal circuit for disconnect. 2. Repair if necessary. Free from trouble now?	—	Go to Step 10	Go to Step 7
6	1. Check harness signal circuit and power source circuit for disconnect. 2. Repair if necessary. Free from trouble now?	—	Go to Step 10	Go to Step 8
7	1. Check the iron core of RACK Sensor for damage, seizure, and wear. 2. After check, repair if necessary. Was there any trouble in the iron core (RACK end) inside RACK Sensor?	—	Go to Step 10	Go to Step 9
8	1. Replace the RACK Sensor. Is the action complete?	—	Go to Step 10	—
9	1. Replace the ECM. Is the action complete?	—	Go to Step 10	—
10	1. Reconnect all the connectors removed. 2. Ignition -ON+, Engine “OFF” Is DTC 21 all right under Scan Tool Check?	—	Go to Step 10	Go to Step 2
11	Is any current trouble other than DTC 21 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P22 Rack Sensor Circuit High Voltage



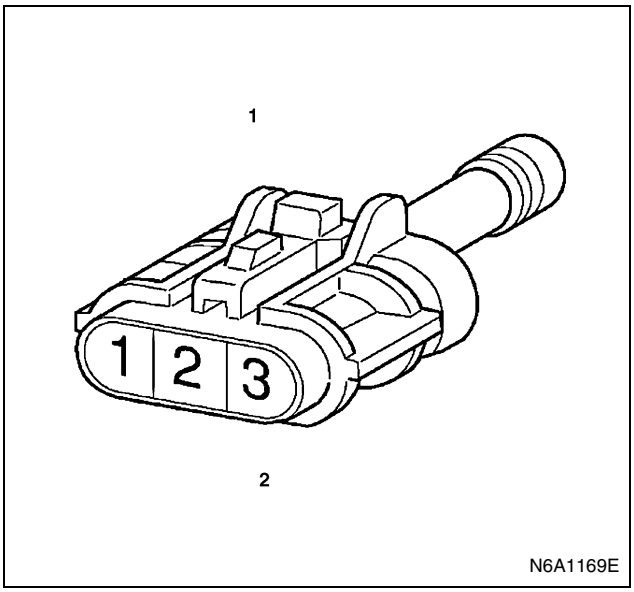
Location of Rack Sensor Connector



Legend

1. OSC (red)
2. MDL (white)
3. GND (black)
4. Rack sensor

Connector Name of Rack Sensor



Legend

1. Rack sensor connector
2. Natural 3 pin

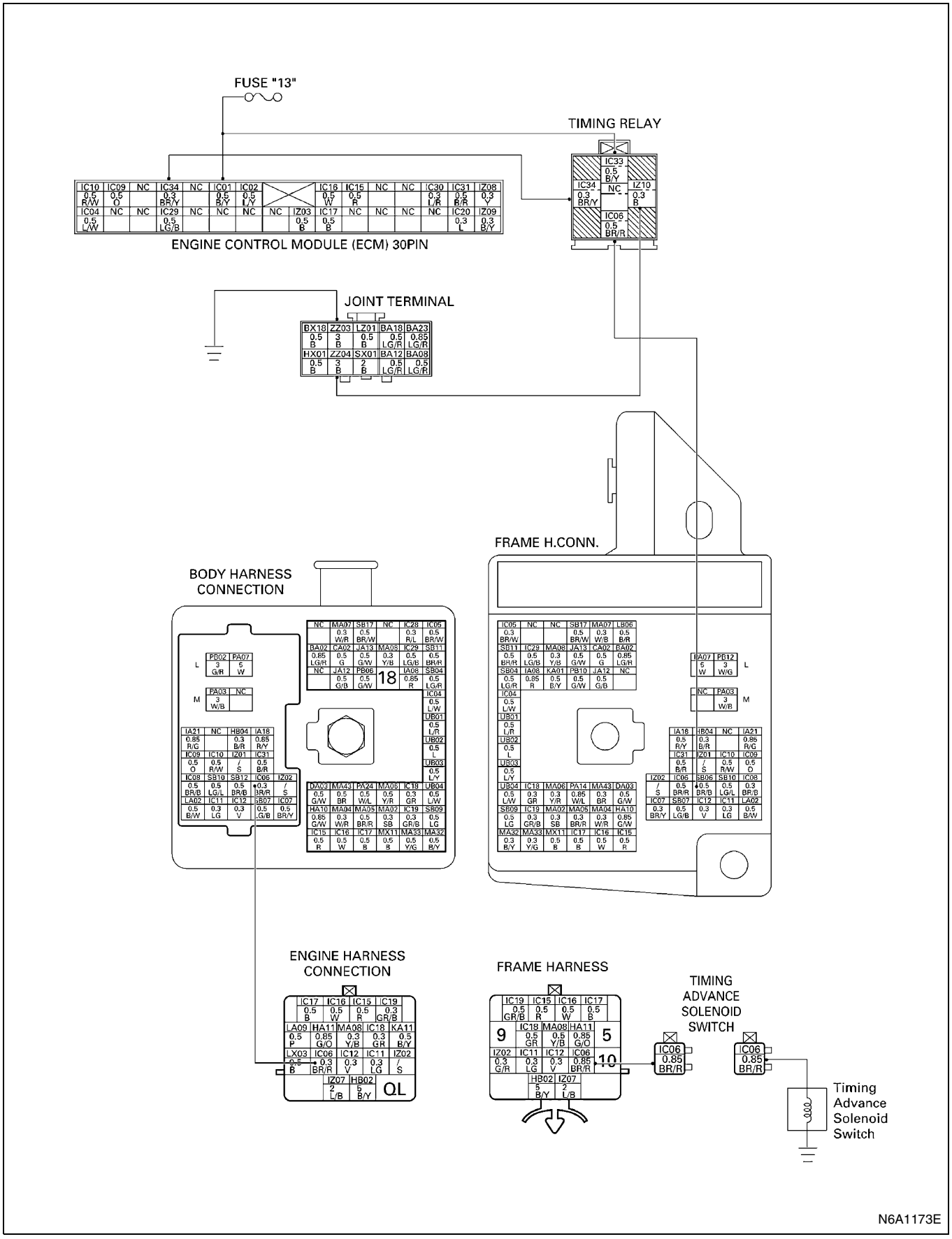
Notice:
Mark "___" on connector which is plugged, therefore, should be confirmed to be played.

Relation Between Connector Number and Signal Name

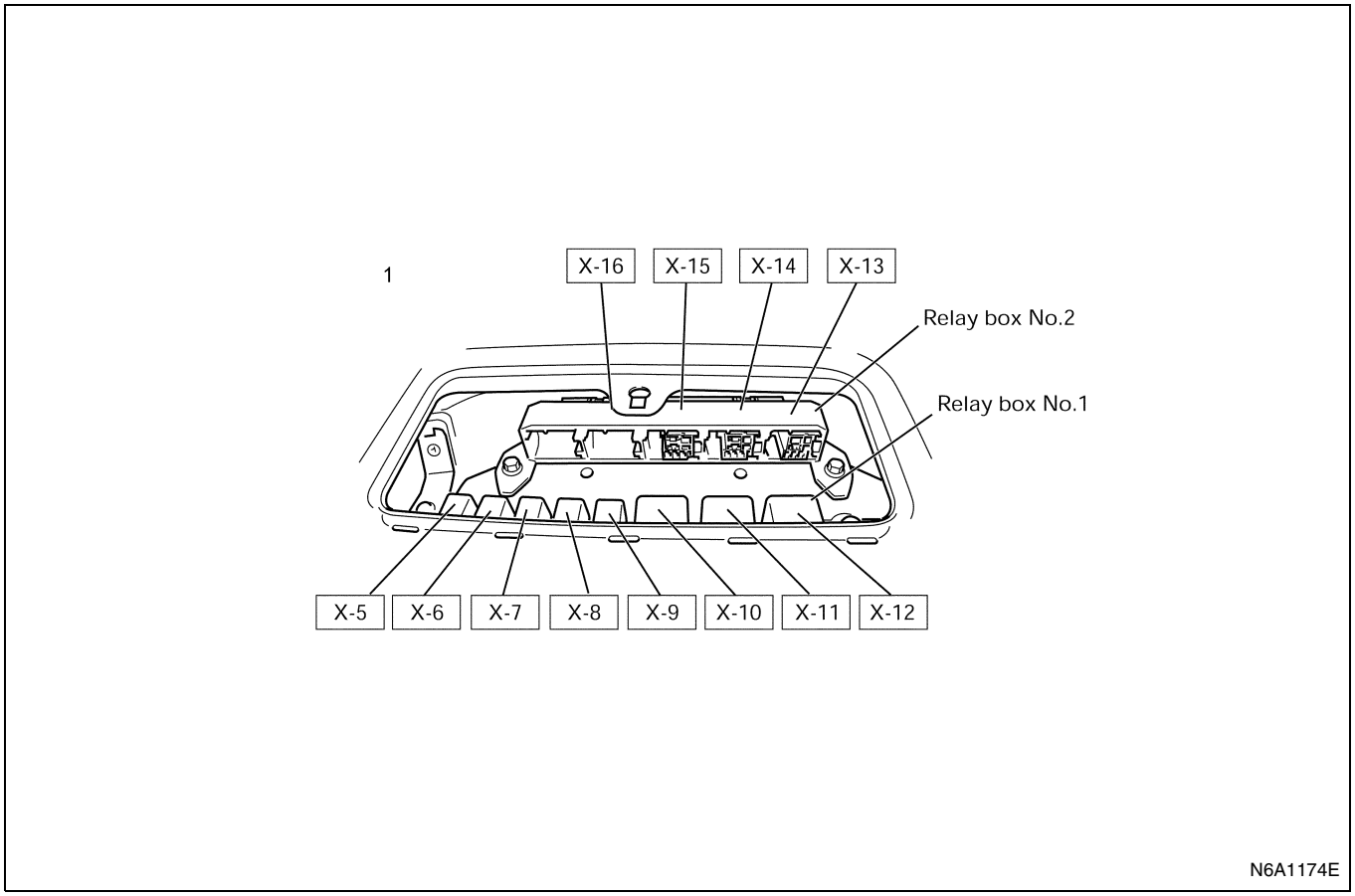
Connector No	Signal	Wire color
1	Rack sensor (OSC)	R
2	Rack sensor (MDL)	W
3	Rack sensor (GND)	B

Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	Remove Sensor Connector. Has DTC22 been corrected? (Ignore DTC21)	—	Go to Step 3	Go to Step 7
3	1. Jump between Harness signal Terminal and GND terminal at the Sensor side of Connector. 2. Ignition “ON” Has DTC22 been corrected?	—	Go to Step 4	Go to Step 5
4	1. Check the Sensor Connector for inter terminal short. After check, repair if necessary. Was Connector Terminal shorted?	—	Go to Step 12	Go to Step 6
5	1. Check GND Circuit for disconnect. After check, repair if necessary. Is GND circuit disconnect?	—	Go to Step 12	Go to Step 11
6	1. Check Sensor Harness signal circuit and power source circuit for short. After check, repair if necessary. Was Harness shorted?	—	Go to Step 12	Go to Step 8
7	1. Check Harness signal circuit and power source for short. After check, repair if necessary. Was Harness shorted?	—	Go to Step 12	Go to Step 11
8	1. Apply 5V to RACK+ TERMINAL. 2. Measure RACK SIG Voltage. Is RACK SIG VOLTAGE as specified?	0.9 — 2.0V (Idling speed)	Go to Step 9	Go to Step 10
9	1. Check the iron core of RACK Sensor for damage, seizure, and wear. 2. After check, repair if necessary. Was there any trouble in the iron core(RACK end) inside RACK Sensor?	—	Go to Step 12	Go to Step 11
10	Replace the RACK Sensor. Is the action complete?	—	Go to Step 12	—
11	Replace the ECM. Is the action complete?	—	Go to Step 12	—
12	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC22 all right under Scan Tool Check?	—	Go to Step 13	Go to Step 2
13	Is any current trouble other than DTC 22 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P23 Solenoid Switch Control Circuit Low Voltage



Location of Relay

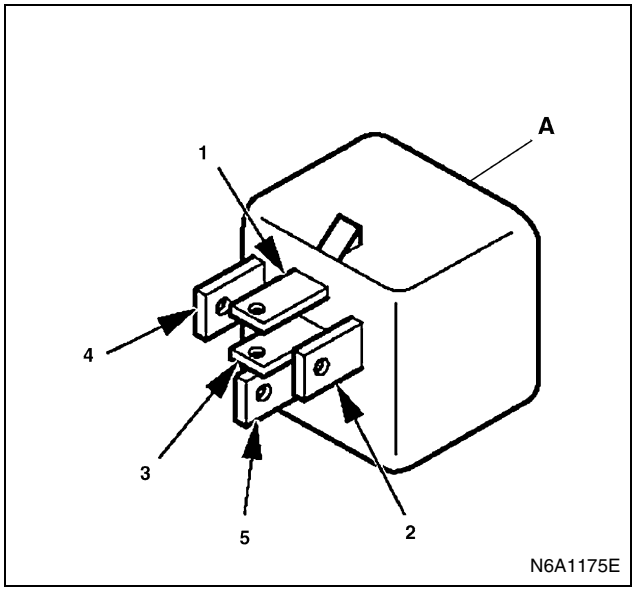


Legend

1. Relay box (Installed on the instrument panel)

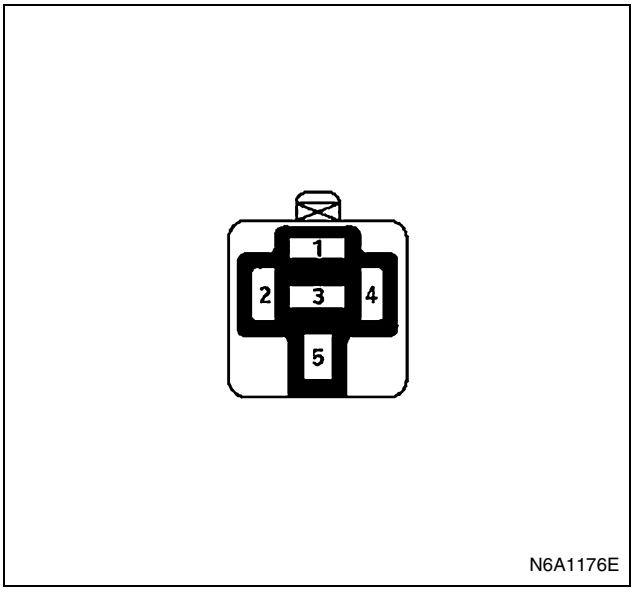
NO	RELAY NAME
X-5	ABS IND.
X-6	Dimmer
X-7	Power window
X-8	Exh. brake
X-9	Cornering lamp
X-10	Thermo A/C
X-11	Exh. Brake, Charge warning, Key ON
X-12	Heater & A/C
X-13	Buzzer cancel, Heater
X-14	ECU, PTO main, Timing
X-15	Tail, PTO solenoid, M/T
X-16	PTO cut

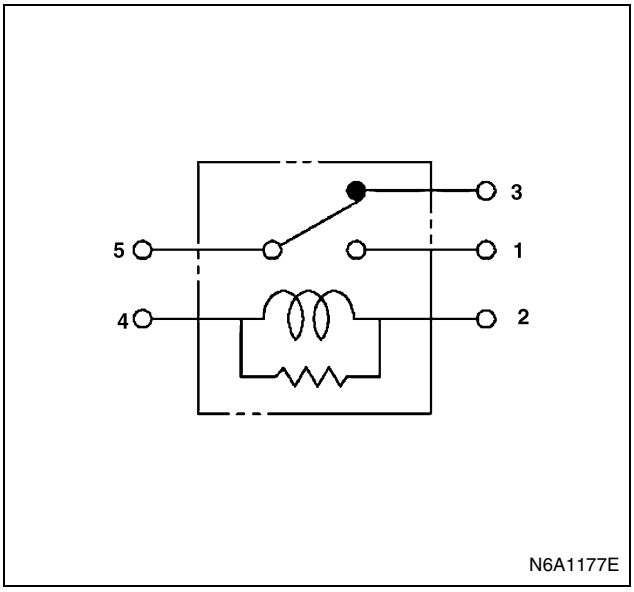
Inspection for Timing Advance Solenoid Switch cut relay



Legend

A. Timing advance solenoid





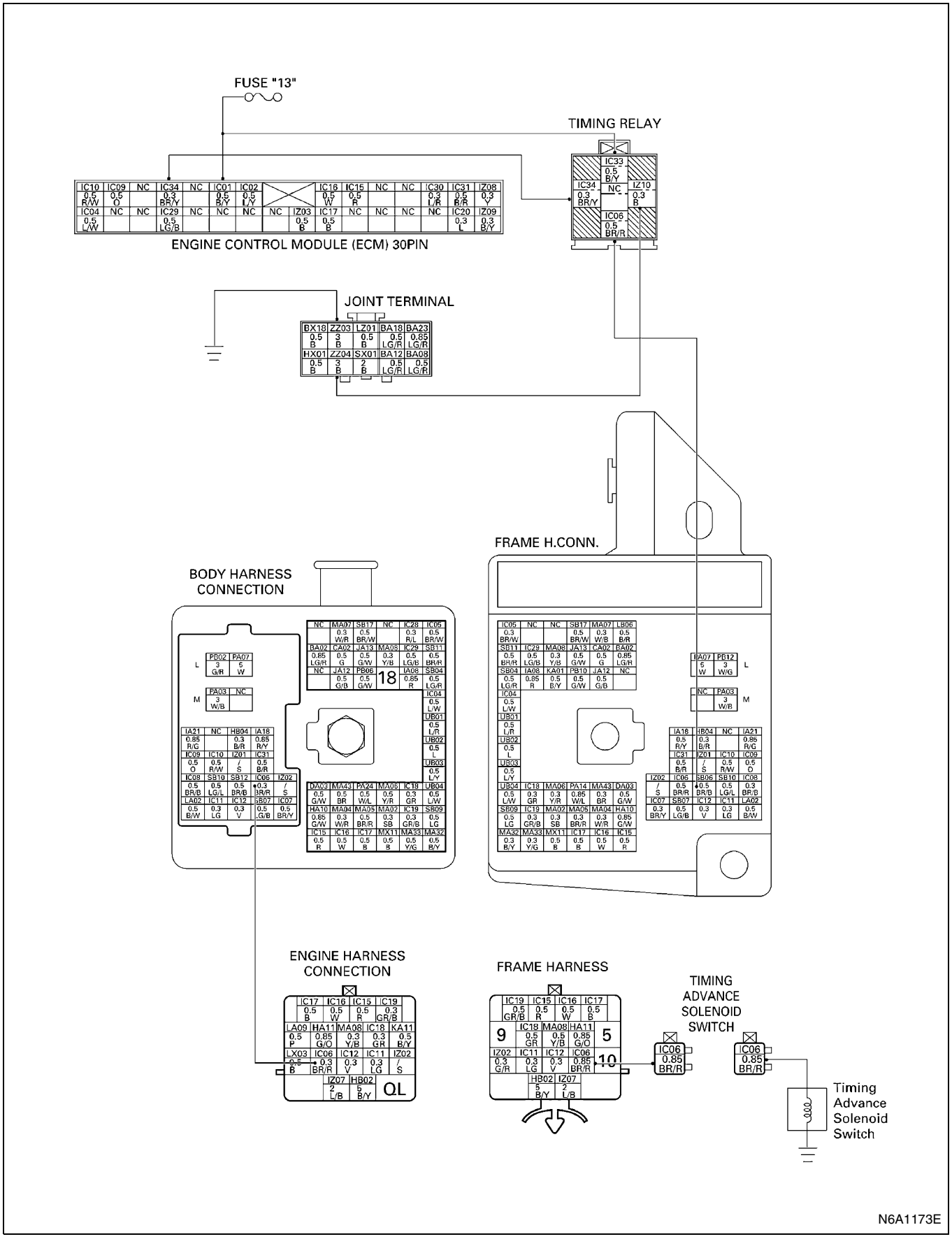
Resistance value

Inspection Point		Resistance	Reference
Inspection relay unit	2 ⟷ 4	240 to 290 (Ω) (for 12 volt) 256 to 276 (Ω) (for 24 volt)	
	1 ⟷ 5	∞	Not be supplied electricity
		Below 0.5 (Ω)	Be supplied electricity
	3 ⟷ 5	Below 0.5 (Ω)	Be supplied electricity
		∞	Not be supplied electricity

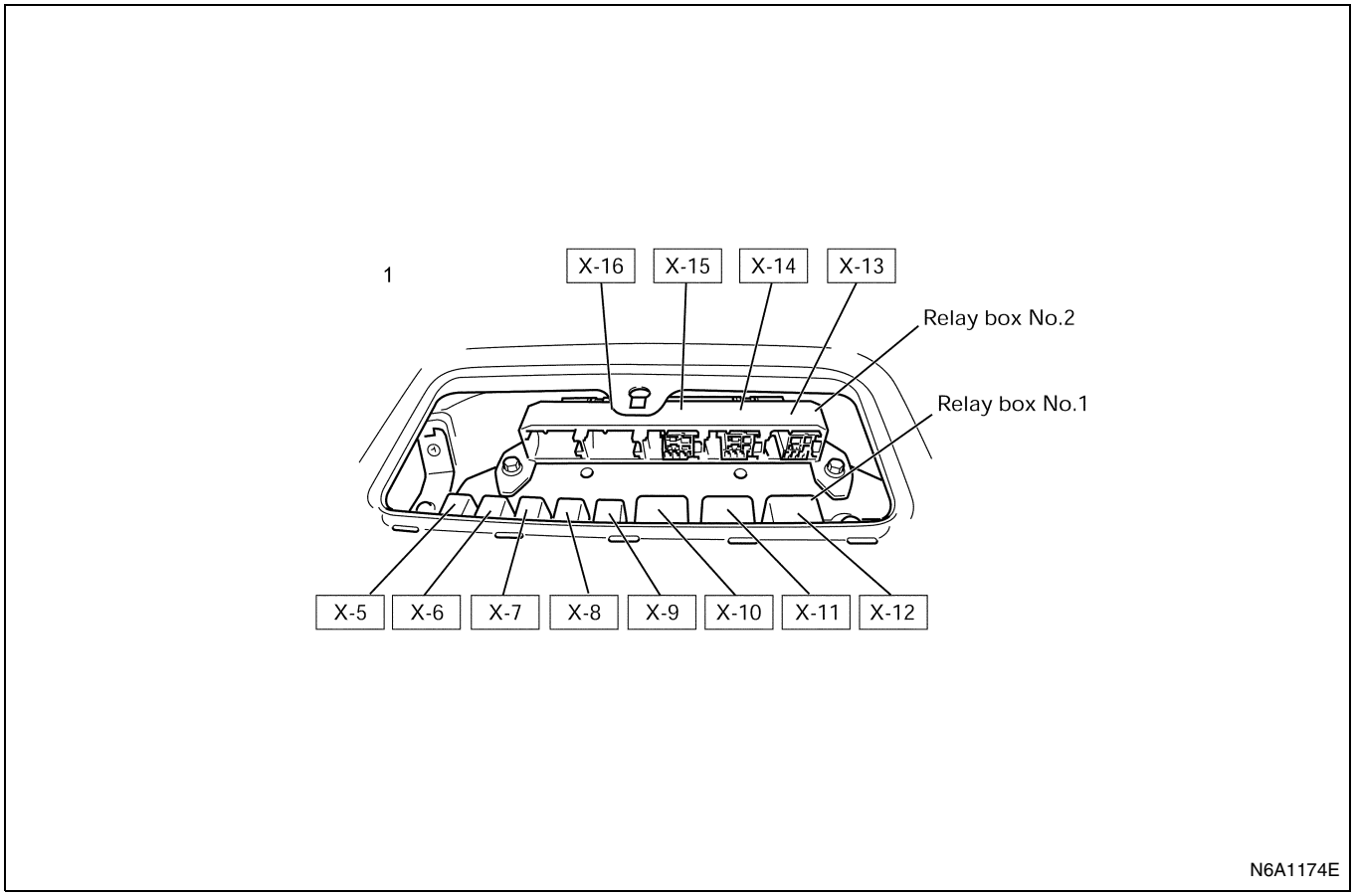
Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	1. Ignition “OFF”, Engine “ON”. 2. Jumper the magnetic switch Relay ground circuit at the Relay connector to chassis ground. 3. Observe the “Relay; solenoid switch” circuit open status on the scan tool. Has DTC23 been corrected?	—	Go to Step 4	Go to Step 3
3	1. Check for poor connector at the Relay connector and replace the terminals if necessary. Did any terminals require replacement?	—	Go to Step 11	Go to Step 5
4	1. Check the Relay ground circuit for an open. 2. If the Relay ground circuit is open, repair it as necessary. Was the Relay ground circuit open?	—	Go to Step 11	Go to Step 2

Step	Action	Value	YES	NO
5	1. Ignition “OFF”, with scan tool disconnected. 2. Disconnect the Solenoid switch Relay connector. 3. Apply a circuit tester with voltage range or a test light to the output line for the Relay. 4. Ignition “ON”, Measure the voltage or check the test light “ON”. Ignition “OFF”	≥8V or light “ON” (for 12 Volt) ≥16V or light “ON” (for 24 Volt)	Go to Step 8	Go to Step 6
6	1. Ignition “ON”. 2. Disconnect ECM, and check for the Relay signal circuit terminal connector at the ECM and clean or replace terminal if necessary. Did any terminals need to be repaired?	—	Go to Step 11	Go to Step 7
7	1. Check the Relay signal circuit for an open. 2. If the Relay signal circuit is open, repair it as necessary. Was the Relay signal circuit open?	—	Go to Step 11	Go to Step 8
8	1. Disconnect the Relay. 2. Measure the resistance between the coil circuit terminals of the Relay. Is the resistance within specific value?	240 — 290Ω (for 12 Volt) 256 — 276Ω (for 24 Volt)	Go to Step 10	Go to Step 9
9	1. Replace the Relay. Is the action complete?	—	Go to Step 11	—
10	1. Replace the ECM Is the action complete?	—	Go to Step 11	—
11	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF”. 3. Ignition “OFF” after 30 seconds. 4. Install Scan tool. Is DTC 23 all right under Scan Tool Check?	—	Go to Step 12	Go to Step 2
12	Is any current trouble other than DTC 23 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P24 Solenoid Switch Control Circuit High Voltage



Location of Relay

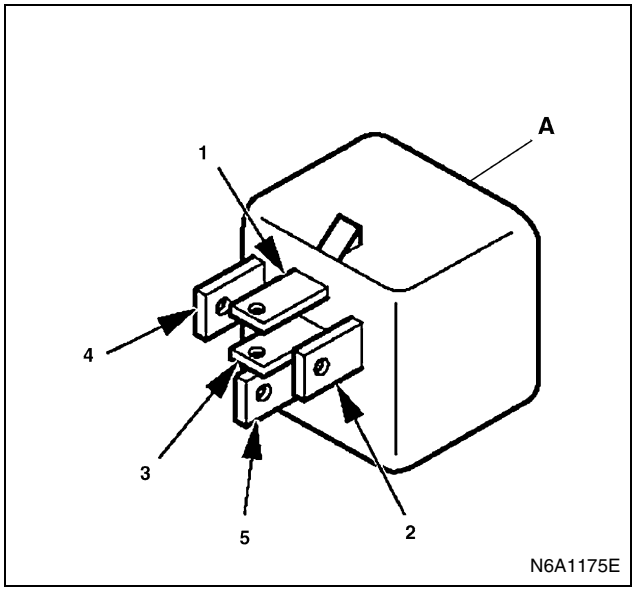


Legend

1. Relay box (Installed on the instrument panel)

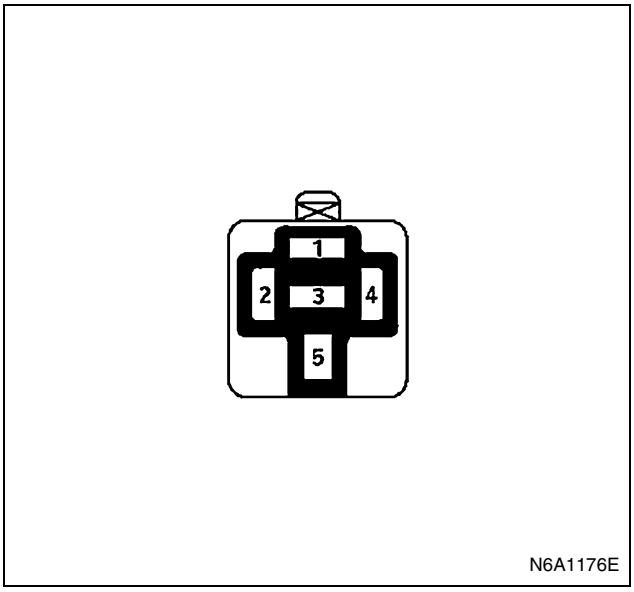
NO	RELAY NAME
X-5	ABS IND.
X-6	Dimmer
X-7	Power window
X-8	Exh. brake
X-9	Cornering lamp
X-10	Thermo A/C
X-11	Exh. Brake, Charge warning, Key ON
X-12	Heater & A/C
X-13	Buzzer cancel, Heater
X-14	ECU, PTO main, Timing
X-15	Tail, PTO solenoid, M/T
X-16	PTO cut

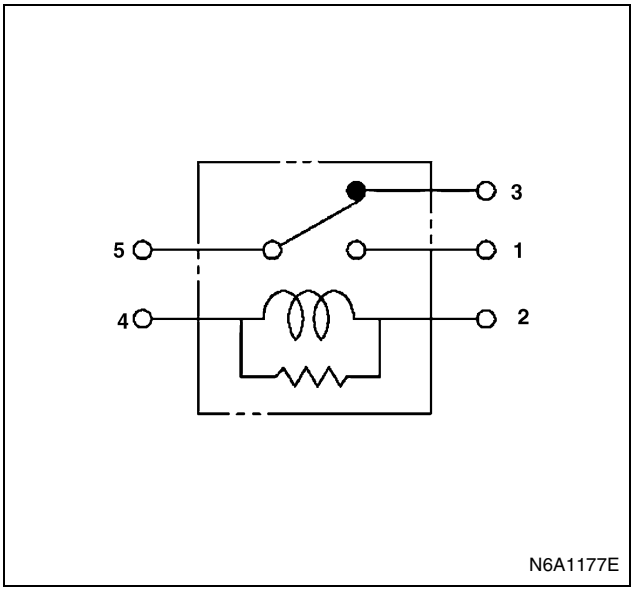
Inspection for Timing Advance Solenoid Switch cut relay



Legend

A. Timing advance solenoid



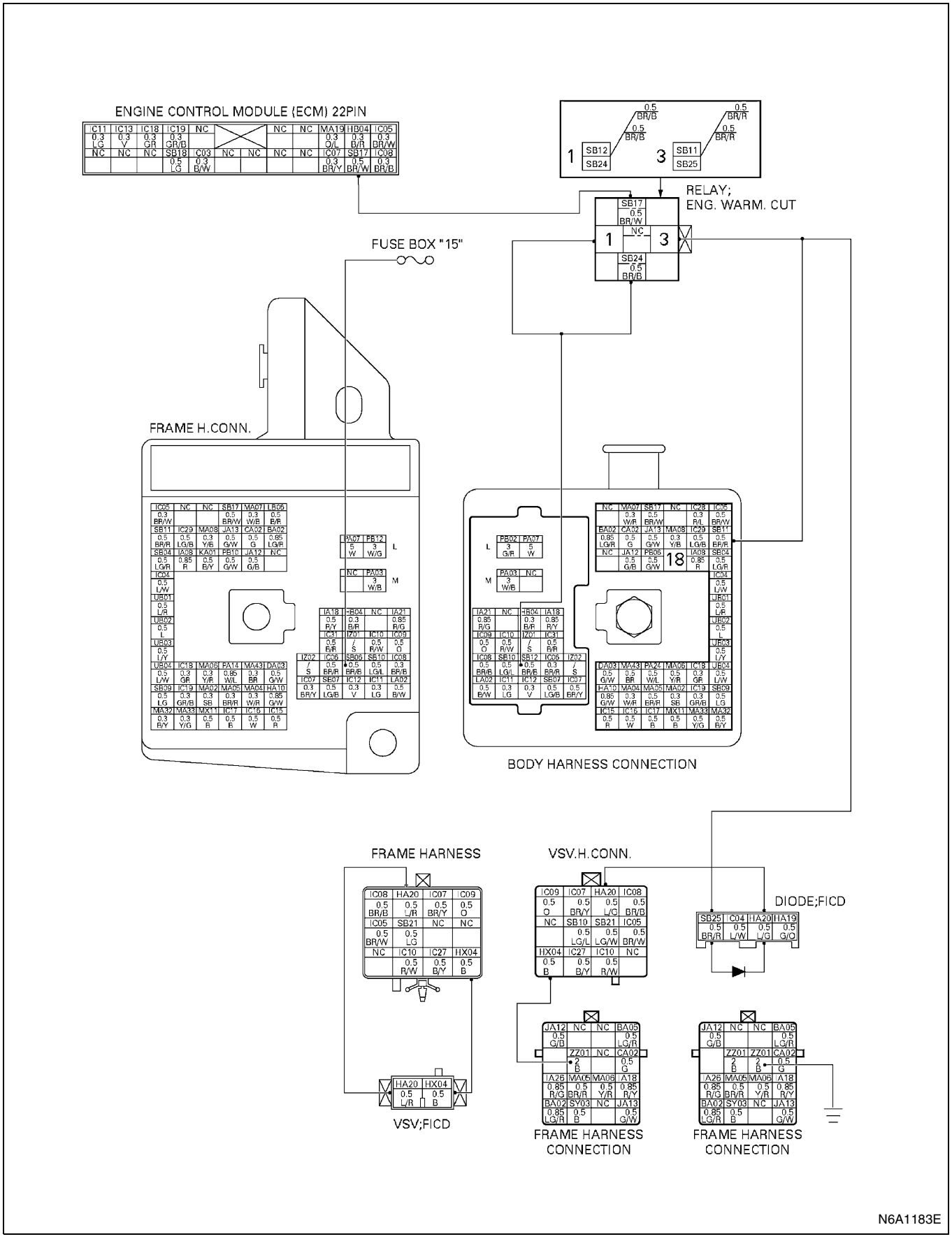


Resistance value

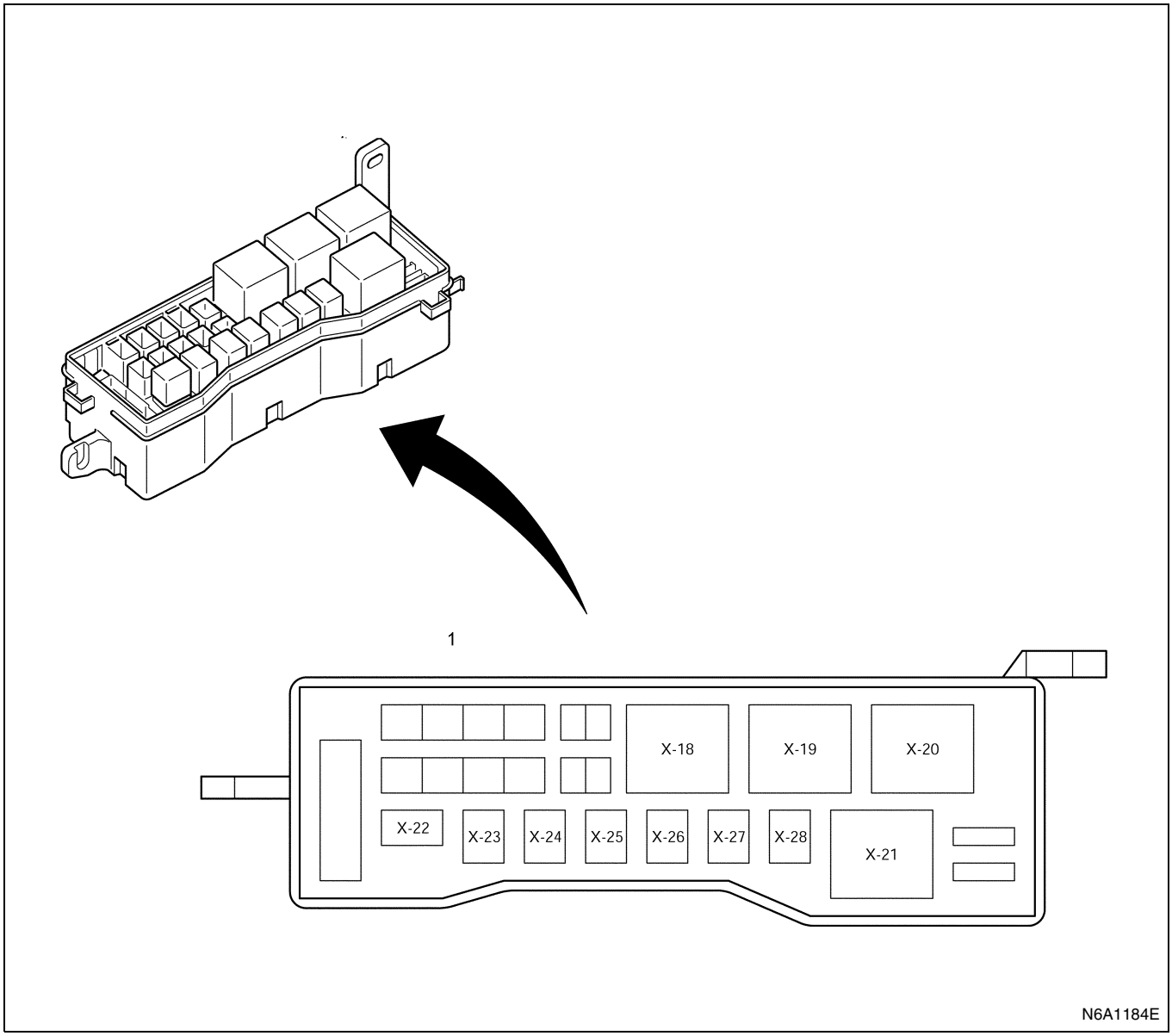
Inspection Point		Resistance	Reference
Inspection relay unit	2 ⟷ 4	240 to 290 (Ω) (for 12 volt) 256 to 276 (Ω) (for 24 volt)	
	1 ⟷ 5	∞	Not be supplied electricity
		Below 0.5 (Ω)	Be supplied electricity
	3 ⟷ 5	Below 0.5 (Ω)	Be supplied electricity
		∞	Not be supplied electricity

Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	1. Ignition “OFF”, with scan tool disconnected. 2. Disconnect the Relay solenoid switch from the Relay box. 3. Apply a circuit tester with the voltage range or a test light to the output circuit for the Relay. 4. Ignition “ON”, Engine “OFF”. Is voltage as prescribed, or is test Light lit until 18 seconds?	≥8V or light “ON” (for 12 Volt) ≥16V or light “ON” (for 24 Volt)	Go to Step 6	Go to Step 3
3	1. Ignition “OFF”. 2. Check if there is no short between Relay Box Terminals. 3. Repair if necessary. Was the circuit shorted between Relay Box Terminals?	—	Go to Step 8	Go to Step 4
4	1. Disconnect the ECM. 2. Check if Relay Sig Circuit for a short to Chassis/GND or short to voltage. 3. Repair if necessary. Was Relay signal circuit shorted?	—	Go to Step 8	Go to Step 5
5	1. Disconnect the Relay. 2. Measure the resistance between the coil circuit terminal of the Relay. Is the resistance with in specific valve?	240 — 290Ω (for 12 Volt) 256 — 276Ω (for 24 Volt)	Go to Step 8	Go to Step 6
6	1. Ignition “OFF”. 2. Replace the Relay. Is the action complete?	—	Go to Step 8	—
7	1. Ignition “ON”. 2. Replace the ECM. Is the action complete?	—	Go to Step 8	—
8	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine OFF, and Ignition off after 30sec. 3. Install Scan tool. 4. Ignition “ON”, Engine “OFF”. Is DTC 24 all right under Scan Tool Check?	—	Go to Step 9	Go to Step 2
9	Is any current trouble other than DTC 24 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P26 Quick Warm System (QWS) Relay Control Circuit High Voltage



Location of Relay

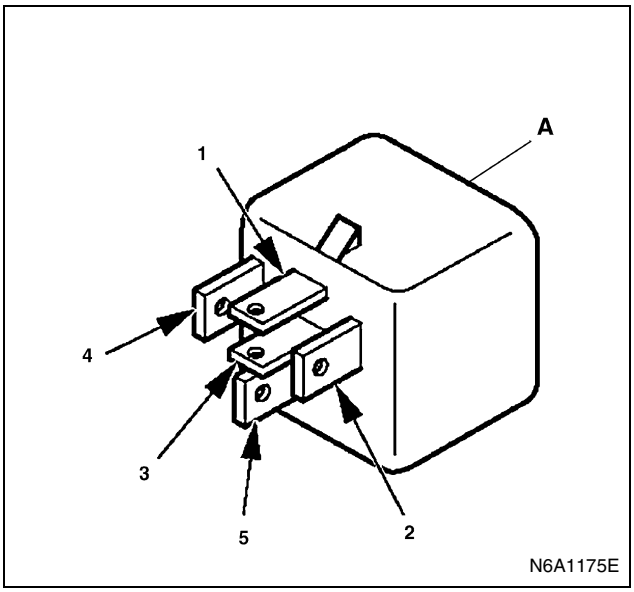


Legend

1. Relay box (Installed on the left side rear of the cab)

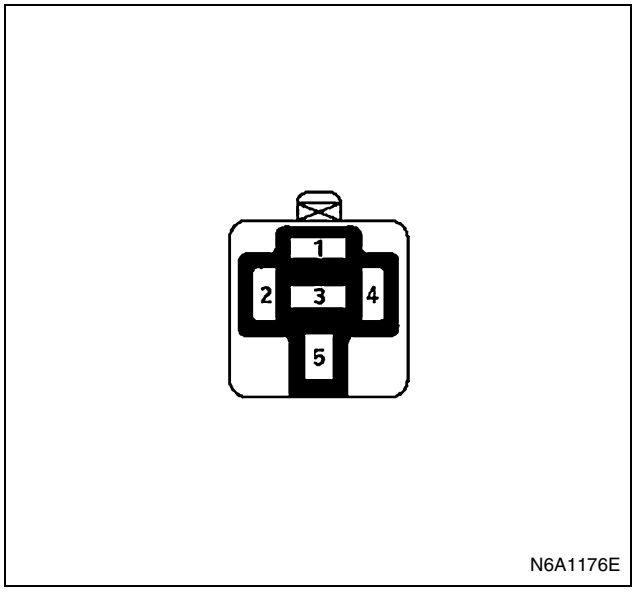
NO	RELAY NAME
X-20	Glow plug
X-21	Starter
X-22	Marker lamp
X-23	Rear fog
X-24	A/C COMP, 4WD ind. lamp
X-25	Exh, Brake control
X-26	CSD, A/C ON SIGNAL
X-27	Condenser fan
X-28	Exh. Brake cut

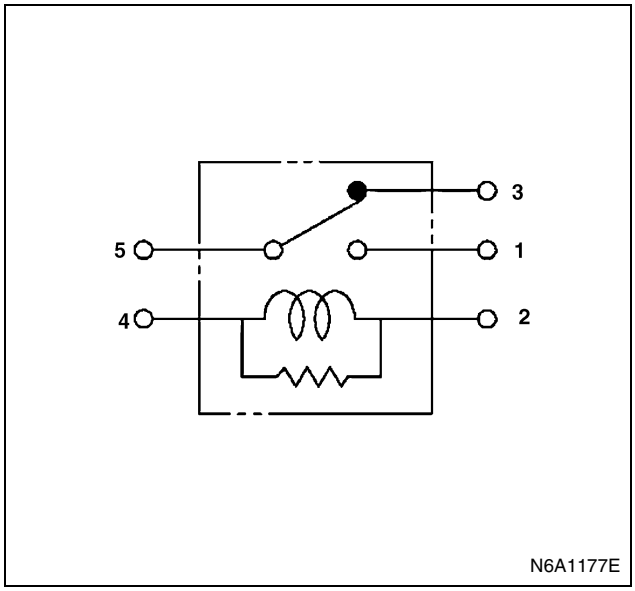
Inspection for Timing Advance Solenoid Switch cut relay



Legend

A. Timing advance solenoid



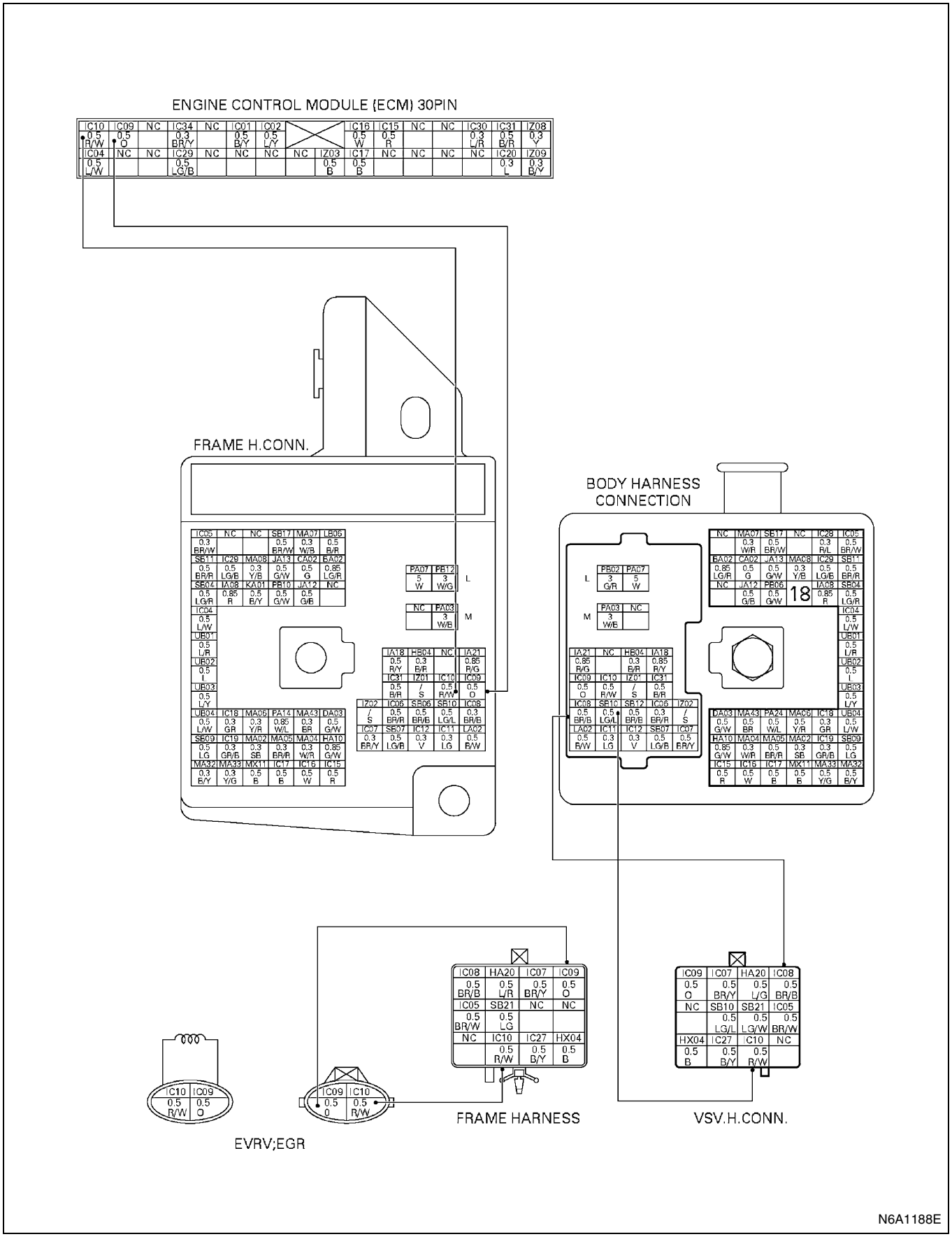


Resistance value

Inspection Point		Resistance	Reference
Inspection relay unit	2 ⟷ 4	240 to 290 (Ω) (for 12 volt) 256 to 276 (Ω) (for 24 volt)	
	1 ⟷ 5	∞	Not be supplied electricity
		Below 0.5 (Ω)	Be supplied electricity
	3 ⟷ 5	Below 0.5 (Ω)	Be supplied electricity
		∞	Not be supplied electricity

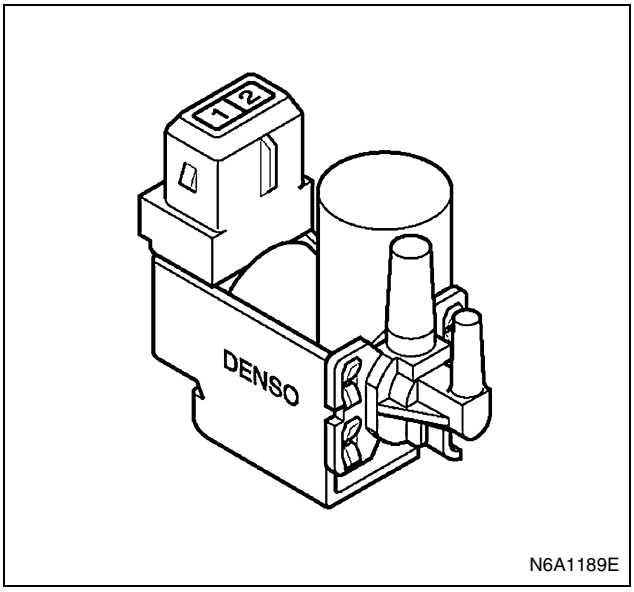
Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	1. Ignition “OFF”, with scan tool disconnected. 2. Disconnect the Relay solenoid switch from the Relay box. 3. Apply a circuit tester with the voltage range or a test light to the output circuit for the Relay. 4. Ignition “ON”, Engine “OFF”. Is voltage as prescribed, or is test Light lit until 18 seconds?	≥8 V or light “ON” (for 12 Volt) ≥16 V or light “ON” (for 24 Volt)	Go to Step 3	Go to Step 4
3	1. Ignition “OFF” 2. Disconnect the ECM connector from ECM. 3. Check the short to voltage of Relay circuit between the ECM and Relay connector. 4. Repair if necessary. Has DTC 26 been corrected?	—	Go to Step 6	Go to Step 5
4	Replace the Relay. Is the action complete?	—	Go to Step 6	—
5	Replace the ECM. Is the action complete?	—	Go to Step 6	—
6	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC 26 all right under Scan Tool Check?	—	Go to Step 7	Go to Step 2
7	Is any current trouble other than DTC 26 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P31 Exhaust Gas Recirculation (EGR) Electronic Vacuum Regulating Valve (EVRV) Solenoid Control Low Voltage

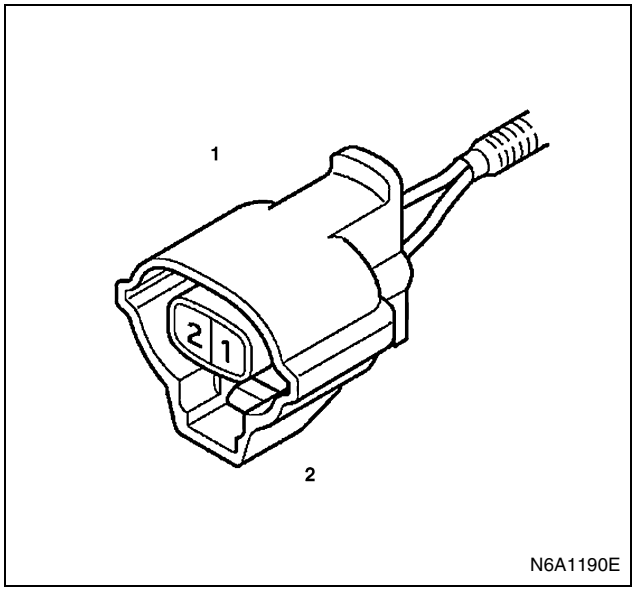


Appearance of Electronic Vacuum Regulating Valve (EVRV): Exhaust Gas Recirculation (EGR) Sensor and Connector Name

EVRV: EGR



EVRV: EGR Connector

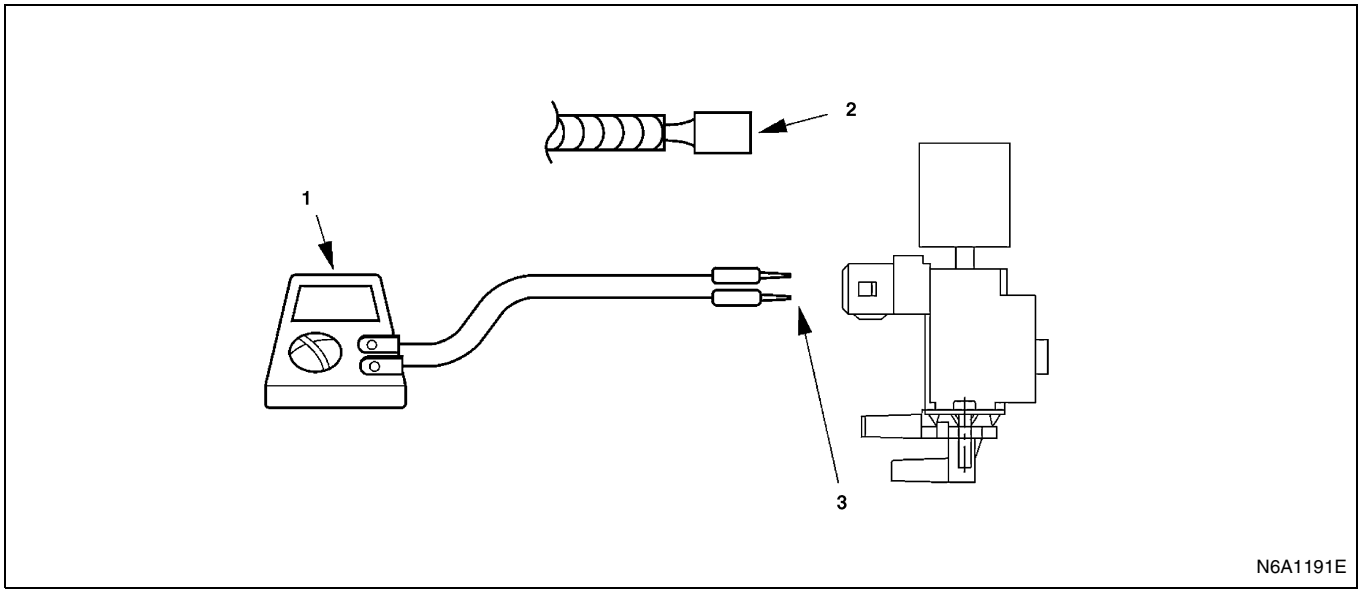


Legend

1. To EVRV: EGR
2. 2 pin

Connector No	Signal
1	GND
2	SIG

Measure Resistance at EVRV: EGR



Legend

1. Circuit tester
2. Remove EVRV wire harness
3. Measure resistance between connector pin

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

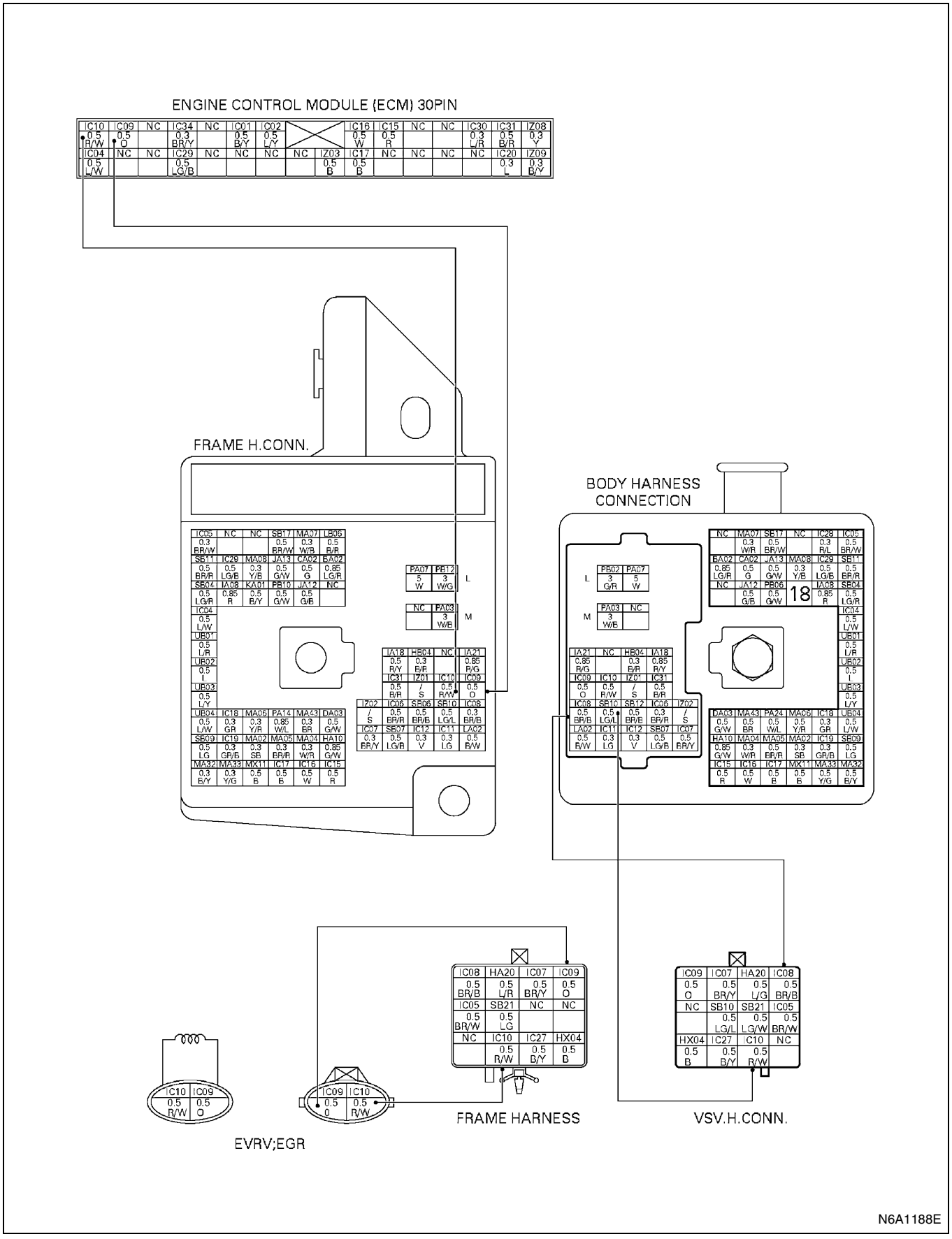
Resistance value

Inspection Point		Resistance Value (kΩ)	Reference
Connector	Pin No.		
2 pin Black	2 ←→ 1	12±1 (for 12 volt) 48±2 (for 24 volt)	SIG ←→ GND
	1 ←→ Body	∞	SIG ←→ Body

Notice:
Resistance value is difference according to the engine temperature (condition of engine warming up).

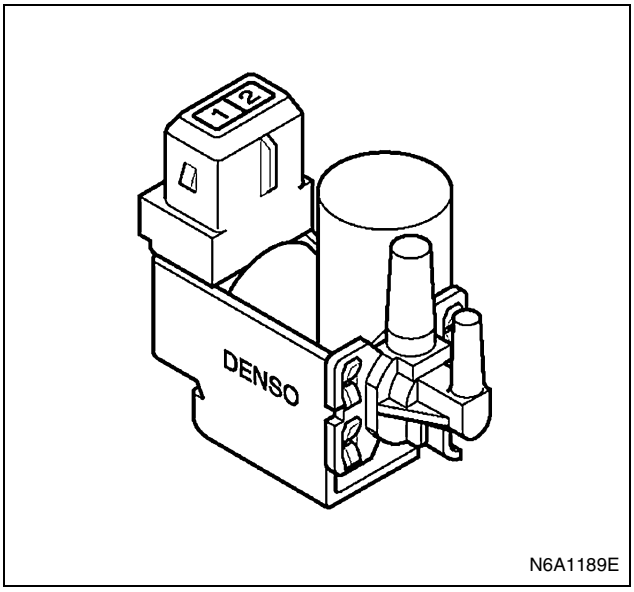
Step	Action	Value	YES	NO
1	Was the "on-board diagnostic (OBD) system check" performed?	—	Go to Step 2	Go to self diag system check
2	1. Ignition "OFF" 2. Disconnect the EVRV from the wiring harness connector. 3. Check the EVRV signal circuit between the EVRV connector and the ECM for the following condition. • A short to ground • An open circuit 4. Repair if necessary. Has DTC31 been corrected?	—	Go to Step 7	Go to Step 3
3	Using the DVM, check the resistance of the EVRV. Does the DVM read the following Value?	12Ω (for 12 Volt) 48Ω (for 24 Volt)	Go to Step 4	Go to Step 5
4	1. Ignition "OFF" 2. Check an open circuit of the EVRV ground circuit between the ECM and EVRV connector. 3. Repair if necessary. Has DTC31 been corrected?	—	Go to Step 7	Go to Step 6
5	Replace the EVRV. Is the action complete?	—	Go to Step 7	Go to Step 6
6	Replace the ECM. Is the action complete?	—	Go to Step 7	—
7	1. Reconnect all the connectors removed. 2. Ignition "ON", Engine "OFF" Is DTC31 all right under Scan Tool Check?	—	Go to Step 8	Go to Step 2
8	Is any current trouble other than DTC31 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P32 Exhaust Gas Recirculation (EGR) Electronic Vacuum Regulating Valve (EVRV) Solenoid Control High Voltage

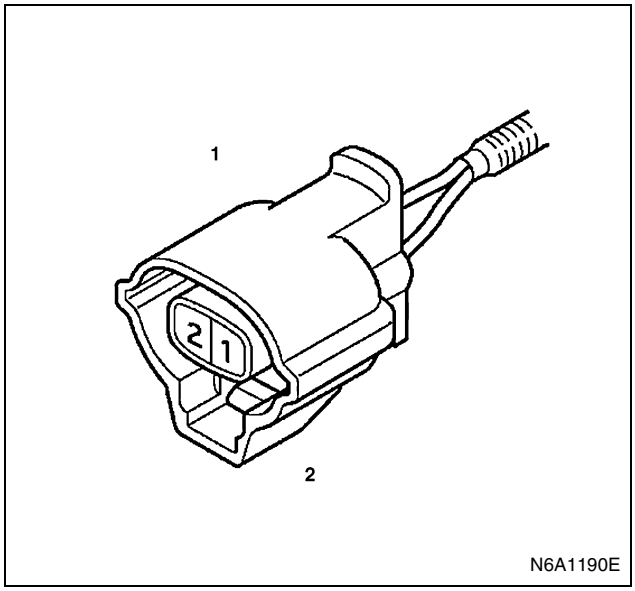


Appearance of Electronic Vacuum Regulating Valve (EVRV): Exhaust Gas Recirculation (EGR) Sensor and Connector Name

EVRV: EGR



EVRV: EGR Connector

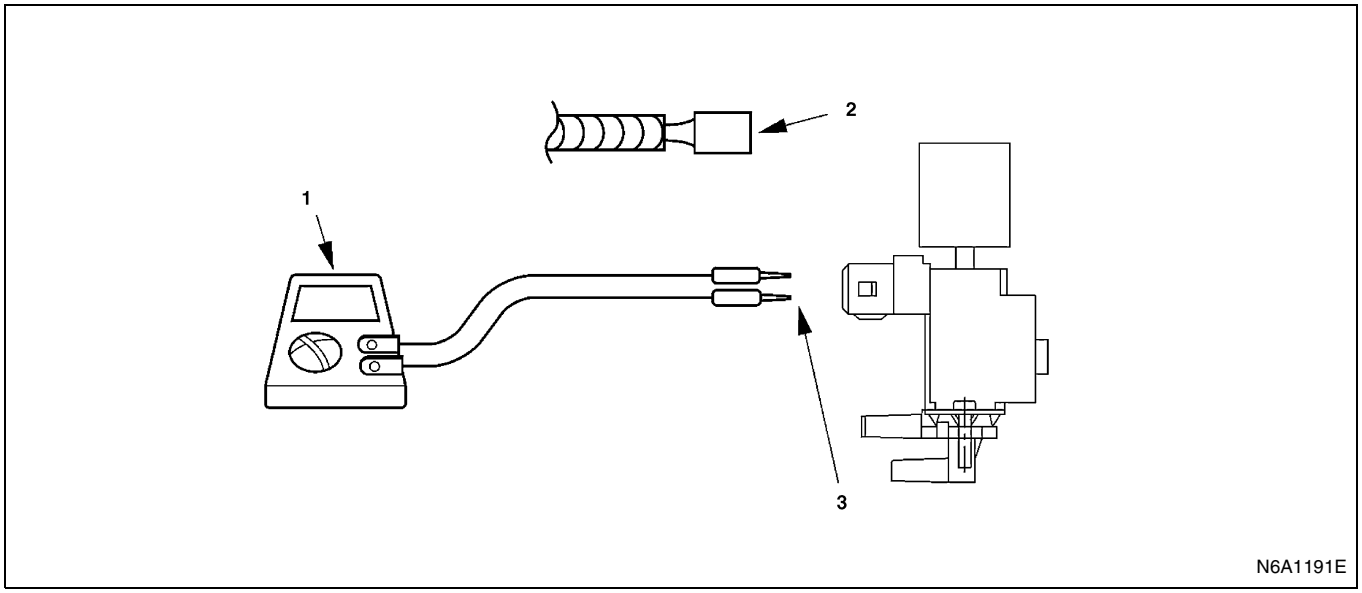


Legend

1. To EVRV: EGR
2. 2 pin

Connector No	Signal
1	GND
2	SIG

Measure Resistance at EVRV: EGR



Legend

1. Circuit tester
2. Remove EVRV wire harness
3. Measure resistance between connector pin

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

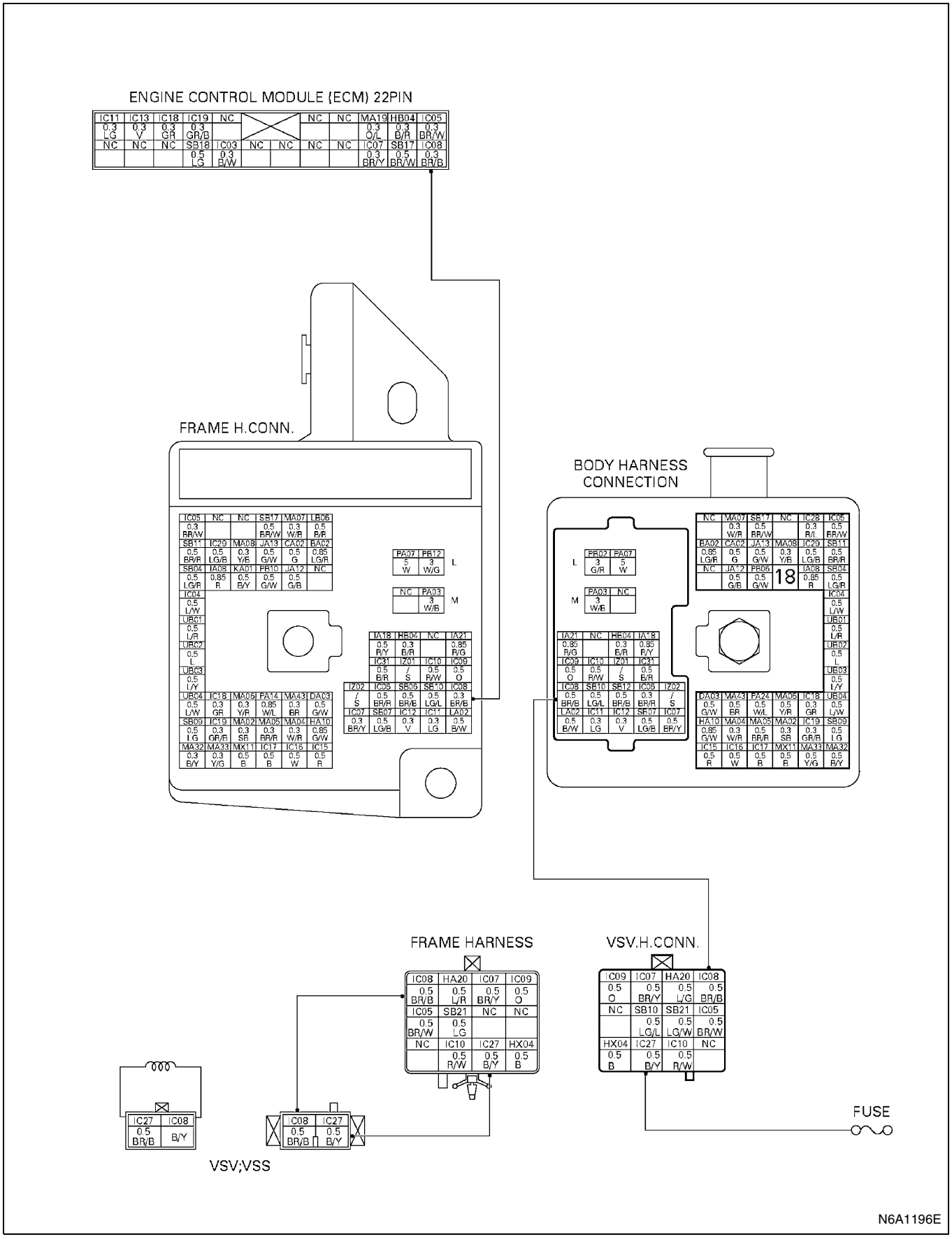
Resistance value

Inspection Point		Resistance Value (kΩ)	Reference
Connector	Pin No.		
2 pin Black	2 ←→ 1	12±1 (for 12 volt) 48±2 (for 24 volt)	SIG ←→ GND
	1 ←→ Body	∞	SIG ←→ Body

Notice:
Resistance value is difference according to the engine temperature (condition of engine warming up).

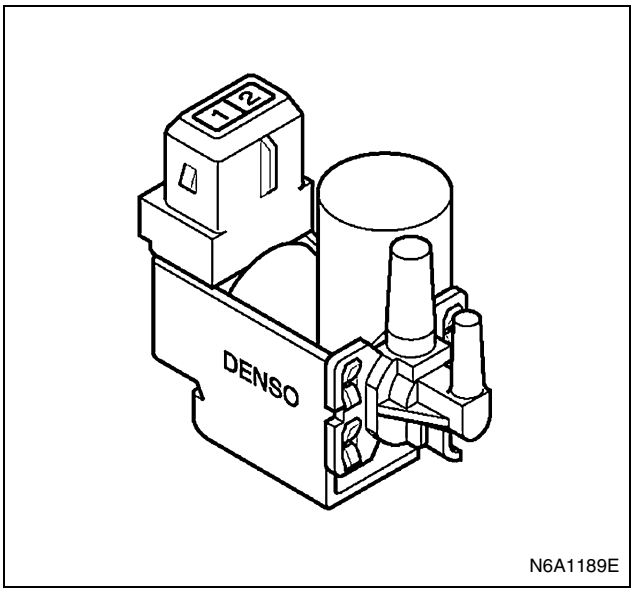
Step	Action	Value	YES	NO
1	Was the "on-board diagnostic (OBD) system check performed?	—	Go to Step 2	Go to self diag system check
2	1. Ignition "OFF" 2. Disconnect the EVRV from the wiring harness connector. 3. Check a short to voltage of the EVRV signal circuit and GND circuit between the EVRV connector and the ECM. 4. Repair if necessary. Has DTC32 been corrected?	—	Go to Step 5	Go to Step 3
3	1. Ignition "OFF" 2. Disconnect the ECM connector from ECM. 3. Check the short to voltage of EVRV circuit between the ECM and EVRV connector 4. Repair if necessary. Has DTC32 been corrected?	—	Go to Step 5	Go to Step 4
4	Replace the ECM. Is the action complete?		Go to Step 5	—
5	1. Reconnect all the connectors removed. 2. Ignition "ON", Engine "OFF" Is DTC32 all right under Scan Tool Check?	—	Go to Step 6	Go to Step 2
6	Is any current trouble other than DTC32 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P33 Variable Swirl System (VSS) Control Circuit Low Voltage

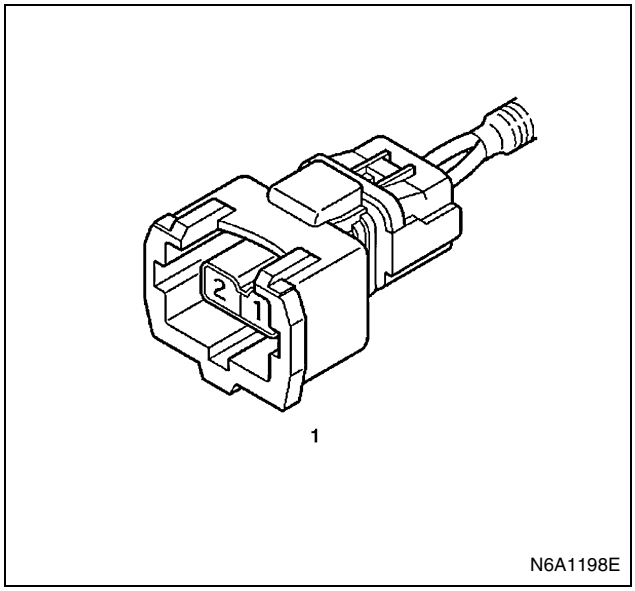


Appearance of VSV for VSS and Connector Name

VSV for VSS



VSV Connector

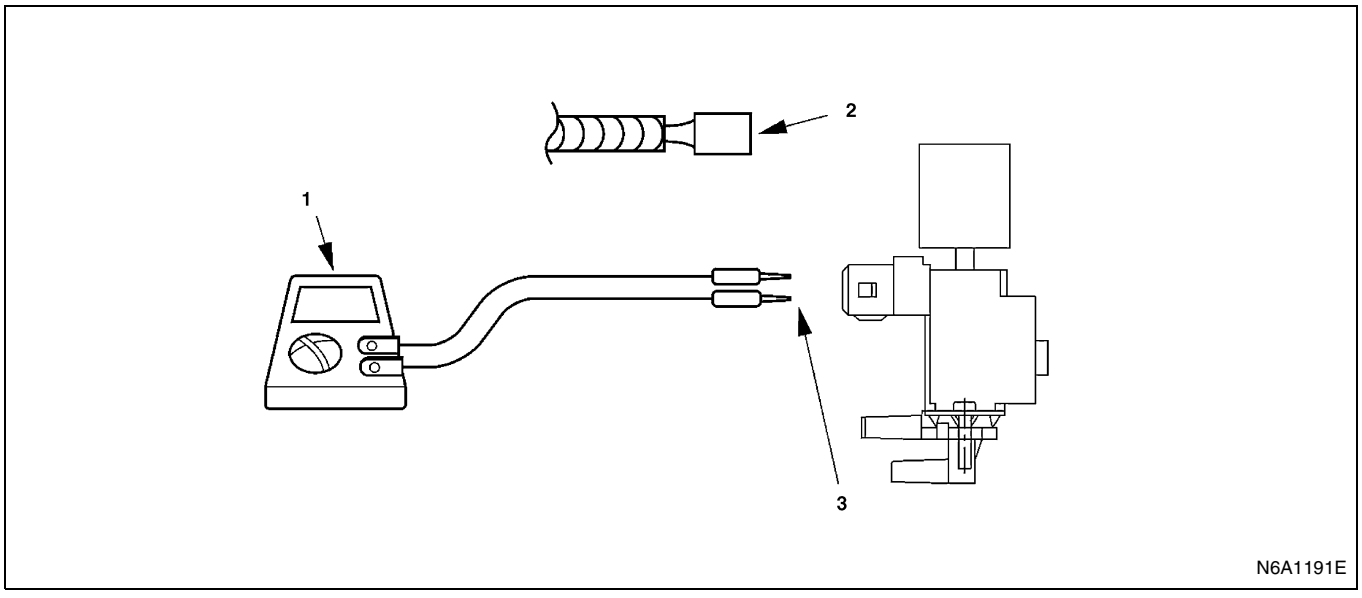


Legend

1. 2 pin

Connector No	Signal
1	SIG
2	GND

Measure Resistance at VSV for VSS



Legend

1. Circuit tester
2. Remove VSV wire harness
3. Measure resistance between connector pin

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

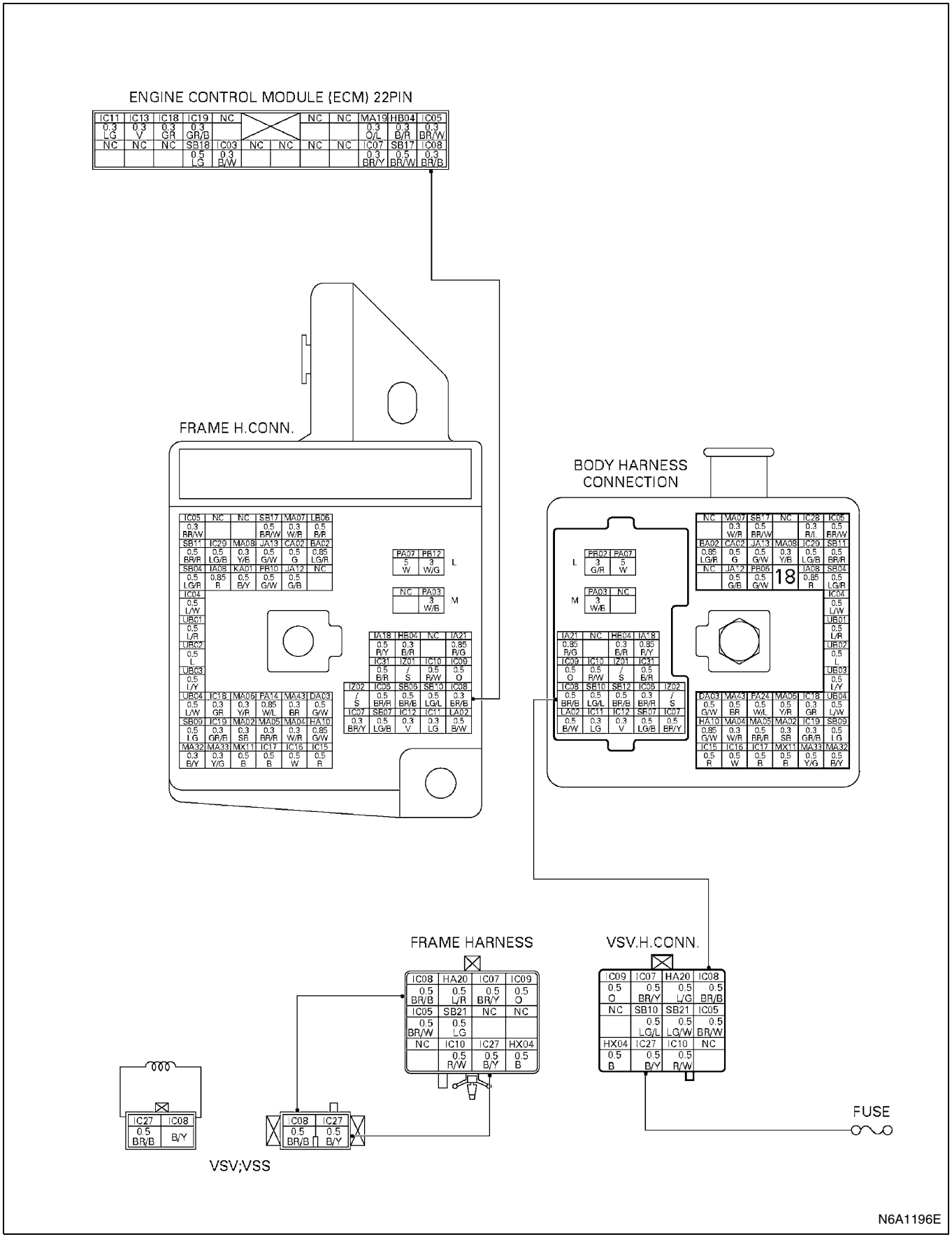
Resistance value

Inspection Point		Resistance Value (kΩ)	Reference
Connector	Pin No.		
2 pin Gray	2 ←→ 1	37 to 44 (for 12 volt) 159 to 169 (for 24 volt)	SIG ←→ GND
	1 ←→ Body	∞	SIG ←→ Body

Notice:
Resistance value is difference according to the engine temperature (condition of engine warming up).

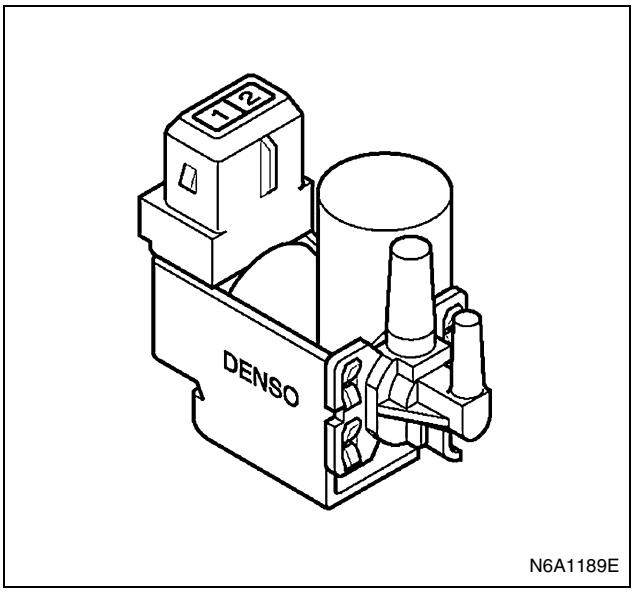
Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	1. Ignition “OFF” 2. Disconnect the VSV from the wiring harness connector. 3. Ignition “ON” Engine “OFF” 4. Using the Digital Voltmeter (DVM), check for voltage on the “IC27” of the VSV harness connector. Does the DVM read the following value?	12 Volt or 24 Volt	Go to Step 4	Go to Step 3
3	1. Check the suspect circuit between the VSV connector and “Engine Ignition.” Fuse for the following condition. • A short to ground • An open circuit 2. Repair if necessary. Has DTC 33 been corrected?	—	Go to Step 8	—
4	Using the DVM, check the resistance of the VSV. Does the DVM read the following Value?	37 — 44Ω (for 12 Volt) 159 — 169Ω (for 24 Volt)	Go to Step 5	Go to Step 6
5	1. Ignition “OFF” 2. Disconnect the ECM connector from ECM. 3. Check the VSV circuit between the ECU and VSV connector. • A short to ground • An open circuit 4. Repair if necessary. Has DTC 33 been corrected?	—	Go to Step 8	Go to Step 7
6	Replace the VSV. Is the action complete?	—	Go to Step 8	—
7	Replace the ECM. Is the action complete?	—	Go to Step 8	—
8	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC 33 all right under Scan Tool Check?	—	Go to Step 9	Go to Step 2
9	Is any current trouble other than DTC 33 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P34 Variable Swirl System (VSS) Control Circuit High Voltage

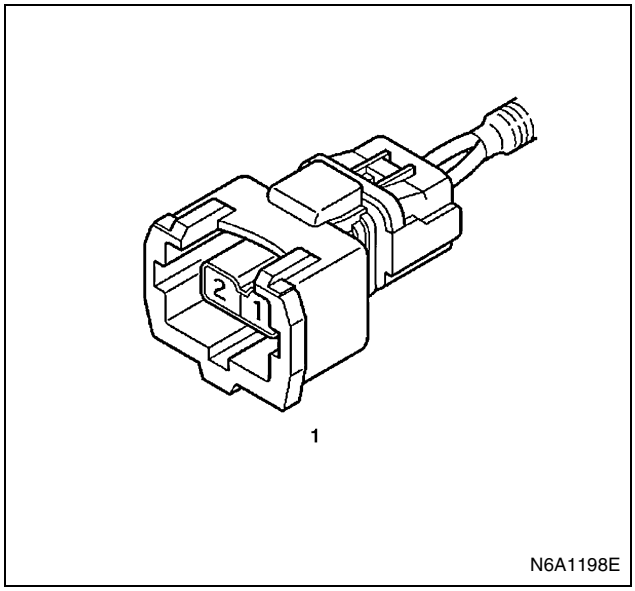


Appearance of VSV for VSS and Connector Name

VSV for VSS



VSV Connector

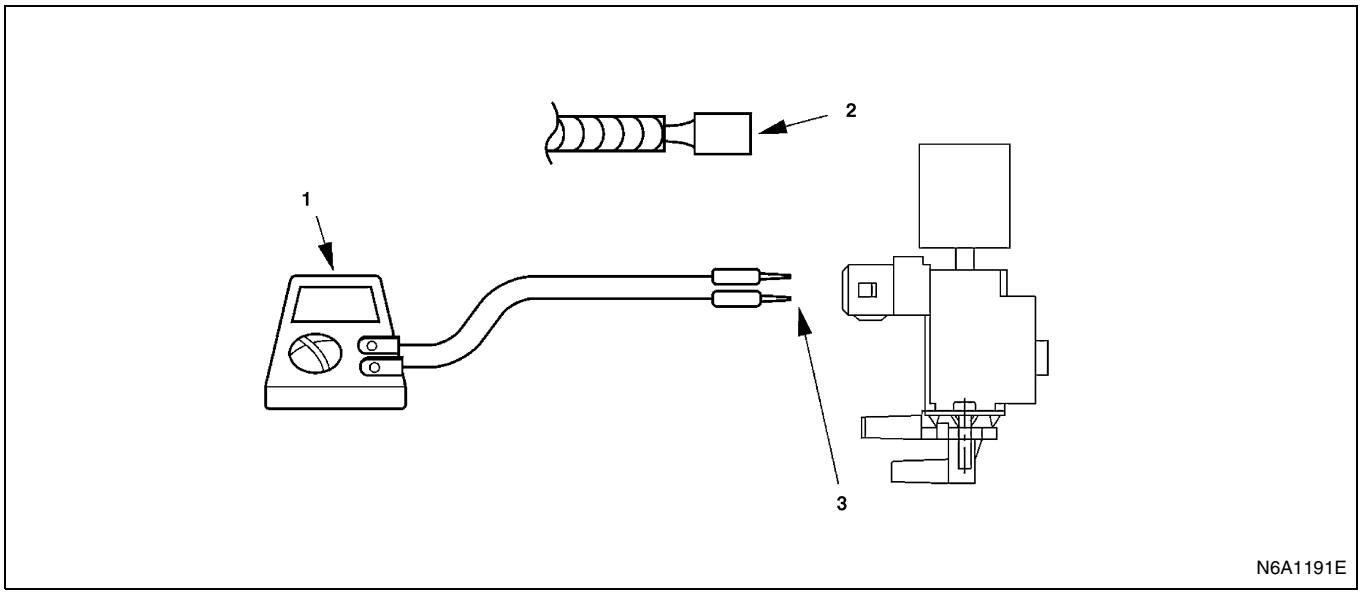


Legend

1. 2 pin

Connector No	Signal
1	SIG
2	GND

Measure Resistance at VSV for VSS



Legend

1. Circuit tester
2. Remove VSV wire harness
3. Measure resistance between connector pin

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

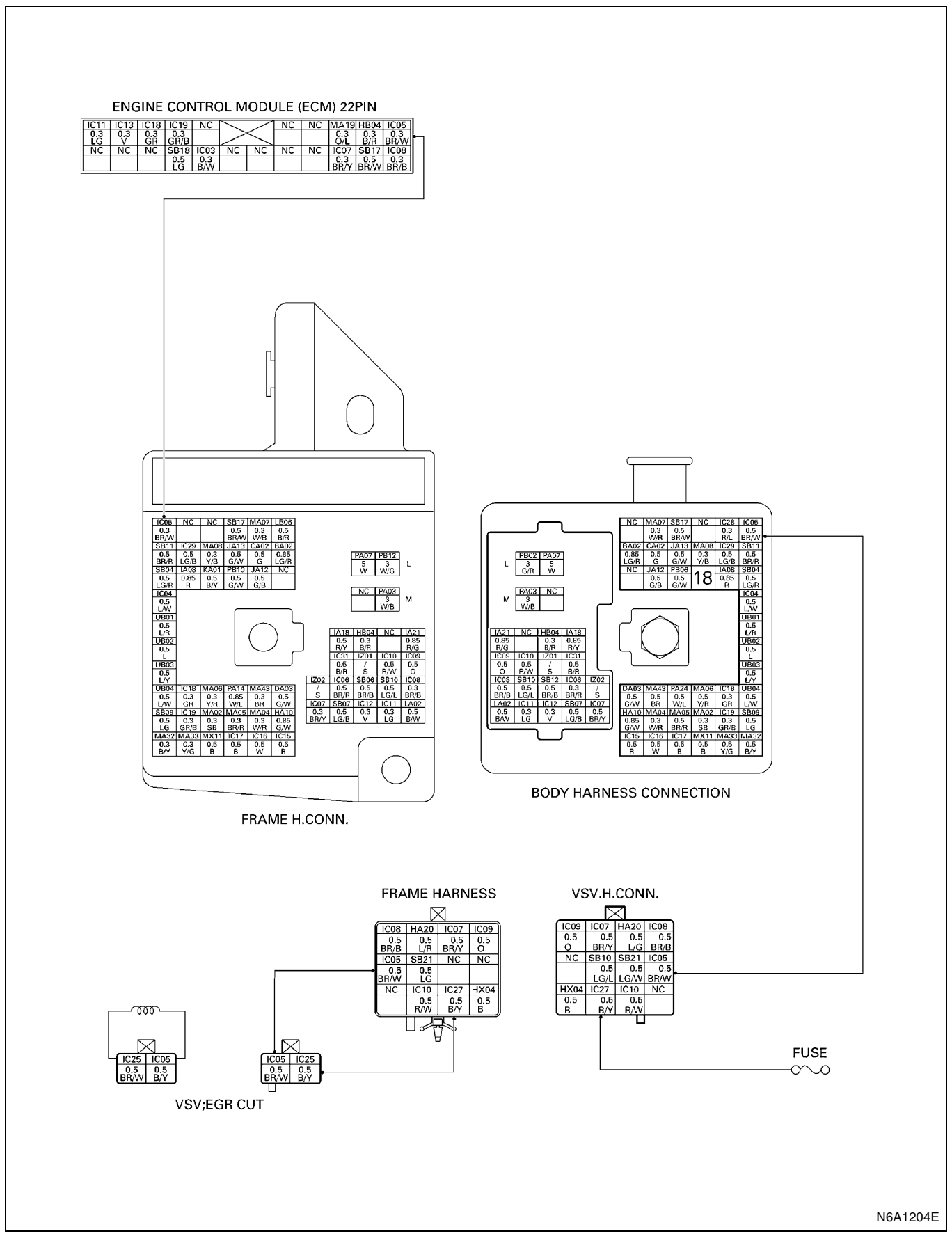
Resistance value

Inspection Point		Resistance Value (kΩ)	Reference
Connector	Pin No.		
2 pin Gray	2 ←→ 1	37 to 44 (for 12 volt) 159 to 169 (for 24 volt)	SIG ←→ GND
	1 ←→ Body	∞	SIG ←→ Body

Notice:
Resistance value is difference according to the engine temperature (condition of engine warming up).

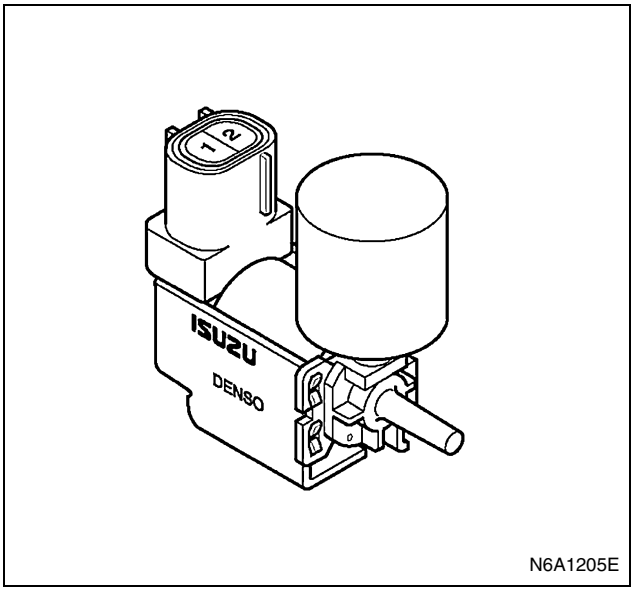
Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	Using the DVM, check the resistance of the VSV. Does the DVM read the following Value?	37 — 44Ω (for 12 Volt) 159 — 169Ω (for 24 Volt)	Go to Step 3	Go to Step 4
3	1. Ignition “OFF” 2. Disconnect the ECM connector from ECM. 3. Check the short to voltage of VSV circuit between the ECM and VSV connector 4. Repair if necessary. Has DTC 34 been corrected?	—	Go to Step 6	Go to Step 5
4	Replace the VSV. Is the action complete?	—	Go to Step 6	—
5	Replace the ECM. Is the action complete?	—	Go to Step 6	—
6	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC 34 all right under Scan Tool Check?	—	Go to Step 7	Go to Step 2
7	Is any current trouble other than DTC 34 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P35 Exhaust Gas Recirculation (EGR) Quick Cut Vacuum Switching Valve (VSV) Control Circuit Low Voltage

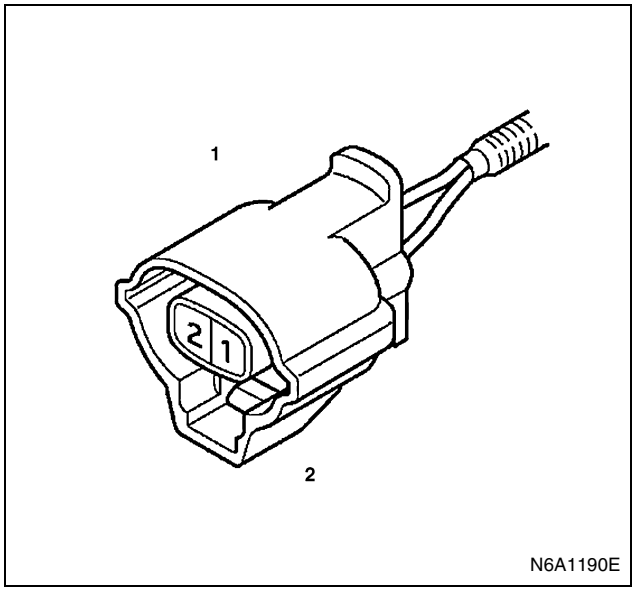


Appearance of Vacuum Switching Valve (VSV): Exhaust Gas Recirculation (EGR) CUT and Connector Name

VSV: EGR CUT



VSV: EGR CUT Connector

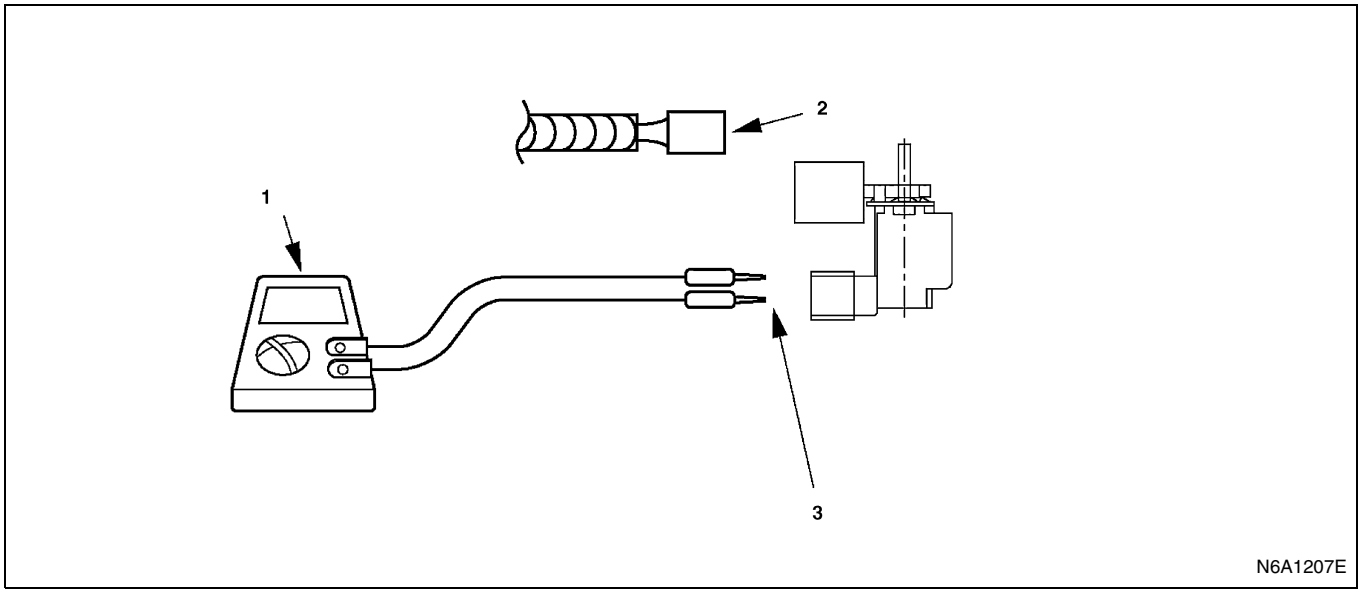


Legend

1. To VSV: EGR
2. 2 pin

Connector No	Signal
1	SIG
2	GND

Measure Resistance at VSV: EGR CUT



Legend

1. Circuit tester
2. Remove VSV wire harness
3. Measure resistance between connector pin

Caution:
When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

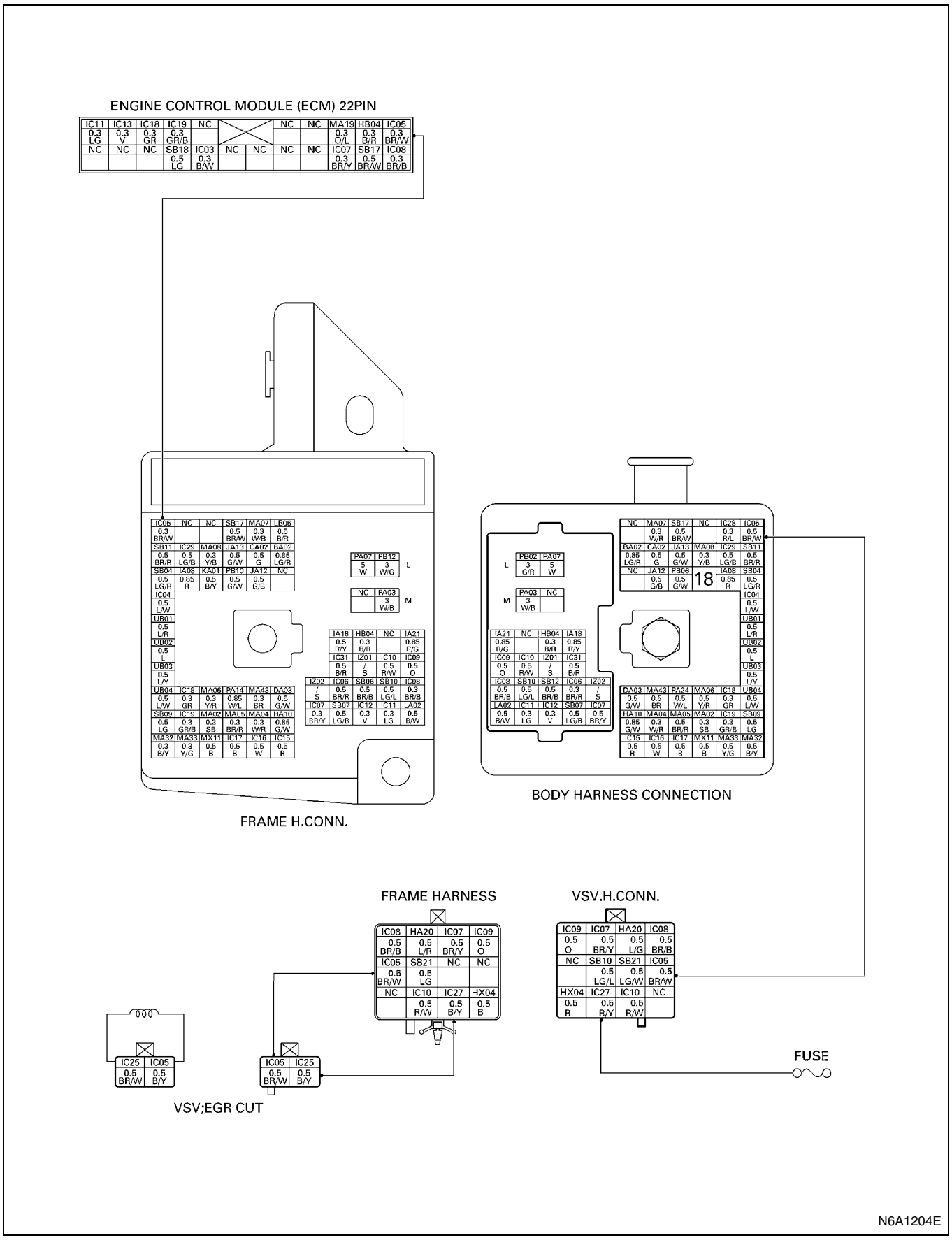
Resistance value

Inspection Point		Resistance Value (kΩ)	Reference
Connector	Pin No.		
2 pin Black	2 ←→ 1	37 to 44 (for 12 volt) 159 to 169 (for 24 volt)	SIG ←→ GND
	1 ←→ Body	∞	SIG ←→ Body

Notice:
Resistance value is difference according to the engine temperature (condition of engine warming up).

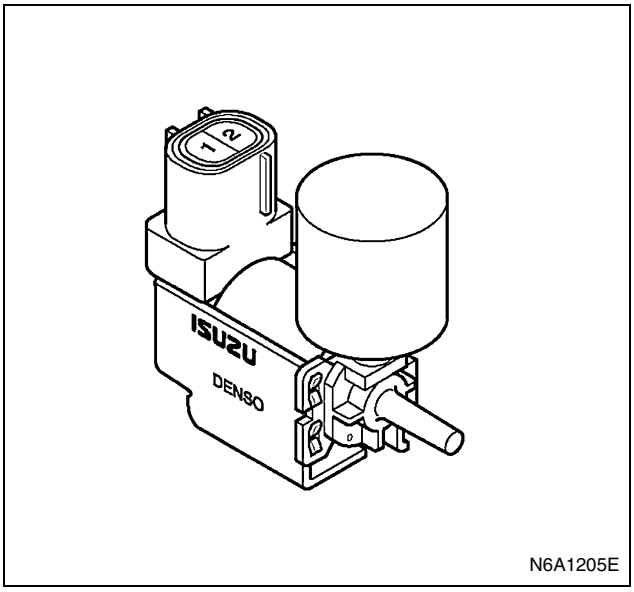
Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	1. Ignition “OFF” 2. Disconnect the VSV from the wiring harness connector. 3. Ignition “ON” Engine “OFF” 4. Using the Digital Voltmeter (DVM), check for voltage on the “IC25” of the VSV harness connector. Does the DVM read the following value?	12 Volt or 24 Volt	Go to Step 4	Go to Step 3
3	1. Check the suspect circuit between the VSV connector and “Engine Ignition.” Fuse for the following condition. • A short to ground • An open circuit 2. Repair if necessary. Has DTC 35 been corrected?	—	Go to Step 8	—
4	Using the DVM, check the resistance of the VSV. Does the DVM read the following Value?	37 — 44Ω (for 12 Volt) 159 — 169Ω (for 24 Volt)	Go to Step 5	Go to Step 6
5	1. Ignition “OFF” 2. Disconnect the ECM connector from ECM. 3. Check the VSV circuit between the ECM and VSV connector. • A short to ground • An open circuit 4. Repair if necessary. Has DTC 35 been corrected?	—	Go to Step 8	Go to Step 7
6	Replace the VSV. Is the action complete?		Go to Step 8	—
7	Replace the ECM. Is the action complete?	—	Go to Step 8	—
8	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC 35 all right under Scan Tool Check?	—	Go to Step 9	Go to Step 2
9	Is any current trouble other than DTC 35 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P36 Exhaust Gas Recirculation (EGR) Quick Cut Vacuum Switching Valve (VSV) Control Circuit High Voltage

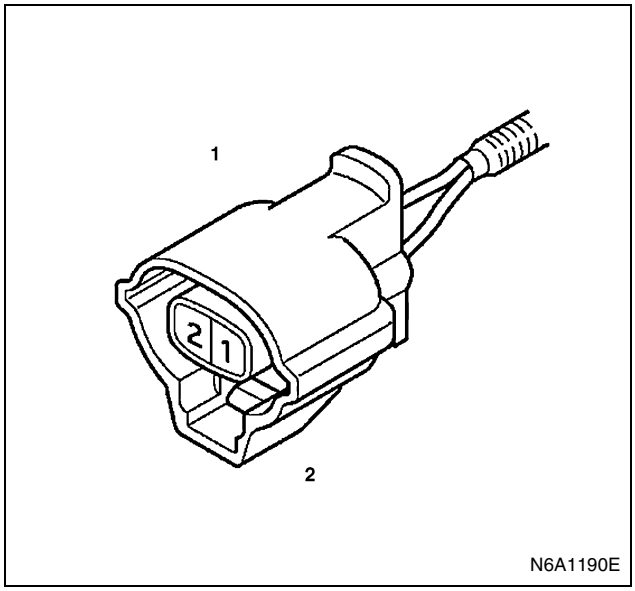


Appearance of Vacuum Switching Valve (VSV): Exhaust Gas Recirculation (EGR) CUT Sensor and Connector Name

VSV: EGR CUT



VSV: EGR CUT Connector

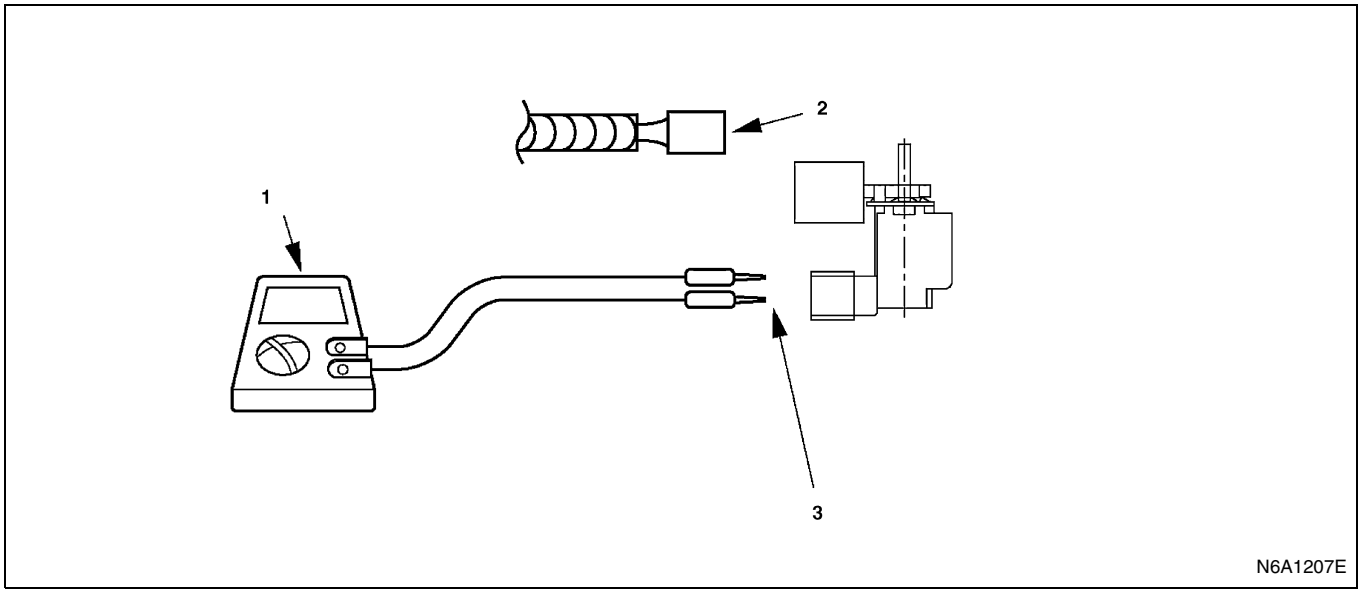


Legend

1. To VSV: EGR
2. 2 pin

Connector No	Signal
1	SIG
2	GND

Measure Resistance at VSV: EGR CUT



Legend

1. Circuit tester
2. Remove VSV wire harness
3. Measure resistance between connector pin

Caution:
When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

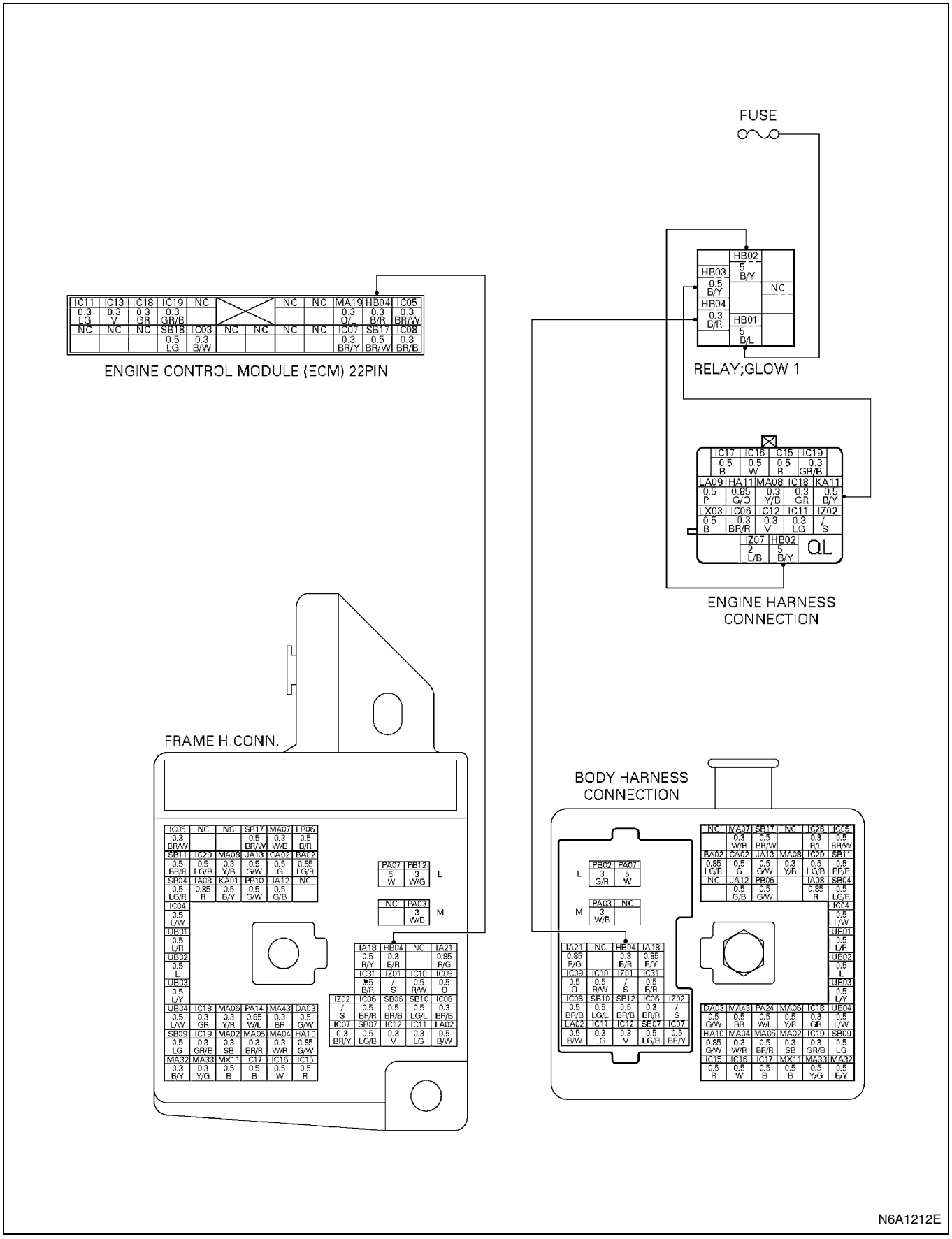
Resistance value

Inspection Point		Resistance Value (kΩ)	Reference
Connector	Pin No.		
2 pin Black	2 ←→ 1	37 to 44 (for 12 volt) 159 to 169 (for 24 volt)	SIG ←→ GND
	1 ←→ Body	∞	SIG ←→ Body

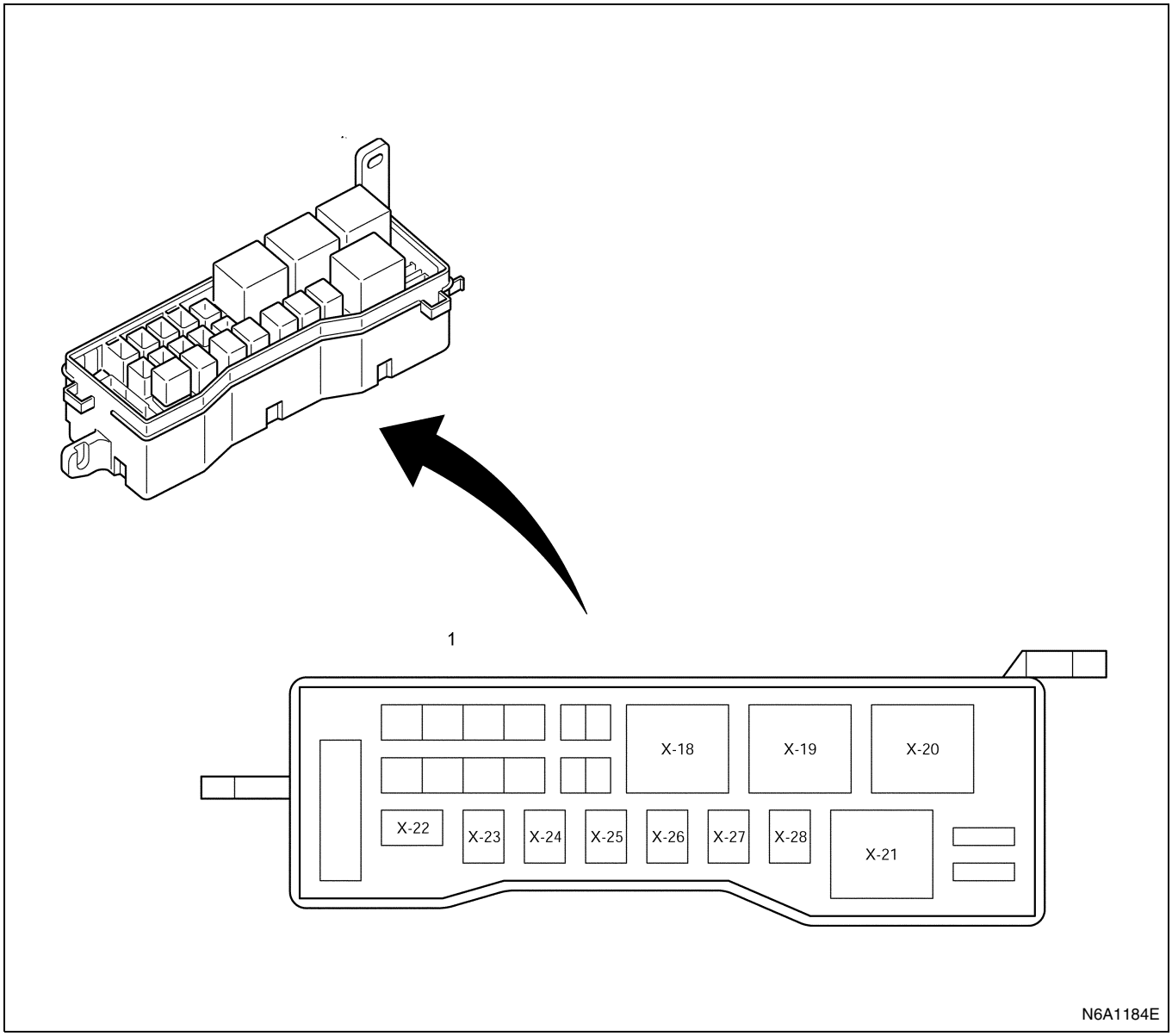
Notice:
Resistance value is difference according to the engine temperature (condition of engine warming up).

Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	Using the DVM, check the resistance of the VSV. Does the DVM read the following Value?	37 — 44Ω (for 12 Volt) 159 — 169Ω (for 24 Volt)	Go to Step 3	Go to Step 4
3	1. Ignition “OFF” 2. Disconnect the ECM connector from ECM. 3. Check the short to voltage of VSV circuit between the ECM and VSV connector. 4. Repair if necessary. Has DTC 36 been corrected?	—	Go to Step 6	Go to Step 5
4	Replace the VSV. Is the action complete?	—	Go to Step 6	—
5	Replace the ECM. Is the action complete?	—	Go to Step 6	—
6	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC 36 all right under Scan Tool Check?	—	Go to Step 7	Go to Step 2
7	Is any current trouble other than DTC 36 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P41 Quick On Start (QOS) Relay Control Circuit Low Voltage



Location of Relay

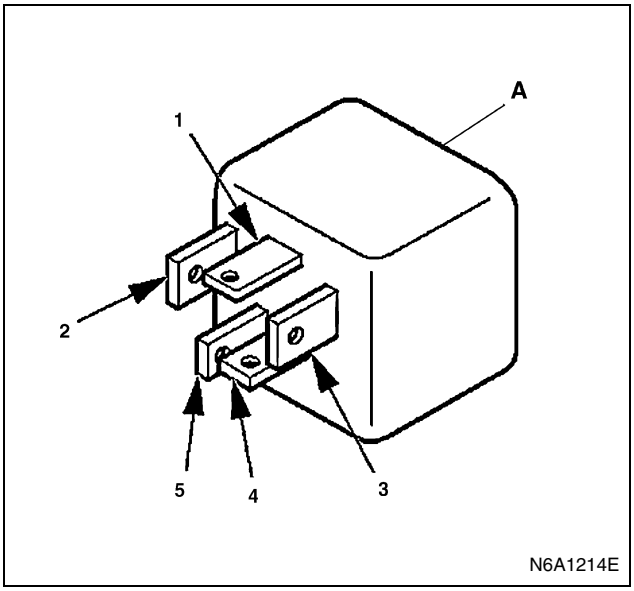


Legend

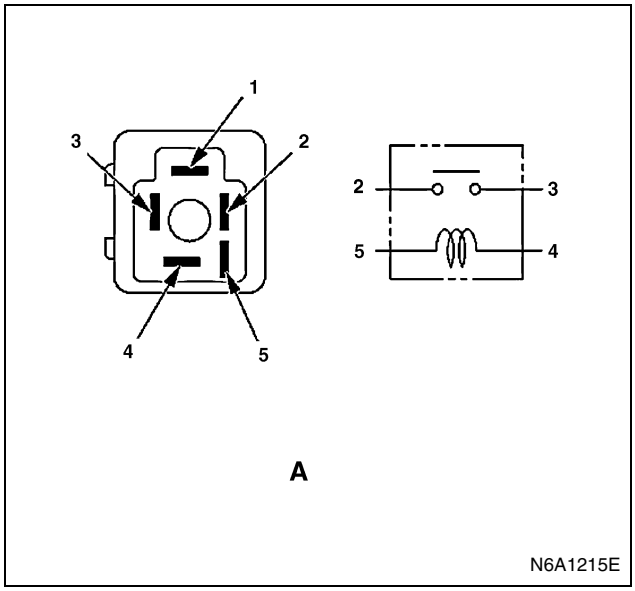
1. Relay box (Installed on the left side rear of the cab)

NO	RELAY NAME
X-20	Glow plug
X-21	Starter
X-22	Marker lamp
X-23	Rear fog
X-24	A/C COMP, 4WD ind. lamp
X-25	Exh, Brake control
X-26	CSD, A/C ON SIGNAL
X-27	Condenser fan
X-28	Exh. Brake cut

Inspection for quick on start (QOS) power cut relay



Legend
A. QOS relay



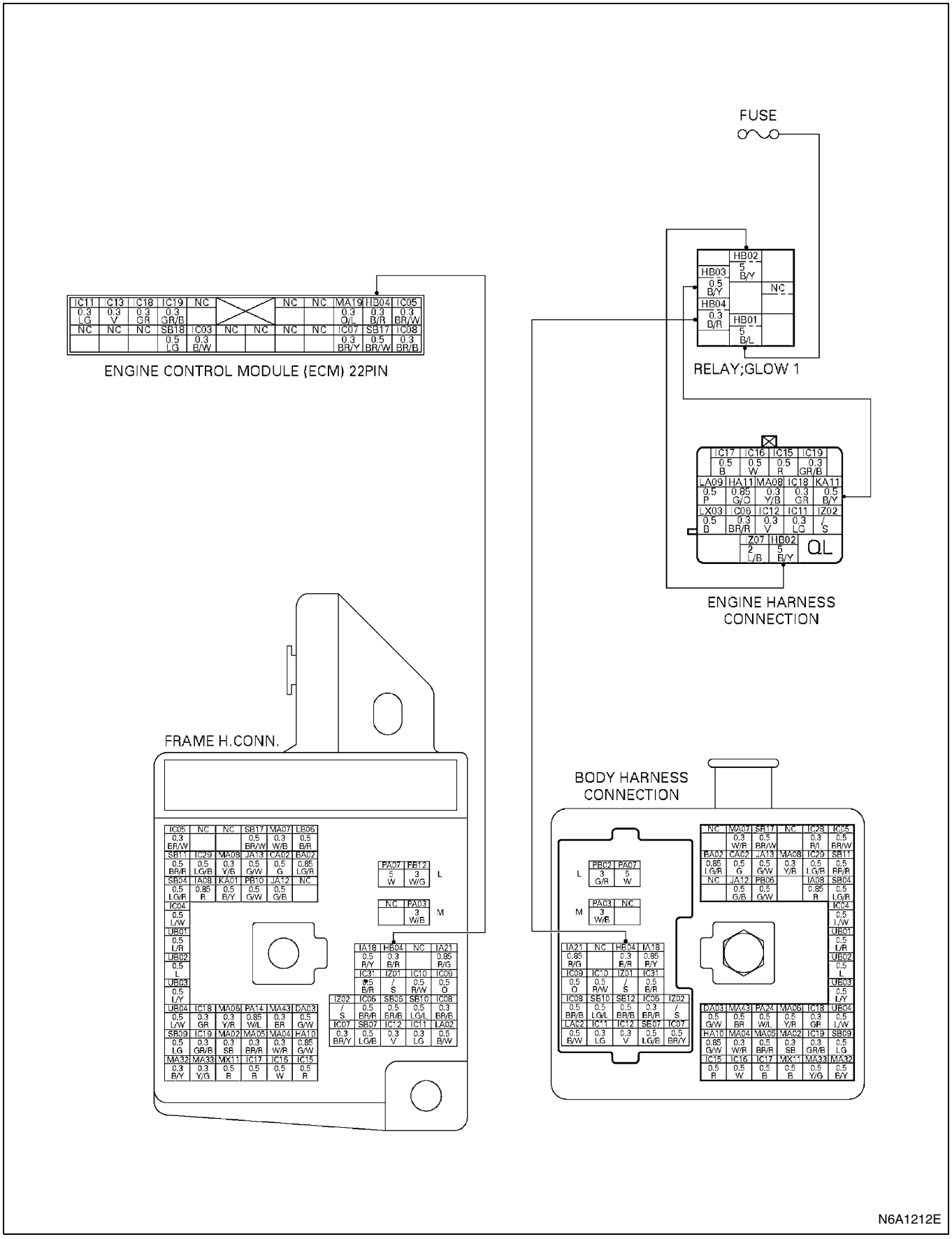
Legend
A. QOS relay

Resistance value

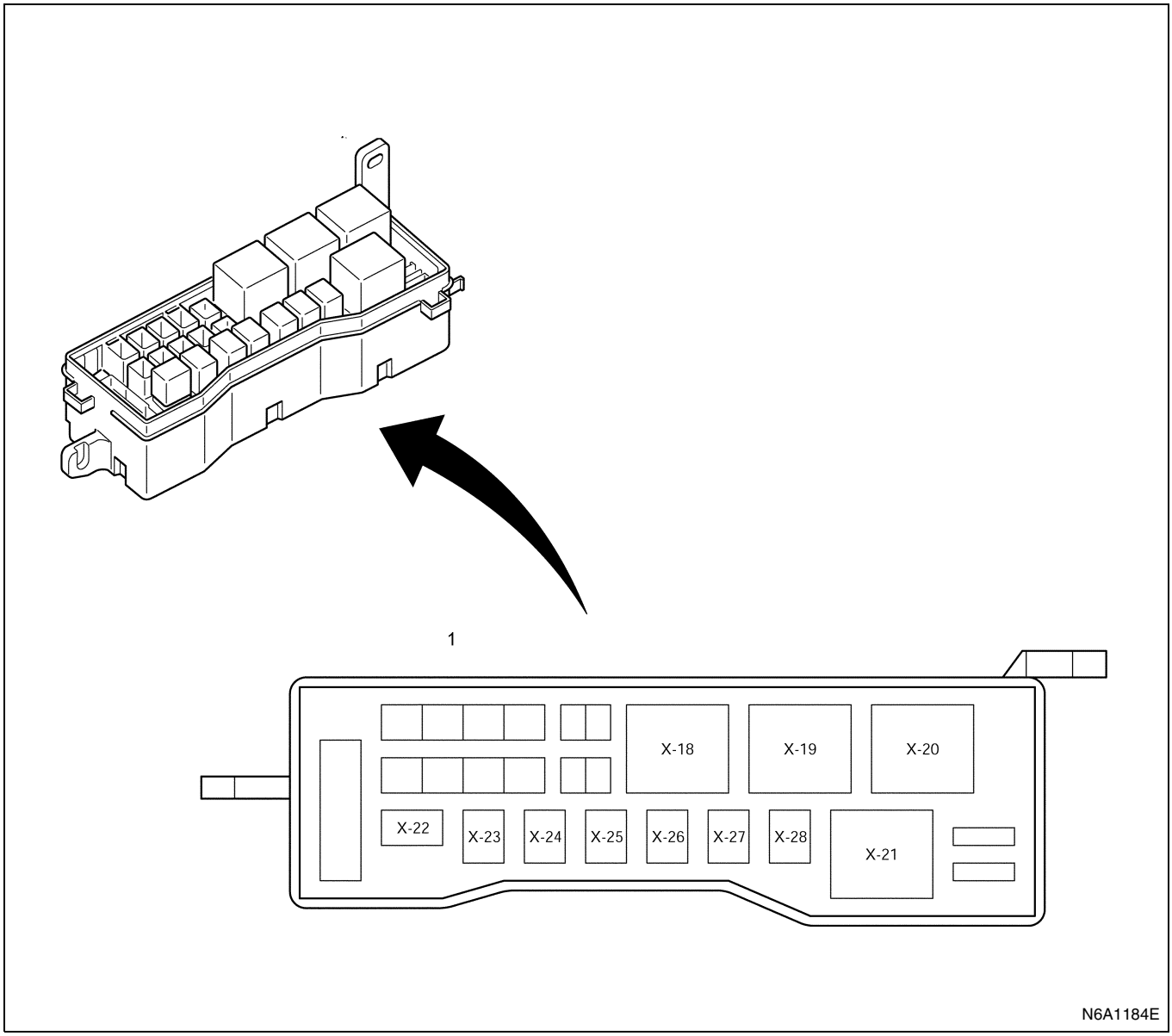
Inspection Point		Resistance	Reference
Inspection relay unit	4 ⟷ 5	23 (Ω) (for 12 volt) 100 (Ω) (for 24 volt)	
	2 ⟷ 3	∞	Not be supplied electricity to coil
		Below 0.5 (Ω)	Be supplied electricity to coil

Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	1. Ignition “OFF” 2. Disconnect the Relay from the Relay box connector. 3. Ignition “ON” Engine “OFF” 4. Using the Digital Voltmeter (DVM), check for voltage on the “HBOL” terminal of the Relay Box Connector. Does the DVM read the following value?	12 Volt or 24 Volt	Go to Step 4	Go to Step 3
3	1. Check the suspect circuit between the Relay connector. Fuse for the following condition. • A short to ground • An open circuit 2. Repair if necessary. Has DTC 41 been corrected?	—	Go to Step 8	Go to Step 4
4	Using the DVM, check the resistance of inter “4” “5” Relay terminal. Does the DVM read the following Value?	23Ω (for 12 Volt) 100Ω (for 24 Volt)	Go to Step 5	Go to Step 6
5	1. Ignition “OFF” 2. Disconnect the ECM connector from ECM. 3. Check the VSV circuit between the ECU and Relay connector. • A short to ground • An open circuit 4. Repair if necessary. Has DTC 41 been corrected?	—	Go to Step 8	Go to Step 7
6	Replace the Relay. Is the action complete?	—	Go to Step 8	—
7	Replace the ECM. Is the action complete?	—	Go to Step 8	—
8	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC 41 all right under Scan Tool Check?	—	Go to Step 9	Go to Step 2
9	Is any current trouble other than DTC 41 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P42 Quick On Start (QOS) Relay Control Circuit High Voltage



Location of Relay

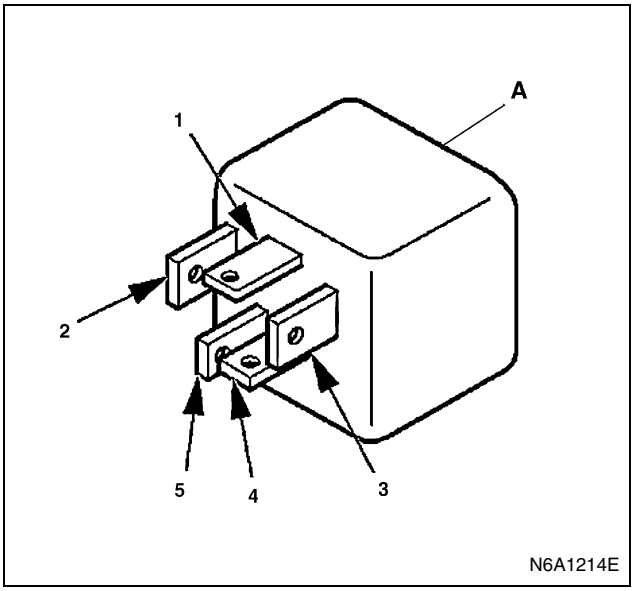


Legend

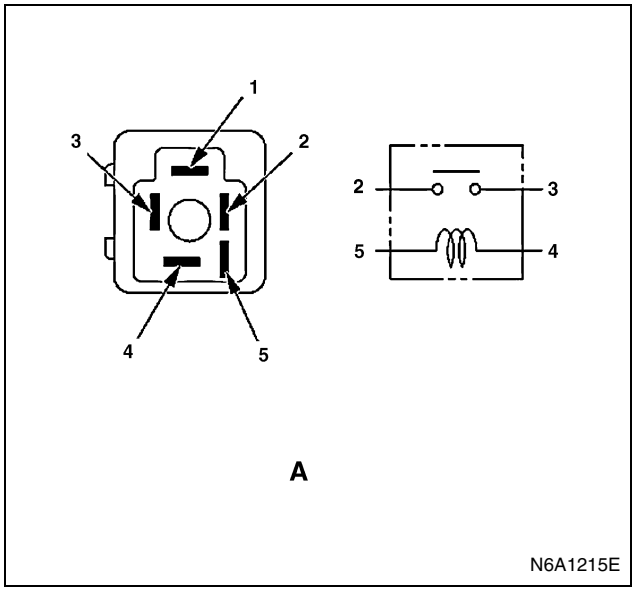
1. Relay box (Installed on the left side rear of the cab)

NO	RELAY NAME
X-20	Glow plug
X-21	Starter
X-22	Marker lamp
X-23	Rear fog
X-24	A/C COMP, 4WD ind. lamp
X-25	Exh, Brake control
X-26	CSD, A/C ON SIGNAL
X-27	Condenser fan
X-28	Exh. Brake cut

Inspection for quick on start (QOS) power cut relay



Legend
A. QOS relay



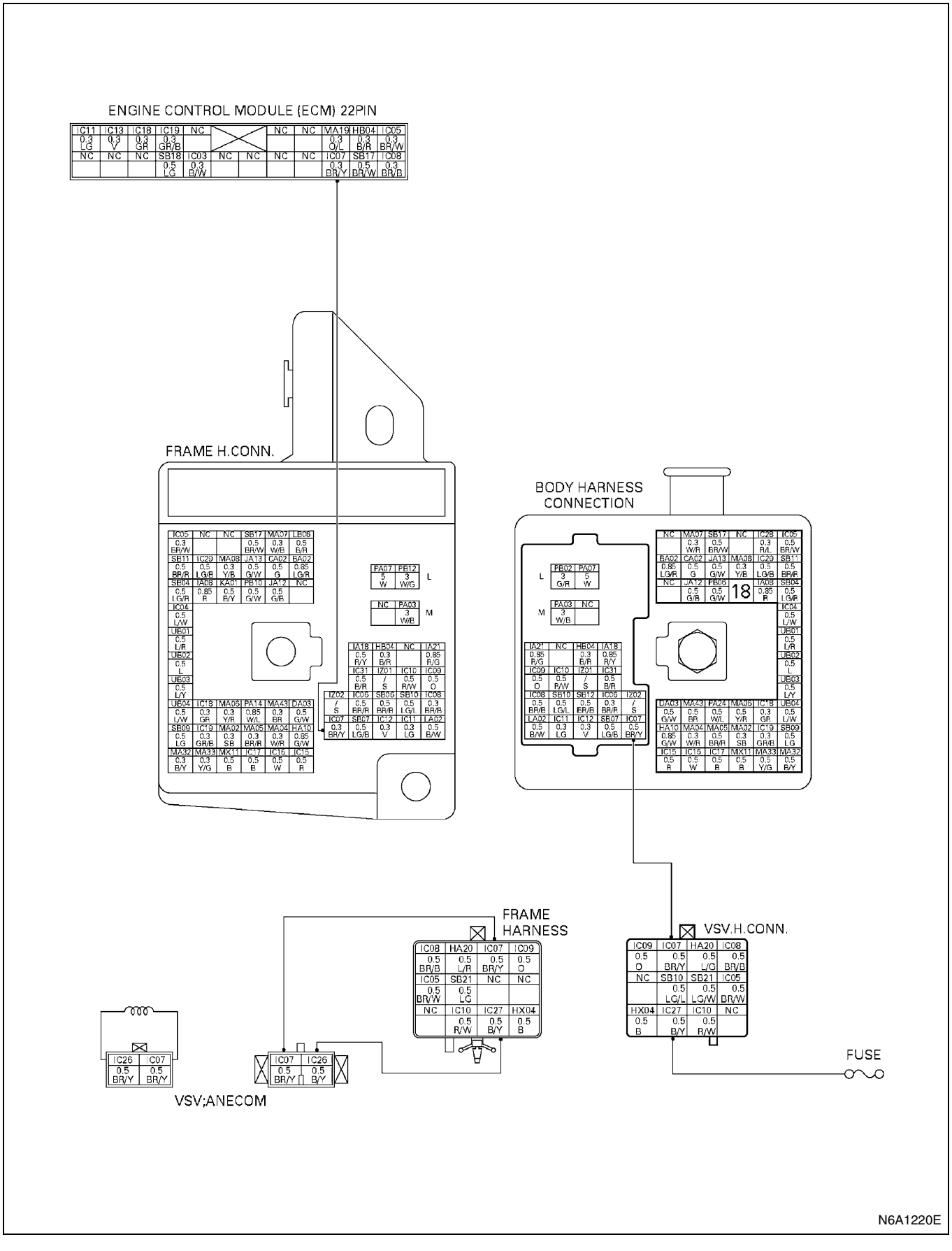
Legend
A. QOS relay

Resistance value

Inspection Point		Resistance	Reference
Inspection relay unit	4 ⟷ 5	23 (Ω) (for 12 volt) 100 (Ω) (for 24 volt)	
	2 ⟷ 3	∞	Not be supplied electricity to coil
		Below 0.5 (Ω)	Be supplied electricity to coil

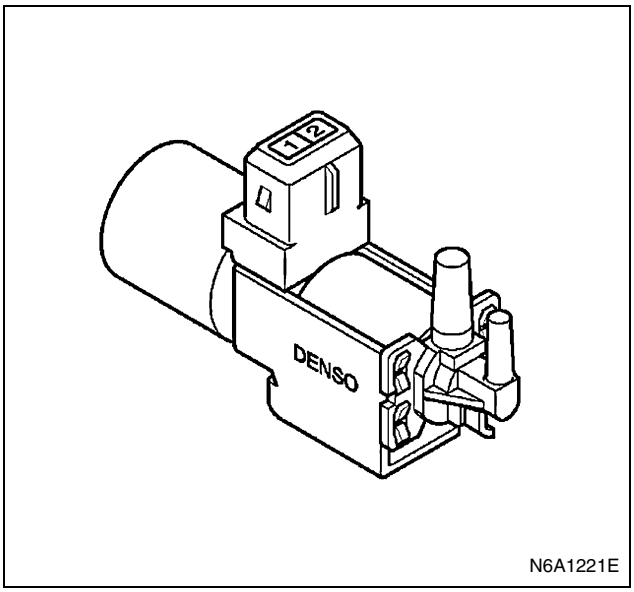
Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	1. Ignition “OFF”, with scan tool disconnected. 2. Disconnect the Relay solenoid switch from the Relay box. 3. Apply a circuit tester with the voltage range or a test light to the output circuit for the Relay. 4. Ignition “ON”, Engine “OFF”. Is voltage as prescribed, or is test Light lit until 18 seconds?	≥8V or light “ON” (for 12 Volt) ≥16V or light “ON” (for 24 Volt)	Go to Step 3	Go to Step 4
3	1. Ignition “OFF” 2. Disconnect the ECM connector from ECM. 3. Check the short to voltage of Relay circuit between the ECM and Relay connector. 4. Repair if necessary. Has DTC 42 been corrected?	—	Go to Step 6	Go to Step 5
4	Replace the VSV. Is the action complete?	—	Go to Step 6	—
5	Replace the ECM. Is the action complete?	—	Go to Step 6	—
6	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC 42 all right under Scan Tool Check?	—	Go to Step 7	Go to Step 2
7	Is any current trouble other than DTC 42 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P43 Aneroid Compensator Vacuum Switching Valve (VSV) Control Circuit Low Voltage



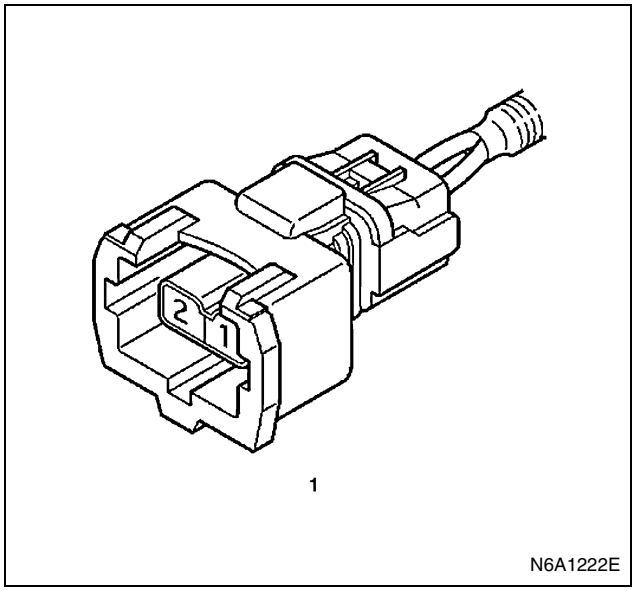
Appearance of Vacuum Switching Valve (VSV): Aneroid Compensator and Connector Name

VSV: Aneroid Compensator



N6A1221E

VSV: Aneroid Compensator



1

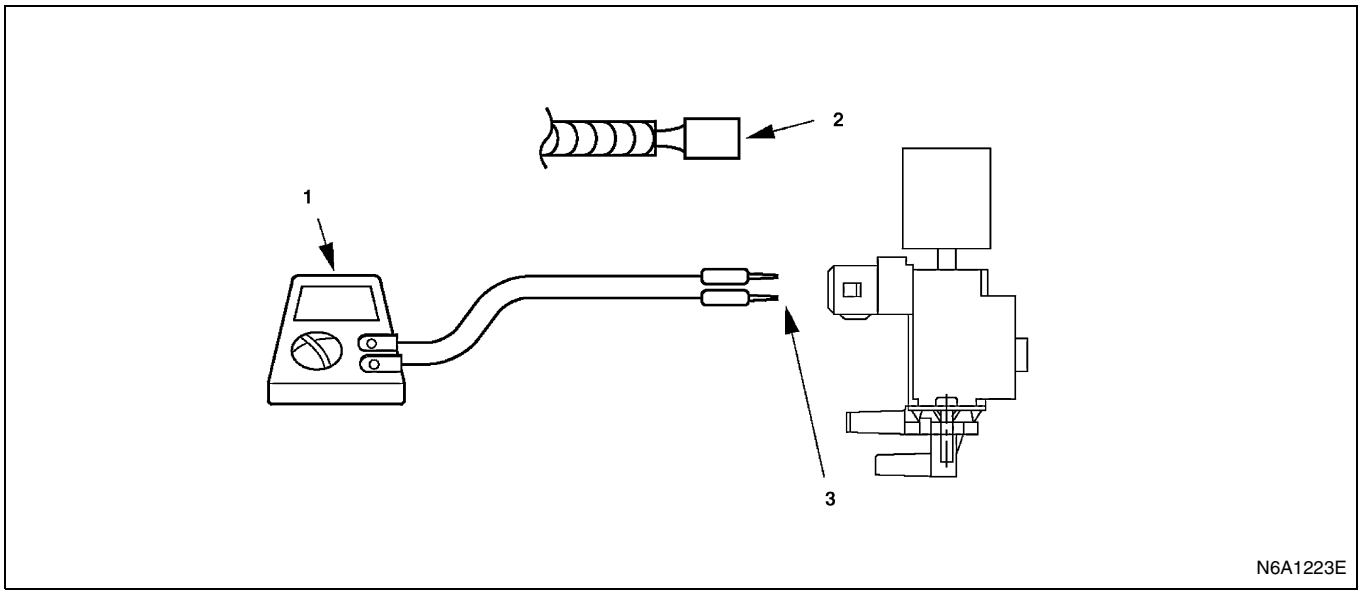
N6A1222E

Legend

1. 2 pin

Connector No	Signal
1	SIG
2	GND

Measure Resistance at VSV Aneroid Compensator



N6A1223E

Legend

1. Circuit tester
2. Remove VSV wire harness
3. Measure resistance between connector pin

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

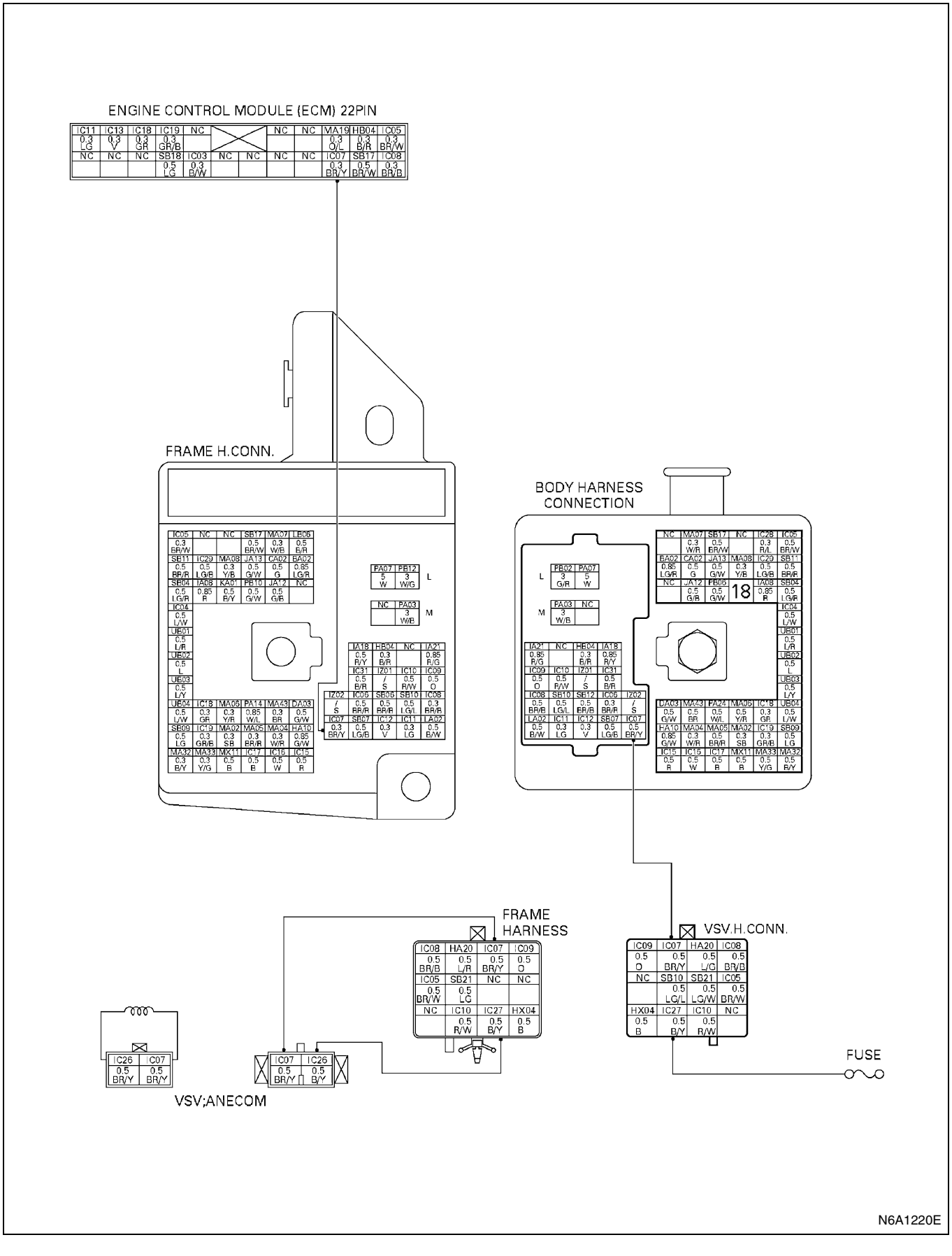
Resistance value

Inspection Point		Resistance Value (kΩ)	Reference
Connector	Pin No.		
2 pin Gray	2 ←→ 1	37 to 44 (for 12 volt) 159 to 169 (for 24 volt)	SIG ←→ GND
	1 ←→ Body	∞	SIG ←→ Body

Notice:
Resistance value is difference according to the engine temperature (condition of engine warming up).

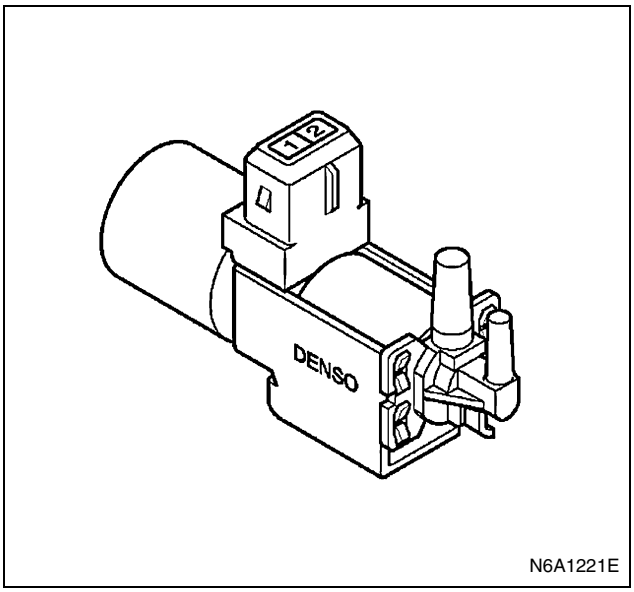
Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	1. Ignition “OFF” 2. Disconnect the VSV from the wiring harness connector. 3. Ignition “ON” Engine “OFF” 4. Using the Digital Voltmeter (DVM), check for voltage on the “IC26” of the VSV harness connector. Does the DVM read the following value?	12 Volt or 24 Volt	Go to Step 4	Go to Step 3
3	1. Check the suspect circuit between the VSV connector and “Engine Ignition.” Fuse for the following condition. • A short to ground • An open circuit 2. Repair if necessary. Has DTC 43 been corrected?	—	Go to Step 8	Go to Step 4
4	Using the DVM, check the resistance of the VSV. Does the DVM read the following Value?	37 — 44Ω (for 12 Volt) 159 — 169Ω (for 24 Volt)	Go to Step 5	Go to Step 6
5	1. Ignition “OFF” 2. Disconnect the ECM connector from ECM. 3. Check the VSV circuit between the ECM and VSV connector. • A short to ground • An open circuit 4. Repair if necessary. Has DTC 43 been corrected?	—	Go to Step 8	Go to Step 7
6	Replace the VSV. Is the action complete?	—	Go to Step 8	—
7	Replace the ECM. Is the action complete?	—	Go to Step 9	—
8	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC 43 all right under Scan Tool Check?	—	Go to Step 9	Go to Step 2
9	Is any current trouble other than DTC 43 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P44 Aneroid Compensator Vacuum Switching Valve (VSV) Control Circuit High Voltage



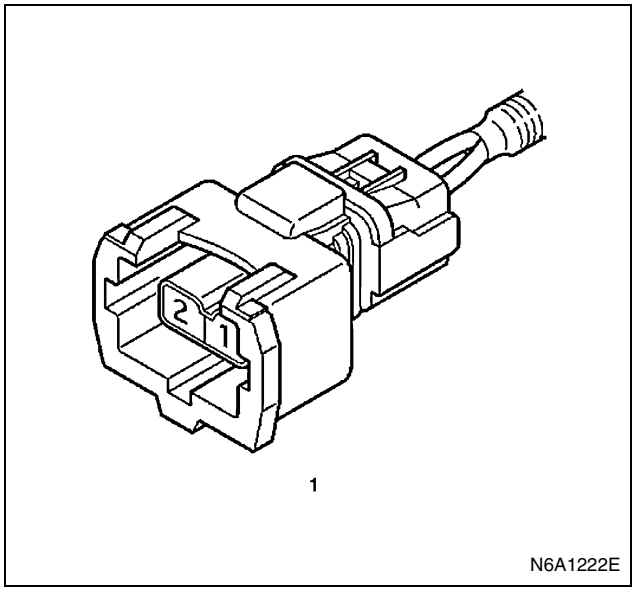
Appearance of Vacuum Switching Valve (VSV): Ameroid Compensator and Connector Name

VSV: Aneroid Compensator



N6A1221E

VSV: Aneroid Compensator



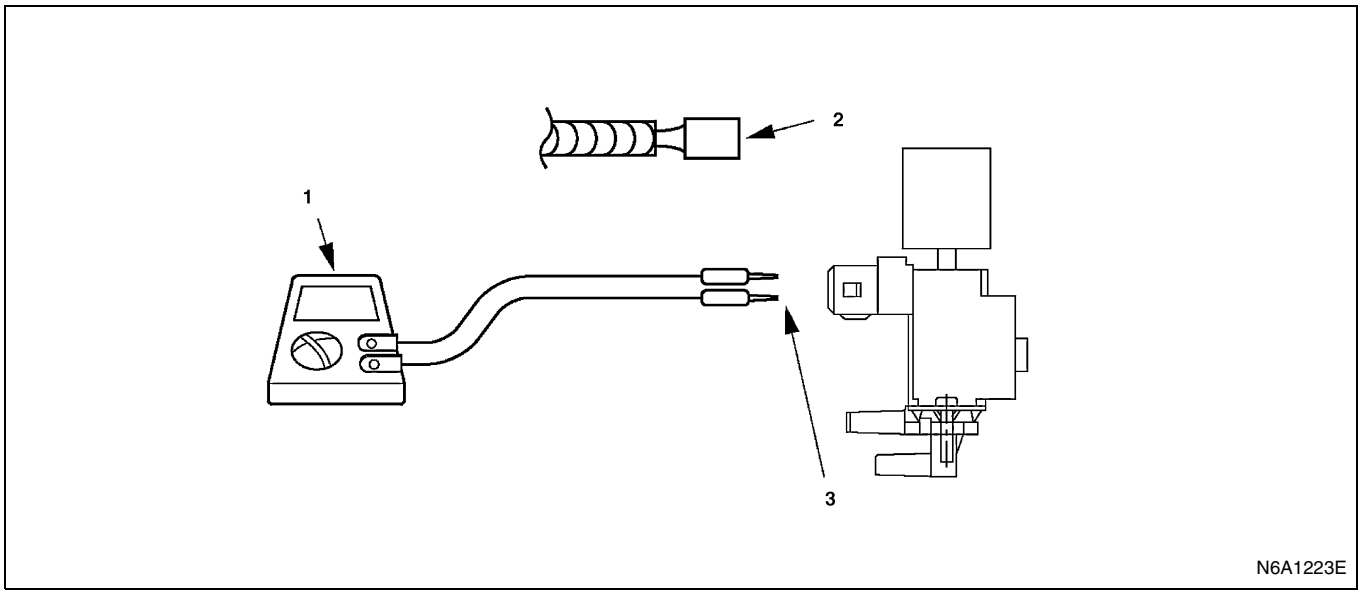
N6A1222E

Legend

1. 2 pin

Connector No	Signal
1	SIG
2	GND

Measure Resistance at VSV Aneroid Compensator



N6A1223E

Legend

1. Circuit tester
2. Remove VSV wire harness
3. Measure resistance between connector pin

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

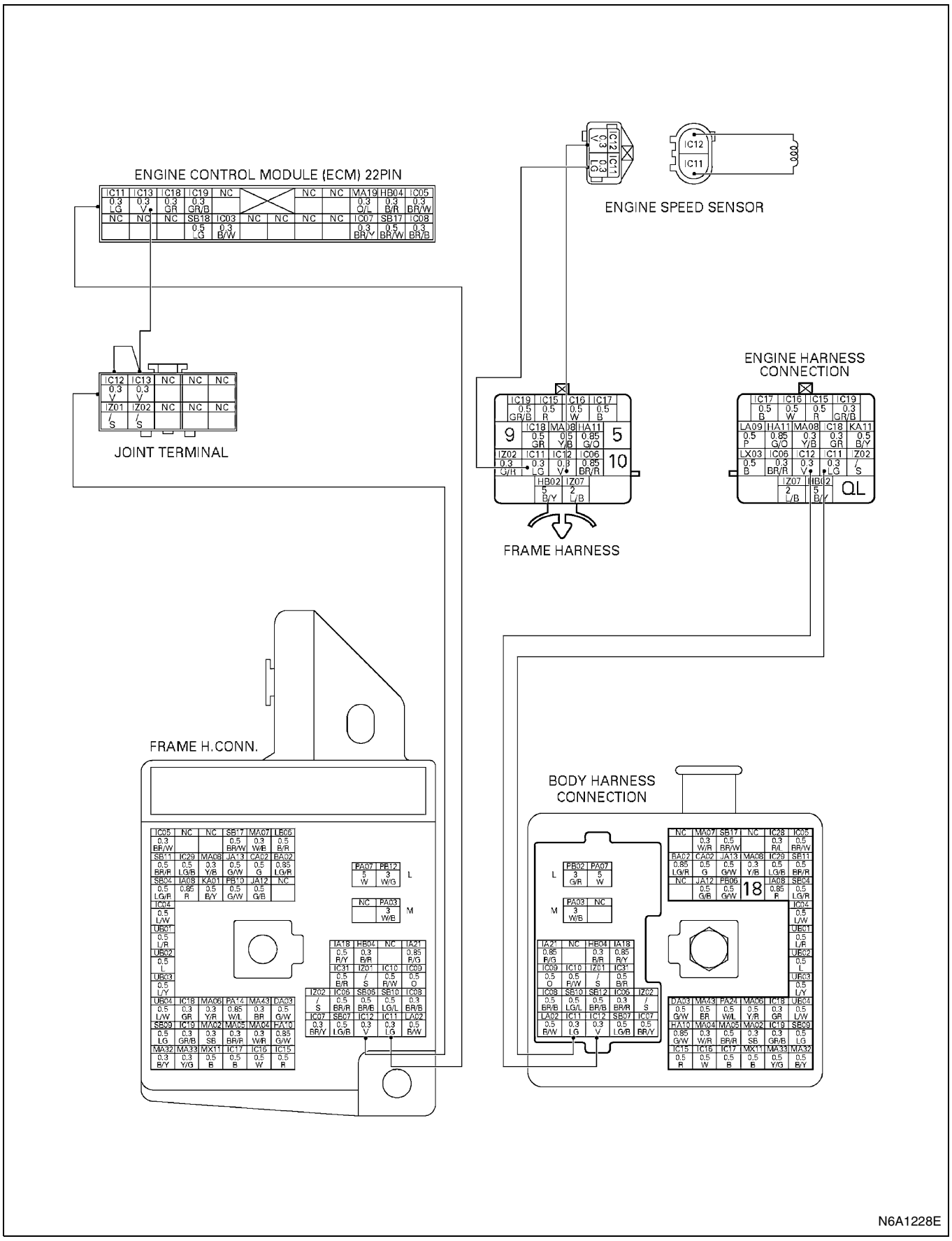
Resistance value

Inspection Point		Resistance Value (kΩ)	Reference
Connector	Pin No.		
2 pin Green	2 ←→ 1	37 to 44 (for 12 volt) 159 to 169 (for 24 volt)	SIG ←→ GND
	1 ←→ Body	∞	SIG ←→ Body

Notice:
Resistance value is difference according to the engine temperature (condition of engine warming up).

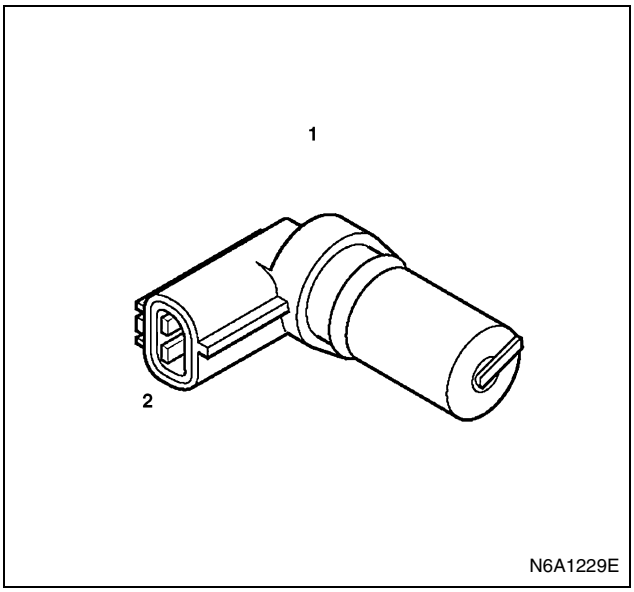
Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	Using the DVM, check the resistance of the VSV. Does the DVM read the following Value?	37 — 44Ω (for 12 Volt) 159 — 169Ω (for 24 Volt)	Go to Step 3	Go to Step 4
3	1. Ignition “OFF” 2. Disconnect the ECM connector from ECM. 3. Check the short to voltage of VSV circuit between the ECM and VSV connector. 4. Repair if necessary. 5. Clear trouble code by Scan Tool. 6. Ignition “ON” Engine “ON”. Does the MIL blink?	—	Go to Step 6	Go to Step 5
4	Replace the VSV. Is the action complete?	—	Go to Step 6	—
5	Replace the ECM. Is the action complete?	—	Go to Step 7	—
6	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF”. Clear trouble code by Scan Tool. 3. Ignition “ON” Engine “ON”. Does the MIL blink?	—	Go to Step 7	Go to Step 2
7	Connect Scan Tool. Is any current trouble other than DTC 44 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P45 Engine Speed Sensor Circuit Low Voltage



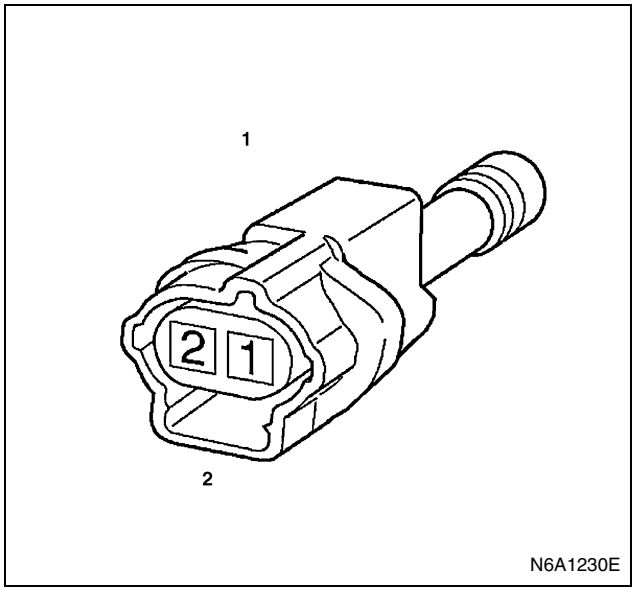
Appearance of Engine Speed Sensor and Connector Name

Engine Speed Sensor



Legend
1. To engine speed sensor
2. 2 pin

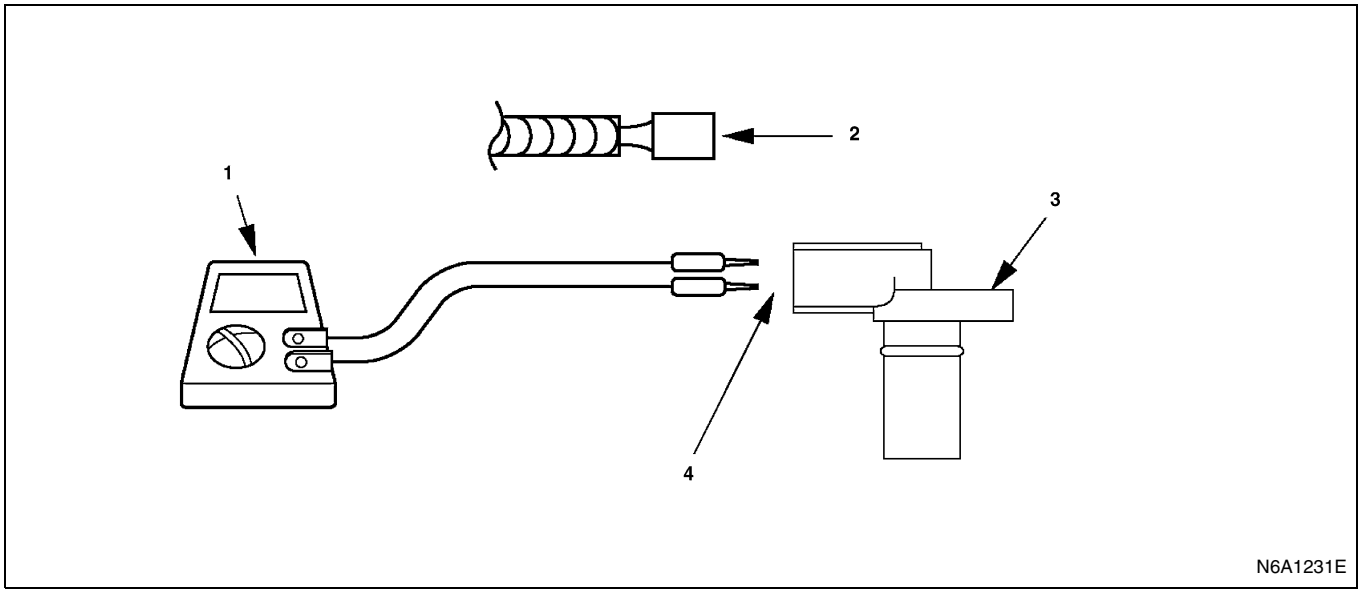
Engine Speed Sensor Connector



Legend
1. To engine speed sensor
2. 2 pin

Connector No	Signal
1	GND
2	SIG

Measure Resistance at Engine Speed Sensor



Legend
1. Circuit tester
2. Remove engine wire harness
3. Engine speed sensor
4. Measure resistance between connector pin

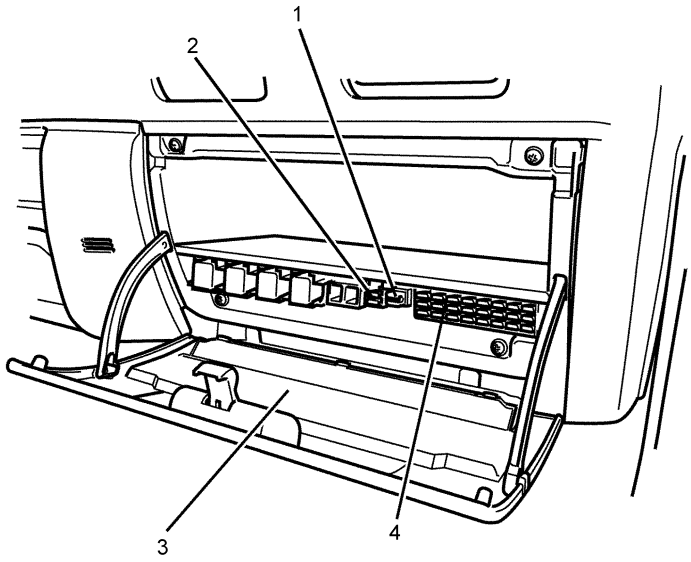
Caution:
When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

Resistance value

Inspection Point		Resistance Value (kΩ)	Reference
Connector	Pin No.		
2 pin Black	2 ←→ 1	840±20%	SIG ←→ GND
	2 ←→ Body	∞	SIG ←→ Body

Notice:
Resistance value is difference according to the engine temperature (condition of engine warming up).

Location of Fuse



N6A1232E

Legend

1. Fuse puller
2. Spare fuses
3. Label
4. Fuses (F-1 — F-24)

Step	Action	Value	YES	NO
1	1. Ignition “ON”, Engine “OFF” 2. Connect a voltmeter to the ECM connector terminals (ENGINE+) and (ENGINE-) Is the voltage 0V?	—	Go to Step 3	Go to Step 5
2	1. Ignition “ON”, Engine “ON” 2. Connect a voltmeter to the ECM connector terminals (ENGINE+) and (ENGINE-). Is the voltage under the range of 0 — 1V (AC intermittently) when the engine speed is about 2000RPM? Does the Voltage increase as the engine speed is increased?	—	Go to Step 4	Go to Step 6
3	Check for poor sensor ground or sensor signal circuit terminal connection and terminal shorted at the ECM and replace terminal(s) if necessary. Did any of the terminals need to be replaced?	—	Go to Step 8	Go to Step 4
4	1. Check sensor signal circuit for disconnection and power source for short. 2. Check sensor GND circuit for disconnection and power source for short. 3. Repair if necessary. Was repair needed?	—	Go to Step 8	Go to Step 5
5	1. Check signal circuit for GND short. 2. Repair if necessary. Was repair needed?	—	Go to Step 8	Go to Step 7
6	Replace the sensor. Is the action complete?	—	Go to Step 8	—
7	Replace the ECM. Is the action complete?	—	Go to Step 8	—
8	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” 3. Connect the Scan Tool. 4. Ignition “ON” Engine “OFF” 5. Make Scan Tool indicate engine speed. Is a speed range of 700 rpm to 900 rpm indicated with the engine idling (accel. off)? And as engine speed rises with accel. on, does the indicated value rise?	—	Go to Step 9	Go to Step 2
9	Is any current trouble other than DTC 45 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P52 Electronically Erasable Programmable Read Only Memory (EEPROM) Error

Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	Replace the ECM. Is the action complete?	—	Go to Step 3	—
3	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC 52 all right under Scan Tool Check?	—	Go to Step 4	Go to Step 2
4	Is any current trouble other than DTC 52 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-P61 Barometric Pressure Sensor Circuit Error

Step	Action	Value	YES	NO
1	Was the “on-board diagnostic (OBD) system check” performed?	—	Go to Step 2	Go to self diag system check
2	Replace the ECM. Is the action complete?	—	Go to Step 3	—
3	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC 61 all right under Scan Tool Check?	—	Go to Step 4	Go to Step 2
4	Is any current trouble other than DTC 61 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

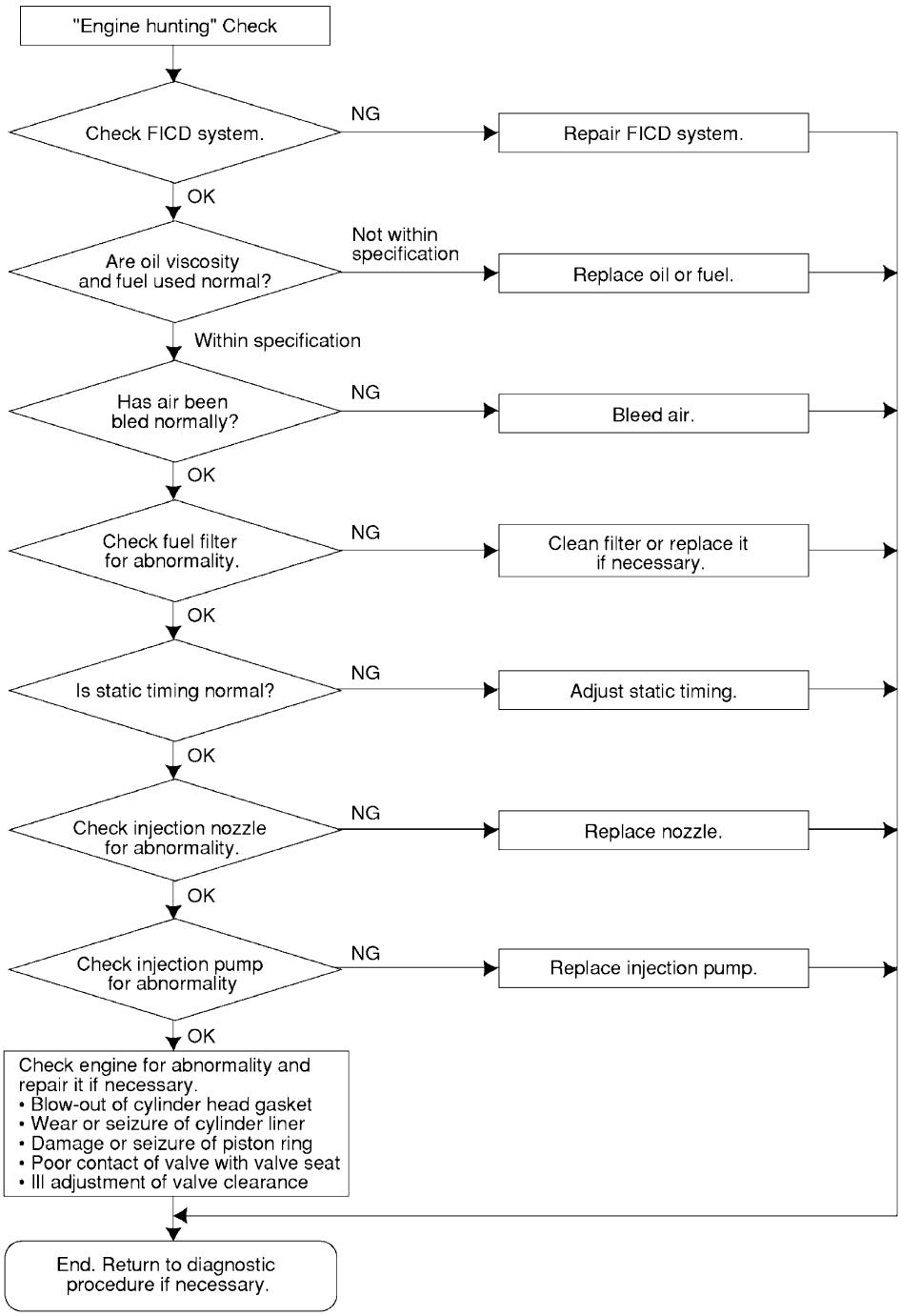
WITHOUT DIAGNOSIS TROUBLE CODE

Introduction

If there occurs a malfunction although no Diagnostic Trouble Code (DTC) is generated, then inspect and repair the system in accordance with the flowcharts given on the following pages.

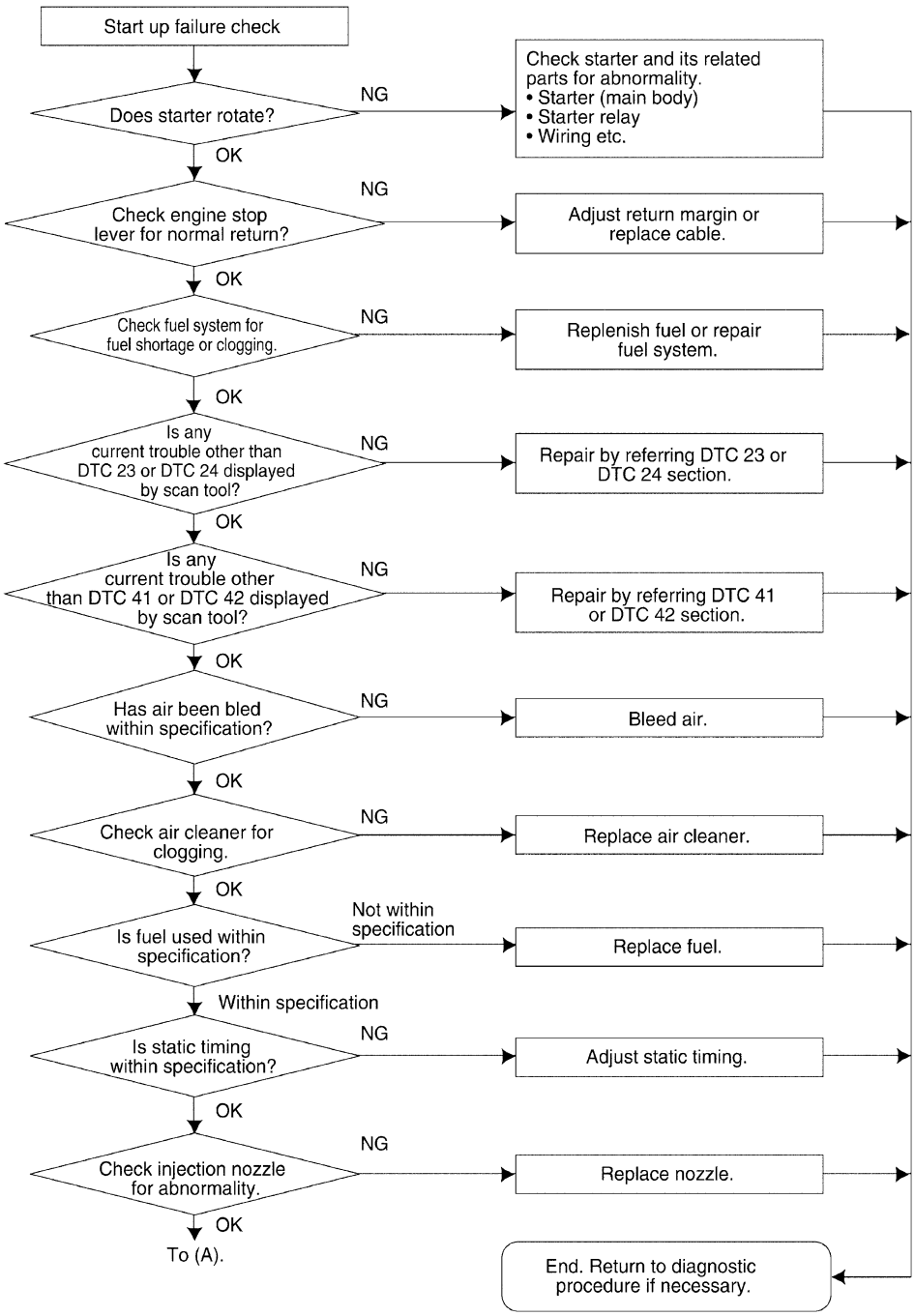
When a Diagnostic Trouble Code (DTC) is produced, inspect and repair system with reference to “EMISSION AND ELECTRICAL DIAGNOSIS”.

Engine Hunting

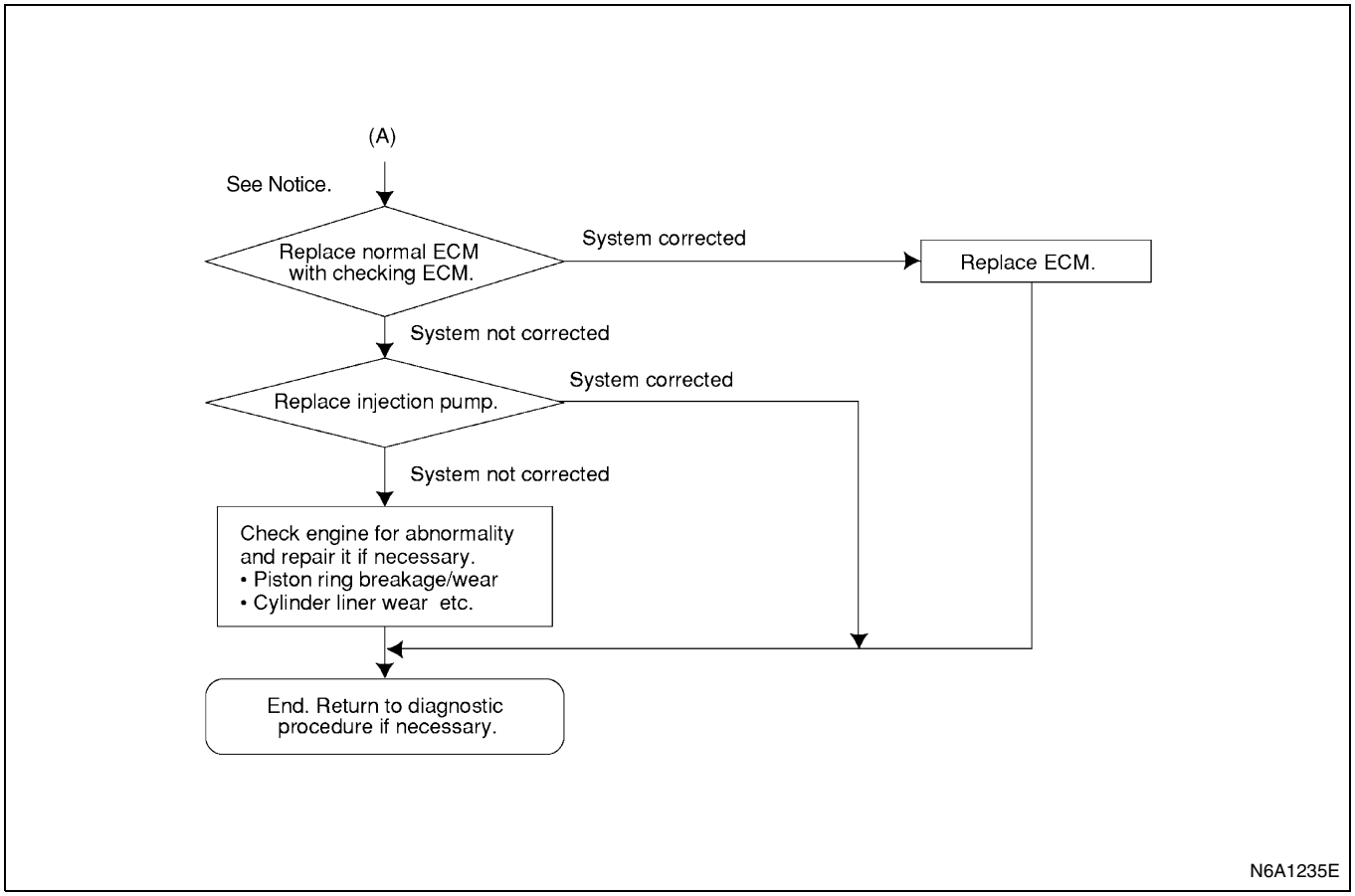


N6A1233E

Startup Failure

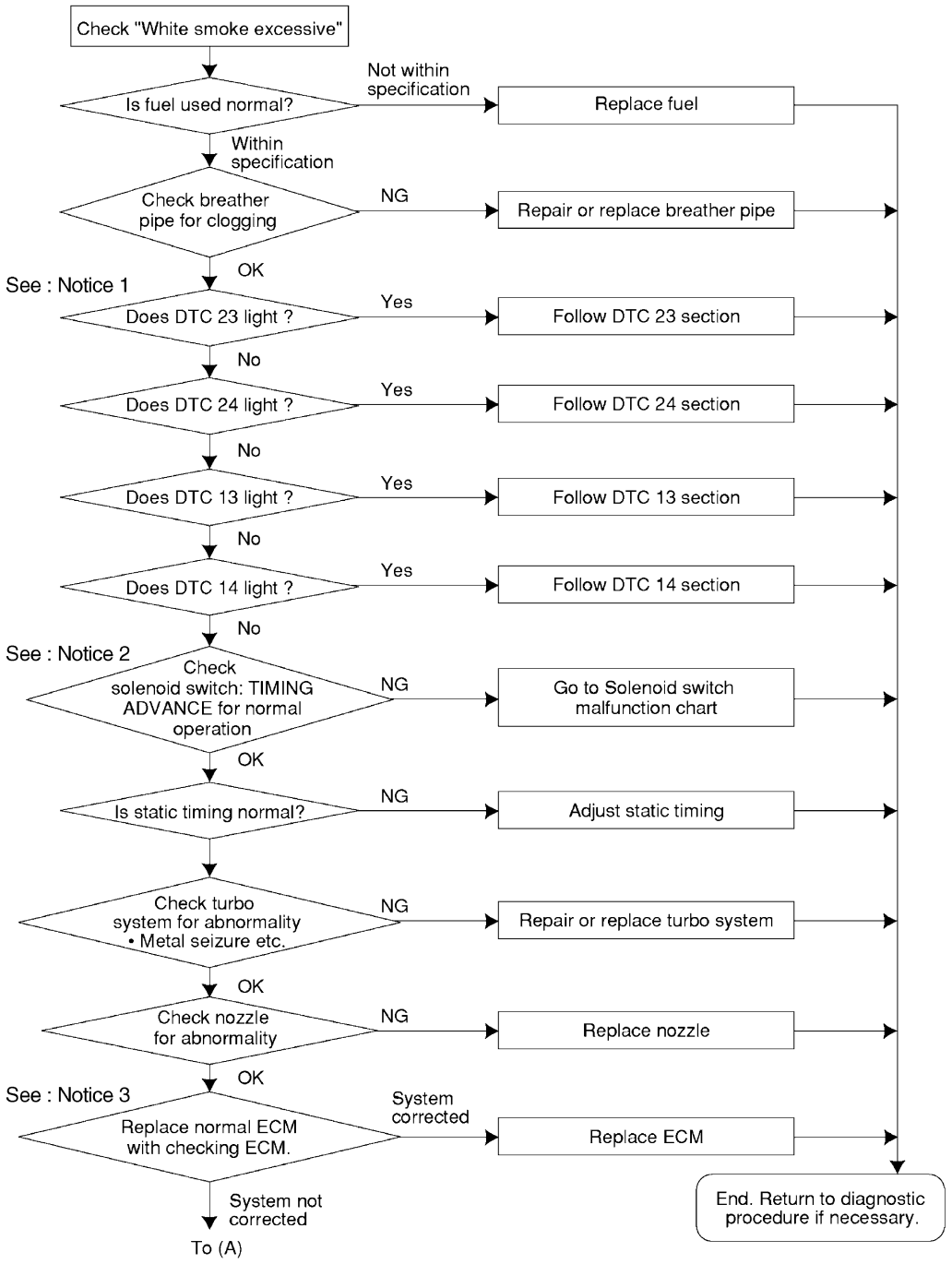


N6A1234E

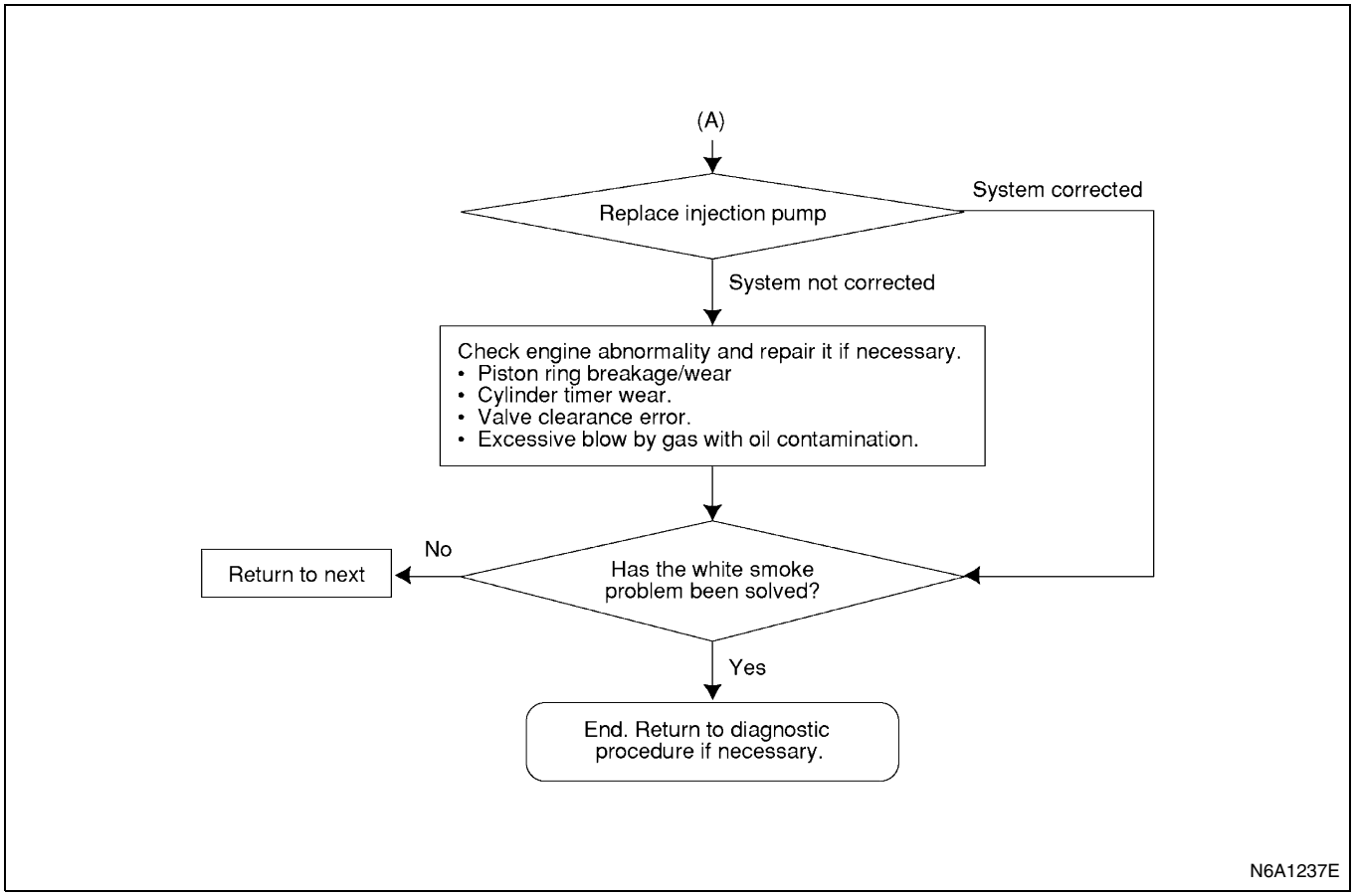


Notice:
The condition of the system in which the malfunction has occurred should be checked by making comparisons between the vehicle Engine Control Module (ECM) and the checking ECM.

White Smoke (Excessive)



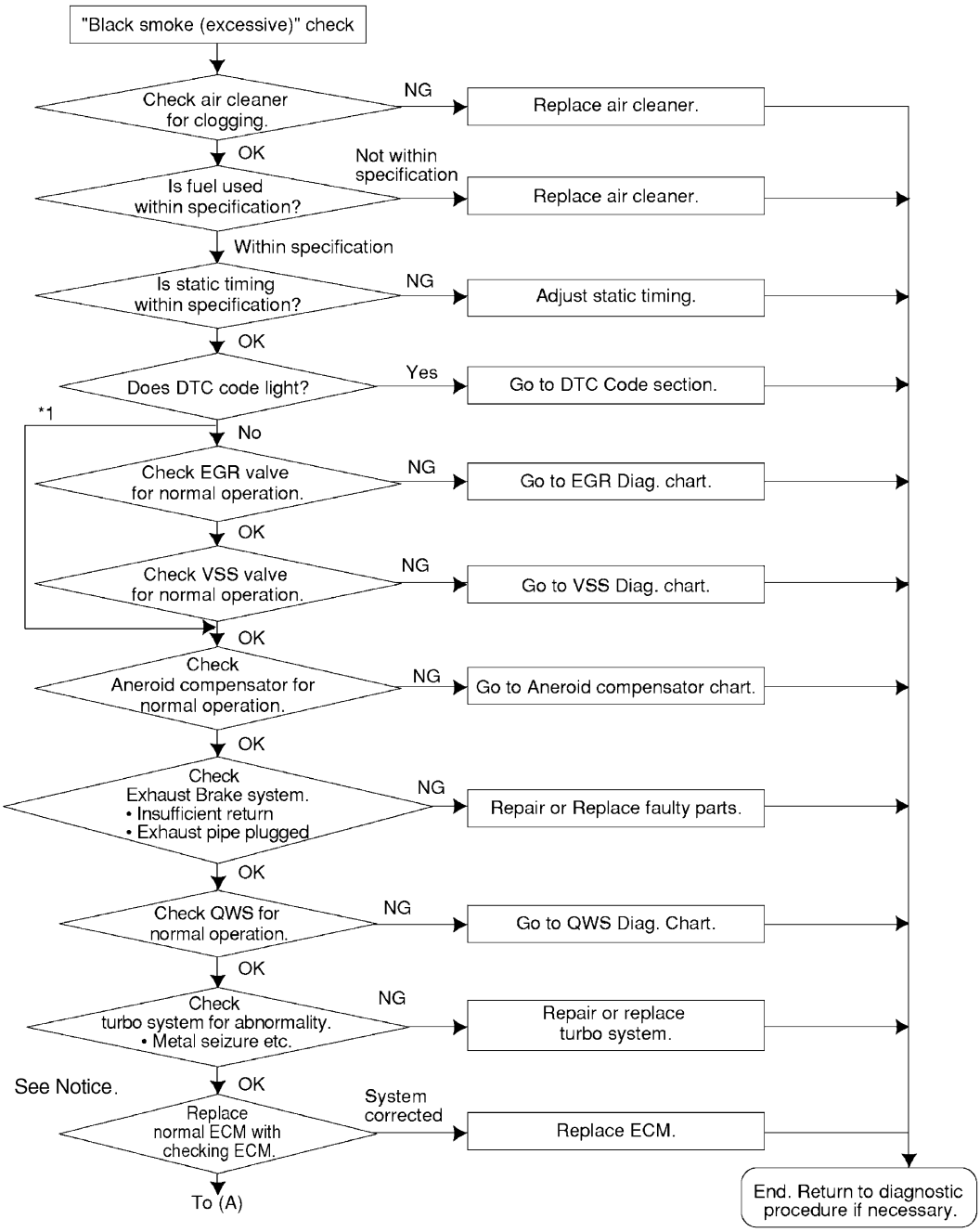
N6A1236E



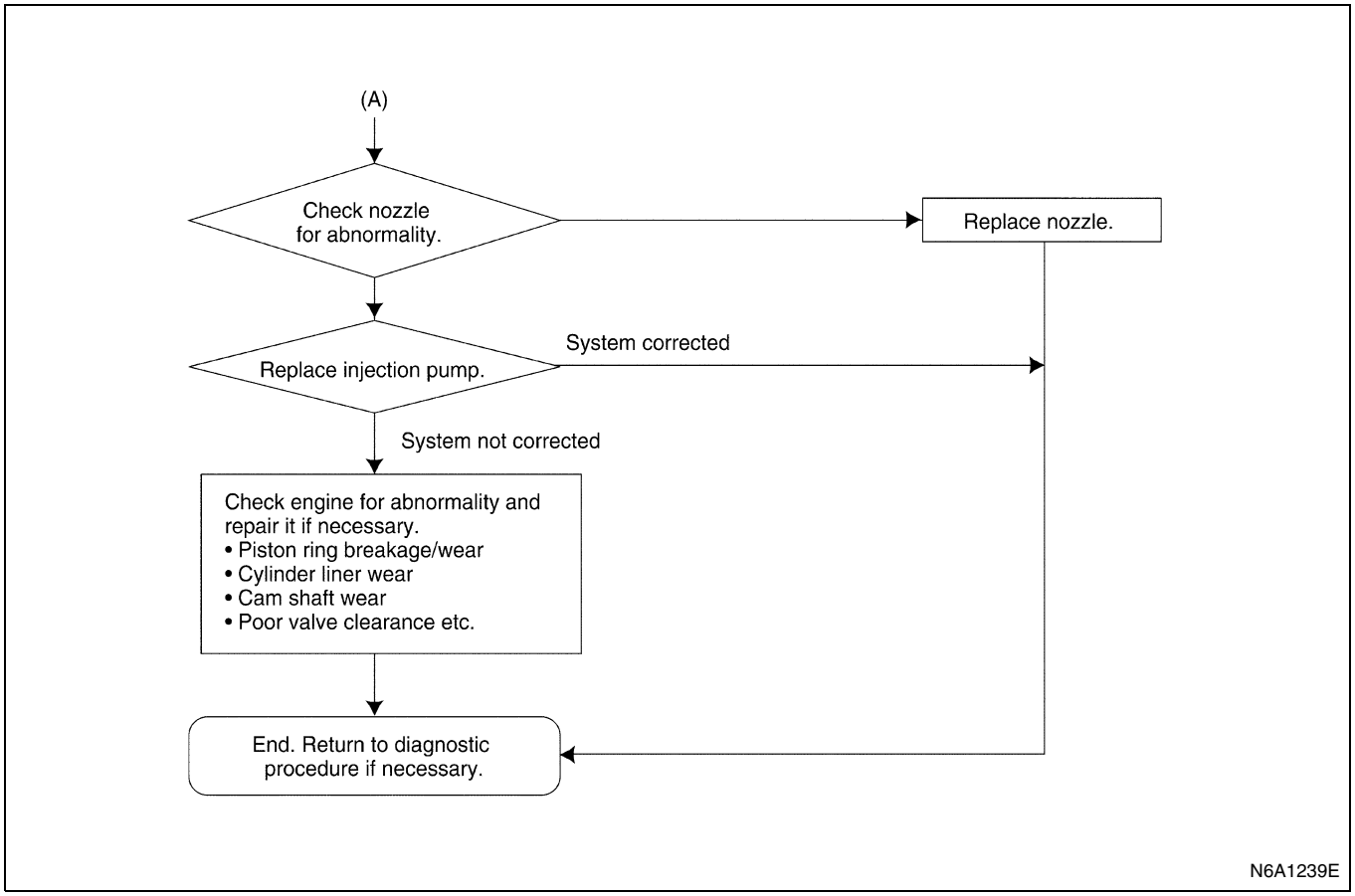
Notice:

1. “Follow (DTC-13, 14, 23, 24)” means to refer “Workshop Manual EMISSION AND ELECTRICAL DIAGNOSIS 4HE1 6E Section of Diagnosis Trouble Code (DTC-13, 14, 23, 24)” for other DTC code, follow concerned DTC sections.
2. Turn the ignition key from the “OFF” position to the “ON” position to put on the solenoid switch attached to the injection pump. After the solenoid switch being on for 18 consecutive seconds, check from the outside of the vehicle if the release sound of the solenoid switch is heard.
3. The condition of the system in which the malfunction has occurred should be checked by making comparisons between the vehicle Engine Control Module (ECM) and the checking ECM.

Black Smoke (Excessive)



N6A1238E

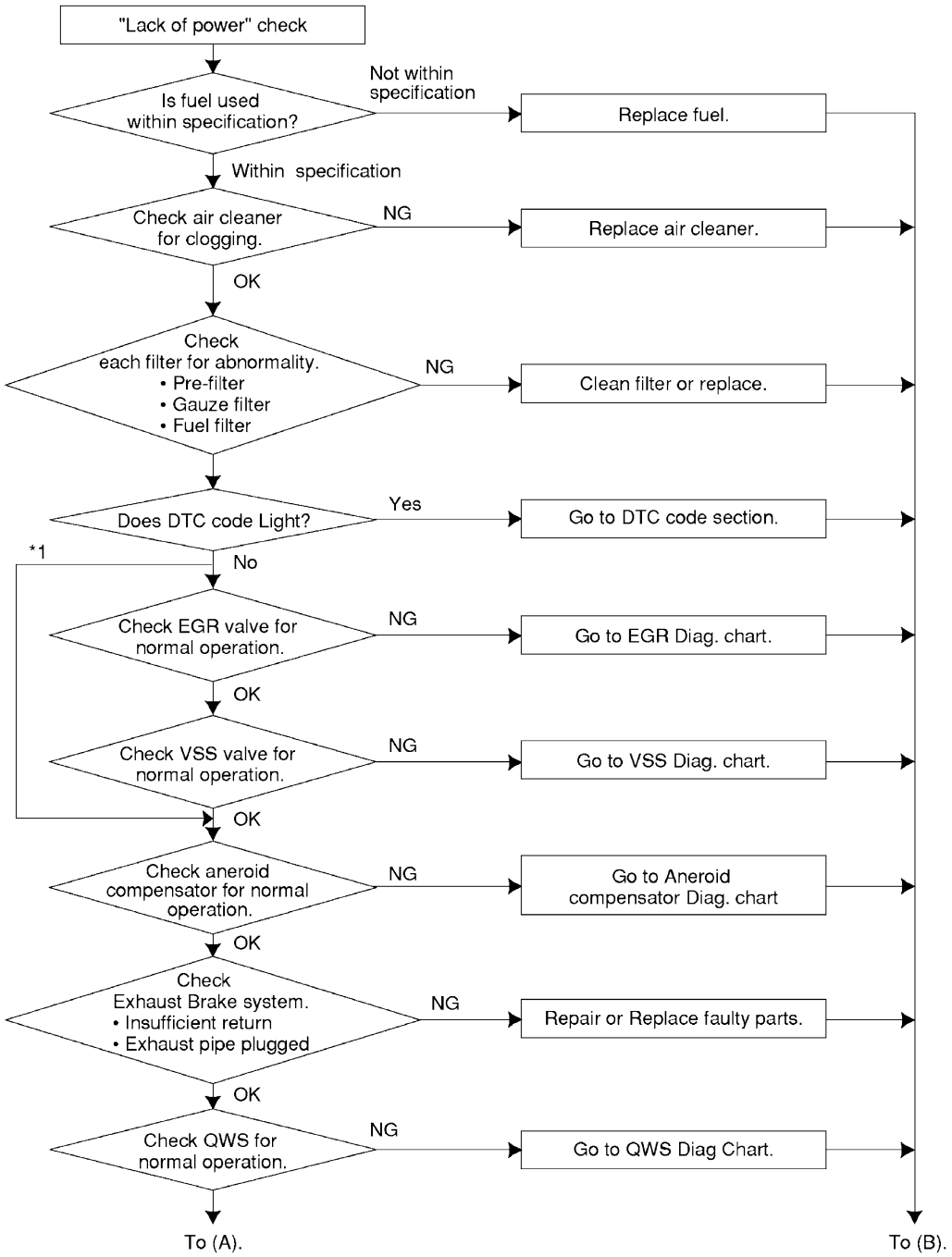


Notice:
The condition of the system in which the malfunction has occurred should be checked by making comparisons between the vehicle Engine Control Module (ECM) and the checking ECM.

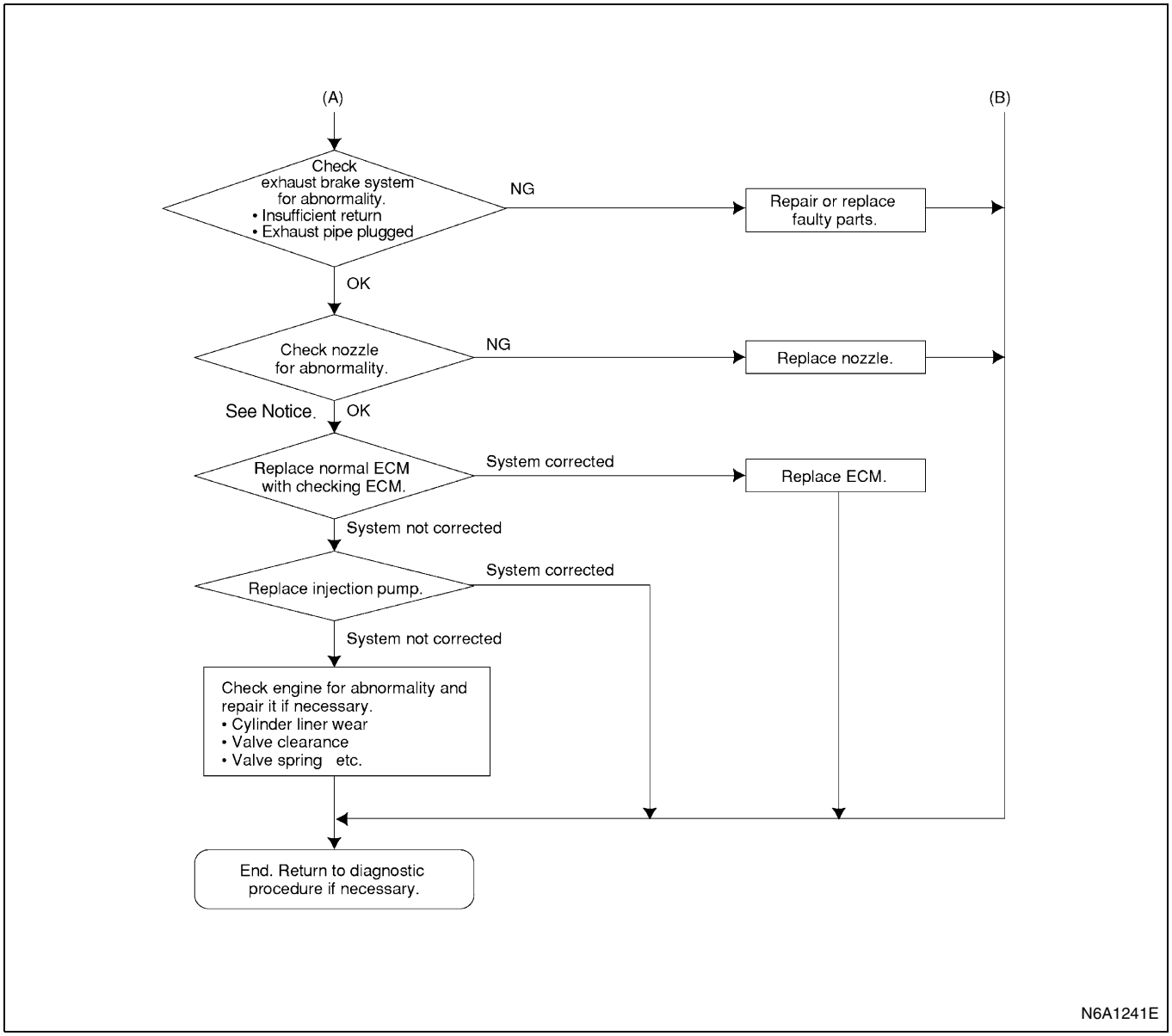
Refer to a trouble code for a supplier's check, if available.

*1. Equipped without Exhaust Gas Recirculation (EGR) and Variable Swirl System (VSS).

Lack of Power



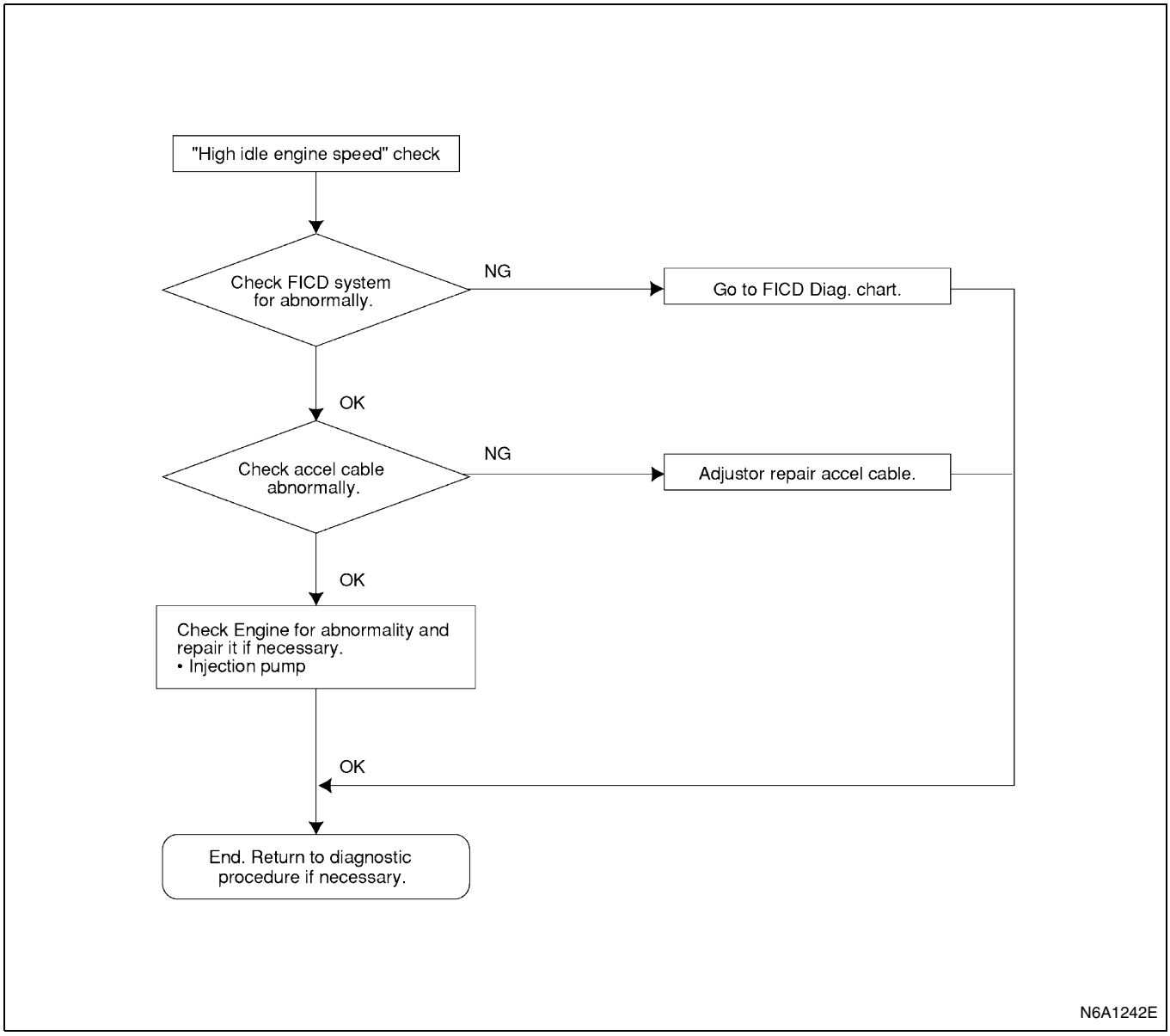
N6A1240E



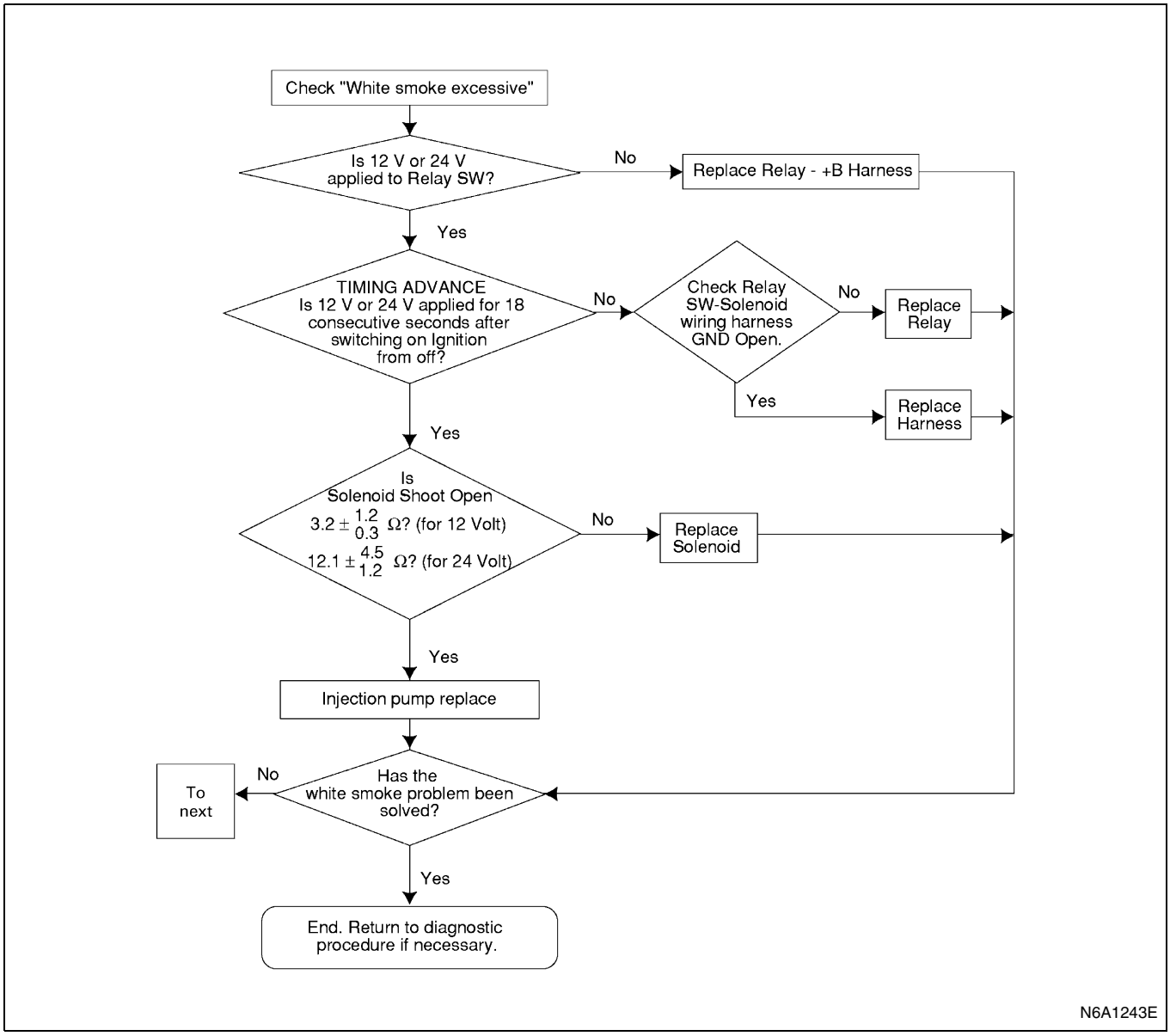
Notice:
The condition of the system in which the malfunction has occurred should be checked by making comparisons between the vehicle Engine Control Module (ECM) and the checking ECM.

*1. Equipped without Exhaust Gas Recirculation (EGR) and Variable Swirl System (VSS).

High Idle Engine Speed



Solenoid Switch Malfunction



Inspection

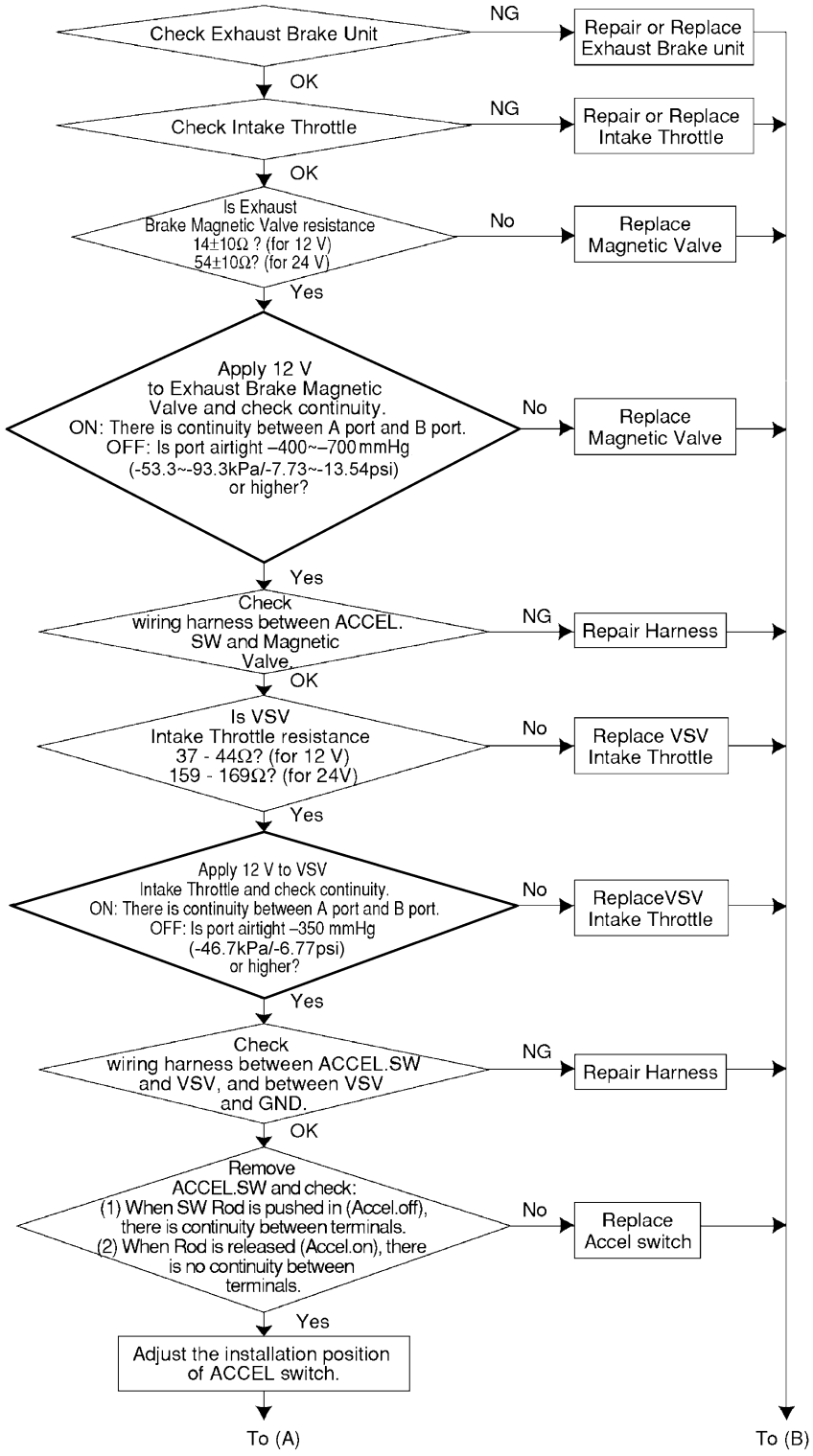
Solenoid Switch

Disconnect the connector on the solenoid switch.

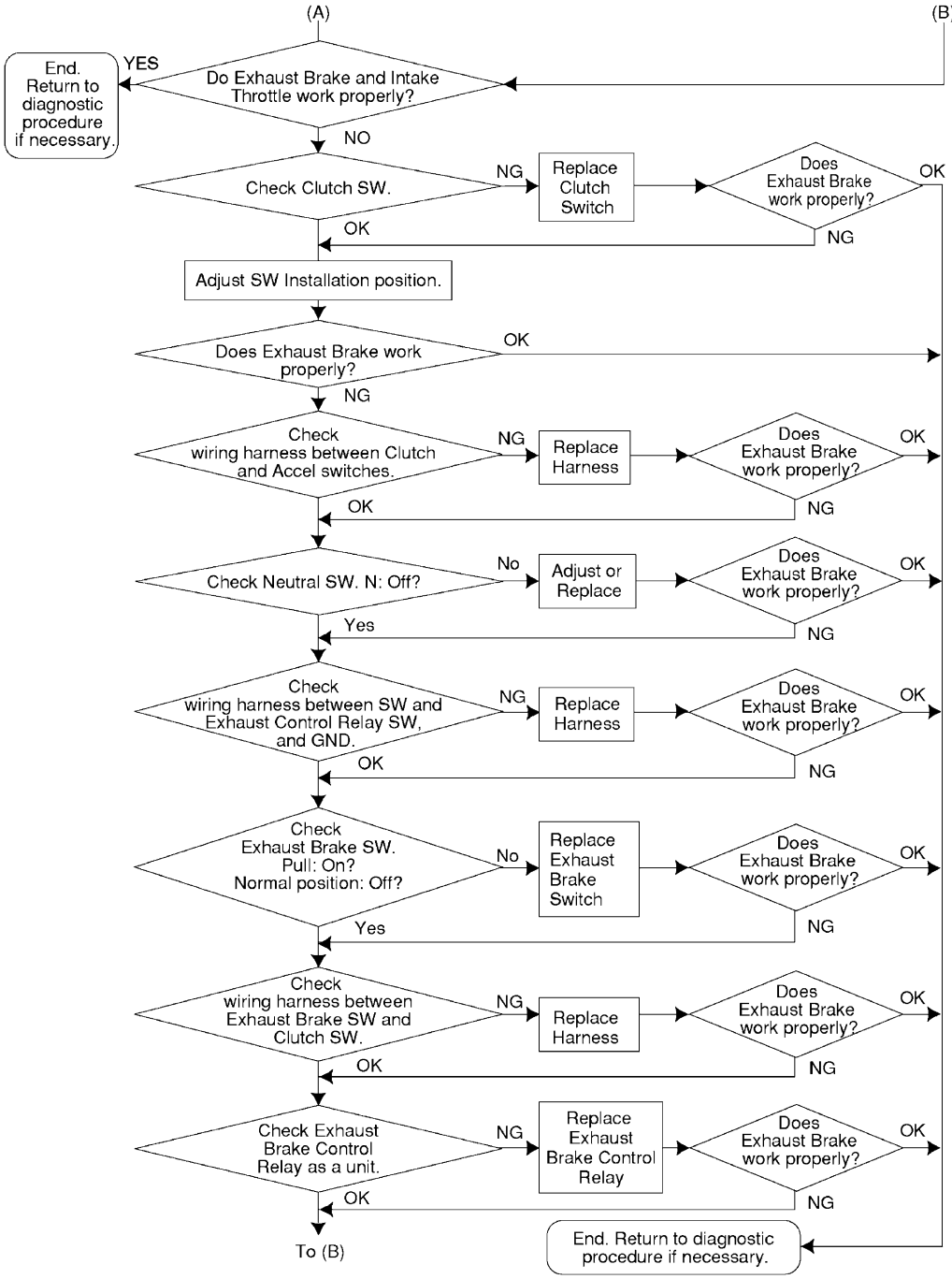
Apply 12 volts or 24 volts DC to the solenoid switch and hear the touching noise between solenoid switch and advance lever in the injection pump.

If can not hear the touching noise, do not remove the solenoids switch and contact injection pump service shop to repair it.

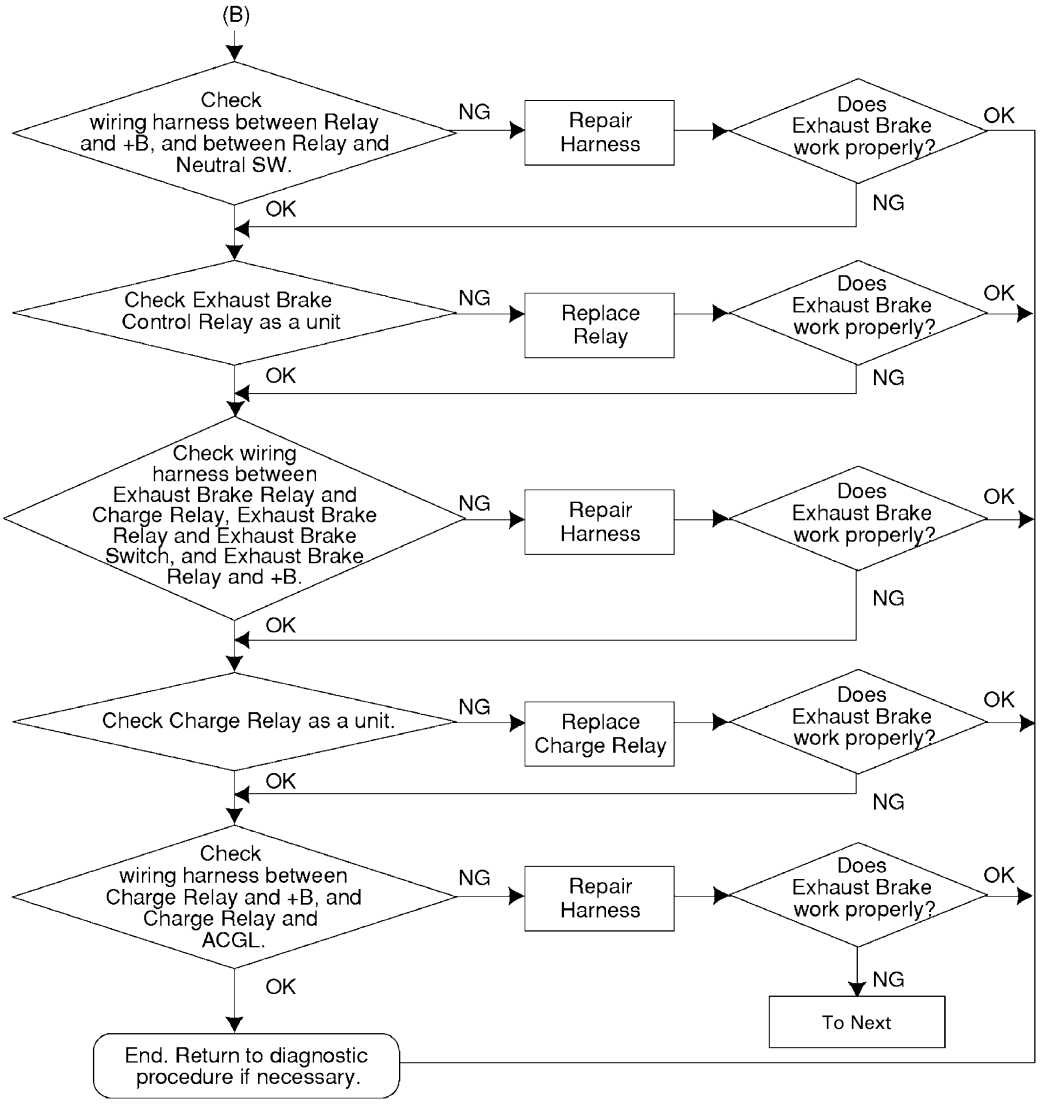
Exhaust Brake Malfunction



N6A1673E


(A)
(B)
Do Exhaust Brake and Intake Throttle work properly?
YES
End. Return to diagnostic procedure if necessary.
NO
Check Clutch SW.
NG
Replace Clutch Switch
Does Exhaust Brake work properly?
OK
NG
OK
Adjust SW Installation position.
Does Exhaust Brake work properly?
OK
NG
Check wiring harness between Clutch and Accel switches.
NG
Replace Harness
Does Exhaust Brake work properly?
OK
NG
OK
Check Neutral SW. N: Off?
No
Adjust or Replace
Does Exhaust Brake work properly?
OK
NG
Yes
Check wiring harness between SW and Exhaust Control Relay SW, and GND.
NG
Replace Harness
Does Exhaust Brake work properly?
OK
NG
OK
Check Exhaust Brake SW. Pull: On? Normal position: Off?
No
Replace Exhaust Brake Switch
Does Exhaust Brake work properly?
OK
NG
Yes
Check wiring harness between Exhaust Brake SW and Clutch SW.
NG
Replace Harness
Does Exhaust Brake work properly?
OK
NG
OK
Check Exhaust Brake Control Relay as a unit.
NG
Replace Exhaust Brake Control Relay
Does Exhaust Brake work properly?
OK
NG
OK
To (B)
End. Return to diagnostic procedure if necessary.

N6A1245E



* Repair of wiring harness includes diode check.

N6A1246E

Inspection

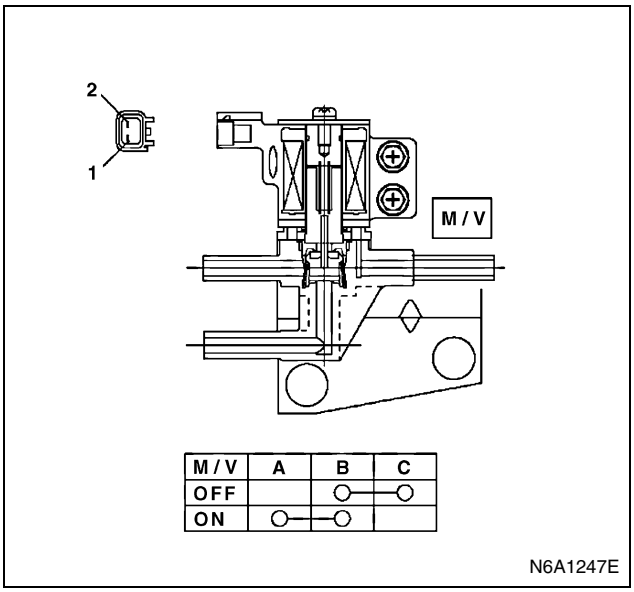
1. Exhaust Brake Magnetic Valve

Inspection

Connect the magnetic valve connector terminal No.1 and No.2 to (+) terminal and (-) terminal of battery, respectively, and check the continuity between the ports.

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.



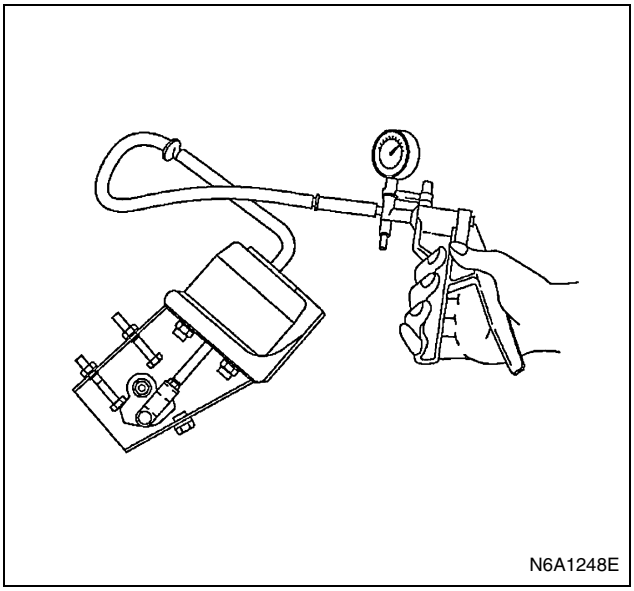
Legend

A. Inlet (Vacuum pump)
B. Outlet (unit)
C. Exhaust (air filter)

2. Exhaust Throttle Valve

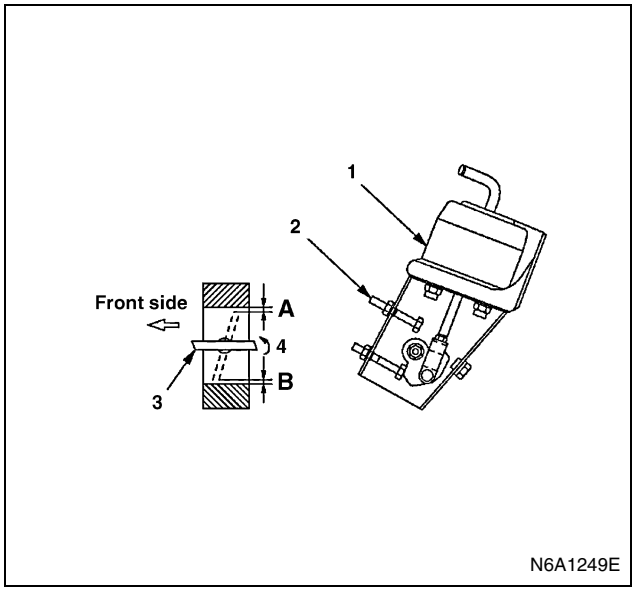
Working Check

Actuate the exhaust brake with the engine idling and make sure that you hear the valve strike on the stopper.



Airtight Check

Apply a negative pressure of 53.3 — 93.3 kPa (400 — 700 mmHg/7.73 — 13.54 psi) to the power chamber by means of a vacuum pump and make sure of the smooth opening/closing of the exhaust brake valve.

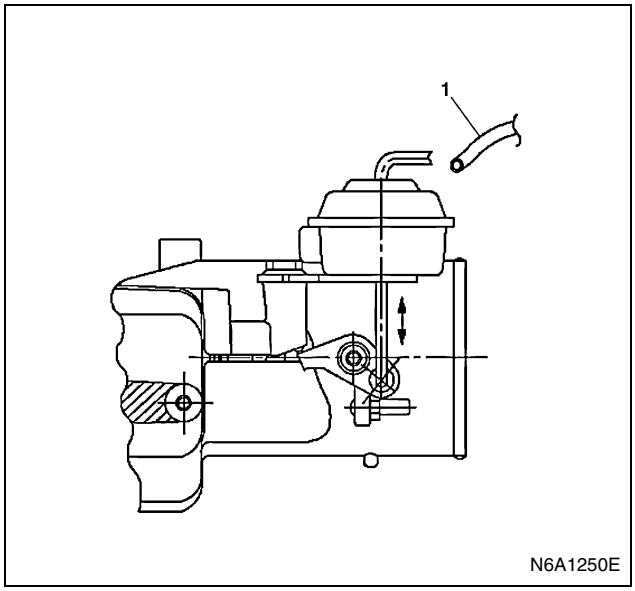


Legend

1. Power chamber
2. Adjust bolt
3. Valve
4. Close

Apply a negative pressure of 86.7 — 93.3 kPa (650 — 700 mmHg/12.57 — 13.54 psi) to the power chamber using a vacuum pump and make sure the average of measurements at Point A and Point B of the clearance between valve and body is as follows: 0.4 — 0.6 mm (0.016 — 0.024 in) (Minimum: 0.4 mm/0.016 in)

If the clearance is out of this range, adjust with the adjusting bolt.



Legend

1. Vacuum hose

3. Intake Throttle Valve

Working Check

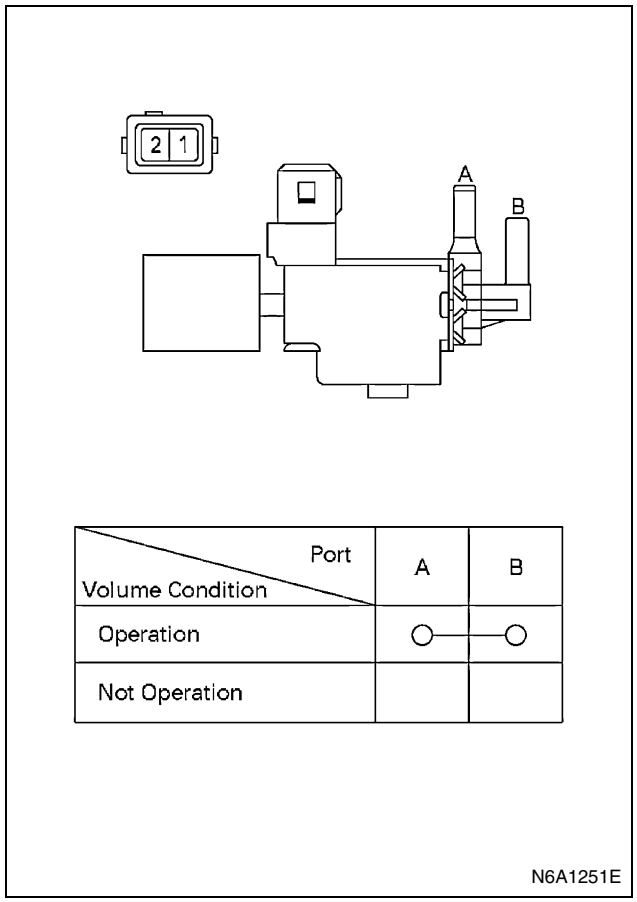
Disconnect the vacuum hose from the actuator and try to move the rod by hand, making sure of the smooth move of the rod.

4. Vacuum Switching Valve; Intake Throttle

Inspection

Connect the vacuum switching valve connector terminals No.1 and No.2 to (+) terminal and (-) terminals of battery, respectively, and check the continuity between the ports.

If the check result is abnormal, repair or replace the valve.



5. Accelerator Switch (2-pole connector type)

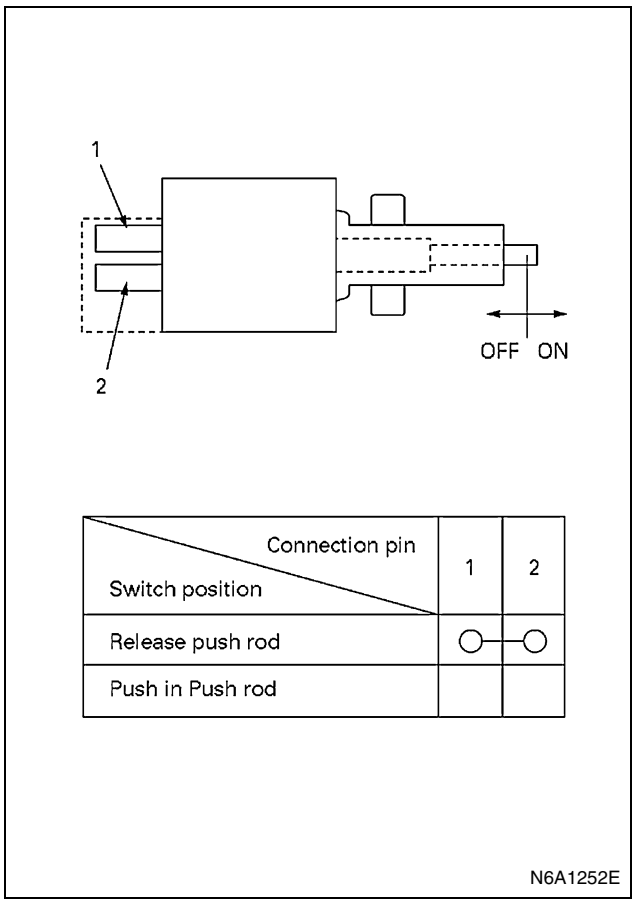
Inspection

1) Check the continuity between the switch connector terminals.

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

2) Check the smooth move of the pushrod. If the check result is abnormal, repair or replace the push rod.



Removal

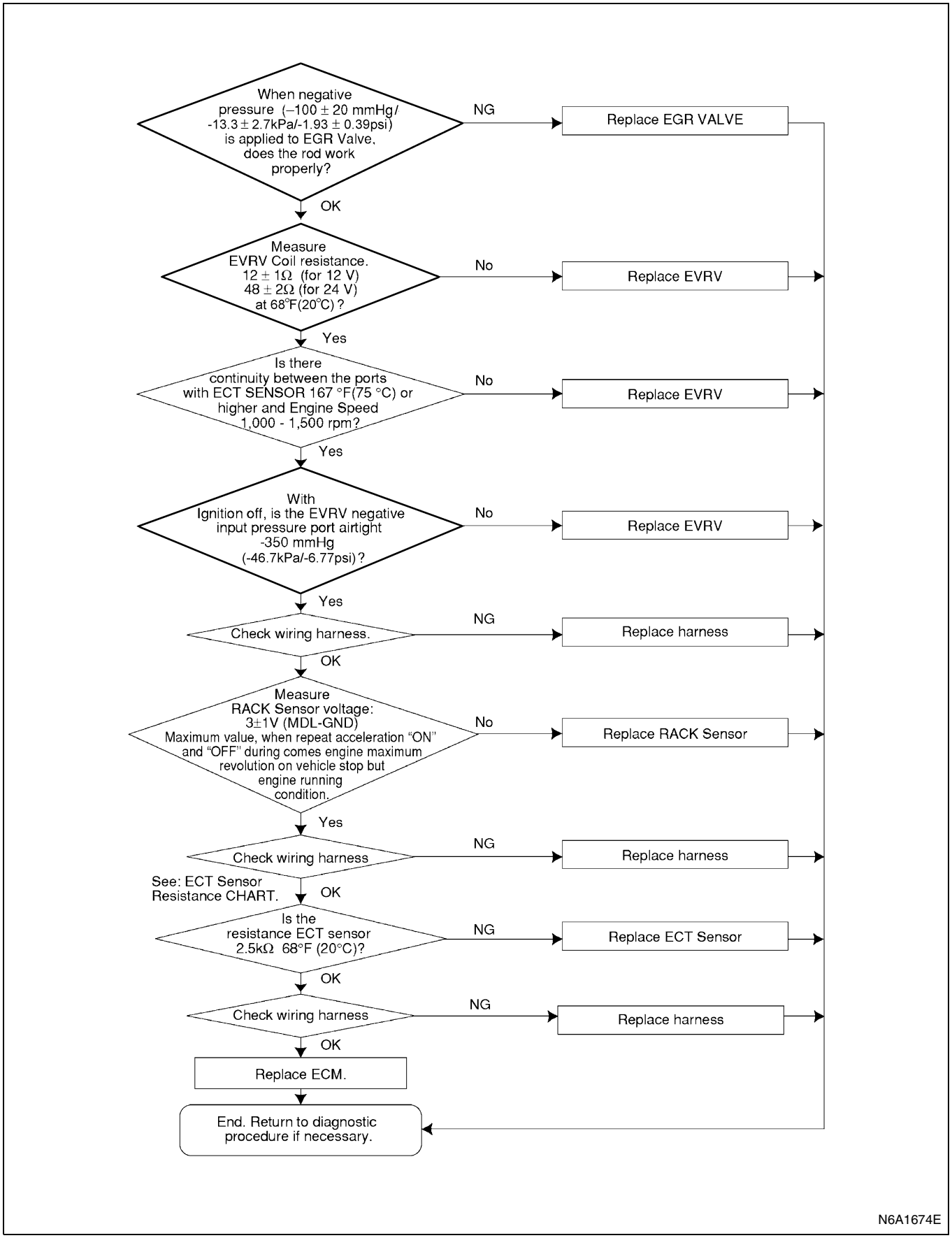
1) Accelerator Switch
2) Disconnect the connector.
   Loosen the lock nut.
   Turn the switch to remove.

Reinstallation

To install, follow the removal procedure in reverse order:

1) Drive the threaded part of the switch until its end surface becomes flush with that of the bracket side of nut.
2) Tighten the lock nut.
   Tightening torque: 1.3 N·m (0.13 kg·m/11.5 lb·in)

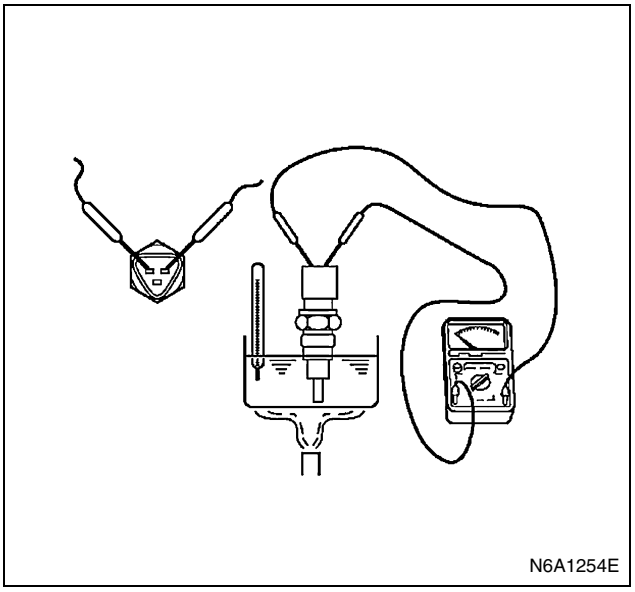
EGR System Malfunction

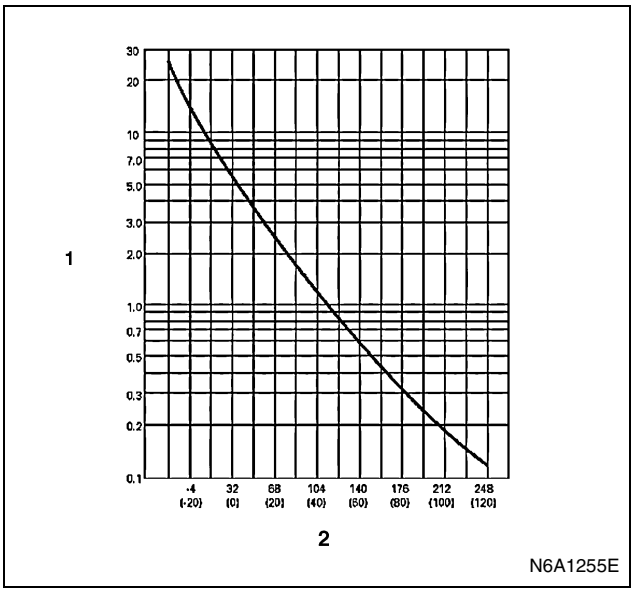


N6A1674E

Inspection

1. Thermosensor (Engine Coolant Temperature)
   Soak the temperature sensitive part of a thermosensor in the water, and while changing the water temperature, make sure the resistance is changed as the following graph shows:


N6A1254E



N6A1255E

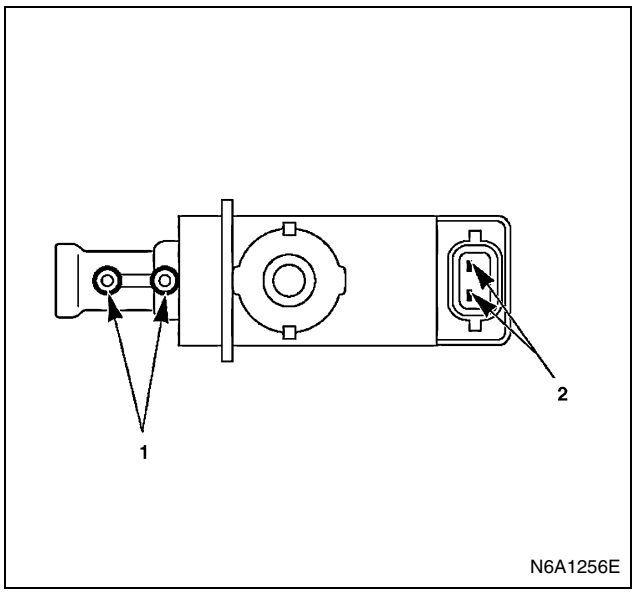
Legend
1. Resistance (kΩ)
2. ECT °F (°C)

2. Electronic Vacuum Regulating Valve (EVRV) (Equipped with Exhaust Gas Recirculation (EGR) and Variable Swirl System (VSS))

Resistance Check

Check the resistance between the EVRV connector terminals using a circuit tester.

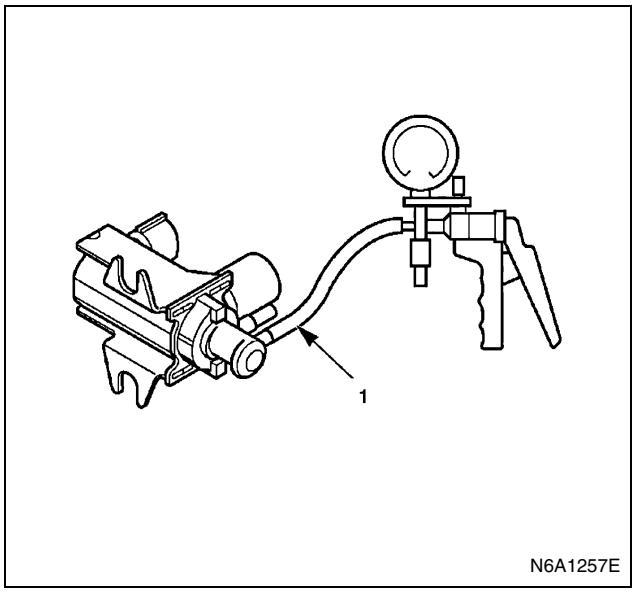
Cold Resistance: 12±1 (Ω)



N6A1256E

Legend
1. Port
2. Pin

Connect battery voltage between EVRV connector terminals and make sure of the continuity between the ports.



N6A1257E

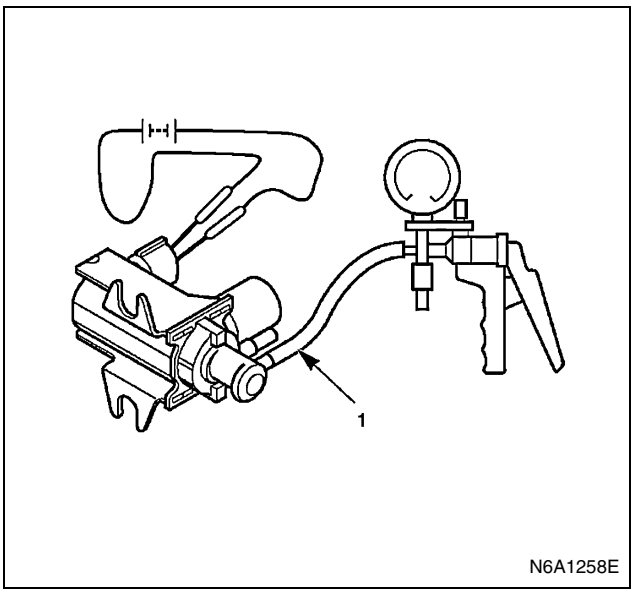
Legend
1. Vacuum port

Airtight Check

Apply negative pressure to the negative pressure input port as illustrated on the left.

Although there is leakage, it is no problem if the negative pressure rises to -46.7 kPa (-350 mmHg / -6.77 psi) or more.

Caution:
When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.



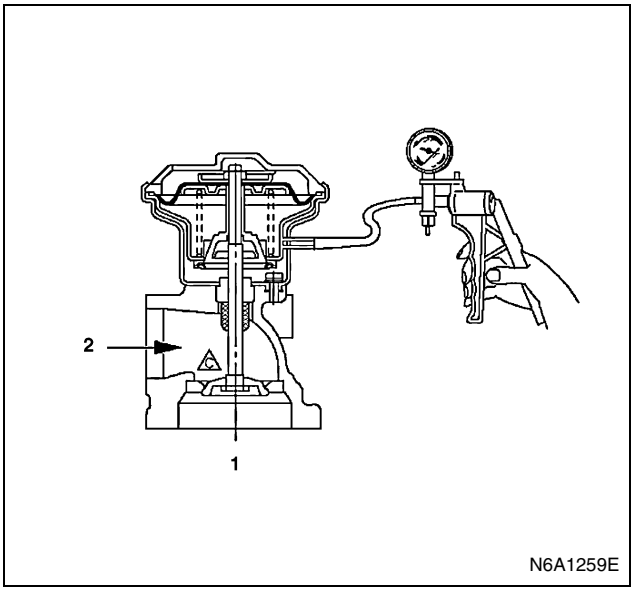
Legend

1. Vacuum port

Working Check

Apply powervoltage between the terminals, there is no problem if the negative pressure does not rise when applied to the input port.

3. Exhaust Gas Recirculation (EGR) Valve (Equipped with EGR and Variable Swirl System (VSS))
   With negative pressure applied to the diaphragm chamber, make sure that the valve is smoothly actuated to make the area between (1) and (2) ventilated.
   Startup: About -13.3 ± 2.7 kPa (-100 ± 20 mmHg / -1.93 ± 0.39 psi)

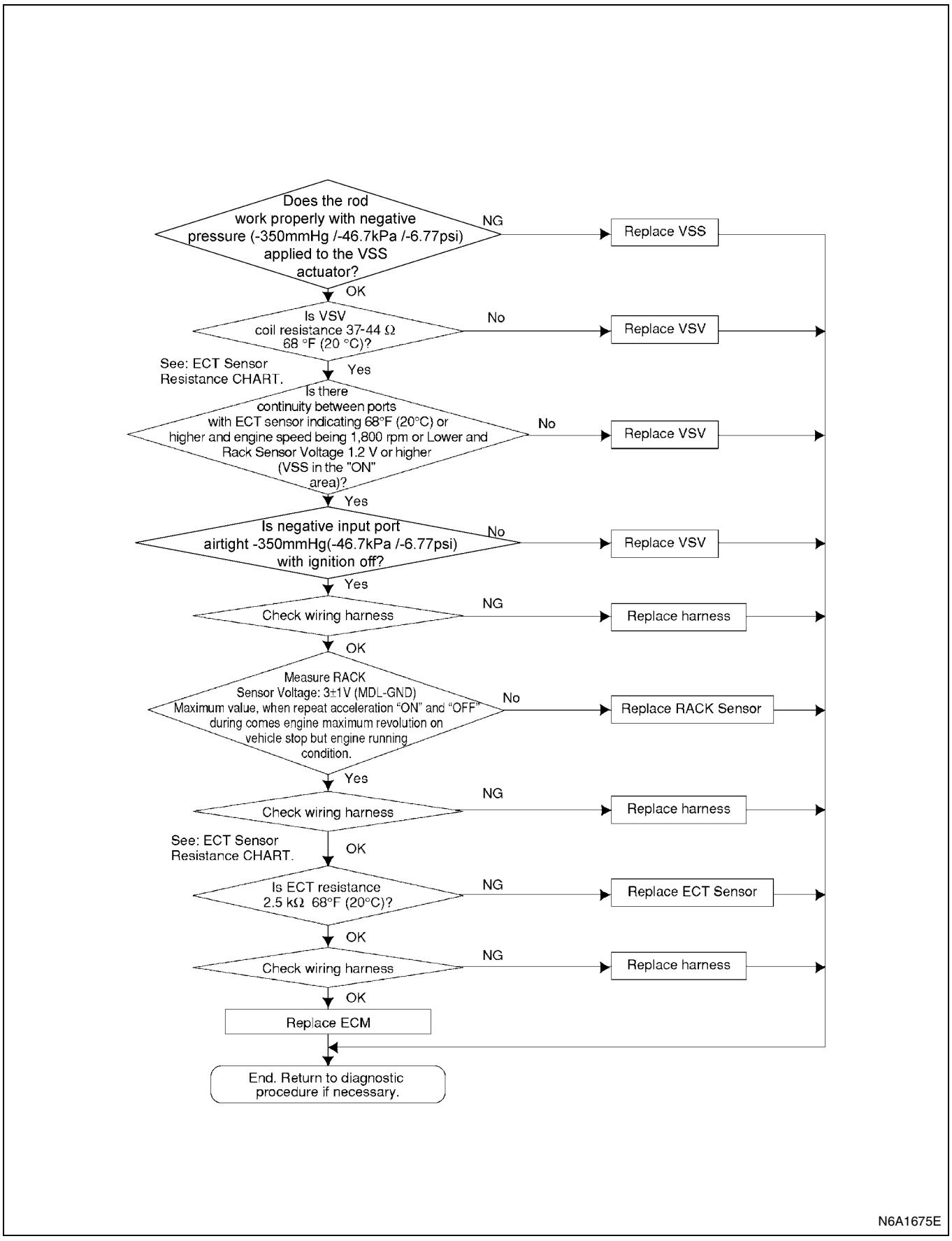


Check to see if EGR valve is normally actuated under the following conditions:

QWS off (After warming up)

Engine coolant temp.: 80°C (176°F) or higher

Variable Swirl System (VSS) System Malfunction (Equipped with Exhaust gas recirculation and VSS)

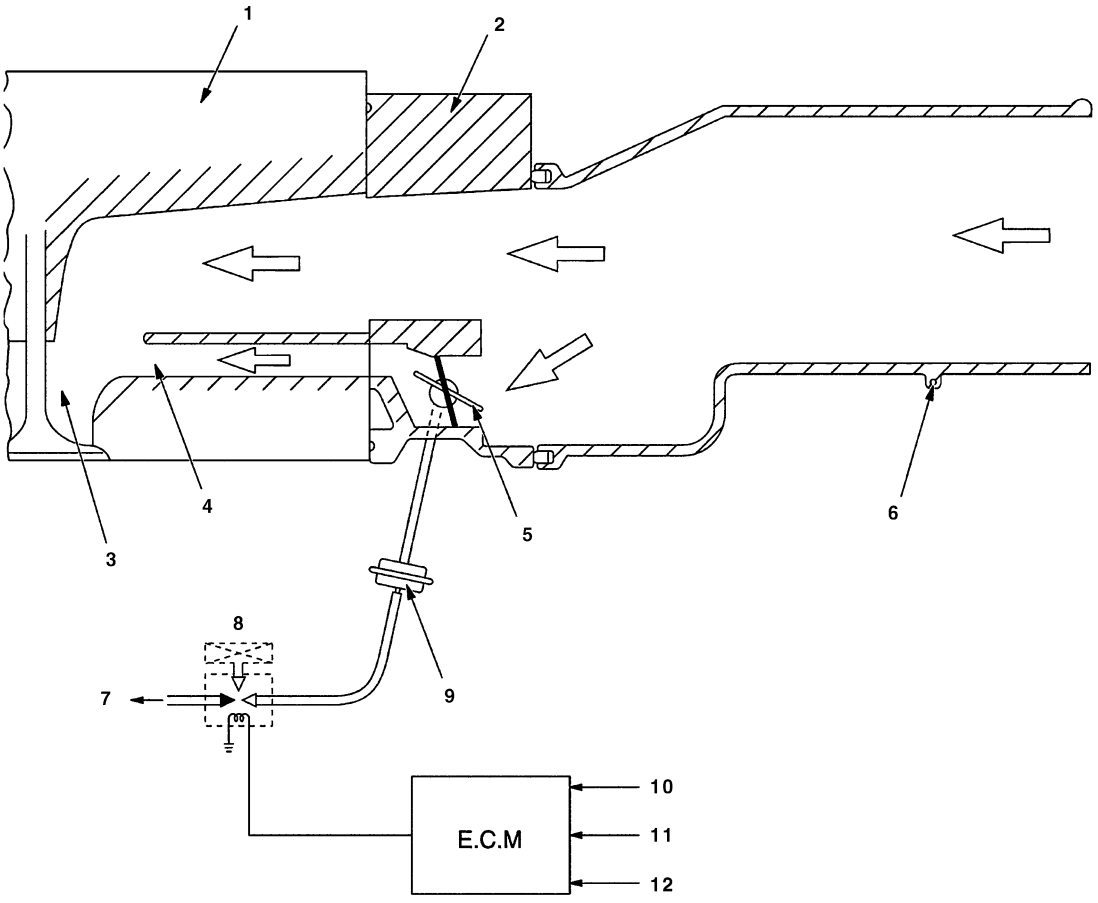


N6A1675E

VSS (Variable Swirl System)

The Variable Swirl System (VSS) is designed to adjust the intensity of swirl by allowing or not allowing air to flow through a sub-port (or bypass) the runs in parallel with the intake port for each cylinder. The swirl intensifies when there is no air flow through the sub-port, and vice versa.
The air flow is controlled by the on-off valve at the inlet to the sub-port and the valve in turn is turned on and off by computer signals which are dependent on engine speed, load and coolant temperature, Basically, the air is cut off at low speeds to maintain high swirl and is allowed to flow at high speeds to maintain low swirl.

Variable Swirl System (Equipped with Exhaust gas recirculation (EGR) and VSS)



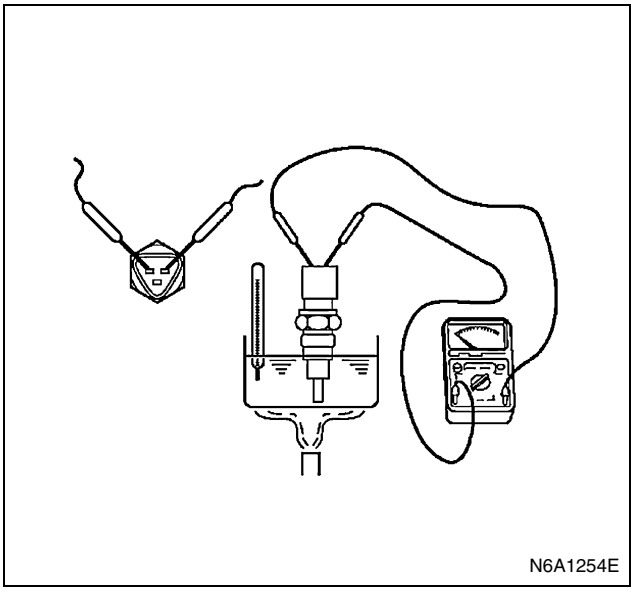
N6A1261E

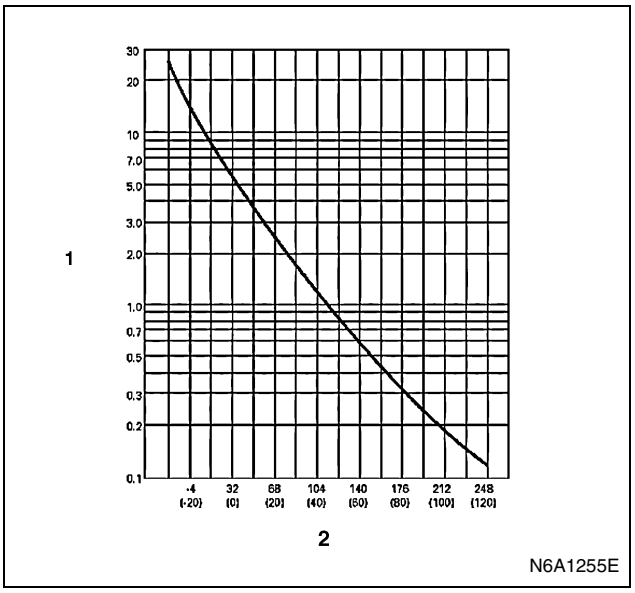
Legend

1. Cylinder head
2. VSS case
3. Inlet port
4. Sub-port
5. Control valve
6. Inlet manifold
7. Vacuum
8. VSV; VSS
9. Actuator
10. Thermo sensor
11. Engine speed sensor
12. Rack sensor

Inspection

1. Thermosensor (Engine coolant temperature)
   Soak the temperature sensitive part of a thermosensor in the water, and while changing the water temperature, make sure the resistance is changed as the following graph shows:


N6A1254E



N6A1255E

Legend
1. Resistance (kΩ)
2. ECT °F (°C)

2. Vacuum Switching Valve (VSV)

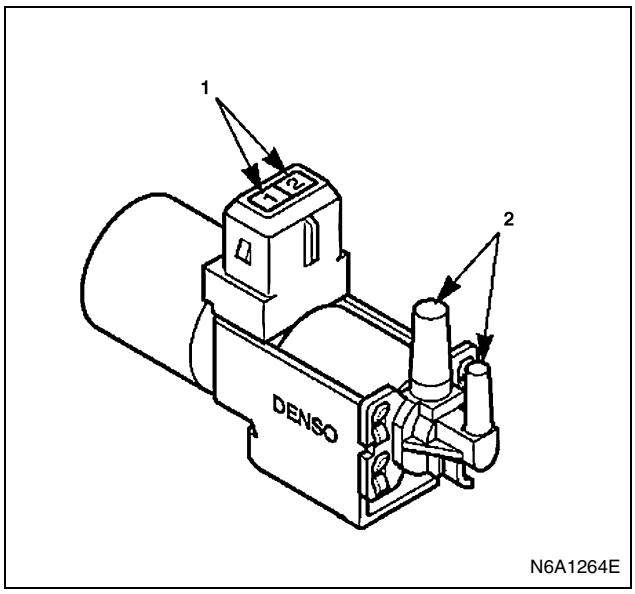
Resistance Check

Check the resistance between the VSV connector terminals using a circuit tester.

Cold Resistance

: 37 — 44 (Ω) (for 12 volt)

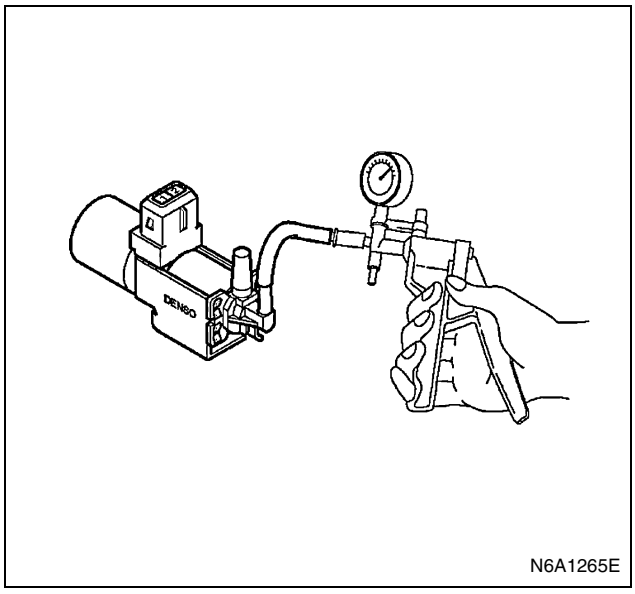
: 159 — 169 (Ω) (for 24 volt)



N6A1264E

Legend
1. 2 Pin
2. Port

Connect battery voltage between VSV connector terminals and make sure of the continuity between the ports.

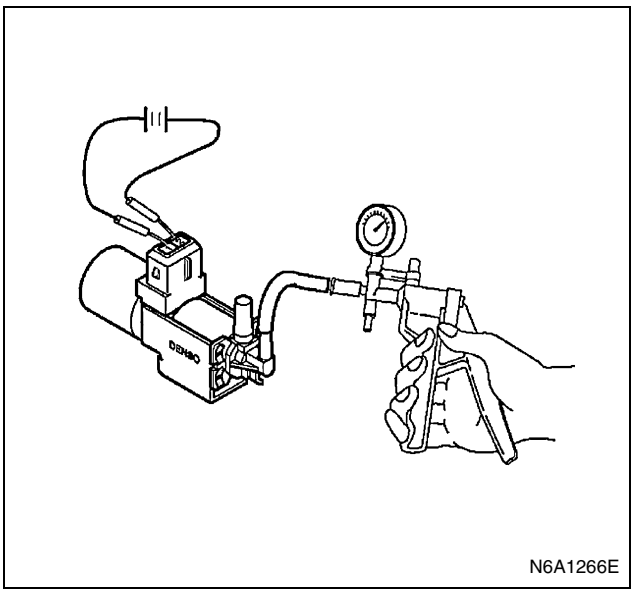


N6A1265E

Airtight Check

Apply negative pressure to the negative pressure input port as illustrated on the left.

Although there is leakage, it is no problem if the negative pressure rises to -46.7 kPa (-350 mmHg / -6.77 psi) or more.



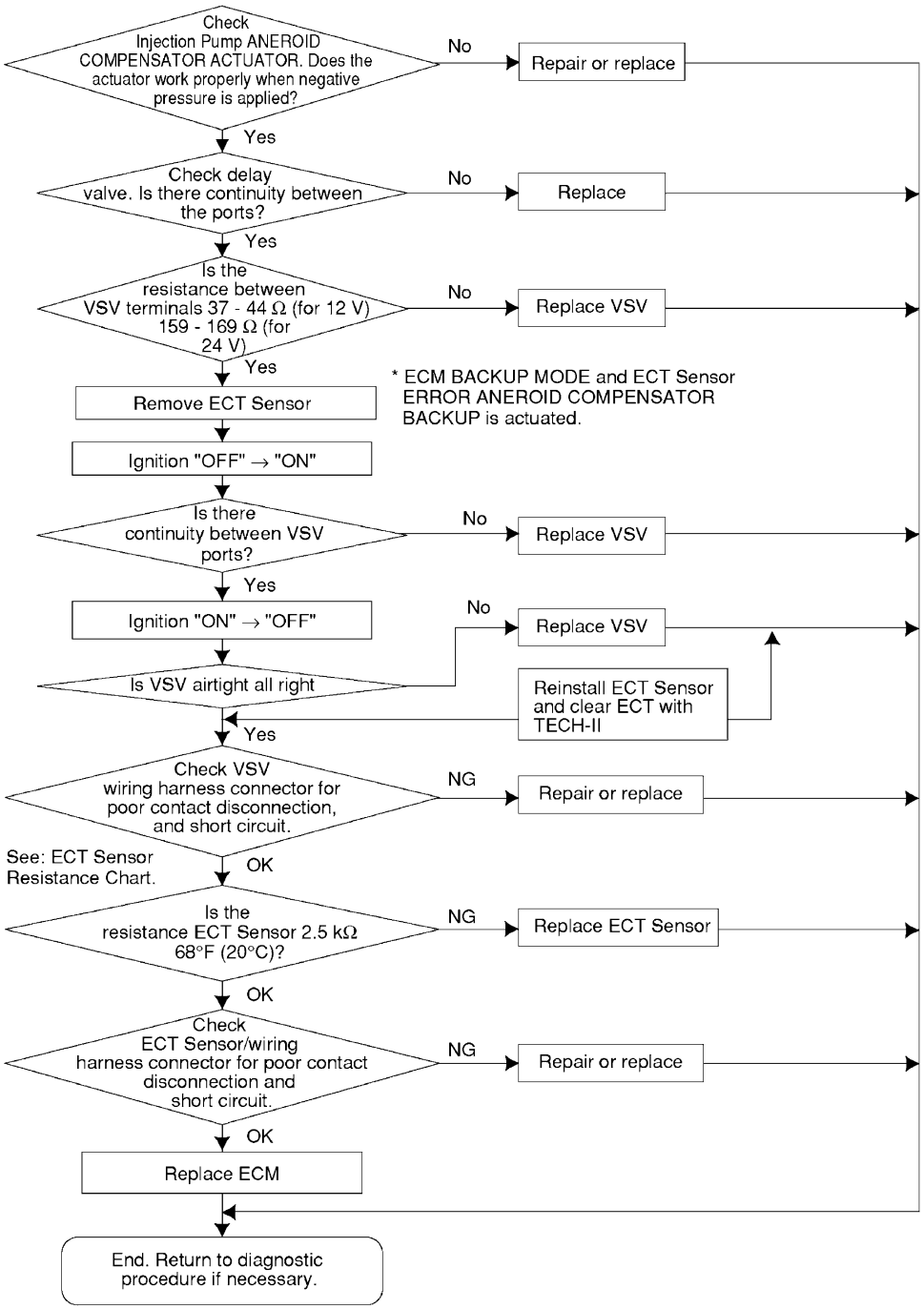
Working Check

Apply powervoltage between the terminals, there is no problem if the negative pressure does not rise when applied to the input port.

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

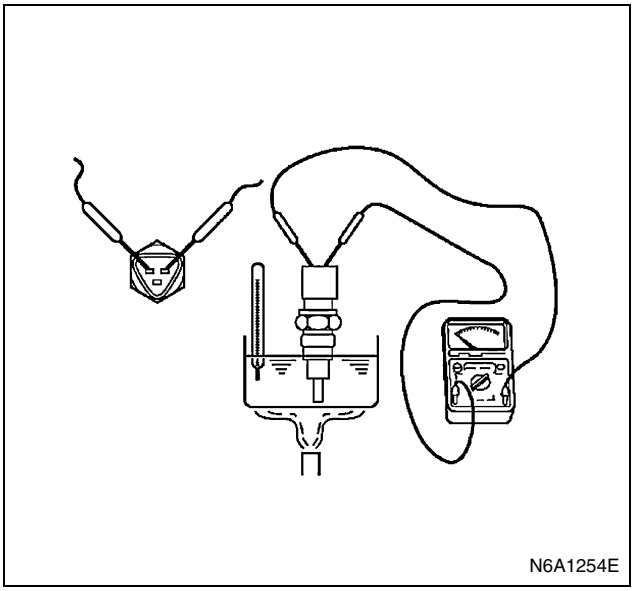
Aneroid Compensator Malfunction

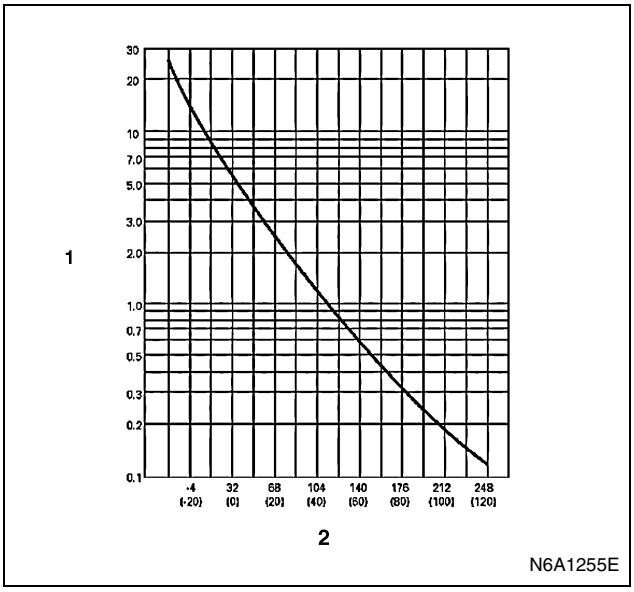


N6A1267E

Inspection

1. Thermosensor (Engine coolant temperature (ECT))
   Soak the temperature sensitive part of a thermosensor in the water, and while changing the water temperature, make sure the resistance is changed as the following graph shows:


N6A1254E



N6A1255E

Legend
1. Resistance (kΩ)
2. ECT °F (°C)

2. Vacuum Switching Valve (VSV)

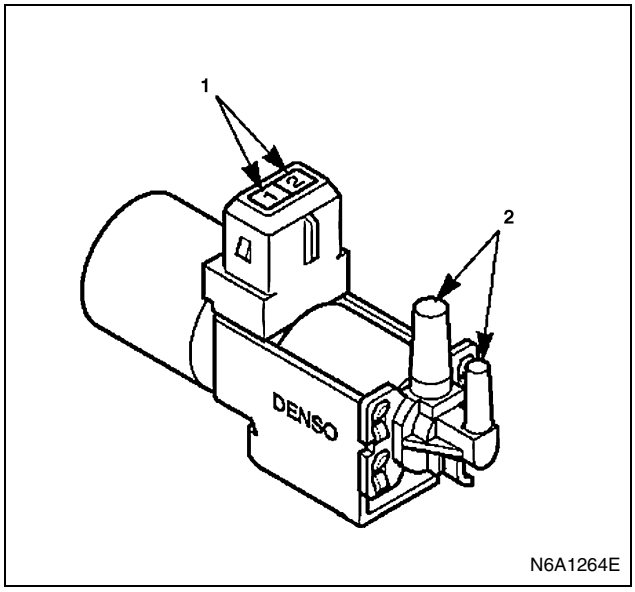
Resistance Check

Check the resistance between the VSV connector terminals using a circuit tester.

Cold Resistance

: 37 — 44 (Ω) (for 12 Volt)

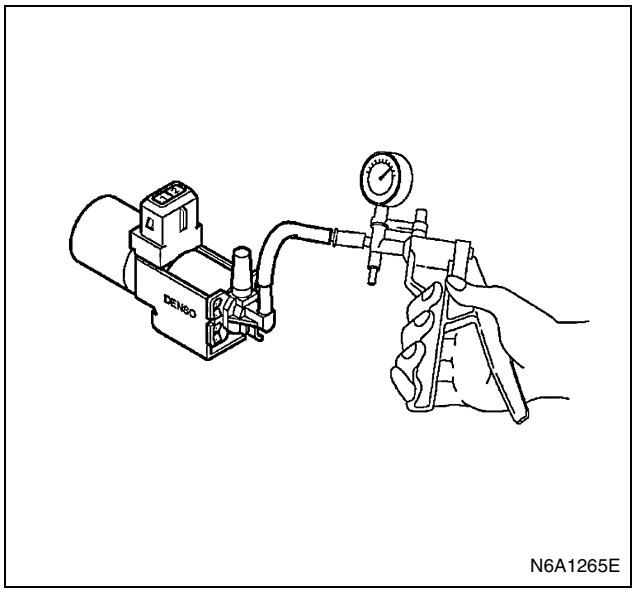
: 159 — 169 (Ω) (for 24 Volt)



N6A1264E

Legend
1. 2 Pin
2. Port

Connect battery voltage between VSV connector terminals and make sure of the continuity between the pots.

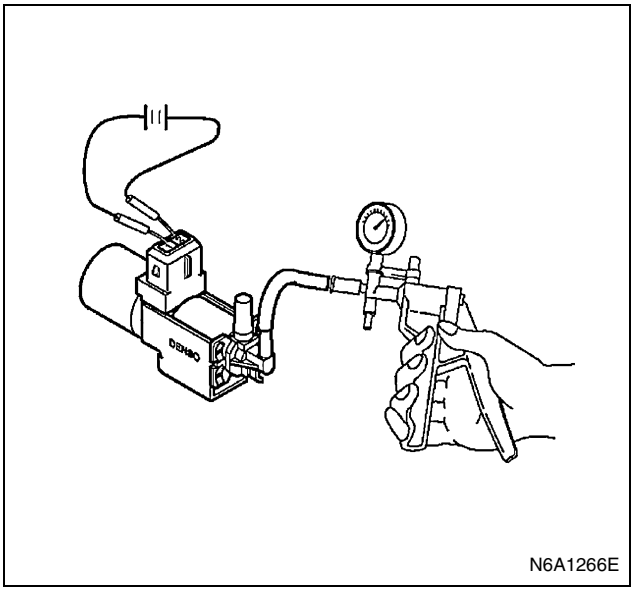


N6A1265E

Airtight Check

Apply negative pressure to the negative pressure input port as illustrated on the left.

Although there is leakage, it is no problem if the negative pressure rises to -46.7 kPa (-350 mmHg / -6.77 psi) or more.


N6A1266E

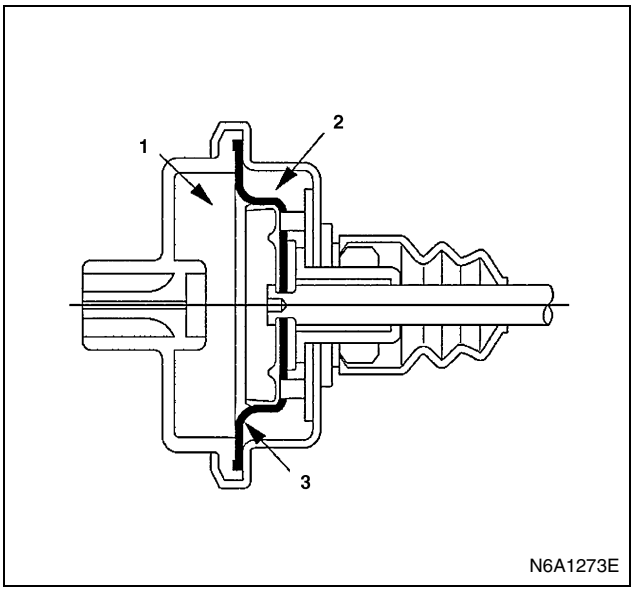
Working Check

Apply powervoltage between the terminals, there is no problem if the negative pressure does not rise when applied to the input port.

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

3. Actuator
   Diaphragm is built in the actuator, by which the inside of the actuator is divided into two, atmospheric room and negative pressure room.

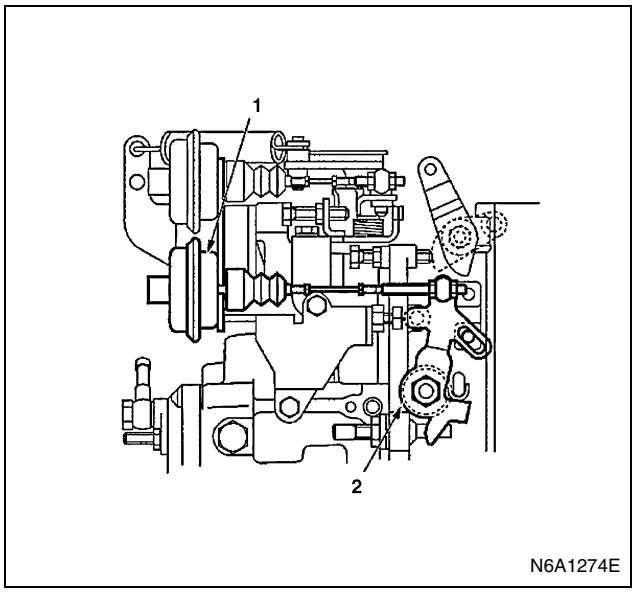


N6A1273E

Legend

1. Vacuum chamber
2. Atmospheric chamber
3. Diaphragm

4. Aneroid compensator Actuator
   The link of the actuator for the aneroid compensator is connected to full load set lever.
   The full load set lever is connected to a U-lever.
   When the atmospheric sensor built in Engine Control Module (ECM) makes the actuator work, the full load set lever and U-lever are rotated to a specified position so that the control rack is drawn in the direction of reducing fuel injection amount.

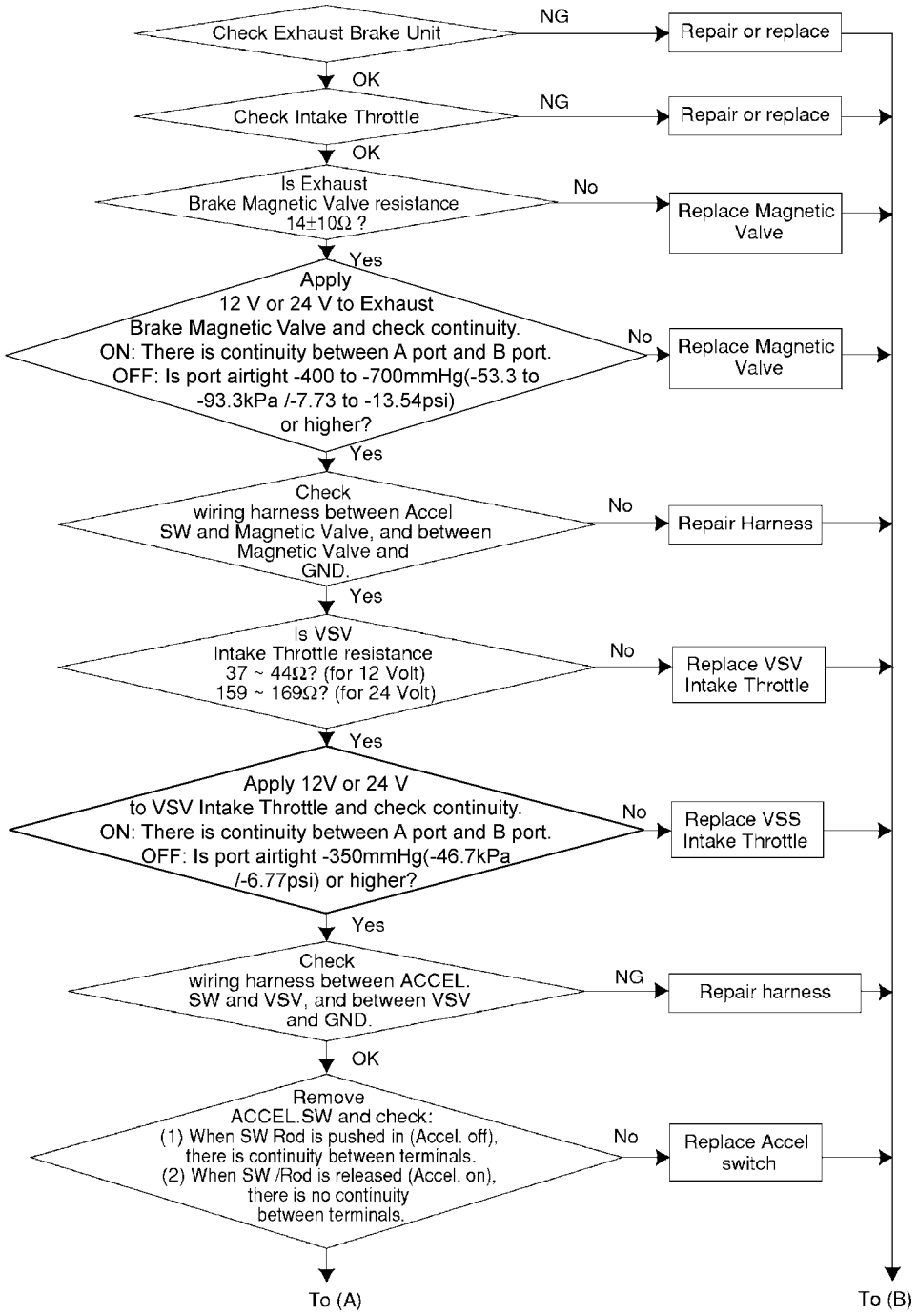


N6A1274E

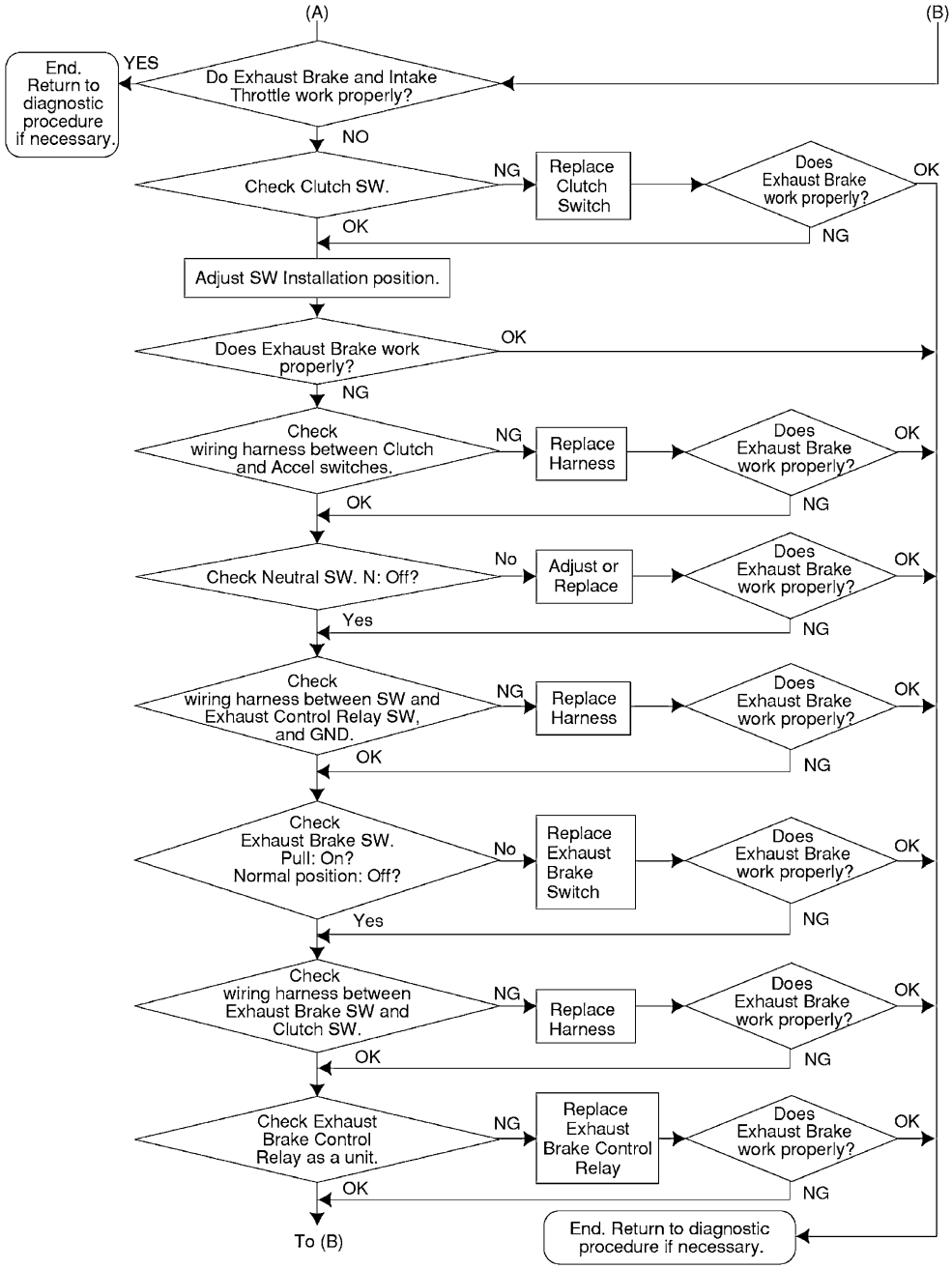
Legend

1. Aneroid compensator actuator
2. Full load set lever

Quick Warm System (QWS) Malfunction



N6A1676E


(A)
(B)
End. Return to diagnostic procedure if necessary.
YES
Do Exhaust Brake and Intake Throttle work properly?
NO
Check Clutch SW.
NG
Replace Clutch Switch
Does Exhaust Brake work properly?
OK
NG
OK
Adjust SW Installation position.
Does Exhaust Brake work properly?
OK
NG
Check wiring harness between Clutch and Accel switches.
NG
Replace Harness
Does Exhaust Brake work properly?
OK
NG
OK
Check Neutral SW. N: Off?
No
Adjust or Replace
Does Exhaust Brake work properly?
OK
NG
Yes
Check wiring harness between SW and Exhaust Control Relay SW, and GND.
NG
Replace Harness
Does Exhaust Brake work properly?
OK
NG
OK
Check Exhaust Brake SW. Pull: On? Normal position: Off?
No
Replace Exhaust Brake Switch
Does Exhaust Brake work properly?
OK
NG
Yes
Check wiring harness between Exhaust Brake SW and Clutch SW.
NG
Replace Harness
Does Exhaust Brake work properly?
OK
NG
OK
Check Exhaust Brake Control Relay as a unit.
NG
Replace Exhaust Brake Control Relay
Does Exhaust Brake work properly?
OK
NG
OK
To (B)
End. Return to diagnostic procedure if necessary.

N6A1276E

Inspection

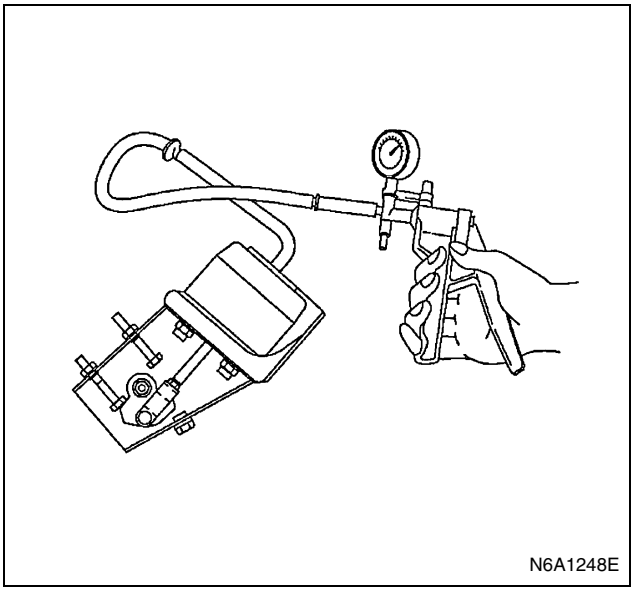
1. Exhaust Throttle Valve

Working Check

Actuate the exhaust brake with the engine idling and make sure that you hear the valve strike on the stopper.

Airtight Check

Apply a negative pressure of -53.3 — -93.3 kPa (-400 — -700 mmHg/-7.73 — -13.54 psi) to the power chamber by means of a vacuum pump and make sure of the smooth opening/closing of the exhaust brake valve.

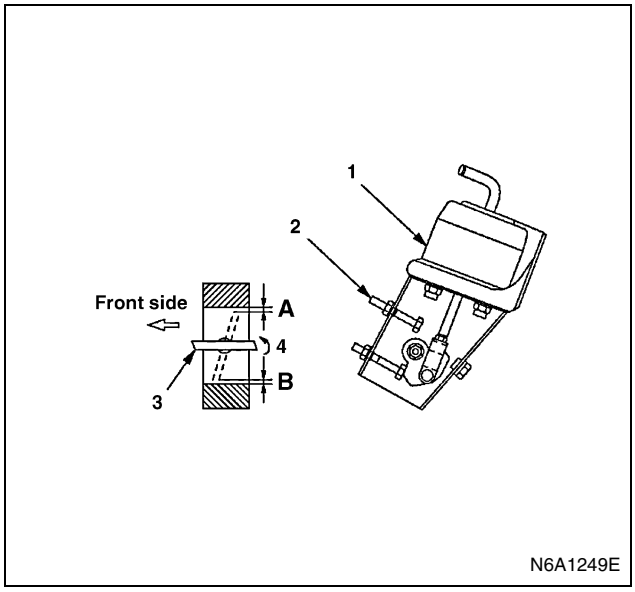


N6A1248E

Apply a negative pressure of -86.7 — -93.3 kPa (-650 — -700 mmHg/-12.57 — -13.54 psi) to the power chamber using a vacuum pump and make sure the average of measurements at Point A and Point B of the clearance between valve and body is as follows:

0.4 — 0.6 mm (0.016 — 0.024 in) (Minimum: 0.4 mm/0.016 in)

If the clearance is out of this range adjust with the adjusting bolt.



N6A1249E

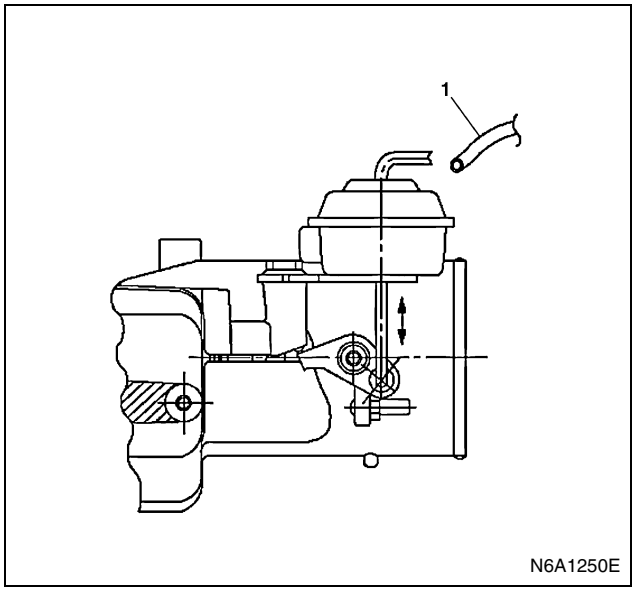
Legend

1. Power chamber
2. Adjust bolt
3. Valve
4. Close

2. Intake Throttle Valve

Working Check

Disconnect the vacuum hose from the actuator and try to move the rod by hand, making sure of the smooth move of the rod.



N6A1250E

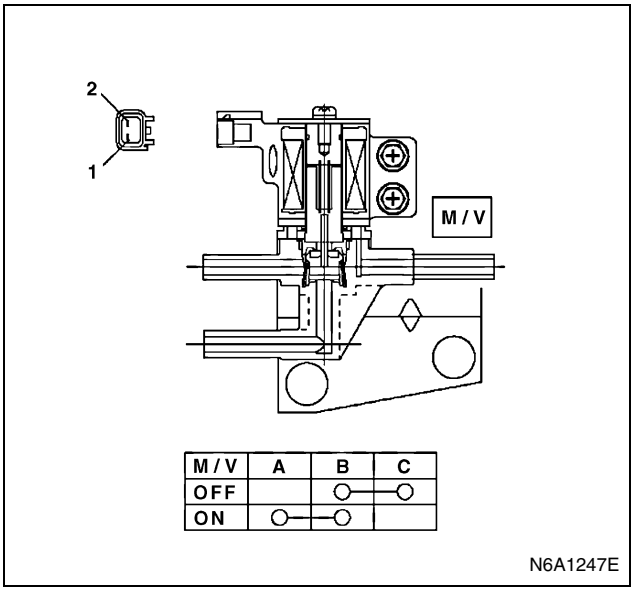
Legend

1. Vacuum hose

3. Exhaust Brake Magnetic Valve

Inspection

Connect the magnetic valve connector terminal No.1 and No.2 to (+) terminal and (-) terminal of battery respectively, and check the continuity between the ports.



Legend

A. Inlet (vacuum pump)
B. Outlet (unit)
C. EXH (air filter)

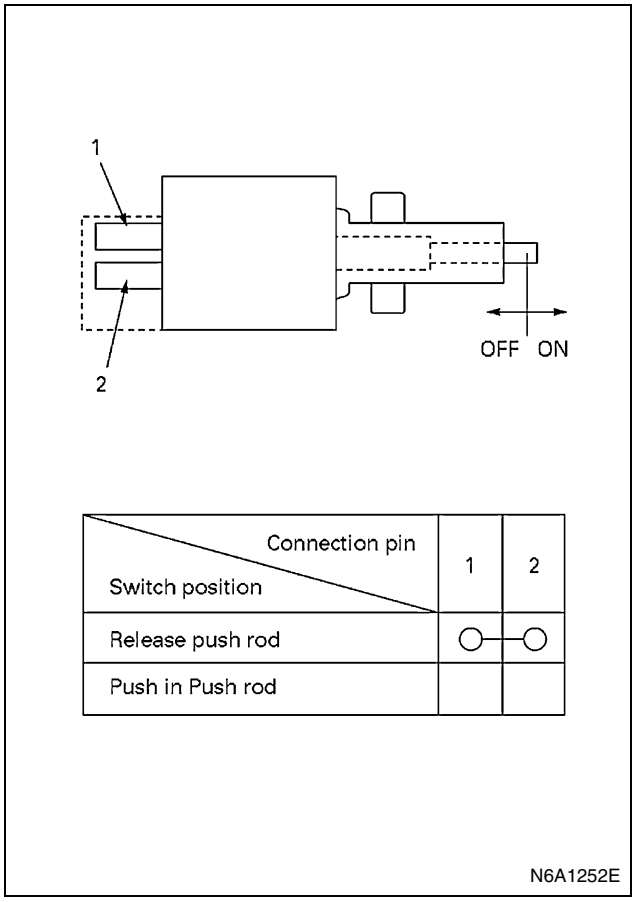
4. Accelerator Switch (2-pole connector type)

Inspection

1) Check the continuity between the switch connector terminals.
2) Check the smooth move of the pushrod. If the check result is abnormal, repair or replace the pushrod.

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.



Removal

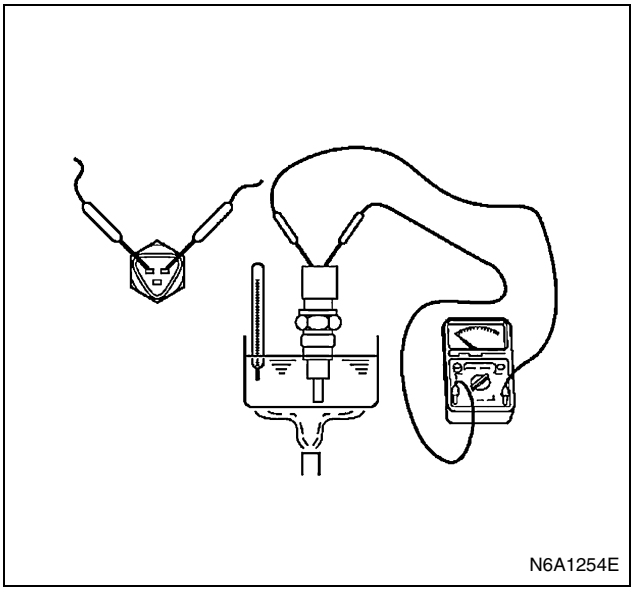
1) Accelerator Switch
   Disconnect the connector.
   Loosen the lock nut.
   Turn the switch to remove.

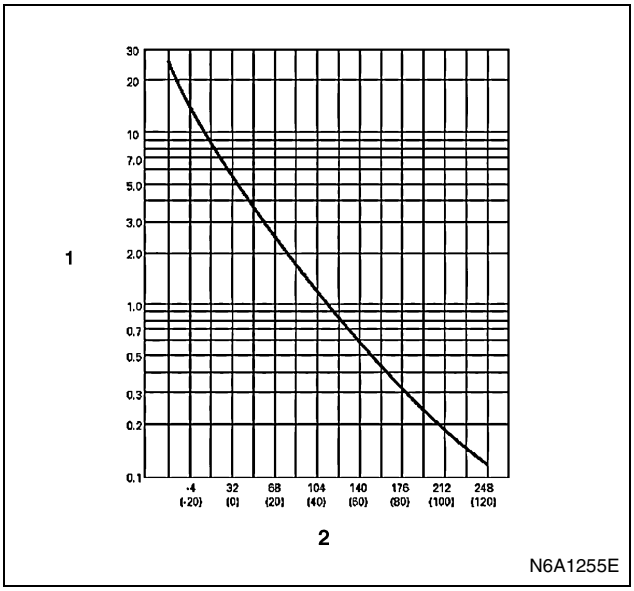
Reinstallation

To install, follow the removal procedure in reverse order:

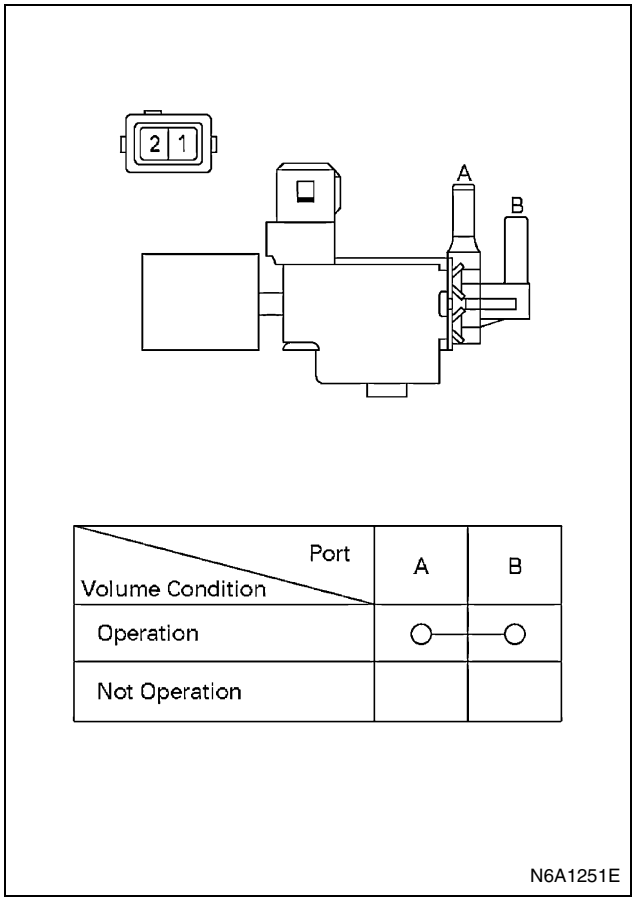
1) Drive the threaded part of the switch until its end surface becomes flush with that of the bracket side of nut.
2) Tighten the lock nut.
   Tightening torque: 1.3 N·m (0.13 kg·m/11.5 lb·in)

5. Thermosensor (Engine coolant temperature)
   Soak the temperature sensitive part of a thermosensor in the water, and while changing the water temperature, make sure the resistance is changed as the following graph shows:


N6A1254E



N6A1255E



N6A1251E

Legend

1. Resistance (kΩ)
2. ECT °F (°C)

6. Vacuum Switching Valve; Intake Throttle

Inspection

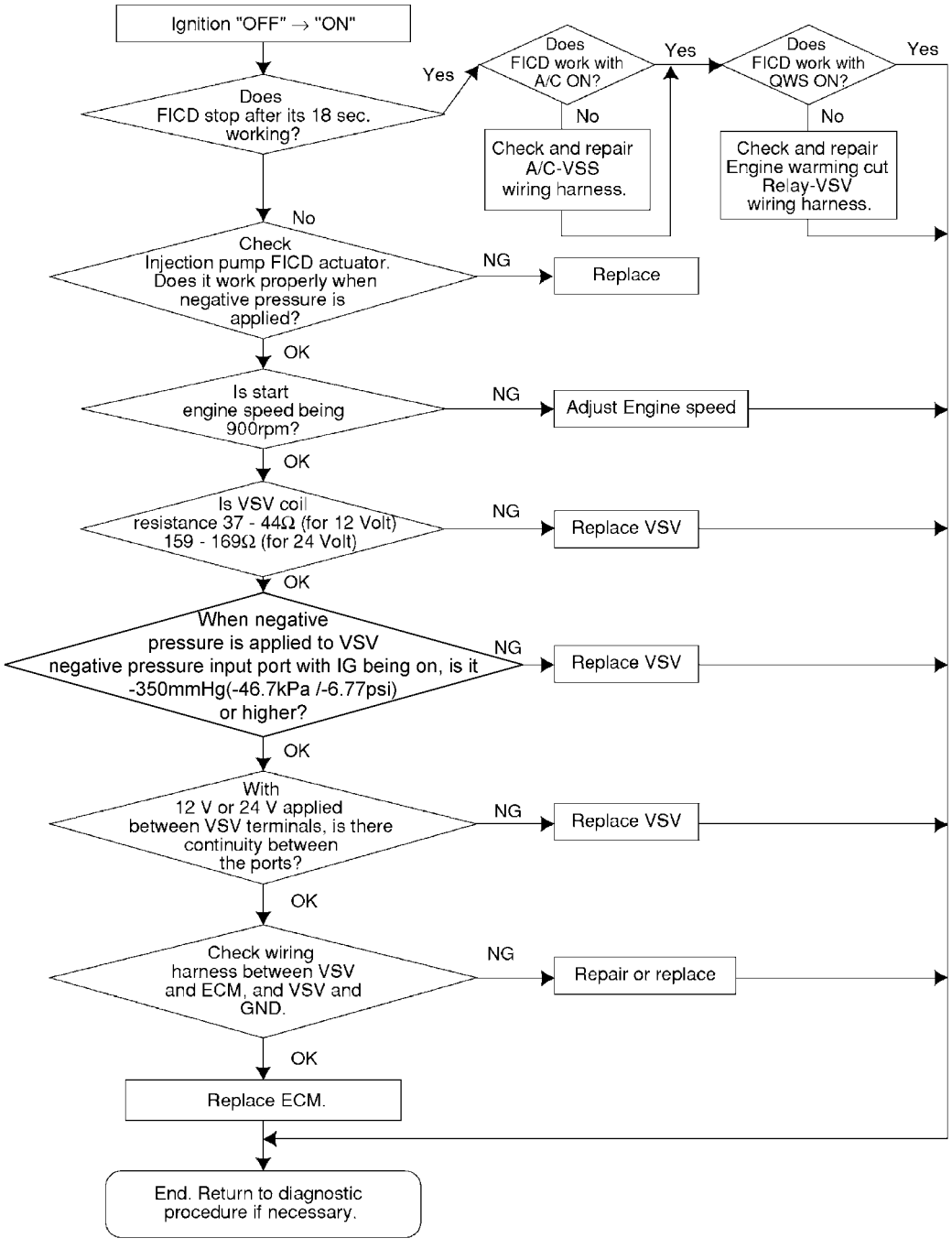
Connect the vacuum switching valve connector terminals No.1 and No.2 to (+) terminal and (-) terminals of battery respectively, and check the continuity between the ports.

If the check result is abnormal, repair or replace the valve.

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

Fast Idle Control Device (FICD) System Malfunction



N6A1677E

Inspection

Vacuum Switching Valve (VSV)

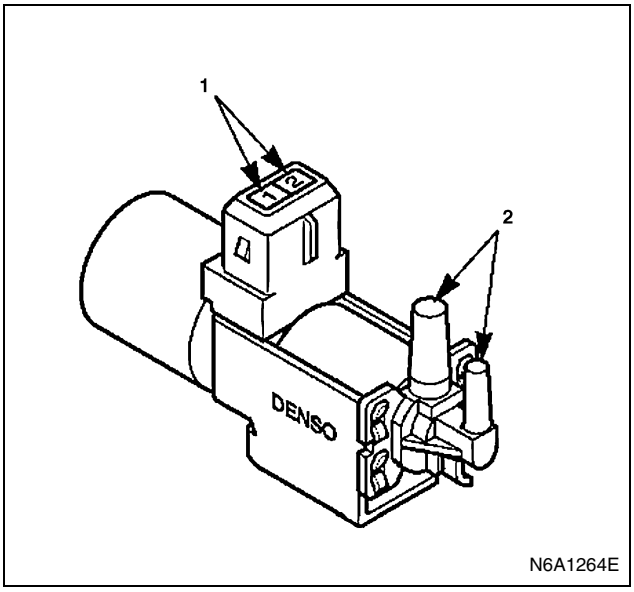
Resistance Check

Check the resistance between the VSV connector terminals using a circuit tester.

Cold Resistance

: 37 — 44 (Ω) (for 12 Volt)

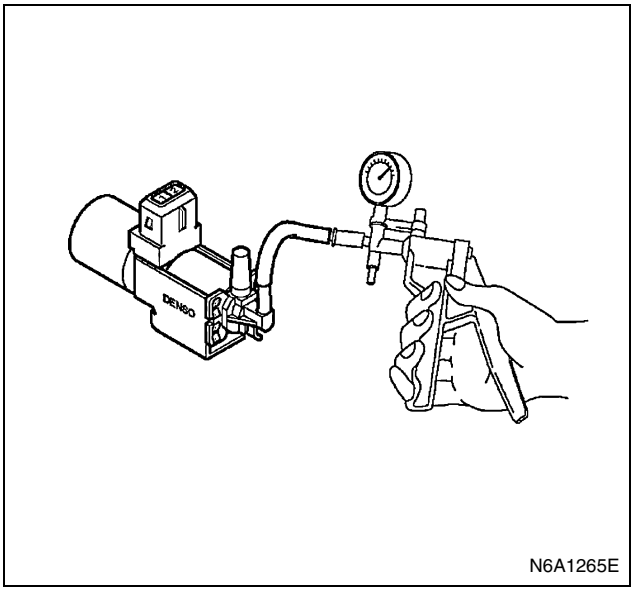
: 159 — 169 (Ω) (for 24 Volt)



Legend

1. 2 Pin
2. Port

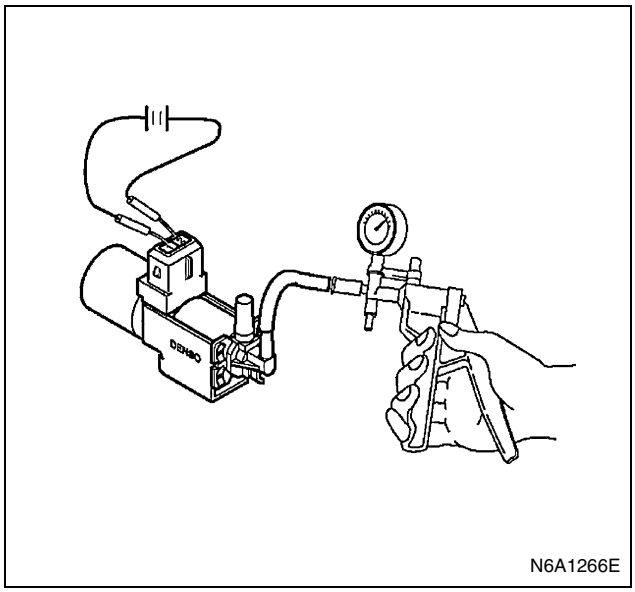
Connect the battery voltage between VSV connector terminals and make sure of the continuity between the ports.



Airtight Check

Apply negative pressure to the negative pressure input port as illustrated on the left.

Although there is leakage, it is no problem if the negative pressure rises to -46.7 kPa (-350 mmHg / -6.77 psi) or more.

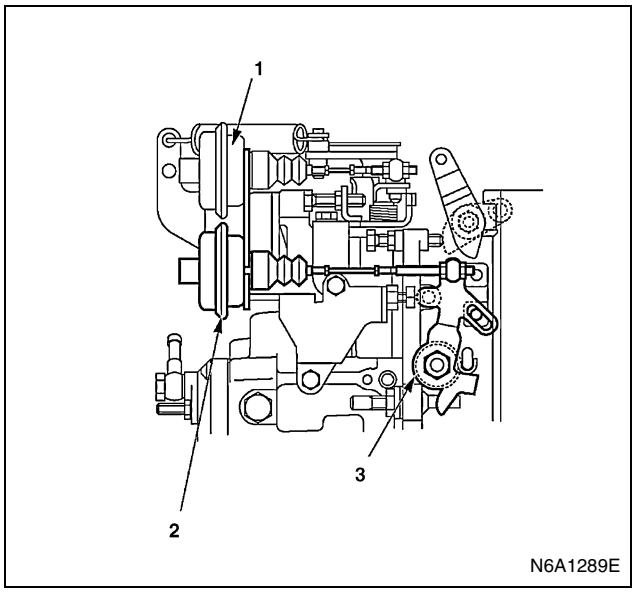


Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

Working Check

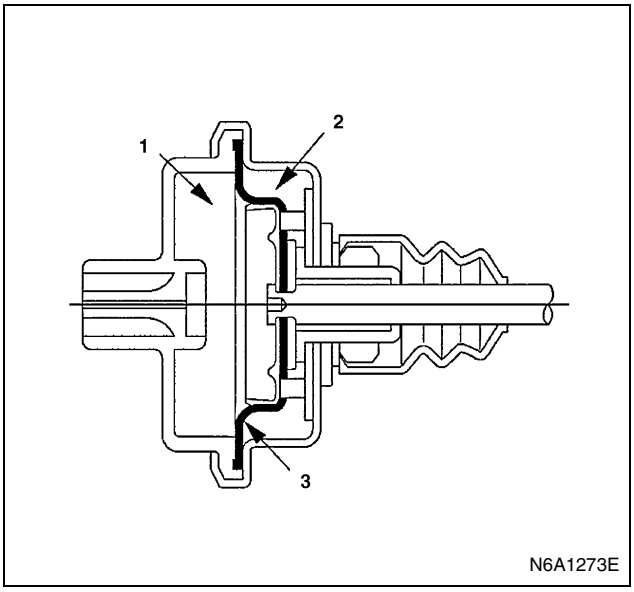
Apply powervoltage between the terminals, there is no problem if the negative pressure does not rise when applied to the input port.



Legend

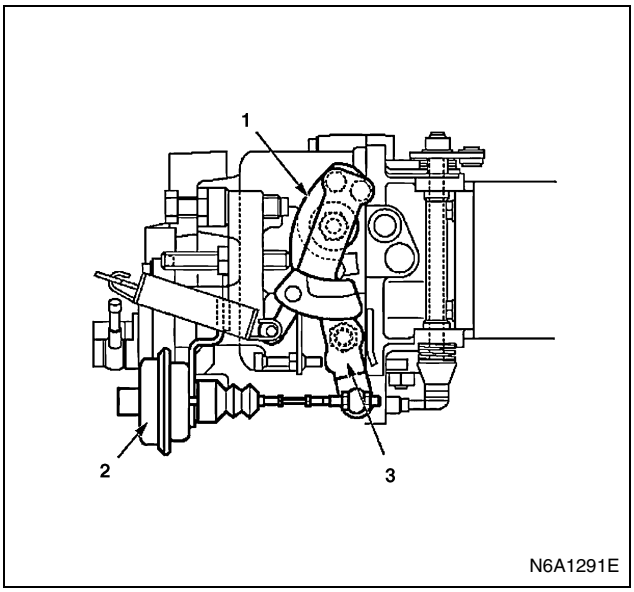
1. FICD actuator
2. Aneroid compensator actuator
3. Full rod set lever

1. Diaphragm is built in the actuator, by which the inside of the actuator is divided into two, atmospheric room and negative pressure room.



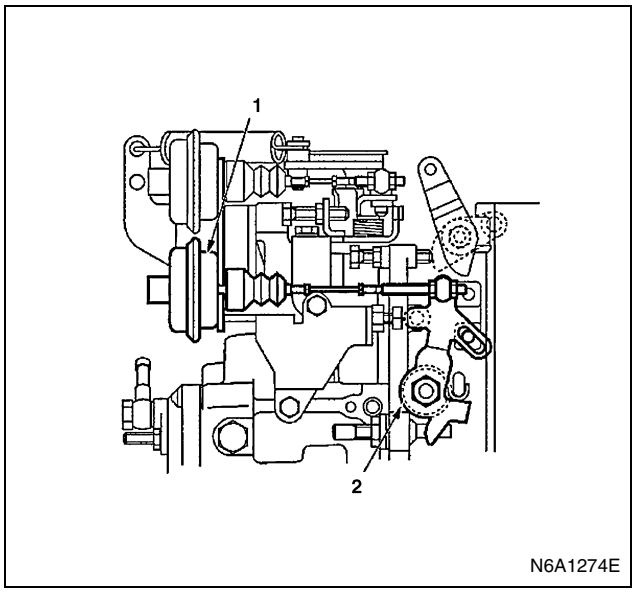
Legend
1. Vacuum chamber
2. Atmospheric chamber
3. Diaphragm

2. Fast Idle Control Device (FICD) actuator link is connected to FICD lever, setting speed control lever at a specified speed when FICD is at work at the time of idling.



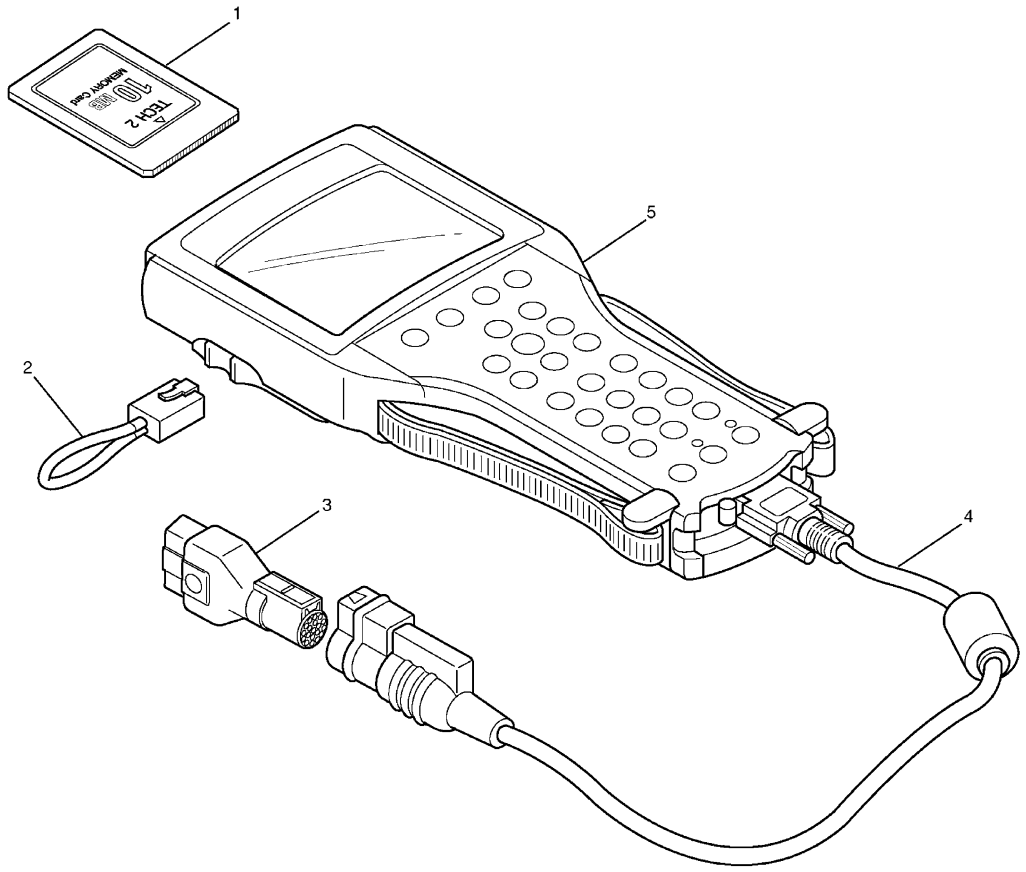
Legend
1. Speed control lever
2. FICD actuator
3. FICD lever

3. The link of the actuator for the aneroid compensator is connected to full load set lever. The full load set lever is connected to a U-lever. When the atmospheric sensor built in Engine Control Module (ECM) makes the actuator work, the full load set lever and U-lever are rotated to a specified position so that the control rack is drawn in the direction of reducing fuel injection amount.



Legend
1. Aneroid compensator actuator
2. Full load set lever

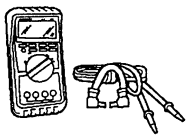
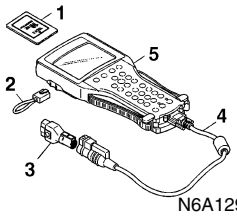
SPECIAL TOOLS



N6A1293E

Legend

1. PCMCIA card
2. RS232 loop back connector
3. SAE 16/19 adapter
4. DLC cable
5. TECH-2

Illustration	Tool Number / Description / Remarks
 5884003660	5-8840-0366-0 (J 39200) / High Impedance Multimeter (Digital Voltmeter-DVM)
 N6A1295E	1. PCMCIA Card 2. RS232 Loop Back 3. SAE 16/19 Adapter 4. DLC Cable 5. TECH-2
 5884002790	5-8840-0279-0 (J 23738-A) / Vacuum Pump with Gauge

DIAGNOSIS (4HG1-T Only)

Strategy-Based Diagnostics

Strategy-Based Diagnostics

The strategy-based diagnostic is a uniform approach to repair all Electrical/Electronic (E/E) systems. The diagnostic flow can always be used to resolve an E/E system problem and is a starting point when repairs are necessary. The following steps will instruct the technician how to proceed with a diagnosis:

1. Verify the customer complaint.
   - To verify the customer complaint, the technician should know the normal operation of the system.
2. Perform preliminary checks.
   - Conduct a thorough visual inspection.
   - Review the service history.
   - Detect unusual sounds or odors.
   - Gather diagnostic trouble code information to achieve an effective repair.
3. Check bulletins and other service information.
   - This includes videos, newsletters, etc.
4. Refer to service information (manual) system check (s).
   - “System checks” contain information on a system that may not be supported by one or more DTCs.
     System checks verify proper operation of the system. This will lead the technician in an organized approach to diagnostics.
5. Refer to service diagnostics.

Diagnostic Trouble Code (DTC) Stored

Follow the designated DTC chart exactly to make an effective repair.

No DTC

Select the symptom from the symptom tables.
Follow the diagnostic paths or suggestions to complete the repair. You may refer to the applicable component/ system check in the system checks.

No Matchig Symptom

1. Analyze the complaint.
2. Develop a plan for diagnostics.
3. Utilize the wiring diagrams and the theory of operation.

Call technical assistance for similar cases where repair history may be available. Combine technician knowledge with efficient use of the available service information.

Intermittents

Conditions that are not always present are called intermittents. To resolve intermittents, perform the following steps:

1. Evaluate the symptoms and the conditions described by the customer.
2. Use a check sheet or other method to identify the circuit or electrical system component.
3. Follow the suggestions for intermittent diagnosis found in the service documentation.

No Trouble Found

This condition exists when the vehicle is found to operate normally. The condition described by the customer may be normal. Verify the customer complaint against another vehicle that is operating normally. The condition may be intermittent. Verify the complaint under the conditions described by the customer before releasing the vehicle.

1. Re-examine the complaint When the Complaint cannot be successfully found or isolated, a re-evaluation is necessary.
   The complaint should be re-verified and could be intermittent as defined in Intermittents, or could be normal.
2. Repair and verify.
   After isolating the cause, the repairs should be made.
   Validate for proper operation and verify that the symptom has been corrected. This may involve road testing or other methods to verify that the complaint has been resolved under the following conditions:
   - Conditions noted by the customer.
   - If a DTC was diagnosed, verify a repair by duplicating conditions present according to customer complaint.

Verifying Vehicle Repair

Verification of the vehicle repair will be more comprehensive for vehicles with self diagnostic system diagnostics. Following a repair, the technician should perform the following steps:

Important:
Follow the steps below when you verify repairs on self diagnostic systems. Failure to follow these steps could result in unnecessary repairs.

1. Review and record the Failure Records for the DTC which has been diagnosed.
2. Clear the DTCs.
3. Operate the vehicle within conditions according to customer complaint.
4. Monitor the Diagnostic Trouble Code (DTC) status information for the specific DTC which has been diagnosed until the diagnostic test associated with that DTC runs.

GENERAL SERVICE INFORMATION

Visual/Physical Engine Compartment Inspection
Perform a careful visual and physical engine compartment inspection when performing any diagnostic procedure or diagnosing the cause of an emission test failure. This can often lead to repairing a problem without further steps. Use the following guidelines when performing a visual/physical inspection:

- Inspection all vacuum hoses for punches, cuts, disconnects, and correct rouring.
- Inspect hoses that are difficult to see behind other components.
- Inspect all wires in a engine compartment for proper connections, burned or chafed spots, pinched wires, contact with sharp edges or contact with hot exhaust manifolds or pipes.

Basic Knowledge of Tools Required

Notice:
Lack of basic knowledge of this powertrain when performing diagnostic procedures could result in an incorrect diagnosis or damage to powertrain components. Do not attempt to diagnose a powertrain problem without this basic knowledge.

A basic understanding of hand tools is necessary to effectively use this section of the Servise Manual

Self Diagnostic System Check
Self Diagnostic System should be checked as follows:

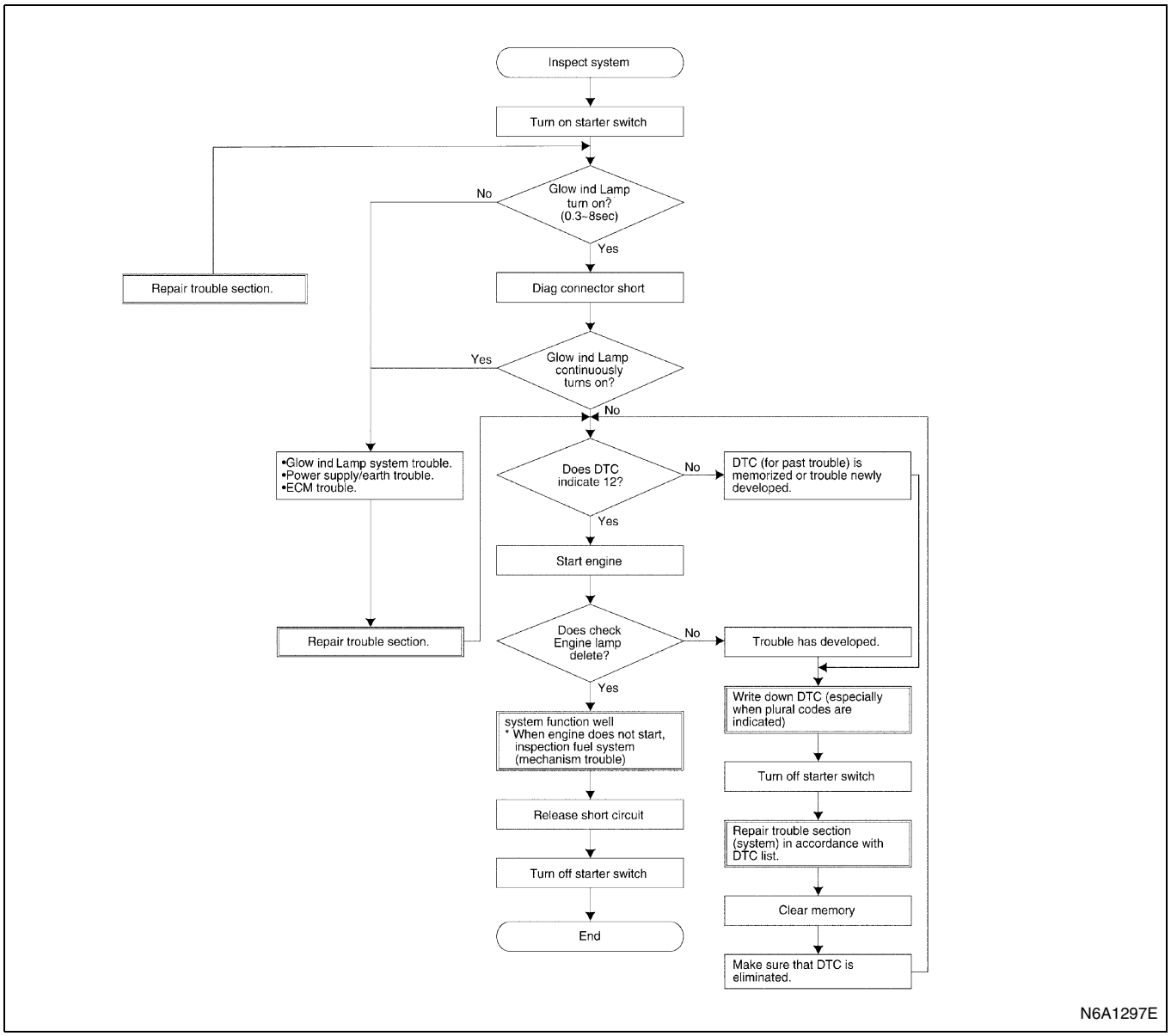
1. When Ignition key is turned from the “OFF” to the “ON” position, make sure that Malfunction Indicator Lamp (MIL) is lit for 0.3 — 0.8 sec.
2. Connect Scan Tool and check to see if MIL is always lit.
   If so, Self Diagnostic System is normal.

Troubleshooting

Caution taken in inspecting

1. In inspecting system, write down Diagnostic Trouble Code (DTC) to be indicated. (especially, when plural self-diagnosis codes are indicated.)
2. Before eliminating the indicated DTC by a memory clear switch, doubly inspect abnormal place as indicated in DTC.

Inspection Procedure Flowchart (Diagnostic System Check)



Notice:

Please note that some items of DTC may not be generated unless the engine is warmed up or unless the vehicle is driven under load.

Self-diagnosis Functions

Memorization of diagnostic trouble code

The self-diagnosis code indicated will be memorized in Electronically Erasable Programmable Read Only Memory (EEPROM) with in the Engine Control Module (ECM).

Accordingly even if the starter switch turns off or the ECM is removed from the vehicle, the memorized self-diagnosis code will not be eliminated.

* Unless an elimination procedure is taken, the diagnostic trouble code (DTC) will remain in memory. (The memory will be eliminated only by a memory clear switch.)

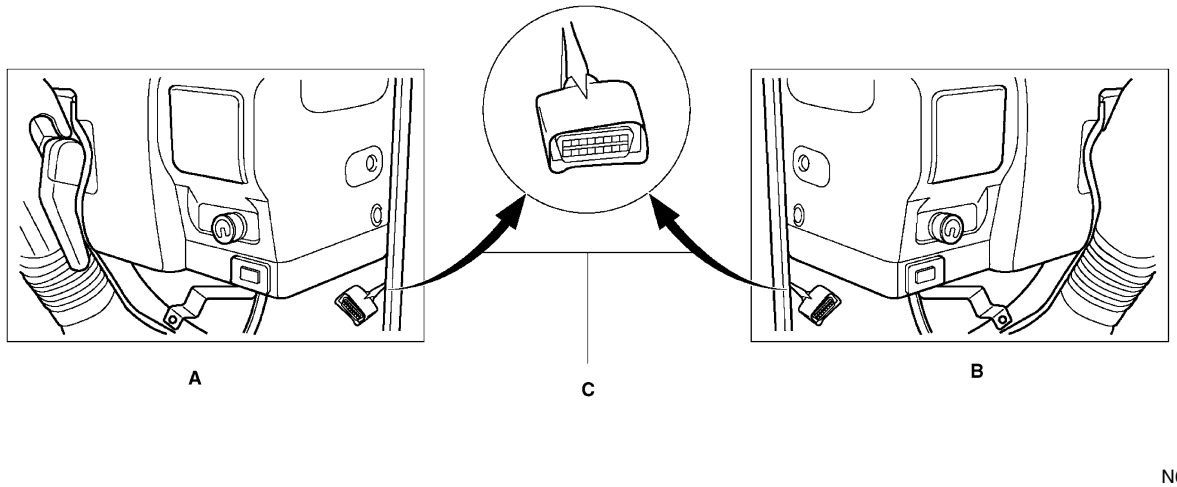
Elimination of diagnostic trouble code

The DTC memorized in the EEPROM with in the ECM can be eliminated only by the operation of the memory clear switch. The elimination method memory clear switch will be described below:

1. Turn OFF ignition switch.
2. Use 4.7kΩ resistance and make short circuit on memory clear switch.
3. Turn ON ignition switch. The indication lamp turn on (lighting) continuously after three seconds flashing the indication lamp.
4. Turn OFF ignition switch.
5. Remove shortage resistance from memory clear switch.

Location of the Memory Clear Switch

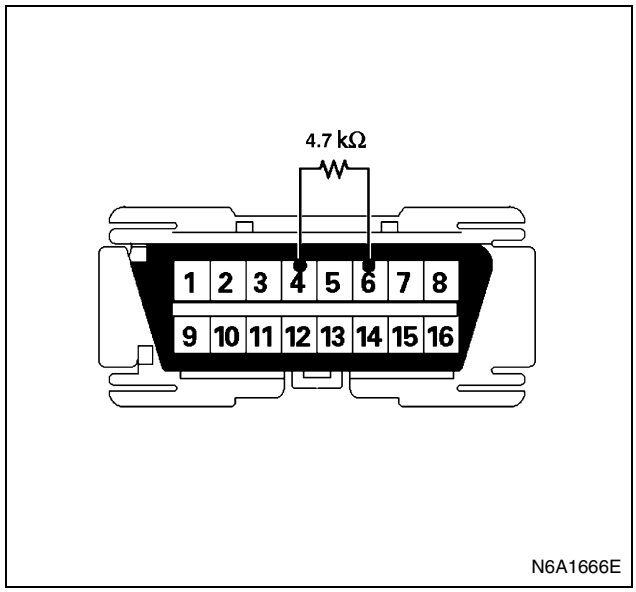
Location of the Memory Clear Switch (Diagnosis Connector)



N6A1665E

Legend

A. Right-hand drive
B. Left-hand drive
C. Terminal assignment of diagnosis connector



N6A1666E

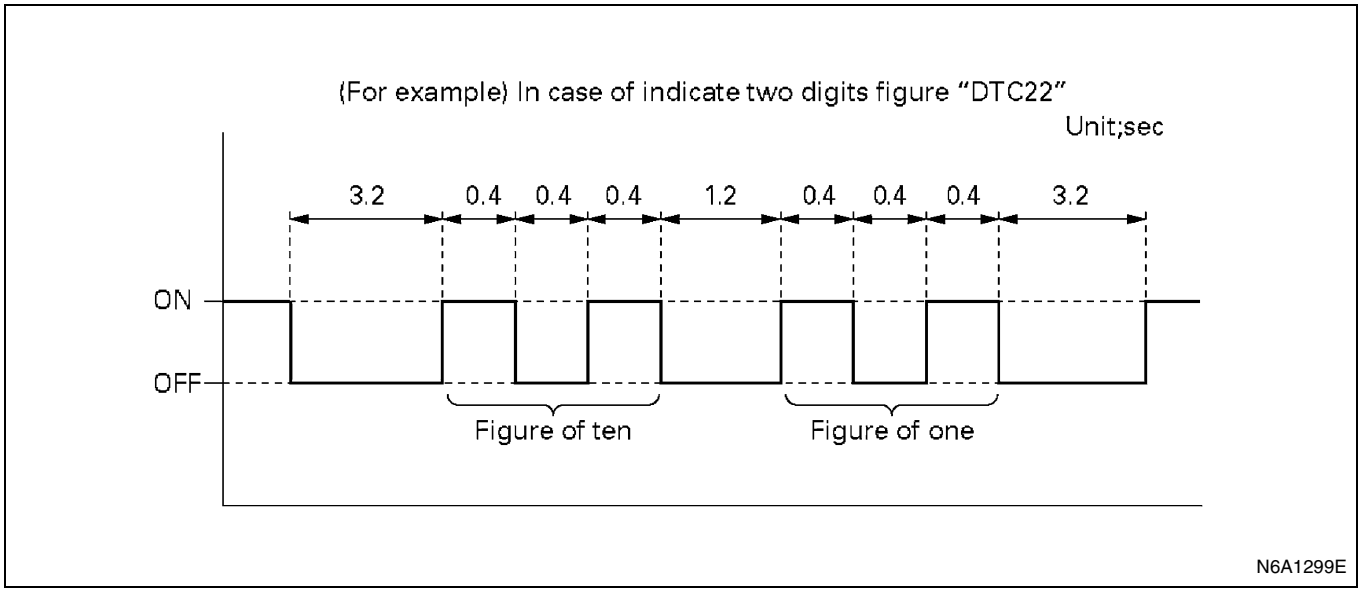
NO	TERMINAL NAME
6	DIAG CONTROL
7	CHECKER SIG
4, 5	CHECKER GND

How to read flashing of the indicator lamp:

The two-digit diagnosis code flashes starting from ten's figure to indicate the diagnosis code.
Please read the diagnosis code from the flashing.
If the plural diagnosis codes are indicated, the same diagnosis code is flashed repeatedly in steps of three times.
Please read it correctly.

- Diagnostic Trouble Code (DTC) outputting is done in decreasingly order of DTC number.
- Indication is changed over on completion of output DTC indication.
- DTC indicator is stopped with diagnostic switch being off.
- When there is no DTC output, -12+ is outputted in normal DTC code.
- After indicating 3 times pear 1 DTC, shift is conducted to the next DTC. (After making a round, the indications are repeated again.)
- In case of the same diagnostic code, it is used 1 DTC (3 times indication.)

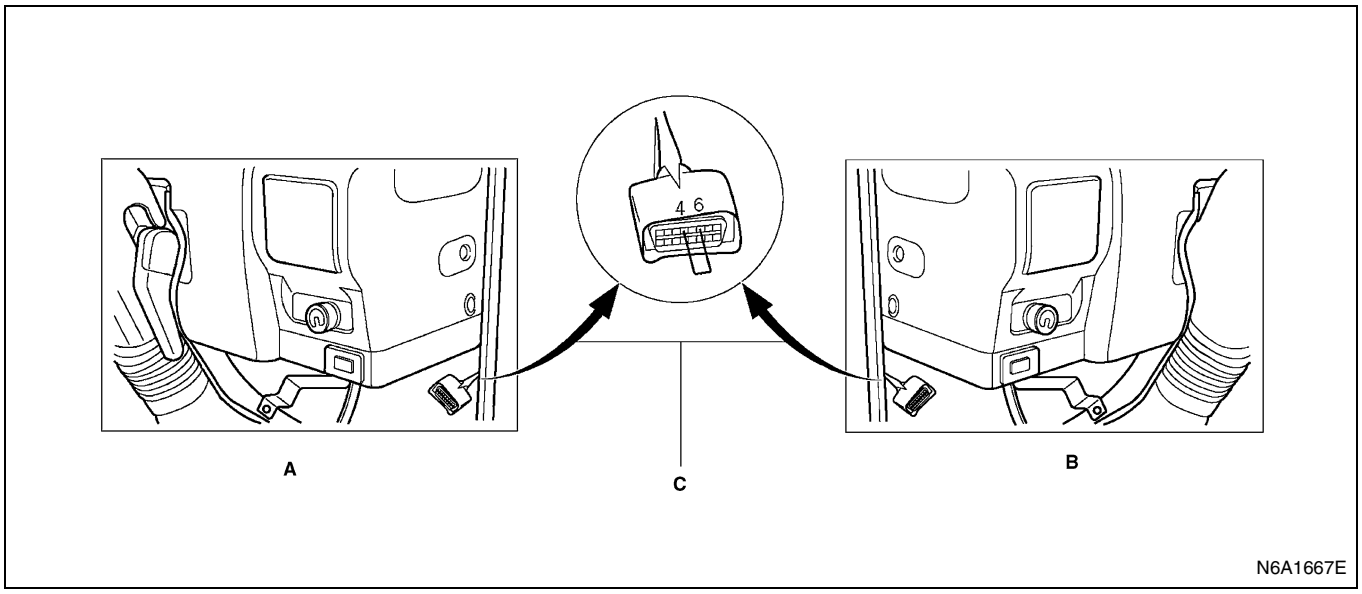
Example Diagnosis Trouble Code Output



Legend

1. (For example) In case of indicate two digits figure "DTC22"
2. Figure of ten
3. Figure of one

Flashing of Indicator Lamp



Legend

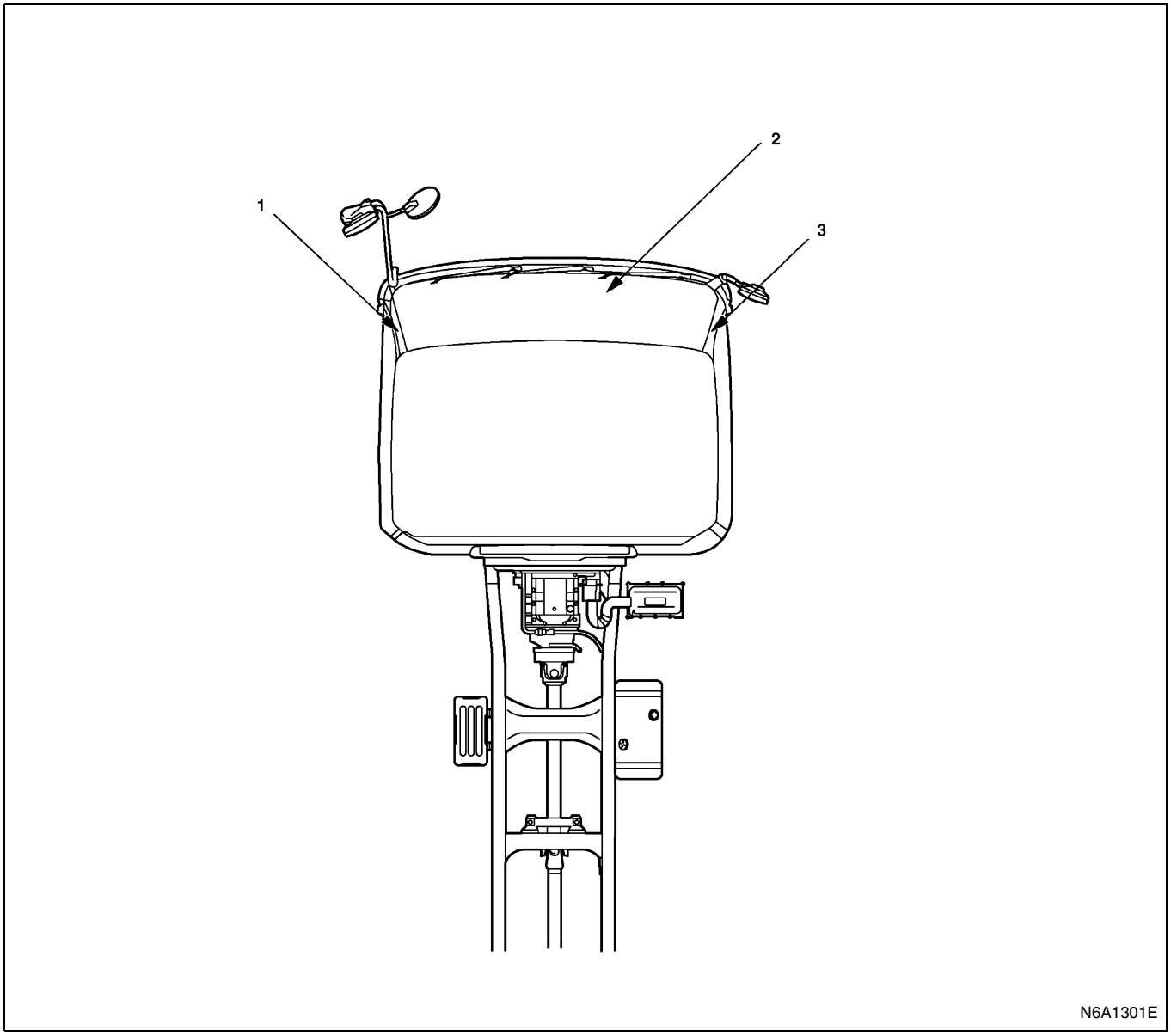
A. Right-hand drive
B. Left-hand drive
C. Terminal assignment of diagnosis connector

Diagnosis Trouble Code (DTC) List

DTC#	TECH 2 STRING
21	Rack Sensor Circuit Low Voltage
22	Rack Sensor Circuit High Voltage
13	Engine Coolant Temperature (ECT) Sensor Circuit High Voltage
14	ECT Sensor Circuit Low Voltage
31	Exhaust Gas Recirculation (EGR) Vacuum Switching Valve (VSV) Solenoid Circuit Low Voltage
32	EGR VSV Solenoid Circuit High Voltage
52	Electronically Erasable Programmable Read Only Memory (EEPROM) Error

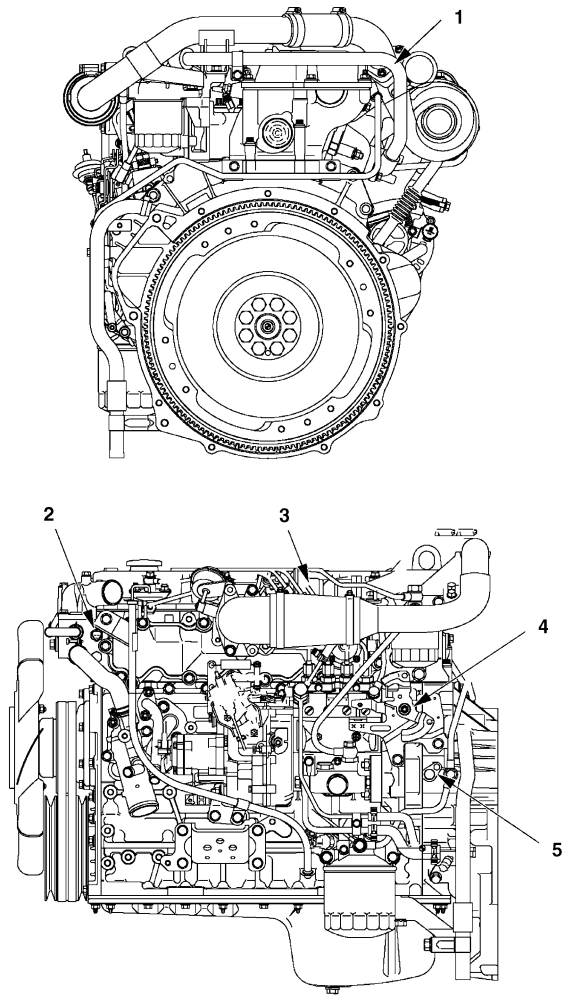
Error Classified		Trouble Code	Diagnostic Condition	Return Condition	Back Up	Judging Time
Normal		12	No other trouble code.		No history of this diagnosis recorded	—
Rack Sensor	Harness Open GND short	21	Rack Voltage 0.3V or lower, Engine speed 600 — 900rpm, and water Temp. 0°C (32°F) or higher are detected for 3 seconds running.	When forward normal	VSV: EGR Output stop. Rack Learning valve: 0	3.52 sec
	+5V short Rack Sensor Power Voltage	22	5V or higher Rack Voltage detected.			0.52 sec
Water Temp Sensor	Harness Open +B short	13	-79°C/-110°F (390kΩ) or lower, or 120°C/248°F (115kΩ) or higher detected.	When forward normal	VSV: EGR Output stop.	0.52 sec
	GND short	14				
VSV: EGR	Harness Open GND short	*31	Output TR Monitor	When forward normal	VSV: EGR Output stop.	1.57 sec
	+B short	*32				
	ECM EEPROM error	52	Check when ECM is started and when Trouble Code is written.	When forward normal	Trouble Code other than 52 (EEPROM error) not indicated.	

Location of Sensor and Switch



Legend

1. Diagnosis connector (Left-hand drive)
2. ECM including atmospheric
3. Diagnosis connector (Right-hand drive)

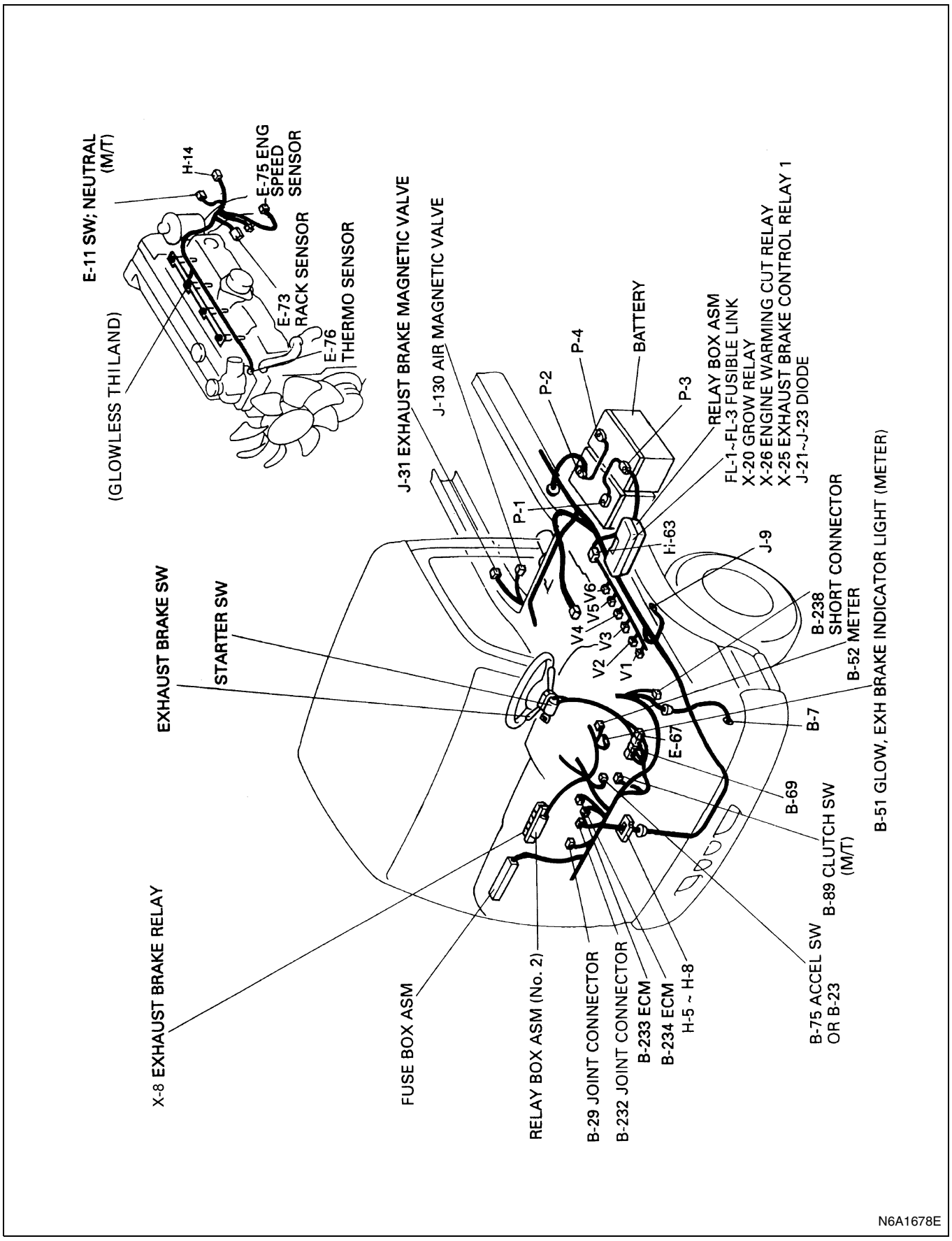


N6A1302E

Legend

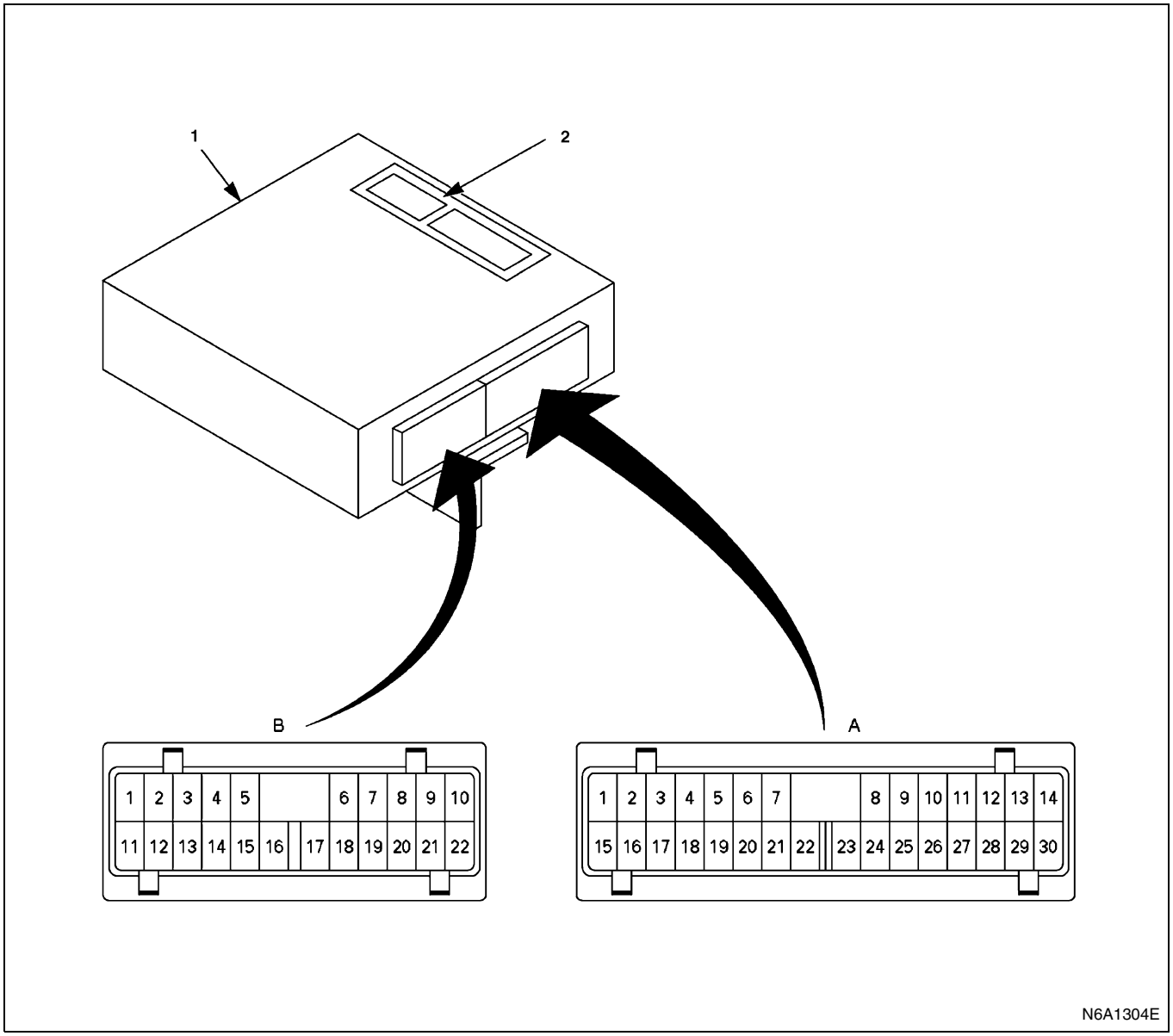
1. EGR pipe
2. Coolant temp sensor
3. EGR valve
4. Rack sensor
5. Speed sensor

Parts Location



Engine Control Module (ECM)

Appearance of ECM



Legend

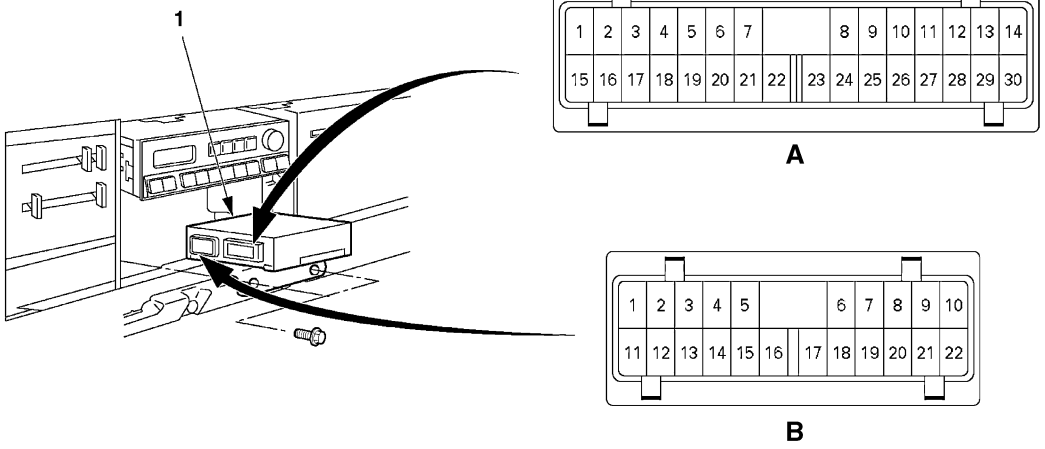
A. Detail of 30 pins connector
B. Detail of 22 pins connector
1. ECM
2. Name plate

Chart of Engine Control Module (ECM) Input/Output

Connector number	Connector name
A-1	CHECKER
A-2	Not used
A-3	QOS (W/Glow only)
A-4	Not used
A-5	Not used
A-6	RACK+
A-7	RACK SIG
A-8	BATTERY
A-9	IGKBY
A-10	Not used
A-11	Not used
A-12	Not used
A-13	Not used
A-14	Not used
A-15	CHECKER GND
A-16	DIAG
A-17	Not used
A-18	Not used
A-19	Not used
A-20	Not used
A-21	RACK-
A-22	GND
A-23	Not used
A-24	Not used
A-25	Not used
A-26	Not used
A-27	Not used
A-28	Not used
A-29	Not used
A-30	Not used

Connector number	Connector name
B-1	VSV: EGR
B-2	GLOW RELAY
B-3	GLOW IND LAMP
B-4	Not used
B-5	Not used
B-6	Not used
B-7	THERMO -
B-8	THERMO +
B-9	ENGINE -
B-10	ENGINE +
B-11	Not used
B-12	Not used
B13	Not used
B-14	Not used
B-15	Not used
B-16	Not used
B-17	Not used
B-18	STARTER
B-19	EXH BRAKE
B-20	Not used
B-21	Not used
B-22	Not used

Location of the Engine Control Module (ECM) Connector

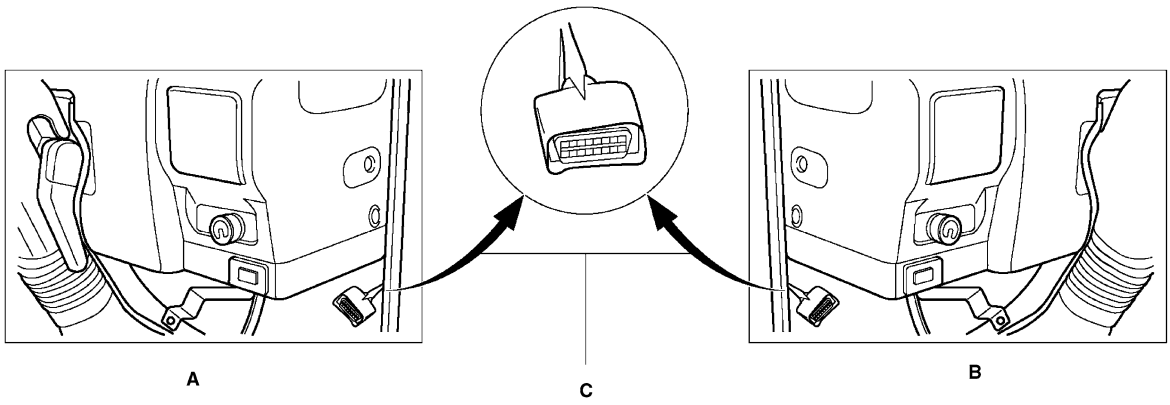


N6A1305E

Legend

A. 30 pins connector (green)
B. 22 pins connector (green)
1. Engine control module (ECM)

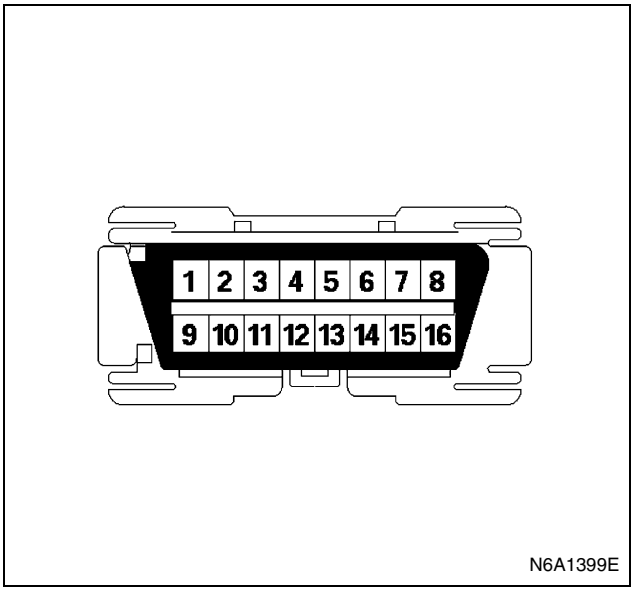
Location of Data Link Connector (DLC)



N6A1665E

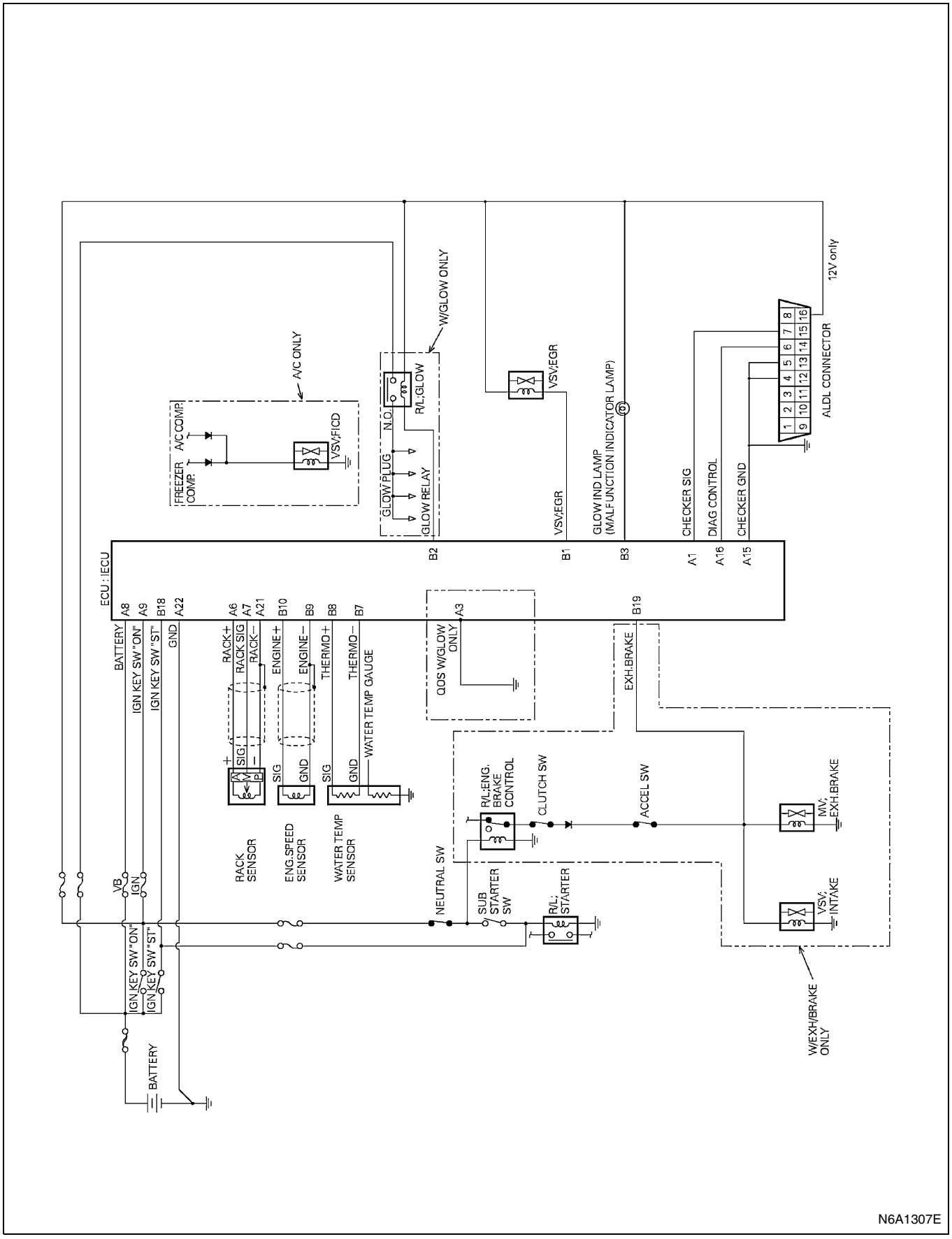
Legend

A. Right-hand drive
B. Left-hand drive
C. Terminal assignment of diagnosis connector

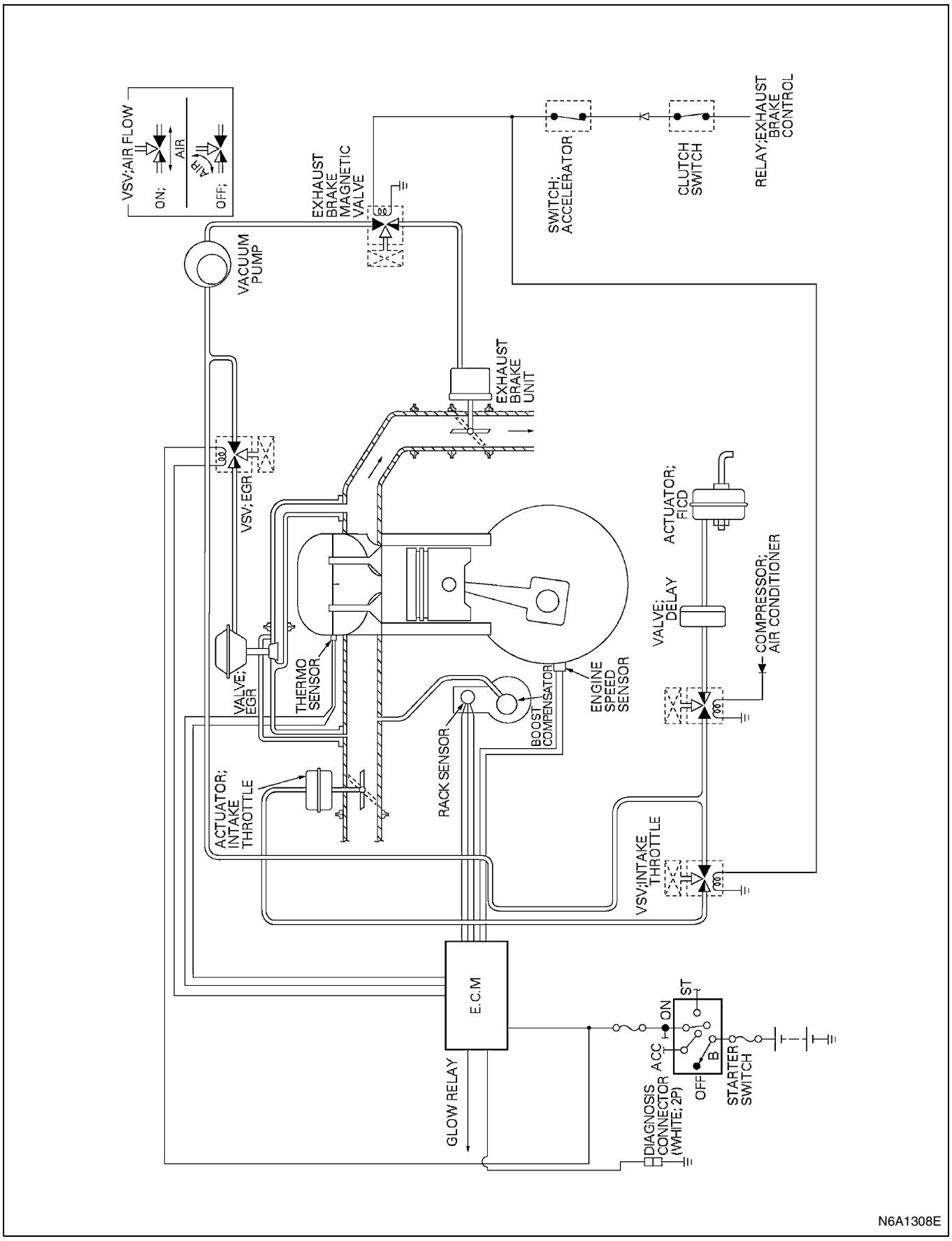


NO	TERMINAL NAME
6	DIAG CONTROL
7	CHECKER SIG
4, 5	CHECKER GND

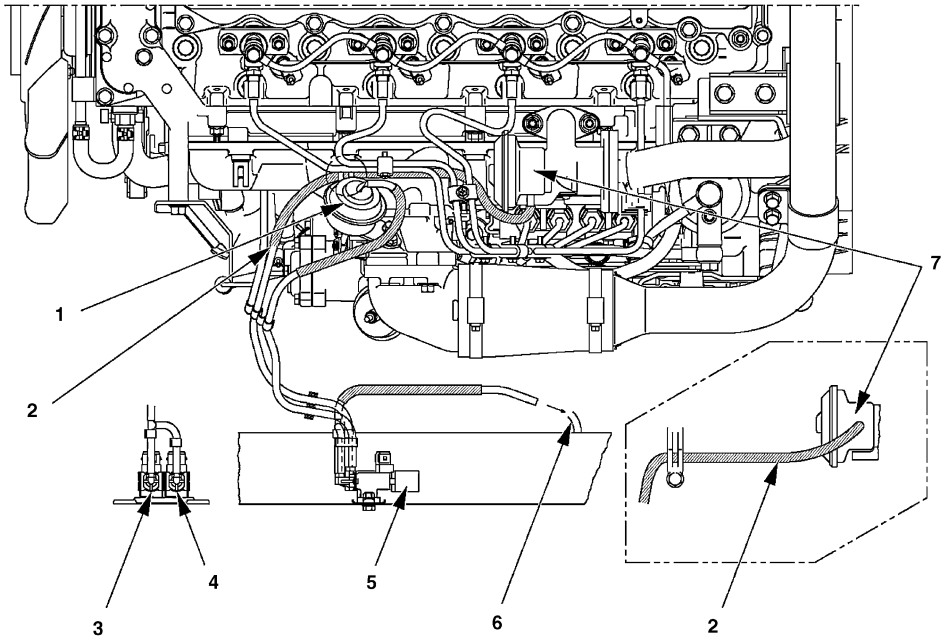
Engine Control Module (ECM) System Wiring Diagram



Auxiliary Engine Control System (Equipped with Exhaust gas recirculation (EGR))



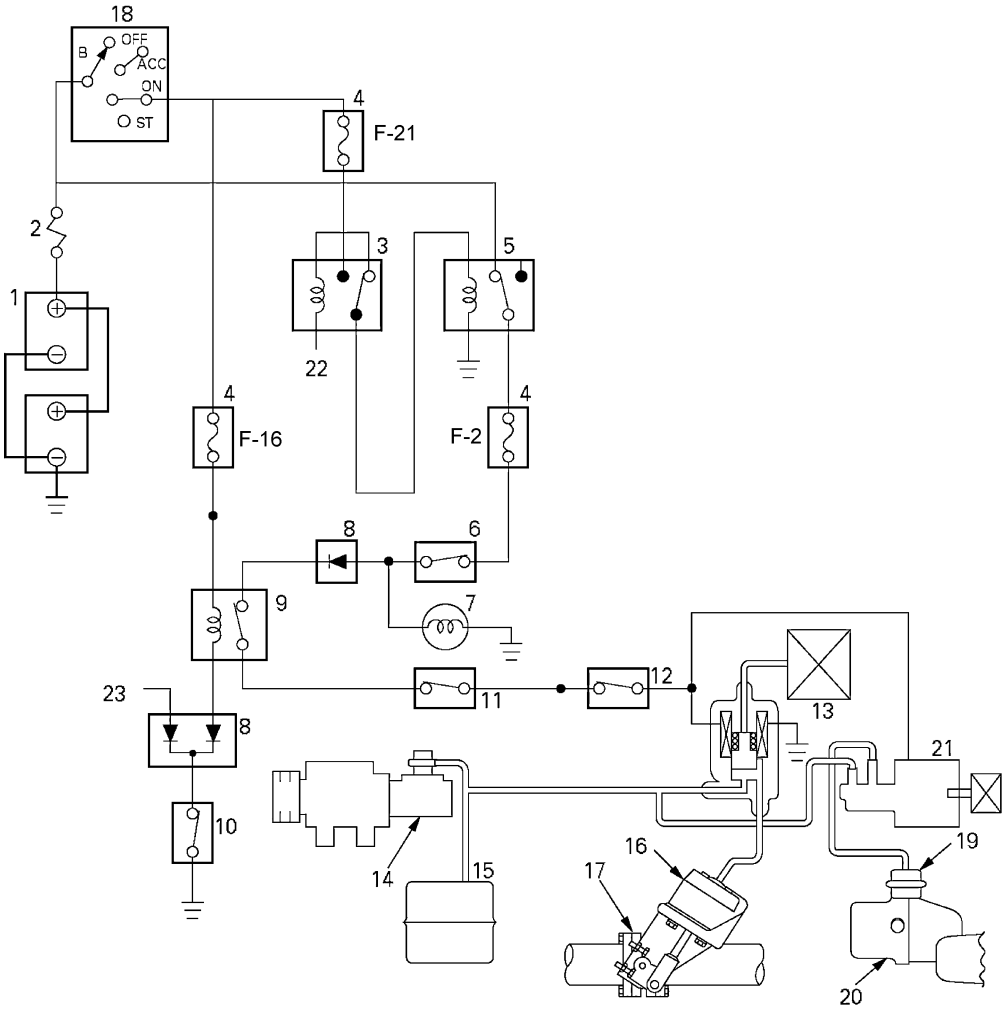
Vacuum Switching Valve (VSV) Circuit (Equipped with Exhaust gas recirculation (EGR))



Legend

1. Intake throttle chamber
2. Vacuum hose
3. Intake throttle valve
4. FICD valve
5. Vacuum Switching Valve
6. Vacuum source
7. EGR valve

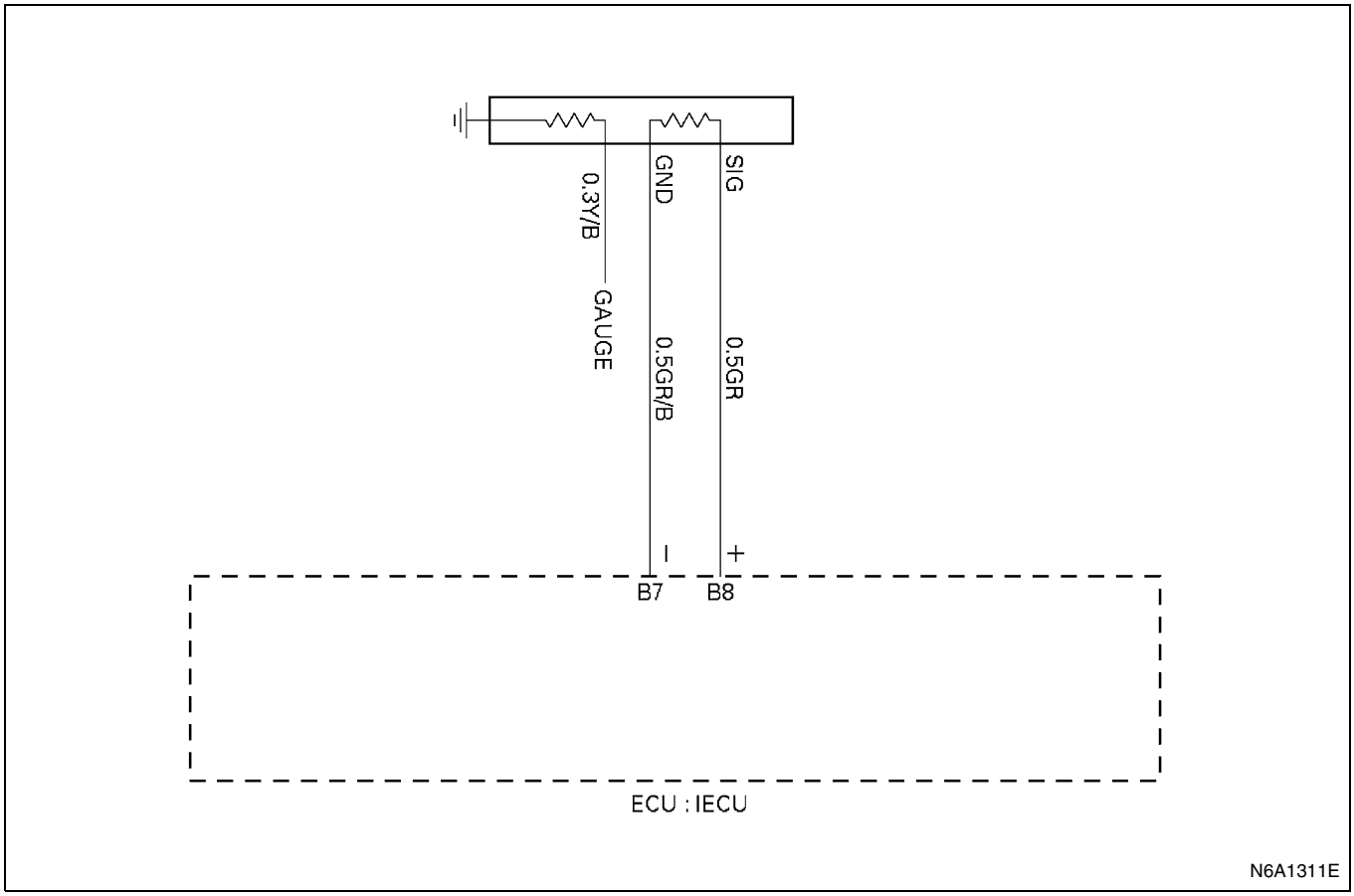
Exhaust Brake Control



Legend

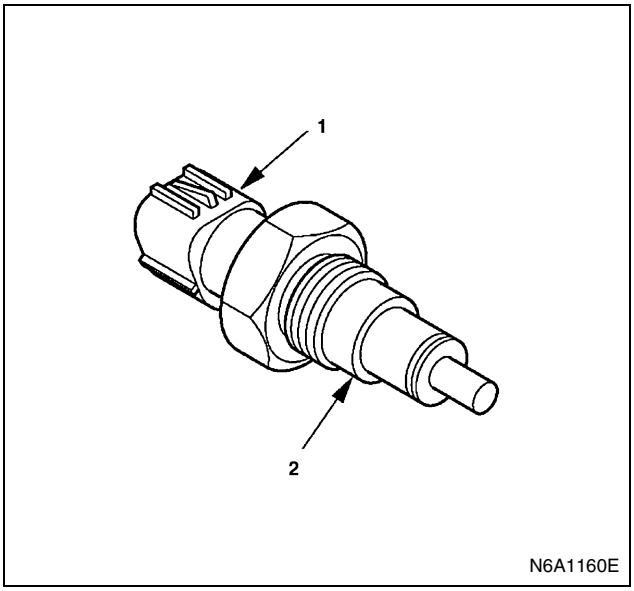
1. Batteries
2. Fusible link wire
3. Charge relay
4. Fuse
5. Exhaust brake relay
6. Exhaust brake switch
7. Indicator light
8. Diode
9. Exhaust brake control relay
10. Neutral switch
11. Clutch switch
12. Accelerator switch
13. Magnetic valve: Exhaust brake
14. Vacuum pump
15. Vacuum tank
16. Vacuum chamber: Exhaust brake
17. Exhaust brake valve
18. Key switch
19. Vacuum chamber: Intake throttle
20. Intake throttle
21. Magnetic valve intake throttle
22. Generator (L)
23. Starter relay coil

DTC-13 Engine Coolant Temperature (ECT) Sensor Circuit High Voltage



Appearance of Water Temperature Sensor and Connector Pin Assignment

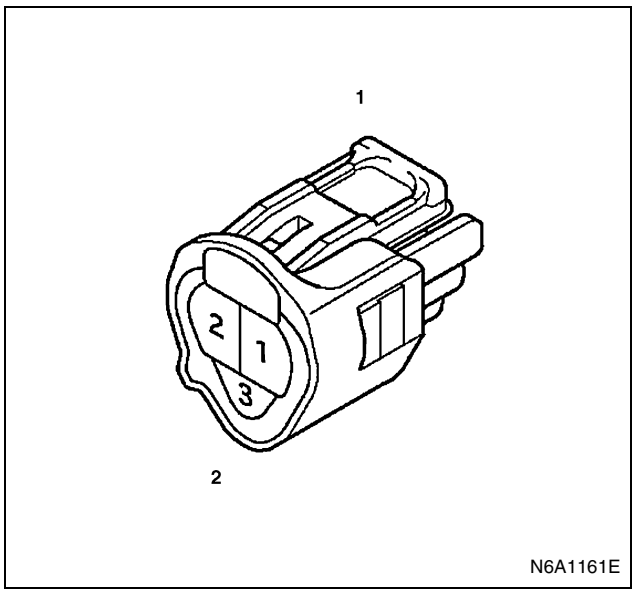
Temperature Sensor



Legend

1. 3 pin connector
2. Engine coolant temperature sensor

Connector Pin Assignment



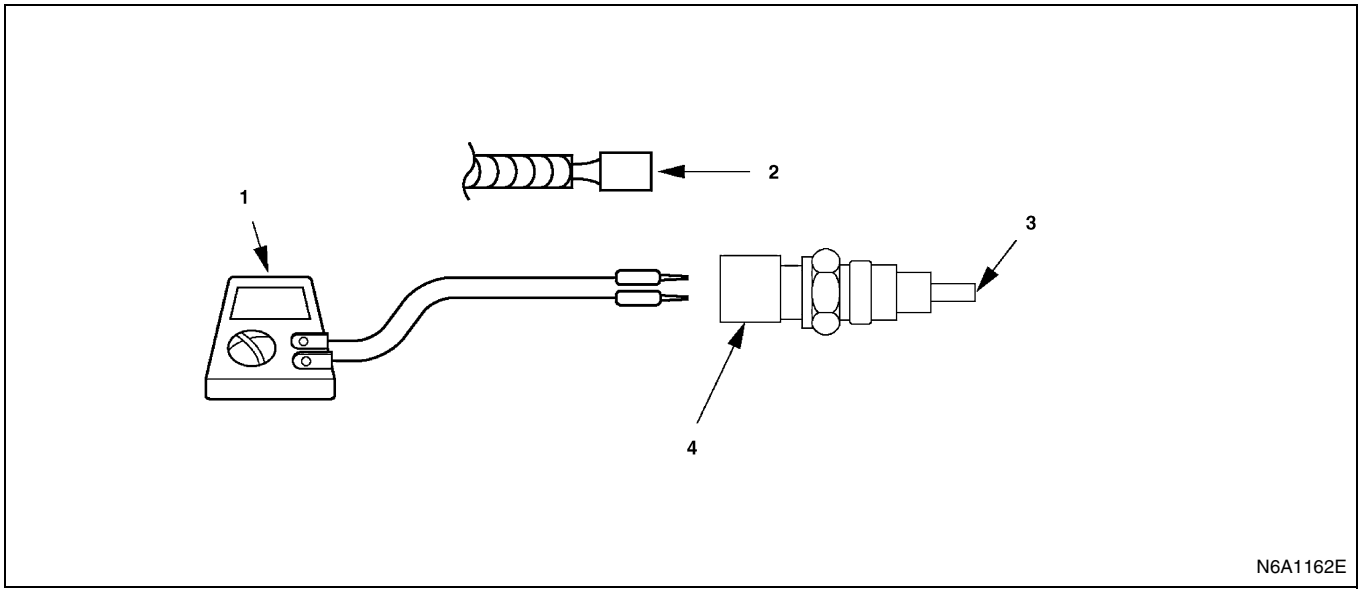
Legend

1. To ECT sensor
2. 3 pin gray

Connector No	Signal
1	Thermistor for engine
2	Thermistor for engine
3	Thermistor for meter

Measure Resistance at Engine Coolant Temperature (ECT) Sensor

Caution:
When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.



Legend
1. Circuit tester
2. Remove engine wire harness
3. Engine coolant temperature sensor
4. Measure resistance between connector pin

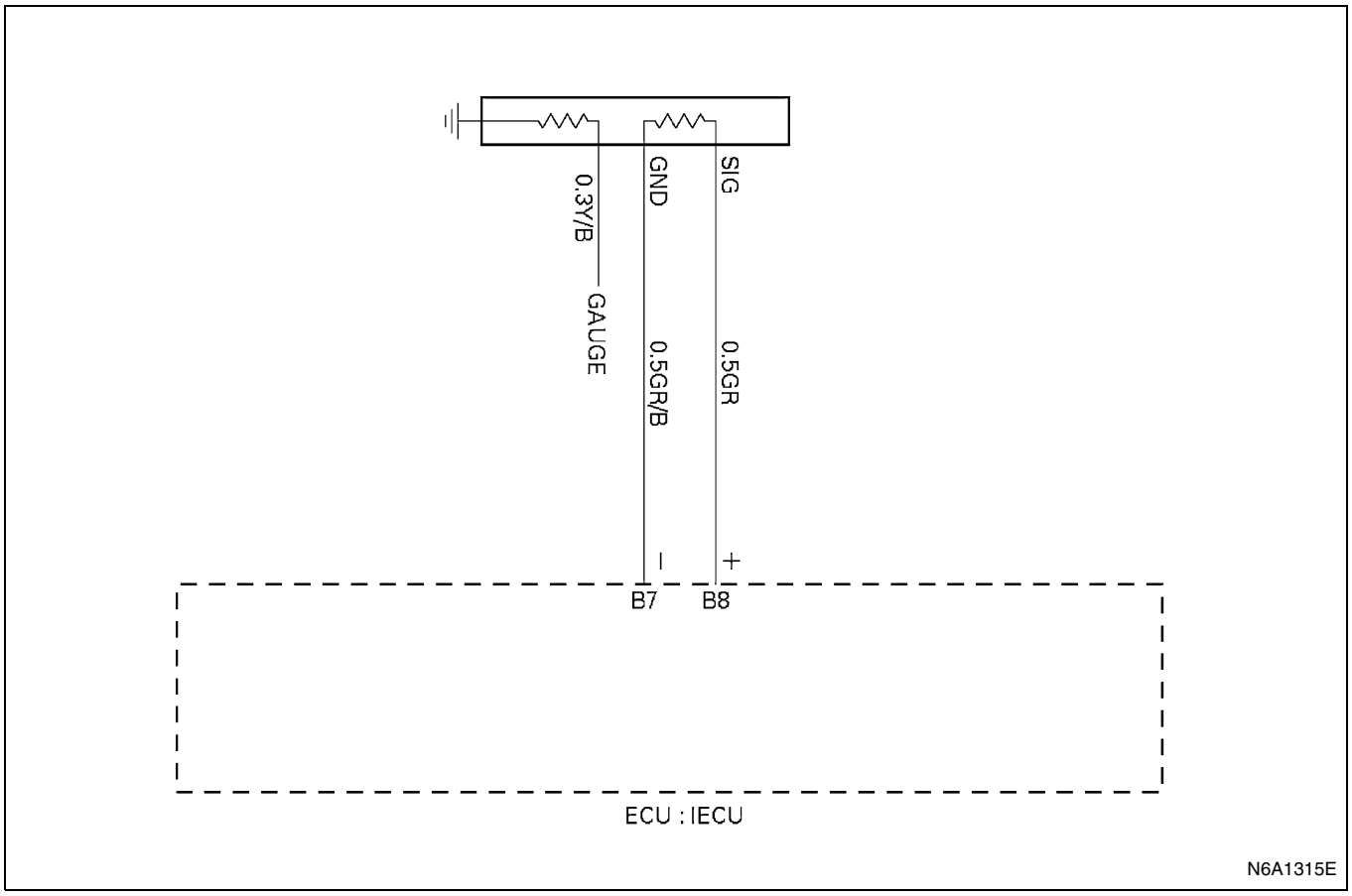
Resistance value

Inspection Point		Resistance Value	Temperature on sensor	Reference
Connector	Pin No.			
3 pin Black	1 ←→ 3	∞	—	Thermistor for ENGINE ←→ Thermistor for meter
	1 ←→ 2	2.5 (kΩ)	20°C (68°F)	Thermistor for ENGINE
		247 (Ω)	90°C (194°F)	
	1 ←→ Body	∞	—	Thermistor for ENGINE ←→ Body
	2 ←→ 3	∞	—	Thermistor for ENGINE ←→ Thermistor for meter
	3 ←→ Body	146.6 (Ω)	60°C (140°F)	Thermistor for meter ENGINE
	2 ←→ Body	∞	—	Thermistor for ECM ←→ Body

Notice:
Resistance value is difference according to the temperature of temperature sensor.

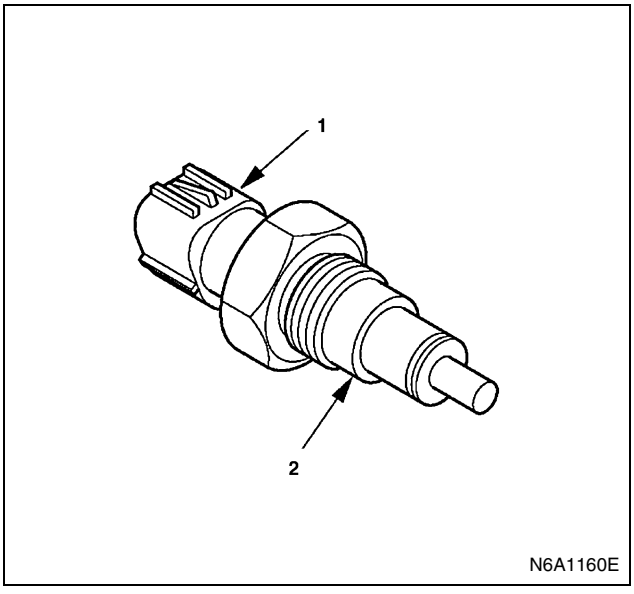
Step	Action	Value	YES	NO
1	Was the “Diagnostic system check” performed?	—	Go to Step 2	Go to self diagnostic system check
2	1. Ignition “OFF” 2. Disconnect the ECT sensor electrical connector. 3. Jumper the ECT sensor signal circuit and the ECT sensor ground circuit together at the ECT sensor harness connector. Does indicate DTC 13?	—	Go to Step 4	Go to Step 3
3	1. Ignition “OFF” 2. Jumper the ECT signal circuit at the ECT sensor harness connector to chassis ground. Does indicate DTC 13?	—	Go to Step 5	Go to Step 6
4	Check four poor connection at the ECT sensor and replace terminals if necessary. Did any terminals require replacement?	—	Go to Step 10	Go to Step 8
5	1. Ignition “OFF”. 2. Disconnect the ECM, and check the ECT sensor ground circuit for an open. 3. If the ECT sensor ground circuit is open, repair it as necessary. Was the ECT sensor ground circuit open?	—	Go to Step 10	Go to Step 7
6	1. Ignition “OFF”. 2. Disconnect the ECM, and check the ECT sensor signal circuit for an open. 3. If the ECT signal circuit is open, repair it as necessary. Was the ECT sensor signal circuit open?	—	Go to Step 10	Go to Step 7
7	Check for poor sensor ground or ECT sensor signal circuit terminal connection at the ECU and replace terminal(s) if necessary. Did any of the terminals need to be replaced?	—	Go to Step 10	Go to Step 9
8	1. Ignition “OFF” 2. Replace the ECT Sensor. Is the action complete?	—	Go to Step 10	—
9	1. Replace the ECM. Is the action complete?	—	Go to Step 10	—
10	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Does DTC 13 come normal condition?	—	Go to Step 11	Go to Step 2
11	Is any current trouble other than DTC 13 displayed by indicator light?	—	Go to trouble code section	Trouble code clear

DTC-14 Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage



Appearance of Water Temperature Sensor and Connector Pin Assignment

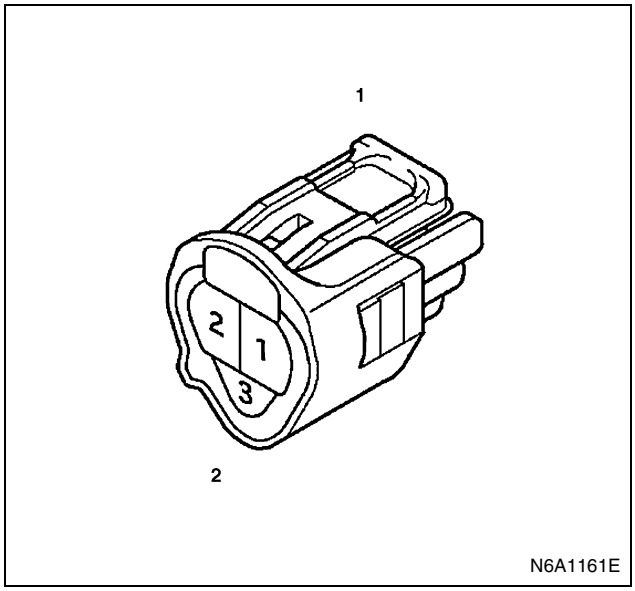
Temperature Sensor



Legend

1. 3 pin connector
2. Engine coolant temperature sensor

Connector Pin Assignment



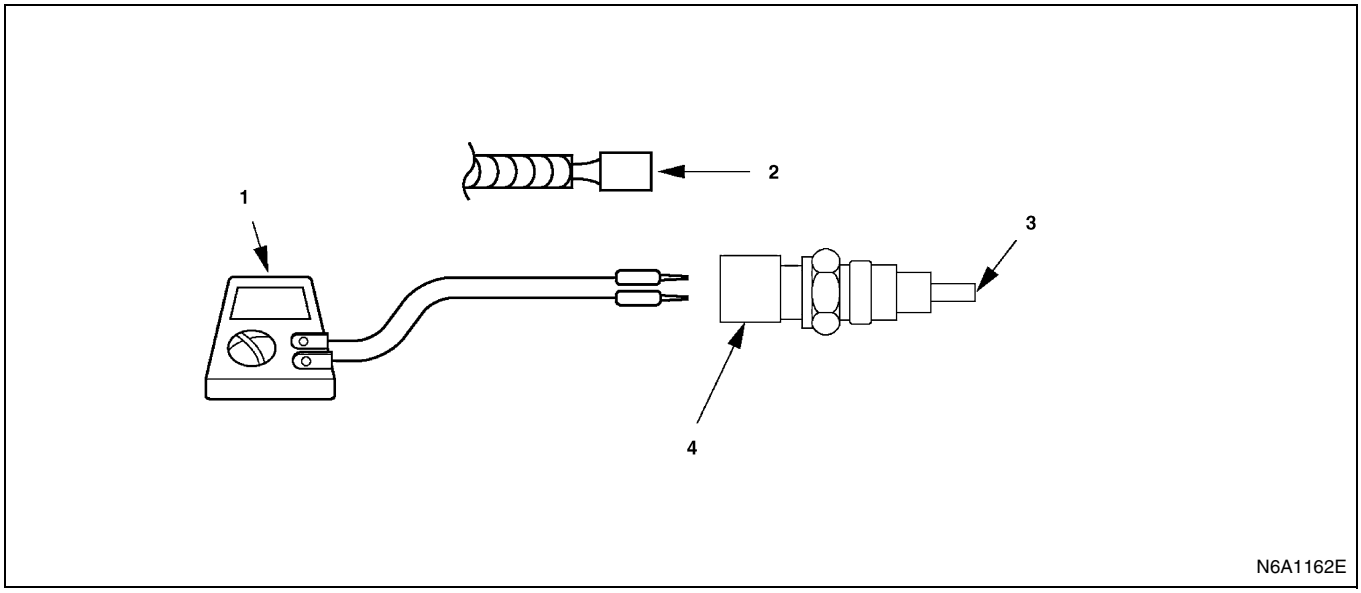
Legend

1. To ECT sensor
2. 3 pin gray

Connector No	Signal
1	Thermistor for engine
2	Thermistor for engine
3	Thermistor for meter

Measure Resistance at Engine Coolant Temperature (ECT) Sensor

Caution:
When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.



Legend
1. Circuit tester
2. Remove engine wire harness
3. Engine coolant temperature sensor
4. Measure resistance between connector pin

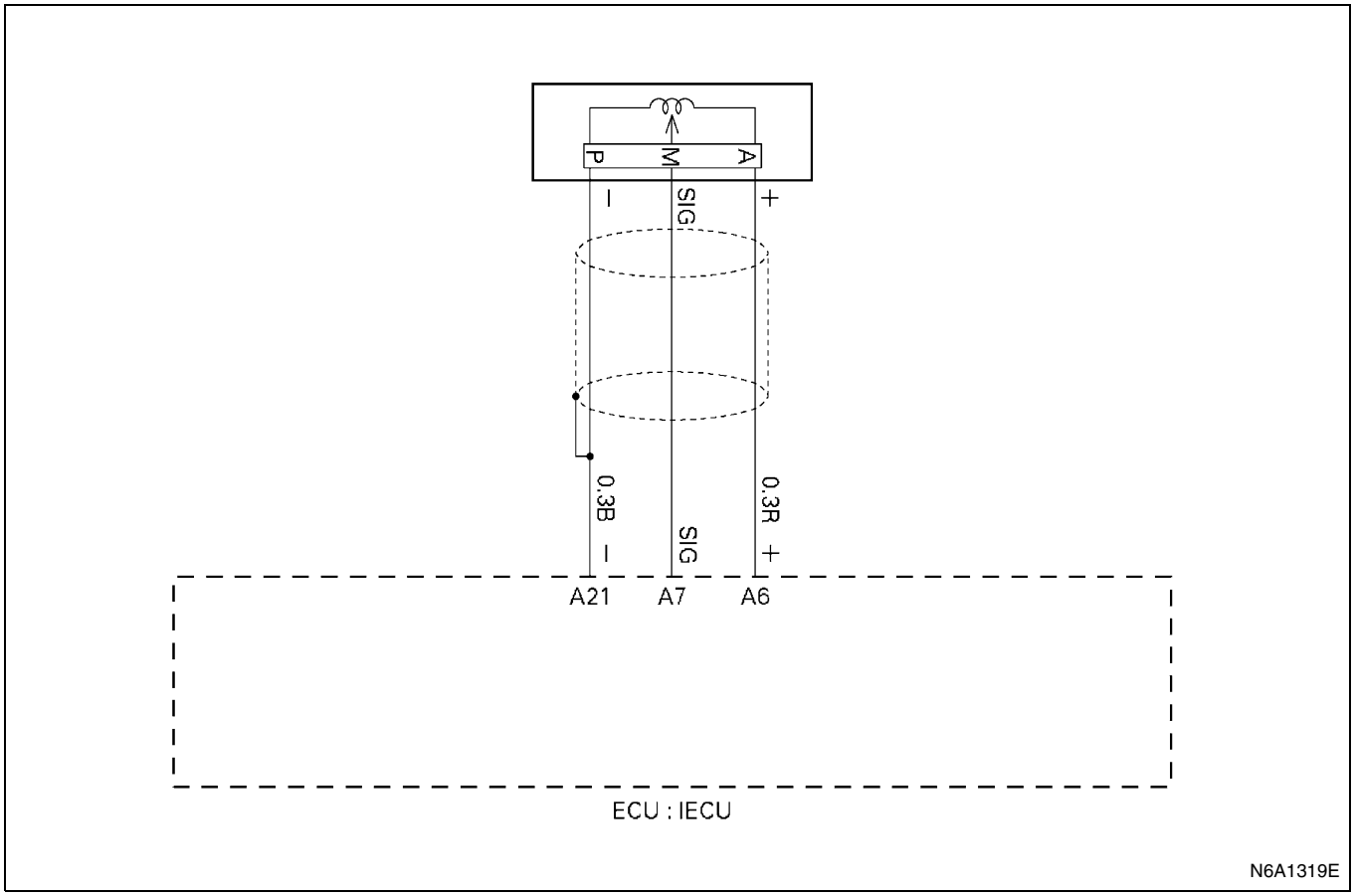
Resistance value

Inspection Point		Resistance Value	Temperature on sensor	Reference
Connector	Pin No.			
3 pin Black	1 ⟷ 3	∞	—	Thermistor for ENGINE ⟷ Thermistor for meter
	1 ⟷ 2	2.5 (kΩ)	20°C (68°F)	Thermistor for ENGINE
		247 (Ω)	90°C (194°F)	
	1 ⟷ Body	∞	—	Thermistor for ENGINE ⟷ Body
	2 ⟷ 3	∞	—	Thermistor for ENGINE ⟷ Thermistor for meter
	3 ⟷ Body	146.6 (Ω)	60°C (140°F)	Thermistor for meter ENGINE
	2 ⟷ Body	∞	—	Thermistor for ECM ⟷ Body

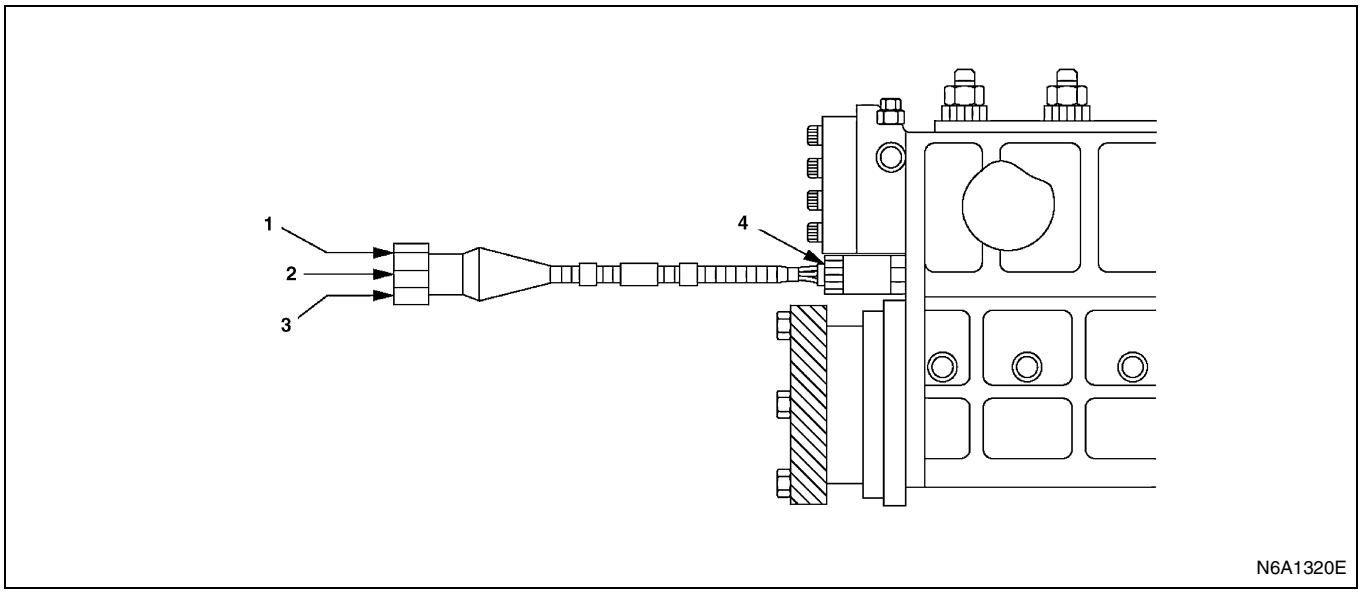
Notice:
Resistance value is difference according to the temperature of temperature sensor.

Step	Action	Value	YES	NO
1	Was the “Diagnostic system check” performed?	—	Go to Step 2	Go to self diagnostic system check
2	1. Memory DTC to ECM. 2. Clear DTC. 3. Ignition “OFF” 4. Disconnect the ECT sensor. 5. Ignition “ON”, Engine “OFF” Does indicate DTC 14? (Ignore DTC 13)	—	Go to Step 3	Go to Step 6
3	1. Ignition “OFF” 2. Check Connector ECT Sensor Harness for interterminal short. 3. Repair if necessary. Was ECT Sensor connector shorted?	—	Go to Step 8	Go to Step 4
4	1. Ignition “OFF” 2. Check the ECM connector terminal short. 3. Repair if necessary. Was ECM terminal shorted?	—	Go to Step 8	Go to Step 5
5	1. Disconnect the ECM. 2. Check if ECT sensor signal circuit for a short to ground or a short to ground circuit. 3. Repair if necessary. Is ECT sensor signal circuit shorted to ground?	—	Go to Step 8	Go to Step 7
6	1. Ignition “OFF” 2. Replace the ECT Sensor. Is the action complete?	—	Go to Step 8	—
7	1. Replace the ECM. Is the action complete?	—	Go to Step 8	—
8	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Does DTC 14 come normal condition?	—	Go to Step 9	Go to Step 2
9	Is any current trouble other than DTC 14 displayed by indicator light?	—	Go to trouble code section	Trouble code clear

DTC-21 Rack Sensor Circuit Low Voltage



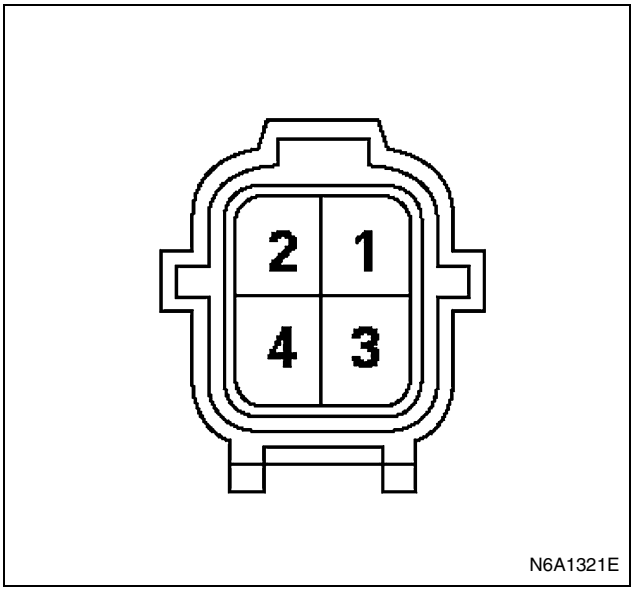
Location of Rack Sensor Connector



Legend

1. OSC (red)
2. MDL (white)
3. GND (black)
4. Rack sensor

Connector Name of Rack Sensor



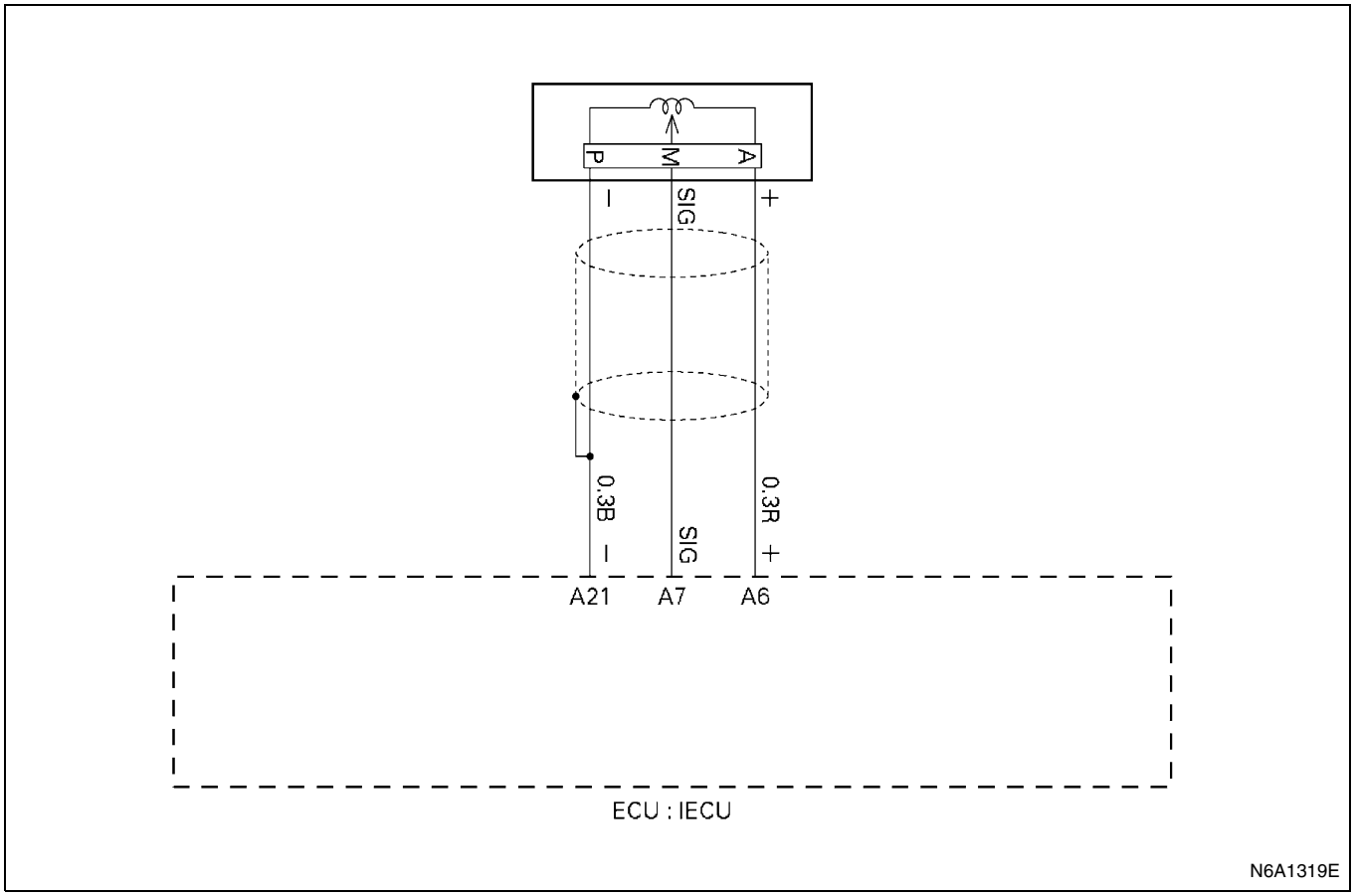
Notice:
Mark "___" on connector which is plugged, therefore, should be confirmed to be played.

Relation Between Connector Number and Signal Name

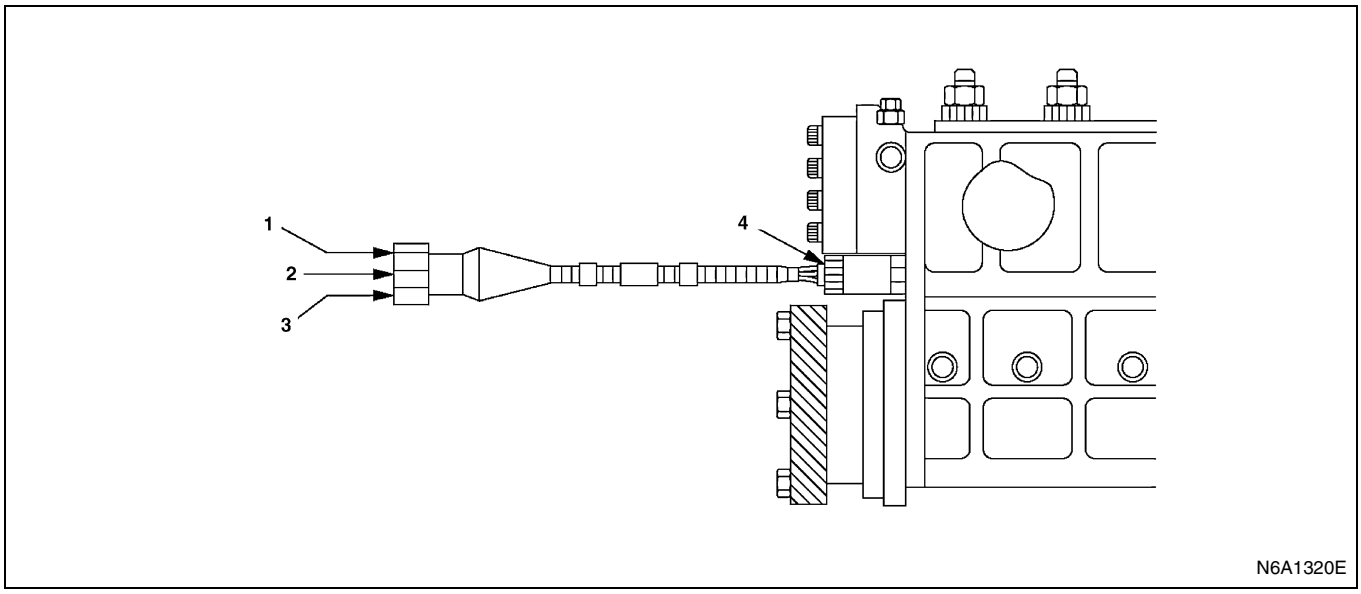
Connector No	Signal name	Wire color
1	Rack sensor (OSC)	R
2	Rack sensor (GND)	W
4	Rack sensor (MDL)	B

Step	Action	Value	YES	NO
1	Was the “Diagnostic system check” performed?	—	Go to Step 2	Go to diagnostic system check
2	1. Check harness side power source circuit and signal circuit for GND short. 2. Repair if necessary. Has DTC21 been corrected?	—	Go to Step 10	Go to Step 3
3	Disconnect Sensor Connector. Jumper RACK+ and RACK signal. Free from trouble now? Ignore code 22.	—	Go to Step 4	Go to Step 6
4	1. Apply 5V to RACK+ TERMINAL. Measure RACK SIG Voltage. Is RACK SIG VOLTAGE as specified?	0.9 — 2.0V (Idling speed)	Go to Step 7	Go to Step 5
5	1. Check Rack Sensor Harness Signal Circuit and power source for GND short. Check signal circuit for disconnect. 2. Repair if necessary. Free from trouble now?	—	Go to Step 10	Go to Step 7
6	1. Check harness signal circuit and power source circuit for disconnect. 2. Repair if necessary. Free from trouble now?	—	Go to Step 10	Go to Step 9
7	1. Check the iron core of RACK Sensor for damage, seizure, and wear. 2. After check, repair if necessary. Was there any trouble in the iron core (RACK end) inside RACK Sensor?	—	Go to Step 10	Go to Step 8
8	1. Replace the RACK Sensor. Is the action complete?	—	Go to Step 10	—
9	1. Replace the ECM. Is the action complete?	—	Go to Step 10	—
10	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC 21 all right under Scan Tool Check?	—	Go to Step 11	Go to Step 2
11	Is any current trouble other than DTC 21 displayed by scan tool?	—	Go to trouble code section	Trouble code clear

DTC-22 Rack Sensor Circuit High Voltage



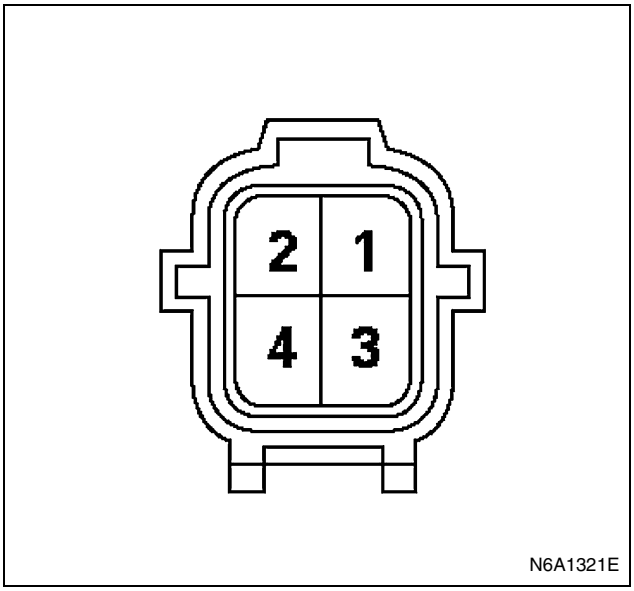
Location of Rack Sensor Connector



Legend

1. OSC (red)
2. MDL (white)
3. GND (black)
4. Rack sensor

Connector Name of Rack Sensor



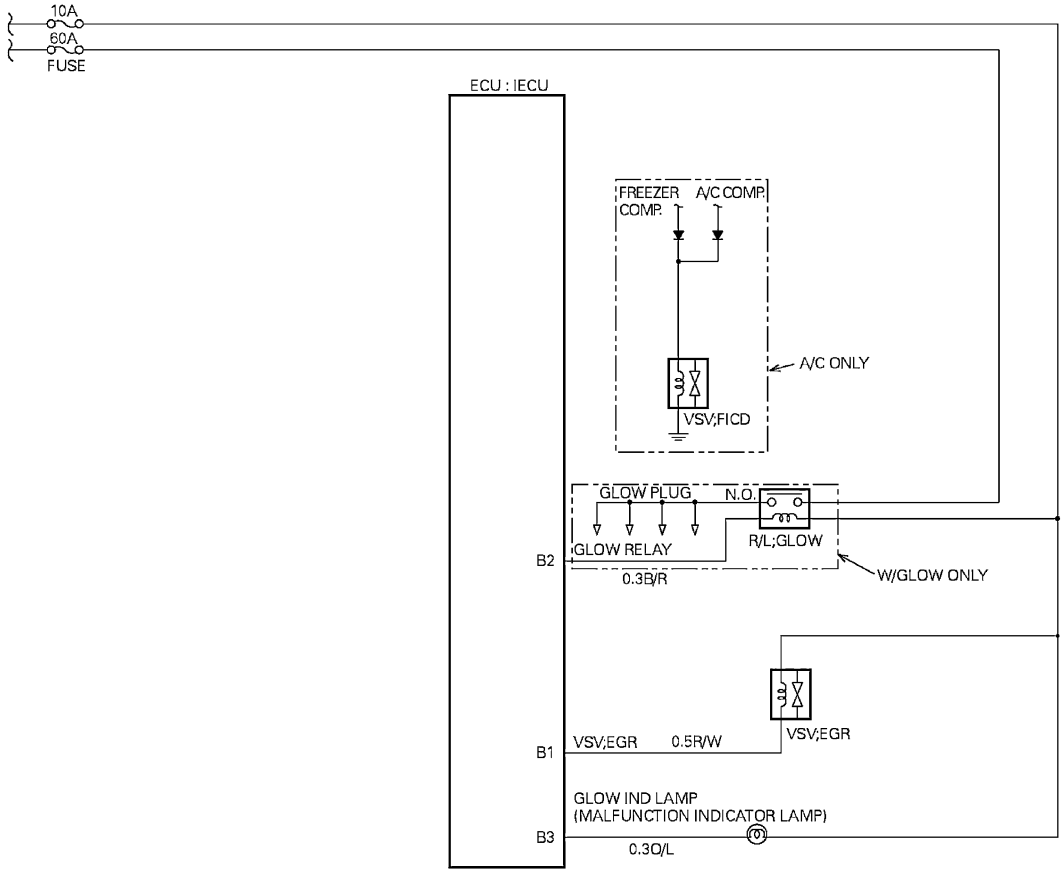
Notice:
Mark "___" on connector which is plugged, therefore, should be confirmed to be played.

Relation Between Connector Number and Signal Name

Connector No	Signal name	Wire color
1	Rack sensor (OSC)	R
2	Rack sensor (GND)	B
4	Rack sensor (MDL)	W

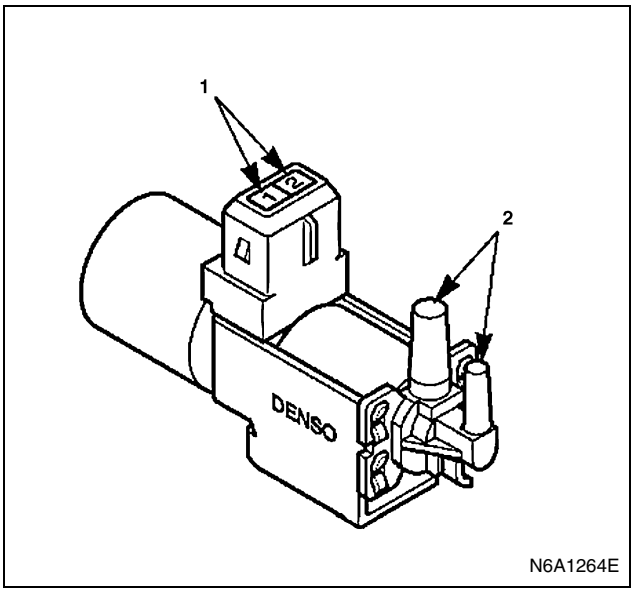
Step	Action	Value	YES	NO
1	Was the “Diagnostic system check” performed?	—	Go to Step 2	Go to diagnostic system check
2	Remove Sensor Connector. Has DTC22 been corrected? (Ignore DTC 21)	—	Go to Step 3	Go to Step 7
3	1. Jumper Harness signal Terminal and GND terminal at the Sensor side of Connector. 2. Ignition “ON” Has DTC22 been corrected?	—	Go to Step 4	Go to Step 5
4	1. Check the Sensor Connector for inter terminal short. After check, repair if necessary. Was Connector Terminal shorted?	—	Go to Step 12	Go to Step 6
5	1. Check the GND Circuit for disconnect. After check, repair if necessary. Is GND circuit disconnect?	—	Go to Step 12	Go to Step 11
6	1. Check the Sensor Harness signal circuit and power source circuit for short. After check, repair if necessary. Was Harness shorted?	—	Go to Step 12	Go to Step 8
7	1. Check the Harness signal circuit and power source for short. After check, repair if necessary. Was Harness shorted?	—	Go to Step 12	Go to Step 11
8	1. Apply 5V to RACK+ TERMINAL. 2. Measure RACK SIG Voltage. Is RACK SIG VOLTAGE as specified?	0.9 — 2.0V (Idling speed)	Go to Step 9	Go to Step 10
9	1. Check the iron core of RACK Sensor for damage, seizure, and wear. 2. After check, repair if necessary. Was there any trouble in the iron core(RACK end) inside RACK Sensor?	—	Go to Step 12	Go to Step 11
10	Replace the RACK Sensor. Is the action complete?	—	Go to Step 12	—
11	Replace the ECM. Is the action complete?	—	Go to Step 12	—
12	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC22 all right under Scan Tool Check?	—	Go to Step 13	Go to Step 2
13	Is any current trouble other than DTC 22 displayed by indicator light?	—	Go to trouble code section	Trouble code clear

DTC-31 Exhaust Gas Recirculation (EGR) Vacuum Switching Valve (VSV) Solenoid Control Low Voltage



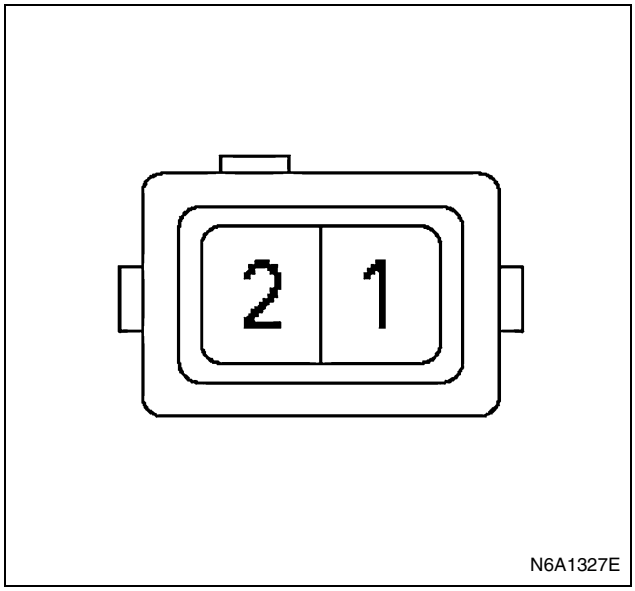
Appearance of Vacuum Switching Valve (VSV): Exhaust Gas Recirculation (EGR) Connector

VSV: EGR



Legend
1. 2 pin
2. Port

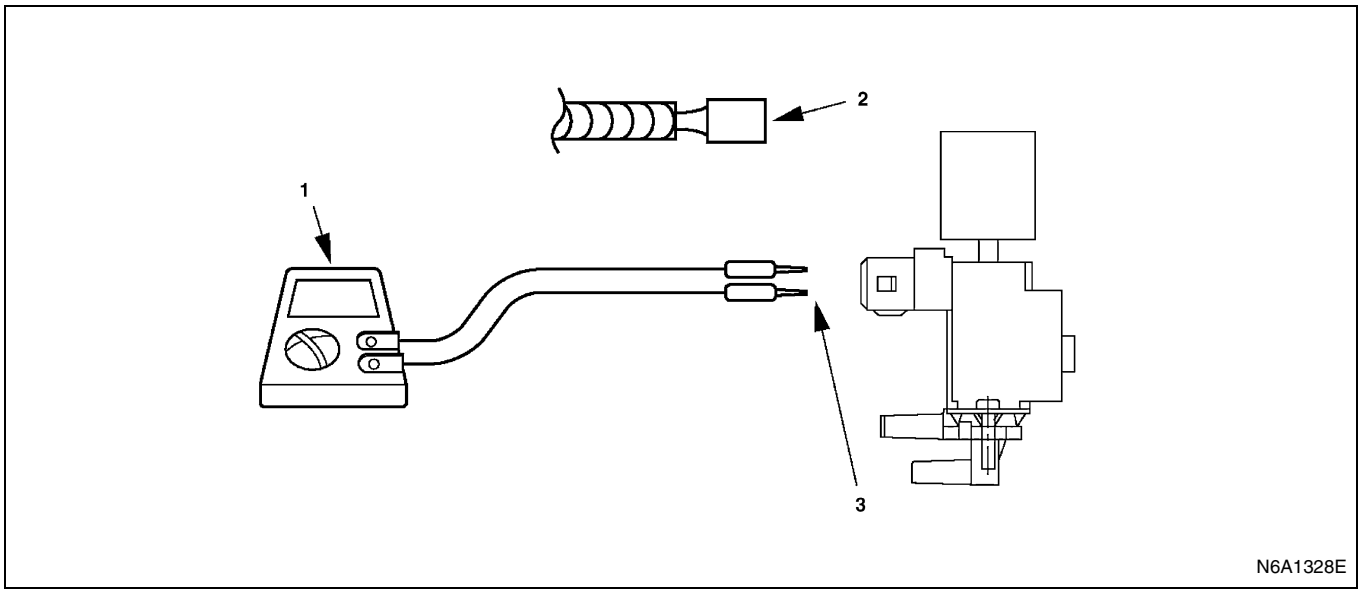
VSV: EGR Connector



Connector No	Signal
1	GND
2	SIG

Measure Resistance at VSV: EGR

Caution:
When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.



Legend
1. Circuit tester
2. Remove VSV wire harness
3. Measure resistance between connector pin

Resistance value

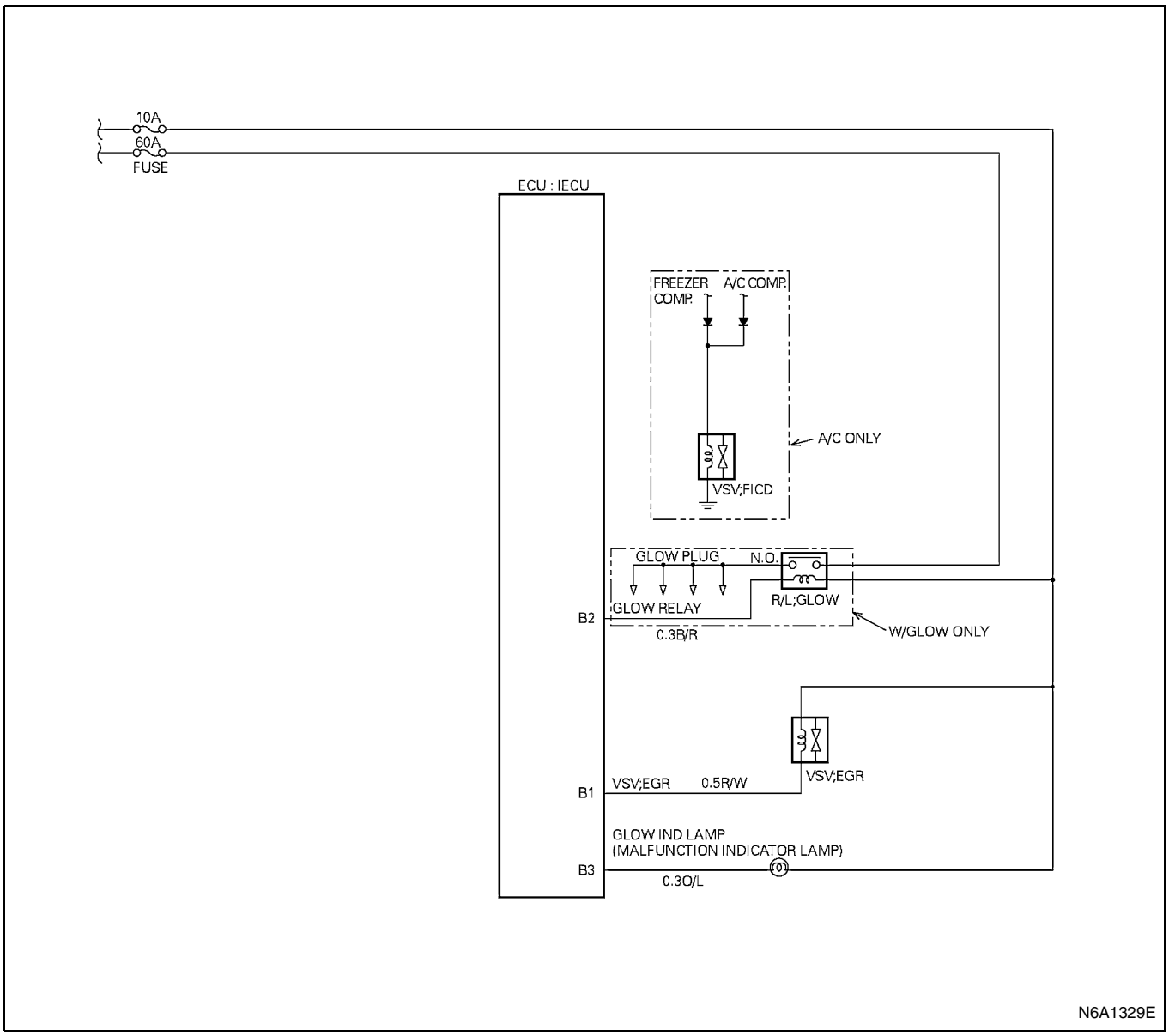
Inspection Point		Resistance Value (kΩ)	Reference
Connector	Pin No.		
2 pin Black	2 ←→ 1	37 to 44 (for 12 volt) 159 to 169 (for 24 volt)	SIG ←→ GND
	1 ←→ Body	∞	SIG ←→ Body

Notice:
Resistance value is difference according to the engine temperature (condition of engine warming up).

Step	Action	Value	YES	NO
1	Was the "Diagnostic system check" performed?	—	Go to Step 2	Go to diagnostic system check
2	1. Ignition "OFF". 2. Disconnect the VSV from the wiring harness connector. 3. Ignition "ON" Engine "OFF". 4. Using the Digital Voltmeter (DVM), check for voltage on the "Power supply side terminal" of the VSV harness connector. Does the DVM read the following value?	12 Volt or 24 Volt	Go to Step 4	Go to Step 3
3	1. Check the suspect circuit between the VSV connector and "Engine Ignition". Fuse for the following condition. • A short to ground • An open circuit 2. Repair if necessary. Has DTC 31 been corrected?	—	Go to Step 8	—
4	Using the DVM, check the resistance of the VSV. Does the DVM read the following Value?	37 — 44Ω 159 — 169Ω	Go to Step 5	Go to Step 6
5	1. Ignition "OFF" 2. Disconnect the ECM connector from ECM. 3. Check the VSV circuit between the ECU and VSV connector. • A short to ground • An open circuit 4. Repair if necessary. Has DTC 31 been corrected?	—	Go to Step 8	Go to Step 7
6	Replace the VSV. Is the action complete?	—	Go to Step 8	—
7	Replace the ECM. Is the action complete?	—	Go to Step 8	—
8	1. Reconnect all the connectors removed. 2. Ignition "ON", Engine "OFF". Does DTC 31 come normal condition?	—	Go to Step 9	Go to Step 2

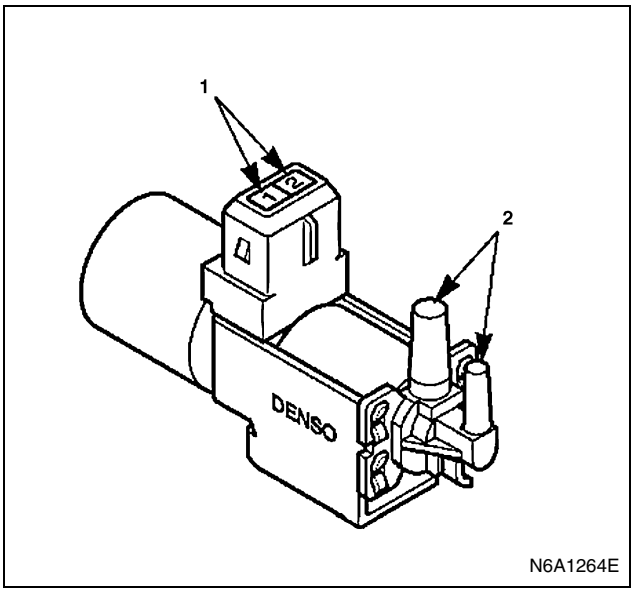
Step	Action	Value	YES	NO
9	Is any current trouble other than DTC 31 displayed by indicator light?	—	Go to trouble code section	Trouble code clear

DTC-32 Exhaust Gas Recirculation (EGR) Vacuum Switching Valve (VSV) Solenoid Control High Voltage



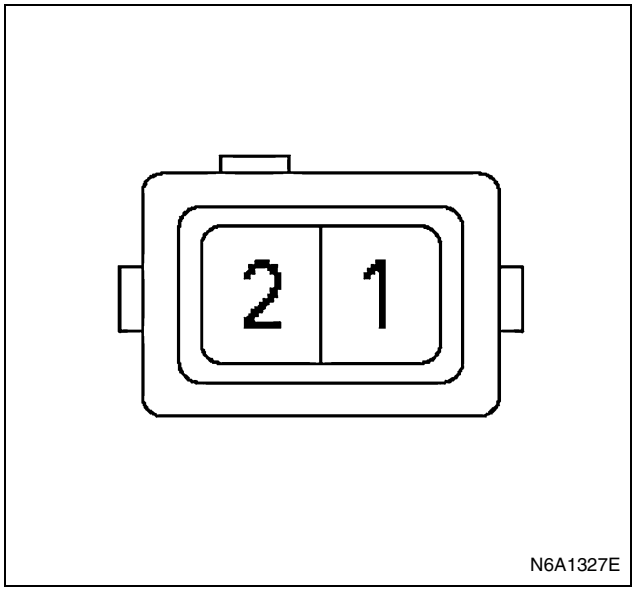
Appearance of Vacuum Switching Valve (VSV): Exhaust Gas Recirculation (EGR) Connector

VSV: EGR



Legend
1. 2 pin
2. Port

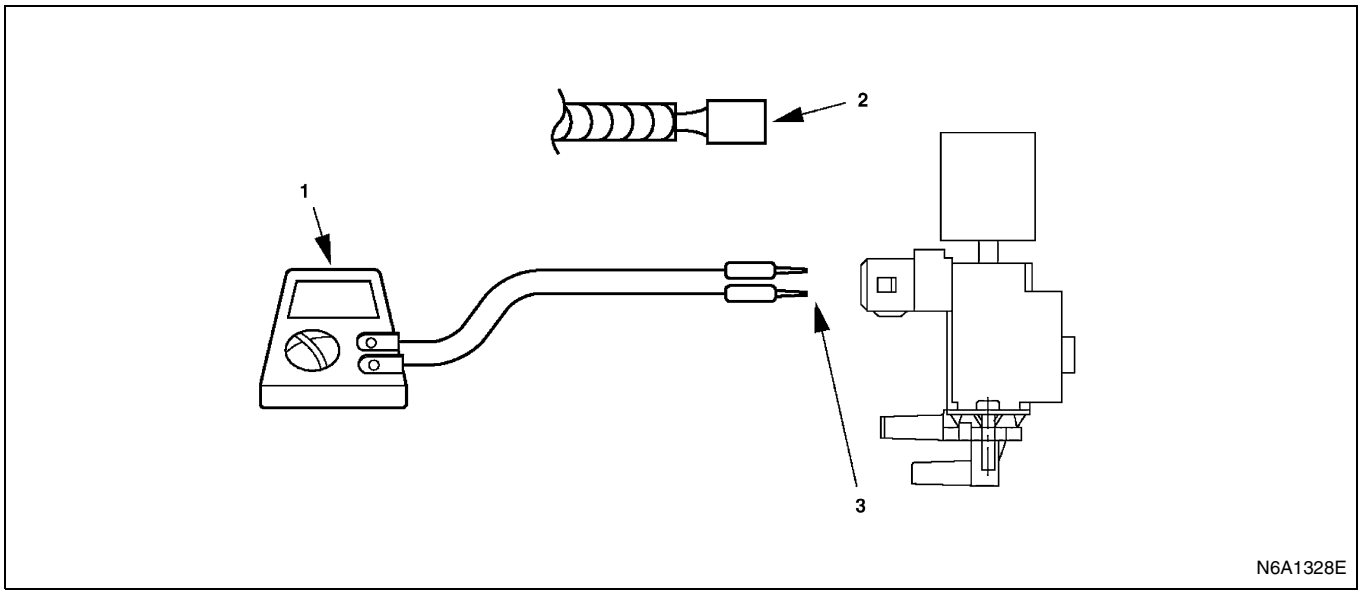
VSV: EGR Connector



Connector No	Signal
1	GND
2	SIG

Measure Resistance at VSV: EGR

Caution:
When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.



Legend
1. Circuit tester
2. Remove VSV wire harness
3. Measure resistance between connector pin

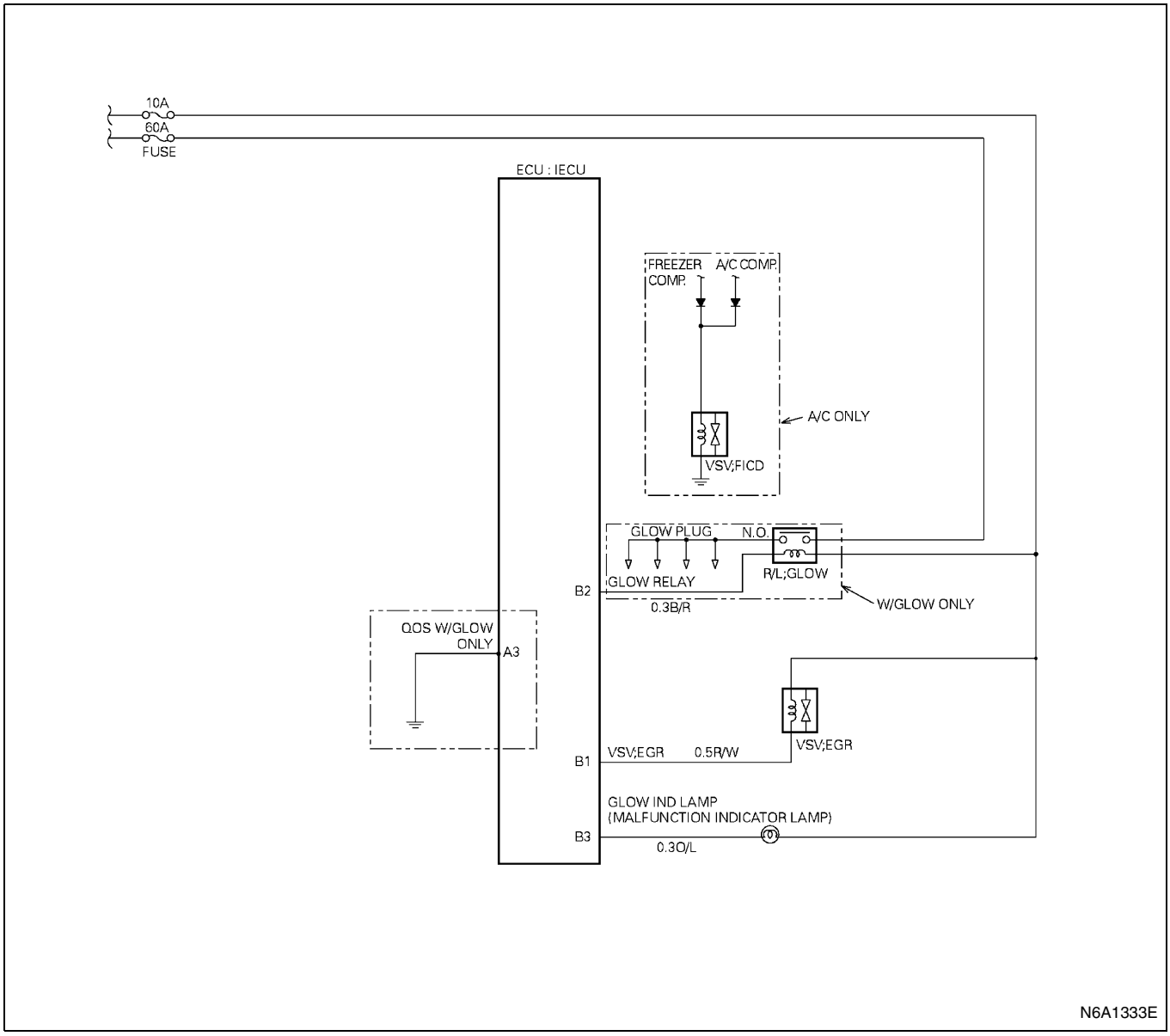
Resistance value

Inspection Point		Resistance Value (kΩ)	Reference
Connector	Pin No.		
2 pin Black	2 ←→ 1	37 to 44 (for 12 volt) 159 to 169 (for 24 volt)	SIG ←→ GND
	1 ←→ Body	∞	SIG ←→ Body

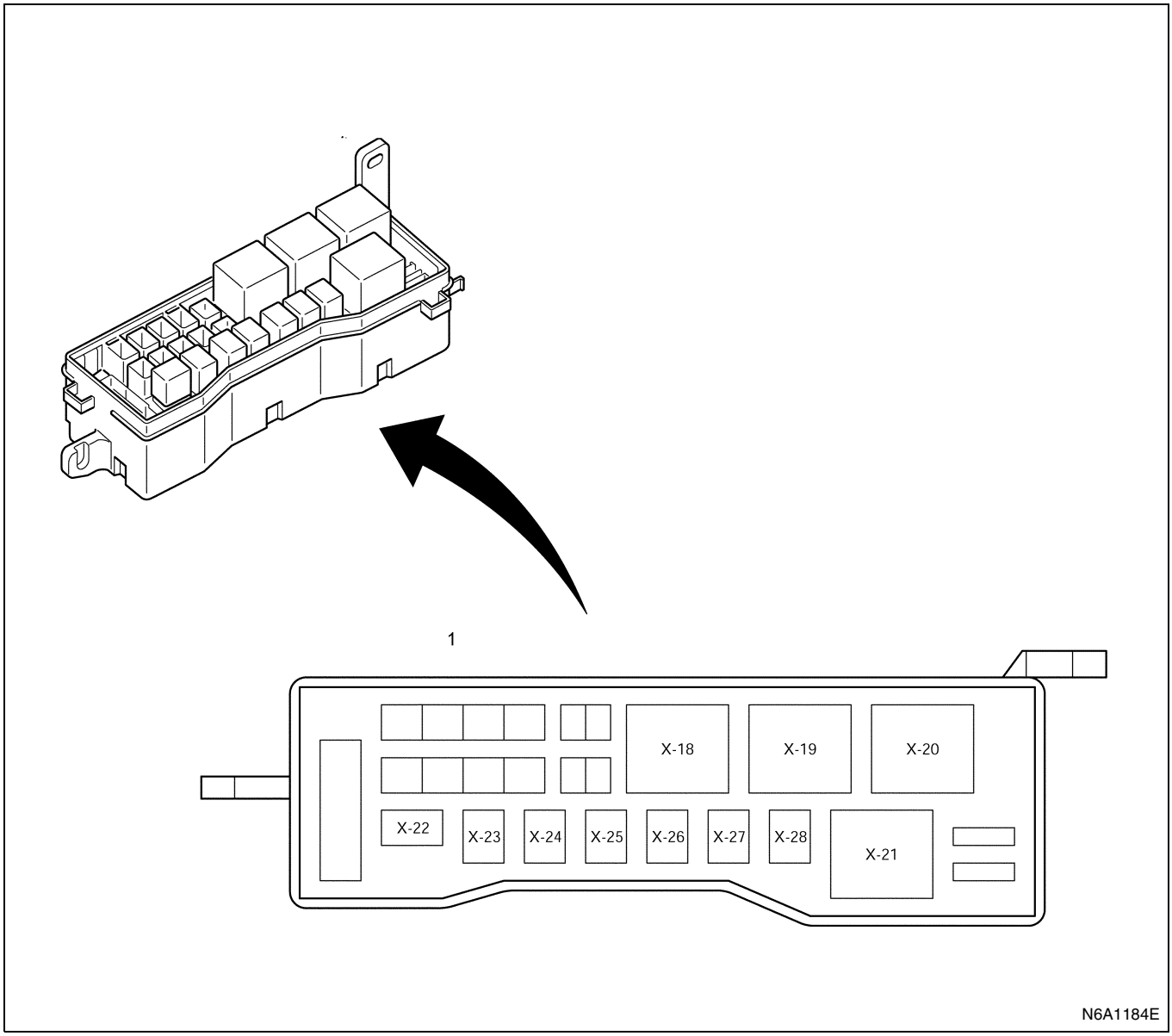
Notice:
Resistance value is difference according to the engine temperature (condition of engine warming up).

Step	Action	Value	YES	NO
1	Was the “Diagnostic system check” performed?	—	Go to Step 2	Go to diagnostic system check
2	Using the DVM, check the resistance of the VSV. Does the DVM read the following Value?	37 — 44Ω 159 — 169Ω	Go to Step 3	Go to Step 4
3	1. Ignition “OFF”. 2. Disconnect the ECM connector from ECM. 3. Check the short to voltage of VSV circuit between the ECM and VSV connector. 4. Repair if necessary. Has DTC 32 been corrected?	—	Go to Step 6	Go to Step 5
4	Replace the VSV. Is the action complete?	—	Go to Step 6	—
5	Replace the ECM. Is the action complete?	—	Go to Step 6	—
6	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF”. Does DTC 32 come normal condition?	—	Go to Step 7	Go to Step 2
7	Is any current trouble other than DTC 32 displayed by indicator light?	—	Go to trouble code section	Trouble code clear

DTC-41 Quick On Start (QOS) Relay Control Circuit Low Voltage



Location of Relay

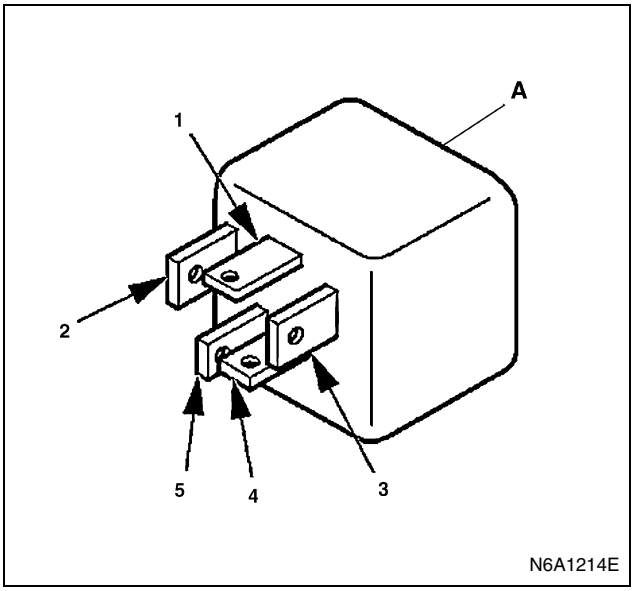


Legend

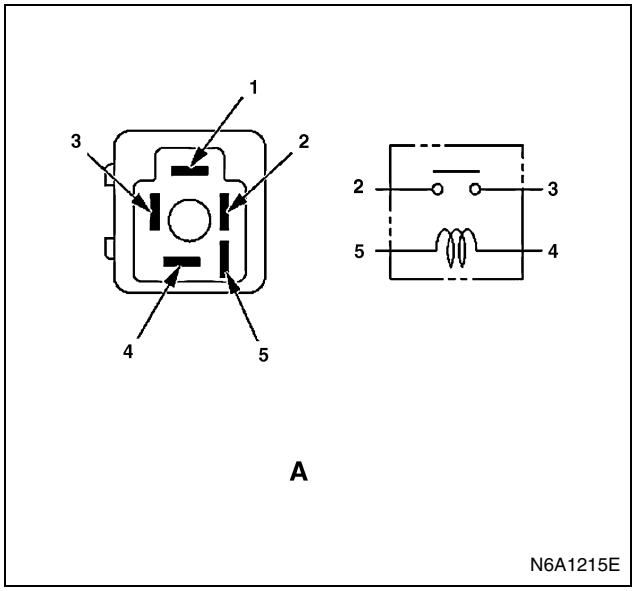
1. Relay box (Installed on the left side rear of the cab)

NO	RELAY NAME
X-20	Glow plug
X-21	Starter
X-22	Marker lamp
X-23	Rear fog
X-24	A/C COMP, 4WD ind. lamp
X-25	Exh, Brake control
X-26	CSD, A/C ON SIGNAL
X-27	Condenser fan
X-28	Exh. Brake cut

Inspection for prestroke power cut relay



Legend
A. QOS relay



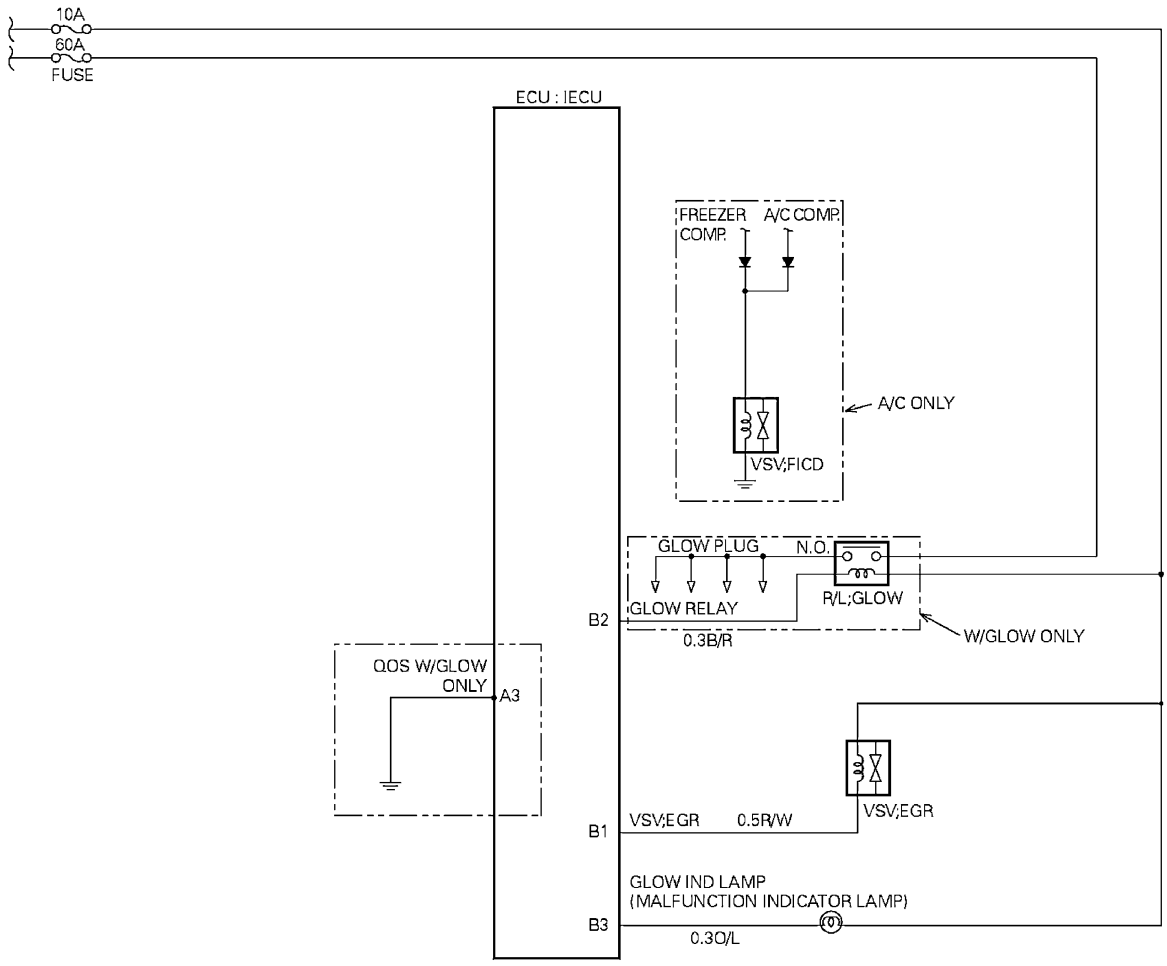
Legend
A. QOS relay

Resistance value

Inspection Point		Resistance	Reference
Inspection relay unit	4 ⟷ 5	23 (Ω) (for 12 volt) 100 (Ω) (for 24 volt)	
	2 ⟷ 3	∞	Not be supplied electricity to coil
		Below 0.5 (Ω)	Be supplied electricity to coil

Step	Action	Value	YES	NO
1	Was the “Diagnostic system check” performed?	—	Go to Step 2	Go to diagnostic system check
2	1. Ignition “OFF” 2. Disconnect the Relay from the Relay box connector. 3. Ignition “ON” Engine “OFF” 4. Using the Digital Voltmeter (DVM), check for voltage on the “Power supply side terminal” terminal of the Relay Box Connector. Does the DVM read the following value?	12 Volt or 24 Volt	Go to Step 4	Go to Step 3
3	1. Check the suspect circuit between the Relay connector. Fuse for the following condition. • A short to ground • An open circuit 2. Repair if necessary. Has DTC 41 been corrected?	—	Go to Step 8	—
4	Using the DVM, check the resistance of inter “4” “5” Relay terminal. Does the DVM read the following Value?	23Ω (for 12 Volt) 100Ω (for 24 Volt)	Go to Step 5	Go to Step 6
5	1. Ignition “OFF” 2. Disconnect the ECM connector from ECM. 3. Check the Relay circuit between the ECU and Relay connector. • A short to ground • An open circuit 4. Repair if necessary. Has DTC 41 been corrected?	—	Go to Step 8	Go to Step 7
6	Replace the Relay. Is the action complete?	—	Go to Step 8	—
7	Replace the ECM. Is the action complete?	—	Go to Step 8	—
8	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Does DTC 41 come normal condition?	—	Go to Step 9	Go to Step 2
9	Is any current trouble other than DTC 41 displayed by indicator light?	—	Go to trouble code section	Trouble code clear

DTC-42 Quick On Start (QOS) Relay Control Circuit High Voltage



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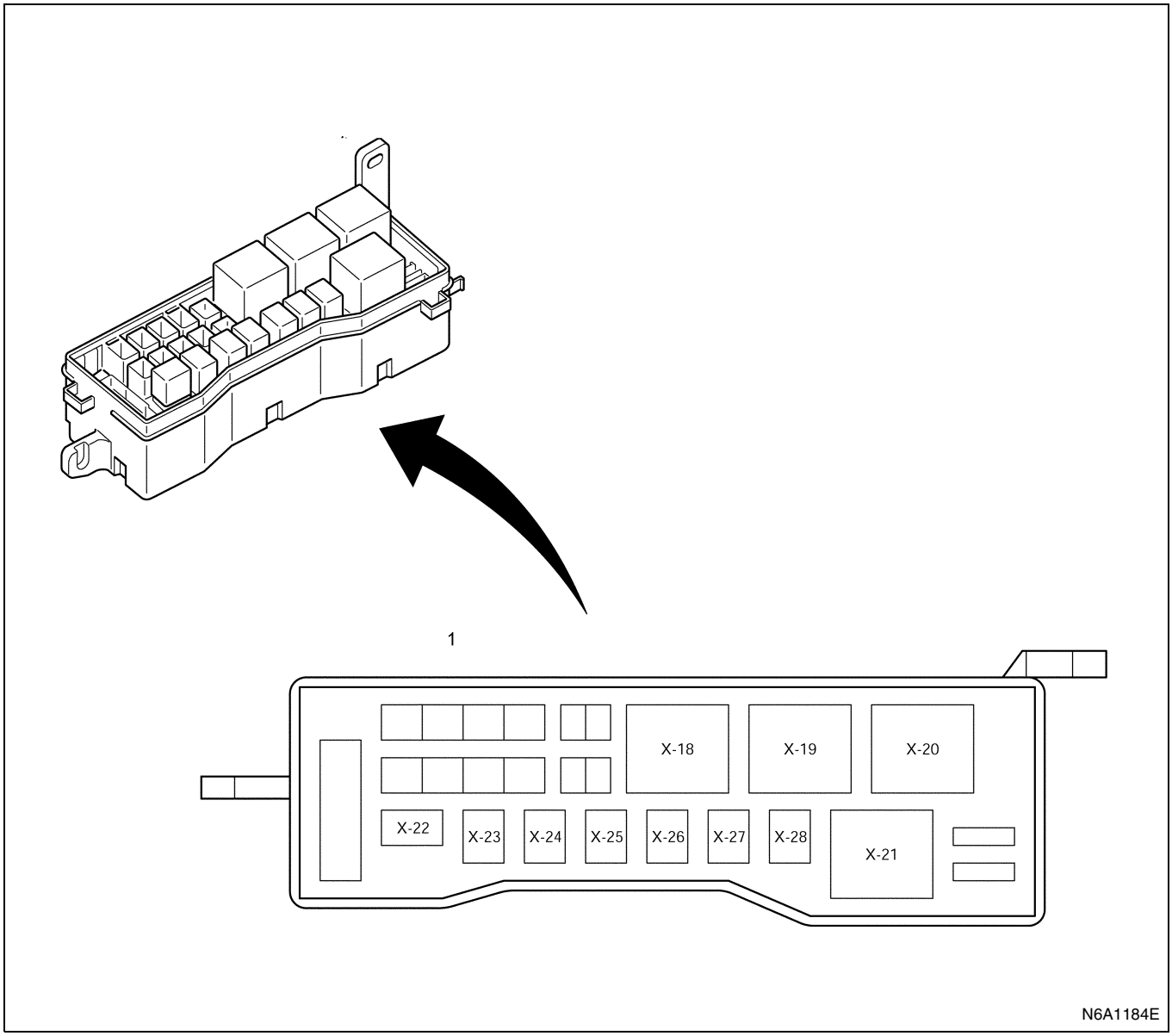
Location of Relay

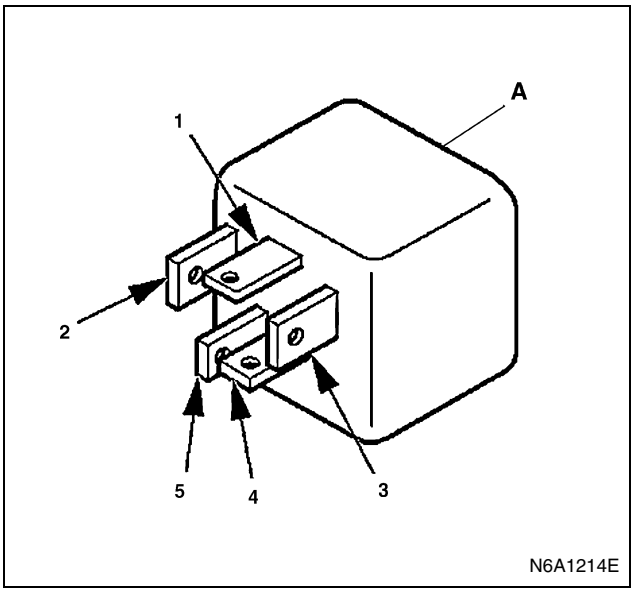


Legend

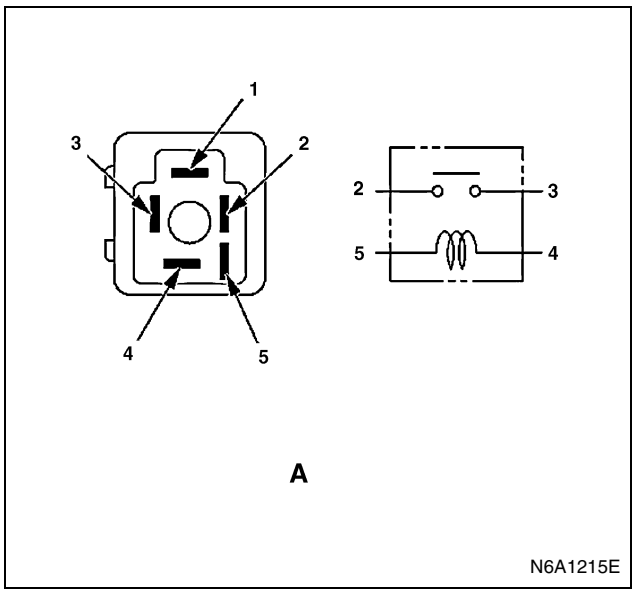
1. Relay box (Installed on the left side rear of the cab)

NO	RELAY NAME
X-20	Glow plug
X-21	Starter
X-22	Marker lamp
X-23	Rear fog
X-24	A/C COMP, 4WD ind. lamp
X-25	Exh, Brake control
X-26	CSD, A/C ON SIGNAL
X-27	Condenser fan
X-28	Exh. Brake cut

Inspection for Quick On Start (QOS) power cut relay



Legend
A. QOS relay



Legend
A. QOS relay

Resistance value

Inspection Point		Resistance	Reference
Inspection relay unit	4 ⟷ 5	23 (Ω) (for 12 volt) 100 (Ω) (for 24 volt)	
	2 ⟷ 3	∞	Not be supplied electricity to coil
		Below 0.5 (Ω)	Be supplied electricity to coil

Step	Action	Value	YES	NO
1	Was the “Diagnostic system check” performed?	—	Go to Step 2	Go to diagnostic system check
2	Using the DVM, check the resistance between terminal number 4 and 5 of the Relay. Does the DVM read the following Value?	23Ω (for 12 Volt) 100Ω (for 24 Volt)	Go to Step 3	Go to Step 4
3	1. Ignition “OFF” 2. Disconnect the ECM connector from ECM. 3. Check the short to voltage of Relay circuit between the ECM and Relay connector 4. Repair if necessary. Has DTC 42 been corrected?	—	Go to Step 6	Go to Step 5
4	Replace the Relay. Is the action complete?	—	Go to Step 6	—
5	Replace the ECM. Is the action complete?	—	Go to Step 6	—
6	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Does DTC 42 come normal condition?	—	Go to Step 7	Go to Step 2
7	Is any current trouble other than DTC 42 displayed by indicator light?	—	Go to trouble code section	Trouble code clear

DTC-52 Electronically Erasable Programmable Read Only Memory (EEPROM) Error

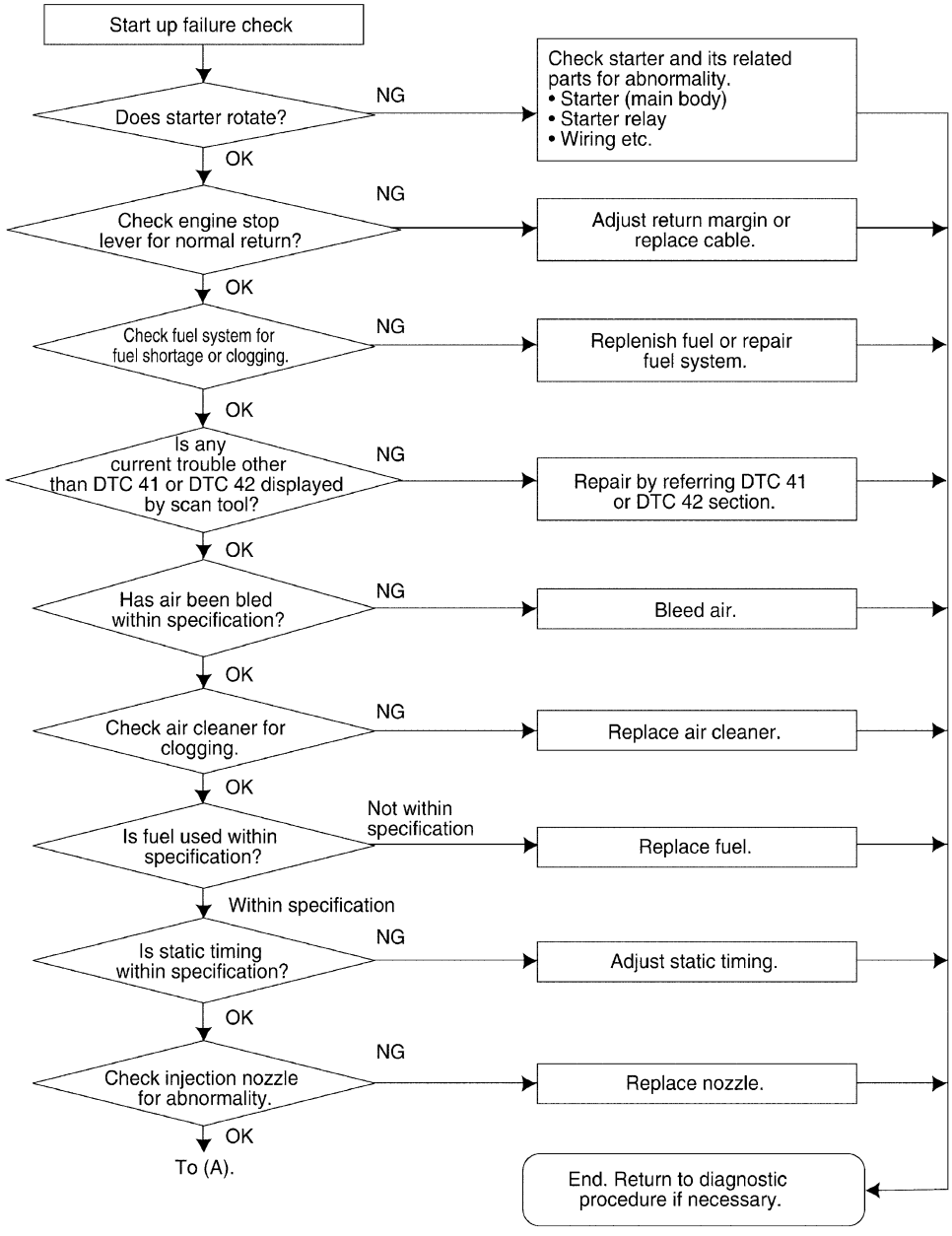
Step	Action	Value	YES	NO
1	Was the “Diagnostic system check” performed?	—	Go to Step 2	Go to diagnostic system check
2	Replace the ECM. Is the action complete?	—	Go to Step 3	—
3	1. Reconnect all the connectors removed. 2. Ignition “ON”, Engine “OFF” Is DTC 52 all right under Scan Tool Check?	—	Go to Step 4	Go to Step 2
4	Is any current trouble other than DTC 52 displayed by indicator light?	—	Go to trouble code section	Trouble code clear

WITHOUT DIAGNOSIS TROUBLE CODE

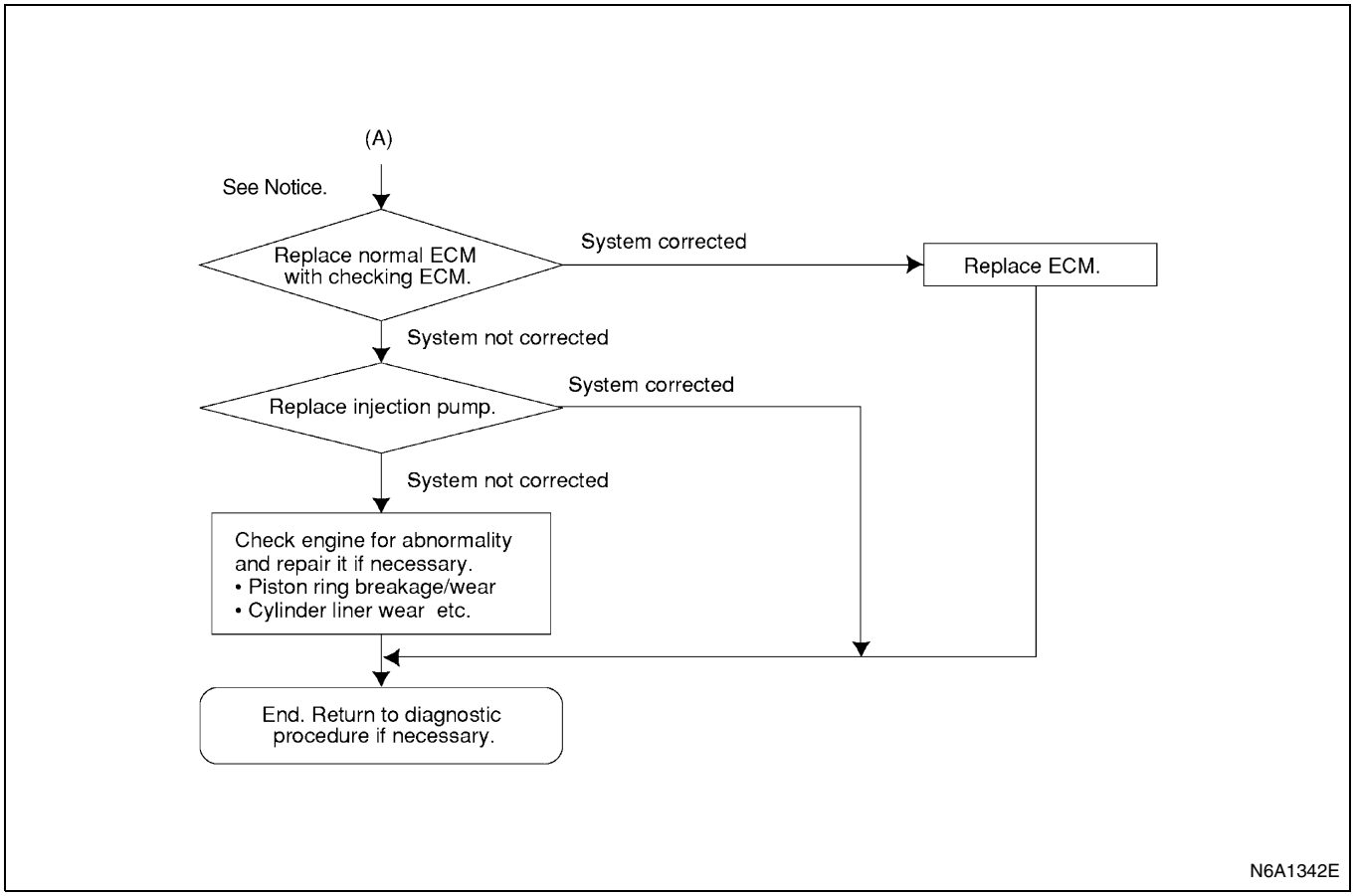
Introduction
If there occurs a malfunction although no Diagnostic Trouble Code (DTC) is generated, then inspect and repair the system in accordance with the flowcharts given on the following pages.

When a Diagnostic Trouble Code (DTC) is produced, inspect and repair system with reference to “EMISSION AND ELECTRICAL DIAGNOSIS”

Startup Failure (Quick On Start (QOS) only)

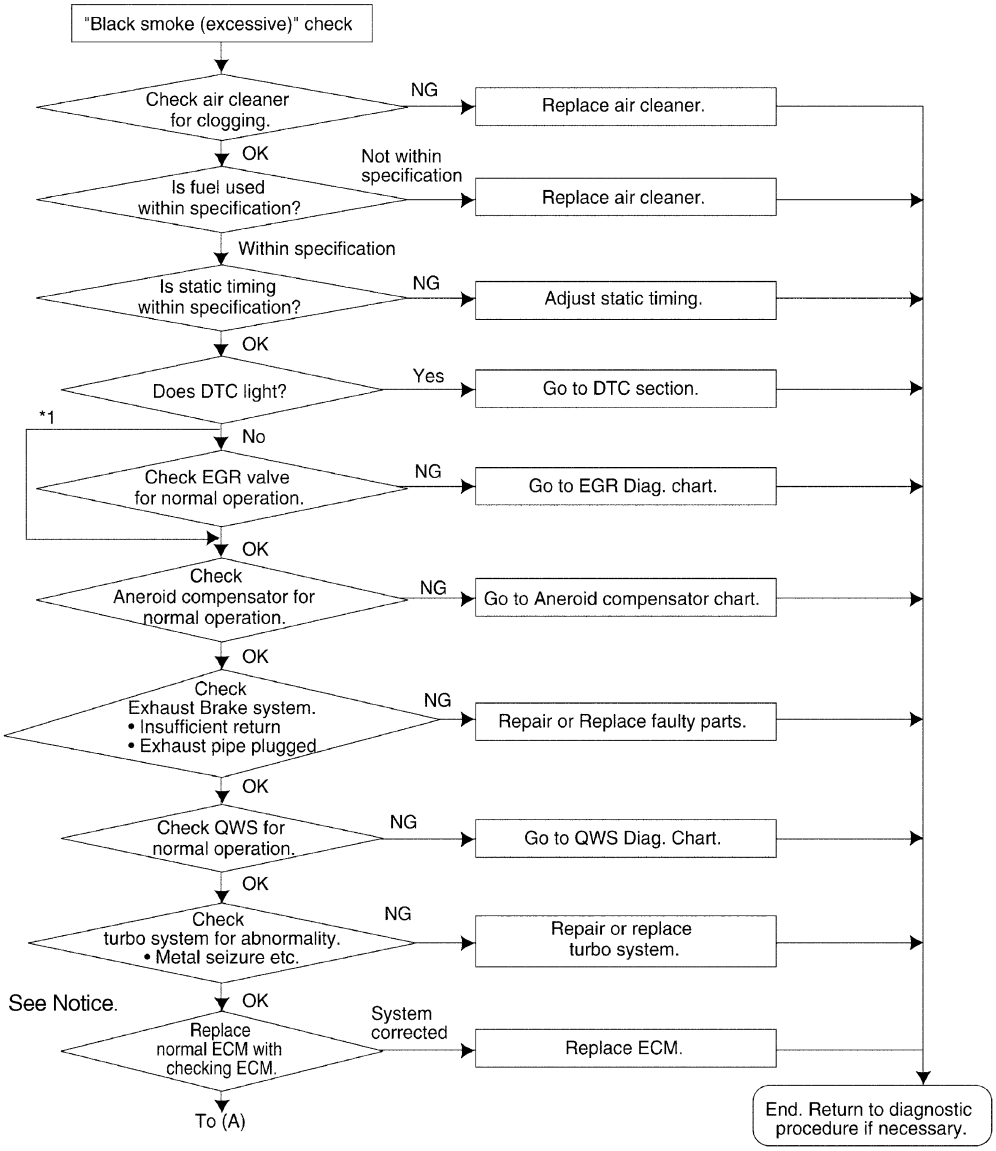


N6A1341E

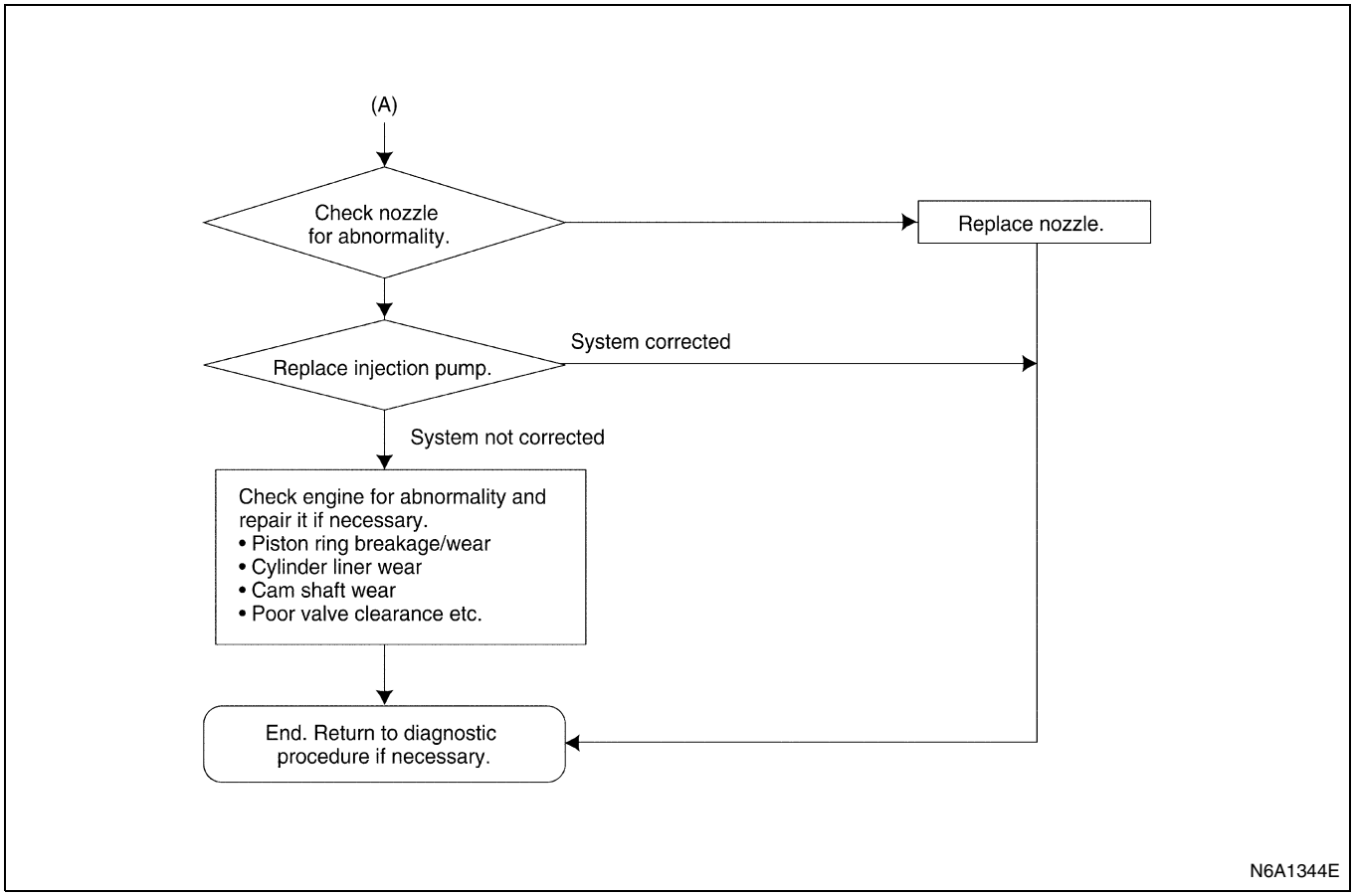


Notice:
The condition of the system in which the malfunction has occurred should be checked by making comparisons between the vehicle Engine Control Module (ECM) and the checking ECM.

Black Smoke (Excessive)



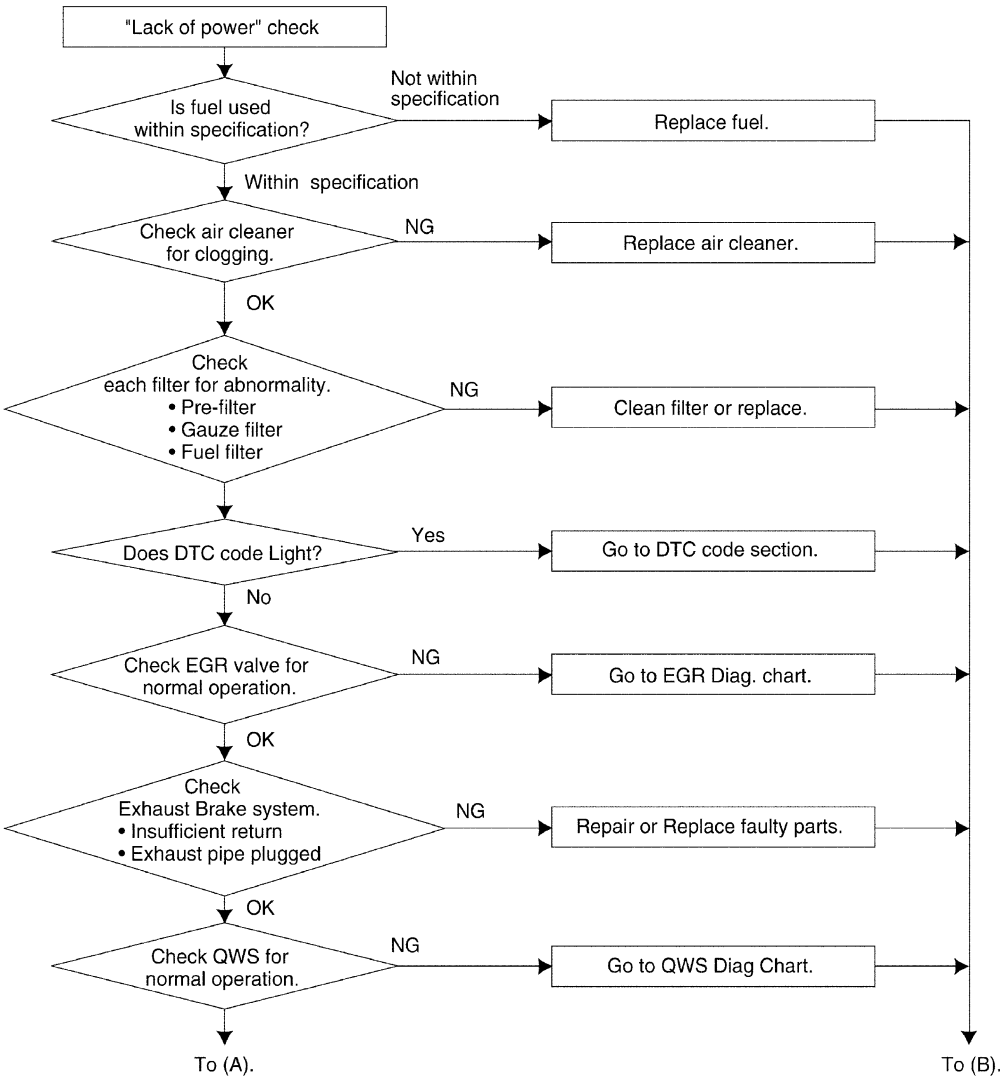
N6A1343E



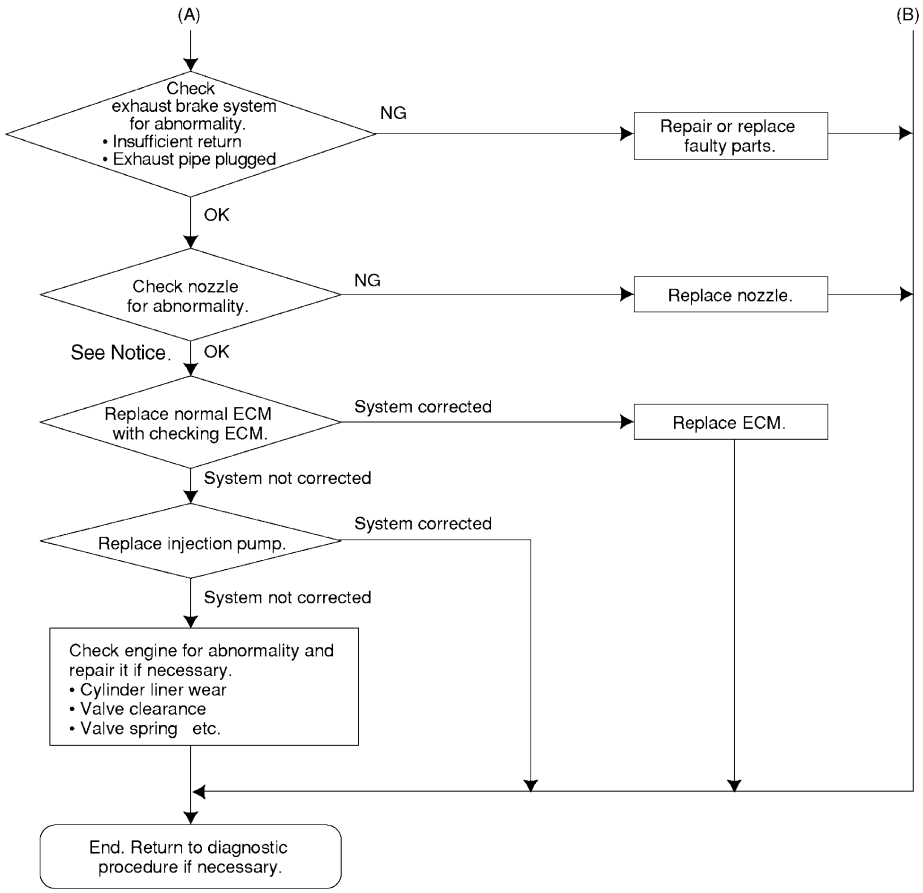
Notice:
The condition of the system in which the malfunction has occurred should be checked by making comparisons between the vehicle Engine Control Module (ECM) and the checking ECM.

Refer to a trouble code for a supplier's check, if available.

Lack of Power



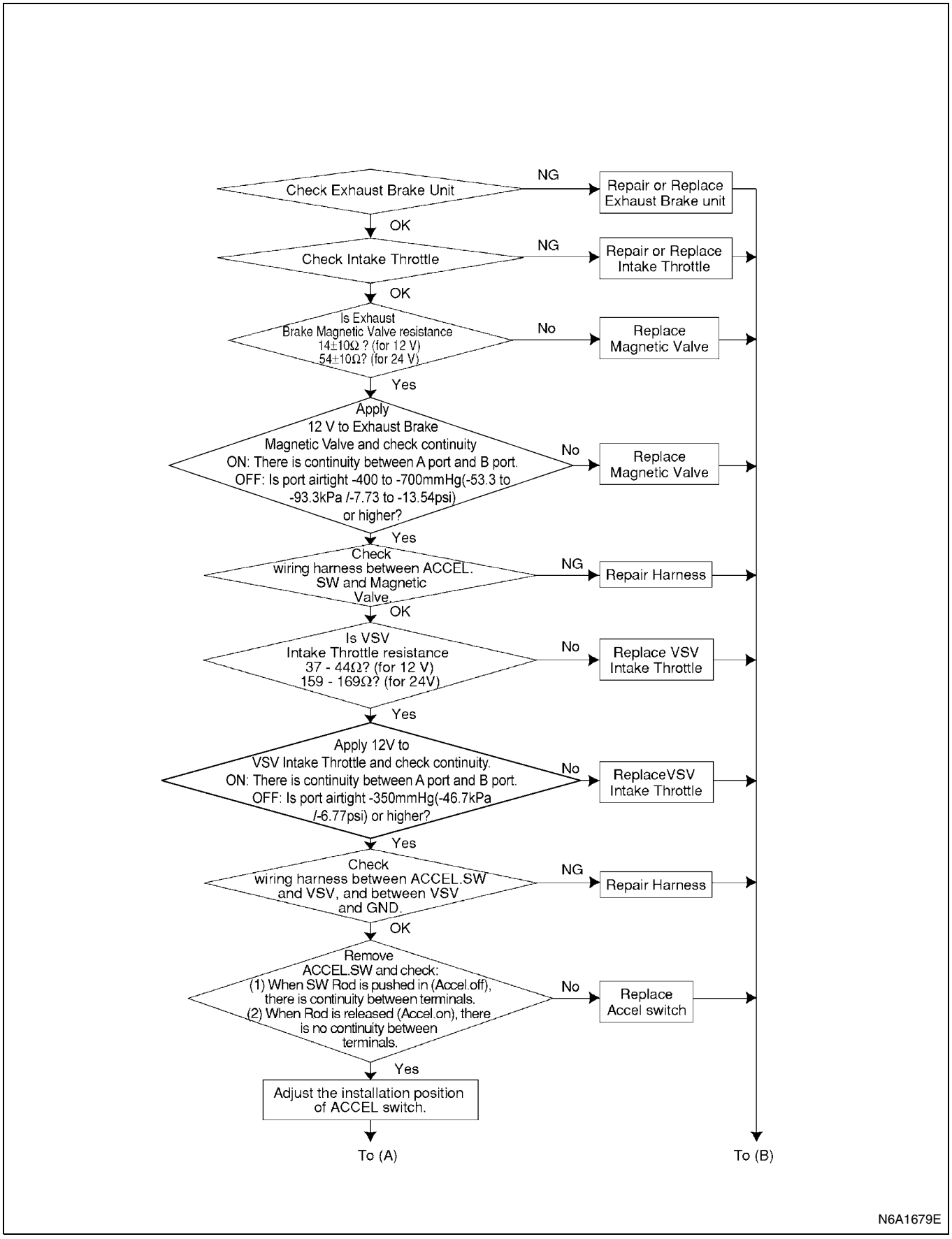
N6A1345E

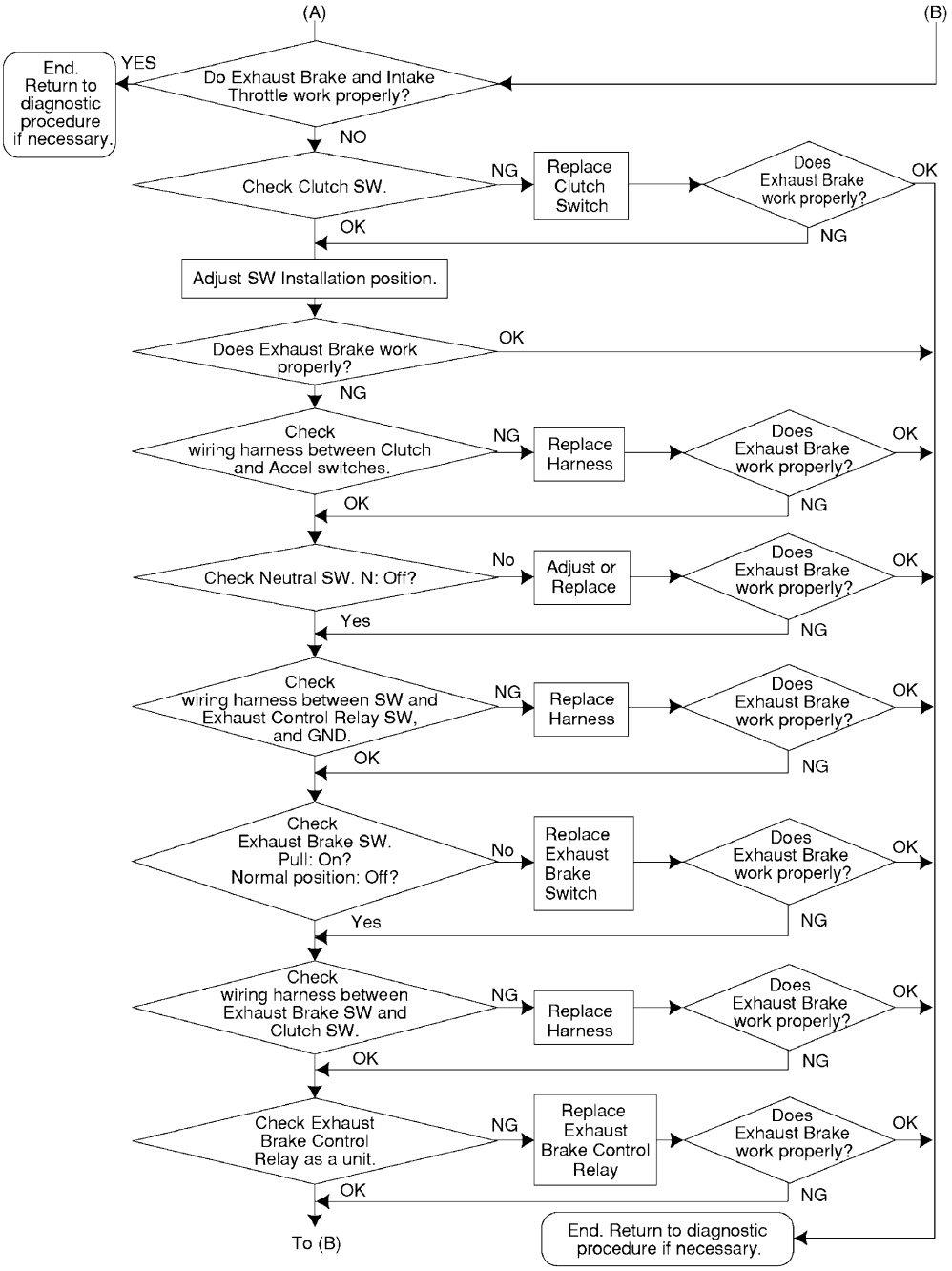


N6A1346E

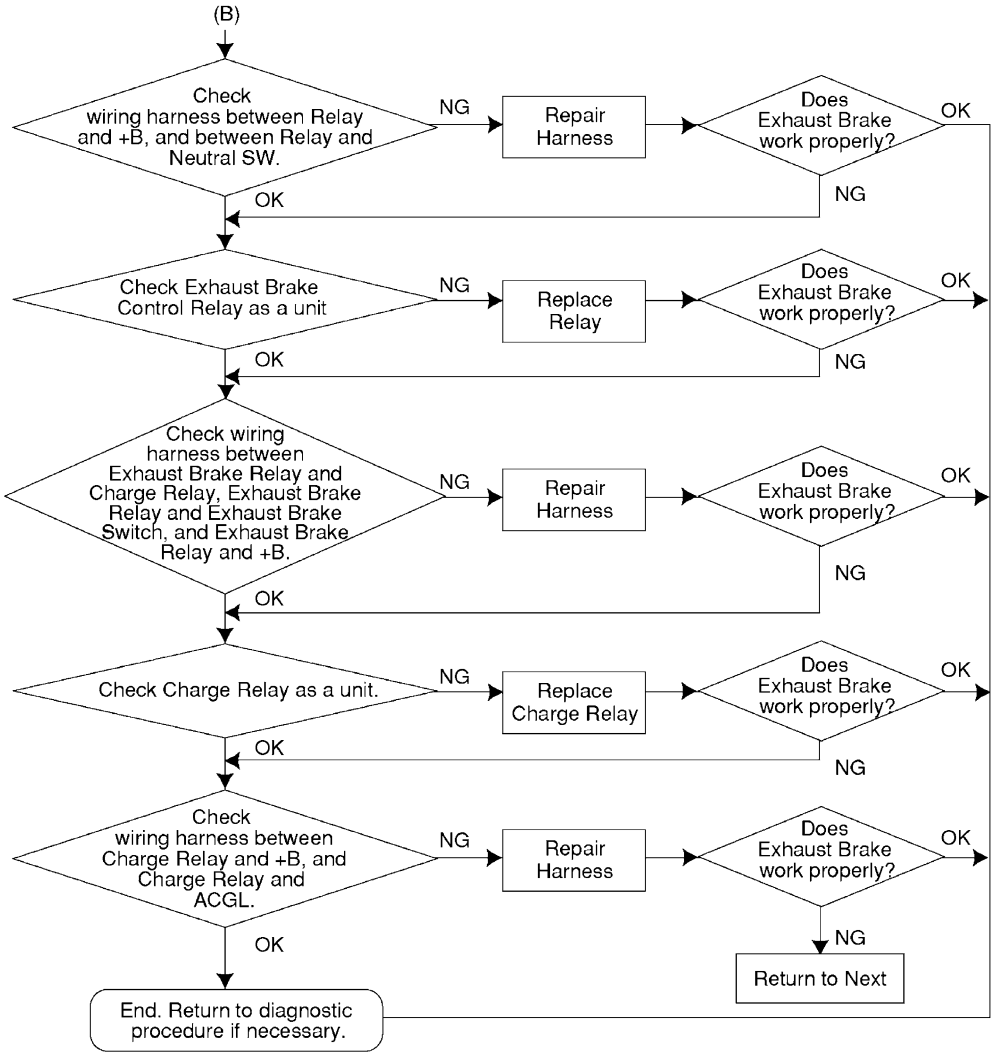
Notice:
The condition of the system in which the malfunction has occurred should be checked by making comparisons between the vehicle Engine Control Module (ECM) and the checking ECM.

Exhaust Brake Malfunction (Exhaust Brake only)




(A)
(B)
End. Return to diagnostic procedure if necessary.
YES
Do Exhaust Brake and Intake Throttle work properly?
NO
Check Clutch SW.
NG
Replace Clutch Switch
Does Exhaust Brake work properly?
OK
NG
OK
Adjust SW Installation position.
Does Exhaust Brake work properly?
OK
NG
Check wiring harness between Clutch and Accel switches.
NG
Replace Harness
Does Exhaust Brake work properly?
OK
NG
OK
Check Neutral SW. N: Off?
No
Adjust or Replace
Does Exhaust Brake work properly?
OK
NG
Yes
Check wiring harness between SW and Exhaust Control Relay SW, and GND.
NG
Replace Harness
Does Exhaust Brake work properly?
OK
NG
OK
Check Exhaust Brake SW. Pull: On? Normal position: Off?
No
Replace Exhaust Brake Switch
Does Exhaust Brake work properly?
OK
NG
Yes
Check wiring harness between Exhaust Brake SW and Clutch SW.
NG
Replace Harness
Does Exhaust Brake work properly?
OK
NG
OK
Check Exhaust Brake Control Relay as a unit.
NG
Replace Exhaust Brake Control Relay
Does Exhaust Brake work properly?
OK
NG
OK
To (B)
End. Return to diagnostic procedure if necessary.

N6A1348E



* Repair of wiring harness includes diode check.

N6A1349E

Inspection

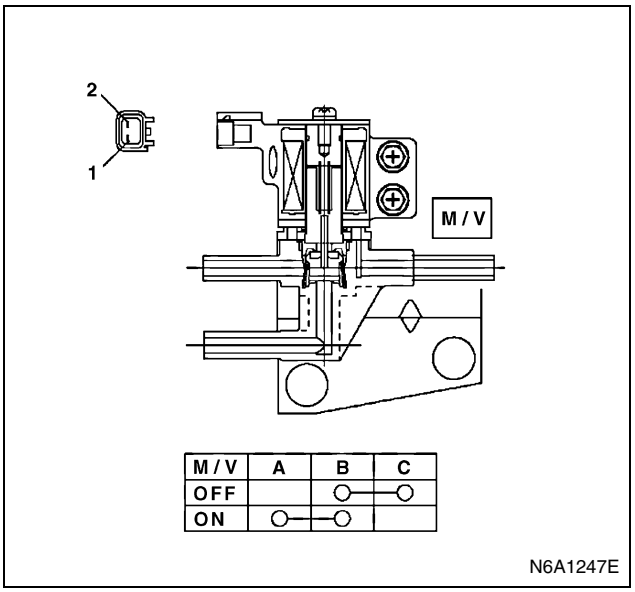
1. Exhaust Brake Magnetic Valve

Inspection

Connect the magnetic valve connector terminal No.1 and No.2 to (+) terminal and (-) terminal of battery, respectively, and check the continuity between the ports.

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.



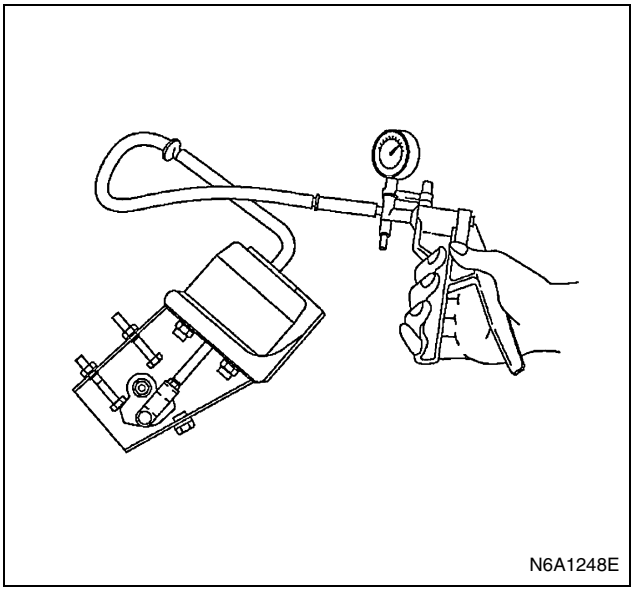
Legend

A. Inlet (Vacuum pump)
B. Outlet (unit)
C. EXH (air filter)

2. Exhaust Throttle Valve

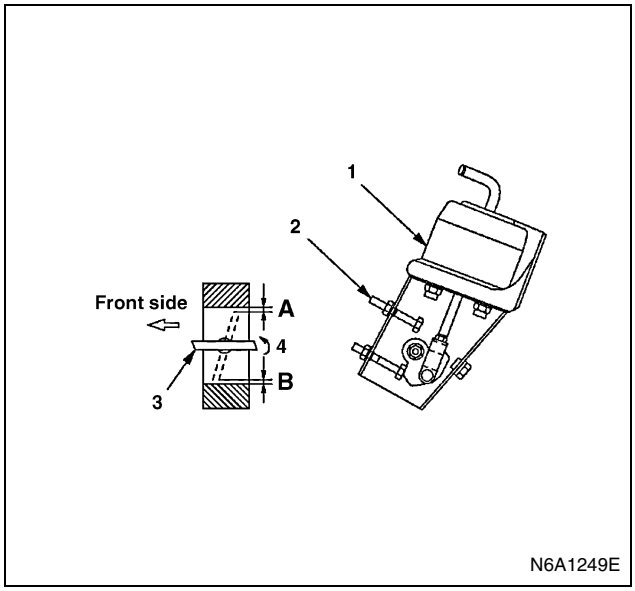
Working Check

Actuate the exhaust brake with the engine idling and make sure that you hear the valve strike on the stopper.



Airtight Check

Apply a negative pressure of 53.3 — 93.3 kPa (400 — 700 mmHg/7.73 — 13.54 psi) to the power chamber by means of a vacuum pump and make sure of the smooth opening/closing of the exhaust brake valve.



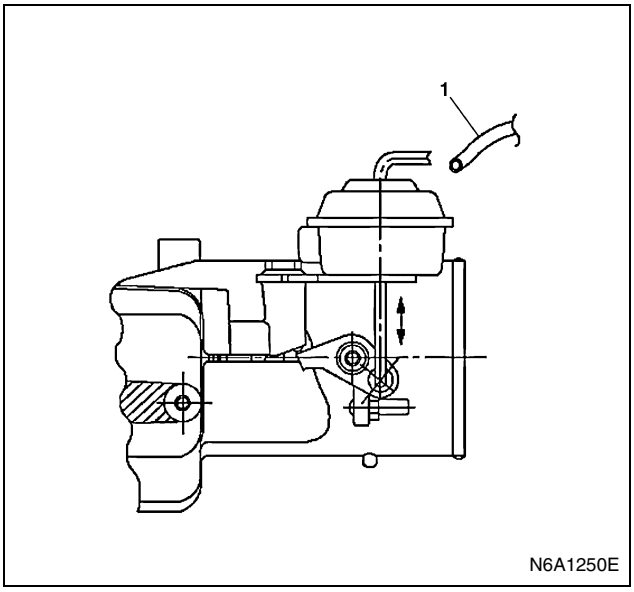
Legend

1. Power chamber
2. Adjust bolt
3. Valve
4. Close

Apply a negative pressure of 86.7 — 93.3 kPa (650 — 700 mmHg/12.57 — 13.54 psi) to the power chamber using a vacuum pump and make sure the average of measurements at Point A and Point B of the clearance between valve and body is as follows:

0.4 — 0.6 mm (0.016 — 0.024 in) (Minimum: 0.4 mm/0.016 in)

If the clearance is out of this range, adjust with the adjusting bolt.



Legend

1. Vacuum hose

3. Intake Throttle Valve

Working Check

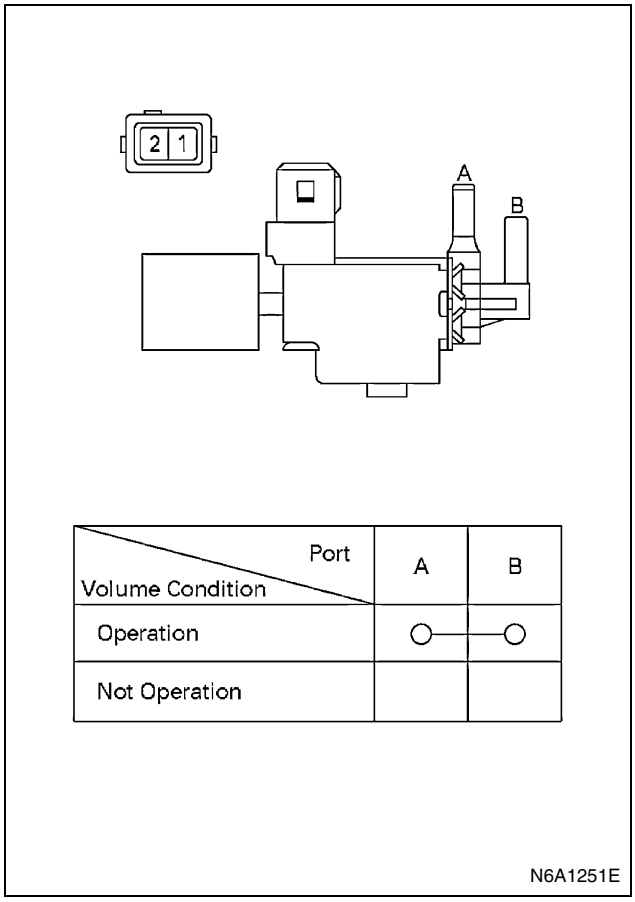
Disconnect the vacuum hose from the actuator and try to move the rod by hand, making sure of the smooth move of the rod.

4. EXHAUST GAS RECIRCULATION (EGR) SYSTEM MALFUNCTION4. Vacuum Switching Valve; Intake Throttle

Inspection

Connect the vacuum switching valve connector terminals No.1 and No.2 to (+) terminal and (-) terminals of battery, respectively, and check the continuity between the ports.

If the check result is abnormal, repair or replace the valve.



5. Accelerator Switch (2-pole connector type)

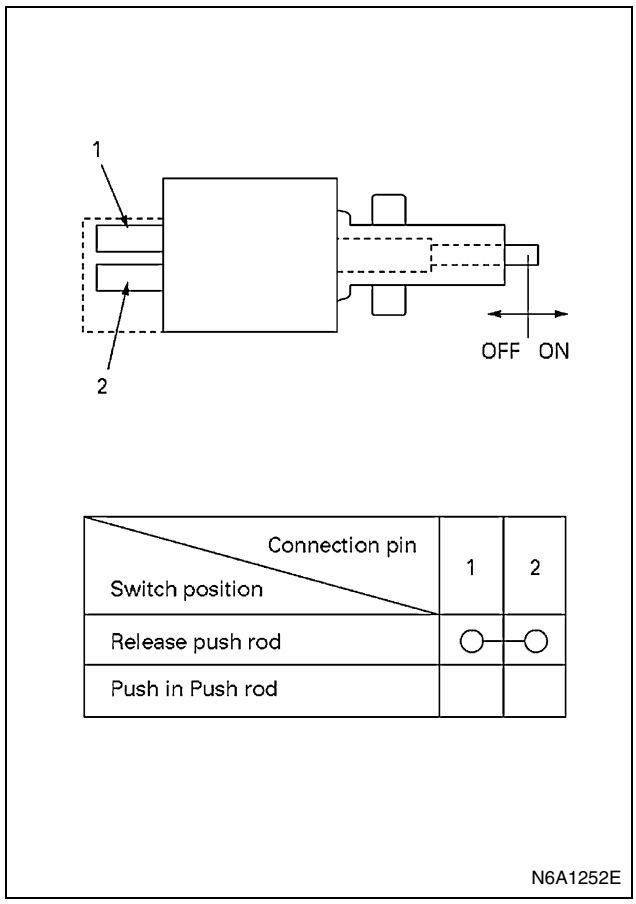
Inspection

1) Check the continuity between the switch connector terminals.

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

2) Check the smooth move of the pushrod. If the check result is abnormal, repair or replace the pushrod.



Removal

1) Accelerator Switch
   Disconnect the connector.
   Loosen the lock nut.
   Turn the switch to remove.

Reinstallation

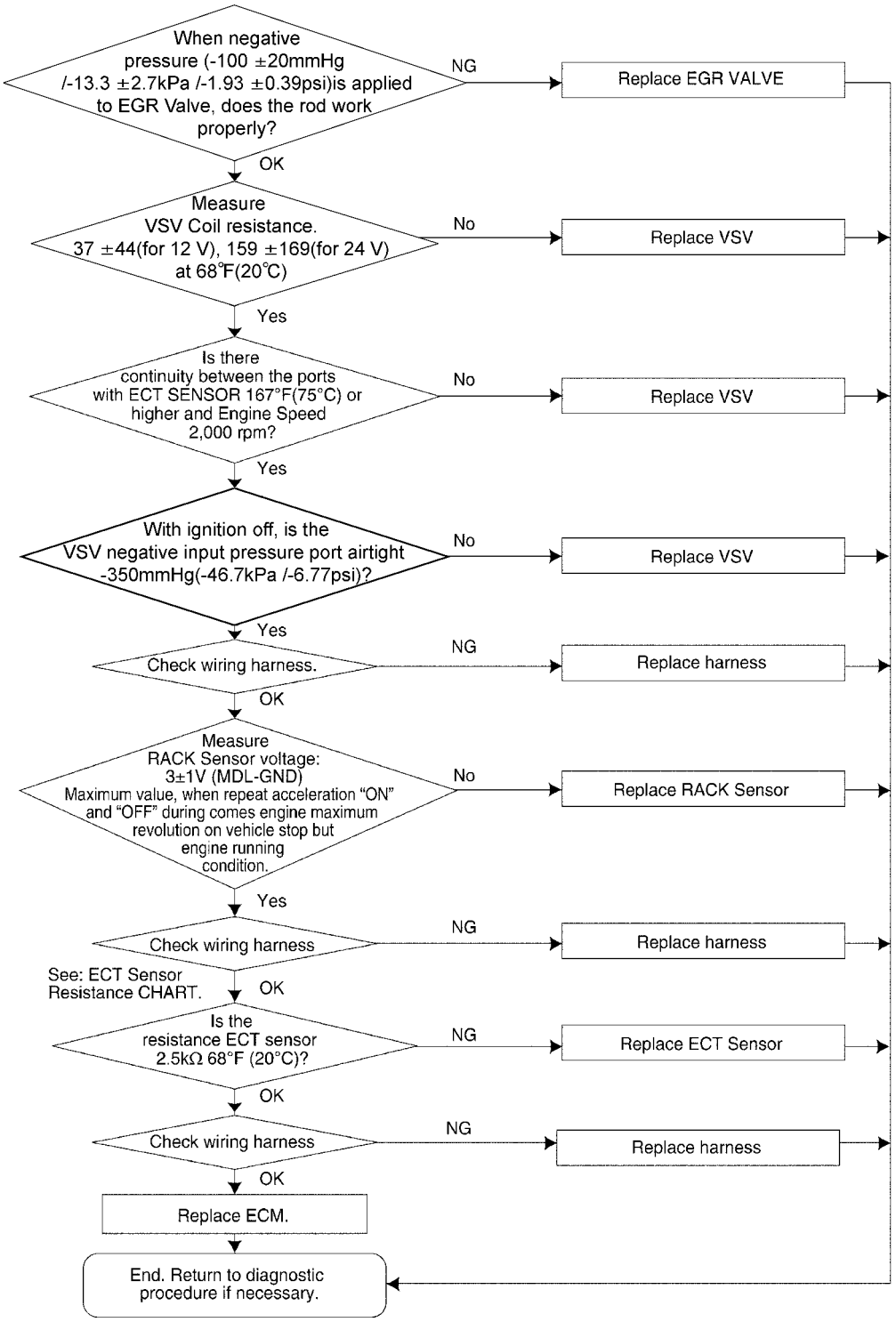
To install, follow the removal procedure in reverse order:

1) Drive the threaded part of the switch until its end surface becomes flush with that of the bracket side of nut.
2) Tighten the lock nut.

Tighten:

- Lock nut to 1.3 N·m (0.13 kg·m/11.5 lb·in)

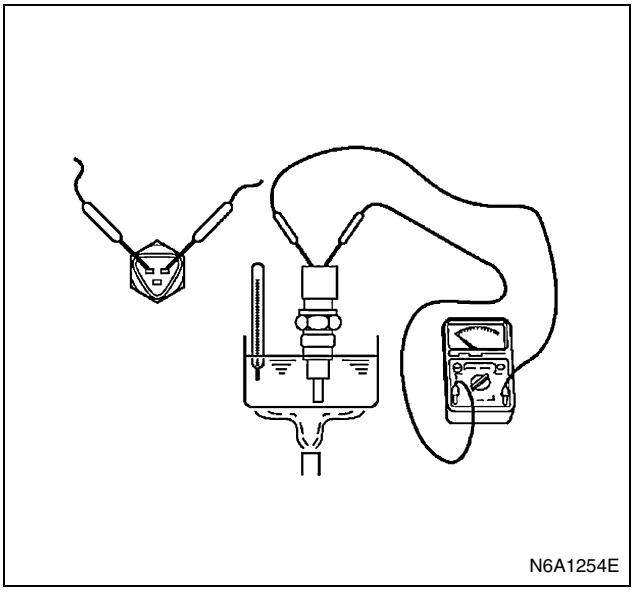
Exhaust Gas Recirculation (EGR) System Malfunction

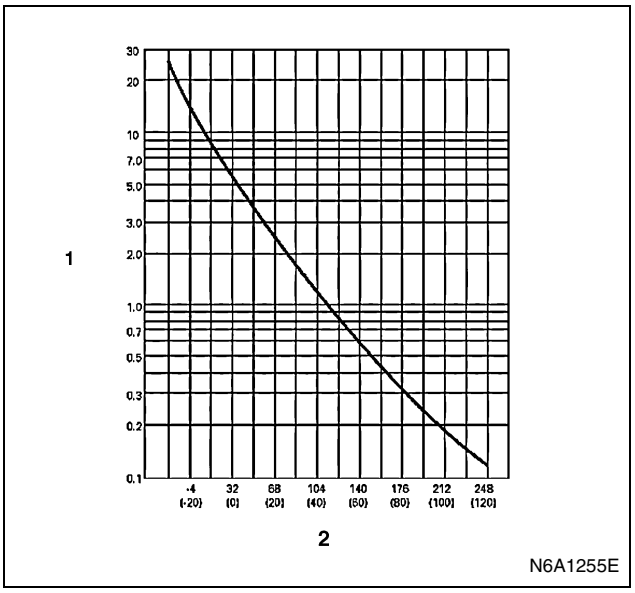


N6A1680E

Inspection

1. Thermosensor (Engine coolant temperature)
   Soak the temperature sensitive part of a thermosensor in the water, and while changing the water temperature, make sure the resistance is changed as the following graph shows:


N6A1254E



N6A1255E

Legend
1. Resistance (kΩ)
2. ECT °F (°C)

2. Vacuum Switching Valve (VSV)

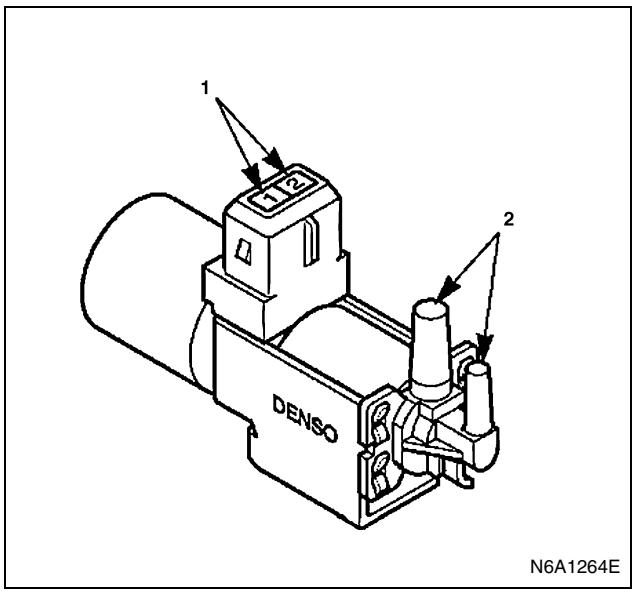
Resistance Check

Check the resistance between the VSV connector terminals using a circuit tester.

Cold Resistance

: 37 — 44 (Ω) (for 12 volt model)

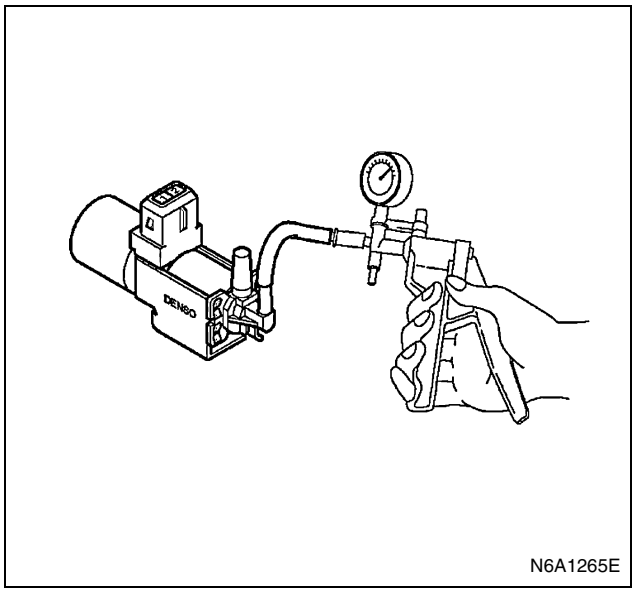
: 159 — 169 (Ω) (for 24 volt model)



N6A1264E

Legend
1. 2 Pin
2. Port

Connect battery voltage between VSV connector terminals and make sure of the continuity between the ports.

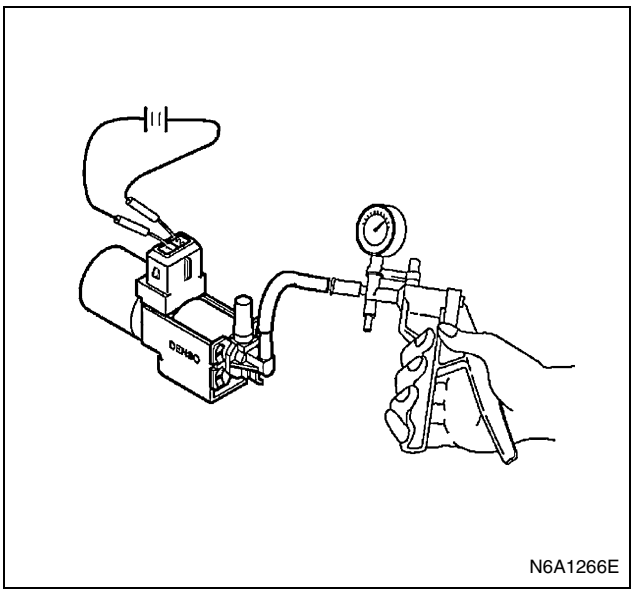


N6A1265E

Airtight Check

Apply negative pressure to the negative pressure input port as illustrated on the left.

Although there is leakage, it is no problem if the negative pressure rises to -46.7 kPa (-350 mmHg / -6.77 psi) or more.



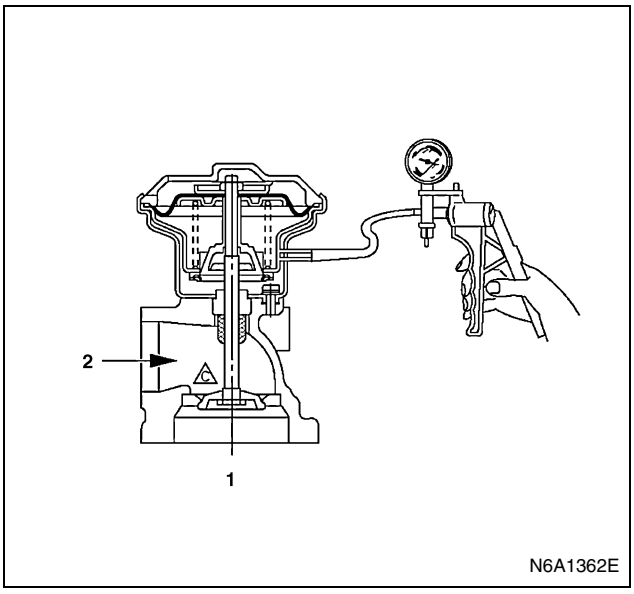
Working Check

Apply powervoltage between the terminals, there is no problem if the negative pressure does not rise when applied to the input port.

Caution:

When measuring resistance with a circuit tester, be careful not to damage or deform the terminals.

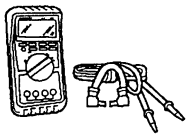
3. Exhaust Gas Recirculation (EGR) Valve
   With negative pressure applied to the diaphragm chamber, make sure that the valve is smoothly actuated to make the area between (1) and (2) ventilated.
   Startup: About -13.3 ± 2.7 kPa (-100 ± 20 mmHg / -1.93 ± 0.39 psi)



Check to see if EGR valve is normally actuated under the following conditions:

Engine coolant temp.: 80°C (176°F) or higher

SPECIAL TOOLS

Illustration	Tool Number / Description / Remarks
 5884003660	5-8840-0366-0 (J 39200) / High Impedance Multi-meter (Digital Voltmeter-DVM)
5884002790	5-8840-0279-0 (J 23738-A) / Vacuum Pump with Gauge

ENGINE 4H SERIES

SECTION 6F
EXHAUST

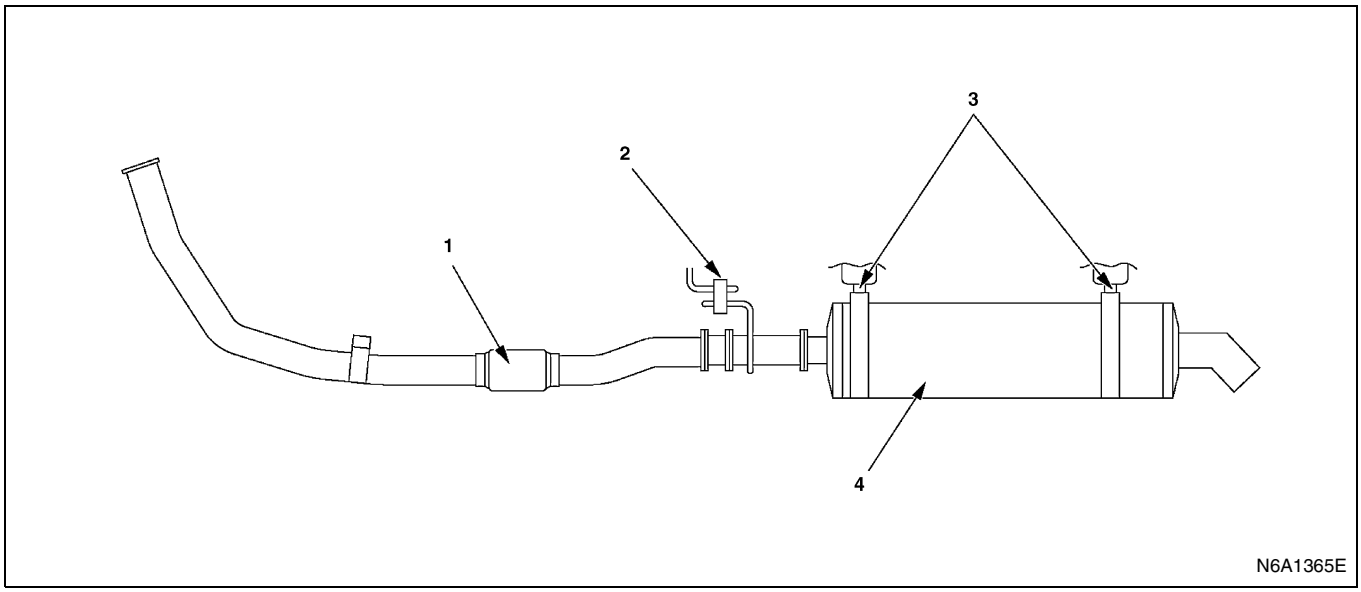
Caution:
Exhaust system components must have enough clearance from the underbody to prevent overheating of the floor pan and possible damage to the passenger compartment, insulation and trim materials.

Contents

GENERAL DESCRIPTION 6F-2
Component 6F-2
Gasket 6F-2
ON-VEHICLE SERVICE 6F-4
Component 6F-4
Removal 6F-4
Installation 6F-5

GENERAL DESCRIPTION

Component



Legend

1. Flexible tube
2. Rubber support
3. Rubber mount
4. Silencer with converter

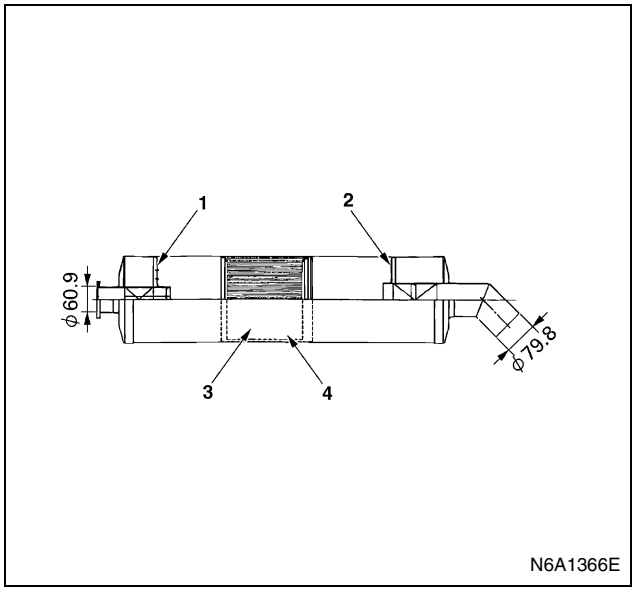
The vehicle is equipped with a single horizontal exhaust system which consists of a front exhaust pipe with a heat shield attached, a main exhaust pipe, a silencer with catalytic converter and a tail pipe.
An engine exhaust brake is attached between the front exhaust pipe and the exhaust manifold.
The exhaust brake, when turned on, restricts the flow of exhaust gases and thereby slows the engine.
Be sure the exhaust brake system is turned off before performing any exhaust system diagnosis.

Gasket

The gasket must be replaced whenever a new exhaust pipe, muffler or exhaust throttle is installed.

Catalytic Converter

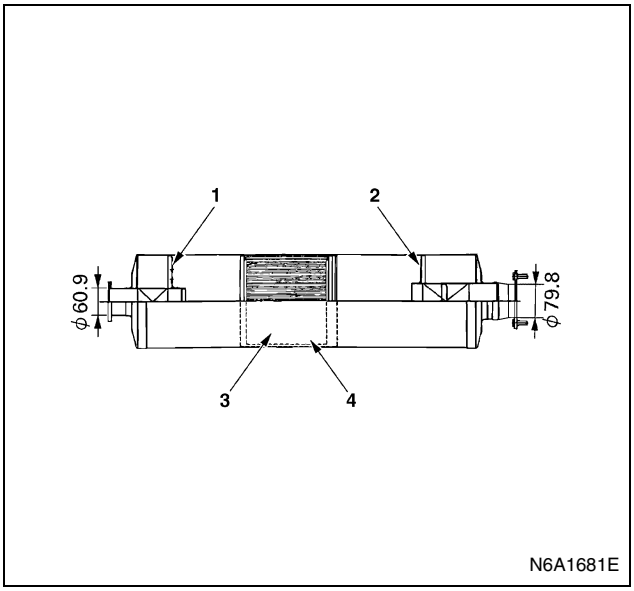
For Taiwan



Legend

1. Inlet assembly
2. Outlet assembly
3. Catalyst assembly
4. P.NO.

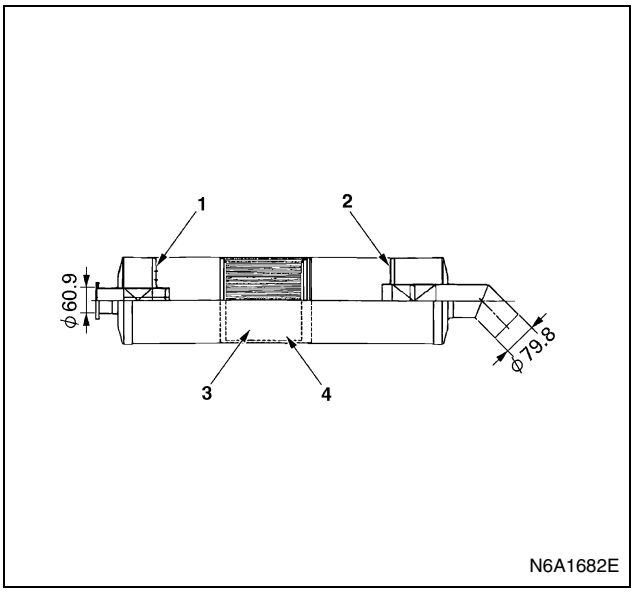
For Venezuela



Legend

1. Inlet assembly
2. Outlet assembly
3. Catalyst assembly
4. P.NO.

For Hongkong



Legend

1. Inlet assembly
2. Outlet assembly
3. Catalyst assembly
4. P.NO.

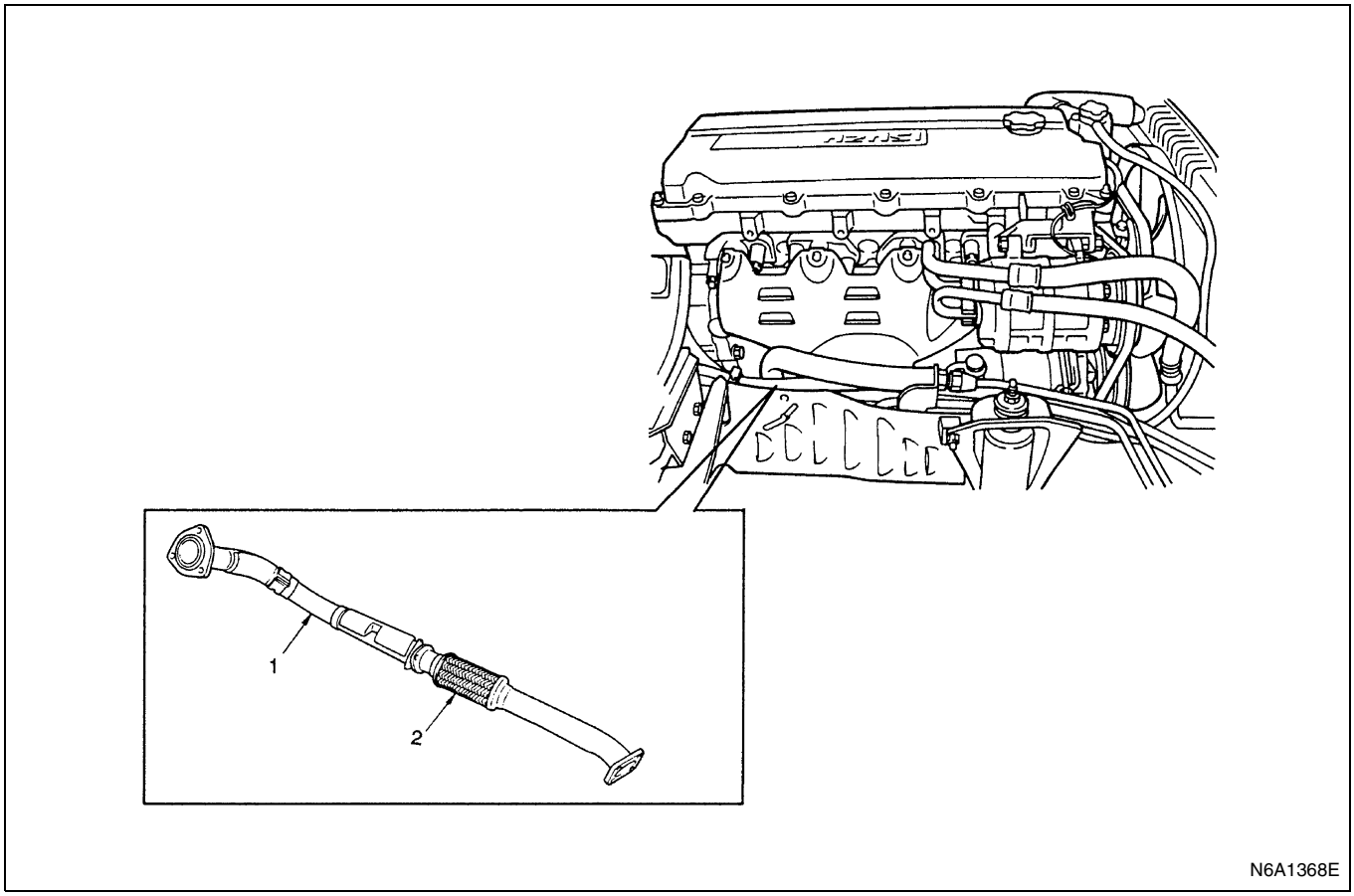
ON-VEHICLE SERVICE

Rattles and noise vibrations in the exhaust system are usually caused by misalignment of parts. When aligning the system, leave all bolts or nuts loose until all parts are properly aligned; then tighten, working from front to rear.

1. Check connections for looseness or damage, especially for exhaust gas leakage.
2. Check clamps and rubbers for weakness, cracks or damage.
3. Check for dents or damage and for any holes or cracks caused by corrosion.

Component

Front Exhaust Pipe



Legend

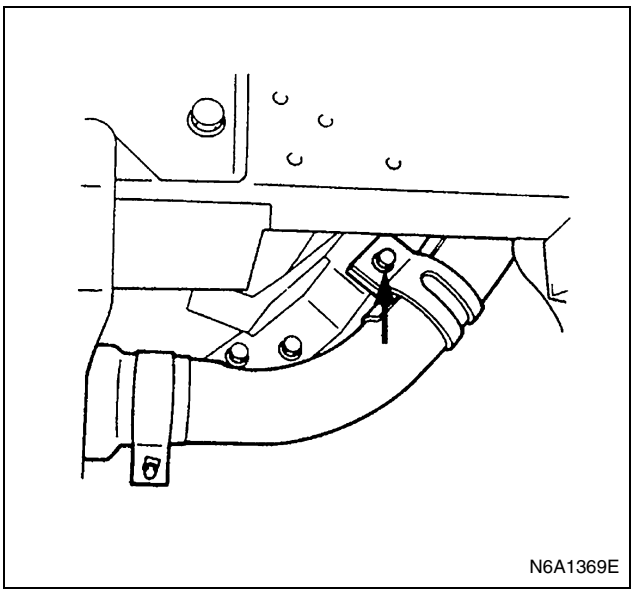
1. Front exhaust pipe I (Exhaust manifold side)
2. Front exhaust pipe II (Exhaust brake side)

Removal

Preparation

- Disconnect battery negative cable.

1. Front Exhaust Pipe I (Exhaust manifold side)
   - Remove the three nuts from front exhaust pipe I (exhaust manifold side)
   - Remove the bolt from mounting bracket (engine right side)



- Remove the four bolts and nuts from front exhaust pipe II (exhaust brake side)

2. Front Exhaust Pipe II (exhaust brake side)

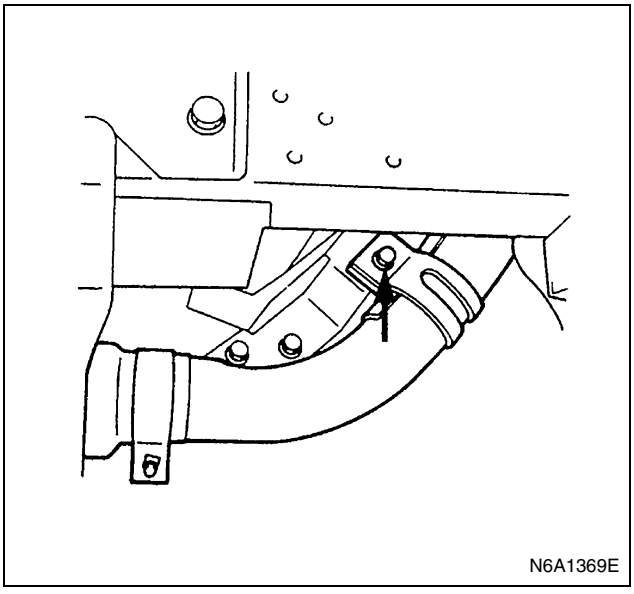
Installation

1. Front Exhaust Pipe II (exhaust brake side)

Tighten:
Exhaust brake unit fixing bolt to 17 N·m (1.7 kg·m/12 lb·ft)

2. Front Exhaust Pipe I (exhaust manifold side)

Tighten:
Exhaust Pipe II side to 17 N·m (1.7 kg·m/12 lb·ft)
Mounting Bracket Bolt to 18 N·m (1.8 kg·m/13 lb·ft)



Tighten:
Manifold Fixing Nut to 67 N·m (6.8 kg·m /49 ft·lb)

- Connect battery ground cable.
- Start engine and check for exhaust gas leakage from exhaust pipes.

ENGINE 4H SERIES

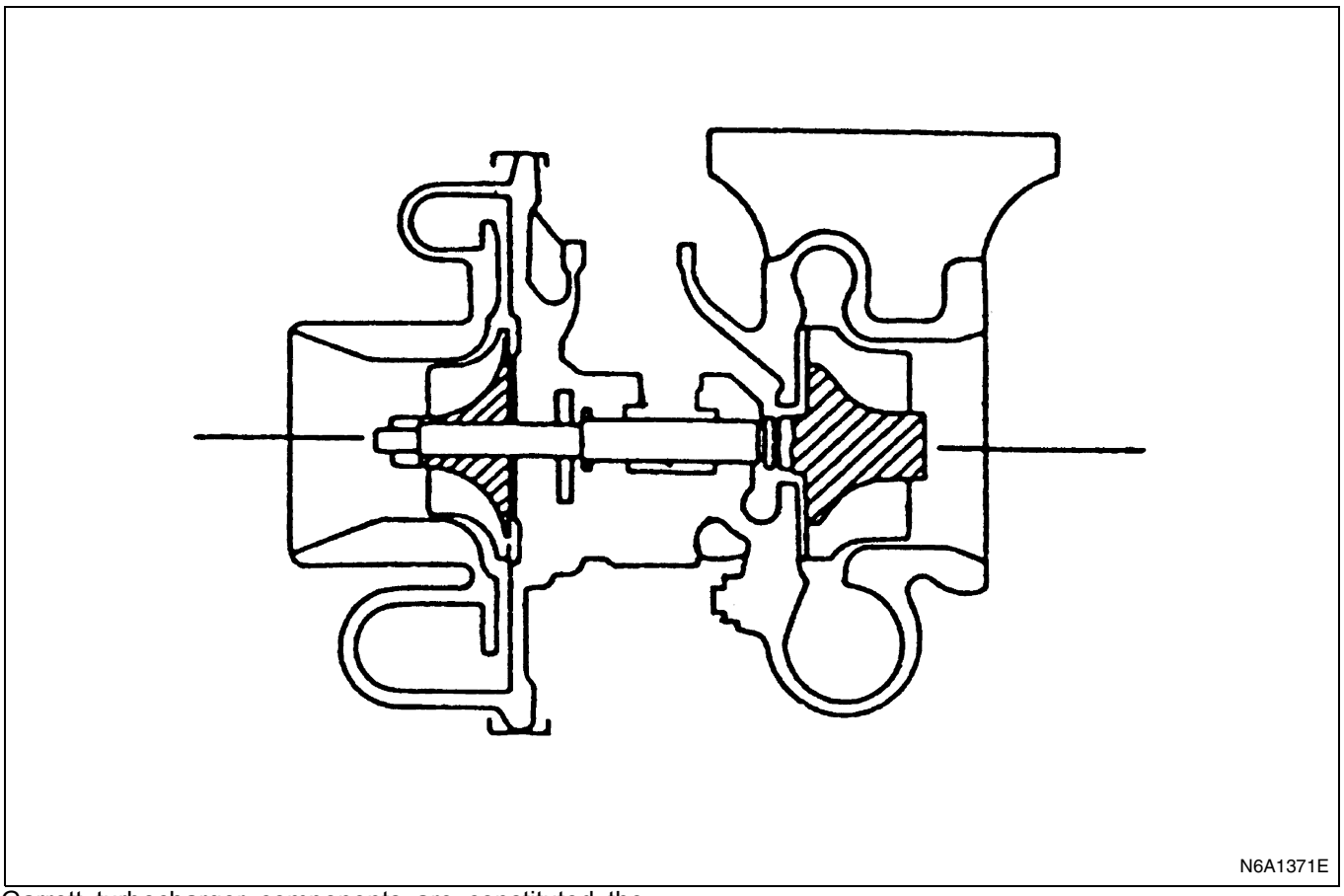
SECTION 6G
TURBOCHARGER

Contents

GENERAL DESCRIPTION 6G-2
ON-VEHICLE SERVICE 6G-3
Charge Air Pipe 6G-3
Intake Manifold 6G-3
Turbocharger 6G-4
Inspection and Repair.....6G-5
Exhaust Manifold 6G-8
Turbocharger Turbine Housing Replacement (For 4HG1-T Model).....6G-8
Charge Air Cooler.....6G-12

GENERAL DESCRIPTION

Turbocharger



N6A1371E

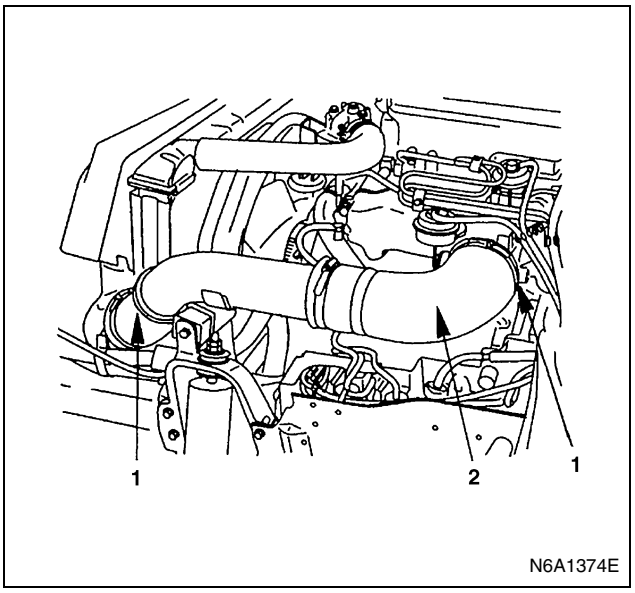
Garrett turbocharger components are constituted the Center Housing and Rotating Assembly (CHRA), the compressor housing, and the turbine housing.
Rotating parts include the turbine shaft, the compressor wheel, the shaft bearings, the thrust bearings and the oil seal rings. These parts are supported by the center housing.
The turbocharger bearing and turbine shaft are lubricated with engine oil and at the same time are cooled with engine coolant to improve their durability.
The turbocharger increase air intake efficiency, the results in increased engine power, reduced fuel consumption and minimal engine noise.
Turbocharger rotating parts operate at very high speeds and temperatures. The parts materials have been carefully selected and machined to extremely high precision.
The turbocharger for 4HG1-T Engine has a unit construction of turbine housing and exhaust manifold.
Color for caution plate on the 4HE1-TC turbocharger are, EURO3 vehicles have a blue caution plate. All other vehicles have a silver caution plate.

ON-VEHICLE SERVICE

Charge Air Pipe

Removal

1. Connecting hose clamps.
2. Connecting hoses.



3. Bracket bolts and washers and charge air pipe.
4. Clamps.
5. Connecting hose.
6. Bracket accelerator cable.
7. Bracket engine stop cable and vacuum hose.
8. Engine harness connector.
9. Charge air pipe.
10. Gasket.

Caution:

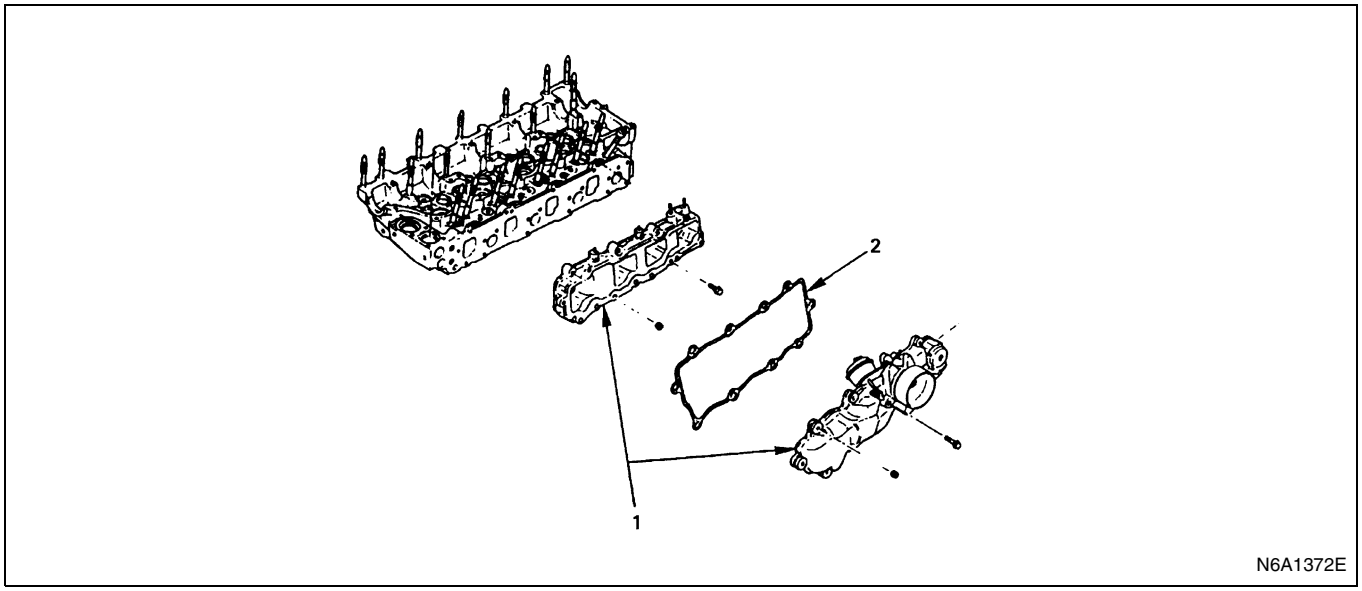
- Check hoses for deterioration, or damage.
- Charge air pipes for damage.

Installation

1. Gasket to the intake manifold.
2. Charge air pipe.
3. Engine harness connector.
4. Bracket engine stop cable and vacuum hose.
5. Bracket accelerator cable.
6. Connecting hose.
7. Clamps.
8. Charge air pipe and bracket bolts.
9. Connecting hoses.
10. Clamps.

Intake Manifold

Component



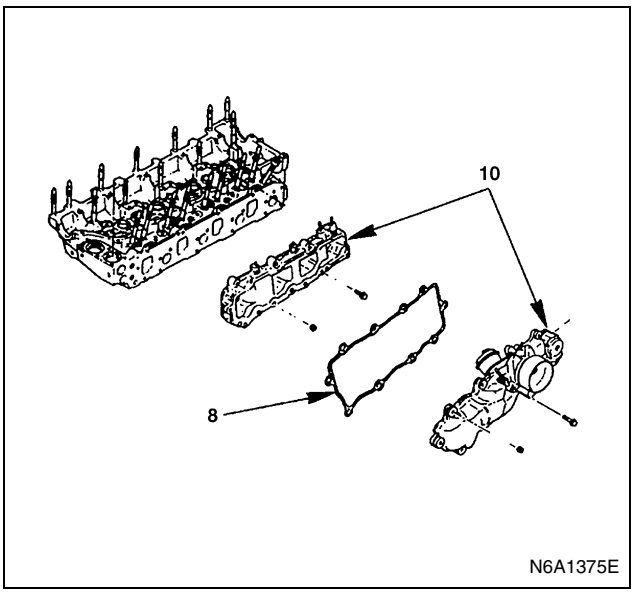
Legend

1. Intake manifold
2. Intake manifold gasket

Removal

1. PCV hose.
2. Accelerator cable injection pump side.
3. Connecting hose.
4. Bracket accelerator cable.
5. Bracket engine stop cable and vacuum hose.
6. Engine harness connector.
7. Charge air pipe.

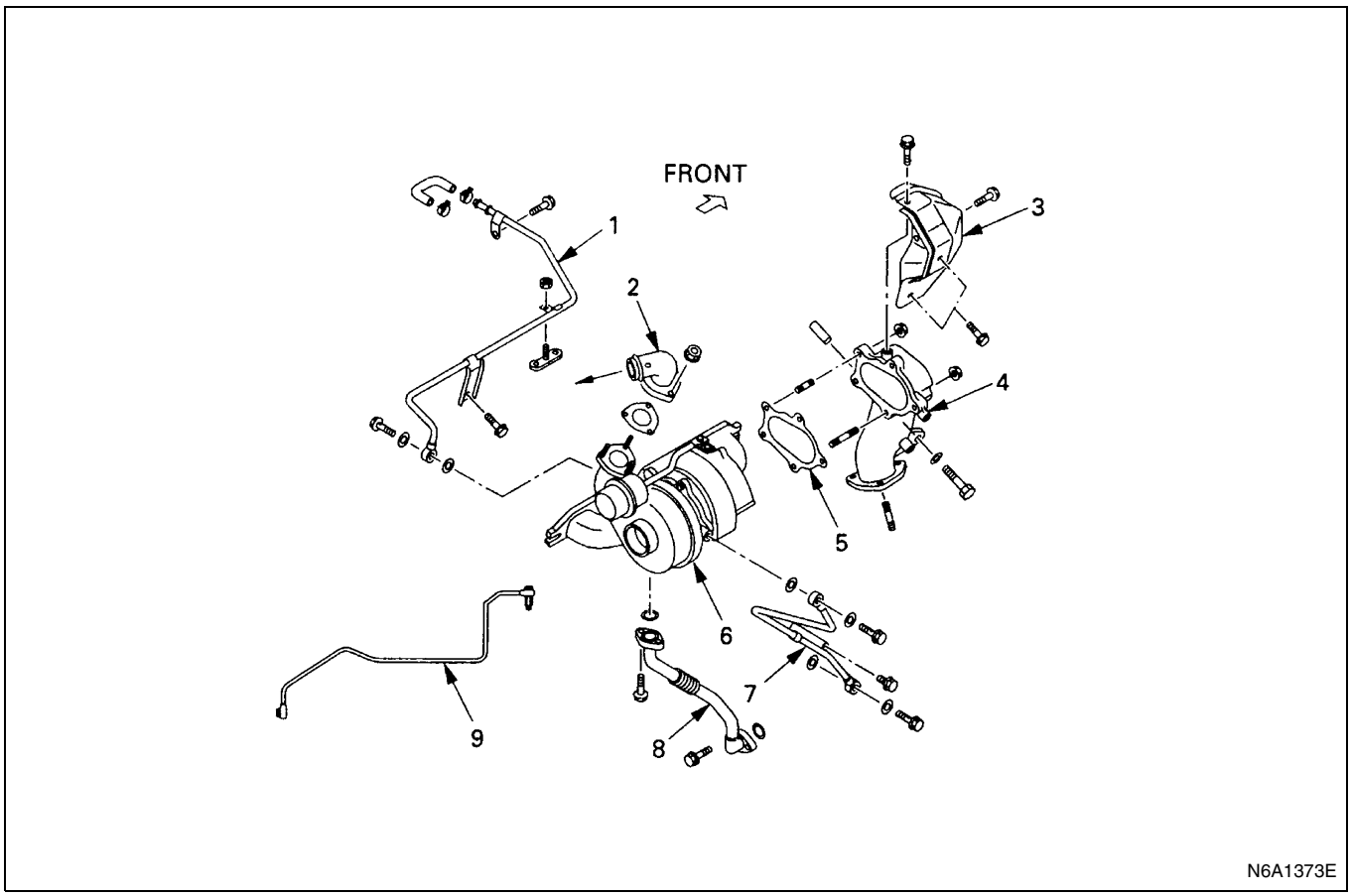
8. Gasket.
9. Injection pipe.
10. Intake manifold.
11. Gasket and discard.



Turbocharger

Refer to “Statement on Cleanliness and Care” previously in this section.

Component



Installation

1. Intake manifold.

Tighten:
Intake manifold to 19 N·m(1.9 kg·m/ 14 lb·ft)

2. Injection pipe

Tighten:
Fuel injector line nuts to 26 N·m(2.7 kg·m/ 20 lb·ft)

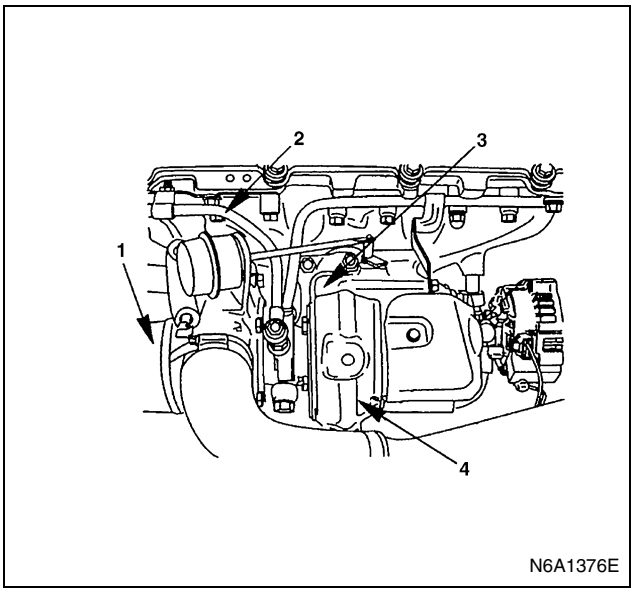
3. Gasket
4. Charge air pipe.
5. Engine harness connector.
6. Bracket engine stop cable and vacuum hose.
7. Bracket accelerator cable.
8. Connecting hose.
9. Accelerator cable injection pump side.
10. PCV hose.

Legend

1. Water return pipe
2. Turbocharger intake pipe
3. Heat shield
4. Exhaust adapter
5. Gasket
6. Turbocharger assembly
7. Water feed pipe
8. Oil return pipe
9. Oil feed pipe

Removal

1. Turbocharger air inlet pipe.
2. Turbocharger intake pipe.
3. Connecting hose.
4. Exhaust gas recirculation (EGR) pipe.
5. Heat shield bolt.
6. Water feed and drain lines.
7. Oil feed line.
8. Oil drain line.
9. Exhaust pipe to exhaust adapter nuts.
10. Exhaust adapter to turbocharger nuts.
11. Turbocharger to exhaust manifold nuts.



Legend

1. Air inlet pipe
2. Oil supply line
3. Turbo charger
4. Heat shield

Caution:
The turbocharger for 4HG1-T Engine has a unit construction of turbin housing and exhaust manifold.

Inspection and Repair

Caution:

- Turbocharger housing for cracks or damage.
- Gasket surfaces for damage.
- Seals and gaskets for damage.
- Turbine and compressor blades for damage or carbon buildup.
- Air and exhaust exit openings for oil or wetness.
- For grinding or roughness when spinning turbine and compressor wheels by hand.
- For evidence of turbine or compressor blades contacting the shroud or housing. If any of the above conditions exist, the turbocharger must be replaced or repaired by an authorized repair facility.

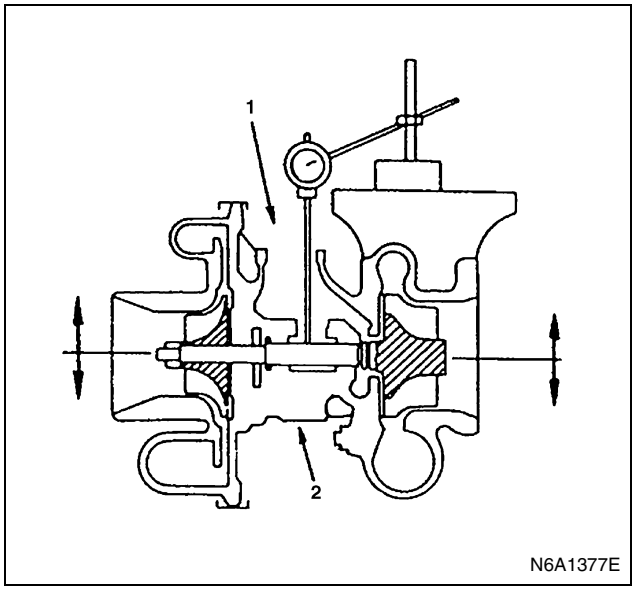
Play in Radial Clearance

Moving the rotor in the radial clearance, measure the play by a dial gage.

- Measure the play at several points while letting the rotor revolve.
- Use only the flat dial gage attachment. Do not use the pointed one.
- Attach the turbocharger and dial gage firmly.

Play in radial clearance	mm (in)
Standard	Limit
0.056 — 0.127 (0.0022 — 0.0050)	0.140 (0.0055)

If excessive, replace the turbocharger.



Legend

1. Oil outlet
2. Oil inlet

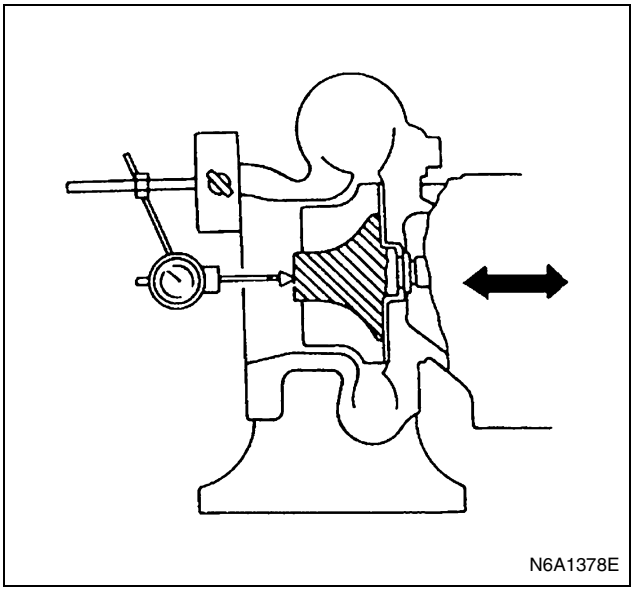
Play in Axial Clearance

Moving the rotor in the axial clearance, measure the play by a dial gage.

- Measure the play at several points while letting the rotor revolve.
- Attach the turbocharger and dial gage firmly.

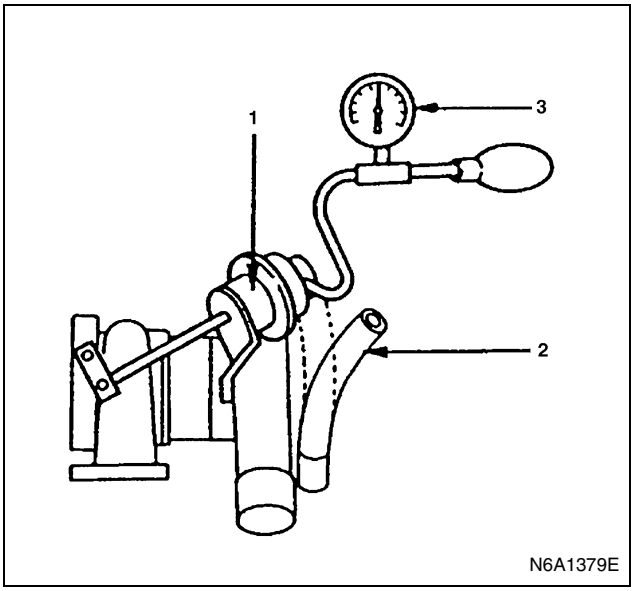
Play in axial clearance	mm (in)
Standard	Limit
0.013 — 0.097 (0.0005 — 0.0038)	0.097 (0.0038)

If excessive, replace the turbocharger.


N6A1378E

Operation of Waste Gate

- Disconnect hose (2) from waste gate (1), and install pressure gauge (3) as shown in the figure.
- With the engine stopped, operate the pressure gauge pump to apply pressure to the waste gate for check the waste gate function.



N6A1379E

Oil Leakage Check

1. Remove the charge air pipe connecting hose to the compressor side of the turbocharger.
2. Clean the area around the compressor wheel.
3. Remove the blow-by hose.
4. Start the engine and let idle. Rev the engine and hold at wide open throttle (WOT) for five seconds, then release and let idle for five seconds. Repeat this cycle for a total of five times then let the engine idle steady for five minutes.
5. Shut off the engine.
6. Check the compressor area for an oil stream.

Caution:

- A stream of oil indicates a possible defective turbocharger. If mist or spray is present, however, this is normal and is NOT indicative of a turbocharger problem.

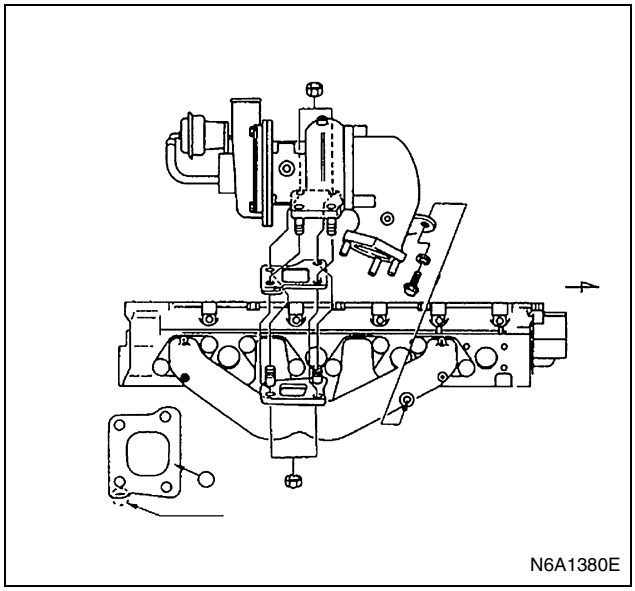
7. If the turbocharger is suspect, refer to the on-vehicle service procedures in this section.

Installation

1. Exhaust manifold to turbocharger.
2. New gasket and turbocharger to exhaust manifold.

Tighten:

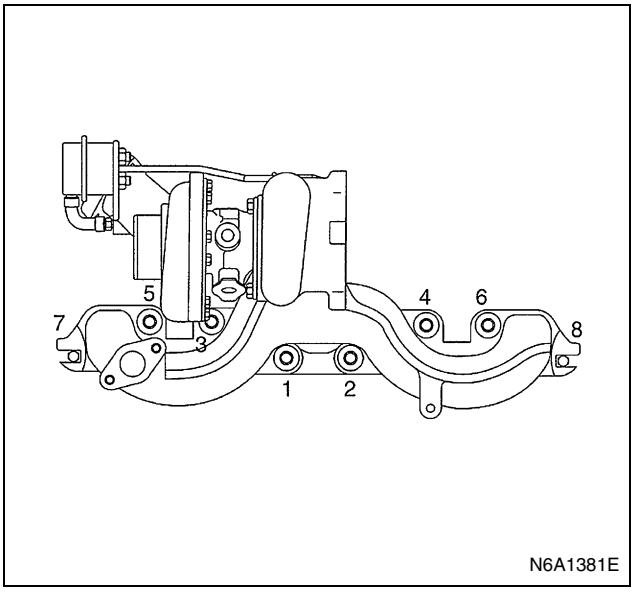
Turbo charger to 52 N·m (5.3 kg·m/ 38 lb·ft)


N6A1380E

3. Tighten the cylinder head to turbinhousing and exhaust manifold to the specified torque in the numerical order shown in the illustration. (4HG1-T)

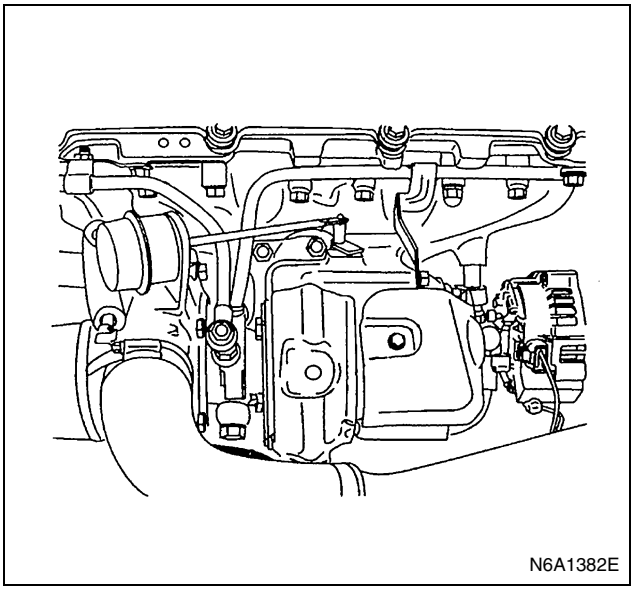
Tighten:

Exhaust manifold to 34 N·m (3.5 kg·m/ 25 lb·ft)



4. Turbocharger to exhaust adapter.

Tighten:
Exhaust adapter to 32 N·m (3.3 kg·m/ 24 lb·ft)



5. Exhaust pipe to exhaust adapter.

Tighten:
Exhaust pipe to 67 N·m (6.8 kg·m/ 49 lb·ft)

6. Turbocharger oil drain line.

Tighten:
Oil drain line to
- Turbocharger 9 N·m (0.9 kg·m/ 6 lb·ft)
- Cylinder body 21 N·m (2.1 kg·m/ 15 lb·ft)

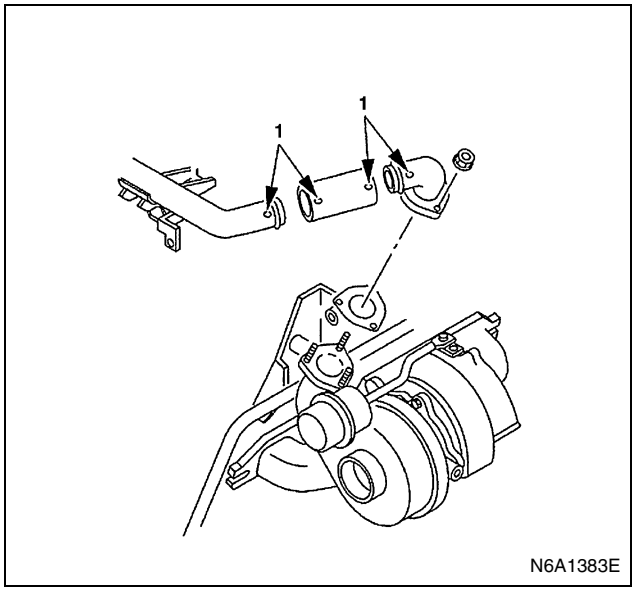
7. Turbocharger oil supply line to turbocharger.

Tighten:
Oil supply line to 27 N·m (2.8 kg·m/ 20 lb·ft)

8. Water supply and drain lines.

Tighten:
Water supply to 41 N·m (4.2 kg·m/ 30 lb·ft)

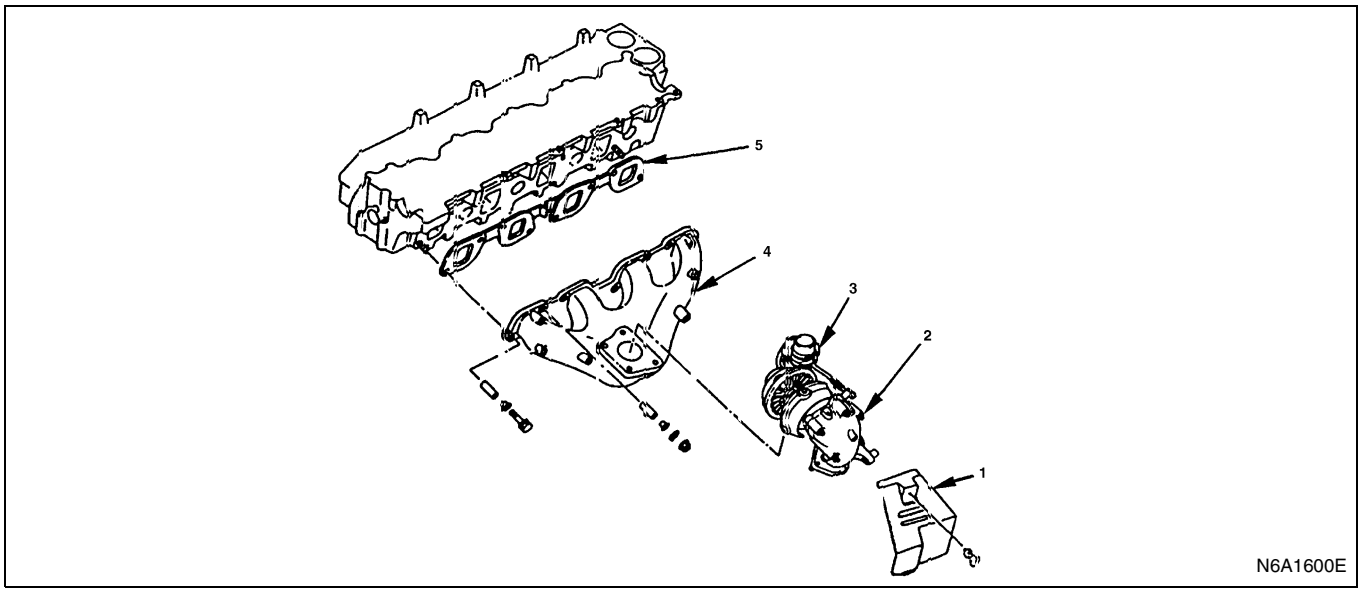
9. Heat shield to exhaust adapter
10. Charge air pipe connecting hoses and clamps to turbocharger.
11. Air inlet pipe to turbocharger.
12. Fit the connecting hose over the pipe to its projecting part. (4HG1-T)
13. Align connecting hose and pipe marks with each other (4HG1-T)



Legend
1. Mark

Exhaust Manifold

Component

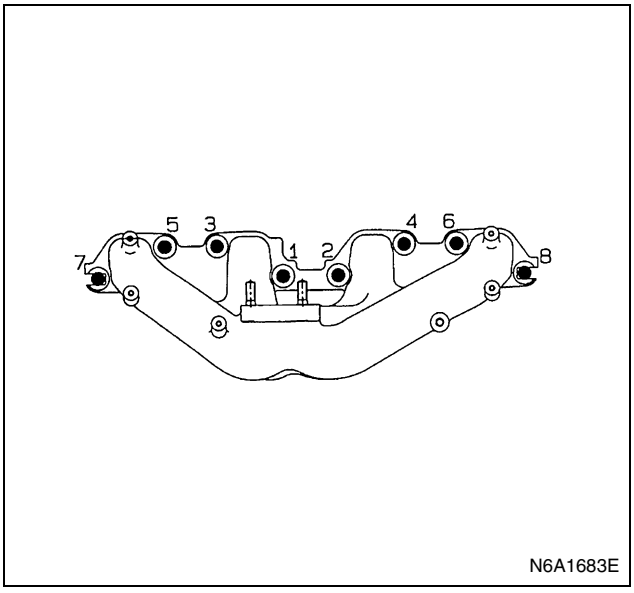


Legend

1. Heat shield
2. Exhaust adapter
3. Turbocharger
4. Exhaust manifold
5. Exhaust manifold gasket

Removal

1. Turbocharger as outlined previously in this section.
2. Heat shield
3. Loosen the exhaust manifold bolts, nuts and washers in numerical order shown in the illustration.



4. Exhaust manifold
5. Gaskets

Caution:

- Exhaust manifold and cylinder head for cracks or damage to gasket surfaces.

Installation

1. Gaskets.
2. Exhaust manifold.
3. Washers nuts and bolts.

Tighten:

Exhaust manifold to 34 N·m (3.5 kg·m/ 25 lb·ft)

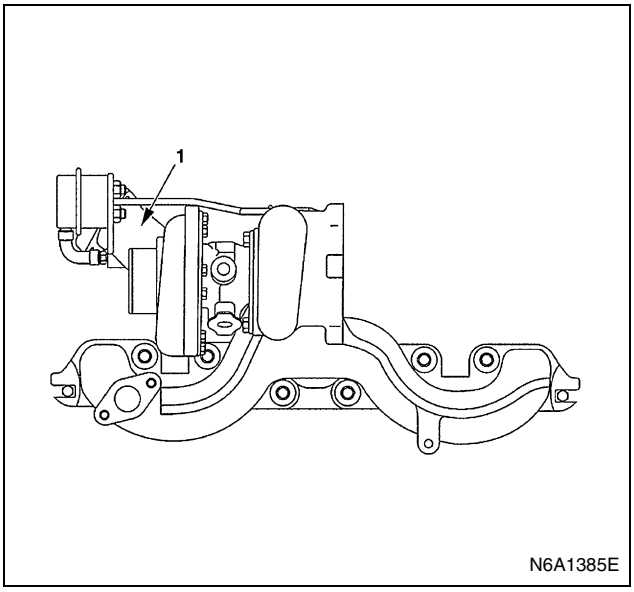
4. Heat shield
5. Turbocharger as outlined previously in this section.

Turbocharger Turbine Housing Replacement (For 4HG1-T Model)

Changing the turbine housing of the turbocharger (integrated with the exhaust manifold)

Inspection

Before replacing the turbine housing, make sure there are no abnormalities in other parts.



Legend

1. Compressor port

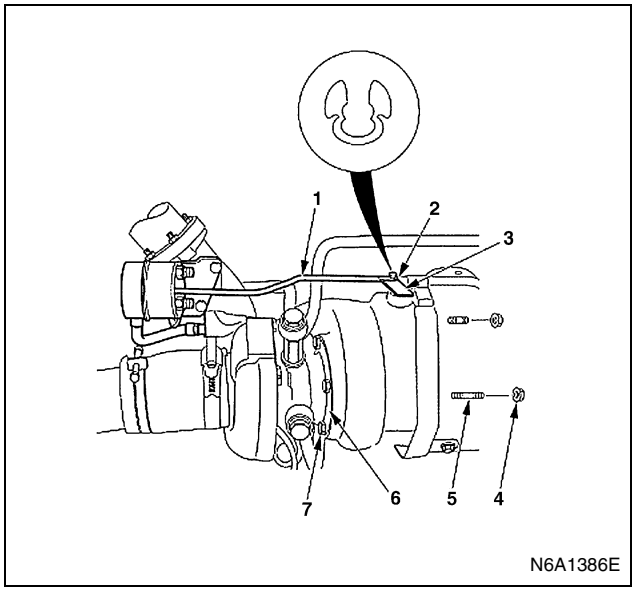
Notice:

- It is normal to find some oil inside the compressed-air duct. The oil is to lubricate the turbine shaft, and as long as the exhaust is not abnormally white in color, this does not indicate a problem.

1. Make sure the parts have no cracks, impeded movement, damage, or distortion of shape, that there is no oil leakage from the seal, and that there is no gas leakage.
2. Turn the rotor to see if it rotates smoothly, also checking the rotation direction as well as the amount of slack.
   Refer to the separate reference sheet for the proper amount of slack.
   If there is an abnormality in any of the above, you will have to change the turbocharger as a unit.

Disassembly

1. Separate the end of the actuator rod (1) from the E Ring (2), then remove the crank (3) from the end of the rod (1).
2. Remove the turbine housing tie-down bolts (7).



3. Separate the turbine housing from the sensor housing.

Notice:

- Be careful not to scratch the turbine blades when removing parts.

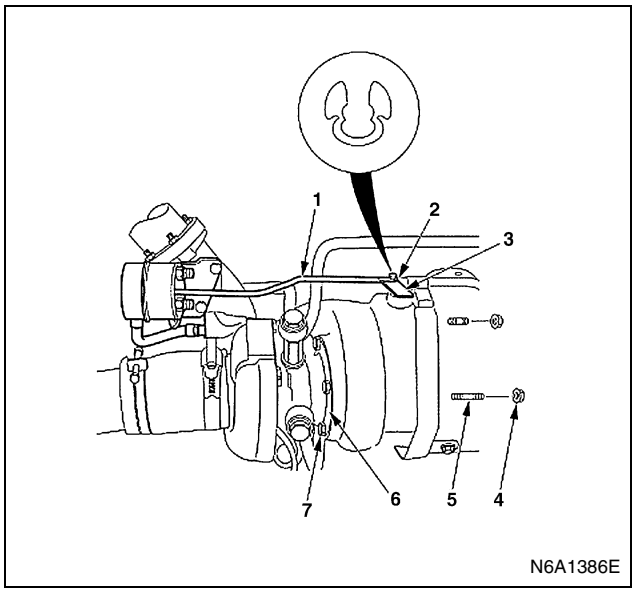
Inspecting the center housing assembly:

Check that none of the blades is bent, cracked, or scratched. Make sure there are no obstructions that would interfere with the movement of the blades or with mounting the new housing. Remove any excess carbon or oil.

Replacing Parts

When reassembling, be sure to replace the following parts. (Use only genuine Isuzu parts.)

1. E Ring (2)
2. Turbine housing tie-down bolts (7)
3. Turbine housing clamp (6)
4. Adapter nut (4)
5. Adapter stud (5)



Cleaning

Thoroughly clean off the oil and carbon from abutting surfaces, the oil passages, flange surfaces, air and exhaust ducts, etc. Always air-dry the parts after cleaning.

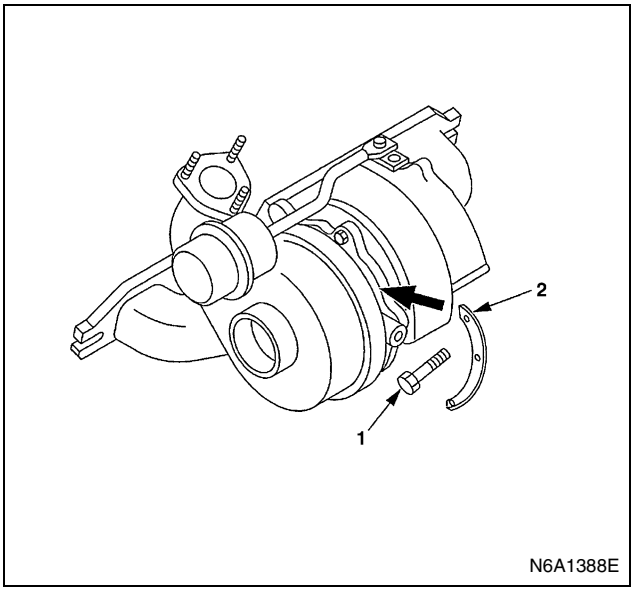
Assembly

1. Insert the sensor housing into the turbine housing.

Notice:

- When inserting the sensor housing, make sure it will not impede the movement of the turbine blades.

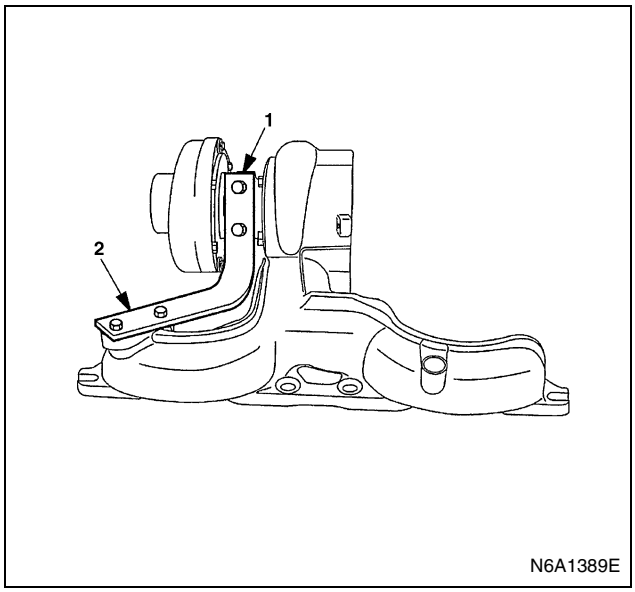
2. Apply molybdenum disulfide to the thread and underside of the head of each bolt (1).
3. Temporarily secure the sensor housing in place with the clamp (2).



4. Connect the oil side of the sensor housing (1) and the EGR-connection side of the exhaust manifold (2) to the angle setting gauge, then tighten the bolt to secure the gauge in place. (The angle of the sensor housing and turbine housing will be set with the use of this gauge).

Turbocharger housing setting gauge: 5-8840-2673-0
(1) M6 × P = 1.00
(2) M8 × P = 1.25

5. To give the sensor housing some slack, loosen the bolt on side (1) by half a turn.

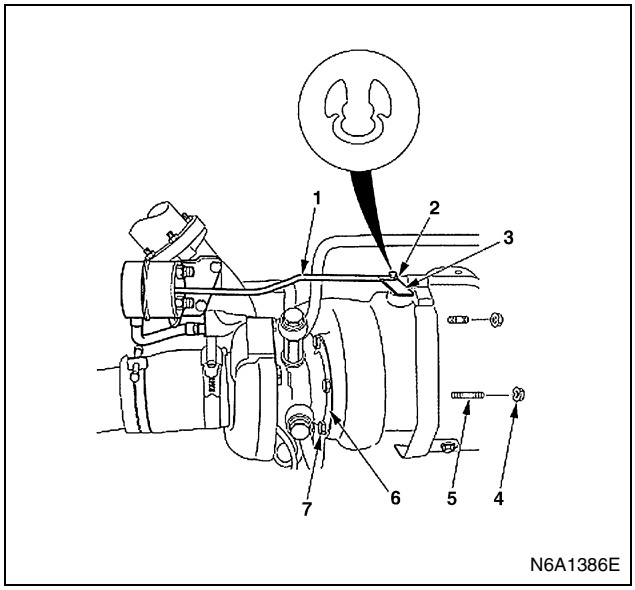


6. Tighten the turbine housing tie-down bolts to the specified torque.

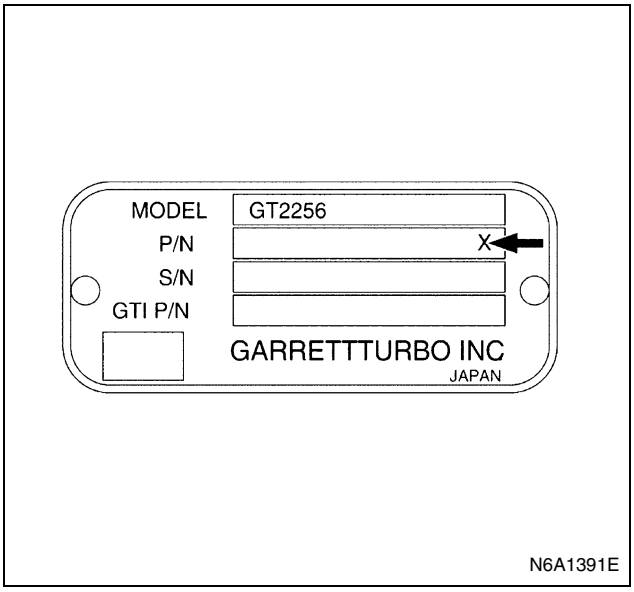
Tighten:

Housing tie-down bolts to 22 N·m (2.2 kg·m/ 16 lb·ft)

7. Remove the bolt that secures the pressure gauge, then remove the gauge.
8. Manually turn the rotor clockwise to be sure it it rotates smoothly. Check for abnormal noise, drag, etc.
9. Attach the end of the actuator rod (1) to the crank at the waste gate (3), and secure with the E Ring (2).



10. (Indicate on the nameplate that parts were replaced.)

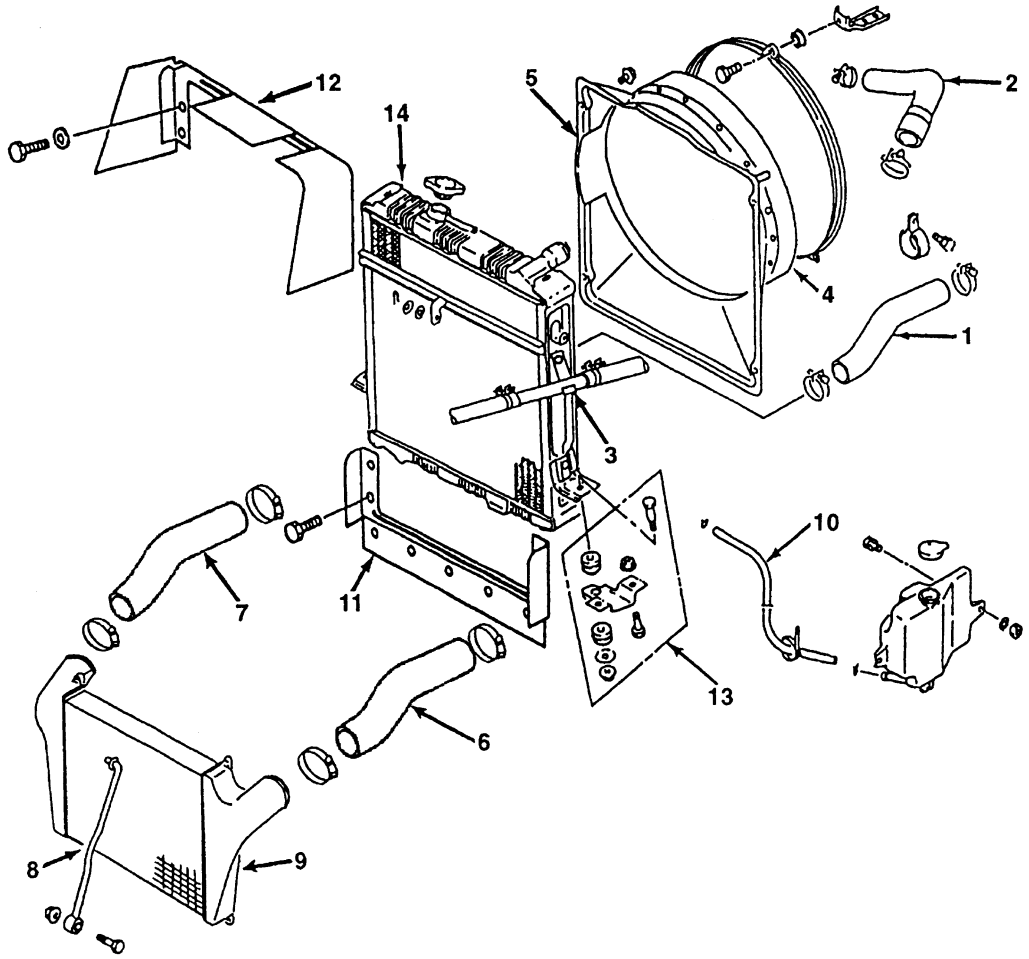


11. Pour clean oil through the oil filler port to prevent corrosion.
12. Seal the air and exhaust ducts of the turbocharger, as well as the water and oil filler ports to prevent foreign matter from entering.

Follow the assembly directions to reattach to the engine.

Charge Air Cooler

Component



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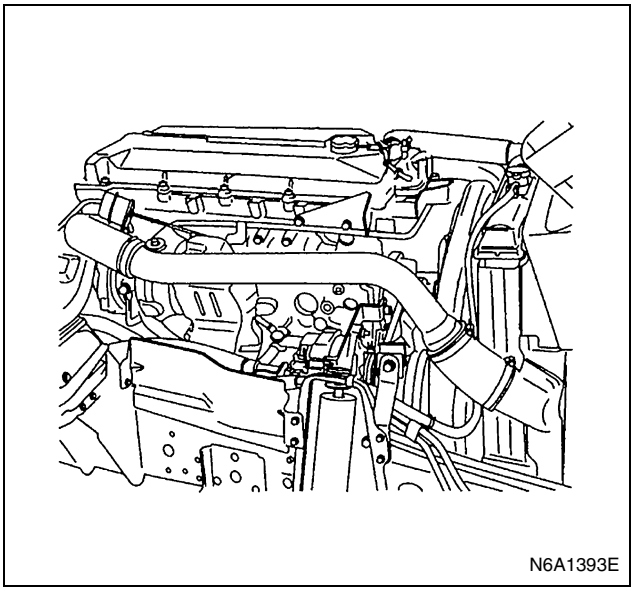
Legend

1. Lower radiator hose
2. Upper radiator hose
3. Heater hose bracket
4. Rubber ring and bell-mouth
5. Fan shroud assembly
6. Flexible hose
7. Flexible hose
8. Stay radiator support
9. Charge air cooler
10. Reserve tank hose
11. Air duct panel
12. Guide panel
13. Mount nut and cushion rubber
14. Radiator assembly

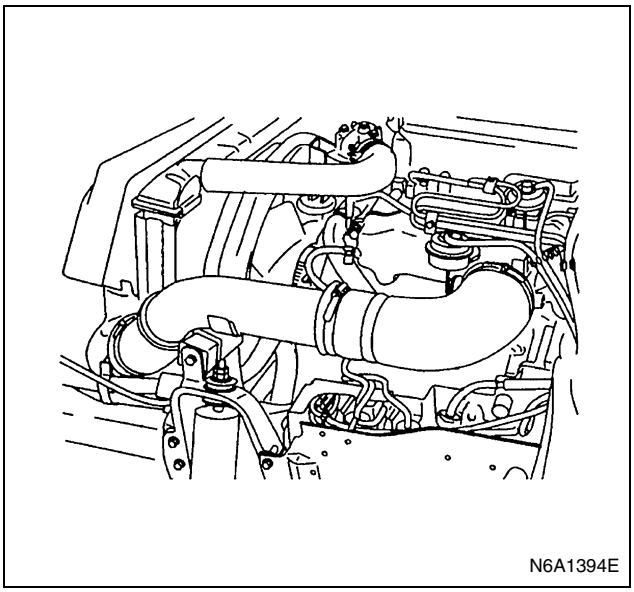
Removal

- Disconnect the battery ground cables.
- Drain the engine coolant.

1. Lower radiator hoses.


N6A1393E

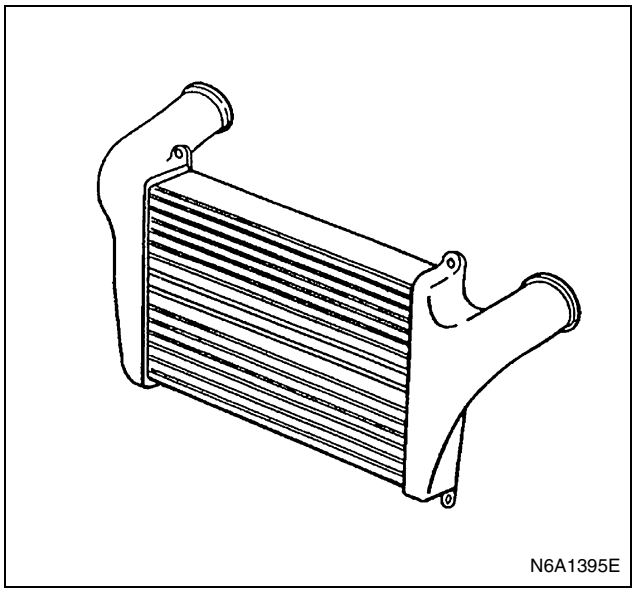
2. Upper radiator hoses.
3. Heater hose bracket.
4. Rubber Ring, bell-mouth to shroud.
5. Fan shroud assembly.
6. Flexible hose LH.
7. Flexible hose RH.


N6A1394E

8. Stay radiator support.
9. Charge air cooler.
10. Reserve tank hose.
11. Air duct panel.
12. Guide panel.
13. Mount nut and cushion rubber.
14. Radiator assembly.

Installation

1. Radiator assembly.
2. Mount nut and cushion rubber.
3. Guide panel.
4. Air duct panel.
5. Reserve tank hose.
6. Charge air cooler.


N6A1395E

7. Stay radiator support.
8. Flexible hose RH.
9. Flexible hose LH.
10. Fan shroud assembly.
11. Rubber Ring.
12. Heater hose bracket.
13. Upper radiator hoses.
14. Lower radiator hoses.
    or brackets that were removed.
    - Fill the system with new engine coolant as described in ENGINE COOLING (SEC. 6B) of this manual. Then check the system for leaks.
    - Connect the battery ground cables.

LG4H-WE-0552

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LG4H-WE-0552 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

ENGINE 4H SERIES

SECTION 6

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

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6A	ENGINE MECHANICAL
6A3	ENGINE (4HF1 / 4HF1-2 / 4HE1-TC / 4HG1 / 4HG1-T)
6B	ENGINE COOLING
6C	FUEL SYSTEM
6D	ENGINE ELECTRICAL
6E	EMISSION AND ELECTRICAL DIAGNOSIS
6F	EXHAUST
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ENGINE

Engine Mechanical (4HK1-TC)

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ISUZU DIESEL ENGINE (4HK1-TC)

Service Precautions

Matters that require attention in terms of maintenance

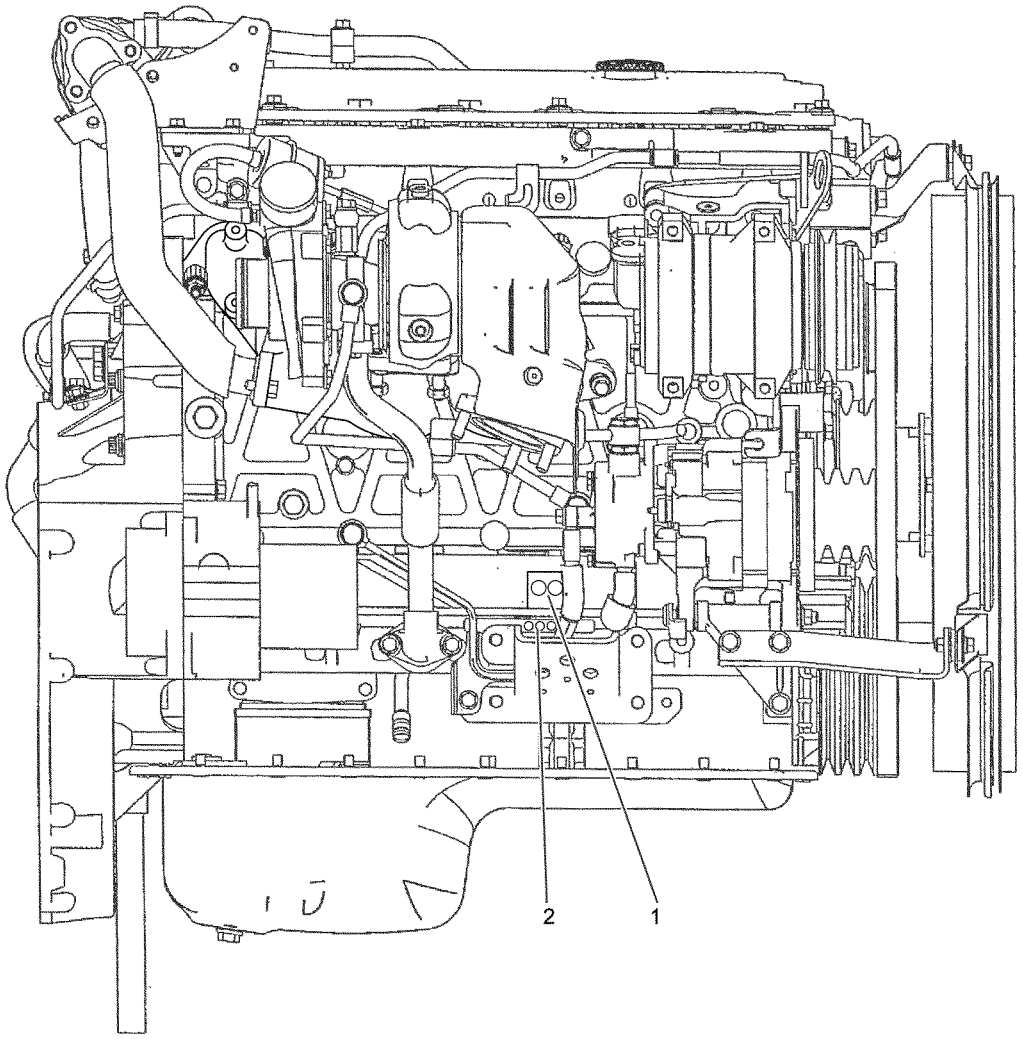
To prevent damage to the engine and ensure reliability of its performance, pay attention to the following in maintaining the engine:

- When lifting up or supporting the engine, do not apply a jack on the oil pan.
  When taking down the engine on the ground, do not make the bearing surface of the oil pan touch directly the ground. Use a wood frame, for example, to support the engine with the engine foot and the flywheel housing.
  Because there is only a small clearance between the oil pan and the oil pump strainer, it can damage the oil pan and the oil strainer.
- When the air duct or air cleaner is removed, cover the air intake opening to prevent foreign matter from getting into the cylinder. If it gets into it, it can considerably damage the cylinder and others while the engine is operating.
- When maintaining the engine, never fail to remove the battery earth cable. If not, it may damage the wire harness or electrical parts. If you need electricity on for the purpose of inspection, for instance, watch out for short circuits and others.
- To protect and lubricate the rotational surface during the initial operation, apply plenty of engine oil to it.
- When valve train parts, pistons, piston rings, connecting rods, connecting rod bearings or crankshaft journal bearings are removed, put them in order and keep them.
- When installing them, put them back to the same location as they were removed.
- Parts, such as gaskets, oil seals and O-rings, have to be replaced by brand-new ones every time the engine is dismantled.
- As for parts where a liquid gasket is used, remove an old liquid gasket completely and clean it up thoroughly so that no oil, water or dust may be clung to them. Then, apply the designated liquid gasket to each place anew before assembly.
- Assemble it within 7 minutes after applying the liquid gasket.
  If 7minutes or longer passed, remove the liquid gasket and apply it again.
- When assembling or installing parts, fasten them with the prescribed tightening torque so that they may be installed properly.

Matters that require attention in specifically dealing with this engine

Holes or clearances in the fuel system which serve as a passage of fuel, including the inside of injector, are finished extremely precisely. For this reason, they are highly sensitive to foreign matter. If it gets inside, it can lead to breakdown on the road. Be sure to prevent it from getting inside.

How To Read The Model



Legend

1. Engine Model
2. Engine Selial Number

Explanation of Functions and Operations

Electronic Engine Control

With the control unit, the range from injection to air intake/exhaust, including fuel injection quantity, injection timing, intake air restriction, EGR, and idling rpm, is controlled.

Cylinder Block

The cylinder block is cast-iron with the center distance of each bore being equal and is of the highly rigid, symmetrical structure with the crankshaft center being the center. The bearing cap is of the ladder frame structure and tightened up under the plastic range rotation angle method.

Cylinder Liner

The cylinder liner is selected to match an internal diameter of a bore of the cylinder block and built, which is imprinted on the left side of the cylinder.

Piston

The piston is aluminum-alloy and an autothermatic piston with a strut cast, while the combustion chamber is a round reentrant type.

Cylinder Head

The cylinder head is cast-iron and there are 4 valves per cylinder. The angular tightening method of the cylinder head bolt further increases reliability and durability.

Crankshaft

Tuftriding is given, while on the No. 1 balance weight imprinted is the grade of each journal diameter.

EGR System

Based upon data, including water temperature, engine speeds or engine loads, it is controlled via Engine Control Module (ECM) to purify exhaust by recycling part of it.
Its main components include an EGR valve, an EGR cooler and various sensors.

Connecting Rod Cap Bolt

The angular tightening method of the connecting rod cap bolt further increases reliability and durability.

Common Rail-type Electronic Control Injection System

The common rail-type electronic control injection system is composed of a fuel supply pump that sets the target pressure of high-pressure fuel and supply it, a fuel rail that measures such high-pressure fuel and an fuel injector that turns it into a fine spray and injects it. Each is controlled via ECM based upon various signals, while injection timing or fuel injection quantity is controlled under every possible driving condition.

Fuel Injector

The fuel injector is a 7-hole nozzle that adjusts fuel injection quantity or injection timing by opening or closing an electromagnetic valve on the head of the fuel injector.
ECM corrects the dispersion of fuel injection quantity between fuel injectors according to ID code data in memory. At the replacement of fuel injectors, ID code data should be stored in ECM.

Fuel Filter with Sedimenter

It is a fuel filter with sedimenter that gets rid of water by making use of the difference in specific gravity between light oil and water, which comes with an indicator that notifies you that it is filled with water.

Preheating System

The preheating system consists the ECM, the glow relay, glow plugs and the glow indicator lamp. The preheating system is operated when the engine coolant temperature is low, and make the engine easy to start.

Lubrication System

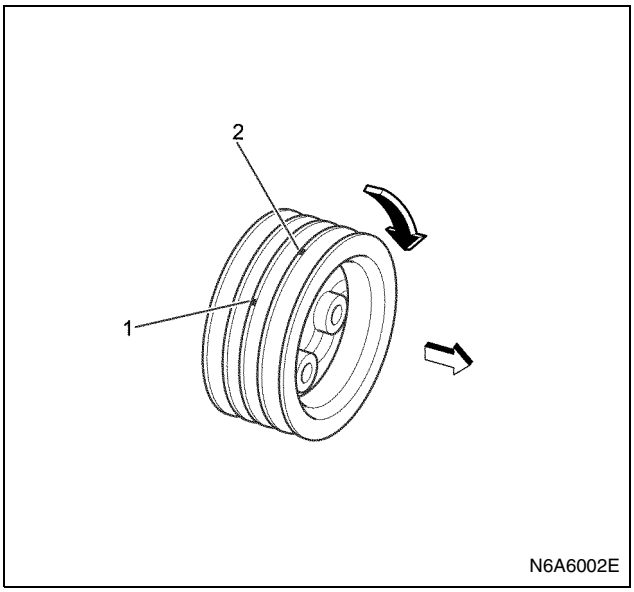
It is an oil filter with full-flow bypass, which uses a water-cool oil cooler and oil jet to cool the piston.

Functional Inspection

Inspection/adjustment of valve clearance

1. Inspection of valve clearance
   a. Remove the cylinder head cover.
   b. Remove the fuel injector harness assembly.
   c. Loosen the terminal nuts alternately to remove.
   d. Remove the leak-off pipe.
   e. Rotate the crankshaft to make the No.1 cylinder meet the compression top dead center (TDC).

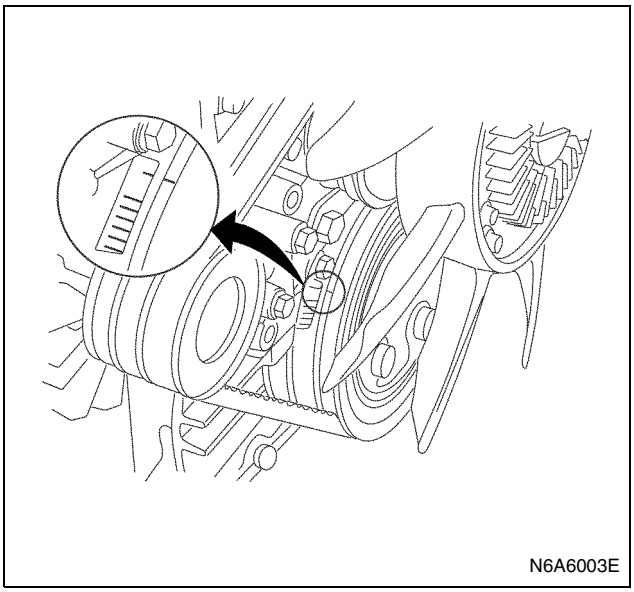
Notice:
There are 2 timing marks on the crankshaft pulley.
Mark (1) is near the cylinder block and is used to bring the 4HK1-TC engine to TDC.
Mark (2) is not applicable to this engine.
Be sure to use mark (1) when bringing the engine to TDC.



   - Insert a 0.4 mm (0.016 in) thickness gauge into a clearance between the rocker arm and the bridge to check it and adjust it if needed.

Valve clearance	mm (in)
Intake valve	0.4 (0.016)
Exhaust valve	0.4 (0.016)

Caution:
Adjust while being cold.

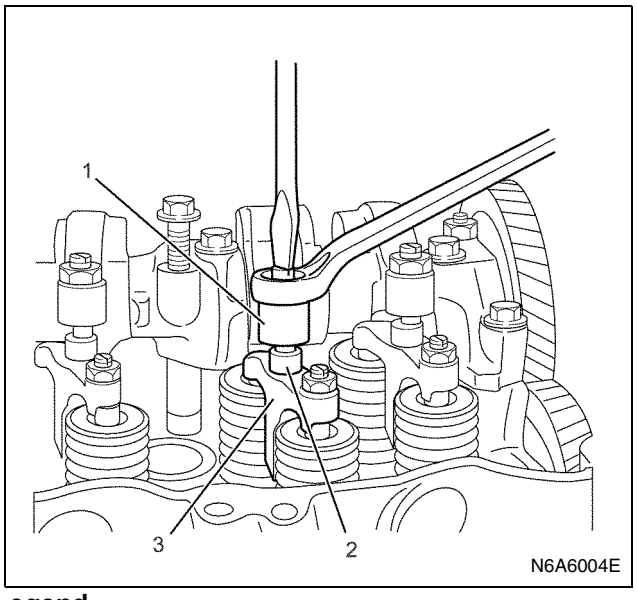


2. Adjustment of valve clearance

Caution:
Adjust valve clearance carefully so that the bridge contacts the end of the 2 valve stem.

a. Completely loosen all of the bridge and rocker arm adjusting nuts and adjusting screws (8 nuts and 8 screws).
b. Place a 0.4 mm (0.016 in) thickness gauge between the No. 1 cylinder rocker arm end and the bridge cap.
c. Tighten the rocker arm adjusting screw until the thickness gauge is snug (not tight) between the rocker arm end and the bridge cap.
d. Tighten the rocker arm lock nut.
e. Tighten the bridge adjusting screw until the bridge contacts the valve head.
f. Tighten the bridge lock nut.
g. Check that the thickness gauge is still held snugly between the rocker arm end and the bridge cap. If it is too tight, slightly loosen the bridge adjusting screw and lock nut to restore snugness.
h. Remove the thickness gauge.
i. Repeat Steps b through h for the remaining cylinders.

Tighten:
Bridge lock nut to 22 N·m (2.2 kg·m/16 lb·ft)

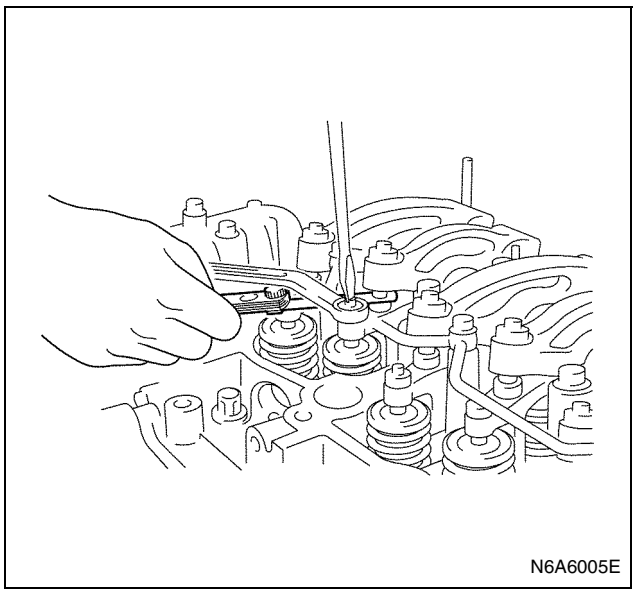


Legend
1. Rocker Arm
2. Bridge Cap
3. Bridge

a. With a thickness gauge kept inserted, tighten an adjusting screw of the bridge lightly and make sure that the tip of the adjusting screw touches the end of valve stem and the movement of the thickness gauge has become tight.
b. Then, check if the end of the valve stem on the opposite side is unstable or hits diagonally. If so, loosen the bridge adjusting screw a little so that the end of the valves on both sides may touch properly.
Valve bridge clearance: ± 0.1 mm (0.0039 in) or less
c. After making an adjustment so that the end of the valves on both sides may touch properly, tighten up an adjusting screw nut of the bridge with a minus driver so that the bridge adjusting screw may not rotate.

Tighten:
Adjusting screw nut to 22 N·m (2.2 kg·m/16 lb·ft)

Caution:
If the adjusting screw of the bridge is poorly adjusted, the bridge would tilt and be pushed down and seized, which may damage the bridge guide, for example. Thus, adjust it accurately.



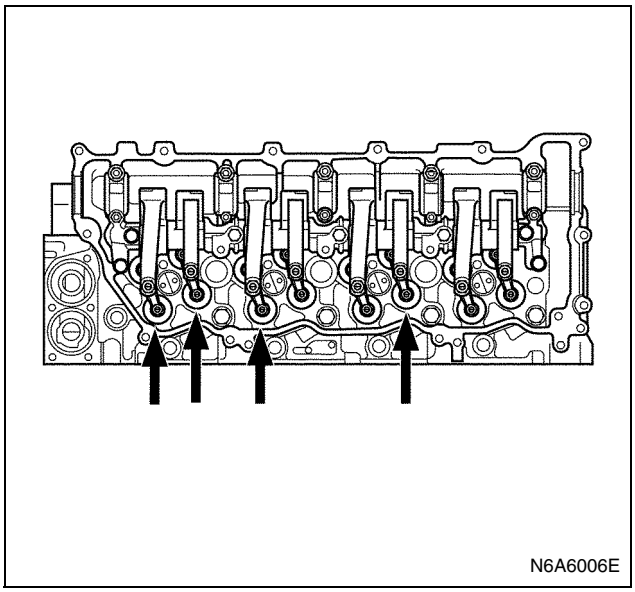
Tighten:
Rocker arm adjustment screw nut to 22 N·m (2.2 kg·m/16 lb·ft)

Bridge adjustment screw nut to 22 N·m (2.2 kg·m/16 lb·ft)

Adjustment table

Cylinder No.	1		2		3		4	
Valve arrangement	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder Compression TDC	○	○	○			○		
No. 4 cylinder Compression TDC				×	×		×	×

- If the No. 1 cylinder is the compression TDC, adjust a valve clearance with ○ mark given on the table and if the No. 4 cylinder is the compression top dead center, that with × mark.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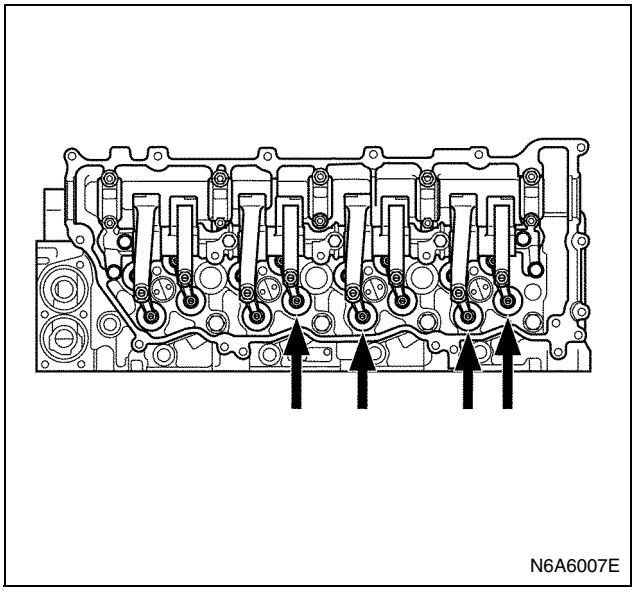
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- Attach the harness assembly to the fuel injector.
  Tighten the harness bracket with the designated torque.

Tighten:
Harness bracket to 48 N·m (4.9 kg·m/35 lb·ft)

- Attach the terminal nuts to the fuel injector.

Tighten:
Terminal nuts to 2 N·m (0.2 kg·m/17 lb·in)

Notice:

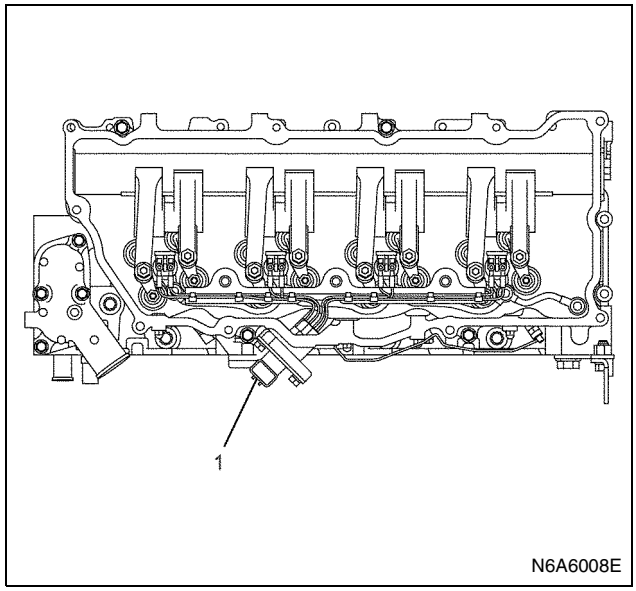
- Tighten the terminal nuts alternately in order to prevent imbalance in tightening because they are unified.
- Do not tighten the nuts too tightly because it leads to damage to the terminal studs.

- Install the cylinder head cover.
  Refer to “Cylinder Head Cover.”

Compression pressure inspection

- Warm up the engine.
- Remove a minus terminal of the battery and remove all the glow plugs.
- Remove the harness connector for the fuel injector built on the lower head cover (no fuel will be injected).

Caution:
When the harness connector is removed, ECM judges that it broke down and DTC is recorded. Upon completion of measurement, never fail to clear memory of ECM.
(For how to clear memory of ECM, refer to Section 6E)



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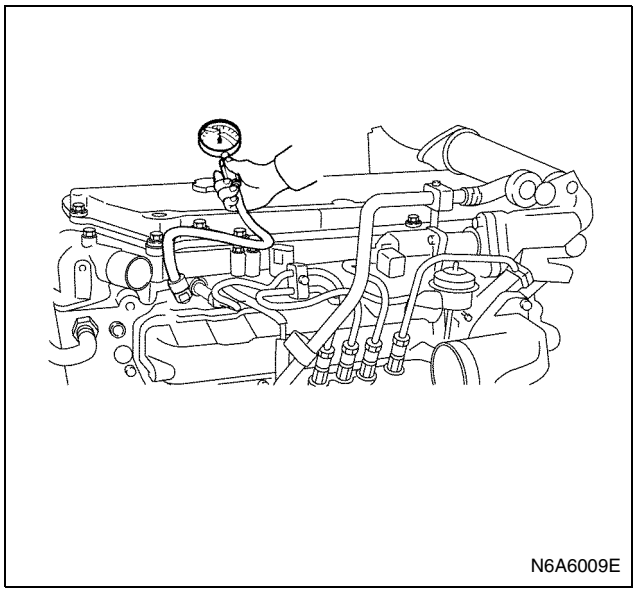
Legend
1. Fuel Injector Harness Connector

- Install the minus terminal of the battery.
- Turn on the starter to emit foreign matter within the cylinders.

- Install an adapter and a gauge of a compression gauge of the special tool.



Compression gauge set: 5-8840-2008-0
(Compression gauge: J-26999-12,
Gauge adapter: EN-46722)

- Turn on the starter to inspect compression pressure.

Compression pressure	MPa (kg/cm^2 / psi) / 220 rpm
Standard	2.60 – 2.89 (26.5 – 29.5 / 377 – 419)
Limit	1.96 (20.0 / 284)
Differences among the cylinders	294 kPa (3.0 kg/cm^2 / 43 psi)

- Measure each cylinder one by one.

Caution:
To keep engine speed at 220 rpm or more, use fully charged batteries.

- Remove a compression gauge of the special tool.
- Remove a minus terminal of the batteries.
- Install a harness connector for the fuel injector built on the lower head cover.
- Install all the glow plugs.

Tighten:
Glow plugs to 20 N·m (2.0 kg·m/15 lb·ft)

- Install a minus terminal of the batteries.

A list of defective phenomena

- Engine does not turn over.
- Engine turns over but does not start.
- Excessive black exhaust smoke.
- Excessive white exhaust smoke.
- Engine knocking.
- Abnormal engine rotation.
- Abnormal battery charging.

Trouble Shooting

Engine does not turn over

Condition	Possible Cause	Correction
Starter motor does not rotate	Dead or weak battery	Charge or Replace battery
	Incomplete circuit	Connect Repair
	Starter relay	Replace starter relay
	Starter motor brushes stuck, worn, or broken	Replace brushes
	Starter motor internal damage	Repair motor
Starter motor not meshed with flywheel	Ring gear abrasion	Replace ring gear
	Pinion gear abrasion	Replace pinion gear
	Magnetic switch (starter motor) not properly adjusted	Adjust
Starter motor pinion meshed with ring gear but does not rotate	Dead or weak battery	Charge battery Replace battery
	Insufficient contact pressure between starter motor brushes and commutator	Adjust pressure
	Armature (starter motor) stuck	Repair armature
	Engine internal damage (Seizure)	Repair engine

Engine turns over but does not start

Condition	Possible Cause	Correction
Fuel is not delivered to fuel supply pump	Air in fuel system	Bleed air from fuel system
	Air entering fuel pipe	Replace pipe and bleed air from fuel system
	Empty fuel tank	Replenish fuel
	Clogged strainer (fuel suction)	Clean or replace strainer
	Clogged fuel pipe	Clean or replace pipe
	Use of wrong fuel for prevailing temperatures	Drain existing fuel and replace with appropriate fuel
	Clogged fuel filter	Replace filter
Fuel is delivered to fuel supply pump	Loose injection pipe connections	Tighten connections
	Loose or broken electrical connectors	Tighten and/or replace connectors
	Bad rotational sensor	Replace sensor
	Engine control system malfunction	System diagnosis
Insufficient or unstable fuel delivery volume	Air in fuel system	Bleed air from fuel system
	Feed pump malfunction	Repair pump
	Loose or broken electrical connectors	Tighten and/or replace connectors
	Clogged fuel filter	Replace filter
	Engine control system malfunction	System diagnosis

Excessive black exhaust smoke

Condition	Possible Cause	Correction
Bad injection timing	Engine control system malfunction	System diagnosis
Bad injection nozzle condition	Carbon deposit at nozzle tip	Clean nozzle tip
	Sticking nozzle	Replace fuel injector assembly
	Engine control system malfunction	System diagnosis
Insufficient compression pressure	Excessive valve clearance	Adjust clearance
	Sticking valve stem (valve open)	Repair or replace valve
	Damaged valve spring	Replace spring
	Valve seat abrasion	Repair valve seat
	Compression leakage due to damaged piston ring	Replace piston ring
	Damaged gasket	Replace gasket
	Piston scoring	Replace piston
Fuel condition	Water in fuel	Drain existing fuel and replace with new fuel
	Poor fuel quality	Drain existing fuel and replace with new fuel
Poor engine aspiration	Clogged intake pipes	Clean or replace pipes
	Clogged air cleaner element	Clean or replace element
Malfunction detected by engine control system	Defective sensor	Replace sensor
	Engine control system malfunction	System diagnosis
EGR valve and/or intake throttle valve malfunction	Intake throttle valve sticking	Repair or replace valve
	EGR valve sticking	Repair or replace valve
	Exhaust brake valve sticking	Repair or replace valve
	Engine control system malfunction	System diagnosis
Turbocharger malfunction	Damaged turbocharger fan	Replace turbocharger
	Rough turbocharger shaft rotation	Replace turbocharger
	Oil leakage from oil seal	Replace turbocharger
	Defective booster sensor	Replace sensor

Excessive white exhaust smoke

Condition	Possible Cause	Correction
Bad injection timing	Engine control system malfunction	System diagnosis
Malfunction detected by engine control system	Engine control system malfunction	System diagnosis
	Control unit malfunction	Replace unit
	Defective sensor	Replace sensor
Insufficient compression pressure	Excessive valve clearance	Adjust clearance
	Sticking valve stem (valve open)	Repair or replace valve
	Damaged valve spring	Replace spring
	Valve seat abrasion	Repair valve seat
	Compression leakage due to damaged piston ring	Replace piston ring
	Damaged gasket	Replace gasket
	Piston scoring	Replace piston

Condition	Possible Cause	Correction
Fuel condition	Water in fuel	Drain existing fuel and replace with new fuel
Excessive oil consumption	Worn or damaged piston ring(s)	Replace ring(s)
	Defective valve stem oil seal	Replace oil seal
	Defective turbocharger oil seal	Replace turbocharger
	Clogged turbocharger oil return pipe	Repair pipe

Engine knocking

Condition	Possible Cause	Correction
Bad timing	Engine control system malfunction	System diagnosis
Malfunction detected by engine control system	Defective sensor	Replace sensor
	Control unit malfunction	Replace unit
	Engine control system malfunction	System diagnosis
Fuel condition	Poor quality fuel	Drain existing fuel and replace with new fuel
Poor engine aspiration	Clogged intake pipes	Clean or replace pipes
	Engine control system malfunction	System diagnosis
Engine break-down	Foreign material in cylinders	Engine overhaul
	Scored pistons and/or bearings	Replace pistons and/or bearings

Abnormal engine rotation

Condition	Possible Cause	Correction
Engine speed cannot be increased	Engine control system malfunction	System diagnosis
	Defective control unit	Replace unit
Engine speed unstable	Defective control unit	Replace unit
	Engine control system malfunction	System diagnosis
	Clogged fuel filter element	Replace element
	Defective fuel injector nozzle(s)	Replace fuel injector assembly
	Water in fuel	Drain existing fuel and replace with new fuel
	Air in fuel system	Bleed air from fuel system
	Exhaust brake valve sticking	Repair or replace valve
Turbocharger malfunction	Damaged turbocharger fan	Replace turbocharger
	Rough turbocharger shaft rotation	Replace turbocharger
	Defective booster sensor	Replace sensor

Abnormal battery charging

Condition	Possible Cause	Correction
No charging	Open or shorted wiring and/or connectors	Repair or replace wiring and/or connectors
	Defective generator	Repair or replace generator
	Defective battery	Replace battery

Condition	Possible Cause	Correction
Insufficient charging	Open or shorted wiring and/or connectors	Repair or replace wiring and/or connectors
	Defective generator	Repair or replace generator
	Loose generator drive belt	Adjust belt tension or replace belt
	Defective battery	Replace battery
Excessive charging	Shorted wiring	Repair or replace wiring
	Defective generator	Repair or replace generator
	Defective battery	Replace battery

Turbocharger Troubleshooting

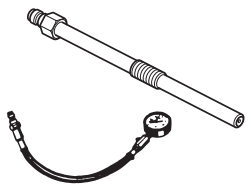
Condition	Possible Cause	Correction
Engine has less than normal power	Air leakage from intake pipe rubber hose	Repair
	Air leakage from inlet cover	Repair
	Clogged intercooler cooling section	Clean
	Clogged air cleaner element	Clean or replace
	Exhaust brake valve stuck	Repair or replace
	Turbine and housing contact (Interference)	Replace
	Excessive carbon deposit near turbine exhaust port that interferes with turbine	Clean or repair
	Rough turbine shaft rotation	Repair or replace
	Damaged turbine fan	Repair or replace
Blue exhaust smoke	Oil leakage from turbocharger oil seal	Repair or replace
	Clogged turbocharger oil return pipe	Repair
	Clogged center housing oil passages	Repair or replace
	Engine oil deterioration	Change engine oil
Noisy turbocharger operation	Gas leakage from intake or exhaust system	Repair
	Turbine and housing contact (Interference)	Repair or replace
	Damaged turbine fan	Replace
	Turbine shaft bearing abrasion or scoring	Repair or replace
Excessive rotating part wear	Engine oil deterioration	Change engine oil
	Clogged turbocharger oil feed pipe	Repair
	Low engine oil pressure	Repair

Main Data and Specifications

Item			Engine model 4HK1-TCS	Engine model 4HK1-TCN
Type			Diesel/4-cycle/water cooling type in-line OHC	Diesel/4-cycle/water cooling type in-line OHC
Combustion chamber type			Direct injection type	Direct injection type
Cylinder liner type			Dry type	Dry type
Number of cylinders -cylinder bore × strokes		mm (in)	4-115 (4.53) × 125 (4.92)	4-115 (4.53) × 125 (4.92)
Displacement		cc (cu.in)	5193(317)	5193(317)
Compression ratio			17.5	17.5
Compression pressure		MPa (kg/cm^2/ psi)/rpm	2.60 – 2.89 (26.5 – 29.5/377 – 419)/220	2.60 – 2.89 (26.5 – 29.5/377 – 419)/220
Idling speed		rpm	650	650
Valve clearance	Intake	mm (in)	0.4 (0.016) (cold)	0.4 (0.016) (cold)
	Exhaust		0.4 (0.016) (cold)	0.4 (0.016) (cold)
Ignition type			Compressed ignition	Compressed ignition
Injection order			1 - 3 - 4 - 2	1 - 3 - 4 - 2
Lubricating system				
Lubricating type			Pressure type	Pressure type
Oil pump type			Gear type	Gear type
Volume of lubricating oil		Liters (US/Imp gal.)	13.0 (3.43/2.86)	13.0 (3.43/2.86)
Oil filter type			Full flow filter (cartridge type)	Full flow filter (cartridge type)
Oil cooling type			Built-in-type, water cooling	Built-in-type, water cooling
Cooling system				
Cooling type			Water cooling type	Water cooling type
Radiator type			Corrugated fin(pressure type)	Corrugated fin(pressure type)
Water pump type			Centrifugal, belt type	Centrifugal, belt type
Thermostat type			2 wax-type units	2 wax-type units
Thermostat valve-opening temperature		°C (°F)	82 (180), 85 (185)	82 (180), 85 (185)
Volume of coolant		Liters (US/Imp gal.)	17.6 (4.65/3.87) (incl. radiator)	17.6 (4.65/3.87) (incl. radiator)
Fuel system				
Injection pump type			Electronic control common rail type	Electronic control common rail type
Governor type			Electronic type	Electronic type
Timer type			Electronic type	Electronic type
Injection nozzle type			Multi-hole type 7-holes ϕ0.14 mm (0.0055 in) inside diameter	Multi-hole type 7-holes ϕ0.14 mm (0.0055 in) inside diameter

Item		Engine model 4HK1-TCS	Engine model 4HK1-TCN
Charging system			
Generator type		AC type	AC type
Power output	V-A	24 - 80, 24 - 60, 24 - 50	24 - 80, 24 - 60, 24 - 50
Regulator type		IC	IC
Starting system			
Starter type		Reduction type	Reduction type
Power output	V-kw	24 - 4.5	24 - 4.5
Preheat system type		Glow plug	Glow plug
Glow plug standard voltage/ electric current	V	24	24

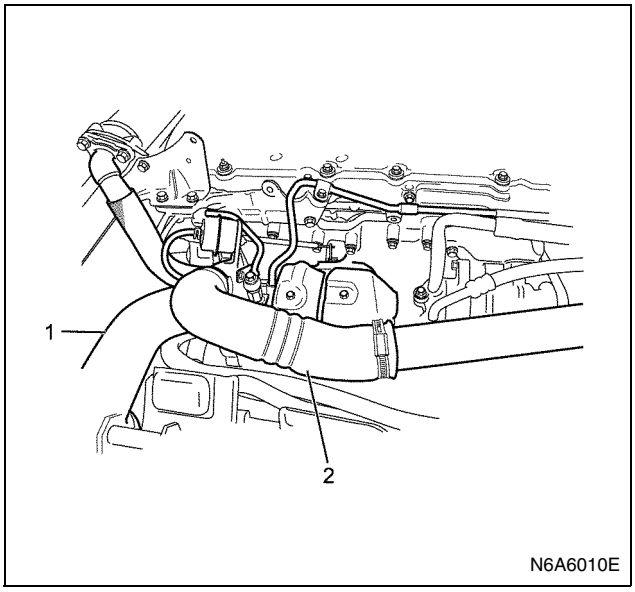
Special Tool

Illustration	Tool Number / Description / Remarks
 5884020080	5-8840-2008-0 Compression Gauge Set (J-26999-12 / Compression Gauge, EN-46722 / Gauge Adapter)

Engine Assembly

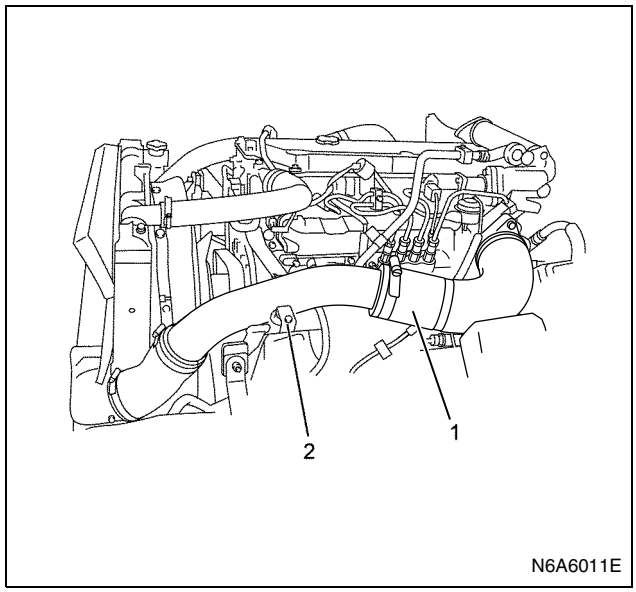
Removal

1. Remove a minus (-) terminal of the battery.
2. Drain the coolant.
3. Remove the starter motor.
   - Disconnect the front frame harness connector in the vicinity of the control box of the transmission and remove each clip that fixes the harness.
   - Remove 2 bolts that fasten the starter and remove the starter from the clutch housing.
   - Fix the starter motor with wire, for instance, in a place that does not get in the way in removing the transmission.
4. Remove the transmission assembly.
   Refer to “Transmission Assembly”
5. Remove the charge air hose (between turbocharger and inlet pipe).



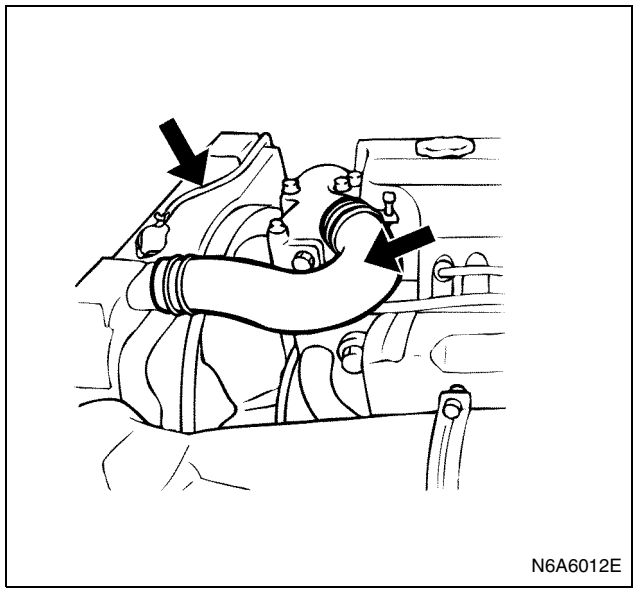
Legend
1. Duct
2. Charge Air Hose

6. Remove the inlet hose (between air cleaner and turbocharger).
7. Remove the charge air hose (between intercooler and inlet duct).
   - Remove the connector of the boost pressure sensor.



Legend
1. Charge Air Hose
2. Boost Pressure Sensor

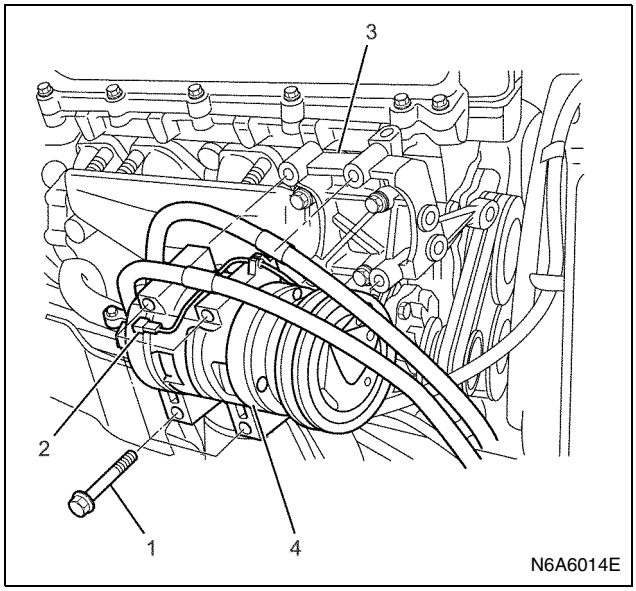
8. Remove the upper hose of the radiator.
   - Remove the band clip and VSV vacuum hose.



9. Remove a bracket of the fan guide.
10. Remove the fan assembly.
    - Remove the nuts and pull them out upward.
11. Remove the heater hoses.

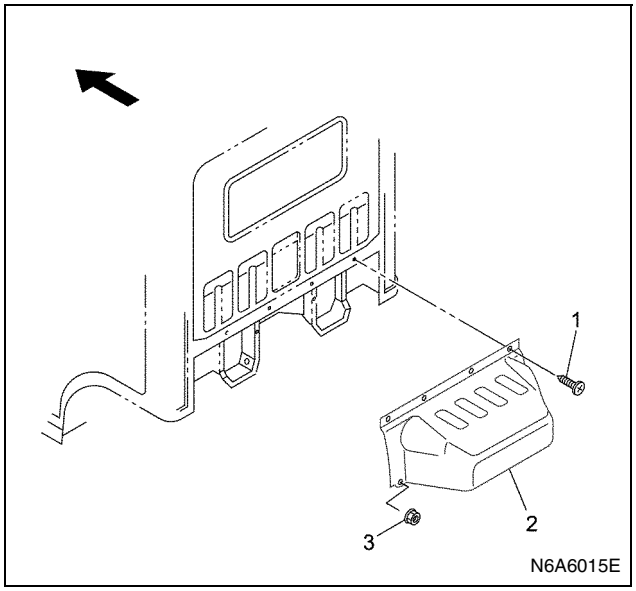
- Remove 2 hoses on the engine side.

12. Remove the engine harness.
    - Remove the ECM.
    - Disconnect the two main harness connectors from the ECM (For SLD equipped, disconnect the unsealed connector.)
    - Remove the engine ground cable.
13. Remove the A/C compressor.
    - Remove the drive belt.
    - Remove the connector.
    - Remove the A/C compressor and fix it with wire, for example, to an appropriate place along with hoses and others.



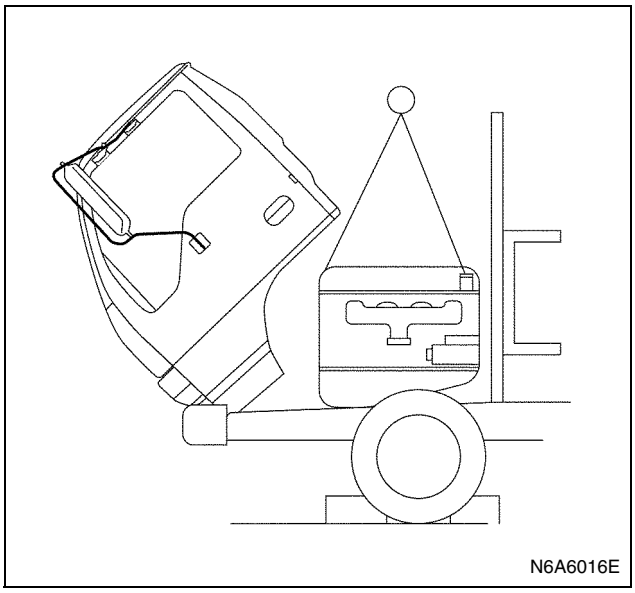
Legend
1. Fixing Bolt
2. Connector
3. Bracket
4. A/C Compressor

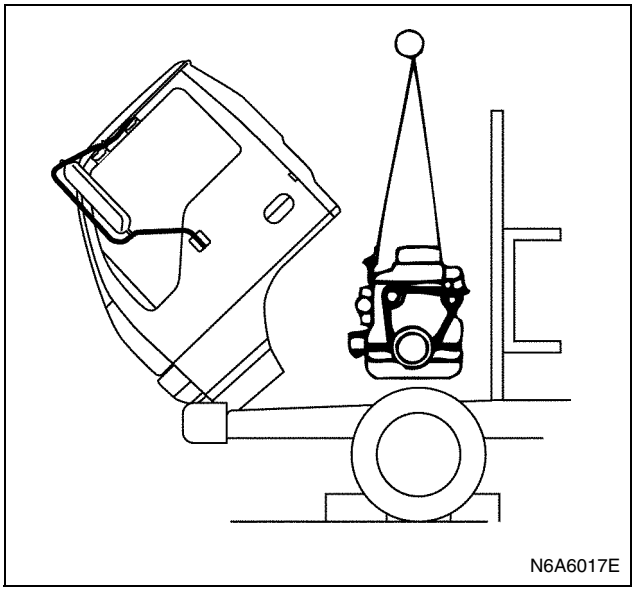
14. Remove the AC generator harness.
    - Remove the terminal B cable and harness connector from the generator.
15. Remove the vacuum hose on the vacuum pump side.
16. Remove a bracket by the blow-by separator and remove the harness connector and HBB oil hose bracket.
17. Remove the blow-by separator hose.
18. To prevent oil from flowing out when the hydraulic booster brake hose is removed, remove the fastening bolts for the hydraulic booster brake tank to lower the tank.
19. Remove one side of the hydraulic booster brake hose on the high-pressure side.
20. To prevent oil from flowing out when the power steering oil hose is removed, remove the fastening bolts for the power steering reserve tank to lower the tank.
21. Remove the power steering oil hose.
22. Remove the lower hose of the radiator on the engine side.
23. Hang wire on the engine hanger and hoist to lift up the engine slightly.
24. Remove the front exhaust pipe.
    - Remove the front exhaust pipe from the turbo and exhaust brake.
25. Remove the fuel hose on the feed and return sides.
26. Remove the engine mount.
    - Remove the fastening bolts for the engine mount on the chassis frame side.
27. Remove the engine assembly.
    - Remove the cab back cover.



Legend
1. Screw
2. Cab Back Cover
3. Nut

- Operate a hoist slowly and hoist the engine until it comes up to the surface of the chassis frame.
- Turn the engine at an angle of 90 degrees to move from the surface of the chassis frame and remove the engine assembly.

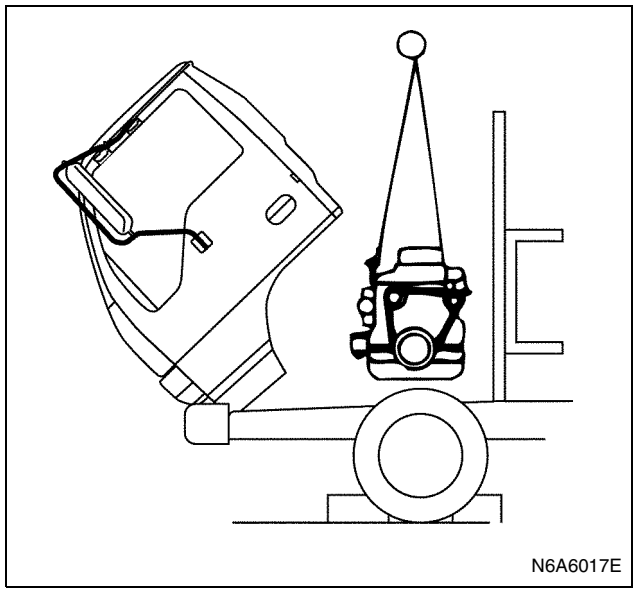

N6A6016E


N6A6017E

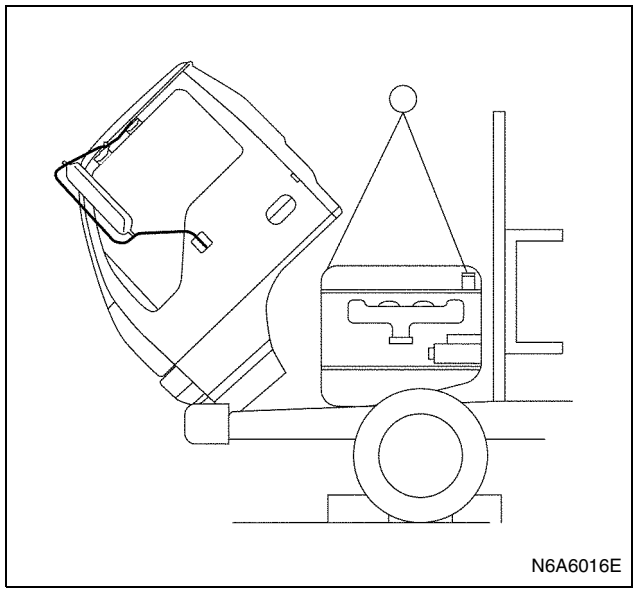
Installation

Notice:
Be absolutely sure that each harness is reconnected to its original position.

1. Install the engine assembly.
   - Hang wire on the engine hanger and hoist to lift up the engine.
   - Operate a hoist slowly to move the engine to the place where it is to be installed.


N6A6017E

   - Turn the engine at an angle of 90 degrees to lower the engine slowly to the place it is to be installed.

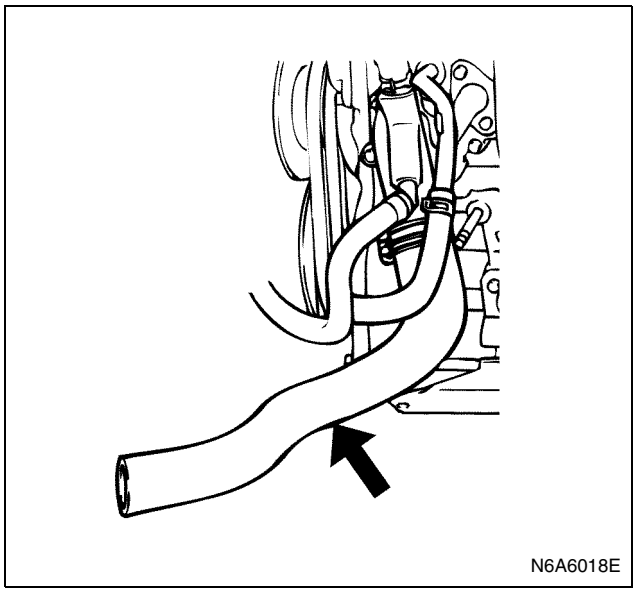

N6A6016E

   - Make the transmission side lower and operate a hoist slowly, pulling it backward to the engine.
2. Install the engine mount.
   - Install the engine mount to fit into the holes of the engine mounting cross member and tighten it up with the specified torque.

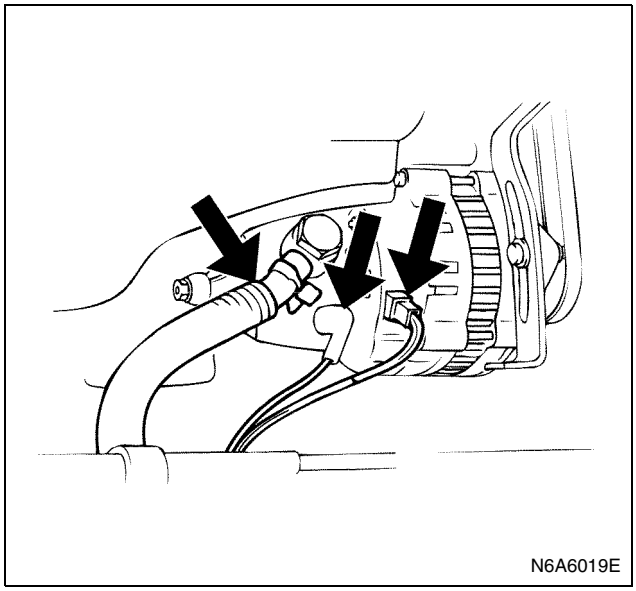
Tighten:
Cross member to 48 N·m (4.9 kg·m/35 lb·ft)

3. Install the feed and return sides of the fuel hose.
4. Install the front exhaust pipe.

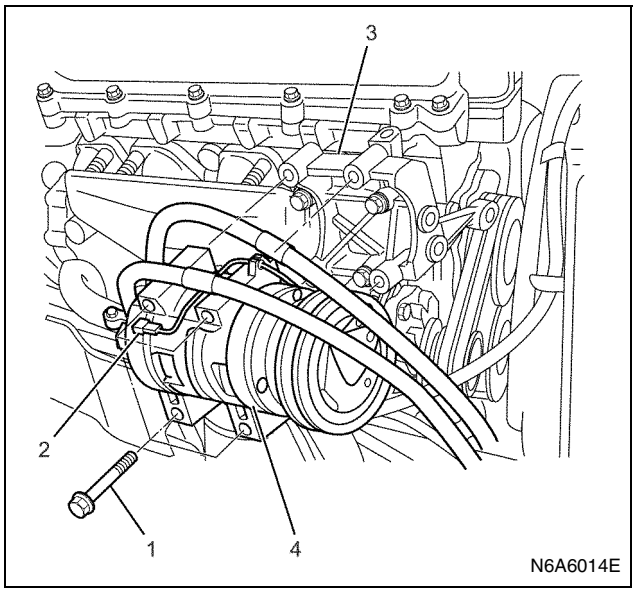
5. Install the lower hose of the radiator.



6. Install the power steering oil hose.
7. Install the power steering reserve tank.
8. Install the hydraulic booster brake hose on the high-pressure side.
9. Install the hydraulic booster brake tank.
10. Install the blow-by separator hose.
11. Install a bracket by the blow-by separator and install the harness connector and HBB oil hose bracket.
12. Install a vacuum hose to the vacuum pump.



13. Install the AC generator harness.
    - Install the terminal B cable and the harness connector to the generator.
14. Install the A/C compressor.
    - Install the connector.

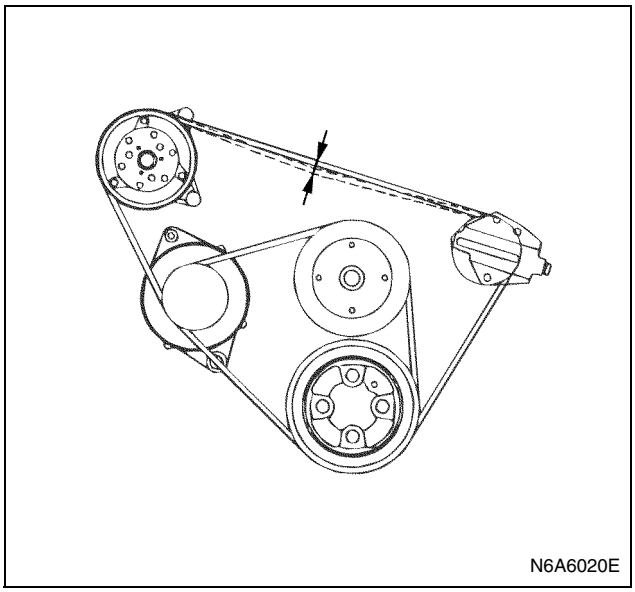


Legend

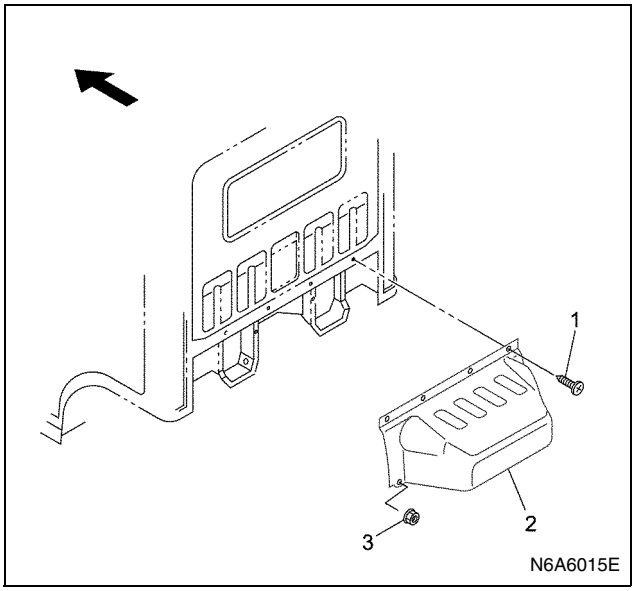
1. Fixing Bolt
2. Connector
3. Bracket
4. A/C Compressor

- Install the drive belt.
- Hang the drive belt to adjust its tension with an adjusting bolt of the tension pulley.
- For further details for adjusting tension of the belt, refer to “Drive Belt” in Section 6B.
- Check if a flexure is within the specified range when the center part is pressed by the hand with 98 N (22 lb) by using a scale, for instance. In addition, check if it is not damaged as well.
- Flexure of the A/C compressor belt.
- 16 – 20 mm (0.62 – 0.79 in) (when the belt is new)
- 18 – 22 mm (0.71 – 0.87 in) (when the belt is reused)

- After adjusting tension of the belt, tighten up the lock nut of the tension pulley.


N6A6020E

15. Install the cab back cover.



N6A6015E

Legend

1. Screw
2. Cab Back Cover
3. Nut

16. Install the engine harness.
17. Install the heater hoses.

- Install 2 hoses.

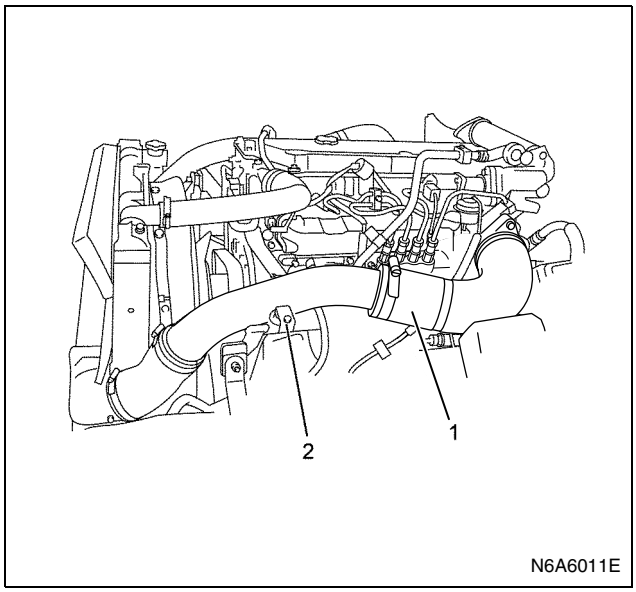
N6A6013E

18. Install the fan assembly.
19. Install a bracket for the fan guide.
20. Install an upper hose of the radiator.
    - Install the VSV vacuum hose and bundle it and upper hose with a band clip.

N6A6012E

21. Install the charge air hose (between intercooler and inlet duct).

- Install the connector of the boost pressure sensor.

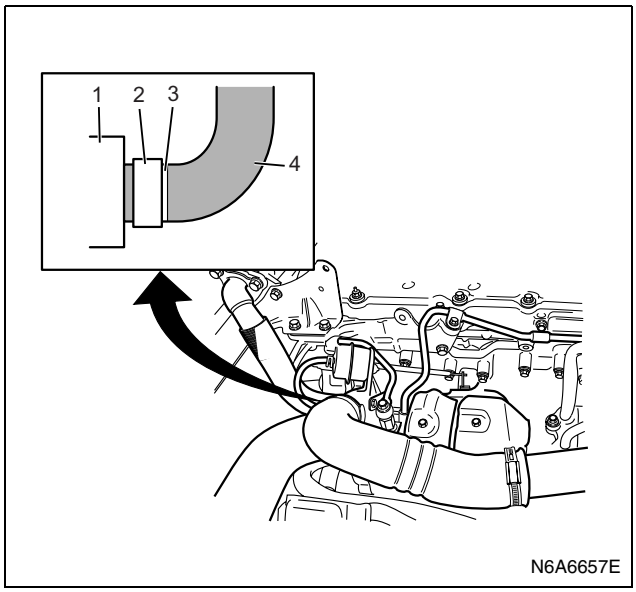


Legend

1. Charge Air Hose
2. Boost Pressure Sensor

22. Install the inlet hose (between air cleaner and turbocharger).
    - Hose is inserted until bumping to turbocharger.
    - Clip assembled along the white line on hose.

Clip Tightening torque: 6.3 N·m (56 lb ft)



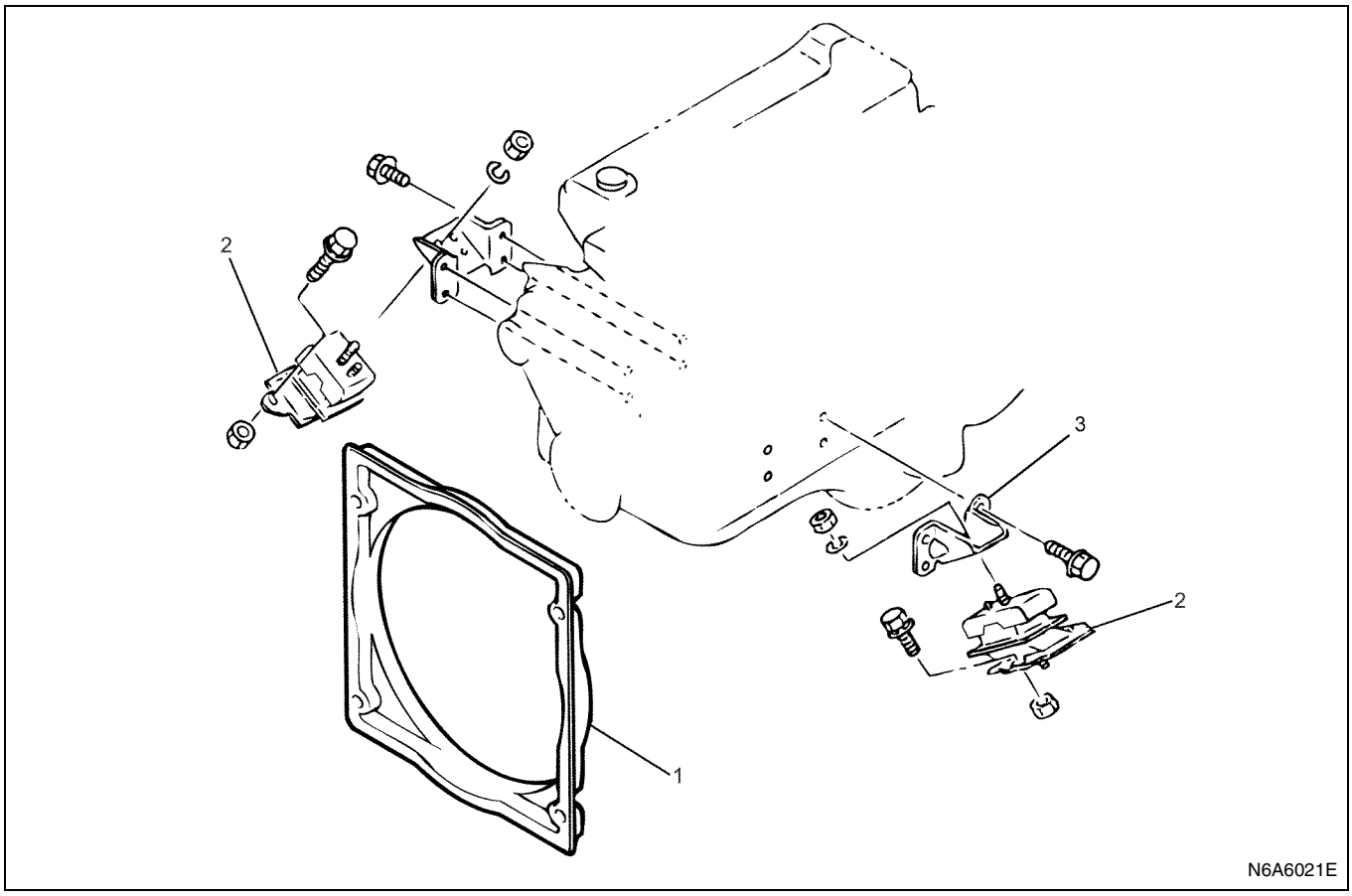
Legend

1. Turbocharger
2. Clip
3. White Line
4. Hose

23. Install the charge air hose (between turbocharger and intercooler).
24. Install the transmission assembly.
    Refer to “Transmission Assembly”.
25. Install the starter motor.
    - Install 2 up and down bolts to fasten the starter.
    - Connect the front frame harness connector and install each clip which fixes the harness.
26. Replenish the coolant.
27. Install a minus (–) terminal of the battery.

Engine Mount

Component



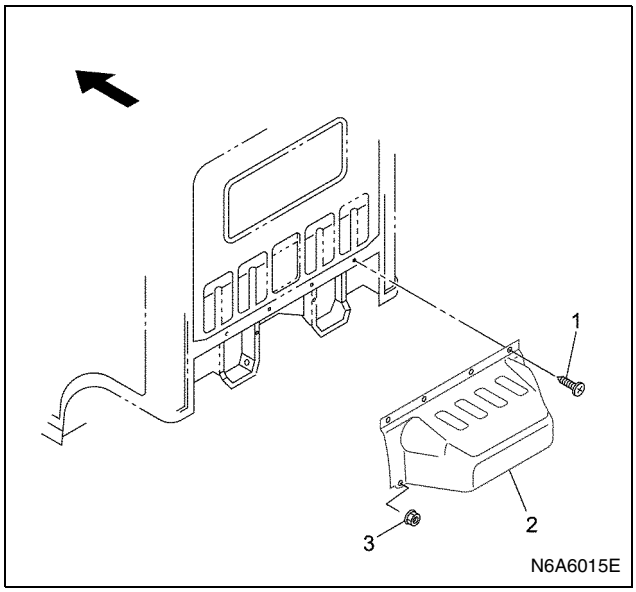
Legend

1. Fan Guide
2. Engine Mount
3. Engine Foot

Removal

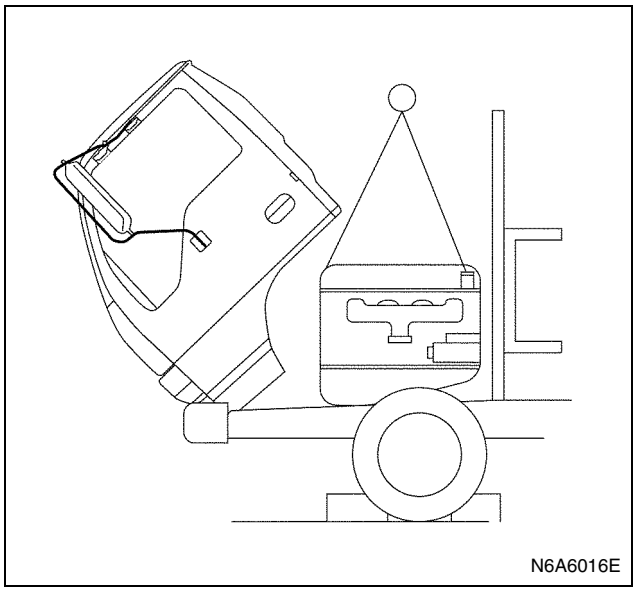
1. Remove the fan guide bracket.
2. Remove the engine mount.

- Remove the cab back cover.



Legend
1. Screw
2. Cab Back Cover
3. Nut

- Before removing the engine mount, hang the engine with a hoist.
- Remove the nuts fastened to the engine foot and engine mount.
- Remove the bolts fastened to the engine mount on the chassis frame side.
- Hoist the engine assembly slightly to remove the engine mount.

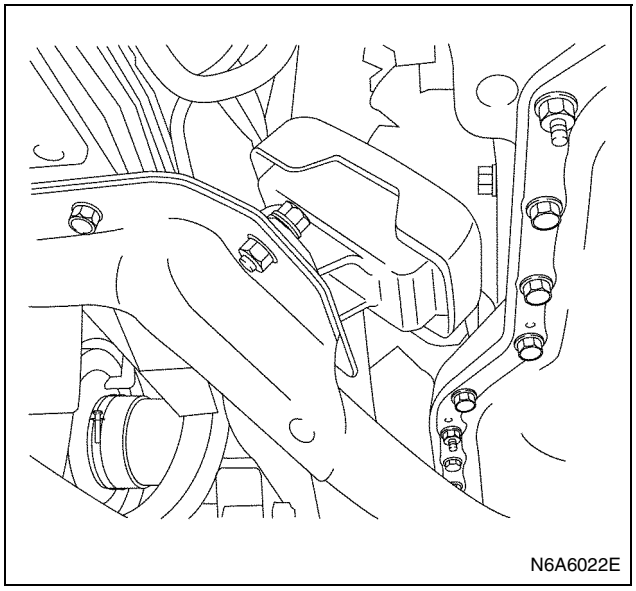


Installation

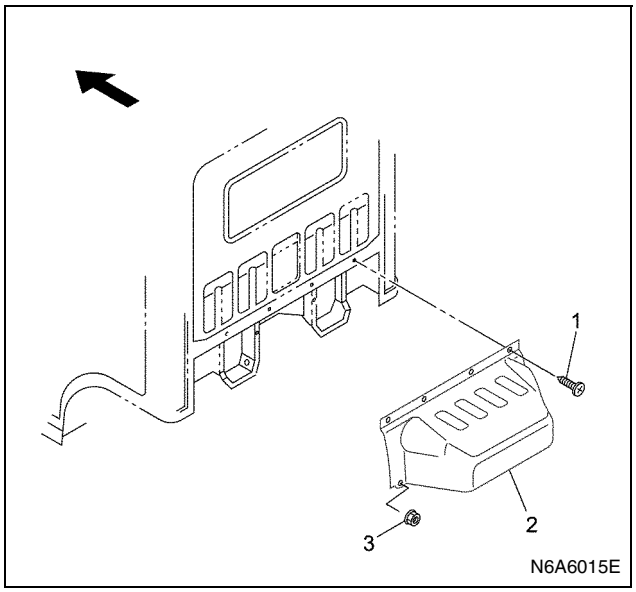
1. Install the engine mount and tighten up with the specified torque.

Tighten:
The nuts on the chassis frame side to 82 N·m (8.4kg·m/ 61 lb·ft)

The bolts on the engine foot side to 51 N·m (5.2kg·m/38 lb·ft)

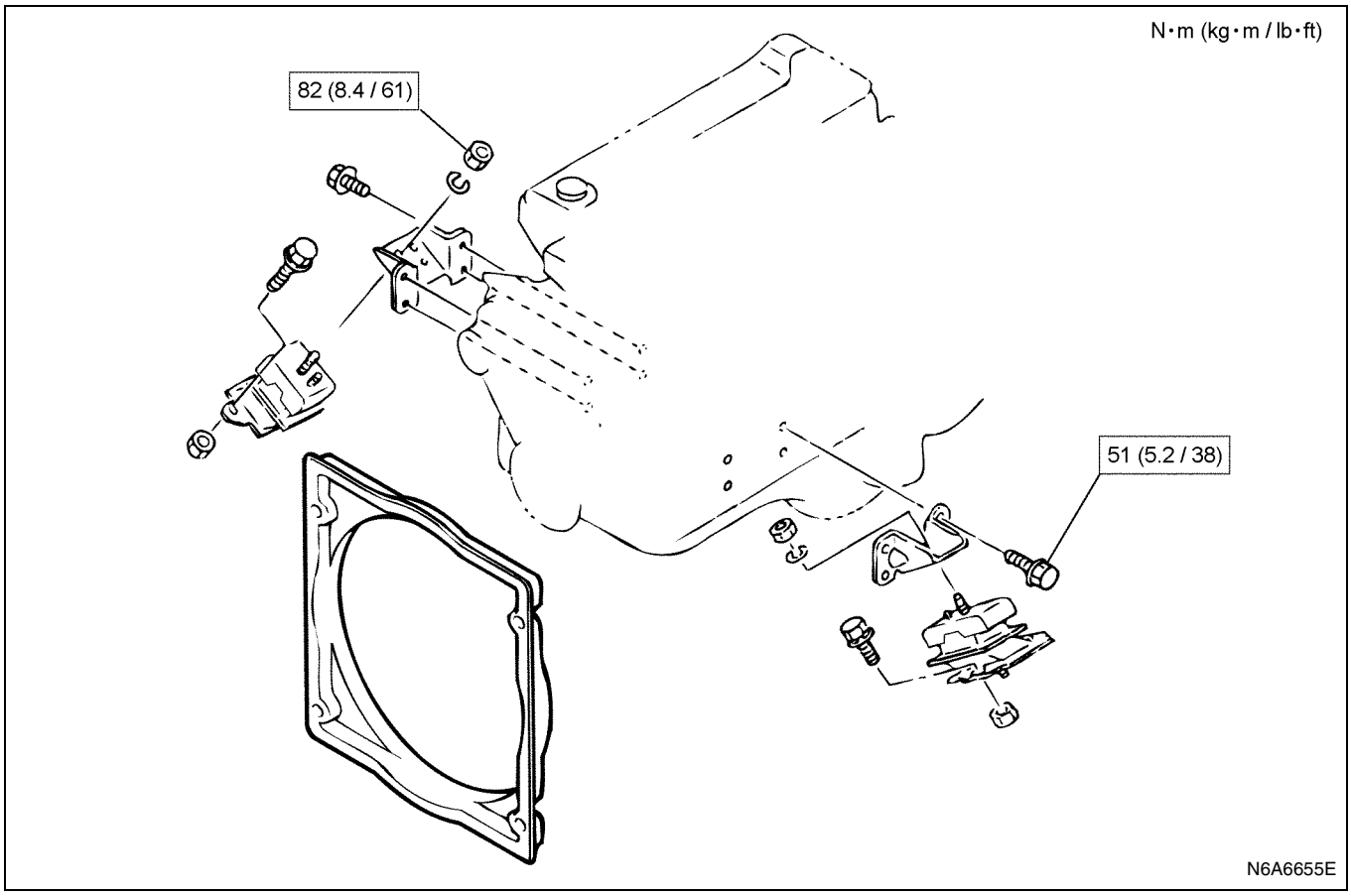


2. Install the fan guide bracket.
   - Check if nothing is wrong with the engine mount by starting the engine.
3. Install the cab back cover.



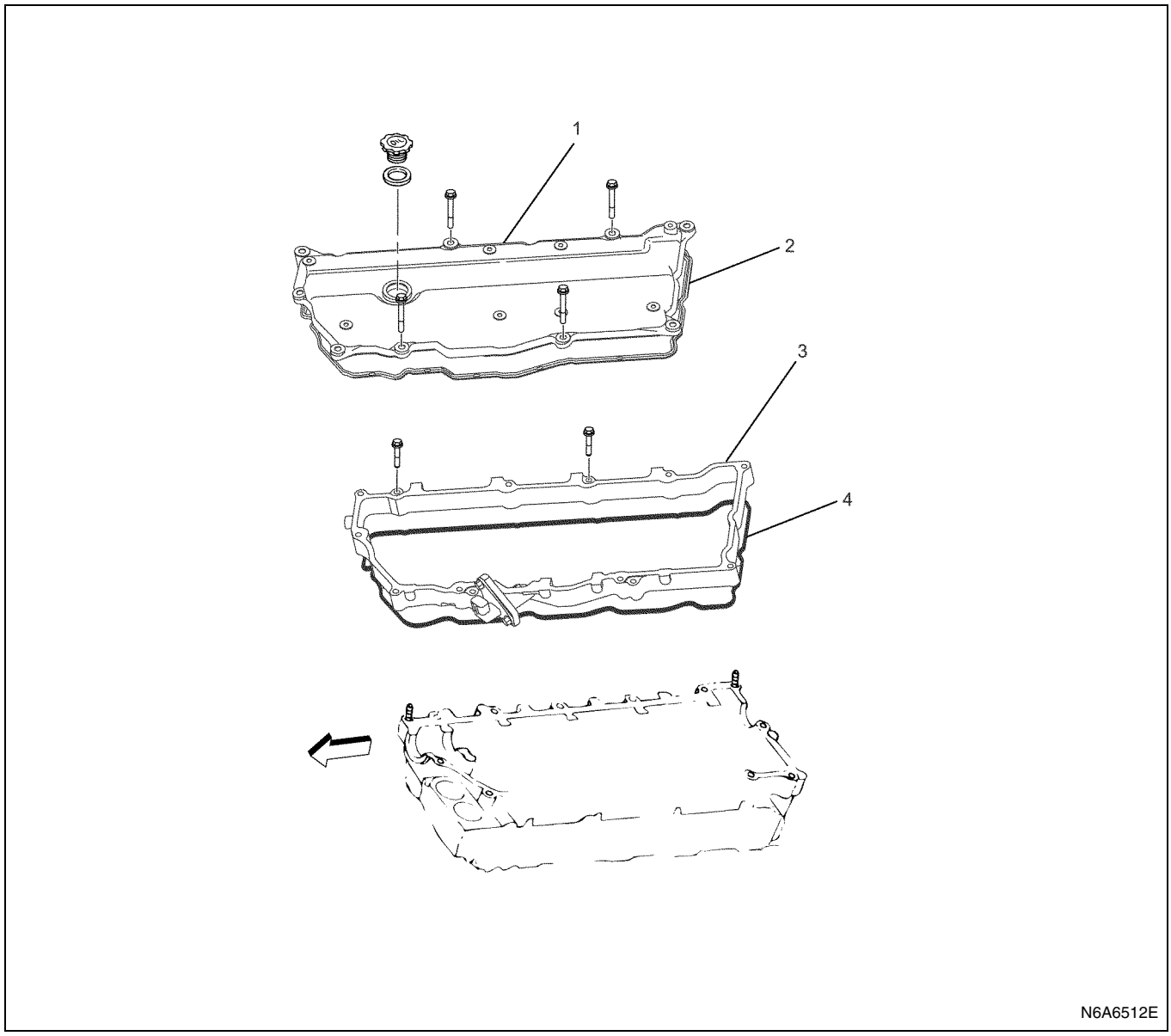
Legend
1. Screw
2. Cab Back Cover
3. Nut

Torque Specifications



Cylinder Head Cover (Except Europe)

Component



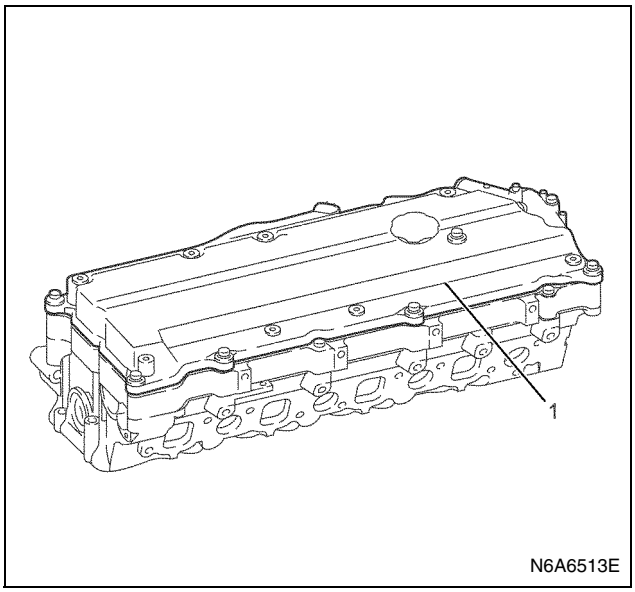
Legend

1. Head Cover
2. Gasket
3. Head Cover Case
4. Gasket

Removal

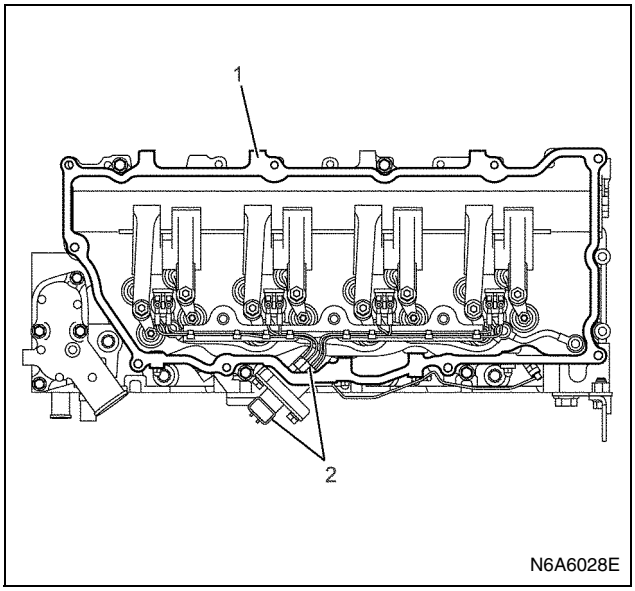
1. Remove the head cover.

2. Remove the gasket.



Legend
1. Head Cover

3. Remove the fuel injector harness connector.
4. Remove the head cover case.
5. Remove the gasket.



Legend
1. Head Cover Case
2. Fuel Injector Harness Connector

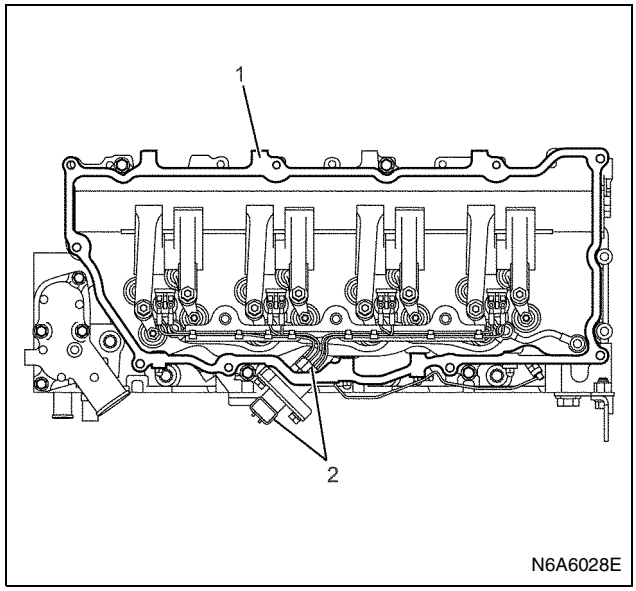
Installation

1. Install the gasket on the lower cover.
2. Install the head cover case.

Tighten:
Bolts to 18 N·m (1.8 kg·m/13 lb·ft)

3. Install the fuel injector harness connector.

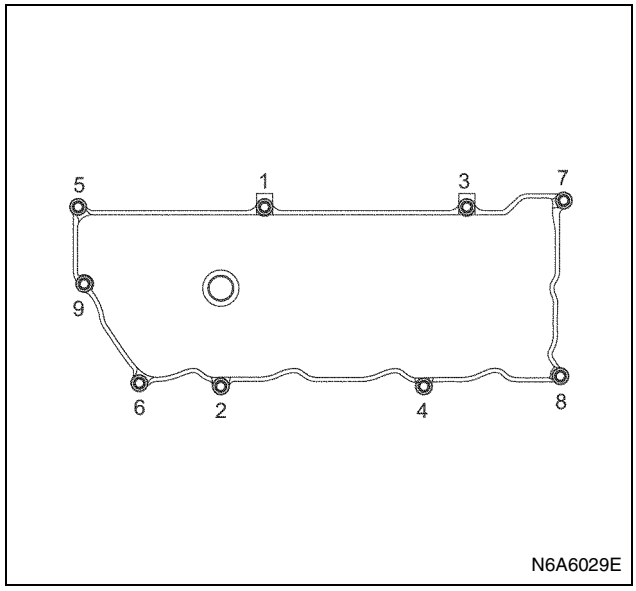
Caution:
Push it in thoroughly until the claws of the lock raise.



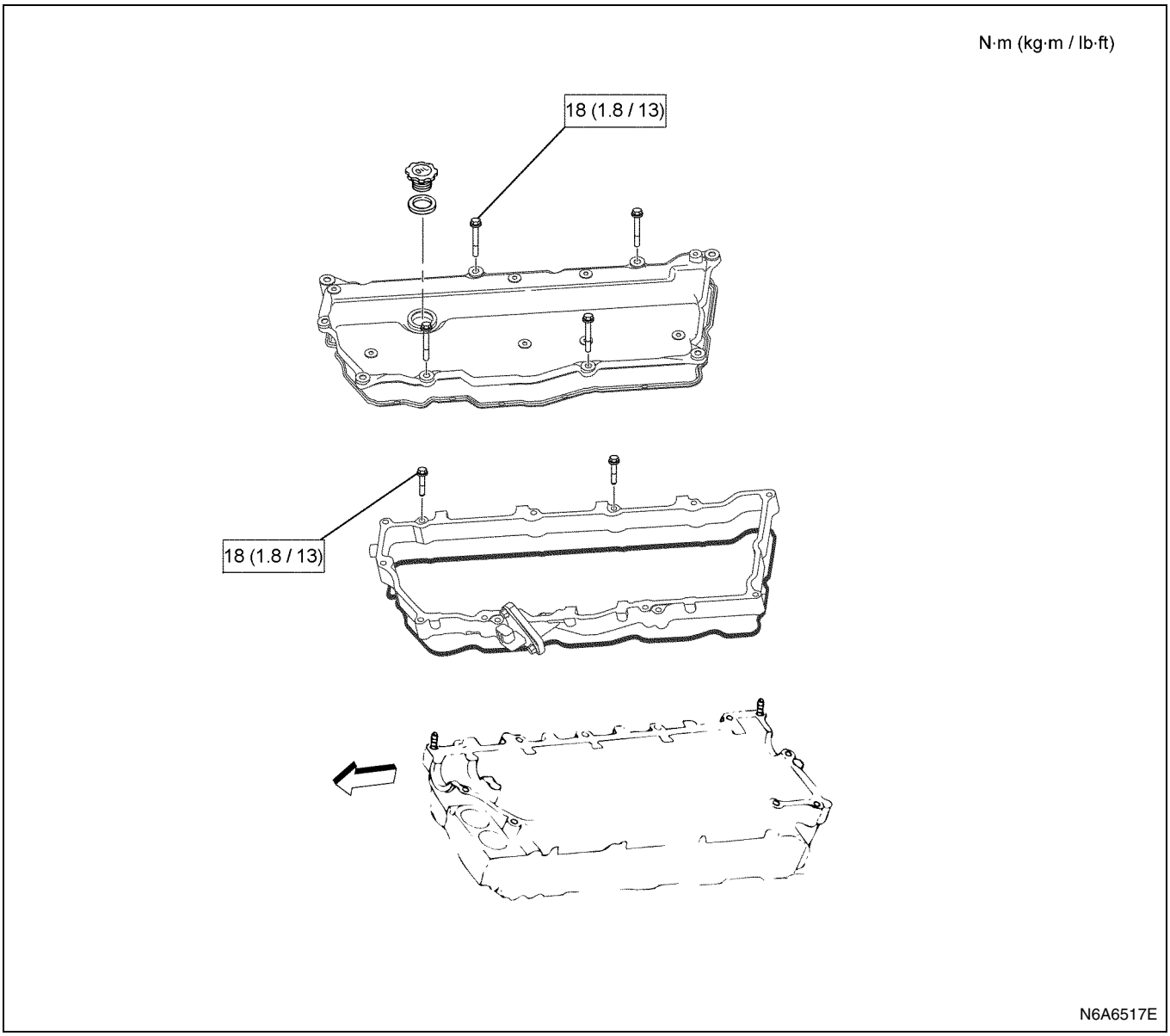
Legend
1. Head Cover Case
2. Fuel Injector Harness Connector

4. Install the gasket on the head cover.
5. Install the head cover and tighten up according to the orders given on the figure.

Tighten:
Bolts to 18 N·m (1.8 kg·m/13 lb·ft)

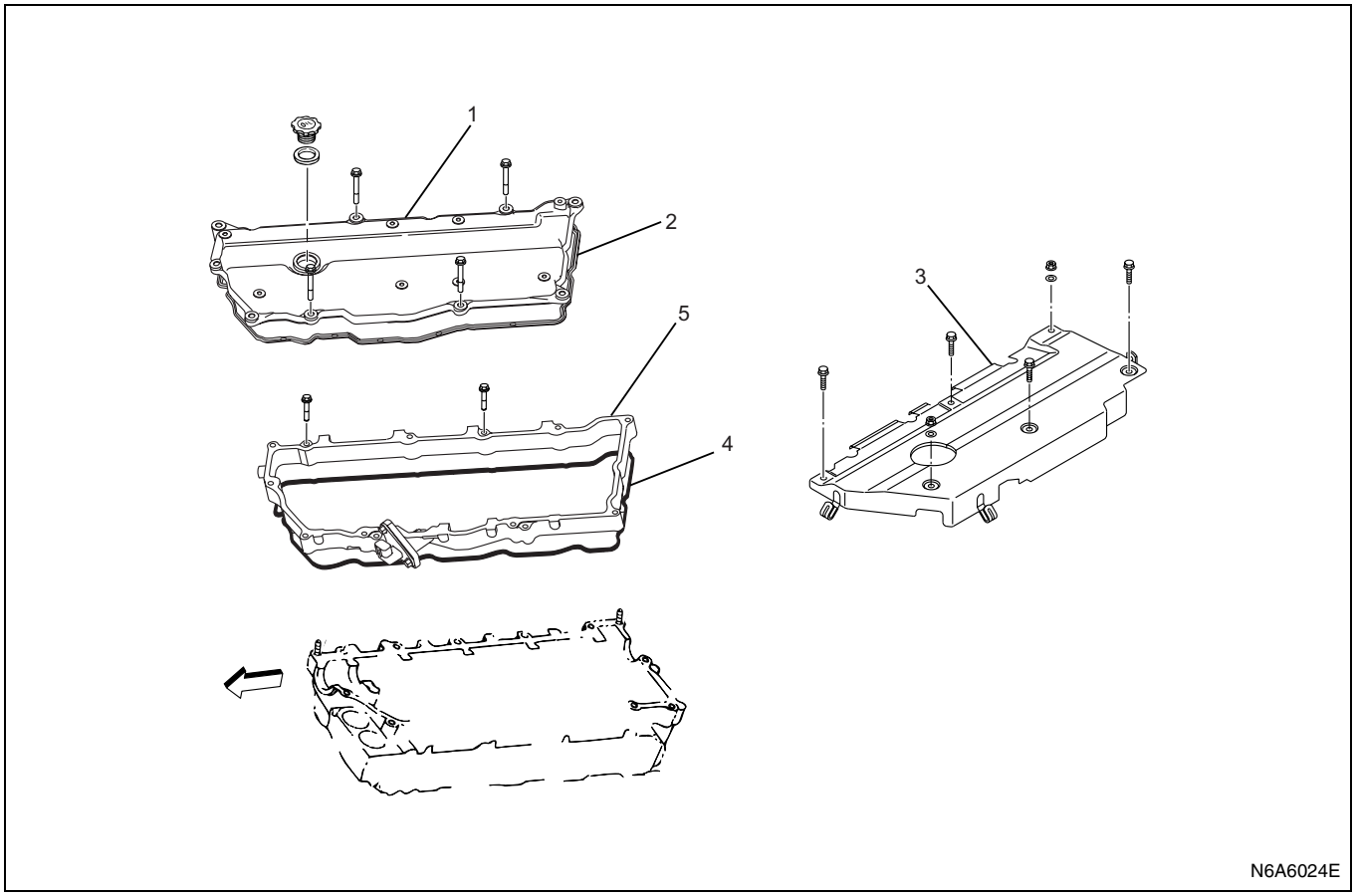


Torque Specifications



Cylinder Head Cover (For Europe)

Components



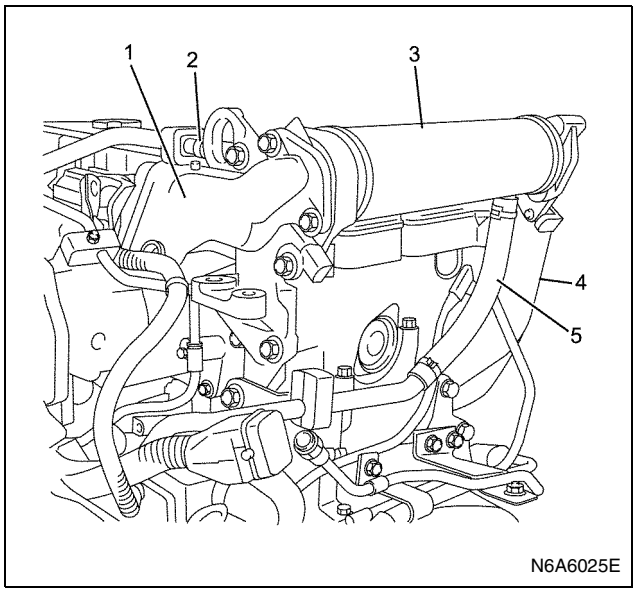
Legend

1. Head Cover
2. Gasket
3. Sound Insulation Cover
4. Gasket
5. Head Lower Cover

Removal

1. Drain engine coolant. Refer to Engine Cooling System section.
2. Remove EGR valve connector.

3. Remove the EGR pipe.

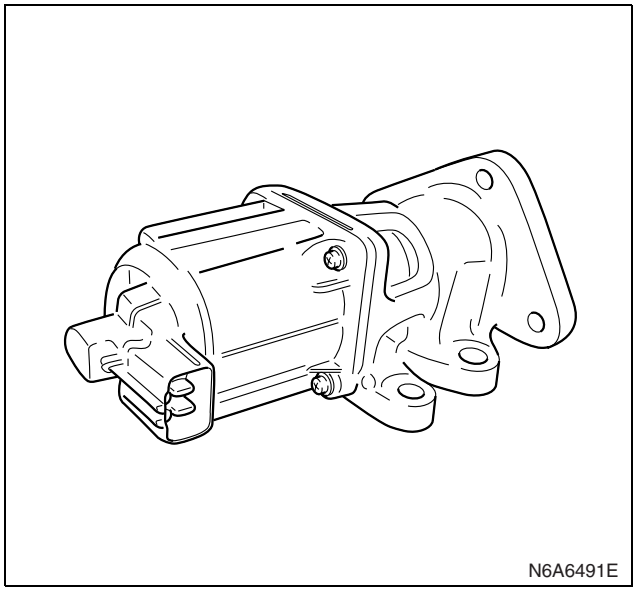


Legend

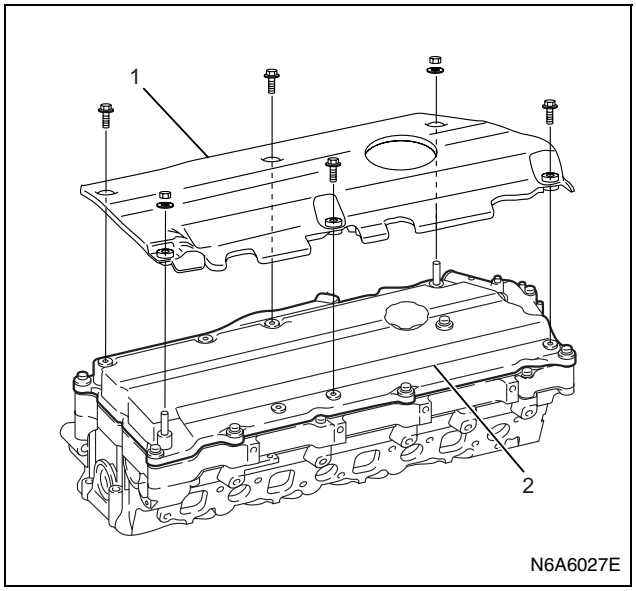
1. EGR Adapter
2. Water Return Pipe
3. EGR Cooler
4. EGR Pipe
5. Water Feed Pipe

4. Remove the cooling water pipes.
5. Remove the EGR adapter.
6. Remove the EGR cooler.
7. Remove the EGR valve.

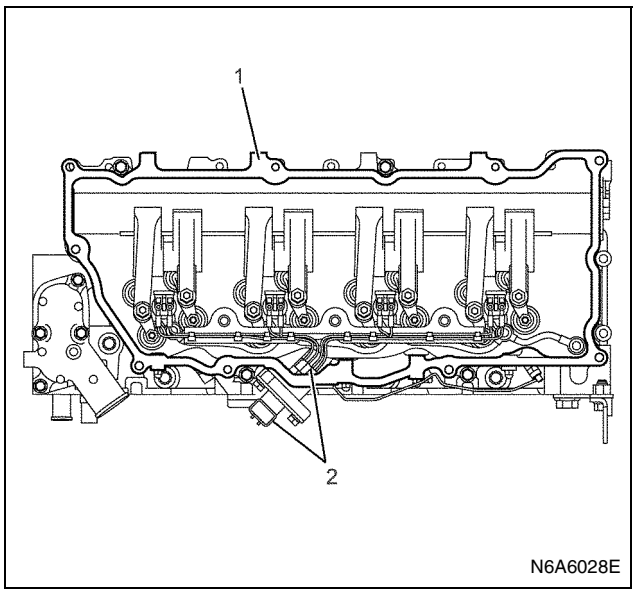
Caution:
After removing the EGR valve and EGR adapter, seal the opening so that foreign matter does not enter.



8. Remove the sound insulation cover (1).
9. Remove the head cover (2)
10. Remove the gasket.



11. Remove the fuel injector harness connector (2).
12. Remove the head lower cover (1).
13. Remove the gasket.



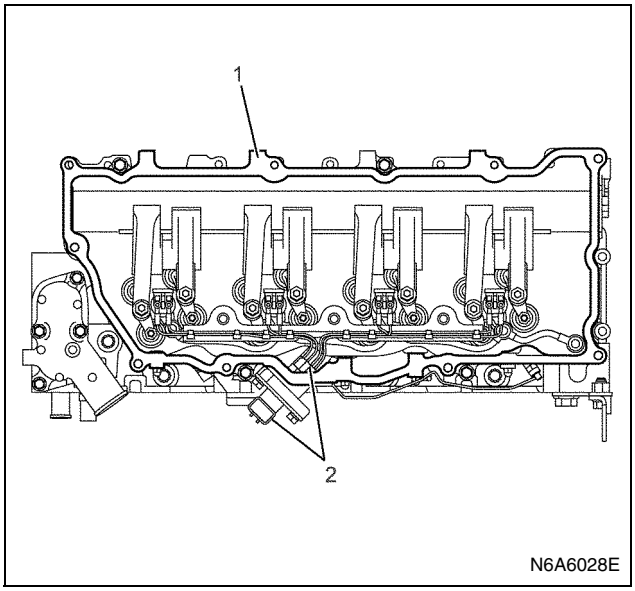
Installation

1. Install the gasket on the head lower cover (1).
2. Install the head lower cover (1).

Tighten:
Bolts to 18 N·m (1.8 kg·m/13 lb·ft)

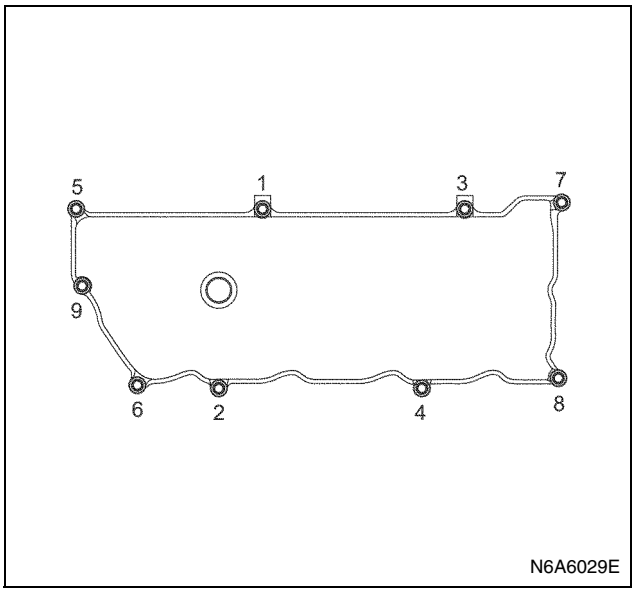
3. Install the fuel injector harness connector (2).

Caution:
Push it in thoroughly until the claws of the lock raise.



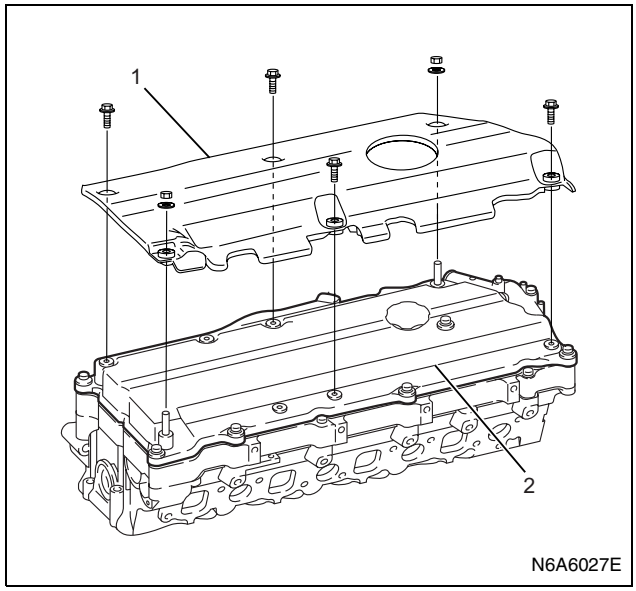
4. Install the gasket on the head cover.
5. Install the head cover and tighten up according to the orders given on the figure.

Tighten:
Bolts to 18 N·m (1.8 kg·m/13 lb·ft)



6. Install the sound insulation cover.

Tightening torque: 8 N·m (0.8 kg·m/6 lb·ft)



Legend
1. Sound Insulation Cover
2. Head Cover

7. Mount the EGR valve.
   - Insert the gasket and temporarily fit the EGR valve.

Notice:
Temporarily tighten the bolts.

8. Install the EGR cooler.
   - Temporarily fit the EGR cooler to the bracket.

Notice:
Temporarily tighten the bolts.

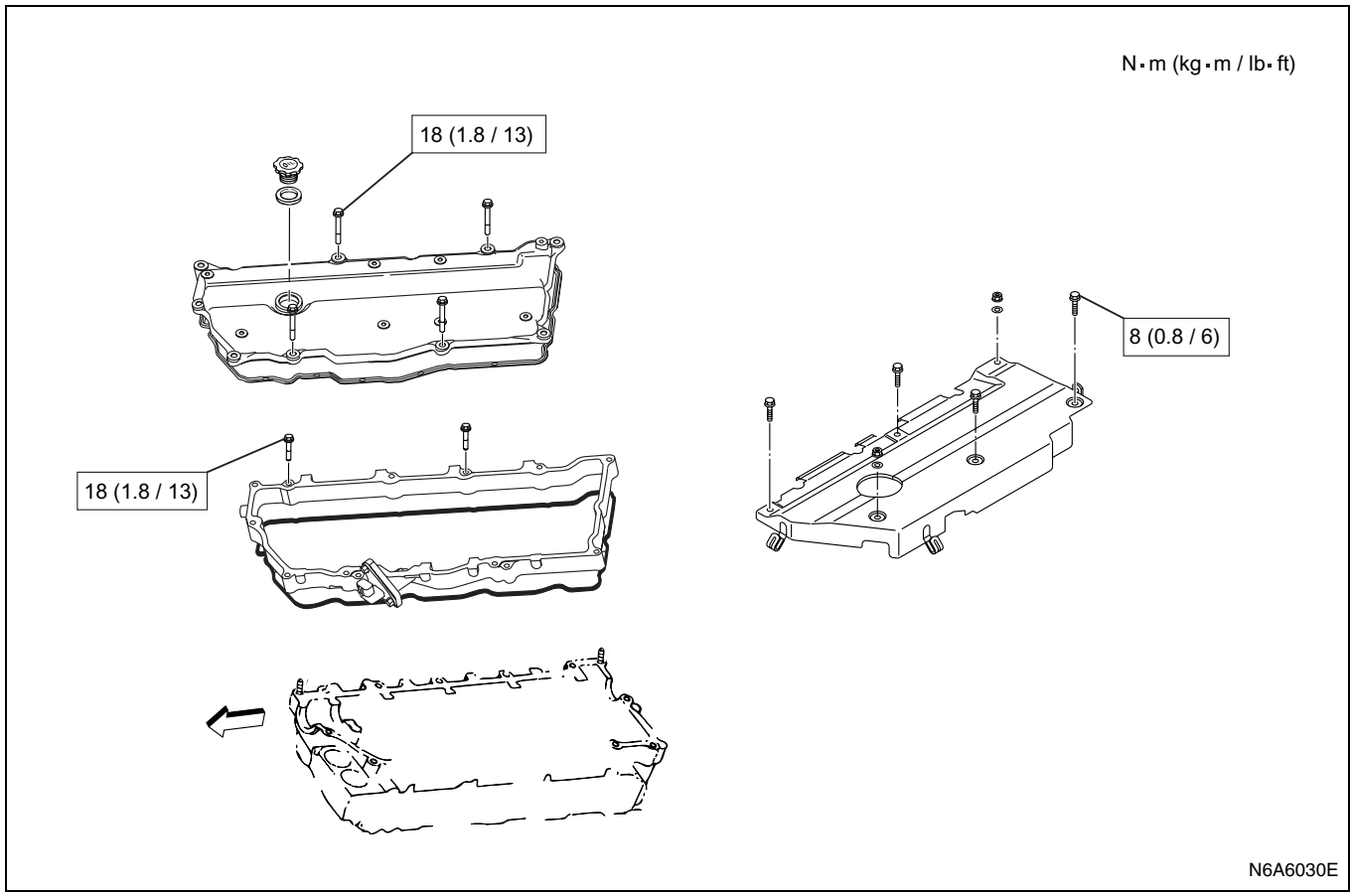
9. Install the EGR adapter.
   - Temporarily fit the EGR adapter between the EGR cooler and exhaust manifold.

Notice:
Temporarily tighten the bolts.

10. Install the EGR pipe.
    - Insert the gasket between the two ends of the EGR pipe and temporarily fit it.

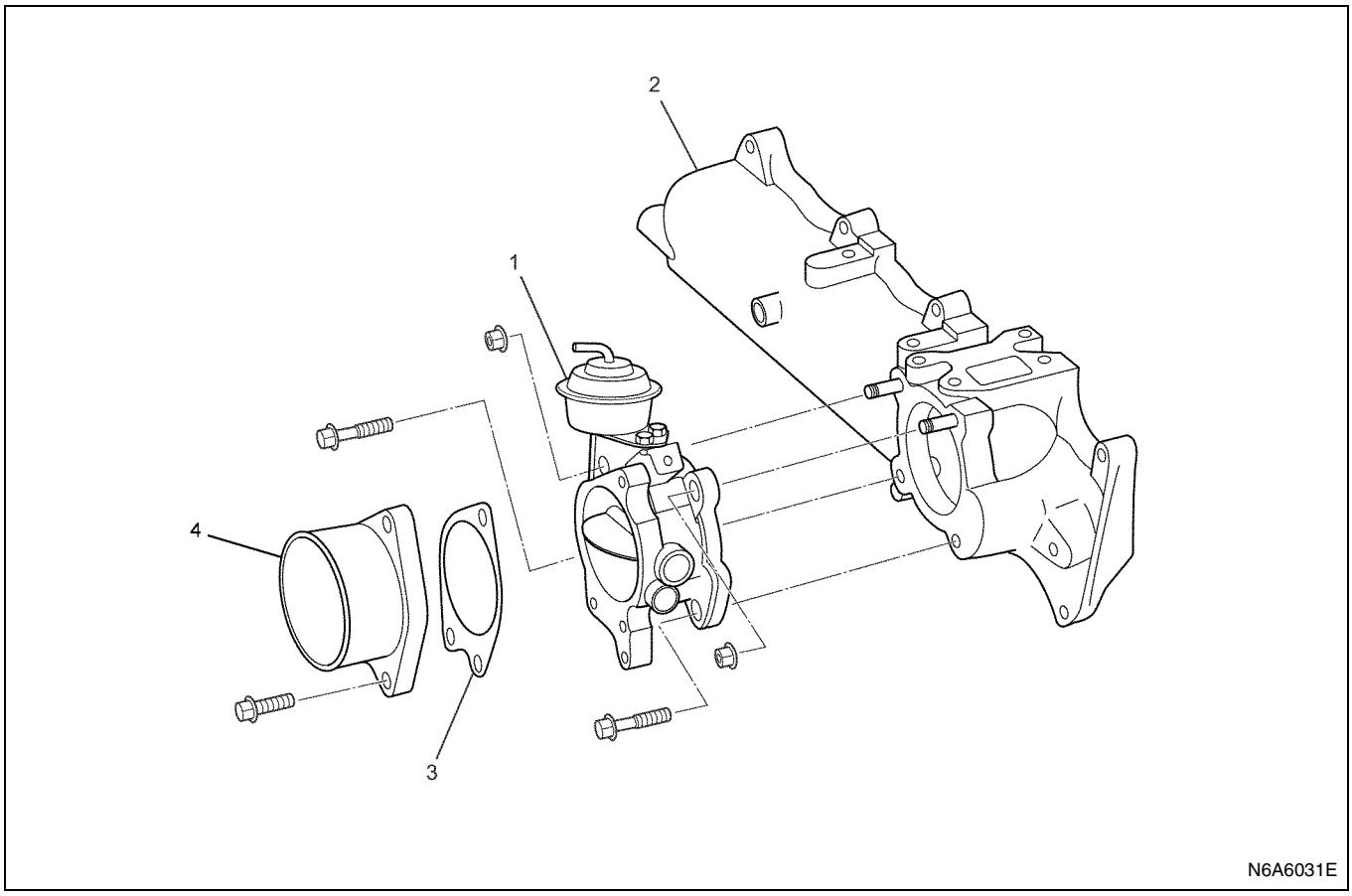
Notice:
Temporarily tighten the bolts.

Tightening Torque Specifications



Inlet Cover

Component

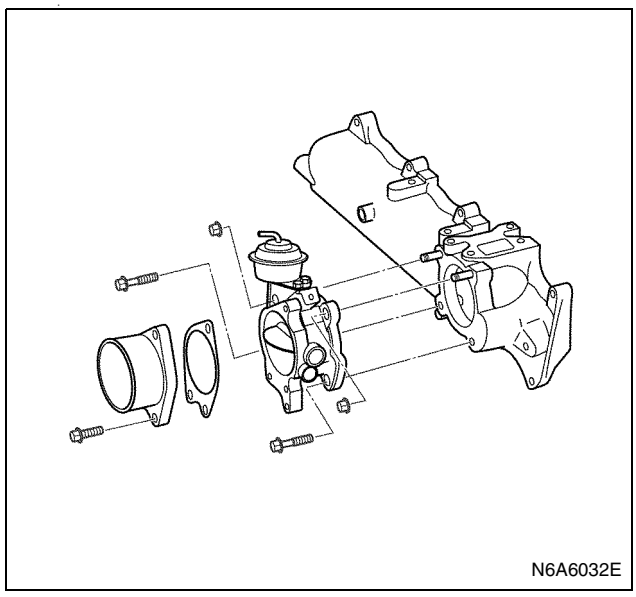


Legend

1. Throttle Assembly
2. Inlet Cover
3. Inlet Pipe Gasket
4. Inlet Pipe

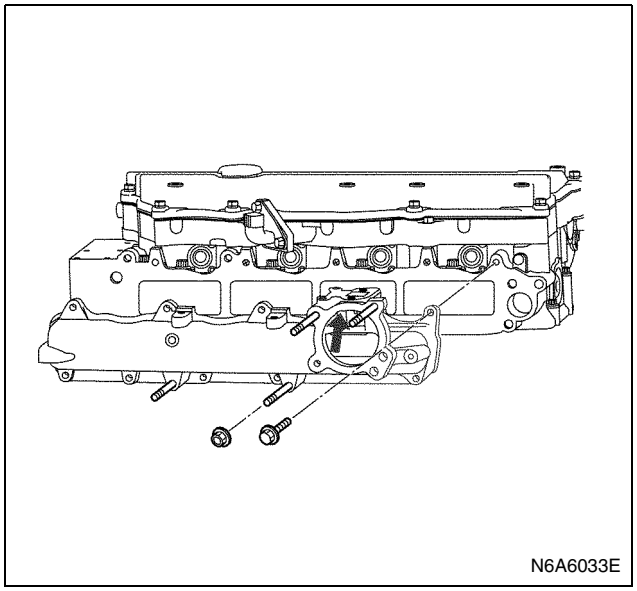
Removal

1. Remove the fuel rail.
   Refer to “Fuel Rail” in Section 6C.
2. Remove the EGR valve.
   Refer to “EGR Valve and EGR Cooler” in Section 6F.
3. Remove the inlet pipe.
4. Remove the throttle assembly.



5. Remove the inlet cover.

- On the place where the throttle assembly is to be installed inside the inlet cover (arrow) is a bolt. Be careful not to forget to remove it.
- Peel the liquid gasket off carefully.


N6A6033E

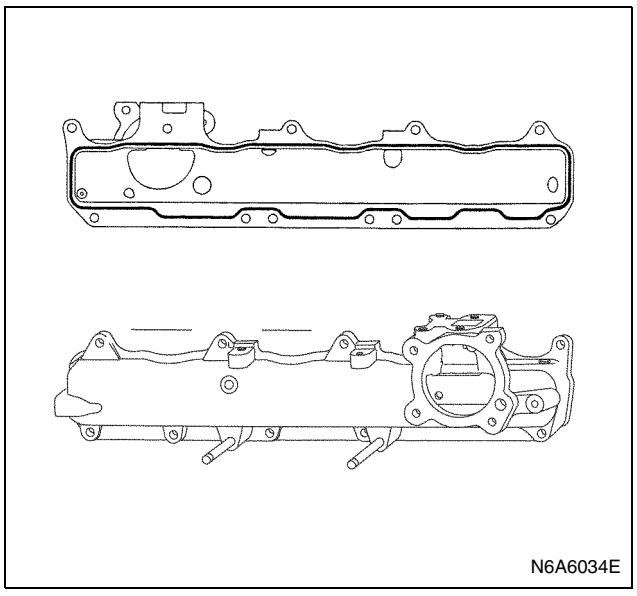
Installation

1. Install the inlet cover.
   - Apply the liquid gasket (ThreeBond 1207C or equivalent) keeping a bead diameter of 2.5–5.5 mm (0.1–0.2 in) along the groove of the inlet cover.
   - Install it within 7 minutes after applying the liquid gasket.

Tighten:
Bolt and nut to 22 N·m (2.2 kg·m/16 lb·ft)

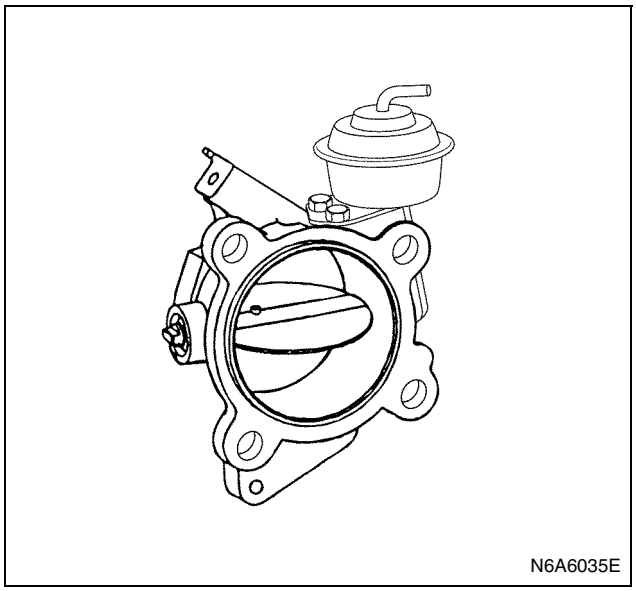
Caution:

- Be careful not to forget to fasten the bolt indicated with an arrow.
- Tighten up the stud part together with the fuel rail.


N6A6034E

2. Install the throttle assembly.
   - Apply the liquid gasket and mount within 7 minutes.

Tighten:
Bolt and nut to 24 N·m (2.4 kg·m/17 lb·ft)

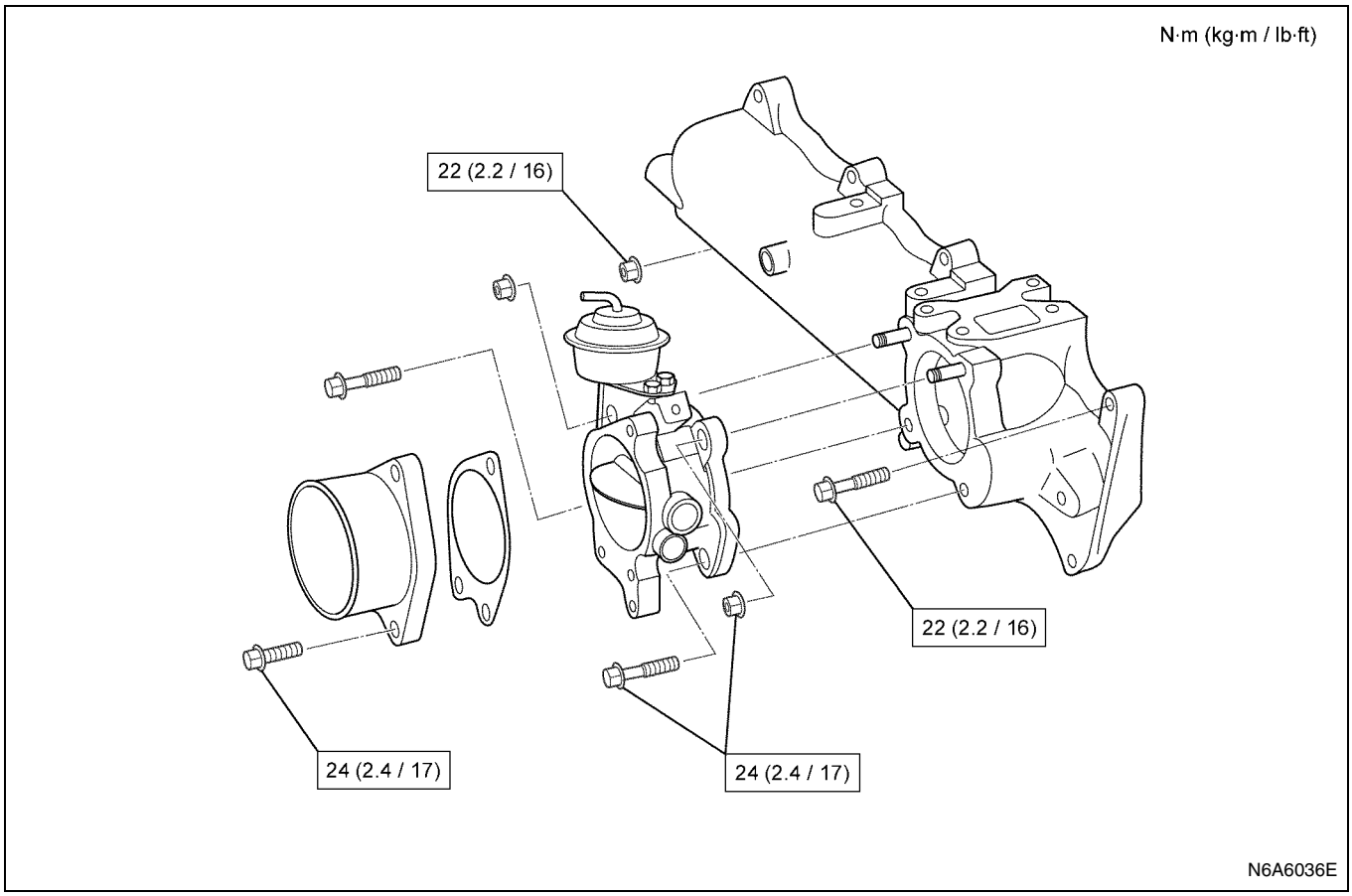

N6A6035E

3. Install the gasket on the inlet pipe and tighten up with the prescribed torque.

Tighten:
Bolt to 24 N·m (2.4 kg·m/17 lb·ft)

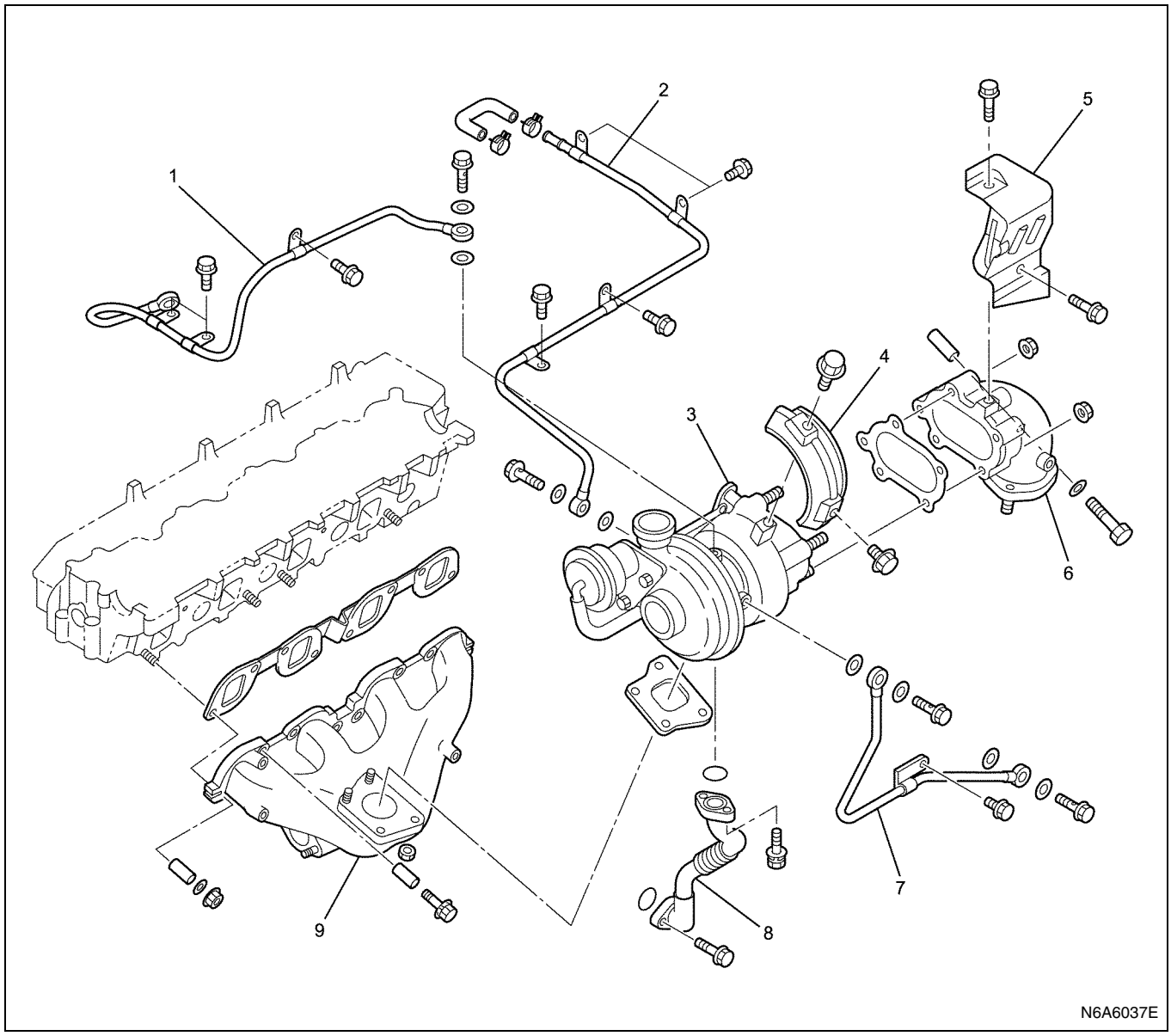
4. Install the EGR valve.
   Refer to “EGR Valve and EGR Cooler” in Section 6F.
5. Install the fuel rail.
   Refer to “Fuel Rail” in Section 6C.

Torque Specifications



Turbocharger and Exhaust Manifold

Component



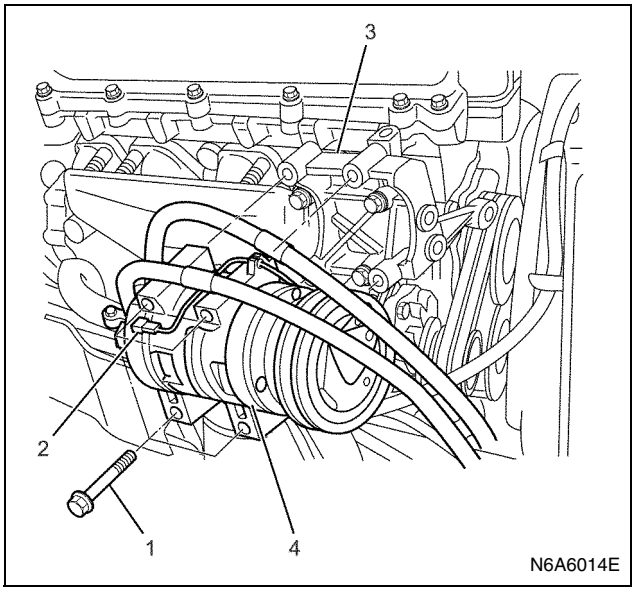
Legend

1. Oil Feed Pipe
2. Water Return Pipe
3. Turbocharger Assembly
4. Heat Protector
5. Heat Protector
6. Exhaust Adapter
7. Water Feed Pipe
8. Oil Return Pipe
9. Exhaust Manifold

Removal

1. Loosen the radiator drain cock to drain coolant.
2. Remove the air intake duct from the turbocharger and the air cleaner.
3. Remove the charge air pipe from the turbocharger and the charge air cooler.
4. Remove the front exhaust pipe.
5. Remove the EGR pipe.
6. Remove the A/C compressor harness.
7. Remove the A/C compressor bracket.

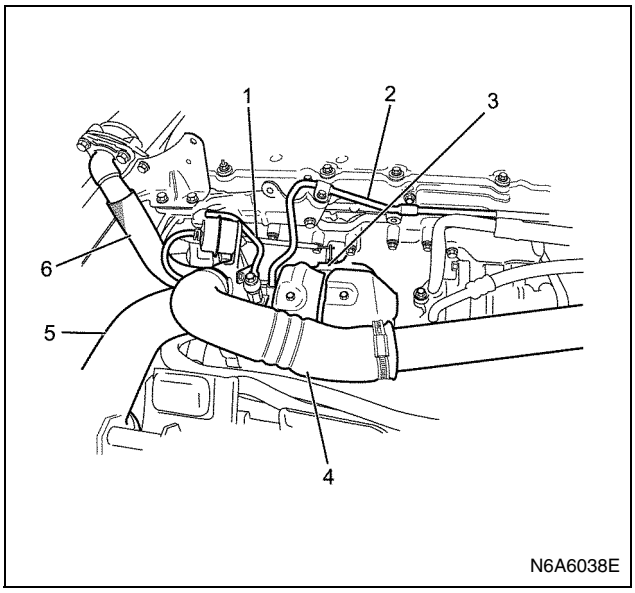
- Without disconnecting the hose of the A/C compressor, remove the compressor from the bracket and remove the compressor bracket from the cylinder head.



Legend

1. Fixing Bolt
2. A/C Compressor Harness
3. A/C Compressor Bracket
4. A/C Compressor

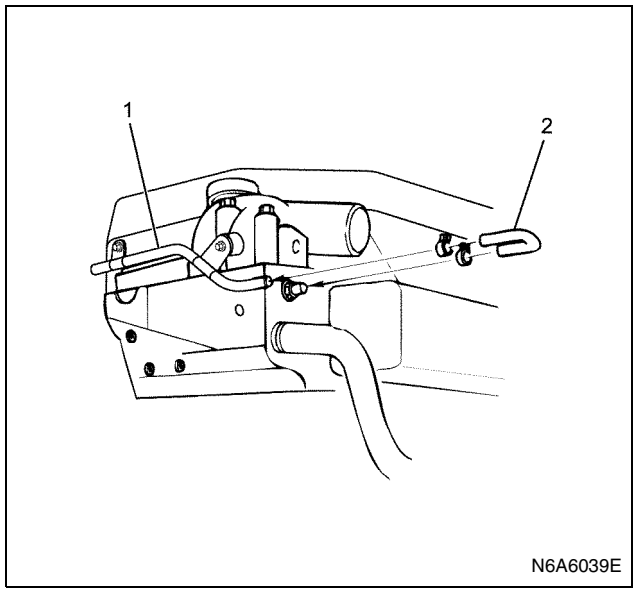
- Remove the oil feed pipe.
- Remove the oil return pipe.
- Remove the oil feed pipe.



Legend

1. Oil Feed Pipe
2. Water Return Pipe
3. Heat Protector
4. Charge Air Hose
5. Inlet Duct
6. EGR Pipe

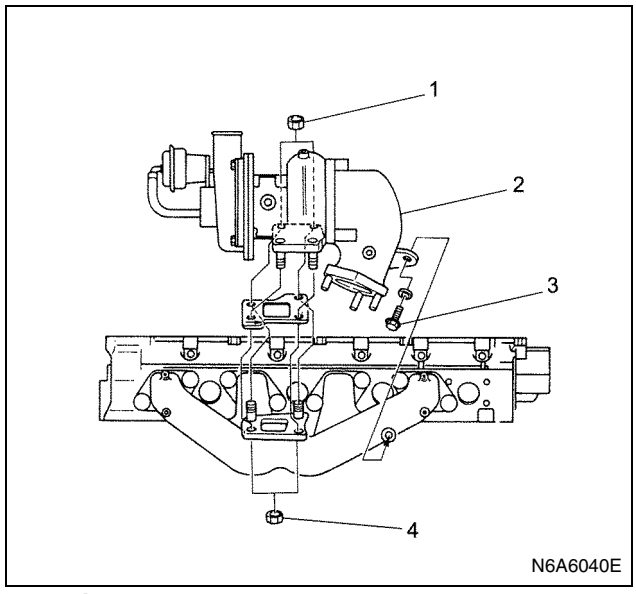
- Remove the water return pipe.



Legend

1. Water Return Pipe
2. Rubber Hose

- Remove the heat protector on the turbocharger.
- Remove the exhaust adapter bolts.
- Remove the four turbocharger clamping nuts.
- Remove the turbocharger from the exhaust manifold.



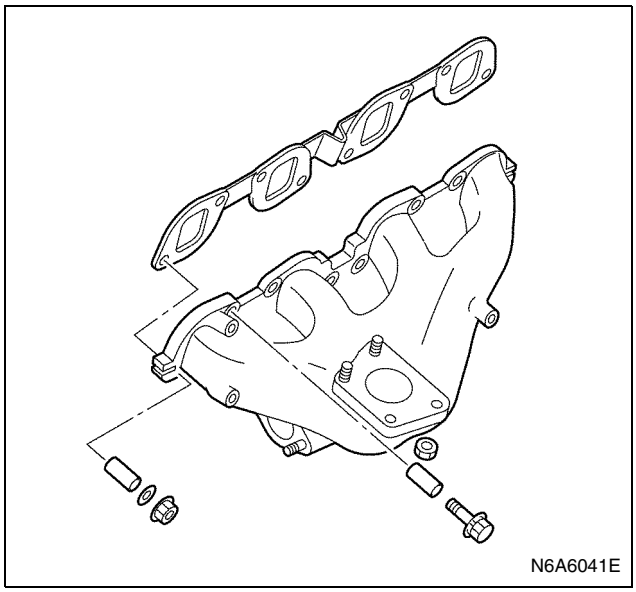
Legend

1. Fixing Nut
2. Exhaust Adapter
3. Fixing Bolt
4. Fixing Nut

---

8. Remove the exhaust manifold.

- Remove the 2 nuts and 6 bolts to remove the exhaust manifold.

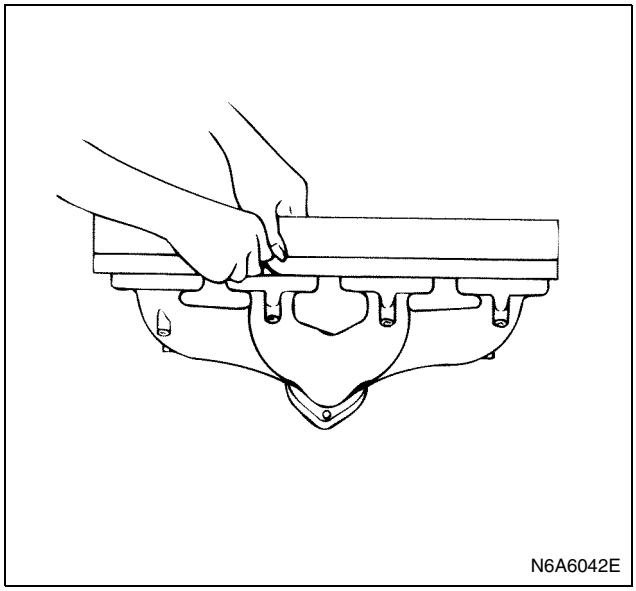

N6A6041E

Inspection

- Inspection of the exhaust manifold
  Inspect the plane surface of the plane on which the manifold and the cylinder head are to be installed.

Manifold installation plane surface	mm (in)
Standard	0.3 (0.01) or lower
Limit	0.5 (0.02)

Caution:
If the plane surface exceeds the limit, replace it.


N6A6042E

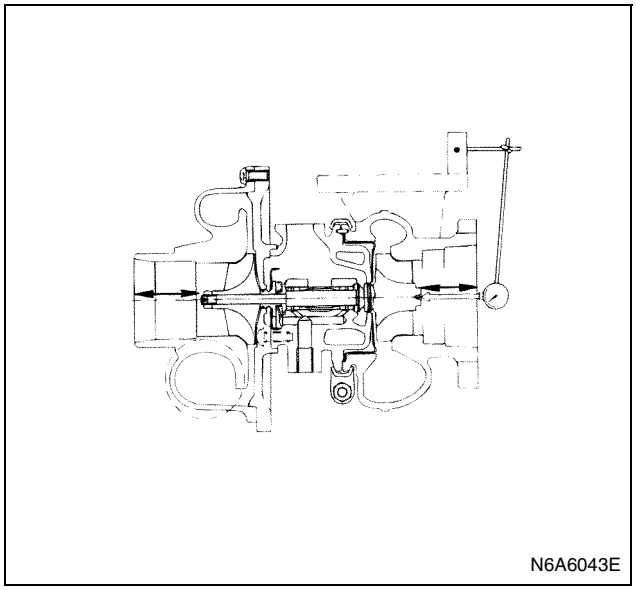
- Check a crack in the exhaust manifold visually.

Carefully inspect the turbocharger for abrasion and/or excessive wear. Make any necessary adjustments, repairs, and/or part replacements.

Wheel shaft axle play

Use a dial gauge to measure the wheel axle shaft play when a fore of 12 N (2.6 lb) is alternately applied to both sides of the compressor wheel.

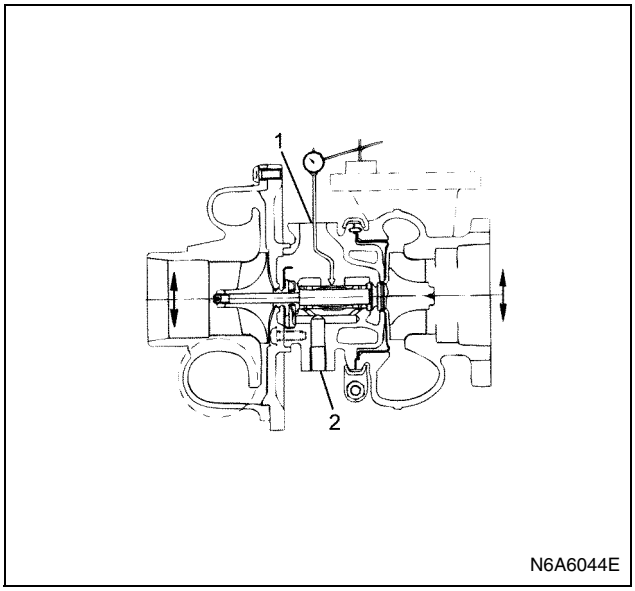
Axle play	mm (in)
Standard	0.013 – 0.097 (0.0005 – 0.0038)
Limit	0.100 (0.0039)


N6A6043E

Wheel shaft and bearing clearance

Use a dial gauge to measure the clearance between the wheel shaft and the bearing.

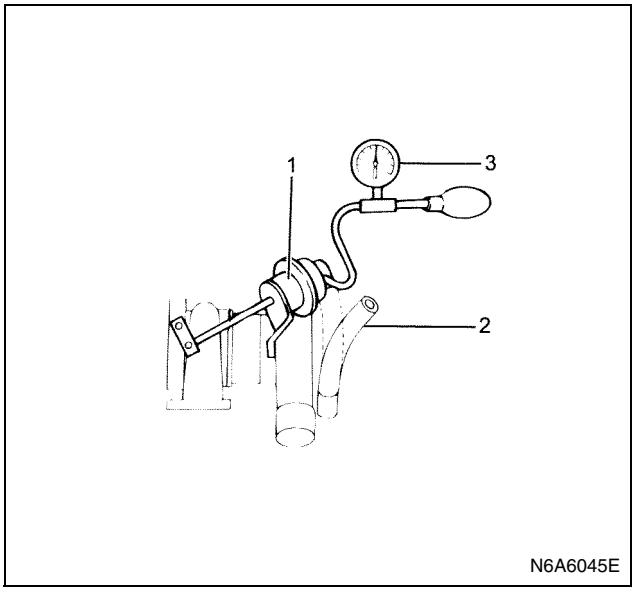
Clearance	mm (in)
Standard	0.069 – 0.140 (0.0027 – 0.0055)
Limit	0.15 (0.0059)



Legend
1. Oil Outlet
2. Oil Inlet

Waste gate operation (absolute pressure)

1. Remove the hose from the waste gate actuator.
2. Install the pressure gauge (general tool). Refer to the illustration.



Legend
1. Waste Gate Actuator
2. Waste Gate Hose
3. Pressure Gauge (General Tool)

3. Use the pressure gauge pump to apply pressure (load) to the waste gate actuator (the engine must be off).
4. Check the pressure and control rod movement.

Movement, mm (in)	0.38 (0.0150)	4.00 (0.1575)
Pressure, kPa (psi)	160 (23)	180 (26)

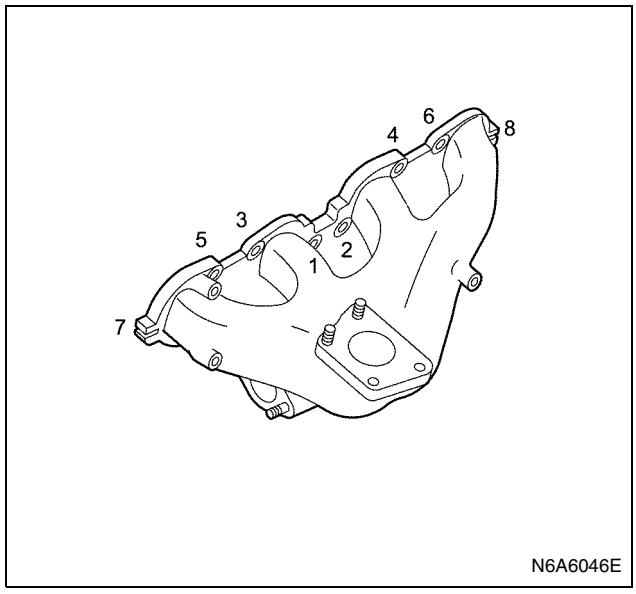
5. Inspect the hose for cracks and other damage. Replace the hose if necessary.
6. Do not apply a pressure of more than 200 kPa (1.2 kg/cm^2 / 29 psi) to the waste gate actuator.

Installation

1. Put the gasket in to install the exhaust manifold.
   - Tighten up with the 2 nuts and 6 bolts according to the order given on the figure.

Tighten:
Bolts (1), (2), (3), (4), (5), (6) and Nuts (7), (8) to 34 N·m (3.5 kg·m/25 lb·ft)

Caution:
Do not tighten up too much because it hampers expansion and contraction due to the heat from the manifold.

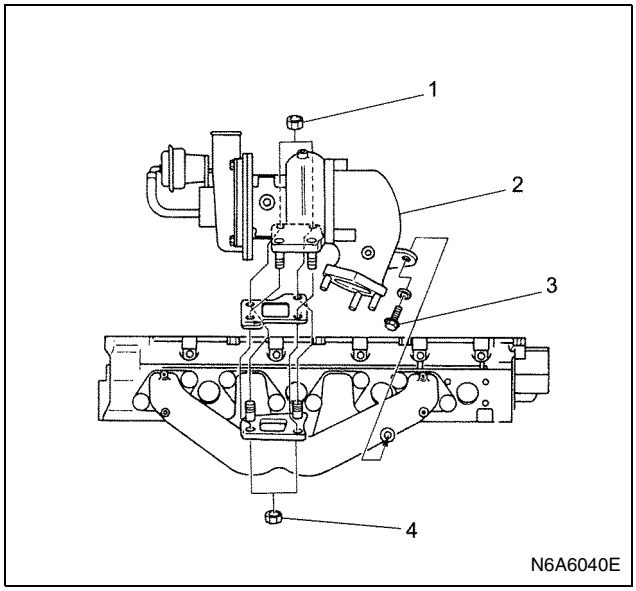


2. Install the gasket and turbocharger to the exhaust manifold. Tighten the nuts to the specified torque.

Tighten:
Nuts to 52 N·m (5.3 kg·m/38 lb·ft)

3. Tighten the adapter bolts (exhaust manifold side) to the specified torque.

Tighten:
Bolts to 25 N·m (2.5 kg·m/19 lb·ft)



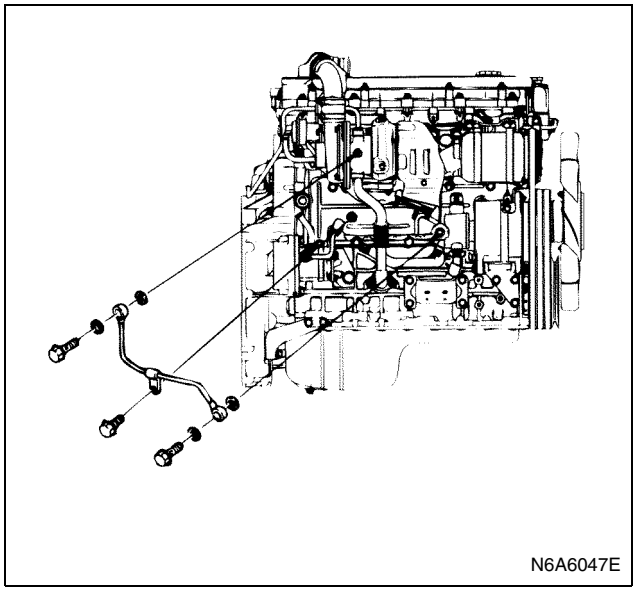
Legend
1. Fixing Nut
2. Exhaust Adapter
3. Fixing Bolt
4. Fixing Nut

4. Install the water feed pipe to the turbocharger.
   - Tighten the joint bolts to the specified torque.

Tighten:
Joint bolts to 41 N·m (4.2 kg·m/30 lb·ft)

   - Install the pipe bracket and tighten the bolts to the specified torque.

Tighten:
Bolts to 24 N·m (2.4 kg·m/17 lb·ft)



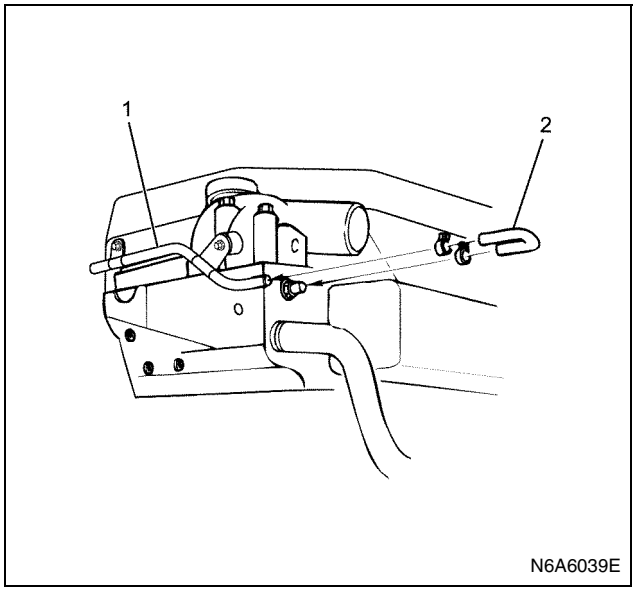
5. Install the water return pipe. Tighten the joint bolts to the specified torque.

Tighten:
Joint bolts to 41 N·m (4.2 kg·m/30 lb·ft)

6. Install the water return pipe bracket. Tighten the bolts to the specified torque.

Tighten:
Bolts to 24 N·m (2.4 kg·m/17 lb·ft)

   - Install the rubber hose between the water return pipe and the thermostat housing.



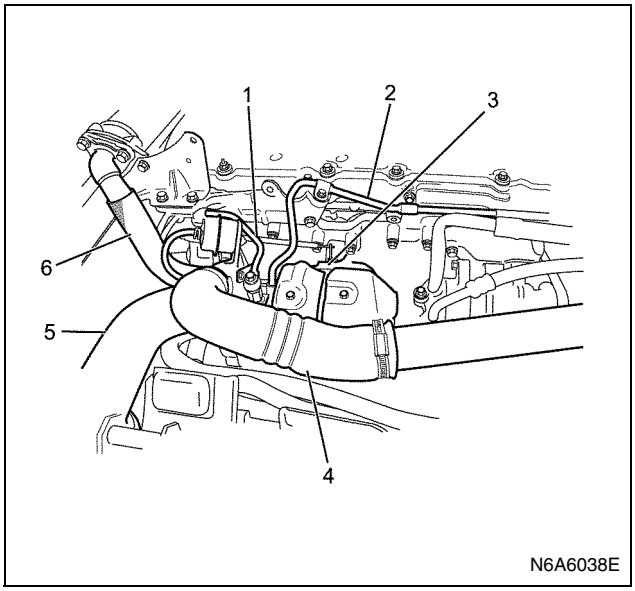
Legend
1. Water Return Pipe
2. Rubber Hose

7. Install the turbocharger oil feed pipe to the top of the turbocharger. Tighten the joint bolts to the specified torque.

Tighten:
Joint bolts to 27 N·m (2.8 kg·m/19.9 lb·ft)

   - Install the pipe bracket and tighten the bolts to the specified torque.

Tighten:
Bolts to 24 N·m (2.4 kg·m/17 lb·ft)

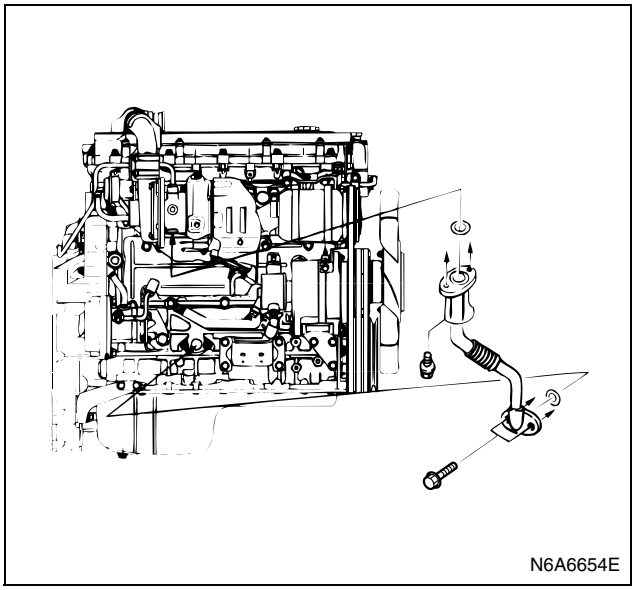


Legend

1. Oil Feed Pipe
2. Water Return Pipe
3. Heat Protector
4. Charge Air Hose
5. Inlet Duct
6. EGR Pipe

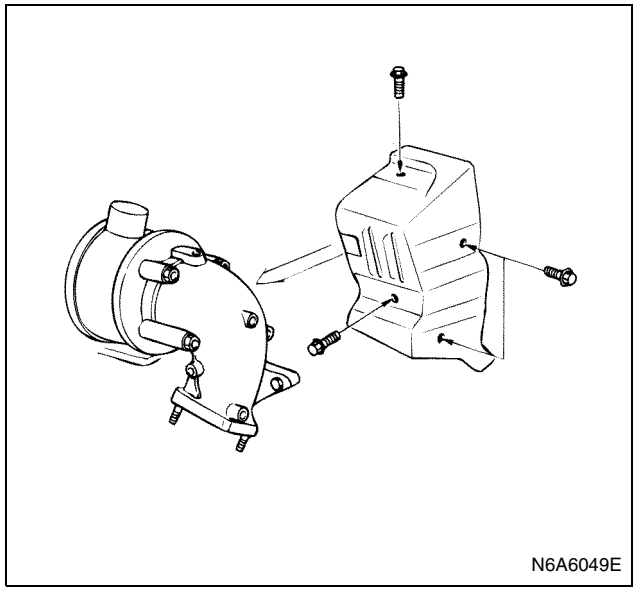
8. Tighten the oil return pipe bolts to the specified torque.

Tighten:
Bolts to
Turbocharger side: 9 N·m (0.9 kg·m/78 lb·in)
Cylinder block side: 22 N·m (2.2 kg·m/15 lb·ft)



9. Install the heat protector and tighten the bolts to the specified torque.

Tighten:
Bolts to 10 N·m (1.0 kg·m/87 lb·in)



10. Install the air intake duct and tighten the bolts to the specified torque.

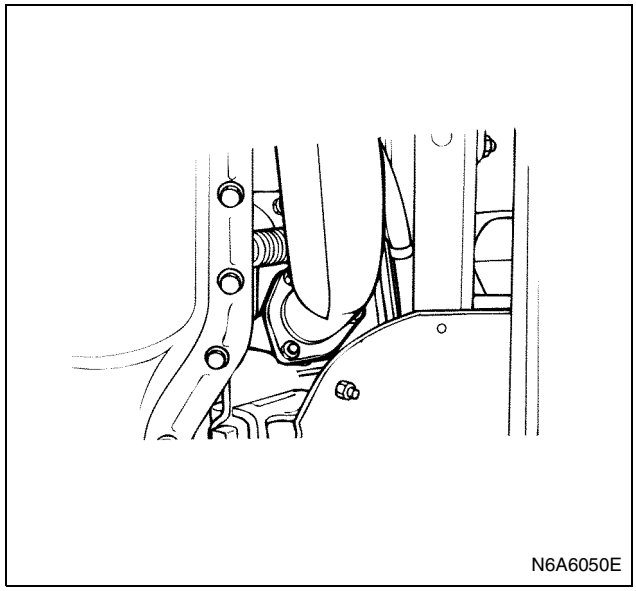
Tighten:
Bolts to 10 N·m (1.0 kg·m/87 lb·in)

11. Install the charge air pipe in the turbo charger and the charge air cooler.

Tighten:
Duct bolt to 21 N·m (2.1 kg·m/15 lb·ft)
Duct clip to 6 N·m (0.6 kg·m/52 lb·in)

12. Install the front exhaust pipe to the turbocharger and tighten the nuts to the specified torque.

Tighten:
Nuts to 67 N·m (6.8 kg·m/49 lb·ft)

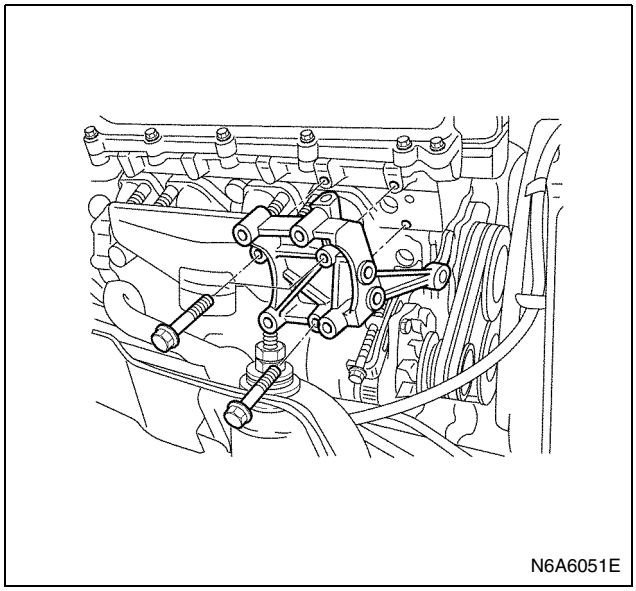


13. Add cooling water to the radiator.
14. Install the A/C compressor bracket.
    - Install the A/C compressor bracket on the cylinder head and tighten up with the prescribed toque.

Tighten:
Bolts to 48 N·m (4.9 kg·m/35 lb·ft)

- Install the A/C compressor on the bracket and tighten up with the prescribed torque.

Tighten:
Bolts to 24 N·m (2.4 kg·m/17 lb·ft)

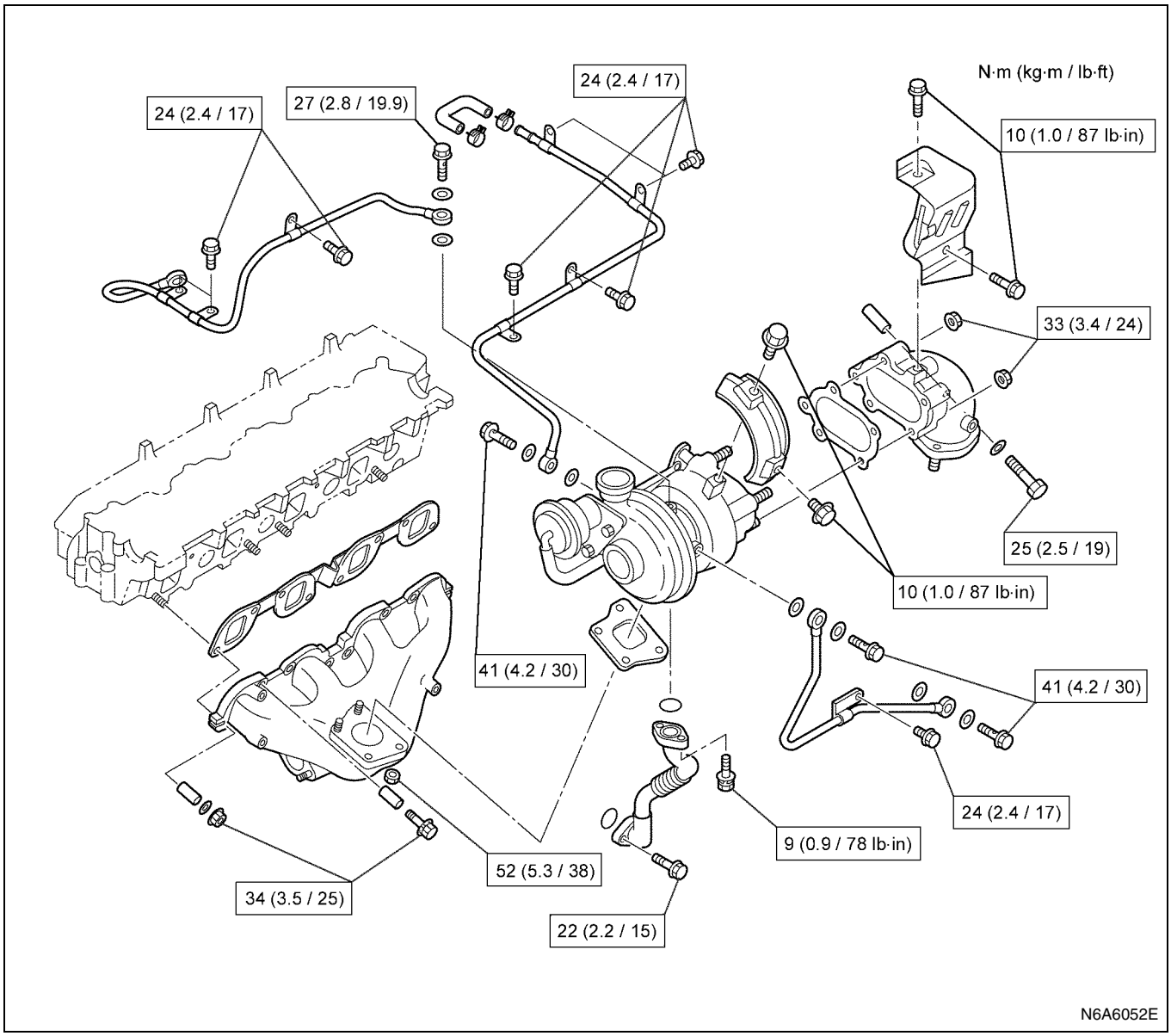


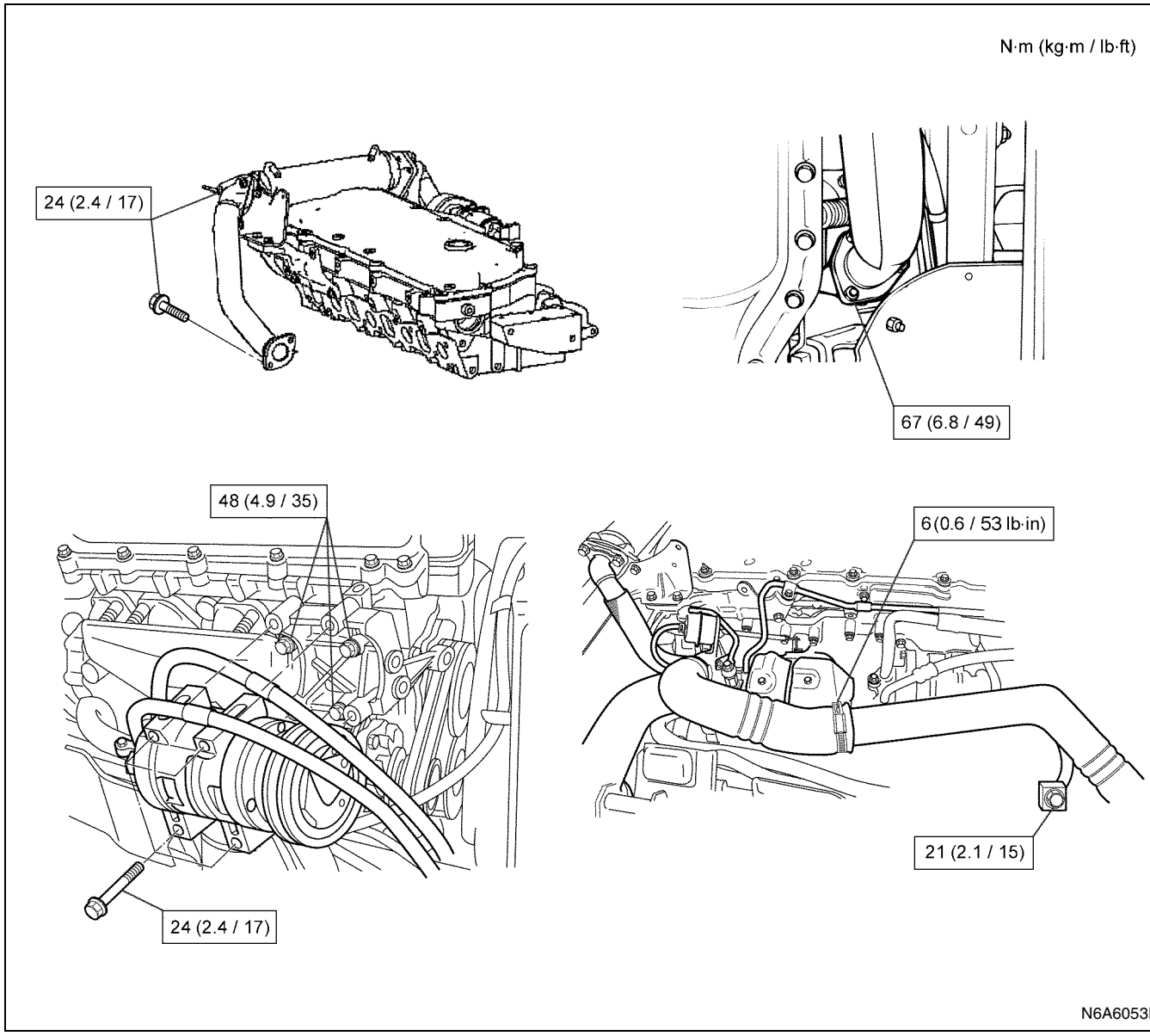
15. Install the EGR pipe.
    - Put the gasket between both ends of the EGR pipe and install to the specified torque.

Tighten:
Bolts to 24 N·m (2.4 kg·m/17 lb·ft)

16. Replenish the coolant.

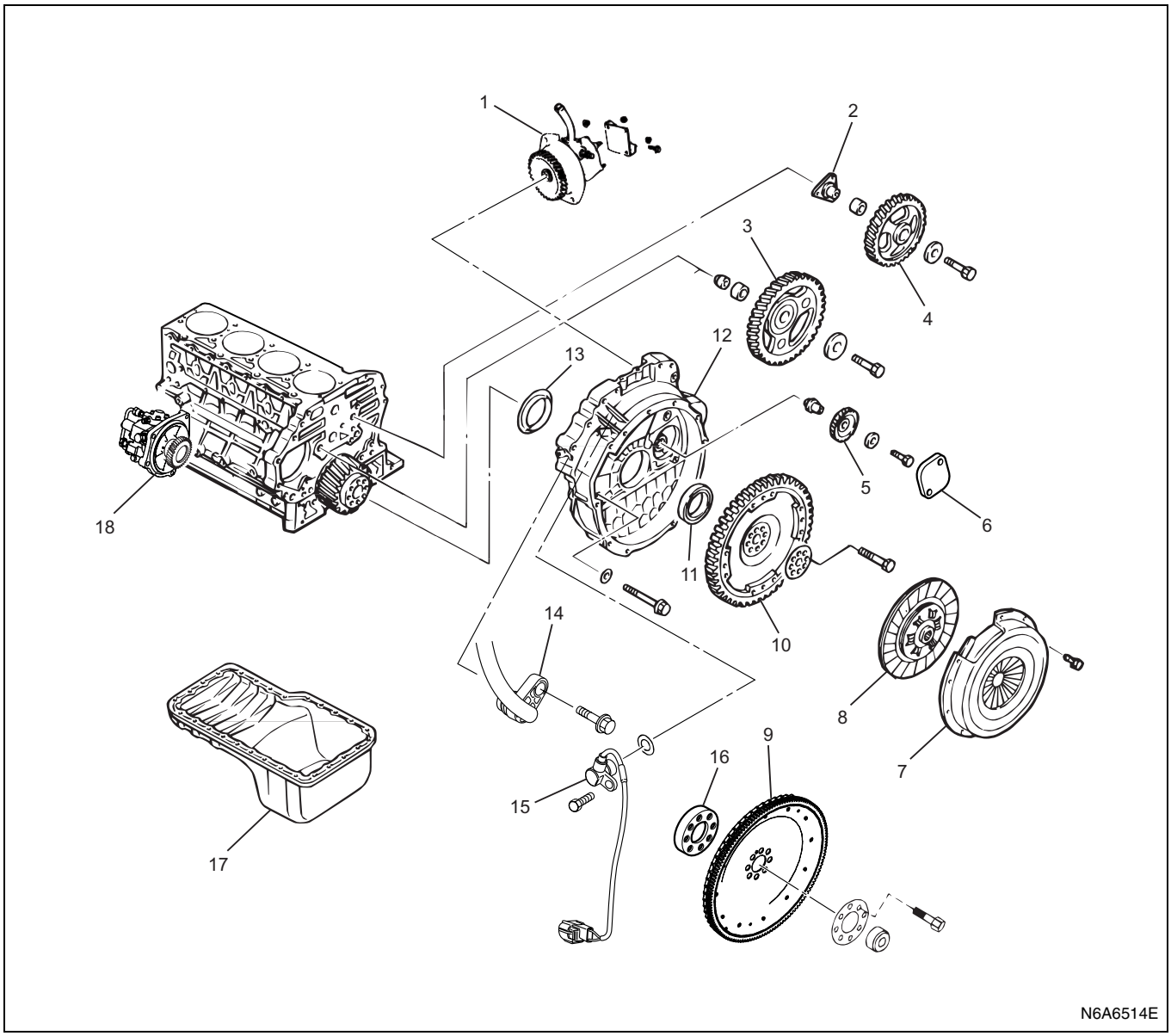
Torque Specifications




N·m (kg·m / lb·ft)
24 (2.4 / 17)
67 (6.8 / 49)
48 (4.9 / 35)
6 (0.6 / 53 lb·in)
21 (2.1 / 15)
24 (2.4 / 17)
N6A6053E

Timing Gear Train

Component



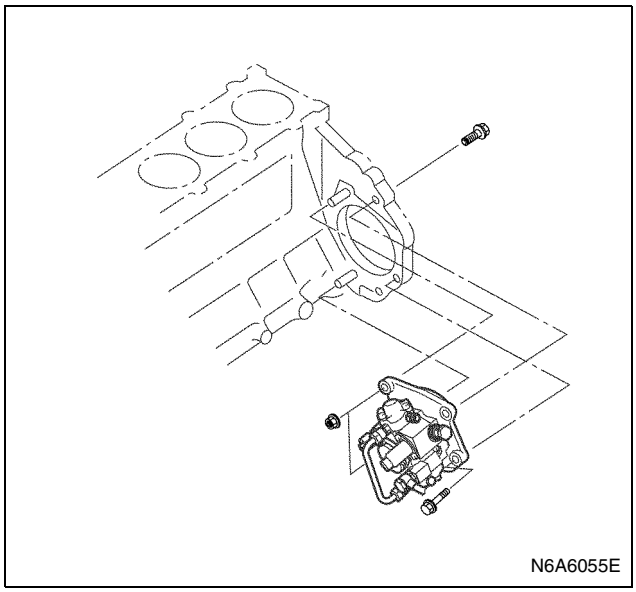
Legend

1. Power Steering Pump
2. Idle Gear B Shaft
3. Idle Gear A
4. Idle Gear B
5. Power Steering Pump Idle Gear
6. Power Steering Pump Idle Gear Cover
7. Clutch Pressure Plate
8. Driven Plate
9. Flexible Plate (Smoother)
10. Flywheel (M/T)
11. Rear Oil Seal
12. Flywheel Housing
13. Slinger
14. Plug
15. Crankshaft Position Sensor
16. Crank shaft End Spacer (Smoother)
17. Oil Pan
18. Fuel Supply Pump

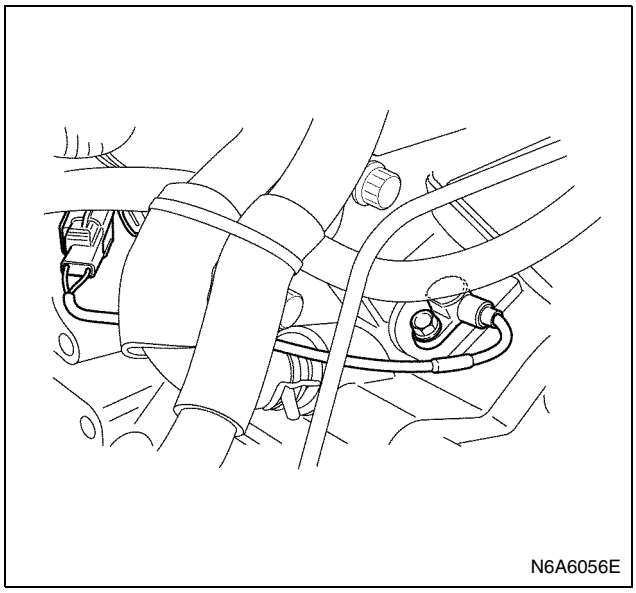
Removal

1. Remove the cylinder head cover.
   Refer to “Cylinder Head Cover”.
2. Remove the rocker arm shaft assembly.
   Refer to “Rocker Arm Shaft Assembly”.
3. Remove the camshaft assembly.
   Refer to “Camshaft Assembly”.
4. Remove the cylinder head assembly.
   Refer to “Cylinder Head”.

5. Remove the fuel supply pump assembly.
   Refer to “Fuel Supply Pump” in Section 6C.


N6A6055E

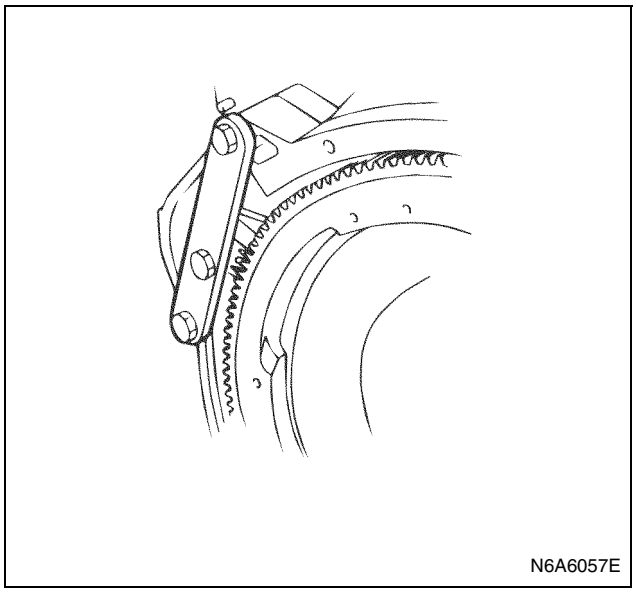
6. Remove the crankshaft position sensor.
   - Remove the crankshaft position sensor before remove flywheel.


N6A6056E

7. Remove the flywheel.
   - Install the crankshaft stopper on the starter part of the flywheel housing to stop the crankshaft from rotating.

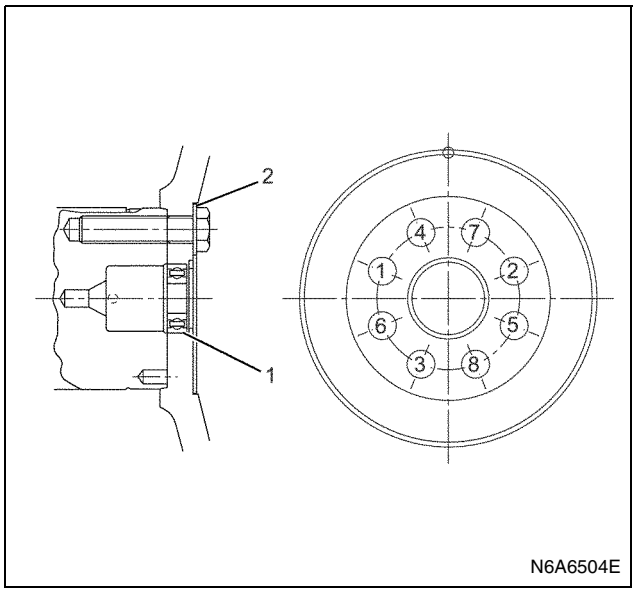
Caution:
Check if the stopper meshes with the ring gear without fail and is installed properly.

Special tool
Crankshaft stopper: 5-8840-2230-0 (EN-47680)


N6A6057E

   - Loosen the fastening bolts of the flywheel little by little according to the order given on the figure.
   - After loosening all the bolts, remove the stopper to remove the flywheel.

In the case of smoother vehicle, after loosening the bolts to fasten the flexible plate, remove the washer, the flexible plate, the spacer according to this order.

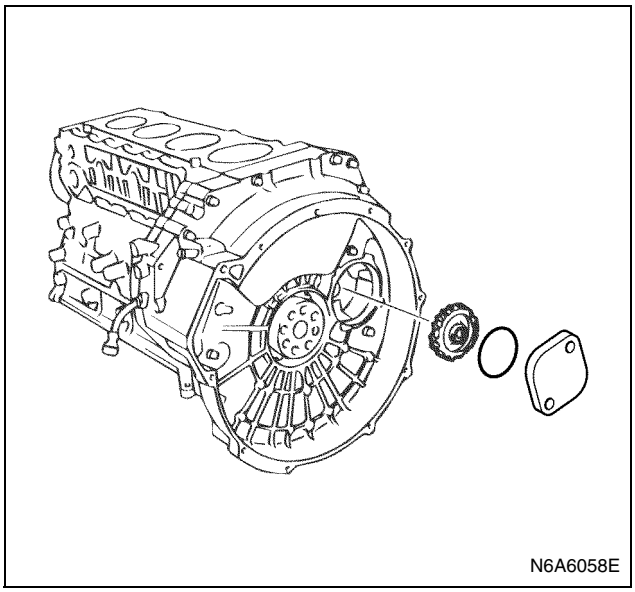


N6A6504E

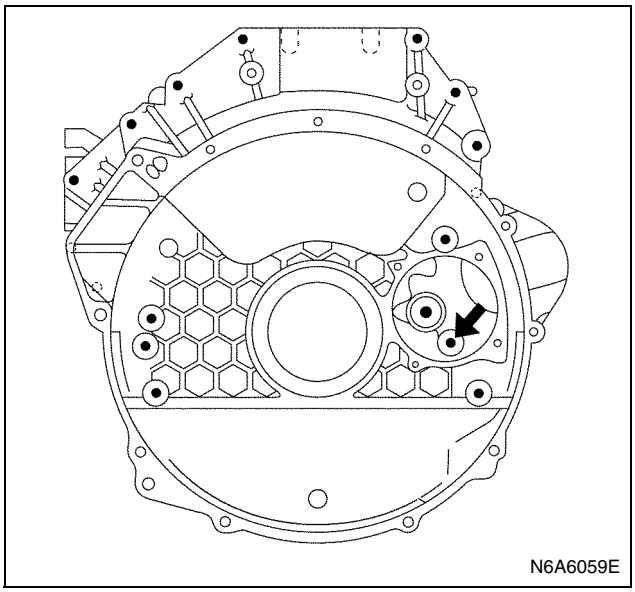
Legend
1. Pilot Bearing
2. Washer

8. Remove the rear oil seal and the slinger.
   Refer to “Crankshaft Rear Oil Seal”.
9. Remove the oil pan.
10. Remove the power steering pump.
11. Remove the power steering pump idle gear cover.

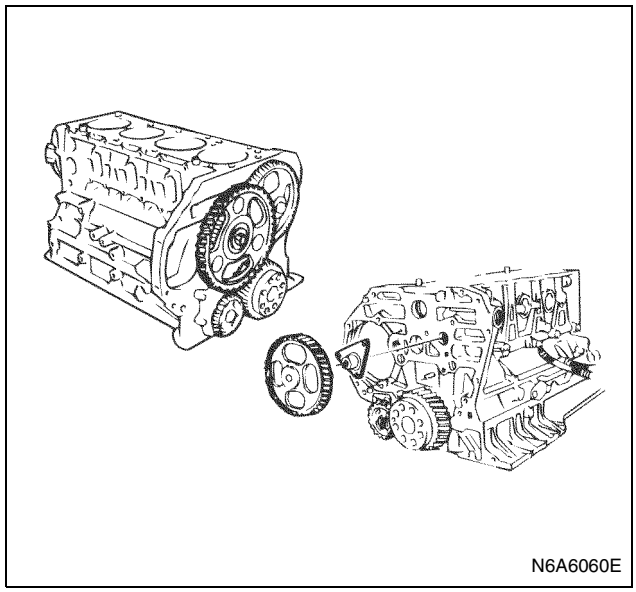
12. Remove the power steering pump idle gear.



13. Remove the flywheel housing.
    - Never fail to remove the bolt(s) given on the figure.



14. Remove the idle gear A.
15. Remove the idle gear B.
16. Remove the idle gear B shaft.

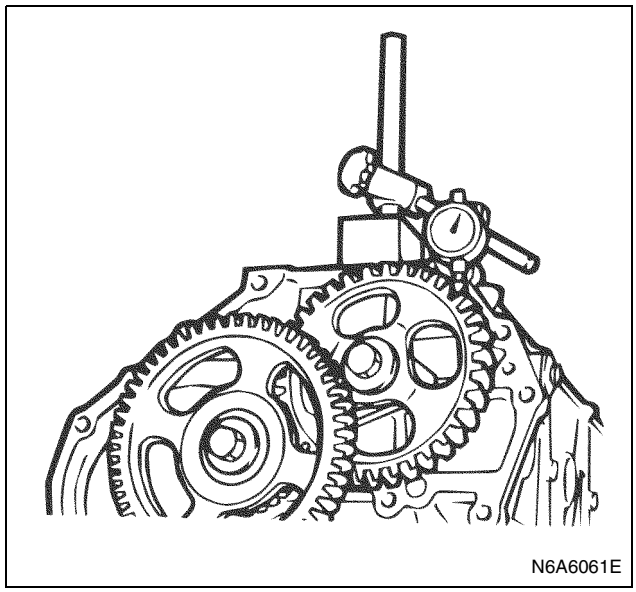


Inspection

1. Measurement of idle gear backlash
    - Apply a dial gauge on the teeth of the idle gear to be measured and move the gear to right and left lightly to read how much the dial gauge shook (never fail to fix the gear).
    - If the measurement exceeds the limit, replace the idle gear.

Backlash of the timing gear	mm(in)
Standard	0.10 – 0.17 (0.004 – 0.006)
Limit	0.30 (0.01)

    - Measure backlash of the idle gear before removing the idle gear A.

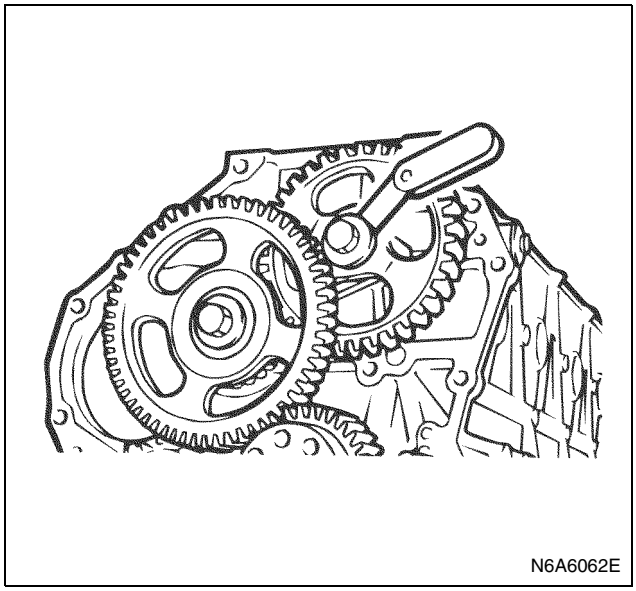


2. Measurement of end clearance of the idle gear.

- Insert a thickness gauge between the idle gear and the thrust collar to measure a clearance.
- If the measurement exceeds the limit, replace either the idle gear or the thrust collar.

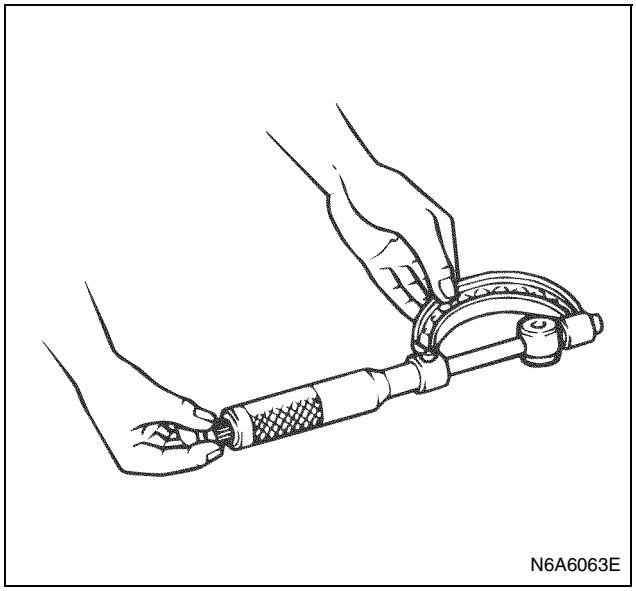
End clearance of the idle gear	mm (in)
Standard	0.080 – 0.155 (0.003 – 0.006)
Limit	0.20 (0.008)

- Measure an end clearance of the idle gear before removing the idle gear B.


N6A6062E

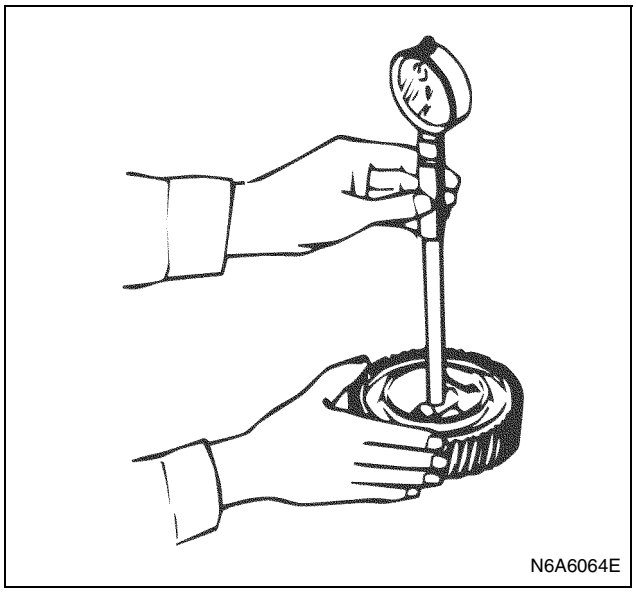
3. External diameter of the idle gear shaft
   - Use a micrometer to measure an external diameter of each idle gear shaft.
   - If the measurement exceeds the limit, replace the shaft.

External diameter of the idle gear shaft	mm (in)
Standard	29.959 – 29.980 (1.179 – 1.180)
Limit	29.80 (1.173)


N6A6063E

4. Clearance between the idle gear and the idle gear shaft
   - Measure an inside diameter of the idle gear bush to calculate a clearance between the idle gear and the idle gear shaft.
   - If the measurement exceeds the limit, replace either the idle gear or the shaft.

Clearance between the idle gear and the shaft	mm (in)
Standard	0.020 – 0.062 (0.0007 – 0.0024)
Limit	0.200 (0.0079)

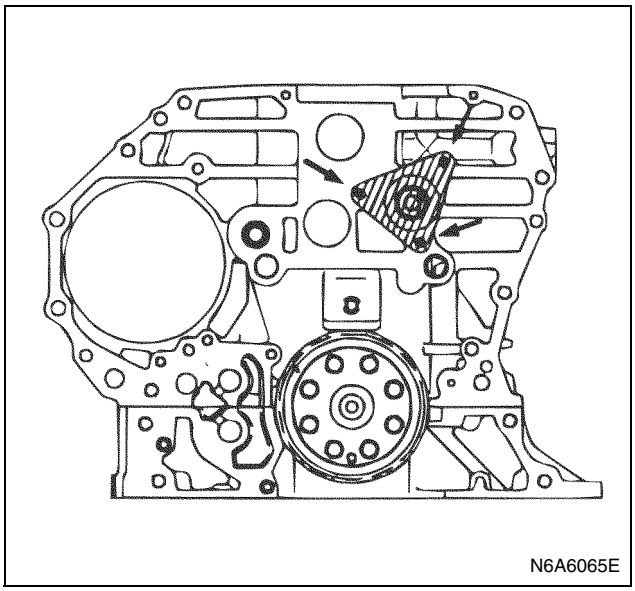

N6A6064E

Installation

1. Install the idle gear B shaft.
   - Tighten up the idle gear B shaft with the prescribed torque.

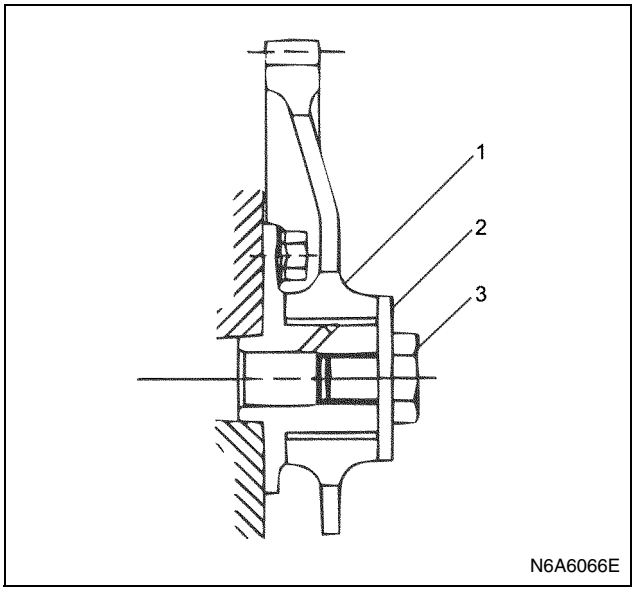
Tighten:
Bolts to 31 N·m (3.2 kg·m/23 lb·ft)

   - After installation, apply engine oil over the shaft.


N6A6065E

2. Install the idle gear B.
   - Install the idle gear B in the direction given on the figure and tighten up the fastening bolts with the prescribed torque.

Tighten:
Bolts to 110 N·m (11.2 kg·m/81 lb·ft)

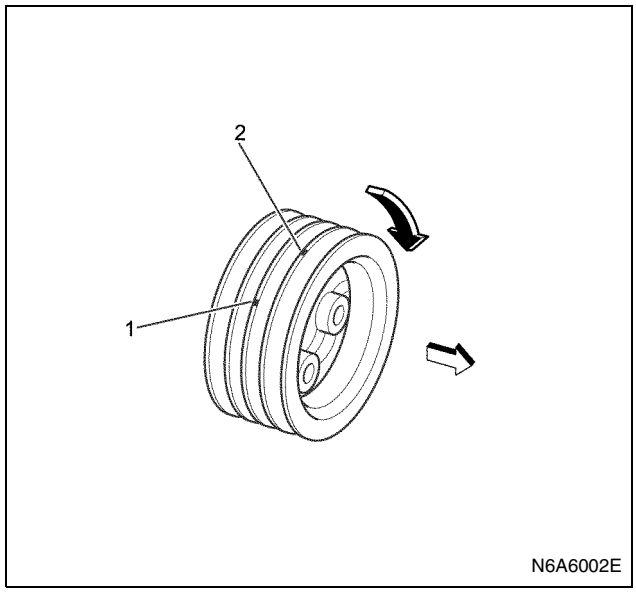


N6A6066E

Legend
1. Idle Gear
2. Thrust Collar
3. Bolt

3. Install the idle gear A.
   - Turn the crankshaft in the normal direction of engine rotation until the No. 1 or No. 4 cylinder is at TDC on the compression stroke.

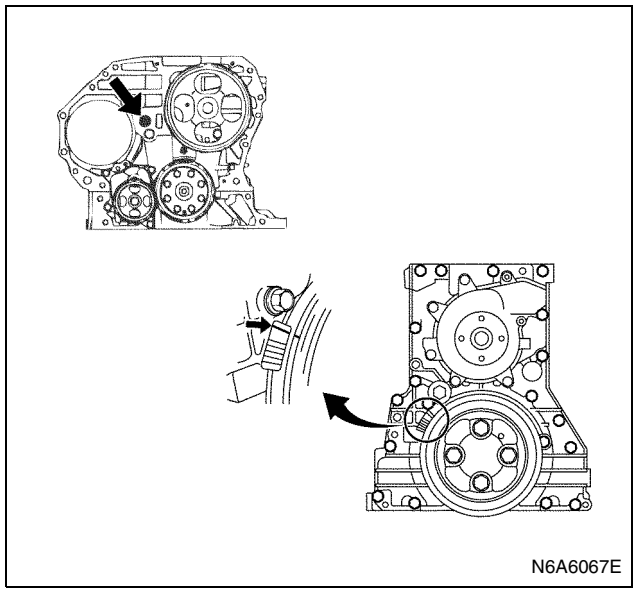
Notice:
There are 2 timing marks on the crankshaft pulley.
Mark (1) is near the front cover and is used to bring the 4HK1-TC engine to TDC.
Mark (2) is not applicable to this engine.
Be sure to use mark (1) when bringing the engine to TDC.

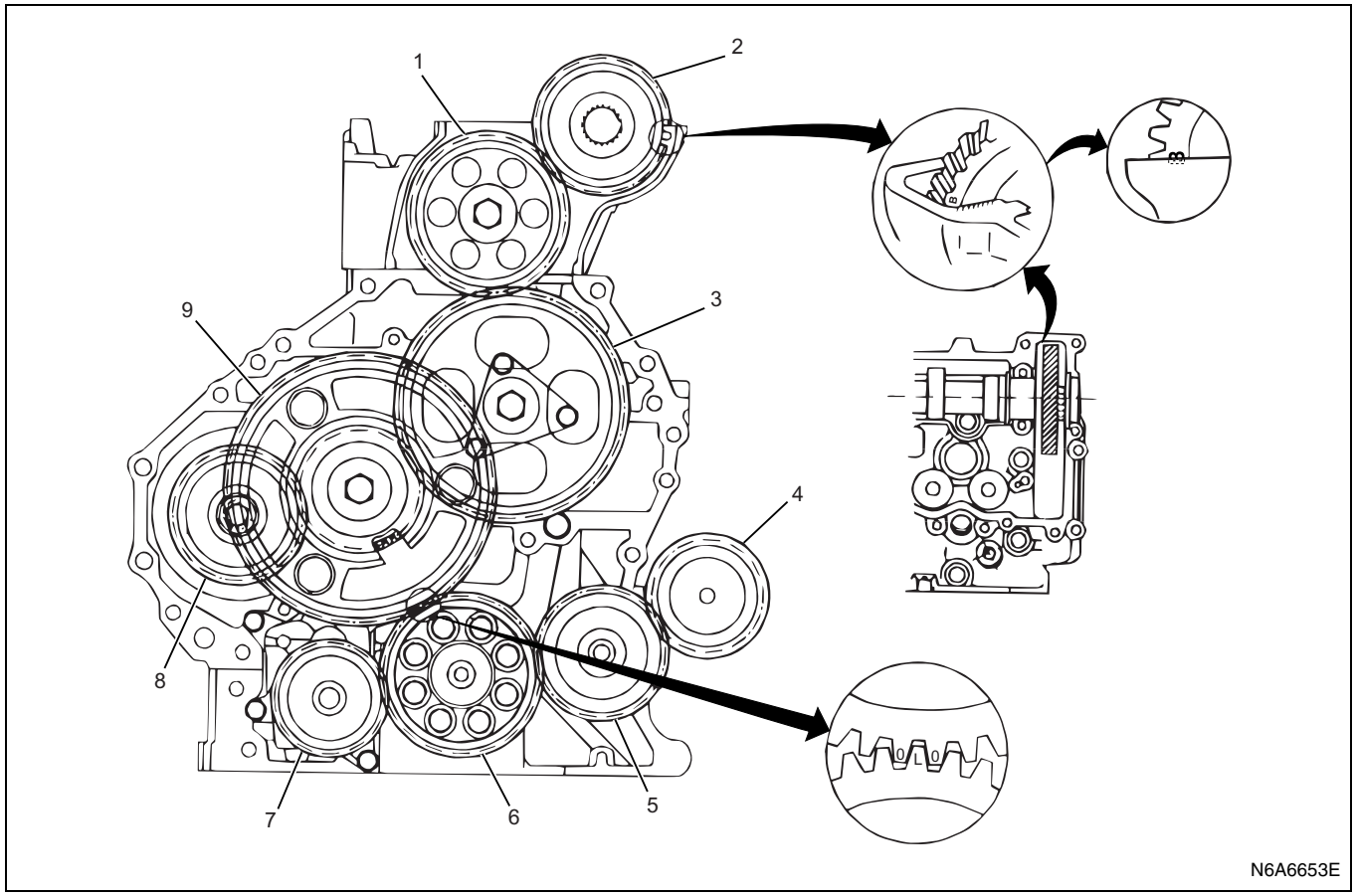


N6A6002E

   - Make the meeting marks of the crankshaft gear and the idle gear A meet and install it on the cylinder block.
   - Tighten up the fastening bolts with the prescribed torque.

Tighten:
Bolts to 133 N·m (13.6 kg·m/98 lb·ft)

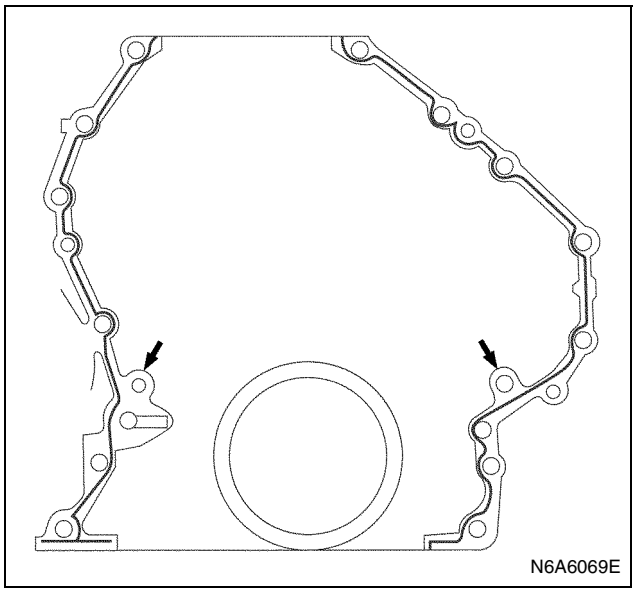

N6A6067E



Legend

1. Idle Gear C
2. Camshaft Gear
3. Idle Gear B
4. Power Steering Pump Gear
5. Power Steering Pump Idle Gear
6. Crankshaft Gear
7. Oil pump Drive Gear
8. Fuel Supply Pump Gear
9. Idle Gear A

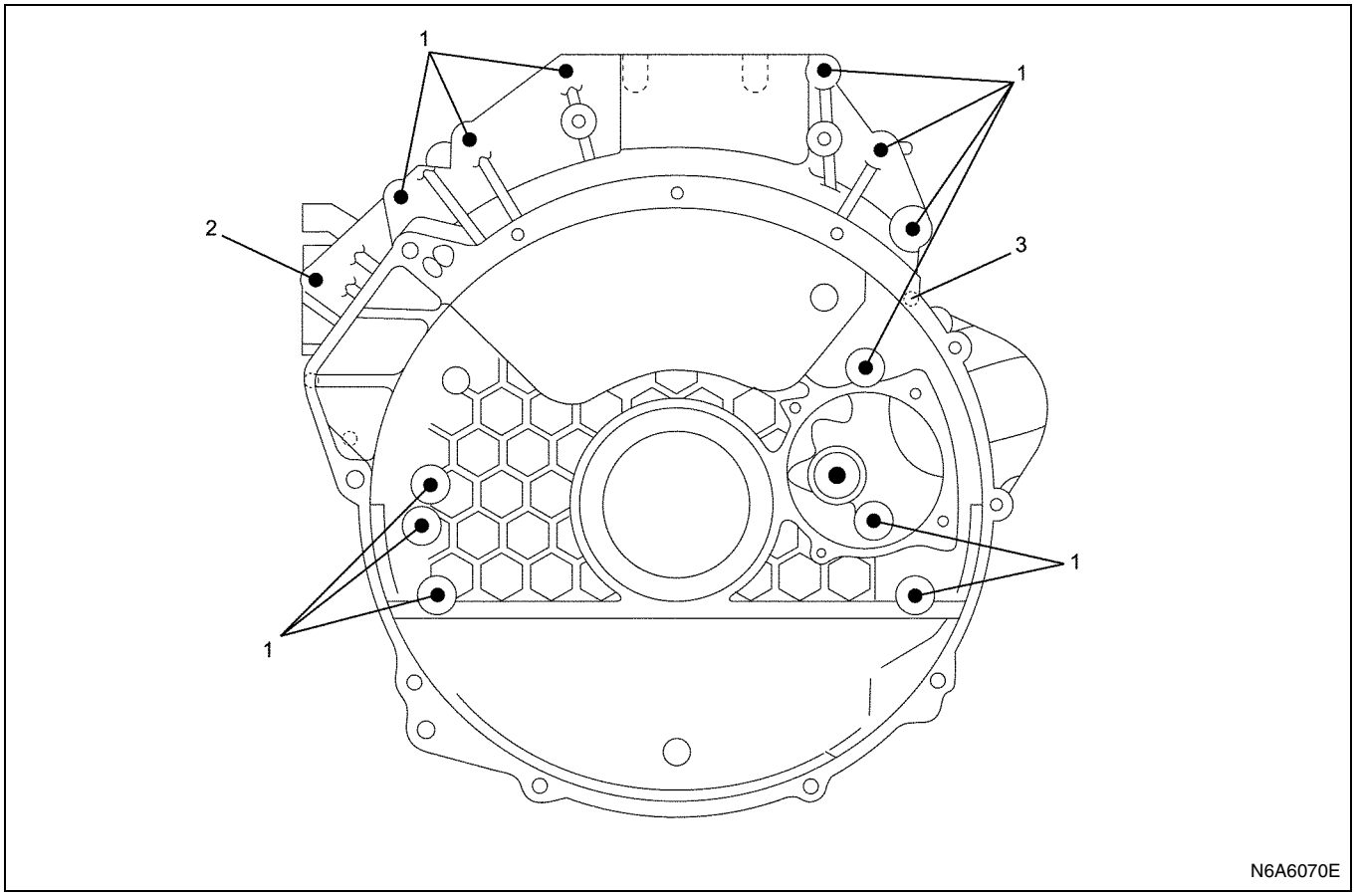
4. Install the flywheel housing.
   - Clean the rear side of the cylinder block. In particular, remove overflow liquid gasket thoroughly when the crankcase is installed.
   - As the figure shows, apply the liquid gasket (ThreeBond 1207C or equivalent) inside a hole of the bolt (except the bolt holes indicated with an arrow) evenly.



   - Along with the dowel pin of the cylinder block, install the flywheel housing.

Tighten:
Bolts (1) to 96 N·m (9.8 kg·m/71 lb·ft)
Bolts (2) to 77 N·m (7.9 kg·m/57 lb·ft)
Bolts (3) to 38 N·m (3.9 kg·m/28 lb·ft)

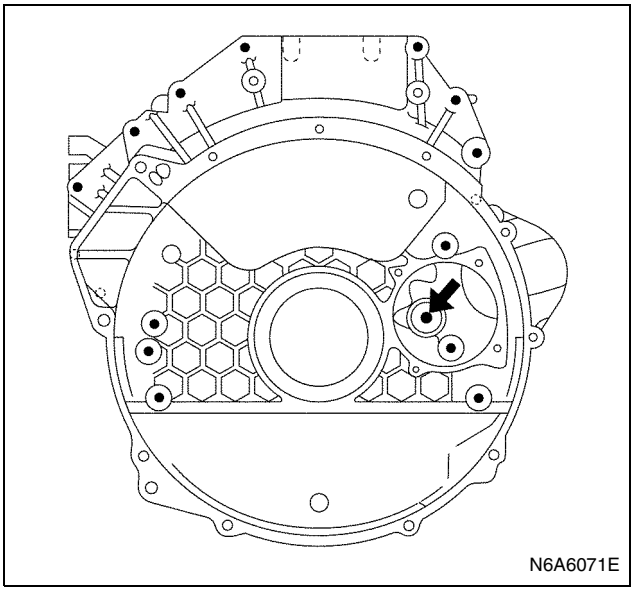
- Tighten up the Mark 3 from the cylinder block side.

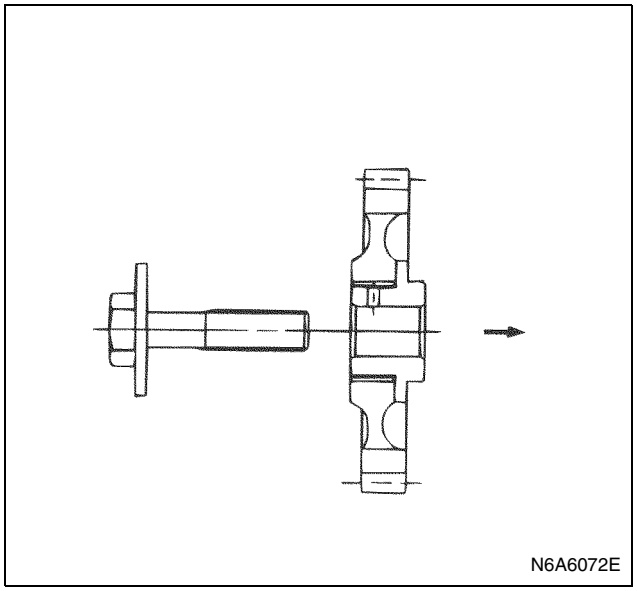


N6A6070E

5. Install the power steering pump idle gear.
   - Apply engine oil over the part where the gear of the idle gear shaft is to be put together.
   - Put the idle gear and the shaft together and install it on the location given on the figure and tighten up with the prescribed torque.

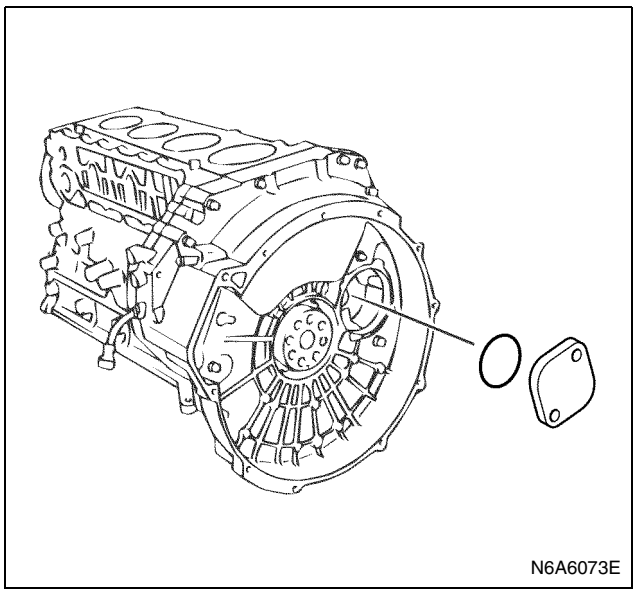
Tighten:
Bolts to 133 N·m (13.6 kg·m/98 lb·ft)


N6A6071E


N6A6072E

6. Install the power steering pump idle gear cover.
   - Install the O-ring on the cover and install it on the flywheel housing and tighten up the tightening bolts with the prescribed torque.

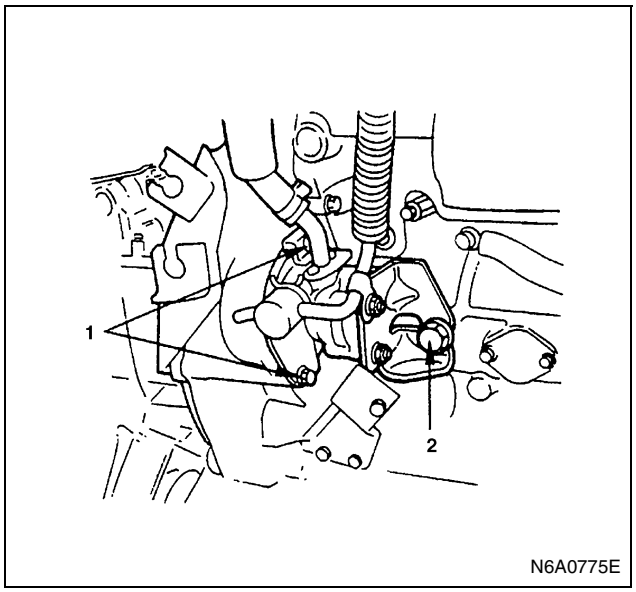
Tighten:
Bolts to 19 N·m (1.9 kg·m/14 lb·ft)


N6A6073E

7. Install the power steering pump.
   - Install the power steering pump and tighten up with the prescribed torque.

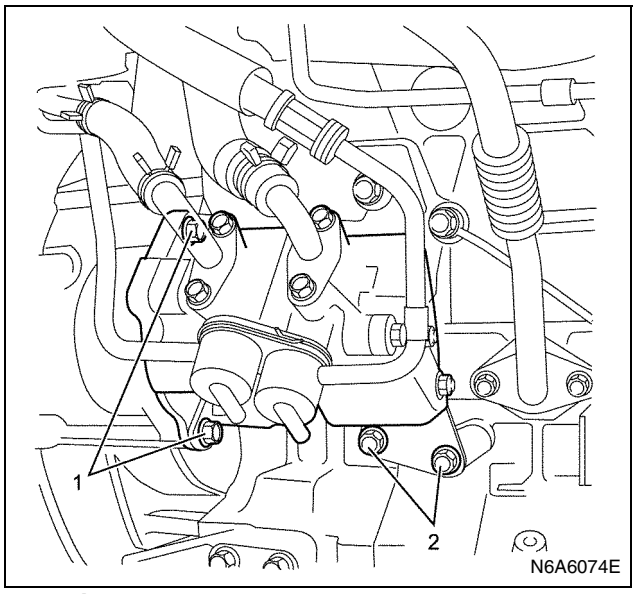
Tighten:
Fixing bolts to
Flywheel housing side (1): 43 N·m (4.4 kg·m/32 lb·ft)
Cylinder block side (2): 44 N·m (4.5 kg·m/32 lb·ft)

Without HBB



N6A0775E

With HBB

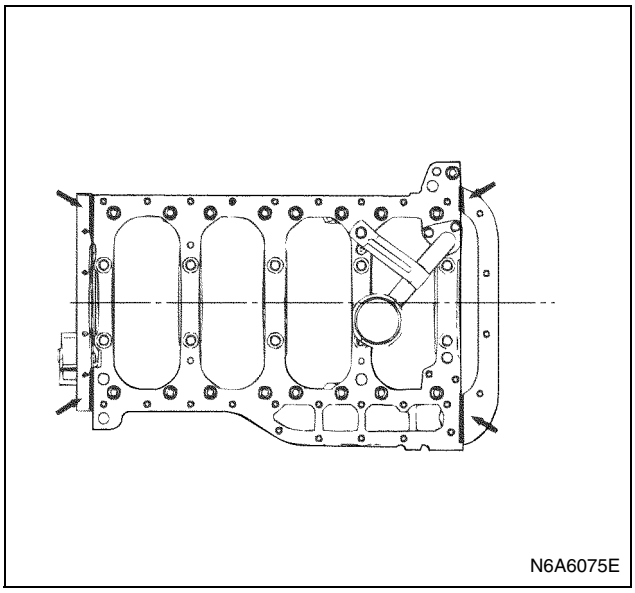


N6A6074E

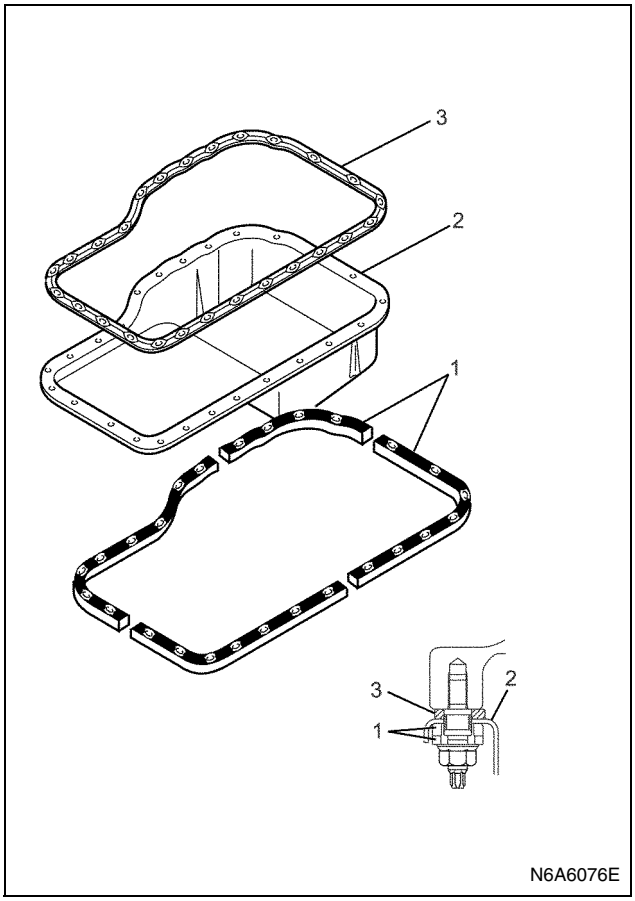
Legend
1. Flywheel Housing Fixing Bolt
2. Cylinder Block Fixing Bolt

8. Install the oil pan
   - Apply the liquid gasket (ThreeBond1207C or equivalent) on a joint between the cylinder block, the front cover and the flywheel housing with a beat diameter of 3 mm (0.1 in).

- Install the oil pan within 7 minutes after applying the liquid gasket.


N6A6075E

- With the flywheel housing, the front cover and the stud of the crankcase as a guide, put together the gasket and put the oil pan on it. Then, put the rubber assembly on the oil pan and fix it by fastening bolts and nuts.

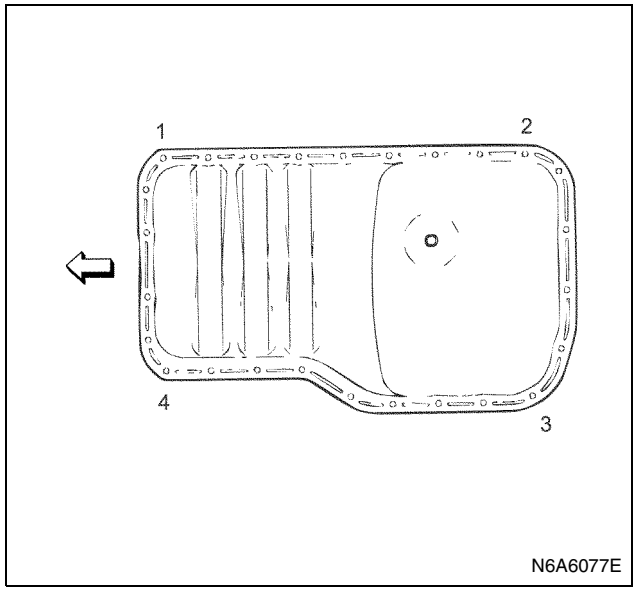


N6A6076E

Legend
1. Rubber Assembly
2. Oil Pan
3. Gasket

- After fastening the oil pan at the respective points of (1), (2), (3), and (4), fasten other parts.

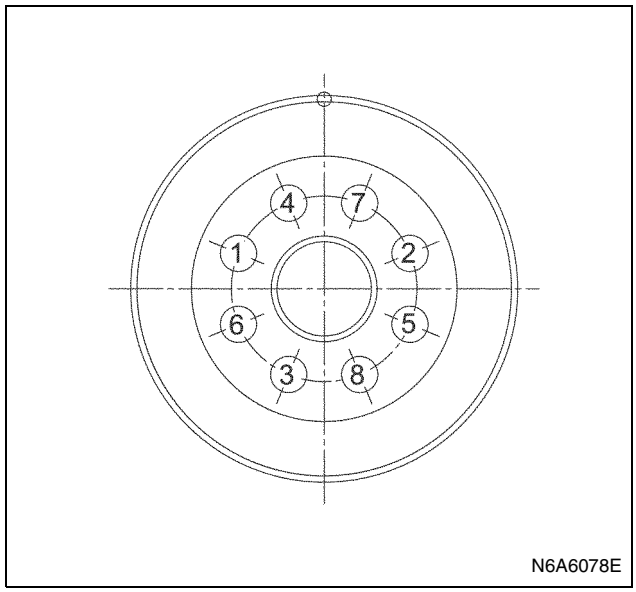
Tighten:
Bolts and nuts to 11 N·m (1.1 kg·m/95 lb·in)



N6A6077E

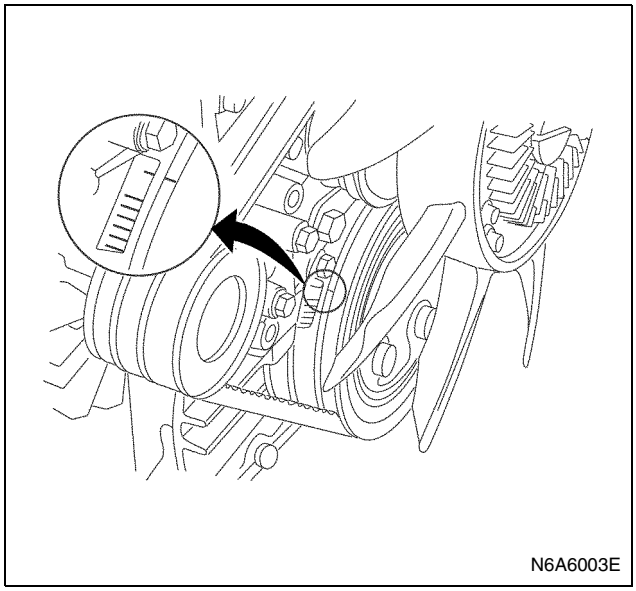
9. Install the rear slinger and the oil seal. Refer to “Crankshaft Rear Oil Seal”.
10. Install the flywheel.
    - Along with the knock pin of the crankshaft, install the flywheel and tighten up with the prescribed torque according to the order given on the figure.

Tighten:
Bolts to
1st step: 78 N·m (8.0 kg·m/57 lb·ft)
2nd step: 120° – 150° (degrees)

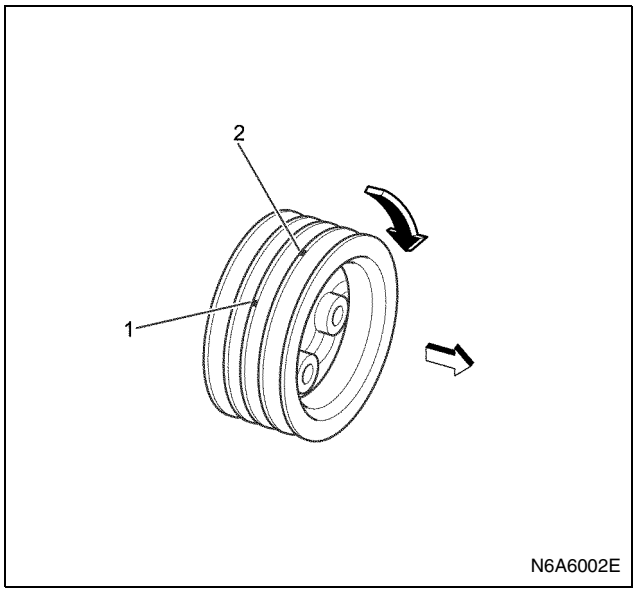


N6A6078E

11. Turn the crankshaft in the normal direction of engine rotation until the No. 1 or No. 4 cylinder is at TDC on the compression stroke.
    Refer to illustration.


N6A6003E

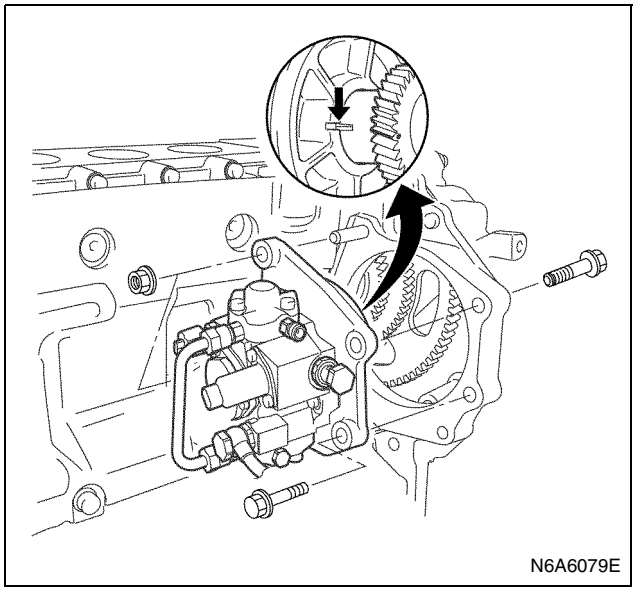
Notice:
There are 2 timing marks on the crankshaft pulley.
Mark (1) is near the front cover and is used to bring the 4HK1-TC engine to TDC.
Mark (2) is not applicable to this engine.
Be sure to use mark (1) when bringing the engine to TDC.



N6A6002E

12. Remove the oil drain adapter.
13. Install the O-ring on the fuel supply pump.
14. Align the slits as shown in the illustration.
15. Insert the stud bolts into the guides and temporarily tighten them.

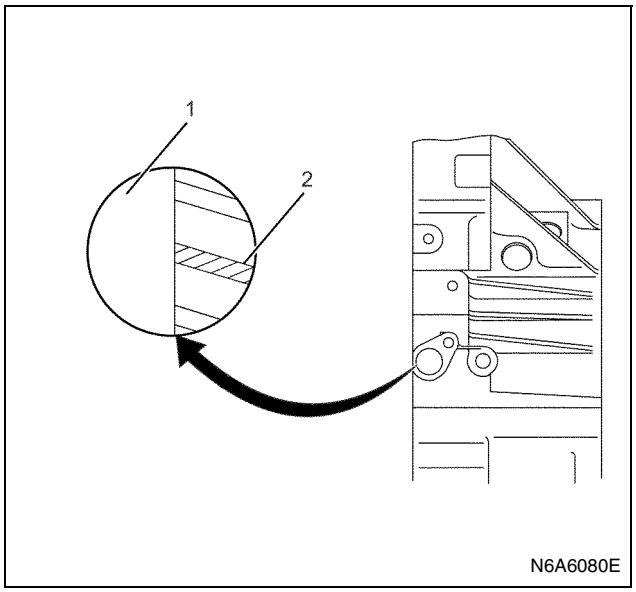
Caution:
- If the stud bolts (cylinder block side) have been loosened or replaced, apply Loctite No. 262 to the recessed portion of the bolts.


N6A6079E

- Check if the meeting mark of the gear painted white is at the location given on the figure when viewed from the plug hole and tighten up with the prescribed torque.

Tighten:
Nut to 50 N·m (5.1 kg·m/36 lb·ft)
Bolt to 76 N·m (7.7 kg·m/56 lb·ft)

- If the location of the teeth of the painted gear is not in the right place, put it together all over again.



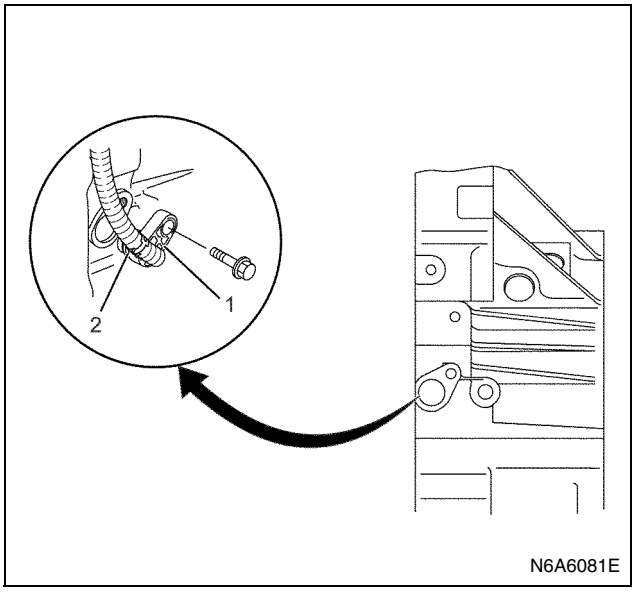
N6A6080E

Legend
1. Plug Hole
2. Meeting Mark

16. Install the adapter assembly: oil drain on the plug hole and tighten up with the prescribed torque.

Tighten:
Bolt to 8 N·m (0.8 kg·m/69 lb·in)

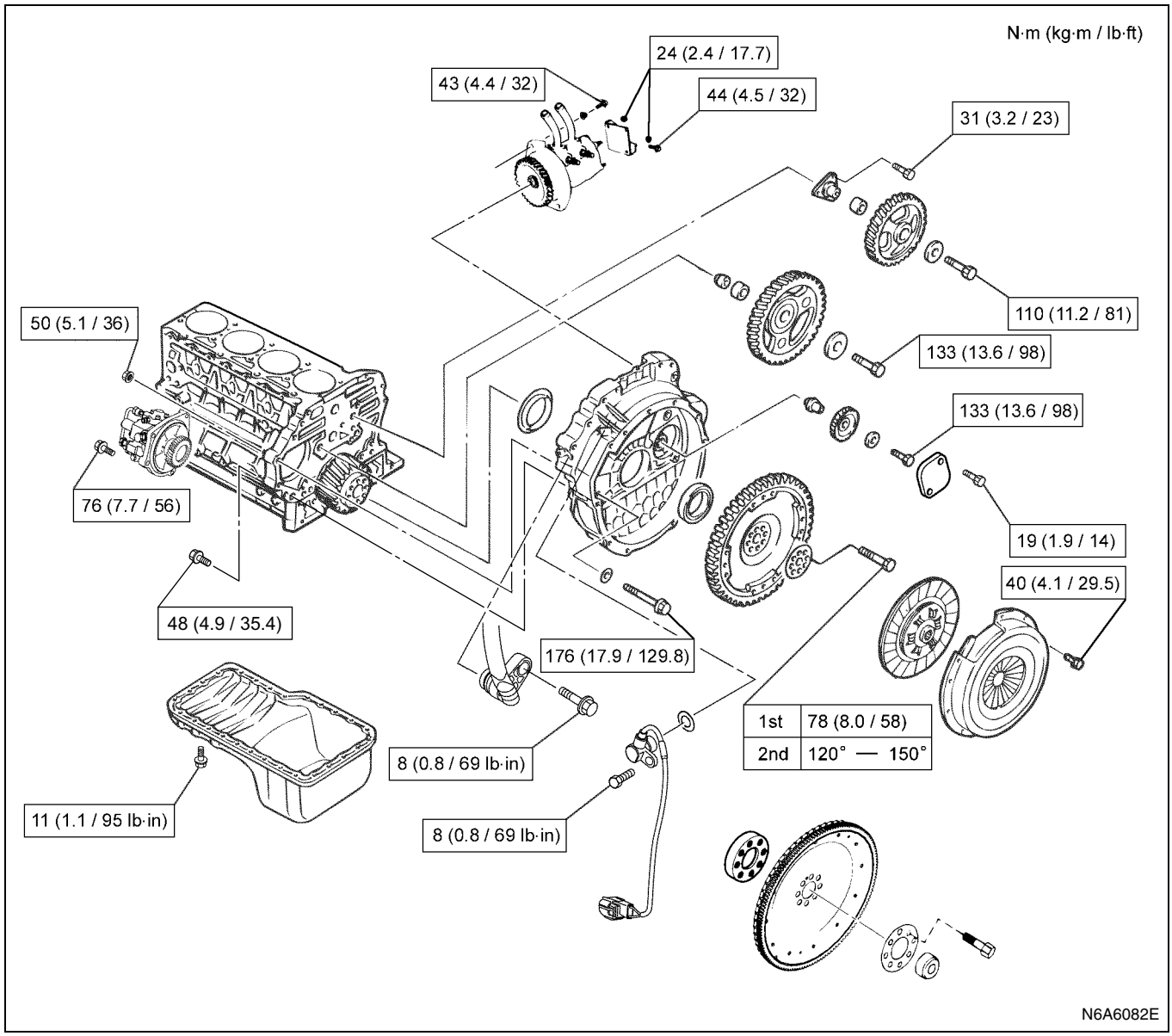
- Apply engine oil over the O-ring nice and thin and install it.



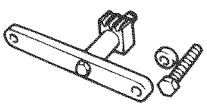
Legend
1. Adapter
2. O-ring

17. Install the cylinder head assembly.
    Refer to “Cylinder Head”.
18. Install the camshaft assembly.
    Refer to “Camshaft Assembly”.
19. Install the rocker arm shaft assembly.
    Refer to “Rocker Arm Shaft Assembly”.
20. Install the cylinder head cover.
    Refer to “Cylinder Head Cover”.

Torque Specifications

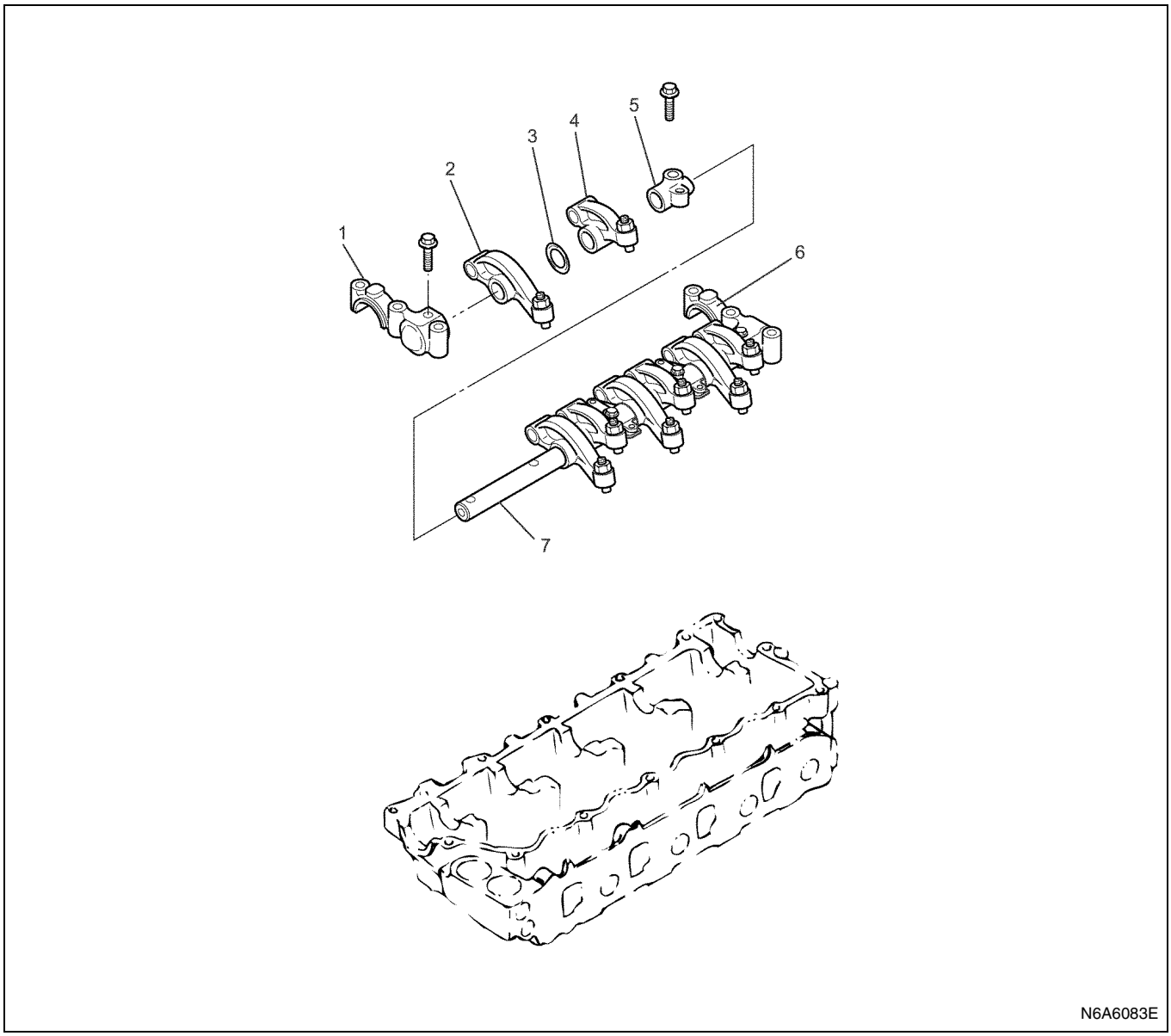


Special Tool

Illustration	Tool Number / Description / Remarks
 5884022300	5-8840-2230-0 (EN-47680) Crankshaft Stopper

Rocker Arm Shaft Assembly

Component



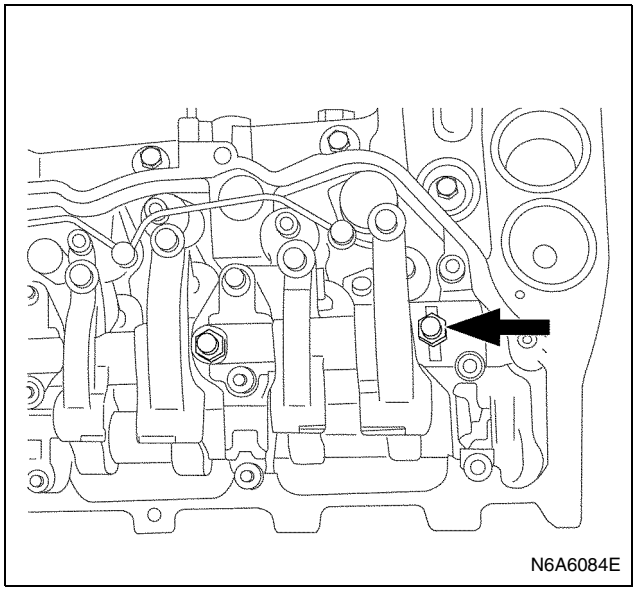
Legend

1. Camshaft Bracket
2. Rocker Arm
3. Wave Washer
4. Rocker Arm
5. Rocker Arm Bracket
6. Camshaft Bracket
7. Rocker Arm Shaft

Removal

1. Remove the cylinder head cover.
   Refer to “Cylinder Head Cover”.
2. Remove the rocker arm shaft assembly.
   - Along with the camshaft bracket, remove the rocker arm shaft assembly.

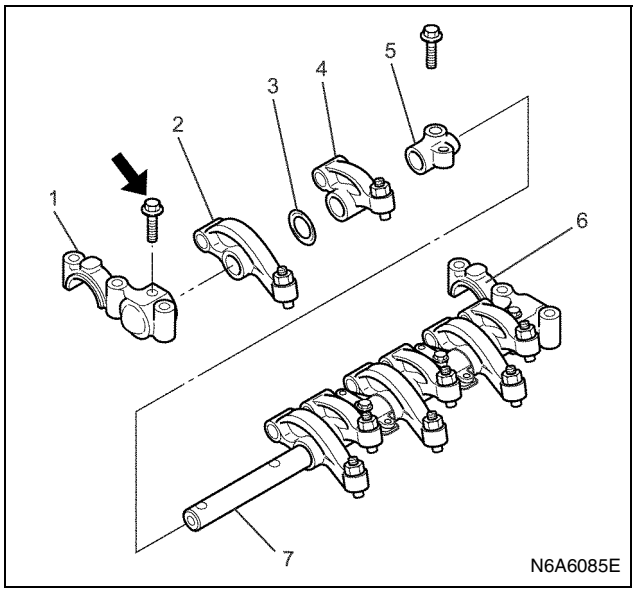
- Keep the 2-bolts (arrowed in the figure) fixing the rocker arm shaft to the camshaft bracket, before removal of all the rocker arm brackets


N6A6084E

Caution:
Pay full attention so as not to drop the bridge cap in the gear case of the rear part of the cylinder head or the hole into which oil pours back in the front.

Dismount

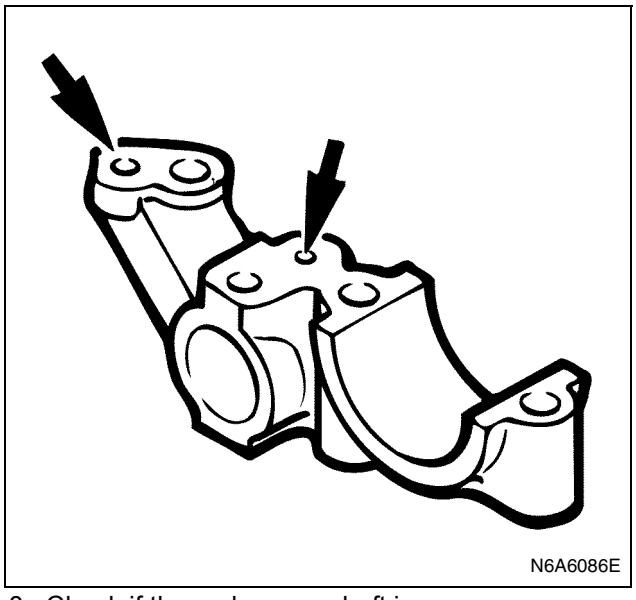
1. Remove the camshaft bracket.
2. Remove the rocker arm.
3. Remove the wave washer.
4. Remove the rocker arm.
5. Remove the rocker arm bracket.
   - Repeat the procedure of (2) to (5).
6. Remove the camshaft bracket to take the shaft out.



N6A6085E

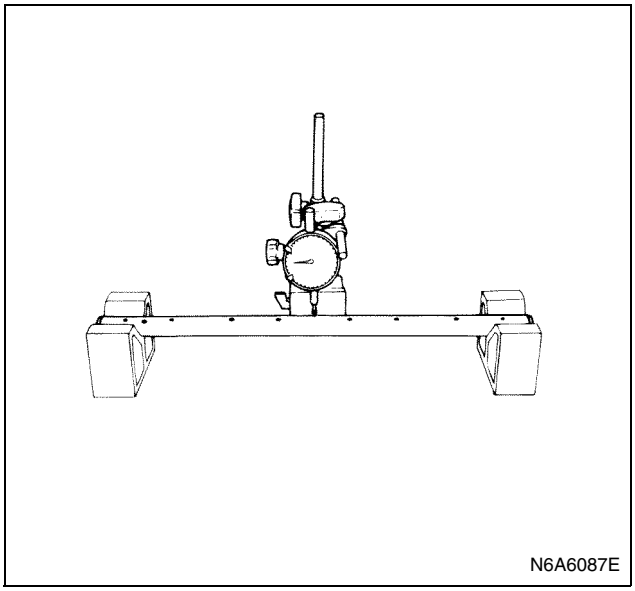
Legend
1. Camshaft Bracket
2. Rocker Arm
3. Wave Washer
4. Rocker Arm
5. Rocker Arm Bracket
6. Camshaft Bracket
7. Rocker Arm Shaft

7. Check if the oil hole of the camshaft bracket (on the rear side) is clogged.


N6A6086E

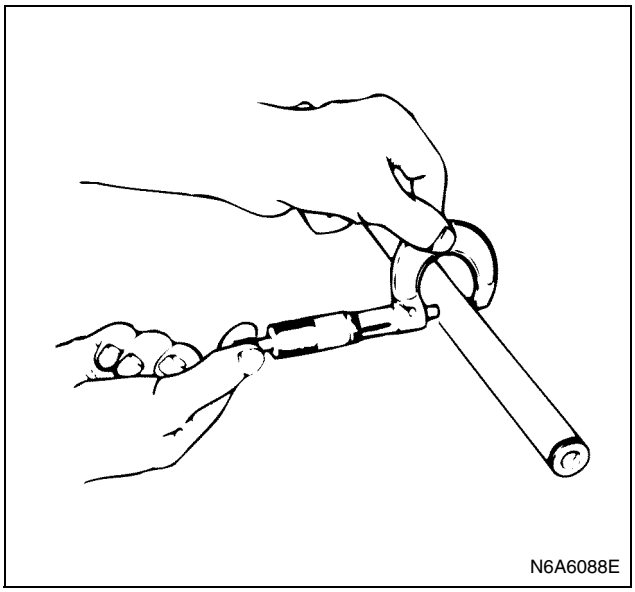
8. Check if the rocker arm shaft is warpage.
   - Place the rocker arm shaft on a V block.
   - Mesure the runout of the rocker arm shaft with a dial gauge on the center of the shaft.
   - As a result of measurement, if its bend is slight, press it to rectify it (do not heat).
   - If the warpage of the shaft exceeds the limit, replace the shaft.

Bend of the rocker arm shaft	mm (in)
Limit	0.3 (0.012)



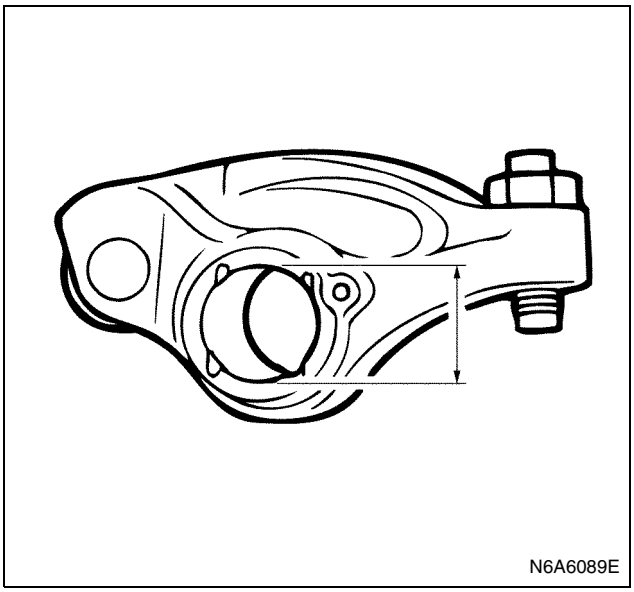
9. Check if the rocker arm shaft is worn.
   - Use a micrometer to measure 8 places rubbed by the rocker arms.
   - Replace the shaft if the diameter is less than the limit.

External diameter of the rocker arm shaft	mm (in)
Standard	21.979 – 22.000 (0.865 – 0.866)
Limit	21.85 (0.860)



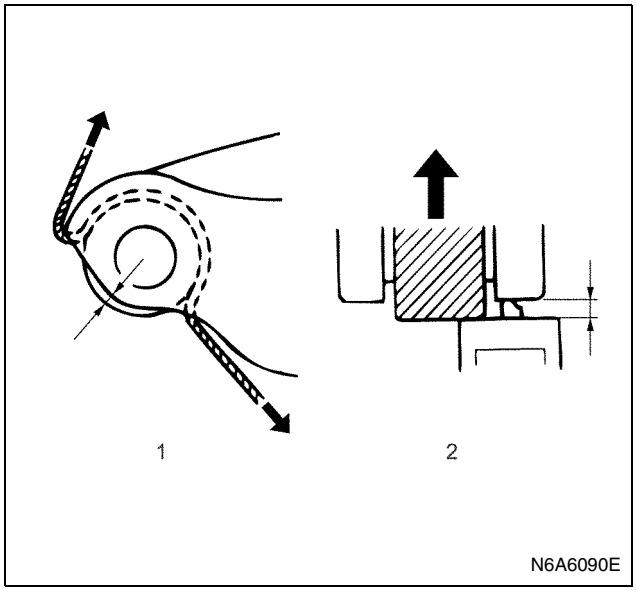
10. Inspect a clearance between the rocker arm and the rocker arm shaft.
    - Use a cylinder gauge to measure an inside diameter of the bush of the rocker arm to measure a clearance between the external diameter of the shaft.
    - If the measurement exceeds the limit, replace the rocker arm and the shaft.

Clearance between the rocker arm and rocker arm shaft	mm (in)
Standard	0.010 – 0.056 (0.0004 – 0.0022)
Limit	0.2 (0.0079)



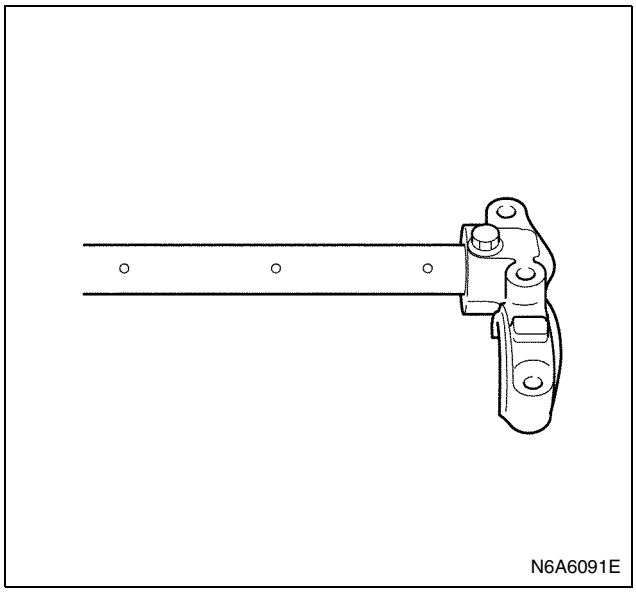
11. Inspect a clearance between the roller of the rocker arm and the rocker arm pin.
    a. Pass a string, through the opening between the rocker arm and the roller, pull it strongly in the direction indicated with arrows and measure the gap between the rocker arm and the roller with the roller being hulled out. (Figure 1)
    b. After marking the measuring point, pull the string out push the roller fully into the rocker arm, and measure the gap of the marked place. (Figure 2)
    c. The gap between the measurement taken under a. and that under b. Is the a clearance between the roller and the rocker arm pin. If it exceeds the limit, replace the rocker arm.

Clearance between the roller and the rocker arm pin	mm (in)
Standard	0.068 – 0.100 (0.0026 – 0.0039)
Limit	0.2 (0.0079)

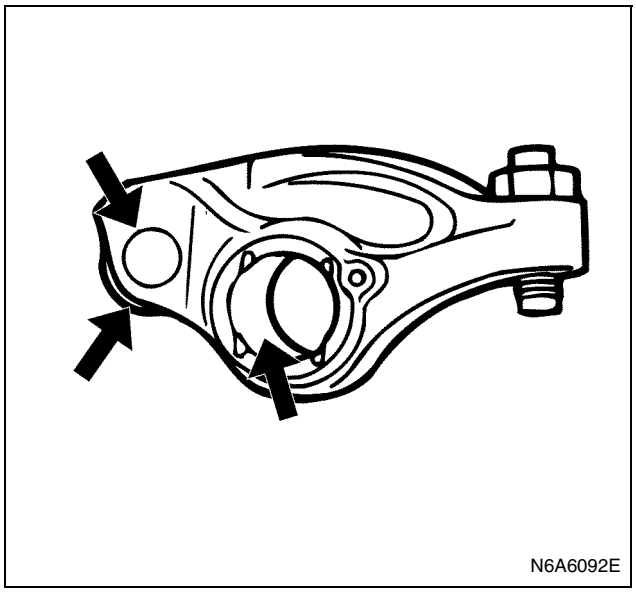


Reassembly

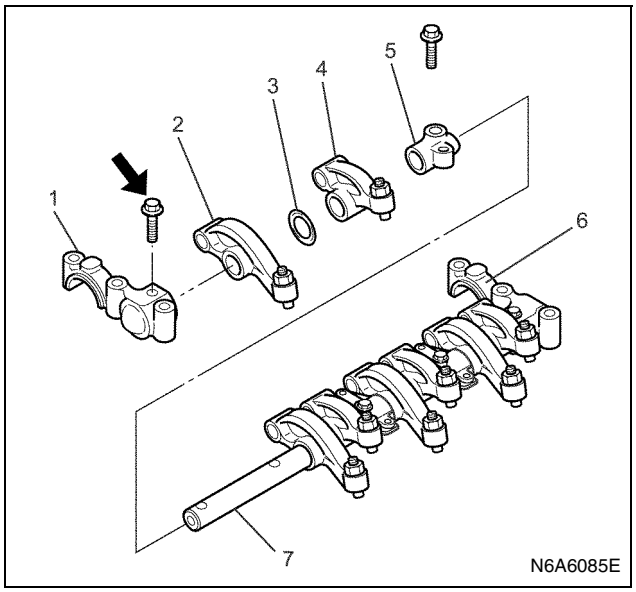
1. Install the camshaft bracket to one side of the rocker arm shaft tentatively first. (Tighten them up, after the rocker arm shaft assembly is installed on the cylinder head.)
   - Assemble in the reverse order to dismounting.



2. Install the rocker arm.
   - Apply engine oil to the hole of the rocker arm, the roller and the rocker arm pin.



3. Install the wave washer between the rocker arm.
4. Install the rocker arm bracket.
   - Paying attention to the direction of the rocker arm bracket, repeat the step 2 to 4.
5. Install the camshaft bracket.
   - Install the camshaft bracket on the rocker arm shaft with the bolts indicated with an arrow tightened tentatively. (Tighten them up, after the rocker arm shaft assembly is installed on the cylinder head.)



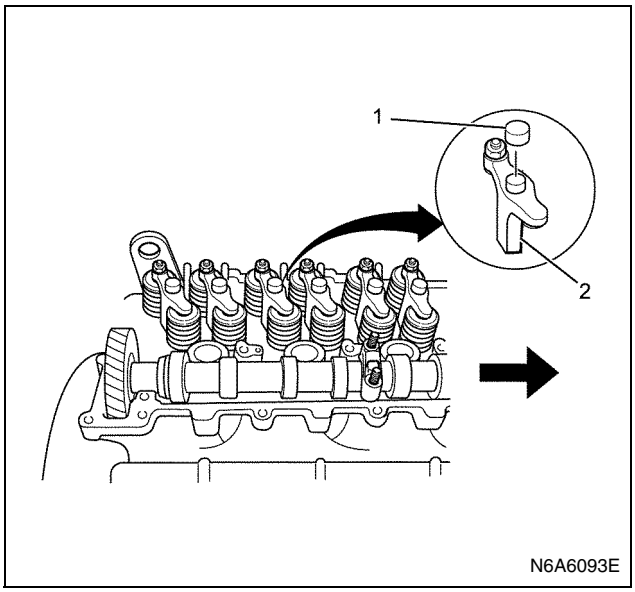
Legend

1. Camshaft Bracket
2. Rocker Arm
3. Wave Washer
4. Rocker Arm
5. Rocker Arm Bracket
6. Camshaft Bracket
7. Rocker Arm Shaft

Installation

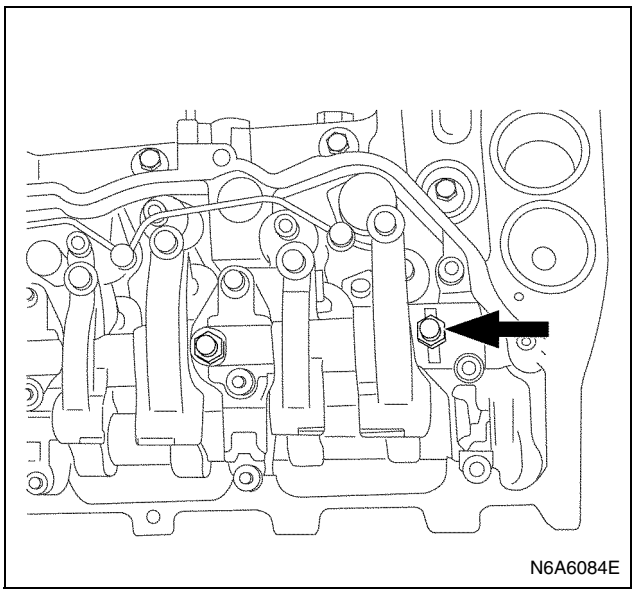
1. Install the rocker arm shaft assembly.
   - If the bridge cap comes off, apply engine oil over the inside of the bridge cap and put it together with the bridge.

Caution:
Pay full attention so as not to drop the bridge cap in the gear case of the rear part of the cylinder head or the hole into which oil pours back in the front.



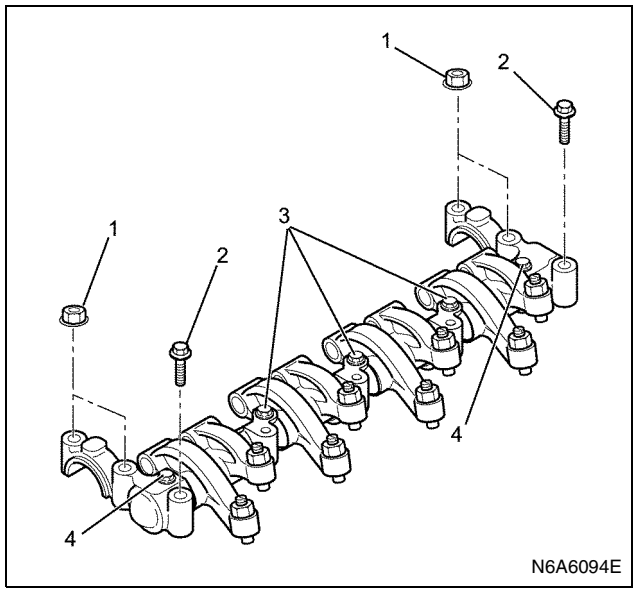
Legend
1. Bridge Cap
2. Bridge

   1) Temporarily tighten the bolts marked with the arrow in the illustration.
   2) Loosen the rocker arm adjust screws and apply engine oil to the rocker arm roller portions.
   3) Install the rocker arm assembly on the cylinder head.



   - Apply engine oil on threads of the bolts and nuts, and fix them tentatively (about tighten up).
   - Tighten them up according to the order specified below gradually, taking care not to incline the entire rocker arm assembly.
     Tightening order:
     1. Nuts (1) from near side of the rocker arm shaft
     2. Bolts (2)
     3. Bolts (3) from out side
     4. Bolts (4)

Tighten:
Bolt (3) to 56 N·m (5.7 kg·m/41 lb ft)
Nut (1), Bolt (2), (4) to 27 N·m (2.8 kg·m/20 lb ft)

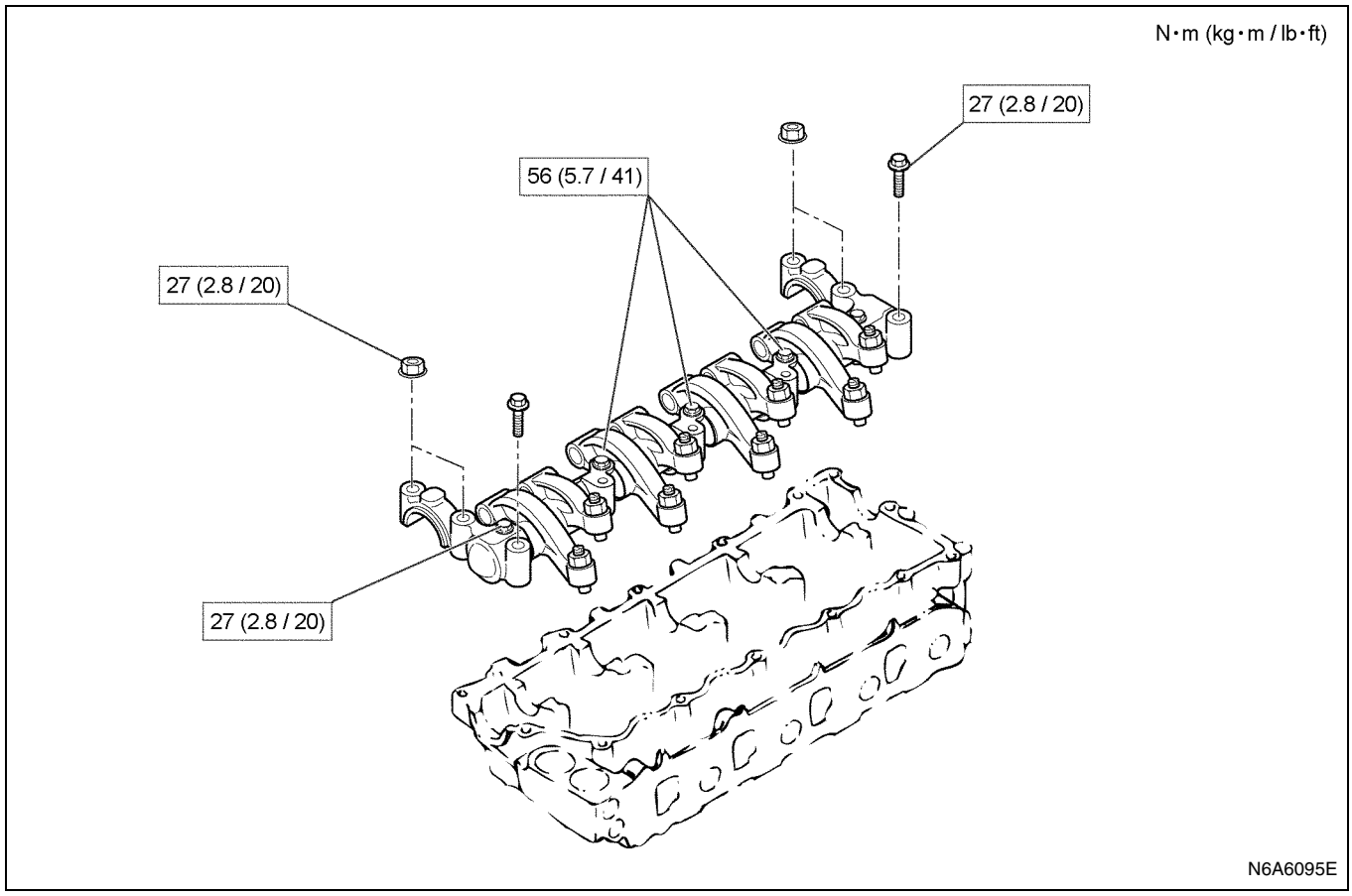


Legend
1. Camshaft Bracket Fixing Nut
2. Camshaft Bracket Fixing Bolt
3. Rocker Arm Bracket Fixing Bolt
4. Rocker Arm Shaft Set Bolt

   - Adjust valve clearance.
     Refer to “Functional Inspection”.

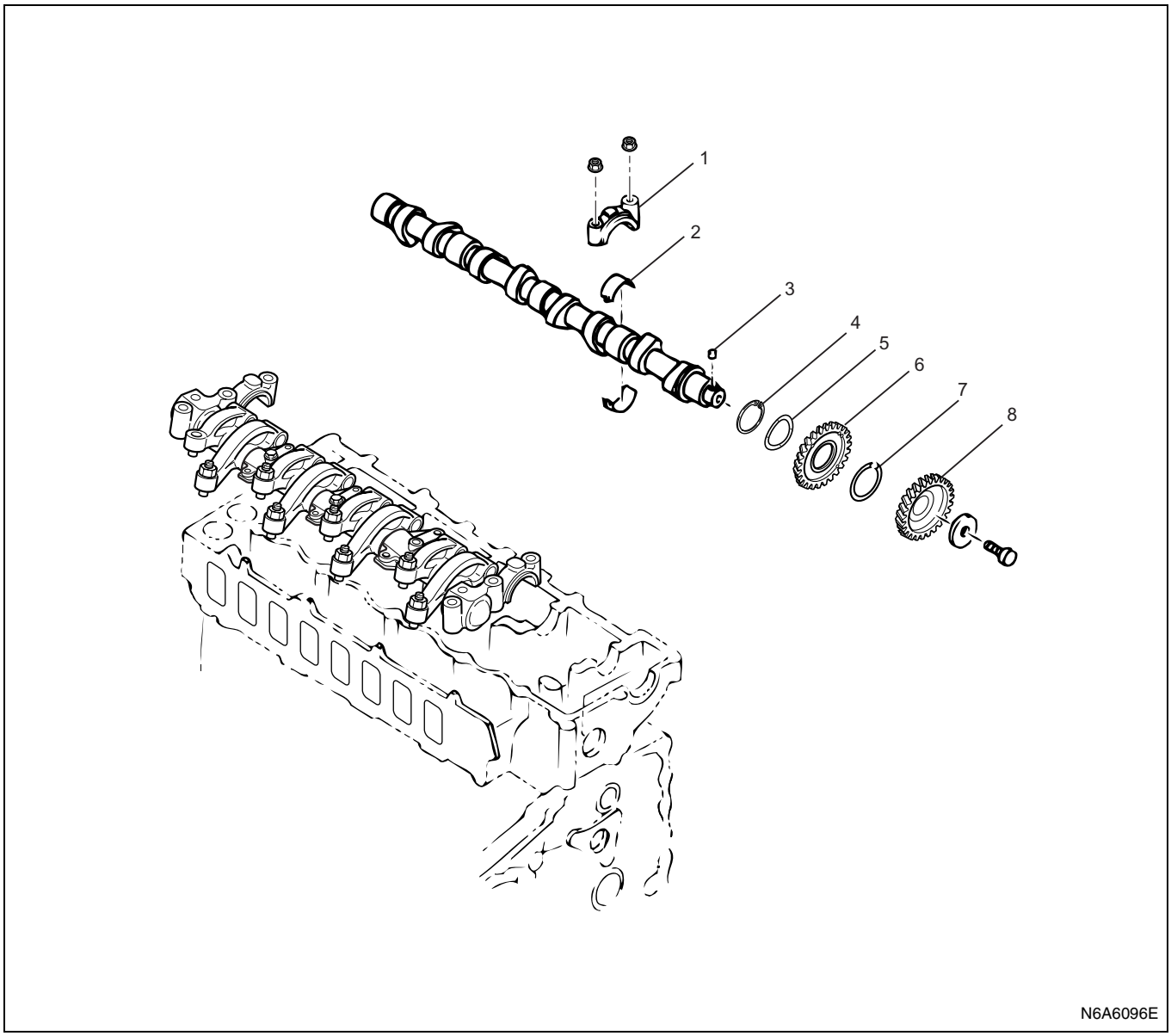
2. Install the cylinder head cover.
   Refer to “Cylinder Head Cover”.

Torque Specifications



Camshaft Assembly

Component



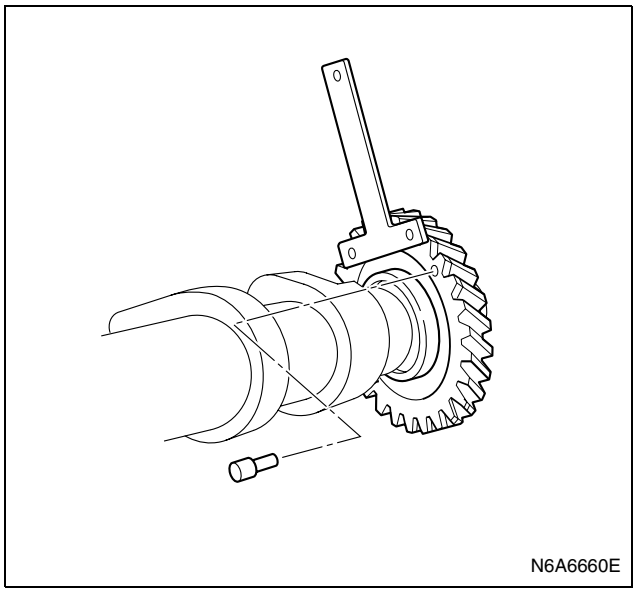
Legend

1. Bearing Cap
2. Bearing
3. Knock Pin
4. Snap Ring
5. Dish Washer
6. Sub Gear
7. Spring
8. Camshaft Gear

Removal

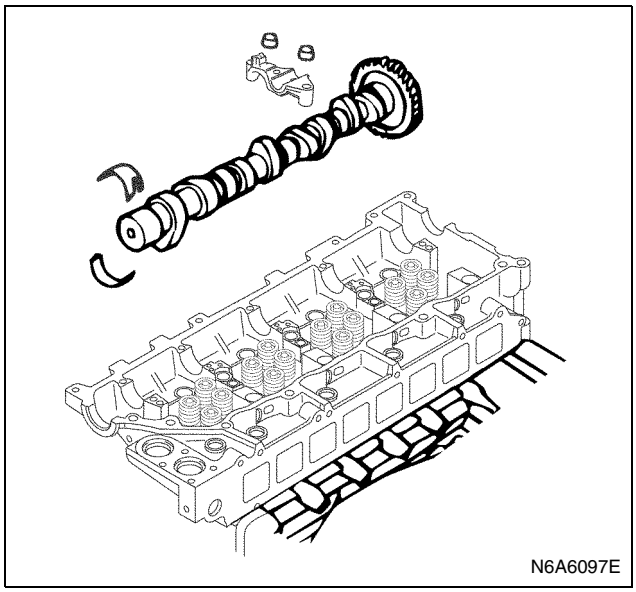
1. Rotate the crank shaft to make the No. 1 cylinder meet the compression TDC.
2. Remove the cylinder head cover.
   Refer to the “cylinder head cover.”
3. Remove the rocker arm shaft assembly.
   Refer to the “rocker arm shaft assembly.”
4. Remove the camshaft bearing cap.

- Before removing the camshaft from the cylinder head, rotate the sub gear using the special tool to prevent the spring force which acts on the sub gear from affecting. Align the hole of the sub gear with the camshaft main gear and install the phase alignment pin from the sub gear side to match the teeth.
  Special tool
  Scissors gear spring wrench: 5-8840-2674-0


N6A6660E

5. Remove the bearing upper.
6. Remove the camshaft assembly.
7. Remove the bearing lower.

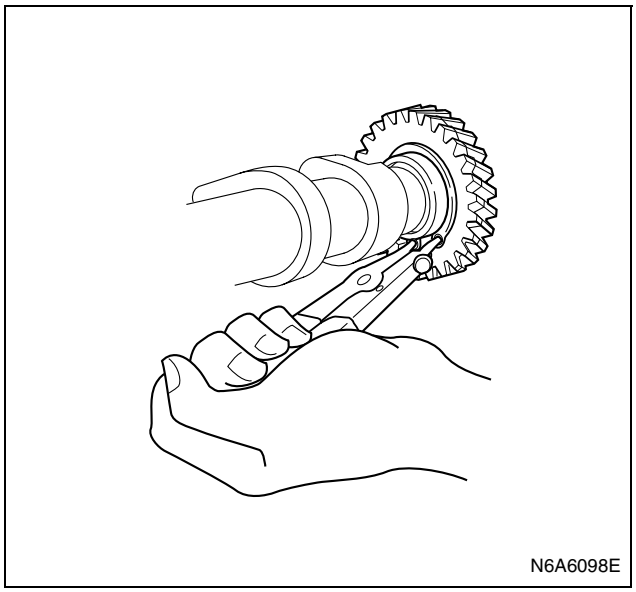
Caution:
Put the removed bearings in order with a tag, for example, by cylinder.

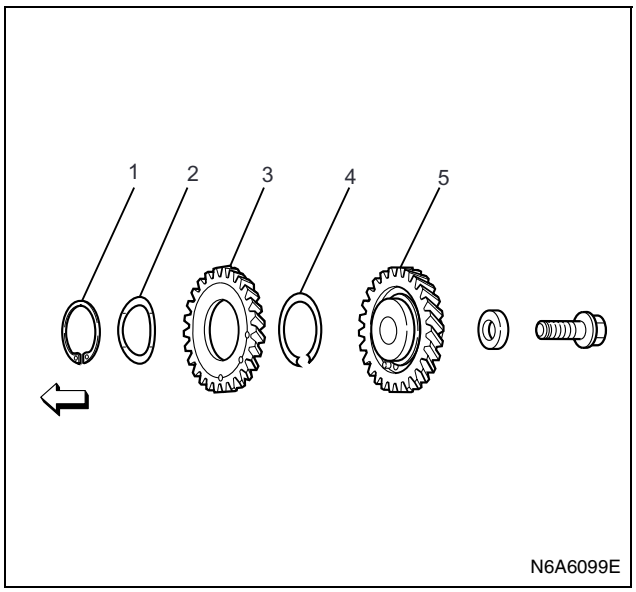

N6A6097E

Disassembly

1. Remove the scissors gear assembly.
   - Fix the hexagon portion of the camshaft in a vise using a mouth ring. Use snap ring pliers to remove the sub gear.

Caution:
Take care not to damage to the cam portion and the journal portion of the camshaft.

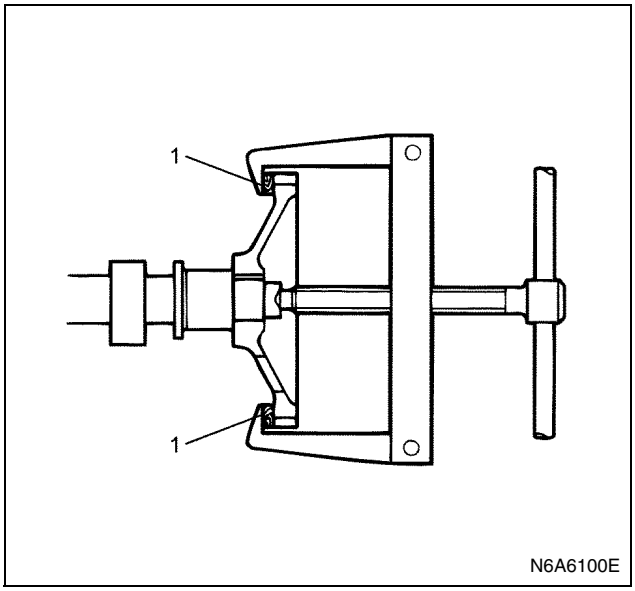

N6A6098E



N6A6099E

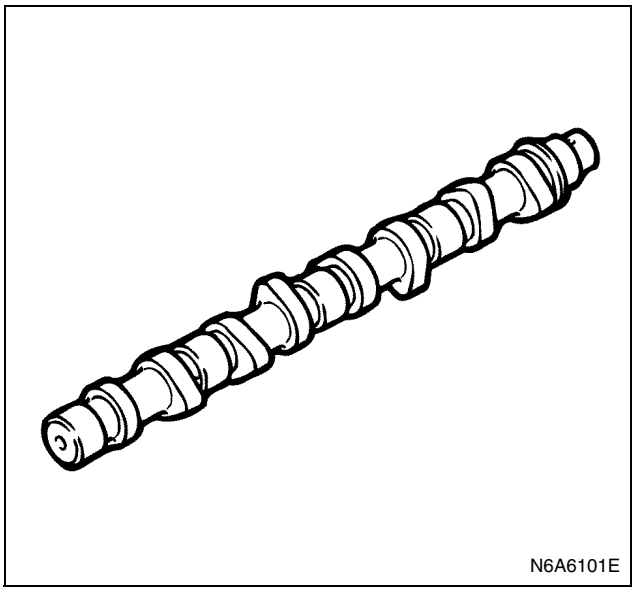
Legend
1. Snap Ring
2. Dish Washer
3. Sub Gear
4. Spring
5. Camshaft Gear

2. Remove the camshaft gear.
   - Remove the fastening bolts of the camshaft gear and put the block of wood in a puller to remove the camshaft gear.



Legend
1. Wood

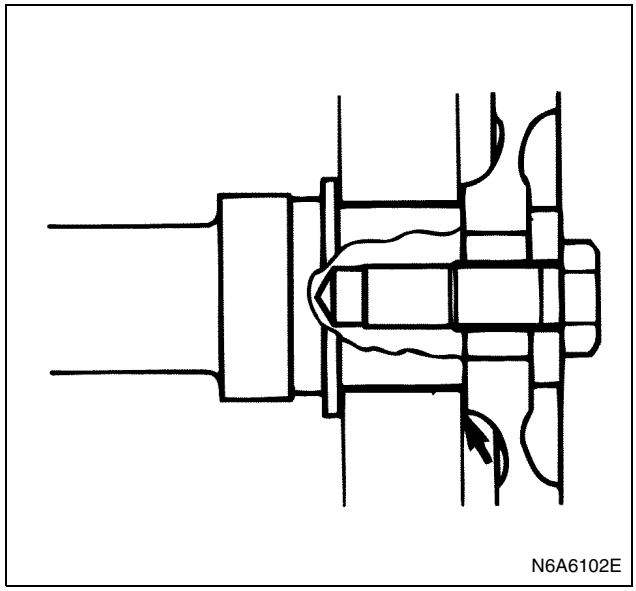
3. Remove the dowel pin.
4. Inspect the camshaft visually.
   - Check if the journal and cam parts of the camshaft are worn or damaged, if so, replace it.



5. Inspect an end clearance of the camshaft.
   - Use a thickness gauge to measure an end clearance of the camshaft gear and the camshaft bracket.
   - If the measurement exceeds the limit, replace the camshaft gear or the camshaft.

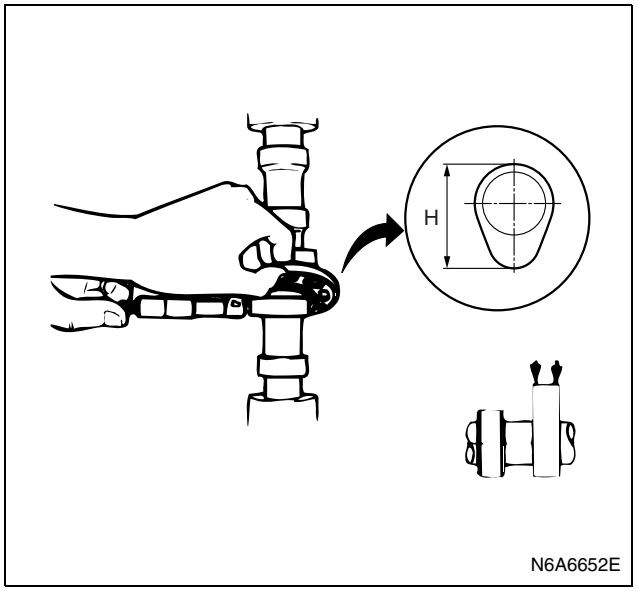
End clearance of the camshaft	mm (in)
Standard	0.085 – 0.205 (0.033 – 0.008)
Limit	0.25 (0.009)

Caution:
Measure an end clearance of the camshaft before disassembling.



6. Check if the cam lobe is worn.
   - Measure the height “H” of the cam lobe with a micrometer.
   - If the height of the cam lobe is the limit or less, replace the camshaft.

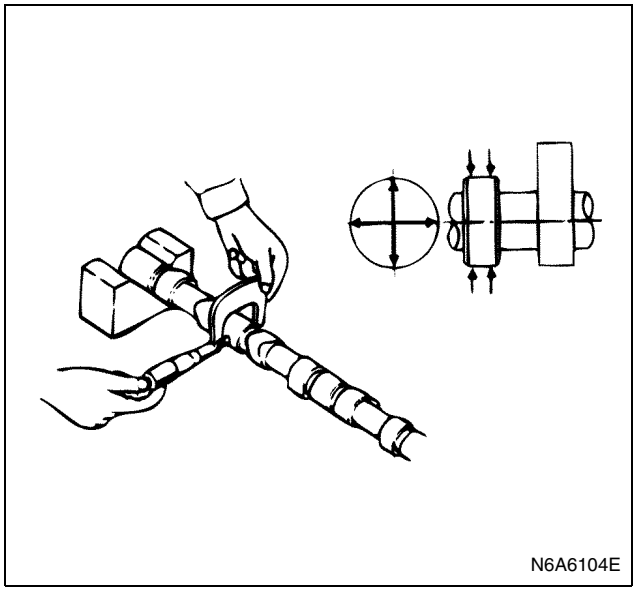
Height of the cam lobe		mm (in)
	Inlet	Exhaust
Standard	52.8 (2.08)	54.5 (2.15)
Limit	51.8 (2.04)	53.5 (2.11)



7. Check if the camshaft journal is worn.
   - Use a micrometer to measure wear which is not even with a diameter of the camshaft journal.
   - If the measured uneven wear exceeds the limit, replace the camshaft.

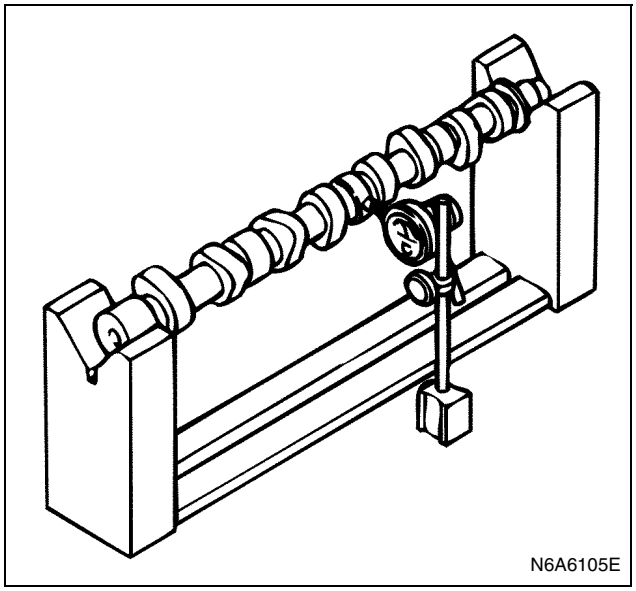
External diameter of the camshaft journal part	mm (in)
Standard	39.950 – 39.975 (1.5728 – 1.5738)
Limit	39.850 (1.5688)

Partial wear of the camshaft journal part	mm (in)
Limit	0.05 (0.0019)



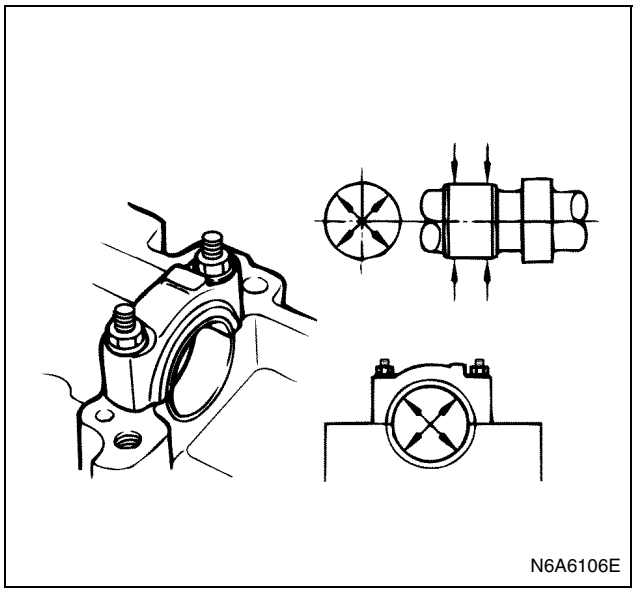
8. Check if the camshaft is warpage.
   - Place the camshaft on a V block to measure a runout with a dial gauge.
   - Rotate the camshaft slowly and measure the range of fluctuation. If it exceeds the limit, replace the camshaft.

Warpage of the camshaft	mm (in)
Limit	0.05 (0.0019)



9. Measure camshaft journal oil clearance.
   a. Measure the inside diameter of the camshaft bearing with a dial gauge.
   b. Read the difference between the inside diameter of the camshaft bearing and the diameter of the camshaft journal.
      If the measured oil clearance exceeds the limit, replace the camshaft bearing.

Clearance of the journal part	mm (in)
Standard	0.025 – 0.087 (0.0009 – 0.0034)
Limit	0.15 (0.0059)

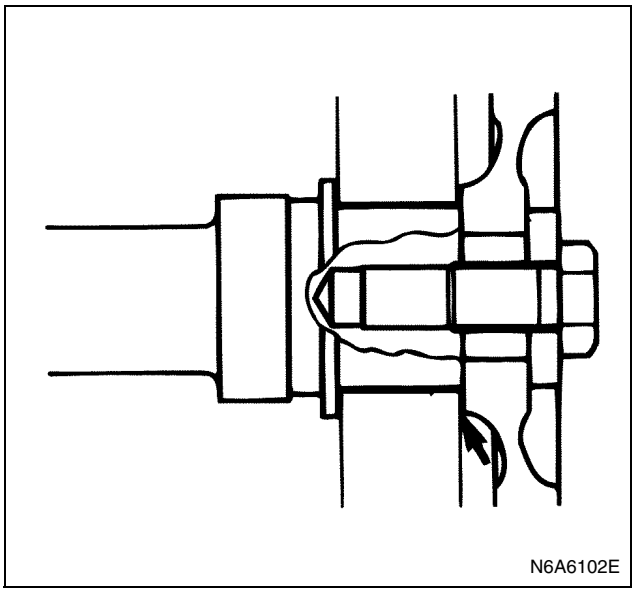


Reassembly

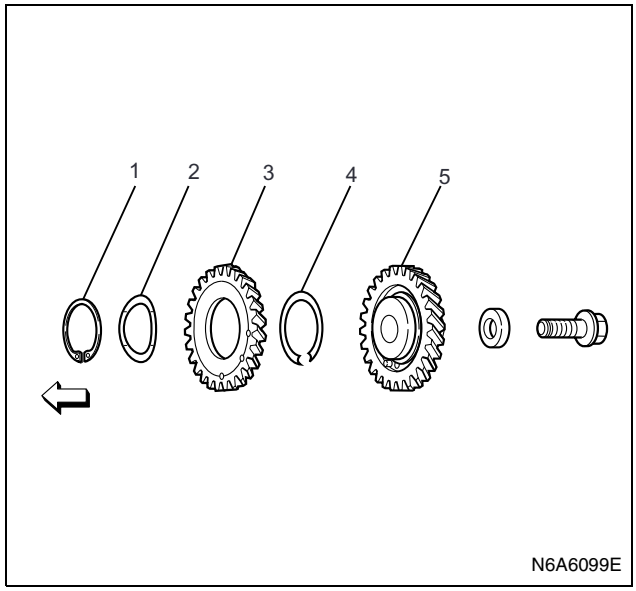
1. Install the knock pin.
2. Install the camshaft gear.
   - With the side of the camshaft gear center boss part stuck out being on the camshaft side, install the camshaft gear along with the knock pin.

Tighten:
Bolt to 142 N·m (14.5 kg·m/105 lb·ft)

Caution:
Be careful not to damage the cam and journal parts when tightening up the gear.


N6A6102E

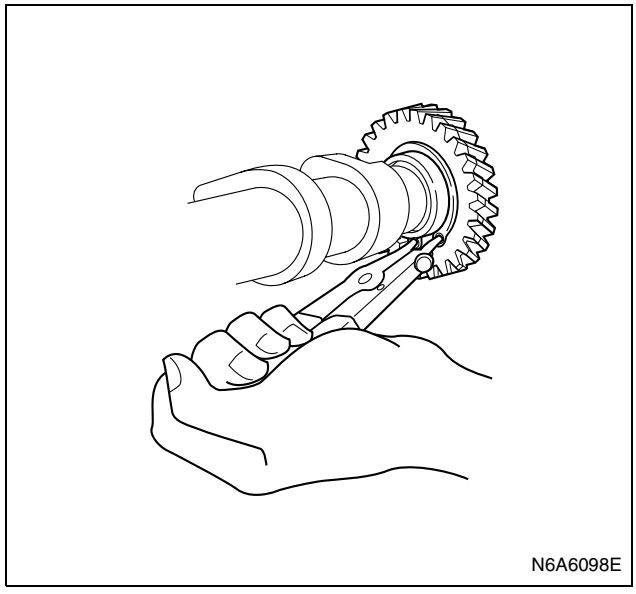
3. Install the scissors gear assembly.
   - Fix the hexagon portion of the camshaft in a vise using a mouth ring. Assemble the spring with its left end contacting the pin of camshaft main gear to make a gap on the right.
   - Assemble the sub gear so that its pin is inserted into the gap between the right side of pin of the camshaft main gear and the right end of the spring.



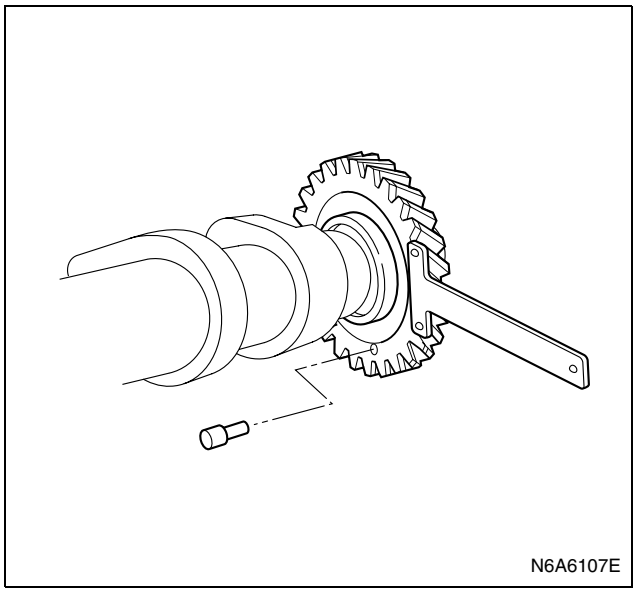
N6A6099E

Legend
1. Snap Ring
2. Dish Washer
3. Sub Gear
4. Spring
5. Camshaft Gear

   - Use snap ring pliers to assemble the snap ring and the dish washer securely.


N6A6098E

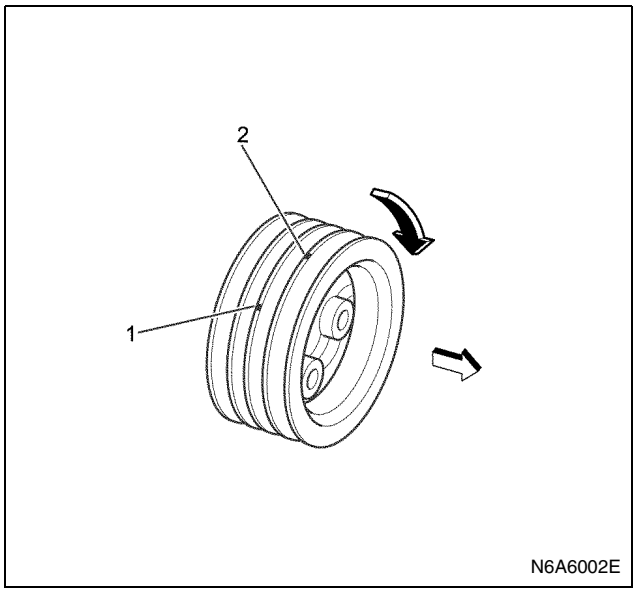
- Before installing the camshaft to the cylinder head, rotate the sub gear using the special tool to prevent the spring force which acts on the sub gear from affecting. Align the hole of the sub gear with the camshaft main gear and install the phase alignment pin from the sub gear side to match the teeth.
  Special tool
  Scissors gear spring wrench: 5-8840-2674-0


N6A6107E

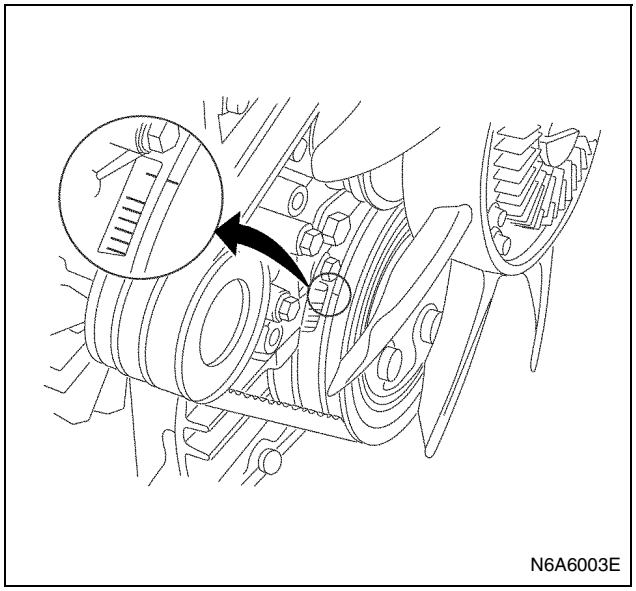
Installation

1. Turn the crankshaft in the normal direction of engine rotation until the No. 1 or No. 4 cylinder is at TDC on the compression stroke.

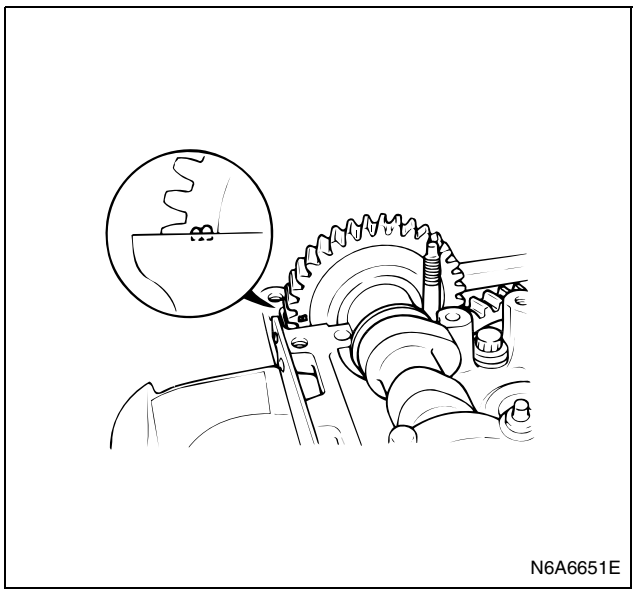
Notice:
There are 2 timing marks on the crankshaft pulley.
Mark (1) is near the cylinder block and is used to bring the 4HK1-TC engine to TDC.
Mark (2) is not applicable to this engine.
Be sure to use mark (1) when bringing the engine to TDC.



N6A6002E

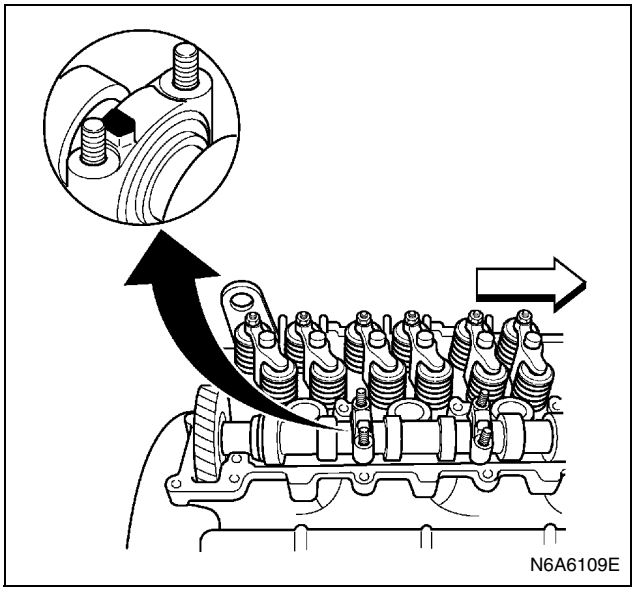

N6A6003E

2. Install the camshaft bearing lower.
   - Apply engine oil over the camshaft bearing lower and install it on the cylinder head.
3. Install the camshaft assembly.
   - The camshaft assembly 'B' mark must be facing the cylinder head upper face. If not, serious engine damage will result.


N6A6651E

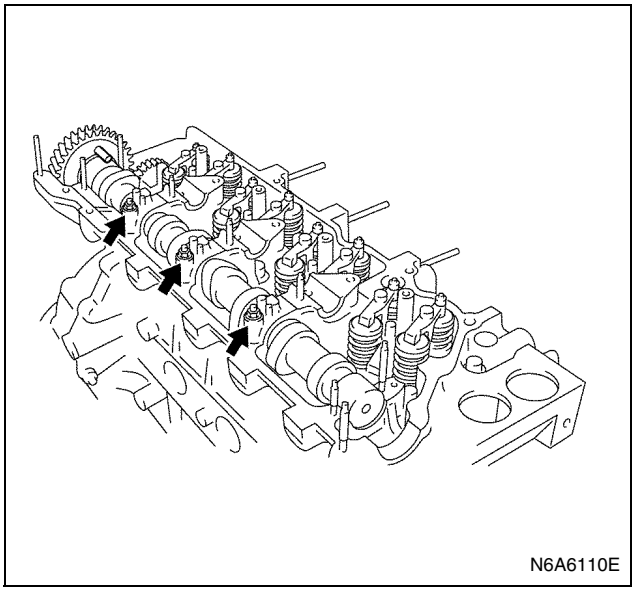
4. Install the baring upper to the bearing cap.
5. Install the bearing cap.
   - Apply engine oil on the bearing upper.

- Direct the front mark of the bearing cap toward the front of the engine and put it together with the cylinder head in numerical order.


N6A6109E

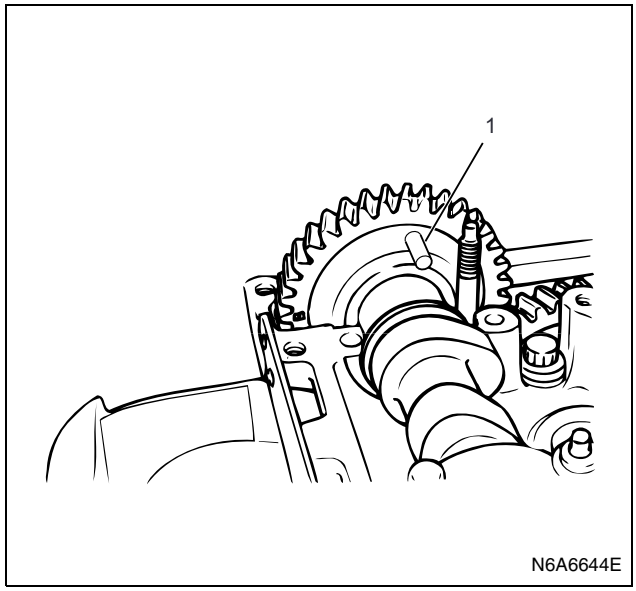
- Apply engine oil to the thread and tighten up the bearing cap with the prescribed torque.

Tighten:
Nut to 27 N·m (2.8 kg·m/20 lb·ft)


N6A6110E

- Pull out the phase alignment pin of the gear (1) carefully so that it does not fall into inside the engine.

Caution:
Be careful not to forget to pull out the phase alignment pin of the gear.

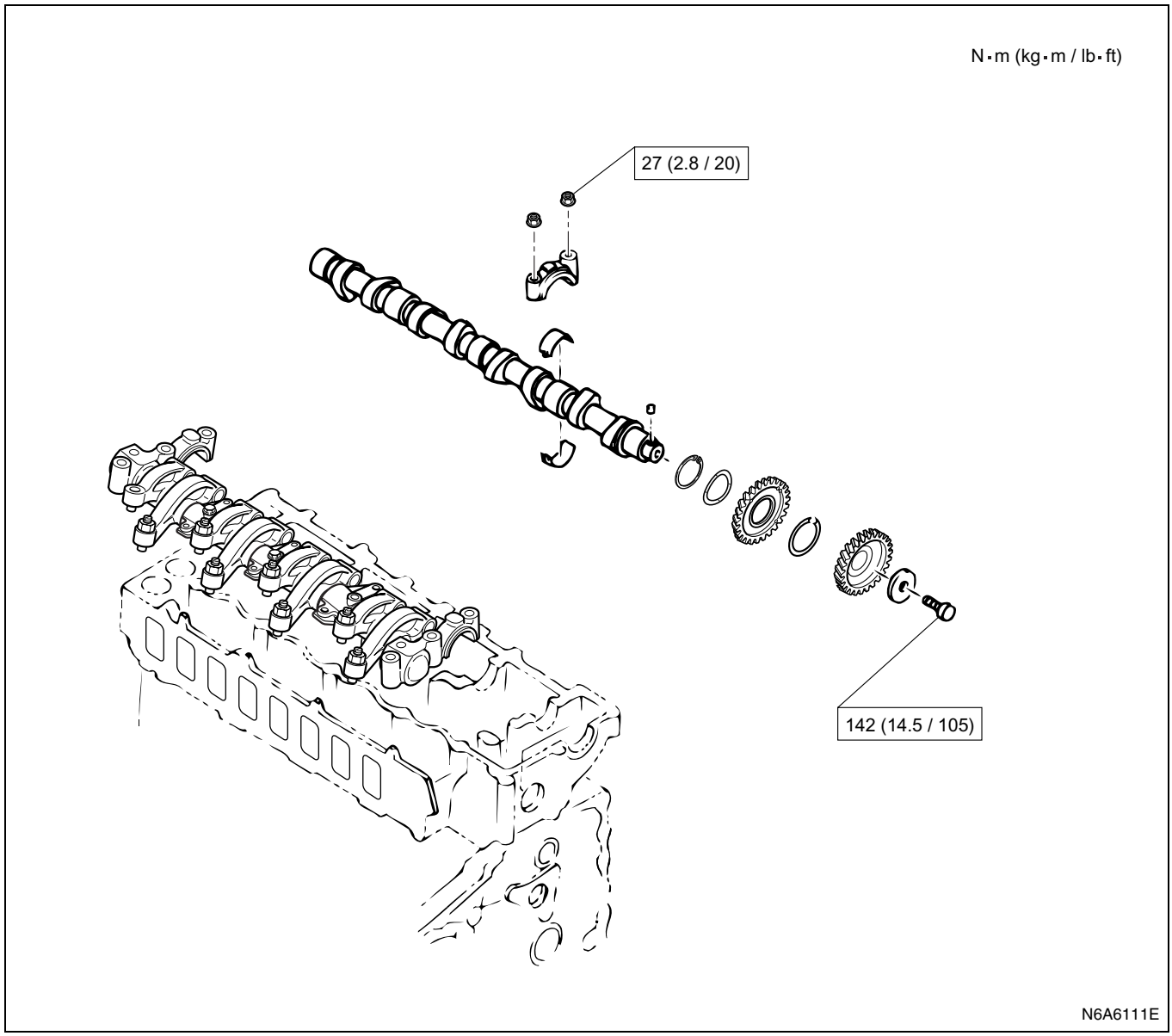


N6A6644E

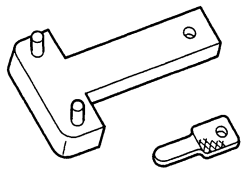
Legend
1. Phase Alignment Pin

6. Install the rocker arm shaft assembly.
   Refer to “Rocker Arm Shaft Assembly”.
7. Install the cylinder head cover.
   Refer to “Cylinder Head Cover”.

Torque Specifications

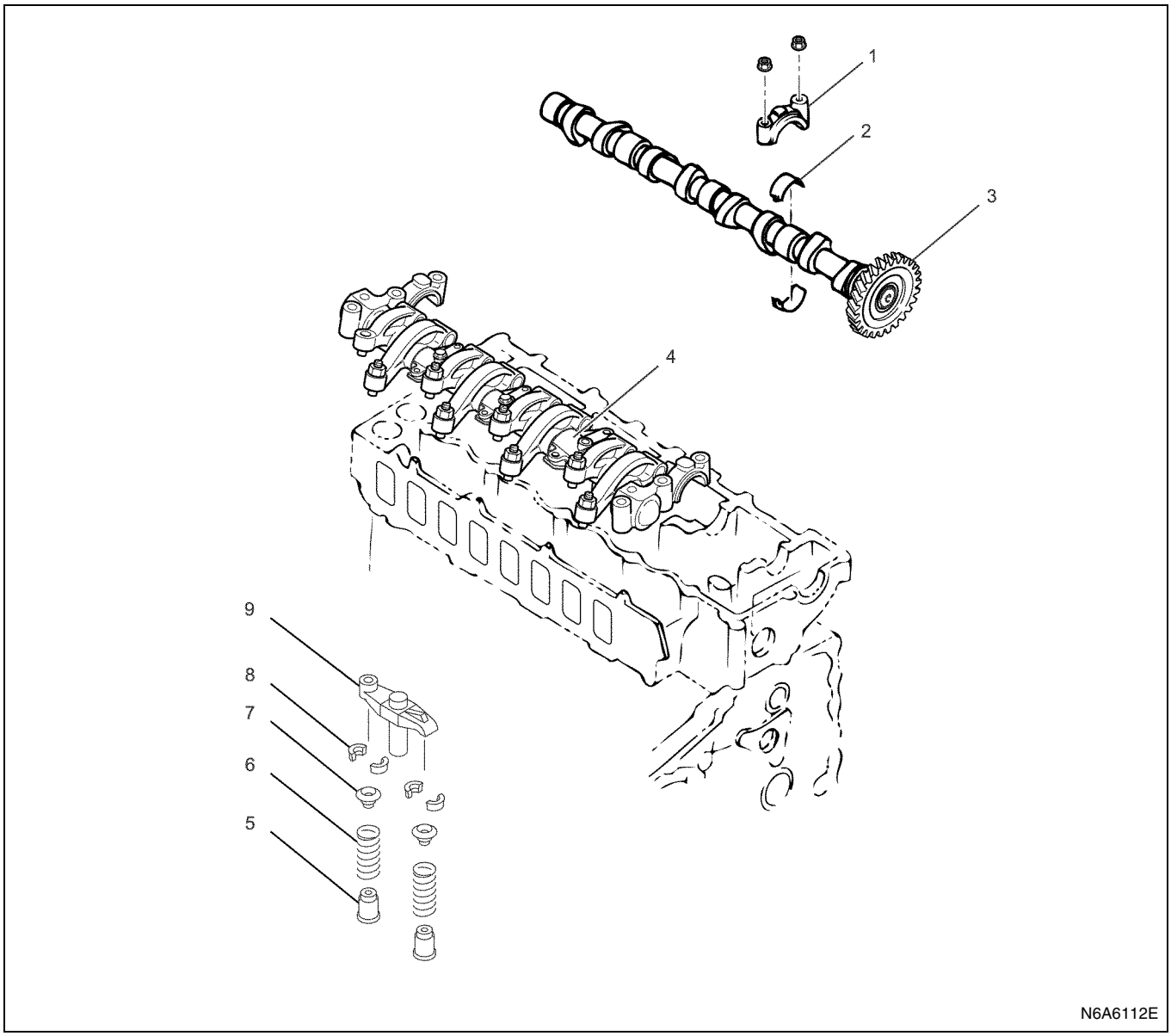


Special Tool

Illustration	Tool Number / Description / Remarks
 5884026740	5-8840-2674-0 Scissors Gear Spring Wrench

Valve Stem Seal and Valve Spring

Component



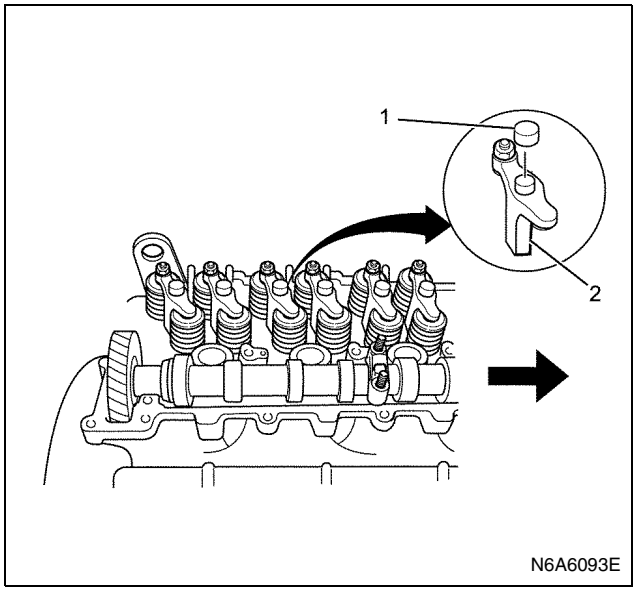
Legend

1. Camshaft Bearing Cap
2. Camshaft Bearing
3. Camshaft Assembly
4. Rocker Arm Shaft Assembly
5. Valve Stem Oil Seal
6. Valve Spring
7. Spring Upper Seat
8. Split Collar
9. Bridge

Removal

1. Remove the cylinder head cover.
   Refer to “Cylinder Head Cover”.
2. Remove the rocker arm shaft assembly.
   Refer to “Rocker Arm Shaft Assembly”.
3. Remove the camshaft assembly.
   Refer to “Camshaft Assembly”.
4. Remove the bridge cap (1).
5. Remove the bridge (2).

Caution:
Keep the removed bridge and bridge cap properly so that they may be put back to the original position.

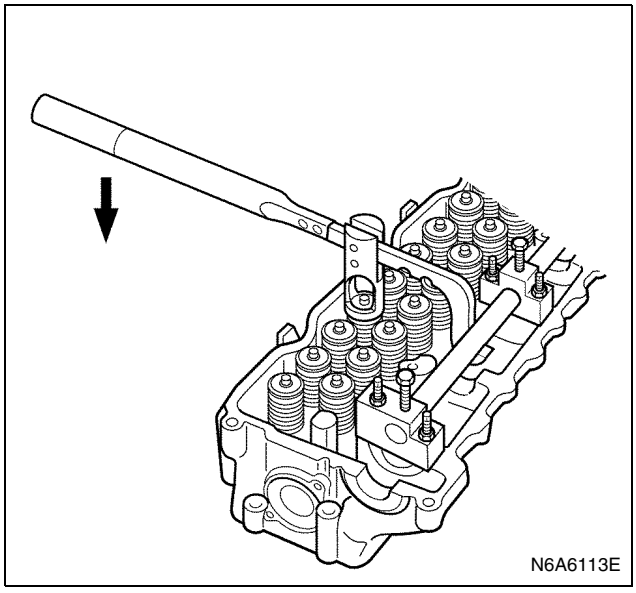


Legend
1. Bridge Cap
2. Bridge

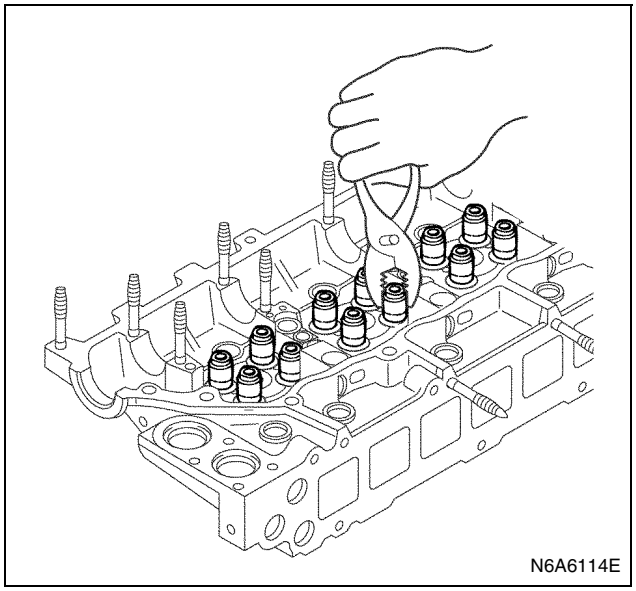
Caution:
Pay full attention so as not to drop the bridge cap in the gear case of the rear part of the cylinder head or a hole into which oil pours back in the front.

6. Remove the split collar.
   - Apply compressed air over the cylinder from a glow plug hole to keep the valve at the home position.
   - Use a replacer to compress the valve spring to remove the split collar.

     Special tool
     Valve spring replacer: 5-8840-2621-0 (J-43263)
     Pivot: 5-8840-2808-0 (EN-46721)



7. Remove the spring upper seat.
   - Remove the special tool to remove the upper seat.
8. Remove the valve spring.
   Put the removed valve springs in order by cylinder number.
9. Remove the valve stem oil seal.
   - Use pliers to remove the oil seal.



Caution:
Do not use the removed oil seal again.

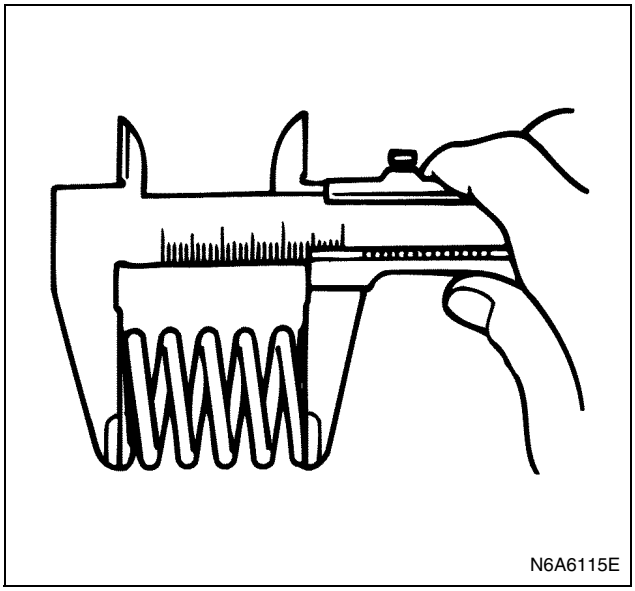
Inspection

Inspect the valve spring

Caution:
Check the valve spring visually and if there is clear damage or wear-out, replace it.

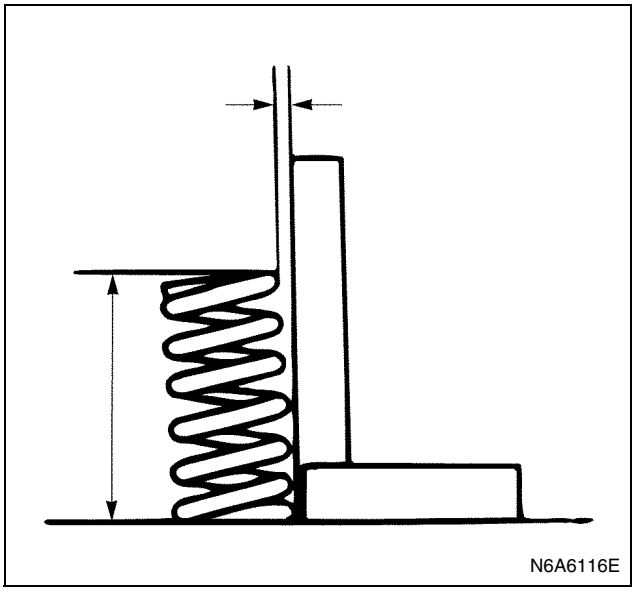
1. Free length
   - Measure free length of the spring and if it is shorter than the prescribed limit, replace the spring.

Free length of the valve spring		mm (in)
	Inlet	Exhaust
Standard	59.9 (2.36)	70.3 (2.76)
Limit	56.9 (2.24)	67.3 (2.65)


N6A6115E

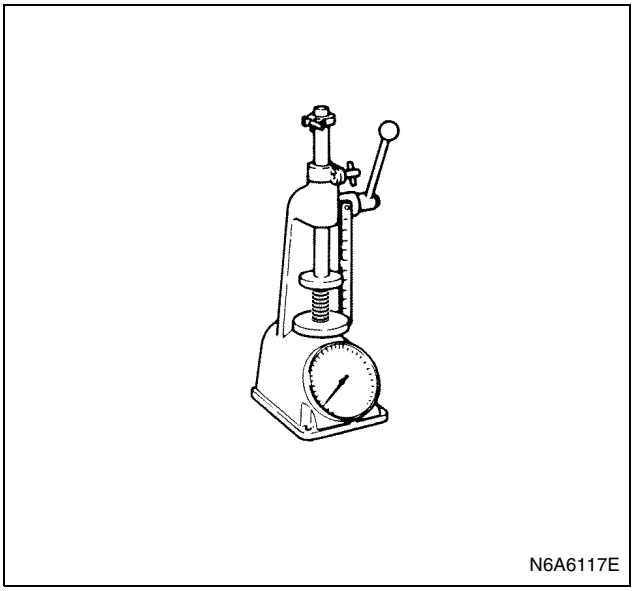
2. Valve spring squareness
   - Use a surface plate and a square to measure the valve spring squareness.
     If the measured value exceeds the specified limit, replace the valve spring.

Valve spring squareness	mm (in)
Limit	1.0 (0.04)


N6A6116E

3. Tension
   - Use a spring tester to compress the spring to the installation height. Measure tension of the compressed spring. If the measurement is lower than the limit, replace the spring.

Tension of the valve spring		
	Inlet	Exhaust
Installation length mm (in)	47.0 (1.85)	47.0 (1.85)
Standard N (lb)	333 (74.9)	490 (110.2)
Limit N (lb)	315 (71.0)	463 (104.3)

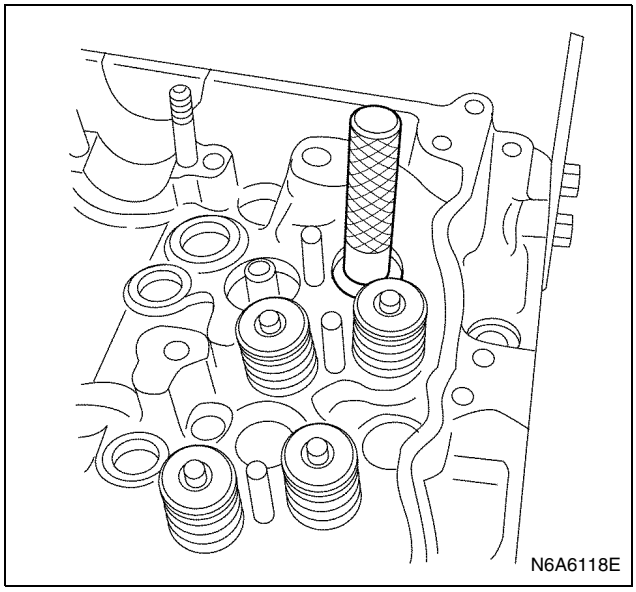

N6A6117E

Installation

1. Install the valve stem oil seal.
   - Apply engine oil over the peripheral part of the valve guide and install the oil seal by using a valve stem seal installer.

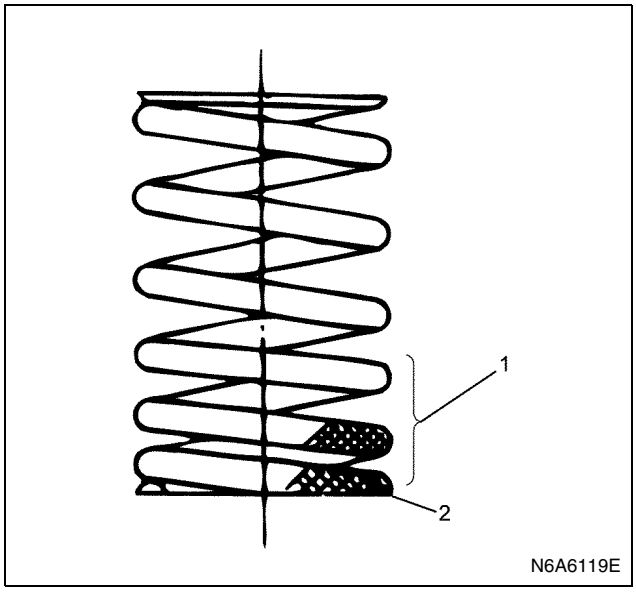
Caution:
After installing the valve stem oil seal, check if it is inserted deeply enough and the oil seal is not tilted or the garter spring has not come off.

Special tool
Valve stem seal installer: 5-8840-2833-0 (EN-47685)



2. Install the valve spring.
   - Install it with the paint mark or the narrow side of the spring pitch being the lower side (cylinder head side).

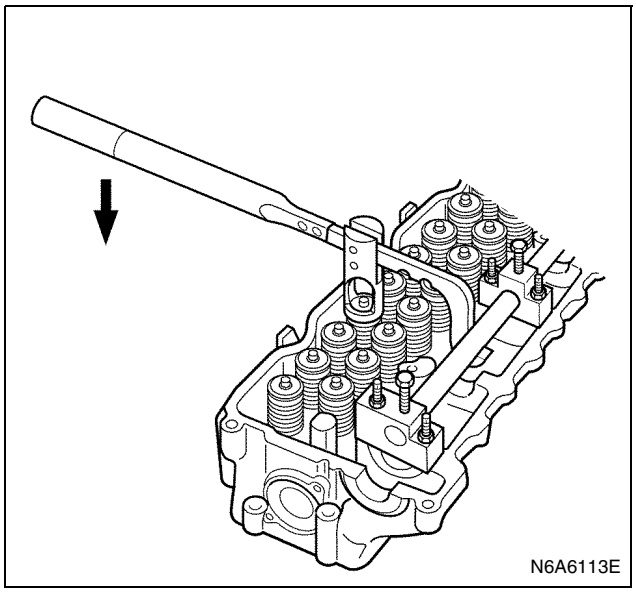
	Paint mark
Inlet	Blue
Exhaust	Red



Legend
1. Spring Pitch
2. Paint Mark

3. Install the spring upper seat.
4. Install the split collar.
   - Apply compressed air over the cylinder from the glow plug holes to keep the valve at the home position.
   - Use a replacer to compress the valve spring and install the split collar.

   Special tool
   Valve spring replacer: 5-8840-2621-0 (J-43263)
   Pivot: 5-8840-2808-0 (EN-46721)

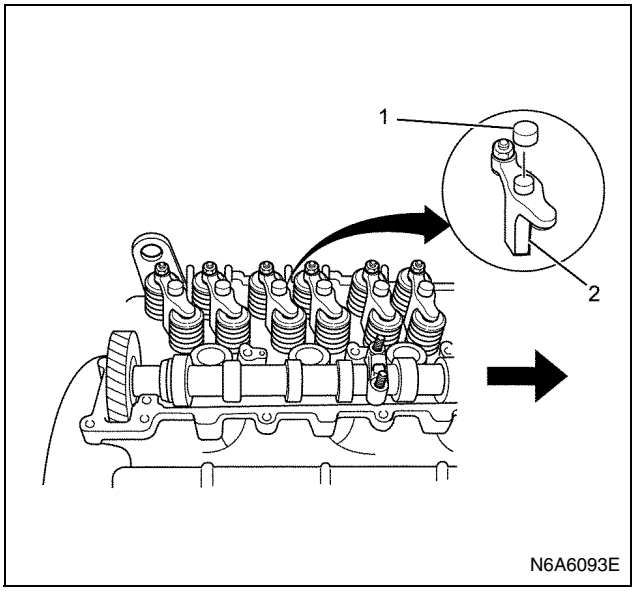


5. Apply engine oil over the bridge and install it.

Caution:
Move it up and down to check if them moves smoothly.

6. Apply engine oil over the bridge cap and install it.

Caution:
Pay full attention so as not to drop the bridge cap in the gear case of the rear part of the cylinder head or the hole into which oil pours back in the front.

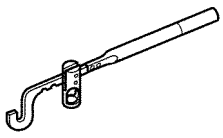
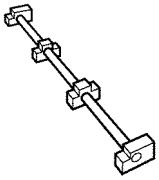
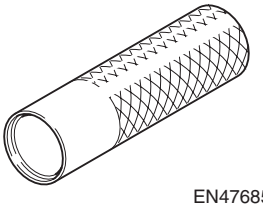


Legend

1. Bridge Cap
2. Bridge

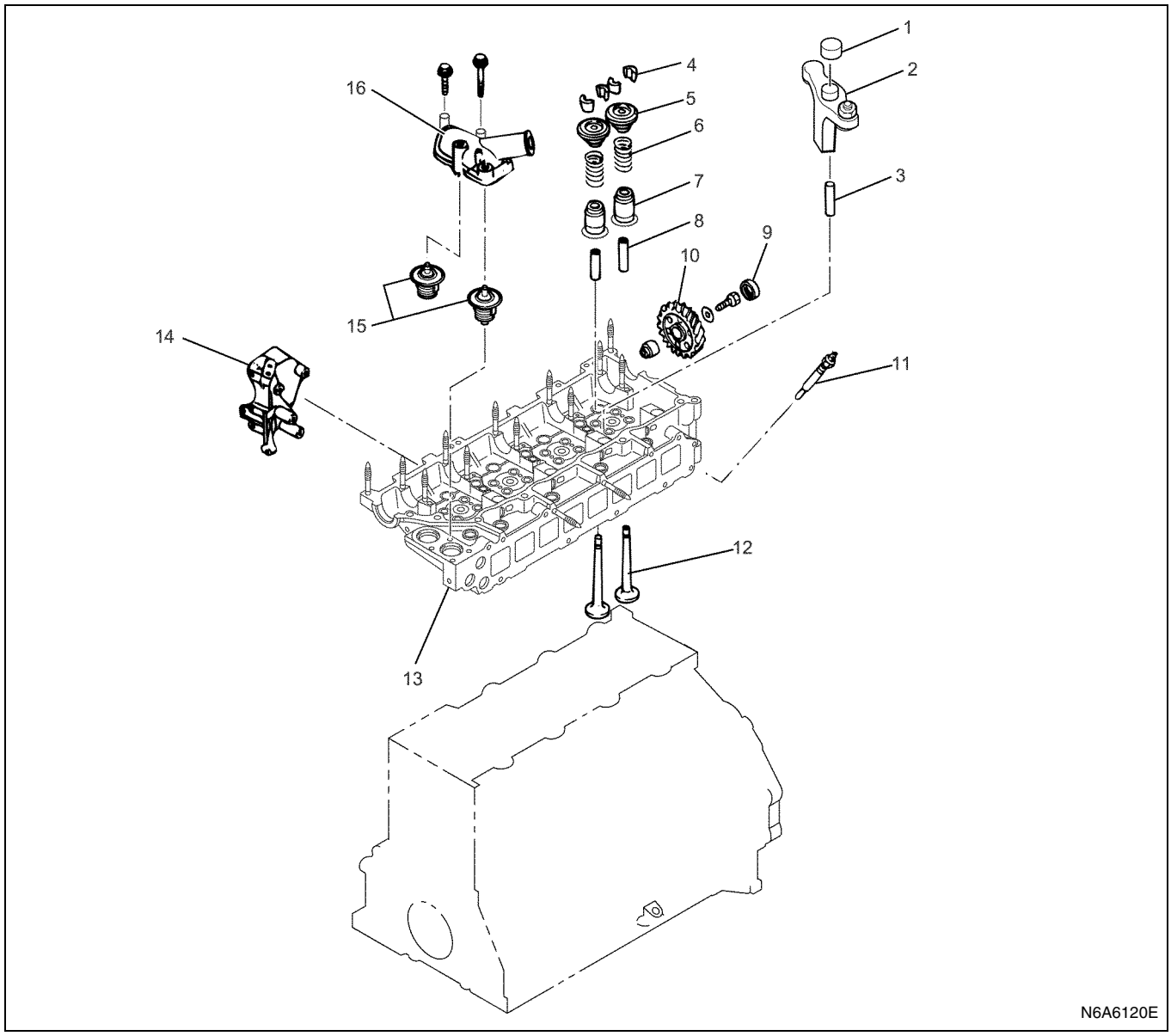
7. Install the camshaft assembly.
   Refer to “Camshaft Assembly”.
8. Install the rocker arm shaft assembly.
   Refer to “Rocker Arm Shaft Assembly”.
9. Install the cylinder head cover.
   Refer to “Cylinder Head Cover”.

Special Tool

Illustration	Tool Number / Description / Remarks
 5884026210	5-8840-2621-0 (J-43263) Valve Spring Replacer
 8943968620	5-8840-2808-0 (EN-46721) Pivot Assembly
 EN47685	5-8840-2833-0 (EN-47685) Valve Stem Seal Installer

Cylinder Head

Component



Legend

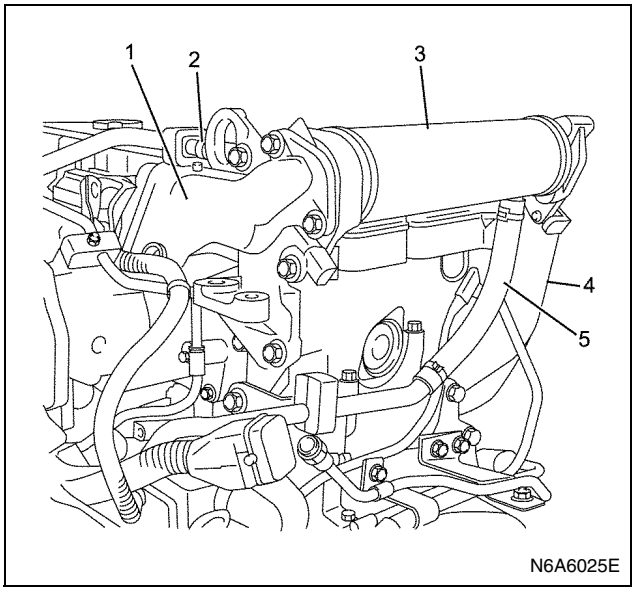
1. Bridge Cap
2. Bridge
3. Bridge Guide
4. Split Collar
5. Spring Upper Sheet
6. Valve Spring
7. Valve Stem Oil Seal
8. Valve Guide
9. Idle Gear C Cover
10. Idle Gear C
11. Glow Plug
12. Intake and Exhaust Valves
13. Cylinder Head
14. A/C Compressor Bracket
15. Thermostat
16. Water Outlet Pipe

Caution:
To avoid electric shock;
Set the switch to the 'OFF' position and disconnect battery negative cable before checking or repairing the fuel injector, wiring or/and connectors.

Removal

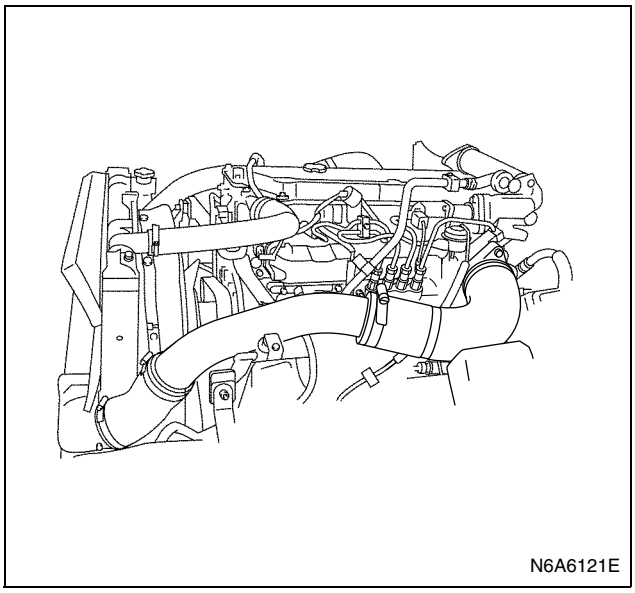
1. Drain the coolant.
2. Remove the engine harness.
3. Remove the front exhaust pipe.
4. Remove the turbocharger.
   Refer to "Turbocharger and Exhaust Manifold".

5. Remove the left-hand EGR adapter and right-hand EGR pipe.
6. Remove the EGR water feed pipe.
7. Remove the EGR water return pipe.
8. Remove the EGR cooler.
9. Remove the water feed pipe for coolant water for the EGR cooler and the water return pipe.

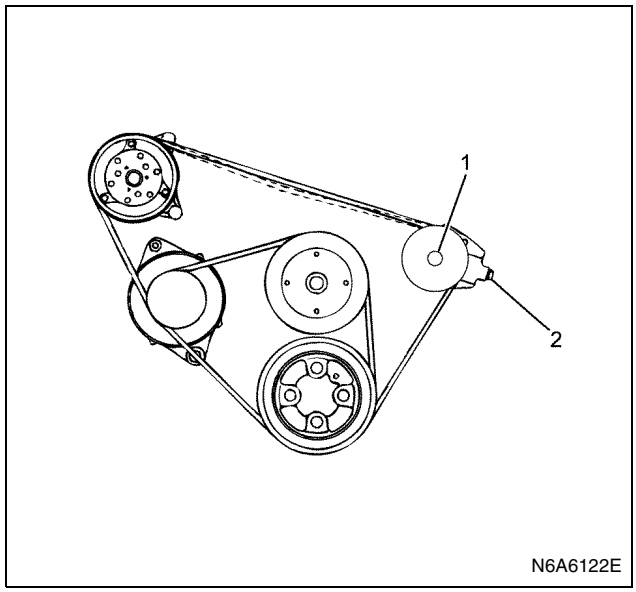


Legend
1. EGR Adapter
2. Water Return Pipe
3. EGR Cooler
4. EGR Pipe
5. Water Feed Pipe

10. Remove the fan guide bracket.
11. Remove the left-hand intake pipe between the inter-cooler and the inlet duct.

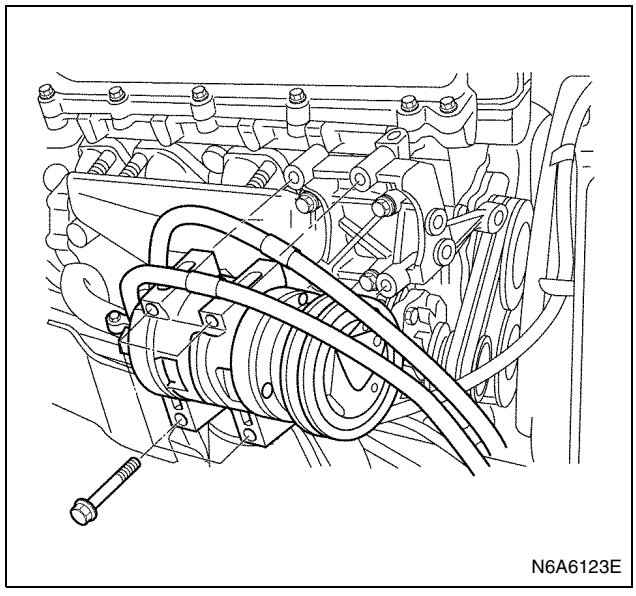


12. Remove the A/C compressor drive belt.
    - Loosen the tension pulley nut and the adjust bolt and remove the drive belt.



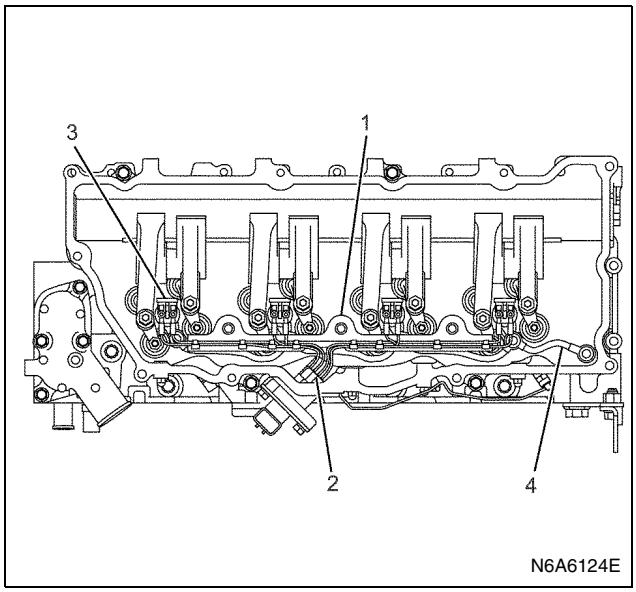
Legend
1. Tension Pulley Nut
2. Adjust Bolt

13. Remove the A/C compressor.
    - Remove the A/C compressor harness connector, remove the compressor from the A/C compressor bracket, and fix it with wires and others.



14. Remove the cylinder head cover.
    Refer to “Cylinder Head Cover.”
15. Remove radiator upper hose.
16. Loosen the fuel injector terminal nuts alternately to the same level, and remove the terminal.
17. Loosen the fuel injector harness bracket bolt, remove the inside connector, and remove the harness bracket.

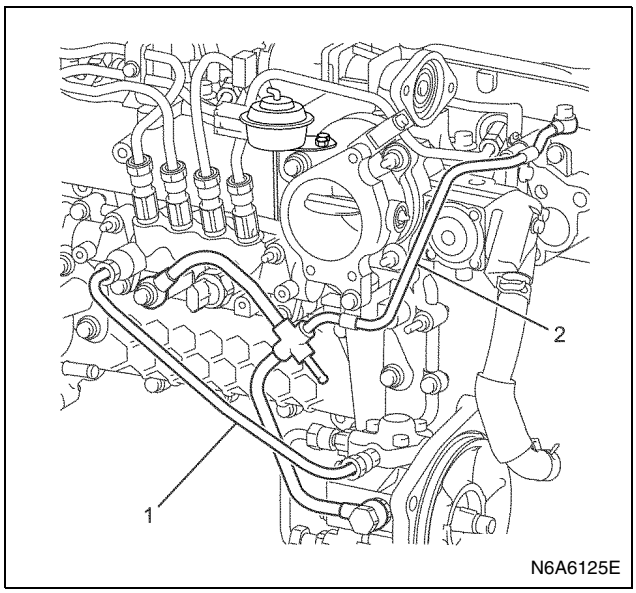
18. Remove the nozzle leak-off pipe (4).



Legend

1. Harness Bracket
2. Harness Connector
3. Fuel Injector Terminal Nut
4. Nozzle Leak-off Pipe

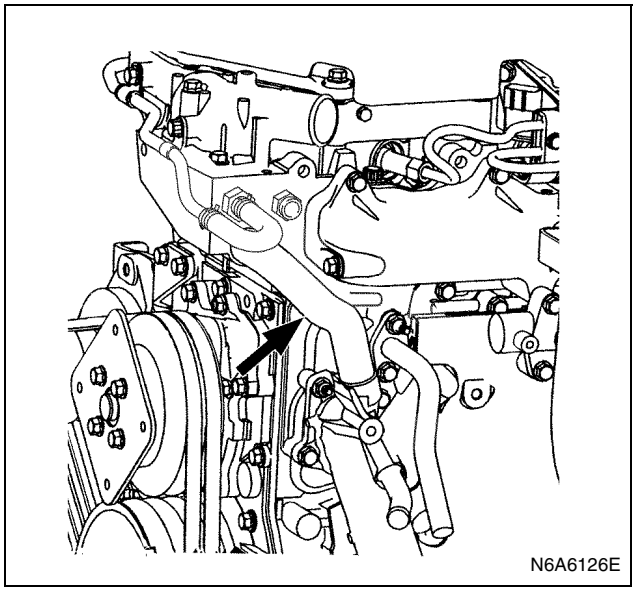
19. Remove the fuel leak-off hose.
20. Remove the fuel leak-off pipe (2).



Legend

1. High Pressure Pipe
2. Leak-off Pipe

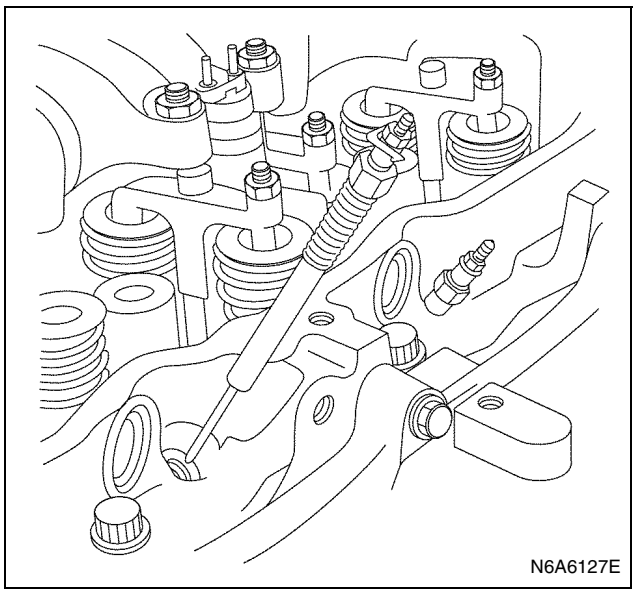
21. Remove the water bypass hose from the cylinder head side.
    - Remove the engine coolant temperature sensor connector.



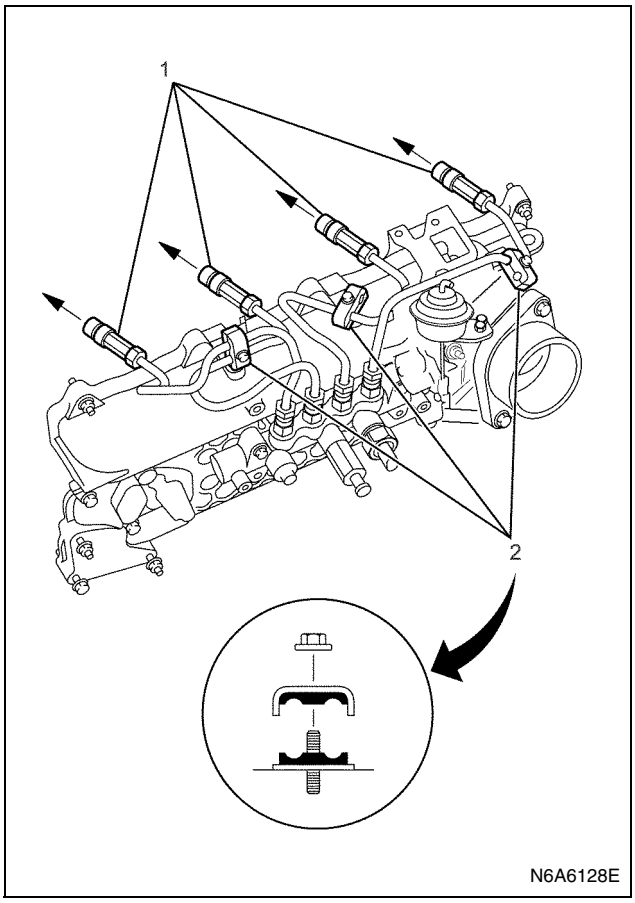
22. Remove the EGR valve and EGR valve connector.
23. Remove the camshaft position sensor connector.
24. Remove the rocker arm shaft assembly.
    Refer to “Rocker Arm Shaft Assembly”.
25. Remove the camshaft assembly.
    Refer to “Camshaft Assembly”.
26. Remove the bridge cap carefully so that it does not fall into inside the engine.
27. Remove the bridge.

Caution:
Store the removed bridge and bridge cap so that they can be placed in their original locations.

28. Remove the glow plug connector.
29. Remove the glow plug.



30. Remove the injection pipe clip, and remove the injection pipes.



Legend
1. Fuel Injection Pipe
2. Fuel Injection Pipe Clip

31. Remove the fuel rail.
    - Remove the fuel rail pressure sensor connector.
32. Remove the fuel injector bracket.
33. Loosen the fuel injector clamp fixing bolts and remove the fuel injectors.

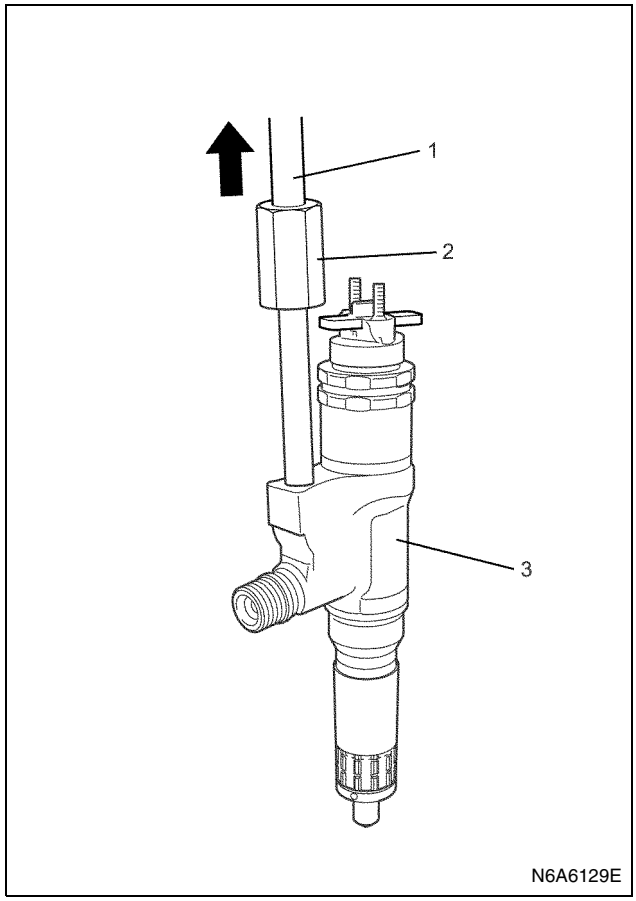
If the fuel injectors are difficult to remove, use the fuel injector remover. Install the fuel injector remover to the leak-off pipe attachment part on the fuel injector. Use a sliding hammer to force the fuel injector clamp off the fuel injector.

Caution:
Do not remove the fuel injector sleeve.

Special tool
Fuel injector remover: 5-8840-2826-0 (EN-46720)
Sliding hammer: 5-8840-0019-0 (J-23907)

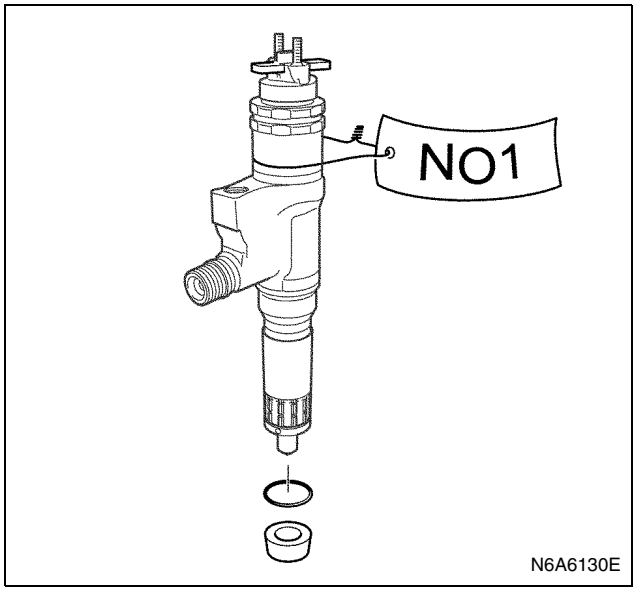
34. Mark each fuel injector with the number of the cylinder from which it was removed. Store the fuel injectors in a safe place. Position the fuel injector so that the nozzle is protected.

Caution:
- Do not tamper with the electromagnetic portion of the fuel injector. Reduced electromagnetic function will result in injector failure.



Legend
1. Sliding Hammer
2. Fuel Injector Remover
3. Fuel Injector Assembly

Caution:
Attach a cylinder number to the removed fuel injectors til re-install them.
Be sure not to make the nozzle touch something.

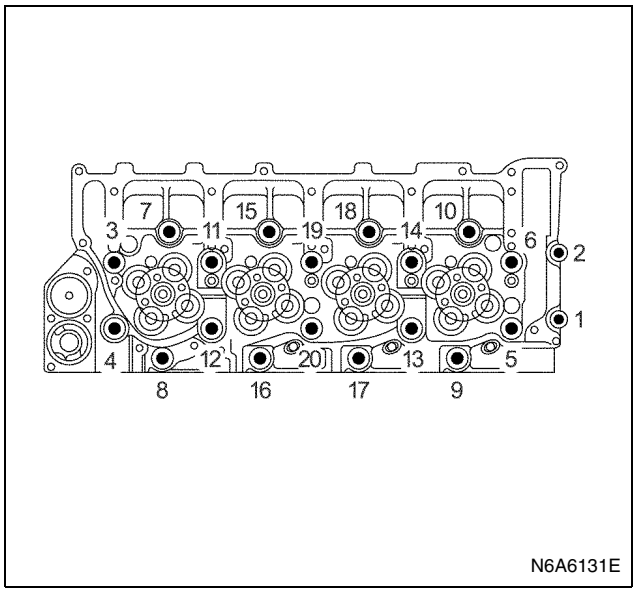


35. Remove the lower head cover.
36. Remove the cylinder head assembly.
    - Loosen the cylinder head bolts in the described order in the drawing.

Caution:
Be sure not to overlook (1) and (2) because they are attached with the flywheel housing with M10 bolts.

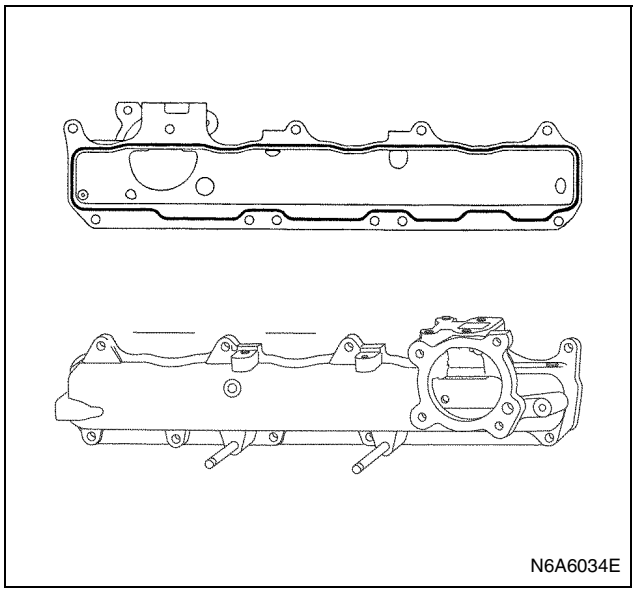
- Remove the cylinder head gasket.

Caution:
Replace the head gasket with a new one once it was removed.

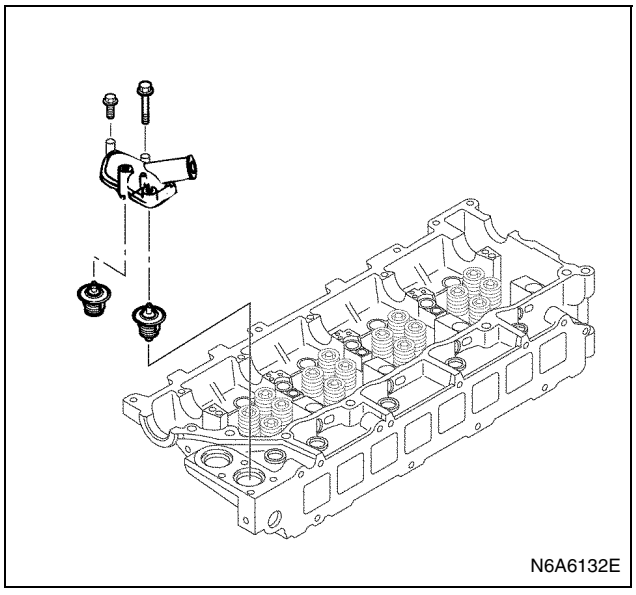


Disassembly

1. Remove the throttle assembly.
    - Remove the intake throttle valve connector.
2. Remove the inlet cover.
    - Remove liquid gasket adherent to the removed inlet cover.

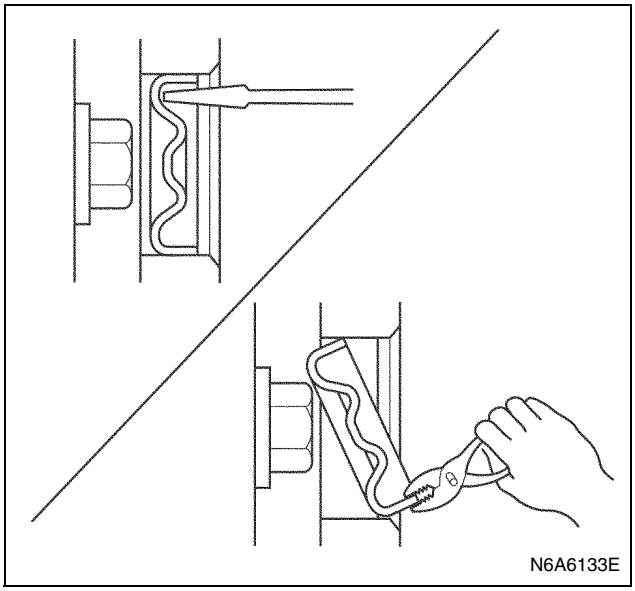


3. Remove the A/C compressor bracket.
4. Remove the exhaust manifold.
   Refer to “Exhaust”.
5. Remove the exhaust gasket.
6. Remove the water outlet pipe.
7. Remove the thermostat.

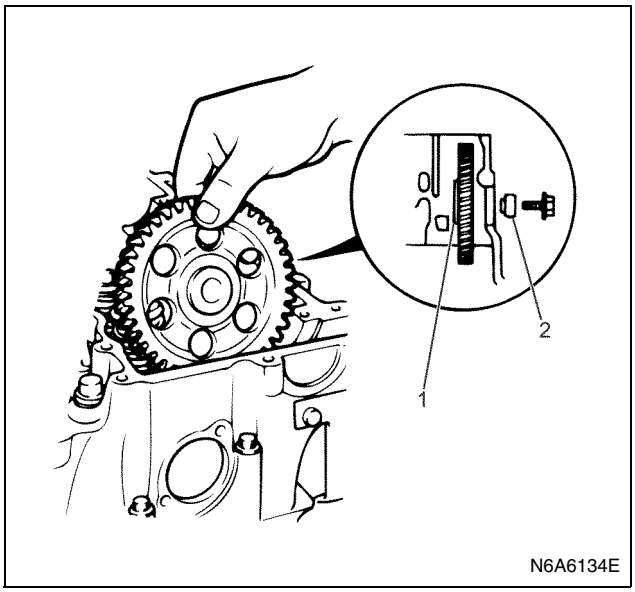


8. Remove the idle gear C cover.

- Put the edge of a driver on the outer circle of the sealing cup as shown in the drawing, tap it lightly, reverse it, then pull it out with pliers or other equipment.



9. Remove the idle gear C.



Legend

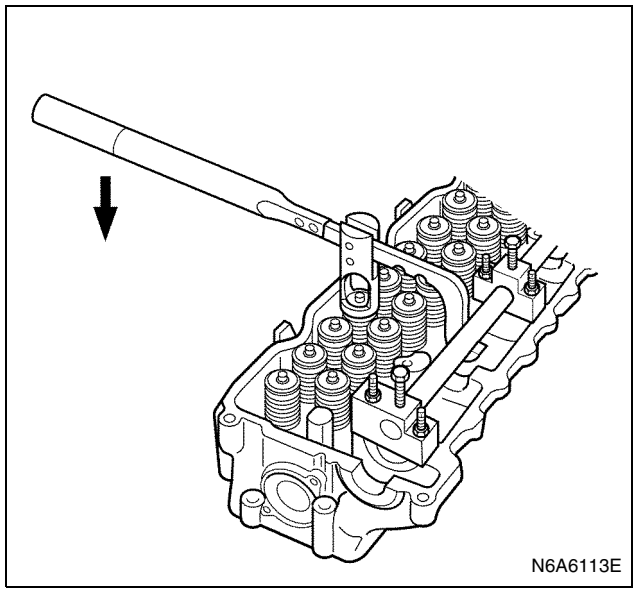
1. Idle Gear C
2. Shaft

10. Remove the split collar.
11. Remove the spring upper sheet.
12. Remove the valve spring.
    - Use a replacer to compress the valve spring, then remove the split collar.

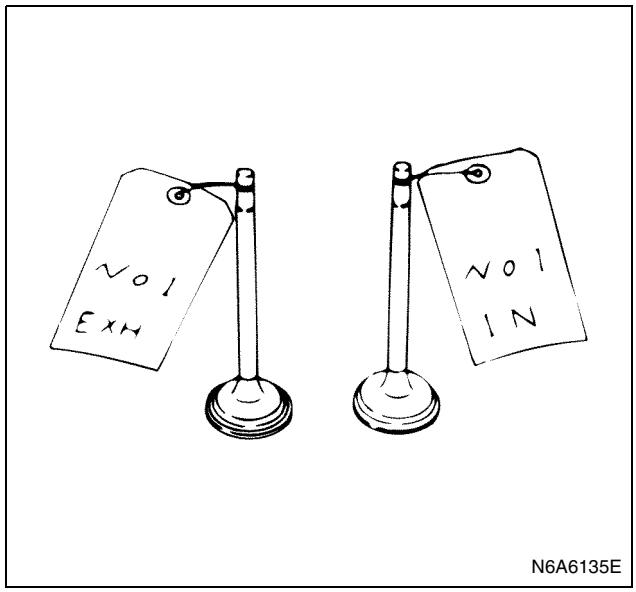
      Special tool
      Valve spring replacer: 5-8840-2621-0 (J-43263)
      Pivot: 5-8840-2808-0 (EN-46721)

- Remove the special tool, then remove the upper sheet and springs.

  Sort the removed valve springs by cylinder number.

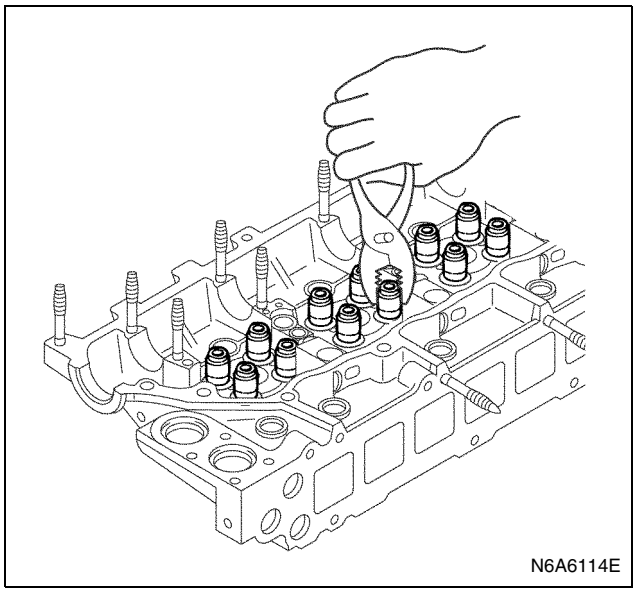


13. Remove the intake and exhaust valves.
    - Sort the removed valves according to cylinders by using tags and others.



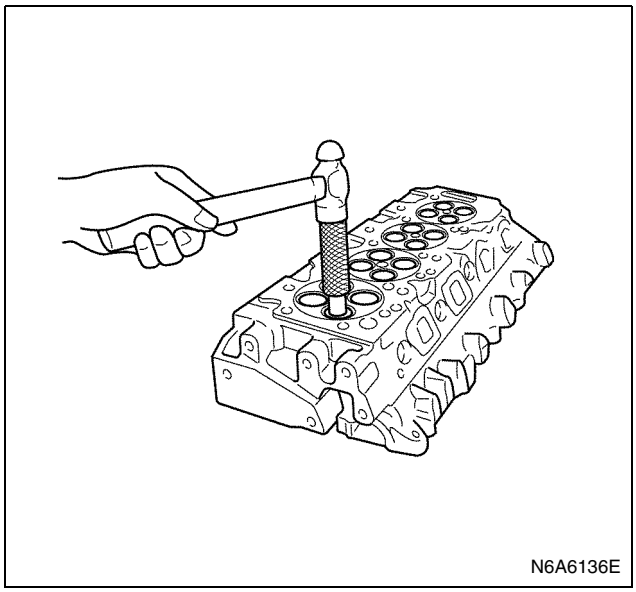
14. Remove the valve stem oil seals.

- Use pliers to remove the oil seals.



15. Remove the valve guides.
    - Use the valve guide replacer to press out the valve guides from the bottom side of the cylinder head.

      Special tool
      Valve guide replacer: 5-8840-2628-0 (J-43272)

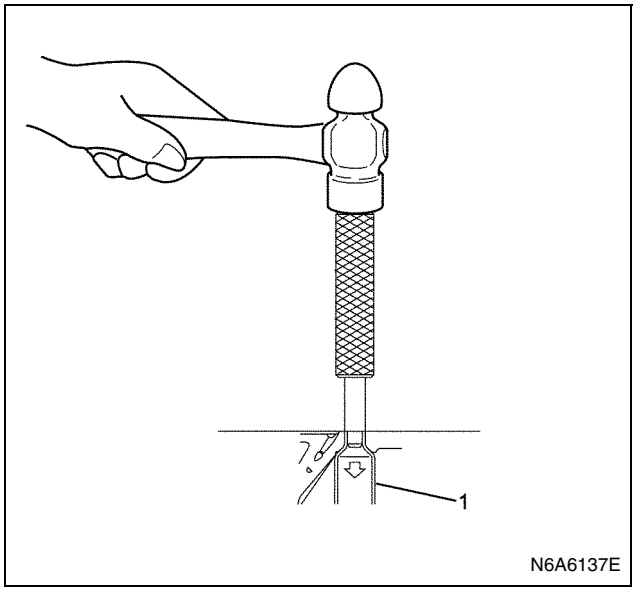


16. Put the nozzle sleeve remover on the nozzle sleeve from the bottom side of the cylinder head, then pull out the nozzle sleeve.

    Special tool
    Nozzle sleeve remover: 5-8840-2623-0 (J-43265)

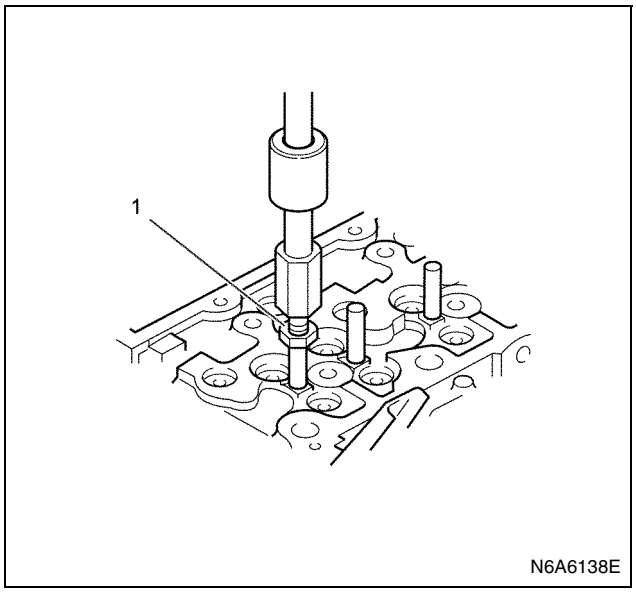
Caution:

- Be sure not to scratch the bottom side of the cylinder head.
- Do not reuse the removed nozzle sleeve.
- Carefully remove sawdust in the screw groove.



Legend
1. Nozzle Sleeve

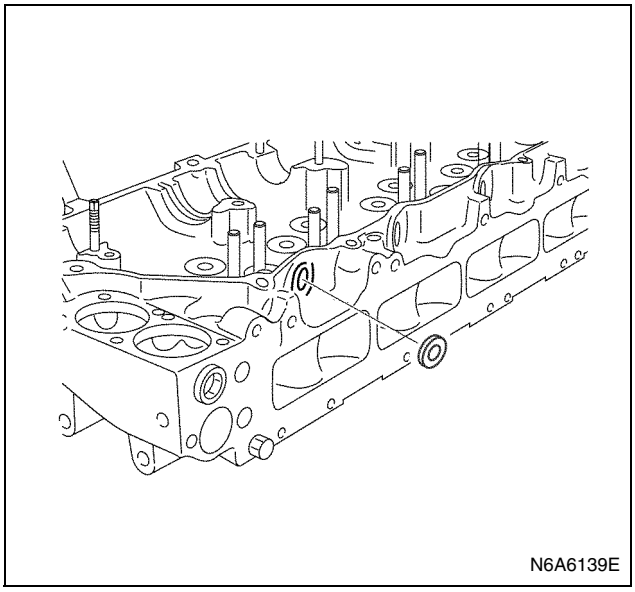
17. Remove the bridge guide.
    - Electrically weld the nut on the head of the bridge guide, attach the sliding hammer and pull it out.



Legend
1. Nut

18. Remove the oil seal.

- Press the tool against the oil seal. Strike the tool to remove the seal from the inside of the cylinder head.



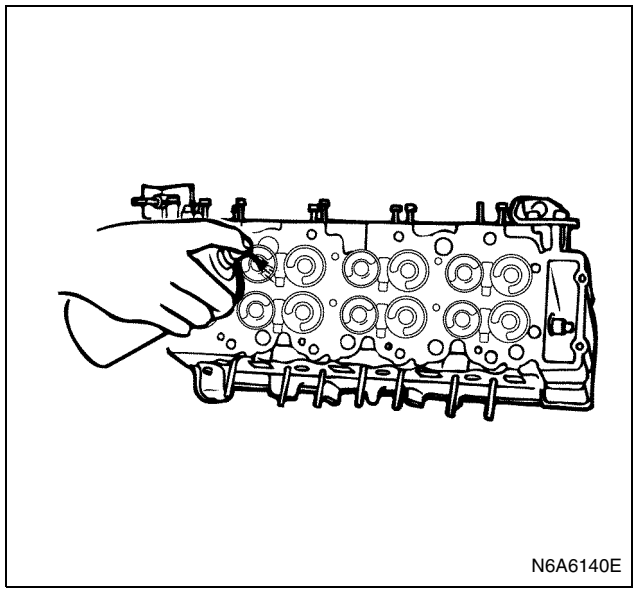
Inspection

1. Inspect the cylinder head assembly.
   - Remove varnish, soot and others adhered on the metal surface completely. Use metal brush and others so that the seal surface of the surface where the gasket is installed is not damage.
   - Check the following causes in the case of leak of the seal surface of the cylinder head, corrosion, air leak and defective gasket.
     - Defective installation.
     - Defective tightening of the cylinder head.
     - Winding seal surface of the cylinder block.

a. Damage on the screw surface or extracted cylinder head bolt due to extra tightening torque

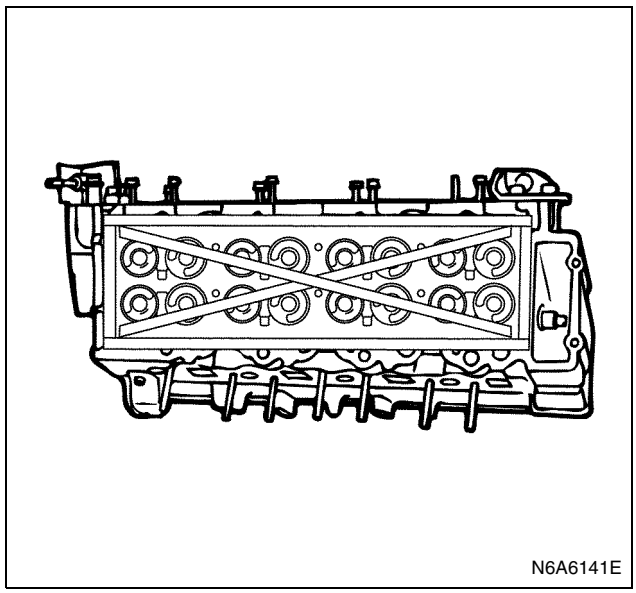
Caution:
Replace suspicious bolt.

b. Inside the combustion chamber, glow plug hole.
   - Check whether there is a crack between the valve sheets and in the cylinder head of the exhaust port part, and replace the cylinder head if there is serious damage or crack. Check the collar if necessary.



c. Flatness of the under surface of the cylinder head
   - Use a straight edge ruler and thickness gauge to measure the four sides and diagonal lines as shown in the drawing, and replace if they exceed the limit.

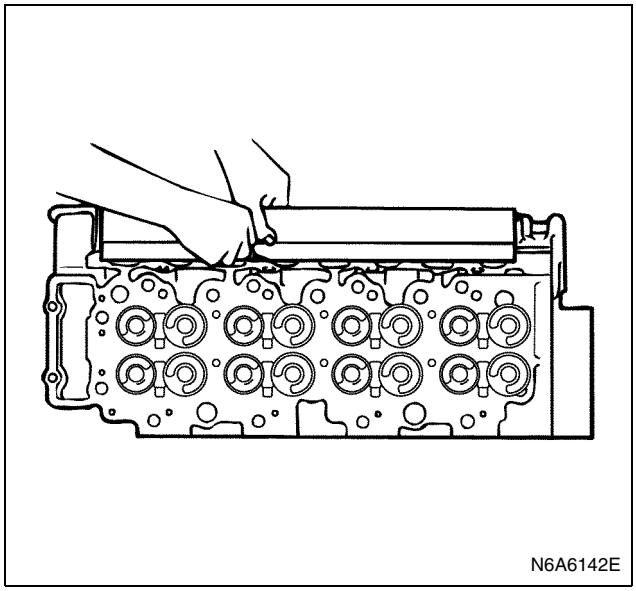
Distortion of the under surface of the cylinder head	mm (in)
Standard	0.05 (0.002) or less
Limit	0.20 (0.0079)



d. Flatness of the surface where the exhaust manifold and inlet cover are installed

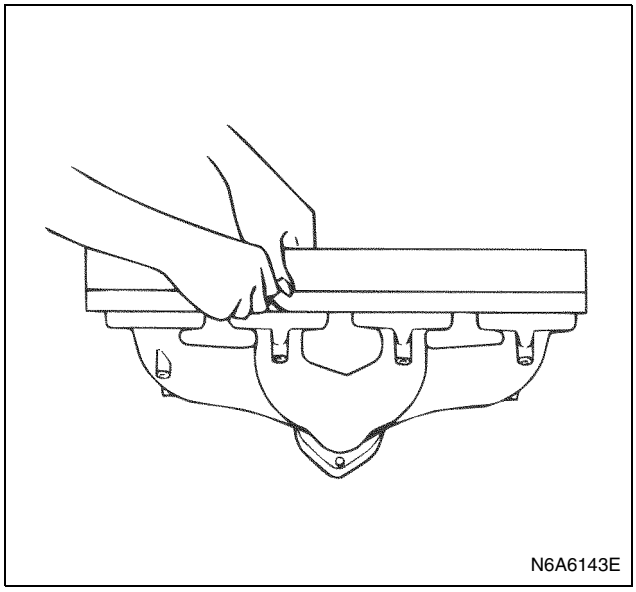
- Use a straight edge ruler and thickness gauge to measure the four sides and diagonal lines as shown in the drawing, and replace if they exceed the limit.

Distortion of the surface where the manifold and cover are installed	mm (in)
Standard	0.05 (0.002) or less
Limit	0.2 (0.0079)


N6A6142E

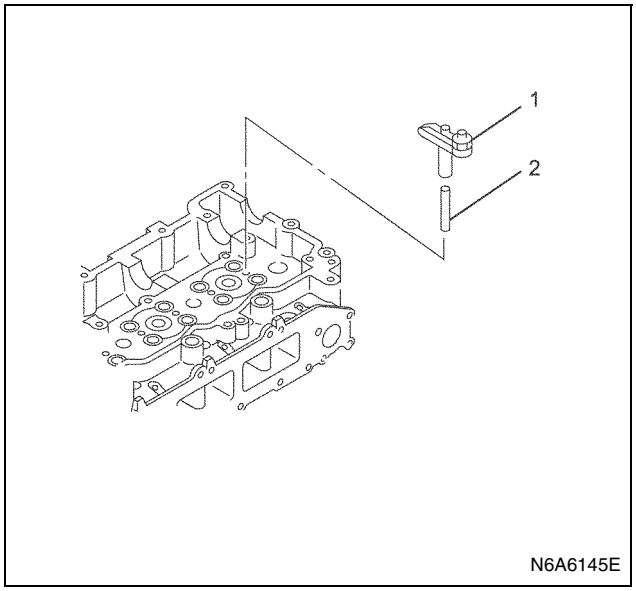
e. Flatness of the exhaust manifold
- Use a straight edge ruler and thickness gauge to measure the flatness. If it exceeds the limit, replace the exhaust manifold.

Distortion of the exhaust manifold	mm (in)
Standard	0.3 (0.0118)or less
Limit	0.5 (0.0197)


N6A6143E

2. Bridge
- Make sure the bridge moves smoothly along the bridge guide.
- Measure the gap between the bridge and bridge guide.

Gap between the bridge guide and bridge guide	mm (in)
Assembly standard	0.020 (0.00079) – 0.056 (0.00220)
Usage limit	0.1 (0.0039)



N6A6145E

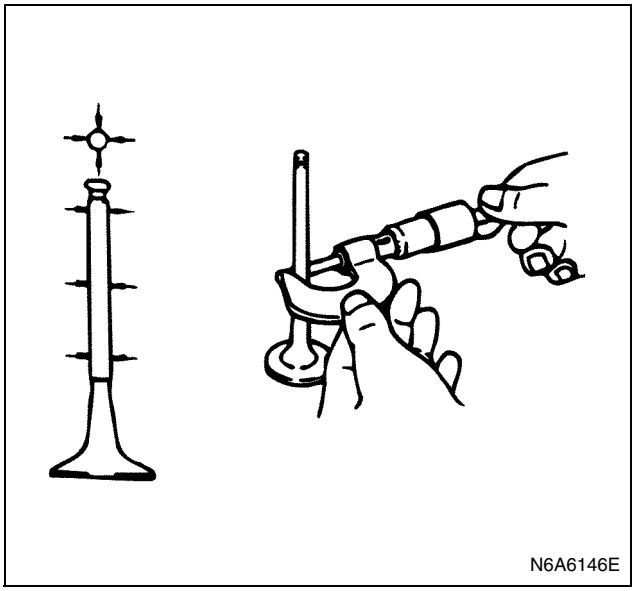
Legend
1. Bridge
2. Bridge Guide

3. Inspect the valve guide.

Caution:
If there is a scratch or abnormal abrasion in the valve stem and the inner diameter part of the valve guide, replace it with new one along with valve guide.

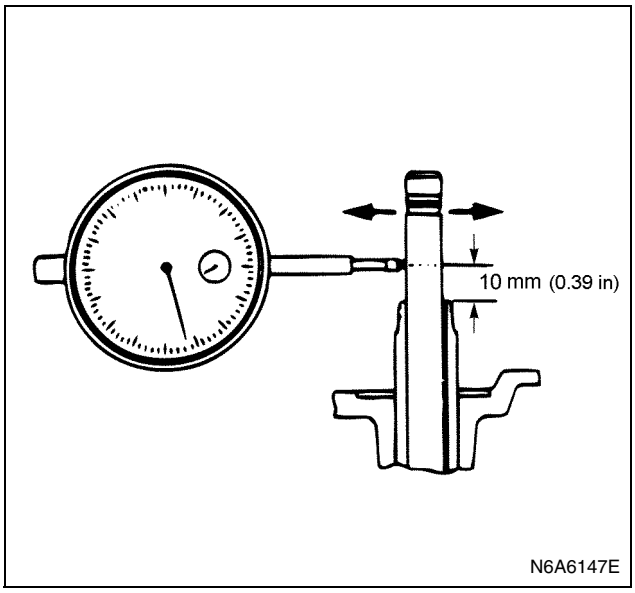
a. Measure the valve guide clearance.
- Measure the diameter of the valve stem with a micro meter.
  If the diameter of the valve stem is smaller than the limit, replace the valve and valve stem altogether.

The external diameter of the valve stem		mm (in)
	Standard	Limit
Intake valve	7.946 (0.3128) – 7.961 (0.3134)	7.88 (0.3102)
Exhaust valve	7.921 (0.3118) – 7.936 (0.3124)	7.80 (0.3071)



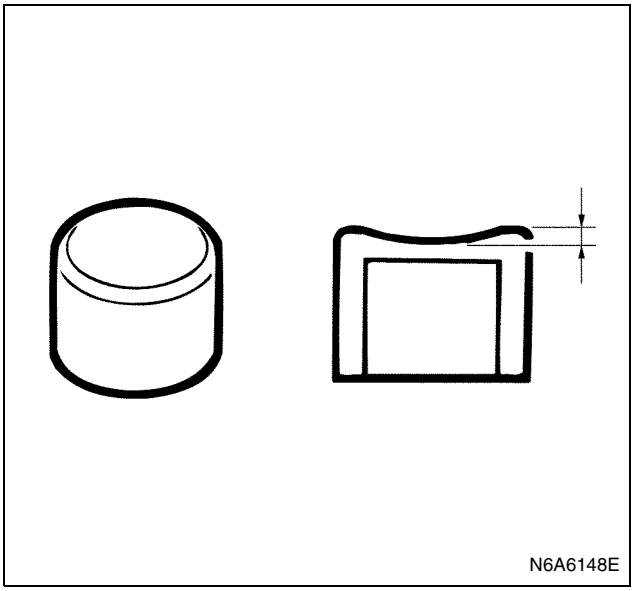
- Measure the gap between the valve guide and valve stem within 10 mm (0.39 in) from the valve guide, using a dial gauge.
- If the measured value exceeds the limit, replace the valve guide and valve altogether.

Gap between the valve guide and valve stem		mm (in)
	Standard	Limit
Intake valve	0.039 (0.00153) – 0.071 (0.00280)	0.20 (0.00787)
Exhaust valve	0.064 (0.00252) – 0.096 (0.00378)	0.25 (0.00984)



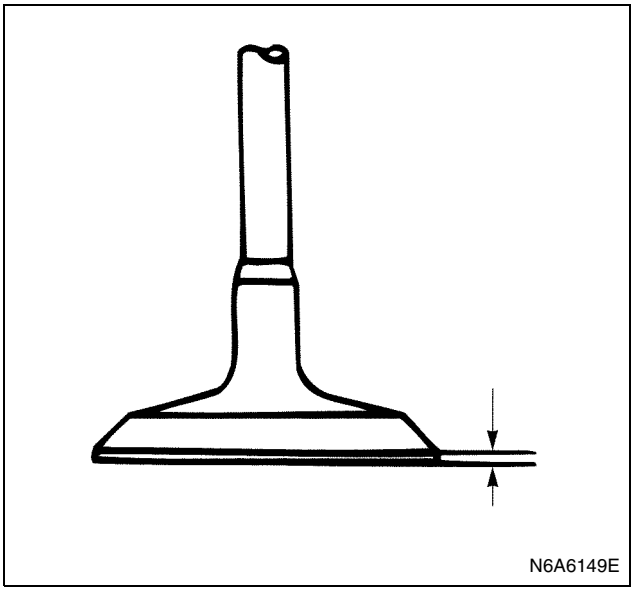
4. Inspect abrasion of the bridge gap.
   - Measure the contact surface of bridge cap and the rocker arm, using a dial gauge.
   - If the abrasion exceeds the limit, or there is an abnormal abrasion (zonal abrasion), replace the bridge cap.

Abrasion of the bridge cap	mm (in)
Limit	0.1 (0.00394)



5. Inspect the valve.
   Thickness of the valve
   - Measure the thickness of the valve.
   - If the measured value exceeds the limit, replace the valve and valve guide altogether.

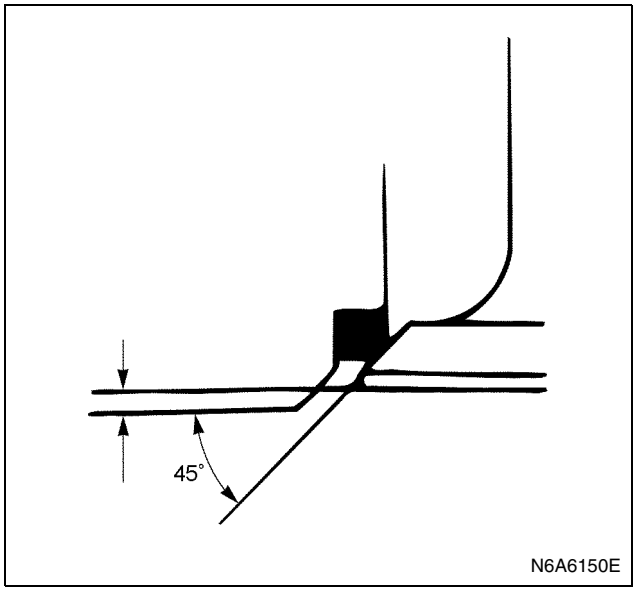
Thickness of the valve		mm (in)
	Standard	Limit
Intake valve	1.71 (0.0673)	1.3 (0.0512)
Exhaust valve	1.75 (0.0689)	1.3 (0.0512)



Valve sheet

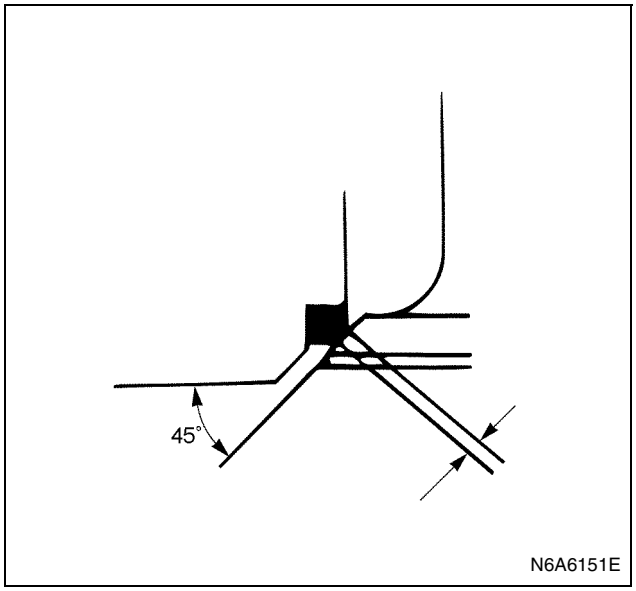
- Remove carbon, water stain and others on the under surface of the cylinder head.
  Install the valve in the cylinder head.
  Measure the depth of the valve from the under surface of the cylinder head, using a depth gauge or straight edge ruler.
  If it exceeds the limit, replace the valve insert or cylinder head assembly.

Depth of the valve	mm (in)
Standard	0.7 (0.0276) – 1.2 (0.0472)
Limit	2.5 (0.0984)



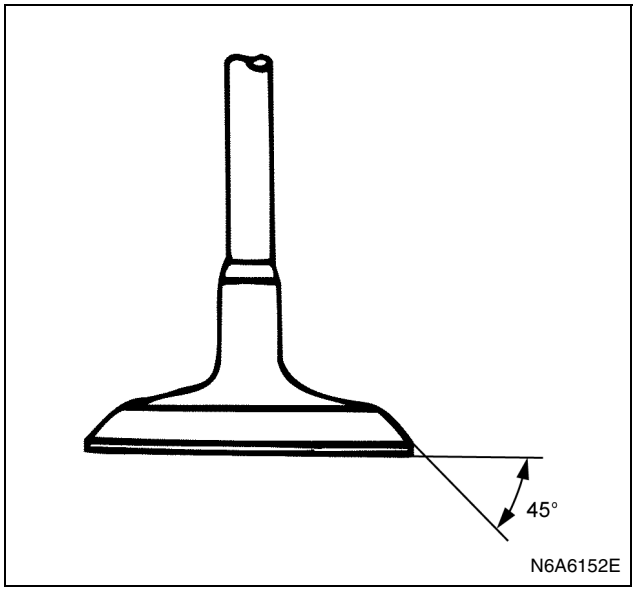
- Measure the contact width of the valve seat. If the seat contact surface has a scratch or is rough, or if the abrasion of the contact surface exceeds the limit, modify or replace it.

Contact width of the valve seat		mm (in)
	Standard	Limit
Intake valve	2.5 (0.0984)	3.0 (0.1181)
Exhaust valve	2.0 (0.0787)	2.5 (0.0984)



Contact surface of the valve seat

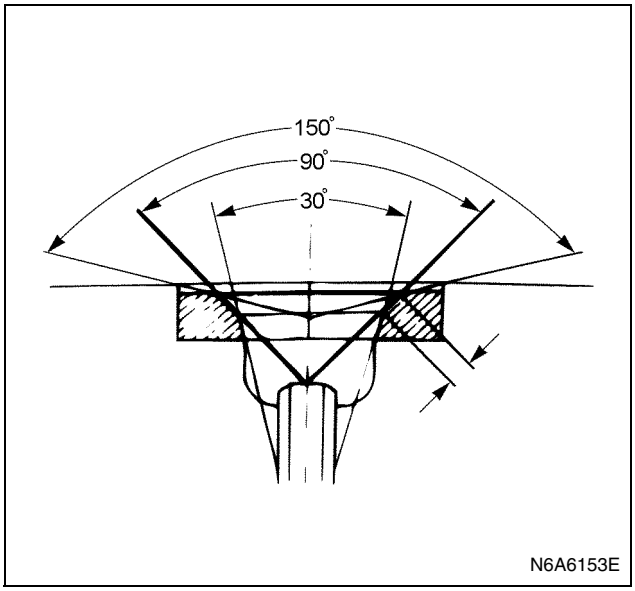
- If the contact surface of the valve seat is defective, modify it or replace the valve, valve guide and valve seat altogether.
  Angle of the contact surface: 45° (degrees)



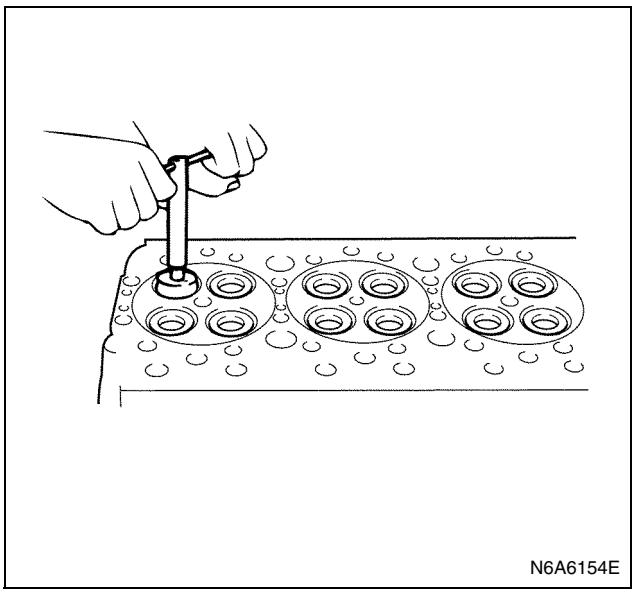
Repair of the seat surface

- Remove carbon from the surface of the valve insert seat.

- Use a seat cutter to minimize the scratch and other roughness (15/45/75 degree-blade), thereby returning the contact width to the standard value.

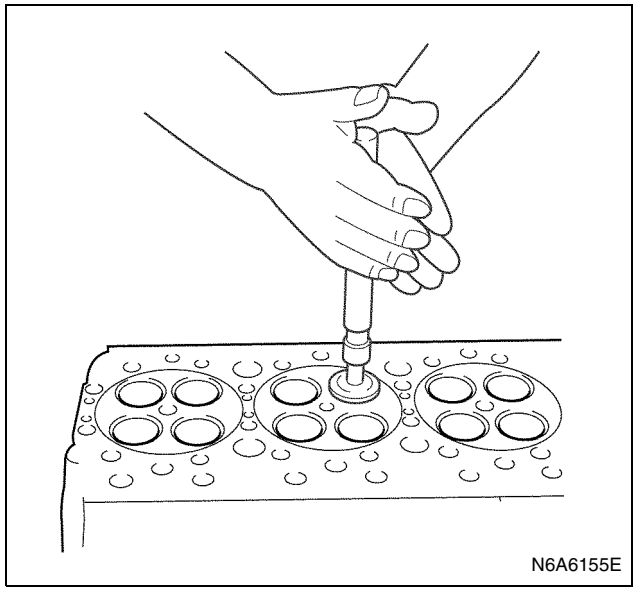


Caution:
Remove only scratches and roughness, and do not cut the surface too much.
Use the free adjustment valve cutter pilot.
Do not let the valve cutter pilot waver inside the valve guide.



- Attach abrasives in the valve insert seat.
- Insert the valve into the valve guide.
- Attach abrasives on the valve seat surface, rotate the valve and hit it lightly to grind them, and confirm that it has even contact all round.

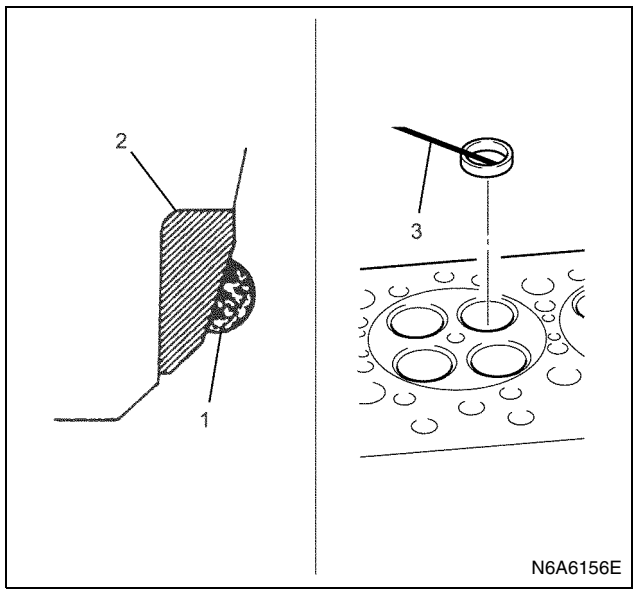
Caution:
Remove abrasives completely after grinding.



Replace the valve seat insert

Remove the valve seat insert

- Arc-weld the entire inner diameter of the valve seat insert.
- Cool the valve seat insert for two to three minutes. Contraction fur to cooling makes it easier to remove the valve seat insert.
- Remove the valve seat insert, using a screw driver. Be sure not to damage the cylinder head.

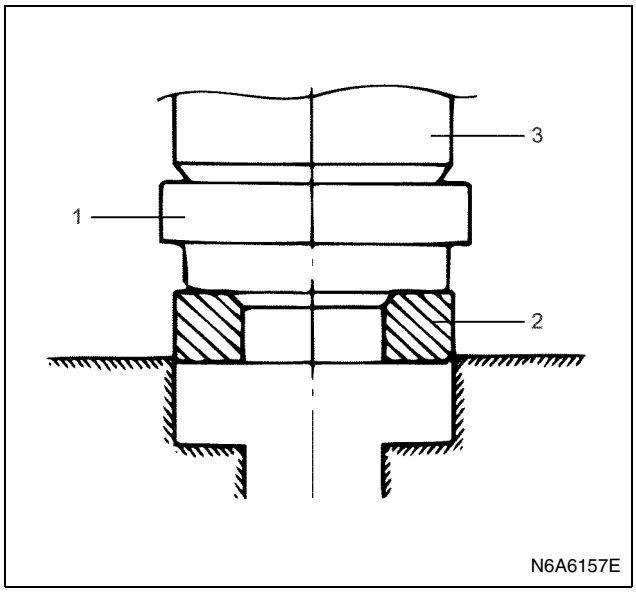


Legend
1. Arc-weld
2. Valve Seat Insert
3. Screw Driver

Install the valve seat insert

- Carefully place an attachment (the outer diameter is smaller than the valve seat insert) on the valve seat insert.
- Use the press to apply pressure gradually on the washer, thereby pushing the valve seat insert.

Caution:
Do not apply too much pressure with the press.
Attach compound on the valve seat surface, rotate the valve and hit it lightly to grind them, and confirm that it has even contact all round.



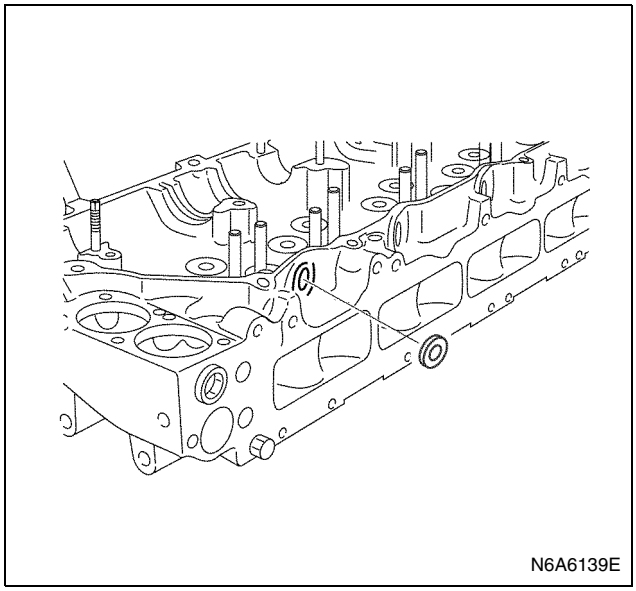
Legend
1. Attachment
2. Valve Seat Insert
3. Press

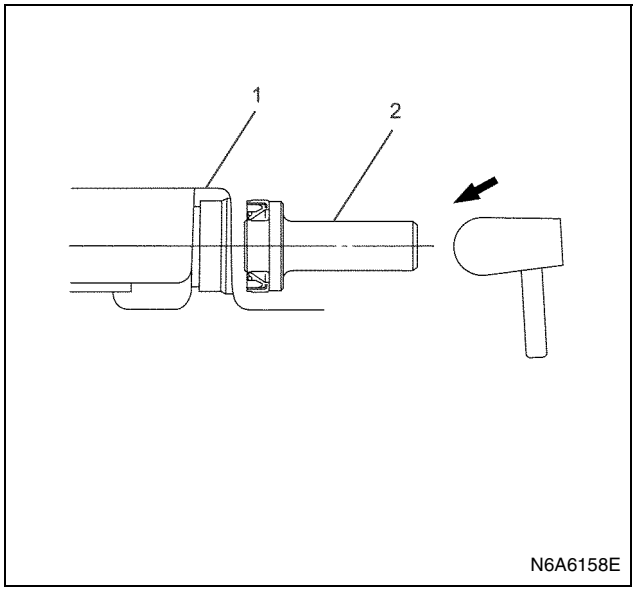
Reassembly

1. Install the oil seal.
   - Install on the surface of injection pipe insert.
   - Hammer it in so that the seal does not incline.

Caution:
Be sure not to damage the rip.

Special tool
Oil seal installer: 5-8840-2627-0 (J-43269)

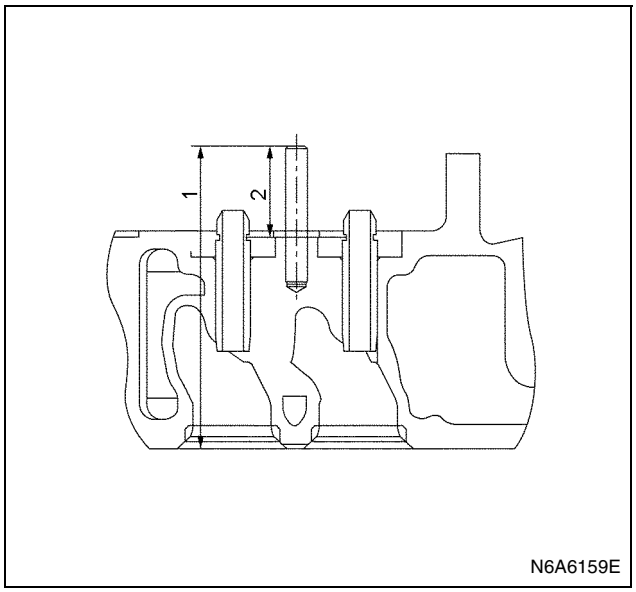




Legend
1. Cylinder Head
2. Oil Seal Installer

2. Install the bridge guide.
   - Apply engine oil on the outer diameter of the guide, then use the installer to hammer it into the depth of the finishing part of the hole of the cylinder head.
     (Note: the height of the bridge guide is about 37.5 mm (1.48 in) from the upper surface of the head)

     Special tool
     Bridge guide installer: 5-8840-2626-0 (J-43268)

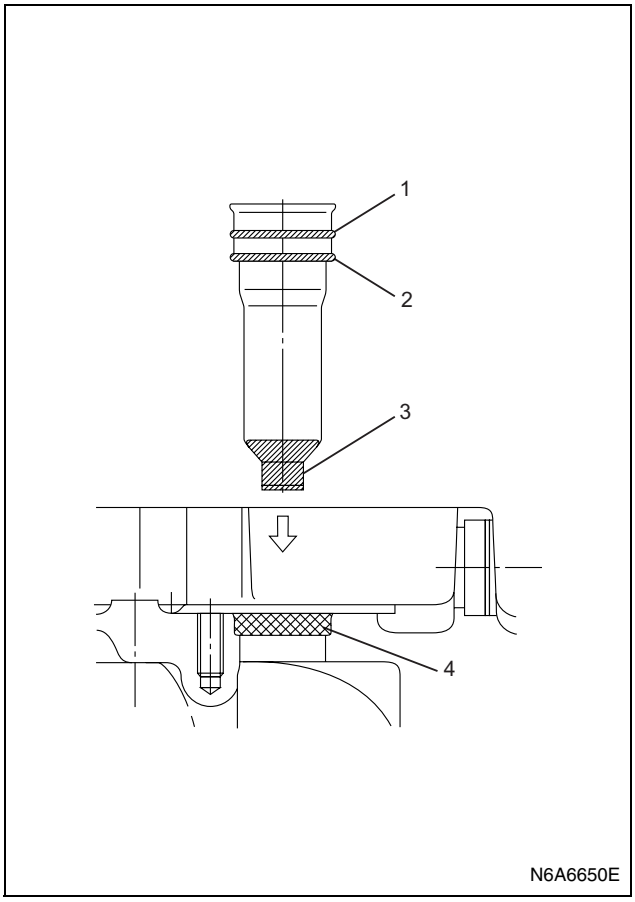


Legend
1. 122.5 ± 0.5 mm (4.82 ± 0.02 in)
2. 37.5 mm (1.48 in)

3. Install the nozzle sleeve.
   - Install the O-ring on the nozzle sleeve, apply engine oil.

- Apply seal material on the taper section.

Loctite No.TL290



Legend

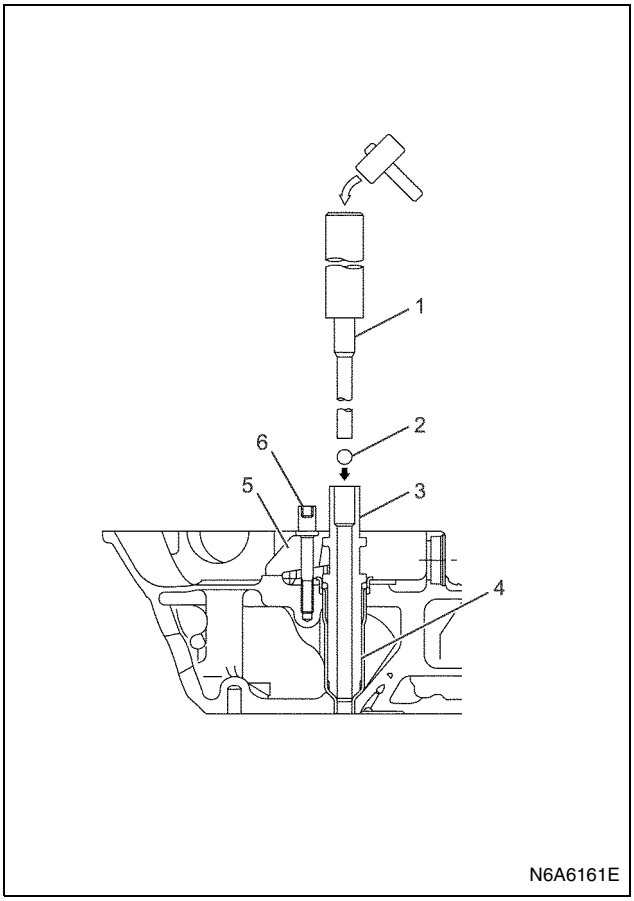
1. O-ring (White Paint)
2. O-ring
3. Apply the Loctite
4. Engine Oil

- Install the nozzle sleeve on the cylinder head, insert the guide sleeve.
- Use the guide sleeve to push in so that the nozzle sleeve fully contacts with the under surface of the cylinder head.
- Insert the sleeve and fix it with the tighten and bolt.
- Insert the ball (bearing steel ball 9.525 mm (0.375 in)) into the guide sleeve, attach the punch bar and hammer out the ball.

Caution:

- Leave the cylinder head floating so that the ball comes off from the under surface.

Special tool
Nozzle sleeve installer: 5-8840-2624-0 (J-43266)



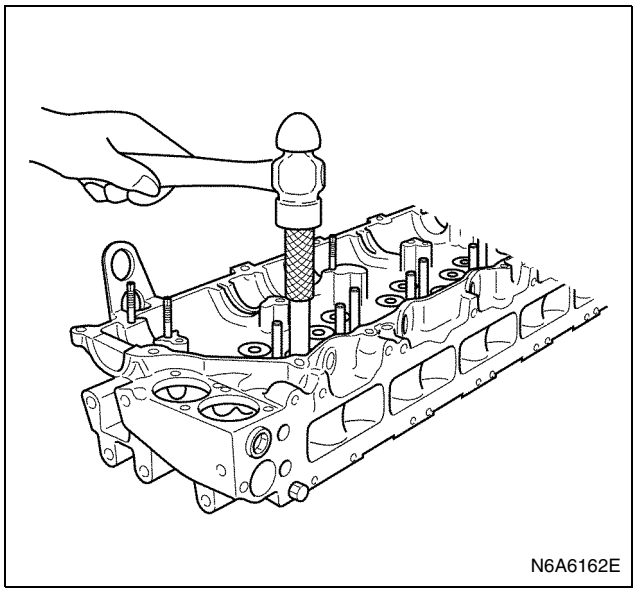
Legend

1. Punch Bar
2. Ball
3. Guide Sleeve
4. Nozzle Sleeve
5. Bracket
6. Bolt

4. Install the valve guide.

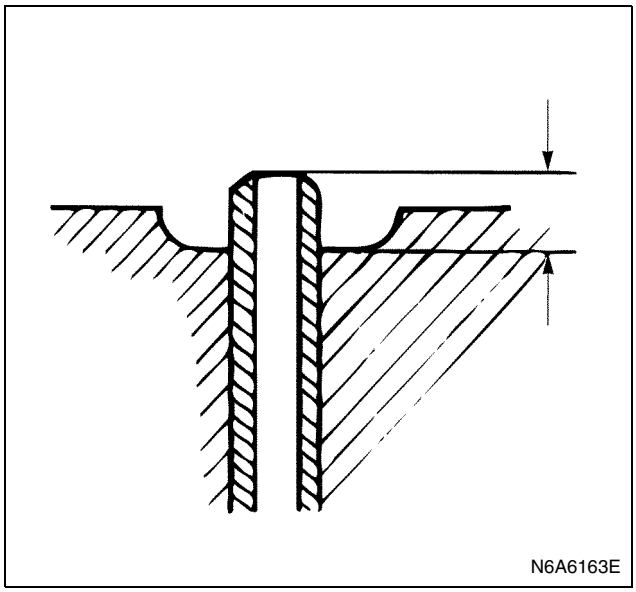
- Hammer in the valve guide from the upper surface of the cylinder head, using the valve guide replacer.

  Special tool
  Valve guide replacer: 5-8840-2628-0 (J-43272)



  Height from the upper surface of the cylinder head to the edge surface of the valve guide: 18.75 – 19.25 mm (0.7381 – 0.7578 in)

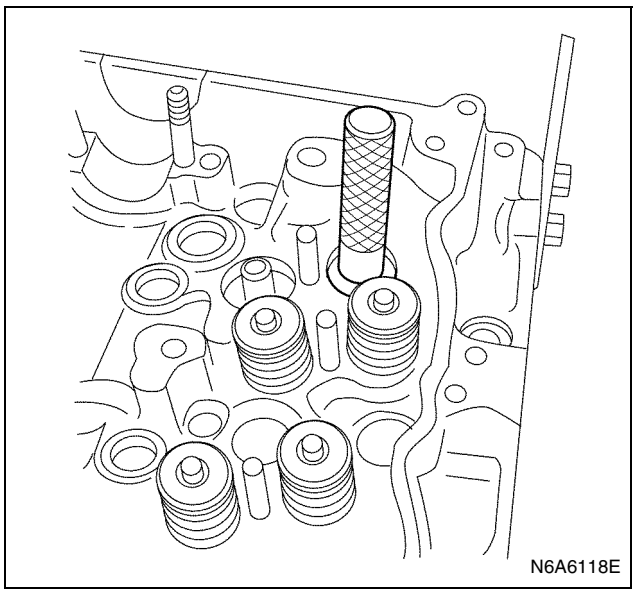
Caution:
When replacing the valve guide, it must be replaced together with the valve.



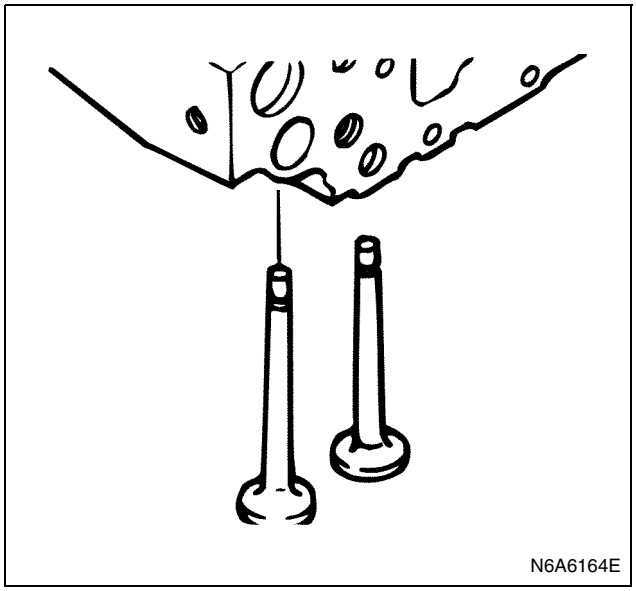
5. Install the valve stem oil seal.
   - Apply engine oil on the outer diameter of the valve guide, use the valve stem seal installer to install the oil seal.

Caution:
After installation of the valve stem seal, confirm that the oil seal is not inclining and the garter spring is in place.

  Special tool
  Valve stem seal installer: 5-8840-2833-0 (EN-47685)

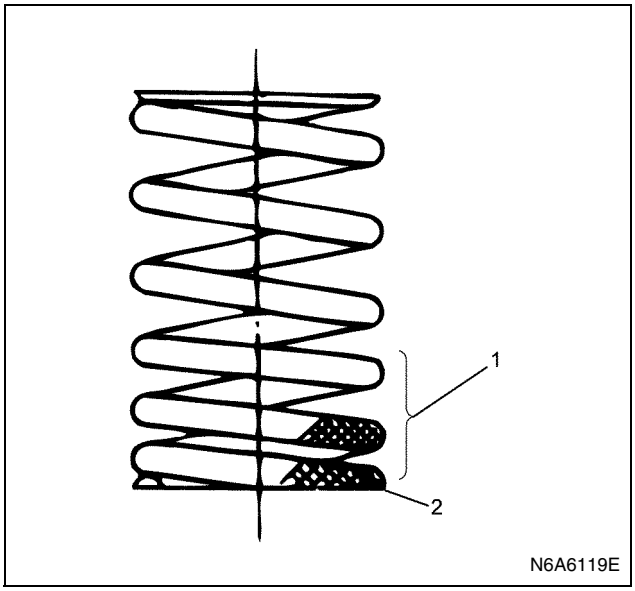


6. Install the intake and exhaust valves.
   - Apply engine oil on the valve stem part and install the valve.



7. Install the valve spring.
   - Install the valve spring with the paint mark or the narrower side of the spring pitch on the under side (the cylinder head side).

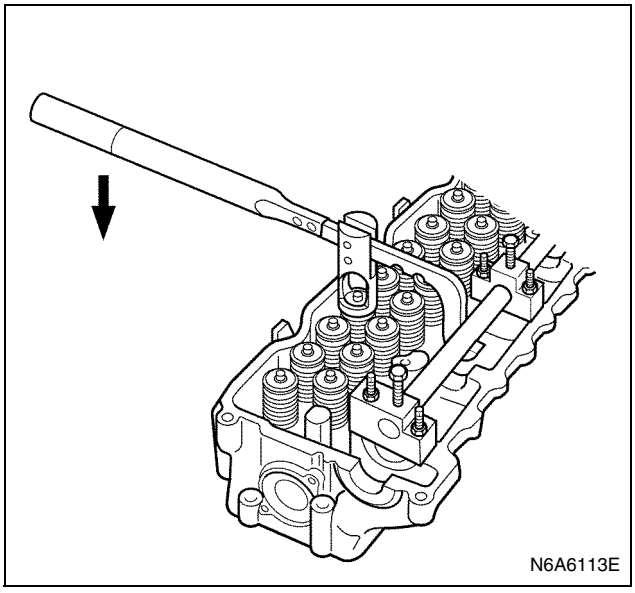
	Paint mark
Intake side	Blue
Exhaust side	Red



Legend
1. Spring Pitch
2. Paint Mark

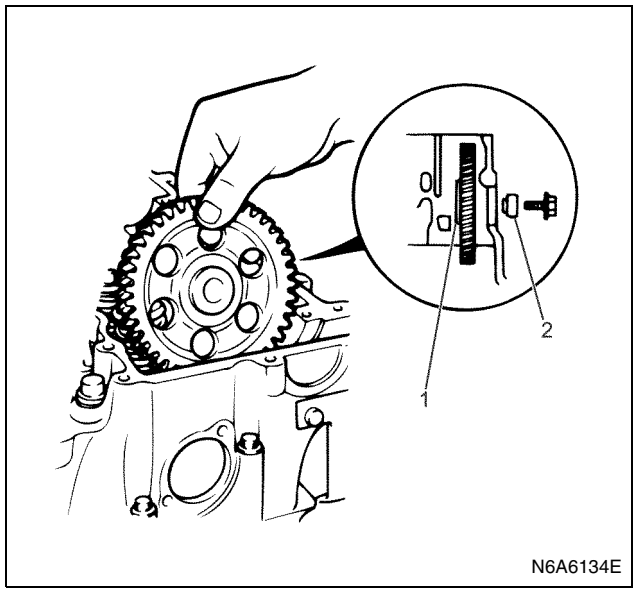
8. Install the spring upper sheet.
9. Install the split collar.
   - Use the replacer to compress the valve spring and install the split collar.

     Special tool
     Valve spring replacer: 5-8840-2621-0 (J-43263)
     Pivot: 5-8840-2808-0 (EN-46721)



10. Install the idle gear C.
    - Apply engine oil on the idle gear C shaft and the inner diameter of the idle gear, install the idle gear C so that the side with gear groove is on the side of the rear surface of the engine.
    - Tighten the idle gear C with the designated torque.
    - Do not use impact wrench and like.

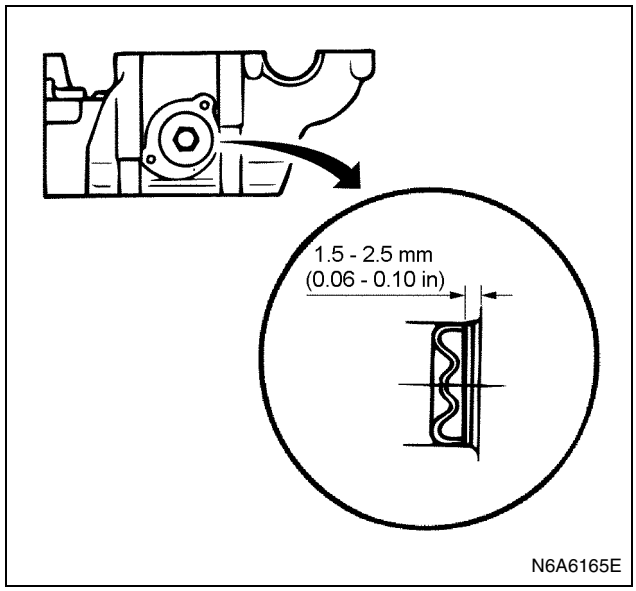
Tighten:
Bolt to 95 N·m (9.7 kg·m/70 lb·ft)



Legend
1. Idle Gear C
2. Shaft

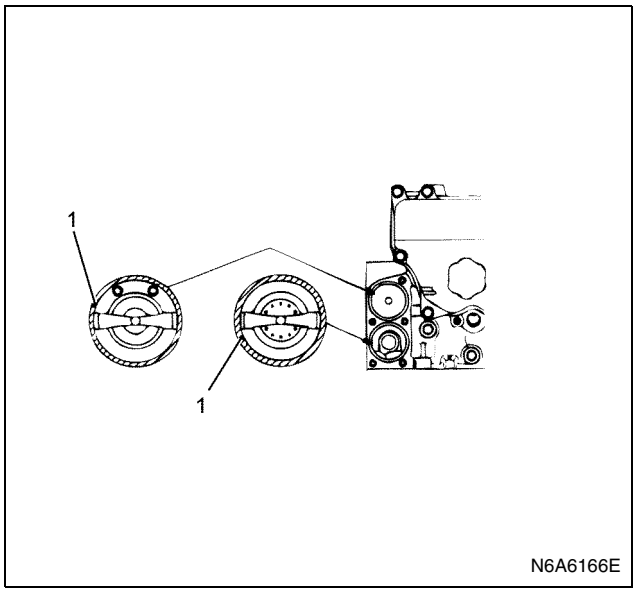
11. Install the idle gear C cover.
    - Apply liquid gasket (Loctite 262) on the outer diameter of the idle gear C cover, use the sealing cup setting tool to hammer it in so that the measurements follow the drawing.

      Special tool
      Sealing cup installer: 5-8840-2222-0 (EN-47690)



12. Install the thermostat.

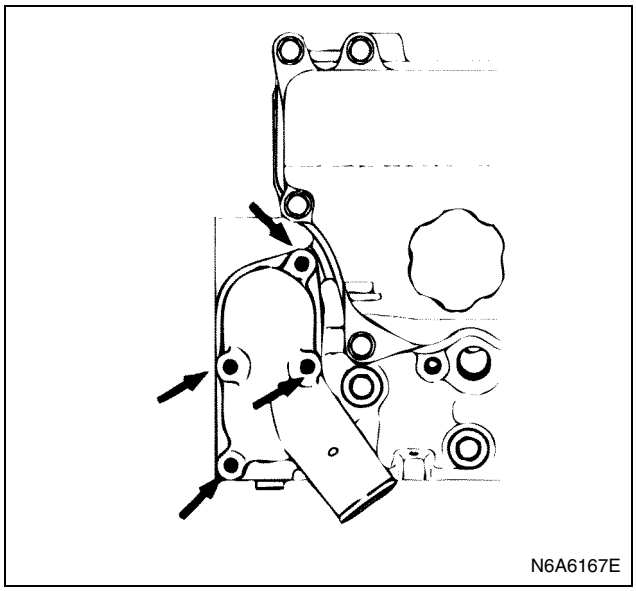
- Install the thermostat on the position shown in the drawing.



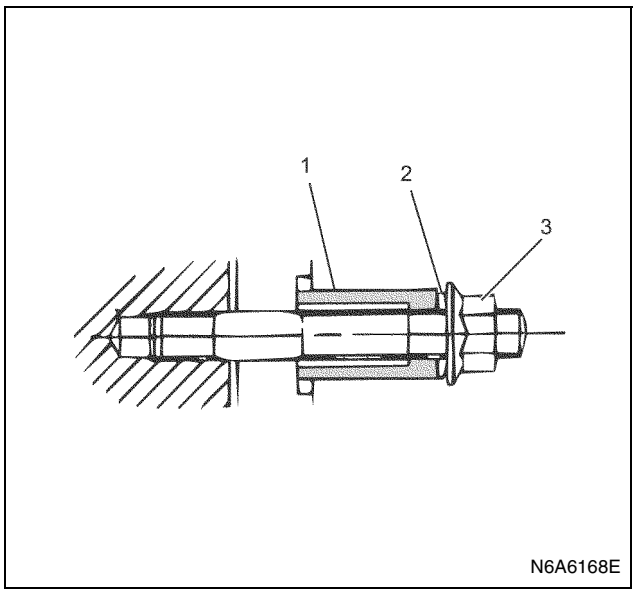
Legend
1. Thermostat

13. Install the water outlet pipe.
    - Tighten the water outlet pipe with the designated torque.

Tighten:
Bolts to 24 N·m (2.4 kg·m/17 lb·ft)



14. Install the exhaust gasket.
15. Install the exhaust manifold.
    - Install the distance tube conical spring and the nut on the stud of the cylinder head in this order.

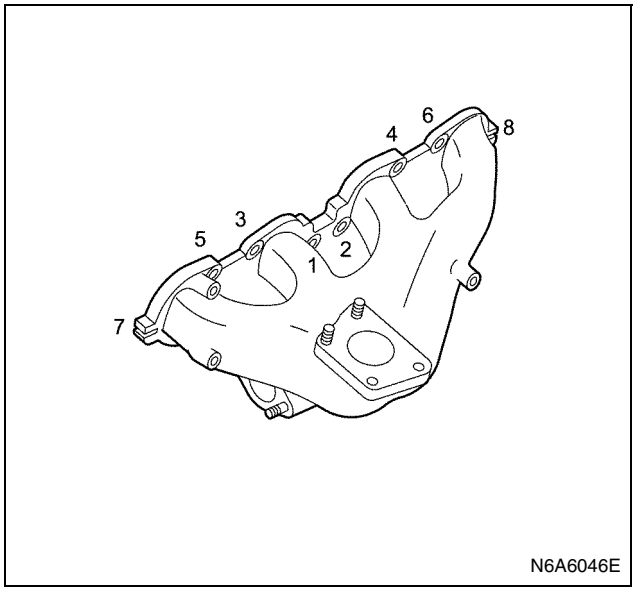


Legend
1. Distance Tube
2. Conical Spring
3. Nut

    - Tighten the exhaust manifold in the order described in the drawing.

Tighten:
Bolt (1),(2),(3),(4),(5),(6) and Nut (7), (8) to 34 N·m (3.5 kg·m/25 lb·ft)

Caution:
Do not tighten it too much so that it hinders extraction and contraction of the manifold due to heat.

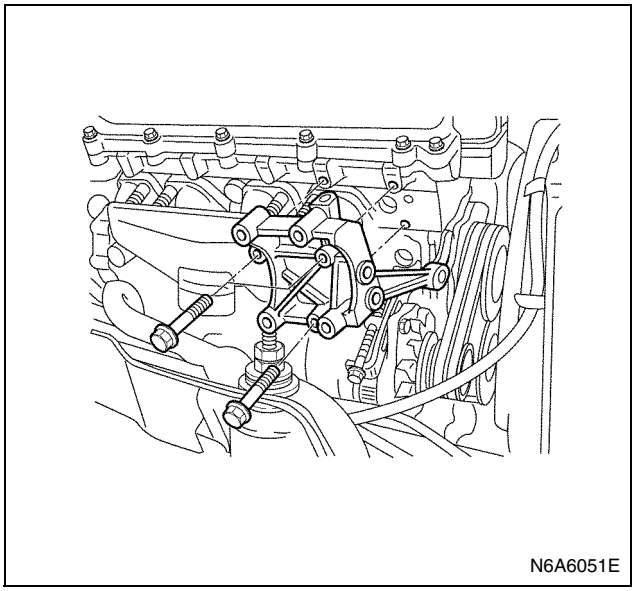


    - Install the heat protector.

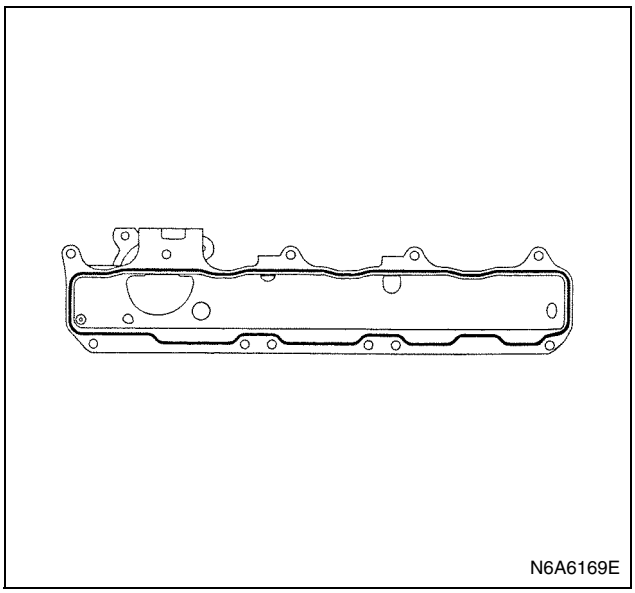
Tighten:
Bolts to 10 N·m (1.0 kg·m/87 lb·ft)

16. A/C compressor bracket.
    Install the bracket, tighten the bolt with the designated torque.

Tighten:
Bolts to 48 N·m (4.9 kg·m/35 lb·ft)

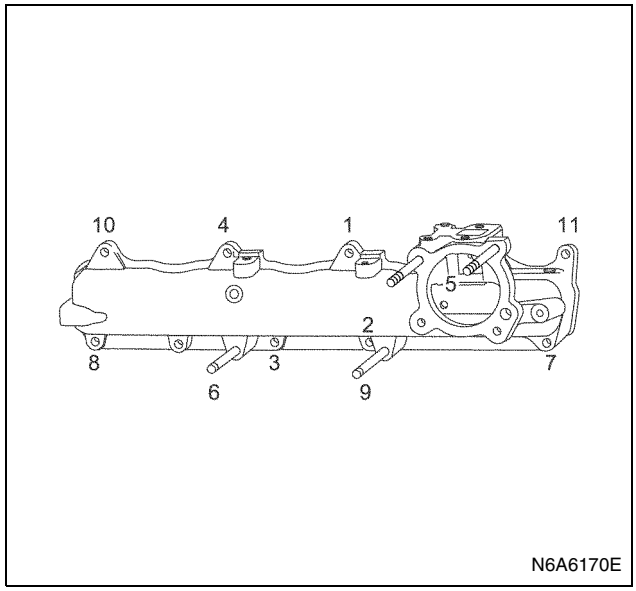

N6A6051E

17. Install the inlet cover.
    - Apply liquid gasket (ThreeBond1207C or equivalent) in accordance with the groove of the inlet cover, with the bead diameter of ϕ2.5 – 5.5 mm (0.0984 – 0.2165 in).


N6A6169E

- Tighten in the order described in the drawing.
- Tighten the stud bolts (6) and (9) jointly with the fuel rail.

Tighten:
Stud bolts to 22 N·m (2.2 kg·m/16 lb·ft)

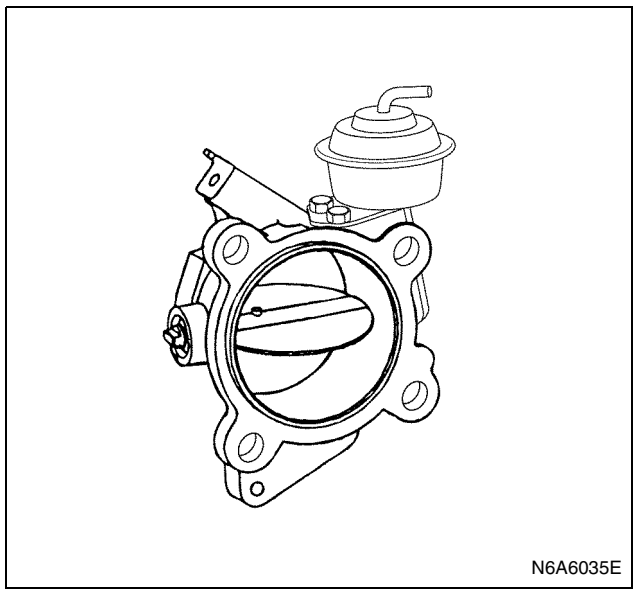


N6A6170E

18. Install the throttle assembly.
    - Coat the liquid gasket and mount within 7 minutes.

Tighten:
Bolt and nut to 24 N·m (2.4 kg·m/17 lb·ft)

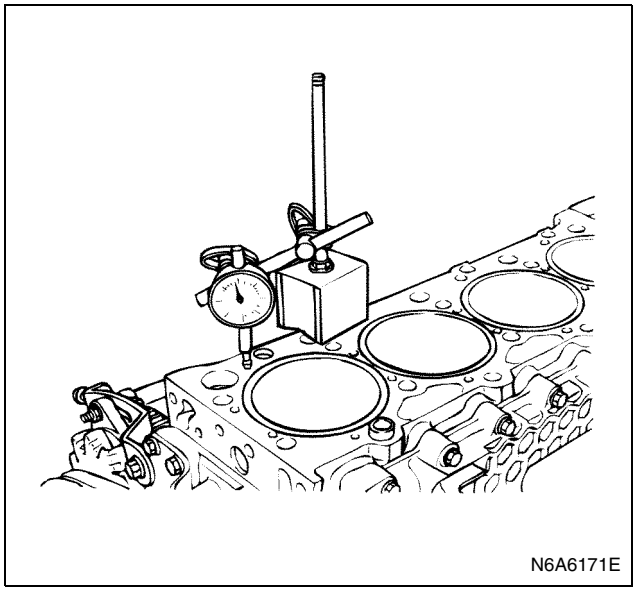
- Install the intake throttle valve connector.


N6A6035E

Installation

1. Install the cylinder head gasket.
   - Select the cylinder head gasket.
   - Clean the head of the piston and the upper surface of the cylinder block.
   - Use a dial gauge to measure the extrusion of the piston. Measure at two points of each cylinder.

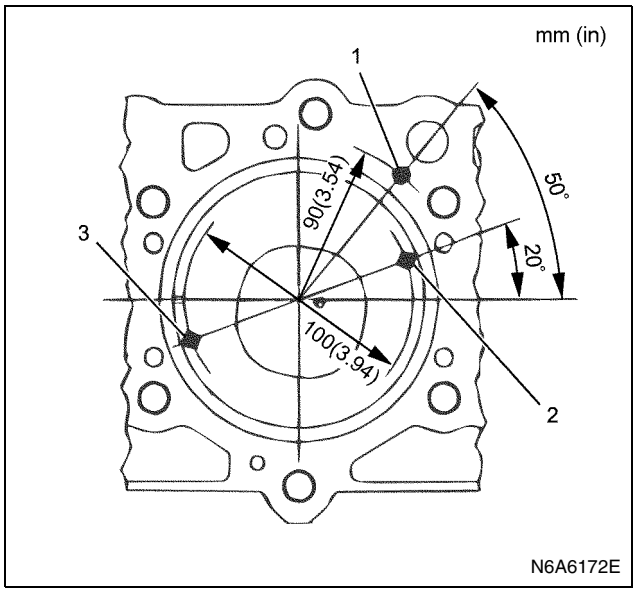
- The following drawing shows the measurement points and the standard point of the cylinder block.


N6A6171E

Measurement points:	Head of the piston	(2) and (3)
Standard point:	Upper surface of the cylinder block	(1)

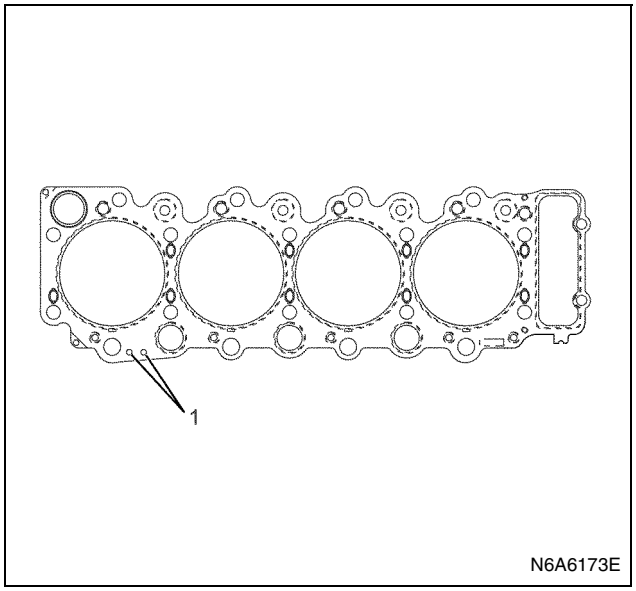
Caution:
Note that there are three options for the head gasket according to the amount of extrusion of piston shown in the following table.

- Calculate the average piston extrusion amount of each cylinder.
- Calculate the maximum amount of the average amount of each cylinder.
- Select a gasket of an appropriate grade based on Timax.



N6A6172E

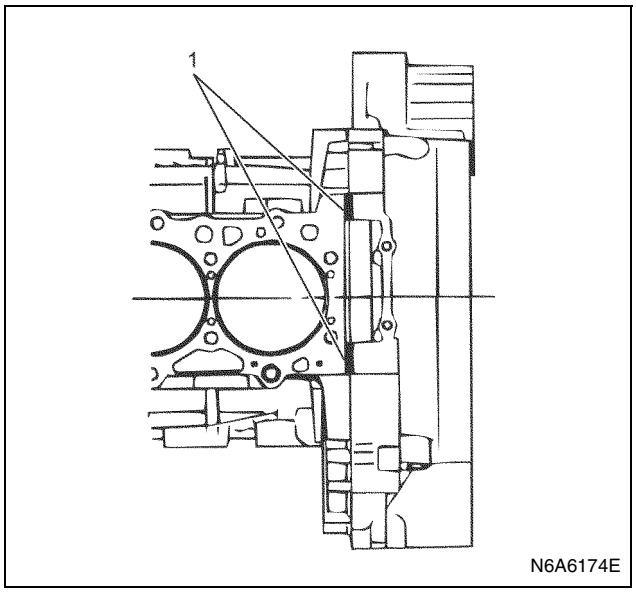
Gasket Grade	Recognized by	Piston extrusion amount mm (in)
A	(no hole)	0.439 (0.01728) – 0.519 (0.02043)
B	(1 hole)	0.519 (0.02043) – 0.589 (0.02319)
C	(2 holes)	0.589 (0.02319) – 0.669 (0.02633)



N6A6173E

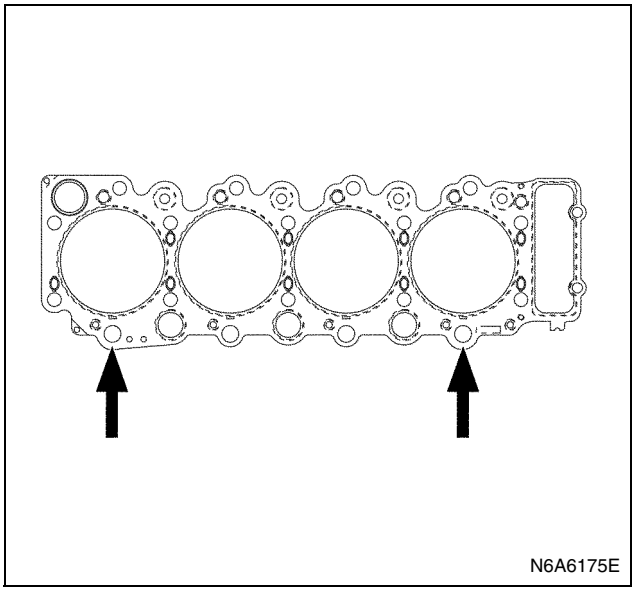
Legend
1. Grade Recognition Hole

- Apply liquid gasket
- Apply liquid gasket (ThreeBond 1207C or equivalent) on the joint (1) of the cylinder block and the flywheel housing with the bead diameter of 3 mm (0.118 in).
- Install the cylinder head within seven minutes after applying liquid gasket.



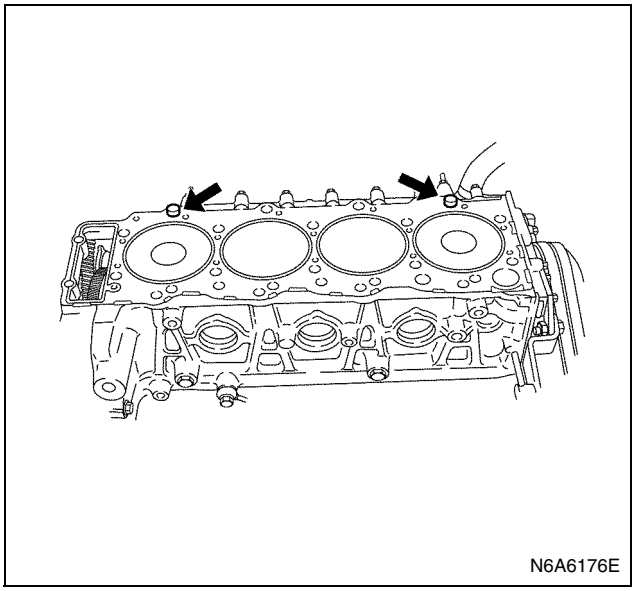
N6A6174E

- Install the cylinder head gasket.
- Install the cylinder head gasket with the parts number upside, along with the cylinder head rear gear case and dowel.



2. Install the cylinder head assembly.
   - Install the cylinder head, adjusting the dowel of the cylinder block.

Caution:
Be sure not to damage the head gasket when installing it.

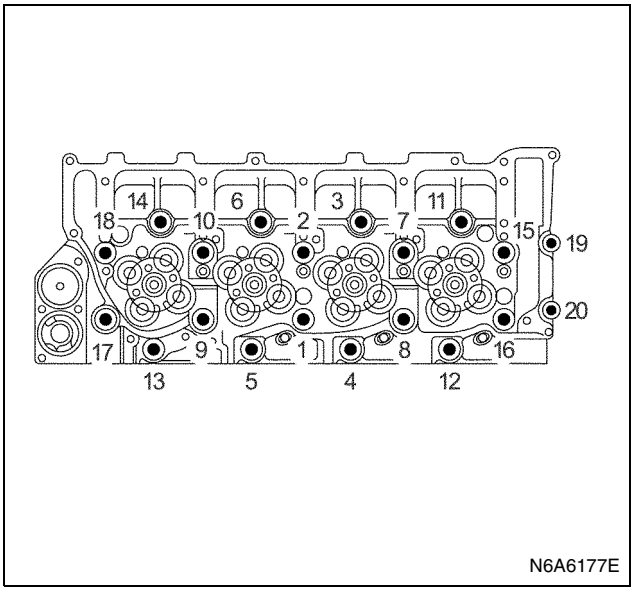


- Apply molybdenum disulfide on the thread and setting face of the head bolt of M14, and apply engine oil on the thread and setting face of the head bolt of M10.
- Use a torque wrench and angle gauge to tighten the head bolts in the order described in the drawing.

Tighten:
M14 bolts (1 – 18) to
1st step: 98 N·m (10.0 kg·m/72 lb·ft)
2nd step: 147 N·m (15.0 kg·m/108 lb·ft)
3rd step: 30° – 60° (degrees)
M10 bolts (19, 20) to
4th step: 38 N·m (3.9 kg·m/28 lb·ft)

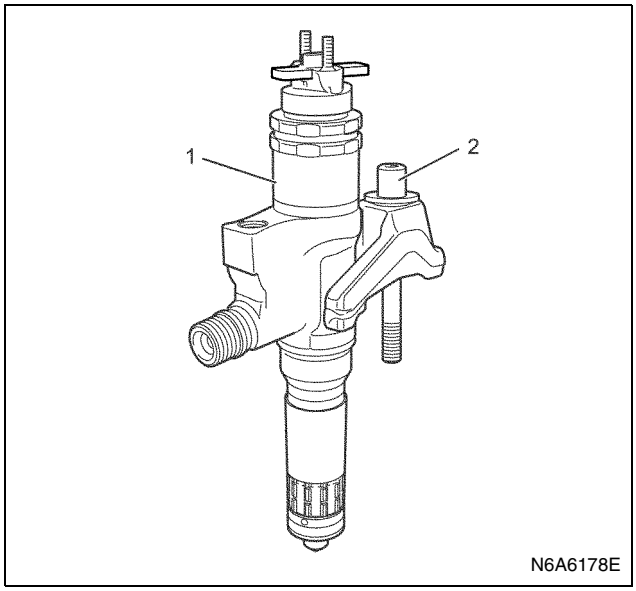
- Tighten bolts from 1-18 (M14) and confirm that they are tightened to a torque of 167 N·m (17.0 kg·m/123 lb·ft) or more.

  Special tool
  Angle gauge: 5-8840-0266-0 (J-45059)



3. Install the fuel injector on the cylinder head.
4. Apply molybdenum disulfide on the thread and setting face of the fuel injector tighten bolt and tighten it tentatively.

Important:
Reinstall each fuel injector to the original cylinder from which it was removed during the disassembly procedure.



Legend
1. Fuel Injector Assembly
2. Fuel Injector Tighten Bolt

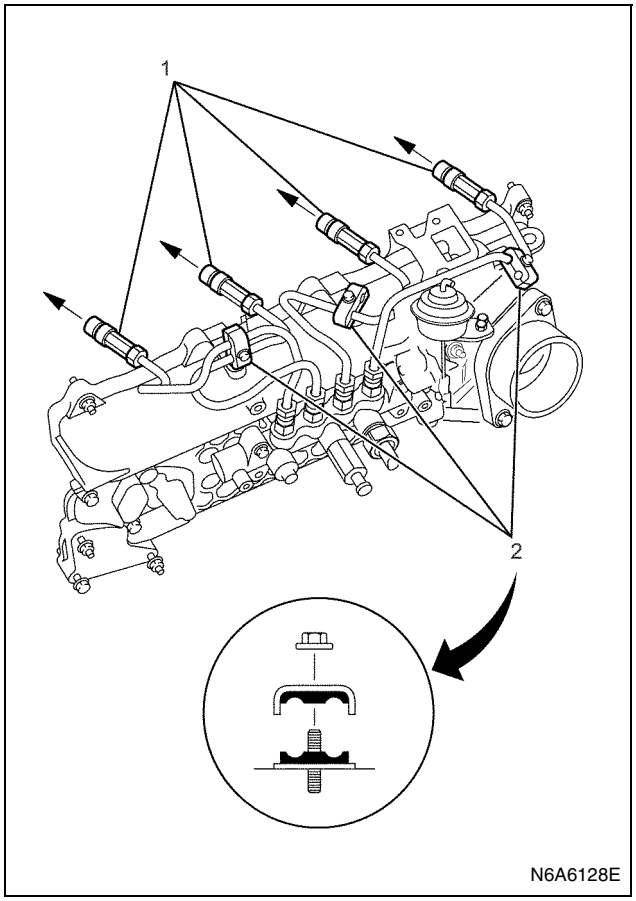
5. Install the fuel rail.

Tighten:
Fuel rail to 19 N·m (1.9 kg·m/14 lb·ft)

- Install the fuel rail pressure sensor.

6. Install the injection pipe.
   - Apply a thin coat of engine oil on the outer diameter of the sleeve nut on the side of the fuel injector and install the injection pipe.
   - Use a spanner to tighten the sleeve nut until it completely contacts both on the fuel injector and fuel rail.
   - Tighten the injection pipe clip with the designated torque.

Tighten:
Clip to 6 N·m (0.6 kg·m/52 lb·in)



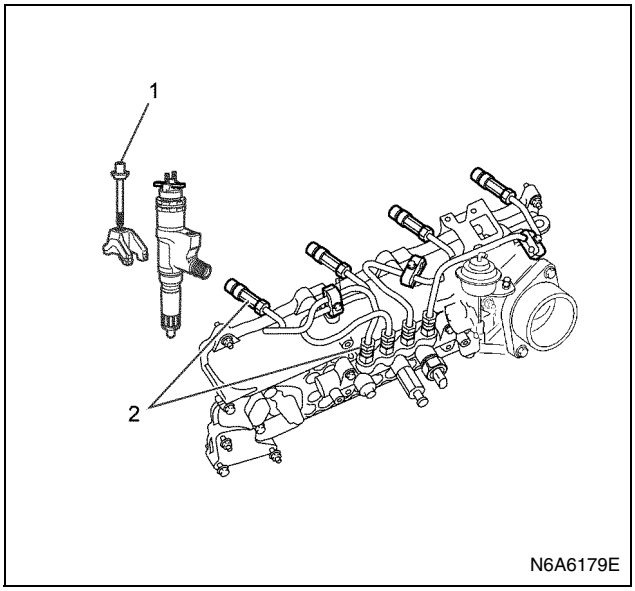
Legend
1. Fuel Injection Pipe
2. Fuel Injection Pipe Clip

7. Final tighten the injection clamp bolts to the specified torque.

Tighten:
Bolts to 30 N·m (3.0 kg·m/22 lb·ft)

8. Tighten the injection pipes to the specified torque.

Tighten:
Nuts to 44 N·m (4.5 kg·m/33 lb·ft)



Legend
1. Injection Clamp Bolt
2. Injection Pipe Sleeve Nut

9. Install the glow plug.

Tighten:
Glow plug to 20 N·m (2.0 kg·m/15 lb·ft)

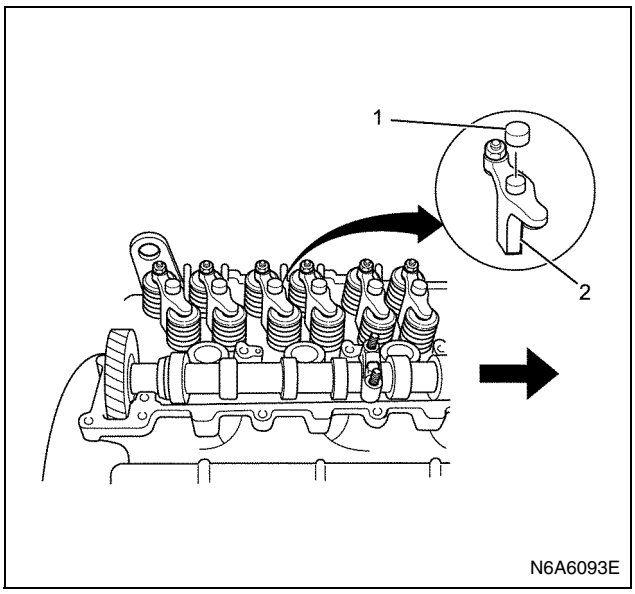
10. Install and tighten the glow connector with the designated torque.

Tighten:
Glow connector to 1.2 N·m (0.1 kg·m/10.5 lb·in)

11. Apply engine oil on the bridge, install it.

Caution:
Move it up and down to confirm that it moves smoothly.

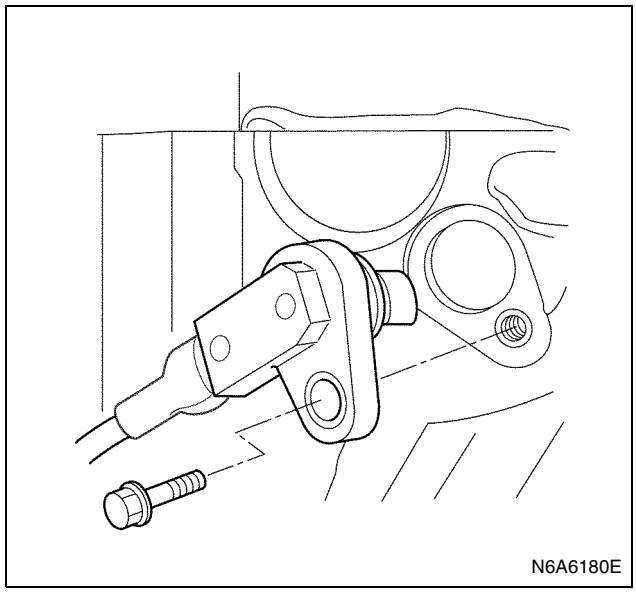
12. Apply a thin coat of engine oil inside the bridge cap, install it.



Legend
1. Bridge Cap
2. Bridge

13. Install the camshaft assembly.
Refer to “Camshaft Assembly”.
14. Install the rocker arm shaft assembly.
Refer to “Rocker Arm Shaft Assembly”.
15. Install and tighten the camshaft position sensor with the designated torque.

Tighten:
Bolt to 8 N·m (0.8 kg·m/69 lb·in)



16. Install the water bypass hose.
17. Install the engine coolant temperature sensor on the thermostat housing.

Tighten:
Engine coolant temperature sensor to 25 N·m (2.5 kg·m/18.4 lb·ft)

18. Install the leak-off pipe.

Tighten:
Leak-off pipe to 12 N·m (1.2 kg·m/104 lb·in)

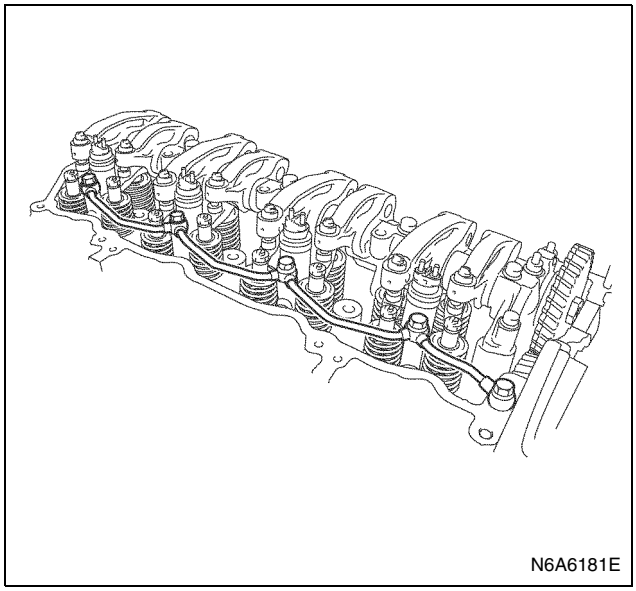
19. Install the fuel leak-off hose.
20. Clip a new gasket to the fuel nozzle leak-off pipe and install the fuel leak-off pipe.

Tighten:
Nozzle leak-off pipe (injector to cylinder head) to 12 N·m (1.2 kg·m/104 lb·in)

Fuel leak-off pipe (cylinder head side) 12 N·m (1.2 kg·m/104 lb·in)

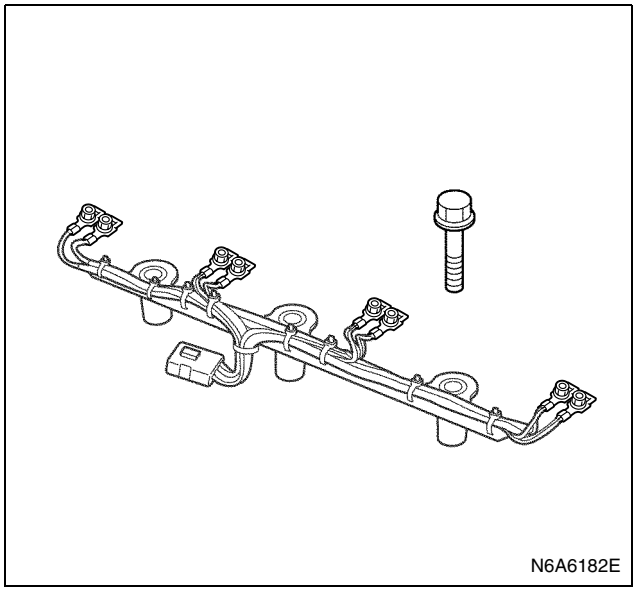
Fuel leak-off pipe (supply pump side) 18 N·m (1.8 kg·m/13.3 lb·ft)

Caution:
Use new gaskets.


N6A6181E

21. Install the fuel injector harness connectors.
22. Install the harness bracket and tighten the bolts to the specified torque.

Tighten:
Bolt to 48 N·m (4.9 kg·m/35 lb·ft)

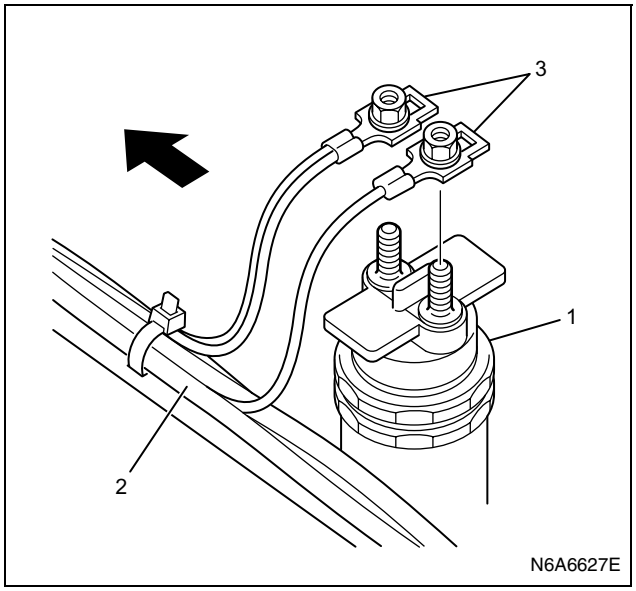

N6A6182E

23. Install the terminal nuts on the fuel injector.

Tighten:
Terminal nuts to 2 N·m (0.2 kg·m/17 lb·in)

Caution:

- Do not over tighten the nuts. Damage to the terminal studs will result.
- The terminal nut with two wires is engine front side.



N6A6627E

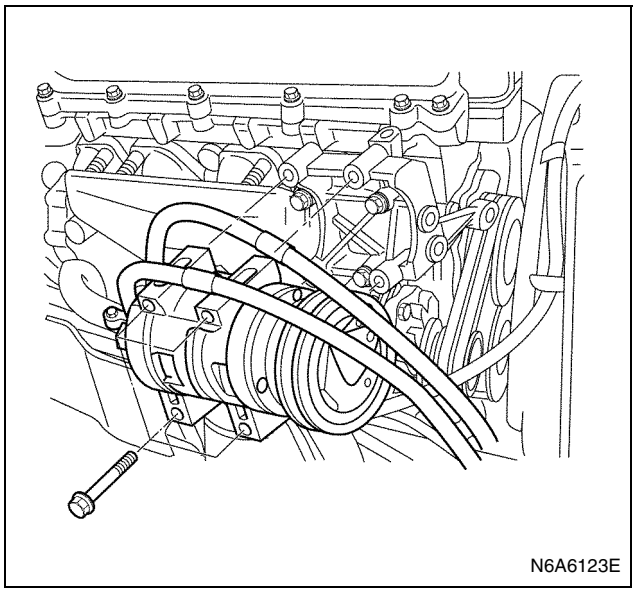
Legend

1. Fuel Injector
2. Fuel Injector Harness
3. Fuel Injector Terminal Nut

24. Install the cylinder head cover.
    Refer to “Cylinder Head Cover”.
25. Install the radiator upper hose.
26. Install the A/C compressor.
    - Install the A/C compressor bracket on the A/C compressor and tighten it with the designated torque.

Tighten:
Bolt to 24 N·m (2.4 kg·m/18 lb·ft)

- Install the A/C compressor harness connector.


N6A6123E

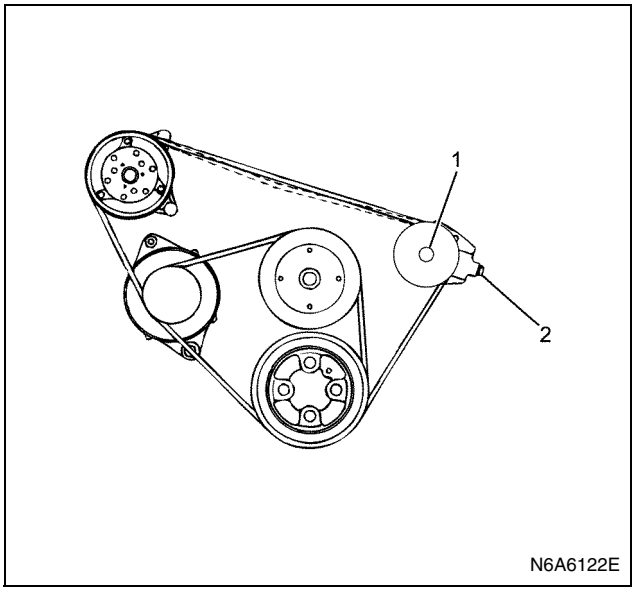
27. Install the A/C compressor drive belt.
    - Place the drive belt and adjust its tension with the adjust bolt of the tension pulley.

- Use a scale or other equipment to inspect whether the flexure of the belt when it was pushed by hand with pressure of 98 N (22 lb) is within the designated range.

A/C belt flexure	mm (in)
New belt	16 (0.63) – 20 (0.79)
Reused belt	18 (0.71) – 22 (0.87)

- Tighten the locknut of the tension pulley with the designated torque after adjusting the tension of the belt.

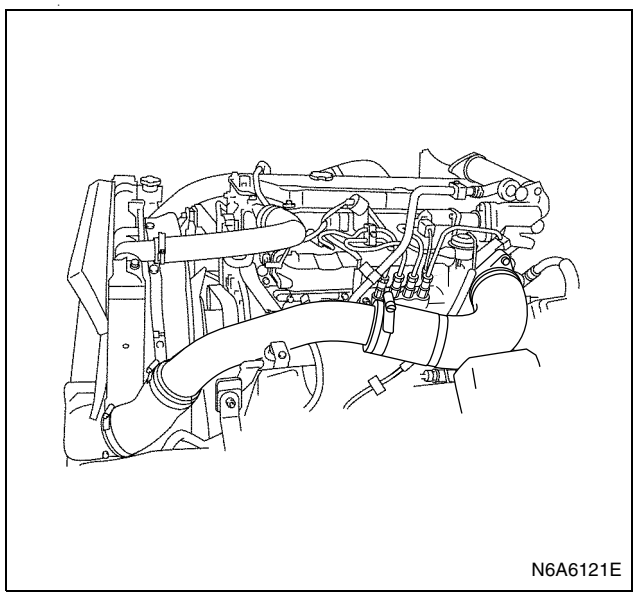
Tighten:
Lock nut to 27 N·m (2.8 kg·m/20 lb·ft)



Legend
1. Tension Pulley Lock Nut
2. Tension Pulley Adjusting Bolt

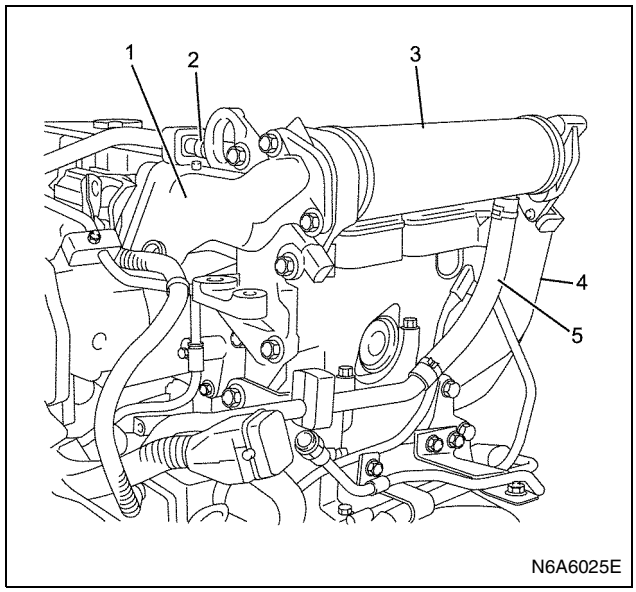
28. Install the intake pipe.
    - Install the bolt and clip band, tighten the bolt with the designated torque.

Tighten:
Bolt to 10 N·m (1.0 kg·m/87 lb·in)



- Install the fan guide bracket.

29. Install the EGR valve and EGR cooler.
    For details of installation, refer to “EGR Valve and EGR Cooler” in Section 6F.



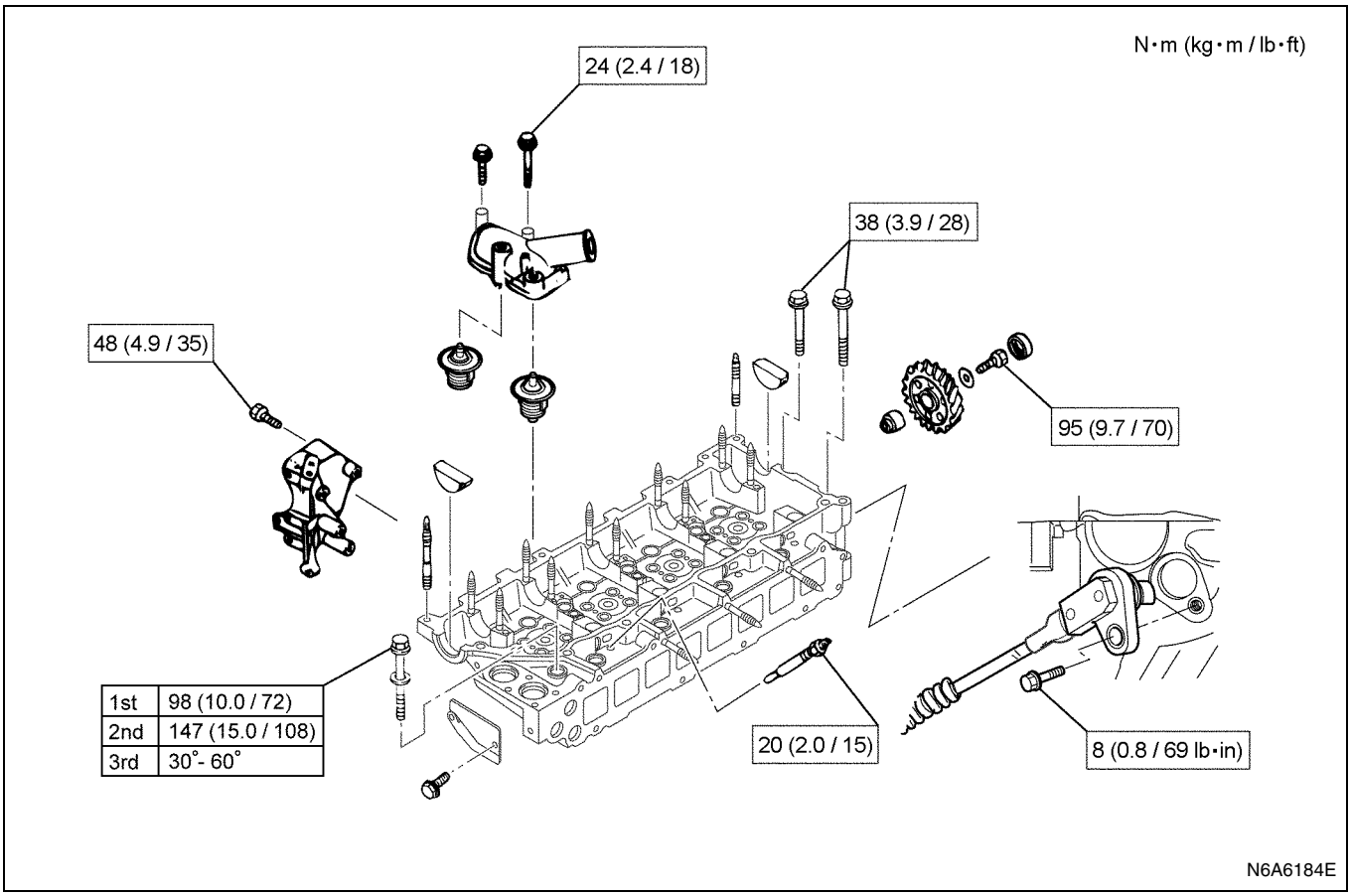
Legend
1. EGR Adapter
2. Water Return Pipe
3. EGR Cooler
4. EGR Pipe
5. Water Feed Pipe

30. Install the oil level gauge and guide tube.
31. Install the exhaust pipe.
    - Install the front exhaust pipe and tighten with the designated torque.

Tighten:
Nuts to
Exhaust manifold side: 67 N·m (6.8 kg·m/49 lb·ft)
Exhaust brake side: 17 N·m (1.7 kg·m/13 lb·ft)

32. Install the engine harness.
33. Replenish the coolant.

Torque Specifications



Special Tool

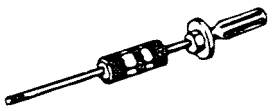
Illustration	Tool Number / Description / Remarks
 584000190	5-8840-0019-0 (J-23907) Sliding Hammer
5884022270	5-8840-2628-0 (J-43272) Valve Guide Replacer

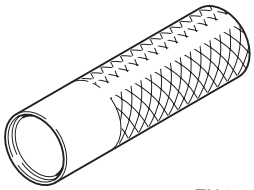
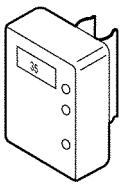
Illustration	Tool Number / Description / Remarks
 EN47685	5-8840-2833-0 (EN-47685) Valve Stem Seal Installer
 J45059	5-8840-0266-0 (J-45059) Angle Gauge

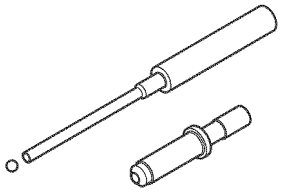
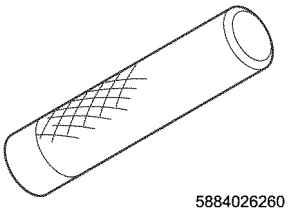
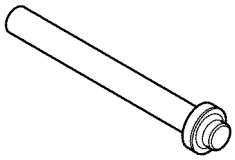
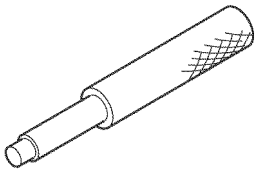
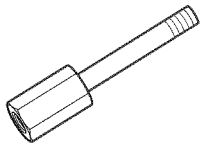
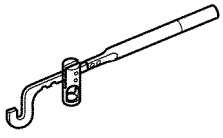
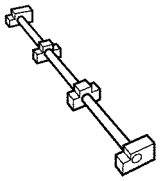
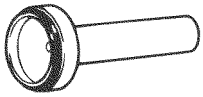
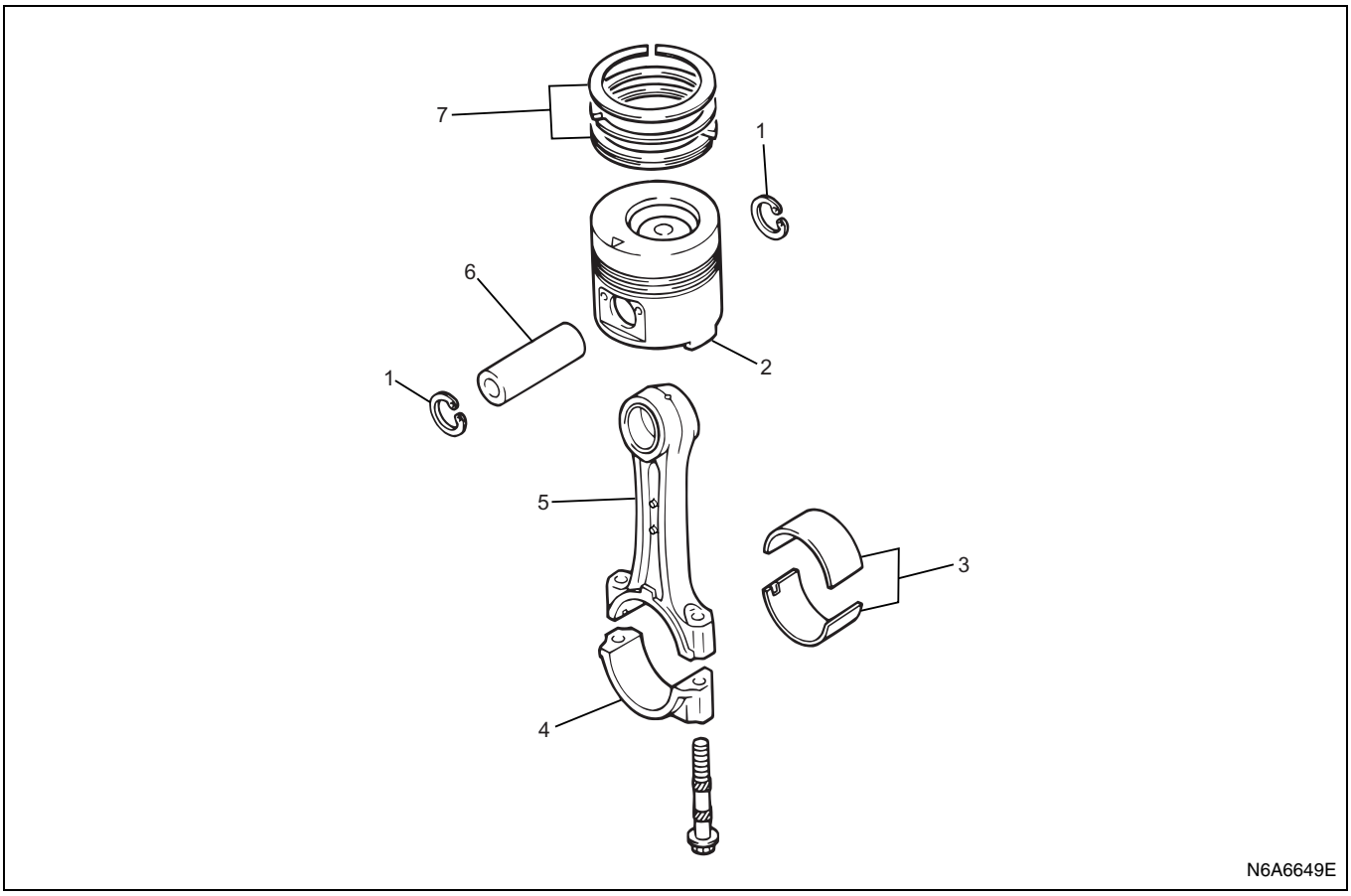
Illustration	Tool Number / Description / Remarks
 5884026240	5-8840-2624-0 (J-43266) Nozzle Sleeve Installer
 5884026260	5-8840-2626-0 (J-43268) Bridge Guide Installer
 5884026270	5-8840-2627-0 (J-43269) Oil Seal Installer
 5884026230	5-8840-2623-0 (J-43265) Nozzle Sleeve Remover
 EN46720	5-8840-2826-0 (EN-46720) Fuel Injector Remover
 5884026210	5-8840-2621-0 (J-43263) Valve Spring Replacer

Illustration	Tool Number / Description / Remarks
 8943968620	5-8840-2808-0 (EN-46721) Pivot Assembly
 5884022220	5-8840-2222-0 (EN-47690) Sealing Cup Installer

Piston and Connecting Rod

Component



Legend

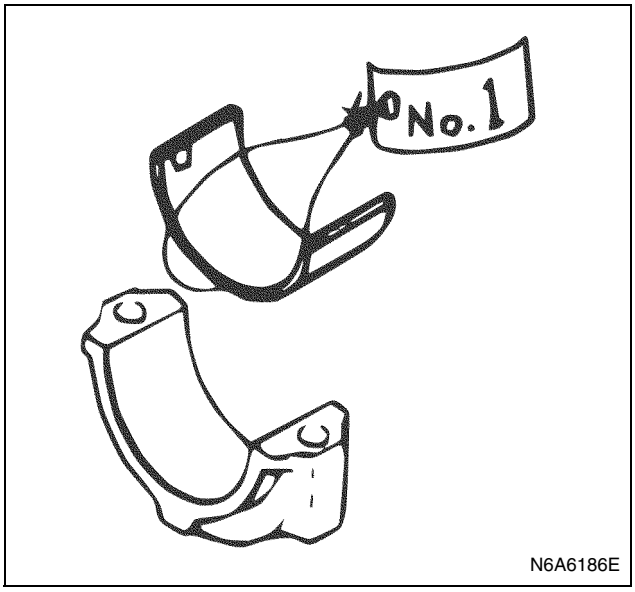
1. Snap Ring
2. Piston
3. Bearing
4. Connecting Rod Cap
5. Connecting Rod
6. Piston Pin
7. Piston Ring

Removal

1. Remove the oil pan.

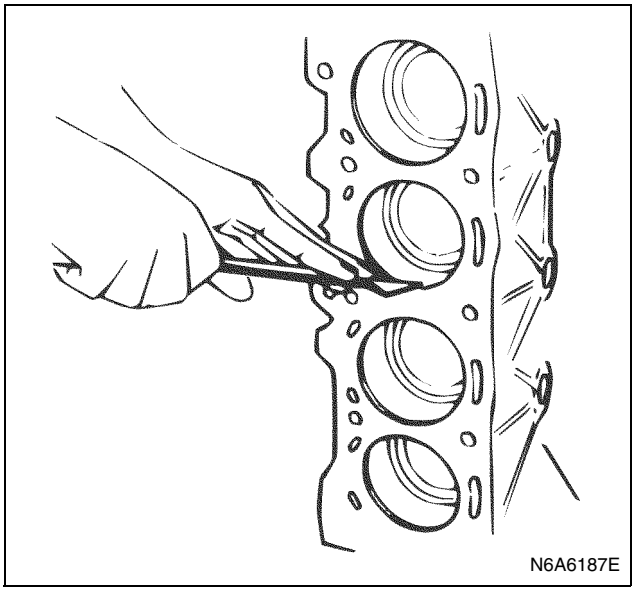
   Refer to “Oil Pan”.
2. Remove the cylinder head cover.
   Refer to “Cylinder Head Cover”.
3. Remove the rocker arm shaft assembly.
   Refer to “Rocker Arm Shaft Assembly”.
4. Remove the camshaft assembly.
   Refer to “Camshaft Assembly”.
5. Remove the cylinder head.
   Refer to “Cylinder Head”.
6. Remove the connecting rod cap.

Caution:
Sort the removed bearings according to cylinders by using tags.



7. Remove the piston and connecting rod.
   - Remove carbon on the upper side of the cylinder liner with a scraper.
   - Pull out the piston and connecting rod towards the cylinder head.

Caution:
Be sure not to damage the oil jet and cylinder liner when pushing out the connecting rod.



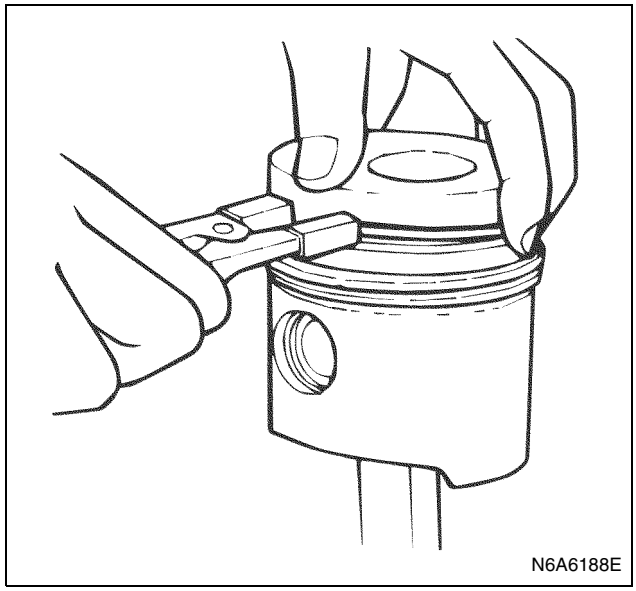
8. Remove the connecting rod bearing.

Caution:
Arrange the bearings in the order of cylinders. Be sure to put them back to the original cylinders.

Disassembly

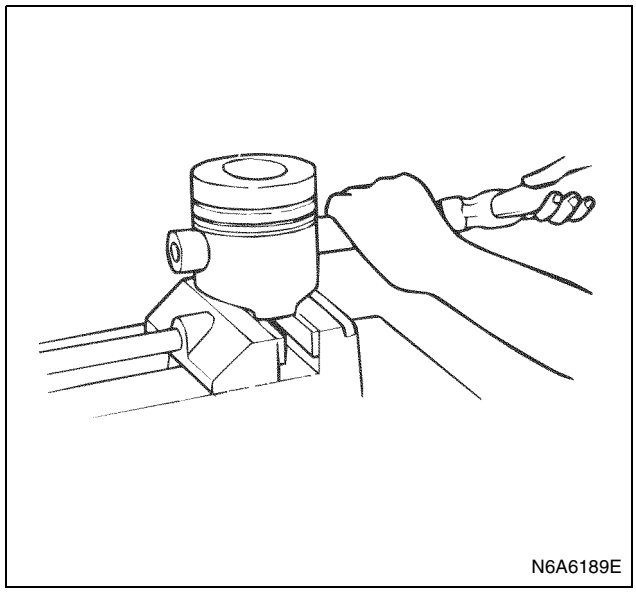
1. Remove the piston ring.
   - Use ring pliers to remove the piston ring.

Caution:
Sort the piston rings in the order of cylinders when reusing them so that they will not be confused with the pistons and piston rings of other cylinders.



2. Remove the snap ring.
3. Remove the piston pin.

Caution:
Sort the disassembled piston pins, pistons and connecting rods together in the order of cylinders.

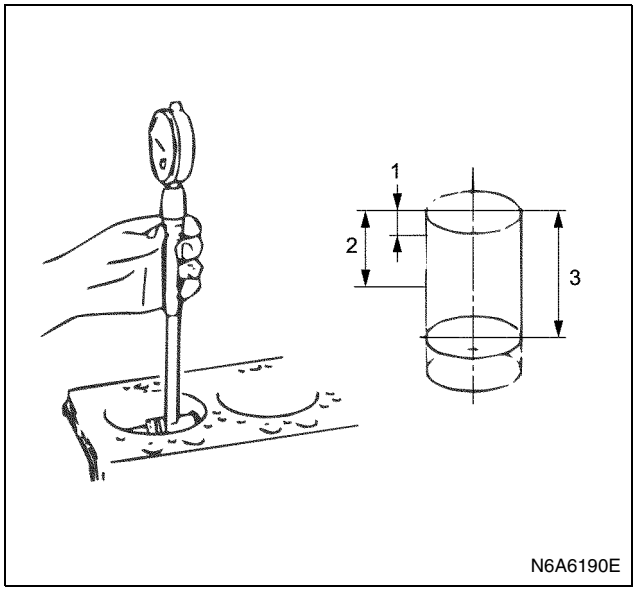


4. Remove the connecting rods from the piston.
5. Piston
   - Clean carbon carefully that is adhered to the head of the piston and the groove of the piston ring.

Caution:
Do not use wire brush to clean the piston because it scratches the piston.
Inspect the piston with eyes for cracks, burns and other excessive wear, and replace it if there is any abnormality.

6. Measure the gap between the piston and the inner diameter of the cylinder liner.
   Inner diameter of the cylinder liner.
   - Use a cylinder bore dial indicator to measure the liner inner diameter both in the thrust and radial directions in the designated position.
   - Measurement position (from the upper surface of the cylinder block)
     1. 20 mm (0.79 in)
     2. 110 mm (4.33 in)
     3. 190 mm (7.48 in)
   - Measure the liner inner diameter based on the average value of the actual measurement values on 6 positions.

Cylinder liner inner diameter	mm (in)
115.021 – 115.050 (4.52838 – 4.52952)	



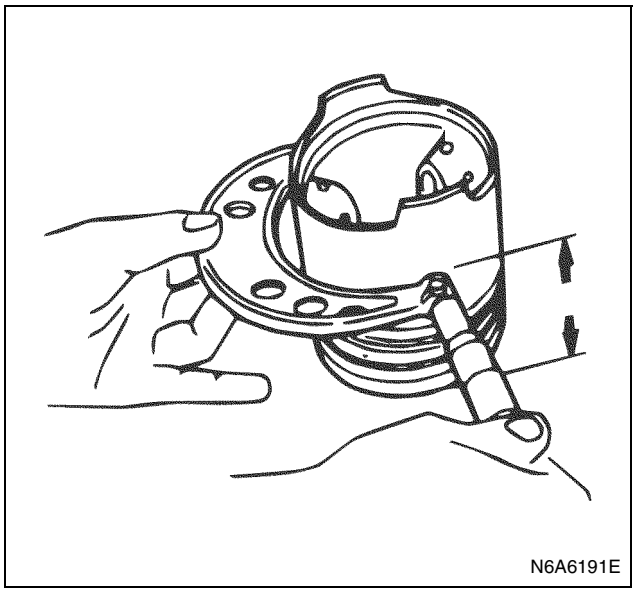
Legend
1. 20 mm (0.79 in)
2. 110 mm (4.33 in)
3. 190 mm (7.48 in)

Piston outside diameter
- Use a micrometer to measure the outside diameter of the piston in the right angle to the piston pin in the designated position.
- Measurement position (from the upper surface of the piston) 82 mm (3.2 in).

Piston diameter	mm (in)
Standard	114.924 – 114.939 (4.52456 – 4.52515)

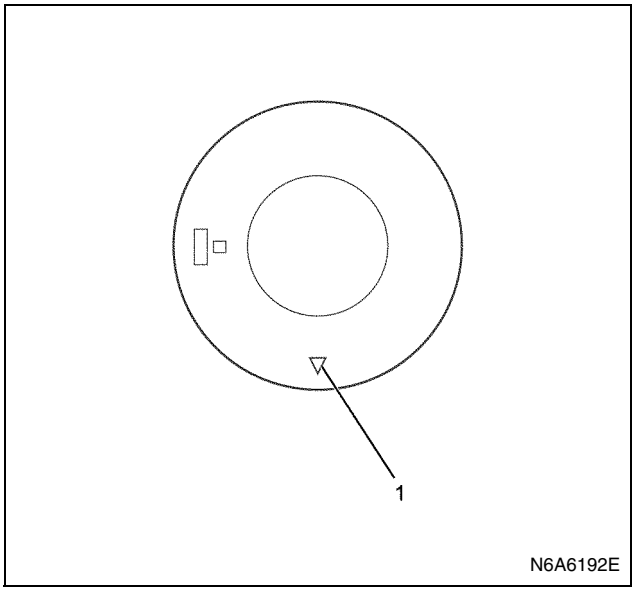
Gap between the piston and the inner diameter of the cylinder liner	mm (in)
Standard	0.082 – 0.126 (0.0032 – 0.0050)

Caution:
If it is found that the gap between the cylinder liner inner diameter and the piston exceeds the standard value, replace the piston or cylinder liner.



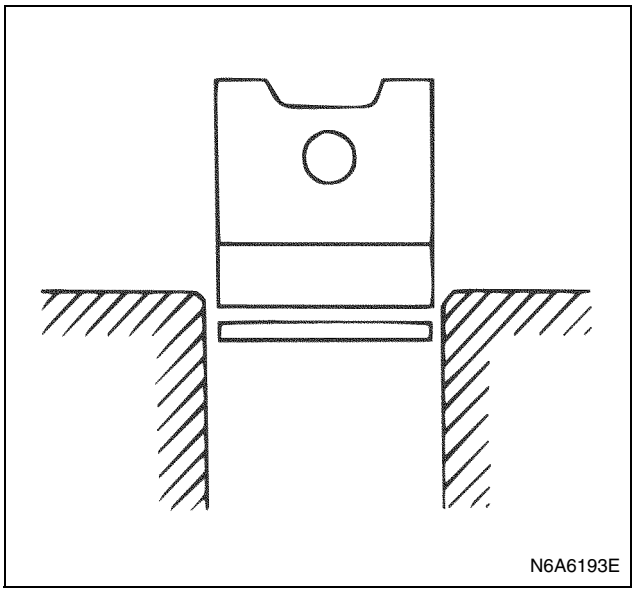
7. Piston replacement
   - You do not need to select grades because there is only one grade for each of the piston and the cylinder liner inner diameter.
     If you replace the cylinder liner, you must select the cylinder block (1, 2, 3) because there are two types of the liner outer diameter.
   - Refer to “Cylinder Block” if you replace the cylinder liner.

Caution:
The head of piston has a marking of grade B or C when it is shipped from the factory.

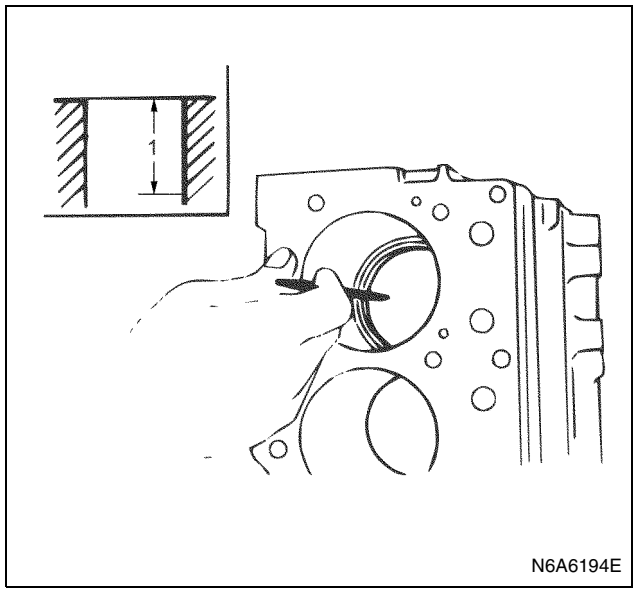


Legend
1. Front Mark Cut

8. Inspect the piston ring.
   Measure the joint of the piston ring (remove carbon on the ring joint)
   - Insert the piston ring into the cylinder liner.
   - Use the piston to push the ring to reach the under edge of the cylinder liner.



   - Use a thickness gauge to measure the gap of the ring joint.

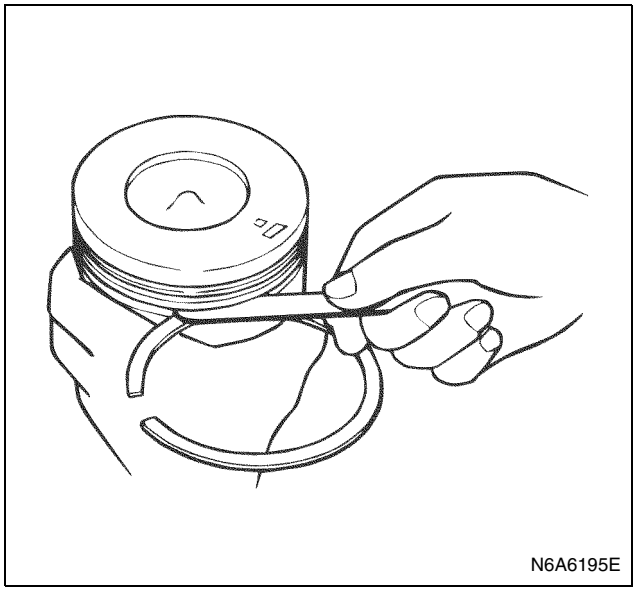


   - If the measurement exceeds the limit, replace the piston ring.

Piston ring gap		mm (in)
	Standard	Limit
1st compression ring	0.20 – 0.30 (0.0079 – 0.0118)	1.20 (0.047)
2nd compression ring	0.30 – 0.45 (0.0118 – 0.0177)	1.20 (0.047)
Oil ring	0.20 – 0.40 (0.0079 – 0.0157)	1.20 (0.047)

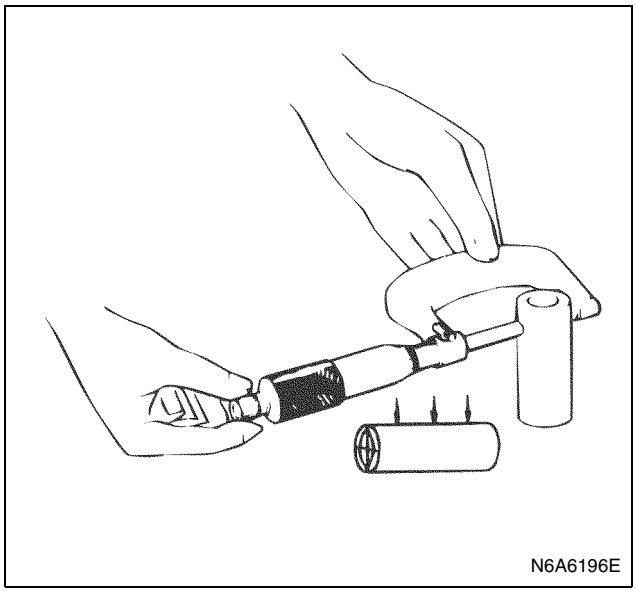
Measure the clearance between the piston ring groove and the piston.
- Remove carbon in the piston ring groove.
- Put the piston ring in the piston ring groove, use a thickness gauge to measure the gap between them.
- If the clearance between the piston ring groove and the piston exceeds the limit, replace the piston and the piston ring.

Piston ring and piston ring groove clearance		mm (in)
Piston ring	Standard	Limit
1st compression ring	0.07 – 0.11 (0.0028 – 0.0043)	0.20 (0.0079)
2nd compression ring	0.03 – 0.07 (0.0012 – 0.0028)	0.15 (0.0059)
Oil ring	0.03 – 0.07 (0.0012 – 0.0028)	0.15 (0.0059)

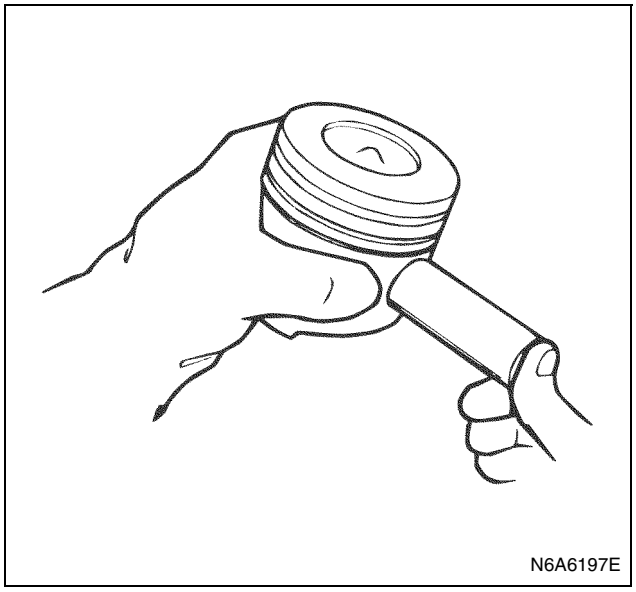

N6A6195E

9. Inspect the piston pin.
   - Inspect the piston pin with eyes for cracks, scratches and other damages, replace it if necessary.
   - Use a micrometer to measure the outer diameter of the piston pin. If the measured value exceeds the limit, replace the piston pin.

Piston pin outer diameter	mm (in)
Standard	39.995 – 40.000 (1.5746 – 1.5748)
Limit	39.970(1.5736)

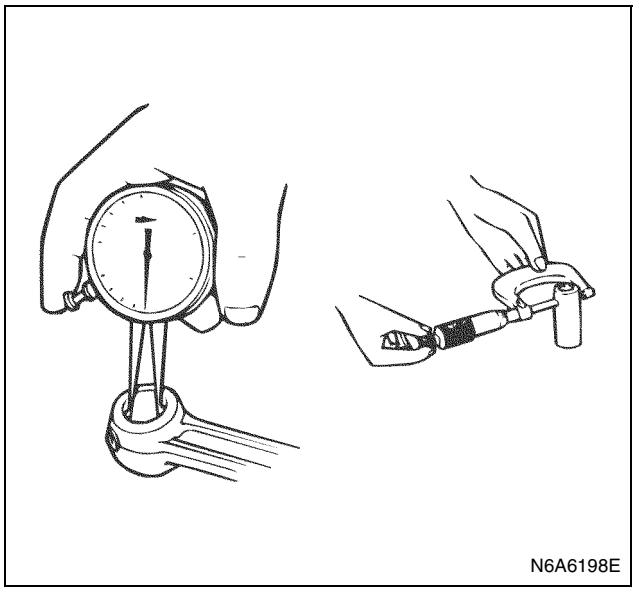

N6A6196E

   - Inspect to make sure that there is a resistance to the extent which the piston can push the piston pin lightly in normal temperatures.
   - If it feels a large looseness or instability in normal temperatures, replace the piston or piston pin.


N6A6197E

   - Measure the bush of the small edge of the connecting rod. If the clearance of the bush inner diameter and the pin diameter exceeds the limit, replace the bush or connecting rod assembly, and the pin.

Piston pin and connecting rod small end bushing clearance	mm (in)
Standard	0.012 – 0.027 (0.0005 – 0.0011)
Limit	0.05(0.0020)

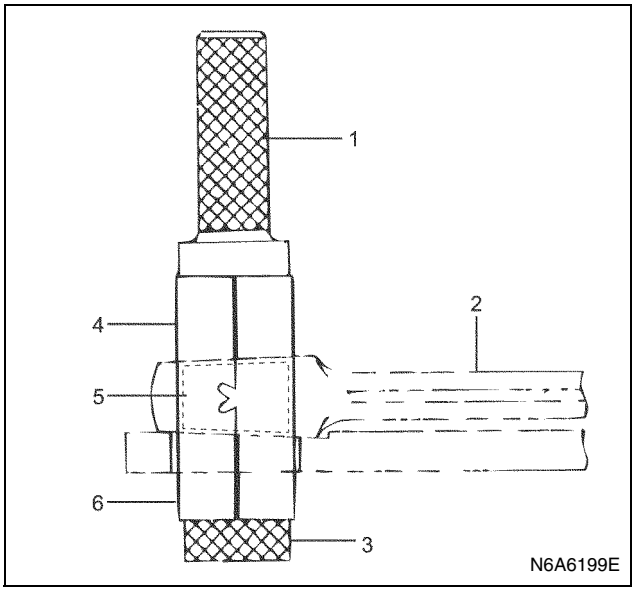

N6A6198E

10. Measure the clearance between the piston and the piston pin.

- Apply engine oil on the piston pin. Use your finger to push it in hole of the piston and rotate it. If the pin smoothly rotates without instability, the clearance is normal. If there is instability, measure the clearance. If the clearance exceeds the limit, replace the piston and the piston pin.

Piston pin and piston pin hole clearance	mm (in)
Standard	0.004 – 0.017 (0.00016 – 0.00067)
Limit	0.04 (0.0016)

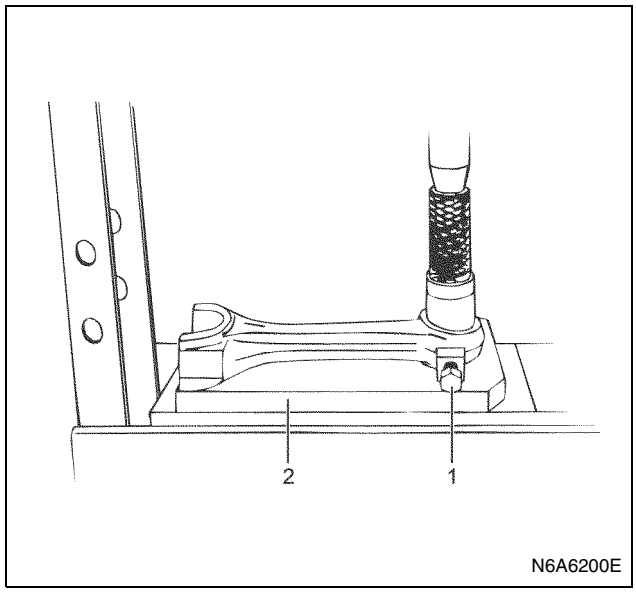
11. Remove the bush.
    - Set the collar, connecting rod and collar on the setting bar as shown in the drawing.
    - Tighten the nut.



Legend
1. Setting Bar
2. Connecting Rod
3. Nut
4. Collar
5. Bush
6. Collar

- Place the connecting rod bush replacer base on press, tighten the fixation bolt.
- Use the bench press to replace the bush.

  Special tool
  Connecting rod bush replacer: 5-8840-2340-0 (EN-47682)

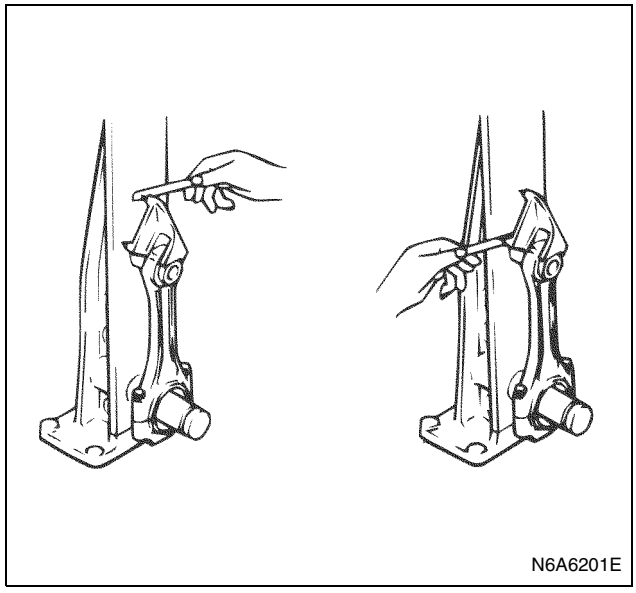


Legend
1. Bolt
2. Connecting Rod Bush Replacer

---

12. Measure the connecting rod alignment.
    - Use a connecting rod aligner to measure the parallelism of the big end hole and the small end hole. If the measured value exceeds the limit, replace it.

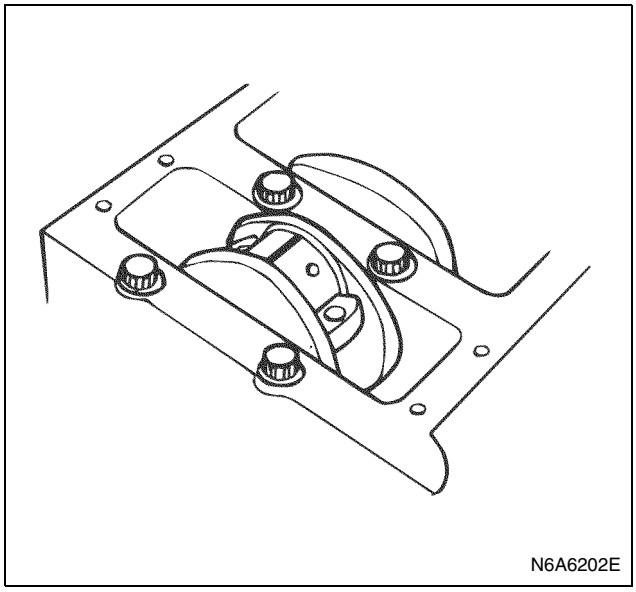
Connecting rod alignment (par length of 100 mm (3.94 in))		mm (in)
	Standard	Limit
Distortion and Parallelism	0.05 (0.002)	0.20 (0.008)



13. Measure the bearing oil clearance.
    - Measure the oil clearance between the connecting rod bearing and the crank pin with the following method.
      - Remove the connecting rod cap. Sort the removed caps according to the cylinder number.
      - Clean the bearing and the shaft pin.
      - Inspect the bearing. If it is damaged or worn seriously, replace the entire bearing.
    - Place the plastigauge on the crankshaft pin.
    - Install the bearing cap and tighten the bolt with the designated torque.
      Apply molybdenum disulfide on the screw part and the bearing surface.

Tighten:
Connecting rod bearing cap bolt to
1st step: 39 N·m (4.0 kg·m/29 lb·ft)
2nd step: 60° (degrees)
3rd step: 30° (degrees)

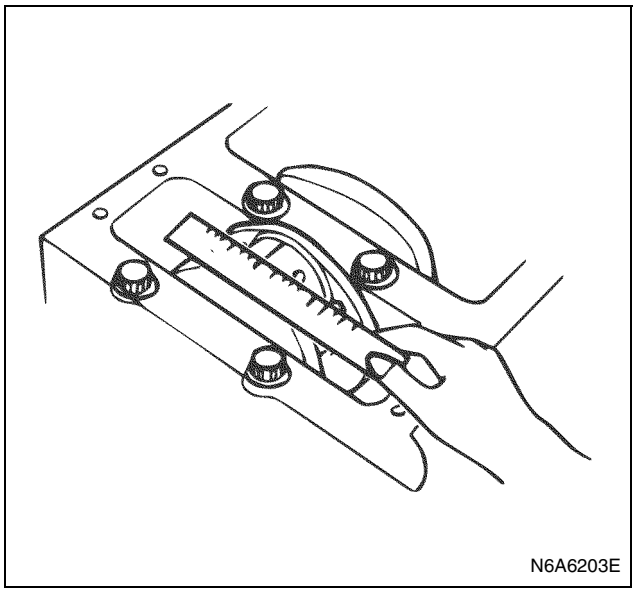
Caution:
Do not rotate the crankshaft.


N6A6202E

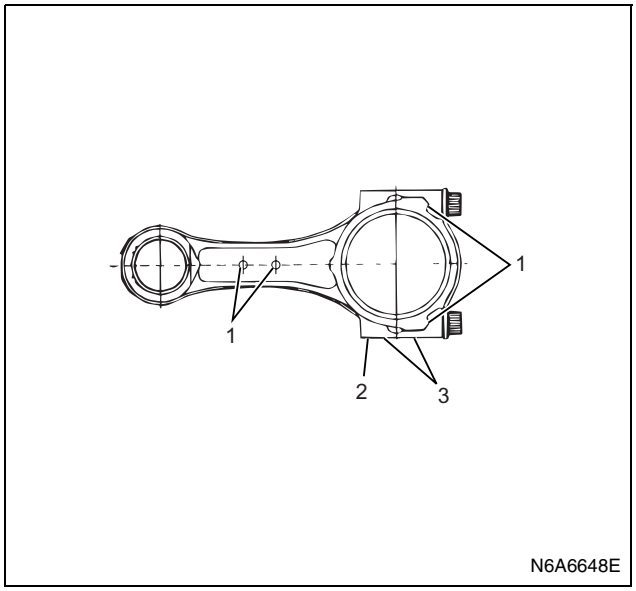
      - Remove the cap.
      - Measure the largest width of the plastigauge to calculate the oil clearance. If the clearance exceeds the limit, replace the entire bearing.

Crankpin and bearing clearance	mm (in)
Standard	0.037 – 0.077 (0.0015 – 0.0030)
Limit	0.10 (0.0039)

      - Remove the plastigauge from the bearing and crankpin.


N6A6203E

14. Select the connecting rod bearing.
    - Select bearings carefully by the grade of big end hole diameter of the connecting rod according to the selection table.

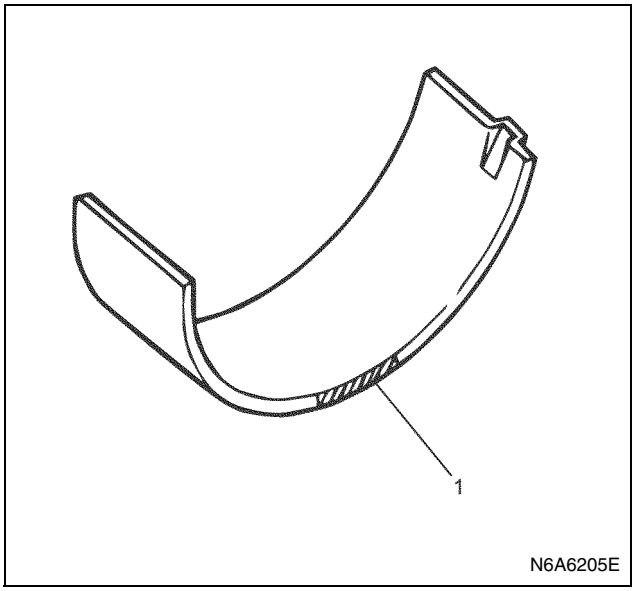


N6A6648E

Legend
1. Top and Back Recognition Boss
2. Big End Diameter Grade Mark
3. Cylinder Number

Bearing selection table

Big end hole diameter Grade	Bearing recognition color	Oil clearance mm (in)
A	Green	0.037 – 0.077 (0.0015 – 0.0030)
B	Yellow	0.037 – 0.077 (0.0015 – 0.0030)

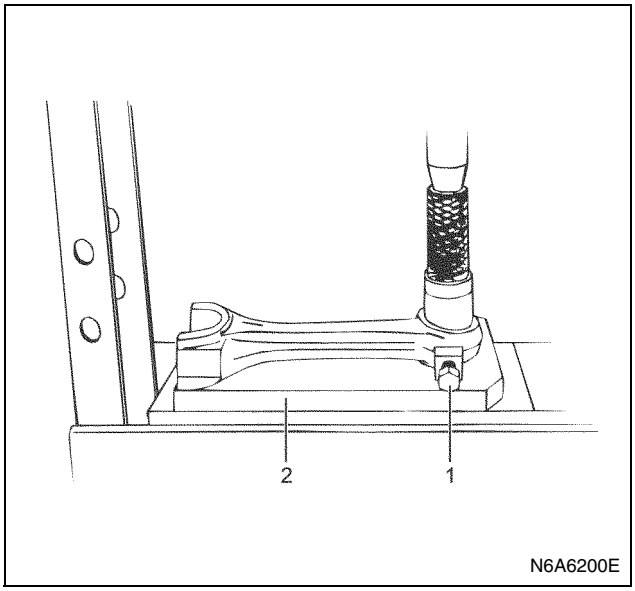


Legend
1. Grade Recognition Color

Reassembly

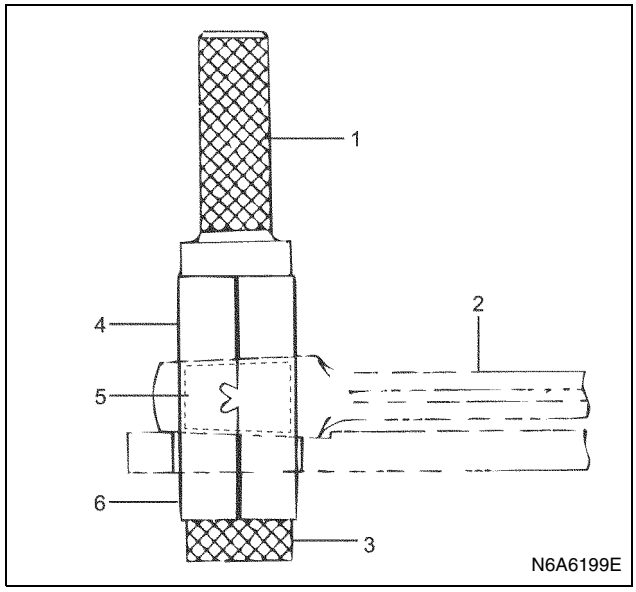
1. Install the bush
   - Place the connecting rod bush replacer base on a press, set the connecting rod and tighten the fixation bolt.

     Special tool
     Connecting rod bush replacer: 5-8840-2340-0 (EN-47682)



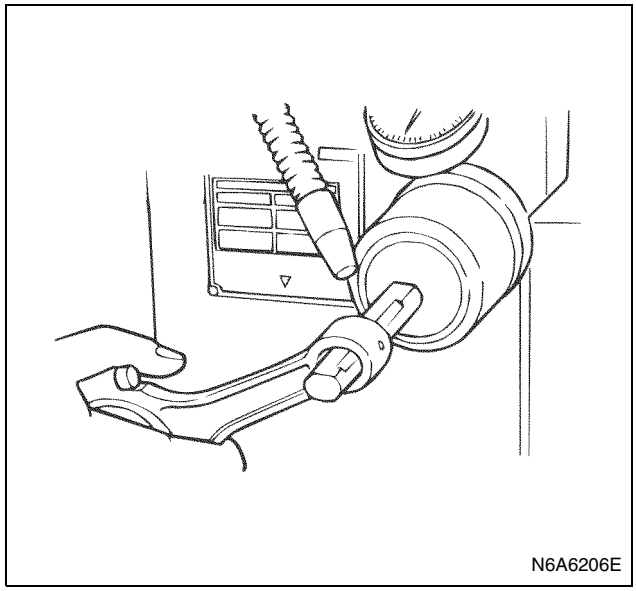
Legend
1. Bolt
2. Connecting Rod Bush Replacer

   - Set the collar, new bush and collar on the setting bar as shown in the drawing.
   - Tighten the nut.
   - Adjust the oil hole of the connecting rod and the oil hole of the bush, and use the bench press to install the bush.



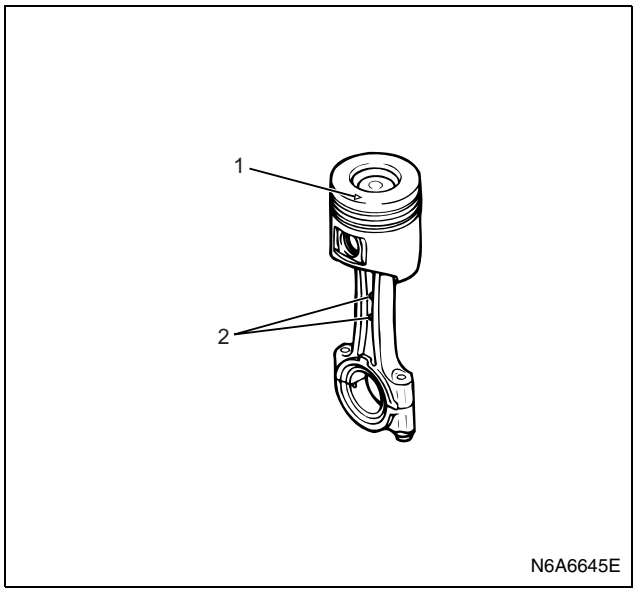
Legend
1. Setting Bar
2. Connecting Rod
3. Nut
4. Collar
5. Bush
6. Collar

   - After installing the new bush, use a grinder to machine the pin hole so that the pin clearance equals the standard value.



2. Install the piston.
3. Install the connecting rod.
   - Install it so that the front mark of the head of the piston and the connecting rod forging mark (projecting) on the connecting rod face the same direction.

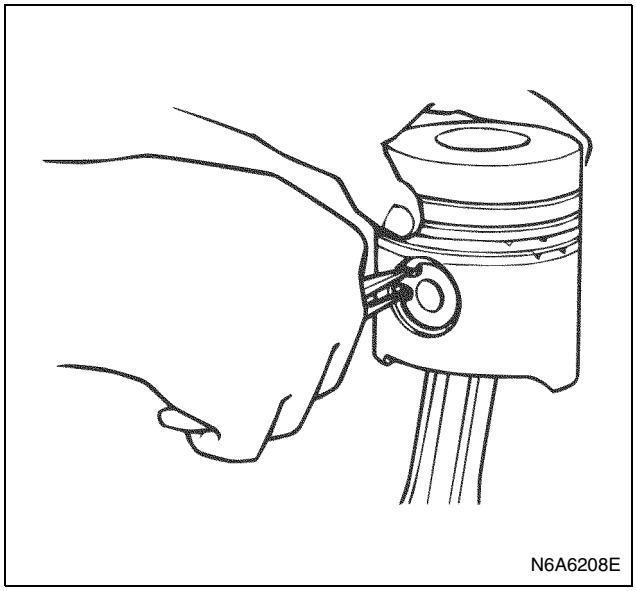
- Use snap ring pliers to install the snap ring of one side.



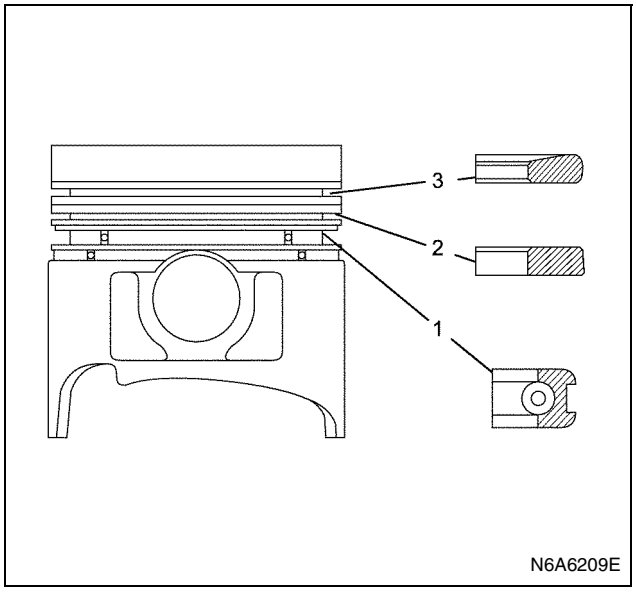
Legend
1. Front Mark
2. Forging Mark (Projecting)

4. Apply enough engine oil on the piston pin, push it in the piston and the connecting rod small edge.
5. Use snap ring pliers to install the snap ring.

Caution:
Make sure that the snap ring is installed in the ring groove properly. Make sure that the connecting rod moves smoothly.

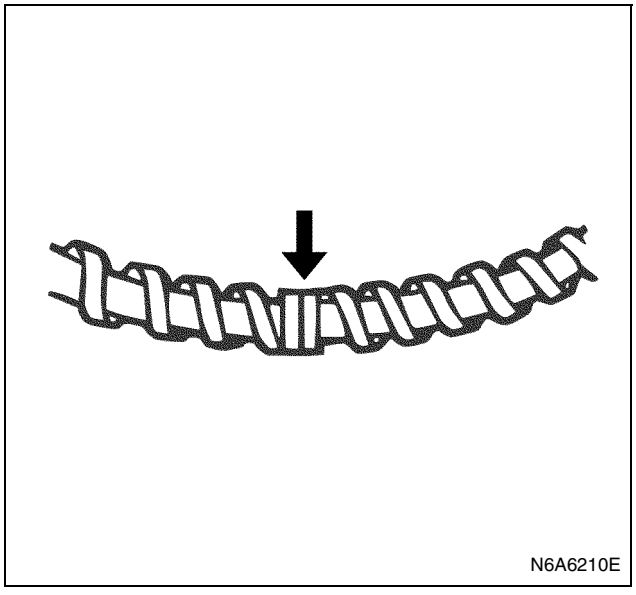


6. Use ring pliers to install the piston ring.
   - Install the oil ring so that the joint angle of the ring and coil expander is in the opposite 180° direction.
   - Install 2nd and 1st compression rings in this order so that the marks “2T” and “1T” face upward.



Legend
1. Oil ring
2. Compression Ring 2nd
3. Compression Ring 1st

Caution:
Note that the shapes of compression rings 1st and 2nd are different.
Make sure that there is no gap in the position indicated in the drawing when the oil ring coil expander was installed.



Installation

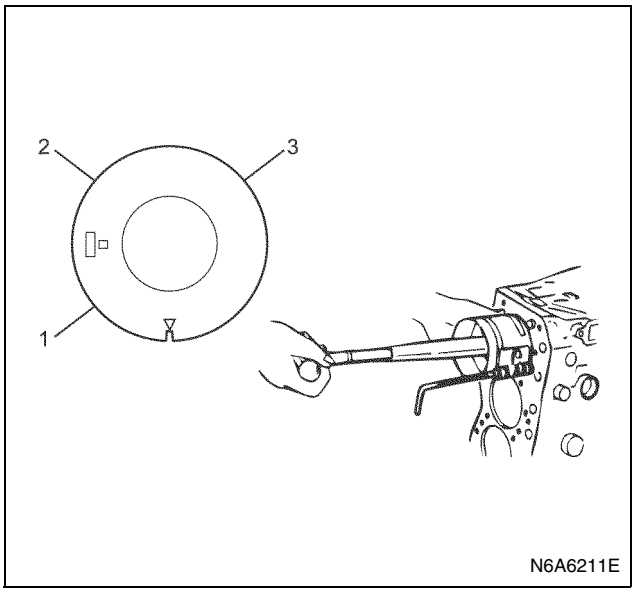
1. Install the connecting rod bearing.
   - Install the bearing on the connecting rod, apply engine oil on the bearing.
2. Install the piston and connecting rod assembly.

- Apply enough engine oil on the piston ring, ring groove and piston side surface.
- Dislocate the piston ring joint so that (1) is 1st ring, (3) is 2nd ring and (2) is oil ring, as shown in the drawing.
- Face the piston front mark cut to forward, use the piston ring compressor to insert the piston in the cylinder liner.

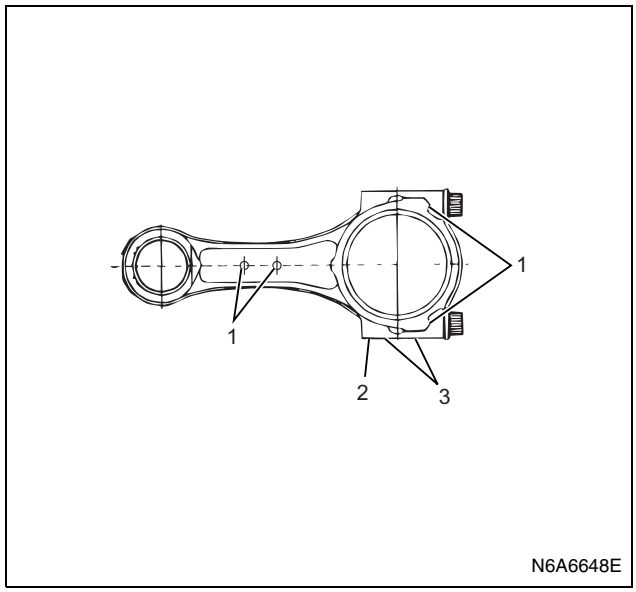
Caution:

- Be sure not to make the connecting rod touch the oil jet when pushing in the piston.
- Be sure not to damage the inside of the liner when pushing in the piston.

Special tool
Piston ring compressor: 5-8840-9018-0 (J-8037)



3. Install the connecting rod cap.
   - Install the bearing on the connecting rod cap and apply engine oil.
   - Install the cap, matching the numbers (1, 2, 3, 4) of the caps and connecting rods.



Legend

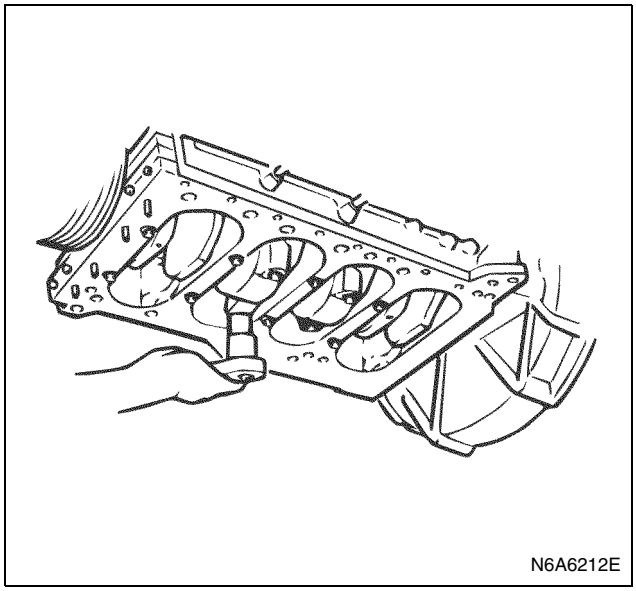
1. Back and Top Recognition Boss
2. Big End Hole Diameter Grade Mark
3. Cylinder Number

- Apply molybdenum disulfide on the screw part and the setting face of the tightening bolt and tighten it with the designated torque.
- Tighten two bolts alternately in each step.

Tighten:
Tightening bolt to
1st step: 39 N·m (4.0 kg·m/29 lb·ft)
2nd step: 60° (degrees)
3rd step: 30° (degrees)

Special tool
Angle gauge: 5-8840-0266-0 (J-45059)

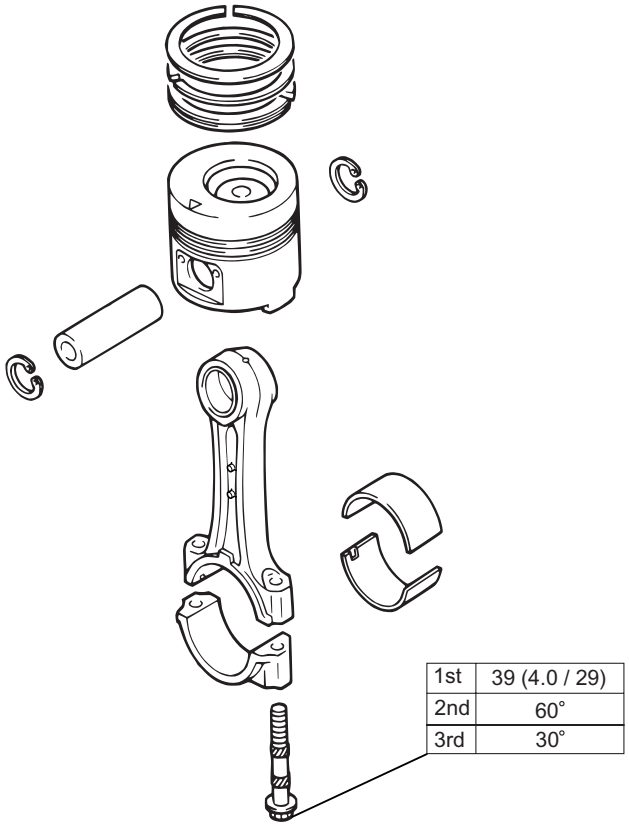
Caution:
Make sure that the crankshaft smoothly rotates.


N6A6212E

4. Install the cylinder head.
   Refer to “Cylinder Head”.
5. Install the camshaft assembly.
   Refer to “Camshaft Assembly”.
6. Install the rocker arm shaft assembly.
   Refer to “Rocker Arm Shaft Assembly”.
7. Install the cylinder head cover.
   Refer to “Cylinder Head Cover”.
8. Install the oil pan.
   Refer to “Oil Pan”.

Torque Specifications

N·m (kg·m / lb·ft)



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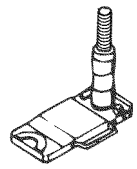
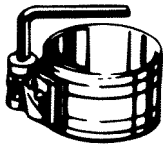
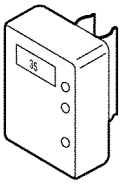
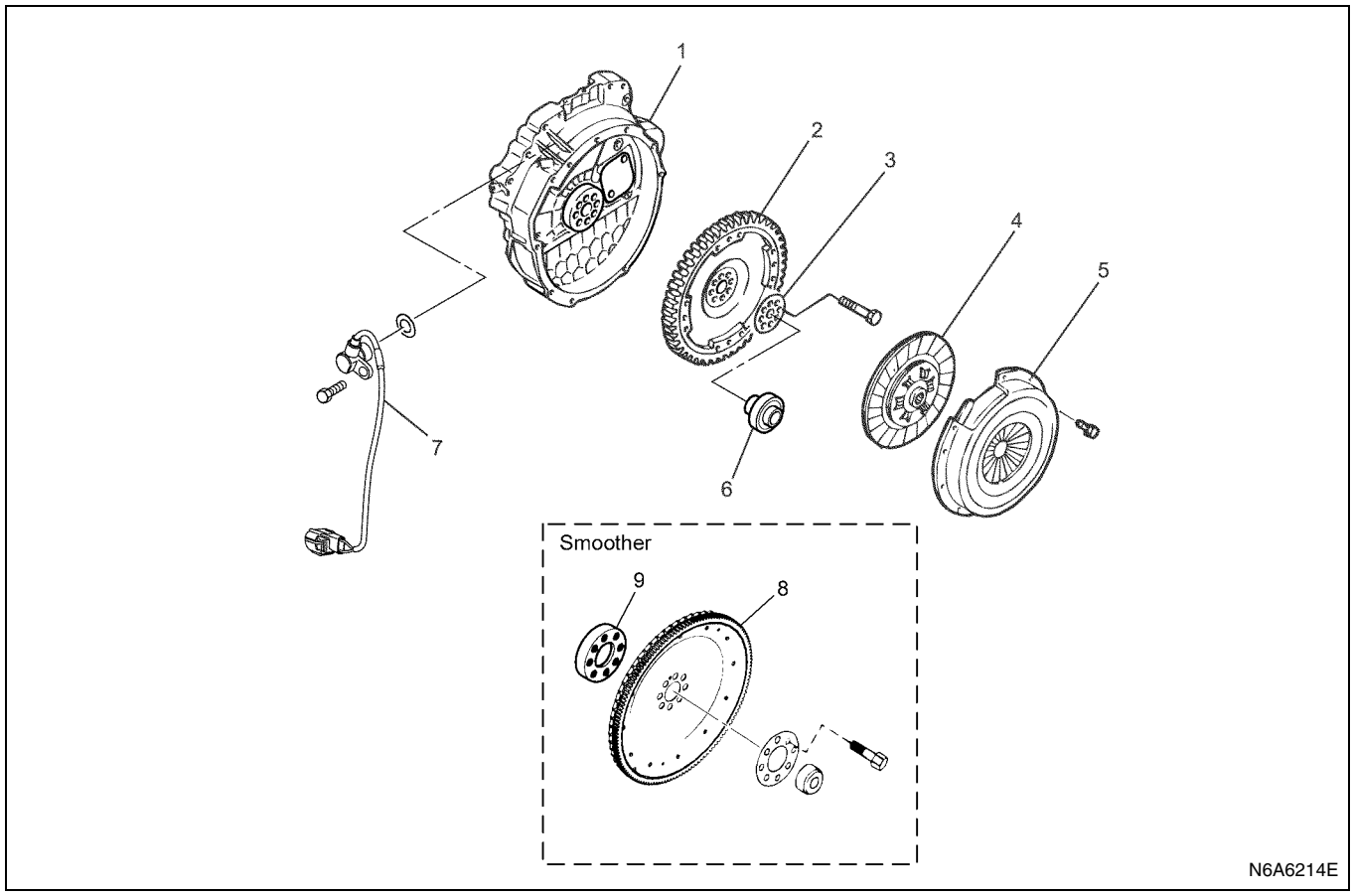
Special Tool

Illustration	Tool Number / Description / Remarks
 5884023400	5-8840-2340-0 (EN-47682) Connecting Rod Bush Replacer
 5884090180	5-8840-9018-0 (J-8037) Piston Ring compressor
 J45059	5-8840-0266-0 (J-45059) Angle Gauge

Flywheel

Component



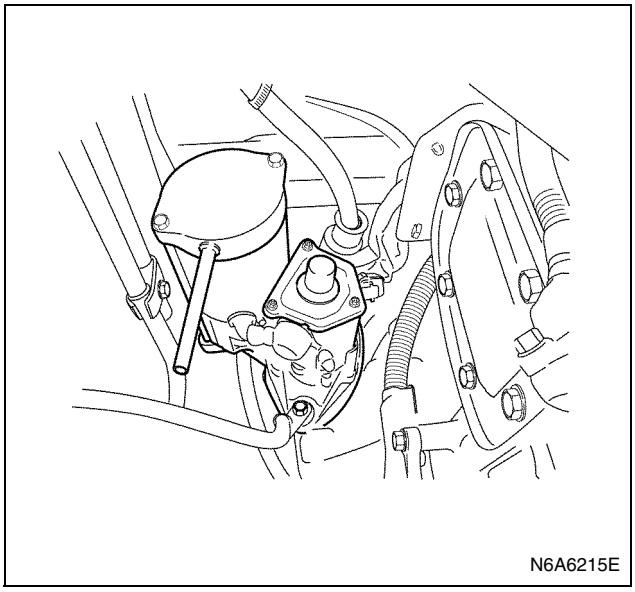
Legend

1. Flywheel Housing
2. Flywheel Assembly (MT)
3. Washer
4. Clutch Assembly (MT)
5. Clutch Pressure Plate Assembly (MT)
6. Pilot Bearing (MT)
7. Crankshaft Position Sensor
8. Flexible Plate (Smoother)
9. Crankshaft End Spacer (Smoother)

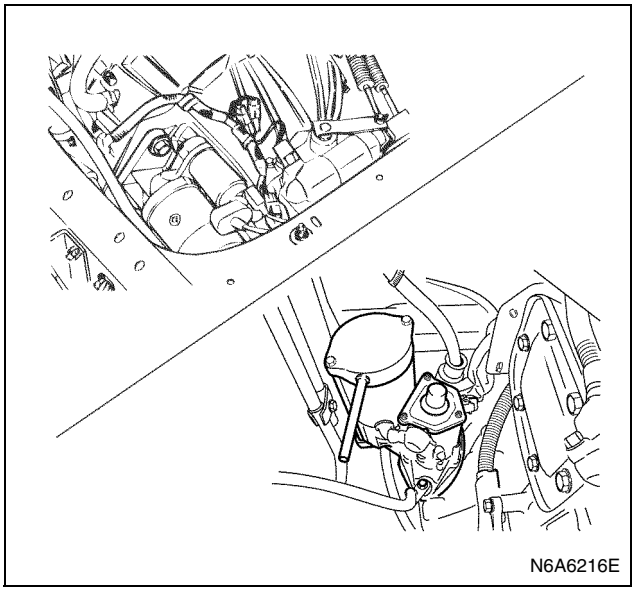
Removal

1. Remove the starter motor.
   - Remove the earth cable of the starter motor.

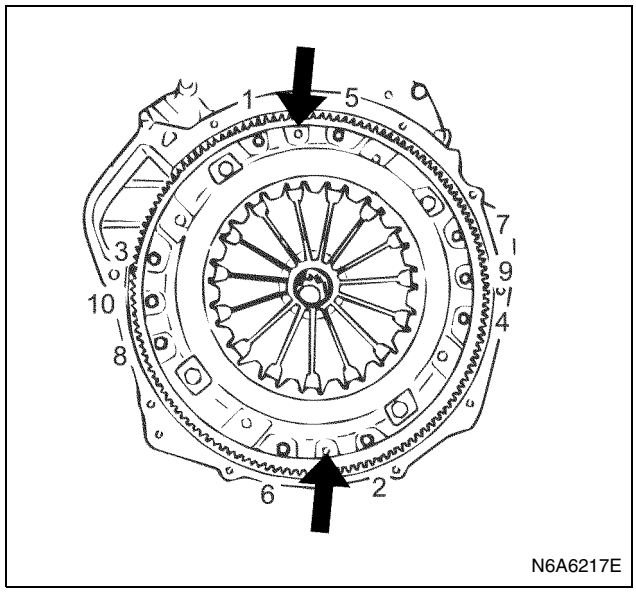
- Disconnect the front frame harness connector near the control box of the transmission, remove the clips that fix the harness.


N6A6215E

- Remove the two bolts on the upper side and lower side that fix the starter, remove the starter from the clutch housing.
- Use wire to secure the starter to the transmission. Position the wire and starter so that it does not interfere with the transmission removal procedure.


N6A6216E

2. Remove the transmission assembly.
   Refer to “Engine Assembly”.
3. Remove the clutch pressure plate assembly.
   - Insert the clutch aligner on the spline of the driven plate.
   - Remove the clutch pressure plate assembly installation bolts in the order shown in the drawing.
   - Remove the clutch pressure plate assembly from the flywheel.



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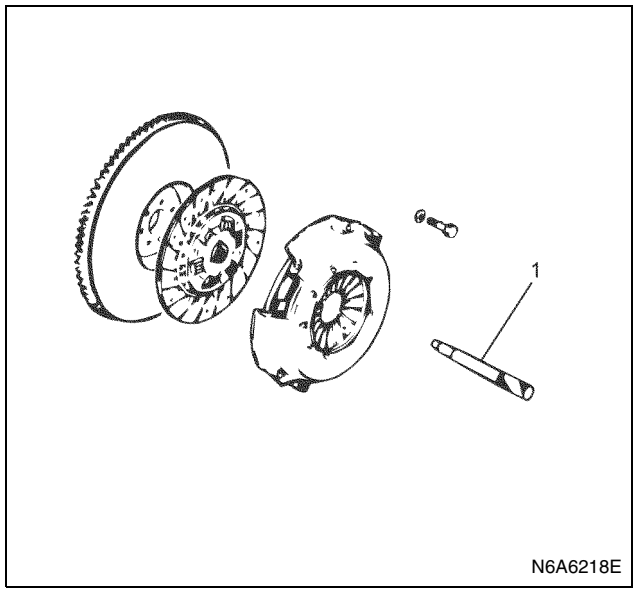
4. Remove the clutch plate assembly.
   - Remove the clutch plate assembly from the flywheel along with the clutch aligner (1).



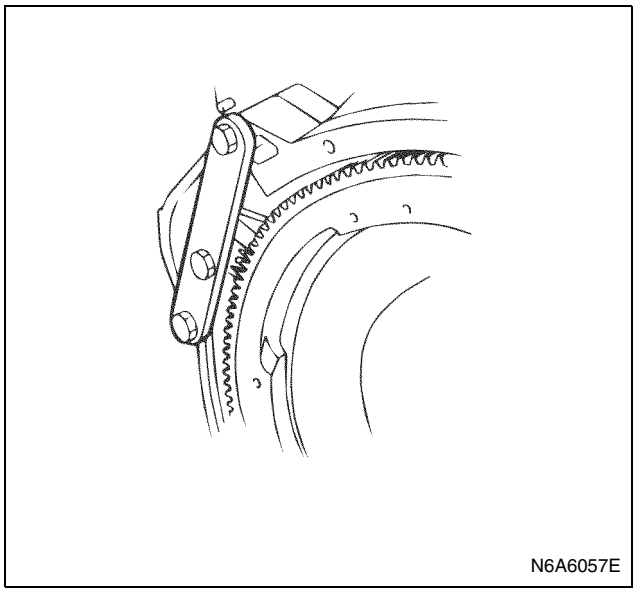
N6A6218E

Legend
1. Clutch Aligner

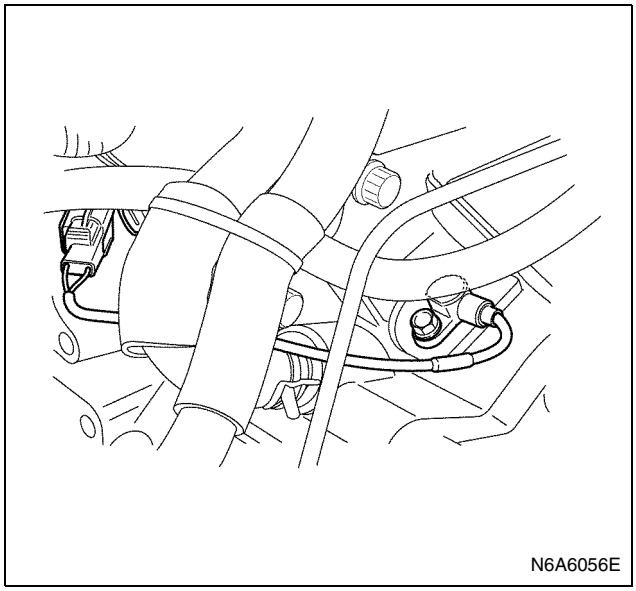
- Install the crankshaft stopper in the starter installation part of the flywheel housing.

Caution:
Make sure that the stopper is applied with the ring gear and installed properly.

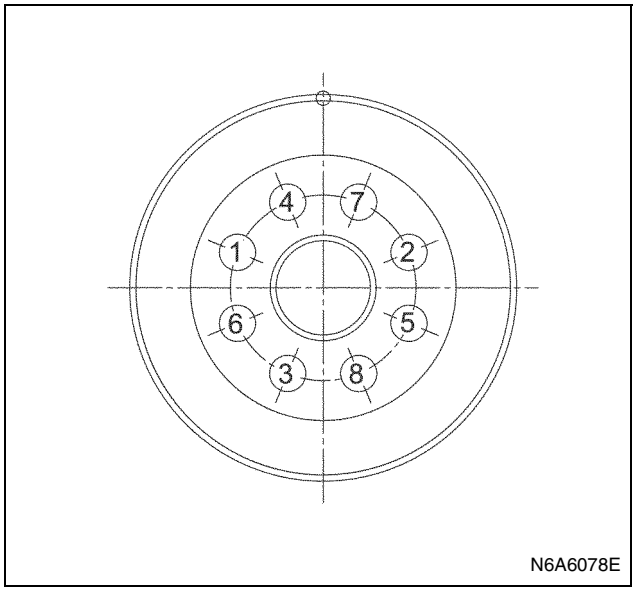
Special tool
Crankshaft stopper: 5-8840-2230-0 (EN-47680)



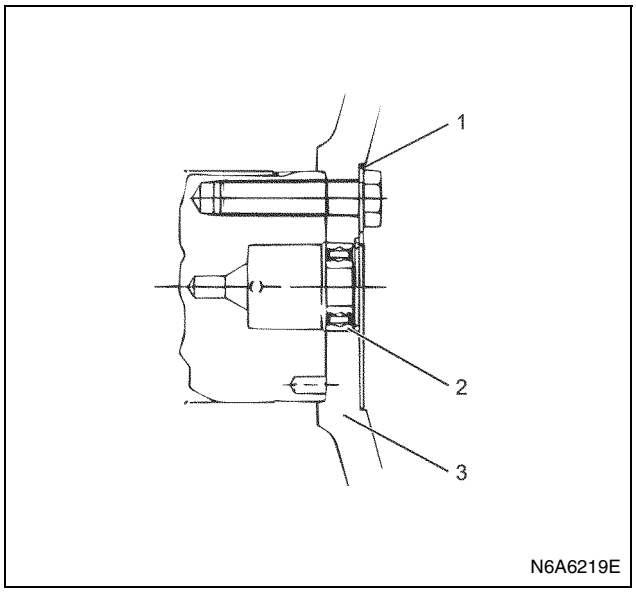
5. Remove the crankshaft position sensor.
   - Remove to prevent contact damage when the flywheel is removed.
   - Do not throw or drop because it is vulnerable to shock.



6. Remove the washer.
7. Remove the flywheel.
   - Gradually loosen the flywheel installation bolts in the order shown in the drawing so that the flywheel does not rotate.
   - After loosening the bolts, remove the stopper and remove the flywheel.
   - In the case of smoother vehicle, after loosening the flexible plate installation bolts, remove the washer, flexible plate, spacer in this order.



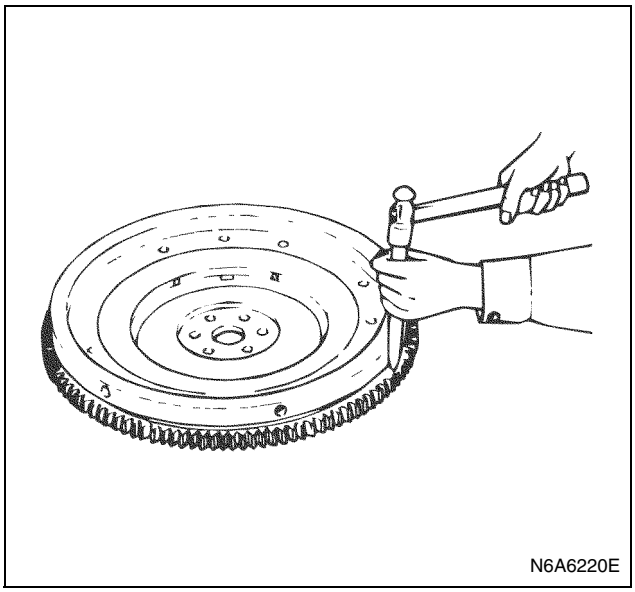
8. Remove the pilot bearing.
   - Remove the pilot bearing from the flywheel.



Legend
1. Washer
2. Pilot Bearing
3. Flywheel

9. Remove the ring gear.

- Put a bar on the ring gear and hit it with a hammer to remove it.

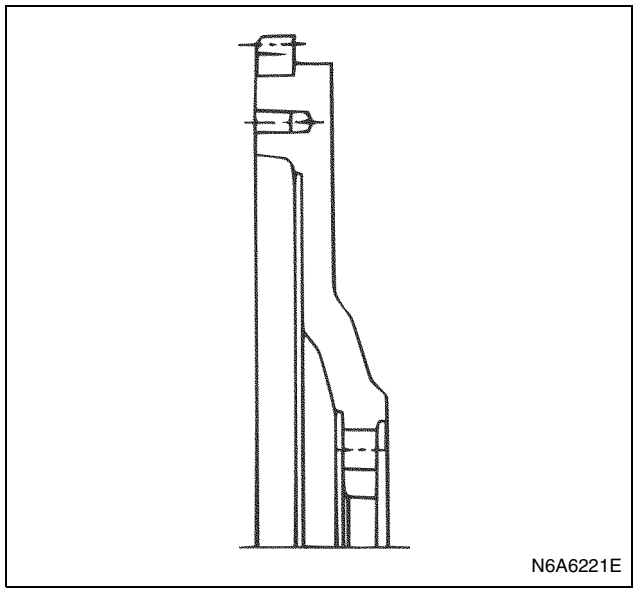

N6A6220E

Inspection

1. Inspection with eyes
   - Inspect the flywheel friction surface for cracks and damages, and replace it if it has abnormality.
   - Inspect the tooth part of the ring gear, replace the ring gear if it has damage or serious wear.
2. Measurement of the friction surface
   - Measure the depth of the friction surface of the flywheel.
   - Adjust it if the measured value is between the standard value and the limit.
   - If the measured value exceeds the limit, replace the flywheel.

Depth of the friction surface of the flywheel mm (in)	
Standard	19 (0.75)
Limit	20 (0.79)

Depth = From the pressure installation surface to the friction surface.

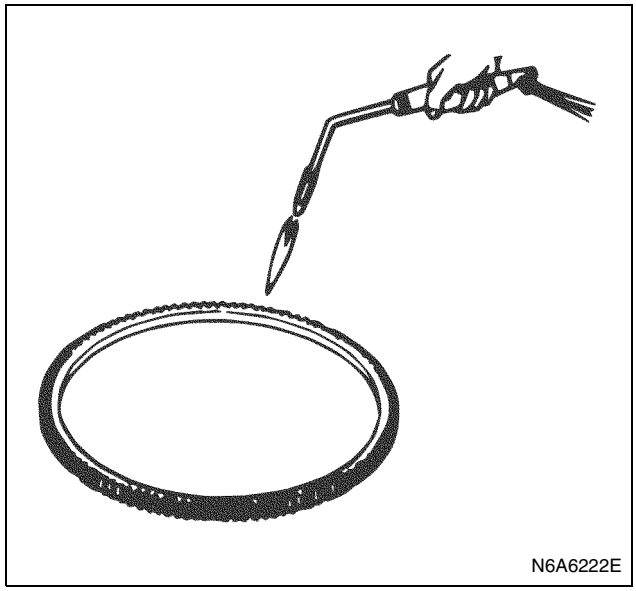

N6A6221E

Installation

1. Install the ring gear.
   - After heating the ring gear with a gas burner equally, install it in the flywheel.
   - During shrinkage cooling of the ring gear, maintain the flatness by applying force of 68.6 kN (15,400 lbf).

Caution:

- Install the ring gear in the direction within the chamfered face comes to the side of pressure installation surface.
- Shrink fit the ring gear to the flywheel.
  Make sure that flywheel and ring gear adhesion is complete.


N6A6222E

2. Install the flywheel.
3. Install the washer.

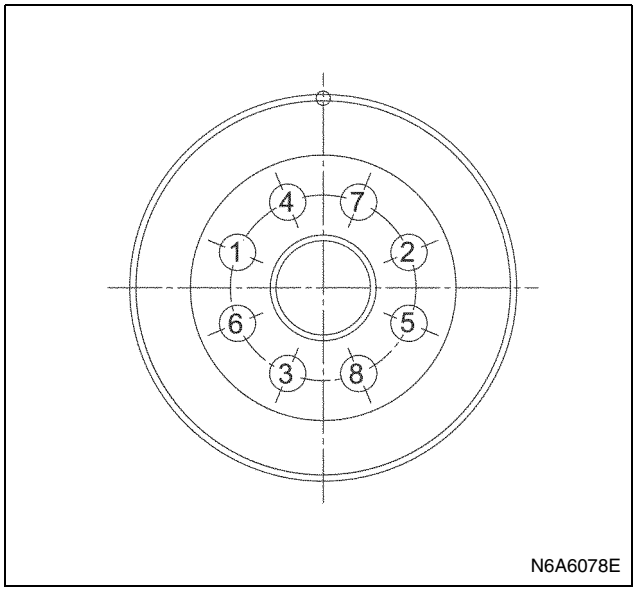
M/T specification

1) Align the flywheel with the crankshaft knock pin and temporarily tighten the flywheel bolts.
2) Use the crankshaft stopper to prevent the crankshaft from turning.
   Crankshaft stopper: 5-8840-2230-0 (EN-47680)
- Apply molybdenum disulfide on the thread and setting face of the bolt.

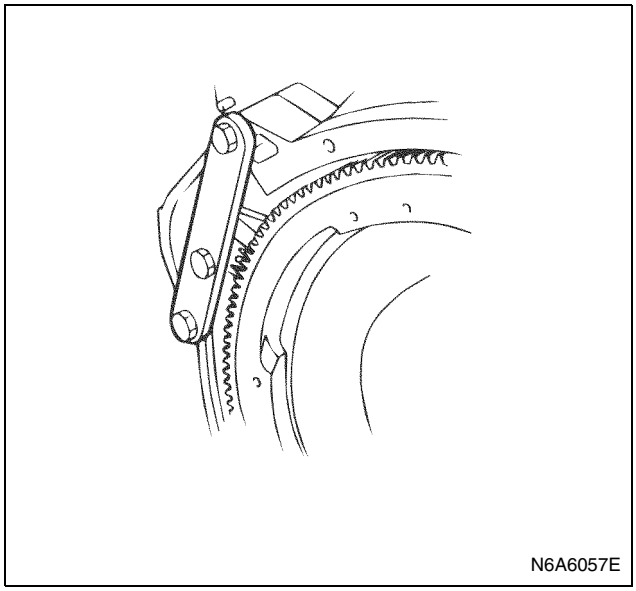
3) Install the washer and the flywheel bolts and tighten to the specified torque in numerical order show in the illustration.

Tighten:
Bolts to
1st step: 78 N·m (8.0 kg·m/58 lb·ft)
2nd step: 120° – 150° (degrees)

Special tool
Crankshaft stopper: 5-8840-2230 (EN-47680)
Angle gauge: 5-8840-0266-0 (J-45059)

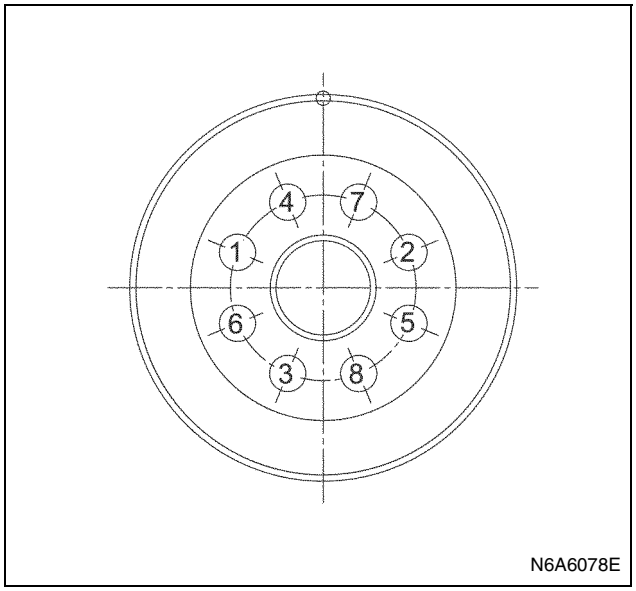


N6A6078E


N6A6057E

Smoother specification

1) Align the knock pin on the crankshaft to install the spacer.
2) Install the flexible plate and washer, also aligning to the knock pin on the crankshaft.
3) Apply molybdenum disulfide grease to the bolt thread and seat to install the flywheel fixing hole. Tighten bolt to two stage tightening method in the numerical order.
   1st step; 78 N·m (8.0 kg·m/58 lb·ft)
   2nd step; 90° – 120° (degrees)



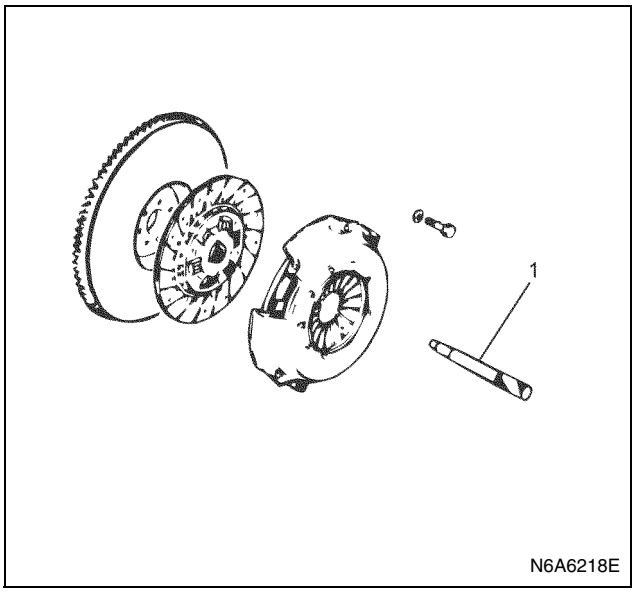
N6A6078E

4. Install and tighten the crankshaft position sensor with the designated torque.

Tighten:
Bolt to 8 N·m (0.8 kg·m/69 lb·in)

5. Hammer in the pilot bearing until it reaches the edge surface of the crank.
6. Install the clutch plate assembly.

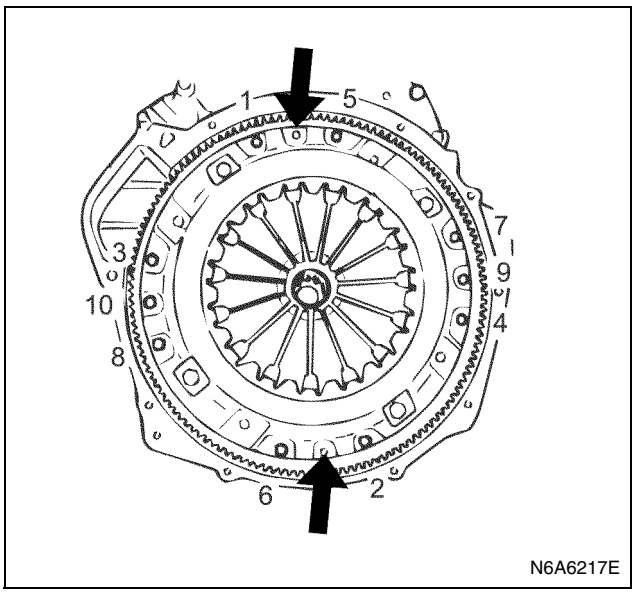
- Use a clutch aligner to install the clutch plate assembly on the flywheel.



Legend
1. Clutch Aligner

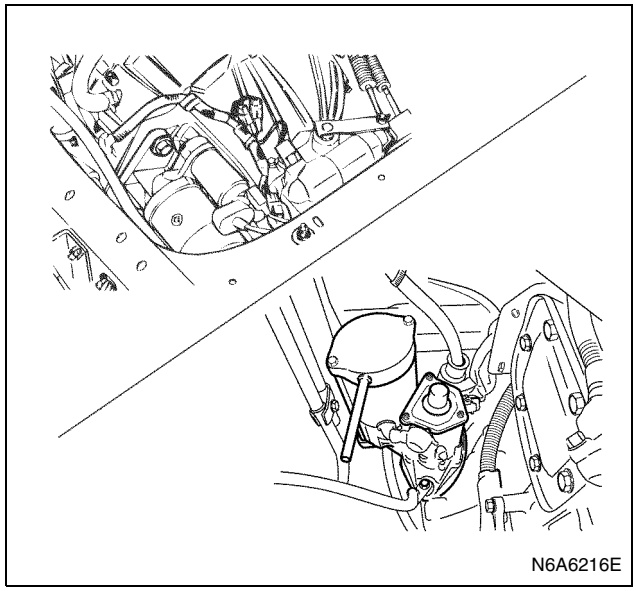
7. Install the clutch pressure plate assembly.
   - Install the clutch pressure plate assembly on the flywheel so that the installation hole of the clutch pressure plate assembly matches with the dowel pins of the flywheel.
   - Tighten the clutch pressure plate assembly in the order shown in the drawing.

Tighten:
Bolts to 40 N·m (4.1 kg·m/30 lb·ft)

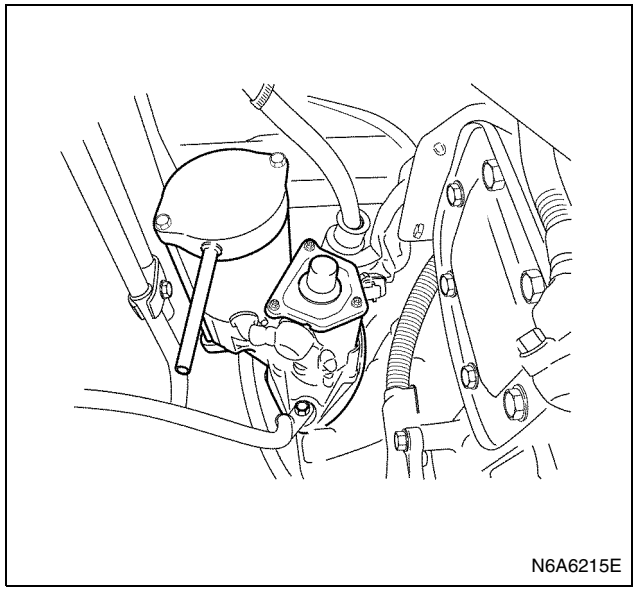


8. Install the transmission assembly.
   Refer to “Engine Assembly”.
9. Install the starter motor on the clutch housing with bolts.

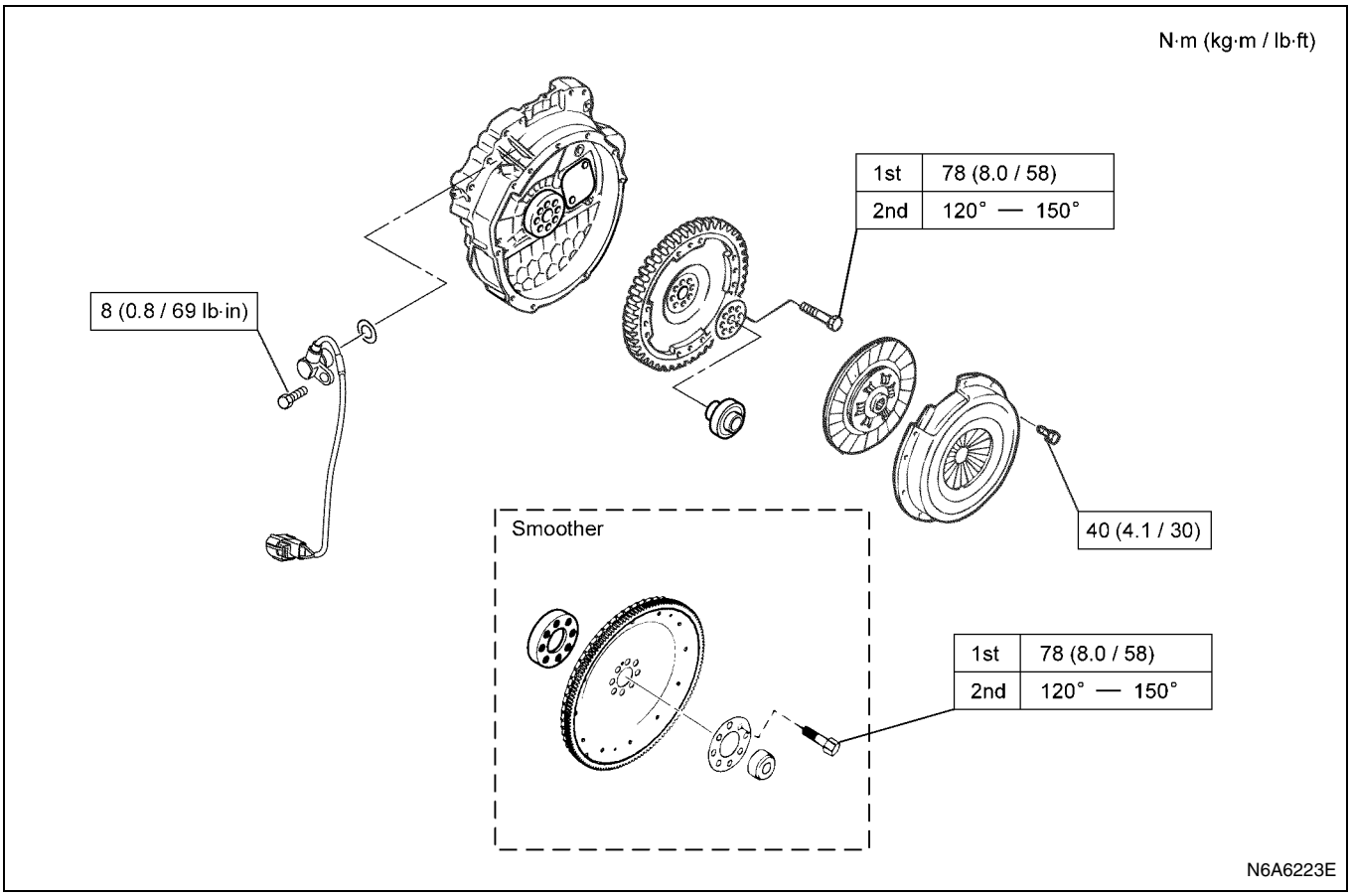
Tighten:
Bolts to 76 N·m (7.7 kg·m/56 lb·ft)



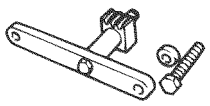
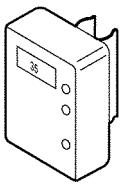
- Install the earth cable of the starter motor.
- Connect the front frame harness connector.



Torque Specifications

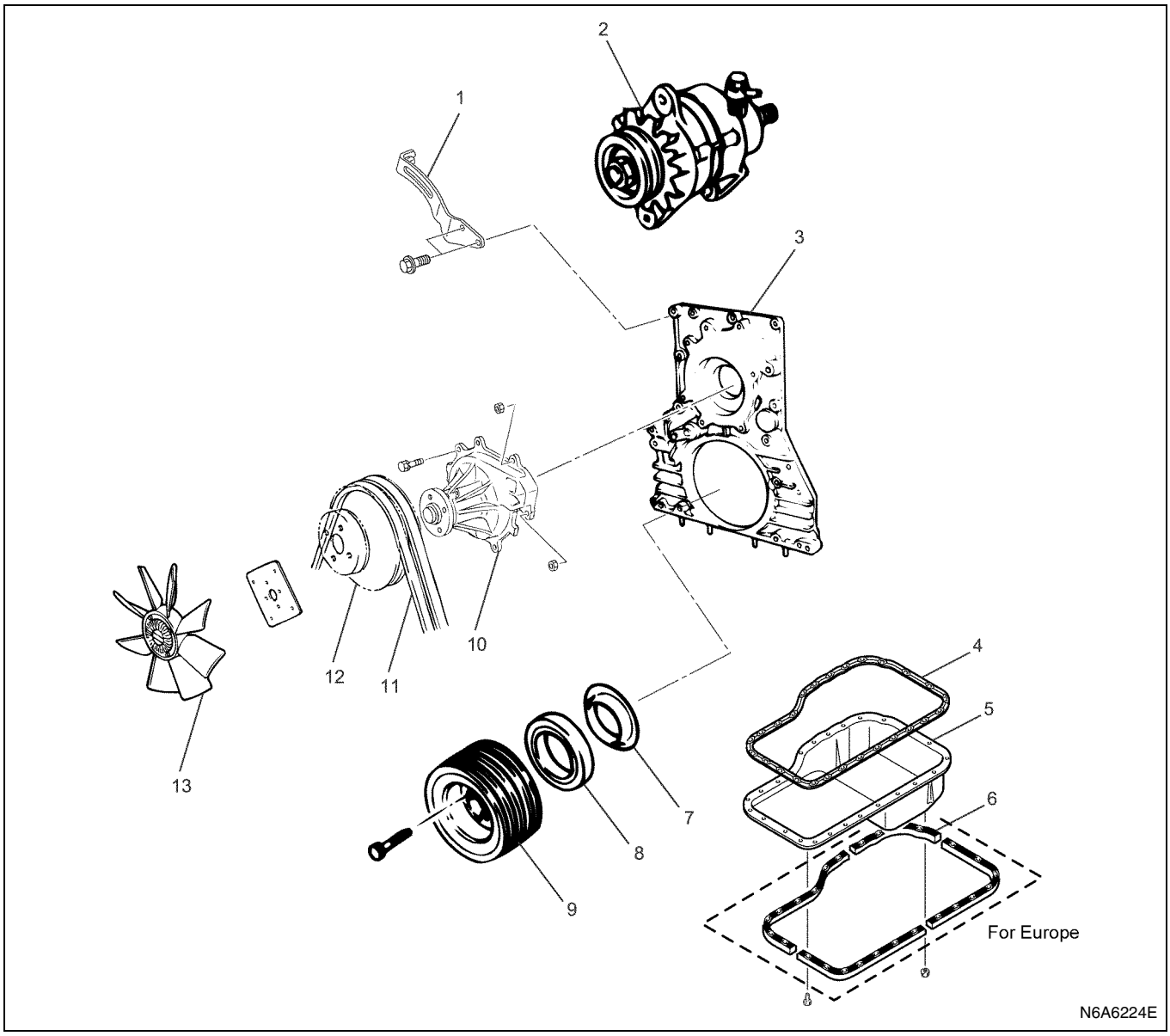


Special Tool

Illustration	Tool Number / Description / Remarks
 5884022300	5-8840-2230-0 (EN-47680) Crankshaft Stopper
 J45059	5-8840-0266-0 (J-45059) Angle Gauge

Front Cover

Component



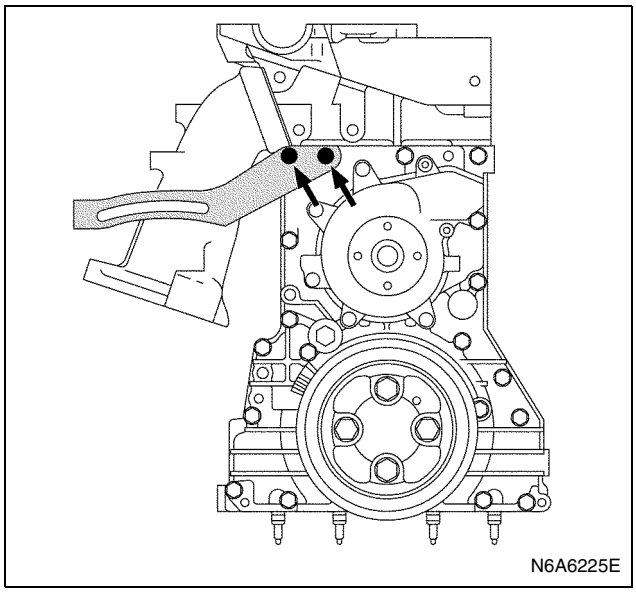
Legend

1. Adjust Plate
2. Generator
3. Front Cover
4. Oil Pan Gasket
5. Oil Pan
6. Rubber Assembly (For Europe)
7. Front Slinger
8. Front Oil Seal
9. Crankshaft Pulley
10. Water Pump Assembly
11. Fan Belt
12. Water Pump Pulley
13. Fan Assembly

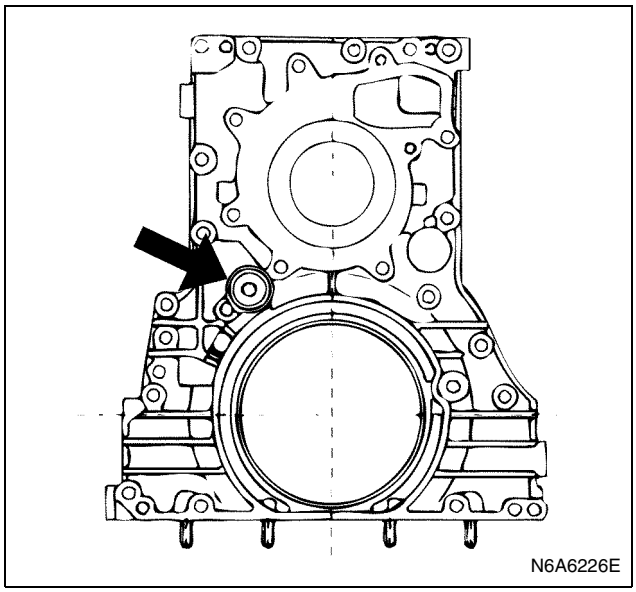
Removal

1. Remove the front oil seal.
   Refer to “Crankshaft Front Oil Seal”.
2. Remove the oil pan
   Refer to “Oil Pan”.
3. Remove the water pump.
   Refer to “Water Pump” in Section 6B.
4. Remove the front cover.

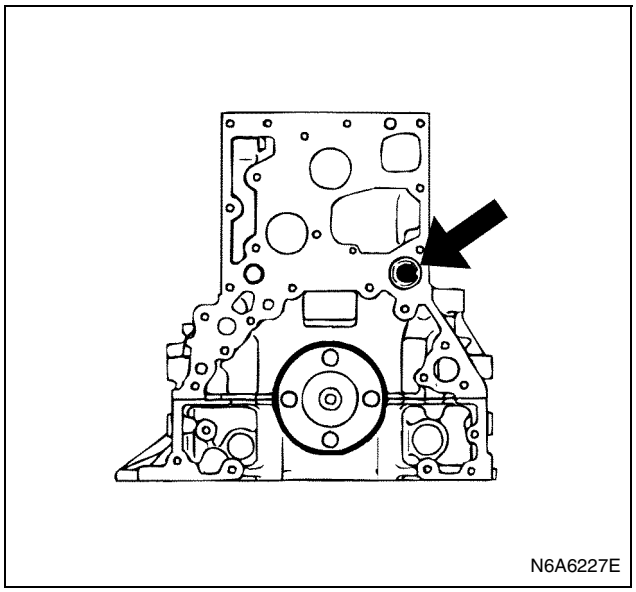
- Remove the generator adjust plate.


N6A6225E

- Remove the oil relief valve (arrowed), loosen the front cover installation bolts and remove the front cover.

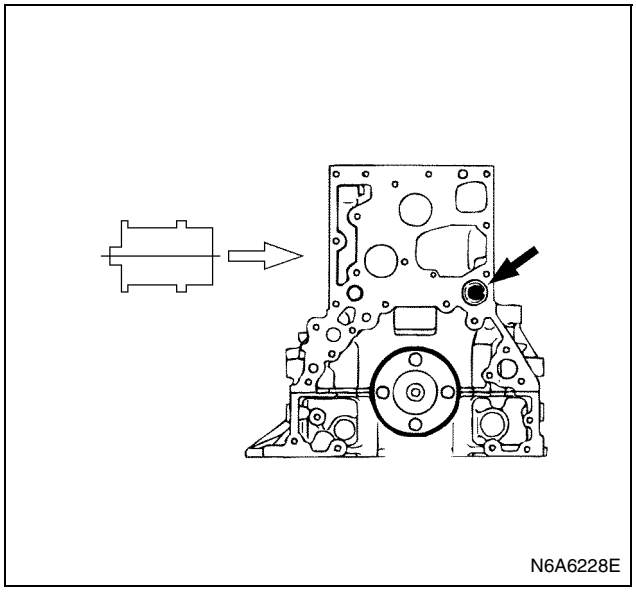

N6A6226E

5. Remove the oil cooler bypass valve.
   - Pull out the oil cooler bypass valve from the cylinder block.


N6A6227E

Installation

1. Install the oil cooler bypass valve.
   - Insert the oil cooler bypass valve into the cylinder block. Be sure not to insert in a wrong direction.

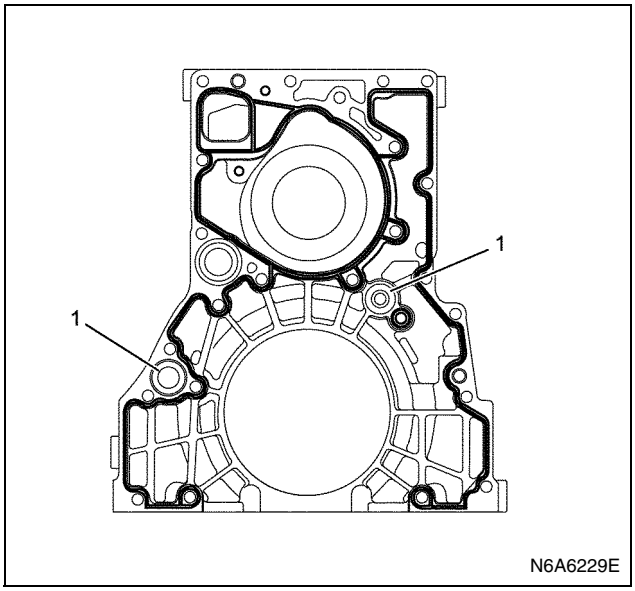

N6A6228E

2. Install the front cover.
   - Clean the cylinder block front surface. In particular, remove liquid gasket leaked during installation of the crankcase.
   - Install two O-rings and apply liquid gasket (ThreeBond 1207B, 1207C, 1207F or equivalent) along with the groove of the front cover installation surface.

Beat width:	1.5 – 5mm (0.059 – 0.20 in)
Beat height:	0.3 – 1.5mm (0.012 – 0.059 in) from the joint surface

- Install within seven minutes after applying liquid gasket.

Caution:
Apply liquid gasket so that it does not adhere to the O-ring.



Legend
1. O-ring

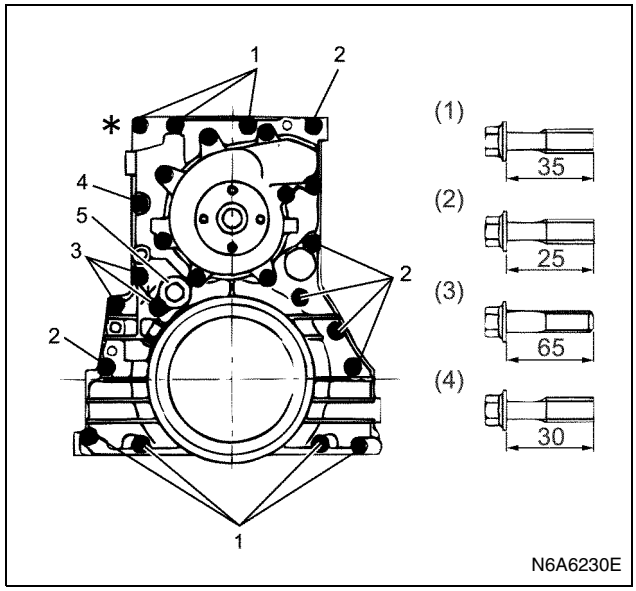
- Install the front cover to match with the dowel pins of the cylinder block.

Caution:
Along with the front cover, install the water pump assembly (before liquid gasket becomes dry)

Tighten:
Front cover bolt to 24 N·m (2.4 kg·m/18 lb·ft)

- Tighten bolts with (*) mark together with the adjust plate of the generator.
- Tighten the oil relief valve (5) with the designated torque.

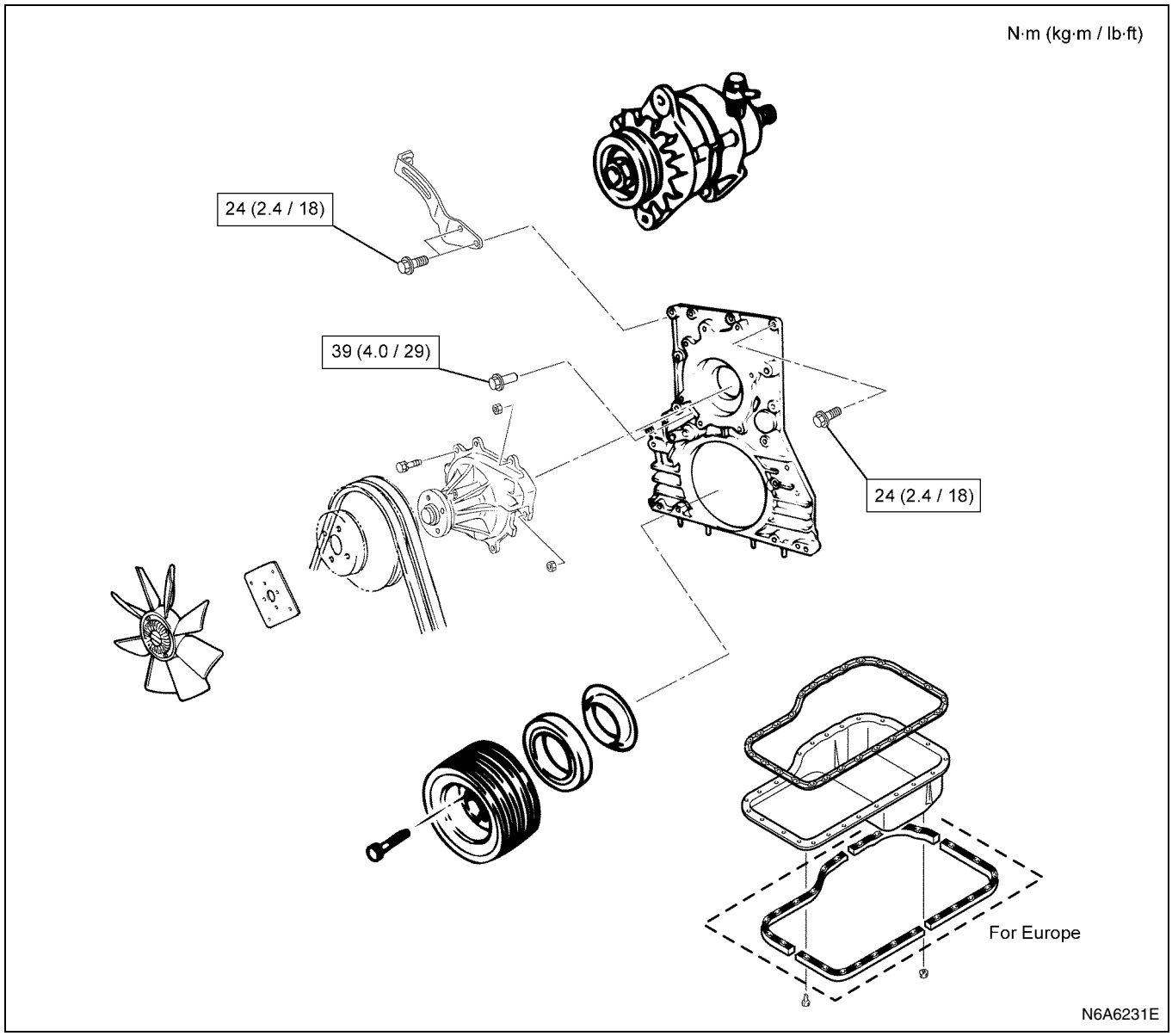
Tighten:
Oil relief valve to 39 N·m (4.0 kg·m/29 lb·ft)



Legend
1. BOLT : L = 35 mm (1.38 in)
2. BOLT : L = 25 mm (0.98 in)
3. BOLT : L = 65 mm (2.56 in)
4. BOLT : L = 30 mm (1.18 in)
5. Oil Relief Valve

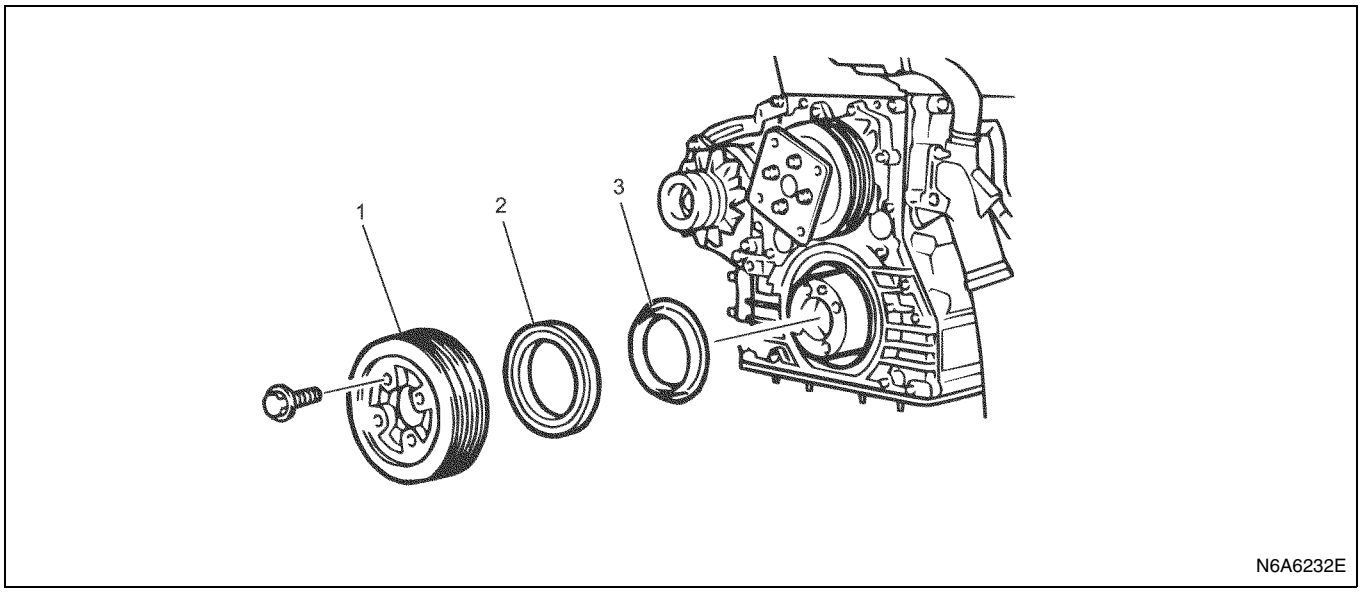
3. Install the water pump.
   Refer to “Water Pump” in Section 6B.
4. Install the oil pan.
   Refer to the “Oil Pan”.
5. Install the front oil seal.
   Refer to the “Crankshaft Front Oil Seal”.

Torque Specifications



Crankshaft Front Oil Seal

Component

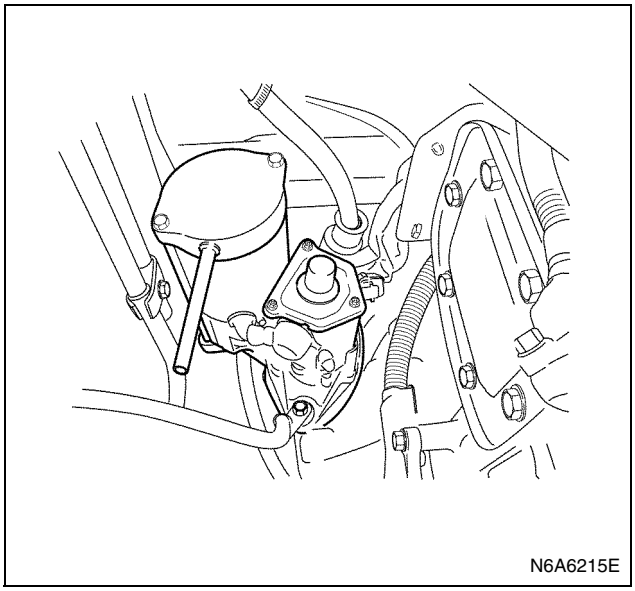


Legend

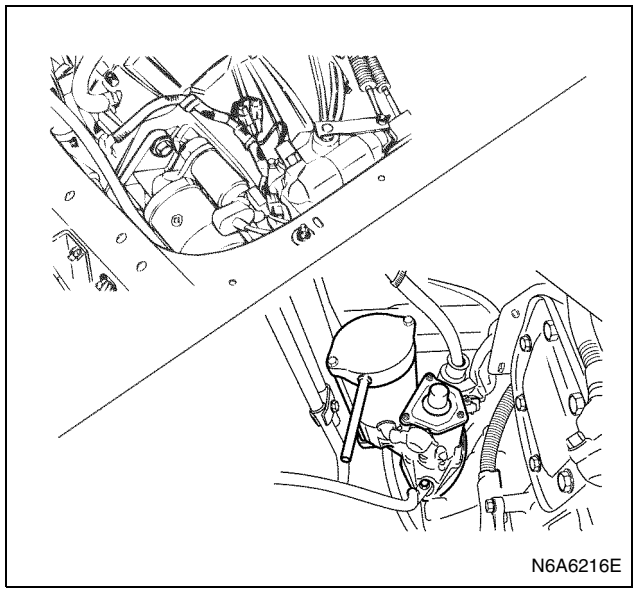
1. Crankshaft Pulley
2. Crankshaft Front Oil Seal
3. Crankshaft Front Slinger

Removal

1. Drain coolant.
2. Remove the starter.
   - Disconnect the starter ground cable.
   - Disconnect the front frame harness connector at a position near the transmission control box and unlatch fixing clips from the harness.



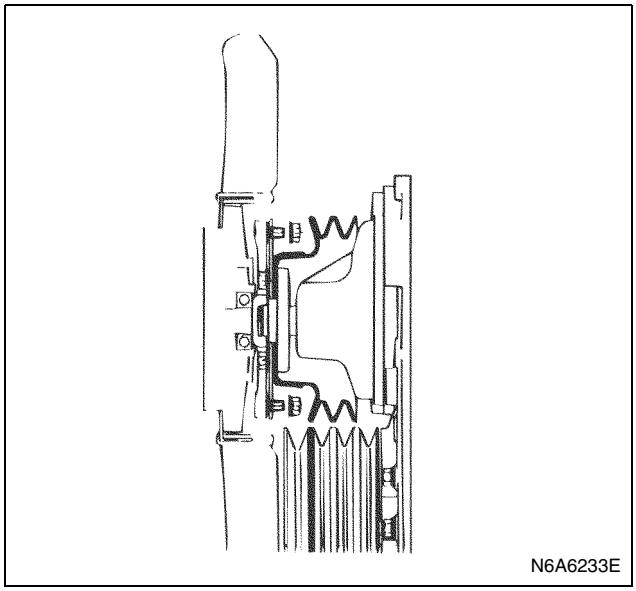
   - Remove two mounting bolts.
   - Fix the detached starter with a wire or the like at a position where it will not be a hindrance to removing the transmission.



3. Disconnect the upper radiator hose on the engine side.
4. Disconnect the coolant reserve tank hose on the radiator side.
5. Disconnect the lower radiator hose on the engine side.
6. Remove the radiator (with the fan guide) detaching right and left brackets.
7. Remove the fan assembly.

- Remove the fan assembly unscrewing four mounting nuts.

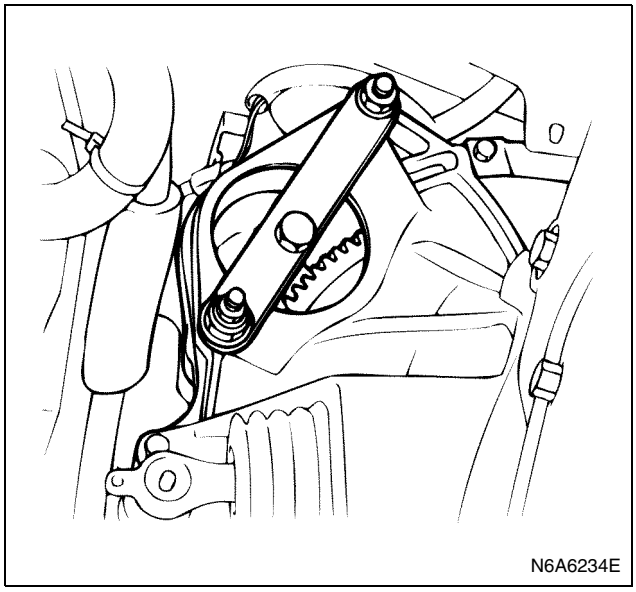
8. Remove the fan belt.


N6A6233E

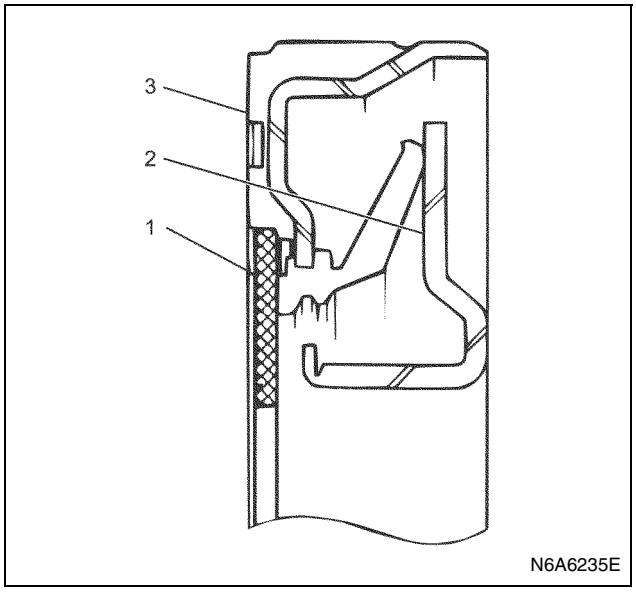
9. Remove the crankshaft pulley.
   - Loosen the pulley bolts blocking the crankshaft from turning by placing a crankshaft stopper on the starter mounting position on the flywheel housing.

Caution:
Make sure that the stopper is properly fitted and engaged with the ring gear.

Special tool
Crankshaft stopper: 5-8840-2230-0 (EN-47680)


N6A6234E

10. Remove the crankshaft front oil seal.
    - Remove only the oil seal off with a screwdriver or the like avoiding damage to the oil seal contact surface on the front cover and the shaft.

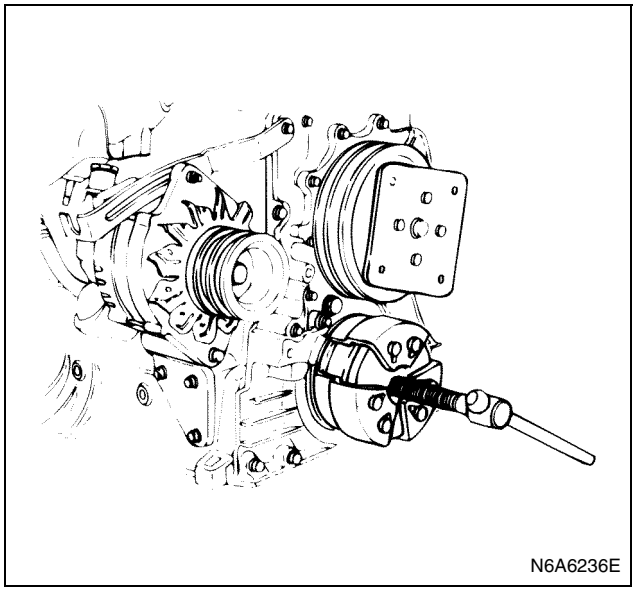


N6A6235E

Legend
1. Felt
2. Slinger
3. Oil Seal

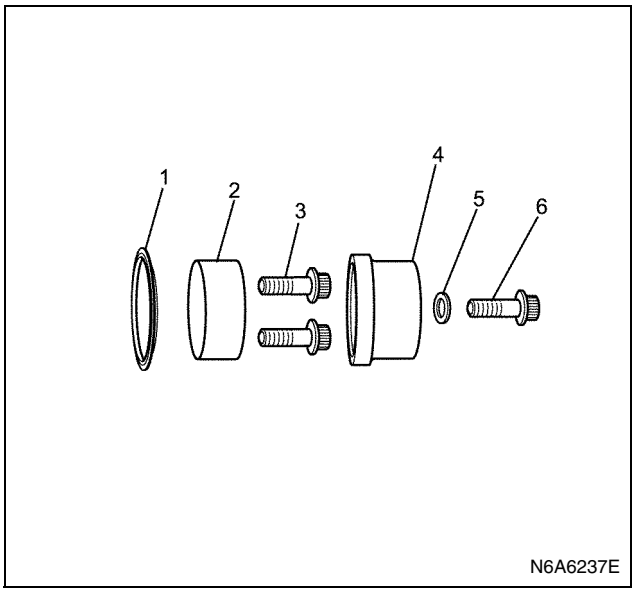
11. Remove the crankshaft front slinger.
    - Pull out the slinger using a slinger puller. (Fixing the circumference of the puller with a clip band will make the procedure easier.)

Special tool
Slinger puller: 8-9439-6858-0 (J-43285)


N6A6236E

Installation

1. Install the crankshaft front slinger.
   - Press-fit the slinger using an oil seal installer kit.

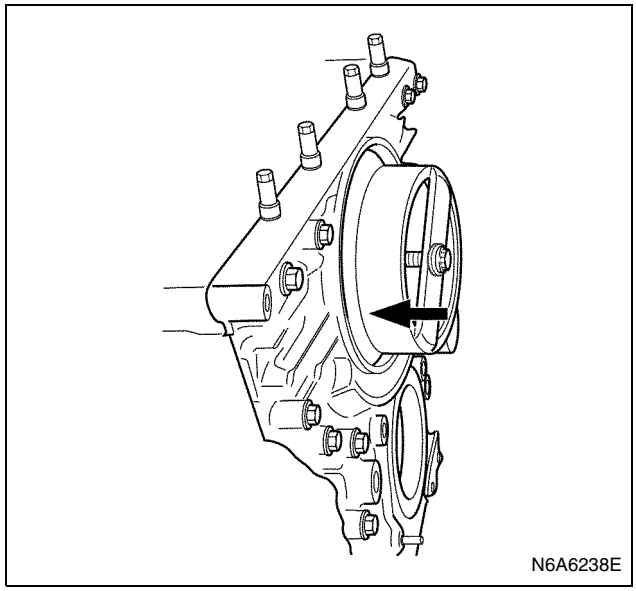


Legend
1. Front Slinger
2. Adapter (Front)
3. Fixing Bolt
4. Sleeve (Front)
5. Washer (Front)
6. Center Bolt

Special tool
Oil seal installer kit: 5-8840-2703-0 (J-43282)
(Use the parts listed below for the front oil seal.)

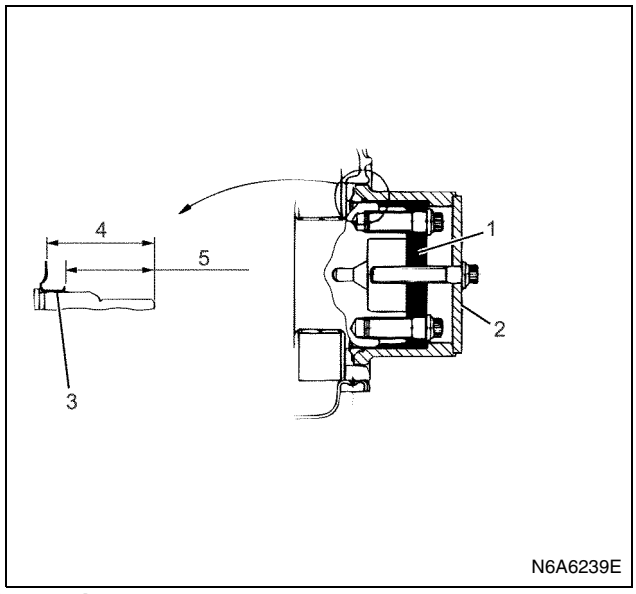
No.	Part Name	Slinger	Oil seal
1	Sleeve (front)	O	O
2	Adapter (front)	O	O
3	Adapter ring (front)	—	O
4	Washer (front)	O	O
5	Center bolt	O	O
6	Fixing bolt	O	O

   - Insert the front slinger into the end of the adapter and fit them on the crankshaft.
   - Put the sleeve over the adapter, place a washer on the center bolt and tighten the bolt until the sleeve touches the adapter to press fit the front slinger.



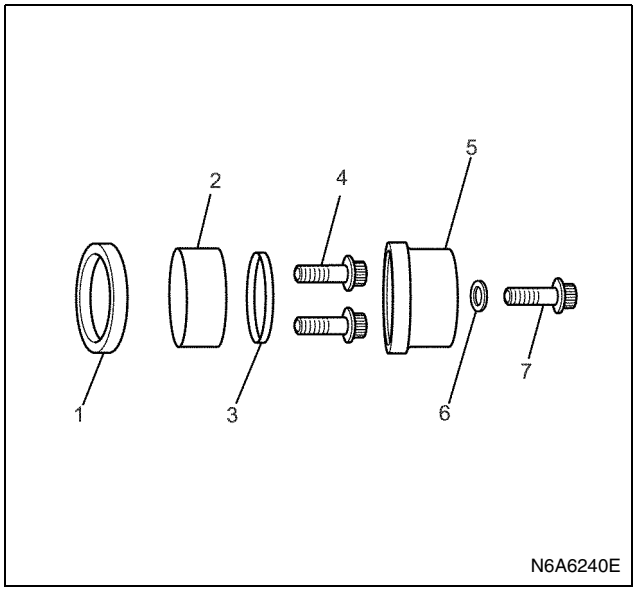
   - After you have pressed the front slinger, confirm the measurement shown (depth from the end surface of the crankshaft to the flange of the slinger) and check for deflection of the slinger.

Caution:
Be careful not to put the slinger inside out or mistake front side slinger for rear one, and vice versa. Rear side slinger has four right-hand threads on it while front one has four left-hand threads. Slinger and oil seal should always be replaced in pairs.



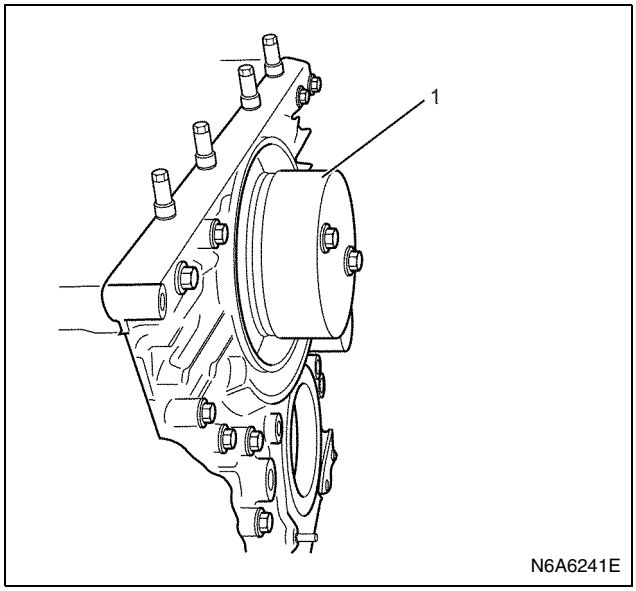
Legend
1. Adapter
2. Sleeve
3. Slinger
4. 40.5 ± 0.3 mm (1.594 ± 0.012 in)
5. 34 ± 0.1 mm (1.339 ± 0.004 in)

2. Install the crankshaft front oil seal.
   - Press fit the oil seal using an oil seal installer kit.



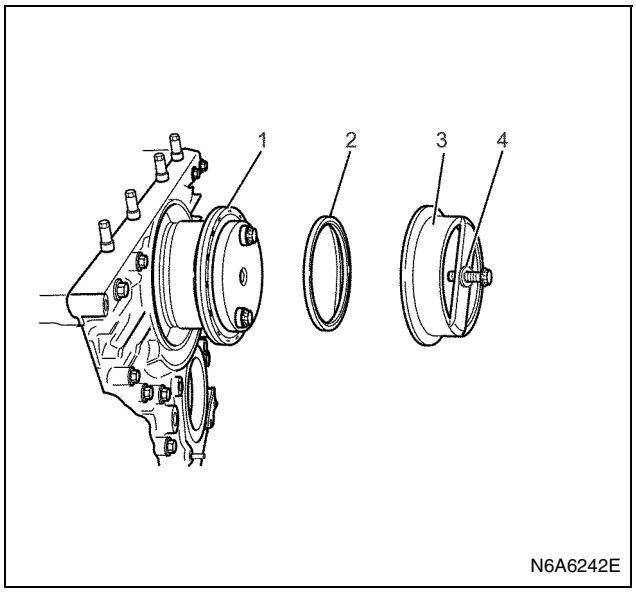
Legend
1. Oil Seal
2. Adapter (Front)
3. Adapter Ring (Front)
4. Fixing Bolt
5. Sleeve (Front)
6. Washer (Front)
7. Center Bolt

   - Mount the adapter onto the crankshaft with fixing bolts.

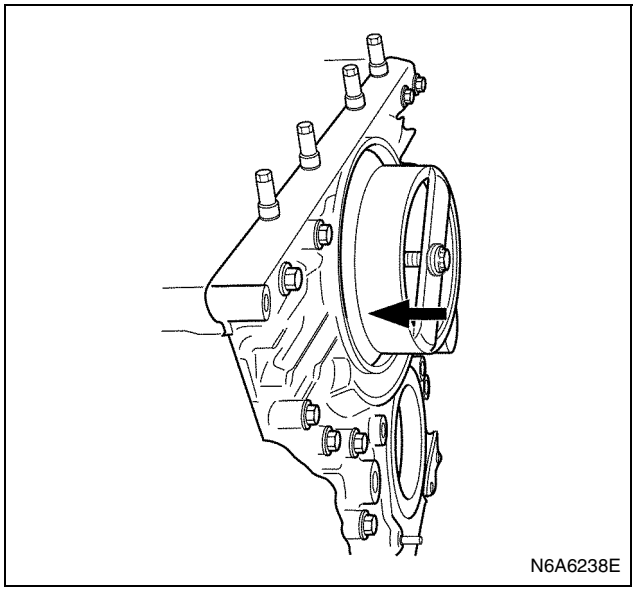


Legend
1. Adapter

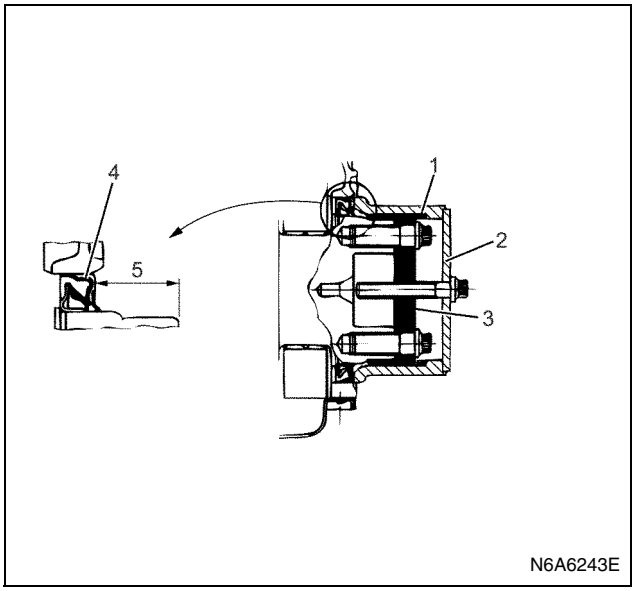
   - Apply engine oil to the lip of the oil seal and place it on the front side adapter.
   - Put the front side adapter ring in the sleeve and fix the sleeve on the adapter with the center bolt and a washer.
   - Tighten the bolt until the sleeve touches the adapter to press fit the front oil seal.



Legend
1. Oil Seal
2. Adapter Ring
3. Sleeve
4. Bolt and Washer



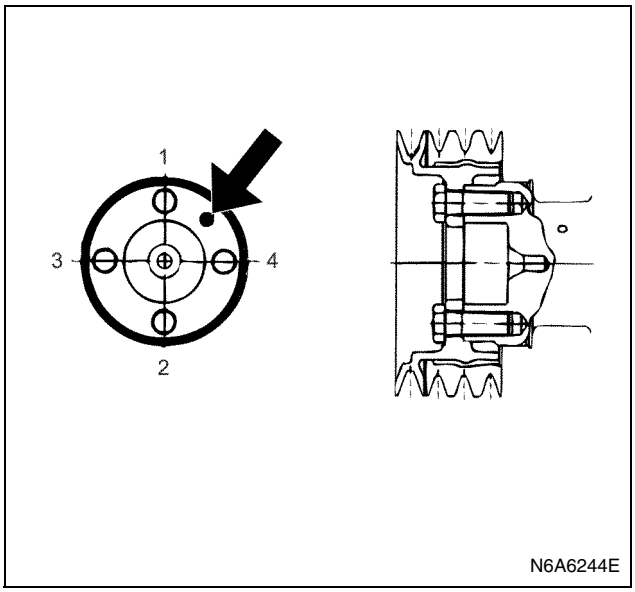
- After you have press-fitted the front oil seal, confirm the measurement shown (depth from the end surface of the crankshaft to the oil seal) and check for deflection of the oil seal.



Legend
1. Adapter Ring
2. Sleeve
3. Adapter
4. Oil Seal
5. 31 ± 0.3 mm (1.220 ± 0.012 in)

3. Install the crankshaft pulley.
   - Apply engine oil to the threads of the fastening bolts.
   - Install the crankshaft pulley aligning with the dowel pins on the crankshaft.
   - Tighten in the sequence shown.

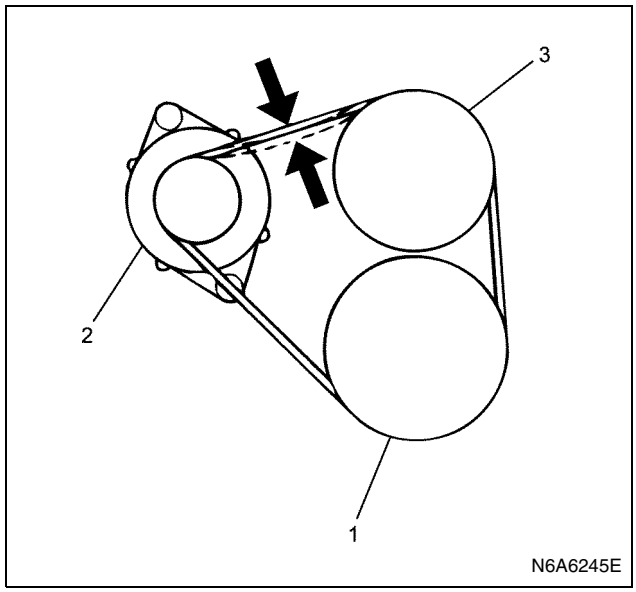
Tighten:
Bolt to 200 N·m (20.4 kg·m/148 lb·ft)



4. Install the fan belt.
   - When adjusting the fan belt, you should also adjust ACG belt and air conditioner belt at the same time.
   - Fit the fan belt and adjust the tension following the below procedures.
   - Refer to “Drive Belt” in Section 6B for details of the belt tension adjustment.

   a. Inspection of fan belt deflection
      - Check with a scale if the belt deflection is within the specified limits when pressure of 98 N (22 lb) is applied mid-way along the belt’s longest run. Also check the belt for damage.

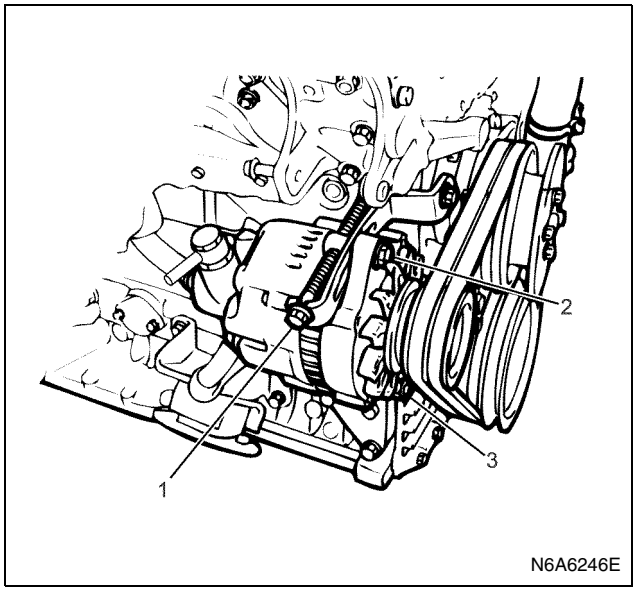
Fan belt deflection	mm (in)
New belt	8 – 12 (0.31 – 0.47)
Reused belt	10 – 14 (0.39 – 0.55)
A/C belt deflection	mm (in)
New belt	16 – 20 (0.630 – 0.787)
Reused belt	18 – 22 (0.709 – 0.866)



Legend
1. Crankshaft Pulley
2. Generator
3. Fan Pulley

   b. Adjustment of the fan belt
      - Loosen (2) and (3), adjust the fan belt moving the generator.

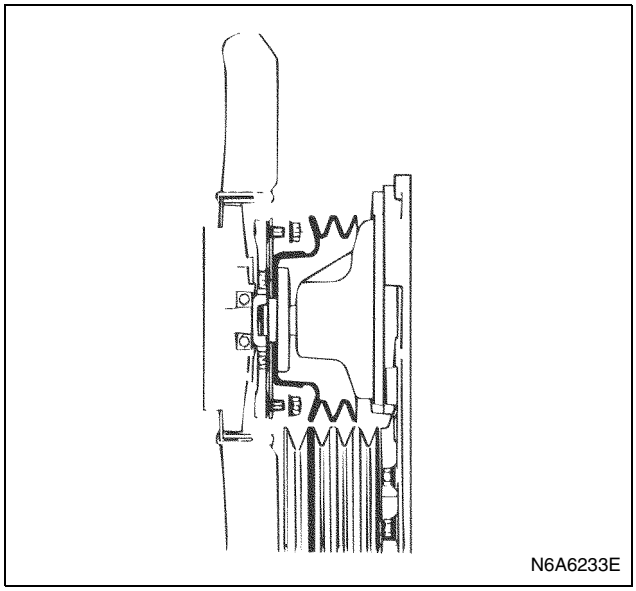
Tighten:
Bolt (2) to 24 N·m (2.4 kg·m/18 lb·ft)
Bolt (3) to 40 N·m (4.1 kg·m/30 lb·ft)



Legend
1. Adjustment Bolt
2. Fixing Nut
3. Fixing Bolt

5. Tighten the fan assembly to the specified tightening torque.

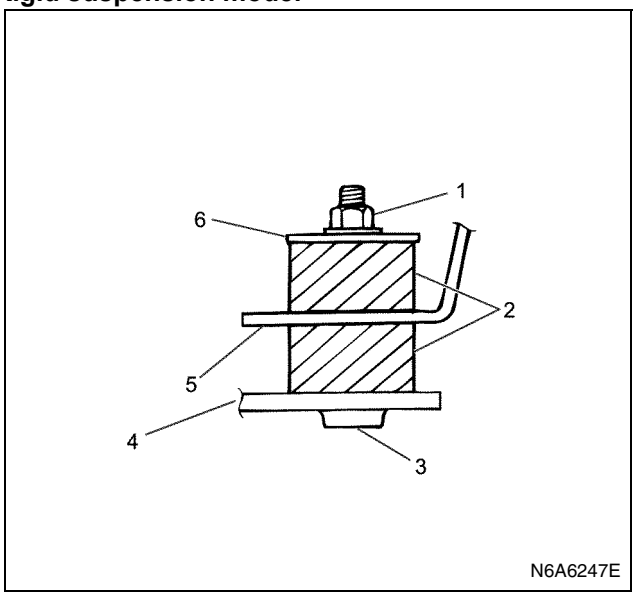
Tighten:
Nuts to 24 N·m (2.4 kg·m/18 lb·ft)



6. Install the radiator.
   - Attach right and left brackets of the radiator to the brackets on the frame as illustrated.

Tighten:
Brackets to 55 N·m (5.6 kg·m/41 lb·ft)

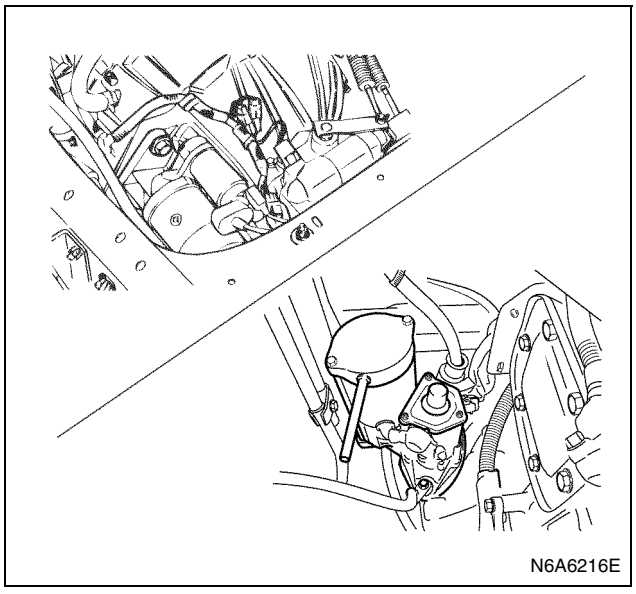
Rigid suspension model



Legend
1. Flange Nut
2. Rubber
3. Stud Bolt
4. Frame Side Bracket
5. Radiator Side Bracket
6. Washer

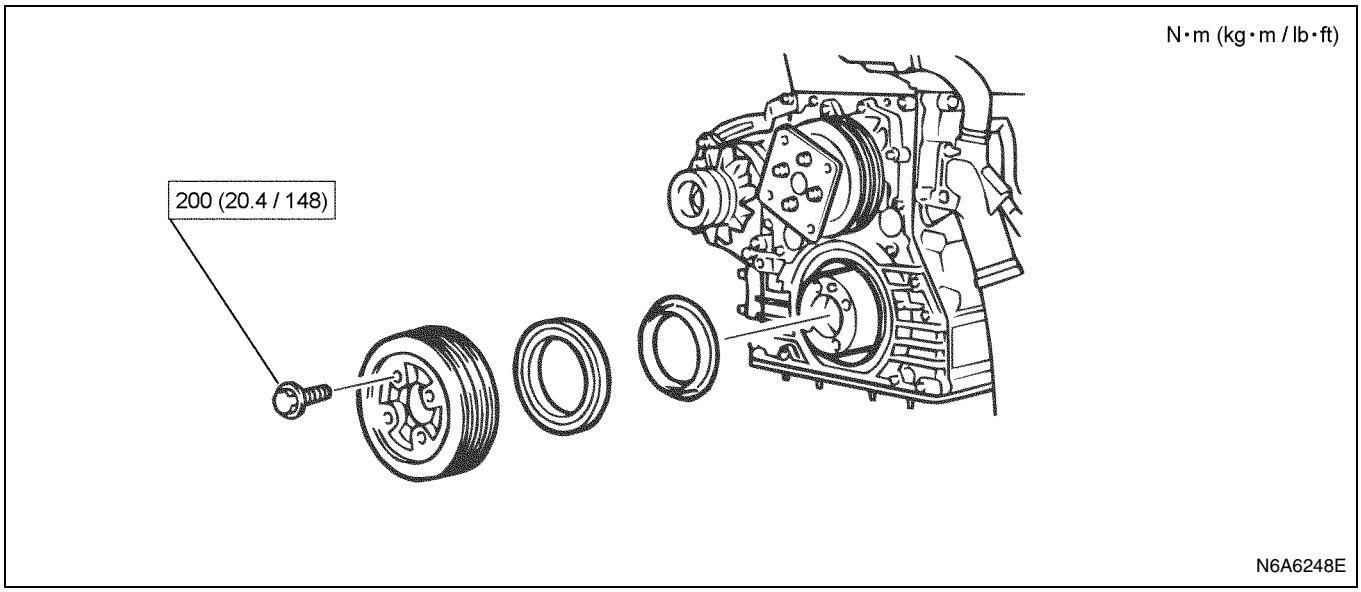
7. Connect the lower radiator hose.
8. Connect the coolant reserve tank hose.
9. Connect the upper radiator hose.
10. Install the starter in the clutch housing with bolts and tighten to the specified tightening torque.

Tighten:
Bolt to 76 N·m (7.7 kg·m/56 lb·ft)
   - Connect the starter ground cable.
   - Connect the front frame harness connector.

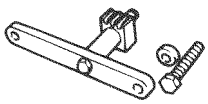
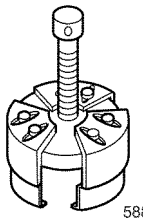
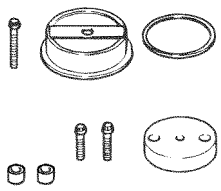


11. Refill the radiator with coolant.

Torque Specifications

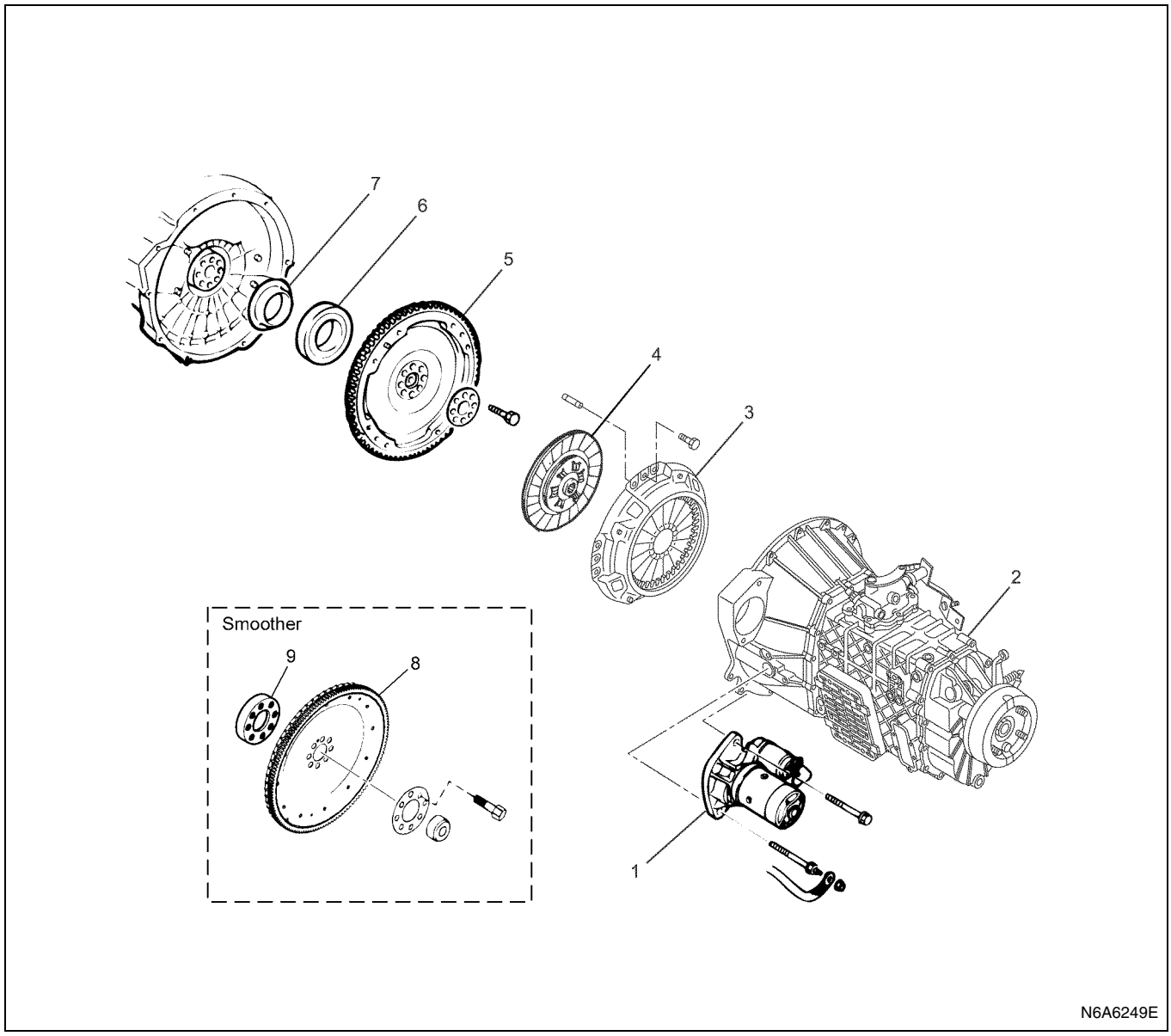


Special Tool

Illustration	Tool Number / Description / Remarks
 5884022300	5-8840-2230-0 (EN-47680) Crankshaft Stopper
 5884023600	8-9439-6858-0 (J-43285) Slinger Puller
 5884027030	5-8840-2703-0 (J-43282) Oil Seal Installer Kit

Crankshaft Rear Oil Seal

Component



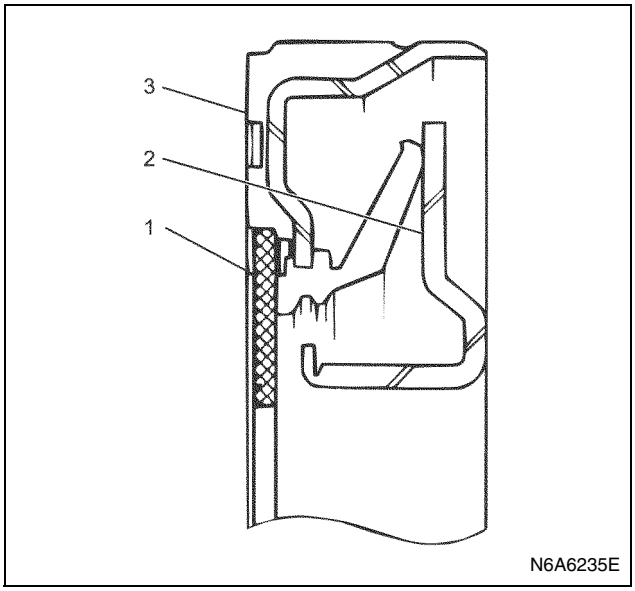
Legend

1. Starter
2. Transmission Assembly
3. Clutch Pressure Plate Assembly (MT)
4. Clutch Plate Assembly (MT)
5. Flywheel (MT)
6. Crankshaft Rear Oil Seal
7. Crankshaft Rear Slinger
8. Flexible Plate (Smoother)
9. Crankshaft End Spacer (Smoother)

Removal

1. Remove the flywheel.
   Refer to “Flywheel”.
2. Remove the crankshaft rear oil seal.

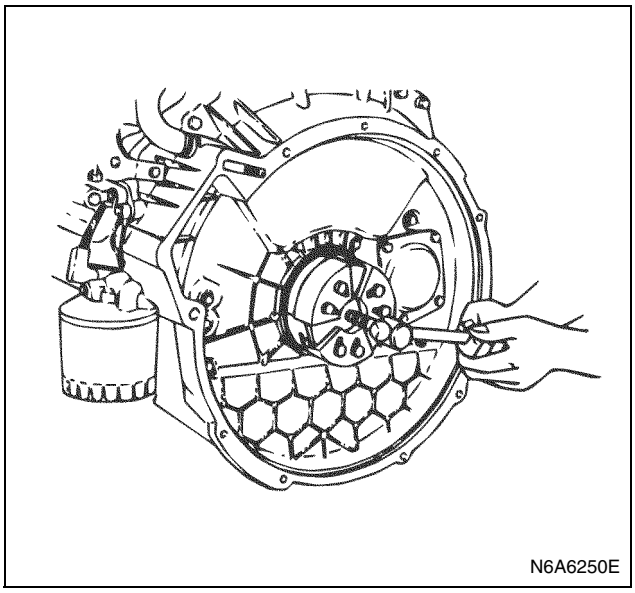
- Remove only the oil seal off with a screwdriver or the like avoiding damage to the oil seal contact surface on the flywheel housing and the shaft.



Legend
1. Felt
2. Slinger
3. Oil Seal

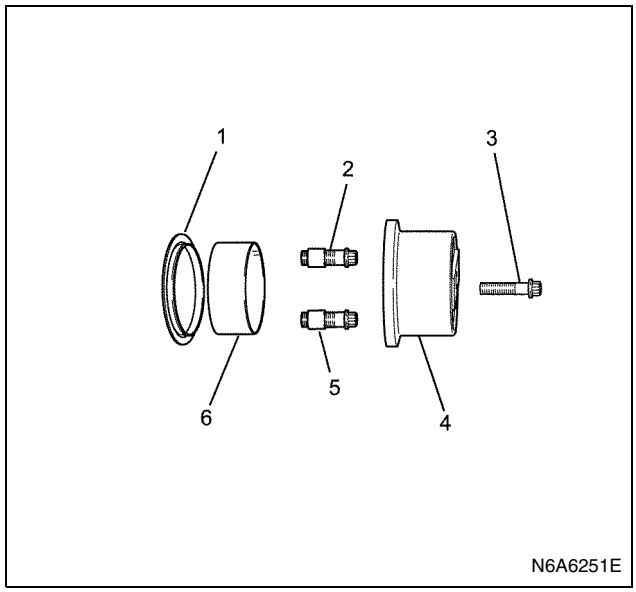
3. Remove the crankshaft slinger.
   - Pull out the slinger using a slinger puller. (Fixing the circumference of the puller with a clip band will make the procedure easier.)

     Special tool
     Slinger puller: 8-9439-6858-0 (J-43285)



Installation

1. Install the crankshaft rear slinger.
   - Press fit the rear sling using the oil seal installer kit.

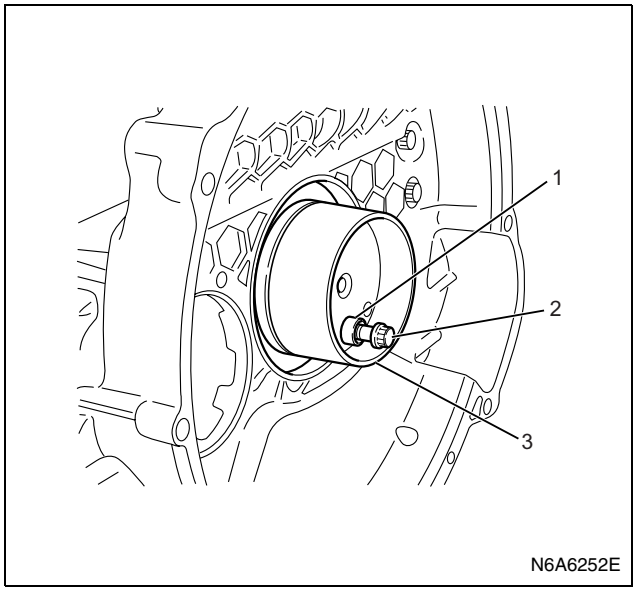


Legend
1. Rear Slinger
2. Fixing Bolt
3. Center Bolt
4. Sleeve (Rear)
5. Collar (Rear)
6. Adapter (Rear)

Special tool
Oil seal installer kit: 5-8840-2703-0 (J-43282)

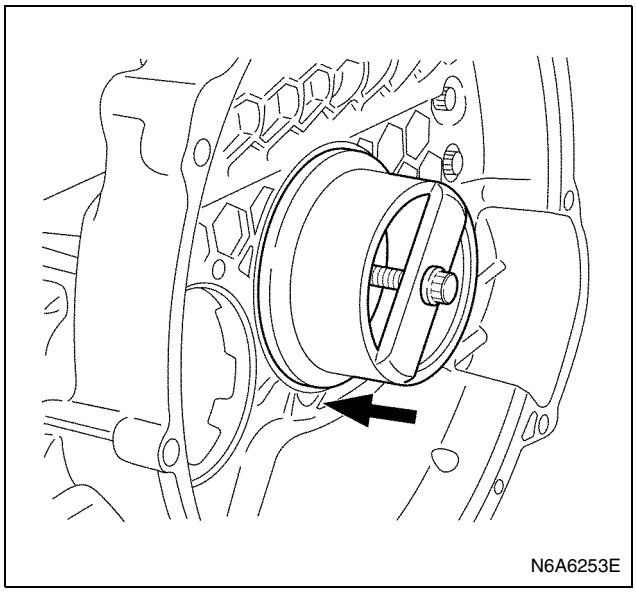
No.	Part Name	Slinger	Oil seal
1	Sleeve (rear)	○	○
2	Adapter (rear)	○	○
3	Collar (rear)	○	○
4	Adapter ring (rear)	—	○
5	Center bolt	○	○
6	Fixing bolt	○	○

- Insert the rear slinger into the end of the rear side adapter and mount the adapter on the crankshaft with the fixing bolt with a collar placed on it.



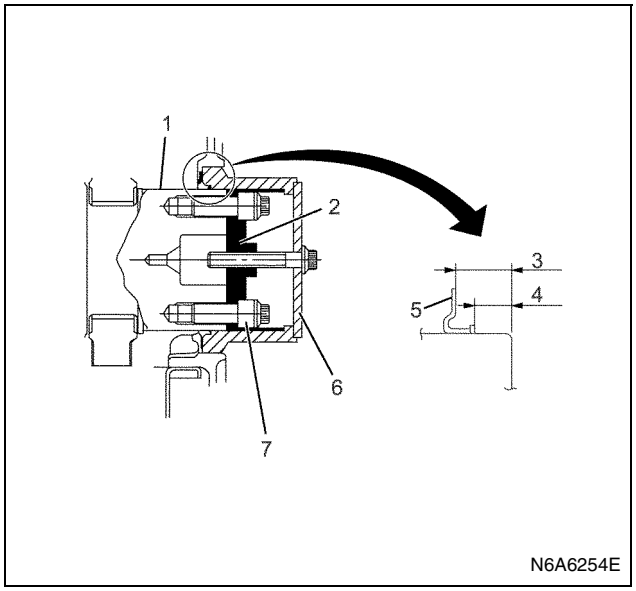
Legend
1. Collar
2. Fixing Bolt
3. Adapter

- Put a sleeve over the adapter and tighten the center bolt until the sleeve touches the adapter to press fit the rear slinger.



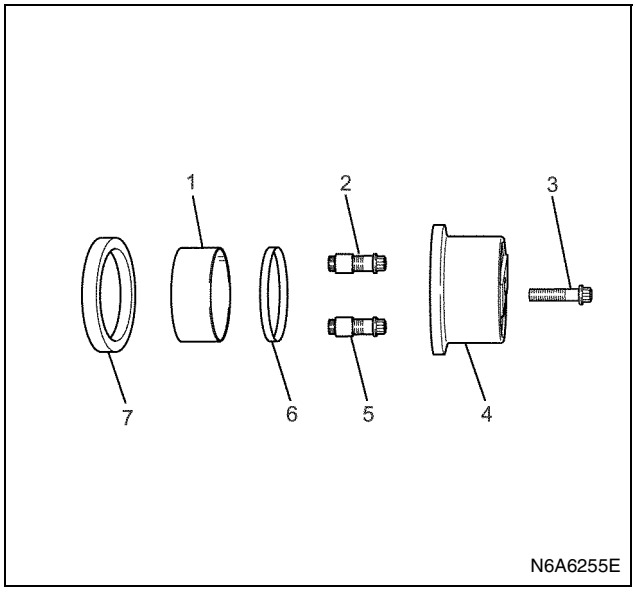
- After you have press-fitted the rear slinger, confirm the measurement shown (depth from the end surface of the crankshaft to the slinger) and check for deflection of the slinger.

Caution:
Be careful not to put the slinger inside out or mistake the front slinger for the rear one, and vice versa. Rear side slinger has four right-hand threads on it while front one has four left-hand threads. Slinger and oil seal should always be replaced in pairs.



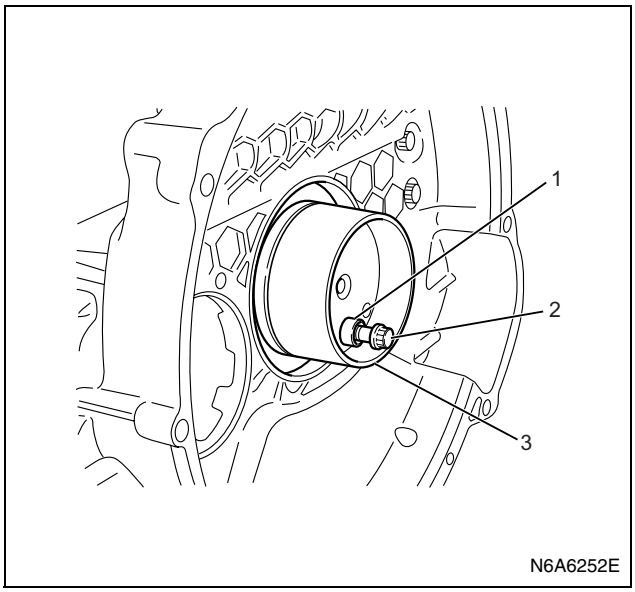
Legend
1. Rear Part of The Crankshaft
2. Adapter
3. 17.3 ± 0.3 mm (0.681 ± 0.012 in)
4. 10.8 ± 0.1 mm (0.425 ± 0.004 in)
5. Slinger
6. Sleeve
7. Collar

2. Install the crankshaft rear oil seal.
   - Press-fit the rear oil seal using an oil seal installer kit.



Legend
1. Adapter (Rear)
2. Fixing Bolt
3. Center Bolt
4. Sleeve (Rear)
5. Collar (Rear)
6. Adapter Ring (Rear)
7. Oil Seal

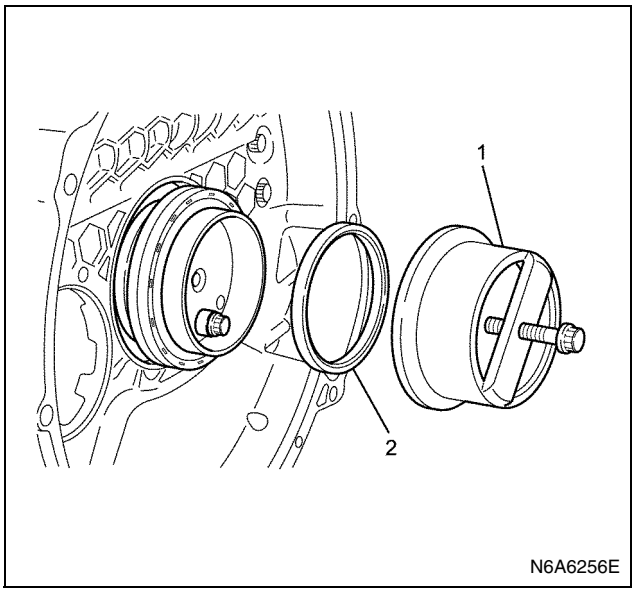
- Put a collar on the fixing bolt and mount the adapter onto the crankshaft.



Legend

1. Collar
2. Fixing Bolt
3. Adapter

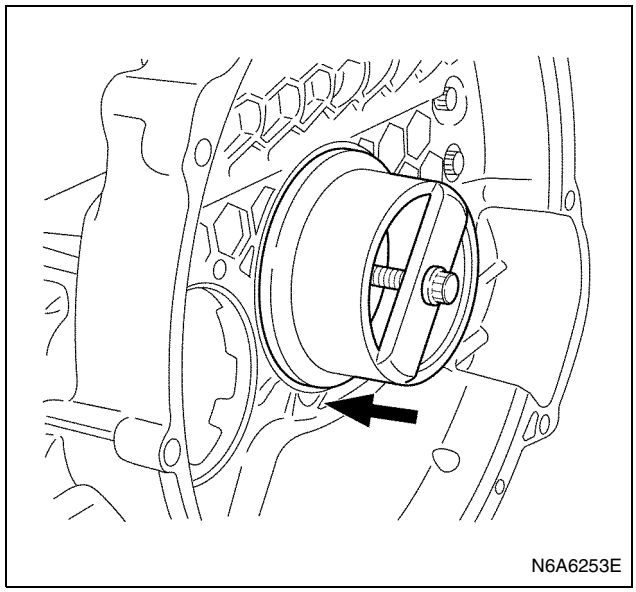
- Apply engine oil to the lip of the oil seal and place it in the rear side adapter.
- Put the rear side adapter ring in the sleeve and put the sleeve on the adapter and fix with the center bolt.



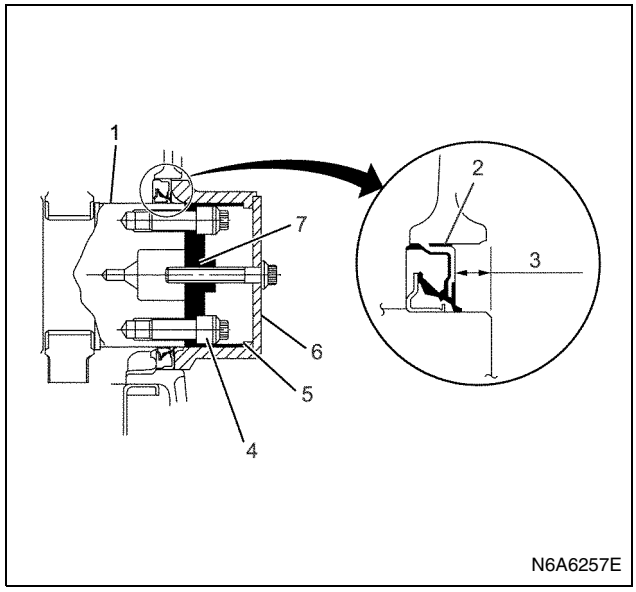
Legend

1. Sleeve
2. Adapter Ring

- Tightening the center bolt until the sleeve touches the adapter to press fit the oil seal.



- After you have pressed in the rear oil seal, confirm the measurement shown (depth from the end surface of the crankshaft to the oil seal).

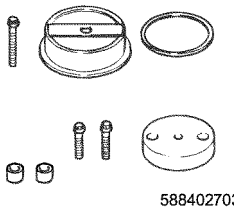
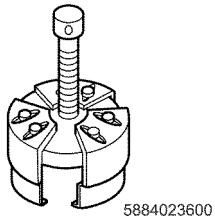


Legend

1. Rear Part of The Crankshaft
2. Oil Seal
3. 7.8 ± 0.3 mm (0.31 ± 0.012 in)
4. Collar
5. Adapter Ring
6. Sleeve
7. Adapter

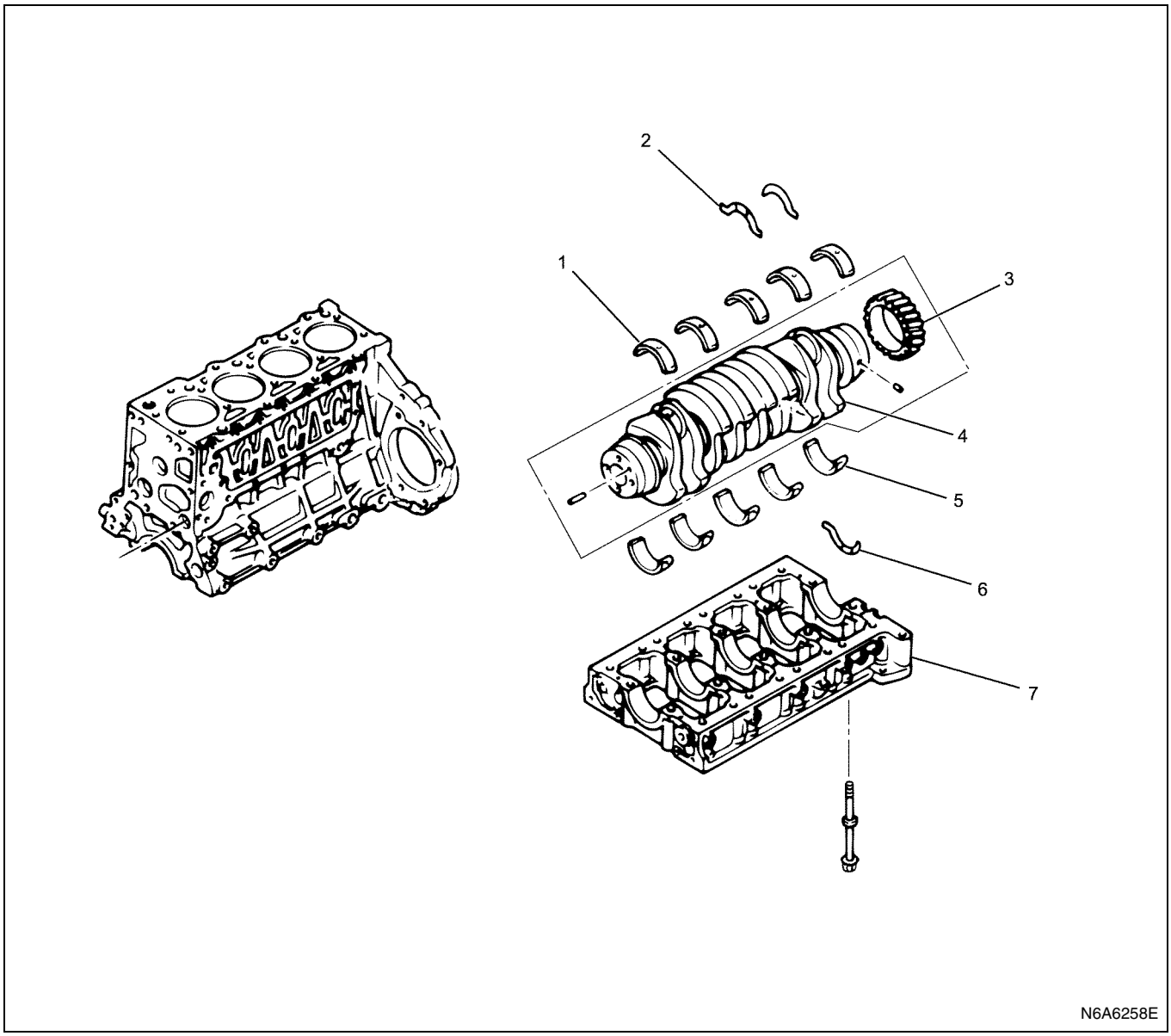
3. Install the flywheel.
   Refer to “Flywheel”.

Special Tool

Illustration	Tool Number / Description / Remarks
 5884027030	5-8840-2703-0 (J-43282) Oil Seal Installer Kit
 5884023600	8-9439-6858-0 (J-43285) Slinger Puller

Crankshaft

Component



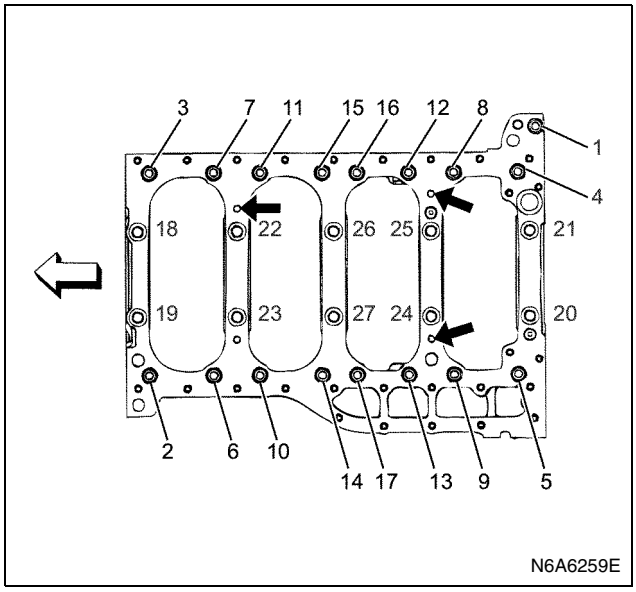
Legend

1. Upper Bearing
2. Upper Thrust Bearing
3. Gear
4. Crankshaft
5. Lower Bearing
6. Lower Thrust Bearing
7. Crankcase

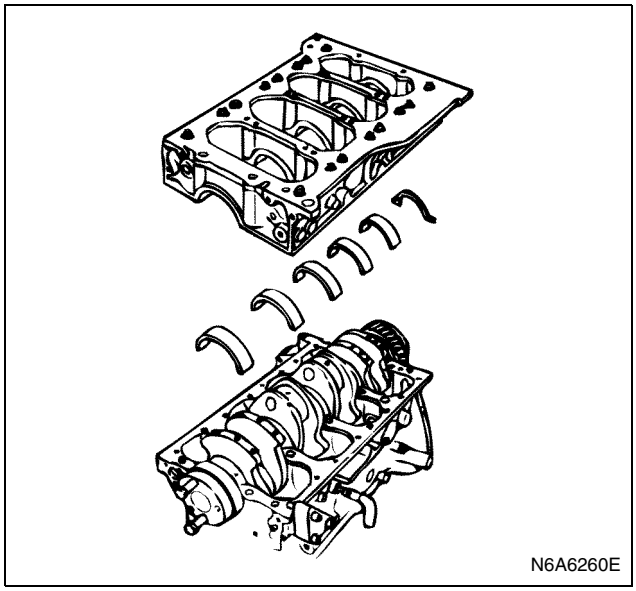
Removal

1. Demount the engine assembly.
   Refer to “Engine Assembly”.
2. Remove the cylinder head cover.
   Refer to “Cylinder Head Cover”.
3. Remove the rocker arm shaft.
   Refer to “Rocker Arm Shaft Assembly”.
4. Remove the camshaft.
   Refer to “Camshaft Assembly”.
5. Remove the cylinder head.
   Refer to “Cylinder Head”.
6. Remove the fuel supply pump.
   Refer to “Fuel Supply Pump” in Section 6C.
7. Remove the crankshaft front oil seal.
   Refer to “Crankshaft Front Oil Seal”.
8. Remove the crankshaft rear oil seal.
   Refer to “Crankshaft Rear Oil Seal”.
9. Remove the oil pan.
   Refer to the “Oil Pan”.

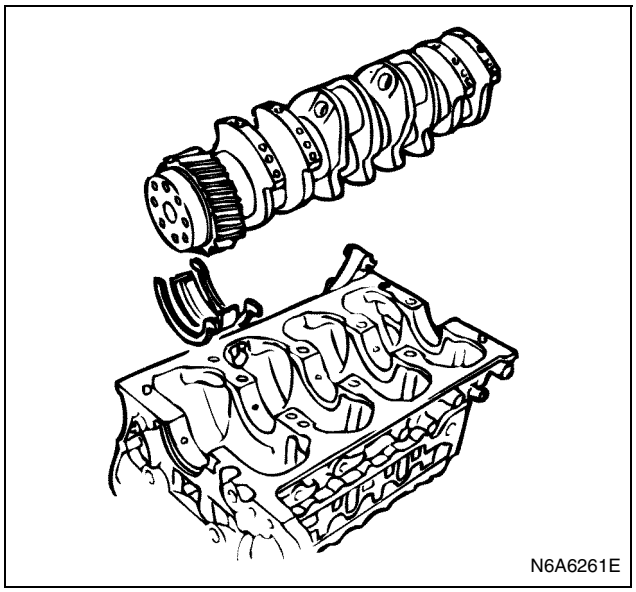
10. Remove the water pump.
    Refer to “Water Pump” in Section 6B.
11. Remove the front cover.
    Refer to “Front Cover”.
12. Remove the timing gear train.
    Refer to “Timing Gear Train”.
13. Remove the oil pump.
    Refer to “Oil Pump”.
14. Remove pistons and connecting rods.
    Refer to “Pistons and Connecting Rod”.
15. Remove the crankcase.
    - Gradually loosen crankcase mounting bolts in the sequence shown and remove the crankcase using the three replacer holes (arrowed holes in the figure).



16. Remove the lower thrust bearing.
17. Remove the lower crankshaft bearings.



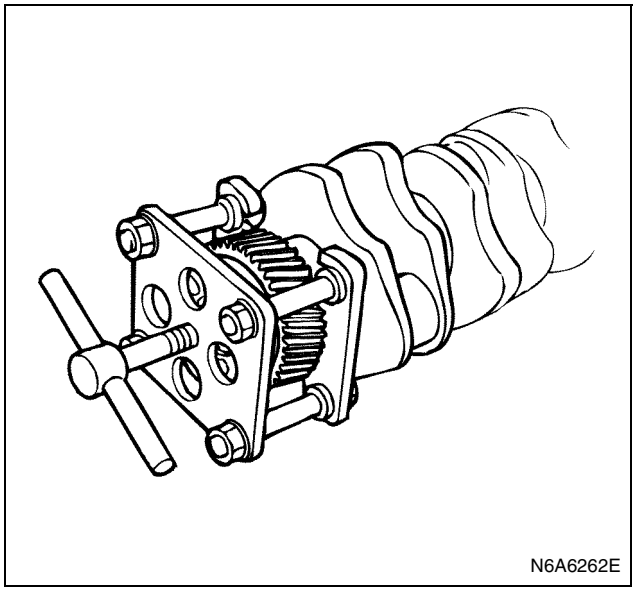
18. Remove the crankshaft assembly.
19. Remove the upper thrust bearing.
20. Remove the upper crankshaft bearings.



Disassembly

1. Remove the gear.
   - Remove the gear using a gear puller.

     Special tool
     Crankshaft gear puller: 8-9439-1097-0 (EN-47684)

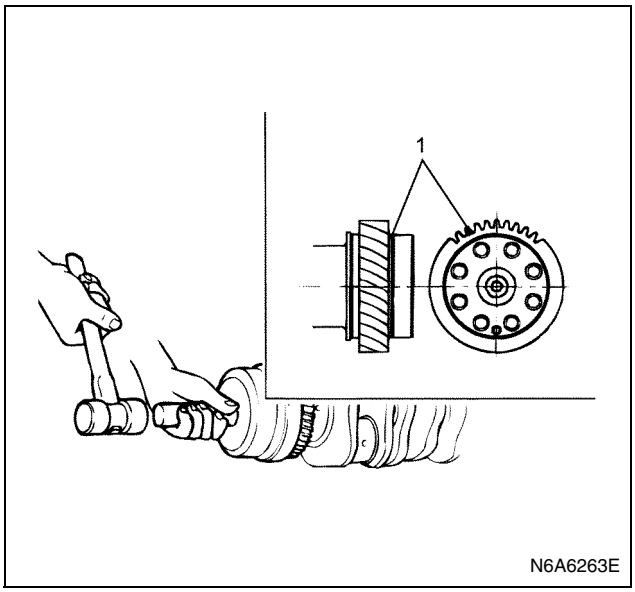


Reassembly

1. Install the gear.
   - Heat the gear to 170 – 250°C (338 – 482°F) and install it aligning the groove on the gear with the pin on the crankshaft.

- Insert the gear at one push into the flange with its end side with the alignment mark “S” facing outward. If you are fitting the gear while it is cold, beat the gear in until it impinges on the end using the installer.

  Special tool
  Crankshaft gear installer: 5-8840-2667-0 (J-41222)



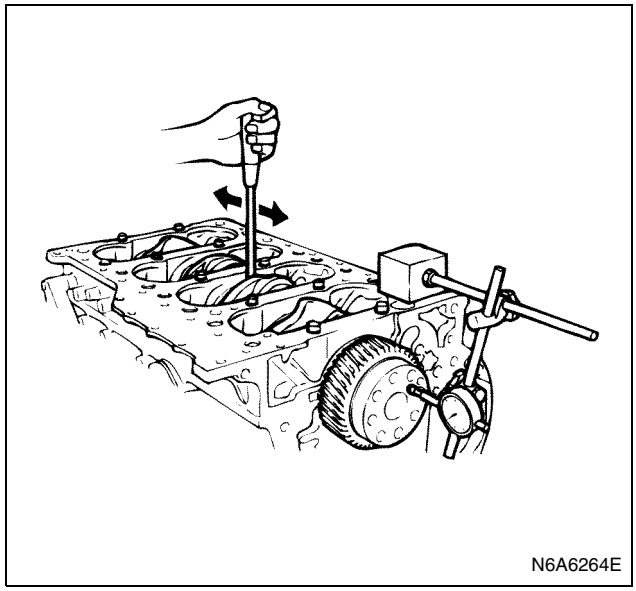
Legend
1. Alignment Mark

Inspection

1. Thrust clearance
   - Set a dial gauge as shown and measure the crankshaft thrust clearance.
   - If the thrust clearance exceeds the limit, replace the thrust bearings in a pair.

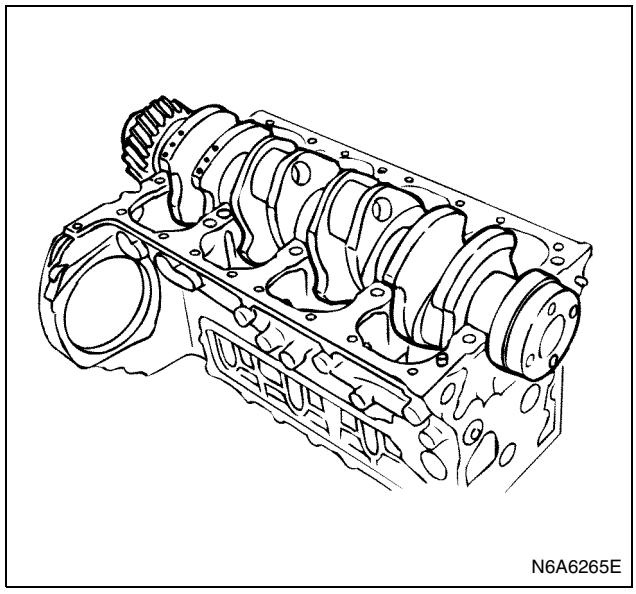
Axial play of the crankshaft	mm (in)
Standard	0.104 – 0.205 (0.0041 – 0.0081)
Limit	0.35 (0.0138)

Caution:
Measure the thrust clearance before dismounting.



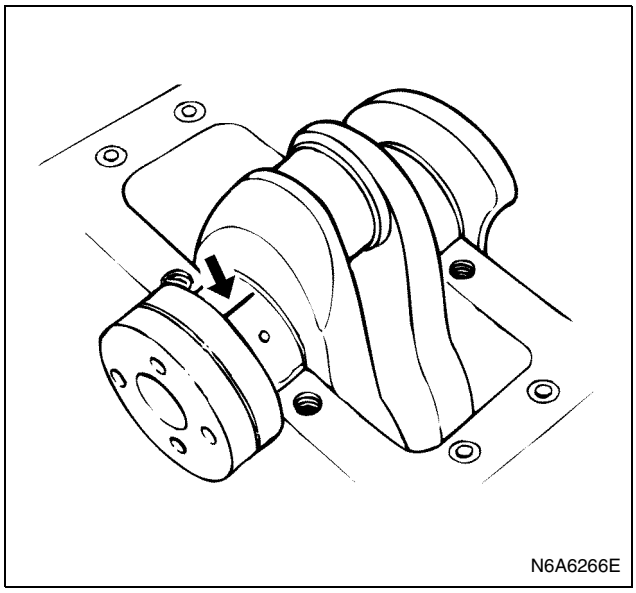
2. Main bearing clearance
   - Remove the crankshaft. Remove the main bearings.
     Set out disassembled main bearings in the order of the numbers.
   - Clean the crankshaft journal upper and lower bearings and upper and lower thrust bearings.
   - Check the bearings for damage or excessive wear. If you find damage or excessive wear in the check, replace the bearings in pairs.
   - Place the upper bearings and the crankshaft on the cylinder block. Install the crankshaft so that it becomes horizontal.

Caution:
Turn the crankshaft about 30 degrees to allow the bearings to settle in.

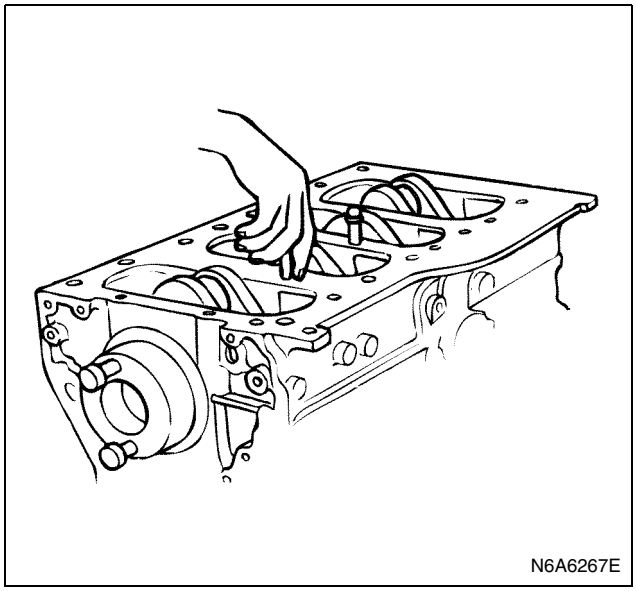


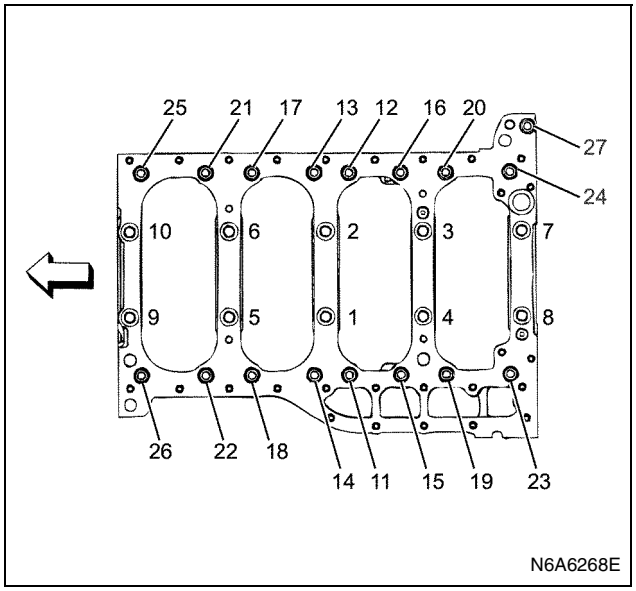
   - Place Plastigage on the crankshaft journal as shown.

- Place the lower bearings at original positions on the crankcase.


N6A6266E

- Install the crankcase and tighten bolts to the specified tightening torque.
- Tighten the crankcase in the sequence shown using a torque wrench and an angle gauge.


N6A6267E



N6A6268E

Tighten:
M14 bolts (1 – 10) to
1st step: 98 N·m (10.0 kg·m/72 lb·ft)
2nd step: 132 N·m (13.5 kg·m/97 lb·ft)
3rd step: 30° – 60° (degrees)
M10 bolts (11 – 27) to
4th step: 38 N·m (3.9 kg·m/28 lb·ft)

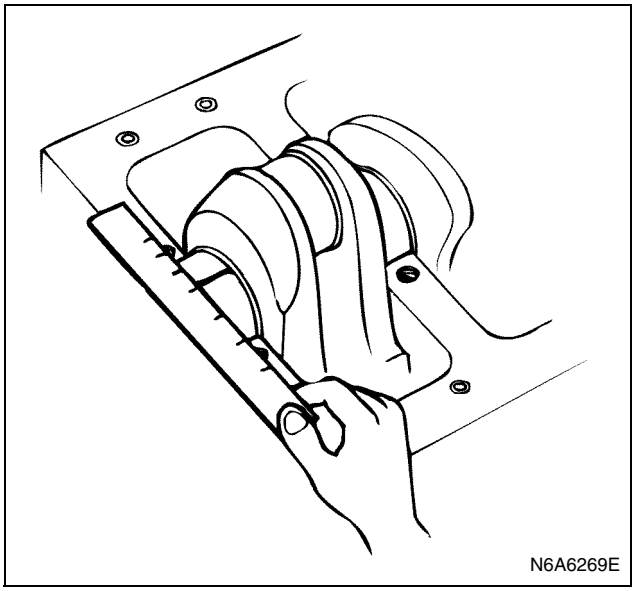
- Tighten the bolts (M14) from 1-10 and confirm that they are tightened to a torque of 167 N·m (17.0 kg·m/123 lb·ft) or more.

  Special tool
  Angle gauge: 5-8840-0266-0 (J-45059)

Caution:
Do not turn the crankshaft after you have tightened the crankcase.

- Loosen the bolts and gently remove the crankcase.
- Measure the widest part of the Plastigage flattened by tightening the crankcase to determine the clearance.

Journal oil clearance		mm (in)
	Standard	Limit
No.1, 2, 4, 5	0.039 – 0.070 (0.0015 – 0.0028)	0.11 (0.0043)
No.3	0.053 – 0.084 (0.0021 – 0.0033)	0.11 (0.0043)


N6A6269E

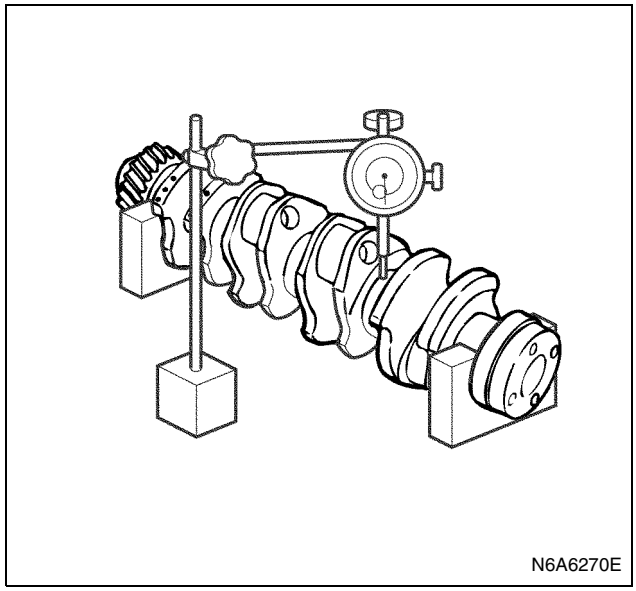
- If the journal oil clearance exceeds the limit, replace the main bearings altogether or the crankshaft.
- Remove the Plastigage from the bearings and the crankshaft.

Inspection of the crankshaft

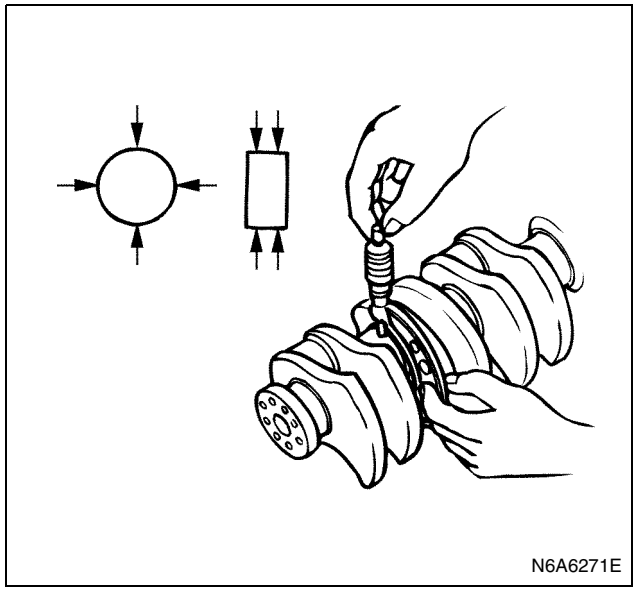
- Check the crankshaft journal and crank pin surfaces for wear and damage. Check the oil seal contact surface for excessive wear and damage.
- Check the oil port for clogging.

3. Crankshaft run-out
   Carefully set the crankshaft on the V block. Slowly turn the crankshaft to measure the run-out. If the crankshaft run-out exceeds the limit, replace the crankshaft.

Crankshaft run-out	mm (in)
Standard	0.05 or less (0.0020 or less)
Limit	0.30 (0.012)


N6A6270E

4. Measure the journal and the crankpin diameters and uneven wear.
   - Measure outer diameters of the journal and the pin and calculate differences between the maximum and the minimum values. Take measurements at four positions for both the journal and the pin.


N6A6271E

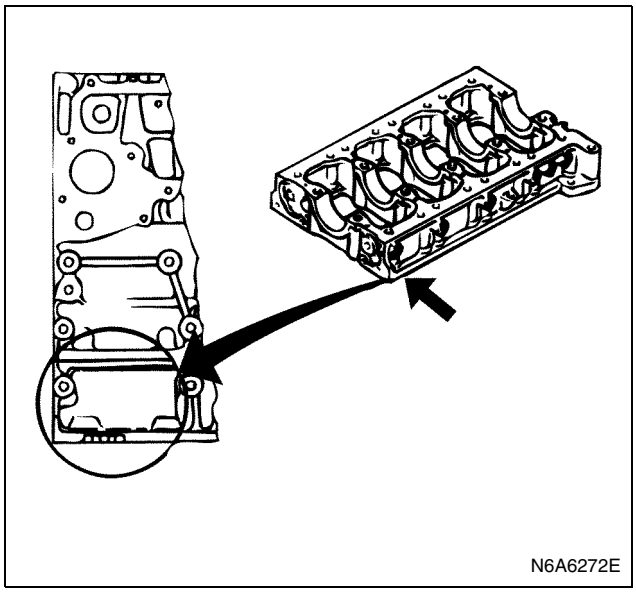
Crankshaft outside diameter		mm (in)
	Standard	Limit
Journal #1, 2, 4, 5	81.905 – 81.925 (3.22460 – 3.22538)	81.85 (3.222)
Journal #3	81.891 – 81.911 (3.22408 – 3.22483)	81.85 (3.222)
Pin	72.902 – 72.922 (2.87015 – 2.87094)	72.850 (2.8681)

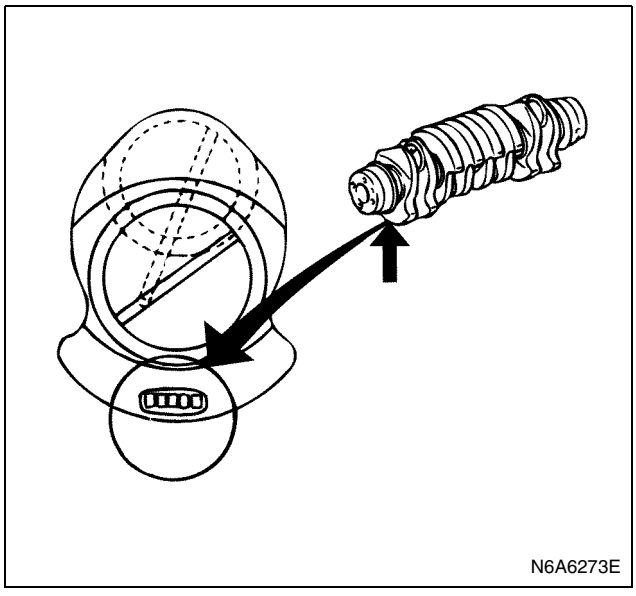
Difference	mm (in)
Limit	0.005 (0.0002)

Caution:
Tufftriding (soft nitriding treatment) is applied to enhance strength of the crankshaft. Therefore, do not polish the surface of the crankshaft.

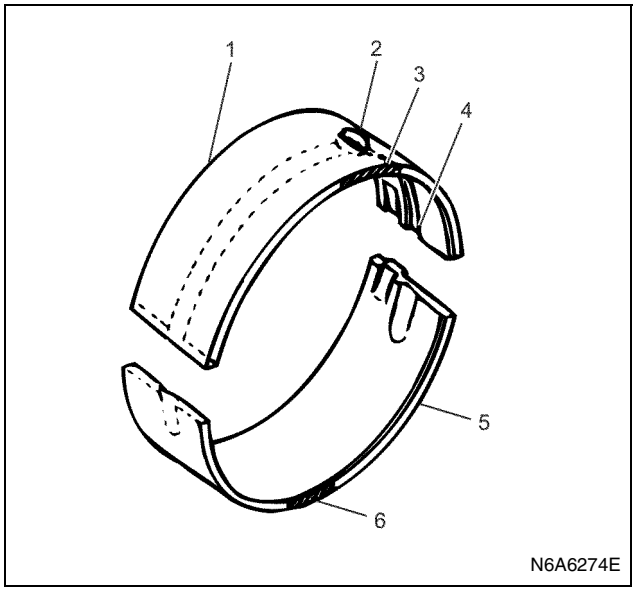
Crankshaft bearing selection

- When installing new crankshaft bearings or replacing bearings in use, make reference to the Bearing Selection Table.
- Select and install new bearings paying close attention to the cylinder block journal internal diameter grade and the crankshaft journal diameter grade.
- Journals are numbered from 1 to 5 from left to right when viewed so that the numbers are in normal reading orientation.


N6A6272E


N6A6273E

Caution:
Be careful about difference in the shape of the bearings when installing them.



N6A6274E

Legend
1. Upper Bearing
2. Oil Gallery
3. Grade Identification Color
4. Oil Groove
5. Lower Bearing
6. Grade Identification Color

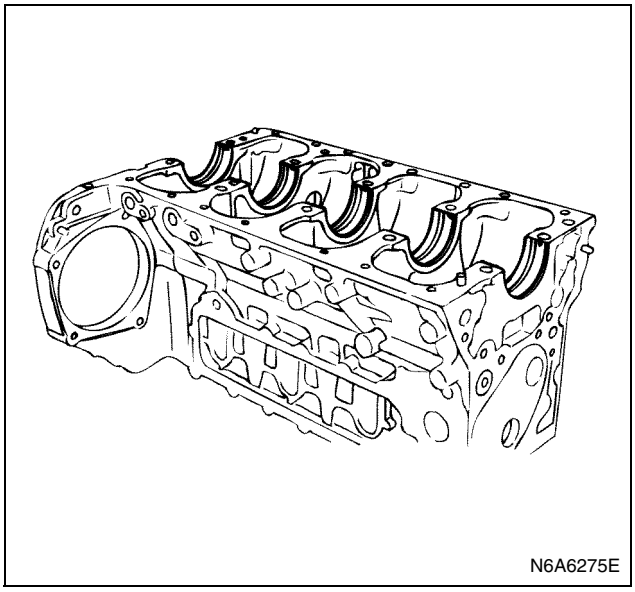
Bearing Selection Table

Combination of grades			Oil clearance mm (in)	
Cylinder block Grade	Crank journal Grade	Bearing identification color	#1, 2, 4, 5	#3
1	1	Black	0.039 – 0.070 (0.00154 – 0.00276)	0.053 – 0.084 (0.00209 – 0.00331)
1	2	Brown	0.037 – 0.068 (0.00146 – 0.00267)	0.051 – 0.082 (0.00201 – 0.00323)
2	1	Blue	0.041 – 0.072 (0.00161 – 0.00283)	0.055 – 0.086 (0.00217 – 0.00339)
2	2	Black	0.039 – 0.070 (0.00154 – 0.00276)	0.053 – 0.084 (0.00209 – 0.00331)

Installation

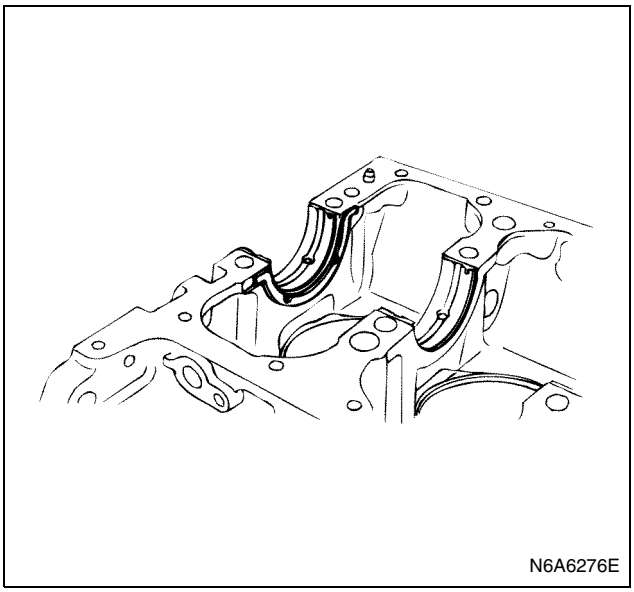
1. Install the crankshaft upper bearing.
   - Install the upper bearing in the cylinder block and apply oil.

Caution:
When replacing the crankshaft bearings, select grades referring to the Bearing Selection table. Do not apply oil to the bearing installation surface on the cylinder block and external surface of the bearing.


N6A6275E

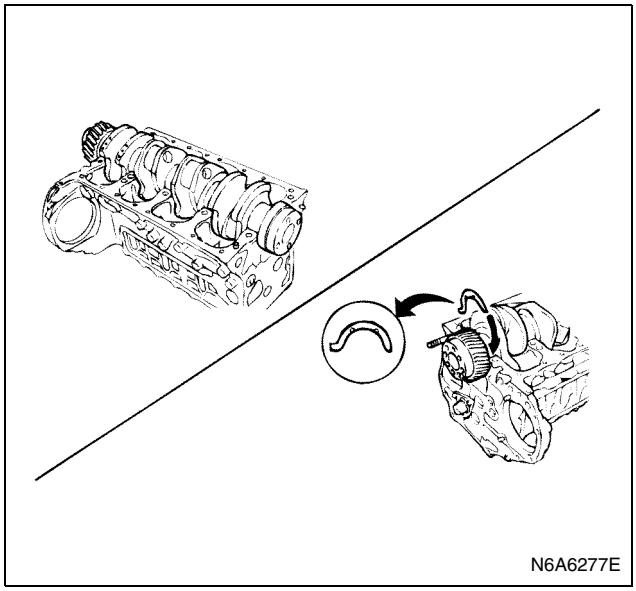
2. Install the upper thrust bearing.
   - Install the upper thrust bearing in the front side of the cylinder block journal No.5. In doing this, you may attach the upper thrust bearing to the cylinder block with grease. Then, be sure to wipe up excess grease.

Caution:
Install the thrust bearing so that the oil groove contacts the crankshaft.

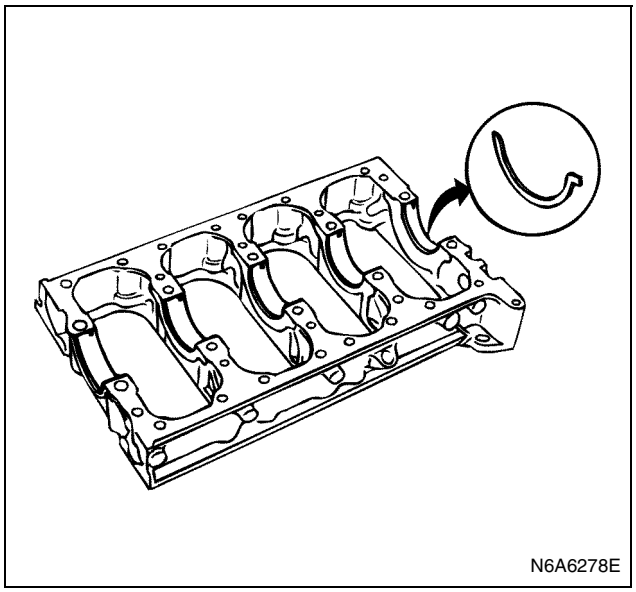

N6A6276E

3. Install the crankshaft assembly.
   - Apply engine oil to the crankshaft journal and gently place the crankshaft on the cylinder block.
   - Press the crankshaft to the rear and insert the upper thrust bearing in the rear side of the cylinder block journal No.5.

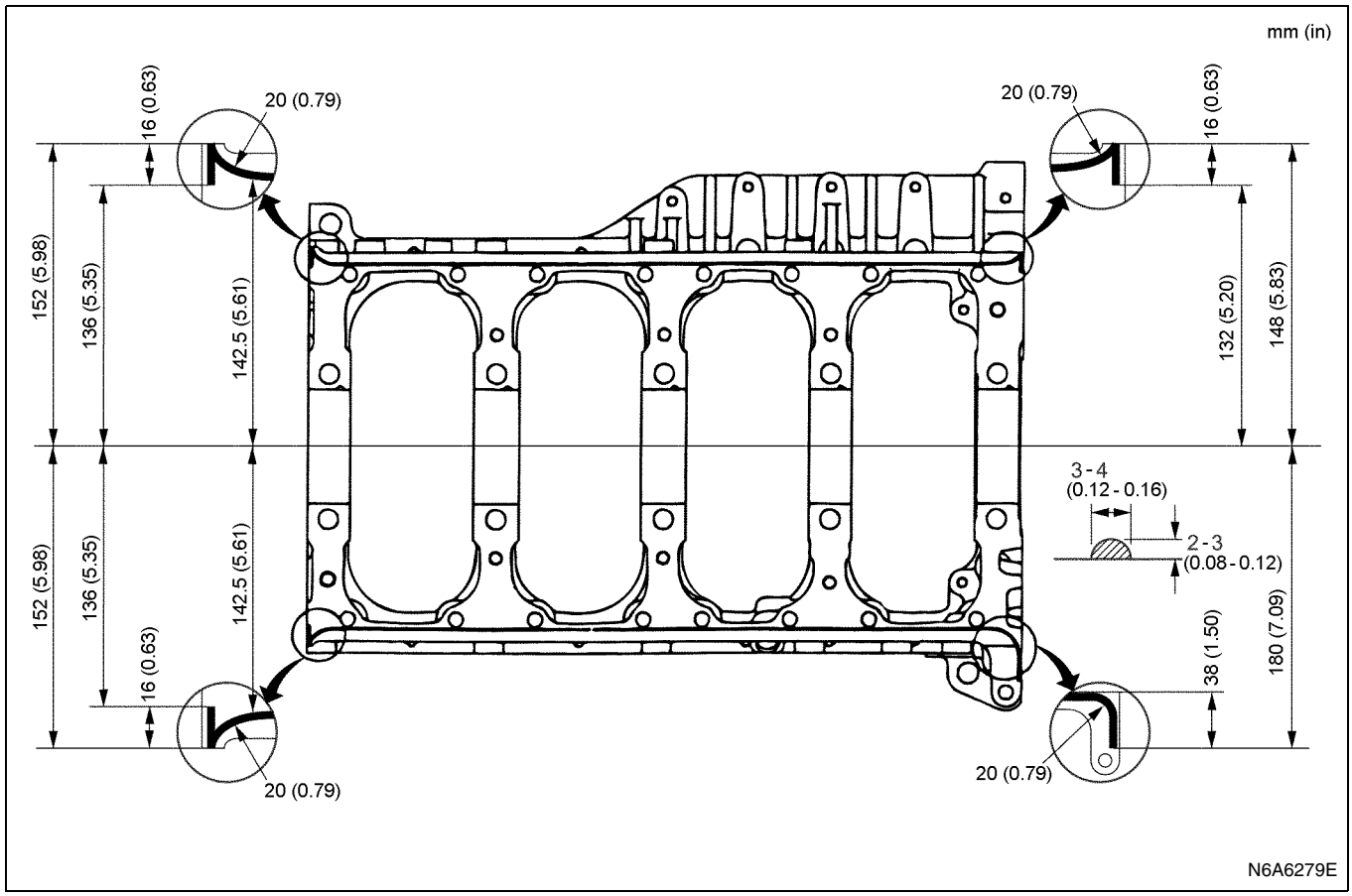
Caution:
Install the thrust bearing so that the oil groove contacts the crankshaft.


N6A6277E

4. Install the lower crankshaft bearing.
5. Install the lower thrust bearing.
   - Install the lower thrust bearing in the rear side of the crankcase journal No.5.
   - Install the thrust bearing so that the oil groove contacts the crankshaft.


N6A6278E

6. Install the crankcase.
   - Apply liquid gasket (ThreeBond 1207C or equivalent) to the crankcase forming beads with diameters of 3 – 4 mm (0.12 – 0.16 in).
   - Install the crankcase within 7 minutes after you have applied the liquid gasket.
   - Gently place the crankcase on the cylinder block.



N6A6279E

   - Apply Molybdenum Disulfide to M14 bolt's threads and setting faces and tighten them to the specified tightening torque in the sequence shown.

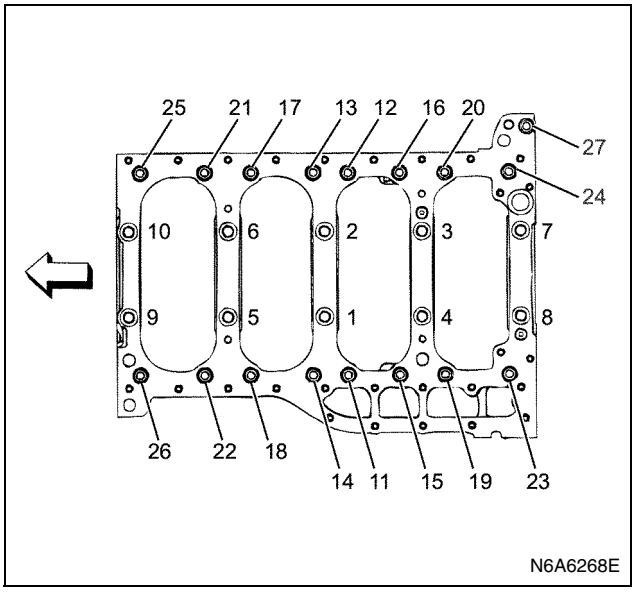
- Do not apply any oil to M10 bolts.

Tighten:
M14 bolts (1 – 10) to
1st step: 98 N·m (10.0 kg·m/72 lb·ft)
2nd step: 132 N·m (13.5 kg·m/97 lb·ft)
3rd step: 30° – 60° (degrees)
M10 bolts (11 – 27) to
4th step: 38 N·m (3.9 kg·m/28 lb·ft)

- Tighten bolts from 1-10 (M14) and confirm that they are tightened to a torque of 167 N·m (17.0 kg·m/123 lb ft) or more.

  Special tool
  Angle gauge: 5-8840-0266-0 (J-45059)

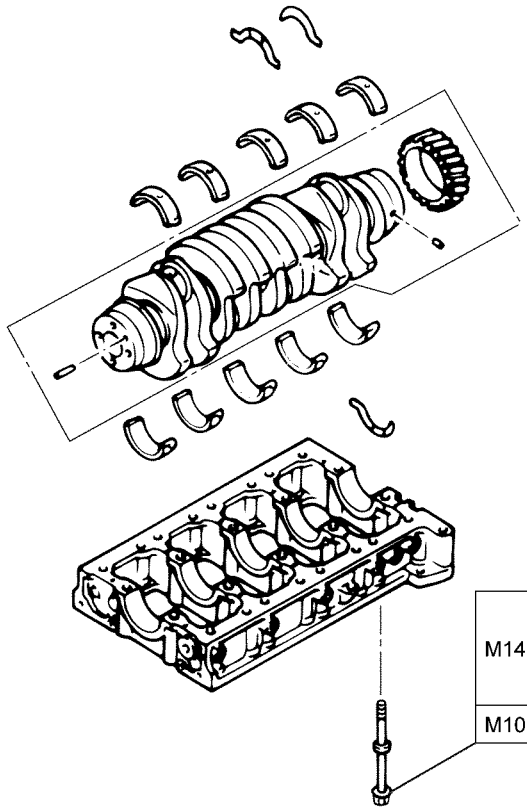
Caution:
Confirm that the crankshaft turns smoothly.



7. Install pistons and connecting rods.
   Refer to “Piston and Connecting Rod”.
8. Install the oil pump.
   Refer to “Oil Pump”.
9. Install the timing gear train.
   Refer to “Timing Gear Train”.
10. Install the front cover.
    Refer to the “Front Cover”.
11. Install the water pump.
    Refer to “Water Pump” in Section 6B.
12. Install the oil pan.
    Refer to “Oil Pan”.
13. Install the crankshaft rear oil seal.
    Refer to “Crankshaft Rear Oil Seal”.
14. Install the crankshaft front oil seal.
    Refer to “Crankshaft Front Oil Seal”.
15. Install the fuel supply pump.
    Refer to “Fuel Supply Pump” in Section 6C.
16. Install the cylinder head.
    Refer to “Cylinder Head”.
17. Install the camshaft assembly.
    Refer to “Camshaft Assembly”.
18. Install the rocker arm shaft assembly.
    Refer to “Rocker Arm Shaft Assembly”.
19. Install the cylinder head cover.
    Refer to “Cylinder Head Cover”.
20. Mount the engine assembly on the chassis.
    Refer to “Engine Assembly”.

Torque Specifications

N·m (kg·m / lb·ft)



M14	1st	98 (10.0 / 72)
	2nd	132 (13.5 / 97)
	3rd	30° — 60°
M10		38 (3.9 / 8)

N6A6280E

Special Tool

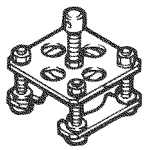
Illustration	Tool Number / Description / Remarks
 8943968180	8-9439-1097-0 (EN-47684) Crankshaft Gear Puller

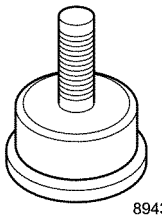
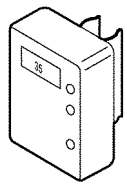
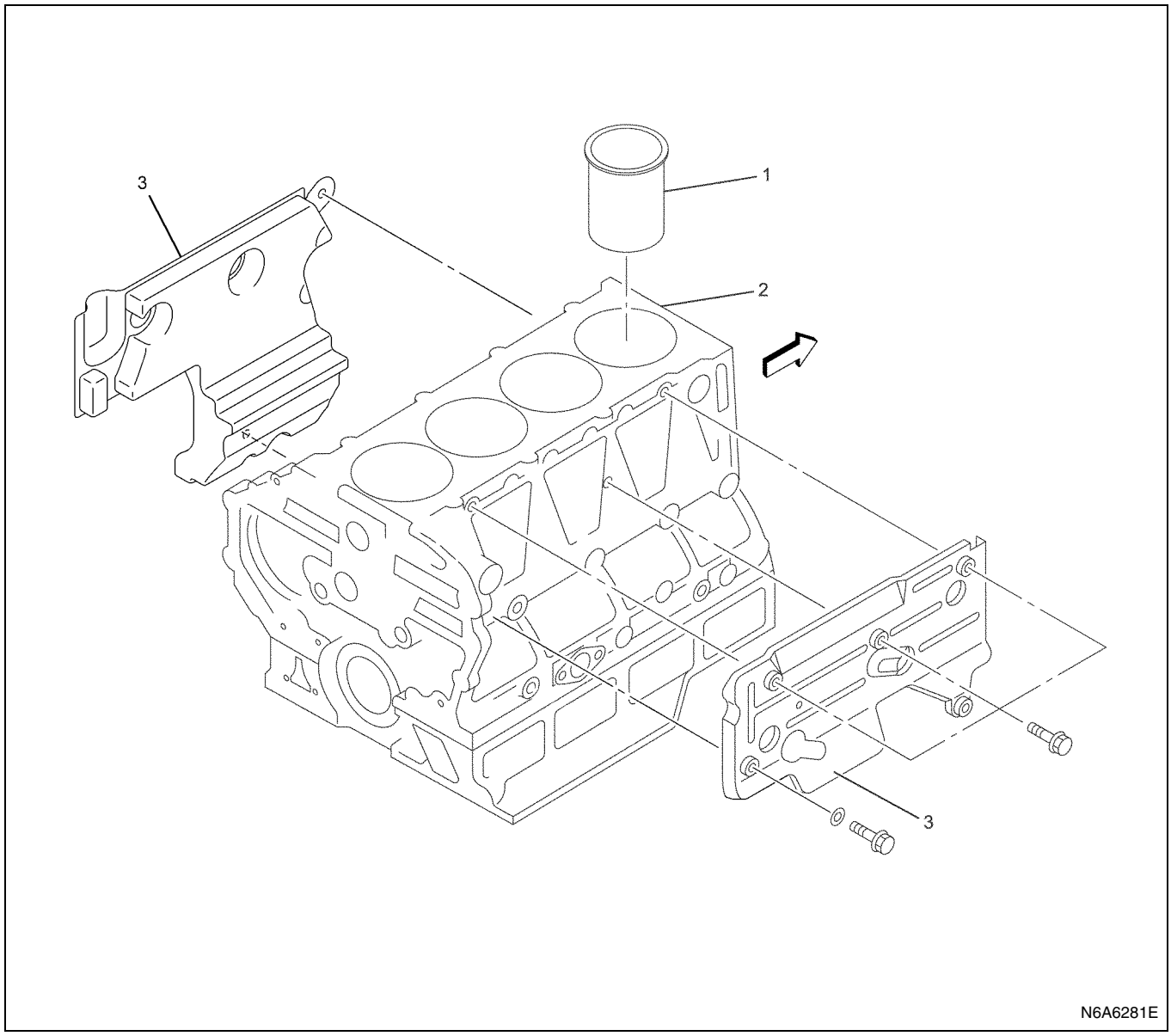
Illustration	Tool Number / Description / Remarks
 8943968190	5-8840-2667-0 (J-41222) Crankshaft Gear Installer

Illustration	Tool Number / Description / Remarks
 J45059	5-8840-0266-0 (J-45059) Angle Gauge

Cylinder Block

Component



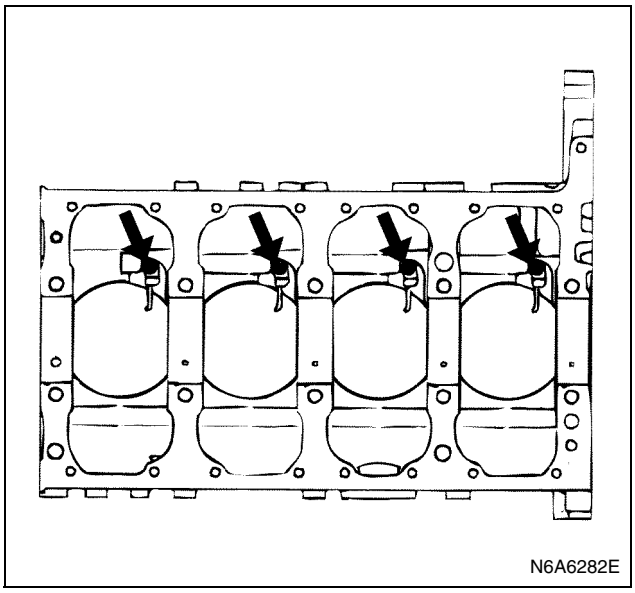
Legend

1. Cylinder Liner
2. Cylinder Block
3. Cover (For Europe)

Removal

1. Demount the engine assembly.
   Refer to “Engine Assembly”.
2. Remove the cylinder head cover.
   Refer to “Cylinder Head Cover”.
3. Remove the rocker arm shaft assembly.
   Refer to “Rocker Arm Shaft Assembly”.
4. Remove the camshaft assembly.
   Refer to “Camshaft Assembly”.
5. Remove the cylinder head.
   Refer to “Cylinder Head”.
6. Remove the fuel supply pump.
   Refer to “Fuel Supply Pump” in Section 6C.
7. Remove the crankshaft front oil seal.
   Refer to “Crankshaft Front Oil Seal”.
8. Remove the crankshaft rear oil seal.
   Refer to “Crankshaft Rear Oil Seal”.
9. Remove the oil pan.
   Refer to “Oil Pan”.
10. Remove the water pump.
    Refer to “Water Pump” in Section 6B.
11. Remove the front cover.
    Refer to the “Front Cover”.

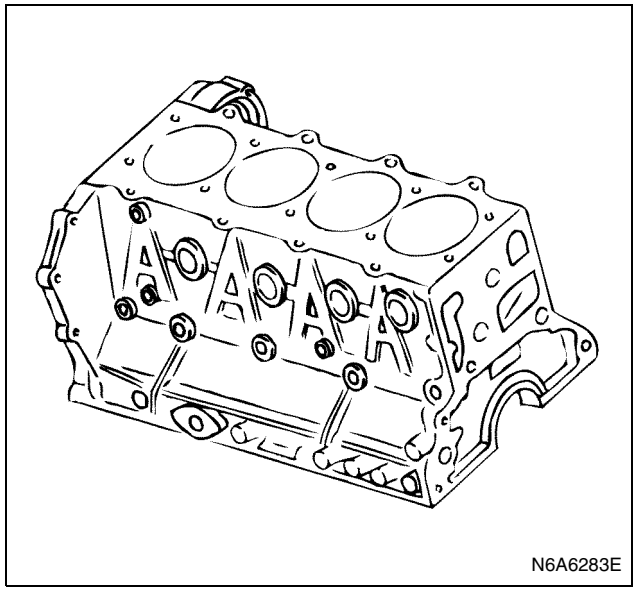
12. Remove the timing gear train.
    Refer to “Timing Gear Train”.
13. Remove the oil pump.
    Refer to “Oil Pump”.
14. Remove pistons and connecting rods.
    Refer to “Pistons and Connecting Rod”.
15. Remove the crankshaft.
    Refer to “Crankshaft”.
16. Remove piston oil jet.


N6A6282E

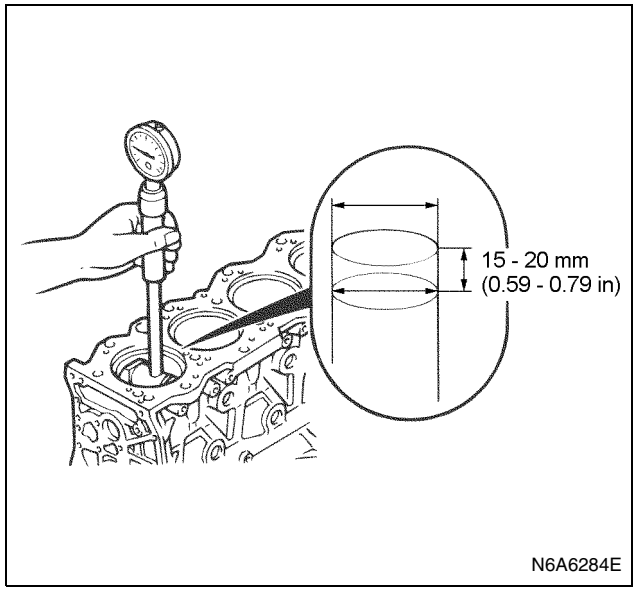
17. Remove the cylinder liner.
    If the cylinder liner cannot be pulled free by hand, tap around the lower side of the liner with a hammer grip or similar object loosen it.

Inspection

1. Carefully remove water stains or other foreign matters on the surface of the cylinder block.
   - Be careful not to damage the cylinder block.
2. Carefully remove the liquid gasket on the crankcase mounting surface.
3. Clean up the cylinder block.
4. Visually inspect the cylinder block.
   - Conduct color check and hydraulic (or pneumatic) test and if you find crack or other damage, replace the cylinder block.


N6A6283E

5. Cylinder liner wear measurement
   - Check the internal surface of the liner for flaw or damage.
   - Measure the liner bore diameter at the most worn part (it wears more in the rotation direction) at 15 – 20 mm (0.59 – 0.79 in) from the top end of the liner with the liner installed in the cylinder block. If the wear is over the application limit, replace it.



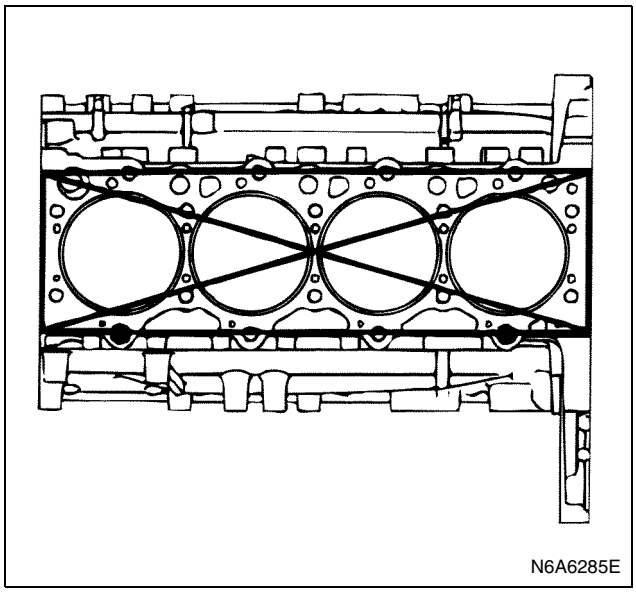
N6A6284E

Cylinder liner bore diameter	mm (in)
Standard	115.021 – 115.050 (4.52837 – 4.52952)
Limit	115.20 (4.5354)

Caution:
You need not select piston grade since cylinder liner bore is only available in one size against the liner grade selection of its outer diameter.

6. Cylinder block upper face warpage
   - Pull out the cylinder liners and remove water stains on the cylinder block.
   - Measure four sides and two diagonals of the top surface of the cylinder block using a straight edge and a thickness gauge.
   - Replace the cylinder block if the measurements exceed limit values.

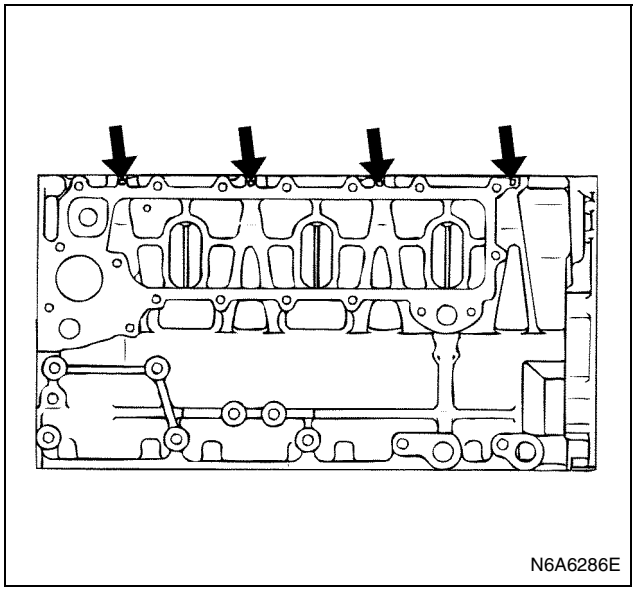
Cylinder block upper face warpage	mm (in)
Standard	0.05 or less (0.002 or less)
Limit	0.20 (0.079)


N6A6285E

Installation

1. Cylinder liner grade selection
   - Select liner outer diameter grades according to the cylinder block bore grades stamped on the cylinder block at arrowed positions in the figure.

Grade matching of cylinder block and liner		
Grade of Cylinder block (stamp)	1, 2	3
Grade of Liner outside diameter	1X	3X

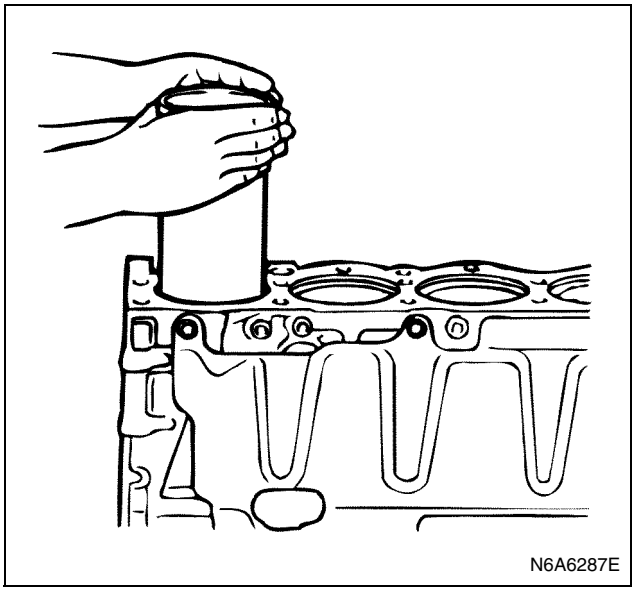

N6A6286E

Cylinder block bore and liner grade (for reference)		mm (in)
Grade	(1,2)/(1X)	(3)/(3X)
Cylinder block Bore diameter	118.001 – 118.020 (4.64699 – 4.64654)	118.021 – 118.030 (4.64649 – 4.64684)
Liner outside diameter	117.991 – 118.000 (4.64531 – 4.64566)	118.001 – 118.010 (4.64570 – 4.64605)

(Reference)
When replacing liners, a “liner set” let you obtain a piston of proper grade for a given liner bore diameter only by specifying a liner outside diameter grade.

2. Install the cylinder liners.
   - Install the cylinder liners perpendicular to the cylinder block.
   - Do not hammer the liner or apply excessive force to insert it.

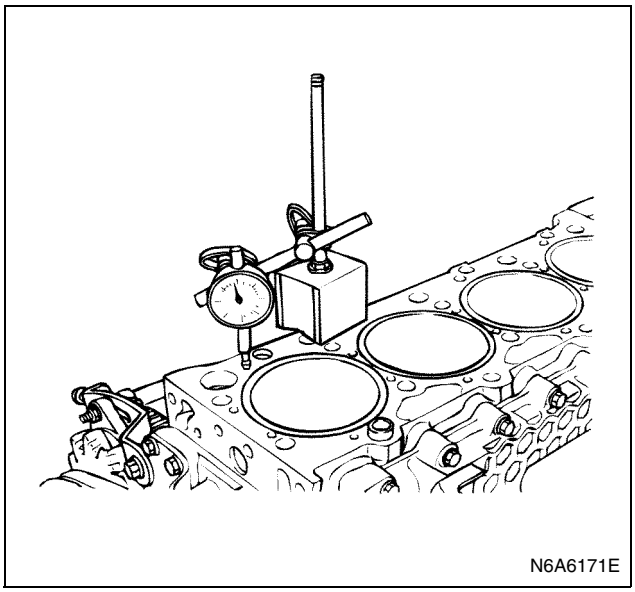
Caution:
Clean up and blow with compressed air the cylinder block and the cylinder liners before installing them.


N6A6287E

3. Amount of the cylinder liner extrusion
   Measure the amount of the cylinder liner extrusion using a dial gauge.
   Difference of the amount of the extrusion between adjacent two cylinders should be within 0.03 mm (0.0012 in).

Amount of the cylinder liner extrusion	mm (in)
Standard	0.05 – 0.10 (0.0020 – 0.0039)

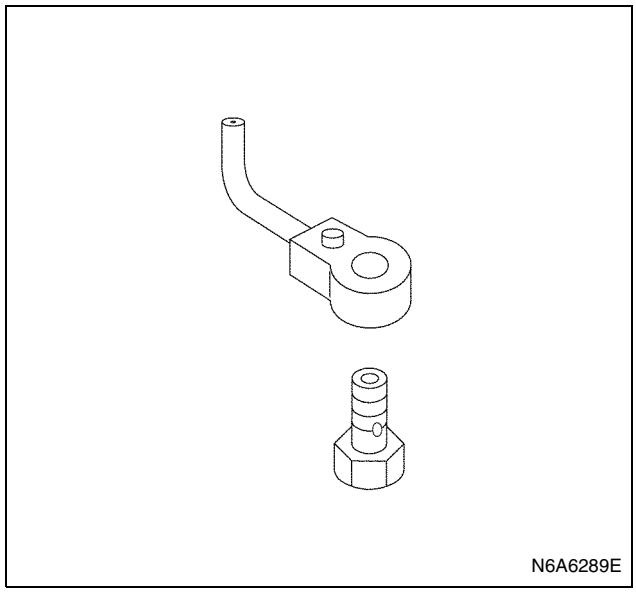
Caution:
Be sure to measure the cylinder liner extrusion whenever you have replaced cylinder liners.


N6A6171E

4. Install the piston oil jet.
   - Align the dowel pin of the oil jet with the pin hole on the cylinder block and tighten with the check valve.

Tighten:
Bolts to 21 N·m (2.1 kg·m/15 lb·ft)

Caution:
Be careful not to deform or damage the oil jet nozzle.


N6A6289E

5. Install the crankshaft.
   Refer to “Crankshaft”.
6. Install pistons and connecting rods.
   Refer to “Pistons and Connecting Rod”.
7. Install the oil pump.
   Refer to “Oil Pump”.
8. Install the timing gear train.
   Refer to “Timing Gear Train”.
9. Install the front cover.
   Refer to “Front Cover”.
10. Install the water pump.
    Refer to “Water Pump” in Section 6B.
11. Install the oil pan.
    Refer to “Oil Pan”.
12. Install the crankshaft rear oil seal.
    Refer to “Crankshaft Rear Oil Seal”.
13. Install the crankshaft front oil seal.
    Refer to “Crankshaft Front Oil Seal”.
14. Install the fuel supply pump.
    Refer to “Fuel Supply Pump” in Section 6C.
15. Install the cylinder head.
    Refer to “Cylinder Head”.
16. Install the camshaft assembly.
    Refer to “Camshaft Assembly”.
17. Install the rocker arm shaft assembly.
    Refer to “Rocker Arm Shaft Assembly”.
18. Install the cylinder head cover.
    Refer to “Cylinder Head Cover”.
19. Mount the engine assembly on the chassis.
    Refer to “Engine Assembly”.

Lubrication System

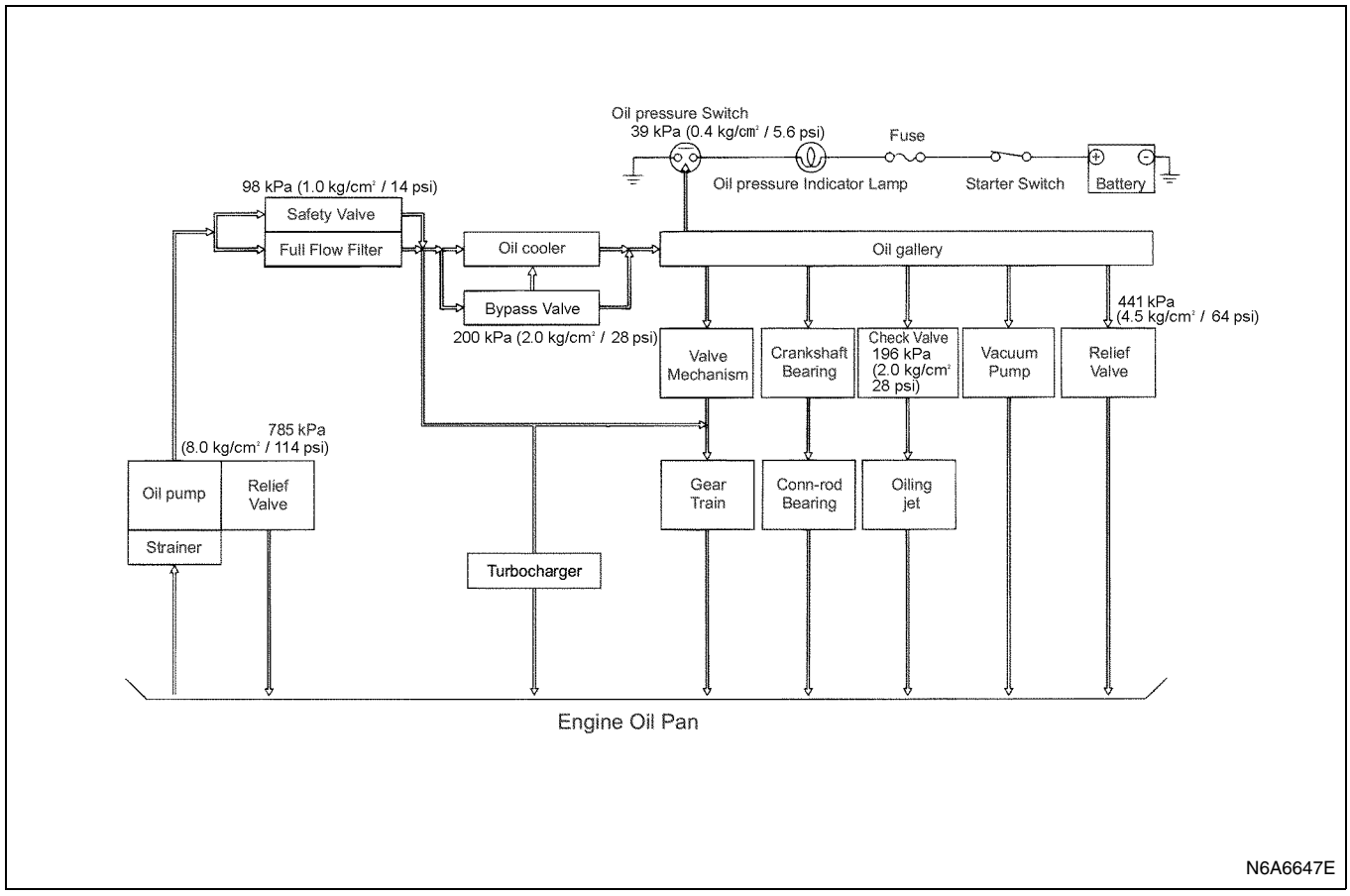
Service Precautions

- During each disassembly, remove the old gasket adhering to each part and mating part completely using a scraper at the location, where the fluid gasket is to be used, clean the traces of oil, moisture, and dirt completely using waste cotton and apply the specified new fluid gasket at each location.
- Avoid excessive or insufficient coating amount. Note that seizure may occur in case of excessive coating due to clogging of the oil gallery and oil jet, and oil and water leakage may occur if the coating is insufficient.
- Always, the starting and ending piston of application should be overlapped.

Explanations on Functions and Operation

The lubrication system uses the filter element combined with a full flow bypass, water-cooled oil cooler, and oil jet for piston cooling.

Lubricating System Diagram



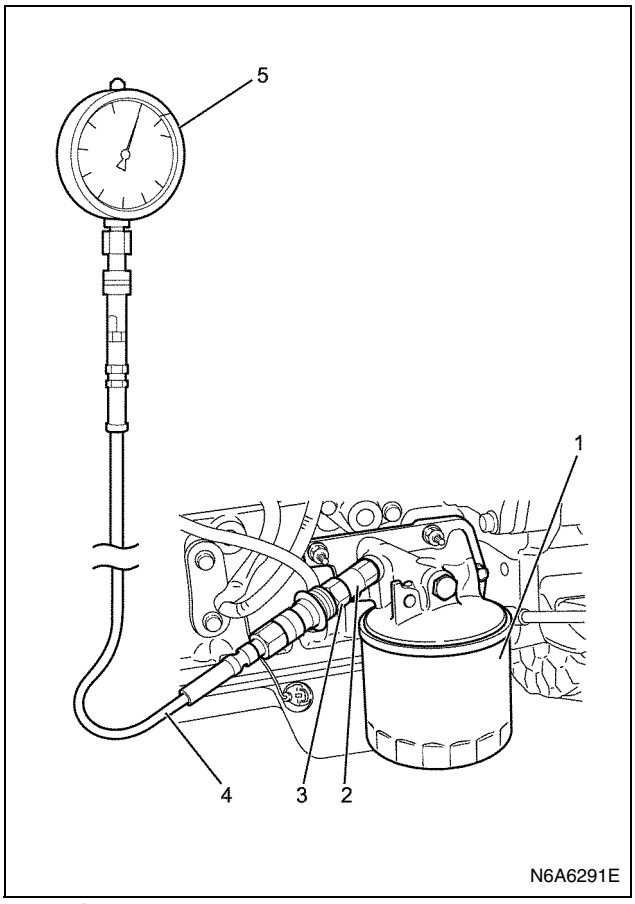
Functional Check

Oil pressure check

1. Check whether the engine oil is contaminated with dirt, fuel or water. If contaminated with dirt, fuel, or water (after examining the cause and taking the appropriate measures for fuel or water contamination), replace the oil.
2. Check the engine oil level. The oil level should be between the two holes of the level gauge. If the oil level is insufficient, replenish it.
3. Remove the oil pressure switch on the oil filter body.

4. Install the oil pressure gauge on the oil filter body.

   Special tool
   Oil pressure gauge set:
   5-8840-2843-0
   (Oil pressure gauge: J-43630-20)
   (Hose: J-43630)
   (Connector: J-43630-14)
   (Oil pressure testing adapter: EN-46333)

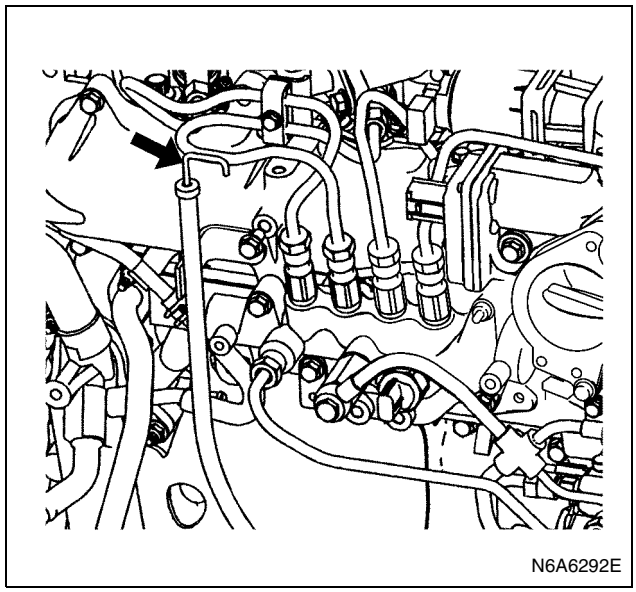


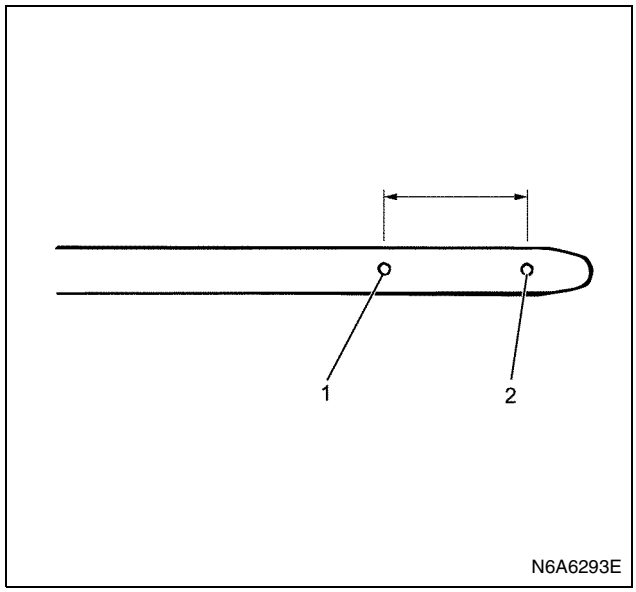
Legend
1. Oil Filter Cartridge
2. Oil Pressure Testing Adapter
3. Connector
4. Hose
5. Oil Pressure Gauge

5. Warm the engine.
6. Measure the oil pressure, to check whether it is more than 343 kPa (3.5 kg/cm^2 / 50 psi) at 3200 rpm.
7. Stop the engine.
8. Remove the oil pressure gauge.
9. Install the oil pressure switch.
10. Start the engine and check for oil leakage.

Engine oil

- Ensure the car is at a level ground. Before starting the engine or when 5 minutes or more have elapsed after stopping the engine, check the engine oil volume using the level gauge. The volume is appropriate if the engine oil is between the upper and lower limits of the level gauge. Replenish the engine oil, if level is below the lower limit. Also, check for contamination of the engine oil.



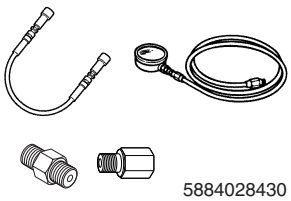


Legend
1. Upper Limit
2. Lower Limit

Engine oil leakage

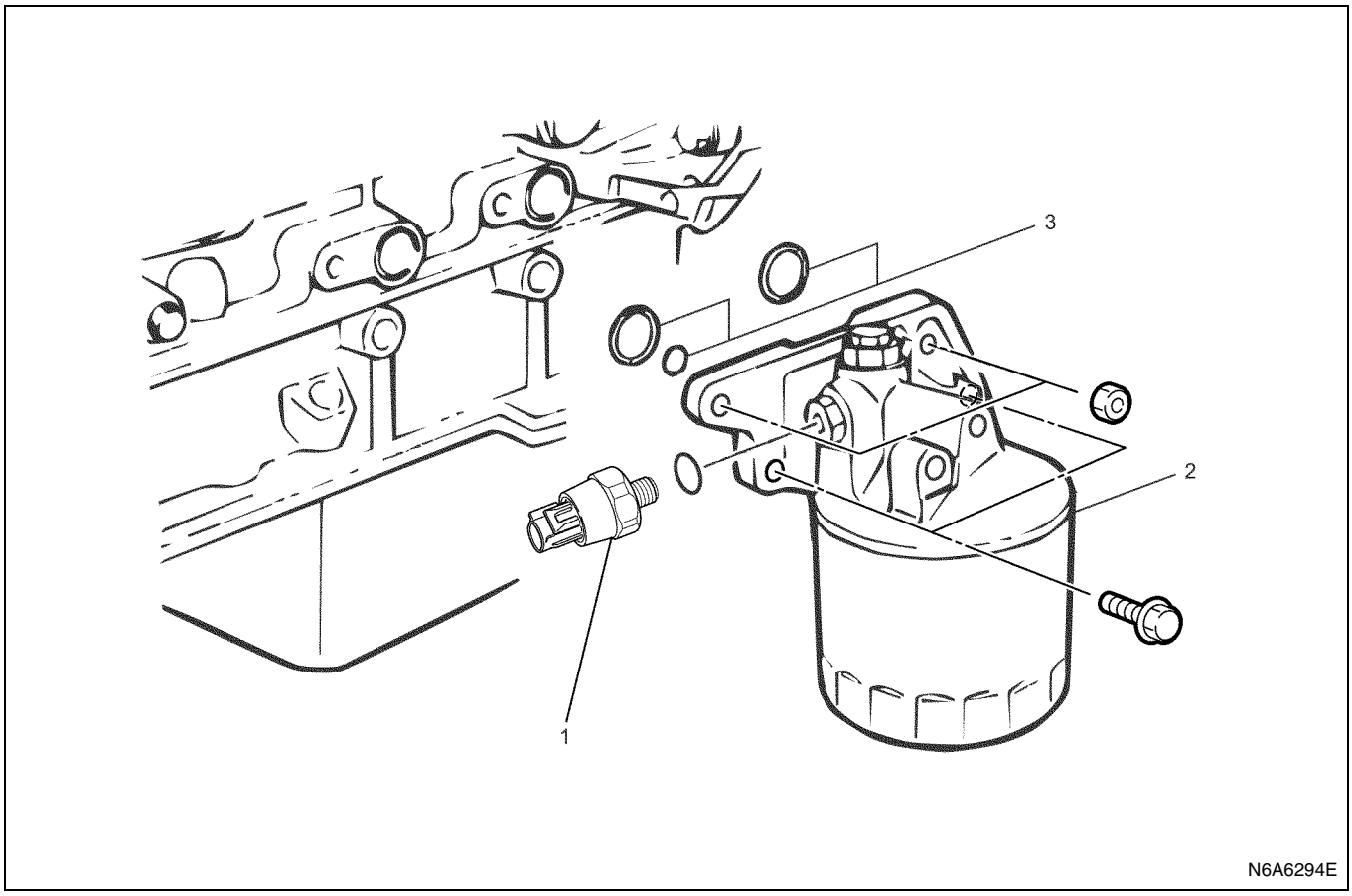
- In the lift up condition, confirm that there are no leaks from the cylinder head cover and oil pan.

Special Tool

Illustration	Tool Number / Description / Remarks
 5884028430	5-8840-2843-0 Oil Pressure Gauge Set (J-43630-20 / Oil Pressure Gauge, J-43630 / Hose, J-43630-14 / Connector, EN-46333 / Oil Pressure Testing Adapter)

Oil Filter Assembly

Components



Legend

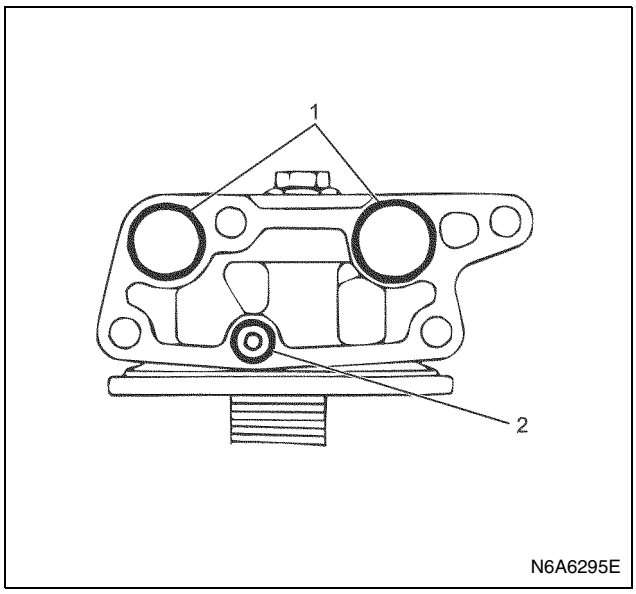
1. Oil Pressure Switch
2. Oil Filter Body
3. O-ring

Removal

1. Place a tray under the oil filter cartridge.
2. Remove the oil filter cartridge.
3. Remove the oil pressure switch.
4. Remove the oil filter body.
5. Remove the O-ring.

Installation

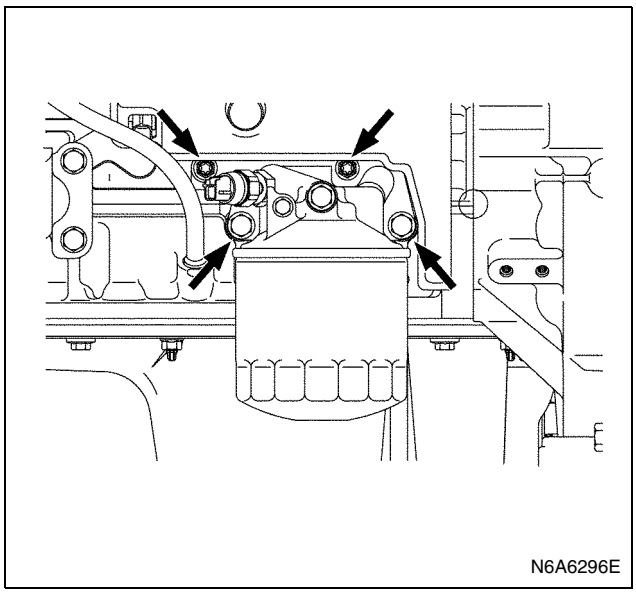
1. Install the O-rings and on the oil filter body.



Legend
1. O-ring
2. O-ring

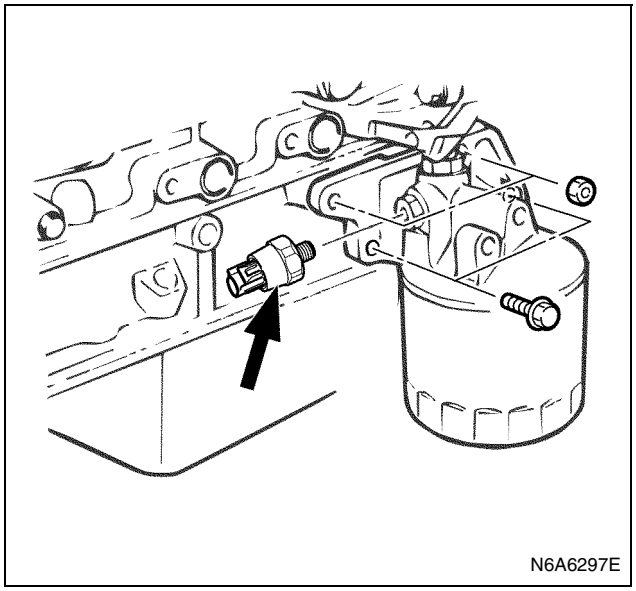
2. Install the oil filter on the cylinder block and tighten it using the specified torque.

Tighten:
Nuts and bolts to 48 N·m (4.9 kg·m/35 lb·ft)



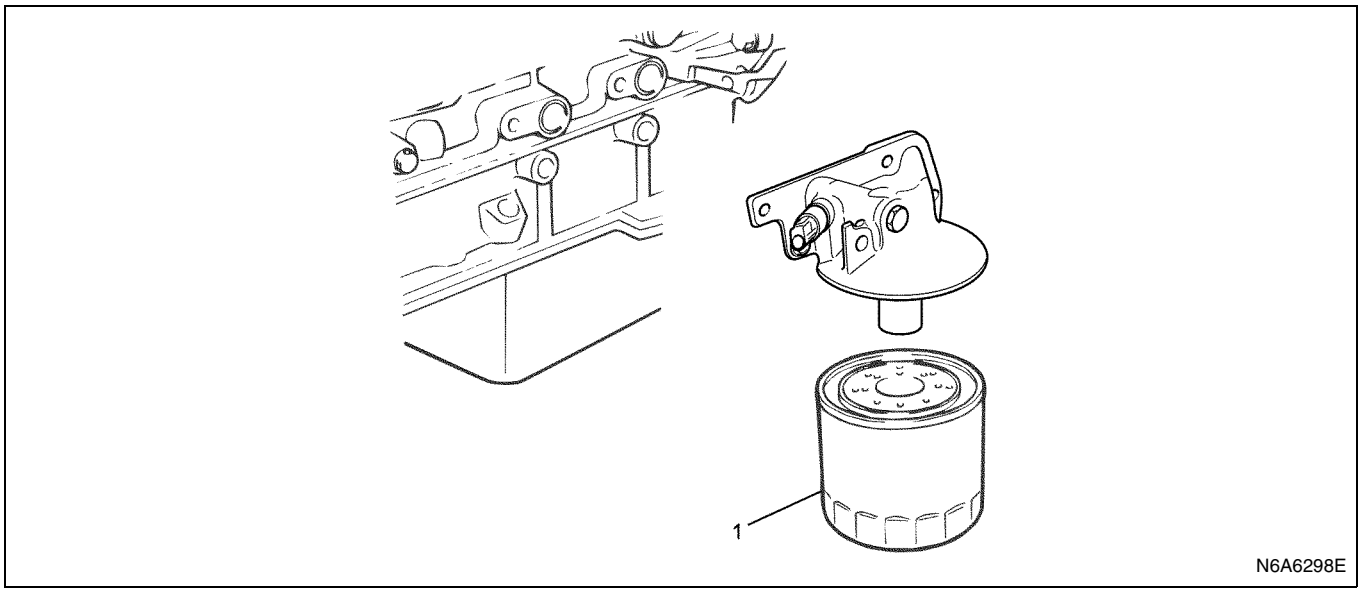
3. Install the oil pressure switch on the oil filter body.
   - Apply the liquid gasket (Loctite 262) on 2 to 3 peaks from the tip of the threaded part of the oil pressure switch and install it at the position shown in the figure.

Tighten:
Oil pressure switch to 13 N·m (1.3 kg·m/113 lb·in)



Oil Filter Cartridge

Components

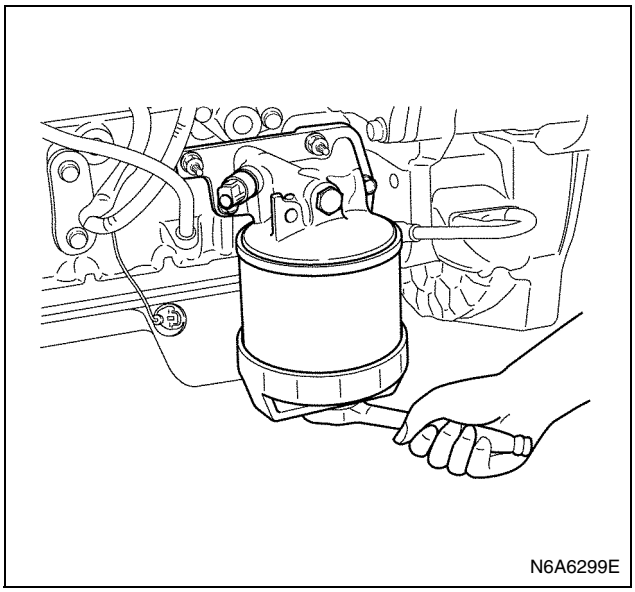


Legend
1. Oil Filter Cartridge

Removal

1. Place a tray under the oil filter cartridge.
2. Remove the oil filter cartridge using the oil filter wrench.

   Special tool
   Oil filter wrench: 1-8522-1097-0 (EN-47683)



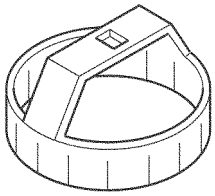
Installation

1. Install the oil filter cartridge.
   - Apply grease or engine oil to the seal in the cartridge and install it using the oil filter wrench.
   - Tighten the cartridge using the specified torque.

Tighten:
Cartridge to 20 N·m (2.0 kg·m/14 lb·ft)
After it comes in contact with the oil seal, tighten it through an additional turn of 1 and 1/4.

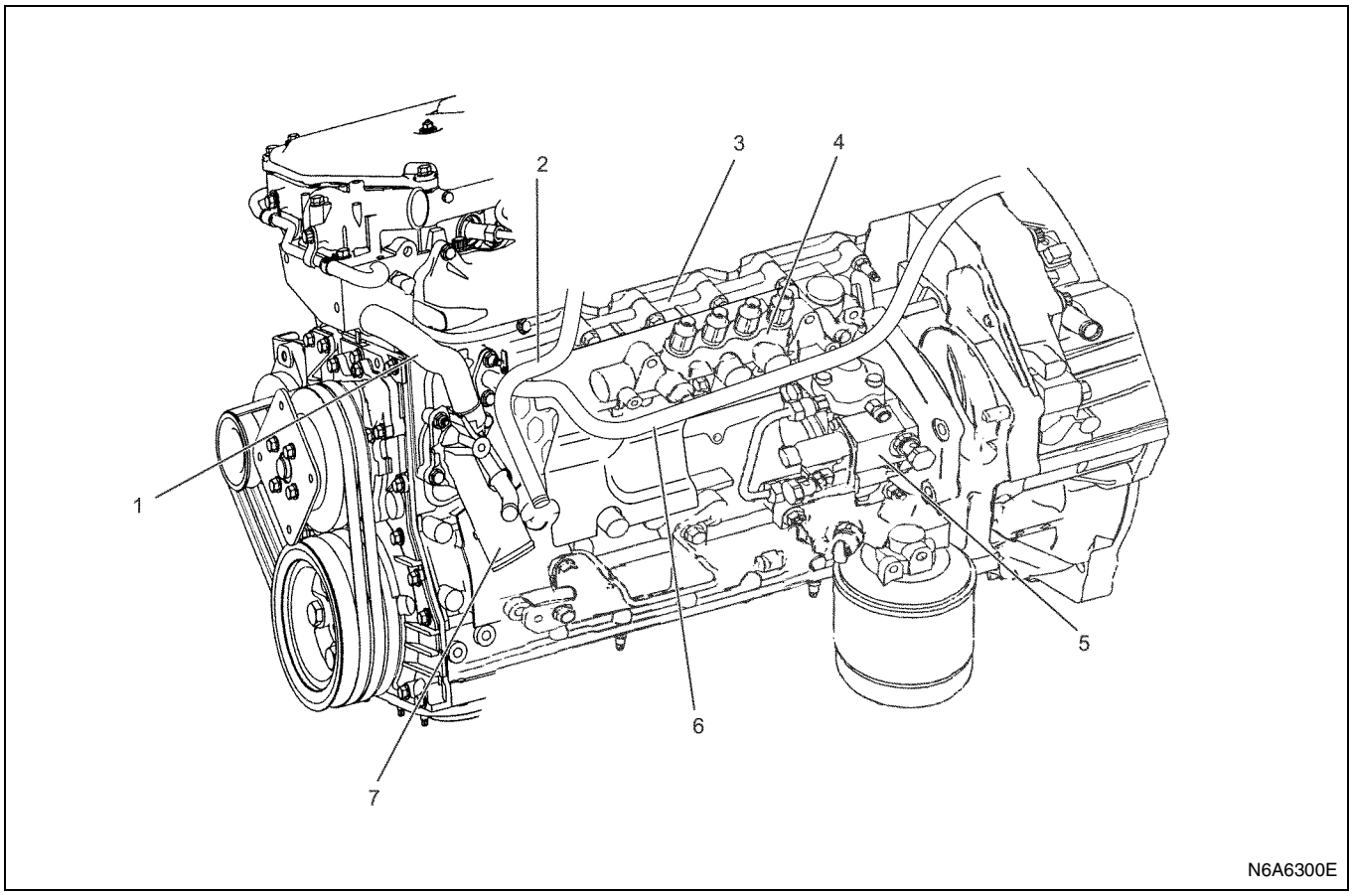
Special tool
Oil filter wrench: 1-8522-1097-0 (EN-47683)

Special Tool

Illustration	Tool Number / Description / Remarks
 1852210970	1-8522-1097-0 (EN-47683) Oil Filter Wrench

Oil Cooler

Components

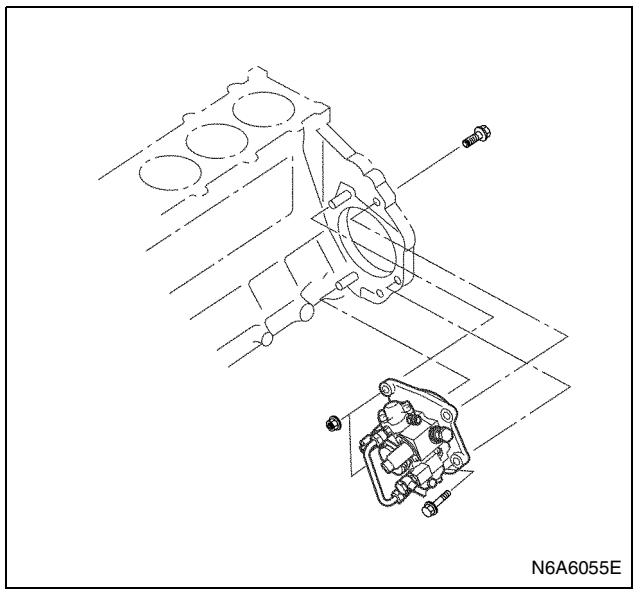


Legend

1. Bypass Hose
2. EGR Cooler Water Return Pipe
3. Oil Cooler
4. Fuel Rail
5. Fuel Supply Pump
6. EGR Cooler Water Feed Pipe
7. Suction Pipe

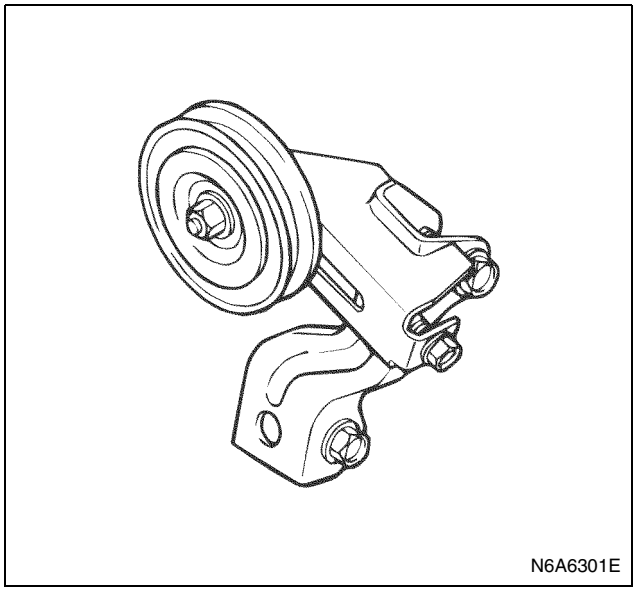
Removal

1. Remove the fuel rail.
   Refer to “Fuel Rail” in Section 6C.
2. Remove the fuel supply pump.

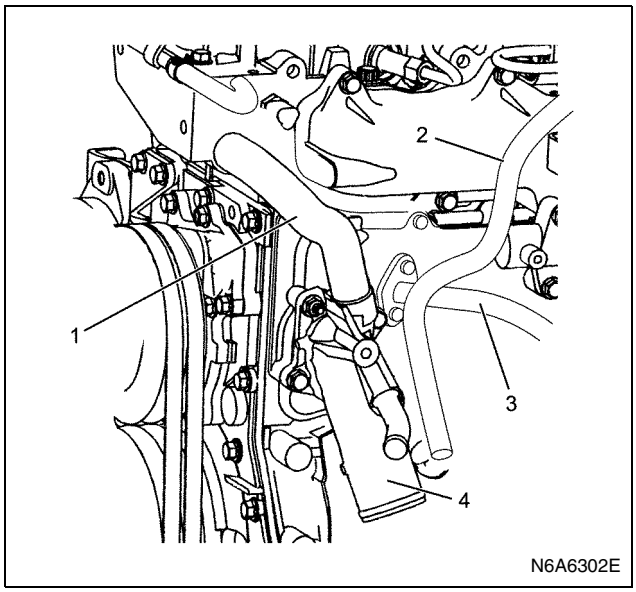


3. Remove the A/C drive belt.

4. Remove the idling pulley bracket.
   - Remove the drive belt for A/C and the bracket fixing bolts, and then remove the bracket along with tensioner and idling pulley.


N6A6301E

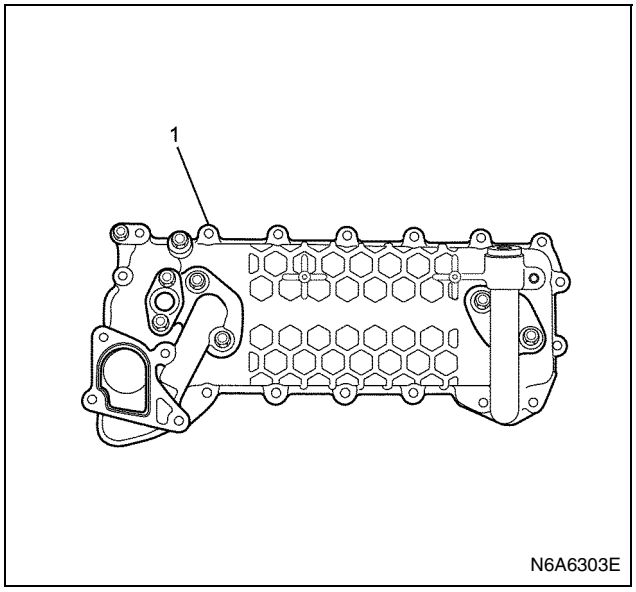
5. Remove the EGR cooler water return pipe.
   - Remove the brackets to the water pipe at three locations to make the pipe unsupported.
6. Remove the EGR cooler water feed pipe.
7. Remove the clip on the head side of the water bypass hose and remove the hose from the suction pipe and assembly.



N6A6302E

Legend
1. Bypass Hose
2. EGR Cooler Water Return Pipe
3. EGR Cooler Water Feed Pipe
4. Suction Pipe

8. Remove the oil cooler assembly.
   - Screw the removed fixing bolt of the oil cooler into the replacer hole at the location 1 of the figure and remove the oil cooler.



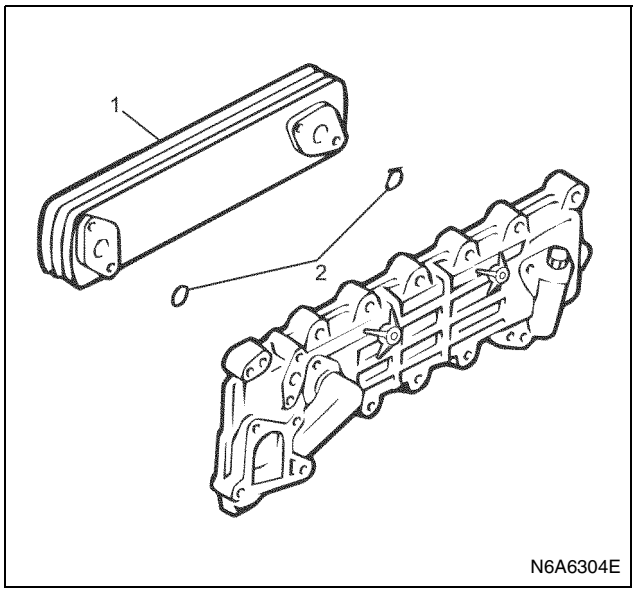
N6A6303E

Legend
1. Oil Cooler Assembly

9. Remove the O-ring.

Disassembly

1. Remove the element mounting bolts.
2. Remove the element.
3. Remove the O-ring.



N6A6304E

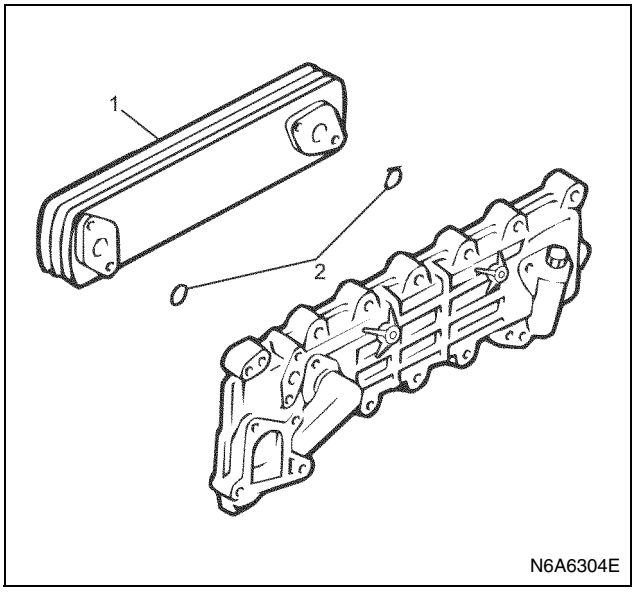
Legend
1. Element
2. O-ring

Reassembly

1. Install the O-ring on the oil cooler case.
2. Install the element.

3. Tighten the element fixing bolts using the specified torque.

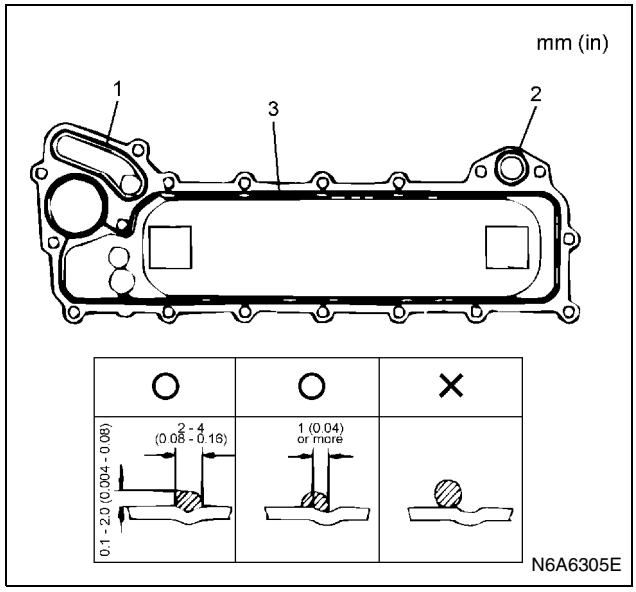
Tighten:
Bolts to 20 N·m (2.0 kg·m/15 lb·ft)



Legend
1. Element
2. O-ring

Installation

1. Install the oil cooler assembly.
   - Apply liquid gasket (ThreeBond1207C or equivalent) to the flange surface groove (cylinder block). Bead diameter must be between 2 and 4 mm (0.08 and 0.16 in).
     Refer to the illustration for the offset position (no more than 1 mm (0.04 in)).
   - Install the O-rings (1) and (2) to the oil passage inlet and outlet. Do not allow the liquid gasket to contact the O-ring.

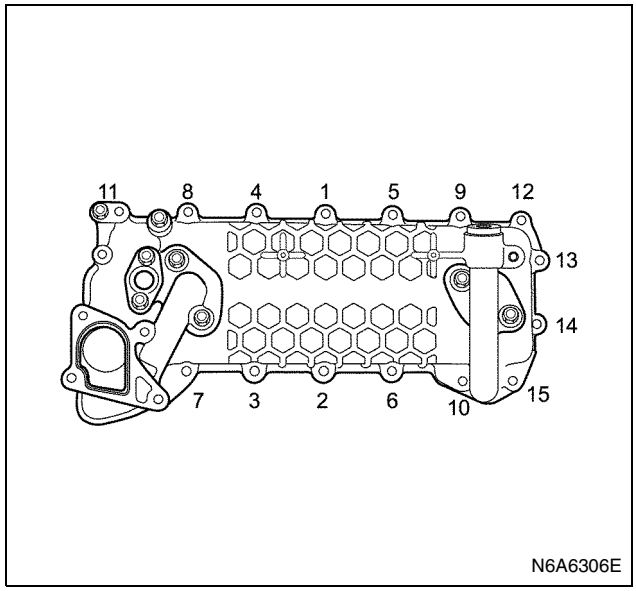


Legend
1. O-ring
2. O-ring
3. Liquid Gasket

   - Align the oil cooler holes with the cylinder block studs.
   - Install the oil cooler and glow plug controller bracket to the cylinder block.
   - Tighten the bolts to the specified torque in the order shown in the illustration.

Tighten:
Bolts to 24 N·m (2.4 kg·m/18 lb·ft)

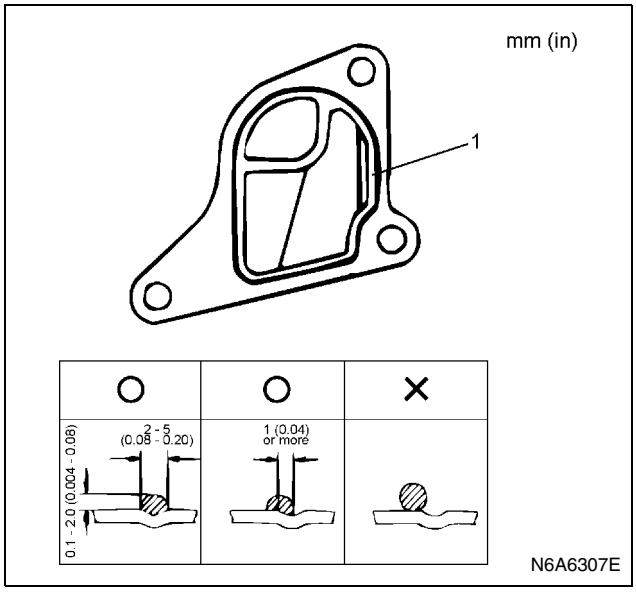
   - Liquid gasket quickly hardens.
     Make it complete within 7 minutes after applying the liquid gasket.



Legend
1. Oil Cooler Assembly

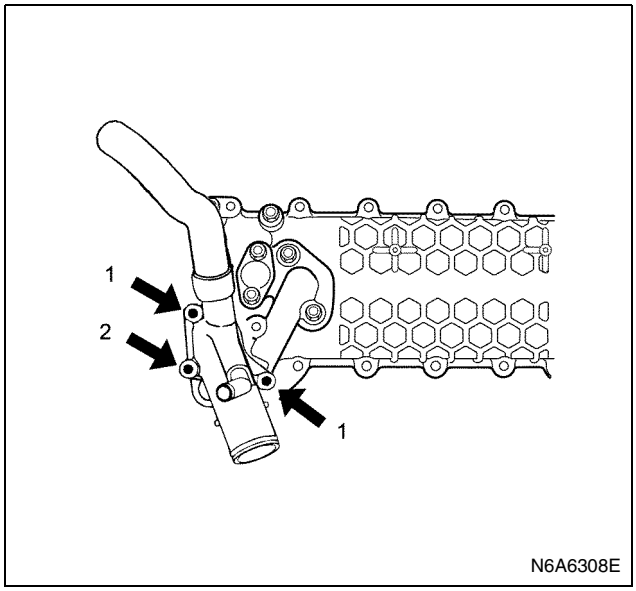
2. Install the water suction pipe.
   - Apply liquid gasket (ThreeBond 1207C) to the flange of the water suction pipe. Bead diameter must be between 2 and 5 mm (0.008 and 0.20 in). Refer to the illustration for the offset position (no more than 1 mm (0.04 in)).
   - Install the water suction pipe to the oil cooler. Refer to the illustration.
   - Tighten the bolts to the specified torque.

Tighten:
Bolts to 24 N·m (2.4 kg·m/18 lb·ft)



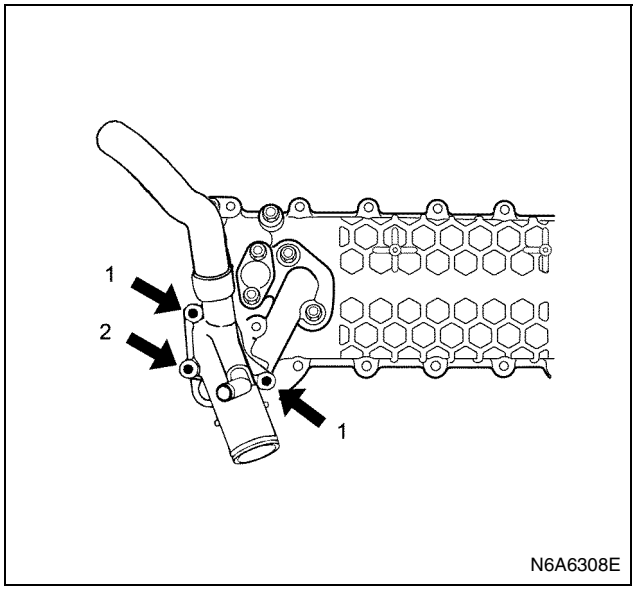
Legend
1. Liquid Gasket

Caution:
The water suction pipe must be installed immediately after the oil cooler (the pipe and cooler use the same liquid gasket).



3. Install the EGR cooler water feed pipe.
   - Install the O-ring on the EGR cooler water feed pipe.
   - Install at the position shown in the figure and tighten using the specified torque.

Tighten:
Bolts to 24 N·m (2.4 kg·m/18 lb·ft)



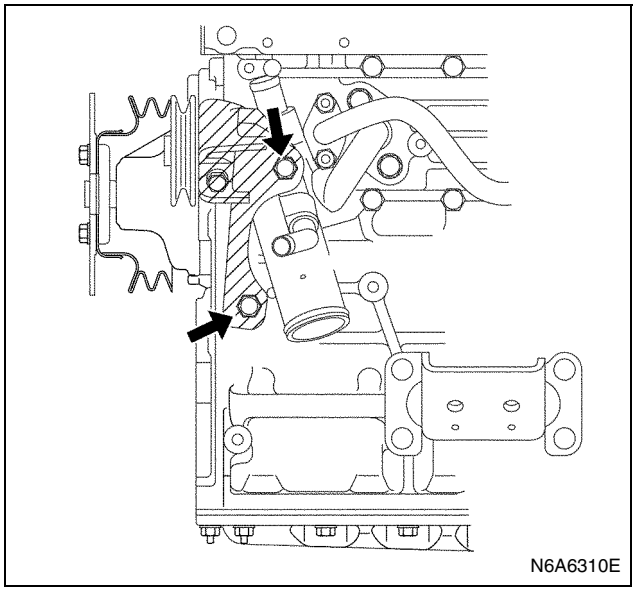
4. Install the EGR cooler water pipe.
5. Install the body cover assembly LH on the surface of the oil cooler and cylinder block and tighten it using the specified torque.

Tighten:
Body cover assembly LH to 19 N·m (1.9 kg·m/14 lb·ft)

6. Install the idling pulley bracket and tighten it using the specified torque.

Tighten:
Idling pulley bracket to 24 N·m (2.4 kg·m/18 lb·ft)

7. Install the A/C drive belt.
   Refer to “Drive Belt” in Section 6B.

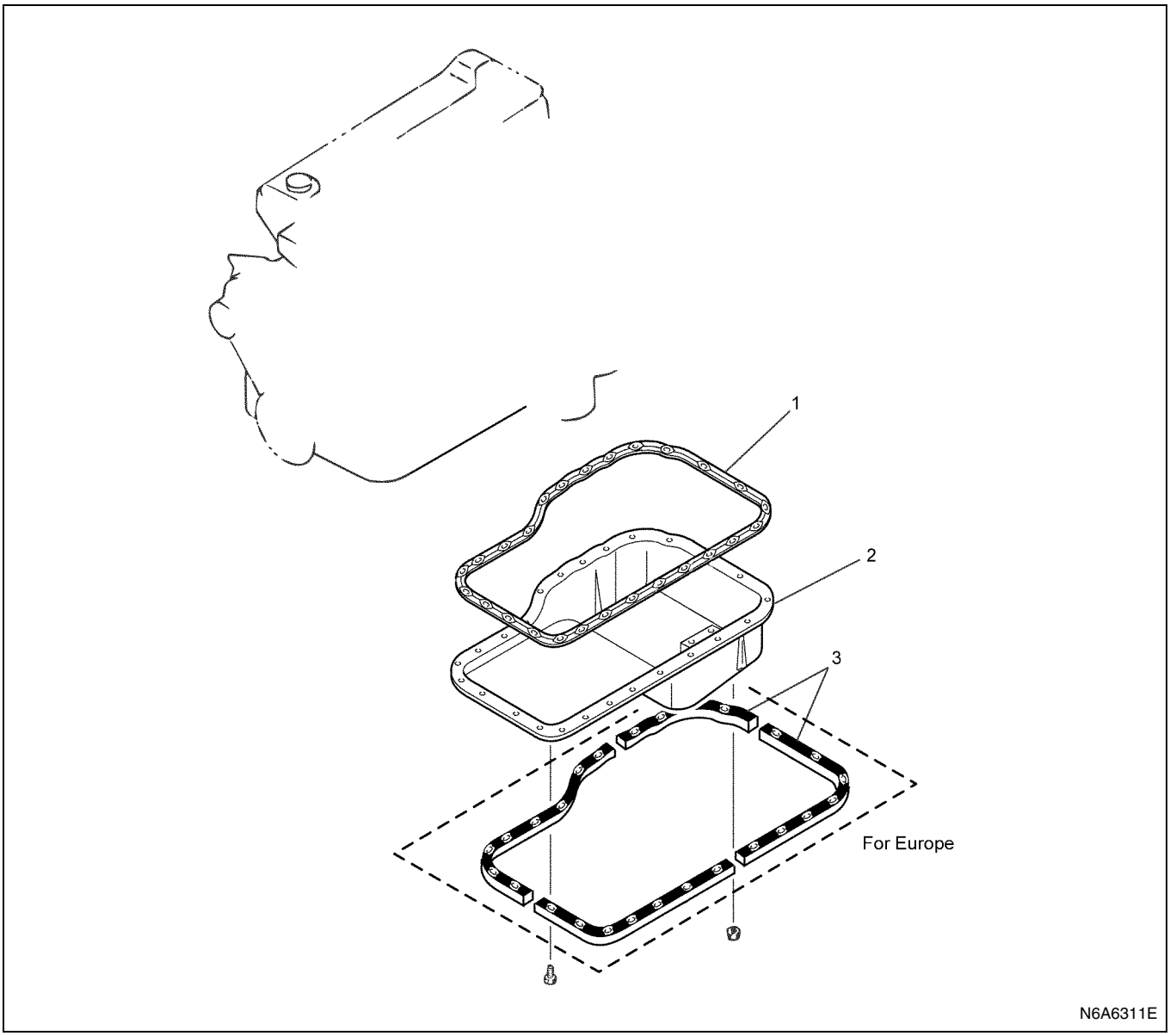


8. Remove the oil drain adapter.

9. Install the fuel supply pump.
    - Refer to “Fuel Supply Pump” in Section 6C.
10. Install the fuel rail.
    - Refer to “Fuel Rail” in Section 6C.

Oil Pan

Components



Legend

1. Oil Pan Gasket
2. Oil Pan
3. Oil Pan Rubber (For Europe)

Removal

1. Drain out the engine oil.
   - Install the drain plug.

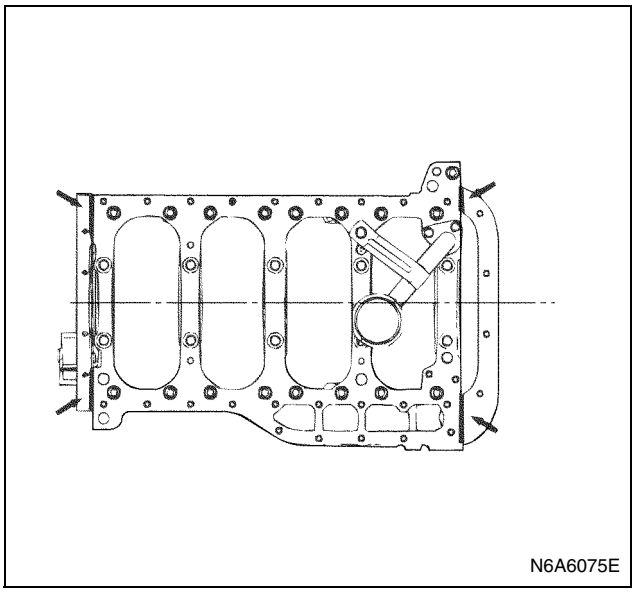
Tighten:
Drain plug to 8.5 N·m (0.9 kg·m/61 lb·ft)

2. Remove the oil pan.

Installation

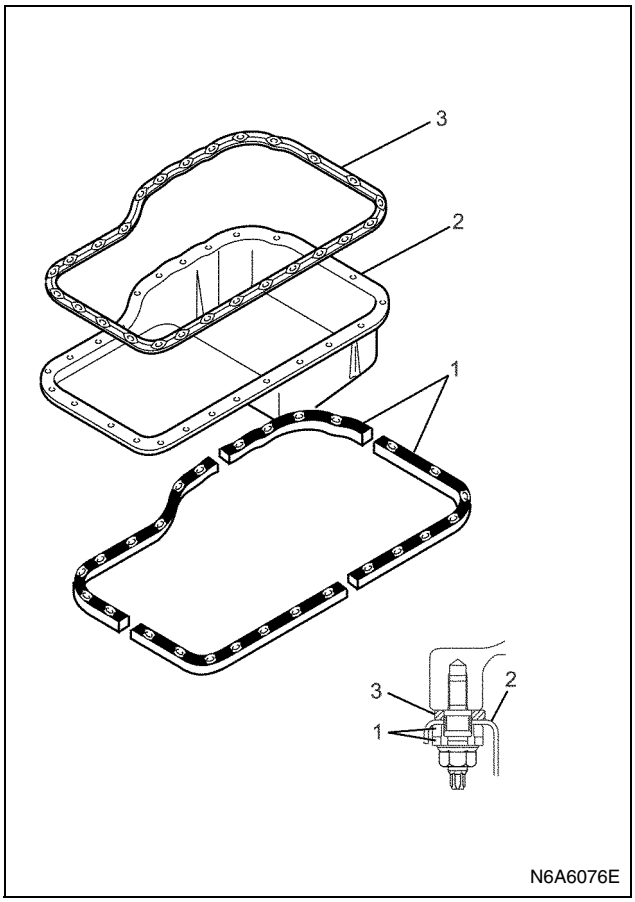
1. Install the oil pan.
   - At the seam between the cylinder block and the front cover with the flywheel housing, apply the liquid gasket (ThreeBond 1207C or equivalent) to a bead diameter of 3 mm (0.12 in).

- Apply the liquid gasket and install the oil pan within 7 minutes.


N6A6075E

For Europe

- Install the gasket using the studs of the crankcase, flywheel housing, and front cover as guide and mount the oil pan.
  Install the rubber assembly on the oil pan and secure it using nuts and bolts.

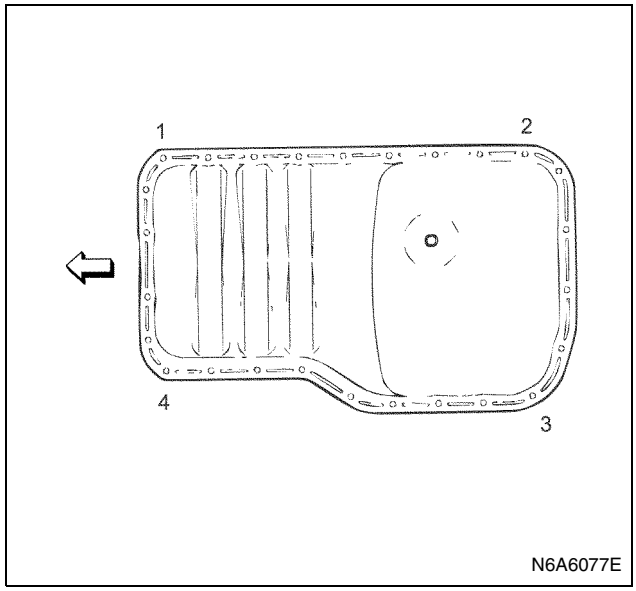


N6A6076E

Legend

1. Rubber Assembly (For Europe)
2. Oil Pan
3. Gasket

- Tighten the locations (1), (2), (3), and (4) as shown in the figure and then tighten others. (In any sequence)

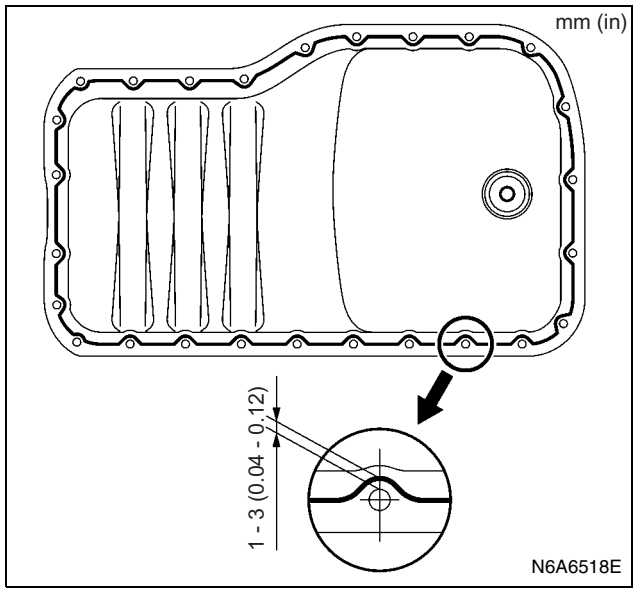


N6A6077E

Tighten:
Nuts and bolts to 11 N·m (1.1 kg·m/95 lb·in)

Except Europe

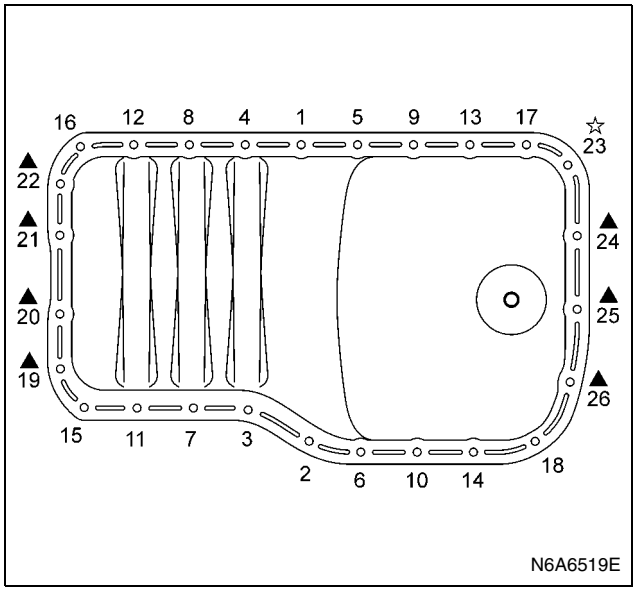
- As the figure shows, apply the liquid gasket (Three bond 1207C or equivalent) inside a hole of the bolt evenly.



N6A6518E

- Tighten the oil pan nut and bolts to the specified torque in the numerical order as shown in the figure.
  ▲ marks are located on nut positions.

Tighten:
Star mark bolt to 18 N·m (1.8 kg·m/13 lb·ft)
Other bolts and nuts to 24N·m (2.4 kg·m/17 lb·ft)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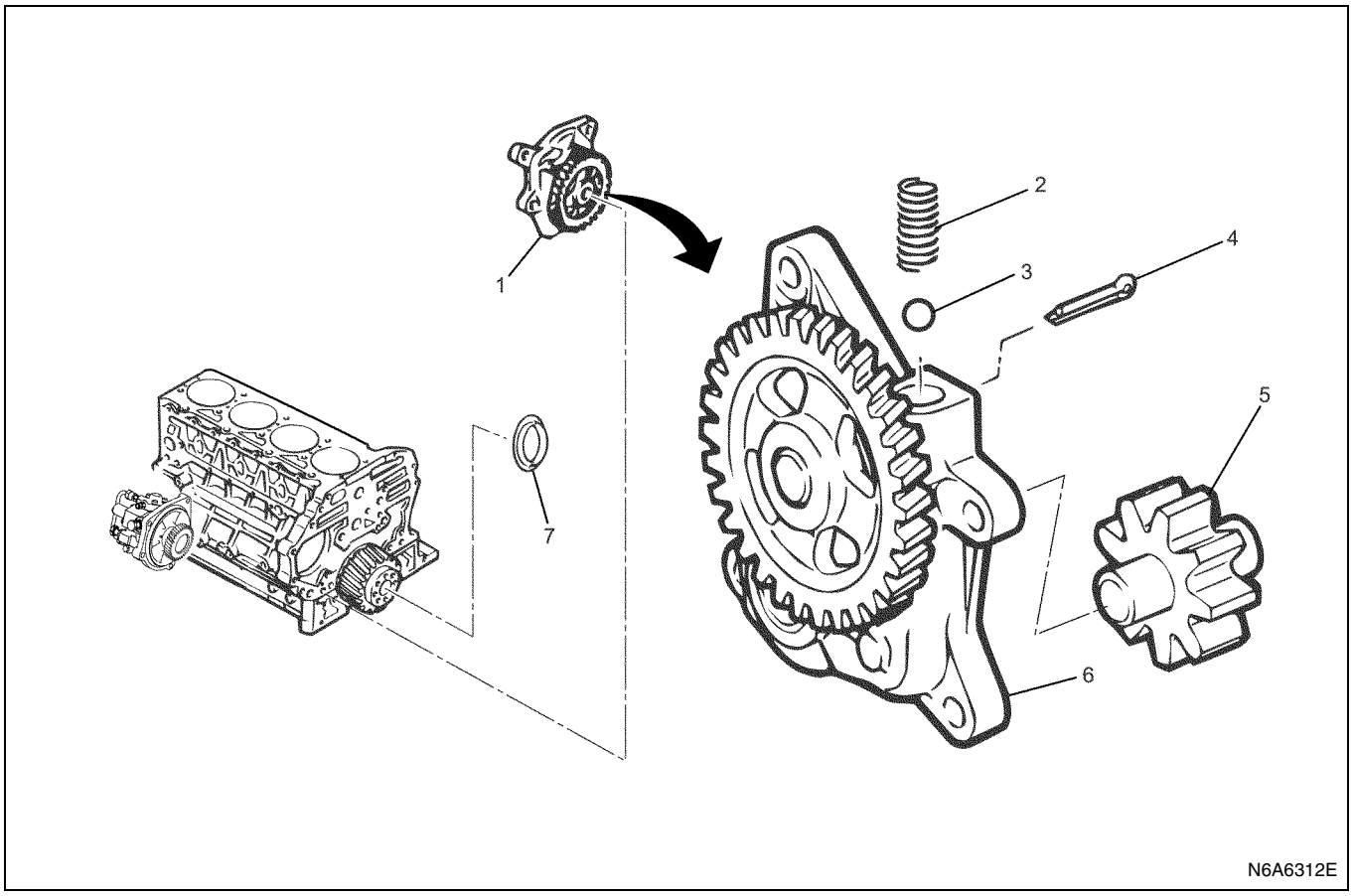
18
N6A6519E

Oil Pump

Components



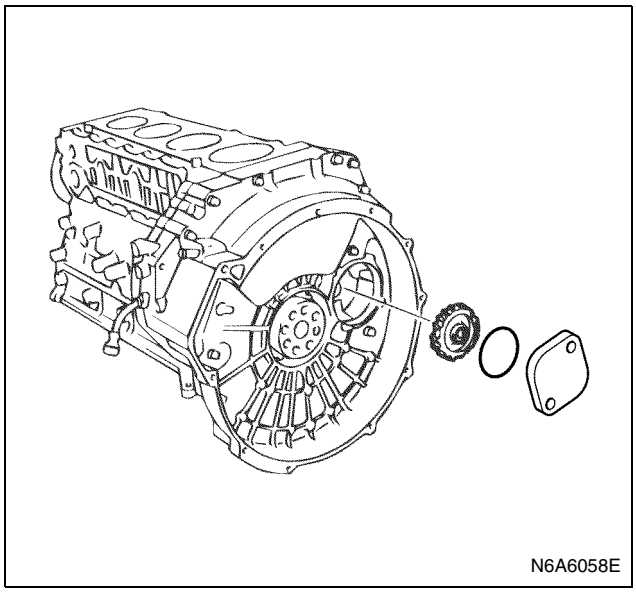
Legend

1. Oil Pump Assembly
2. Spring
3. Ball
4. Split Pin
5. Driven Gear and Shaft
6. Oil Pump Body
7. Slinger

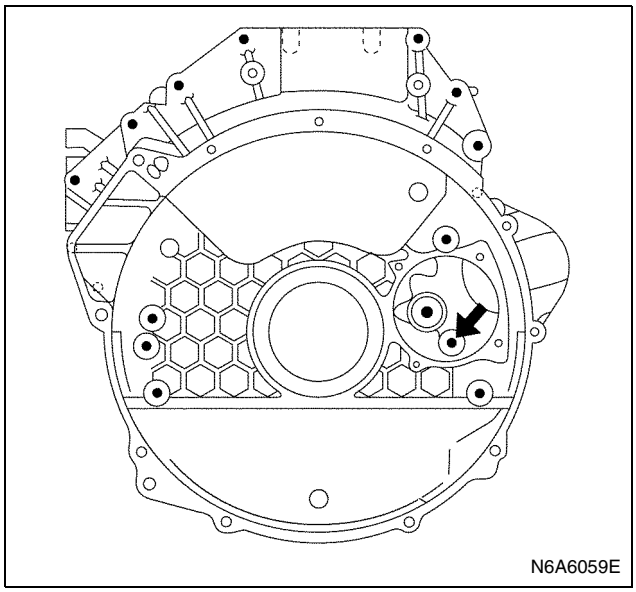
Removal

1. Drain out the engine oil.
2. Drain out the cooling water.
3. Remove the cylinder head cover.
   Refer to “Cylinder Head Cover”.
4. Remove the rocker arm shaft assembly.
   Refer to “Rocker Arm Shaft Assembly”.
5. Remove the camshaft assembly.
   Refer to “Camshaft Assembly”.
6. Remove the cylinder head assembly.
   Refer to “Cylinder Head”.
7. Clutch pressure plate assembly
   Refer to “Flywheel”.
8. Driven plate
   Refer to “Flywheel”.
9. Remove the fuel supply pump assembly.
   Refer to “Fuel Supply Pump” in Section 6C.
10. Remove the flywheel.
    Refer to “Flywheel”.
11. Remove the rear oil seal of the crankshaft.
    Refer to “Crankshaft Rear Oil Seal”.
12. Remove the oil pan.
13. Remove the power steering pump.
14. Remove the idle gear cover of the power steering pump.

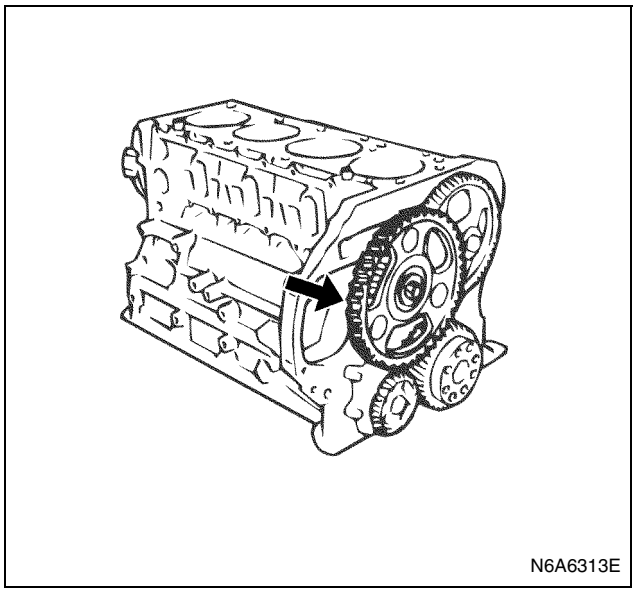
15. Remove the idle gear of the power steering pump.



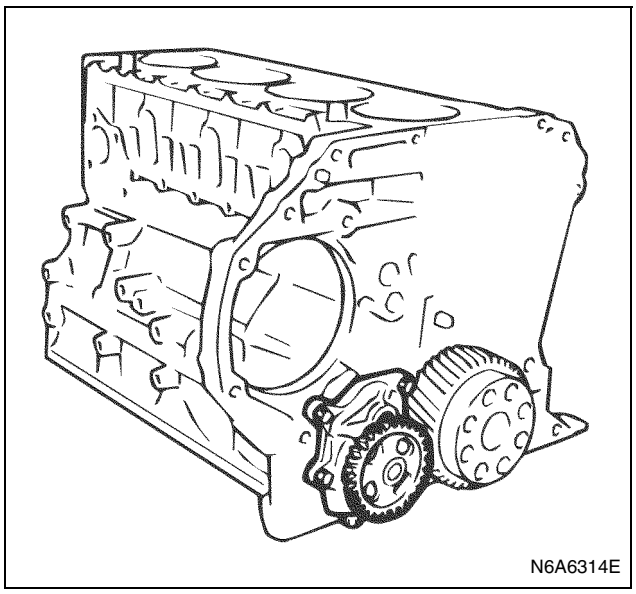
16. Remove the flywheel housing.
    - Make sure you remove the bolts shown in the figure.



17. Remove the idle gear A.



18. Remove the oil pump assembly.



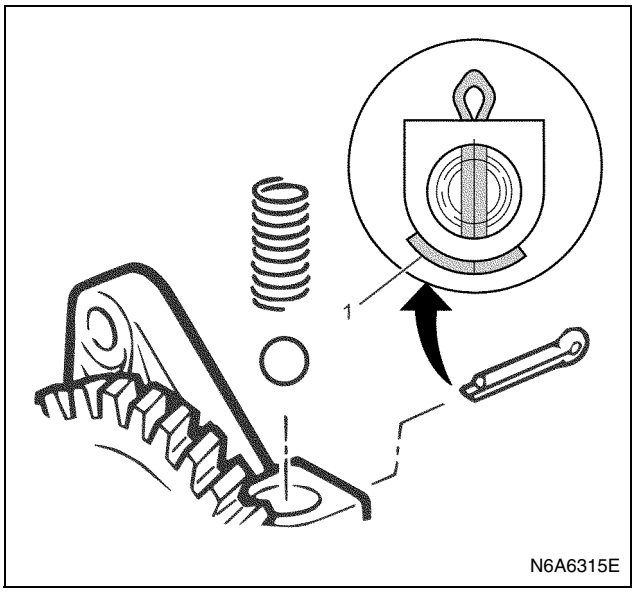
Disassembly

1. Remove the driven gear and shaft.
2. Remove the split pin.
3. Remove the spring.
4. Remove the ball.

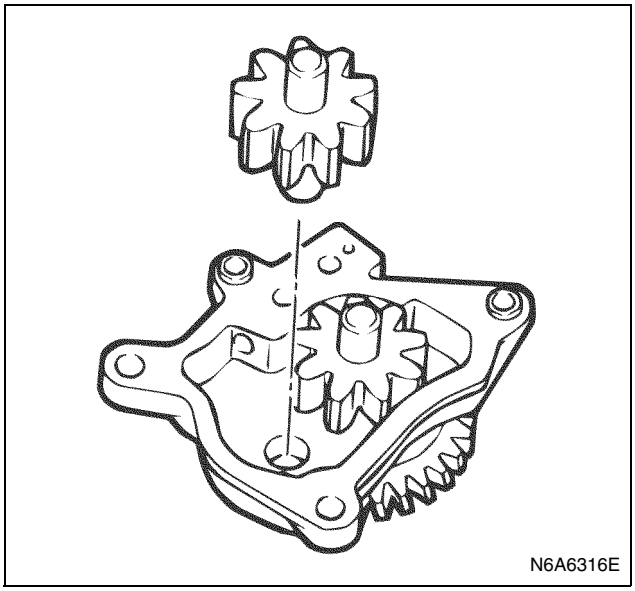
Reassembly

1. Install the ball.
2. Install the spring.

3. Install the split pin and fold it according to (1).



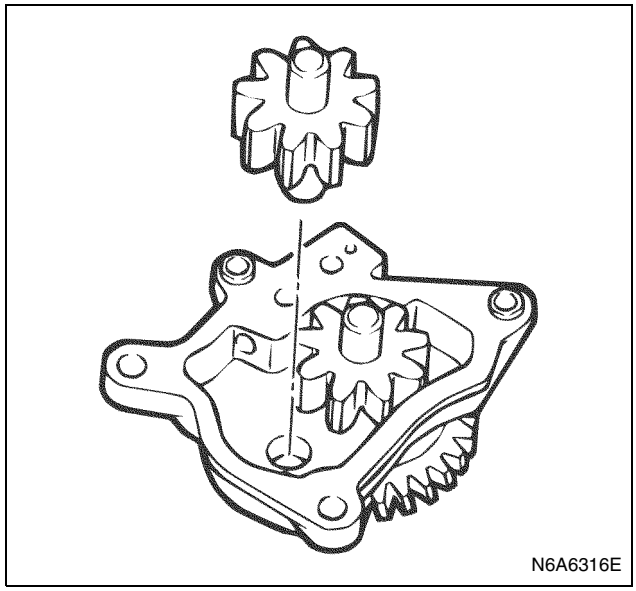
4. Apply engine oil on the driven gear and shaft and mount them on the oil pump body.



Inspection

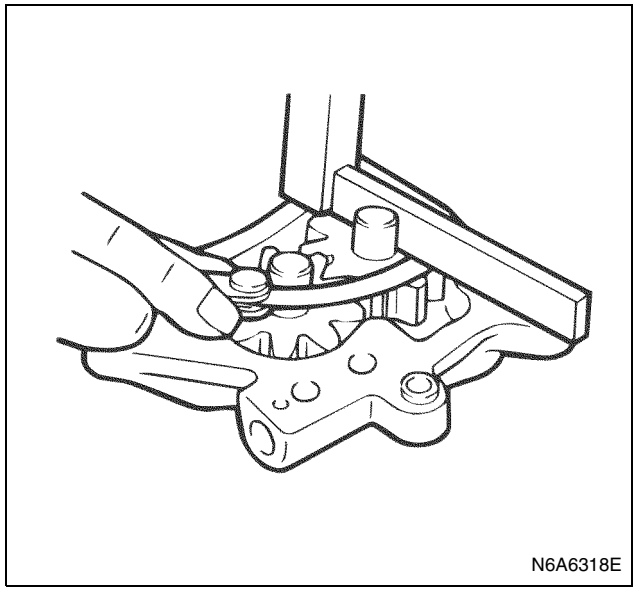
1. Measure the clearance between the gear and the inner wall of the oil pump body.
   - Measure the clearance between the gear and oil pump body using a thickness gauge.
   - If the clearance between the gear and inner wall of the body exceeds the limit, replace the gear assembly or the driven gear assembly.

Clearance between the gear and inner wall of the body	mm (in)
Standard	0.125 – 0.220 (0.0049 – 0.0087)
Limit	0.30 (0.0118)



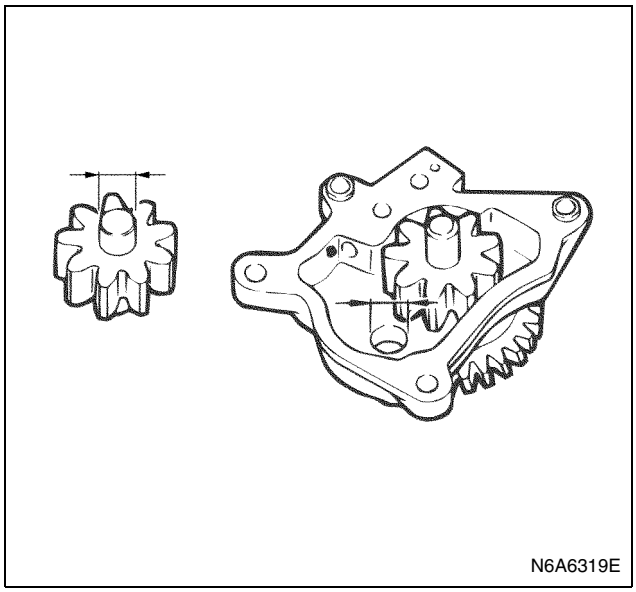
2. Measure the clearance between the gear side surface and the upper surface of the oil pump body.
   - Measure the clearance between the gear surface and the upper surface of the oil pump body using the thickness gauge and square.
   - If the clearance between the gear and inner wall of the body exceeds the limit, replace the gear assembly or the driven gear assembly.

Clearance between the gear side surface and the upper surface of the oil pump body	mm (in)
Standard	0.064 – 0.109 (0.0025 – 0.0043)
Limit	0.20 (0.0079)



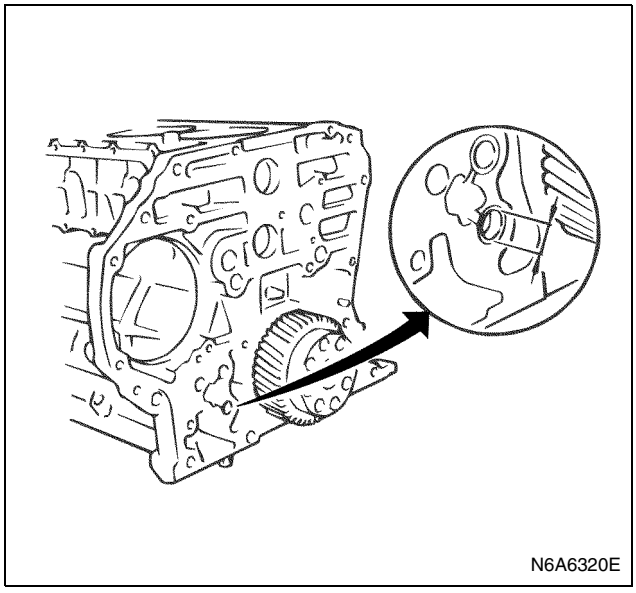
3. Measure the clearance between the driven gear shaft and the bush.
   - Measure the outside diameter of the driven gear shaft using a micrometer.

Outside diameter of the driven gear shaft mm (in)	
Standard	15.989 – 16.000 (0.62949 – 0.62992)
Limit	15.900 (0.62598)



- Measure the inside diameter of the bushes of the oil pump body and cylinder block using the dial gauge.
- If the clearance between the driven gear shaft and bush exceeds the limit, replace the driven gear assembly.

Clearance between the driven gear shaft and bush mm (in)	
Standard	0.04 – 0.07 (0.0016 – 0.0028)
Limit	0.20 (0.0079)

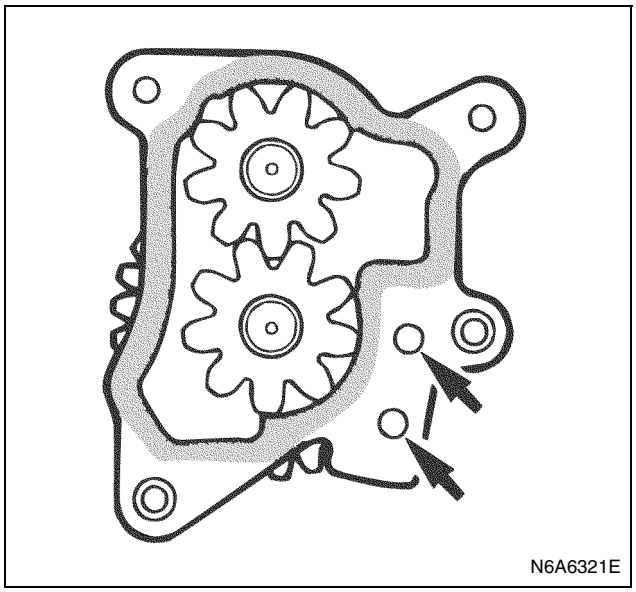


Installation

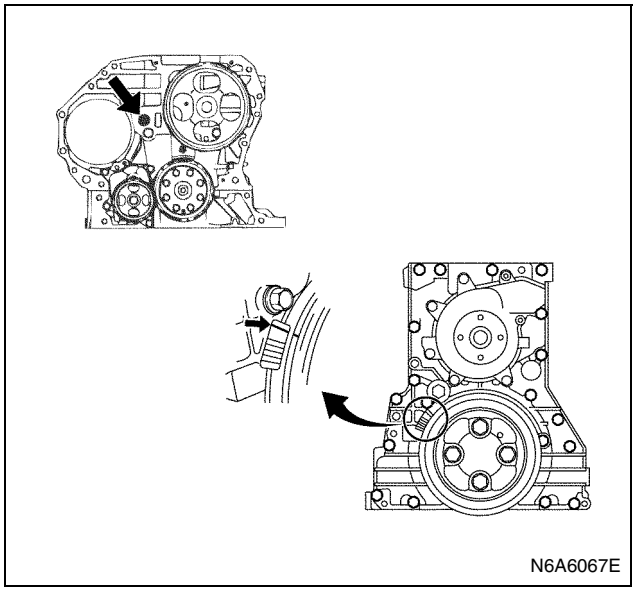
1. Install the oil pump assembly.
   - Apply the liquid gasket (ThreeBond 1141E or equivalent) as shown in the figure, mount it on the cylinder block within one hour, and tighten it using the specified torque.

Tighten:
Oil pump assembly to 24 N·m (2.4 kg·m/17 lb·ft)

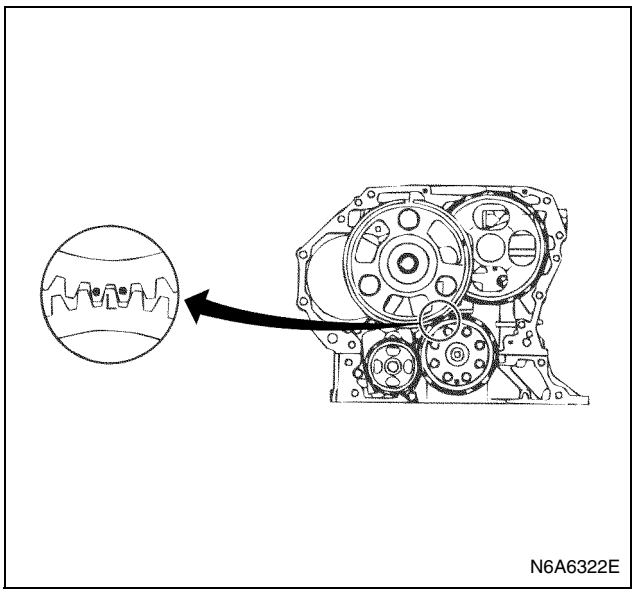
Caution:
Apply the fluid gasket such that it does not enter the holes shown by arrows in the figure, gear, and the oil pump body.



2. Install the idling gear A.
   - Install the idling gear shaft at the position shown in the figure and apply engine oil on the shaft.
   - Rotate the crankshaft clockwise and bring the piston of the No.1 cylinder to the top dead center.



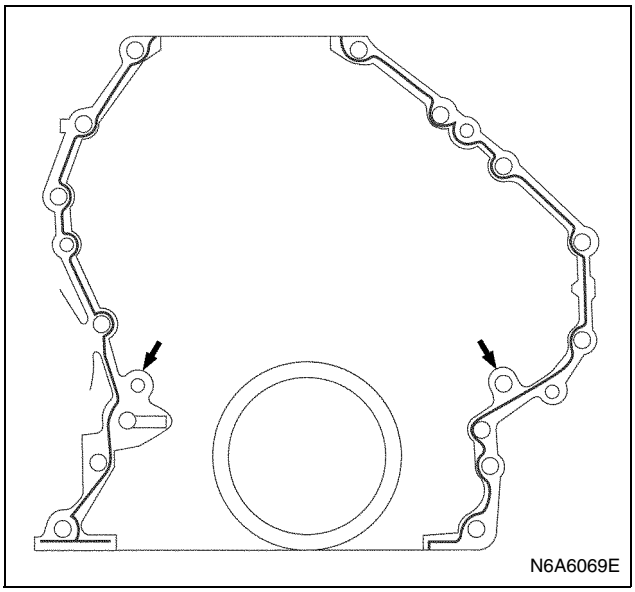
- Match the coincidence marks of the crankshaft gear and the idle gear A, and install them on the cylinder block.


N6A6322E

- Tighten the mounting bolts using the specified torque.

Tighten:
Bolts to 133 N·m (13.6 kg·m/98 lb·ft)

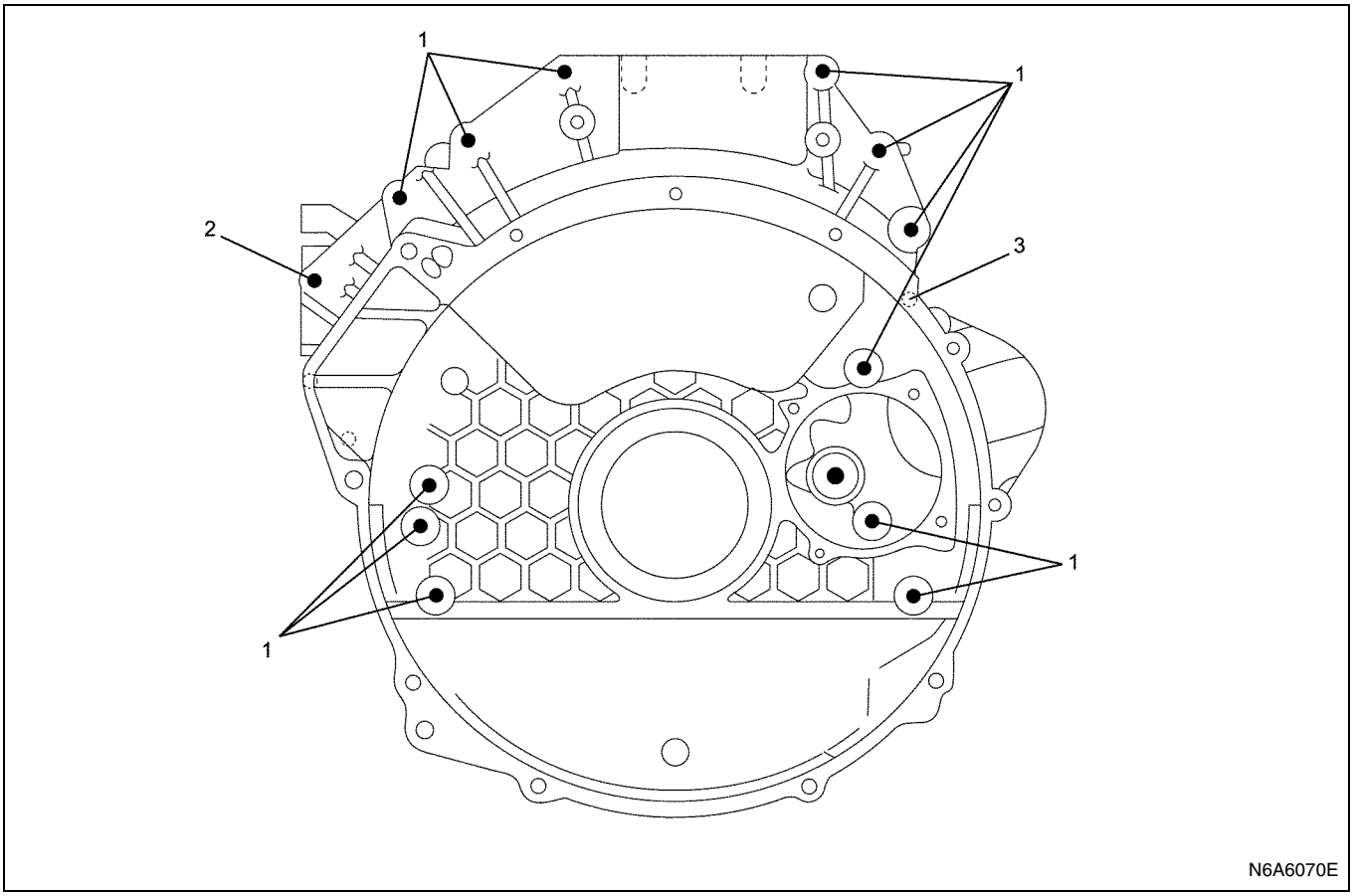
3. Install the flywheel housing.
   - Clean properly the rear surface of the cylinder block. Remove the protruding fluid gasket thoroughly, especially, when mounting the crankcase.
   - Apply the liquid gasket (ThreeBond1207C) uniformly on the inside surface of the bolt holes (excluding the bolt holes indicated by arrows) as shown in the figure.
   - After applying the liquid gasket, quickly install it.


N6A6069E

- Match the dowel pin of the cylinder block and then install the flywheel housing.

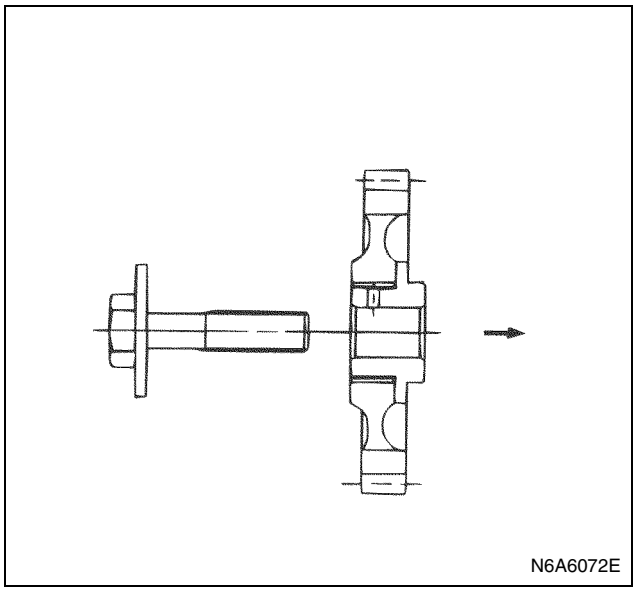
Tighten:
Bolts (1) to 96 N·m (9.8 kg·m/71 lb·ft)
Bolts (2) to 77 N·m (7.9 kg·m/57 lb·ft)
Bolts (3) to 38 N·m (3.9 kg·m/28 lb·ft)

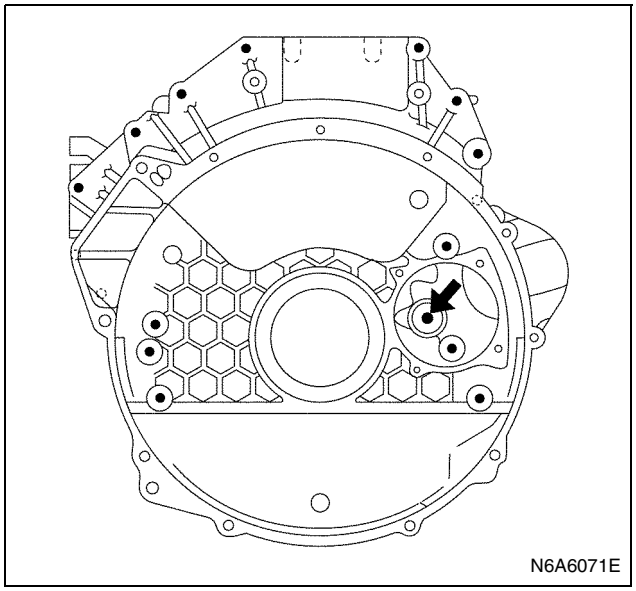
- The seal is tightened from the cylinder block side.



4. Install the power steering pump idling gear.
   - Apply the engine oil on the gear assembly unit of the idling gear shaft.
   - Assemble the idling gear and the shaft in the direction shown in the figure, mount it on the flywheel housing, and tighten it using the specified torque.

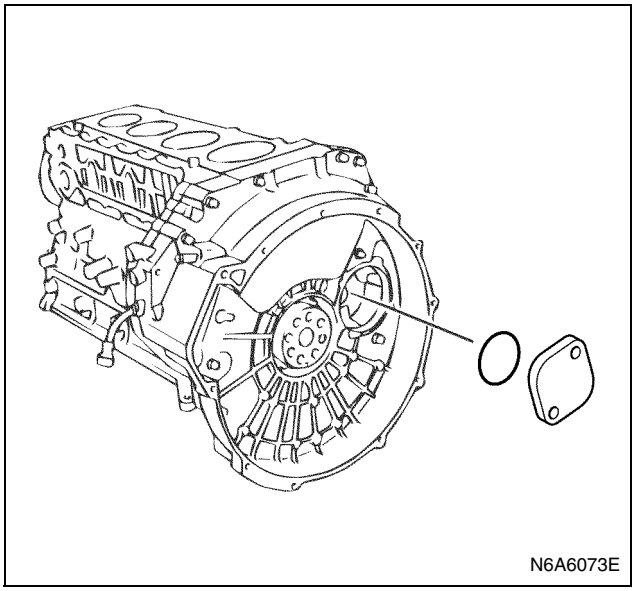
Tighten:
Bolt to 133 N·m (13.6 kg·m/98 lb·ft)





5. Install the idling gear cover of the power steering pump.
   - Install the O-ring on the cover and on the flywheel housing, and tighten the fixing bolts using the specified torque.

Tighten:
Bolt to 19 N·m (1.9 kg·m/14 lb·ft)


N6A6073E

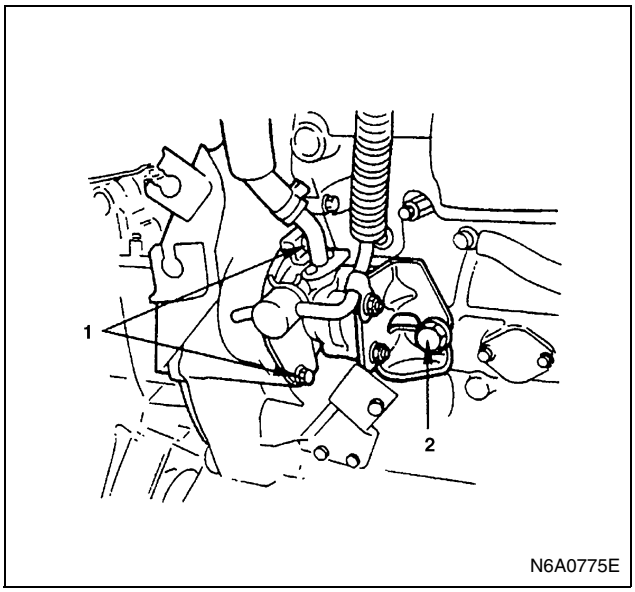
6. Install the power steering pump and tighten it using the specified torque.

Tighten:

Flywheel housing fixing bolt (1) to 43 N·m (4.4 kg·m/32 lb·ft)

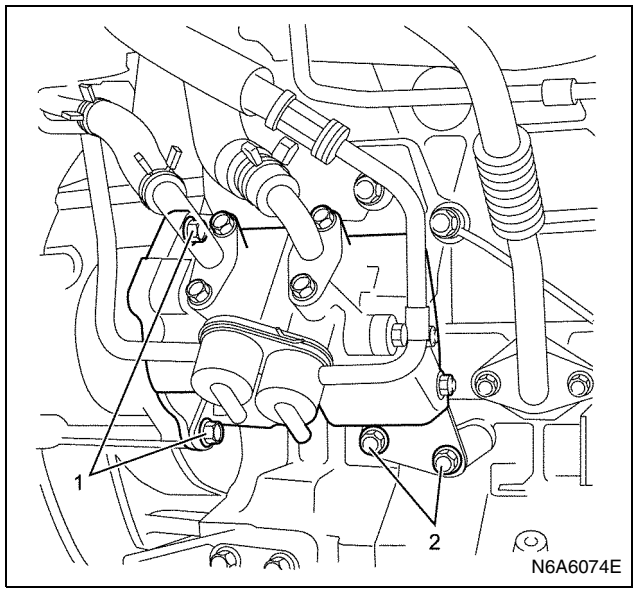
Cylinder block fixing bolts (2) to 44 N·m (4.5 kg·m/33 lb·ft)

Without HBB



N6A0775E

With HBB



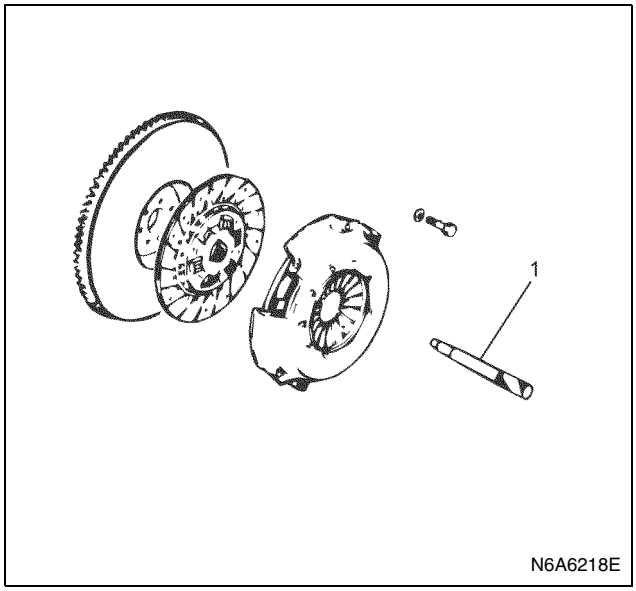
N6A6074E

Legend

1. Flywheel Housing Bolt
2. Cylinder Block Bolt

7. Install the oil pan.
   Refer to “Oil Pan”.
8. Install the rear seal of the crankshaft.
   Refer to “Crankshaft Rear Oil Seal”.
9. Install the flywheel.
   Refer to “Flywheel”.
10. Install the fuel supply pump assembly.
    Refer to “Fuel Supply Pump” in Section 6C.
11. Install the clutch plate assembly.
12. Install the clutch pressure plate assembly.
    - Insert the clutch aligner in the spline of the clutch plate assembly.
    - Install the clutch plate assembly on the flywheel.

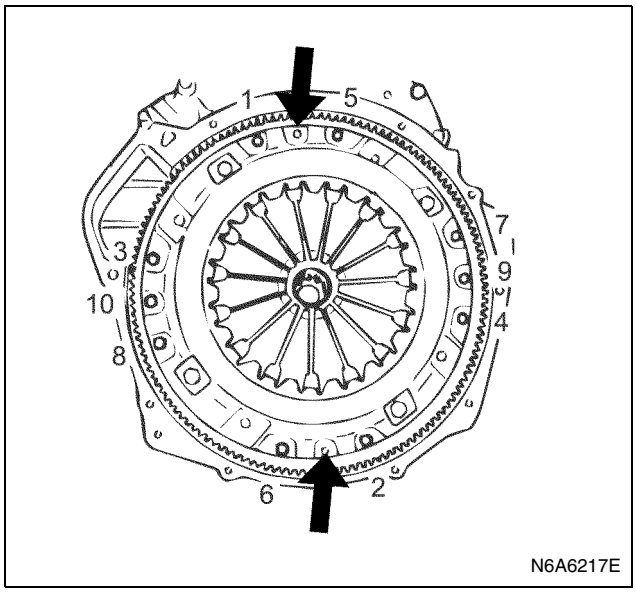
- Match the mounting hole of the clutch pressure plate assembly with the dowel pin of the flywheel, and install the clutch pressure plate assembly on the flywheel.



Legend
1. Clutch Aligner

- Tighten the clutch pressure plate assembly in the sequence shown in the figure using the specified torque.

Tighten:
Bolts to 40 N·m (4.1 kg·m/30 lb·ft)

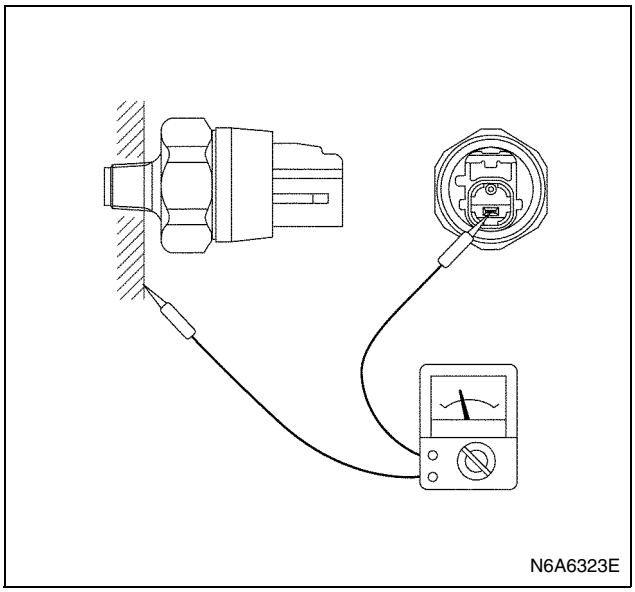


13. Install the cylinder head assembly.
    Refer to “Cylinder Head”.
14. Install the camshaft assembly.
    Refer to “Camshaft Assembly”.
15. Install the rocker arm shaft assembly.
    Refer to “Rocker Arm Shaft Assembly”.
16. Tighten the cylinder head cover.
    Refer to “Cylinder Head Cover”.

Oil Pressure Switch

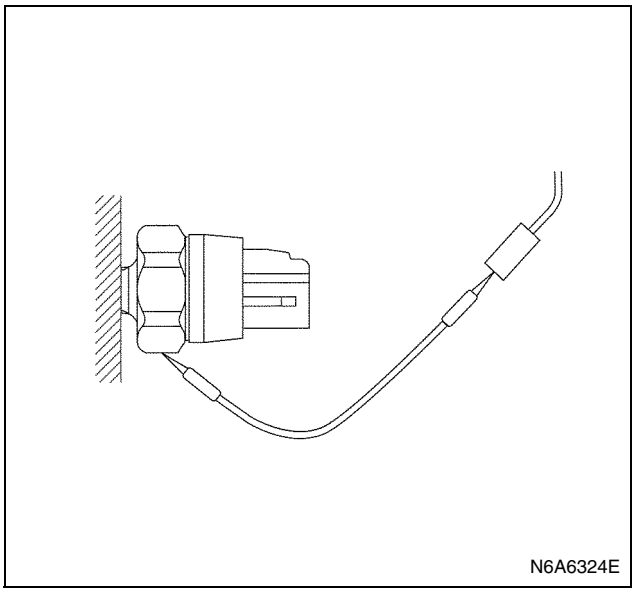
Inspection

Check the continuity between the switch terminal and the body grounding in the no-load condition.
If there is no connectivity, replace with normal parts. (Refer to “Oil Filter Assembly”)



Circuit check

1. Turn the starter switch to ON.
2. Disconnect the oil pressure switch connector, and confirm that the oil pressure-warning lamp lights when the connector on the harness side is grounded.
   If the warning lamp does not light up, check the circuit between the meter and the oil pressure switch, and repair the disconnected locations.



Air Cleaner Element

Removal

1. Remove the air cleaner cover fixing bolt.
2. Remove the air cleaner element assembly.

Inspection

- Check for damage to the element or clogging due to dirt. If the element is damaged, then replace it. If clogged, then clean it.
- The viscous-type (wet type) element cannot be cleaned; therefore, it has to be replaced if it is very dirty.

Replacement period	Every 40,000 km (24,000 miles) or every two years

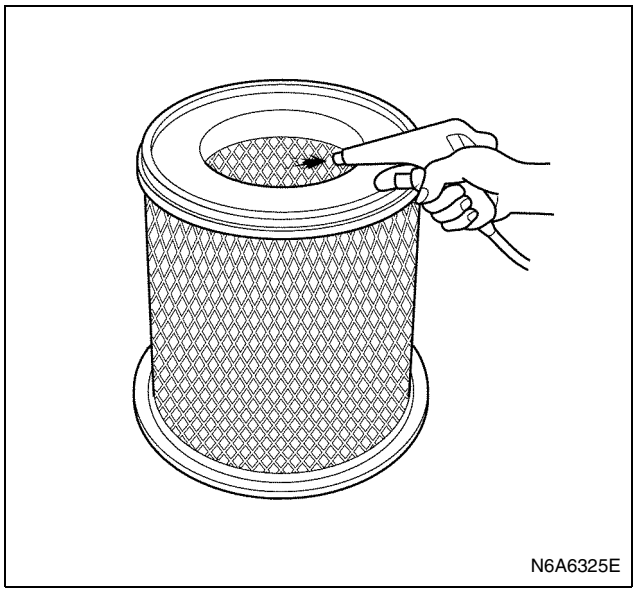
Installation

1. Install the air cleaner element assembly.
2. Tighten the air cleaner cover fixing bolt.

Cleaning

Dry type element

- While rotating the element, blow air under 690 kPa (7.0 kg/cm^2 / 100 psi) and remove the dust.



- Dissolve the filter cleaner ND1500 in water and soak the element for approximately 30 minutes. Then wash it properly with water and allow it to dry in natural conditions (two to three days.)

ENGINE

Cooling System

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Cooling System

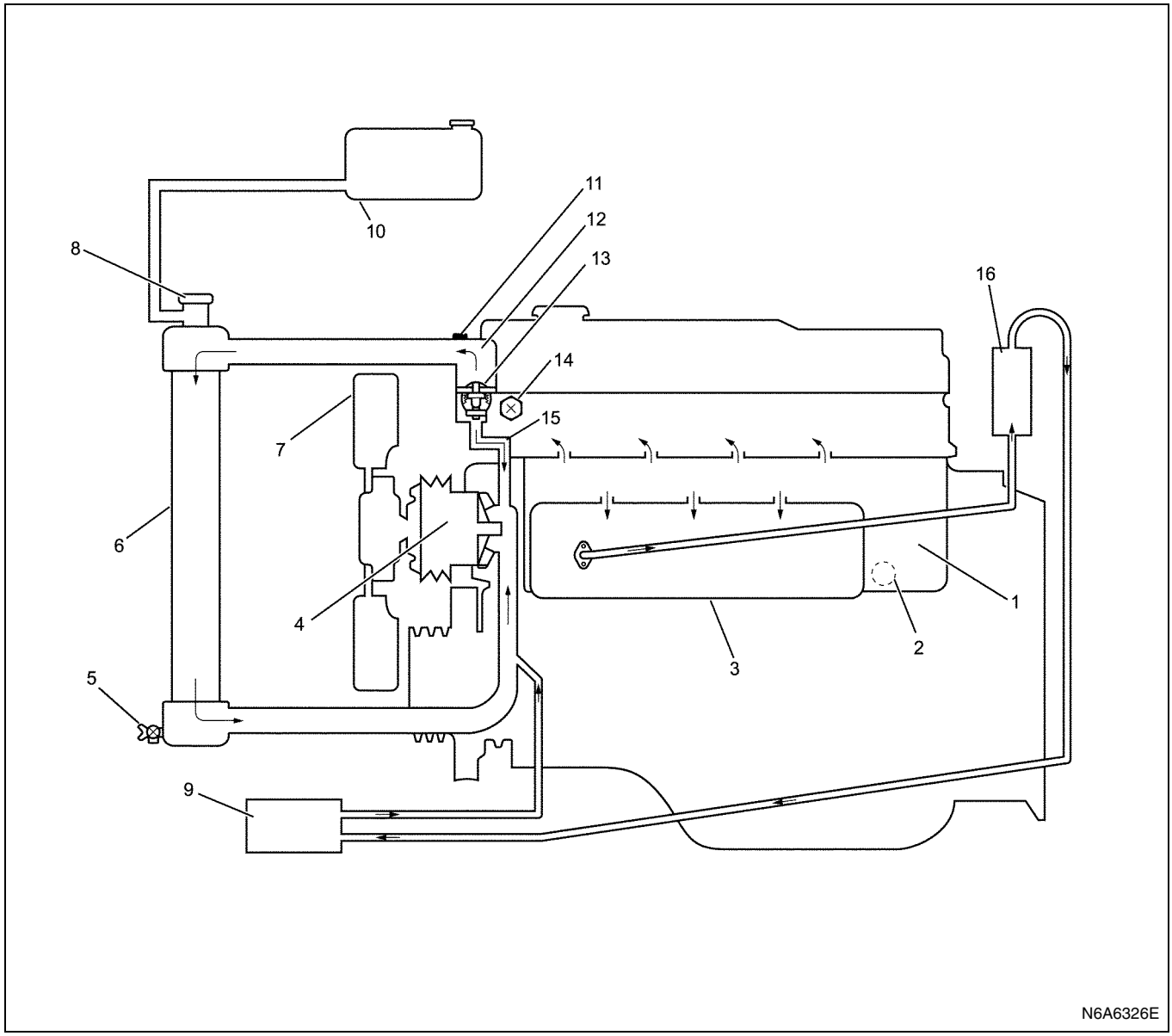
Service Precautions

WARNING:
Do not remove the radiator cap when the cooling water is at high temperature. Steam or boiling water will gush out and you may be burnt. To open the radiator cap, cover the cap with a thick cloth when the cooling water is cool, release the pressure by slowly turning the cap, and then remove the cap.

Explanations on Functions and Operation

Cooling Water System

The cooling water system, which is the forced circulation system, consists of a water pump, thermostat, and radiator as its main components.

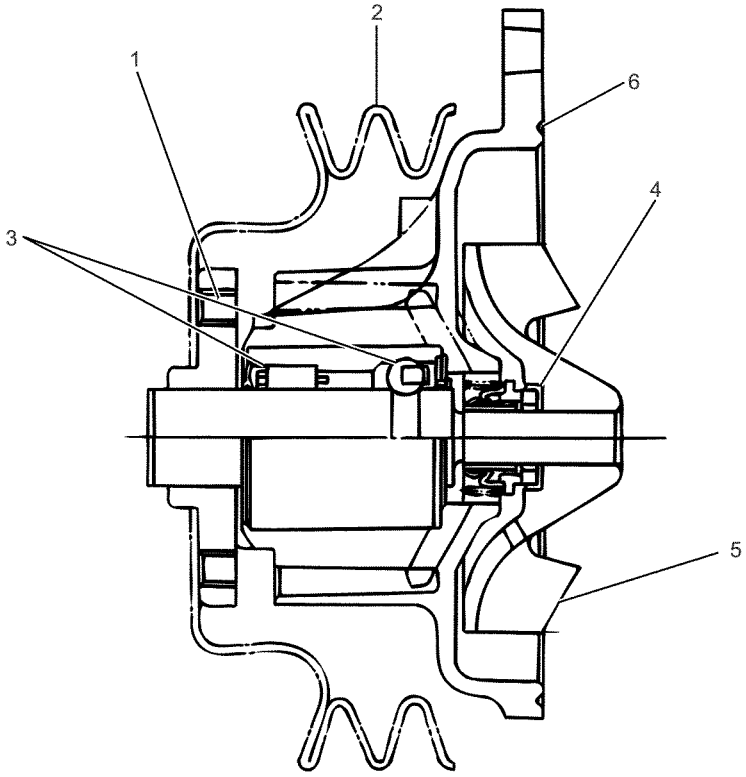


Legend

1. Water Jacket
2. Drain Plug
3. Oil Cooler
4. Water Pump
5. Drain Cock
6. Radiator
7. Cooling Fan
8. Radiator Cap
9. Heater Core
10. Reserve Tank
11. Air Bleeding Plug
12. Water Outlet Pipe
13. Thermostat (2 nos.)
14. Thermometer Unit
15. Bypass Route
16. EGR Cooler

Water Pump

The water pump, which uses the centrifugal impeller system, is driven by the engine fan belt.



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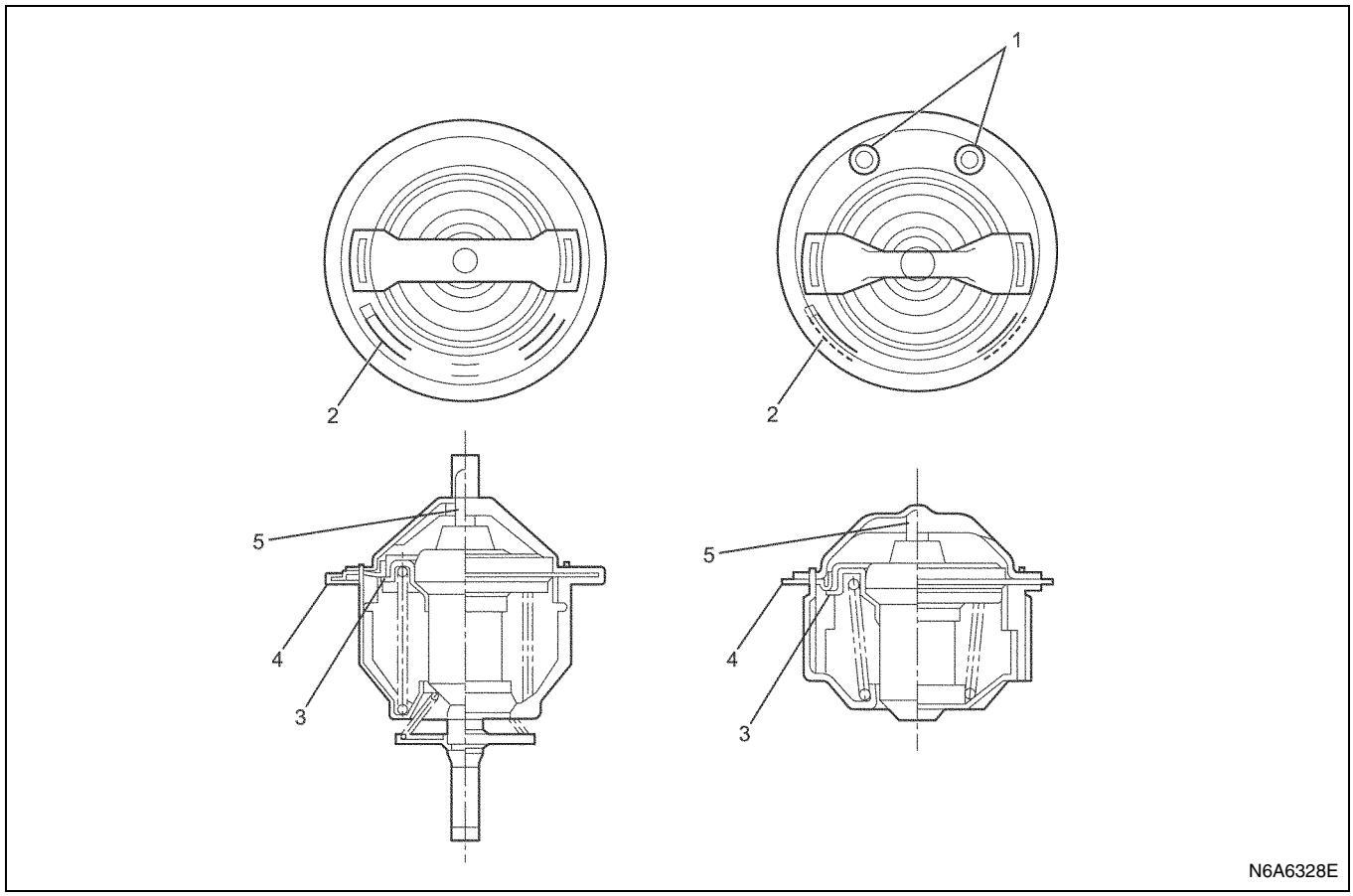
Legend

1. Fan Center
2. Fan Pulley
3. Bearing
4. Seal Unit
5. Impeller
6. Groove

Thermostat

The thermostat is a wax pellet type and consists of two units, in which one unit (bottom bypass type) has an valve initial opening temperature of 82 °C (180 °F) and the second (inline type) has an valve initial opening temperature of 85 °C (185 °F). It is designed such that the water temperature can be adjusted finely and it is mounted within the thermostat-housing unit.

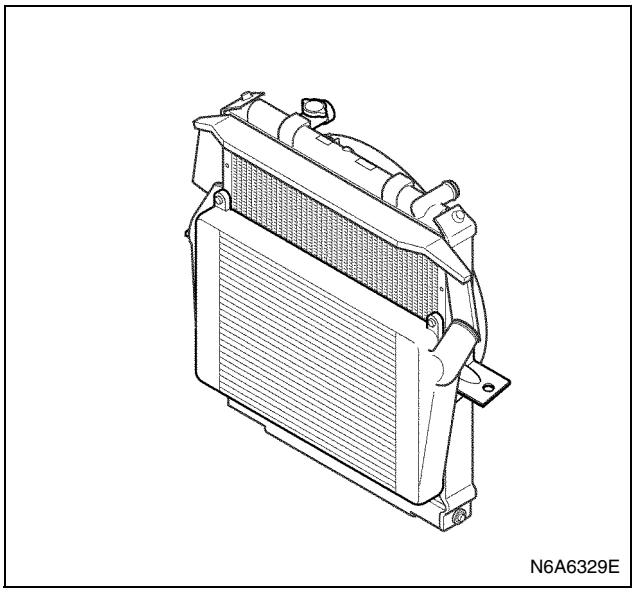


Legend

1. Jiggle Valve
2. Stamp Mark (Valve Initial Opening Temperature)
3. Valve
4. Gasket
5. Piston

Radiator

The radiator is a tube with corrugated fins. To increase the boiling point of the cooling water, a radiator cap of injection valve opening pressure of 108 ± 14.7 kPa (1.1 ± 0.15 kg/cm^2 / 15.7 ± 2.1 psi) is attached.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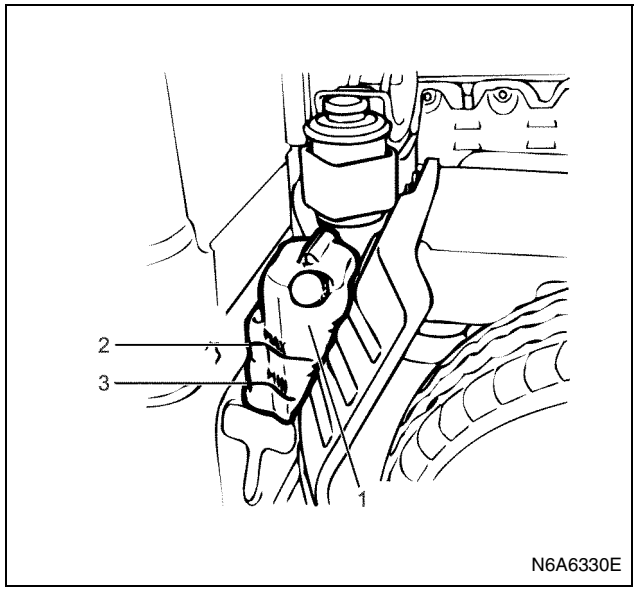
Functional Check

1. Cooling water level check
   - Check the cooling water level within the reserve tank and the level is appropriate when the cooling water level is within the MAX (upper limit) and MIN (lower limit) range. In case the volume of the cooling water is deficient, remove the reserve tank cap and replenish with a mixture of tap water and engine coolant in the ratio of 1:1 until the level comes close to the MAX line.

Standard value	
Cooling water level	17.6 liters (4.65 US gal. / 3.87 Imp gal.) (between MIN and MAX level)
Replacement period	Every two years or 40,000 kilometers (24,000 miles)



N6A6330E

Legend

1. Reserve Tank
2. MAX Line (Upper Limit)
3. MIN Line (Lower Limit)

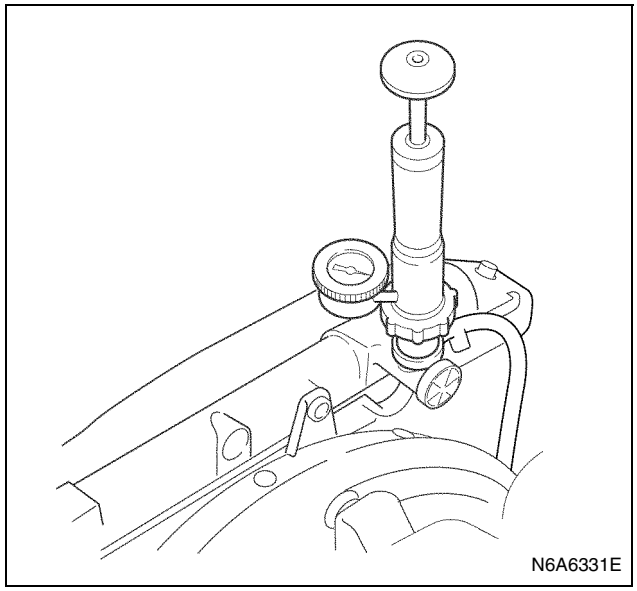
Inspection

Cooling water leak check

- Use the radiator cap tester and apply a pressure of 196 kPa (2.0 kg/cm^2 / 28.4 psi) and check for leaks in the locations given below. Check that the radiator hose and heater hose are not damaged or degraded and the hose clamp is not loose.

Inspection locations

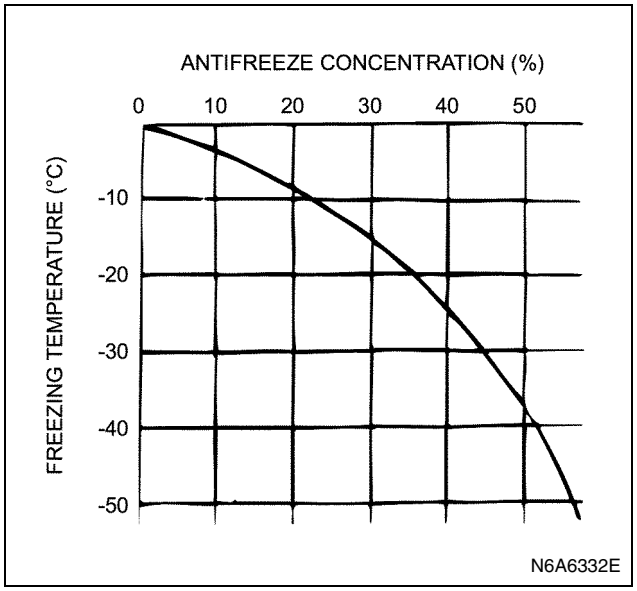
- Radiator assembly, water pump assembly, radiator hose, and heater hose.


N6A6331E

Coolant

1. About the engine coolant concentration

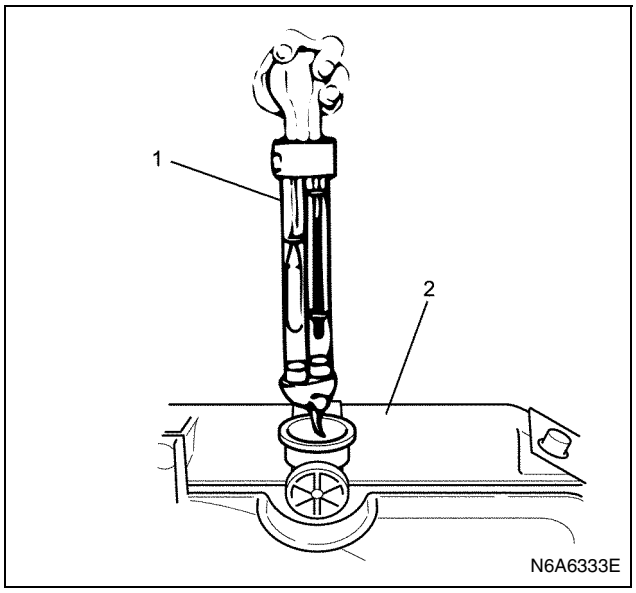
- Take the concentration corresponding to the minimum temperature because the freezing temperature varies according to the concentration of the engine coolant.
- Use only genuine Isuzu engine coolant.
- Use engine coolant with a mix ratio in the range of 30 to 60% because over heating is likely to occur if the ratio is greater than 60% and corrosion prevention is inadequate if the ratio is less than 30%.



Freezing temperature guideline	Mix ratio Liter (qts)		Concentration of engine coolant
	Engine coolant	Tap water	
-18°C (-0.4°F)	4.2 (4.4)	7.8 (8.2)	35%
-25°C (-13°F)	5.0 (5.3)	7.0 (7.4)	42%
-35°C (-31°F)	6.0 (6.3)	6.0 (6.3)	50%
-40°C (-40°F)	6.4 (6.8)	5.6 (5.9)	53%

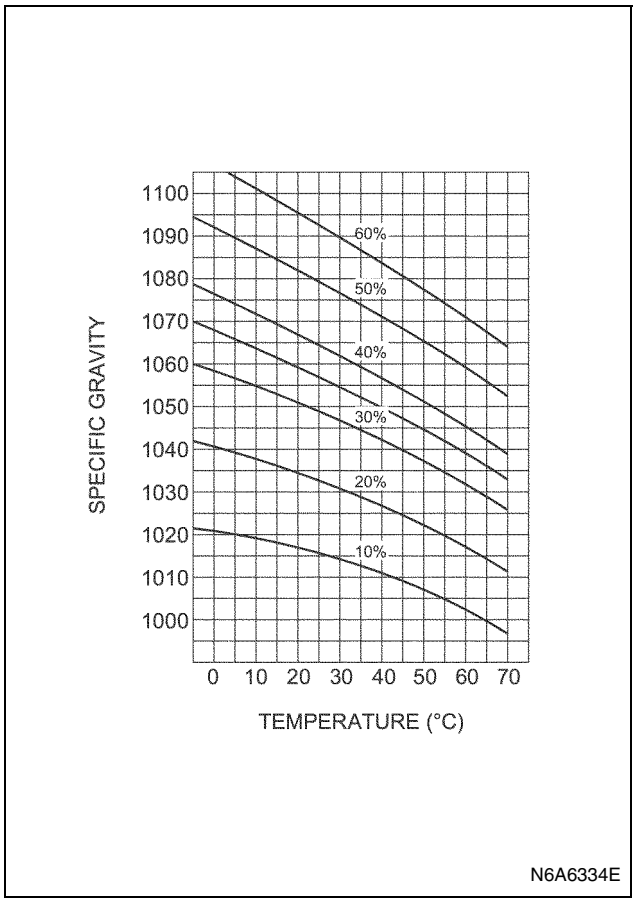
2. Engine coolant density measurement
   Methods for measuring specific gravity
   - Measure the specific gravity and the temperature of the cooling water using an anti-freeze specific gravity meter and thermometer.

     Take precautionary measures as the boiled cooling water may gush out at high temperatures if the cap is removed.
   - Use a deep container to suit the height of the specific gravity meter.



Legend
1. Radiator
2. Anti-Freeze Specific Gravity Meter

- Fix the temperature of the cooling water being measured in the range of 0 to 50 °C (32 to 122 °F).
- Measure the temperature and specific gravity and determine the concentration from the table given below.



Coolant scooping method

- Measure the concentration using the coolant scoop.

A List of Defective Phenomena

- Engine overheats
- Engine overcools

Engine overheats

Condition	Possible Cause	Correction
Engine overheats	Cooling water volume is deficit.	Replenish.
	Thermometer unit is defective.	Replace.
	Thermostat is defective.	Replace.
	Water pump is defective.	Replace.
	Radiator is clogging.	Clean or replace.
	Radiator cap is defective.	Replace.
	Engine oil volume is deficient or incorrect engine oil is used.	Replenish or change the engine oil.
	Cylinder head gasket is defective.	Replace.
	The fan belt is loose.	Adjust.
	Exhaust system is clogging.	Clean or replace.
	The fuel injection quantity is in surplus.	Diagnose the engine control system.
	Fuel injection timing is incorrect.	Diagnose the engine control system.
	Starting pressure of fuel injection is low.	Diagnose the engine control system.

Engine overcools

Condition	Possible Cause	Correction
Engine overcools	Thermostat is defective.	Replace.

Main Data and Specifications

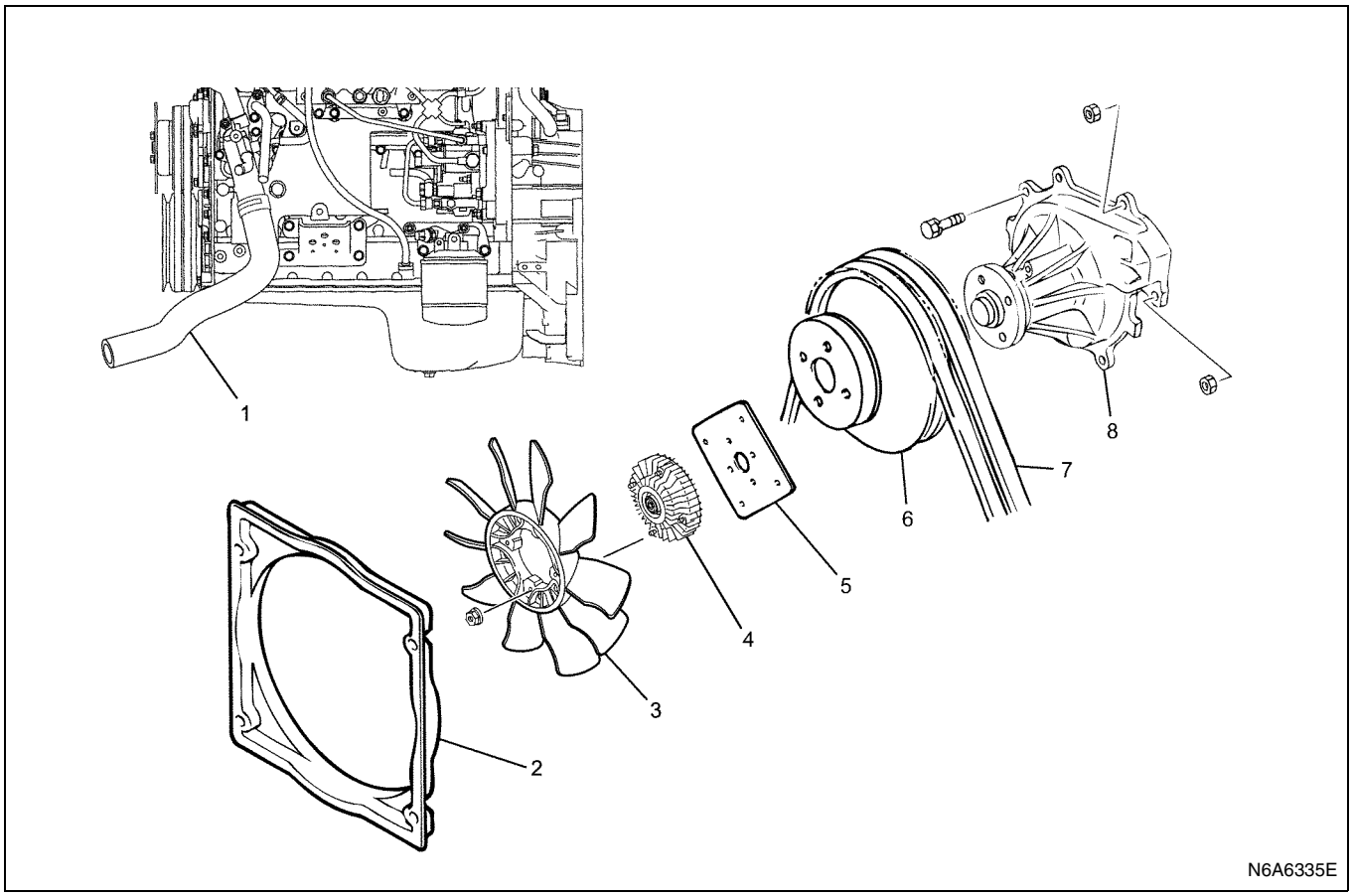
Main Data and Specifications

Cooling methods		Forced circulation system
Radiator		Tubes with corrugated fins
Radiation capacity	kW (kcal/h)	120 (103200)
Radiation area	m^2 (ft^2)	17.78 (191.3)
Frontal area	m^2 (ft^2)	0.367 (4.05)
Dry mass	N (lb)	196 (44.1)
Radiator cap		
Valve opening pressure	kPa (kg/cm^2 / psi)	108 ± 14.7 (1.1 ± 0.15 / 15.7 ± 2.1)
Cooling water capacity	Liters (US / Imp gal.)	3.2 (0.85 / 0.70)
Water pump		Centrifugal impeller system
Pulley ratio		1.190

Thermostat		Wax pellet system
Valve opening temperature	°C (°F)	With jiggle valve 85 (185) Without jiggle valve 82 (180)
Temperature when fully open	°C (°F)	With jiggle valve 100 (212) Without jiggle valve 95 (203)
Cooling water total capacity	Liters (US / Imp gal.)	17.6 (4.65 / 3.87)

Water Pump

Components

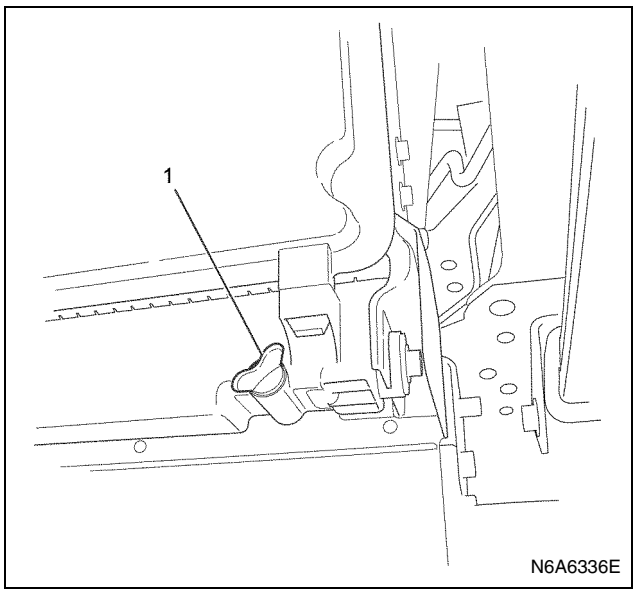


Legend

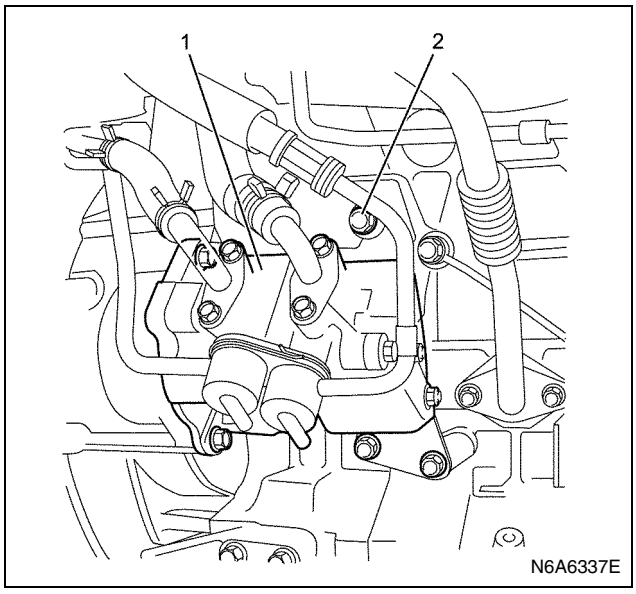
1. Radiator Lower Hose
2. Fan Guide
3. Fan
4. Cooling Fan Clutch
5. Setting Plate
6. Water Pump Pulley
7. Fan Belt
8. Water Pump Assembly

Removal

1. Drain the coolant water.

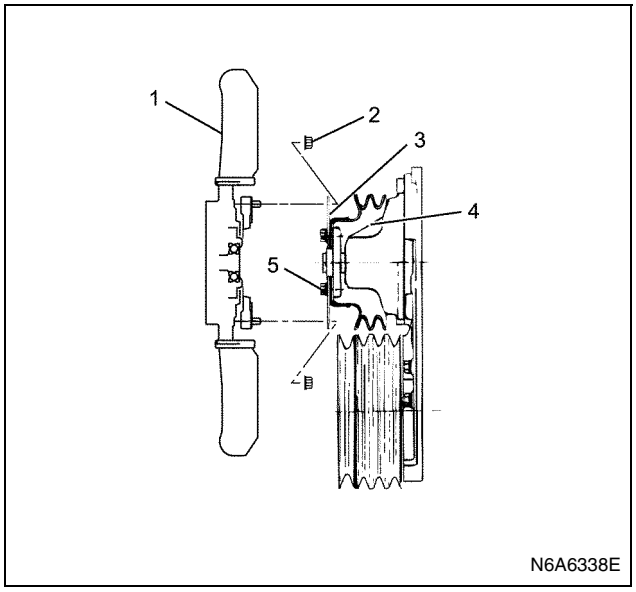


Legend
1. Radiator Drain Cock



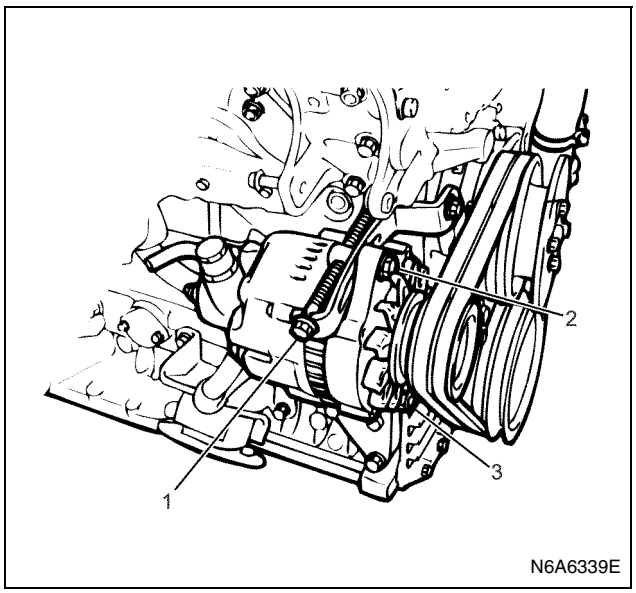
Legend
1. Power Steering Pump
2. Drain Plug

2. Remove the radiator lower hose on the radiator side.
3. Take out the fan guide from below.
4. Remove the four mounting nuts and then the fan assembly. Also, loosen the four bolts for tightening the setting plate and water pump pulley together.



Legend
1. Fan
2. Nut
3. Setting Plate
4. Water Pump Pulley
5. Bolt

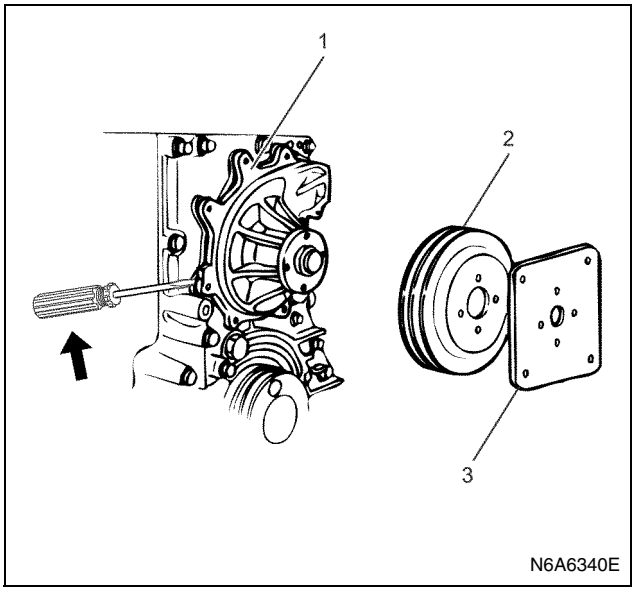
5. (2) and (3) that tighten the setting plate and water pump together. Loosen the adjusting bolts (1) in the generator and remove the fan belt.



Legend
1. Adjusting Bolt (With A/C)
2. Lock Nut
3. Bolt

6. Remove the setting plate and water pump pulley.

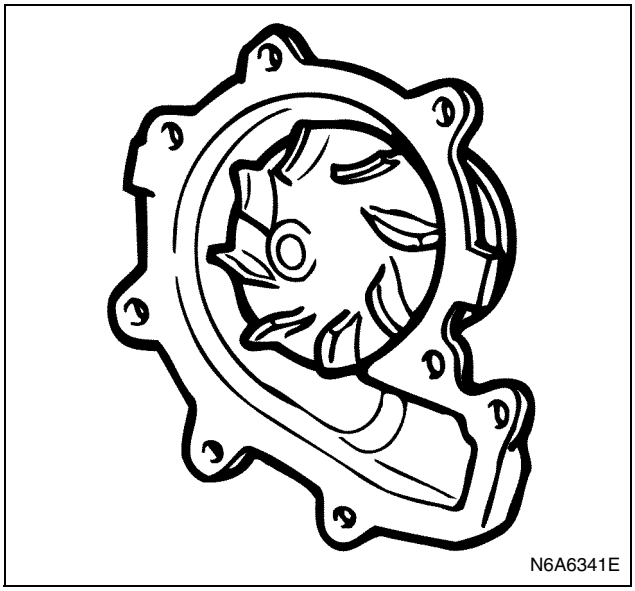
7. Remove the water pump assembly while inserting and scraping with the driver at the position shown in the figure.



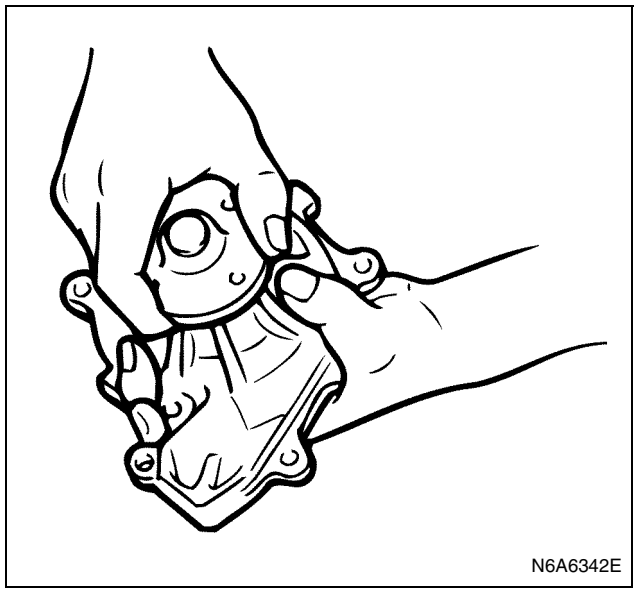
Legend
1. Water Pump
2. Water Pump Pulley
3. Setting Plate

Inspection

1. External check
   - Check for cracks or damage in the pump body.
   - Check for cracks and corrosion in the impeller.
   - Check for water leakage from the seal unit.
   - If you find abnormalities, replace with the water pump assembly.



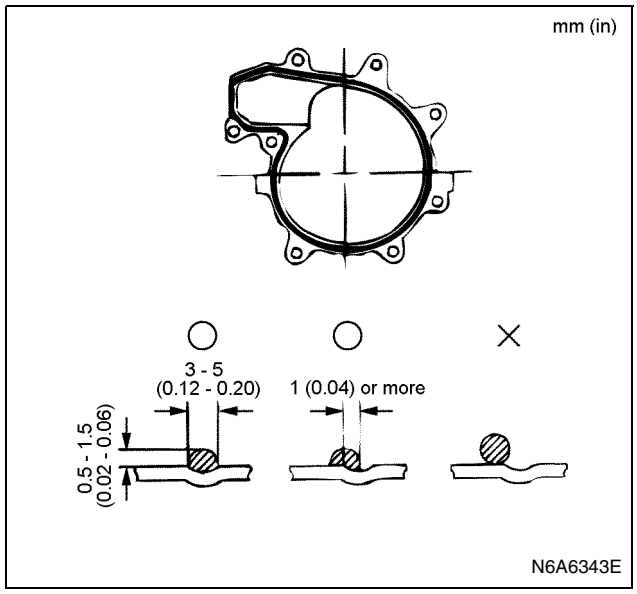
2. Bearing nut check
   - Rotate the fan center while pushing it along the radial direction. Confirm that there is no abnormal noise and no excessive play.
   - If you find abnormalities, replace with the water pump assembly.



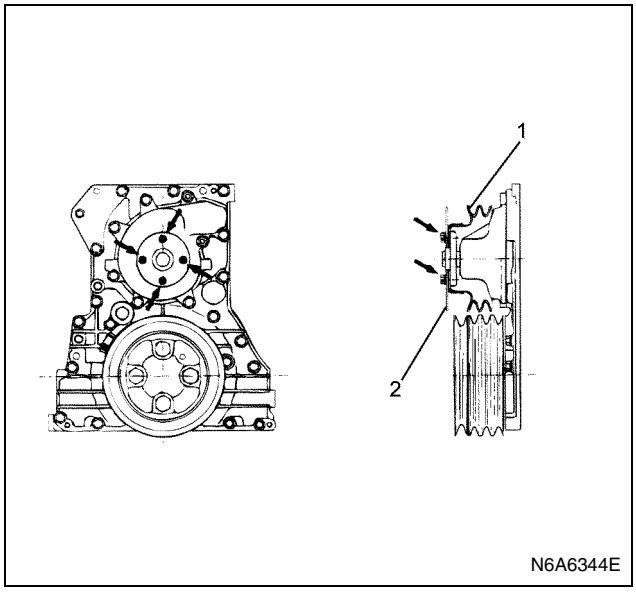
Installation

1. Mount the water pump assembly.
   - Coat the fluid gasket (ThreeBond 1207C or equivalent) to a bead diameter 3 to 5 mm (0.12 to 0.20 in) in the groove of the mounting surface of the water pump.
   - Mount the water pump to match with the studs of the front cover within 7 minutes after coating the fluid gasket.
   - Refer to the figure for the offset in position of the fluid gasket.

Tighten:
Bolts and nuts to 24 N·m (2.4 kg·m/17 lb·ft)



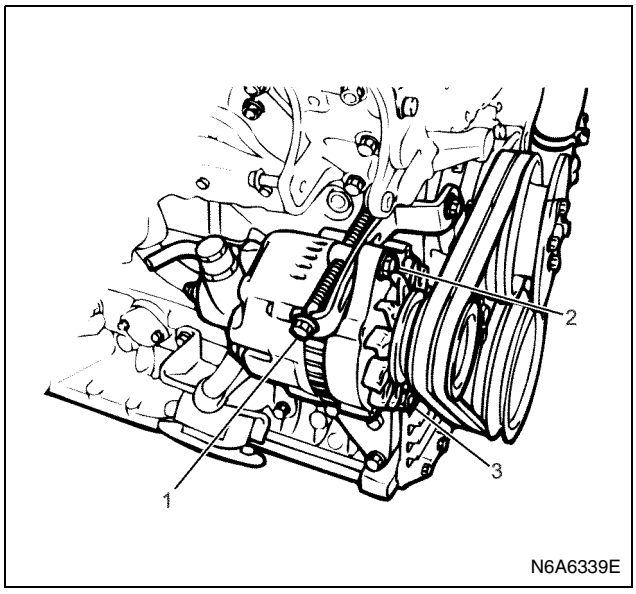
2. Temporarily fit the bolts until the water pump pulley and the setting plate are properly seated in the water pump assembly.



Legend
1. Fan Pulley
2. Setting Plate

3. Mount the fan belt, tighten the adjusting bolts of the generator, and adjust the tension.
   - Refer to “Drive Belt” in Section 6B.
4. After fan belt adjustments, tighten the generator using the specified torque.

Tighten:
Nut and bolt to 2 members: 24 N·m (2.4 kg·m / 17 lb·ft)
Nut and bolt to 3 members: 40 N·m (4.1 kg·m / 30 lb·ft)



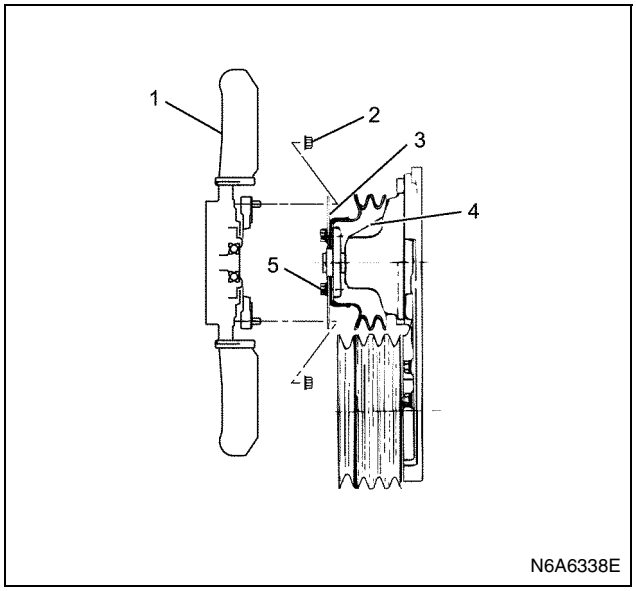
Legend
1. Adjusting Bolt (With A/C)
2. Lock Nut
3. Bolt

5. After the fan belt adjustments, tighten the temporarily fitted fan pulley and setting plate using the specified torque.

Tighten:
Bolt to 24 N·m (2.4 kg·m / 17 lb·ft)

6. Tighten the fan assembly using the specified torque for mounting.

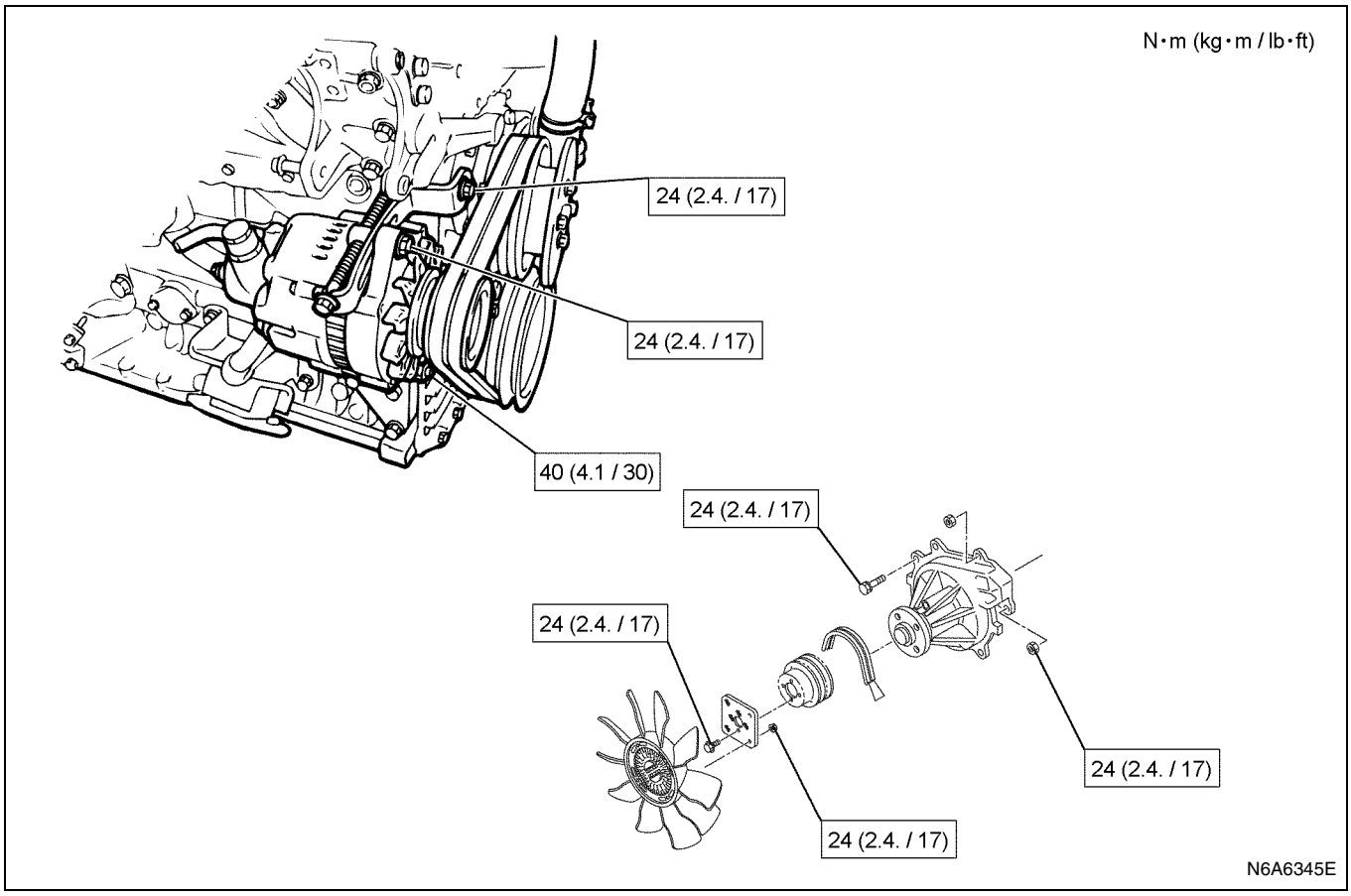
Tighten:
Nut to 24 N·m (2.4 kg·m / 17 lb·ft)



Legend
1. Fan Assembly
2. Nut
3. Setting Plate
4. Fan Pulley
5. Bolt

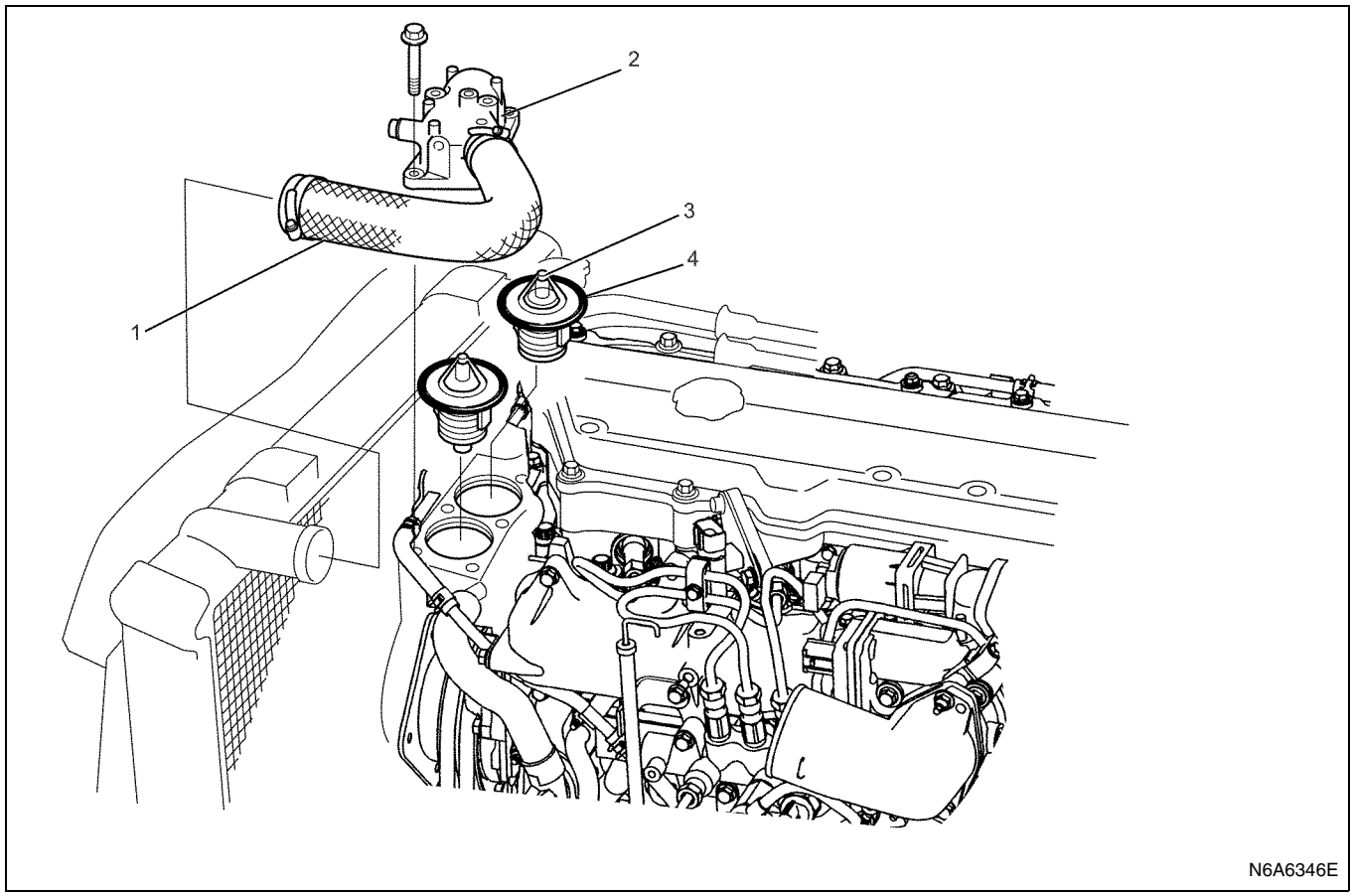
7. Mount the fan guide.
8. Mount the radiator lower hose.
9. Fill the cooling water.

Torque Specifications



Thermostat

Components



Legend

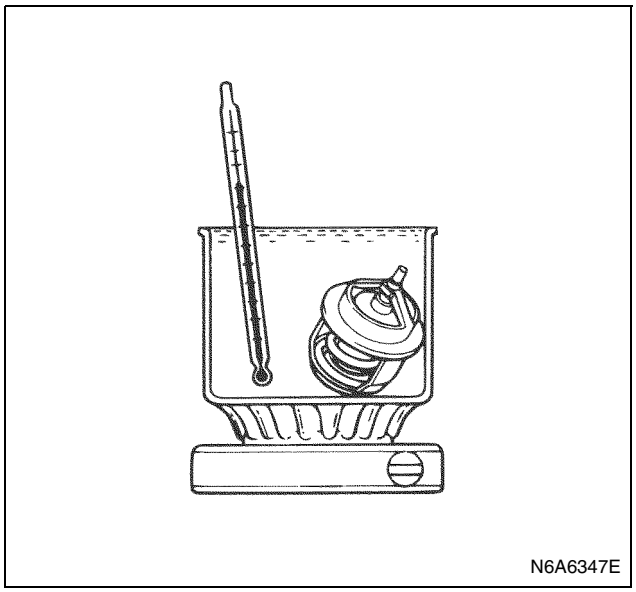
1. Radiator Upper Hose
2. Water Outlet Pipe
3. Thermostat
4. Gasket

Removal

1. Drain the cooling water. Prepare the container for discharging and use it for replenishment when mounting the thermostat. Set the discharge of cooling water such that the water does not flow out of the thermostat housing.
2. Remove the radiator upper hose from the radiator side.
3. Remove the water outlet pipe.
4. Remove the thermostat.
5. Remove the gasket from the thermostat.

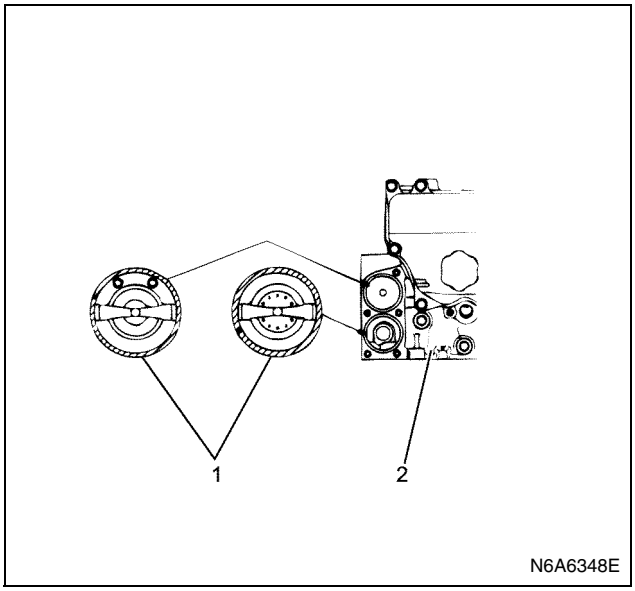
Inspection

- Place the thermostat in water and increase the temperature while stirring it sufficiently.
- Measure the temperature when the valve is just opened and when it is fully open.



Installation

1. Mount the gasket on the thermostat and mount it at the position shown in the figure.
   - Mount the thermostat at the position shown in the figure, as there are two types of thermostats with different shapes.
   - Fit the thermostat gasket ensuring that it does not come out of and on top of the external housing on the cylinder head side.

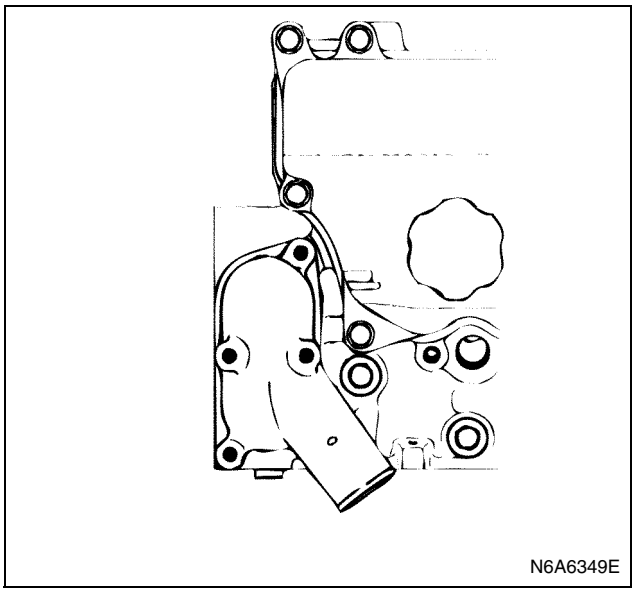


Legend
1. Thermostat
2. Cylinder Head

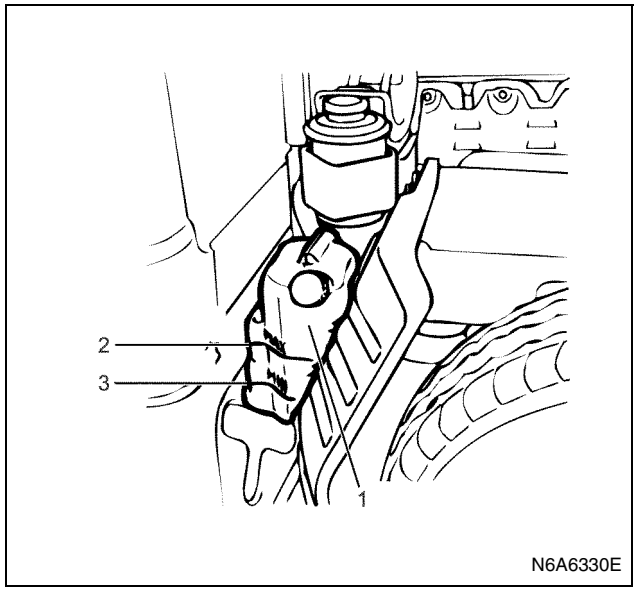
2. Mount the water outlet pipe.

Tighten:
Bolt to 24 N·m (2.4 kg·m / 17 lb·ft)

3. Mount the radiator upper hose.

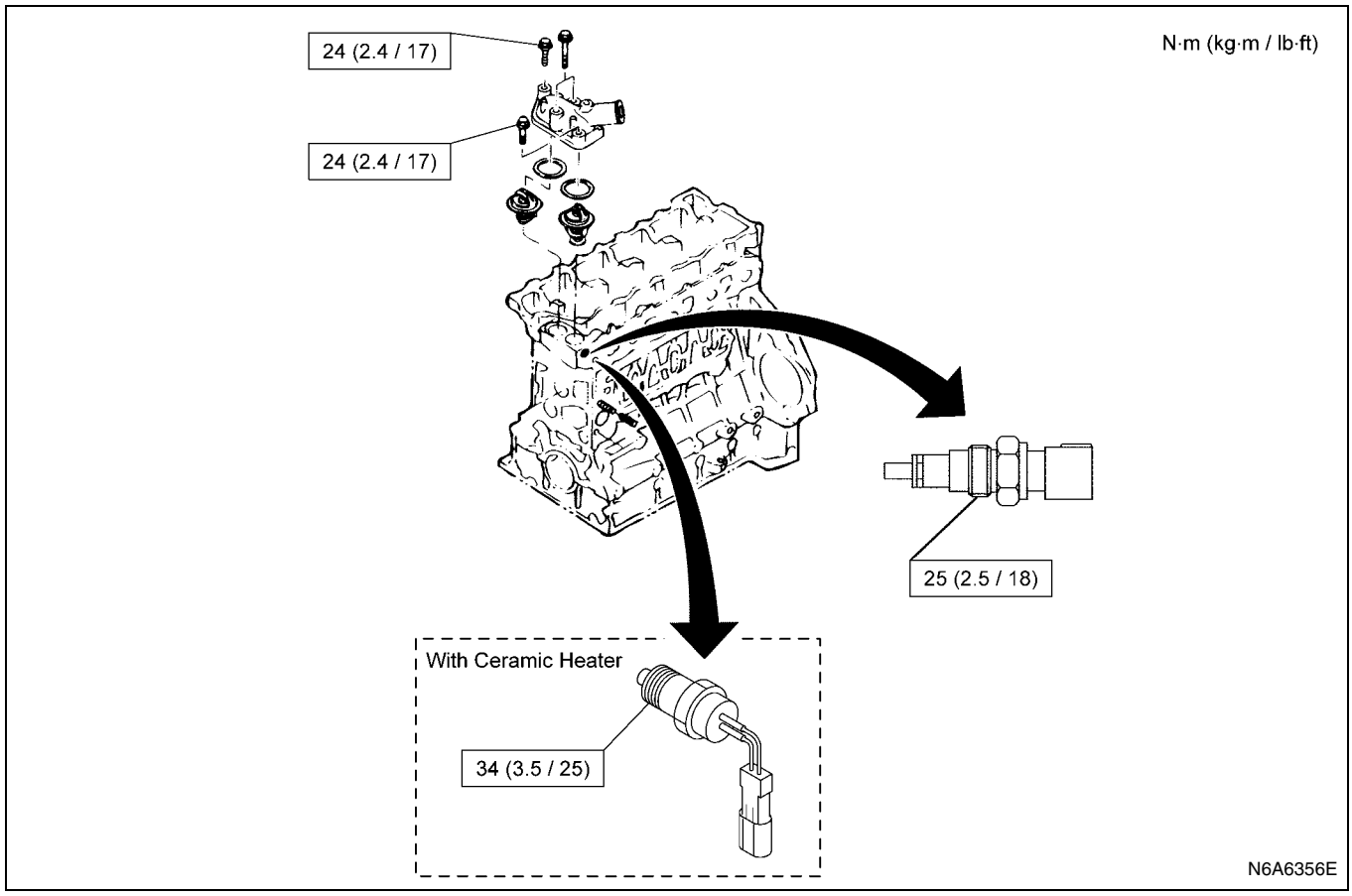


4. Replenish the cooling water stored during the discharge, and check the volume of the cooling water.



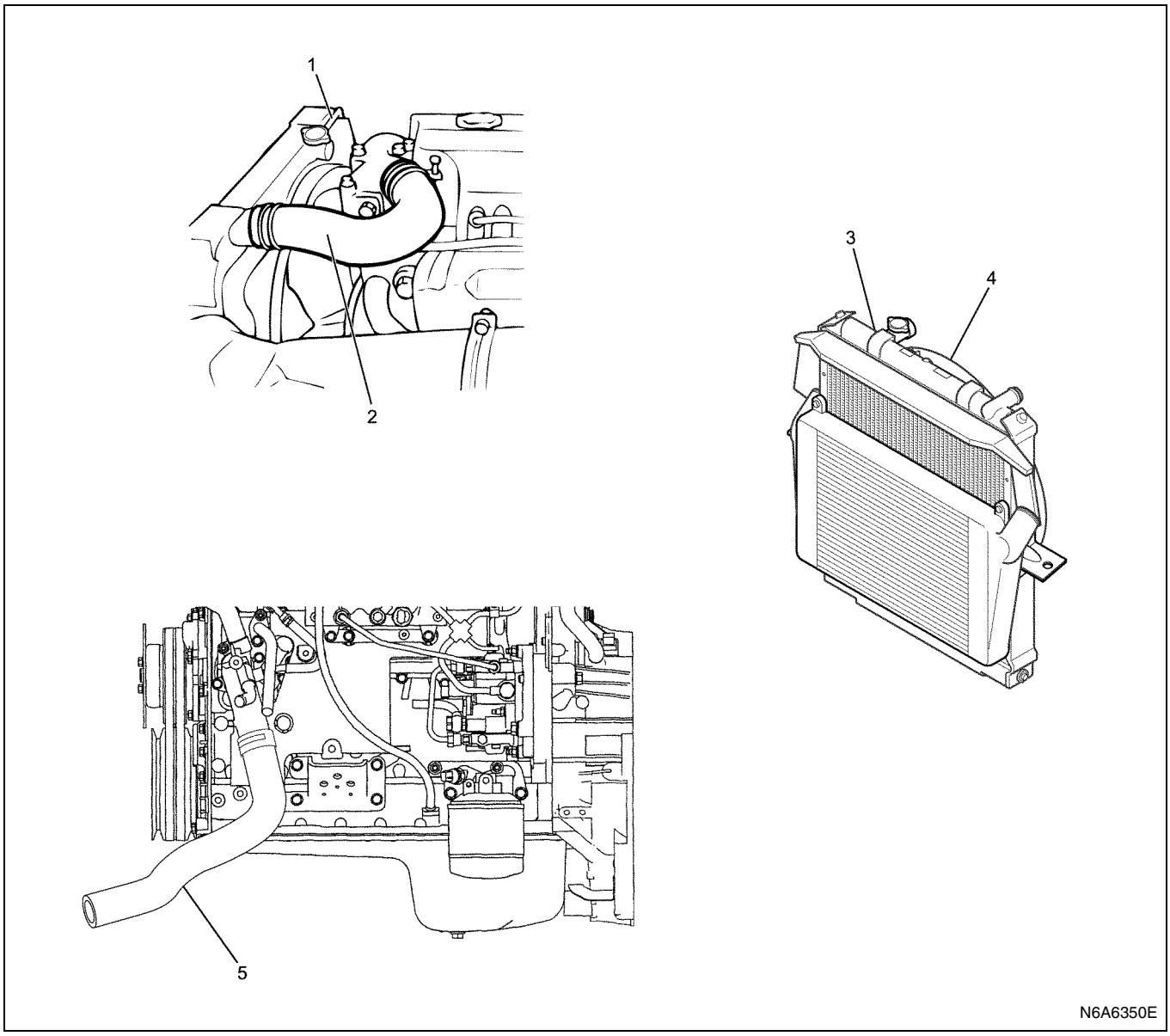
Legend
1. Reserve Tank
2. MAX Line (Upper Limit)
3. MIN Line (Lower Limit)

Torque Specifications



Radiator and Intercooler

Components



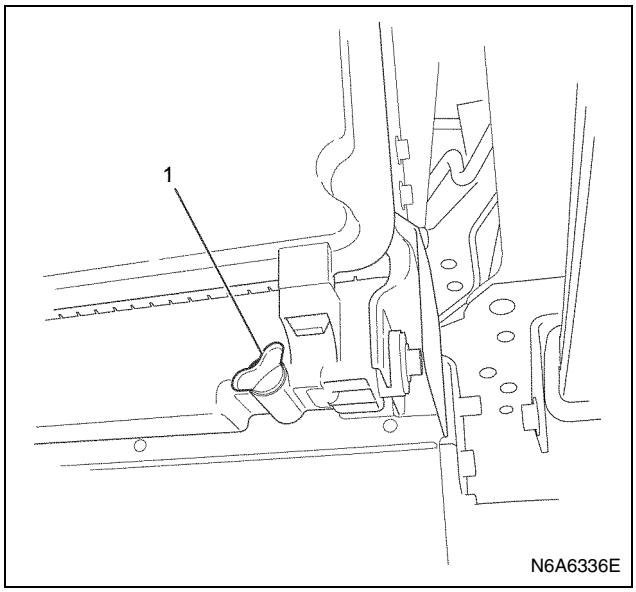
Legend

1. Coolant Reserve Tank Hose
2. Radiator Upper Hose
3. Radiator and Intercooler
4. Fan Guide
5. Radiator Lower Hose

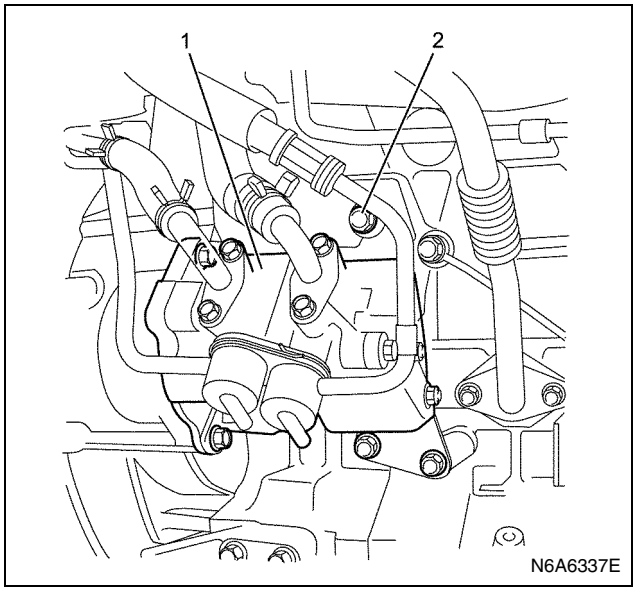
Removal

1. Loosen the water drain plug (to the right of the engine toward the rear) and radiator drain plug, and discharge the cooling water completely.

- After discharging the water, tighten the drain cock.

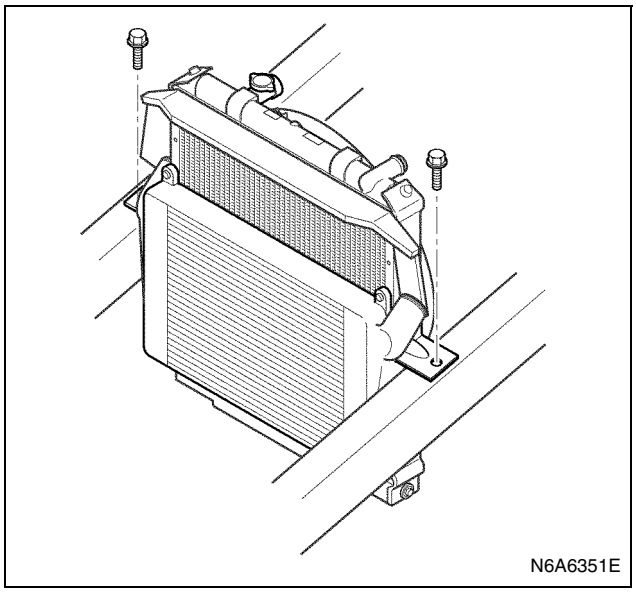


Legend
1. Radiator Drain Cock



Legend
1. Power Steering Pump
2. Drain Plug

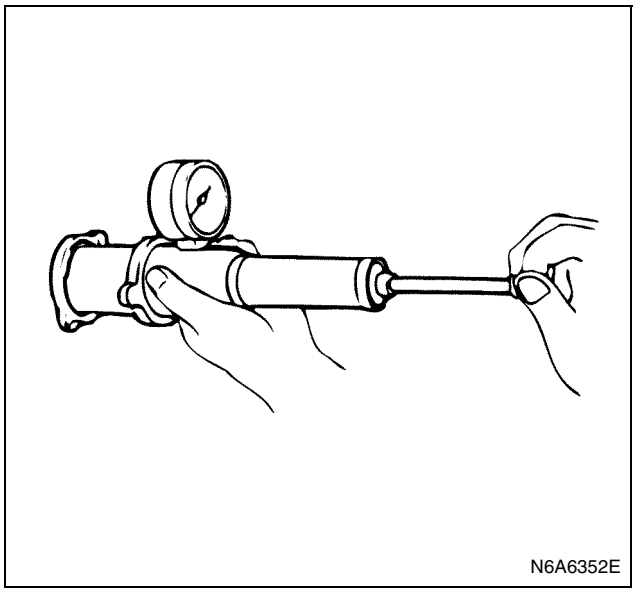
2. Remove the intake pipe from the intake manifold and inter-cooler (right side).
3. Remove the intake pipe from the turbo charger and inter-cooler (left side).
4. Remove the 2 transmission oil pipes on the underside of the radiator.
5. Remove the upper hose on the radiator side.
6. Remove the lower hose on the radiator side.
7. Remove the coolant reserve tank hose from the radiator side.
8. Take care to avoid damage to the radiator core from the fan blade, and remove the brackets on the right and left sides of the radiator. Simultaneously remove the radiator and inter-cooler.



Inspection

Radiator cap

1. Check the valve opening pressure using the radiator cap tester. If the valve opening pressure deviates from the standard value, replace the radiator cap.
   Valve opening pressure =
   108 ± 14.7 kPa (1.1 ± 0.15 kg/cm^2 / 15.7 ± 2.1 psi)



2. Check the state of the negative pressure valve situated at the center on the valve seat side of the cap. If the valve seat does not function smoothly due to rust or dirt, clean or replace the radiator cap.

Radiator core

1. If the radiator fin is deformed, the radiation effect deteriorates causing overheating. Therefore, modify the fin. Make sure that the root base of the fin is not damaged during modification.
   - Eliminate dust or other foreign matter.

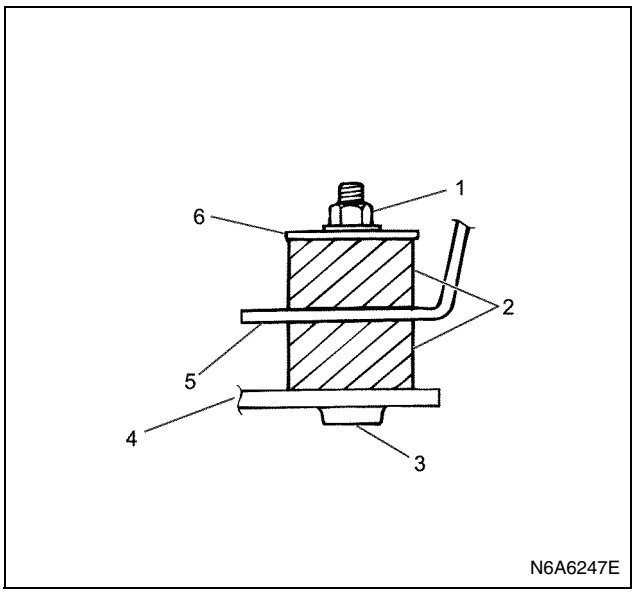
Washing the radiator

1. Wash the internal parts of the radiator and cooling water passage using water and detergent. Eliminate scale and rust completely.

Installation

1. Ensure that no damage occurs to the radiator core because of the fan blade. Mount the brackets on the left and right sides of the radiator on the frame according to the figure.

Tighten:
Bolts to 55 N·m (5.6 kg·m / 41 lb·ft)



Legend
1. Flange Nut
2. Rubber
3. Stud Bolt
4. Frame
5. Bracket on The Radiator Side
6. Washer

2. Mount the reserve tank hose of the coolant on the radiator.
3. Mount the radiator lower hose.
4. Mount the radiator upper hose.
   - Fill the cooling water.
5. Install the 2 transmission oil pipes on the underside of the radiator.
6. Install the intake pipe from the turbocharger and inter-cooler (left side).
7. Install the intake pipe from the intake manifold and inter-cooler (right side).

Reference

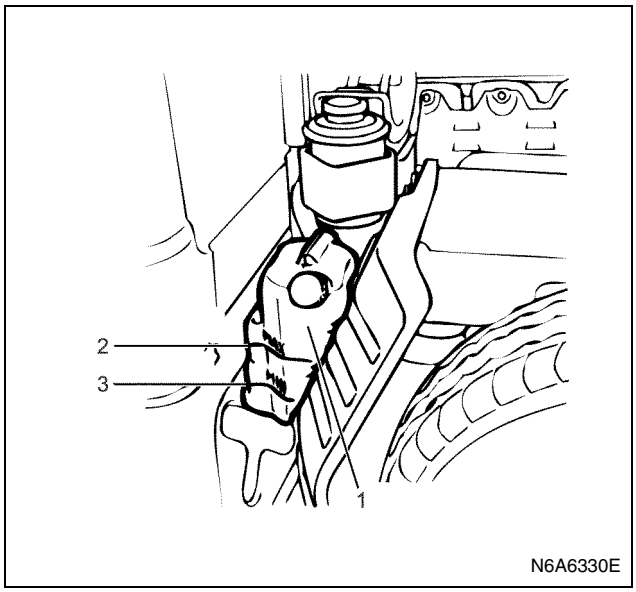
Cooling water injection procedure (in case of changing the cooling water completely)

- Confirm that the engine has cooled.
- Open the radiator cap and the reserve tank cap.
- Pour the cooling water up to the filler neck.
- Pour the cooling water up to the “MAX” line in the reserve tank.
- Close the radiator cap and the reserve tank cap and start the engine. Stop the engine after running for about 2 to 3 minutes at the idling rpm. Open the radiator cap again and replenish if the water level is low.

WARNING:
DO NOT LOOSEN OR REMOVE THE RADIATOR CAP WHEN THE TEMPERATURE OF THE COOLING WATER IS HIGH. STEAM OR BOILING WATER WILL GUSH OUT AND YOU MAY BE BURNT. TO OPEN THE RADIATOR CAP, COVER THE CAP WITH A THICK CLOTH WHEN THE COOLING WATER IS COOL, RELEASE THE PRESSURE BY SLOWLY TURNING THE CAP, AND THEN REMOVE THE CAP.

- After tightening the radiator cap, warm up the engine by running it at about 2000 rpm. Also, adjust the temperature of the heater to maximum temperature and circulate the cooling water even in the heater water conduit system.
- When the pointer of the thermometer crosses the median and the thermostat has activated, run at idling rpm for another 5 minutes, then stop the engine and leave it as-is.
- After the engine has cooled down sufficiently, check the water level in the filler neck part and replenish if necessary. If the level is extremely low, check for leaks in the cooling water conduit system and reserve tank hose.

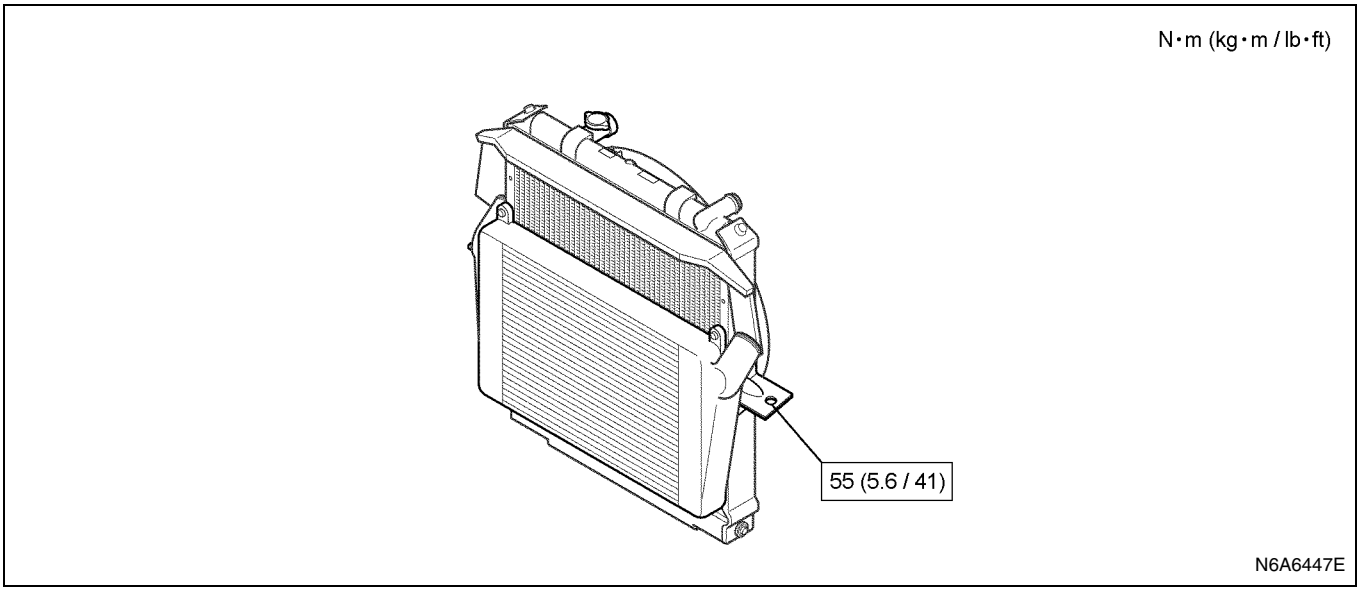
- Pour the cooling water up to the “MAX” line in the reserve tank again.



Legend

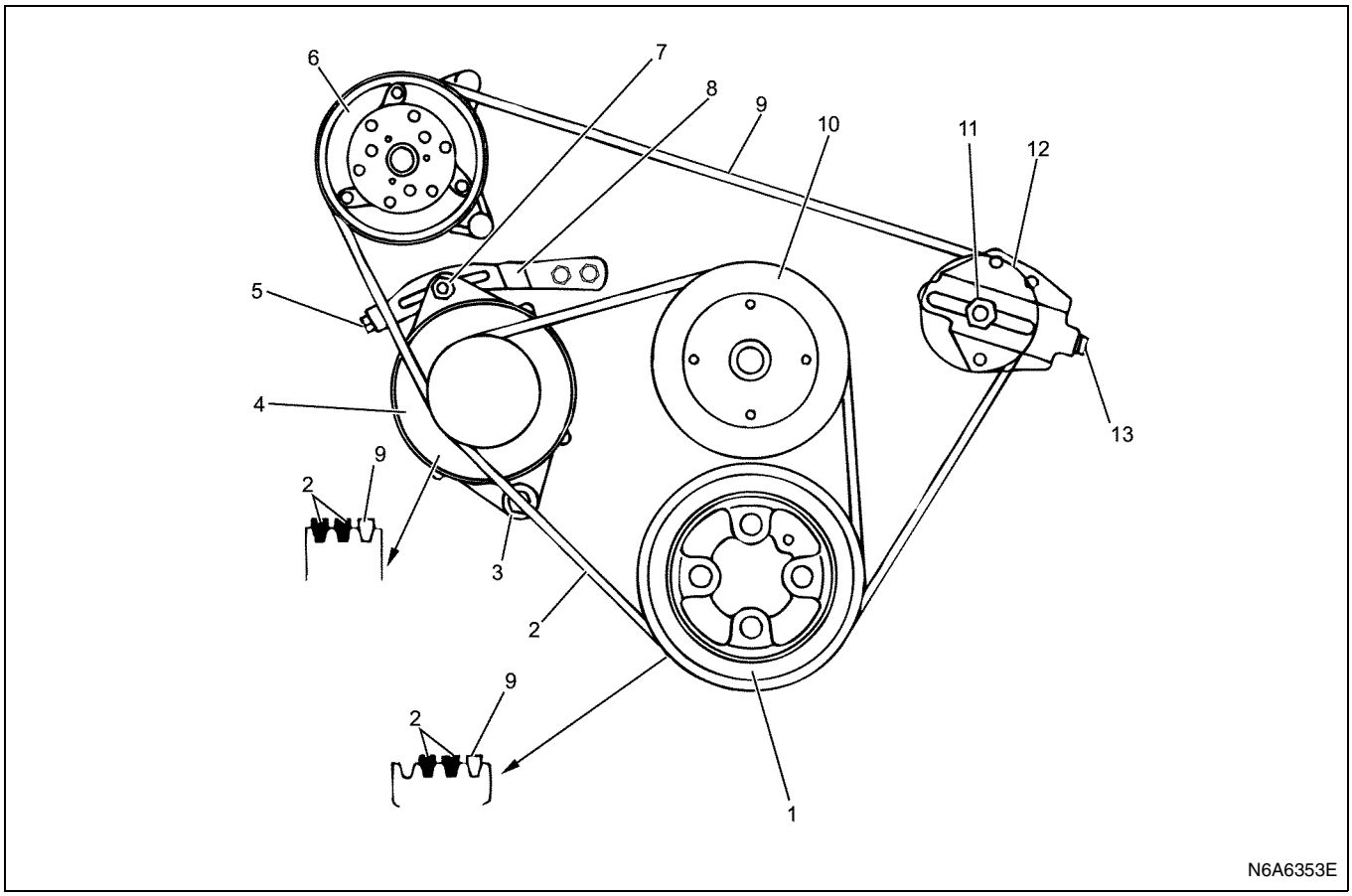
1. Reserve Tank
2. MAX Line (Upper Limit)
3. MIN Line (Lower Limit)

Torque Specifications



Drive Belt

Components



Legend

1. Crank Pulley
2. Generator Drive Belt
3. Bolt
4. Generator
5. Adjusting Bolt
6. A/C Compressor
7. Lock Nut
8. Adjusting Plate
9. A/C Compressor Drive Belt
10. Water Pump Pulley
11. Lock Nut
12. Tension Pulley
13. Adjusting Bolt

Inspection

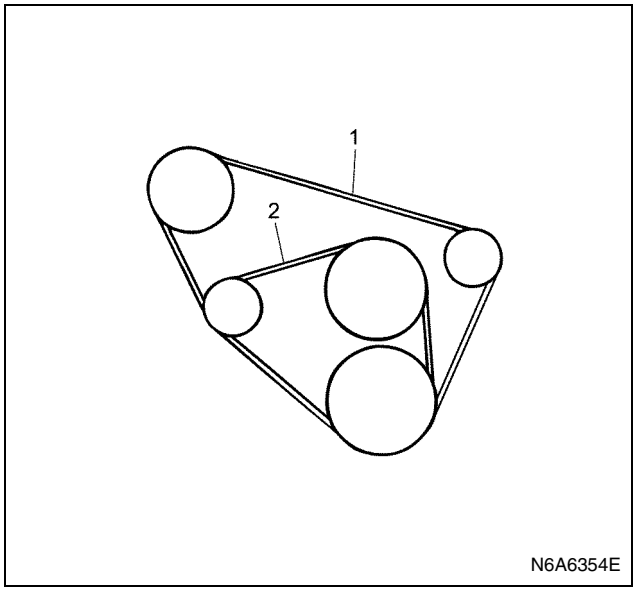
Check for the presence of wear or damage in the drive belt and renew the parts if necessary.
Check the tension of the belt and adjust if necessary.

Deflection Standard

Apply a pressure of 98 N (22 lb) at the center of the long span of each belt and check the deflection of the belt.

Deflection of A/C compressor drive belt
- When the belt is new
  16 to 20 mm (0.630 to 0.787 in)
- When the belt is reused
  18 to 22 mm (0.709 to 0.866 in)

Deflection of generator drive belt
- When the belt is new
  8 to 12 mm (0.315 to 0.472 in)
- When the belt is reused
  10 to 14 mm (0.394 to 0.551 in)



Legend
1. A/C Compressor Drive Belt
2. Generator Drive Belt

Adjustment

Adjust simultaneously the generator drive belt and A/C compressor drive belt for adjustment of belt.

With A/C

1. Loosen the tension pulley lock nut and tension pulley adjusting bolt of the tension pulley of the A/C compressor drive belt and bring the belt to free state.
2. Loosen the adjusting plate lock nuts and the mounting bolts of generator on the underside of the generator.
3. Rotate the adjusting bolts of generator and adjust the belt (remove and fit).
   - When replacing the belt, you must always replace both the belts.
4. After adjustments, tighten the adjusting plate lock nuts and the mounting bolts of generator on the underside of the generator using the specified torque.

Without A/C

Fan belt tension is adjusted by moving the generator.

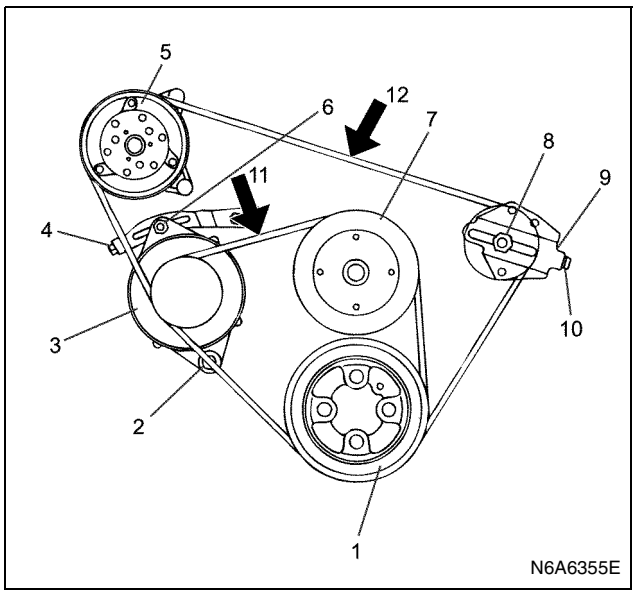
Tighten:
Nuts and bolts to 6 members: 24 N·m (2.4 kg·m / 17 lb·ft)
Nuts and bolts to 2 members: 40 N·m (4.1 kg·m / 30 lb·ft)

- Finally, adjust the tension of A/C compressor drive belt.

Caution:
You must adjust the tension of A/C compressor drive belt after adjusting generator belt.

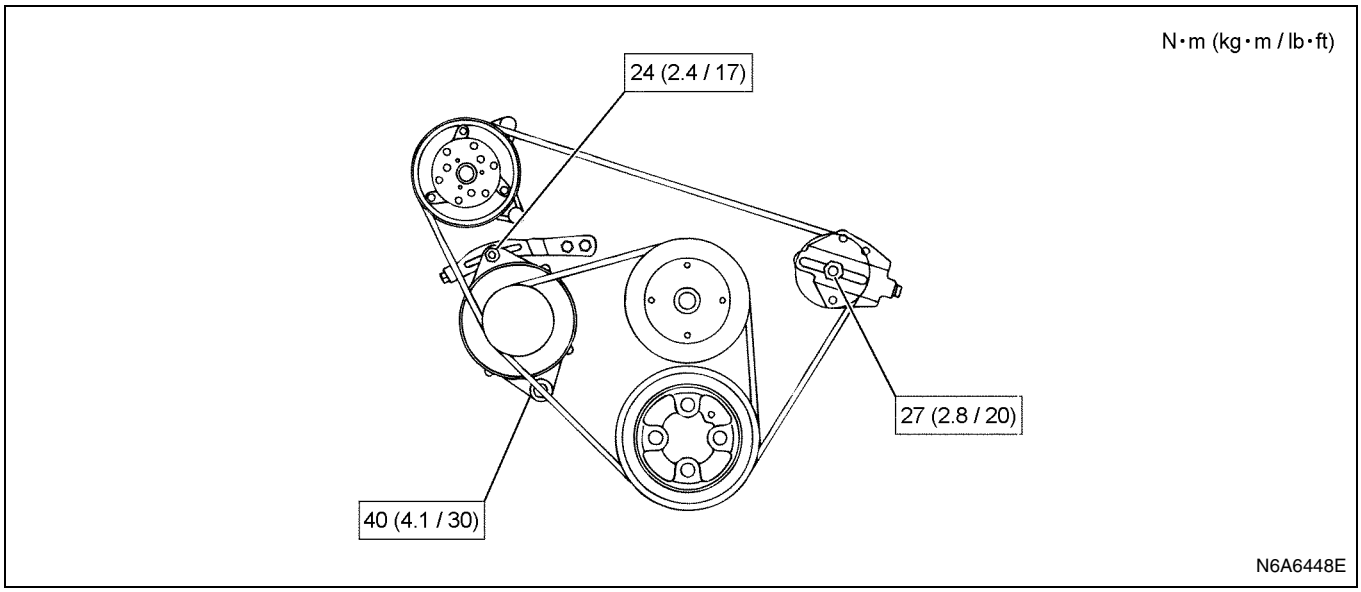
a. Rotate the tension pulley adjusting bolt of the tension pulley and adjust the belt (remove and fit).
b. After adjustments, tighten the tension pulley lock nut using the specified torque.

Tighten:
Lock nut to 27 N·m (2.8 kg·m / 20 lb·ft)



Legend
1. Crank Pulley
2. Bolt
3. Generator
4. Adjusting Bolt
5. A/C Compressor
6. Lock Nut
7. Water Pump Pulley
8. Lock Nut
9. Tension Pulley
10. Adjusting Bolt
11. Generator Drive Belt
12. A/C Compressor Drive Belt

Torque Specifications



ENGINE

Fuel System

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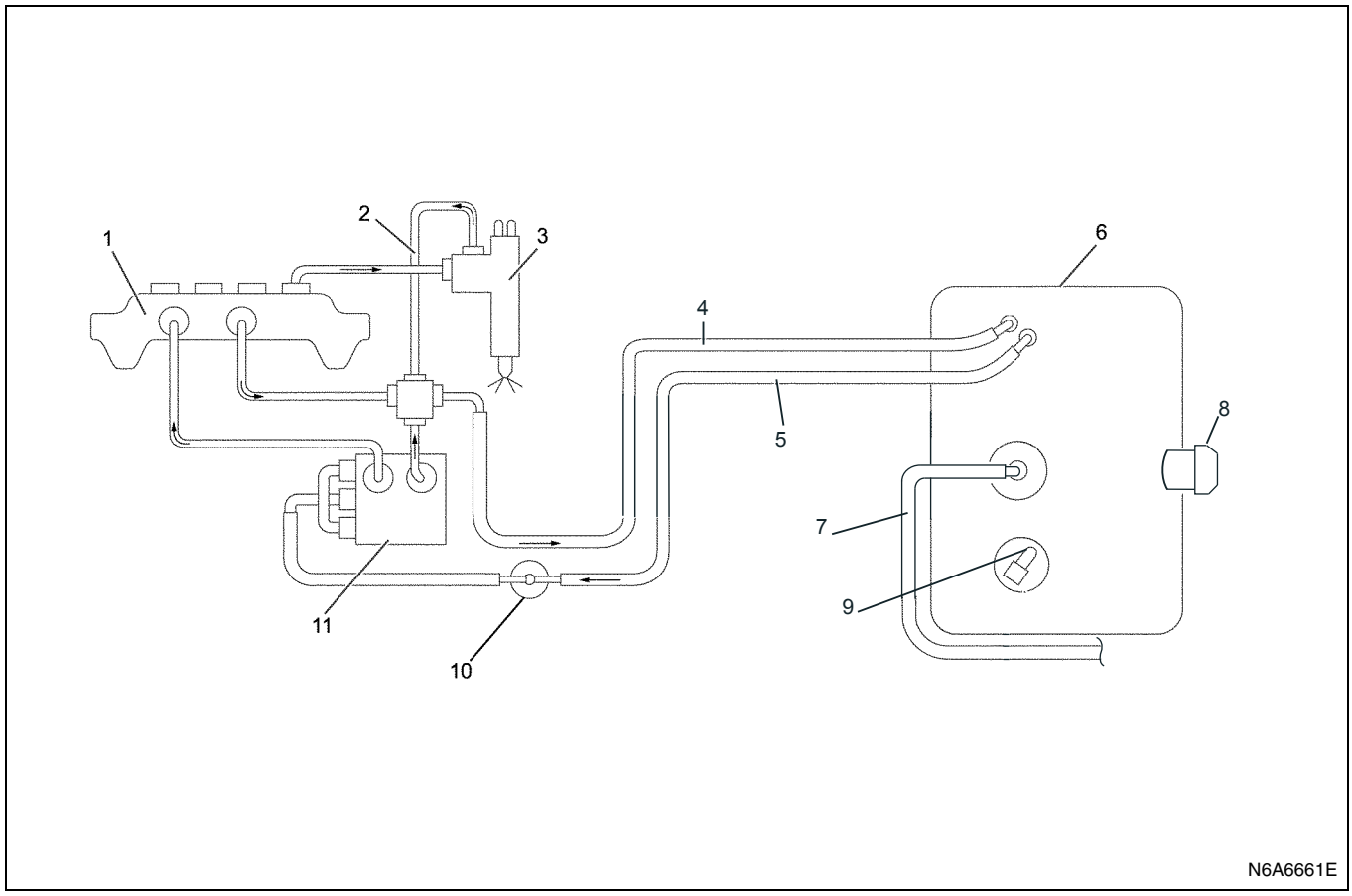
Fuel System

Service Precautions

Parts of the fuel system such as the internal part of the fuel injector, holes and clearances that form passages for fuel are finished to a very high degree of accuracy. They are therefore highly sensitive to foreign matter and the entry of foreign matter could cause damage to the fuel passage. Therefore, effective measures should be taken to prevent the entry of foreign matter.
If water removal agent is used in the fuel then it will absorb moisture in the light oil and may cause rust. Therefore, do not use water removal agent in the fuel tank.

Explanations on Functions and Operation

Fuel System Diagram



Legend

1. Fuel Rail
2. Leak-off Pipe
3. Fuel Injector
4. Fuel Return Pipe
5. Fuel Feed Pipe
6. Fuel Tank
7. Ventilation Hose
8. Fuel Filler Cap
9. Fuel Level Sensor
10. Fuel Filter With Sedimenter
11. Fuel Supply Pump

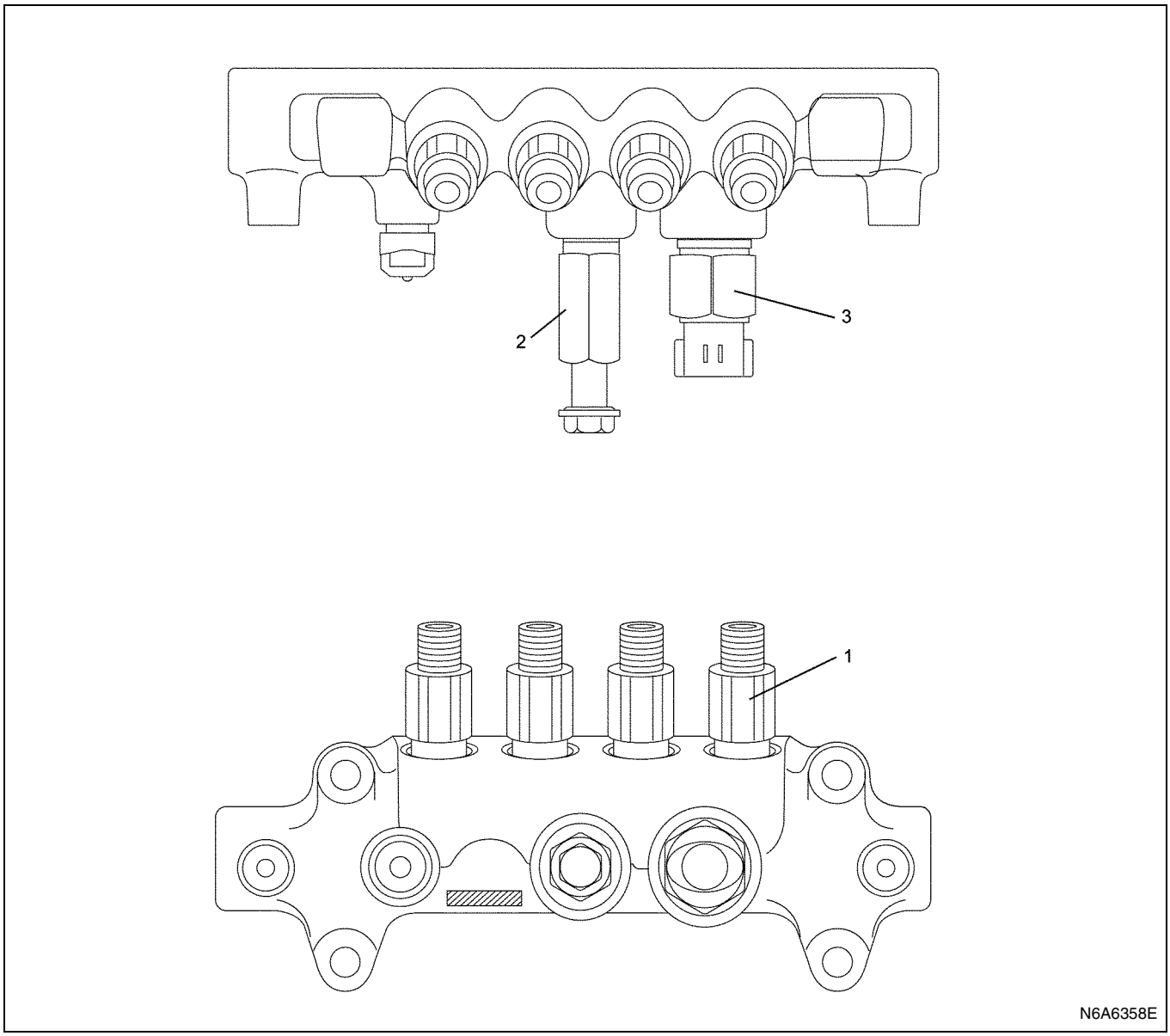
Work Procedure

- The fuel opening must be quickly sealed when removing the fuel pipe, injection pipe, fuel injector, fuel supply pump, and fuel rail.
- The eyebolts and gasket must be stored in a clean parts box with a lid to prevent adhesion of foreign matter.
- Fuel leakage could cause fires. Therefore, after finishing the work, wipe off the fuel that has leaked out and make sure there is no fuel leakage after starting the engine.

Caution:

- Do not let foreign matter such as sand or dust get into fuel.
- Use gas oil for fuel, not others.

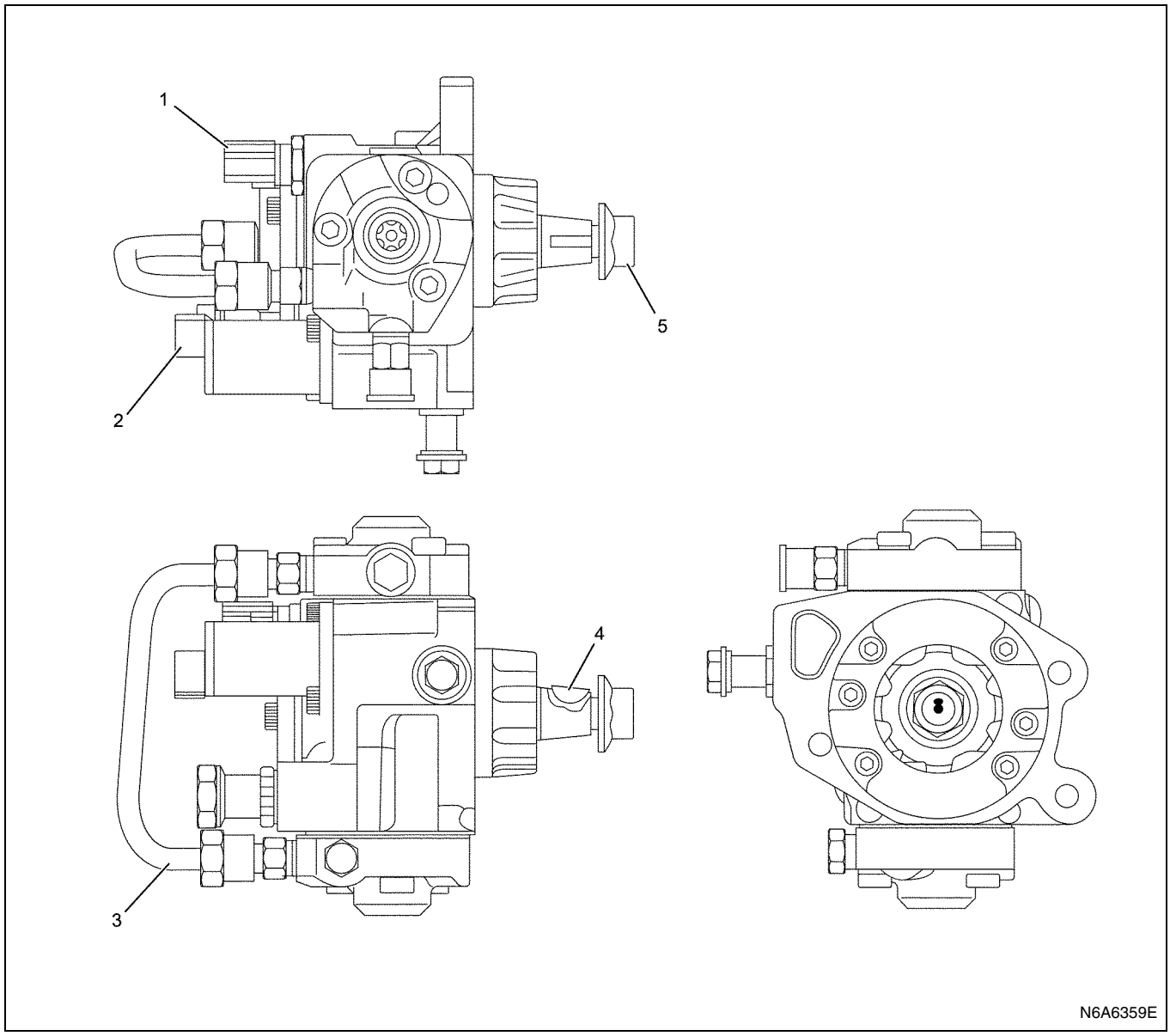
Fuel Rail



Legend

1. Flow Damper
2. Pressure Limiter
3. Pressure Sensor

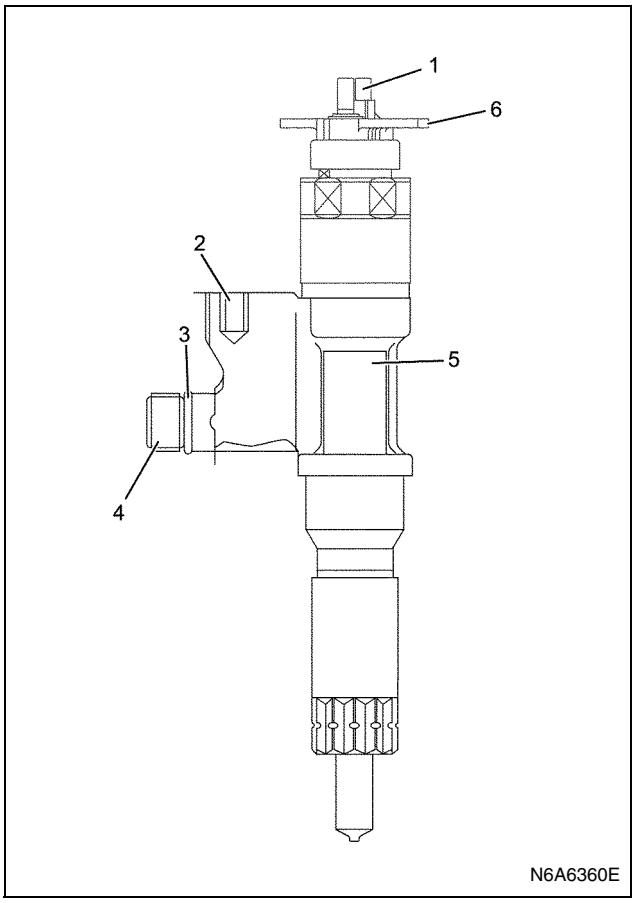
Fuel Supply Pump



Legend

1. Fuel Temperature Sensor
2. Fuel Rail Pressure Regulator
3. High Pressure Piping
4. Camshaft Key
5. Camshaft Nut

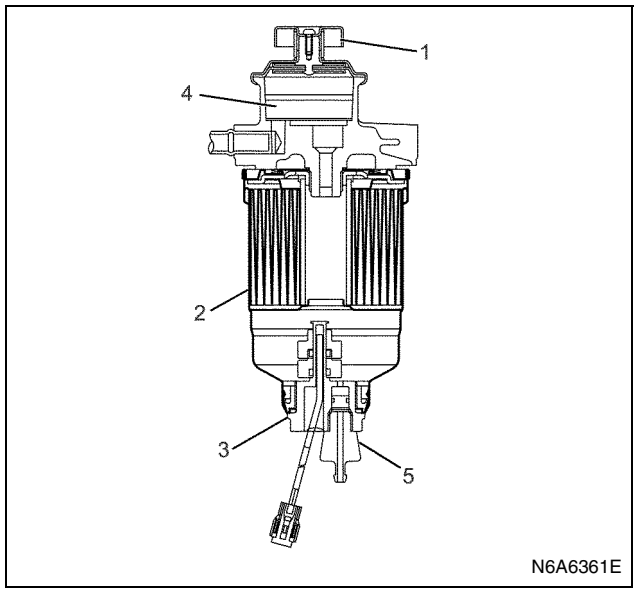
Fuel Injector



Legend

1. Terminal Stud
2. Fuel Leak-off Port
3. O-ring
4. Fuel Inlet Port
5. Injector Parts Number Marking
6. Fuel Injector ID Plate

Fuel Filter

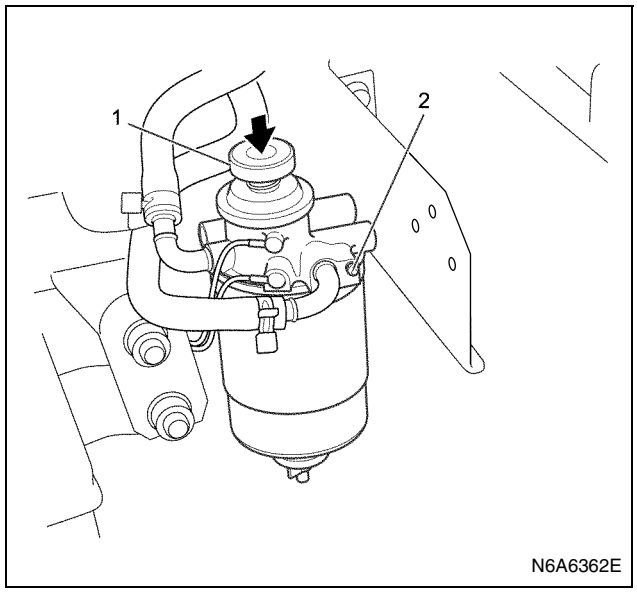


Legend

1. Priming Pump
2. Cartridge
3. Sensor
4. Heater
5. Drain Plug

Functional check

Air bleeding



Legend

1. Priming Pump
2. Air Bleed Plug

1. Before starting the engine
   a. Fit a tray below the fuel filter (below the air bleed plug).
   b. Loosen the plug adequately and operate the priming pump more than 20 times until the fuel overflows from the plug hole.

c. Tighten the plug, and operate the priming pump more than 10 times until it is filled with fuel. After waiting for approximately a minute, loosen the plug and bleed off the air in the fuel filter. (This work must be repeated a minimum of three times until no more air comes out from the plug.)

d. Tighten the plug firmly and wipe the fuel in the surrounding area. Operate the priming pump (10 to 15 times) till it is filled with fuel and then send fuel to the engine.

2. After starting the engine

a. Start the engine by rotating the starter without depressing the accelerator pedal.

b. After starting, maintain the idling rotation for 5 seconds.

c. Slowly rotate the idling control knob clockwise and maintain it for 3 minutes.

d. Fully depress the accelerator pedal and increase the rotations to maximum. (Repeat this operation several times)

e. Rotate the idling knob counterclockwise and return to idling mode.

Caution:
If the air bleeding work is insufficient then it could lead to faults in the engine. Therefore, the procedures after starting the engine should always be implemented.

Water drain

A warning lamp will light up if water is collected more than fixed quantity in the sedimenter. If the warning lights up, drain out the water by following operations:

- Fit a tray below the fuel filter.
- Loosen the drain plug.
- Operate the priming pump several times to discharge the water.
- Tighten the drain plug after discharging the water.
- Operate the priming pump several times and check for fuel leakage.
- Check that the warning lamp in the meter is off.

Fuel system vacuum check

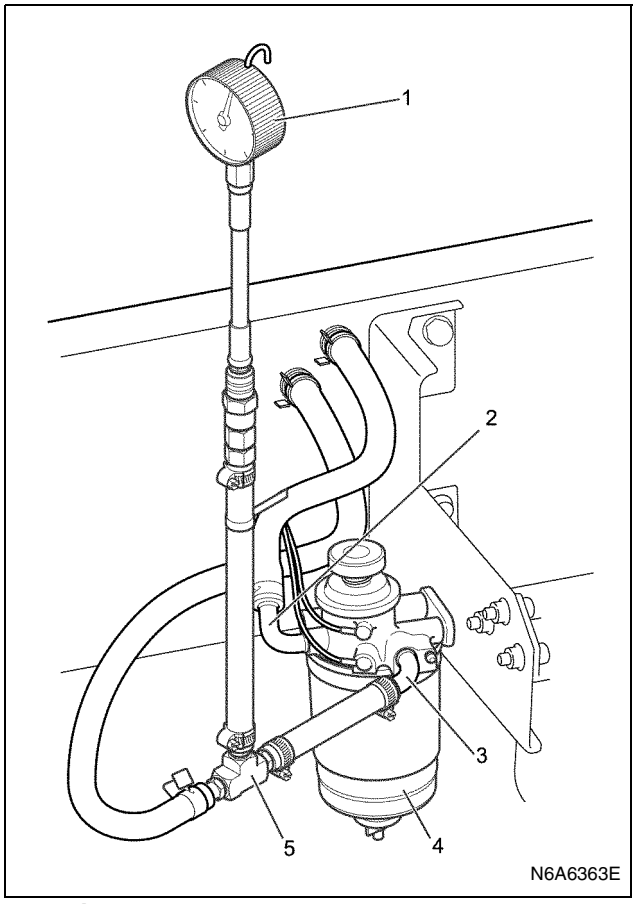
Use this procedure to measure the vacuum (negative pressure) discharge side the fuel system.

Important:
The fuel pressure/vacuum gauge assembly (gauge (1)) and the fuel pressure/vacuum gauge adapter (adapter (5)) must be cleaned before connect to the fuel line. Otherwise, foreign material adherent to the tools may damage the fuel supply pump.

1. Disconnect the fuel hose from the fuel filter housing. (fuel supply pump side).
2. Install the adapter.

   Special tool
   Fuel Pressure/Vacuum Gauge Set:
   5-8840-2844-0
   (Fuel pressure/vacuum gauge adapter:
   EN-47667)
3. Connect the gauge (1) with hose to the adapter (5).

   Special tool
   Fuel Pressure/Vacuum Gauge Set:
   5-8840-2844-0
   (Fuel pressure/vacuum gauge assembly:
   J-44638)



Legend
1. Fuel Pressure/Vacuum Gauge Assembly
2. Fuel Pipe (Intake Side)
3. Fuel Pipe (Discharge Side)
4. Fuel Filter
5. Fuel Pressure/Vacuum Gauge Adapter

4. Loosen the air bleeding plug on the supply pump.
5. Use your hand to operate the fuel filter priming pump. Operate the pump until all the air has been bled from the system.
6. Start the engine and allow it to idle.

7. Note the gauge (1) reading. If the reading is normal, go to Step 8. If the fuel vacuum is greater than the specified value, there is a problem in the fuel system. Perform the procedures outlined below.

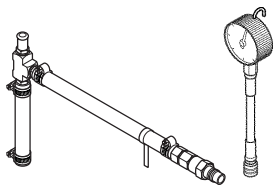
Standard fuel vacuum: Less than 5 inHg

- Replace the cartridge fuel filter element.
- Check the fuel delivery pipe. If it is clogged, it must be replaced.
- Remove the fuel pipe at the fuel filter inlet. Use high-pressure air forced through the fuel pipe to clean the fuel system.

Caution:

- Remove the fuel filler cap before applying high-pressure air.
- Do not perform this procedure if the fuel tank is nearly full (fuel approaching or flowing into the fuel filler neck). The forced air will spray fuel from the fuel filler neck.

Special Tool

Illustration	Tool Number / Description / Remarks
 5884028440	5-8840-2844-0 Fuel Pressure / Vacuum Gauge Set (J-44638 [Fuel Pressure / Vacuum Gauge Assembly] EN-47667 [Suction Side Fuel Pressure / Vacuum Gauge Adapter])

8. Remove the gauge (1) and hose from the adapter (5).
9. Remove the adapter (5).
10. Connect the fuel hose.
11. Use your hand to operate the fuel filter priming pump. Operate the pump until all the air has been bled from the system.
12. Start the engine and allow it to idle.
13. Inspect the fuel system for fuel leakage.

A List of Defective Phenomena

- Problems with starting
- Hunting during idling
- Insufficient horsepower
- Maximum engine speed is too low
- Engine does not stop
- Exhaust gas is blue or black.

Trouble Shooting

Problems with starting

Condition	Possible Cause	Correction
Problems with starting	Fuel tank is empty	Fill the tank.
	Air has entered the fuel system.	Bleed the air.
	Fuel line is clogged or damaged. Connection to the fuel line is loose.	Repair or replace the fuel line. Re-tighten the connection.
	Fuel filter element is clogged.	Replace the cartridge.
	Fault in the feed pump	Replace the fuel supply pump.
	Regulating valve is open.	Replace.
	Sticking of the fuel injector nozzle	Replace the fuel injector.
	Defective engine control system	Diagnose the engine control system.

Unstable idling

Condition	Possible Cause	Correction
Hunting during idling	Air has entered the fuel system.	Bleed air from the fuel system.
	Leakage or clogging of the fuel system	Repair or replace the fuel system.
	Water particles or foreign matter in the fuel system.	Replace the fuel.
	Fuel filter element is clogged.	Replace the fuel filter element (cartridge).
	Sticking of the fuel injector nozzle	Replace the fuel injector.
	Defective engine control system	Diagnose the engine control system.

Insufficient power

Condition	Possible Cause	Correction
Insufficient horsepower	Air has entered the fuel system.	Bleed air from the fuel system.
	Leakage or clogging of the fuel system	Repair or replace the fuel system.
	Water mixes in the fuel system	Replace the fuel.
	Fuel filter element is clogged.	Replace the element or the cartridge.
	Sticking of the fuel injector nozzle	Replace the fuel injector.
	Defective engine control system	Diagnose the engine control system.

Maximum engine speed is too low

Condition	Possible Cause	Correction
Maximum engine speed is too low	Fuel line is clogged or damaged.	Repair or replace the fuel line.
	Defective engine control system	Diagnose the engine control system.

Engine does not stop

Condition	Possible Cause	Correction
Engine does not stop	Defective engine control system	Diagnose the engine control system.

Exhaust gas is blue or black

Condition	Possible Cause	Correction
Exhaust gas is blue or black.	Reduction in injection-valve opening pressure or defective atomizing status	Replace the fuel injector.
	Engine control system malfunction	System diagnosis.

Fuel System Check

Description

The common rail fuel system is comprised of two fuel Pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the engine control module (ECM) using the fuel rail pressure (FRP) regulator dependant upon values from the FRP sensor attached to the fuel rail. In case of fuel rail overpressure, a pressure limiter valve threaded into the fuel rail will open to release overpressure and return fuel back to the fuel tank.

The Fuel System Check diagnostic table directs the service technician to the appropriate fuel system diagnosis. The diagnostic table assumes the following conditions are met:

- The batteries are completely charged.
- The engine cranking speed is normal.
- There is adequate fuel in the fuel tank.
- There is no air in the fuel line.

Diagnostic Aids

- The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight or if there is a crack in one of the fuel hoses. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load.
- If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted. Perform bleeding of fuel system after refilling.

Step	Action	Value(s)	Yes	No
1	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Diagnostic Trouble Code (DTC) Information of the engine control module with a Tech 2. Are any DTC(s) set?	—	Refer to Applicable DTC in Engine Control Section	Go to Step 2

Step	Action	Value(s)	Yes	No
2	1. Inspect the high pressure side between the fuel supply pump and the fuel injectors for fuel leakage. The following components may contain an external leak: • Fuel supply pump • Fuel rail • Pressure limiter valve • Flow damper valve • Fuel rail pressure (FRP) sensor • Fuel pipe between the fuel supply pump and fuel rail • Fuel pipe between the fuel rail and fuel injectors • Each fuel pipe sleeve nuts **Notice:** Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel in the engine oil. 2. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 3
3	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load. 3. Pump the priming pump on the fuel filter until it becomes firm .If there is a leak on the suction side of the fuel system between the priming pump and the fuel supply pump, the priming pump will not build up sufficient firmness and fuel leakage may occur. 4. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Make sure the fuel tank(s) have adequate fuel and the fuel quality is good (take a sample). 2. Bleed the air from the fuel system as necessary. Refer to Fuel System Air Bleeding in this section. 3. Start the engine and let idle. If the engine does not start, continue to crank. 4. Observe the Differential Fuel Rail Pressure parameter with the Tech 2 while cranking over the engine or running the engine. Is the Differential Fuel Rail Pressure parameter within the specified value?	±5MPa ±(725 psi)	System OK	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the fuel injector in-line harness connector (H-125) from the cylinder head cover case. 3. Remove the rubber fuel hose from the fuel filter housing (fuel supply pump side). Use a pan to catch the fuel leakage from the removed fuel line. **Important:** The fuel vacuum pump/pressure gauge connector and the adapter hose must be cleaned before connecting to the fuel line. Otherwise, foreign material internal to the tools line may damage the fuel supply pump. 4. Connect the suction side fuel pressure adapter 5-8840-2844-0 (EN-47667) with fuel vacuum/pressure gauge assembly 5-8840-2844-0 (J-44638) in series with the filter housing and the disconnected fuel hose. Ensure the service tool and fuel line connections are tight. 5. Bleed the fuel system by priming the priming pump until it becomes firm, then crank over the engine for a maximum of 5 seconds. Perform procedure three times. 6. Fully clamp off a fuel hose as close to the fuel tank as possible (this will draw vacuum on the fuel system). You can also disconnect a fuel line and plug it. 7. Crank over the engine (for no longer than 15 seconds) while monitoring the fuel pressure/vacuum gauge. **Notice:** Release the clamp or open the plug when the gauge is likely to be more than 8 inHg during the test. Can a vacuum of at least the specified amount be pulled on the fuel system?	8 inHg	Go to Step 8	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Inspect the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. 2. Draw fuel from the fuel tank at the fuel line going to the fuel pickup tube to verify a clean stream of fuel comes out (use the hand-held vacuum pump 5-8840-0279-0 (J-23738-A) with a clear hose or equivalent) This will ensure the fuel pickup tube is not cracked drawing air into the fuel line. 3. Repair as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 7
7	1. Replace the fuel filter cartridge. Refer to Fuel Filter Cartridge Replacement in this section. 2. Retest the fuel system vacuum test described in Step 5. Can a vacuum of at least the specified amount be pulled on the fuel system?	8 inHg	Go to Step 18	Go to Step 17
8	1. Unclamp or unplug the fuel line from Step 5 and reconnect the fuel line. 2. Prime the priming pump until firmness is felt. 3. Crank over the engine for 5 seconds. 4. Repeat steps 2 and 3 three times to bleed the fuel system. 5. Crank over the engine (for no longer than 15 seconds at a time) while monitoring the fuel pressure/vacuum gauge. Does the vacuum/pressure gauge ever indicate a larger than the specified value?	5 inHg	Go to Step 9	Go to Step 10
9	1. Inspect the fuel lines between the fuel supply pump and fuel tank for being crushed or kinked. 2. Inspect the fuel tank vent hose for a plugged or kinked condition. 3. Inspect the fuel cap for a plugged or kinked condition. 4. Inspect inside the fuel tank (if possible) for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. 5. Repair the condition as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 14

Step	Action	Value(s)	Yes	No
10	1. Turn OFF the ignition. 2. Make sure the fuel injector in-line harness connector (H-125) is disconnected from the cylinder head cover case. 3. Remove the eyebolt from the cylinder head that connects to the leak-off pipe. 4. Connect the fuel adapter 5-8840-2845-0 (J-45873-103) with hose assembly to the cylinder head. Install the hose into a graduated cylinder from the 5-8840-2845-0 (J-45873-100) kit. 5. Remove the eyebolt from the pressure limiter valve that connects to the leak-off pipe. 6. Connect the fuel adapter 5-8840-2845-0 (J-45873-105) with hose assembly to the pressure limiter valve. 7. Crank over the engine for 10 seconds. Make sure the batteries are fully charged and the engine is cranking at normal speed for each test. **Notice:** Perform this test three times and take the average of the fuel return amount coming from the cylinder head. Is fuel leaking from the pressure limiter valve?	—	Go to Step 15	Go to Step 11
11	Is the average fuel return coming from the cylinder head less than the specified value?	15ml	Go to Step 12	Go to Step 13
12	1. Remove each glow plug from the cylinder head. 2. Inspect the tip of the plugs for wet fuel. Did you find wet fuel on any glow plug?	—	Go to Step 16	Go to Step 17
13	1. Remove the cylinder head cover and injector harness in order to connect the fuel adapter 5-8840-2845-0 (J-45873-101) with hose assembly to each injector leak-off port. Refer to Fuel Injector Replacement in this section. 2. Crank over the engine for 10 seconds. **Important:** Replacement injector must be programmed. 3. Replace the injector(s) that return fuel more than the specified value. Refer to Fuel Injector Replacement/Fuel Injector ID Code Data Programming in this section. 4. Retest after replacement of the fuel injector(s). Did you complete the replacement?	3ml	Go to Step 18	—

Step	Action	Value(s)	Yes	No
14	Replace the fuel filter cartridge. Refer to Fuel Filter Cartridge Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—
15	Replace the pressure limiter valve. Refer to Fuel Rail Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—
16	**Important:** Replacement injector must be programmed. Replace the appropriate injector(s) that was leaking fuel found at Step. Refer to Fuel Injector Replacement/Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 18	—
17	**Important:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. Replace the fuel supply pump. Refer to Fuel Supply Pump Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—
18	1. Reconnect all previously disconnected harness connector(s) or components. 2. Turn OFF the ignition for 30 seconds. 3. Bleed the air from the fuel system. Refer to Fuel System Air Bleeding in this section. 4. Start the engine and let idle. 5. Observe the Differential Fuel Rail Pressure parameter with the Tech 2. Is the Differential Fuel Rail Pressure parameter within the specified value?	±5 MPa (±725 psi)	System OK	Go to Step 1

Special Tool

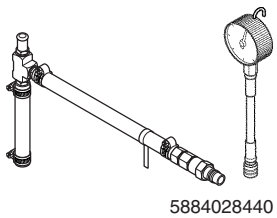
Illustration	Tool Number / Description
 5884028440	5-8840-2844-0 Fuel Pressure / Vacuum Gauge Set (J-44638 [Fuel Pressure / Vacuum Gauge Assembly] EN-47667 [Suction Side Fuel Pressure / Vacuum Gauge Adapter])

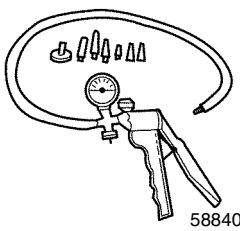
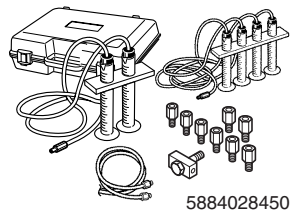
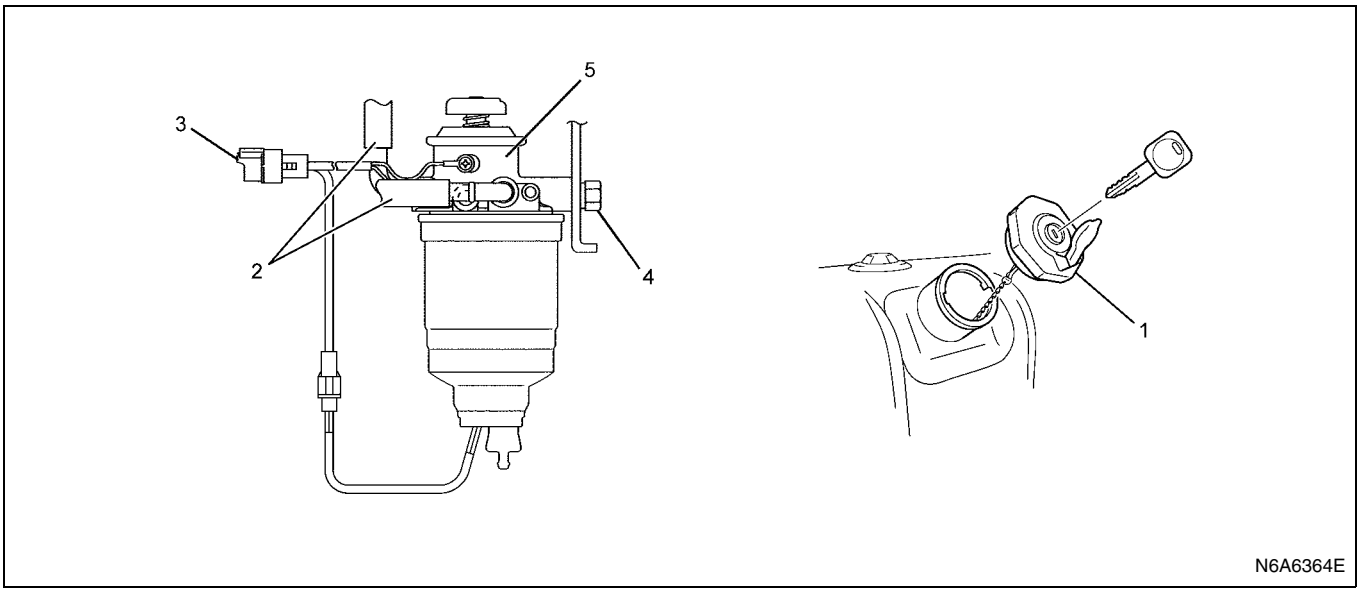
Illustration	Tool Number / Description
 5884002790	5-8840-0279-0 (J-23738-A) Vacuum Pump

Illustration	Tool Number / Description
 5884028450	5-8840-2845-0 Fuel Test Adapter Set (J-45873 / Fuel Test Adapter Kit, J-45873-100 / Fuel Test Adapters)

Fuel Filter Assembly

Components



Legend

1. Filler Cap
2. Fuel Hose
3. Fuel Sedimenter Connector
4. Bolt
5. Fuel Filter Assembly

Removal

1. Remove the filler cap.
2. Remove the fuel sedimenter connector and the clip on the bracket.
3. Remove the feed hose and the return hose from the fuel filter and plug it so that the fuel does not flow out.
4. Remove the bolts for mounting the fuel filter.
5. Remove the fuel filter assembly.

Installation

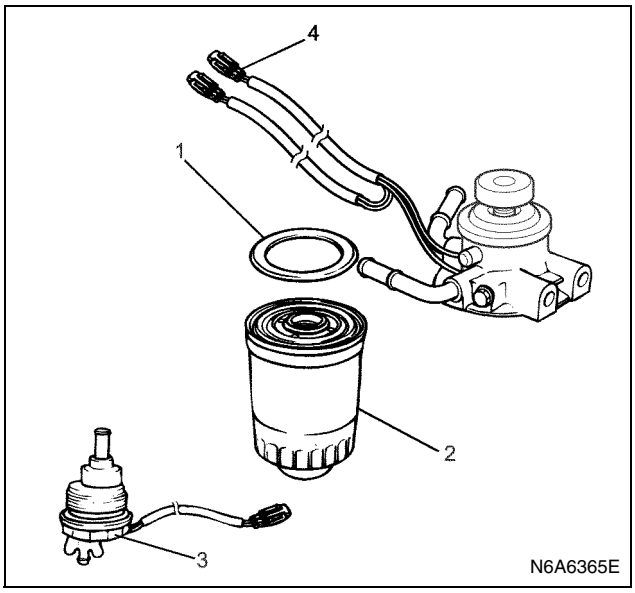
1. Install the fuel filter assembly.
2. Install the bolts for mounting the fuel filter.
3. Install the inlet hose and the outlet hose.
4. Install the fuel sedimenter and clip the cable to the bracket.
5. Install the filler cap.
6. Bleed out the air.
   - Refer to “Fuel System/Air bleeding”.

Fuel Filter Cartridge

Removal

1. Remove the cartridge using the filter wrench.

   Special tool
   Filter wrench: 5-8840-0253-0 (J-22700)
2. Remove the sedimenter sensor.



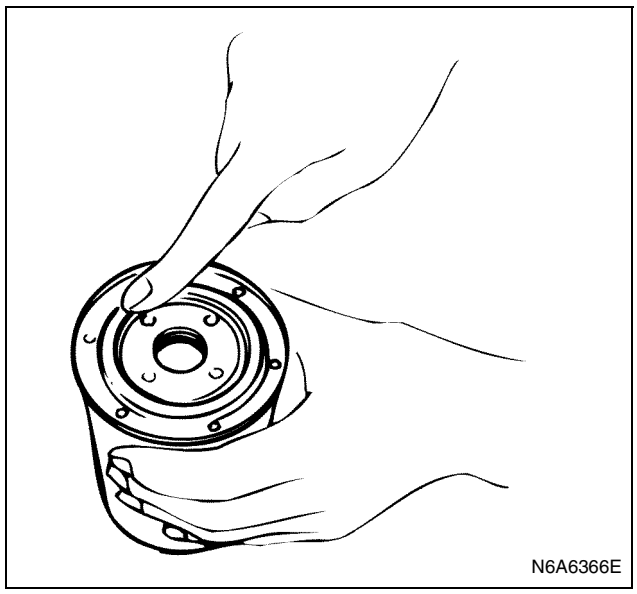
Legend

1. O-Ring
2. Cartridge
3. Sedimenter Sensor
4. Fuel Heater Connector

Installation

1. Assemble the sedimenter sensor in the new cartridge.
2. Clean the cartridge mounting surface in the filter body so that the cartridge can be seated securely.
3. Coat a thin layer of fuel on the O-ring in the new cartridge.
4. To simplify air bleed, fill light oil on the new cartridge.
5. Tighten the cartridge until the O-ring touches the sealing surface. During this process take adequate care that the fuel inside does not flow out.
6. Use the filter wrench and tighten rotating by 1/3 to 2/3.

   Special tool
   Filter wrench: 5-8840-0253-0 (J-22700)

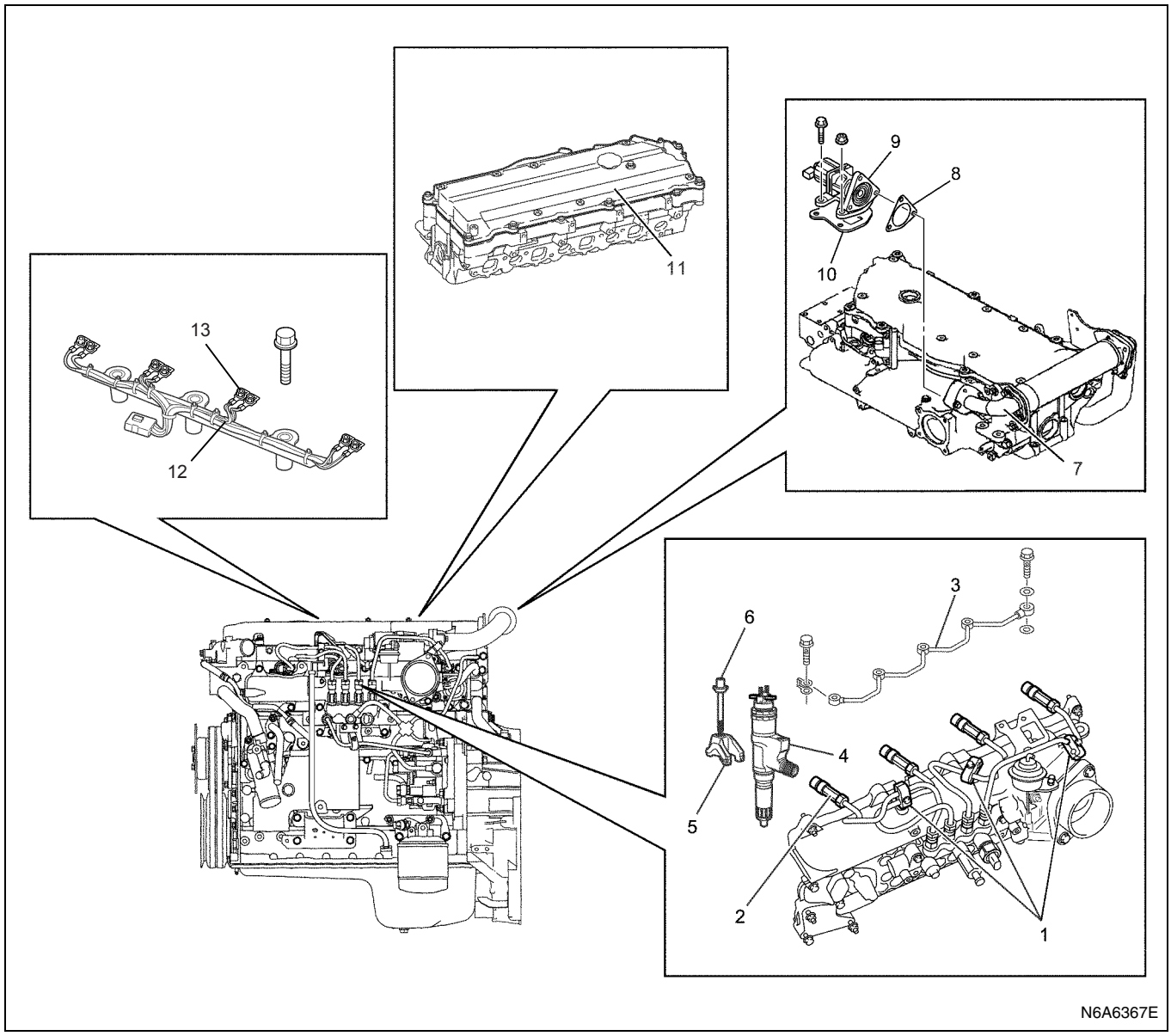


Special Tool

Illustration	Tool Number / Description / Remarks
5884002530	5-8840-0253-0 (J-22700) Filter Wrench

Fuel Injector

Components



Legend

1. Fuel Injection Pipe Clip
2. Fuel Injection Pipe
3. Fuel Injector Leak-off Pipe
4. Fuel Injector
5. Fuel Injector Clamp
6. Fuel Injector Clamp Bolt
7. EGR Adapter
8. EGR Valve Gasket
9. EGR Valve
10. EGR Valve Gasket
11. Cylinder Head Cover
12. Fuel Injector Harness Bracket
13. Fuel Injector Terminal

The fuel system consists of many tiny holes and spaces that allow the movement of fuel from one place to another. These holes and spaces are milled to extremely high precision. This is especially true of the fuel injectors.

The fuel injector is very sensitive to foreign material. Foreign material will result in fuel system breakdown. Exercise great care not to allow the entry of foreign material into the fuel system or fuel injectors during the removal and installation procedure.

Caution:

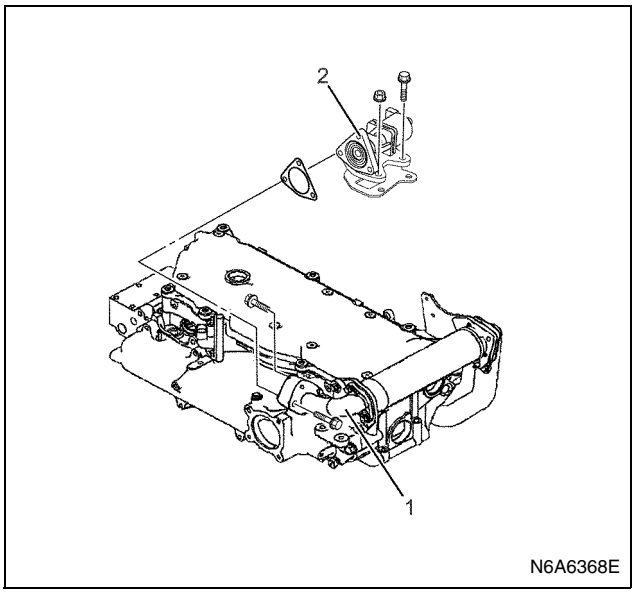
To avoid electric shock;

Set the switch to the ‘OFF’ position and disconnect battery negative cable before checking or repairing the fuel injector, wiring or/and connectors.

Important:
The Fuel Injector ID Code Data Programming MUST be done when the fuel injector is being replaced. The Fuel Injector ID Code information MUST be recorded before assembling the cylinder head cover.

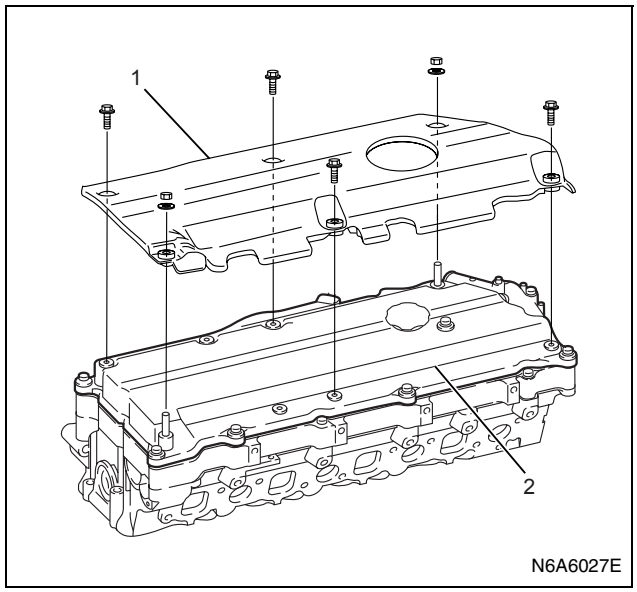
Removal

1. Remove the engine harness, the throttle position sensor, the EGR valve, the pressure sensor, and all of the fuel injector connectors.
2. Remove the EGR valve and the EGR adapter.
3. Tape the EGR case holes shut to prevent the entry of foreign material.



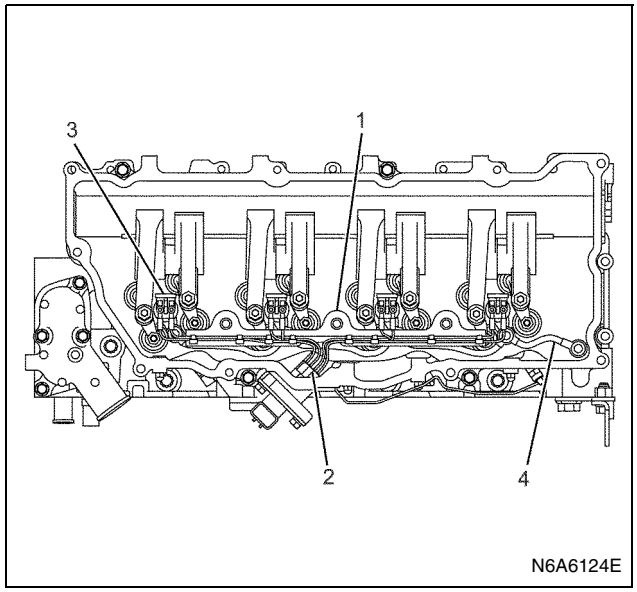
Legend
1. EGR Adapter
2. EGR Valve

4. Remove the sound insulation cover.
5. Remove the head cover.



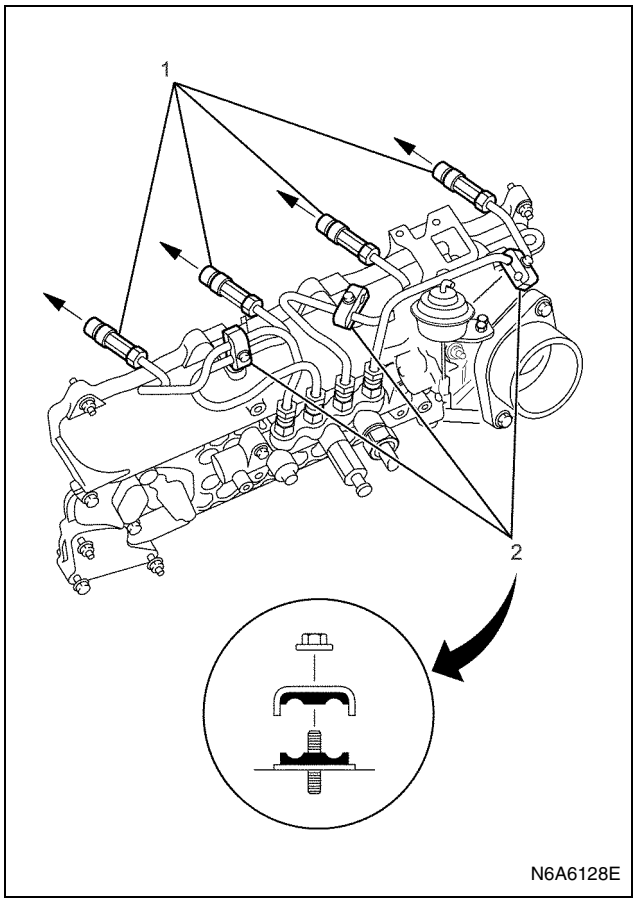
Legend
1. Sound Insulation Cover (For Europe)
2. Head Cover

6. Loosen the fuel injector terminal nuts.
7. Loosen the fuel injector harness bracket bolts. Remove the inside connector and the harness bracket.
8. Remove the fuel injector leak-off pipe.
9. Remove the lower cover.



Legend
1. Harness Bracket
2. Harness Connector
3. Fuel Injector Terminal
4. Fuel Leak-off Pipe

10. Remove the fuel injection pipe clips and the injection pipes.



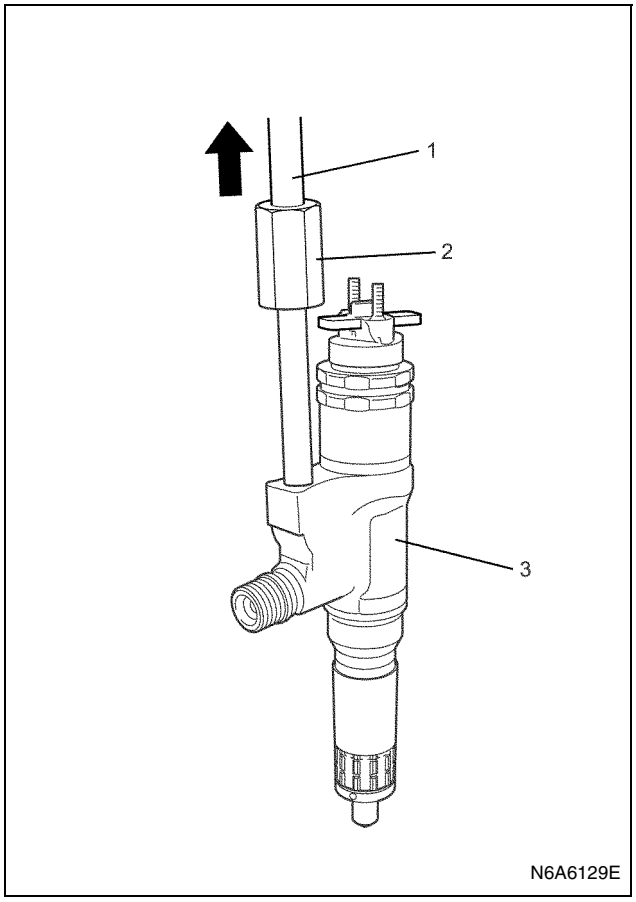
Legend
1. Fuel Injection Pipe
2. Pipe Clip

11. Loosen the fuel injector clamp fixing bolts and remove the fuel injectors.

If the fuel injectors are difficult to remove, use the fuel injector remover. Install the fuel injector remover to the leak-off pipe attachment part on the fuel injector. Use a sliding hammer to force the fuel injector clamp off the fuel injector.

Caution:
Do not remove the fuel injector sleeve.

Special tools
Fuel injector remover: 5-8840-2826-0 (EN-46720)
Sliding hammer: 5-8840-0019-0 (J-23907)



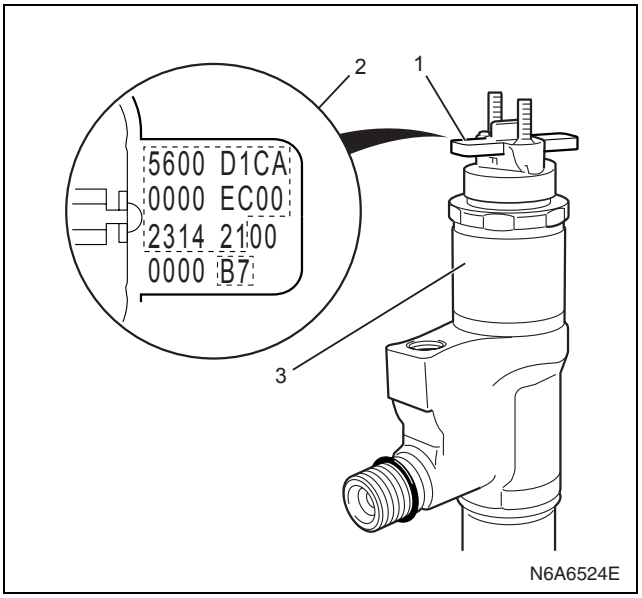
Legend
1. Sliding Hammer
2. Remover
3. Fuel Injector Assembly

12. Mark each fuel injector with the number of the cylinder from which it was removed. Store the fuel injectors in a safe place. Position the fuel injector so that the nozzle is protected.

Caution:
- Do not tamper with the electromagnetic portion of the fuel injector. Reduced electromagnetic function will result in injector failure.

Recording from the each fuel injector ID plate

Record 24 figures of each fuel injector ID plate. The correct order for the fuel injector ID code for the following illustration is as follows:
56 00 D1 CA 00 00 EC 00 23 14 21 B7

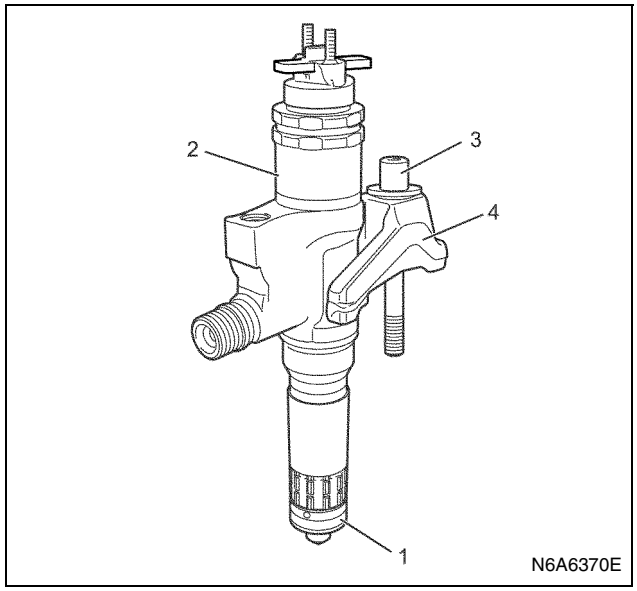


Legend
1. Fuel Injector ID Plate
2. Fuel Injector ID Code
3. Fuel Injector

Installation

Important:
Install each of the fuel injectors on its original position. (the cylinder from which it was removed)

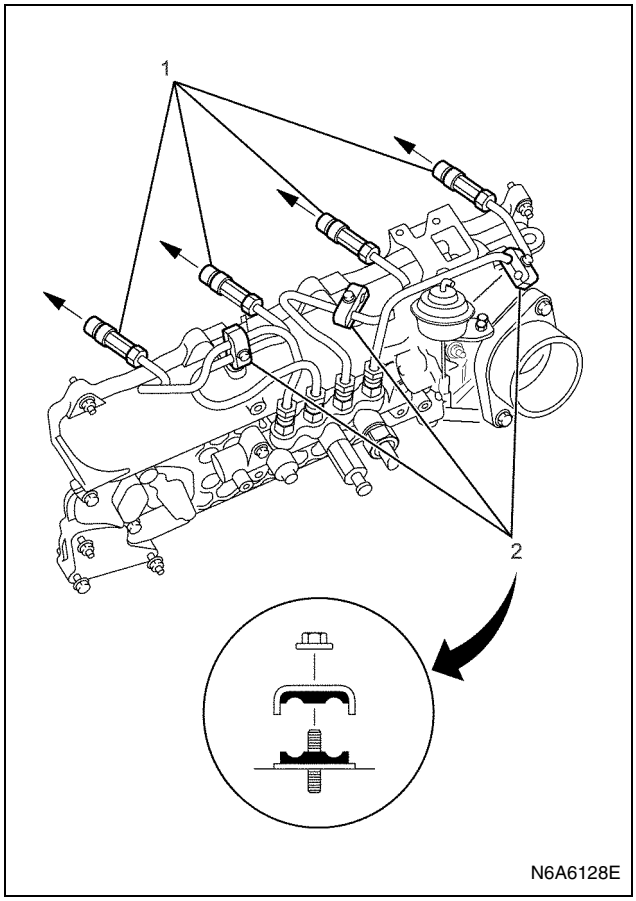
1. Install a new gasket and O-ring to each of the fuel injector clamps. Refer to the illustration.



Legend
1. Gasket
2. Fuel Injector
3. Bolt
4. Fuel Injector Clamp

2. Apply molybdenum to the threads and seating surfaces of the clamp bolts.
3. Install the fuel injector clamps to the cylinder head.
4. Temporarily tighten the clamp bolts.
5. Apply a thin coat of engine oil to the outer surface of the fuel injector side sleeve nuts.
6. Install the fuel injection pipes to the position shown in the illustration.
7. Use a spanner to carefully the sleeve nuts until the fuel injection pipes contact the fuel injector and common rail.
8. Tighten the fuel injection pipe clips to the specified torque.

Tighten:
Clips to 6 N·m (0.6 kg·m/52 lb·in)



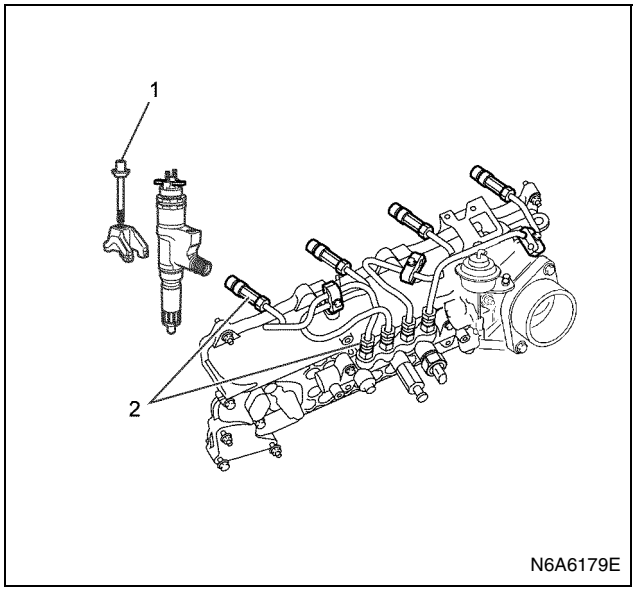
Legend
1. Fuel Injection Pipe
1. Pipe Clip

9. Final tighten the injection clamp bolts to the specified torque.

Tighten:
Bolts to 30 N·m (3.1 kg·m/22 lb·ft)

10. Tighten the injection pipes to the specified torque.

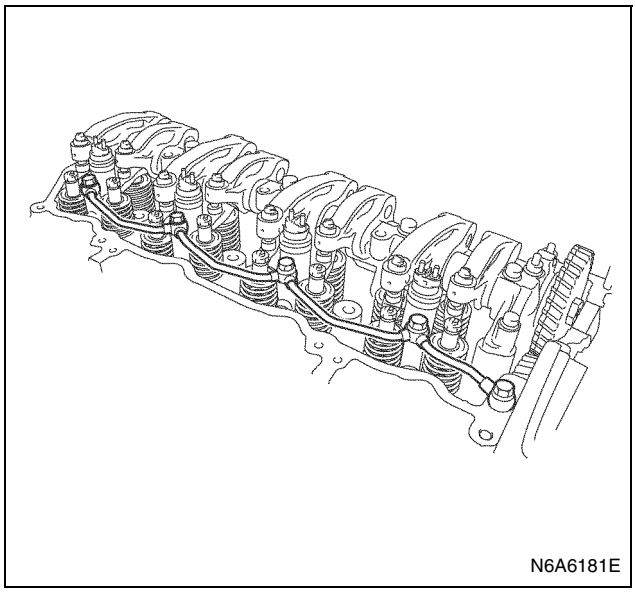
Tighten:
Injection pipes to 44 N·m (4.5 kg·m/33 lb·ft)



Legend
1. Clamp Bolt
2. Sleeve Nut

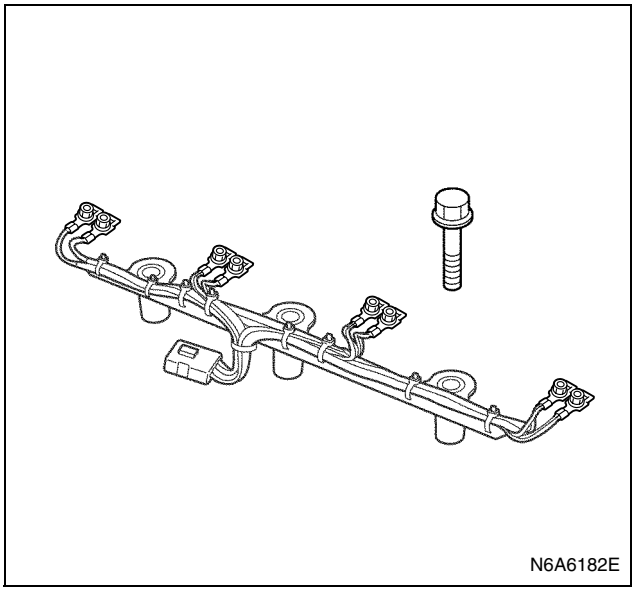
11. Install the nozzle leak-off pipes together with the new gaskets. Tighten the pipes to the specified torque.

Tighten:
Pipes to 12 N·m (1.2 kg·m/104 lb·in)



12. Install the fuel injector harness connectors. Work from the inside out.
13. Install the harness bracket and tighten the bolts to the specified torque.

Tighten:
Bolts to 48 N·m (4.9 kg·m/35 lb·ft)

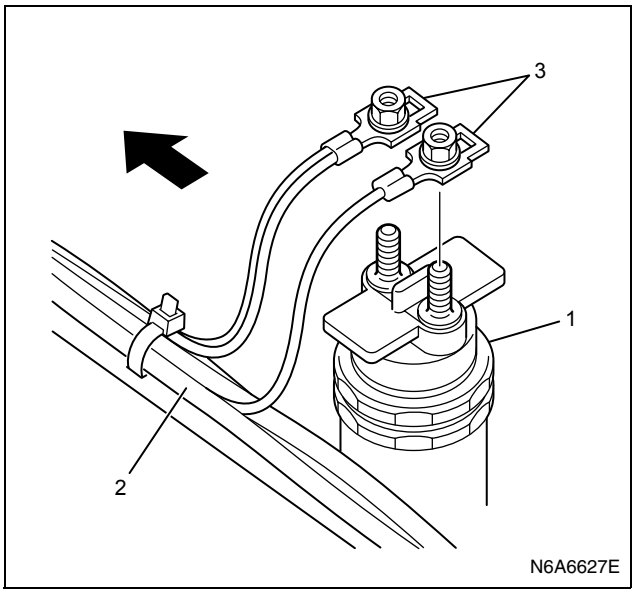


14. Install the fuel injector terminal nuts to the injector.

Tighten:
Nut to 2 N·m (0.2 kg·m/17 lb·in)

Caution:

- Do not overtighten the nuts. Damage to the terminal studs will result.
- The terminal nut with two wires is engine front side.

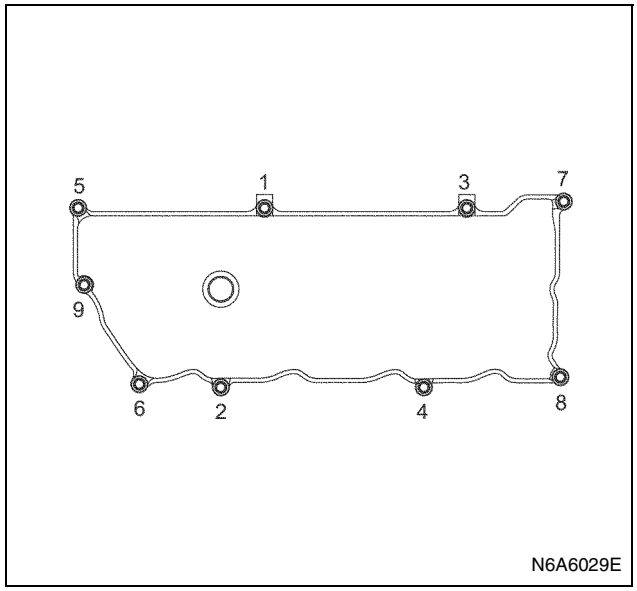


Legend

1. Fuel Injector
2. Harness
3. Terminal Nut

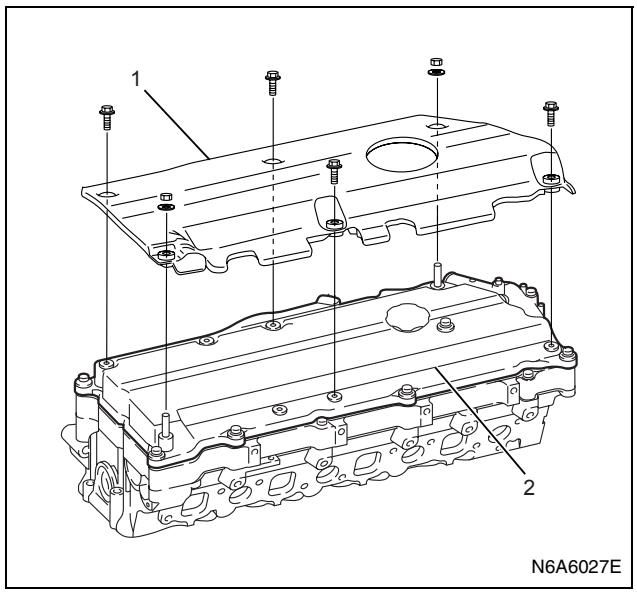
15. Install the gasket to the cylinder head cover.
16. Install the cylinder head cover and tighten up according to the order.

Tighten:
Bolts to 18 N·m (1.8 kg·m/13 lb·ft)



17. Install the sound insulation cover (For Europe).

Tighten:
Bolts to 8 N·m (0.8 kg·m/6 lb·ft)



Legend

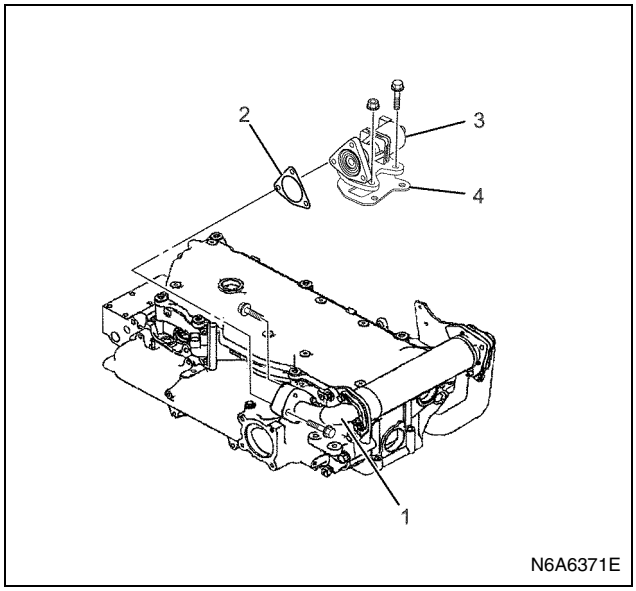
1. Sound Insulation Cover (For Europe)
2. Head Cover

18. Install the gasket to the EGR valve and tighten the bolts to the specified torque.

Tighten:
Bolts to 24 N·m (2.4 kg·m/17 lb·ft)

19. Install the gasket to the EGR adapter and tighten the bolts to the specified torque.

Tighten:
Bolts to 24 N·m (2.4 kg·m/17 lb·ft)



Legend

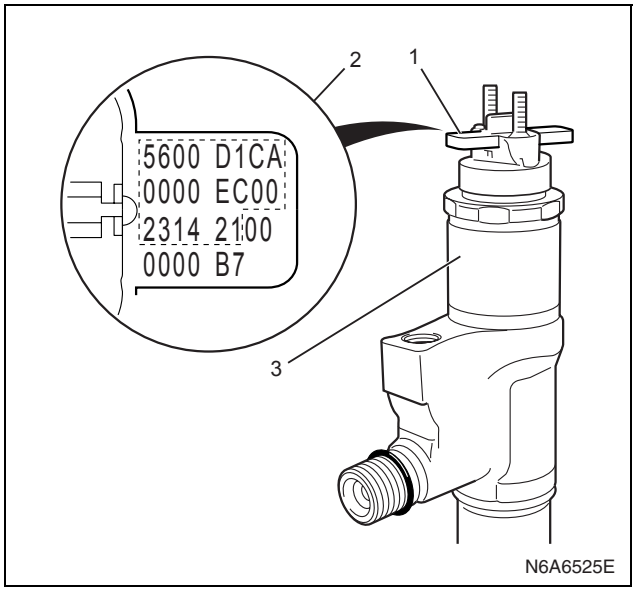
1. EGR Adapter
2. EGR Valve Gasket
3. EGR Valve
4. EGR Valve Gasket

20. Attach the engine harness connectors. Each composite connector should make a loud click when it is securely attached.

Fuel Injector ID Code Data Programming Procedure

1. Install the Tech 2.
2. Turn ON the ignition, with the engine OFF.
3. Select Diagnostics > appropriate vehicle identification > 4HK1 (Common Rail) > Programming > Injector ID Code > ID Code Registration.
4. Select replaced cylinder and press Change. Input 22 figures. Then, input in order from the left edge of upper sequence to the right sequence. The correct order for the fuel injector ID code for the following illustration is as follows:
   56 00 D1 CA 00 00 EC 00 23 14 21

Important:
The number of places required for input is 22 figures except last 2 figures.



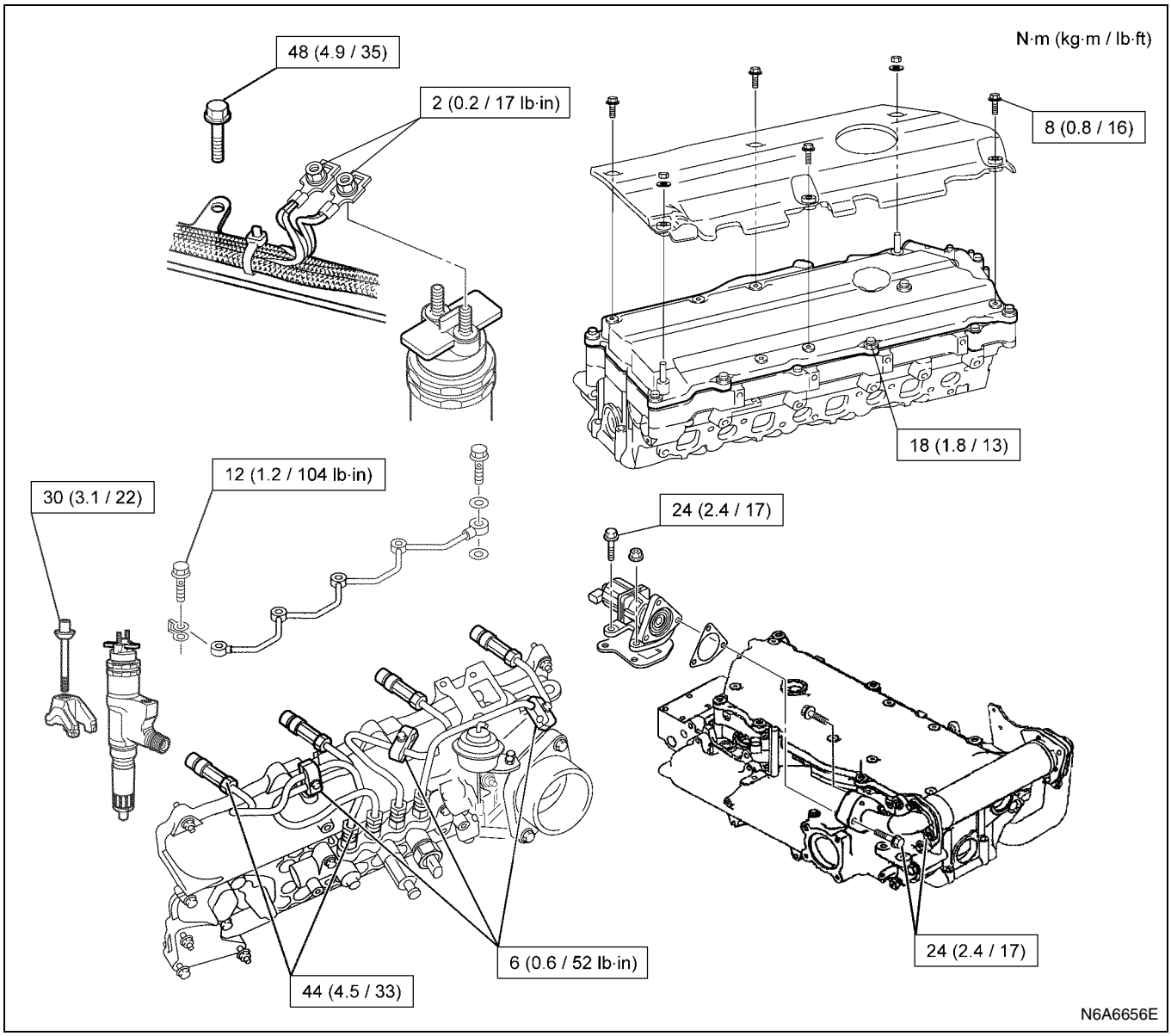
Legend

1. Fuel Injector ID Plate
2. Fuel Injector ID Code
3. Fuel Injector

5. After complete the registration, turn OFF the ignition for 30 second.
6. Turn ON the ignition.
7. Select Diagnostics > appropriate vehicle identification > 4HK1 (Common Rail) > Programming > Injector ID Code > Injector ID Code. At this point, all registered fuel injector ID code data can be verified. Compare the ID code values registered into the ECM and each fuel injector including the last 2 figures. If the registered ID code is incorrect, go back to Step 4 ID Code Registration.
8. Start the engine and let idle.
9. Inspect for a proper engine running condition and for no DTC's. Refer to the Diagnostic System Check-Engine Controls if needed.

Notice:
After replacement of the fuel injector, perform the following procedure.
All fuel injectors are replaced:
Remove the fuel injector ID code label on the cylinder head cover.
Any fuel injector(s) is replaced:
Blackout the replaced cylinder fuel injector ID code on the cylinder head cover with a marking pen or equivalent.

Torque Specifications



Special Tool

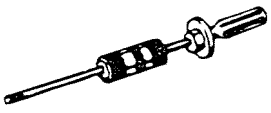
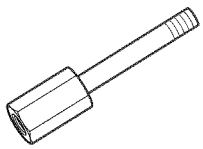
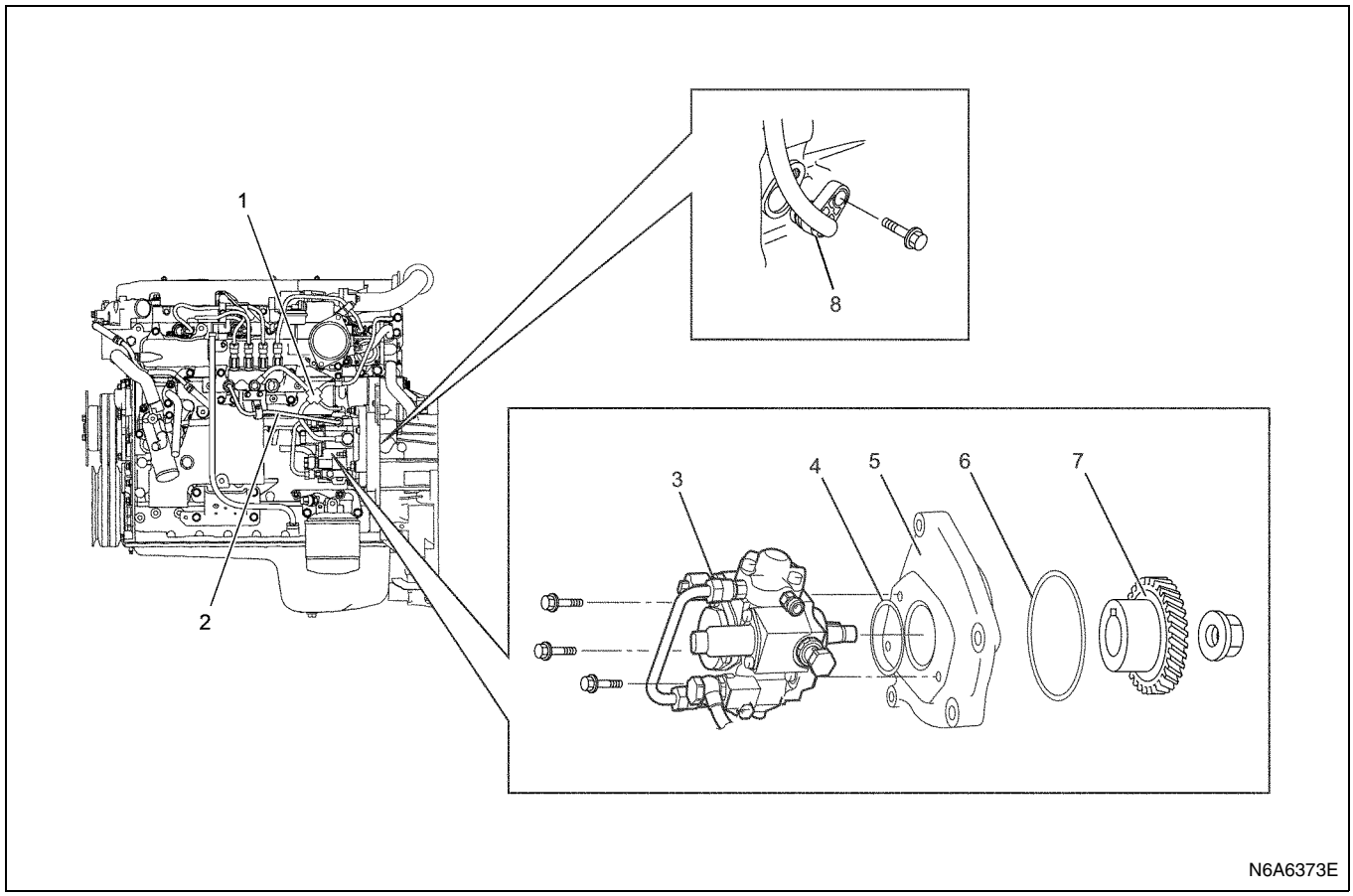
Illustration	Tool Number / Description / Remarks
 5884000190	5-8840-0019-0 (J-23907) Sliding Hammer

Illustration	Tool Number / Description / Remarks
 EN46720	5-8840-2826-0 (EN-46720) Fuel Injector Remover

Fuel Supply Pump

Components



Legend

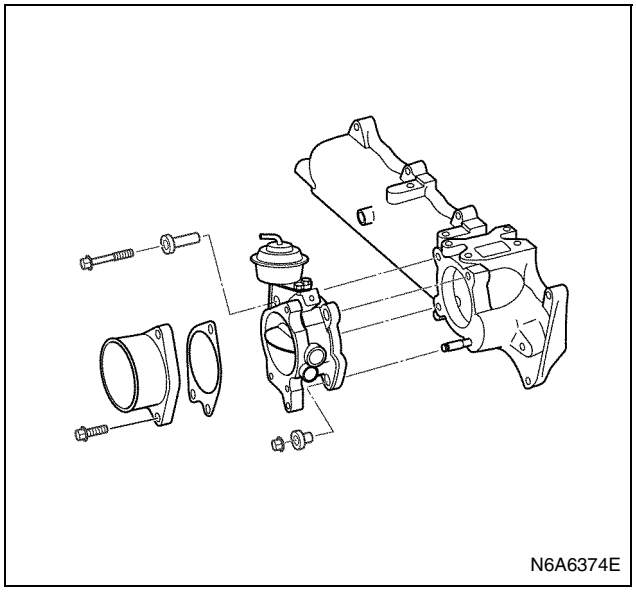
1. Fuel Leak-off Pipe
2. Fuel Pipe
3. Fuel Supply Pump
4. O-ring
5. Bracket
6. Bracket O-ring
7. Drive Gear
8. Oil Drain Adapter

The fuel system consists of many tiny holes and spaces that allow the movement of fuel from one place to another. These holes and spaces are milled to extremely high precision. This is especially true of the fuel injectors.
The fuel injector is very sensitive to foreign material. Foreign material will result in fuel system breakdown. Exercise great care not to allow the entry of foreign material into the fuel system or fuel injectors during the removal and installation procedure.

Important:
The Fuel supply pump must be timed to the engine.

Removal

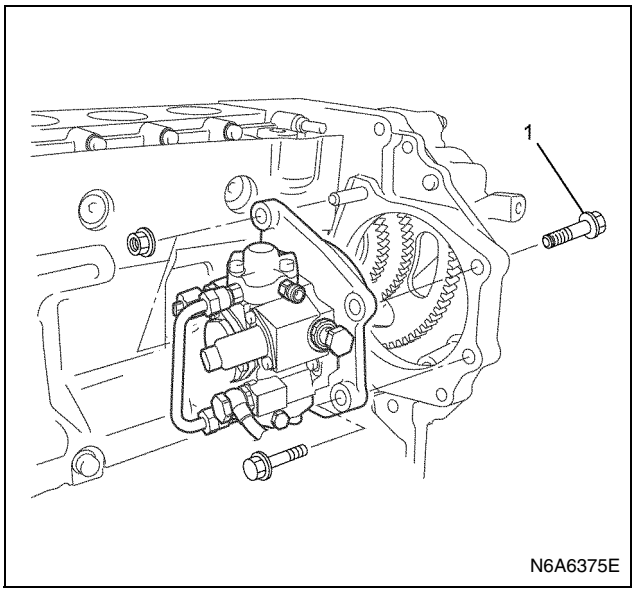
1. Remove the intake pipe and the intake throttle valve.
2. Remove the fuel pipe and fuel leak-off pipe.



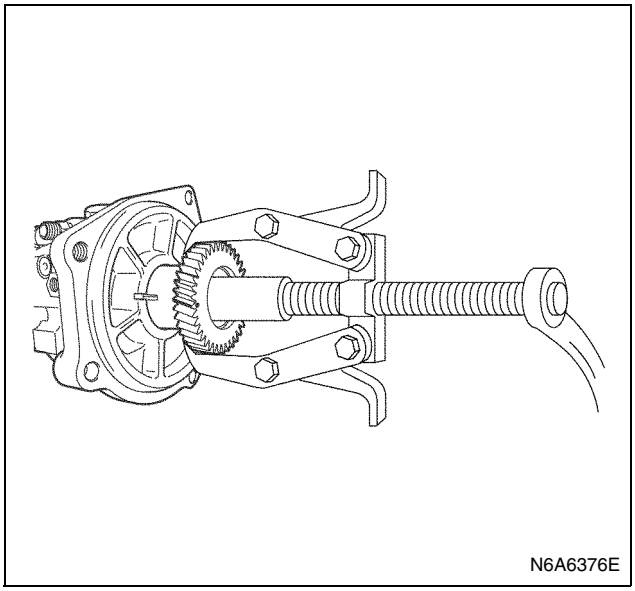
3. Remove the fuel feed hose.

4. Disconnect the fuel temperature sensor and the fuel rail pressure regulator harness connector from the fuel supply pump.
5. Remove the fuel supply pump attachment bolts and nuts, then remove the fuel supply pump.

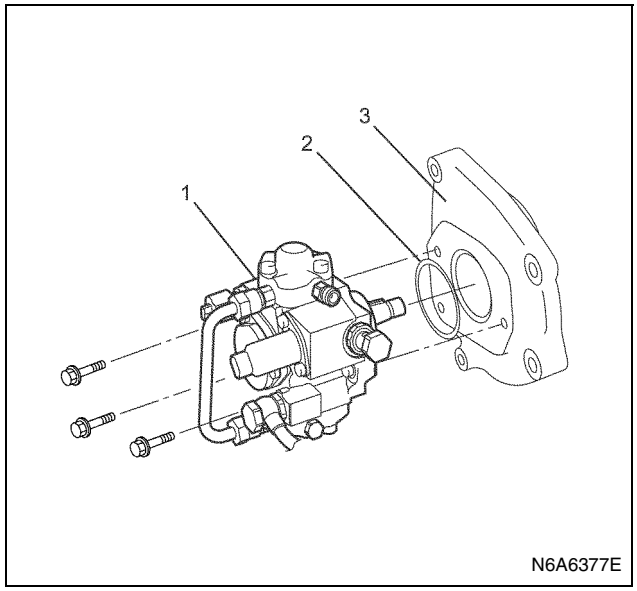
Notice:
One of the attachment bolt (1) secures the fuel supply pump to the flywheel housing as denoted in the picture below.



6. Use a gear puller to remove the fuel supply pump gear and the O-ring.



7. Loosen the 3 bolts holding the fuel supply pump bracket. Remove the bracket and the O-ring.



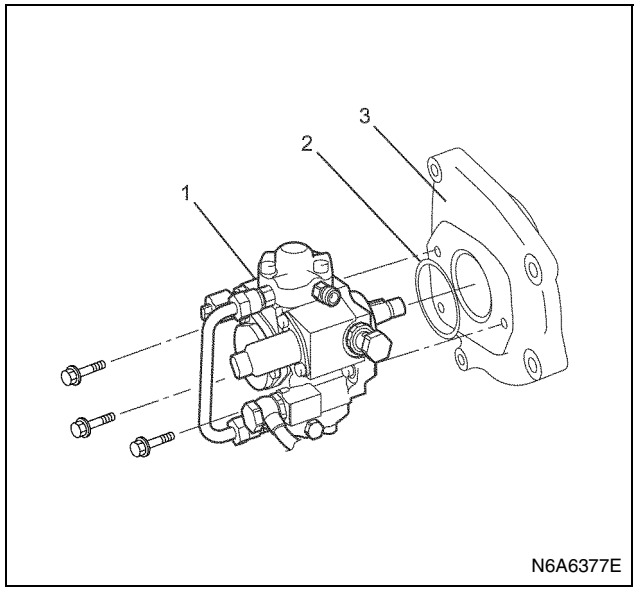
Legend
1. Fuel Supply Pump
2. O-ring
3. Fuel Supply Pump Bracket

Installation

1. Install the O-ring to the fuel supply pump.
2. Install the pump to the bracket and tighten the 3 bolts to the specified torque.

Tighten:
Bolts to 19 N·m (1.9 kg·m/14 lb·ft)

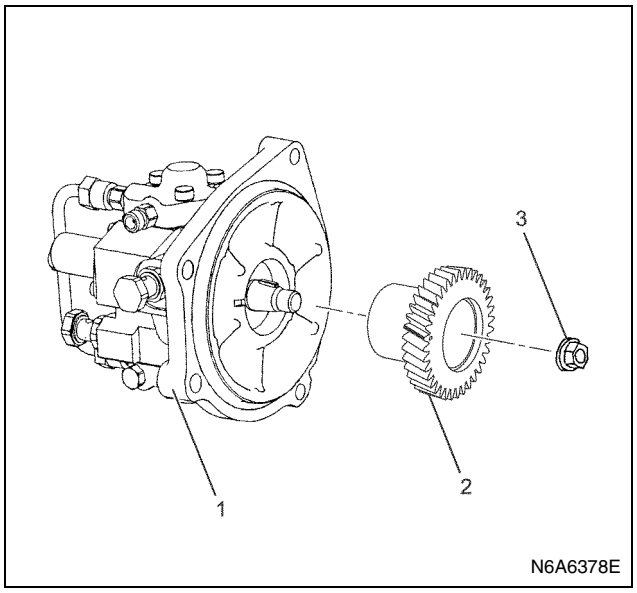
Caution:
Take care not to twist the O-ring.



Legend
1. Fuel Supply Pump
2. O-ring
3. Fuel Supply Pump Bracket

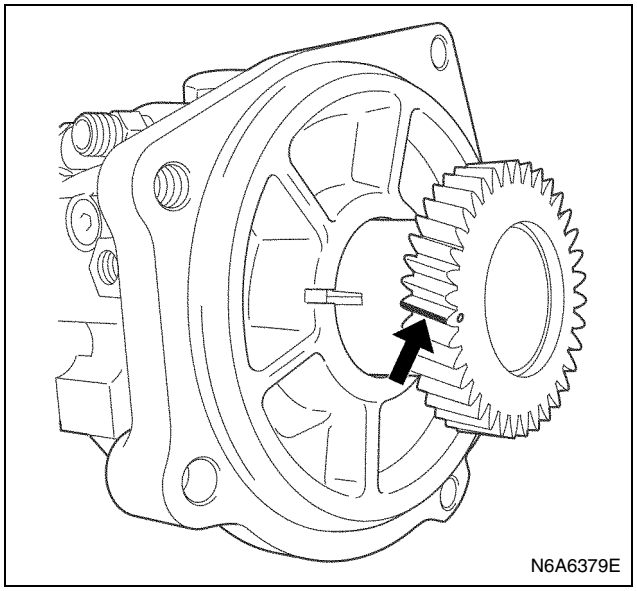
3. Align the fuel supply pump shaft key and gear. Install the gear and tighten the nut to the specified torque.
   There is a round alignment mark on the gear (white paint).

Tighten:
Nut to 64 N·m (6.5 kg·m/47 lb·ft)

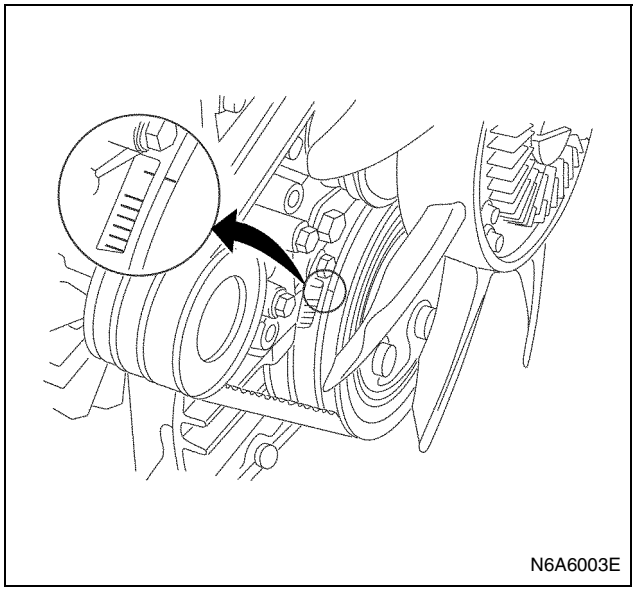


Legend
1. Fuel Supply Pump
2. Fuel Supply Gear
3. Nut

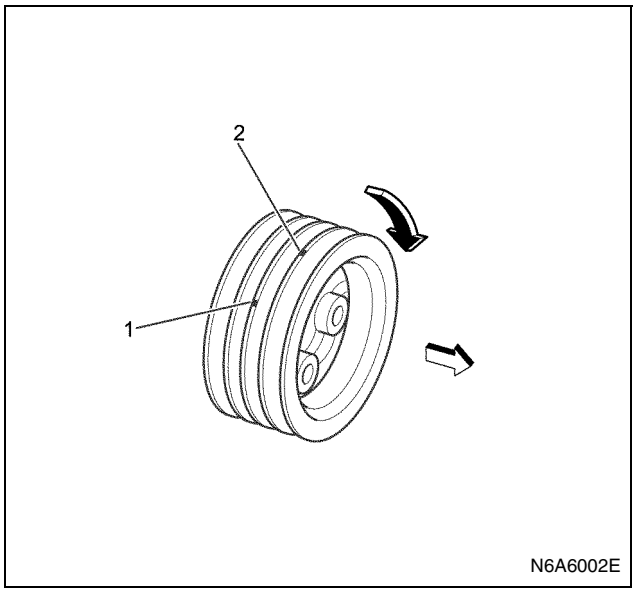
4. Apply white paint to the top of the fuel supply pump gear tooth directly above the stamped 'O' mark. Refer to the illustration.



5. Turn the crankshaft in the normal direction of engine rotation until the No. 1 or No. 4 cylinder is at TDC on the compression stroke.
   Refer to the illustration.



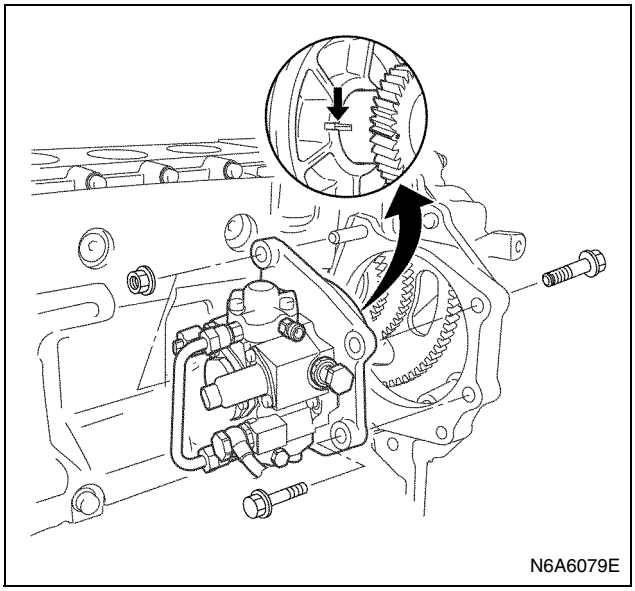
Notice:
There are 2 timing marks on the crankshaft pulley.
Mark (1) is near the front cover and is used to bring the 4HK1-TC engine to TDC.
Mark (2) is not applicable to this engine.
Be sure to use mark (1) when bringing the engine to TDC.



6. Remove the oil drain adapter.
7. Install the O-ring to the fuel supply pump.
8. Align the slits as shown in the illustration.
9. Insert the stud bolts into the guides and temporarily tighten them.

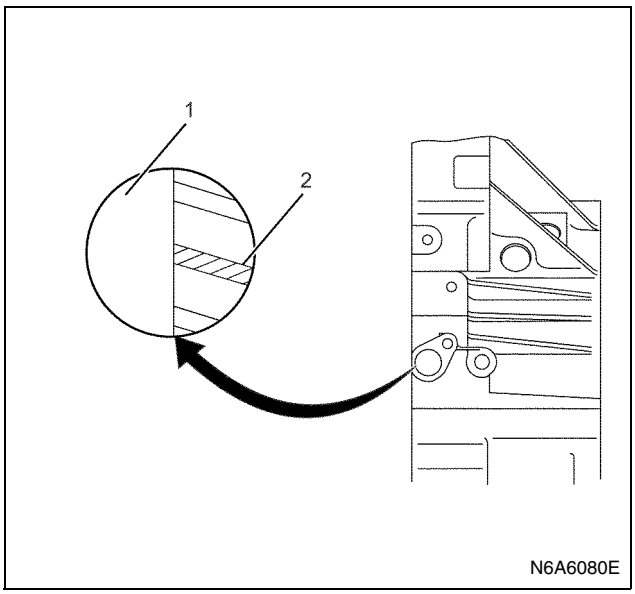
Caution:

- If the stud bolts (cylinder block side) have been loosened or replaced, apply Loctite 262 to the recessed portion of the bolts.



- Check that the round alignment mark (white paint) is positioned as shown in the illustration when viewed from the plug hole. If necessary, reposition the gear.
- Tighten the stud bolts and the nuts to the specified torque.

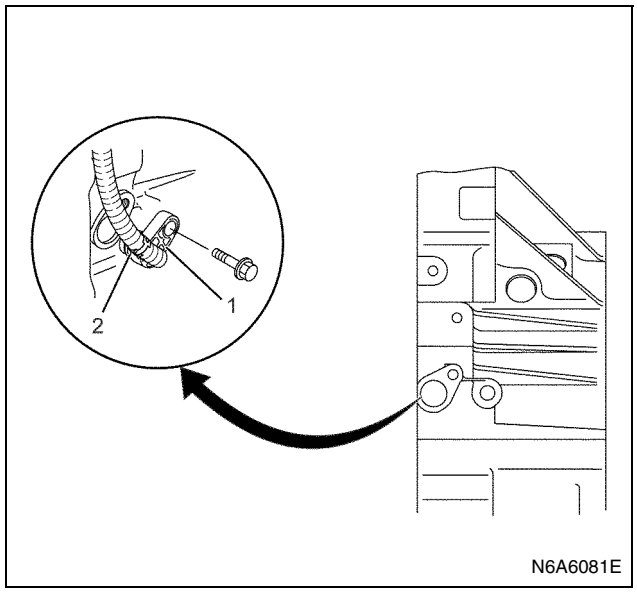
Tighten:
Nut to 50 N·m (5.1 kg·m/37 lb·ft)
Bolt to 76 N·m (7.7 kg·m/56 lb·ft)



Legend
1. Plug Hole
2. Alignment Mark

10. Apply a light coat of engine oil to the O-ring.
11. Install the oil drain adapter to the plug hole. Tighten the bolt to the specified torque.

Tighten:
Bolt to 8 N·m (0.8 kg·m/69 lb·in)

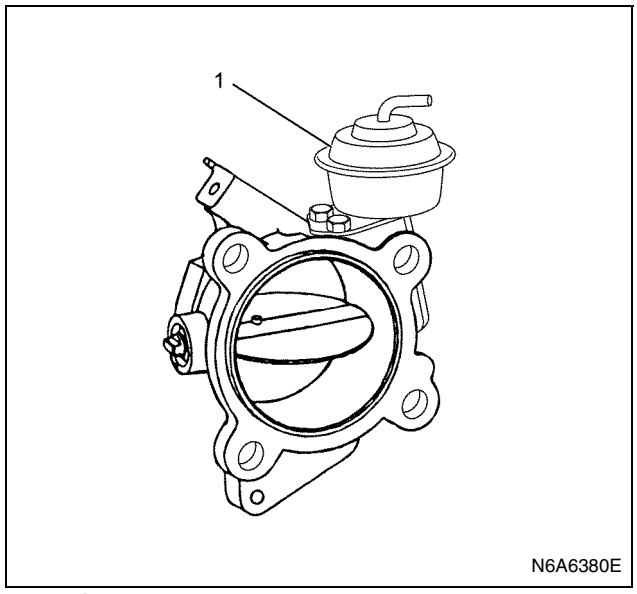


Legend
1. Oil Drain Adapter
2. O-ring

12. Connect the fuel temperature sensor and the suction control valve connectors to the fuel supply pump.
13. Install the fuel feed hose.
14. Install the throttle assembly.
    - Coat the fluid gasket and mount within 7 minutes.

Tighten:
Throttle assembly to 24 N·m (2.4 kg·m/17 lb·ft)

- Install the intake throttle valve chamber hose.



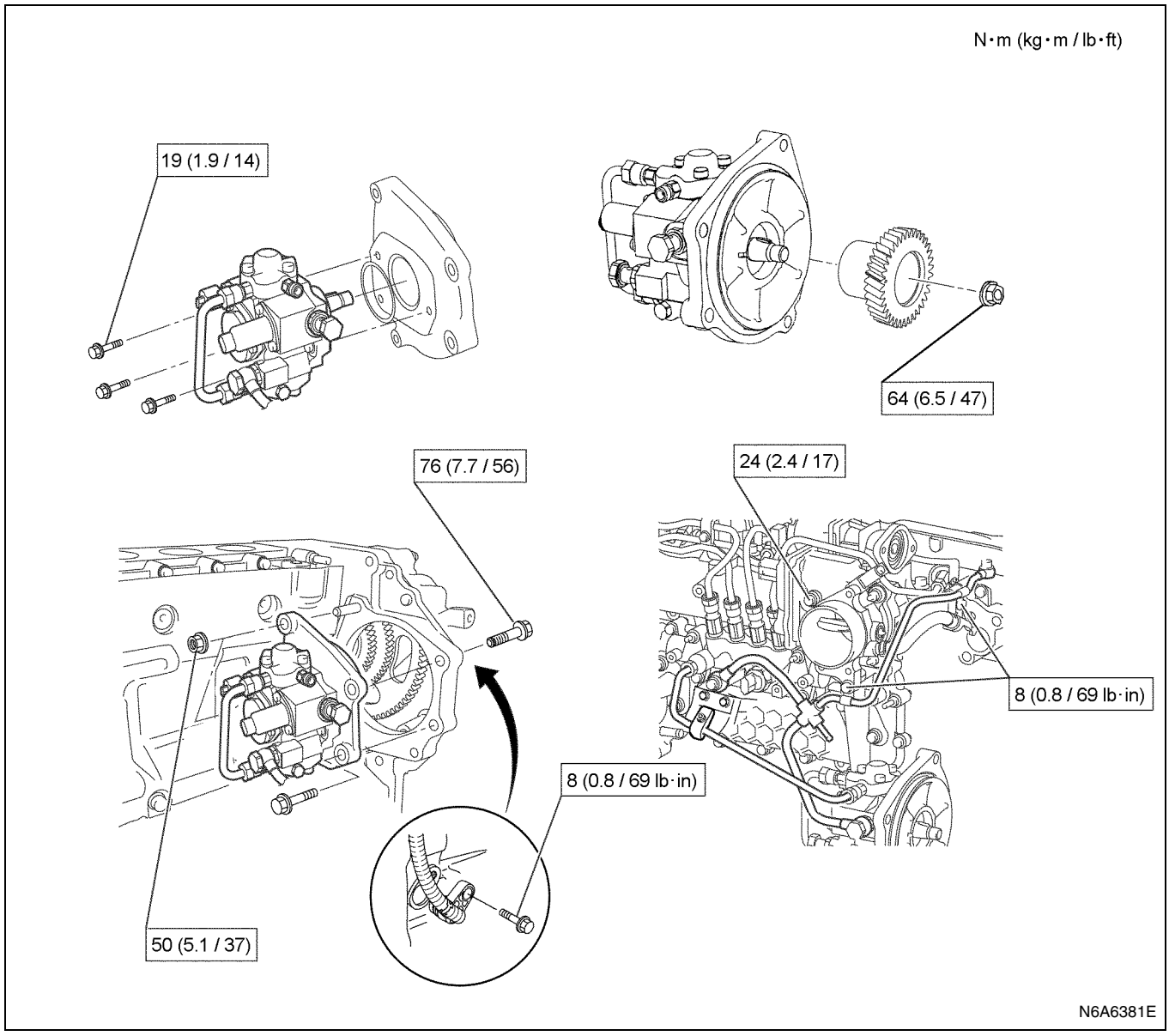
Legend
1. Intake Throttle Valve Chamber

15. Install the fuel pipe and fuel leak-off pipe.

Important:
In order to make the fuel supply pump characteristic learn into the ECM, let the engine idle until warm-up. If the fuel system DTC's stored in the meantime, once clear DTC and warm-up the engine again.

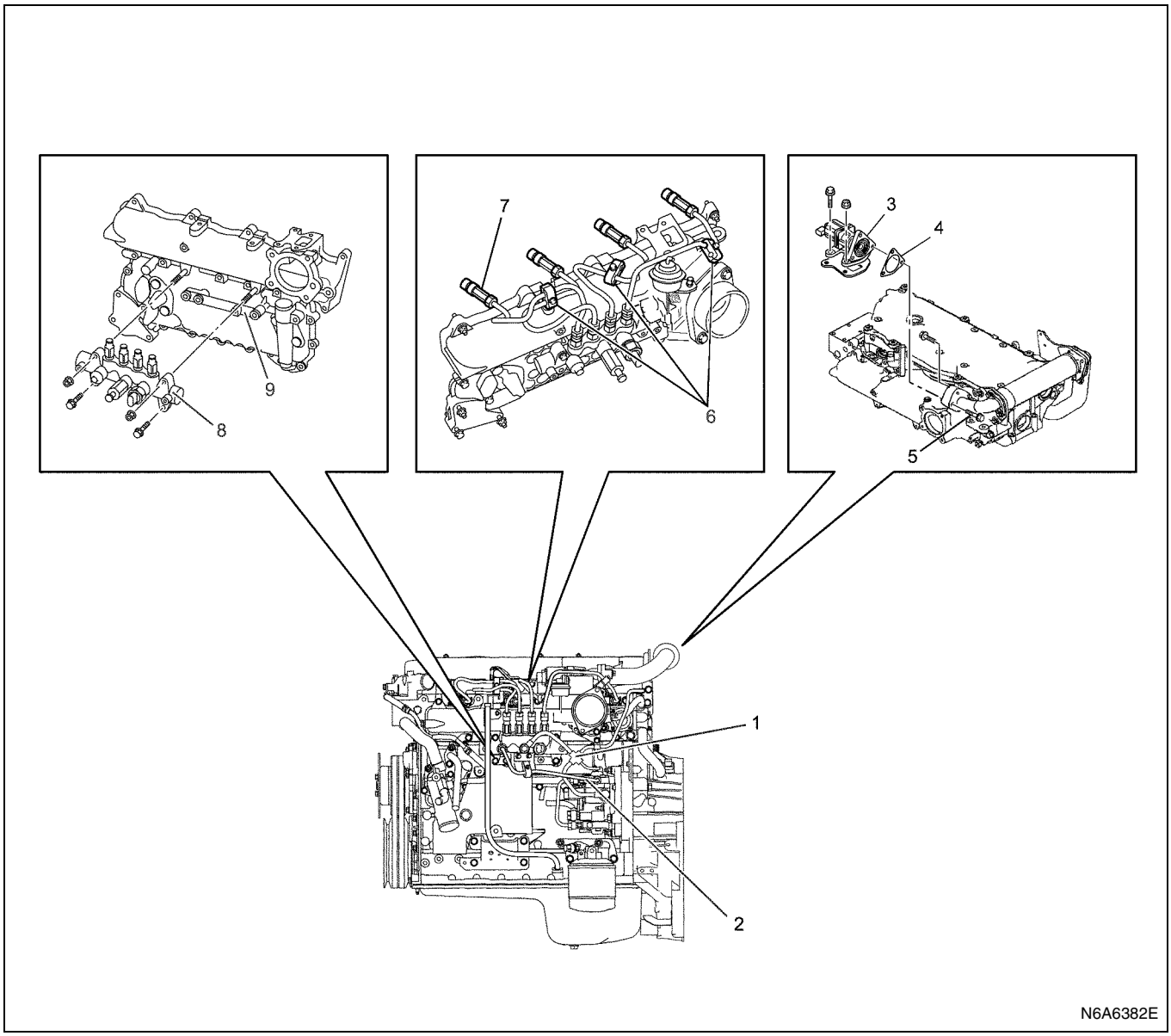
16. Inspect for a proper engine running condition and for no DTC's. Refer to the Diagnostic System Check-Engine Controls if needed.

Torque Specifications



Fuel Rail

Components



Legend

1. Fuel Leak-off Pipe
2. Fuel Pipe
3. EGR Valve
4. EGR Valve Gasket
5. EGR Adapter
6. Injection Pipe Clip
7. Injection Pipe (#1 to #4)
8. Fuel Rail
9. Fuel Rail Bracket

Parts of the fuel system such as the internal part of the fuel injector, holes and clearances that form passages for fuel are finished to a very high degree of accuracy. They are therefore highly sensitive to foreign matter and the entry of foreign matter could cause damage to the fuel passage. Therefore, effective measures should be taken to prevent the entry of foreign matter.

Removal

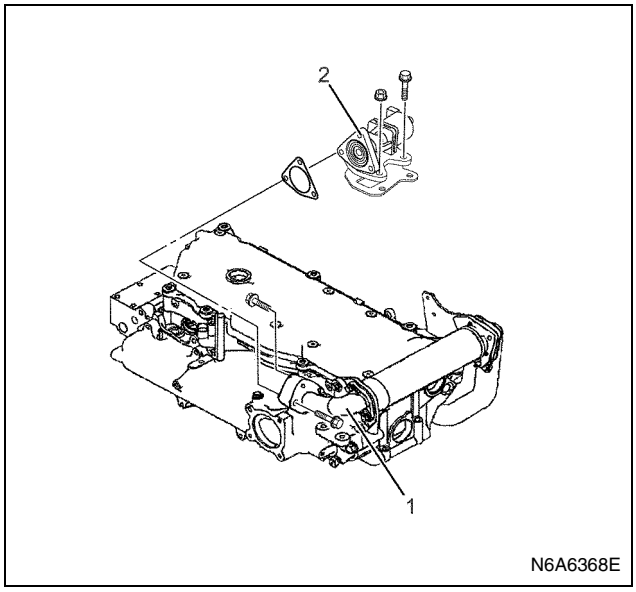
WARNING:
TO PREVENT LEAKED FUEL FROM CATCHING FIRE, DO NOT WORK WHILE THE ENGINE IS HOT.

Preparation:

- Pour detergent into a steam cleaner, and throughly wash around the sensor and the fuel rail.
- Remove water completely using air blow.

Notice:
Make sure that foreign matter will be prevented from getting in.

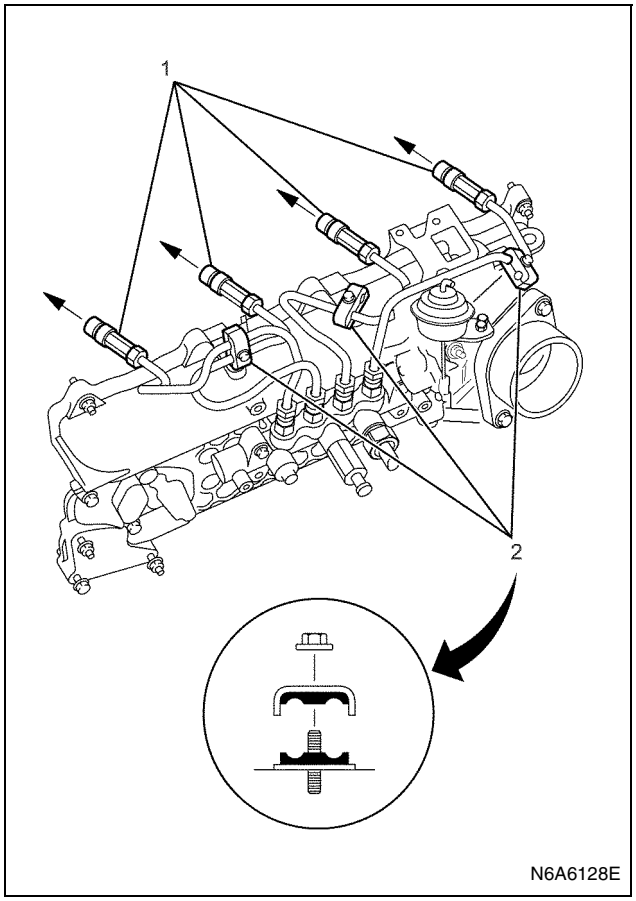
1. Remove the air intake pipe.
   - Disconnect the connector for the intake air temperature sensor.
2. Remove the fuel leak-off hose from the leak-off pipe.
   - Cover the removed fuel hose, keep it facing upward and secure it using wire, etc.
3. Disconnect the fuel rail pressure sensor harness connectors.
4. Remove the EGR valve and the EGR adapter.
5. Tape the EGR case holes shut to prevent the entry of foreign material.



Legend
1. EGR Adapter
2. EGR Valve

6. Remove the injection pipe clip and remove the injection pipes.

Important:
Loosen the injection pipes gradually not to scatter high pressure fuel.

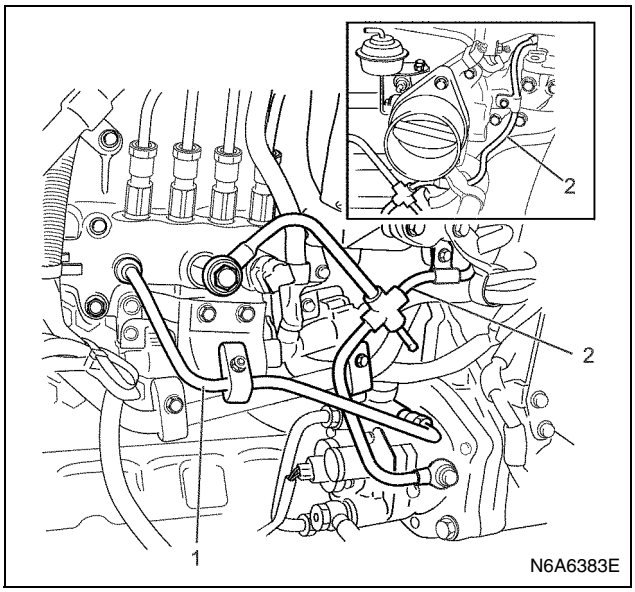


Legend
1. Fuel Injection Pipe
2. Fuel Injection Pipe Clip

7. Remove the fuel pipe.

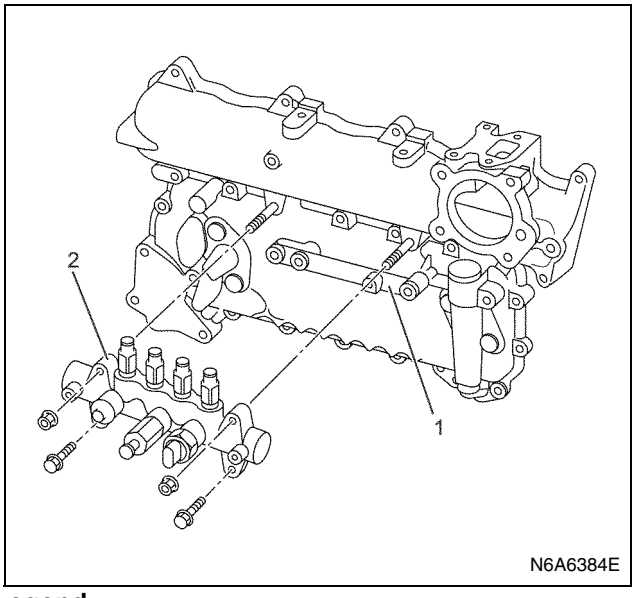
Important:
Loosen the fuel pipe gradually not to scatter high pressure fuel.

8. Remove the clips and the fuel leak-off pipe.



Legend
1. Fuel Pipe
2. Fuel Leak-off Pipe

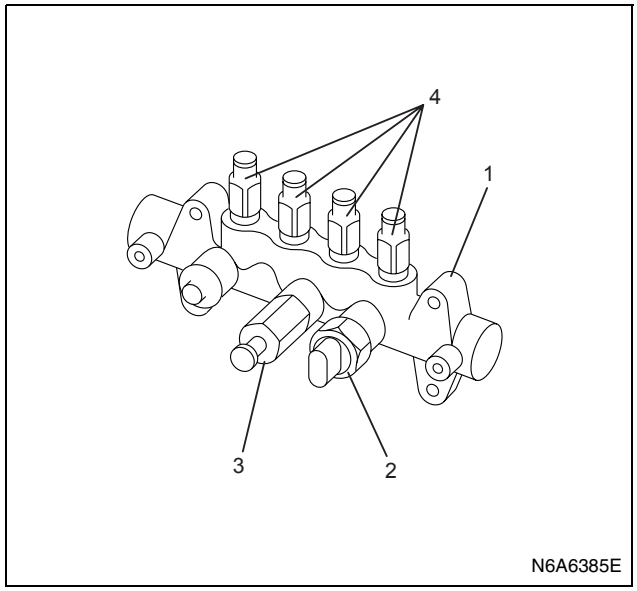
9. Remove the fuel rail and the fuel rail bracket.
   - Do not remove the flow damper.
     The dampers should always remain in the fuel rail.
   - Take care not to damage the connector unit of the pressure sensor.



Legend
1. Fuel Rail Bracket
2. Fuel Rail

Disassembly

1. Remove the fuel pressure limiter.
2. Remove the fuel rail pressure sensor.



Legend
1. Fuel Rail
2. Fuel Rail Pressure Sensor
3. Fuel Pressure Limiter
4. Flow Damper

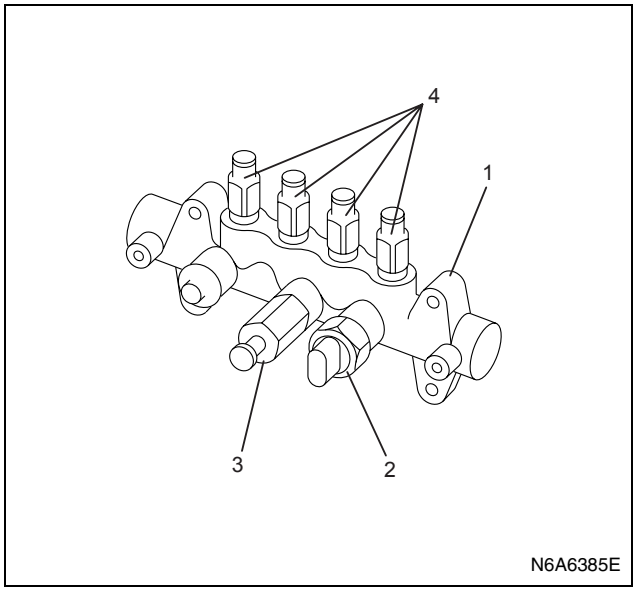
Reassembly

1. Install the fuel pressure limiter.

Tighten:
Fuel pressure limiter to 172 N·m (17.5 kg·m/127 lb·ft)

2. Install the fuel rail pressure sensor.

Tighten:
Fuel rail pressure sensor to 98 N·m (10 kg·m/72 lb·ft)



Legend
1. Fuel Rail
2. Fuel Rail Pressure Sensor
3. Fuel Pressure Limiter
4. Flow Damper

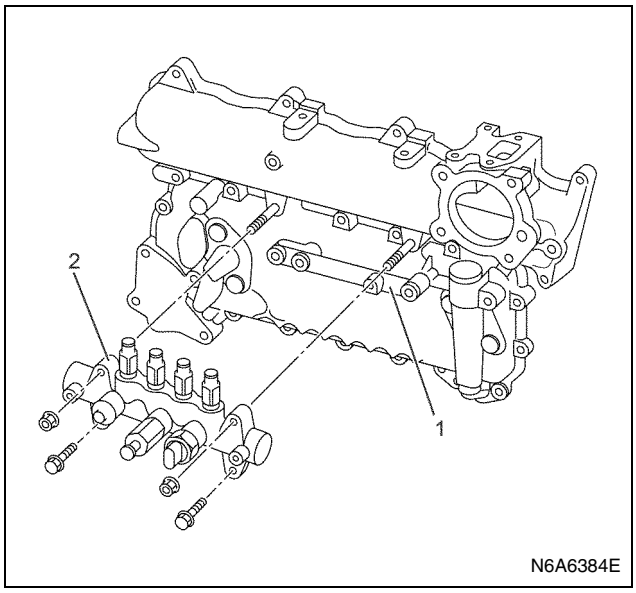
Installation

1. Tighten the fuel rail bracket using the specified mounting torque.

Tighten:
Nuts to 19 N·m (1.9 kg·m/14 lb·ft)

2. Tighten the fuel rail using the specified mounting torque.

Tighten:
Bolts to 19 N·m (1.9 kg·m/14 lb·ft)



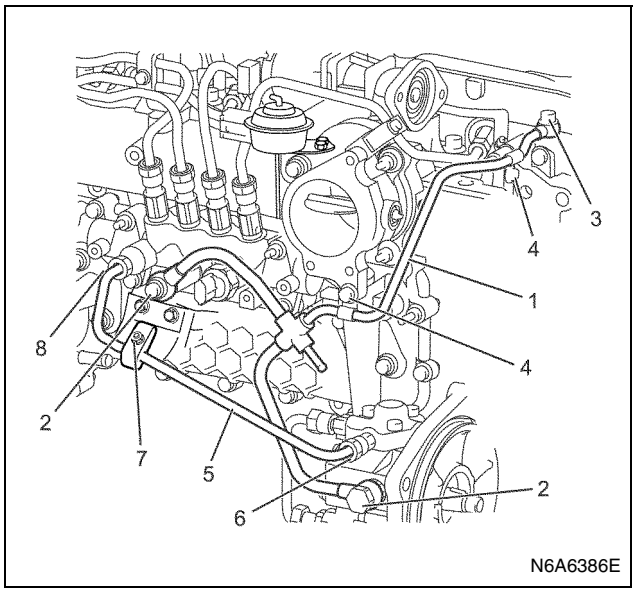
Legend
1. Fuel Rail Bracket
2. Fuel Rail

3. Tighten the fuel leak-off pipe (1) using the mounting eyebolt and the clips using the specified torque.

Tighten:
(2) to 18 N·m (1.8 kg·m/13 lb·ft)
(3) to 12 N·m (1.2 kg·m/104 lb·in)
(4) to 8 N·m (0.8 kg·m/69 lb·in)

4. Tighten the fuel pipe (5) using the mounting sleeve nut and the clip using the specified torque.

Tighten:
(6) to 44 N·m (4.5 kg·m/33 lb·ft)
(7) to 6 N·m (0.6 kg·m/52 lb·in)
(8) to 44 N·m (4.5 kg·m/33 lb·ft)

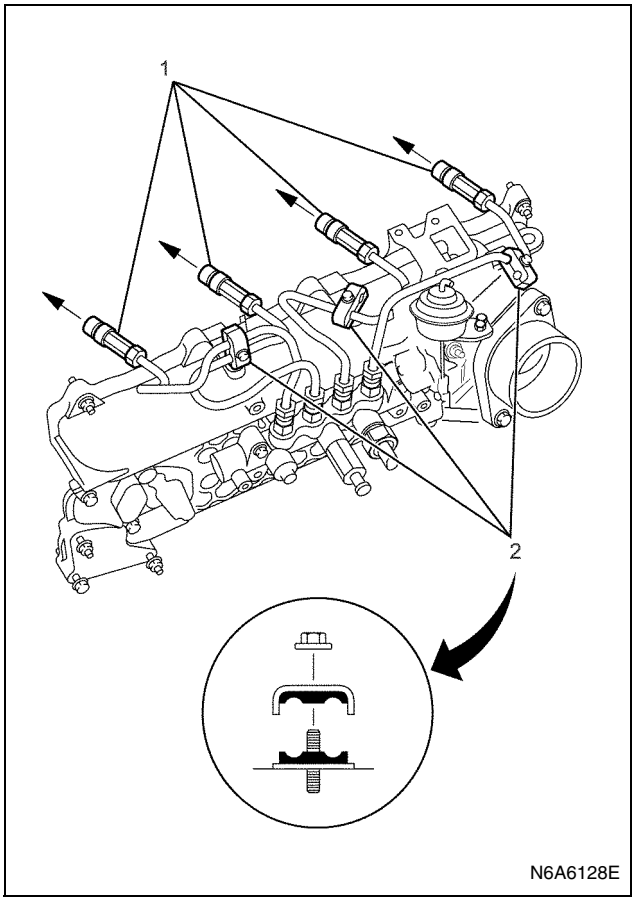


5. Install the fuel leak-off hose to the fuel leak-off pipe.
6. Tighten the injection pipe and the clip using the specified mounting torque.

Tighten:
Injection pipe sleeve nut to 44 N·m (4.5 kg·m/33 lb·ft)

Tighten:
Injection pipe clip to 6 N·m (0.6 kg·m/52 lb·in)

- Apply a thin coat of engine oil on the periphery of the sleeve nut on the fuel injector side and assemble.



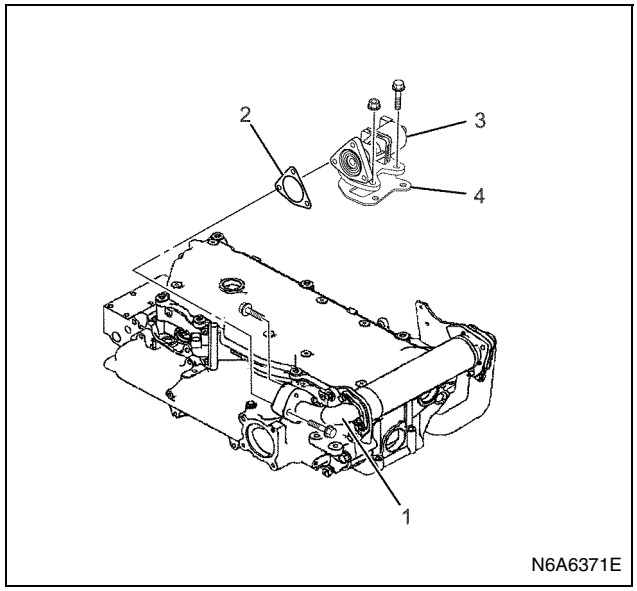
Legend
1. Fuel Injection Pipe
2. Fuel Injection Pipe Clip

7. Connect the fuel rail pressure (FRP) sensor connector.
8. Install the gasket to the EGR valve and tighten the bolts to the specified torque.

Tighten:
Bolt to 24 N·m (2.4 kg·m/17 lb·ft)

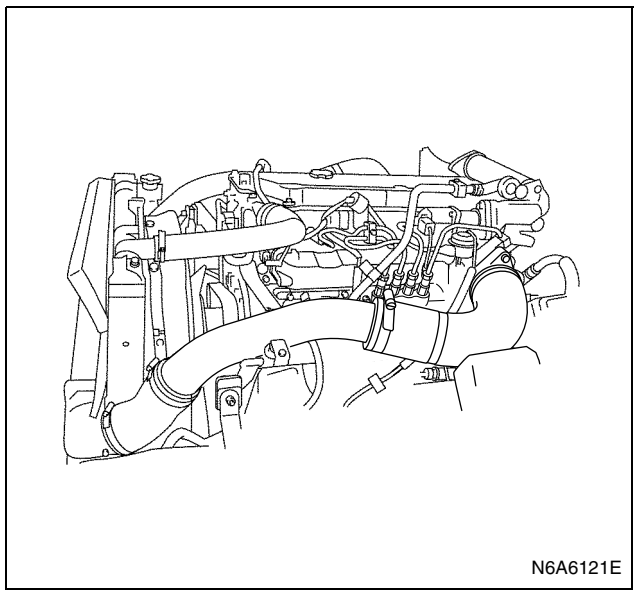
9. Install the gasket to the EGR adapter and tighten the bolts to the specified torque.

Tighten:
Bolt to 24 N·m (2.4 kg·m/17 lb·ft)

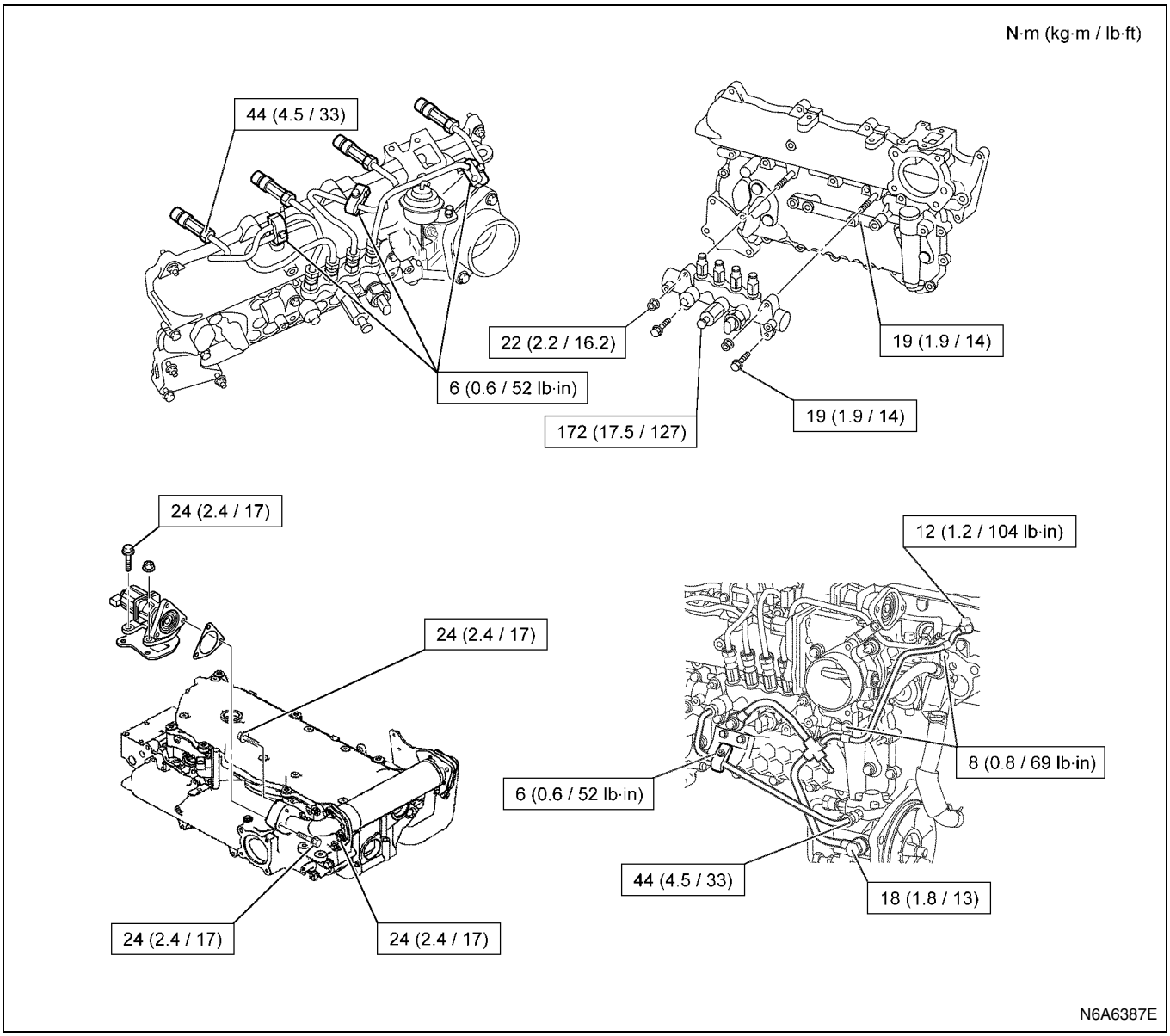


Legend
1. EGR Adapter
2. EGR Valve Gasket
3. EGR Valve
4. EGR Valve Gasket

10. Install the air intake duct.
    - Connect the connector for the intake air temperature sensor.



Torque Specifications

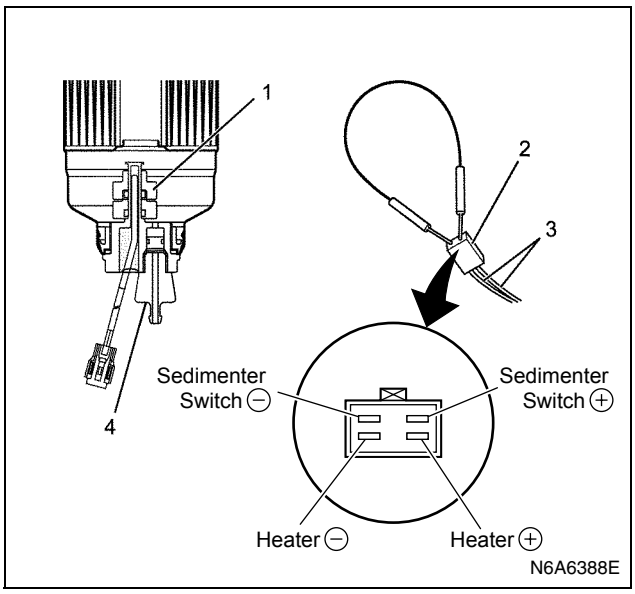


Fuel Sedimenter Switch

Inspection

1. Check that there is continuity between the switch connector terminals when the float in the fuel sedimenter is above the water drain line.
2. Turn on the ignition switch, disconnect the fuel sedimenter connector, and connect the terminals of the connectors on the vehicle side. Confirm that the sedimenter warning lamp lights up.

If abnormalities are detected during the check, replace the switch parts and carry out repairs in case of defective connection between circuits or short circuits.

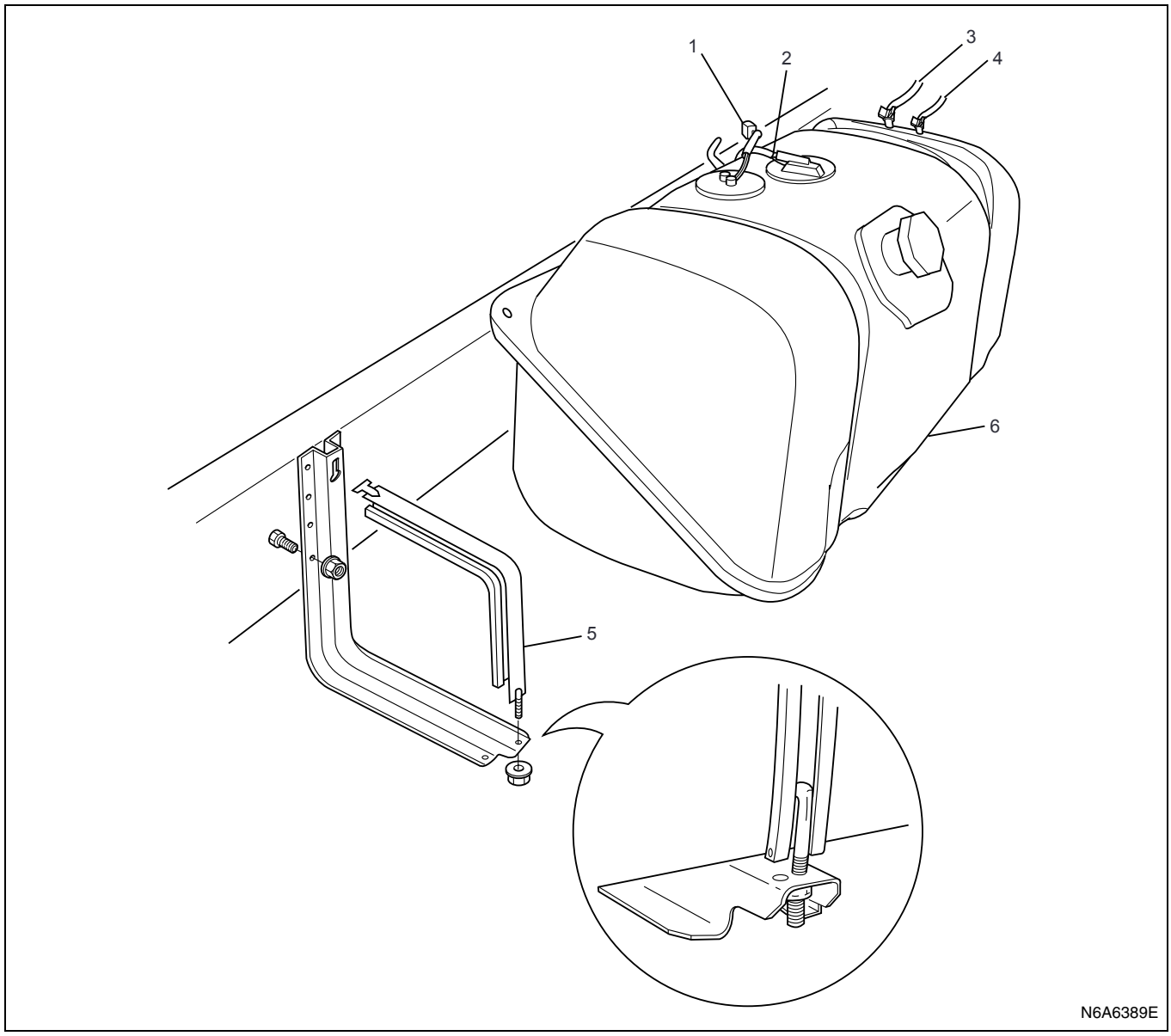


Legend

1. Sensor
2. Connector on The Vehicle Side
3. Harness
4. Drain Cock

Fuel Tank

Components



Legend

1. Fuel Gauge Unit Connector
2. Evaporated Fuel Hose
3. Fuel Feed Hose
4. Fuel Return Hose
5. Band
6. Fuel Tank

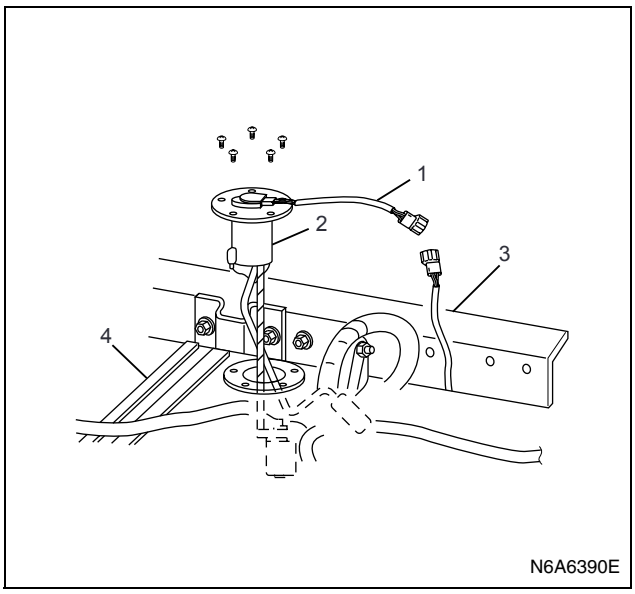
Removal

1. Loosen the fuel filler cap.
2. Drain the fuel from the drain plug.
3. After draining, tighten the drain plug with the specified torque.

Tighten:
20 N·m (2.0 kg·m/15 lb·ft)

4. Remove the fuel gauge unit connector.
5. Remove the evaporated fuel hose.
6. Remove the fuel feed hose.
7. Remove the fuel return hose.
   - Plug the hose so that fuel does not flow out, and tie it to the frame-side with the opening faced up.
8. Remove the nut of band which installs fuel tank, and remove the band tip in the frame-side.
9. Pull out the fuel tank to the outside.

Caution:
If the fuel tank cannot be pulled out, remove the bracket and pull out the fuel tank downward.



Legend
1. Fuel Gauge Unit Connector
2. Fuel Gauge Unit
3. Cross-member
4. Fuel Tank

Installation

1. Install the fuel tank.

Caution:
When the bracket has been removed while taking out the fuel tank, attach the bracket to the frame and tighten it to the specified torque.

Tighten:
55 N·m (5.6 kg·m/41 lb·ft)

Also, when placing the fuel tank on the bracket, make sure that the rubber part attached on the fuel tank is put onto the bracket.

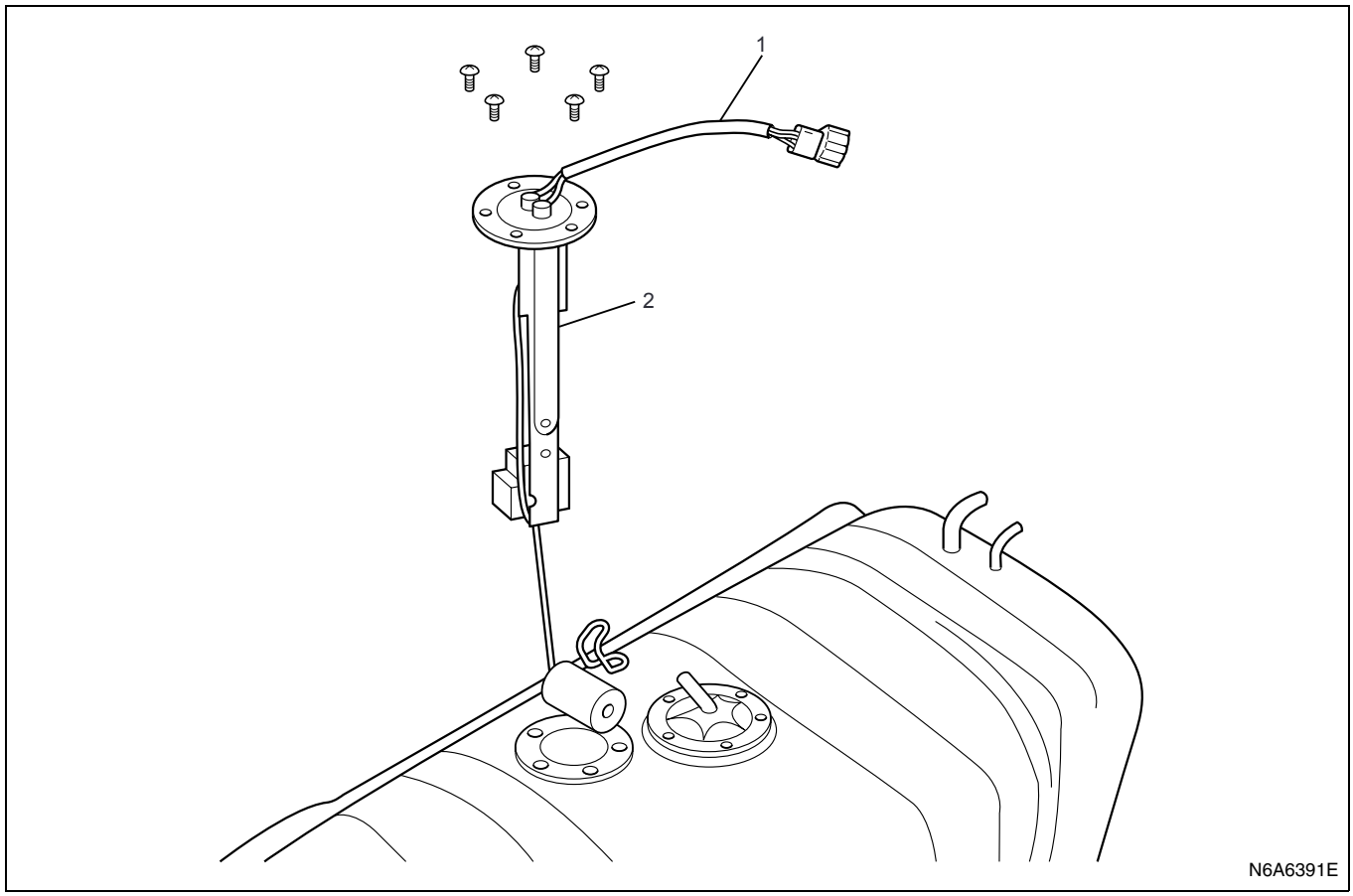
2. Install the band to the fuel tank and tighten up the nuts with the specified torque.

Tighten:
12 N·m (1.2 kg·m/9 lb·ft)

3. Install the fuel return hose.
4. Install the fuel feed hose.
   - Insert the hose into the pipe for more than 25 mm (1.0 in).
5. Install the evaporated fuel hose.
   - Fill the fuel tank with fuel, and tighten the fuel filler cap.
   - Connect the battery earth cable.
   - Make sure there is no fuel leakage from the connector parts of hoses after starting the engine.
6. Connect the fuel gauge unit connector.

Fuel Gauge Unit

Components



Legend

1. Fuel Gauge Unit Connector
2. Fuel Gauge Unit

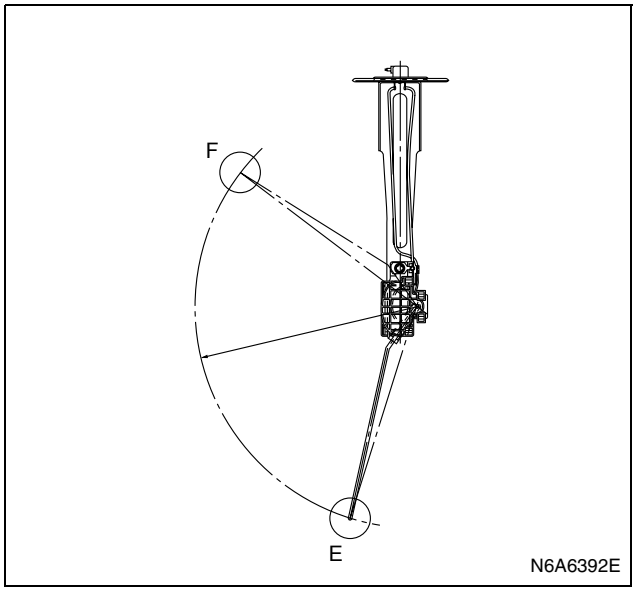
Removal

1. Remove the wiring connector from the fuel gauge unit.
2. Remove the installed screw and remove the fuel gauge unit.

Caution:
When removing/installing the fuel gauge unit, take care not to interfere with adjacent parts and not to let the arm etc. deformed. Also, after removing the fuel gauge unit, cover the tank with a cloth to prevent the entry of dust.

Inspection

The fuel tank unit changes the internal resistance according to the float position (fluid level) to operate the indicator of the fuel meter.



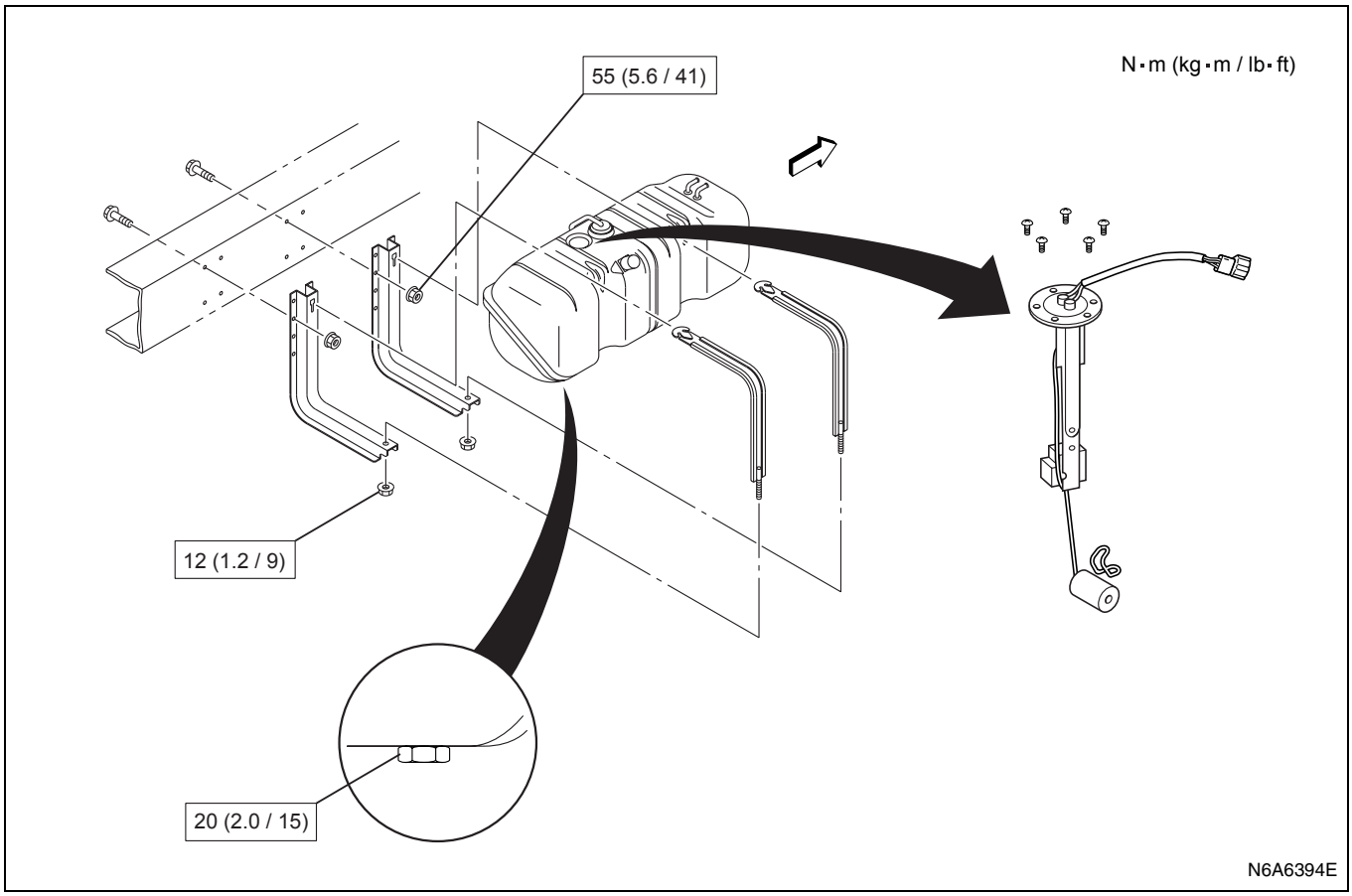
1. While moving the float from “E” to “F”, measure the resistance between the connector terminals 1J-28 and 2J-28.
2. Check that the fuel level warning lamp comes on when the float is at “E” position. If the result of the inspection is unsatisfactory, replace with a new part.

Installation

Assemble in the reverse order of disassembly.

1. Install the fuel gauge unit.
2. Connect the wiring connector to the fuel gauge unit.

Tightening Torque Specifications



ENGINE

Engine Electrical

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Service Precautions

General Procedure

When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

Battery

General Description

There are six battery fluid caps at the top of the battery.

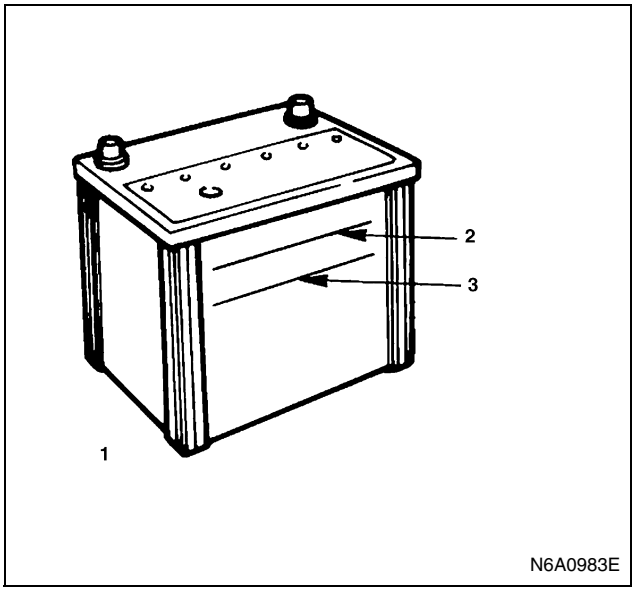
Diagnosis

Visual Inspection

Inspect the battery for obvious physical damage, such as a cracked or broken case, which would permit electrolyte loss.
Replace the battery if obvious physical damage is discovered during inspection.
Check for any other physical damage and correct it as necessary.

Fluid Level Check

The fluid level should be between the upper level line and lower level line on side of the battery.



Legend

1. Battery
2. Upper Level
3. Lower Level

Voltage Check

1. Put voltmeter test leads to battery terminals.
   a. VOLTAGE IS 12.4V OR ABOVE - Go to “Load Test”.
   b. VOLTAGE IS UNDER 12.4V - Go to procedure 2 below.
2. Determine fast charge amperage from specification.
   Fast charge battery for 30 minutes at amperage rate no higher than specified value.
   Take voltage and amperage readings after charge.
   a. VOLTAGE IS ABOVE 16V AT BELOW 1/3 OF AMPERAGE RATE - Replace battery.
   b. VOLTAGE IS ABOVE 16V AT ABOVE 1/3 OF AMPERAGE RATE - Drop charging voltage to 15V and charge for 10 — 15 hours.

   Then go to “Load test”.
   c. VOLTAGE IS BETWEEN 12V AND 16V
      - Continue charging at the same rate for an additional 3-1/2 hours. Then go to “Load test”.
   d. VOLTAGE IS BELOW 12V - Replace battery.

Load Test

1. Connect a voltmeter and a battery load tester across the battery terminals.
2. Apply 300 ampere load for 15 seconds to remove surface charge from the battery.
   Remove load.
3. Wait 15 seconds to let battery recover. Then apply specified load from specifications (See Main Data and Specifications in this section).
   Read voltage after 15 seconds, then remove load.
   1) VOLTAGE DOES NOT DROP BELOW THE MINIMUM LISTED IN FOLLOWING TABLE
      - The battery is good and should be returned to service.
   2) VOLTAGE IS LESS THAN MINIMUM LISTED
      - Replace battery.

ESTIMATED TEMPERATURE		MINIMUM VOLTAGE
°F	°C	
70	21	9.6
60	16	9.5
50	10	9.4
40	4	9.3
30	– 1	9.1
20	– 7	8.9
10	– 12	8.7
0	– 18	8.5
The battery temperature must be estimated by feel and by the temperature the battery has been exposed to for the preceding few hours.		

On-vehicle Service

Battery Charging

Observe the following safety precautions when charging the battery:

1. Never attempt to charge the battery when the fluid level is below the lower level line on the side of the battery.
   In this case, the battery must be replaced.

2. Pay close attention to the battery during the charging procedure.
   Battery charging should be discontinued or the rate of charge reduced if the battery feels hot to the touch.
   Battery charging should be discontinued or the rate of charge reduced if the battery begins to gas or spew electrolyte from the vent holes.
3. Battery temperature can have a great effect on battery charging capacity.
4. The sealed battery used on this vehicle may be either quick-charged or slow-charged in the same manner as other batteries.
   Whichever method you decide to use, be sure that you completely charge the battery. Never partially charge the battery.

Jump Starting

Jump Starting With An Auxiliary (Booster) Battery

Caution:
Never push or to the vehicle in an attempt to start it.
Serious damage to the emission system as well as other vehicle parts will result.
Treat both the discharged battery and the booster battery with great care when using jumper cables.
Carefully follow the jump starting procedure, being careful at all times to avoid sparking.

WARNING:
FAILURE TO CAREFULLY FOLLOW THE JUMP STARTING PROCEDURE COULD RESULT IN THE FOLLOWING:

1. **SERIOUS PERSONAL INJURY, PARTICULARLY TO YOUR EYES.**
2. **PROPERTY DAMAGE FROM A BATTERY EXPLOSION, BATTERY ACID, OR AN ELECTRICAL FIRE.**
3. **DAMAGE TO THE ELECTRONIC COMPONENTS OF ONE OR BOTH VEHICLES PARTICULARLY.**

Never expose the battery to an open flame or electrical spark. Gas generated by the battery may catch fire or explode.
Remove any rings, watches, or other jewelry before working around the battery. Protect your eyes by wearing an approved set of goggles.
Never allow battery fluid to come in contact with your eyes or skin.
Never allow battery fluid to come in contact with fabrics or painted surfaces.
Battery fluid is a highly corrosive acid.
Should battery fluid come in contact with your eyes, skin, fabric, or a painted surface, immediately and thoroughly rinse the affected area with clean tap water.
Never allow metal tools or jumper cables to come in contact with the positive battery terminal, or any other metal surface of the vehicle. This will protect against a short circuit.
Always keep batteries out of the reach of young children.

Jump Starting Procedure

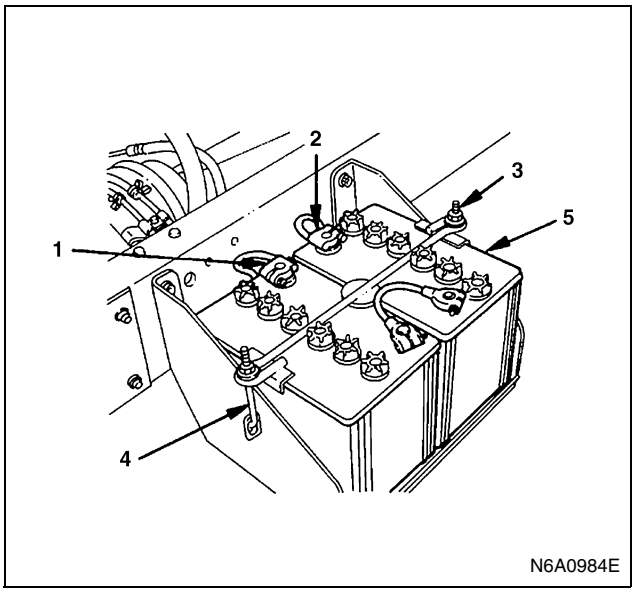
1. Set the vehicle parking brake.
   If the vehicle is equipped with an automatic transmission, place the selector lever in the “PARK” position.
   If the vehicle is equipped with a manual transmission, place the shift lever in the “NEUTRAL” position.
   Turn “OFF” the ignition.
   Turn “OFF” all lights and any other accessory requiring electrical power.
2. Look at the built-in hydrometer. (If equipped)
   If the indication area of the built-in hydrometer is completely clear, do not try to jump start.
3. Attach the end of one jumper cable to the positive terminal of the booster battery.
   Attach the other end of the same cable to the positive terminal of the discharged battery.
   Do not allow the vehicles to touch each other.
   This will cause a ground connection, effectively neutralizing the charging procedure.
   Be sure that the booster battery has a 12 volt rating.
4. Attach one end of the remaining cable to the negative terminal of the booster battery.
   Attach the other end of the same cable to a solid engine ground (such as the A/C compressor bracket or the generator mounting bracket) of the vehicle with the discharged battery.
   This ground connection must be at least 450 mm (18 in) from the battery of the vehicle whose battery is being charged.

WARNING:
NEVER ATTACH THE END OF THE JUMPER CABLE DIRECTLY TO THE NEGATIVE TERMINAL OF THE DEAD BATTERY.

5. Start the engine of the vehicle with the good battery.
   Make sure that all unnecessary electrical accessories have been turned “OFF”.
6. Start the engine of the vehicle with the dead battery.
7. To remove the jumper cables, follow the above directions in the reverse order.
   Be sure to first disconnect the negative cable from the vehicle with the discharged battery.

Removal

1. Negative cable
2. Positive cable
3. Retainer screw and rods
4. Retainer
5. Battery



Installation

To install the battery, follow the removal procedure in the reverse order, noting the following points:

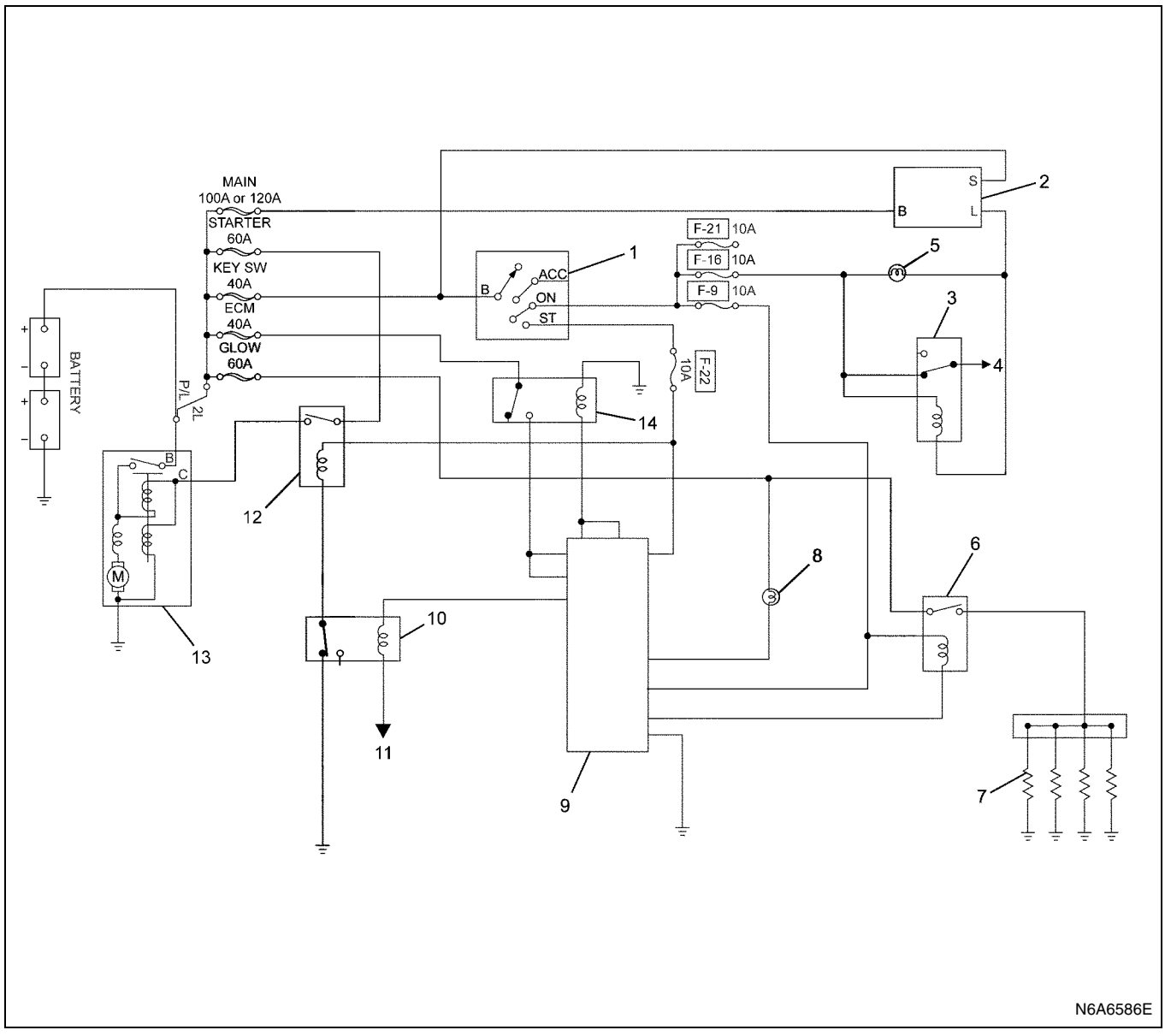
1. Make sure that the rod is hooked on the body side.

Charging System

General Description

The main charging system components are the batteries, the generator and the battery discharge indicator light circuit. The generator is a 110-amp, selfrectifying type with a built-in regulator. The battery discharge indicator light is mounted in the instrument panel. For more details on this circuit, refer to “Meter and Warning/Indicator Lights” in Section 8.

Circuit Diagram



Legend

1. Engine Control Switch
2. Generator (Integral Regulator)
3. Charge Relay
4. To Heater and A/C Relay
5. Low Charge Indicator Light
6. Glow Plug Relay
7. Glow Plugs
8. Glow Plug Indicator Light
9. ECM
10. Starter Cut Relay
11. To Exhaust Brake Solenoid Valve
12. Starter Relay
13. Starter
14. ECM Main Relay

Maintenance

The most common indication of charging system troubles is an undercharged or overcharged battery.
Since the battery itself may be defective, the first step should be to check its condition as described under “Diagnosis of Battery.” In the case of an undercharged battery, check for battery drain caused by grounds or by accessories left turned on.
Keep the generator and all other electrical system terminals clean and tight. A loose or badly corroded terminal connection will create excessive resistance in the system and result in hard starting, dim lights etc.
Inspect the generator system at regular intervals and correct any potential causes of trouble before vehicle performance is affected.

Diagnosis of Charging System

Trouble in the charging system will be evidenced as one or more of the following three conditions:

1. The battery discharge warning light will stay on.
2. An undercharged battery as evidenced by slow cranking.
3. An overcharge, or overvoltage, condition.

Undercharged Battery

Inspection

1. Accessories to be sure none were left on for extended periods.
2. Drive belt for proper tension. Refer to “Drive Belt” in Section 6B.
3. The ECM main relay has been ON stuck at the ignition switch OFF position. (Battery voltage is consumed.)
4. Battery. Refer to “Diagnosis of Battery” earlier in this section.
5. Wiring and connections for corrosion or looseness.

Overcharge (or Overvoltage) condition

A charging rate in excess of 29.5-volts for a prolonged period may cause early electrical system failure.
Blown fuses, light bulbs burned out, and even battery failure may result. If this condition exists, test the generator as described under “Generator Output Tests” later in this section.

Noisy Generator

Inspection

1. Drive pulley for looseness.
2. Mounting bolts for looseness.
3. Bearings for dirt, damage, or wear.
   Generator noise may also be caused by worn or damaged diodes and/or starter.

Electrical Tests

Before performing the following generator electrical tests on the vehicle, be certain that the system wiring is not defective and generator belts are not slipping. Also, the battery must be fully charged for a valid test of the charging system.

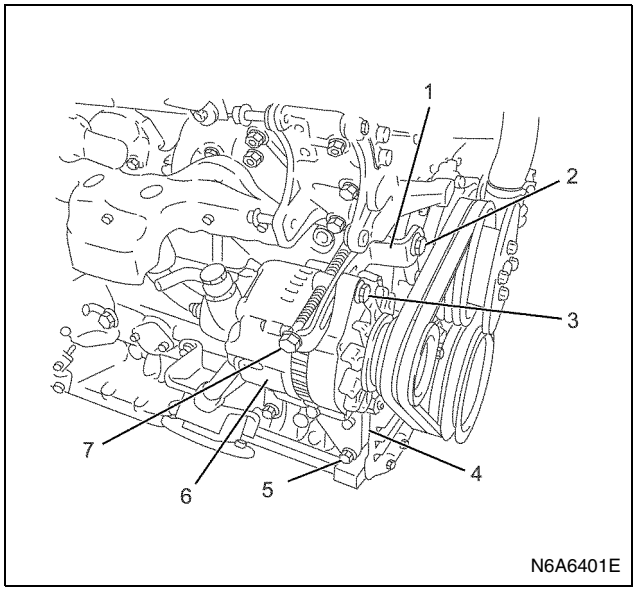
Notice:
To avoid damage to the vehicle electrical system, always observe the following precautions:

- Do not polarize the generator.
- Do not short across or ground any of the terminals in the charging circuit except as specifically instructed herein.
- NEVER operate the generator with the output terminal open-circuited.
- Be sure the generator and battery have the same ground polarity.
- When connecting a charger or booster battery to the vehicle battery, connect negative to negative and positive to positive.

1. With the engine control switch “ON” and engine not running, connect a voltmeter from terminal “E” to ground. The voltmeter should read zero volts.
2. With the engine control switch “ON” and engine not running, connect a voltmeter from terminal “B” to ground. The voltmeter should read at least 24 volts.
3. With the engine control switch “ON” and the engine not running, connect a voltmeter from white wire side of the connector to ground. The voltmeter should show 24 volts.
4. With the engine control switch “ON” and the engine not running, the “charge” light should be on. This shows that the other circuit in the connection is working.
5. With the engine running and the headlight high beams turned on, read the voltage at the “B” post on the generator. The voltage should be at least 24 volts.
6. If steps 1 through 4 are not OK, check connectors in the harness for looseness or corrosion and retest.
7. If step 5 voltage is low, substitute a known good regulator and test again. If the voltage is still low, bench test the generator.

Generator

Component



Legend

1. Generator Adjusting Bracket
2. Bracket Mounting Bolt
3. Generator Adjusting Nut
4. Generator Bracket
5. Generator Bracket Mounting Bolt
6. Generator
7. Generator Adjusting Bolt (Model equipped with A/C only)

Repair Instruction

Description of Generator

The generator is a 24 volt, 50A or 60A or 80A, model with a solid state regulator mounted to the brush holder. The generator must be disassembled to remove the regulator or brush holder assembly. The generator rotor bearings contain enough grease to eliminate periodic lubrication. Two brushes carry current through two slip rings to the field coil.

The stator windings are assembled on the inside of a laminated core that forms part of the generator frame. A rectifier bridge connected to the stator windings contains six diodes that change the stator AC voltages to a DC voltage.

The vacuum pump is attached to the rear of the generator.

Generator Output Tests

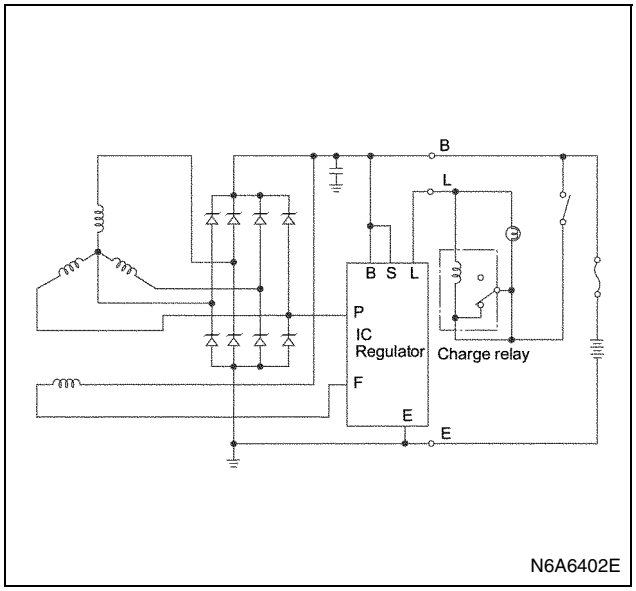
To check the generator in a test stand, proceed as follows:

Important:

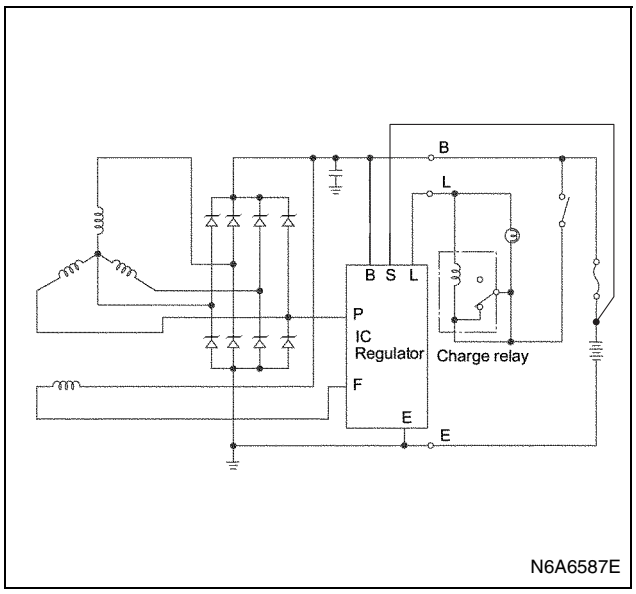
- Use a fully charged battery when performing these tests.

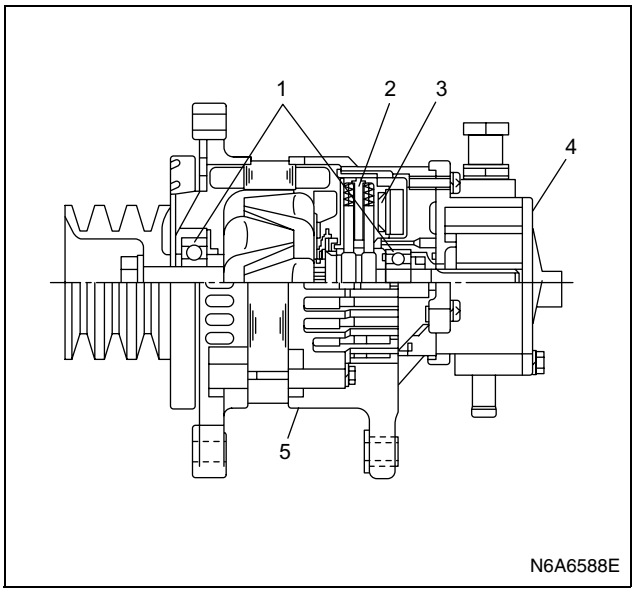
1. Connect an ammeter from the positive (+) battery side to the generator output wire. This is 8 mm (0.032 in) (black) wire. Leave the carbon pile disconnected.
2. Slowly increase the generator speed and observe the voltage meter. If voltage is uncontrolled with speed and increases above 30 volts on a 24-volt system, replace the regulator and check the rotor winding. If the voltage is below 30 volts, connect the carbon pile across the battery.
3. Run the generator at 5,000 RPM and adjust the carbon pile to obtain maximum current output, which should be more than 42A (50A) or 50A (60A) or 75A (80A) at 28 to 29 volts.
4. If the output is not within 10 amperes of the rated output, check the rotor winding, rectifier bridge, and stator as described later under “Inspection” and “Electrical Bench Tests.”

50A Model



60A, 80A Model





Legend

1. Ball Bearings
2. Brush Holder
3. Voltage Regulator
4. Vacuum Pump
5. Generator

Notice:

- Before performing the generator output test, inspect all charging system components, wires and terminals for wear or damage. Repair or replace any parts found defective.

Removal

- Disconnect the battery negative cable.
- Remove the A/C compressor. (Refer to “Engine Assembly” in Section 6A)

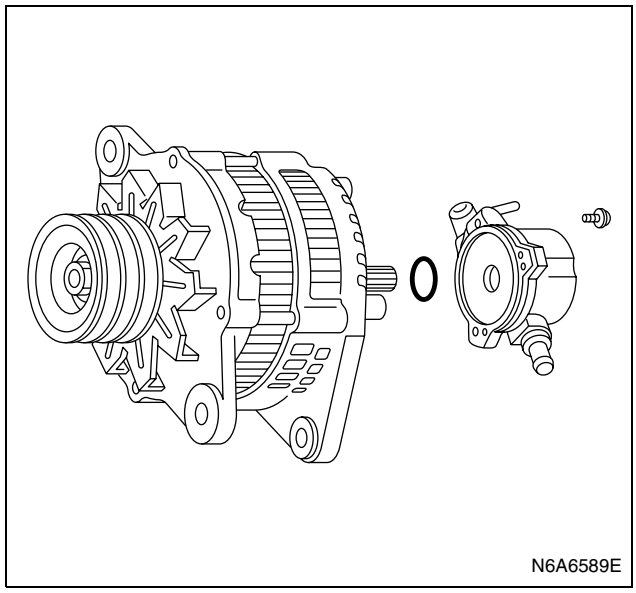
1. Electrical wiring at the generator.
2. Vacuum and oil hoses attached to the rear of the vacuum pump.
3. Loosen the lower mounting bolts.
4. Loosen the adjusting nut.
5. Drive belts.
6. Adjusting bolts.
7. Generator.

Inspection

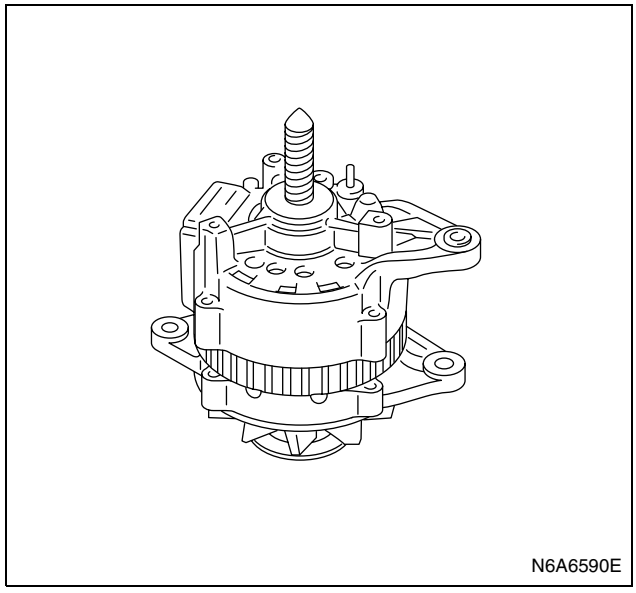
- Mount brackets for damage.
- Drive belts for wear or damage.

Disassembly

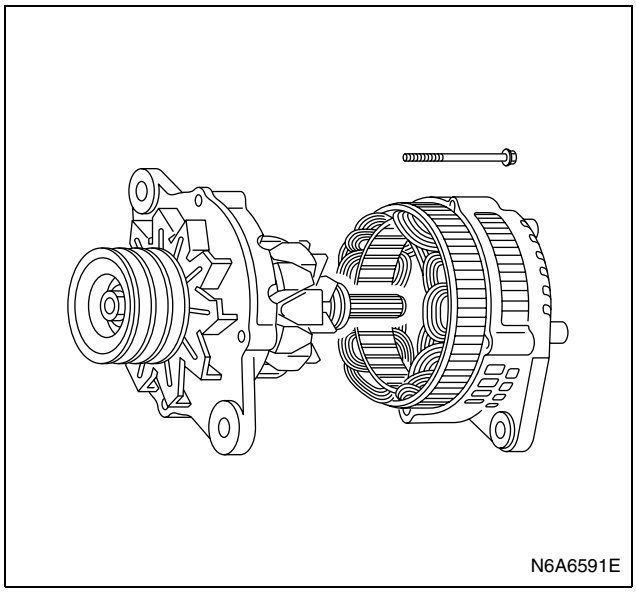
1. Vacuum pump assembly.
   - Remove the vacuum pump screws attached to the back of the generator. Remove the vacuum pump in the direction in line with the rotor shaft. Remove the side plate fixing bolts and the side plate, then remove the rotor and vanes.



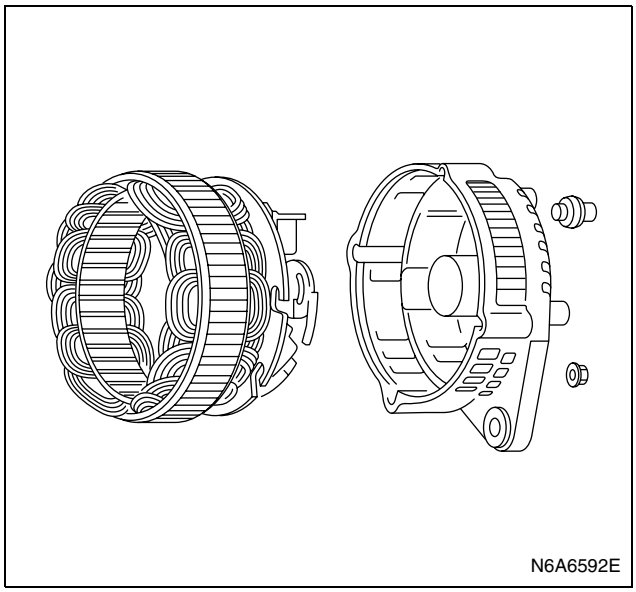
2. Through bolts.
   - Tape the rotor shaft splines to prevent accidental damage.



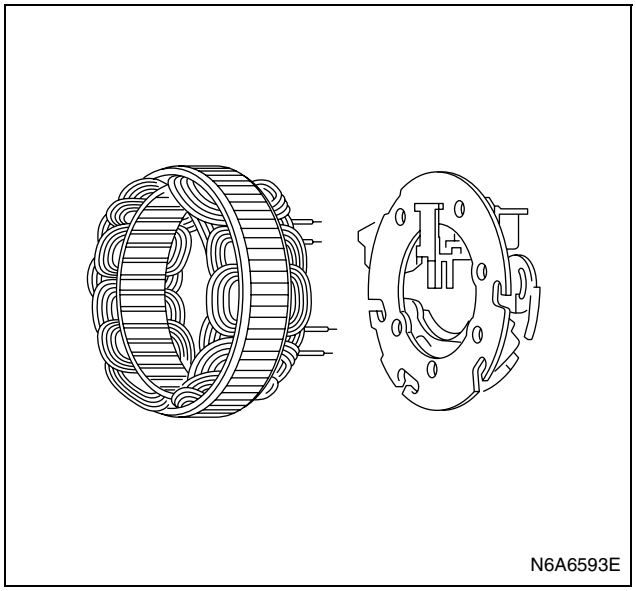
   - Separate the front cover assembly from the rear cover assembly.
     When separating the front and rear cover assemblies, be sure the stator assembly stays seated in the rear cover.


N6A6591E

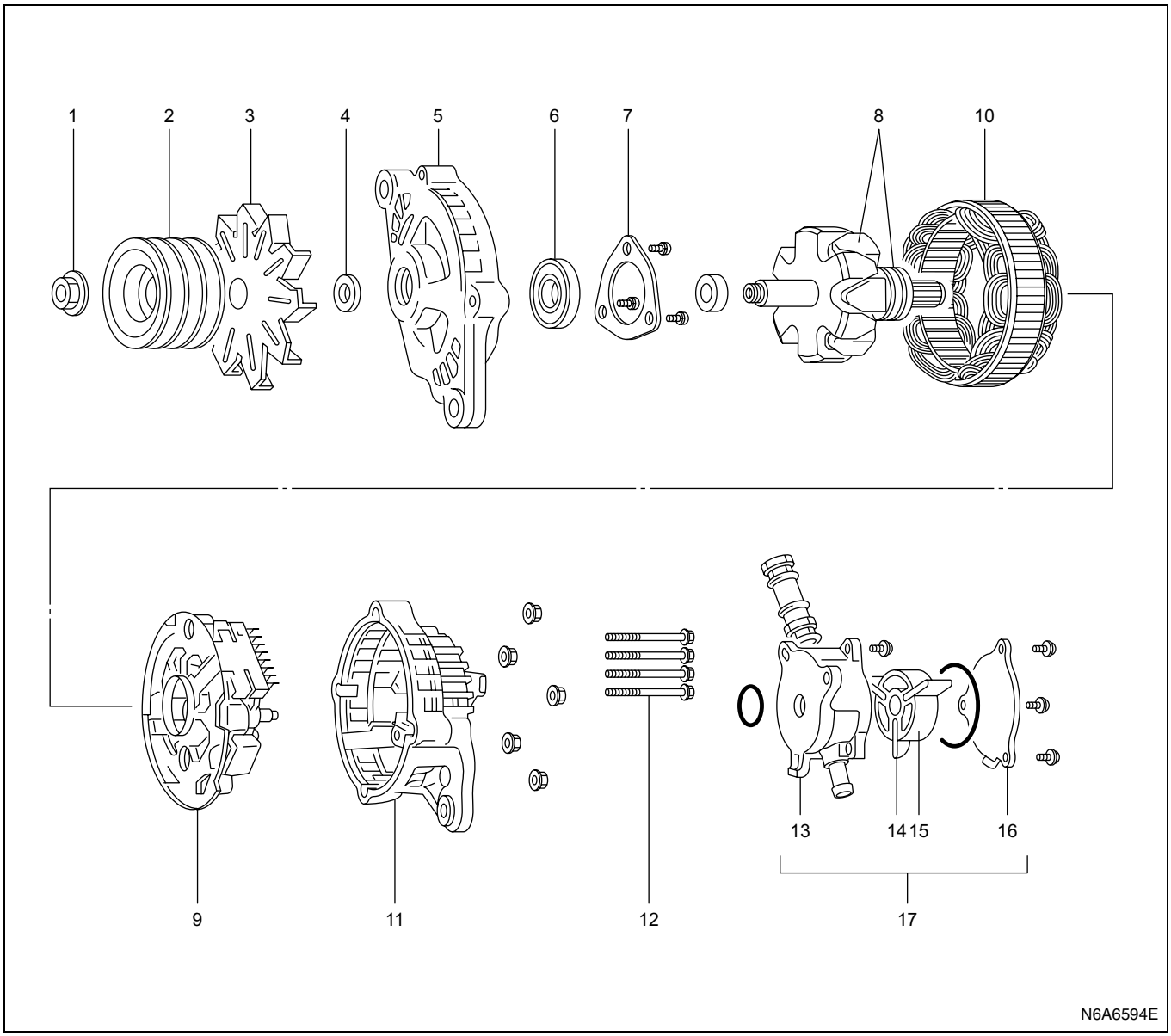
3. Pulley and rotor assembly.
   - Be sure not to damage the oil seal when removing the pulley and rotor assembly from the rear cover assembly.
4. Rear cover and stator assembly.
5. Pulley nut.
   - Clamp the rotor assembly in a vise to remove the pulley nut.
6. Pulley.
7. Fan.
8. Spacer.
9. Rotor and rear bearing.
10. Bearing retainer.
11. Front ball bearing.
12. Front cover.
13. Rear cover.
    - Remove nuts at the rear cover battery terminal and diode brush regulator assembly.


N6A6592E

14. Stator and diode brush regulator assembly
15. Diode brush regulator assembly.
    - Separate the diode brush regulator assembly from the stator by melting the solder on the stator coils, diodes and N terminal leads. When melting solder, hold the lead wire with long-nose pliers to prevent heat from being transferred to the diodes.


N6A6593E

16. Stator.



Legend

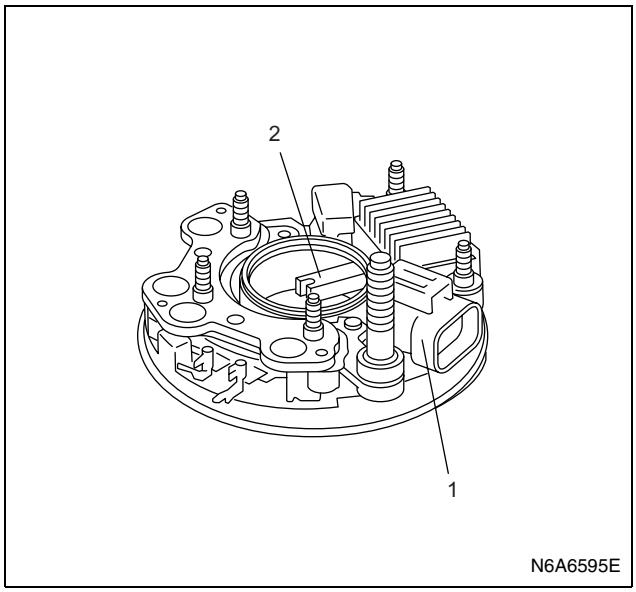
1. Nut
2. Pulley
3. Fan
4. Spacer
5. Front Cover
6. Front Ball Bearing
7. Bearing Retainer
8. Rotor and Rear Bearing
9. Diode Brush Regulator Assembly
10. Stator
11. Rear Cover
12. Through Bolt
13. Housing
14. Vane
15. Pump Rotor
16. Side Plate
17. Vacuum Pump Assembly

Important:

- Separate the stator and rear cover. Be sure you identify the proper position of the insulated washers to prevent improper installation.

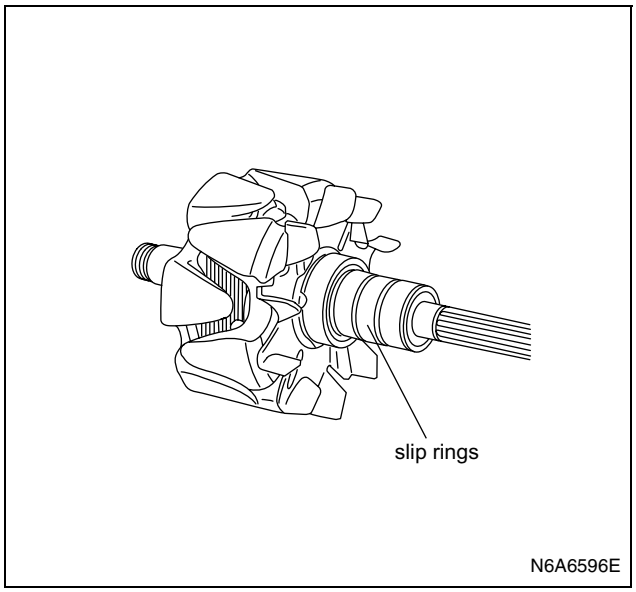
Inspection

- All metal parts except the voltage rectifier bridge, stator, rotor and bearing assemblies in a suitable solvent.
- Wipe or blow the components dry.
- Brush holder and brushes. The brushes have a line that indicates their limit. If the brushes are shorter than 6.5 mm (0.256 in) replace the brushes.



Legend
1. Brush Holder
2. Brushes

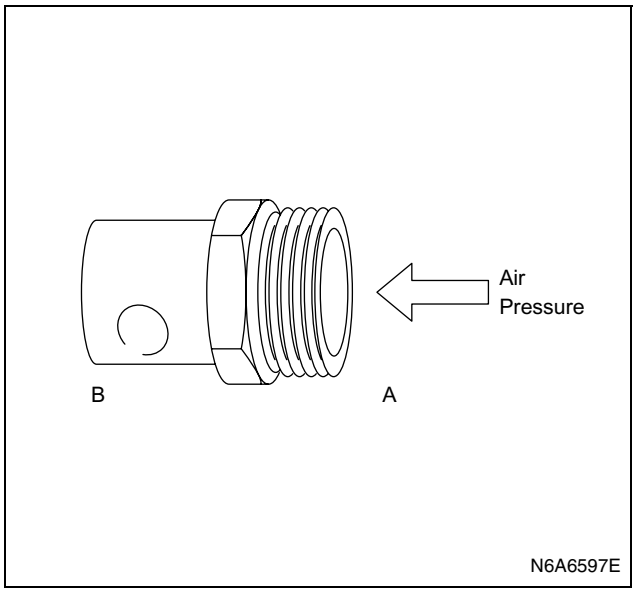
- Voltage regulator for damage or corrosion.
- Bearings and spacer. Rotate the bearing and check for roughness or excessive drag. If in doubt about the bearing, replace it.
- Rotor and stator windings for burned insulation or broken terminal connectors, wires, etc.
  Burned insulation may appear as very dark or blackened wiring, and sometimes charred paint or a combination of the two. Replace the rotor or stator if the windings are burned.
- Generator frames. Check for distortion, cracks or damage. Replace as necessary.
- Rotor slip rings. If the rings are dirty, clean them with 500–600 grain or finer polishing cloth.
  Clean the slip rings with rubbing alcohol if the rings are contaminated. Spin the rotor and hold the polishing cloth against the rings until they are clean. Slip rings which are rough, scored, or out-of-round, must be machined in a lathe to 31.7 mm (1.248 in). Finish the slip rings with 500 – 600 grain or finer polishing cloth and blow away all dust particles after the machining process.



- All vacuum pump components for wear, damage or other abnormal conditions.
- Check valve.
  1) Carefully force the valve from the “B” side as shown in the illustration.
     The valve must move smoothly.
     If it does not, the check valve must be replaced.
  2) Apply compressed air to the “A” side.

Air Pressure	kPa (kg/cm^2 / psi)
98 – 490 (1 – 5/14 – 71)	

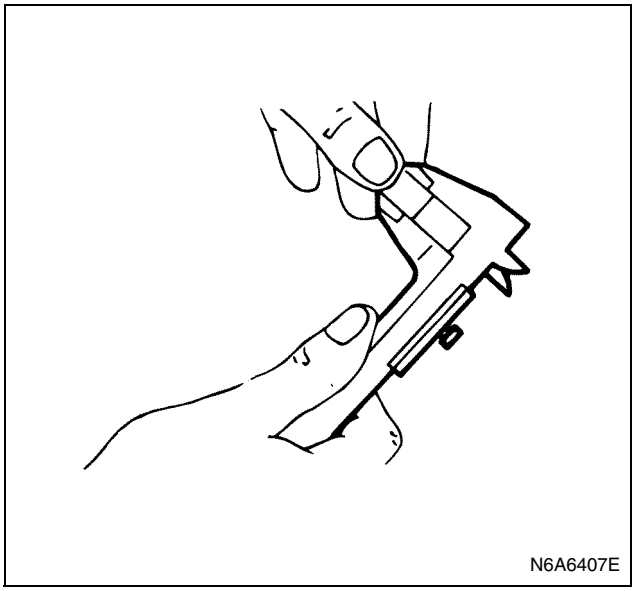
Check for air leakage from the check valve.
If there is air leakage, the valve must be replaced.



- Oil seal (O-ring). Check the inner face of the rear cover for traces of oil leakage. Be sure the inner face of the oil seal is not worn or damaged.
  If worn or damaged, use a screwdriver to remove the oil seal (O-ring) from the rear cover.
  Install a new oil seal (O-ring) using an oil seal installer or equivalent.

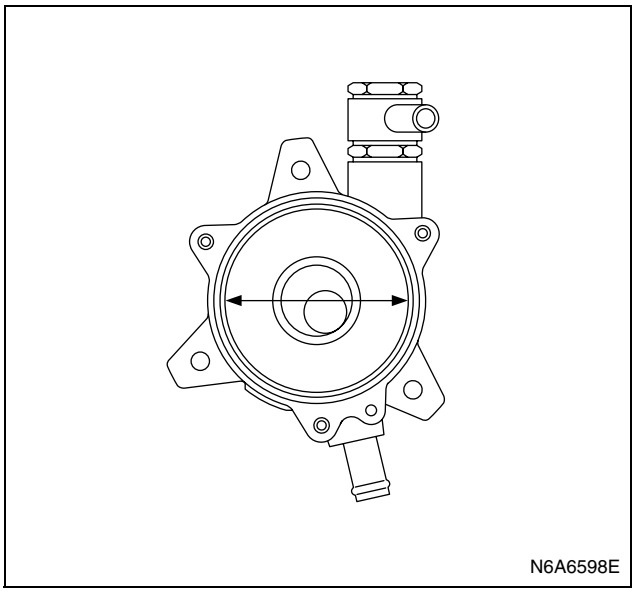
Measure

The length of the vanes	mm (in)
17.0 – 18.0 (0.669 – 0.709)	



Replace the housing if not within these specifications.

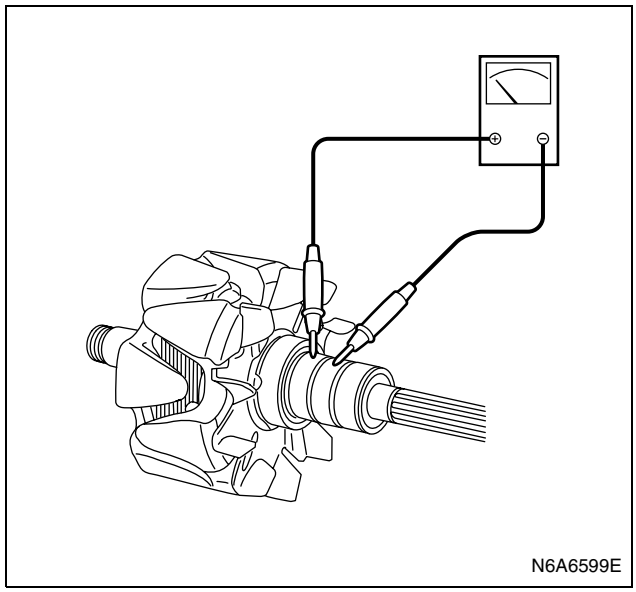
The inside diameter of the vacuum pump housing	mm (in)
69.5 – 69.6 (2.736 – 2.740)	



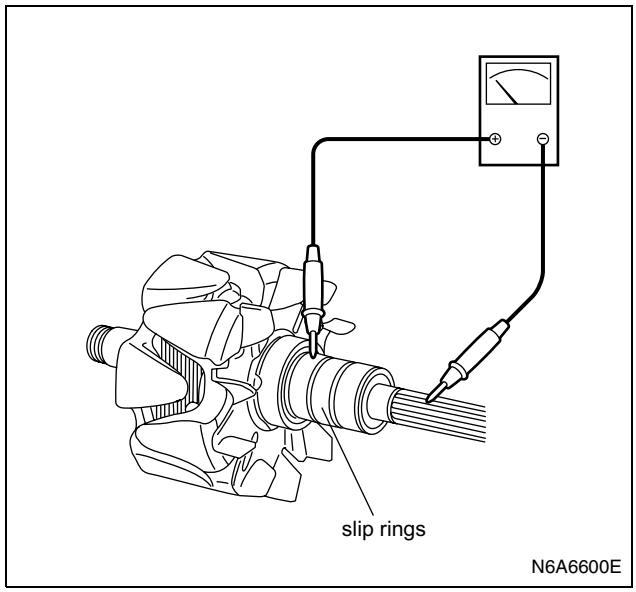
Electrical Bench Tests (Generator)

1. Measure the rotor coil resistance.

Rotor Coil Resistance at 20°C (68°F)		ohms
Standard	50A	7.6
	60A	9.2
	80A	10.2



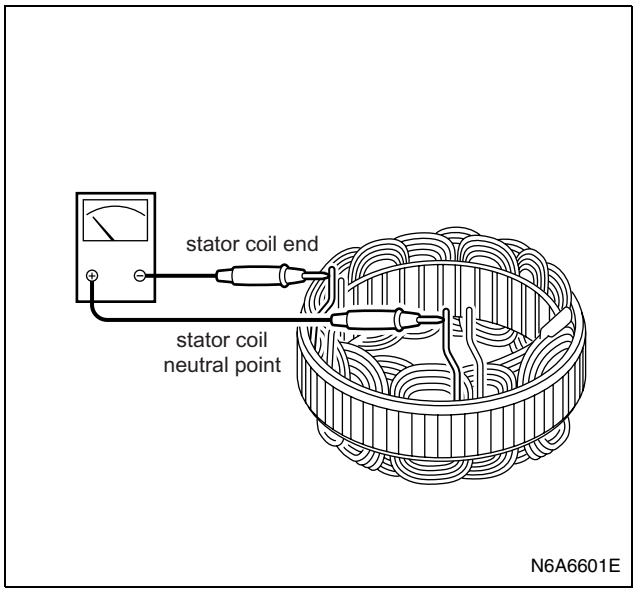
2. Check for continuity between the slip rings and the rotor core or shaft.
   If there is continuity, the entire rotor assembly must be replaced.



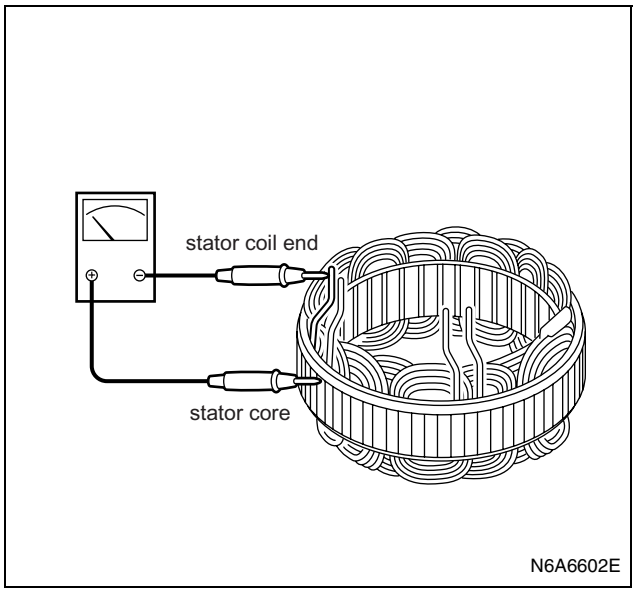
Stator Coil Assembly

1. Check for continuity across the stator coils
   If there is no continuity, the stator coils must be replaced.

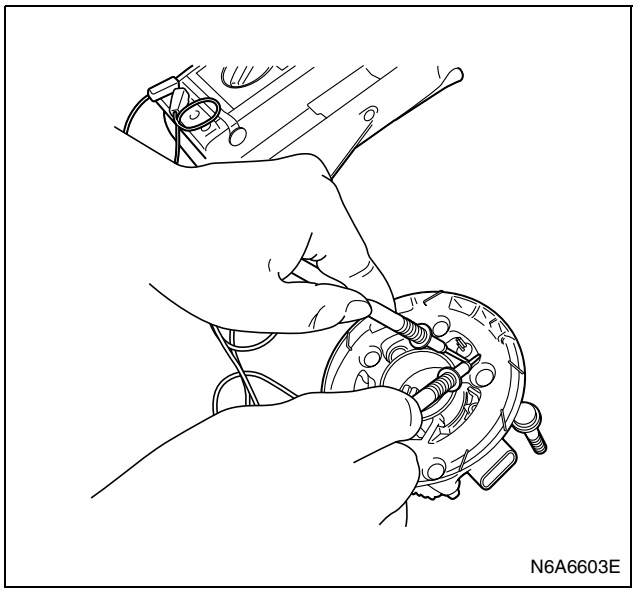
Resistance Between Stator coil neutral point and the Coil Ends (Reference)		mm (in)
Standard	50A	0.195
	60A	0.137
	80A	0.073



2. Check for continuity between each stator coil end and the stator core.
   If there is continuity, the stator coils must be replaced.

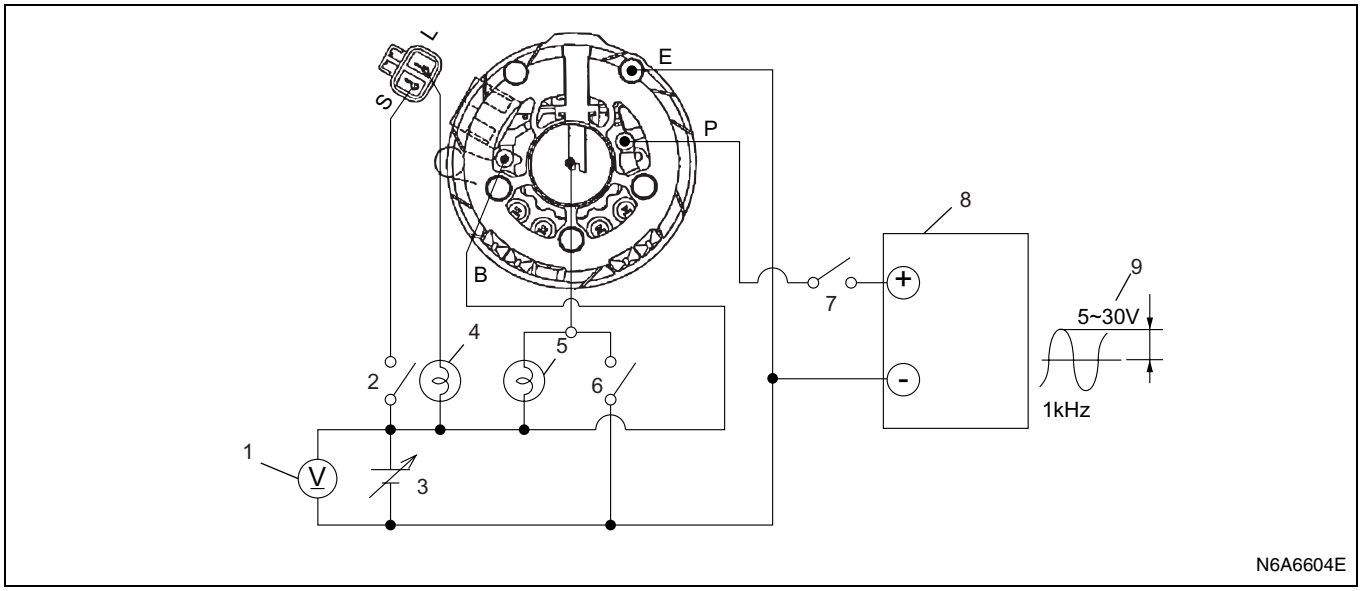


Rectifier



Tester wire					
E U, V, and WN	+	–	BAT U, V, and WN	+	–
+	-----	Conductivity	+	-----	No conductivity
–	No conductivity	-----	–	Conductivity	-----
Negative side diode check			Positive side diode check		

Rectifier Assembly



Legend

1. Voltmeter
2. Switch 1
3. DC Regulated Power Supply
4. Lamp 2
5. Lamp 1
6. Switch 3
7. Switch 2
8. Pulse Generator
9. Output Signal

Test circuit

Refer to the judgment criteria shown in the Table below. Carefully check Items 1 – 5. If all the items are OK, the IC regulator is normal.

Circuit components

1	DC regulated power supply	0 – 30 volts variable with output of 1 ampere or more
2	Lamps (2)	24 volts, 1.8 watts
3	Switches (3)	-----
4	DC voltmeter	0 – 60 volts, 0.5 grade
5	Pulse generator (Oscillator)	5 – 30 volts output at a frequency of 1kHz

Judgment criteria

No.	Switch 1	Switch 2	Switch 3	Voltmeter reading	Lamp condition		Remarks
					Lamp 1	Lamp 2	
1	ON	OFF	OFF	24V	On (dim)	ON	Initial excitation check
2	ON	ON	OFF		On or flashing	OFF	Full excitation check
3	ON	ON	OFF	32V	Off or on (dim)		Lamp 1 off or dimly lit when the voltmeter shows less than 24 volts or 32 volts
4	OFF	ON	OFF	24V	On or flashing	ON	Stator and brush separation check
5	ON	ON	ON	36V	On		Excess voltage check

Reassembly

Important:

- When connecting the stator coil leads and diode leads using solder, use long-nose pliers and work as quickly as possible to prevent the heat from transferring to the diodes.

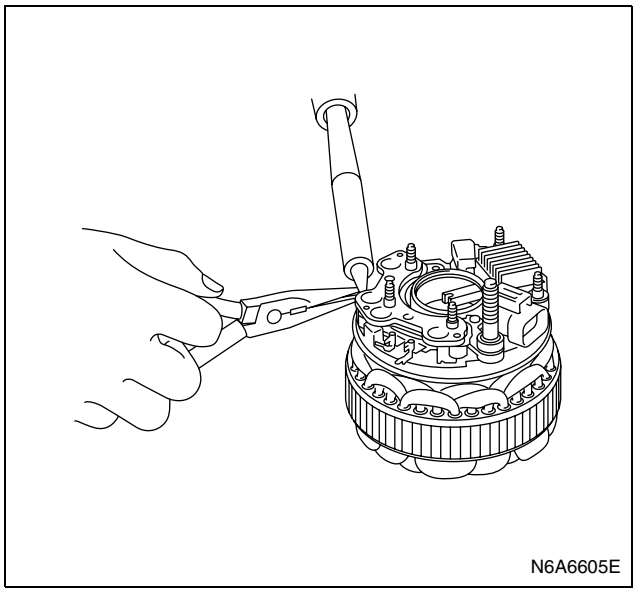
1. Stator.
2. Diode brush regulator assembly.
3. Stator and diode brush regulator assembly.
4. Rear cover.
5. Front cover.
6. Front ball bearing.
7. Bearing retainer.
8. Rotor and rear bearing.
9. Spacer.
10. Fan.
11. Pulley.
12. Pulley nut.

Tighten:
Pulley nut (50A) to 98.0 N·m (10 kg·m/72.3 lb·ft)

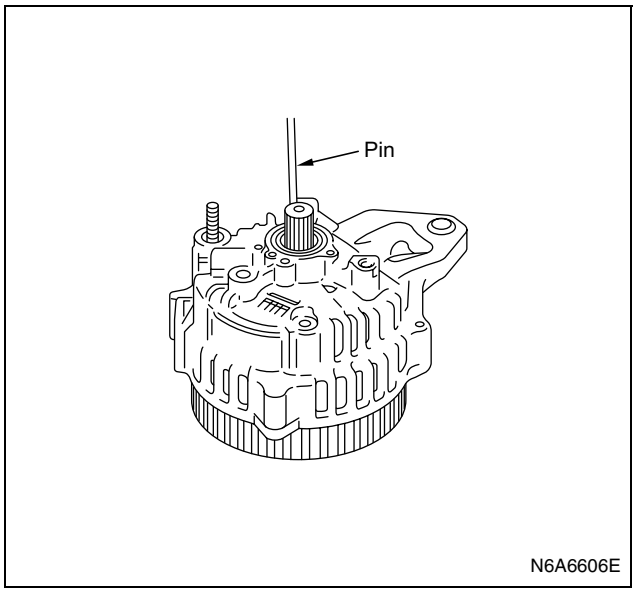
Pulley nut (60A, 80A) to 107.8 N·m (11 kg·m/79.5 lb·ft)

13. Rear cover and stator assembly.
    Use a pair of long-nose plier to connect the stator coil leads and the rectifier leads.

    Finish the work as quickly as possible to prevent the rectifier from heat transferred by the soldering.



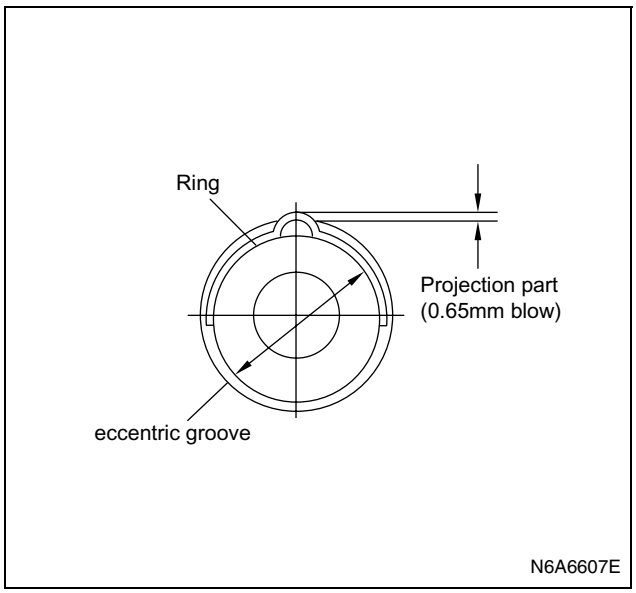
Insert the pin from the outside of the rear cover. Press the brushes into the brush holder. Complete the assembly procedure.



14. Pulley and rotor assembly.
    - Install the pulley and rotor assembly

    The rear ball bearing is pressed into the wheel eccentric groove. The bearing ring projects from the groove.

    During installation, rotate the bearing to the point of minimum bearing ring projection.

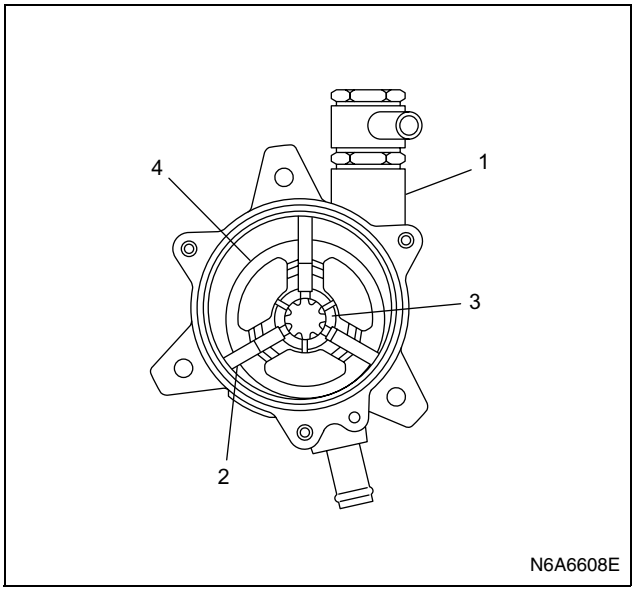


15. Through bolts.
    - Place a guide bar through the holes in the front cover and rear cover flange for proper alignment. Install the through bolts.
    - Remove the tape from the splines.

Tighten:
Through bolts to 4 N·m (0.4 kg·m/35 lb·in)

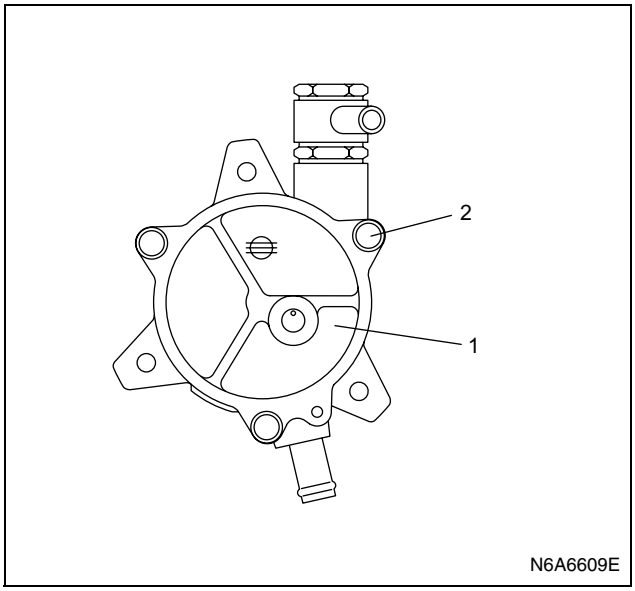
16. Vacuum pump assembly.

- Position the rotor, with the serrated boss turned up, on the housing.



Legend
1. Housing
2. Vane
3. Serrated Boss
4. Pump Rotor

- Align the holes in the housing and rotor.
- Install vanes into the slits in pump rotor.
  The vanes must be installed with the round side turned outward.
- After installation of O-ring, install the side plate.



Legend
1. Side Plate
2. Bolt

- Install the vacuum pump assembly to the back of the generator with 3 screws.

Tighten:
Vacuum pump screws to 7 N·m (0.7 kg·m/61 lb·in)

- Install 5 cc (0.016 oz) engine oil in the filler port, then check that the generator pulley can be turned smoothly by hand.

Installation

1. Generator.

Tighten:
Bracket Mount Bolt to 48 N·m (4.9 kg·m/35.4 lb·ft)

2. Adjusting bolts.

Tighten:
Adjusting Nut to 24 N·m (2.4 kg·m/17 lb·ft)

3. Drive belts.

Tighten:
Lower mount bolt to 40 N·m (4.1 kg·m/30 lb·ft)

4. Vacuum and oil hoses at the vacuum pump.
5. Electrical wiring at the generator.
   - Battery negative cable.
6. Install the A/C compressor. (Refer to “Engine Assembly” in Section 6A.)

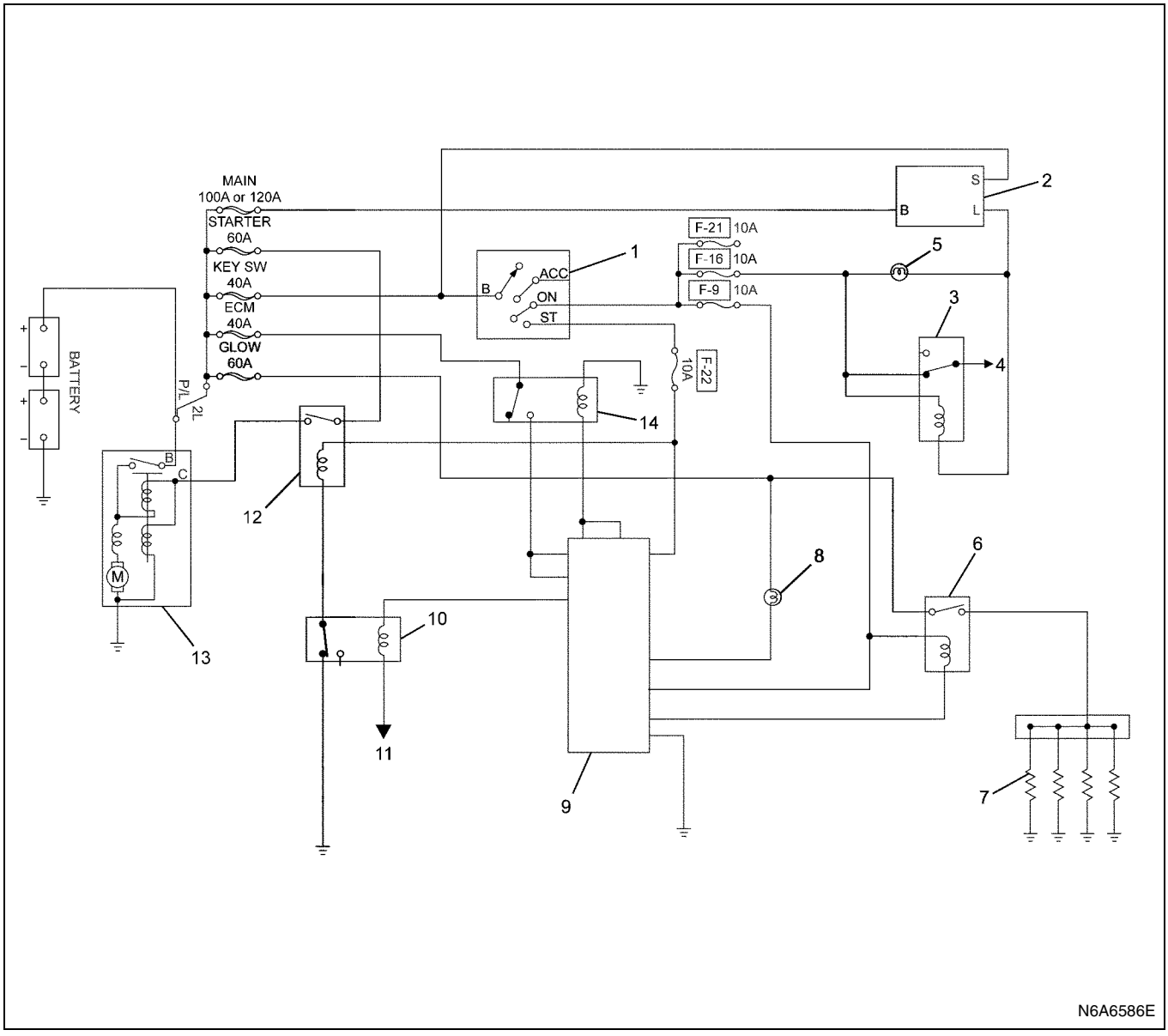
Main Data and Specifications

Rated Voltage	24 V
Rated Output	50/60/80 amp
Rated Output at 5000 RPM	More than 42/50/75 amp
Regulated Voltage	28.0 – 29.0 V
Brush Length	
Standard	25 mm (0.984 in)
Limit	6.5 mm (0.256 in)
Slip Ring Diameter	
Standard	31.7 mm (1.248 in)
Limit	30.6 mm (1.205 in)
Generator Pulley Direction (Viewed From Pulley Side) Clockwise Pulley	
Pulley Diameter	82 mm (3.23 in)
Generator Weight (With Vacuum Pump)	50A: 7.4 kg (16.3 lb) 60A: 9.0 kg (19.8 lb) 80A: 9.6 kg (21.2 lb)
Maximum Vacuum Pump Output	90.7 kPa (0.29 kg/cm^2 / 13.2 psi)
Vacuum Pump Vane	
Standard Length	17.0 – 18.0 mm (0.669 – 0.709 in)
Vacuum Pump Housing Inside Diameter	
Standard	69.5 – 69.6 mm (2.736 – 2.740 in)

Starting System

General Description

Circuit Diagram

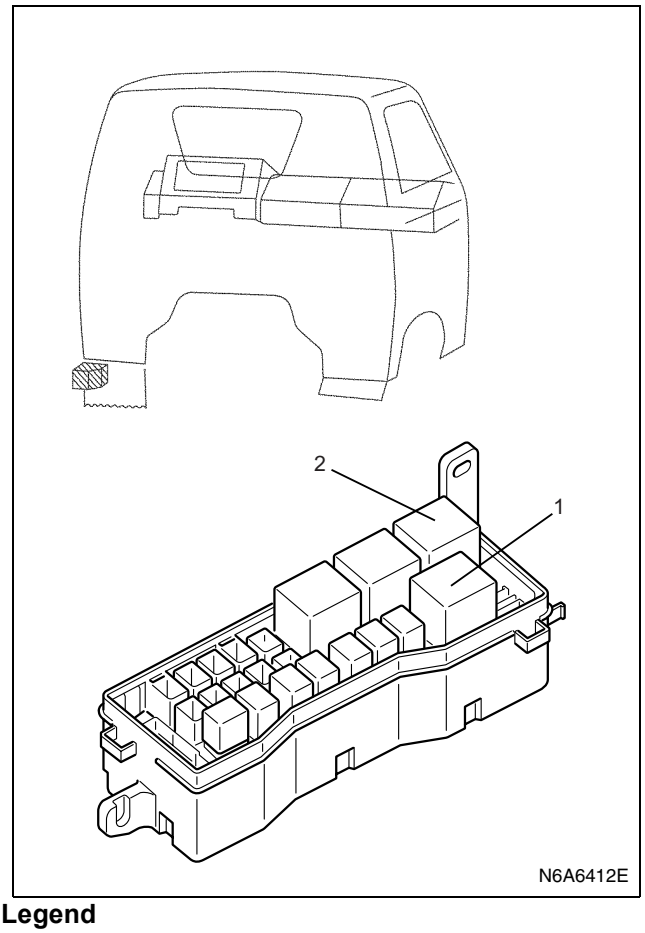


Legend

1. Engine Control Switch
2. Generator (Integral Regulator)
3. Charge Relay
4. To Heater and A/C Relay
5. Low Charge Indicator Light
6. Glow Plug Relay
7. Glow Plugs
8. Glow Plug Indicator Light
9. ECM
10. Starter Cut Relay
11. To Exhaust Brake Solenoid Valve
12. Starter Relay
13. Starter
14. ECM Main Relay

Starter and Glow Plug Relays

The starter is a 4.5 kilowatt, reduction drive model.
The gear housing and armature end bearing housings are aluminum. The brush assembly has replaceable brushes. The commutator bars are mica insulated and are undercut.
The starter circuit starts at the batteries. The battery cable goes to the large terminal on the starter.
From that terminal wires lead to the engine control switch and the starter relay.
From the engine control switch the starter circuit goes through Fuse #3 and the transmission neutral switch to the starter relay. When the engine control switch is turned to start and the transmission neutral switch is closed, the starter relay closes to complete the circuit from the batteries to the starter solenoid. The starter circuit is also connected to the Engine Control Module (ECM). The Engine Control Module (ECM) operates when the engine control switch is turned to the “ON” position.
The starter and glow plug relays are located on the frame at the left rear side of the cab.



Legend

1. Starter Relay
2. Glow Plug Relay

Maintenance

Keep the starter’s exterior clean. Remove corrosion from the terminals, leads, and connectors.
Tighten the starter to engine mounting bolts and the electrical cable retaining nuts.

Diagnosis of Starting System

1. No Cranking, No Sound
   - Discharged batteries. Turn on the headlights and check the brightness. If the headlights are dim, charge the batteries. Check for the cause of the discharged batteries.
   - Sulfated battery terminals. Turn on the headlights. The headlights will be bright. Attempt to start the engine. The headlights will be very dim or go out. Clean all the battery terminals and cable ends.
   - A starter that draws too much current.
   - Starter relay won’t work. Attempt to start and listen for a “click” at the starter relay. If there is no “click,” check the starter relay control terminals with a test light. If the test light shows that power is getting to the starter relay, check the ground circuit with the test light. If the ground circuit is OK, replace the starter relay.
   - Engine control switch start circuit won’t close.

     With the engine control switch turned to start, check the starter relay with a test light. If the test light doesn’t come on, check the starter circuit at the engine control switch with the test light. If the test light comes on, check the harness for an open and repair. If the test light does not come on, replace the engine control switch.
   - Starter relay power circuit isn’t closing. Attempt to start. The starter relay “clicks.” Check the secondary terminals with a test light. If the test light lights on the battery side only, replace the starter relay. If the test light lights on both terminals, check for an open at the starter.
   - Starter clicks when start is attempted. Check all power connections for corrosion. Clean connections if corrosion is present. Terminal on starter should have at least 18 volts on it when cranking the engine. If voltage is OK, replace the starter.
   - Starter cut relay

     If the problem found, repair the following circuit as necessary.
     - Starter cut relay ground circuit. (Between starter cut relay and ECM.)
     - ECM power supply circuit. (Between fuse 10 A and starter cut relay circuit.)
   - Neutral switch or inhibitor switch

     If the problem found, repair the following circuit as necessary.
     - Neutral switch or inhibitor switch ground circuit. (Between Frame-LH and neutral switch.)
     - Starter relay power supply circuit. (Between fuse 10 A and starter relay.)
     - Starter relay ground circuit. (Between starter cut relay and diode.)
2. Slow Cranking, Solenoid Clicks or Chatters

- Discharged batteries. Turn on the headlights and check the brightness. If the headlights are dim, charge the batteries. Check for cause of discharged batteries.
- Corrosion on the battery terminals. Check for corrosion. Hint: Test for warm terminals. Clean all the battery terminals and connectors.
- Loose or dirty connections. Measure the cranking voltage at the battery terminals. If the voltage is less than 18 volts, load test the battery. If the battery is bad, replace the battery. If the battery is good, repair the starter.

If the voltage is 18 volts or more, measure the voltage from the battery NEGATIVE terminal to the engine block. If the voltage is 0.5 volt or more, repair the ground cable and connections.
If the voltage is less than 0.5 volt, measure the voltage at the battery cable terminal on the starter. If the voltage is 18 volts or more, repair the starter. If the voltage is less than 18 volts, clean and tighten the positive cable connections. If the voltage is still less than 18 volts, replace the positive cable.

On-vehicle Service: Starter System

Maintenance

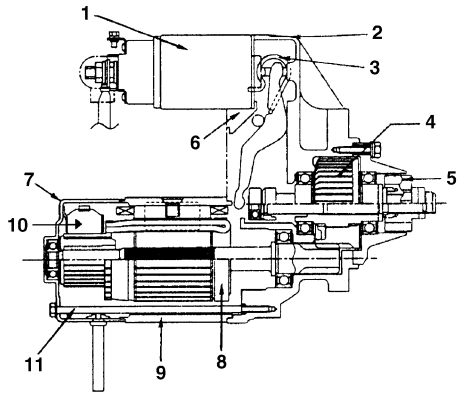
Keep starter terminals and all other terminals in the electrical system clean and tight. A loose or corroded connection or terminal will cause excessive resistance in the system that will result in hard starting.
At regular intervals, inspect the starting system to locate and correct potential causes of trouble before the system performance is affected.
Starting motors do not require lubrication except during overhaul.

Starter

Components

Starting Motor

S25—505G



N6A6516E

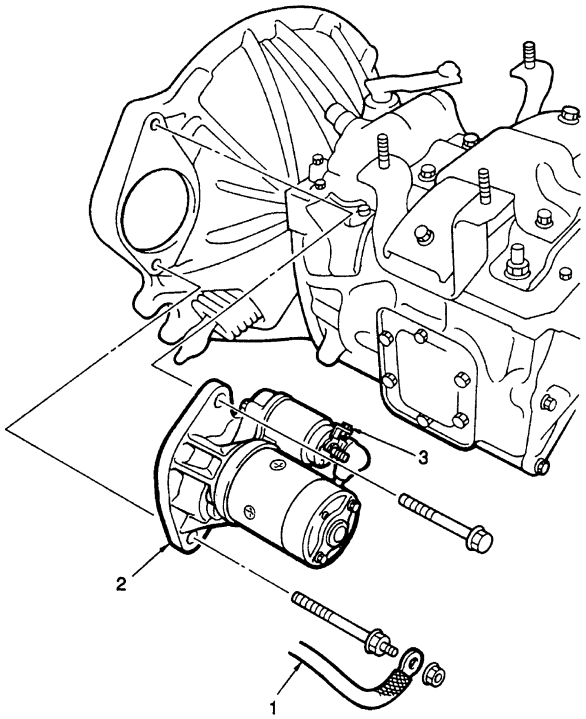
Legend

1. Magnetic Switch
2. Gear Case
3. Torsion Spring
4. Clutch
5. Pinion
6. Dust Cover
7. Rear Cover
8. Armature
9. Yoke
10. Brush
11. Through Bolt

On-vehicle Service

Component

Starter



N6A0988E

Legend

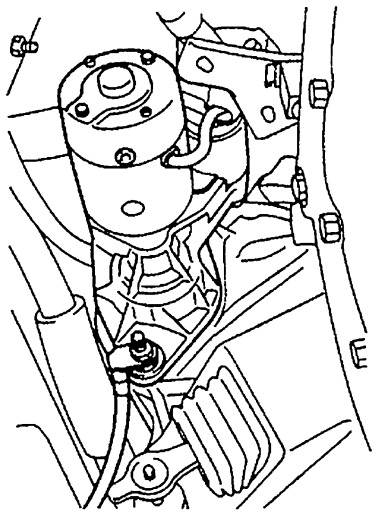
1. Starter Earth Cable
2. Starter Assembly
3. Starter Wiring Connector

Removal

Preparation

- Disconnect the battery ground cable (both batteries).

1. Starter Earth Cable

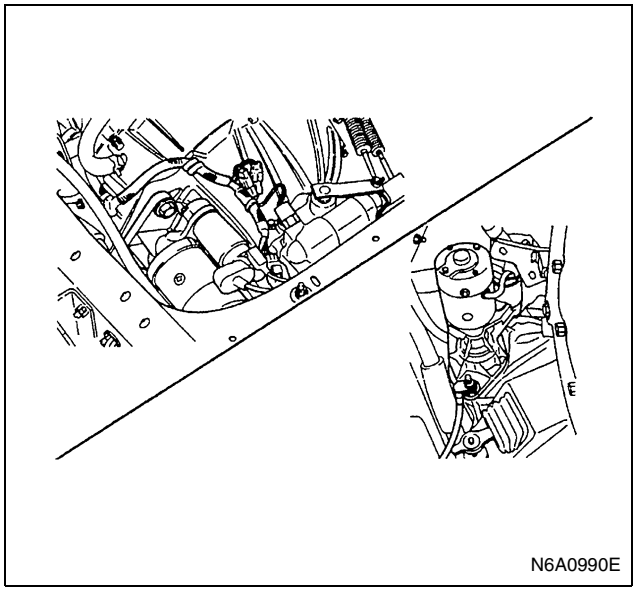


N6A0989E

- Disconnect the starter earth cable at the starter motor.

- Disconnect the front frame harness connector somewhere near the control box of the transmission, remove each clip that fastens the harness.

2. Starter Assembly

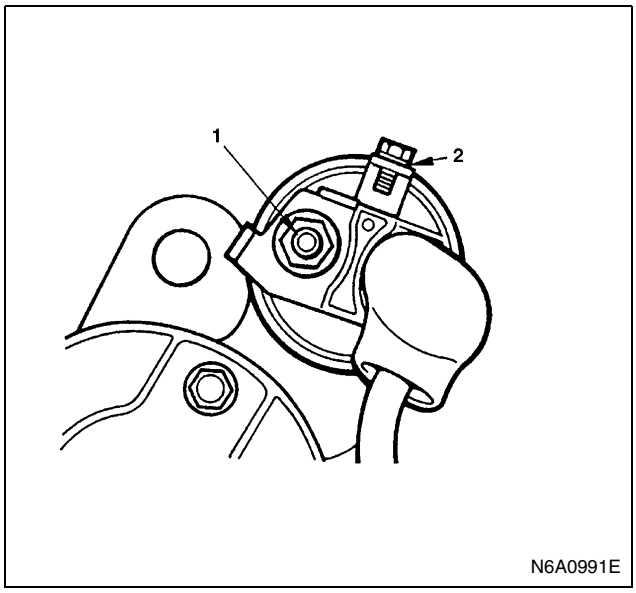


- Remove the starter assembly from flywheel housing.

3. Starter Wiring Connector

Installation

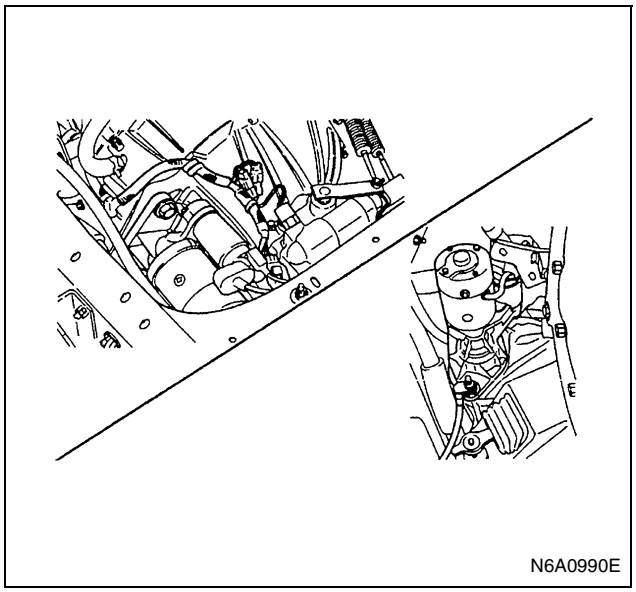
1. Starter Wiring Connector



Legend

1. Terminal B
2. Terminal S

2. Starter Assembly



- Install the starter to the flywheel housing.

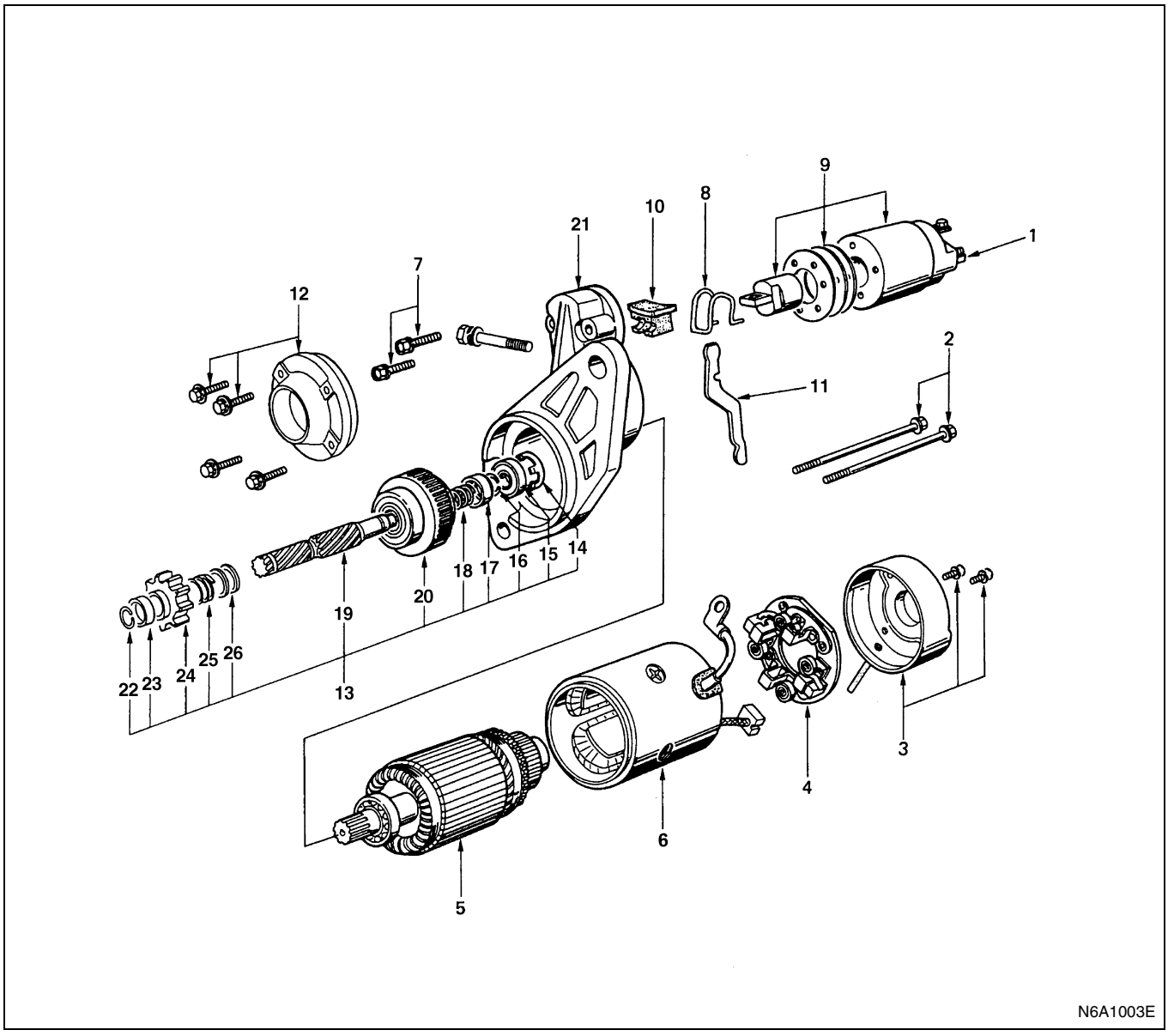
Tighten:
Starter bolt to 76 N·m (7.7 kg·m / 56.1 lb·ft)

3. Starter Earth Cable
   - Connect the earth cable to the starter motor.
   - Connect the battery ground cable.

Unit Repair

Component

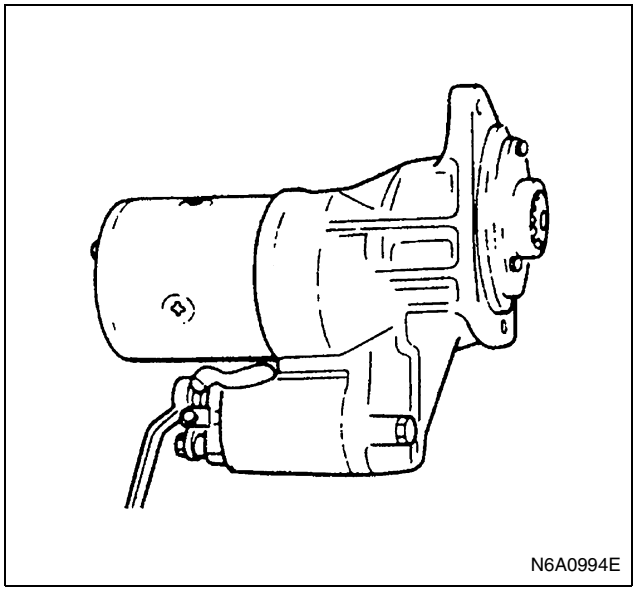
S25-505G



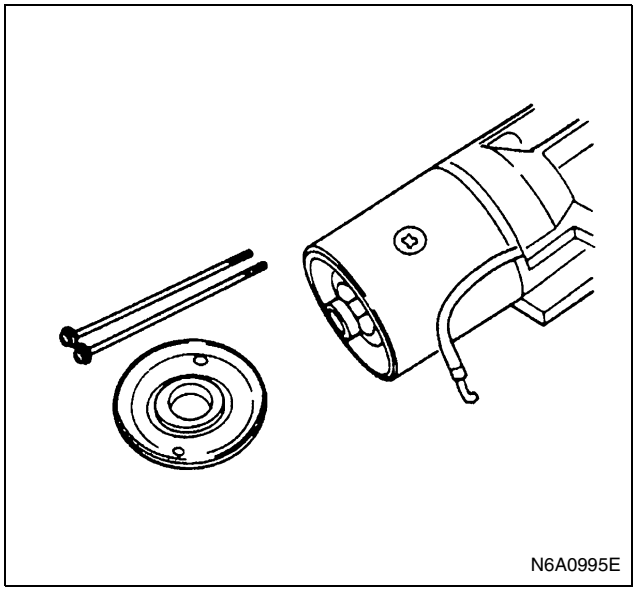
Legend

1. Lead Wire Nut
2. Through Bolt
3. Rear Cover
4. Brush Holder
5. Armature
6. Yoke
7. Bolt
8. Torsion Spring
9. Magnetic Switch Assembly
10. Dust Cover
11. Shift Lever
12. Bearing Retainer
13. Clutch Assembly
14. Bearing Holder
15. Ball Bearing
16. Pinion Stopper Clip
17. Pinion Stopper
18. Return Spring
19. Pinion Shaft
20. Pinion Clutch
21. Gear Case
22. Clip
23. Pinion Stopper
24. Pinion
25. Cushion Spring
26. Washer

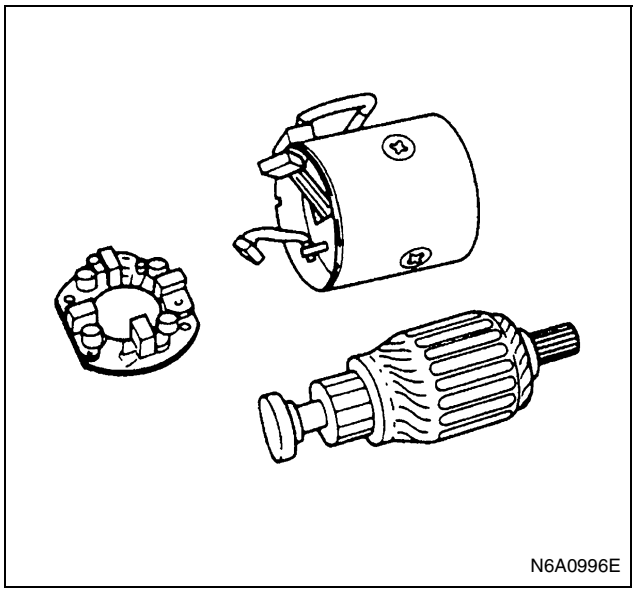
Disassembly



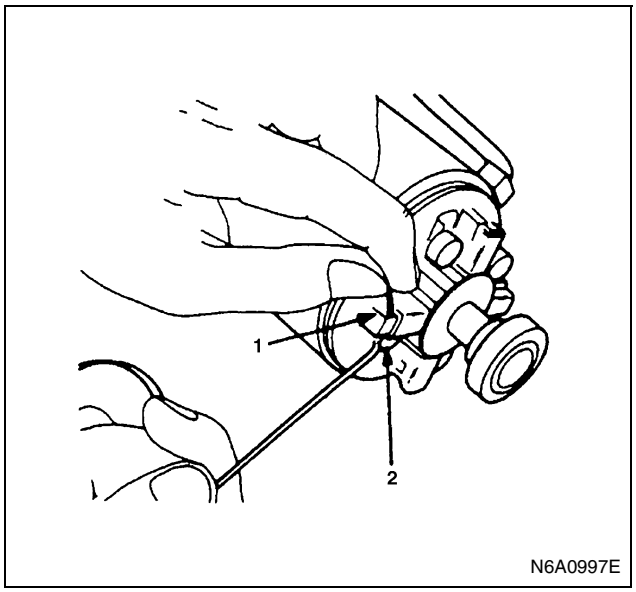
1. Lead Wire Nut
   Disconnect the lead wire at the magnetic switch.
2. Through Bolt



3. Rear Cover
   Remove the through bolts, then remove the rear cover.
4. Brush Holder



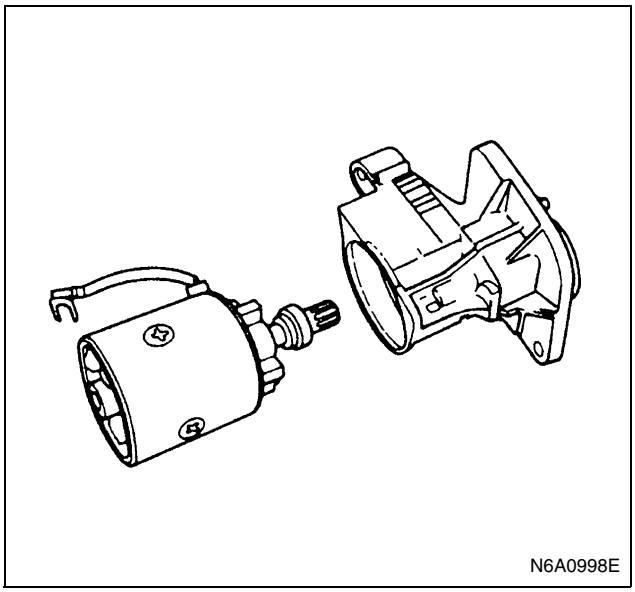
5. Armature
6. Yoke
   Remove the brush holder and pull the armature assembly from the yoke.
   Remove the four brushes from the brush holders.



Legend

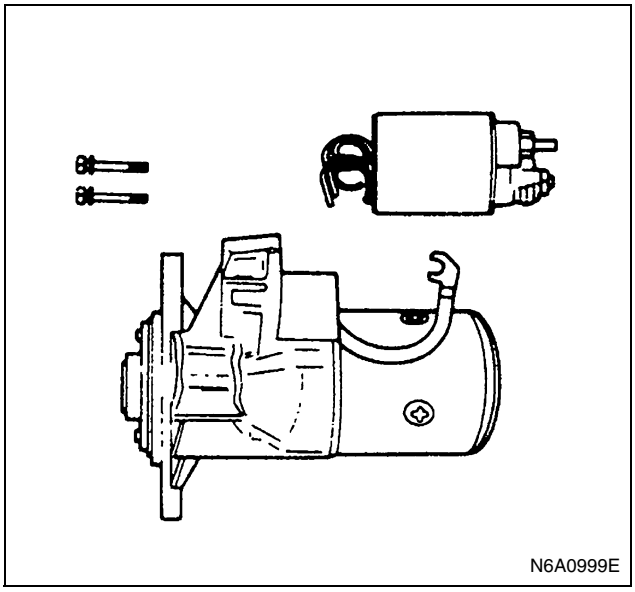
1. Brush
2. Brush Spring

Remove the yoke along with the armature and the brush holder from the drive housing.


N6A0998E

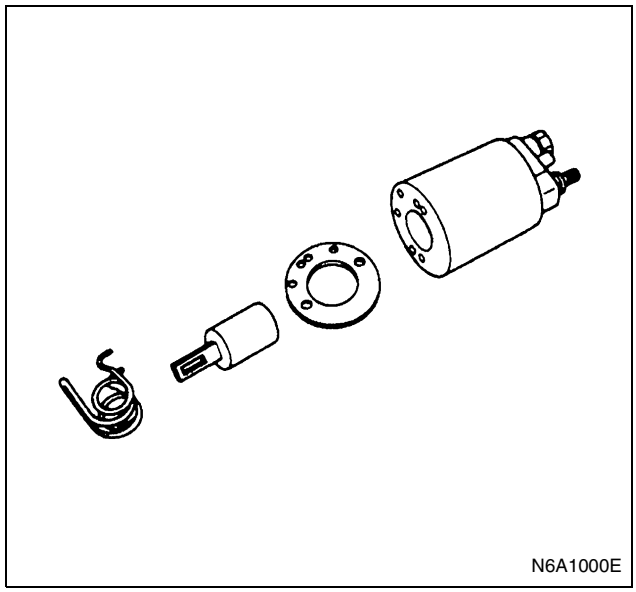
Remove the brushes and commutator carefully so as not to allow them in contact with the adjacent parts.

7. Bolt
8. Torsion Spring
9. Magnetic Switch Assembly

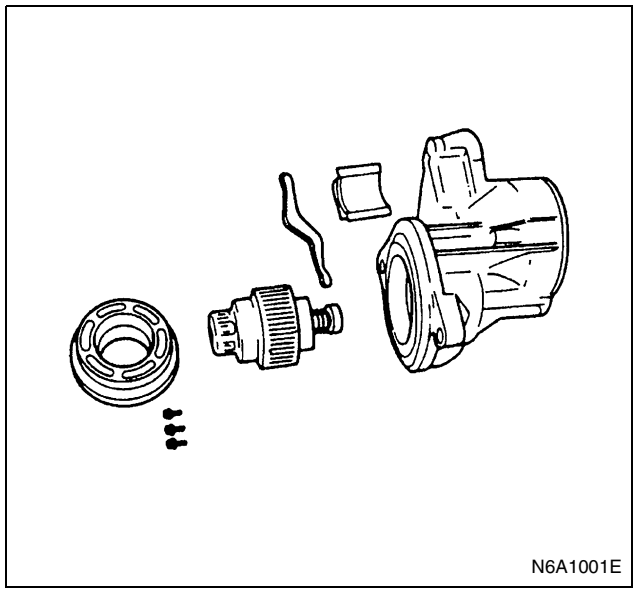

N6A0999E

Remove the magnetic switch bolts, then remove the switch from the shift lever.

Remove the torsion spring from the magnetic switch.


N6A1000E

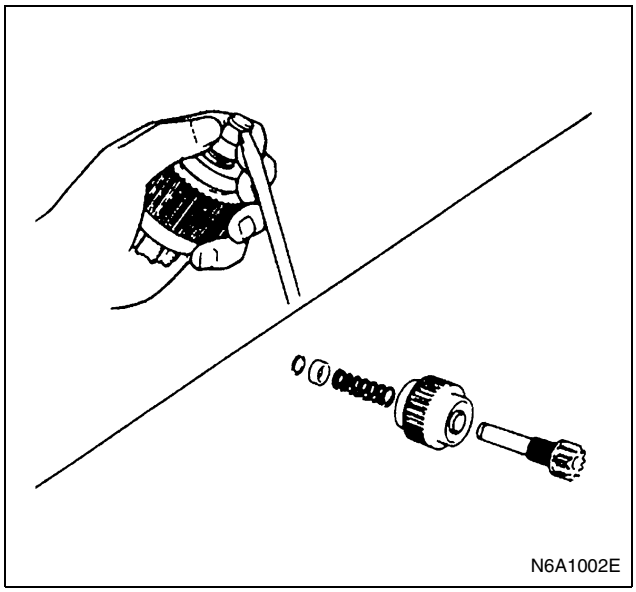
10. Dust Cover
11. Shift Lever
12. Bearing Retainer
13. Clutch Assembly


N6A1001E

1) Remove the bearing retainer.
2) Remove the clutch assembly from the gear case.

14. Bearing Holder
15. Ball Bearing
16. Pinion Stopper Clip
17. Pinion Stopper
18. Return Spring
19. Pinion Shaft
20. Pinion Clutch

Use a screwdriver to remove the stopper clip. Then disassemble the clutch assembly.


N6A1002E

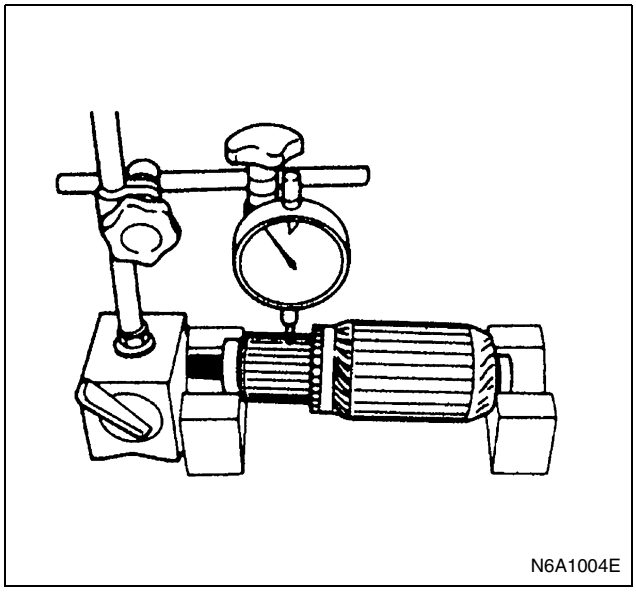
Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Armature

1. Measure the commutator run-out.
   Replace the commutator if the measured run-out exceeds the specified limit.

Commutator Run-Out	mm (in)
Standard	Limit
0.05 (0.002) or less	0.2 (0.008)

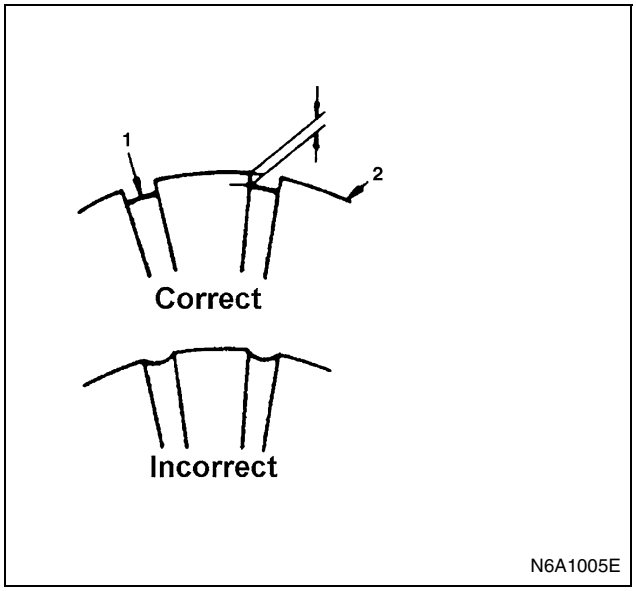

N6A1004E

2. Check the commutator mica segments for excessive wear.
3. Measure the mica segment depth.

Mica Segment Depth	mm (in)
Standard	Limit
0.5 — 0.8 (0.020 — 0.031)	0.2 (0.008)

If the mica segment depth is less than the standard but more than the limit, the commutator may be reground.

If the mica segment depth is less than the limit, the commutator must be replaced.

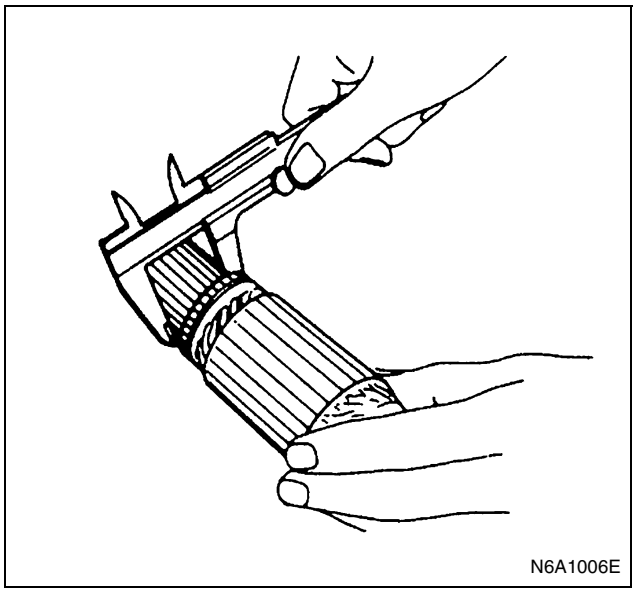


N6A1005E

Legend

1. Insulator
2. Commutator Segments

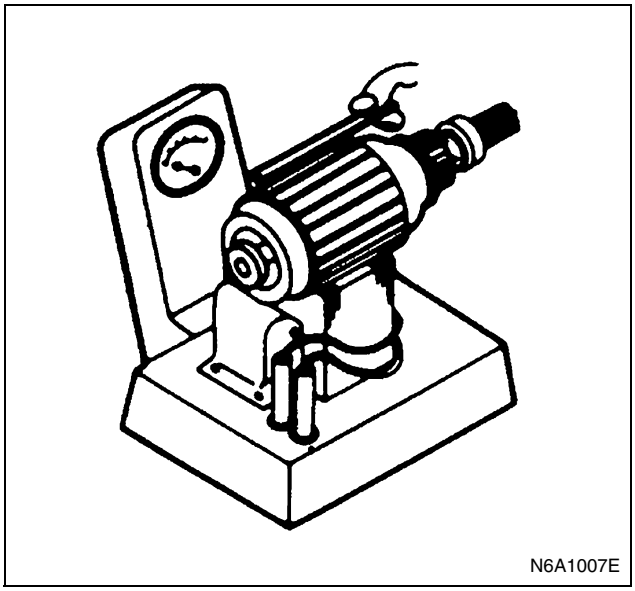
4. Measure the commutator outside diameter.


N6A1006E

Commutator Outside Diameter			mm (in)
Model	Yoke Diameter	Standard	Limit
S25-505G	ϕ90	36.5 (1.437)	35.5 (1.398)

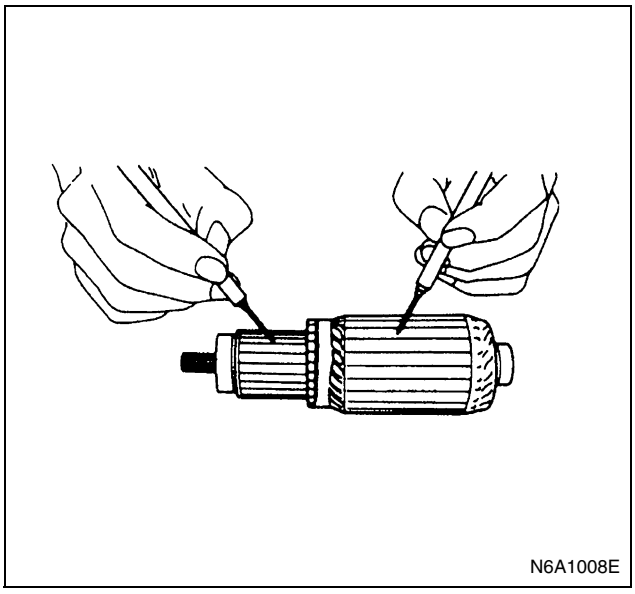
If the measured outside diameter is less than the specified limit, the commutator must be replaced.

5. Test the armature for short circuiting.


N6A1007E

1) Place the armature in a growler tester.
2) Hold a hacksaw blade against the armature core.
   If the armature has a short circuit, the hacksaw blade will vibrate.
   Replace the armature if there is a short circuit.

6. Use a circuit tester to check the armature for grounding.

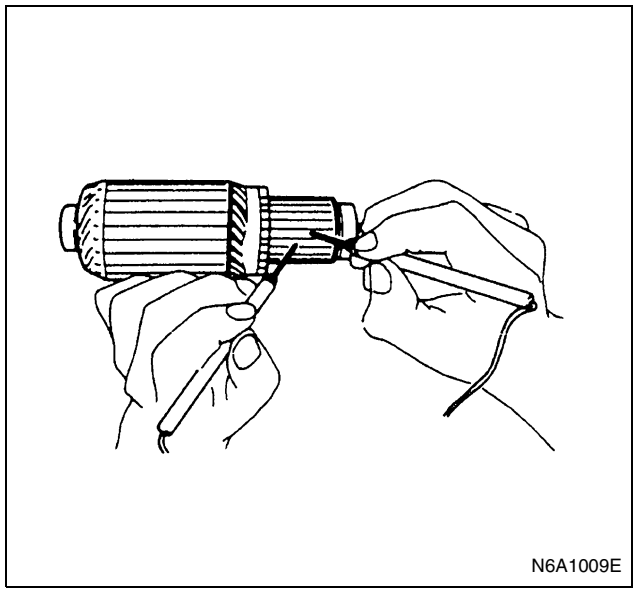

N6A1008E

1) Hold one probe of the circuit tester against the commutator segment.
2) Hold the other circuit tester probe against the armature core.

If the circuit tester indicates continuity, the armature is grounded.

The armature must be replaced.

7. Use the circuit tester to check the armature for continuity.


N6A1009E

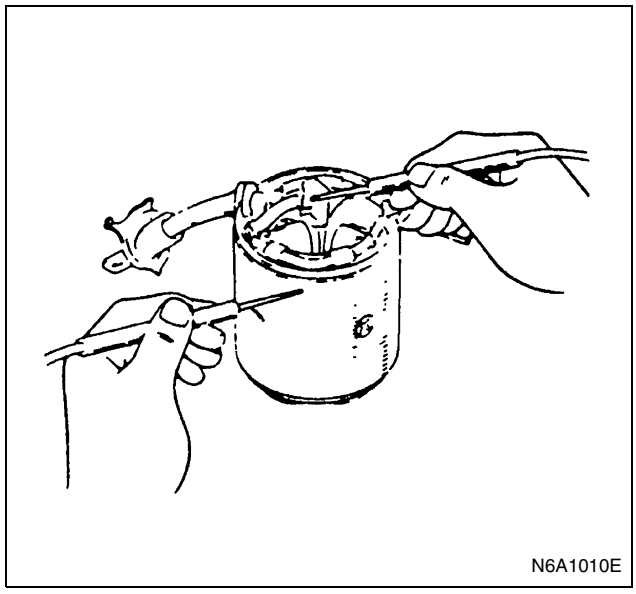
1) Hold the circuit tester probes against two armature core segments.
2) Repeat Step 1 at different segments of the armature core.

There should be continuity between all segments of the armature core.

If there is not, the armature must be replaced.

Yoke

1. Use a circuit tester to check the field winding ground.


N6A1010E

1) Hold one circuit tester probe against the field winding end or brush.

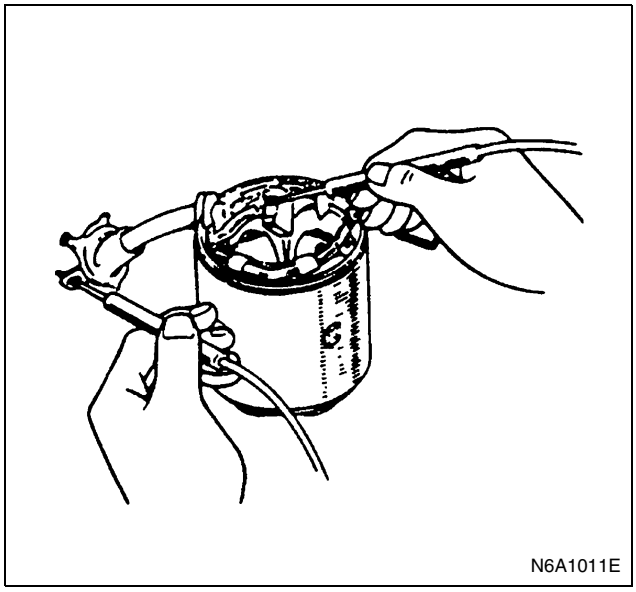
2) Hold the other circuit tester probe against the bare surface of the yoke body.

There should be no continuity.

If there is continuity, the field coil is grounded.

The yoke must be replaced.

2. Use the circuit tester to check the field winding continuity.


N6A1011E

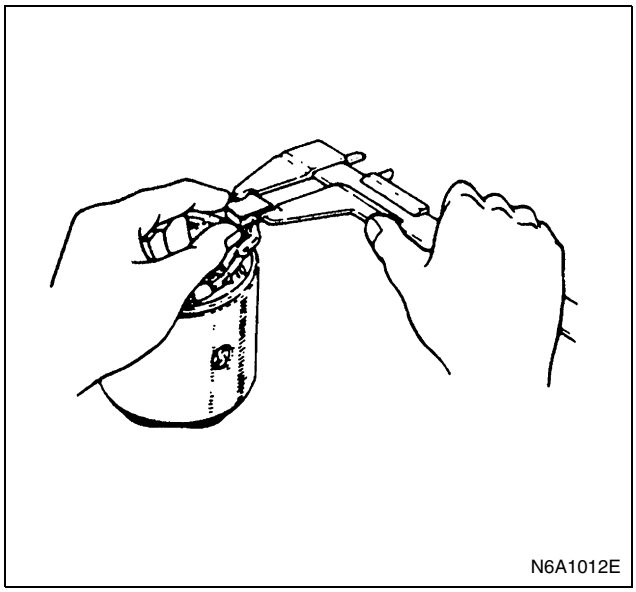
1) Hold one circuit tester probe against the “C” terminal lead wire.
2) Hold the other circuit tester probe against the field winding brush.

There should be continuity.

If there is no continuity, the yoke must be replaced.

Brush and Brush Holder

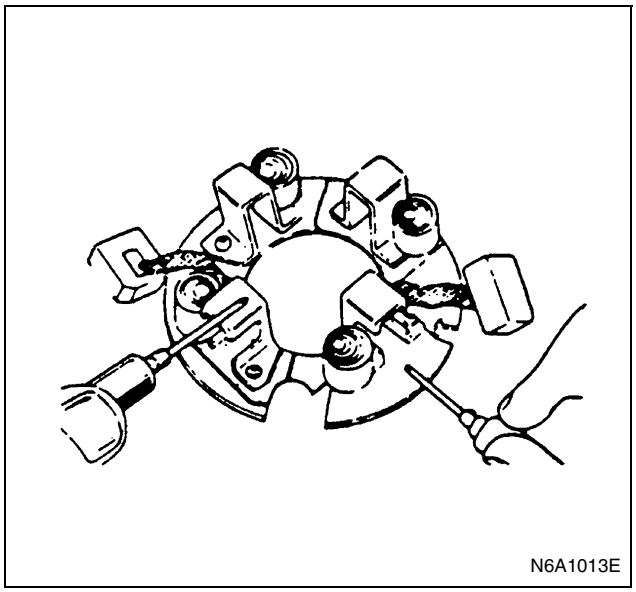
1. Use a vernier caliper to measure the brush length (four brushes).


N6A1012E

Replace the brushes as a set if one or more of the brush length is less than the specified limit.

Brush Length			mm (in)
Model	Yoke Diameter	Standard	Limit
S25-505G	ϕ90	15.0 (0.591)	10.5 (0.413)

2. Use a circuit tester to check the brush holder insulation.


N6A1013E

Touch one probe to the holder plate and the other probe to the positive brush holder.

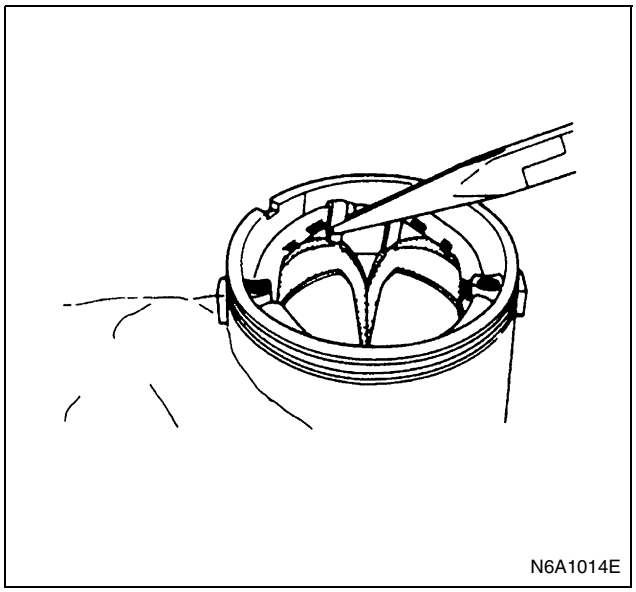
There should be no continuity.

3. Inspect the brushes for excessive wear.

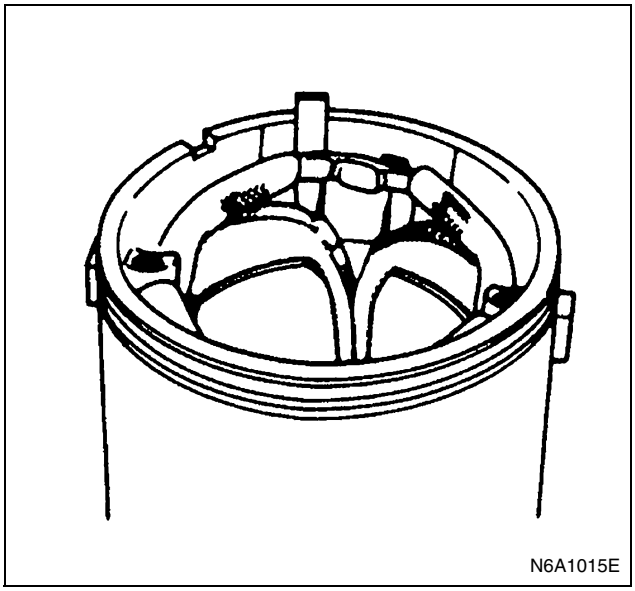
If the negative brushes have excessive wear, the entire brush holder assembly must be replaced.

If the positive brushes have excessive wear, only the brushes must be replaced.

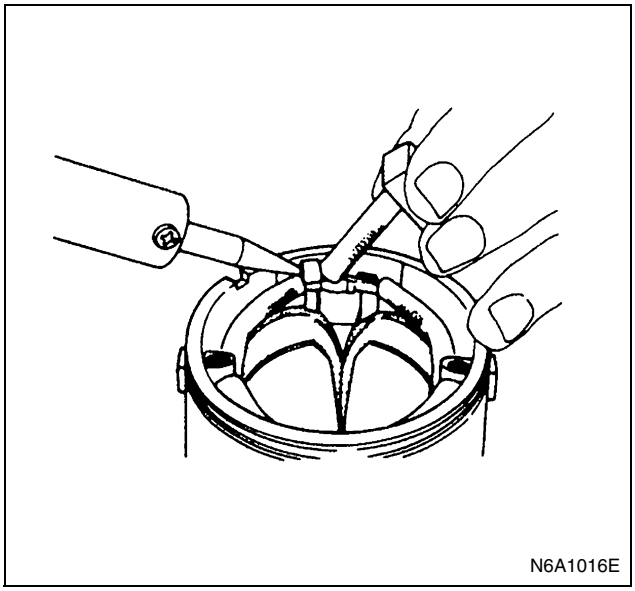
1) Use a pair of side cutters to cut the lead wire from the brush.


N6A1014E

2) File away any foreign material clinging to the edge of the lead wire.
3) Remove the brushes from the brush holder.
4) Install the new brushes.
5) Straighten the bent portion of the clip.


N6A1015E

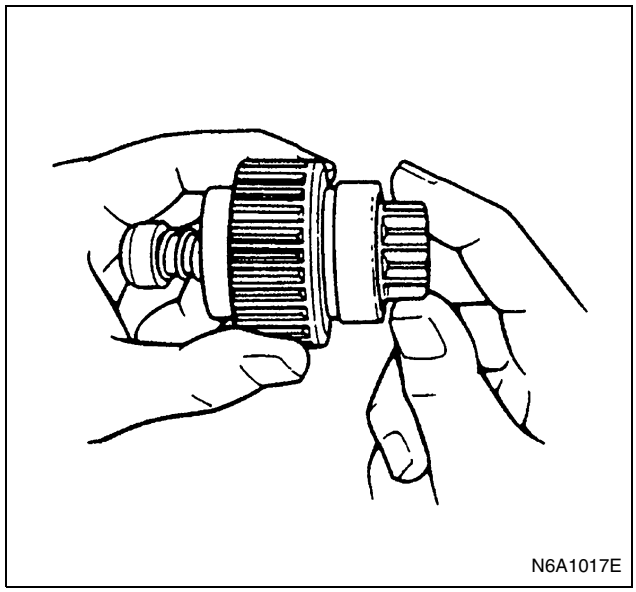
6) File away any foreign material clinging to the clip surface.
7) Place the lead wire in the clip.
8) Bend the clip shut.
9) Solder the brush lead.


N6A1016E

10) Repeat the procedure for each of the brushes.

Overrunning Clutch

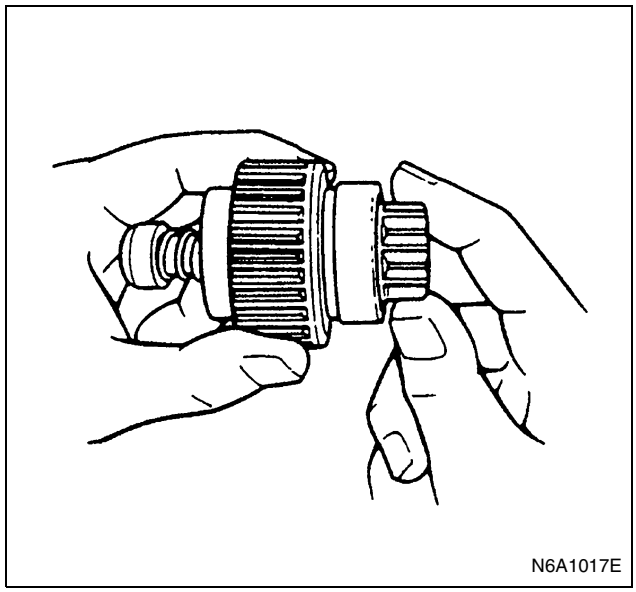
1. Inspect the overrunning clutch gear teeth for excessive wear and damage.
   Replace the overrunning clutch if necessary.
2. Rotate the pinion clockwise.


N6A1017E

   It should turn smoothly.
3. Try to rotate the pinion in the opposite direction. The pinion should lock.

Ball Bearing

Inspect the bearings for excessive wear and damage. Replace the bearings if necessary.

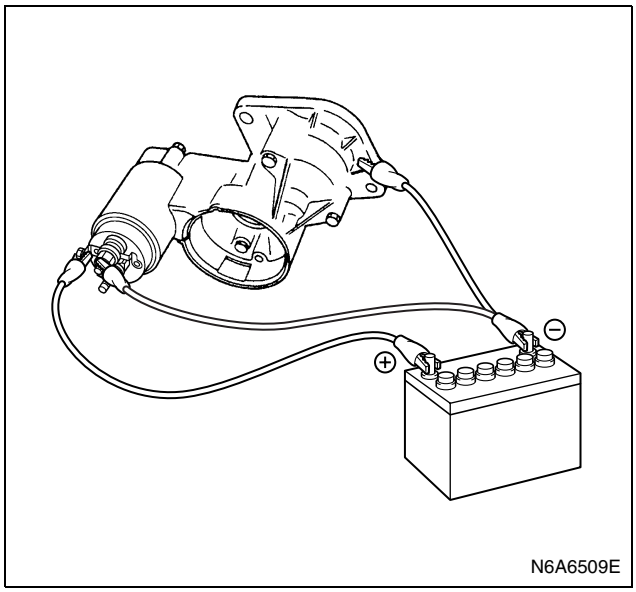

N6A1017E

Magnetic Switch

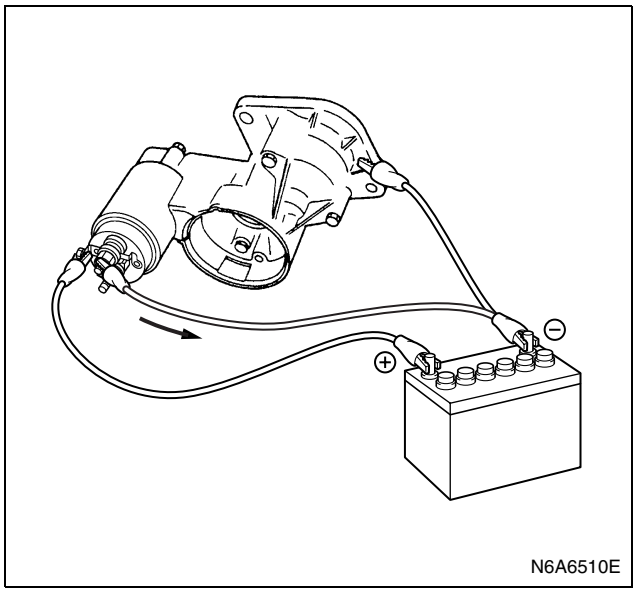
The following tests must be performed with the starter motor fully assembled.
The yoke lead wire must be disconnected from the “C” terminal.
To prevent coil burning, complete each test as quickly as possible (within three to five seconds).
Temporarily connect the magnetic switch between the clutch and the housing and run the following test.
Complete each test within three to five seconds.

1. Pull-Out Test
   Connect the battery negative terminal with the magnetic switch body and the C terminal. When

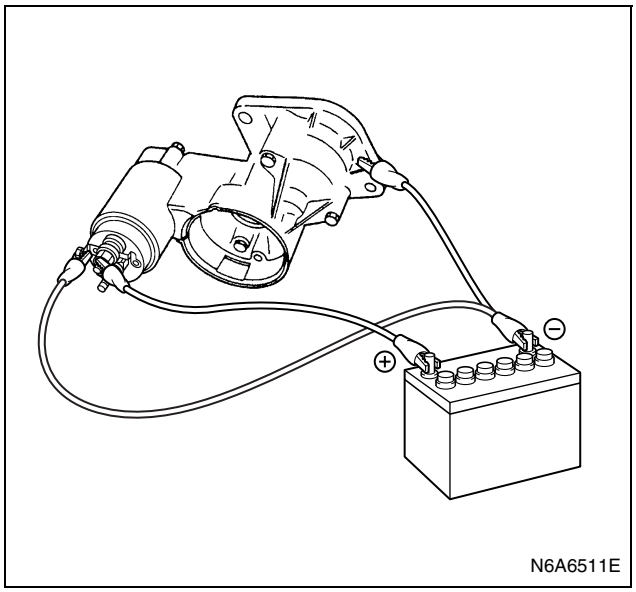
current is applied to the 50 terminal from the battery positive terminal, the pinion should flutter.



2. Hold-in Maintenance Test
   Disconnect the lead at the C terminal. The pinion should continue to flutter.



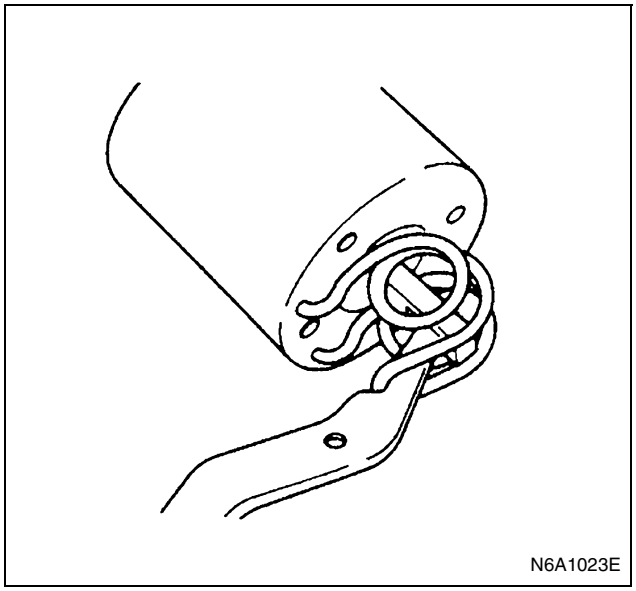
3. Return Test
   Connect the battery negative leads to the starter body and the 50 terminal.



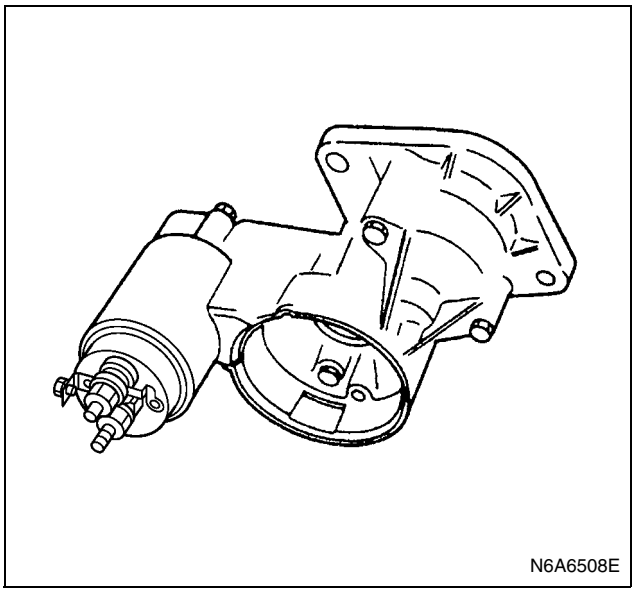
   Connect the battery positive lead at the C terminal. The pinion should return to its home position.

Reassembly

1. Gear Case
2. Magnetic Switch Assembly
3. Torsion Spring
4. Shift Lever
   1) Attach the torsion spring to the hole in the magnetic switch as illustrated.

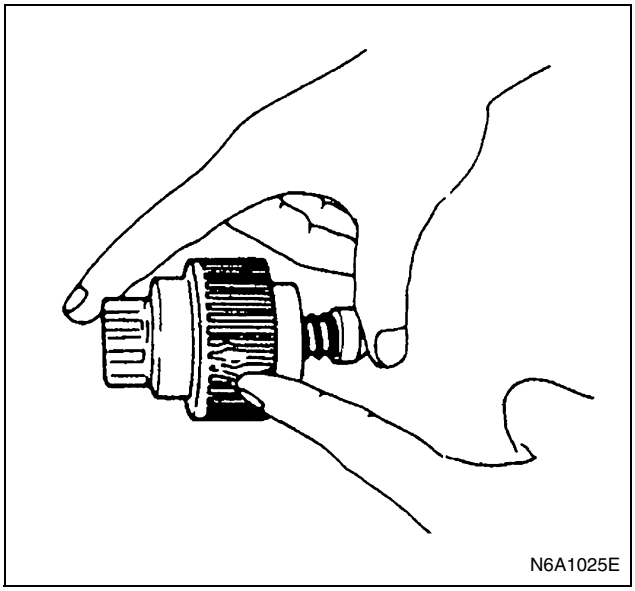


   2) Insert the shift lever into the plunger hole of the magnetic switch.
5. Dust Cover
   Install the dust cover.
6. Bolt
   Install the magnetic switch assembly in the gear case and tighten the bolt to the specified torque.

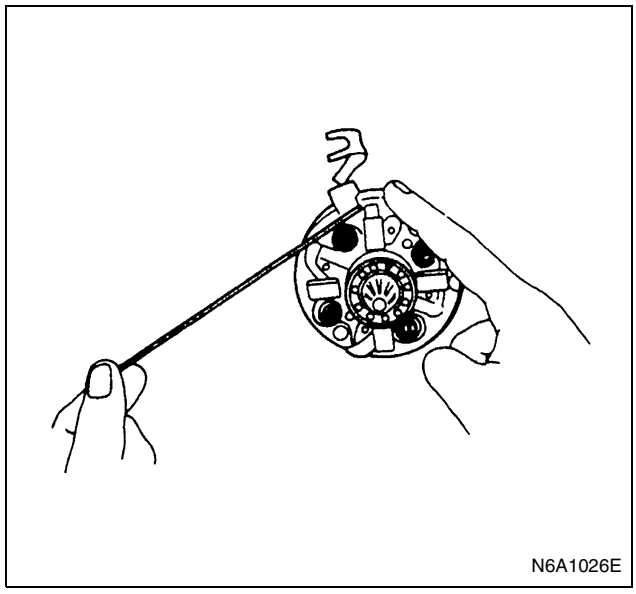

N6A6508E

Tighten:
Gear case bolt to 8 N·m (0.8 kg·m / 69 lb·in)

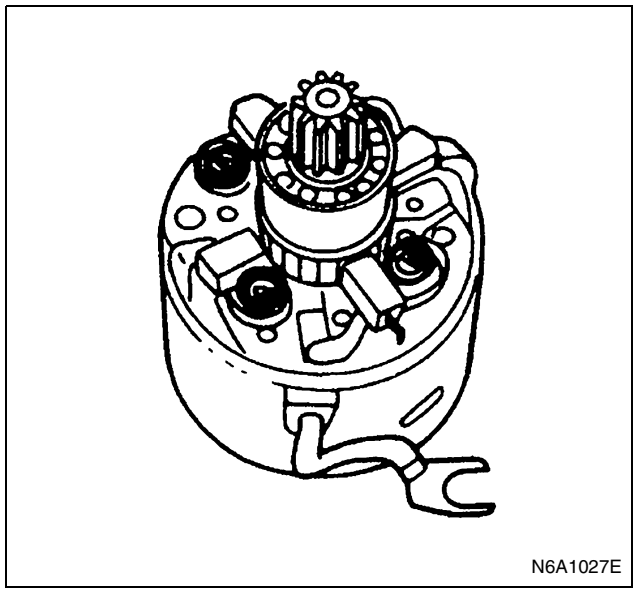
7. Pinion Clutch
8. Pinion Shaft
   Apply a coat of grease to the pinion clutch gear and install the pinion assembly to the armature shaft.


N6A1025E

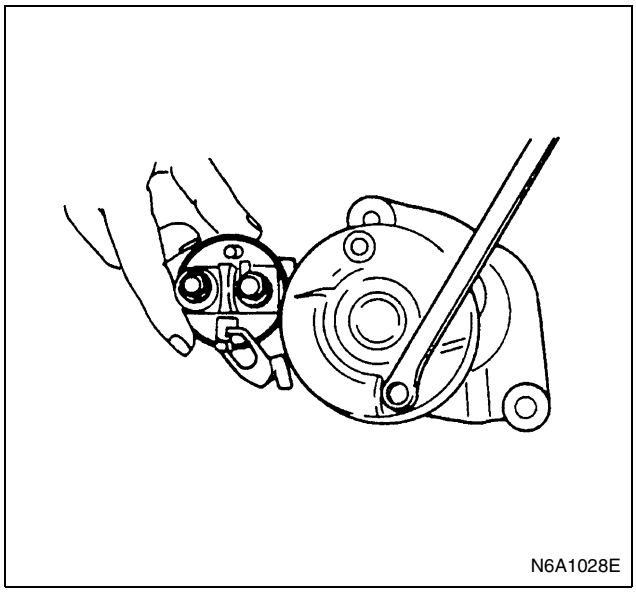
9. Return Spring
10. Pinion Stopper
11. Pinion Stopper Clip
12. Ball Bearing
13. Bearing Holder
14. Clutch Assembly
15. Bearing Retainer
16. Armature
17. Yoke
18. Brush Holder


N6A1026E

1) Twist the holder spring and hold it.
2) Install the brush to the brush holder.
3) Repeat step 1 and 2 for the reaming holders.
4) Install the brush holder assembly to the yoke.

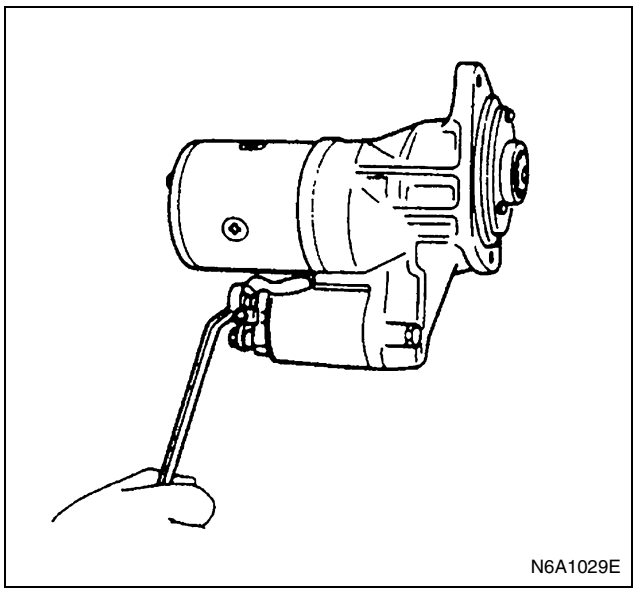

N6A1027E

   Take care not to damage the commutator face and the brushes.
19. Rear Cover
20. Through Bolt
    Install the through bolts in the rear cover and tighten them to the specified torque.


N6A1028E

Tighten:
Through bolt to 6 N·m (0.6 kg·m / 52 lb·in)

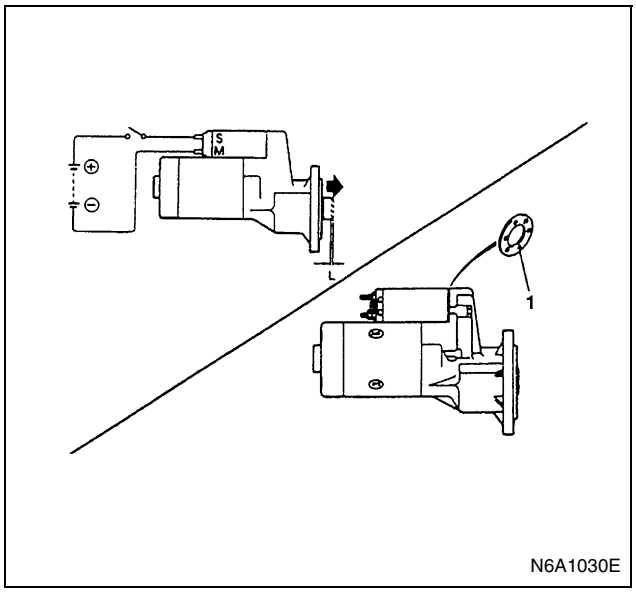
21. Lead Wire Nut
    Connect the lead wire in the magnetic switch and tighten the terminal nut to the specified torque.


N6A1029E

Tighten:
Lead wire terminal nut to 10 N·m (1.0 kg·m / 87 lb·in)

Pinion Jump-out dimension

- Connect the (+) cable of battery to terminal S and the (−) cable to terminal M. Turn the switch on, and measure pinion travel dimension “L” in thrust direction from the jump-out position.



N6A1030E

Legend
1. Spacer

In measuring the dimension, pull the pinion out a little in the arrow direction.

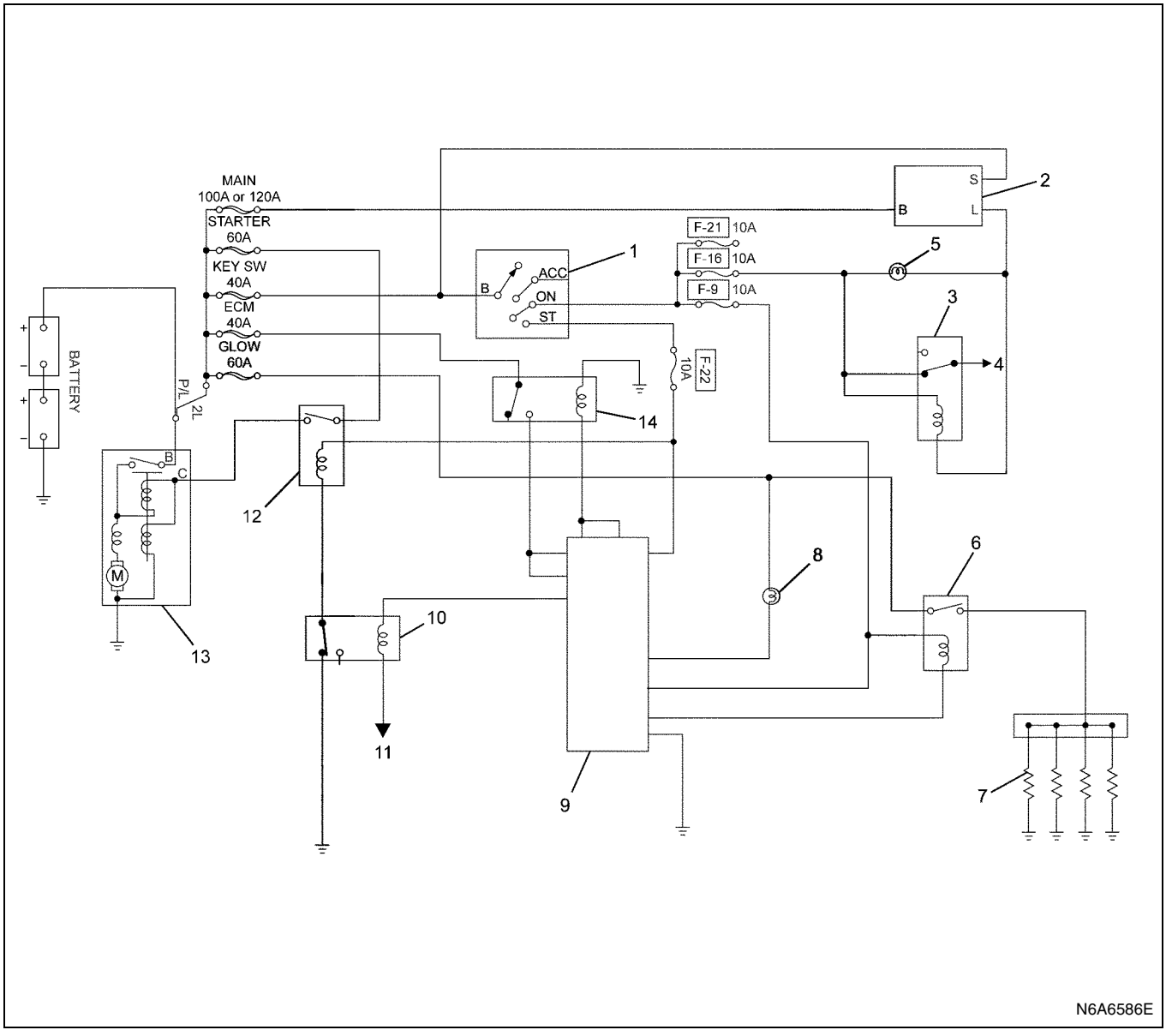
	mm (in)
Dimension	Standard
L	0.3 — 0.1 (0.01 — 0.004)

If the measured value is out of standard, adjust the of shims.

Preheating System

Glow Plug Replacement

Circuit Diagram



Legend

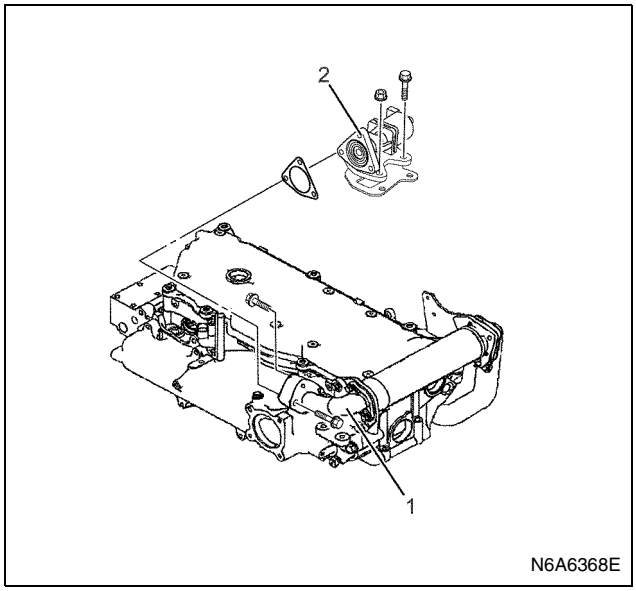
1. Engine Control Switch
2. Generator (Integral Regulator)
3. Charge Relay
4. To Heater and A/C Relay
5. Low Charge Indicator Light
6. Glow Plug Relay
7. Glow Plugs
8. Glow Plug Indicator Light
9. ECM
10. Starter Cut Relay
11. To Exhaust Brake Solenoid Valve
12. Starter Relay
13. Starter
14. ECM Main Relay

Precautions during maintenance

Adequate care should be taken as over-tightening the glow plug could lead to damage.

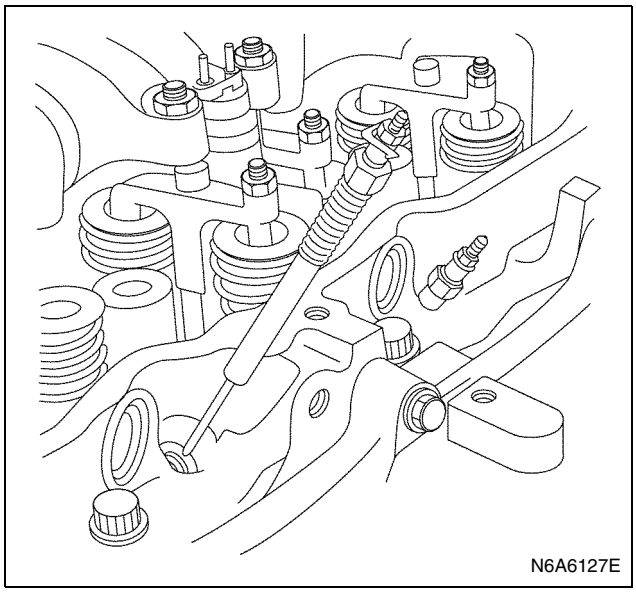
Removal

1. Remove the engine harness, the throttle position sensor, the EGR valve, the pressure sensor, and all of the fuel injector connectors.
2. Remove the EGR valve and the EGR adapter.
3. Tape the EGR case holes shut to prevent the entry of foreign material.



Legend
1. EGR Adapter
2. EGR Valve

4. Remove the glow connector.
5. Remove the glow plug.



Installation

1. Install the glow plug.

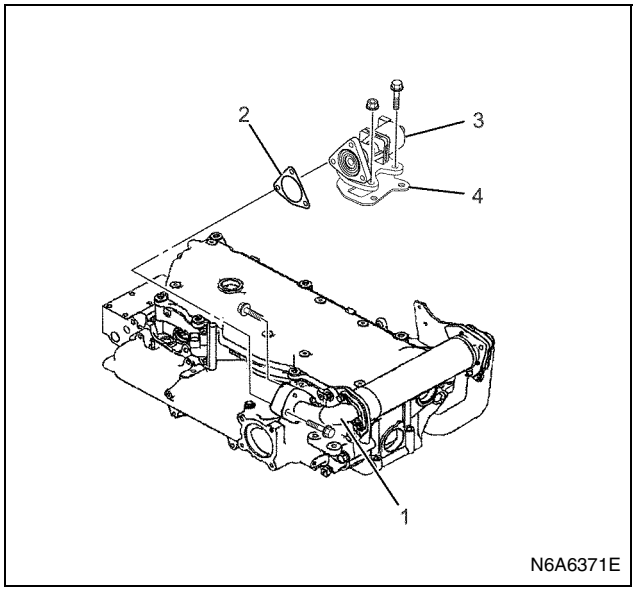
Tighten:
Glow plug to 20 N·m (2.0 kg·m/15 lb·ft)

2. Install and tighten the glow connector with the designated torque.

Tighten:
Glow connector to 12 N·m (1.2 kg·m/10 lb·ft)

3. Install the EGR valve and the EGR adapter.

Tighten:
EGR valve and adapter to 24 N·m (2.4 kg·m/17 lb·ft)



Legend
1. EGR Adapter
2. EGR Valve Gasket
3. EGR Valve
4. EGR Valve Gasket

4. Attach the engine harness connectors. Each composite connector should make a loud click when it is securely attached.

Service Precautions

Adequate care should be taken as over-tightening the glow plug could lead to damage.

Explanations on Functions and Operation

The preheating system consists the ECM, the glow relay, glow plugs and the glow indicator lamp. The preheating system is operated when the engine coolant temperature is low, and make the engine easy to start.

Functional check

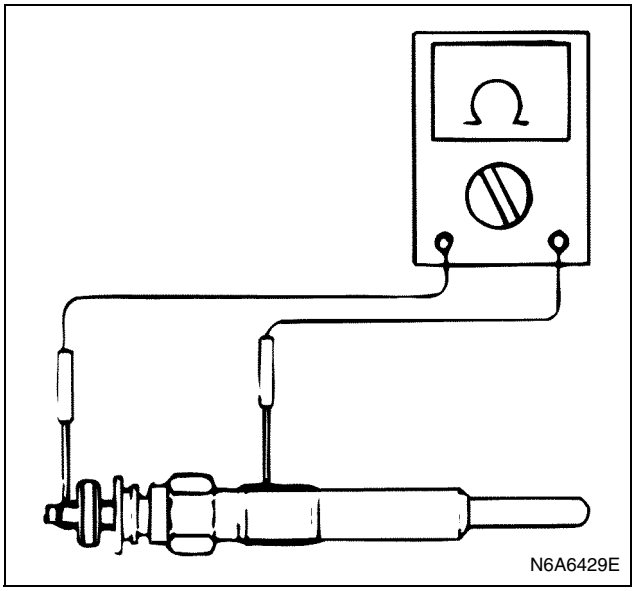
Refer to Section 6E (Glow Control System Check). Except the glow plug.

Glow plug check

- Use the circuit tester and measure the resistance of the glow plug.
- If the measured value deviates from the specified value, then replace the glow plug.

  Resistance value of glow plug is approximately less than 6Ω.

Caution:
Use a set of four glow plugs from the same manufacturer.



A List of Defective Phenomena

- The glow indicator lamp does not light up.
- Preheating does not work.
- The preheating time is too long or too short.

Trouble Shooting

1. The glow indicator lamp does not light up.

Condition	Possible Cause	Correction
The glow indicator lamp does not light up.	Slow blow fuse has blown.	Replace the slow blow fuse.
	Fuse is unavailable.	Replace the fuse.
	Indicator valve is burnt out.	Replace the indicator valve.
	Engine control system is faulty.	Refer to Section 6E.

2. Preheating does not work.

Condition	Possible Cause	Correction
Preheating does not work.	Slow blow fuse has blown.	Replace the slow blow fuse.
	Defective or faulty glow plug relay connector contact.	Re-mount or replace the glow plug relay.
	Engine control system is faulty.	Refer to Section 6E.

3. Preheating time is too long or too short.

Condition	Possible Cause	Correction
The Preheating time is too long or too short.	Thermosensor fault and break in circuit or short circuit.	Replace the thermosensor. Repair the circuit.
	Fault in glow plug.	Replace or tighten the glow plug.
	Engine control system is faulty.	Refer to Section 6E.

Main Data and Specifications

Preheating device model	Glow plug
Glow plug rated voltage (V)	24

ENGINE

Exhaust System

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EGR System

Service Precautions

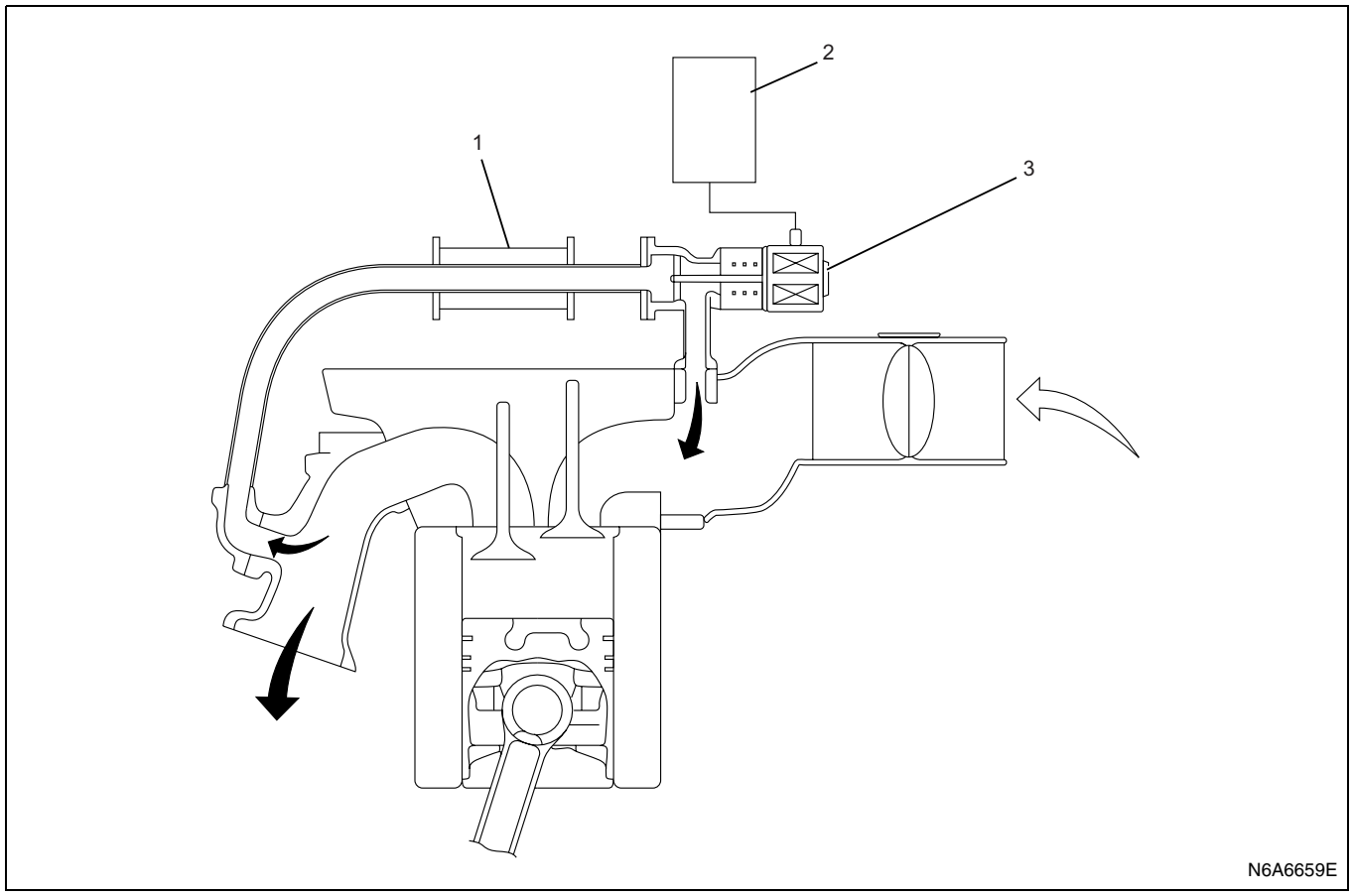
Perform EGR related assembly according to the usual procedure of temporarily fitting and then permanently tightening the parts so that unnecessary stresses are not applied on the parts.

Explanations on Functions and Operation

The EGR system recirculates a part of exhaust gas back into the intake manifold, which results in reducing nitrogen oxide (NOx) emissions. The EGR control system uses an electronic control system to ensure both driveability and low emission. The control current from the engine control module (ECM) operates the motor to control the lift amount of EGR valve. Also, an EGR position sensor is provided at the rear of the motor to feed actual valve lift amount back to the ECM for more precision control of the EGR amount.

The EGR control starts when the conditions for engine speed, engine coolant temperature and barometric pressure are satisfied. Then, the valve opening is calculated according to the engine speed, and target fuel injection quantity. Based on this valve opening, the drive duty of the motor is determined and the motor is driven accordingly.

A potentiometer type EGR valve position sensor is employed and installed on the EGR valve body. The EGR valve position sensor is supplied with reference voltage (5V) and ground at all times from the ECM. The ECM reads the EGR position sensor voltage input and determines the EGR lift position.

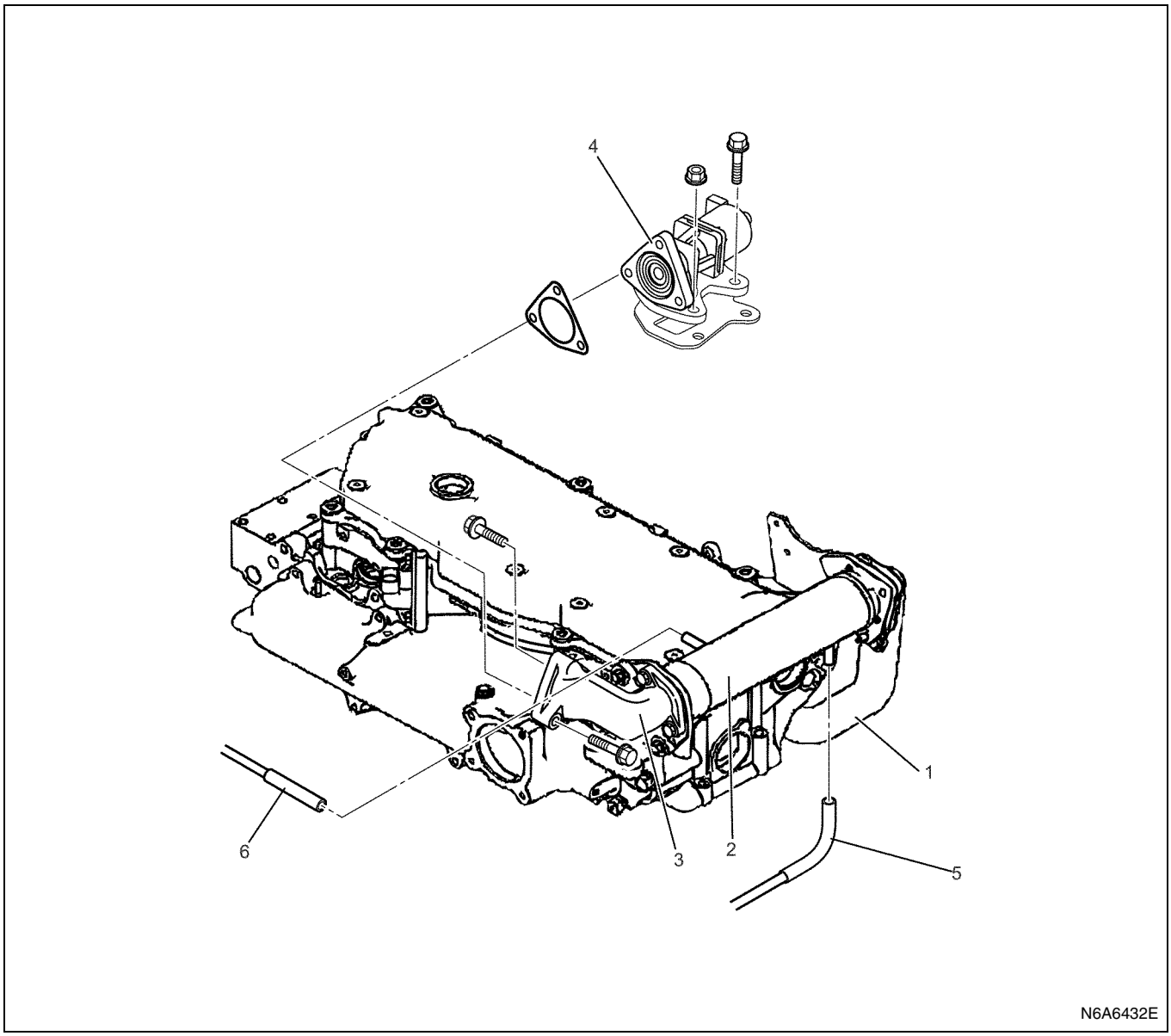


Legend

1. EGR Cooler
2. ECM
3. EGR Valve

EGR Valve and EGR Cooler

Components



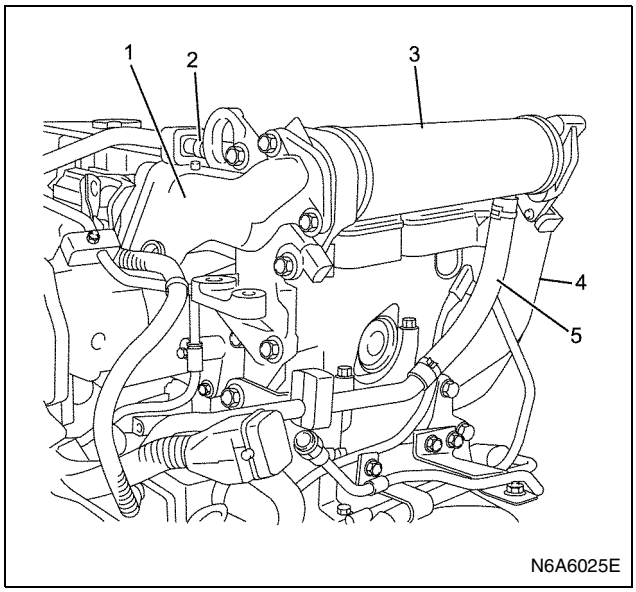
Legend

1. EGR Pipe
2. EGR Cooler
3. EGR Adapter
4. EGR Valve
5. Cooling Water Pipe (IN)
6. Cooling Water Pipe (OUT)

Removal

1. Drain engine coolant. Refer to Engine Cooling System section.
2. Remove the EGR valve connector.

3. Remove the EGR pipe.

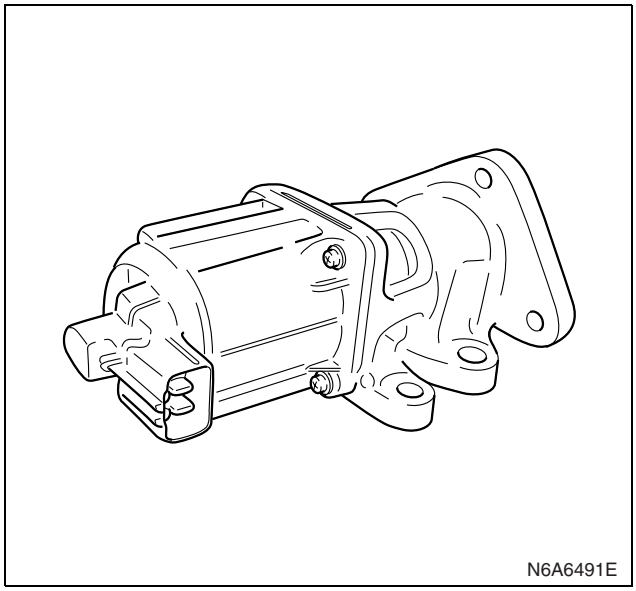


Legend

1. EGR Adapter
2. Water Return Pipe
3. EGR Cooler
4. EGR Pipe
5. Water Feed Pipe

4. Remove the cooling water pipes.
5. Remove the EGR adapter.
6. Remove the EGR cooler.
7. Remove the EGR valve.

Caution:
After removing the EGR valve and EGR adapter, seal the opening so that foreign matter does not enter.



Inspection

- **Gas leak check**
  - Check for gas leak in various parts of the EGR gas line.
    If the results of the check show abnormalities, repair or replace the defective parts.
- **EGR valve check**

Installation

1. Mount the EGR valve.
   - Insert the gasket and temporarily fit the EGR valve.

Notice:
Temporarily tighten the bolts.

2. Install the EGR cooler.
   - Temporarily fit the EGR cooler to the bracket.

Notice:
Temporarily tighten the bolts.

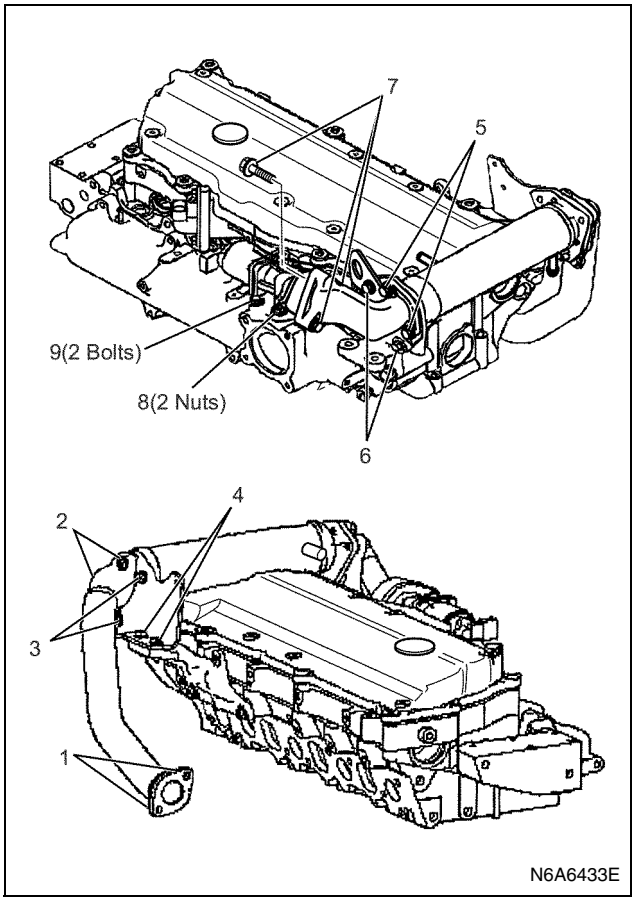
3. Install the EGR adapter.
   - Temporarily fit the EGR adapter between the EGR cooler and exhaust manifold.

Notice:
Temporarily tighten the bolts.

4. Install the EGR pipe.
   - Insert the gasket between the two ends of the EGR pipe and temporarily fit it.

Notice:
Temporarily tighten the bolts.

During temporary assembly, tighten the nuts and bolts to the specified torque in the order shown in the illustration.



Tighten:

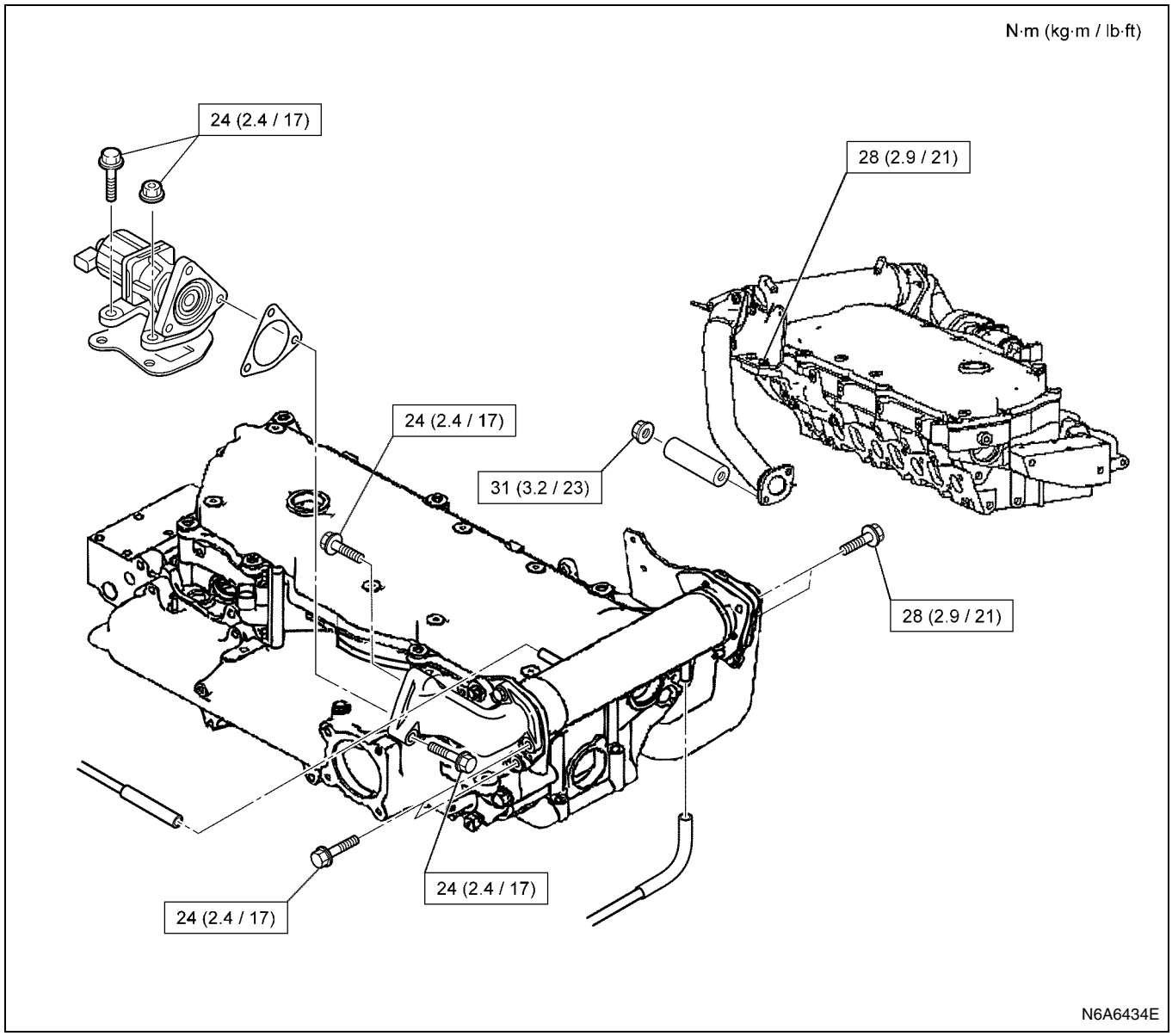
Bolts and nuts to

(1): 31 N·m (3.2 kg·m/23 lb·ft)

(2), (4): 28 N·m (2.9 kg·m/21 lb·ft)

(3), (5), (6), (7), (8), (9): 24 N·m (2.4 kg·m/17 lb·ft)

Torque Specifications



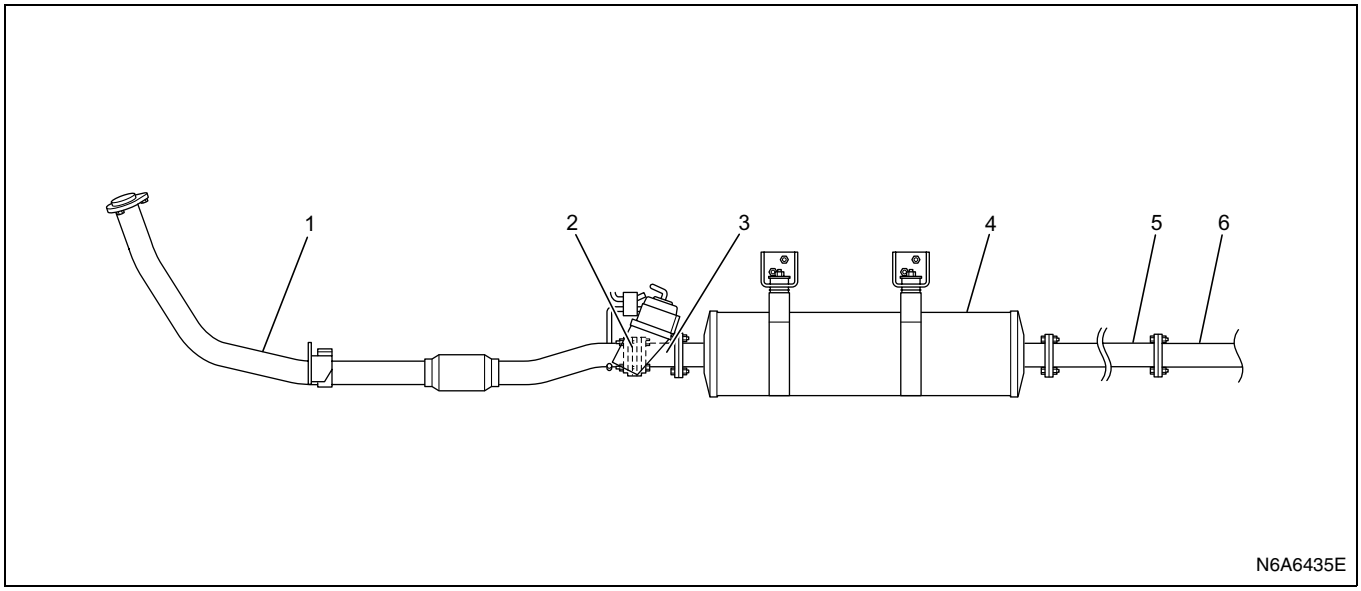
Exhaust System

Service Precautions

Offset in position of the exhaust system during assembly may sometimes cause vibrations or rattling noise. Therefore, temporarily tighten the bolts until all the parts have been positioned, and sequentially tighten from the engine side to the rear pipe side.

Explanations on Functions and Operation

The exhaust brake assembly operates the auxiliary brakes by adjusting the exhaust pressure. The tail pipe has a built-in post silencer. (S-spec only) This improves the silencing effect.
The main parts consist of the front exhaust pipe, center exhaust pipe, exhaust brake unit, silencer, extension pipe, and tail pipe.



Legend

1. Front Exhaust Pipe A
2. Exhaust Brake Assembly
3. Front Exhaust Pipe B
4. Silencer
5. Extension Pipe
6. Tail Pipe

Functional Check

- During check or repairs of the exhaust system, confirm that the clearance between the body and the floor is adequate.
- Adequate care should be taken to prevent damage due to heating or vibrations in the body panel as it may lead to exhaust gas entering the cabin.
- Check for loose or damaged connectors and leakage of exhaust gas.
- Check for degradation, cracks or damage to the clamp or rubber.
- If the pipe or silencer is damaged or has a dent then repair or replace it.
- Check for dents, damage, holes or cracks due to corrosion, and abnormal noise during operation.

List of Abnormal Phenomena

- Vibration or rattling noise from the exhaust system
- Clogging of the exhaust system
- Exhaust leakage or noise

Trouble Shooting

Vibration or rattling noise from the exhaust system

Condition	Possible Cause	Correction
Vibration or rattling noise from the exhaust system	Loose or misaligned components	Match the joints and then re-tighten. Or, check for damage in the hanger, mounting brackets and clamps.

Clogging of the exhaust system

Condition	Possible Cause	Correction
Clogging of the exhaust system	The exhaust brake is in the ON status.	Refer to Section 6E, check the electric system and repair if there are abnormalities. Check if the shaft movement in the exhaust brake throttle valve moves is jerky and replace if there is an abnormality.
	Clogging or deformation of the exhaust piping	Repair or replace the exhaust piping.

Exhaust leakage or noise

Condition	Possible Cause	Correction
Exhaust leakage or noise	Defect or misalignment in mounting	Match the joints and then re-tighten.
	Damage or burn-out of exhaust piping or silencer	Replace the damaged parts.
	Defective components in the exhaust system (clamps, pipes, silencer)	Replace the defective parts.
	Internal damage to silencer	Replace the silencer.

Exhaust Pipe

Removal

1. Remove the silencer fixing nut.
2. Remove the silencer brackets.
3. Remove the silencer.
4. Remove the front exhaust pipe B.
5. Remove the exhaust brake assembly.
6. Remove the front exhaust pipe A.
   - Remove the clamps and then the front exhaust pipe.

Inspection

- Adequate care should be taken to prevent damage due to heating or vibrations in the body panel as it may lead to exhaust gas entering the cabin.
- Check for loose or damaged connectors and leakage of exhaust gas.
- Check for degradation, cracks or damage to the clamp or rubber.
- Check for dents in the pipes or silencer and also for cracks due to corrosion, and repair or replace in case of damage.

Installation

Caution:

- Offset in the position of the exhaust system during assembly may sometimes cause vibrations or rattling noise. Therefore, temporarily tighten the bolts until all the parts have been positioned and then tighten sequentially from engine side to the tail pipe side.
- Do not reuse the removed gasket or nuts.

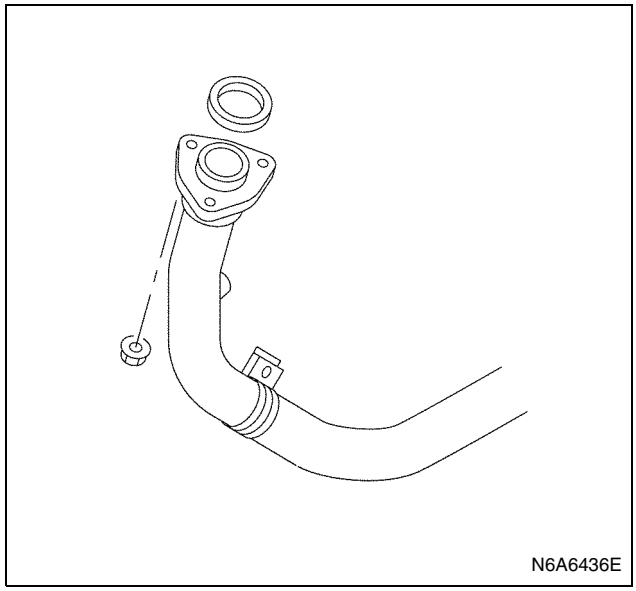
1. Mount the front exhaust pipe A.
   - Assemble the gasket, mount the front exhaust pipe in the turbo charger, and tighten to the specified torque.

Tighten:
Nut to 67 N·m (6.8 kg·m/49 lb·ft)

   - Clamp the front exhaust pipe.

Tighten:
M10 bolt to 41 N·m (4.2 kg·m/30 lb·ft)

Caution:
Tighten the front exhaust pipe evenly and take care to avoid gas leakage.

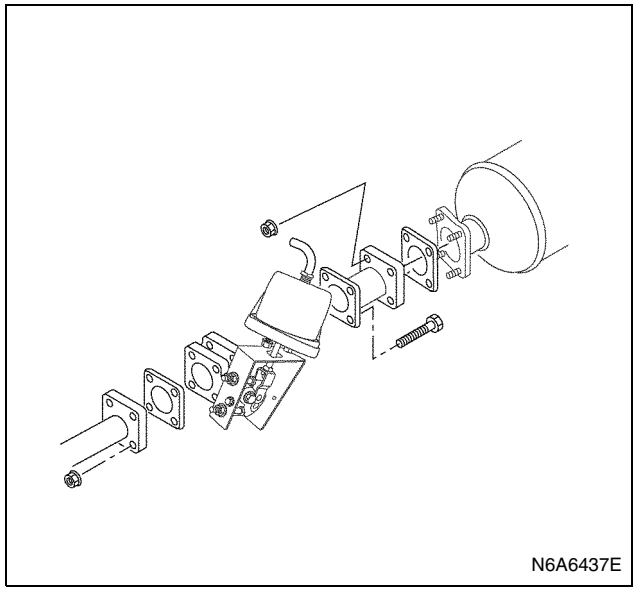

N6A6436E

2. Mount the exhaust brake assembly.
   - Assemble the gasket, connect the front exhaust pipe and the front exhaust pipe B, and tighten.

Tighten:
Bolt to 17 N·m (1.7 kg·m/12 lb·ft)

3. Mount the silencer.
   - Assemble the gasket, mount to the front exhaust pipe B, and tighten to the specified torque.

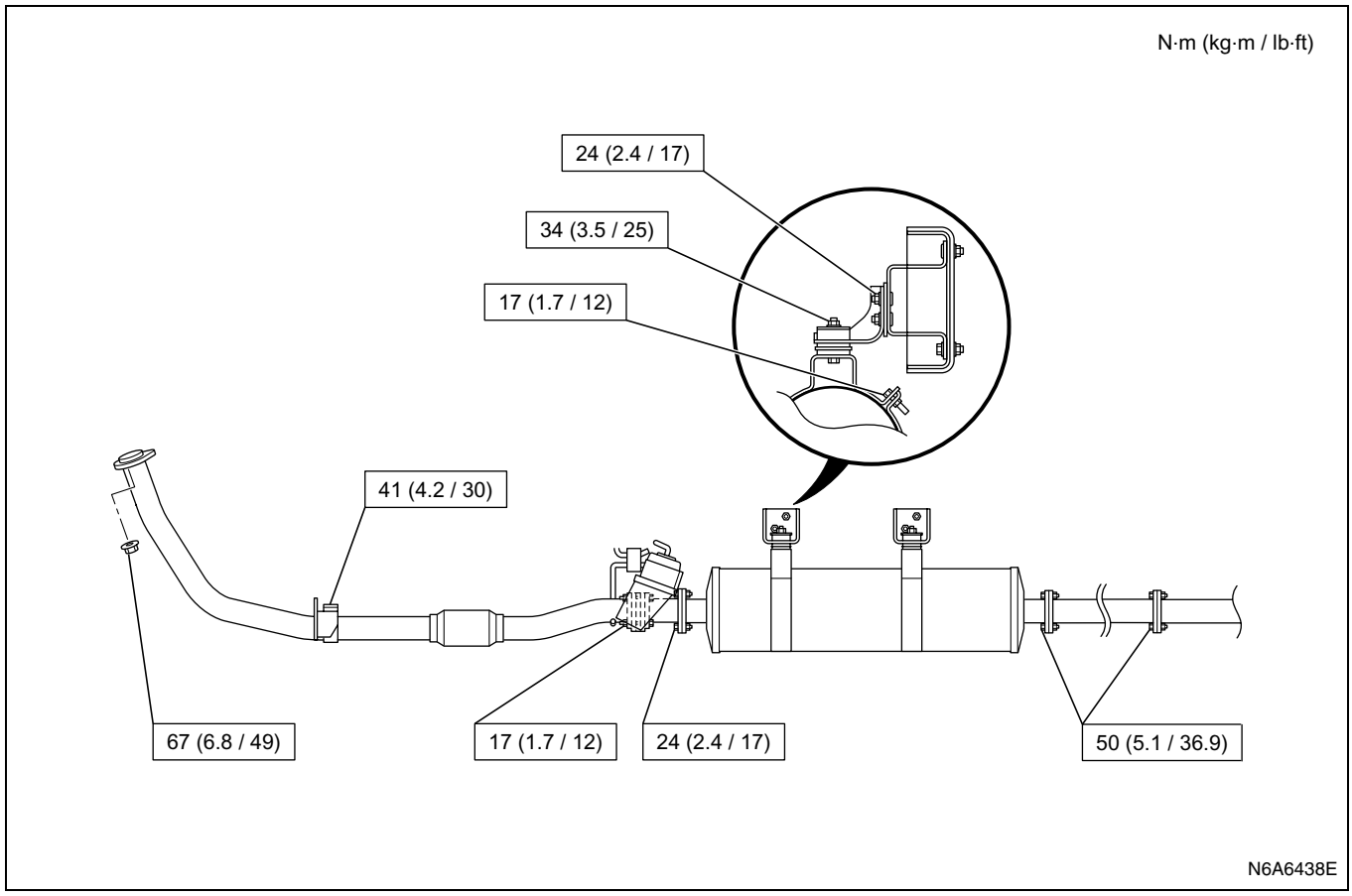
Tighten:
Nut to 24 N·m (2.4 kg·m/17 lb·ft)


N6A6437E

4. Mount the silencer brackets.
   - Mount the silencer in the brackets.

Tighten:
Nut to 34 N·m (3.5 kg·m/25 lb·ft)

Torque Specifications

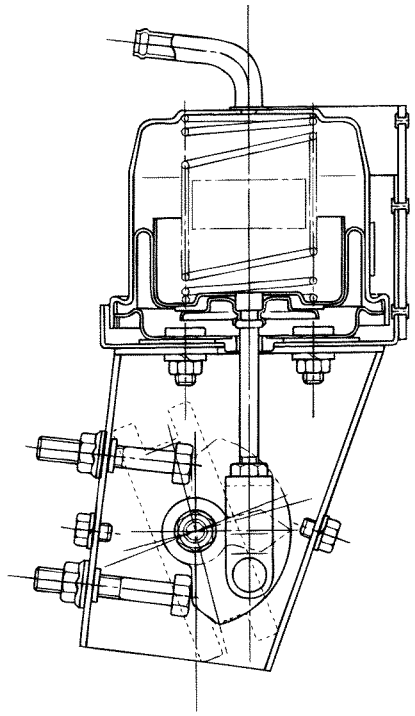


Exhaust Brake System

Service Precautions

During assembly and mounting, mount the parts appropriately at the specified tightening torque value.

Explanations on Functions and Operation



N6A6439E

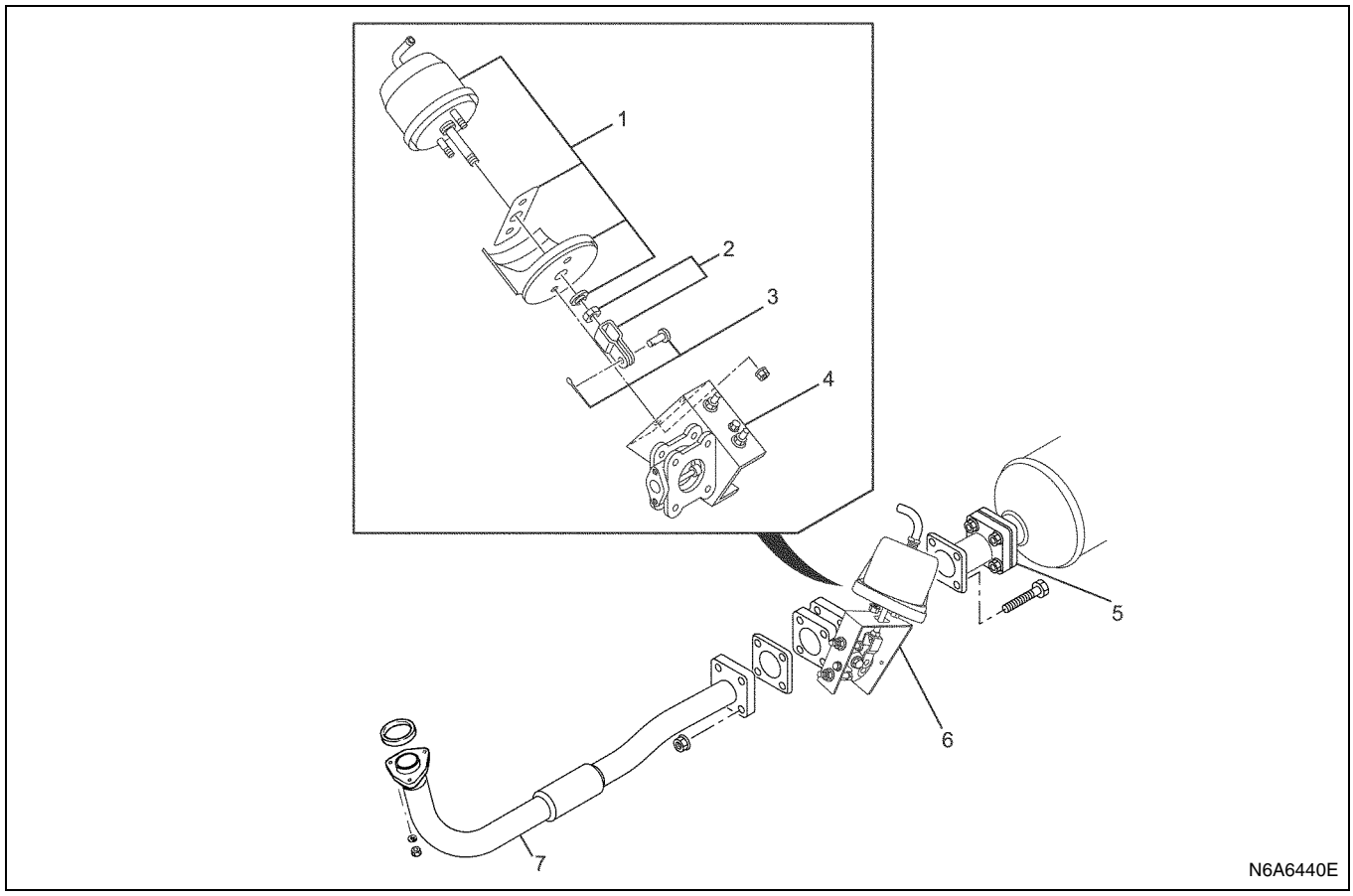
Functional Check

Operational check

- Confirm the sound of the valve touching the stopper when the exhaust brake is operated in the idling condition.

Exhaust Brake

Components



Legend

1. Power Chamber, Insulator, Gasket and Bearing
2. Lock Nuts and Clevis Joint
3. Split Pin and Washer
4. Exhaust Brake Valve
5. Front Exhaust Pipe B
6. Exhaust Brake Assembly
7. Front Exhaust Pipe A

Removal

1. Remove the vacuum hose and clips.
2. Remove the nut.
3. Remove the exhaust pipe.
4. Remove the exhaust brake assembly.

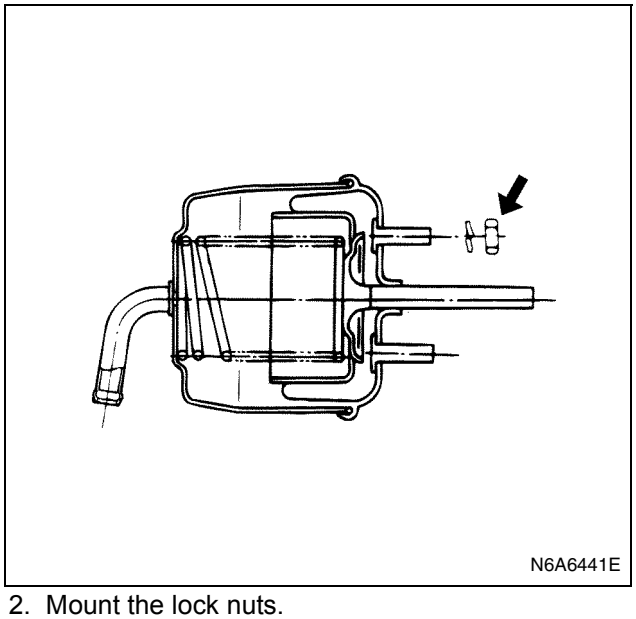
Disassembly

1. Remove the split pin.
2. Remove the lock nuts.
3. Remove the clevis joint.
4. Remove the power chamber.

Reassembly

1. Mount the power chamber.

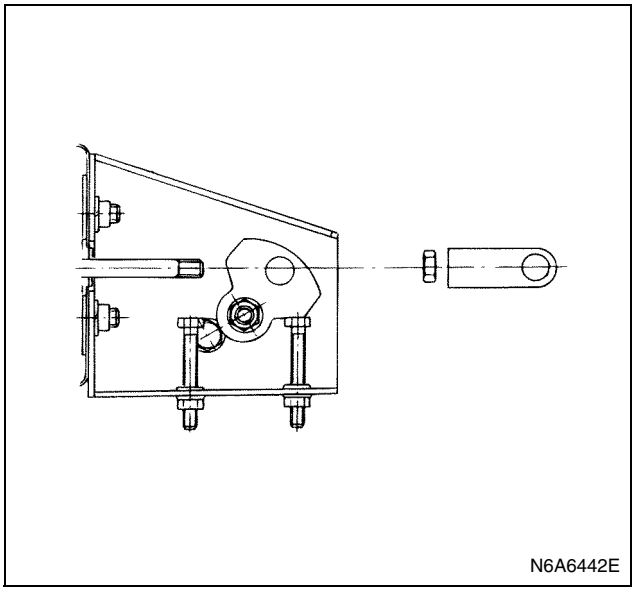
Tighten:
Nut to 14 N·m (1.4 kg·m/122 lb·in)



2. Mount the lock nuts.

3. After mounting the clevis joint, tighten the lock nuts to the specified torque.

Tighten:
Lock nut to 13 N·m (1.3 kg·m/113 lb·in)


N6A6442E

4. Mount the split pin.

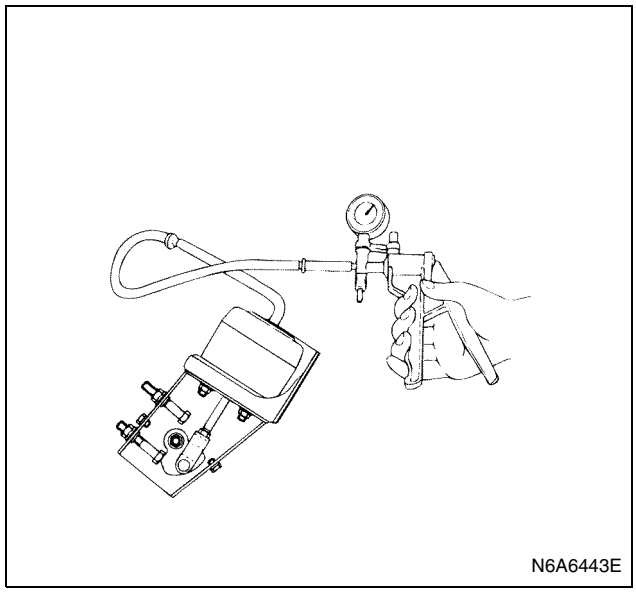
Inspection

Check for damage or degradation in the parts mentioned below.

- Exhaust brake valve
- Exhaust brake shaft
- Butterfly valve
- Bush
- Power chamber

Unit check

- Negative pressure in the power chamber caused by the vacuum pump
  When a pressure of 53.3 - 93.3 kPa (0.54 - 0.95 kg/cm^2 / 7.7 - 13.5 psi) is applied, the exhaust brake valve should open or close smoothly.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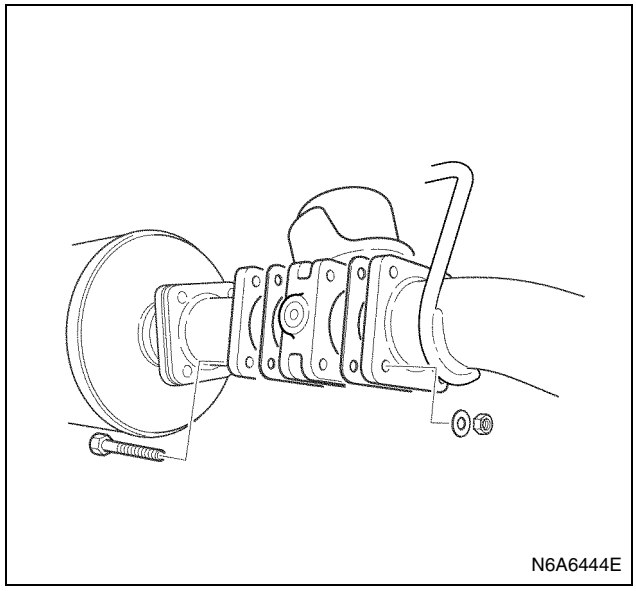
Installation

1. Mount the exhaust brake assembly.

Tighten:
Bolt and nut to 17 N·m (1.7 kg·m/12 lb·ft)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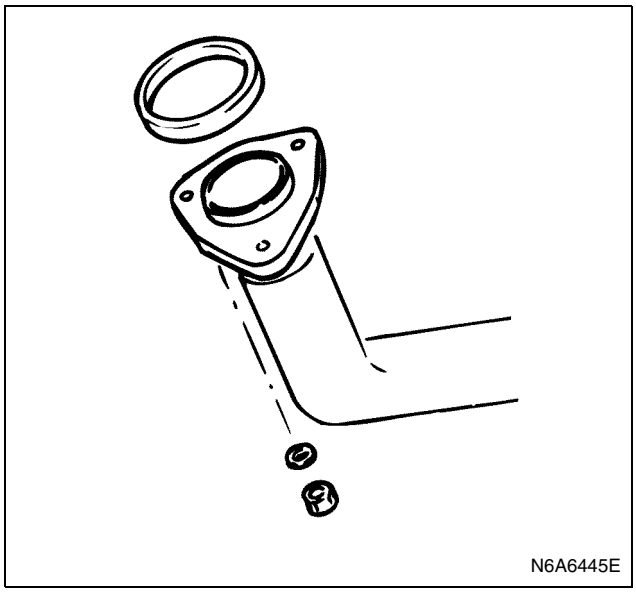
2. Mount the exhaust pipe.

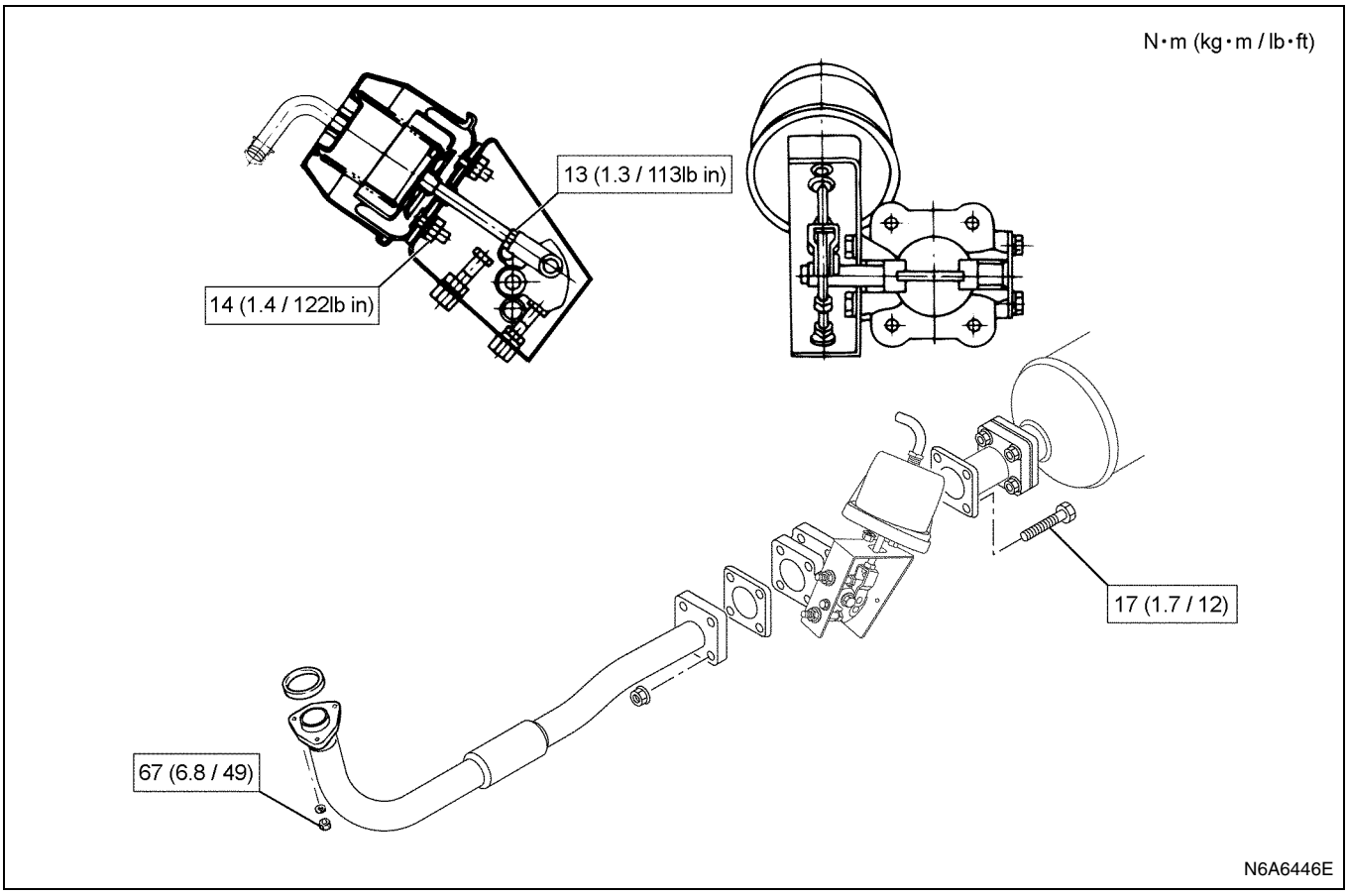


3. Mount the nuts.

Tighten:
Nut to 67 N·m (6.8 kg·m/49 lb·ft)

4. Mount the vacuum hose and the clips.

Torque Specifications



LG4HK-WE-0551

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LG4HK-WE-0551 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

ENGINE 4HK1-TC

SECTION 6

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

SECTION No.	CONTENTS
6A	ENGINE MECHANICAL (4HK1-TC)
6B	COOLING SYSTEM
6C	FUEL SYSTEM
6D	ENGINE ELECTRICAL
6F	EXHAUST SYSTEM

ENGINE 4J SERIES

SECTION 00
SERVICE INFORMATION

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TROUBLE SHOOTING

Hard Starting

1. Starter Inoperative

Checkpoint	Possible cause	Correction
Battery	Loose battery cable terminal poor connections due to rusting	Clean and/or retighten the battery cable terminal
	Battery discharged or weak	Recharge or replace the battery
	Fan belt loose or broken	Adjust or replace the fan belt
Fusible link	Fusible link shorted	Replace the fusible link
Starter switch	Defective starter switch or starter relay	Replace the starter switch or the starter relay
Starter motor	Defective magnetic switch or starter relay	Repair or replace the magnetic switch
	Defective starter motor	Repair or replace the starter motor

2. Starter Motor Operates But Engine Does Not Turn Over

Checkpoint	Possible cause	Correction
Battery	Loose battery cable terminal	Clean and/or retighten the battery cable terminal
	Poor connections due to rusting	Recharge or replace the battery
	Battery discharged or weak	Recharge or replace the battery
	Fan belt loose or broken	Adjust or replace the fan belt
Starter	Defective pinion gear	Replace the pinion gear
	Defective magnetic switch	Repair or replace the magnetic switch
	Brush wear, Weak brush spring	Replace the brush and/or the brush spring
Engine	Piston, crank bearing seizure, or other damage	Repair or replace the related parts

3. Engine Turns Over But Does Not Start

Checkpoint	Possible cause	Correction
Engine stop mechanism	Defective fuel cut solenoid valve	Replace the fuel cut solenoid valve
Fuel is not Being Delivered to the Injection Pump		
Fuel	Fuel tank is empty	Fill the fuel tank
Fuel piping	Clogged or damaged fuel lines. Loose fuel line connection	Repair or replace the fuel lines Retighten the fuel line connection
Fuel filter	Fuel filter overflow valve does not close	Repair or replace the fuel filter overflow valve
	Clogged fuel filter element	Replace the fuel filter element or the filter cartridge
Fuel system	Air in the fuel system	Bleed the air from the fuel system
Fuel feed pump	Defective feed pump	Repair or replace the feed pump
Fuel is Being Delivered to the Injection Pump		
Fuel	Use of the wrong fuel	Use the correct fuel
	Water particles in the fuel	Change the fuel
Fuel system	Air in the injection pump	Bleed the air from the fuel system
Injection nozzle	Injection nozzle sticking	
	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
Injection pump	Defective fuel injection nozzle resulting in the fuel drippage after fuel injection	Replace the delivery valve
	Defective injection pump control rack operation	Repair or replace the injection pump control rack
	Injection pump plunger worn or stuck	Replace the injection pump plunger assembly
	Injection pump drive shaft seizure or other damage	Replace the injection drive shaft
	Injection pump governor spring seizure	Replace the injection pump governor spring

4. Quick-On Start System

Preparation

1. Disconnect the thermoswitch connector.
2. Determine whether or not the glow plugs are receiving power.
   a. Make sure that the starter switch is “OFF”.
   b. Connect a voltmeter between one of the glow plugs and the cylinder wall.
   c. Move the starter switch to the “ON” position.
      The voltmeter needle will show the souse voltage (12V) if the glow plugs are receiving power.
      If the voltmeter needle does not move, the glow plugs are not receiving power.
3. Perform the troubleshooting procedure.

Checkpoint	Possible cause	Correction
Glow Plugs are Receiving Power		
Glow plug indicator light does not turn on	Defective indicator light bulb	Replace the indicator light bulb
Quick-on start timer	Defective quick-on start timer	Replace the quick-on start timer
Glow plug indicator light turns on the 0.3 seconds	Defective quick-on start timer	Replace the quick-on start timer
Glow plug indicator light turns on for 3.5 seconds	Return the starter switch to the “ON” position from the “START” position after the engine starts if the glow plug relay remains on less than 14 seconds, the quick-on start timer is defective	Replace the quick-on start timer
	Move the starter switch from the “OFF” position to the “ON” position if the glow plug relay remains on less than 14 seconds, the quick-on start timer is defective	Replace the quick-on start timer
Thermo switch	Defective thermo switch	Replace the thermo switch
Glow plug continuity	No glow plug continuity	Replace the glow plugs
Glow Plugs are not Receiving Power		
Glow plug indicator light does not turn on	Broken indicator light fuse	Replace the fuse
Quick-on start timer	Defective quick-on start timer	Replace the quick-on start timer
Glow plug indicator light turns on for 3.5 seconds	Defective glow plug relay The glow plug relay does not turn on after the starter switch is moved from the “OFF” position to the “ON” position	Replace the glow plug relay
	Defective quick-on start timer	Replace the quick-on start timer
	Defective glow plug relay wiring harness	Repair or replace the wiring harness
	Defective fusible link or wiring harness The glow plug relay turns on when the starter switch is moved from the “OFF” position to the “ON” position	Replace the fusible link or the wiring harness

* When being normal temperature, the indicator lamp of 4JH1TC is not turn on.

Unstable Idling

Checkpoint	Possible cause	Correction
Idling system	Idling improperly adjusted	Adjust the idling
Fast idling speed	Defective fast idling speed control device	Repair or replace the fast idling speed control device
Accelerator control system	Accelerator control system improperly adjusted	Adjust the accelerator control system
Fuel system	Fuel system leakage or blockage	Repair or replace the fuel system
	Air in the fuel system	Bleed the air from the fuel system
	Water particles in the fuel system	Change the fuel
Fuel filter	Clogged fuel filter element	Replace the fuel filter element or the fuel filter cartridge
Fuel feed pump	Defective fuel feed pump	Repair or replace the fuel feed pump
Injection nozzle	Injection nozzle sticking	Replace the injection nozzle
	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
Injection pump	Defective delivery valve resulting in fuel drippage after fuel injection	Replace the delivery valve
	Injection timing improperly adjusted	Adjust the injection timing
	Insufficient injection volume	Adjust the injection volume
	Defective idle spring	Replace the idle spring
	Defective governor lever operation	Repair or replace the governor lever
	Regulator valve improperly adjustment	Adjust or replace the regulator valve
	Broken plunger spring	Replace the plunger spring
	Worn plunger	Replace the plunger assembly
	Worn cam disc	Replace the cam disc
Valve clearance	Valve clearance improperly adjusted	Adjust the valve clearance
Compression pressure	Blown out cylinder head gasket. Worn cylinder liner. Piston ring sticking	Replace the related parts

*The adjustment of the position which is related to the injection pump is unnecessary for 4JH1TC by the adoption of the electronic control injection pump.

Insufficient Power

Checkpoint	Possible cause	Correction
Air cleaner	Clogged air cleaner element	Clean or replace the air cleaner element
Fuel	Water particle in the fuel	Replace fuel
Fuel filter	Clogged fuel filter element	Replace the fuel filter element or the fuel filter cartridge
Fuel feed pump	Defective fuel feed pump	Repair or replace the fuel feed pump
Injection nozzle	Injection nozzle sticking	Replace the injection nozzle
	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
Fuel injection pipes	Fuel injection pipes damaged or obstructed	Replace the fuel injection pipes
Injection pump	Defective regulating valve	Repair or replace the regulating valve
	Defective delivery valve	Replace the delivery valve
	Defective timer	Repair or replace the timer
	Worn cam disc	Replace the cam disc
	Improper control lever operation	Adjust or replace the control lever
	Defective injection timing	Adjust the injection timing Repair or replace the injection pump timer
	Weak governor spring	Replace the governor spring
	Worn plunger	Replace the plunger assembly
Compression pressure	Blown out cylinder head gasket. Worn cylinder liner. Piston ring sticking	Replace the related parts
Valve clearance	Valve clearance improperly adjusted	Adjust the valve clearance
Valve spring	Valve spring weak or broken	Replace the valve spring
Exhaust system	Exhaust pipe clogged	Clean the exhaust pipe
Full load adjusting screw seal	Open and improperly set adjusting screw seal	Adjust and reseal the adjusting screw

Excessive Fuel Consumption

Checkpoint	Possible cause	Correction
Fuel system	Fuel leakage	Repair or replace the fuel system related parts
Air cleaner	Clogged air cleaner element	Clean or replace the air cleaner element
Idling speed	Poorly adjusted idling speed	Adjust the idling speed
Injection nozzle	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
Fuel injection timing	Fuel injection timing improperly	Adjust the fuel injection timing
Injection pump	Defective Delivery valve resulting is fuel drippage after fuel injection	Replace the delivery valve
Valve clearance	Valve clearance improperly adjusted	Adjust the valve clearance
Compression pressure	Blown out cylinder head gasket. Worn cylinder liner. Piston ring sticking	Replace the related parts
Valve spring	Valve spring weak or broken	Replace the valve spring

Excessive Oil Consumption

Checkpoint	Possible cause	Correction
Engine oil	Engine oil unsuitable Too much engine oil	Replace the engine oil Correct the engine oil level
Oil seal and gasket	Oil leakage from the oil seal and/or the gasket	Replace the oil seal and/or the gasket
Air breather	Clogged air breather	Clean the air breather
Intake and exhaust valve	Worn valve stems and valve guides	Replace the intake and exhaust valves and the valve guides

Overheating

Checkpoint	Possible cause	Correction
Cooling water	Insufficient cooling water	Replenish the cooling water
Fan clutch	Oil leakage from the fan clutch	Replace the fan clutch
Fan belt	Fan belt loose or cracked causing slippage	Replace the fan belt
Radiator	Defective radiator cap or clogged radiator core	Replace the radiator cap or clean the radiator core
Water pump	Defective water pump	Repair or replace the water pump
Cylinder head and cylinder body sealing cap	Defective sealing cap resulting in water leakage	Replace the sealing cap
Thermostat	Defective thermostat	Replace the thermostat
Cooling system	Cooling system clogged by foreign material	Clean the foreign material from the cooling system
Fuel injection timing	Fuel injection timing improperly adjusted	Adjust the fuel injection timing

White Exhaust Smoke

Checkpoint	Possible cause	Correction
Cooling water	Insufficient cooling water	Replace the cooling water
Fuel	Water particles in the fuel	Replace the fuel
Fuel injection timing	Delayed fuel injection timing	Adjust the fuel injection timing
Compression pressure	Blown out cylinder head gasket. Worn cylinder liner. Piston ring sticking	Replace the related parts
Inlet and exhaust valve Valves seals	Defective valve seals. Worn valves stems and valve guides	Replace the valve seals, the valves, and the valve guides

Dark Exhaust Smoke

Checkpoint	Possible cause	Correction
Air cleaner	Clogged air cleaner element	Clean or replace the air cleaner element
Injection nozzle	Injection nozzle injection starting pressure too low Improper spray condition	Adjust or replace the injection nozzle
Fuel injection timing	Fuel injection timing improperly adjusted	Adjust the fuel injection timing
Injection pump	Defective delivery valve resulting in fuel drippage after fuel injection	Replace the delivery valve
	Excessive injection volume	Adjust the injection volume

Oil Pressure Does Not Rise

Checkpoint	Possible cause	Correction
Engine oil	Improper viscosity engine oil. Insufficient engine oil	Replace the engine oil Correct the engine oil volume
Oil pressure gauge or unit	Defective oil pressure gauge or unit	Repair or replace the oil pressure gauge or unit
Oil pressure indicator light	Defective indicator light	Replace the indicator light
Oil filter	Clogged oil filter element	Replace the oil filter element or the oil filter cartridge
Relief valve and by-pass valve	Relief valve sticking and/or weak by-pass valve spring	Replace the relief valve and/or the by-pass valve spring
Oil pump	Clogged oil pump strainer	Clean the oil pump strainer
	Worn oil pump related parts	Replace the oil pump related parts
Rocker arm shaft	Worn rocker arm bushing	Replace the rocker arm bushing
Camshaft	Worn camshaft and camshaft bearing	Replace the camshaft and the camshaft bearing
Crankshaft and bearings	Worn crankshaft and bearings	Replace the crankshaft and/or the bearings

Abnormal Engine Noise

1. Engine Knocking

Check to see that the engine has been thoroughly warmed up before beginning the troubleshooting procedure.

Checkpoint	Possible cause	Correction
Fuel	Fuel unsuitable	Replace the fuel
Fuel injection timing	Fuel injection timing improperly adjusted	Adjust the fuel injection timing
Injection nozzle	Improper injection nozzle starting pressure and spray condition	Adjust or replace the injection nozzle
Compression pressure	Blown out head gasket Broken piston ring	Replace the head gasket or the piston ring

2. Gas Leakage Noise

Checkpoint	Possible cause	Correction
Exhaust pipes	Loosely connected exhaust pipes. Broken exhaust pipes	Tighten the exhaust pipe connections Replace the exhaust pipes
Injection nozzles and/ or glow plugs	Loose injection nozzles and/or glow plugs	Replace the washers Tighten the injection nozzles and/or the glow plugs
Exhaust manifold	Loosely connected exhaust manifold and/ or glow plugs	Tighten the exhaust manifold connections
Cylinder head gasket	Damaged cylinder head gasket	Replace the cylinder head gasket

3. Continuous Noise

Checkpoint	Possible cause	Correction
Fan belt	Loose fan belt	Readjust the fan belt tension
Cooling fan	Loose cooling fan	Retighten the cooling fan
Water pump bearing	Worn or damaged water pump bearing	Replace the water pump bearing
Generator or vacuum pump	Defective generator or vacuum pump Defective generator or vacuum pump	Repair or replace the generator or the vacuum pump
Valve clearance	Clearance improperly adjust	Adjust the valve clearances

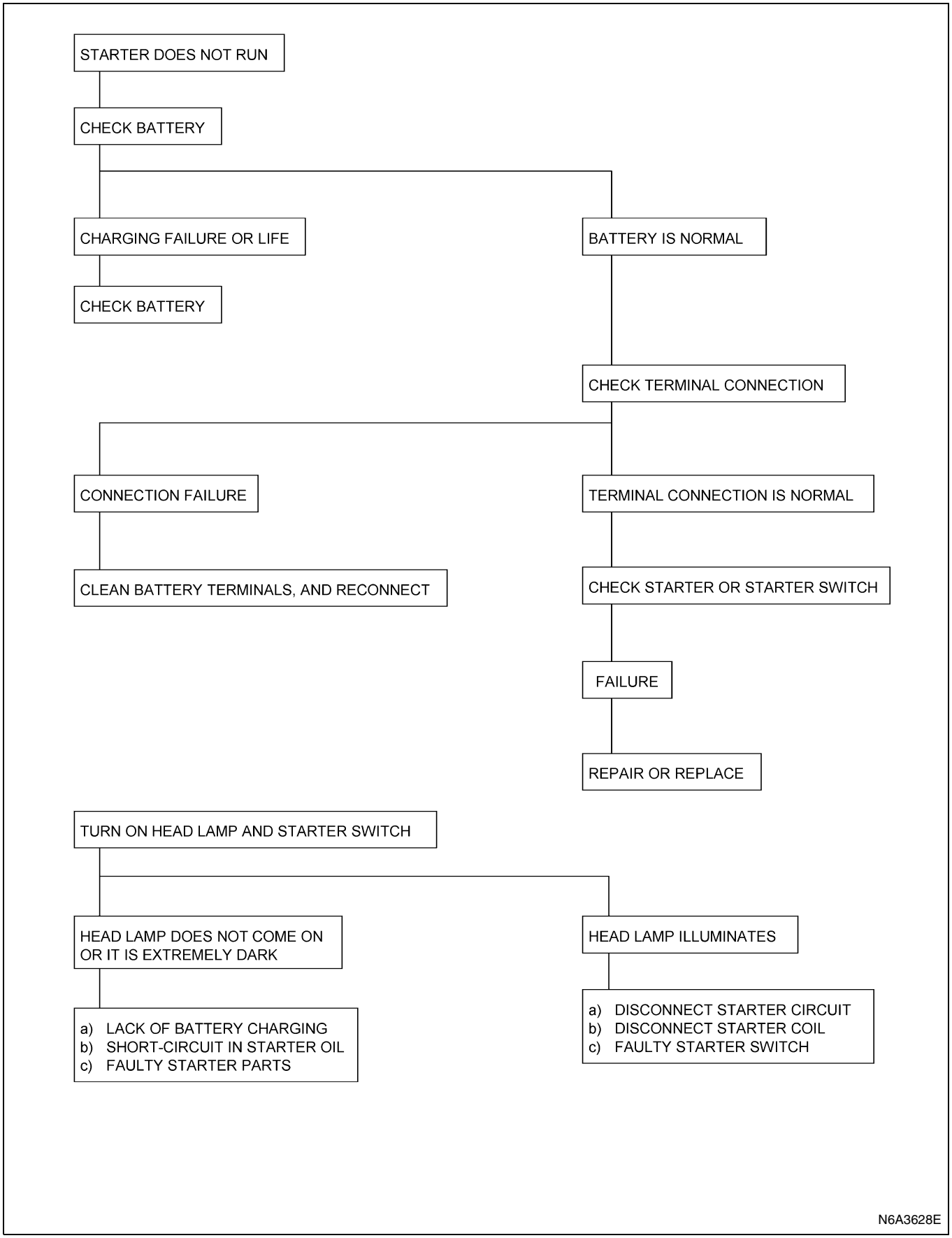
4. Slapping Noise

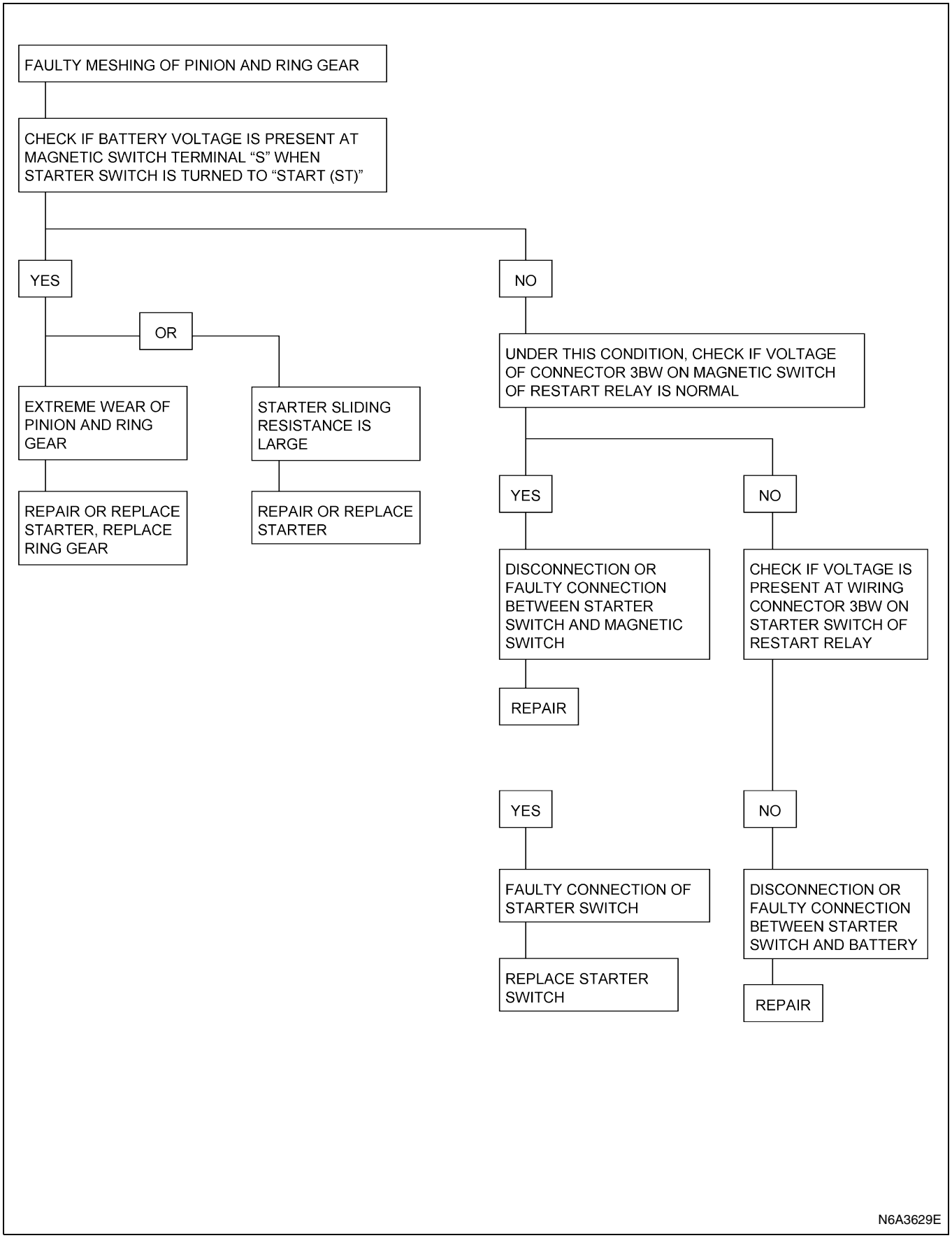
Checkpoint	Possible cause	Correction
Valve clearance	Valve clearance improperly adjusted	Adjust the valve clearance
Rocker arm	Damaged rocker arm	Replace the rocker arm
Flywheel	Loose flywheel bolts	Retighten the flywheel bolts
Crankshaft and thrust bearings	Worn or damaged crankshaft and/or thrust bearings	Replace the crankshaft and/or the thrust bearings
Crankshaft and connecting rod bearings	Worn or damaged crankshaft and/or connecting rod bearings	Replace the crankshaft and/or the connecting rod bearings
Connecting rod bushing and piston pin	Worn or damaged connecting rod bushing and piston pin	Replace the connecting rod bushing and/ or the piston pin
Piston and cylinder liner	Worn or damaged piston and cylinder liner.	Replace the piston and the cylinder liner.

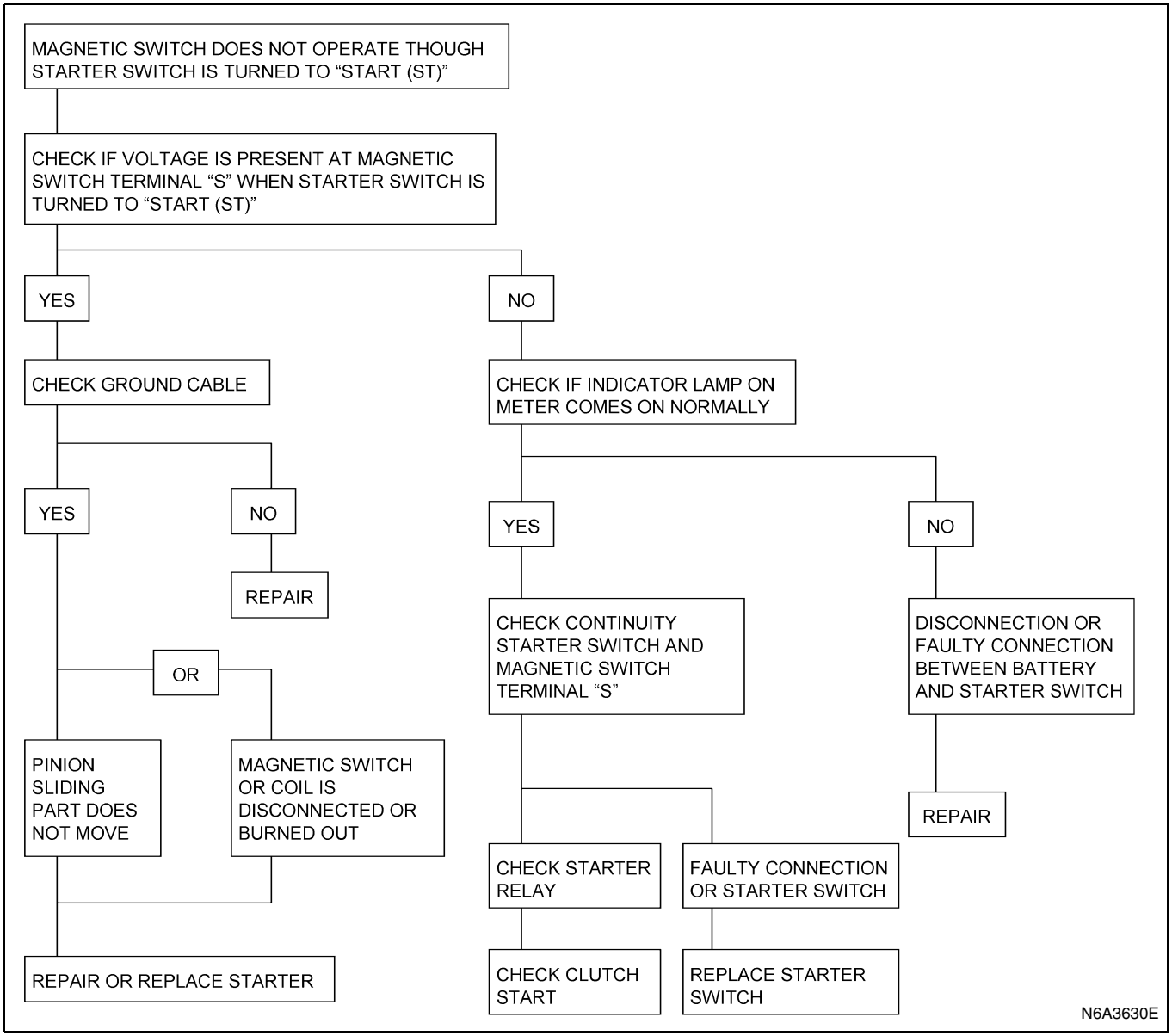
Engine Cooling Trouble

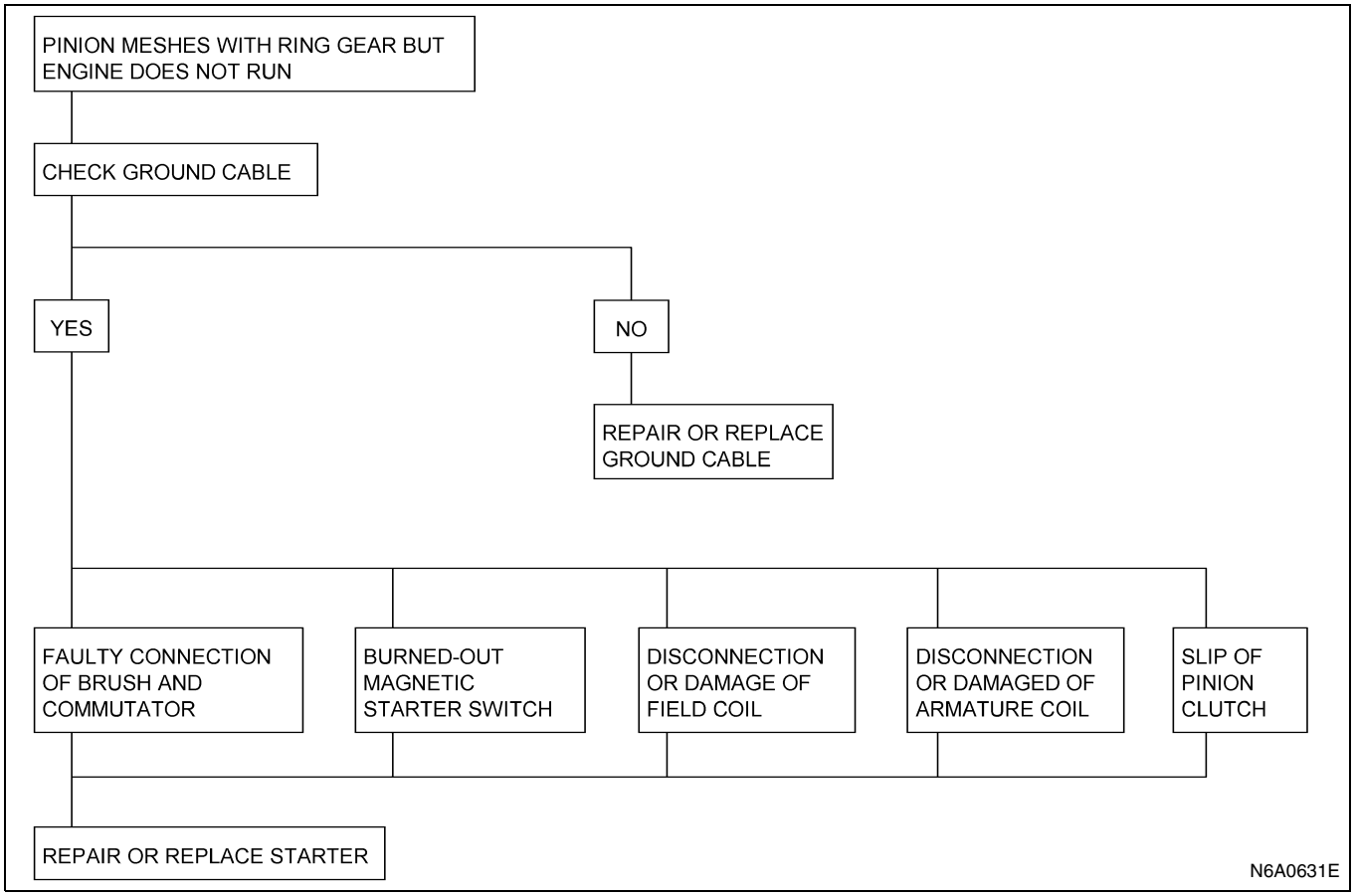
Checkpoint	Possible cause	Correction
Engine overheating	Low coolant level	Replenish
	Thermo unit faulty	Replace
	Faulty thermostat	Replace
	Faulty coolant unit	Repair or replace
	Clogged radiator	Clean or replace
	Faulty radiator cap	Replace
	Low engine oil level or use of improper engine oil	Replenish or change oil Replenish
	Damaged cylinder head gasket	Replace
	Clogged exhaust system	Clean exhaust system or replace faulty parts
	Loose fan belt	Adjust
	Excessive fuel injected	Adjust
	Improper injection timing	Adjust
Engine overcooling	Faulty thermostat	Replace
Too long engine warm-up time	Faulty thermostat	Replace
	Thermo unit faulty	Replace

Engine Electrical Part Trouble




FAULTY MESHING OF PINION AND RING GEAR
CHECK IF BATTERY VOLTAGE IS PRESENT AT MAGNETIC SWITCH TERMINAL “S” WHEN STARTER SWITCH IS TURNED TO “START (ST)”
YES
OR
EXTREME WEAR OF PINION AND RING GEAR
REPAIR OR REPLACE STARTER, REPLACE RING GEAR
STARTER SLIDING RESISTANCE IS LARGE
REPAIR OR REPLACE STARTER
NO
UNDER THIS CONDITION, CHECK IF VOLTAGE OF CONNECTOR 3BW ON MAGNETIC SWITCH OF RESTART RELAY IS NORMAL
YES
DISCONNECTION OR FAULTY CONNECTION BETWEEN STARTER SWITCH AND MAGNETIC SWITCH
REPAIR
NO
CHECK IF VOLTAGE IS PRESENT AT WIRING CONNECTOR 3BW ON STARTER SWITCH OF RESTART RELAY
YES
FAULTY CONNECTION OF STARTER SWITCH
REPLACE STARTER SWITCH
NO
DISCONNECTION OR FAULTY CONNECTION BETWEEN STARTER SWITCH AND BATTERY
REPAIR
N6A3629E


MAGNETIC SWITCH DOES NOT OPERATE THOUGH STARTER SWITCH IS TURNED TO “START (ST)”
CHECK IF VOLTAGE IS PRESENT AT MAGNETIC SWITCH TERMINAL “S” WHEN STARTER SWITCH IS TURNED TO “START (ST)”
YES
NO
CHECK GROUND CABLE
CHECK IF INDICATOR LAMP ON METER COMES ON NORMALLY
YES
NO
REPAIR
YES
NO
OR
CHECK CONTINUITY STARTER SWITCH AND MAGNETIC SWITCH TERMINAL “S”
DISCONNECTION OR FAULTY CONNECTION BETWEEN BATTERY AND STARTER SWITCH
PINION SLIDING PART DOES NOT MOVE
MAGNETIC SWITCH OR COIL IS DISCONNECTED OR BURNED OUT
REPAIR
CHECK STARTER RELAY
FAULTY CONNECTION OR STARTER SWITCH
REPAIR OR REPLACE STARTER
CHECK CLUTCH START
REPLACE STARTER SWITCH
N6A3630E


PINION MESHES WITH RING GEAR BUT ENGINE DOES NOT RUN
CHECK GROUND CABLE
YES
NO
REPAIR OR REPLACE GROUND CABLE
FAULTY CONNECTION OF BRUSH AND COMMUTATOR
BURNED-OUT MAGNETIC STARTER SWITCH
DISCONNECTION OR DAMAGE OF FIELD COIL
DISCONNECTION OR DAMAGED OF ARMATURE COIL
SLIP OF PINION CLUTCH
REPAIR OR REPLACE STARTER
N6A0631E

STARTER DOES NOT STOP THOUGH STARTER SWITCH IS RETURNED TO “ON” FROM “START”

DISCONNECTED STARTER SWITCH WIRING CONNECTOR, AND CHECK STARTER SWITCH OPERATION.

KEY POSITION	BATTERY B1	IGNITION IG1	BATTERY B2	ACCESSORIES ACC	IGNITION IG2	STARTER ST
LOCK						
OFF						
ACC			●	●		
ON	●	●	●	●	●	
START	●	●	●		●	●

THERE MUST BE NO CONTINUITY EXCEPT ABOVE LINES.

YES

MAGNETIC SWITCH CONTACTS ARE FUSED AND NOT MOVED, OR A RETURN SPRING IS BROKEN OR DETERIORATED

REPLACE MAGNETIC SWITCH

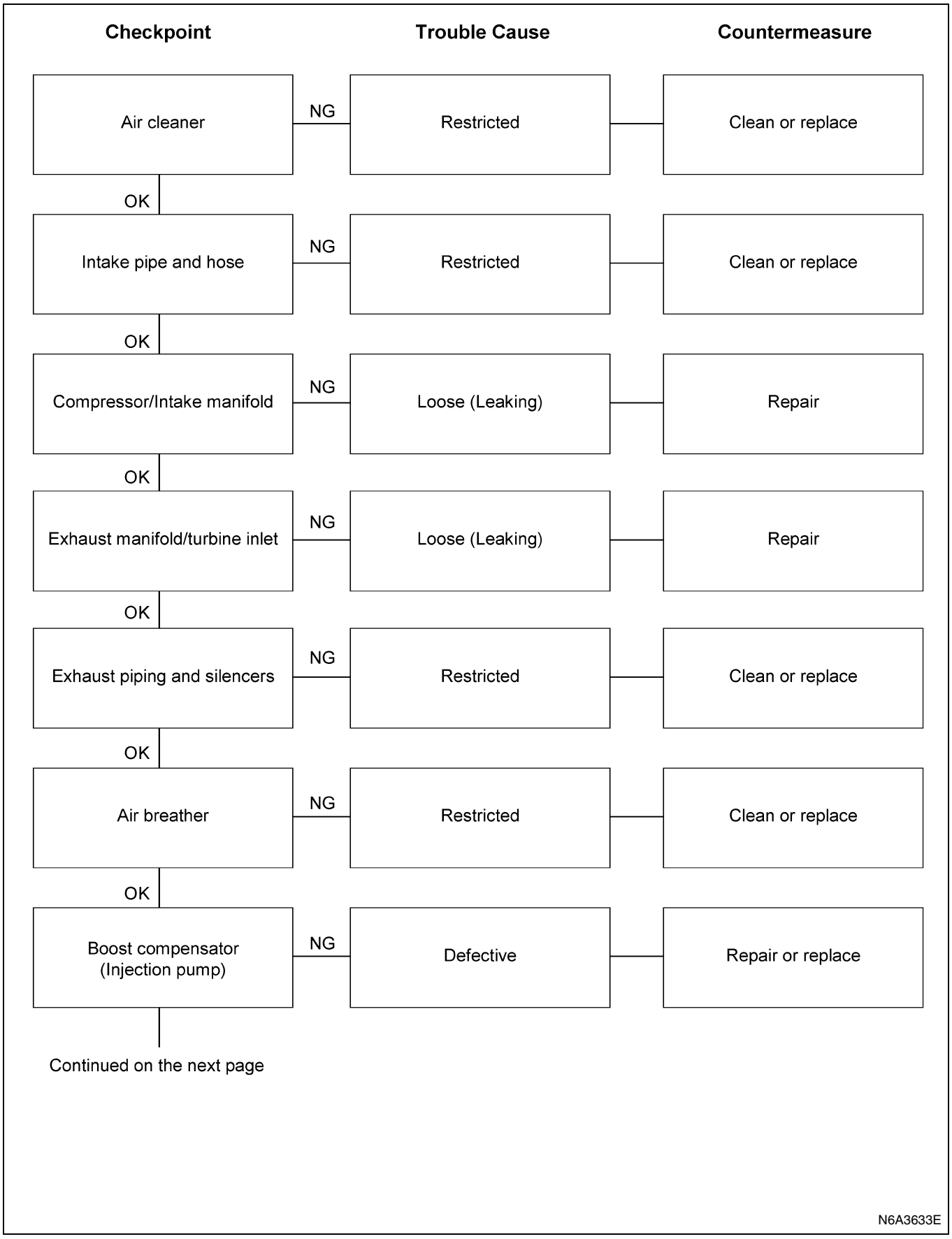
NO

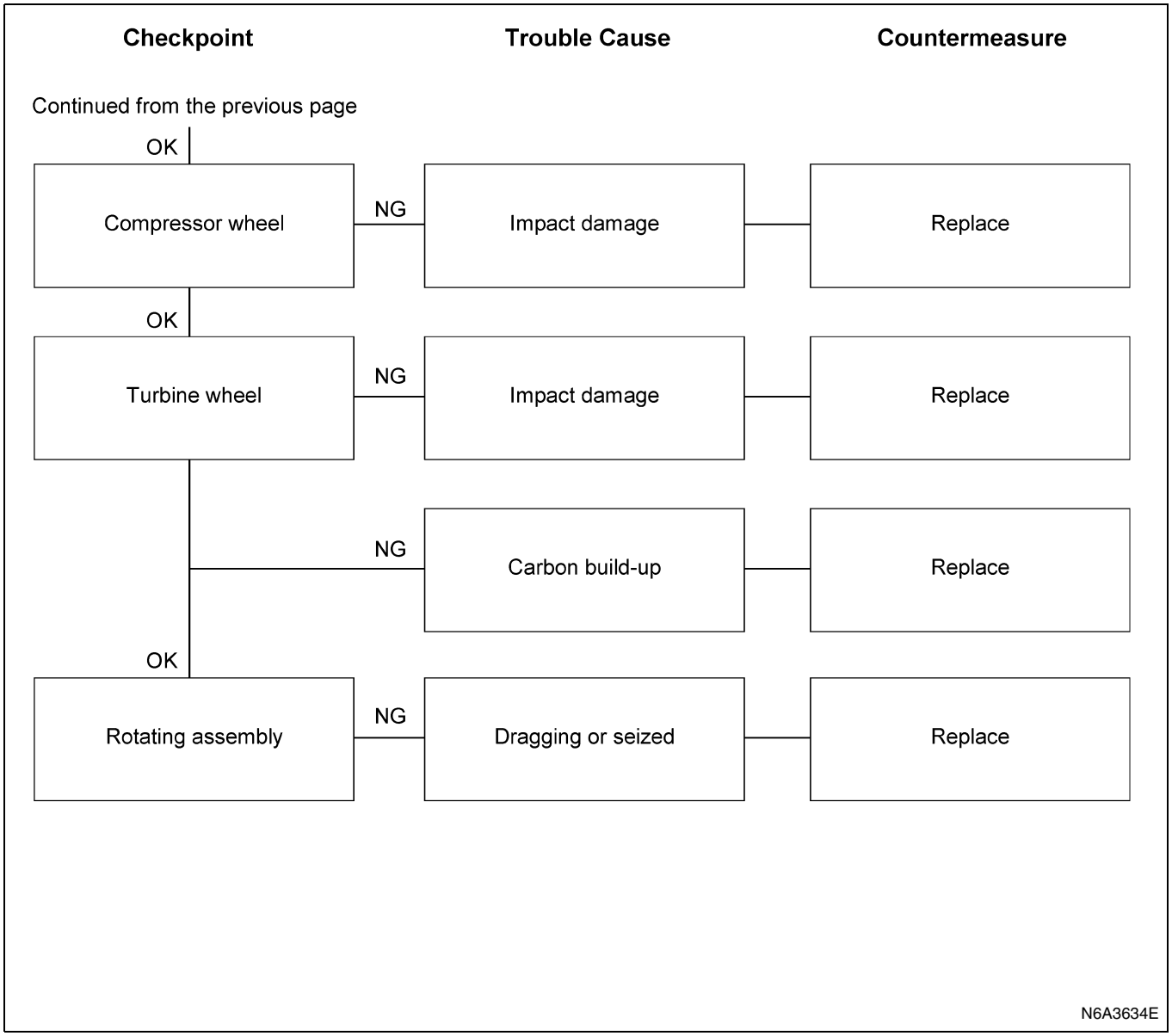
REPLACE STARTER SWITCH

N6A3632E

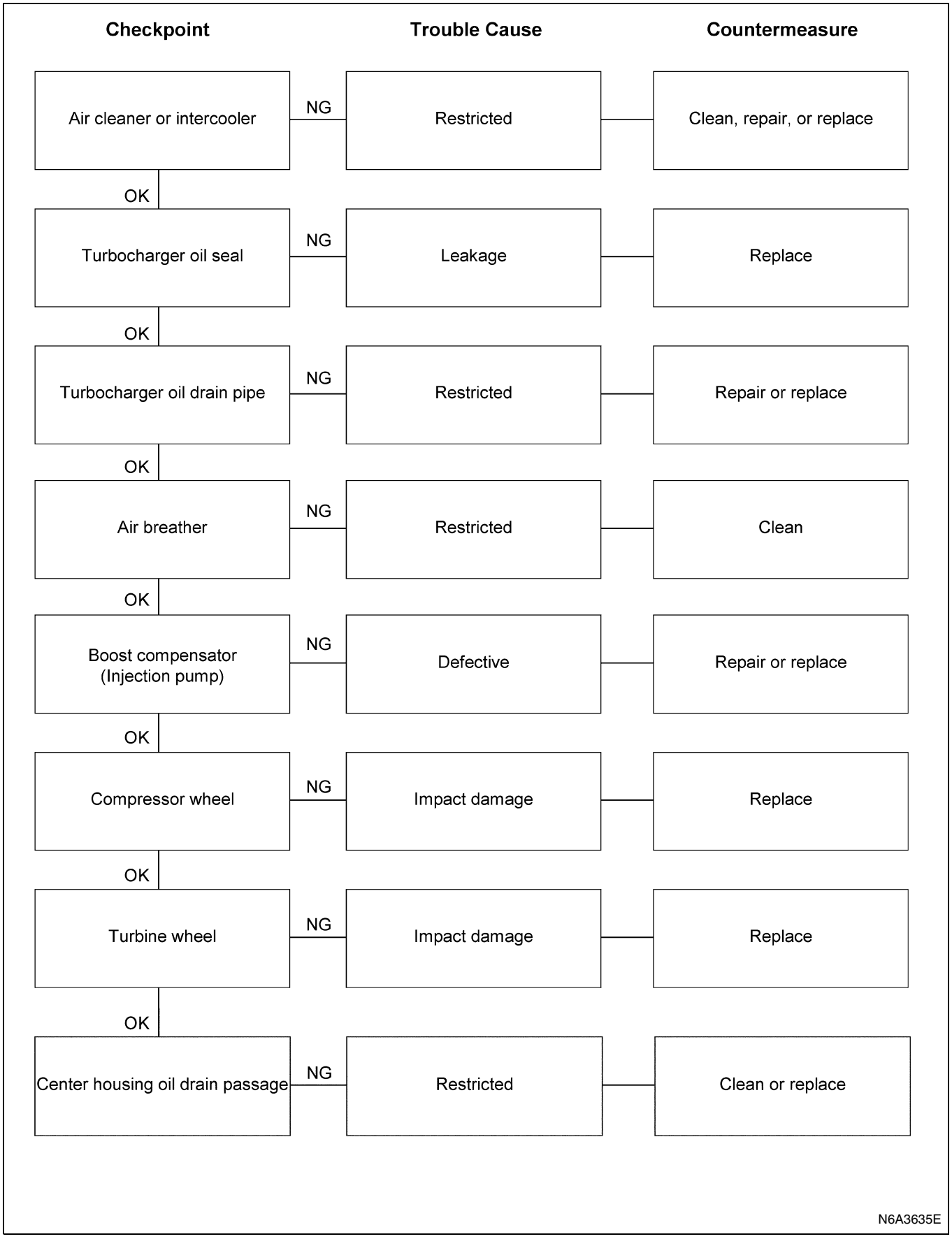
Turbocharger

Engine Has Less Than Normal Power

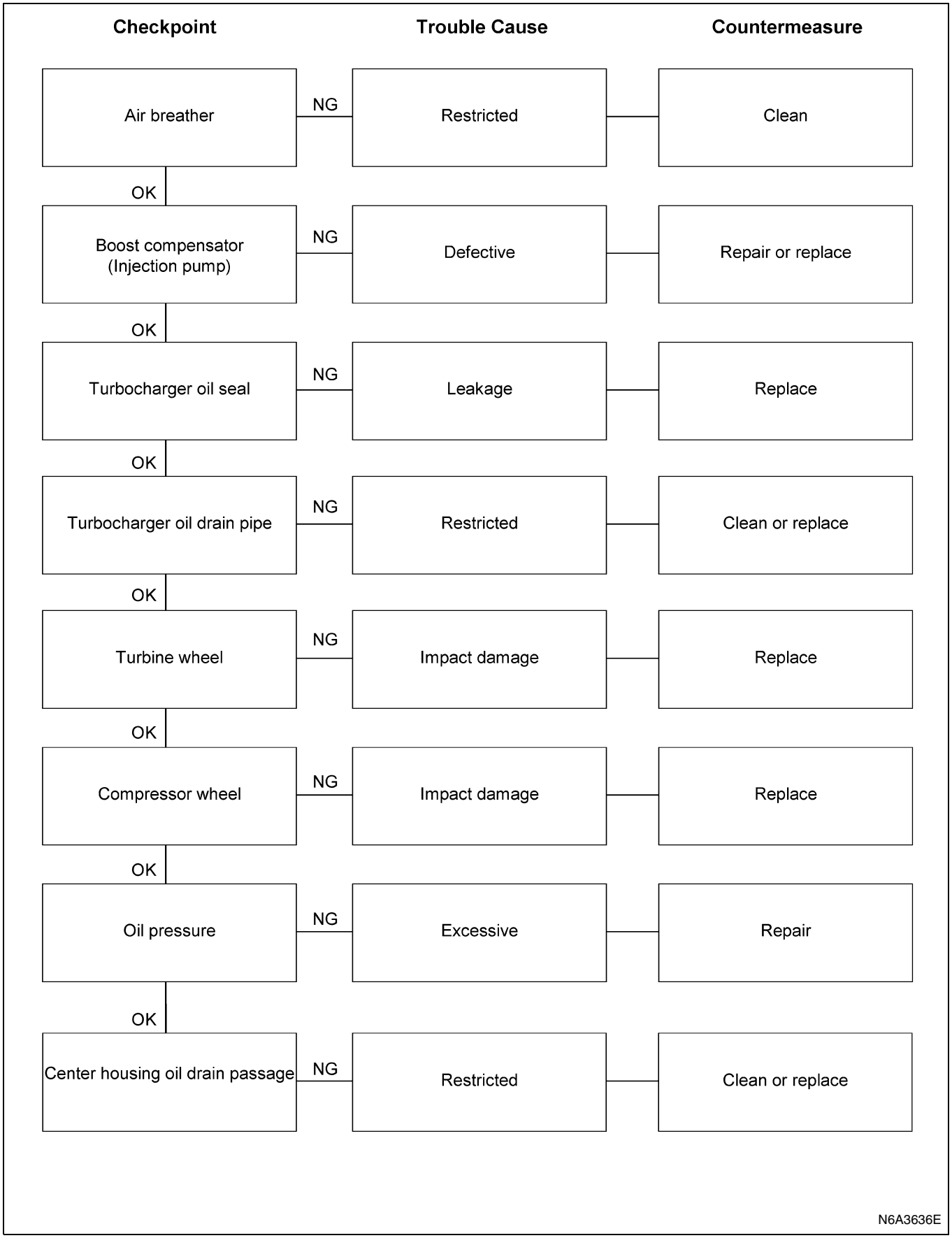



Checkpoint
Trouble Cause
Countermeasure
Continued from the previous page
OK
Compressor wheel
NG
Impact damage
Replace
OK
Turbine wheel
NG
Impact damage
Replace
NG
Carbon build-up
Replace
OK
Rotating assembly
NG
Dragging or seized
Replace
N6A3634E

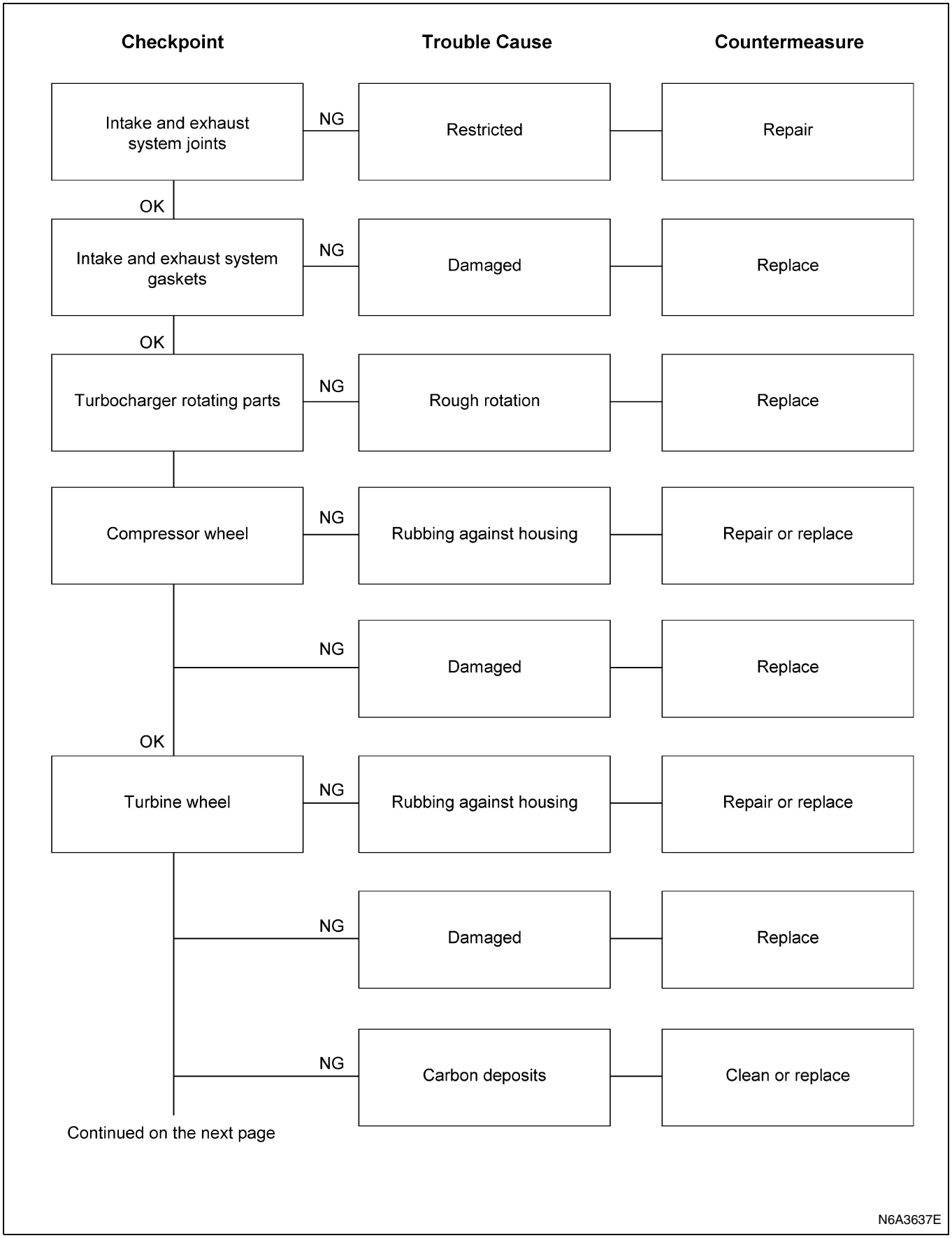
Blue or Black Smoke

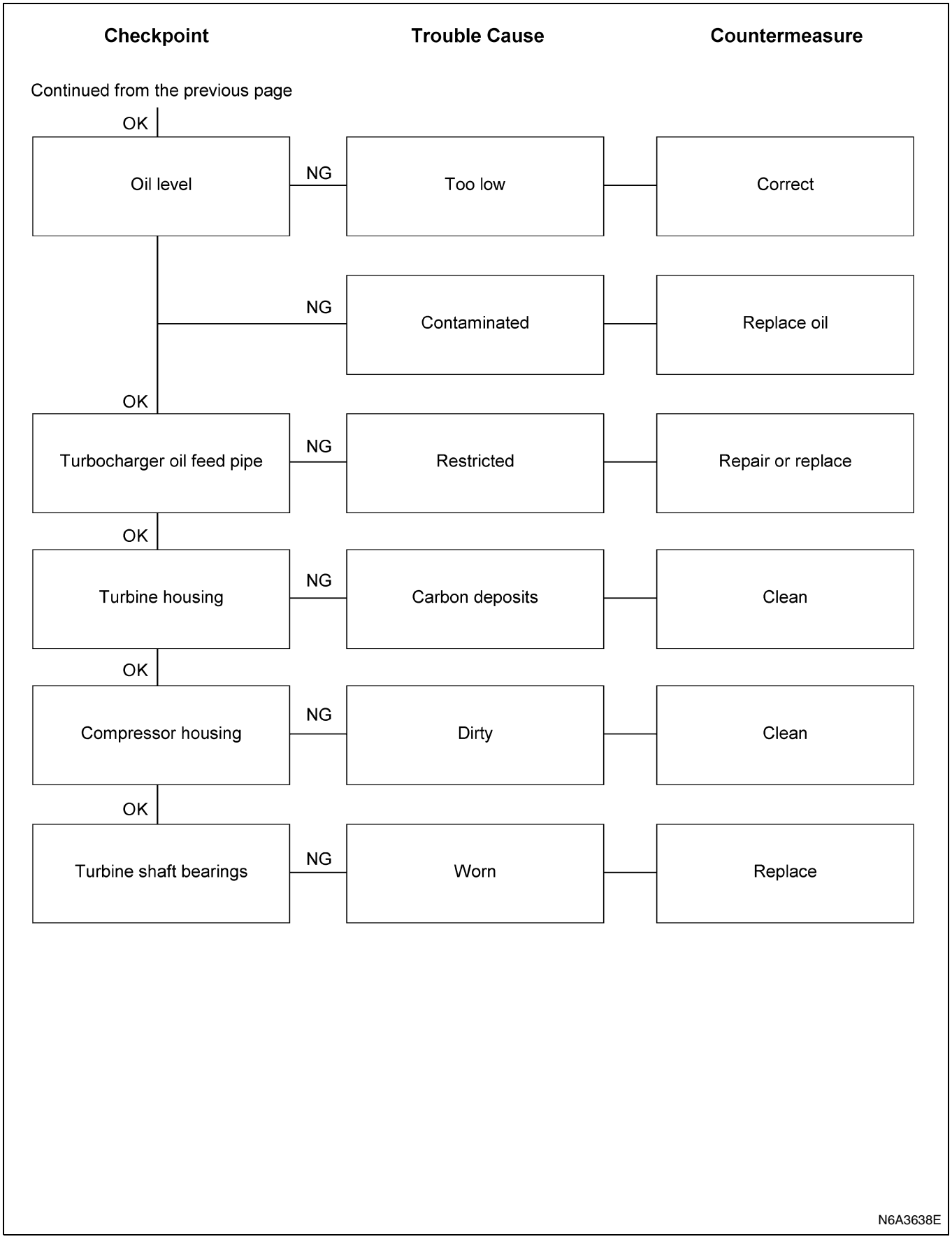


Excessive Oil Consumption

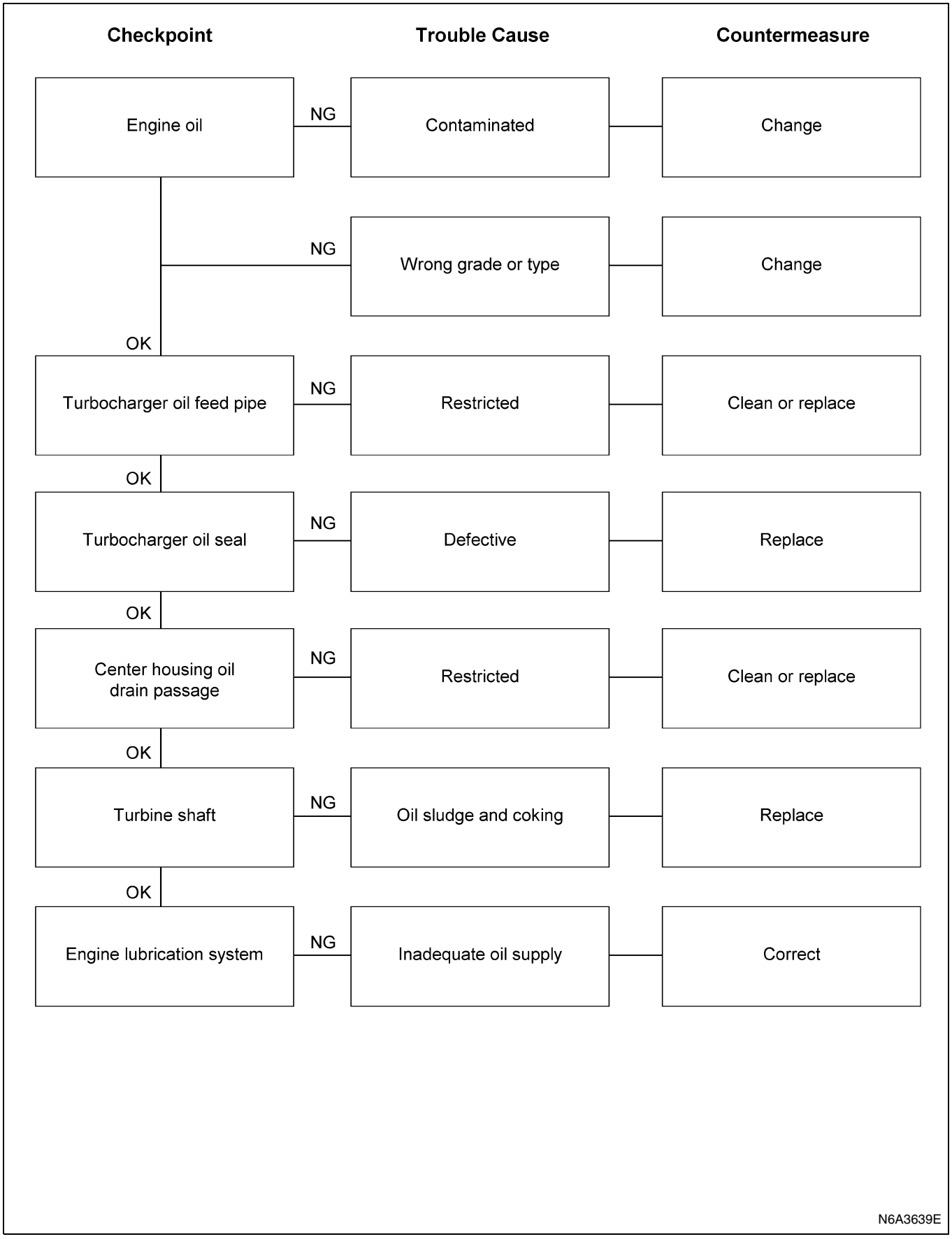


Excessive Turbocharger Noise



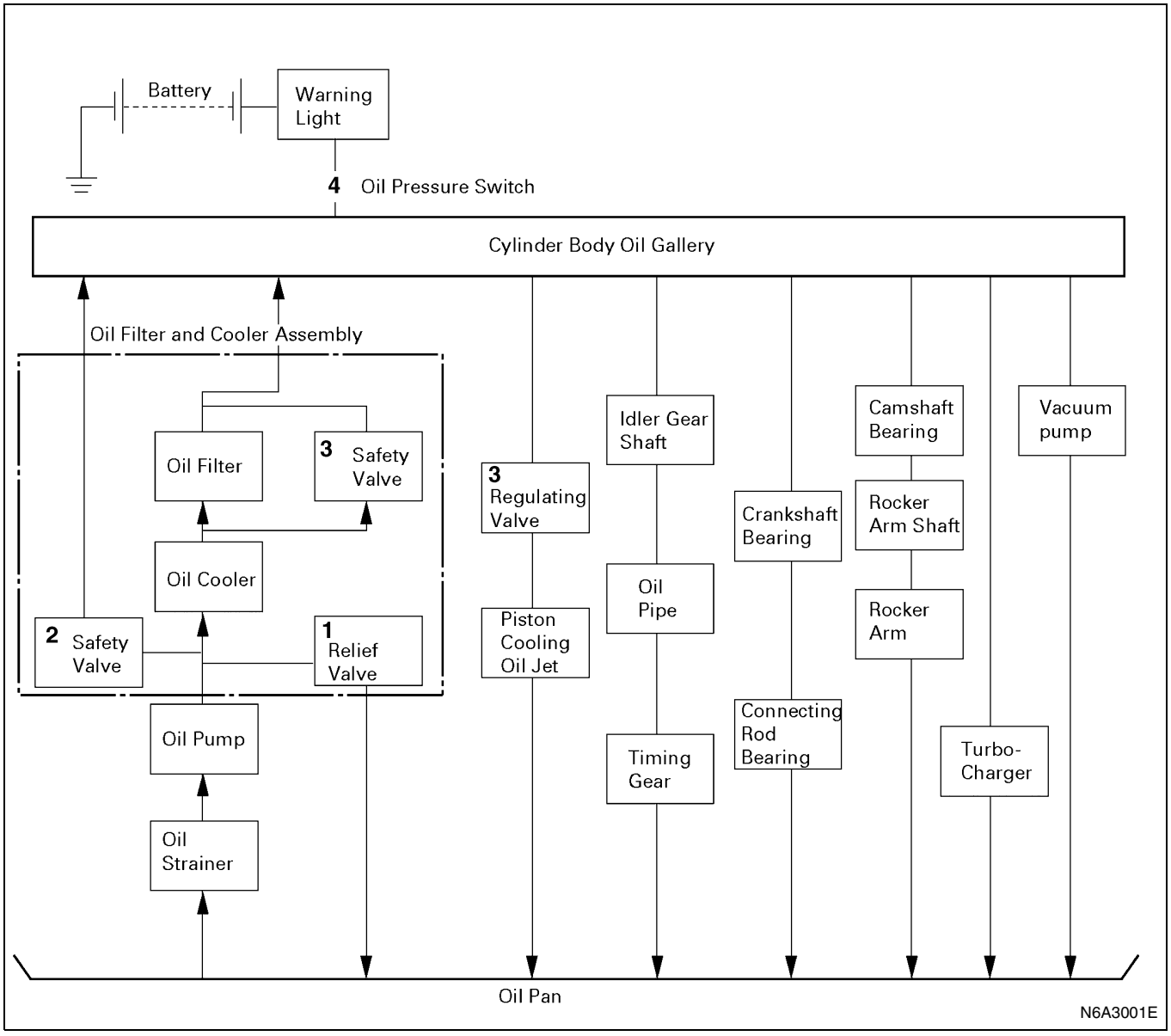

Checkpoint
Trouble Cause
Countermeasure
Continued from the previous page
OK
Oil level
NG
Too low
Correct
NG
Contaminated
Replace oil
OK
Turbocharger oil feed pipe
NG
Restricted
Repair or replace
OK
Turbine housing
NG
Carbon deposits
Clean
OK
Compressor housing
NG
Dirty
Clean
OK
Turbine shaft bearings
NG
Worn
Replace
N6A3638E

Excessive Rotating Part Wear



Lubrication Chart

4JB1, 4JB1-TC, 4JG2, 4JH1-TC, Oil Filter & Oil Cooler



Operating Pressure

Oil filter relief valve (1): 559 — 618 kPa (5.7 — 6.3 kg/cm^2/81 — 90 psi)
Oil cooler safety valve (2): 314 — 373 kPa (3.2 — 3.8 kg/cm^2/46 — 54 psi)
Oil filter safety valve (3): 78 — 118 kPa (0.8 — 1.2 kg/cm^2/11 — 19 psi)
Oil pressure switch (4): 29.4 — 49.0 kPa (0.3 — 0.5 kg/cm^2/4.3 — 7.1 psi)
The 4J Series engine lubricating system is a full flow type.
Lubricating oil is pumped from the oil pump to the cylinder body oil gallery through the oil cooler and the oil filter (replaceable type oil filters have on oil cooler). It is then delivered to the vital parts of the engine from the cylinder body oil gallery.

MAIN DATA AND SPECIFICATIONS

Main Data and Specifications

			Engine model		
			4JB1 / 4JB1-TC	4JG2	4JH1-TC
Item	Engine type		Four-cycle, overhead valve, water injection		
	Combustion chamber type		Direct injection	Swirl	Direct injection
	Cylinder liner type		Dry type, chrome plate, stainless steel tube		
	Timing train system		Gear drive	Gear and Belt Drive	Gear drive
	No. of cylinders — Bore × stroke	mm (in)	4 — 93 × 102 (3.66 × 4.02)	4 — 95.4 × 107 (3.76 × 4.21)	4 — 95.4 × 104.9 (3.76 × 4.16)
	No. of piston rings		Compression rings: 2 / Oil ring: 1		
	Total piston displacement	cm^3 (in^3)	2,771 (169.0)	3,059 (186.6)	2,999 (183.3)
	Compression ratio (to 1)		18.2 (4JB1) 18.1 (4JB1-TC)	20.1	18.3
	Compression pressure	kPa (kg/cm^2/psi)	3,038 (31/441)	3,334 (34/483.8)	2,746 (28/398)
	Engine weight (Dry)	N (kg/lb)	Approximately 2,245 (229/505) (4JB1) 2,511 (256/564) (4JB1-TC)	Approximately 2,403 (245/540)	Approximately 2,500 (255/562)
	Fuel injection order		1 — 3 — 4 — 2		
	Fuel injection timing	deg	BTDC 12 (′91/542A) (4JB1) BTDC 4 (4JB1-TC)	TDC 0° (Belt ′91/542B)	Not Adjustment
	Specified fuel type		SAE No. 2 diesel fuel		
	Idling speed	rpm	750 — 790	700 — 740	675 — 725
	Valve clearance (AT cold)	Intake: mm (in)	0.40 (0.016)		
		Exhaust: mm (in)	0.40 (0.016)		
	Valve clearance (AT hot)	Intake: mm (in)	0.45 (0.018)		
		Exhaust: mm (in)	0.45 (0.018)		
	Intake valves	Open at (BTDC) deg	24.5		
		Close at (BTDC) deg	55.5		
	Exhaust valves	Open at (BTDC) deg	54		
		Close at (BTDC) deg	26		

Notice:
G.EXP: General Export Model
EC: European Countries
Emission Gas Control Standard

′91/542A: Euro 1
′91/543 B: Euro 2

		Engine model		
		4JB1 / 4JB1-TC	4JG2	4JH1-TC
Item	**Lubrication system**			
	Lubrication method	Pressurized circulation		
	Specified engine oil (API grade)	CC (4JB1) CD (4JB1-TC)	CC	CD
	Oil pump type	Gear		
	Oil filter type	Disposable cartridge (Spin-on) Paper element		
	Oil capacity lit (US/UK gal) (Including oil filter)	6.6 — 7.1 (1.74 — 1.87/2.62 — 2.82) (For EC 6.2 — 8.2 (2.17 — 1.64/1.36 — 1.80))		6.0 — 8.0 (1.59 — 2.11/2.38 — 3.18)
	Oil cooler type	Water cooled		
	Fuel system			
	Injection pump type	Bosch distributor		Bosch VP44
	Governor type	Mechanical (Partially variable speed) (For EC Variable speed)		Electronically controlled fuel injection system
	Injection nozzle type	Hole	Pinttle	Hole
	Injection nozzle opening pressure kPa (kg/cm^2/psi)	18,142 (185/2,631) (4JB1) 1st: 19,500 (199/2,830) 2nd: 26,500 (270/3,840) (4JB1-TC)	14,710 (150/2,133)	1st: 19,500 (199/2,830) 2nd: 33,800 (345/4,906)
	Main fuel filter type	Cartridge paper element and water separator		Cartridge paper element with built in water separator
	Air cleaner type	Dry paper element		
	Generator capacity V — A (W)	12 — 40 (480) and 12 — 15 (600)	12 — 50	12 — 60 (720) 12 — 80 (960)
	Starter motor output V — kW	12 — 2.0 and 12 — 2.2	12 — 2.0	12 — 2.2 12 — 2.0 (For Taiwan)
	Turbocharger	IHI RHF4 (4JB1-TC)		IHI RHF5

Engine Cooling

Cooling system		Coolant forced circulation
Radiator		(2 tube in row) Tube type Corrugated
Heat radiation capacity	kcal/h	71400
Heat radiation area	m^2 (ft^2)	11.78 (126.8)
Front area	m^2 (ft^2)	0.216 (2.325)
Dry weight	N (kg/lb)	105 (10.7/23.6)
Radiator cap		
Valve opening pressure	kPa (kg/cm^2/psi)	88.2 — 116. 7 (0.899 — 1.199/12.78 — 17.05)
Coolant capacity	lit (Imp.qt./US qt.)	3.1 (2.73/3.28) (For EC 5.8 (5.1/6.13))
Coolant pump		
Pulley type		Centrifugal impeller type
Pulley ratio		1.2
Thermostat type		Wax pellet with jiggle valve.
Valve opening	°C (°F)	82 (180)
Valve full open	°C (°F)	95 (203)
Coolant total capacity	lit (Imp.qt./US qt.)	10 (8.80/10.57) (For EC 7.3 (6.42/7.71))

Starting System

Manufacturer		DENSO		
Engine model		4JB1 / 4JB1-TC	4JG2 (G. EXP)	4JH1-TC
Rating				
Voltage	V		12	
Output	kW	2.0	2.2	2.2
Time	Sec.		30	
Number of tooth of pinion			9	
Rotating direction (as viewed from pinion)			Clockwise	
Weight (approx.)	kg	4.6	5.4	6.0
No-load characteristics				
Voltage / current	V/A	11.5/100 or less		11.5/120
Speed	rpm	3700 or more		4000
Load characteristics				
Voltage / current	V/A	7.5/500 or less		7.5/500
Torque	N·m (kg·m/lb·ft)	13.7 (1.4/10.1)		12.7 (1.3/9.4)
Speed	rpm	1200 or more	1400 or more	1400
Locking characteristics				
Voltage / current	V/A	2.4/800 or less	2.0/850 or less	2.0/850
Torque	N·m (kg·m/lb·ft)	18 (1.8/13 or more)	16 (1.6/12) or more	15.7 (1.6/12)

Charging system

Manufacturer		HITACHI LR150-449B	HITACHI LR160-502B	HITACHI LR180-512
Rated voltage	V	12	12	12
Rated out put	A	50	60	80
Rotating direction (As viewed from pulley)		Clockwise	Clockwise	Clockwise
Pulley effective diameter	mm (in)	80 (3.15)	82 (3.23)	82 (3.23)
Weight (with pump)	kg (lb)	6.0 (13.27) 4JB1-TC 4JB1/4JG2	5.8 (12.78) 4JH1-TC	6.3 (13.88) 4JH1-TC

SERVICE STANDARD

Engine Mechanical

mm (in)

Parts	Item	Service standard			Service limit			Remarks
		4JH1-TC	4JG2	4JB1 / 4JB1-TC	4JH1-TC	4JG2	4JB1 / 4JB1-TC	
Cylinder Head	Cylinder head deck, and exhaust manifold mating surface for flatness	0.05 (0.002) or less			0.2 (0.0079)			Cannot be Regroun d
	Cylinder head height	92.0 (3.622)			91.55 (3.6043)			
	Cylinder Head Lower Face Warpage.	0.05 (0.002) or less			0.20 (0.008)			
	Manifold Warpage.	0.05 (0.002) or less			0.20 (0.008)			
	Hot plug sinking	—			0.02 (0.0008)			
	Hot plug exert pressure	4,500 — 5,500 kg (9922.5 — 12127.5 lbs)			—			
Valve Spring	Free height	48.0 (1.891)			47.10 (1.856)			
	Squareness	—			1.7 (0.067)			
	Spring tension N (kg/lb)	296 (30.2/66.4)			257.9 (26.3/57.9)			At installed height 38.9 (1.531)
Valve and Valve Guide	Diameter Valve Stem IN	7.946 — 7.961 (0.3128 — 0.3134)			7.880 (0.3102)			
	EX	7.921 — 7.936 (0.3118 — 0.3124)			7.850 (0.3090)			
	Valve and valve guide clearance IN	0.039 — 0.069 (0.0015 — 0.0027)			0.200 (0.0079)			
	EX	0.064 — 0.096 (0.0025 — 0.0038)			0.250 (0.0098)			
	Valve guide upper end height (Measured from the Cylinder head upper face)	13.0 (0.512)			—			
	Valve guide margin	1.1 (0.0433)			1.6 (0.0630)			
	Valve thickness IN	1.41 (0.0556)		1.79 (0.0705)	1.1 (0.0433)		1.5 (0.06)	
	EX	1.39 (0.0547)		1.83 (0.0720)	1.1 (0.0433)		1.5 (0.06)	
	Valve seat contact surface angle	45°						
	Valve seat contact width IN	1.7 (0.0669)			2.2 (0.0866)			
	EX	2.0 (0.0787)			2.5 (0.0984)			
Push rod	Curvature	—			0.4 (0.0157) or less			

mm (in)

Parts	Item	Service standard			Service limit			Remarks
		4JH1-TC	4JG2	4JB1 / 4JB1-TC	4JH1-TC	4JG2	4JB1 / 4JB1-TC	
Cam-shaft	End play	0.08 (0.0031)			0.2 (0.0079)			
	Cam lobe height	42.02 (1.6543)			41.65 (1.6397)			
	Journal diameter	49.945 — 49.975(1.9663 — 1.9675)			49.60 (1.9527)			
	Runout	0.02 (0.0008) or less			0.10 (0.0039)			
	Camshaft bearing inside diameter	50.000 — 50.030 (1.9685 — 1.9697)			50.08(1.9716)			
	Camshaft oil clear-ance	0.025 — 0.085 (0.0098 — 0.00334)			0.12 (0.0047)			
Tappet	Outside diameter	12.97 — 12.99 (0.5106 — 0.5114)			12.95 (0.5098)			
	Oil clearance (Between tappet and cylinder body)	0.03 (0.0118)			0.10 (0.0039)			
Rocker arm Assem-bly	Rocker shaft outside diameter	18.98 — 19.00 (0.7472 — 0.7480)			18.90 (0.7440)			
	Rocker arm inside diameter	19.036 — 19.060 (0.7494 — 0.7504)			19.10 (0.7520)			
	Oil clearance (Between rocker arm and rocker shaft)	0.06 — 0.08 (0.00235 — 0.00315)			0.10 (0.004)			
	Rocker shaft runout	—			0.2 (0.0079) or less			
Oil pump	Oil clearance Body and gear	0.14 (0.0055)			0.20 (0.0079)		0.15 (0.0059)	
	Body cover and gear	0.06 (0.0024)			0.15 (0.0059)			
Crank-shaft	Thrust clearance	0.10 (0.0039)			0.30 (0.018)			
	Main bearing clear-ance (Between main bearing and Crank-shaft)	0.037— 0.068 (0.0015 — 0.0027)	0.031 — 0.063 (0.0012 — 0.0025)	0.035 — 0.080 (0.0014 — 0.0032)	0.11 (0.0043)			
	Crankshaft runout	0.05 (0.00197) or less			0.08 (0.0031)			
	Main journal diameter	69.917 — 69.932 (2.7526 — 2.7532)			69.91 (2.7524)			
	Crankshaft pin diam-eter	52.915 — 52.930 (2.0833 — 2.0839)			52.90 (2.0827)			
	Crankshaft Journal and Crank Pin uneven wear	0.05 (0.002) or less			0.08 (0.003)			
	Crank Pin and Bear-ing Clearance.	0.029 — 0.066 (0.0011 — 0.0026)			0.100 (0.0039)			

mm (in)

Parts	Item	Service standard			Service limit			Remarks
		4JH1-TC	4JG2	4JB1 / 4JB1-TC	4JH1-TC	4JG2	4JB1 / 4JB1-TC	
Piston, Piston pin, Piston ring and Connecting rod	Piston diameter	95.355 — 95.394 (3.7541 — 3.7557)	95.365 — 95.404 (3.7545 — 3.9039)	92.985 — 93.024 (3.6600 — 3.6623)	—			
	Piston Clearance (Between piston and Cylinder liner)	0.047 — 0.065 (0.0019 — 0.0026)		0.025 — 0.045 (0.0010 — 0.0018)	—			
	Piston ring gap 1st	0.30 — 0.50 (0.0118 — 0.0197)	0.20 — 0.35 (0.0079 — 0.0138)	0.20 — 0.40 (0.0079 — 0.0157)	1.5 (0.0591)			
	2nd	0.30 — 0.50 (0.0118 — 0.0197)	0.37 — 0.52 (0.0146 — 0.0205)	0.20 — 0.40 (0.0079 — 0.00157)	1.5 (0.0591)			
	Oil	0.25 — 0.45 (0.0098 — 0.0177)	0.20 — 0.40 (0.0079 — 0.00157)	0.10 — 0.30 (0.0039 — 0.0118)	1.5 (0.0591)			
	Piston ring clearance 1st	0.09 — 0.13 (0.0035 — 0.0051)		0.090 — 0.125 (0.0035 — 0.0049)				
	2nd	0.05 — 0.09 (0.002 — 0.0035)		0.050 — 0.075 (0.0020 — 0.0030)	0.15 (0.0059)			
	Oil	0.03 — 0.07 (0.0012 — 0.0028)			0.15 (0.0059)			
	Piston pin diameter	30.995 — 31.000 (1.2202 — 1.2204)	33.995 — 34.000 (1.3384 — 1.3386)	30.995 — 31.000 (1.2202 — 1.2204)	33.970 (1.3374)		30.970 (1.2190)	
	Fitting interference (Between connecting rod and piston pin)	0.008 — 0.020 (0.0003 — 0.0008)			0.05 (0.0020)			
	Fitting interference (Between piston and piston pin)	0.002 — 0.015 (0.0001 — 0.0006)			0.04 (0.0016)			

mm (in)

Parts	Item	Service standard			Service limit			Remarks
		4JH1-TC	4JG2	4JB1 / 4JB1-TC	4JH1-TC	4JG2	4JB1 / 4JB1-TC	
Piston, Piston pin, Piston ring and Connecting rod	Connecting rod alignment Bend	0.08 (0.0031) or less			0.20 (0.0079)			Per 100 (3.94)
	Twist	0.05 (0.0020) or less			0.15 (0.0059)			Per 100 (3.94)
	Piston pin and Connecting Rod Bushing Clearance	0.008 — 0.020 (0.0003 — 0.0008)			0.050 (0.0020)			
	Connecting rod thrust clearance	0.230 (0.0091)			0.35 (0.0138)			
	Oil clearance (Between crank pin and Connecting rod)	0.029 — 0.083 (0.0014 — 0.0033)		0.029 — 0.066 (0.0011 — 0.0026)	0.100 (0.0039)			
Cylinder Block	Warpage (Upper surface of the cylinder block)	—			0.20 (0.0079)			
	Cylinder bore diameter	97.000 — 97.040 (3.8189 — 3.8205)		95.011 — 95.040 (3.7406 — 3.7417)				
	Cylinder liner projection	0.0 — 0.1 (0.00 — 0.0039)						
	Cylinder liner inside diameter	95.420 — 95.460 (3.7567 — 3.7583)		93.020 — 93.060 (3.6622 — 3.6638)				
	Cylinder liner outside diameter	97.011 — 97.050 (3.8193 — 3.8209)		95.011 — 95.050 (3.7405 — 3.7421)				

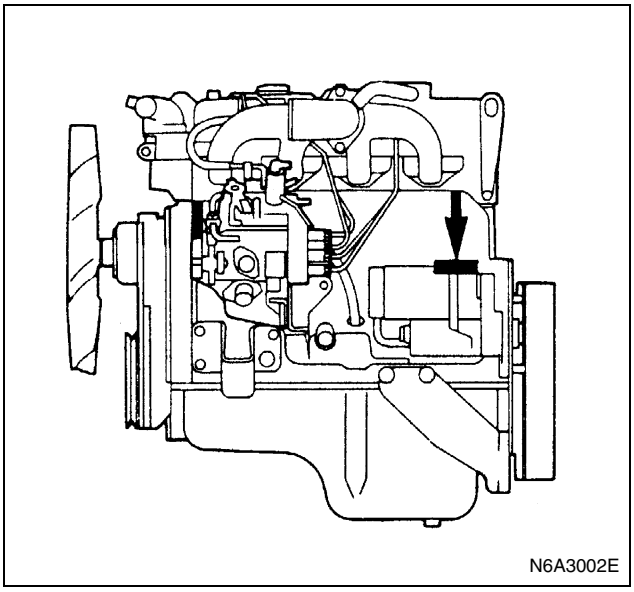
SERVICING

Servicing refers to general maintenance procedures to be performed by qualified service personnel.

Model Identification

Engine Serial Number

The engine number is stamped on the front left hand side of the cylinder body.



Air Cleaner

Dry Type Paper Element

Element cleaning procedures will vary according to the condition of the element.

Dust Fouled Element

Rotate the element with your hand while applying compressed air to the inside of the element. This will blow the dust free.

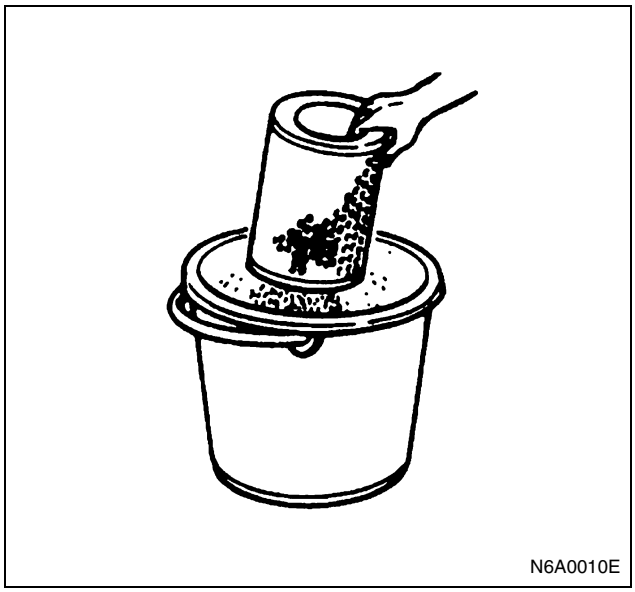
Compressed air pressure	kPa (kg/cm^2/psi)
392 — 490 (4 — 5/57 — 71)	

Caution:

Do not bang the element against another object in an attempt to clean it. Damage to the element will result.

Carbon and Dust Fouled Element

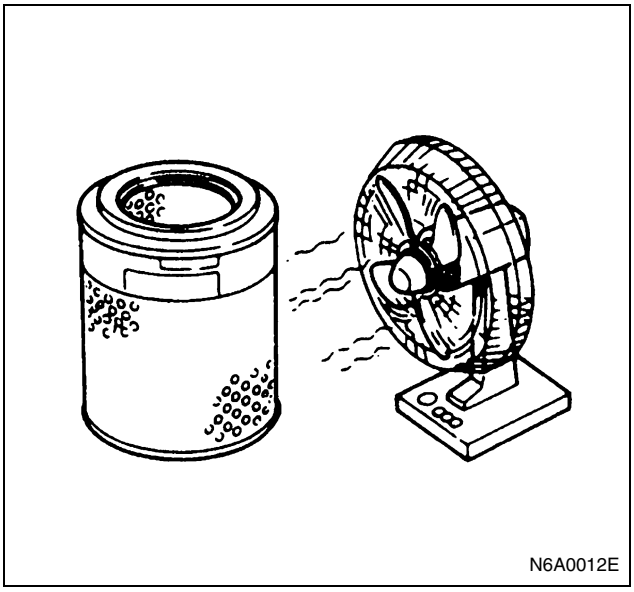
1. Prepare a cleaning solution of Isuzu Genuine Element Cleaner (Donaldson D1400) diluted with water.
2. Submerge the element in the solution for twenty minutes.



3. Remove the element from the solution and rinse it well with running water.
   Water pressure must not exceed 274 kPa (2.8 kg/cm^2/40 psi)

N6A0011E

4. Dry the element in a well ventilated area.
   An electric fan will hasten drying.

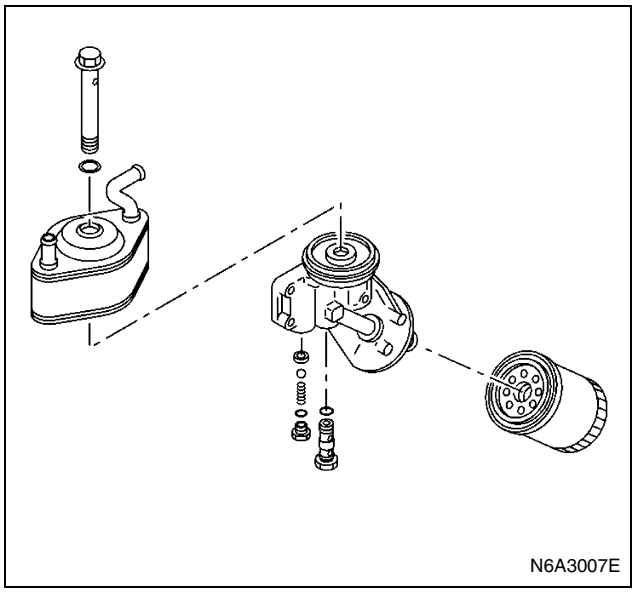

N6A0012E

Notice:
Do not use compressed air or an open flame to dry the element quickly. Damage to the element will result. It will usually take two or three days for the element to dry completely. Therefore, it is a good idea to have a spare on hand to use in the interim.

Lubricating System

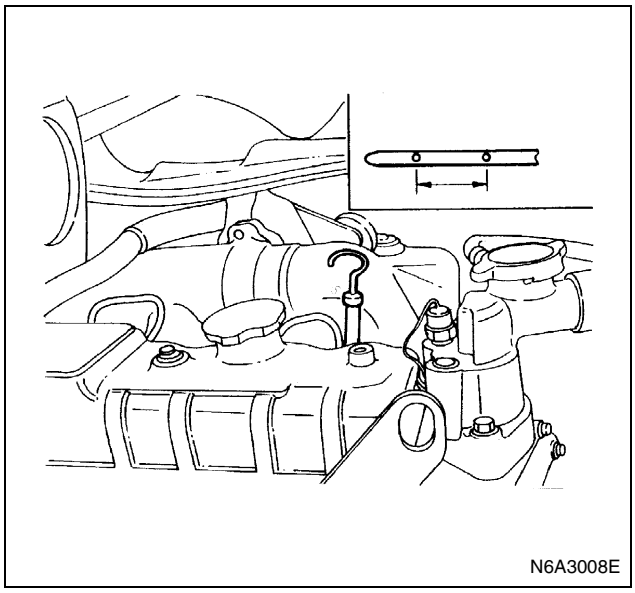
Main Oil Filter (Cartridge Type Paper Element) Replacement Procedure

1. Loosen the used oil filter by turning it counterclockwise with the filter wrench.
2. Clean the oil filter fitting face.
   This will allow the new oil filter to seat properly.
3. Apply a light coat of engine oil to the O-ring.
4. Turn in the new oil filter until the filter O-ring is fitted against the sealing face.
5. Use the filter wrench to turn in the filter an additional 1 and 1/4 turns.
   Filter Wrench:
   5-8840-0200-0 (89mm/3.5in)
   5-8840 0202-0 (106mm/4.2in)
   5-8840-2209-0 (100.6mm/4.0in)


N6A3007E

6. Check the engine oil level and replenish to the specified level if required.

Replenishment Engine Oil	lit (Imp qt/US qt)
0.7 (0.62/0.74)	

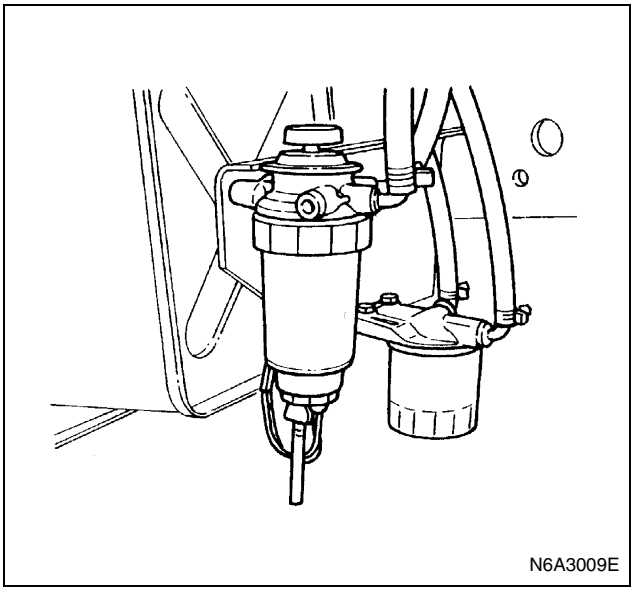

N6A3008E

7. Start the engine and check for oil leakage from the main oil filter.

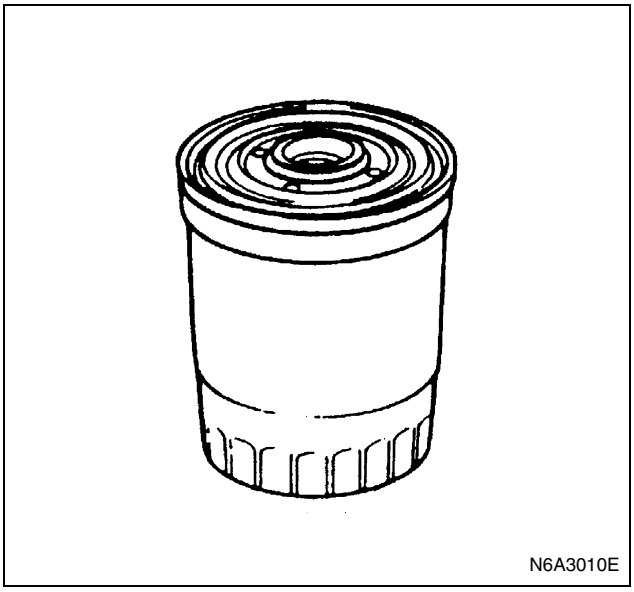
Fuel System

Fuel Filter Replacement Procedure

1. Loosen the used fuel filter by turning it counterclockwise with the filter wrench.
   Filter Wrench: 5-8840-0253-0 (J-22700)


N6A3009E

2. Clean the filter cover fitting faces.
   This will allow the new fuel filter to seat properly.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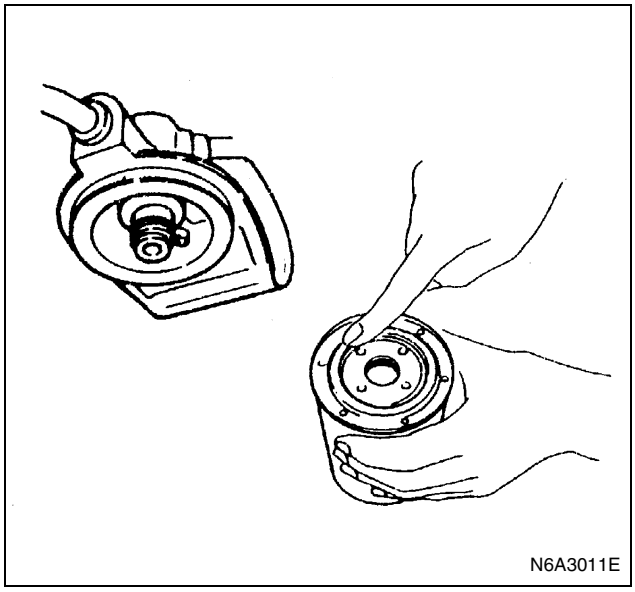
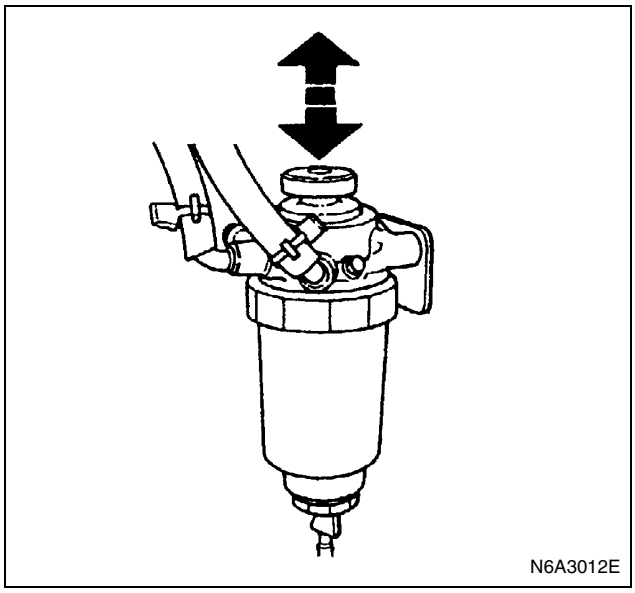
3. Turn in the fuel filter until the sealing face comes in contact.


N6A3011E

4. Turn in the fuel filter an additional 2/3 of a turn with a filter wrench.
   Filter Wrench: 5-8840-0253-0 (J-22700)
5. Loosen the bleeder plug on the injection pump overflow valve.

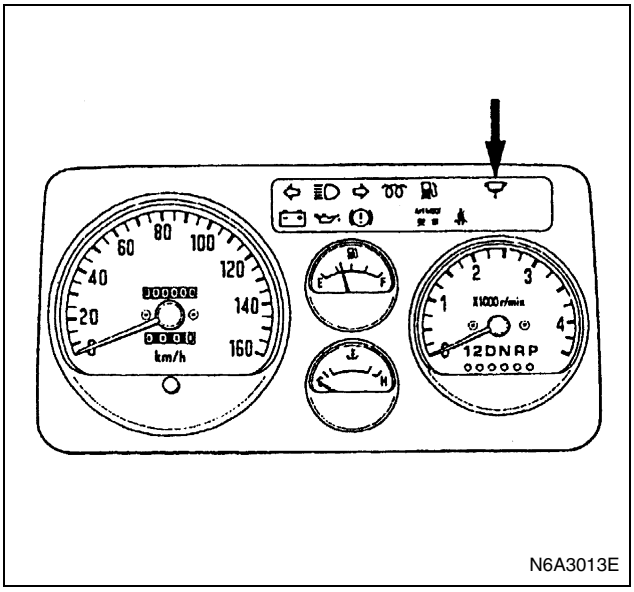

N6A3012E

6. Operate the priming pump until fuel begins to flow from the fuel filter.
7. Retighten the bleeder plug.
8. Operate the priming pump several times and check for fuel leakage.

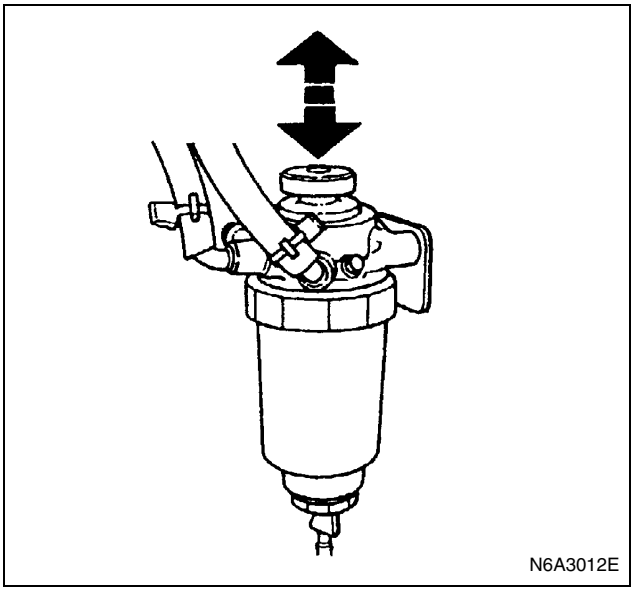
Notice:
The use of an ISUZU genuine fuel filter is strongly recommended.

Fuel Filter Water Draining Procedure

The indicator light will come on when the water level in the water separator exceeds the specified level.
Drain the water and foreign material from the water separator with the following procedure.



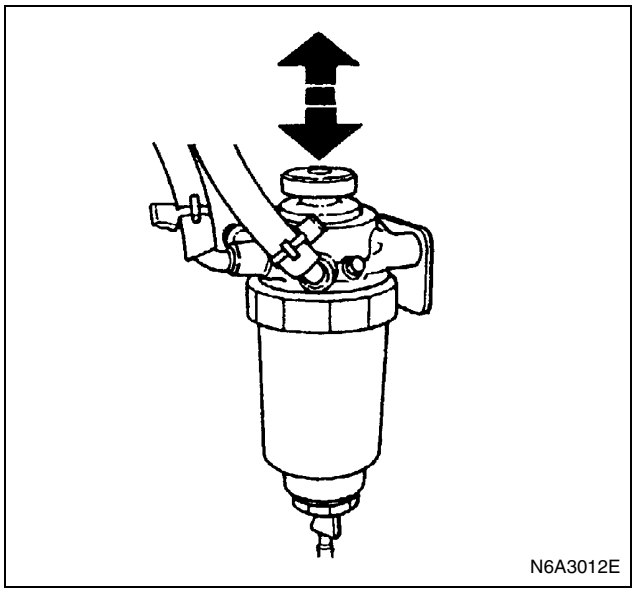
1. Find a safe place to park the vehicle.
2. Open the engine hood and place a container (Approximately 0.2 liter capacity) at the end of the vinyl hose beneath the drain plug on the separator.
3. Loosen the drain plug by turning it counterclockwise (Approximately 5 turns) and operate the priming pump up and down about 10 times until water is drained approximately 0.1 liter.



4. After draining, securely tighten the drain plug by turning it clockwise and operate the priming pump manually up and down several times.
5. After starting the engine, check to see that there is no fuel leak from the drain plug. Also check to see that the fuel filter water indicator light has turned off.
   If water separator requires frequent draining, have the fuel tank drained for removal of water at your Isuzu Dealer.

Air Bleeding

1. Loosen the bleeding plug on the injection pump overflow valve.
2. Operate the priming pump until fuel mixed with foam flows from the bleeding plug.
3. Tighten the bleeding plug.
4. Operate the priming pump several times and check for fuel leakage.



Injection Pump Air Bleeding (4JH1-TC only)

Injection pump air bleeding is required to start the engine when —

- The fuel supply has been exhausted (running out of gas).
- The fuel filter has been replaced.
- The injection pump has been replaced.

Caution:
If the injection pump has been replaced, the air bleeding procedure will require more time and effort (this is because there is no fuel in the pump).

1. Loosen the air bleed nut on the priming pump plunger (at the top of the fuel filter).
2. Move the priming pump plunger up-and-down until strong resistance is felt (about 15 cycles).
3. Stop pumping and tighten the air bleed nut.
4. Wait for 1 minute.
5. Loosen the air bleed nut on the priming pump plunger again.
6. Move the priming pump plunger up-and-down until strong resistance if felt (about 10 cycles).
7. Stop pumping and tighten the air bleed nut.
8. Wait for 1 minute.
9. Loosen the air bleed nut on the priming pump plunger again.
10. Move the priming pump plunger up-and-down until strong resistance is felt (about 5 cycles).
11. Stop pumping and tighten the air bleed nut.

12. Press the accelerator and clutch pedals all the way to the floor and hold them down. Turn the ignition switch to the ON position. Wait until the glow indicator lamp turns on and off.

Caution:
If the engine is cold, the glow indicator light will stay on for 4 — 7 seconds before turning off.

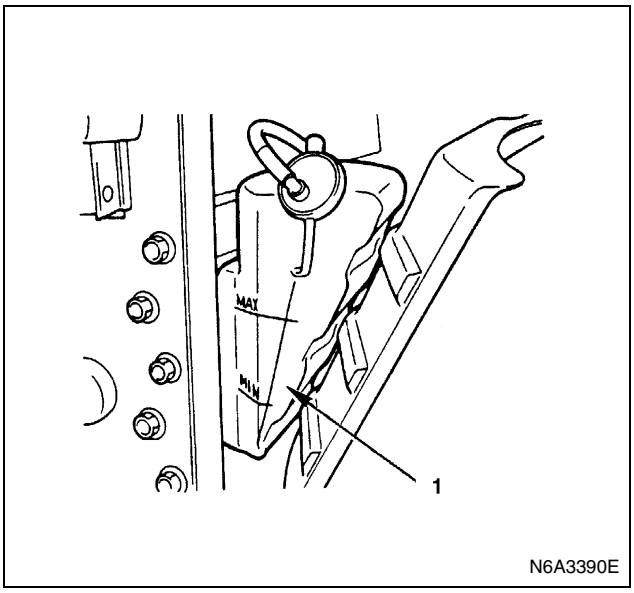
However, if the engine is hot, the lamp will not turn on.

13. Turn the ignition switch to the START position and crank the engine until it starts (do not crank the engine for more than 10 seconds).
    If the engine does not start, repeat Steps 9 — 13.
14. Allow the engine to idle for 5 minutes.

Cooling System

Coolant Level

Check the coolant level and replenish the radiator reserve tank as necessary.
If the coolant level falls below the “MIN” line, carefully check the cooling system for leakage. Then add enough coolant to bring the level up to the “MAX” line.



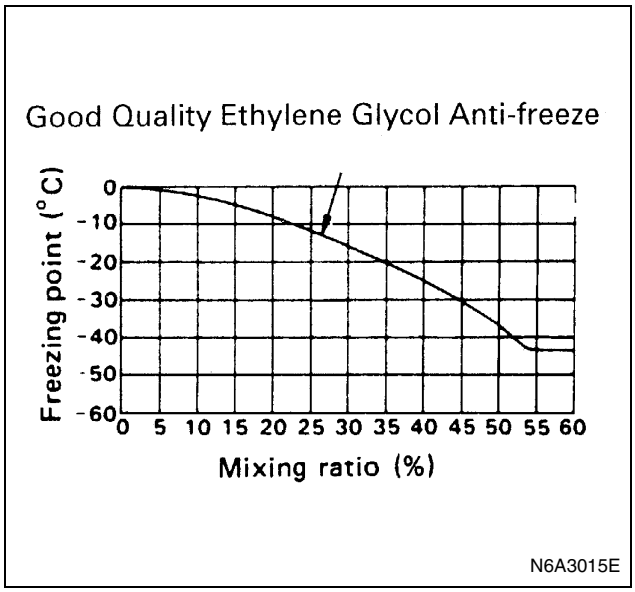
Legend
1. Reserve tank

Engine Coolant Change Procedure

1. To change engine coolant, make sure that the engine is cool.

WARNING:
WHEN THE COOLANT IS HEATED TO A HIGH TEMPERATURE, BE SURE NOT TO LOOSEN OR REMOVE THE RADIATOR CAP. OTHERWISE YOU MIGHT GET SCALDED BY HOT VAPOR OR BOILING WATER. TO OPEN THE RADIATOR CAP, PUT A PIECE OF THICK CLOTH ON THE CAP AND LOOSEN THE CAP SLOWLY TO REDUCE THE PRESSURE WHEN THE COOLANT HAS BECOME COOLER.

2. Open radiator cap and drain the cooling system by loosening the drain valve on the radiator and on the cylinder body.



Notice:
For best result it is suggested that the engine cooling system be flushed at least once a year. It is advisable to flush the interior of the cooling system including the radiator before using anti-freeze (ethylene-glycol based).

Replace damaged rubber hoses as the engine anti-freeze coolant is liable to leak out even minor cracks. Isuzu recommends to use Isuzu genuine anti-freeze (ethylene-glycol based) or equivalent, for the cooling system and not add any inhibitors or additives.

Caution:
A failure to correctly fill the engine cooling system in changing or topping up coolant may sometimes cause the coolant to overflow from the filler neck even before the engine and radiator are completely full. If the engine runs under this condition, shortage of coolant may possibly result in engine overheating. To avoid such trouble, the following precautions should be taken in filling the system.

3. To refill engine coolant, pour coolant up to filler neck using a filling hose which is smaller in outside diameter of the filler neck.
   Otherwise air between the filler neck and the filling hose will block entry, preventing the system from completely filling up.
4. Keep a filling rate of 9 liter/min. or less. Filling over this maximum rate may force air inside the engine and radiator. And also, the coolant overflow will increase, making it difficult to determine, whether or not the system is completely full.
5. After filling the system to the full, pull out the filling hose and check to see if air trapped in the system is dislodged and the coolant level goes down. Should the coolant level go down, repeat topping-up until there is no more drop in the coolant level.

6. After directly filling the radiator, fill the reservoir to the maximum level.
7. Install and tighten radiator cap and start the engine. After idling for 2 to 3 minutes, stop the engine and reopen radiator cap. If the water level is lower, replenish.

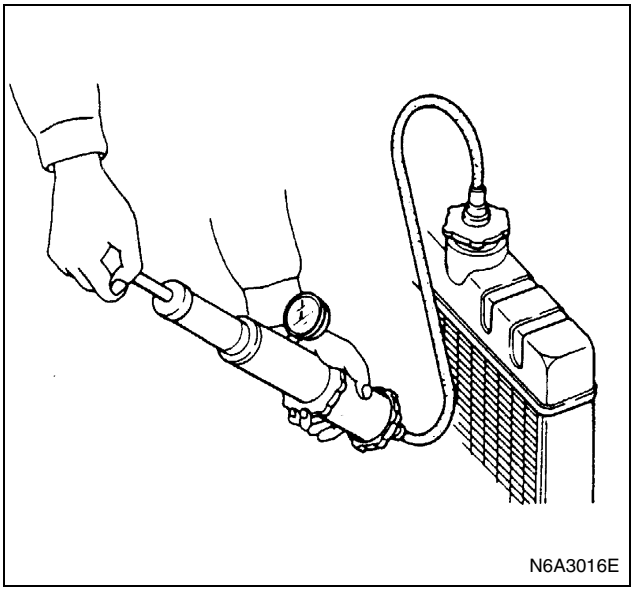
WARNING:
WHEN THE COOLANT IS HEATED TO A HIGH TEMPERATURE, BE SURE NOT TO LOOSEN OR REMOVE THE RADIATOR CAP. OTHERWISE YOU MIGHT GET SCALDED BY HOT VAPOR OR BOILING WATER. TO OPEN THE RADIATOR CAP, PUT A PIECE OF THICK CLOTH ON THE CAP AND LOOSEN THE CAP SLOWLY TO REDUCE THE PRESSURE WHEN THE COOLANT HAS BECOME COOLER.

8. After tightening radiator cap, warm up the engine at about 2,000 rpm. Set heater adjustment to the highest temperature position, and let the coolant circulate also into heater water system.
9. Check to see the thermostat has opened through the needle position of water thermometer, conduct a 5 minutes idling again and stop the engine.
10. When the engine has been cooled, check filler neck for water level and replenish if required. Should extreme shortage of coolant is found, Check the coolant system and reservoir tank hose for leakage.
11. Fill the coolant into the reservoir tank up to “MAX” line.

Cooling System Inspection

Install a radiator filler cap tester to the radiator. Apply testing pressure to the cooling system to check for leakage.
The testing pressure must not exceed the specified pressure.

Testing Pressure	kPa (Kg/cm^2/psi)
147 (1.5/21)	

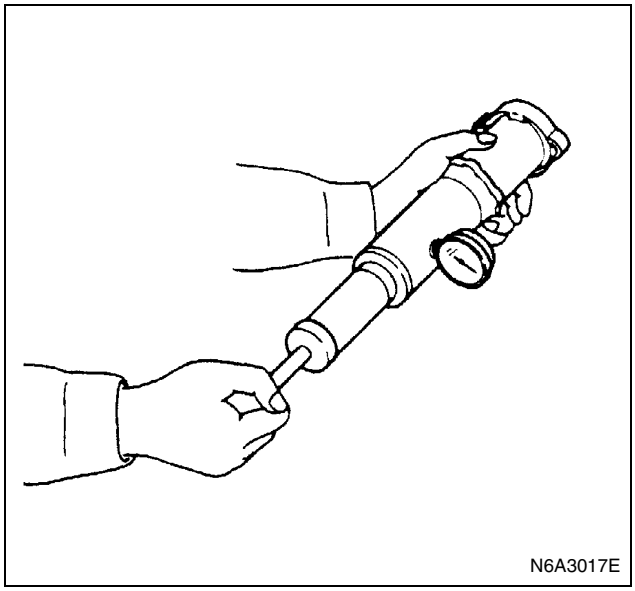

N6A3016E

Radiator Cap Inspection

The radiator filler cap is designed to maintain coolant pressure in the cooling system at 1.05 kg/cm^2 (15 psi / 103 kPa). Check the radiator filler cap with a radiator filler cap tester. The radiator filler cap must be replaced if it fails to hold the specified pressure during the test procedure.
Radiator Filler Cap Pressure

Pressure Valve	kPa (kg/cm^2/psi)
88 — 118 (0.9 — 1.2/12.8 — 17.1)	

Negative Valve (Reference)	kPa (kg/cm^2/psi)
1.0 — 13.9 (0.01 — 0.04/0.14 — 0.57)	


N6A3017E

Thermostat Operating Test

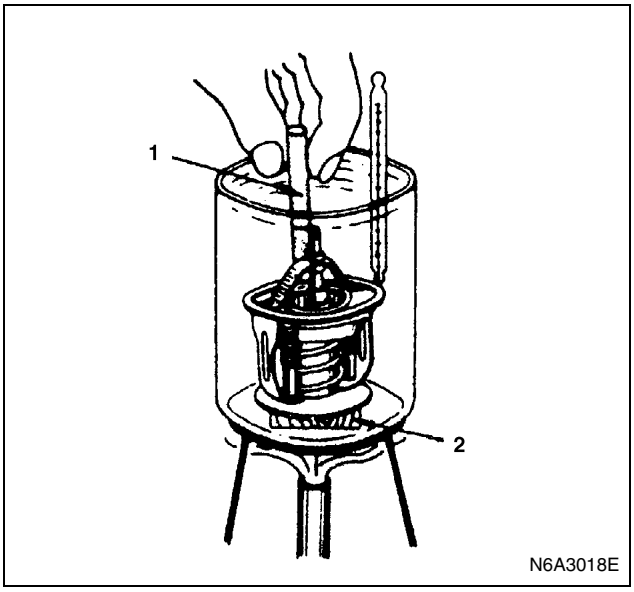
1. Completely submerge the thermostat in water.
2. Heat the water.
   Stir the water constantly by suitable wood bar (1) to avoid direct heat being applied use wood plate (2) to the thermostat.
3. Check the thermostat initial opening temperature.

Thermostat Initial Opening Temperature	°C (°F)
82 (180)	

4. Check the thermostat full opening temperature.

Thermostat Full Opening Temperature	°C (°F)
95 (203)	

Valve Lift at Fully Open Position	mm (in)
10 (0.39)	



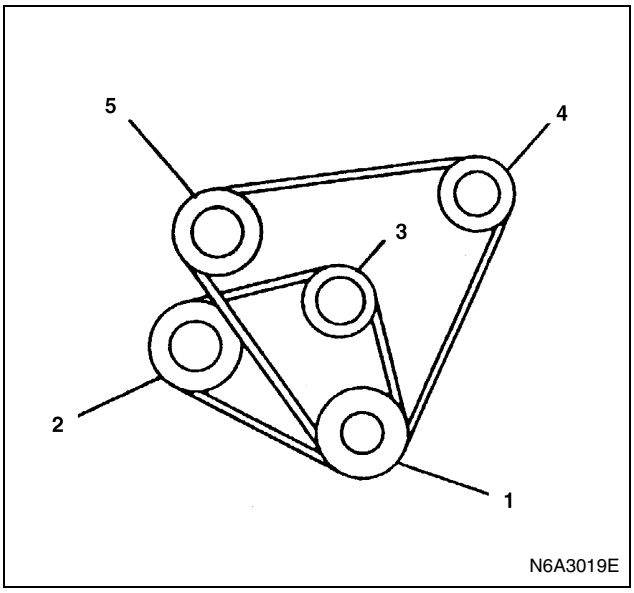
Drive Belt Adjustment

Depress the drive belt mid portion with a 98 N (10 kg / 22 lb) force.

Drive Belt Deflection	mm (in)
8 — 12 (0.32 — 0.47)	

Check the drive belt for cracking and other damage.

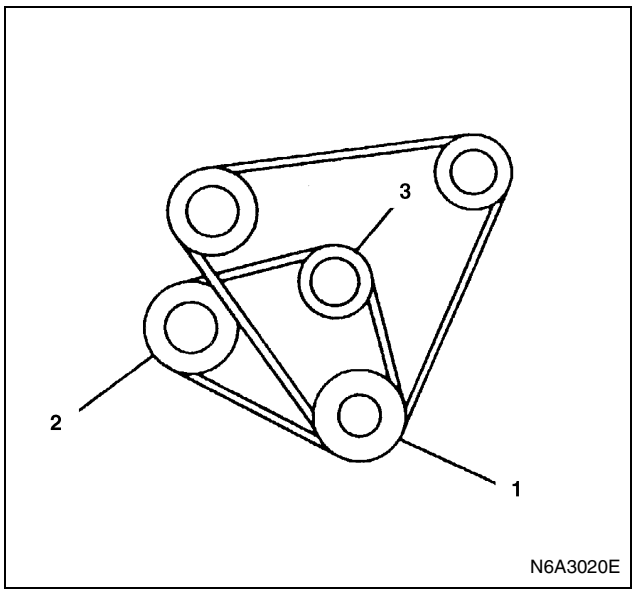
1. Crankshaft damper pulley (1)
2. Generator pulley (2)
3. Cooling fan pulley (3)
4. Oil pump pulley or idler pulley (4)
5. Compressor pulley or idle pulley (5)



Cooling Fan Pulley Drive Belt

Fan belt tension is adjusted by moving the generator.
Depress the drive belt mid portion with a 98 N (10 kg / 22 lb) force.

1. Crankshaft damper pulley (1)
2. Generator pulley (2)
3. Cooling fan pulley (3)

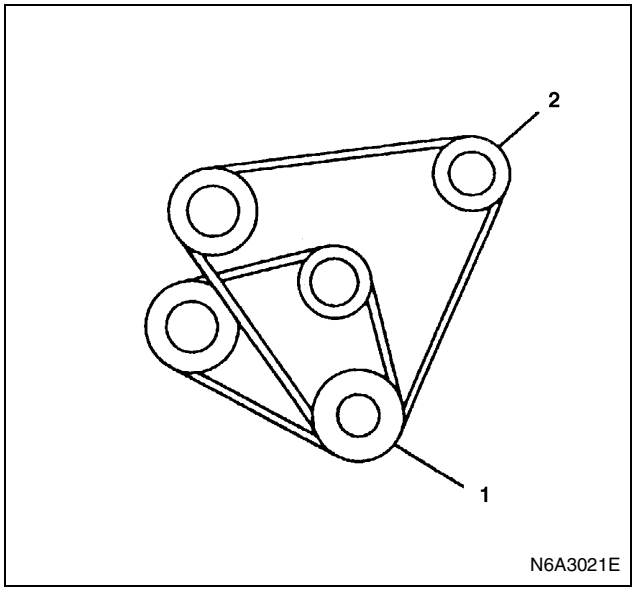


Compressor Pulley Drive Belt

Move the idler pulley as required to adjust the compressor drive belt tension.
If the vehicle is equipped with power steering, move the oil pump as required.
Depress the drive belt mid portion with a 98 N (10 kg / 22 lb) force.

Belt Deflection	mm (in)
8 — 12 (0.32 — 0.47)	

1. Crankshaft damper pulley (1)
2. Oil pump pulley or idler pulley (2)



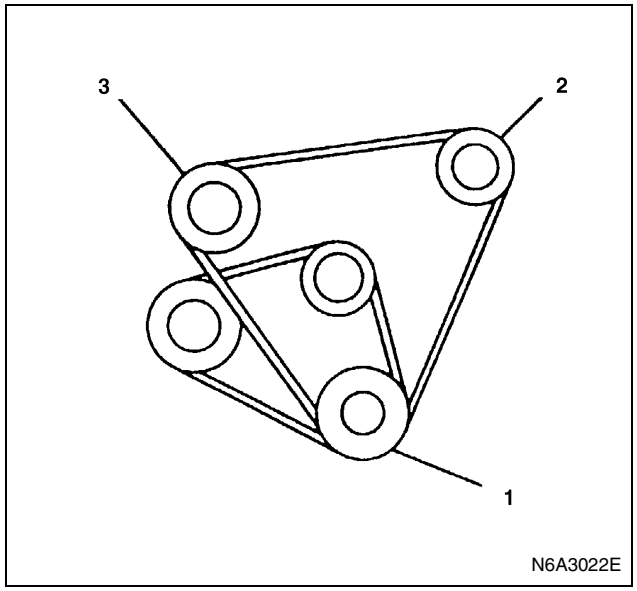
Power Steering Oil Pump Pulley Drive Belt

Move the oil pump as required to adjust the oil pump drive belt tension.
On air conditioner equipped models, both drive belts pulley must always be replaced as a set.

Depress the drive belt mid portion with a 98 N (10 kg / 22 lb) force.

Belt Deflection	mm (in)
8 — 12 (0.32 — 0.47)	

1. Crankshaft damper pulley (1)
2. Oil pump pulley (2)
3. Compressor pulley or idler pulley (3)



Engine Control

Idling Speed Inspection

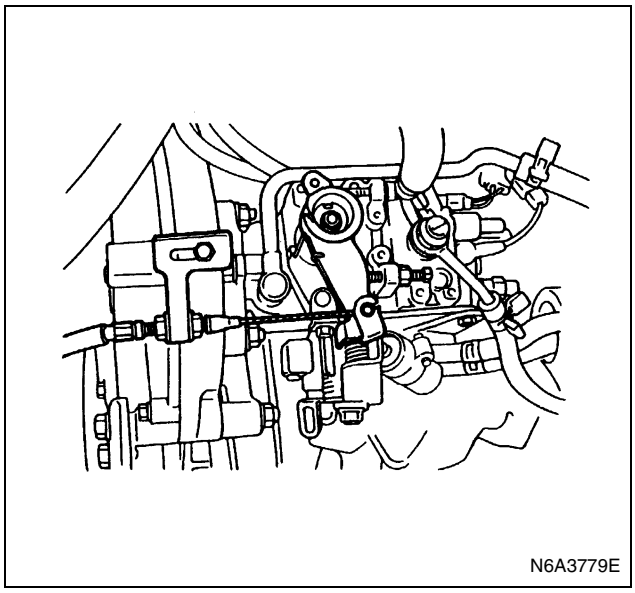
1. Set the vehicle parking brake and choke the drive wheels.
2. Place the transmission in neutral.
3. Start the engine and allow it to warm up.
4. Disconnect the engine control cable from the control lever.
5. Set a tachometer to the engine.
6. Check the engine idling speed.
   If the engine idling speed is outside the specified range, it must be adjusted.

Engine Idling Speed	rpm
4JB1 / 4JB1-TC	750 — 790
4JG2	700 — 740
4JH1-TC	675 — 725

Idling Speed Adjustment

(4JB1/4JB1-TC/4JG2 only)

1. Loosen the idling set bolt lock nut on the injection pump idling set bolt.
2. Adjust the idling speed to the specified range by turning the idling set bolt.
3. Lock the idling set bolt with the idling set bolt lock nut.
4. Check that the idling control cable is tight (free of slack).
   If required, remove the slack from the cable.



Accelerator Control Cable Adjustment

(4JB1/4JB1-TC/4JG2 Only)

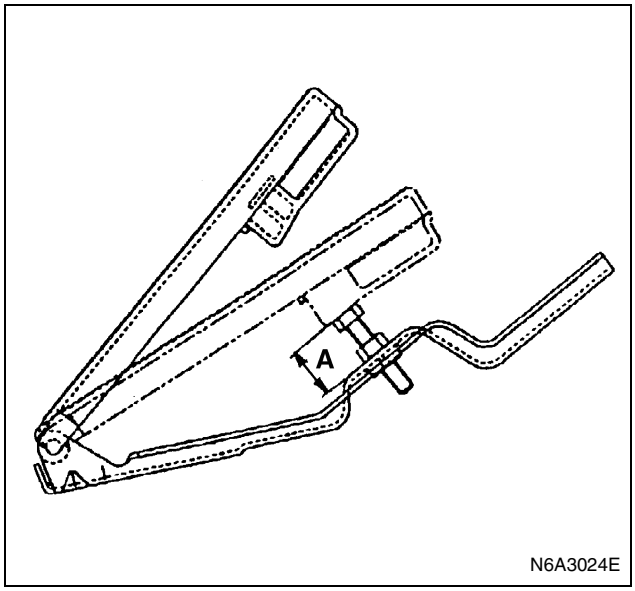
1. Loosen the accelerator cable clamp bolt.
2. Check that the idling control knob on the instrument panel is in the engine idling position.
3. Hold the accelerator lever in the fully closed position and stretch the control cable in the direction indicated by the arrow to remove any slack.

Accelerator Pedal Adjustment

LHD

1. Loosen the lock nut.
2. Adjust bolt height from floor.

Adjust Bolt Height (A)	mm (in)
18 — 28 (0.71 — 1.1)	

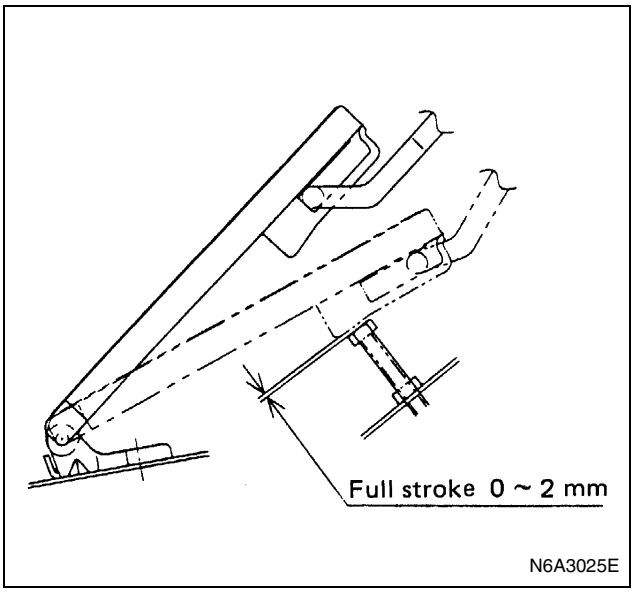


3. Check to see if the accelerator pedal play is in the range of 5 to 10mm above the pedal pad.
4. Press down on the accelerator pedal fully and check to see if the engine rotates at its maximum speed with each of the linkage in the smooth operation.
5. In the operating range of accelerator pedal and the injection pump lever returns to their respective original positions without fail.

RHD

1. Hold the accelerator pedal pad securely by hand, and give it a full stroke.
2. Adjust the stopper bolt so that the clearance between the pad stopper bolt and the rear side of the pad becomes the specified length.

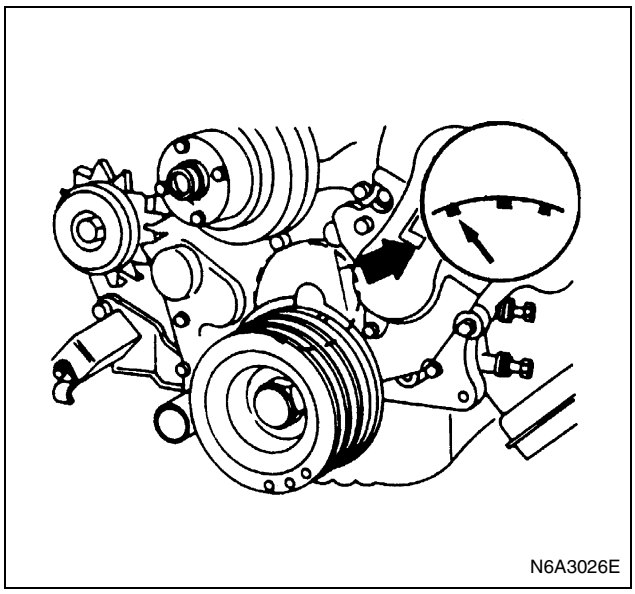
mm (in)
0 — 2 (0 — 0.079)



3. Check to see if the accelerator pedal play is in the range of 5 to 10mm above the pedal pad.
4. Press down on the accelerator pedal fully and check to see if the engine rotates at its maximum speed with each of the linkage in the smooth operation.
5. In the operating range of accelerator pedal and the injection pump lever returns to their respective original positions without fail.

Valve Clearance Adjustment

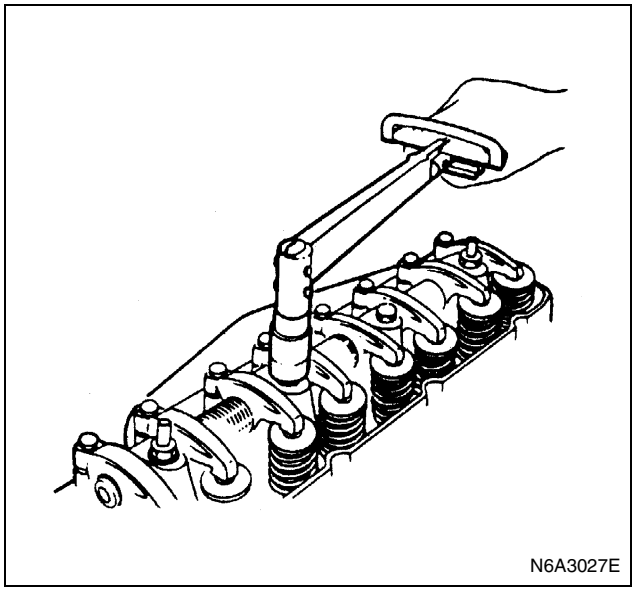
1. Bring the piston in either the No. 1 cylinder or the No. 4 cylinder to TDC on the compression stroke by turning the crankshaft until the crankshaft damper pulley TDC line is aligned with the timing pointer.



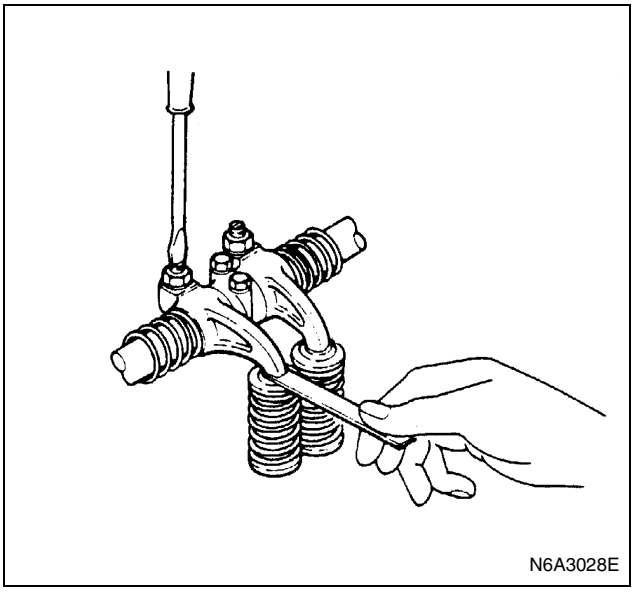
2. Check the rocker arm shaft bracket nuts for looseness.
   Tighten any loose rocker arm shaft bracket nuts before adjusting the valve clearance.

Tighten:

- Rocker arm shaft bracket nut to 54 N·m (5.5 kg·m / 40 lb·ft)



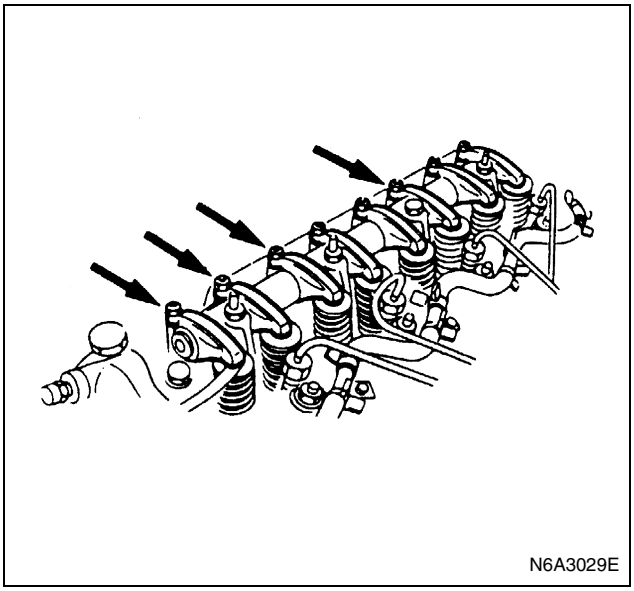
3. Check for play in the No. 1 intake and exhaust valve push rods.
   If the No. 1 cylinder intake and exhaust valve push rods have play, the No. 1 piston is at TDC on the compression stroke.
   If the No. 1 cylinder intake and exhaust valve push rods are depressed, the No. 4 piston is at TDC on the compression stroke.


N6A3028E

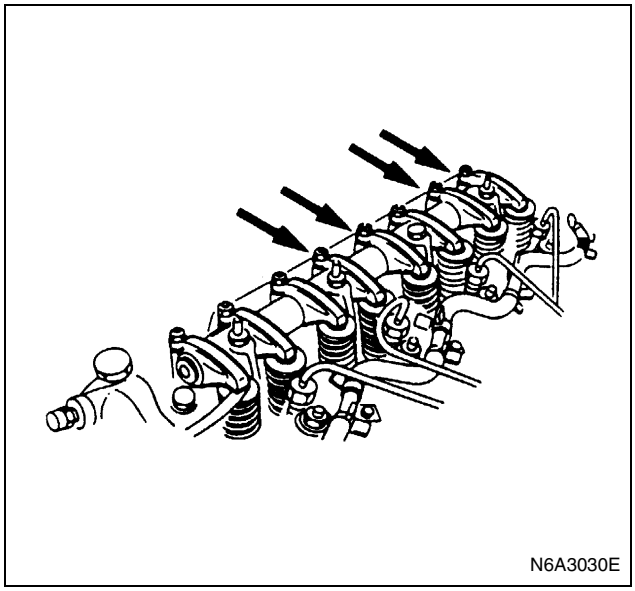
Adjust the No. 1 or the No. 4 cylinder valve clearance while their respective cylinders are at TDC on the compression stroke.

Valve Clearance (At Cold)	mm (in)
0.4 (0.016)	

4. Loosen each valve clearance adjusting screw as shown in the illustration.
   - No.1 Cylinder T.D.C. (Compression stroke)


N6A3029E

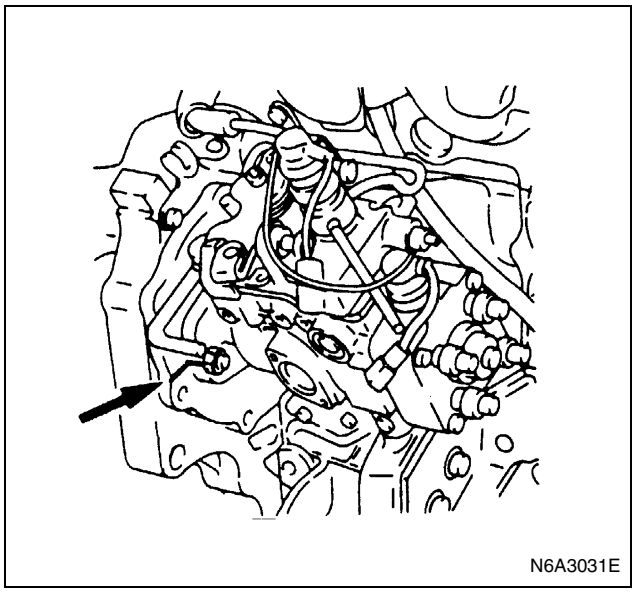
5. Insert a feeler gauge of the appropriate thickness between the rocker arm and the valve stem end.
6. Turn the valve clearance adjusting screw until a slight drag can be felt on the feeler gauge.
7. Tighten the lock nut securely.
8. Rotate the crankshaft 360°.
9. Realign the crankshaft damper pulley TDC notched line with the timing pointer.
10. Adjust the clearance for the remaining valves as shown in the illustration.
    - No.4 Cylinder T.D.C. (Compression stroke)


N6A3030E

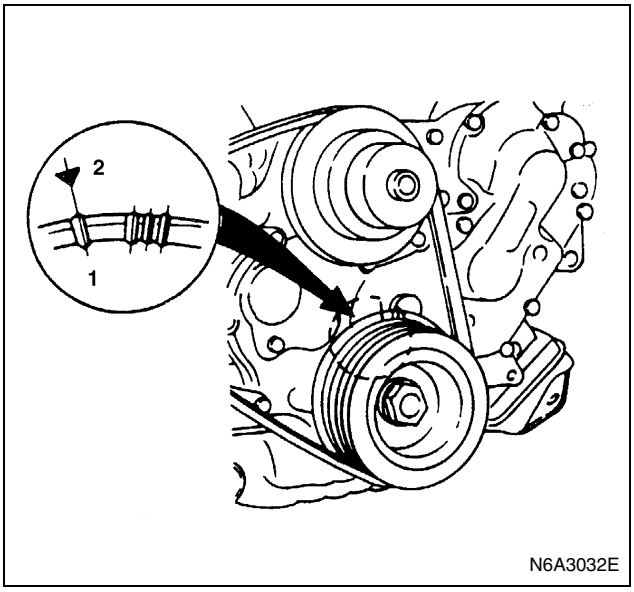
Injection Timing Adjustment

(4JB1/4JB1-TC/4JG2 Only)

1. Check that the notched line on the injection pump flange is aligned with the front plate or the timing gear case notched line.


N6A3031E

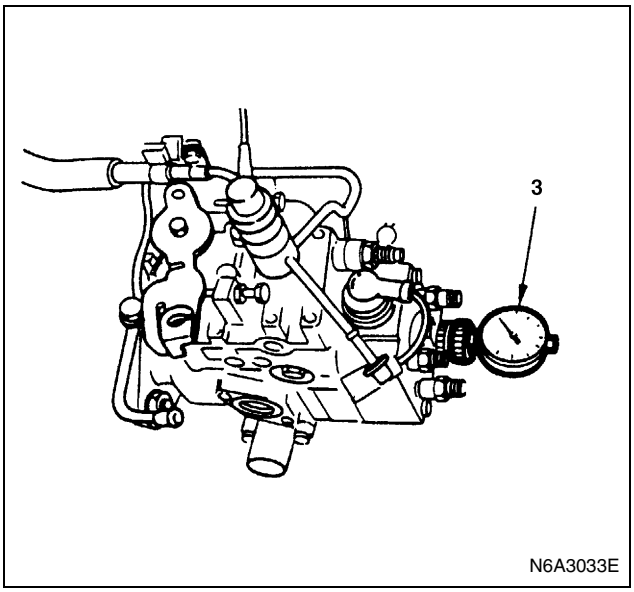
2. Bring the piston in the No. (1) cylinder to TDC 1 on the compression stroke by turning the crankshaft until the crankshaft pulley TDC line is aligned with the timing mark (2).



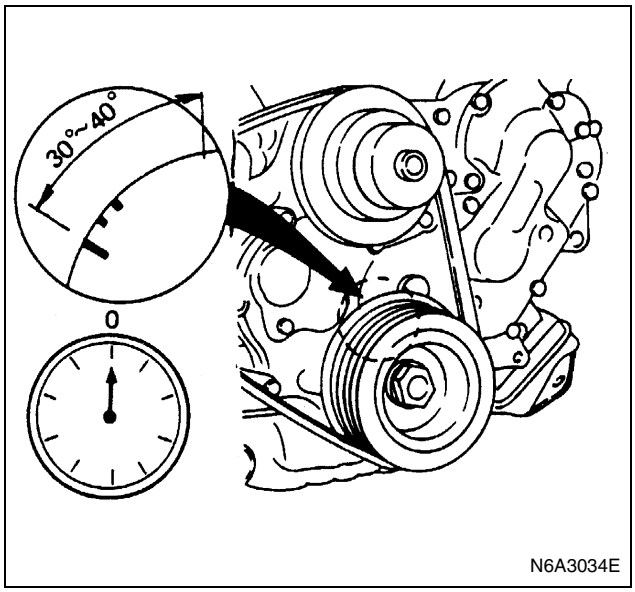
Notice:
Check for play in the No. 1 intake and exhaust valve push rods.

If the No. 1 cylinder intake and exhaust valve push rods have play, the No. 1 piston is at TDC on the compression stroke.

3. Disconnect the injection pipe from the injection pump.
4. Remove one bolt from the distributor head.
5. Insert a screwdriver into a hole in the fast idle lever and turn the lever to release the W-C.S.D. function. (If so equipped)
6. Install the static timing gauge (3).
   The probe of the gauge should be depressed inward approximately 2 mm (0.079 in).
   Static Timing Gauge: 5-8840-0145-0 (J-28827)



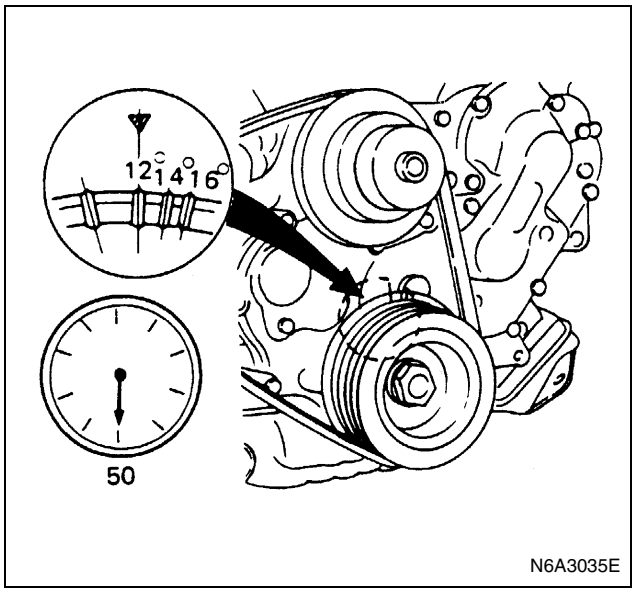
7. Rotate the crankshaft to bring the piston in the No. 1 cylinder to a point 30 — 40° BTDC.
8. Set the timing gauge needle to zero.
9. Move the crankshaft pulley slightly in both directions to check that the gauge indication is stable.



10. Turn the crankshaft clockwise and read the gauge indication when the crankshaft pulley timing mark is aligned with the pointer.

4JB1	BTDC 14°
4JB1-TC	BTDC 4°
4JG2	ATDC 2°

Standard Reading	mm (in)
0.5 (0.02)	



If the injection timing is outside the specified range, continue with the following steps.

11. Loosen the injection pump fixing nuts and bracket bolts.
12. Adjust the injection pump setting angle.

	When large than standard value	When smaller than standard value
Gear drive	A	B

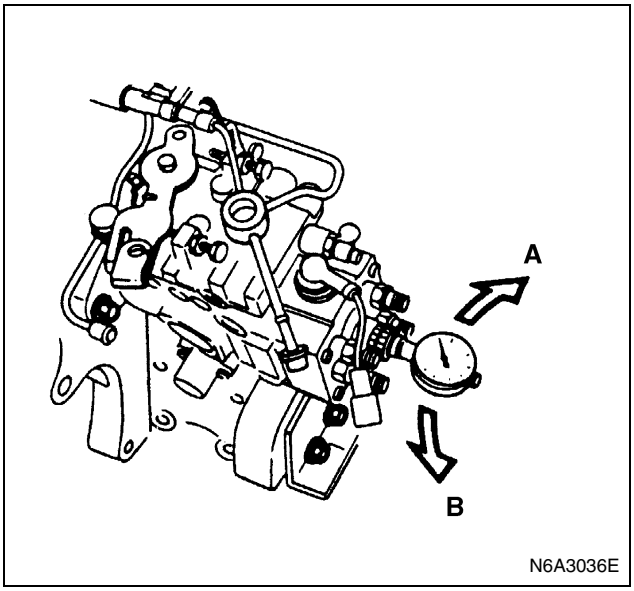
A: Move the injection pump toward the engine.

B: Move the injection pump away from the engine.

Tighten the pump fixing nut, adjust bolt and pump distributor head plug to the specified torque.

Tighten:

- Pump fixing bolt to 24 N·m (2.4 kg·m / 17 lb·ft)
- Adjust bolt to 19 N·m (1.9 kg·m / 14 lb·ft)
- Injection pump distributor head plug to 17 N·m (1.7 kg·m / 12 lb·ft)



Legend

A. To advance

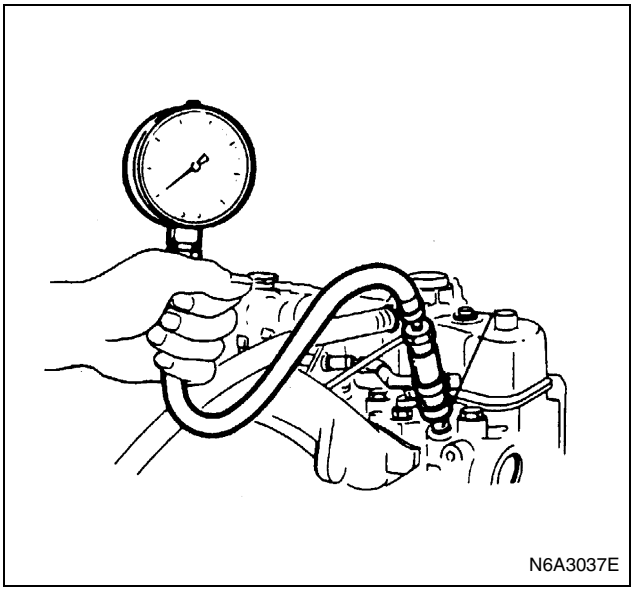
B. To retard

Caution:

When installing the distributor head/plug, be sure to use new copper washer.

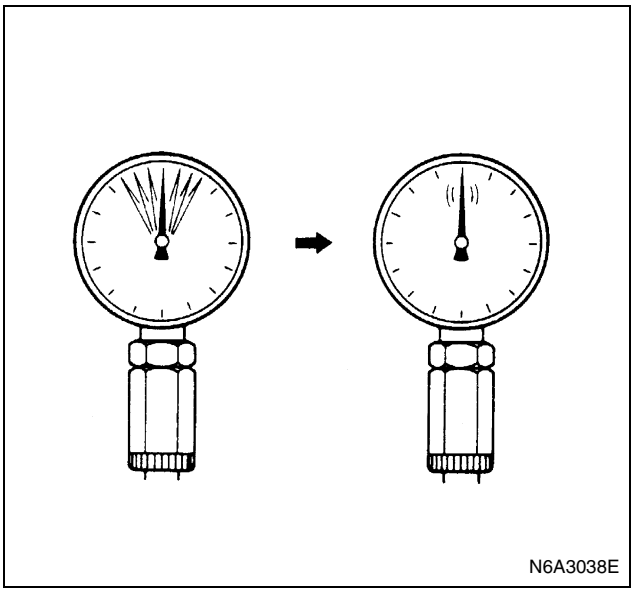
Compression Pressure Measure-ment

1. Start the engine and allow it to idle until the coolant temperature reaches 70 — 80°C (158 — 176°F).
2. Remove the following parts.
   - Glow plugs
   - Fuel cut solenoid connector
   - QOS (Quick-On Start System) fusible link wire at the connector.
3. Set the adapter and compression gauge to the No. 1 cylinder glow plug hole.
   Compression Gauge
   (with Adapter): 5-8840-2008-0 (J-29762)
   Adapter: 5-8531-7001-0



4. Turn the engine over with the starter motor and take the compression gauge reading.

Compression Pressure at 200 rpm kPa (kg/cm^2/psi)		
	Standard	Limit
4JB1	3,038 (31/441)	2,157 (22/313)
4JG2	3,334 (34/484)	2,452 (25/356)

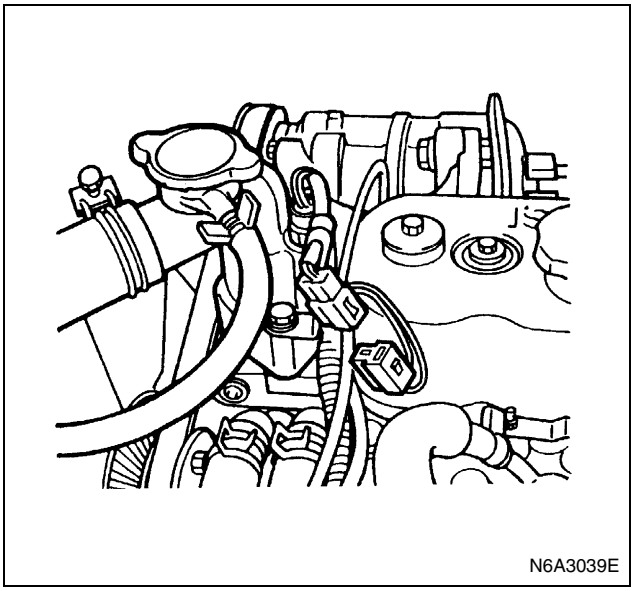


5. Repeat the procedure (Steps 3 and 4) for the remaining cylinders.
   If the measured value is less than the specified limit, refer to “Troubleshooting” in this Manual.

Quick-On Start II System (4JB1 / 4JB1-TC / 4JH1-TC only)

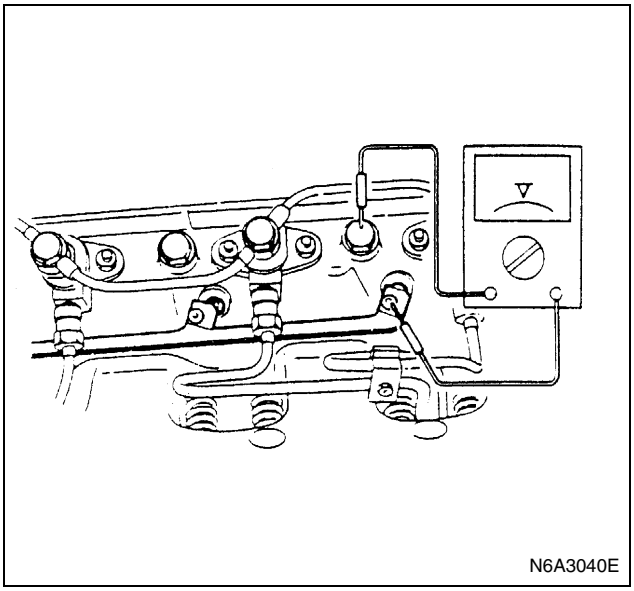
Quick-On Start System Inspection Procedure

1. Disconnect the thermo-sensor connection on the thermostat outlet pipe.


N6A3039E

2. Turn the starter switch to the “ON” position.
   If the Quick-On Start II System is operating properly, the glow relay will make a clicking sound within 15 seconds after the starter switch is turned on.
3. Measure the glow plug terminal voltage with a circuit tester immediately after turning the starter switch to the “ON” position.

Glow Plug Terminal Voltage	V
Approx. 11	



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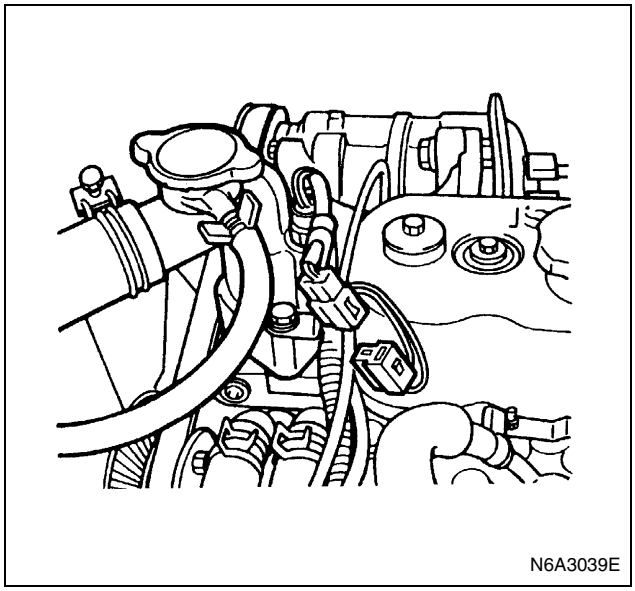
Quick-ON Start III System (4JG2 only)

Quick-On Start System Inspection Procedure

1. Disconnect the thermo-sensor connection on the thermostat outlet pipe.


N6A3039E

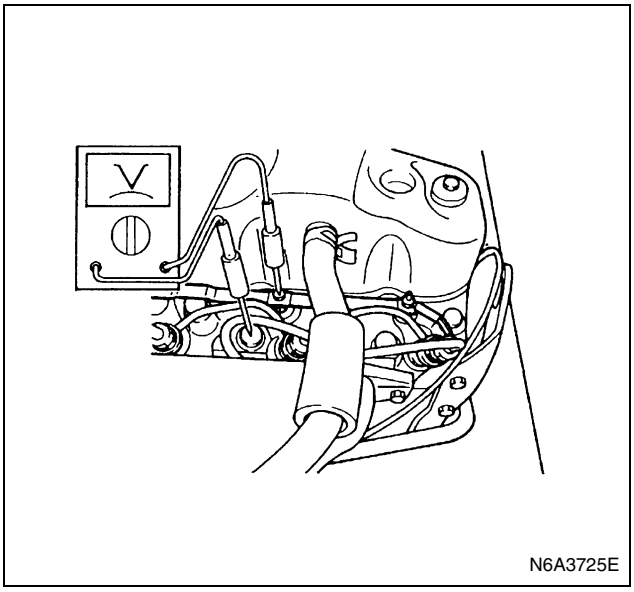
2. Turn the starter switch to the “ON” position.
   If the Quick-On Start III System is operating properly, the glow relay will make a clicking sound within seven seconds after the starter switch is turned on.
3. Measure the glow plug terminal voltage with a circuit tester immediately after turning the starter switch to the “ON” position.

Glow Plug Terminal Voltage	V
8 — 9	

Notice:
Electrical power to the quick-on start system will be cut after the starter has remained in the “ON” position for twenty seconds.

Turn the starter switch to the “OFF” position and back to the “ON” position.

This will reset the Quick-On Start III System.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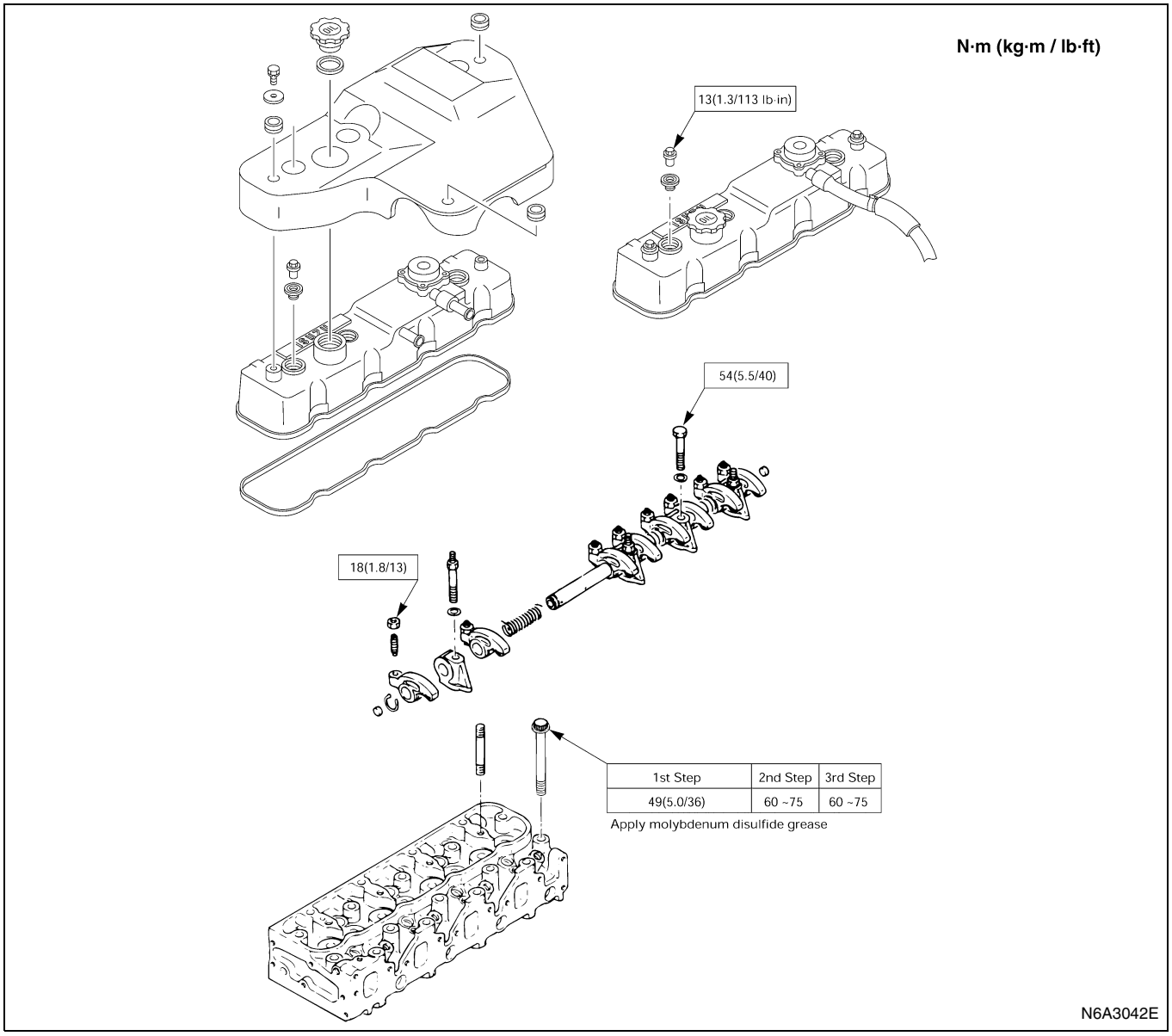
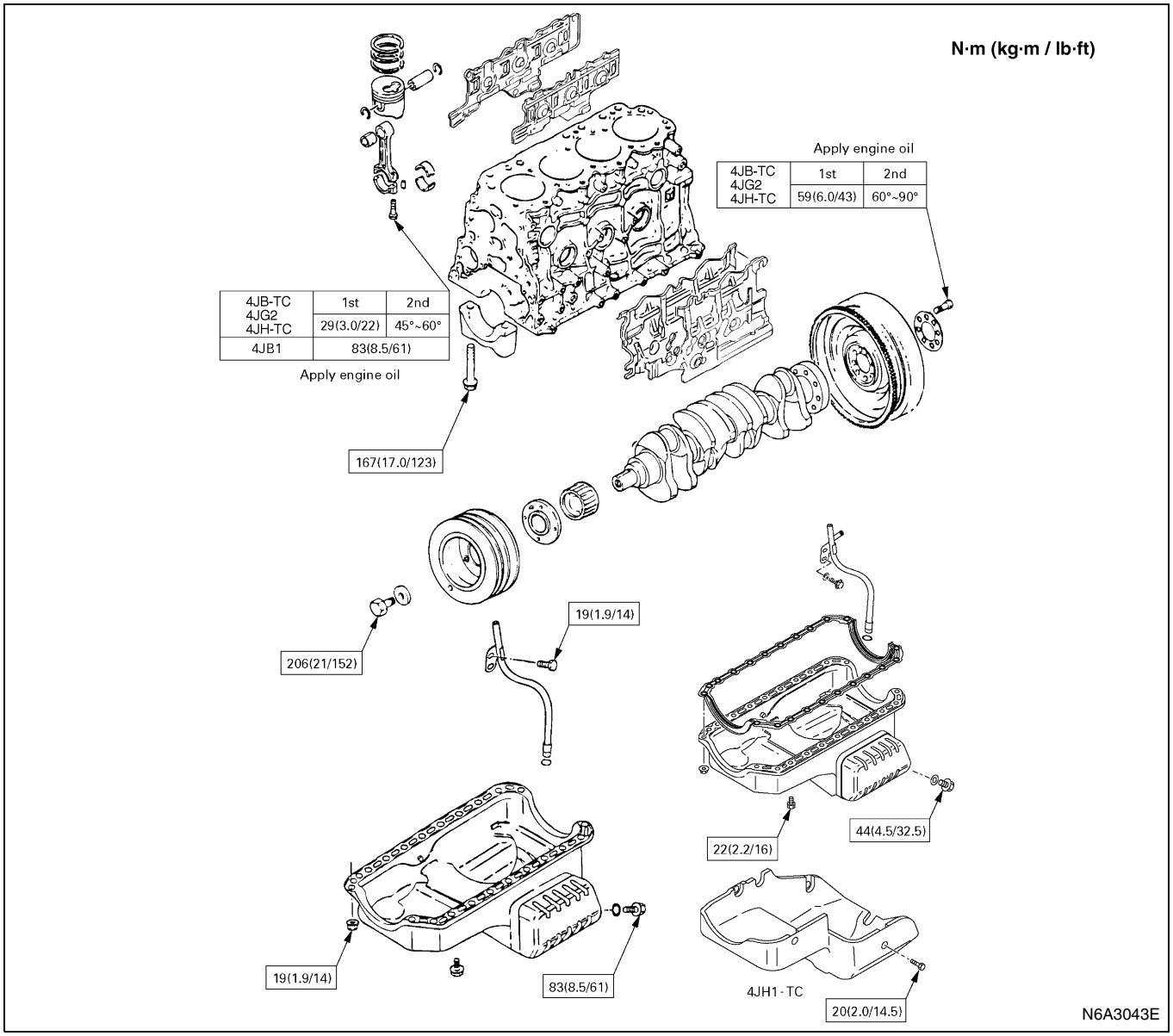
FIXING TORQUE

Cylinder Head Cover, Cylinder Head Rocker, Shaft Braker



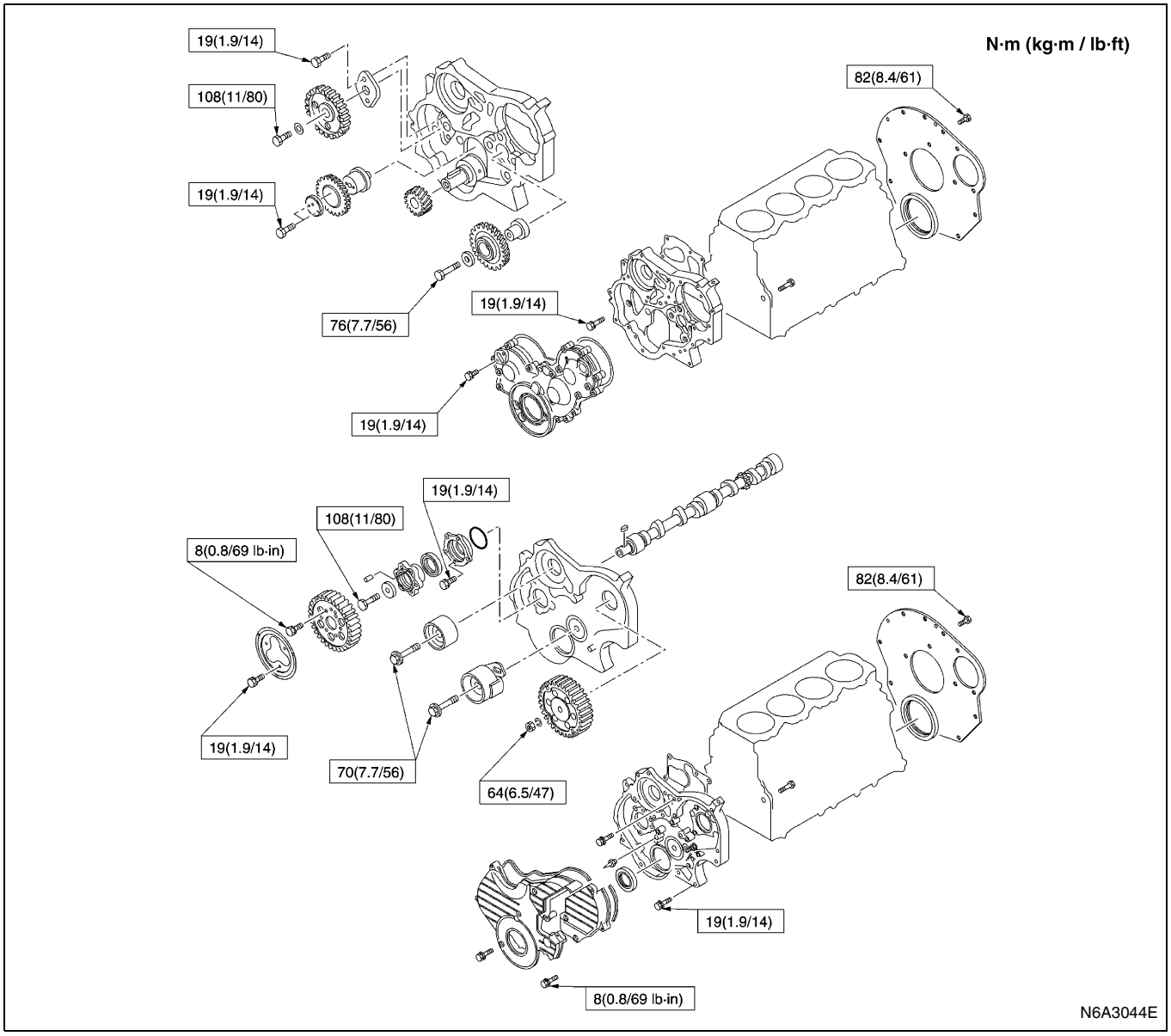
Crankshaft, Bearing Cap, Connecting Rod Bearing Cap, Crankshaft Damper Pulley, Flywheel, Oil Pan



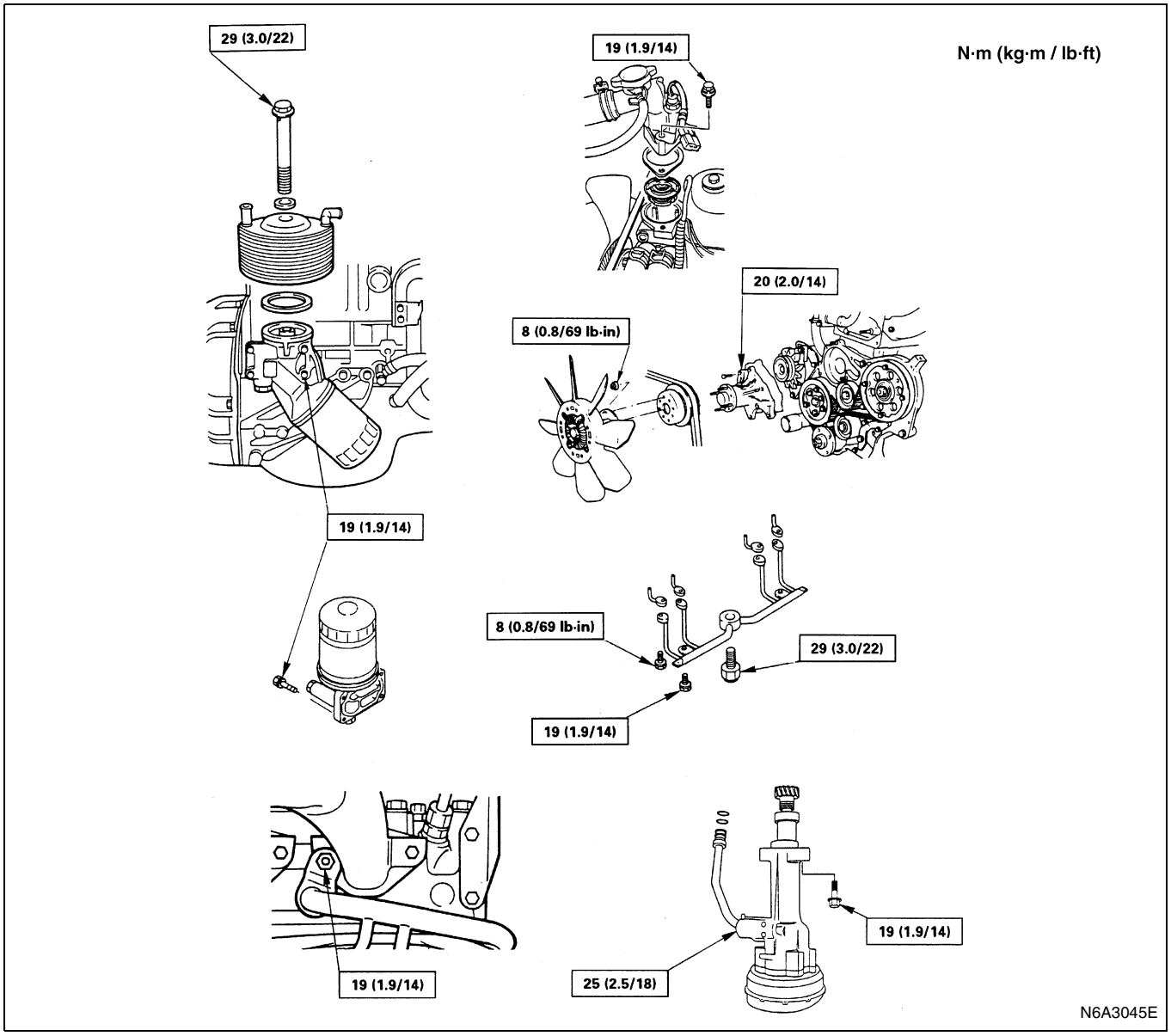
Legend

A. Apply engine oil

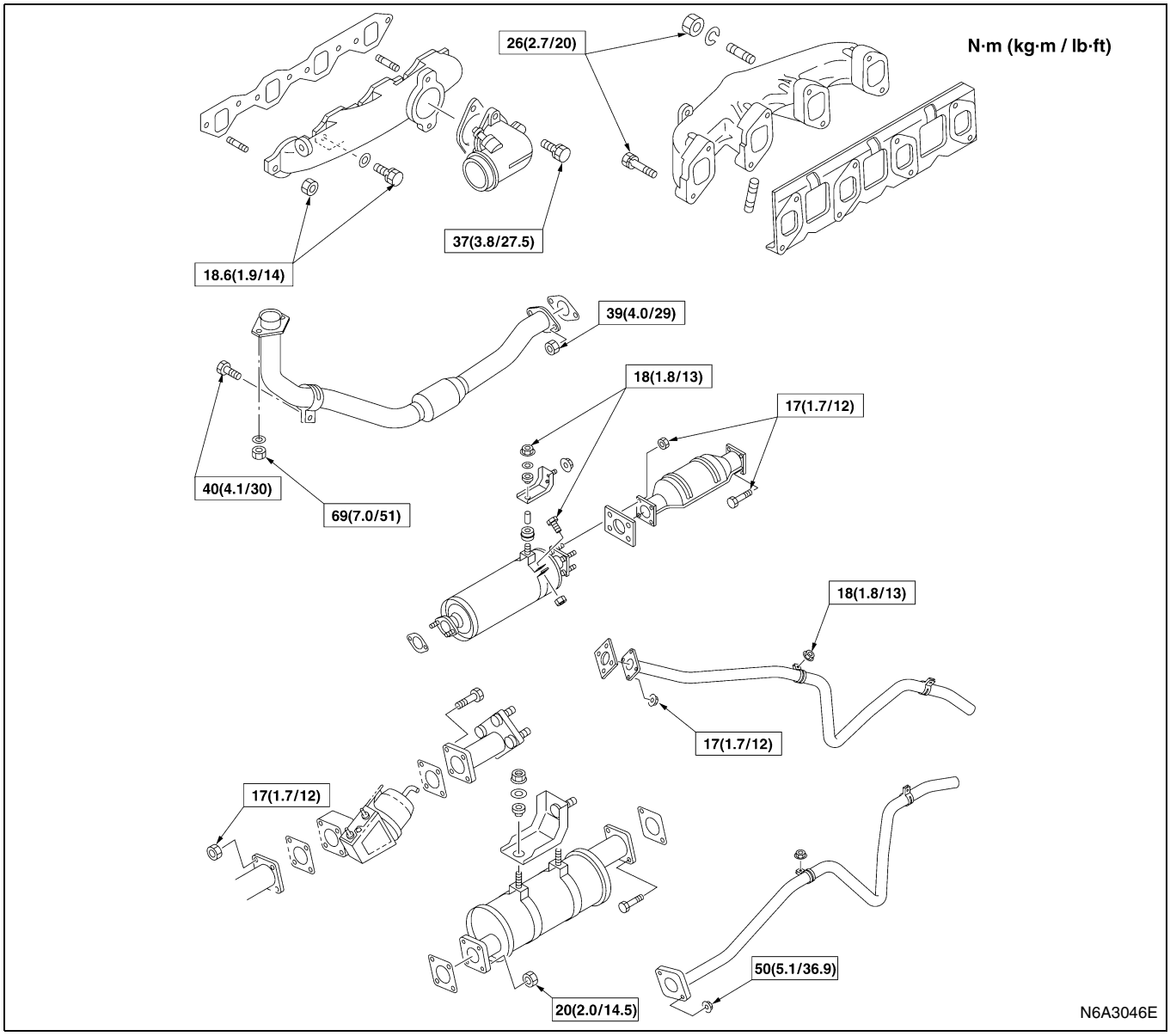
Timing Pulley Housing, Timing Pulley, Timing Gear, Camshaft Oil Seal Retainer

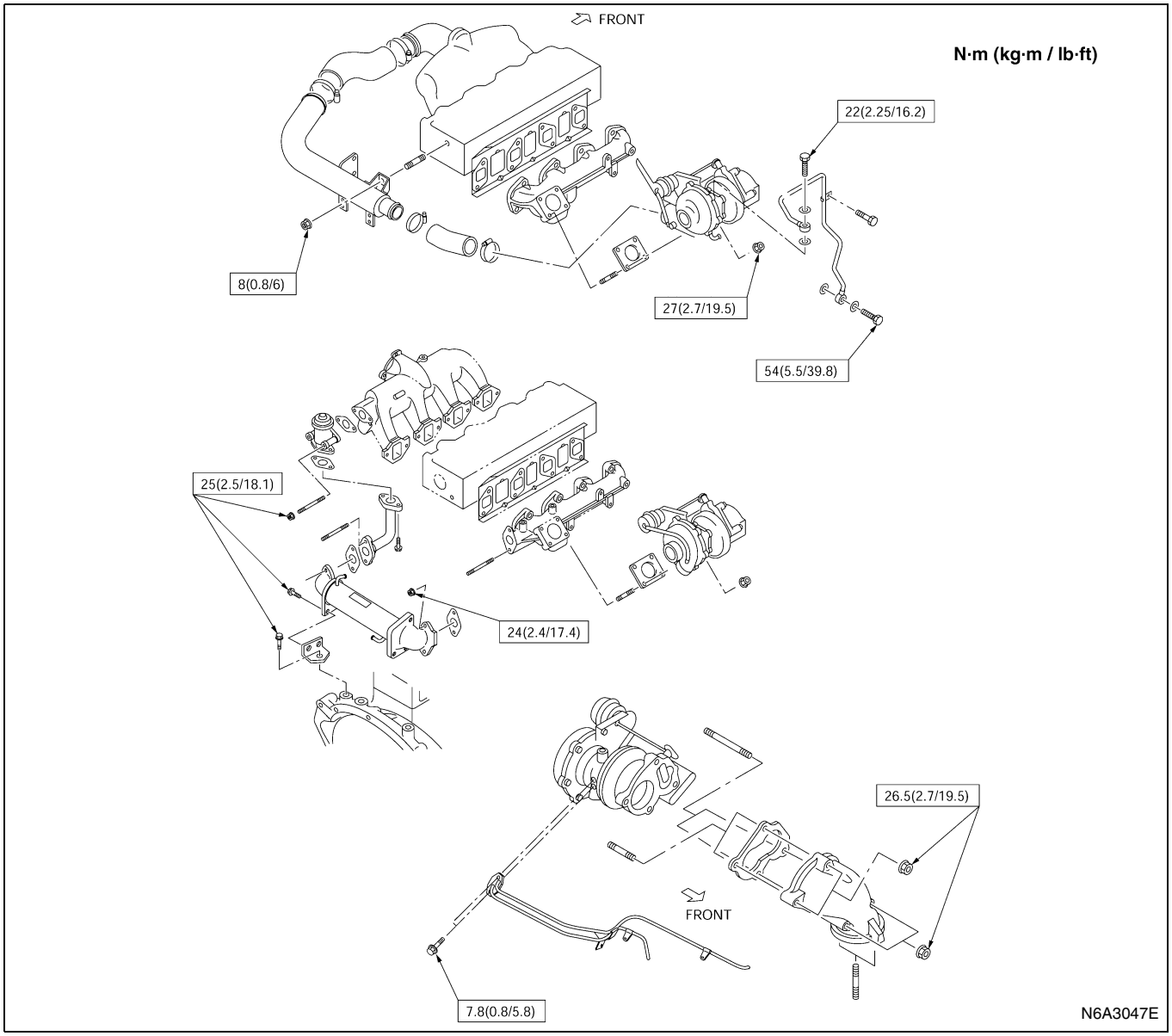


Cooling System and Lubrication System

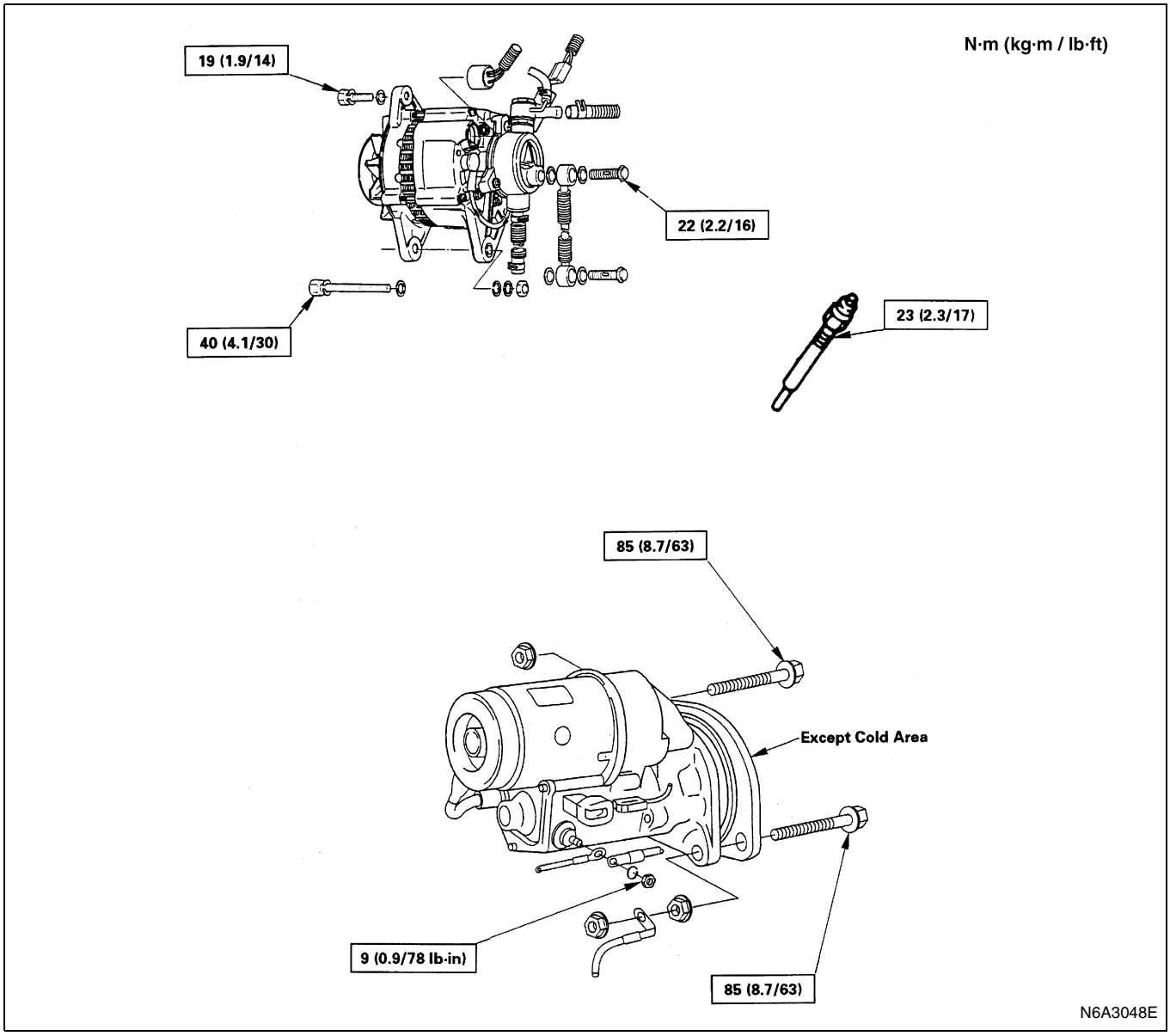


Intake Manifold, Exhaust Manifold, Exhaust Pipe



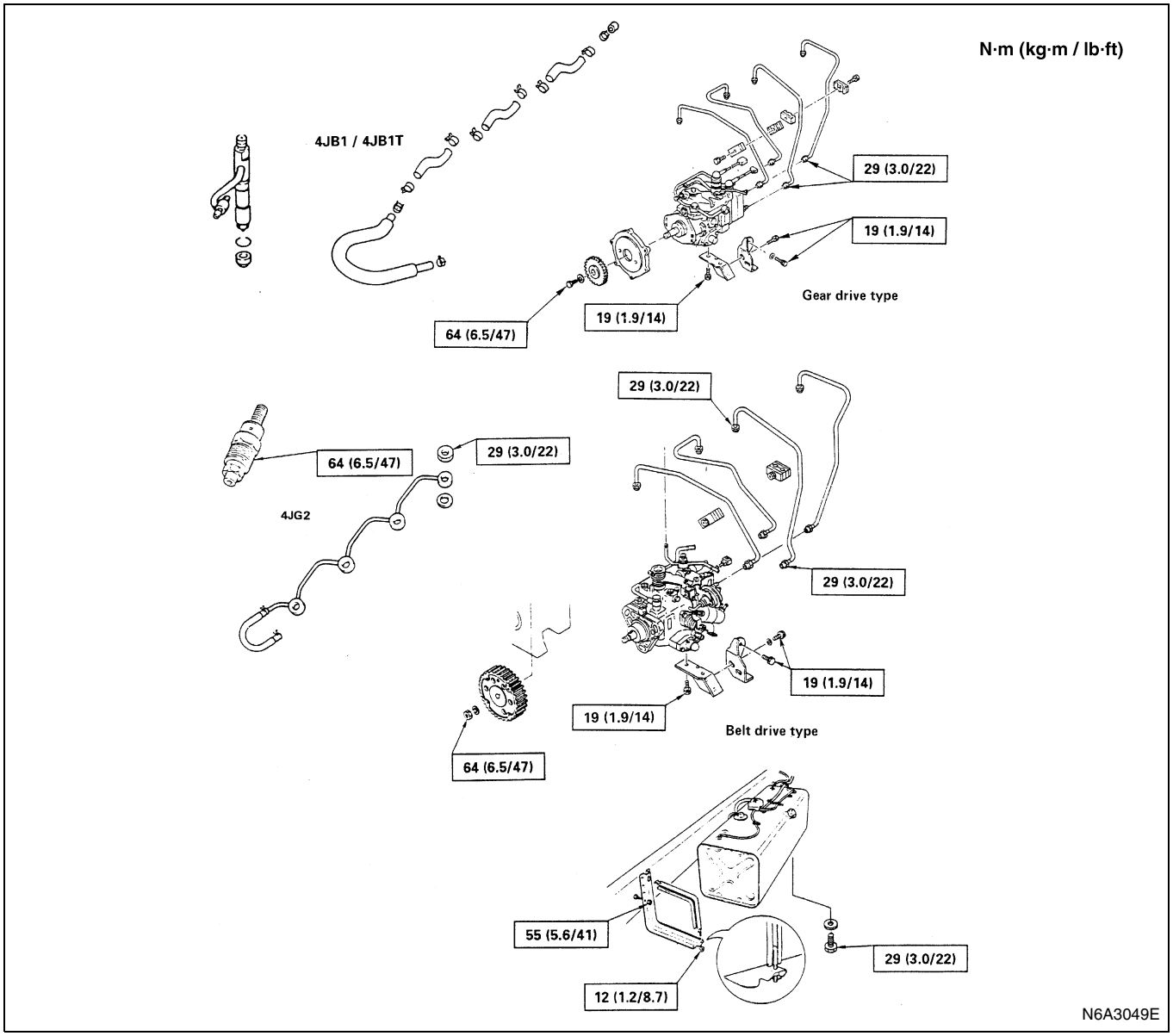

FRONT
N·m (kg·m / lb·ft)
22(2.25/16.2)
8(0.8/6)
27(2.7/19.5)
54(5.5/39.8)
25(2.5/18.1)
24(2.4/17.4)
26.5(2.7/19.5)
FRONT
7.8(0.8/5.8)
N6A3047E

Engine Electricals

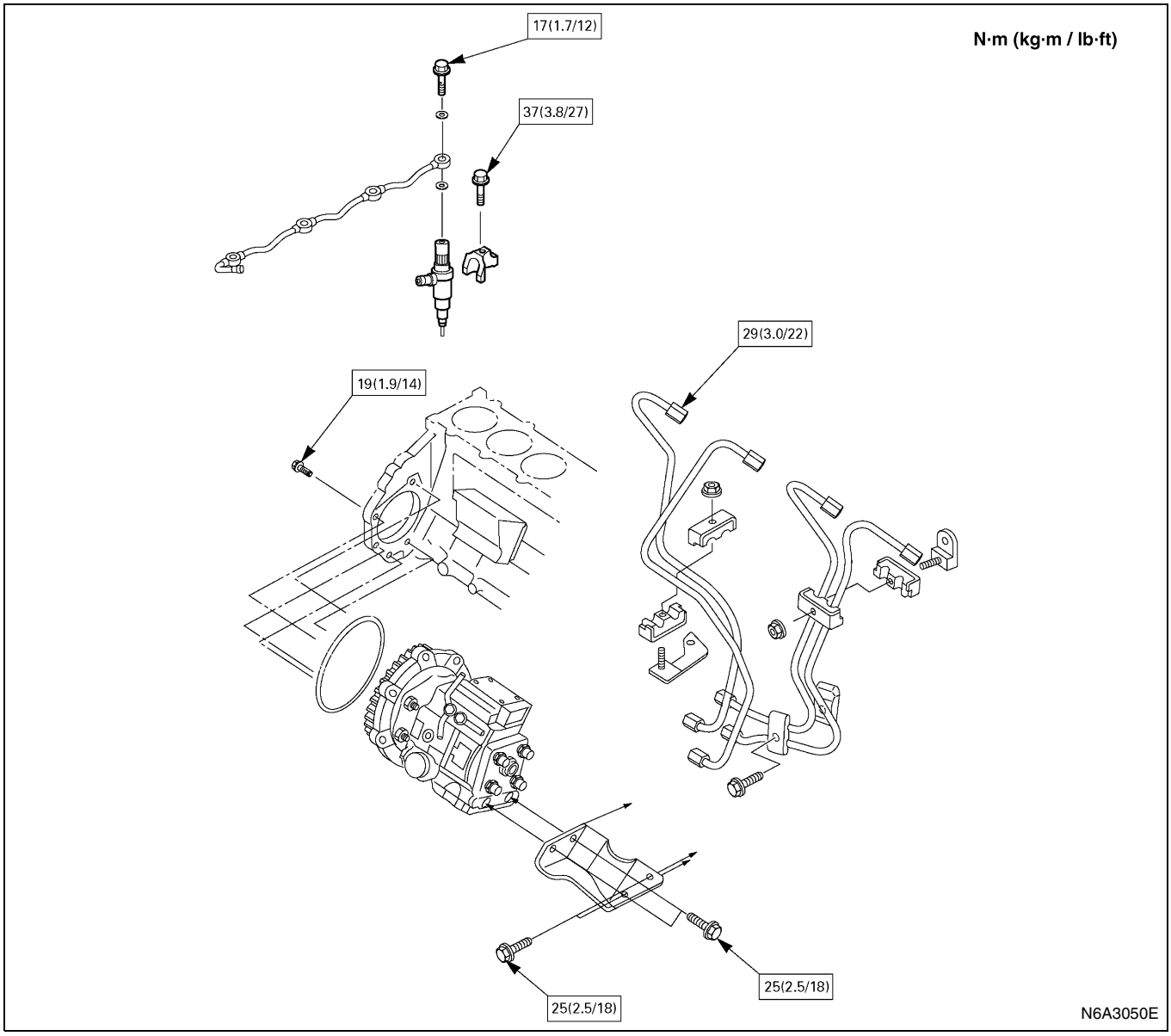


Engine Fuel

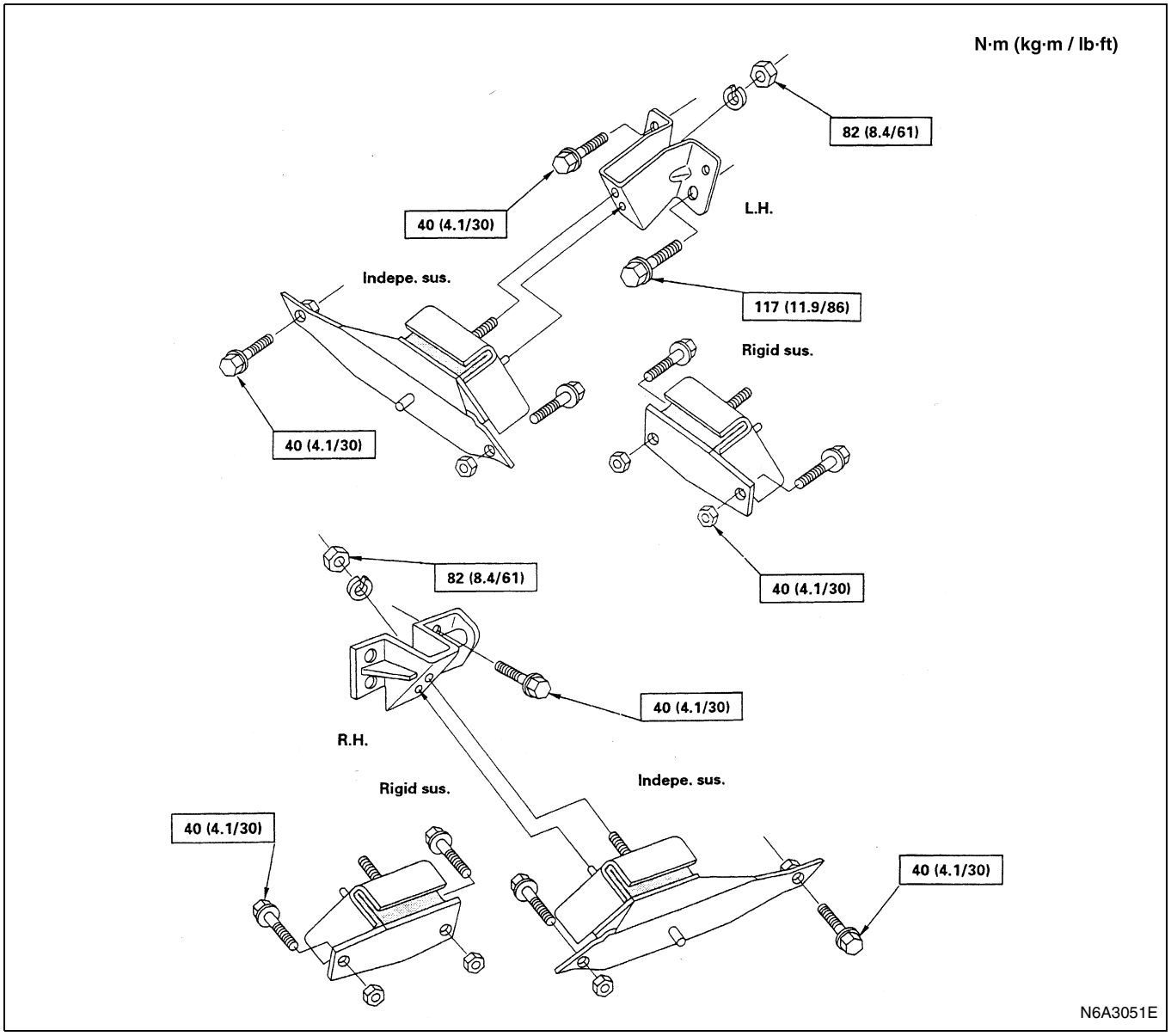
Except 4JH1-TC



4JH1-TC


N·m (kg·m / lb·ft)
17(1.7/12)
37(3.8/27)
29(3.0/22)
19(1.9/14)
25(2.5/18)
25(2.5/18)
N6A3050E

Engine Mounting Bracket



SPECIAL TOOLS

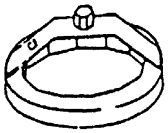
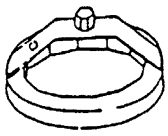
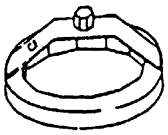
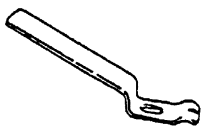
Illustration	Tool Number / Description / Remarks
5884020350	5-8840-2035-0 / Crank Timing Pulley (4JG2 Belt Drive only)
 5884002000	5-8840-0200-0 / Oil Filter Wrench (89.0 mm/3.5 in)
 5884002020	5-8840-0202-0 / Oil Filter Wrench (106.0 mm/4.2 in)
 5884022090	5-8840-2209-0 / Oil Filter Wrench (100.6 mm/4.0 in)
 9852314230	9-8523-1423-0 (J-29760) / Valve Spring Compressor
5884020330	5-8840-2033-0 / Oil Seal Installer

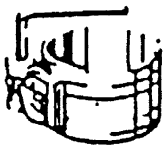
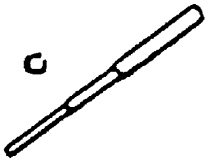
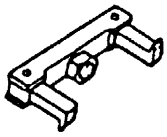
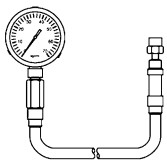
Illustration	Tool Number / Description / Remarks
 5884090180	5-8840-9018-0 / Piston Ring Compressor
5884020930	5-8840-2093-0 / Tacho Meter
 9852312120	9-8523-1212-0 / Valve Guide Replacer
 5884000860	5-8840-0086-0 / Camshaft Timing Pulley Remover (4JG2 Belt Drive only)
5884001990	5-8840-0199-0 / Rubber Hardness Tester
 5884026750	5-8840-2675-0 / Compression gauge

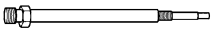
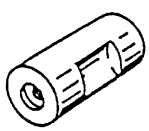
Illustration	Tool Number / Description / Remarks
5853170010	5-8531-7001-0 / Gauge Adapter
 5853170020	5-8531-7002-0 / Gauge Adapter
5884001450	5-8840-0145-0 / Measuring Device
-1	x-xxxx-xxxx-x / Crankshaft Timing Pulley Installer (4JG2 Belt Drive only)
5884002660	5-8840-0266-0 / Angle Gauge
5884090160	5-8840-9016-0 / Injection Nozzle Tester
 5884020340	5-8840-2034-0 / Nozzle Holder Remover (4JB1 only)

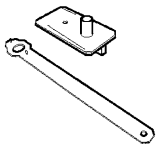
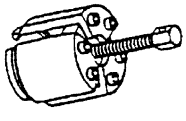
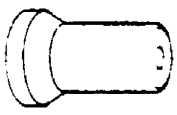
Illustration	Tool Number / Description / Remarks
5884020380	5-8840-2038-0 / Camshaft Bearing Replacer
5884020360	5-8840-2036-0 / Front Oil Seal Installer (4JB1, 4JG2, Gear Drive only)
 5867391490	Base 5-86739-149-0 / Lever 5-86739-150-0 / Scissor gear setting tool
5884002590	5-8840-0259-0 / Nozzle Holder Wrench (4JG2 only)
5884002530	5-8840-0253-0 / (J-22700) Fuel Filter Wrench
 5884023620	5-8840-2362-0 / Front Oil Seal Remover (4JG2, Belt Drive only)
 5884023610	5-8840-2361-0 / Front Oil Seal Installer (4JG2, Belt Drive only)

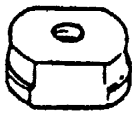
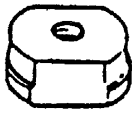
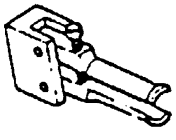
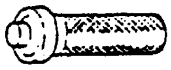
Illustration	Tool Number / Description / Remarks
5884023600	5-8840-2360-0 / Rear Oil Seal Remover
5884023590	5-8840-2359-0 / Rear Oil Seal Installer
5884020400	5-8840-2040-0 / Cylinder Liner Installer (4JB1 only)
5884023130	5-8840-2313-0 / Cylinder Liner Installer (4JG2 only)
 5884020390	5-8840-2039-0 / Cylinder Liner Remover (4JB1 only)
 5884023040	5-8840-2304-0 / Cylinder Liner Remover Ankle (4JG2 only)
 5884020000	5-8840-2000-0 / Pilot Bearing Remover

Illustration	Tool Number / Description / Remarks
5884000190	5-8840-0019-0 / Sliding Hammer
 5852200240	5-8522-0024-0 / Pilot Bearing Installer

ENGINE 4J SERIES

SECTION 6A

GENERAL ENGINE MECHANICAL

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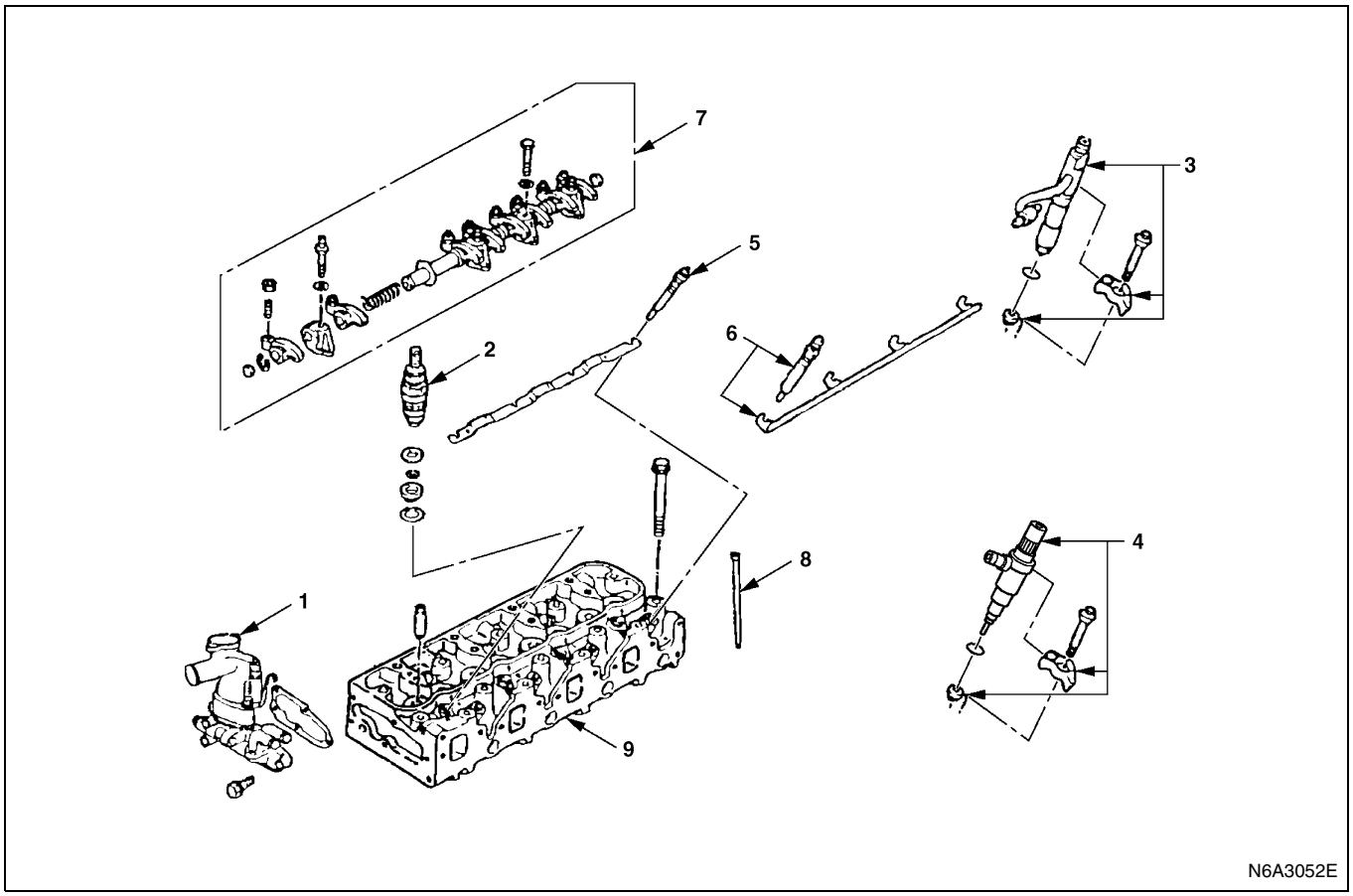
CYLINDER HEAD

Component



Legend

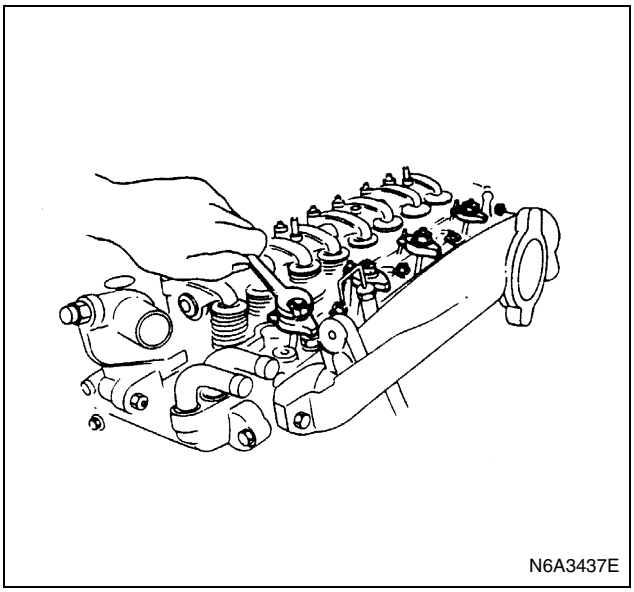
1. Thermostat housing assembly
2. Injection nozzle holder (4JG2)
3. Injection nozzle holder (4JB1, 4JB1-TC)
4. Injection nozzle holder (4JH1-TC)
5. Glow plug and plug connector (4JG2)
6. Glow plug and plug connector (4JB1, 4JB1-TC)
7. Rocker arm shaft and rocker arm
8. Push rod
9. Cylinder head

Notice:

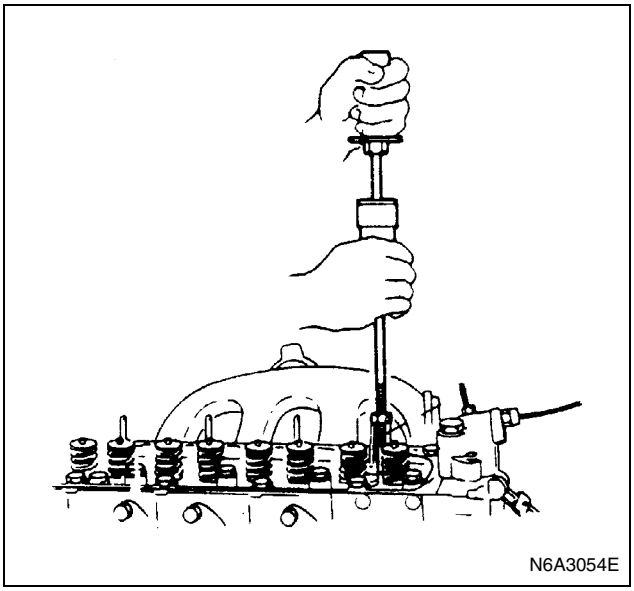
- During disassembly, be sure that the valve train components are kept together and identified so that they can be re-installed in their original locations.
- Before removing the cylinder head from the engine and before disassembling the valve mechanism, make a compression test and note the results.

Disassembly

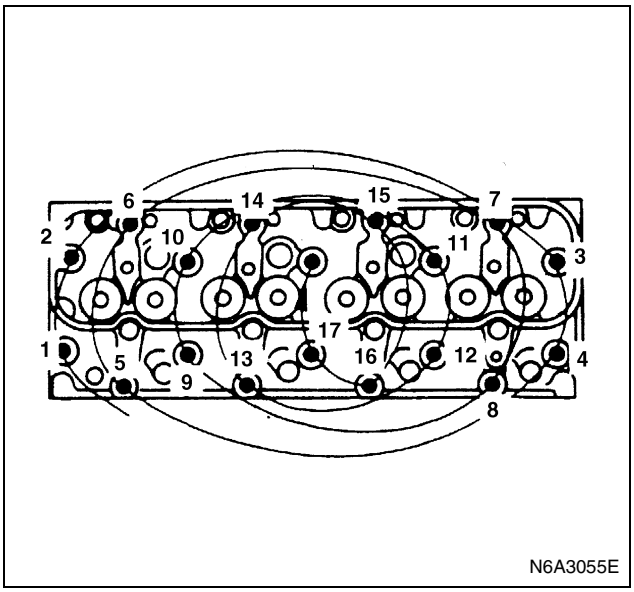
1. Thermostat Housing Assembly
2. Injection Nozzle Holder (4JG2)
3. Injection Nozzle Holder (4JB1, 4JB1-TC)
4. Injection Nozzle Holder (4JH1-TC)
   1) Remove the nozzle holder bracket nuts.



2) Use the nozzle holder remover and the sliding hammer to remove the nozzle holder together with the holder bracket.
Nozzle Holder Remover: 5-8840-2034-0
Sliding Hammer: 5-8840-0019-0


N6A3054E

5. Glow Plug and Glow Plug Connector (4JG2)
6. Glow Plug and Glow Plug Connector (4JB1, 4JB1-TC, 4JH1-TC)
7. Rocker Arm Shaft and Rocker Arm
8. Push Rod
9. Cylinder Head
   - Loosen the cylinder head bolts a little at a time in the numerical order shown in the illustration.



N6A3055E

Notice:
Failure to loosen the cylinder head bolts a little at a time in numerical order will adversely effect the cylinder head lower surface.

Clean

- Cylinder head bolts
- Cylinder head
  Carefully remove all varnish, soot and carbon to the bare metal. Do not use a motorized wire brush on any gasket sealing surface.

Inspection and Repair

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

- Cylinder head gasket and mating surfaces for leaks, corrosion and blow-by. If the gasket has failed, determine the cause;
  - Improper installation
  - Loose or warped cylinder head
  - Insufficient torque on head bolts
  - Warped case surface

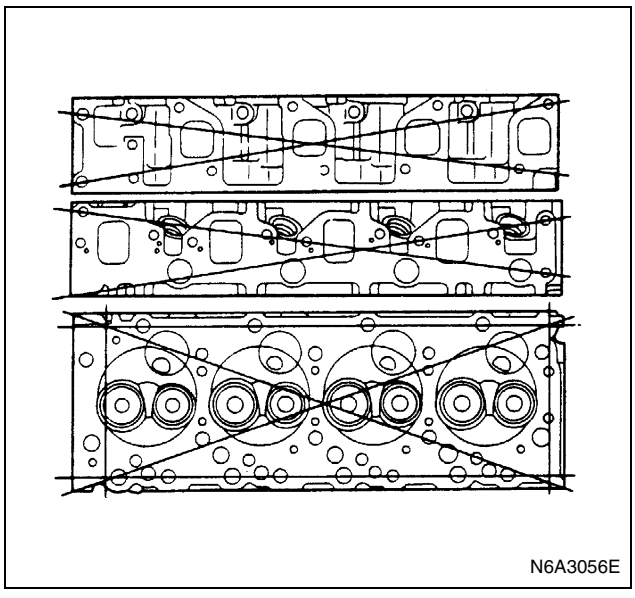
1. Cylinder head bolts for damaged threads or stretching and damaged heads caused by improper use of tools.

Caution:
Suspected bolts must be replaced.

2. Cylinder head for cracks, especially between valve seats and in the exhaust ports.
3. Cylinder head deck for corrosion, sand particles in head and porosity.

Caution:
Do not attempt to weld the cylinder head. Replace it.

4. Cylinder head deck, intake and exhaust manifold mating surfaces for flatness.
   These surfaces may be re-conditioned by milling (except cylinder head lower face). If the surfaces are “out of flat” by more than specification, the surface should be ground to within specifications. If more than limit of specification, it should be replaced.

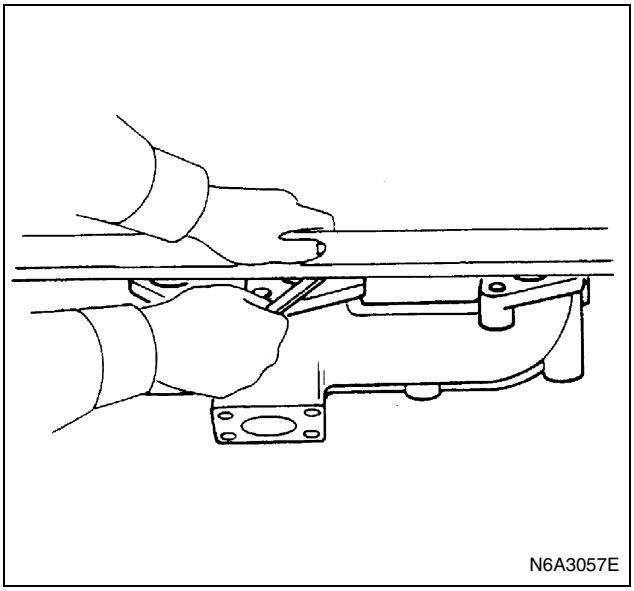

N6A3056E

Notice:
The cylinder head lower face cannot be reground.

		mm (in)
	Standard	Limit
Standard Limit Cylinder Head Lower Face	0.05 (0.002) or less	0.20 (0.0079)
Cylinder Head Height	92 (3.622)	91.55 (3.6043)

5. Water jacket sealing plugs seating surfaces.
6. Use a straight edge and a feeler gauge to measure the manifold cylinder head lifting face warpage. Regrind the exhaust manifold cylinder head lifting surfaces if the measured values are between the specified limit and the standard.
   If the measured values exceed the specified limit, the manifold must be replaced.

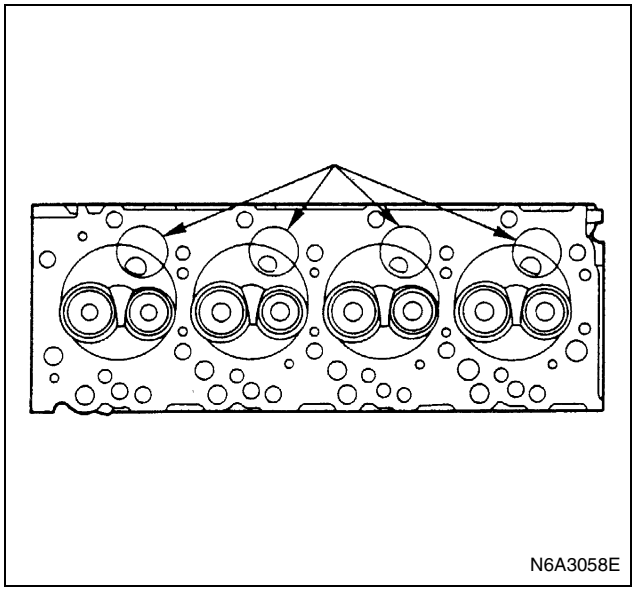
Exhaust Manifold Warpage	mm (in)
Standard	Limit
0.05 (0.002) or less	0.20 (0.0079)


N6A3057E

Hot Plug Depression (4JG2 only)

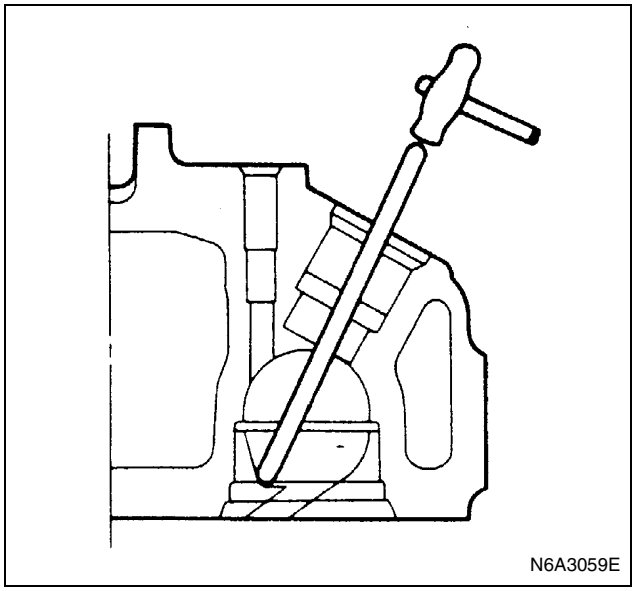
1. Clean the cylinder head lower side, taking care not to damage the hot plug surfaces.
2. Use a straight edge and feeler gauge to measure hot plug depression in a straight line from the No. 1 hot plug to the No. 4 hot plug.
   If the measured value exceeds the limit, the hot plugs must be replaced.

Depression Limit	mm (in)
0.02 (0.0008)	


N6A3058E

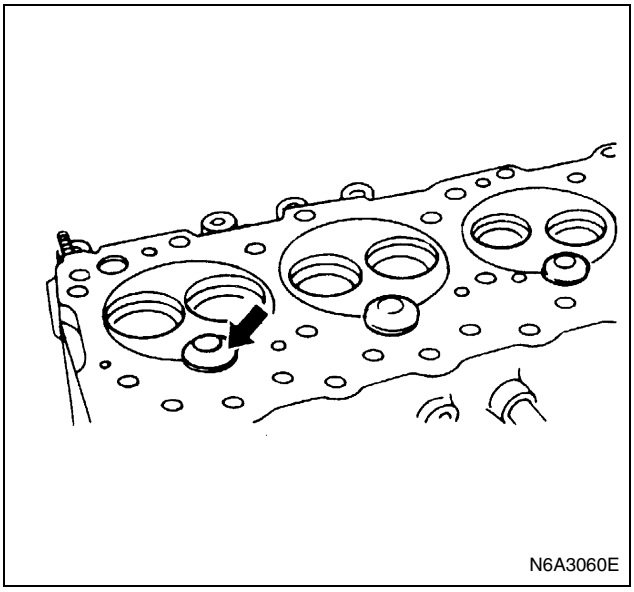
Hot Plug Removal (4JG2 only)

1. Insert a 3.0 — 5.0 (0.12 — 0.20.) diameter bar into the nozzle holder fitting hole unit it makes contact with the hot plug.
2. Lightly tap the bar with a hammer to drive the hot plug free.
   If the measured value exceeds the limit, the hot plugs must be replaced.


N6A3059E

Combustion Chamber Inspection (4JG2 only)

1. Remove the carbon adhering to the inside of the combustion chamber. Take care not to damage the hot plug fitting positions.


N6A3060E

2. Inspect the inside of the combustion chamber, the hot plug, and the hot plug machined faces for cracking and other damage.
   If cracking or damage is present, the cylinder head must be replaced.

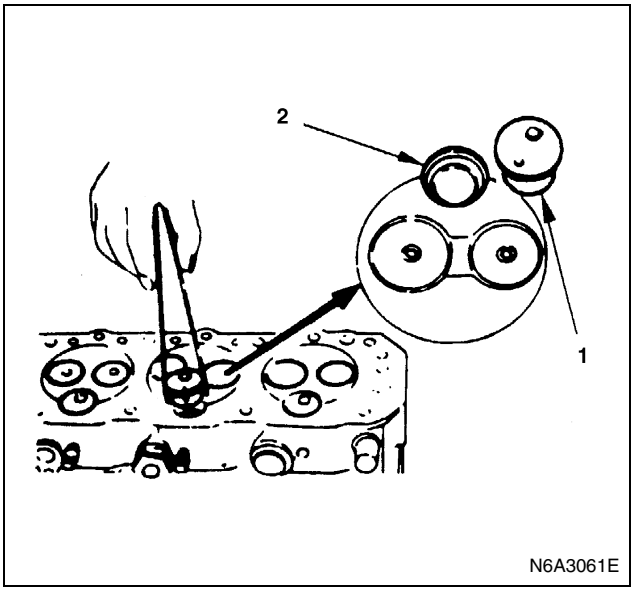
Notice:
Be absolutely certain that there are no scratches or protuberance on the combustion chamber surfaces which will be in contact with the hot plug after it is installed. There flaws will prevent the hot plug from seating correctly.

Hot Plug Inspection

Inspection the hot plugs for excessive wear and other damage. Replace the hot plugs if either of these conditions are discovered.

Hot Plug Installation (4JG2 only)

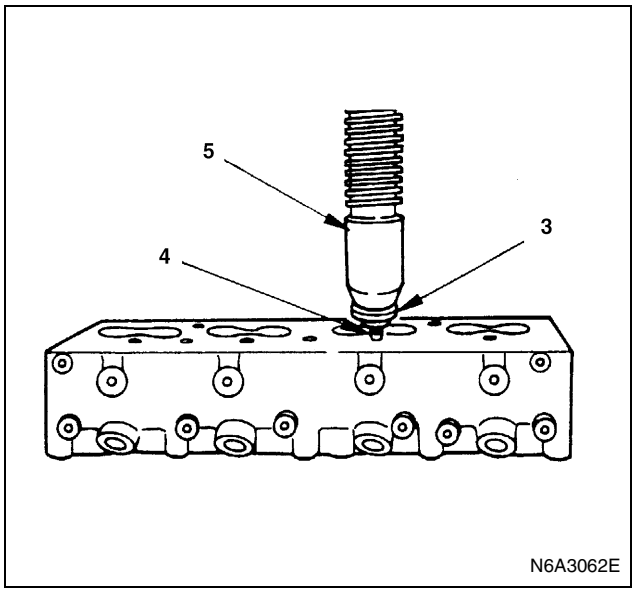
1. Align the hot plug knock ball (1) with the cylinder head groove (2) and tap it temporarily into position with a plastic hammer.



N6A3061E

2. Place an appropriate metal plate (3) thick over the hot plug upper surface (4).
3. Use a press (5) to exert a pressure of 44130 — 53937N (4500 — 5500 kg/9923 — 12128 lbs.) on the metal plate covering the hot plug upper surface. This will drive the hot plug into position.
4. Lightly tap the hot plug heads to make sure that they are firmly seated.
5. Repeat the procedure Steps 1-4 for the remaining hot plugs.

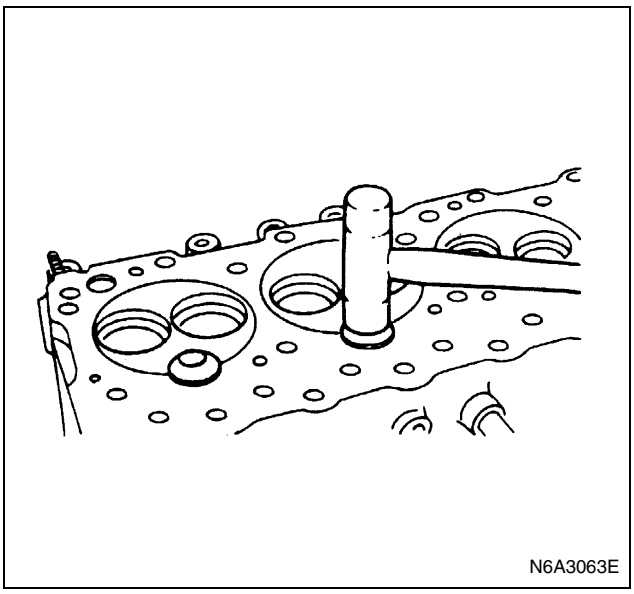
Caution:
Do not apply pressure greater than that specified.
Damage to the cylinder head will result.



N6A3062E

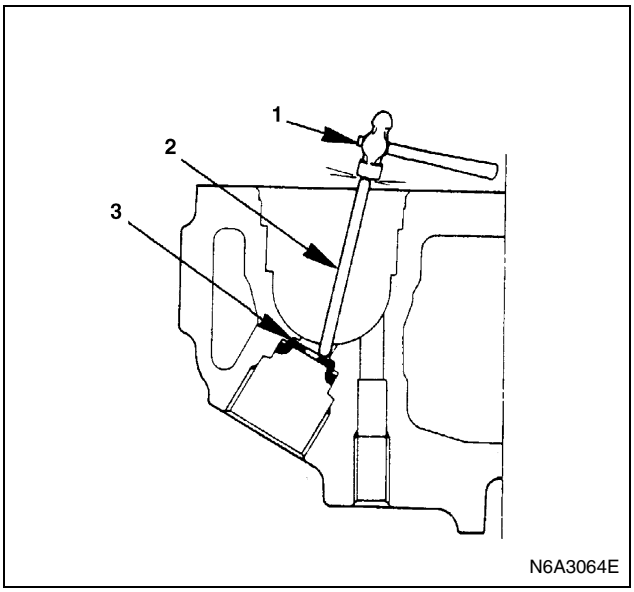
6. Use a surface grinder to grind off any hot plug surface protuberances.
   The hot plug surfaces must be perfectly flush with the cylinder head.
7. After grinding, make sure that the hot plug surfaces are completely free of protuberances.
   The hot plug surfaces must also be free of depressions.

Once again, lightly tap the hot plug heads to make sure that they are firmly seated.


N6A3063E

Heat Shield Removal (4JG2 only)

After removing the hot plugs, use a hammer (1) and a brass bar (2) to lightly tap the lower side of the heat shield (3) and drive it free.



N6A3064E

Heat Shield Installation (4JG2 only)

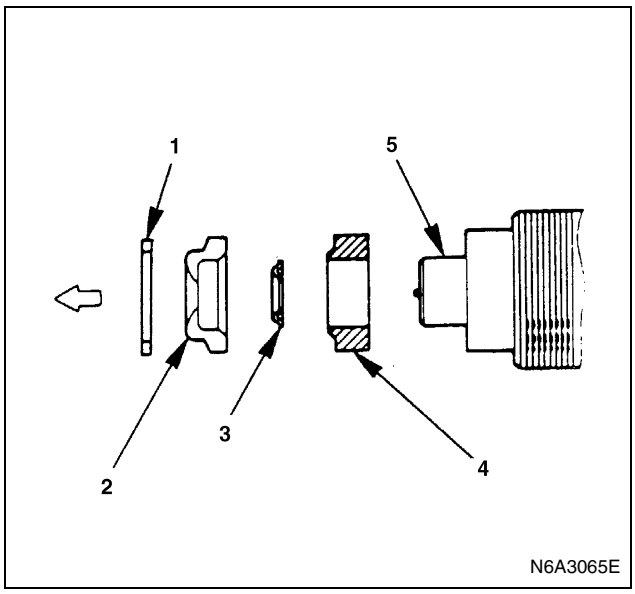
Install the heat shield washer and the heat shield to the cylinder head from the nozzle holder installation hole side.

Lightly tap the flange into place with a brass bar.

The heat shield flange side must be facing up.

Notice:

Always install a new heat shield. Never reuse the old heat shield.



N6A3065E

Legend

1. Gasket
2. Nozzle heat shield
3. Colgate washer
4. Gasket heat shield
5. Nozzle

Reassembly

Cylinder Head

1. Hot plug
   - Set the nock ball in the positioning groove on the cylinder head side according to the order of the cylinders, and hit it lightly with a plastic hammer.

Notice:

After being pressed into the cylinder head, the hot plugs were provided with surface grinding.

Accordingly, their dimensions are different individually among them, and take care not confuse the order of the cylinders.

When replacing the hot plug with new one:

When assembling a new hot plug, set the knock ball in the positioning groove on the cylinder side and hit it lightly with a plastic hammer until the hot plug is set in stably.

With patch attached to the hot plug to prevent it from being damaged, press it in with a force of 4.5 to 5.5 ton applied.

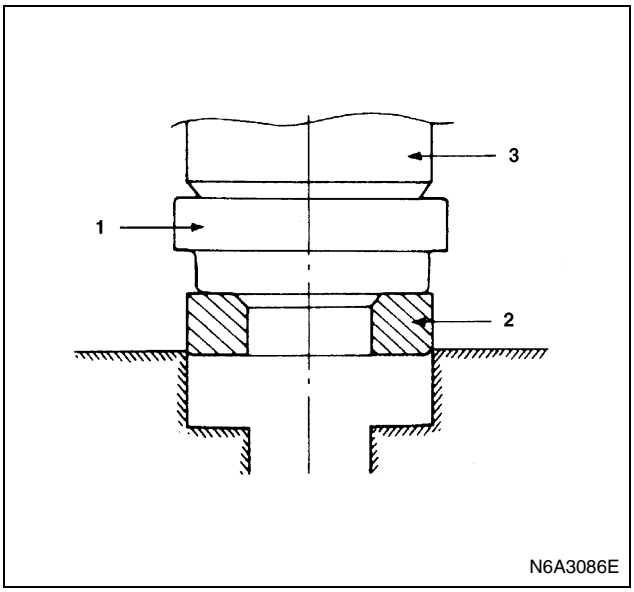
After pressing the hot plug, grind its surface to the cylinder head.

And finally, hit the hot plug lightly with a plastic hammer and check it for any excessive sinking, protrusion or backlash.

2. Valve Seat Insert Installation
   1) Carefully place the attachment (1) (having a smaller outside diameter than the valve seat insert) on the valve seat insert (2).

Notice:
The smooth side of the attachment must contact the valve seat insert.

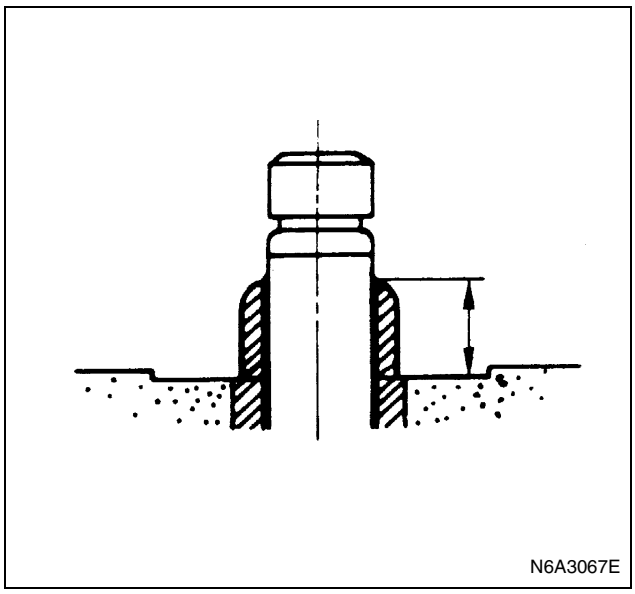
   2) Use the bench press (3) to gradually apply pressure to the attachment and press the valve seat insert into place.



Notice:
Do not apply an excessive amount of pressure with the bench press. Damage to the valve seat will result.

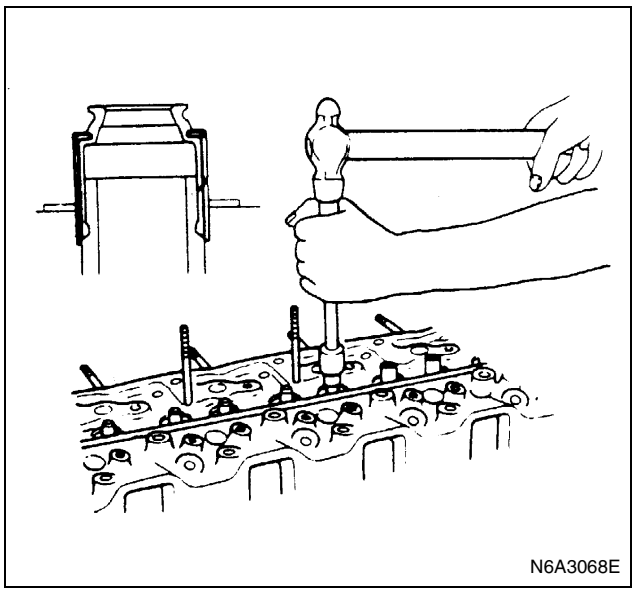
Measure the height of the valve guide upper end from the upper face of the cylinder head.

Valve Guide Upper End Height (H) (Reference) mm (in)
13 (0.51)



Notice:
If the valve guide has been removed, both the valve and the valve guide must be replaced as a set.

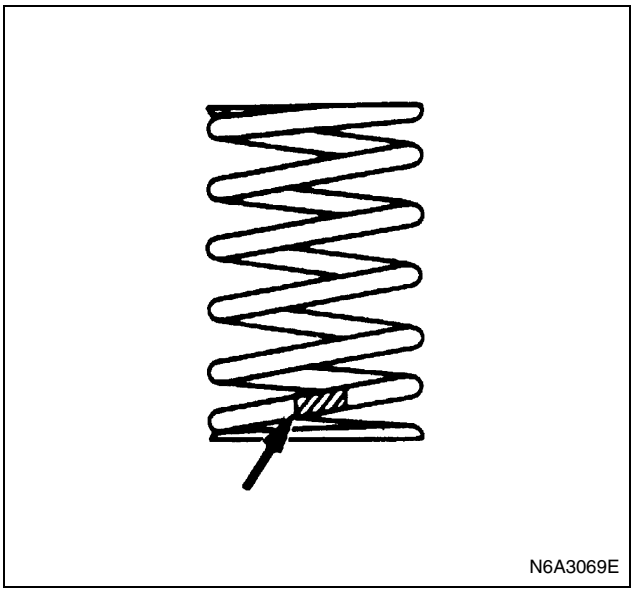
   3) Spring lower seat
   4) Valve stem oil seal
      - Install a new oil controller in the valve.
      - Guide using special tool
        Oil seal installer: 5-8840-2003-0



   5) Valve
      - Apply engine oil to the outside of the valve stem before installing it.
   6) Valve Spring
      - Attach the valve spring to the upper spring seat.

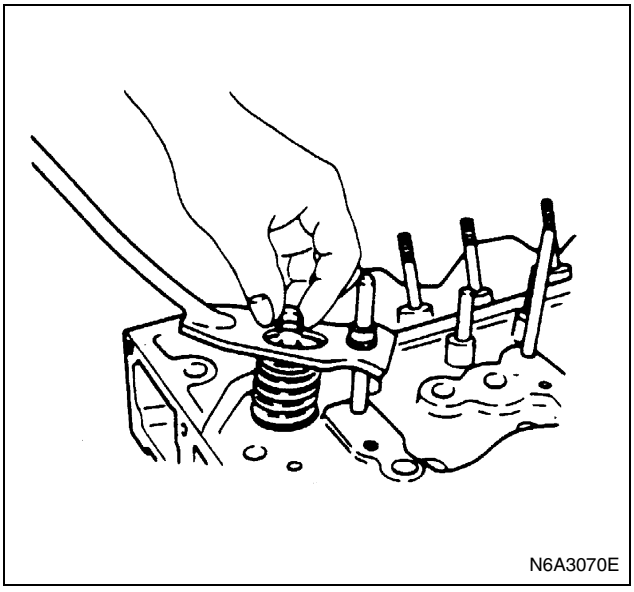
Caution:
- The painted area of the valve spring should be facing downward.
    - Apply compressed air to cylinder from the glow plug hole to hold the valve in place.
    - Install split collar by special tool.

Valve spring compressor: 9-8523-1423-0 (J-29760)


N6A3069E

7) Split Collar
    - Use a spring compressor to push the valve spring into position.
    - Install the spring seat split collar.
    - Set the split collar by tapping lightly around the head of the collar with a rubber hammer.

Valve spring compressor: 9-8523-1423-0 (J-29760)


N6A3070E

3. Push Rod
4. Rocker Arm Shaft and Rocker Arm

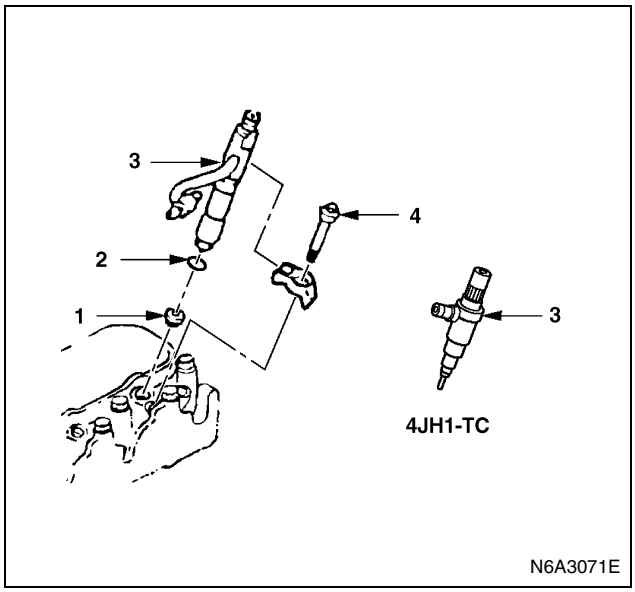
Tighten:
- Rocker arm shaft fixing bolts to 54 N·m (5.5 kg·m/40 lb·ft)

5. Glow Plug and Glow Plug Connector (4JB1/4JB1-TC/4JH1-TC)

Tighten:
Glow plugs to 23 N·m (2.3 kg·m/17 lb·ft)

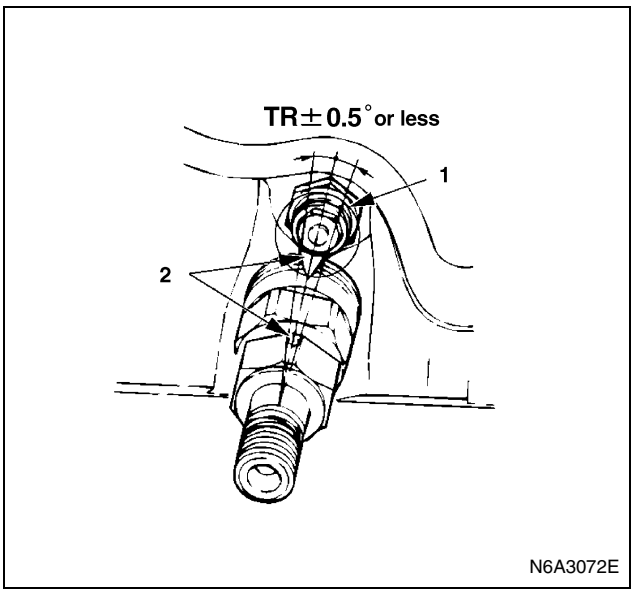
6. Injection Nozzle Holder (4JB1/4JB1-TC only)
7. Injection Nozzle Holder (4JH1-TC only)
    1) Install the injection nozzle gasket (1) and the O-ring (2) to the injection nozzle holder (3). Be sure that the O-ring fits snugly in the injection nozzle groove.
    2) Apply engine oil to the cylinder head nozzle holder hole.
    3) Install the nozzle holder together with the nozzle holder bracket (4) to the cylinder head.

Tighten:
37 N·m (3.8 kg·m/27 lb·ft)



N6A3071E

8. Injection Nozzle (4JG2 only)
    - Lightly tighten the holder nut to suck extent that the nozzle holder can turn one word and one word.
    - Set positioning confirmation drilled hole (ϕ2) within a nozzle turning angle of $\pm$5° against the cylinder head side positioning boss.



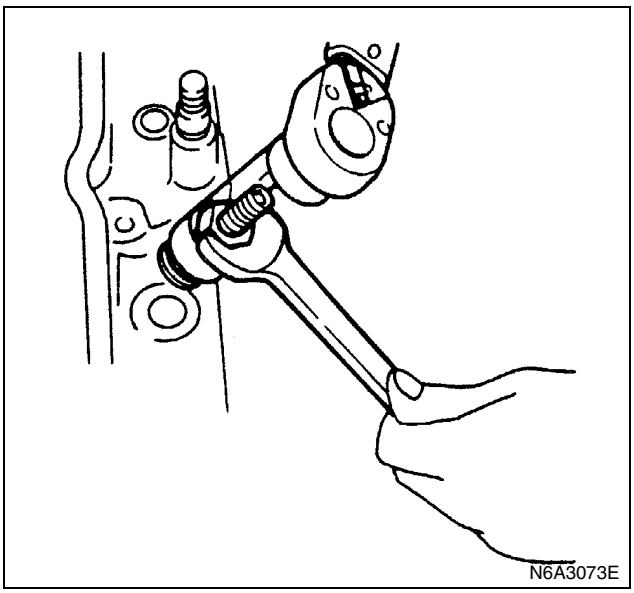
Legend
1. Glow plug
2. Positioning boss

- Apply a wrench as illustrated and tighten the holder nut to the specified torque using a special tool.

Caution:
- After tightening the holder nut, make sure that the drilled hole makes ±5° or smaller with the cylinder head-side positioning boss.
- When mounting leak off pipe, injection nozzle and pipe, clean then with air so that dust may not enter.

Tighten:
Nozzle fixing to 64 N·m (6.5 kg·m/47 lb·ft)

Wrench: Nozzle holder 5-8840-0259-0

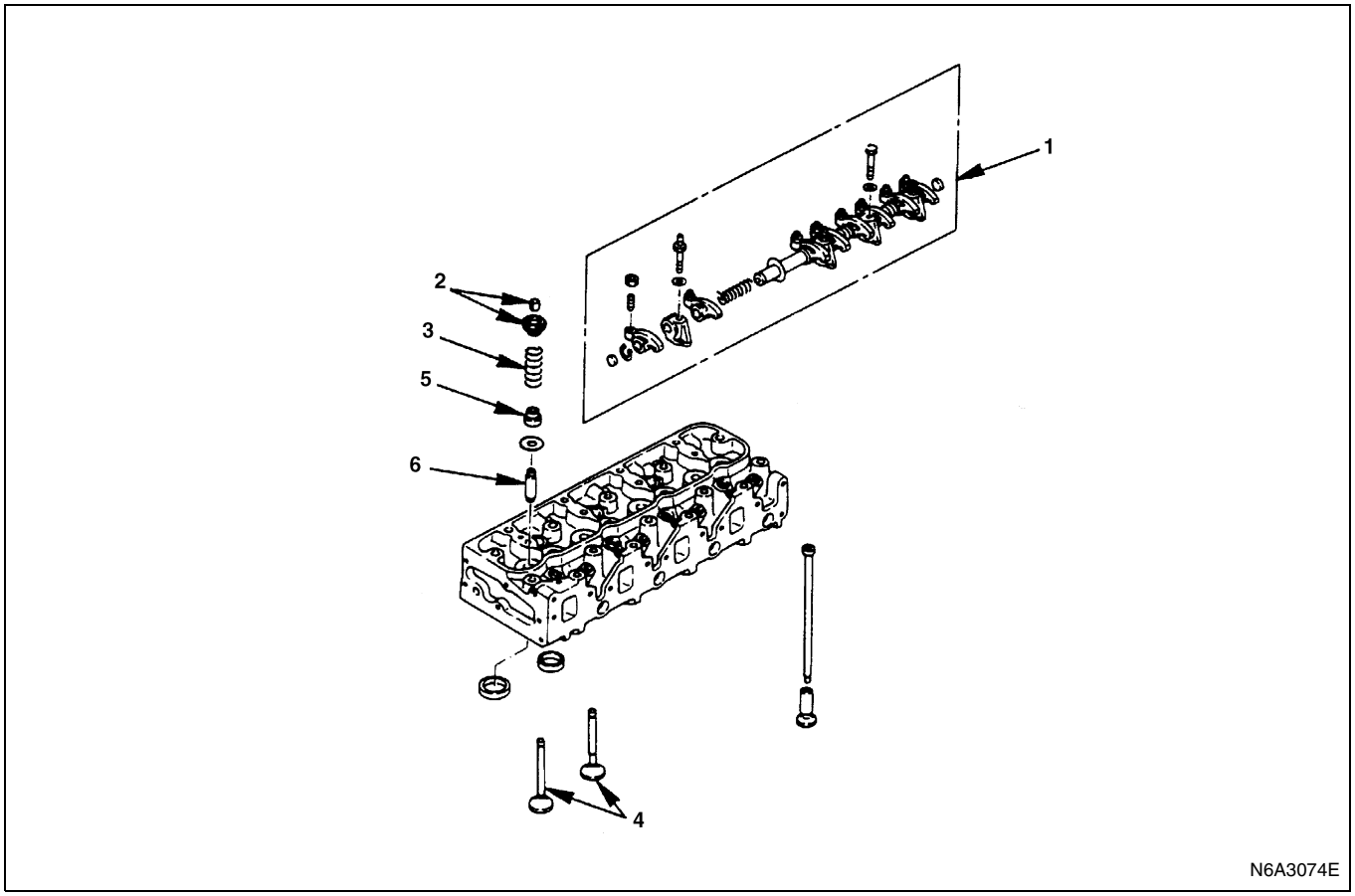


9. Thermostat Housing Assembly

Tighten:
Thermostat housing assembly fixing bolt to 19 N·m (1.9 kg·m/14 lb·ft)

VALVE SPRING, VALVE GUIDE OIL SEAL, VALVE GUIDE, PUSH ROD

Component

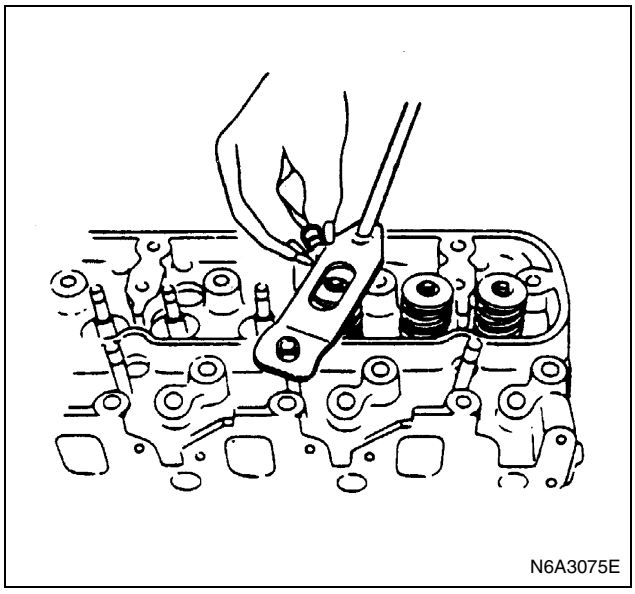


Legend

1. Rock arm assembly
2. Split collar
3. Valve spring
4. Valve
5. Valve guide oil seal
6. Valve guide

Disassembly

1. Rocker Arm Assembly
2. Split Collar
   Using special Tool, compress valve spring
   Valve spring compressor: 9-8523-1423-0 (J-29760)



3. Valve Spring
4. Valve

5. Valve Guide Oil Seal
6. Valve Guide
   Valve Guide Replacer: 9-8523-1212-0

Inspection and Repair

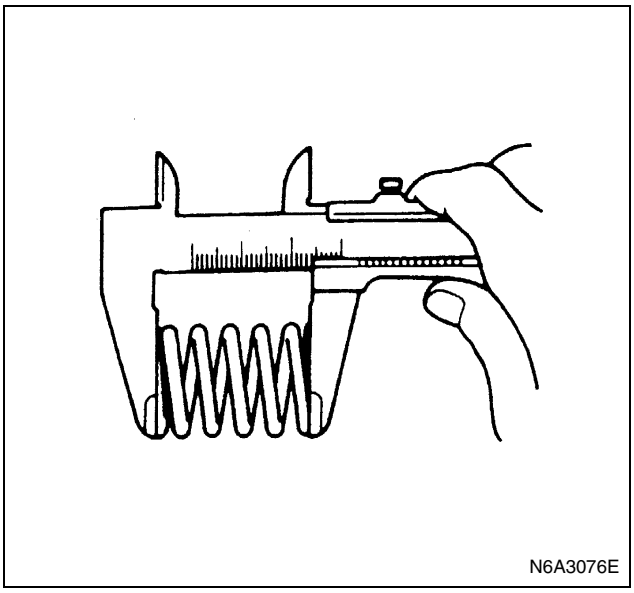
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Valve spring

Caution:
Visually inspect the valve springs and replace them if damage or abnormal wear is evident.

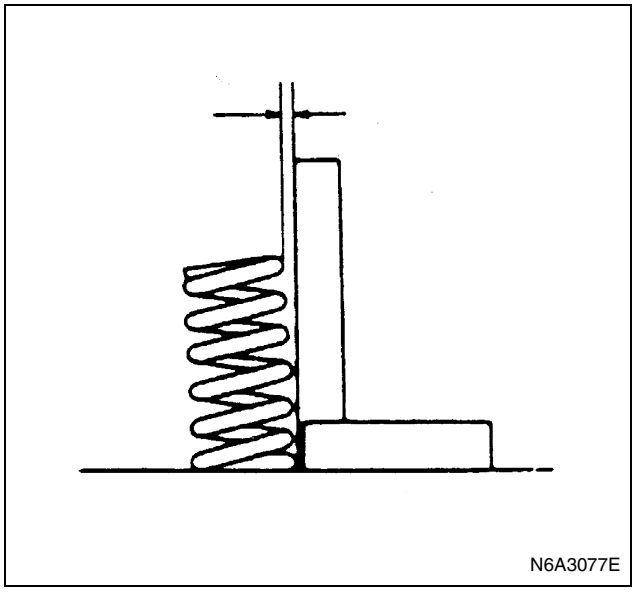
1. Free height
   - Measure the free height of the springs. The springs must be replaced if the height is below the specified limit.

Free Height	mm (in)
Standard	Limit
48.0 (1.891)	47.100 (1.8560)


N6A3076E

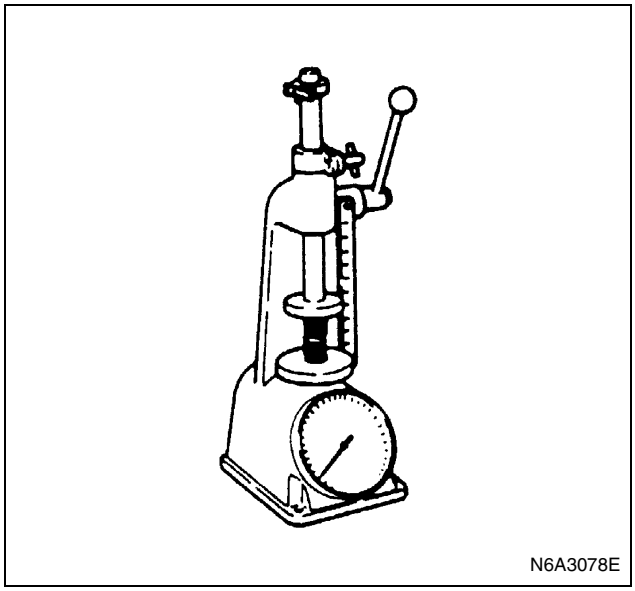
2. Squareness
   - Measure the valve spring squareness with a steel square.
   - Replace the valve springs if the measured value exceeds the specified limit.

Limit	mm (in)
1.7 (0.067)	


N6A3077E

3. Spring tension
   - Use spring tester to compress the springs to the installed height. Measure the compressed spring tension.
     Replace the springs if the measured tension is below the specified limit.

Tension		N (kg/lb)
At installed height 38.9 mm (1.5 in)	Standard	Limit
	296.2 (30.2/66.6)	257.9 (26.3/57.9)


N6A3078E

Valve Guide

Caution:
Taking care not to damage the valve seat contact surface, when removing carbon adhering to the valve head.

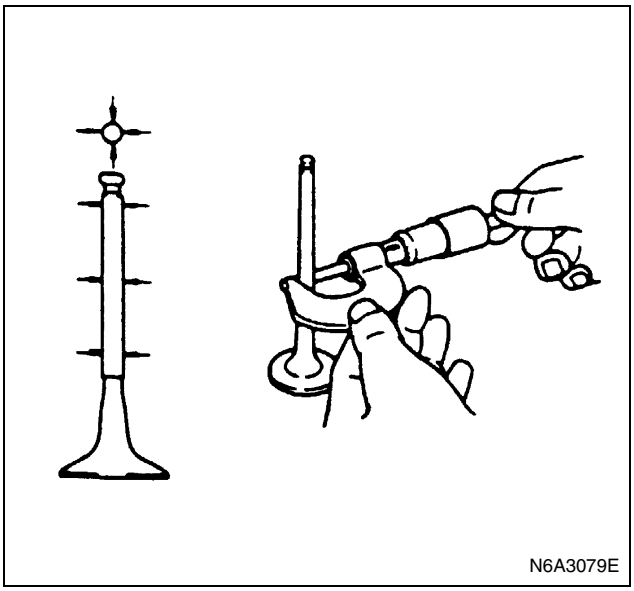
Carefully inspect the valve stem for scratching or abnormal wear. If these conditions are present, the valve and the valve guide must be replaced as a set.

1. Valve Guide Clearance
   - Measure the valve stem diameter with a micrometer.
     If the valve stem diameter is less than the specified limit, the valve and the valve guide must be replaced as a set.

			mm (in)
		Standard	Limit
Diameter of Valve stem	Inlet	7.946 — 7.961 (0.3128 — 0.3134)	7.880 (0.310.2)
	Exhaust	7.921 — 7.936 (0.3118 — 0.3124)	7.850 (0.3091)

   - Measure the inside diameter of the valve guide with a micrometer.
   - Subtract the measured outer diameter of the valve stem from the measured inner diameter of the valve guide. If the valve exceeds of the valve guide.
     If the valve exceeds the specified limit, the valve and the valve guide must be replaced as a set.

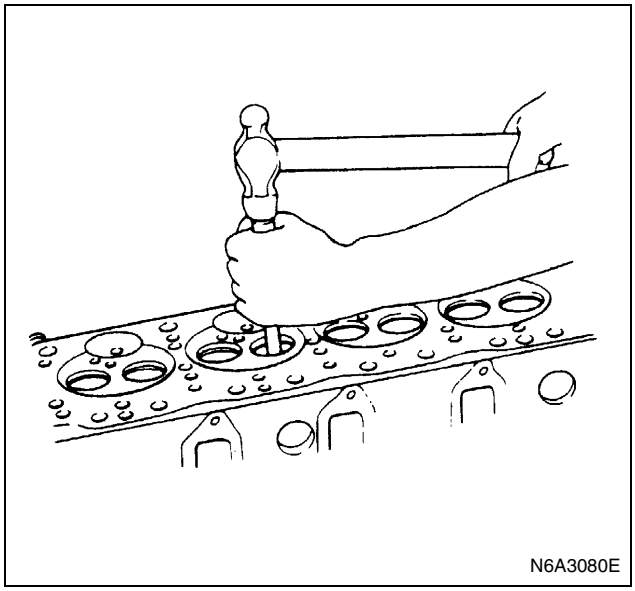
Valve Guide Clearance		mm (in)
	Standard	Limit
Inlet clearance	0.039 — 0.069 (0.0015 — 0.0027)	0.200 (0.0079)
Exhaust clearance	0.064 — 0.096 (0.0025 — 0.0038)	0.250 (0.0098)


N6A3079E

Valve Guide Replacement

1. Using special tool, drive out the valve guide from the combustion chamber side.

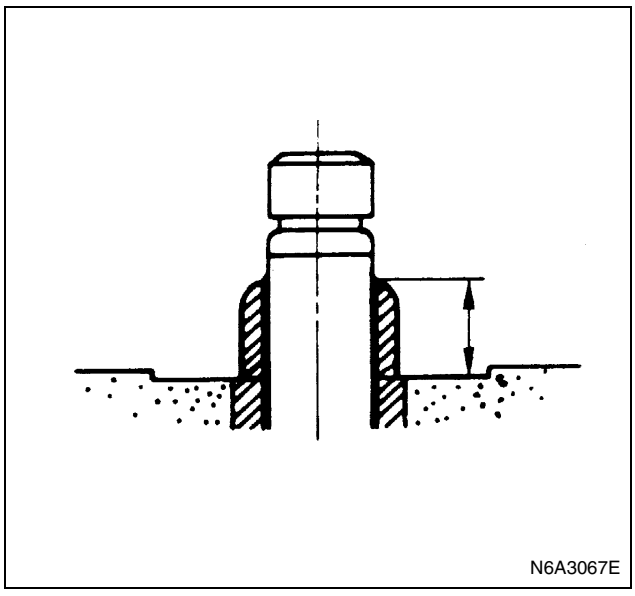
Valve guide replacer: 9-8523-1212-0


N6A3080E

2. Apply engine oil to the outside of the valve guide. Using special tool, drive in a new valve guide from cylinder head upper face side, and check the valve guide height.

Valve guide replacer: 9-8523-1212-0

Height	mm (in)
13 (0.51)	

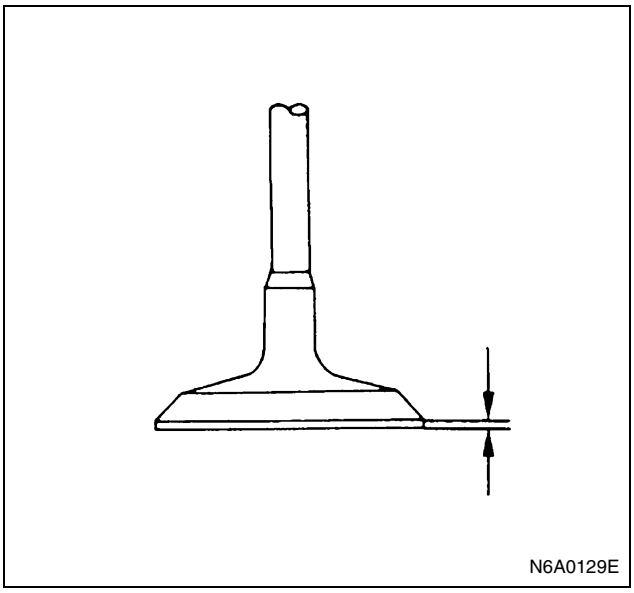

N6A3067E

Notice:
If the valve guide has been removed, both the valve and the valve guide must be replaced as a set.

Valve Thickness

1. Measure the valve thickness
2. If the measured value is less than the specified limit the valve and the valve guide must be replaced as a set.

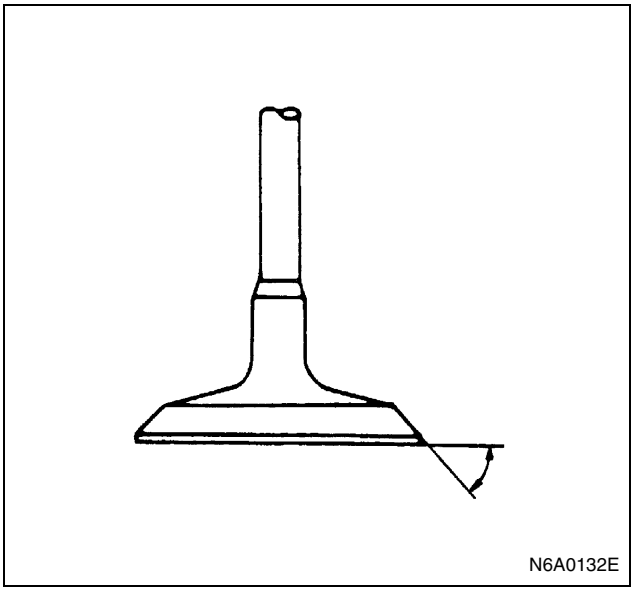
Valve Thickness			mm (in)
	Standard		Limit
4JB1 4JB1-TC	Inlet	1.79 (0.0705)	1.5 (0.06)
	Exhaust	1.83 (0.0720)	
4JG2	Inlet	1.41 (0.0555)	1.1 (0.043)
	Exhaust	1.39 (0.0547)	
4JH1-TC	Inlet	1.41 (0.0555)	1.1 (0.043)
	Exhaust	1.38 (0.0543)	



Contact Surface Angle on Valve Seat on Valve

1. Measure contact surface angle on valve seat.
2. If the measured value exceeds the limit, replace valve guide and valve seat as a set.

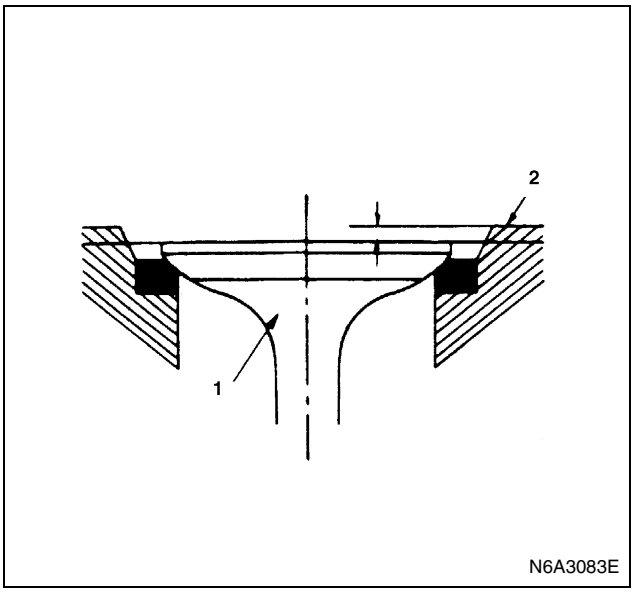
Standard	Degrees
45°	



Valve Depression

1. Install the valve (1) to the cylinder head (2).
2. Use a depth gauge or a straight edge with steel rule to measure the valve depression from the cylinder head lower surface.
   If the measured value exceeds the specified limit, the valve seat insert must be replaced.

Valve Depression			mm (in)
	Standard		Limit
4JB1 4JB1-TC	Inlet	0.73 (0.029)	1.28 (0.050)
	Exhaust	0.70 (0.028)	1.20 (0.047)
4JG2 4JH1-TC	Inlet	1.1 (0.043)	1.6 (0.063)
	Exhaust		

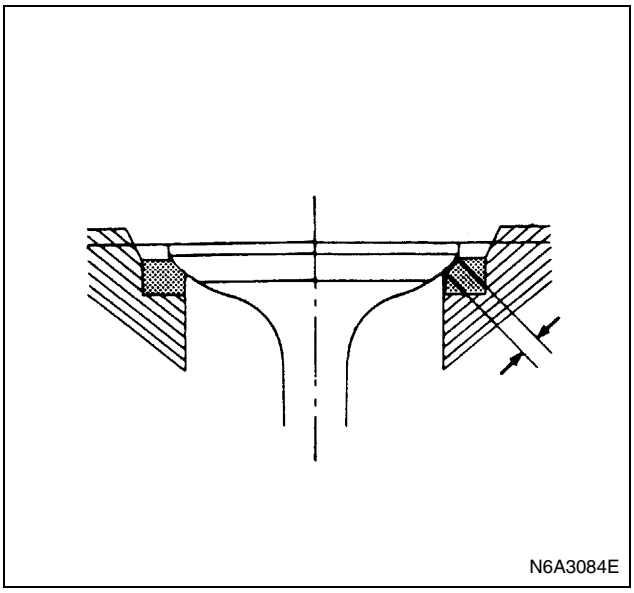


Valve Contact Width

1. Check the valve contact faces for roughness and unevenness. Make smooth the valve contact surfaces.

2. Measure the valve contact width.
   If the measured value exceeds the specified limit, the valve seat insert must be replaced.

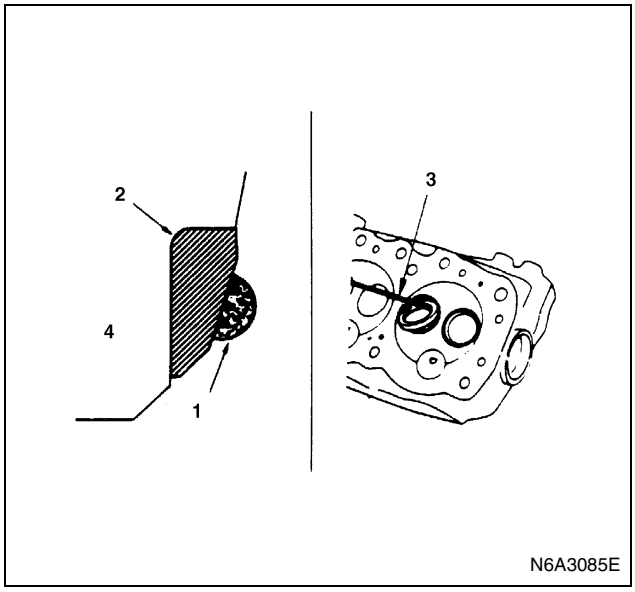
Contact Width		mm (in)
	Standard	Limit
Inlet	1.7 (0.0670)	2.2 (0.0866)
Exhaust	2.0 (0.0788)	2.5 (0.0984)



Valve Seat Insert Replacement

Valve Seat Insert Removal

1. Arc weld the tire inside circumference (1) of the valve seat insert (2).
2. Allow the valve seat insert to cool for a few minutes.
   This will invite contraction and make removal of the valve seat insert easier.
3. Use a screwdriver (3) to pry the valve seat insert free.
   Take care not to damage the cylinder head (4).
4. Carefully remove carbon and other foreign material from the cylinder head insert bore.

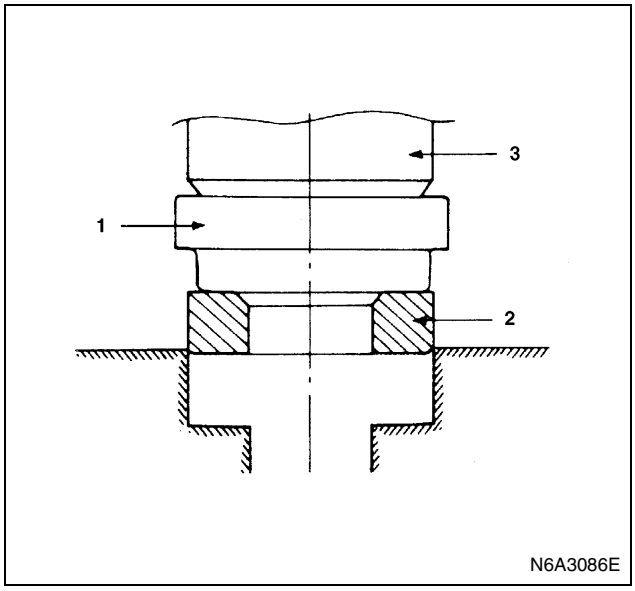


Valve Seat Insert Installation

1. Carefully place the attachment (1) (having a smaller outside diameter than the valve seat insert) on the valve seat insert (2).

Notice:
The smooth side of the attachment must contact the valve seat insert.

2. Use a bench press (3) to gradually apply pressure to the attachment and press the valve seat insert into place.



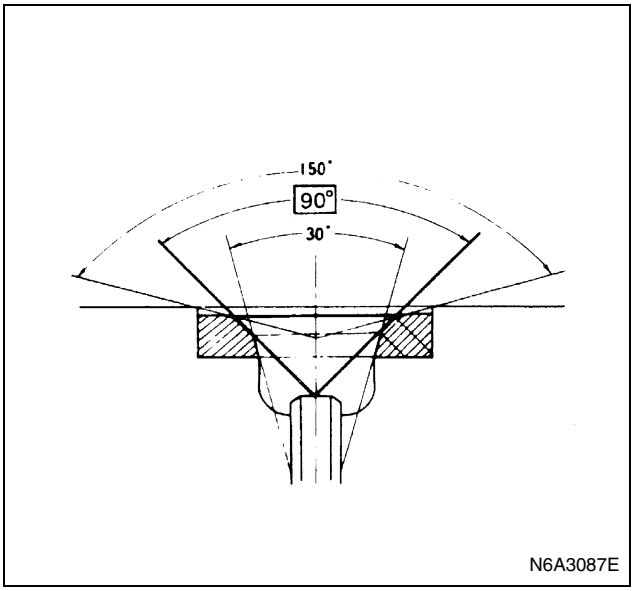
Notice:
Do not apply an excessive amount of pressure with the bench press. Damage to the valve seat insert will result.

Valve Seat Insert Correction

1. Remove the carbon from the valve seat insert surface.

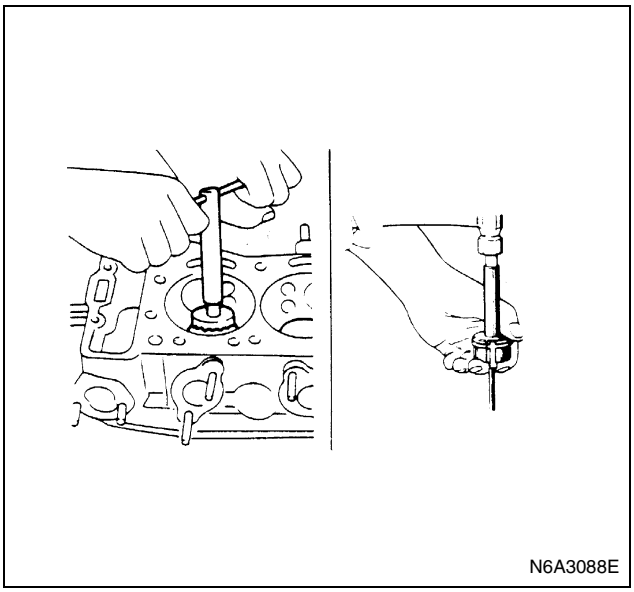
2. Use a valve cutter (15°, 45°, and 75° blades) to minimize scratches and other rough areas, this will bring the contact width back to the standard value. Remove only the scratches and rough areas. Do not cut away too much. Take care not to cut away unblemished area of the valve seat surface.

Valve Seat Angle	degree
45°	

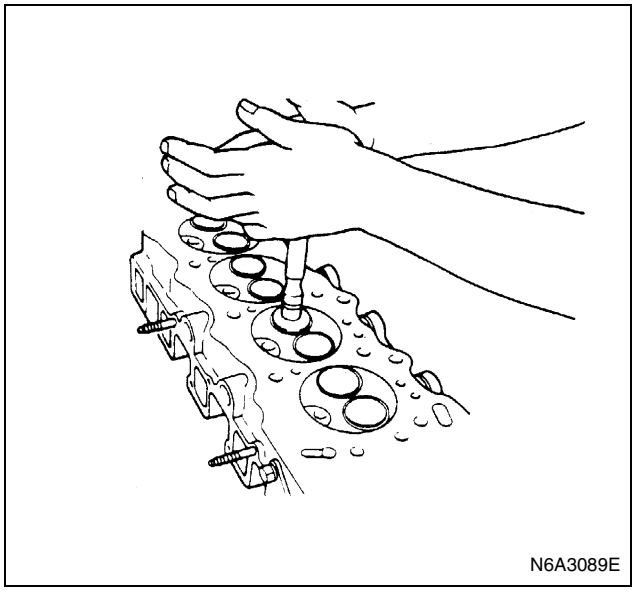


Notice:
Use an adjustable valve cutter pilot.
Do not allow the valve cutter pilot to wobble inside the valve guide.

3. Apply abrasive compound to the valve seat insert surface.



4. Insert the valve into the valve guide.
5. Turn the valve while tapping it to fit the valve seat insert.

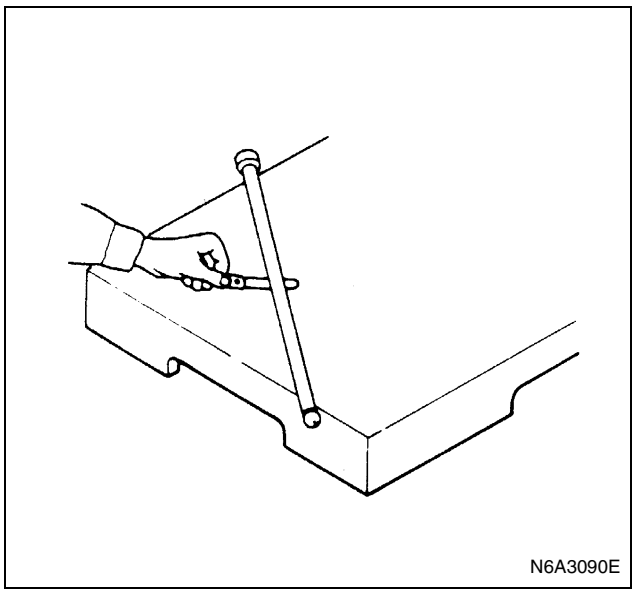


6. Check that the valve contract width is correct.
7. Check that the valve seat insert surface is in contact with the entire circumference of the valve.

Push Rod Curvature

1. Lay the push rod on a surface plate.
2. Roll the push rod along the surface plate and measure the push rod curvature with a thickness gauge.
   If the measure value exceeds the specified limit, the push rod must be replaced.

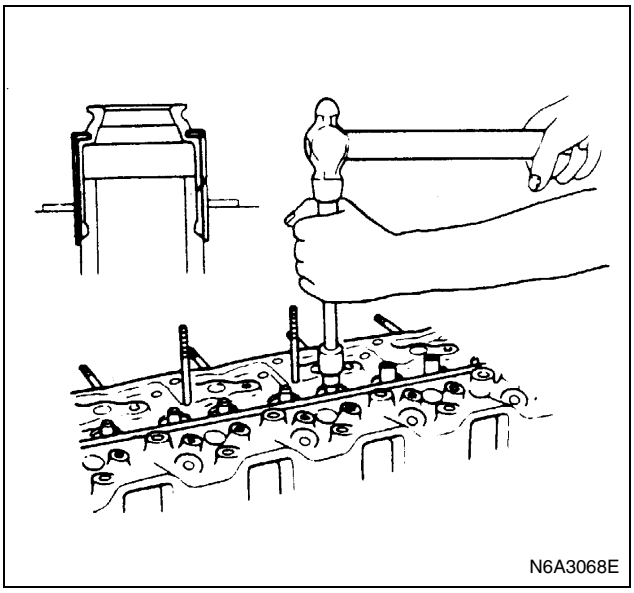
Push Rod Curvature Limit	mm (in)
0.4 (0.0157) or less	



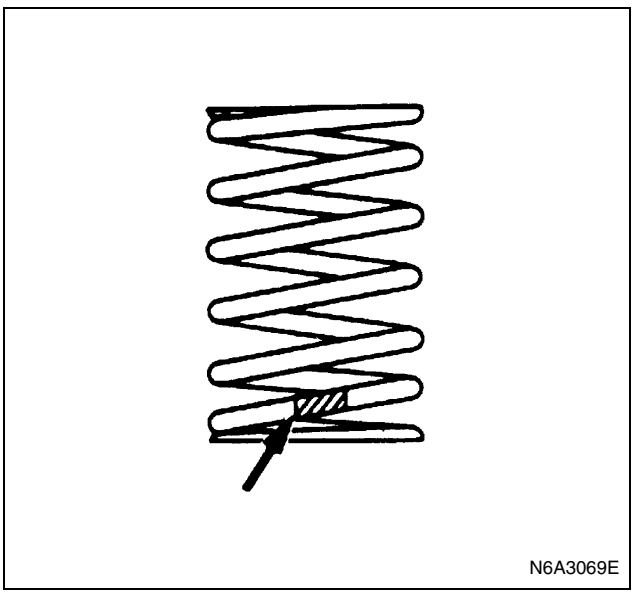
3. Visually inspect both ends of the push rod for excessive wear and damage. The push rod must be replaced if these conditions are discovered during inspection.

Reassembly

1. Valve Guide
   - Apply engine oil to the outside of the valve guide.
     Using special tool, drive in a new valve guide from the rocker arm shaft side.
     Valve guide replacer: 9-8523-1212-0
2. Valve Guide Oil Seal
   - Using special tool, drive in a new oil seal
     Oil special tool, drive in a new oil seal
     Oil seal installer: 5-8840-2033-0


N6A3068E

3. Valve
   - Apply engine oil to the outside of the valve stem.
4. Valve Spring
   - Attach the valve seat to the upper spring seat. The painted area of the valve spring should be facing downward.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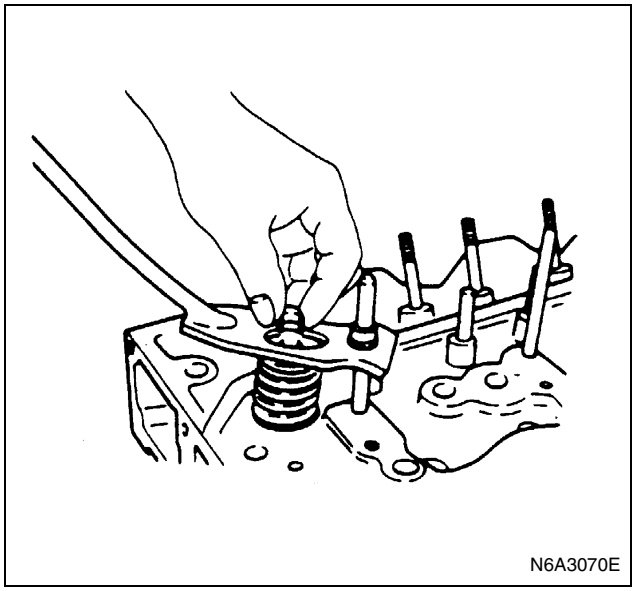
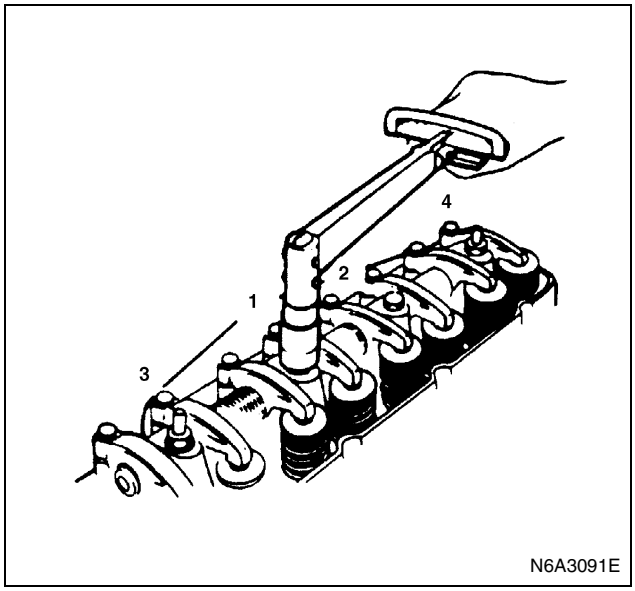
5. Split Collar
   - Use a spring compressor to push the valve spring into position.
   - Install the spring seat split collar.
   - Set the split collar by tapping lightly around the head of the collar with a rubber hammer.

Valve spring compressor: 9-8523-1423-0 (J-29760)


N6A3070E

6. Rocker Arm Assembly

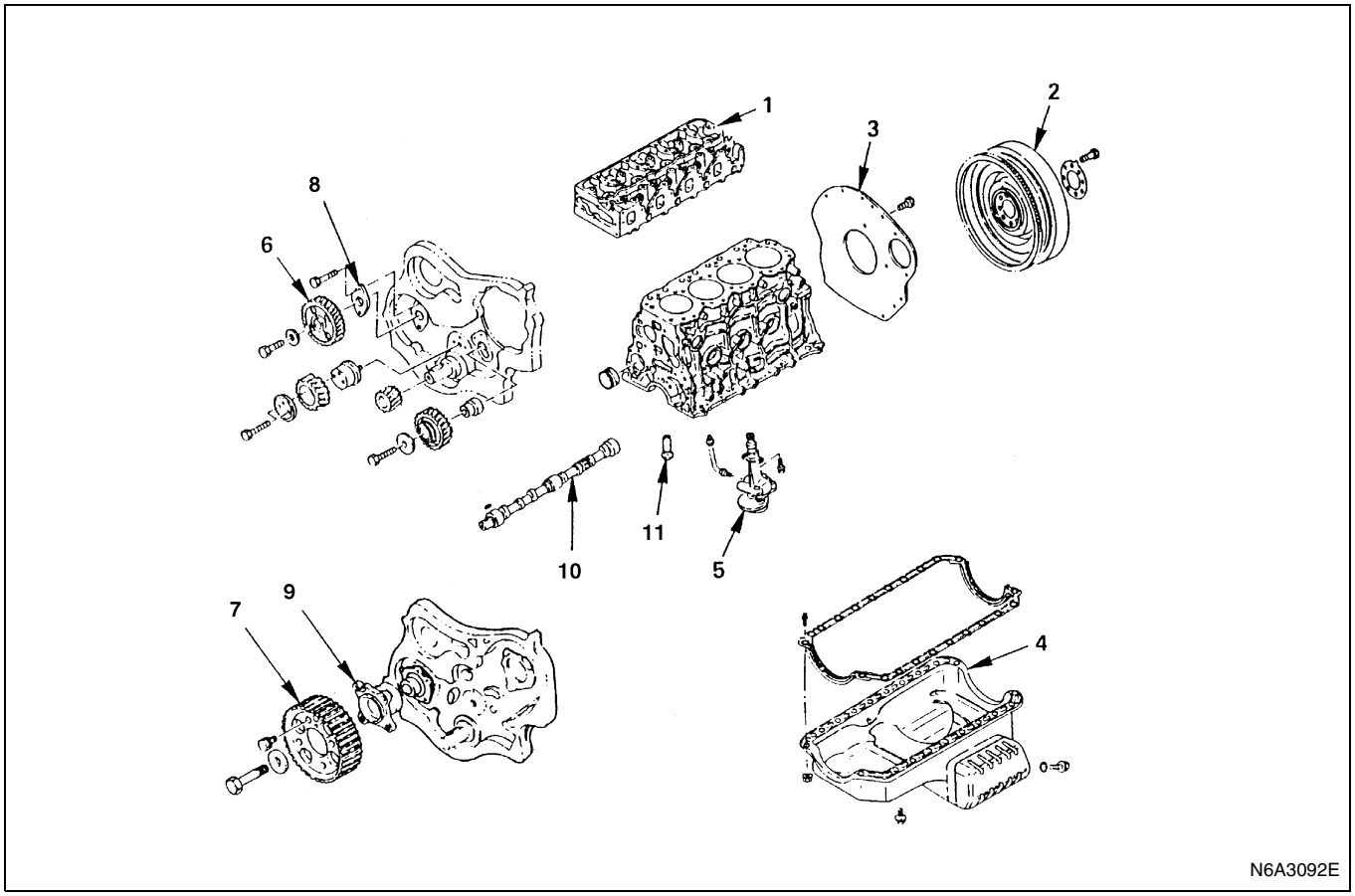
Tighten:
54 N·m (5.5 kg·m/40 lb·ft)



N6A3091E

CAMSHAFT, TAPPET

Component



Legend

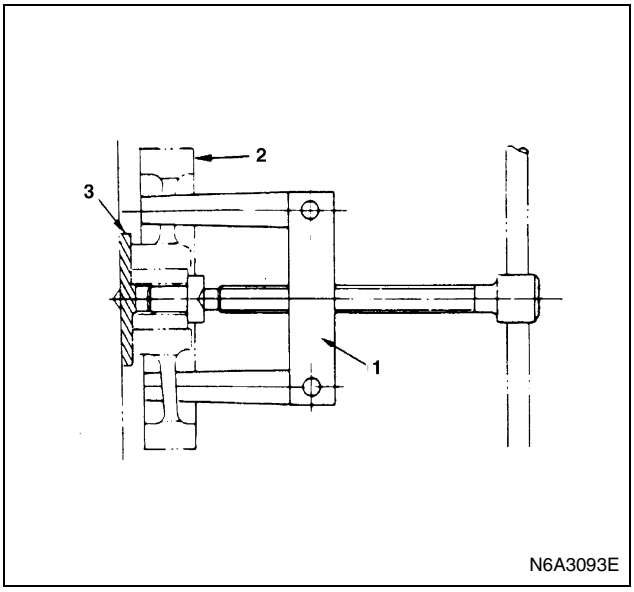
1. Cylinder head assembly
2. Flywheel
3. Cylinder block rear plate
4. Oil pan assembly
5. Oil pump assembly
6. Camshaft timing gear
7. Camshaft timing pulley
8. Camshaft thrust plate
9. Camshaft pulley center
10. Camshaft
11. Tappet

Disassembly

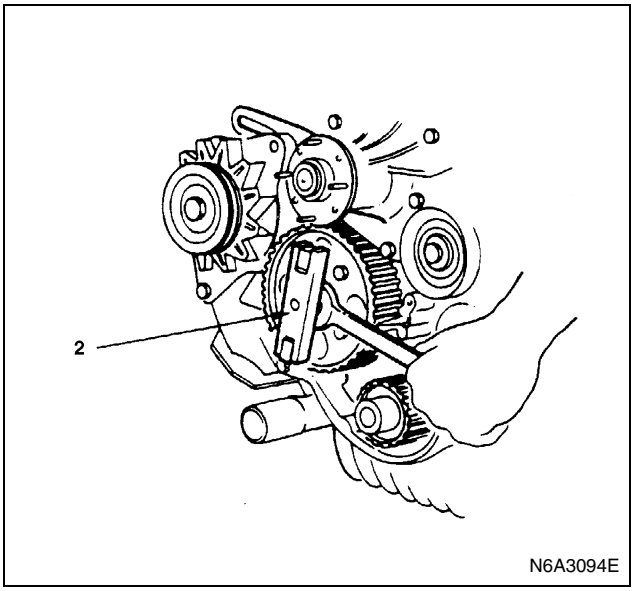
1. Cylinder Head Assembly
2. Flywheel
3. Cylinder Block Rear Plate
4. Oil Pan Assembly
5. Oil Pump Assembly
6. Camshaft Timing Gear (Gear Drive Model)
   - Remove the camshaft timing gear bolt from the camshaft.

Notice:
Hold the camshaft stationary to prevent the camshaft from turning.

- Use the universal puller (1) to pull out the camshaft timing gear (2).
- Universal Puller: 5-8521-0002-0
  Remove the thrust plate (3).



7. Camshaft Timing Pulley (Belt Drive Model)
   - Use the timing pulley puller (2) to remove the pulley.
     Timing Pulley Puller: 5-8840-0086-0
   - Remove the stopper bolt.
8. Camshaft Thrust Plate (Gear Drive Model)
9. Camshaft Pulley Center (Belt Drive Model)
10. Camshaft
11. Tappet



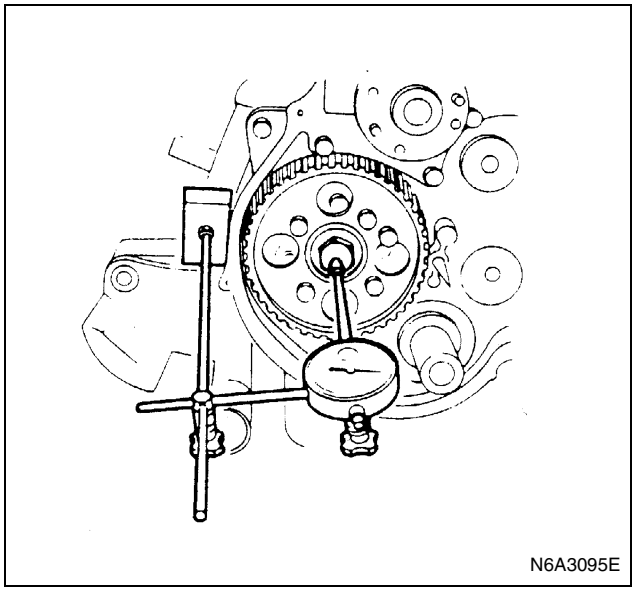
Inspection and Repair

Make the necessary adjustment, repairs, and part replacements if excessive wear or damage is discovered during inspection.

1. Measure the Camshaft Thrust Clearance
   - Use a dial indicator to measure the camshaft end play.
     This must be done before removing the camshaft gear.

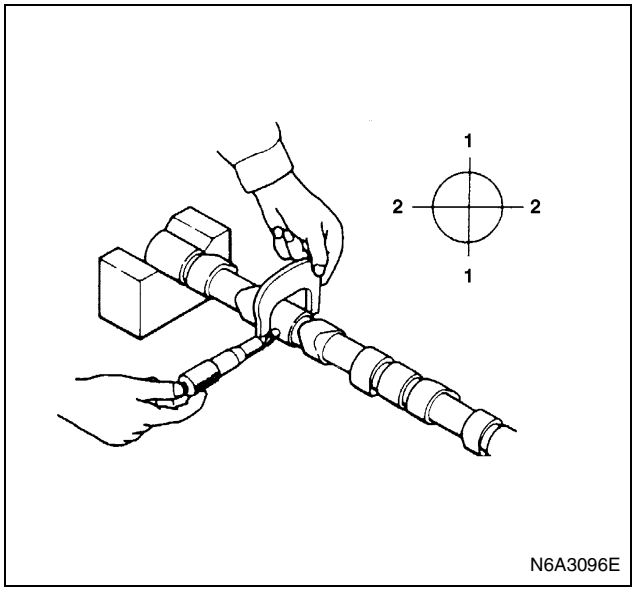
     If the camshaft end play exceeds the specified limit, the thrust plate must be replaced.

Camshaft End Play	mm (in)
Standard	Limit
0.08 (0.0031)	0.2 (0.0079)



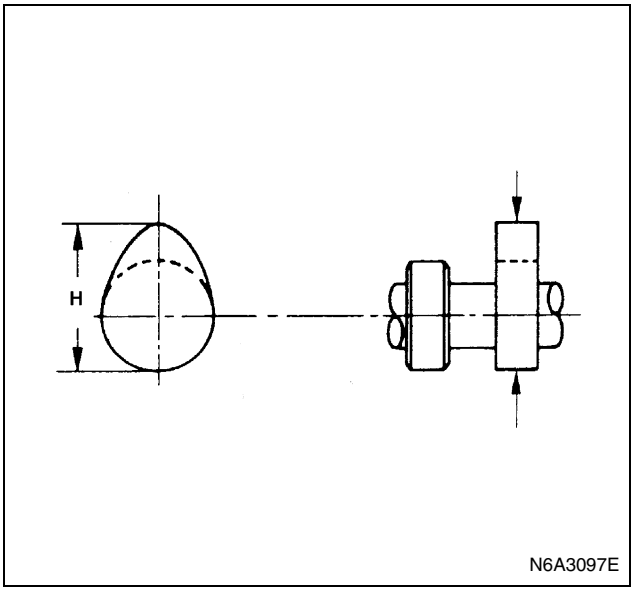
2. Camshaft Journal Diameter
   - Use a micrometer to measure each camshaft journal diameter in two directions (1) and (2). If the measured value is less than the specified limit, the camshaft must be replaced.

Journal Diameter	mm (in)
Standard	Limit
49.945 — 49.975 (1.9663 — 1.9675)	49.60 (1.9528)



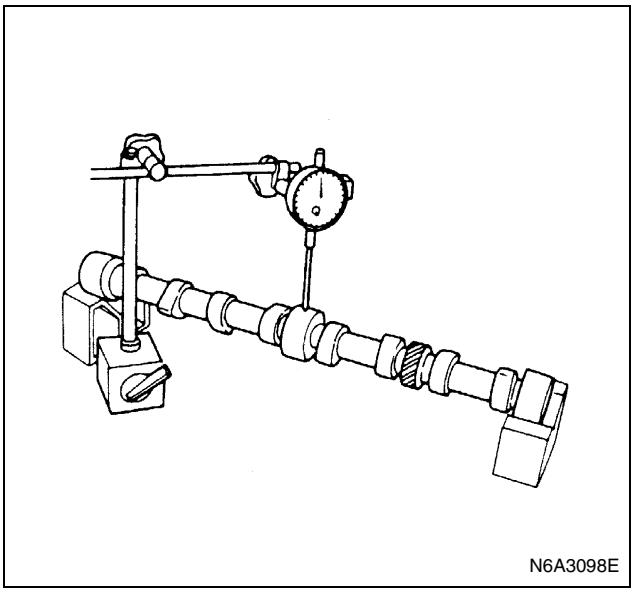
3. Cam Height
   - Measure the cam height H with a micrometer. If the measured value is less than the specified limit, the camshaft must be replaced.

Cam Height	mm (in)
Standard	Limit
42.02 (1.6543)	41.65 (1.6398)



4. Camshaft Run-Out
   - Mount the camshaft on V-blocks.
   - Measure the run-out with a dial indicator. If the measured value exceeds the specified limit, the camshaft must be replaced.

Run-Out	mm (in)
Standard	Limit
0.02 (0.008) or less	0.10 (0.0039)

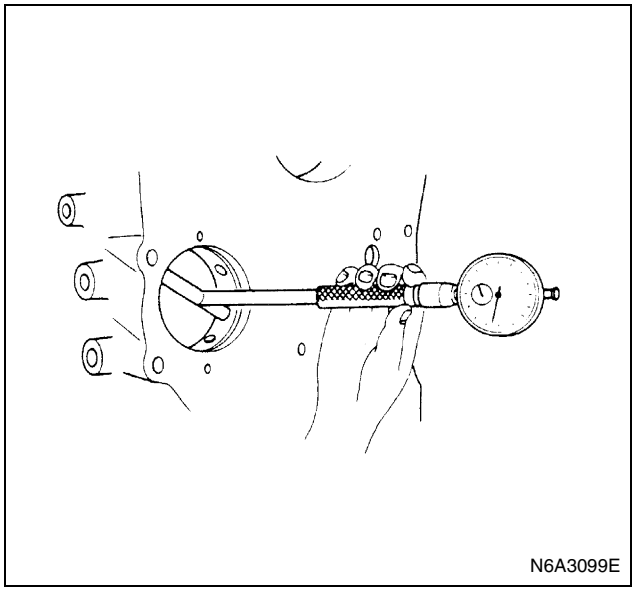


5. Camshaft and Camshaft Bearing Clearance
   - Use an inside dial indicator to measure the camshaft bearing inside diameter.

Camshaft Bearing Inside Diameter	mm (in)
Standard	Limit
50.00 — 50.03 (1.9685 — 1.9696)	50.08 (1.9716)

Camshaft Bearing Clearance	mm (in)
Standard	Limit
0.025 — 0.085 (0.0010 — 0.0033)	0.12 (0.005)

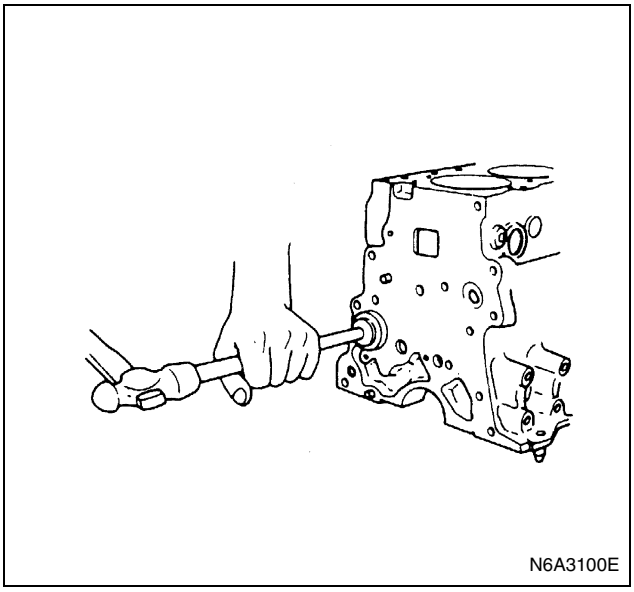
   - If the clearance between the camshaft bearing inside diameter and the journal exceeds the specified limit, the camshaft bearing must be replaced.



Camshaft Bearing Replacement

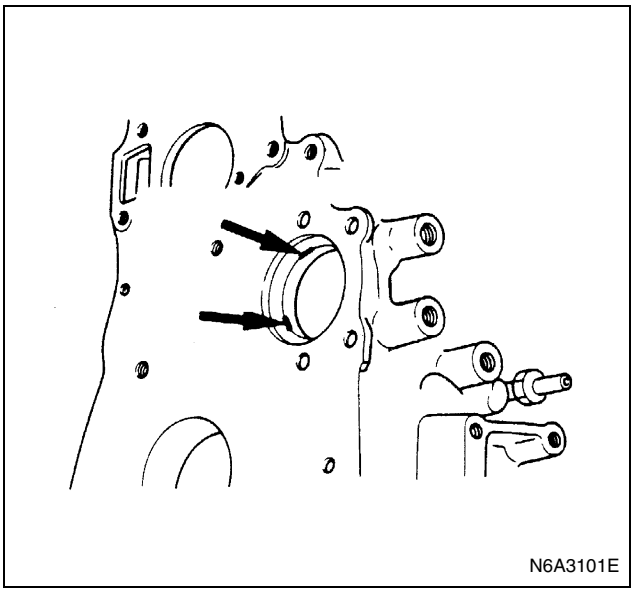
Camshaft Bearing Removal

1. Remove the cylinder body plug plate.
2. Use the bearing replacer to remove the camshaft bearing.
   Bearing Replacer: 5-8840-2038-0


N6A3100E

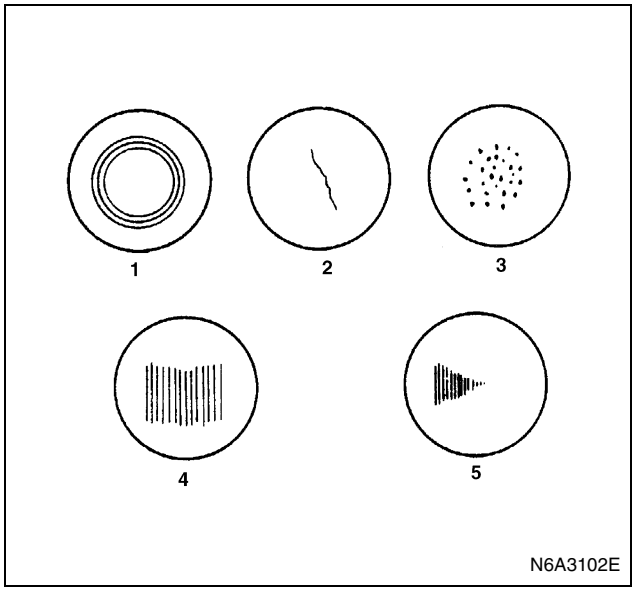
Camshaft Bearing Installation

1. Align the bearing oil holes with the cylinder body oil holes.
2. Use the replacer to install the camshaft bearing.
   Bearing Replacer: 5-8840-2038-0


N6A3101E

Tappet

Visually inspect the tappet camshaft contact surfaces for pitting, cracking, and other abnormal conditions. The tappet must be replaced if any of these conditions are present.



N6A3102E

Legend

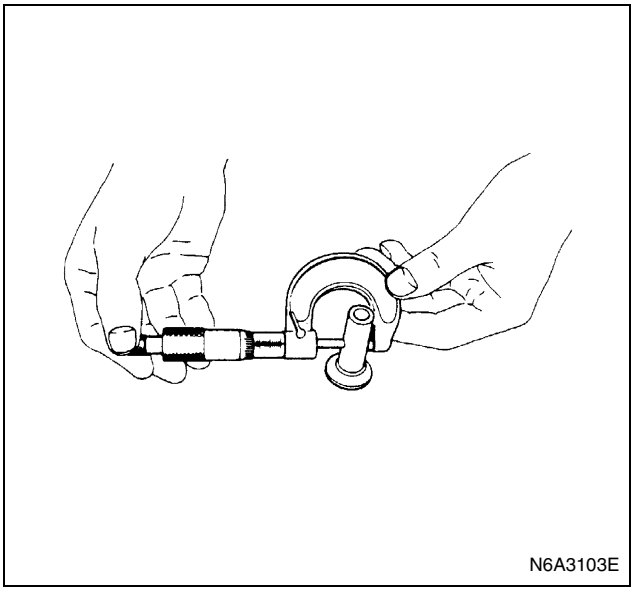
1. Normal contact
2. Cracking
3. Pitting
4. Irregular contact
5. Irregular contact

Notice:
The tappet surfaces are spherical. Do not attempt to grind them with an oil stone or similar tool in an effort to repair the tappet. If the tappet is damaged, it must be replaced.

Tappet Outside Diameter

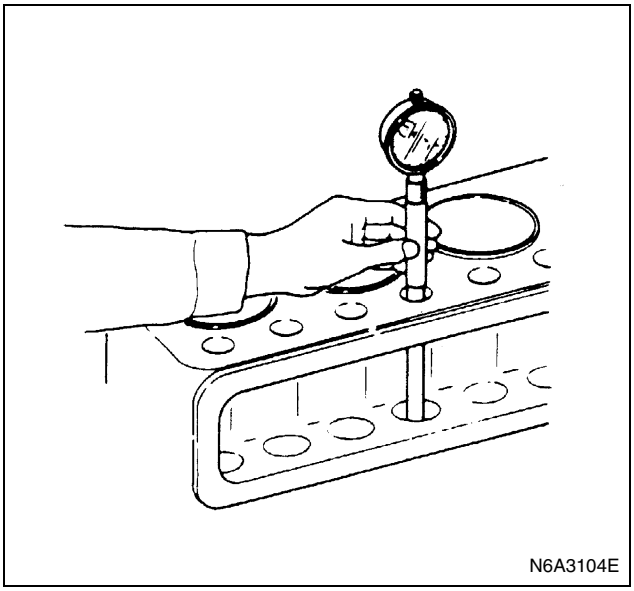
1. Measure the tappet outside diameter with a micrometer. If the measured value is less than the specified limit, the tappet must be replaced.

Tappet Outside Diameter	mm (in)
Standard	Limit
12.97 — 12.99 (0.510 — 0.511)	12.95 (0.509)


N6A3103E

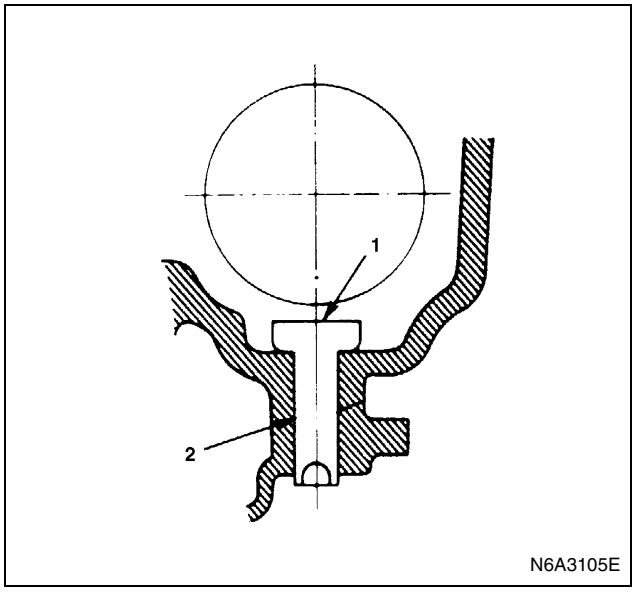
2. Measure the inside diameter tappet on the cylinder block and calculate the clearance.
   If the clearance exceeds the limit, replace tappet or/and cylinder block.

Tappet and Cylinder Body Clearance	mm (in)
Standard	Limit
0.03 (0.001)	0.10 (0.004)


N6A3104E

Reassembly

1. Tappet
   1) Apply a coat of engine oil to the tappet (1) and the cylinder body tappet insert holes (2).

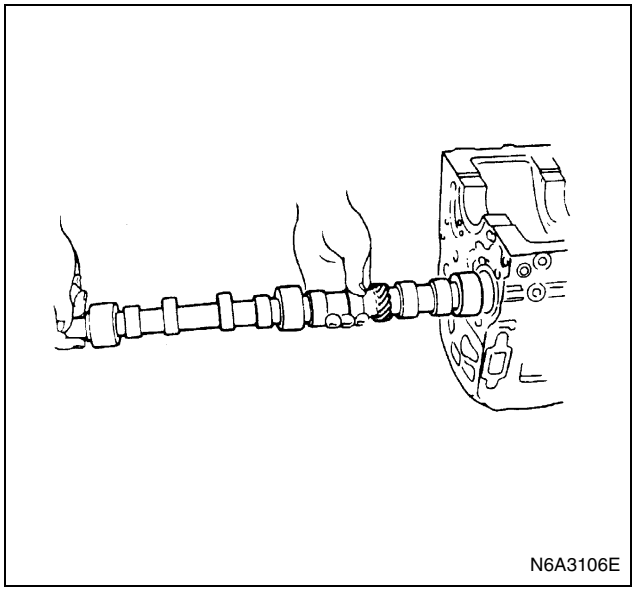


N6A3105E

   2) Locate the position mark applies at disassembly (if the tappet is to be reused).

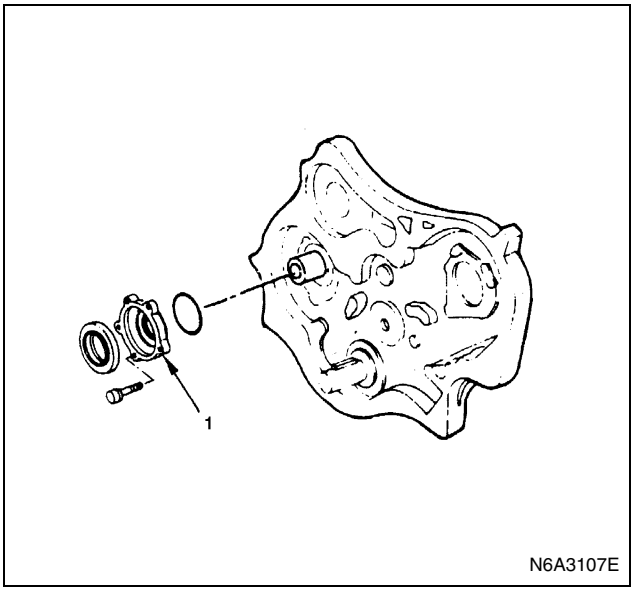
Notice:
The tappet must be installed before the camshaft.

2. Camshaft
   1) Apply a coat of engine oil to the camshaft and the camshaft bearings.
   2) Install the camshaft to the cylinder body.
      Take care not damage the camshaft bearings.


N6A3106E

3. Camshaft Timing Pulley Center (Belt Drive Model)
   - Apply engine oil to the oil seal lip portion of the oil seal retainer.
   - Apply the recommended liquid gasket or its equivalent to the retainer.
   - Install the oil seal retainer to the cylinder body.
   - Tighten the retainer bolts to the specified torque.

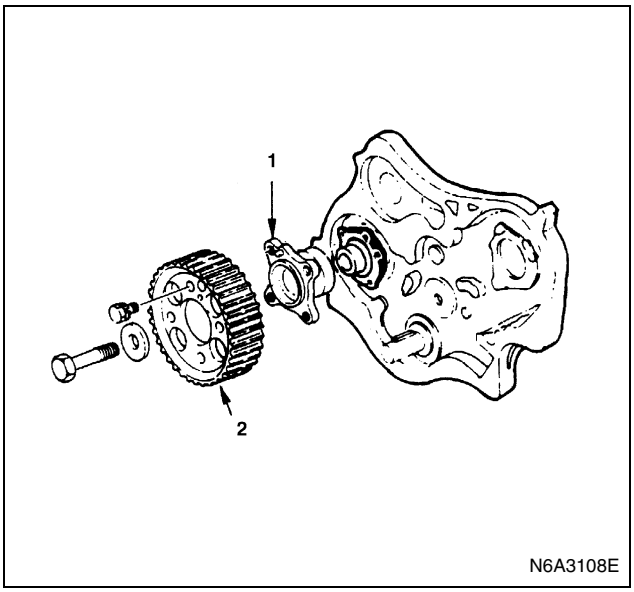
Tighten:
Oil Seal Retainer Bolt to 19 N·m (1.9 kg·m/14 lb·ft)



Legend
1. Retainer

- Align the camshaft timing pulley center with the camshaft key.
- Tighten the timing pulley bolts to the specified torque.

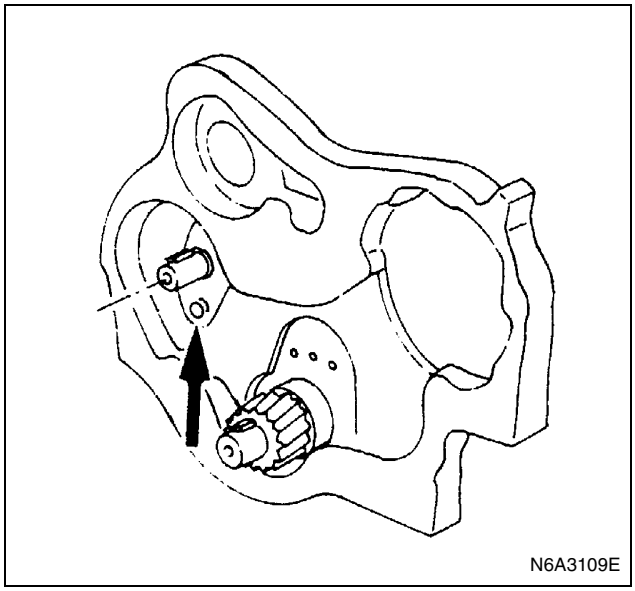
Tighten:
Timing Pulley Bolt to 8 N·m (0.8 kg·m/69 lb·ft)



Legend
1. Timing pulley center
2. Timing pulley

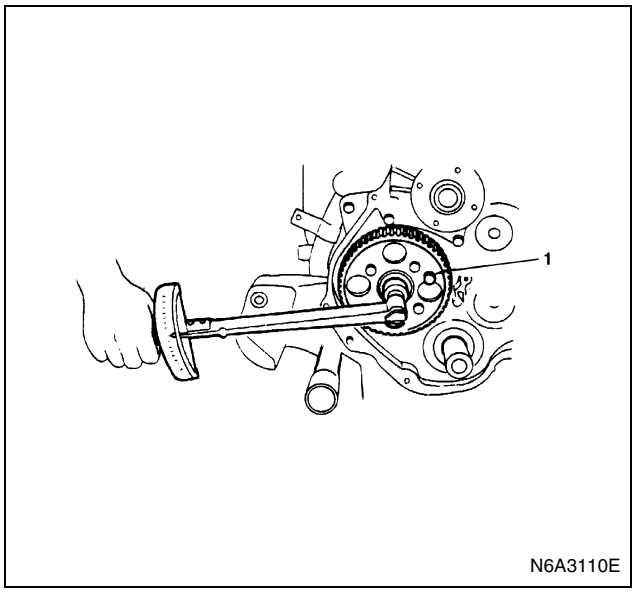
4. Camshaft Thrust Plate (Gear Drive Model)
   Install the thrust plate to the cylinder body and tighten the thrust plate bolts to specified torque.

Tighten:
Thrust Plate Bolt to 18 N·m (1.8 kg·m/13 lb·ft)



5. Camshaft Timing Pulley (Belt Drive Model)
   - Prevent the camshaft from turning when tightening the timing center bolt.
   - Tighten the timing pulley center bolt to the specified torque.

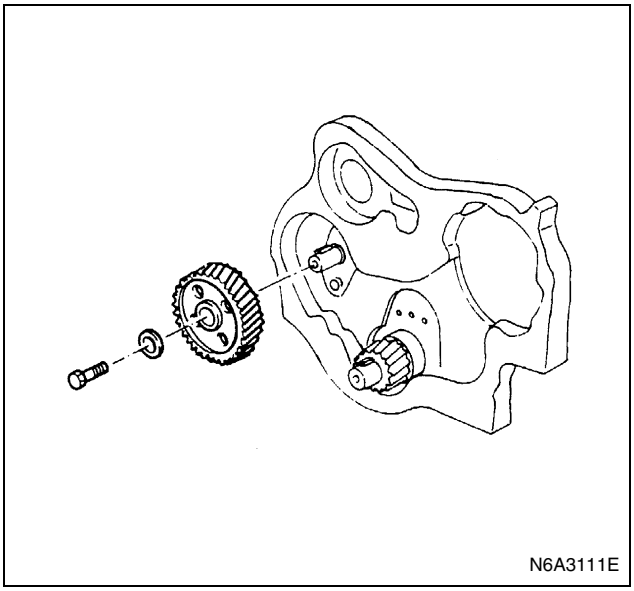
Tighten:
Center Bolt to 64 N·m (6.5 kg·m/47 lb·ft)



Legend
1. Lock bolt

6. Camshaft Timing Gear (Gear Drive Model)
   1) Install the camshaft timing gear to the camshaft.
      The timing gear mark (“Y — Y”) must be facing outward.
   2) Tighten the timing gear to the specified torque

Tighten:
Timing Gear Bolt to 64 N·m (6.5 kg·m/47 lb·ft)

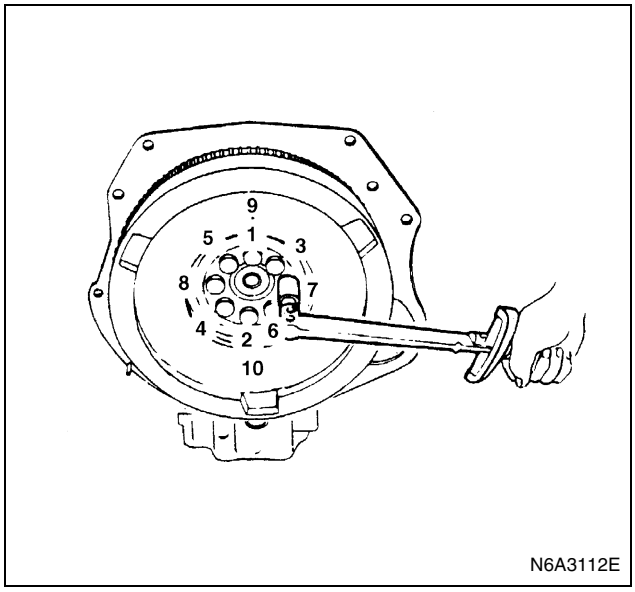

N6A3111E

7. Oil Pump Assembly
8. Oil Pan Assembly
   Above works refer to “OIL PUMP” Section in this manual.
9. Cylinder Block Rear Plate
   - Tighten cylinder block rear plate fixing bolts to the specified torque.

Tighten:
Rear Plate Bolt to 82 N·m (8.4 kg·m/61 lb·ft)

10. Flywheel
    - Apply engine oil to fixing bolts.
    - Tighten the flywheel bolts to the specified torque in two steps using the Angular Tightening Method.
      Follow the numerical order shown in the illustration.

Tighten:
- Flywheel Bolt to
  1st Step (Snug torque): 59 N·m (6.0 kg·m/43 lb·ft)
  2nd Step (Final torque): 60° — 90°



N6A3112E

11. Cylinder Head Assembly
    1) Hot plug
       - Set the nock ball in the positioning groove on the cylinder head side according to the order of the cylinders, and hit it lightly with a plastic hammer.

Notice:
After being pressed into the cylinder head, the hot plugs were provided with surface grinding.

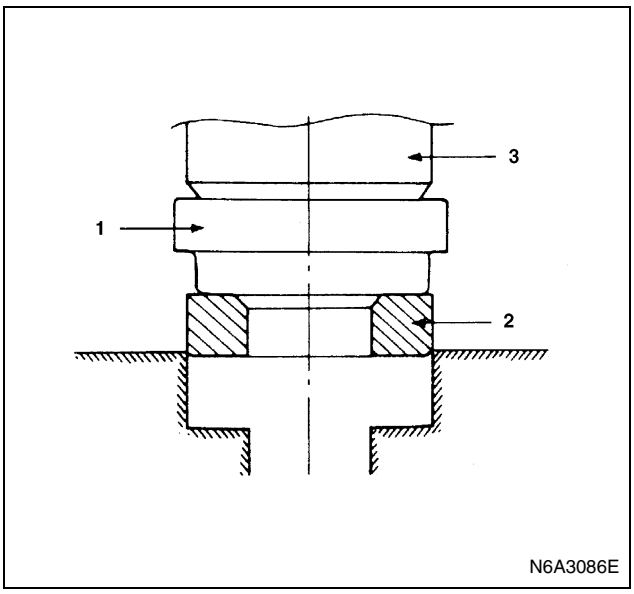
Accordingly, their dimensions are different individually among them, and take care not confuse the order of the cylinders.

When replacing the hot plug with new one:
When assembling a new hot plug, set the knock ball in the positioning groove on the cylinder side and hit it lightly with a plastic hammer until the hot plug is set in stably.
With patch attached to the hot plug to prevent it from being damaged, press it in with a force of 4.5 ~ 5.5 ton applied.

    2) Valve Seat Insert Installation
       - Carefully place the attachment (1) (having a smaller outside diameter than the valve seat insert) on the valve seat insert (2).

Notice:
The smooth side of the attachment must contact the valve seat insert.

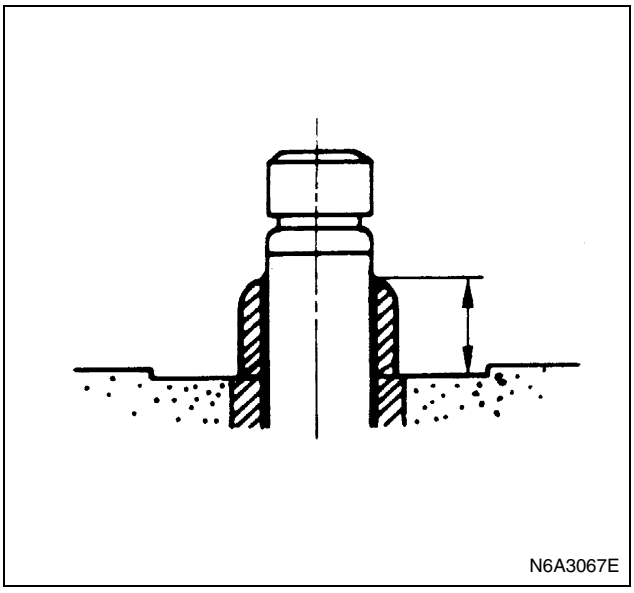
       - Use the bench press (3) to gradually apply pressure to the attachment and press the valve seat insert into place.



Notice:
Do not apply an excessive amount of pressure with the bench press. Damage to the valve seat insert will result.

Measure the height of the valve guide upper end from the upper face of the cylinder head.

Valve Guide Upper End Height (H) (Reference) mm (in)
13 (0.51)

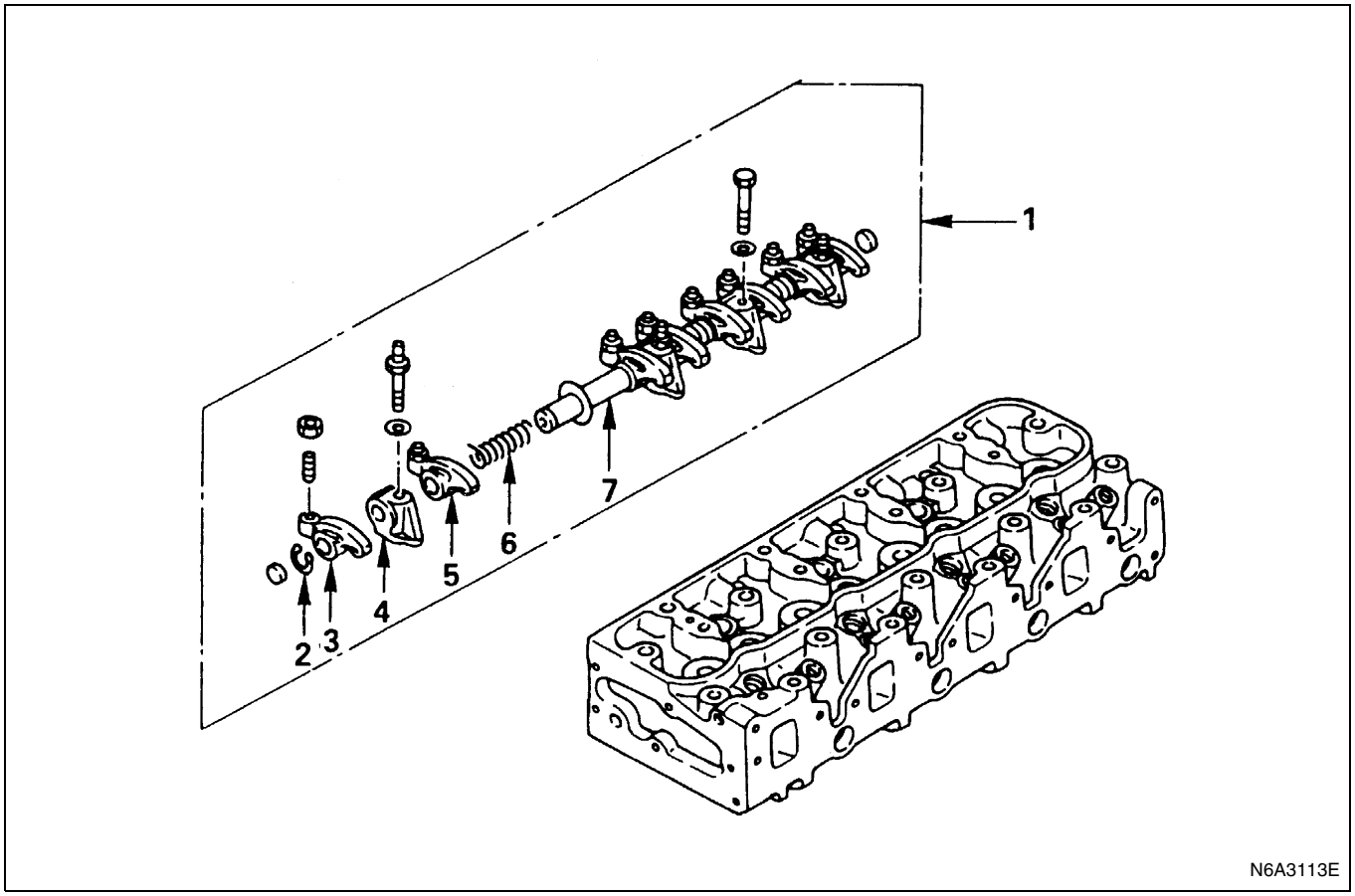


Notice:
If the valve guide has been removed, both the valve and the valve guide must be replaced as a set.

3) Spring Lower Seat
4) Valve Stem Oil Seal
5) Valve
6) Valve Spring
7) Split Collar
   Above works refer to “VALVE” Section in this manual.

ROCKER ARM ASSEMBLY

Component



Legend

1. Rocker arm shaft assembly
2. Rocker arm shaft snap ring
3. Rocker arm
4. Rocker arm shaft bracket
5. Rocker arm
6. Rocker arm shaft spring
7. Rocker arm shaft

Disassembly

1. Rocker Arm Shaft Assembly
2. Rocker Arm Shaft Snap Ring
3. Rocker Arm
4. Rocker Arm Shaft Bracket
5. Rocker Arm
6. Rocker Arm Shaft Spring
7. Rocker Arm Shaft

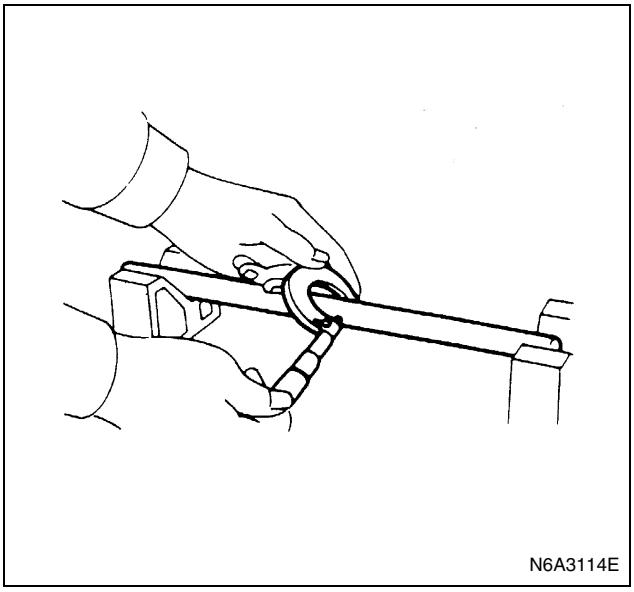
Inspection and Repair

Make the necessary adjustment, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Use a micrometer to measure the rocker shaft outside diameter at the point where the rocker arm moves on the rocker shaft.

Replace the rocker shaft if the diameter exceeds the specified limit.

	mm (in)
Standard	Limit
18.98 — 19.00 (0.7472 — 0.7480)	18.9 (0.744)


N6A3114E

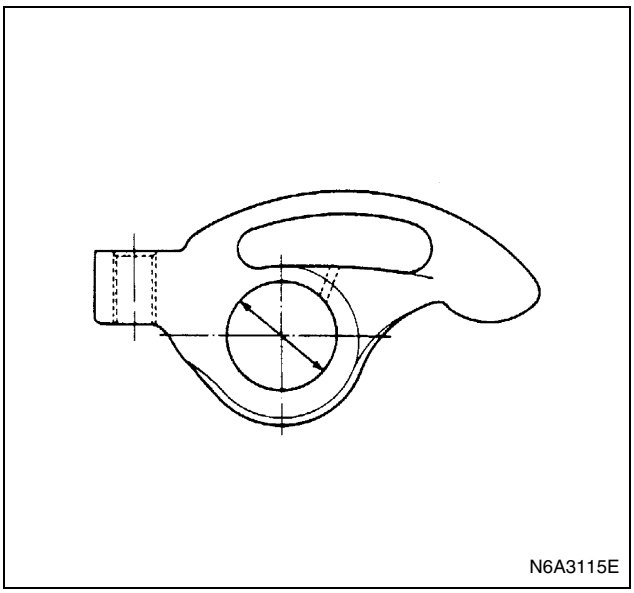
Oil Clearance

1. Use either a vernier caliper or a dial indicator to measure the rocker arm inside diameter.

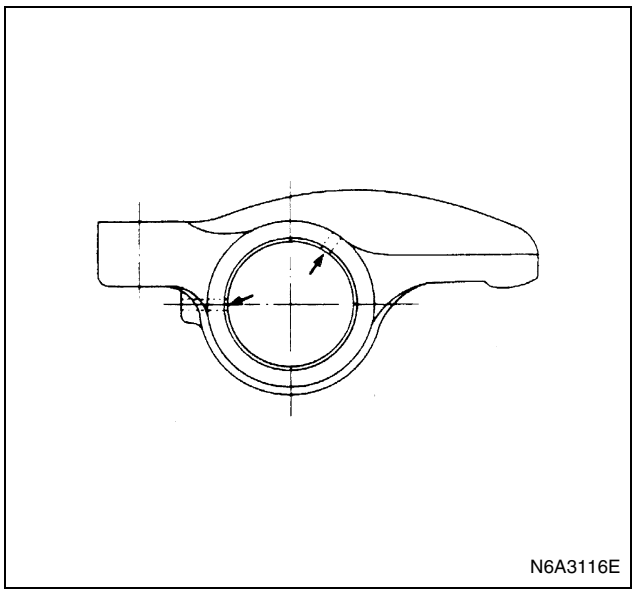
Rocker Arm Inside Diameter mm (in)	
Standard	Limit
19.036 — 19.060 (0.7494 — 0.7503)	19.100 (0.7519)

2. Measure the rocker arm shaft outside diameter.
   If the measured value exceeds the specified limit, replace either the rocker arm or the rocker arm shaft.

Rocker Arm and Rocker Shaft Clearance mm (in)	
Standard	Limit
0.06 — 0.08 (0.0024 — 0.0031)	0.10 (0.0039)

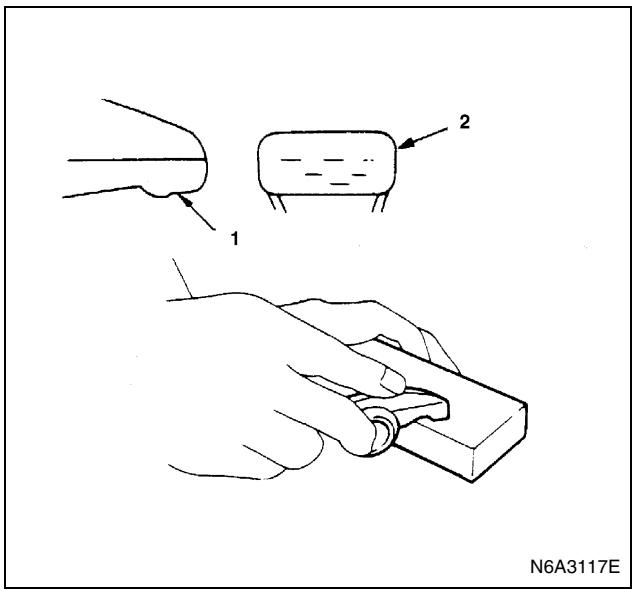

N6A3115E

3. Check that the rocker arm oil port is free is obstructions.
   If necessary, use compressed air to clean the rocker arm oil port.


N6A3116E

Rocker Arm Correction

Inspection the rocker arm valve stem contact surface for step wear (1) and scoring (2).
If the contact surfaces have light step wear or scoring, they may be honed with an oil stone.
If the step wear or scoring is severe, the rocker arm must be replaced.

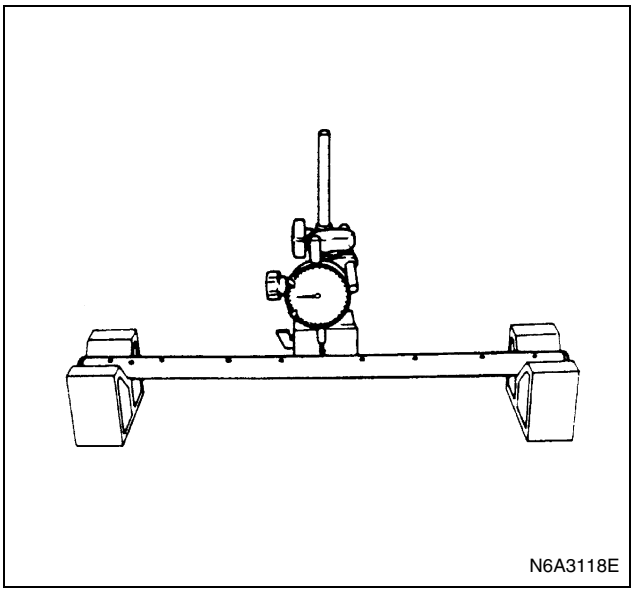


N6A3117E

Rocker Arm Shaft Run-Out

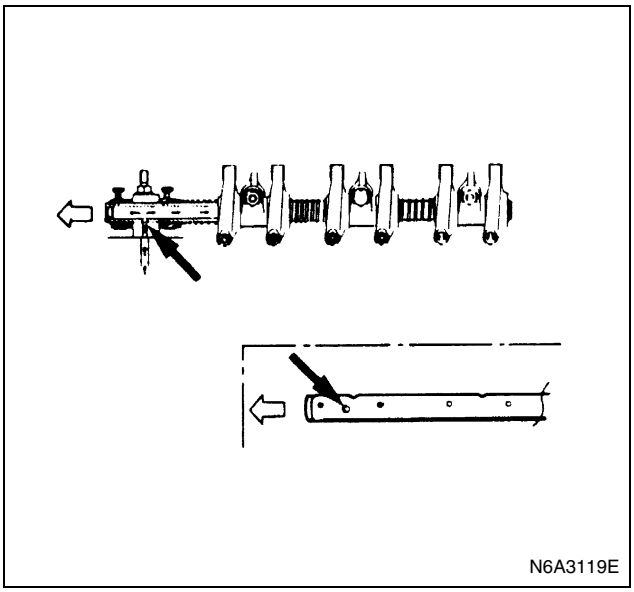
1. Place the rocker arm shaft on a V-block.
2. Use a dial indicator to measure the rocker arm shaft central portion run-out.
   If the run-out is very slight, correct the rocker arm shaft run-out with a bench press. The rocker arm must be at cold condition.
   If the measured rocker arm shaft run-out exceeds the specified limit, the rocker arm shaft must be replaced.

Rocker Arm Shaft Run-Out	mm (in)
	Limit
4JB1 / 4JB1-TC	0.2 (0.008)
4JH1-TC	

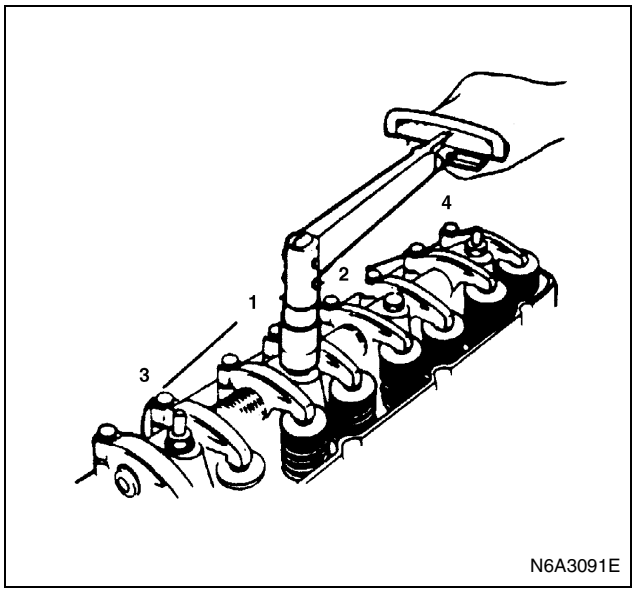

N6A3118E

Reassembly

1. Rocker Arm Shaft
   - Apply a light coat of engine oil to the rocker arm shafts.
   - Position the rocker arm shaft with the large oil hole (4ϕ) facing the front of the engine.
   - Install the rocker shaft together with the rocker arm, the rocker arm shaft bracket, and the spring.


N6A3119E

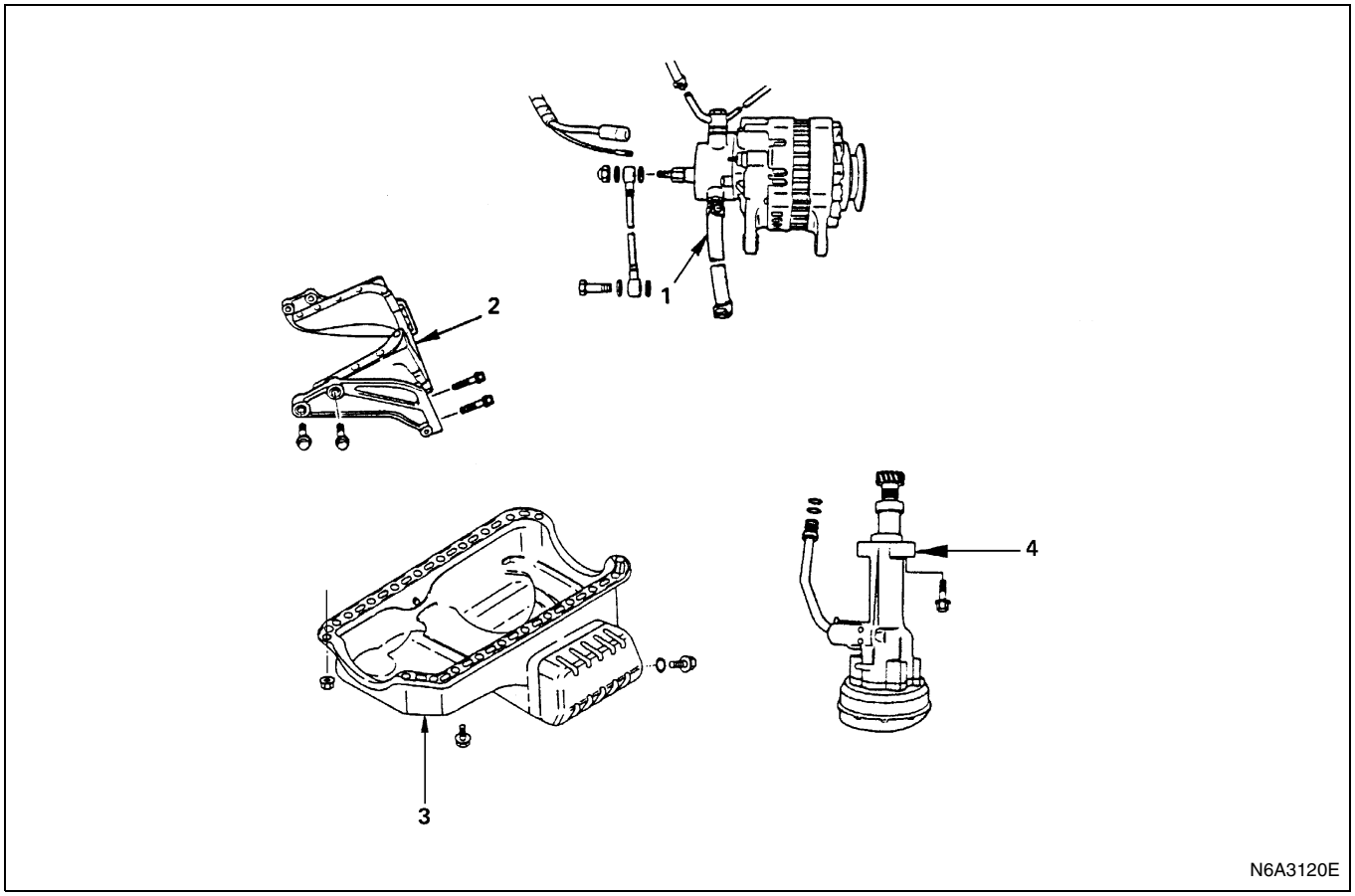
2. Rocker Arm Shaft Spring
3. Rocker Arm
4. Rocker Arm Shaft Bracket
5. Rocker Arm
6. Rocker Arm Shaft Snap Ring
7. Rocker Arm Shaft Assembly
   - Install the rocker arm shaft assembly in cylinder head.
   - Tighten the rocker arm shaft fixing bolts to the specified torque.



N6A3091E

OIL PUMP

Component

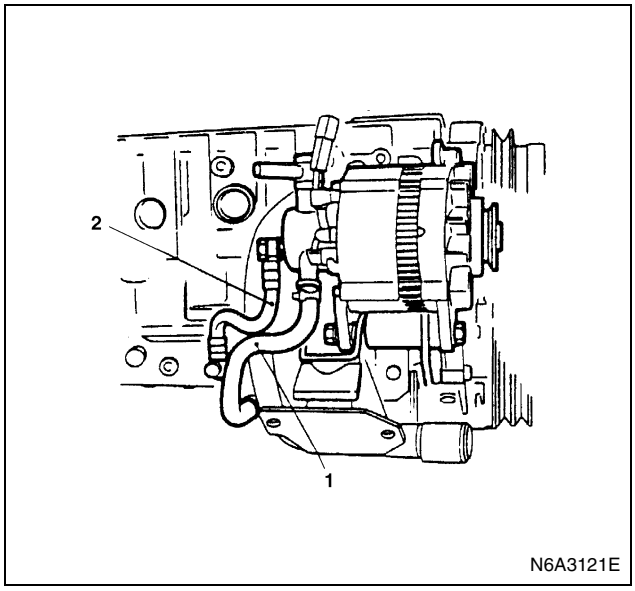


Legend

1. Vacuum pump oil hose
2. Stiffener & space rubber
3. Oil pan assembly
4. Oil pump assembly

Removal

1. Vacuum Pump Oil Hose
   - Remove the oil hose (1) from oil pan.



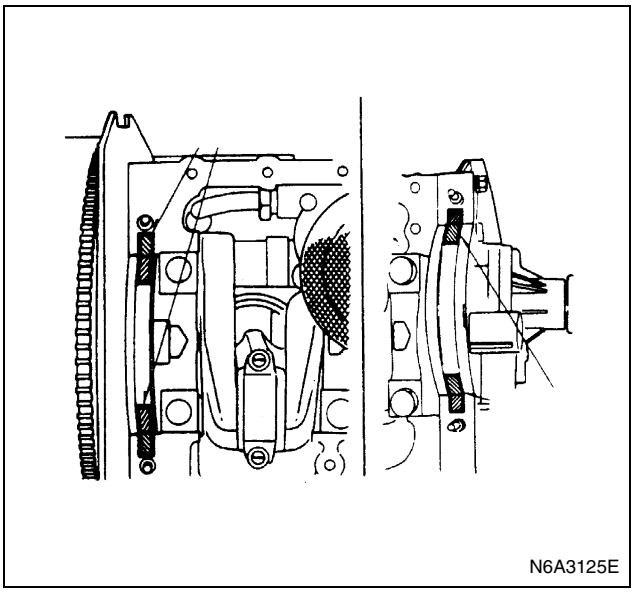
2. Stiffener & Space Rubber
   - Remove the stiffener from of the oil pan left & right side.
   - Take out space rubber.
3. Oil Pan Assembly
4. Oil Pump Assembly

Installation

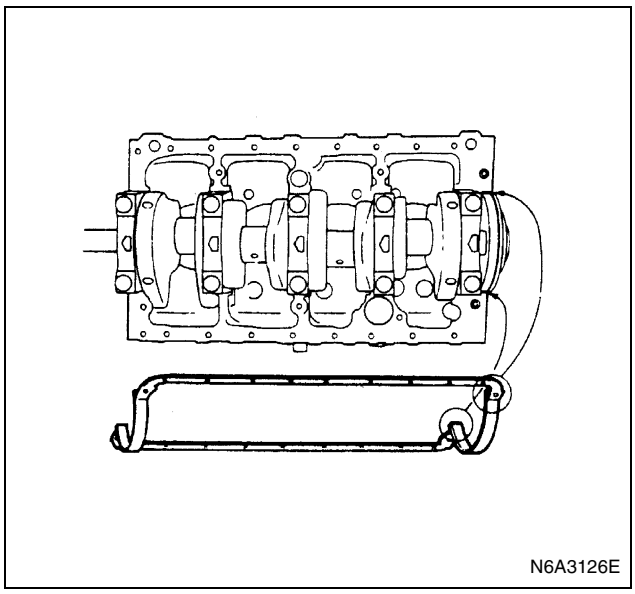
1. Oil Pump Assembly
   - Apply molybdenum mixed engine oil to drive gear of camshaft and driven gear of oil pump.
   - Tighten the oil pump fixing bolt to the specified torque.

Tighten:
19 N·m (1.9 kg·m/14 lb·ft)

2. Oil Pan Assembly
   - Apply the recommended liquid gasket or its equivalent to the No. 5 bearing cap arches, the grooves, the cylinder block and the timing gear case fitting face at the positions shown in the illustration.


N6A3125E

   - Fit the gasket rear lipped portion into the No. 5 groove.


N6A3126E

   - Be absolutely sure that the lipped portion is fitted snugly into the groove.
   - Install the oil pan to the cylinder body.
   - Tighten the oil pan bolts to the specified torque.

Tighten:
Oil Pan Bolt to 19 N·m (1.9 kg·m/14 lb·ft)

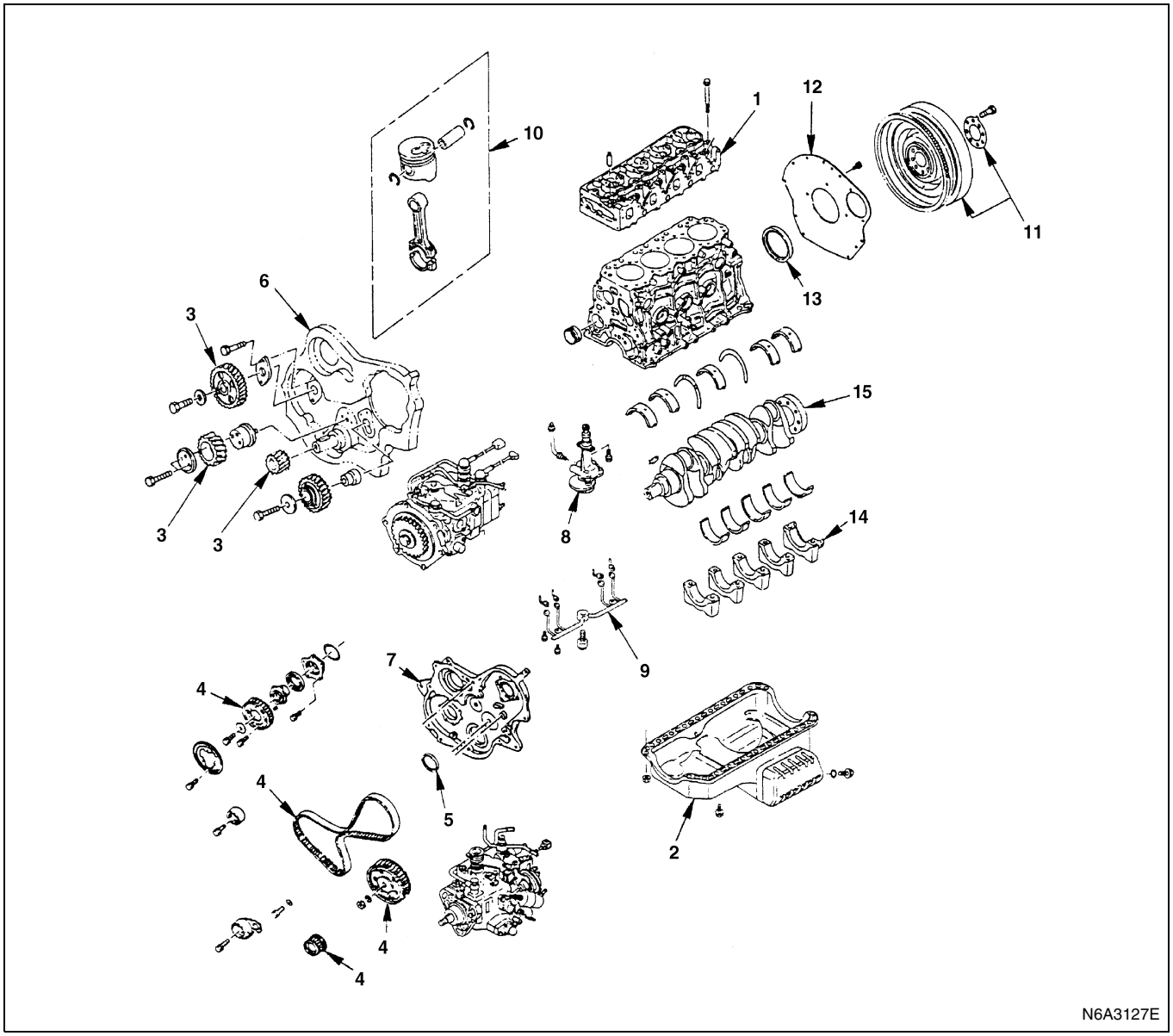
3. Stiffener & Space Rubber
   - Install the space rubber.
   - Install the stiffener tighten to the specified torque.

Tighten:
- Engine Body Side to 37 N·m (3.8 kg·m/27 lb·ft)
- Clutch Housing Side to 78 N·m (8.0 kg·m/58 lb·ft)

4. Vacuum Pump Oil Hose
   - Install the oil hose to oil pan.

CRANKSHAFT

Component

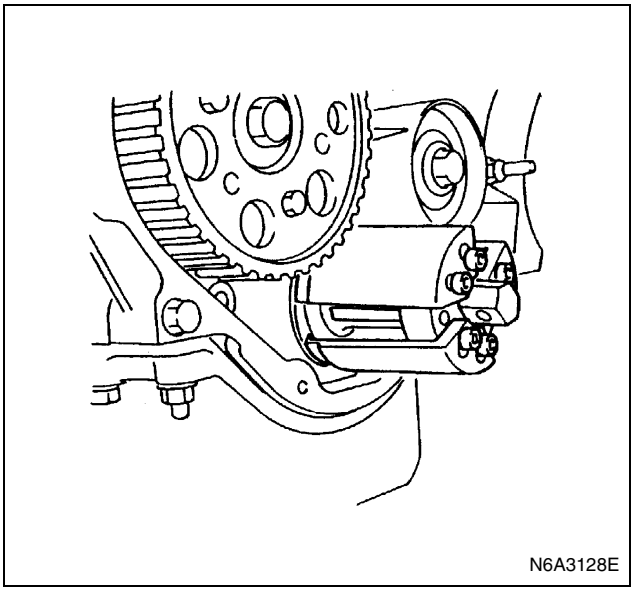


Legend

1. Cylinder head assembly and gasket
2. Oil pan assembly
3. Timing gear
4. Timing belt and pulley
5. Front oil seal
6. Timing gear housing
7. Timing pulley housing
8. Oil pump assembly
9. Piston cooling oil pipe
10. Piston and connecting rod
11. Flywheel
12. Cylinder block rear plate
13. Crankshaft rear oil seal
14. Main bearing cap
15. Crankshaft

Disassembly

1. Cylinder Head Assembly and Gasket
2. Oil Pan Ambly
3. Timing Gear (Gear Drive Model)
4. Timing Belt and Pulley (Belt Drive Model)
5. Front Oil Seal
   - With the oil seal pushed in deep, install the special tool as shown in the illustration to remove the oil seal.
     Remover: 5-8840-2362-0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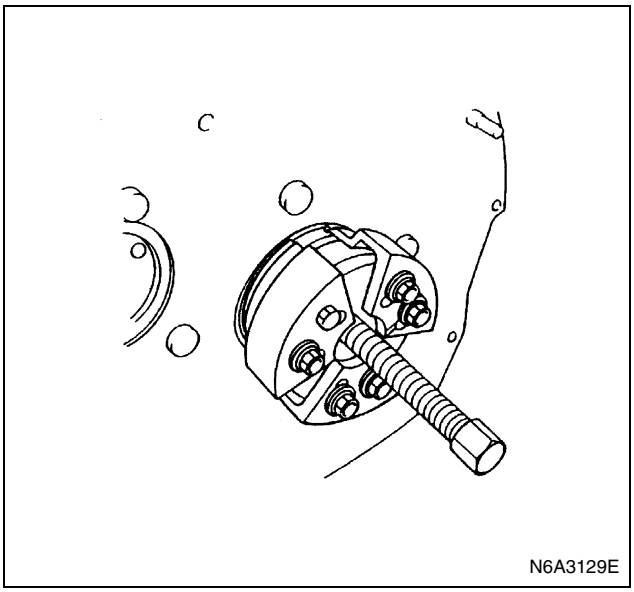
6. Timing Gear Housing
7. Timing Pulley Housing
8. Oil Pump Assembly
9. Piston Cooling Oil Pipe
10. Piston and Connecting Rod
11. Flywheel
12. Cylinder Block Rear Plate
13. Crankshaft Rear Oil Seal (Gear and Belt Drive Model)
    - With the oil seal pushed in deep, install the special tool as shown in the illustration to remove the oil seal.
      Remover: Rear Oil Seal 5-8840-2360-0


N6A3129E

Notice:
Take care not to damage sealing surface of rear plate and crankshaft when removing oil seal.

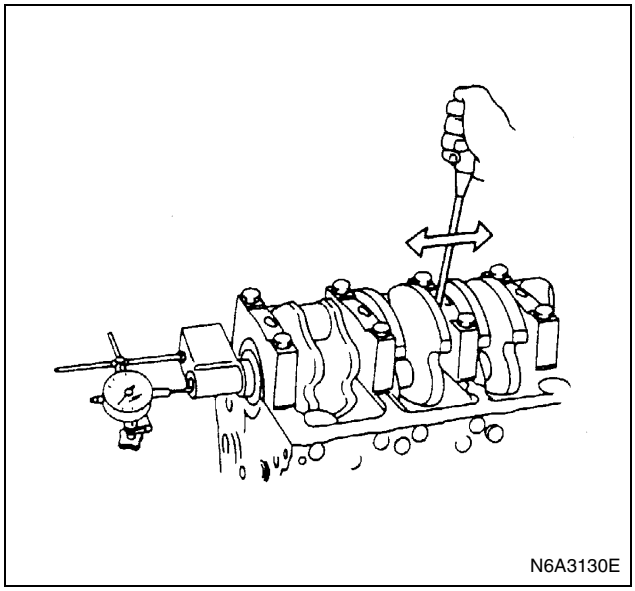
14. Main Bearing Cap
15. Crankshaft

Inspection and Repair

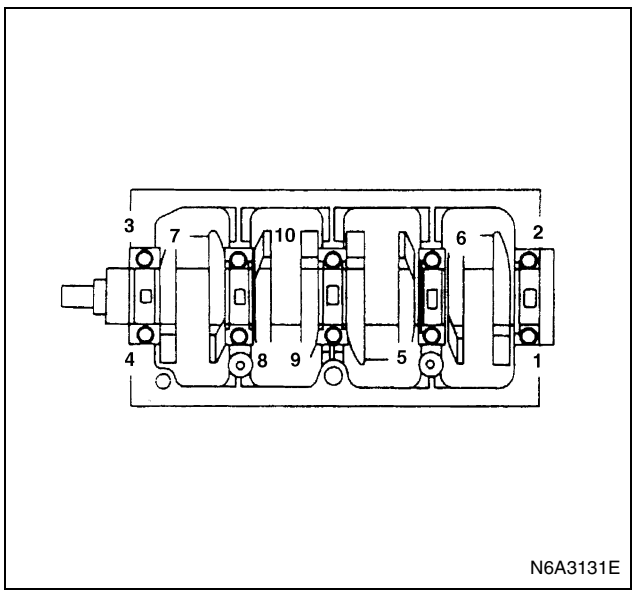
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

1. Crankshaft
   Thrust clearance
   Set the dial indicator as shown in the illustration and measure the crankshaft thrust clearance.
   If the thrust clearance exceeds the specified limit, replace the thrust bearing as a set.

Thrust clearance	mm (in)
Standard	Limit
0.10 (0.0039)	0.30 (0.0118)

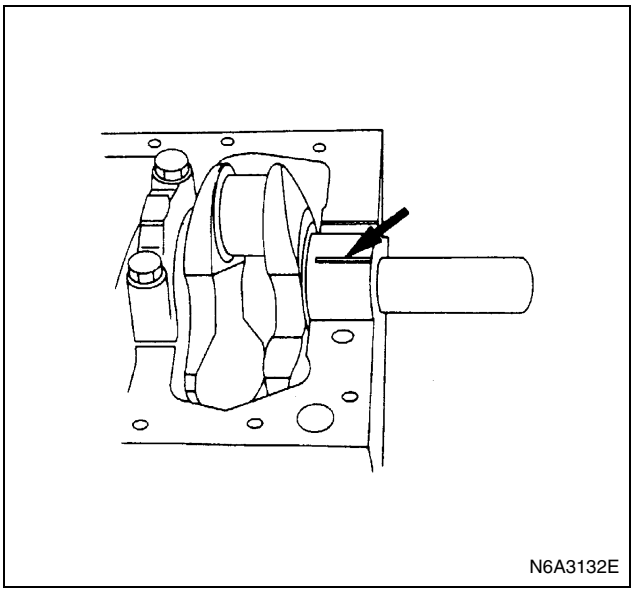

N6A3130E

2. Main bearing clearance
   1) Remove the main bearing caps in the sequence shown in the illustration.
      Arrange the removed main bearing caps in the cylinder number order.



N6A3131E

2) Remove the crankshaft. Remove the main bearings.
3) Clean the upper and lower bearings as well as the crankshaft main journal.
4) Check the bearings for damage or excessive wear.
   The bearings must be replace as a set if damage or excessive wear is discovered during inspection.
5) Set the upper bearings and the thrust washers to their original positions. Carefully install the crankshaft.
6) Set the lower bearings to the bearing cap original position.
7) Apply plastigage to the crankshaft journal unit as shown in the illustration.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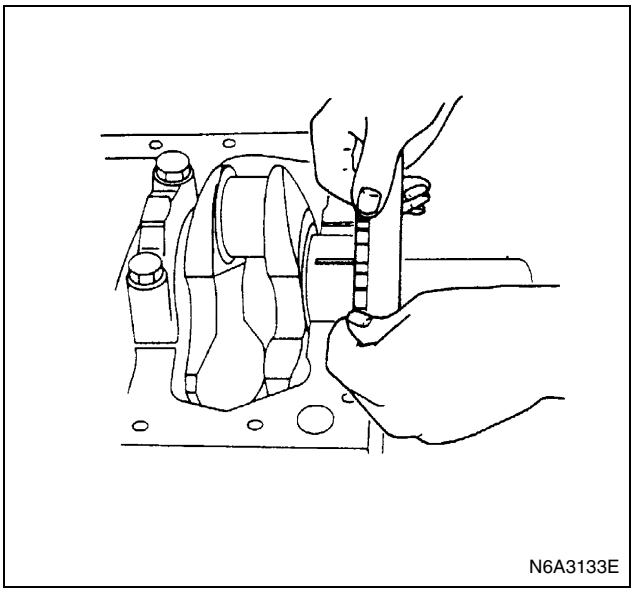
8) Install the main bearing caps. Apply engine oil to the bolt threads and the seats. Tighten the bolts to the specified torque.

Tighten:
167 N·m (17 kg·m/123 lb·ft)

Notice:
Do not allow the crankshaft to rotate.

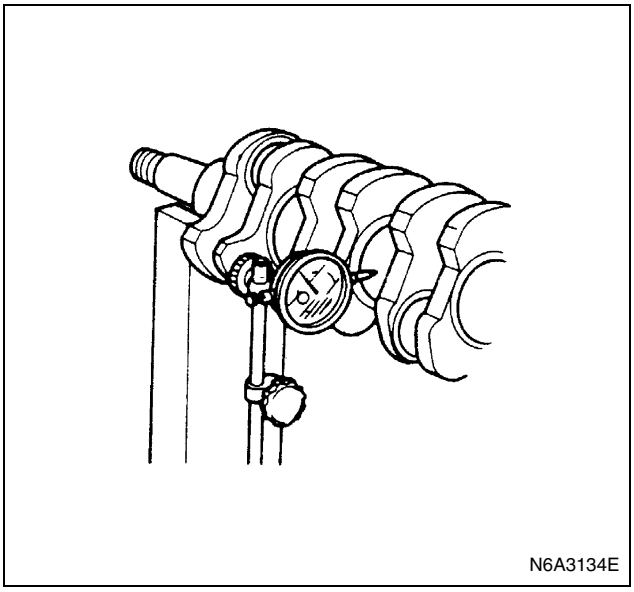
9) Remove the main bearing caps.
10) Measure the plastigage width and determine the oil clearance. If the oil clearance exceeds the specified limit, replace the main bearings as a set and/or replace the crankshaft.
11) Clean the plastigage from the bearings and the crankshaft.
12) Remove the crankshaft and the bearings.

Oil Clearance		mm (in)
	Standard	Limit
4JB1 4JB1-TC	0.035 — 0.080 (0.0014 — 0.0036)	0.11 (0.0043)
4JG2	0.031 — 0.063 (0.0012 — 0.0025)	
4JH1-TC	0.037 — 0.068 (0.0015 — 0.0027)	


N6A3133E

3. Run-out
   1) Carefully set the crankshaft on the V-blocks. Slowly rotate the crankshaft and measure the runout.
      If the crankshaft runout exceeds the specified limit, the crankshaft must be replaced.

Run-Out	mm (in)
Standard	Limit
0.05 (0.0020) or less	0.08 (0.0031)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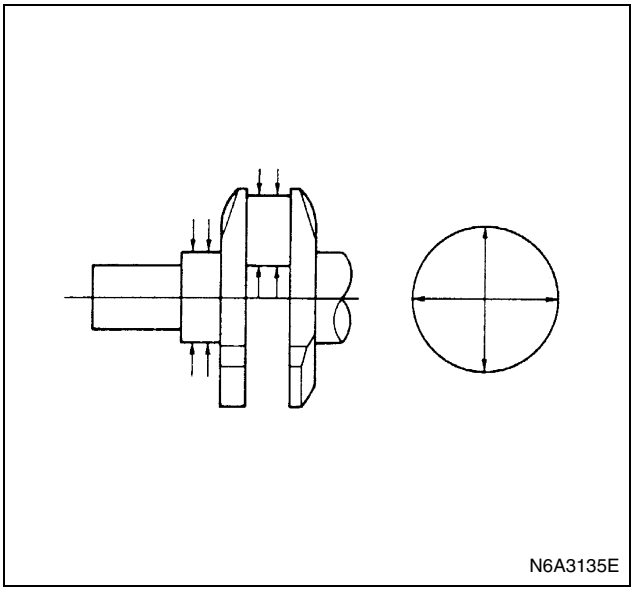
Measure the diameter and the uneven wear of main journal and crank pin.

If the crankshaft wear exceeds the specified limit, crankshaft must be replaced.

		mm (in)
	Standard	Limit
Main journal diameter	69.917 — 69.932 (2.7526 — 2.7532)	69.91 (2.7524)
Crank pin diameter	52.915 — 52.930 (2.0833)	52.90 (2.0843)
Uneven wear limit	0.05 (0.0020) or less	0.08 (0.0031)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Crankshaft Inspection

Inspect the surface of the crankshaft journals and crank pins for excessive wear and damage.

Inspect the oil seal fitting surfaces for excessive wear and damage.

Inspect the oil ports for obstructions.

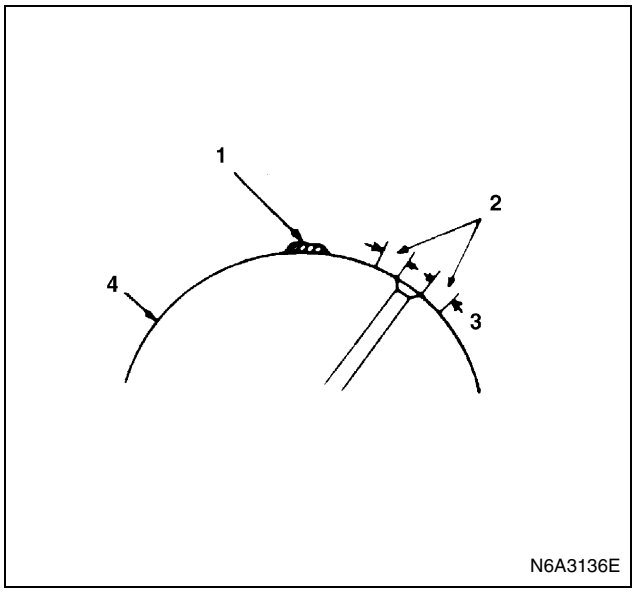
Crankshaft Tufftriding Inspection

The portion to be tested must be held horizontally so as not let the test solution flow (1).

Test liquid should not be applied to the area around the oil port (2).

Approximately 10 mm (0.39 in) (3)

The sliding surface of the pin or journal (4).



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Notice:

To increase crankshaft strength, Tufftride Method (Soft nitriding) has been applied. Because of this, it is not possible to regrind the crankshaft surfaces.

1. Use an organic cleaner to thoroughly clean the crankshaft. There must be no traces of oil the surfaces to be inspected.
2. Prepare a 5 — 10% solution of ammonium cupric chloride (dissolved in distilled water).
3. Use a syringe to apply the solution to the surface to be inspected.
   Hold the surface to be inspected perfectly horizontal to prevent the solution from running.

Notice:

Do not allow the solution to come in contact with the oil ports and their surrounding area.

Testing

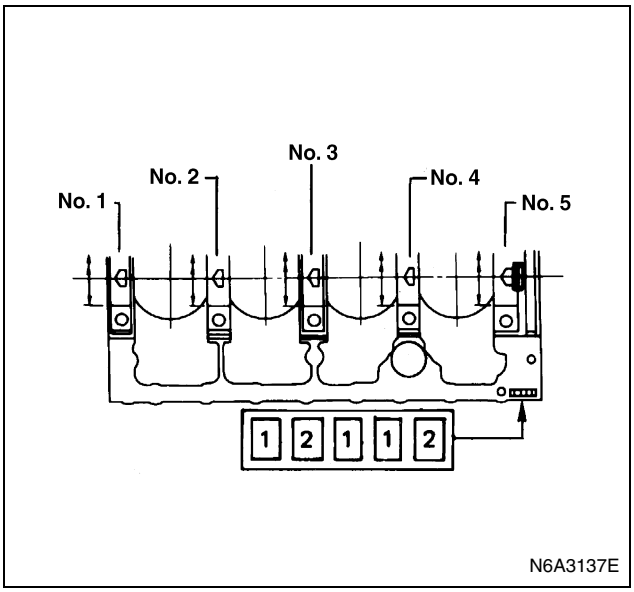
1. Wait for thirty to forty seconds.
   If there is no discoloration after thirty or forty seconds, the crankshaft is usable.
   If discoloration appears (the surface being tested will become the color copper), the crankshaft must be replaced.
2. Steam clean the crankshaft surface immediately after completing the test.

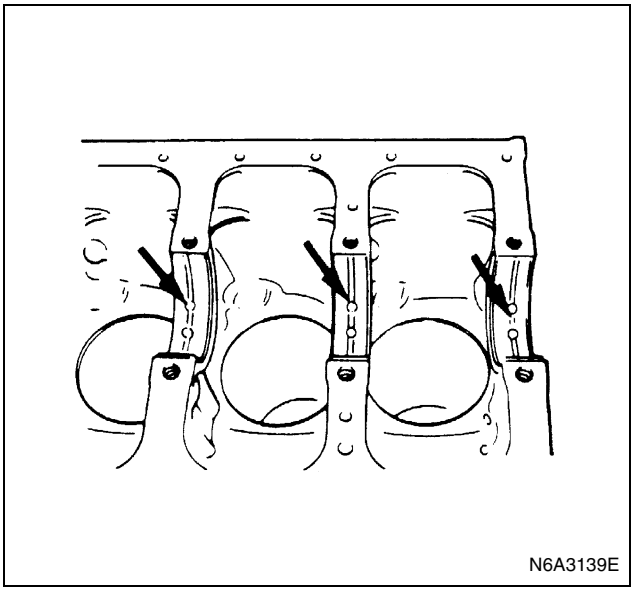
Notice:

The ammonium cupric chloride solution is highly corrosive. Because of this, it is imperative that the surfaces being tested be cleaned immediately after completing the test.

Crankshaft Bearing Selection

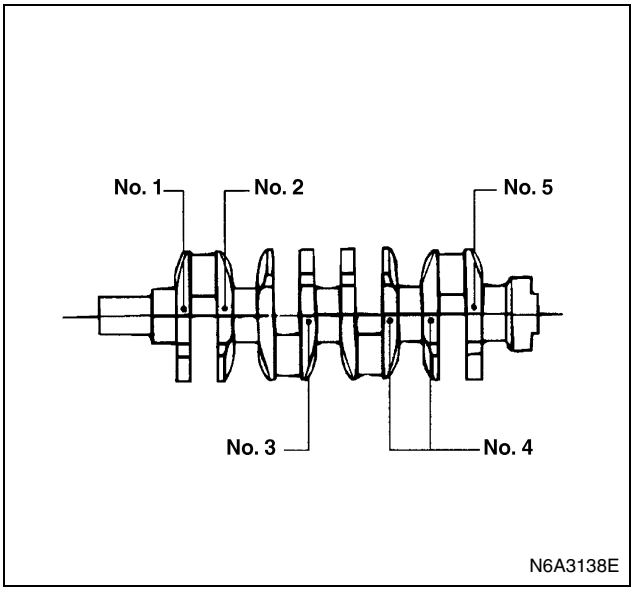
When installing new crankshaft bearings or replacing old bearings, refer to the selection table.





Notice:

Please note that some Crankshaft No. 4 journals made during a limited production period have their number (No. 4) marked on either their front or rear side of webs as shown below.



Notice:

Although all upper journal bearings (cylinder body side) have oil grooves and holes, all lower bearings (bearing cap side) have no groove and hole.

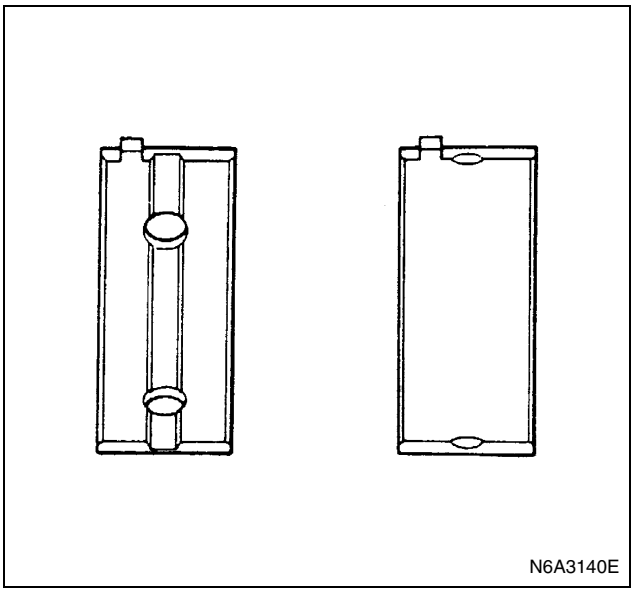
Play close attention to the distinction during the installation procedure.

mm (in)

Crankshaft Bearing Housing		Crankshaft Journal		Crankshaft Bearing Size Code
Grade Mark	Diameter	Grade Mark	Diameter	
1	73.992 — 74.000 (2.9131 — 2.9134)	1 or -	69.927 — 69.932 (2.7530 — 2.7532)	4
		2 or - -	69.922 — 69.927 (2.7528 — 2.7530)	
		3 or - - -	69.917 — 69.922 (2.7556 — 2.7528)	5
2	73.983 — 73.992 (2.9127 — 2.9131)	1 or -	69.927 — 69.932 (2.7530 — 2.7532)	2
		2 or - -	69.922 — 69.927 (2.7528 — 2.7530)	3
		3 or - - -	69.917 — 69.922 (2.7556 — 2.7528)	4
3	73.975 — 73.983 (2.9124 — 2.9127)	1 or -	69.927 — 69.932 (2.7530 — 2.7532)	1
		2 or - -	69.922 — 69.927 (2.7528 — 2.7530)	2
		3 or - - -	69.917 — 69.922 (2.7526 — 2.7528)	

Reassembly

1. Crankshaft
   - Install the main bearings to the cylinder body and the main bearing caps.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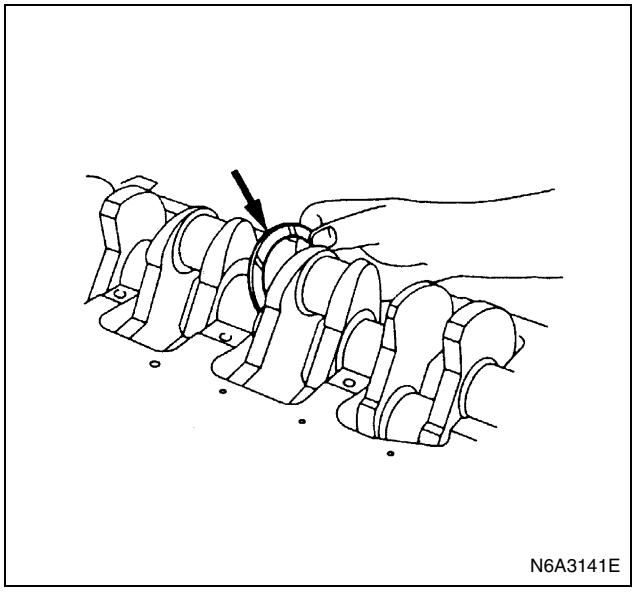
   - Be sure that they are positioned correctly.
   - Apply new engine oil to the upper and lower main bearing faces.
   - Carefully mount the crankshaft.
   - Apply engine oil to the thrust washer.
   - Assemble the thrust washer to the No.3 bearing journal. The oil grooves must face the crankshaft.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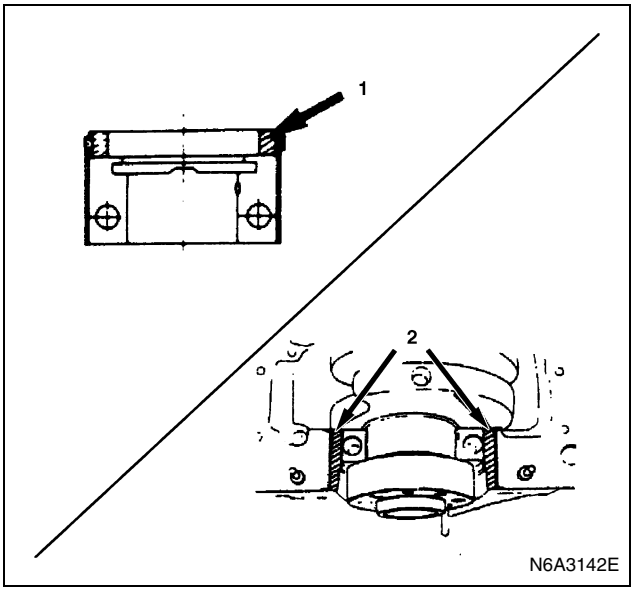
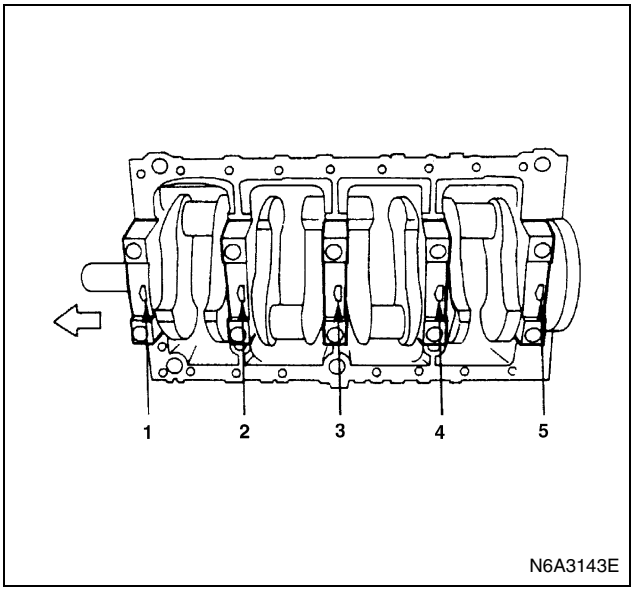
2. Main Bearing Cap
   - Apply the recommended liquid gasket or its equivalent to the No. 5 crankshaft bearing cap (1) as shown in the illustration.
   - Install the arch gasket (2) to the No. 5 bearing cap.
     Use your fingers to push the arch gasket into the bearing cap groove.



Notice:
Be sure that the bearing cap fitting surface is completely free of oil before applying the liquid gasket.

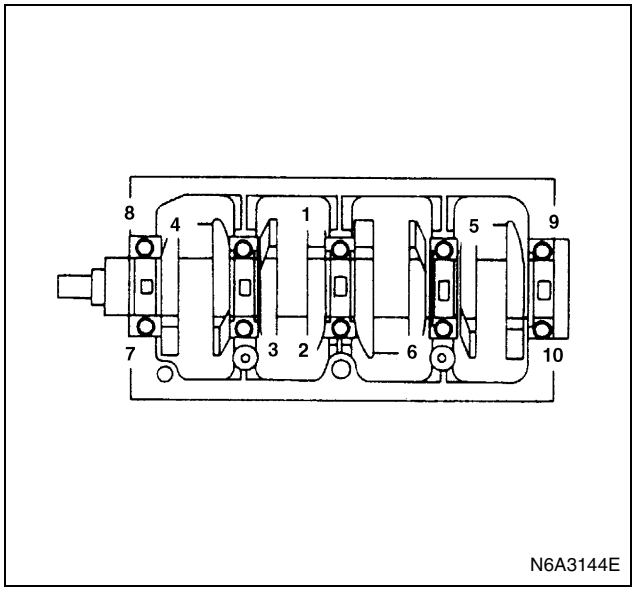
Do not allow the liquid gasket to obstruct the cylinder thread holes and bearings.

- Install the bearing caps with the bearing cap head arrow mark facing the front of the engine.



- Apply engine oil to the crankshaft bearing cap bolts.
- Tighten the crankshaft bearing cap bolts to the specified torque a little at a time in the sequence shown in the illustration.

Tighten:
167 N·m (17 kg·m/123 lb·ft)



Notice:
Check to see that the crankshaft turns smoothly by rotating it manually.

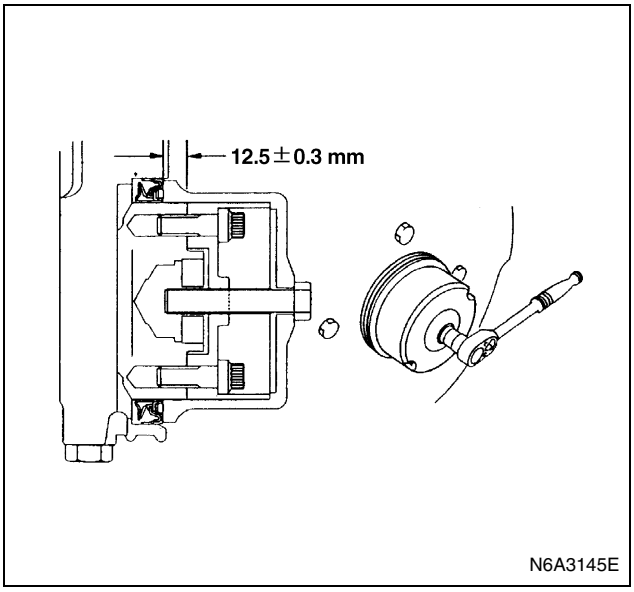
3. Crankshaft Rear Oil Seal (Gear and Belt Drive Model)
   Use the oil seal installer to install the oil seal to the cylinder body.
   Installer: Rear Oil Seal 5-8840-2359-0

Notice:
Wipe off rust and scraps clean from the press-in portion of the oil seal.

Take note of the press-in direction of the oil seal.

1) Install the adapter of the special tool to the rear end of the crankshaft with two bolts.
2) Install the oil seal to the outer circumference of the adapter.
3) Insert the slave into the adapter portion, and tighten it in with the bolt (M12 × 1.75L=70) until the adapter section hits the slave.
4) Remove the adapter and the slave.
5) After installing the oil seal, check the measurement of the oil seal.

Standard	mm (in)
12.2 — 12.8 (0.48 — 0.50)	

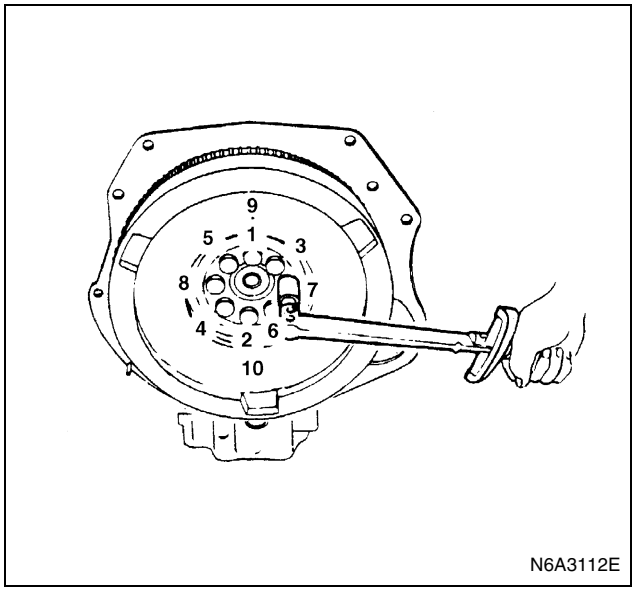


4. Cylinder Block Rear Plate
   Align the rear plate with the cylinder body knock pins.
   Tighten the rear plate to the specified torque

Tighten:
82 N·m (8.4 kg·m/61 lb·ft)

5. Flywheel
   1) Thoroughly clean the remove the oil from the threads of crankshaft.
   2) Mount the flywheel on the crankshaft and then install the washer.
   3) Apply a coat of engine oil to the threads of the flywheel bolts.
   4) Align the flywheel with the crankshaft dowel pin.
   5) Tighten the flywheel bolts to the specified torque in two steps using the Angular Tightening Method.
      Follow the numerical order shown in the illustration.

Tighten:
- Flywheel Bolt to
  1st Step: 59 N·m (6.0 kg·m/43 lb·ft)
  2nd Step: 60° — 90°



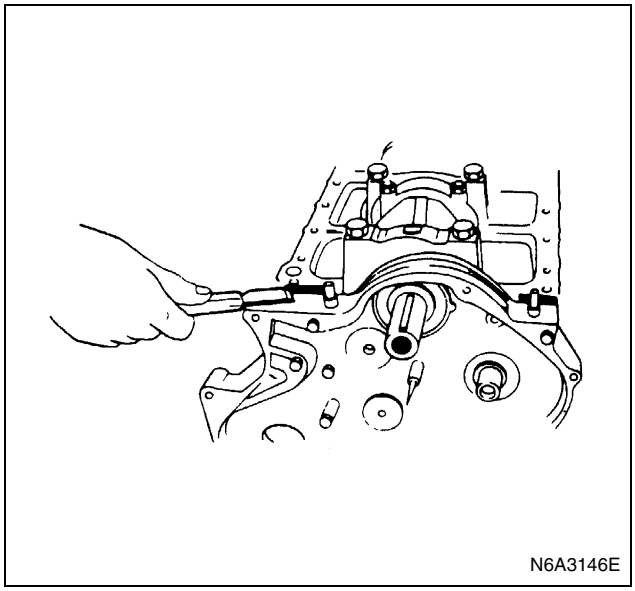
6. Piston and Connecting Rod
7. Piston Cooling Oil Pipe
8. Oil Pump Assembly
   Above works refer to “PISTON AND CONNECTING ROD”
   Section in this manual.
9. Timing Pulley Housing
   1) Install the timing pulley housing to the cylinder body.

Notice:
Take care not to twist the front oil seal.

   2) Tighten the timing pulley housing bolt together with the timing pulley housing gasket to the specified torque.

Tighten:
19 N·m (1.9 kg·m/14 lb·ft)

   3) Cut away the gasket protruding above the fitting surfaces (as shown in the illustration).



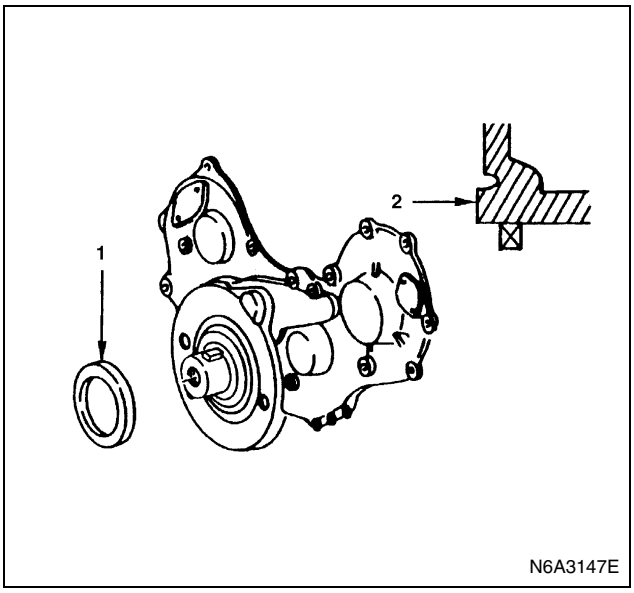
10. Timing Gear Housing

1) Install the timing gear housing to the cylinder body.
2) Tighten the timing gear housing bolt together with the timing gear housing gasket to the specified torque.

Tighten:
19 N·m (1.9 kg·m/14 lb·ft)

3) Cut away the gasket protruding above the fitting surface (as shown in the illustration).

11. Front Oil Seal (Gear Drive Model)
    - Install oil seal using special tool.
      Installer: 5-8840-2061-0



Legend
1. Oil seal
2. Timing pulley housing

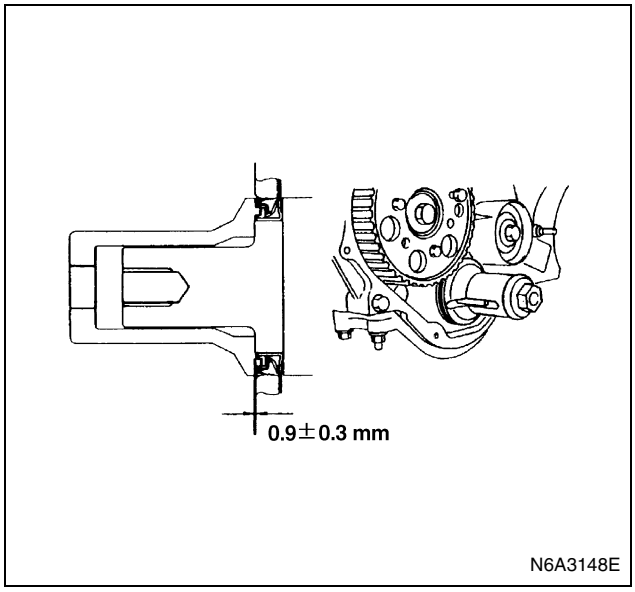
12. Front Oil Seal (Belt Drive model)
    - Install oil seal using special tool.
      Installer: 5-8840-2361-0

Notice:
Wipe off rust and scraps clean from the press-in portion of the oil seal.

Take note of the press-in direction of the oil seal.

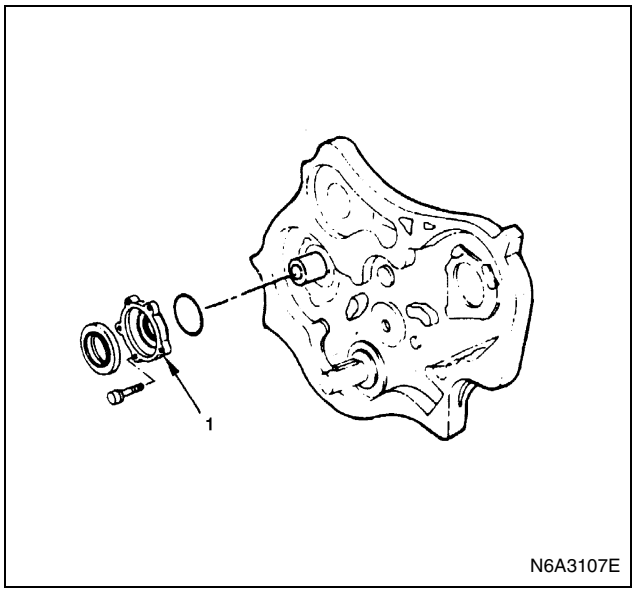
1) With the oil seal attached to the sleeve, put it in the front end of the crankshaft.
2) With the edge of the oil seal attached securely to the crankshaft, tighten it with the center bolt until the sleeve hits securely against the reference plane at the front end of the crankshaft.
3) Remove the sleeve.
4) After pressing in the oil seal, check the measurement of the oil seal.

Standard	mm (in)
0.6 — 1.2 (0.024 — 0.047)	



13. Camshaft Timing Pulley (Belt Drive model)
    1) Apply engine oil to the oil seal lip portion of the oil seal retainer.
    2) Apply the recommended liquid gasket or its equivalent to the retainer.
    3) Install the oil seal retainer to the cylinder body.
    4) Tighten the retainer bolts to the specified torque.

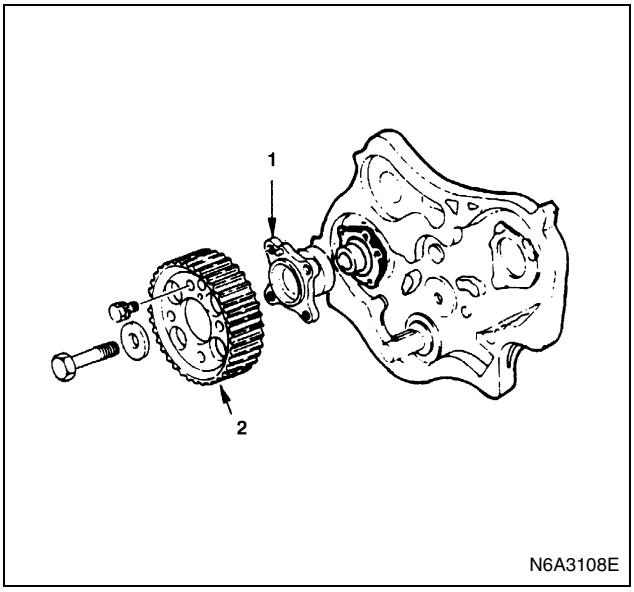
Tighten:
Oil Seal Retainer Bolt to 19 N·m (1.9 kg·m/14 lb·ft)



Legend
1. Retainer

5) Align the camshaft timing pulley center with the camshaft key.
6) Tighten the timing pulley bolts to the specified torque.

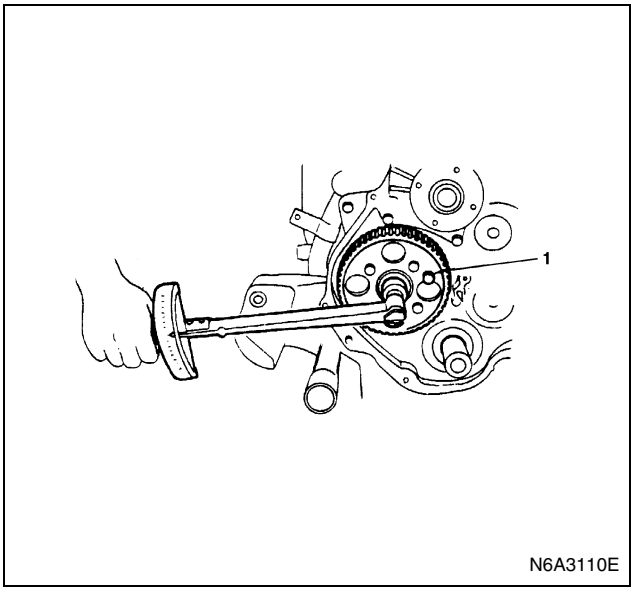
Tighten:
Timing Pulley Bolt to 8 N·m (0.8 kg·m/69 lb·ft)



Legend
1. Timing pulley center
2. Timing pulley

7) Prevent the camshaft from turning when tightening the timing center bolt.
8) Tighten the timing pulley center bolt to the specified torque.

Tighten:
Center Bolt to 64 N·m (6.5 kg·m/47 lb·ft)



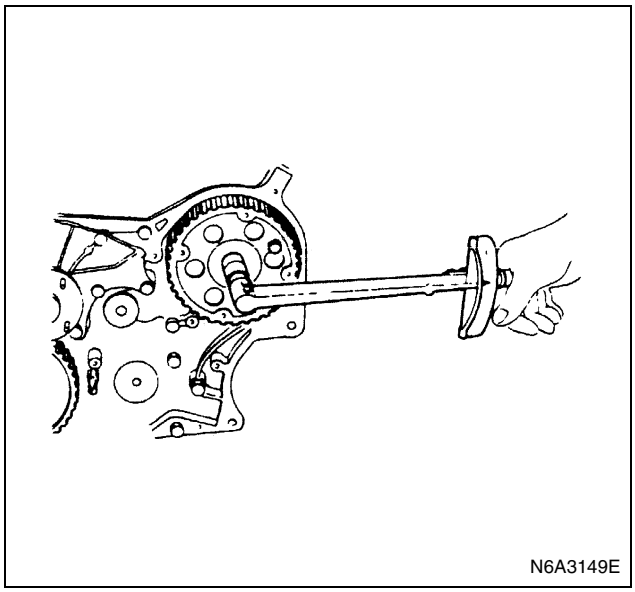
Legend
1. Lock bolt

9) Install the crank pulley.
10) Install the idle pulley and idler pulley.

Tighten:
76 N·m (7.8 kg·m/56 lb·ft)

11) Install the injection pump assembly and install timing pulley.
12) Align the timing pulley with the pump shaft key.
13) Install the stopper bolt to the timing pulley.
This will prevent the timing pulley from moving.
14) Tighten the timing pulley nut to the specified torque.

Tighten:
Injection Pump Timing Pulley Nut to 64 N·m (6.5 kg·m/47 lb·ft)



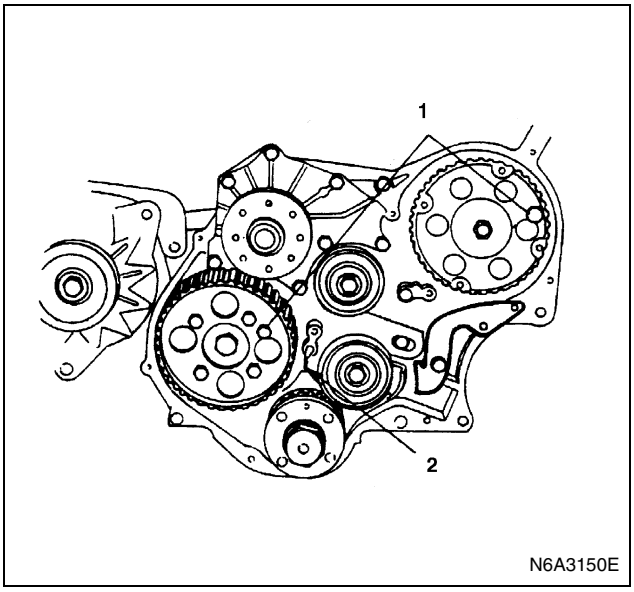
15) Remove the stopper bolt from the injection timing.

14. Timing Belt (Belt Drive model)

Notice:
- When the timing belt is removed, be sure to replace it with a new one.
- The tension of the timing belt may be affected by the changes in temperature. Be sure to install it while the engine cold.
- When the timing belt is bent forcibly, the cord may got snapped, thus resulting in the reduced strength. Do not bend it unnecessarily.

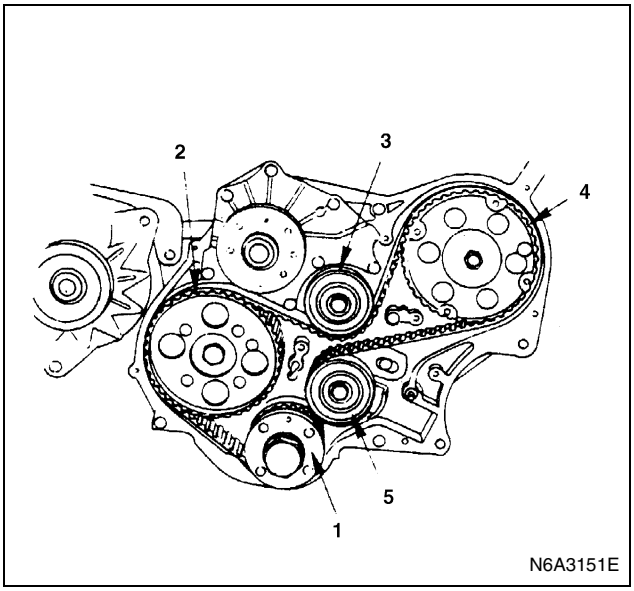
1) Check that the stopper bolts are properly installed to the camshaft timing pulley and the injection pump timing pulley.
2) Check that the timing pulley housing mark and the crankshaft timing pulley mark are aligned.
The No. 1 cylinder should be at TDC on the compression stroke.

Rotate the crankshaft damper pulley clockwise to align the marks.



Legend
1. Lock bolt
2. Setting mark

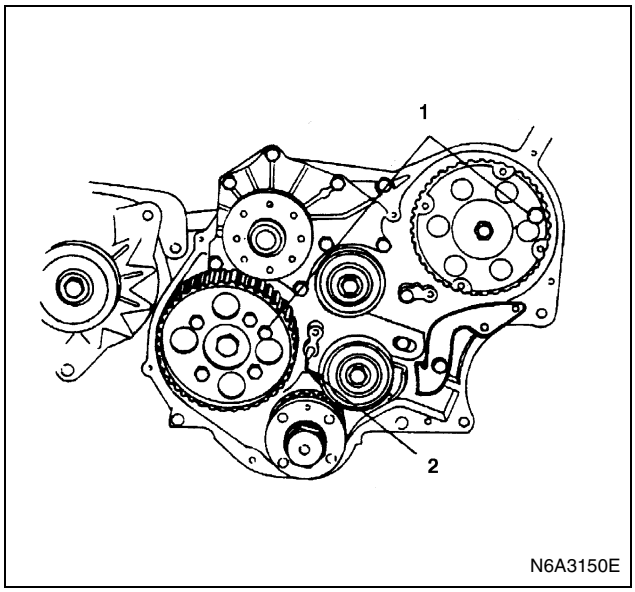
3) Install the timing belt to the crankshaft timing pulley (1), the camshaft timing pulley (2), the tensioner idler (3), and the injection timing pulley (4).
   Follow the numerical order.
4) Install the timing belt tensioner (5) to the timing pulley housing.
5) Temporarily tighten the tensioner bolt.
   The tensioner should move freely.



Notice:
The timing belt is easily damaged. Be careful.

Notice:
After completion of the installation of the timing belt, check to see if the alignment mark of the crankshaft timing pulley is in line with the alignment mark provided on the housing.

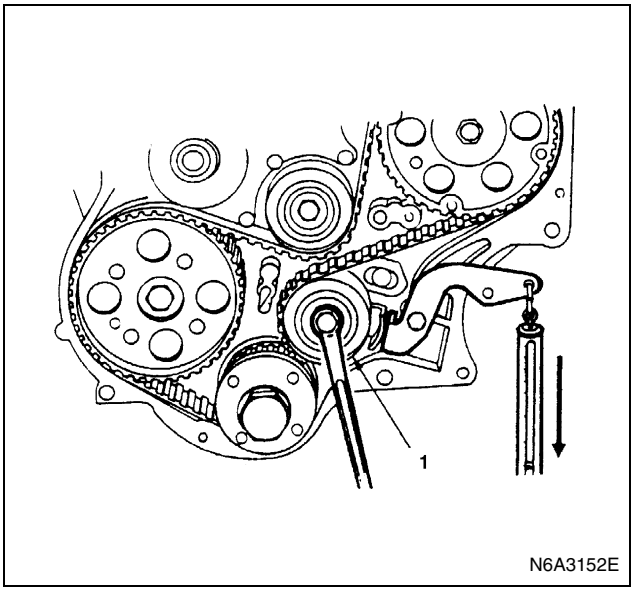
- When the alignment marks are not in line with each other, set them together and reinstall the timing belt.



Legend
1. Lock bolt
2. Setting mark

6) Set the tensioner adjusting lever to the timing pulley housing.
7) Remove the stopper bolts from the camshaft timing pulley and the injection pump timing pulley.
8) Attach the spring balancer.
9) Adjust the timing belt tension by pulling straight down on the spring balancer with the specified force.

Tension Adjusting Lever Force	N (kg/lb)
98 — 118 (10 — 12/22 — 26)	



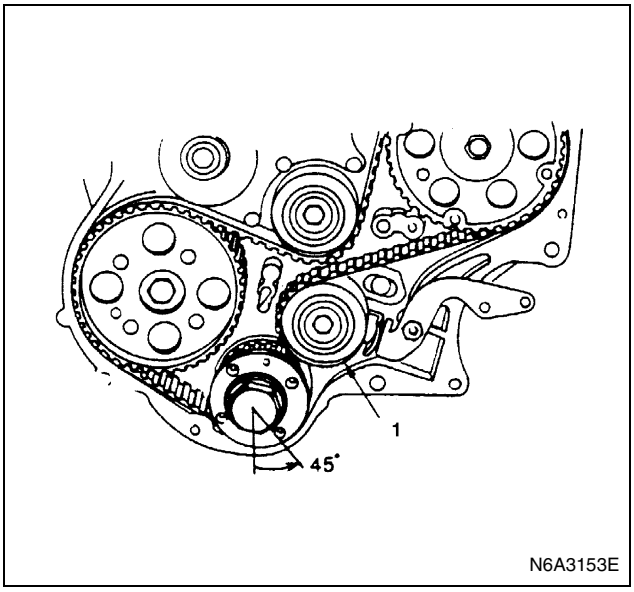
Legend
1. Tensioner

Notice:
Timing belt tension must be adjusted.

Failure to adjust the timing belt tension will result in timing belt damage.

10) Tighten the tension bolt.

11) Rotate the crankshaft 45 degrees counterclockwise.



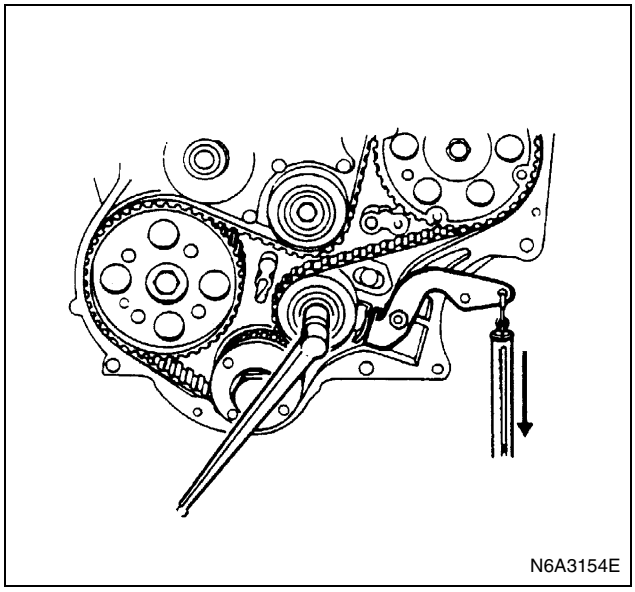
Legend
1. Tensioner

Notice:
Never rotate the crankshaft clockwise when adjusting the timing belt.

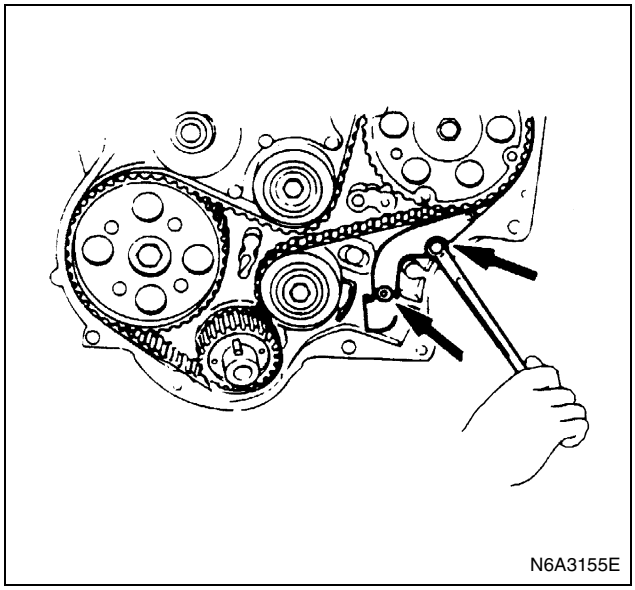
12) Readjust the timing belt tension.
Refer to Step 9
This will remove any remaining timing belt slack.

13) Tighten the tension bolt to the specified torque.

Tighten:
Tensioner Bolt to 76 N·m (7.7 kg·m/56 lb·ft)



14) Tighten the tension adjusting lever nut and bolt.



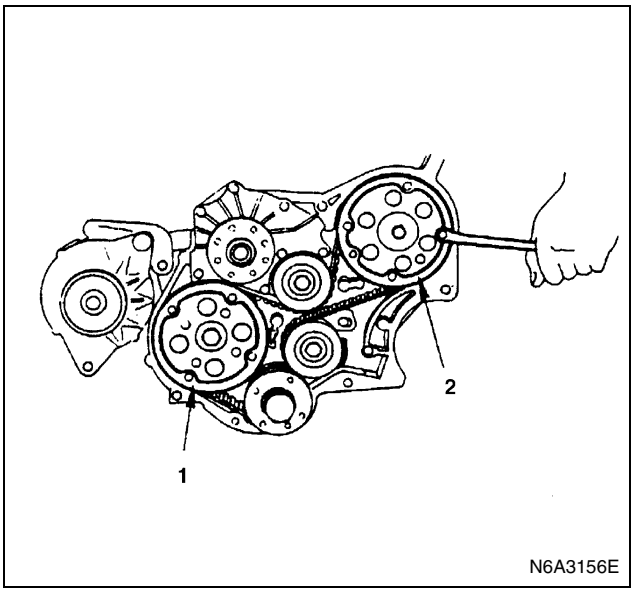
Notice:
If on-vehicle timing belt replacement is performed, the crankshaft must not be allowed to turn.

If the crankshaft is allowed to turn, piston and valve damage will result.

15. Flange: Camshaft Pulley (Belt Drive model)
16. Flange: Injection Pump Pulley (Belt Drive model)
    1) Install the timing pulley flange to the camshaft and injection pump timing pulley.

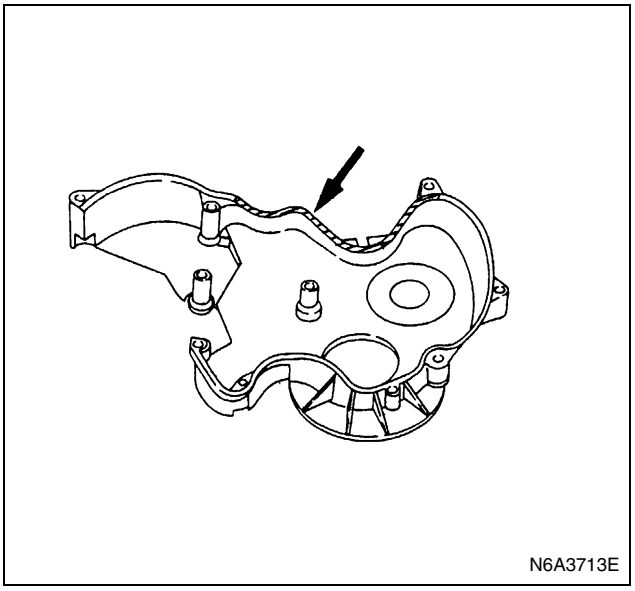
2) Tighten the timing pulley flange bolts to the specified torque.

Tighten:
Timing Pulley Flange Bolt to 19 N·m (1.9 kg·m/14 lb·ft)



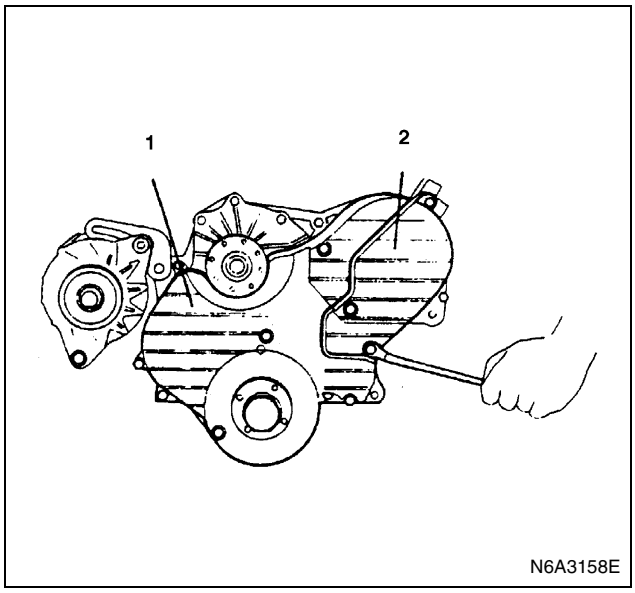
Legend
1. Camshaft pulley
2. Injection pump pulley

17. Timing Pulley Lower Cover (Belt Drive model)
    1) Apply the recommended liquid gasket or its equivalent to the timing pulley lower cover.



    2) Install the lower cover to the timing pulley housing.
    3) Use the lower cover guide bolts to prevent the liquid gasket from running.
18. Timing Pulley Upper Cover (Belt Drive model)
    1) Install the upper cover to the lower cover and the pulley housing.
    2) Tighten the timing pulley cover bolts to the specified torque a little at a time.

Tighten:
Timing Pulley Cover Bolt to 8 N·m (0.81 kg·m/6 lb·ft)



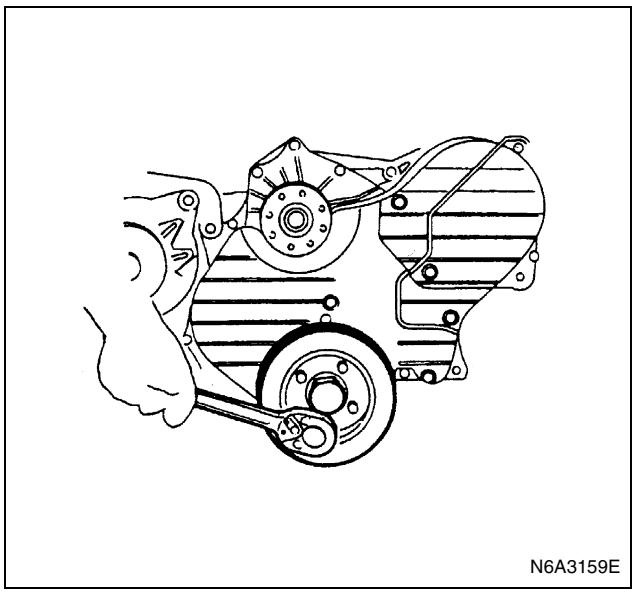
Legend
1. Lower cover
2. Upper cover

    3) Remove the lower cover guide pin.

Tighten:
Crankshaft Center Pulley to 206 N·m (21 kg·m/152 lb·ft)

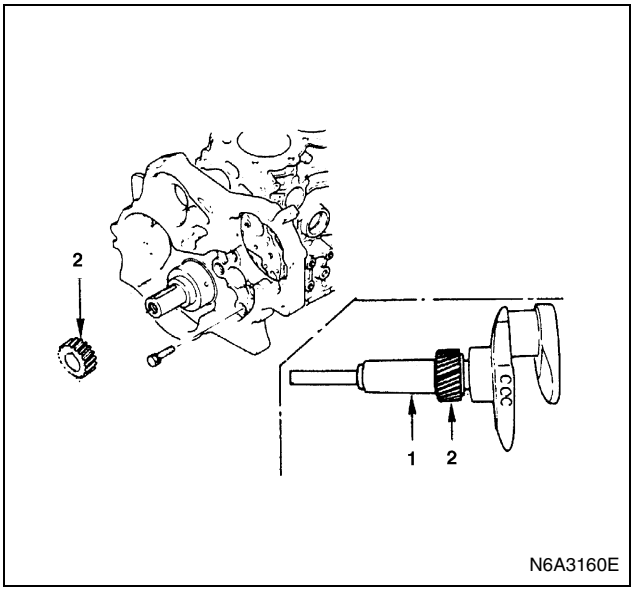
19. Crankshaft Damper Pulley (Belt Drive model)
    1) Install the damper pulley and tighten bolts to the specified torque.

Tighten:
Pulley Bolts to 19 N·m (1.9 kg·m/14 lb·ft)



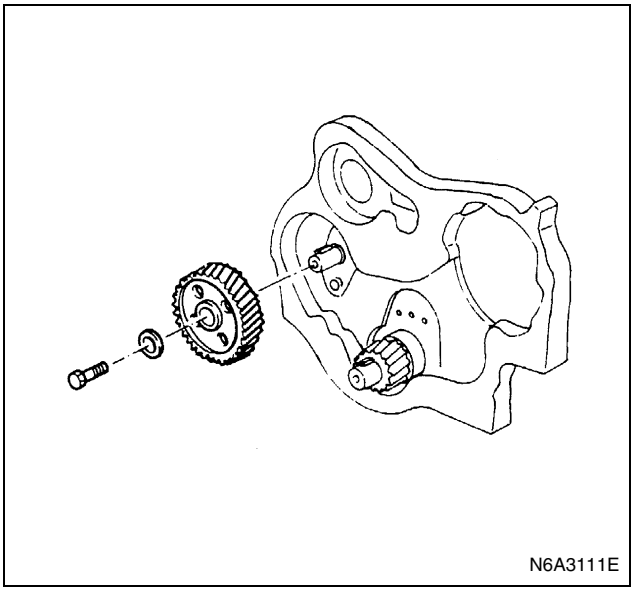
20. Crank Shaft Gear (Gear Drive model)
    1) Install the crankshaft gear.

2) Use the crankshaft gear installer (1) to install the crankshaft gear (2).
The crankshaft gear timing mark ("X — X") or ("· — ·") must be facing outward.
Crankshaft Gear Installer: 9-8522-0020-0

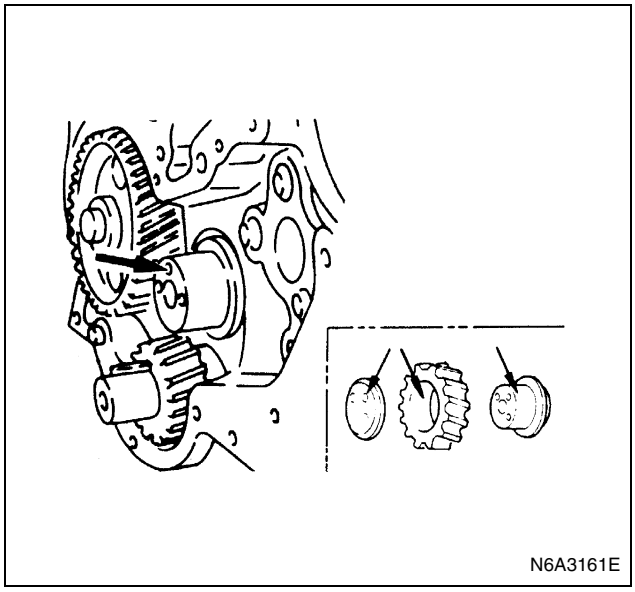


21. Crankshaft Timing Gear (Gear Drive model)
    1) Install the camshaft timing gear to the camshaft.
    The timing gear mark ("Y — Y") or ("· · — · ·") must be facing outward.
    2) Tighten the timing gear to the specified torque.

Tighten:
64 N·m (6.5 kg·m/47 lb·ft)

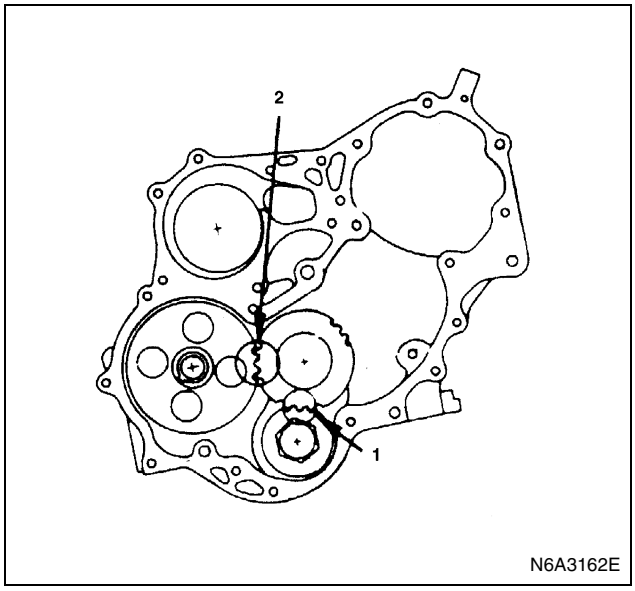


22. Idle Gear (Gear Drive model)
    1) Apply engine oil to the idle gear and the idler gear shaft.
    The idler shaft oil hole must be facing up.
    2) Position the idler gear setting marks "X" or "·" and "Y" or "· ·" so that they are facing the front of the engine.



    3) Align the idler gear "X" or "·" setting mark with the crankshaft timing gear (1) "X — X" or "· — ·" setting mark.
    4) Align the idler gear "Y" setting mark with the camshaft timing gear (1) "Y — Y" or "· · — · ·" setting mark.
    5) Install the thrust collar and bolts to the cylinder body through the shaft.
    The thrust collar oil hole must be facing up, and the thrust collar chamfered must be outward.
    6) Tighten the idler gear bolt to the specified torque.

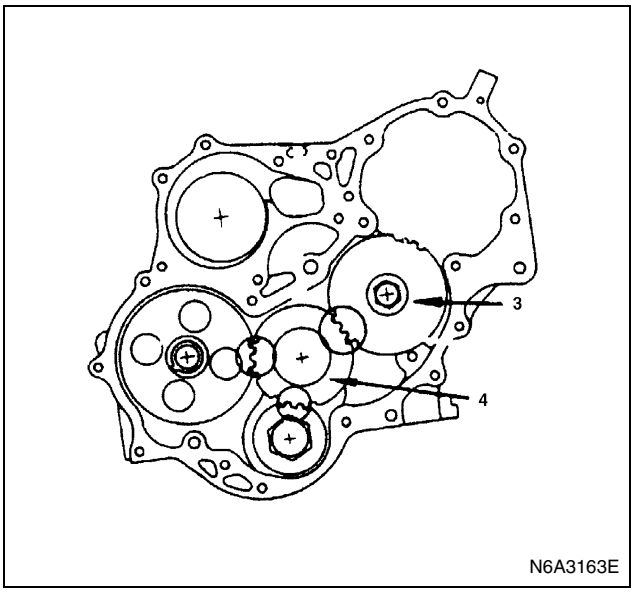
Tighten:
19 N·m (1.9 kg·m/14 lb·ft)



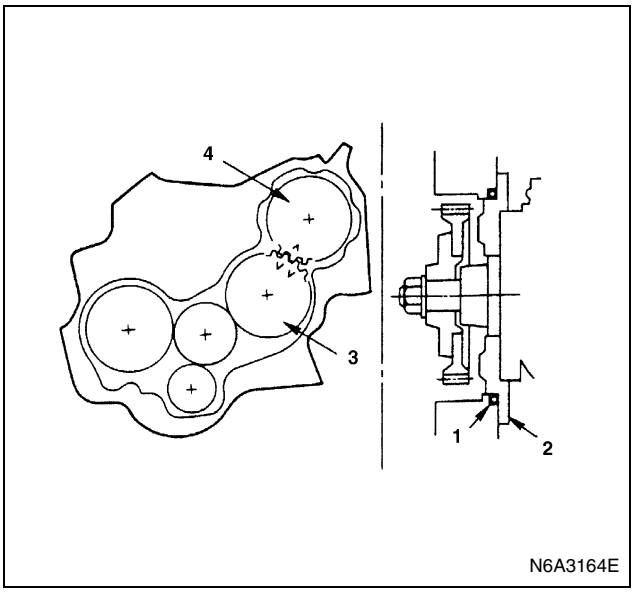
23. Idler Gear "B" and Shaft (Gear Drive model)
    1) Apply engine oil to the idler gear and the idler gear shaft.
    2) Align the idler gear "B" (3) "Z" or ":·" setting mark with the idler gear "A" (4) "Z — Z" or ":· — ·:" setting mark.

3) Tighten the idler gear bolt to the specified torque.

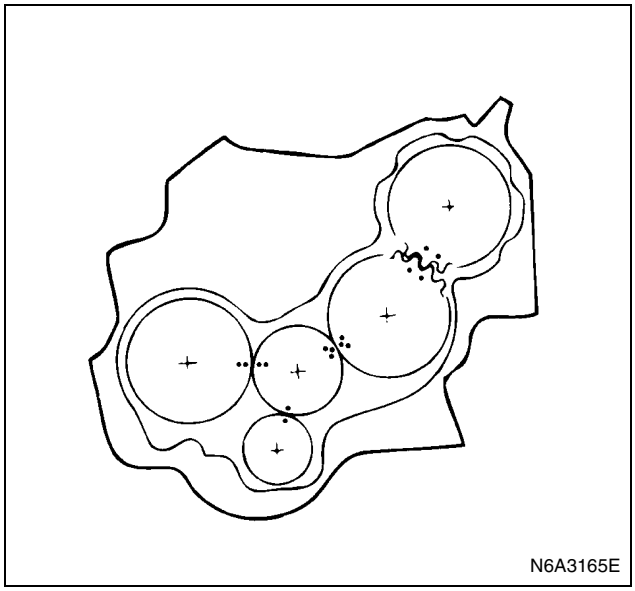
Tighten:
76 N·m (7.7 kg·m/56 lb·ft)



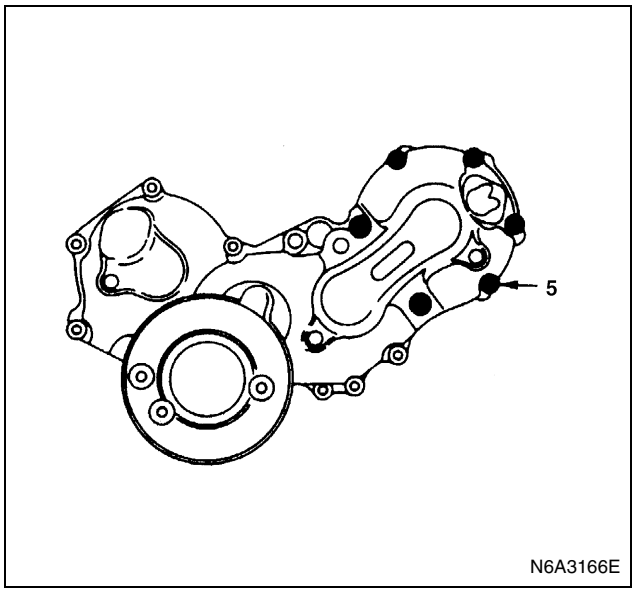
24. Injection Pump (Gear Drive model)
    1) Install the O-ring (1) to the injection pump flange (2).
    2) Install the injection pump to the timing gear case.
       Align the idler gear "B" (3) "V — V" or ": — :" mark.



Gear	4JB1-TC 4JG2	4JH1-TC
Crank gear A|Idle gear "A"	X — X	· — ·
Idle gear "A" — Cam gear	Y — Y	· · — · ·
Idle gear "A" — Idle gear "B"	Z — Z	:· — ·:
Idle gear "B" — Injection pump	V — V	: — :



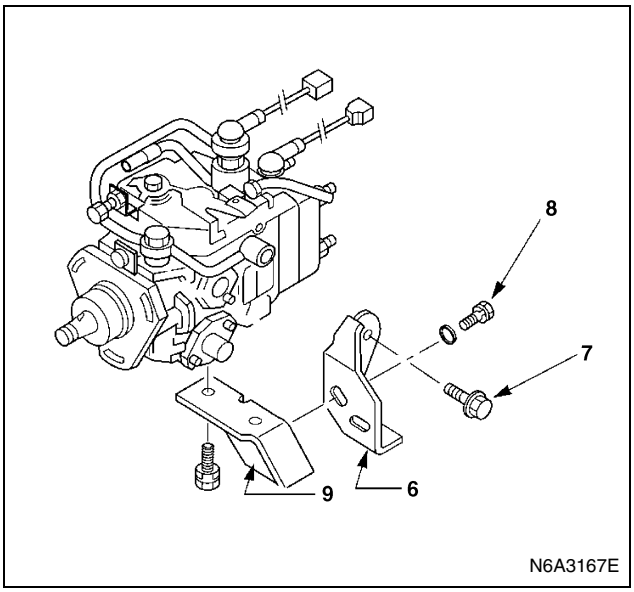
3) Temporarily tighten the six injection pump bolts (5).
   The injection pump bolts will be finally tightened after the injection pump rear bracket bolts.



4) Install the injection pump rear bracket (6) and the rear bracket bolts (7) to the cylinder body.

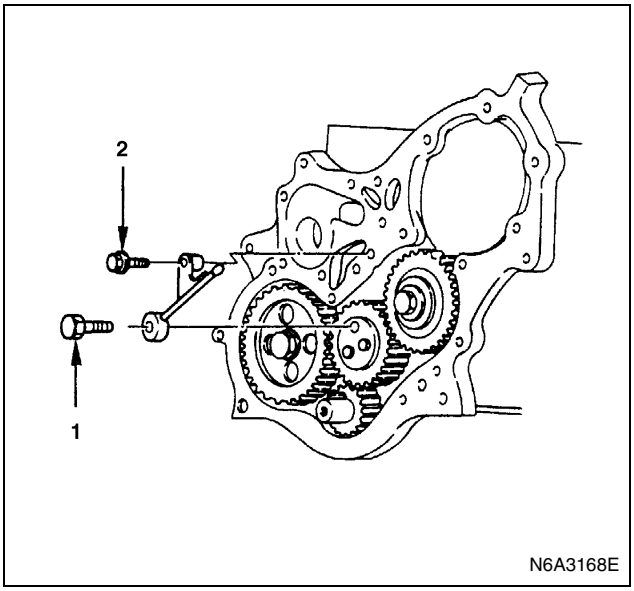
5) Install the rear bracket bolts (8) to the injection pump bracket (9).
Do not tighten the bolts.
The rear bracket bolts (7) and (8) will be finally tightened to the specified torque.

Tighten:
19 N·m (1.9 kg·m/14 lb·ft)



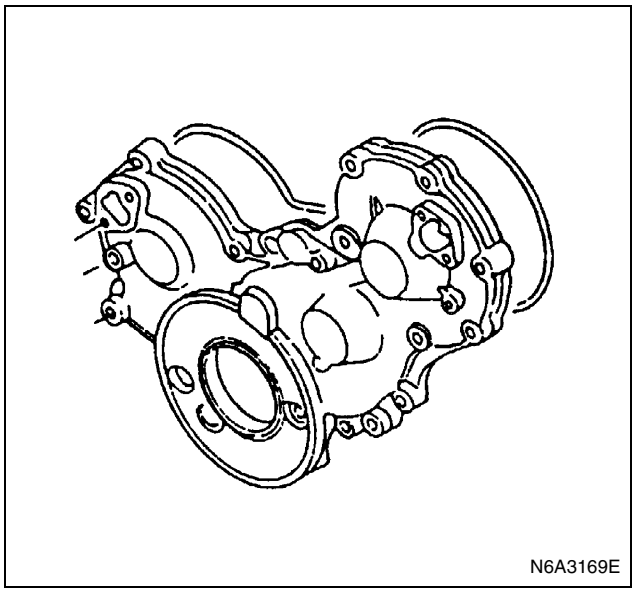
25. Timing Gear Oil Pipe (Gear Drive model)
    1) Install the oil pipe to the timing gear case and idler gear “A”.
    2) Tighten the oil pipe eye bolt (1) and bolt (2) to the specified torque.

Tighten:
13 N·m (1.3 kg·m/9 lb·ft)



26. Timing Gear Case Cover (Gear Drive model)
    1) Align the gear case with the timing gear case knock pin and then install the timing gear case cover.
    2) Tighten the gear case cover bolts to the specified torque.

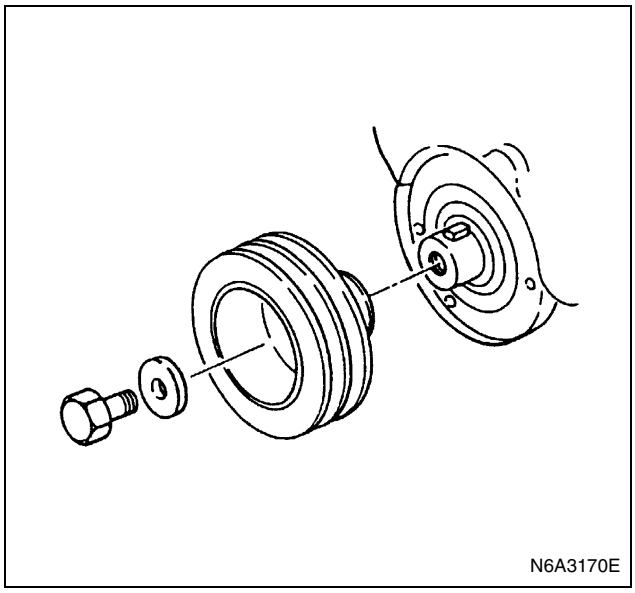
Tighten:
8 N·m (0.8 kg·m/69 lb·in)



27. Crankshaft Damper Pulley (Gear Drive model)
    Tighten the crankshaft damper pulley bolt to the specified torque.

Notice:
Hold the flywheel ring gear stationary to prevent the crankshaft from turning when tightening the damper pulley.

Tighten:
206 N·m (21 kg·m/152 lb·ft)



28. Cooling Fan Assembly (Gear Drive model)
    1) Mount fan pulley, distance piece, and cooling fan asm (in this order) on the water pump, and tighten to the specified torque.

Tighten:
8 N·m (0.8 kg·m/69 lb·in)

29. AC Generator, Power Steering Pump Drive Belt (Gear Drive model)
    1) Install AC Generator, Power Steering pump drive belt and adjust belt tension.
    2) Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

Drive Belt Deflection	mm (in)
8 (0.31) — 12 (0.47)	

    3) Tighten the idler lock nut to the specified torque.

Tighten:
27 N·m (2.8 kg·m/20 lb·ft)

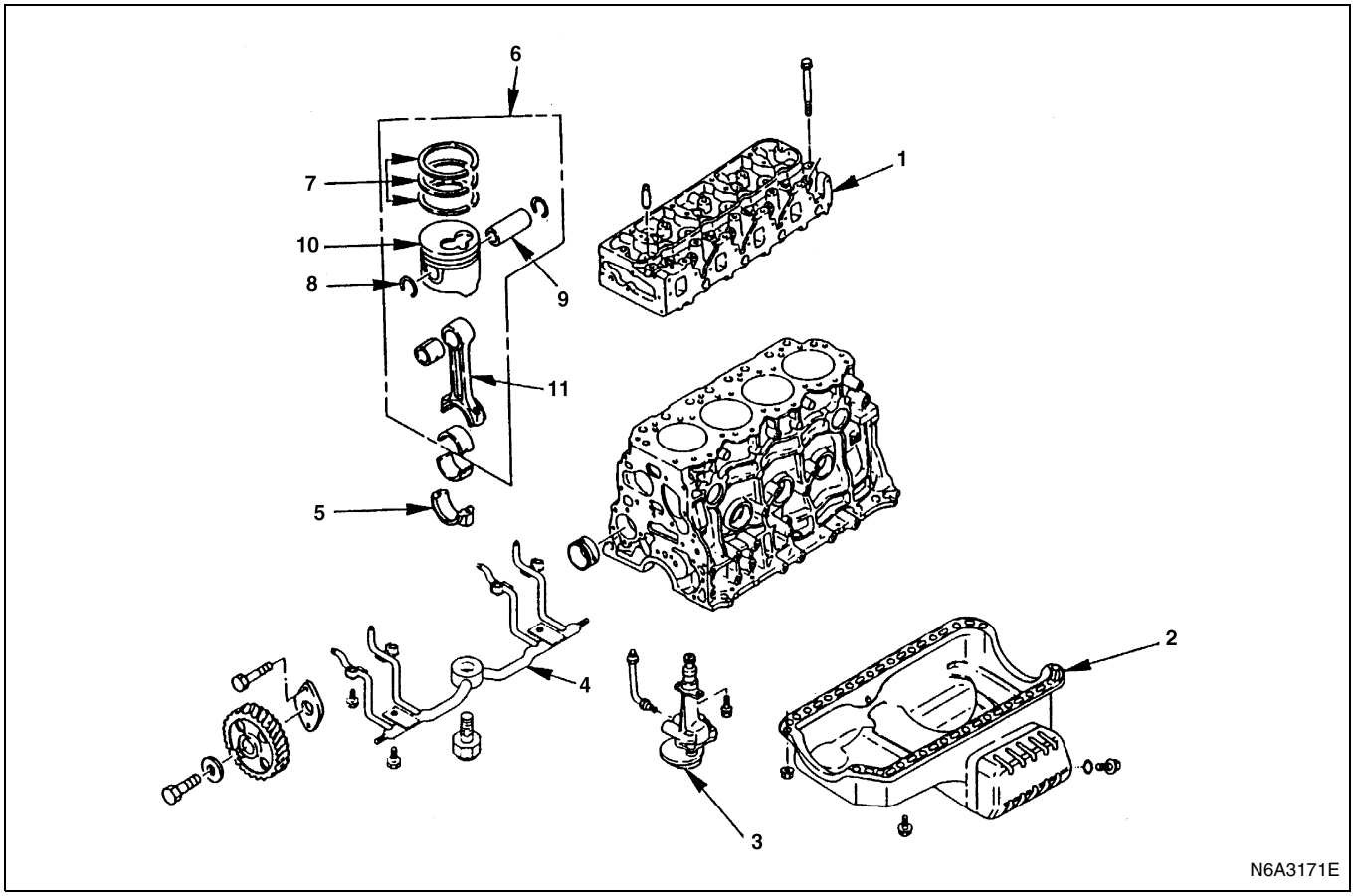
30. Fan Shroud (Gear Drive model)
    1) Install the fan shroud and reservoir tank hose.
    2) Pour coolant
    3) Start the engine and check coolant leakage.
31. Oil Pan Assembly
    Above works refer to “OIL PUMP” Section in this manual.
32. Cylinder Head Assembly and Gasket
    - Piston Head Projection Measurement Point
    - Cylinder Head Assembly
    - Push Rod
    - Rocker Arm Shaft Assembly

    Valve clearance adjustment.

    Above works refer to “CYLINDER BLOCK” Section in this manual.

PISTON AND CONNECTING ROD

Component

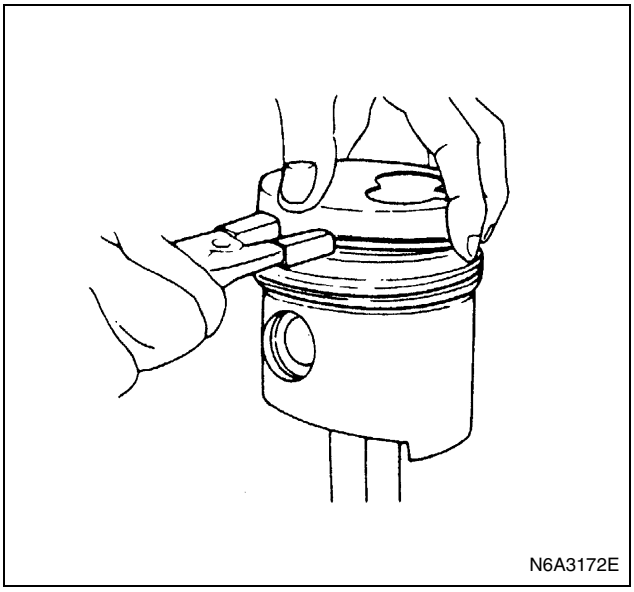


Legend

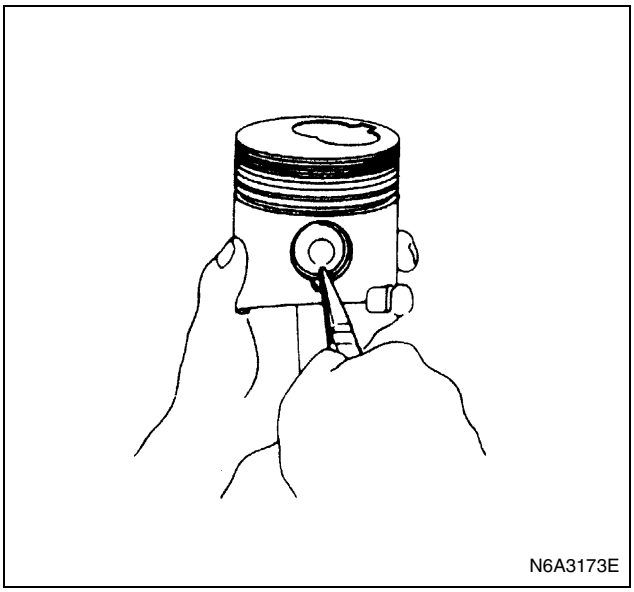
1. Cylinder head assembly
2. Oil pan assembly
3. Oil pump assembly
4. Piston cooling oil pipe
5. Connecting rod bearing cap
6. Piston and connecting rod
7. Piston ring
8. Piston pin snap ring
9. Piston pin
10. Piston
11. Connecting rod

Disassembly

1. Cylinder Head Assembly
2. Oil Pan Assembly
3. Oil Pump Assembly
4. Piston Cooling Oil Pipe
5. Connecting Rod Bearing Cap
6. Piston and Connecting Rod
   - Remove carbon deposits from the upper portion of the cylinder wall with a scraper before removing the piston and connecting rod.
7. Piston Ring
   Remove the piston rings with a piston ring expander.
   Arrange the removed piston rings in the cylinder number order.


N6A3172E

8. Piston Pin Snap Ring
   - Use a pair of pliers to remove the piston pin snap rings.


N6A3173E

9. Piston Pin

Notice:
Keep the parts removed from each cylinder separate.
All parts must be reinstalled in their original positions.

10. Piston
11. Connecting Rod

Inspection and Repair

Piston and Piston Ring

Pistons
Carefully clean away all the carbon adhering to the piston head and the piston ring grooves.

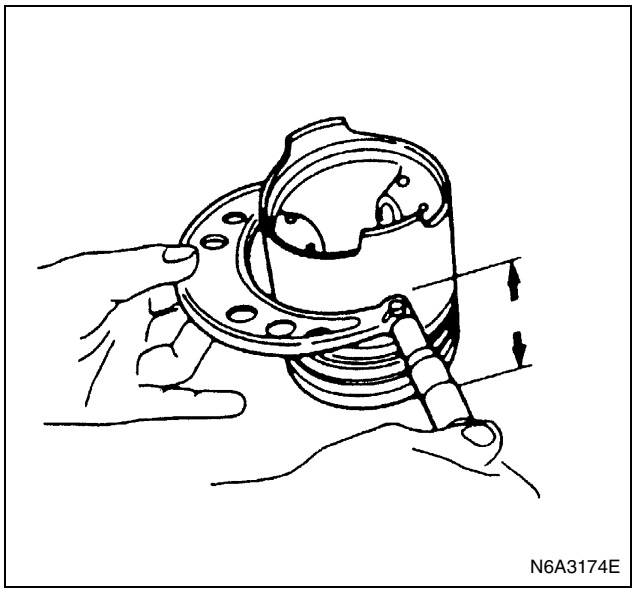
Notice:
Never use a wire brush to clean the pistons. Damage will result.

Visually check each piston for cracking, scoring, and other signs of excessive wear.
If any of the above conditions are present, the piston must be replaced.

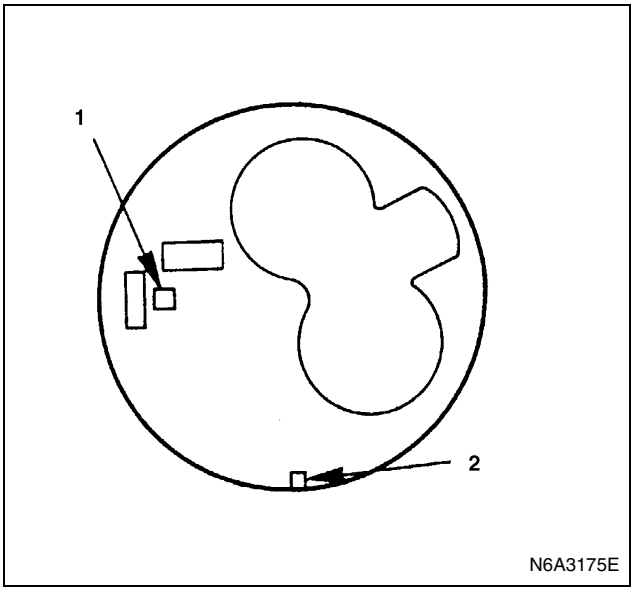
Piston Diameter

1. Measure the piston outside diameter with micrometer at the piston grading position.

Piston Grading Position	mm (in)
4JB1 / 4JB1-TC	74 (2.913)
4JG2, 4JH1-TC	71.00 (2.797)


N6A3174E

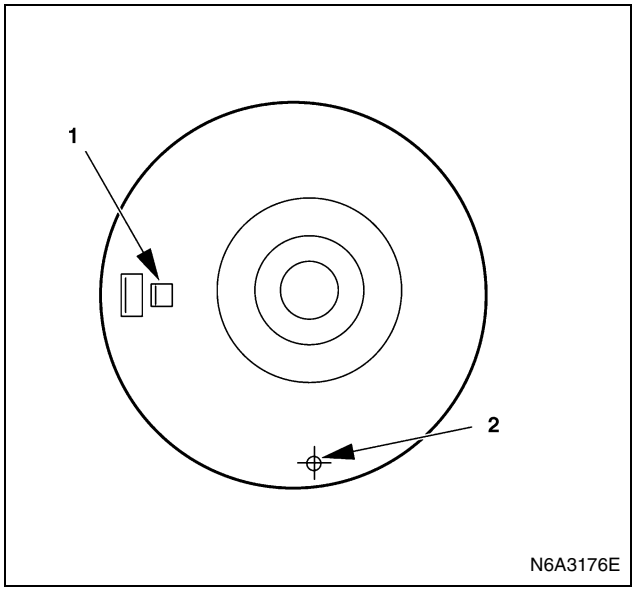
4JB1 / 4JB1-TC mm (in)	
Size Mark	Outside Diameter
A	92.985 — 92.994 (3.6608 — 3.6612)
B	92.995 — 93.004 (3.6612 — 3.6616)
C	93.005 — 93.014 (3.6616 — 3.6620)
D	93.015 — 93.024 (3.6620 — 3.6624)



Legend
1. G-mark
2. Front mark

4JG2	mm (in)
Size Mark	Outside Diameter
A	95.365 — 95.374 (3.7545 — 3.7549)
B	95.375 — 95.384 (3.7549 — 3.7553)
C	95.385 — 95.394 (3.7553 — 3.7557)
D	95.395 — 95.404 (3.7557 — 3.7561)

4JH1-TC	mm (in)
Size Mark	Outside Diameter
A	95.355 — 95.364 (37.5413 — 37.5449)
B	95.365 — 95.374 (37.5453 — 37.5488)
C	95.375 — 95.384 (37.5492 — 37.5528)
D	95.385 — 95.394 (37.5531 — 37.5567)



Legend
1. G-mark
2. Front mark

The grading position for piston outside diameter is represented by the 'G' as shown in Figure.
Measure the cylinder bore inside diameter (refer to "inspection of the cylinder Block" in this Section).
If the piston clearance does not conform to the specified valve, the piston and/or cylinder liners must be replaced.

Piston Clearance	mm (in)
4JB1 / 4JB1-TC	0.061 (0.0024)
4JG2	0.066 (0.0026)
4JH1-TC	0.057 — 0.075 (0.0022 — 0.0029)

Selection Method of Piston Grade for Service Parts.
If you find piston grade A from size mark or piston outside diameter measurement result, you will select AX for service piston grade.
The stamped piston grade on the head of piston for service parts.

Service piston grade	
Piston Size Mark	Service Parts Grade
A	AX
B	AX
C	CX
D	CX

Service piston diameter mm (in)	
Piston Grade	4JB1 / 4JB1-TC
AX	92.989 — 93.004 (3.6610 — 3.6616)
CX	93.005 — 93.020 (3.6616 — 3.6622)

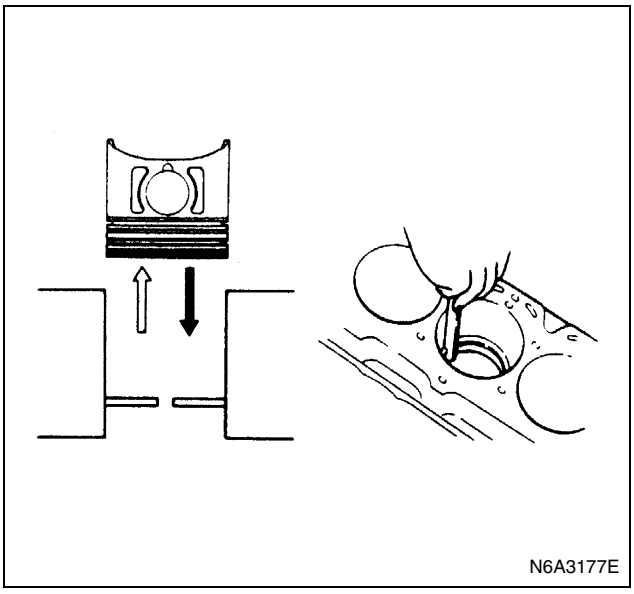
Piston Grade	4JG2
AX	95.369 — 95.384 (3.7547 — 3.7553)
CX	95.385 — 95.400 (3.7553 — 3.7559)

Piston Grade	4JH1-TC
AX	95.359 — 95.374 (3.7543 — 3.7549)
CX	95.375 — 95.390 (3.7549 — 3.7555)

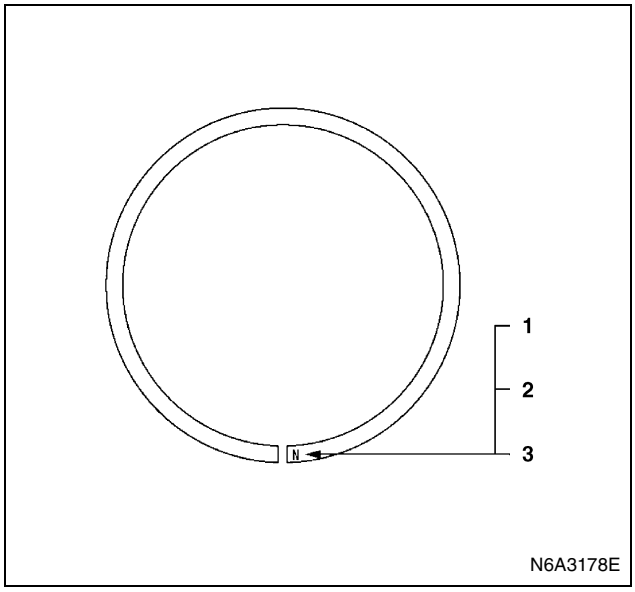
Notice:
It is most important that the correct piston grade be used. Failure to select the correct piston grade will result in engine failure. Always measure the cylinder bore and select the correct piston grade.

Piston Rings
Any worn or damaged part discovered during engine overhaul must be replaced with a new one.

1. Ring end gap measurement
   - Insert the piston ring into the bore.
   - Push the ring by the piston, at a right angle to the wall, into the point ring at which the cylinder bore diameter is the smallest.



   - The top mark of the piston ring are shown in the illustration.



Legend
1. N mark (Top ring) (2nd ring) (4JB1)
2. 1N mark (Top ring) 2N mark (2nd ring) (4JG2)
3. R mark (Top ring) (2nd ring) (4JH-TC)

4JB1 / 4JB1-TC			mm (in)
		Standard	Limit
Compression ring	1st	0.20 — 0.40 (0.0079 — 0.0157	1.5 (0.059)
	2nd	0.20 — 0.40 (0.0079 — 0.0157	
Oil ring		0.10 — 0.30 (0.0039 — 0.0118)	

4JG2			mm (in)
		Standard	Limit
Compression ring	1st	0.20 — 0.35 (0.0079 — 0.0138)	1.5 (0.059)
	2nd	0.37 — 0.52 (0.0146 — 0.0205)	
Oil ring		0.20 — 0.40 (0.0079 — 0.0157)	

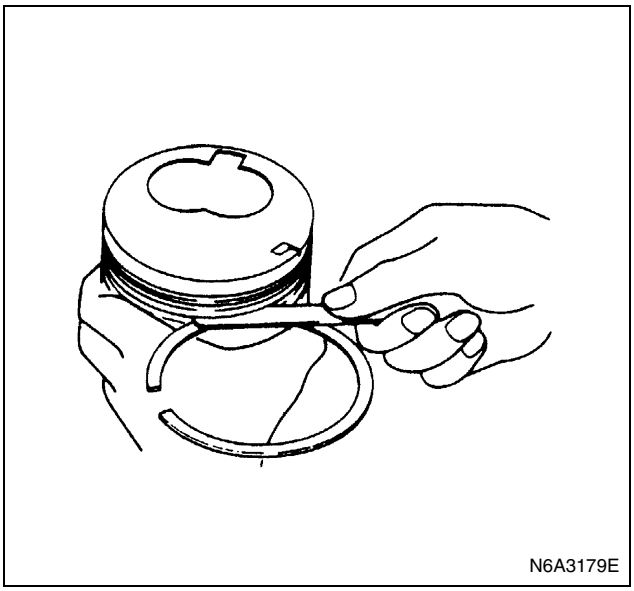
4JH1-TC			mm (in)
		Standard	Limit
Compression ring	1st	0.30 — 0.50 (0.0118 — 0.0197)	1.5 (0.059)
	2nd	0.30 — 0.50 (0.0118 — 0.0197)	
Oil ring		0.25 — 0.45 (0.0098 — 0.0117)	

2. Measure the clearance between the piston ring groove and the piston ring with a feeler gauge. If the piston ring groove/piston ring clearance exceeds the specified limit, the piston must be replaced.

4JB1 / 4JB1-TC			mm (in)
		Standard	Limit
Compression ring	1st	0.090 — 0.125 (0.0035 — 0.0049)	1.5 (0.059)
	2nd	0.050 — 0.075 (0.0020 — 0.0030)	
Oil ring		0.03 — 0.07 (0.0012 — 0.0028)	

4JG2			mm (in)
		Standard	Limit
Compression ring	1st	0.09 — 0.13 (0.0035 — 0.0051)	1.5 (0.059)
	2nd	0.05 — 0.07 (0.0020 — 0.0028)	
Oil ring		0.03 — 0.07 (0.0012 — 0.0028)	

4JH1-TC			mm (in)
		Standard	Limit
Compression ring	1st	0.09 — 0.13 (0.0035 — 0.0051)	1.5 (0.059)
	2nd	0.05 — 0.09 (0.002 — 0.0035)	
Oil ring		0.03 — 0.07 (0.00118 — 0.0028)	

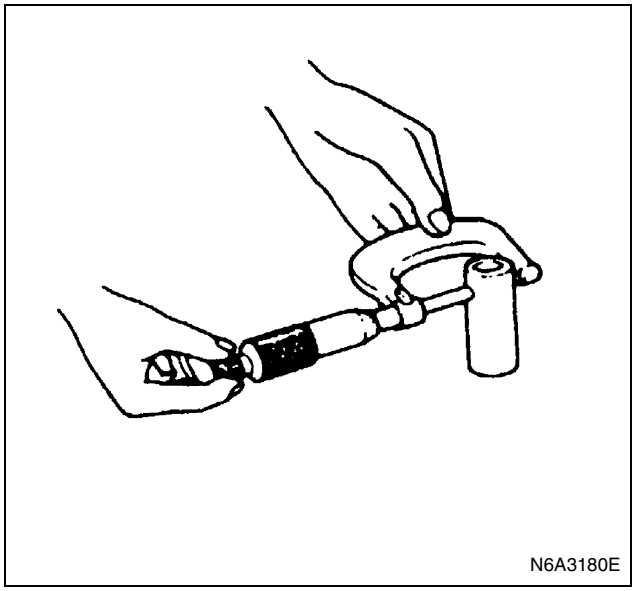

N6A3179E

Piston Pin

Visually inspect the piston pin for cracks, flaws, and other damage and replace if necessary.

1. Use a micrometer to measure the piston pin outside diameter in both directions at three different positions.
   If the measurement exceed the specified limit the piston pin must be replaced.

Piston pin outside diameter		mm (in)
	Standard	Limit
4JB1 4JB1-TC 4JH1-TC	30.995 — 31.000 (1.2202 — 1.2204)	30.970 (1.2190)
4JG2	33.995 — 34.000 (1.3384 — 1.3386)	33.970 (1.3374)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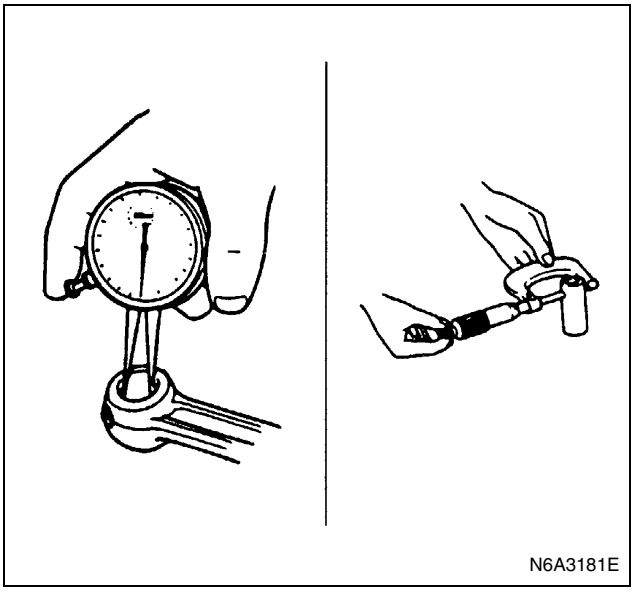
2. Measure the inside diameter of the connecting rod small end. If the clearance between the small end and pin does not conform to the specified value, the connecting rod or bushing and pin must be replaced.

		mm (in)
	Standard	Limit
Clearance	0.008 — 0.020 (0.0003 — 0.0008)	0.05 (0.0020)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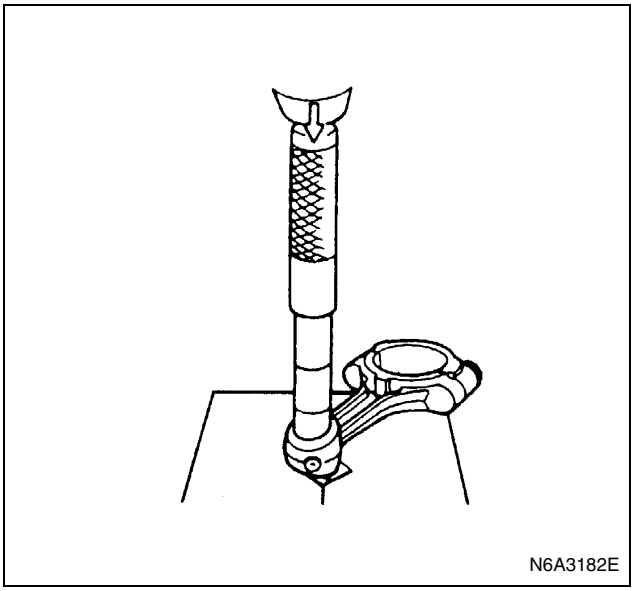
3. Insert the piston pin into the piston and rotate it. If the pin rotates smoothly with no backlash, the clearance is normal. If there is backlash or roughness, measure the clearance. If the clearance exceeds the specified limit, the piston and the piston pin must be replaced.

		mm (in)
	Standard	Limit
Clearance	0.002 — 0.004 (0.00008 — 0.00016)	0.04 (0.0016)

Bushing Replacement

Removal: Use a suitable bar and bench press or hammer.

Installation: Use a suitable bar and bench press.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Notice:

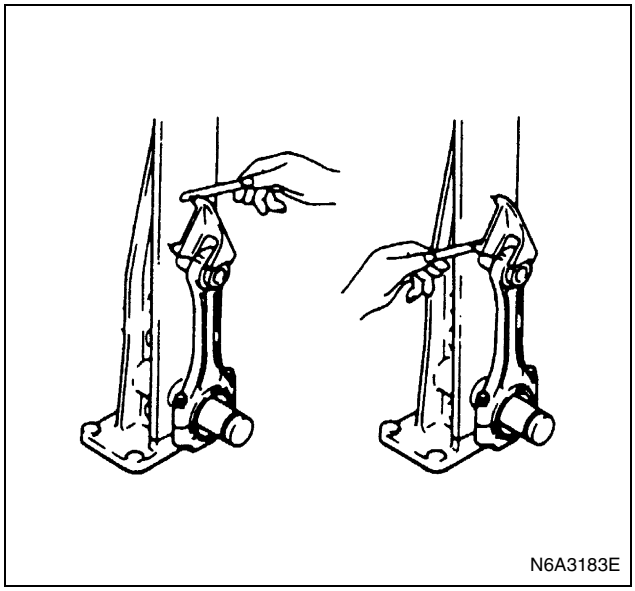
Align the bushing with the connecting rod oil port.

After installing a new bushing, finish the bushing bore with a pin hole grinder.

Connecting Rods

1. Check the connecting rod alignment with a connecting rod aligner.
   If either the bend or the twist exceeds the specified limit, the connecting rod must be replaced.

		mm (in)
	Standard	Limit
Bend per 100 (3.94)	0.08 (0.0031) or less	0.20 (0.0079)
Twist per 100 (3.94)	0.05 (0.0020) or less	0.15 (0.0059)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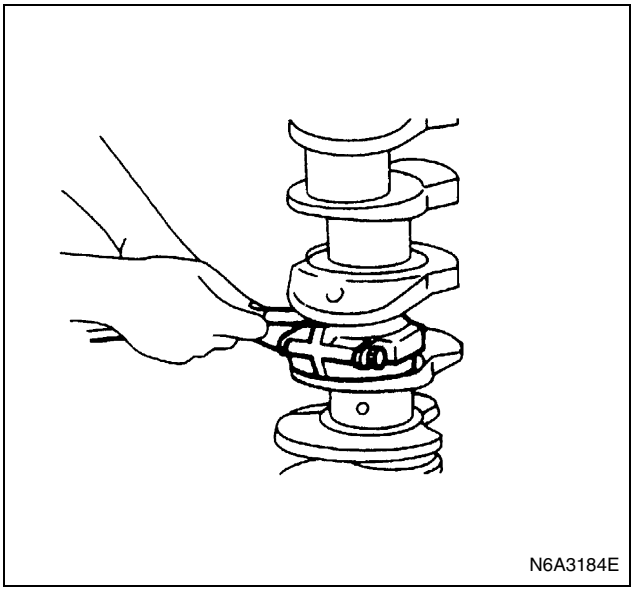
2. Measure the connecting rod thrust clearance.
   Use a feeler gauge to measure the thrust clearance at the big end of the connecting rod.
   If the clearance exceeds the specified limit, the connecting rod must be replaced.

Thrust Clearance	mm (in)
Standard	Limit
0.230 (0.0091)	0.350 (0.0138)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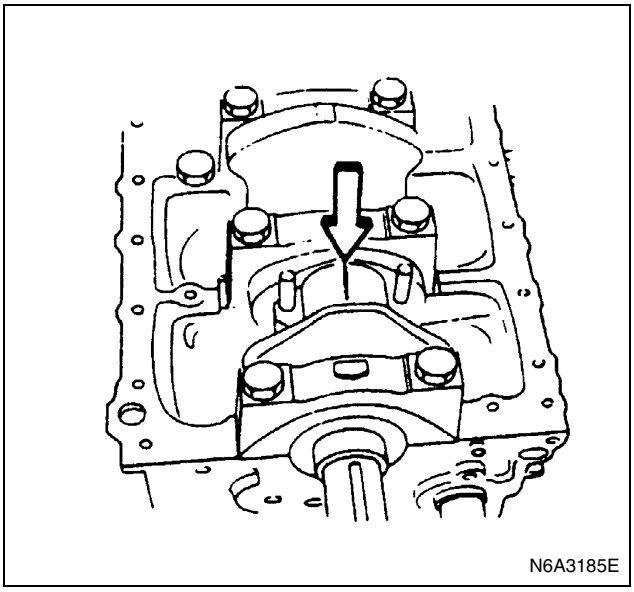
3. Measure the oil clearance between the connecting rod and the crankshaft by:
   1) Remove the connecting rod cap nuts and the rod caps.
      Arrange the removed rod caps in the cylinder number order.
   2) Clean the rod bearings and the crankshaft pins.
   3) Carefully check the rod bearings.
      If even one bearing is found to be damaged or badly worn, the entire bearing assembly must be replaced as a set. Reinstall the bearings in their original positions.
      Apply plastigage to the crank pin.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   4) Put the plastigage, and reinstall the rod caps to their original positions.
   5) Tighten the cap nuts in 2 steps, using angular tightening method as shown in the following specifications. (4JG2, 4JH1-TC, 4JB1-TC)

Tighten:
- 4JH1-TC, 4JB1-TC to
  1st Step: 29 N·m (3 kg·m/22 lb·ft)
  2nd Step: 45° — 60°
- 4JB1 to 83 N·m (8.5 kg·m/61 lb·ft)

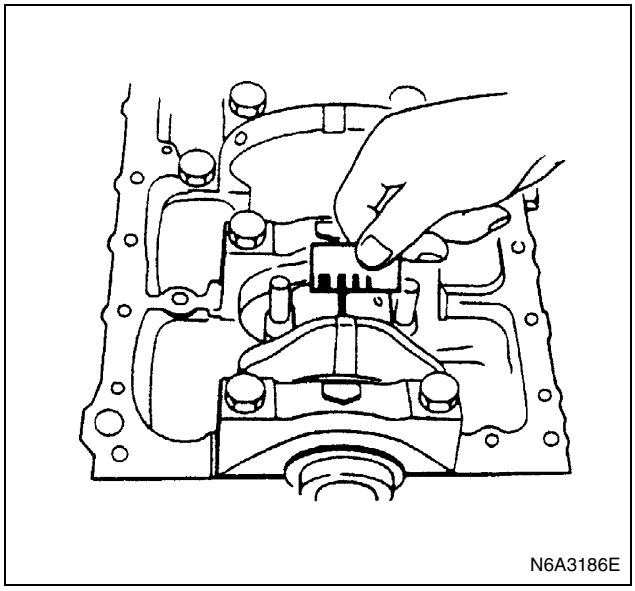
Notice:
Do not allow the crankshaft to rotate.

   6) Remove the rod caps.
   7) Measure the width of the plastigage and determine the oil clearance. If the oil clearance exceeds the limit, replace the rod bearings as a set.
   8) Remove the plastigage from the bearings and the crankshaft pins.

Crankshaft Journal and Bearing Clearance

mm (in)

	Standard	Limit
4JB1 / 4JB1-TC	0.029 — 0.066 (0.0011 — 0.0026)	0.100 (0.0039)
4JG2 4JH1-TC	0.029 — 0.083 (0.0011 — 0.0033	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Reassembly

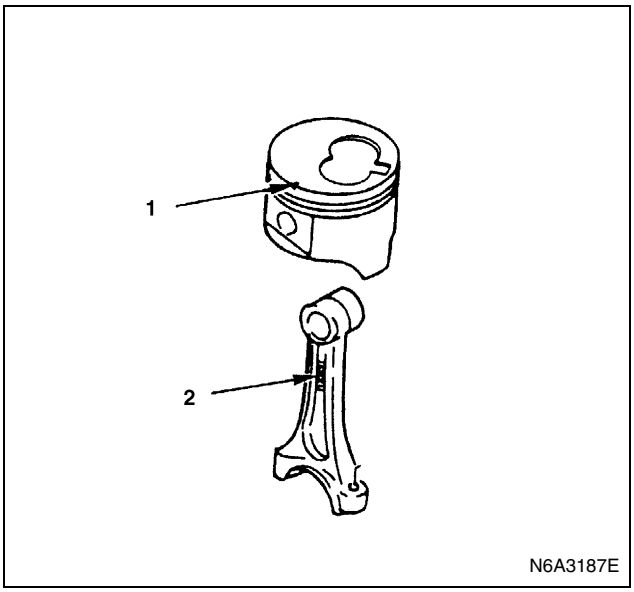
1. Connecting Rod
2. Piston
3. Piston Pin
   Apply a cost of engine oil to the piston pin and the piston pin hole.

4. Piston Pin Snap Ring
   Apply a thin coat of engine oil to the piston pin.
   Try to insert the piston pin into the piston pin hole with normal finger pressure.
   Weigh each piston and connecting rod assembly.
   Select piston and connecting rod combinations so that the weight variation of the different assemblies a held within the specified limits.

	g (oz)
Variance in weight after assembly	Less than 3 (0.1058)

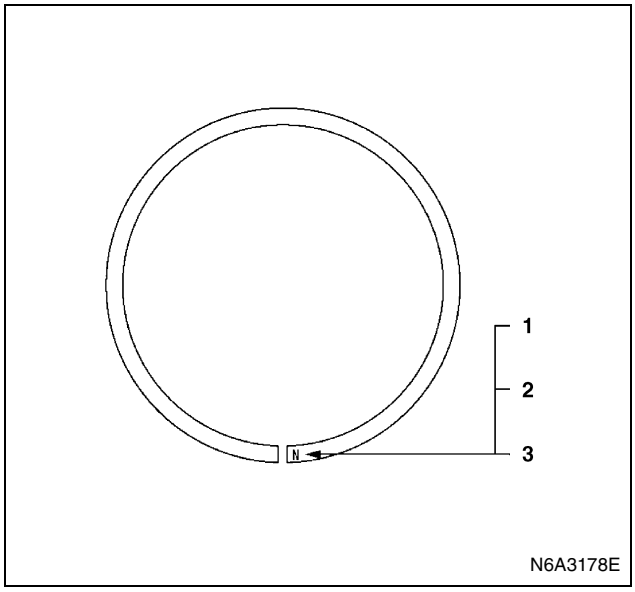
Notice:
When changing piston/connecting rod combinations, do not change the piston/piston pin combination

- Attach the piston to the connecting rod with the piston front mark and the connecting rod ISUZU mark on the same side.



Legend
1. Front mark
2. ISUZU mark

5. Piston Ring
   - Install the piston rings with the piston ring expander.
     The compression ring must be set with the N mark facing up.
   - Discrimination mark is painted as shown in the illustration.

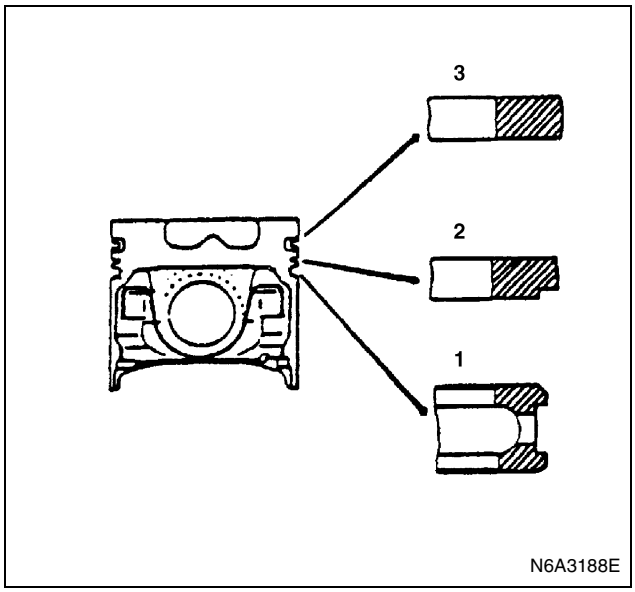


Legend
1. N mark (Top ring) (2nd ring) (4JB1)
2. 1N mark (Top ring) 2N mark (2nd ring) (4JG2)
3. R mark (Top ring) (2nd ring) (4JH-TC)

   - Install piston rings in the following sequence.

   1) Oil ring

4JB1, 4JH1-TC

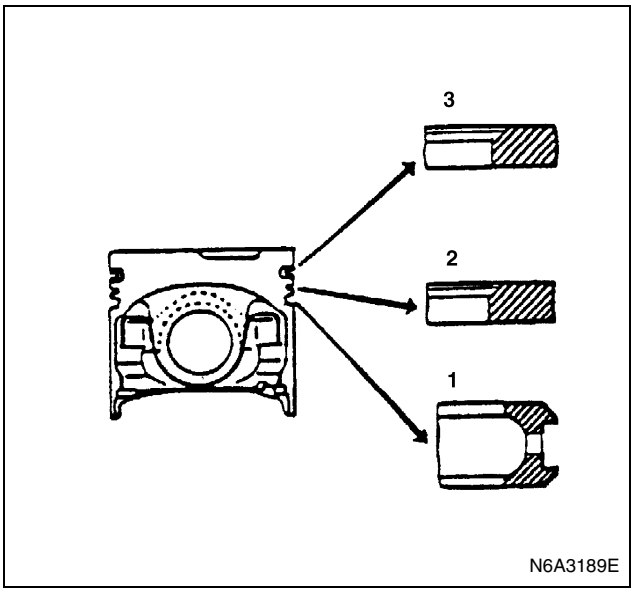


Legend
1. Expander ring
2. Upper side rail
3. Lower side rail

   2) 2nd compression ring
   3) 1st compression ring
      - The compression ring must be set with the 1N or 2N mark (4JG2) facing up.
      - 1st compression ring: 1N (4JG2), N (4JB1), R (4JH1-TC)

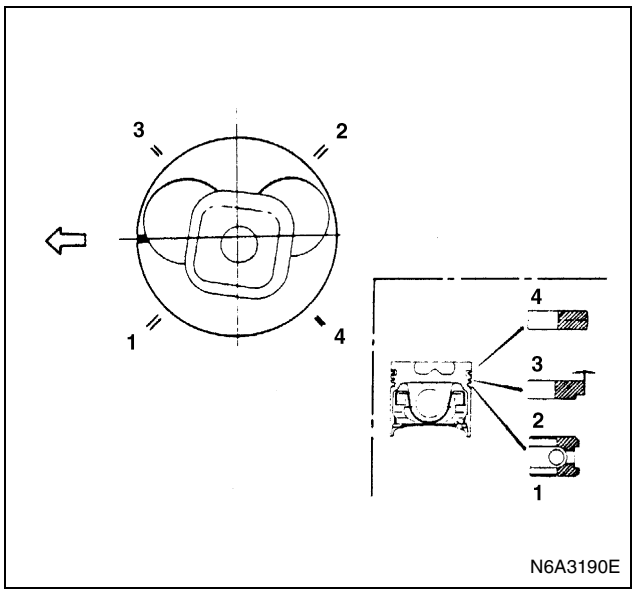
- 2nd compression ring: 2N (4JG2), N (4JB1), R (4JH1-TC)
- After installation, apply engine oil to the entire circumference of the piston rings. Check to see that all the rings rotate smoothly.
- Insert the bearings into the connecting rods and caps. Apply new engine oil to the bearing faces. Cap side bearings have no oil hole. Connecting rod side bearings oil hole should be aligned with oil hole on the connecting rod.

4JG2



Legend
1. Oil ring
2. Compression ring No. 2
3. Compression ring No. 1

6. Piston and Connecting Rod
   - Apply engine oil to the cylinder bores, the connecting rod bearings and the crankshaft pins.
   - Check to see that the piston ring end gaps are correctly positioned.
   - Insert the piston/connecting rod assemblies into each cylinder with the piston ring compressor.
   - The front marks must be facing the front of the engine.



Legend
1. Expander ring
2. Expander ring
3. Upper side rail
4. Lower side rail

7. Connecting Rod Bearing Cap
   - Tighten the cap nuts in 2 steps, using angular tightening method as shown in the following specifications.

Tighten:
4JH1-TC, 4JB1-TC to
- 1st Step: 29 N·m (3.0 kg·m/22 lb·ft)
- 2nd Step: 45° — 60°

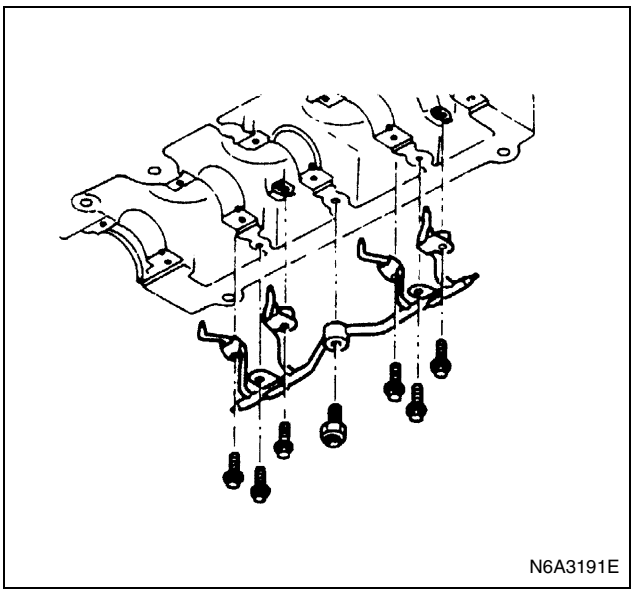
4JB1 to 83 N·m (8.5 kg·m/61 lb·ft)

After tightening the cap nuts, check to see that the crankshaft rotates smoothly.

8. Piston Cooling Oil Pipe
   - Install the piston cooling oil pipe to the cylinder body.
   - Tighten the oil pipe bolts and relief valve to the specified torque.

Tighten:
Oil Pipe Bolt to
- M8 × 1.25: 19 N·m (1.9 kg·m/14 lb·ft)
- M6 × 1.00: 8 N·m (0.8 kg·m/69 lb·in)

Oil Pressure Regulating Valve to
- M16 × 1.5: 29 N·m (3.0 kg·m/22 lb·ft)



Notice:
Check that there is no interference between the piston and the oiling jet pipe by slowly rotating the crankshaft.

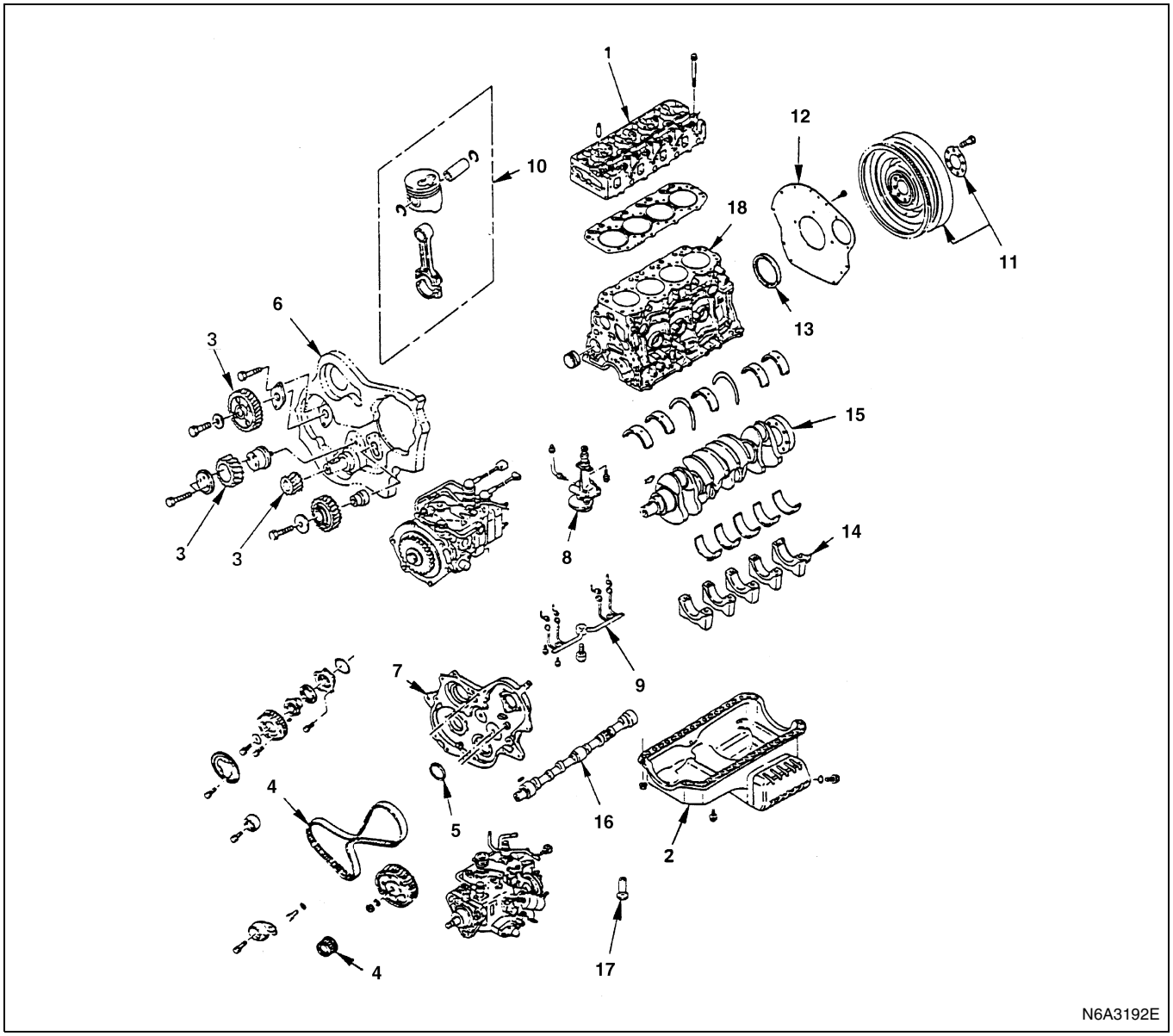
9. Oil Pump Assembly
10. Oil Pan Assembly
    Above works refer to “OIL PUMP” Section in this manual.
11. Cylinder Head Assembly
    - Piston Head Projection Measurement Point
    - Cylinder Head Assembly
    - Push Rod
    - Rocker Arm Shaft Assembly

    Valve clearance adjustment.

    Above works refer to “CYLINDER BLOCK” Section in this manual.

CYLINDER BLOCK

Component



Legend

1. Cylinder head assembly and gasket
2. Oil pan assembly
3. Timing gear
4. Timing belt and pulley
5. Front oil seal (Belt Drive Model)
6. Timing gear housing
7. Timing pulley housing
8. Oil pump assembly
9. Piston cooling oil pipe
10. Piston and connecting rod
11. Flywheel
12. Cylinder block rear plate
13. Crankshaft rear oil seal
14. Main bearing cap
15. Crankshaft
16. Camshaft
17. Tappet
18. Cylinder block

Disassembly

1. Cylinder Head Assembly and Gasket
2. Oil Pan Assembly
3. Timing Gear
4. Timing Belt and Pulley
5. Front Oil Seal (Belt Drive Model)
6. Timing Gear Housing
7. Timing Pulley Housing

8. Oil Pump Assembly
9. Piston Cooling Oil Pipe
10. Piston and Connecting Rod
11. Flywheel
12. Cylinder Block Rear Plate
13. Crankshaft Rear Oil Seal
14. Main Bearing Cap
15. Crankshaft
16. Camshaft
17. Tappet
18. Cylinder Block

Inspection and Repair

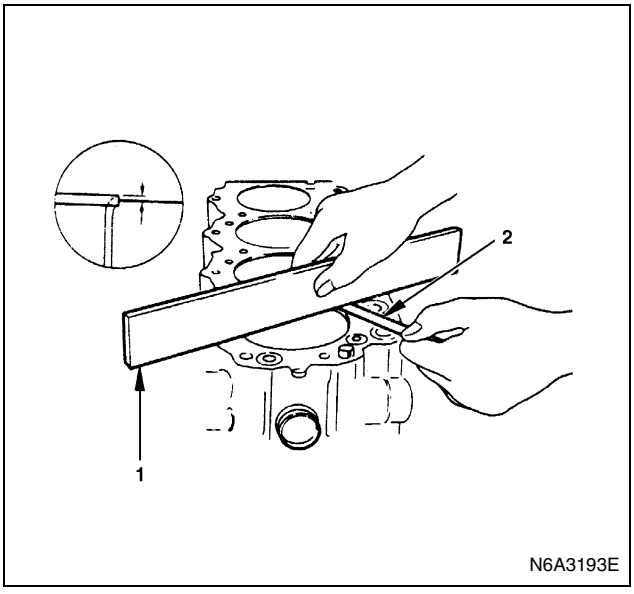
Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

1. Remove the gasket and any other material adhering the upper surface of the cylinder block.
   Be very careful not to allow any material to accidental drop into the cylinder block.
   Be very careful not to scratch the cylinder block.
2. Carefully remove the oil pump, Rear Seal retainer and oil pan installation surface seal.
3. Wipe the cylinder block clean.

Cylinder Liner Projection Inspection

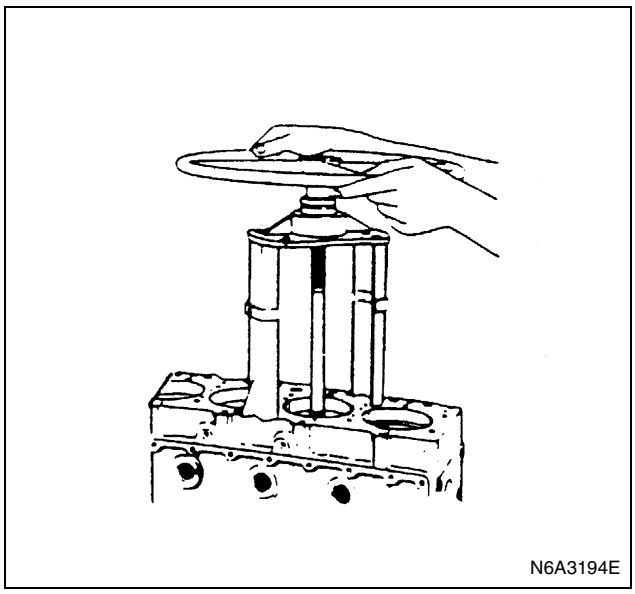
1. Hold a straight edge (1) along the top edge of the cylinder liner to be measured.
2. Use a feeler gauge (2) to measure each cylinder line projection.
   The difference in the cylinder liner projection height between any two adjacent cylinders must not exceed 0.03 mm (0.0012 in).

Standard	mm (in)
0.0 — 0.1 (0.0000 — 0.0039)	



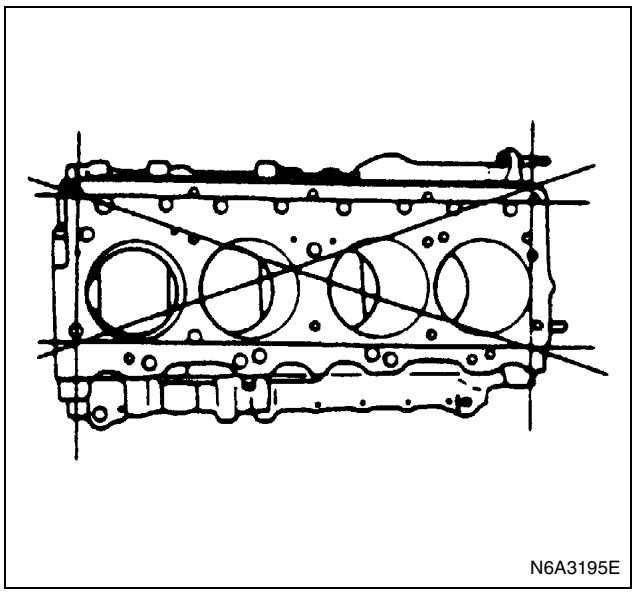
Flatness

1. Remove the cylinder body dowel.
2. Set the cylinder liner remover to the cylinder liner.
3. Check that the remover shaft ankle is firmly gripping the cylinder liner bottom edge.
4. Slowly turn the remover shaft handle counterclockwise to pull the cylinder liner free.
   Cylinder Liner Remover Ankle:
   5-8840-2304-0 (4JG2/4JH1-TC)
   5-8840-2039-0 (4JB1/4JB1-TC)



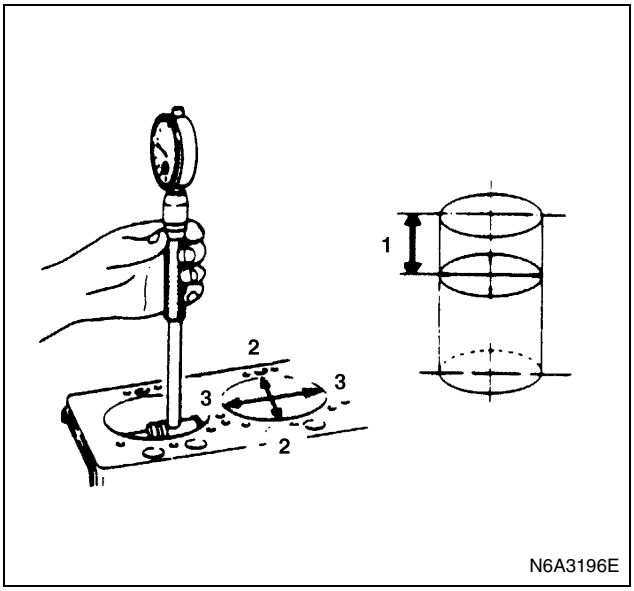
Notice:
Take care not to damage the cylinder body upper during the cylinder liner removal procedure.

5. Use a straight edge and a feeler gauge to measure the four sides and the two diagonals of the cylinder body upper face.
   If the measured values exceeds the limit, the cylinder body must be replaced.



Cylinder Liner Bore Measurement

Use a cylinder indicator to measure the cylinder liner bore at measuring point (1) in the thrust (2) — (2) and axial (3) direction of the crankshaft.
Measuring Point (1) 20mm (0.79 in)
If the measured value exceeds the specified limit, the cylinder liner must be replaced.

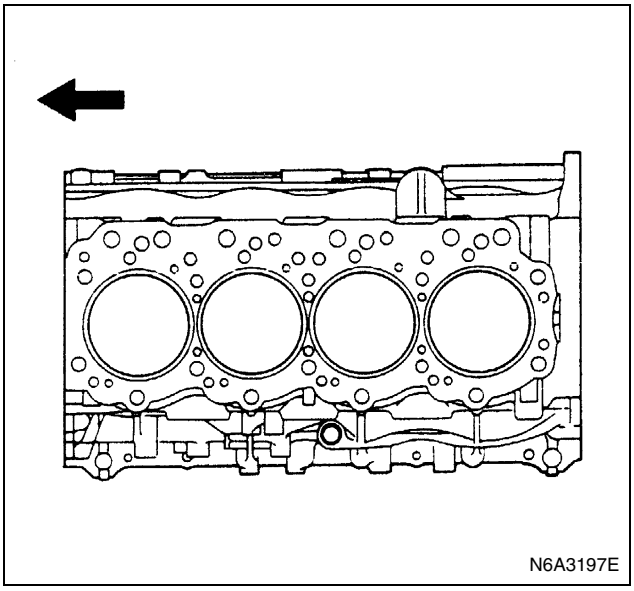


Notice:
The inside of the dry type cylinder liner is chrome plated. It cannot be rebored or honed.

If the inside of the cylinder liner is scored or scorched, the cylinder liner must be replaced.

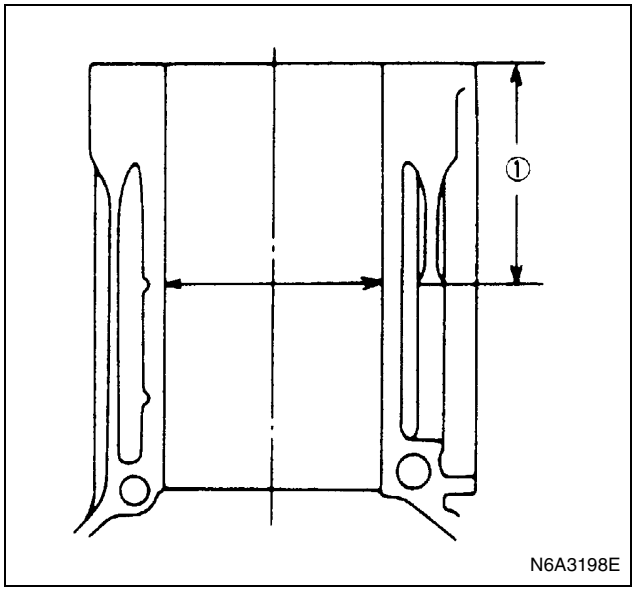
Cylinder Liner Grade Selection

Measure the cylinder body inside diameter and select the appropriate cylinder liner grade.



Standard Lifting Interference	mm (in)
0.01 — 0.019 (0.0004 — 0.0007)	

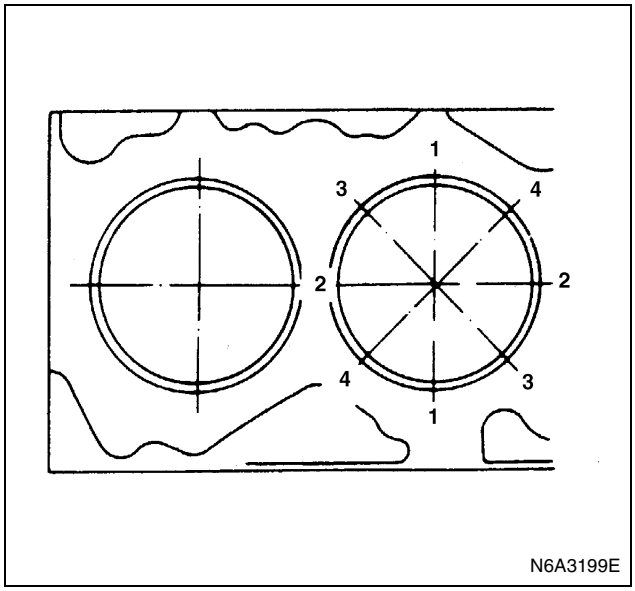
If the cylinder liner fitting interference (1) is too small, engine cooling efficiency will be adversely effected.
If the cylinder liner fitting interference is too large, it will be difficult to insert the cylinder liner into the cylinder body.

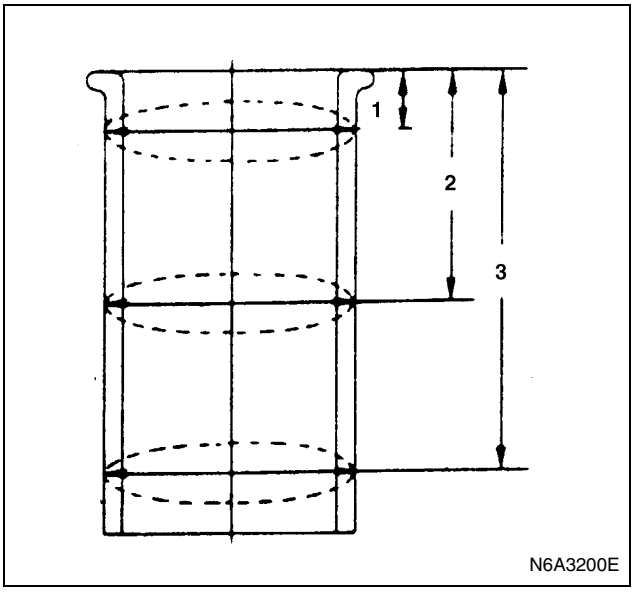


Cylinder Body Bore Measurement

1. Take measurements at measuring point (A) across positions (1) — (1), (2) — (2), (3) — (3), and (4) — (4).

Measuring Point (A) 98mm (3.86 in).





2. Calculate the average value of the four measurements to determine the correct cylinder grade.
3. Consult the following table with the resultant diameter for the correct liner application.

Selection method of cylinder liner and piston grade for service parts.

The production line stamped cylinder liner grade on the top of cylinder body, the cylinder liner outside diameter grade 1, 2, 3, 4.

If you find cylinder liner outside diameter grade 1 and piston outside diameter B on the cylinder body or result of measurement for each parts, you will select service parts grade for cylinder liner 1, AX grade and for piston AX grade.

The stamping grade code on the service parts are;

For cylinder liner grade stamped on the outside of cylinder liner.

For piston grade stamped on the head of piston.

4JB1 / 4JB1-TC — mm (in)

Liner outside Grade	Cylinder bore diameter average	Liner outside diameter	Liner bore Grade	Service liner bore measurement
1	95.001 — 95.010 (3.7402 — 3.7406)	95.011 — 95.020 (3.7406 — 3.7409)	AX	93.035 (3.6628) — 93.050 (3.6634)
			CX	93.051 (3.6634) — 93.066 (3.6640)
2	95.011 — 95.020 (3.7406 — 3.7409)	95.021 — 95.030 (3.7410 — 3.7413)	AX	93.035 (3.6628) — 93.050 (3.6634)
			CX	93.051 (3.6634) — 93.066 (3.6640)
3	95.021 — 95.030 (3.7410 — 3.7413)	95.031 — 95.040 (3.7414 — 3.7417)	AX	93.035 (3.6628) — 93.050 (3.6634)
			CX	93.051 (3.6634) — 93.066 (3.6640)
4	95.031 — 95.040 (3.7414 — 3.7417)	95.041 — 95.050 (3.7418 — 3.7421)	AX	93.035 (3.6628) — 93.050 (3.6634)
			CX	93.051 (3.6634) — 93.066 (3.6640)

4JG2 / 4JH1-TC — mm (in)

Liner outside Grade	Cylinder bore diameter average	Liner outside diameter	Liner bore Grade	Service liner bore measurement
1	97.001 — 97.010 (3.8189 — 3.8193)	97.011 — 97.020 (3.8193 — 3.8197)	AX	95.435 (3.7573) — 95.450 (3.7579)
			CX	95.451 (3.7579) — 95.466 (3.7585)
2	97.011 — 97.020 (3.8193 — 3.8197)	97.021 — 97.030 (3.8197 — 3.8201)	AX	95.435 (3.7573) — 95.450 (3.7579)
			CX	95.451 (3.7579) — 95.466 (3.7585)
3	97.021 — 97.030 (3.8197 — 3.8201)	97.031 — 97.040 (3.8201 — 3.8205)	AX	95.435 (3.7573) — 95.450 (3.7579)
			CX	95.451 (3.7579) — 95.466 (3.7585)
4	97.031 — 97.040 (3.8201 — 3.8205)	97.041 — 97.050 (3.8205 — 3.8209)	AX	95.435 (3.7573) — 95.450 (3.7579)
			CX	95.451 (3.7579) — 95.466 (3.7585)

Notice:

It is most important that the correct piston grade be used. Failure to select the correct piston grade will result in engine failure. Always measure the cylinder bore and select the correct piston grade.

Cylinder liner kit clearances are preset. However, the cylinder liner installation procedure may result in slight decreases in cylinder liner clearances. Always measure the cylinder liner clearance after installation to be sure that it is correct.

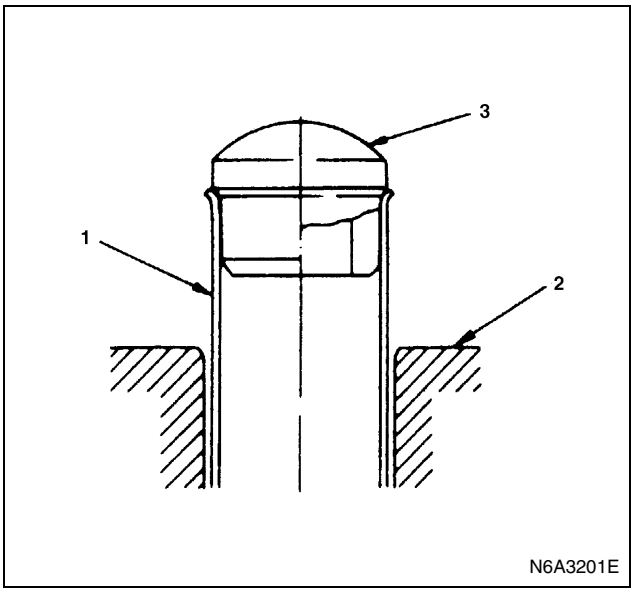
Cylinder Liner Installation

1. Cylinder Liner Installation Using The Special Tool.
   1) Use new kerosene or diesel oil to thoroughly clean the cylinder liners and bores.
   2) Use compressed air to blow-dry the cylinder liner and bore surfaces.

   Cylinder Liner Installer
   : 5-8840-2313-0 (4JG2 / 4JH1-TC)
   : 5-8840-2040-0 (4JB1 / 4JB1-TC)

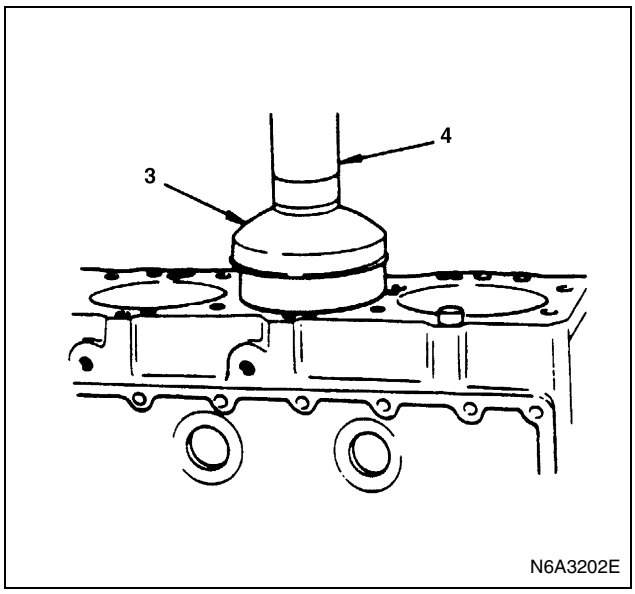
Notice:
All foreign material must be carefully removed from the cylinder liner and the cylinder bore before installation.

   3) Insert the cylinder liner (1) into the cylinder body (2) from the top of the cylinder body.



   4) Set the cylinder liner installer (3) to the top of the cylinder liner.
      Position the cylinder body so that the installer center is directly beneath the bench press shaft center (4).

   Cylinder Liner Installer
   : 5-8840-2313-0 (4JG2 / 4JH1-TC)
   : 5-8840-2040-0 (4JB1 / 4JB1-TC)

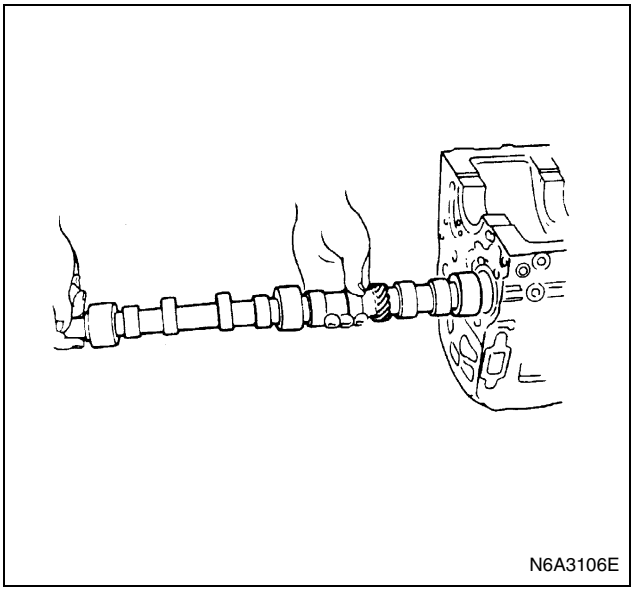


Notice:
Check that the cylinder liner is set perpendicular to the bench press and that there is no wobble.

   5) Use the bench press to apply a seating force of 500 kg (1,102.5 lb/4,900 N) to the cylinder liner.
   6) Apply a force 2,500 kg (5,512.5 lb/24,500 N) to fully seat the cylinder liner.
   7) After installing the cylinder liner, measure the cylinder liner projection.
   8) After installing the cylinder liner, measure the cylinder liner projection.
      Refer to “Cylinder Liner Projection Inspection” in this Section.
      Measure the cylinder liner bore inside diameter and select the appropriate piston grade.

Reassembly

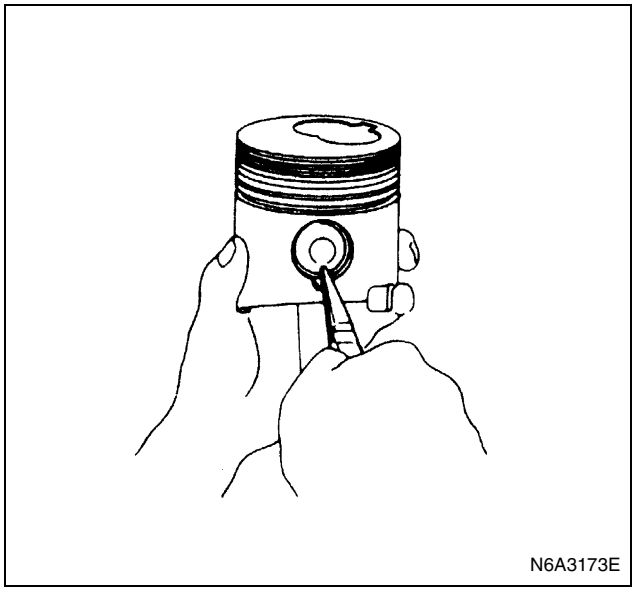
1. Cylinder Block
2. Tappet
3. Camshaft
   - Apply a coat of engine oil to the tappet and the cylinder body tappet insert holes.
   - Locate the position mark applied at disassembly (if the tappet is to be reused).
   - Apply a coat of engine oil to the camshaft and the camshaft bearings.
   - Install the camshaft to the cylinder body.
     Take care not to damage the camshaft bearings.


N6A3106E

4. Crankshaft
5. Main Bearing Cap
6. Crankshaft Rear Oil Seal
7. Cylinder Block Rear Plate
8. Flywheel
   Above works refer to “CRANKSHAFT” Section in this manual.
9. Piston and Connecting Rod
   1) Try to insert the piston pin into the piston pin hole with normal finger pressure.
      Weigh each piston and connecting rod assembly.
      Select piston and connecting rod combinations so that the weight variation of the different assemblies is held within the specified limits.

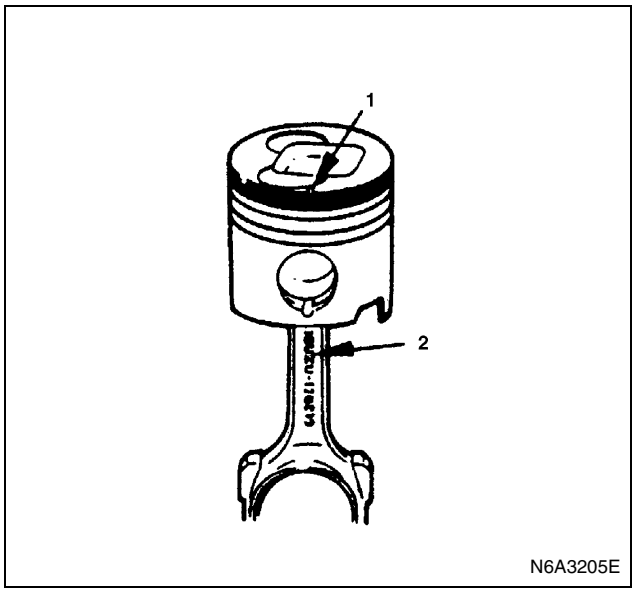
	g (oz)
Variance in weight after assembly	Less than 3 (0.1058)

   2) Clamp the connecting rod in a vise.
      Take care not to damage the connecting rod.
   3) Use a pair of pliers to install the piston pin snap ring to the piston.


N6A3173E

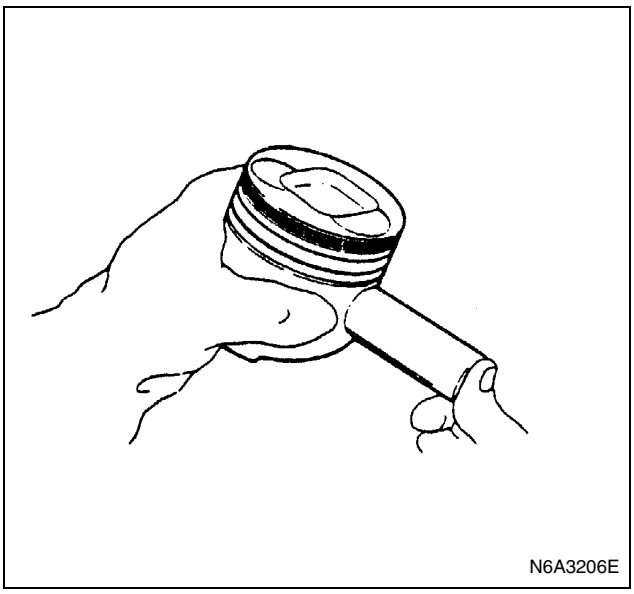
Notice:
When changing piston/connecting rod combinations, do not change the piston/piston pin combination.

   4) Install the piston to the connecting rod.
      The piston head front mark (1) and the connecting rod “ISUZU” casting mark (2) must be facing the same direction.

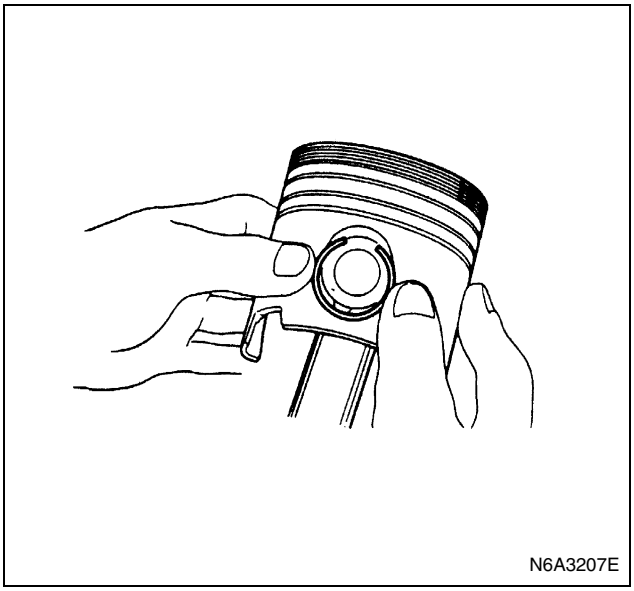


N6A3205E

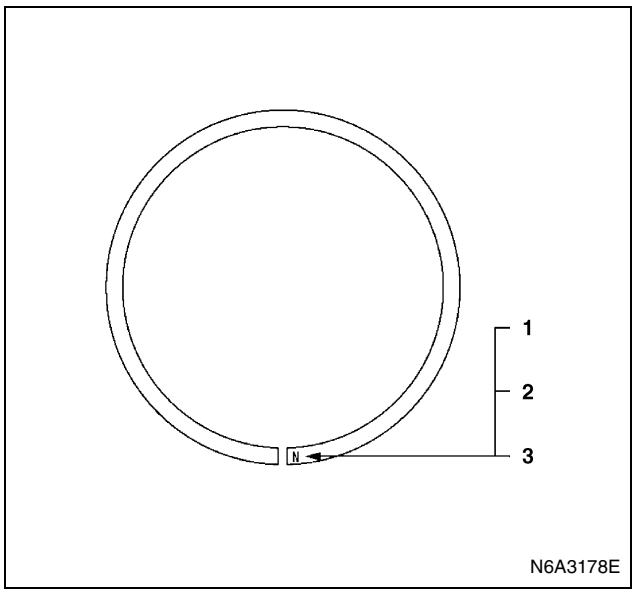
   5) 5Apply a coat of engine oil to the piston pin and the piston pin hole.
      Use your fingers to force the piston pin into the piston until it makes contact with the snap ring.


N6A3206E

6) Use your fingers to force the piston pin snap ring into the piston snap ring groove.
Check that the connecting rod moves smoothly on the piston pin.


N6A3207E

7) Install the piston rings with the piston ring expander.
The compression ring must be set with the 1N, 2N mark (4JG2) facing up.
Discrimination mark is painted as shown in the illustration.

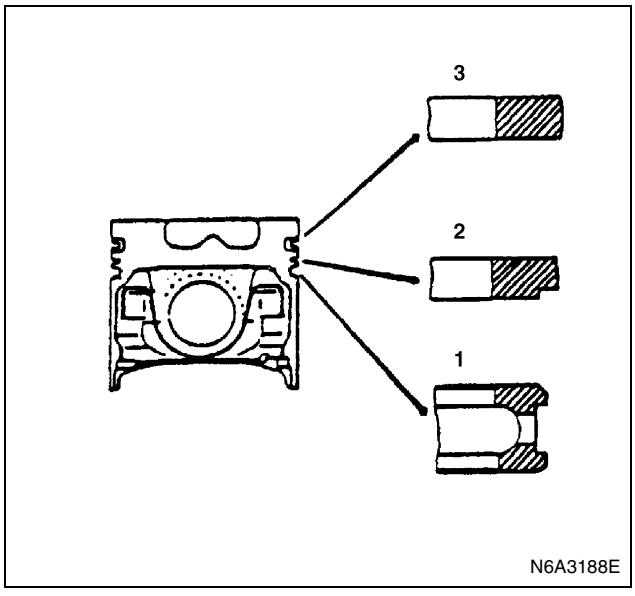


N6A3178E

Legend
1. N mark (Top ring) (2nd ring) (4JB1)
2. 1N mark (Top ring) 2N mark (2nd ring) (4JG2)
3. R mark (Top ring) (2nd ring) (4JH-TC)

8) Use a piston ring replacer to install the three piston rings.
Piston Ring Replacer:
Install the piston rings in the numerical order shown in the illustration.

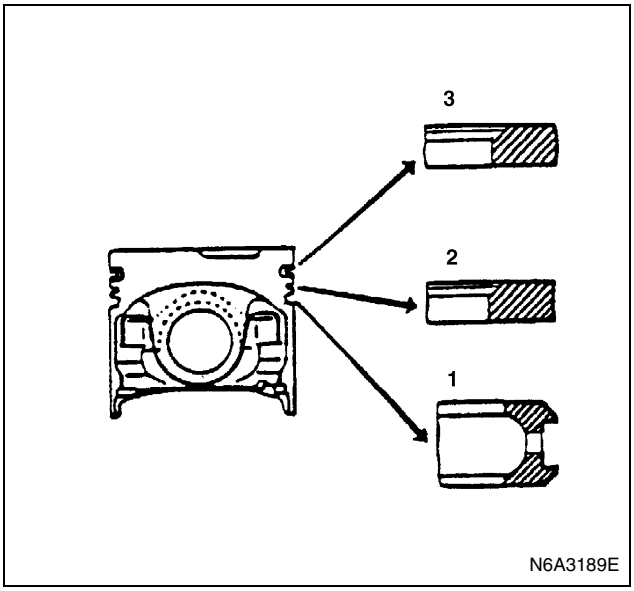
4JB1, 4JH1-TC



N6A3188E

Legend
1. Oil ring
2. 2nd compression ring
3. 1st compression ring

4JG2



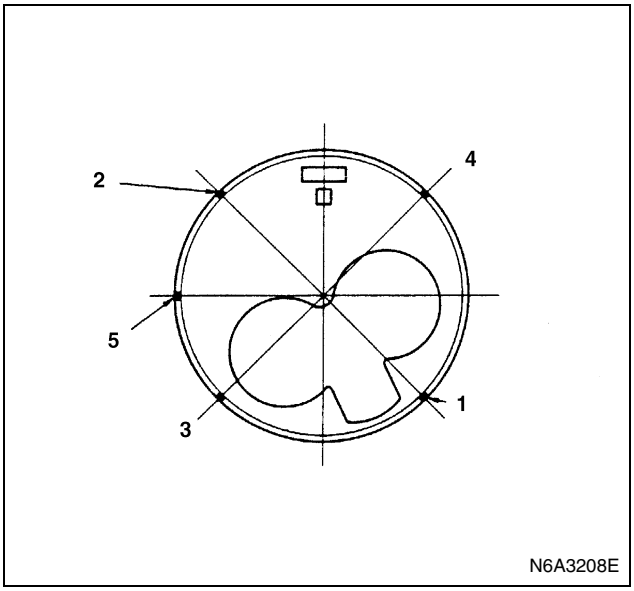
Legend

1. Oil ring
2. Compression ring No. 2
3. Compression ring No. 1

Notice:
Install the compression rings with the stamped side facing up.

Insert the expander coil into the oil ring groove so that there is no gap on either side of the expander coil before installing the oil ring.

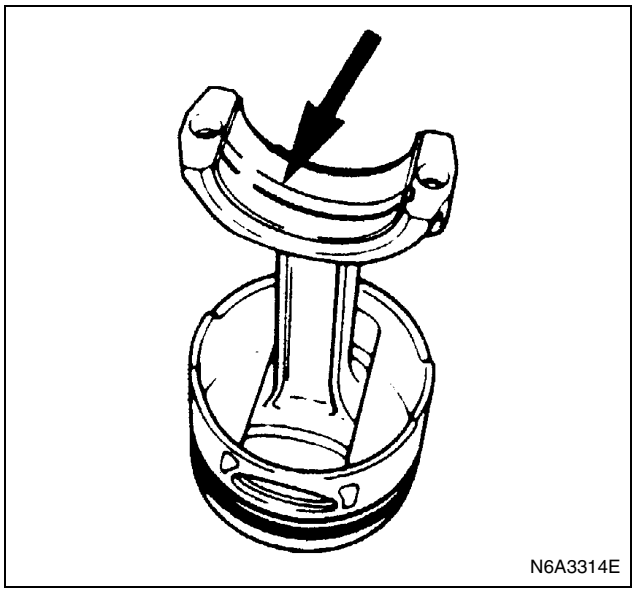
9) Apply engine oil to the piston ring surfaces.
10) Check that the piston rings rotate smoothly in the piston ring grooves.
11) Position the piston ring gaps as shown in the illustration.



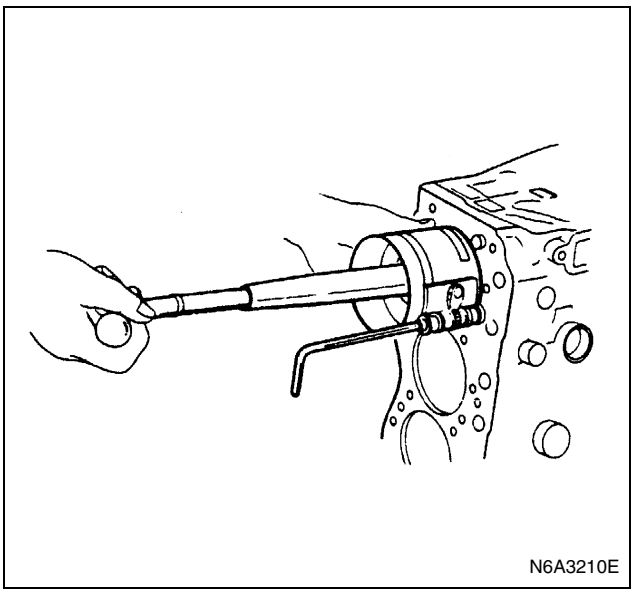
Legend

1. No. 1 Compression ring
2. No. 2 Compression ring
3. Oil ring
4. Expand ring
5. Front mark

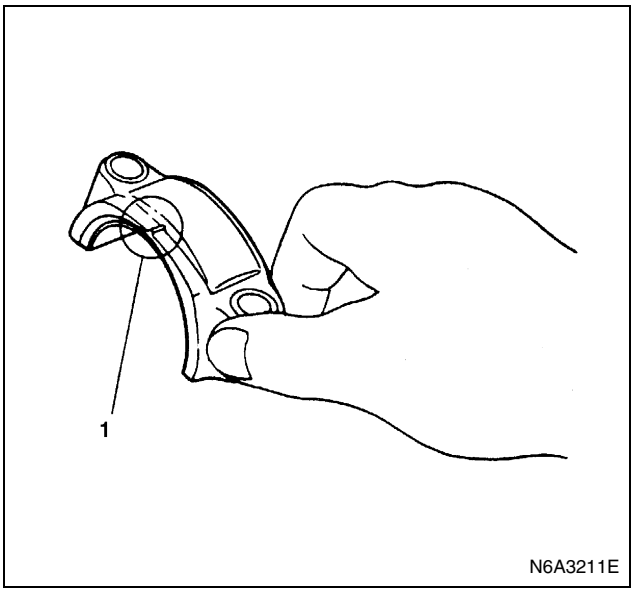
12) Carefully wipe any oil or other foreign material from connect rod bearing back face and the connecting rod bearing fitting surface.
13) Apply a coat of engine oil to the upper bearing surfaces.
Apply a coat of engine oil to the cylinder wall.



14) Position the piston head from mark so that it is facing the front of engine.
Use the piston ring compressor to compress the piston rings.
Piston Ring Compressor: 5-8840-9018-0 (J-8037)
15) Use a hammer grip to push the piston in until the connecting rod makes contact with the crankpin.
At the same time, rotate the crankshaft until the crankpin is at BDC.


N6A3210E

16) Position the bearing cap front mark so that it is facing the front of the engine.
17) Install the connecting rod bearing caps.
Align the bearing cap cylinder number marks and the connecting rod cylinder number marks.

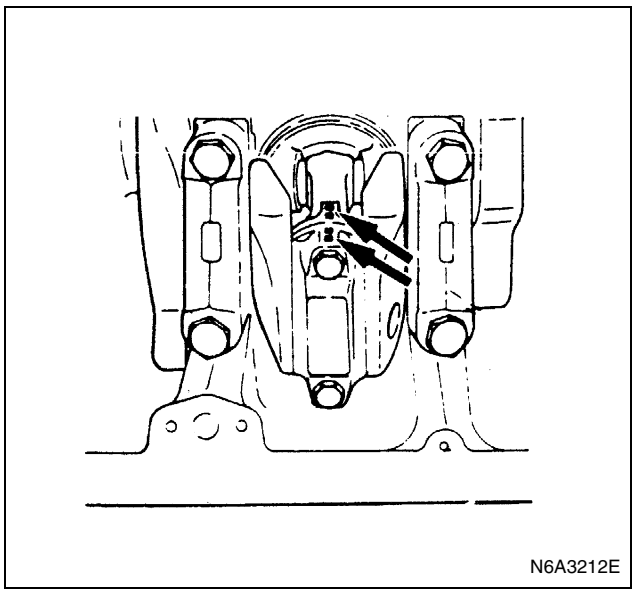


N6A3211E

Legend
1. Front mark

18) Apply a coat of engine oil to the threads and setting faces of each connecting rod cap bolt.
19) Tighten the connecting rod bearing cap bolts to the specified torque in two steps using the Angular Tightening Method.

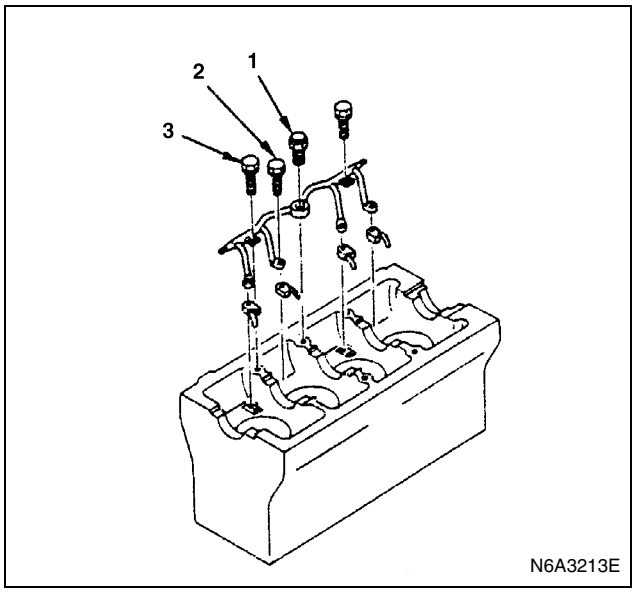
Tighten:
Connecting Rod Bearing Cap Bolt to
- 4JB1-TC, 4JH1-TC
  1st Step: 29 N·m (3.0 kg·m/22 lb·ft)
  2nd Step: 45° — 60°
- 4JB1: 83 N·m (8.5 kg·m/61 lb·ft)


N6A3212E

Notice:
Check to see that the crankshaft turns smoothly by rotating it manually.

10. Piston Cooling Oil Pipe
    1) Fix the oil jet pipes with knock pins on the cylinder block.
    2) Install the oil pipe for piston cooling in the cylinder block, tightening a relief valve (1) and four joint bolts (2) to the specified torque.

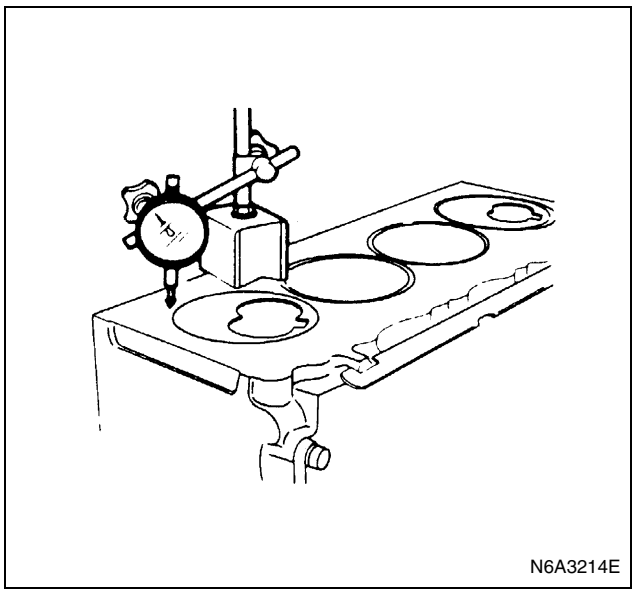
Tighten:
- Oil pipe fixing bolts to
  M8: 19 N·m (1.9 kg·m/14 lb·ft)
  M6: 8 N·m (0.8 kg·m/69 lb·in)
- Relief valve fixing bolt to 29 N·m (3 kg·m/22 lb·ft)



N6A3213E

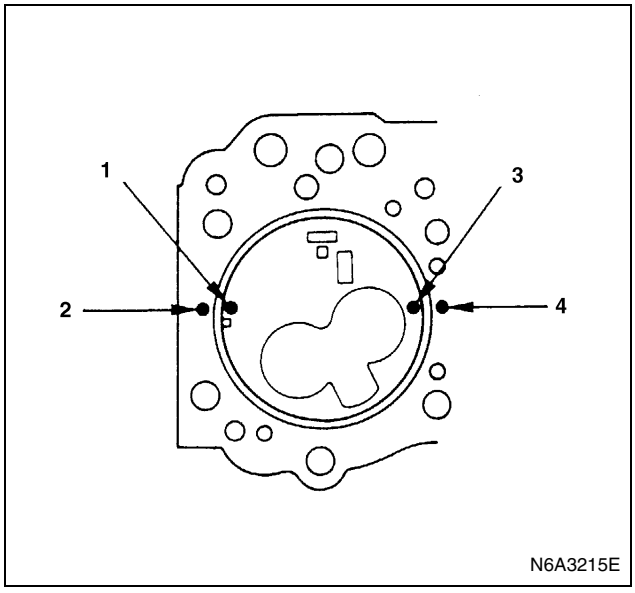
Caution:
After installed the piston assembly. Check and see that there is appropriate clearance between pistons and oil jet pipes by rotating crankshaft slowly.

11. Oil Pump Assembly
    Above works refer to “OIL PUMP” Section in this manual.
12. Timing Pulley Housing
13. Timing Gear Housing
14. Front Oil Seal (Belt Drive Model)
15. Timing Belt and Pulley
    1) Camshaft Timing Pulley
    2) Timing Belt
    3) Flange: Camshaft Pulley
    4) Timing Pulley Lower Cover
    5) Timing Pulley Upper Cover
    6) Crankshaft Damper Pulley
16. Timing Gear (Gear Drive Model)
    1) Crankshaft Gear
    2) Crankshaft Timing Gear
    3) Idle Gear
    4) Idler Gear “B” and Shaft
    5) Injection Pump
    6) Timing Gear Oil Pipe
    7) Timing Gear Case Cover
    8) Crankshaft Damper Pulley
    9) Cooling Fan Assembly
    10) AC Generator, Power Steering Pump Drive Belt
    11) Fan Shroud
        Above works refer to “CRANKSHAFT” Section in this manual.
17. Oil Pan Assembly
    Above works refer to “OIL PUMP” Section in this manual.
18. Cylinder Head Assembly and Gasket
    1) Cylinder head gasket is determined by the piston head projection from the cylinder body upper surface, in order to improve engine performance.
       Three types of gasket are provided by the difference of thickness. Select the adequate one out of three grades of gasket, according to the following procedure.
       Before measurement, clear off carbon from the piston head and cylinder body surface and also clean the place where a gasket was installed.


N6A3214E

Piston Head Projection Measurement Point

    2) Use a dial indicator to measure the piston projection amount.
    3) Refer to the illustration for the piston head projection measuring positions.
       All measuring positions should be as close as possible to the cylinder liner.
    4) Measure the points (1) (2) (3) (4) and obtain two difference (1) — (2) and (3) — (4) on each cylinder.
       Calculate the average value of the piston head projection on each cylinder.
    5) Obtain the maximum value in the four cylinders.
    6) Determine the gasket grade required to the maximum value described above in accordance with the following table.



N6A3215E

4JB1 / 4JB1-TC
Cylinder Head Gasket Thickness

mm (in)

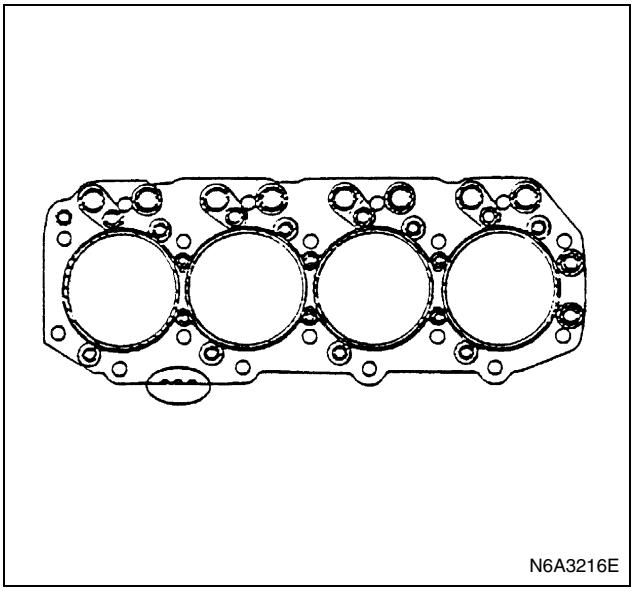
1		2	3
A		0.758 - 0.813 (0.030 - 0.032)	1.60 (0.0630)
B		0.813 - 0.859 (0.032 - 0.034)	1.65 (0.0650)
C		0.859 - 0.914 (0.034 - 0.036)	1.70 (0.0670)

N6A3690E

Legend

1. Gasket grade mark
2. Piston projection
3. Gasket thickness (Reference)

4JB1



N6A3216E

Notice:
The difference between the highest measured piston head projection and the lowest measured piston head projection must not exceed 1.0mm (0.039 in).

4JG2 Cylinder Head Gasket Thickness

mm (in)

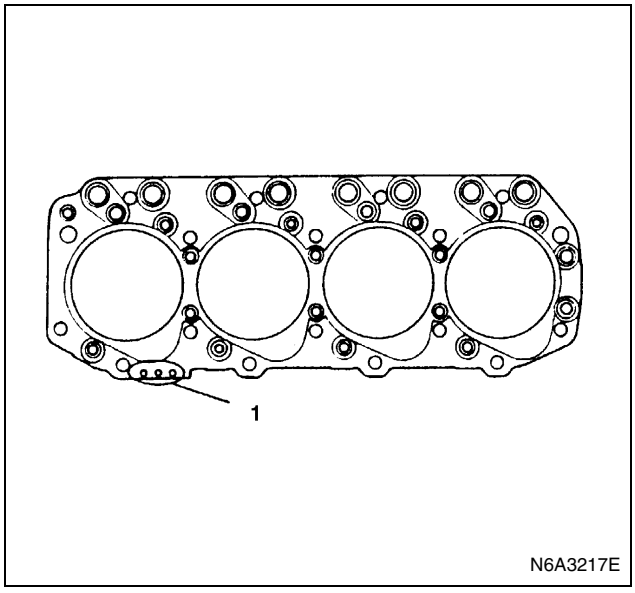
1		2	3
A		0. 658-0.713 (0.0259-0.0281)	1.60 (0.0630)
B		0.713-0.759 (0.0281-0.0299)	1.65 (0.0650)
C		0.759-0.814 (0.0299-0.0320)	1.70 (0.0670)

N6A3693E

Legend

1. Gasket mark
2. Average piston projection
3. Gasket thickness

4JG2



N6A3217E

Legend

1. Gasket mark

4JH1-TC

Cylinder Head Gasket Thickness

mm (in)

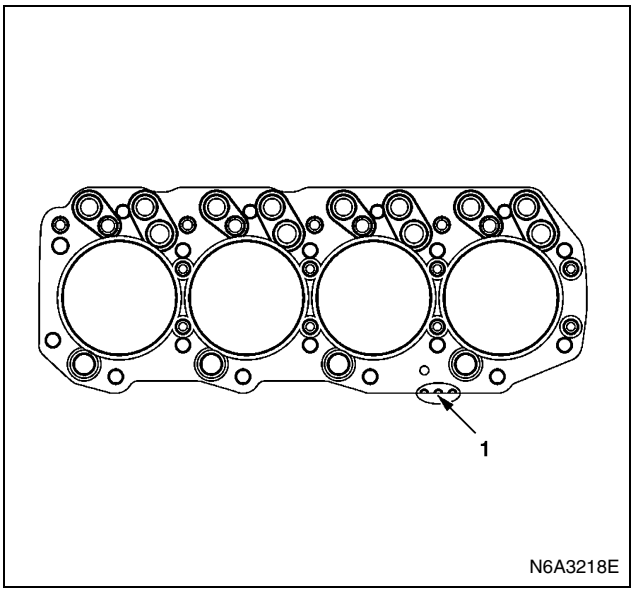
1		2	3
A		0.215 - 0.265 (0.0085 - 0.0104)	1.3 (0.5118)
B		0.265 - 0.315 (0.0104 - 0.0124)	1.35 (0.5315)
C		0.315 - 0.365 (0.0124 - 0.0144)	1.4 (0.5512)

N6A3691E

Legend

1. Gasket grade mark
2. Piston projection
3. Gasket thickness (Reference)

4JH1



N6A3218E

Legend

1. Grade mark

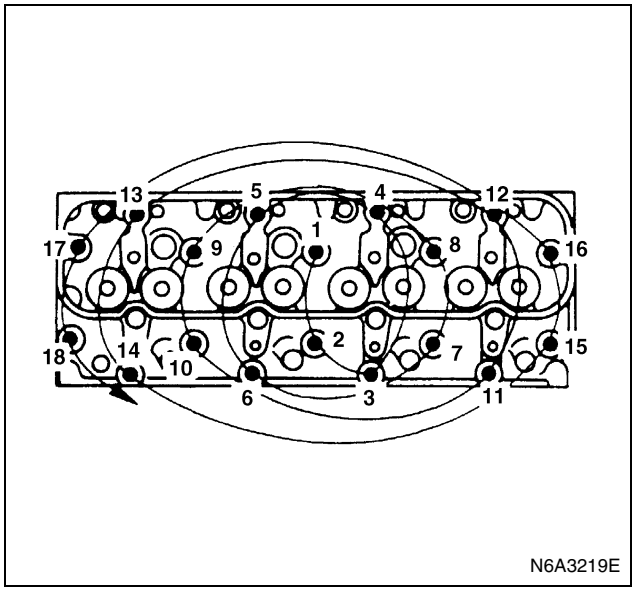
Notice:
The difference between the highest measured piston head projection and the lowest measured piston head projection must not exceed 1.0mm (0.039 in).

Cylinder Head Assembly

1. Install the dowel in cylinder block.
2. Install the cylinder head gasket with top mark up.
3. Clean up cylinder head lower surface and cylinder body upper surface.
4. Install the cylinder head as softly.
5. Apply molybdenum disulfide grease to screw and seat of cylinder head bolts.
6. Tighten the cylinder head bolts to the specific torque in three step following the numerical and shown in the illustration.

Tighten:
Cylinder Head Bolts to

- 1st Step: 49 N·m (5 kg·m/36 lb·ft)
- 2rd Step: 60° — 75°
- 3rd Step: 60° — 75°



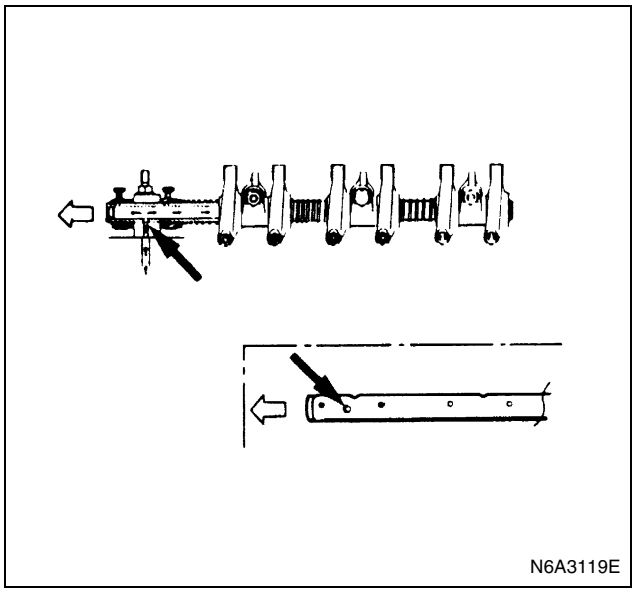
N6A3219E

Push Rod

- Apply engine oil to push rod and into the cylinder head.

Rocker Arm Shaft Assembly

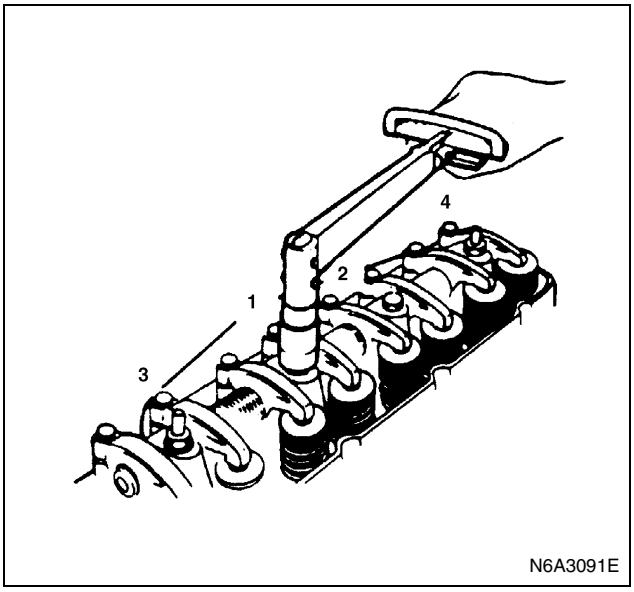
1. Loosen all adjusting screws.
2. Position the rocker arm shaft with the large oil hole (4ϕ) facing the front of the engine.



N6A3119E

3. Tighten the rocker arm shaft bracket bolts to the specified torque in the numerical order shown in the illustration.

Tighten:
Rocker Arm Shaft Bracket Bolt to 54 N·m (5.5 kg·m/40 lb·ft)



- Valve clearance adjustment.

ENGINE 4J SERIES

SECTION 6A1

4JB1/4JB1-TC/4JG2/4JH1-TC - ENGINE

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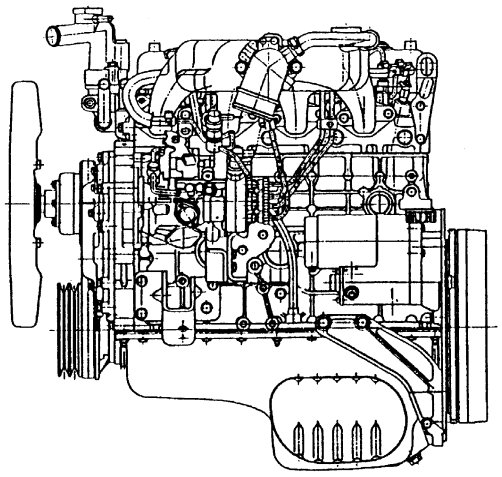
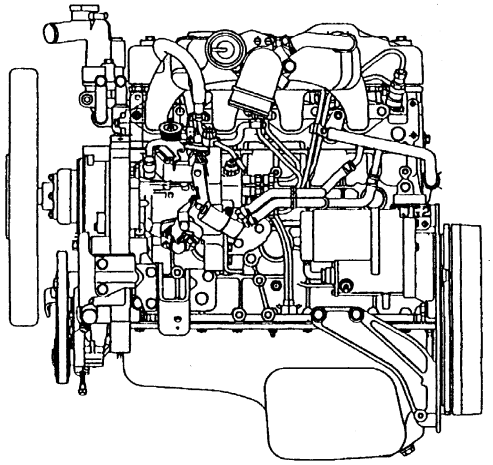
GENERAL DESCRIPTION

4JB1, 4JG2



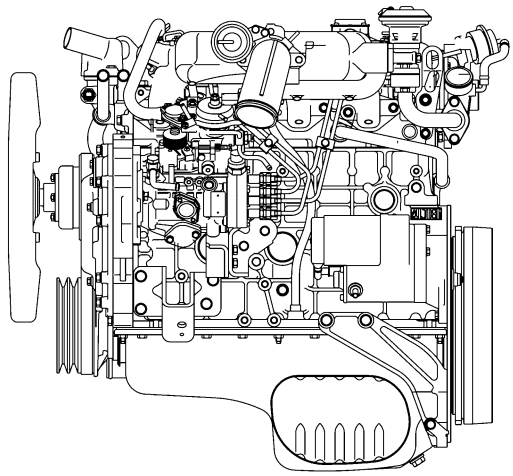
4JB1



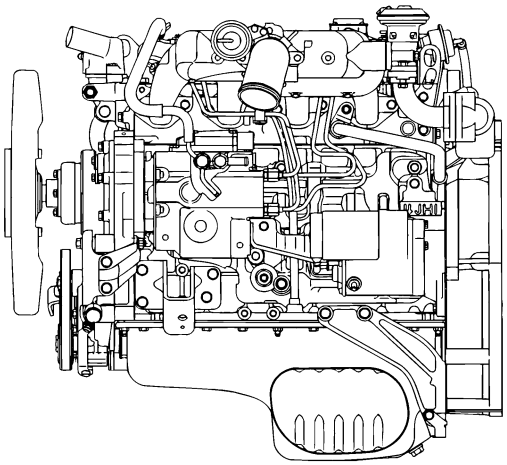
4JG2

N6A3220E

4JB1-TC, 4JH1-TC



4JB1-TC



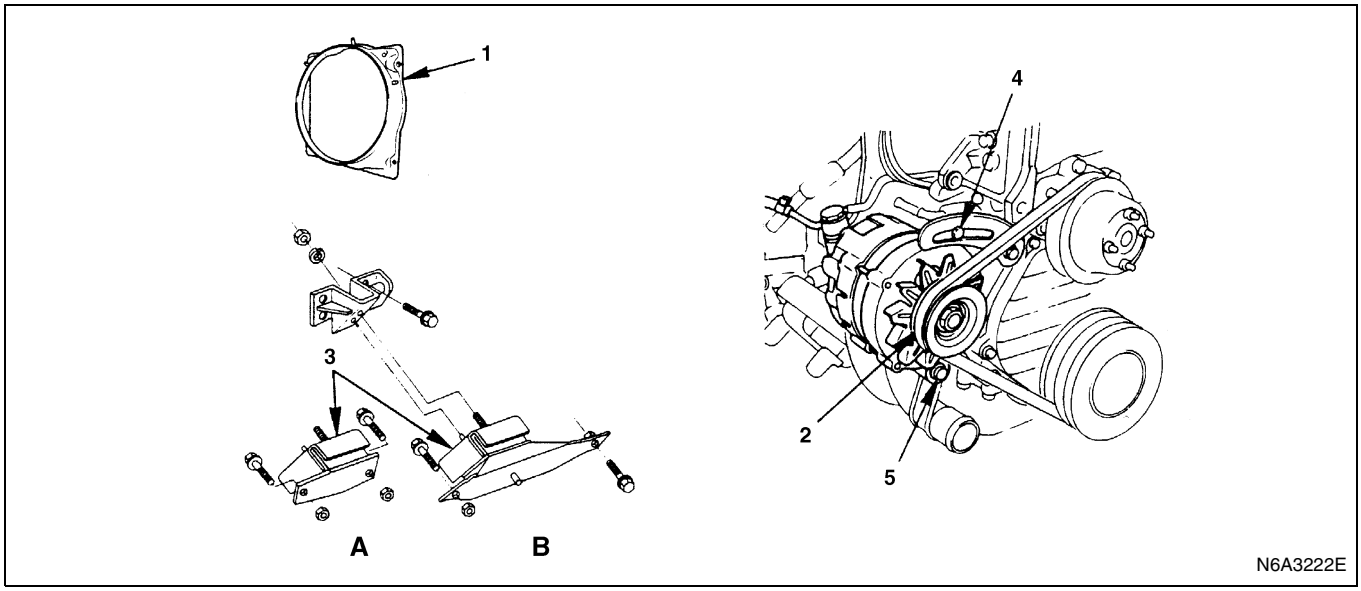
4JH1-TC

N6A3221E

The 4JB1 Model engine employs a square troidal type combustion chamber provided with a fence around it.
These designs employed allow a superior fuel economy over a wide range of driving conditions.
The 4JG2 Model engine employs, for its combustion chamber, the RECARD Comet V Type swirl combustion chamber which provides a superior driving performance, fuel economy and silent combustion over a wide range of driving conditions.
For the cylinder head gasket steel sheets, laminated steel sheets are employed.
Three grades of the gaskets according to the piston head projection measured from the cylinder block are employed to minimize the fluctuation of the engine compression ratio.
The Angular Tightening Method is employed to tighten the cylinder head fixing bolts, connecting rod fixing bolts and flywheel fixing bolts.
The chrome-plated steel dry type (Chromard) cylinder liners provide the highest durability.
Auto-thermic pistons with cast steel struts are used to reduce thermal expansion and resulting engine noise experienced while the engine is cold.
The tufftrided crankshaft has a long service life. Because it is tufftrided, it cannot be reground.
The crankshaft main bearings and the connecting rod bearings are of aluminum alloy. These bearings are especially vulnerable to foreign materials such as metal scraps. It is very important to keep the oil ports and other related surfaces clean and free of foreign materials.
The tufftriding treatment (nitriding treatment) of the crankshaft for the increased strength eliminates the regrinding of crankpins and journals.
An oiling jet device for piston cooling is provided in the lubricating oil circuit which runs through the check valve from the cylinder block oil gallery.
Take care not to damage the oiling jet when removing or installing the piston and the connecting assembly.
The 4JG2 engine use a single spring pintle type injection nozzle.
The 4JB1 Model employs a direct injection type engine provided with a nozzle with four holes, which makes it possible to obtain an excellent mixing ratio of intake air and fuel spray.
4JB1-TC engine has two springs injection nozzle system for efficient control.
The turbocharger increase air intake efficiency, the results in increased engine power, reduced fuel consumption and minimal engine noise.
Turbocharger rotating parts operate at very high speeds and temperatures. The parts materials have been carefully selected and machined to extremely high precision.
The 4JB1 Model engine employs the QOS II preheating system which features a quick-on glow to control the glow time and the afterglow time by the thermometer.
The 4JG2 engine employs the QOS III system which allows the most suitable starting conditions for the glow time to change according to the engine water temperature, and the optimum for the glow time to change according to the engine water temperature, and the optimum changes according to the water temperature immediately after the start of the engine.
The belt-driven type timing drive belt of the 4JG2 Model engine is a very important functional part, and requires the specified maintenance.

ENGINE MOUNT (RH)

Component



Legend

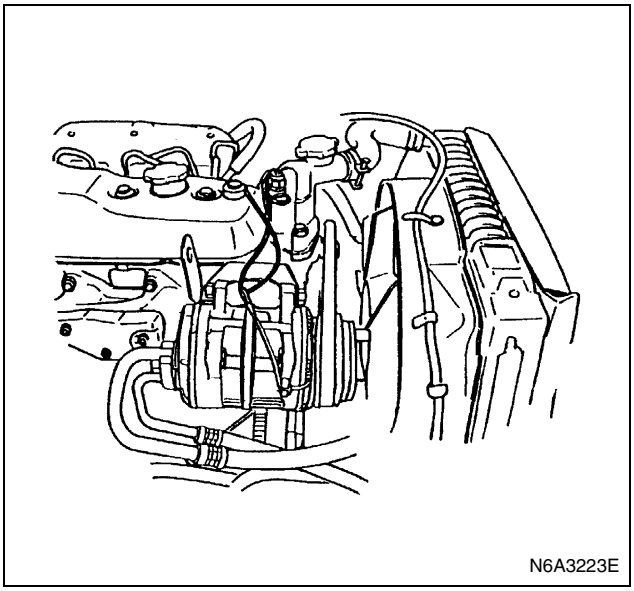
A. Rigid suspension
B. Independent suspension
1. Fan shroud
2. Fan belt
3. Support rubber
4. Lock bolt
5. AC generator fixing bolt

Removal

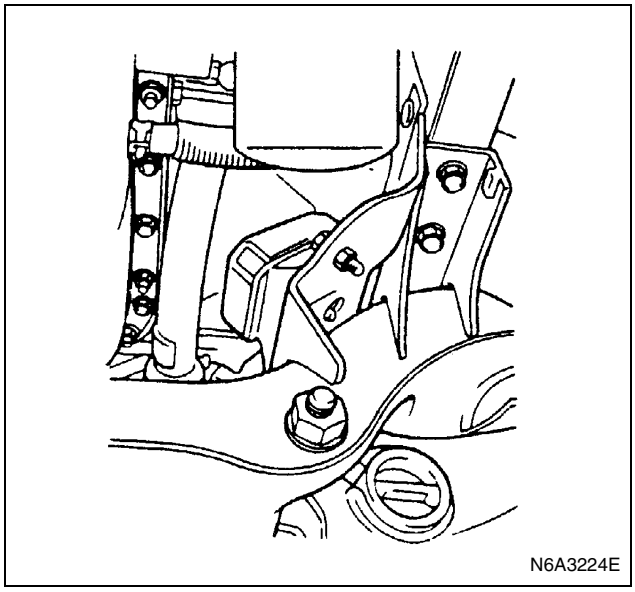
Preparation

- Disconnect battery ground cable.

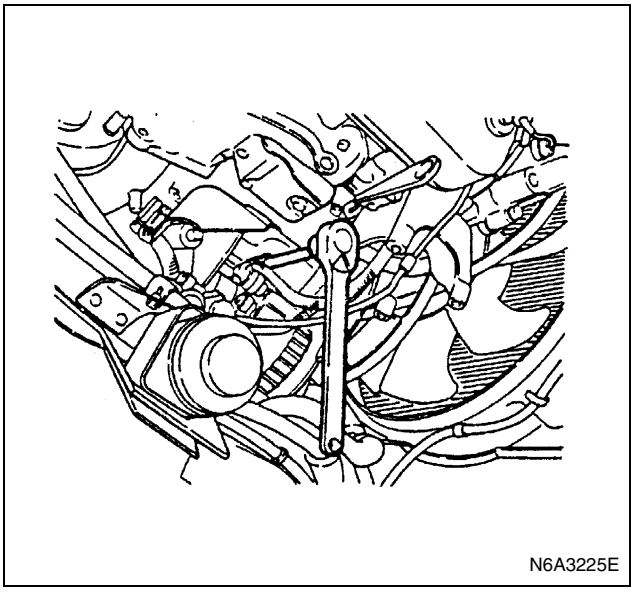
1. Fan Shroud
   - Remove reservoir tank hose and fan shroud.



2. Fan Belt
   - Remove adjust plate lock bolt.
   - Loosen generator fixing bolt then remove fan belt.
3. Support Rubber
   - Remove two fixing nuts at the crossmember side.



   - Separate the generator from the engine.
   - Remove the support rubber nut from engine foot side.
   - Remove the support rubber while raising the engine.


N6A3225E

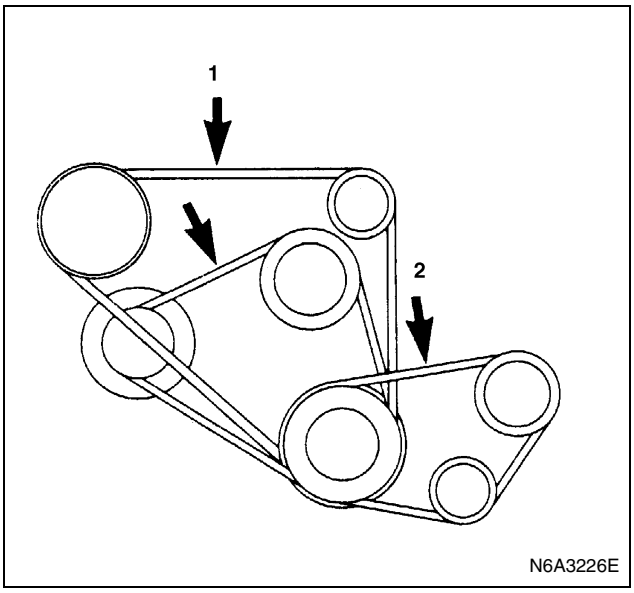
Installation

1. Support Rubber
   - Install the support rubber while raising the engine.
   - Tighten the fixing nuts to the specified torque.

Tighten:
- Engine foot side to 82 N·m (8.4 kg·m / 61 lb·ft)
- Crossmember side to 40 N·m (4.1 kg·m / 30 lb·ft)

2. Fan Belt
   - Install the fan belt.
   - Depress the fan belt mid-portion with a 98 N (10 kg/ 22 lb) force.
   - Tighten the fixing bolt to the specified torque.

Tighten:
- Adjust plate lock bolt to 19 N·m (1.9 kg·m / 14 lb·ft)
- Generator fixing bolt to 40 N·m (4.1 kg·m / 30 lb·ft)



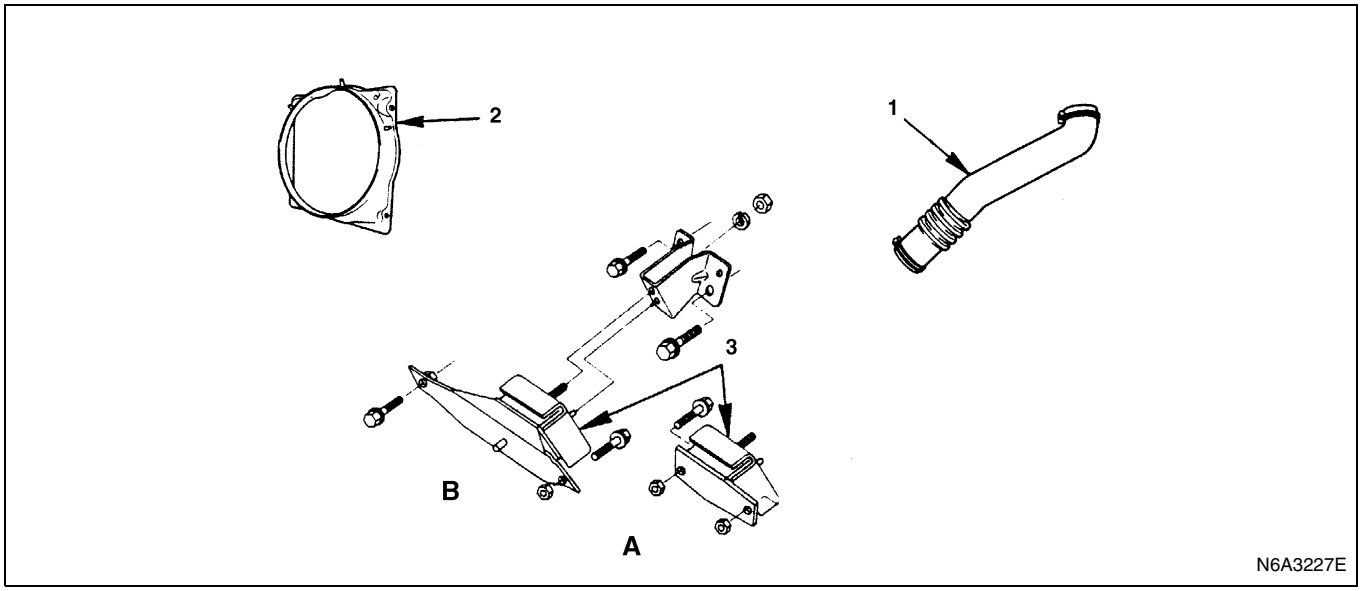
N6A3226E

Legend
1. A/C compressor drive belt
2. P/S oil pump drive belt

3. Fan Shroud
   - Install the fan shroud and clip the reservoir tank hose.

ENGINE MOUNT (LH)

Component



Legend

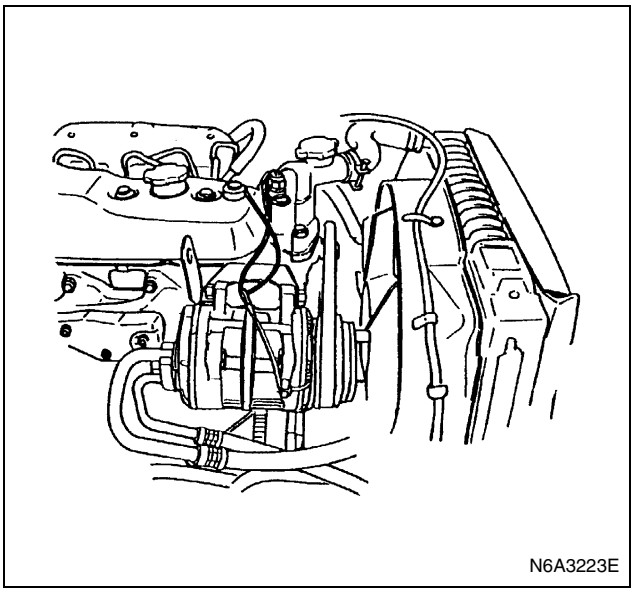
A. Rigid suspension
B. Independent suspension
1. Air intake duct
2. Fan shroud
3. Support rubber

Removal

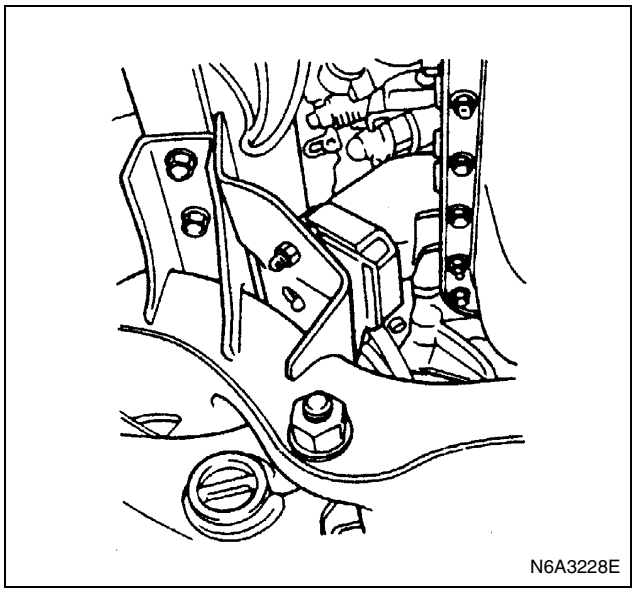
Preparation

- Disconnect battery ground cable.

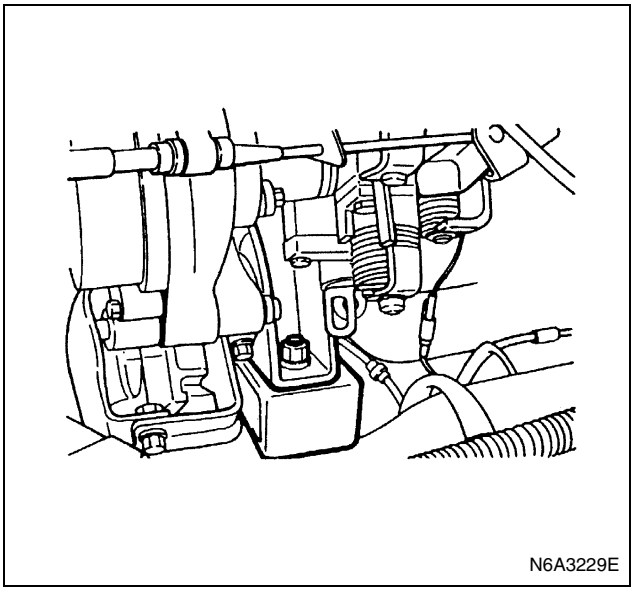
1. Air Intake Duct
   - Remove the intake duct.
2. Fan Shroud
   - Remove reservoir tank hose and fan shroud.

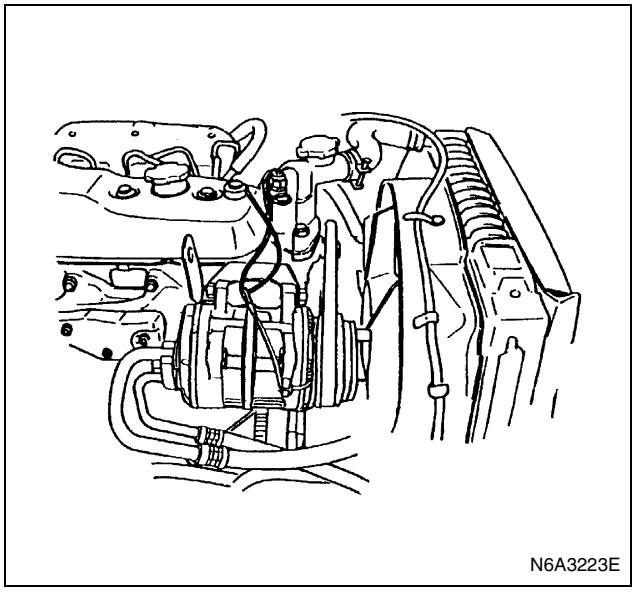


3. Support Rubber
   - Remove two fixing bolts at the crossmember side.



- Remove the support rubber nut from engine foot side.
- Remove the support rubber while raising the engine.

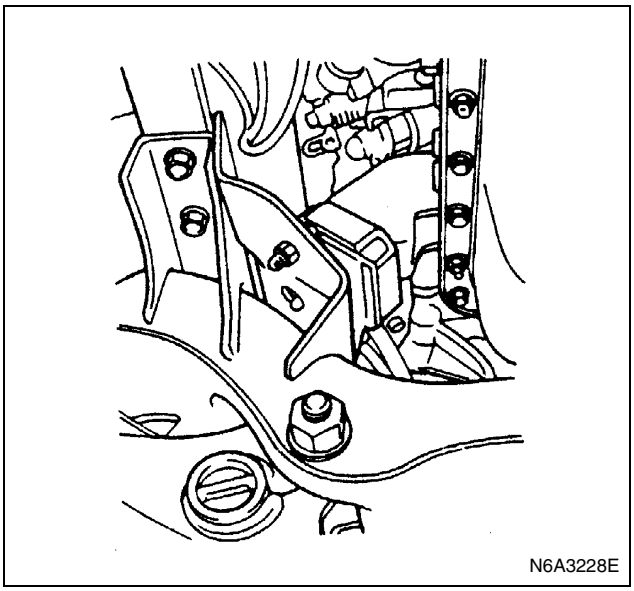

N6A3229E


N6A3223E

Installation

1. Support Rubber
   - Install the support rubber while raising the engine.
   - Tighten the fixing nuts to the specified torque.

Tighten:
- Engine foot side to 82 N·m (8.4 kg·m / 61 lb·ft)
- Crossmember side to 40 N·m (4.1 kg·m / 30 lb·ft)

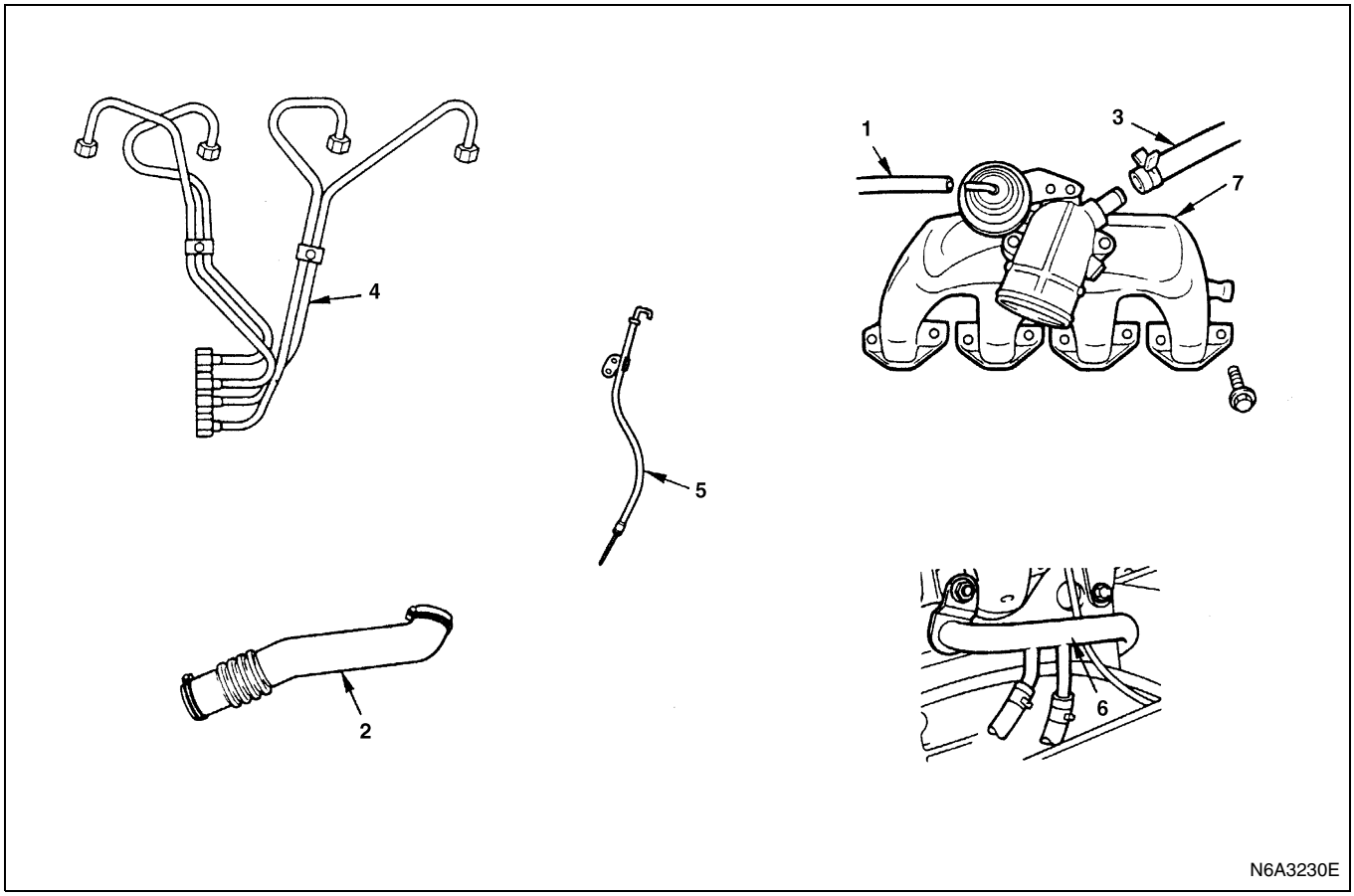

N6A3228E

2. Fan shroud
   - Install the fan shroud and clip the reservoir tank hose.

3. Air Intake Duct
   - Install the air intake duct.
   - Connect battery ground cable.

INLET MANIFOLD

Component



Legend

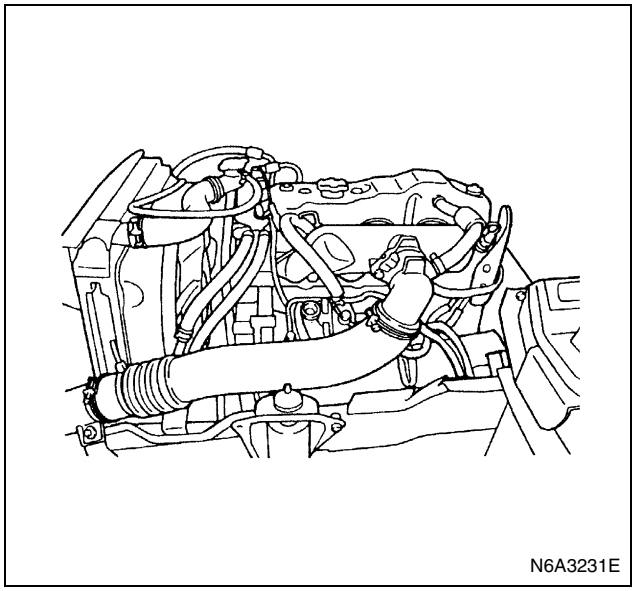
1. Vacuum hose
2. Air intake duct
3. PCV hose
4. Injection pipe
5. Oil level gauge guide tube
6. Oil cooler water pipe (Oil Cooler Model)
7. Inlet manifold

Removal

Preparation

- Disconnect battery ground cable.
- Drain coolant.

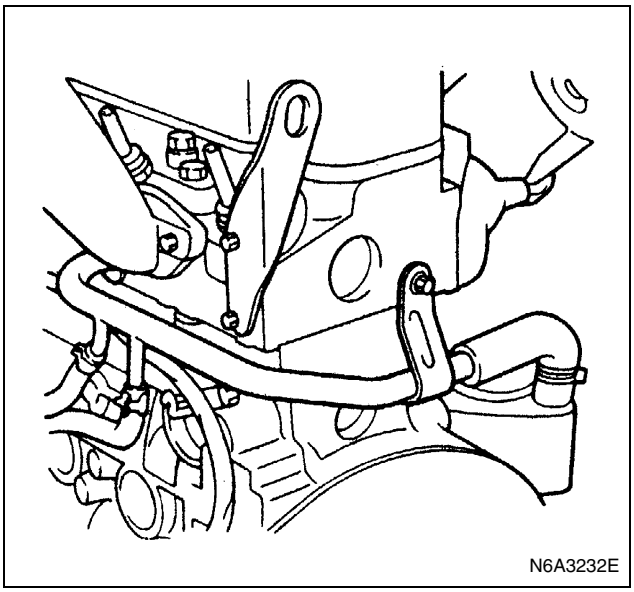
1. Vacuum Hose
2. Air Intake Duct
3. PCV Hose
4. Injection Pipe
   - Release injection pipe clip.
   - Loosen the flare nut on the injection pump side.
   - Loosen the flare nut on the injection nozzle side, disconnect and put a side the pipe.



5. Oil Level Gauge Guide Tube

- Remove the fixing bolt and remove level gauge guide tube.

6. Oil Cooler Water Pipe (Oil Cooler Model)
   - Remove the water pipe bracket bolt.
   - Remove the inlet manifold fixing nut.


N6A3232E

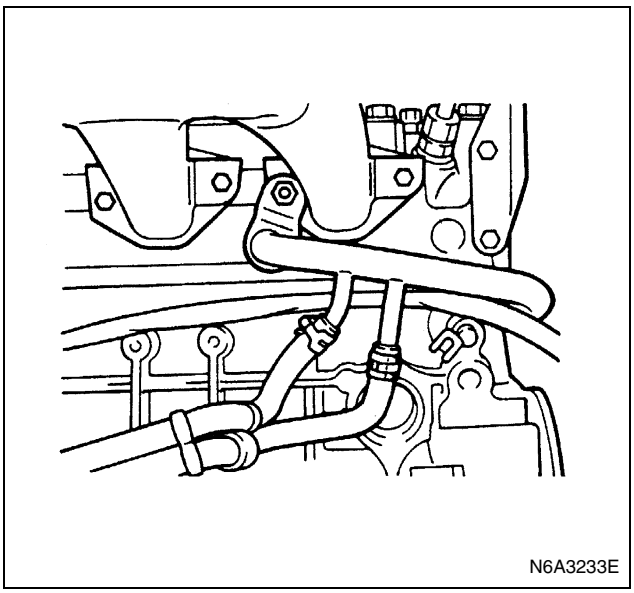
7. Inlet Manifold
   - Remove the manifold fixing bolt and nut.

Installation

1. Inlet Manifold
   - Tighten the fixing bolts and nuts to the specified torque.

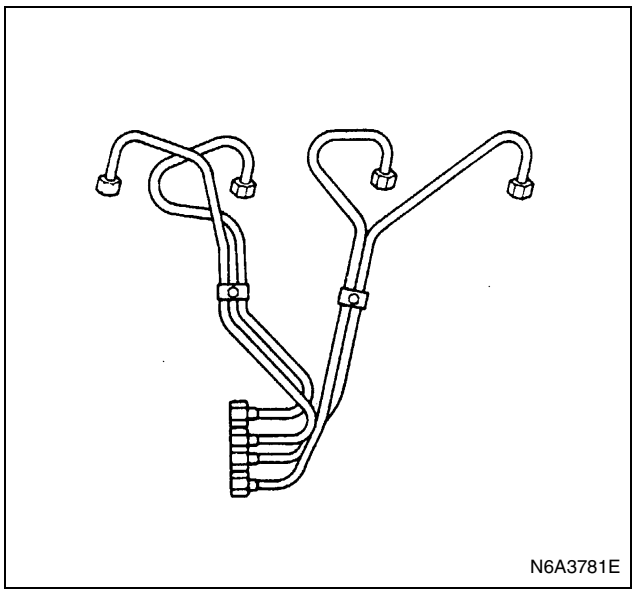
Tighten:
- Bolt & nut to 19 N·m (1.9 kg·m / 14 lb·ft)

2. Oil Cooler Water Pipe (Oil Cooler Model)
   - Install the water pipe and tighten the manifold with water pipe.
   - Tighten the pipe bracket bolt of cylinder head rear side.


N6A3233E

3. Oil Level Gauge Guide Tube
   - Install the guide tube and tighten the manifold with guide tube.
4. Injection Pipe
   - Connect the injection pipe and tighten flare nut to the specified torque.

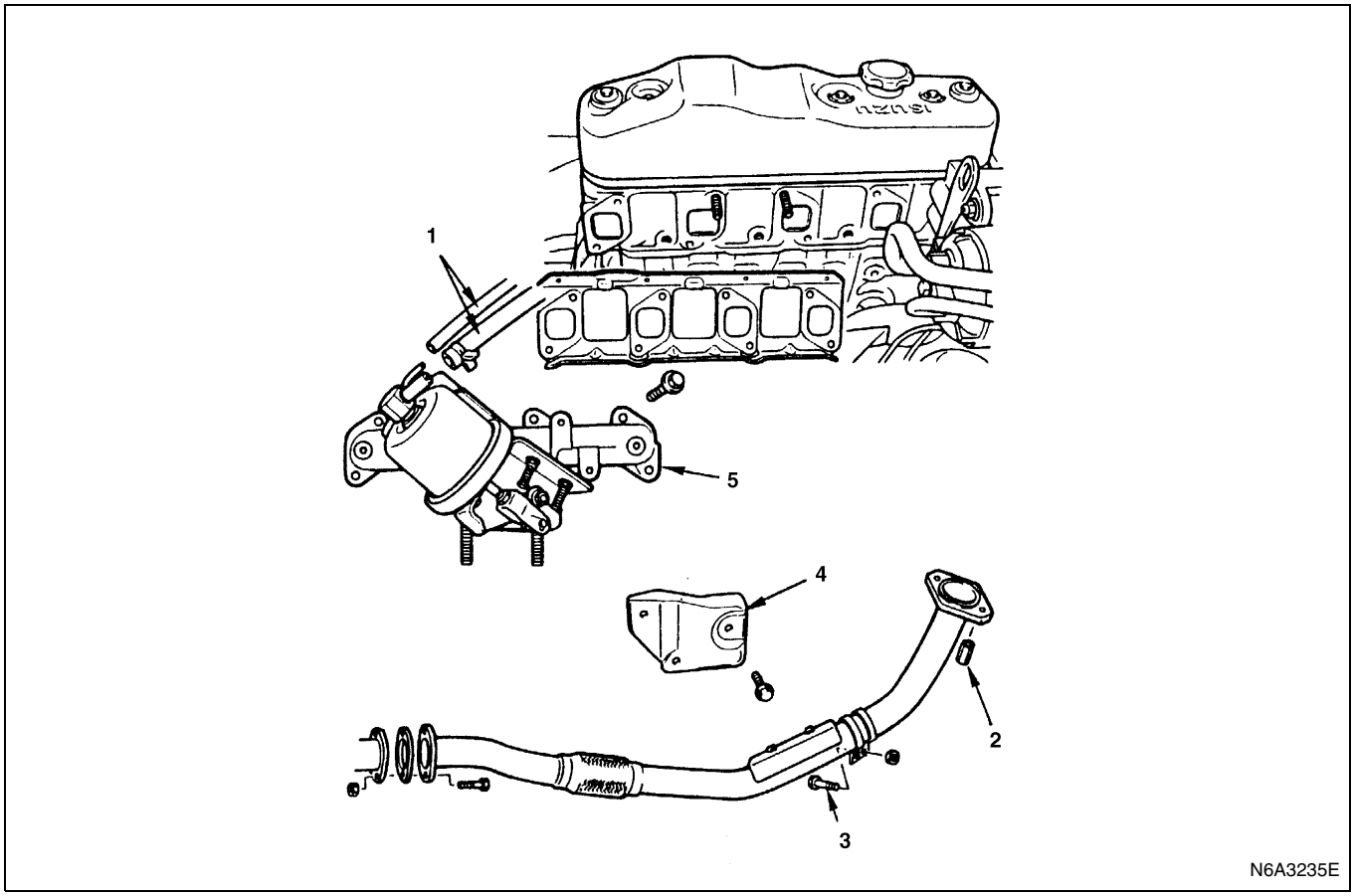
Tighten:
- Flare nut to 29 N·m (3.0 kg·m / 22 lb·ft)
   - Install the pipe clip to the original position.


N6A3781E

5. PCV Hose
6. Air Intake Duct
7. Vacuum Hose
   - Connect the battery ground cable.
   - Pour coolant.
   - Start the engine and check coolant leakage.

EXHAUST MANIFOLD

Component



Legend

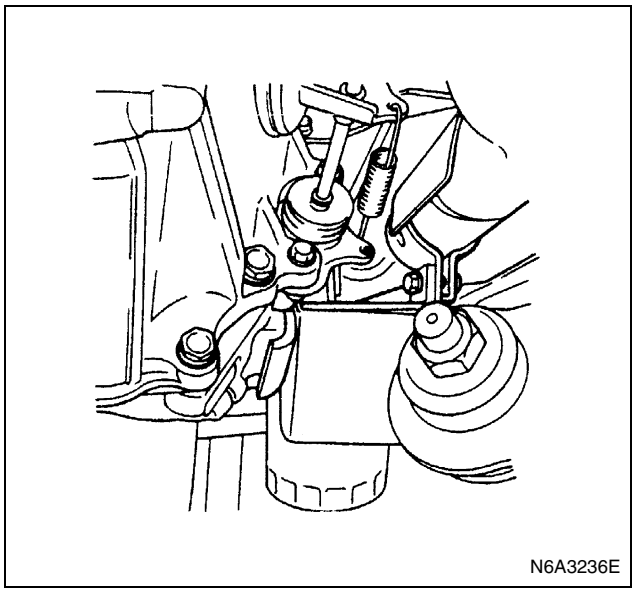
1. Vacuum hose
2. Front exhaust pipe nut
3. Front exhaust pipe stay bolt
4. Heat protector
5. Exhaust manifold

Removal

Preparation

- Disconnect battery ground cable.

1. Vacuum Hose (Exhaust Brake Model)
   - Remove the vacuum actuator hose.
2. Front Exhaust Pipe Nut
   - Remove the fixing nuts from exhaust manifold side.
3. Front Exhaust Pipe Stay Bolt



4. Heat Protector

5. Exhaust Manifold
   - Remove the manifold bolt and nut, then remove the manifold and gasket.

Installation

1. Exhaust Manifold
   - Tighten the fixing nuts and bolts to the specified torque.

Tighten:
- Manifold bolt to 26 N·m (2.7 kg·m / 20 lb·ft)

2. Heat Protector
   - Remove the heat protector and tighten to the specified torque.

Tighten:
- Heat protector bolt to 19 N·m (1.9 kg·m / 14 lb·ft)

3. Front Exhaust Pipe Stay Bolt
   - Tighten the fixing bolts to the specified torque.

Tighten:
- Stay bolt to 40 N·m (4.1 kg·m / 30 lb·ft)

4. Front Exhaust Pipe Nut
   - Tighten the fixing nuts to the specified torque.

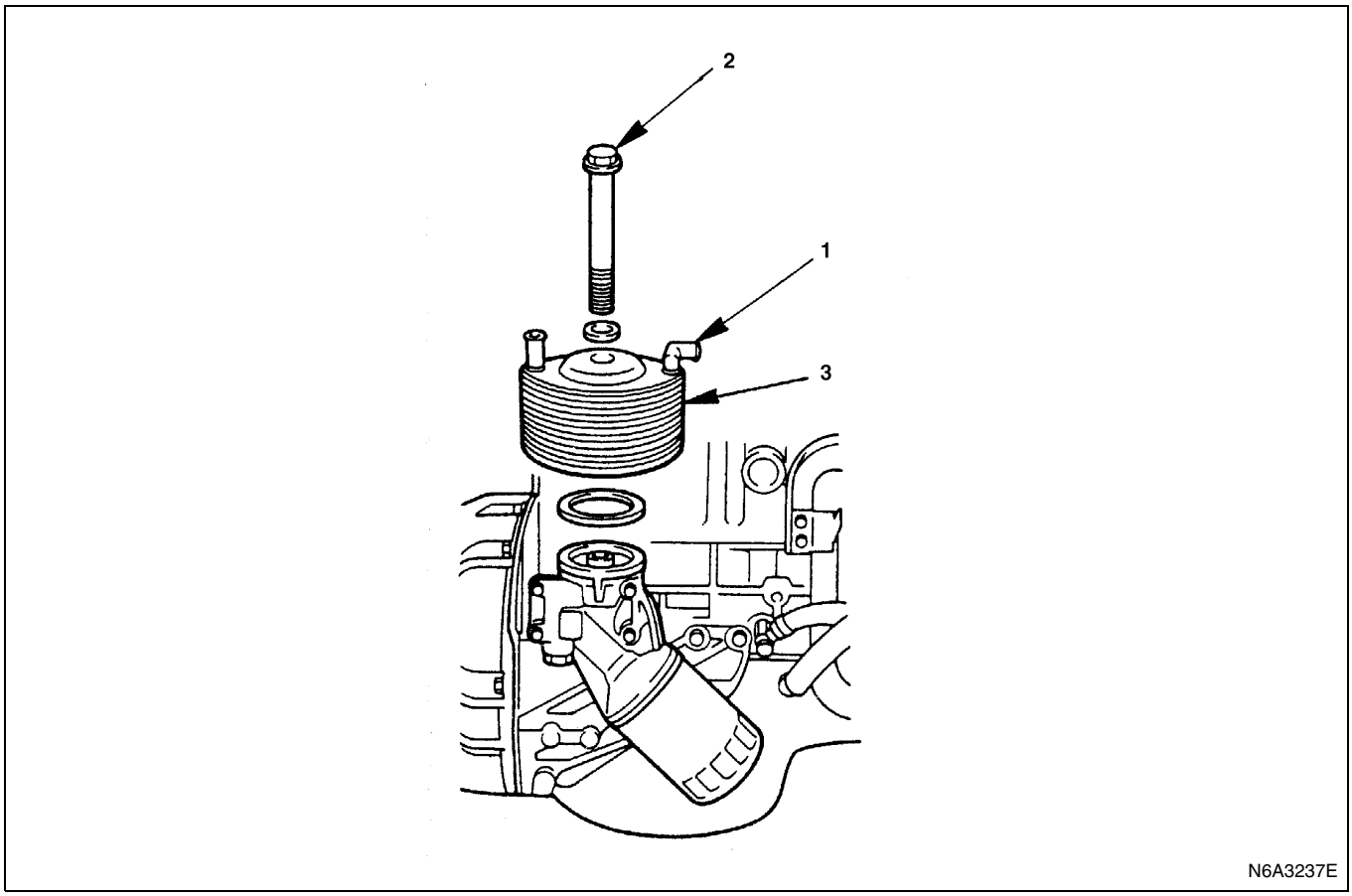
Tighten:
- Without exhaust brake to 69 N·m (7 kg·m / 51 lb·ft)
- With exhaust brake to 69 N·m (7 kg·m / 51 lb·ft)

5. Vacuum Hose (Exhaust Brake Model)
   - Install the two hose a vacuum actuator.
   - Connect battery ground cable.
   - Start the engine and check coolant leakage.

OIL COOLER (Oil Cooler Model)

Component

4JG2, 4JB1, 4JB1-TC, 4JH1-TC



Legend

1. Water hose
2. Oil cooler fixing bolt
3. Oil cooler

Removal

Preparation

- Disconnect battery ground cable
- Drain coolant
- Put rag to beneath side of oil cooler to prevent oil leaking.

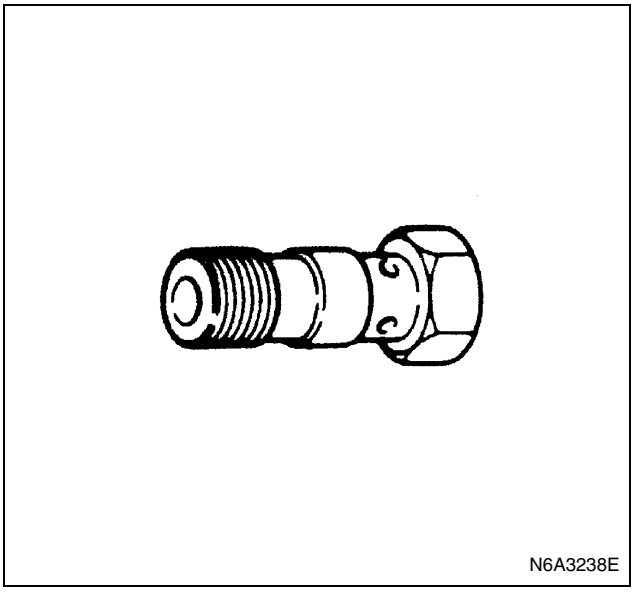
1. Water Hose
   - Disconnect water inlet and outlet hose.
2. Oil Cooler Fixing Bolt
3. Oil Cooler

Inspection

Relief Valve

1. Attach an oil pressure gauge to the oil gallery near the oil filter.
2. Start the engine to check the relief valve opening pressure.

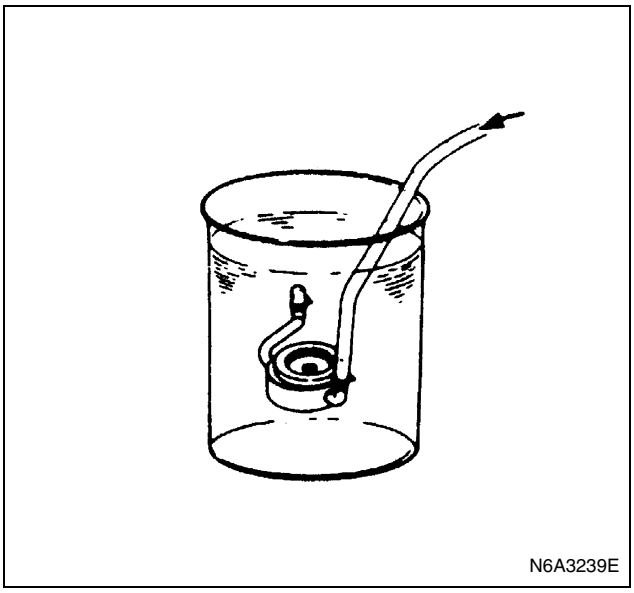
Relief Valve Opening Pressure	kPa (kg/cm^2/psi)
Type1	559 — 618 (5.7 — 6.3/81.0 — 89.6)
Type2	422 — 461 (4.3 — 4.7/61.1 — 66.8)


N6A3238E

Oil Cooler

Check for water leakage at the water passage.

1. Plug one side of the oil cooler water passage.
2. Submerge the oil cooler in water.
3. Apply compressed air (2 kg/cm^2 (28.5 psi / 196.0 kPa)) to the other side of the oil cooler water passage.
   If air bubbles rise to the surface, there is water leakage.

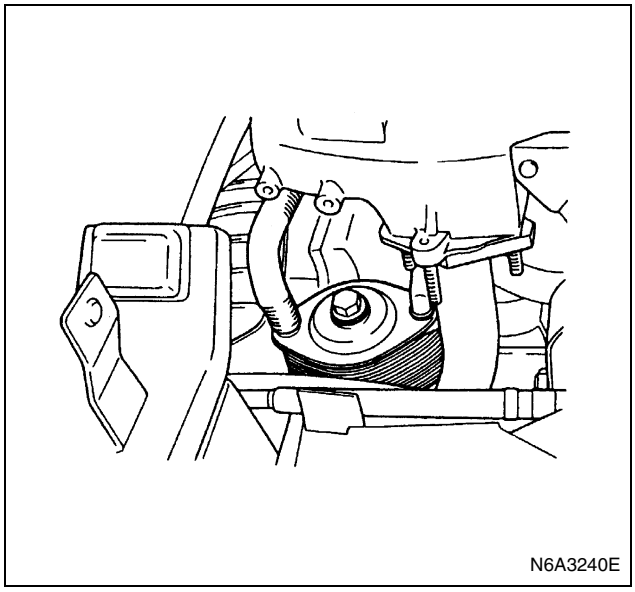

N6A3239E

Installation

1. Oil Cooler
   - Install the O-ring to oil filter body and set the oil cooler.
2. Oil Cooler Fixing Bolt

Tighten:

- Oil cooler bolt to 29 N·m (3.0 kg·m / 22 lb·ft)

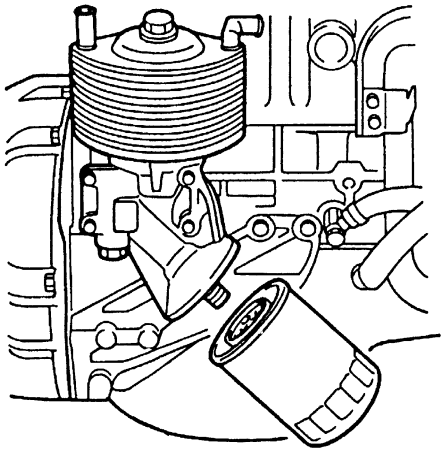

N6A3240E

3. Water Hose
   - Connect water hose.

OIL FILTER CARTRIDGE

Component

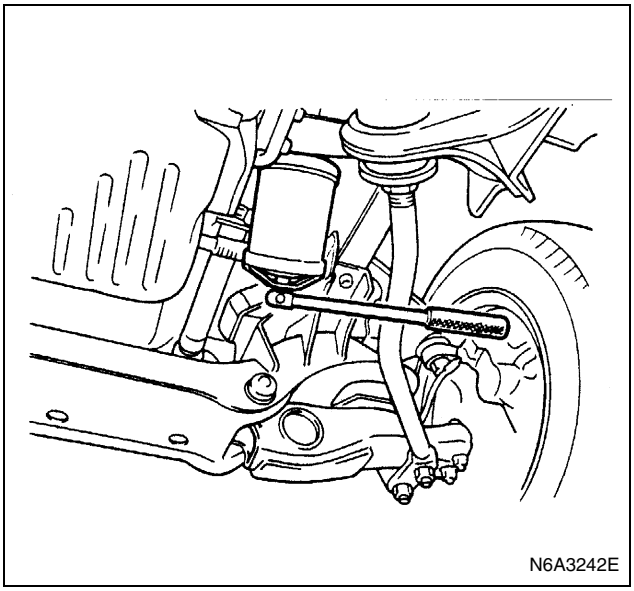
4JG2, 4JB1, 4JB1-TC, 4JH1-TC



N6A3241E

Removal

- Place a receptacle beneath the oil filter to contain the drained oil.
- Remove the oil filter cartridge using filter wrench.
  Filter wrench: 5-8840-0200-0



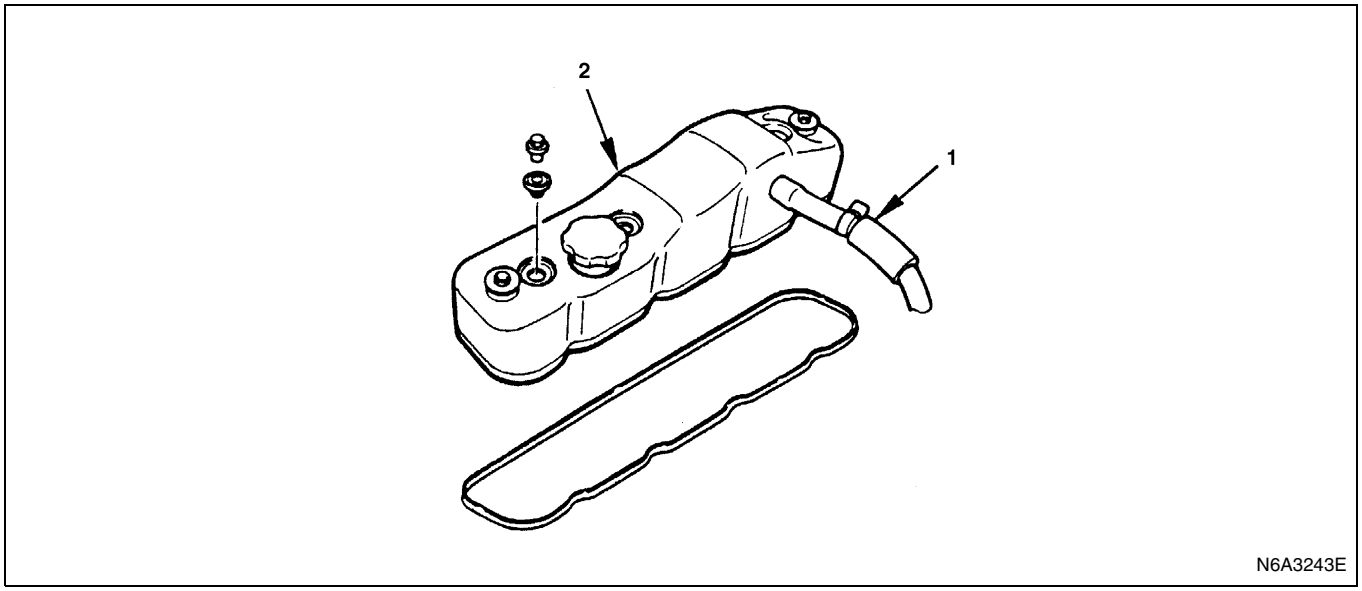
N6A3242E

Installation

- Lightly oil the O-ring of oil filter cartridge.
- Turn in the new oil filter cartridge by hand until the sealing face is fitted against the O-ring.
- Use the filter wrench to turn in the oil filter and additional one and 1.1/8 turns.
- Start the engine and check for oil leakage from oil filter.

CYLINDER HEAD COVER

Component



Legend

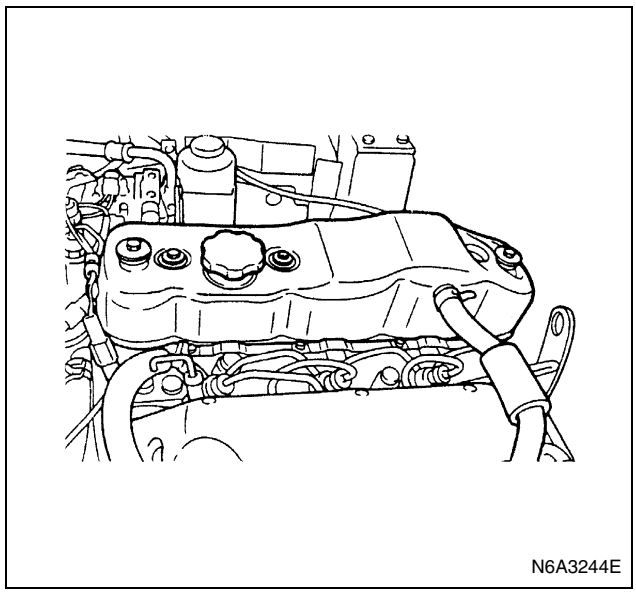
1. PCV hose
2. Cylinder head cover

Removal

Preparation

- Disconnect battery ground cable.

1. PCV Hose
   - Disconnect the PCV hose from intake pipe side.
2. Cylinder Head Cover



Installation

1. Cylinder Head Cover
   - Apply engine oil to the rocker arms and the valve springs.
   - Install the cylinder head cover gasket to the cylinder head cover.
   - The gasket must be perfectly smooth with no loose areas.
   - Tighten the cylinder head cover nuts to the specified torque.

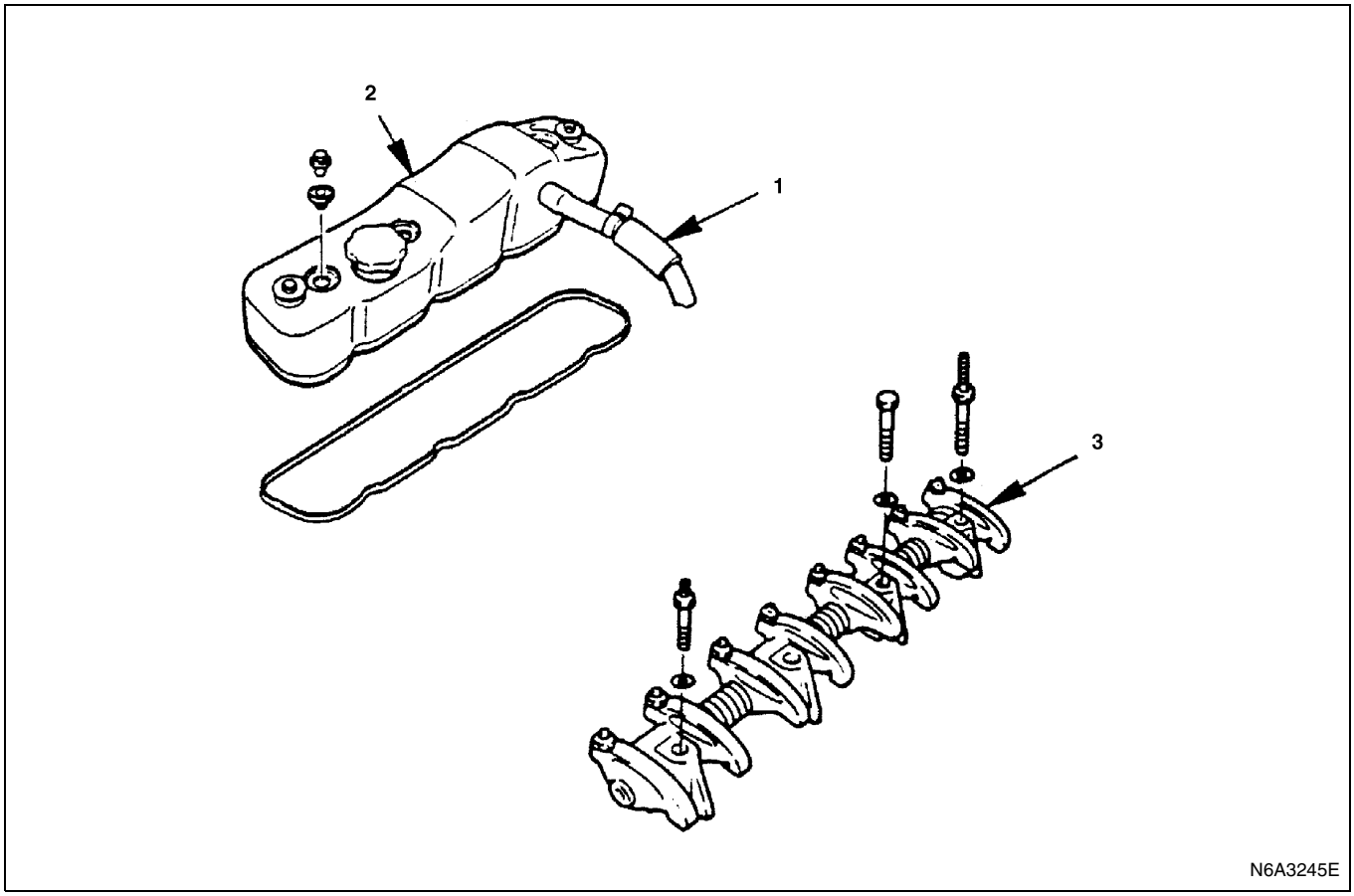
Tighten:

- 13 N·m (1.3 kg·m / 9 lb·ft)

2. PCV Hose
   - Connect the PCV hose to the intake pipe.
   - Connect battery ground cable.

ROCKER ARM SHAFT ASSEMBLY

Component



Legend

1. PCV hose
2. Cylinder head cover
3. Rocker arm shaft assembly

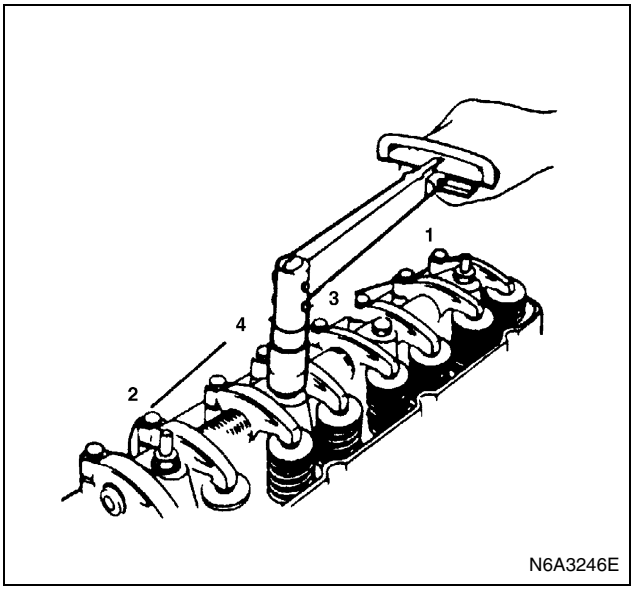
Removal

Preparation

- Disconnect battery ground cable.

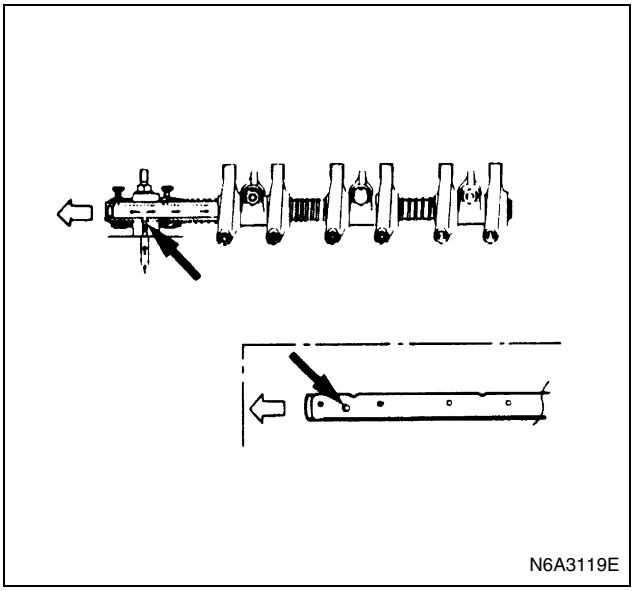
1. PCV Hose
2. Cylinder Head Cover
3. Rocker Arm Shaft Assembly

- Loosen bolts and nuts of rocker shaft bracket by turns and remove rocker shaft assembly.



Installation

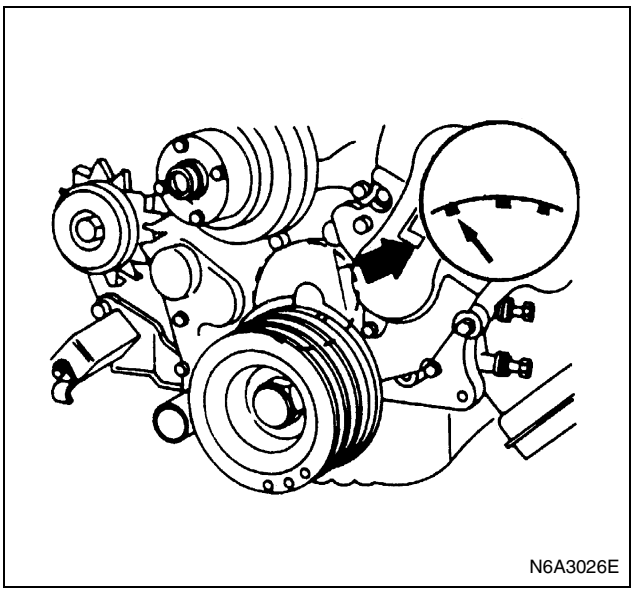
1. Rocker Arm Shaft Assembly
   - Install rocker arm shaft with larger oil hole ϕ4) to the front of engine.


N6A3119E

   - Align fixing bolt with nut of rocker arm shaft and tighten fixing bolts to the specified torque.

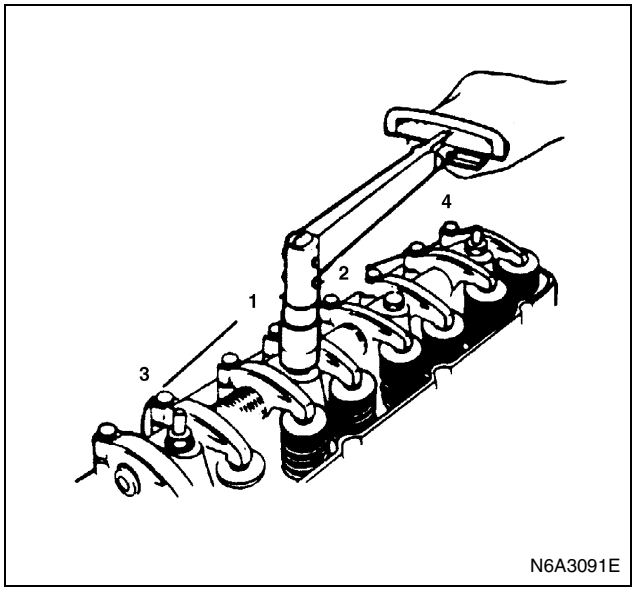
Tighten:
- 54 N·m (5.5 kg·m / 40 lb·ft)

2. Valve clearance adjustment
   1) Bring the piston in either the No.1 cylinder or the No.4 cylinder to TDC on the compression stroke by turning the crankshaft until the crankshaft damper pulley TDC line is aligned with the timing pointer.


N6A3026E

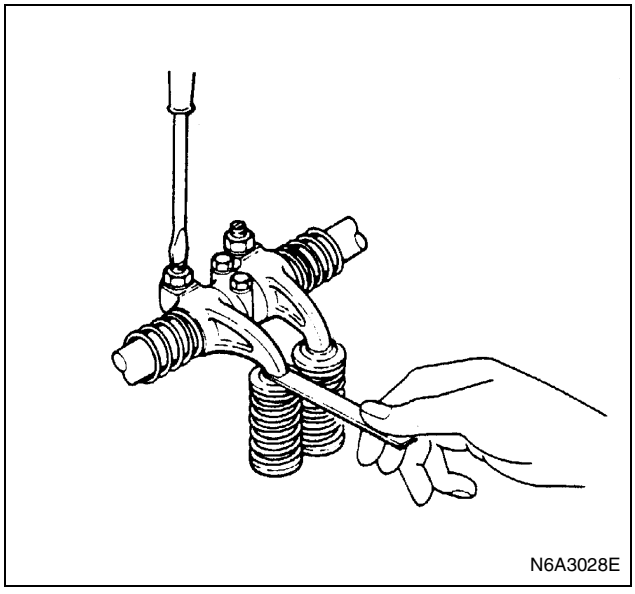
   2) Check the rocker arm shaft bracket nuts for looseness.
      Tighten any loose rocker arm shaft bracket nuts before adjusting the valve clearance.

Tighten:
- Rocker arm shaft bracket nut to 54 N·m (5.5 kg·m / 40 lb·ft)



N6A3091E

   3) Check for play in the No.1 intake and exhaust valve push rods.
      If the No.1 cylinder intake and exhaust valve push rods have play, the No.1 piston is at TDC on the compression stroke.
      If the No.1 cylinder intake and exhaust valve push rods are depressed, the No.4 piston is at TDC on the compression stroke.

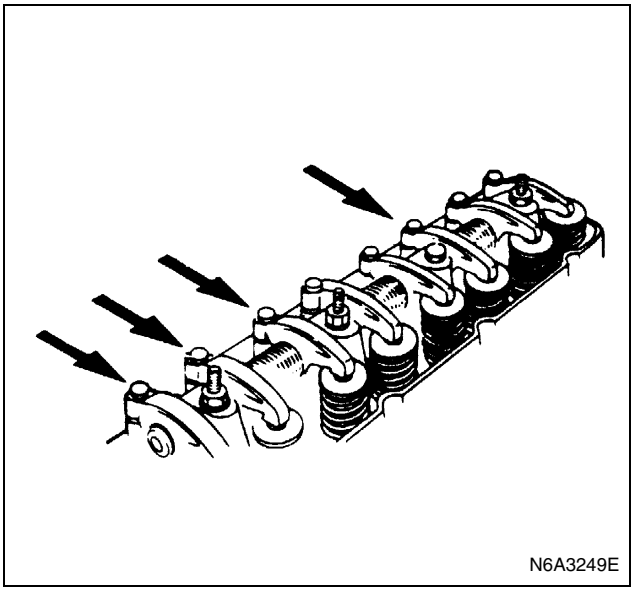

N6A3028E

      Adjust the No.1 or the No.4 cylinder valve clearances while their respective cylinders are at TDC on the compression stroke.

Valve Clearance (At Cold)	mm (in)
0.4 (0.016)	

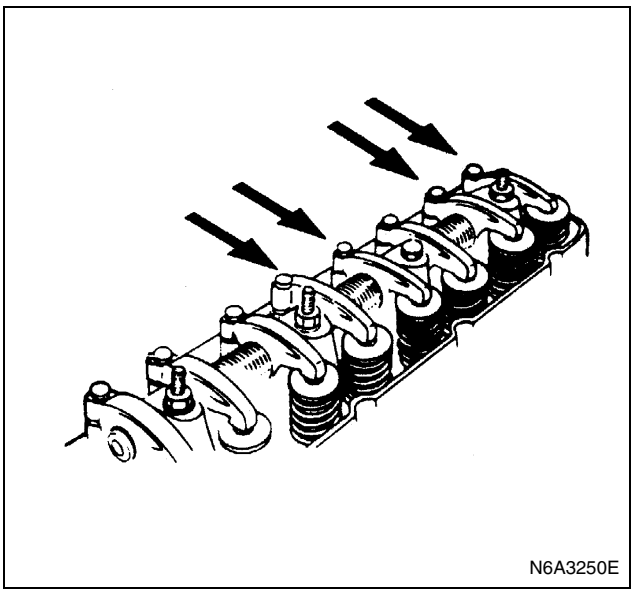
   4) Loosen each valve clearance adjusting screw as shown in the illustration.

No. 1 Cylinder T.D.C (Compression stroke)


N6A3249E

5) Insert a feeler gauge of the appropriate thickness between the rocker arm and the valve stem end.
6) Turn the valve clearance adjusting screw until a slight drag can be felt on the feeler gauge.
7) Tighten the lock nut securely.
8) Rotate the crankshaft 360°.
9) Realign the crankshaft damper pulley TDC notched line with the timing pointer.
10) Adjust the clearances for the remaining valves as shown in the illustration.

No. 4 Cylinder T.D.C (Compression stroke)


N6A3250E

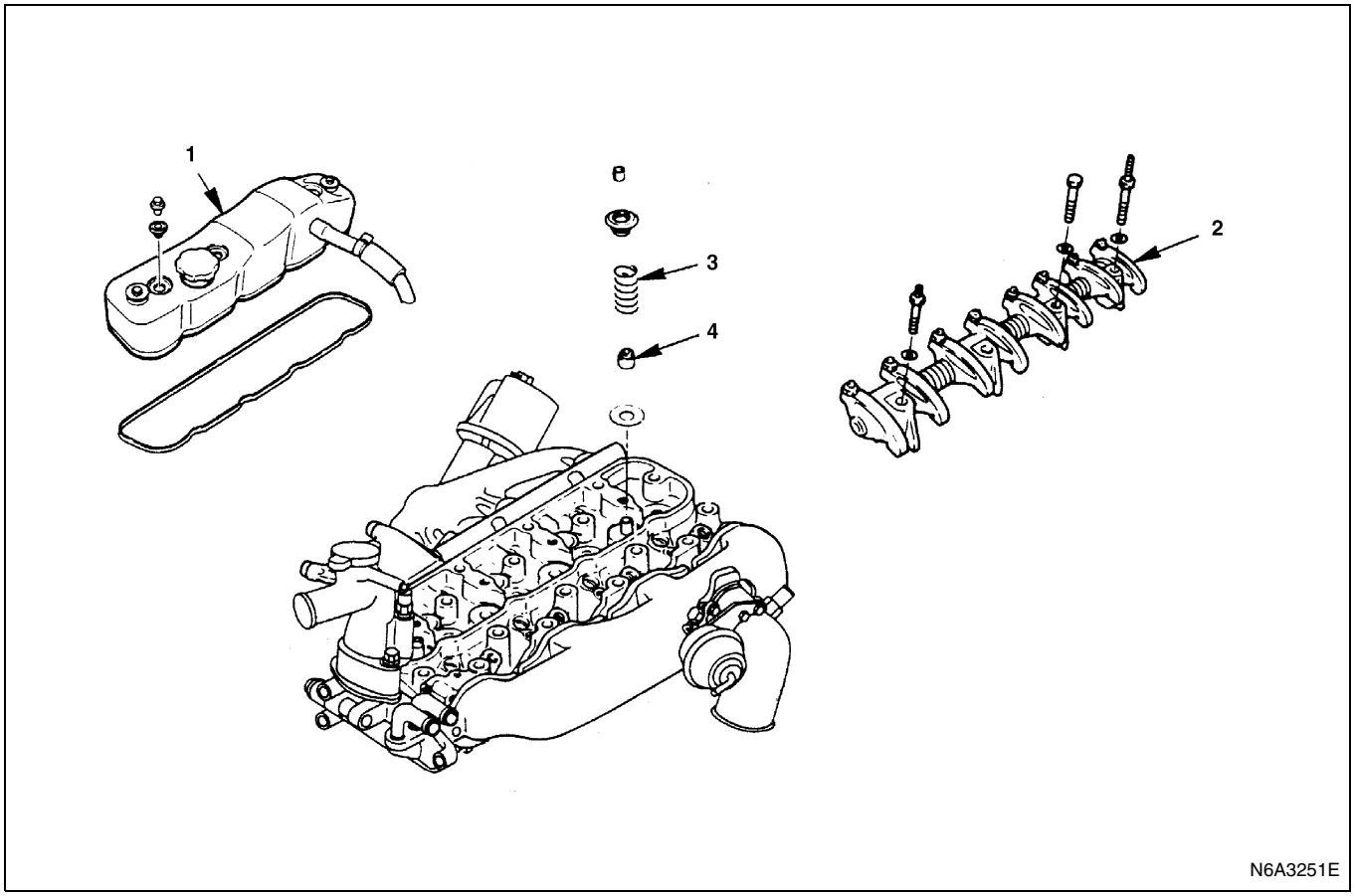
3. Cylinder Head Cover
   • Install cylinder head cover and tighten bolts to the specified torque.

Tighten:
• 13 N·m (1.3 kg·m / 113 lb·in)

4. PCV Hose
   • Connect battery ground cable.

VALVESTEM OIL CONTROLLER & VALVE SPRING

Component



Legend

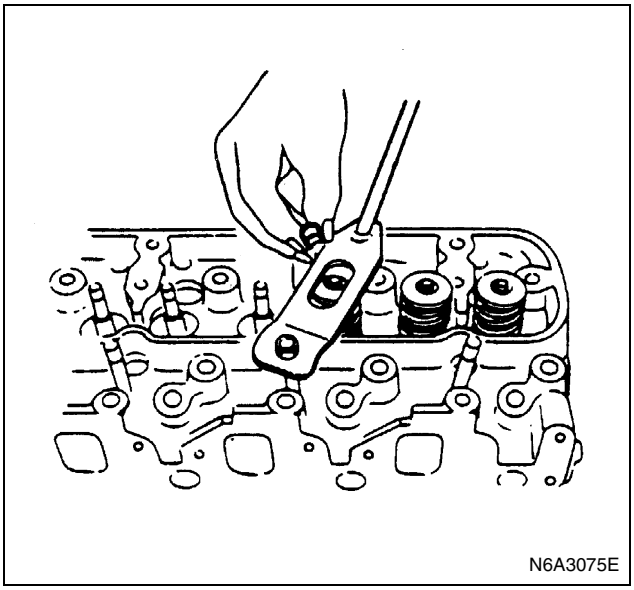
1. Cylinder head cover
2. Rocker arm shaft assembly
3. Valve spring
4. Valve guide oil seal

Removal

Preparation

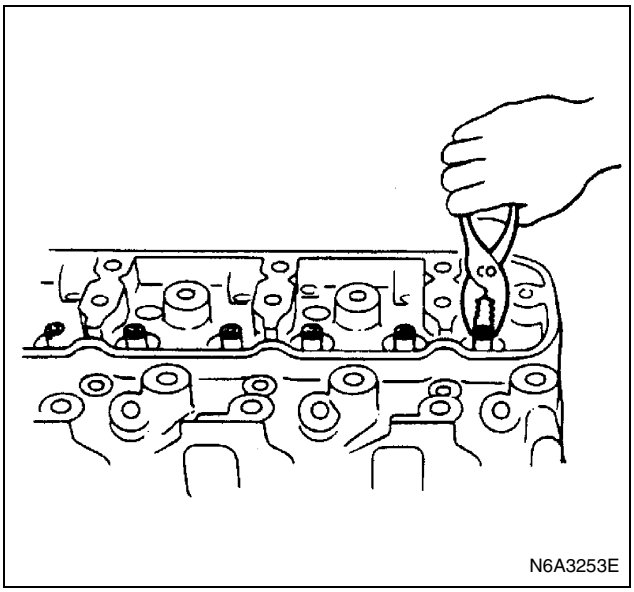
- Disconnect battery cable.

1. Cylinder Head Cover
2. Rocker Arm Shaft Assembly
   - Loosen bolts and nuts of rocker shaft bracket by turns and removal rocker shaft assembly.
3. Valve Spring
   - Apply compressed air to cylinder from the glow plug hole hold the valve in place.
   - Using special tool, compress valve spring and removal split cover.
     Valve spring compressor: 9-8523-1423-0 (J-29760)



Caution:
Put removed valve spring in the order of cylinder number.

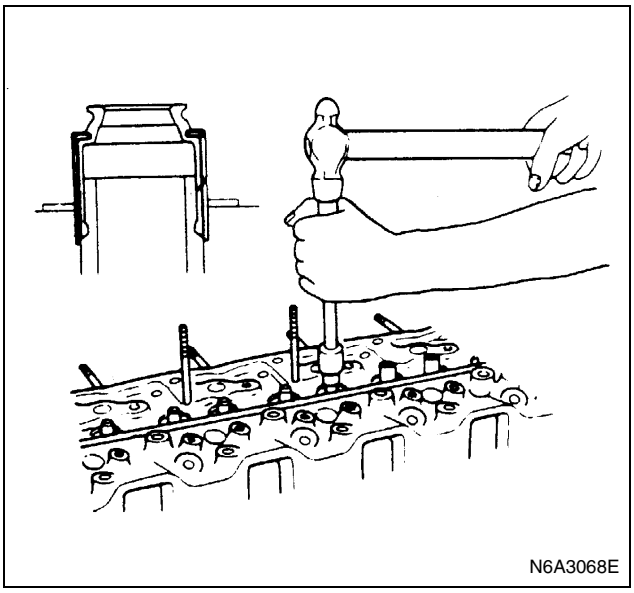
4. Valve Guide Oil Seal
   - Remove valve guide oil seal by pliers


N6A3253E

Caution:
Removed oil controller should not be reused.

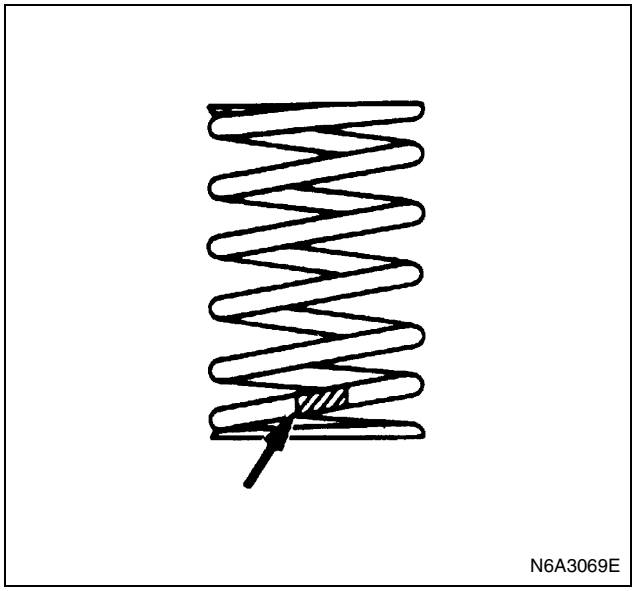
Installation

1. Valve Guide Oil Seal
   - Install new valve guide oil seal in valve.
   - Guide using special tool.
     Special tool: 5-8840-2033-0


N6A3068E

2. Valve Spring
   - Attach the new valve spring to the upper spring seat.

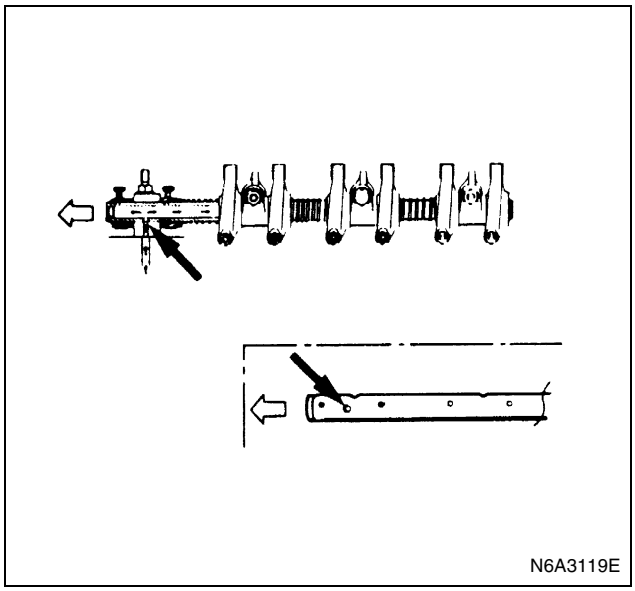
Caution:
- The painted area of the valve spring should be facing toward.


N6A3069E

- Apply compressed air to cylinder from the glow plug hole to hold the valve in place.
- Install split collar by special tool

  Valve spring compressor: 9-8523-1423-0 (J-29760)

3. Rocker Arm Shaft Assembly
   - Install rocker arm shaft with larger oil hole ϕ4) to the front of engine.

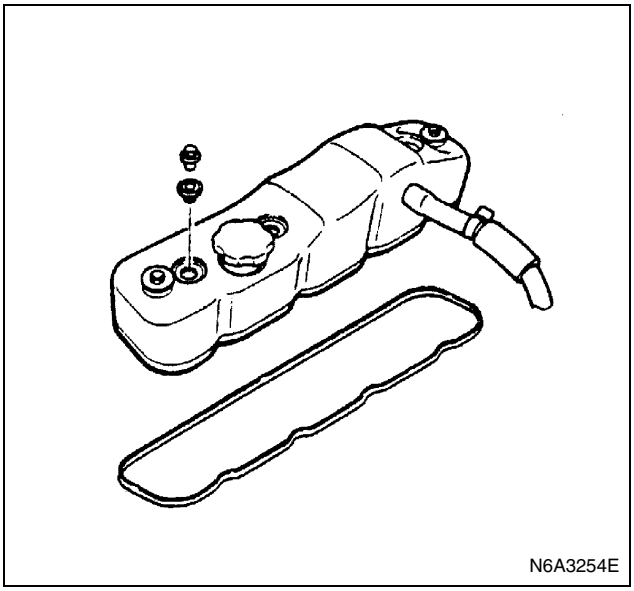

N6A3119E

- Align fixing bolt with nut of rocker arm shaft and tighten fixing bolts to the specified torque.

Tighten:
- 54 N·m (5.5 kg·m / 40 lb·ft)
  - Valve clearance adjustment

4. Valve clearance adjustment
   Above works refer to “ROCKER ARM SHAFT ASSEMBLY” Section in this manual.
5. Cylinder Head Cover
   - Apply engine oil to the rocker arms and the valve spring.
   - Install the cylinder head cover gasket to the cylinder head cover.
     The gasket must be perfectly smooth with no loose areas.
   - Install cylinder head cover and tighten bolt to the specified torque.

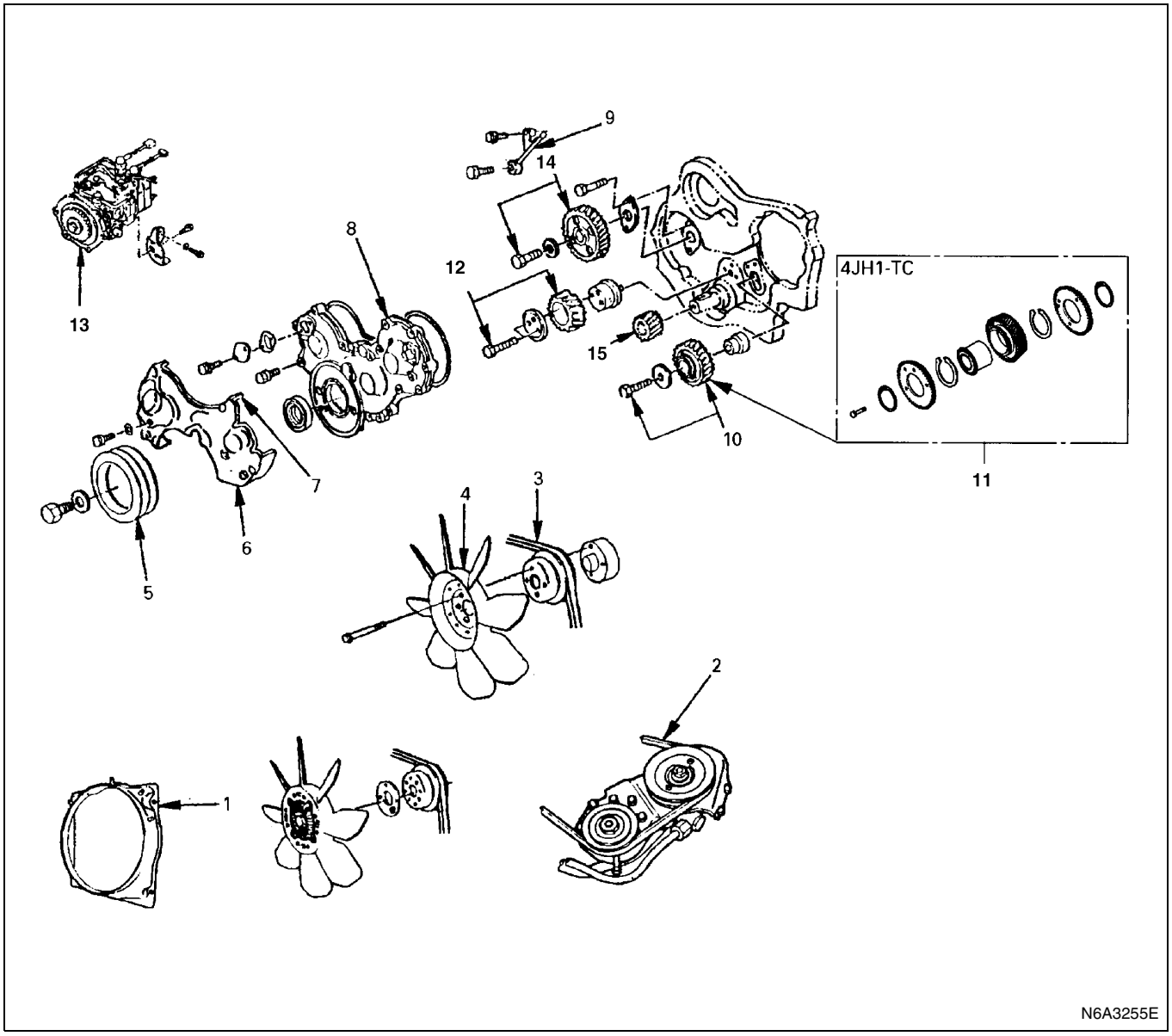
Tighten:
- Head cover bolt to 13 N·m (1.3 kg·m / 113 lb·in)


N6A3254E

- Connected PCV hose.
- Connect battery ground cable.

TIMING GEAR (4JB1, 4JB1-TC, 4JH1-TC Gear Type)

Component



Legend

1. Fan shroud
2. Power steering pump drive belt
3. AC generator drive belt
4. Cooling fan assembly
5. Crankshaft damper pulley
6. Noise shield cover
7. Noise cover spacer
8. Timing gear case cover
9. Oil pipe
10. Idle gear
11. Idle gear “B”
12. Idle gear
13. Injection pump
14. Camshaft timing gear
15. Crankshaft gear

Removal

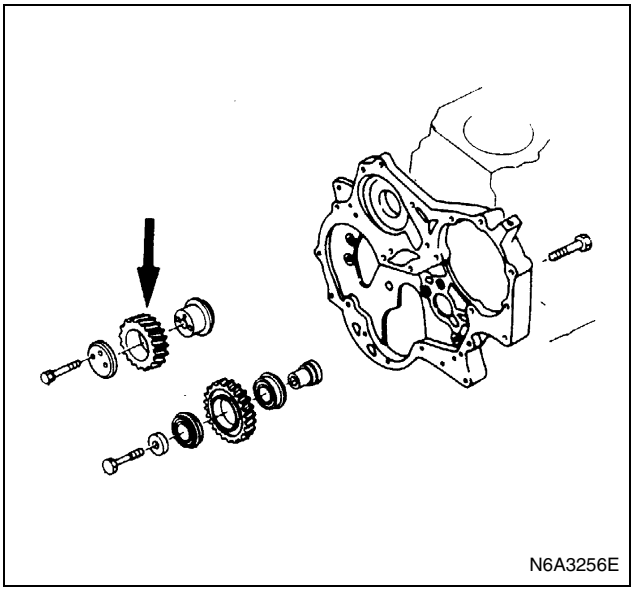
Preparation

- Disconnect battery ground cable.
- Drain coolant.

1. Fan Shroud
2. Power Steering Pump Drive Belt (P/S Model)
   - Loosen power steering pump mounting bolt and adjust bolt, and remove the drive belt.
3. AC Generator Drive Belt

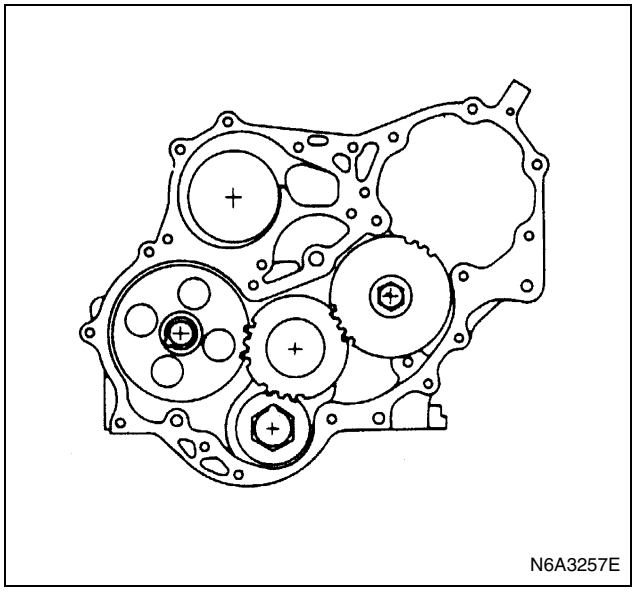
- Loosen AC Generator mounting bolt (under size) and adjust plate lock bolt, and remove the drive belt.

4. Cooling Fan Assembly
   - Remove clamp nut, and remove cooling fan assembly, distant pipe, and fan pulley.
5. Crankshaft Damper Pulley
6. Noise Shield Cover
7. Noise Cover Spacer
8. Timing Gear Case Cover
9. Oil Pipe
10. Idler Gear
    1) Measure the camshaft timing gear backlash and the crankshaft timing gear backlash before removing the idler gear.
    2) Measure the idler gear end play before removing the idler gear.


N6A3256E

Notice:
Refer to the following items for details on the backlash and end play measurement procedures.

11. Timing Gear Backlash Measurement
    1) Set a dial indicator to the timing gear to measured.
       Hold both the gear to be checked and the adjoining gear stationary.

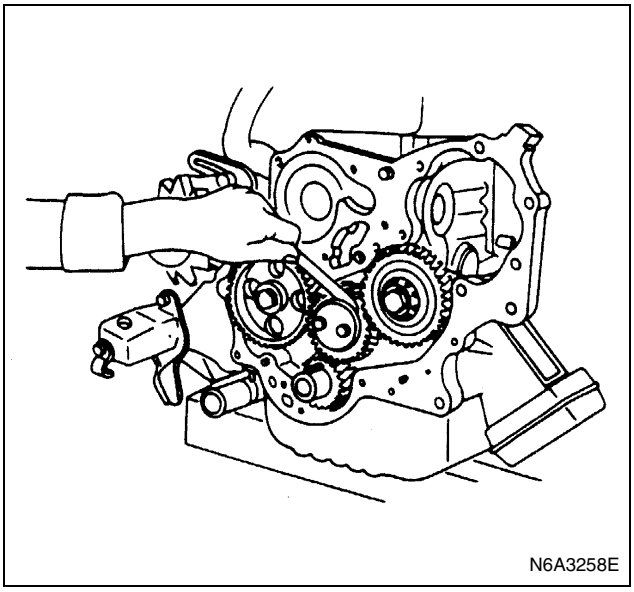

N6A3257E

    2) Move the gear to be checked as far as possible to both the right and the left.
       Take the dial indicator reading.
       If the measured value exceeds the specified limit, the timing gear must be replaced.

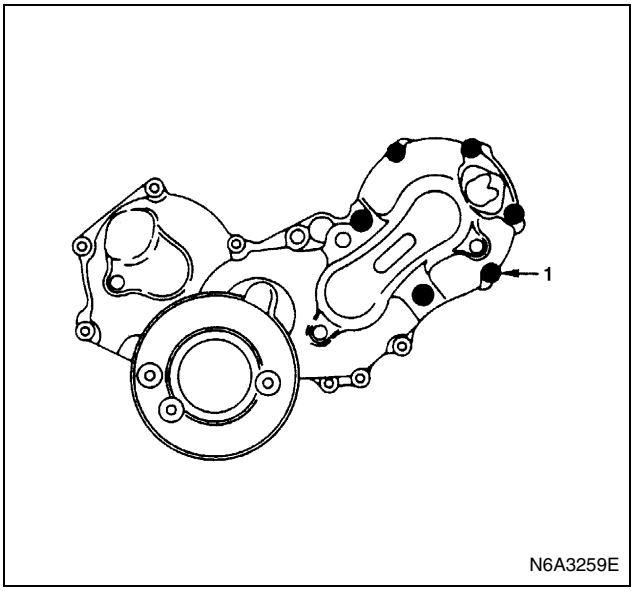
Timing Gear Backlash	mm (in)
Standard	Limit
0.010 — 0.17 (0.0039 — 0.0067)	0.30 (0.012)

12. Idler Gear “A” End Play Measurement
    Insert a feeler gauge between the idler gear and the thrust collar to measure the gap and determine the idler gear end play.
    If the measured value exceeds the specified limit, the thrust collar must be replaced.

Idle Gear End Play	mm (in)
Standard	Limit
0.07 (0.0028)	0.2 (0.0079)

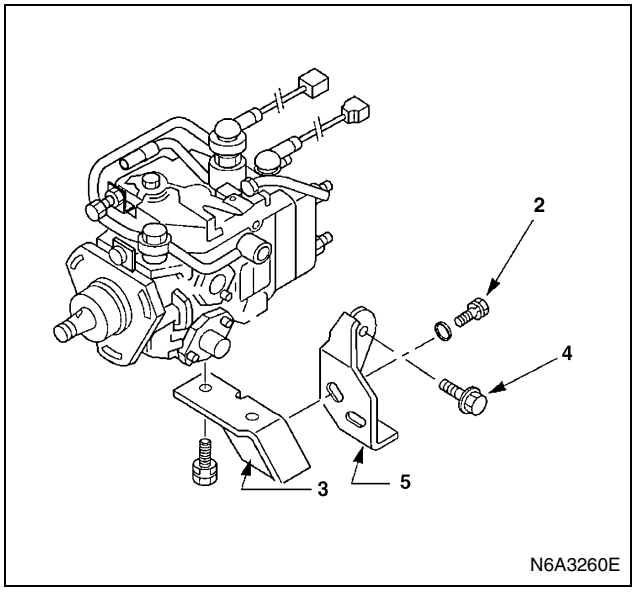

N6A3258E

13. Idle Gear
14. Injection Pump
    1) Remove the six injection pump bracket bolts (1) from the timing gear case.



N6A3259E

    2) Remove the injection pump rear bracket bolts (2) from the injection pump bracket (3).
    3) Remove the injection pump rear bracket bolts (4) and the bracket (5) from the cylinder body.



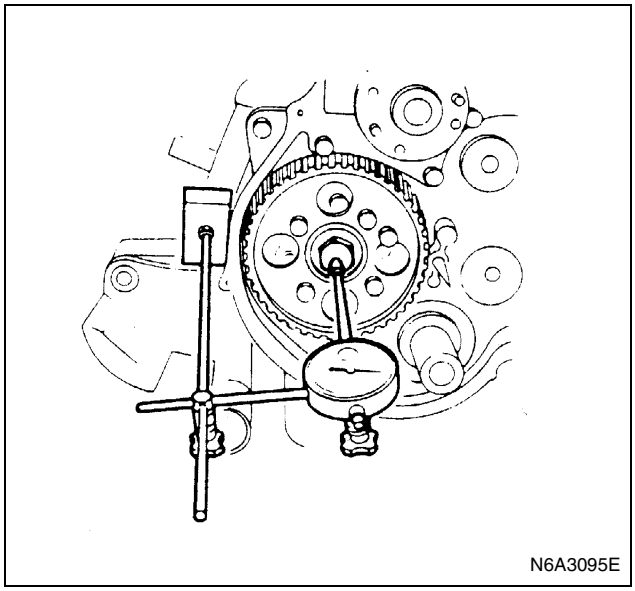
N6A3260E

    4) Pull the injection pump along with the injection pump timing gear free toward the rear of the engine.

Notice:
Plug the injection pump delivery holder ports with the shipping caps (or the equivalent) to prevent the entry of foreign material.

15. Camshaft Timing Gear
    1) Use a dial indicator to measure the camshaft end play. This must be done before removing the camshaft gear.
    If the camshaft end play exceeds the specified limit, the thrust plate must be replaced.

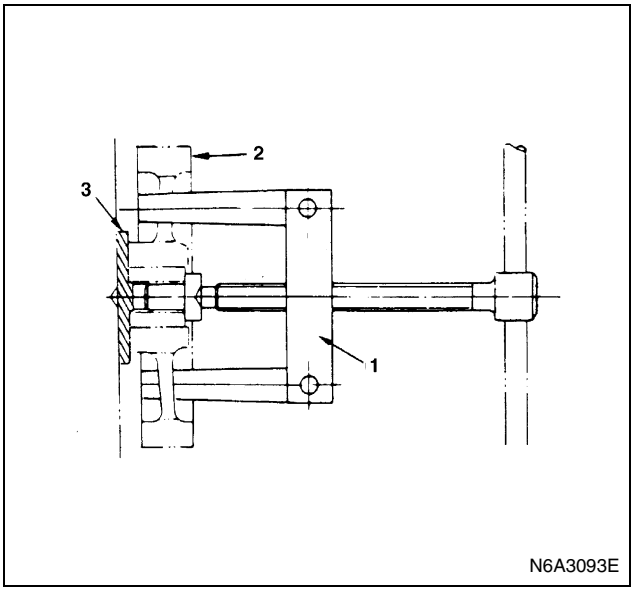
Camshaft End Play	mm (in)
Standard	Limit
0.050 — 0.114 (0.002 — 0.0044)	0.2 (0.008)


N6A3095E

2) Remove the camshaft timing gear bolt from the camshaft.

Notice:
Hold the camshaft stationary to prevent the camshaft from turning.

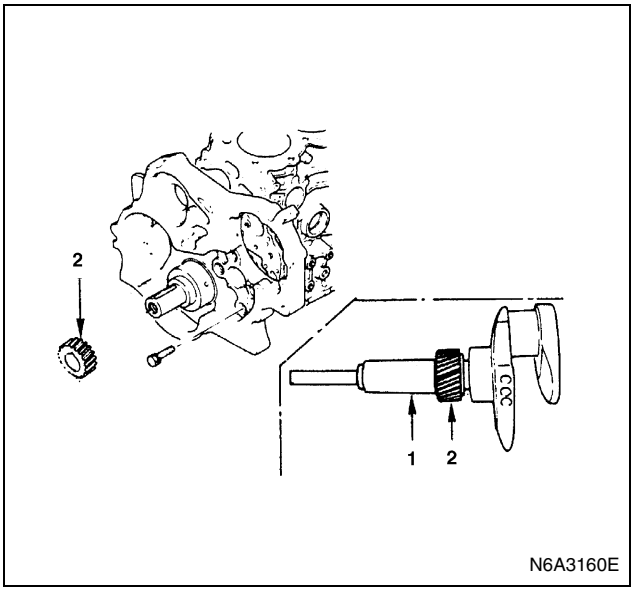
3) Use the universal puller (1) to pull out the camshaft timing gear (2).
Universal Puller: 5-8521-0002-0
4) Remove the thrust plate (3).



16. Crankshaft Gear

Installation

1. Crankshaft Gear
   1) Install the crankshaft gear.
   2) Use the crankshaft gear installer (1) to install the crankshaft gear (2).
   The crankshaft gear timing mark ("X — X") or ("· — ·") must be facing outward.
   Crankshaft Gear Installer: 9-8522-0020-0

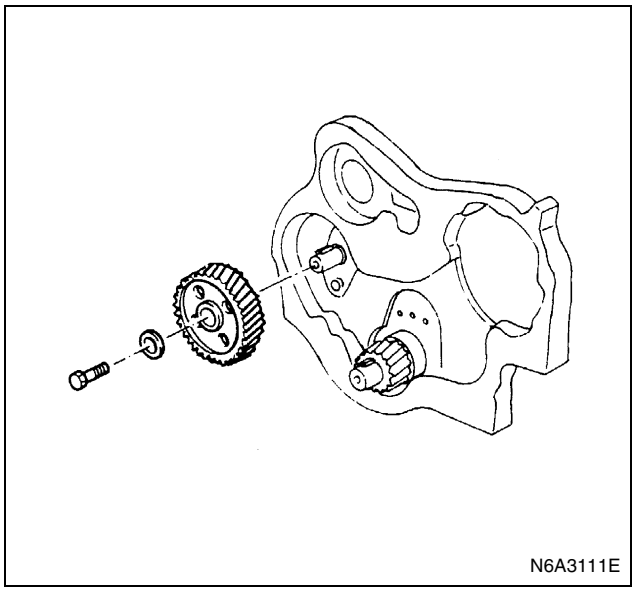


2. Camshaft Timing Gear
   1) Install the thrust plate to the cylinder body.
   2) Tighten the thrust plate bolts to the specified torque.

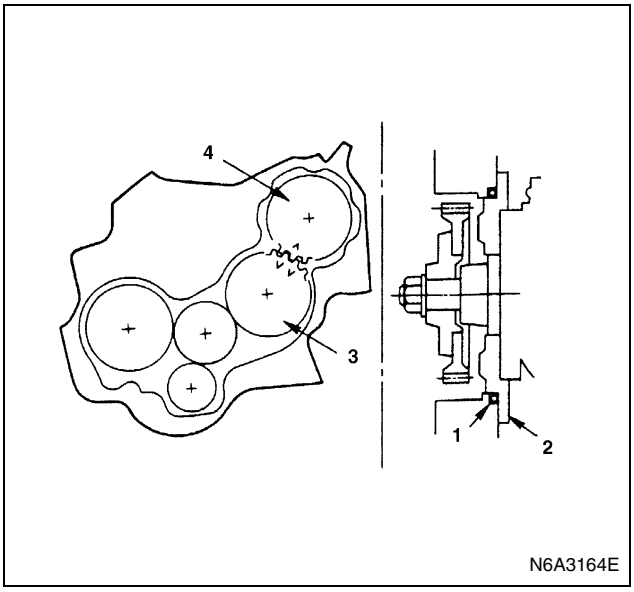
Tighten:
- 18 N·m (1.8 kg·m / 13 lb·ft)

   3) Install the camshaft timing gear to the camshaft.
   The timing gear mark ("Y — Y") or ("·· — ··") must be facing outward.
   4) Tighten the timing gear to the specified torque.

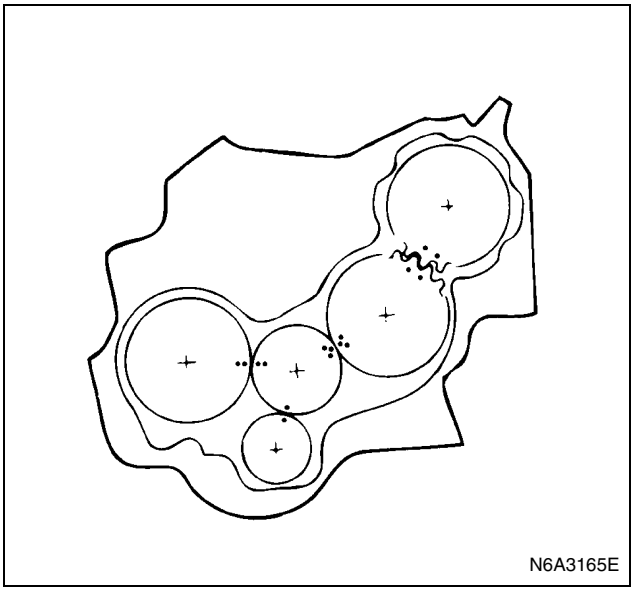
Tighten:
- 64 N·m (6.5 kg·m / 47 lb·ft)



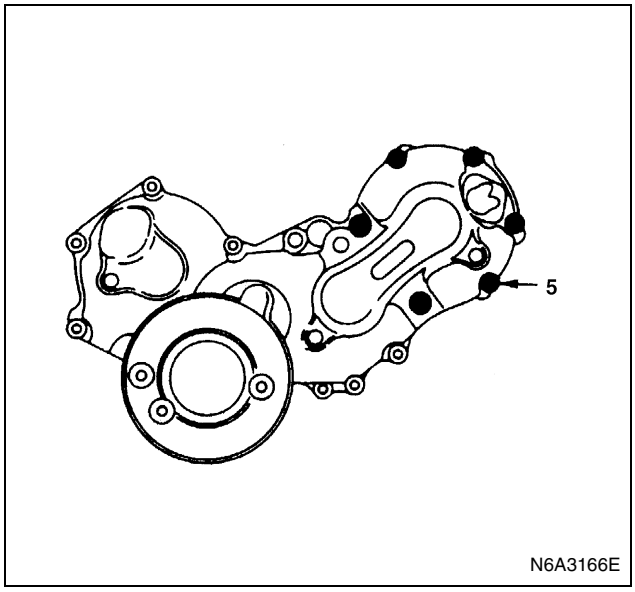
3. Injection Pump
   1) Install the O-ring (1) to the injection pump flange (2).
   2) Install the injection pump to the timing gear case.
   Align the idler gear "B" (3) "V — V" or ": — :" mark with the injection pump timing gear (4) "V" or ":" mark.



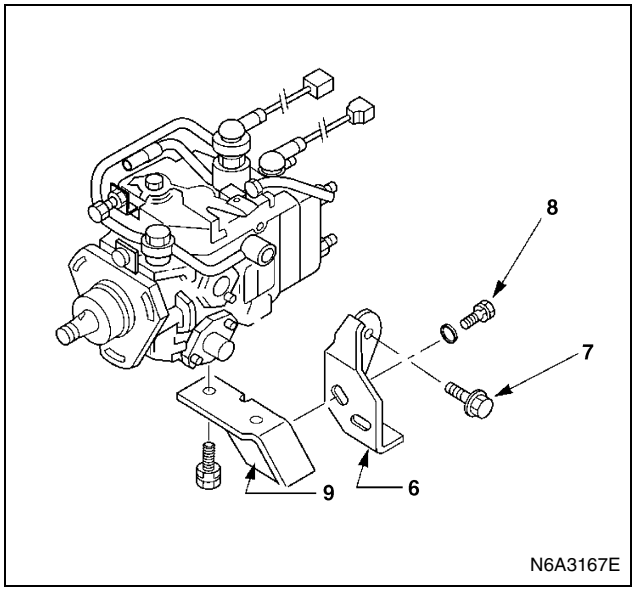
Gear	4JB1-TC, 4JG2	4JH1TC
Crank gear — Idle gear “A”	X — X	· — ·
Idle gear “A” — Cam gear	Y — Y	·· — ··
Idle gear “A” — Idle gear “B”	Z — Z	:· — ·:
Idle gear “B” — Injection pump	V — V	: — :



3) Temporarily tighten the six injection pump bolts (5).
   The injection pump bolts will be finally tightened after the injection pump rear bracket bolts.



4) Install the injection pump rear bracket (6) and the rear bracket bolts (7) to the cylinder body.
5) Install the rear bracket bolts (8) to the injection pump bracket (9).
   Do not tighten the bolts.
   The rear bracket bolts (7) and (8) will be finally tightened to the specified torque after tighten the injection pump nuts.



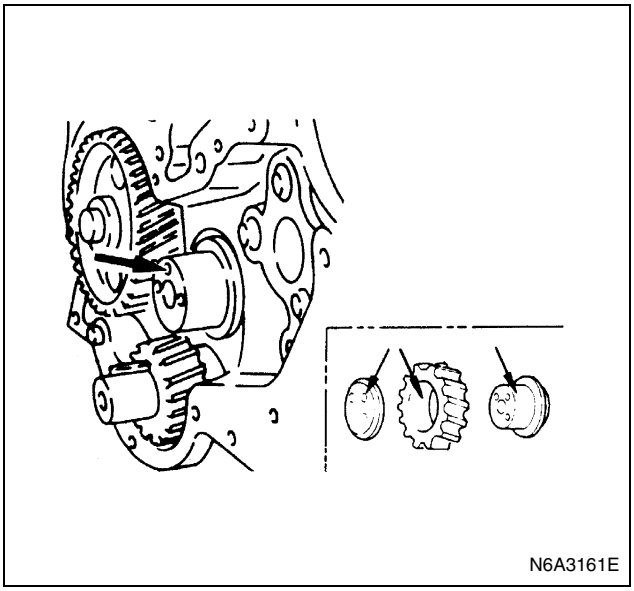
6) Tighten the injection pump nuts to the specified torque.

Tighten:
- 19 N·m (1.9 kg·m / 14 lb·ft)

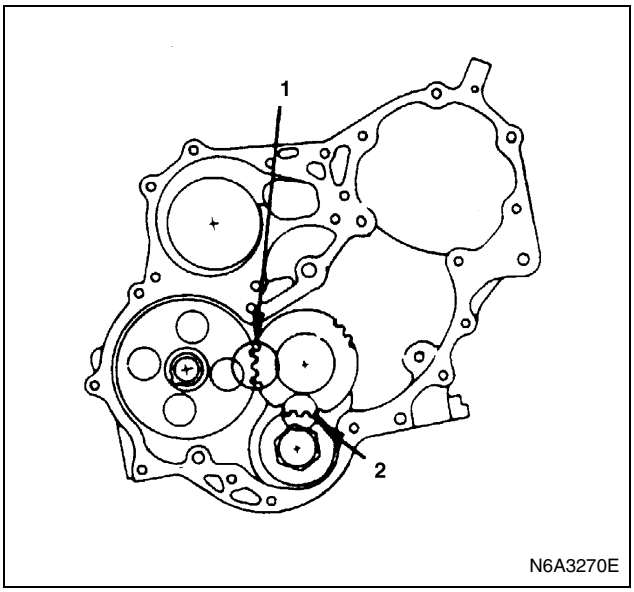
7) Tighten the injection pump bracket bolts to the specified torque.

Tighten:
- 19 N·m (1.9 kg·m / 14 lb·ft)

4. Idler Gear
   1) Apply engine oil to the idler gear and the idler gear shaft.
      The idler gear shaft oil hole must be facing up.


N6A3161E

   2) Position the idler gear setting marks “X” or “·” and “Y” or “··” so that they are facing the front of the engine.
   3) Align the idler gear “X” or “·” setting mark with the crankshaft timing gear (1) “X — X” or “· — ·” setting mark.
   4) Align the idler gear “Y” or “··” setting mark with the camshaft timing gear (2) “Y — Y” or “·· — ··” setting mark.

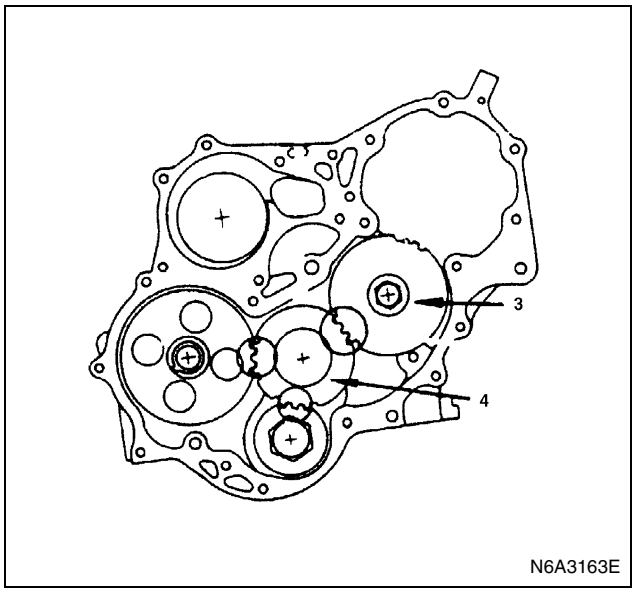


N6A3270E

   5) Install the thrust collar and bolts to the cylinder body through the shaft.
      The thrust collar oil hole must be facing up, and the thrust collar chamfered must be outward.
   6) Tighten the idler gear bolt to the specified torque.

Tighten:
- 19 N·m (1.9 kg·m / 14 lb·ft)

5. Idler Gear
   1) Apply engine oil to the idler gear and the idler gear shaft.
   2) Align the idler gear “B” (3) “Z” or “∴” setting mark with the idler gear “A” (4) “Z — Z” or “:· — ·:” setting mark.



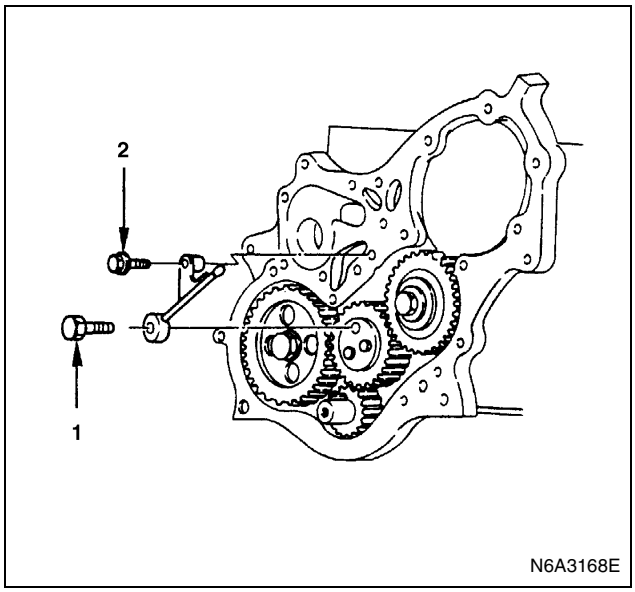
N6A3163E

   3) Tighten the idler gear bolt to the specified torque.

Tighten:
- 76 N·m (7.7 kg·m / 56 lb·ft)

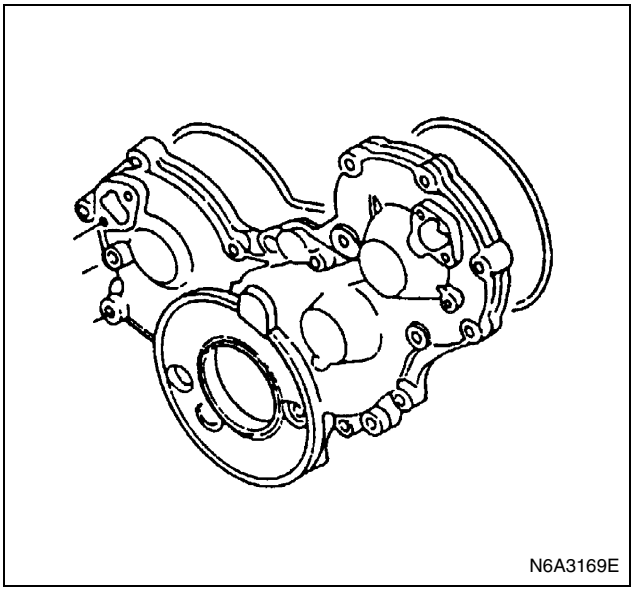
6. Oil Pipe
   1) Install the oil pipe to the timing gear case and idler gear “A”.
   2) Tighten the oil pipe eye bolt (1) and bolt (2) to the specified torque.

Tighten:
- Oil pipe eye bolt to 13 N·m (1.3 kg·m / 9 lb·ft)



N6A3168E

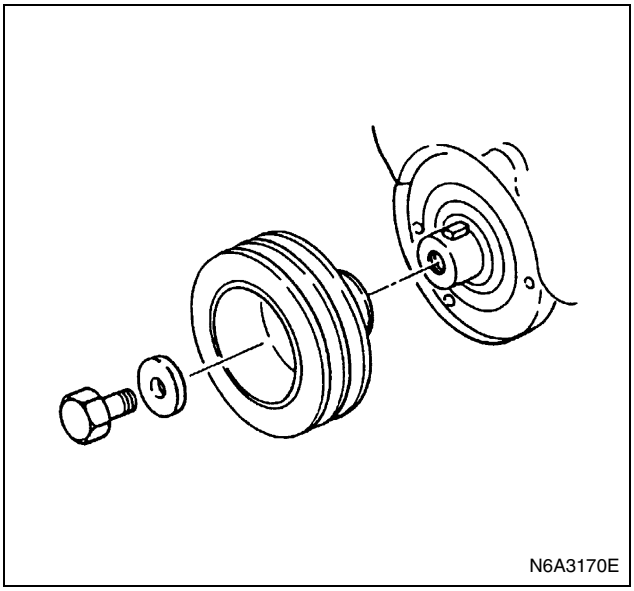
7. Timing Gear Case Cover
   1) Align the gear case with the timing gear case knock pin and then install the timing gear case cover.
   2) Tighten the gear case cover bolts to the specified torque.


N6A3169E

8. Noise Cover Spacer
9. Noise Shield Cover
10. Crankshaft Damper Pulley
    Tighten the crankshaft damper pulley bolt to the specified torque.

Notice:
Hold the flywheel ring gear stationary to prevent the crankshaft from turning when tightening the damper pulley.

Tighten:
- Pulley boss bolt to 206 N·m (21 kg·m / 152 lb·ft)


N6A3170E

11. Cooling Fan Assembly
    - Mount fan pulley, distance piece, and cooling fan assembly (in this order) on the water pump, and tighten to the specified torque.

Tighten:
- 8 N·m (0.8 kg·m / 69 lb·in)

12. AC Generator Drive Belt
    - Install AC Generator drive belt and adjust belt tension.
    - Depress the drive belt mid-portion with a 98 N (10 kg / 22 lb) force.

Drive Belt Deflection	mm (in)
8 (0.31) — 12 (0.47)	

    - Tighten the idler lock nut to the specified torque.

Tighten:
- Idler lock nut to 27 N·m (2.8 kg·m / 20 lb·ft)

13. Power Steering Pump Drive Belt (P/S Model)
    - Install Power Steering pump drive belt and adjust belt tension.
    - Depress the drive belt mid-portion with a 98 N (10 kg / 22 lb) force.

Drive Belt Deflection	mm (in)
8 (0.31) — 12 (0.47)	

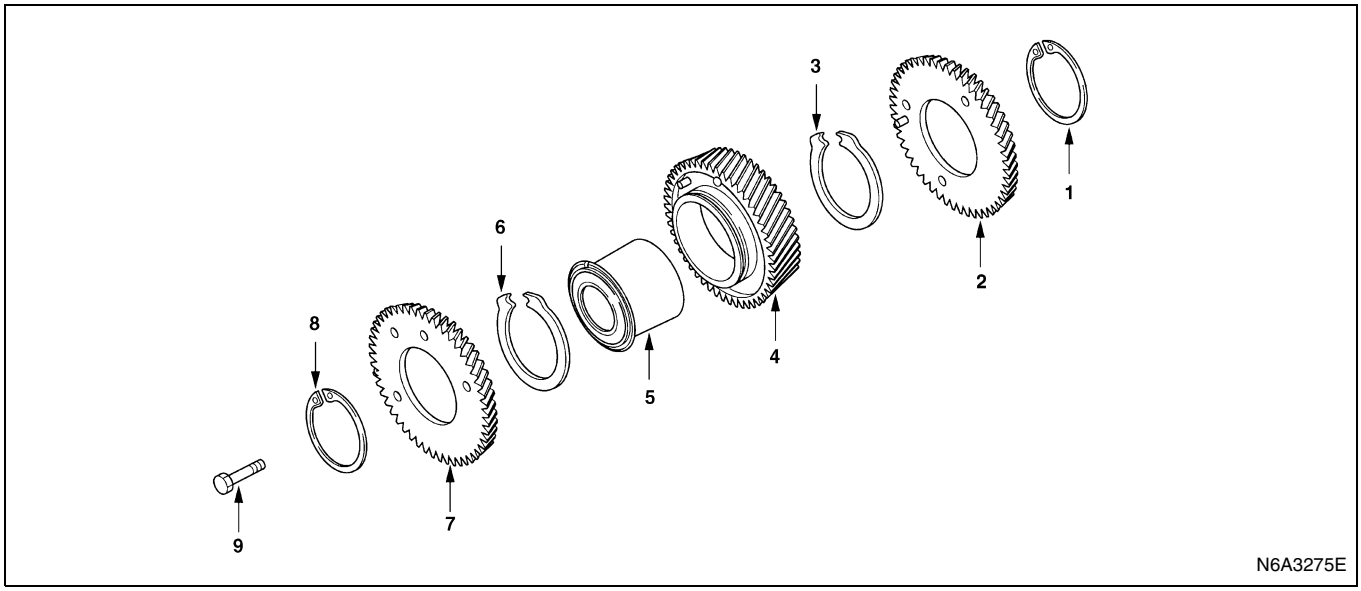
    - Tighten the idler lock nut to the specified torque.

Tighten:
- 27 N·m (2.8 kg·m / 20 lb·ft)

14. Fan shroud
    - Install the fan shroud and reservoir tank hose.
    - Pour coolant
    - Start the engine and check coolant leakage.

IDLE GEAR "B" (4JH1-TC SCISSOR GEAR)

Component

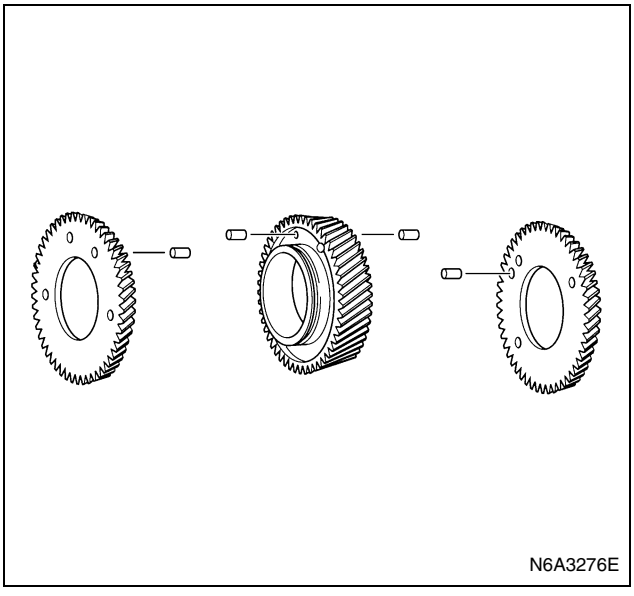


Legend

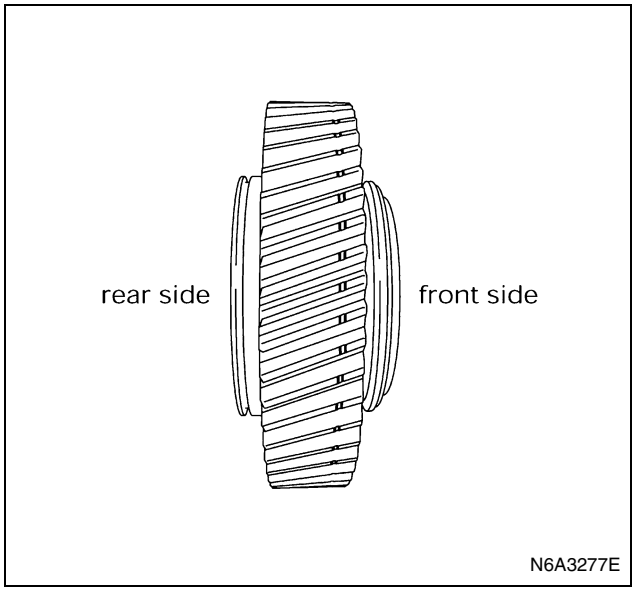
1. Snap ring
2. Rear gear
3. Spring
4. Main gear
5. Bearing
6. Spring
7. Front gear
8. Snap ring
9. Lock bolt

Reassembly

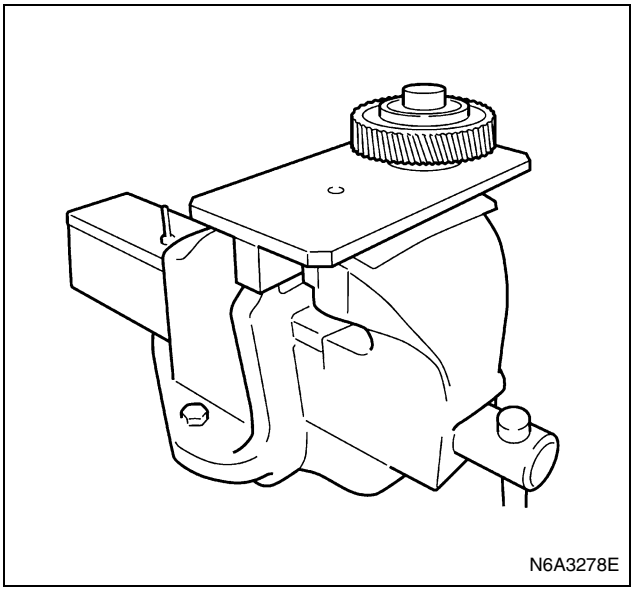
1. Drive pins into the main gear, the front gear, and the rear gear.



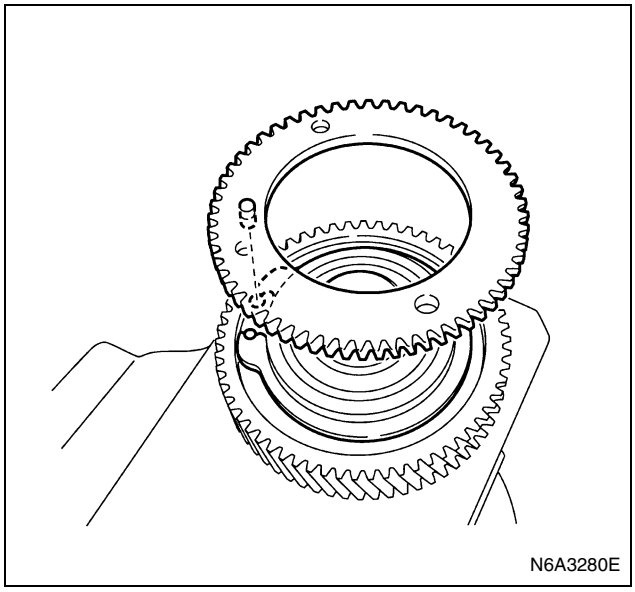
2. Apply pressure to the main gear bearing from the front side of the main gear (the side with the groove).



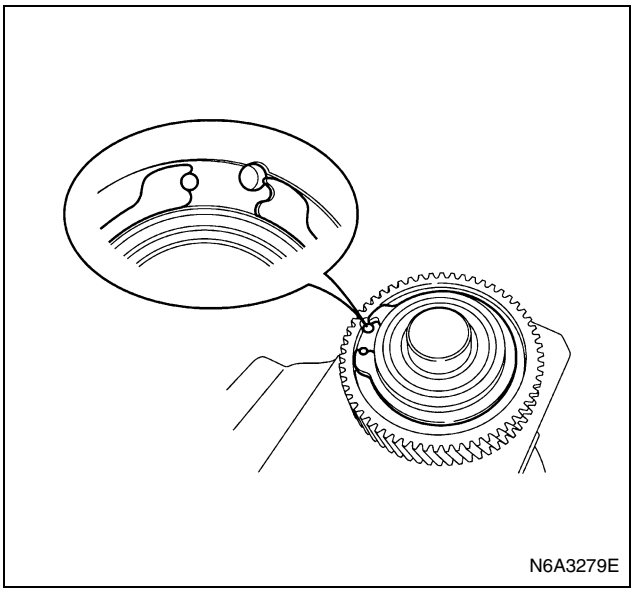
3. Place the special tool in a vise so that the main gear is pushed up toward the rear side.
   Scissor gear setting tool
   Base: 5-86739-149-0


N6A3278E

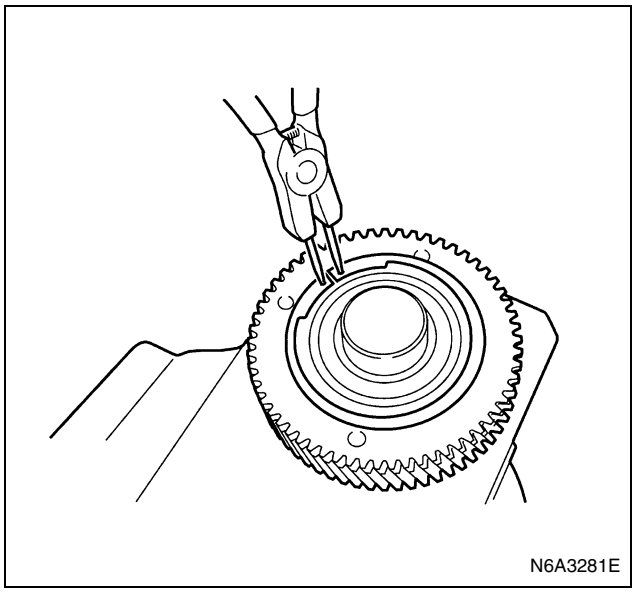
4. Set the spring as shown in the illustration.


N6A3280E

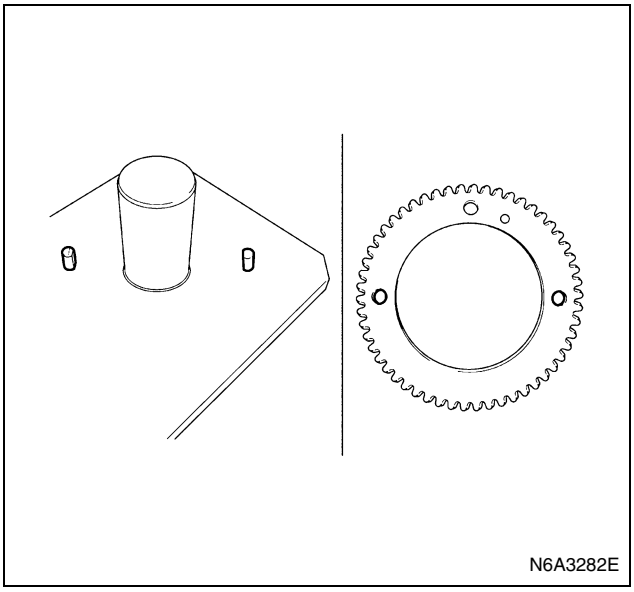
6. Install the snap ring to the main gear groove.

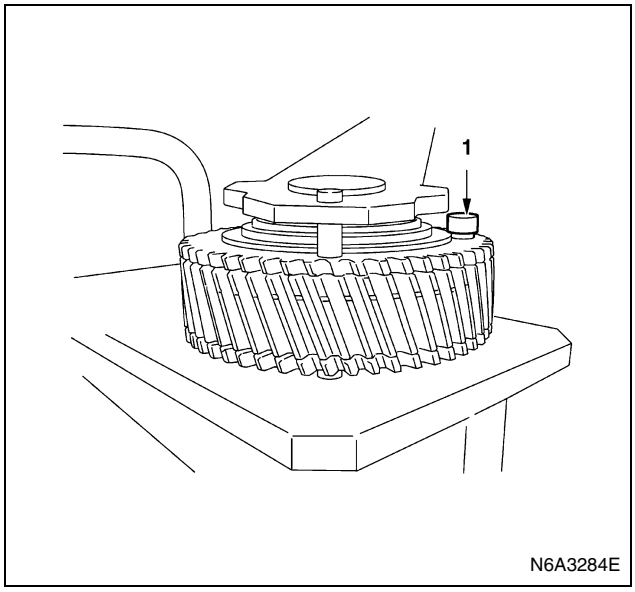

N6A3279E

5. Position the rear gear so that it pin is aligned with the receiving end of the spring.


N6A3281E

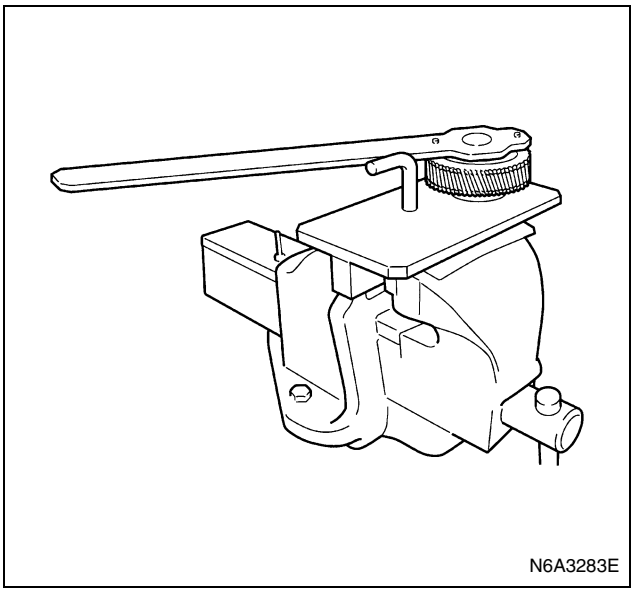
7. Set the rear gear setting hole to the pin of the special tool.


N6A3282E



N6A3284E

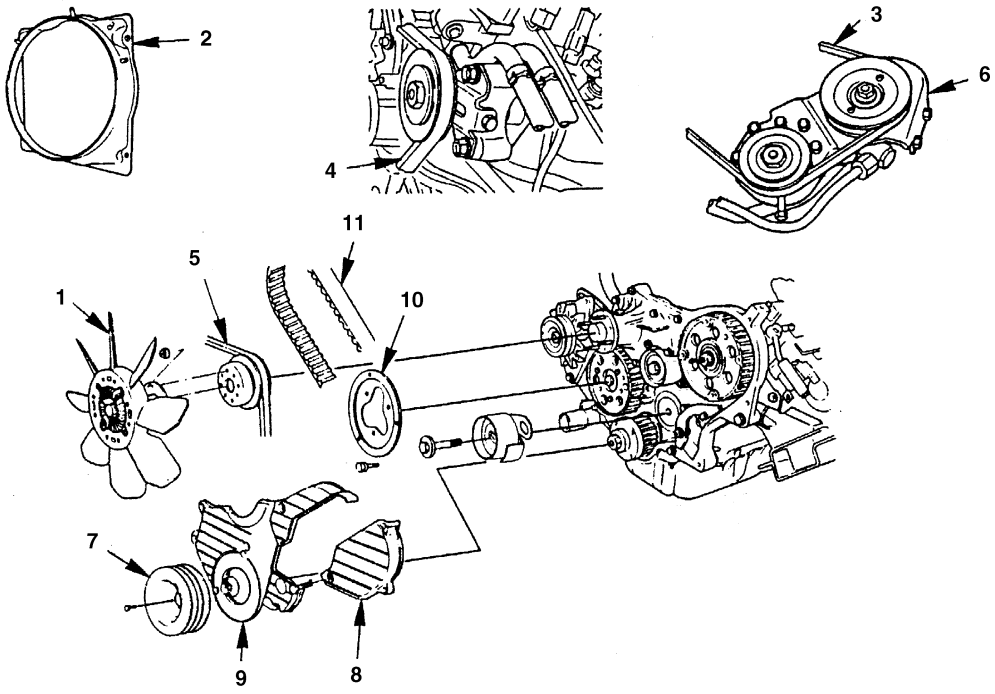
8. Place the special tool in a vise so that the main gear is pushed up toward the front side.
9. Repeat Steps 3, 4, and 5.
10. Use the special tool to mesh the teeth of the front gear, the main gear, and the rear gear.


N6A3283E

11. Insert a lock bolt (M6 × 1.00 L = 30) (1) into the scissor gear fixing hole to prevent the scissor gear from turning.
    Scissor gear setting tool
    Lever: 5-86739-150-0

TIMING BELT (4JG2 Belt Type)

Component



Legend

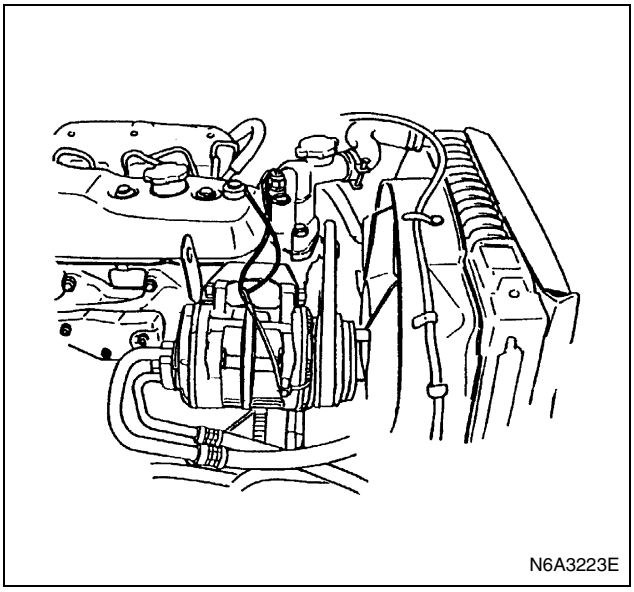
1. Cooling fan assembly
2. Fan shroud
3. Power steering pump drive belt
4. A/C compressor drive belt
5. AC Generator drive belt
6. Power steering pump bracket assembly
7. Crankshaft damper pulley
8. Timing pulley upper cover
9. Timing pulley lower cover
10. Flange; Camshaft pulley
11. Timing belt

Removal

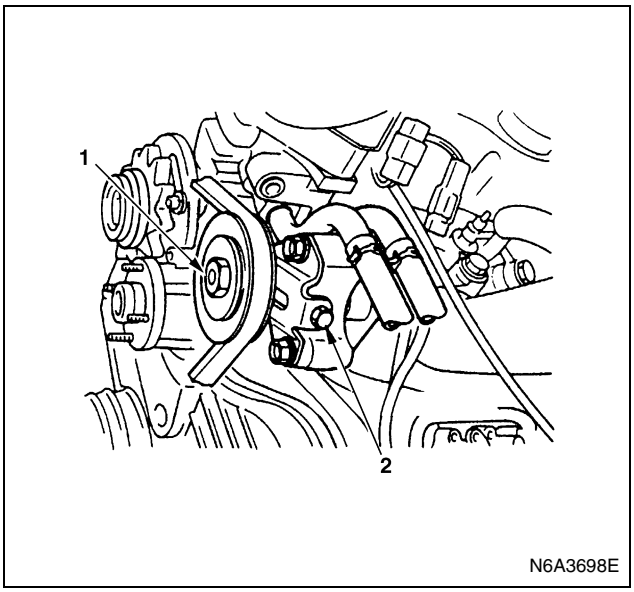
Preparation

- Disconnect battery ground cable.
- Drain coolant.

1. Cooling Fan Assembly
   - Remove clamp nut, and remove cooling fan asm, distant pipe, and fan pulley.
2. Fan Shroud
   - Removal reservoir tank hose and fan shroud.

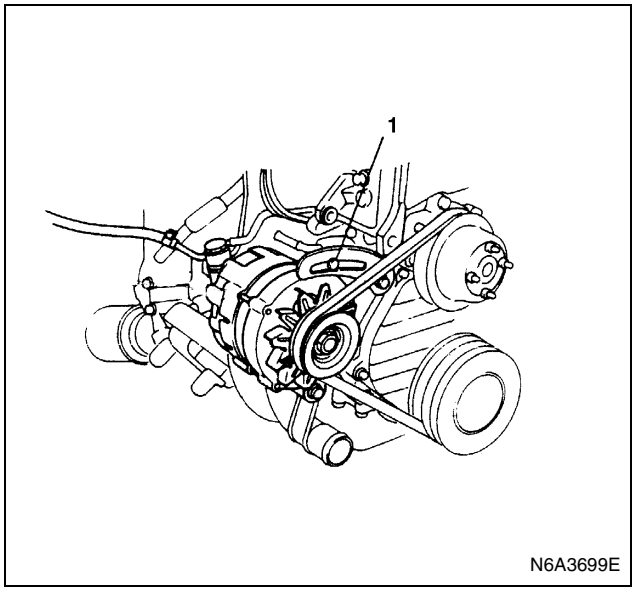

N6A3223E

3. Power Steering Pump Drive Belt (P/S Model)
   - Loosen power steering pump idle pulley lock nut and adjust bolt, and remove the drive belt.



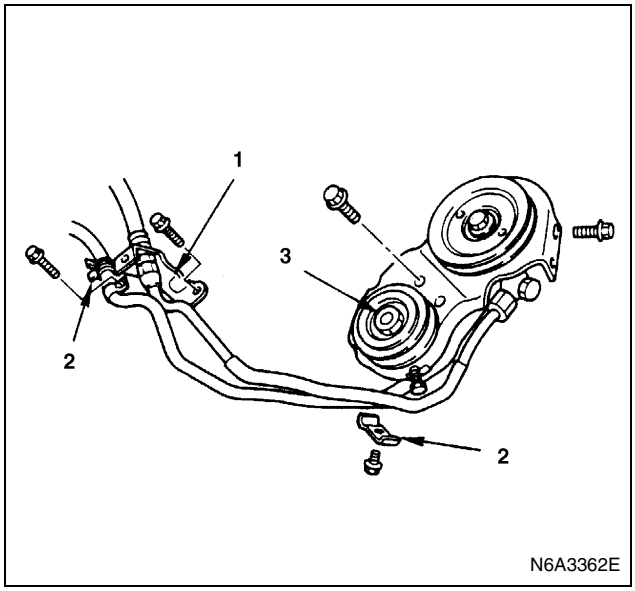
N6A3698E

4. A/C Compressor Drive Belt (A/C Model)
   - Loosen A/C compressor idle pulley lock nut (1) and adjust bolt (2), and remove the drive belt.
5. AC Generator Drive Belt
   - Loosen AC Generator mounting bolt (under side) and adjust plate lock bolt (1), and remove the drive belt.



N6A3699E

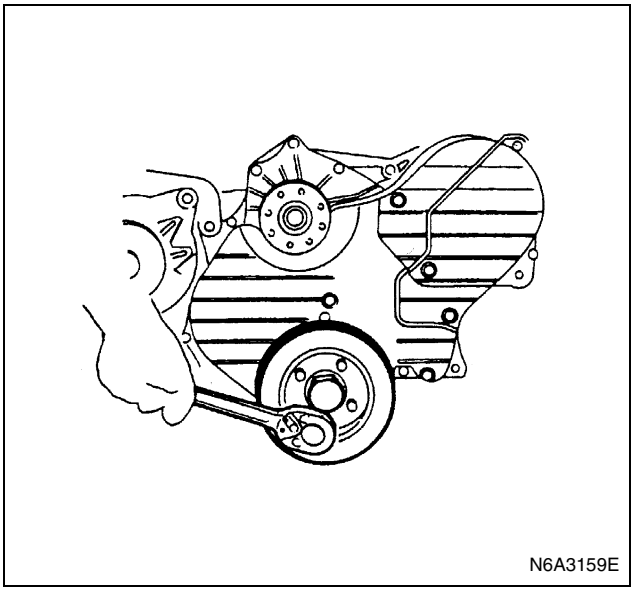
6. Power Steering Pump Bracket Assembly (P/S Model)
   - Loosen power steering oil pipe bracket (1) and clip (2).
   - Remove power steering pump bracket assembly and hang the power steering pump bracket assembly.



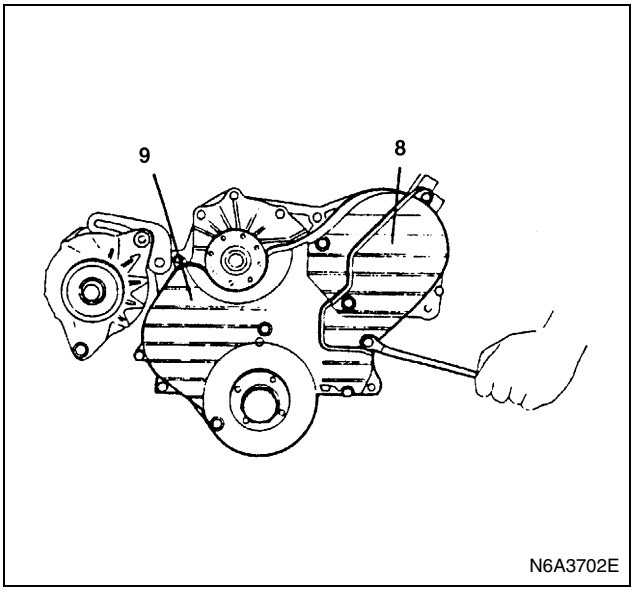
N6A3362E

Legend
1. Pipe bracket
2. Clip
3. Lock nut

7. Crankshaft Damper Pulley

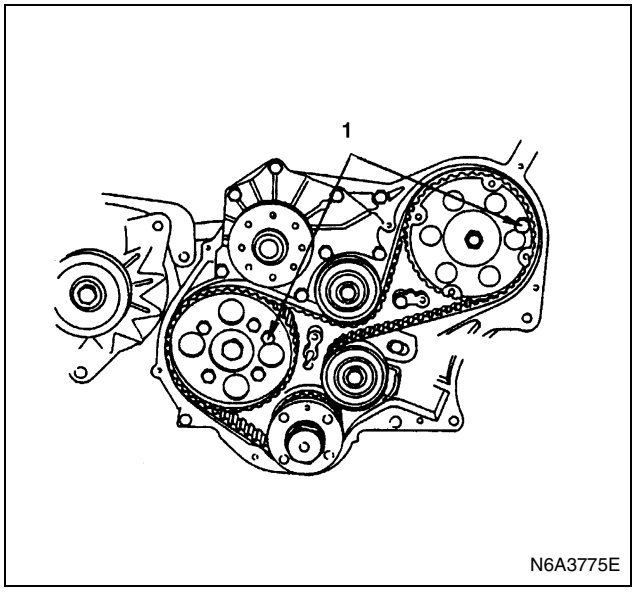

N6A3159E

8. Timing Pulley Upper Cover
9. Timing Pulley Lower Cover



N6A3702E

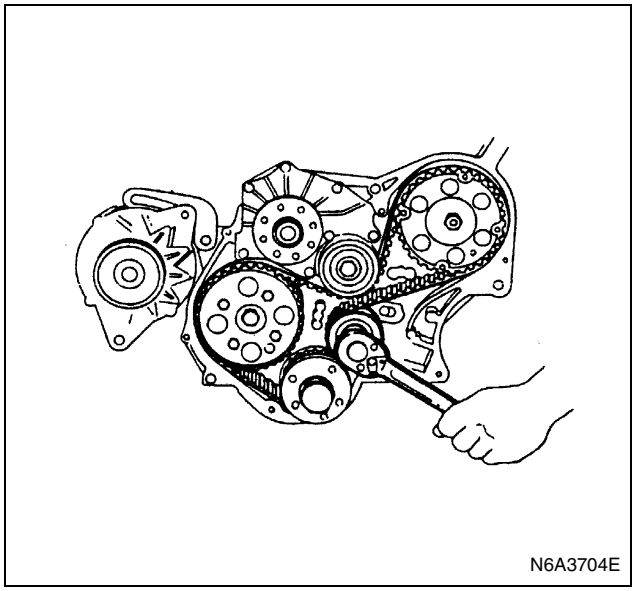
10. Flange; Camshaft Pulley
11. Timing Belt
    - Prepare a fixing bolt (M8 × 40, P = 1.25)
    - Turn crankshaft timing pulley in the normal direction pulley side mark to timing pulley housing side mark.
    - Make sure that the camshaft pulley and injection timing pulley fixing bolt holes are set to each other. Then fit in a fixing bolt (1) and lightly tighten.



N6A3775E

- No.1 cylinder should be at top dead center. If the fixing bolt holes are not set (No.4 cylinder is at top dead center) give another turn.
- Remove tensioner and timing belt.

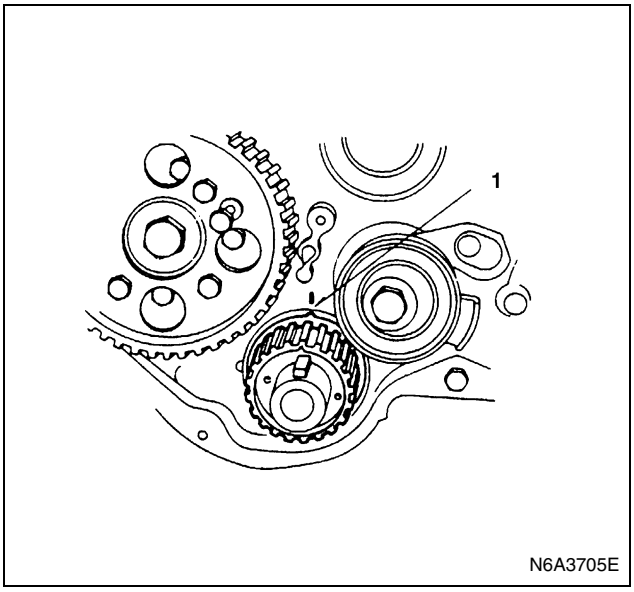
WARNING:
IF CRANKSHAFT AND CAMSHAFT AND TURNED WITH TIMING BELT BEING NOT MOUNTED, PISTON AND VALVE WILL INTERFERE WITH EACH OTHER. THEREFORE, THE SHAFTS MUST NOT BE TURNED.


N6A3704E

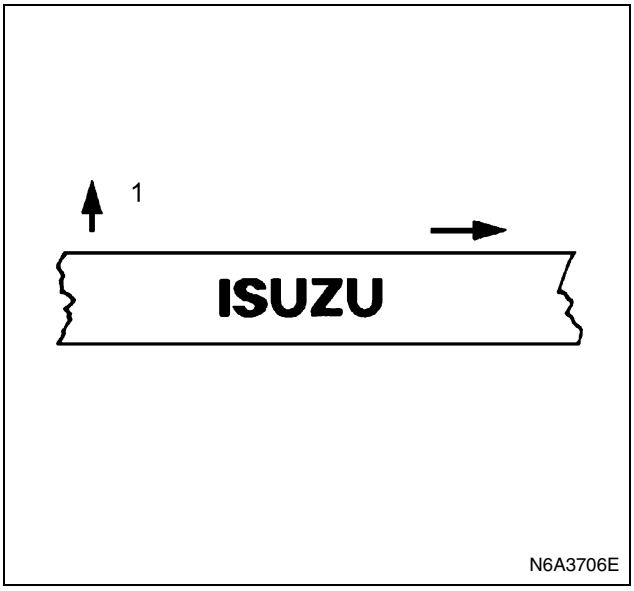
Installation

1. Timing Belt
   - When removing the belt, make sure the marks on the bolt fixed camshaft, injection pulley and crankshaft timing pulley are set to each other (1).

Caution:
Do not turn crankshaft because otherwise piston and valve will interfere with each other.

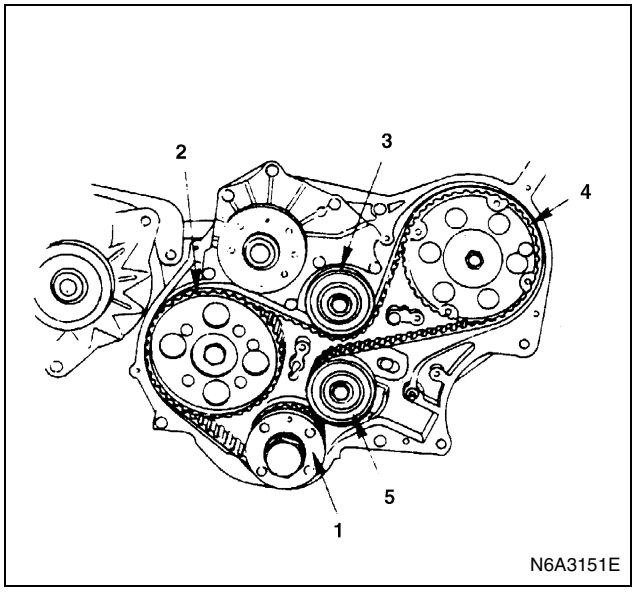


Caution:
For accurate mounting, be sure to mount the belt in the direction that letters on the belt are readable.



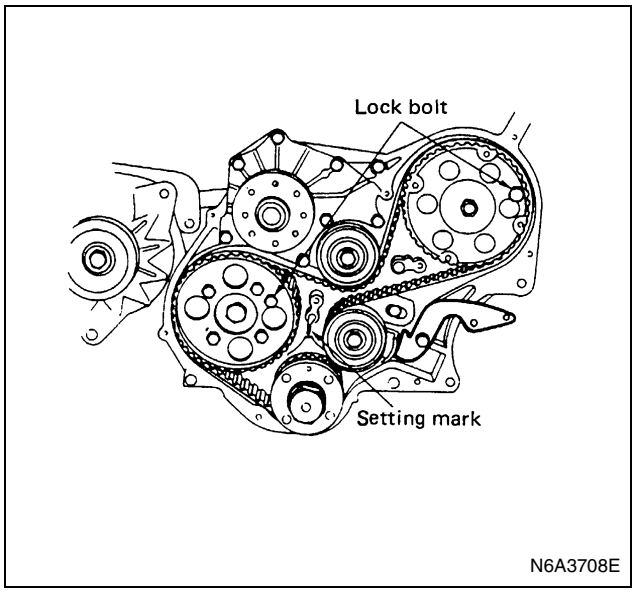
Legend
1. Cylinder head side

- Mount new timing belt on pulleys in the following steps.
  Crankshaft timing pulley (1) → Camshaft Timing pulley (2) → Idle pulley (3) → Injection Pump pulley (4) → tensioner (5)



- Set the belt on crankshaft timing pulley and hold with one hand.
- Stretch and pass the belt round each pulley with the other hand.
- After passing it round injection pump pulley, install tensioner while taking care not to slacken the belt.

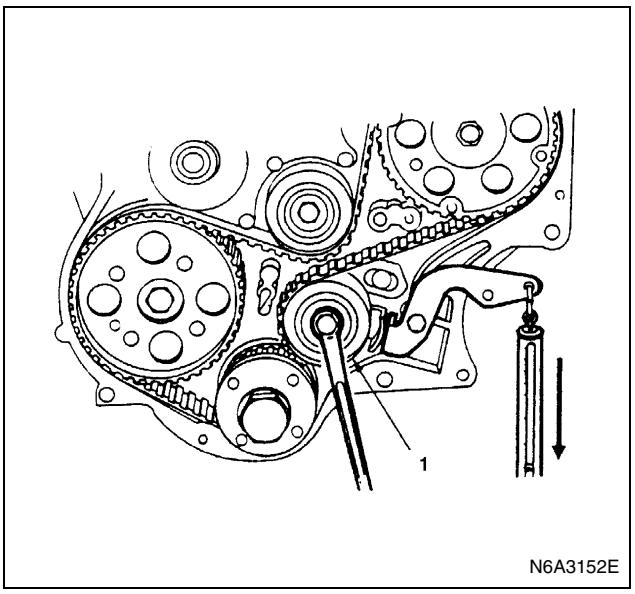
Caution:
- On completion of belt passing, make sure that the setting mark on crankshaft timing pulley is set.
- If not set, reset the mark and repeat the belt passing.



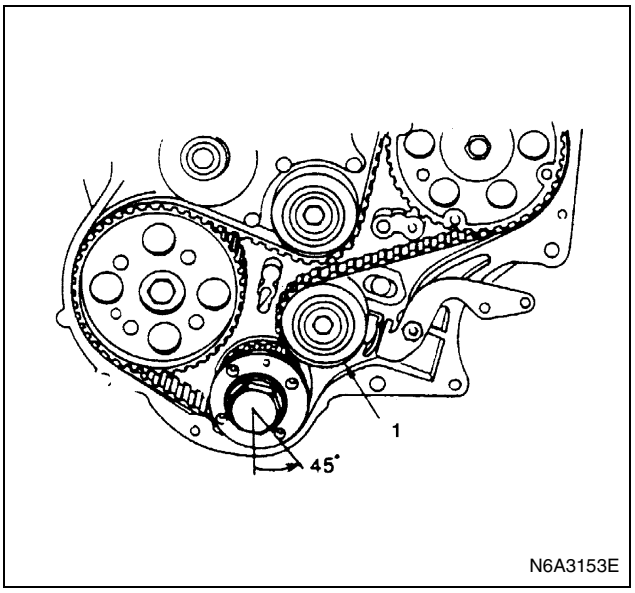
Legend
1. Lock bolt
2. Setting mark

- Remove tension adjust, lever mounting bolt, and loosen the fulcrum bolt to such extent that the lever is movable.

- Hung a spring balance from the end hole of tension adjust lever, and with the balance pulled down with 9 kg., loosen once the tensioner (1) mounting bolt and there retighten it.



- Turn the crankshaft by 45° counterclockwise to shift belt slackness on to the tensioner (1).

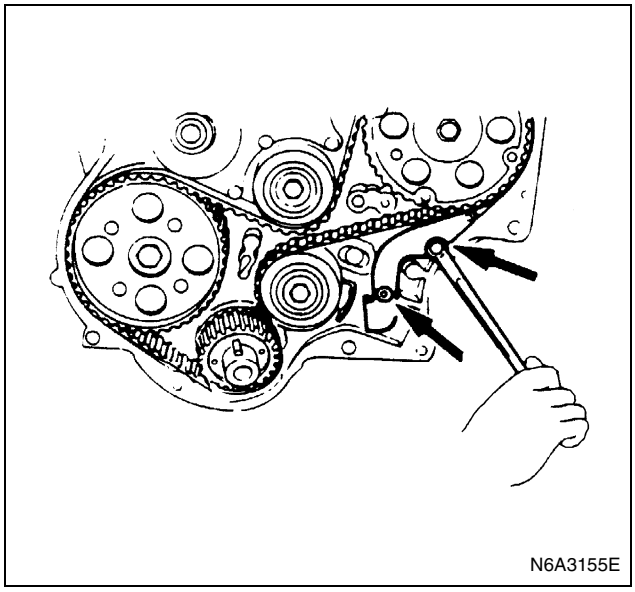


- Again hang the spring balance from the end hole of tension adjust lever and pull it down with the specified force. Under this condition, loosen tensioner mounting bolt to absorb belt slackness and retighten is to specified torque.

Belt	N·(kg/lb)
Tension	98 — 118 (10 — 12/22 — 26)

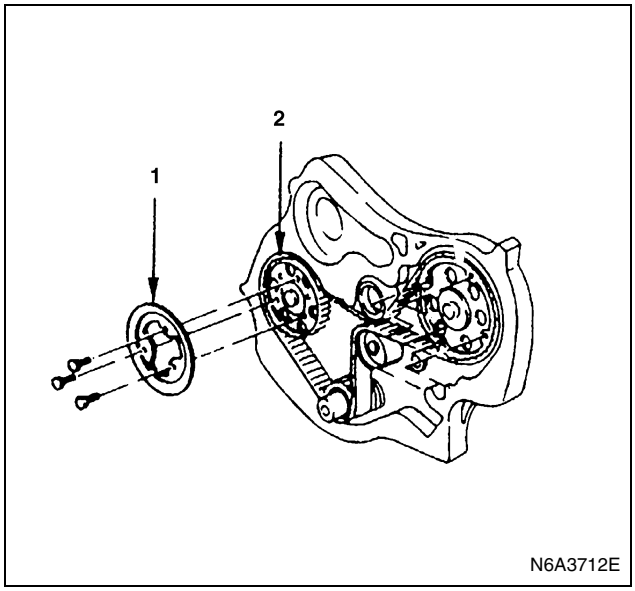
Tighten:
- Bolt to 76 N·m (7.8 kg·m / 56 lb·ft)
  - Fix the tension adjust lever.

Caution:
- In case where the timing belt has been replaced with the actuation of warning light, put off the light with change over switch on the reverse side of meter.
- Refer to Chassis Electrical in Section 8.
- Tighten the tension adjusting lever nut and bolt.



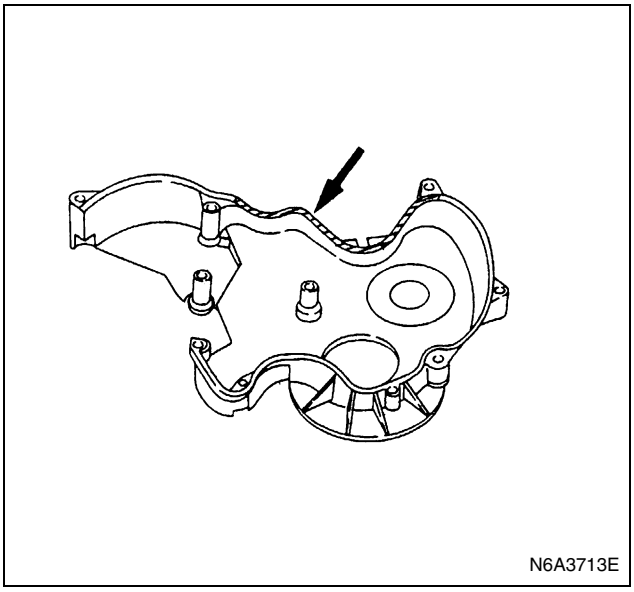
2. Flange; Camshaft Pulley
   - Install the timing pulley flange (1) to the camshaft timing pulley (2).

Tighten:
- Flange bolts to 19 N·m (1.9 kg·m / 14 lb·ft)



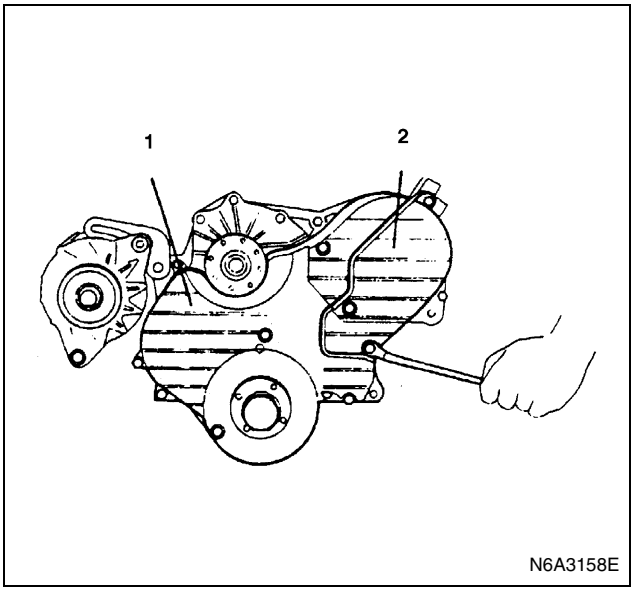
3. Timing Pulley Lower Cover
   - Install timing pulley lower cover and tighten bolt to the specified torque.

Tighten:
- Cover bolts to 8 N·m (0.8 kg·m / 69 lb·in)


N6A3713E

4. Timing Pulley Upper Cover
   - Install timing pulley upper cover and tighten bolt to the specified torque.

Tighten:
- Cover bolts to 8 N·m (0.8 kg·m / 69 lb·in)

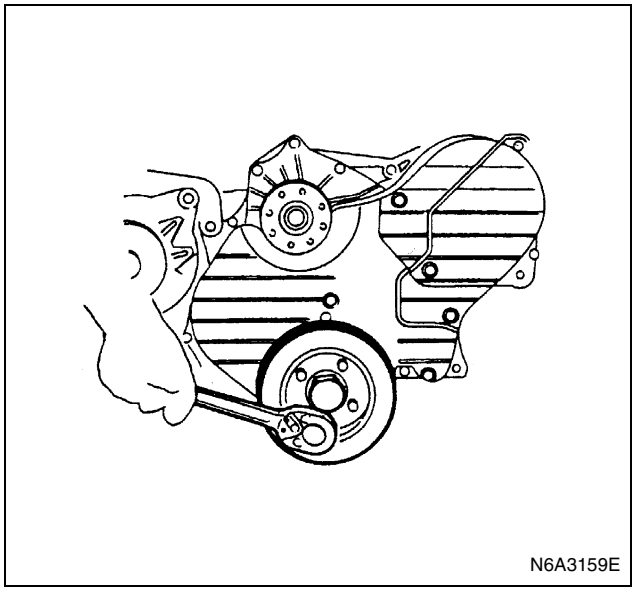


N6A3158E

Legend
1. Lower cover
2. Upper cover

5. Crankshaft Damper Pulley
   - Install crankshaft damper pulley and tighten bolt to the specified torque.

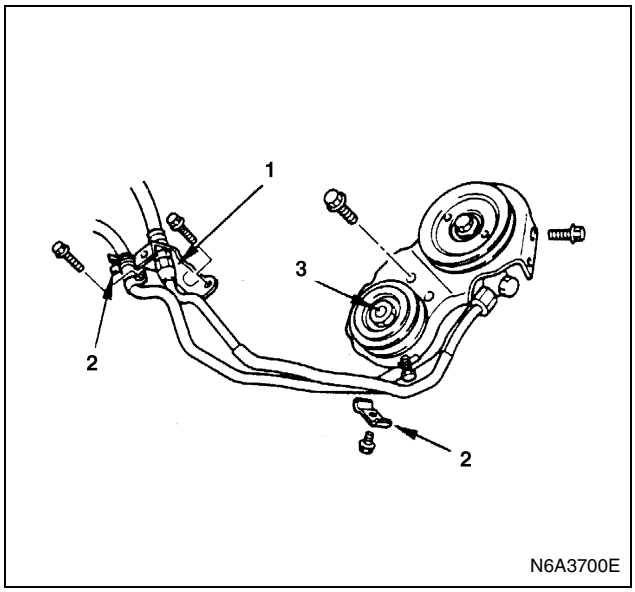
Tighten:
- 19 N·m (1.9 kg·m / 14 lb·ft)


N6A3159E

6. Power Steering Pump Bracket Assembly (P/S Model)
   - Install the pipe bracket & clip and tighten bolts to the specified torque.

Tighten:
- Pipe bracket bolts to 19 N·m (1.9 kg·m / 14 lb·ft)
- Pipe clip bolts to 10 N·m (1.0 kg·m / 87 lb·in)
   - Install the P/S pump & bracket assembly.

Tighten:
- M10 bolts to 40 N·m (4.1 kg·m / 30 lb·ft)
- M8 bolts to 19 N·m (1.9 kg·m / 14 lb·ft)
- Lock nut to 27 N·m (2.8 kg·m / 20 lb·ft)



N6A3700E

Legend
1. Pipe bracket
2. Clip
3. Lock nut

7. AC Generator Drive Belt
   - Install AC Generator drive belt and adjust belt tension.
   - Depress the drive belt mid-portion with a 98 N (10 kg / 22 lb) force.

Drive Belt Deflection	mm (in)
8 (0.31) — 12(0.47)	

   - Install fixing bolt and tighten bolts to the specified torque.

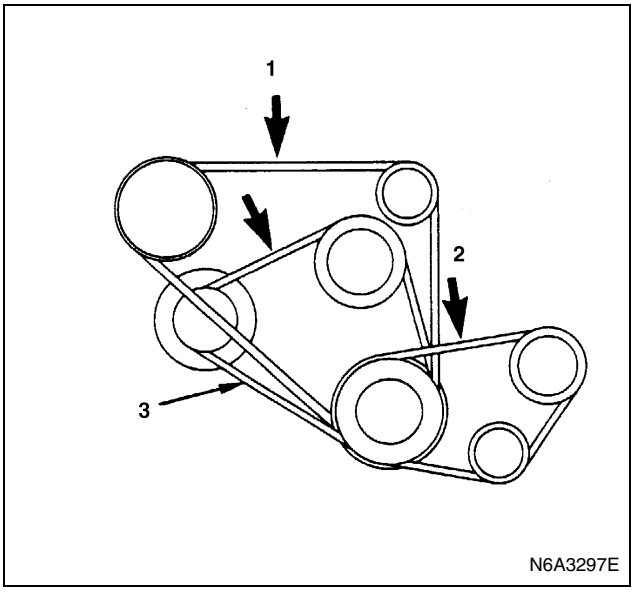
Tighten:
- Generator fixing bolts to 40 N·m (4.1 kg·m / 30 lb·ft)
- Adjust plate fixing bolts to 19 N·m (1.9 kg·m / 14 lb·ft)

8. A/C Compressor Drive Belt (A/C type)
   - Install A/C compressor drive belt and adjust belt tension.
   - Depress the drive belt mid-portion with a 98 N (10 kg / 22 lb) force.

Drive Belt Deflection	mm (in)
8 (0.31) — 12(0.47)	

   - Tighten the idler lock nut to the specified torque.

Tighten:
- Idler lock nut to 27 N·m (2.8 kg·m / 20 lb·ft)



Legend
1. A/C compressor drive belt
2. P/S pump drive belt
3. AC generator fan pulley

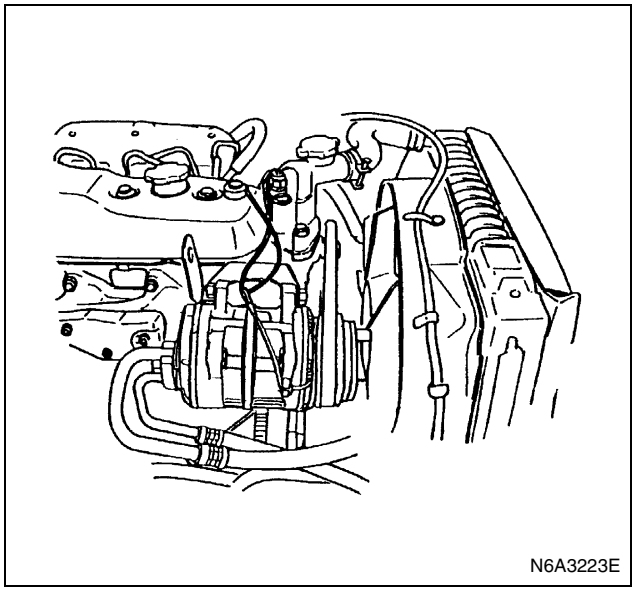
9. Power Steering Pump Drive Belt (P/S pump model)
   - Install PS pump drive belt and adjust belt tension.
   - Depress the drive belt mid-portion with a 98 N (10 kg / 22 lb) force.

Drive Belt Deflection	mm (in)
8 (0.31) — 12(0.47)	

   - Tighten the idler lock nut to the specified torque.

Tighten:
- Idler lock nut to 27 N·m (2.8 kg·m / 20 lb·ft)

10. Fan Shroud
    - Install the fan shroud and reservoir tank hose.



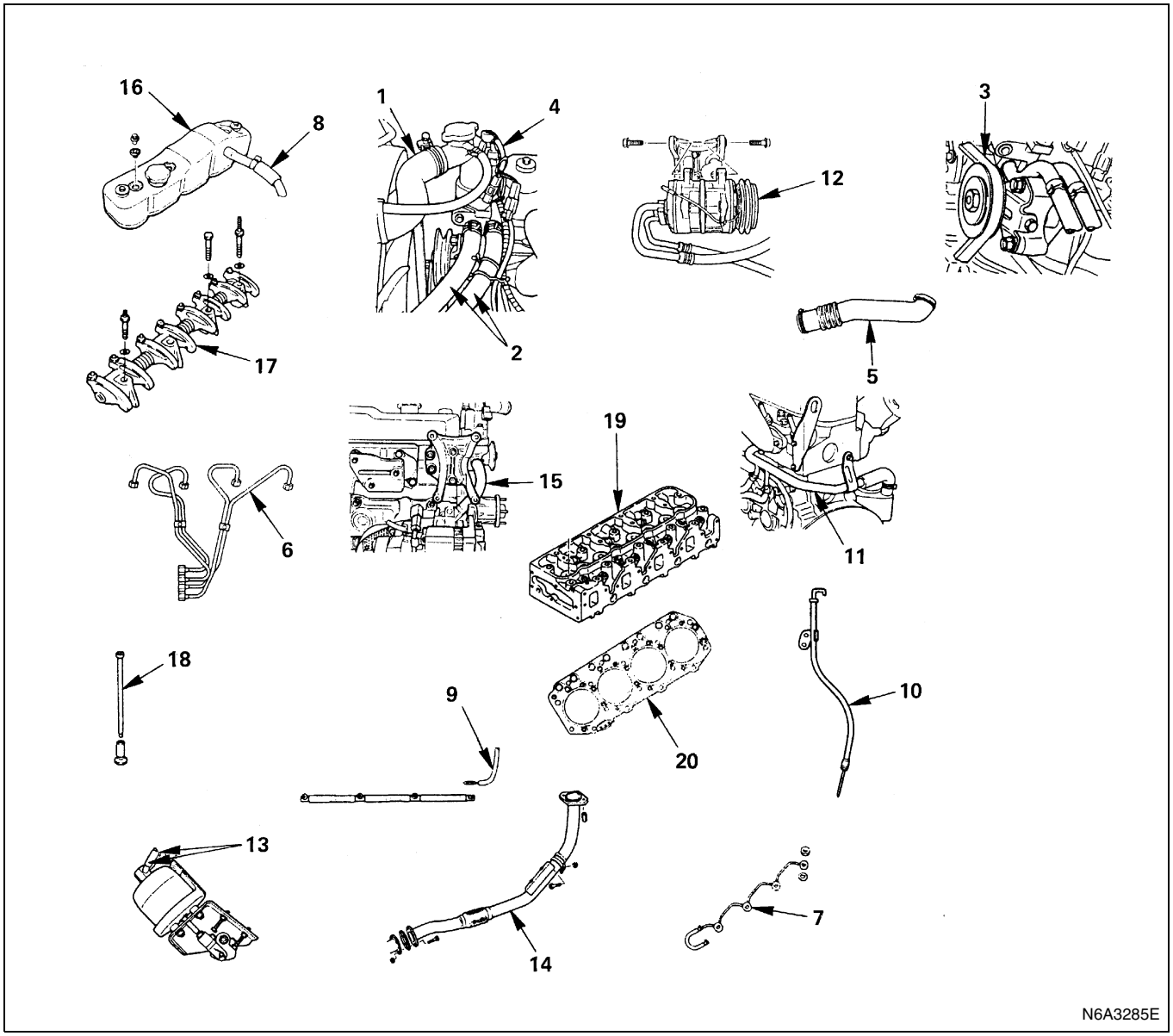
11. Cooling Fan Assembly
    - Mount fan pulley, distance piece, and cooling fan asm (in this order) on the water pump, and tighten to the specified torque.

Tighten:
- Nut to 8 N·m (0.8 kg·m / 69 lb·in)

   - Connect battery ground cable.
   - Pour coolant.
   - Start the engine and check coolant leakage.

CYLINDER HEAD ASSEMBLY AND GASKET

Component



Legend

1. Radiator hose upper
2. Heater hose
3. A/C Compressor drive belt
4. Engine harness
5. Air intake duct
6. Injection pipe
7. Leak off pipe
8. PCV hose
9. Glow plug harness
10. Oil level gauge guide tube
11. Oil cooler water pipe
12. A/C Compressor assembly
13. Vacuum actuator hose
14. Front exhaust pipe
15. By-pass hose
16. Cylinder head cover
17. Rocker arm shaft
18. Push rod
19. Cylinder head assembly
20. Cylinder head gasket

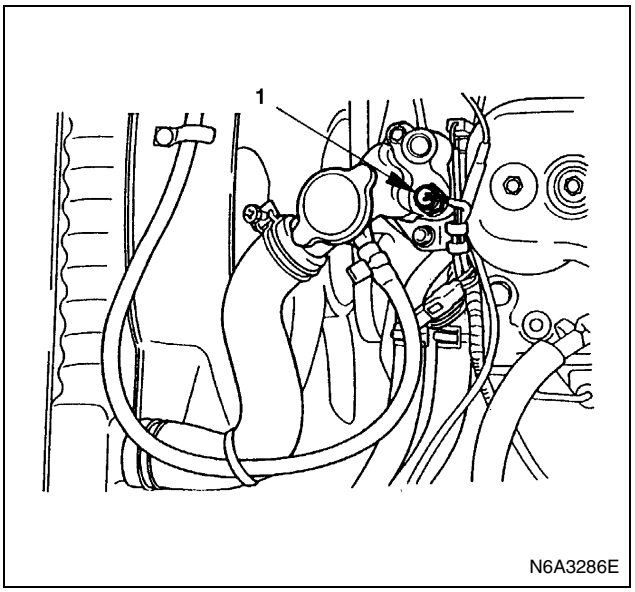
Removal

Preparation

- Disconnect battery ground cable.
- Drain coolant from the radiator and engine.

1. Radiator Hose Upper
   - Disconnect upper radiator hose from engine side.

2. Heater Hose
   - Disconnect heater hose from heater pipe.
3. A/C Compressor Drive Belt
   - Loosen idler lock nut.
   - Loosen adjust bolt and remove drive belt.
4. Engine Harness
   - Disconnect harness connectors from units on thermostat housing.

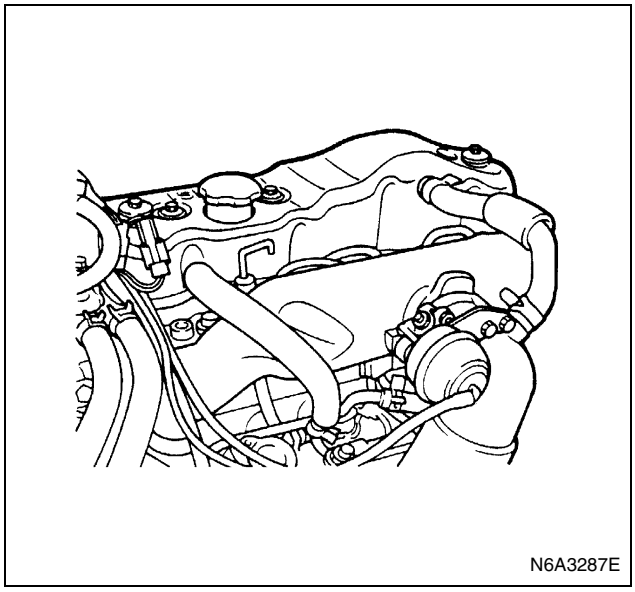


Legend
1. Thermo-sensor

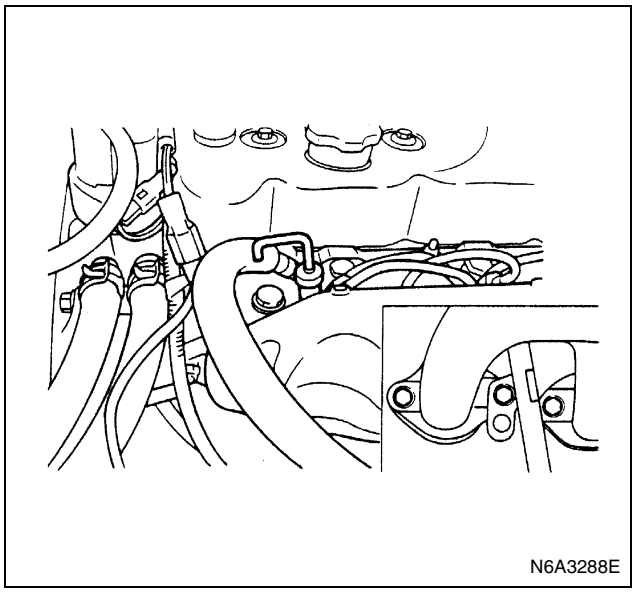
5. Air Intake Duct
   - Remove the clip and air intake duct.
6. Injection Pipe
   - Release injection pipe clip.
   - Remove flare nut injection pump side.
   - Remove flare nut injection nozzle side and remove injection pipe.

Notice:
Plug the injection nozzle holder and the delivery holder to prevent the entry of foreign matters into them.

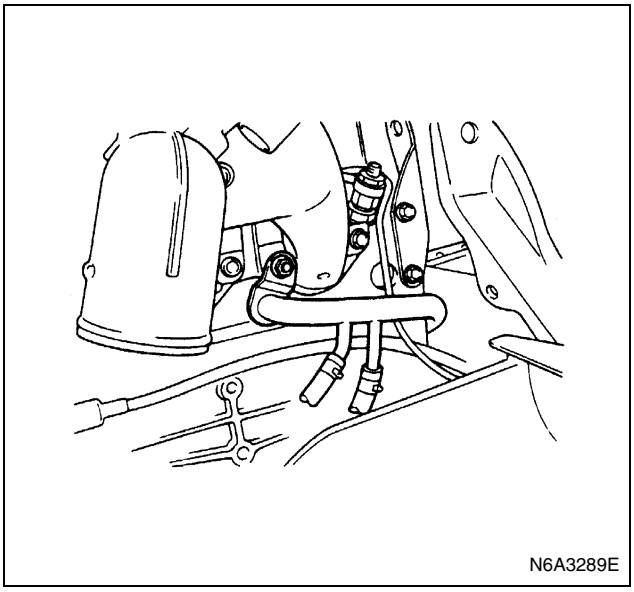
7. Leak Off Pipe
   - Remove the leak off pipe side of leak off hose.
8. PCV Hose
   - Remove the PCV hose from air intake pipe.



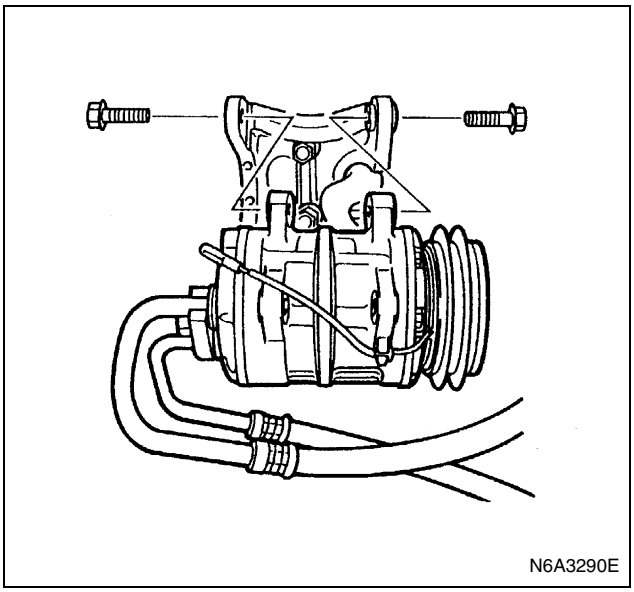
9. Glow Plug Harness
10. Oil Level Gauge Guide Tube
    - Remove the guide tube from cylinder head.



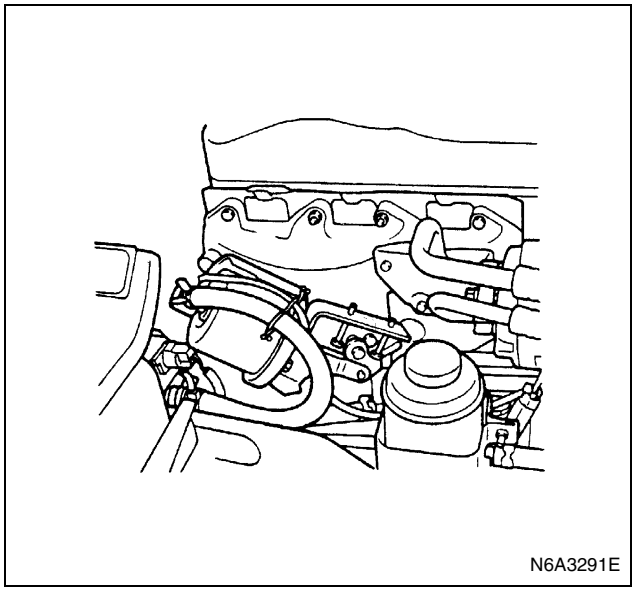
11. Oil Cooler Water Pipe (Oil Cooler Model)
    - Remove the pipe fixing bolt of cylinder head rear side.
    - Remove the oil cooler water pipe fixing nut from inlet manifold.


N6A3289E

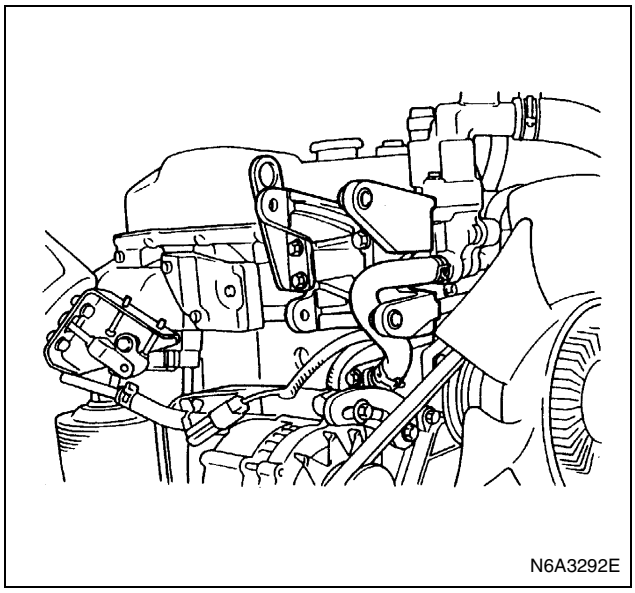
12. A/C Compressor Assembly (A/C Model)
    - Remove the clutch harness connector.
    - Remove the A/C compressor fixing bolts and temporally tighten the A/C compressor to chassis frame side use the wire.


N6A3290E

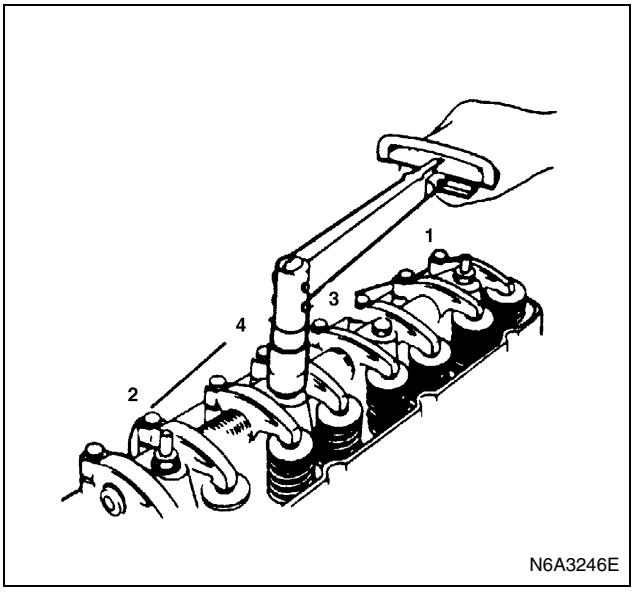
13. Vacuum Actuator Hose (Exhaust Brake Model)
    - Remove the vacuum hoses from vacuum actuator.


N6A3291E

14. Front Exhaust Pipe
    - Remove the exhaust pipe fixing bolts from exhaust manifold.
    - Remove the exhaust pipe stay bolt.
15. By-pass Hose
16. Cylinder Head Cover


N6A3292E

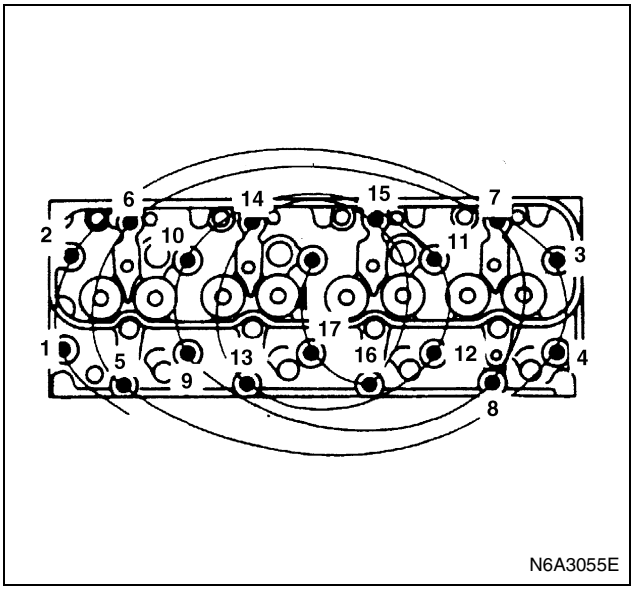
17. Rocker Arm Shaft
    - Loosen the rocker arm shaft bracket bolts a little at a time in the numerical order shown in the illustration.



N6A3246E

Notice:
Failure to loosen the rocker arm shaft bracket bolts a little at a time in numerical order will adversely effect the rocker arm shaft.

18. Push Rod
19. Cylinder Head Assembly
    - Loosen the cylinder head bolts a little at a time in the numerical order shown in the illustration.



N6A3055E

Notice:
Failure to loosen the cylinder head bolts a little at a time in numerical order will adversely effect the cylinder head lower surface.

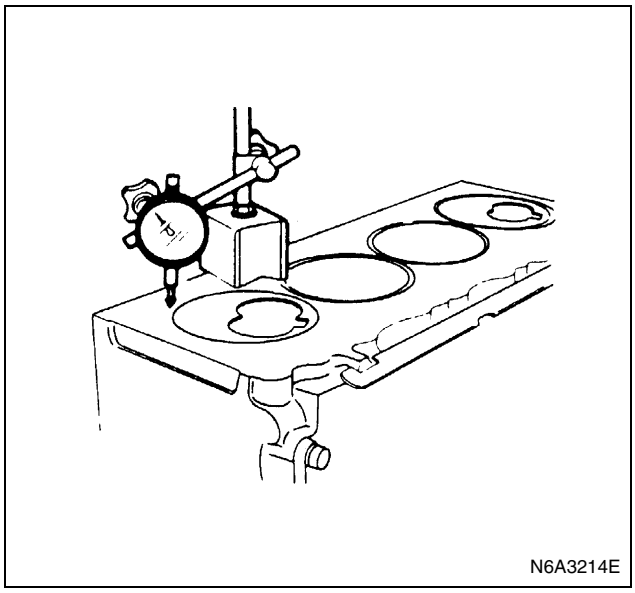
20. Cylinder Head gasket
    - Remove the cylinder head gasket and dowel.

Installation

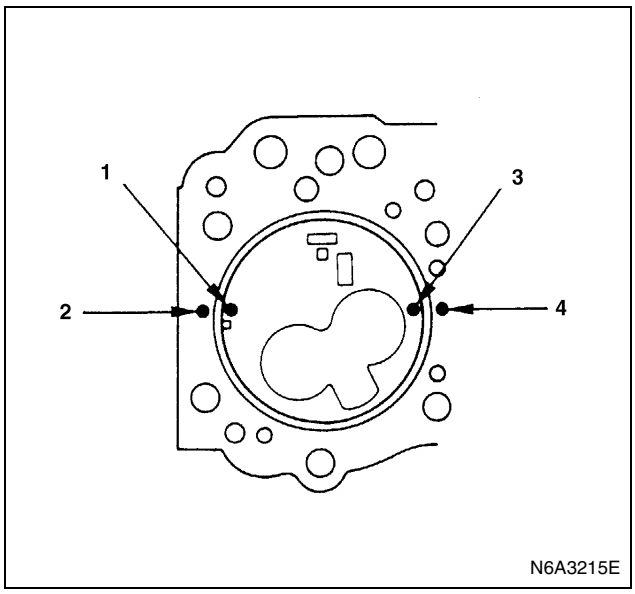
1. Cylinder Head Gasket
   Cylinder head gasket is determined by the piston head projection from the cylinder body upper surface, in order to improve engine performance.
   Three types of gasket are provided by the difference of thickness. Select the adequate one out of three grades of gasket, according to the following procedure.
   Before measurement, clear off carbon from the piston head and cylinder body surface and also clean the place where a gasket was installed.

Piston Head Projection Measurement Point

1) Use a dial indicator to measure the piston projection amount.


N6A3214E

2) Refer to the illustration for the piston head projection measuring positions.
   All measuring positions should be as close as possible to the cylinder liner.



N6A3215E

3) Measure the points (1), (2), (3) and (4) and obtain two differences (1) — (2) and (3) — (4) on each cylinder.
   Calculate the average value of the piston head projection on each cylinder.
4) Obtain the maximum value in the four cylinders.
5) Determine the gasket grade required to the maximum value described above in accordance with the following table.

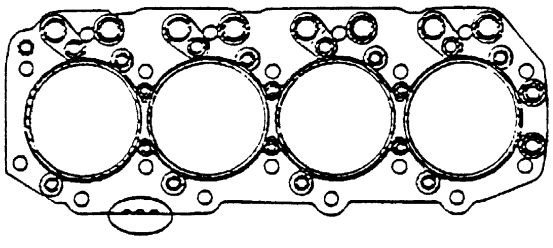
4JB1

mm (in)

1		2	3
A		0.758 - 0.813 (0.030 - 0.032)	1.60 (0.0630)
B		0.813 - 0.859 (0.032 - 0.034)	1.65 (0.0650)
C		0.859 - 0.914 (0.034 - 0.036)	1.70 (0.0670)

N6A3690E

Notice:
The difference between the highest measured piston head projection and the lowest measured piston head projection must not exceed 1.0 mm (0.039 in).



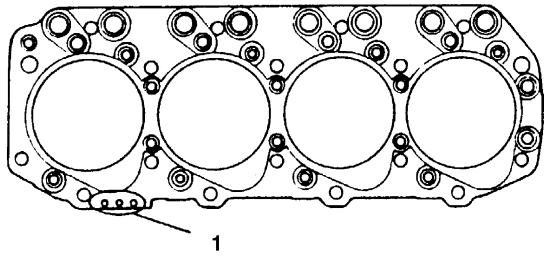
N6A3216E

4JG2

mm (in)

1		2	3
A		0. 658-0.713 (0.0259-0.0281)	1.60 (0.0630)
B		0.713-0.759 (0.0281-0.0299)	1.65 (0.0650)
C		0.759-0.814 (0.0299-0.0320)	1.70 (0.0670)

N6A3693E



N6A3217E

Legend
1. Grade mark

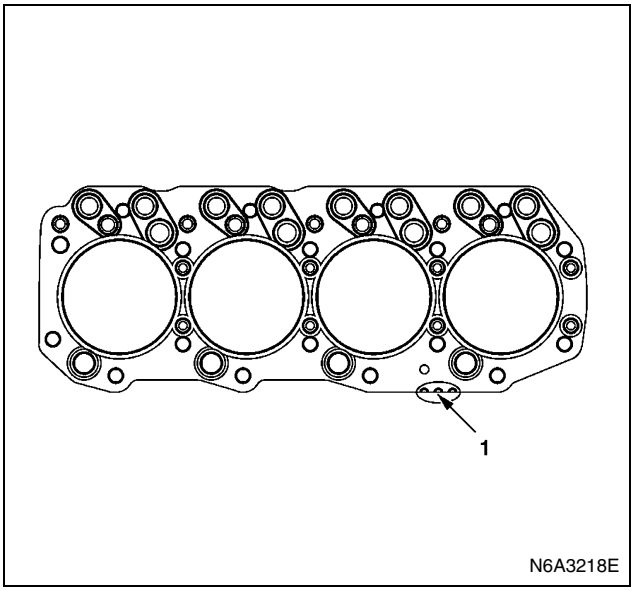
4JH1

mm (in)

1		2	3
A		0.215 - 0.265 (0.0085 - 0.0104)	1.3 (0.5118)
B		0.265 - 0.315 (0.0104 - 0.0124)	1.35 (0.5315)
C		0.315 - 0.365 (0.0124 - 0.0144)	1.4 (0.5512)

N6A3691E

Notice:
The difference between the highest measured piston head projection and the lowest measured piston head projection must not exceed 1.0 mm (0.039 in).



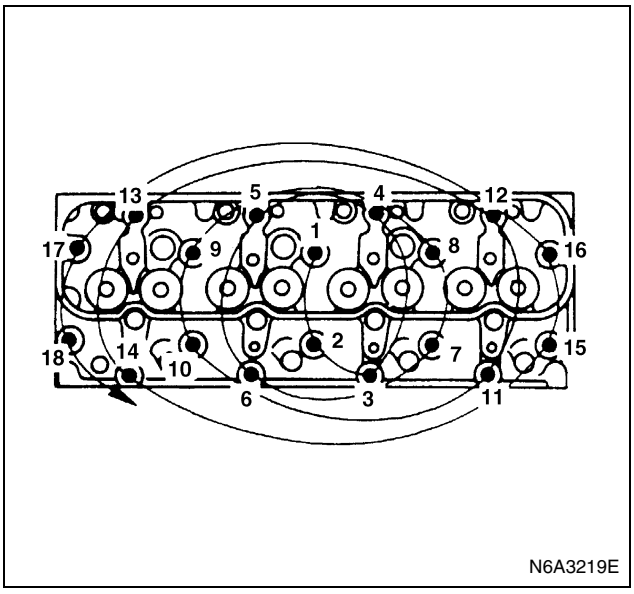
N6A3218E

Legend
1. Grade mark

---

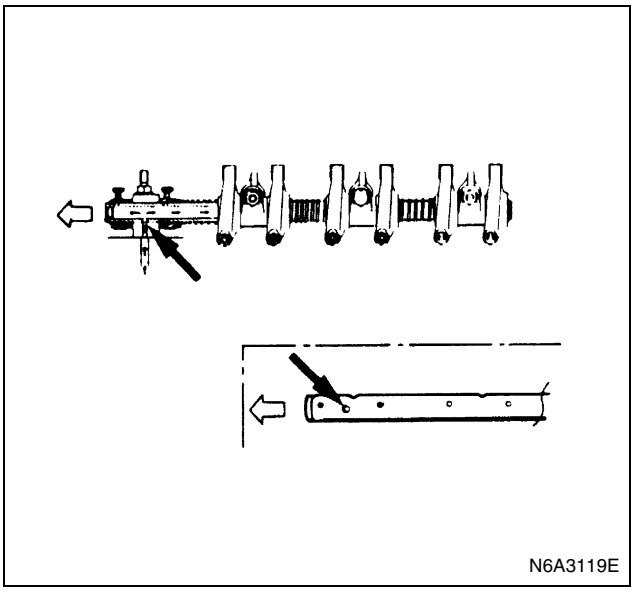
2. Cylinder Head Assembly
   1) Install the dowel in cylinder block.
   2) Install the cylinder head gasket with top mark up.
   3) Clean up cylinder head lower surface and cylinder body upper surface.
   4) Install the cylinder head as softly.
   5) Apply engine oil to screw and seat of cylinder head bolts.
   6) Tighten the cylinder head bolts to the specified torque in three steps following the numerical order shown in the illustration.

Tighten:
Cylinder head bolts to
- 1st step: 49 N·m (5kg·m / 36 lb·ft)
- 2nd step: 60° — 75°
- 3rd step: 60° — 75°



N6A3219E

3. Push Rod
   - Apply engine oil to push rod and in to the cylinder head.
4. Rocker Arm shaft
   1) Loosen all adjusting screws.
   2) Position the rocker arm shaft with the large oil hole (4ϕ) facing the front of the engine.

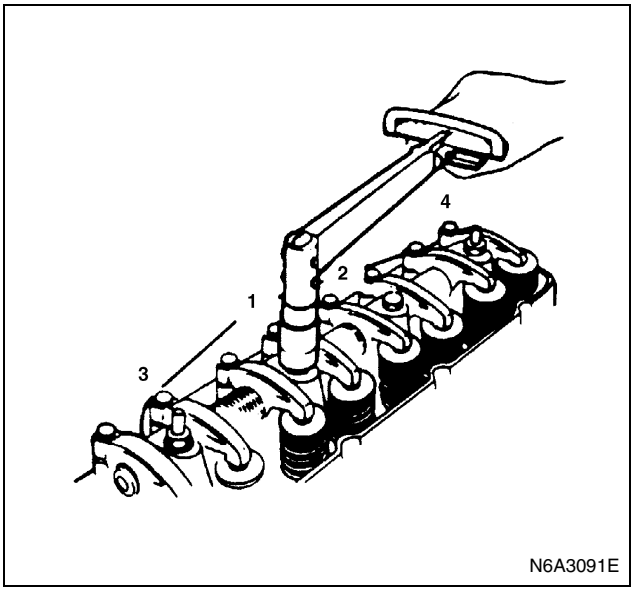


N6A3119E

   3) Tighten the rocker arm shaft bracket bolts to the specified torque in the numerical order shown in the illustration.

Tighten:

- Rocker arm shaft bracket bolt to 54 N·m (5.5kg·m / 40 lb·ft)

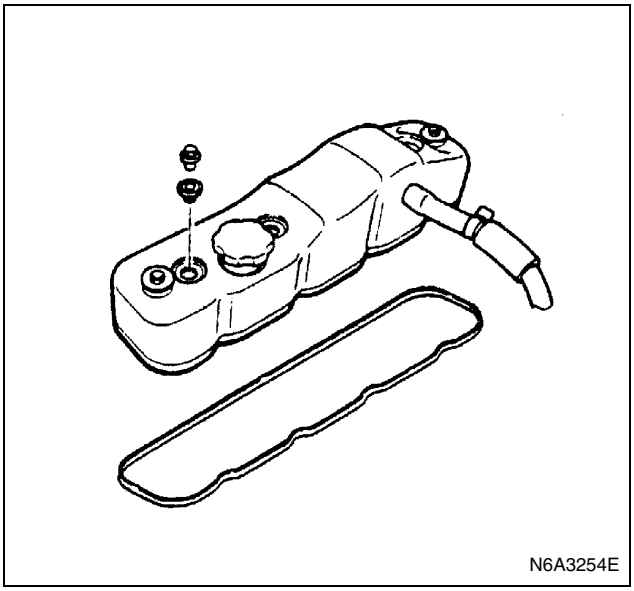


- Valve clearance adjustment.
  Above works refer to "ROCKER ARM SHAFT ASSEMBLY" Section in this manual.

5. Cylinder Head Cover
   - Apply engine oil to the rocker arms and the valve spring.
   - Install the cylinder head cover gasket to the cylinder head cover.
   - The gasket must be perfectly smooth with no loose areas.
   - Tighten the cylinder head cover nuts to the specified torque in the numerical order shown in the illustration.

Tighten:

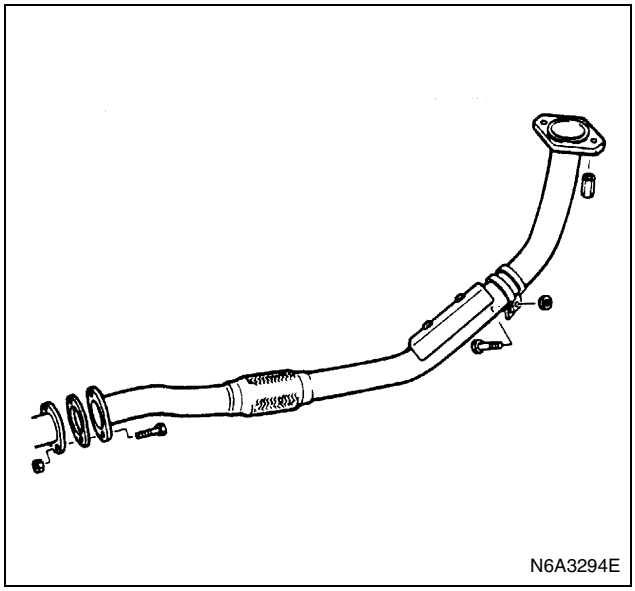
- Cylinder head cover to 13 N·m (1.3kg·m / 113 lb·in)



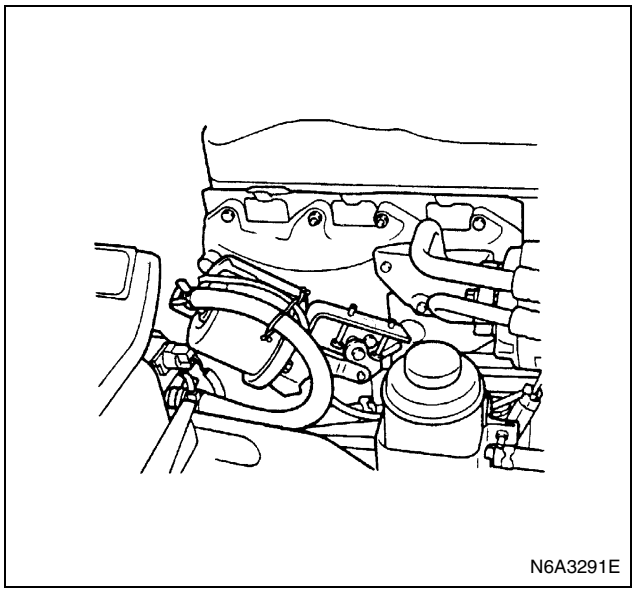
6. By-Pass Hose
7. Front Exhaust Pipe
   - Install the pipe to manifold and tighten bolts and nuts to the specified torque.

Tighten:

- W/Exhaust brake manifold nut to 37 N·m (3.8 kg·m / 27 lb·ft)
- WO/Exhaust brake manifold nut to 40 N·m (4.1 kg·m / 30 lb·ft)
- Pipe stay bolts to 40 N·m (4.1kg·m / 30 lb·ft)



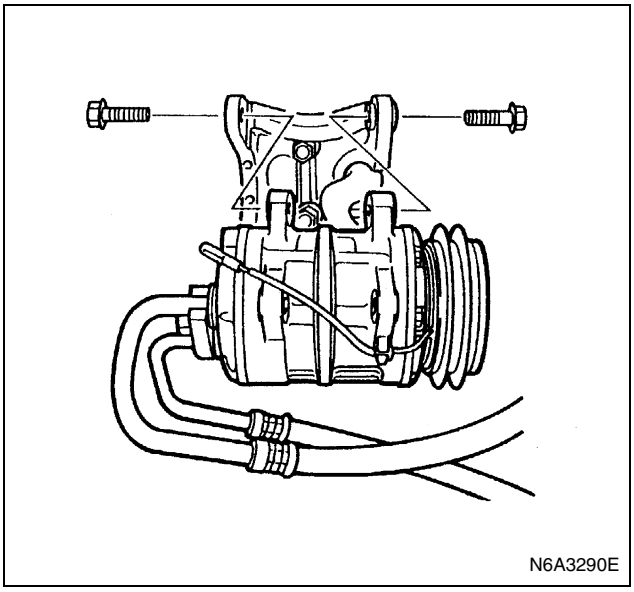
8. Vacuum Actuator Hose (Exhaust Brake Model)
   - Install the vacuum hose to the vacuum actuator.



9. A/C Compressor Assembly (A/C Model)
   - Install the A/C compressor fixing bolts and tighten bolts to the specified torque.

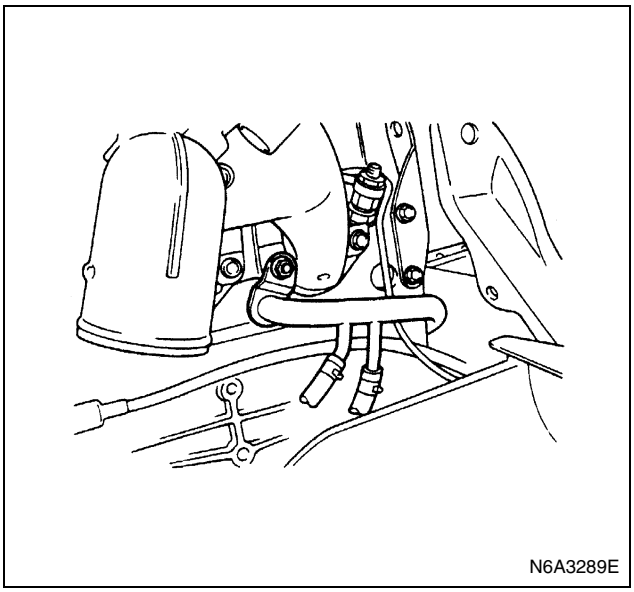
Tighten:

- Compressor bolts to 37 N·m (3.8 kg·m / 27 lb·ft)


N6A3290E

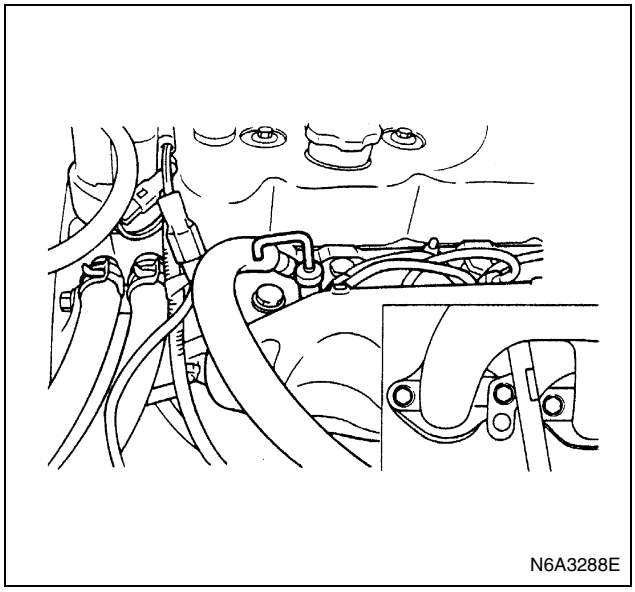
10. Oil Cooler Water Pipe (Oil Cooler Model)
    - Install the water pipe bolt and tighten bolt to the specified torque.

Tighten:
- Water pipe nut to 19 N·m (1.9 kg·m / 1.4 lb·ft)
- Pipe bracket bolt to 40 N·m (4.1kg·m / 30 lb·ft)

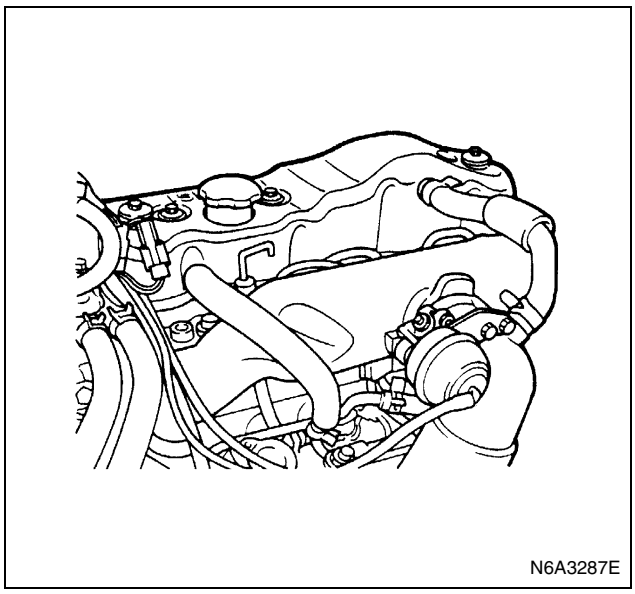

N6A3289E

11. Oil Level Gauge Guide Tube
    - Install the guide tube bolt and tighten bolt to the specified torque.

Tighten:
- Guide tube bolt to 19 N·m (1.9 kg·m / 1.4 lb·ft)

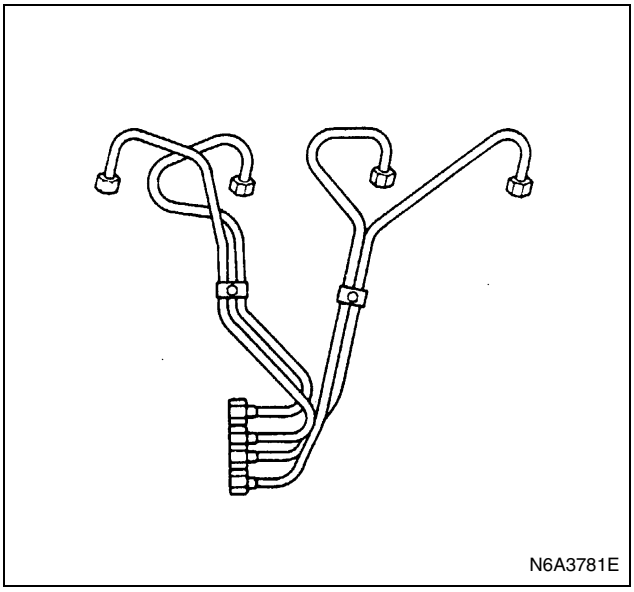

N6A3288E

12. Glow Plug Harness
13. PCV Hose


N6A3287E

14. Leak Off Pipe
    - Mount using a new copper washer.
15. Injection Pipe
    - Install the flare nut to injection pump side.
    - Install the flare nut to injection nozzle side.
    - Tighten the flare nut to the specified torque.

Tighten:
- Flare nut to 29 N·m (3.0 kg·m / 22 lb·ft)

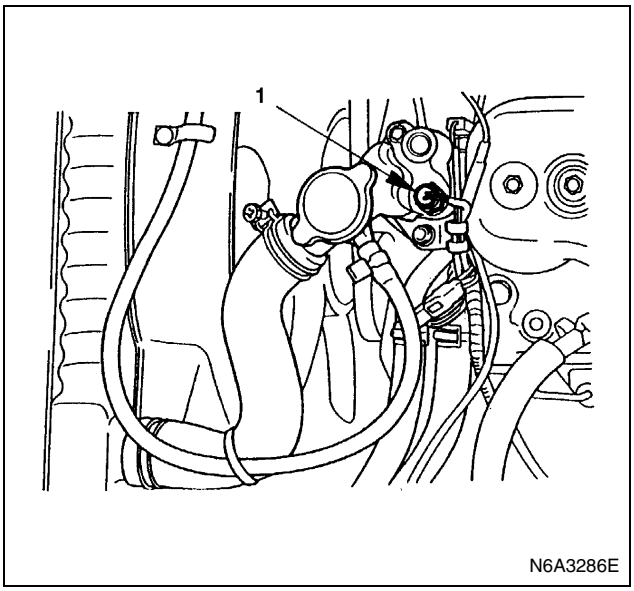

N6A3781E

- Fit pipe clip in specified torque.

Tighten:

- Sleeve nut to 29 N·m (3.0 kg·m / 22 lb·ft)

16. Air Intake Duct
17. Engine Harness
    - Connect the thermo-sensor harness and thermometer unit harness.



N6A3286E

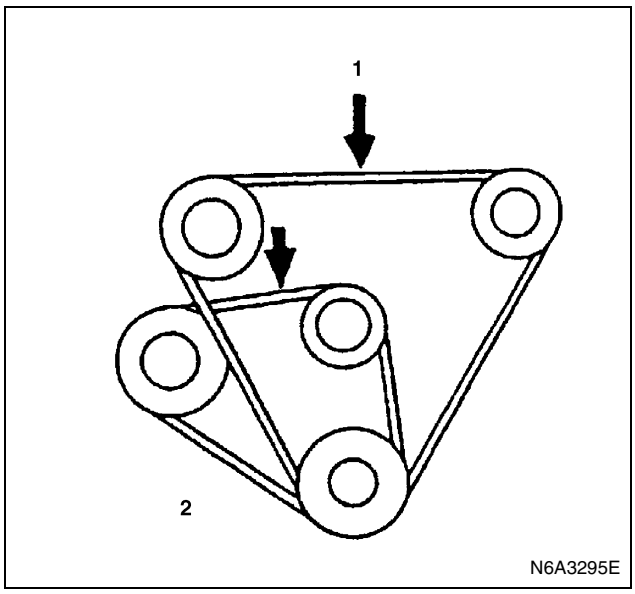
Legend

1. Thermo-sensor

18. A/C Compressor Drive Belt (A/C Model)
    Check drive belts for wear or damage, and replace with new ones as necessary. Check belts for tension, and adjust as necessary.
    - Check drive belts tension.
    - Push the middle of belts with a force of 10 kg and check each bolt for deflection.
    - Standard deflection

	mm (in)
	Initial tension
AC generator & fan pulley drive belt	8 — 12 (0.31 — 0.47)
A/C compressor drive belt	
P/S pump drive belt	

4JB1



N6A3295E

Legend

1. A/C compressor drive belt & P/S pump drive belt
2. AC generator &fan pulley drive belt

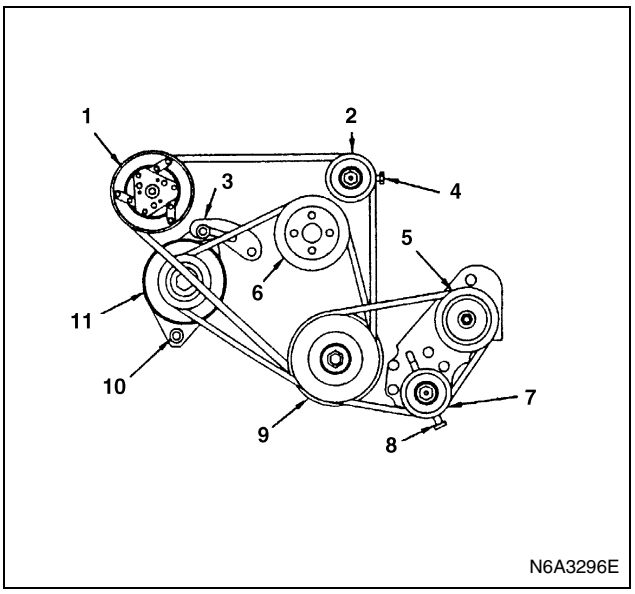
Tension Adjustment

P/S oil pump and A/C compressor pulley belt

- With P/S pump lock bolt loose, adjust belt tension with adjust belt.

Cooling fan pulley belt

- With AC Generator mounting and lock bolts loose, adjust belt tension with adjuster's adjust bolt.



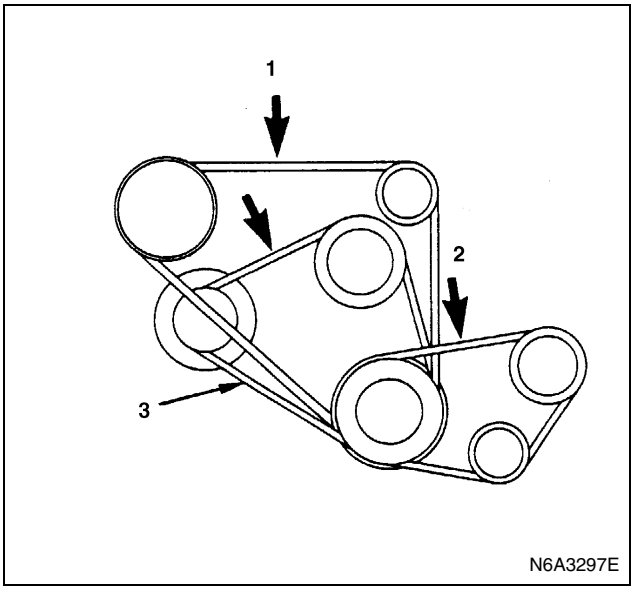
Legend

1. A/C compressor
2. Idle pulley
3. Adjust plate
4. Adjust bolt
5. P/S pump pulley
6. Fan pulley
7. Idle pulley
8. Adjust pulley
9. Crank pulley
10. ACG bolt
11. AC generator

Tighten:

- AC generator fixing bolt to 40 N·m (4.1 kg·m / 30 lb·ft)
- Adjust plate fixing bolt to 19 N·m (1.9kg·m / 1.4 lb·ft)
- Adjust plate lock bolt to 19 N·m (1.9 kg·m / 1.4 lb·ft)

4JG2



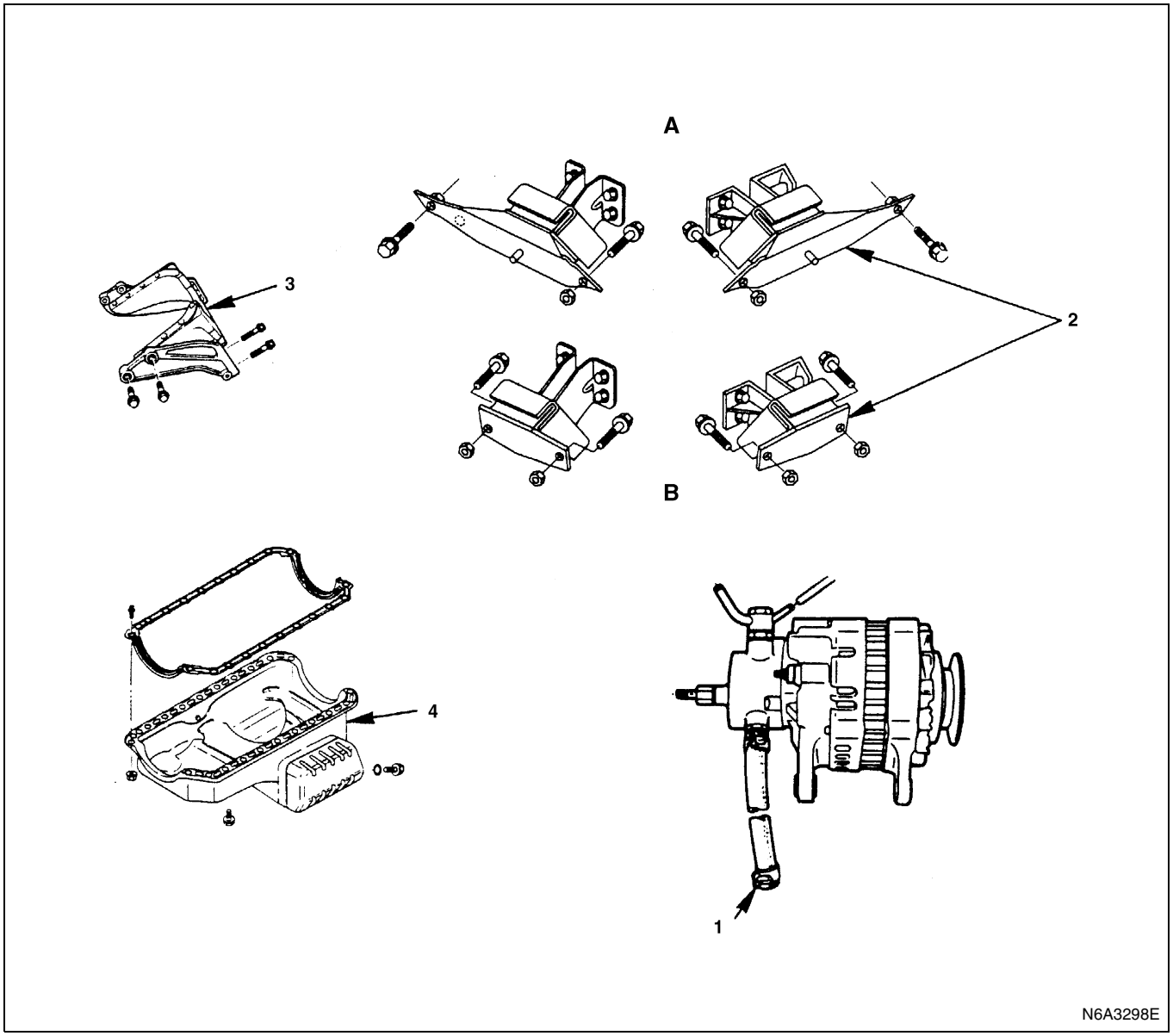
Legend

1. A/C compressor drive belt
2. P/S pump drive belt
3. AC generator fan pulley

19. Heater Core
    - Connect the heater hose them tighten the clip securely.
20. Radiator Hose Upper
    - Connect the radiator hose them tighten clip securely.
    - Pour coolant.
    - Connect the battery ground cable.
    - Start the engine and check coolant leakage.

OIL PAN

Component



Legend

A. Independent suspension (4 × 2)
B. Rigid suspension (4 × 2)
1. Vacuum pump oil hose
2. Engine mount bolts
3. Stiffener and space rubber
4. Oil pan assembly

Removal

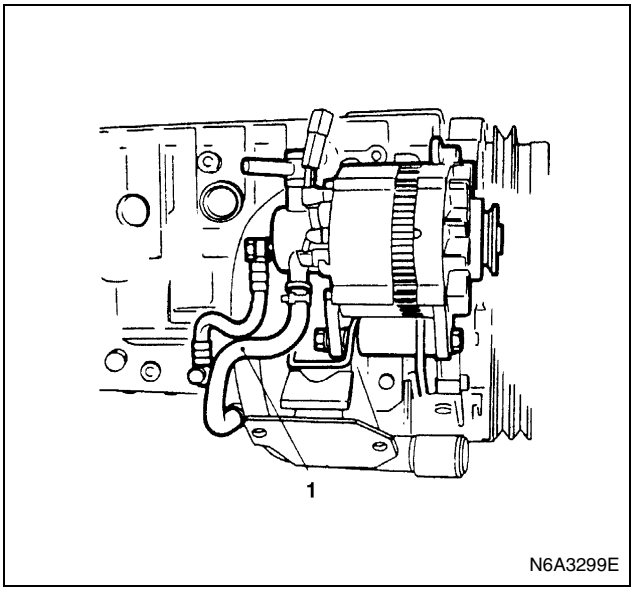
Preparation

- Disconnect battery ground cable.
- Lift up car.
- Drain engine oil.

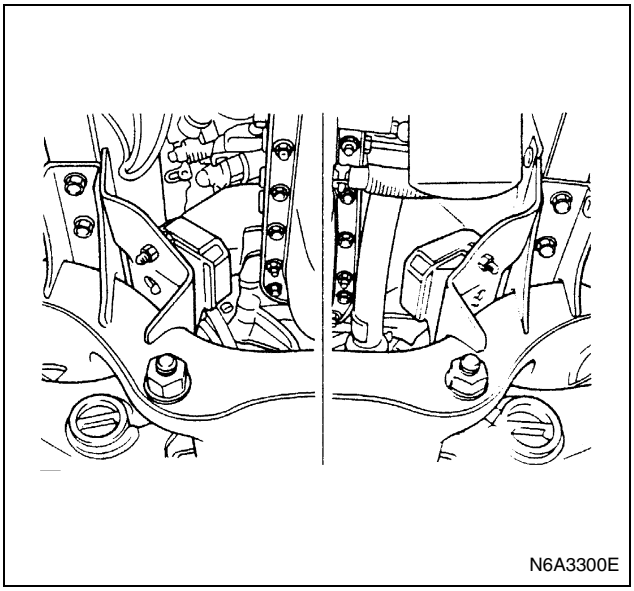
Notice:
Install drain plug with new gasket.

Tighten:
- 44 N·m (4.5 kg·m / 33 lb·ft)

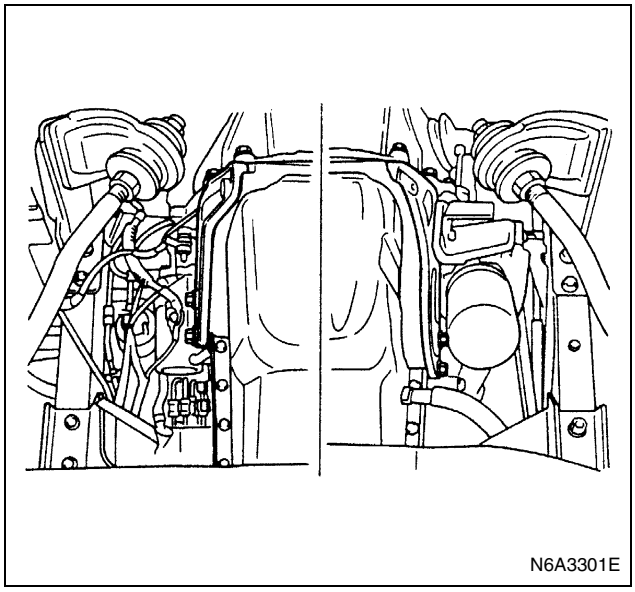
1. Vacuum Pump Oil Hose
   - Remove oil hose (1) from oil pan.



2. Engine Mount Bolts
   - Remove the engine mount bolts right & left side.



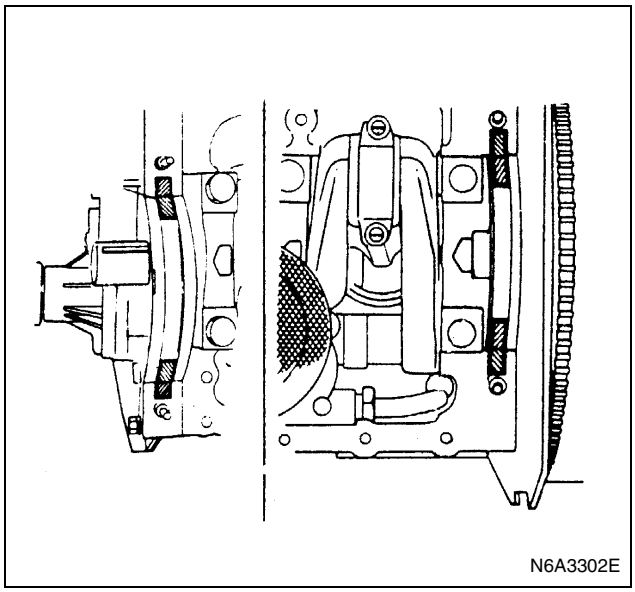
3. Stiffener & Space Rubber
   - Remove the exhaust pipe bracket.
   - Remove the stiffener from of the oil pan left & right side.
   - Take out space rubber.



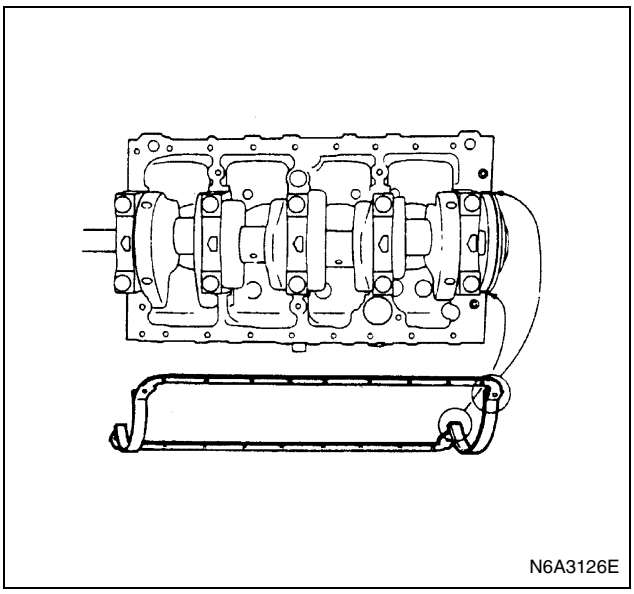
4. Oil Pan Assembly
   - Raising the engine about 50mm.
   - Remove the oil pan from cylinder block.

Installation

1. Oil Pan Assembly
   - Apply the recommended liquid gasket or its equivalent to the No.5 bearing cap arches, the grooves, and the timing gear case arches at the positions shown in the illustration.



   - Fit the gasket rear lipped portion into the No.5 groove.



- Be absolutely sure that the lipped portion in fitted snugly in to the groove.
- Install the oil pan to the cylinder body.
- Tighten the oil pan bolts to the specified torque.

Tighten:
- Oil pan bolt to 19 N·m (1.9 kg·m / 14 lb·ft)

2. Stiffener and Space Rubber
   - Install the space rubber.
   - Install the stiffener left side and right side tighten bolt to the specified torque.

Tighten:
- Engine body side to 37 N·m (3.8 kg·m / 27 lb·ft)
- Clutch housing side to 78 N·m (8.0 kg·m / 58 lb·ft)
  - Install exhaust pipe bracket.

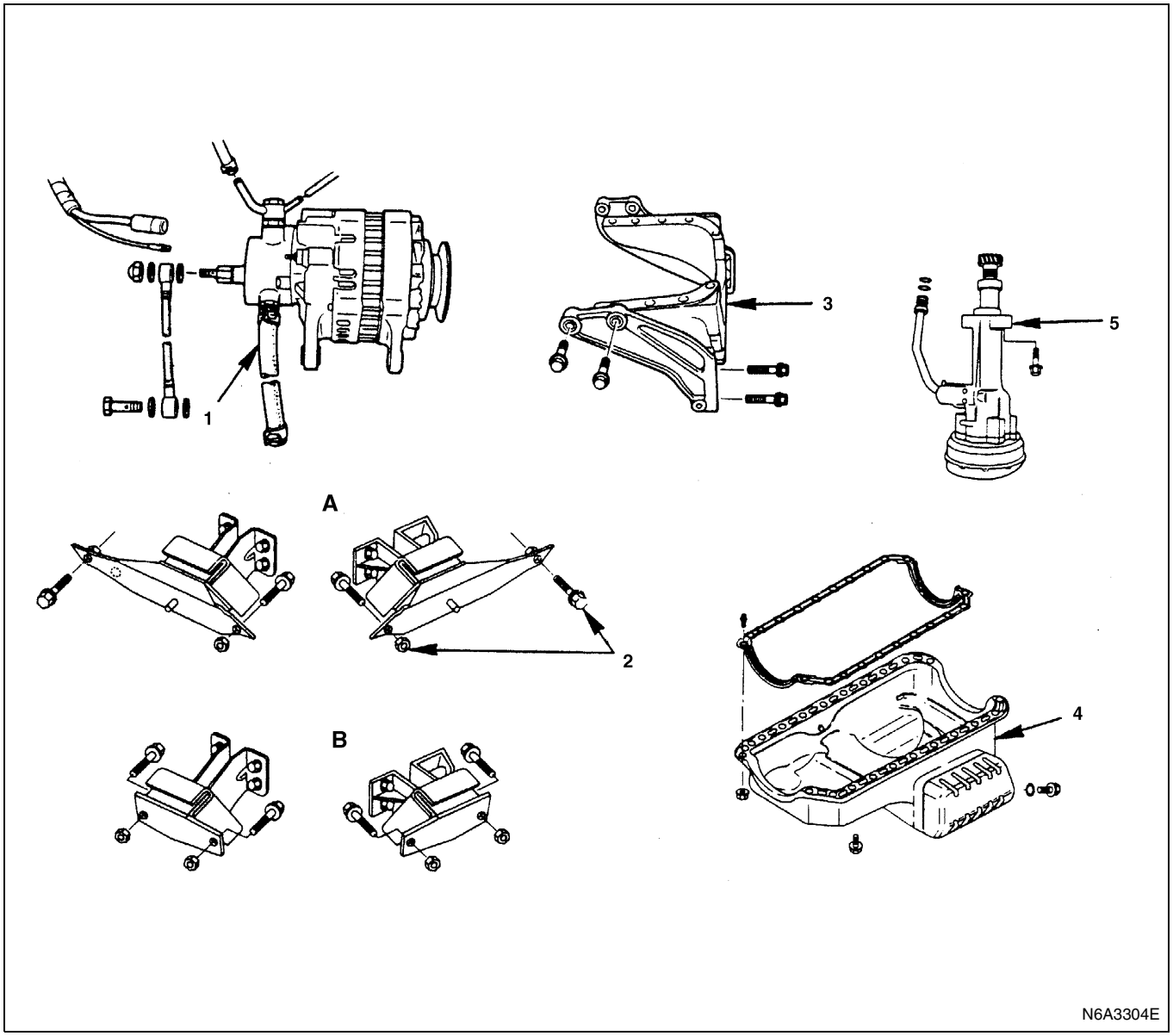
3. Engine Mount Bolts
   - Install the mount bolts and tighten to the specified torque.

Tighten:
- Mount bolt to 40 N·m (4.1 kg·m / 30 lb·ft)
  - Install the oil hose to oil pan.

4. Vacuum Pump Oil Hose
   - Pour engine oil
   - Connect battery ground cable.
   - Start the engine and check coolant leakage.

OIL PUMP ASSEMBLY

Component



Legend

A. Independent suspension (4 × 2)
B. Rigid suspension (4 × 2)
1. Vacuum pump oil hose
2. Engine mount bolts
3. Stiffener and space rubber
4. Oil pan assembly
5. Oil pump assembly

Removal

Preparation

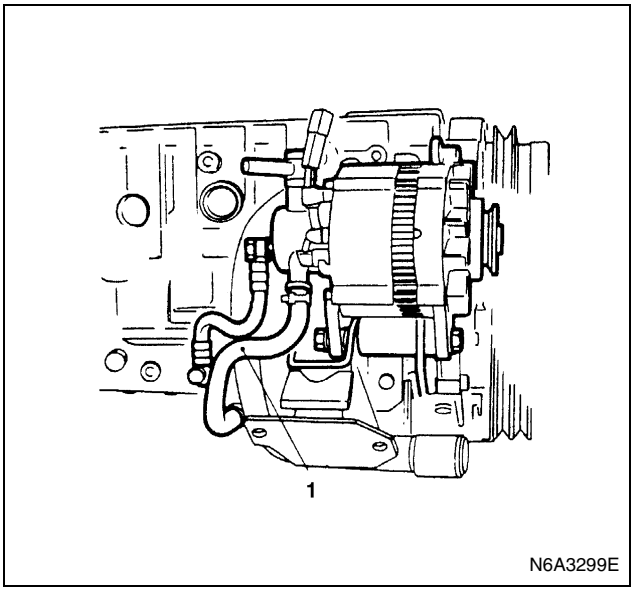
- Disconnect battery ground cable.
- Lift up car.
- Drain engine oil.

Notice:
Install drain plug with new washer.

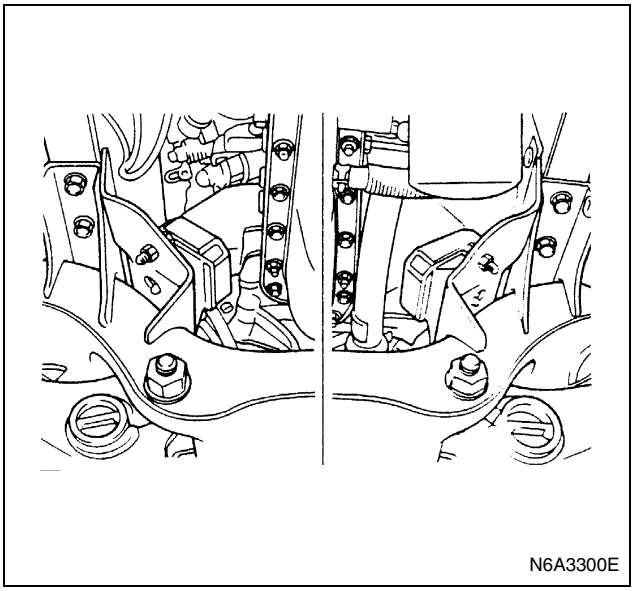
Tighten:

- 44 N·m (4.5 kg·m / 33 lb·ft)

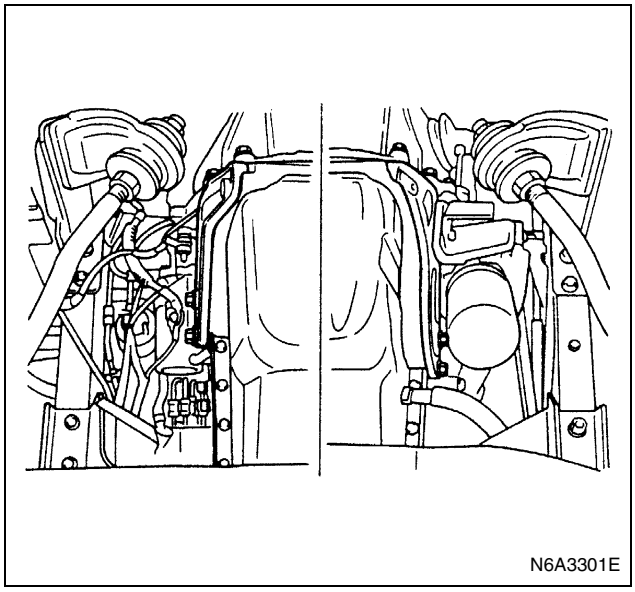
1. Vacuum Pump Oil Hose
   - Remove the oil hose (1) from oil pan.



2. Engine Mount Bolts
   - Remove the engine mount bolts right & left side.



3. Stiffener & Space Rubber
   - Remove the exhaust pipe bracket.
   - Remove the stiffener from of the oil pan left & right side.
   - Take out space rubber.



4. Oil Pan Assembly
   - Raise the engine about 50mm.
   - Remove the oil pan from cylinder block.
5. Oil Pump Assembly
   - Remove the oil pump from cylinder block.

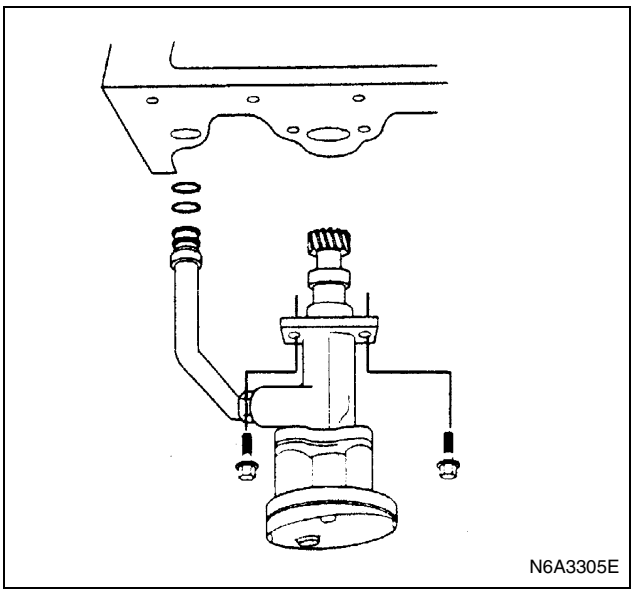
Installation

- Prepare a solution of 80% engine oil and 20% molybdenum disulfide.
- Apply and ample coat of the solution to the teeth of the oil pump pinion.

1. Oil Pump Assembly
   - Apply engine oil to oil pipe O-ring and insert the O-ring in O-ring hold on cylinder block.
   - Install oil pump asm with oil pipe in cylinder block and tighten fixing bolts to the specified torque.

Tighten:
- 19 N·m (1.9 kg·m / 14 lb·ft)
  - Tighten sleeve nut to the specified torque.

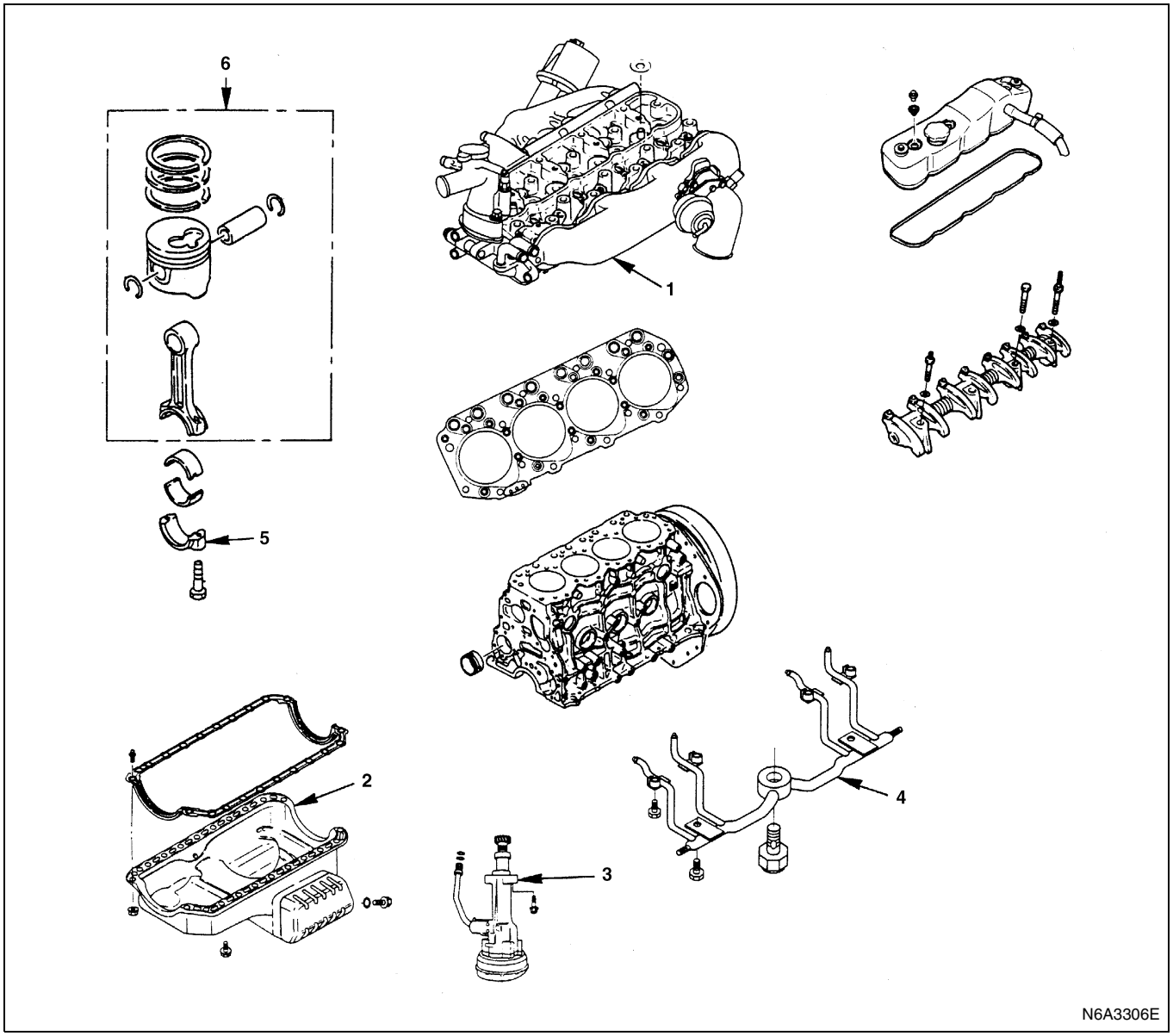
Tighten:
- 25 N·m (2.5 kg·m / 18 lb·ft)



2. Oil Pan Assembly
3. Stiffener & Space Rubber
4. Engine Mount Bolts
5. Vacuum Pump Oil Hose
   Above works refer to “OIL PAN” Section in this manual.

PISTON, PISTON RING AND CONNECTING ROD

Component



Legend

1. Cylinder head assembly
2. Oil pan assembly
3. Oil pan assembly
4. Piston cooling oil pipe
5. Connecting rod bearing cap
6. Piston and connecting rod assembly

Removal

Preparation

- Disconnect battery ground cable
- Drain coolant
- Drain engine oil

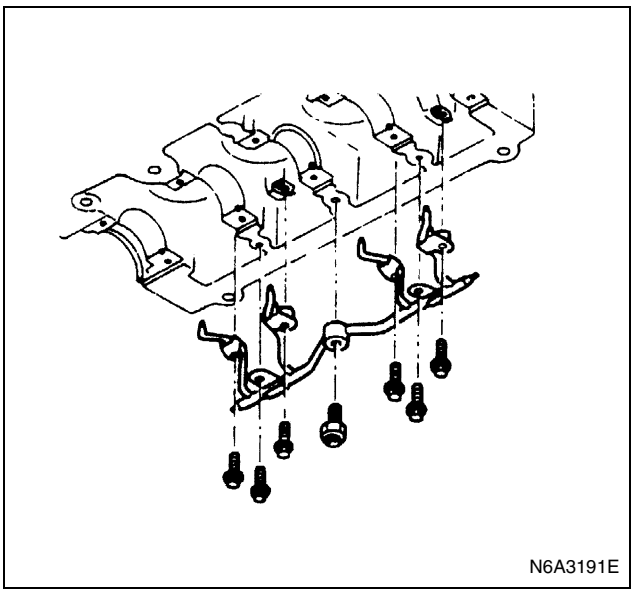
Notice:
Install drain plug with new washer.

Tighten:
- 44 N·m (4.5 kg·m / 33 lb·ft)

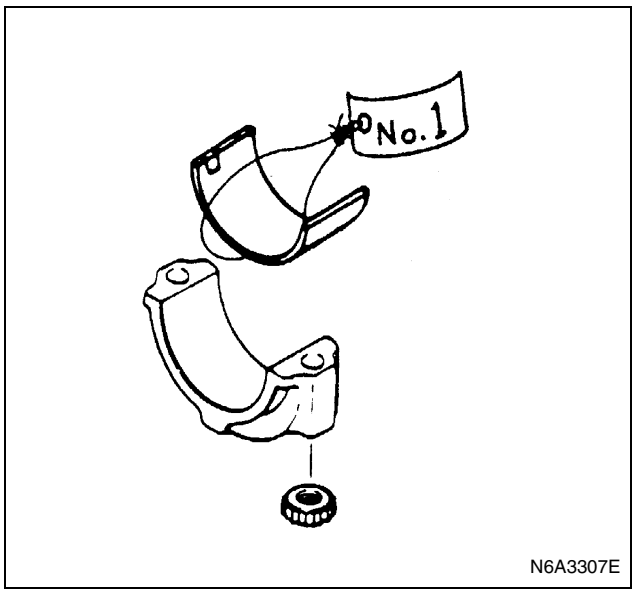
1. Cylinder Head Assembly
   1) Radiator hose upper
   2) Heater hose
   3) A/C compressor drive belt
   4) Engine harness
   5) Air intake duct
   6) Injection pipe
   7) Leak off pipe
   8) PCV hose
   9) Glow plug harness

10) Oil level gauge guide tube
11) Oil cooler water pipe (Oil Cooler Model)
12) A/C compressor assembly (A/C Model)
13) Vacuum actuator hose (Exhaust Brake Model)
14) Front exhaust pipe
15) By-pass hose
16) Cylinder head cover
17) Rocker arm shaft
18) Push rod
19) Cylinder head assembly
20) Cylinder head gasket
Above works refer to “CYLINDER HEAD ASSEMBLY AND GASKET” Section in this manual.

2. Oil Pan Assembly
   1) Vacuum pump oil hose
   2) Engine mount bolt
   3) Stiffener and spacer rubber
   4) Oil pan
   Above works refer to “OIL PAN” Section in this manual.
3. Oil Pump Assembly
4. Piston Cooling Oil Pipe
   • Remove the relief valve and oil pipe.

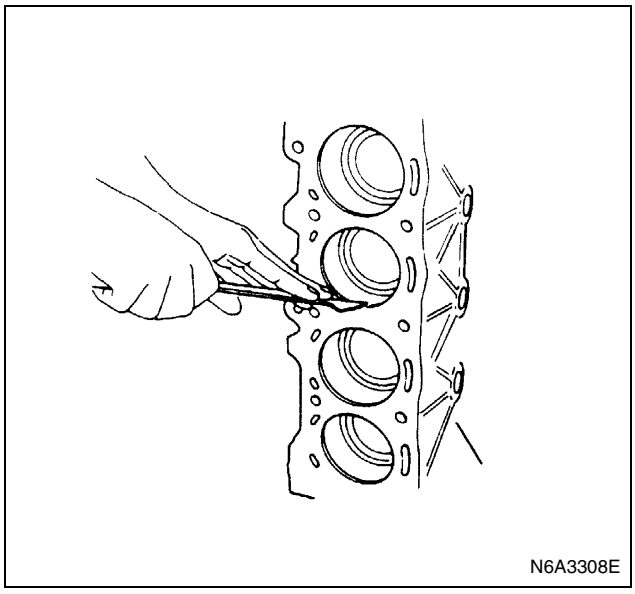

N6A3191E

5. Connecting Rod Bearing Cap
   • If the connecting rod lower bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.

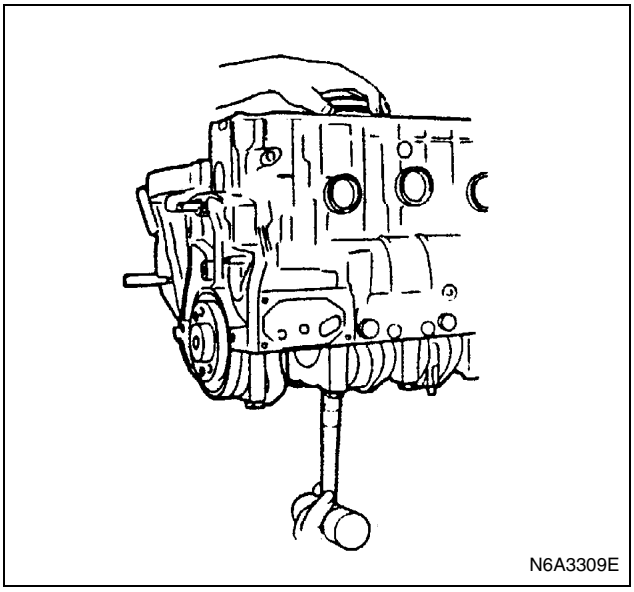


N6A3307E

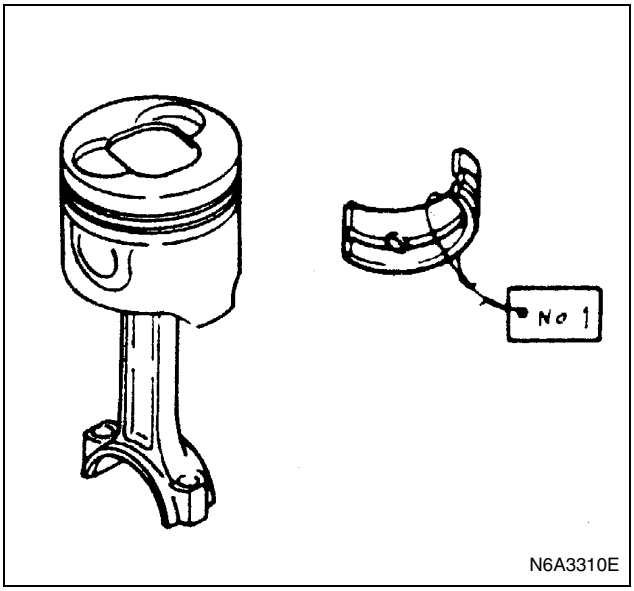
6. Piston and Connecting Rod Assembly
   1) Remove carbon deposits from the upper portion of the cylinder wall with a scraper before removing the piston and connecting rod.


N6A3308E

   2) Move the piston to the top of the cylinder and tap it with a hammer grip or similar object from the connecting rod lower side to drive it out.

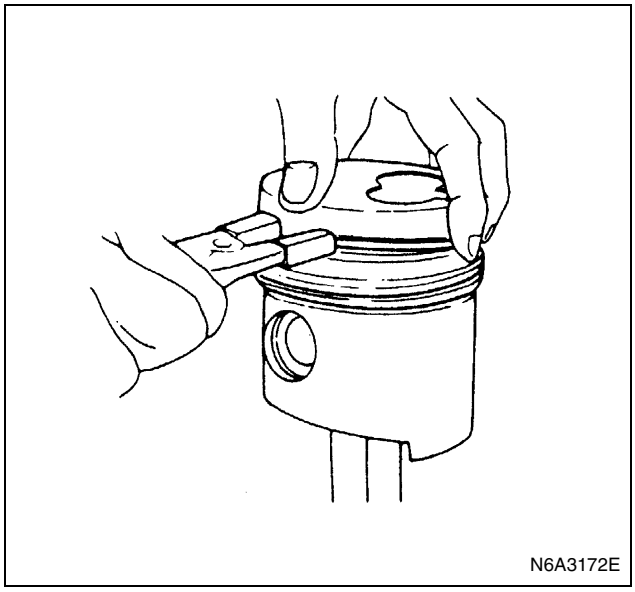

N6A3309E

3) If the connecting rod upper bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.

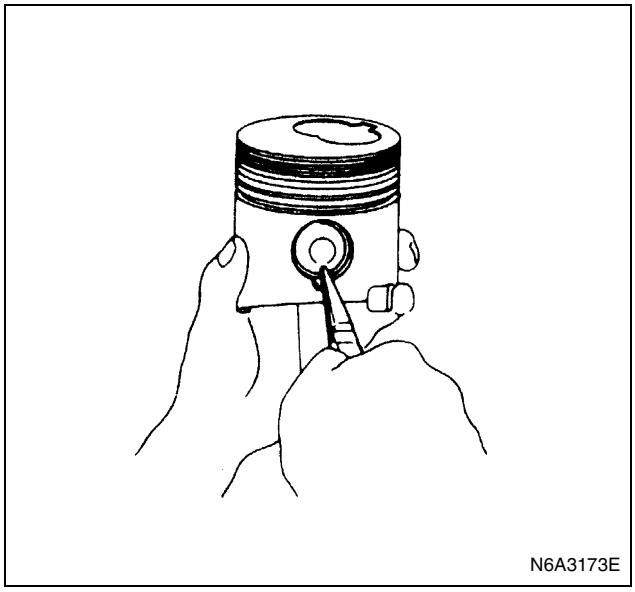


N6A3310E

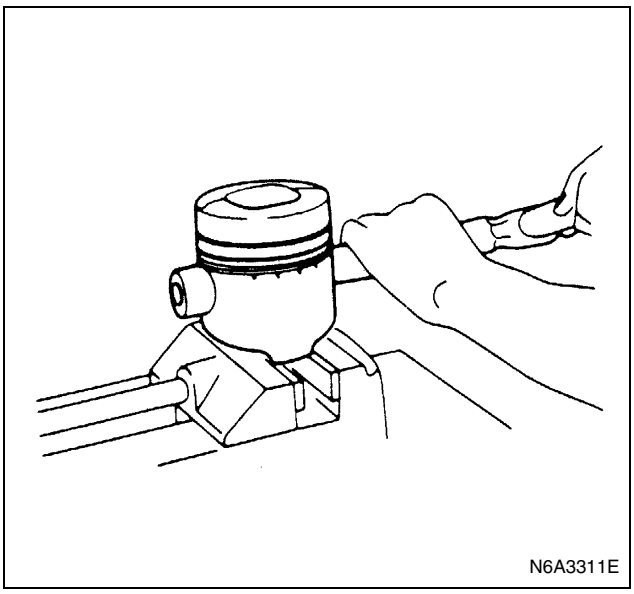
4) Clamp the connecting rod in a vise.
Take care not to damage the connecting rod.
Use a piston ring replacer to remove the piston rings.
Piston Ring Replacer
Do not attempt to use some other tool to remove the piston rings. Piston ring stretching will result in reduced piston ring tension.


N6A3172E

5) Use a pair of pliers to remove the piston pin snap rings.


N6A3173E

6) Tap the piston pin out with a hammer and a brass bar. If the pistons and piston pins are to be reinstalled, mark their installation positions by tagging each piston and piston pin with the cylinder number from which it was removed.

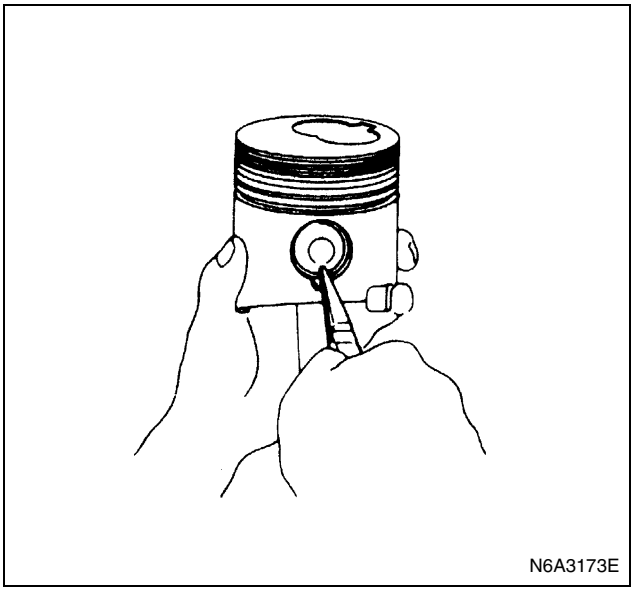

N6A3311E

Installation

1. Piston and Connecting Rod Assembly
   1) Try to insert the piston pin into the piston pin hole with normal finger pressure.
      Weigh each piston and connecting rod assembly.
      Select piston and connecting rod combinations so that the weight variation of the different assemblies is held within the specified limits.

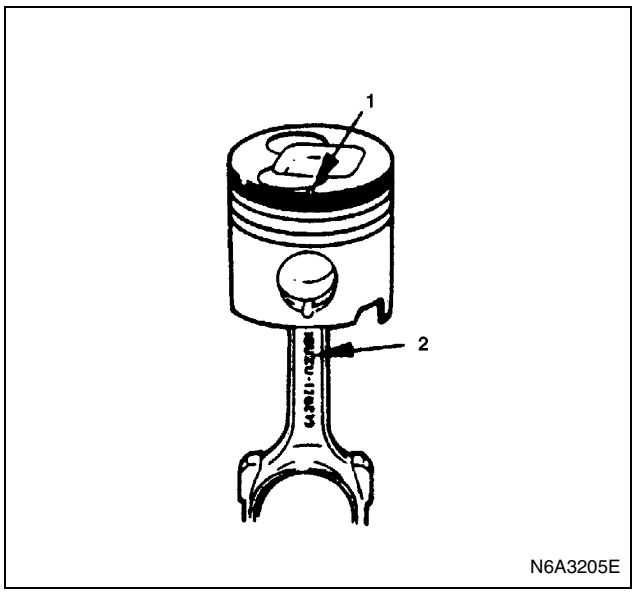
	g (oz)
Variance in weight	Less than
after assembly	3 (0.1058)

   2) Clamp the connecting rod in a vise.
      Take care not to damage the connecting rod.
   3) Use a pair of pliers to install the piston pin snap ring to the piston.


N6A3173E

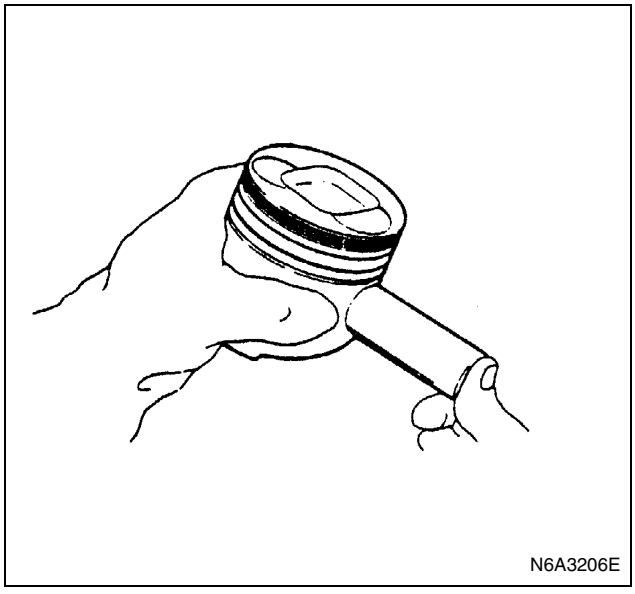
Notice:
When changing piston/connecting rod combinations, do not change the piston/piston pin combination.

   4) Install the piston to the connecting rod.
      The piston head front mark (1) and the connecting rod “ISUZU” casting mark (2) must be facing the same direction.

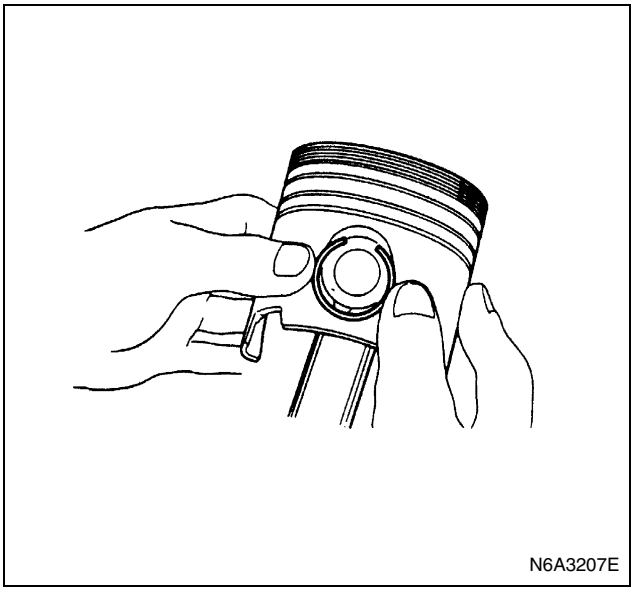


N6A3205E

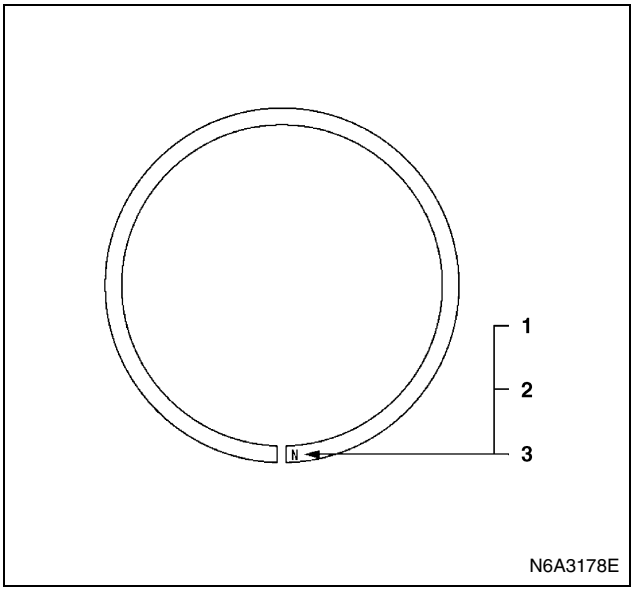
   5) Apply a coat of engine oil to the piston pin and the piston pin hole.
      Use your fingers to force the piston pin into the piston until it makes contact with the snap ring.


N6A3206E

   6) Use your fingers to force the piston pin snap ring into the piston snap ring groove.
      Check that the connecting rod moves smoothly on the piston pin.


N6A3207E

7) Install the piston rings with the piston ring expander.
The compression ring must be set with the 1N, 2N, R mark facing up.
Discrimination mark is painted as shown in the illustration.

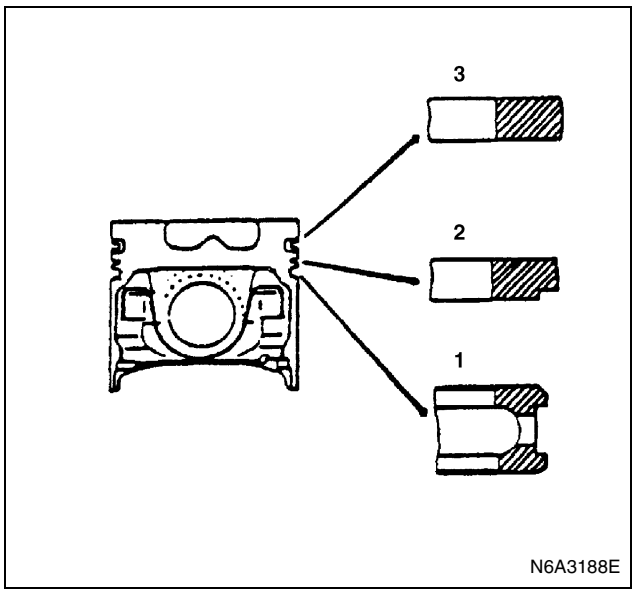


N6A3178E

Legend
1. N mark (Top ring) (2nd ring) (4JB1)
2. 1N mark (Top ring) 2N mark (2nd ring) (4JG2)
3. R mark (Top ring) (2nd ring) (4JH1-TC)

8) Use a piston ring replacer to install the three piston rings.
Piston Ring Replacer
Install the piston rings in the numerical order shown in the illustration.

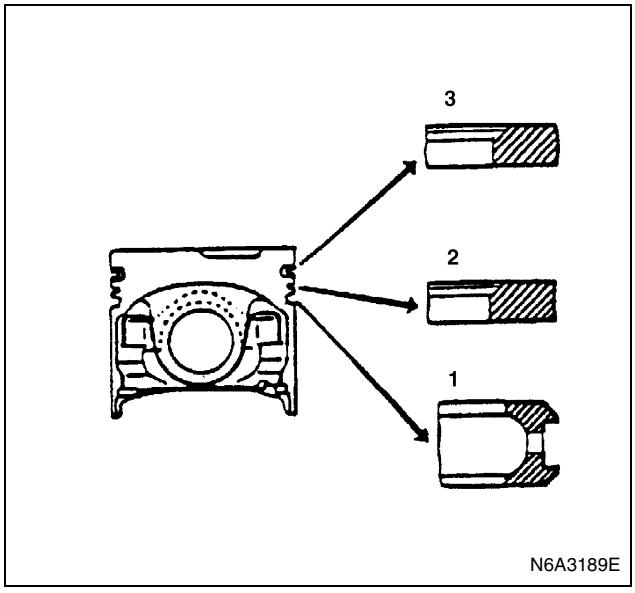
4JH1-TC, 4JB1



N6A3188E

Legend
1. Oil ring
2. 2nd compression ring
3. 1st compression ring

4JG2



N6A3189E

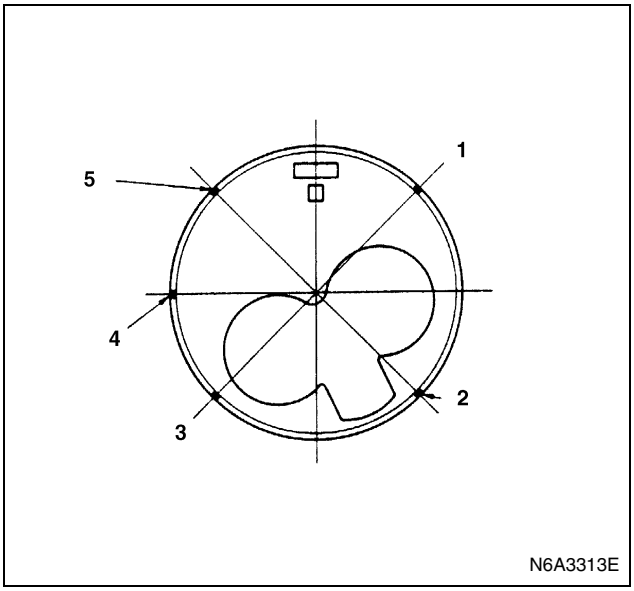
Legend
1. Oil ring
2. Compression ring No. 2
3. Compression ring No. 1

Notice:
Install the compression rings with the stamped side facing up.

Insert the expander coil into the oil ring groove so that there is no gap on either side of the expander coil before installing the oil ring.

9) Apply engine oil to the piston ring surfaces.

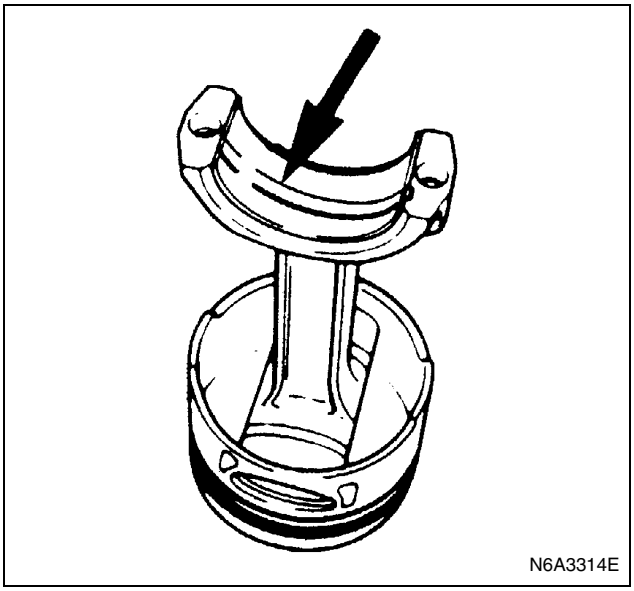
10) Check that the piston rings rotate smoothly in the piston ring grooves.
11) Position the piston ring gaps as shown in the illustration.



Legend

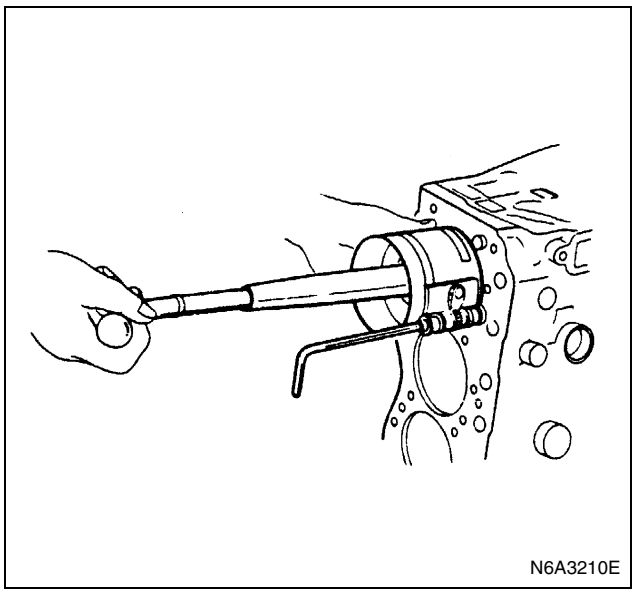
1. Expand ring
2. No. 1 compression ring
3. Oil ring
4. Front mark
5. No. 2 compression ring

12) Carefully wipe any oil or other foreign material from the connecting rod bearing back face and the connecting rod bearing fitting surface.

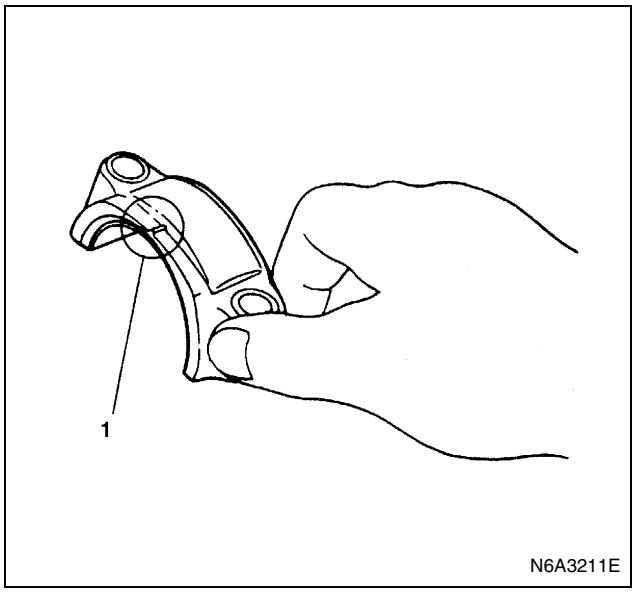


13) Apply a coat of engine oil to the upper bearing surfaces.
Apply a coat of engine oil the cylinder wall.

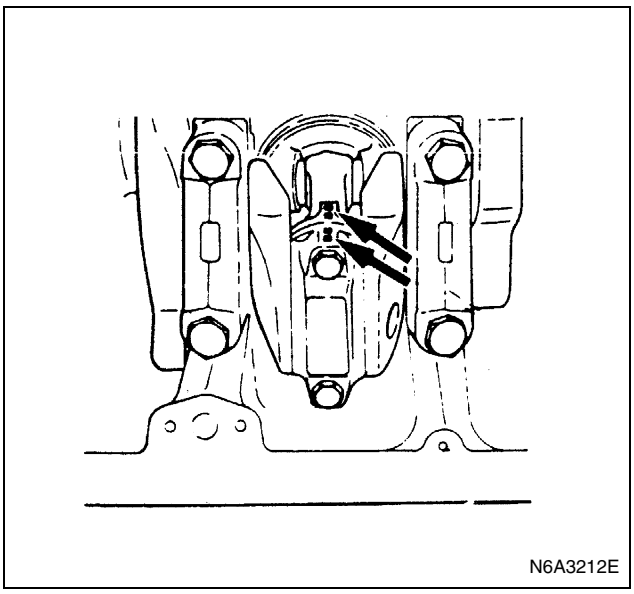
14) Position the piston head front mark so that it is facing the front of the engine.
Use the piston ring compressor to compress the piston rings.
Piston Ring Compressor: 5-8840-9018-0(J-8037)
15) Use a hammer grip to push the piston in until the connecting rod makes contact with the crankpin.
At the same time, rotate the crankshaft until the crankpin is at BDC.



2. Connecting Rod Bearing Cap
   1) Position the bearing cap front mark (1) so that it is facing the front of the engine.



   2) Install the connecting rod bearing caps.
   Align the bearing cap cylinder number marks and the connecting rod cylinder number marks.
   3) Apply a coat of engine oil to the threads and setting faces of each connecting rod cap bolt.


N6A3212E

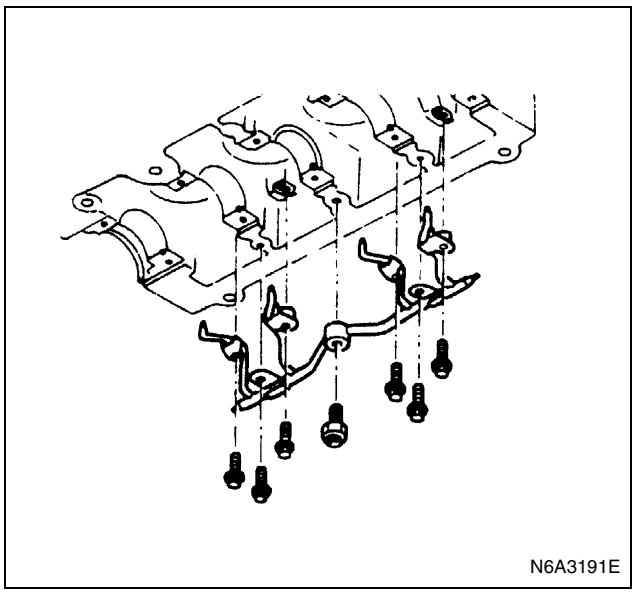
4) Tighten the connecting rod bearing cap bolts to the specified torque in two steps using the Angular Tightening Method.

Tighten:
- 4JB1-TC, 4JG2, 4JH1-TC
  Connecting rod bearing cap bolt to
  1st step: 29 N·m (3.0 kg·m / 22 lb·ft)
  2nd step: 45° — 60°
- 4JB1
  Connecting rod bearing cap bolt to
  83 N·m (8.5 kg·m / 61 lb·ft)

Notice:
Check to see that the crankshaft turns smoothly by rotating it manually.

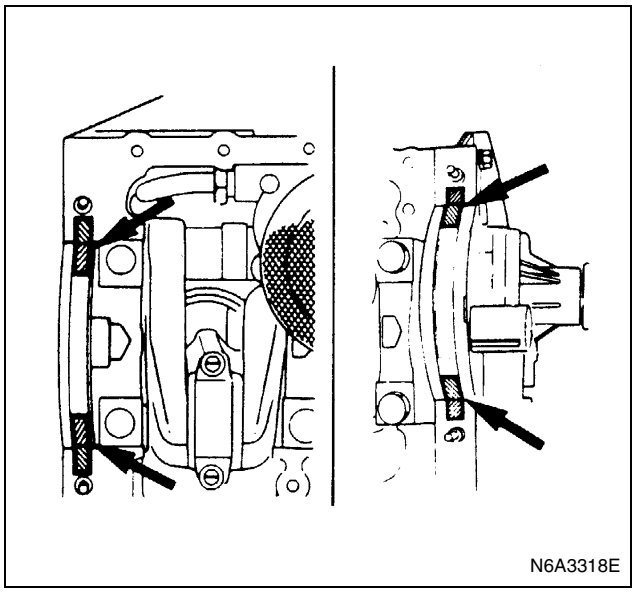
3. Piston Cooling Oil Pipe
   1) Install the piston cooling oil pipe to the cylinder body.
   2) Tighten the oil pipe bolts and relief valve to the specified torque.

Tighten:
- Oil pipe bolt to
  M8 × 1.25: 19 N·m (1.9 kg·m / 14 lb·ft)
  M6 × 1.00: 8 N·m (0.8 kg·m / 69 lb·in)
- Oil pressure regulating valve to
  M6 × 1.5: 29 N·m (3.0 kg·m / 22 lb·ft)

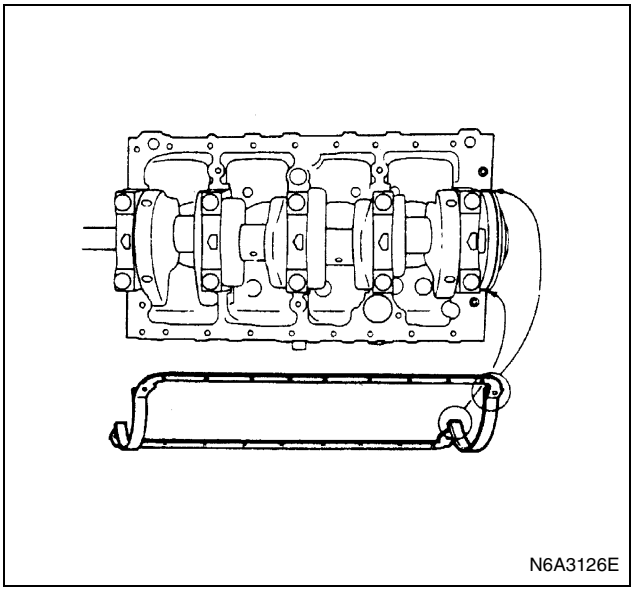

N6A3191E

Notice:
Check that there is no interference between the piston and the oiling jet pipe by slowly rotating the crankshaft.

4. Oil Pump Assembly
   Above works refer to “OIL PUMP” Section in this manual.
5. Oil Pan Assembly
   1) Apply the recommended liquid gasket or its equivalent to the No.5 bearing cap arches, the grooves, and the timing gear case arches at the positions shown in the illustration.


N6A3318E

2) Fit the gasket rear lipped portion into the No.5 groove. Be absolutely sure that the lipped portion is fitted snugly into the groove.

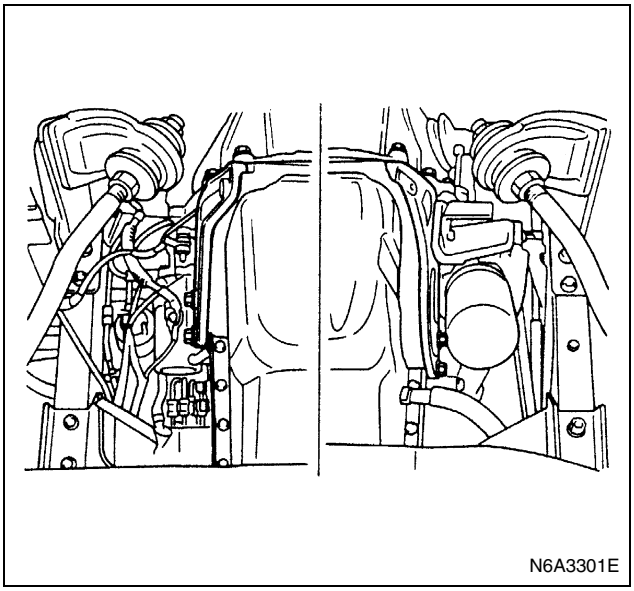

N6A3126E

3) Install the oil pan to the cylinder body.
   - Tighten the oil pan bolts to the specified torque.

Tighten:
- Oil pan bolts to 19 N·m (1.9 kg·m / 14 lb·ft)

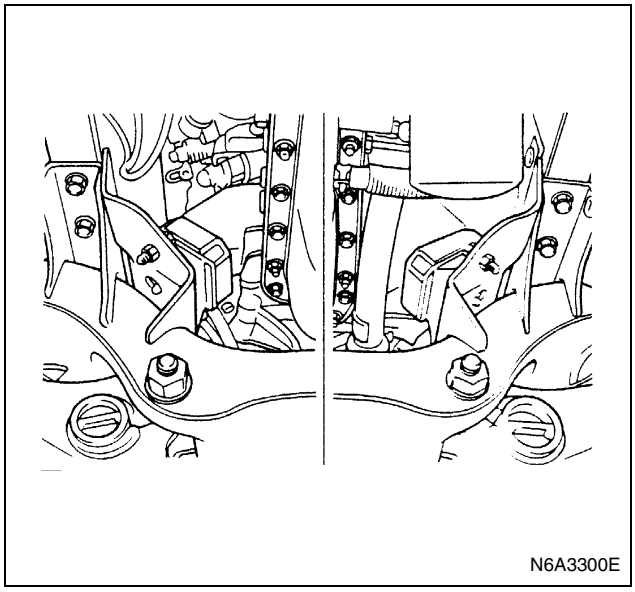
4) Install the space rubber and stiffener (right & left side) then tighten bolts to the specified torque.

Tighten:
- Engine body side stiffener bolts to 37 N·m (3.8 kg·m / 27 lb·ft)
- Clutch housing side stiffener bolts to 78 N·m (8.0 kg·m / 58 lb·ft)

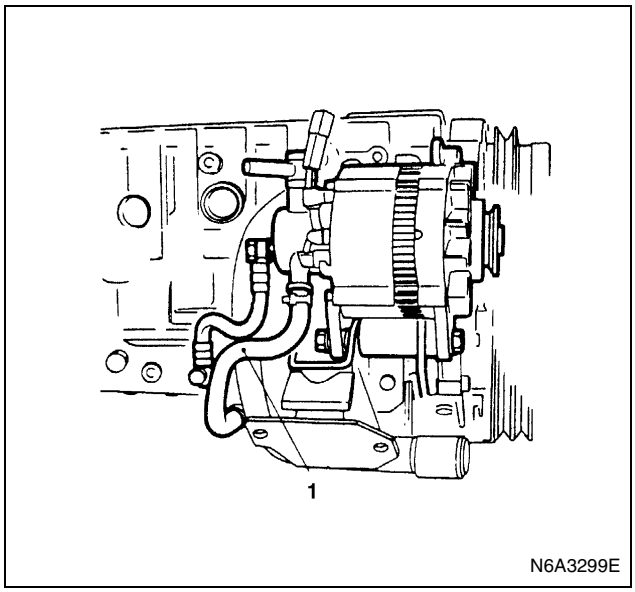

N6A3301E

5) Install the exhaust pipe bracket.
6) Install the support rubber and tighten nuts to the specified torque.

Tighten:
- Support rubber nut to 40 N·m (4.1 kg·m / 30 lb·ft)


N6A3300E

7) Install the vacuum pump oil hose (1) to oil pan.



N6A3299E

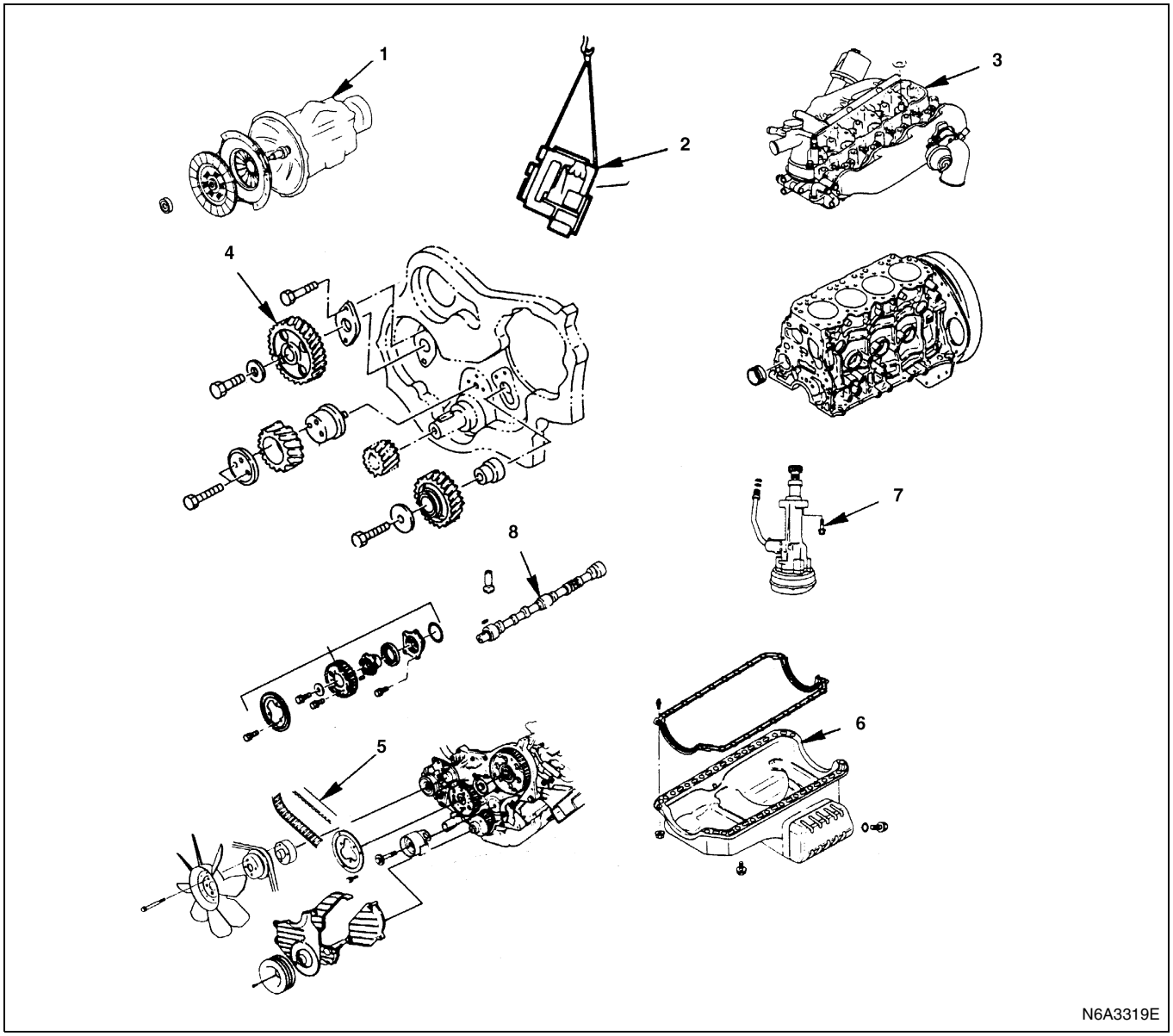
6. Cylinder Head Assembly
   1) Cylinder head gasket
   2) Cylinder head assembly
   3) Push rod
   4) Rocker arm shaft
   5) Valve clearance adjustment
   6) Cylinder head cover
   7) By-pass hoses
   8) Front exhaust pipe
   9) Vacuum actuator hose (Exhaust Brake Model)
   10) A/C compressor assembly (A/C Model)
   11) Oil cooler water pipe (Oil Cooler Model)
   12) Oil level gauge guide tube
   13) Glow plug harness
   14) PCV hose
   15) Leak off pipe
   16) Injection pipe
   17) Air intake duct

18) Engine harness
19) A/C compressor drive belt (With A/C Model)
20) Heater hose

Above works refer to “CYLINDER HEAD ASSEMBLY AND GASKET” Section in this manual.

CAMSHAFT AND TAPPET

Component



Legend

1. Transmission and clutch assembly
2. Engine assembly
3. Cylinder head assembly and gasket
4. Timing gear (Gear drive model)
5. Timing belt (Belt drive model)
6. Oil pan
7. Oil pump
8. Camshaft and tappets

Removal

Preparation

- Disconnect battery ground cable.
- Drain coolant.
- Drain engine oil.

Notice:
Install drain plug with new washer.

Tighten:

- Drain plug to 83 N·m (8.5 kg·m / 61 lb·ft)

1. Transmission and Clutch Assembly
   1) Transmission
   2) Clutch
2. Engine Assembly
   1) Radiator assembly
   2) Intake air duct
   3) Heater hose

4) Engine control cable
5) Glow plug harness
6) Fuel hose
7) Oil pressure switch harness
8) A/C compressor assembly (A/C Model)
9) Power steering pump & bracket assembly (Power steering Model)
10) Actuator vacuum hose (Exhaust Brake Model)
11) Vacuum pump hose (Exhaust Brake Model)
12) Front exhaust pipe
13) Support rubber
14) Engine assembly
Above works refer to “ENGINE ASSEMBLY” Section in this manual.

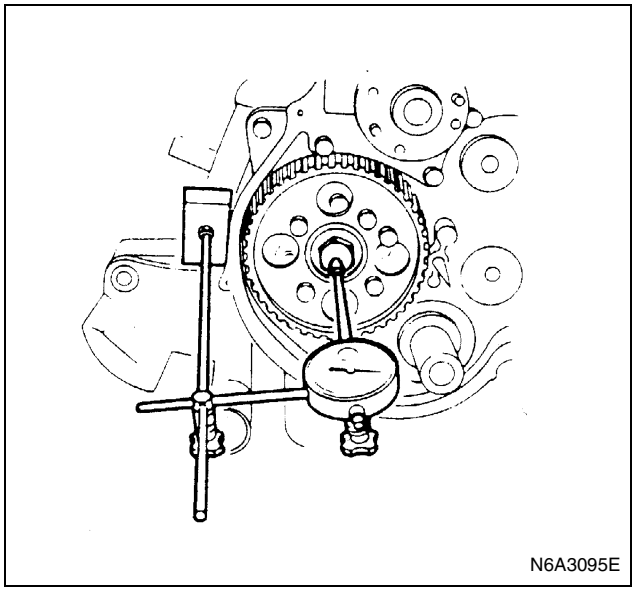
3. Cylinder Head Assembly and Gasket
1) Injection pipe
2) Leak off pipe
3) PCV hose
4) Glow plug harness
5) Oil level gauge guide tube
6) Oil cooler water pipe (Oil Cooler Model)
7) By-pass hose
8) Cylinder head cover
9) Rocker arm shaft
10) Push rod
11) Cylinder head assembly
12) Cylinder head gasket
Above works refer to “CYLINDER HEAD ASSEMBLY AND GASKET” Section in this manual.

4. Timing Gear (Gear Drive Model)
1) Cooling fan assembly
2) Crankshaft damper pulley
3) Noise shield cover
4) Noise cover spacer
5) Timing gear case cover
6) Camshaft timing gear
Above works refer to “TIMING GEAR (Gear Type)” Section in this manual.

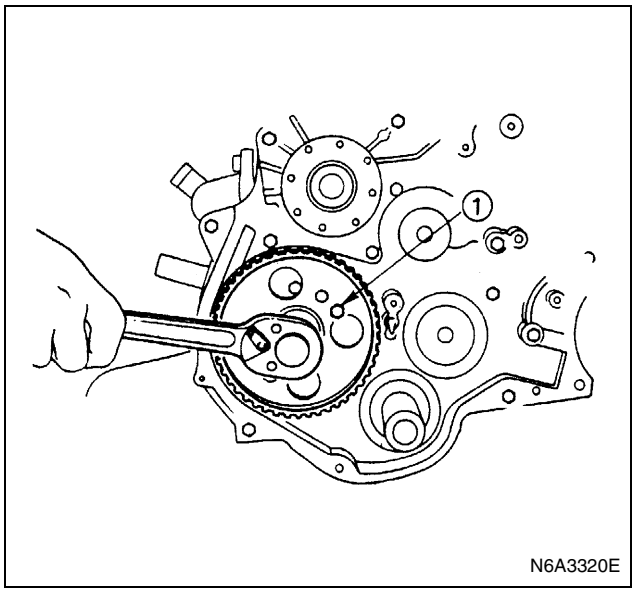
5. Timing Belt (Belt Drive Model)
1) Cooling fan assembly
2) Crankshaft damper pulley
3) Timing pulley upper cover
4) Timing pulley lower cover
5) Flange: camshaft pulley
6) Flange: injection pump pulley
7) Timing belt
Above works refer to “TIMING BELT (Belt Type)” Section in this manual.
8) Camshaft timing pulley

• Use a dial indicator to measure the camshaft end play.
This must be done before removing the oil pump.
If the camshaft end play exceeds the specified limit, the camshaft and/or the driven gear must be replaced.

Camshaft End Play	mm (in)
Standard	Limit
0.08 (0.003)	0.20 (0.008)

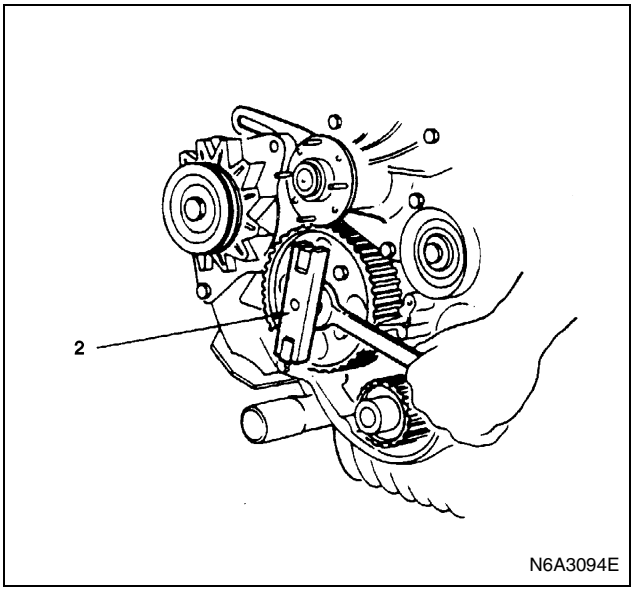

N6A3095E

• Install the stopper bolt (1) to the timing pulley to prevent the pulley from turning.
• Loosen the center bolt.

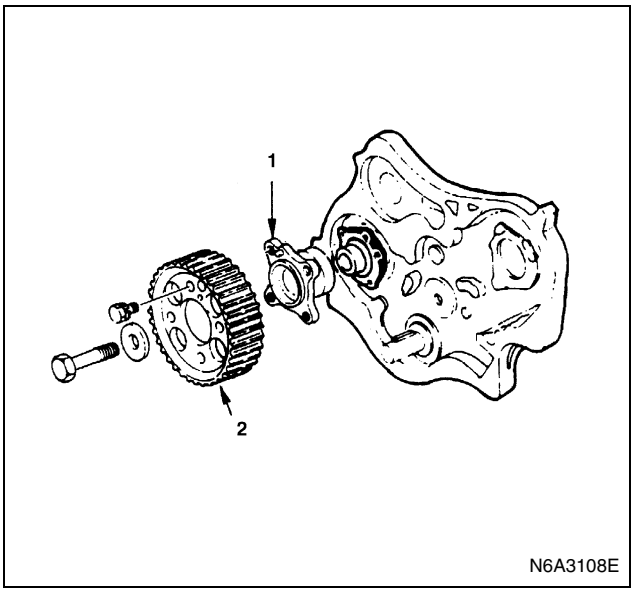


N6A3320E

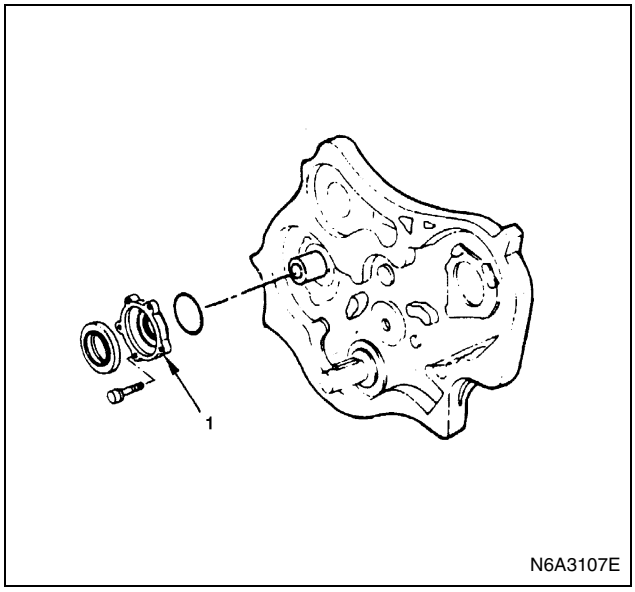
• Use the timing pulley puller (2) to remove the pulley.
Timing Pulley Puller: 5-8840-0086-0



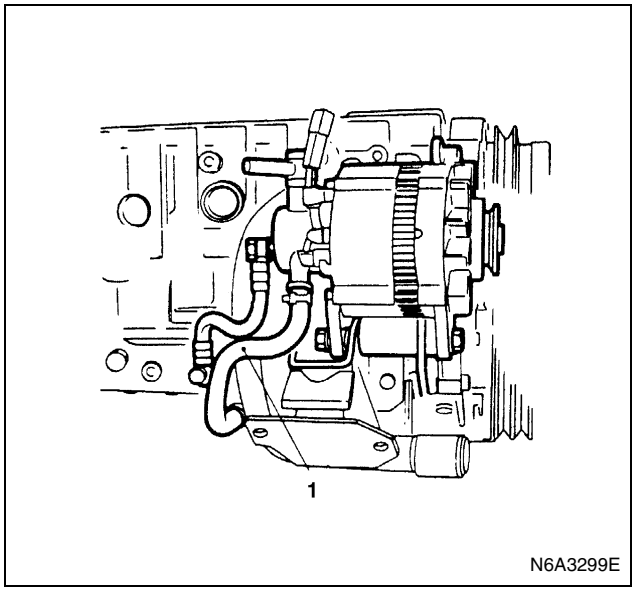
- Remove the stopper bolt.
- Remove the center bolt and remove the timing pulley (2) with pulley center (1).



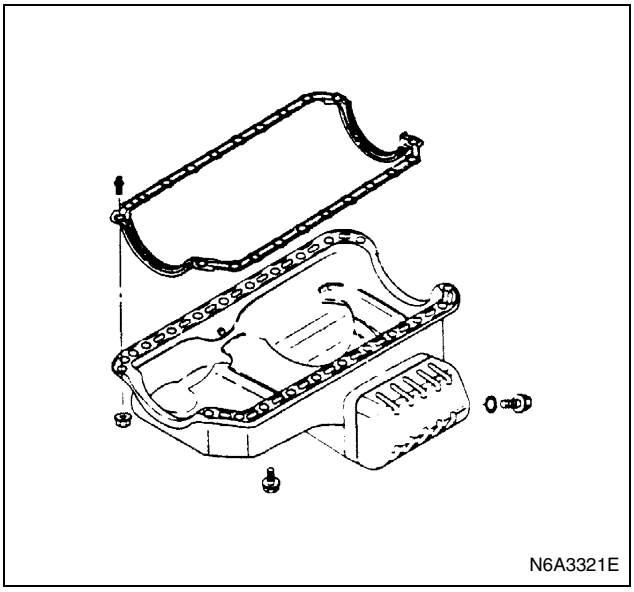
- Remove the oil seal retainer (1).



6. Oil Pan Assembly
   - Disconnect vacuum pump oil hose (1) from oil pan.

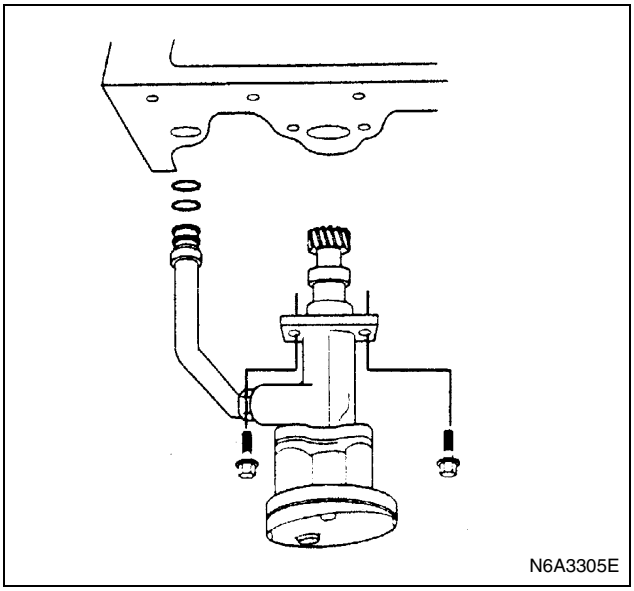


- Remove the stiffener and space rubber from oil pan both side.


N6A3321E

- Remove the oil pan bolts and remove oil pan from cylinder body.

7. Oil Pump Assembly
   - Remove the oil pump assembly from cylinder body.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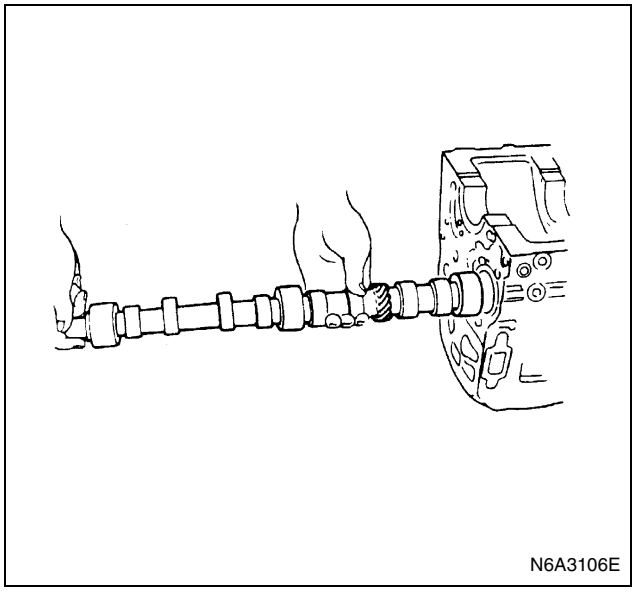
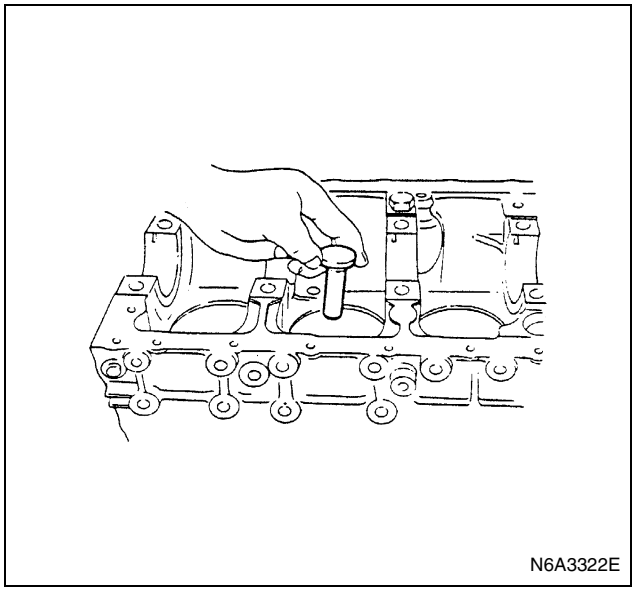
8. Camshaft and Tappets
   - Remove the camshaft from cylinder body.


N6A3106E

- Take care not to damage the camshaft bearings.
- Take out the tappets from cylinder body.

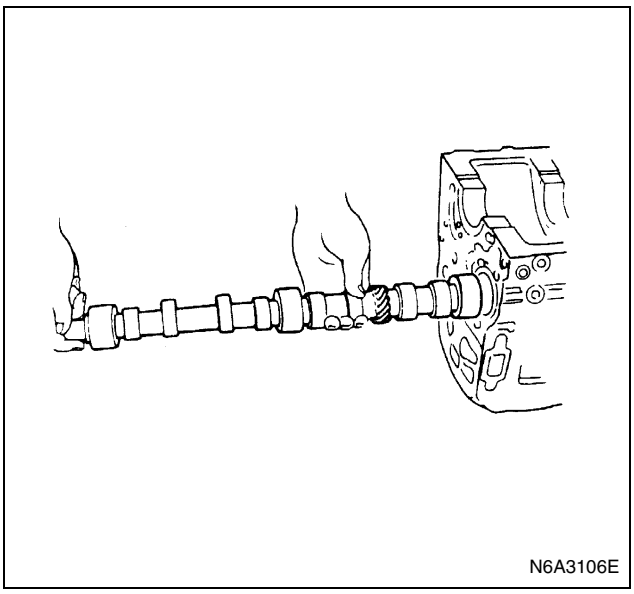

N6A3322E

Installation

1. Camshaft and Tappets
   - Apply a coat of engine oil to the tappet and the cylinder body tappet insert holes.
   - Locate the position mark applied at disassembly (if the tappet is to be reused).

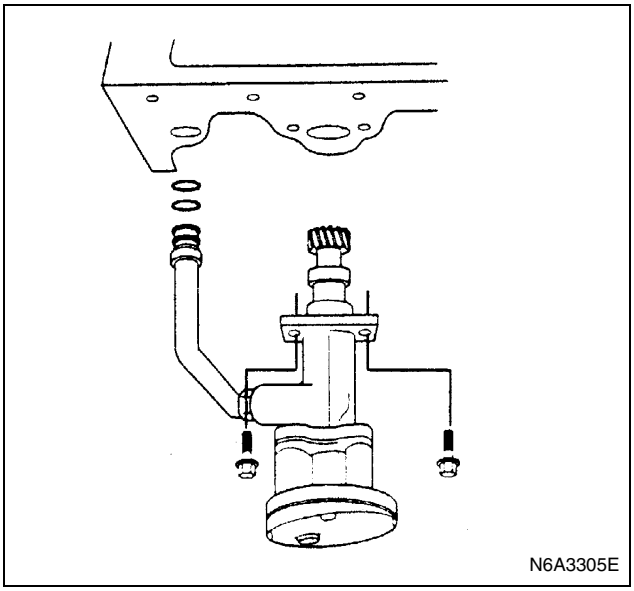
Notice:
The tappet must be installed before the camshaft.

- Apply a coat of engine oil to the camshaft and the camshaft bearings.
- Install the camshaft to the cylinder body.
  Take care not to damage the camshaft bearings.


N6A3106E

2. Oil Pump Assembly
   - Prepare a solution of 80% engine oil and 20% molybdenum disulfide.
   - Apply and ample coat of the solution to the teeth of the oil pump pinion.
   - Apply engine oil to oil pipe O-ring and insert the O-ring in O-ring hold on cylinder block.
   - Install oil pump asm with oil pipe in cylinder block and tighten fixing bolts to the specified torque.

Tighten:
- Oil pump bolt to 19 N·m (1.9 kg·m / 14 lb·ft)


N6A3305E

   - Tighten sleeve nut to the specified torque.

Tighten:
- Oil pump bolt to 25 N·m (2.5 kg·m / 18 lb·ft)

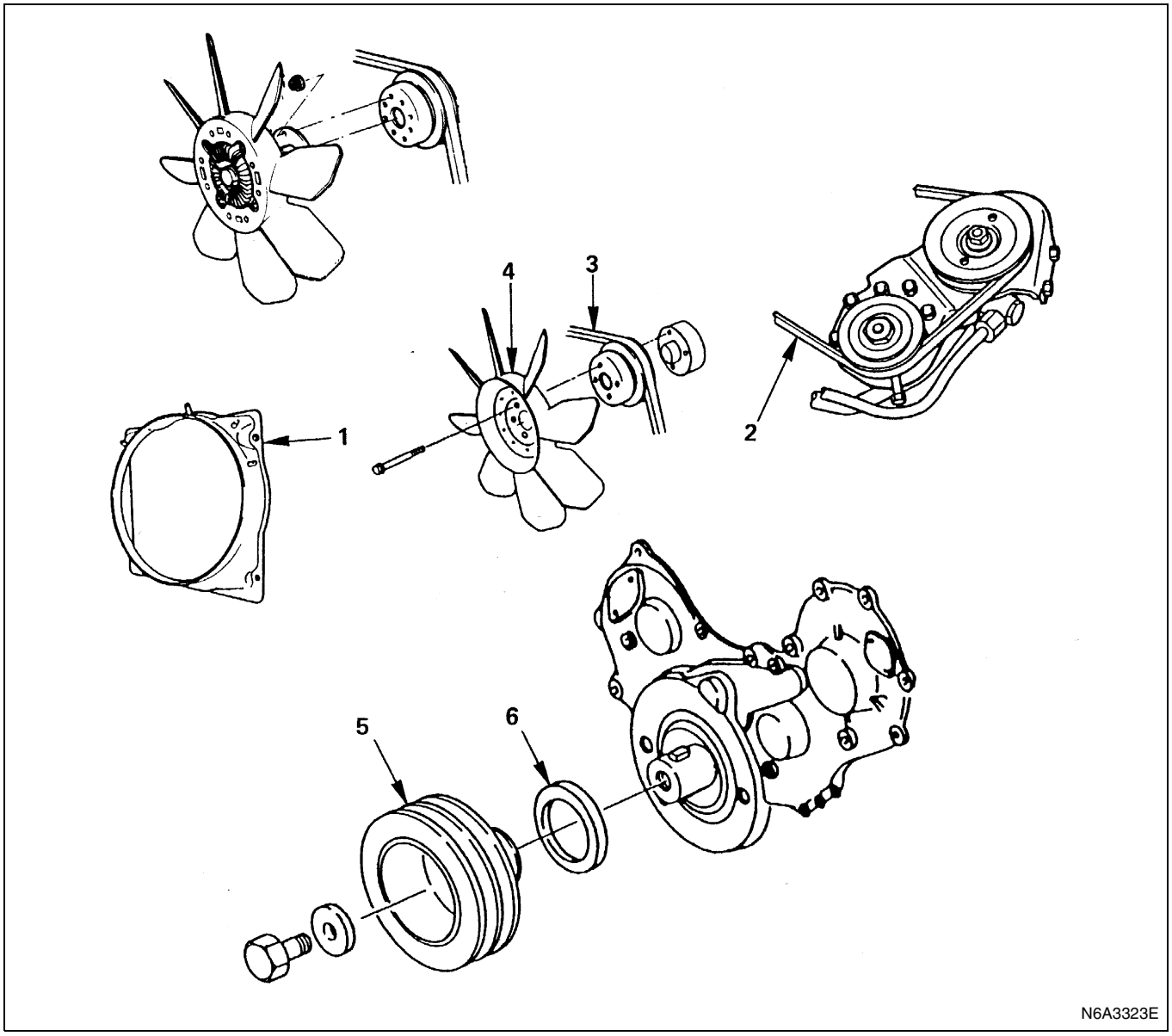
3. Oil Pan Assembly
   Above works refer to “OIL PAN” Section in this manual.
4. Timing Belt
   1) Camshaft timing pulley
   2) Timing belt
   3) Flange: injection pump pulley
   4) Flange: camshaft pulley
   5) Timing pulley lower cover
   6) Timing pulley upper cover
   7) Crankshaft damper pulley
   8) Cooling fan assembly
   Above works refer to “TIMING BELT (Belt Type)” Section in this manual.
5. Timing Gear (Gear Type)
   1) Camshaft timing gear
   2) Timing gear case cover
   3) Noise cover spacer
   4) Noise shield cover
   5) Crankshaft damper pulley
   6) Cooling fan assembly
   Above works refer to “TIMING GEAR (Gear Type)” Section in this manual.
6. Cylinder Head Assembly and Gasket
   1) Cylinder head gasket
   Piston Head Projection Measurement Point
   2) Cylinder head assembly
   3) Push rod
   4) Rocker arm shaft
   Valve Clearance Adjustment
   5) Cylinder head cover
   6) By-pass hose
   7) Oil cooler water pipe (Oil cooler Model)
   8) Oil level gauge guide tube
   9) Glow plug harness
   10) PCV hose
   11) Fuel leak off pipe
   12) Injection pipe
   Above works refer to “CYLINDER HEAD ASSEMBLY AND GASKET” Section in this manual.
7. Engine Assembly
   1) Engine assembly
   2) Support rubber
   3) Front exhaust pipe
   4) Vacuum pump hose
   5) Actuator vacuum hose
   6) Power steering pump & bracket assembly (With Power Steering Model)
   7) A/C compressor assembly (A/C Model)
   8) Oil pressure switch harness
   9) Fuel hose
   10) Glow plug harness
   11) Engine control cable
   12) Heater hose
   13) Intake air duct
   14) Radiator assembly
8. Transmission and Clutch Assembly

1) Clutch
2) Transmission
   Above works refer to “ENGINE ASSEMBLY” Section in this manual.

- Connect the battery ground cable.
- Pour coolant
- Pour engine oil
- Start the engine and check coolant leakage.

CRANKSHAFT FRONT OIL SEAL (Gear Drive Type)

Component



Legend

1. Fan shroud
2. Power steering pump drive belt
3. AC generator drive belt
4. Cooling fan assembly
5. Crankshaft damper pulley
6. Front oil seal

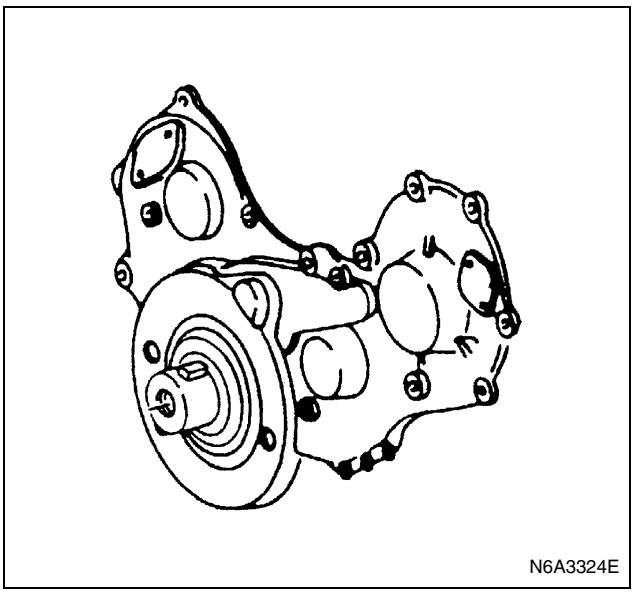
Removal

Preparation

- Disconnect battery ground cable.
- Drain coolant.

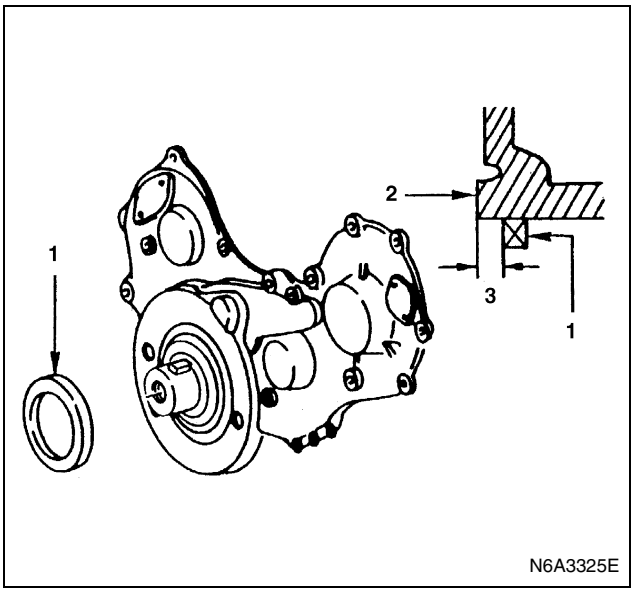
1. Fan Shroud
2. Power Steering Pump Drive Belt
   - Loosen power steering pump mounting bolt and adjust bolt, and remove the drive belt.
3. AC Generator Drive Belt
   - Loosen AC Generator mounting bolt (under side) and adjust plate lock bolt, and remove the drive belt.
4. Cooling Fan Assembly
   - Remove clamp nut, and remove cooling fan assembly, distant pipe, and fan pulley.
5. Crankshaft Damper Pulley

6. Front Oil Seal
   - Use a plastic hammer and a screwdriver to top around the oil seal to free it from the gear case cover.
     Take care not to damage the oil seal fitting surfaces.


N6A3324E

Installation

1. Front Oil Seal
   - Use the installer to install the front oil seal (1) to the gear case cover (2).
     Oil Seal Installer: 5-8840-2061-0
     Note the oil seal installation depth (3) shown in the illustration.
     Depth (3) = 1 mm (0.039 in.)



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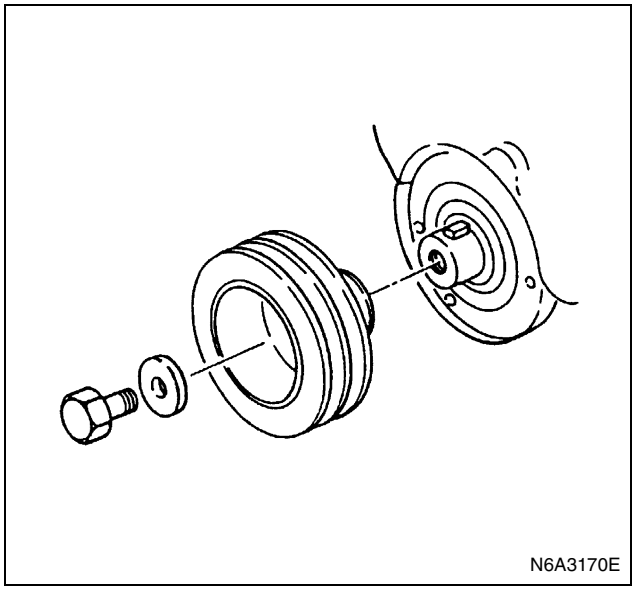
2. Crankshaft Damper Pulley
   Tighten the crankshaft damper pulley bolt to the specified torque.

Notice:
Hold the flywheel ring gear stationary to prevent the crankshaft from turning when tightening the damper pulley.

Tighten:
- Pulley boss bolt to 206 N·m (21 kg·m / 152 lb·ft)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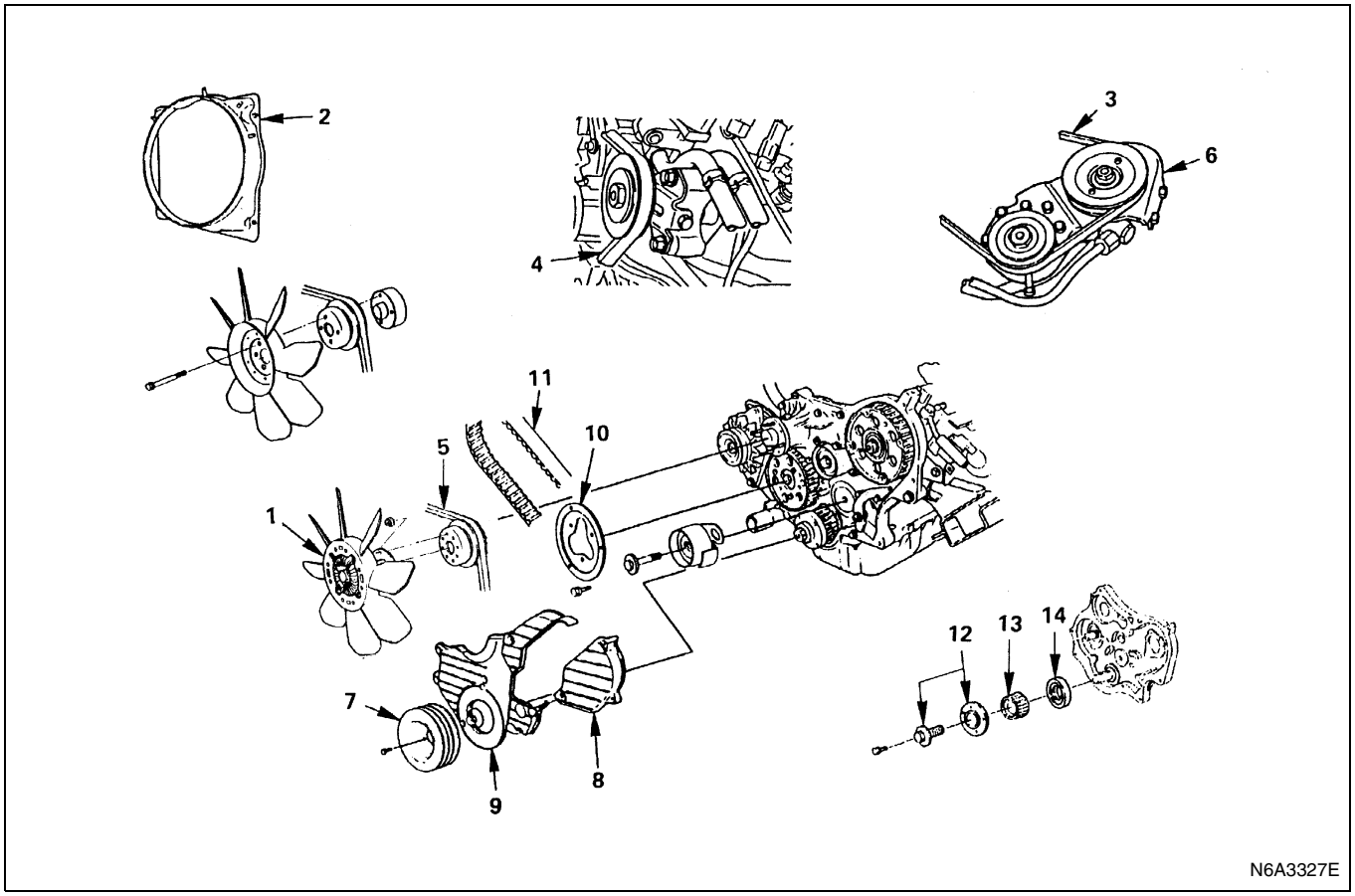
3. Cooling Fan Assembly
   - Mount fan pulley, distance piece, and cooling fan asm (in this order) on the water pump, and tighten to the specified torque.

Tighten:
- Pulley boss bolt to 8 N·m (0.8 kg·m / 69 lb·in)

4. AC Generator Drive Belt
   - Install AC Generator drive belt and adjust belt tension.
   - Refer to Drive Belt Adjustment in this section.
5. Power Steering Pump Drive Belt
   - Install power steering pump drive belt and adjust belt tension.
   - Refer to “Drive Belt Adjustment” in this section.
6. Fan Shroud
   - Install the fan shroud and reservoir tank hose.
   - Pour coolant
   - Start the engine and check coolant leakage.

CRANKSHAFT FRONT OIL SEAL (Belt Drive Type)

Component



Legend

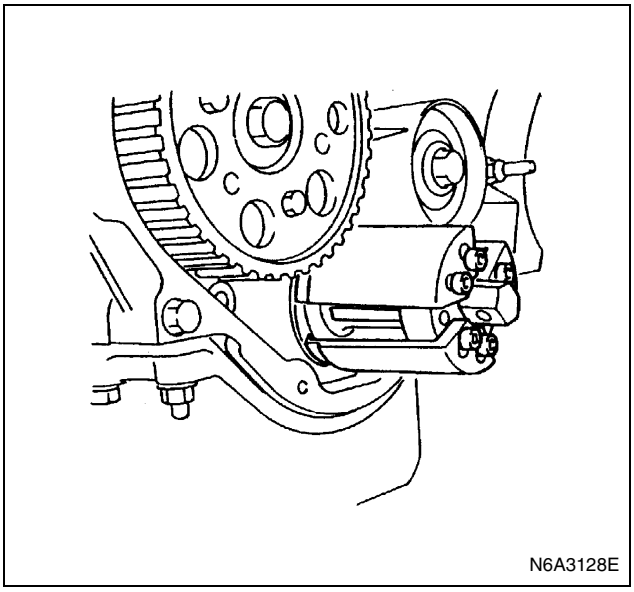
1. Cooling fan assembly
2. Fan shroud
3. Power steering pump drive
4. A/C compressor drive belt
5. AC Generator drive belt
6. Power steering pump bracket assembly
7. Crankshaft damper pulley
8. Timing pulley upper cover
9. Timing pulley lower cover
10. Flange; Camshaft pulley
11. Timing belt
12. Crankshaft pulley center
13. Crankshaft timing pulley
14. Front oil seal

Removal

Preparation

- Disconnect battery ground cable.
- Drain coolant.

1. Cooling Fan Assembly
2. Fan Shroud
3. Power Steering Pump Drive Belt (P/S Model)
4. A/C Compressor Drive Belt (A/C Model)
5. AC Generator Drive Belt
6. Power Steering Pump Bracket Assembly (P/S Model)
7. Crankshaft Damper Pulley
8. Timing Pulley Upper Cover
9. Timing Pulley Lower Cover
10. Flange; Camshaft Pulley
11. Timing Belt
    Above works refer to “TIMING BELT (Belt Type)” Section in this manual.
12. Crankshaft Pulley Center
    - Remove the pulley center by using special tool.
      Remover: 5-8840-0161-0
13. Crankshaft Timing Pulley
14. Front Oil Seal
    - Remove the oil seal by using special tool.
    - With the oil seal pushed in deep, install the special tool as shown in the illustration to remove the oil seal.
      Front oil seal remover: 5-8840-2362-0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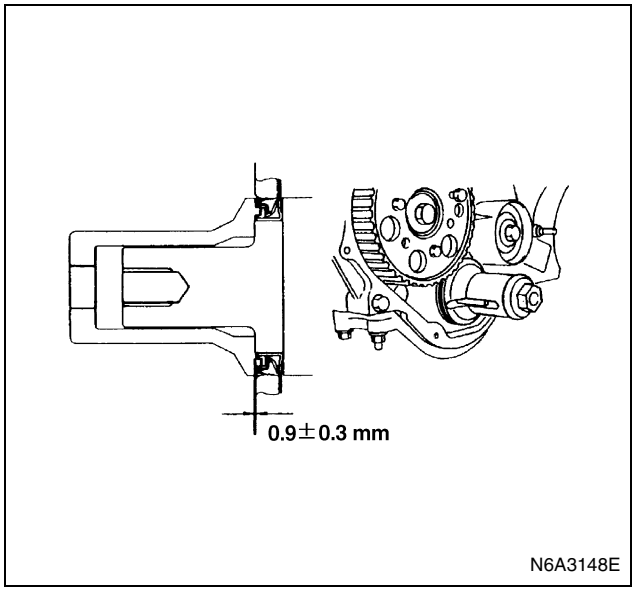
Notice:
Take care not to damage sealing surface of front plate and crankshaft when removing oil seal.

Installation

1. Front Oil Seal
   - Install the oil seal by using special tool.
     Installer: Front oil seal: 5-8840-2361-0
     1) With the sleeve attached to the oil seal, put it in the front end of the crankshaft.
     2) With the edge portion of the oil seal attached securely to the crankshaft, tighten it with the center bolt until the sleeve hits securely against the reference plane at the front end of the crankshaft.
     3) Remove the sleeve.
     4) After pressing in the seal, check the measurement of the oil seal.

Standard	mm (in)
0.6 — 1.2 (0.024 — 0.047)	

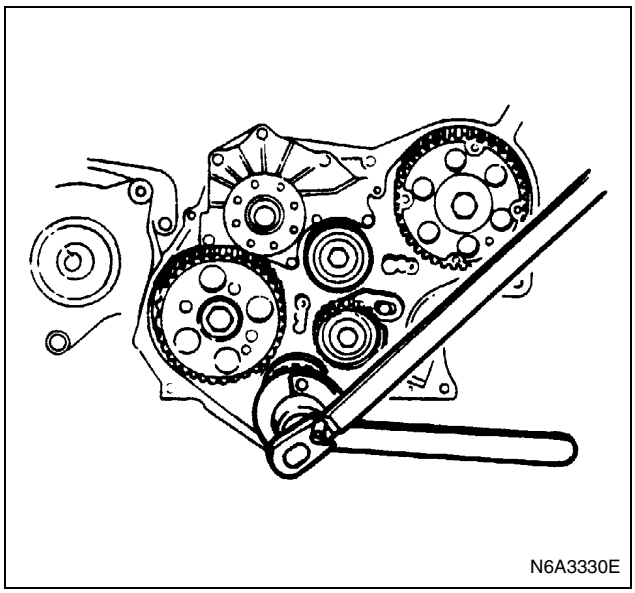


N6A3148E

Notice:
- Install the oil seal after assembling the timing pulley housing.
- The lip portion of the oil seal is applied with oil.
- Take note of the press-in direction of the oil seal.

2. Crankshaft Timing Pulley
3. Crankshaft Pulley Center
   - Install the timing pulley center and tighten bolt to the specified torque.

Tighten:
- Pulley center bolt to 206 N·m (21 kg·m / 152 lb·ft)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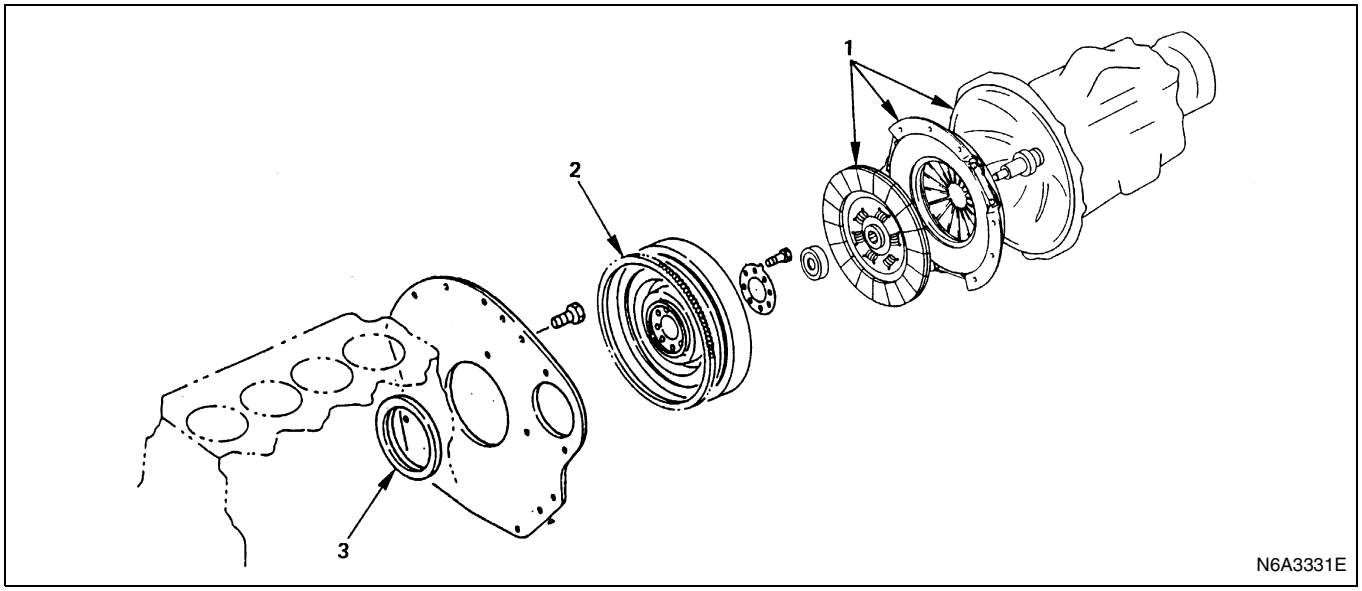
4. Timing Belt
5. Flange; Camshaft Pulley
6. Timing Pulley Lower Cover
7. Timing Pulley Upper Cover
8. Crankshaft Damper Pulley
9. Power Steering Pump Bracket Assembly (P/S Model)

10. AC Generator Drive Belt
11. A/C Compressor Drive Belt (A/C Model)
12. Power Steering Pump Drive Belt (P/S pump Model)
13. Fan Shroud
14. Cooling Fan Assembly
    Above works refer to “TIMING BELT (Belt Type)” Section in this manual.

CRANKSHAFT REAR OIL SEAL (Gear & Belt Drive Type)

Component



Legend

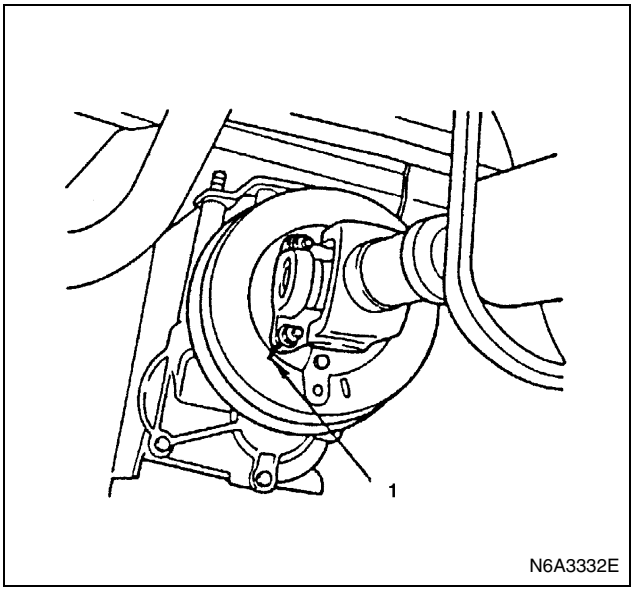
1. Transmission and clutch assembly
2. Flywheel
3. Rear oil seal

Removal

Preparation

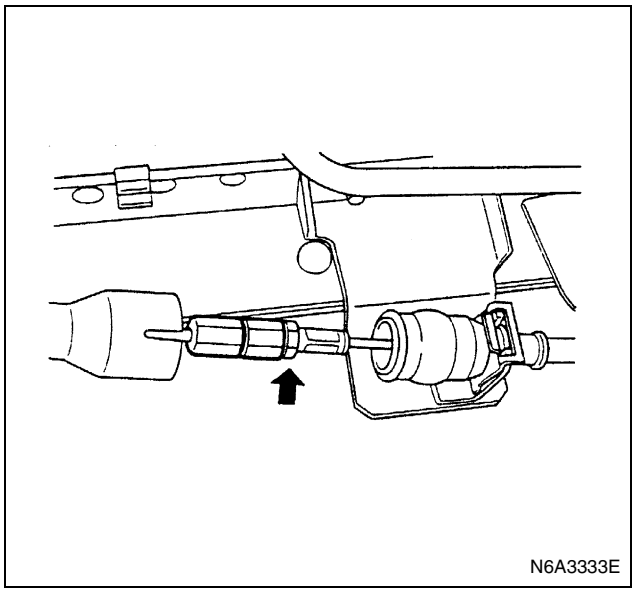
- Disconnect battery ground cable

1. Transmission and Clutch Assembly
   - Raise vehicle and support with suitable safely.
     1) Transmission
        - Reference mark (1) the flange yoke to the parking brake drum.



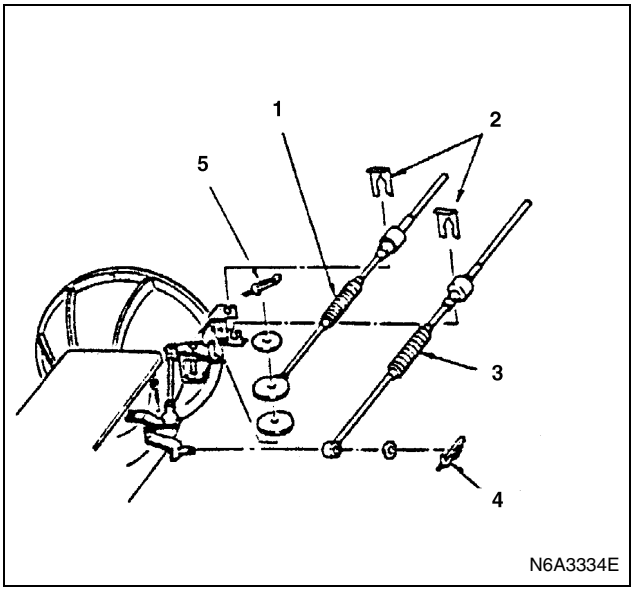
- Disconnect the propeller shaft at flange yoke.
- Put aside the propeller shaft and tie it to the frame so that it does not interface with servicing work.

2) Parking Brake Cable
- Move the joint cover.
- Disconnect the joint bolt.
- Remove the clip then disconnect the cable from the bracket.



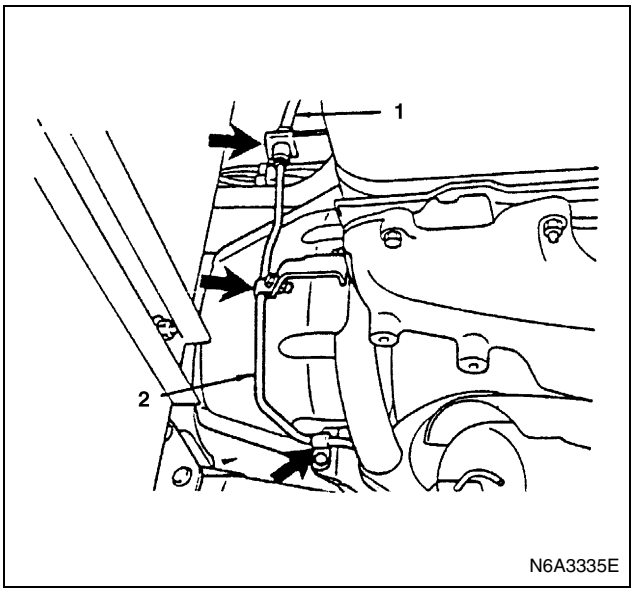
3) Wiring Connector
- Disconnect the wiring connectors from the car speed sensor, the neutral switch and the back-up light switch.

4) Shift Cable and Select Cable
- Disconnect the shift cable and select cable on the transmission side.



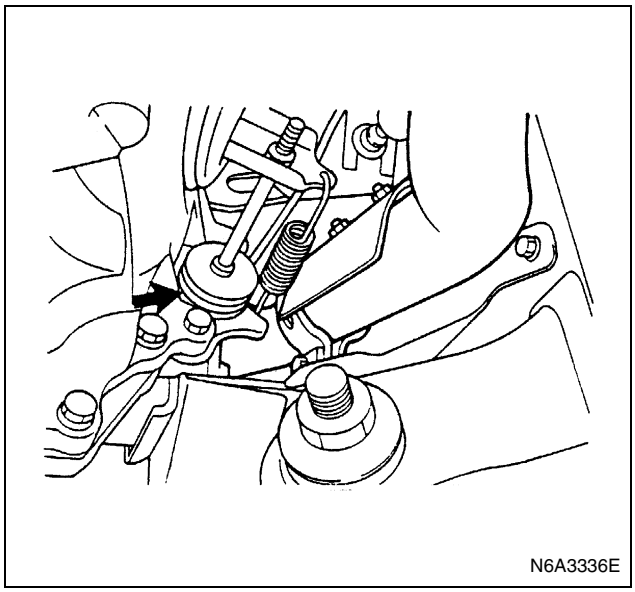
Legend
1. Shift cable
2. Clip
3. Select cable
4. Snap pin
5. Snap pin

5) Clutch Slave Cylinder
- Remove the clutch pipe fixing clips and the clip bracket (Right hand drive models only).

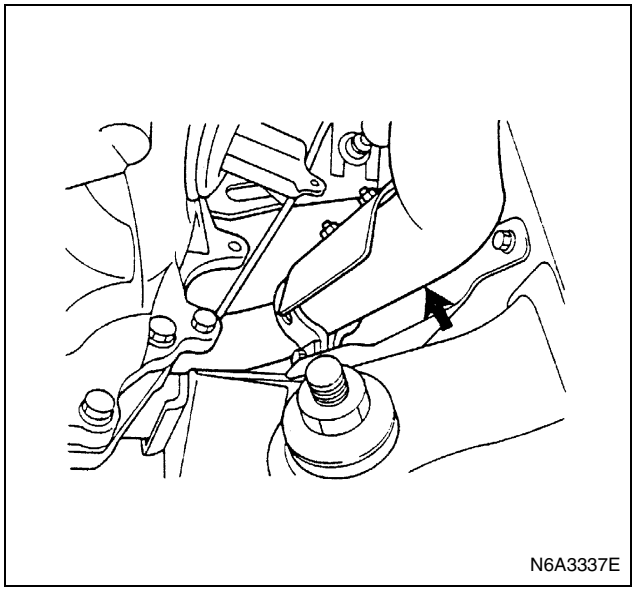


Legend
1. Flexible hose
2. Clutch pipe

- Remove the slave cylinder assembly with the flexible hose attached, and then tie it to the frame so that it does not interface with servicing work.



6) Exhaust Brake Assembly
7) Front Exhaust Pipe



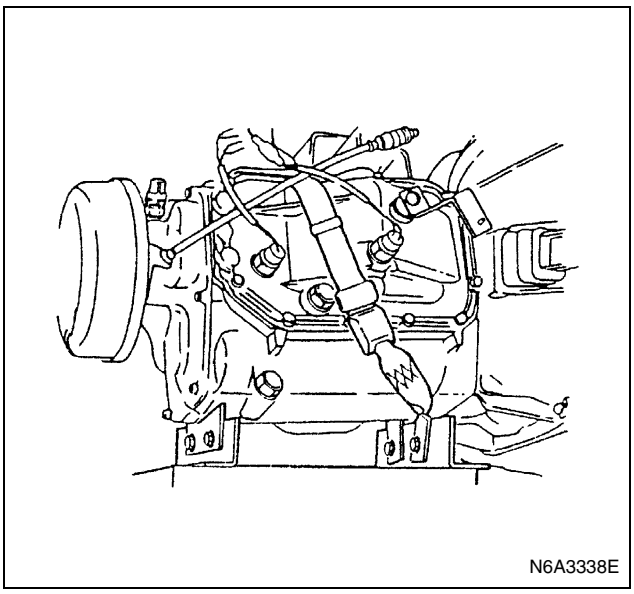
8) Transmission Assembly

Notice:
The exhaust pipe bracket, the gear control bracket and the clips are sometimes installed in the wrong position or direction confusedly. To prevent incorrect installation of these parts, put a correct installation mark on them.

- Support the transmission with mission jack.

Caution:
To prevent the falling of the transmission, tie it firmly to the jack with a chain or belt.

Do not allow transmission to hang unsupported from clutch. Damage to the clutch assembly will result.


N6A3338E

- Remove the nuts of the transmission mounting bracket on the crossmember side.
- Engine and transmission angles may need to be adjusted for removal.
- Hold the rear section of the engine by the jack or hoist.

Caution:
When lifting the engine by the jack, use wood blocks to prevent any possible damage to the oil pan.

- Remove transmission fastening bolts.
- Pull out the transmission assembly rearward.

9) Mounting Bracket

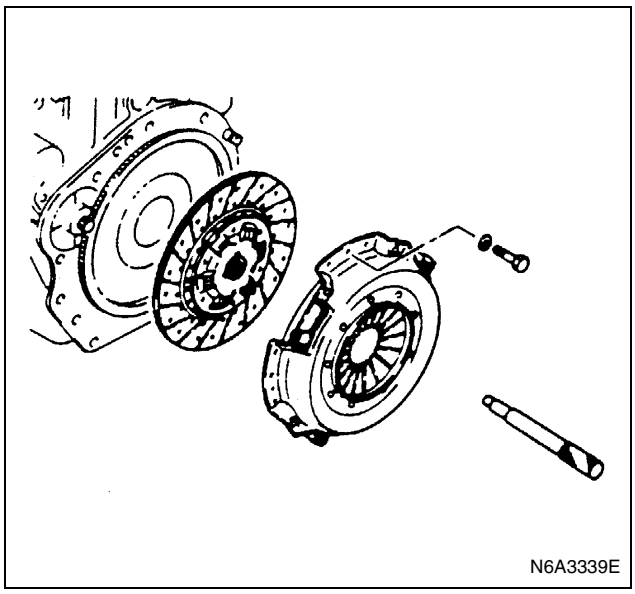
- Raise vehicle and support with suitable safety stands.

Caution:
Do not let clutch fluid remain on a painted surface, wash it off immediately.

10) Pressure Plate Assembly

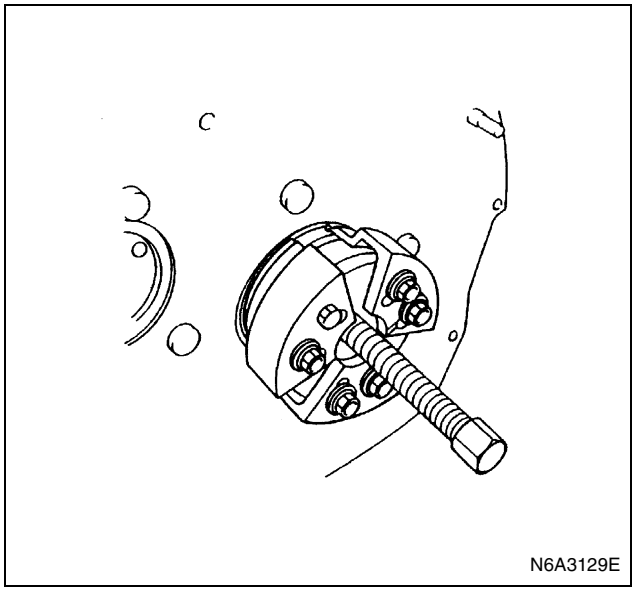
11) Driven Plate Assembly

- Use the pilot aligner to prevent the driven plate assembly from falling free.
  Pilot Aligner: 5-5825-3001-0


N6A3339E

- Mark the flywheel and pressure plate lug for alignment when installing.
- Loosen the pressure plate assembly fixing bolts.

2. Flywheel
3. Rear Oil Seal
   - With the oil seal pushed in deep, install the special tool as shown in the illustration to remove the oil seal.
   - Rear oil seal Remove: 5-8840-2360-0



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Notice:
Take care not to damage the crankshaft or oil seal retainer when removing oil seal.

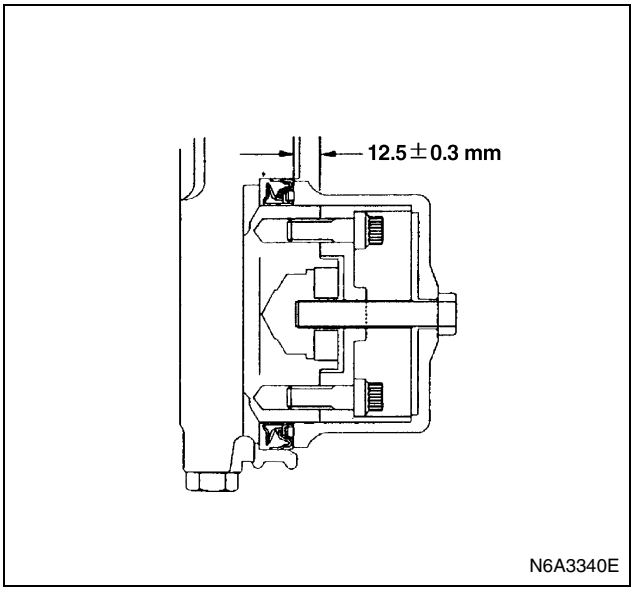
Installation

1. Rear Oil Seal
   - Use the oil seal installer the oil seal to the cylinder body.
     Rear oil seal Install: 5-8840-2359-0

Notice:
Wipe off rust and scraps clean from the press-in portion of the oil seal.

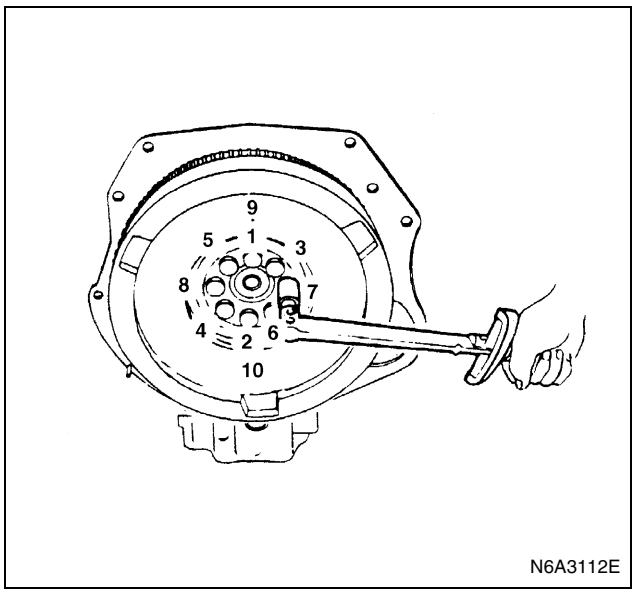
1) Take note of the press-in direction of the oil seal.
2) Install the adapter of the special tool to the rear end of the crankshaft with two bolts.
3) Install the oil seal to the outer circumference of the adapter.
4) Insert the sleeve into the adapter portion, and tighten it in with the bolt (M12 × 1.75L = 70) until the adapter section hits the sleeve.
5) Remove the adapter and the sleeve.
6) After installing the oil seal, check the measurement of the oil seal.

Standard	mm (in)
12.2 — 12.8 (0.48 — 0.50)	

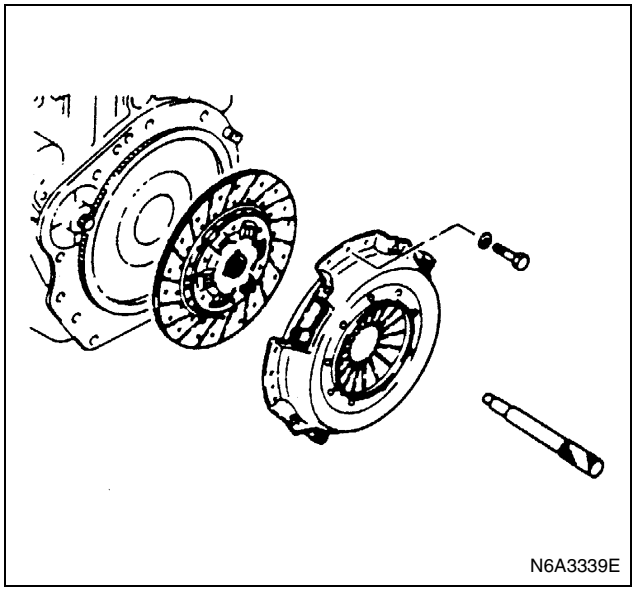


2. Flywheel
   - Apply engine oil to fixing bolts.
   - Tighten the flywheel bolts to the specified torque in two steps using the Angular Tightening Method. Follow the numerical order shown in the illustration.

Tighten:
- Flywheel bolt to
  1st step: 59 N·m (6.0 kg·m / 43 lb·ft)
  2nd step: 60° — 90°

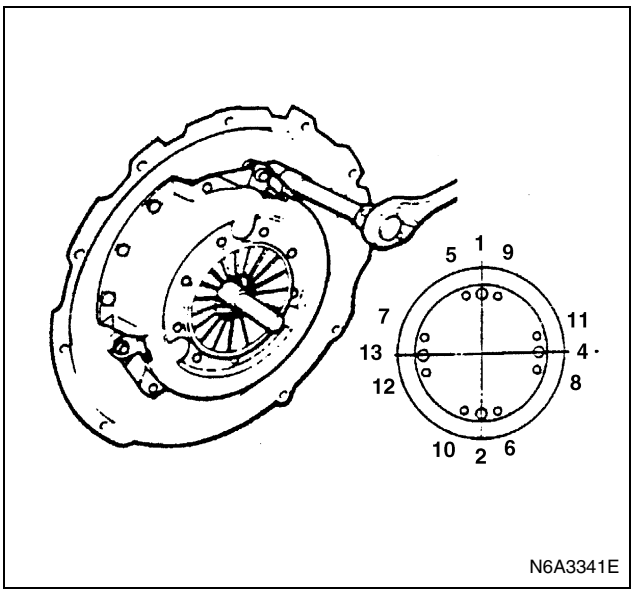


3. Transmission and Clutch Assembly
   1) Driven Plate Assembly
      - Apply multi-purpose with MOS2 type grease to the driven plate hub spline.
      - Use the pilot aligner to install the driven plate assembly.
        Pilot Aligner: 5-5825-3001-0



   2) Pressure Plate Assembly
      - Tighten pressure plate assembly fixing bolts in numerical order.

Tighten:
- Pressure plate fixing bolt to 18 N·m (1.3 kg·m / 13 lb·ft)



- Remove the pilot aligner.

Notice:
In case a new pressure plate assembly is mounted, after tightening a pressure plate at the specified torque, be sure to remove the wiring for protection of a diaphragm spring.

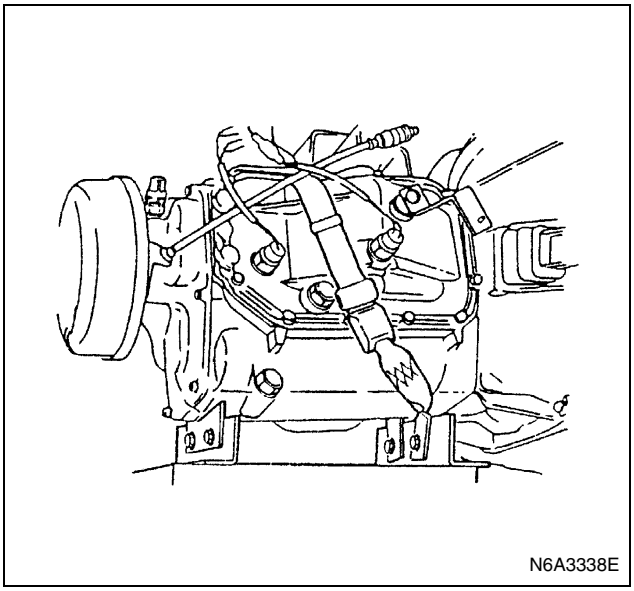
3) Mounting Bracket

Tighten:
- Mounting bracket nuts to 69 N·m (7.0 kg·m / 51 lb·ft)

4) Transmission Assembly

- Support the transmission with mission jack.

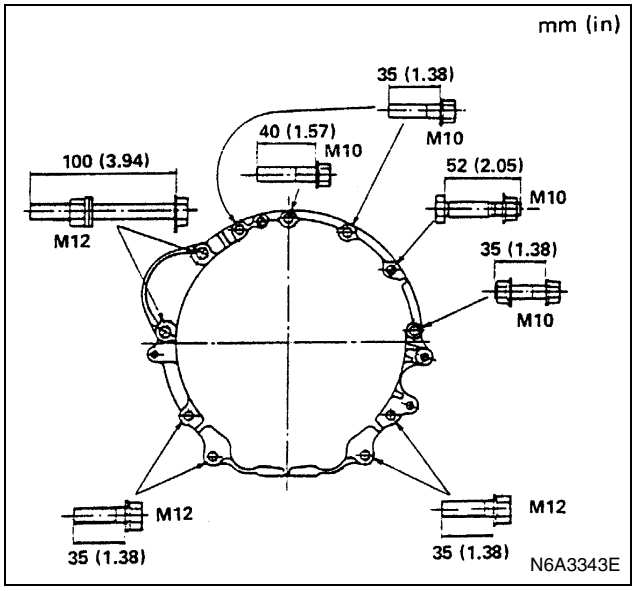
Caution:
To prevent the falling of the transmission, tie it securely to the jack with a chain or belt.



- Shift transmission into high gear.
- Align transmission with engine slope.
- Turn output parking brake drum to aid clutch spring engagement.

Tighten:
- Clutch housing to flywheel hosing bolts to
  M10: 46 N·m (4.7 kg·m / 34 lb·ft)
  M12: 91 N·m (9.3 kg·m / 67 lb·ft)
  - Raise engine and transmission up into rear transmission mount.

Tighten:
- Engine rear mounting nuts and bolts to
  M10: 40 N·m (4.1 kg·m / 30 lb·ft)
  M12: 69 N·m (7.0 kg·m / 51 lb·ft)



5) Front Exhaust Pipe

Tighten:
- Front exhaust pipe bolts to 37 N·m (3.8 kg·m / 27 lb·ft)

6) Exhaust Brake Assembly

Tighten:
- Exhaust brake bolts to 17 N·m (1.8 kg·m / 12 lb·ft)

7) Clutch Slave Cylinder

Tighten:
- Slave cylinder bolts to 19 N·m (1.9 kg·m / 14 lb·ft)
  - Perform slave cylinder adjustment before installation of the return spring.
    a. Loosen the lock nut of the push rod.
    b. Turn the adjust nut until it reaches the shift fork.
    c. Back off the adjust nut 1.5 turns. (shift fork free play Approximately 2 mm / 0.1 in).
    d. Tighten the lock nut.

Tighten:
- Push rod lock nut to 16 N·m (1.6 kg·m / 12 lb·ft)

8) Shift Cable and Select Cable

9) Wiring Connector

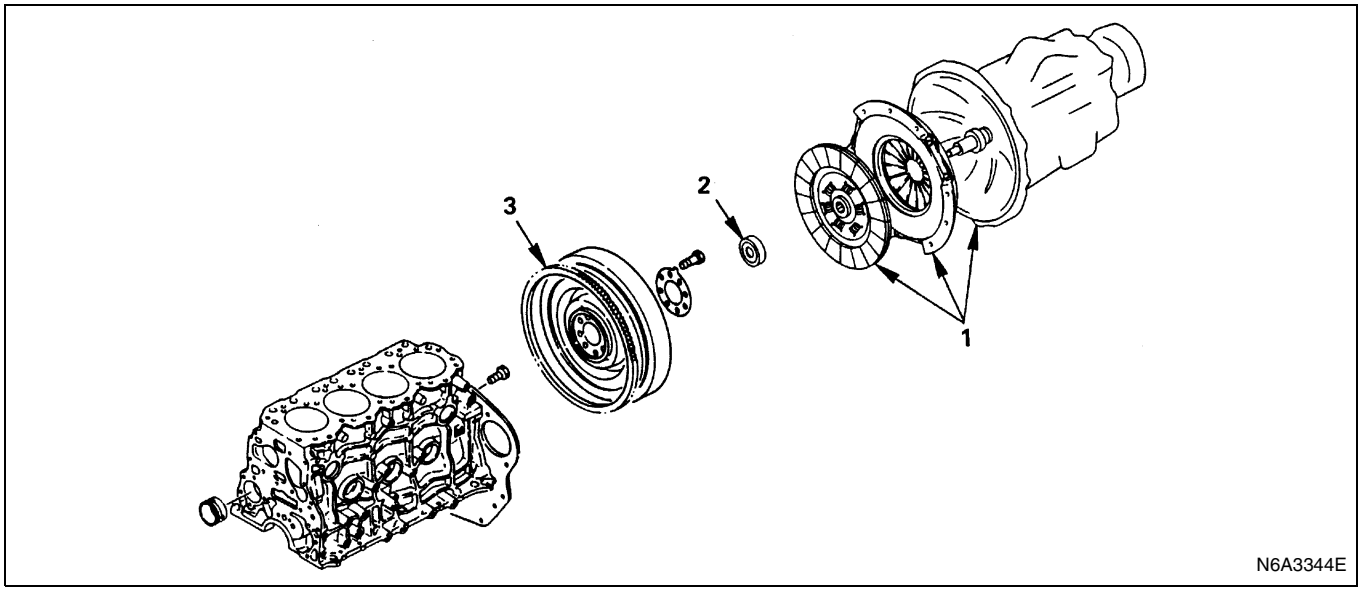
- Color of Connector
  Back-up Light Switch: Brown
  Neutral Switch: Gray

10) Parking Brake Cable
11) Propeller Shaft
- Line up reference mark.

Tighten:
- Propeller shaft nuts to 66 N·m (6.7 kg·m / 48 lb·ft)
- Connect battery ground cable.

FLYWHEEL AND PILOT BEARING

Component



Legend

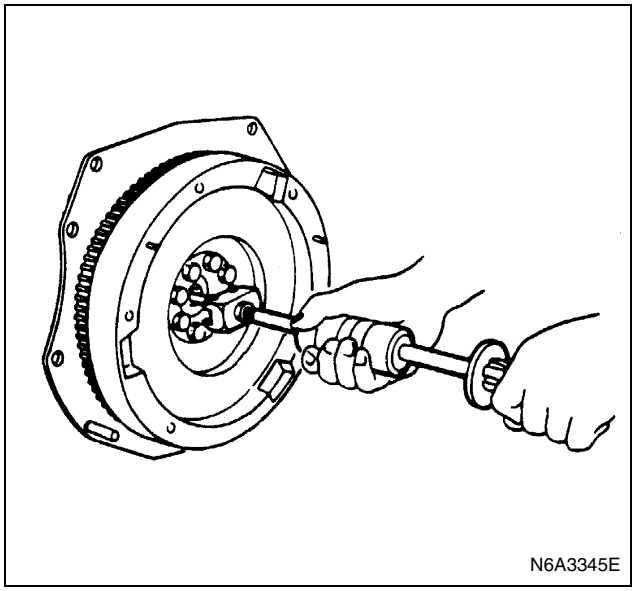
1. Transmission and clutch assembly
2. Pilot bearing
3. Flywheel

Removal

Preparation

- Disconnect battery ground cable.

1. Transmission and Clutch Assembly
   1) Transmission
   2) Clutch
      Above works refer to “ENGINE ASSEMBLY” Section in this manual.
2. Pilot Bearing
   - Remove pilot bearing using remover.
     Pilot Bearing Puller: 5-8840-2000-0
     Sliding hammer: 5-8840-0019-0



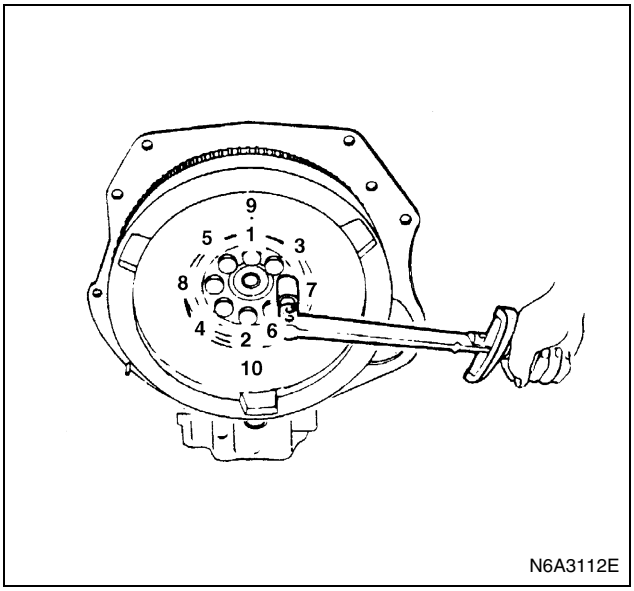
3. Flywheel
   - Set the flywheel stopper.
   - Loosen flywheel fixing bolts then remove the flywheel.

Installation

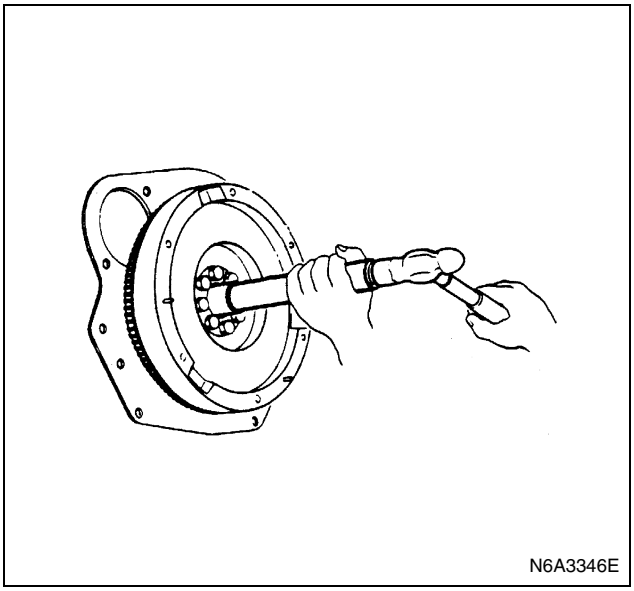
1. Flywheel
   - Apply engine oil to fixing bolts.
   - Tighten the flywheel bolts to the specified torque in two steps using the Angular Tightening Method. Follow the numerical order shown in the illustration.

Tighten:

- Flywheel bolt to
  1st step: 59 N·m (6.0 kg·m / 43 lb·ft)
  2nd step: 60° — 90°



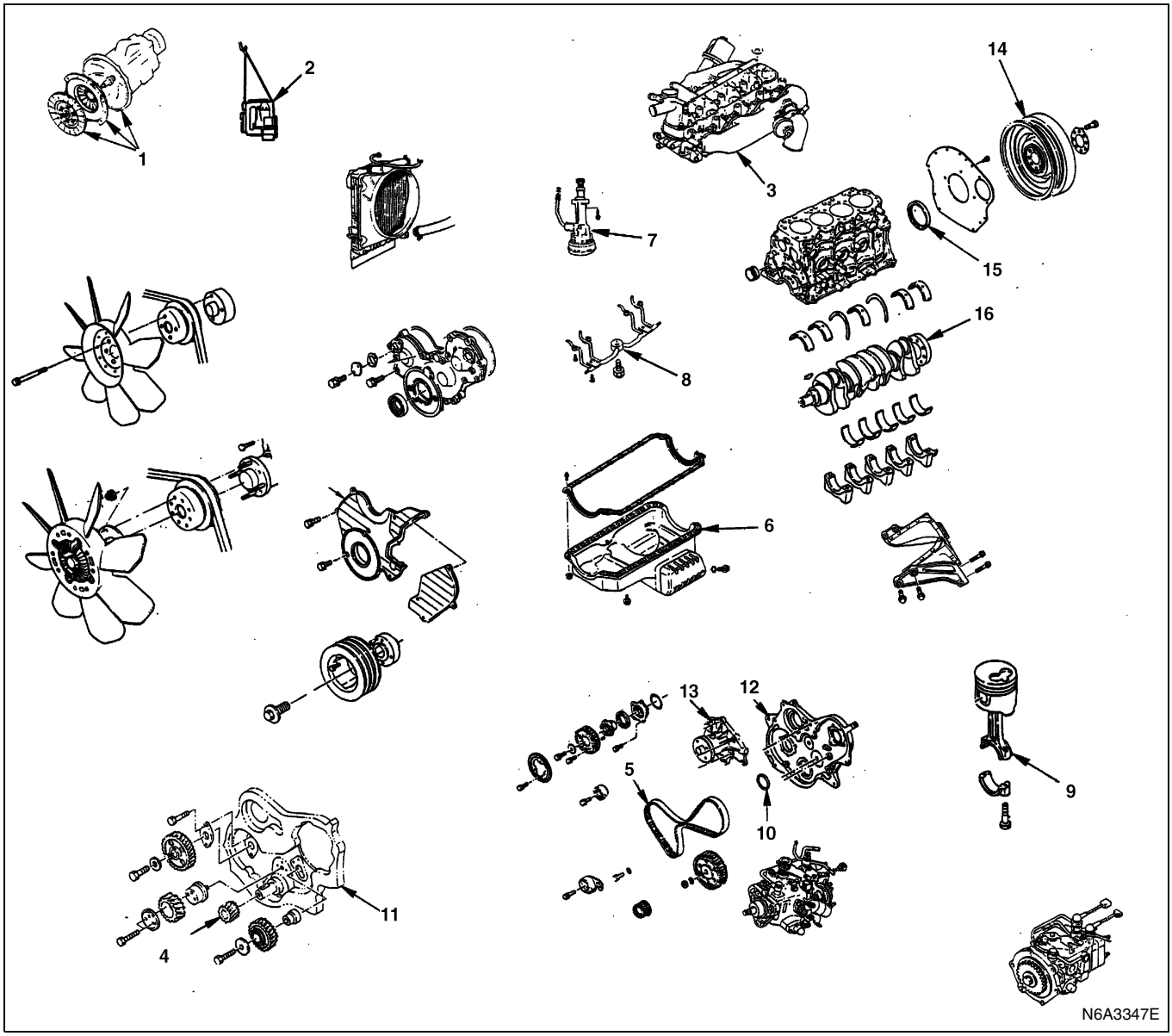
2. Pilot Bearing
   - Install the pilot bearing using installer.
     Pilot bearing Installer: 5-8522-0024-0



3. Transmission and Clutch Assembly
   1) Clutch
   2) Transmission
      Above works refer to “ENGINE ASSEMBLY” Section in this manual.

CRANKSHAFT AND MAIN BEARINGS

Component



Legend

1. Transmission and clutch assembly
2. Engine assembly
3. Cylinder head assembly and gasket
4. Timing gear (Gear drive model)
5. Timing belt (Belt drive model)
6. Oil pan assembly
7. Oil pump assembly
8. Piston cooling oil pipe
9. Piston and connecting rod assembly
10. Front oil seal
11. Timing gear housing
12. Timing pulley housing
13. Water pump assembly
14. Flywheel and rear plate
15. Rear oil seal
16. Crankshaft and main bearing

Removal

Preparation

- Disconnect battery ground cable.
- Drain coolant from the radiator and engine.

1. Transmission and Clutch Assembly
   1) Transmission
   2) Clutch

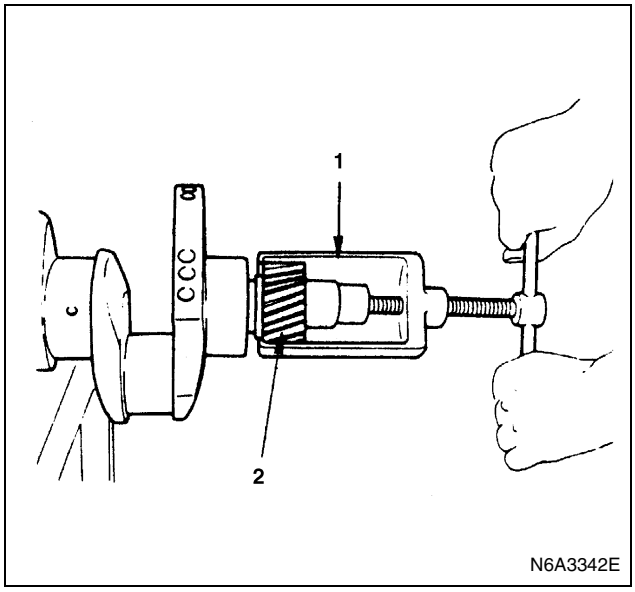
   Above works refer to “ENGINE ASSEMBLY” Section in this manual.
2. Engine Assembly
   1) Radiator assembly

2) Intake air duct
3) Heater hose
4) Engine control cable
5) Glow plug harness
6) Fuel hose
7) Oil pressure switch harness
8) A/C compressor assembly
9) Power steering pump bracket assembly (Power Steering Model)
10) Actuator vacuum hose (Exhaust Brake Model)
11) Vacuum pump hose (Exhaust Brake Model)
12) Front exhaust pipe
13) Support rubber
14) Engine assembly
Above works refer to “ENGINE ASSEMBLY” Section in this manual.

3. Cylinder Head Assembly and Gasket
1) Injection pipe
2) Leak off pipe
3) PCV hose
4) Glow plug harness
5) Oil level gauge guide tube
6) Oil cooler water pipe (Oil Cooler Model)
7) By-pass hose
8) Cylinder head cover
9) Rocker arm shaft
10) Push rod
11) Cylinder head assembly
12) Cylinder head gasket
Above works refer to “CYLINDER HEAD ASSEMBLY AND GASKET” Section in this manual.

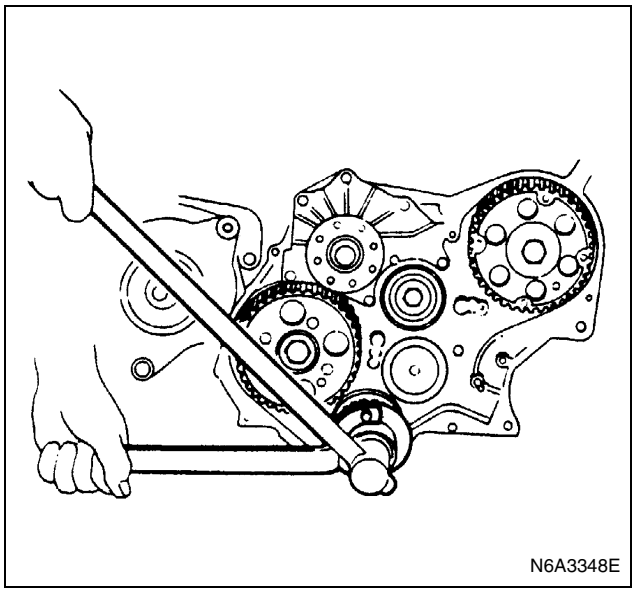
4. Timing Gear (Gear Drive Model)
1) Cooling fan assembly
2) Crankshaft damper pulley
3) Noise shield cover
4) Noise cover spacer
5) Timing gear case cover
6) Oil pipe
7) Idle gear
8) Idle gear “B” and shaft
9) Injection pump
10) Camshaft timing gear
Above works refer to “TIMING GEAR (Gear Type)” Section in this manual.
11) Crankshaft gear

• Use the crankshaft timing gear remover (1) to remove the crankshaft gear (2).
Crankshaft Timing Gear Remover: 5-8840-2057-0



5. Timing Belt (Belt Drive Model)
1) Cooling fan assembly
2) Crankshaft damper pulley
3) Timing pulley upper cover
4) Timing pulley lower cover
5) Flange: camshaft pulley
6) Flange: injection pump pulley
7) Timing belt
Above works refer to “TIMING BELT (Belt Type)” Section in this manual.
8) Crankshaft timing pulley center

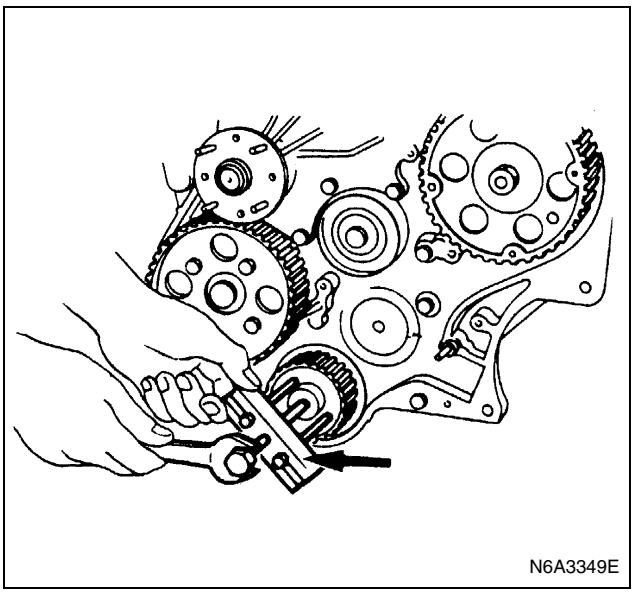
• Use the fixing wrench to prevent the crankshaft from turning.
Fixing Wrench: 5-8840-0161-0
• Remove the timing pulley center from the crankshaft.



9) Crankshaft timing pulley

• Block the crankshaft with a piece of hard wood.

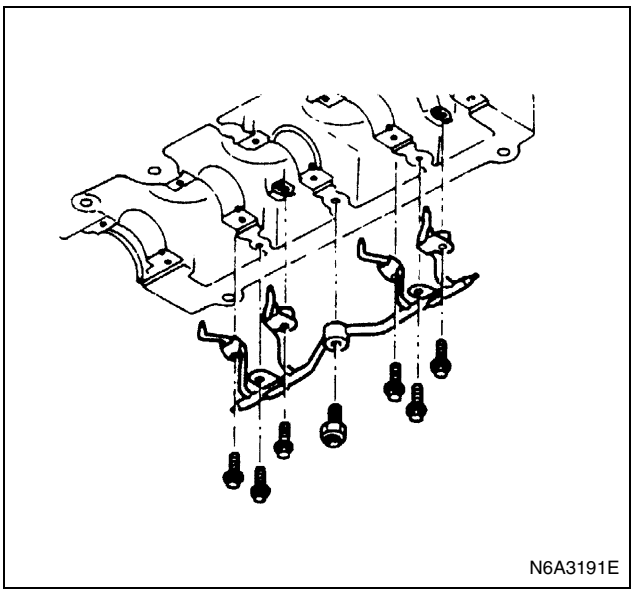
• Use the crankshaft timing pulley puller to remove the timing pulley.
Crankshaft Timing Pulley Puller: 5-8840-2035-0


N6A3349E

10) Injection pump timing pulley
11) Injection pump
Above works refer to “CYLINDER BLOCK ASSEMBLY” Section in this manual.
12) Camshaft timing pulley

6. Oil Pan Assembly
7. Oil Pump Assembly
Above works refer to “CAMSHAFT AND TAPPET” Section in this manual.
8. Piston Cooling Oil Pipe

• Remove the oil pipe from cylinder block.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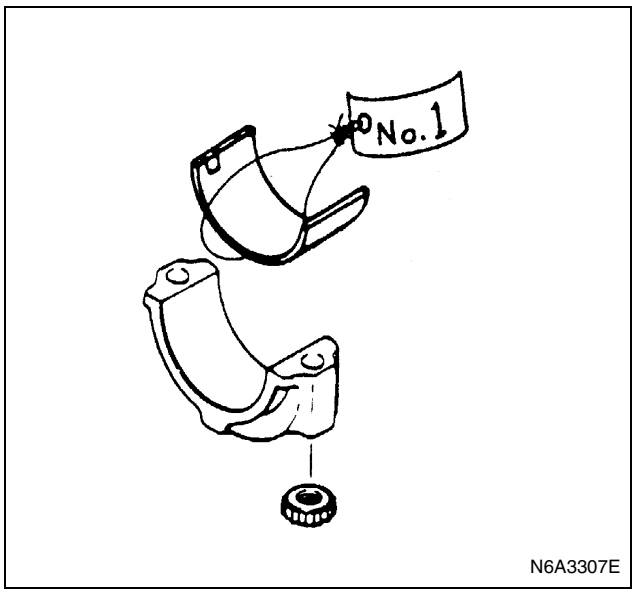
9. Piston and Connecting Rod Assembly

• If the connecting rod lower bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



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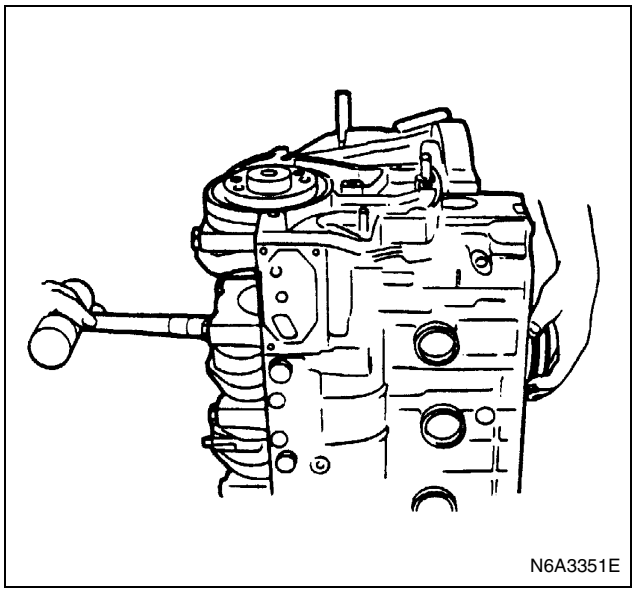
• Remove carbon deposits from the upper portion of the cylinder wall with a scraper before removing the piston and connecting rod.
Move the piston to the top of the cylinder and tap it with a hammer grip or similar object from the connecting rod lower side to drive it out.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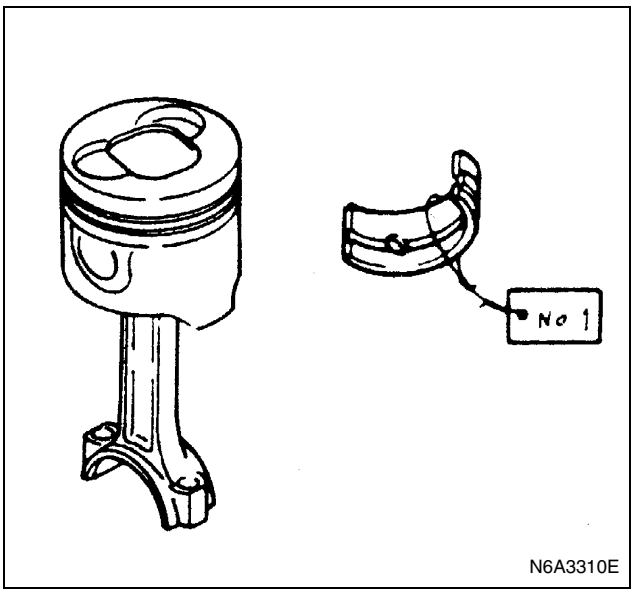
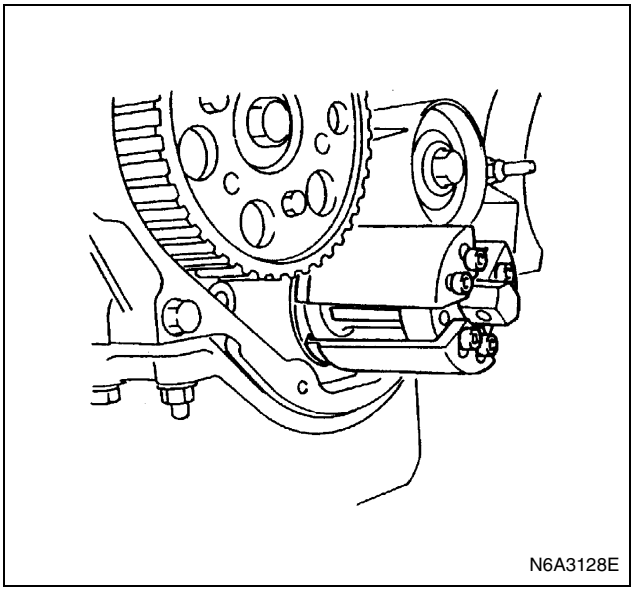
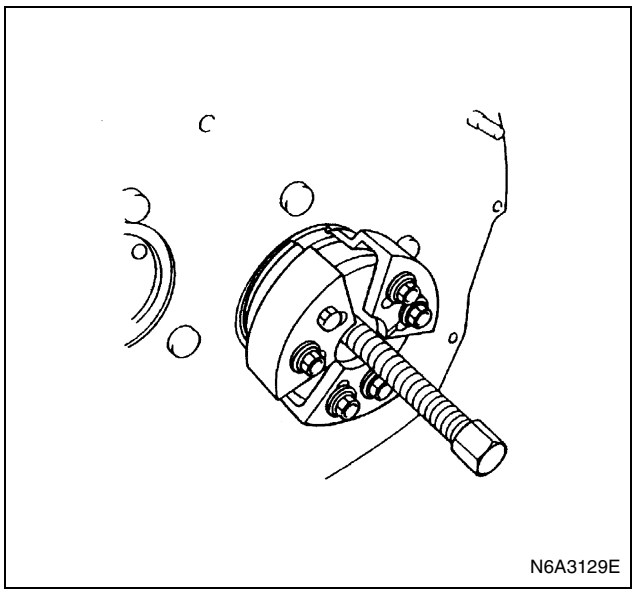
• If the connecting rod upper bearings are to be reinstalled, mark their fitting positions by tagging each bearing with the cylinder number from which it was removed.



10. Front Oil Seal (Belt Drive Model)
    - With the oil seal pushed in deep, install the special tool as shown in the illustration to remove the oil seal.
      Front Oil Seal Remover: 5-8840-2362-0

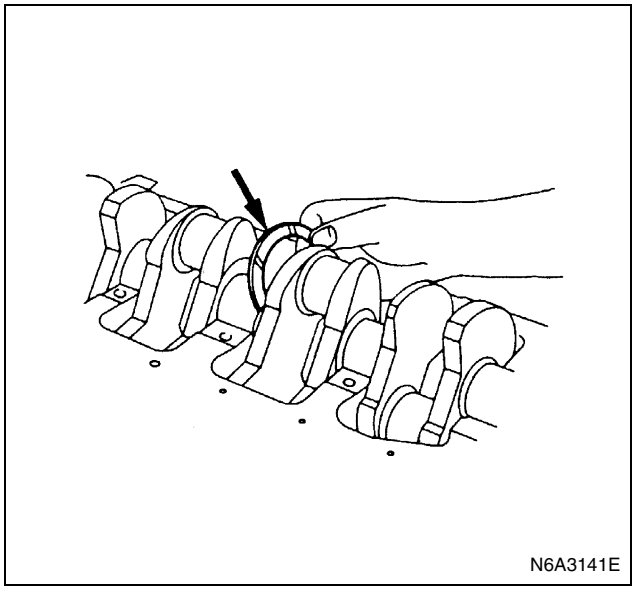


11. Timing Gear Housing
12. Timing Pulley Housing
13. Water Pump Assembly
14. Flywheel and Cylinder Body Rear Plate
    - Set the flywheel stopper.
    - Loosen the flywheel fixing bolts then remove the flywheel.
    - Remove the cylinder block rear plate.
15. Rear Oil Seal (Gear and Belt Drive Model)
    - With the oil seal pushed in deep, install the special tool as shown in the illustration to remove the oil seal.
      Rear Oil Seal Remover: 5-8840-2360-0



Notice:
Take care not to damage sealing surface of front plate and crankshaft when removing oil seal.

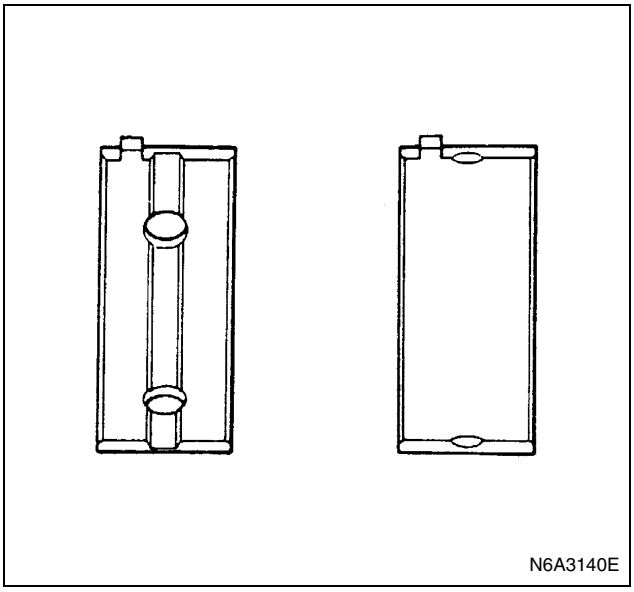
16. Crankshaft and Main Bearing
    1) Remove the main bearing caps and thrust washer.



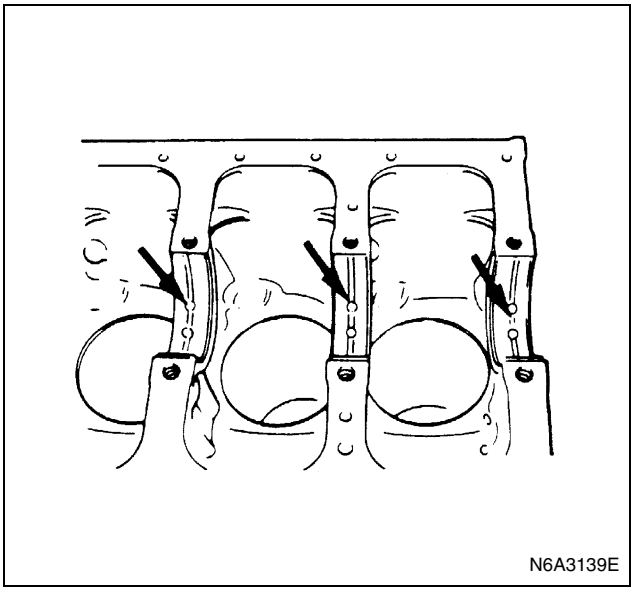
    2) Remover the crankshaft with care.
    3) Remove the crankshaft upper bearing.

Installation

1. Crankshaft and Main Bearings
   - The crankshaft upper bearings have an oil hole and an oil groove. The lower bearings do not.


N6A3140E

- Install main bearings in the cylinder body and main bearing cap respectively.
- Apply new engine oil to upper and lower main bearings.
- Make sure that main bearing are in correct position.
- Carefully wipe any foreign material from the upper bearing.
- Install the main bearings to the cylinder body and the main bearing caps.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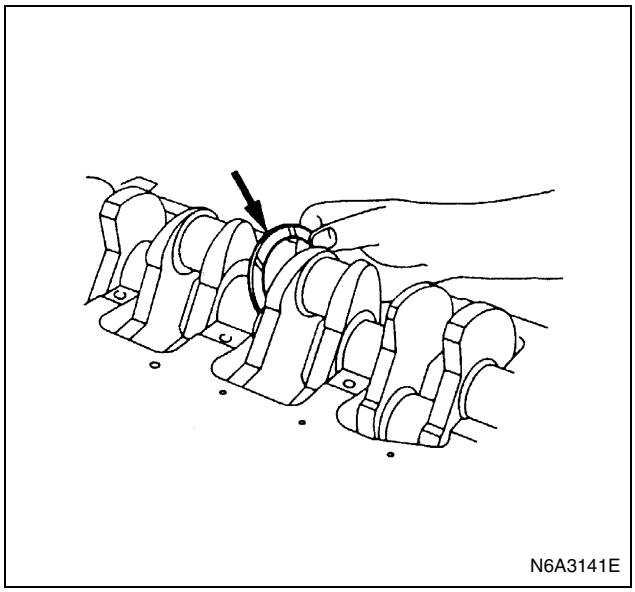
Notice:
Do not apply engine oil to the bearing back faces and the cylinder body bearing fitting surfaces.

- Be sure that they are positioned correctly.
- Apply new engine oil to the upper and lower main bearing faces.
- Carefully mount the crankshaft.
- Apply engine oil to the thrust washer.
- Install thrust washer on No.3 journal.
  Oil grooves in thrust washer must face the crankshaft.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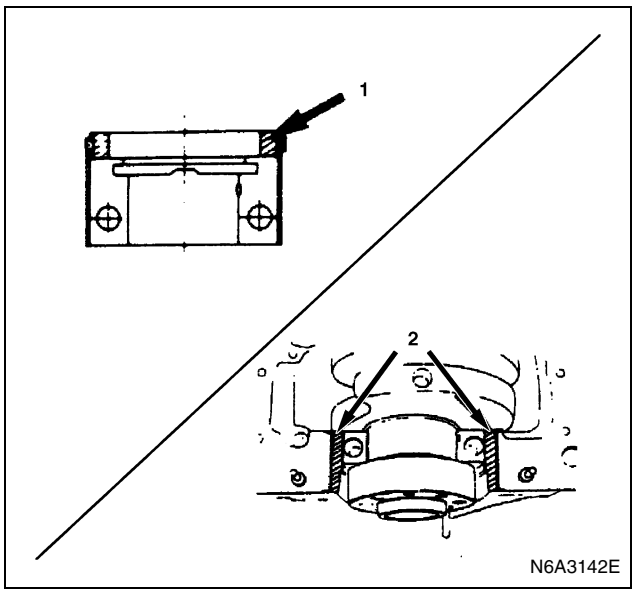
- Apply the recommended liquid gasket or its equivalent to the No.5 crankshaft bearing cap cylinder body fitting surfaces at points and shown in the illustration.



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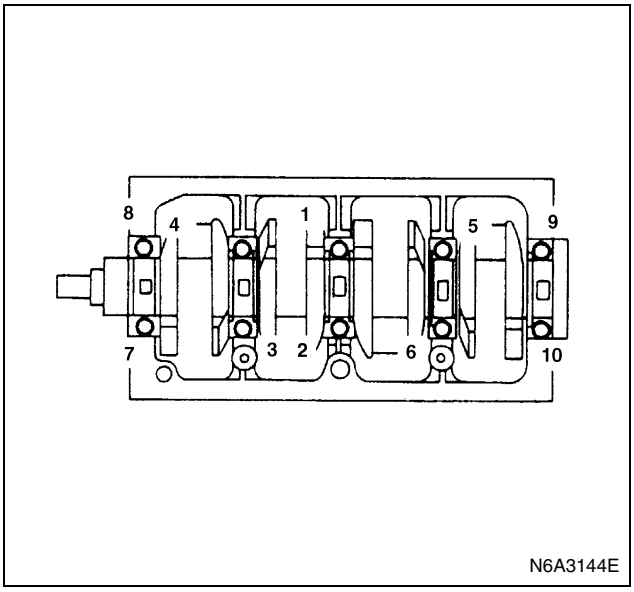
Notice:
Be sure that the bearing cap fitting surface is completely free of oil before applying the liquid gasket.

Do not allow the liquid gasket to obstruct the cylinder thread holes and bearings.

- Install the bearing caps with the bearing cap head arrow mark facing the front of the engine.
- Apply engine oil to the front of the engine.
- Tighten the crankshaft bearing cap bolts to the specified torque a little at a time in the sequence shown in the illustration.

Tighten:
- 167 N·m (17.0 kg·m / 123 lb·ft)



Notice:
Check to see that the crankshaft turns smoothly by rotating it manually.

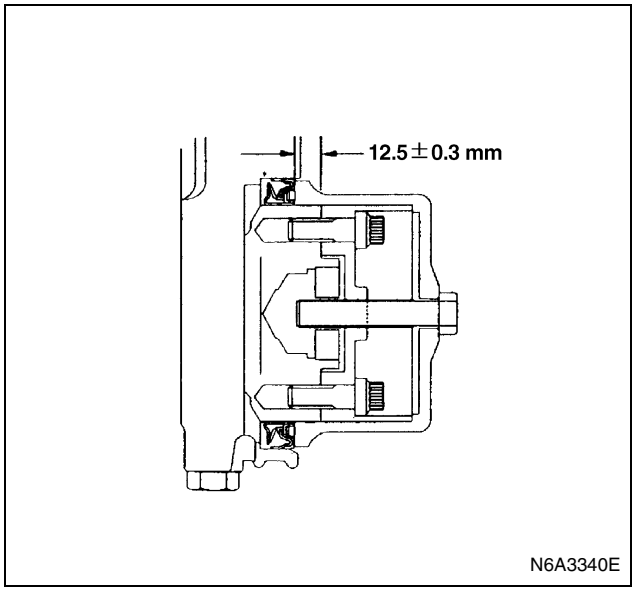
2. Crankshaft Rear Oil Seal
   Use the oil seal installer to install the oil seal to the cylinder body.
   Rear Oil Seal Installer: 5-8840-2361-0

Notice:
Wipe off rust and scraps clean from the press-in portion of the oil seal.

Take note of the press-in direction of the oil seal.

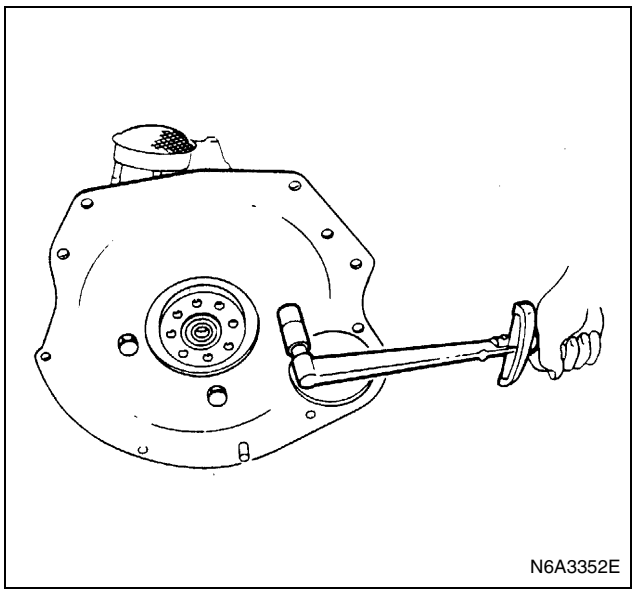
1) Install the adapter of the special tool to the rear end of the crankshaft with two bolts.
2) Install the oil seal to the outer circumference of the adapter.
3) Insert the slave into the adapter portion, and tighten it in with the bolt (M12 × 1.75L = 70) until the adapter section hits the slave.
4) Remove the adapter and the slave.
5) After installing the oil seal, check the measurement of the oil seal.

Standard	mm (in)
12.2 — 12.8 (0.48 — 0.50)	



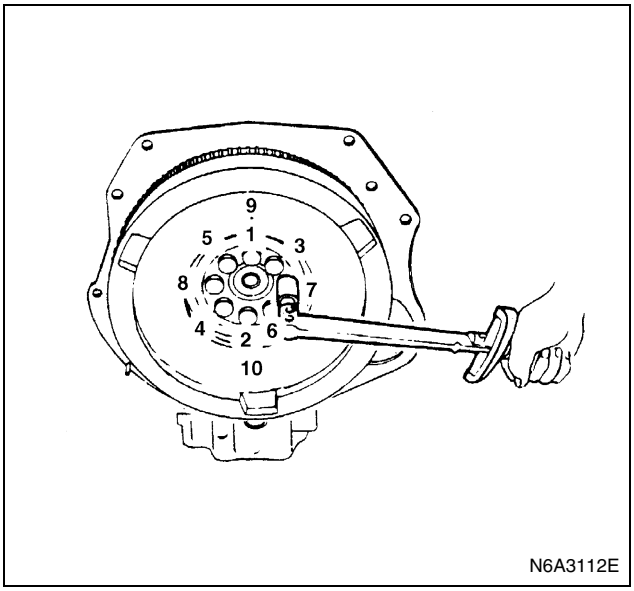
3. Flywheel and Cylinder Body Rear Plate
   - Align the rear plate with the cylinder body knock pins.
   - Tighten the rear plate to the specified torque.

Tighten:
- Rear plate bolts to 82 N·m (8.4 kg·m / 61 lb·ft)



- Block the crankshaft with a piece of hard wood to prevent the flywheel form turning.
- Apply a coat of engine oil to the threads of the flywheel bolts.
- Align the flywheel with the crankshaft dowel pin.
- Tighten the flywheel bolts to the specified torque in two steps using the Angular Tightening Method.
- Follow the numerical order shown in the illustration.

Tighten:
- Flywheel bolt to
  1st step: 59 N·m (6.0 kg·m / 43 lb·ft)
  2nd step: 60° — 90°



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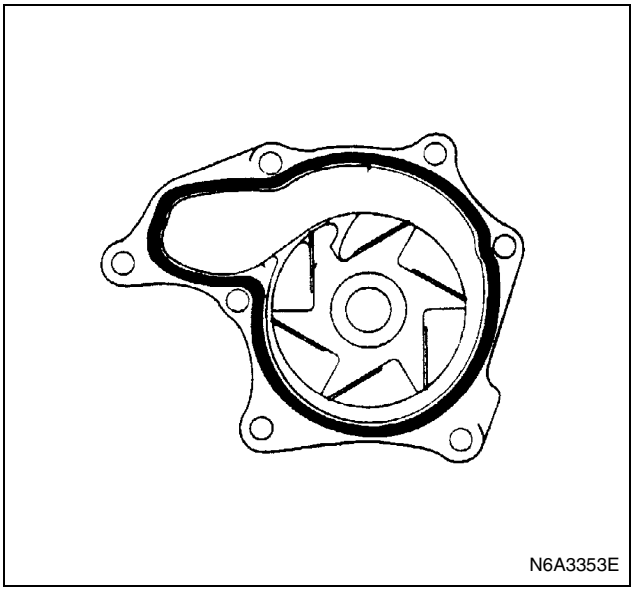
4. Water Pump Assembly
   - Fit the O-ring to the water pump body.
   - Remove the water pump assembly and tighten bolts to the specified torque.

Tighten:
- Water pump bolts to 20 N·m (2.0 kg·m / 14 lb·ft)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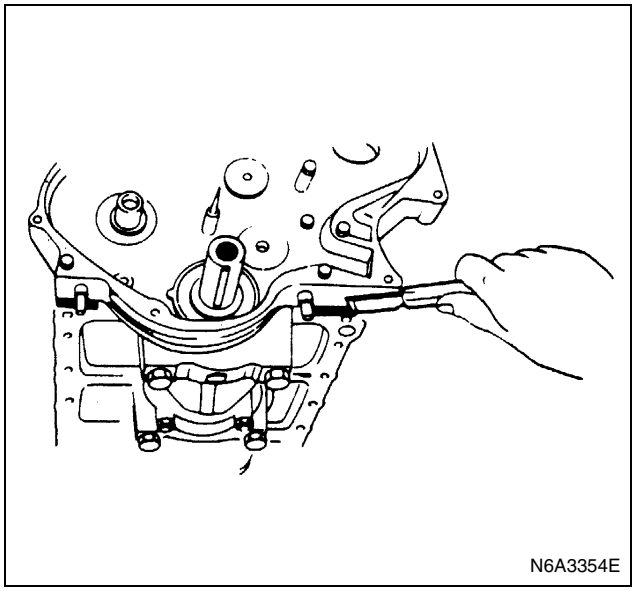
5. Timing Pulley Housing
   - Install the timing pulley housing the cylinder body. Take care not to twist the front oil seal.
   - Tighten the timing pulley housing together with the timing pulley housing gasket to the specified torque.

Tighten:
- Timing pulley housing bolt to 19 N·m (1.9 kg·m / 14 lb·ft)


N6A3354E

   - Cut away the flash from the gasket.
6. Timing Gear Housing
   - Install the timing gear housing the cylinder body.
   - Tighten the timing gear housing together with the timing gear housing gasket to the specified torque.

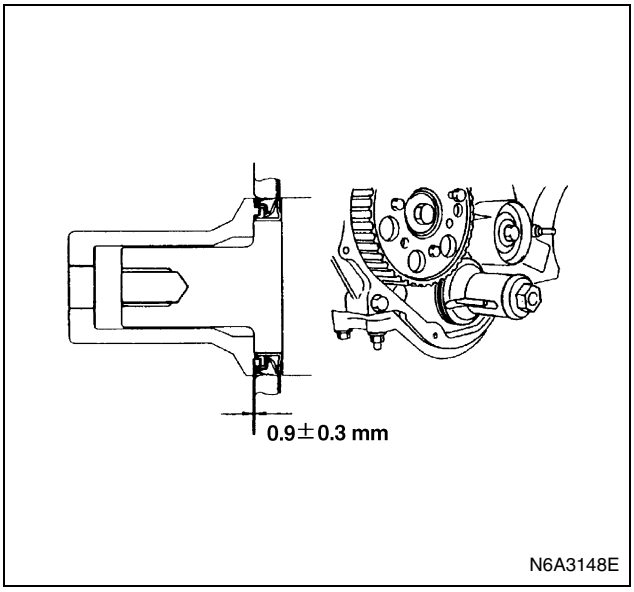
Tighten:
- Timing gear housing bolt to 19 N·m (1.9 kg·m / 14 lb·ft)
  - Cut away the flash from the gasket.
7. Front Oil Seal (Belt Drive Model)
   - Install oil seal using special tool.
     Front Oil Seal Installer: 5-8840-2361-0

Notice:
Wipe off rust and scraps clean from the press-in portion of the oil seal.

Take note of the press-in direction of the oil seal.

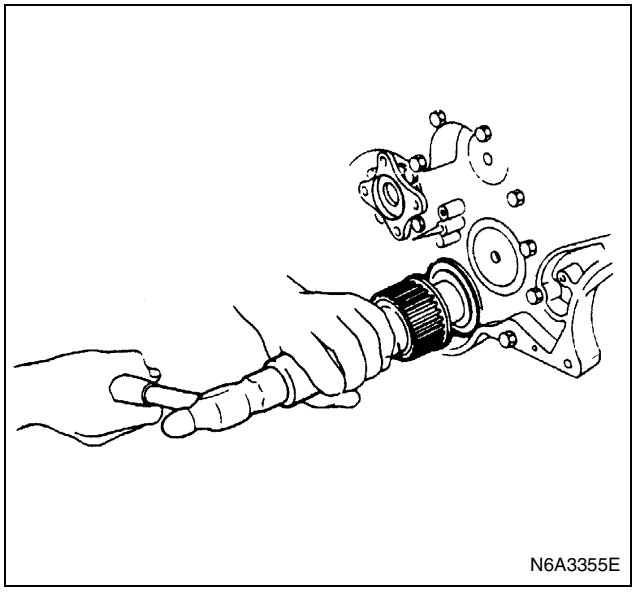
1) With the oil seal attached to the sleeve, put it in the front end of the crankshaft.
2) With the edge of the oil seal attached securely to the crankshaft, tighten it with the center bolt until the sleeve hits securely against the reference plane at the front end of the crankshaft.
3) Remove the sleeve.
4) After pressing in the oil seal, check the measurement of the oil seal.

Standard	mm (in)
0.6 — 1.2 (0.024 — 0.047)	



8. Piston and Connecting Rod Assembly
9. Piston Cooling Oil Pipe
   Above works refer to “PISTON” Section in this manual.
10. Oil Pump Assembly
11. Oil Pan Assembly
    Above works refer to “OIL PUMP AND OIL PAN” Section in this manual.
12. Timing Belt (Belt Drive Model)
    1) Camshaft timing pulley
       Above works refer to “CAMSHAFT AND TAPPET” Section in this manual.
    2) Injection pump
    3) Injection pump timing pulley
       Above works refer to “CYLINDER BLOCK ASSEMBLY” Section in this manual.
    4) Crankshaft timing pulley

- Use the crankshaft timing pulley installer to install the timing pulley.
- The timing pulley flange must be facing the cylinder body.
  Crankshaft Timing Pulley Installer: 5-8522-0020-0

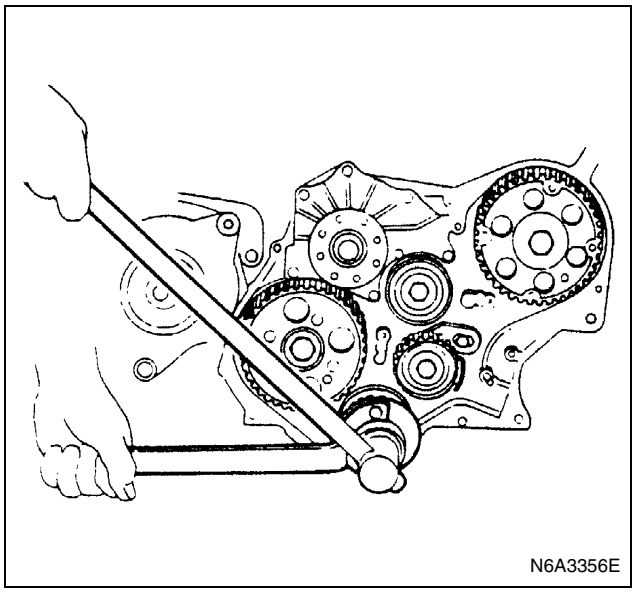


    5) Crankshaft timing pulley center

- Install the crankshaft pulley center.
- Use the fixing wrench to prevent the crankshaft from turning.
  Fixing Wrench: 5-8840-0161-0
- Tighten the crankshaft pulley center bolt to the specified torque.

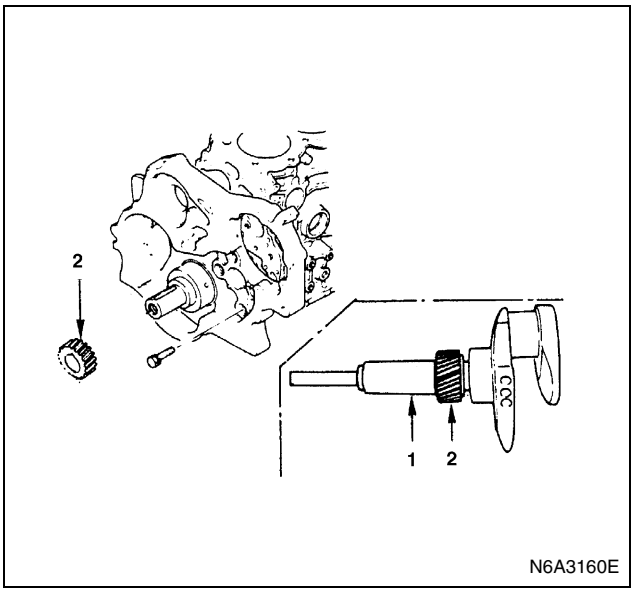
Tighten:

- Crankshaft pulley center bolt to 206 N·m (21 kg·m / 152 lb·ft)



    6) Timing belt
    7) Flange: camshaft pulley
    8) Flange: injection pump pulley
    9) Timing pulley lower cover
    10) Timing pulley upper cover
    11) Crankshaft damper pulley
    12) Cooling fan assembly
        Above works refer to “TIMING GEAR (Belt Type)” Section in this manual.

13. Timing Gear (Gear Drive Model)
    1) Crankshaft gear
    - Install the crankshaft gear.
    - Use the crankshaft gear installer (1) to install the crankshaft gear (2).
    - The crankshaft gear timing mark ("X — X") or ("· — ·") must be facing outward.
      Crankshaft Gear Installer: 9-8522-0020-0



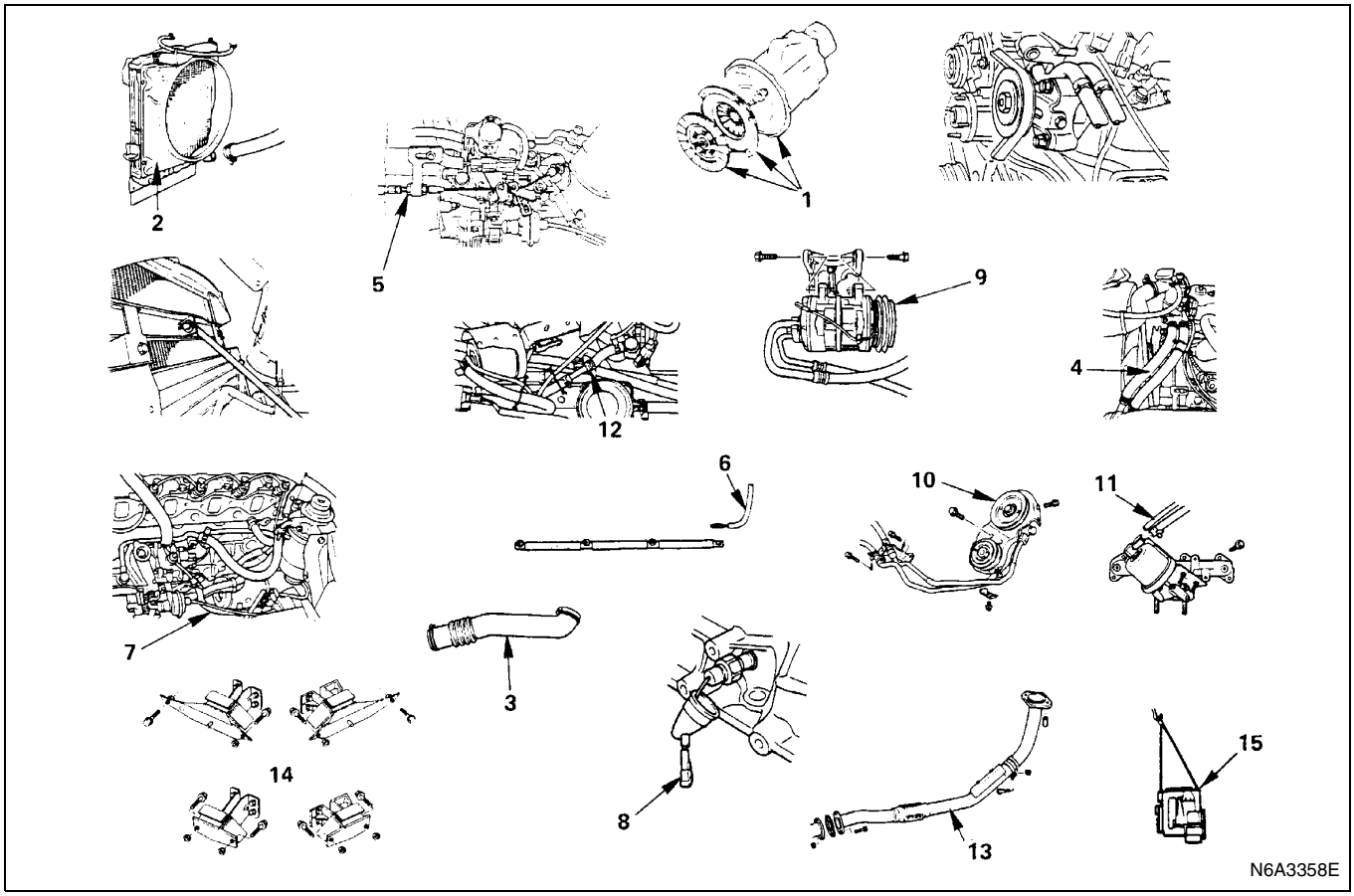
    2) Camshaft timing gear
    3) Injection pump
    4) Idler gear "B" and shaft
    5) Idle gear
    6) Timing gear oil pipe
    7) Timing gear case cover
    8) Noise cover spacer
    9) Noise shield cover
    10) Crankshaft damper pulley
    11) Cooling fan assembly
        Above works refer to "TIMING GEAR (Gear Type)" Section in this manual.
14. Cylinder Head Assembly and Gasket
    1) Cylinder head gasket
    2) Cylinder head assembly
    3) Push rod
    4) Rocker arm shaft assembly

    Valve Clearance Adjustment

    5) Cylinder head cover
    6) By-pass hose
    7) Oil cooler water pipe (Oil Cooler Model)
    8) Oil level gauge guide tube
    9) Glow plug harness connector
    10) PCV hose
    11) Fuel leak off pipe
    12) Injection pipe
        Above works refer to "CYLINDER HEAD ASSEMBLY AND GASKET" Section in this manual.
15. Engine Assembly
    1) Support rubber
    2) Front exhaust pipe
    3) Vacuum pump hose
    4) Actuator vacuum hose (Exhaust Brake Model)
    5) Power steering pump & bracket assembly (Power Steering Model)
    6) A/C compressor assembly (A/C Model)
    7) Oil pressure switch harness
    8) Fuel hose
    9) Glow plug harness
    10) Engine control cable
    11) Heater hose
    12) Intake air duct
    13) Radiator assembly
        Above works refer to "ENGINE ASSEMBLY" Section in this manual.
16. Transmission and Clutch Assembly
    1) Clutch
    2) Transmission
        Above works refer to "ENGINE ASSEMBLY" Section in this manual.

ENGINE ASSEMBLY

Component



Legend

1. Transmission and clutch assembly
2. Radiator assembly
3. Intake air duct
4. Heater hose
5. Engine control cable
6. Glow plug harness
7. Fuel hose
8. Oil pressure switch harness
9. A/C Compressor assembly (A/C model)
10. Power steering pump & bracket assembly (Power steering model)
11. Actuator vacuum hose (Exhaust brake model)
12. Vacuum pump hose
13. Front exhaust pipe
14. Support rubber
15. Engine assembly

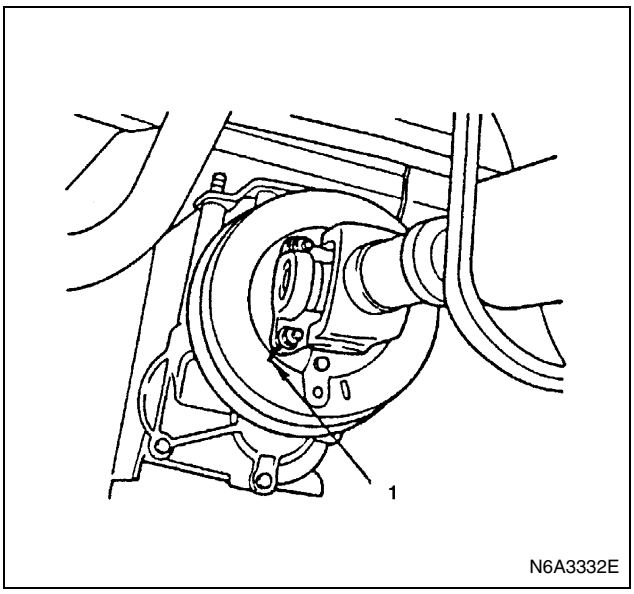
Removal

Preparation

- Disconnect battery ground cable.
- Drain coolant.

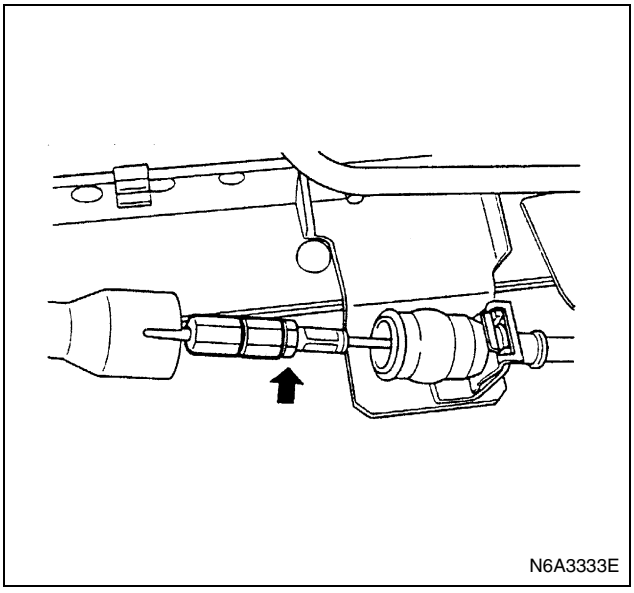
1. Transmission and Clutch Assembly

- Raise vehicle and support with suitable safely.
  1) Propeller Shaft
  - Reference mark the flange yoke to the parking brake drum.
  - Disconnect the propeller shaft at flange yoke.
  - Put aside the propeller shaft and tie it to the frame so that it does not interface with servicing work.



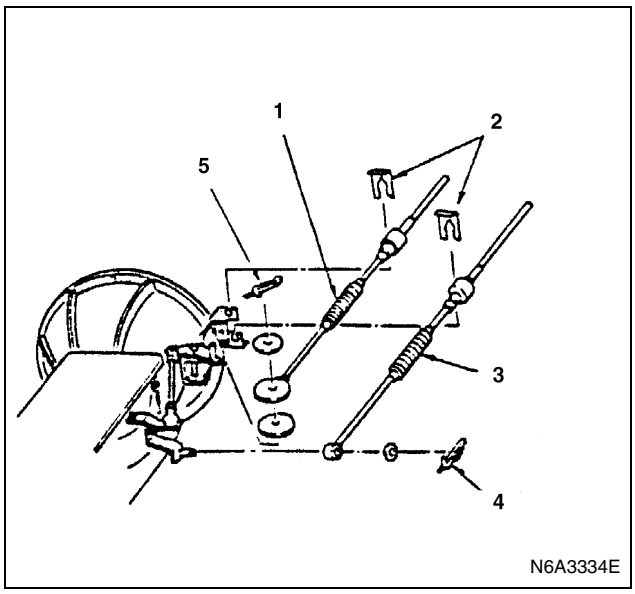
Legend
1. Reference mark

2) Parking Brake Cable
- Move the joint cover.
- Disconnect the joint bolt.
- Remove the clip then disconnect the cable from the bracket.



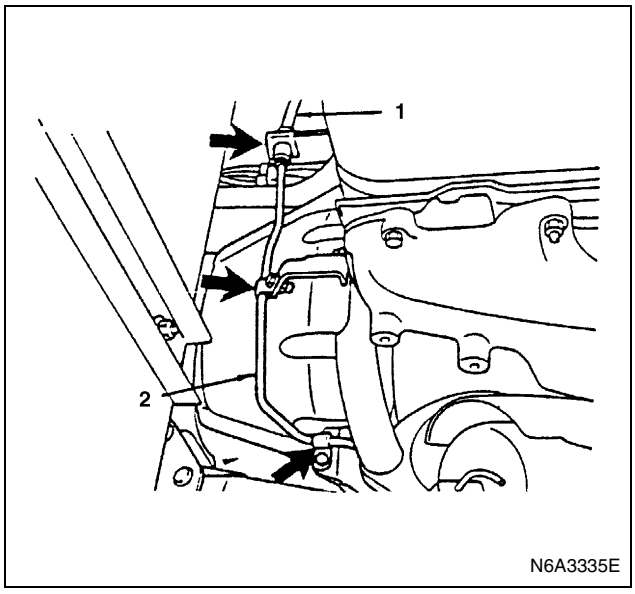
3) Wiring Connector
- Disconnect the wiring connectors from the car speed sensor, the neutral switch and the back-up light switch.

4) Shift Cable and Select Cable
- Disconnect the shift cable and select cable on the transmission side.



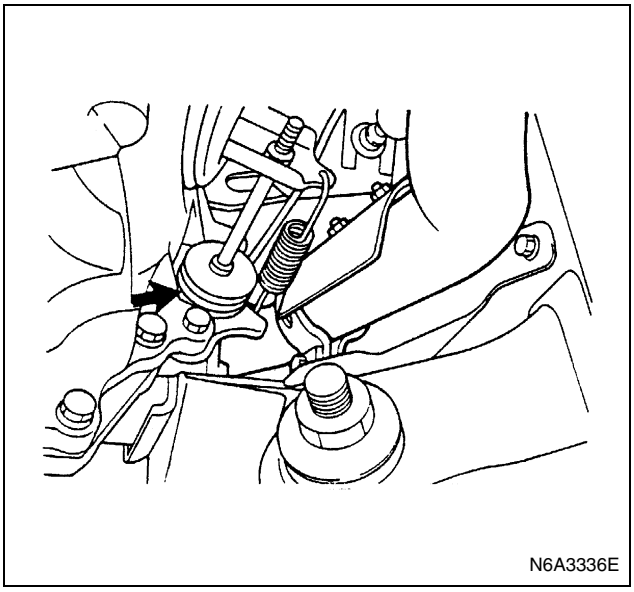
Legend
1. Shift cable
2. Clip
3. Select cable
4. Snap pin
5. Snap pin

5) Clutch Slave Cylinder
- Remove the clutch pipe fixing clips and the clip bracket (Right hand drive models only).



Legend
1. Flexible hose
2. Clutch pipe

- Remove the slave cylinder assembly with the flexible hose attached, and then tie it to the frame so that it does not interface with servicing work.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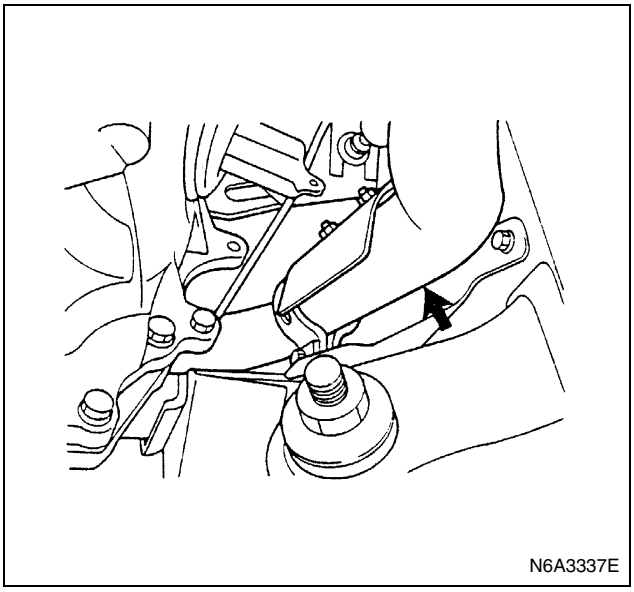
6) Exhaust Brake Assembly
7) Front Exhaust Pipe


N6A3337E

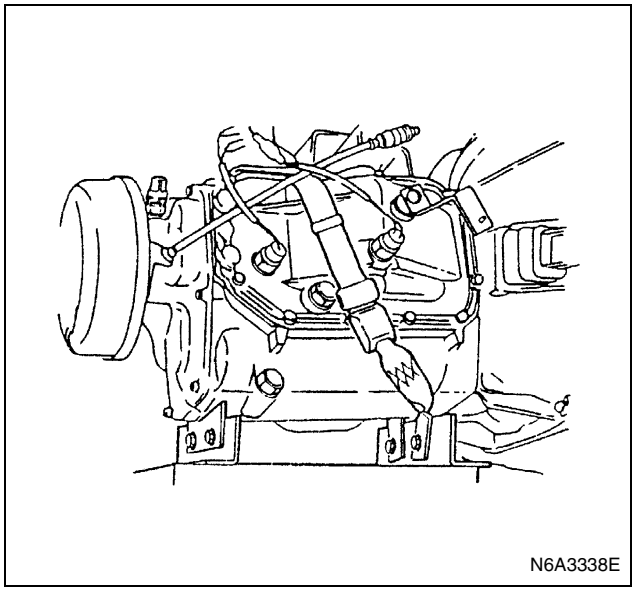
8) Transmission Assembly

Notice:
The exhaust pipe bracket, the gear control bracket and the clips are sometimes installed in the wrong position or direction confusedly. To prevent incorrect installation of these parts, put a correct installation mark on them.

- Support the transmission with mission jack.

Caution:
To prevent the falling of the transmission, tie it firmly to the jack with a chain or belt.

Do not allow transmission to hang unsupported from clutch. Damage to the clutch assembly will result.


N6A3338E

- Remove the nuts of the transmission mounting bracket on the crossmember side.
- Engine and transmission angles may need to be adjusted for removal.
- Hold the rear section of the engine by the jack or hoist.

Caution:
When lifting the engine by the jack, use wood blocks to prevent any possible damage to the oil pan.

- Remove transmission fastening bolts.
- Pull out the transmission assembly rearward.

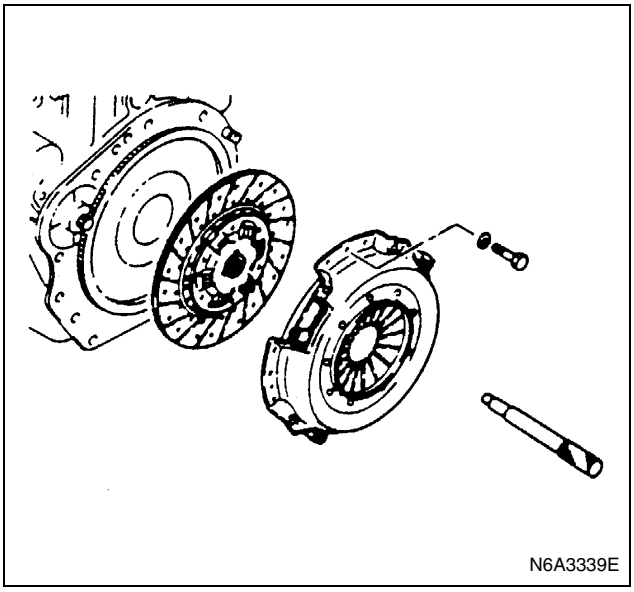
9) Mounting Bracket

- Raise vehicle and support with suitable safety stands.

Caution:
Do not let clutch fluid remain on a painted surface, wash it off immediately.

10) Pressure Plate Assembly
11) Driven Plate Assembly

- Use the pilot aligner to prevent the driven plate assembly from falling free.
  Pilot Aligner: 5-5825-3001-0
- Mark the flywheel and pressure plate lug for alignment when installing.
- Loosen the pressure plate assembly fixing bolts.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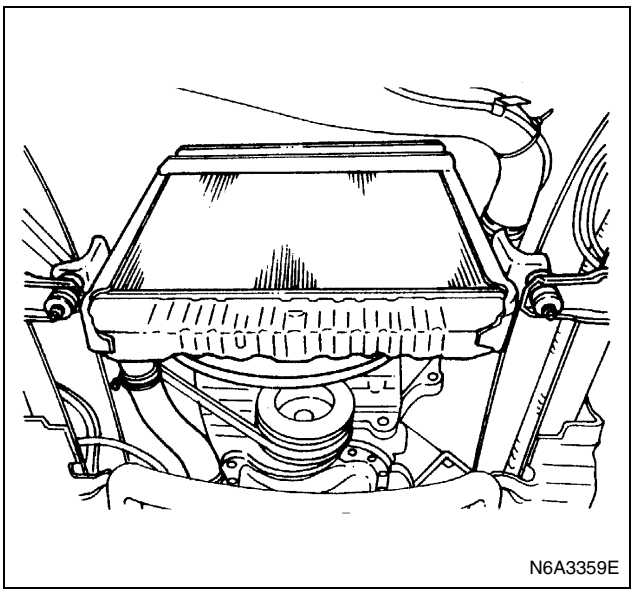
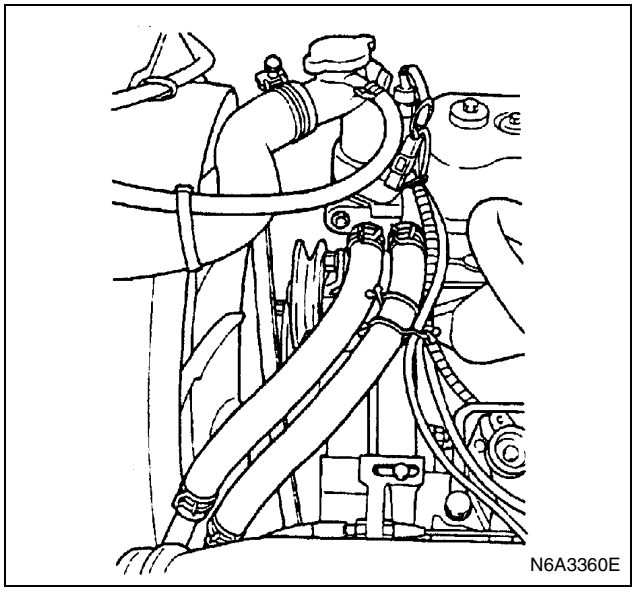
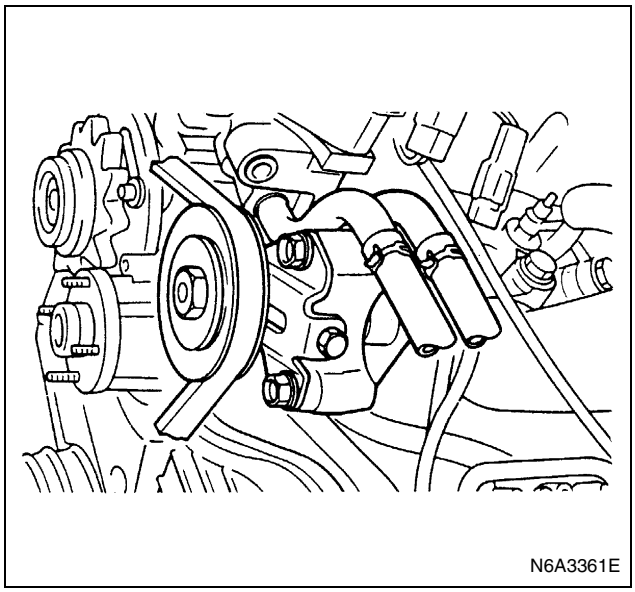
2. Radiator Assembly
   1) Remove the radiator hose upper and lower.
   2) Remove the reservoir tank hose.
   3) Remove the cushion rubbers on both sides.
   4) Remove the radiator stay.


N6A3359E

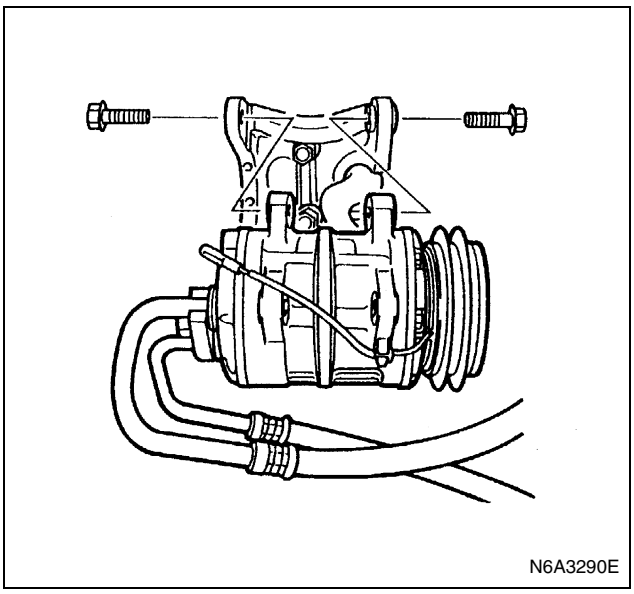
3. Intake Air Duct
4. Heater Hose
5. Engine Control Cable
   - Loosen the locking nut at the bracket and disconnect accelerator cable from injection pump control lever.


N6A3360E

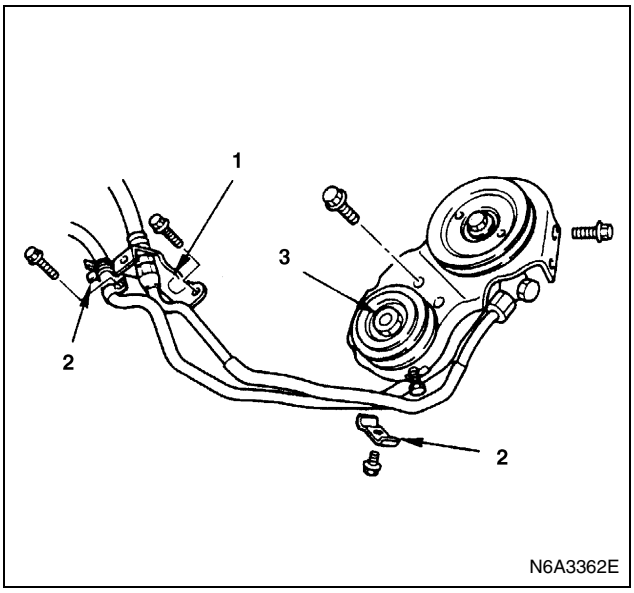
6. Glow Plug Harness
7. Fuel Hose
   - Remove the fuel inlet hose and fuel return hose.
8. Oil Pressure Switch Harness
9. A/C Compressor Assembly
   - Loosen the idler pulley lock nut.
   - Loosen the adjust bolt then remove the drive belt.


N6A3361E

   - Disconnect magnetic clutch harness connector.
   - Remove the A/C compressor fixing bolts and temporally tighten the A/C compressor to chassis frame side use the wire.


N6A3290E

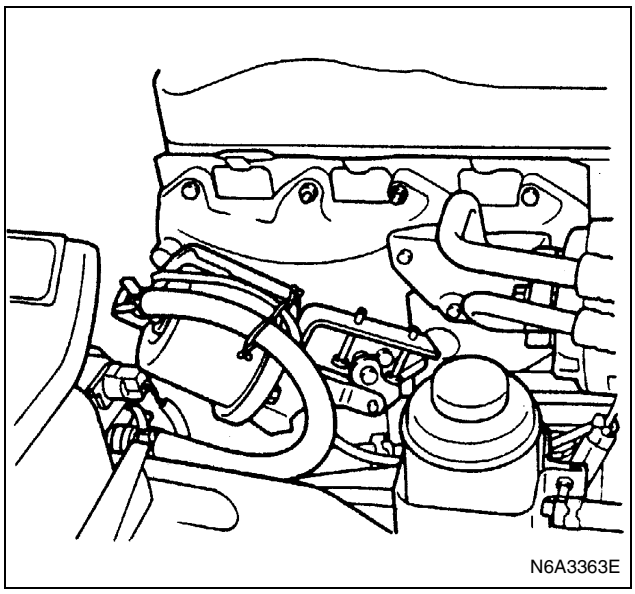
10. Power Steering Pump & Bracket Assembly (Power Steering Model)
    1) Loosen the idler pulley lock nut.
    2) Loosen the adjust bolt then remove the drive belt.
    3) Remove the pipe bracket fixing bolt and clip.
    4) Remove the power steering pump fixing bolts pump to chassis frame side use the wire.



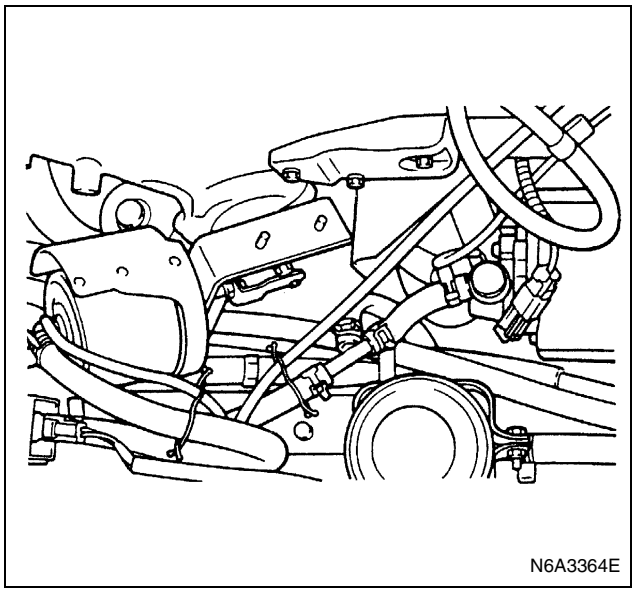
N6A3362E

Legend
1. Bracket
2. Clip
3. Lock nut

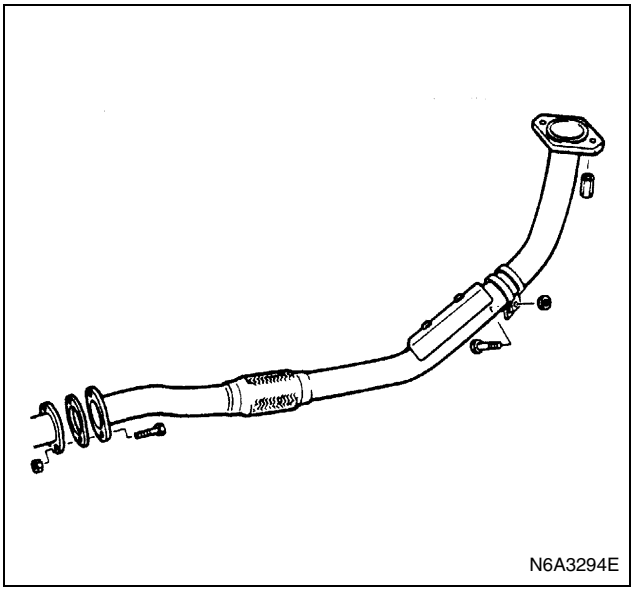
11. Actuator Vacuum Hose (Exhaust Brake Model)
    - Disconnect the vacuum hose from actuator side.


N6A3363E

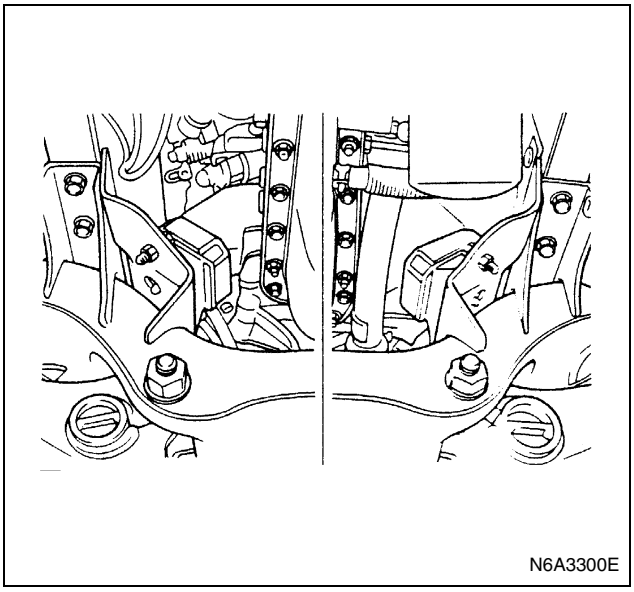
12. Vacuum Pump Hose (Exhaust Brake Model)
    - Disconnect the vacuum hose from vacuum tank side and magnetic valve side.


N6A3364E

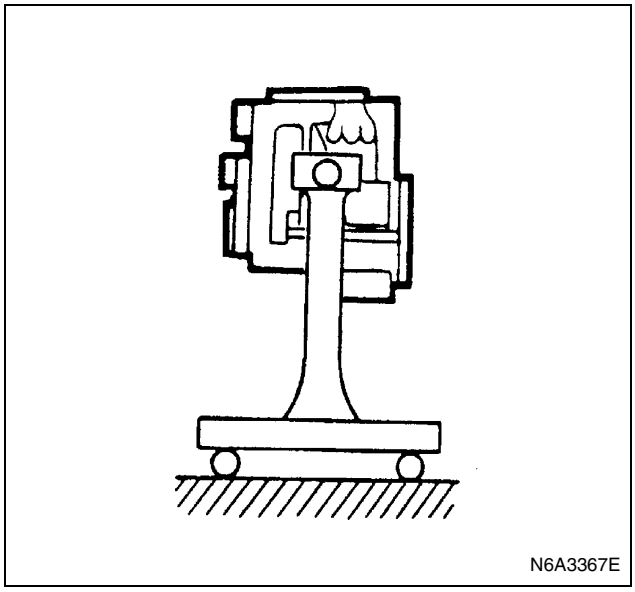
13. Front Exhaust Pipe
    - Remove the exhaust pipe fixing bolts from exhaust manifold.
    - Remove the exhaust pipe stay bolt.
    - Remover the fixing nuts from front pipe.


N6A3294E

14. Support Rubber
    1) Right Hand
    • Remove two fixing nuts at the cross member side.
    2) Left Hand
    • Remove two fixing nuts at the cross member side.


N6A3300E

15. Engine Assembly
    1) Lift engine carefully by using hoist.

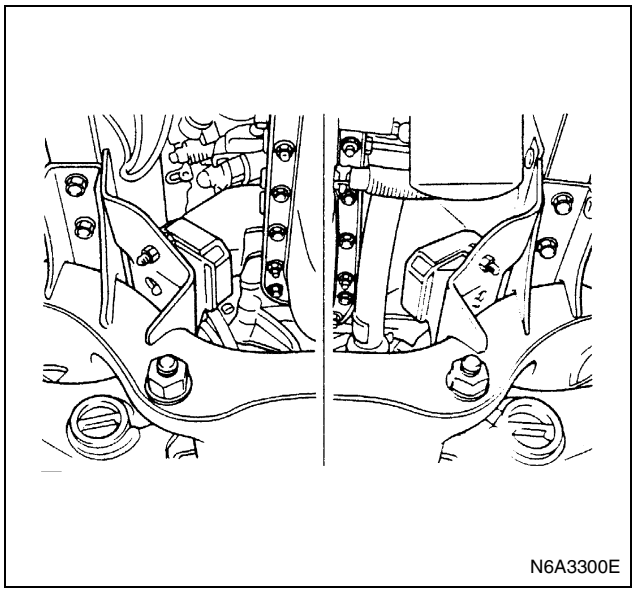

N6A3367E

    2) Lift front part of engine higher than rear part of it.
    3) Take out engine assembly taking care not to damage full pipes, brake pipes and so on.

Installation

1. Engine Assembly
   • Position engine mountings by using hoist.
2. Support Rubber
   • After all fixing bolts (left: two bolts, right: two bolts) were inserted to every holes, and engine asm and tighten fixing bolts to the specified torque.

Tighten:
• 40 N·m (4.1 kg·m / 30 lb·ft)

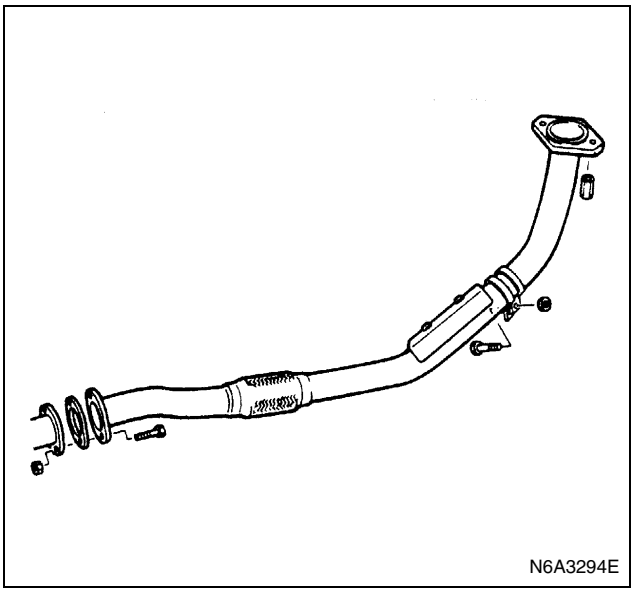

N6A3300E

3. Front Exhaust Pipe
   • Connect the exhaust pipe and tighten nut to the specified torque.

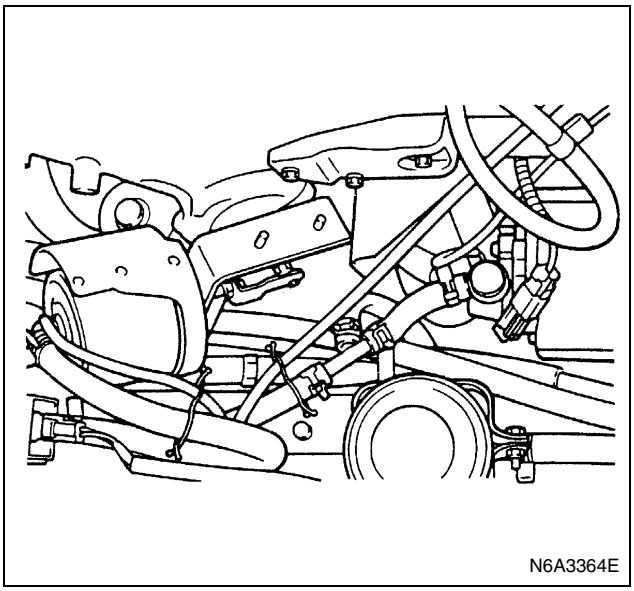
Tighten:
• Exhaust pipe nut to 69 N·m (7.0 kg·m / 51 lb·ft)

- Install the exhaust pipe stay and tighten bolt nut to the specified torque.

Tighten:
- Stay bolt nut to 40 N·m (4.1 kg·m / 30 lb·ft)


N6A3294E

4. Vacuum Pump Hose (Exhaust Brake Model)
   - Connect the vacuum hose to vacuum tank side and magnetic valve side.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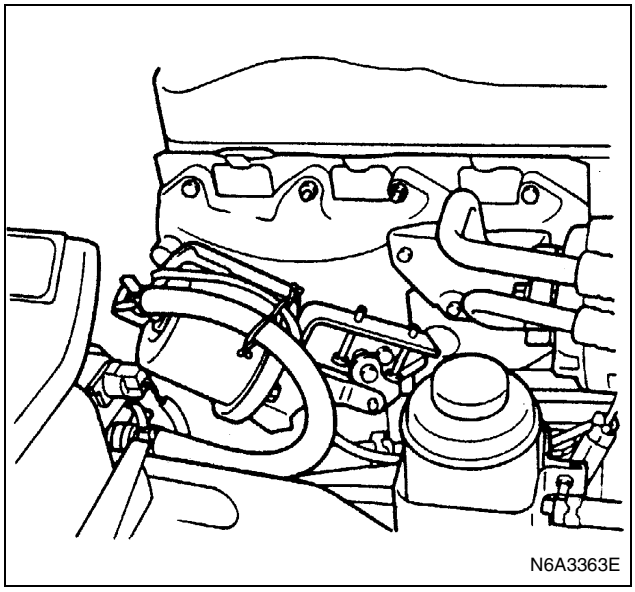
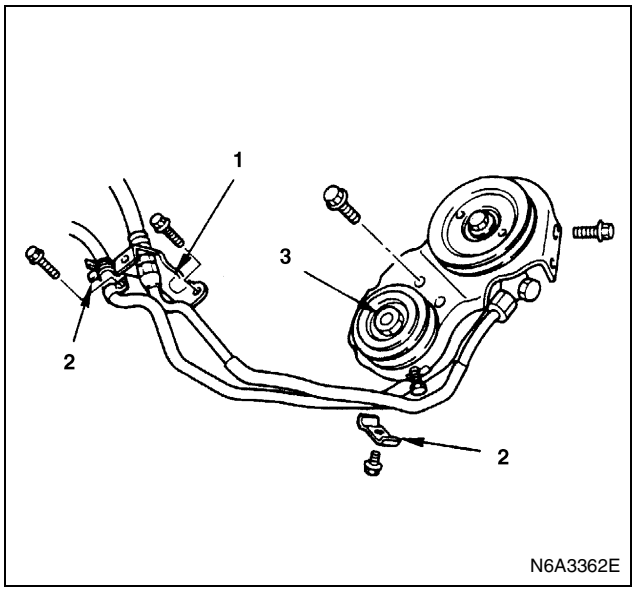
5. Actuator Vacuum Hose (Exhaust Brake Model)
   - Connect the vacuum hose to actuator.


N6A3363E

6. Power Steering Pump & Bracket Assembly (Power Steering Model)
   - Install the power steering pump and pipe bracket then tighten bolts to the specified torque.

Tighten:
- Pump bolts to 19 N·m (1.9 kg·m / 14 lb·ft)
- Pipe bracket bolts to 19 N·m (1.9 kg·m / 14 lb·ft)
- Clip bolt to 10 N·m (1.0 kg·m / 87 lb·in)



N6A3362E

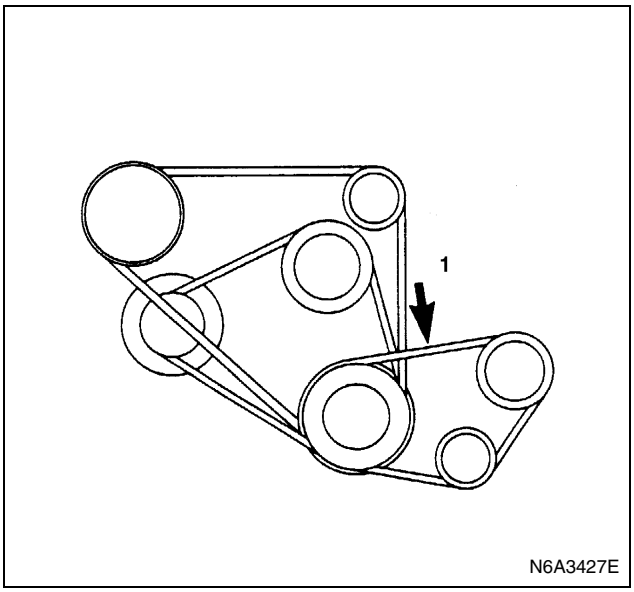
Legend
1. Bracket
2. Clip
3. Lock nut

- Install Power Steering pump drive belt (1) and adjust belt tension.
  Check drive belts for wear or damage, and replace with new ones as necessary.
  Check belts for tension, and adjust as necessary.

- Push the middle of belts with a force of 10 kg and check each bolt for deflection.
- Standard deflection

	mm (in)
	Initial tension
P/S pump drive belt	8 — 12 (0.31 — 0.47)

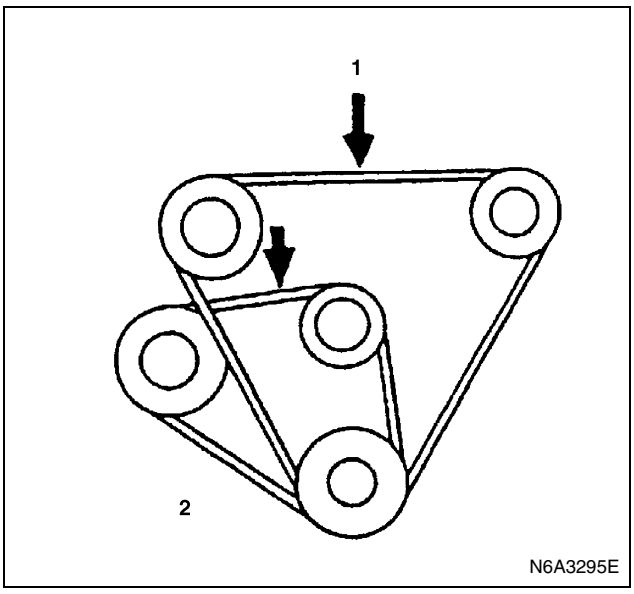
4JG2



- P/S pump lock bolt loose, adjust belt tension with adjust belt.

Tighten:
- Idler lock nut to 27 N·m (2.8 kg·m / 20 lb·ft)

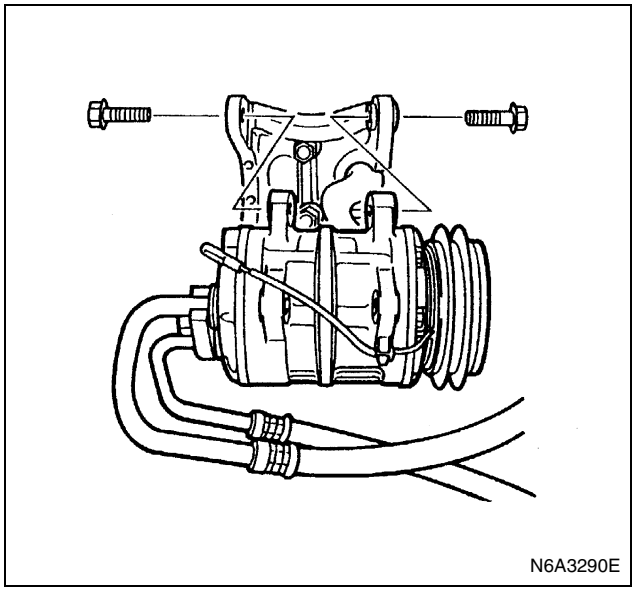
4JB1



Legend
1. A/C compressor drive belt & P/S pump drive belt
2. AC generator & fan pulley drive belt

7. A/C Compressor Assembly (A/C Model)
   - Install the A/C compressor fixing bolts and tighten bolts to the specified torque.

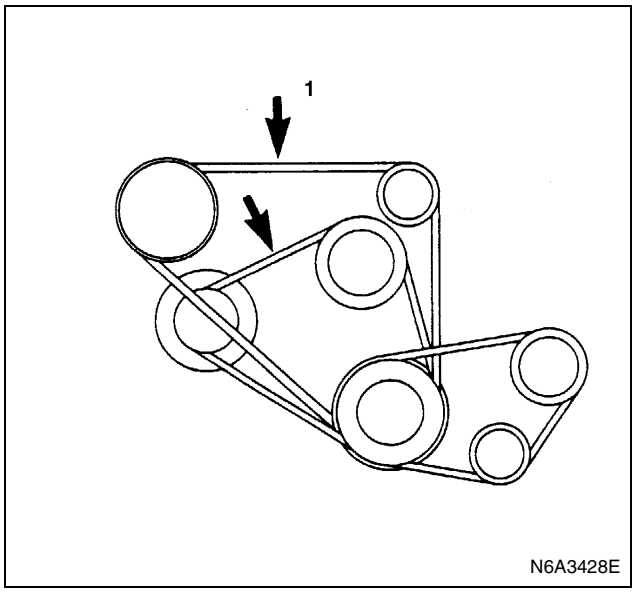
Tighten:
- Compressor fixing bolts to 37 N·m (3.8 kg·m / 27 lb·ft)



- Connect the magnetic clutch harness connector.
- Install A/C compressor drive belt (1) and adjust belt tension.
  Check drive belts for wear or damage, and replace with new ones as necessary. Check belts for tension, and adjust as necessary.
- Push the middle of belts with a force of 10kg and check each bolt for deflection.
- Standard deflection

	mm (in)
	Initial tension
A/C compressor drive belt	8 — 12 (0.31 — 0.47)

4JG2

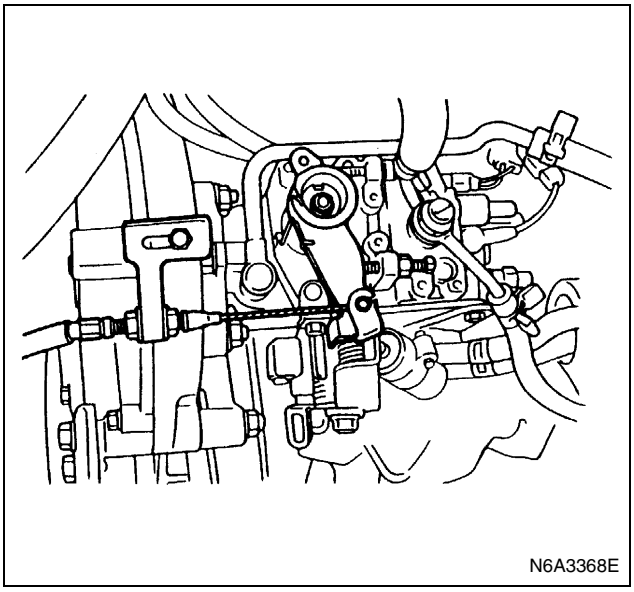


- A/C compressor pulley lock bolt loose, adjust belt tension with adjuster's adjust bolt.

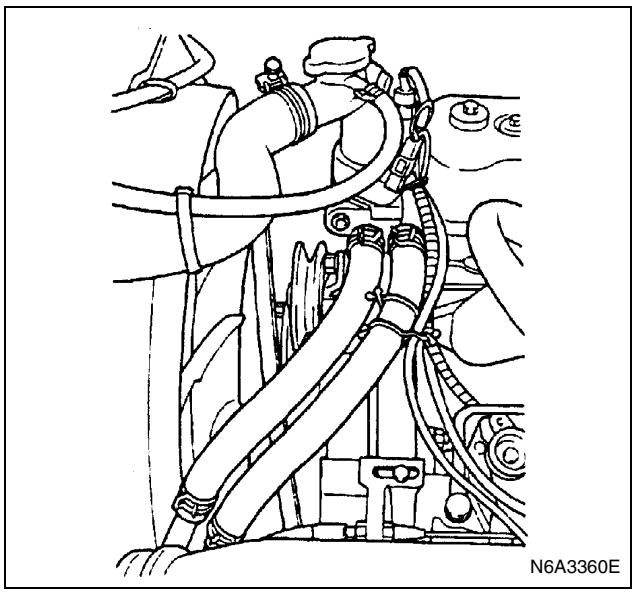
Tighten:

- Idler lock nut to 27 N·m (2.8 kg·m / 20 lb·ft)

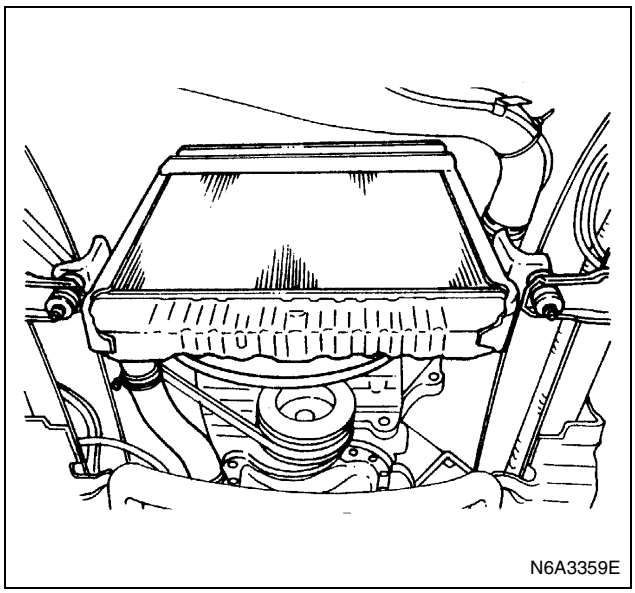
8. Oil Pressure Switch Harness
   - Connect the oil pressure switch harness connector.
9. Fuel Hose
   - Connect the fuel feed hose and return hose then tighten clip securely.
10. Glow Plug Harness
    - Install the harness connector then tighten bolt securely.
11. Engine Control Cable
    1) Install the control wire to the engine control lever.
    2) Hold accelerator lever in the fully closed position and stretch the control cable in the direction indicated by the arrow to remove any slack.
    3) Tighten the accelerator cable bracket bolt.


N6A3368E

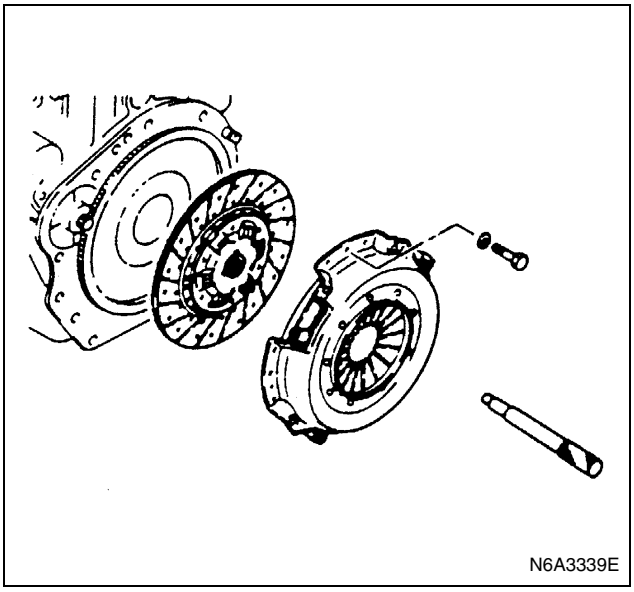
12. Heater Hose
    - Connect the heater hose then tighten clip securely.
13. Intake Air Duct
    - Connect the air duct then tighten clip securely.


N6A3360E

14. Radiator Assembly
    1) Install the cushion rubber on both sides.
    2) Install the radiator stay
    3) Connect the radiator hose upper and lower.
    4) Connect the reservoir tank hose.

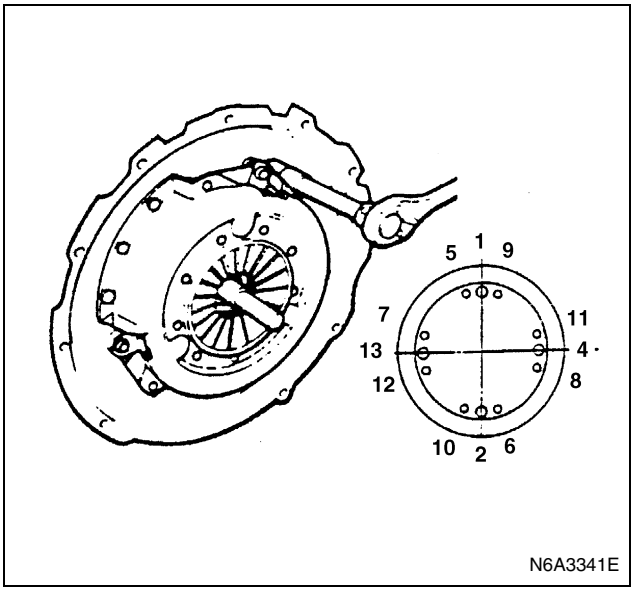

N6A3359E

15. Transmission and Clutch Assembly
    1) Driven Plate Assembly
       - Apply multi-purpose with MOS2 type grease to the driven plate hub spline.
       - Use the pilot aligner to install the driven plate assembly.
         Pilot Aligner: 5-5825-3001-0


N6A3339E

2) Pressure Plate Assembly
   - Tighten pressure plate assembly fixing bolts in numerical order.

Tighten:
- Pressure plate fixing bolt to 18 N·m (1.8 kg·m / 13 lb·ft)



N6A3341E

- Remove the pilot aligner.

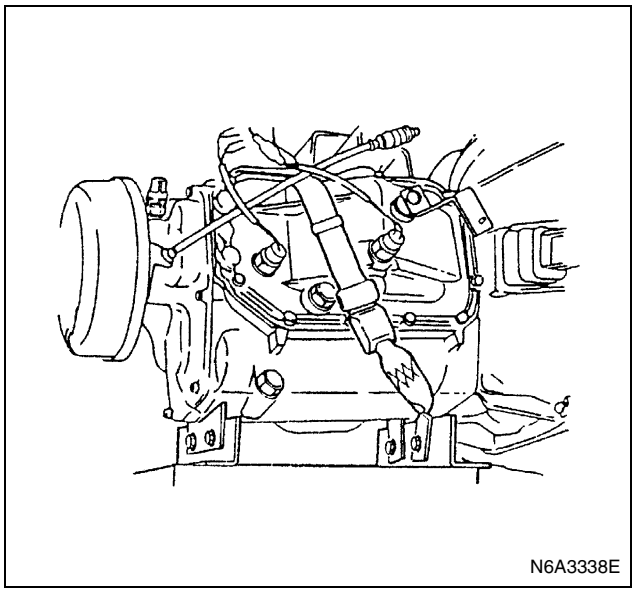
Notice:
In case a new pressure plate assembly is mounted, after tightening a pressure plate at the specified torque, be sure to remove the wiring for protection of a diaphragm spring.

3) Mounting Bracket

Tighten:
- Mounting bracket nuts to 69 N·m (7.0 kg·m / 51 lb·ft)

4) Transmission Assembly
   - Support the transmission with mission jack.

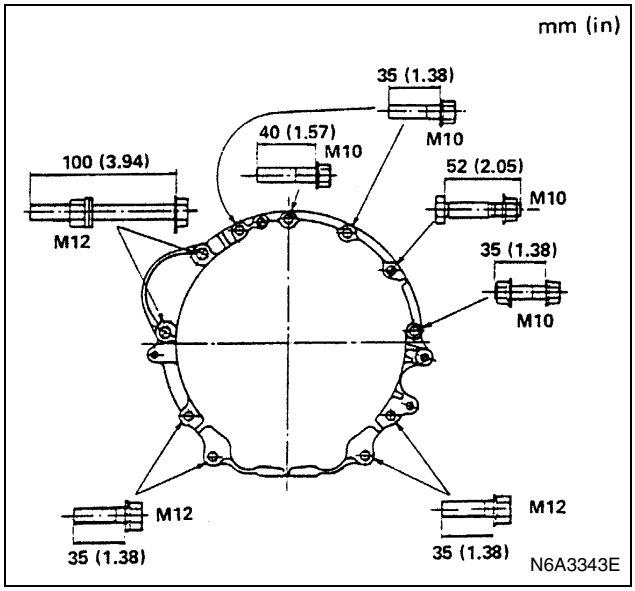
Caution:
To prevent the falling of the transmission, tie it securely to the jack with a chain or belt.


N6A3338E

- Shift transmission into high gear.
- Align transmission with engine slope.
- Turn output parking brake drum to aid clutch spring engagement.

Tighten:
- Clutch housing to flywheel hosing bolts to
  M10: 46 N·m (4.7 kg·m / 34 lb·ft)
  M12: 91 N·m (9.3 kg·m / 67 lb·ft)
  - Raise engine and transmission up into rear transmission mount.

Tighten:
- Engine rear mounting nuts to
  M10: 40 N·m (4.1 kg·m / 30 lb·ft)
  M12: 69 N·m (7.0 kg·m / 51 lb·ft)



N6A3343E

5) Front Exhaust Pipe

Tighten:
- Front exhaust pipe bolts to 37 N·m (3.8 kg·m / 27 lb·ft)

6) Exhaust Brake Assembly

Tighten:
- Exhaust brake bolts to 17 N·m (1.8 kg·m / 12 lb·ft)

7) Clutch Slave Cylinder

Tighten:
- Slave cylinder bolts to 19 N·m (1.9 kg·m / 14 lb·ft)
  - Perform slave cylinder adjustment before installation of the return spring.
    a. Loosen the lock nut of the push rod.
    b. Turn the adjust nut until it reaches the shift fork.
    c. Back off the adjust nut 1.5 turns. (shift fork free play Approximately 2 mm / 0.1 in).
    d. Tighten the lock nut.

Tighten:
- Push rod lock nut to 16 N·m (1.6 kg·m / 12 lb·ft)

8) Shift Cable and Select Cable
9) Wiring Connector
   - Color of Connector
     Back-up Light Switch: Brown
     Neutral Switch: Gray
10) Parking Brake Cable
11) Propeller Shaft
   - Line up reference mark.

Tighten:
- Propeller shaft nuts to 66 N·m (6.7 kg·m / 48 lb·ft)
  - Connect battery ground cable
  - Pour coolant
  - Start the engine and check coolant leakage

ENGINE 4J SERIES

SECTION 6B

ENGINE COOLING

Contents

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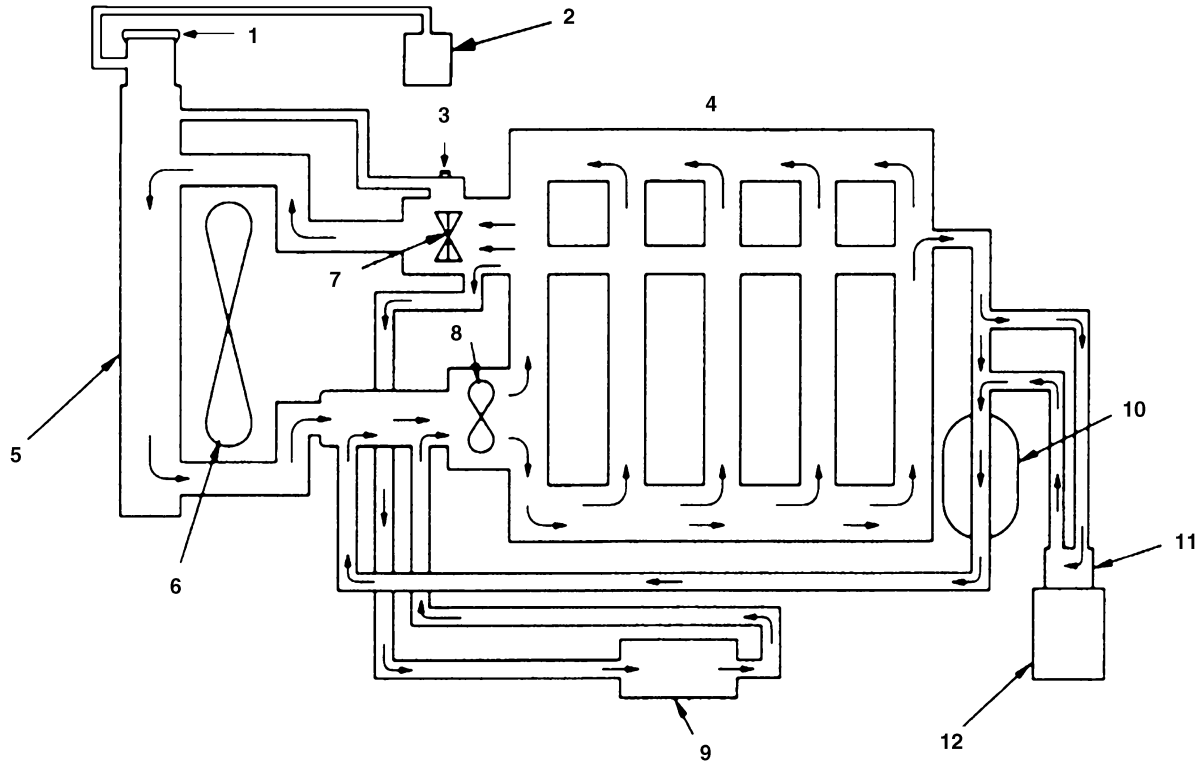
GENERAL DESCRIPTION

Component

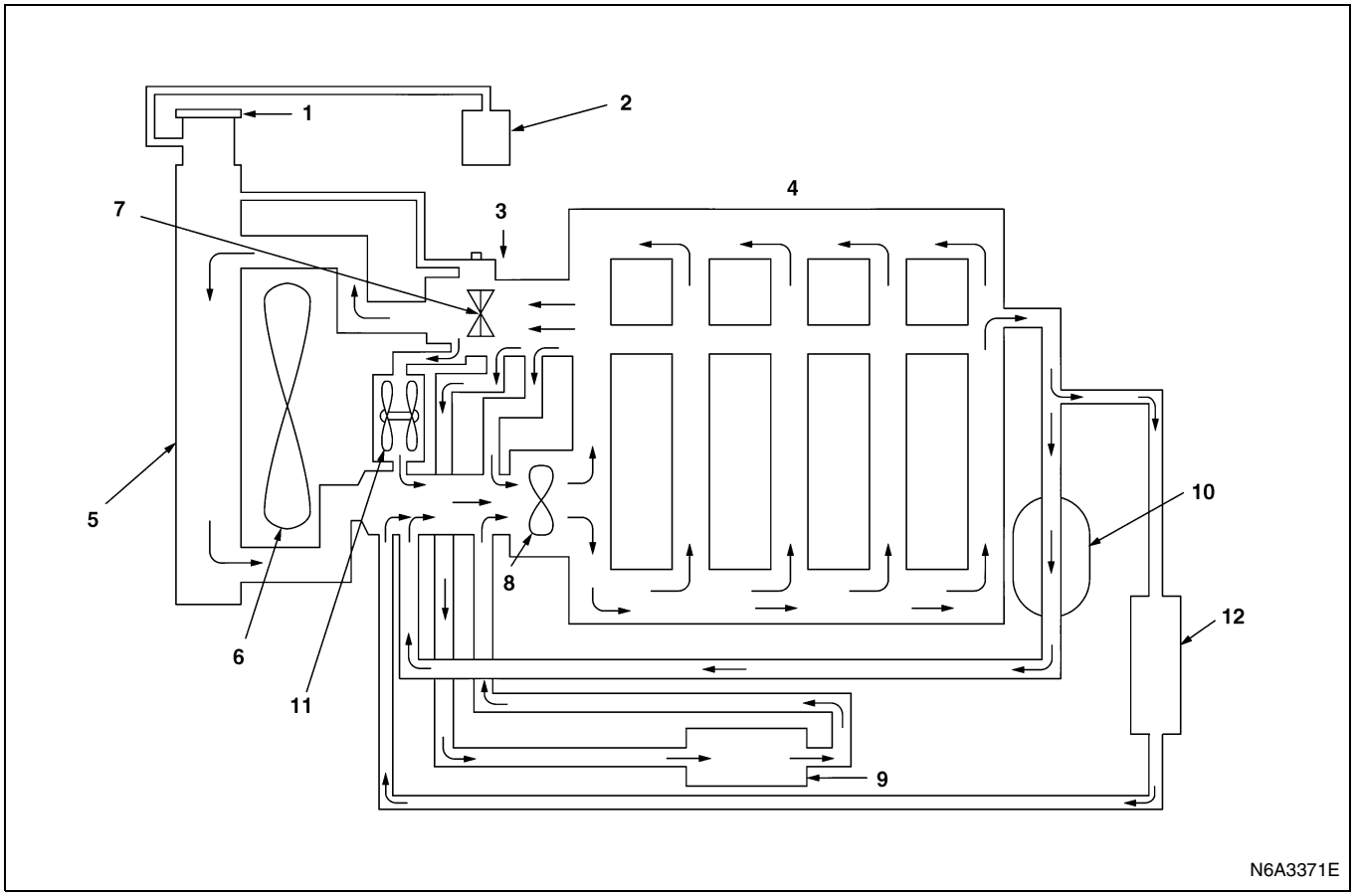
Coolant Flow



Legend

1. Radiator cap
2. Reservoir tank
3. Air bleeding plug
4. Cylinder head
5. Radiator
6. Cooling fan
7. Thermostat
8. Water pump
9. Car heater
10. Oil cooler
11. C.S.D
12. Injection pump

Coolant Flow (4JH1-TC)



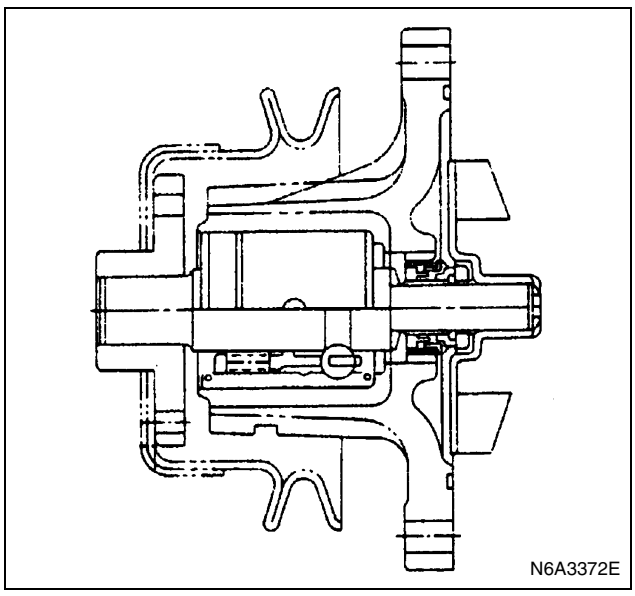
Legend

1. Radiator cap
2. Reservoir tank
3. Air bleeding plug
4. Cylinder head
5. Radiator
6. Cooling fan
7. Thermostat
8. Water pump
9. Car heater
10. Oil cooler
11. Turbo charger
12. EGR Cooler

The cooling system is a pressurized coolant forced circulation type which consists of water pump, thermostat cooling fan, radiator and other components. The circulating coolant cools the lubricating oil in the oil filter and turbocharger.

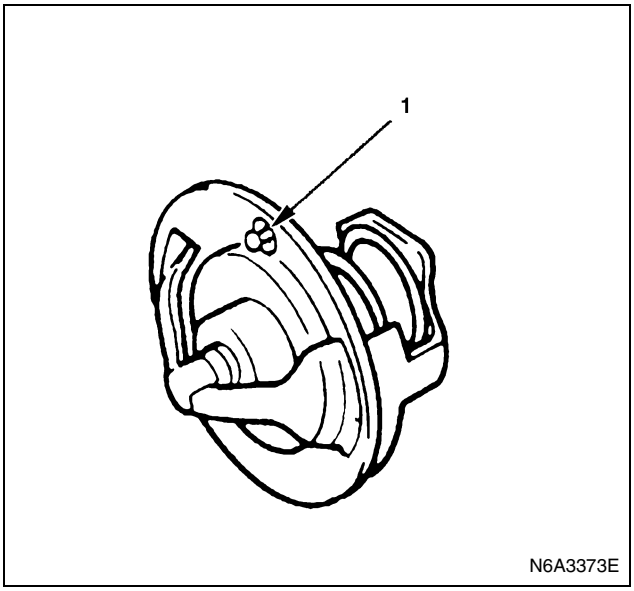
Water Pump

The coolant pump is a centrifugal impeller type and is driven by V type drive belt.
The water pump is not disassembled type.



Thermostat

The thermostat is a wax pellet type with a juggle valve and is installed in the thermostat housing.

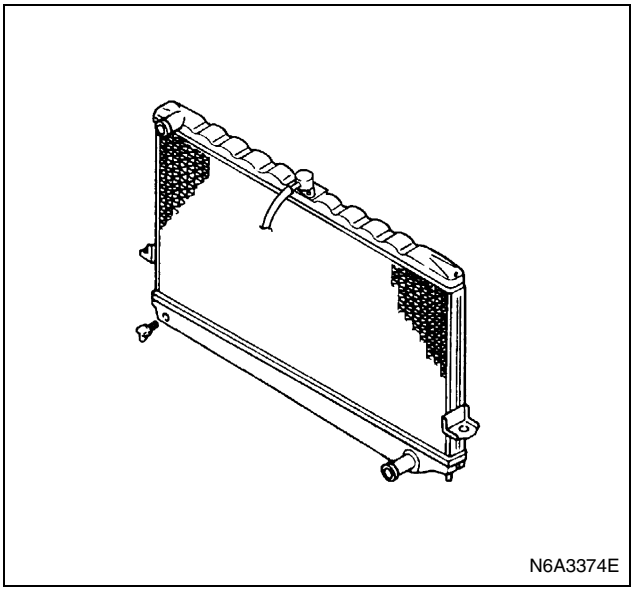


Legend

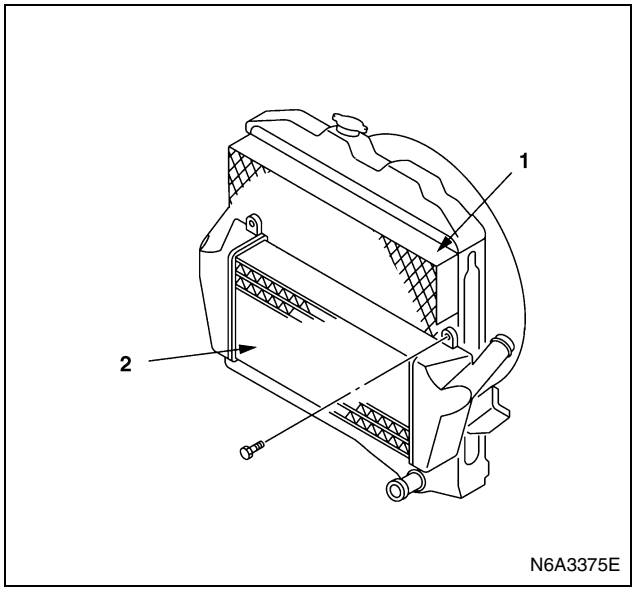
1. Jiggle valve

Radiator

The radiator is a tube type with corrugated fins. In order to raise the boiling point of coolant, the radiator is adjusted through a valve fitted to the upper tank to a pressure range of 93 — 123 kPa (0.95 — 1.25 kg/cm^2). The cap fitted to the cylinder head thermostat housing has only a water supply function.



The 4JH1-TC engine is equipped with the intercooler.



Legend

1. Radiator
2. Charge air cooler

Engine Coolant Change Procedure

1. To change engine coolant, make sure that the engine is cool.

WARNING:
WHEN THE COOLANT IS HEATED TO A HIGH TEMPERATURE, BE SURE NOT TO LOOSEN OR REMOVE THE RADIATOR CAP.
OTHERWISE YOU MIGHT GET SCALDED BY HOT VAPOR OR BOILING WATER. TO OPEN THE RADIATOR CAP, PUT A PIECE OF THICK CLOTH ON THE CAP AND LOOSEN THE CAP SLOWLY TO REDUCE THE PRESSURE WHEN THE COOLANT HAS BECOME COOLER.

2. Open radiator cap and drain the cooling system by loosening the drain valve on the radiator and on the cylinder body.

Notice:
For best result it is suggested that the engine cooling system be flushed at least once a year. It is advisable to flush the interior of the cooling system including the radiator before using specified coolant.

Replace damaged rubber hoses as the engine specified coolant. Coolant is liable to leak out even minor cracks.

Isuzu recommends to use Isuzu genuine specified coolant or equivalent, for the cooling system and not add any inhibitors or additives.

Caution:
A failure to correctly fill the engine cooling system in changing or topping up coolant may sometimes cause the coolant to overflow from the filler neck even before the engine and radiator are completely full.

If the engine runs under this condition, shortage of coolant may possibly result in engine overheating. To avoid such trouble, the following precautions should be taken in filling the system.

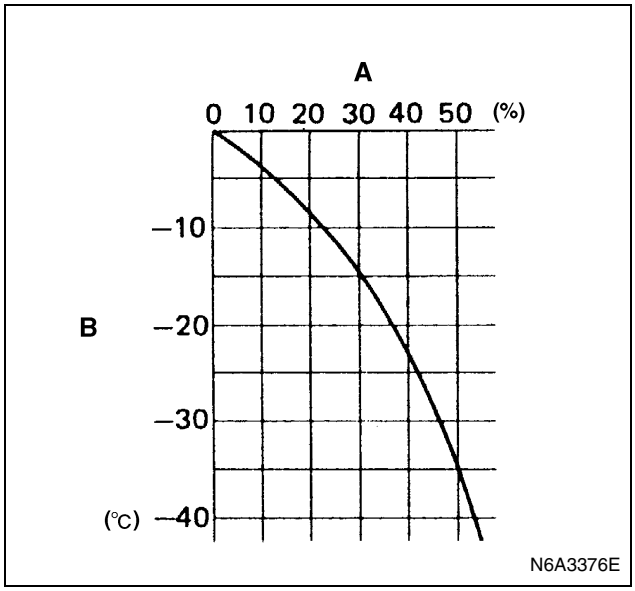
3. To refill engine coolant, pour coolant up to filler neck using a filling hose which is smaller in outside diameter of the filler neck.
   Otherwise air between the filler neck and the filling hose will block entry, preventing the system from completely filling up.
4. Keep a filling rate of 9 liter/min. or less. Filling over this maximum rate may force air inside the engine and radiator.
   And also, the coolant overflow will increase, making it difficult to determine, whether or not the system is completely full.
5. After filling the system to the full, pull out the filling hose and check to see if air trapped in the system is dislodged and the coolant level goes down. Should the coolant level go down, repeat topping-up until there is no more drop in the coolant level.
6. After directly filling the radiator, fill the reservoir to the maximum level.
7. Install and tighten radiator cap and start the engine. After idling for 2 to 3 minutes, stop the engine and reopen radiator cap. If the water level is lower, replenish.

WARNING:
WHEN THE COOLANT IS HEATED TO A HIGH TEMPERATURE, BE SURE NOT TO LOOSEN OR REMOVE THE RADIATOR CAP.
OTHERWISE YOU MIGHT GET SCALDED BY HOT VAPOR OR BOILING WATER. TO OPEN THE RADIATOR CAP, PUT A PIECE OF THICK CLOTH ON THE CAP AND LOOSEN THE CAP SLOWLY TO REDUCE THE PRESSURE WHEN THE COOLANT HAS BECOME COOLER.

8. After tightening radiator cap, warm up the engine at about 2,000 rpm.
   Set heater adjustment to the highest temperature position, and let the coolant circulate also into heater water system.
9. Check to see the thermostat has opened through the needle position of water thermometer, conduct a 5 minutes idling again and stop the engine.
10. When the engine has been cooled, check filler neck for water level and replenish if required. Should extreme shortage of coolant is found, check the coolant system and reservoir tank hose for leakage.
11. Fill the coolant into the reservoir tank up to “MAX” line.

Specified Coolant Solution

- Relation between Mixing ratio and Freezing point
  Freezing temperature of the engine coolant varies with the ratio of specified coolant solution in water. Proper mixing ratio can be determined by referring to the chart. Supplemental inhibitors or additives claiming to increase cooling capability that have not been specifically approved by Isuzu are not recommended for addition to the cooling system.



Legend
A. Mixing ratio
B. Freezing point

- Calculation of mixing ratio

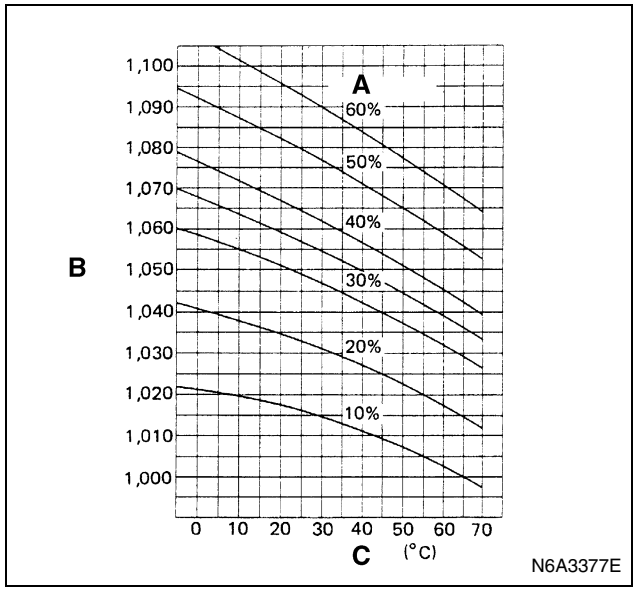
$$\text{Mixing ratio} = \frac{\text{Specified coolant solution (Lit/qt.)}}{\text{Specified coolant solution (Lit/qt.)} + \text{Water (Lit/qt.)}}$$

Notice:
Specified coolant solution + Water = 10 lit
Total cooling system capacity.
In case of 6.8 lit total cooling system capacity

Mixing ratio (%)	Specified coolant solution: lit. (imp. qt./U.S. qt)		Water: lit. (imp. qt/U.S. qt)	
0	0	0	10	(8.80/10.57)
5	0.5	(0.44/0.53)	9.5	(8.36/10.04)
10	1.0	(0.88/1.06)	9.0	(7.92/9.51)
15	1.5	(1.32/1.59)	8.5	(7.48/8.98)
20	2.0	(1.76/2.11)	8.0	(7.04/8.45)
25	2.5	(2.20/2.64)	7.5	(6.60/7.93)
30	3.0	(2.64/3.17)	7.0	(6.16/7.40)
35	3.5	(3.08/3.70)	6.5	(5.72/6.87)
40	4.0	(3.52/4.23)	6.0	(5.28/6.34)
45	4.5	(3.96/4.76)	5.5	(4.84/5.81)

Mixing ratio (%)	Specified coolant solution: lit. (imp. qt./U.S. qt)	Water: lit. (imp. qt/U.S. qt)
50	5.0 (4.40/5.28)	5.0 (4.40/5.28)

- Mixing ratio
  Check the specific gravity of engine coolant in the cooling system in temperature ranges from 0° to 50°C using a suction type hydrometer, then determine the mixing ratio of the coolant by referring to the table.

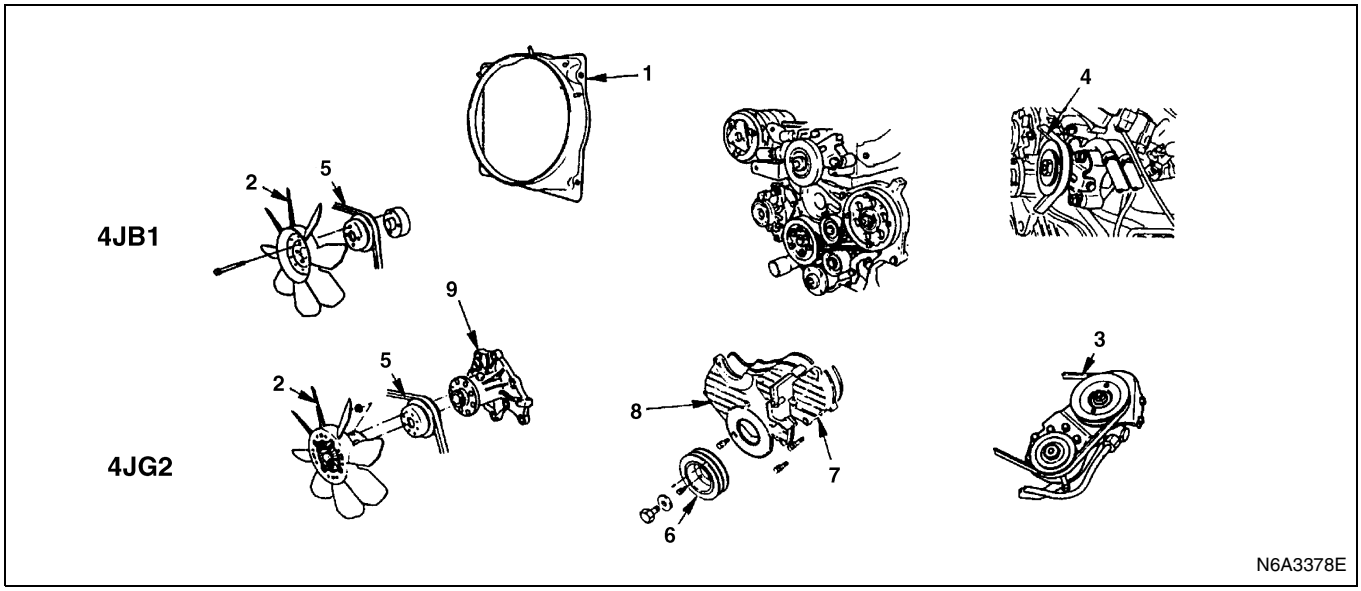


Legend

A. Mixing ratio
B. Specific gravity
C. Coolant temperature

WATER PUMP

Component



Legend

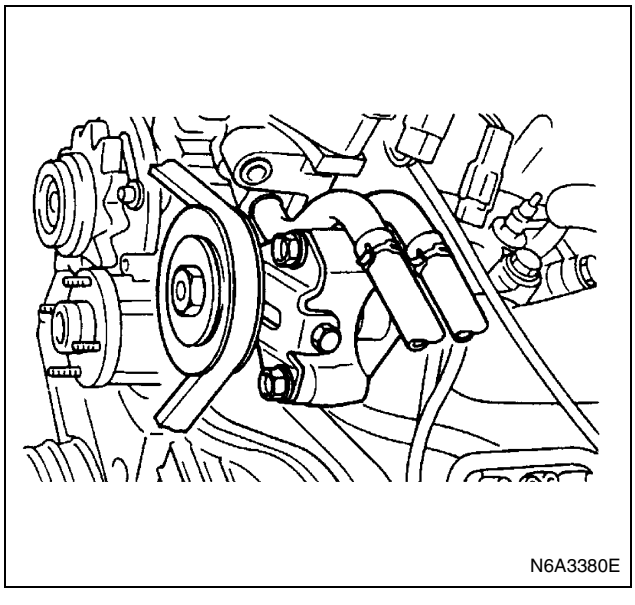
1. Fan shroud
2. Cooling fan assembly
3. Power steering pump drive belt
4. A/C compressor drive belt
5. AC generator drive belt
6. Crankshaft damper pulley
7. Timing pulley upper cover
8. Timing pulley lower cover
9. Water pump assembly

Removal

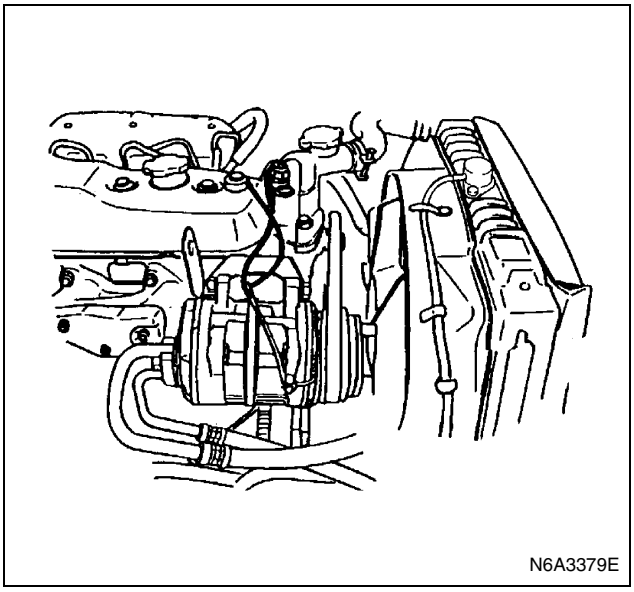
Preparation:

- Disconnect battery ground cable.
- Drain coolant.

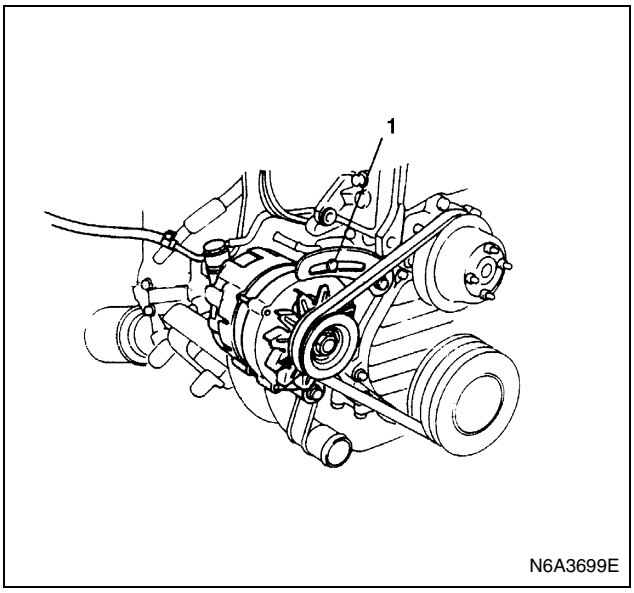
1. Fan Shroud
   - Remove the reservoir tank hose, bypass hose and fan guide.
2. Cooling Fan Assembly
   - Remove lock nut and take out cooling fan assembly.
3. Power Steering Pump Drive Belt
   - Loosen the idler pulley lock nut and loosen adjust bolt, and remove the drive belt.



4. A/C Compressor Drive Belt
   - Loosen A/C compressor idler pulley lock nut and adjust bolt and remove the drive belt.


N6A3379E

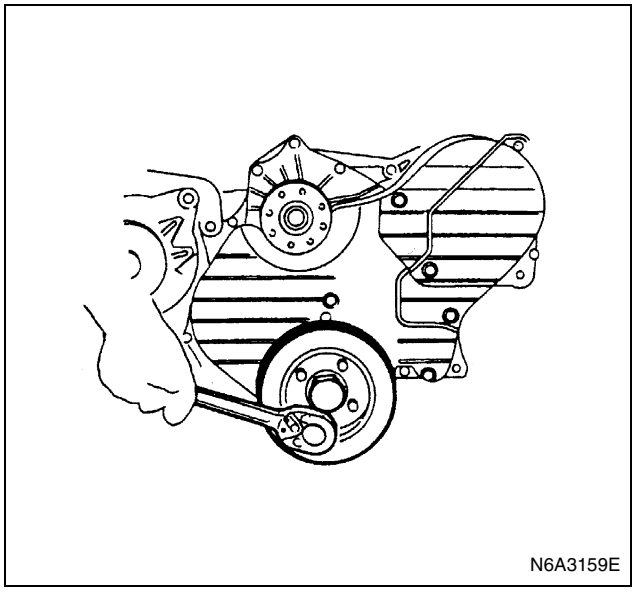
5. AC Generator Drive Belt
   - Loosen AC Generator mounting bolt (under side) and adjust plate lock bolt, and remove the drive belt.



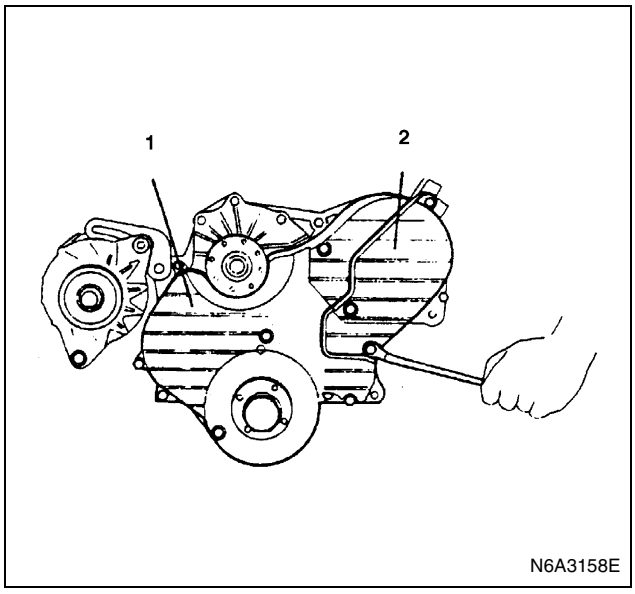
N6A3699E

Legend
1. Lock bolt

6. Crankshaft Damper Pulley


N6A3159E

7. Timing Pulley Upper Cover



N6A3158E

Legend
1. Lower cover
2. Upper cover

8. Timing Pulley Lower Cover
9. Water Pump Assembly
   - Remove the O-ring.

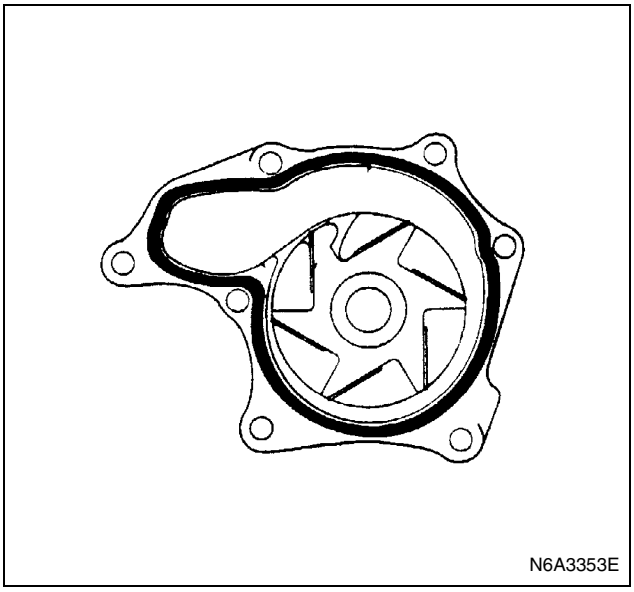
Inspection

Make necessary parts replacement if extreme wear or damage is found during inspection. Should any of the following problems occur, the entire water pump assembly must be replaced.

- Cracks in the coolant pump body
- Coolant leakage from the seal unit
- Play or abnormal noise in the bearing
- Cracks or corrosion in the impeller

Installation

1. Water Pump Assembly
   - Set O-ring in water pump body groove.


N6A3353E

   - Install water pump assembly, and tighten to specified torque.

Tighten:
Pump Fixing Bolt to 20 N·m (2 kg·m/14 lb·ft)

2. Timing Pulley Lower Cover
   - Install timing pulley lower cover, and tighten to specified torque.

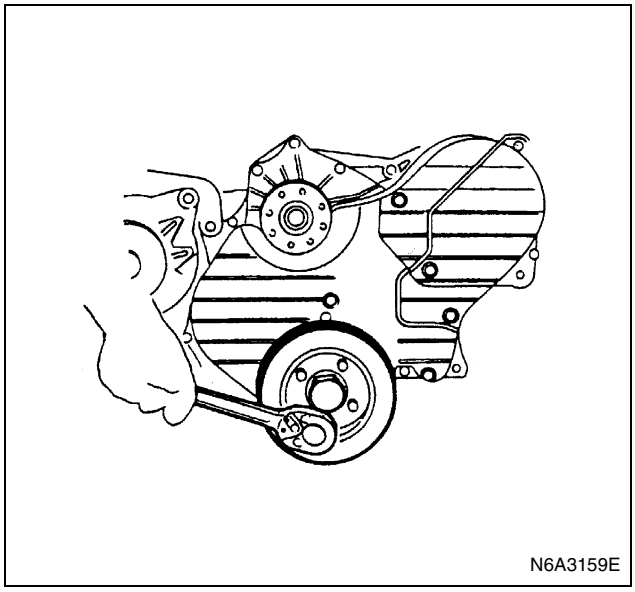
Tighten:
Cover Fixing Bolts to 8 N·m (0.8 kg·m/69 lb·in)

3. Timing Pulley Upper Cover
   - Install timing upper cover, and tighten to specified torque.

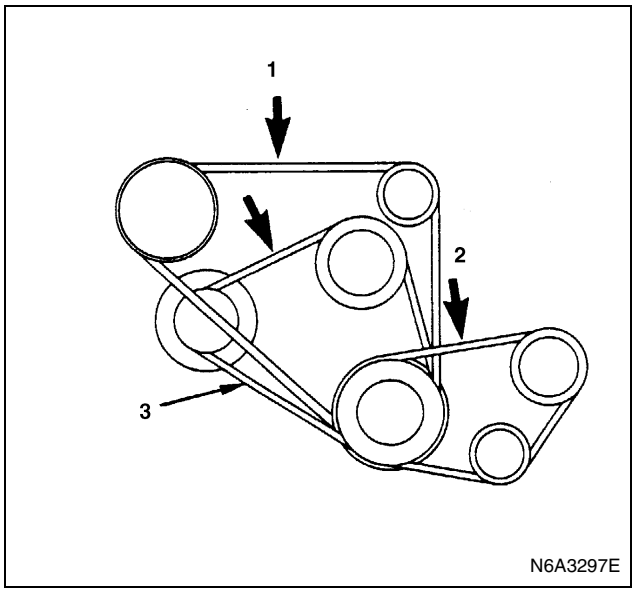
Tighten:
Cover Fixing Bolts to 8 N·m (0.8 kg·m/69 lb·in)

4. Crankshaft Damper Pulley
   - Install crankshaft damper pulley, and tighten to specified torque.

Tighten:
Pulley Bolt to 19 N·m (1.9 kg·m/14 lb·in)


N6A3159E

4JG2



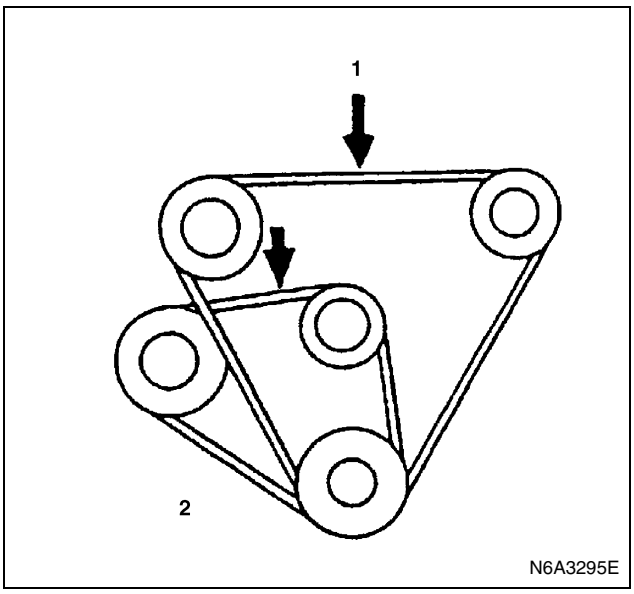
N6A3297E

Legend
1. A/C compressor drive belt
2. P/S oil pump drive belt
3. AC generator & cooling fan drive belt

5. AC Generator Drive Belt
6. A/C Compressor Drive Belt
7. Power Steering Pump Drive Belt
   - Install the drive belts and adjust belt.
     Check drive belts for wear or damage, and replace with new ones as necessary. Check belts for tension, and adjust as necessary.
   - Push the middle of belts with a force of 98 N (10 kg/22 lb) and check each bolt for deflection.
   - Standard deflection

	mm (in)
	Initial tension
AC Generator drive belt A/C compressor drive belt Power Steering pump drive belt	8 — 12 (0.31 — 0.47)

4JB1



Legend

1. A/C compressor drive belt & P/S pump drive belt
2. AC generator & fan pulley drive belt

Tighten:

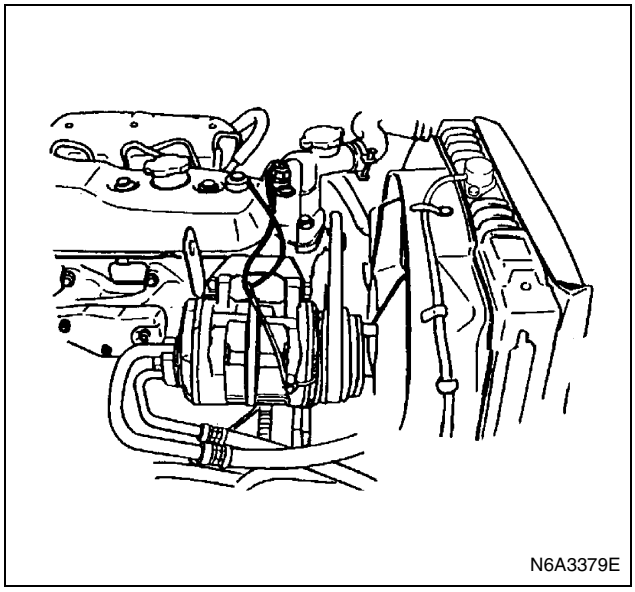
- Generator Fixing Belt to 40 N·m (4.1 kg·m/30 lb·ft)
- Adjust Plate Fixing Belt to 19 N·m (1.9 kg·m/14 lb·ft)
- A/C Idler Pulley Lock Nut to 27 N·m (2.8 kg·m/20 lb·ft)
- P/S Idler Pulley Lock Nut to 27 N·m (2.8 kg·m/20 lb·ft)

8. Cooling Fan Assembly
   - Mount fan pulley and cooling fan assembly on the water pump and tighten to the specified torque.

Tighten:

Fan Pulley Nut to 8 N·m (0.8 kg·m/69 lb·in)

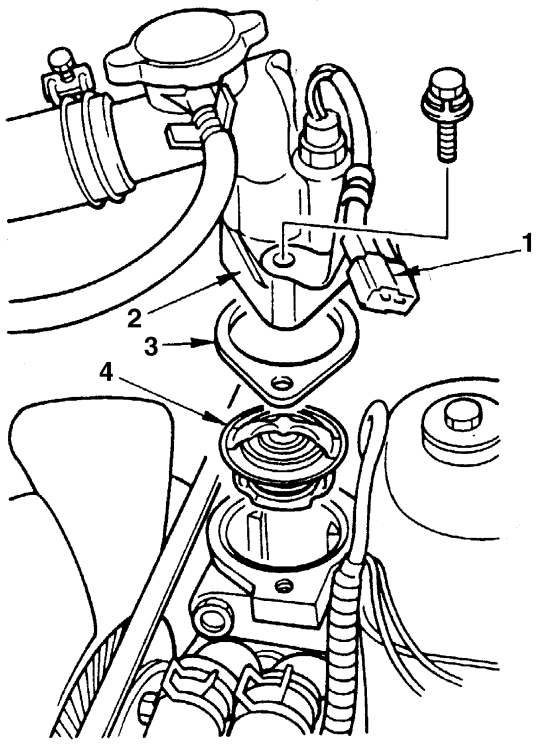
9. Fan Shroud
   - Install the fan shroud and reservoir tank hose and bypass hose.



- Connect the battery ground cable.
- Pour coolant.
- Start the engine and check coolant leakage.

THERMOSTAT

Component



N6A3385E

Legend

1. Switch harness
2. Outlet pipe
3. Gasket
4. Thermostat

Removal

Preparation:

- Disconnect battery ground cable.
- Drain coolant from the radiator and engine.

1. Switch Harness
2. Outlet Pipe
   - Remove mounting bolt and remove outlet pipe together with radiator hose.
3. Gasket
4. Thermostat

Inspection

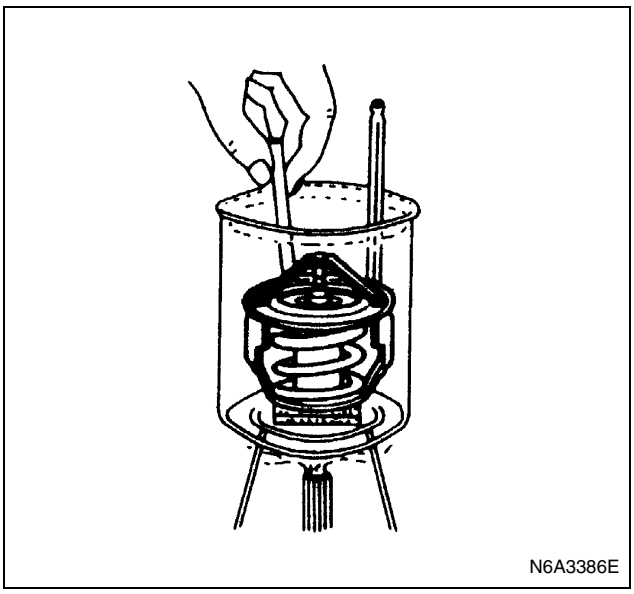
Submerge the thermostat assembly in the water.
Place wooden blocks on the bottom of the water container.
Not to directly heat the thermostat.
Gradually increase the water temperature. Stir the water so that the entire water is same temperature.

- Make sure that primary valve begins to open at the specified temperature.

Valve Opening Temperature °C(°F)
82 (180)

- Make sure that secondary valve opens fully at the specified temperature.

Valve Full Open Temperature °C(°F)
95 (203)


N6A3386E

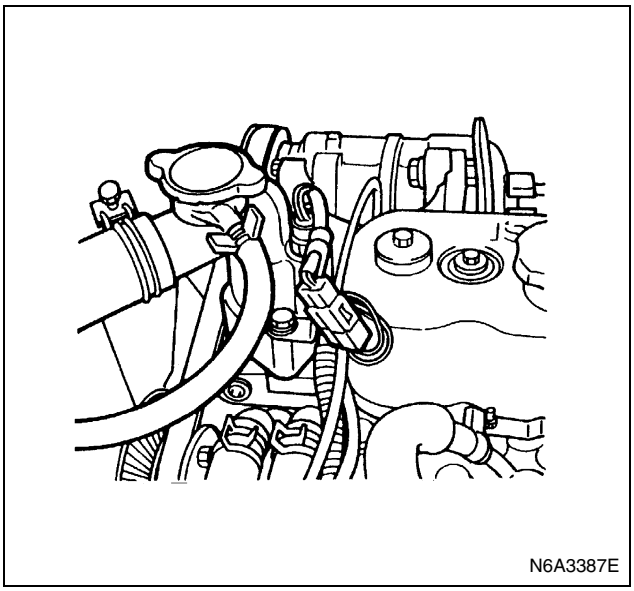
Make necessary repair and parts replacement if extreme wear or damage is found during inspection.

Installation

1. Thermostat
2. Gasket
3. Outlet Pipe
   - Connect outlet pipe and tighten bolts to the specified torque.

Tighten:
19 N·m (1.9 kg·m/14 lb·ft)

4. Switch Harness
   - Install switch harness.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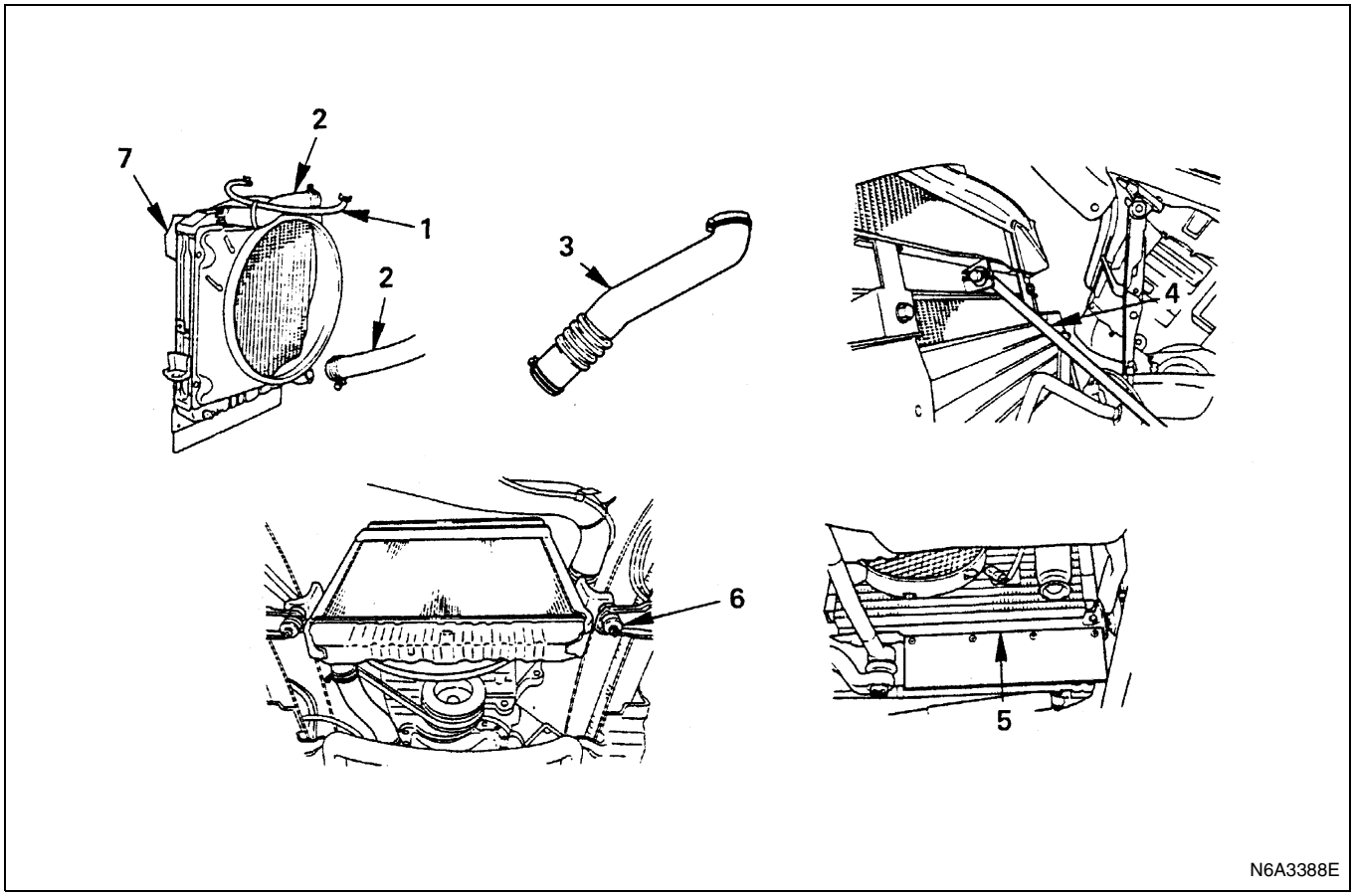
- Install battery ground cable.
- Pour coolant.
- Start the engine and check coolant leakage.

RADIATOR

Component



Legend

1. Reservoir tank hose & Bypass hose
2. Radiator hose
3. Air intake duct
4. Radiator stay
5. Condenser
6. Cushion rubber
7. Radiator assembly

Removal

Preparation:

- Disconnect battery ground cable.
- Loosen drain plug to drain coolant.

1. Reservoir Tank Hose & Bypass Hose
   - Disconnect the hose from radiator.
2. Radiator Hose
   - Disconnect lower hose and upper hose from the engine.
3. Air Intake Duct
4. Radiator Stay
5. Condenser
   - Remove the condenser from radiator and temporarily tighten the condenser to cab body front side, use the wire.
6. Cushion Rubber
   - Remove cushion rubbers on both sides of the bottom.
7. Radiator Assembly
   - Remove upward the radiator assembly with hose, taking care not to damage the radiator core by fan blade.

Inspection

Radiator Valve

- Apply air pressure from filler neck using radiator cap tester and check the opening pressure of radiator valve. If the valve opening pressure is out of the standard value range, replace with a new radiator valve.

Radiator valve opening pressure kPa (kg/cm^2 /psi)
93 — 123 (0.95 — 1.25/13.5 — 17.8)

- Remove the radiator valve and check a negative pressure valve as the center of the valve seat side. If the negative pressure valve does not work smoothly, clean or replace the radiator valve.

Tighten:
Radiator valve to 6 N·m (0.6 kg·m/4 lb·ft)

- Conduct cooling system leakage check after reinstalling the radiator valve.

Radiator Core

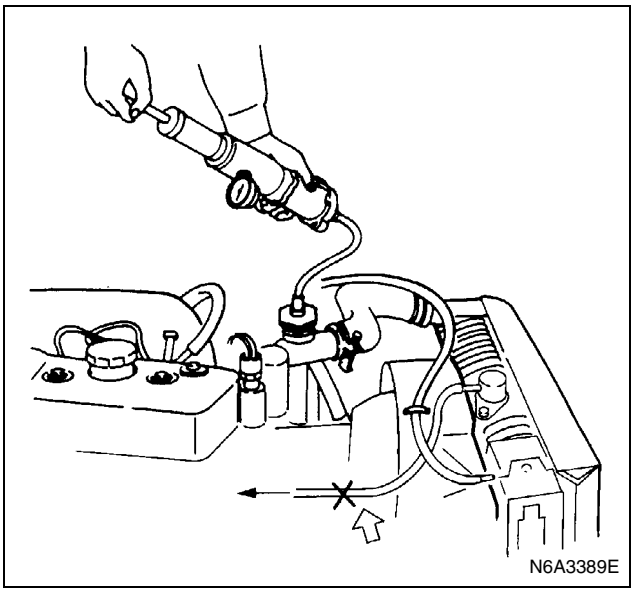
- Deformed radiator fins could reduce radiation effects, resulting in overheat. Straighten the fins. In such a case, take care not to damage the fin roots.
- Remove dust and other foreign materials.

Flushing the Radiator

- Wash the inside of radiator and the coolant passage with water and neutral detergent. Remove all scales and rust.

Checking for Coolant Leakage

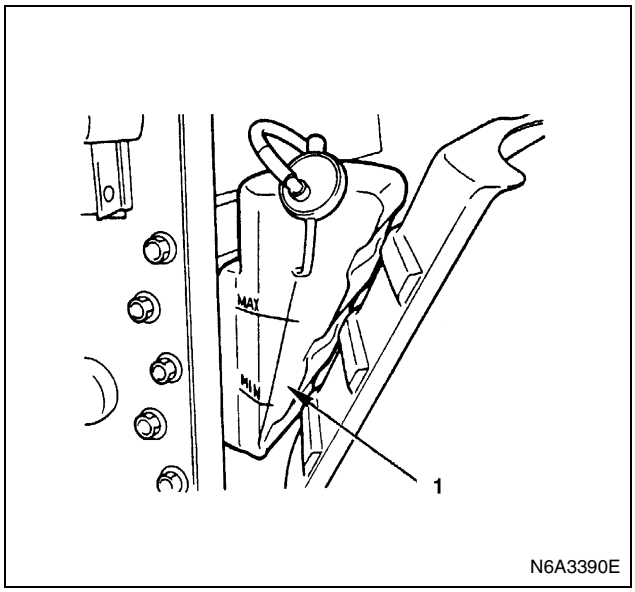
- Clog up the reservoir tank hose carefully and check the cooling system for leakage with a radiator cap tester by applying an air pressure of 147 kPa (1.5 kg/cm^2 /21 psi) from filler neck to inside the radiator.


N6A3389E

- As the radiator upper tank is provided with a valve, the pressure fails to rise higher than the valve opening pressure unless the hose is clogged up.

Installation

1. Radiator Assembly
   - Install the radiator.
2. Cushion Rubber
   - Install cushion rubbers on both sides of radiator bottom.
   - Install radiator assembly with hose, taking care not to damage the radiator core by a fan blade.
3. Condenser
4. Radiator Stay
5. Air Intake Duct
   - Connect the duct and tighten clip securely.
6. Radiator Hose
   - Connect inlet hose and outlet hose to the engine.
   - Connect battery ground cable.
   - Pour coolant up to filler neck of radiator, and up to MAX mark of reservoir tank.
7. Reservoir Tank Hose & Bypass Hose
   - Start engine to warm up, and check for coolant level.

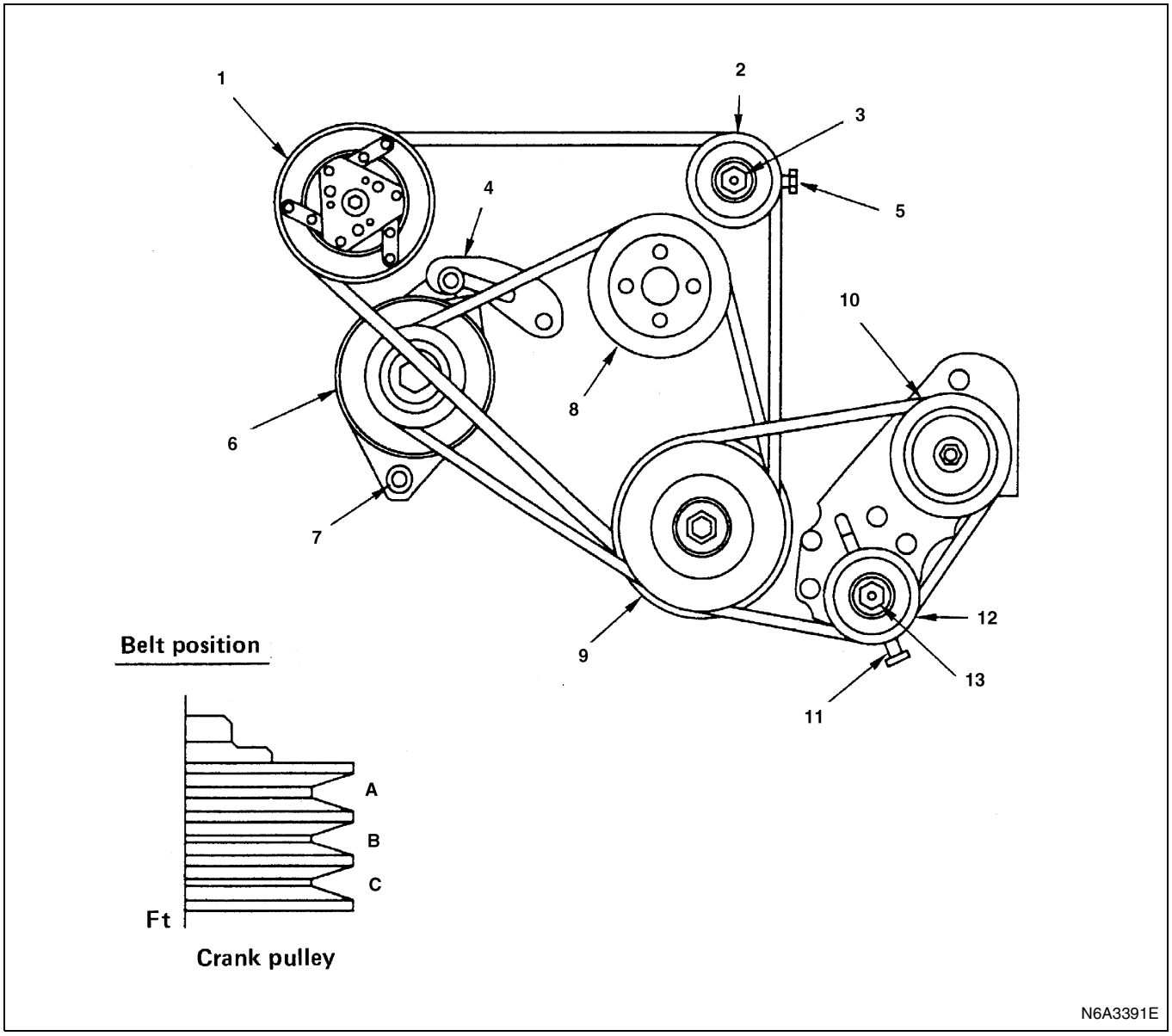


N6A3390E

Legend
1. Reservoir tank

DRIVE BELT ADJUSTMENT

Component



Legend

A. AC, Generator cooling fan
B. A/C compressor P/S oil pump
C. A/C compressor P/S oil pump
1. A/C compressor
2. Idler pulley
3. Adjust lock nut
4. Adjust plate
5. Adjust bolt
6. AC generator
7. AC generator fixing bolt
8. Cooling fan pulley
9. Crank pulley
10. P/S oil pump
11. Adjust bolt
12. Idler pulley
13. Lock nut

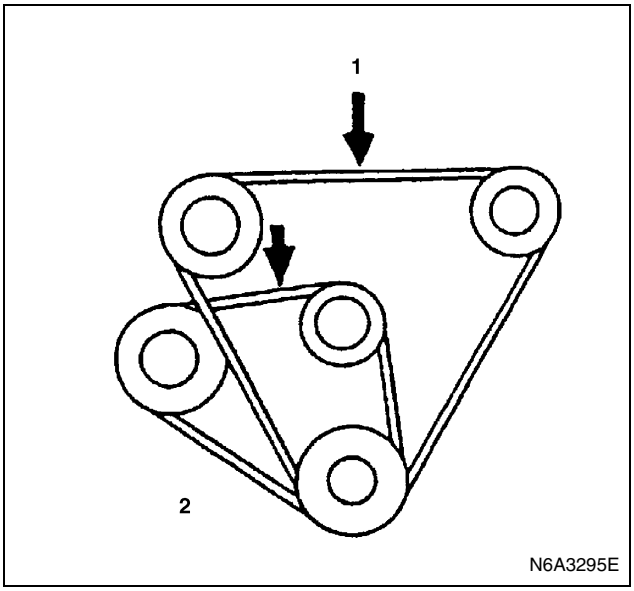
Inspection

Check drive belts for wear or damage, and replace with new ones as necessary. Check belts for tension, and adjust as necessary.

- Check drive belts tension.
- Push the middle of belts with a force of 98 N (10 kg/ 22 lb) and check each bolt for deflection.
- Standard deflection

	mm (in)
	Tension at readjustment
AC generator & fan pulley drive belt A/C compressor drive belt P/S pump drive belt	8 — 12 (0.31 — 0.47)

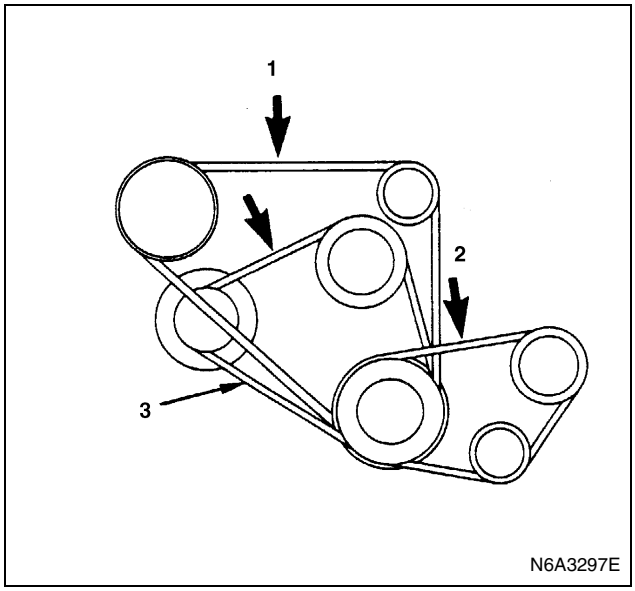
4JB1



Legend

1. A/C compressor drive belt & P/S pump drive belt
2. AC generator & fan pulley drive belt

4JG2



Legend

1. A/C compressor drive belt
2. P/S pump drive belt
3. AC generator & cooling fan drive belt

Tension Adjustment

1. Cooling Fan Pulley Belt
   - With AC Generator mounting and lock bolts loose, adjust belt tension with adjuster's adjust bolt. Tighten bolt to the specified torque.

Tighten:

- Generator Fixing Bolt to 40 N·m (4.1 kg·m/30 lb·ft)
- Adjust Plate Fixing Bolt to 19 N·m (1.9 kg·m/14 lb·ft)

2. P/S Oil Pump and A/C Compressor Pulley Belt
   - With P/S pump lock bolt loose, adjust belt tension with adjust belt.
     Tighten lock nut to the specified torque.

Tighten:

Lock Nut to 27 N·m (2.8 kg·m/20 lb·ft)

ENGINE 4J SERIES

SECTION 6C
ENGINE FUEL

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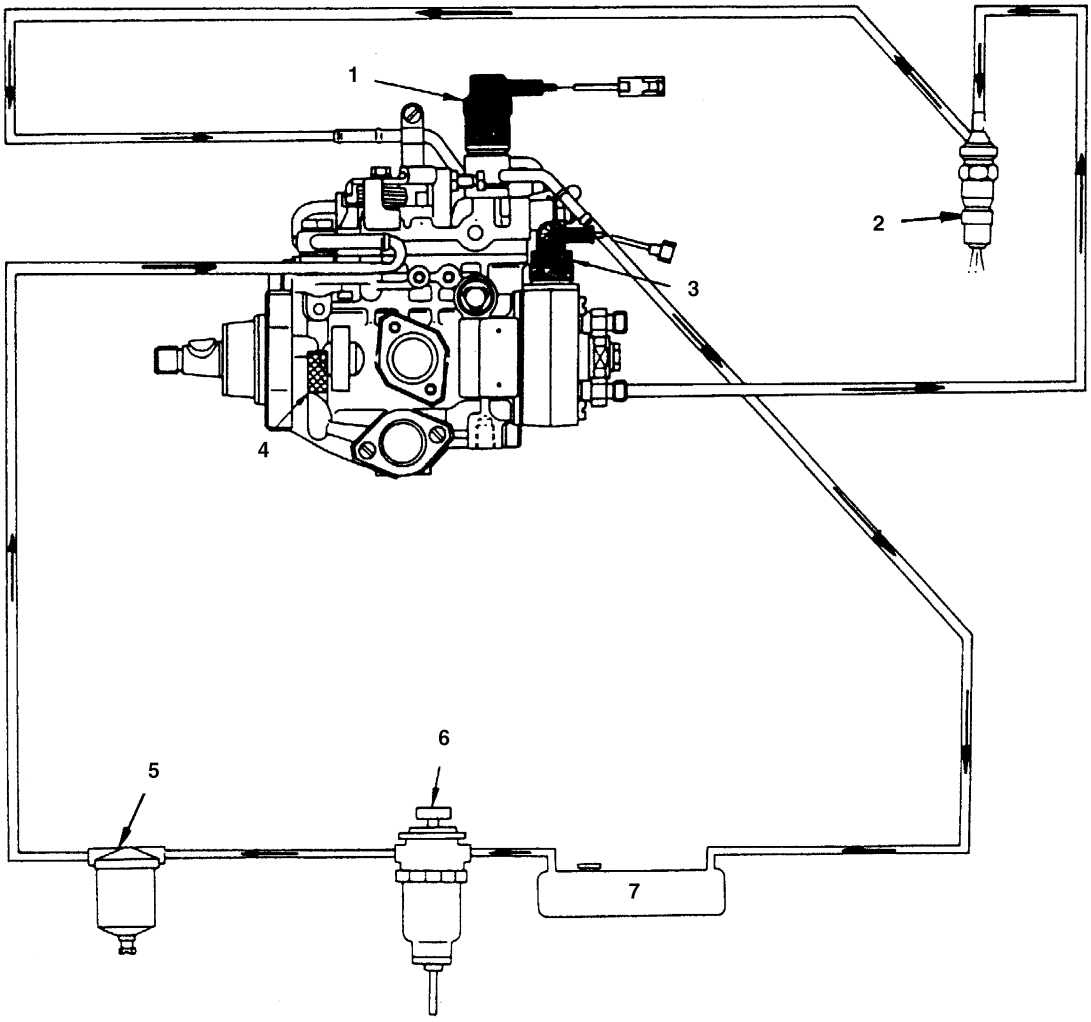
GENERAL DESCRIPTION

When working on the fuel system, there are several things to keep in mind:

- Any time the fuel system is being worked on, disconnect the negative battery cable except for those tests where battery voltage is required.
- Always keep a dry chemical (Class B) fire extinguisher near the work area.
- Replace all pipes with the same pipe and fittings that were removed.
  Clean and inspect O-rings. Replace where required.
- Always relieve the line pressure before servicing any fuel system components.
- Do not attempt repairs on the fuel system until you have read the instructions and checked the pictures relating to that repairs.
- The 4JH1-TC engine is equipped with the electronically controlled fuel injection system.
  For information on fuel injection pump maintenance and/or part replacement, contact the Bosch Automotive Systems Corporation.
- Contact the Bosch Automotive Systems Corporation for information on 4JH1-TC engine fuel injection nozzle maintenance.

Fuel Flow

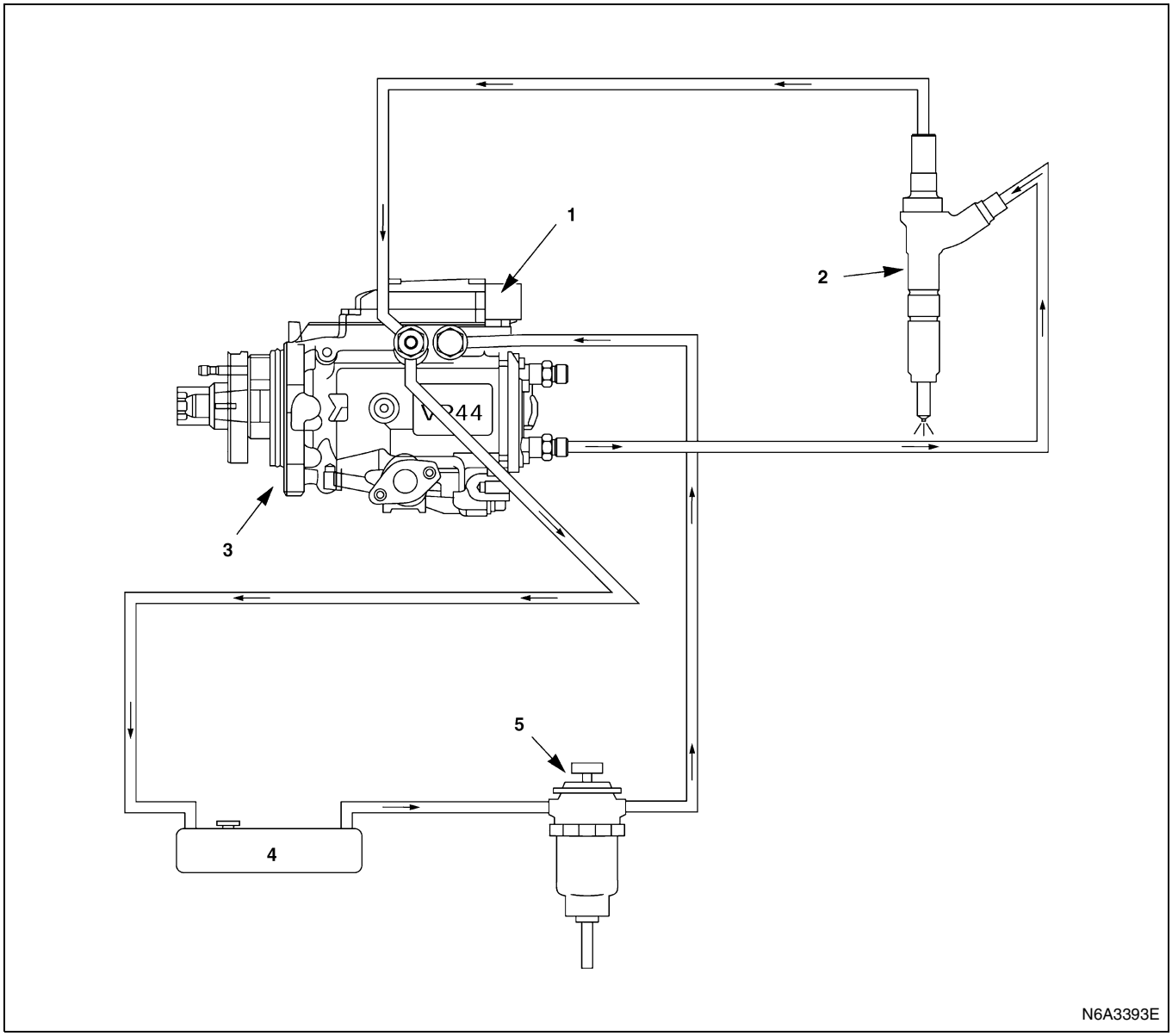


Legend

1. CSD solenoid valve
2. Nozzle
3. Fuel cut solenoid valve
4. VE type injection pump
5. Fuel filter
6. Water separator
7. Fuel tank

The fuel system consists of the fuel tank, the water separator, the fuel filter, the injection pump, and the injection nozzle.
The fuel from the fuel tank passes through the water separator and the fuel filter where water particles and other foreign material are removed from the fuel.
Fuel, fed by the injection pump plunger, is delivered to the injection nozzle in the measured volume at the optimum timing for efficient engine operation.

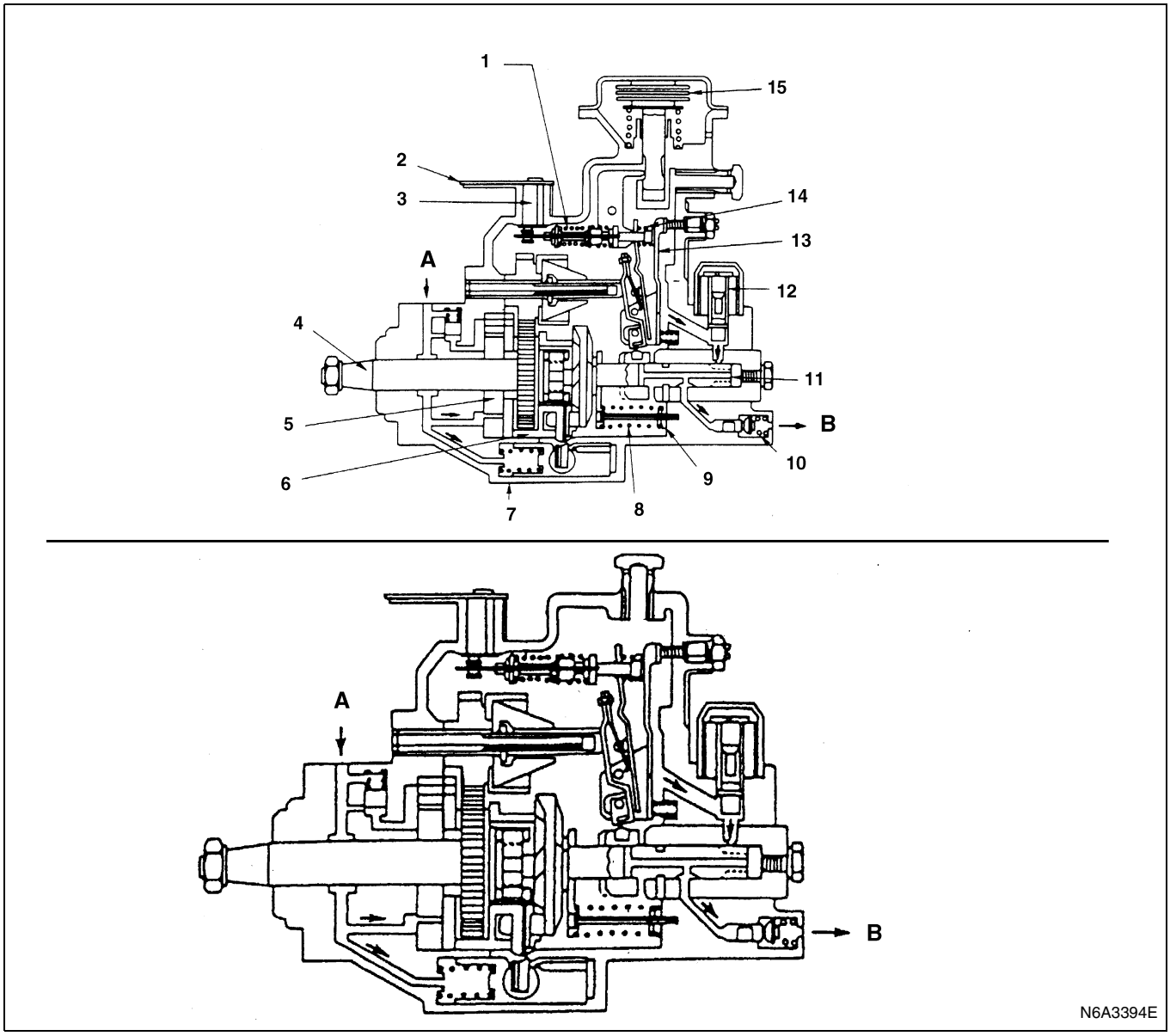
Fuel Flow (4JH1-TC)



Legend

1. EDU
2. Nozzle
3. Injection pump
4. Fuel tank
5. Fuel filter

Injection Pump

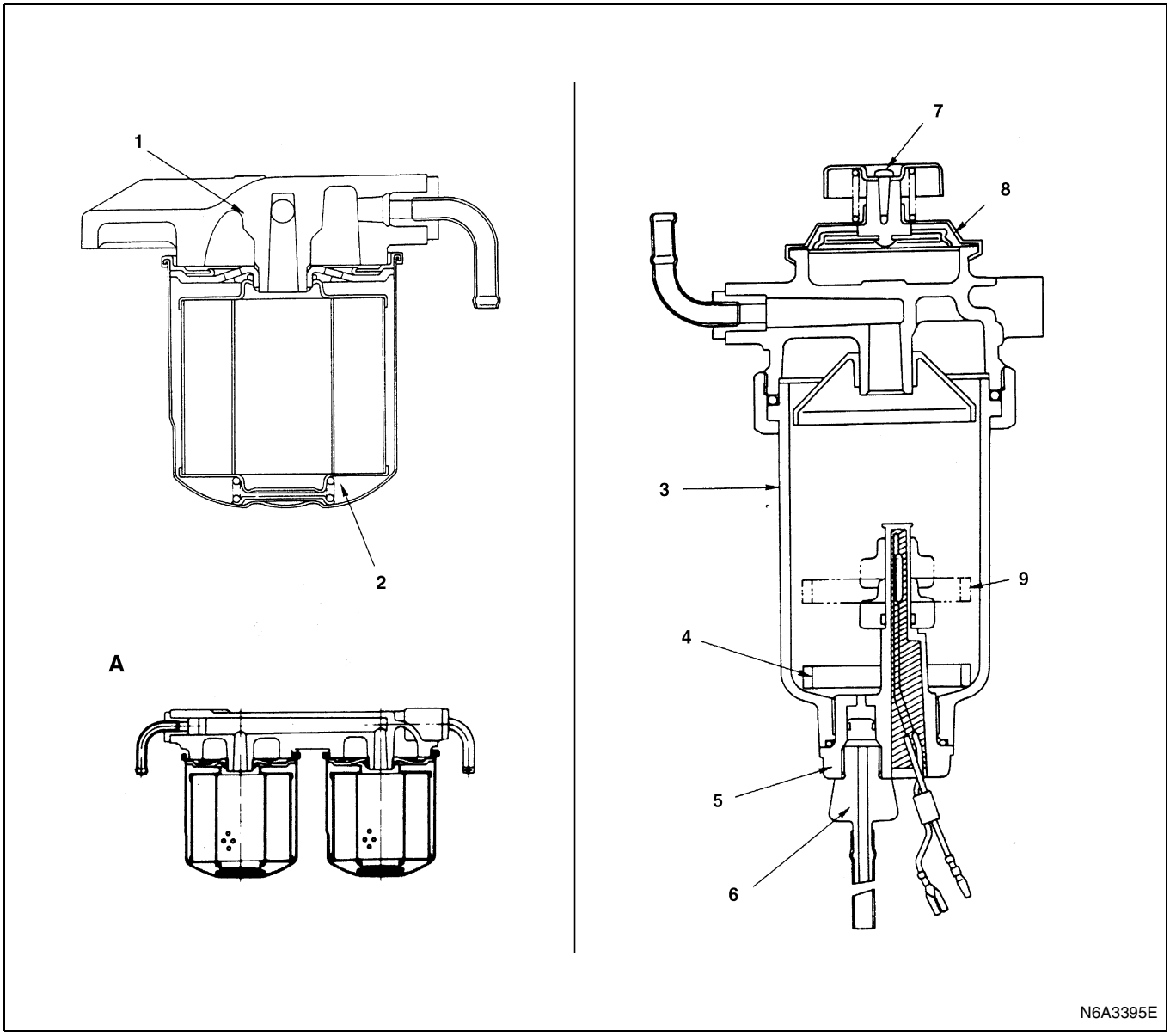


Legend

A. From fuel filter
B. To nozzle
1. Governor spring
2. Control lever
3. Control lever shaft
4. Drive shaft
5. Feed pump gear
6. Driver disc
7. Timer
8. Plunger spring
9. Control sleeve
10. Delivery valve
11. Plunger
12. Fuel cut solenoid valve
13. Tension lever
14. Collector lever
15. Aneroid compensator

A Bosch Distributor Type Injection Pump is used. A single reciprocating/revolving plunger delivers the fuel uniformly to the injection nozzles, regardless of the number of cylinders.
The governor, the injection timer, and the feed pump are all contained in the injection pump housing.
The injection pump is compact, light weight, and provides reliable high-speed operation.
An aneroid compensator is available as an option for vehicles to be operated at high altitudes. It adjusts the fuel and air mixing ratio.

Fuel Filter and Water Separator

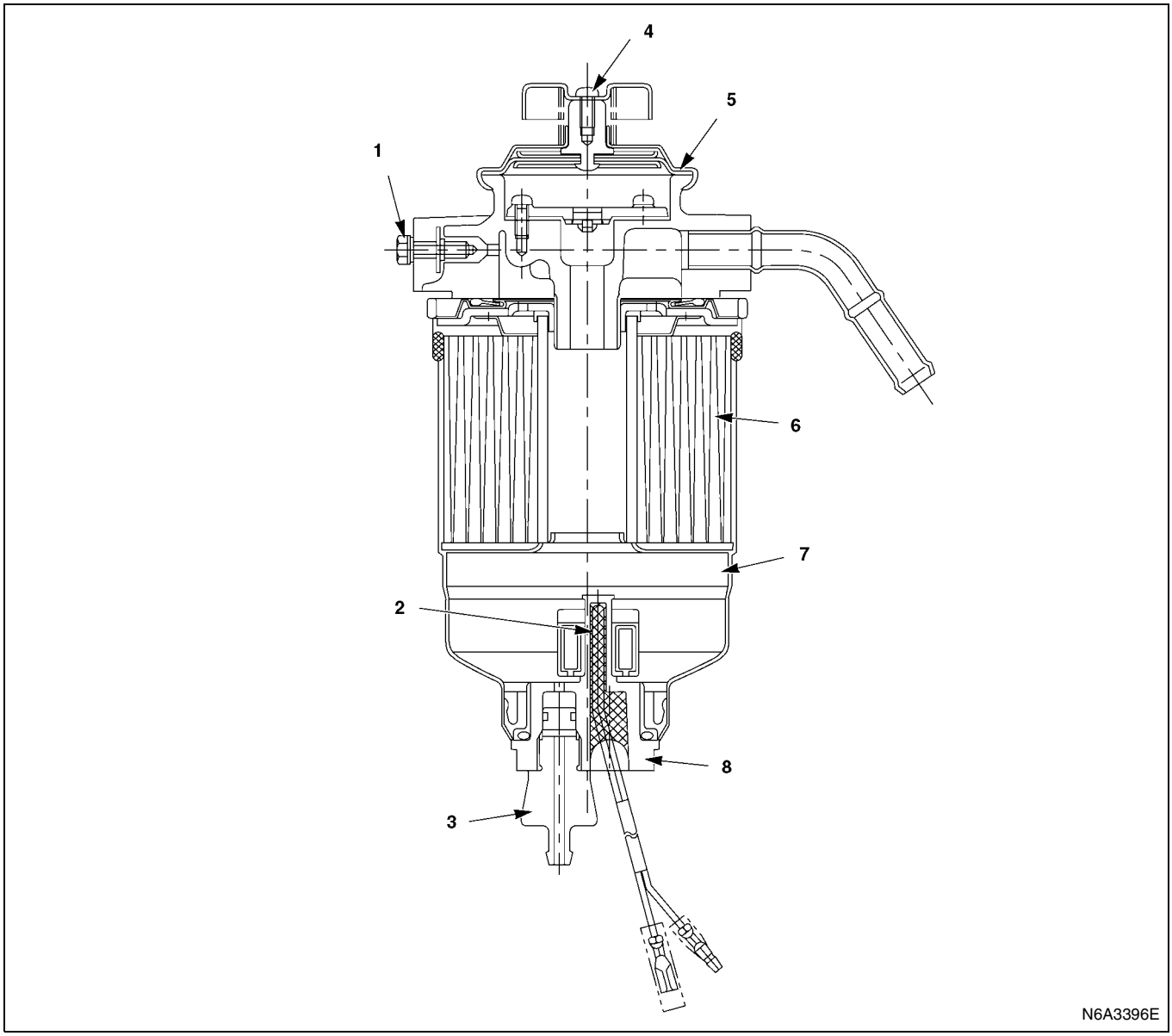


Legend

A. Dual type
1. Body assembly
2. Filter cartridge
3. Case
4. Float
5. Level sensor
6. Drain plug
7. Priming pump
8. Body assembly
9. Water draining level

A cartridge type fuel filter and a water separator are used along with the VE type injection pump.
As the inside of the injection pump is lubricated by the fuel which it is pumping, the fuel must be perfectly clean. The fuel filter and the water separator remove water particles and other foreign material from the fuel before it reaches the injection pump.
The water separator has an internal float. When the float reaches the specified level, a warning light comes on to remind you to drain the water from the water separator.
A diaphragm type priming pump is installed at the top of the water separator. It is used during the water draining and the air bleeding procedures.

Fuel Filter With Built-in Water Separator (4JH1-TC)

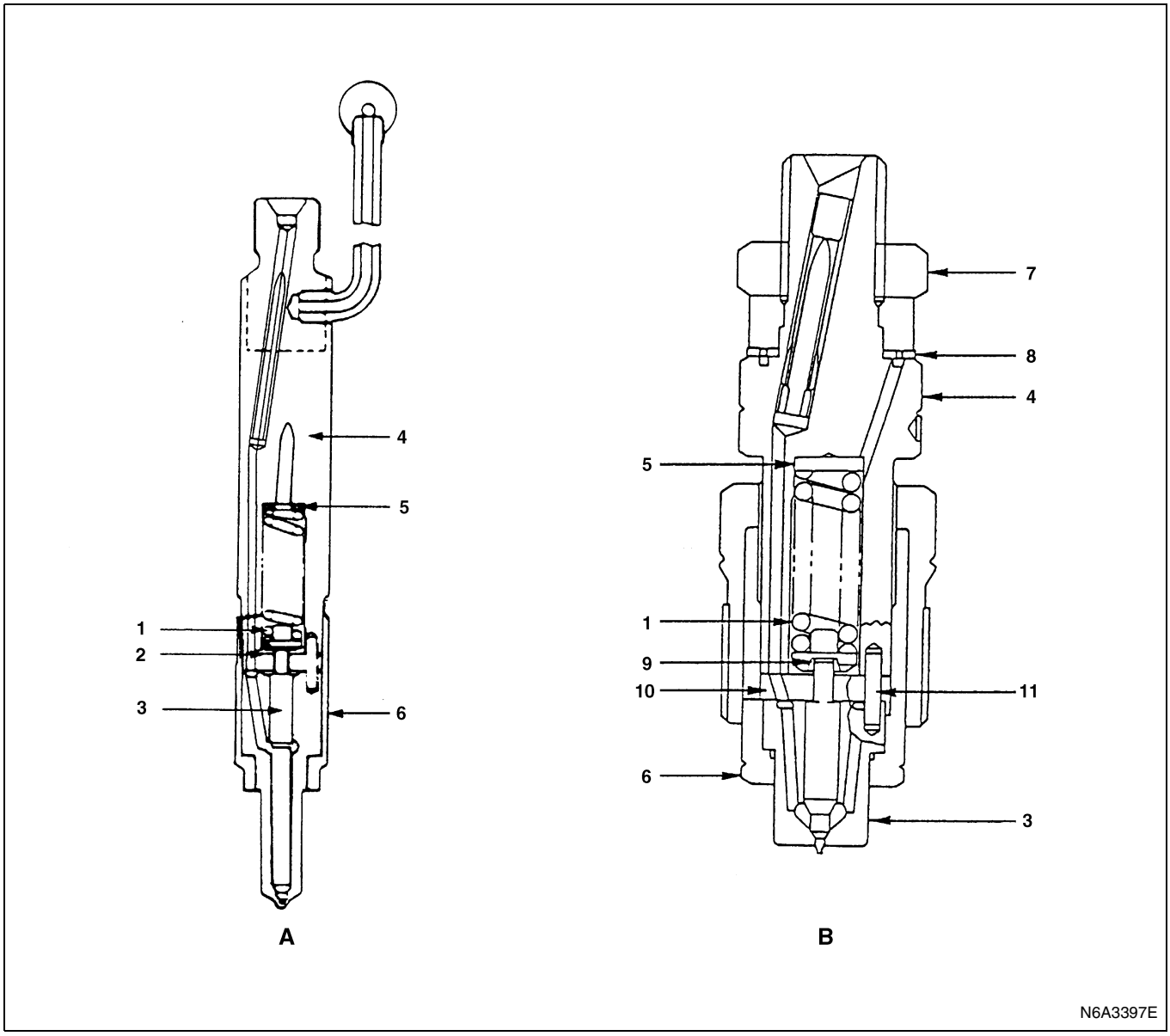


Legend

1. Air bleeder plug
2. Float
3. Drain plug
4. Priming pump
5. Body assembly
6. Filter element
7. Filter cartridge
8. Level sensor assembly

A fuel filter with a built-in water separator is used along with the VE type injection pump.
As the inside of the injection pump is lubricated by the fuel which it is pumping, the fuel must be perfectly clean. The fuel filter and the water separator remove water particles and other foreign material from the fuel before it reaches the injection pump.
The water separator has an internal float. When the float reaches the specified level, a warning light comes on to remind you to drain the water from the water separator.
A diaphragm type priming pump is installed at the top of the water separator. It is used during the water draining and the air bleeding procedures.

Injection Nozzle



Legend

A. Direct injection nozzle
B. Indirect injection nozzle
1. Spring
2. Spring seat
3. Injection nozzle
4. Nozzle holder
5. Adjusting shim
6. Retaining nut
7. Nut
8. Gasket
9. Push rod
10. Spacer
11. Pin

For 4J Series diesel engines, there are two types available: Direct injection engine (4JB1) and Indirect injection engine (4JG2). Accordingly, the injection nozzles to be used are different depending on the type of the engine and the combustion chamber.
The injection nozzle sprays pressurized fuel from the injection pump into the combustion chamber through the injection nozzle orifices.

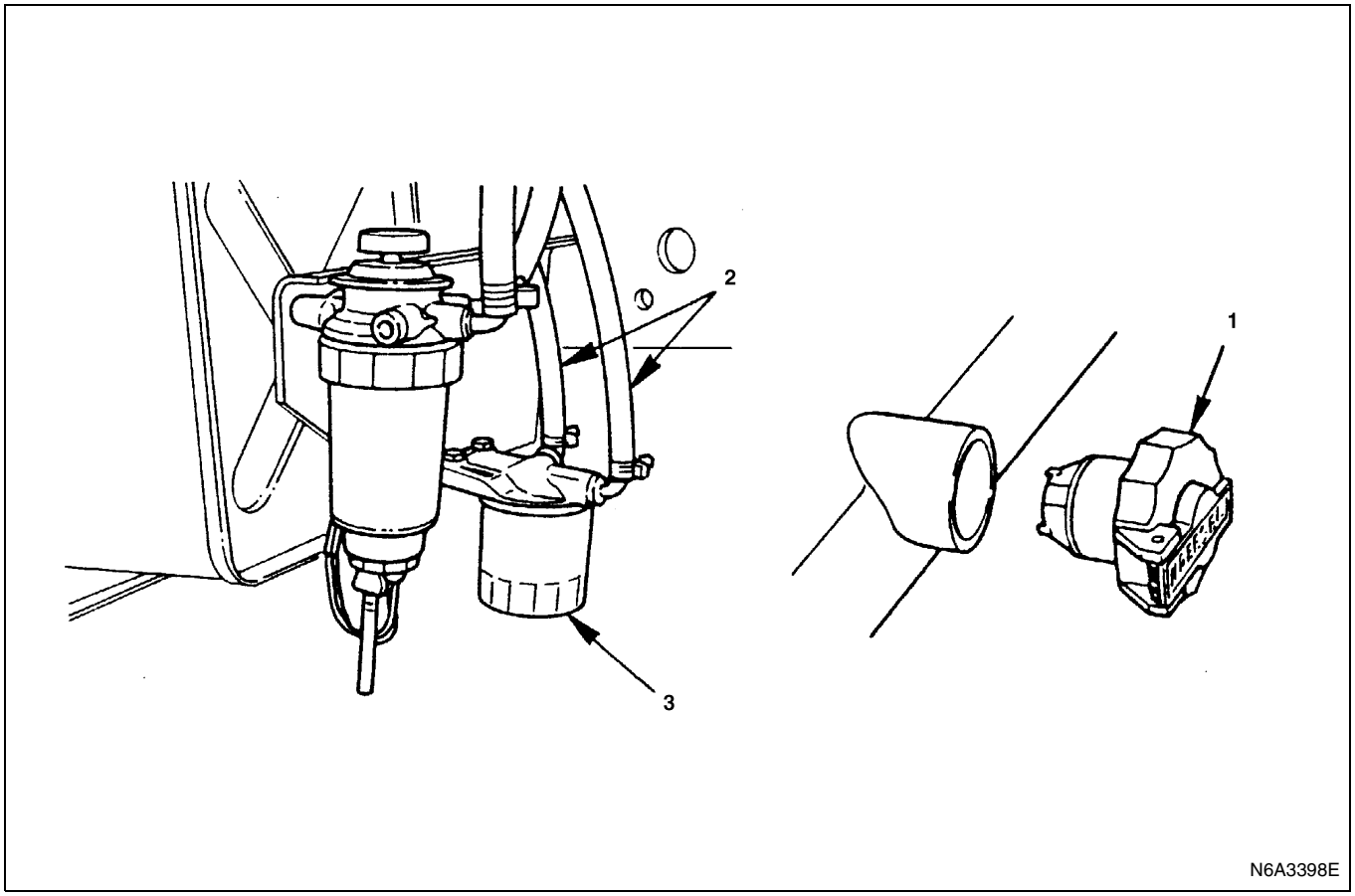
4JB1 engines employ a hole type nozzle with four injection orifices. The nozzle is made up of the nozzle body and the needle valve assembly.
Pressurized fuel from the injection pump is sprayed by the injection nozzle into the combustion chamber through the nozzle body orifices.

4JB1-TC Engine

The two-spring nozzle holder has been developed to reduce NOx (Nitrogen Oxides) and particulates from direct injection diesel engine exhaust.

FUEL FILTER ASSEMBLY

Components



Legend

1. Fuel filler cap
2. Fuel hose
3. Fuel filter assembly

Removal

Preparation

- Disconnect battery ground cable.

1. Fuel Filler Cap
2. Fuel Hose
   - Disconnect fuel hose from filter body.
     Plug the hose ends to prevent fuel spillage.
3. Fuel Filter Assembly
   - Remove the fixing bolts on fuel filter bracket.

Installation

1. Fuel Filter Assembly
   - Install the fuel filter bracket, then tighten fixing bolt.
2. Fuel Hose
   - Connect hoses to filter body.
3. Fuel Filler Cap
   - Connect the battery ground cable.
   - Feed fuel to the injection pump by means of the priming, and bleed the fuel system.

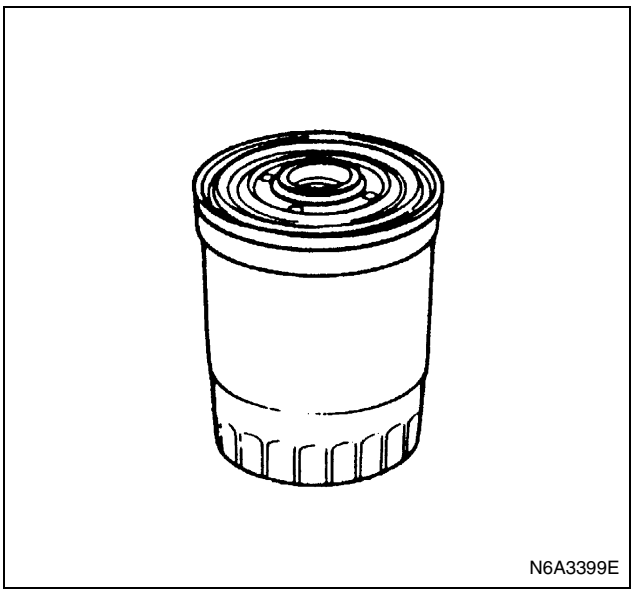
FUEL FILTER CARTRIDGE

Removal

- Remove the cartridge using a filter wrench.
  Filter wrench: 5-8840-0253-0 (J-22700)

Installation

- Clean the cartridge mounting surface of filter body so that the cartridge can be securely.
  Apply engine oil thinly to new cartridge O-ring.
- To facilitate bleeding, fill the new cartridge with light oil.
- Tighten the cartridge until O-ring comes in contact with the sealing, taking care not to spill the light oil.
- Retighten 1/3 — 2/3 using a filter wrench.
  Filter wrench: 5-8840-0253-0 (J-22700)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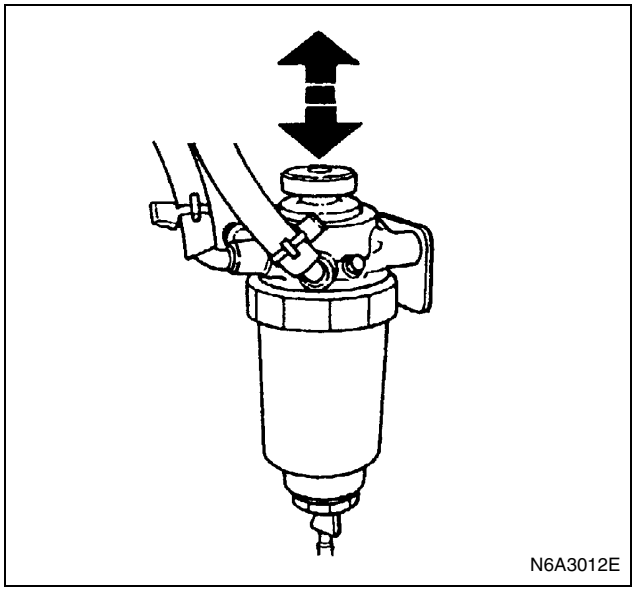
Air Bleeding

- Operate priming pump to send the air in the fuel system to the injection pump.
- Loosen injection pump bleeding plug, and operate the priming pump until no bubble is made.
- Tighten the bleeding plug.
- Start the engine, and if it is not started in 10 seconds or less, repeat the bleeding steps.
- Make sure of no fuel leakage, and tighten the priming pump.

Draining

- When the water in the sedimentor reaches the specified volume, warning light is actuated.
  In this case, follow the draining steps below.
- Set a vinyl hose over the drain plug.
- Loosen the drain plug.
- To drain the water, operate the priming pump several times.
- After draining, tighten the drain plug.
- Operate the priming pump several times to check for fuel leakage.
- Check and see the warning light is off.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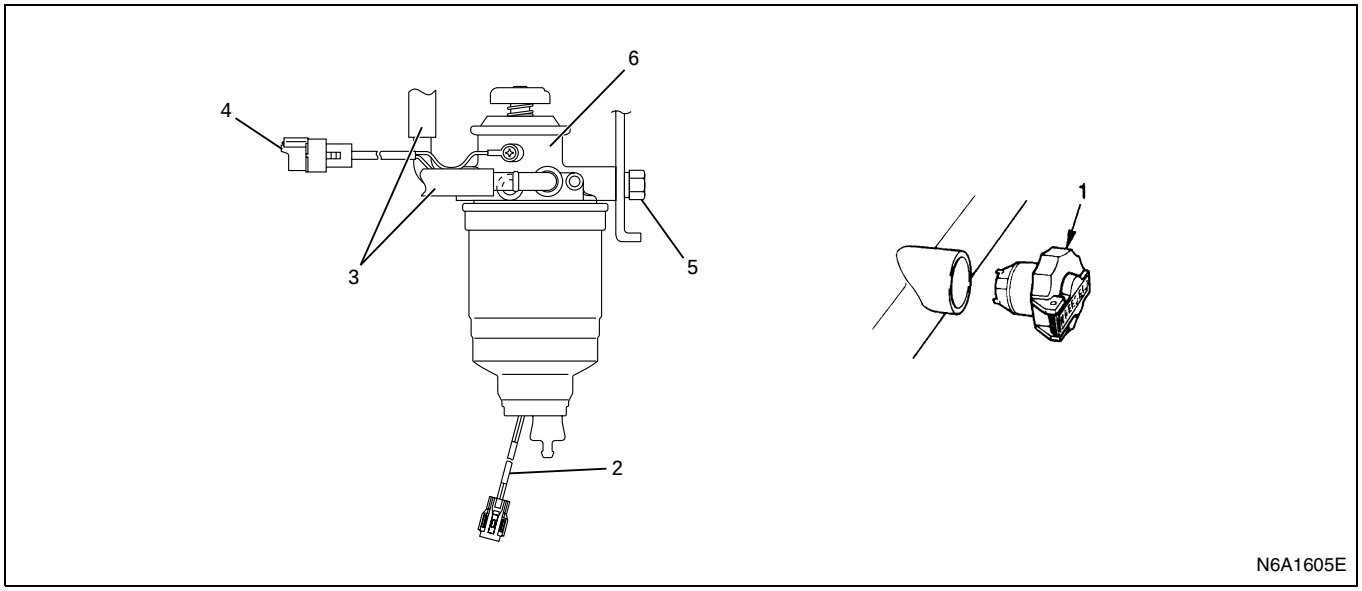
FUEL FILTER ASSEMBLY (4JH1-TC)

Components



Legend

1. Filler Cap
2. Fuel Sedimenter Connector
3. Fuel Hose
4. Fuel Heater Connector
5. Bolt
6. Fuel Filter Assembly

Removal

1. Remove the filler cap.
2. Remove the fuel sedimenter connector and fuel heater connector.
3. Remove the feed hose and the return hose from the fuel filter and plug it so that the fuel does not flow out.
4. Remove the bolts for mounting the fuel filter.
5. Remove the fuel filter assembly.

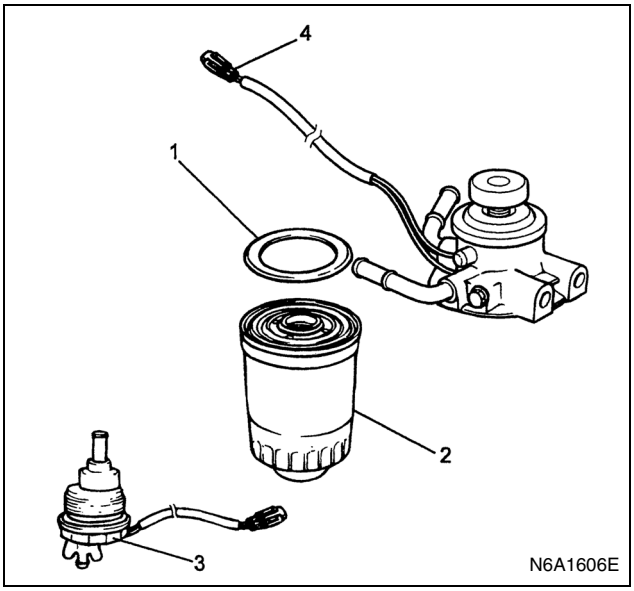
Installation

1. Install the fuel filter assembly.
2. Install the bolts for mounting the fuel filter.
3. Install the feed hose and the return hose.
4. Install the fuel sedimenter and fuel heater connector.
5. Install the filler cap.
6. Bleed out the air.
   - Refer to “Fuel Filter Cartridge (4JH1-TC)”.

FUEL FILTER CARTRIDGE (4JH1-TC)

Removal

1. Remove the cartridge using the filter wrench.
   Filter wrench: J-22700
2. Remove the sedimenter sensor.

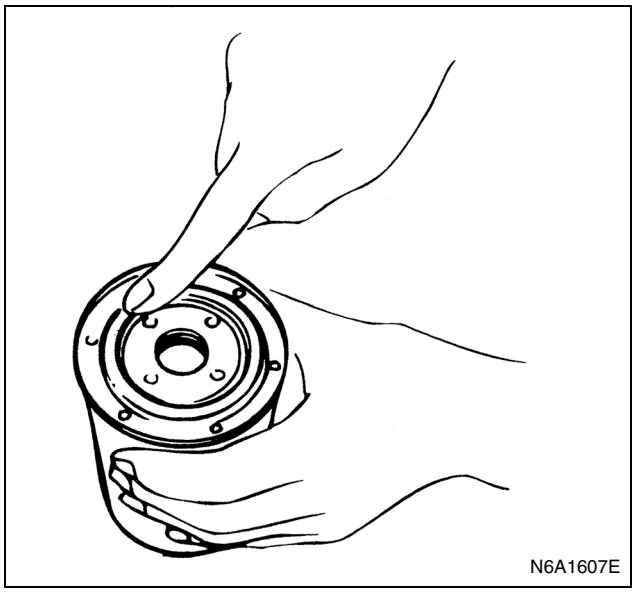


Legend

1. O-ring
2. Cartridge
3. Sendimenter Sensor
4. Fuel Heater Connector

Installation

1. Assemble the sedimenter sensor in the new cartridge.
2. Clean the cartridge mounting surface in the filter body so that the cartridge can be seated securely.
3. Coat a thin layer of engine oil on the O-ring in the new cartridge.
4. To simplify air bleed, fill light oil on the new cartridge.
5. Tighten the cartridge until the O-ring touches the sealing surface. During this process take adequate care that the light oil that is inside does not flow out.
6. Use the filter wrench and tighten rotating by 1/3 to 2/3.
   Filter wrench: J-22700



Injection Pump Air Bleeding (4JH1-TC)

Injection pump air bleeding is required to start the engine when —

- The fuel supply has been exhausted (running out of gas).
- The fuel filter has been replaced.
- The injection pump has been replaced.

Caution:
If the injection pump has been replaced, the air bleeding procedure will require more time and effort (this is because there is no fuel in the pump).

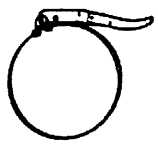
1. Loosen the air bleed nut on the priming pump plunger (at the top of the fuel filter).
2. Move the priming pump plunger up-and-down until strong resistance is felt (about 15 cycles).
3. Stop pumping and tighten the air bleed nut.
4. Wait for 1 minute.
5. Loosen the air bleed nut on the priming pump plunger again.
6. Move the priming pump plunger up-and-down until strong resistance if felt (about 10 cycles).
7. Stop pumping and tighten the air bleed nut.
8. Wait for 1 minute.
9. Loosen the air bleed nut on the priming pump plunger again.
10. Move the priming pump plunger up-and-down until strong resistance is felt (about 5 cycles).
11. Stop pumping and tighten the air bleed nut.
12. Press the accelerator and clutch pedals all the way to the floor and hold them down. Turn the ignition switch to the ON position. Wait until the glow indicator lamp turns on and off.

Caution:
If the engine is cold, the glow indicator light will stay on for 4 — 7 seconds before turning off.

However, if the engine is hot, the lamp will not turn on.

13. Turn the ignition switch to the START position and crank the engine until it starts (do not crank the engine for more than 10 seconds).
    If the engine does not start, repeat Steps 9 — 13.
14. Allow the engine to idle for 5 minutes.

Special Tools

Illustration	Tool Number / Description
	J-22700 Filter wrench

Water drain

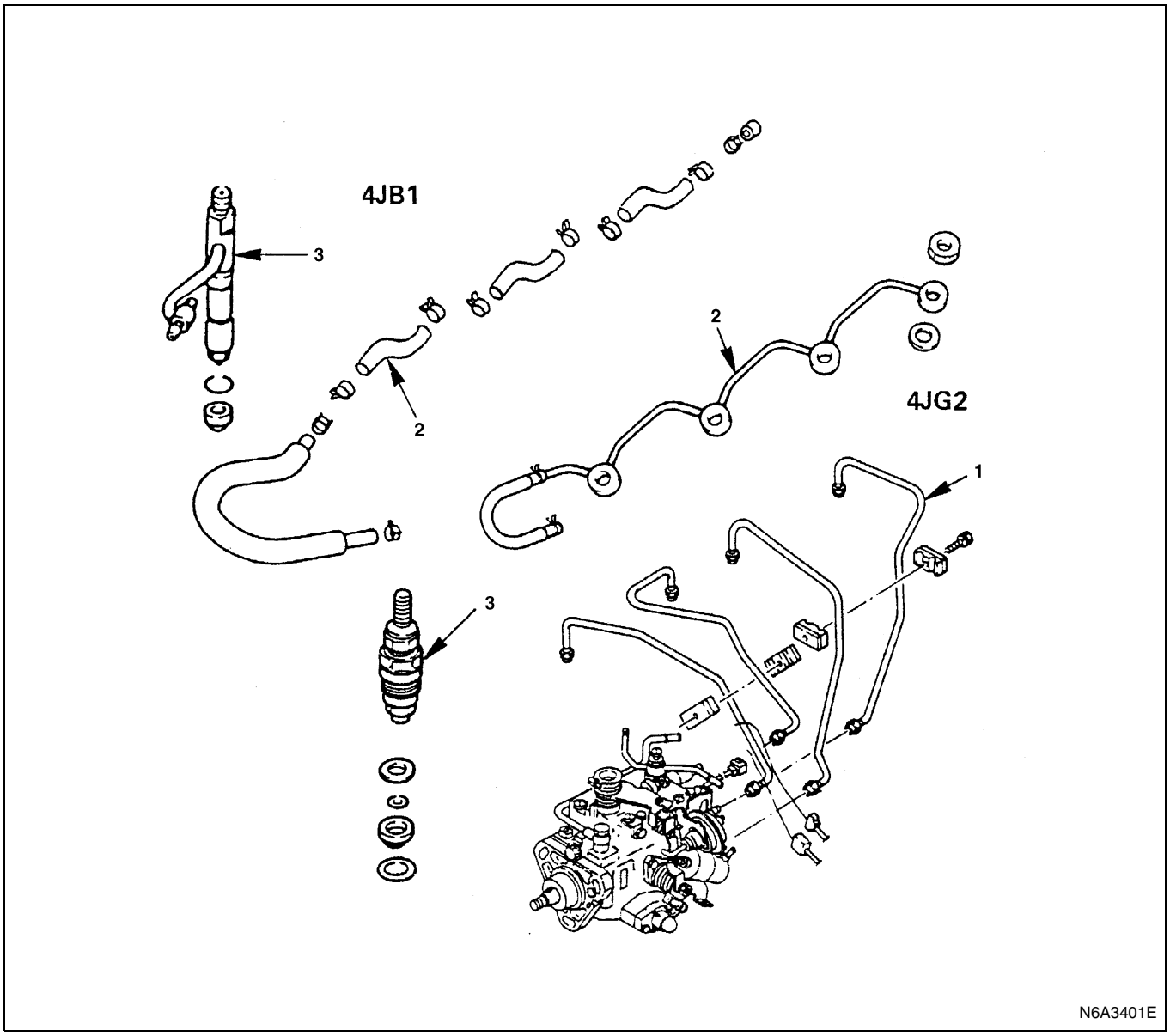
A warning lamp will light up if water above the specified volume collects in the sedimenter. In such cases, drain out the water by performing the following operations:

- Set a container at the tip of the plastic hose.
- Loosen the drain plug.
- Operate the priming pump several times to discharge the water.
- Tighten the drain plug after discharging the water.
- Operate the priming pump several times and check for fuel leakage.
- Check that the warning lamp in the meter is off.

INJECTION NOZZLE

Component

4JB1 / 4JG2



Legend

1. Injection pipe
2. Leak off pipe or hose
3. Injection nozzle

Removal

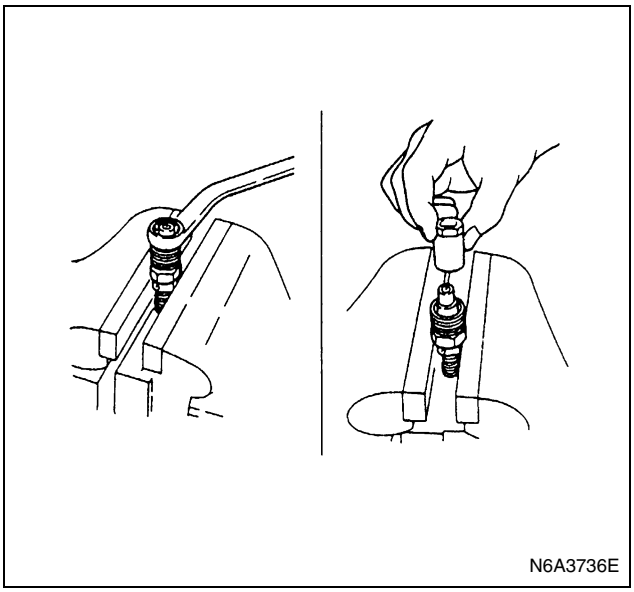
Preparation:

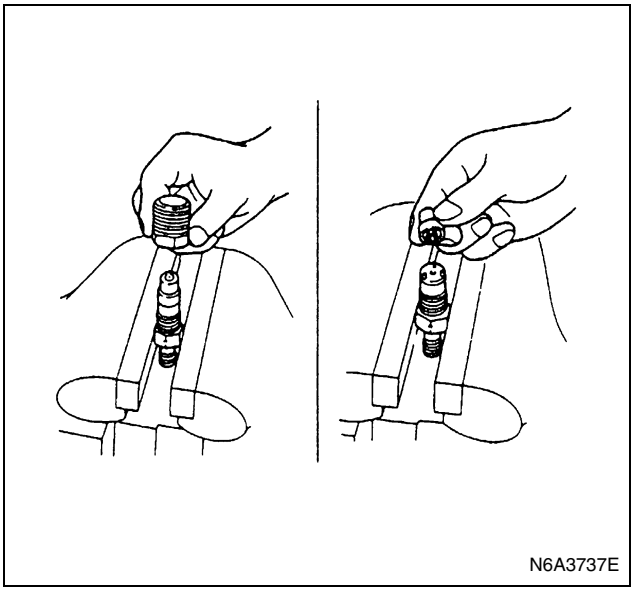
- Disconnect battery ground cable.

1. Injection Pipe
   - Release injection pipe clip.
   - Loosen the flare nut on the injection pump side.
   - Loosen the flare nut on the injection nozzle side, disconnect and put aside the pipe.
2. Leak off Pipe or Hose
3. Injection Nozzle

Disassembly (4JG2 Engine)

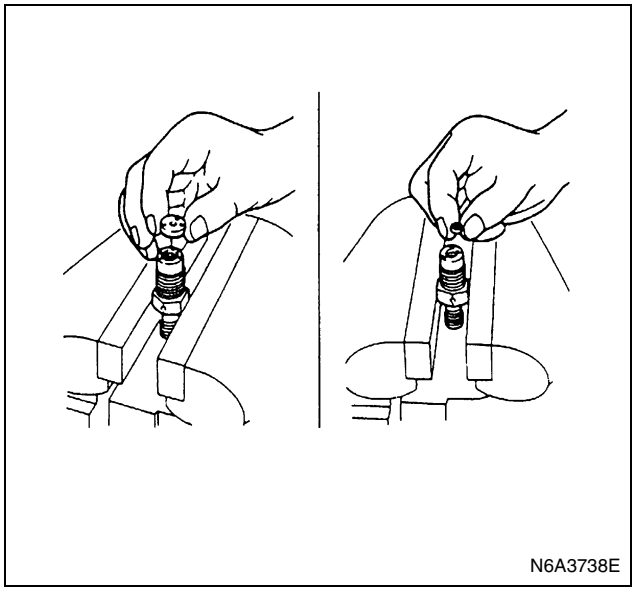
- Grip nozzle holder with a vise, loosen retaining nut and disassemble.
- Loosen holder nut and remove the nozzle.

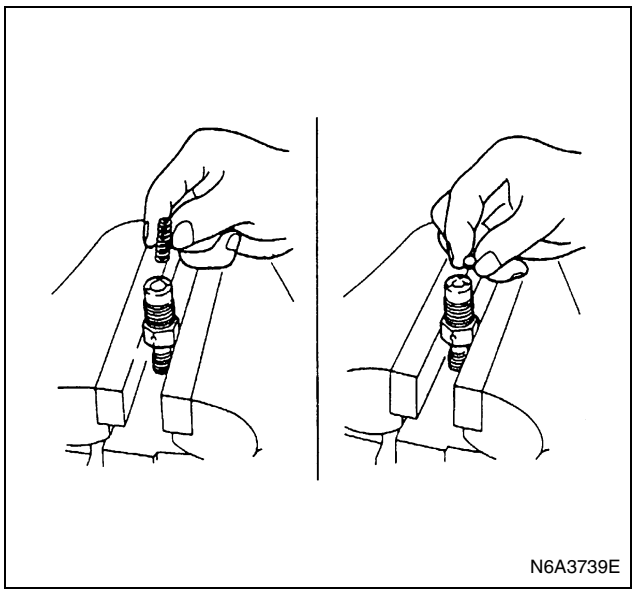

N6A3736E


N6A3737E

Caution:

- Be careful not to damage the needle valve.
- Remove spacer, positioning pin, and push rod.
- Remove spring and adjusting shim.


N6A3738E


N6A3739E

Caution:

- Wash all the parts removed and arrange them on a cylinder basis, care should be taken not to miss any parts.
- Soak the nozzle assembly in a parts receptacle filled with light oil.
- Care should be taken not to miss shim, if used.

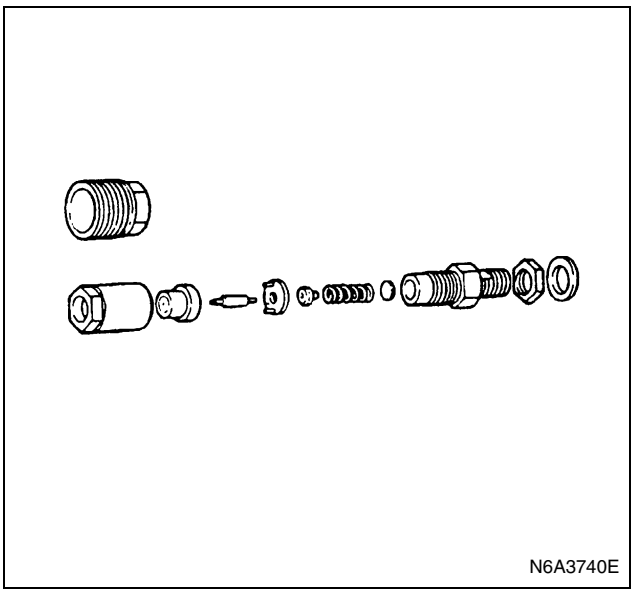
Inspection (4JG2 Engine)

Nozzle

- Soak the nozzle removed in clean light oil, wash nozzle body and needle valve separately, and check and see that the needle valve slide smoothly in the nozzle body.

Caution:

- If the needle valve does not slide smoothly repair or replace with a new nozzle assembly.

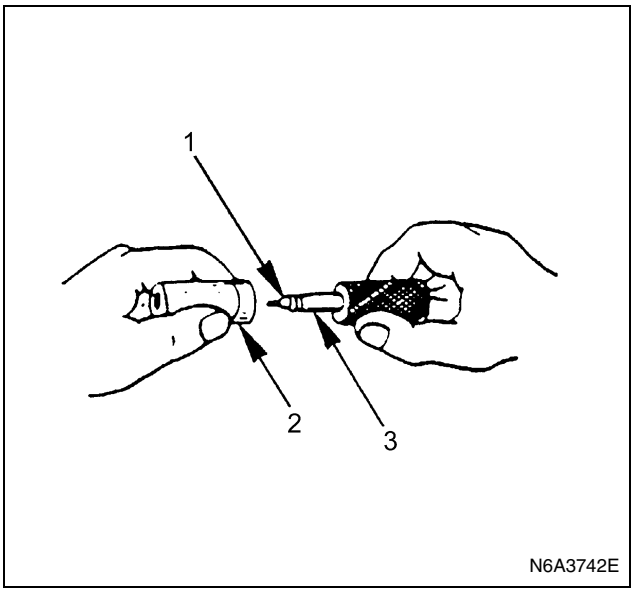

N6A3740E

Nozzle Lapping Procedure

- Apply thinly a compound (Oxide chrome kneaded with animal oil) to the seat of needle valve and lap.

Caution:

- Excess compound may cause worn needle valve, and be sure to wash out the compound after lapping.



N6A3742E

Legend

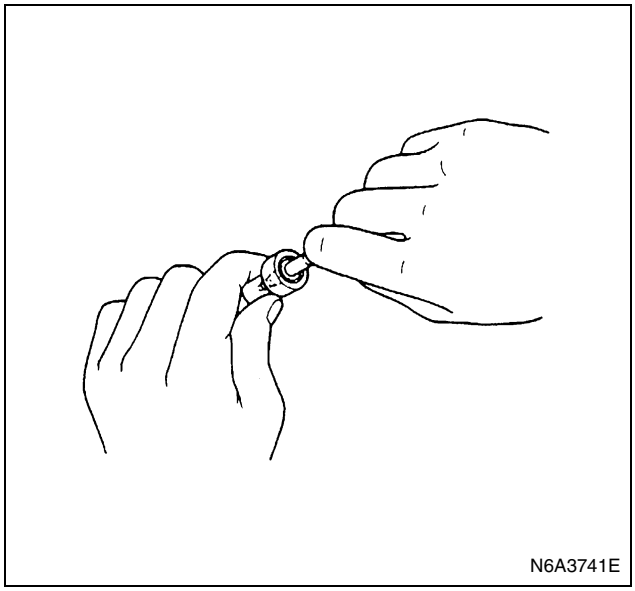
1. Oxidized chrome kneaded with animal oil
2. Nozzle body
3. Needle valve

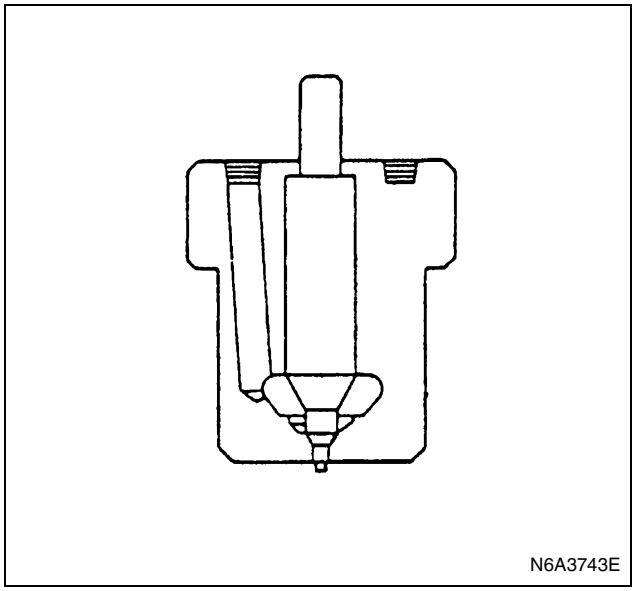
Nozzle Body & Needle

- Check nozzle body and end for seizure.
  If significantly seized, replace as a nozzle assembly basis. Also replace as a nozzle assembly basis, if needle valve end is deformed or seized.

Caution:

- If either nozzle body or needle valve is faulty, replace with a new nozzle assembly.


N6A3741E

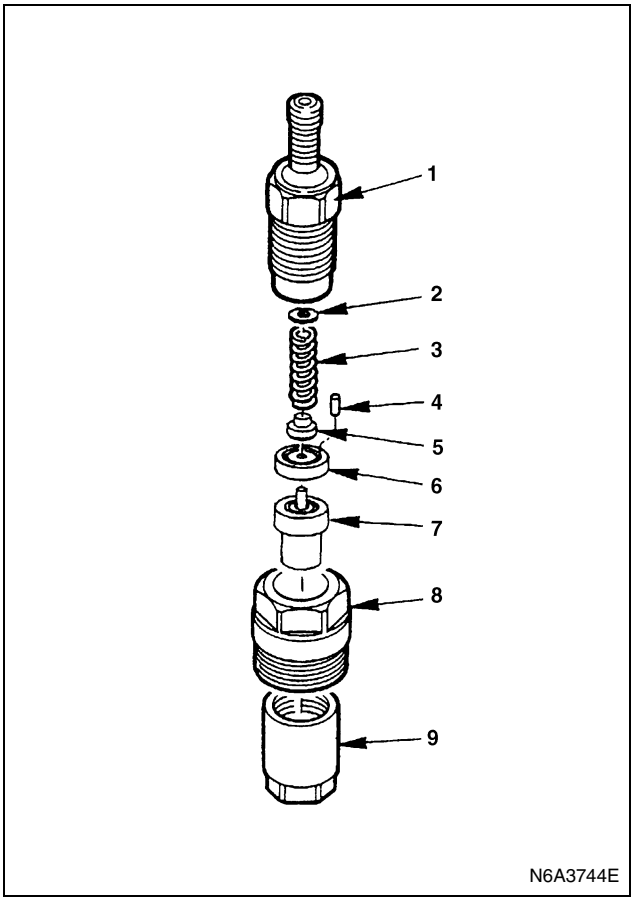

N6A3743E

Reassembly (4JG2 Engine)

To reassemble, follow the removal steps in the reverse order, noting the following point.

Caution:

- Be careful to fit spacer because positioning pins are set off.

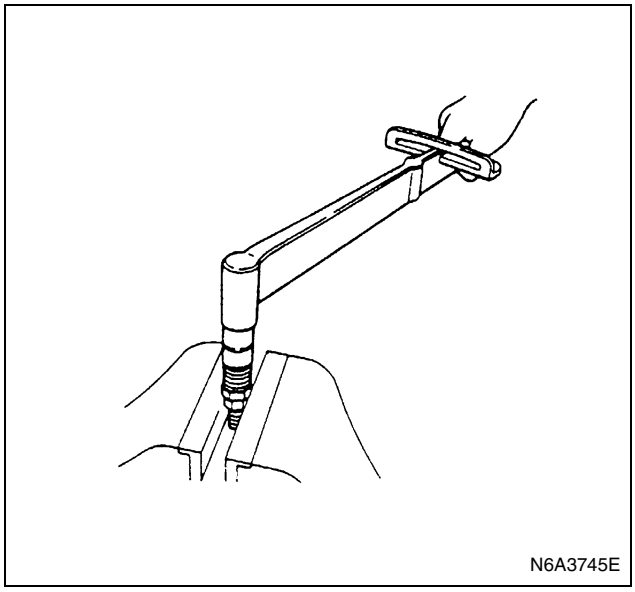


Legend

1. Nozzle holder
2. Adjusting shim
3. Nozzle spring
4. Positioning pin
5. Push rod
6. Spacer
7. Nozzle
8. Holder nut
9. Retaining nut

- Install retaining nut and tighten nut to the specified torque.

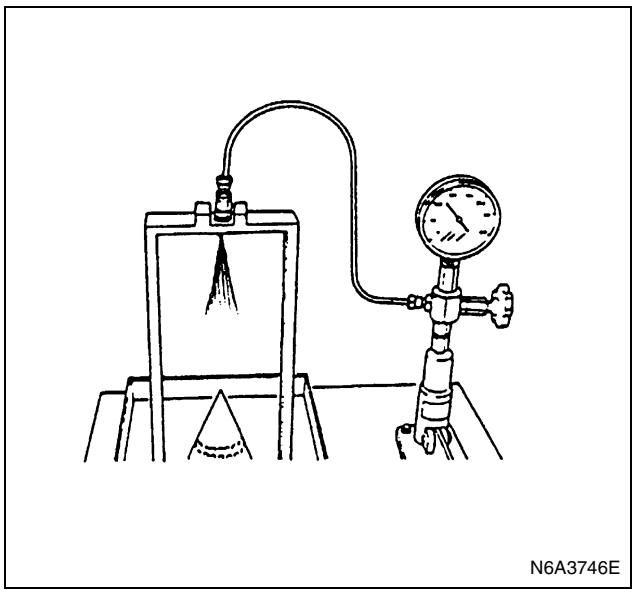
Tighten:
Nut to 39 N·m (4.0 kg·m/32 lb·ft)



Adjustment of Injection Opening Pressure (4JG2 Engine)

- Set nozzle holder assembly on a nozzle tester.
- Apply hydraulic pressure by operating tester handle, and make sure fuel cam be injected under the following pressure.

Kpa (kg/m^2/psi)
14,710 (150/2,133)



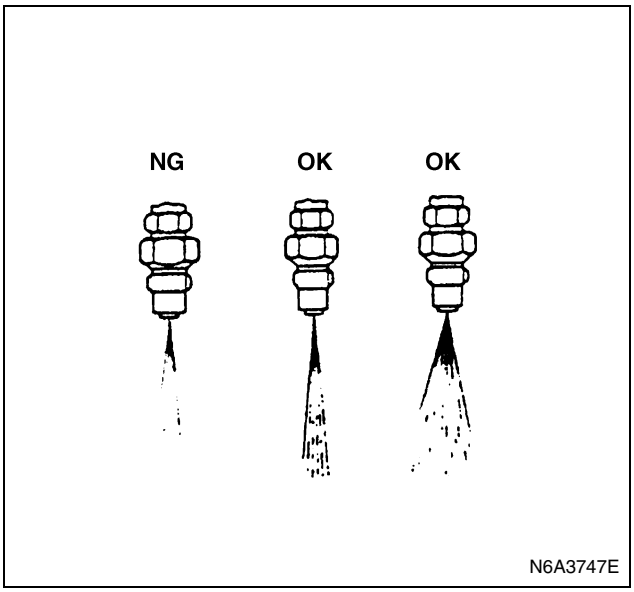
Caution:

- If not injected under the specified pressure, adjust with adjusting shim.

  Types are available in the 1.0 — 1.75 mm (0.039 — 0.069 in) thickness range (on a 0.01 mm (0.00003 in) basis).
- Unless extremely deformed spray in seen, there is no problem.

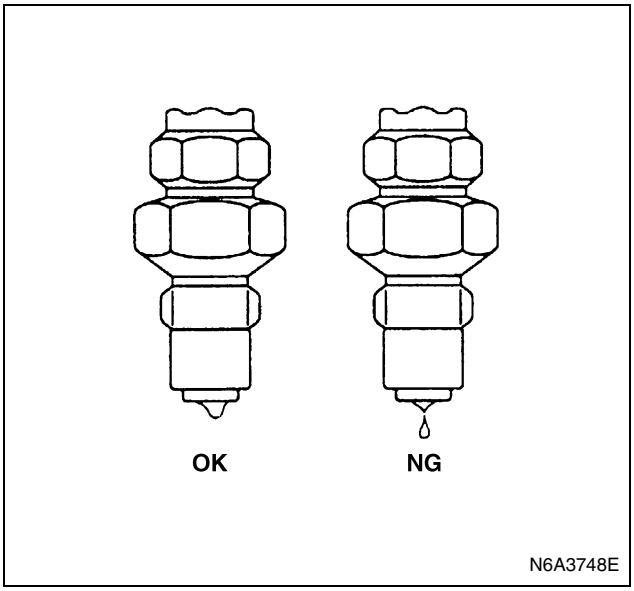
Caution:

- The spray condition, when judged with a nozzle tester, is deemed as normal so long as the spray form is not excessively deformed.



Oil Tight Test (4JG2 Engine)

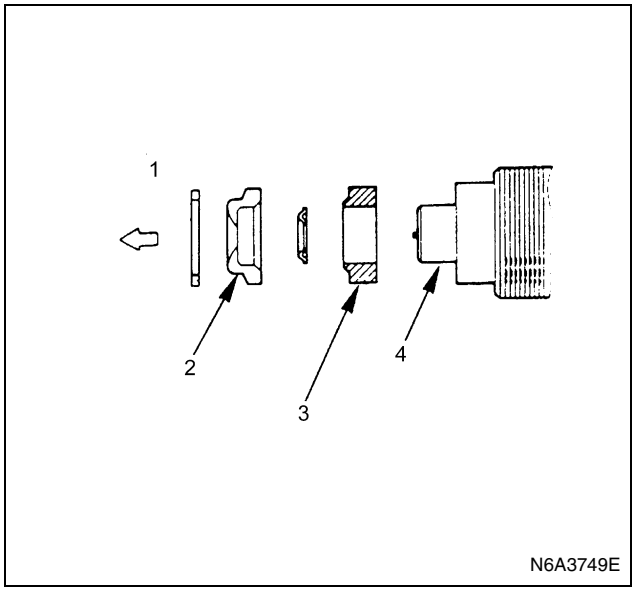
1. After completion of the adjustment of injection pressure, wipe off light oil at the tip of the nozzle with waste.
2. With pressure 1,961 Kpa (20 kg/cm^2/284 psi) less than the specified injection pressure applied, check to see if an oil drop trickles off the tip of the nozzle within 10 seconds after application of pressure. (There is no problem with the nozzle when oil gathers at the tip, but does not drop off.)
3. When an oil drop trickles, clean the nozzle thoroughly.
   Then reassemble it to check for any dropping of oil.
   When oil still drops, change it with a new one.



Installation (4JG2 Engine)

Caution:

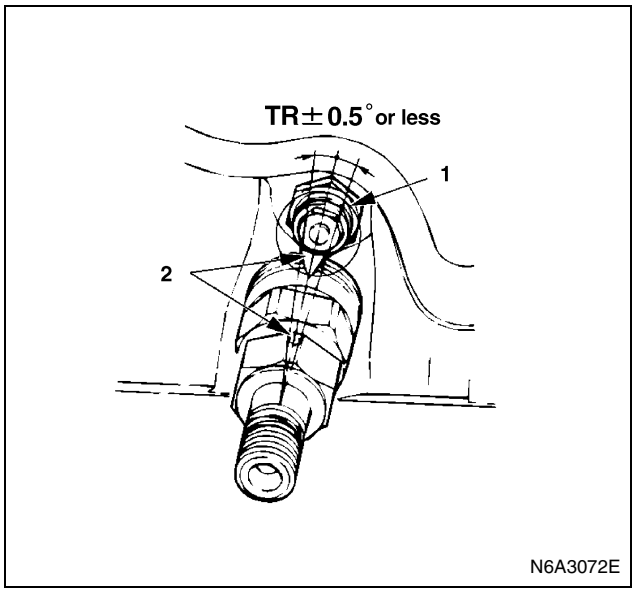
- Nozzle and assembling should be as illustrated.
- Use new heat shield and new corrugated washer.



Legend

1. Cylinder head side
2. Nozzle heat shield
3. Gasket heat shield
4. Nozzle

1. Injection Nozzle (4JG2 only)
   - Lightly tighten the holder nut to suck extent that the nozzle holder can turn one word and one word.
   - Set positioning confirmation drilled hole (ϕ2) within a nozzle turning angle of $\pm$5° against the cylinder headside positioning boss.



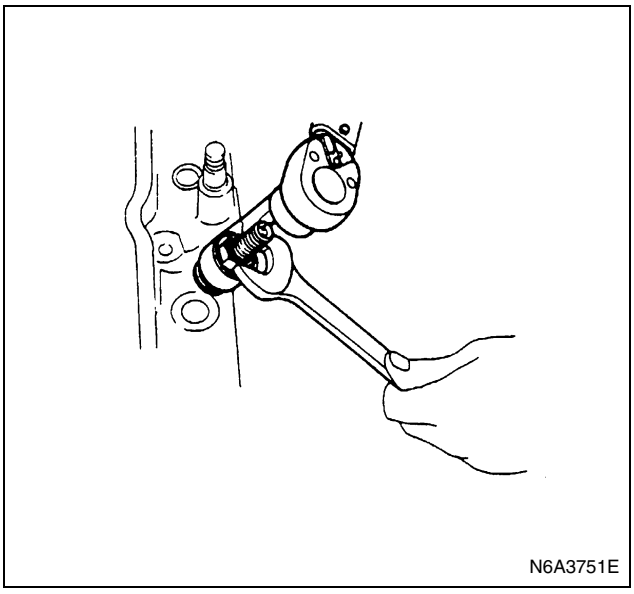
Legend
1. Glow plug
2. Positioning boss

- Apply a wrench as illustrated and tighten the holder nut to the specified torque using a special tool.

Caution:
- After tightening the holder nut, make sure that the drilled hole makes ±5° or smaller with the cylinder head-side positioning boss.
- When mounting leak off pipe, injection nozzle and pipe, clean with air so that dust may not enter.

Tighten:
Nozzle Fixing Nut to 64 N·m (6.5 kg·m/47 lb·ft)

Wrench: nozzle holder 5-8840-0259-0



2. Leak Off Pipe
   - Mount using a new copper washer.
   - Tighten nut to the specified torque.

Tighten:
Pipe Nut to 29 N·m (3.0 kg·m/22 lb·ft)

3. Injection Pipe
   - Connect injection pipe to nozzle holder.
   - Tighten the injection pump side.

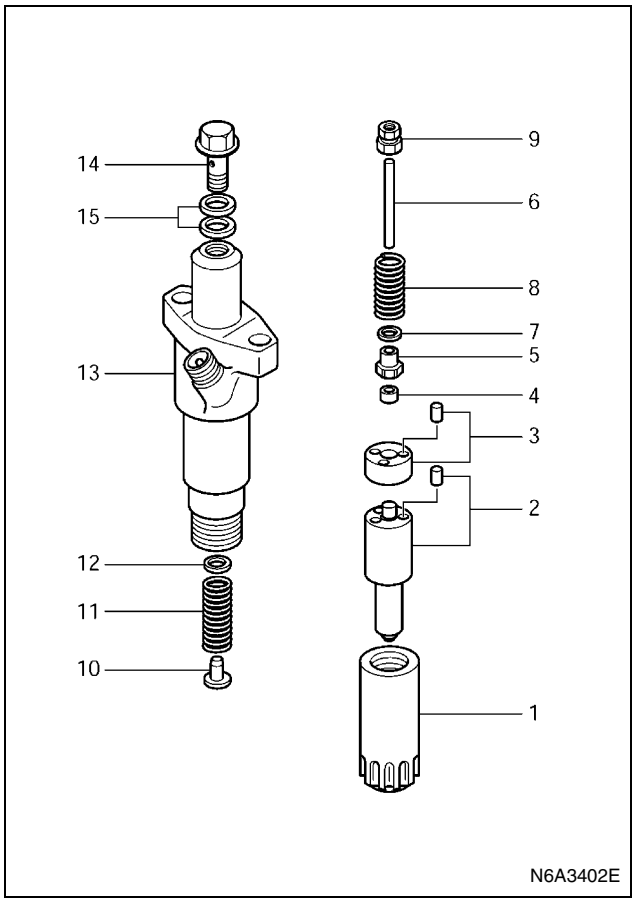
Tighten:
Sleeve Nut to 29 N·m (3.0 kg·m/22 lb·ft)

- Fit pipe clip in specified position.

4-1 Injection Nozzle (Two Spring Nozzle Holder) (4JB1-TC)
The two-spring nozzle holder has been developed to reduce NOx (Nitrogen Oxides) and particulates from direct injection diesel engine exhaust.

Disassembly

1. Retaining nut (1)
2. Nozzle & pin (2)
3. Spacer & pin (3)
4. Lift piece (4)
5. Spring seat (5)
6. Push rod (6)
7. Shim (Second nozzle opening pressure adjustment) (7)
8. Second spring (8)
9. Collar (9)
10. Spring seat (10)
11. First spring (11)
12. Shim (First nozzle opening pressure adjustment) (12)
13. Nozzle holder body (13)
14. Eye bolt (14)
15. Gasket (15)



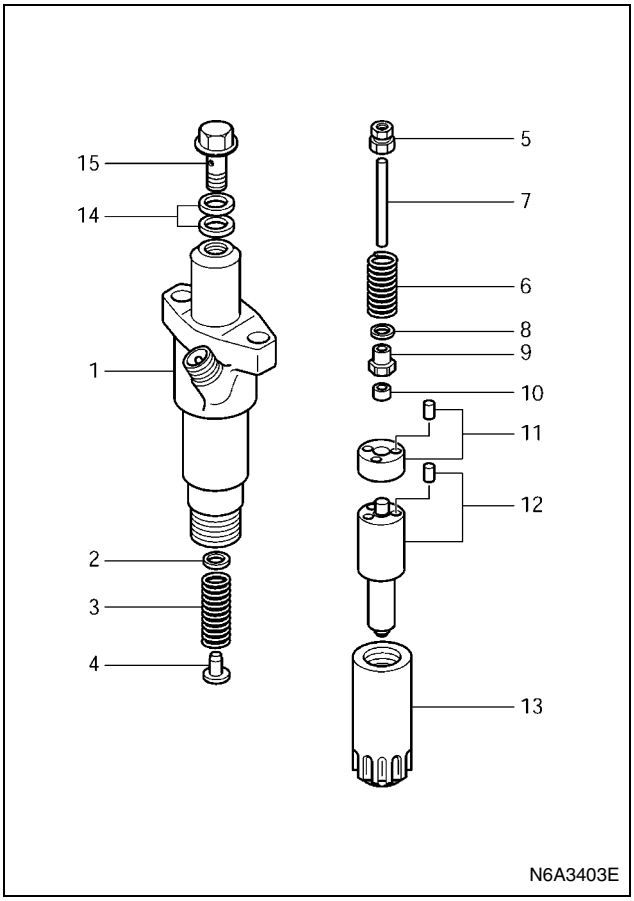
1) Before disassembly, remove carbon deposit from nozzle and nozzle holder using a wire brush and wash the outside nozzle holder assembly.

Caution:
Do not touch nozzle holes with the wire brush during cleaning it.

2) Disassemble the nozzle holder assembly to numerical order.

Reassembly and Opening Pressure Adjustment (4JB1-TC)

1. Nozzle holder body
2. Shim (First opening pressure adjustment)
3. First spring
4. Spring seat
5. Collar
6. Second spring
7. Push rod
8. Shim (Second opening pressure adjustment)
9. Spring seat
10. Lift piece
11. Spacer & pin
12. Nozzle & pin
13. Retaining nut
14. Gasket
15. Eye bolt



The nozzle holder is adjusted as the components are reassembled in the sequence above.
As adjustment of the two-spring nozzle holder is made in hundredths of a millimeter, clean the parts thoroughly in light oil to completely remove any dirt or foreign matter.

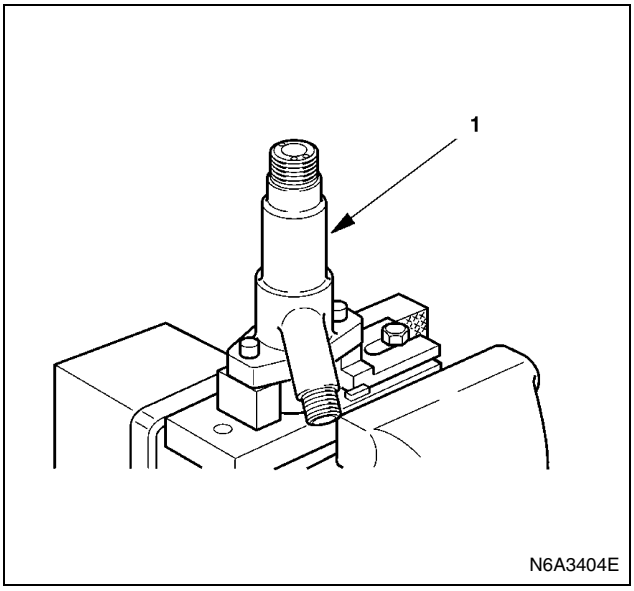
Reassembly and Adjustment Procedure

1	First nozzle opening pressure adjustment	Adjust the first nozzle opening pressure using the shim.
2	Full needle valve lift confirmation	Confirm the full needle valve lift in accordance with the closed method.
3	Pre-lift confirmation	Confirm pre-lift in accordance with the closed method. **CAUTION:** **If not as specified, replace the nozzle assembly, lift piece, pins and spacer using the nozzle service kit.**
4	Second nozzle opening pressure confirmation	Confirm the second nozzle opening pressure in accordance with the closed method.
5	Second nozzle opening pressure adjustment	Adjust the second nozzle opening pressure using the shim.
6	Final inspection	Confirm the condition of the fuel spray with the nozzle and nozzle holder assembled.

N6A3692E

First Nozzle Opening Pressure Adjustment

1. Claim the nozzle holder in a vise.

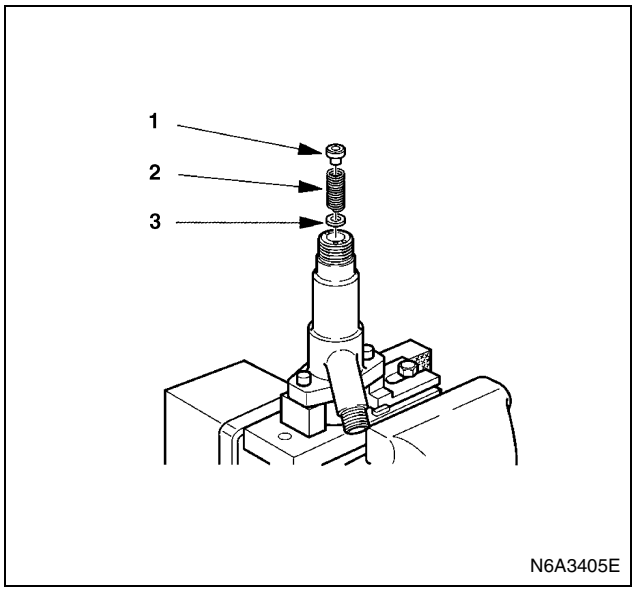


N6A3404E

Legend

1. Nozzle holder body

2. Install the shim, first spring and spring seat in the nozzle holder.

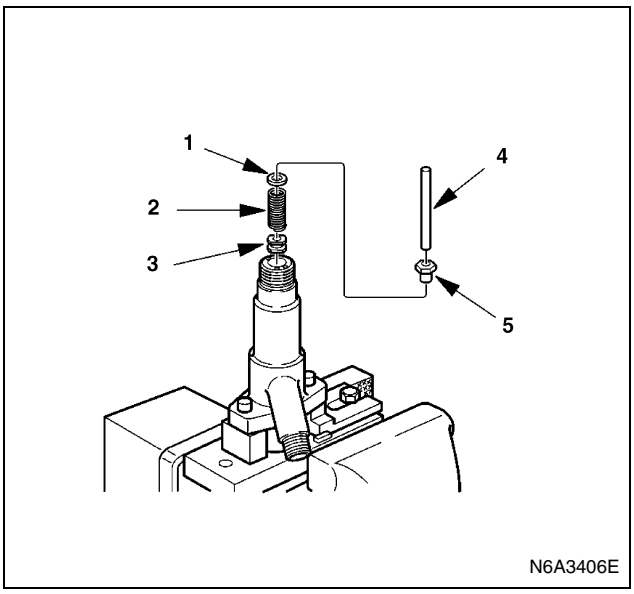


N6A3405E

Legend

1. Spring seat
2. First spring
3. First nozzle opening pressure adjusting shim

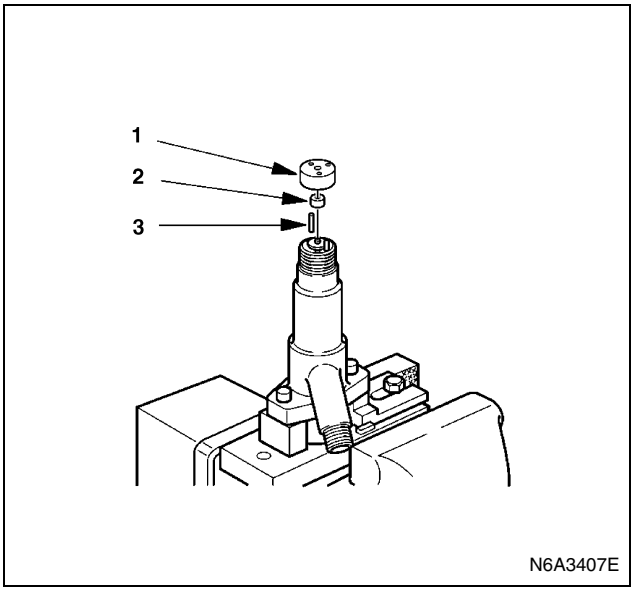
3. Install the collar, second spring, shim, spring seat and push rod in the nozzle holder.



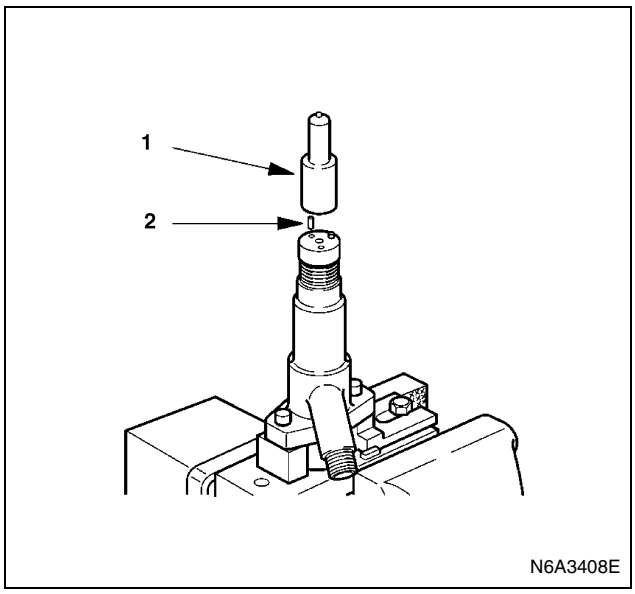
Legend

1. Second nozzle opening pressure adjusting shim
2. Second spring
3. Collar
4. Push rod
5. Spring seat

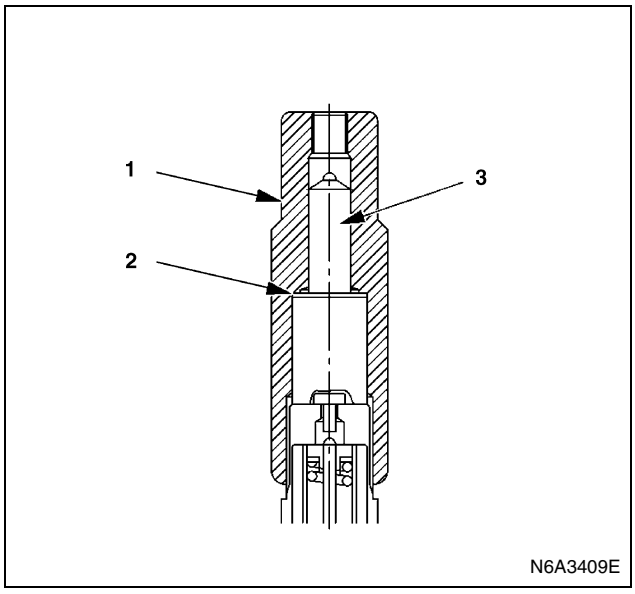
4. Install the pins (3), lift piece (2) and spacer (1) in the nozzle holder.



5. Install the pins (2) in the spacer.
6. Install the nozzle (1) on the spacer.



7. Hand-tighten the adjustment retaining nut together with the gasket to the nozzle holder.
   Retaining nut: 5-8677-7140-0
   Gasket: 5-8677-7139-0

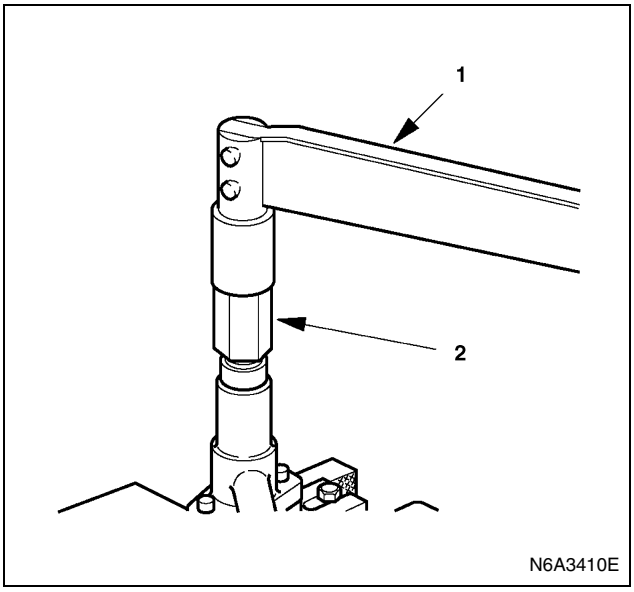


Legend

1. Retaining nut (Special tool)
2. Gasket (Special tool)
3. Nozzle

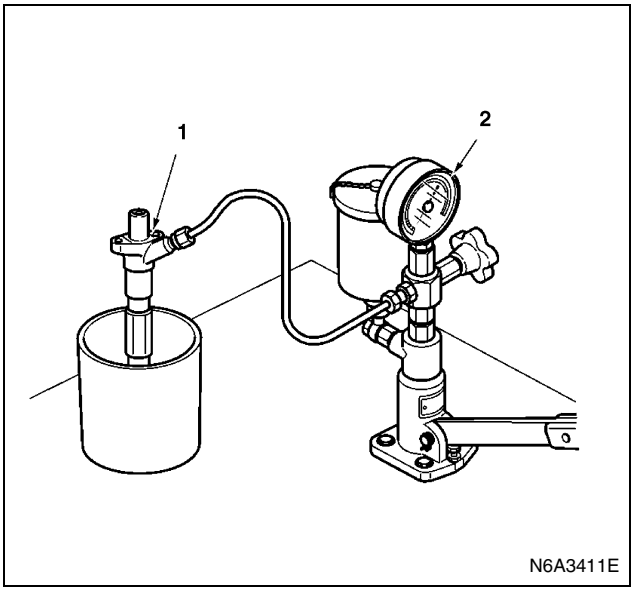
8. Tighten the adjustment retaining nut to the specified torque.

Tighten:
Retaining nut to 29 — 39 N·m (3.0 — 4.0 kg·m)



Legend
1. Torque wrench
2. Retaining nut (Special tool)

9. Set the nozzle holder to the nozzle tester.
10. Operate the nozzle tester and measure the first nozzle opening pressure.



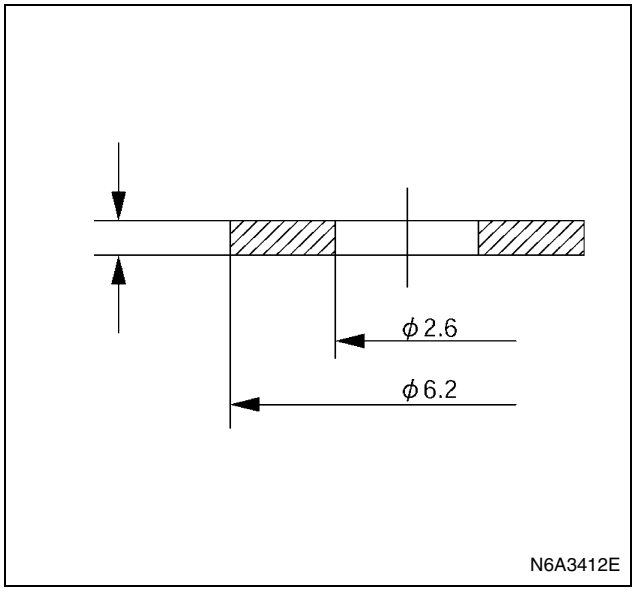
Legend
1. Nozzle holder
2. Nozzle tester

11. If the first nozzle opening pressure is not as specified, disassemble the nozzle holder and replace the shim until the pressure is as specified.

Caution:
Use a micrometer to measure shim thickness.

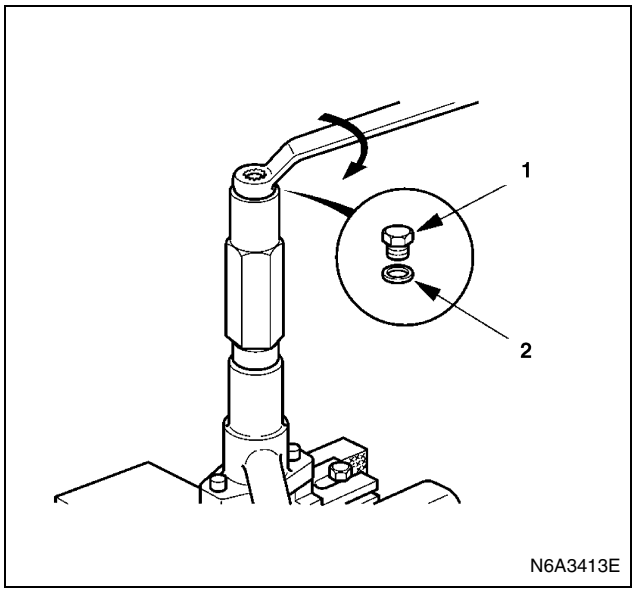
- First nozzle opening pressure adjusting shims

Parts No.	Thickness (mm)
1-1534-9042-0	0.40
1-1534-9043-0	0.50
1-1534-9044-0	0.52
1-1534-9045-0	0.54
1-1534-9046-0	0.56
1-1534-9047-0	0.58
1-1534-9048-0	0.60
1-1534-9049-0	0.70

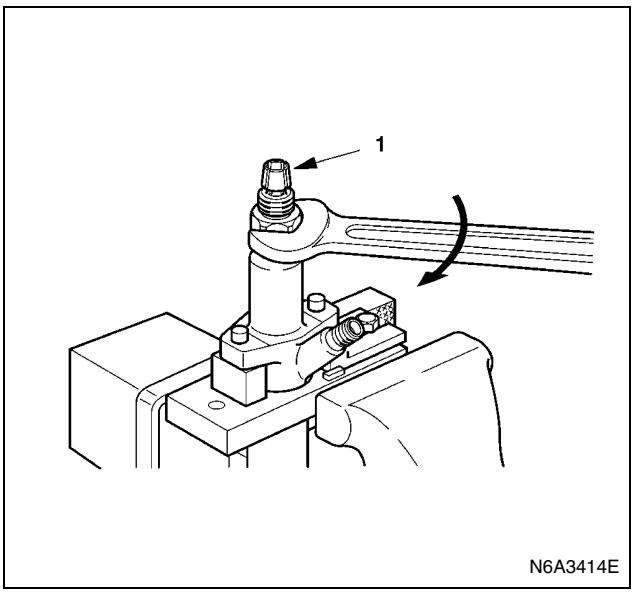


Full Needle Valve Lift Confirmation

1. Install the gasket (2) and plug (1) on the adjustment retaining nut.
   Gasket: 8-9722-7602-0
   Plug: 5-8677-7141-0



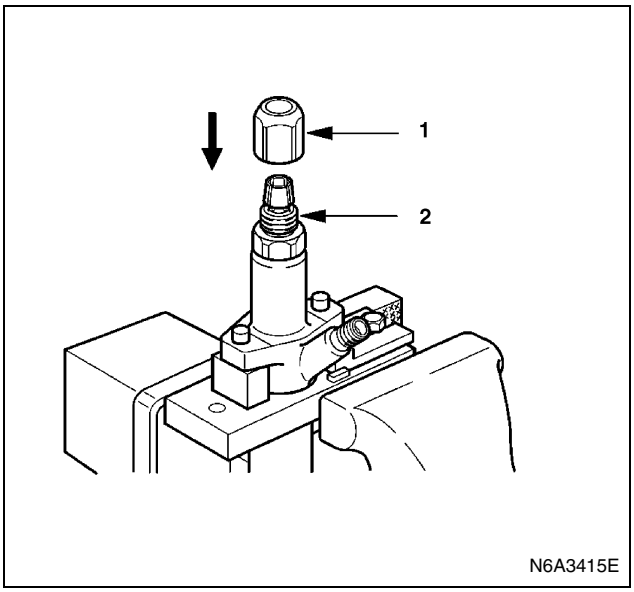
2. Position the nozzle holder with the nozzle facing down and install the dial gauge holder on the nozzle holder.
   Dial gauge holder: 5-8677-7142-0



Legend

1. Dial gauge holder (Special tool)

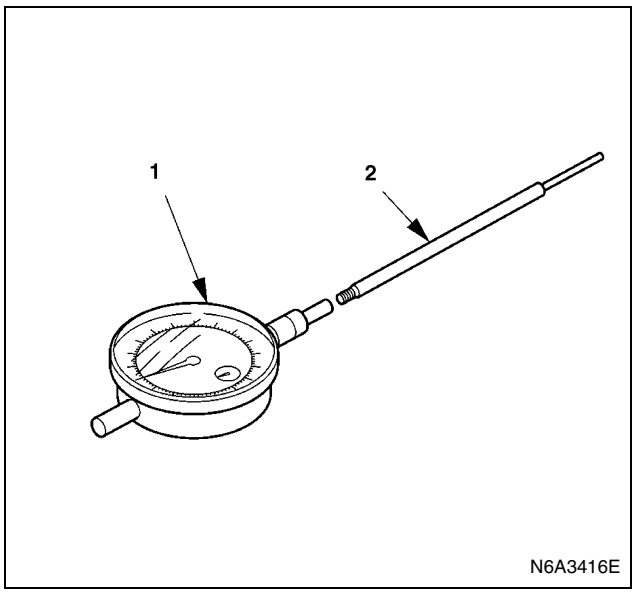
3. Install the nut (1) on the dial gauge holder (2).
   Nut: 5-8677-7143-0



4. Install the pin (2) to the dial gauge (1).

Notice:
The lengths of the pin do not include the threaded portions.

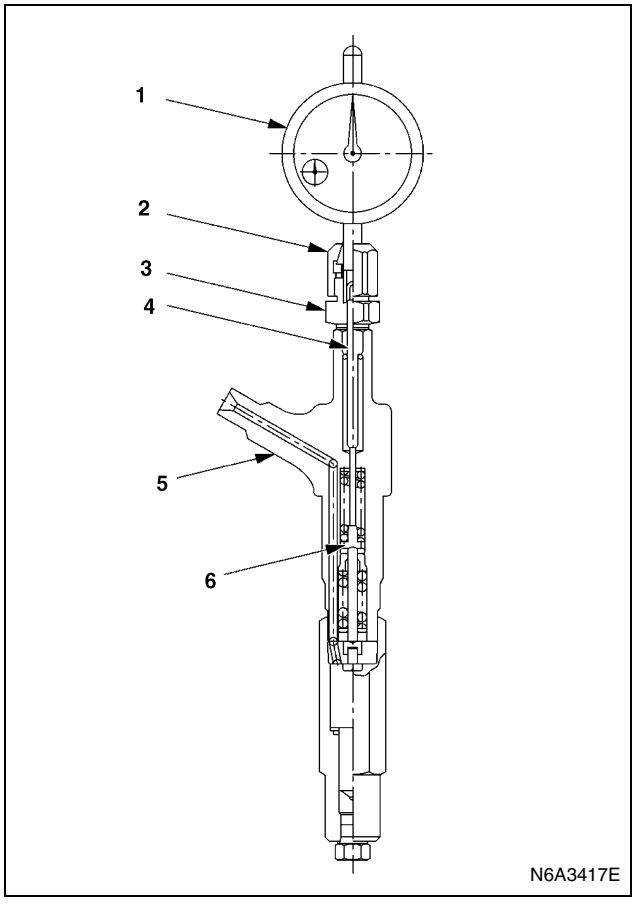
Pin (liter=100 mm): 5-8677-7144-0
Dial gauge: 1-8531-7015-0



5. Secure the dial gauge to the nozzle holder using the nut so that the pin contacts the tip of the first spring seat.

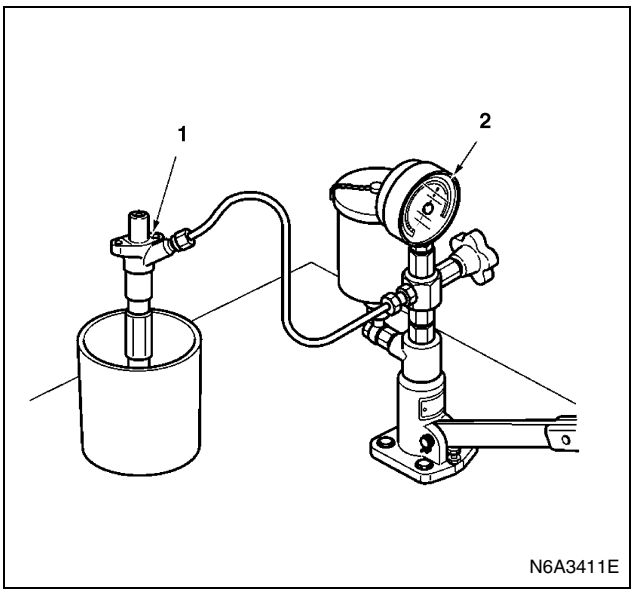
Caution:

- Secure the dial gauge so that a stroke of 2 mm can be measured.
- Do not over-tighten the nut as the dial gauge shaft may jam. (Confirm from the dial gauge that the shaft moves smoothly.)



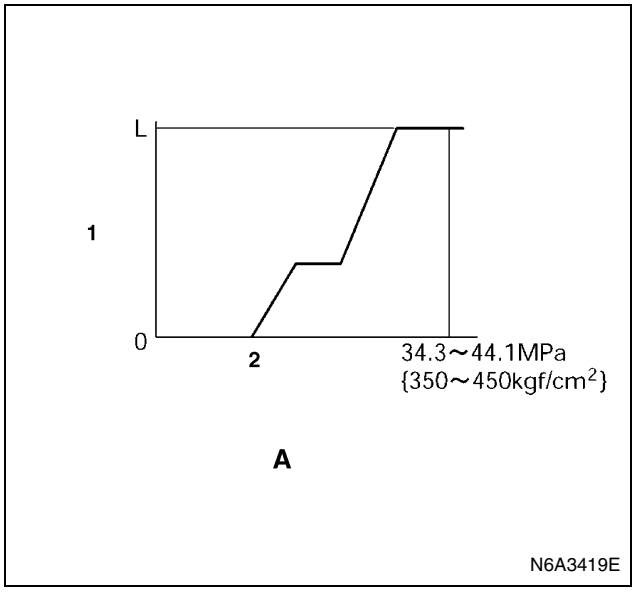
Legend
1. Dial gauge
2. Nut
3. Holder
4. Pin
5. Nozzle holder
6. First spring seat

6. Set the nozzle holder (1) to the nozzle tester (2) and put needle to zero on the dial gauge.
7. Operate the nozzle tester (2) to bleed any air from inside the retaining nut and to confirm that no fuel leaks.



8. Operate the nozzle tester and increase the inline pressure to 34.3 — 44.1 MPa (350 — 450 kg/cm^2) so that the nozzle's needle valve moves through its full lift.
   Record full lift 'L'. (Read dial gauge)

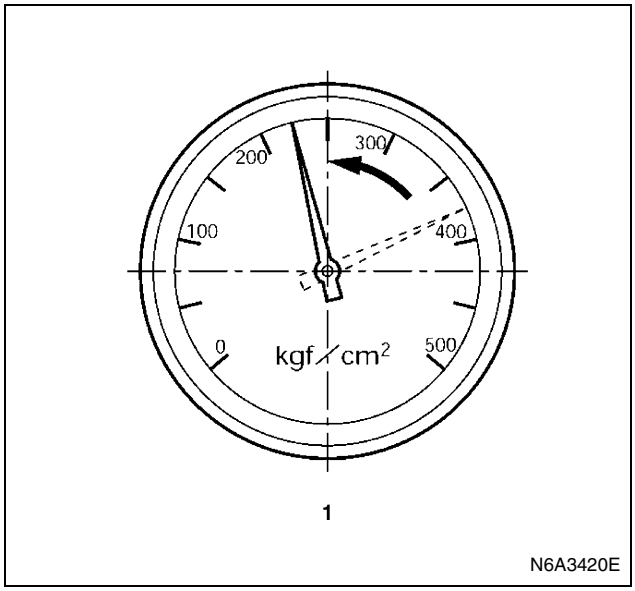
Notice:
The above operation is used to determine whether the nozzle seat is worn and whether the nozzle assembly is in good condition.



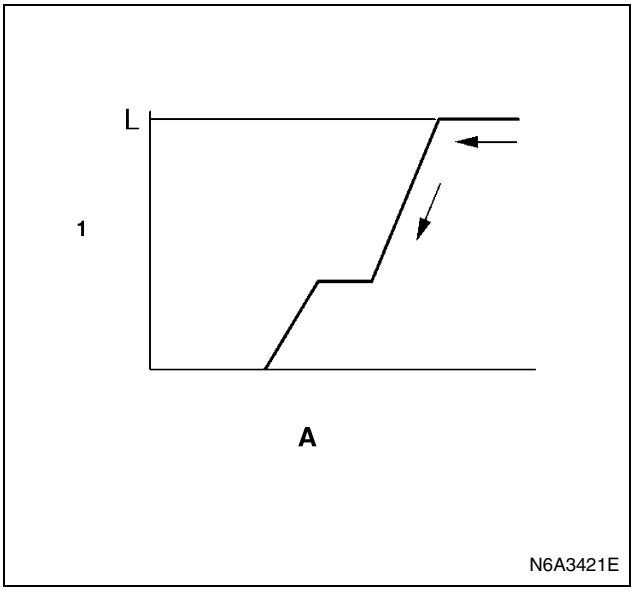
Legend
A. Inline pressure
1. Needle valve lift
2. First nozzle opening pressure

Pre-lift Confirmation

1. With the needle valve at full lift, release the nozzle tester handle.



Legend
1. Pressure gauge

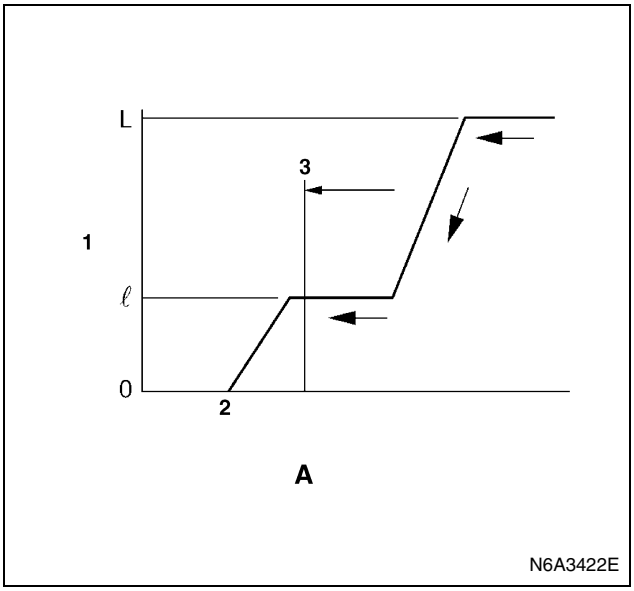


Legend
A. Inline pressure
1. Needle valve lift

Notice:
The inline pressure will decrease and needle valve lift (as indicated on the dial gauge) will also decrease a little.

2. Read the needle valve lift 'liter' from the dial gauge indication (once the needle valve has descended when the second spring has stopped operating). Refer to the pre-lift measuring point for 'liter'.

Pre-Lift Measuring Point:
Read the dial gauge at first nozzle opening pressure +approx 1 MPa (10 kg/cm^2).

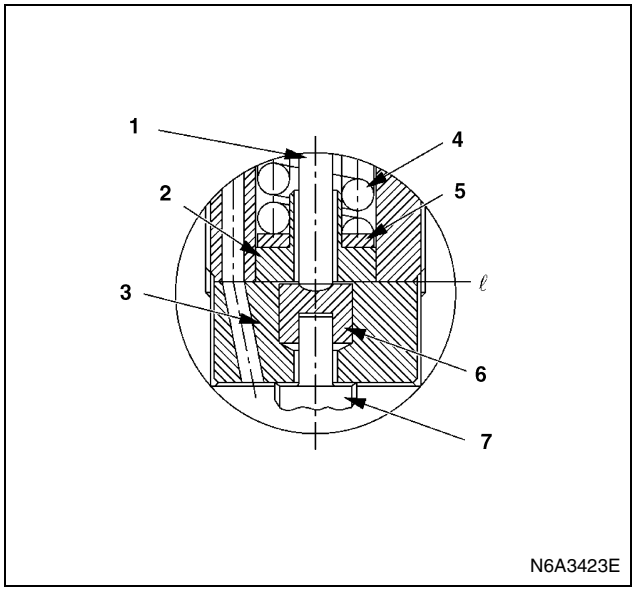


Legend
A. Inline pressure
1. Needle valve lift
2. First nozzle opening pressure
3. Measuring point of pre-lift

Notice:
This point can be found while the pressure is decreasing.

3. Confirm that pre-lift 'liter' is as specified.

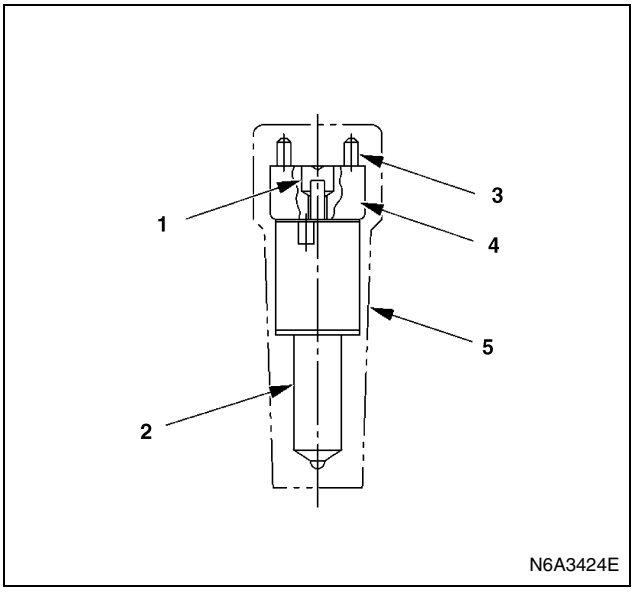
Pre-lift	mm (in)
0.04 (0.002)	



Legend
1. Push rod
2. Spring seat
3. Spacer
4. Second spring
5. Adjusting shim
6. Lift piece
7. Needle valve

4. If pre-lift is not specified, replace the pins, lift piece, spacer and nozzle assembly with the service kit.

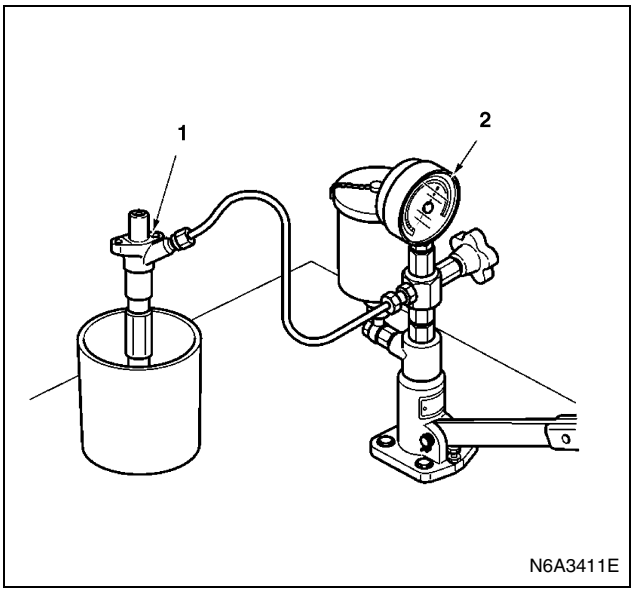
   Service kit:
   8-9720-3470-1



Legend
1. Lift piece
2. Nozzle assembly
3. Pin
4. Spacer
5. Capsule

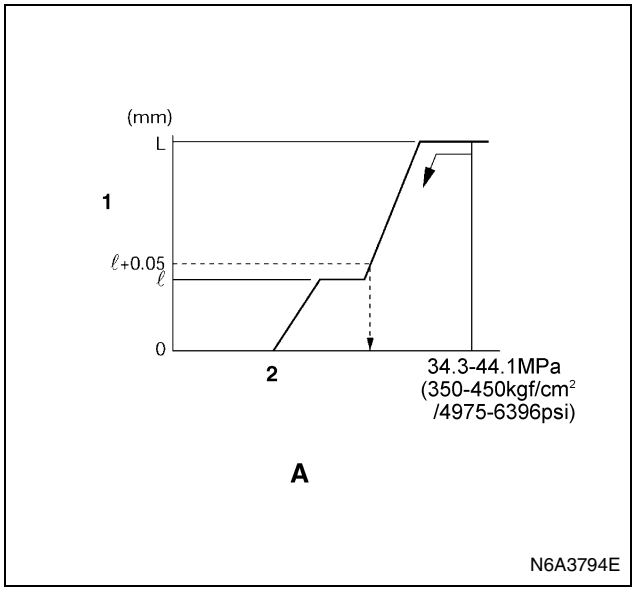
Second Nozzle Opening Pressure Confirmation

1. After pre-lift confirmation, operate the nozzle tester to increase inline pressure to 34.3 — 44.1 MPa (350 — 450 kg/cm^2) so that the nozzle's needle valve moves through its full lift.



Legend
1. Nozzle holder
2. Nozzle tester

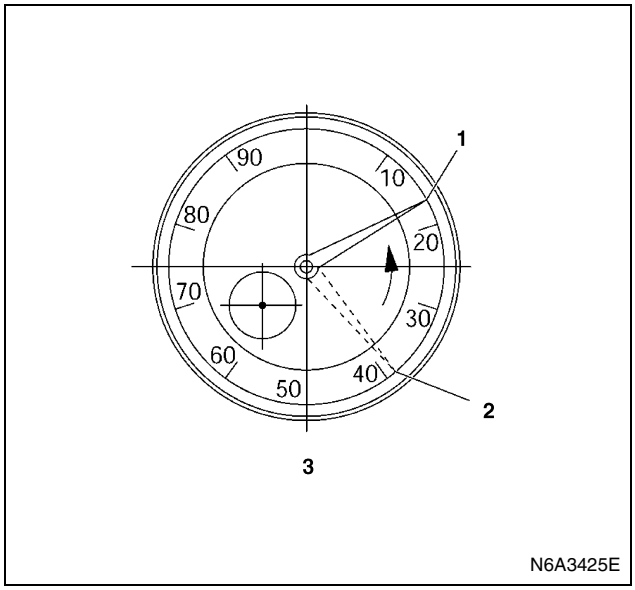
2. Release the nozzle tester handle so that inline pressure decreases.



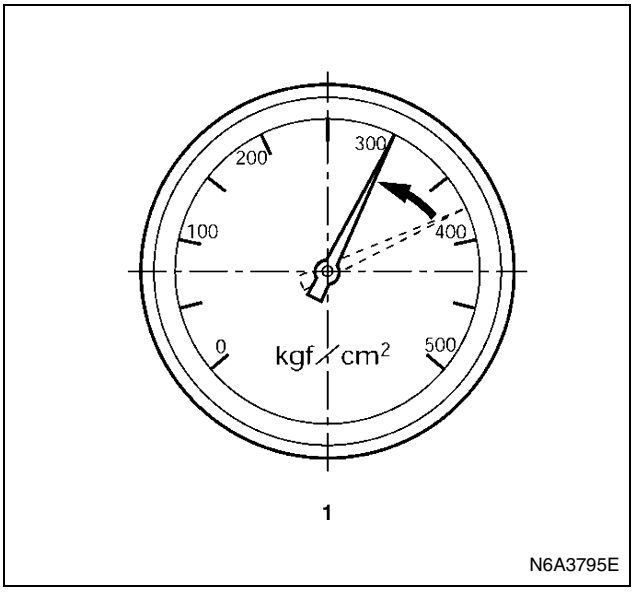
Legend
A. Inline pressure
1. Needle
2. Second nozzle opening pressure

Notice:
The inline pressure will decrease and needle valve lift (as indicated on the dial gauge) will also decrease a little.

3. Then, read the pressure gauge indication (second nozzle opening pressure) the instant that the dial gauge indicates the specified needle valve lift (usually pre-lift liter + 0.05 mm).



Legend
1. When needle valve lift is L + 0.05 mm
2. Full needle valve lift
3. Dial gauge

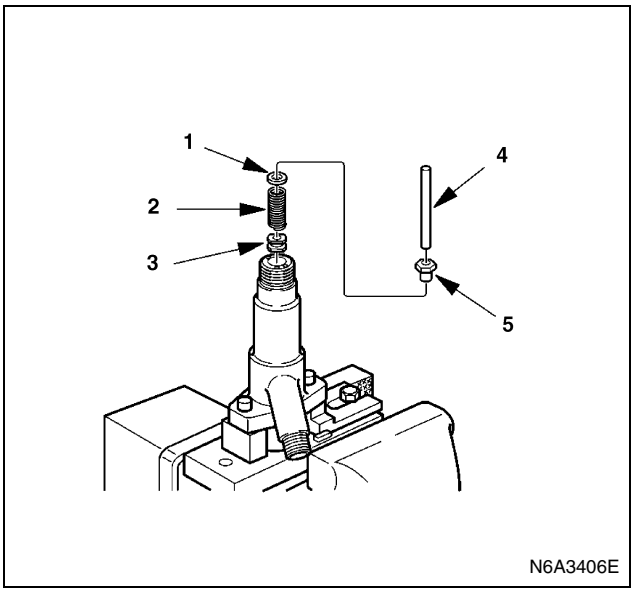


Legend
1. Pressure gauge

Second Nozzle Opening Pressure Adjustment

If the second nozzle opening pressure is not as specified, disassemble the nozzle from the nozzle holder and replace the shim until the pressure is as specified.

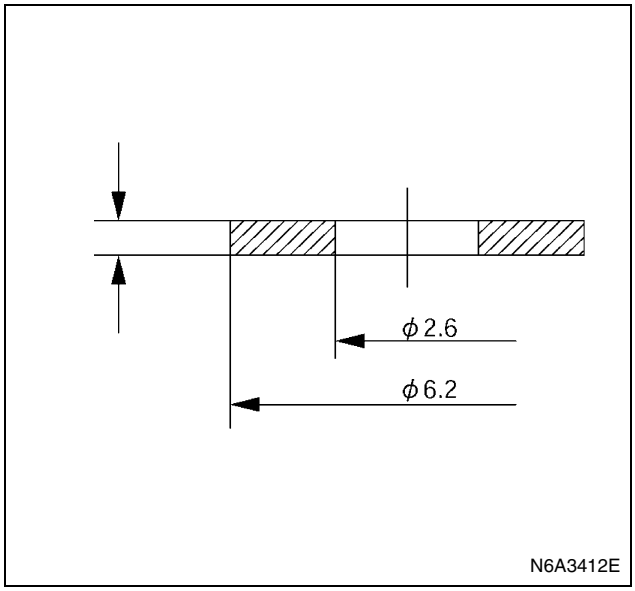
Caution:
- Because the second opening pressure changes when the first opening pressure changes, the second opening pressure must be adjusted when the first opening pressure changes.
- Use a micrometer to measure shim thickness.



Legend
1. Second nozzle opening pressure adjusting shim
2. Second spring
3. Collar
4. Push rod
5. Spring seat

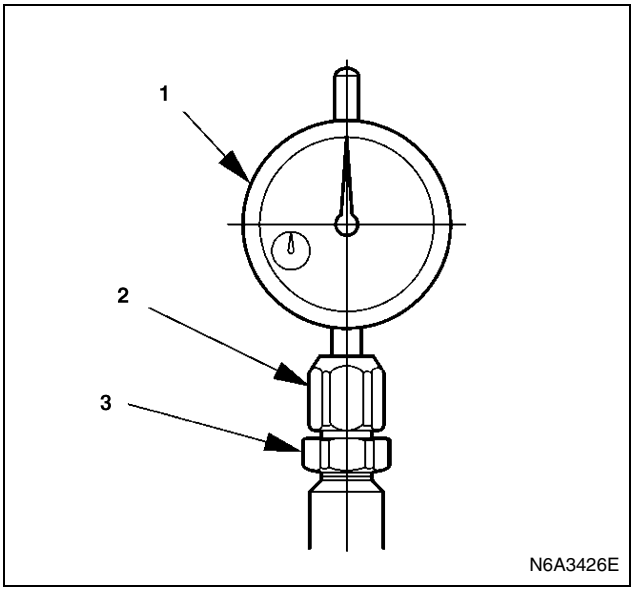
- Second nozzle opening pressure adjusting shims

Part No.	Thickness (mm)
8-9711-6034-0	0.40
8-9711-6035-0	0.50
8-9711-6037-0	0.52
8-9711-6039-0	0.54
8-9711-6041-0	0.56
8-9711-6043-0	0.58
8-9711-6044-0	0.59

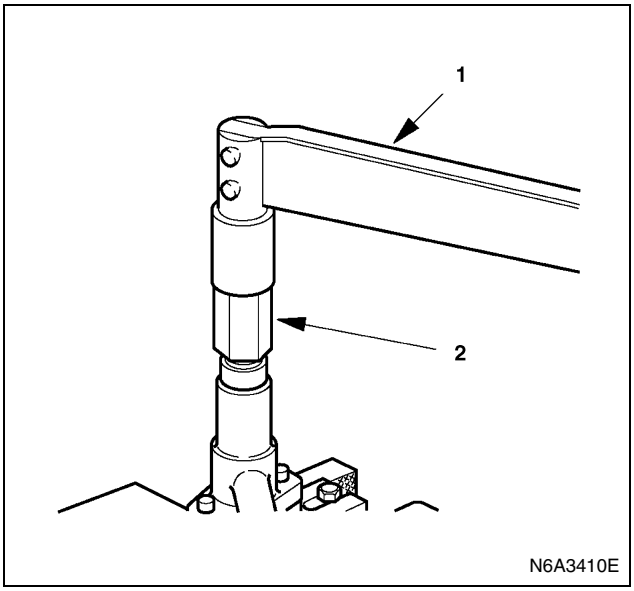


Final Inspection

1. Remove the dial gauge (1), nut (2) and dial gauge holder (3).

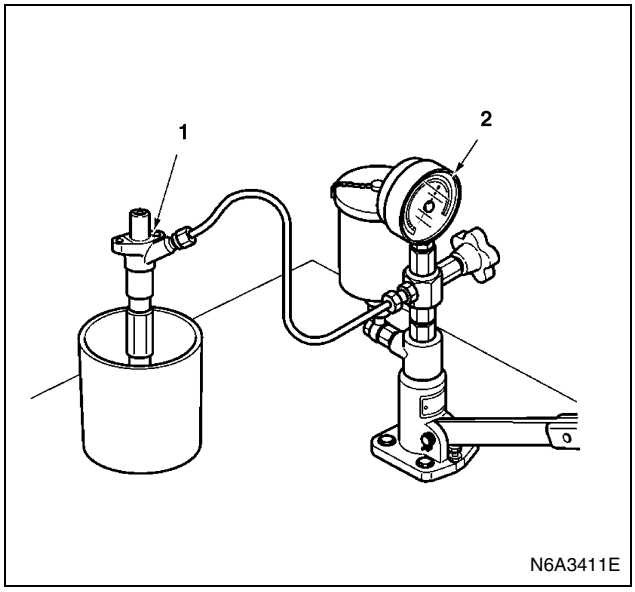


2. Remove the adjustment retaining nut and gasket.
3. Install the original retaining nut, confirm that the pins are inserted fully into the nozzle, and then hand-tighten the retaining nut. Then, tighten the original retaining nut to the specified torque.
   Torque: 59 — 79 N·m (6.0 — 8.0 kg·m/43.5 — 58.2 lb·ft)



Legend
1. Torque wrench
2. Retaining nut (Special tool)

4. Set the nozzle holder to the nozzle tester and check first nozzle opening pressure, spray condition, seat oil tightness and each part for oil leaks.



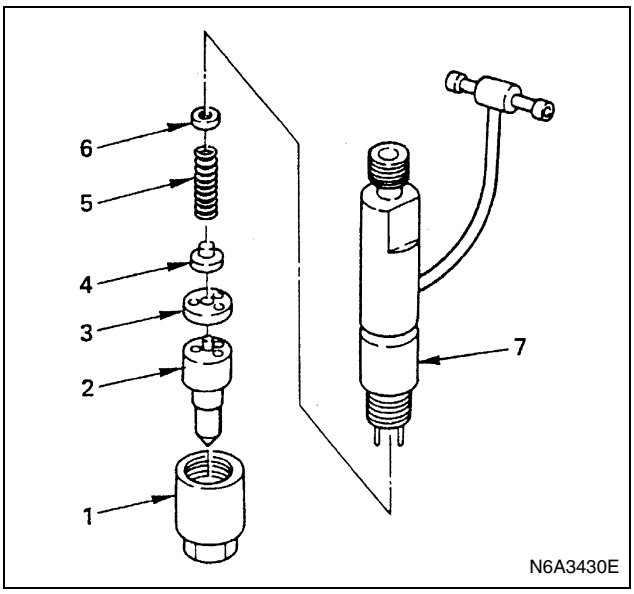
Legend
1. Nozzle holder
2. Nozzle tester

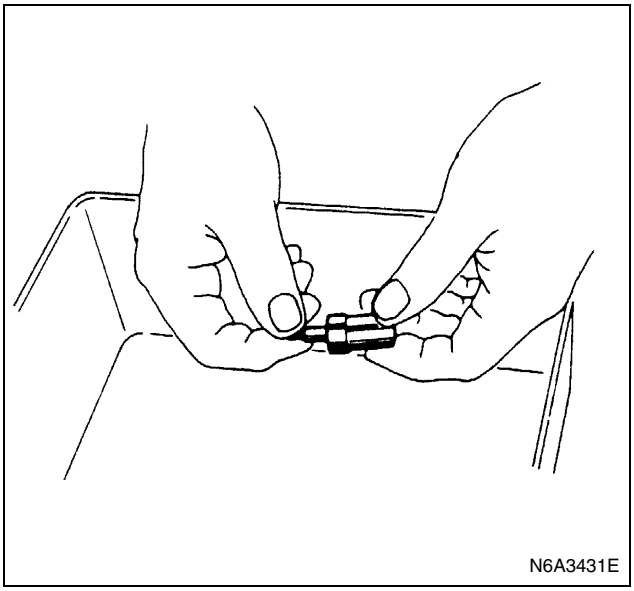
5. When replacing the nozzle, replace the nozzle, lift piece, pins and spacer as a set with the nozzle service kit.

Caution:
Pre-lift will not be as specified if only the nozzle is replaced.

Disassembly (4JB1 Engine)

1. Retaining Nut (1)
2. Injection Nozzle (2)
   1) Remove the nozzle assemblies from the nozzle holders.
      Tag the nozzle assemblies and the nozzle holders to ensure that they are reinstalled in their original positions.
      The nozzle assembly and nozzle holder combinations must not be interchanged.
   2) Immerse the injection nozzle in a tool tray filled with clean diesel oil to protect them from dust.
3. Spacer (3)
4. Spring Seat (4)
5. Spring (5)
6. Adjusting Shim (6)
7. Nozzle Holder (7)



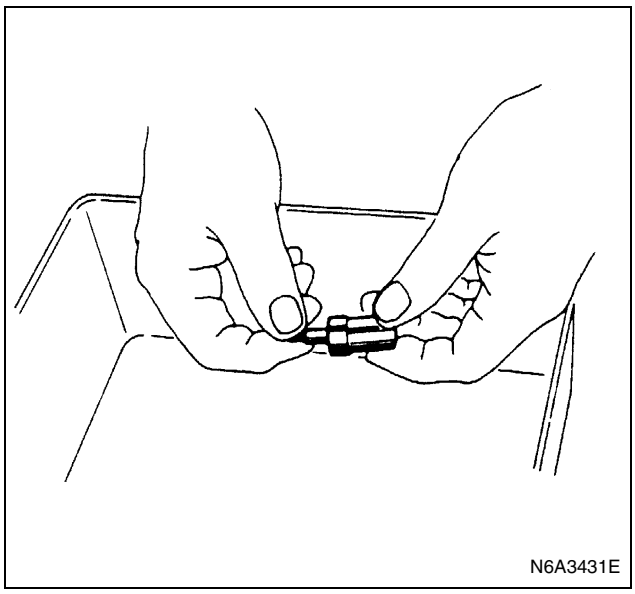


Inspection and Repair (4JB1 Engine)

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Inspection Nozzle Needle Inspection

1. Remove the needle from the nozzle body.
2. Carefully wash the nozzle needle and the nozzle body in clean diesel fuel.
3. Check that the nozzle needle moves smoothly inside the injection nozzle body.
   If the nozzle needle does not move smoothly, it must be repaired (See “Nozzle Lapping Procedure”).

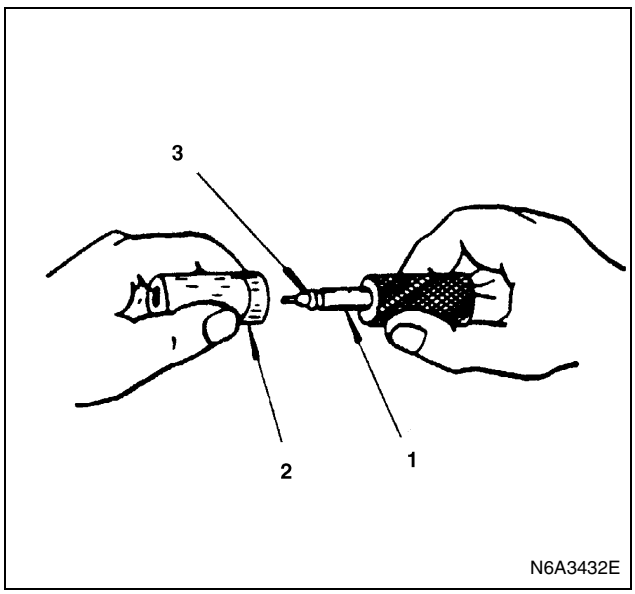


Nozzle Lapping Procedure

1. Lap the nozzle needle (1) and the nozzle body (2) by applying a compound of oxidized chrome and animal oil (3).

Notice:

Do not apply an excessive amount of the oxidized chrome and animal oil compound to the injection needle valve seat area. Applying too much compound will cause the injection nozzle needle and the injection nozzle body cavity to wear excessively.

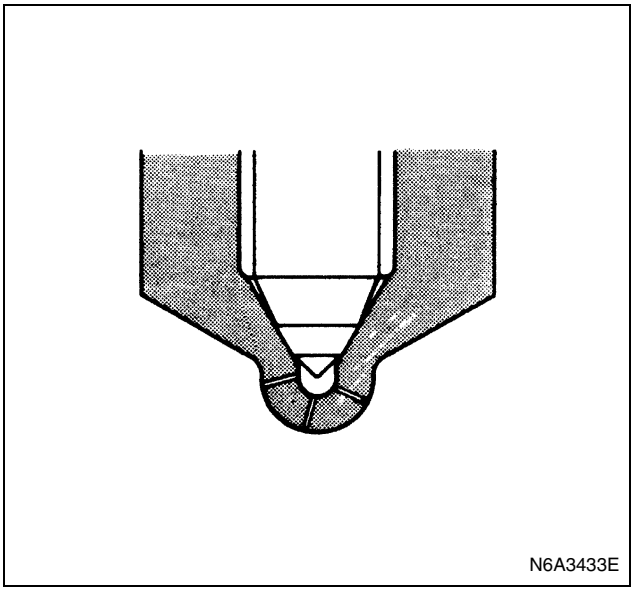


2. Carefully wash the needle valve and the nozzle body in clean diesel fuel after lapping.

Nozzle Body and Needle Valve Inspection

Check the nozzle body and the needle valve for damage and deformation.

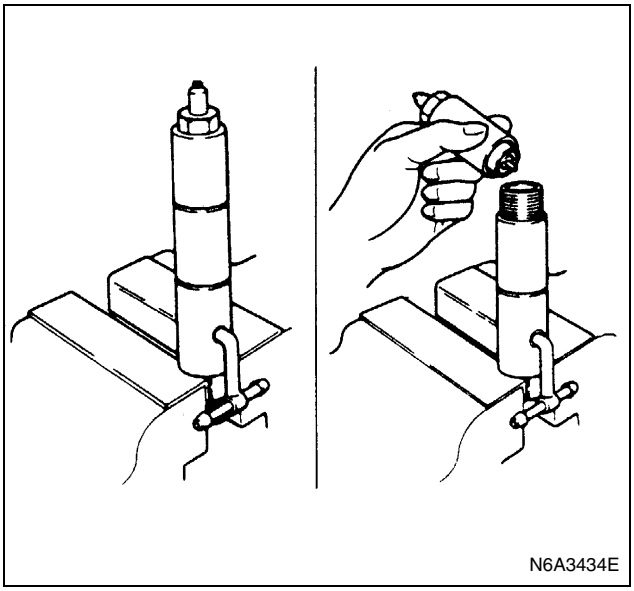
The nozzle and body assembly must be replaced if either of these two conditions are discovered during inspection.


N6A3433E

Reassembly

1. Nozzle Holder
2. Adjusting Shim
3. Spring
4. Spring Seat
5. Spacer
6. Injection Nozzle
7. Retaining Nut

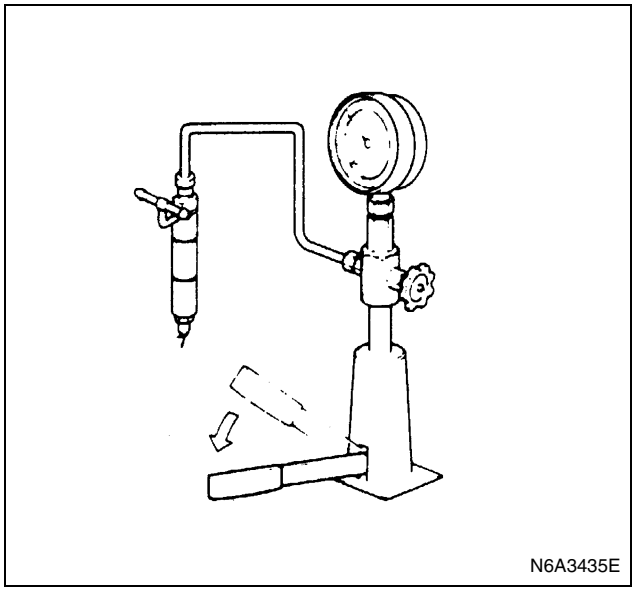
Tighten:
Retaining nut to 34 N·m (3.5 kg·m/25 lb·ft)


N6A3434E

Injection Nozzle Adjustment

1. Attach the injection nozzle holder to the injection nozzle tester.
2. Apply pressure to the nozzle tester to check that the injection nozzle opens at the specified pressure.

kPa (kg/cm^2 /psi)
18,142 (185/2630)


N6A3435E

If the injection nozzle does not open at the specified pressure, install or remove the appropriate number of adjusting shims to adjust it.

Adjusting Shim Availability	mm (in)
Range	0.50 — 1.50 (0.02 — 0.06)
Increment	0.025 (0.001)
Total number of Shims	40

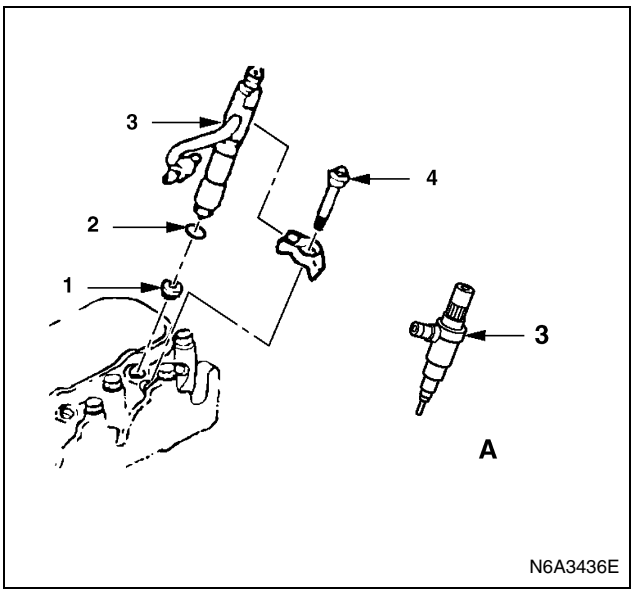
Removing or installing one shim will increase or decrease the nozzle opening pressure approximately 369.46 kPa (3.77 kg/cm^2 /53.6 psi).

WARNING:
TEST FLUID FROM THE INJECTION NOZZLE WILL SPRAY OUT UNDER GREAT PRESSURE. IT CAN EASILY PUNCTURE A PRESON'S SKIN. KEEP YOUR HANDS AWAY FROM THE INJECTION NOZZLE TESTER AT ALL THE TIMES.

Installation (4JB1/4JH1-TC Engine)

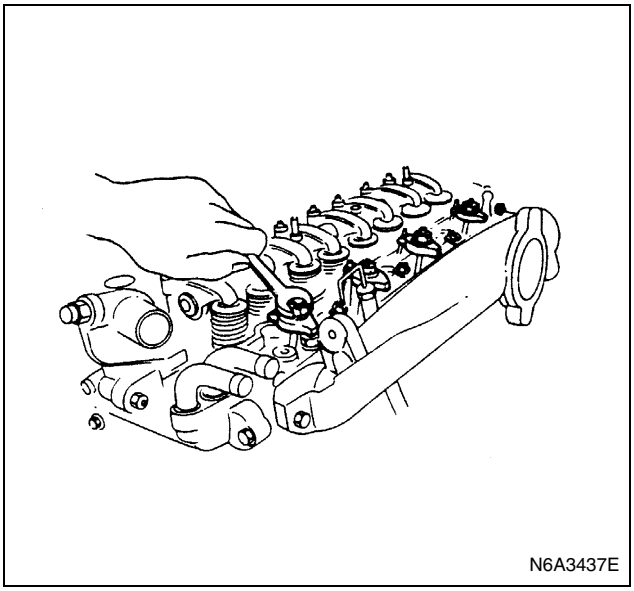
1. Injection Nozzle
   1) Install the injection nozzle gasket (1) and the O-ring (2) to the injection nozzle holder (3).
      Be sure that the O-ring fits snugly in the injection nozzle groove.
   2) Apply engine oil to the cylinder head nozzle holder hole.
   3) Install the nozzle holder together with the nozzle holder bracket (4) to the cylinder head.

Tighten:
37 N·m (3.8 kg·m/27 lb·ft)



Legend

A. 4JH1-TC

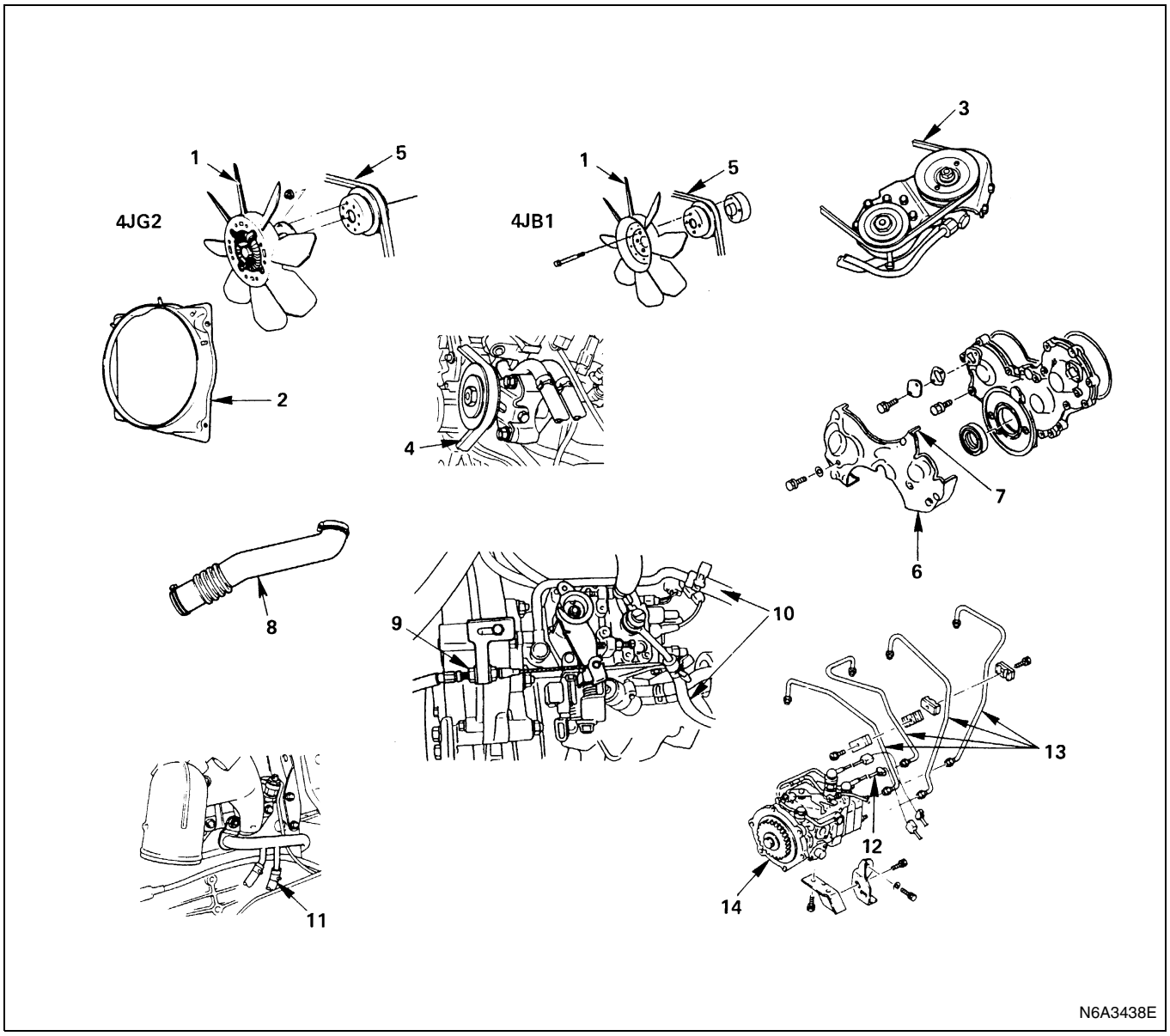


2. Leak Off Hose
3. Injection Pipe

INJECTION PUMP ASSEMBLY (4JB1/4JG2, Gear Drive Type)

Component

4JB1/4JG2



Legend

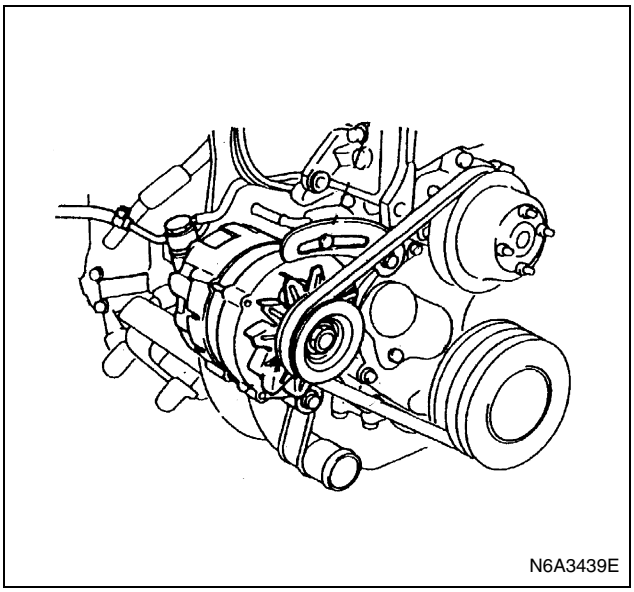
1. Cooling fan assembly
2. Fan Shroud
3. Power steering pump drive belt
4. A/C compressor drive belt
5. AC generator drive belt
6. Noise shield cover
7. Noise cover spacer
8. Air intake duct
9. Injection pump control cable
10. Fuel hose
11. CSD water hose
12. Injection pump harness
13. Injection pipe
14. Injection pump assembly

Removal

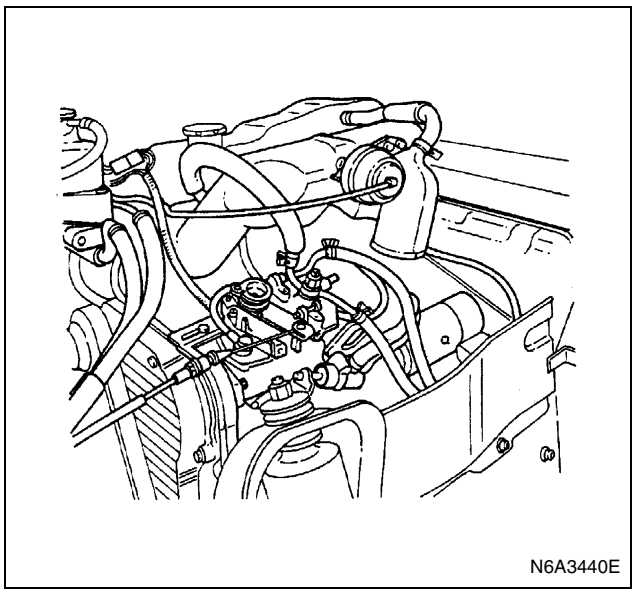
Preparation:

- Disconnect battery ground cable.
- Drain coolant.

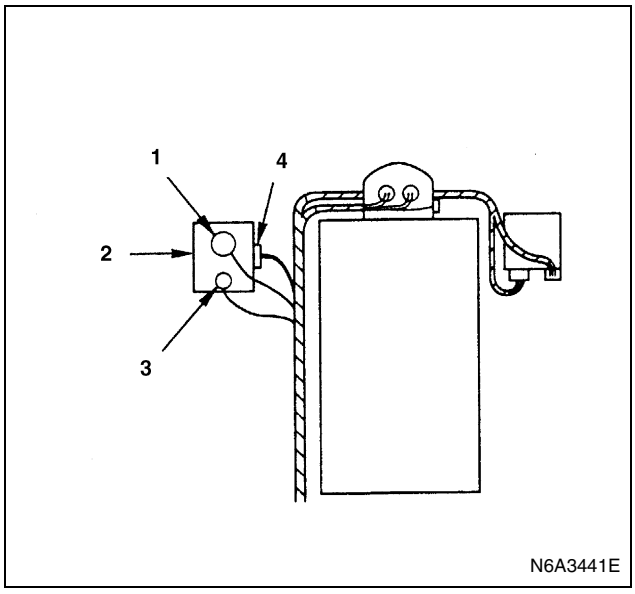
1. Cooling Fan Assembly
   - Remove clamp nut, and remove cooling fan assembly, distant pipe, and fan pulley.
2. Fan Shroud
3. Power Steering Pump Drive Belt (P/S Model)
   - Loosen power steering pump mounting bolt and adjust bolt, and remove the drive belt.
4. A/C Compressor Drive Belt (A/C Model)
   - Loosen A/C compressor idler pulley lock nut, adjust bolt and remove the drive belt.
5. AC Generator Drive Belt
   - Loosen AC generator mounting bolt (under side) and adjust plate lock bolt, and remove the drive belt.


N6A3439E

6. Noise Shield Cover
7. Noise Cover Spacer
8. Air Intake Duct
9. Injection Pump Control Cable
   - Remove the control cable bracket bolt and remove the control lever side.
10. Fuel Hose
    - Disconnect the fuel feed hose and fuel return hose.
11. CSD (Cold Starting Device) Water Hose
    - Disconnect the water hose from injection pump side.


N6A3440E

12. Injection Pump Harness
    - Remove the tachometer sensor (with tachometer), CSD solenoid, fuel cut solenoid.



N6A3441E

Legend

1. CSD solenoid
2. Injection pump
3. Fuel cut solenoid
4. Tachometer sensor

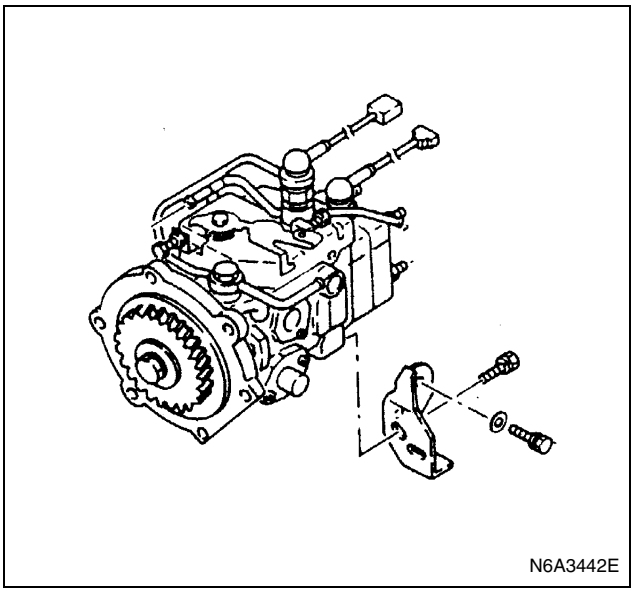
13. Injection Pipe
    - Release pipe clip.
    - Remove the flare nut on the pump side.
    - Remove the flare nut on the injection nozzle side, and remove the injection pipe.

Caution:

- Be sure to plug the injection nozzle holder and delivery holder to prevent the entry of foreign matter.

14. Injection Pump Assembly
    - Remove pump mounting nut.

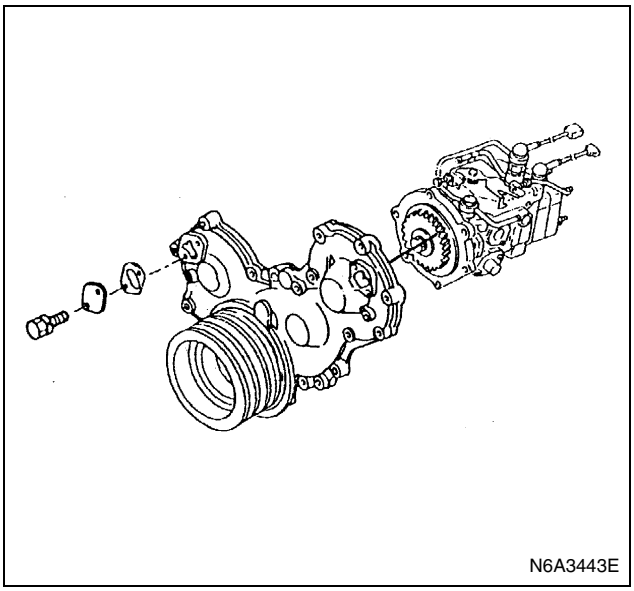
- Loosen injection pump rear bracket adjuster lock bolt.
- Remove the mounting bolt on the engine side, and pull out the pump from the engine.


N6A3442E

Notice:
Plug the injection pump delivery holder parts with the shipping caps (or the equivalent) to prevent the entry of foreign materials.

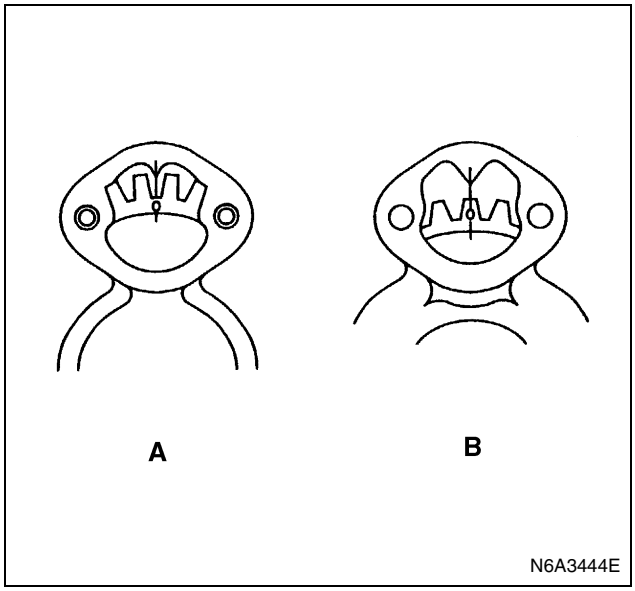
Installation

1. Injection Pump Assembly
   1) Timing gear case a camshaft timing gear side c injection pump timing gear side check hold cover.


N6A3443E

   2) Turn the crankshaft clockwise to see the TDC mark of the crank pulley to the pointer, and then bring the No. 1 cylinder to the TDC on the compression stroke.
   3) Look in through the check hole on the crankshaft timing gear side and check to see if the “O” mark on the timing gear is in line with the pointer of the check hole.
   4) In the condition above with the injection pump gear mark “O” set to the pointer of the check hole, install the injection pump assembly.
   - Install the injection pump fixing bolts and tighten them to the specified torque.

Tighten:
Pump Bolts to 15 N·m (1.5 kg·m/11 lb·ft)

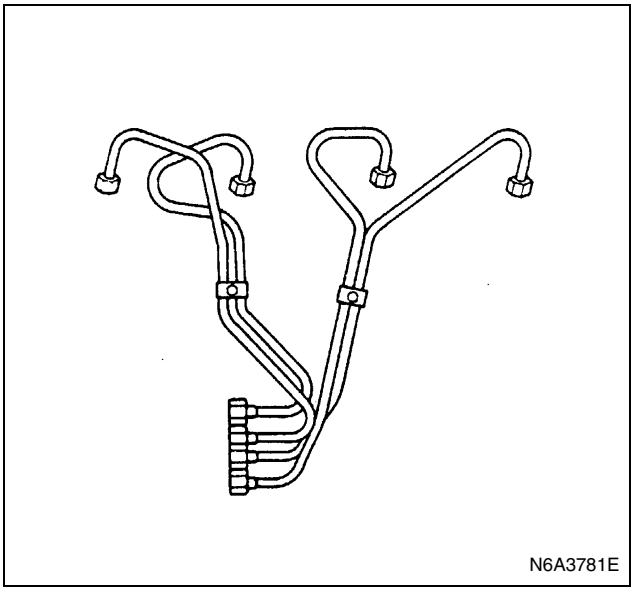


N6A3444E

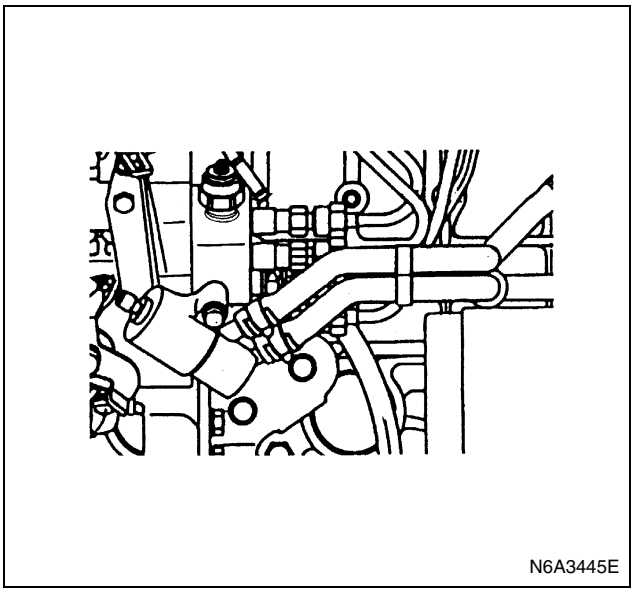
Legend
A. Camshaft gear
B. Injection pump gear

2. Injection Pipe
   - Connect the pump side and nozzle side of the pipe, and tighten securely.
   - Install clip where it was.

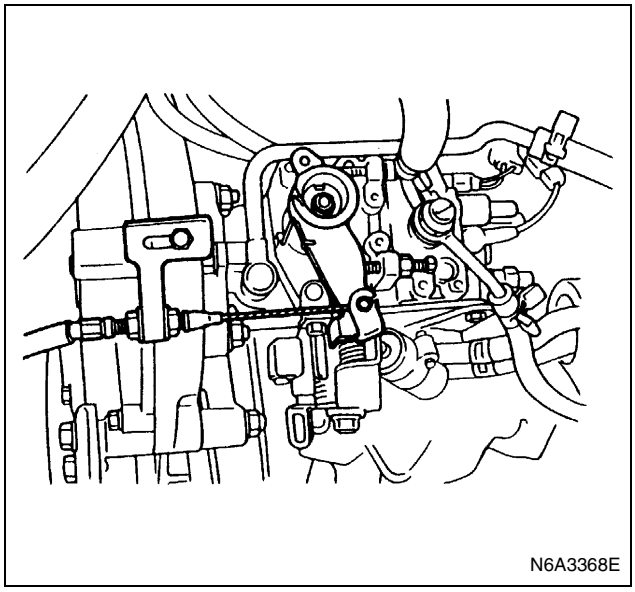
Tighten:
Sleeve Nut to 29 N·m (3.0 kg·m/22 lb·ft)


N6A3781E

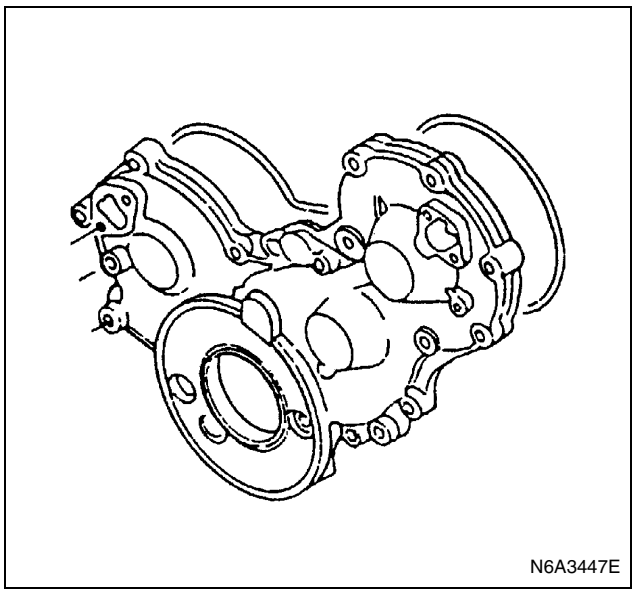
3. Injection Pump Harness
   - Mount engine harness and connect it to switches.
4. CSD Water Hose
   - Connect the water hose and tighten clip securely.


N6A3445E

5. Fuel Hose
   - Connect the fuel feed hose and fuel return hose.
   - Connect the leak off hose.
6. Injection Pump Control Cable
   1) Install the control wire to the engine control lever.
   2) Hold the accelerator lever in the fully closed position and stretch the control cable in the direction indicated by the arrow to remove any slack.
   3) Tighten the accelerator cable bracket bolt.


N6A3368E

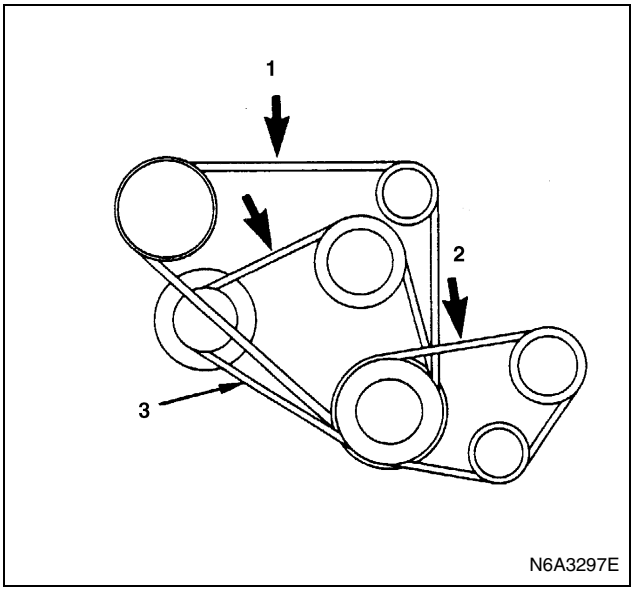
7. Air Intake Duct
8. Noise Cover Spacer
9. Noise Shield Cover


N6A3447E

10. AC Generator Drive Belt
    - Install AC generator drive belt and adjust belt tension.
    - Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

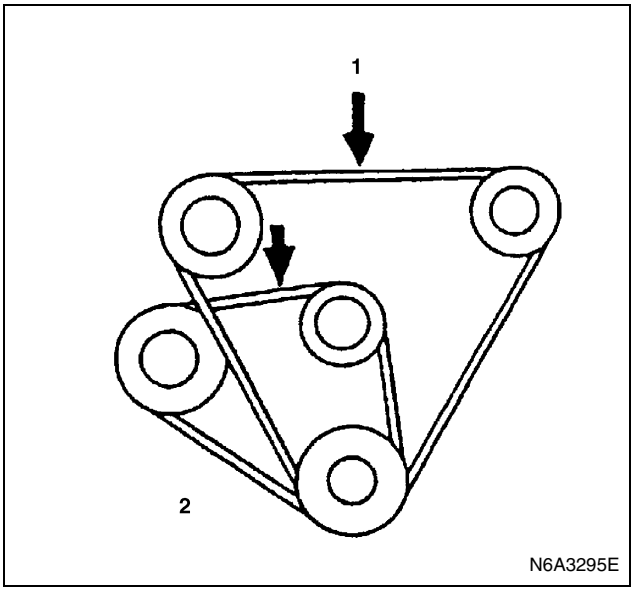
Drive Belt Deflection	mm (in)
8 (0.31) — 12 (0.47)	

4JG2



Legend
1. A/C compressor drive belt
2. P/S oil pump drive belt
3. AC generator fan pulley drive belt

4JB1



Legend
1. A/C compressor drive belt & P/S pump drive belt
2. AC generator & fan pulley drive belt

- Install fixing bolt and tighten bolts to the specified torque.

Tighten:
- Generator Fixing Bolt to 40 N·m (4.1 kg·m/30 lb·ft)
- Adjust Plate Fixing Bolt to 19 N·m (1.9 kg·m/14 lb·ft)

11. A/C Compressor Drive Belt (A/C Model)
    - Install A/C compressor drive belt and adjust belt tension.
    - Depress the drive belt mid-portion with a 98N (10 kg/22 lb) force.

Drive Belt Deflection	mm (in)
8 (0.31) — 12 (0.47)	

    - Tighten the idler lock nut to the specified torque.

Tighten:
27 N·m (2.8 kg·m/20 lb·ft)

12. Power Steering Pump Drive Belt (P/S Model)
    - Install P/S pump drive belt and adjust belt tension.
    - Depress the drive belt mid-portion with a 98 N (10 kg/ 22 lb) force.

Drive Belt Deflection	mm (in)
8 (0.31) — 12 (0.47)	

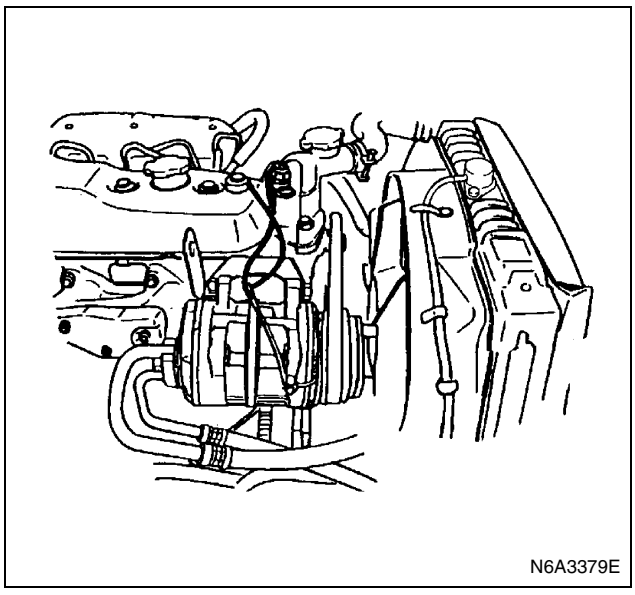
    - Tighten the idler lock nut to the specified torque.

Tighten:
27 N·m (2.8 kg·m/20 lb·ft)

13. Fan Shroud
    - Install the fan shroud and reservoir tank hose.
14. Cooling Fan Assembly
    - Mount fan pulley, distance piece, and cooling fan assembly (in this order) on the water pump, and tighten to the specified torque.

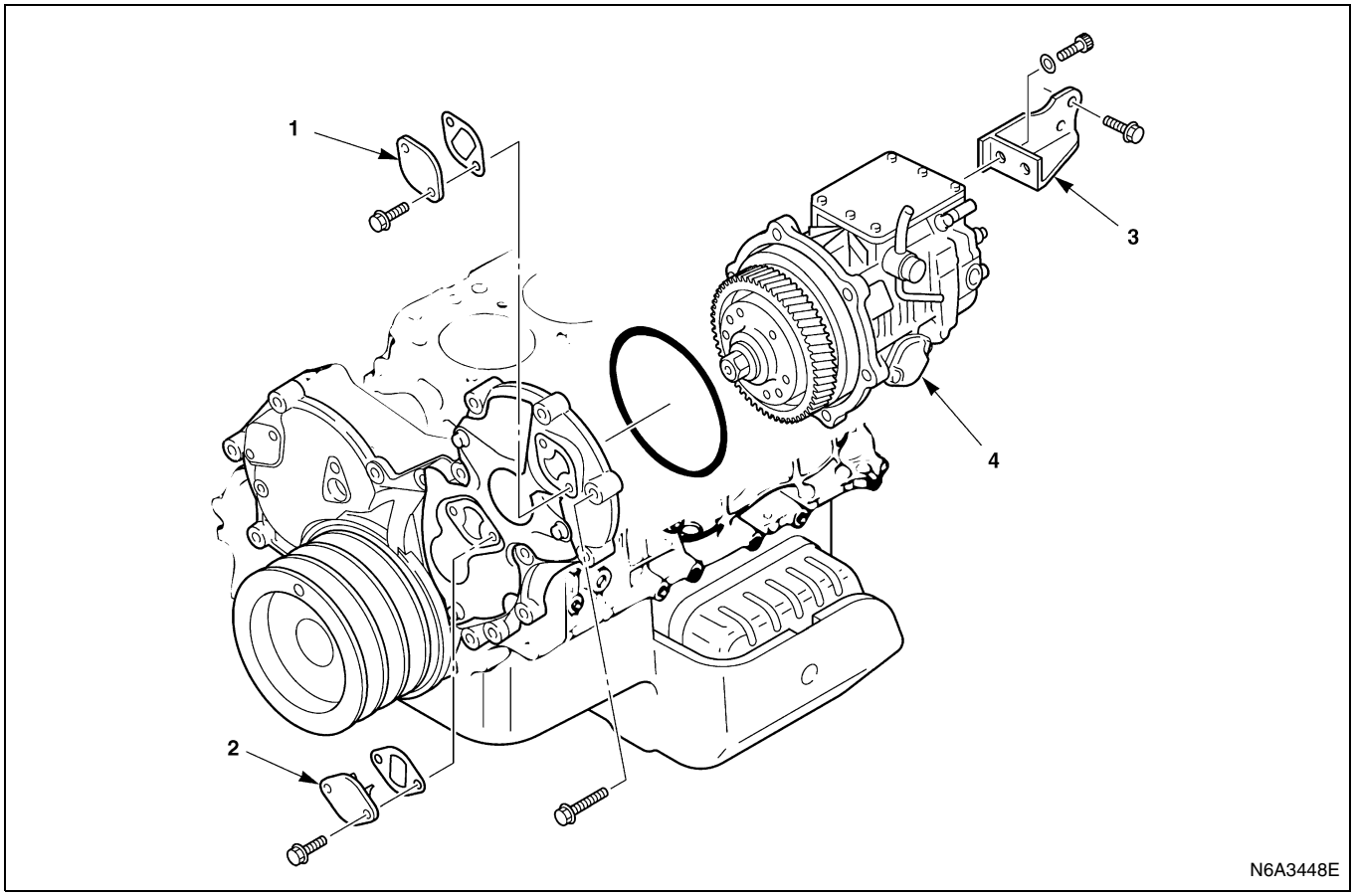
Tighten:
8 N·m (0.8 kg·m/69 lb·ft)

- Connect battery ground cable.
- Pour coolant.



INJECTION PUMP ASSEMBLY (4JH1-TC)

Component



Legend

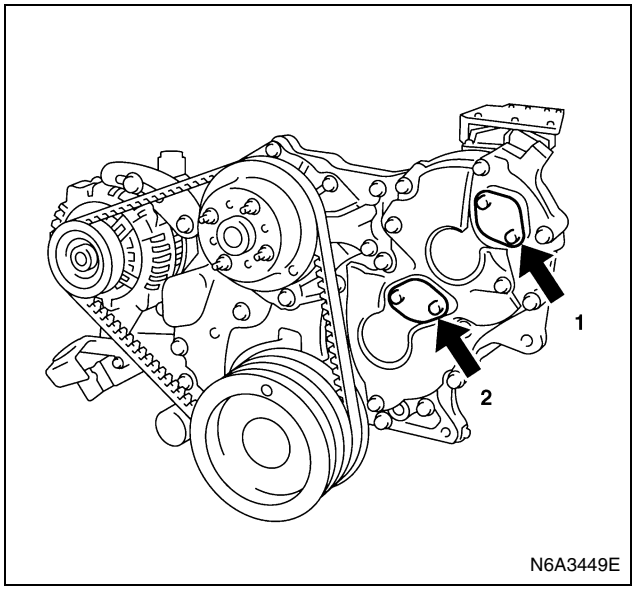
1. Check hole cover: Injection pump gear
2. Check hole cover: Scissor gear
3. Injection pump bracket
4. Injection pump assembly

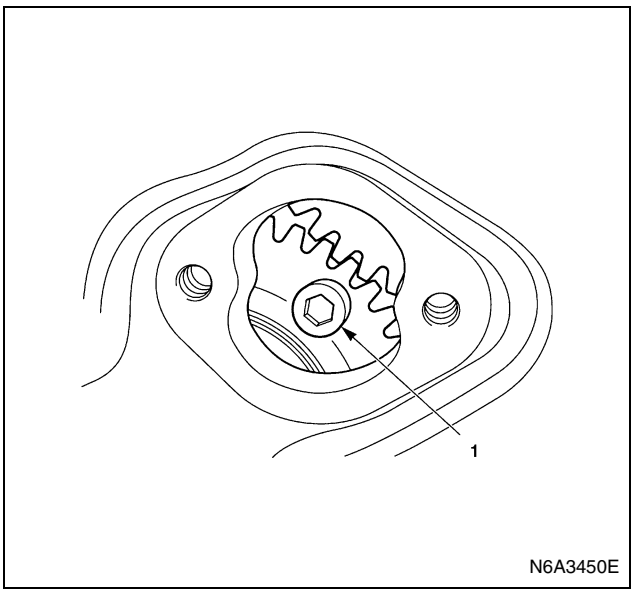
Removal

Preparation:

Remove the fuel pipe and the injection pipe.

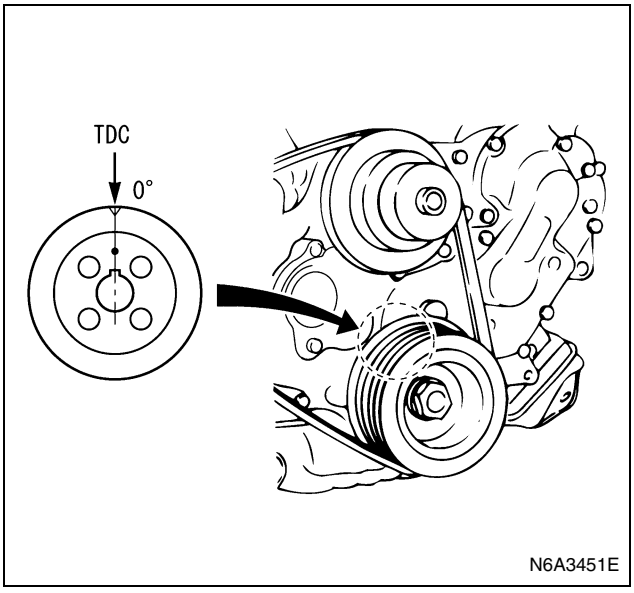
1. Check Hole Cover: Injection Pump Gear
   Remove the check hole cover (1).
2. Check Hole Cover: Scissor Gear
   - Remove the check hole cover (2).
   - Rotate the crank pulley until the hole used to fix the scissor gear (the hole extends from the check hole cover) becomes visible.
   - Thread the lock bolt into the hole in the scissor gear.



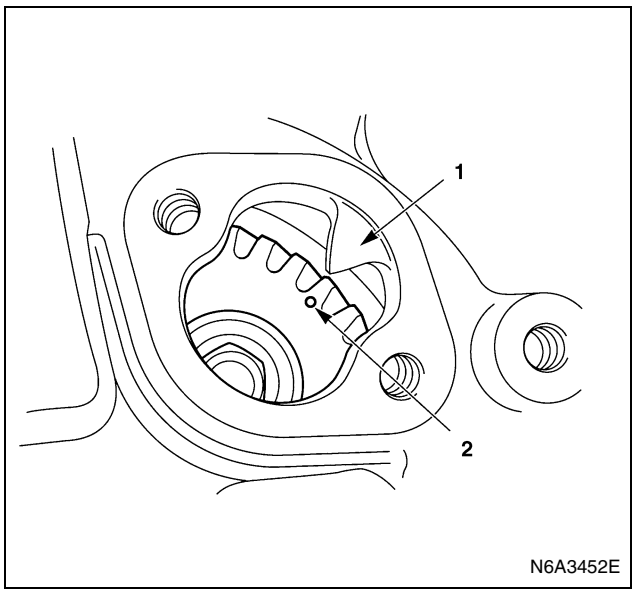


Legend
1. Lock bolt

- Rotate the crank pulley to align the dot on the pulley with the crankshaft TDC mark.



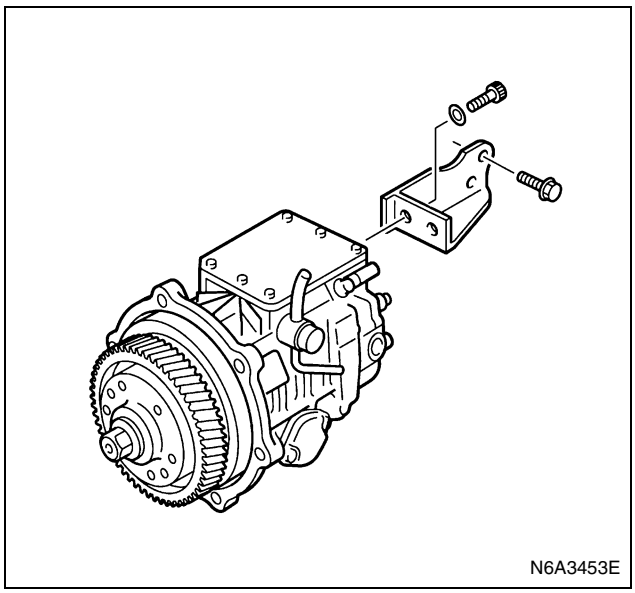
- Check that the injection pump mark is aligned with the arrow mark. If the marks are not aligned, rotate the crank pulley an additional full turn.



Legend
1. Arrow mark
2. Mark

Notice:
When the scissor gear and check hole cover are not installed, the crank pulley can be turned with the scissor gear lock bolt in place.

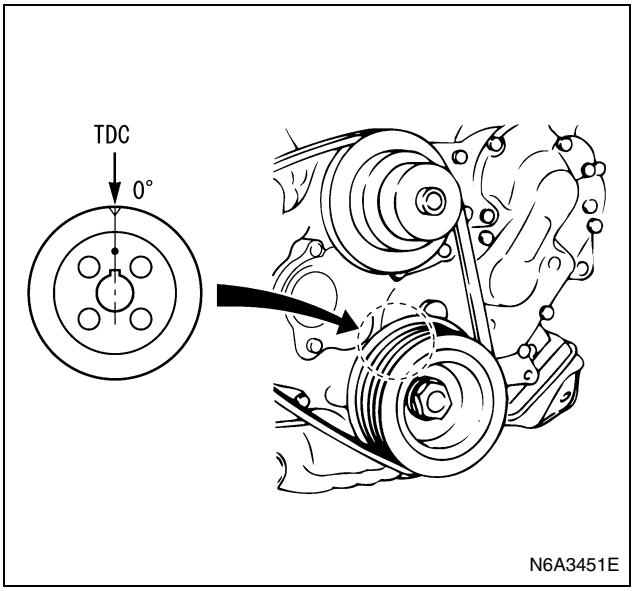
3. Injection Pump Bracket
   Remove the bracket fixing bolts at the rear of the injection pump.
4. Inspection Pump Assembly
   Loosen the 6 bolts holding the injection pump assembly.



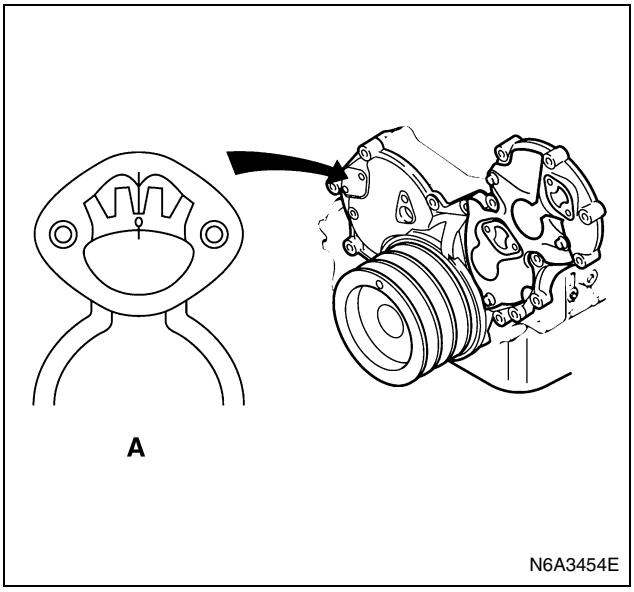
Notice:
Plug the injection pump delivery holder openings with the shipping caps (or some similar object) to prevent the entry of foreign material.

Installation

1. Injection Pump Assembly
   - Check the pulley alignment mark and the crankshaft TDC mark are aligned.

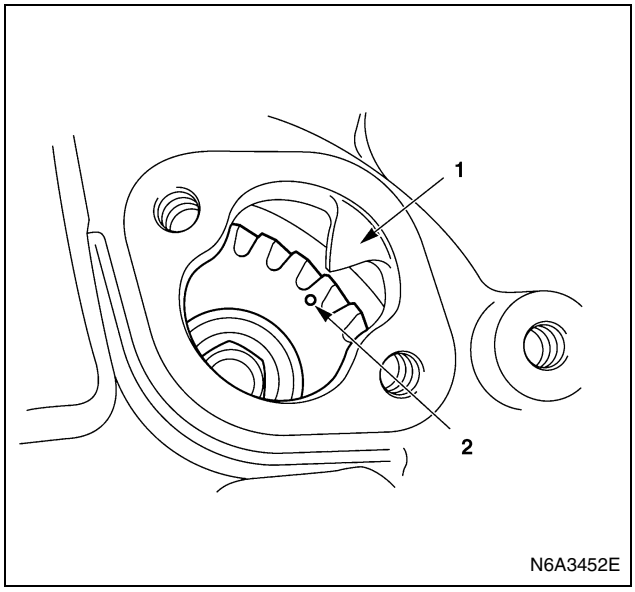


   - Remove the camshaft gear check hole cover to check camshaft gear mark alignment.



Legend
A. Camshaft gear

   - Install the O-ring.
   - Install the injection pump assembly. Maintain injection pump gear mark and arrow mark alignment during the installation procedure (look through the check hole).



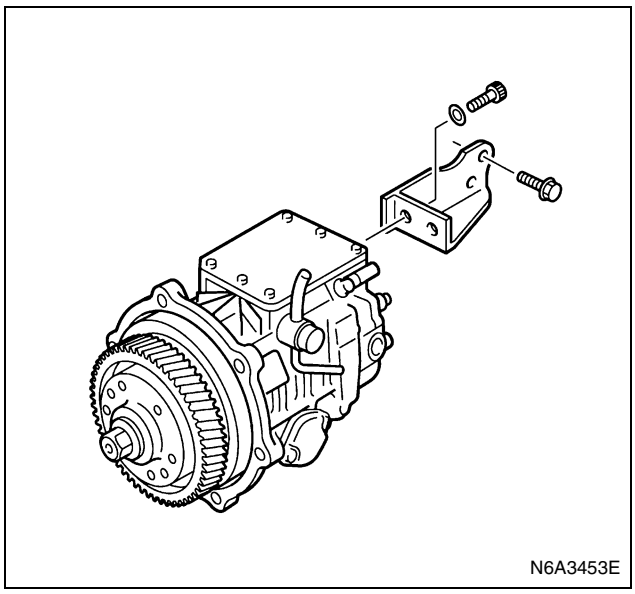
Legend
1. Arrow mark
2. Mark

   - Tighten the injection pump bolts to the specified torque.

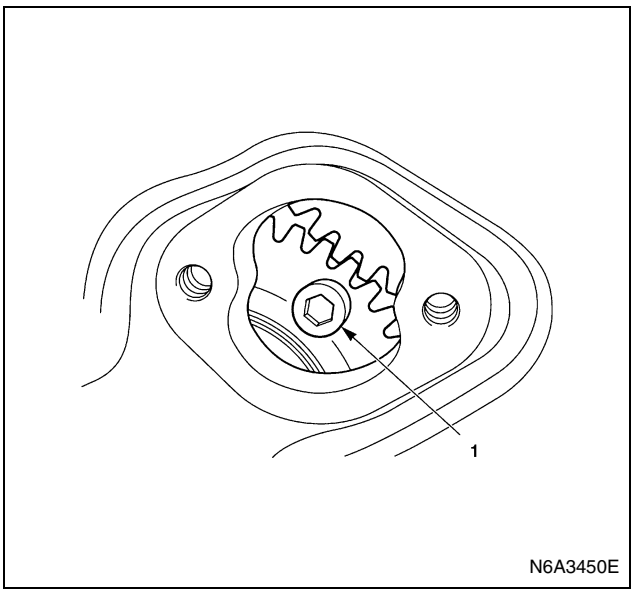
Tighten:
Pump Bolt to 15 N·m (1.5 kg·m/11 lb·ft)

2. Injection Pump Bracket
   - Install the injection pump bracket to the gear of the injection pump and tighten the bolts to the specified torque.

Tighten:
Bracket Bolt to 25 N·m (2.5 kg·m/18 lb·ft)

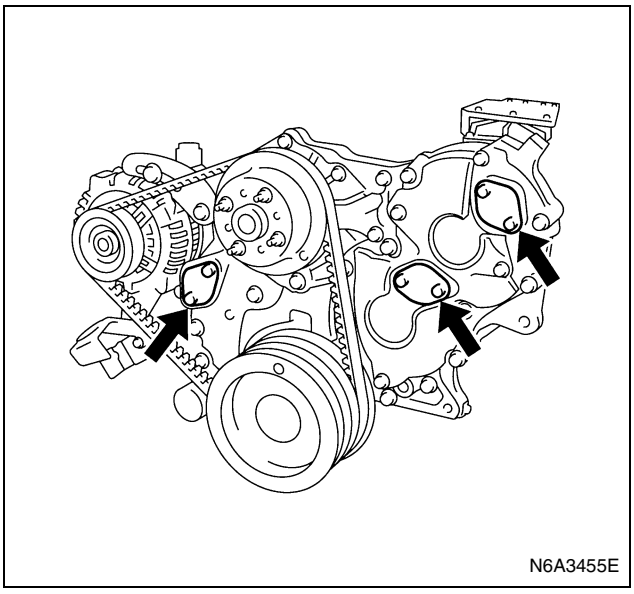


   - Rotate the crank pulley until the scissor gear lock bolt is visible through the check hole. Remove the bolt.



Legend
1. Lock bolt

3. Check Hole Cover: Scissor Gear
4. Check Hole Cover: Injection Pump

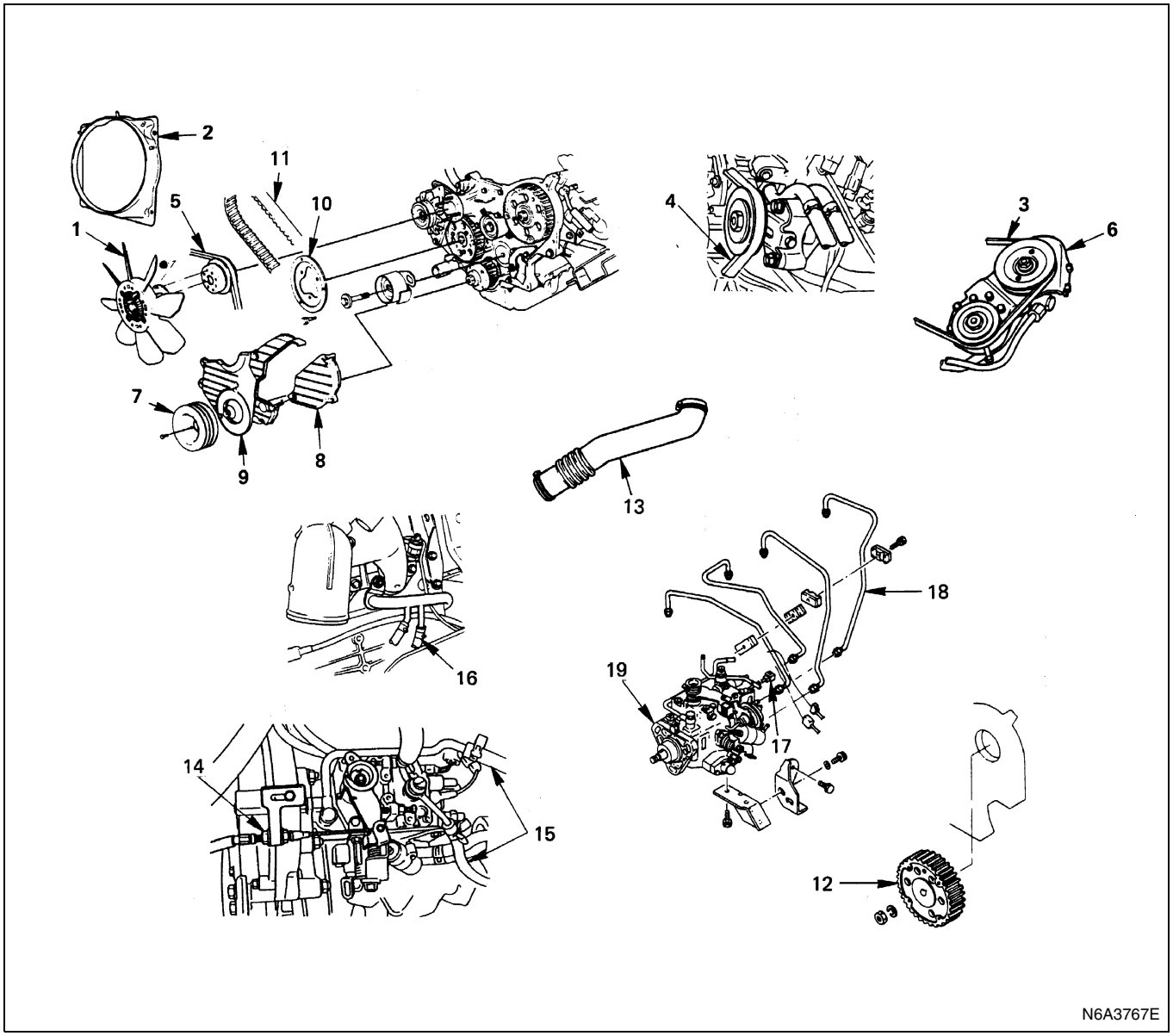


Caution:
Install the check hole covers.

- Be absolutely sure that the check hole covers are properly installed.
- Rotate the crank pulley 2 full turns to confirm that the lock bolt has been removed (if you have forgotten to remove the bolt, the bolt will strike the check hole guides and the crank pulley will not turn).

INJECTION PUMP ASSEMBLY (4JG2 Belt Drive Type)

Component



Legend

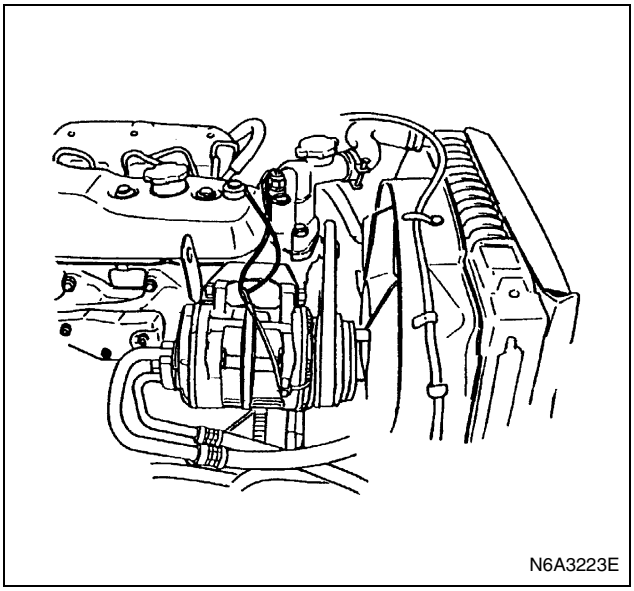
1. Cooling fan assembly
2. Fan shroud
3. Power steering pump drive belt
4. A/C compressor drive belt
5. AC generator drive belt
6. Power steering pump & bracket assembly
7. Crankshaft damper pulley
8. Timing pulley upper cover
9. Timing pulley lower cover
10. Flange; Camshaft pulley
11. Timing belt
12. Injection pump timing pulley
13. Air intake duct
14. Injection pump control cable
15. Fuel hose
16. CSD water hose
17. Injection pump harness
18. Injection pipe
19. Injection pump assembly

Removal

Preparation:

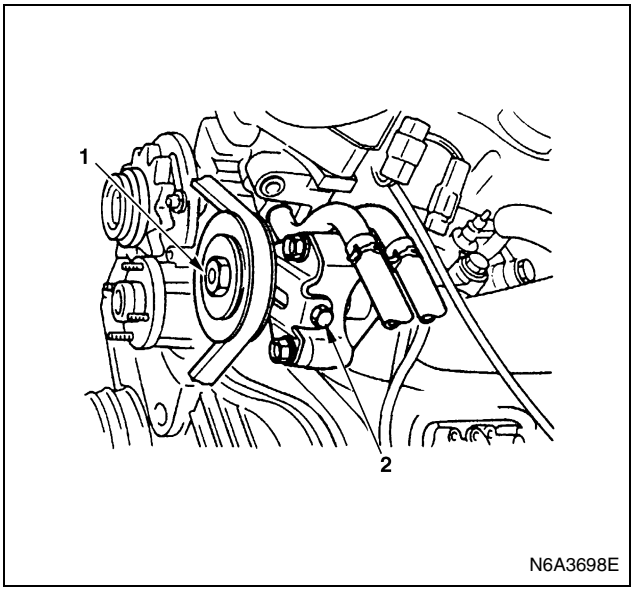
- Disconnect battery ground cable.
- Drain coolant.

1. Cooling Fan Assembly
   - Remove clamp nut, and remove cooling fan assembly, distant pipe, and fan pulley.
2. Fan Shroud
   - Remove reservoir tank hose and fan shroud.



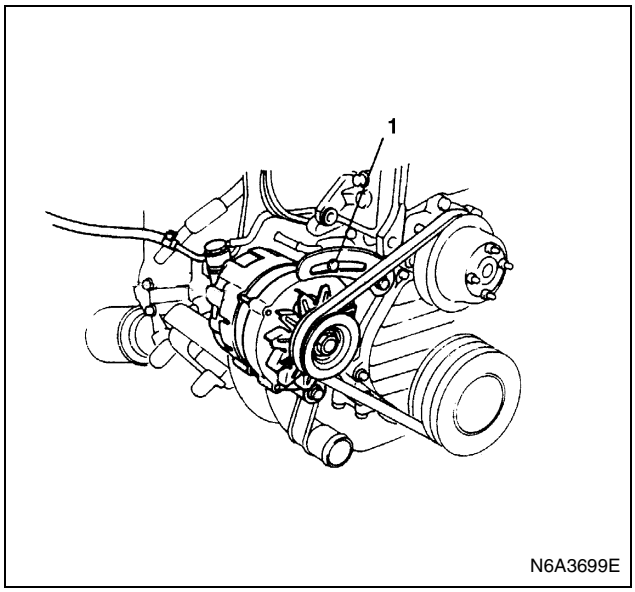
N6A3223E

3. Power Steering Pump Drive Belt (P/S Model)
   - Loosen power steering pump idle pulley lock nut and adjust bolt, and remove the drive belt.
4. A/C Compressor Drive Belt (A/C Model)
   - Loosen A/C compressor idler pulley lock nut (1), adjust bolt (2), and remove the drive belt.



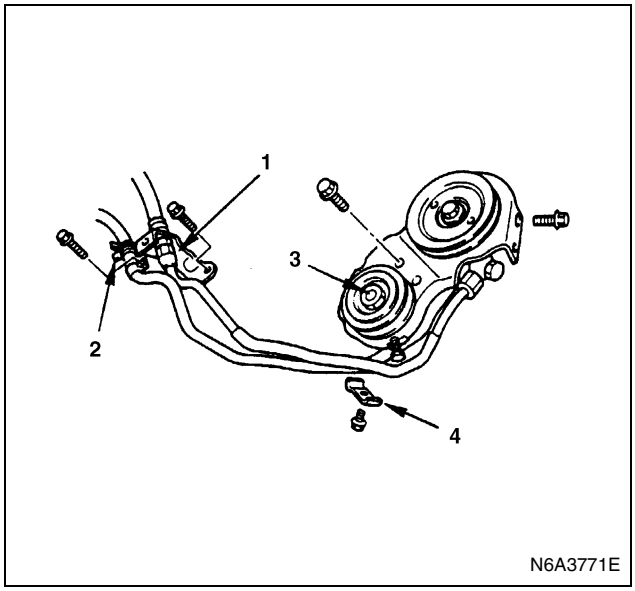
N6A3698E

5. AC Generator Drive Belt
   - Loosen AC generator mounting bolt (under side) and adjust plate lock bolt (1), and remove the drive belt.



N6A3699E

6. Power Steering Pump & Bracket Assembly (P/S Model)
   - Loosen power steering oil pipe bracket (1) and clip (2).
   - Remove P/S pump bracket assembly and hang the P/S pump bracket assembly.

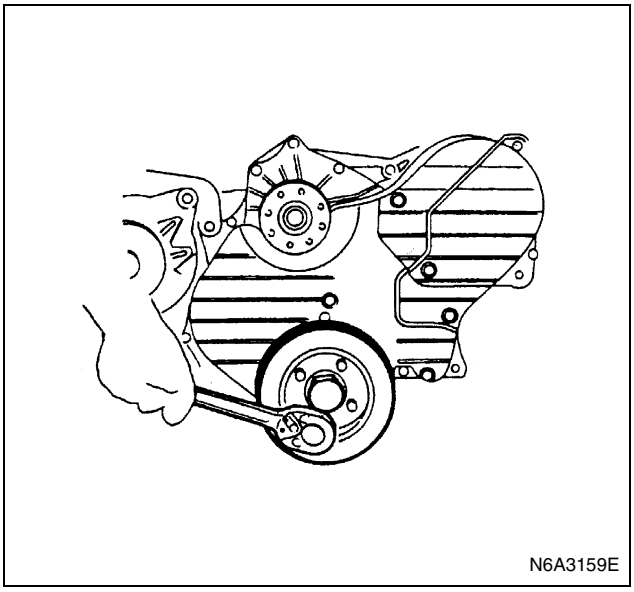


N6A3771E

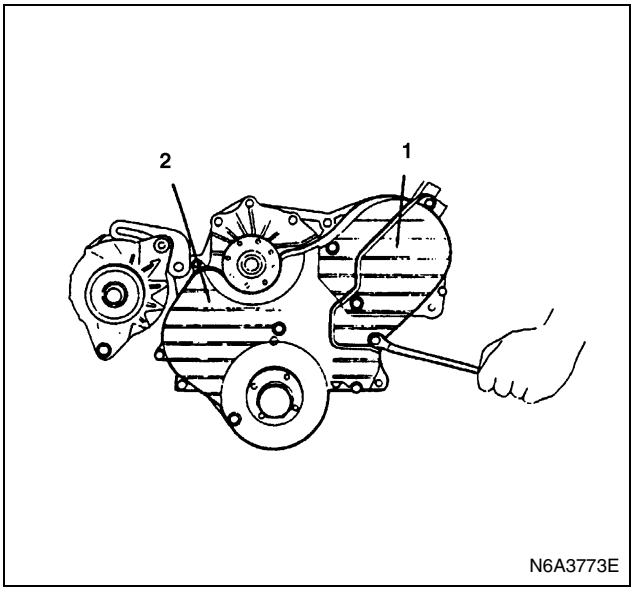
Legend

1. Bracket
2. Clip
3. Lock nut
4. P/S pump bracket

7. Crankshaft Dumper Pulley

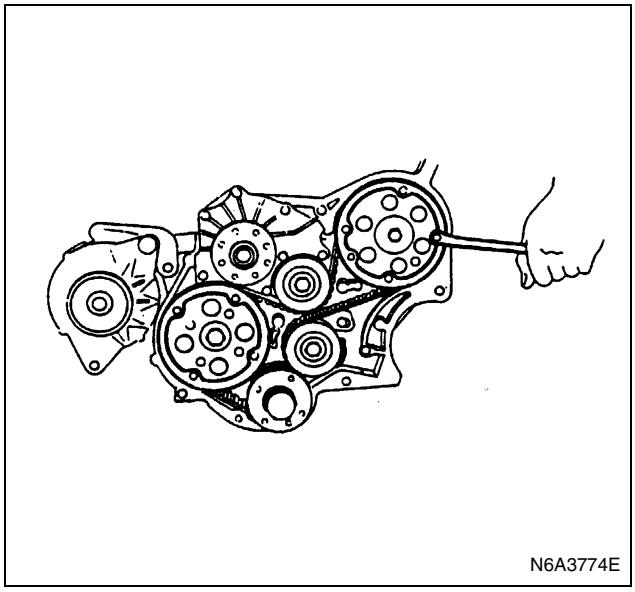

N6A3159E

8. Timing Pulley Upper Cover (1)
9. Timing Pulley Lower Cover (2)

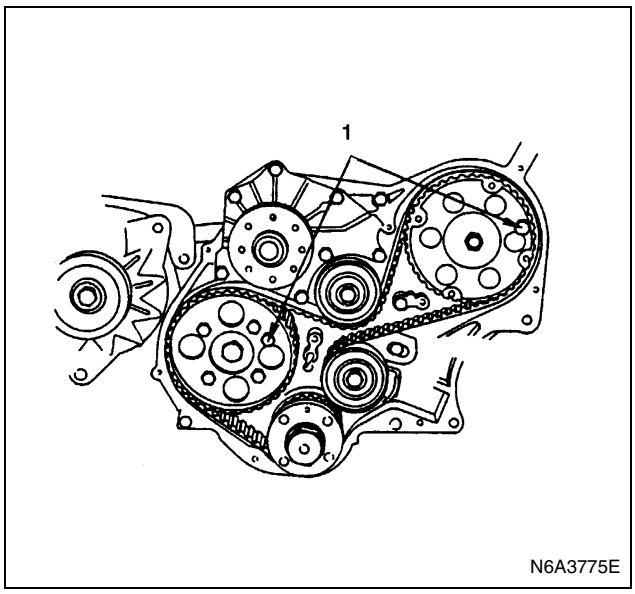


N6A3773E

10. Flange; Camshaft Pulley


N6A3774E

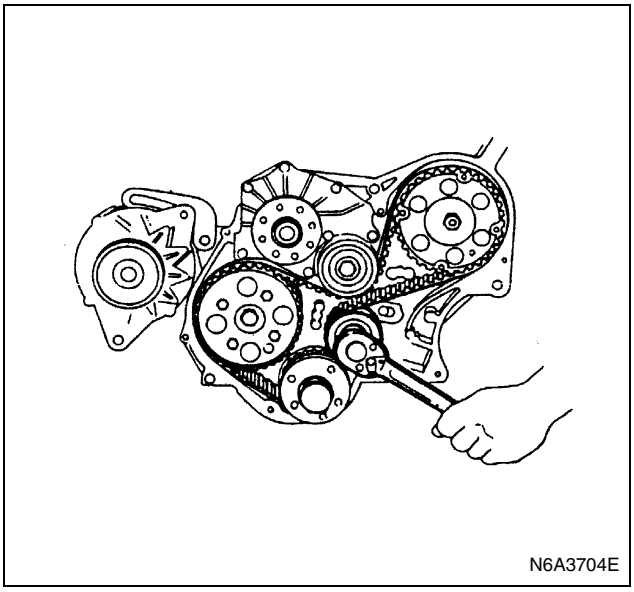
11. Timing Belt
    - Prepare a fixing bolt (M8 × 40, P=1.25).
    - Turn crankshaft timing pulley in the normal direct pulley side mark to timing pulley housing side mark.
    - Make sure that the camshaft pulley and injection timing pulley fixing bolt holes are set to each other. Then fit in a fixing bolt and lightly tighten.



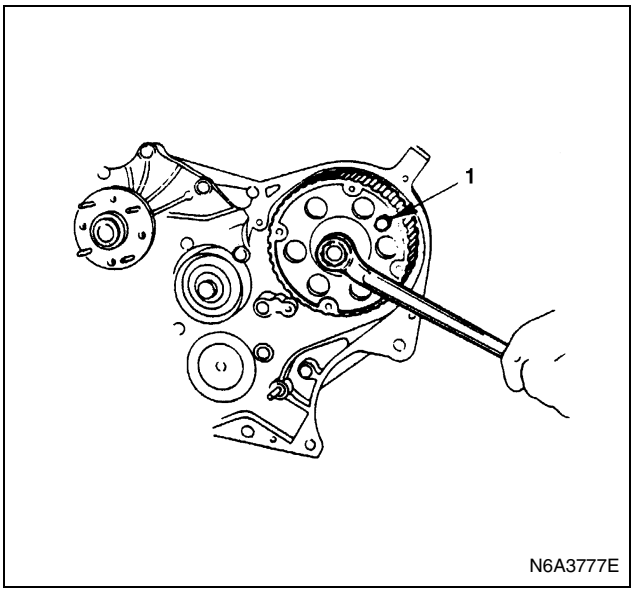
N6A3775E

    - No. 1 cylinder should be at top dead center. If the fixing bolt holes are not set (No. 4 cylinder is at top dead center) give another turn.
    - Remove tensioner and timing belt.

WARNING:
- **IF CRANKSHAFT AND CAMSHAFT ARE TURNED WITH TIMING BELT BEING NOT MOUNTED, PISTON AND VALVE WILL INTERFERE WITH EACH OTHER. THEREFORE, THE SHAFTS MUST NOT BE TURNED.**

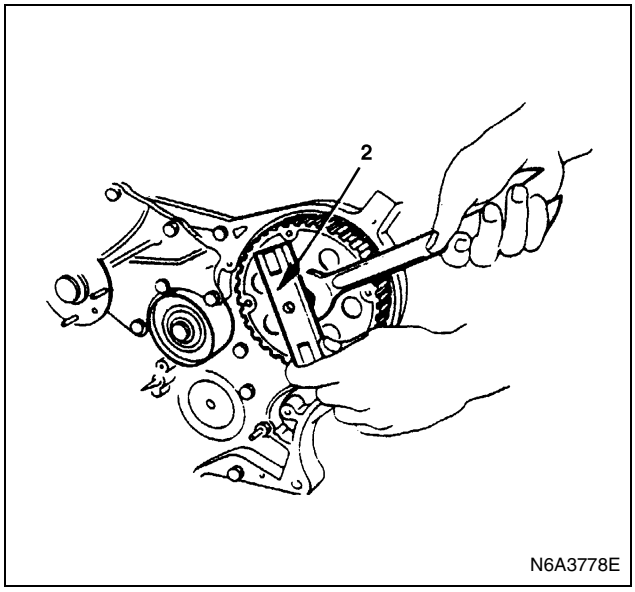

N6A3704E

12. Injection Pump Timing Pulley
    - Install the stopper bolt (1) to the timing pulley to prevent it from turning.



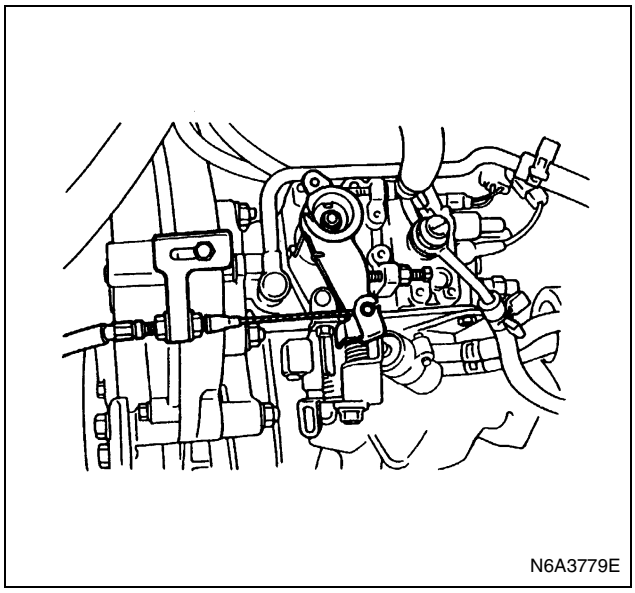
N6A3777E

- Use the timing pulley puller (2) to remove the injection pump timing pulley.
  Timing Pulley Puller: 5-8840-0086-0
- Remove the stopper bolt.



N6A3778E

13. Air Intake Duct
14. Injection Pump Control Cable
    - Remove the control cable bracket bolt and remove the control lever side.
15. Fuel Hose
    - Disconnect the fuel feed hose and fuel return hose.


N6A3779E

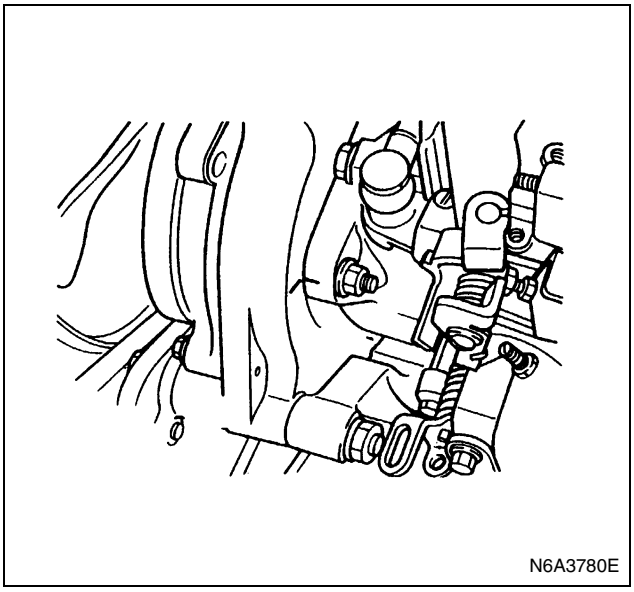
16. CSD Water Hose
17. Injection Pump Harness
18. Injection Pipe
19. Injection Pump Assembly
    - Remove the pump bracket bolt engine side.
    - Remove the adjust lock bolt.
    - Remove the injection pump fixing bolt and take out injection pump.

Installation

1. Injection Pump Assembly
   - Put the timing pulley housing side and injection pump side setting marks together, and temporarily tighten.
   - After adjusting injection timing retighten.
   - Mount rear bracket on cylinder block and tighten to the specified torque.

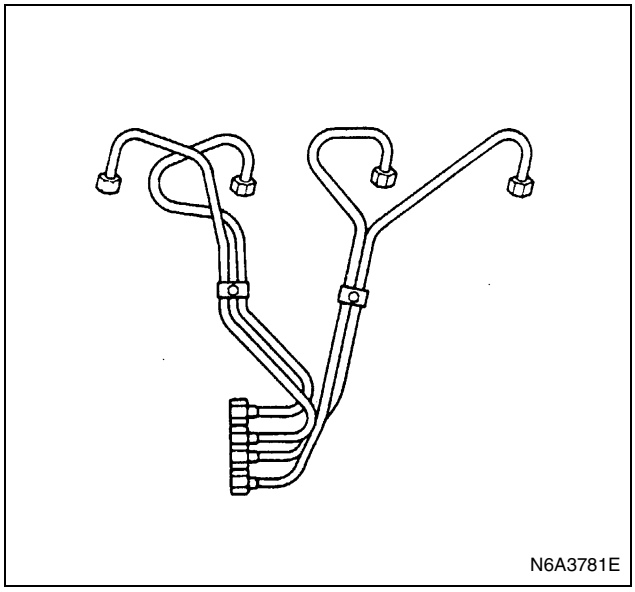
Tighten:
Rear bracket on cylinder block to 19 N·m (1.9 kg·m/14 lb·ft)

   - Install adjust lock bolt and lightly tighten.
   - After adjusting injection timing, retighten.

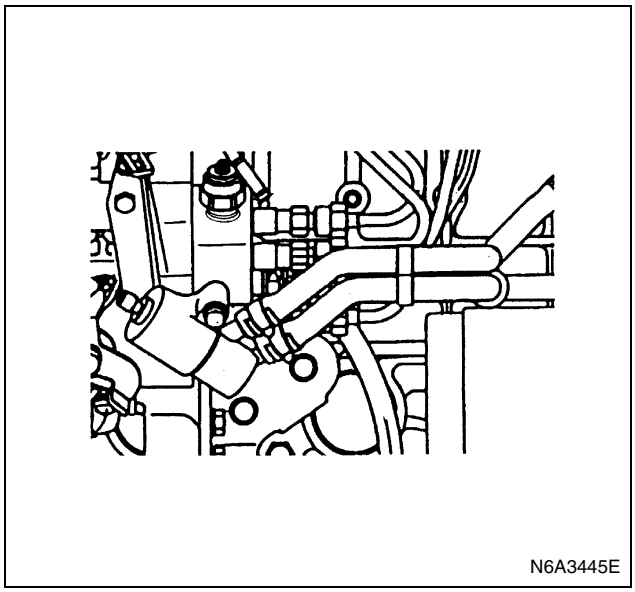

N6A3780E

2. Injection Pipe
   - Connect the pump side and nozzle side of the pipe, and tighten securely.
   - Install clip where it was.

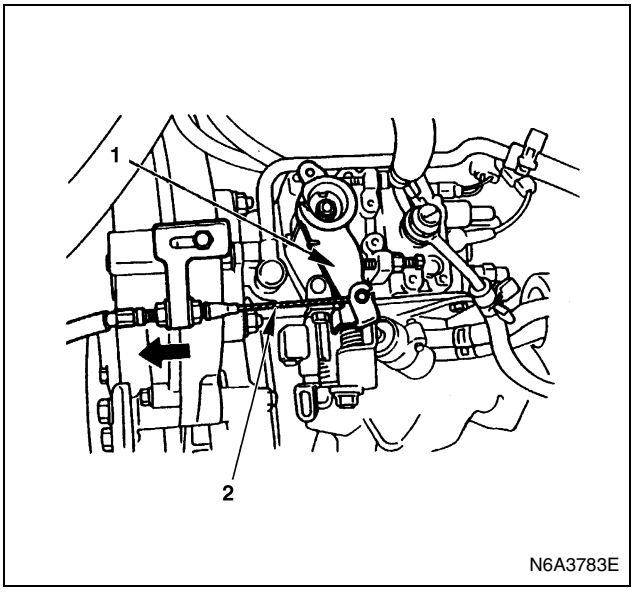
Tighten:
Sleeve Nut to 29 N·m (3.0 kg·m/22 lb·ft)


N6A3781E

3. Injection Pump Harness
   - Mount engine harness and connect it to switches.
4. CSD Water Hose
   - Connect the water hose and tighten clip securely.

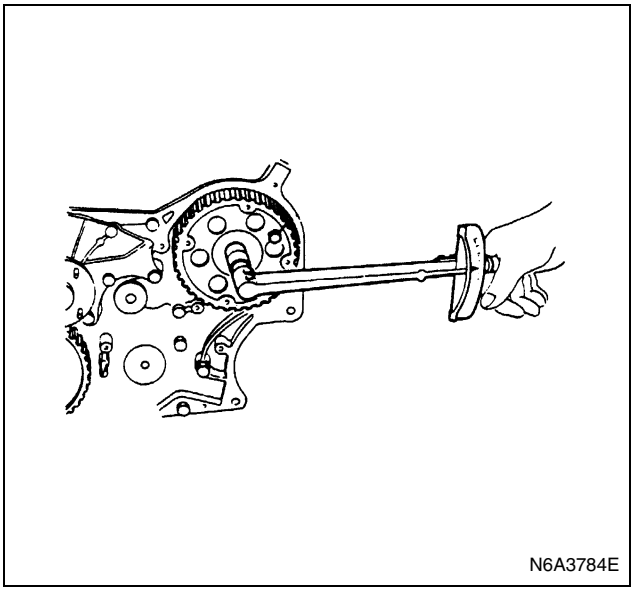

N6A3445E

5. Fuel Hose
   - Connect the fuel feed hose and fuel return hose.
   - Connect the rear off hose.
6. Injection Pump Control Cable
   1) Install the Control wire to the engine control lever.
   2) Hold the accelerator lever (1) in the fully closed position and stretch the control cable (2) in the direction indicated by the arrow to remove any slack.
   3) Tighten the accelerator cable bracket bolt.



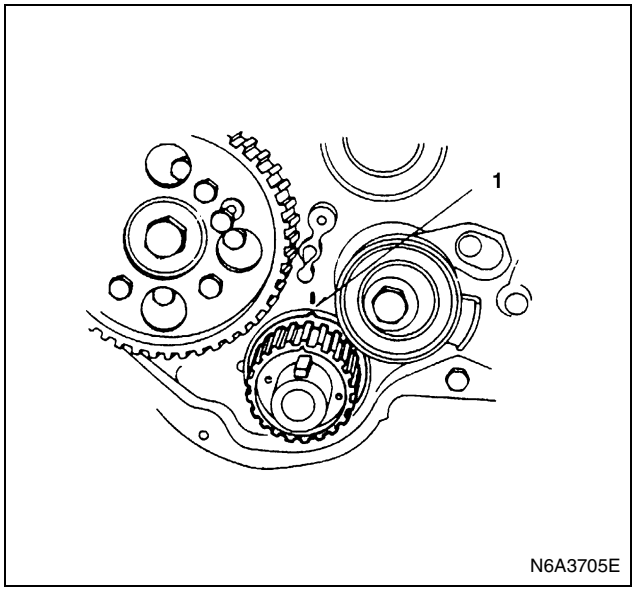
7. Air Intake Duct
   - Connect the air intake duct and tighten clip securely.
8. Injection Pump Timing Pulley
   - Align the timing pulley with the pump shaft key.
   - Install the stopper bolt to the timing pulley.
     This will prevent the timing pulley from moving.
   - Tighten the timing pulley nut to the specified torque.

Tighten:
Injection pump timing pulley nut to 64 N·m (6.5 kg·m/47 lb·ft)



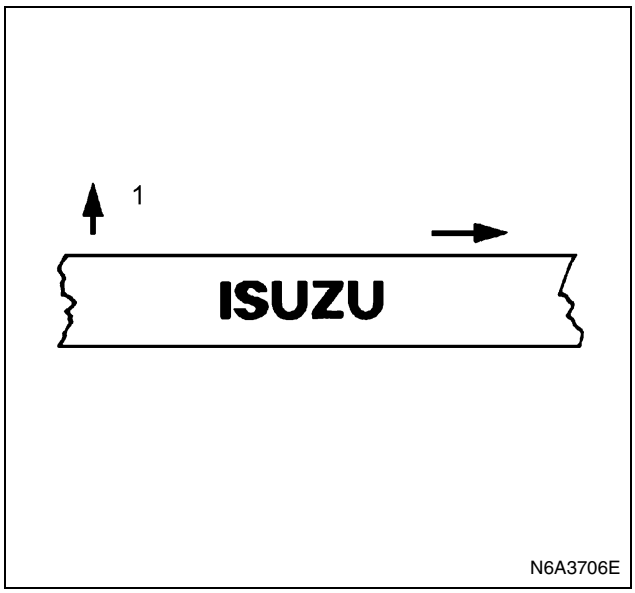
   - Remove the stopper bolt from the injection timing pulley.
9. Timing Belt
   - When removing the belt, make sure the marks on the bolt fixed camshaft, injection pulley and crankshaft timing pulley are set to each other.

Caution:
- Do not turn crankshaft because otherwise piston and valve will interfere with each other.



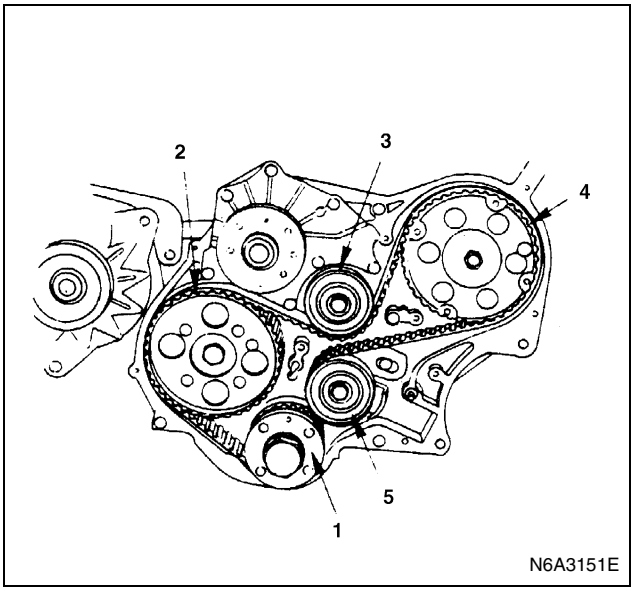
Legend
1. Setting mark

Caution:
- For accurate mounting, be sure to mount the belt in the direction that letters on the belt are readable.



Legend
1. Cylinder head side

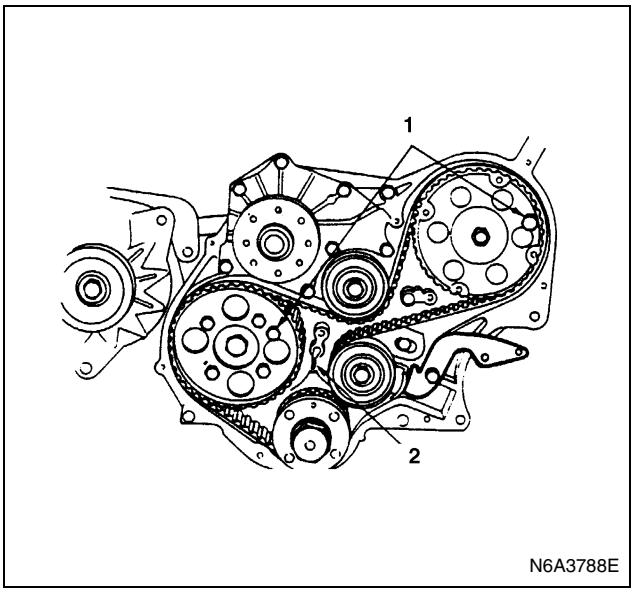
   - Mount new timing belt on pulleys in the following steps.
     Crankshaft timing pulley (1) → Camshaft Timing pulley (2) → Idle pulley (3) → Injection Pump pulley (4) → Tensioner (5)



- Set the belt on crankshaft timing pulley and hold with one hand.
- Stretch and pass the belt round each pulley with the other hand.
- After passing it round injection pump pulley, install tensioner while taking care not to slacken the belt.

Caution:

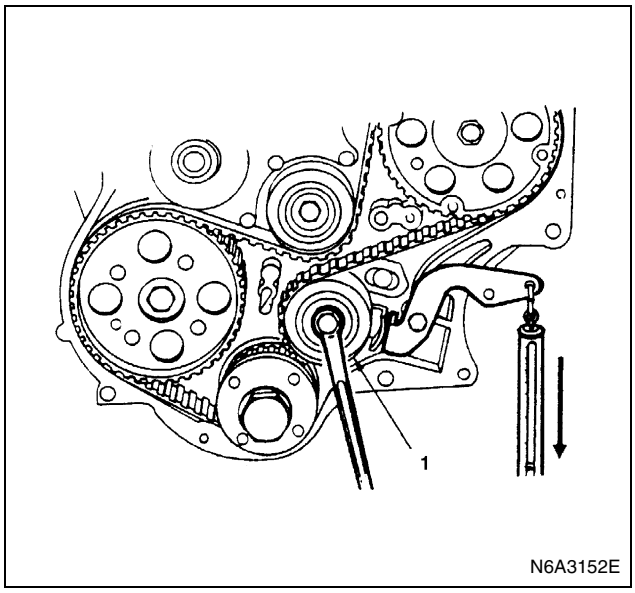
- On completion of belt passing, make sure that the setting mark on crankshaft timing pulley is set.



Legend

1. Lock bolt
2. Setting mark

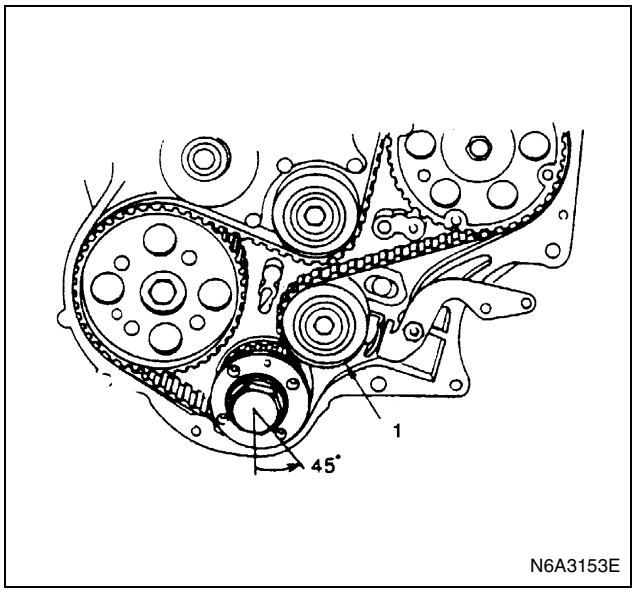
- If not set, reset the mark and repeat the belt passing.
- Remove tension adjust, lever mounting bolt, and loosen the fulcrum bolt to such extent that the lever is movable.
- Hung a spring balance from the end hole of tension adjust lever, and with the balance pulled down with 88 N (9 Kg/20 lb), loosen once the tensioner mounting bolt and then retighten it.



Legend

1. Tensioner

- Turn the crankshaft by 45° counterclockwise to shift belt slackness on the tensioner.



Legend

1. Tensioner

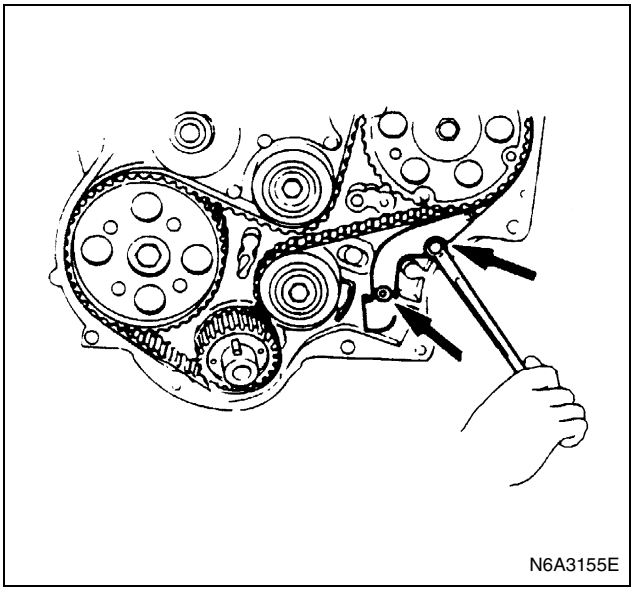
- Again hand the spring balance hanging from the end hole of tension adjust lever and pull it down with the specified force. Under this condition, loosen tensioner mounting bolt to absorb belt slackness and retighten it to specified torque.

Belt Tension	N (Kg/lb)
98 — 118 (10 — 12/22 — 26)	

Tighten:
Bolt to 76 N·m (7.8 kg·m/56 lb·ft)

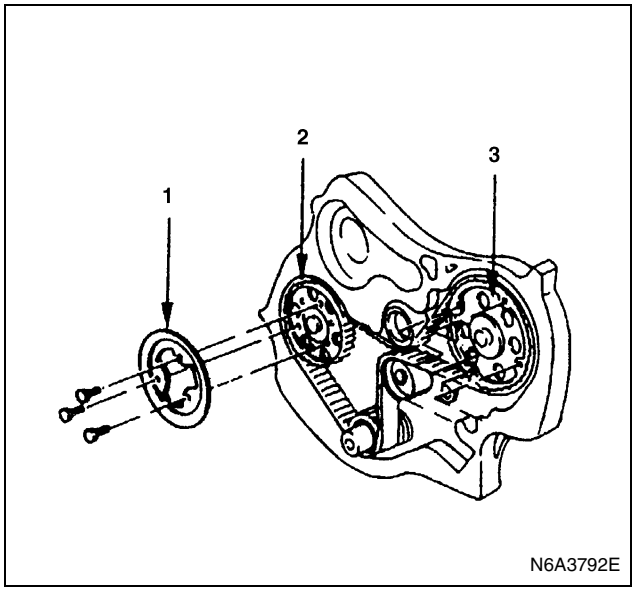
- Fix the tension adjust lever.

Caution:
- In case where the timing belt has been replaced with the actuation of warning light, put off the light with change over switch on the reverse side of meter.
- Refer to Cab and Chassis Electrical in Section 8.
- Tighten the tension adjusting lever nut and bolt.


N6A3155E

10. Flange; Camshaft Pulley
    - Install the timing pulley flange (1) to the camshaft (2).
    - Tighten the timing pulley flange bolts to the specified torque.

Tighten:
19 N·m (1.9 kg·m/14 lb·ft)



N6A3792E

11. Timing Pulley Lower Cover
    - Install timing pulley lower cover and tighten bolt to the specified torque.

Tighten:
Bolt to 8 N·m (0.8 kg·m/69 lb·in)

12. Timing Pulley Upper Cover
    - Install timing pulley upper cover and tighten bolt to the specified torque.

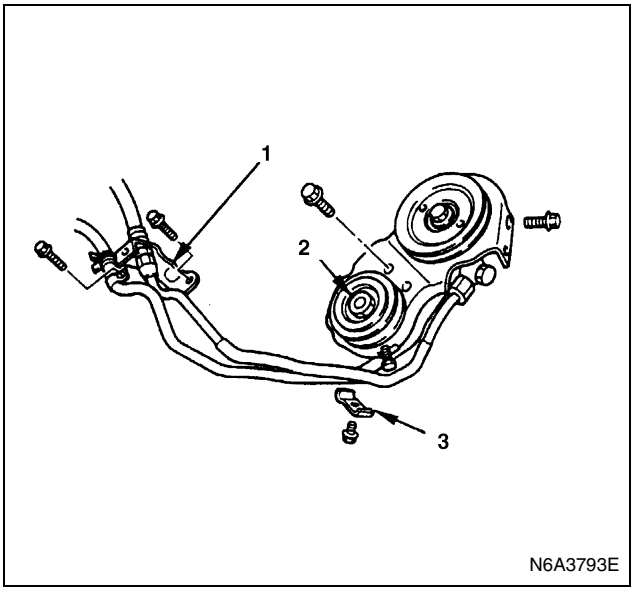
Tighten:
Bolt to 8 N·m (0.8 kg·m/69 lb·in)

13. Crankshaft Damper Pulley
    - Install crankshaft damper pulley and tighten bolt to the specified torque.

Tighten:
Bolt to 19 N·m (1.9 kg·m/14 lb·ft)

14. Power Steering Pump & Bracket Assembly (P/S Model)
    - Install the pipe bracket, clip and tighten bolts to the specified torque.

Tighten:
Pipe bracket bolts to 19 N·m (1.9 kg·m/14 lb·ft)
Pipe clip bolts to 10 N·m (1.0 kg·m/7 lb·ft)



Legend
1. Pipe bracket
2. Lock nut
3. Clip

- Install the Power Steering pump & bracket assembly.

Tighten:
- 10M bolts to 40 N·m (4.1 kg·m/30 lb·ft)
- 8M bolts to 19 N·m (1.9 kg·m/14 lb·ft)
- Lock nut to 27 N·m (2.8 kg·m/20 lb·ft)

15. AC Generator Drive Belt
    - Install AC generator drive belt and adjust belt tension.
    - Depress the drive belt mid-portion with a 98N (10 kg/ 22 lb) force.

Drive Belt Deflection	mm (in)
8 (0.31) — 12 (0.47)	

- Install fixing bolt and tighten bolts to the specified torque.

Tighten:
- Generator fixing bolt to 40 N·m (4.1 kg·m/30 lb·ft)
- Adjust Plate Fixing Bolt to 19 N·m (1.9 kg·m/14 lb·ft)

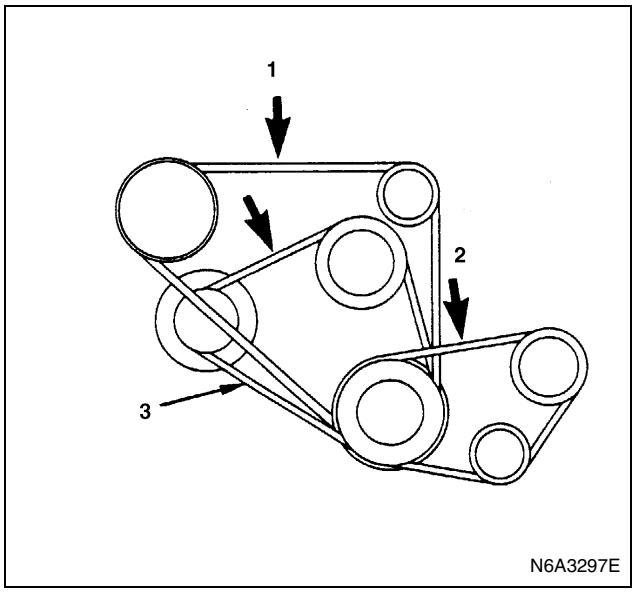
16. A/C Compressor Drive Belt (A/C Model)
    - Install A/C compressor drive belt and adjust belt tension.
    - Depress the drive belt mid-portion with a 98N (10 kg/22lb) force.

Drive Belt Deflection	mm (in)
8 (0.31) — 12 (0.47)	

- Tighten the Idler lock nut to the specified torque.

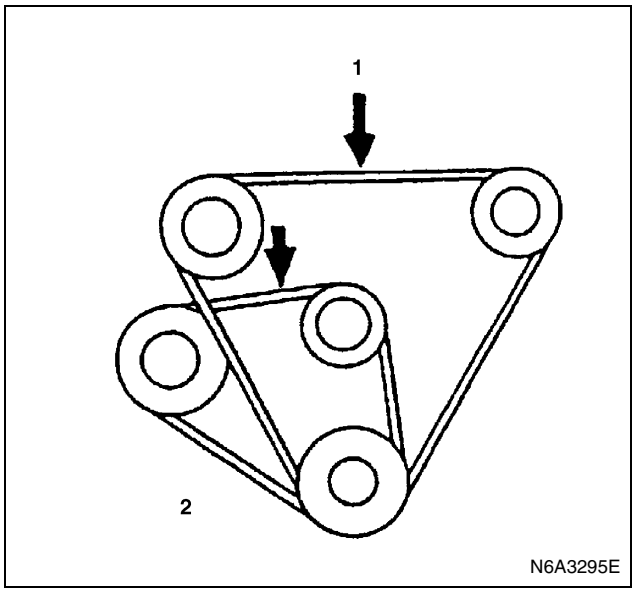
Tighten:
Idler lock nut to 27 N·m (2.8 kg·m/ 20 lb·ft)

4JG2



Legend
1. A/C compressor drive belt
2. P/S oil pump drive belt
3. AC generator fan pulley drive belt

4JB1



Legend
1. A/C compressor drive belt & P/S pump drive belt
2. AC generator & fan pulley drive belt

17. Power Steering Pump Drive Belt (P/S Model)
    - Install power steering pump drive belt and adjust belt tension.

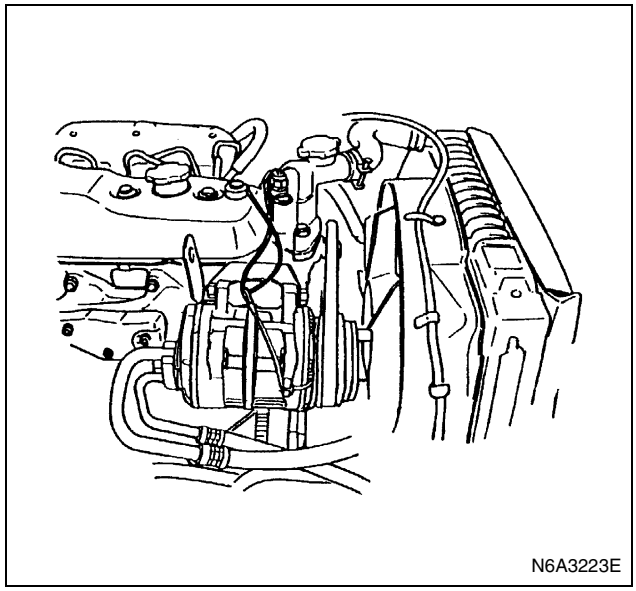
- Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

Drive Belt Deflection	mm (in)
8 (0.31) — 12 (0.47)	

- Tighten the idler lock nut to the specified torque.

Tighten:
Idler lock nut to 27 N·m (2.8 kg·m/ 20 lb·ft)

18. Fan Shroud
    - Install the fan shroud and reservoir tank hose.


N6A3223E

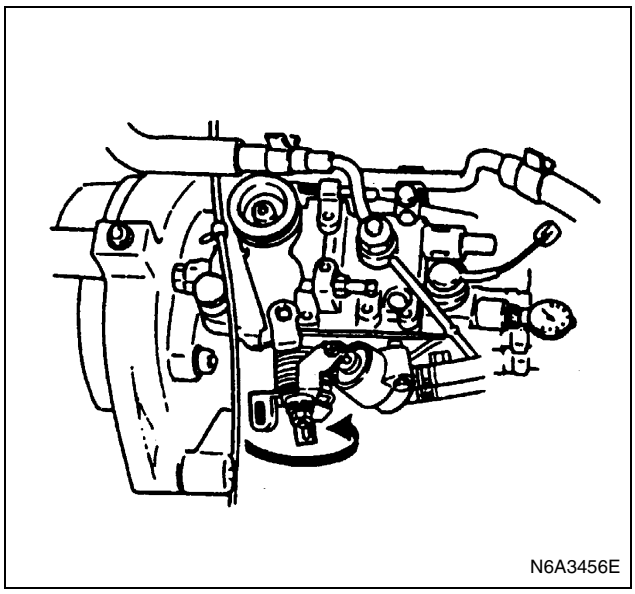
19. Cooling Fan Assembly
    - Mount fan pulley, distance piece, and cooling fan assembly (in this order) on the water pump, and tighten to the specified torque.

Tighten:
Nut to 8 N·m (0.8 kg·m/69 lb·in)

- Connect battery ground cable.
- Pour coolant.
- Start the engine and check coolant leakage.

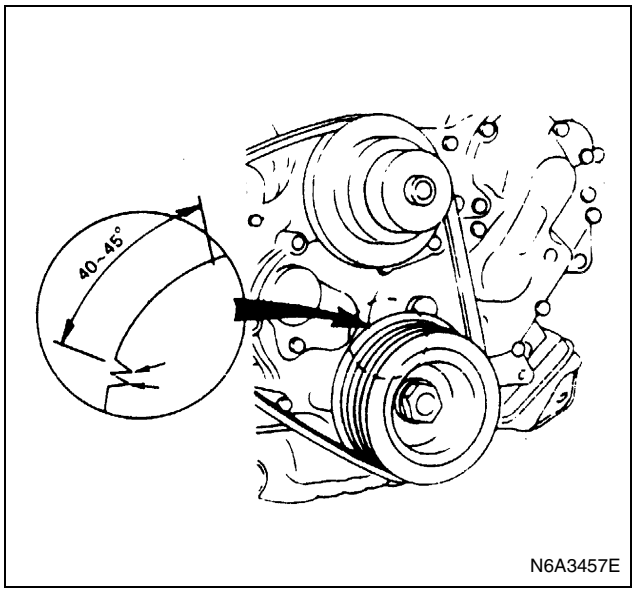
Injection Timing Adjustment

- Set No. 1 cylinder to top dead center.
- Remove injection pump distributor head plug.
- Cancel wax CSD with the handle of a screw driver.
- Fit a dial gauge and set lift to 2 mm.


N6A3456E

Measuring device: 5-8840-0145-0

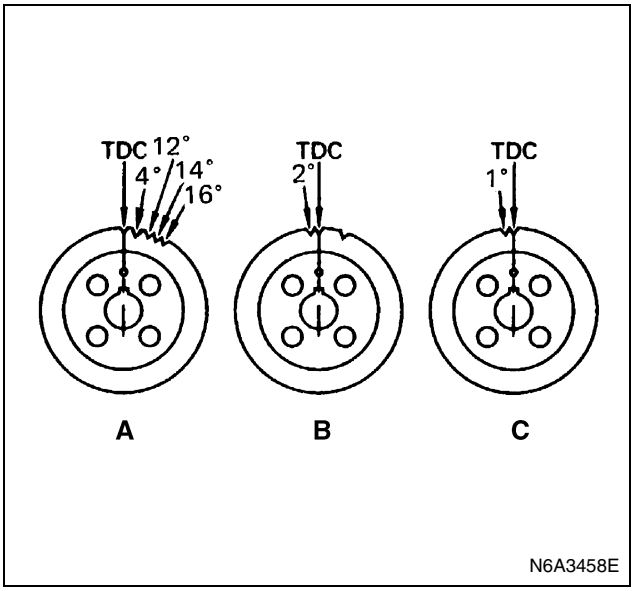
- Set crankshaft damper pulley top dead center mark about 45° before top dead center from the pointer.



N6A3457E

- Set dial gauge in the “0” position.
- Turn the crankshaft a little clockwise and counter-clockwise and see if the pointer is stable in the “0” position.
- Turn the crankshaft in the normal direction and read the measuring device’s indication at as follows.

4JB1	BTDC 14°, BTDC 12° (′91/ 542A)
4JB1-TC	BTDC4°
4JG2 (Belt Drive Type)	ATDC 1° (′91/ 542A) TDC 0° (′91/ 542B)
4JG2 (Gear Drive Type)	ATDC 2 (′91/ 542A)



Legend
A. 4JB1
B. 4JG2 Gear drive type
C. 4JG2 Belt drive type

Measuring Device's Indication	mm (in)
Standard	0.5 (0.0197)

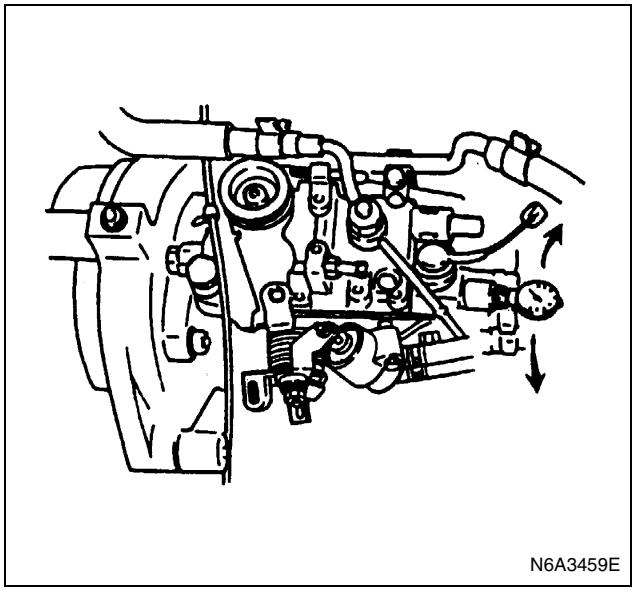
- If it reads abnormal, loosen injection pump fixing nut and pump bracket adjust bolt, make adjustment by changing the pump mounting angle, and tighten the nut and bolt to the specified torque where the dial indicates the specified valve.

Tighten:
- Pump fixing nut to 24 N·m (2.4 kg·m/17 lb·ft)
- Adjust bolt to 19 N·m (1.9 kg·m/14 lb·ft)

- Remove the measuring device and tighten the distributor head plug to the specified torque.

Tighten:
17 N·m (1.7 kg·m/12 lb·ft)

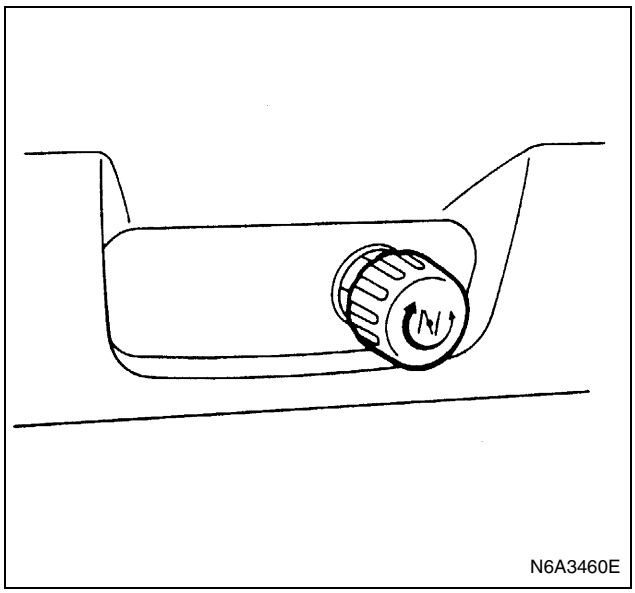
Caution:
- When installing the distributor head plug, be sure to use new copper washer.
- Connect injection pipe.
- Fit pipe clip where specified.



Adjustment of Idling Speed

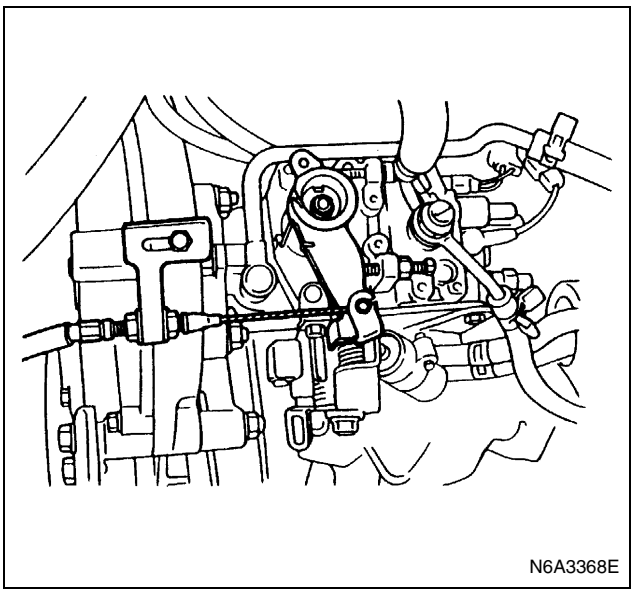
1. Pull the parking brake and lock the wheels.
2. Set the transmission gear to the neutral position.
3. Start the engine and idle it until the water temperature gets to 70 to 80°C (158 to176°F).
4. Turn back the idling control button, and remove the control cable from the control lever (injection pump).
5. Set the engine tachometer.
6. Check the idling rotation.
   When the idling rotation is outside the range of the specified value, adjust it correctly.

Specified value (rpm) = 750 — 790 (4JB1)
700 — 740 (4JG2)
675 — 725 (4JH1-TC)



1) Loosen the lock nut of the idling set bolt.
2) Rotate the idling set bolt to set the idling rotation to the specified value.

3) Tighten the lock nut to lock the set bolt.
4) Check the tension of the control cable, and remove any slackening as required.


N6A3368E

INJECTION PUMP DATA

Test Conditions

Items		Conditions		
Engine Type		4JB1 (Gear)	4JG2 (Belt) (For ′91/542B) Euro 2	4JB1 (Gear) (For ′91/542A) Euro 1
Injection Nozzle				
ZEXEL Part Number		105780-0000	105780-0000	
Bosch Type Number		DN12SD12T	DN12SD12	
Injection Nozzle holder				
ZEXEL Part Number		105780-2080	105780-2080	
Bosch Type Number		EF8511/9	EF8511/9	
Injection Nozzle Opening Pressure	MPa (kg/cm^2/psi)	14.7 (150 / 2,133)		13.0 (133 / 1,891)
Injection Line dimensions	mm (in)			
Inside Diameter		2 (0.079)		
Outside Diameter		6 (0.236)		
Length		840 (33.1)		450 (17.7)
Fuel delivery Pressure	kPa (kg/cm^2/psi)	20 (0.2 / 2.84)		
Test Fuel		SAE Standard Test Diesel Fuel (SAE967D) ISO Standard Test Diesel Fuel (ISO4113)		
Test Fuel Temperature	°C(°F)	48 - 52 (118-126)		
Identification Numbers		104746-1230	196000-1042	104742-1451
		104746-1240		104742-1461
		104746-1250		104742-1471
		104746-1260		104742-1480
		104746-1270		104742-1490
		104746-1280		
		104746-1290		
		104746-1370		

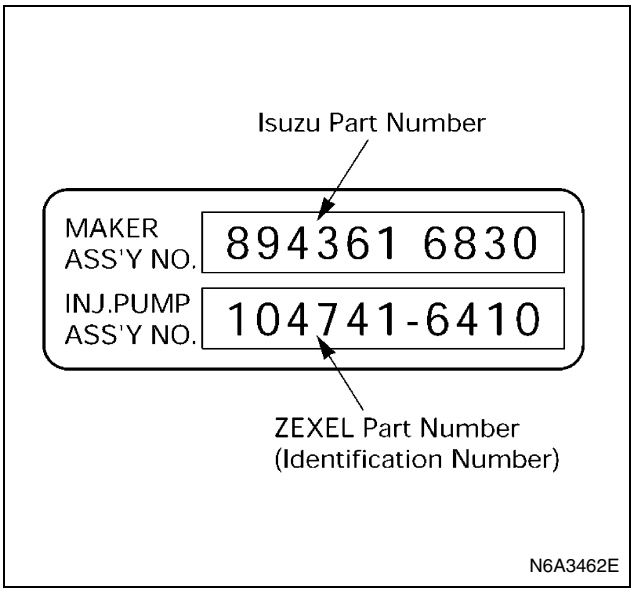
Notice:
′91/542A; Euro 1
′91/542B; Euro 2

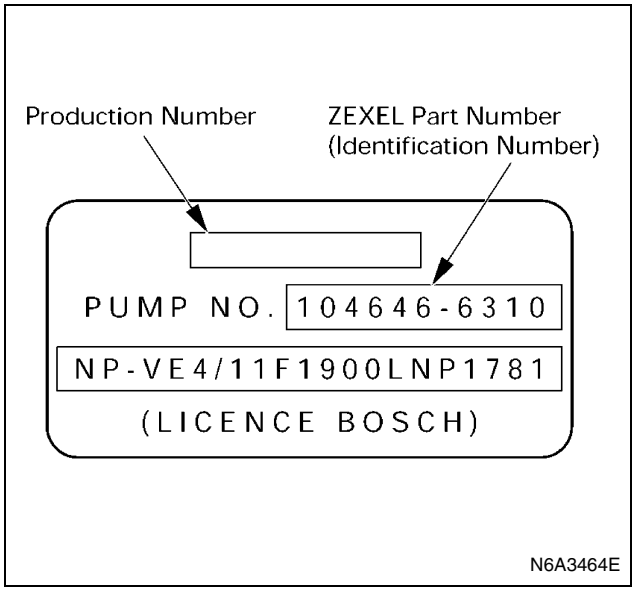
Items		Conditions
Engine Type		4JB1-TC
Injection Nozzle		
ZEXEL Part Number		105780-0060
Bosch Type Number		
Injection Nozzle holder		
ZEXEL Part Number		105780-2150
Bosch Type Number		—
Injection Nozzle Opening Pressure	MPa (kg/cm^2/psi)	13.0 (133 / 1,891)
Injection Line dimensions	mm (in)	
Inside Diameter		2 (0.079)
Outside Diameter		6 (0.236)
Length		450 (17.7)
Fuel delivery Pressure	kPa (kg/cm^2/psi)	20 (0.2 / 2.84)
Test Fuel		SAE Standard Test Diesel Fuel (SAE967D) ISO Standard Test Diesel Fuel (ISO4113)
Test Fuel Temperature	°C(°F)	48 — 52 (118 — 126)
Identification Numbers		104746-6601 104766-6620

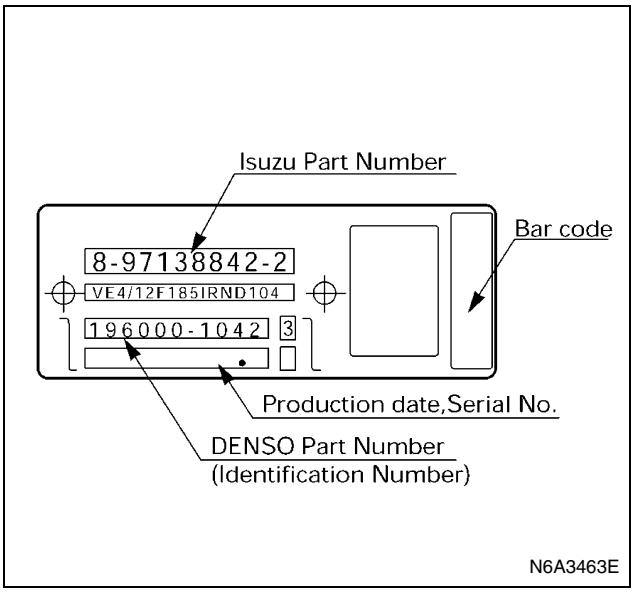
Notice:
′91/542A ; Euro 1
′91/542B ; Euro 2

Identification Plate and Number

Use the data following the injection pump identification number to adjust the injection volume.





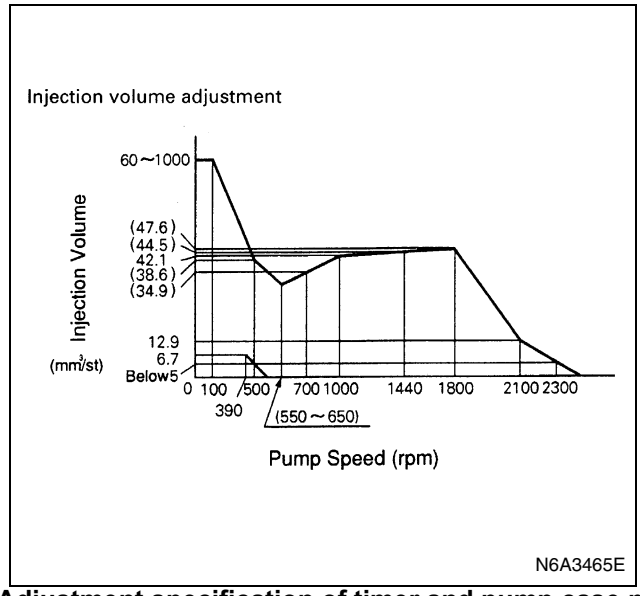


INJECTION VOLUME AND GOVERNOR PERFORMANCE DIAGRAM

Governor Performance Diagram

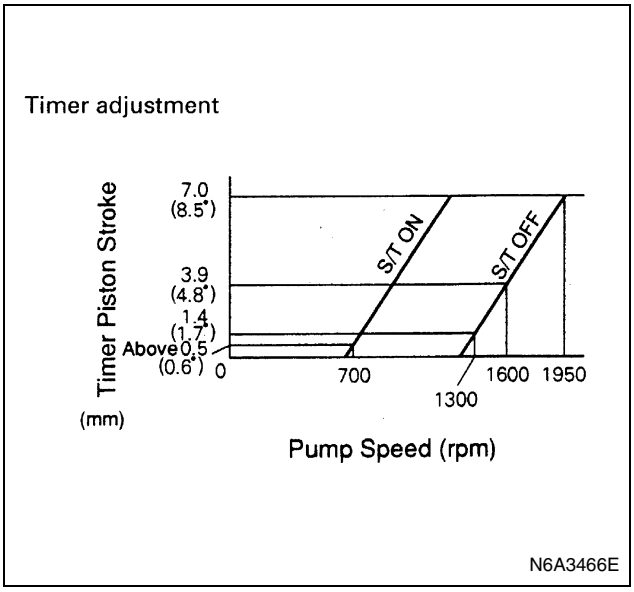
Engine ; 4JB1
Injection pump assembly No. ;
8943616830 (104741-6410)
8943616850 (104741-6430)
Adjustment specification of injection volume

Pump rotation (rpm)	Average injection quantity (mm^3/ST)	Uneven amplitude (mm^3/ST)	Oil temperature (°C)	Remarks
500	(38.6)	—	48±2	
700	34.9±2.5	—	50±2	
1000	42.1±1.0	4.0	50±2	Standard
1450	44.5±2.5	—	50±2	
1800	47.6±3.0	—	60±2	
2100	12.9±3.0	4.0	52±2	
390	6.7±3.0	2.0	48±2	
100	60 -100	—	48±2	



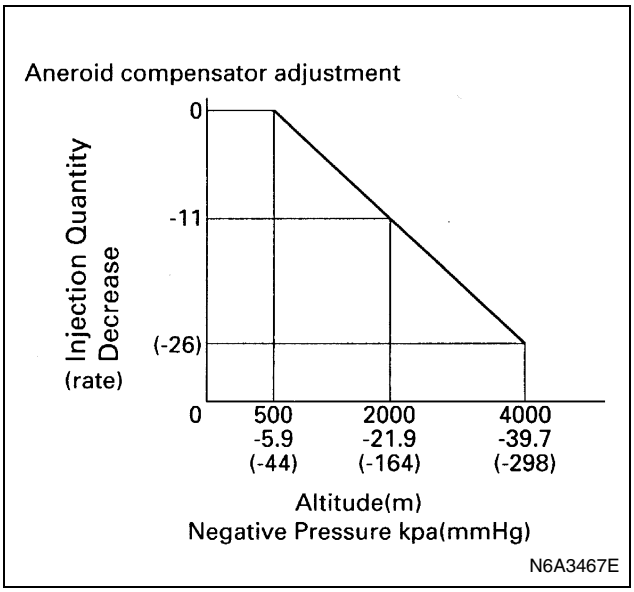
Adjustment specification of timer and pump case pressure

Pump rotation (rpm)	Timer piston stroke (mm)		Air pressure of pump (kPa (kg/cm^2))		Remarks
	Solenoid timer		Solenoid timer		
	ON	OFF	ON	OFF	
700	Over 0.5	—	—	—	
1300	—	1.4±0.4	—	—	
1600	—	3.9±2	—	490±20 (5.0±0.2)	Standard
1950	—	$7.0^{+0.4}_{-0.3}$	—	—	



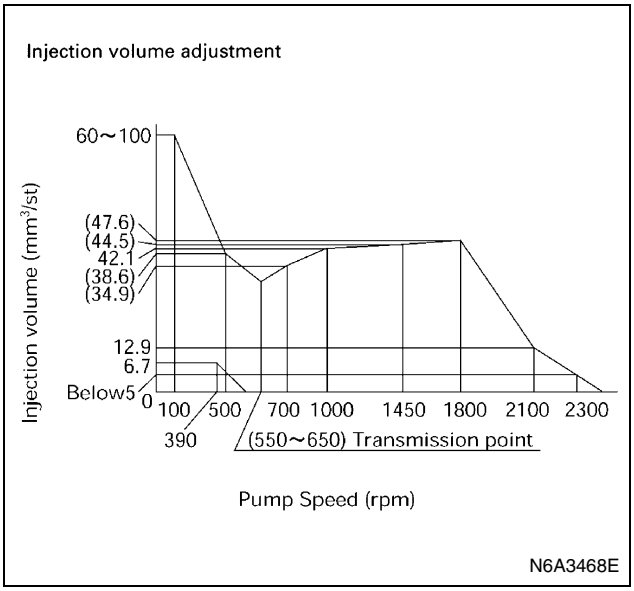
Adjustment specification of aneroid compensator

Pump rotation (rpm)	Altitude (m)	Air pressure difference (kPa (mmHg))	Amount of reduction (mm^3/ST)	Rate of reduction (%)
1000	0	0	0	0
	(500)	-5.9±3.3 (-44±3)	Inflation point	Inflation point
	2000	-21.9 (-164)	-4.6±1	-11±3



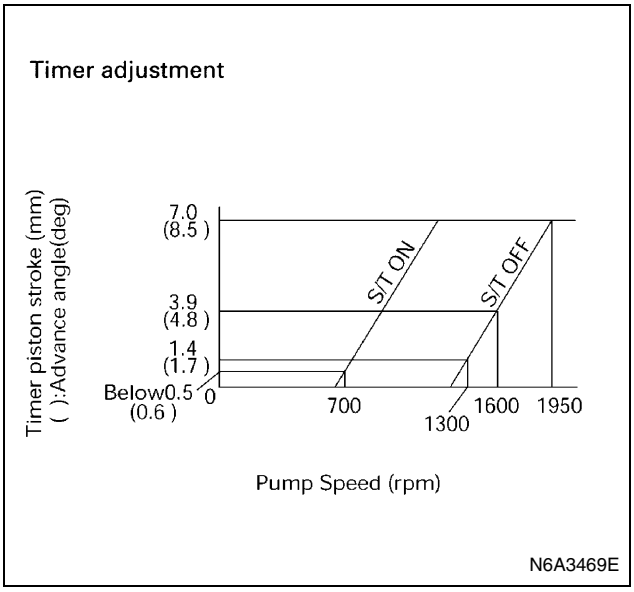
Engine ; 4JB1
Injection pump identification No. ; 104746-1230, 1240, 1250, 1260, 1280, 1290, 1370
Adjustment specification of injection volume

Pump rotation (rpm)	Average injection quantity (mm^3/ST)	Uneven amplitude (mm^3/ST)	Oil temperature (°C)	Remarks
500	(38.6)	—	48±2	
700	34.9±2.5	—	50±2	
1000	42.1±1.0	4.0	50±2	Standard
1450	44.5±2.5	—	50±2	
1800	47.6±3.0	—	50±2	
2100	12.9±3.0	4.0	52±2	
390	6.7±2.0	2.0	48±2	
100	60 -100	—	48±2	



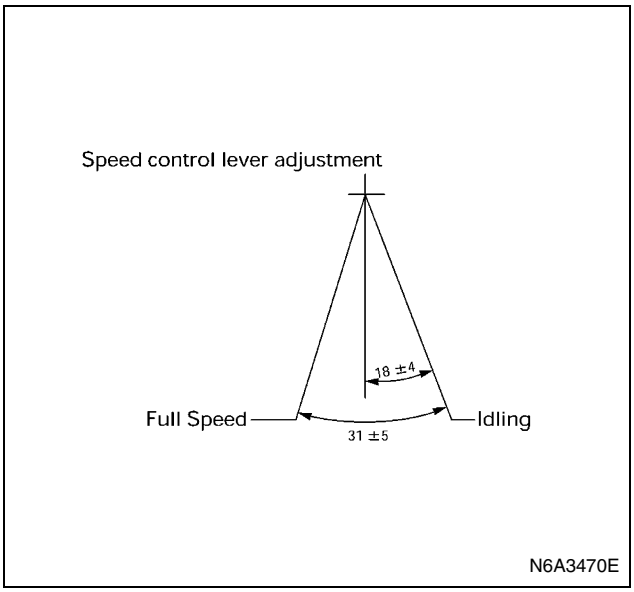
Adjustment specification of timer and pump case pressure

Pump rotation (rpm)	Timer piston stroke (mm)		At pressure of pump (MPa(kg/cm^2))		Remarks
	Solenoid timer		Solenoid timer		
	ON	OFF	ON	OFF	
700	Over 0.5	—	—	—	
1300	—	1.4±0.4	—	—	
1600	—	3.9±2	—	0.49±0.02 (5.0±0.2)	Standard
1950	—	$7.0^{+0.4}_{-0.3}$	—	—	



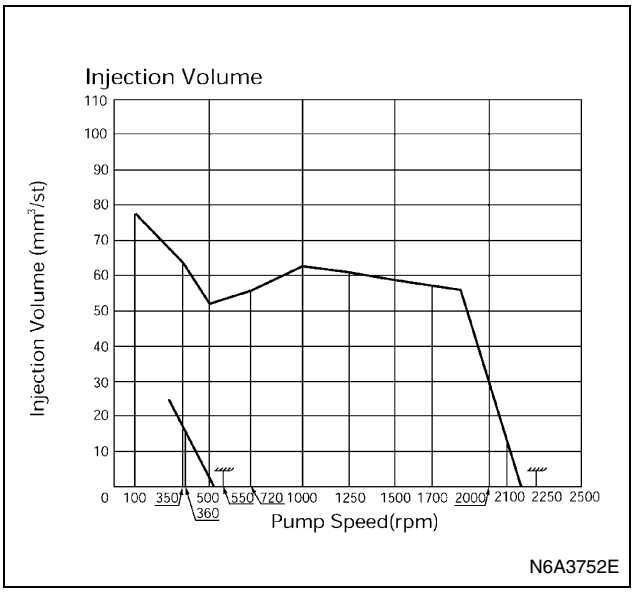
Adjustment specification of aneroid compensator (For 104746-1230,14746- 1280)

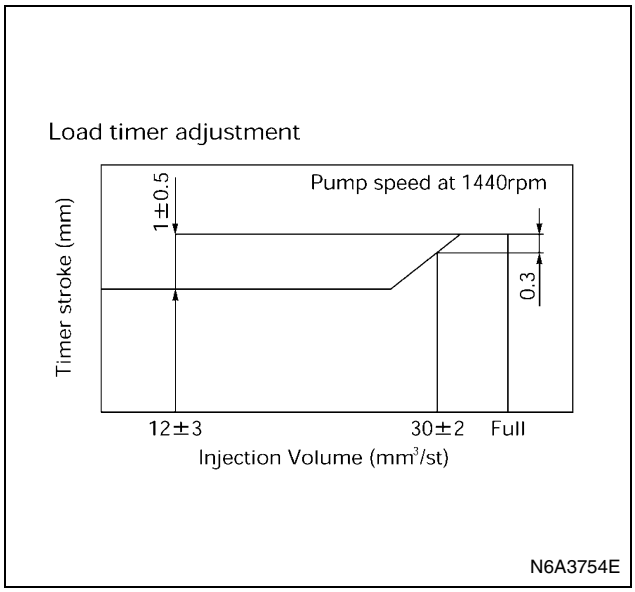
Pump rotation (rpm)	Altitude (m)	Air pressure difference (kPa (mmHg))	Amount of reduction (mm^3/ST)	Rate of reduction (%)
1000	0	0	0	0
	(500)	-5.9±3.3 (-44±25)	Inflation point	Inflation point
	2000	-21.9 (-164)	-4.6±1	-11±3

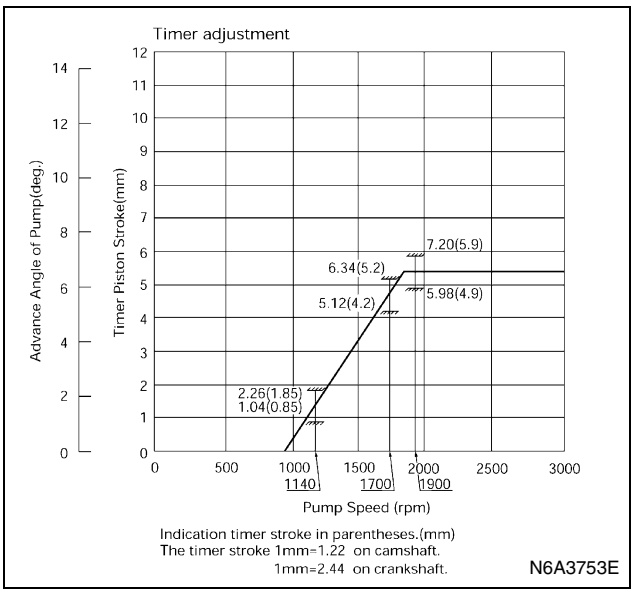


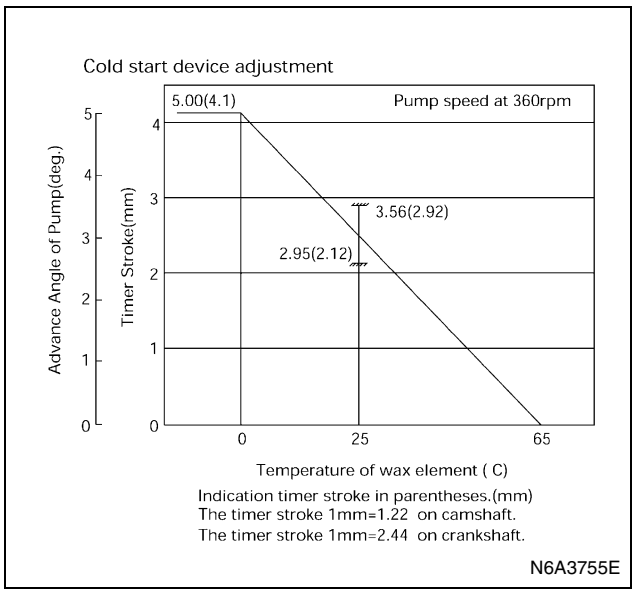
Engine ; 4JG2 (For '91/542B) (Belt drive)
Injection pump assembly No. ; 897138-8422 (196000-1042)
Adjustment specification of injection volume

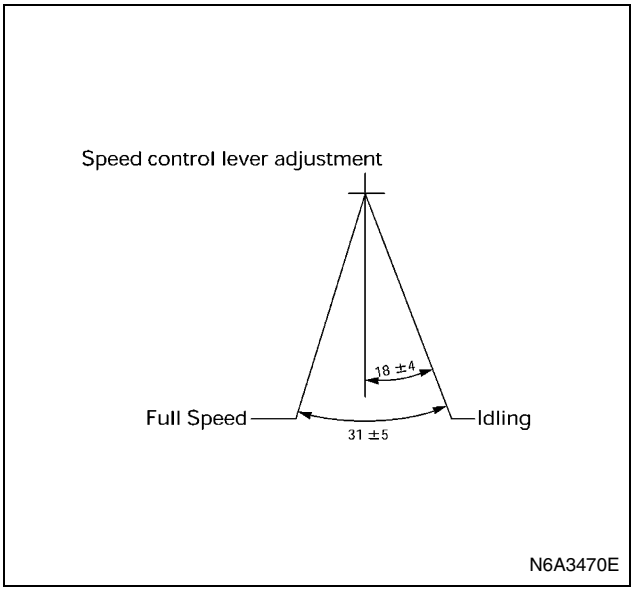
Pump rotation (rpm)	Average injection quantity (mm^3/ST)	Uneven amplitude (mm^3/ST)	Remarks
100	78±12	—	
350	64±6.0	—	
500	52±3.0	—	
720	55.9±3.4	—	
1000	62.6±1.0	4.0	
1250	60.9±3.5	—	
1700	574±3.5	4.0	
2100	13±5.0	—	
2250	Below 5.0	—	
360	15.9±3.0	2.5	
550	Below 3.0	—	





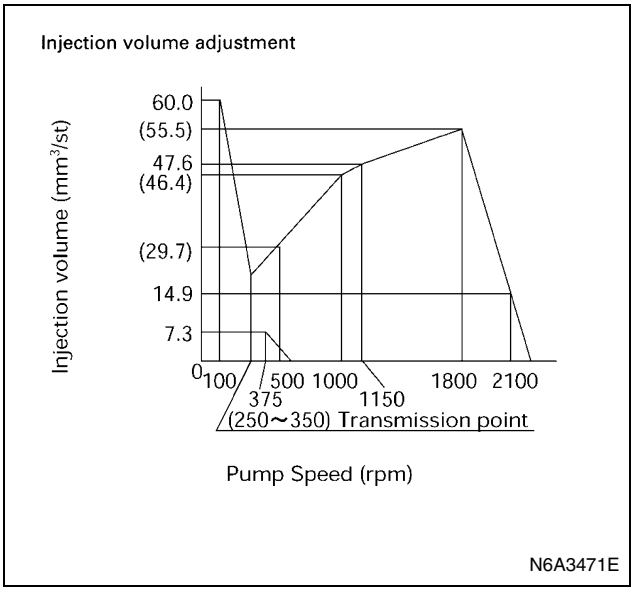






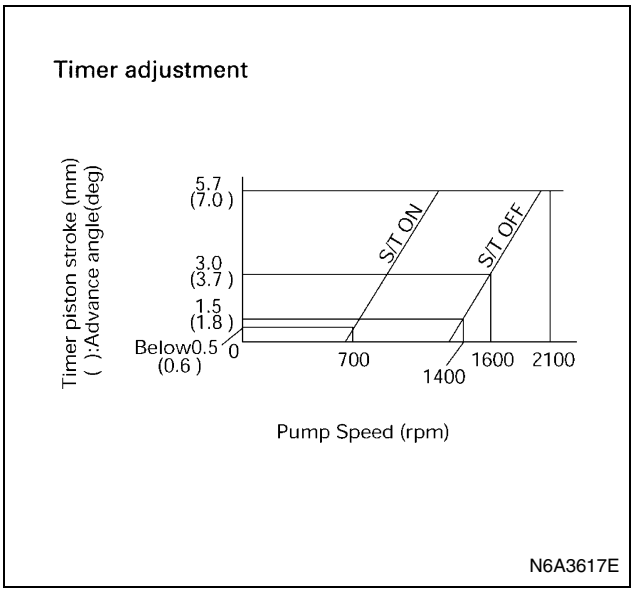
Engine ; 4JB1 (For ′91/542A) (Gear drive)
Injection pump identification No. ; 104742-1451, 1461, 1471
Adjustment specification of injection volume

Pump rotation (rpm)	Average injection quantity (mm^3/ST)	Uneven amplitude (mm^3/ST)	Oil temperature (°C)	Remarks
500	(29.7±4.5)	—	48±2	
1000	(46.4±3.5)	—	50±2	
1150	47.6±1.0	3.5	50±2	Standard
1800	(55.5 $^{+0.4}_{-6.0}$)	—	50±2	
2100	14.9±3.0	4.0	52±2	Standard
375	7.3±2.0	2.0	48±2	Standard



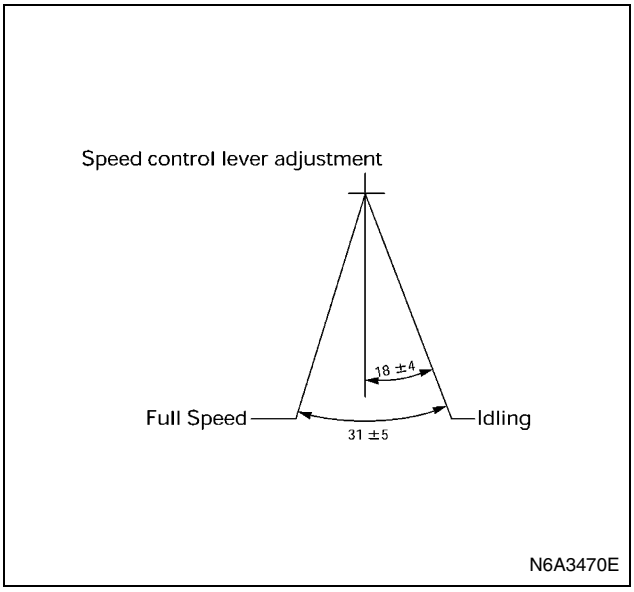
Adjustment specification of timer and pump case pressure

Pump rotation (rpm)	Timer piston stroke (mm)		At of pressure pump (MPa(kg/cm^2))		Remarks
	Solenoid timer		Solenoid timer		
	ON	OFF	ON	OFF	
700	Over 0.5	—	—	—	
1400	—	1.5±0.4	—	—	
1600	—	3.0±0.2	—	0.53±0.02 (5.4±0.2)	Standard
2100	—	5.7 $^{+0.4}_{-0.3}$	—	—	



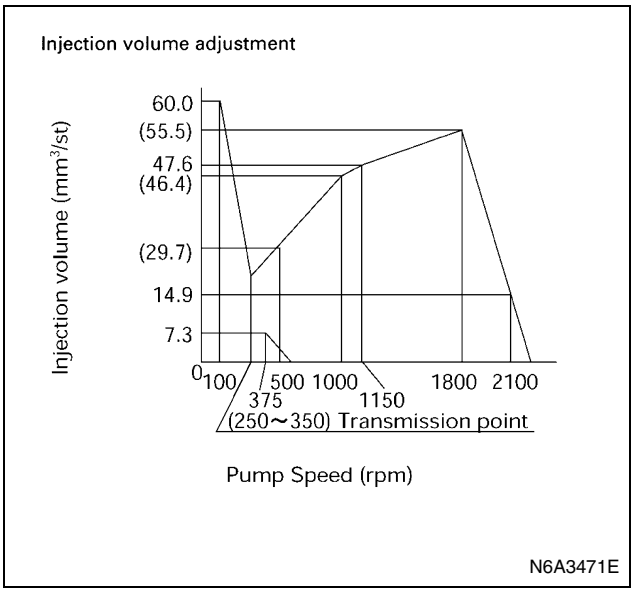
Adjustment specification of aneroid compensator (For 104742-1471)

Pump rotation (rpm)	Altitude (m)	Air pressure difference (kPa (mmHg))	Amount of reduction (mm^3/ST)	Rate of reduction (%)
1150	0	0	0	0
	(500)	−5.9±3.3 (−44±25)	Inflation point	Inflation point
	2000	−21.9 (−164)	(−5.2±1.3)	(−11±3)



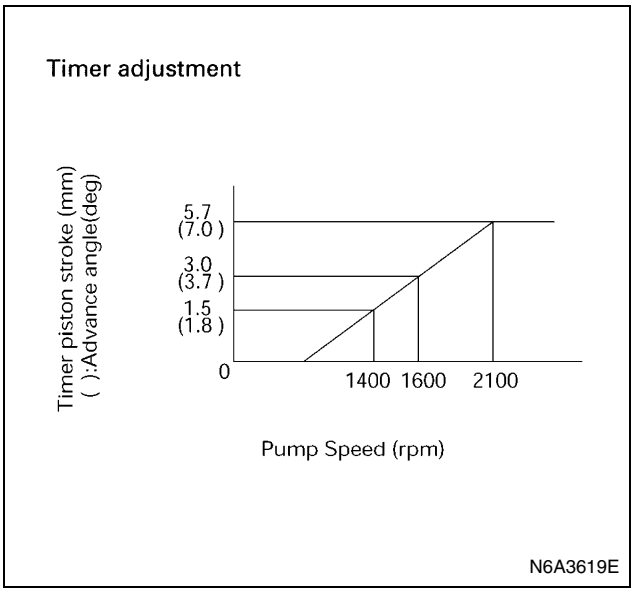
Engine ; 4JB1 (For ′91/542A) (Gear drive)
Injection pump identification No. ; 104742-1480, 1490
Adjustment specification of injection volume

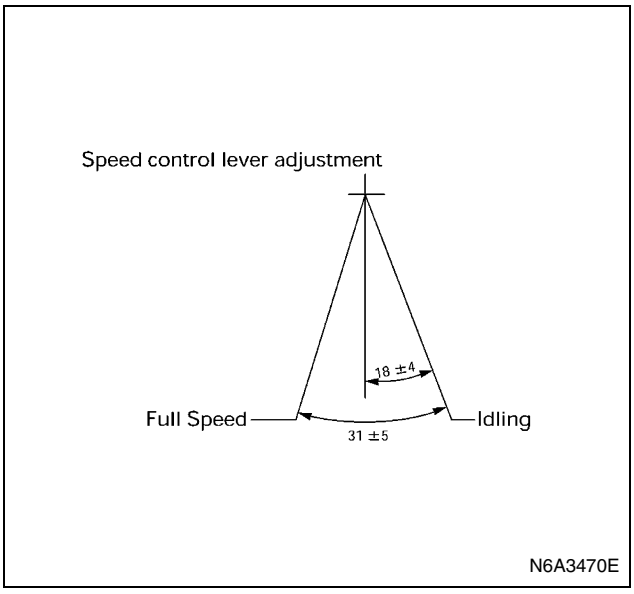
Pump rotation (rpm)	Average injection quantity (mm^3/ST)	Uneven amplitude (mm^3/ST)	Oil temperature (°C)	Remarks
500	(29.7±4.5)	—	48±2	
1000	(46.4±3.5)	—	50±2	
1150	47.6±1.0	3.5	50±2	Standard
1800	(55.5 $^{+0.4}_{-6.0}$)	—	50±2	
2100	14.9±3.0	4.0	52±2	Standard
375	7.3±2.0	2.0	48±2	Standard
100	(60 -100)	—	48±2	



Adjustment specification of timer and pump case pressure

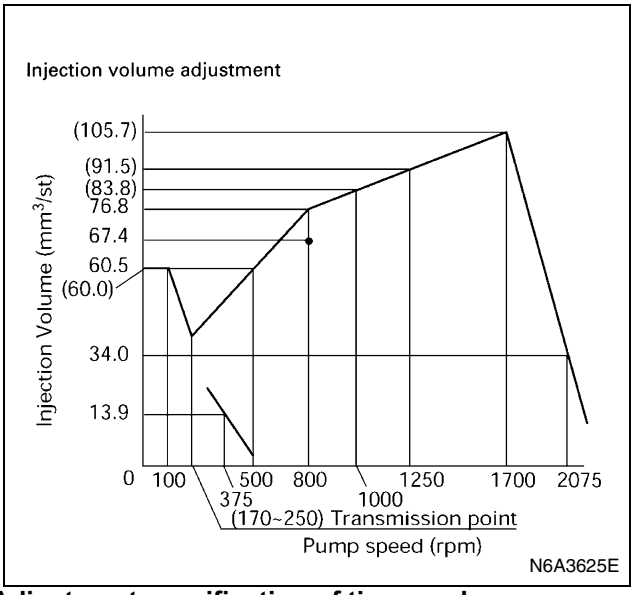
Pump rotation (rpm)	Timer piston stroke (mm)	At pressure of pump (MPa (kg/cm^2))	Remarks
1400	(1.5±0.4)	—	
1600	3.0±0.2	0.53±0.02 (5.4±0.2)	Standard
2100	$5.7\ ^{+0.4}_{-0.3}$	—	





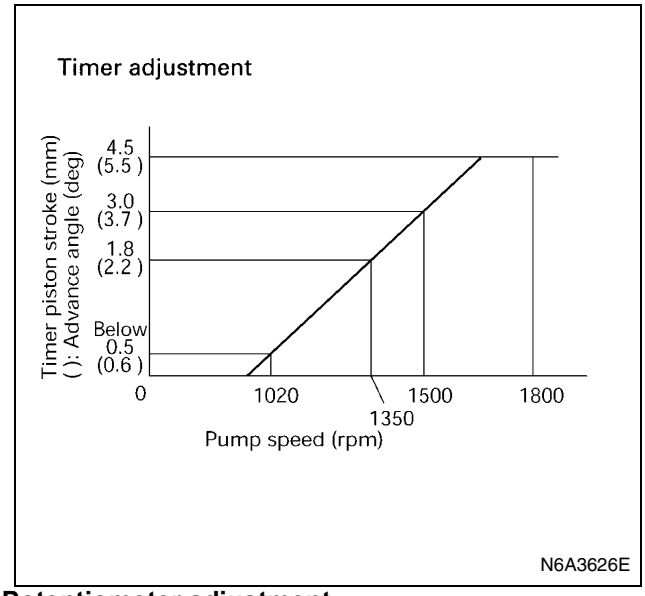
Engine ; 4JB1-TC
Injection pump identification No. ; 104746-6601
Adjustment specification of injection volume

Pump rotation (rpm)	Average injection quantity (mm^3/ST)	Uneven amplitude (mm^3/ST)	Boost pressure (kPa (kg/cm^2))	Oil temperature (°C)	Remarks
500	60.5±1.0	5.0	0	48±2	Standard
800	67.4±1.0	5.5	52.0 (0.531)	50±2	Standard
800	76.8±1.0	6.0	80.0 (0.821)	50±2	Standard
1000	(83.8±6.5)		80.0 (0.821)	50±2	
1250	(91.5±6.5)		80.0 (0.821)	50±2	
1700	(105.7±6.5)		80.0 (0.821)	50±2	
2075	34.0±3.0	7.0	80.0 (0.821)	52±2	Standard
375	13.9±2.0	2.0	0	48±2	Standard
100	$60\ ^{+40}_{-0}$		0	48±2	



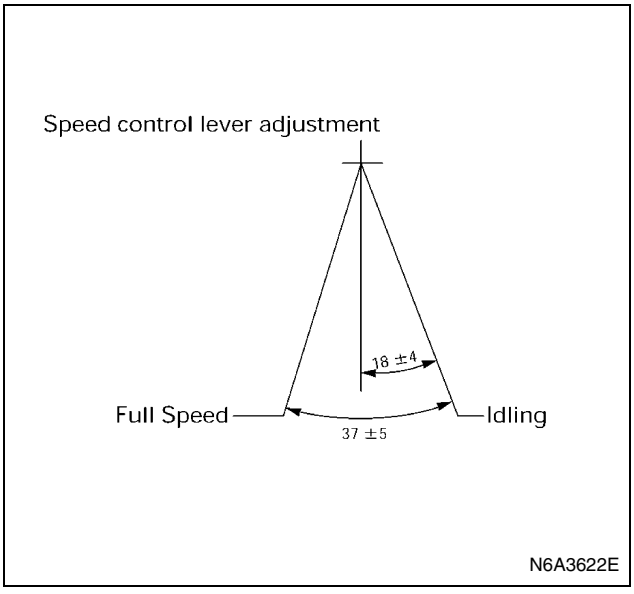
Adjustment specification of timer and pump case pressure

Pump rotation (rpm)	Timer piston stroke (mm)	At pressure of pump (MPa (kg/cm^2))	Boost Pressure (kPa (kg/cm^2))	Remarks
1020	Below 0.5		80.0 (0.82)	
1350	1.8±0.2	471±29 (4.8±0.3)	80.0 (0.82)	Standard
1500	(3.0±0.4)		80.0 (0.82)	
1800	$4.5\ ^{+0.4}_{-0.3}$		80.0 (0.82)	



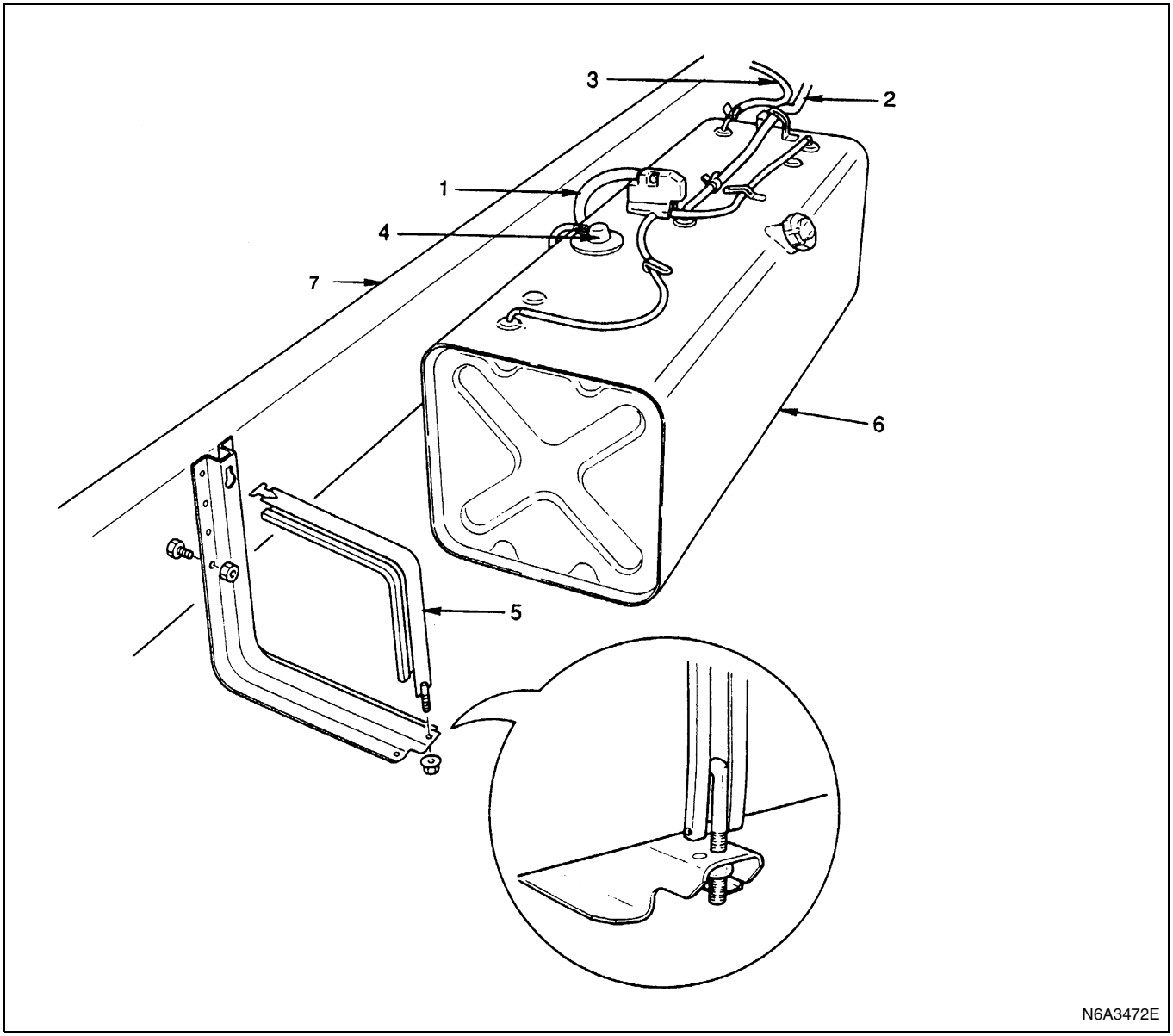
Potentiometer adjustment

Pump speed (r/min)	Out-put voltage (V)	Average injection quantity (mm^3/st)	BoostPressure (kPa (kg/cm^2))	Remarks
1080	3.56±0.03	27.5±2.0	0	Standard
375	(0.93±0.45)	13.9±2.0	0	Standard



FUEL TANK

Component



Legend

1. Evaporator fuel hose
2. Fuel feed hose
3. Fuel return hose
4. Fuel gauge unit connector
5. Band
6. Fuel tank
7. Frame

Removal

Preparation:

- Disconnect battery ground cable.
- Loosen fuel filler cap.
- Drain fuel from drain plug.
- After the drain fuel, tighten the drain plug to the specified torque.

Tighten:
29 N·m(3 kg·m/22 lb·ft)

1. Evaporator Fuel Hose
2. Fuel Feed Hose
3. Fuel Return Hose
   - Plug the hose to prevent fuel from getting spilt, and tie it to the frame with the plugged end up.
4. Fuel Gauge Unit Connector
   - Remove the connector of the fuel gauge.
5. Band
   - Remove the nut of the fuel tank fixing band, and then remove the band end on the frame side.
6. Fuel Tank
   - Pull out the fuel tank to the outside.

Notice:
When it is not possible to pull out the fuel tank, remove the bracket and then draw out the fuel tank downward.

Installation

1. Fuel Tank

Notice:
When the bracket was removed to take off the fuel tank, install the bracket to the frame and tighten it to the specified torque.

Tighten:
55 N·m(5.6 kg·m/41 lb·ft)

When mounting the fuel tank on the bracket, be sure to place the packing section pasted on the fuel tank securely on the bracket.

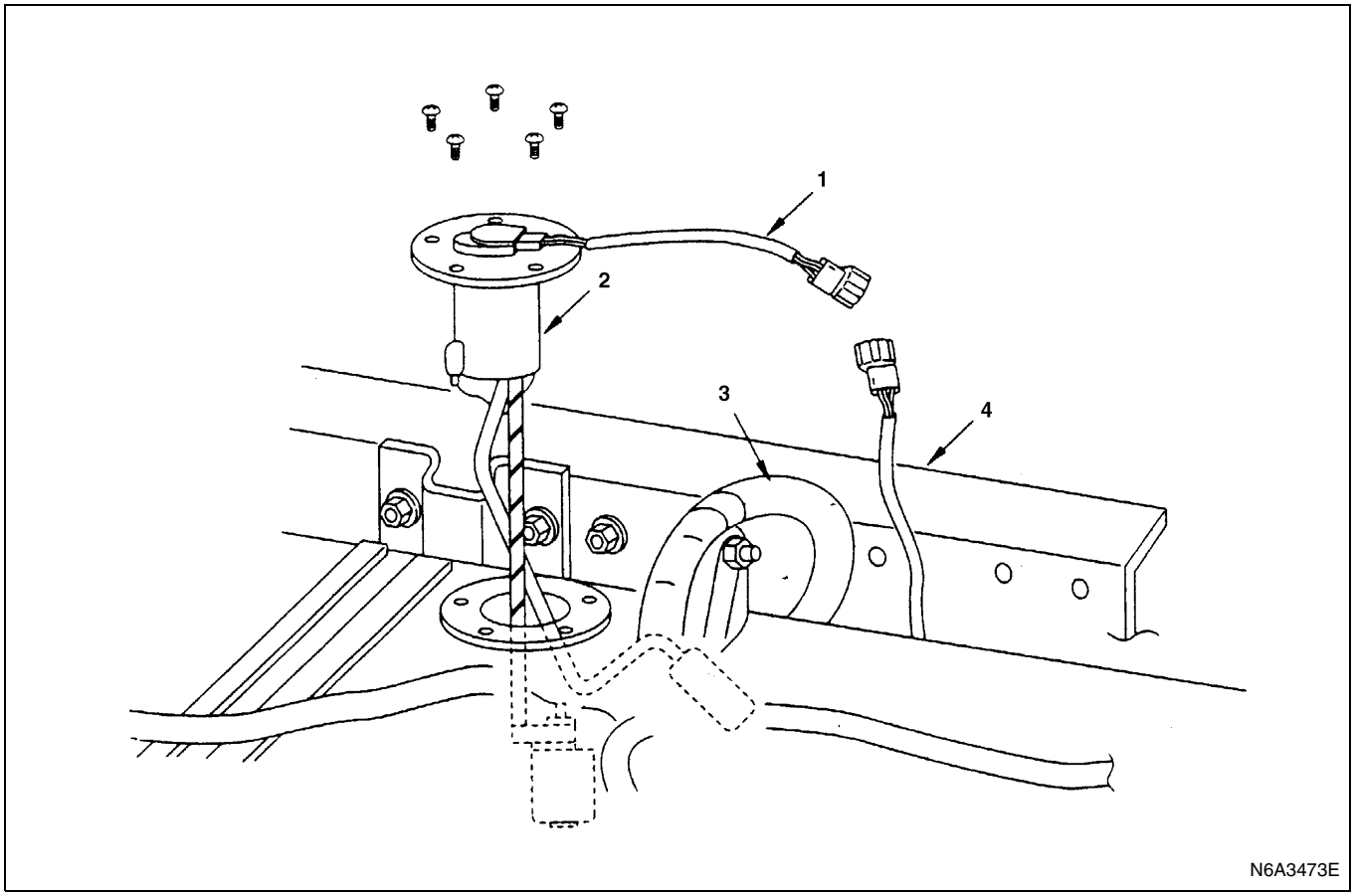
2. Band
   - Tighten the band to the specified torque.

Tighten:
12 N·m(1.2 kg·m/104 lb·ft)

3. Fuel Gauge Unit Connector
   - Connect the fuel gauge unit connector.
4. Fuel Return Hose
5. Fuel Feed Hose
   - Set the hose to the pipe more than 25 mm (0.98 in) deep.
6. Evaporator Fuel Hose
   - Fill the fuel to the fuel tank.
   - Connect battery ground cable.

FUEL GAUGE UNIT

Component



Legend

1. Fuel gauge unit connector
2. Fuel gauge unit
3. Evaporator fuel hose
4. Frame

Removal

Preparation:

- Disconnect battery ground cable.

1. Fuel Gauge Unit Connector
   - Disconnect fuel gauge unit connector from fuel gauge unit.
2. Fuel Gauge Unit
   - Remove fuel gauge unit fixing screw and fuel gauge unit.

Notice:

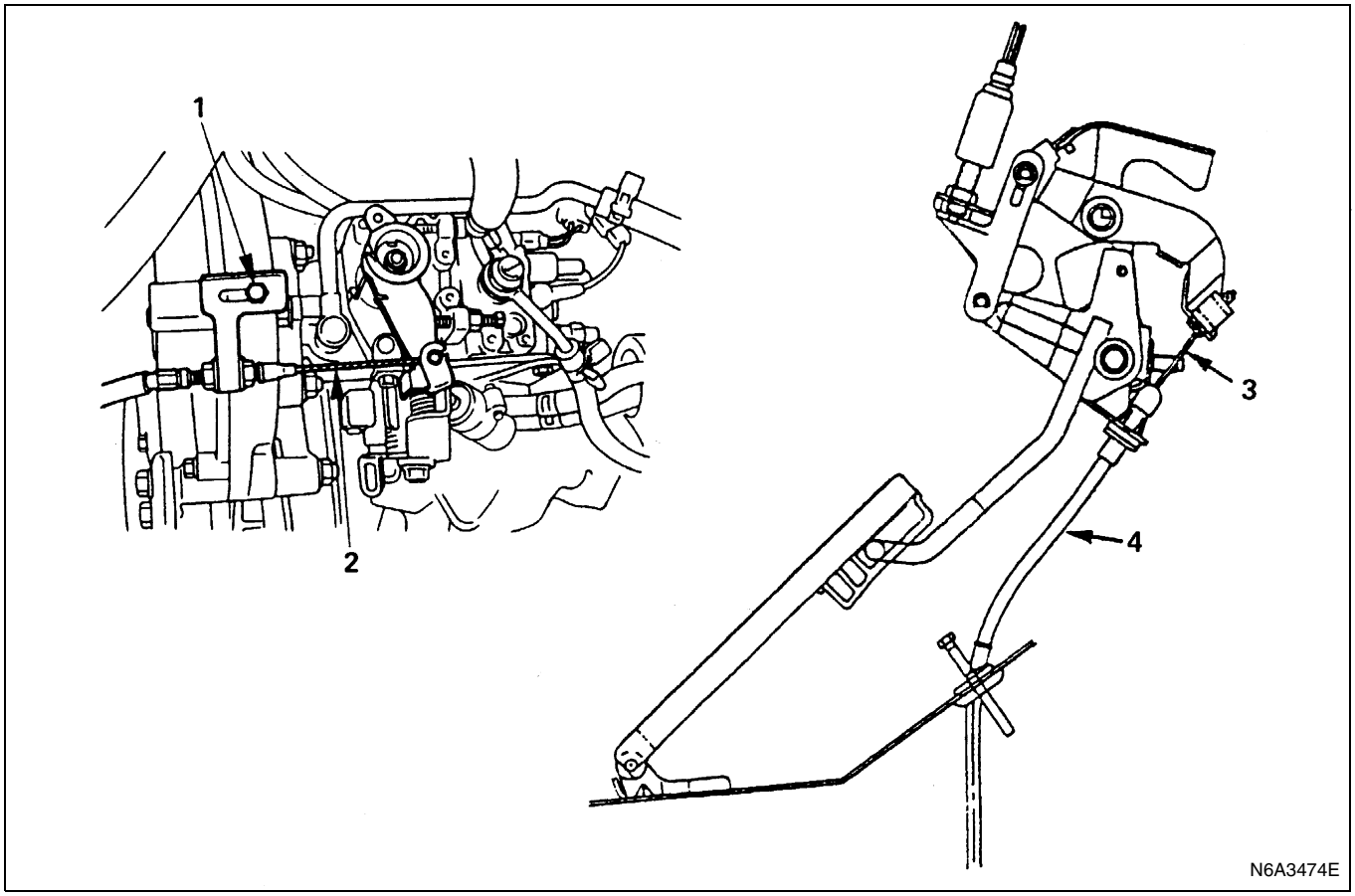
- After removing fuel gauge unit, cover fuel tank with waste to prevent any dust entering.

Installation

1. Fuel Gauge Unit
2. Fuel Gauge Unit Connector
   - Connect the wiring connector to the fuel gauge unit.

ACCELERATOR CONTROL CABLE

Component



Legend

1. Adjust unit
2. Accelerator control wire
3. Accelerator control wire
4. Accelerator control cable

Removal

1. Adjust Nut
   - Loosen the adjust nut on the cable bracket mounted on the inlet manifold.
2. Accelerator Control Wire (Injection Pump Side)
   - Remove the control wire from injection pump control lever.
3. Accelerator Control Wire (Accelerator Pedal Side)
   - Remove the accelerator control wire from accelerator pedal.
4. Accelerator Control Cable
   - Remove the cable clip from intake manifold duct.
   - Remove the cable clip from chassis frame.
   - Pull out the wire to the chassis side through the grommet hole of the floor board, and remove the control cable.

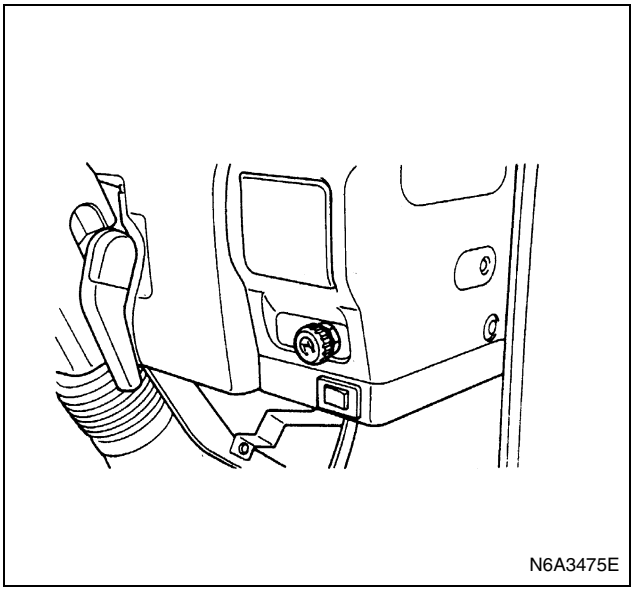
Inspection

Check the following items, and replace the control cable if any abnormality is found.

- The control cable should move smoothly.
- The control cable should not be bent or kinked.
- The control cable should be free of damage and corrosion.

Installation

1. Accelerator Control Cable
   - Take care that the core wire of the cable does not get damaged or kinked.
   - Pull the cable through the grommet hole from under the floor.
   - Set the groove of the grommet securely into the floor panel.
   - Lower the cab.
2. Accelerator Control Wire (Accelerator pedal side)
   - Connect the accelerator control wire to the accelerator pedal.
   - Check to see if the idling control knob is fully turned to the left.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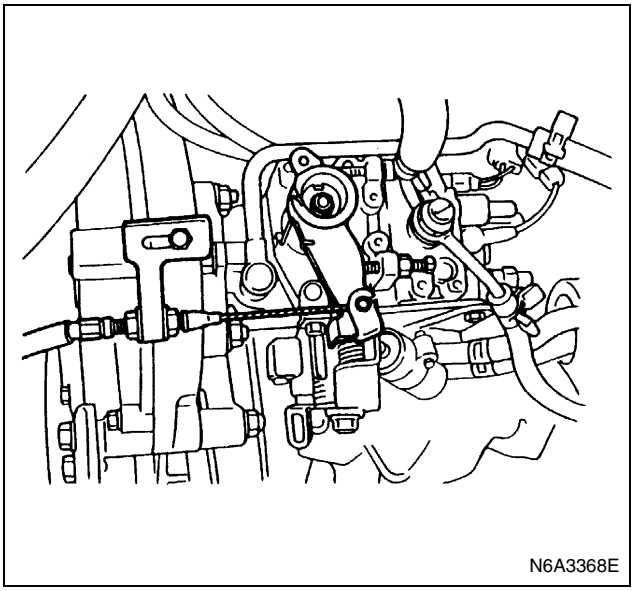
- Tilt up the cab.

3. Accelerator Control Wire (Injection pump side)
   - Install the tip end of the wire to the engine control lever.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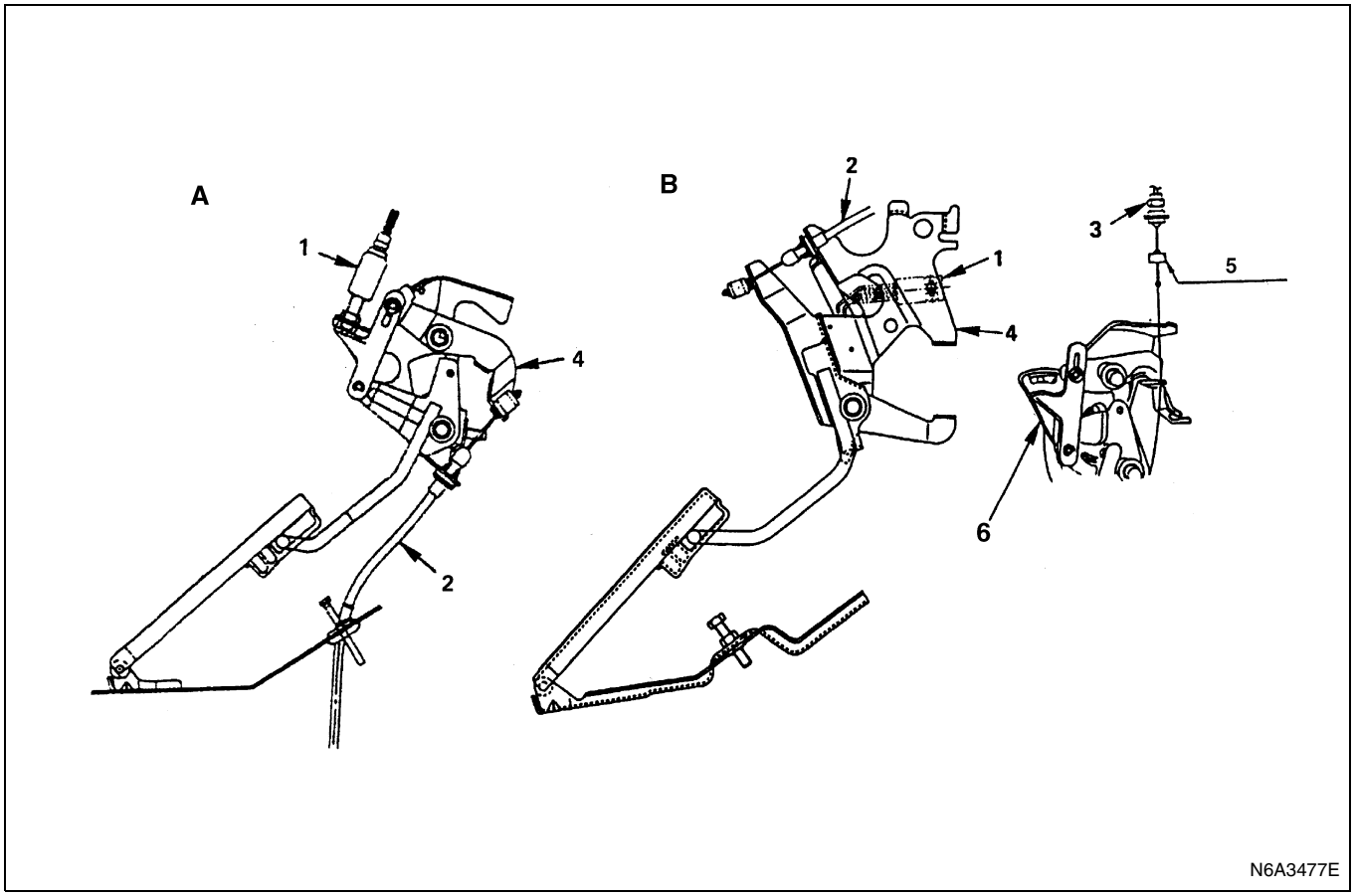
4. Lock Bolt
   - With the accelerator control lever attached to the stopper bolt, pull the cable lightly toward the front of the axis and fasten the cable bracket with the lock bolt.
   - Check to see if the injection pump lever is at the idle position (with the lever in touch with the stopper bolt).
   - Connect the battery ground cable.
   - Lower the cab.
   - Check to see if the accelerator pedal play is in the range of 5 — 10 mm above the pedal pad.
   - Press down on the accelerator pedal fully, and check to see if the engine rotates at the maximum speed with the linkage in the smooth operation.
   - In the operating range of the accelerator pedal, check to see if the accelerator pedal and the injection pump lever return without fail to their original positions respectively.

ACCELERATOR PEDAL

Component



Legend

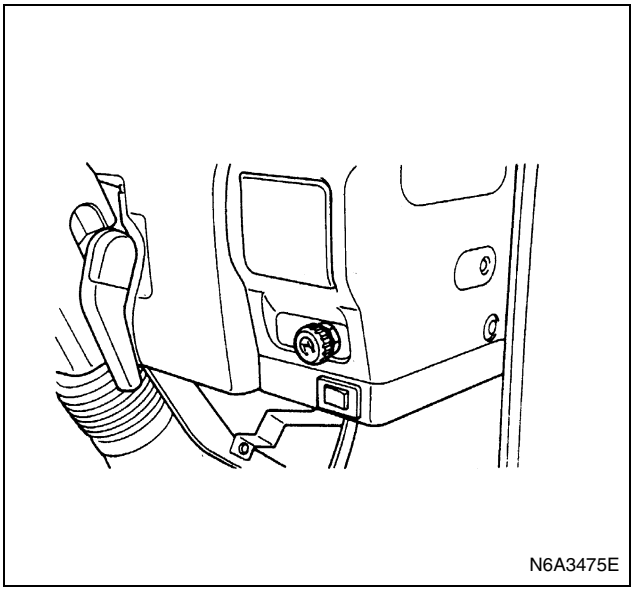
A. RHD
B. LHD
1. Idle switch connector
2. Accelerator control cable
3. Idling control cable
4. Accelerator pedal assembly
5. Wire guard
6. Accelerator pedal bracket

Removal

1. Idle Switch Connector
2. Accelerator Control Cable
   - Remove control cable from accelerator pedal bracket.
3. Idling Control Cable
   - Remove control cable from accelerator pedal bracket.
4. Accelerator Pedal Assembly
   - Remove accelerator pedal assembly from brake pedal bracket.

Installation

1. Accelerator Pedal Assembly
   - Apply the sliding section with grease, and install it to the brake pedal bracket.
2. Idling Control Cable
   - Install the cable to the lever of the accelerator pedal bracket.
3. Accelerator Control Cable
   - After confirming that the idling control knob is fully turned to the left, install the accelerator control cable.
4. Idle Switch Connector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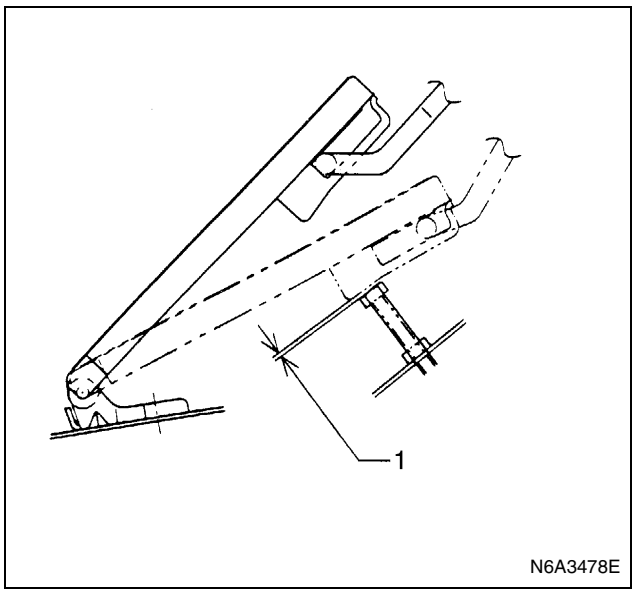
Adjustment of the Press-Down Amount of the Accelerator Pedal

- After installing each cable, give a full stroke to the accelerator pedal while pushing the accelerator pedal pad by hand.
- Adjust the stopper bolt so that the clearance between the pedal pad stopper bolt and the back of the pad becomes 0 — 2 mm (0 — 0.079 in), and tighten the lock nut to the specified torque.

Tighten:
7.4 N·m(0.75 kg·m/65 lb·ft)

- Check to see if the accelerator pedal play is in the range of 5 — 10 mm (0.2 — 0.4 in) above the pedal pad.
- Press down on the accelerator pedal fully, and check to see if the engine rotates at the maximum speed with the linkage in the smooth operation.
- In the operating range of the accelerator pedal, check to see if the accelerator pedal and the injection pump lever return without fail to their original positions respectively.

RHD



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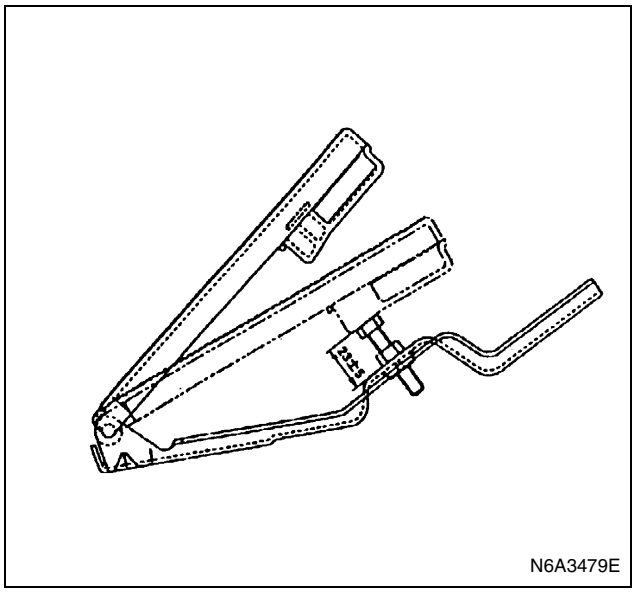
Legend
1. Full stroke 0 — 2 mm

LHD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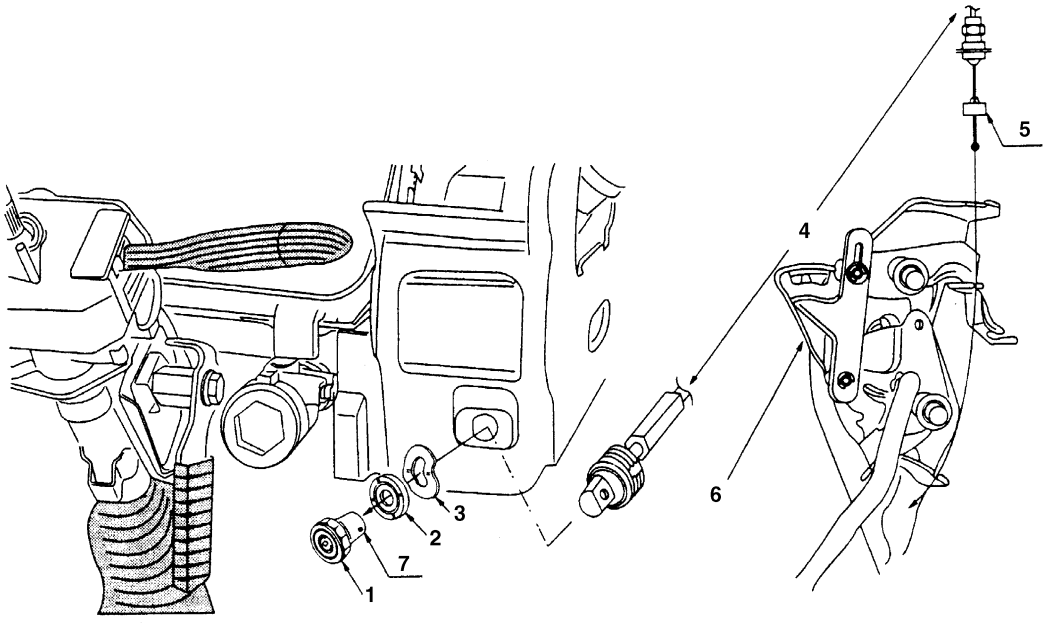
IDLING CONTROL CABLE

Component



N6A3480E

Legend

1. Idling control knob
2. Idling control cable nut
3. Wave washer
4. Idling control cable
5. Wire guide
6. Accelerator pedal bracket
7. Screw

Removal

1. Idling Control Knob
   - Loosen the idling control knob screw and remove the knob from cable.
2. Idling Control Cable Nut
3. Wave Washer
4. Idling Control Cable
   - Remove control cable from accelerator pedal bracket.

Inspection

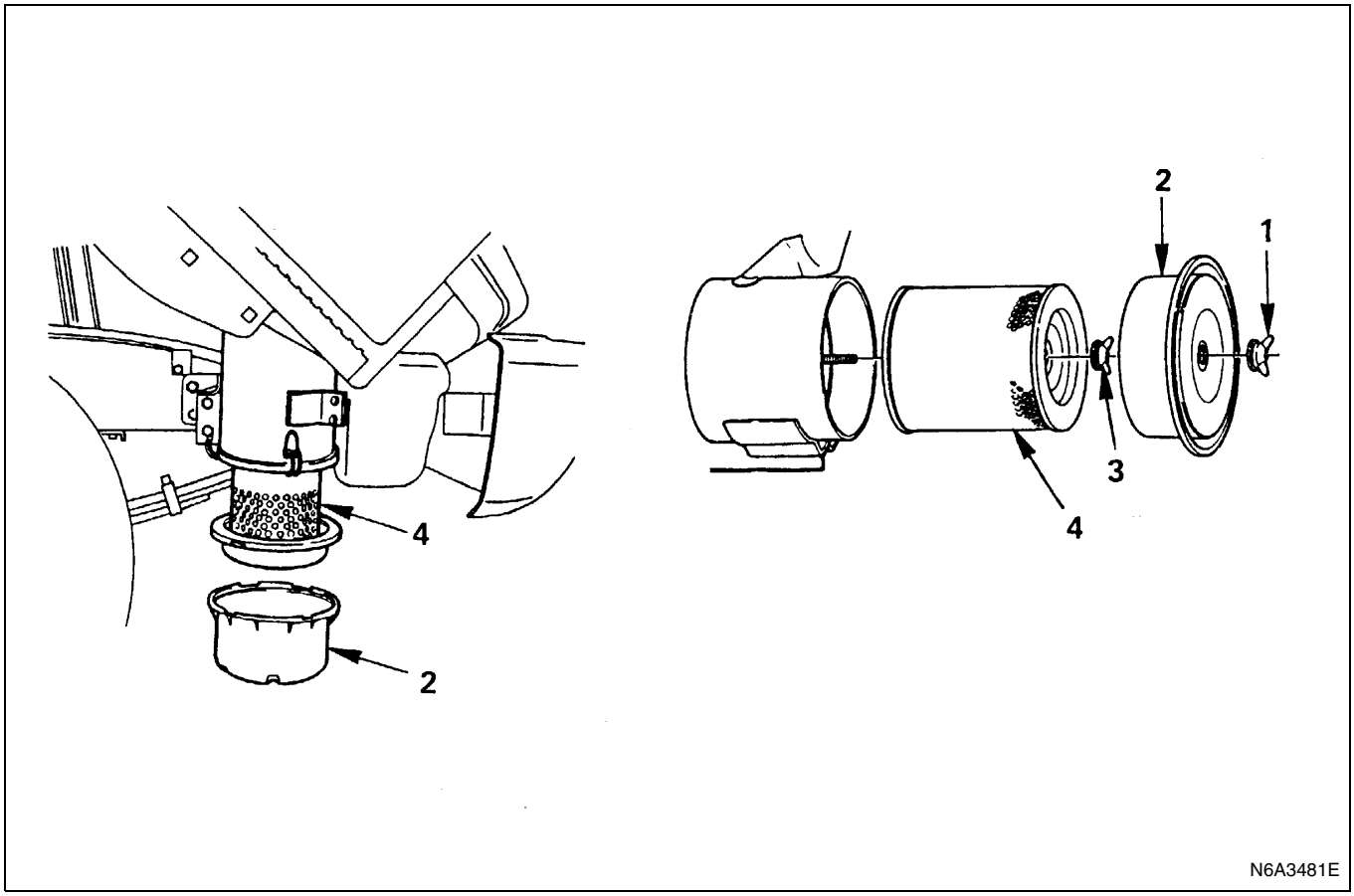
- With the idling control knob not in use, check to see if the injection pump lever is at the idle position (with the lever in contact with the stopper bolt).
- With the idling control knob turned fully to the right, check to see if the engine idles up to 1,500 rpm or more.

Installation

1. Idling Control Cable
   - Install control cable to accelerator pedal bracket.
2. Wave Washer
3. Idling Control Cable Nut
   - Insert the idling control cable into the specified hole of the instrument panel.
   - Install the washer to the cable, and tighten it with the nut.
4. Idling Control Knob
   - Insert the idling control knob into the cable, and tighten the screw.

AIR CLEANER ELEMENT

Component



Legend

1. Cover wing nut
2. End cover
3. Filter wing nut
4. Air cleaner element

Removal

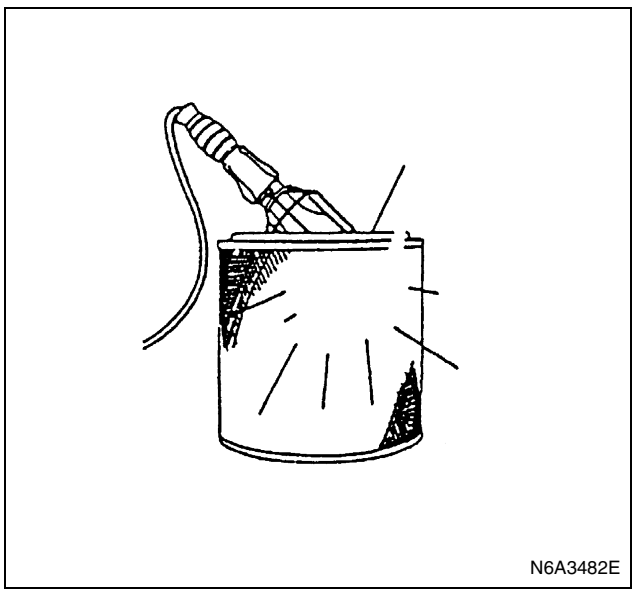
1. Cover Wing Nut
2. End Cover
3. Filter Wing Nut
4. Air Cleaner Element

Clean

- Wipe out the inside of the air cleaner assembly.
- Wipe off the cover.

Inspection

- The air filter with a light for fears or holes.



Cleaning Method
Dust Fouled Element
Rotate the element with your hand while applying compressed air to the inside of the element. This will blow the dust free.

Compressed air pressure	kPa (kg/cm^2 /psi)
392 — 490 (4 — 5/57 — 71)	

Caution:
Do not bang the element against another object in an attempt to clean it. Damage to the element will result.

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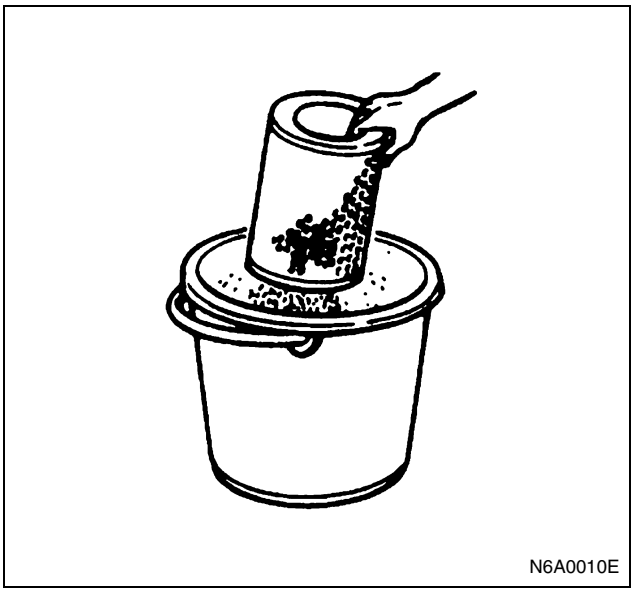
Carbon and Dust Fouled Element

1. Prepare a cleaning solution of Isuzu Genuine Element Cleaner (Donaldson D1400) diluted with water.
2. Submerge the element in the solution for twenty minutes.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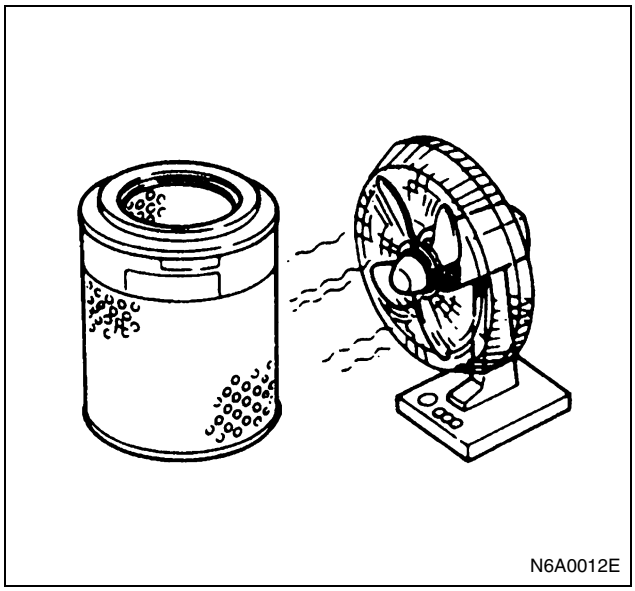
3. Remove the element from the solution and rinse it well with running water.
   Water pressure must not exceed 274 Kpa (2.8 kg/cm^2 /40 psi).

N6A0011E

4. Dry the element in a well ventilated area.
   An electric fan will hasten drying.

Notice:
Do not use compressed air or an open flame to dry the element quickly. Damage to the element will result. It will usually take two or three days for the element to dry completely. Therefore, it is a good idea to have a spare on hand to use in the interim.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Installation

1. Air Cleaner Element
2. Filter Wing Nut
3. End Cover
4. Cover Wing Nut

ENGINE 4J SERIES

SECTION 6D

ENGINE ELECTRICAL

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BATTERY

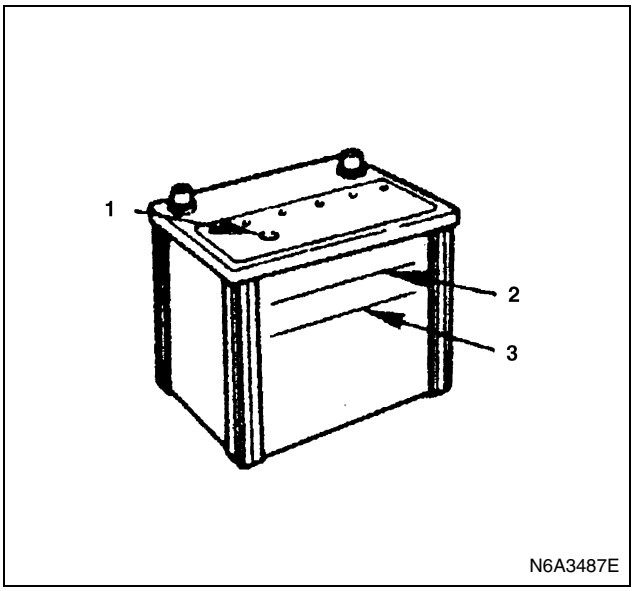
General Description

There are six battery fluid caps at the top of the battery. These are covered by a paper label.
The battery is completely sealed except for the six small vent holes at the side. these vent holes permit the escape of small amounts of gas generated by the battery. This type of battery has the following advantages over conventional batteries.

1. There is no need to add water during the entire service life of the battery.
2. The battery protects itself against overcharging.
   The battery will refuse to accept an excessive charge.
   (A conventional battery will accept an excessive charge, resulting in gassing and loss of battery fluid.)
3. The battery is much less vulnerable to self discharge than a conventional type battery.

Diagnosis

1. Visual Inspection
   Inspect the battery for obvious physical damage, such as a cracked or broken case, which would permit electrolyte loss.
   Replace the battery if obvious physical damage is discovered during inspection.
   Check for any other physical damage and correct it as necessary. If not, proceed to Step 2.
2. Fluid Level Check
   The fluid level should be between the upper level line and lower level line on side of the battery.
   a. Correct Fluid Level - Charge the battery.
   b. Below Lower Level - Replace battery.



Legend
1. Cherge test indicator
2. Upper level
3. Lower level

3. Voltage Check
   1) Put voltmeter test leads to battery terminals.
      a. Voltage is 12.4V or Above - Battery condition OK.
      b. Voltage is Under 12.4V - Go to procedure 2) below.
   2) Determine fast charge amperage from specification (See Main Data and Specifications in this section).
      Fast charge battery for 30 minutes at amperage rate no higher than specified value.
      Take voltage and amperage readings after charge.
      a. Voltage is Above 16V at Below 1/3 of Amperage Rate — Replace battery.
      b. Voltmeter is Above 16V at Above 1/3 of Amperage Rate — Drop charging voltage to 15V and charge for 10 — 15 hours.
      c. Voltage is Between 12V and 16V - Continue charging at the same rate for an additional 3 — 3.5 hours.
      d. Voltage is Below 12V — Replace battery.
4. Load Test
   1) Connect a voltmeter and a battery load tester across the battery terminals.
   2) Apply 300 ampere load for 15 seconds to remove surface charge from the battery.
      Remove load.
   3) Wait 15 seconds to let battery recover. Then apply specified load from specifications (See Main Data and Specifications in this section).
      Read voltage after 15 seconds, then remove load.
      a. Voltage does not Drop Below the Minimum Listed in Following Table - The battery is good and should be returned to service.
      b. Voltage is Less Than Minimum Listed - Replace battery.

Estimated Temperature		Minimum Voltage
°F	°C	Limit
70	21	9.6
60	16	9.5
50	10	9.4
40	4	9.3
30	-1	9.1
20	-7	8.9
10	-12	8.7
0	-18	8.5
The battery temperature must be estimated by atmosphere temperature and outside temperature (the battery has been exposed to for the preceding few hours).		

Battery Charging

Observe the following safety precautions when charging the battery:

1. Never attempt to charge the battery when the fluid level is below the lower level line on the side of the battery. In this case, the battery must be replaced.
2. Pay close attention to the battery during the charging procedure.
   Battery charging should be discontinued or the rate of charge reduced if the battery feels hot to the touch.
   Battery charging should be discontinued or the rate of charge reduced if the battery begins to gas or spew electrolyte from the vent holes.
3. In order to more easily view the hydrometer blue dot or ring, it may be necessary to jiggle or tilt the battery.
4. Battery temperature can have a great effect on battery charging capacity.
5. The sealed battery used on this vehicle may be either quick-charged or slow-charged in the same manner as other batteries.
   Whichever method you decide to use, be sure that you completely charge the battery. Never partially charge the battery.

Jump Starting

Jump Starting With an Auxiliary (Booster) Battery

Caution:
Never push or tow the vehicle in an attempt to start it.

Serious damage to the emission system as well as other vehicle parts will result.

Treat both the discharged battery and the booster battery with great care when using jumper cables.

Carefully follow the jump starting procedure, being careful at all times to avoid sparking.

WARNING:
FAILURE TO CAREFULLY FOLLOW THE JUMP STARTING PROCEDURE COULD RESULT IN THE FOLLOWING:

1. **SERIOUS PERSONAL INJURY, PARTICULARLY TO YOUR EYES.**
2. **PROPERTY DAMAGE FROM A BATTERY EXPLOSION, BATTERY ACID, OR AN ELECTRICAL FIRE.**
3. **DAMAGE TO THE ELECTRONIC COMPONENTS OF ONE OR BOTH VEHICLES PARTICULARLY.**

NEVER EXPOSE THE BATTERY TO AN OPEN FLAME OR ELECTRICAL SPARK. GAS GENERATED BY THE BATTERY MAY CATCH FIRE OR EXPLODE.

REMOVE ANY RINGS, WATCHES, OR OTHER JEWELRY BEFORE WORKING AROUND THE BATTERY. PROTECT YOUR EYES BY WEARING AN APPROVED SET OF GOGGLES.

NEVER ALLOW BATTERY FLUID TO COME IN CONTACT WITH YOUR EYES OR SKIN.

NEVER ALLOW BATTERY FLUID TO COME IN CONTACT WITH FABRICS OR PAINTED SURFACES.

BATTERY FLUID IS A HIGHLY CORROSIVE ACID.

SHOULD BATTERY FLUID COME IN CONTACT WITH YOUR EYES, SKIN, FABRIC, OR A PAINTED SURFACE, IMMEDIATELY AND THOROUGHLY RINSE THE AFFECTED AREA WITH CLEAN TAP WATER.

NEVER ALLOW METAL TOOLS OR JUMPER CABLES TO COME IN CONTACT WITH THE POSITIVE BATTERY TERMINAL, OR ANY OTHER METAL SURFACE OF THE VEHICLE. THIS WILL PROTECT AGAINST A SHORT CIRCUIT.

ALWAYS KEEP BATTERIES OUT OF THE REACH OF YOUNG CHILDREN.

Jump Starting Procedure

1. Set the vehicle parking brake.
   If the vehicle is equipped with an automatic transmission, place the selector lever in the “PARK” position.
   If the vehicle is equipped with a manual transmission place the shift lever in the “NEUTRAL” position.
   Turn “OFF” the ignition.
   Turn “OFF” all lights and any other accessory requiring electrical power.
2. Look at the built-in hydrometer.
   If the indication area of the built-in hydrometer is completely clear, do not try to jump start.
3. Attach the other end of the same cable to the positive terminal of the discharged battery.
   Attach the end of one jumper cable to the positive terminal of the booster battery.
   Do not allow the vehicles to touch each other.
   This will cause a ground connection, effectively neutralizing the charging procedure.
   Be sure that the booster battery has a 12 volt rating.
4. Attach one end of the remaining cable to the negative terminal of the booster battery.
   Attach the other end of the same cable to a solid engine ground (such as the A/C compressor bracket or the generator mounting bracket) of the vehicle with the discharged battery.
   This ground connection must be at least 450 mm (18 in) from the battery of the vehicle whose battery is being charged.

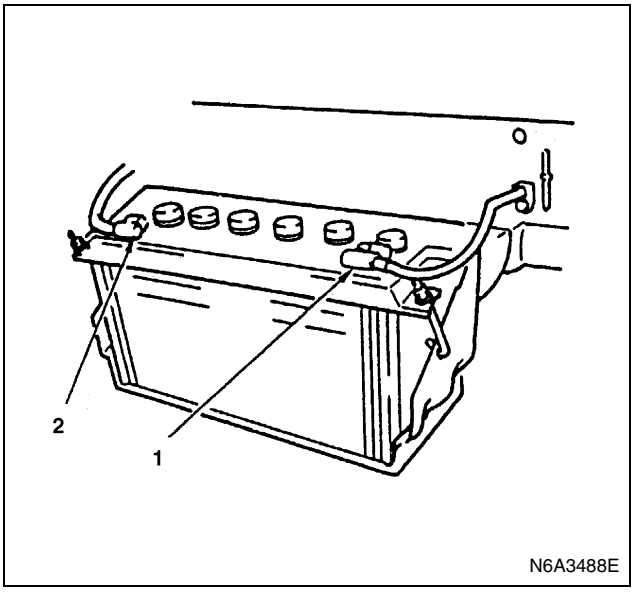
WARNING:
NEVER ATTACH THE END OF THE JUMPER CABLE DIRECTLY TO THE NEGATIVE TERMINAL OF THE DEAD BATTERY.

5. Start the engine of the vehicle with the good battery.
   Make sure that all unnecessary electrical accessories have been turned “OFF”.
6. Start the engine of the vehicle with the dead battery.
7. To remove the jumper cables, follow the above directions in the reverse order.
   Be sure to first disconnect the negative cable from the vehicle with the discharged battery.

Removal and Installation of the Battery

Removal

1. All switches should be in the “OFF” position.
2. Disconnect the battery ground cable. (1)
3. Disconnect the battery positive cable. (2)
4. Disconnect the battery cable.



Caution:
It is important that the battery ground cable be disconnected first.
Disconnecting the battery positive cable first can result in a short circuit.

Installation

To install the battery, follow the removal procedure in the reverse order, noting the following points:

1. Make sure that the rod is hooked on the body side.

Main Data and Specifications

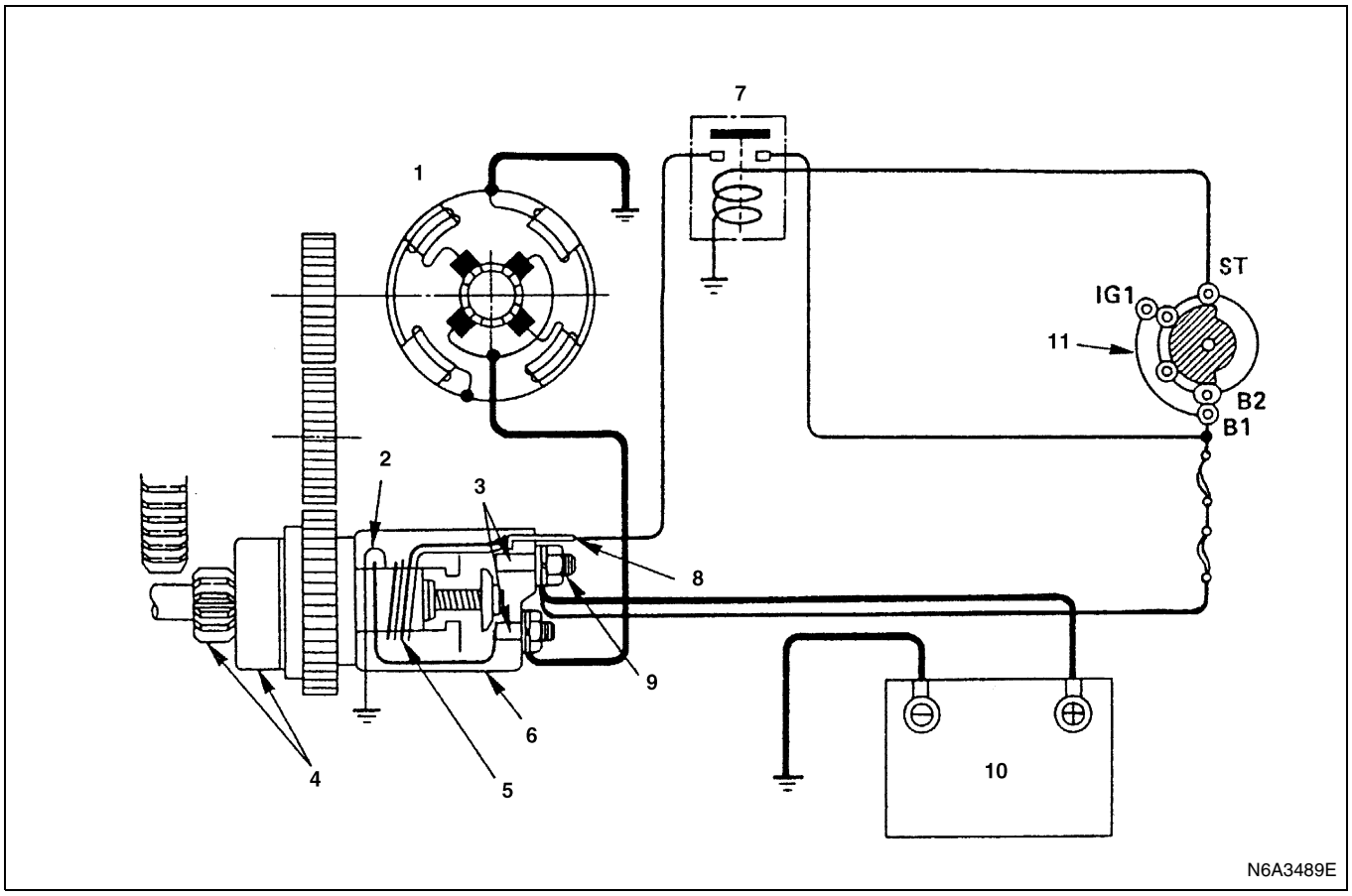
Model	(JIS)	115E41R-MF	130E41R-MF	95D31R-MF	80D26R-MF
Voltage	(V)	12	12	12	12
Cold-Cranking Performance	(Amp)	651	799	622	582
Reserve Capacity	(Min)	212	229	159	133
Load Test	(Amp)	325	400	310	290
Fast Charge Maximum Amperage	(Amp)	20	20	20	20
BCI Group No.		—	—	27	24
Overall Dimension L×W×H	(mm)	410×178×213	410×178×213	—	—

STARTING SYSTEM

General Description

Starting Circuit

The cranking system consists of a battery, starter, starter switch, starter relay, etc. and these main components are connected as shown in Figure. For details of the starting circuit.



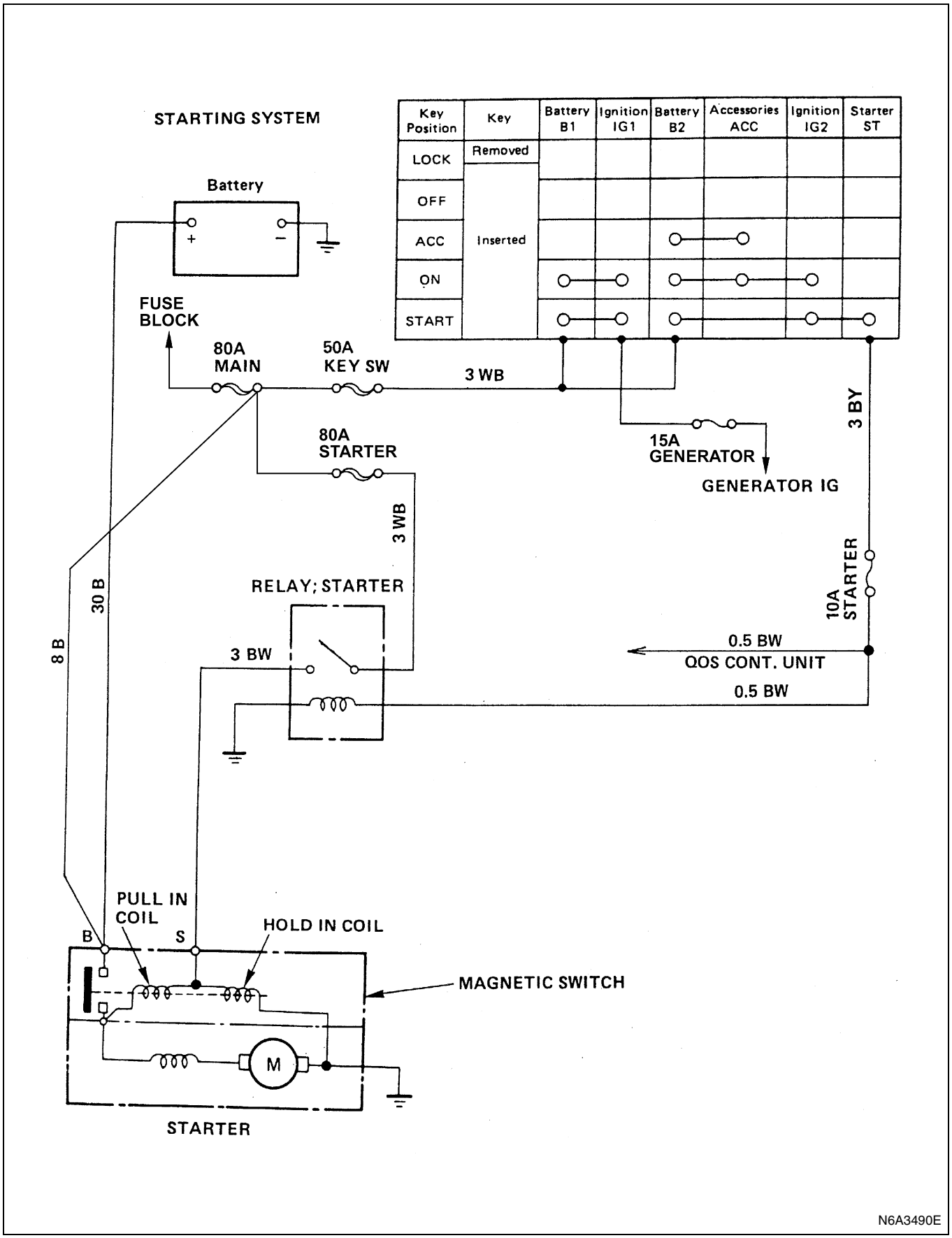
Legend

1. Starter motor
2. Hold coil
3. Contacts
4. Pinion clutch
5. Pull in coil
6. Mognetic switch
7. Relay; starter
8. “50” terminal
9. “30” terminal
10. Battery
11. Starter switch

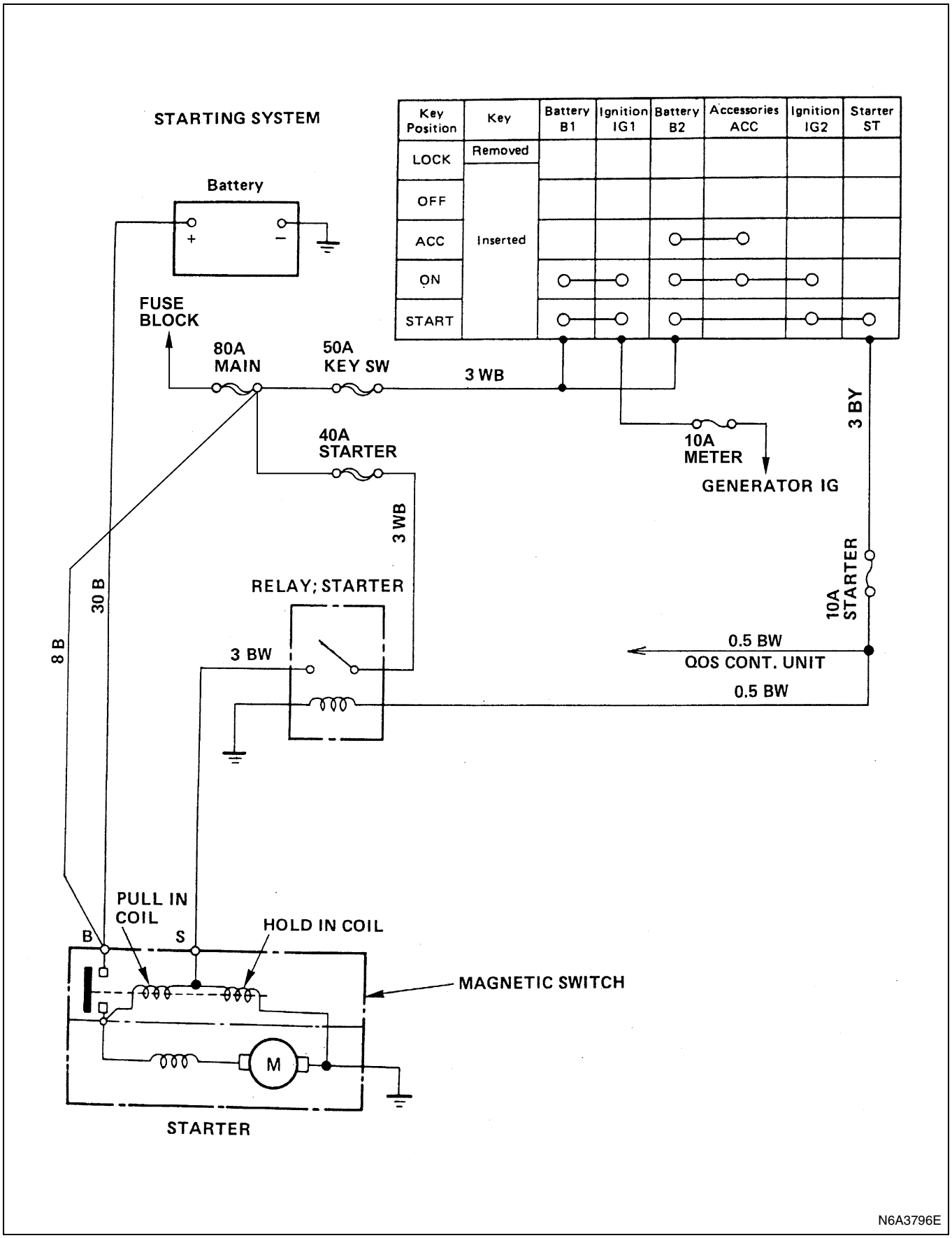
Starter

The starting system employs a magnetic type reduction starter in which the motor shaft is also used as a pinion shaft. When the starter switch is turned on, the contacts of magnetic switch are closed, and the armature rotates.
At the same time, the plunger is attracted, and the pinion is pushed forward by the shift lever to mesh with ring gear. Then, the ring gear runs to start the engine. When the engine starts and the starter switch is turned off, the plunger returns, the pinion is disengaged from ring gear, and the armature stops rotation. When the engine speed is higher than the pinion, the pinion idles, so that the armature is not driven.

Starting Circuit
For 4JB1, 4JB1-TC

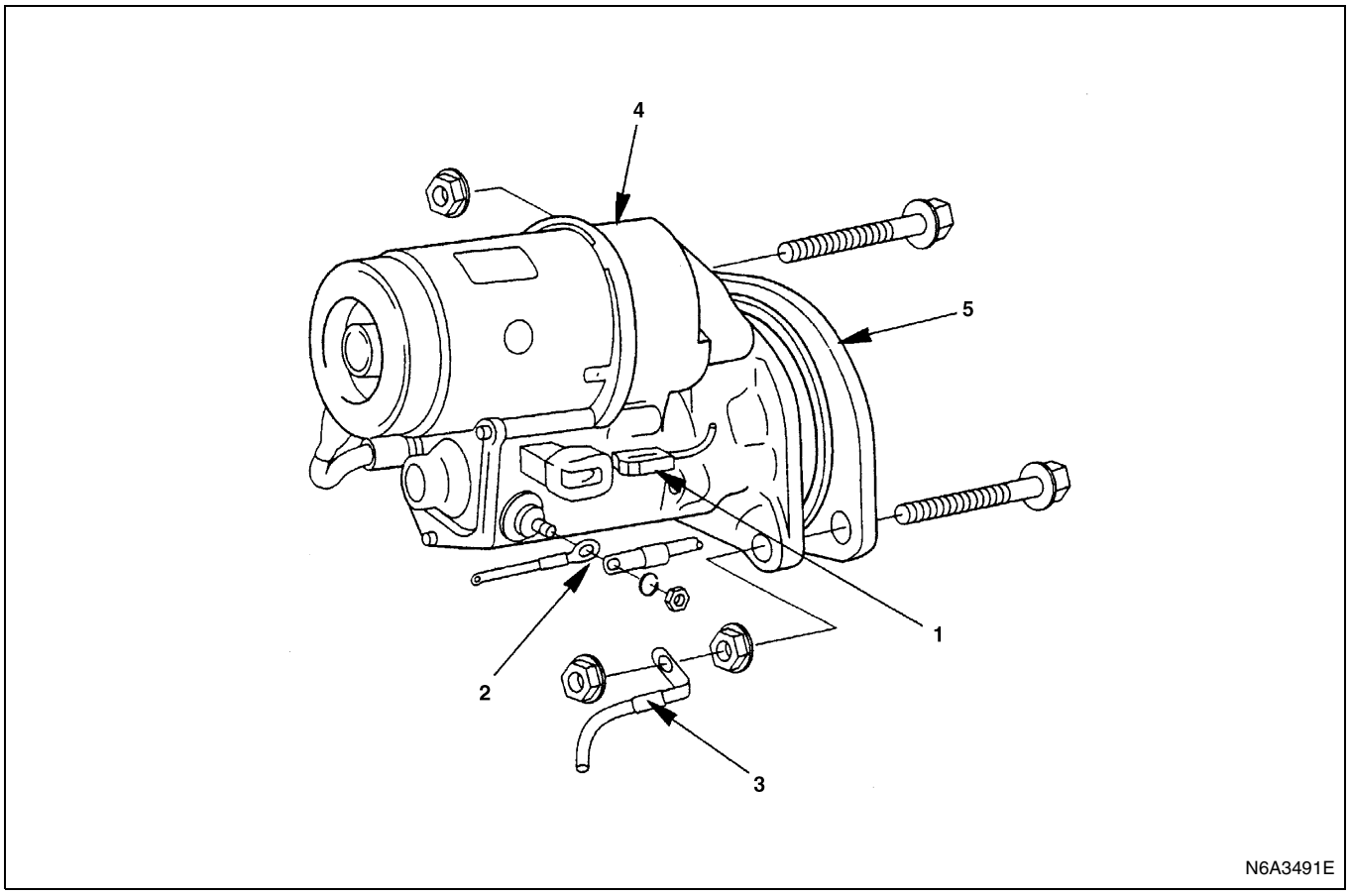


Starting Circuit
For 4JH1



On-Vehicle Service

Component



Legend

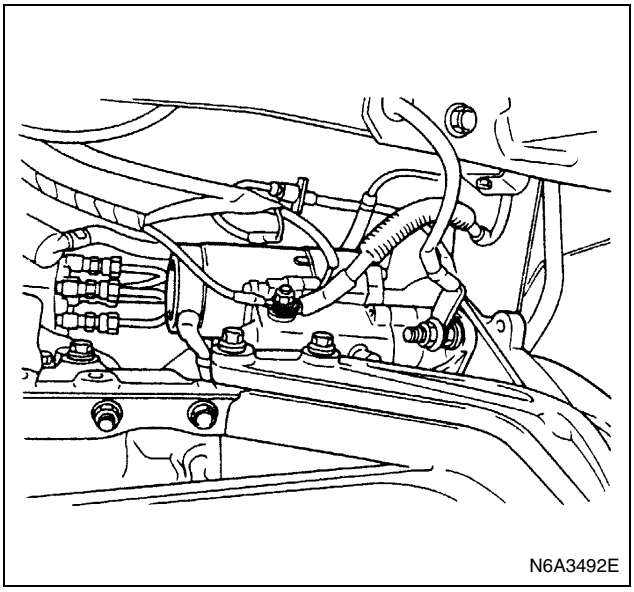
1. 50 terminal
2. 30 terminal
3. Earth cable terminal
4. Starter assembly
5. Spacer (4JB1, except cold area)

Removal

Preparation

- Disconnect Battery Ground Cable.

1. “50” Terminal
2. “30” Terminal
3. Earth Cable Terminal
4. Starter Assembly
5. Spacer (4JB1, Except cold area)



Installation

1. Spacer (4JB1, Except cold area)
2. Starter Assembly
   - Tighten the fixing bolt and nut to the specified torque

Tighten:
Starter Bolts and Nuts to 81 N·m (8.3 Kg·m/60 lb·ft)

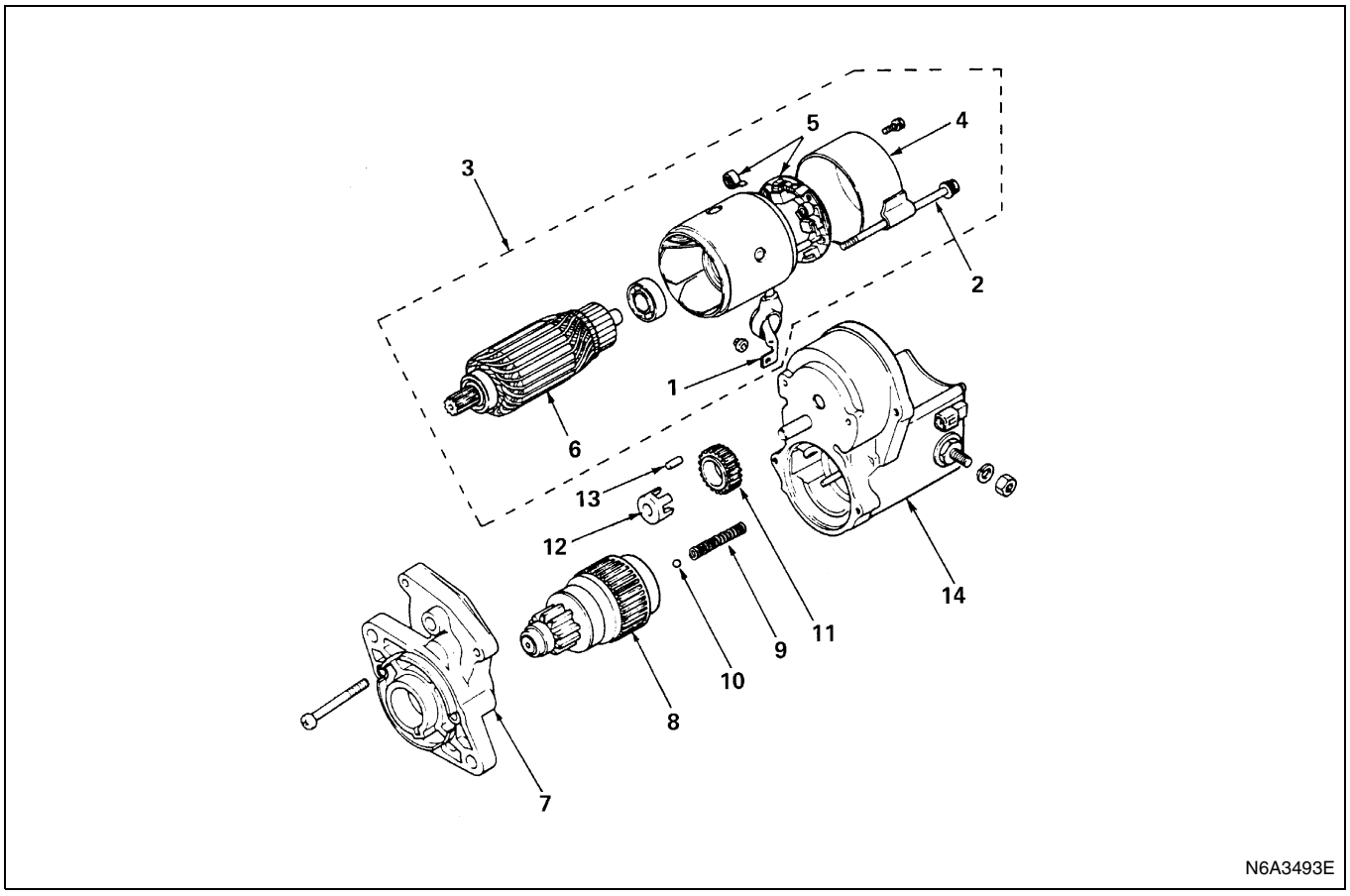
3. Earth Cable Terminal
   - Connect the earth cable terminal.
4. “30” Terminal
   - Connect the harness connector.
5. “50” Terminal
   - Connect the battery cable terminal with starter switch harness terminal, then tighten nut to the specified torque.

Tighten:
Fixing Nut to 9 N·m (0.9 Kg·m/78 lb·in)

   - Connect the battery cable.

Unit Repair

Component

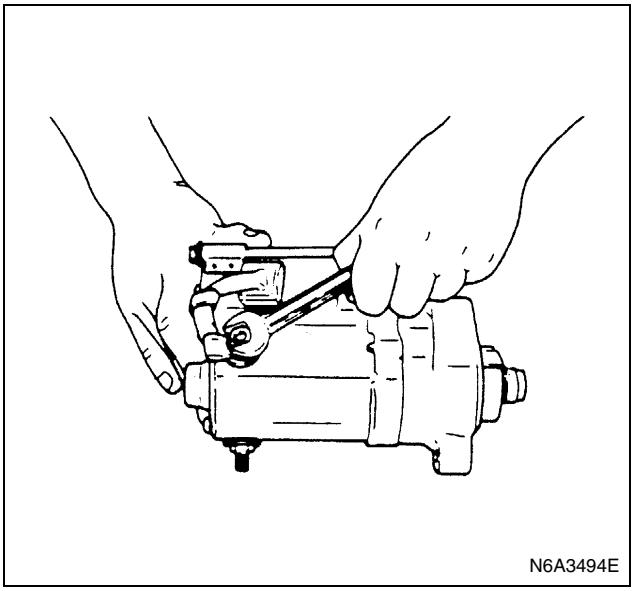


Legend

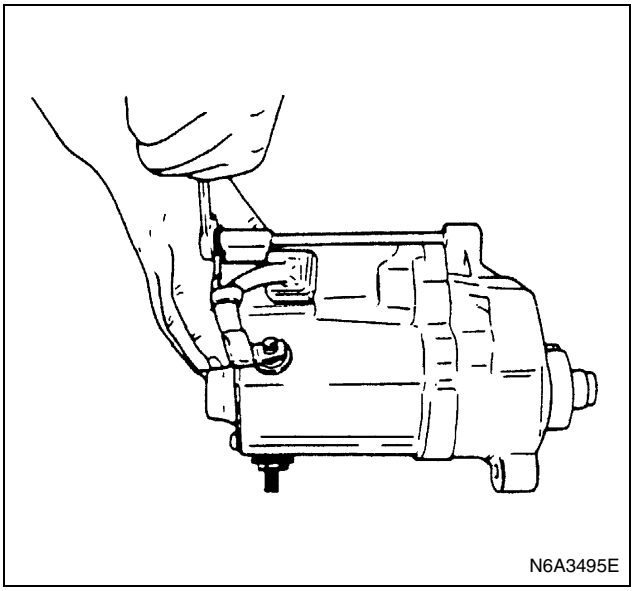
1. Lead wire
2. Through bolt
3. Yoke assembly
4. Cover yoke
5. Brush and brush holder
6. Armature
7. Drive side housing
8. Overrunning clutch
9. Return spring
10. Steel ball
11. Idle pinion
12. Retainer
13. Roller
14. Magnetic switch

Disassembly

1. Lead Wire
   Disconnect the lead wire from the magnetic switch.


N6A3494E

2. Through Bolt
   Remove the through bolts from the yoke.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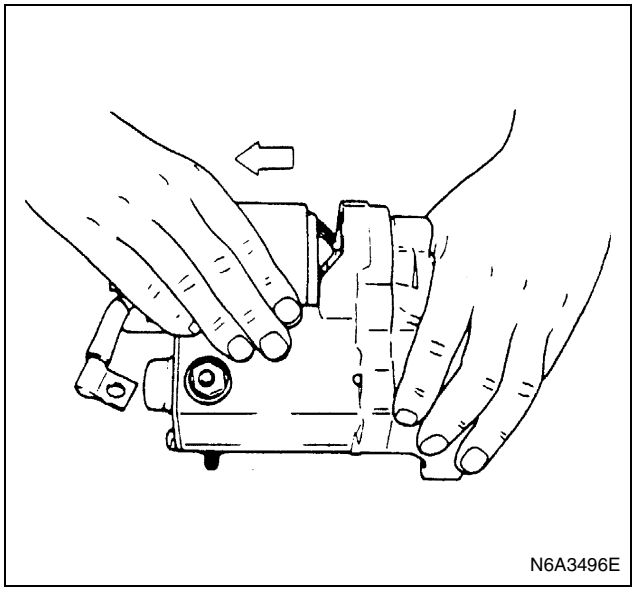
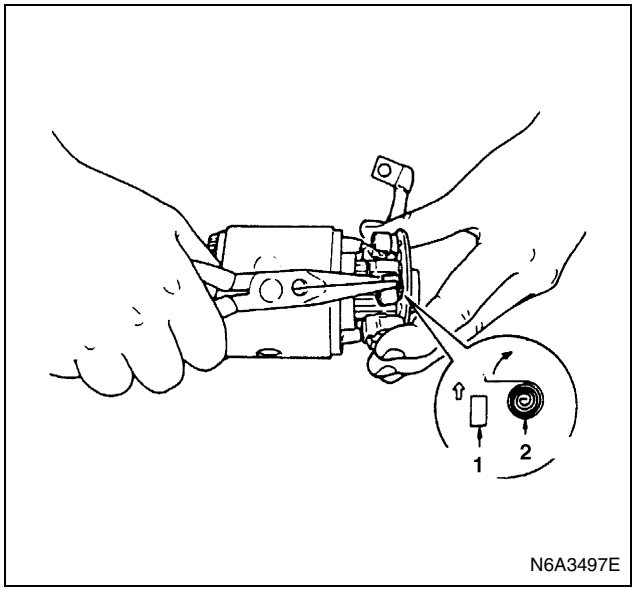
3. Yoke Assembly
   Separate the yoke from the solenoid switch.
4. Yoke Cover


N6A3496E

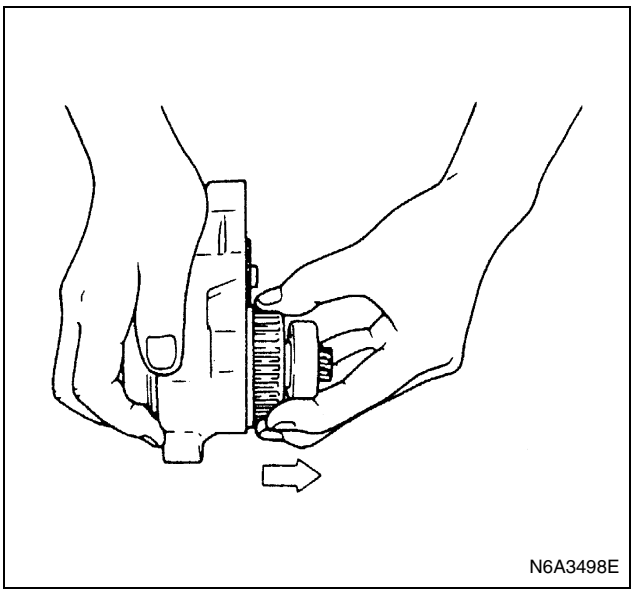
5. Brush and Brush Holder
   Remove (pull out) the brushes and the brush holder from the armature with a pair of long-nose pliers.



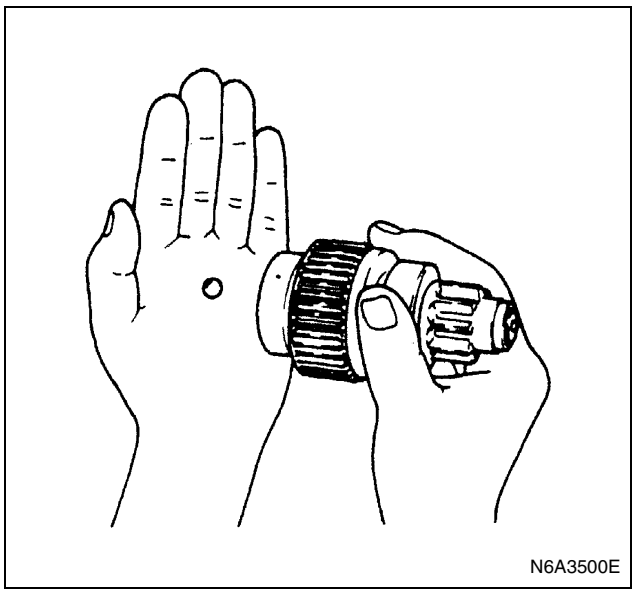
N6A3497E

Legend
1. Bush
2. Spring

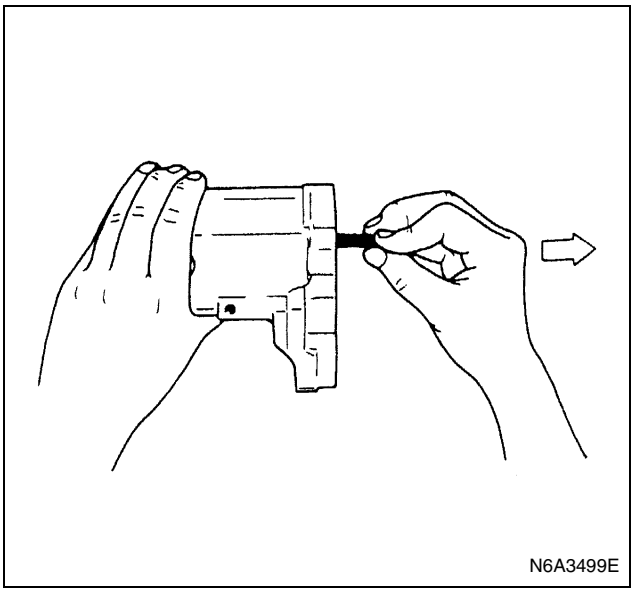
6. Armature
7. Drive Side Housing
8. Overrunning Clutch
   Remove the overrunning clutch from the housing.



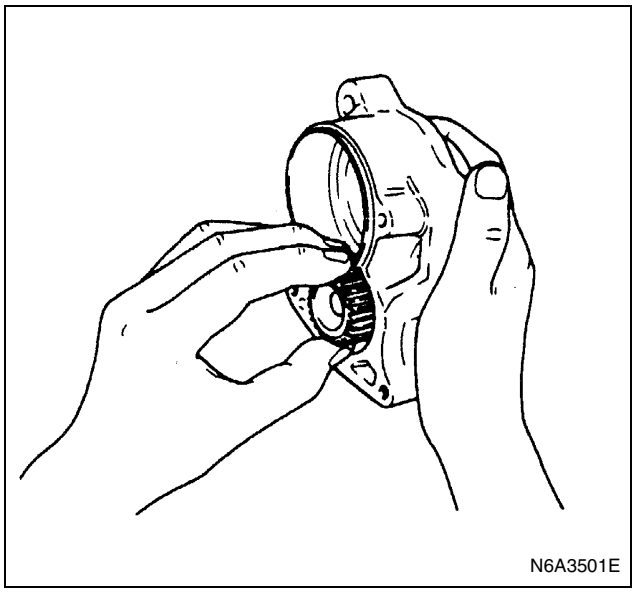
9. Return Spring
   Remove the return spring from magnetic switch.



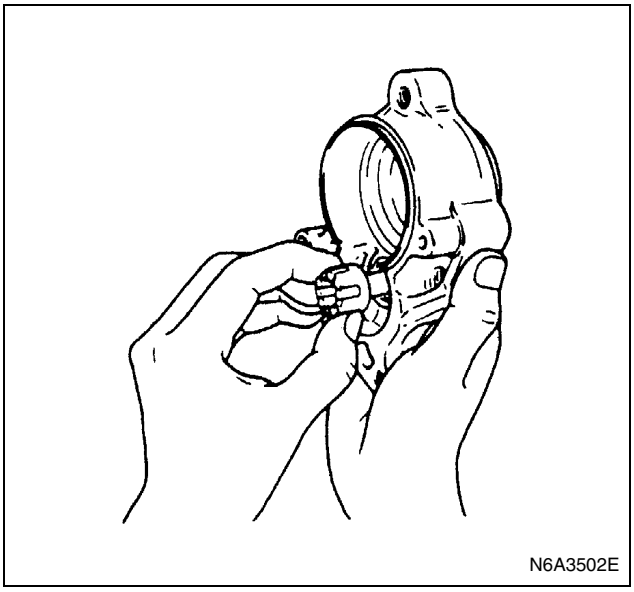
11. Idle Pinion
    Remove the idle pinion from housing.



10. Steel Ball
    Remove the steel ball from the overrunning clutch.



12. Retainer
    Remove the retainer from housing.


N6A3502E

13. Roller
14. Magnetic Switch

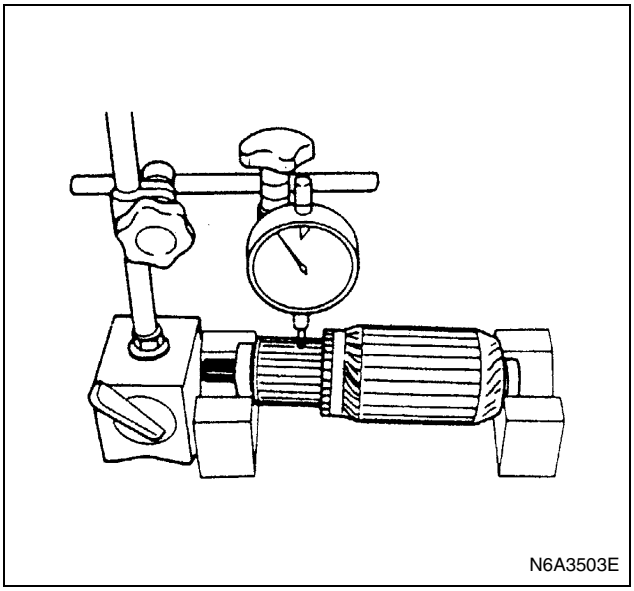
Inspection and Repair

Make necessary correction or parts replacement if wear, damage or any other abnormal condition are found through inspection.

Armature

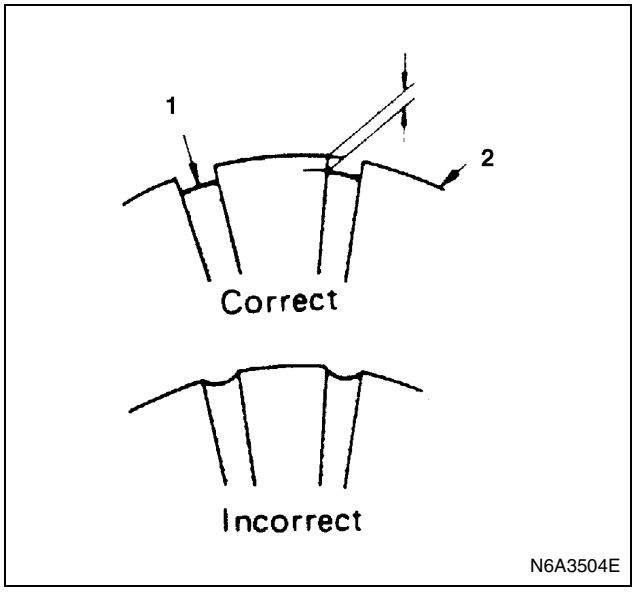
Check the commutator for run-out and replace if the amount of run-out exceeds the limit.

Run-out test		mm (in)
kw	Standard	Limit
2.2	0.02 (0.0008)	0.05 (0.0020)
2.0		


N6A3503E

Check the mica segment for wear.

Depth of mica segment		mm (in)
kw	Standard	Limit
2.2	0.7 — 0.9 (0.028 — 0.035)	0.20 (0.008)
2.0		



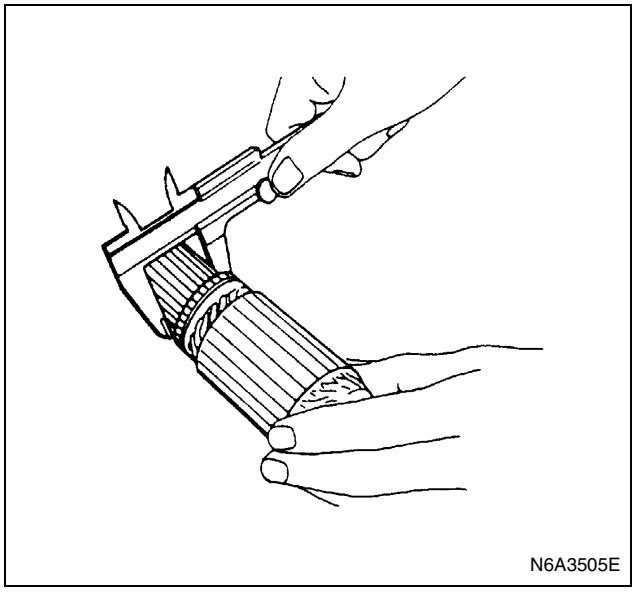
N6A3504E

Legend

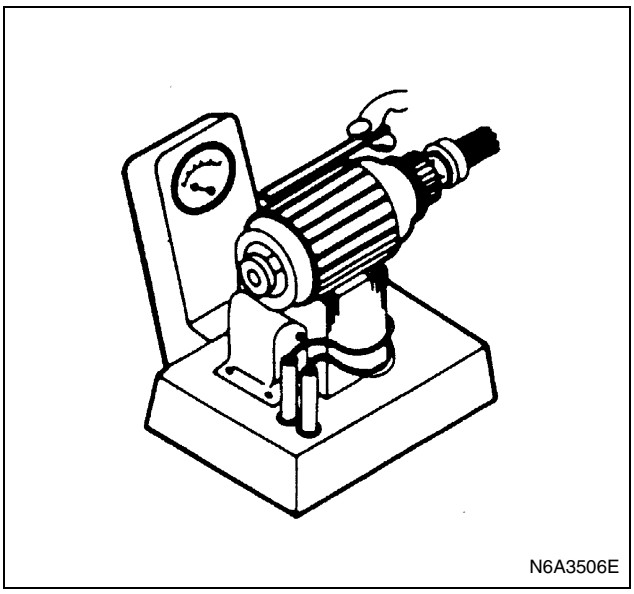
1. Insulator
2. Commutator segments

Check the commutator outer diameter.

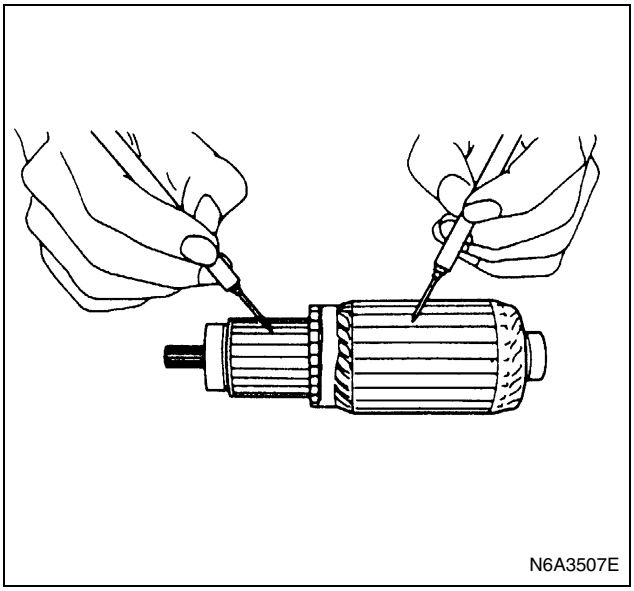
Commutator outer diameter		mm (in)
kw	Standard	Limit
2.2	35.00 (1.378)	34.00 (1.339)
2.0		


N6A3505E

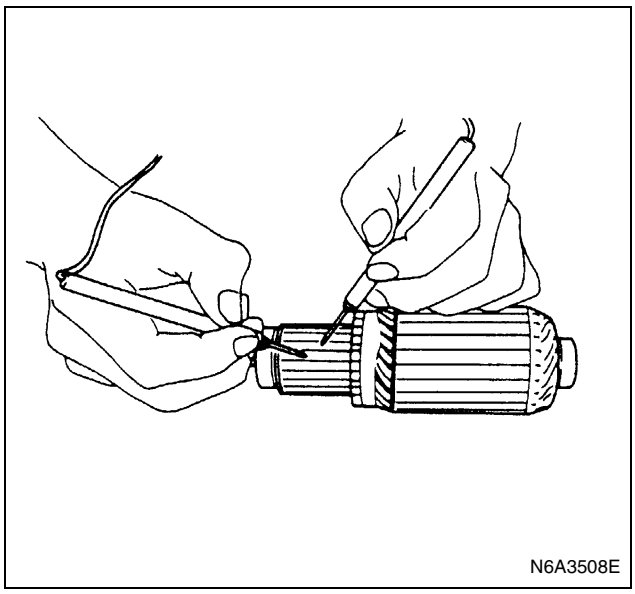
Armature Short Circuit Test
Check the armature for short circuit by placing it on a growler tester. Hold a piece of hacksaw blade against the armature core while slowly rotating the armature. A short-circuited armature will cause the blade to vibrate and to be attracted by the core. If the hacksaw blade is attracted or vibrates, the armature, is short circuited, and must be replaced.


N6A3506E

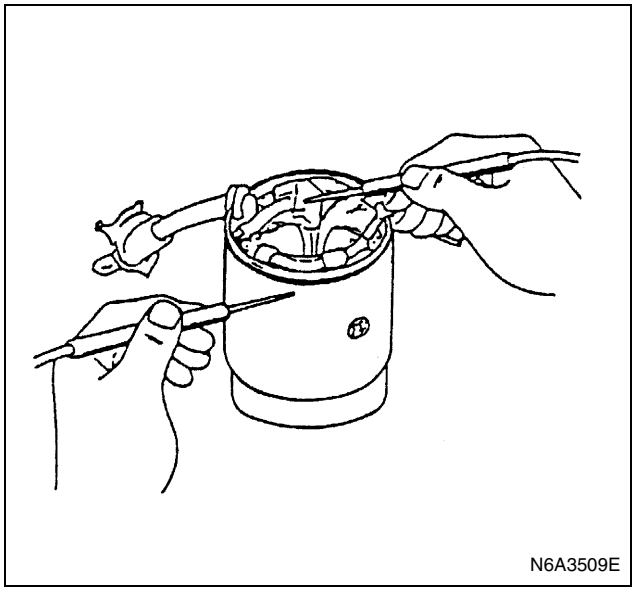
Armature Ground Test
Touch one probe of a circuit tester to the commutator segment and the other to the armature core. There should be no continuity. If there is a continuity, the armature is grounded. Replace the armature if it is grounded.


N6A3507E

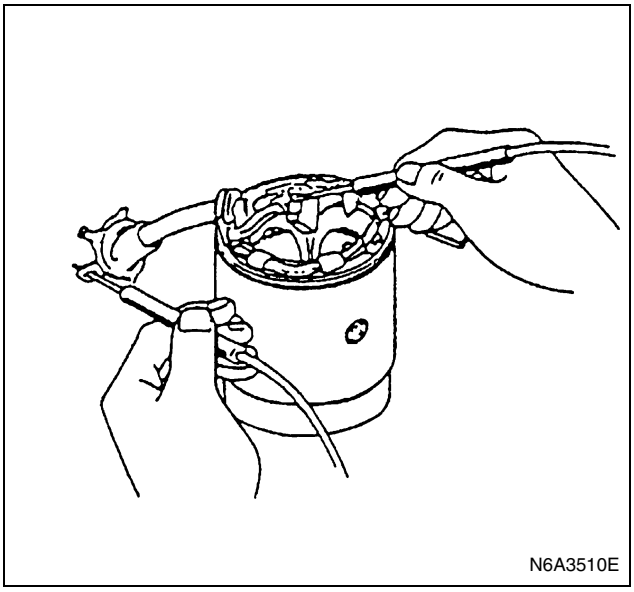
Armature Continuity Test
Connect the probes of a circuit tester across the 2 segments. There should be continuity at any test points. Replace if it is open-circuited.


N6A3508E

Yoke
Field Winding Ground Test
Using circuit tester, touch one probe to the field winding end or brush and the other to the bare surface of yoke body.
There should be no continuity. If the tester indicates a continuity, the field coil is grounded and yoke assembly should be replaced.

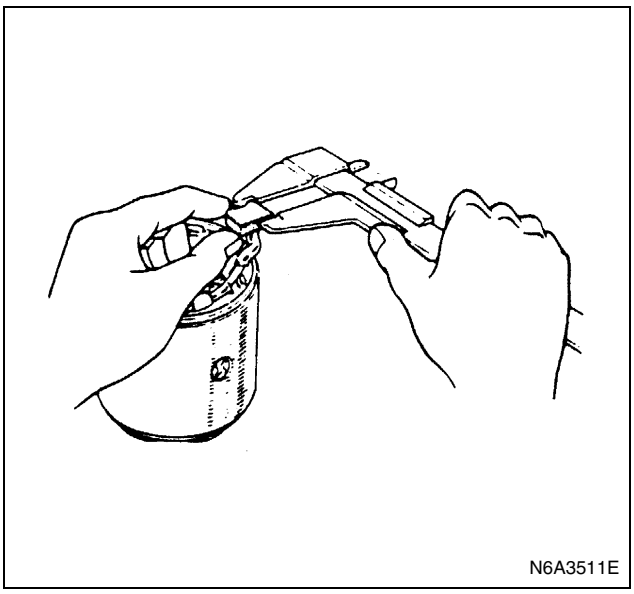

N6A3509E

Field Winding Continuity Test
Using a circuit tester, touch one probe to the “C” terminal lead wire and the other to the brush. There should be continuity. Replace the yoke if it is open.

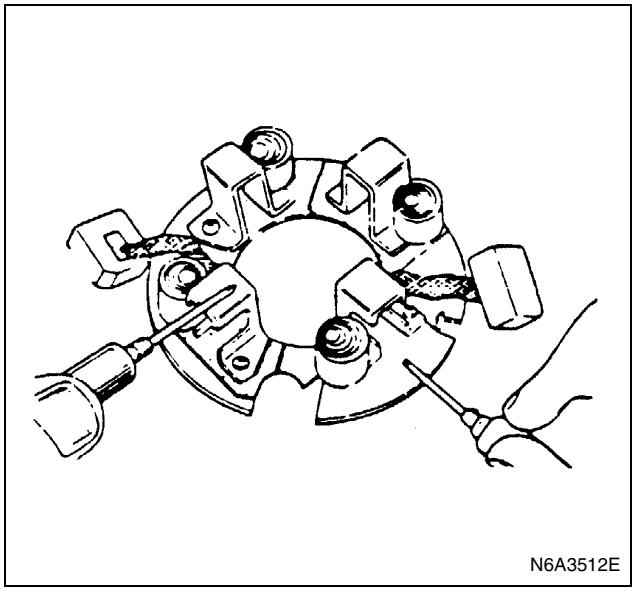

N6A3510E

Brush and Brush Holder
Measure the brush length and replace if it is worn beyond the service limit.

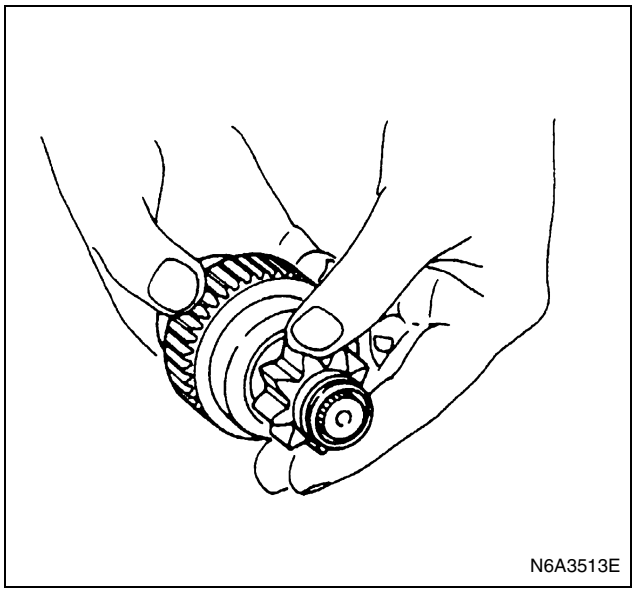
Brush length		mm (in)
kw	Standard	Limit
2.2	14.5 (0.57)	10 (0.39)
2.0	16 (0.63)	


N6A3511E

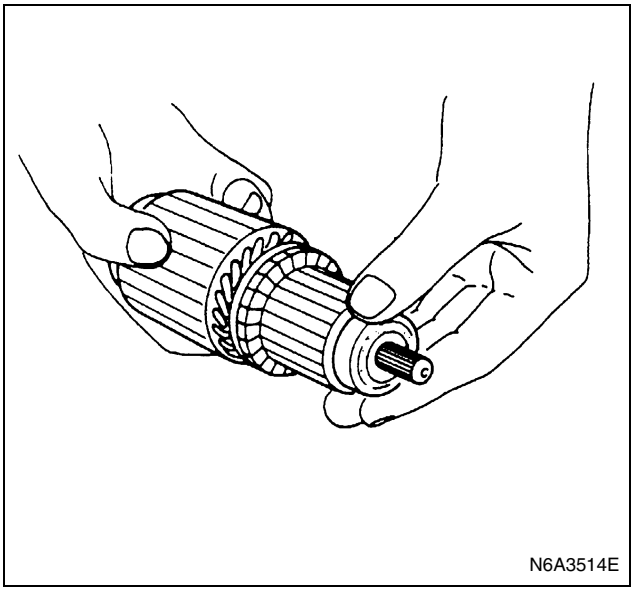
Brush Holder Insulation Test
Using a circuit tester, check the brush holder insulation. Touch one probe to the holder plate and the other to the positive brush holder. There should be no continuity.


N6A3512E

Overrunning Clutch
Inspect the teeth of pinion for wear and damage. Replace if it damaged.
Rotate the pinion in direction of rotation (clockwise). It should rotate smoothly. But in opposite direction, it should be locked.


N6A3513E

Bearing
Check the bearings for wear and damage. If the bearings are noisy during operation, they should be replaced.


N6A3514E

Reassembly

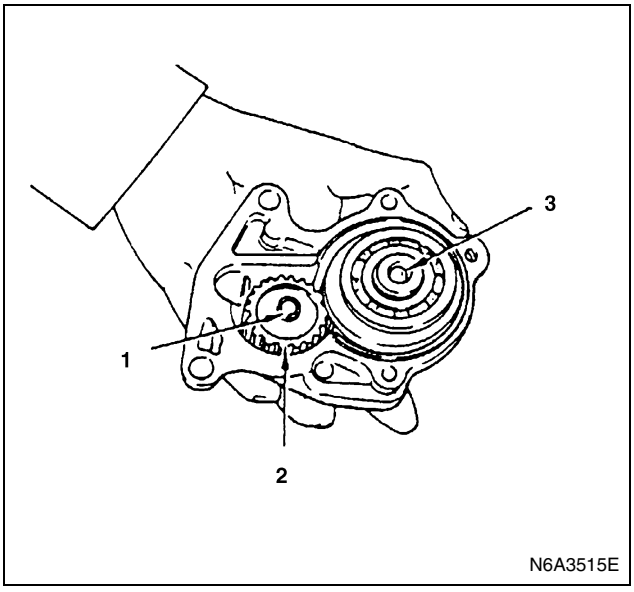
To install, follow the removal steps in the reverse order, noting the following points:

- Magnetic Switch
- Idle Gear
- Clutch assembly
- Housing

1. Install the clutch asm to the magnetic switch.
2. Install the idle gear and housing.

Notice:
Do not fail to assemble the steel ball and the spring between the clutch and magnetic switch.

Assemble the roller to the idle gear in advance.

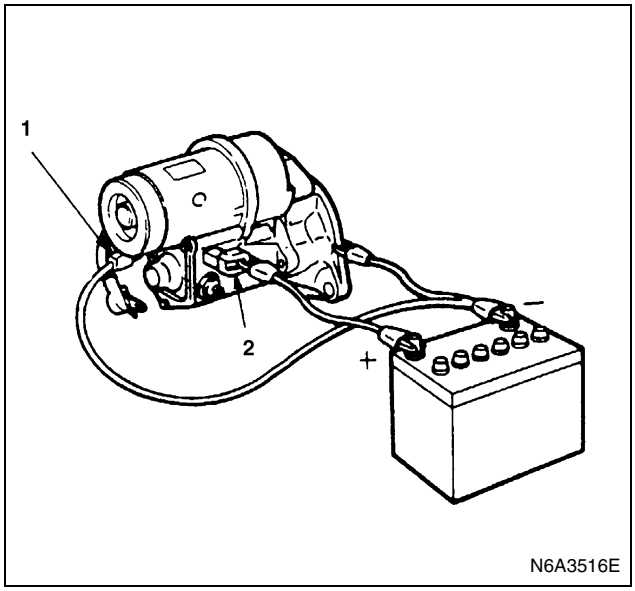


N6A3515E

Legend
1. Roller
2. Idle gear
3. Steel ball

Magnetic Switch
Temporarily connect the solenoid switch between the clutch and the housing and run the following tests.
Complete each test within three to five seconds.

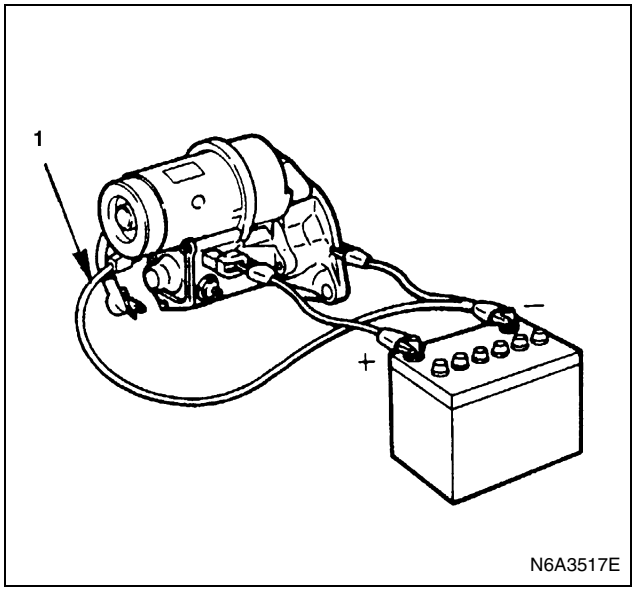
1. Pull-in test
   Connect the battery negative terminal with the solenoid switch body and the M terminal. When current is applied to the 50 terminal from the battery positive terminal, the pinion should flutter.



N6A3516E

Legend
1. M terminal
2. 50 terminal

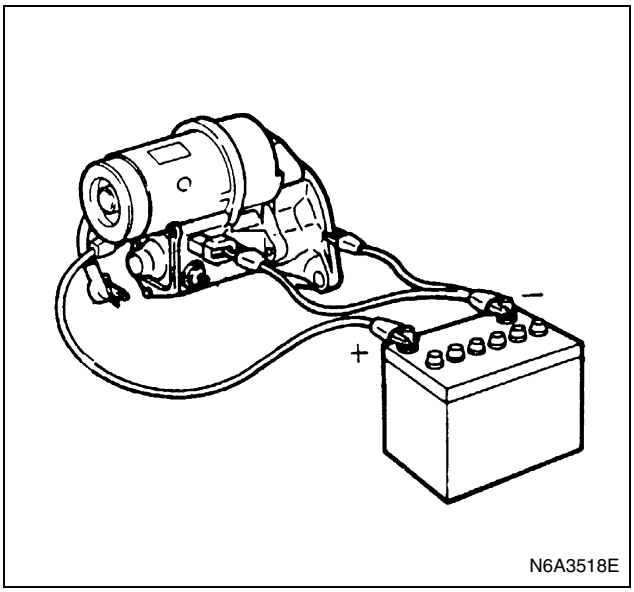
2. Hold-in test
   Disconnect the lead at the M terminal. The pinion should continue to flutter.



N6A3517E

Legend
1. Disconnect

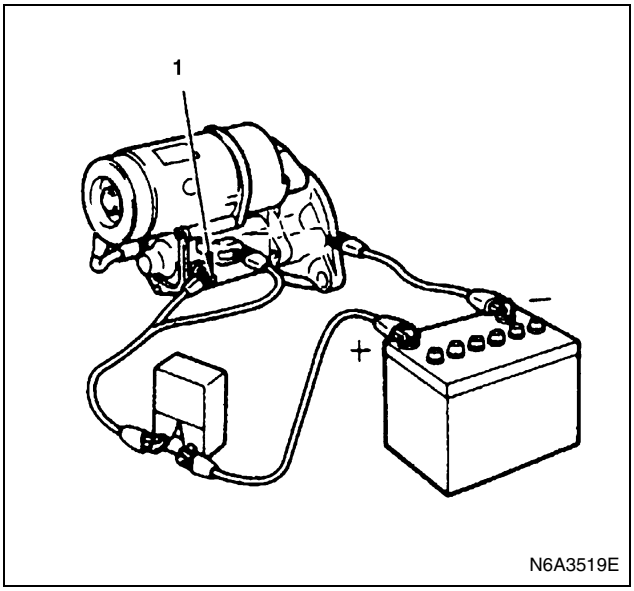
3. Return test
   Connect the battery negative terminal to the 50 terminal and the body. Connect the battery positive terminal to the M terminal. The pinion will flutter. When the lead to the 50 terminal is disconnected, the pinion should immediately return to its stationary positions.



4. Current value
   - Make connections as shown in the illustration, and measure the current value.

Standard = 120 A or less

Notice:
For a battery, be sure to use one fully charged.
For lead wires, use thick ones since a large amount of current flows through them.



Legend
1. 30 terminal

CHARGING SYSTEM

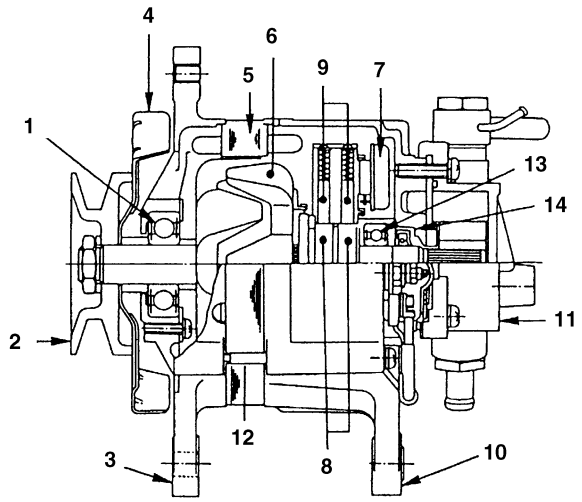
General Description

The charging system is the IC integral regulator charging system and its main components are connected as shown in Figure.

The regulator is a solid state type and it is mounted along with the brush holder assembly inside the generator installed on the rear end cover.

The generator does not require particular maintenance such as voltage adjustment. The rectifier connected to the stators coil has nine diodes to transform A.C. voltage into D.C. voltage. This D.C. voltage is connected to the output terminal of generator.

Generator (12V-50A)



N6A3521E

Legend

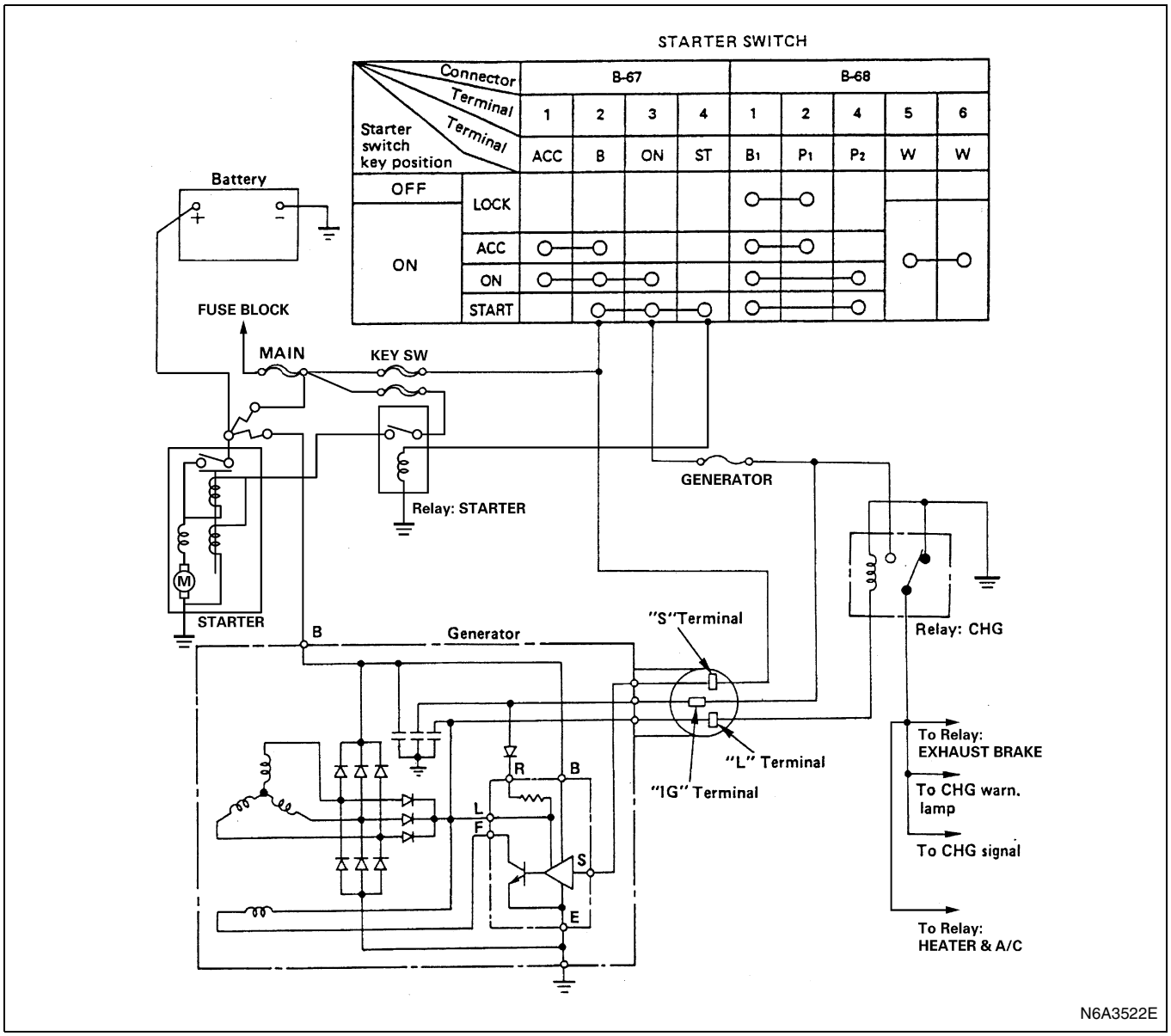
1. Ball bearing
2. Pulley
3. Front cover
4. Fan
5. Stator
6. Rotor
7. IC regulator
8. Slip ring
9. Brush
10. Rear cover
11. Vacuum pump
12. Through bolt
13. Ball bearing
14. Oil seal

Diagnosis

General On-Vehicle Inspection

The operating condition of charging system is indicated by the charge warning lamp. The warning lamp comes on when the starter switch is turned on “ON” position. The charging system operates normally if the lamp goes off when the engine starts. If the warning lamp shows abnormality or if undercharged or overcharged battery condition is suspected, perform diagnosis by checking the charging system as follows:

For 4JB1, 4JB1-TC



1. Check visually the belt and wiring connector.
2. With the engine in stop status, turn the starter switch to “ON” position and observe the warning lamp.

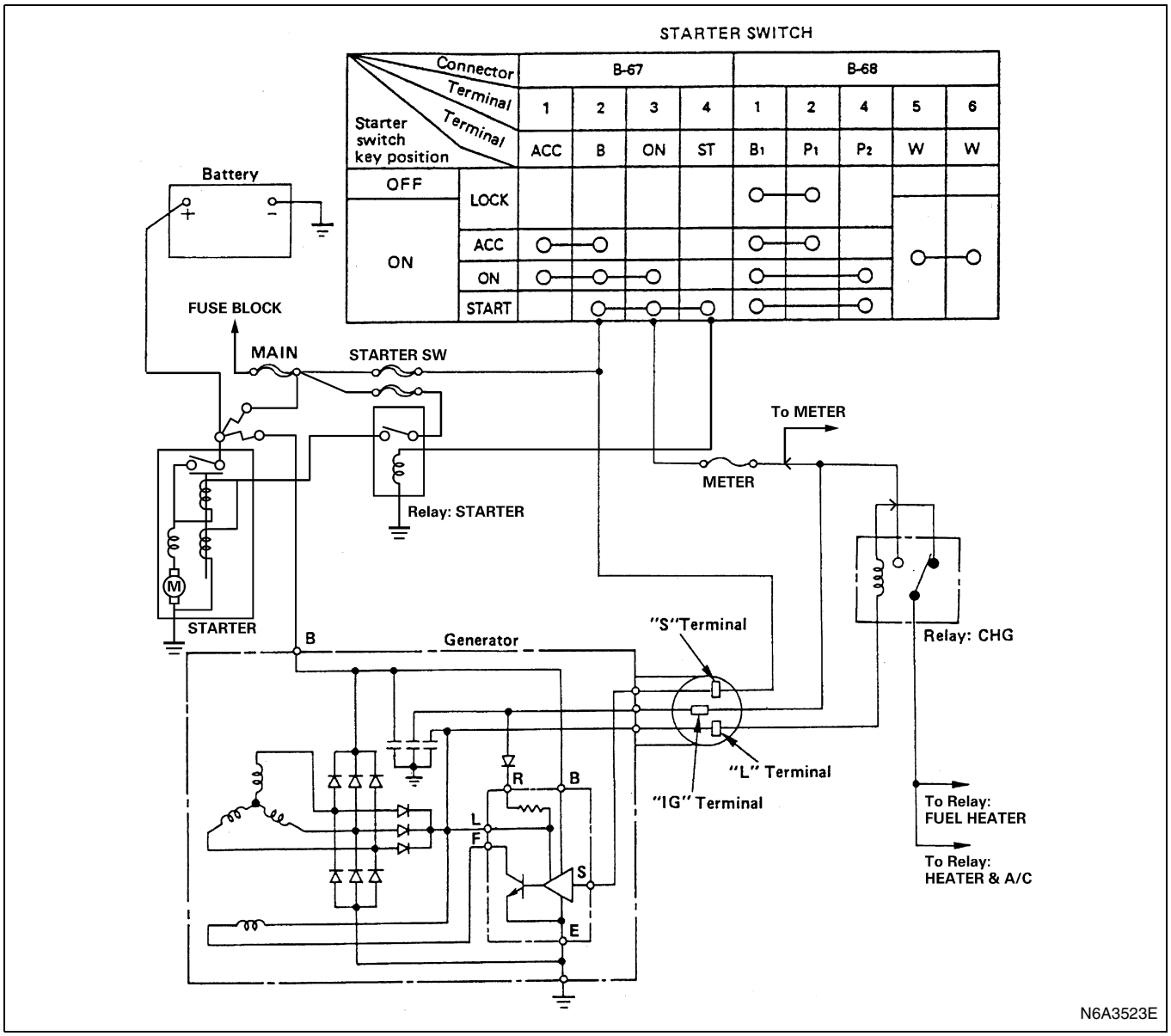
- If lamp does not come on:
  Disconnect wiring connector from generator, and ground the terminal “L” on connector side.
- If lamp comes on:
  Repair or replace the generator.

Diagnosis

General On-Vehicle Inspection

The operating condition of charging system is indicated by the charge warning lamp. The warning lamp comes on when the starter switch is turned on “ON” position. The charging system operates normally if the lamp goes off when the engine starts. If the warning lamp shows abnormality or if undercharged or overcharged battery condition is suspected, perform diagnosis by checking the charging system as follows:

For 4JH1



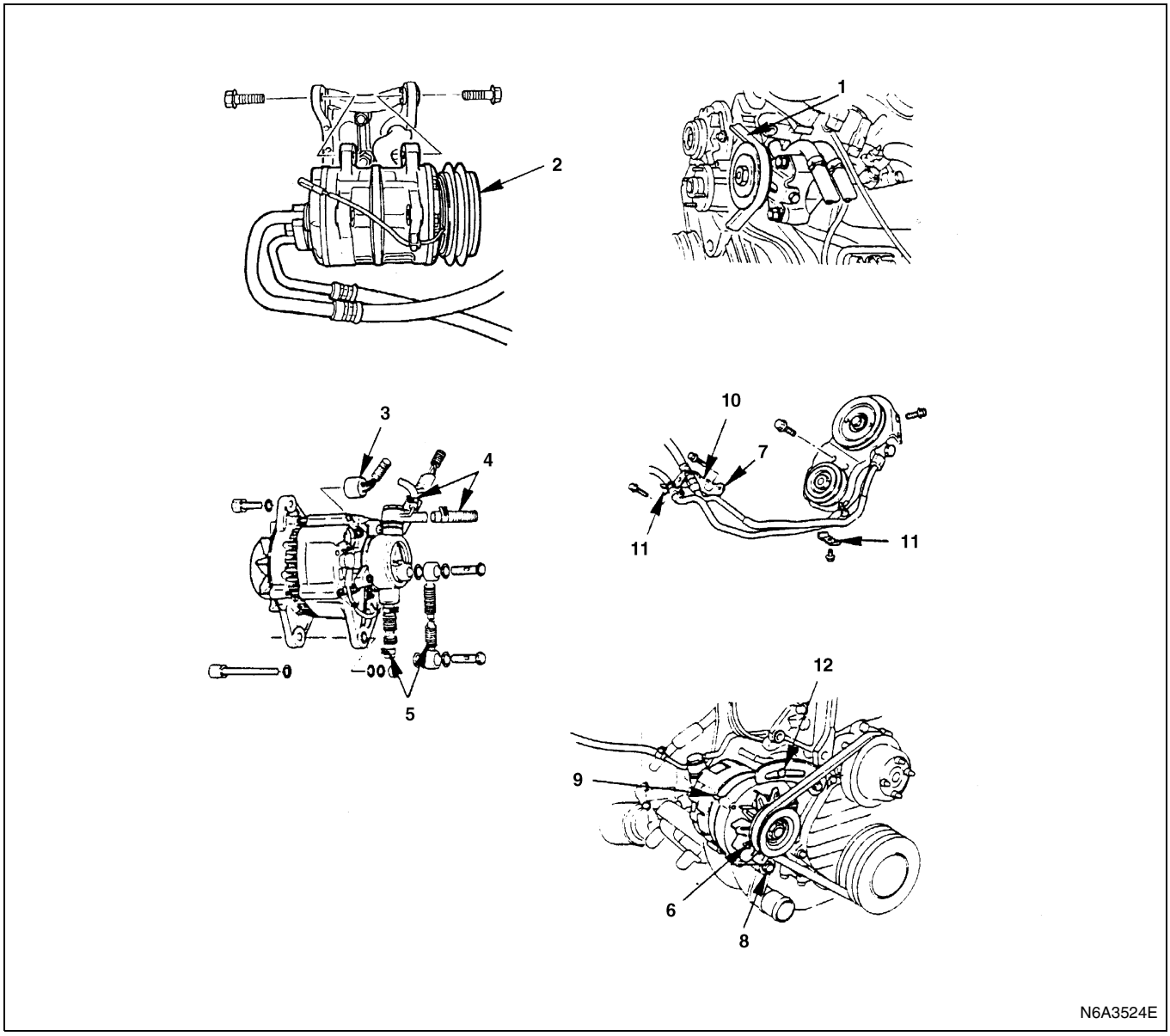
1. Check visually the belt and wiring connector.
2. With the engine in stop status, turn the starter switch to “ON” position and observe the warning lamp.

- If lamp does not come on:
  Disconnect wiring connector from generator, and ground the terminal “L” on connector side.
- If lamp comes on:
  Repair or replace the generator.

On-Vehicle Service

Component

Generator



Legend

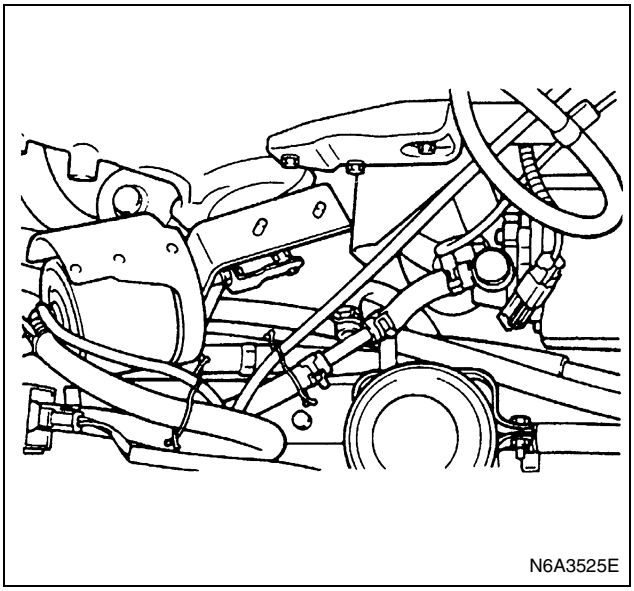
1. A/C compressor drive belt
2. A/C compressor assembly
3. Harness connector
4. Vacuum hose
5. Oil hose
6. AC generator drive belt
7. Power steering oil pipe bracket
8. AC generator fixing bolts
9. AC generator assembly
10. Bracket
11. Clip
12. Lock bolt

Removal

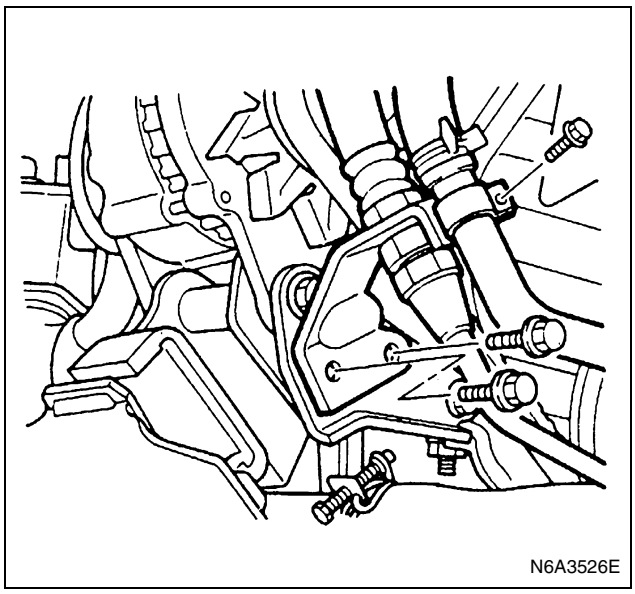
Preparation

- Disconnect battery ground cable.

1. A/C Compressor Drive Belt (A/C Model)
   - Loosen the idler pulley lock nut
   - Loosen the adjust bolt and remove the drive belt.
2. A/C Compressor Assembly (A/C Model)
   - Disconnect the clutch harness connector.
   - Remove the A/C compressor fixing bolts and temporarily tighten the A/C compressor to chassis frame side use the wire.
3. Harness Connector (A/C Model)
   - Disconnect the “L”, “S”, “IG” terminal.
   - Disconnect the “B” terminal.
4. Vacuum Hose (Exhaust Brake Model)
   - Remove the vacuum hose to vacuum tank and exhaust actuator.
5. Oil Hose
   - Remove the oil hose from oil pan.
   - Remove the oil hose of vacuum pump side.


N6A3525E

6. AC Generator Drive Belt
   - Loosen the adjust plate fixing bolt.
   - Remove the adjust bolt.
   - Loosen the AC Generator fixing bolt then remove the fan belt.
7. Power Steering Oil Pipe Bracket (P/S Model)
   - Remove the oil pressure pipe bracket fixing bolt and pipe clip bolt.
   - Remove the oil suction pipe clip bolt.

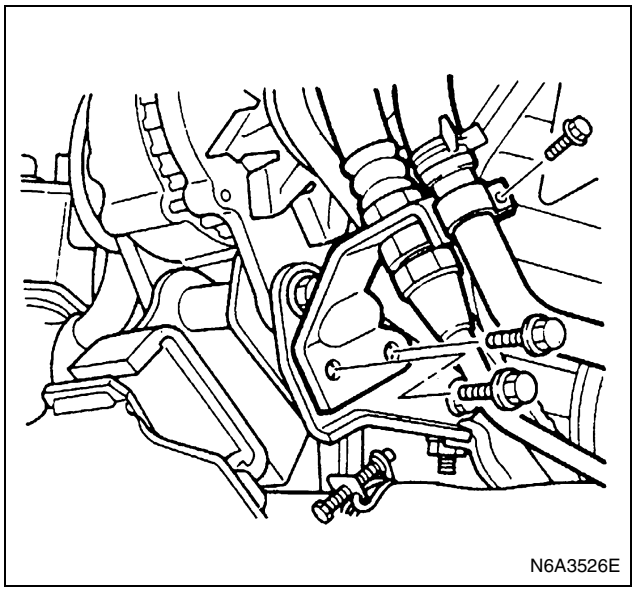

N6A3526E

8. AC Generator Fixing Bolts
9. AC Generator Assembly

Installation

1. AC Generator Assembly
   - Set the AC generator.
2. AC Generator Fixing Bolts
   - Temporary install the AC generator fixing bolt.
3. Power Steering Oil Pipe Bracket (P/S Model)
   - Install the oil pipe bracket and tighten bolts to the specified torque.

Tighten:
Pipe Bracket Bolt to 19 N·m (1.9 kg·m/14 lb·ft)


N6A3526E

- Install the suction pipe clip bolt and tighten bolt to the specified torque.

Tighten:
Pipe Clip Bolt to 10 N·m (1 kg·m/87 lb·in)

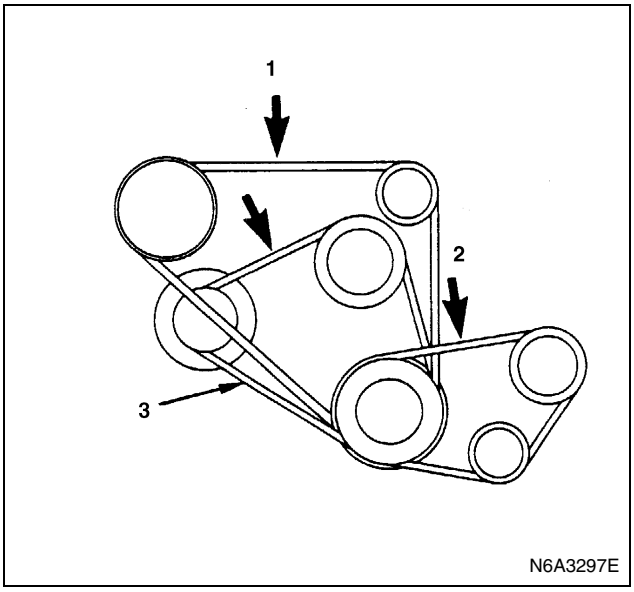
- Install the pressure pipe and suction pipe clip bolt, then tighten bolt to the specified torque.

Tighten:
Pipe Clip Bolt to 10 N·m (1 kg·m/87 lb·in)

4. AC Generator Drive Belt
   - Install the AC Generator drive belt and adjust belt tension.
   - Depress the drive belt mid-portion with a 98 N (10 kg/22 lb) force.

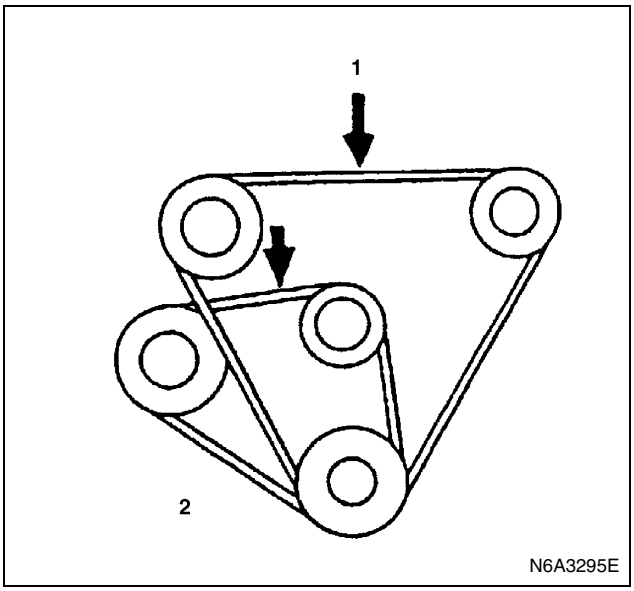
Drive Belt Deflection	mm (in)
8 (0.31) — 12 (0.47)	

4JG2



Legend
1. A/C compressor drive belt
2. P/S oil pump drive belt
3. AC generator fan pulley drive belt

4JB1

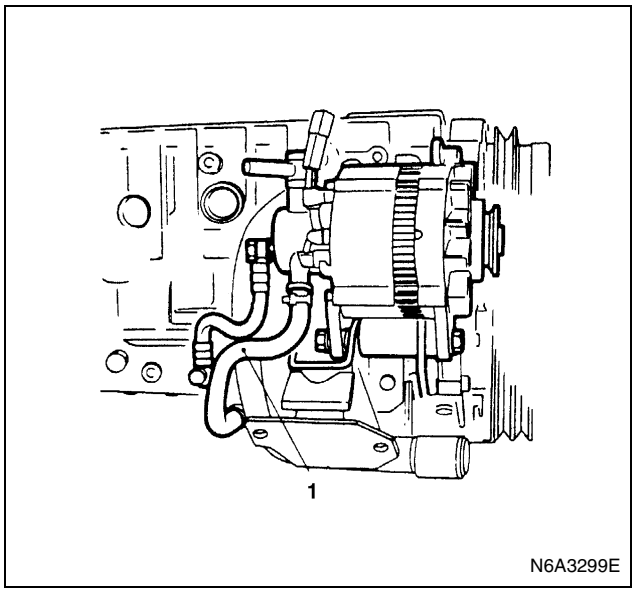


Legend
1. AC compressor drive belt & PS pump drive belt
2. AC generator & fan pulley drive belt

   - Install the fixing bolt and tighten bolt to the specified torque.

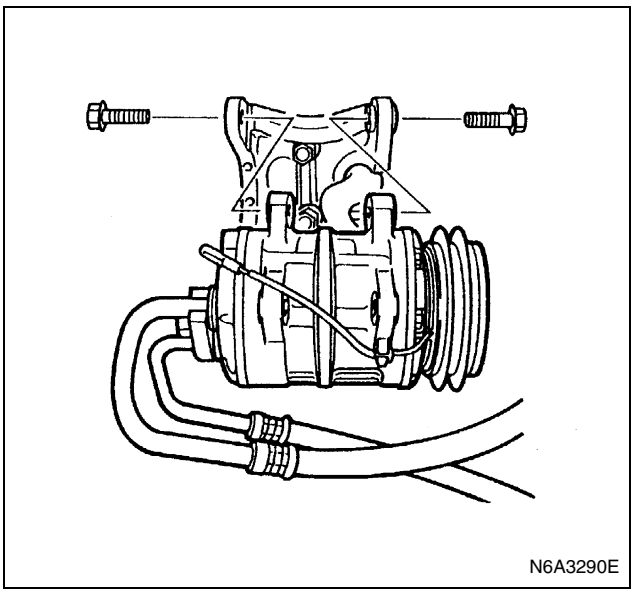
Tighten:
- Generator Fixing Bolt to 40 N·m (4.1/ kg·m/30 lb·ft)
- Adjust Plate Fixing Bolt to 19 N·m (1.9 kg·m/14 lb·ft)

5. Oil Hose
   - Install the oil hose (1) to vacuum pump.
   - Install the oil hose (2) to oil pan.



6. Vacuum Hose (Exhaust Brake Model)
   - Install the vacuum hose to vacuum tank and exhaust actuator.
7. Harness Connector (A/C Model)
   - Connect the “L”, “S”, “IG” terminal and “B” terminal connectors.
8. A/C compressor Assembly (A/C Model)
   - Install the compressor assembly and tighten bolts to the specified torque.

Tighten:
Compressor Bolt to 19 N·m (1.9 kg·m/14 lb·ft)


N6A3290E

- Connect the magnetic switch harness connector.

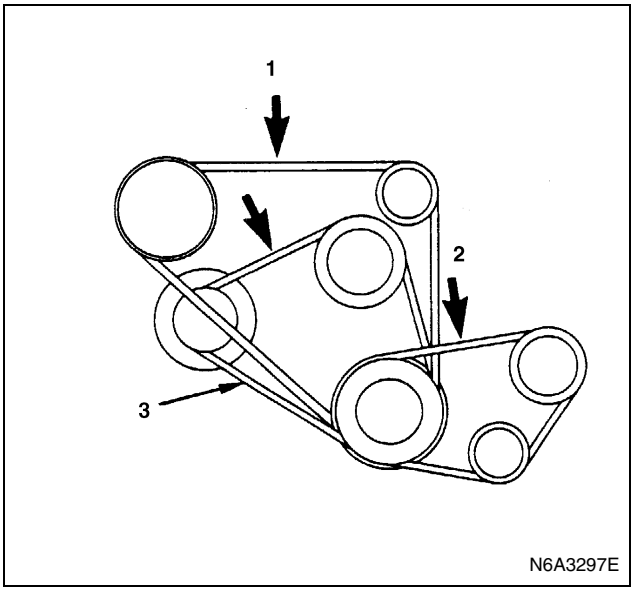
9. A/C compressor Drive Belt (A/C Model)
   - Install A/C compressor drive belt and adjust belt tension.
   - Depress the drive belt mid-portion with a 98N (10 kg/22 lb) force.

Drive Belt Deflection	mm (in)
New 7 — 8 (0.28 — 0.31) Check 12 — 14 (0.47 — 0.55)	

- Tighten the idler lock nut to the specified torque.

Tighten:
Idle Pulley Lock Nut to 27 N·m (2.8 kg·m/20 lb·ft)

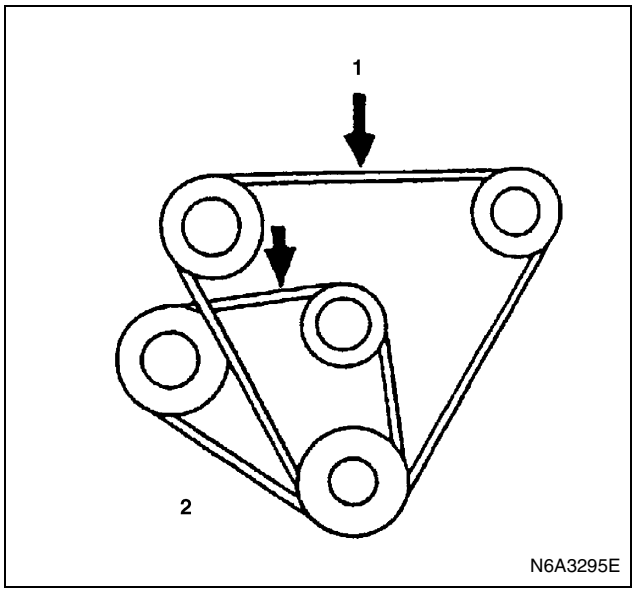
4JG2



N6A3297E

Legend
1. A/C compressor drive belt
2. P/S oil pump drive belt
3. AC generator fan pulley drive belt

4JB1



N6A3295E

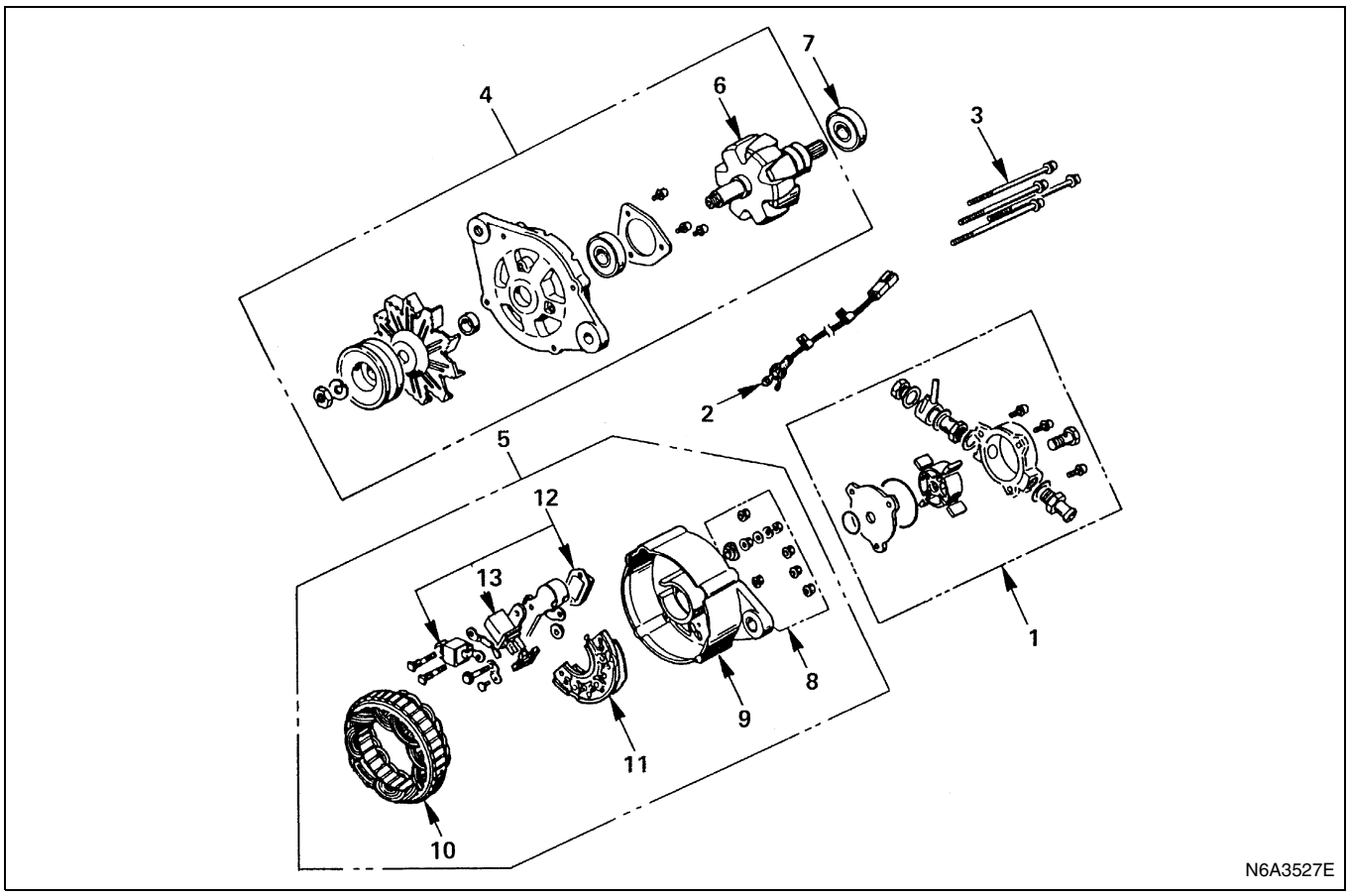
Legend
1. AC compressor drive belt & PS pump drive belt
2. AC generator & fan pulley drive belt

- Connect the battery ground cable.

Unit Repair

Component

12V-50A

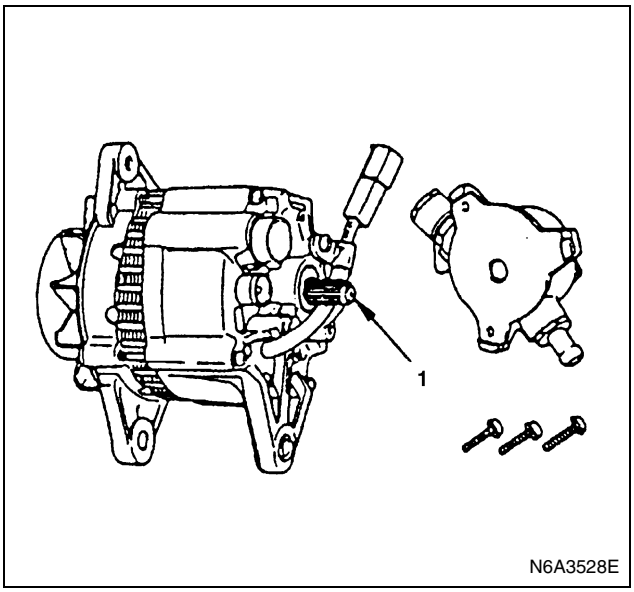


Legend

1. Vacuum pump
2. Lead wire
3. Through bolts
4. Rotor and front cover assembly
5. Stator and rear cover assembly
6. Rotor
7. Rear bearing
8. Terminal bolt and nut
9. Rear cover
10. Stator
11. Diode
12. IC regulator assembly
13. Brush holder

Disassembly

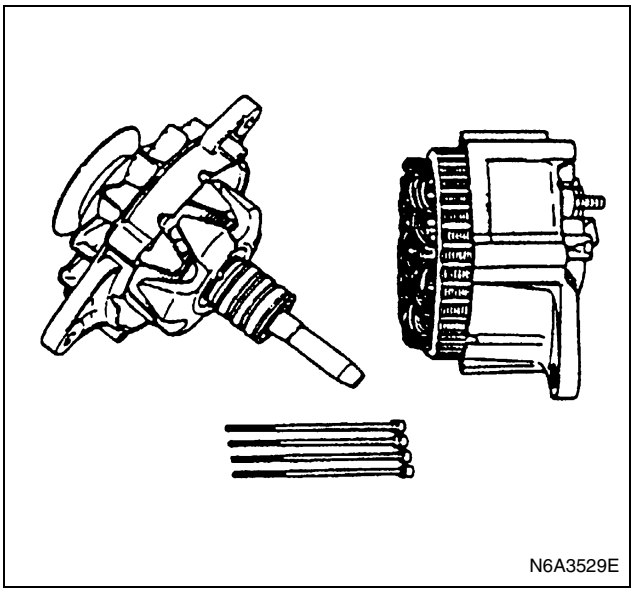
1. Vacuum Pump
   - Drain fluid from discharged port.
   - Remove the vacuum pump fixing bolts. Hold the center plate and remove the vacuum pump horizontally in direction in line with the rotor shaft.
2. Lead Wire
3. Through Bolts



Legend

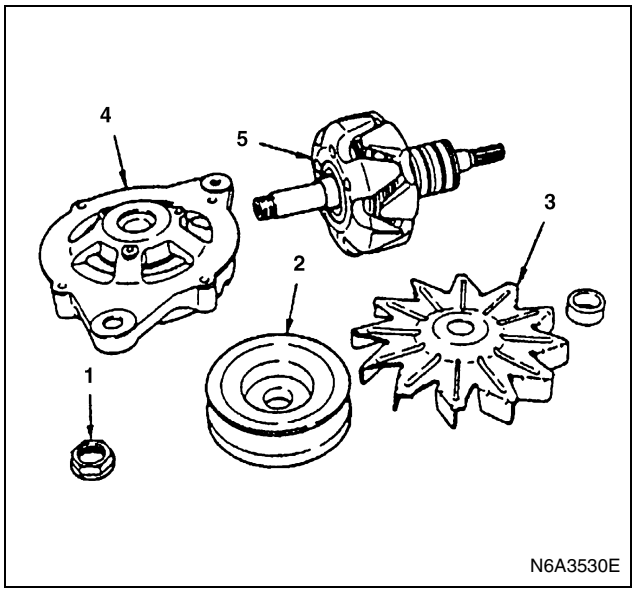
1. Seal protector

4. Rotor and Front Cover Assembly
5. Stator and Rear Cover Assembly
   - Insert a screwdriver into the clearance between the front cover and the stator core, and remove the assembly.

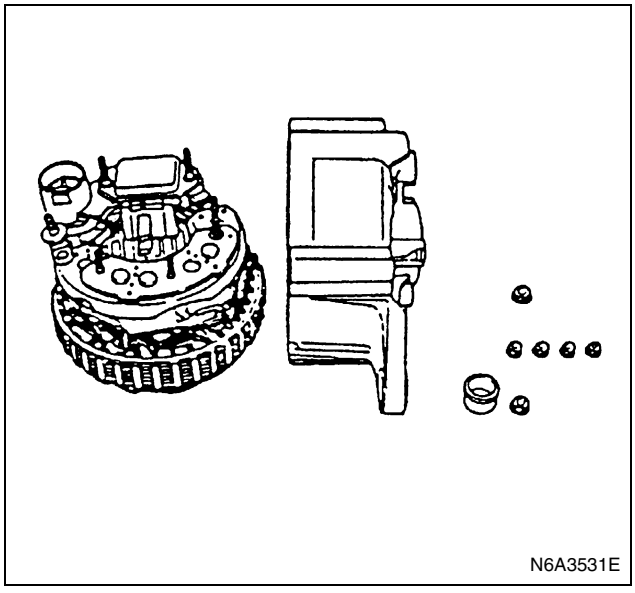


Notice:
Take care not to damage the stator coil with the screwdriver. When the assembly will not come off, hold down the rear cover and hit the end face of the shaft gently with a plastic hammer to detach it.

6. Rotor
   - With the rotor gripped with a vise, remove the pulley nut (1), and then take off the pulley (2), fan (3), front cover (4) and the rotor (5).



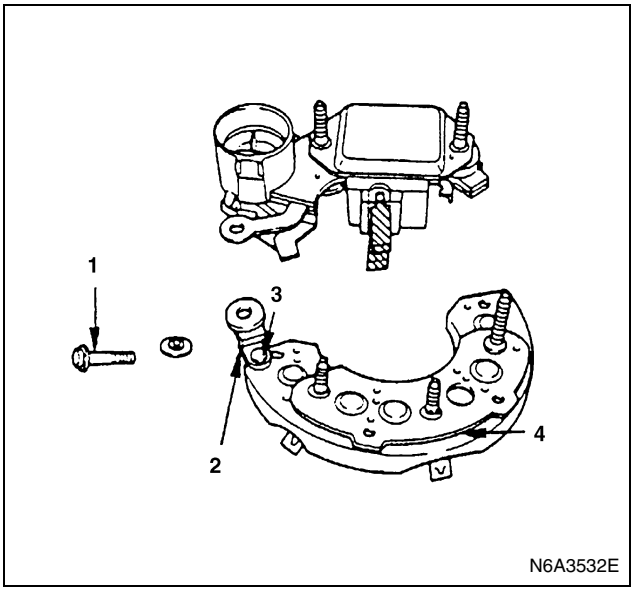
7. Rear Bearing
8. Terminal Bolt and Nut
9. Rear Cover
   - Remove the nuts fixing the B terminal and diode holder.
     Separate the stator and rear cover.
     Note the position of insulation washers to ensure reassembly into original position.



10. Stator
11. Diode

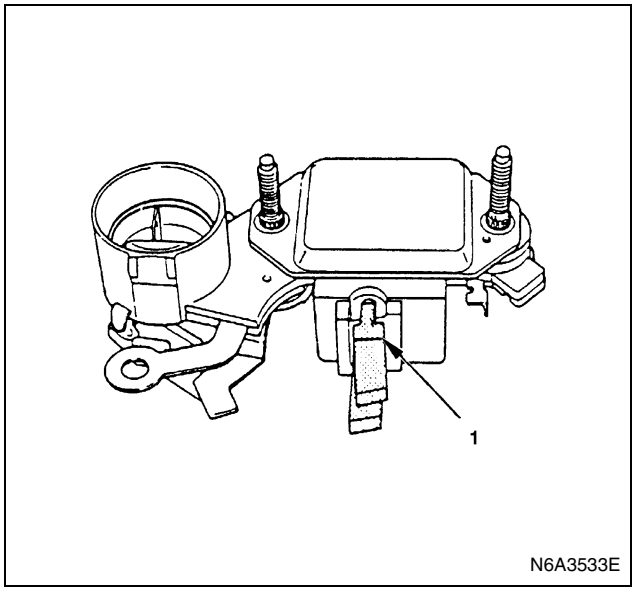
- Separate the diodes from the stator by melting away solder on stator coil and diode.
  When melting solder, hold the lead wire with long nose pliers to prevent heat from being transferred to the diodes.

12. IC Regulator Assembly
    - Separate the IC regulator from the diode by melting away solder on IC regulator holder plate and removing the nut.



Legend
1. Terminal bolt
2. Terminal plate
3. Rivet
4. Diode

13. Brush Holder
    - Remove the serrated bolts and melt away solder on IC regulator.
    - Do not remove the serrated bolts unless the replacement of brush or condenser.
      To install, follow the removal steps in the reverse order.



Legend
1. Wear limit

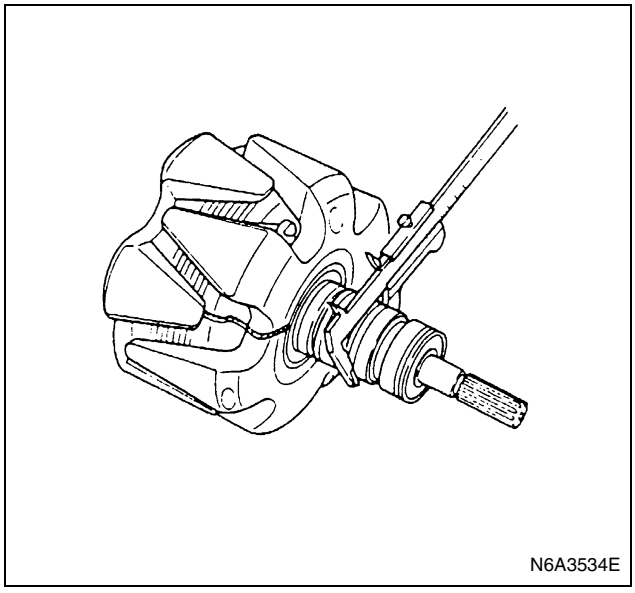
Inspection and Repair

Repair or replace necessary parts if extreme wear or damage is found during inspection.

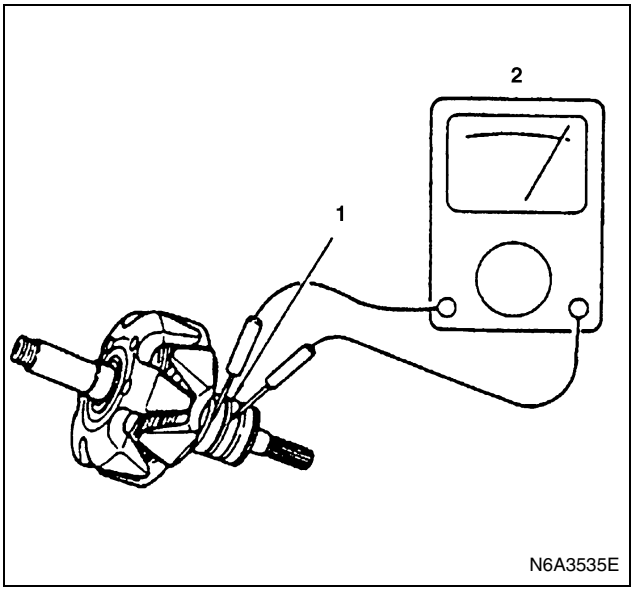
Rotor

1. Check the rotor slip ring surfaces for contamination and roughness. If rough, polish with #500 — 600 sandpaper.
2. Measure the slip ring diameter, and replace if it exceeds the limit.

mm (in)	
Standard	Limit
34.6 (1.36)	33.6 (1.32)

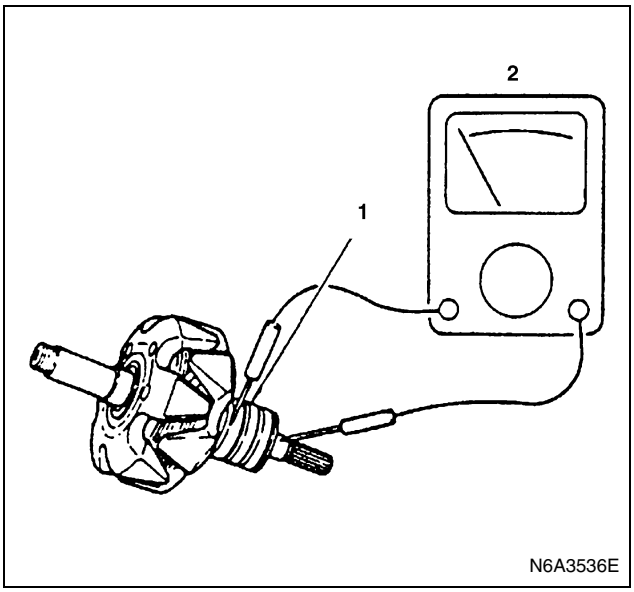


3. Check for continuity between slip rings, and replace if there is no continuity.



Legend
1. Slip ring
2. Tester

4. Check for continuity between slip ring and rotor core or slip ring and rotor shaft.
   In case of continuity, replace the rotor assembly.



Legend
1. Slip ring
2. Tester

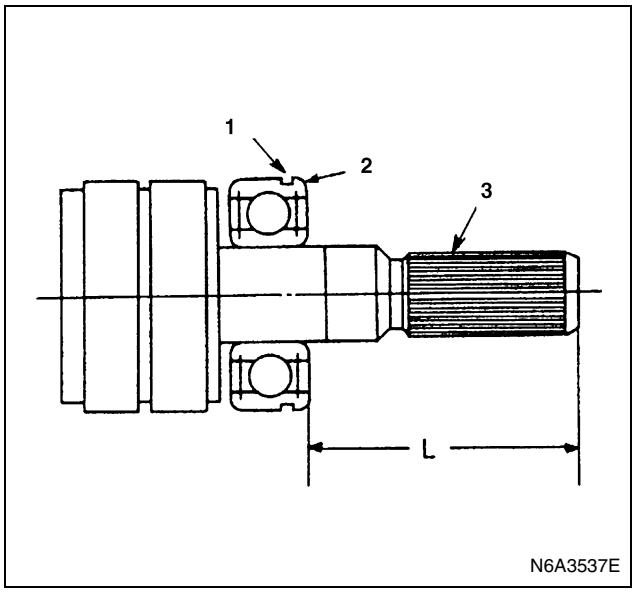
Rear Ball Bearing

Check to see if the ball bearing rotates smoothly with no noises.

When it does not rotate smoothly or any noises are heard, replace it with a new one.

When installing the bearing, press it in with the stopper ring turned to the spline side, while pushing the bearing inner ring.

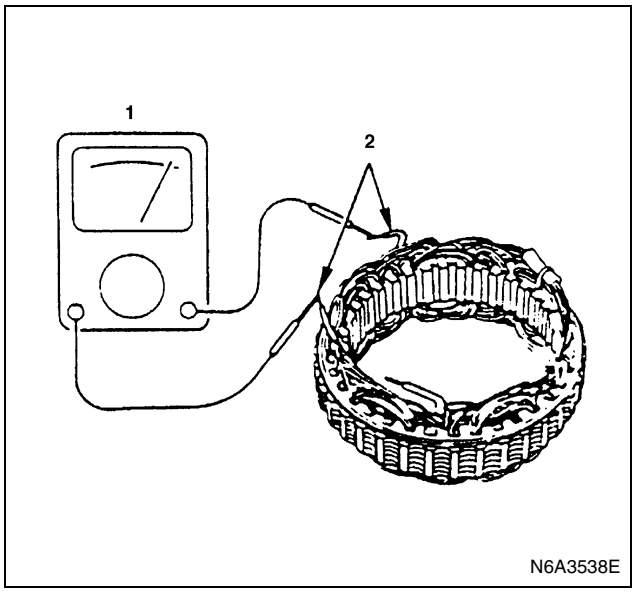
Bearing press-in measurement: L	mm (in)
Standard	41.8 — 42.0 (1.64 — 1.65)



Legend
1. Stopper ring
2. Ball bearing
3. Spline

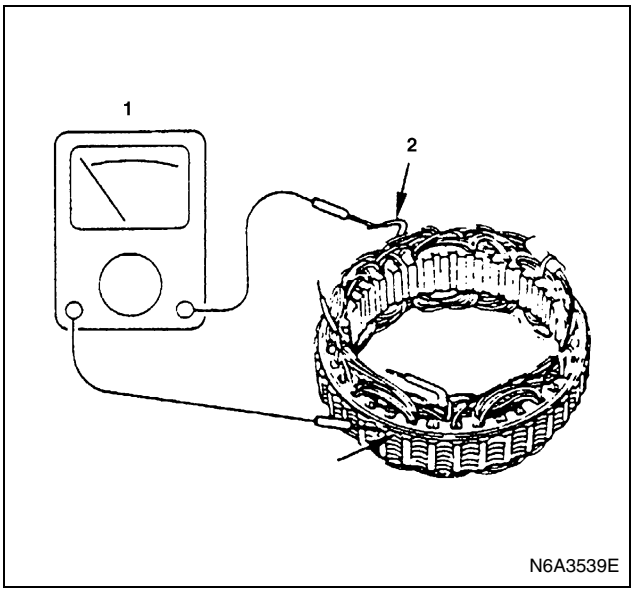
Stator Coil

1. Check for continuity between respective phases.
   In case of no continuity, replace the stator.



Legend
1. Tester
2. Lead wire

2. Check for continuity across one of the stator coils and stator core. If a continuity exists, replace the coil.

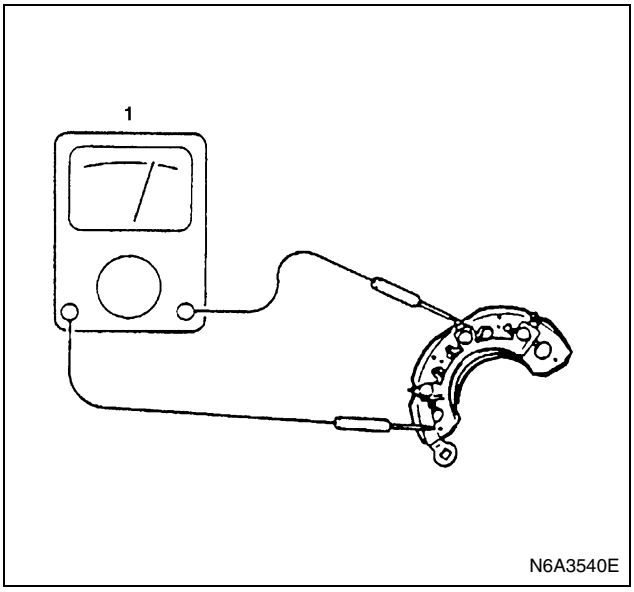


Legend
1. Tester
2. Lead wire

Diode

1. Check for continuity across the terminal (example: across BAT and U). If a continuity exists, the diode is in satisfactory condition. If no continuity exists the diode is defective.
2. Make a test with the polarities reversed. If no continuity exists, the diode is in satisfactory condition. If a continuity exists at any point, the diode is defective and should be replaced.

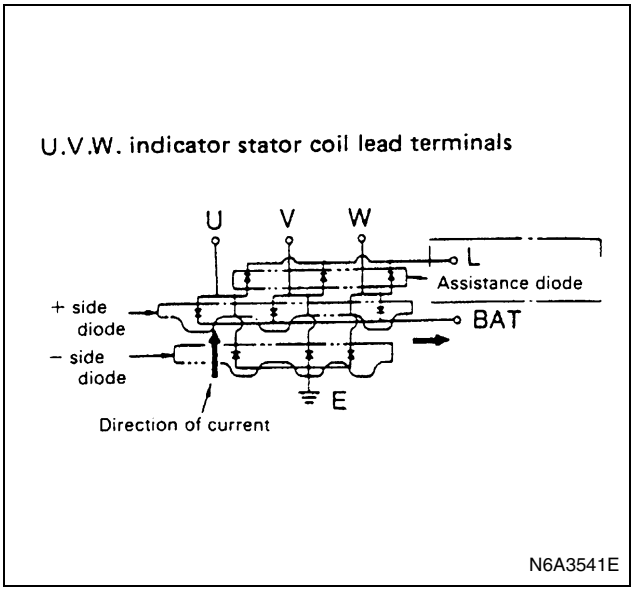
   Auxiliary diodes are not provided with the terminal and continuity test should be made across the terminals of the conventional diodes.



Legend
1. Tester

- side diode check			
Across terminals		BAT (Positive side (+) diodes)	
	Tester pin	Positive side	Negative side
U.V.W	Positive side		No continuity
	Negative side	Continuity	

+ side diode check			
Across terminals		E (Negative side (–) diodes)	
	Tester pin	Positive side	Negative side
U.V.W	Positive side		Continuity
	Negative side	No continuity	

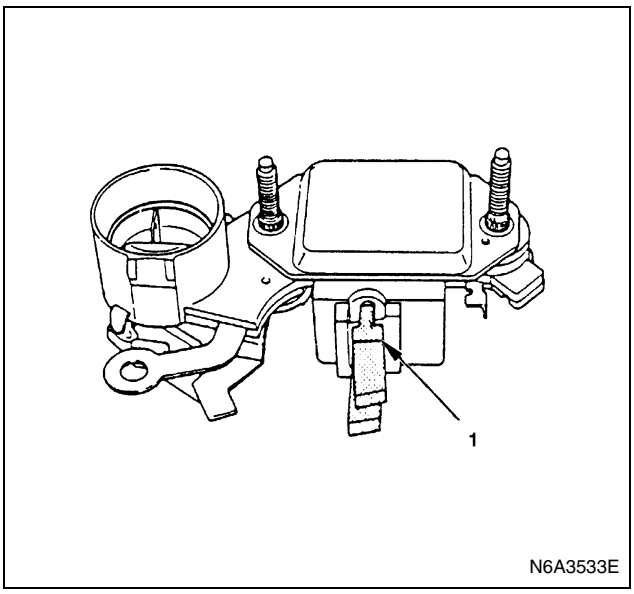


Brush

Measure length of brushes.
Brush length (L)

mm (in)	
Standard	Limit
20 (0.79)	6 (0.24)

Brushes are provided with a line which indicates the limit of usage.



Legend
1. Wear limit

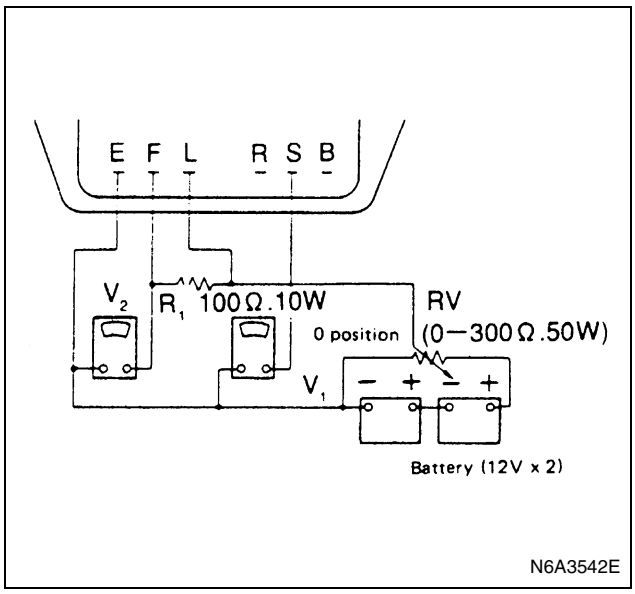
IC Regulator
Measuring instruments is necessary.
Take the following measurements with the instruments connected as shown in the illustration.

V1 Voltage at Battery1	V
Standard	10 — 13

V2 Voltage across F — E	V
Standard	Limit
2 or less	2 or more

Take measurement with 'S' terminal disconnected.

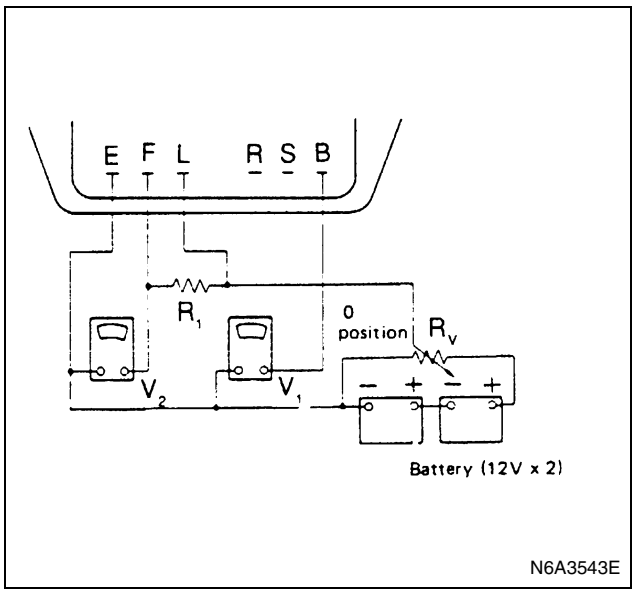
V3 Measure the voltage at Battery1 — Battery2. V	
Standard	20 — 26



- Measurement the voltage across the E — F while varying resistance gradually from zero using variable resistor.
  Then check that voltage increases from 2V to 10 — 13.
  If increase in voltage is interrupted at any point, replace the regulator.
- V4 Measure the voltage across the intermediate tap on variable resistor and 'E' terminal without actuating the variable resistor.

	V
Standard voltage at 20°C (68°F)	14.0 — 14.9

If measured value deviates from the standard, replace the regulator.



Check the following with the instrument connected as illustrated.
Measure the voltage across the terminals B and E by gradually increasing voltage with variable resistor RV.

Check to see if voltage increases from lower than 2V to range from 10 to 13 volts.
If the voltage does not vary, the regulator is defective and should be replaced.
Check the voltage across the intermediate tap of the variable resistor and terminal E without actuating the variable resistor.

	V
Standard voltage at 20°C (68°F)	14.5 — 16.9

If measured voltage deviates from the standard value, replace the regulator.

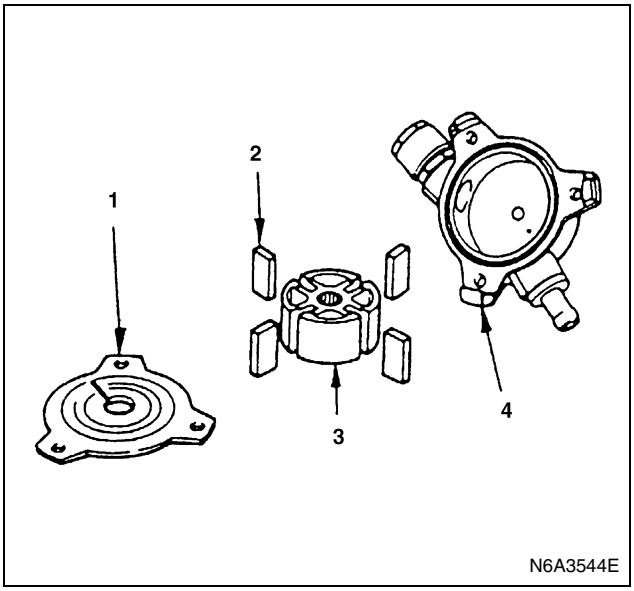
Vacuum Pump

Visual Check

- Inspect the following parts for wear, damage or other abnormal conditions.

Disassembly of Vacuum Pump

- For the center plate, rotor and vane in the mentioned.



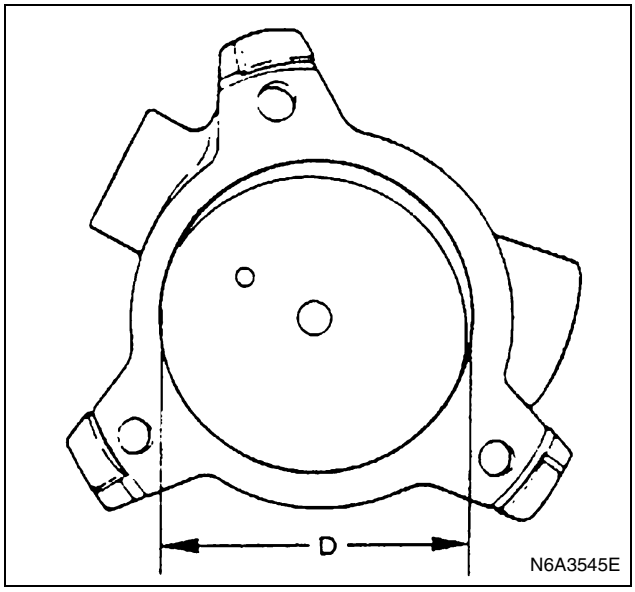
Legend

1. Center plate
2. Vane
3. Rotor
4. Housing

Housing

- Measure the inside diameter of housing and place if it exceed the standard.

	mm (in)
Standard	57.0 — 57.1 (2.244 — 2.248)



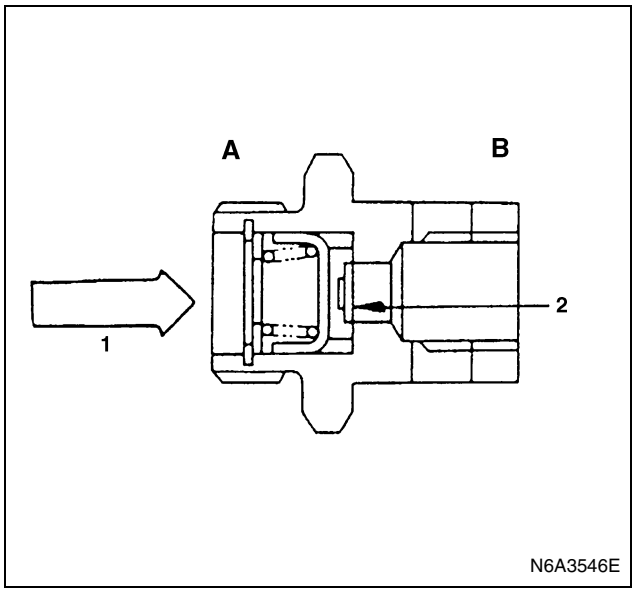
Vane

Measure the length of vanes

	mm (in)
Standard	12.5 — 13.5 (0.492 — 0.531)

Check Valve

1. Apply a light pressure onto the “B” side of valve with a screwdriver and check that valve operates smoothly.
2. Apply compressed air 100 — 500 kPa (1 — 5 kg/cm^2/14.5 — 72.5 psi) onto “A” side of valve and check if there is air leak.

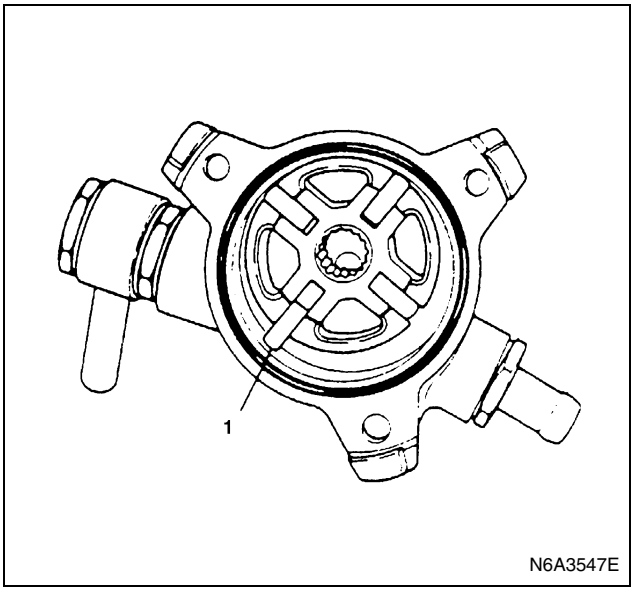


Legend

1. Compressed air
2. Push

Reassembly of Vacuum Pump

1. Position the rotor, with the serrated boss turned up, on the center plate and housing.
   Align the holes in center plate and rotor.
2. Install vanes into slits in rotor.
   The vanes should be installed with chamfered side turned outward.
3. Install the O-ring and center plate

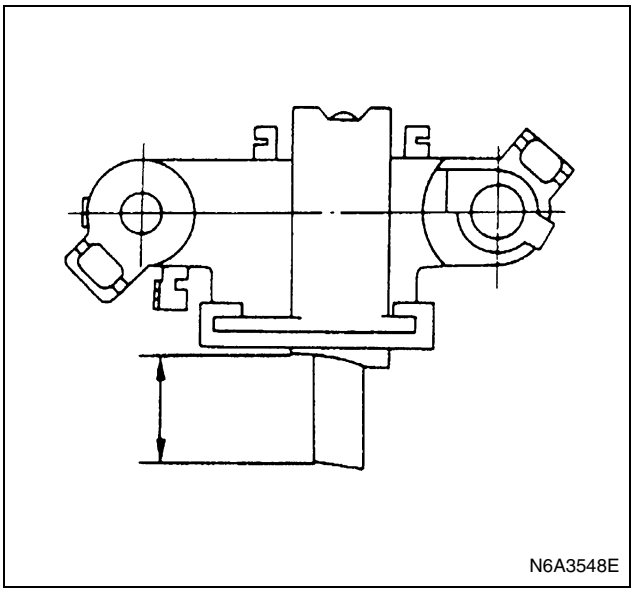


Legend

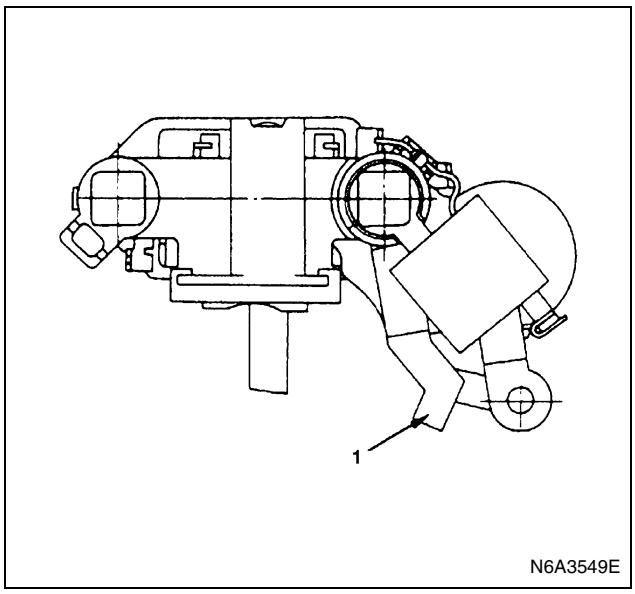
1. Chamfered side

Reassembly

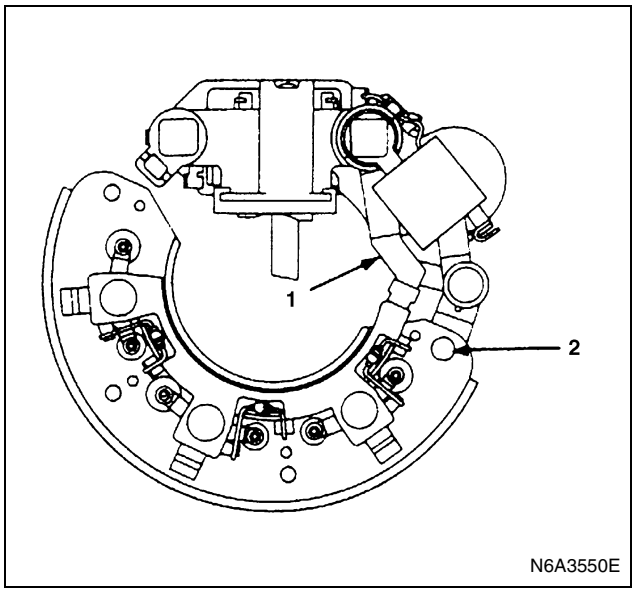
1. Brush Holder
2. IC Regulator Assembly
   - Hold the brush in the holder as shown in the illustration and solder the lead wire.



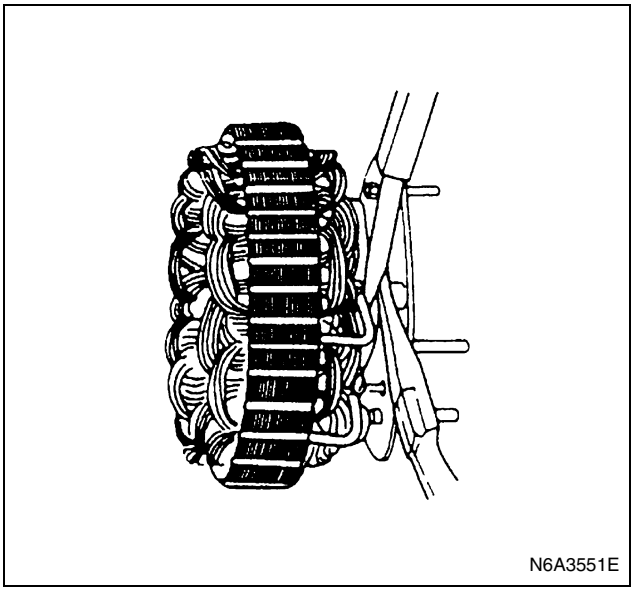
   - Put the IC regulator on the brush holder and press the bolt.
     Bushing and connecting plate (1) must be installed when pressing the bolt.



3. Diode
   - Connect the terminals by fixing the rivet at (1) and soldering the terminal at (2).

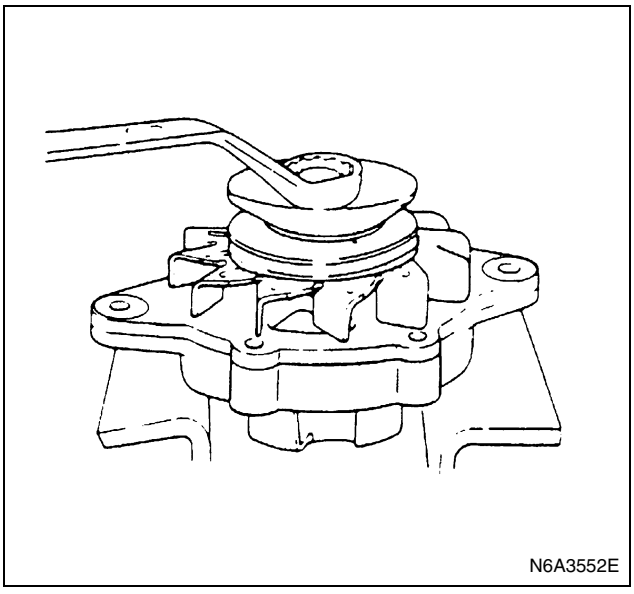


4. Stator
   - When connecting stator coil leads and diode leads using solder, use long-nose pliers and finish the work as quickly as possible to prevent the heat from being transferred to the diodes.


N6A3551E

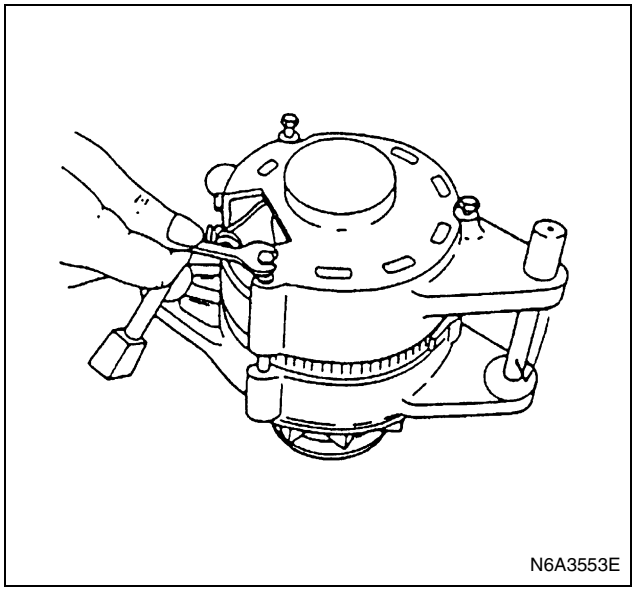
5. Rear Cover
6. Terminal Bolt and Nut
7. Rear Bearing
8. Rotor
   - Cover vice with copper plates, clamp the rotor with the vice, and tighten nut to the specified torque.

Tighten:
Pulley Nut to 90 N·m (9.2 kg·m/67 lb·ft)


N6A3552E

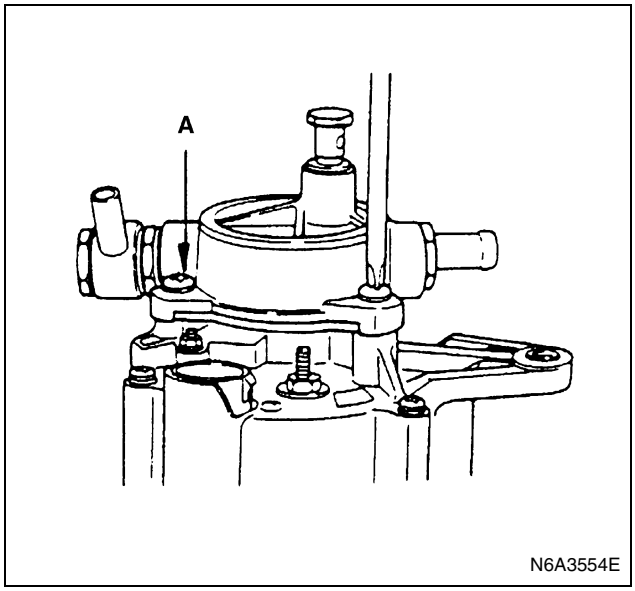
9. Stator and Rear Cover Assembly
10. Rotor and Front Cover Assembly
11. Through Bolts
    - Place guide bar through the holes in front cover and rear cover flange for alignment, then install the through bolts.
    - Tighten the through bolts to the specified torque

Tighten:
Through Bolts to 3.5 N·m (0.36 kg·m/31 lb·in)


N6A3553E

12. Lead wire
13. Vacuum Pump
    - Install and mount the housing to the generator using 3 bolts.
    - Pour engine oil (5 cc or so) in through the filler port, then check that generator pulley can be turned smoothly with hand.
    - Tighten the pump fixing bolts (A) to the specified torque.

Tighten:
Through Bolts to 3.5 N·m (0.36 kg·m/31 lb·in)



N6A3554E

- Pour engine oil (5 cc or so) through the filler port, and then check the pulley for smooth rotation.

QOSII PREHEATING SYSTEM (4JB1/4JB1-TC/4JH1-TC ONLY)

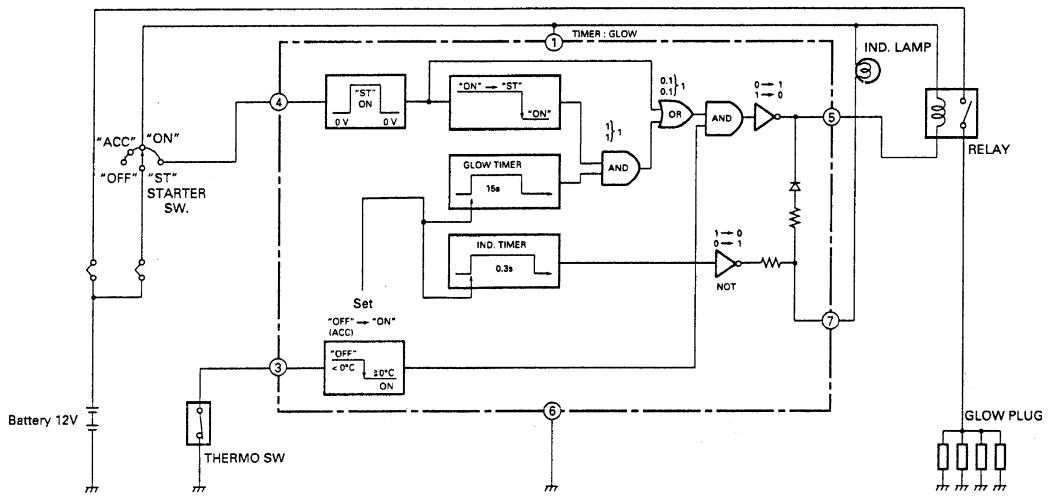
General Description

QOS II preheating system features a quick-on glow plug with thermometer control of the glowing time and the after-glow time function.

The system consists of a controller, indicator lamp, thermoswitch, relay, and glow plug (4 pcs).

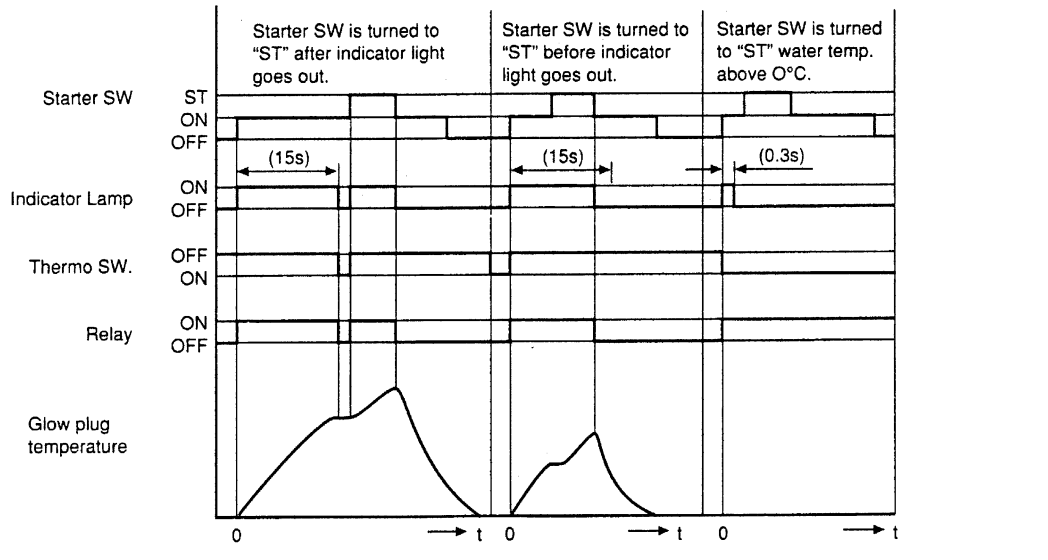
With the employment of the thermoswitch, the glow time changes according to the engine coolant temperature, thus allowing optimum starting conditions to be obtained.

System Diagram



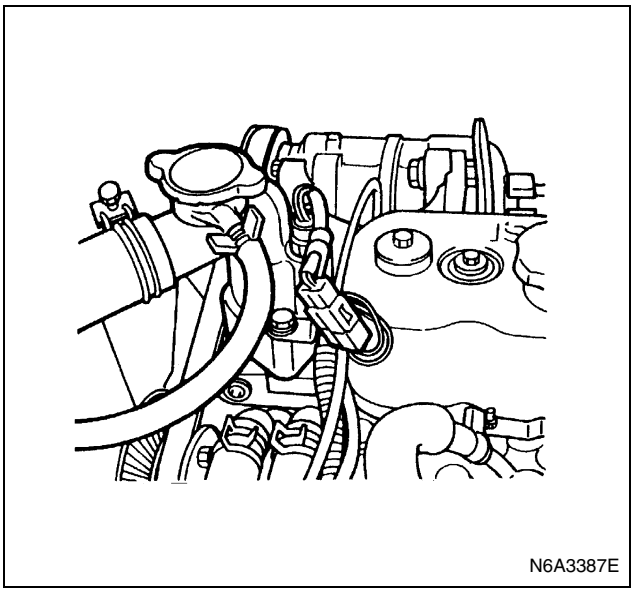
N6A3572E

QOS II Timing Chart



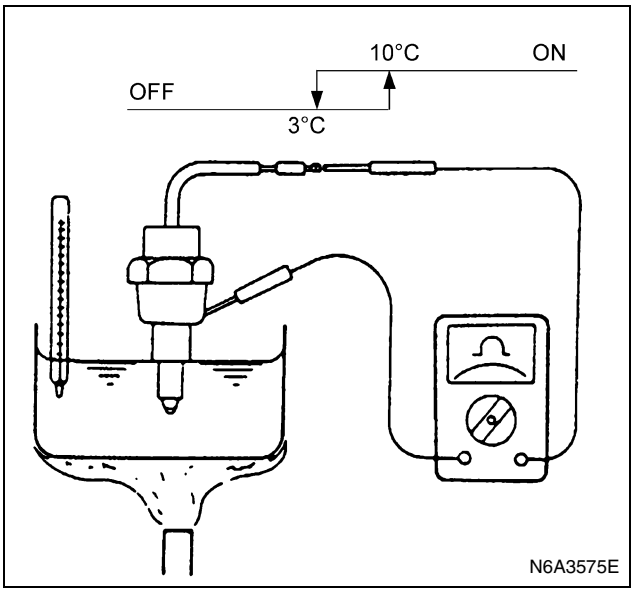
N6A3573E

Inspection on QOSII System Operation
Thermo Switch
The thermo switch is located on the water outlet pipe.

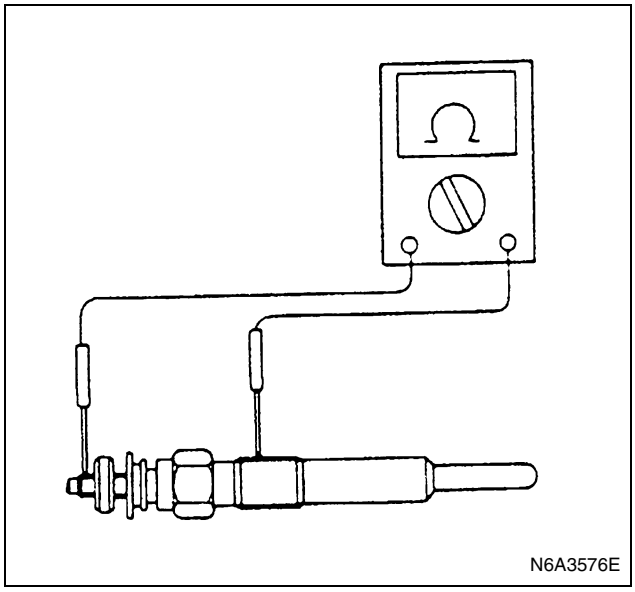

N6A3387E

Use a circuit tester to check the thermo switch for continuity.

OFF → ON	: 7 — 13°C (44.6 — 55.4°F)
ON → OFF	: Below 3°C (37.4°F)



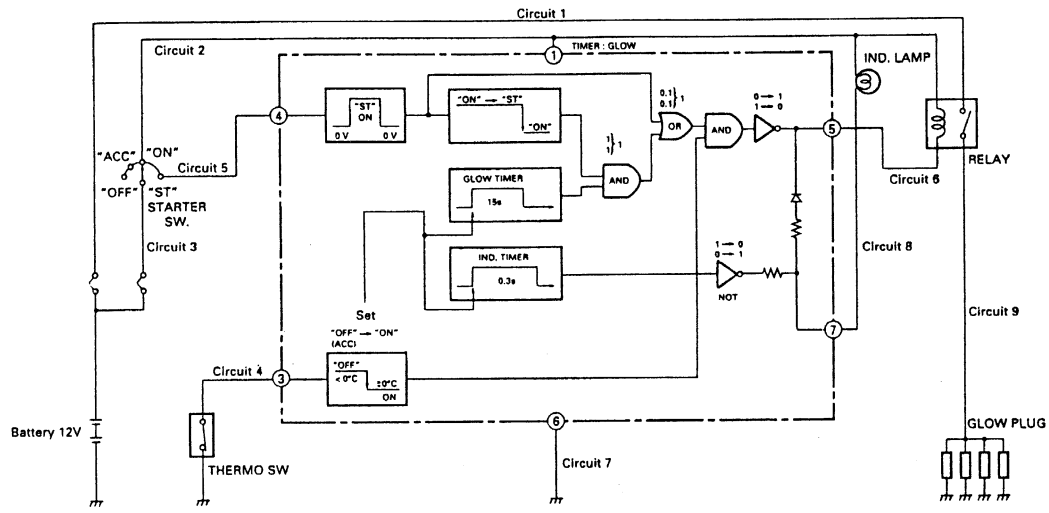
N6A3575E


N6A3576E

Glow Plug
Use a circuit tester to test the glow plugs for continuity.

Glow Plug Resistance (Reference)	Ohms
Conventional model	Approximately 1.5
Quick on start model	Approximately 0.9

QOSII System Troubleshooting



1. Problems when the water temperature of the engine is 0°C below.

Condition	Cause	Circuit
Glow plug relay will not be lit.	Bad connection of Fusible link wire between battery and starter.	3
	Bad connection or disconnection of starter SW circuit	
	Bad connection or disconnection of Fuse No. SBF3 Malfunction of other circuits occurred simultaneously.	2
	Bad starter switch.	
	Bad connection of glow plug relay terminal.	1
	Disconnection of glow plug relay excitation coil.	
	Disconnection of circuit between glow plug relay and timer.	6
	Bad glow relay. (The main contact does not pass electricity.)	
	Bad connection of timer.	
	Bad timer.	
	Bad earth circuit of timer.	7
	Bad thermoswitch. (It remains ON even in water temperature below 0°C.)	
	Earth short-circuiting of thermo switch.	7
Through glow plug relay turns ON, pre-heating is not done.	Bad connection of Fusible link wire between battery and glow relay.	1
	Bad connection or disconnection in preheating circuit of glow relay main contact terminal connector.	
	Bad connection between plug connector and preheating circuit.	9
Glow plug relay turns ON, but does not go OFF.	Bad timer.	
	Bad timer. Short circuiting in circuit or earth between 5 terminal and glow relay.	6
	Bad glow relay.	
Indication lamp is not lit.	Bad timer.	
	Burning-out of light bulb. 8	8

Notice:
Circuit number is shown in the previous pre-heating chart.

2. Problems when the time water temperature of the engine is 0°C or above.

Condition	Cause	Circuit
Indicator lamp is not lit	Bad timer Burning-out of bulb. 8	8
Turn glow relay ON.	Bad thermoswitch or disconnection of thermo SW circuit. (Indicator will light up for 3.5 seconds.) Bad timer. Bad timer. Short-circuiting in circuit or earth between terminals 5 and glow relay.	4

Notice:
Circuit number is shown in the previous pre-heating chart.

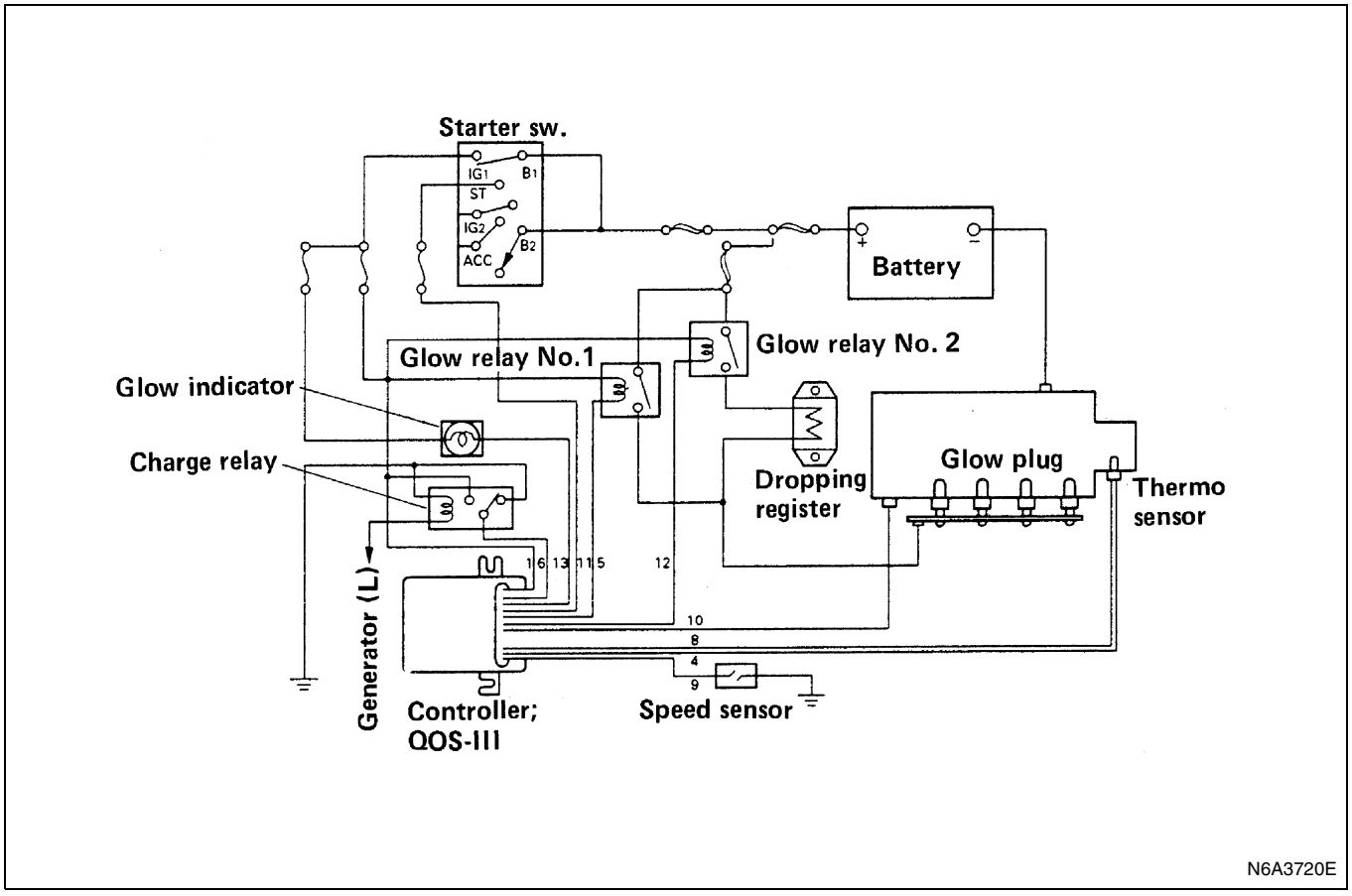
3. Burning-out of glow plug
   When only one line is burned out, it has no effect on the start up of the engine. Even if one line is burned out, judging from the characteristics of the glow plug, the impressed voltage will change only slightly.
   Therefore, no judgment can be made by normal testing while the glow plug is installed. In order to check for disconnections and burn-outs, the glow plugs will have to be removed from the connectors and checked one by one for continuity.

QOSIII PREHEATING SYSTEM (4JG2 ONLY)

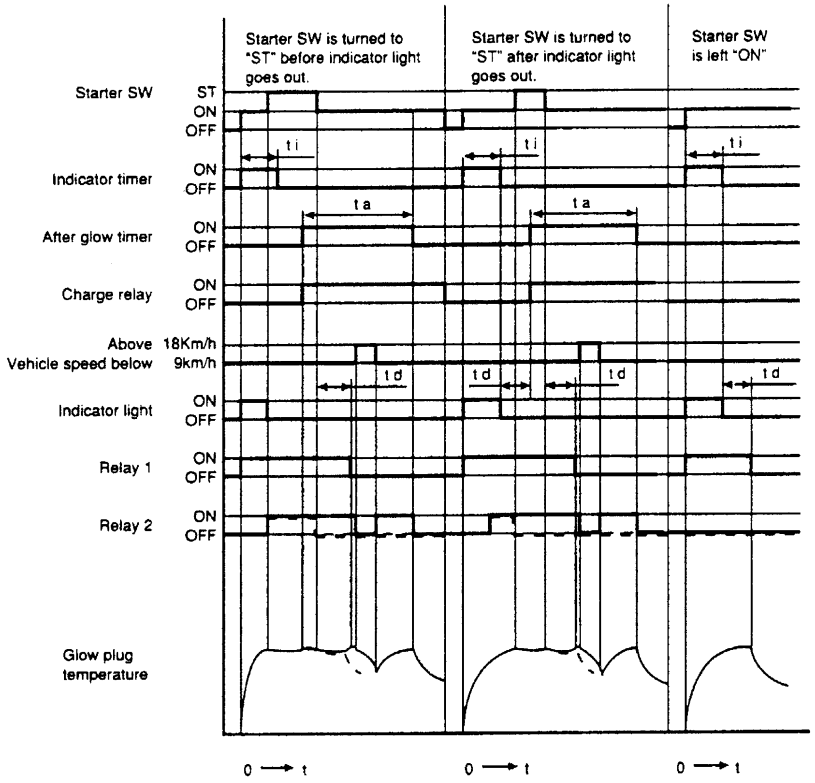
General Description

QOS III preheating system features a quick-on glow plug with thermometer control of the glowing time and the after-glow time function.
The system consists of a controller, indicator lamp, thermosensor, vehicle speedsensor, dropping resistor, relay (2 pcs), and temperature self-control type glow plug (4 pcs)
With the employment of the thermoswitch, the glow time changes according to the engine coolant temperature, thus allowing optimum starting conditions to be obtained.
The afterglow time function is controlled by thermosensor, vehicle speed sensor, and the engine runstall sensor (charge relay).

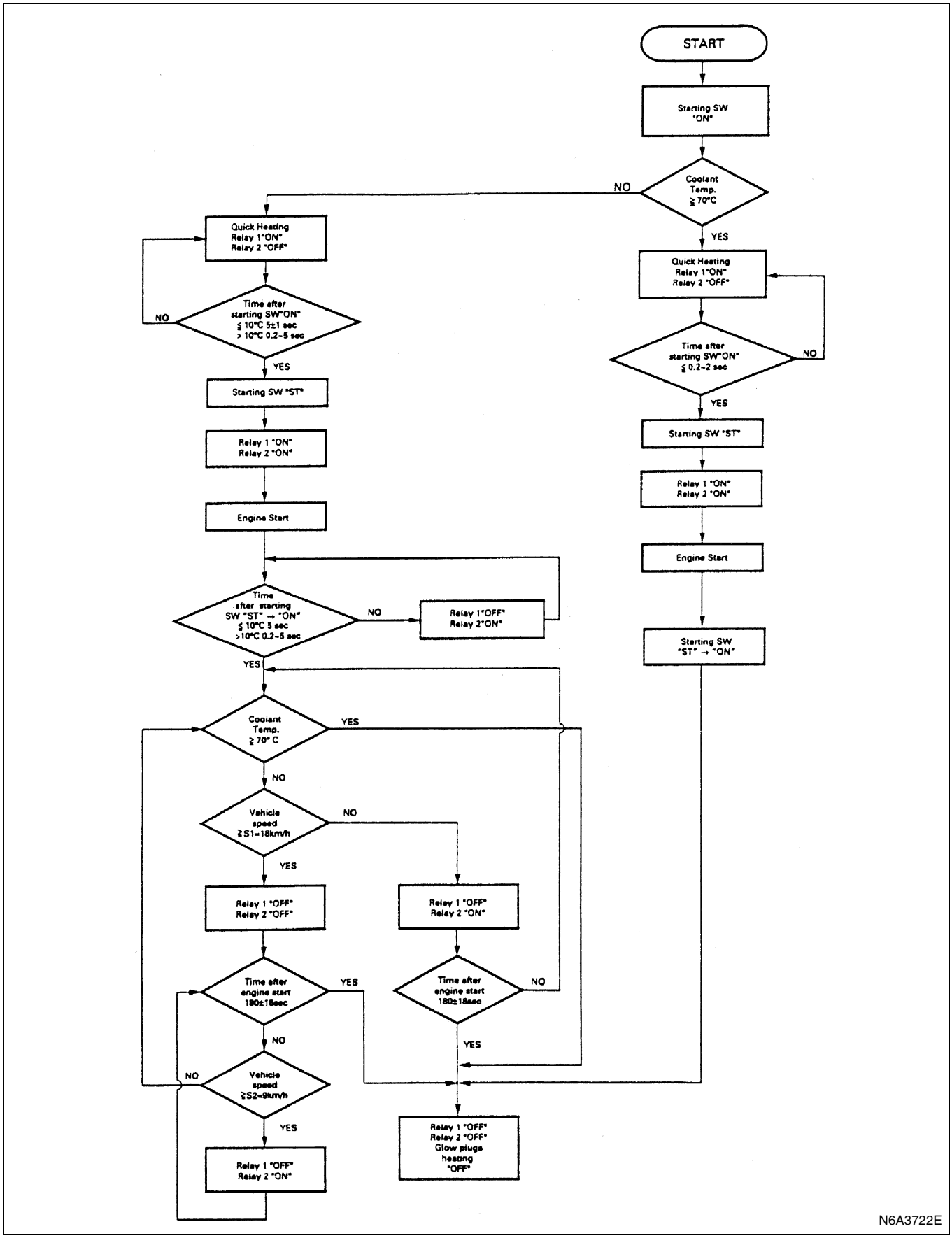
System Diagram



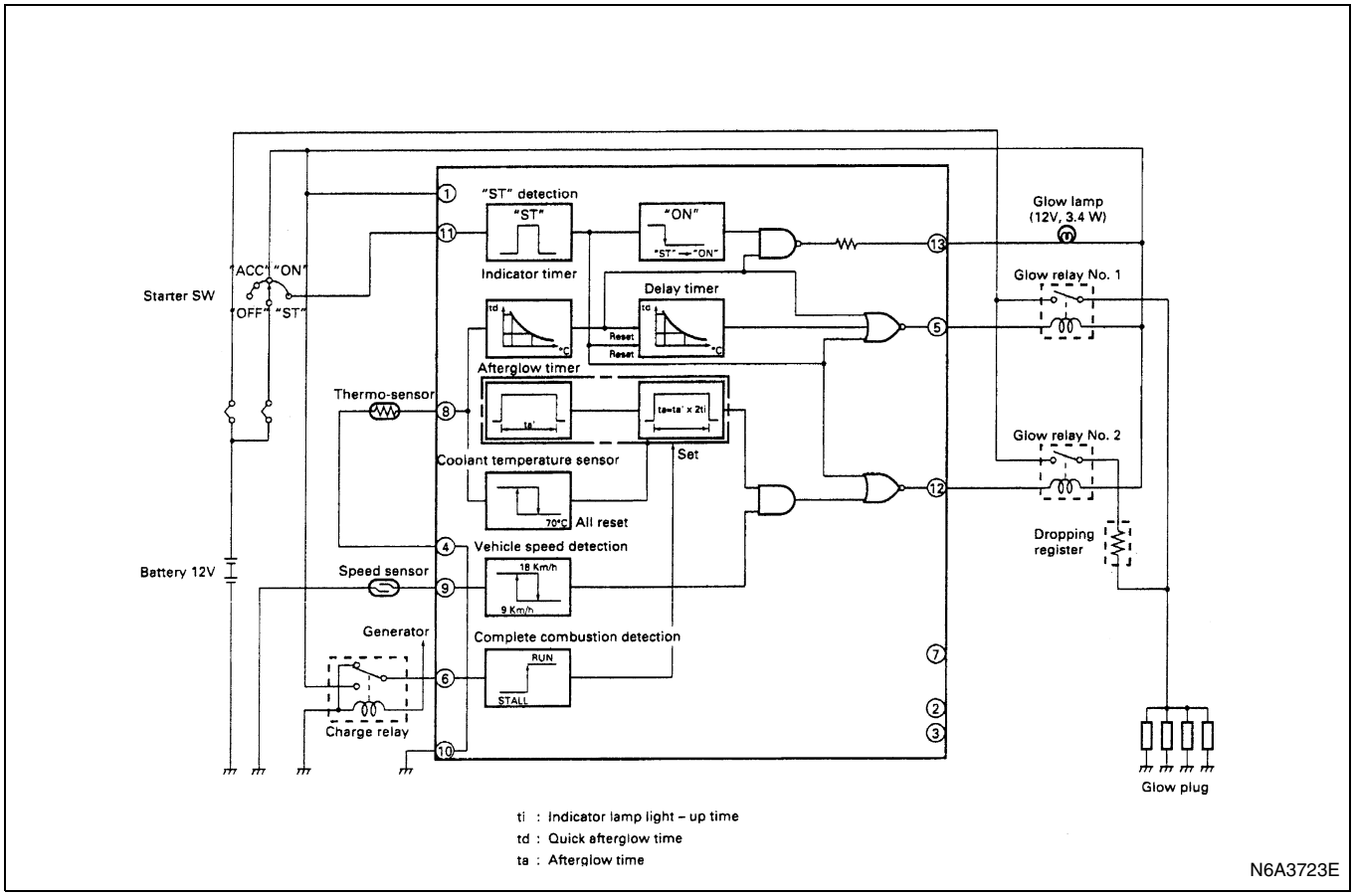
QOS II Timing Chart



QOS III Flow Chart



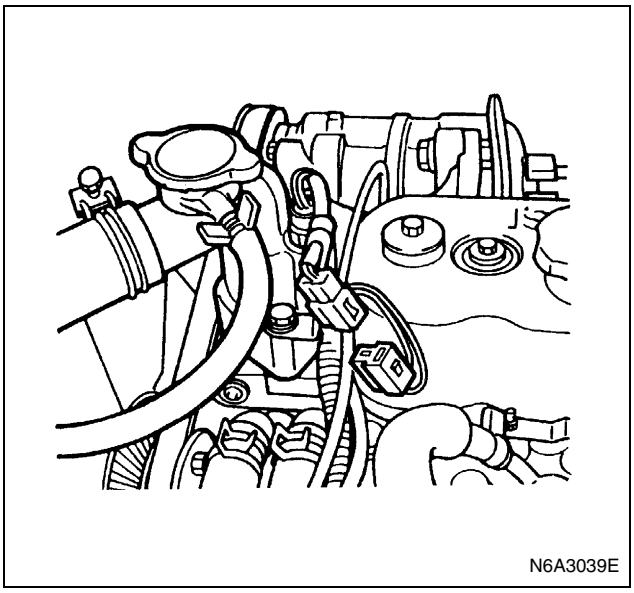
QOS II Timing Chart



Inspection on QOSIII System Operation

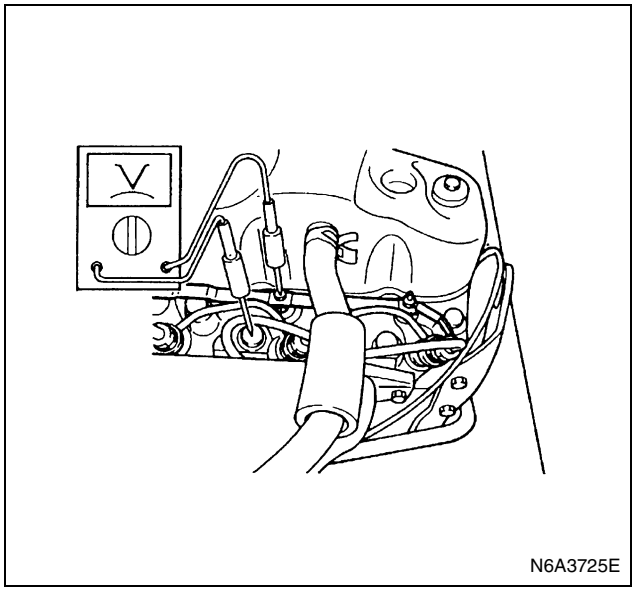
Inspection on Quick Heating Operation

1. Disconnect thermo-sensor connection on the thermostat housing.



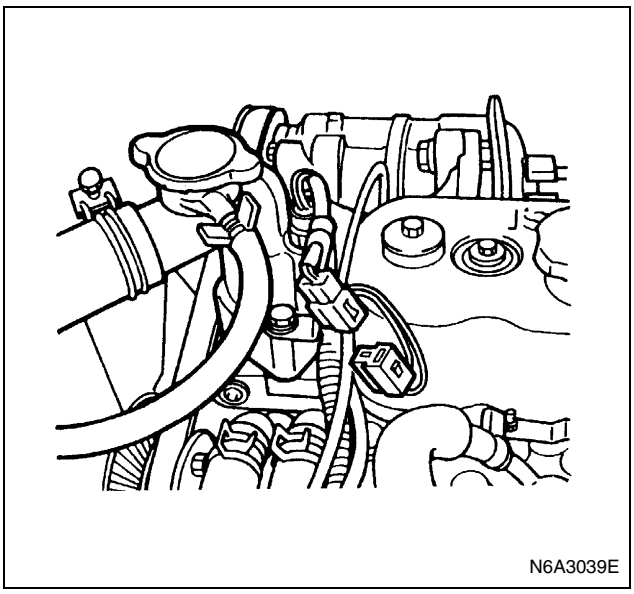
2. Connect the circuit tester between glow plug and engine earth.
3. Inspect the following items with starter switch set to ON position (but do not start the engine).
   1) The glow indicator shall light for 1 — 6 seconds.
   2) The circuit tester shall indicate power supply voltage for 9 — 13 seconds.

- If above specifications are not satisfied, inspect wire harness, glow relay and thermo-sensor. If satisfied, inspect glow plug.

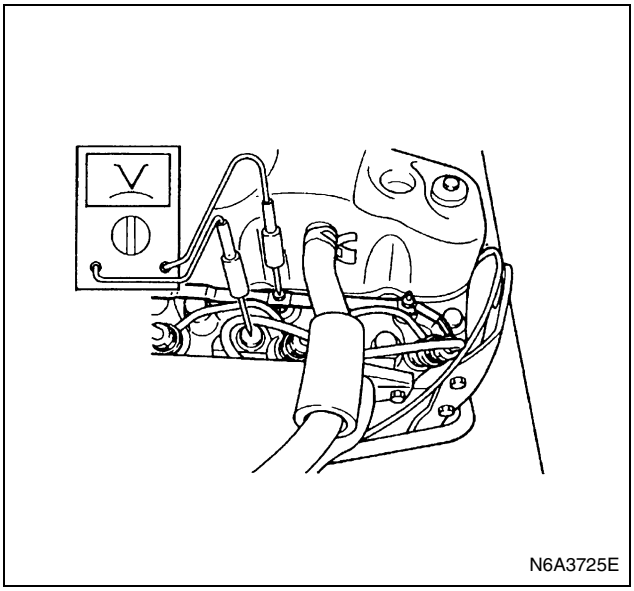


Inspection on Quick Heating Afterglow Operation

1. Disconnect thermo-sensor connection on the thermostat housing.

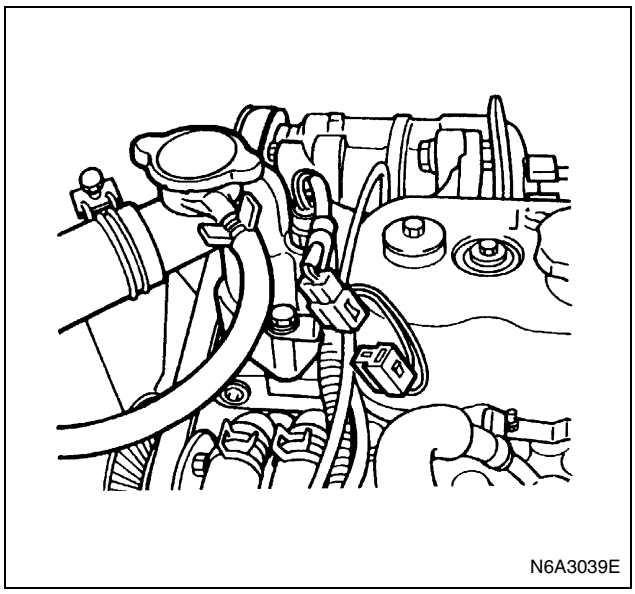

N6A3039E

2. Connect the circuit tester between glow plug and engine earth.
3. Inspect the following item with start the engine.
   1) The circuit tester shall indicate power supply voltage for about 5 seconds.
   - If above specification is not satisfied, inspect battery voltage, engine earth, wire harness and starter switch “st” signal to control unit.
     If satisfied, inspect wiring harness, engine earth and starter switch.

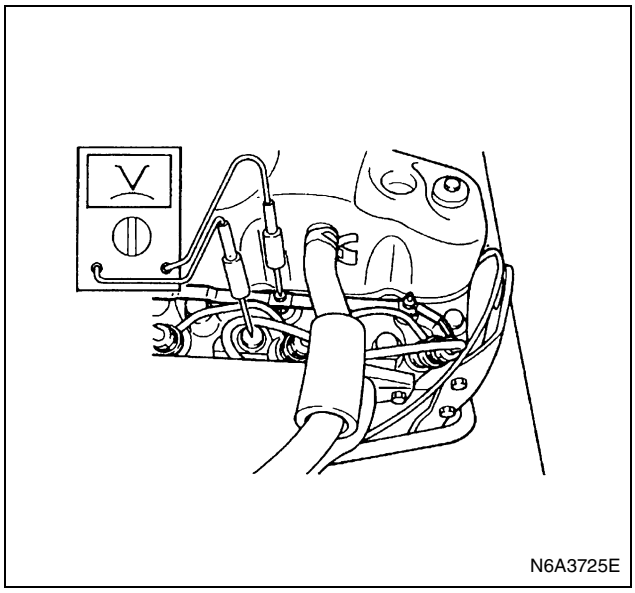

N6A3725E

Inspection on Afterglow Operation

1. Disconnect thermo-sensor connection on the thermostat housing.


N6A3039E

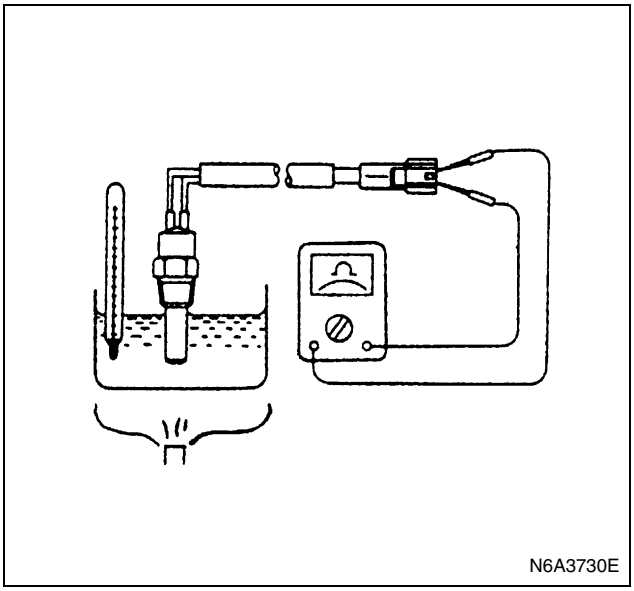
2. Connect the circuit tester between glow plug and engine earth.
3. Inspect the following items with start the engine.
   1) The circuit tester shall indicate about 7 volts after 360 seconds of engine start.
   - If above specifications are not satisfied, inspect battery voltage, engine earth, wiring harness, glow plug, dropping resistor, relay No. 2 and charge relay.


N6A3725E

Thermo Sensor

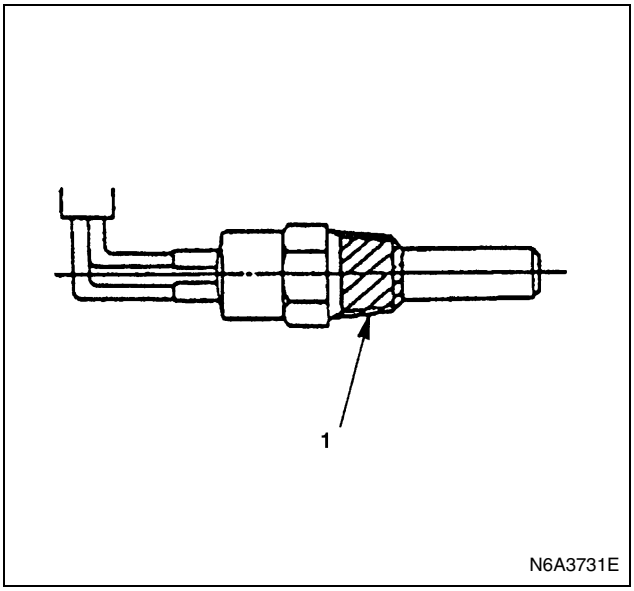
Measure the resistance depending on the water temperature as shown in the left figure. (Measuring range: 10°C — 50°C)

Temperature	Current (mA)	Resistance (KW)
20 ± 1	1.0	2.0 — 3.0
50 ± 1	1.0	0.68 — 1.0


N6A3730E

When installing the thermo sensor, apply sealant (Loctite #262 or equivalent) (1) to narrowed portion in figure to prevent water leakage.

Tighten:
Thermo sensor to 8 N·m (0.8 kg·m/69 lb·in)



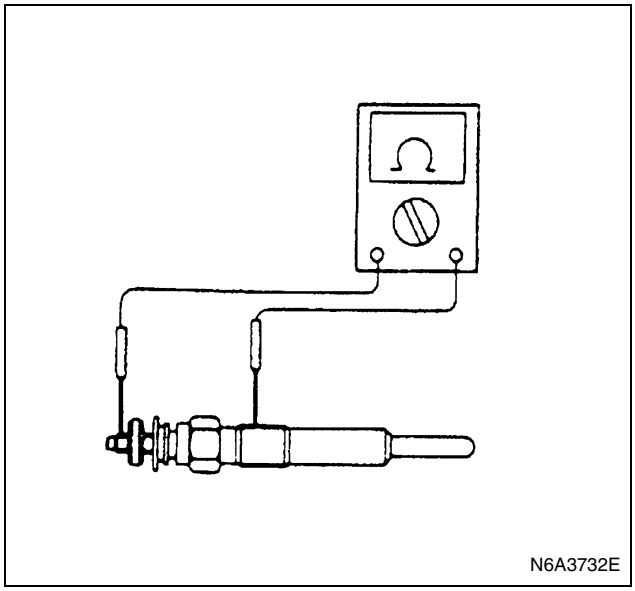
N6A3731E

Glow Plug

Inspect the resistance

Resistance at normal temperature	Ω
0.8 — 1.0	

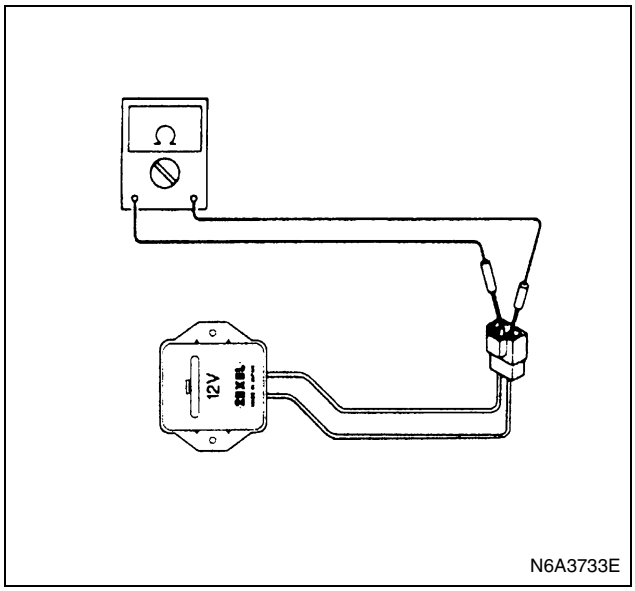
Tighten:
Glow plug to 23 N·m (2.3 kg·m/17 lb·ft)


N6A3732E

Dropping Resistor

Inspect the resistance

Resistance of normal ambient temperature	mΩ
225 — 255	



N6A3733E

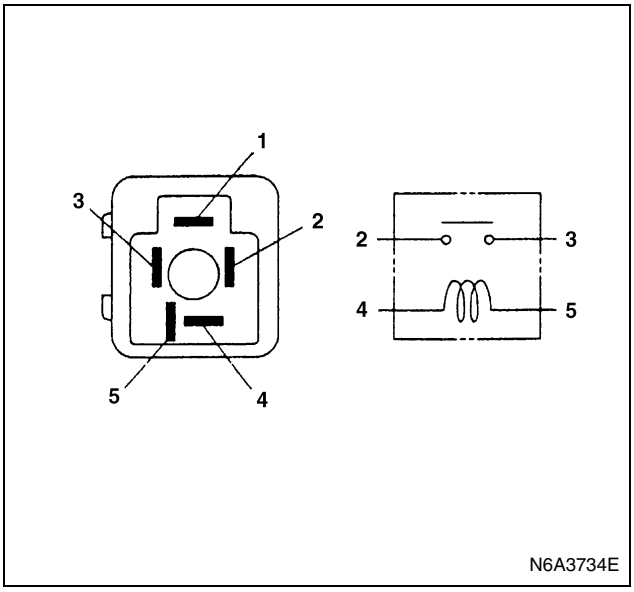
Glow Plug Relay

Inspect the continuity

2 — 3	No Continuity

If apply the battery voltage to terminal between 4 — 5

2 — 3	Continuity

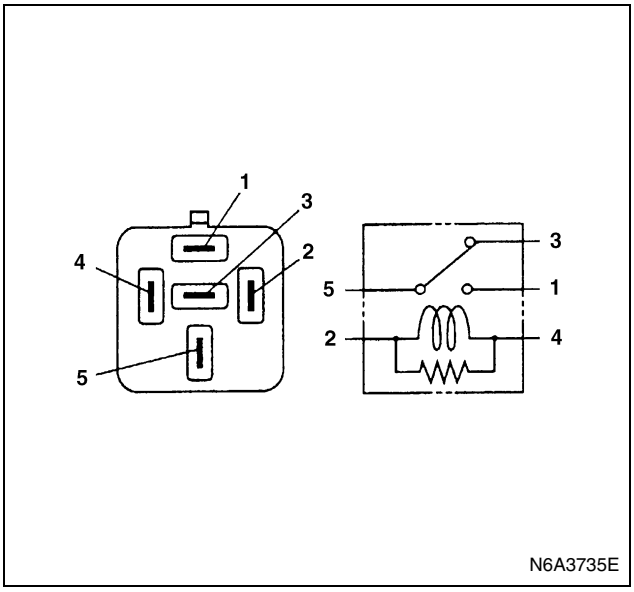


Charge Relay
Inspect the continuity

3 — 5	Continuity
1 — 5	No Continuity

If apply the battery voltage to terminal between 2 — 4

3 — 5	No Continuity
1 — 5	Continuity



ENGINE 4J SERIES

SECTION 6E

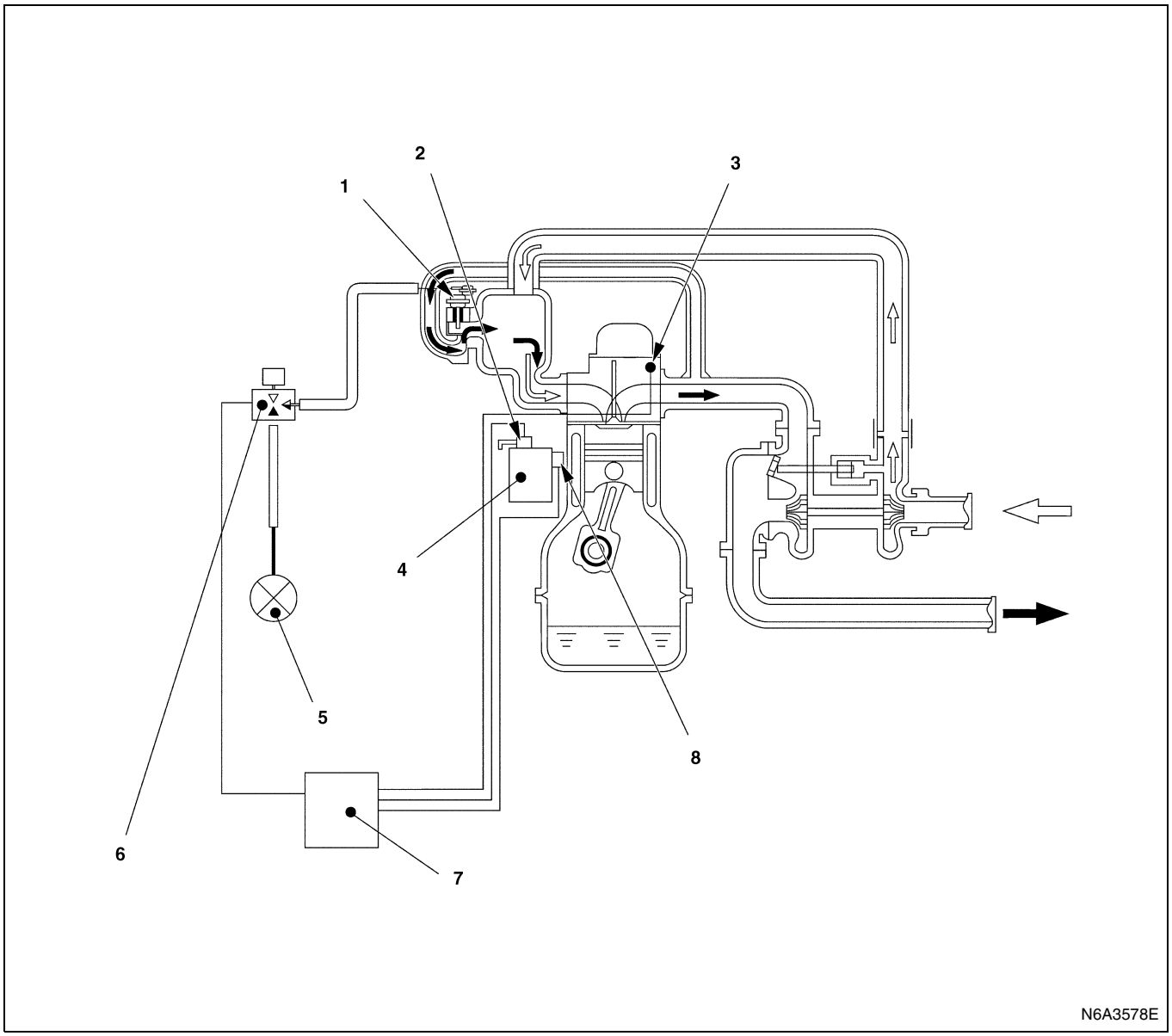
EXHAUST GAS RECIRCULATION (EGR) SYSTEM

Contents

GENERAL DESCRIPTION 6E-2
EGR SYSTEM WIRING DIAGRAM 6E-4
EGR SYSTEM OPERATION 6E-5
INSPECTION 6E-6
EGR COOLER 6E-7
Component 6E-7
Removal 6E-7
Installation 6E-8

GENERAL DESCRIPTION

4JB1-TC

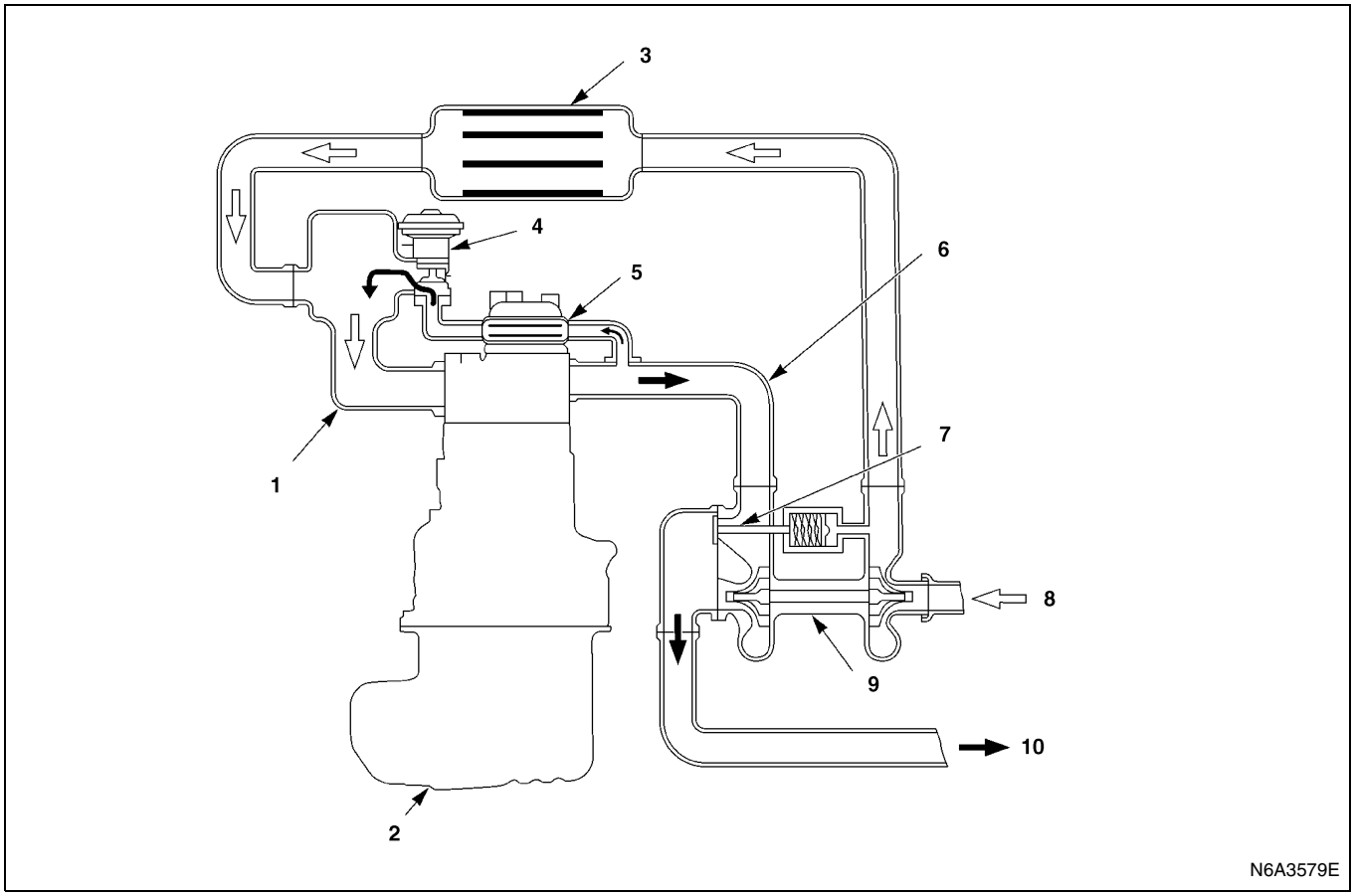


Legend

1. EGR valve
2. Potentiometer
3. Thermo switch
4. Injection pump
5. Vacuum pump
6. V.S.V
7. EGR controller
8. RPM sensor

This system controls the formation of NOx emission by recirculating the exhaust gas into the combustion chamber through the intake manifold.
The EGR valve are controlled by VSV, also VSV are controlled by EGR controller according to signals from RPM sensor and Potentiometer.
The amount of EGR depends on the number of engine rotations and the opening of the accelerator.

4JH1-TC



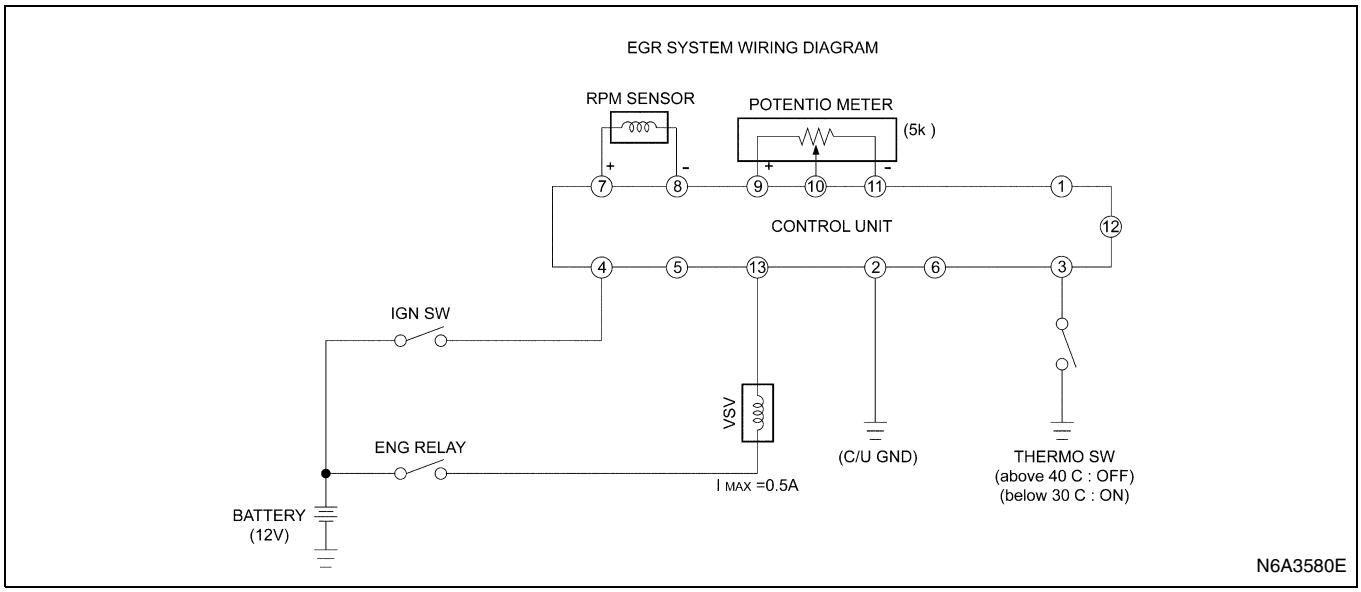
Legend

1. Intake manifold
2. Oil pan
3. Inter cooler
4. EGR valve
5. EGR cooler
6. Exhaust manifold
7. Wast gate
8. Fresh air
9. Turbocharger
10. Exhaust gas

The 4JH1-TC engine is equipped with the EGR cooler. The cooler reduces the temperature of the air being drawn into the engine and the combustion temperatures. This results in reducing nitrogen oxide (NOx) emissions.

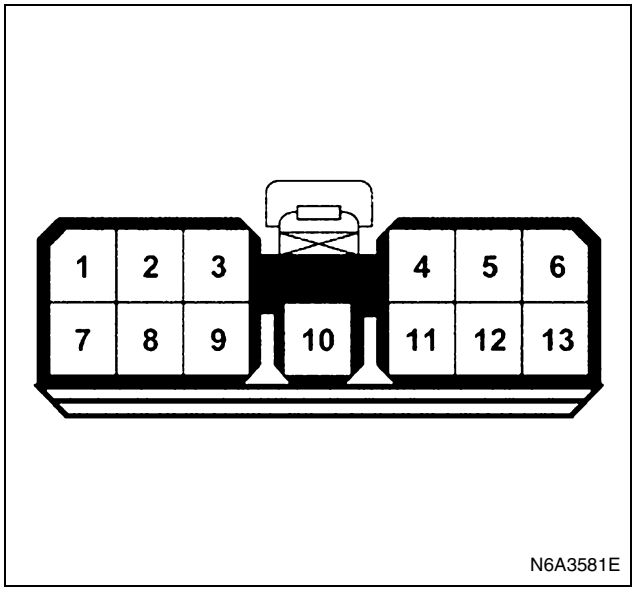
EGR SYSTEM WIRING DIAGRAM

For 4JB1-TC/4JG2



1. Connector Pin Assignment

No.	Connector Name
1	—
2	Battery (–) c/u GND
3	Thermo Switch
4	Battery (+)
5	—
6	—
7	rpm Signal (+)
8	rpm Signal (–)
9	Potentiometer (+)
10	Potentiometer
11	Potentiometer (–)
12	—
13	VSV



EGR SYSTEM OPERATION

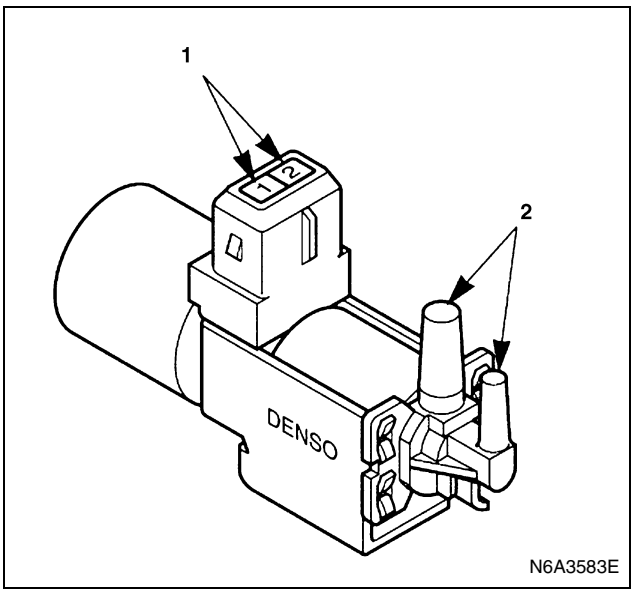
1. On the input side of engine speed, there is provided a hysteresis of 50 rpm on the speed rising side.
2. It does not work until 70 seconds, pass after engine start.
3. It does not work while the water temperature switch is on (30°C or lower).
4. While engine speed drops from 3,800 rpm or higher, it does not work for 25 seconds.

Exhaust Gas Recirculation (EGR) System Check

Step	Action	Value	YES	NO
1	Check the EGR valve for looseness. Is the EGR valve loose?	—	Go to Step 2	Go to Step 3
2	Tighten the EGR valve. Is the action complete?	—	Verify repair	—
3	1. Engine “OFF”. 2. Ignition “ON”. 3. Using test light to ground, check the EGR harness between the EGR valve and ignition feed. Does the test light illuminate?	—	Go to Step 5	Go to Step 4
4	Repair the EGR harness ignition feed. Was the problem corrected?	—	Verify repair	Go to Step 5
5	1. Remove the EGR valve. 2. Visually and physically inspect the EGR valve pintle, valve passages and adapter for excessive deposits, obstructions or any restrictions. Does the EGR valve have excessive deposits, obstructions or any restrictions?	—	Go to Step 6	Go to Step 7
6	Clean or replace EGR system components as necessary. Was the problem corrected?	—	Verify repair	Go to Step 7
7	1. Remove the EGR inlet and outlet pipes from the intake and exhaust manifolds. 2. Visually and physically inspect manifold EGR ports and EGR inlet and outlet pipes for blockage or restriction caused by excessive deposits or other damage. Do the manifold EGR ports or inlet and outlet pipes have excessive deposits, obstructions, or any restrictions?	—	Go to Step 8	EGR system working properly. No problem found.
8	Clean or replace EGR system components as necessary. Is the action complete?	—	Verify repair	—

INSPECTION

Vacuum Switch Valve (VSV)
Check the resistance between the VSV connector terminals using a circuit tester.
Cold Resistance: 37 — 44 (Ω) (for 12 volt)
Connect battery voltage between VSV connector terminals and make sure of the continuity between the ports.



Legend
1. 2 pin
2. Port

EGR Valve
With negative pressure applied to the diaphragm chamber, make sure that the valve is smoothly actuated to make the area between (1) and (2) ventilated.
Startup: About — 18.66±2.67 Kpa (−140±20 mmHg)
Check to see if EGR valve is normally actuated under the following conditions:
QWS off (After warming up)
Engine coolant temp: 80°C or higher

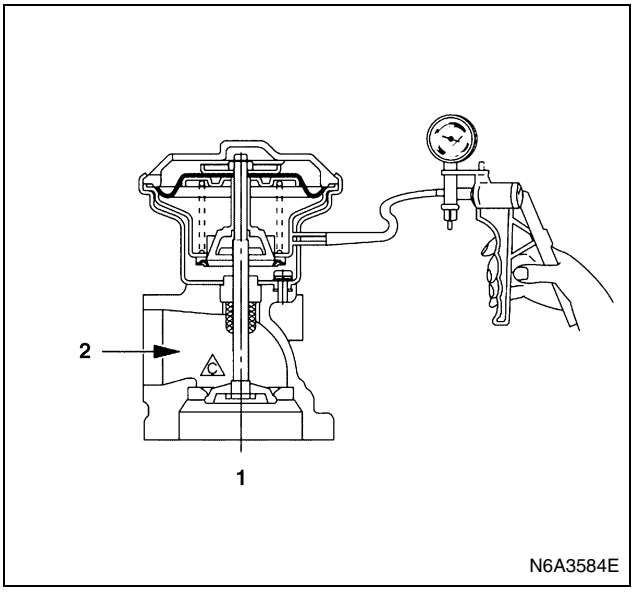
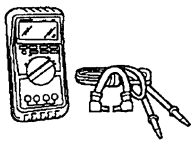
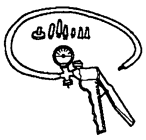
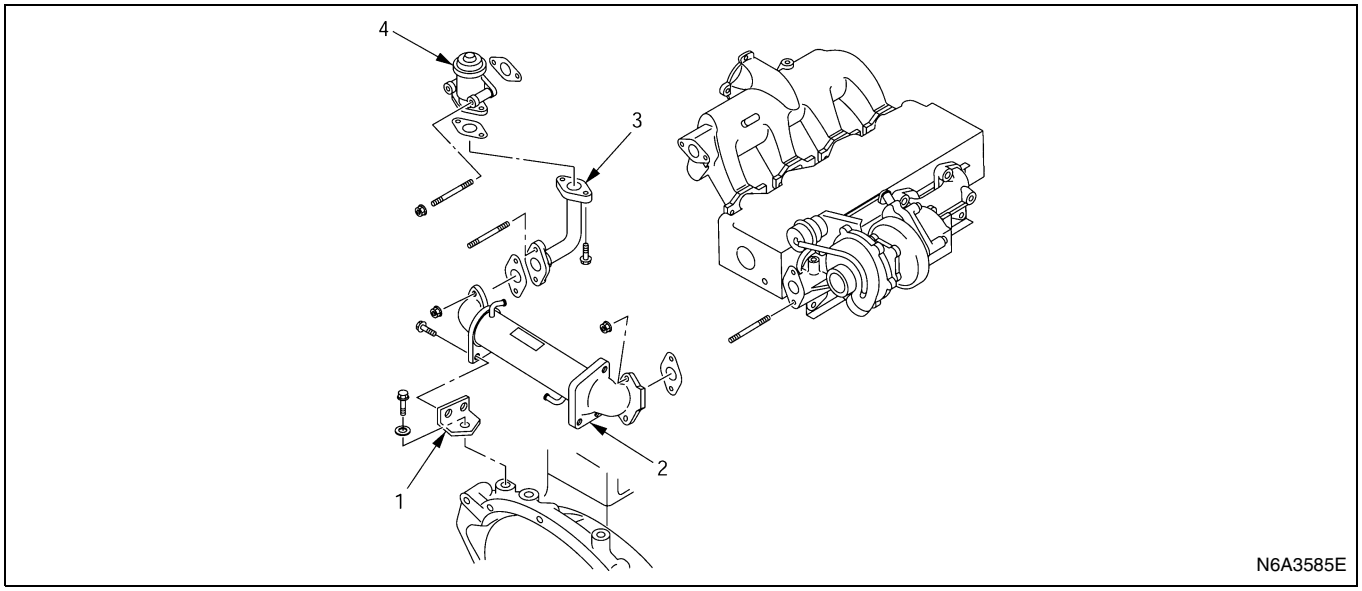


Illustration	Tool Number / Description / Remarks
 5884003660	5-8840-0366-0 / High Impedance Multimeter (Digital Voltmeter-DVM)
 5884002790	5-8840-0279-0 / Vacuum Pump with Gauge

EGR COOLER

Component



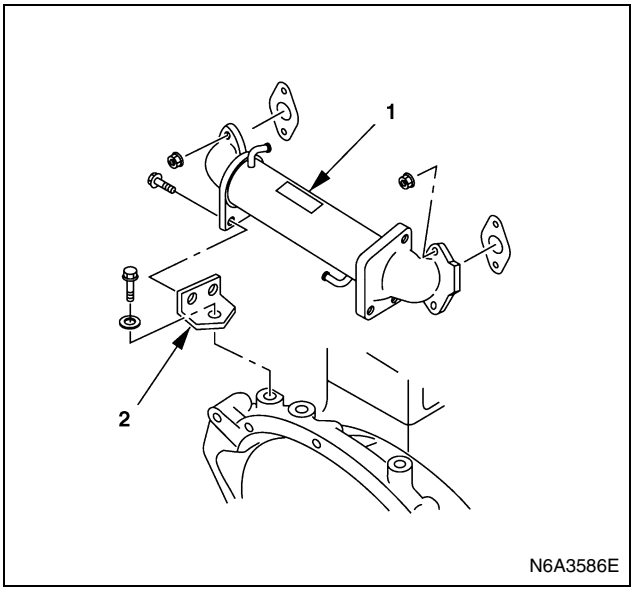
Legend
1. EGR cooler bracket
2. EGR cooler
3. EGR pipe
4. EGR valve

Removal

Preparation

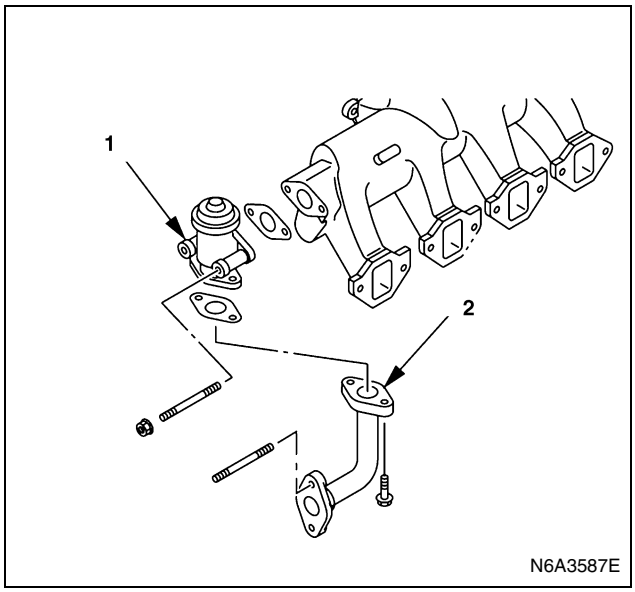
- Disconnect the battery ground cable.
- Drain the coolant.
- Remove the water hose.

1. EGR Cooler Bracket
   Remove the bracket from the flywheel housing.
2. EGR Cooler
   Remove the EGR fixing nuts. Remove the cooler together with the gasket.



Legend
1. EGR cooler
2. EGR cooler bracket

3. EGR Pipe
4. EGR Valve

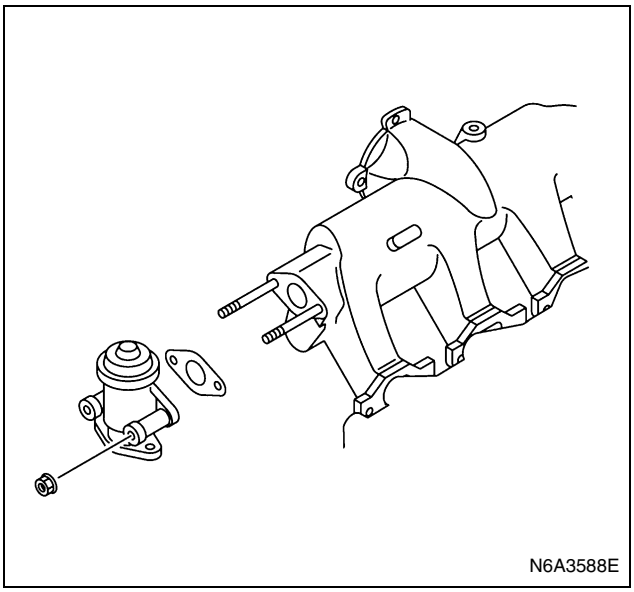


Legend
1. EGR valve
2. EGR pipe

Installation

1. EGR Valve
   - Install the gasket to the intake manifold.
   - Install the EGR valve and tighten the nuts to the specified torque.

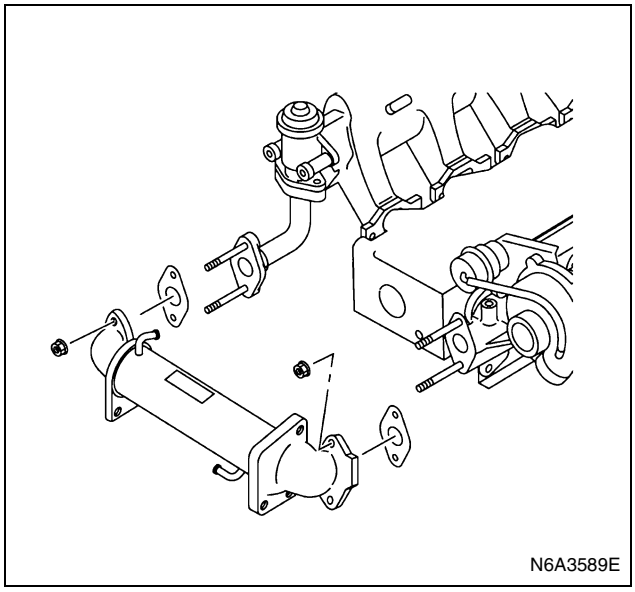
Tighten:
- Nut to 24 N·m (2.4 kg·m / 17 lb·ft)


N6A3588E

2. EGR Pipe
   - Install the gasket to the EGR valve.
   - Install the EGR pipe and tighten the bolts to the specified torque.

Tighten:
- Bolt to 19 N·m (1.9 kg·m / 14 lb·ft)

3. EGR Cooler
   - Install the gaskets to the EGR pipe and the exhaust manifold.
   - Install the EGR cooler.
   - Tighten the nuts until they seat (do not final tighten).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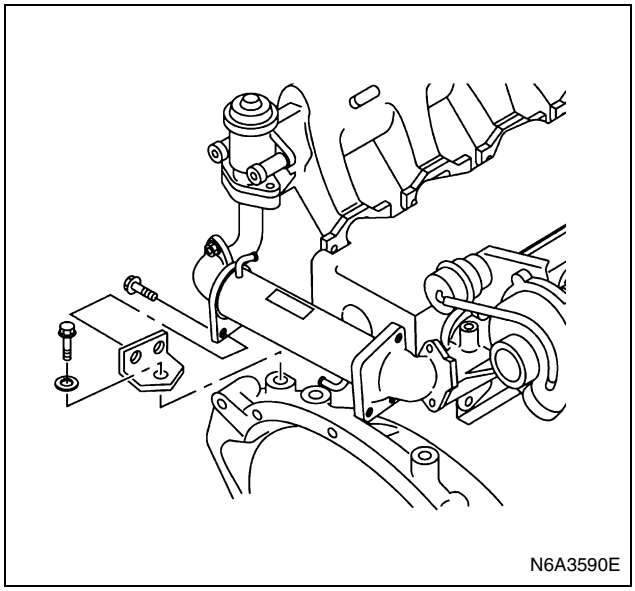
4. EGR Cooler Bracket
   - Install the bracket to the EGR cooler.
   - Install the washer to the flywheel housing side.
   - Tighten the bolts until they seat (do not final tighten).



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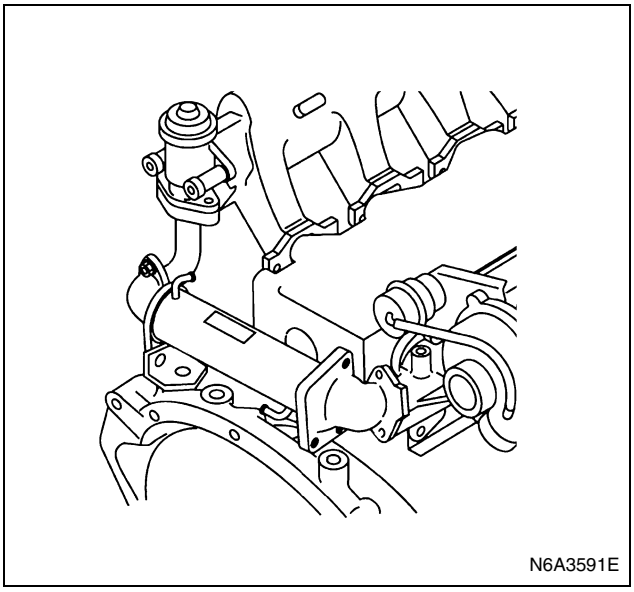
Tighten the nuts and bolts to the specified torque in the order shown in the illustration.

Tighten:
- Nuts to 24 N·m (2.4 kg·m / 17 lb·ft)
- Bolts to 19 N·m (1.9 kg·m / 14 lb·ft)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ENGINE 4J SERIES

SECTION 6F
ENGINE EXHAUST

Caution:
Exhaust system components must have enough clearance from the underbody to prevent overheating of the floor pan and possible damage to the passenger compartment, insulation and trim materials.

Contents

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On-Vehicle Service 6F-3
FRONT EXHAUST PIPE 6F-4
Component 6F-4
Removal 6F-4
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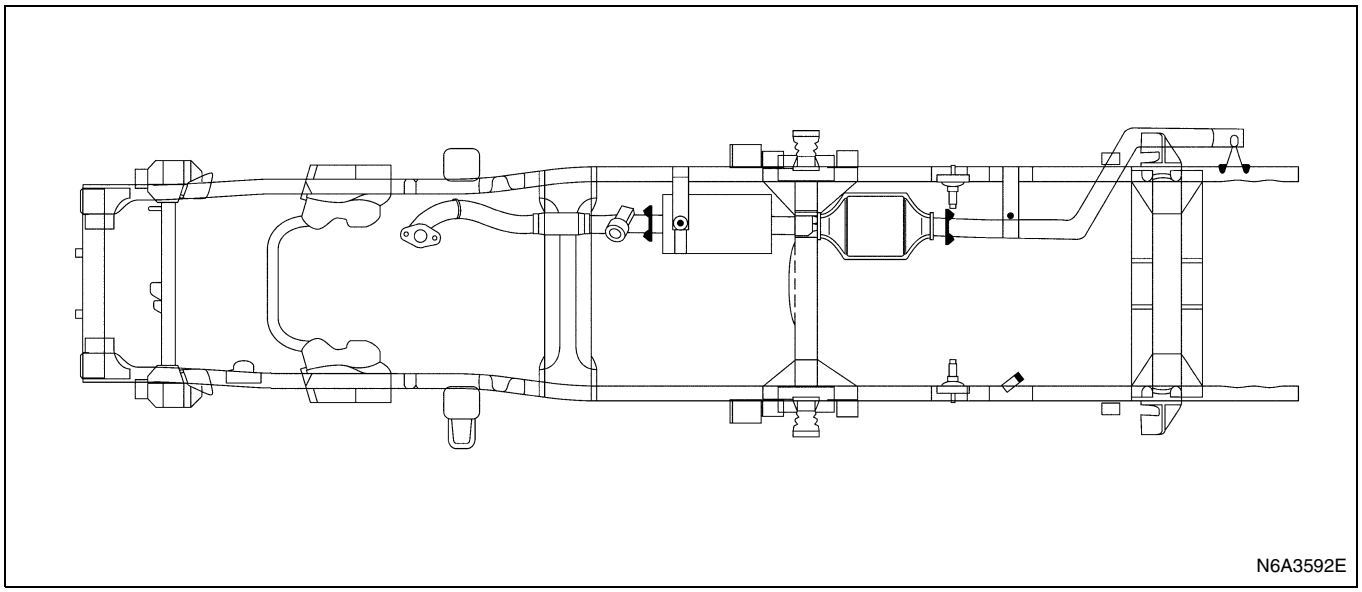
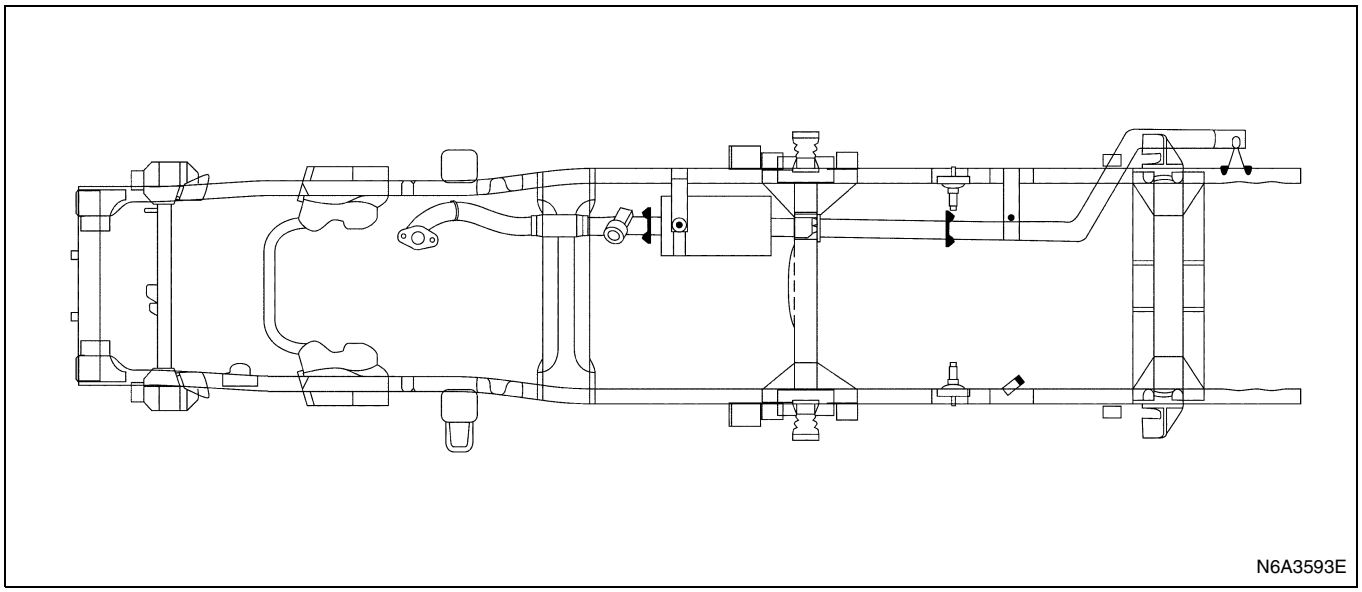
EXHAUST BRAKE UNIT 6F-6
Inspection 6F-6

GENERAL DESCRIPTION

Model '91/542B (Euro 2)



General Export

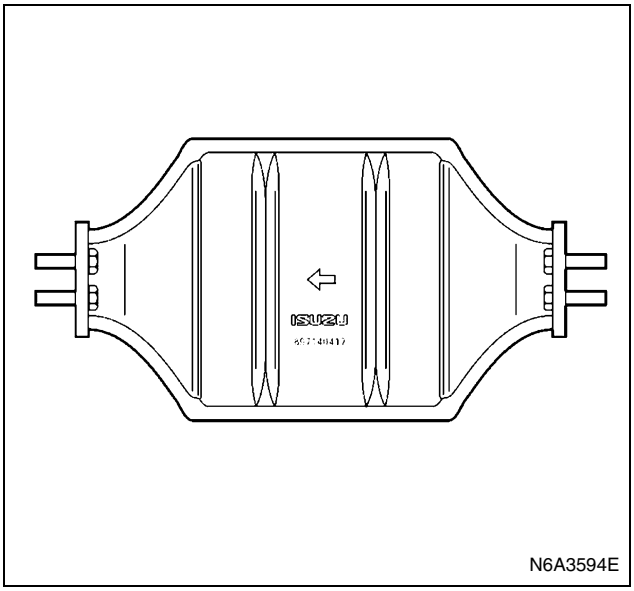


When inspecting or replacing exhaust system components, make sure there is adequate clearance from all points on the underbody to prevent overheating of the floor pan and possible damage to the passenger compartment insulation and trim materials.

Check complete exhaust system and nearby body areas and rear compartment lid for broken, damaged, missing or mispositioned parts, open seams, holes, loose connections or other deterioration which could permit exhaust fumes to seep into the rear compartment or passenger compartment. Dust or water in the rear compartment may be an indication of a problem in one of these areas. Any faulty areas should be corrected immediately.

THREE WAY CATALYTIC CONVERTER

The three way catalytic converter is an emission control device added to the exhaust system to reduce pollutants from the exhaust gas stream.



Caution:
The catalytic converter requires the use of unleaded fuel only.

Periodic maintenance of the exhaust system is not required. If the vehicle is raised for other service, it is advisable to check the condition of the complete exhaust system.
A dual bed monolith catalytic converter is used in combination with three way catalytic converter.
Catalytic Types:
Three way (Reduction/Oxidation) catalyst
The catalyst coating on the three way (reduction) converter contains platinum and rhodium which lowers the levels of oxide of nitrogen (NOx) as well as hydrocarbons (CH) and carbon monoxide (Co).

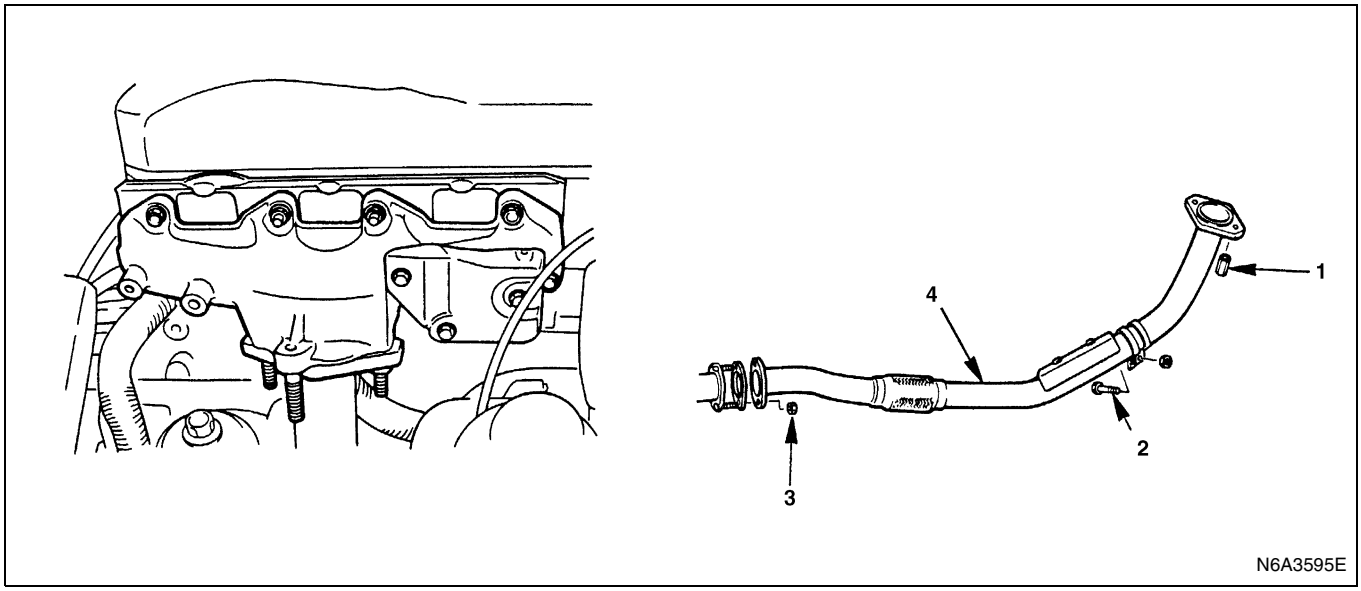
On-Vehicle Service

Rattles and noise vibrations in the exhaust system are usually caused by misalignment of parts. When aligning the system, leave all bolts or nuts loose until all parts are properly aligned; then tighten, working from front to rear.

1. Check connections for looseness or damage, especially for exhaust gas leakage.
2. Check clamps and rubbers for weakness, cracks or damage.
3. If any part of the converter heat shield is damaged or dented to the extent that it contacts the catalyst, repair or replace.
4. Check for dents or damage and for any holes or cracks caused by corrosion.

FRONT EXHAUST PIPE

Component



Legend

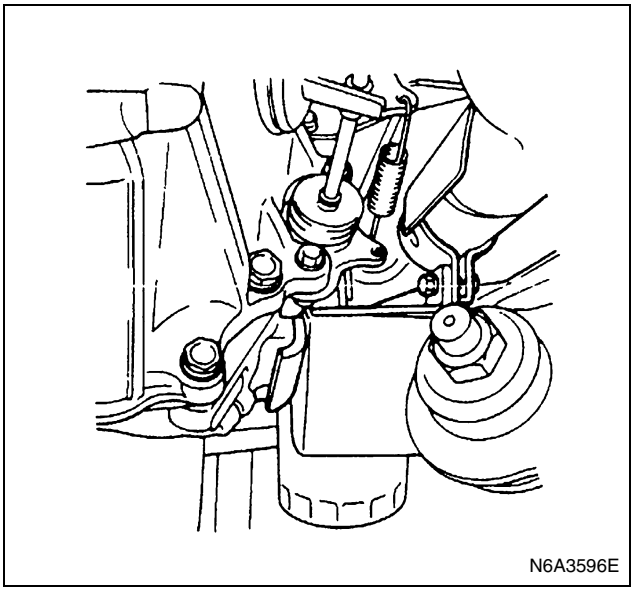
1. Exhaust manifold fixing washer and nut.
2. Front exhaust pipe mounting bracket fixing bolt and nut.
3. Front exhaust pipe fixing nut.
4. Front exhaust pipe.

Removal

Preparation

- Battery ground cable

1. Exhaust manifold fixing nuts.
   - Remove two fixing nuts from exhaust manifold and front pipe.
2. Front exhaust pipe mounting bracket fixing bolt and nut.



3. Front exhaust pipe fixing bolts and nuts.
   - Remove two bolts fixed from front pipe and center pipe.
4. Front exhaust pipe.
   - Take out the exhaust pipe to another side.

Installation

1. Front exhaust pipe.
2. Front exhaust pipe fixing bolts and nuts.
   - Tighten the fixing nuts to the specified torque

Tighten:

- 50 N·m (5.1 kg·m / 37 lb·ft)

3. Front exhaust pipe mounting bracket fixing bolt and nut.
   - Tighten the fixing bolt to the specified torque

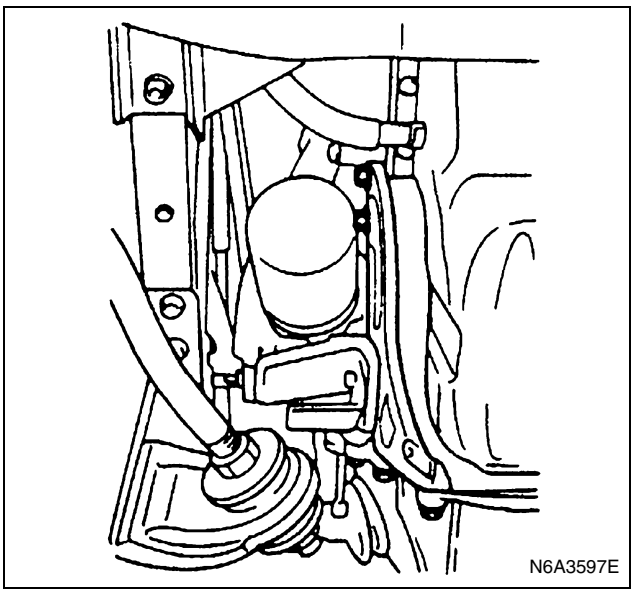
Tighten:

- 40 N·m (4.1 kg·m / 30 lb·ft)

4. Exhaust manifold fixing nuts
   - Tighten the fixing nuts to the specified torque

Tighten:

- 69 N·m (7 kg·m / 51 lb·ft)



- Connect battery ground cable.
- After assembling each part, start the engine to check for any leakage of gas at each connection.

EXHAUST BRAKE UNIT

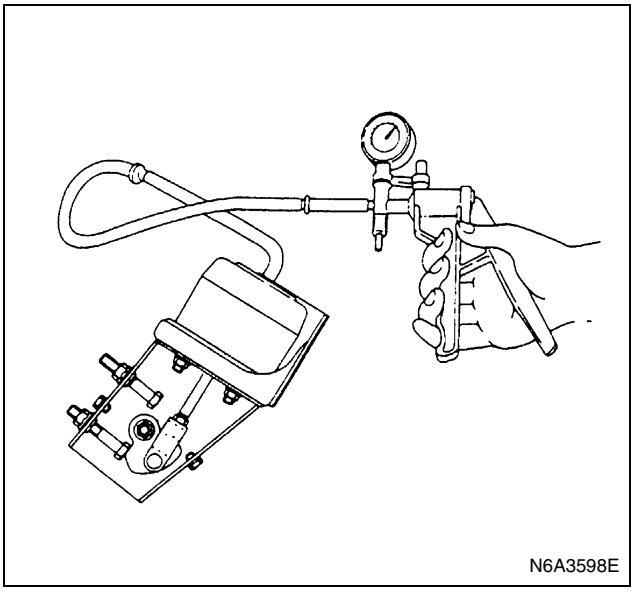
Inspection

Operational Inspection

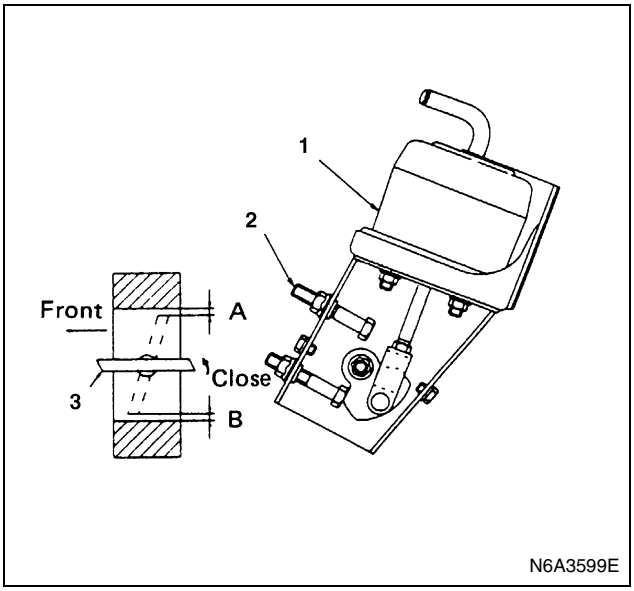
- With the engine idling, operate the exhaust brake to check for the sound of the valve hitting against the stopper.

Unit Inspection

- Check to see if the exhaust valve opens and closes smoothly when the power chamber is applied with a negative pressure (400 mmHg — 700 mmHg) by the vacuum pump.



- Check to see if the clearance between the valve and the body is in the range of 0.1 mm — 0.2 mm (the minimum of 0.1 mm) on an average of the points “A” and “B” when the power chamber is applied with a negative pressure (650 mmHg — 700 mmHg) by the vacuum pump.
  When the clearance is outside this range, adjust the clearance with the adjust bolt.



ENGINE 4J SERIES

SECTION 6G
TURBOCHARGER

Contents

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DISASSEMBLY....6G-5
Component....6G-5
Disassembly Steps....6G-6
INSPECTION AND REPAIR....6G-7
REASSEMBLY....6G-9
Reassembly Steps....6G-9
IHI SERVICE NETWORK....6G-10

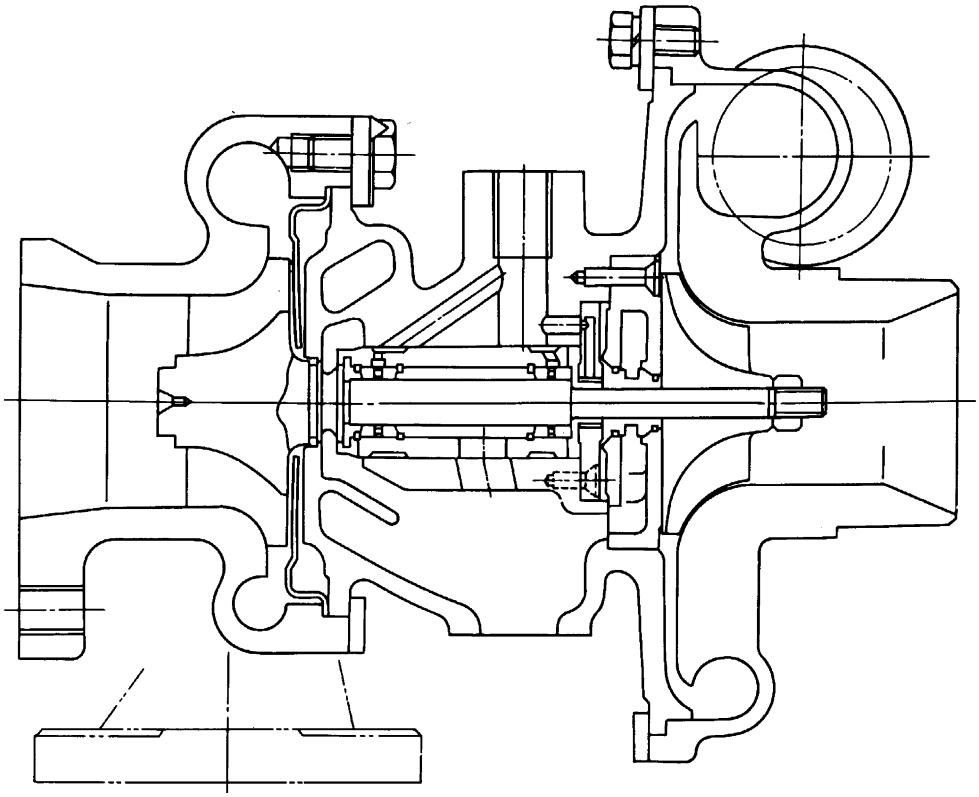
TURBOCHARGER

Main Data and Specifications

Model		IHI RHF 4H	IHI RHB 5
Turbine type		Mixed-flow	Radial-inflow
Compressor type		Centrifugal	
Maximum permissible speed	rpm	180,000	
Wastegate opening pressure	kPa (mmHg)	109 ± 4.4 (815 ± 33)	120 ± 4.8 (898 ± 36)
Weight	N (kg/lb)	41 (4.2/9.3)	45 (4.6/10.1)

IHI: Ishikawajima-Harima Heavy Industries., Ltd.

GENERAL DESCRIPTION



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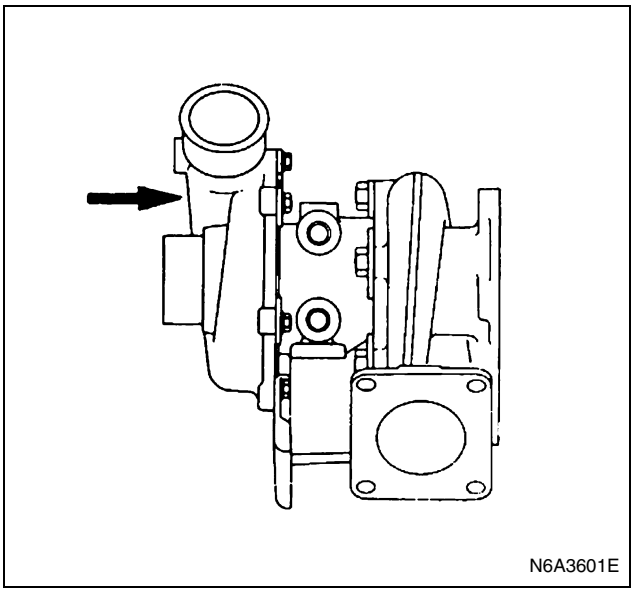
The turbocharger internal mechanism consists of the turbine wheel, the compressor wheel, and the radial bearings. These parts are supported by the bearing housing.
The turbocharger external mechanism consists of the compressor housing air intake port and the turbine housing air exhaust port.
The turbocharger increases air intake efficiency. This results in increased engine power, reduced fuel consumption, and minimal engine noise.
The turbocharger operates at very high speeds and temperatures. Part materials have been carefully selected and machined to extremely high precision.
Turbocharger servicing requires great care and expertise.
If reduced performance is noted, check the engine for damage or wear. If there is no apparent engine damage or wear, trouble with the turbocharger is indicated.

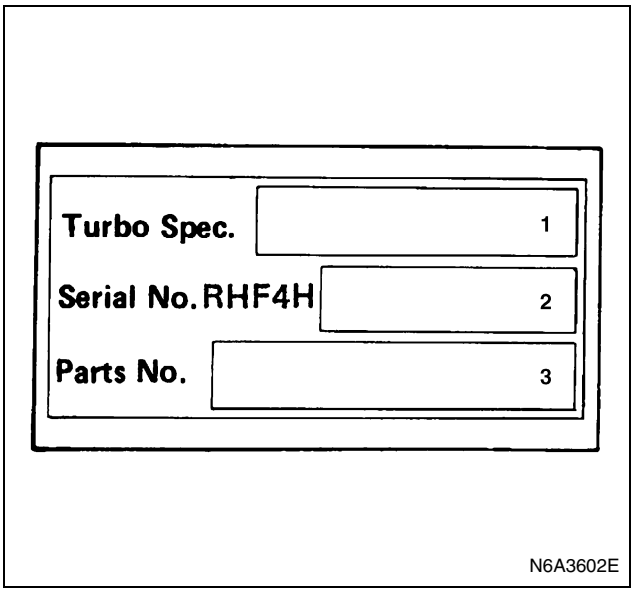
Identification of Unit

The turbocharger nameplate gives the date of manufacture and other important information required to identify the unit when service inquiries are made.



The turbocharger nameplate has the following information stamped on it.

1. Turbocharger Specification Number, Production Year and Month
2. Production Date, Serial Number
3. ISUZU Parts Number



Turbocharger Servicing

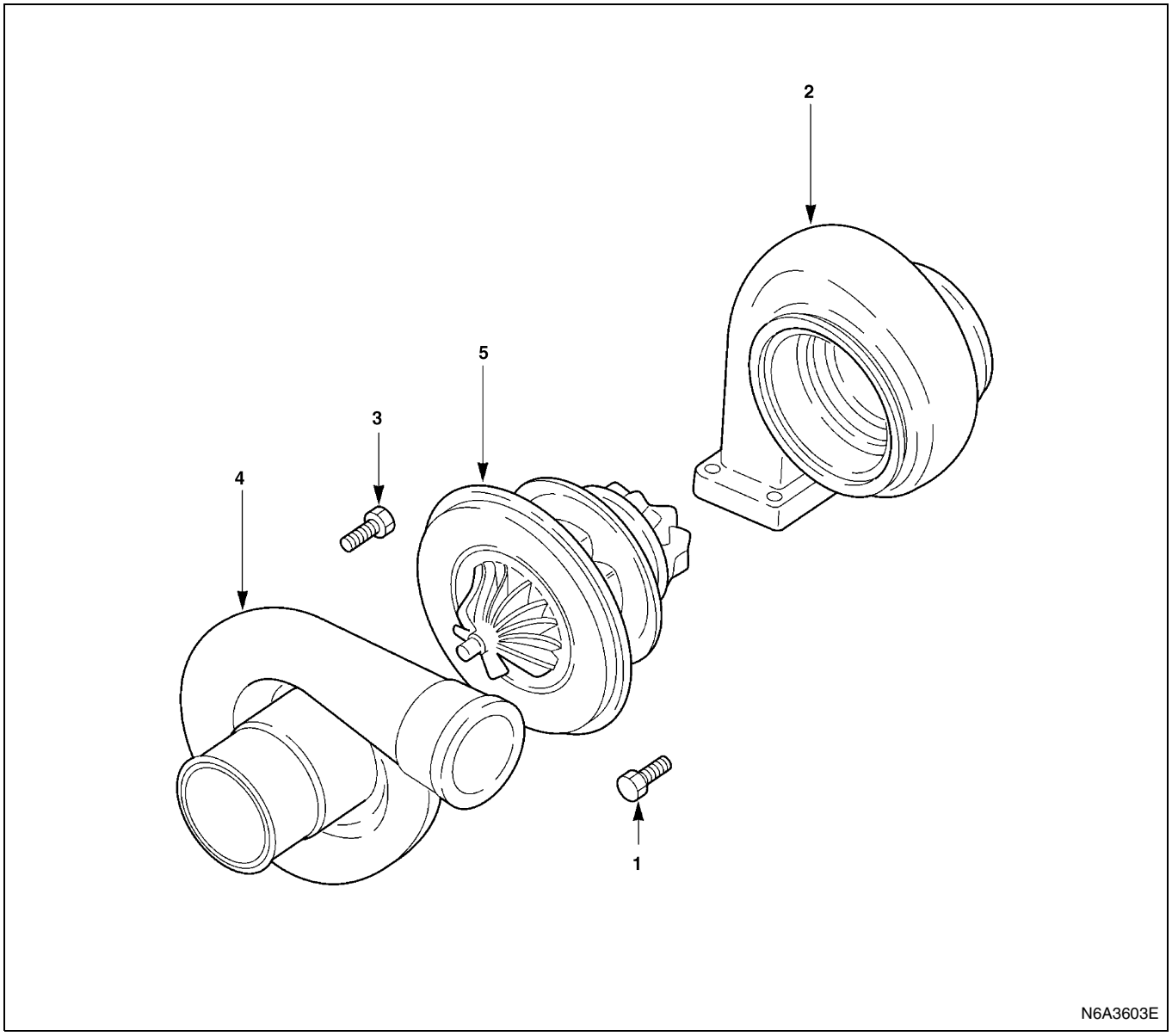
1. Refer to TROUBLESHOOTING in this Manual to determine whether or not turbocharger repair or overhaul is required.
2. The following procedures should also be performed (either with the turbocharger on the vehicle or removed from the vehicle but not disassembled) to determine whether or not turbocharger repair or overhaul is required.
   - Visual checks
   - Clearance measurements
   - End play measurements
     Refer to INSPECTION AND REPAIR
3. The turbocharger compressor and turbine housing may be removed from the center housing and rotating assembly (CHRA) for further visual inspection.
   Refer to DISASSEMBLY and REASSEMBLY.

Precautions

Turbocharger servicing requires great care and expertise.
Faulty turbocharger servicing procedures can result in serious damage to pistons, valves, cylinder liners, and other important engine parts.
ISUZU does not recommended the performance of any servicing procedure not specified described in this Manual.
Contact your nearest IHI service facility to have the turbocharger assembly repaired or overhauled.
The identification plate and assembly number will be required by the service facility.
A list of IHI Turbocharger Service Network locations is given at the end of this Section.

DISASSEMBLY

Component

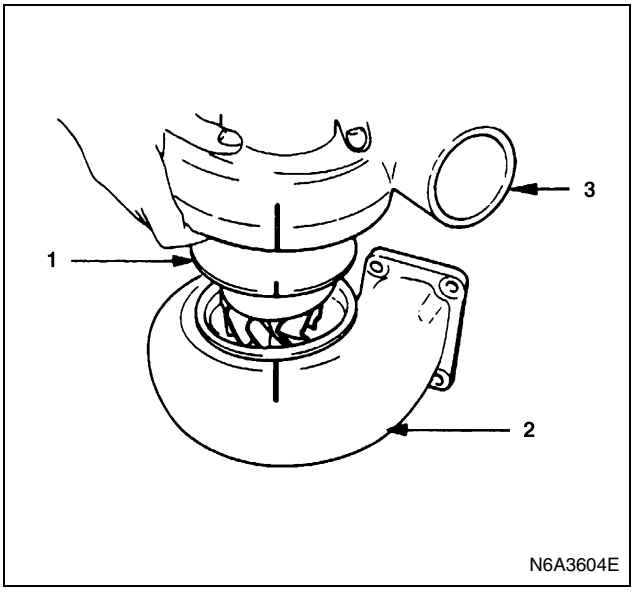


Legend

1. Bolt
2. Turbine housing
3. Bolt
4. Compressor housing
5. Center housing and rotating assembly

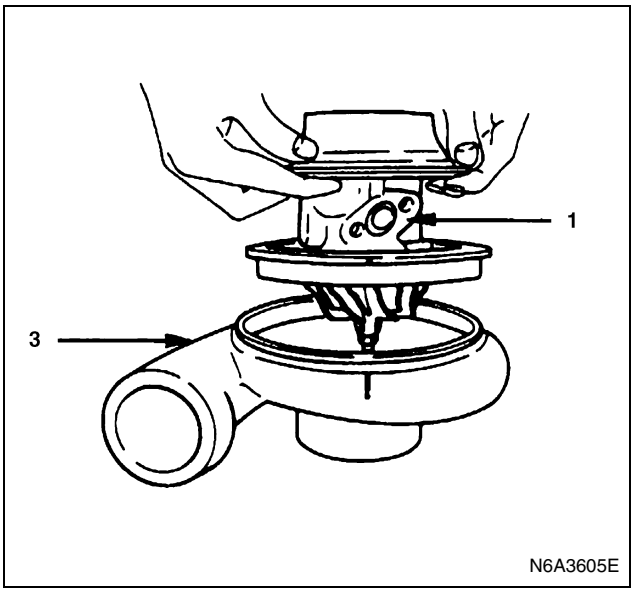
Disassembly Steps

1. Bolt
   Apply a setting mark across the center housing and rotating assembly (1), the turbine housing (2), and the compressor housing (3).



2. Turbine Housing
3. Bolt
4. Compressor Housing
5. Center Housing and Rotating Assembly
   1) Loosen the bolts.
   2) Disassembly the parts.
      Handle the parts with extreme care.
      Be particularly careful not to damage the turbine wheel blades and the compressor wheel blades. Take care not to allow foreign material to enter the center housing.

Notice:
Disassembly and servicing of the center housing and rotating assembly is not recommended.

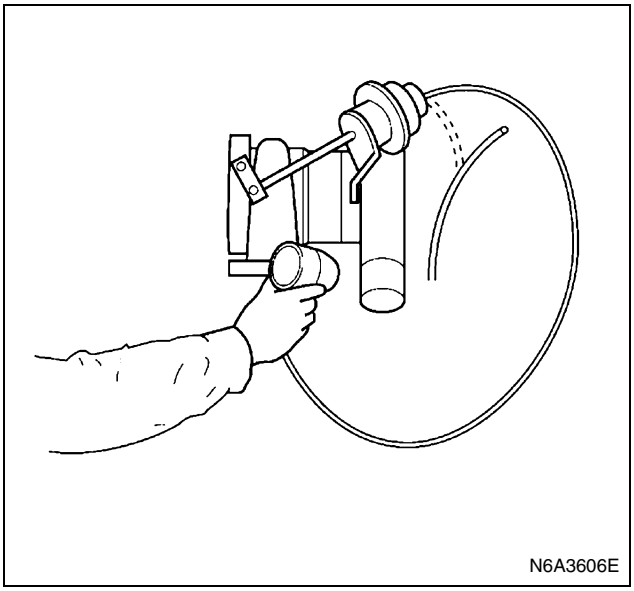


INSPECTION AND REPAIR

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.
Minor servicing operations are described in this Section. Contact the nearest IHI SERVICE FACILITY for major repairs and maintenance.
Refer to “IHI SERVICE NETWORK” at the end of this Section.

Turbocharger Pressure Check

1. Remove the waste gate control chamber connecting hose.
2. Connect the pressure gauge.
3. Start the engine and gradually increase the engine speed (the vehicle must be stationary with no load applied to the engine).
4. Check to see that turbocharger pressure rises to approximately 500 mmHg.
   Pressure Gauge: 5-8840-0075-0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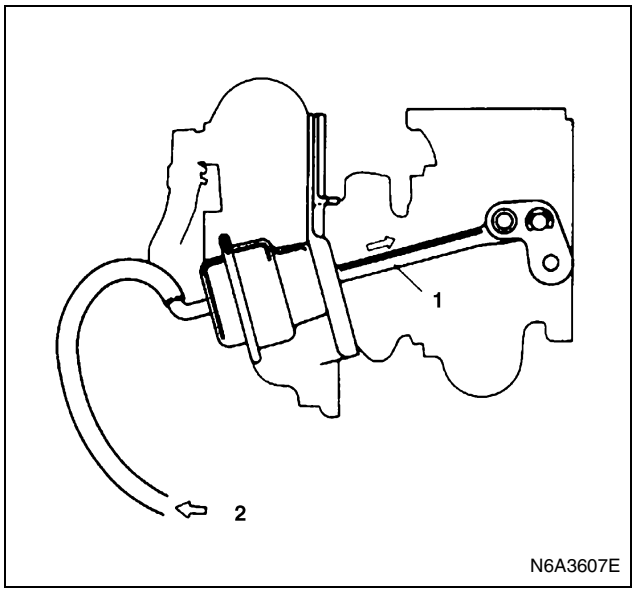
Waste Gate Operation Check

1. Remove the hose between the waste gate control chamber and the intake pipe.
2. Connect the pressure gauge.
3. Check to see that the rod begins to move when a pressure of approximately 665 mmHg is applied to the waste gate, control chamber.

Notice:
Do not apply a pressure greater than 1467 mmHg (196 kPa) to the waste gate during this check.

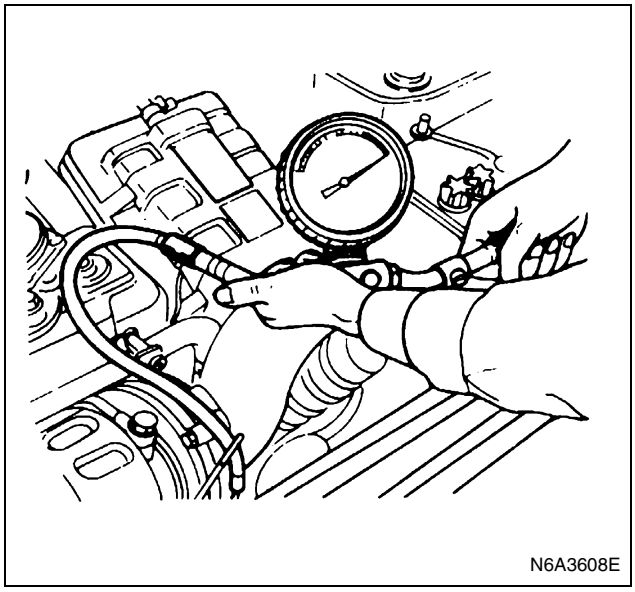


N6A3607E

Legend
1. Rod
2. Pressure

4. Check to see the pressure required to move the control rod 2 mm is within the limits shown below.

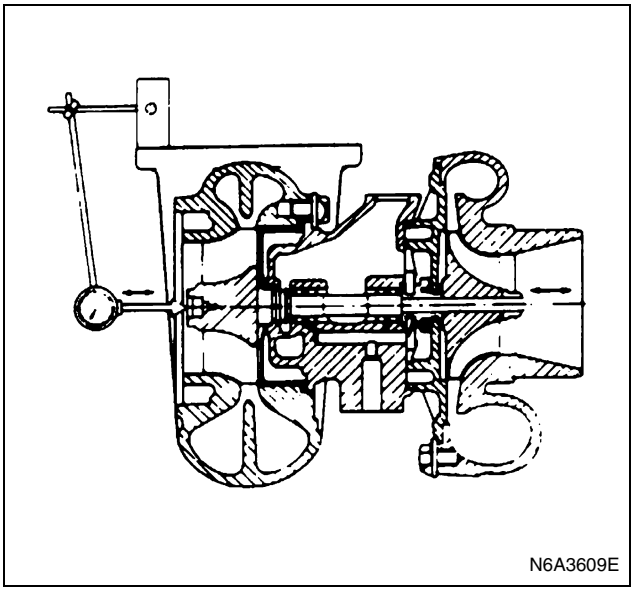
Control Rod Operating Pressure	kPa (mmHg)
4JB1-TC (IHI RHF4)	109 ± 4.4 (815 ± 33)

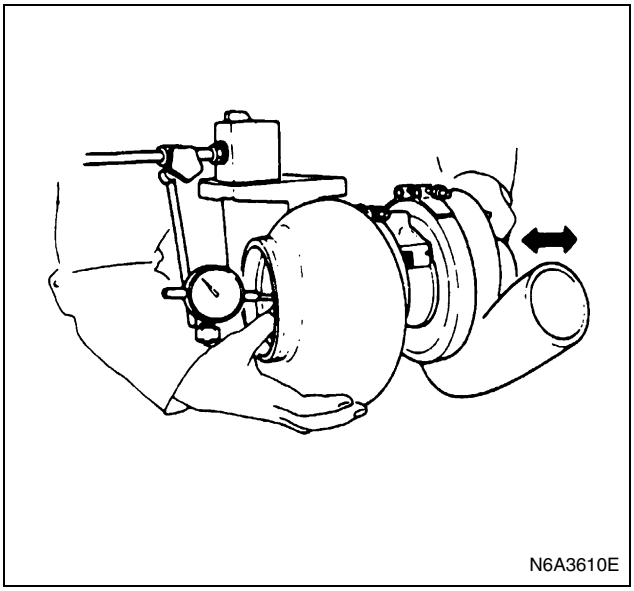

N6A3608E

Important wheel shaft end play and bearing clearance standards and limits are included below for your reference.

Wheel Shaft End Play
Use a dial indicator to measure the wheel shaft end play. Apply a force of 1.2 kg (2.6 lb / 11.8 N) alternately to the compressor wheel end and the turbine wheel end.

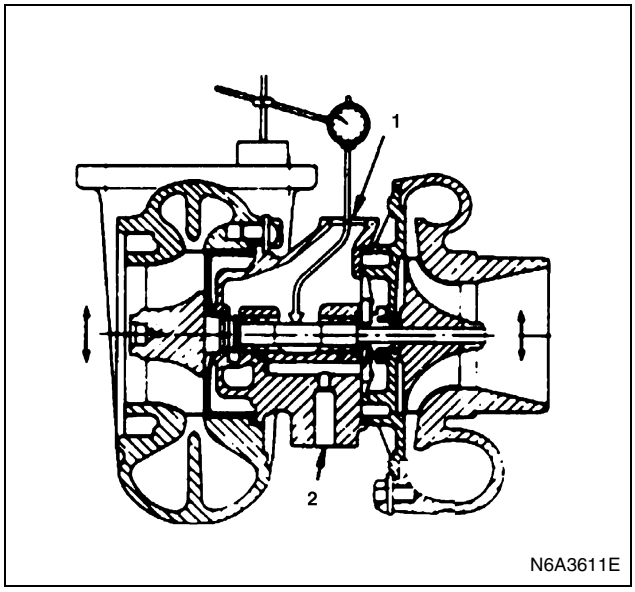
Wheel Shaft End Play	mm (in)
Standard	Limit
0.02 — 0.08 (0.0008 — 0.0031)	0.09 (0.0035)


N6A3609E


N6A3610E

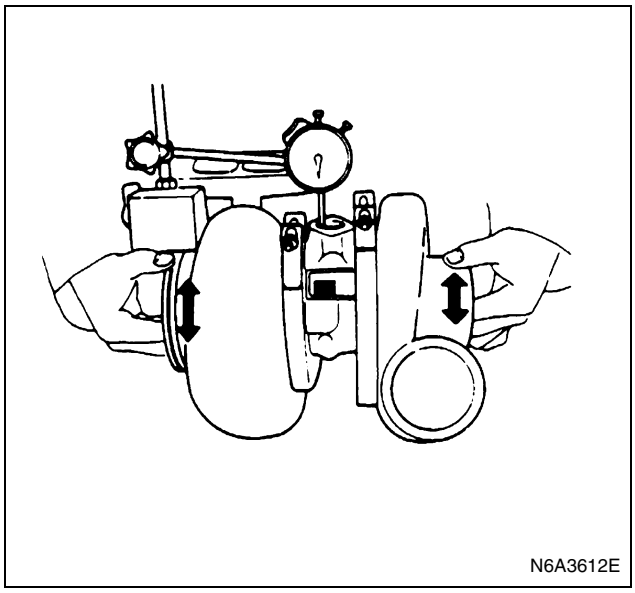
Wheel Shaft and Bearing Clearance
Use a dial indicator to measure the wheel shaft and bearing clearance.

Wheel Shaft and Bearing Clearance	mm (in)
Standard	Limit
0.07 — 0.12 (0.0028 — 0.0047)	0.16 (0.0063)



N6A3611E

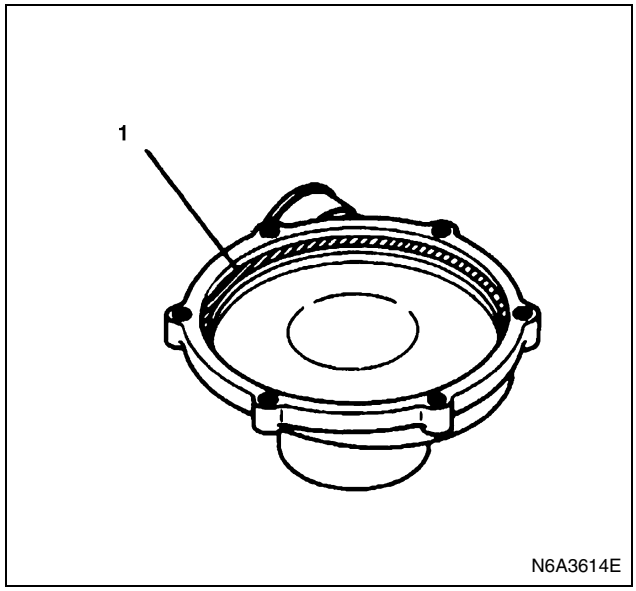
Legend
1. Oil return port
2. Oil feed port


N6A3612E

REASSEMBLY

Reassembly Steps

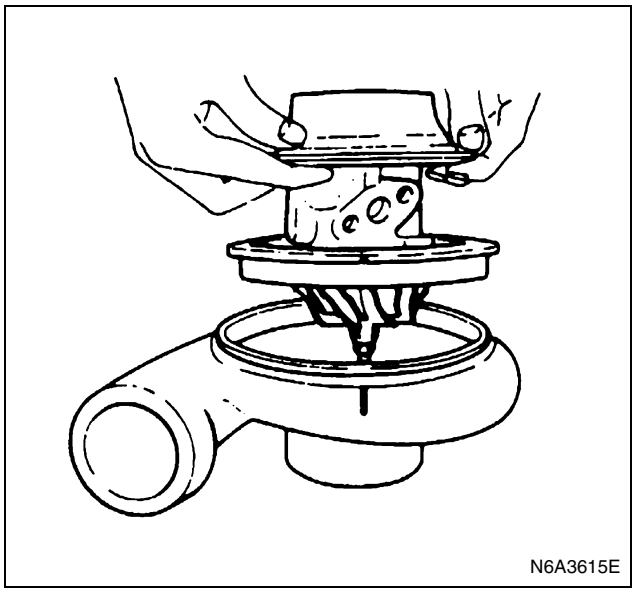
1. Center Housing and Rotating Assembly
2. Compressor Housing
3. Bolt
   1) Apply Threebond 1215 (1) or equivalent to flange surface of compressor housing shown in the illustration.



   2) Align the setting marks (applied at disassembly) on the center housing and rotating assembly and the compressor housing.
      Handle the parts with extreme care to avoid damaging the compressor wheel blades.
   3) Apply and anti-seizing agent (LOCTITE ANTI-SEIZE LUBRICANT or the equivalent) to the new bolt threads.
   4) Install the new bolts to the compressor housing.
   5) Tighten the bolts to the specified torque.

Tighten:

- Compressor housing bolt to 4.7 N·m (0.5 kg·m / 3.5 lb·ft)

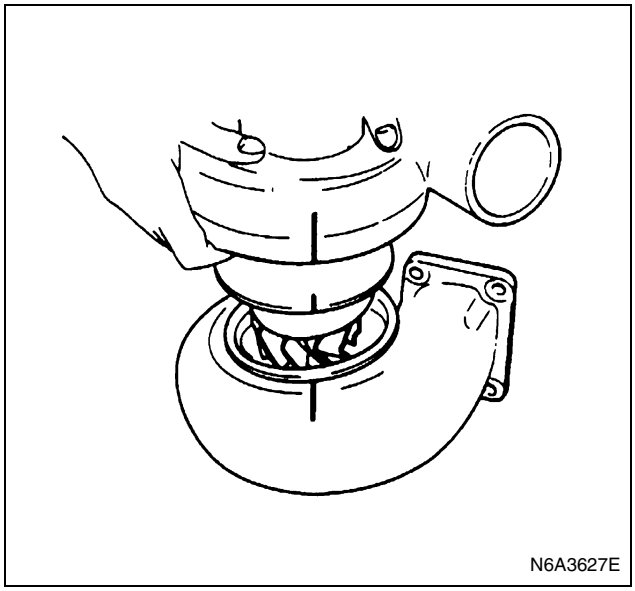


4. Turbine Housing
5. Lock Plate and Bolt
   1) Align the setting marks (applied at disassembly) on the center housing and rotating assembly and the turbine housing.
      Handle the parts with extreme care to avoid damaging the turbine shaft wheel blade.
   2) Apply and anti-seizing agent (LOCTITE ANTI-SEIZE LUBRICANT or the equivalent) to the bolt.
   3) Tighten the bolt to the specified torque.

Tighten:

- Turbine housing bolt to 28.0 N·m (2.85 kg·m / 20.6 lb·ft)

   4) Check that the rotating assembly turns smoothly.



IHI SERVICE NETWORK

For inquiries relating to turbochargers, please contact your ISUZU distributor or the nearest IHI Turbocharger Service Facility.

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LG4J-WE-0552

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LG4J-WE-0552 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

ENGINE 4J SERIES

SECTION 6

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

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6A	GENERAL ENGINE MECHANICAL
6A1	4JB1/4JB1-TC/4JG2/4JH1-TC - ENGINE
6B	ENGINE COOLING
6C	ENGINE FUEL
6D	ENGINE ELECTRICAL
6E	EXHAUST GAS RECIRCULATION (EGR) SYSTEM
6F	ENGINE EXHAUST
6G	TURBOCHARGER

ENGINE

Engine Control System (4HK1)

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Specifications

Temperature vs Resistance

Engine Coolant Temperature vs. Resistance

°C	°F	Ω
Temperature vs. Resistance Value (Approximately)		
110	230	160
100	212	200
90	194	260
80	176	350
70	158	470
60	140	640
50	122	880
40	104	1250
30	86	1800
20	68	2650
10	50	4000
0	32	6180
-10	14	9810
-20	-4	16000
-30	-22	27000

Intake Air Temperature vs. Resistance

°C	°F	Ω
Temperature vs. Resistance Value (Approximately)		
90	194	240
80	176	320
70	158	450
60	140	660
50	122	960
40	104	1440
30	86	2300
20	68	3430
10	50	5410
0	32	9770
-10	14	16410
20	-4	28560

Fuel Temperature vs. Resistance

°C	°F	Ω
110	230	140
100	212	180
90	194	240
80	176	310
70	158	420
60	140	580
50	122	810
40	104	1150
30	86	1660
20	68	2450
10	50	3700
0	32	5740
-10	14	9160
-20	-4	15000
-30	-22	25400

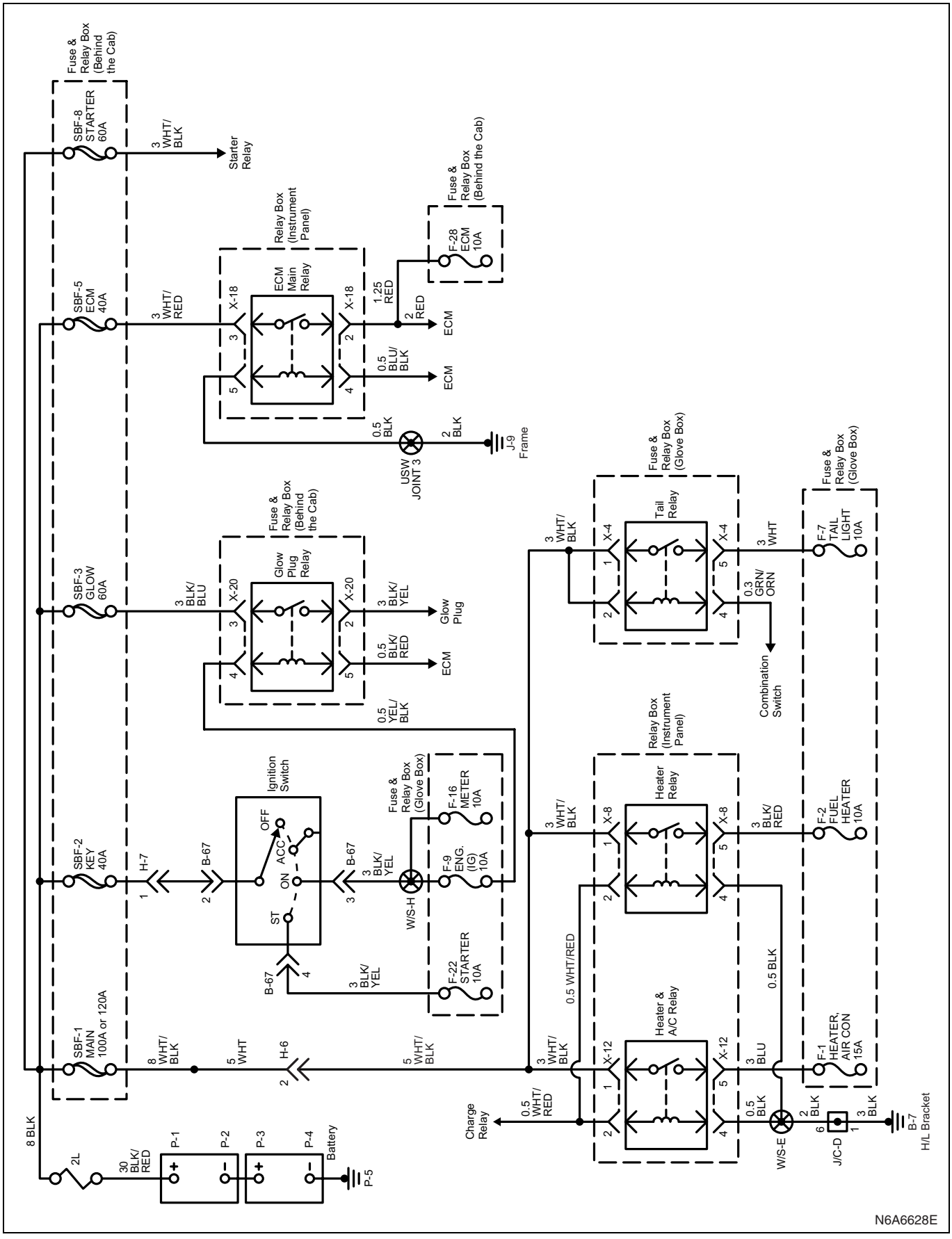
Altitude vs Barometric Pressure

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)
Determine your altitude by contacting a local weather station or by using another reference source.		
4267	14000	56-64
3962	13000	58-66
3658	12000	61-69
3353	11000	64-72
3048	10000	66-74
2743	9000	69-77
2438	8000	71-79
2134	7000	74-82
1829	6000	77-85
1524	5000	80-88
1219	4000	83-91
914	3000	87-98
610	2000	90-98
305	1000	94-102
0	0 Sea Level	96-104
-305	-1000	101-105

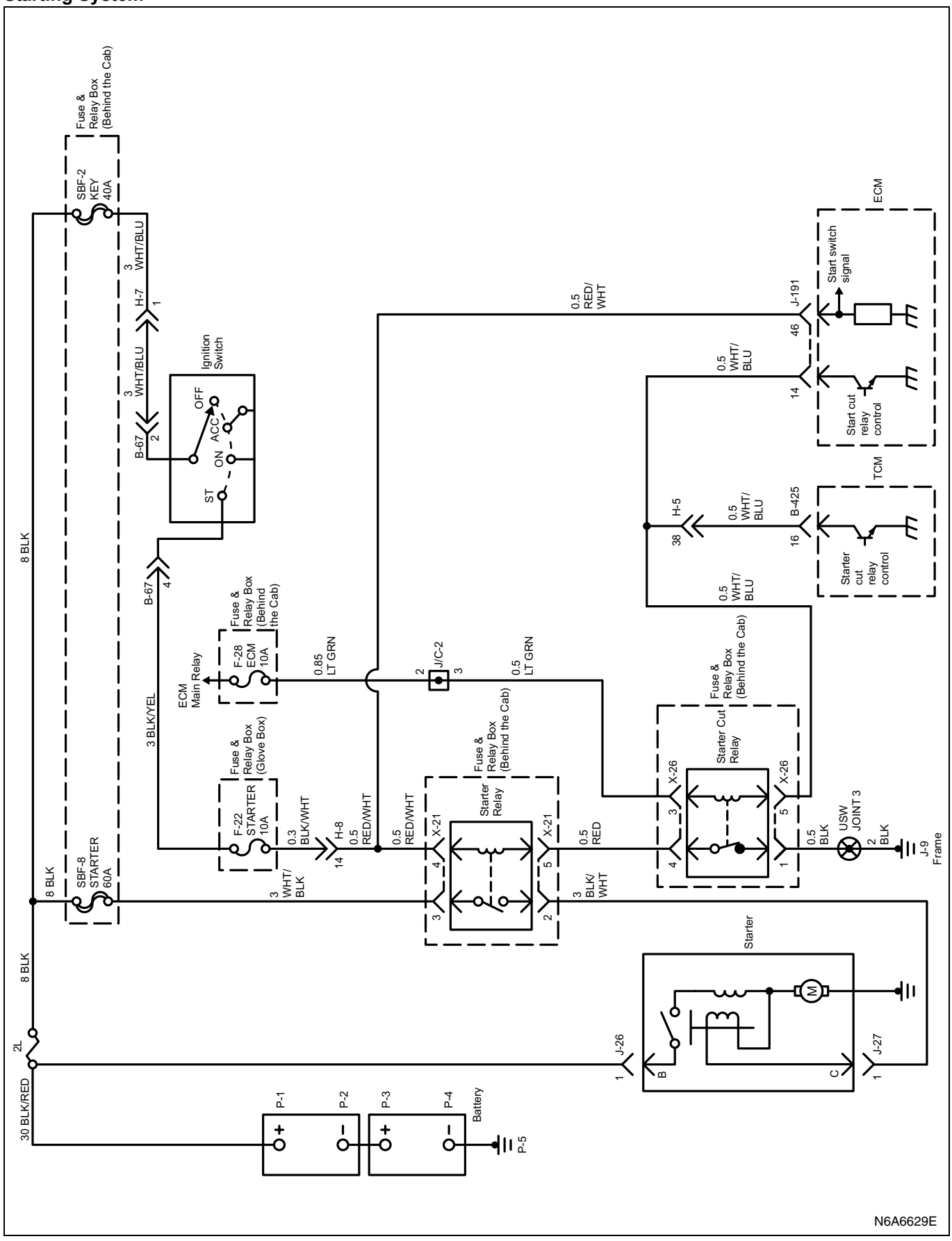
Schematic and Routine Diagrams

Engine Controls Schematics

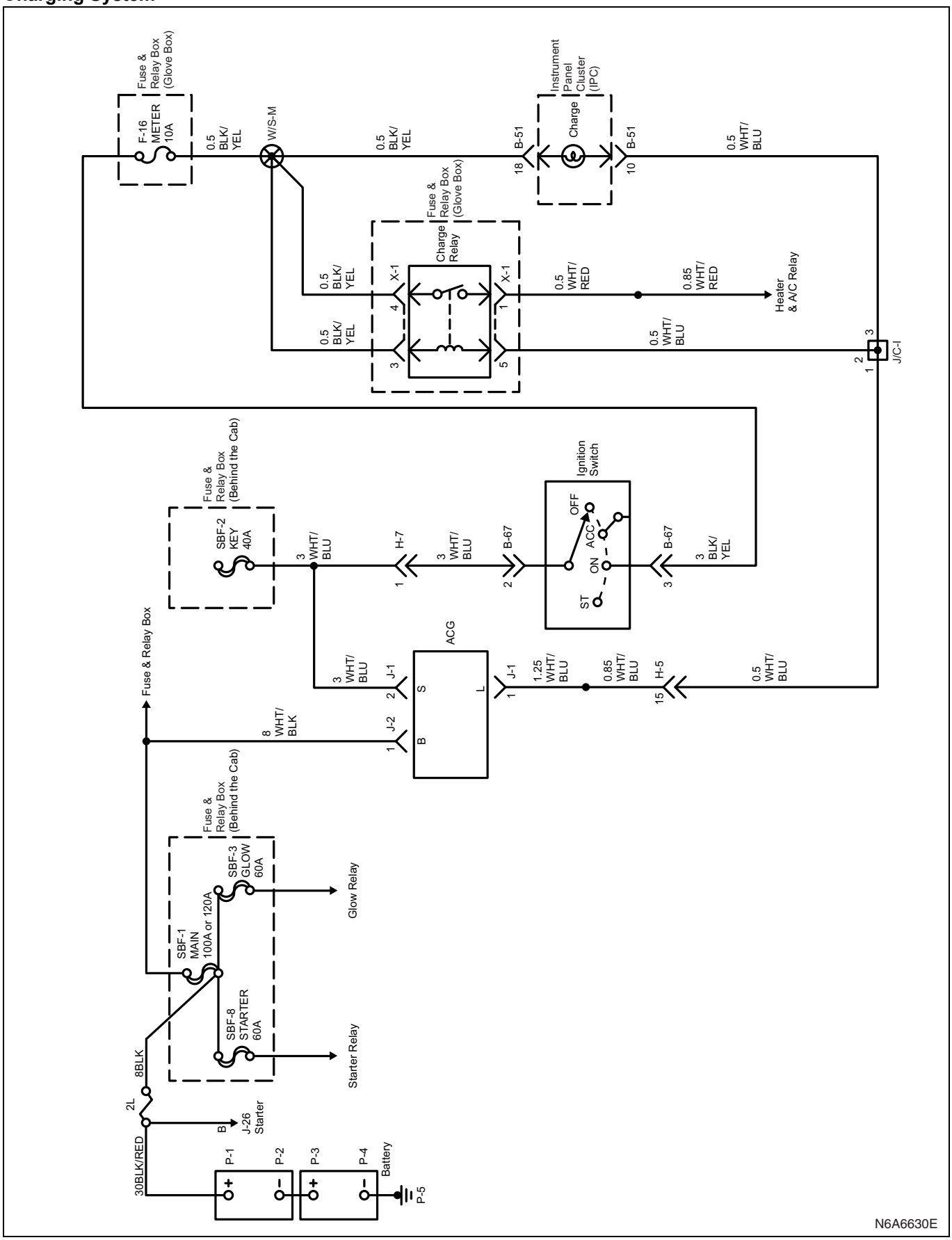
Power Distribution



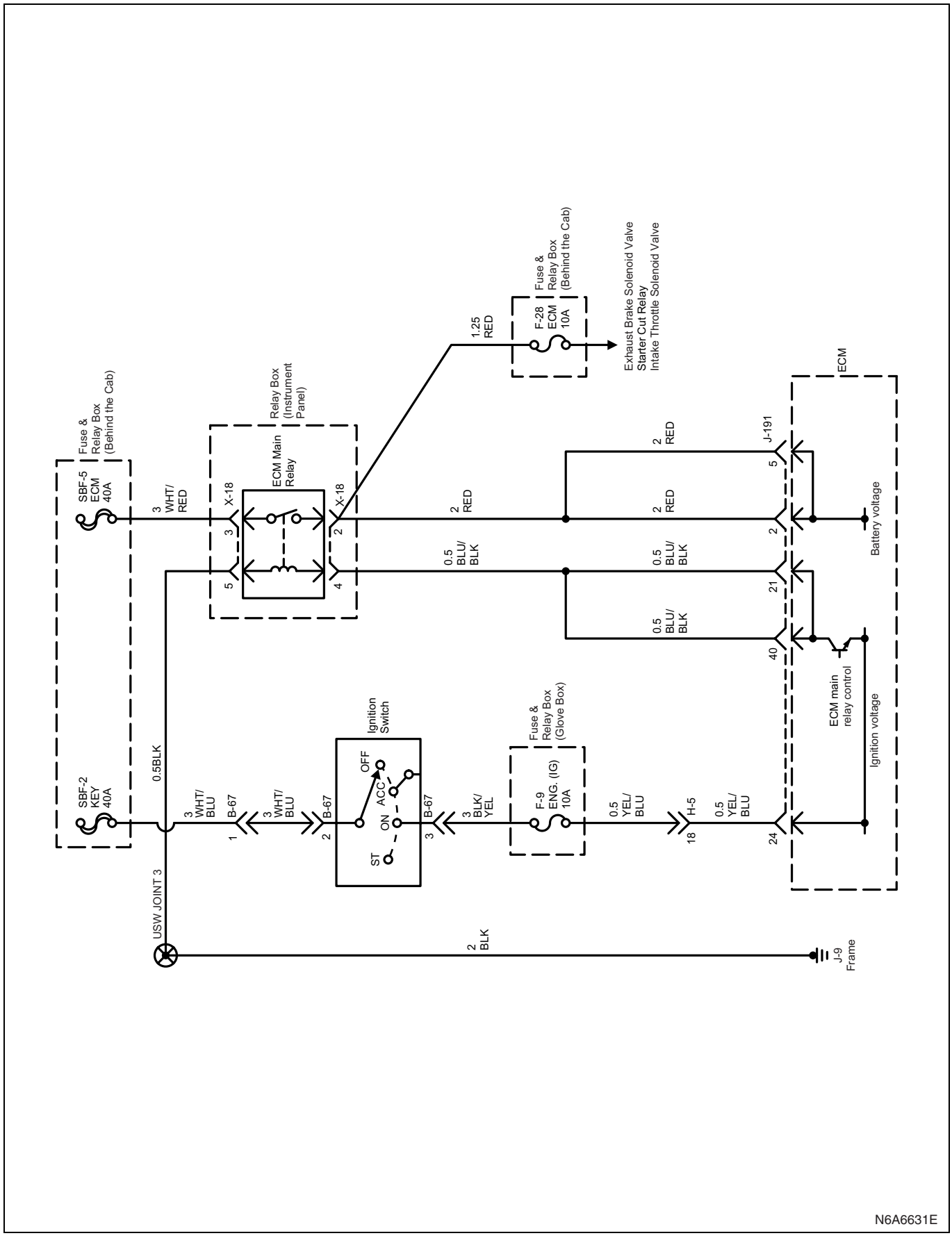
Starting System



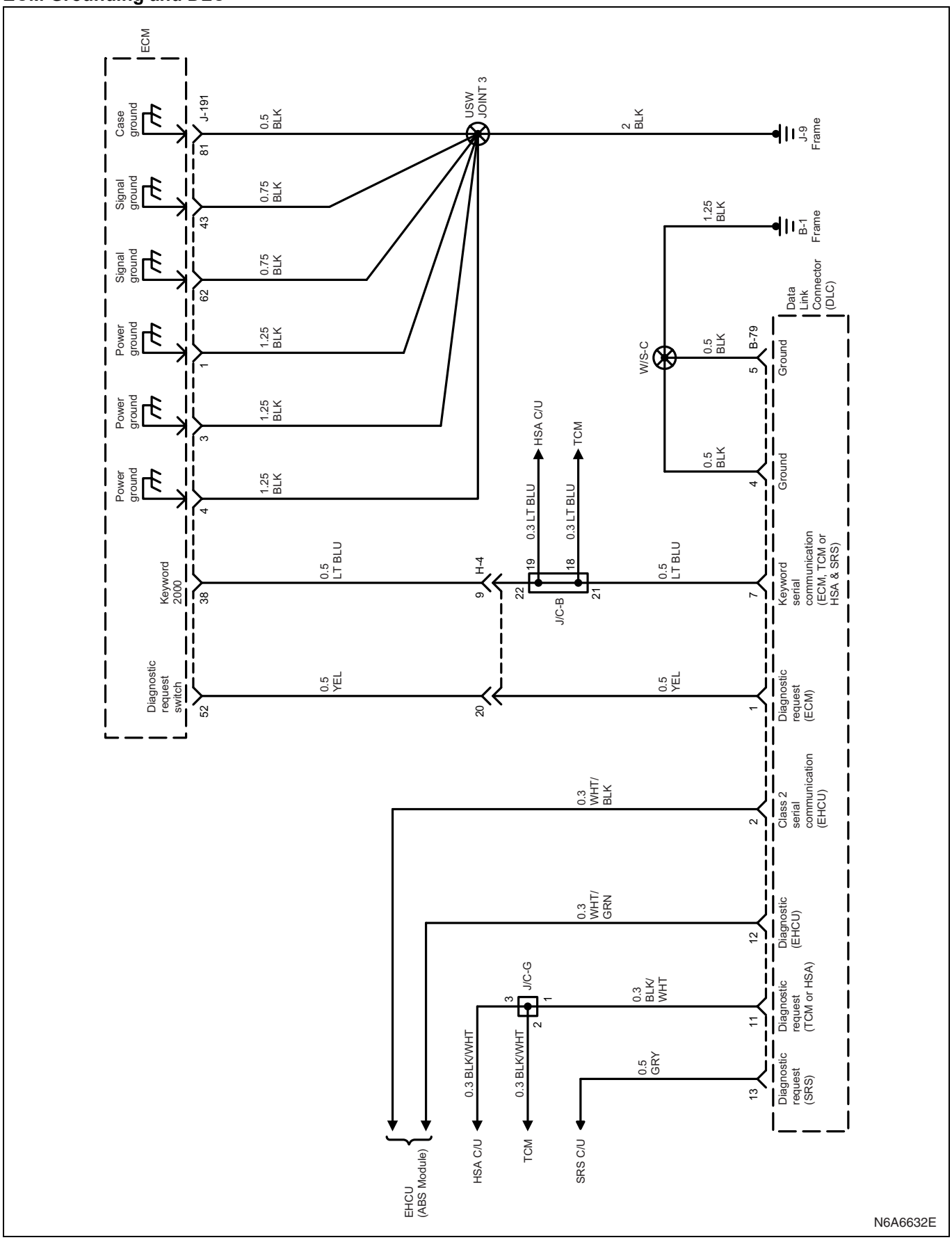
Charging System



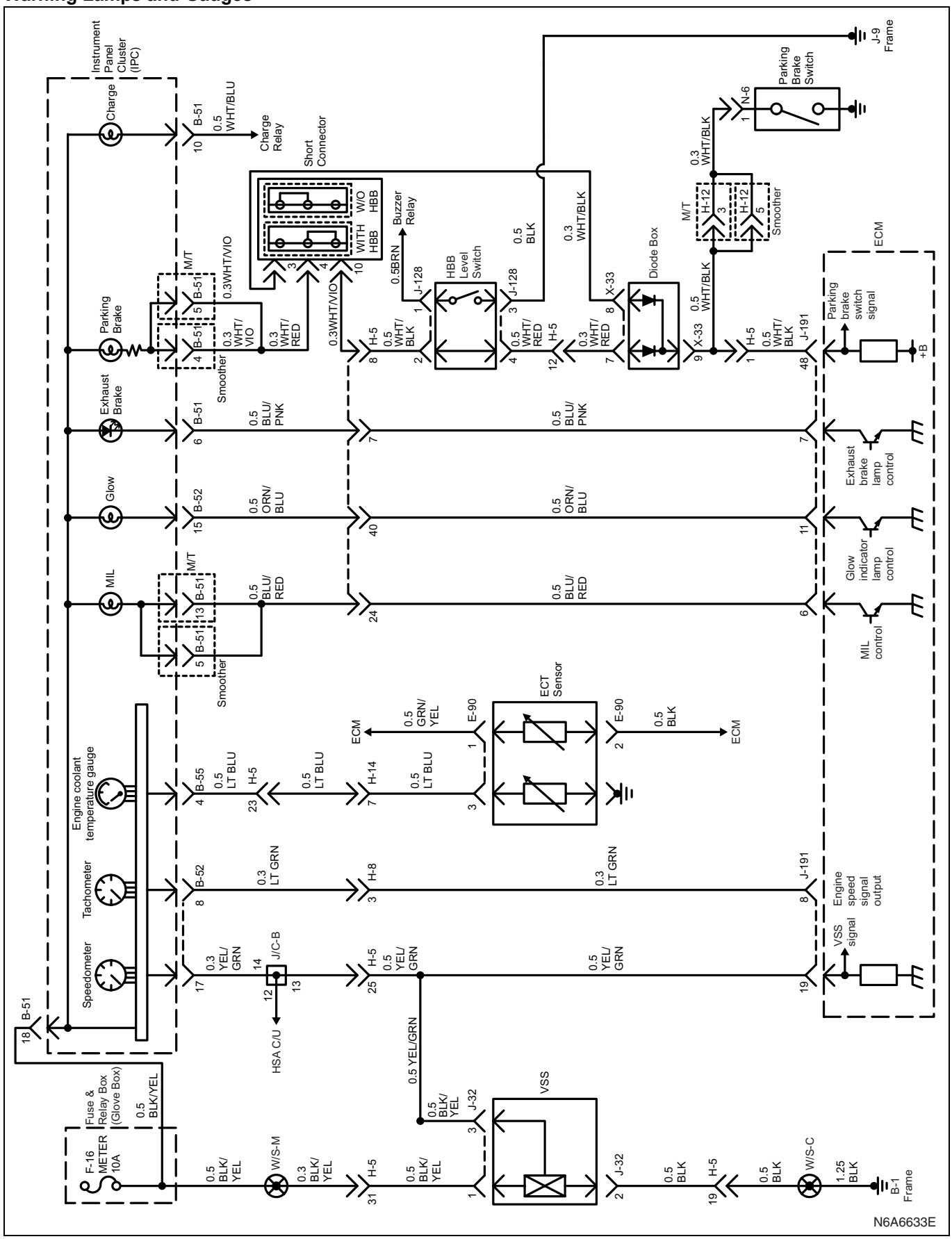
ECM Power


Fuse & Relay Box (Behind the Cab)
SBF-5 ECM 40A
SBF-2 KEY 40A
Relay Box (Instrument Panel)
ECM Main Relay
X-18
Fuse & Relay Box (Behind the Cab)
F-28 ECM 10A
Exhaust Brake Solenoid Valve
Starter Cut Relay
Intake Throttle Solenoid Valve
ECM
J-191
Battery voltage
ECM main relay control
Ignition voltage
Ignition Switch
OFF
ACC
ON
ST
Fuse & Relay Box (Glove Box)
F-9 ENG. (IG) 10A
B-67
H-5
USW JOINT 3
J-9 Frame
3 WHT/RED
1.25 RED
2 RED
0.5 BLU/BLK
0.5BLK
3 WHT/BLU
3 BLK/YEL
0.5 YEL/BLU
2 BLK
N6A6631E

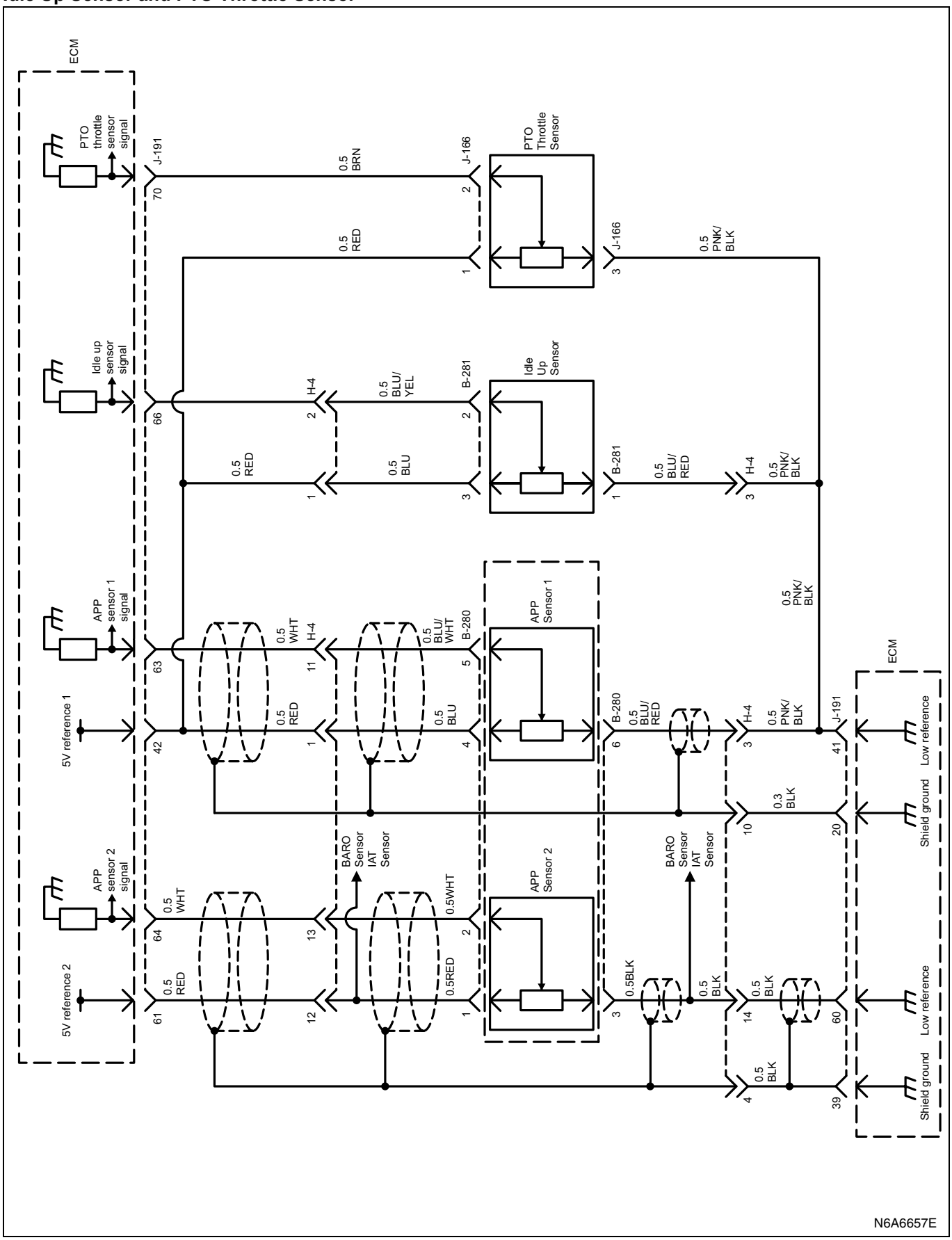
ECM Grounding and DLC



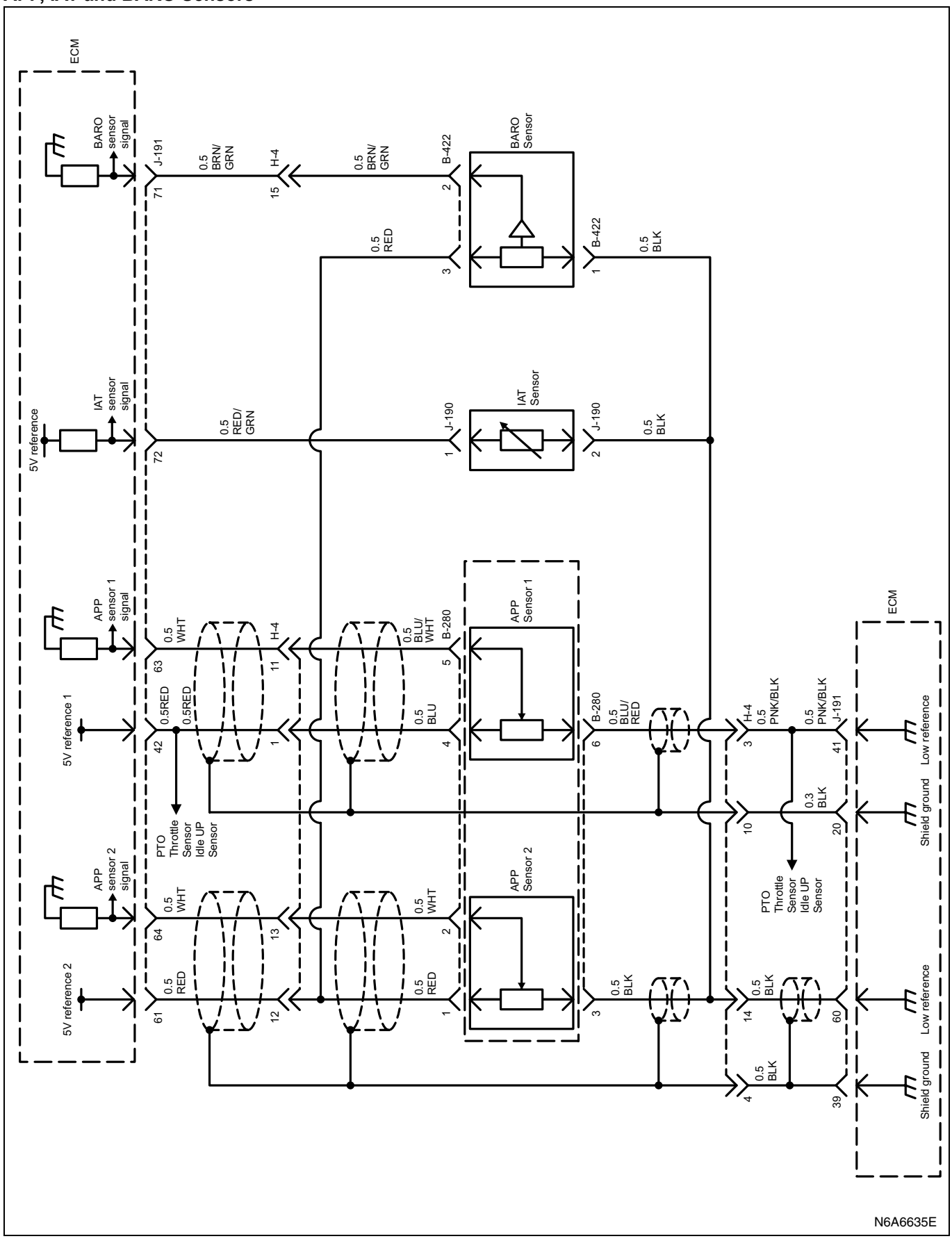
Warning Lamps and Gauges



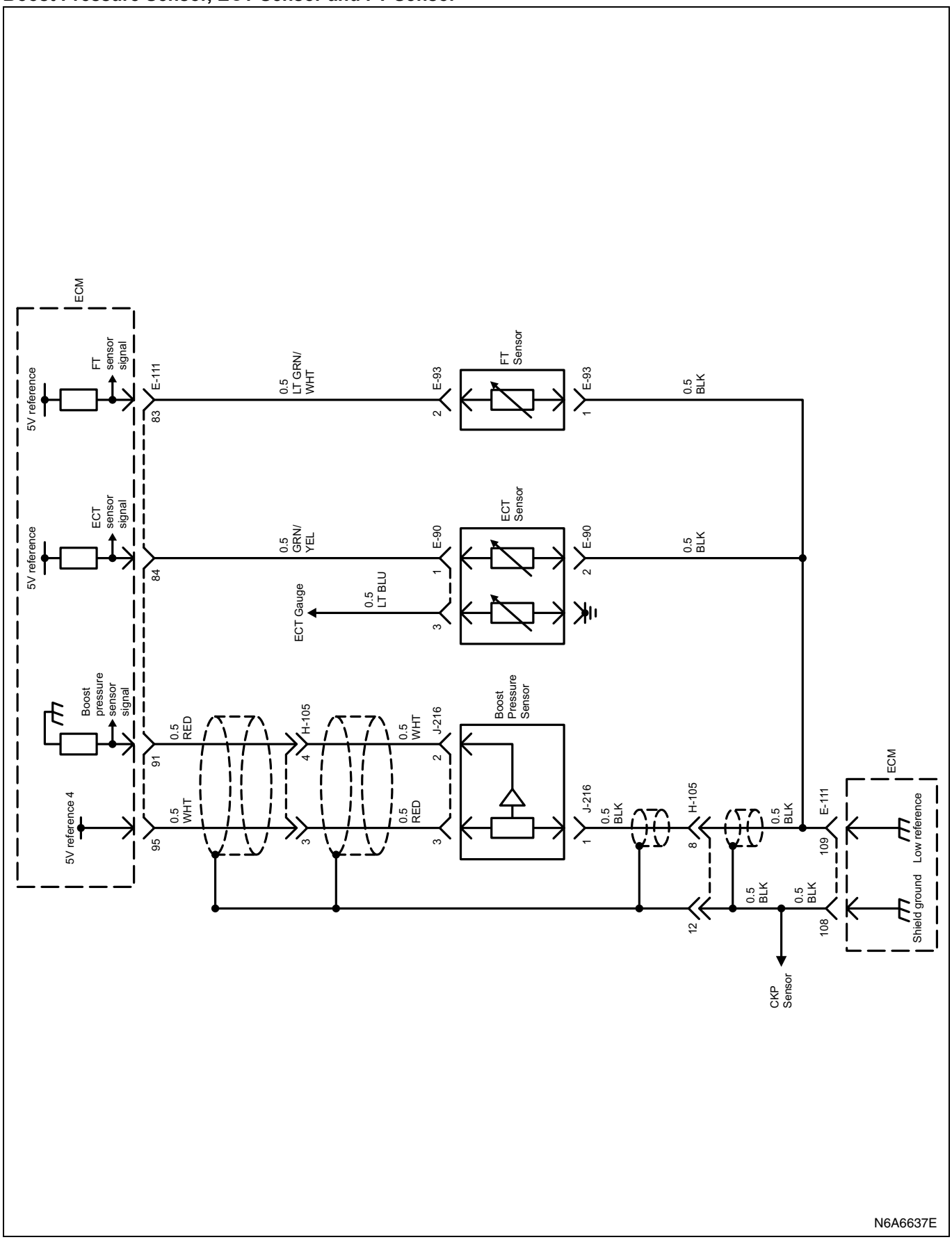
Idle Up Sensor and PTO Throttle Sensor



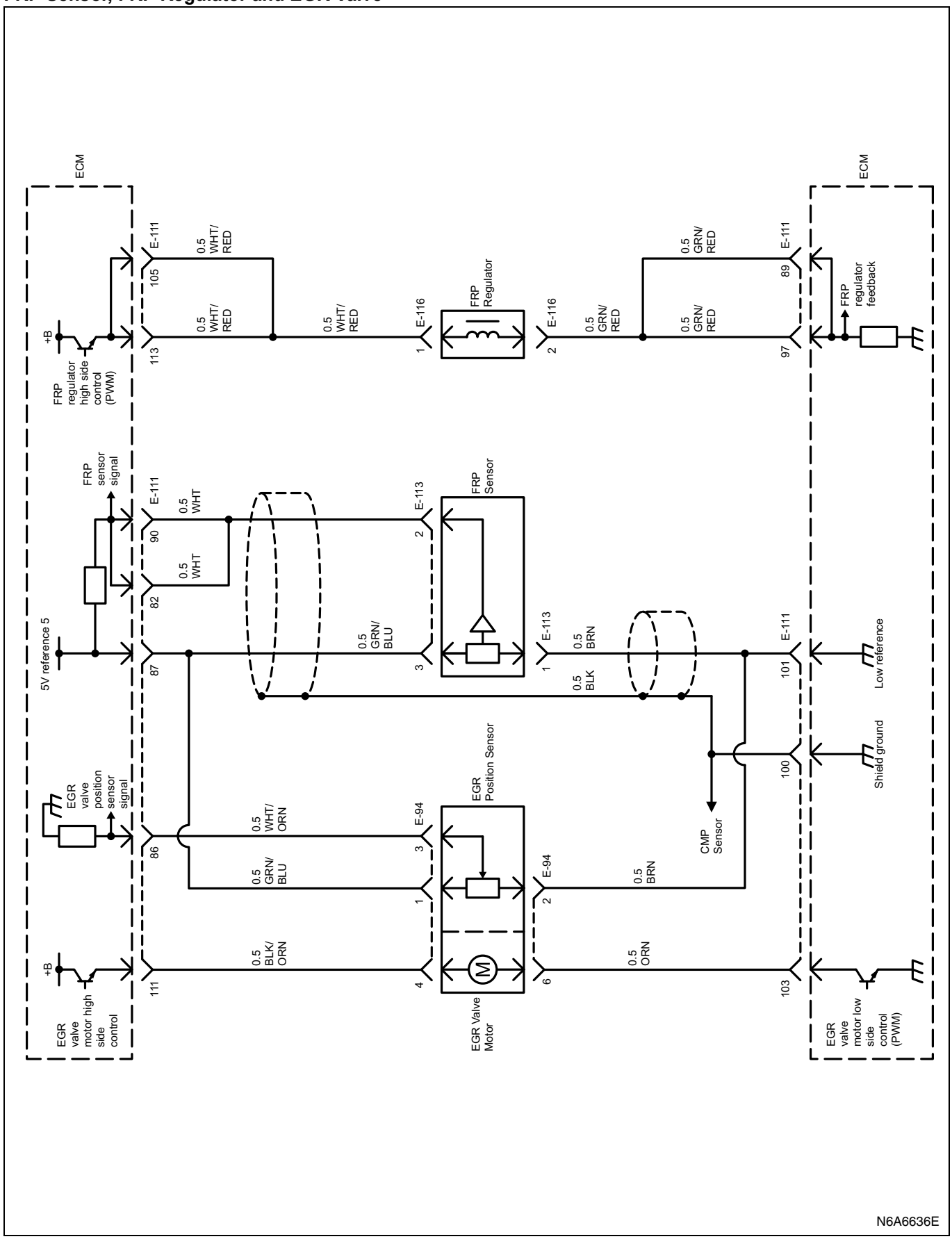
APP, IAT and BARO Sensors



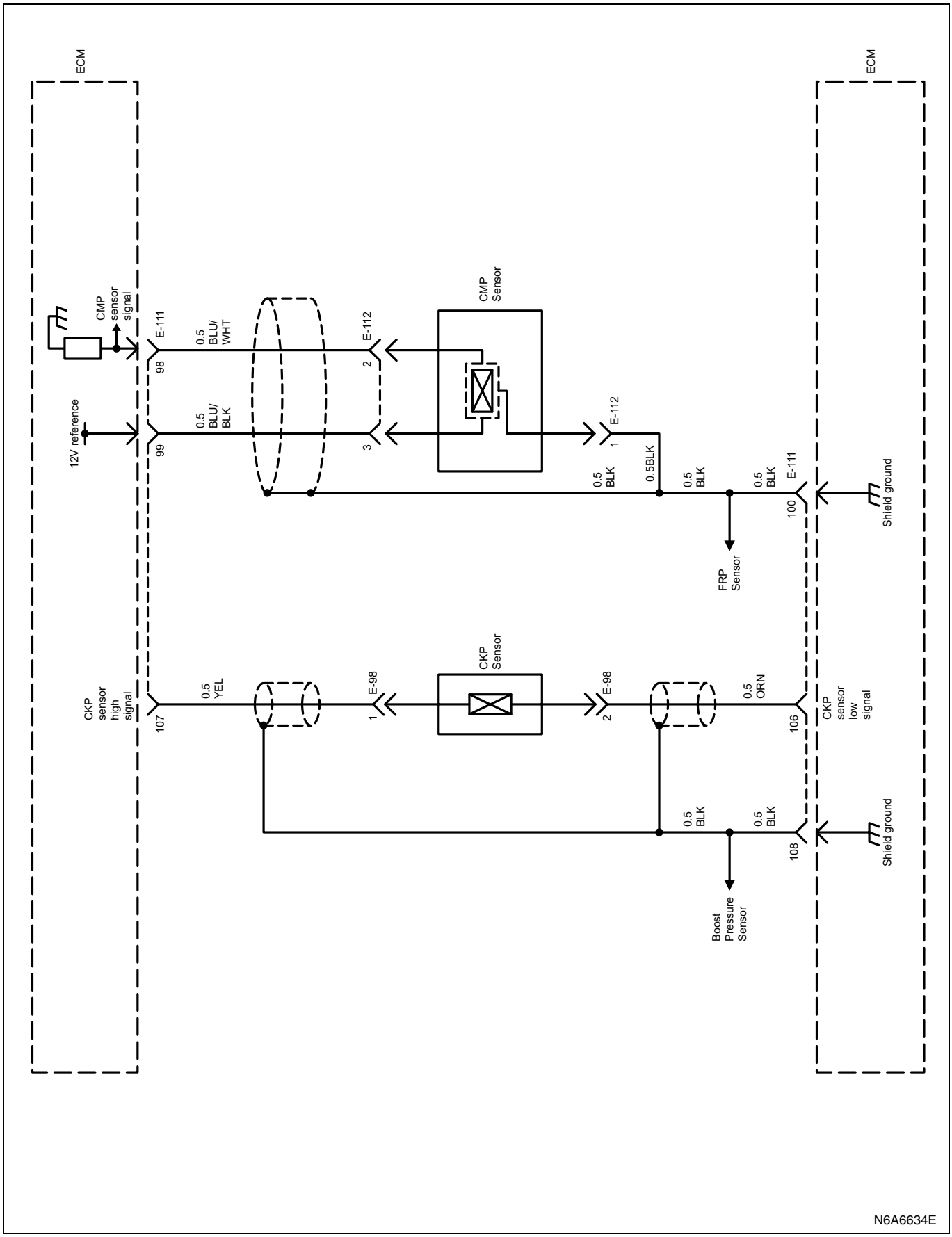
Boost Pressure Sensor, ECT Sensor and FT Sensor



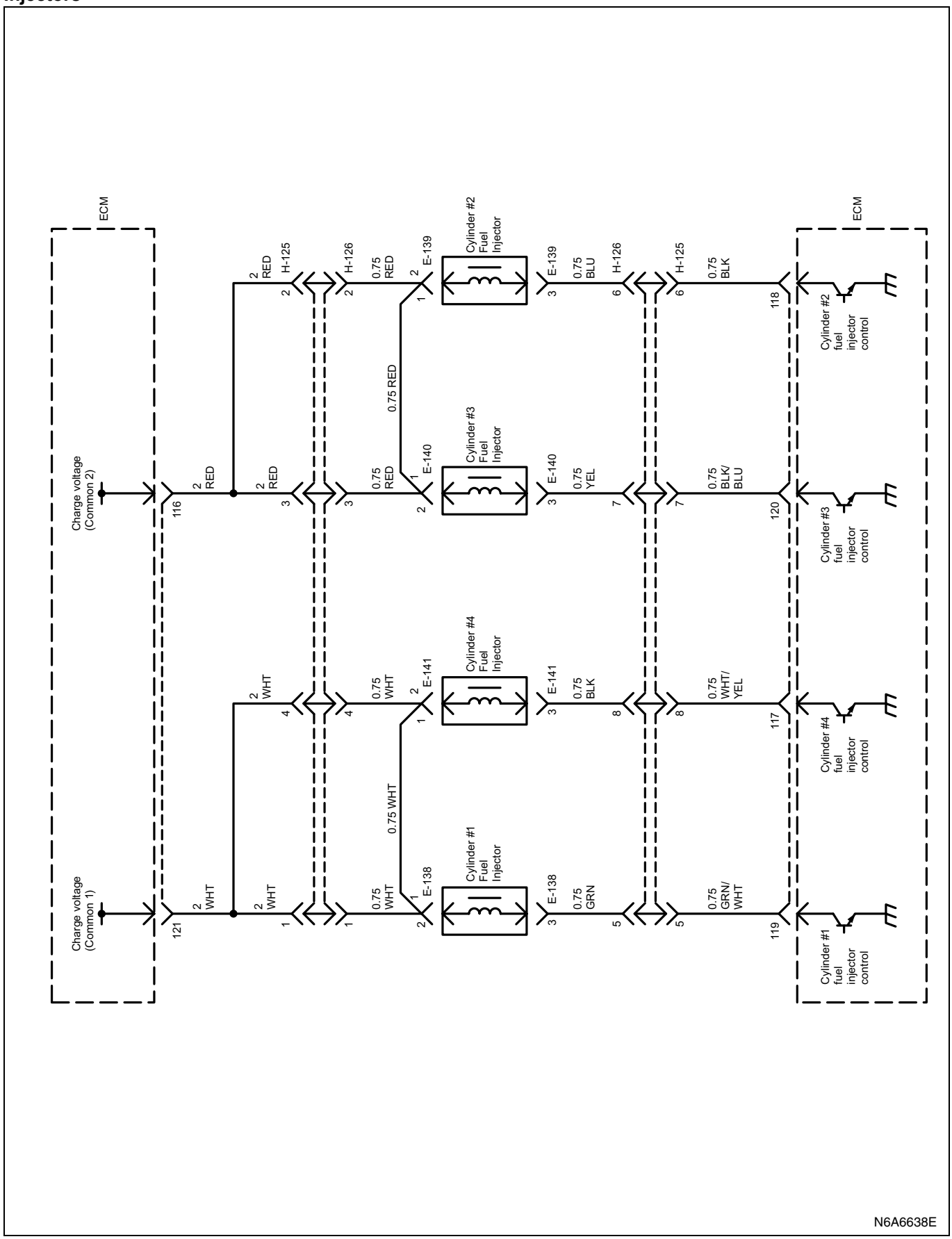
FRP Sensor, FRP Regulator and EGR Valve



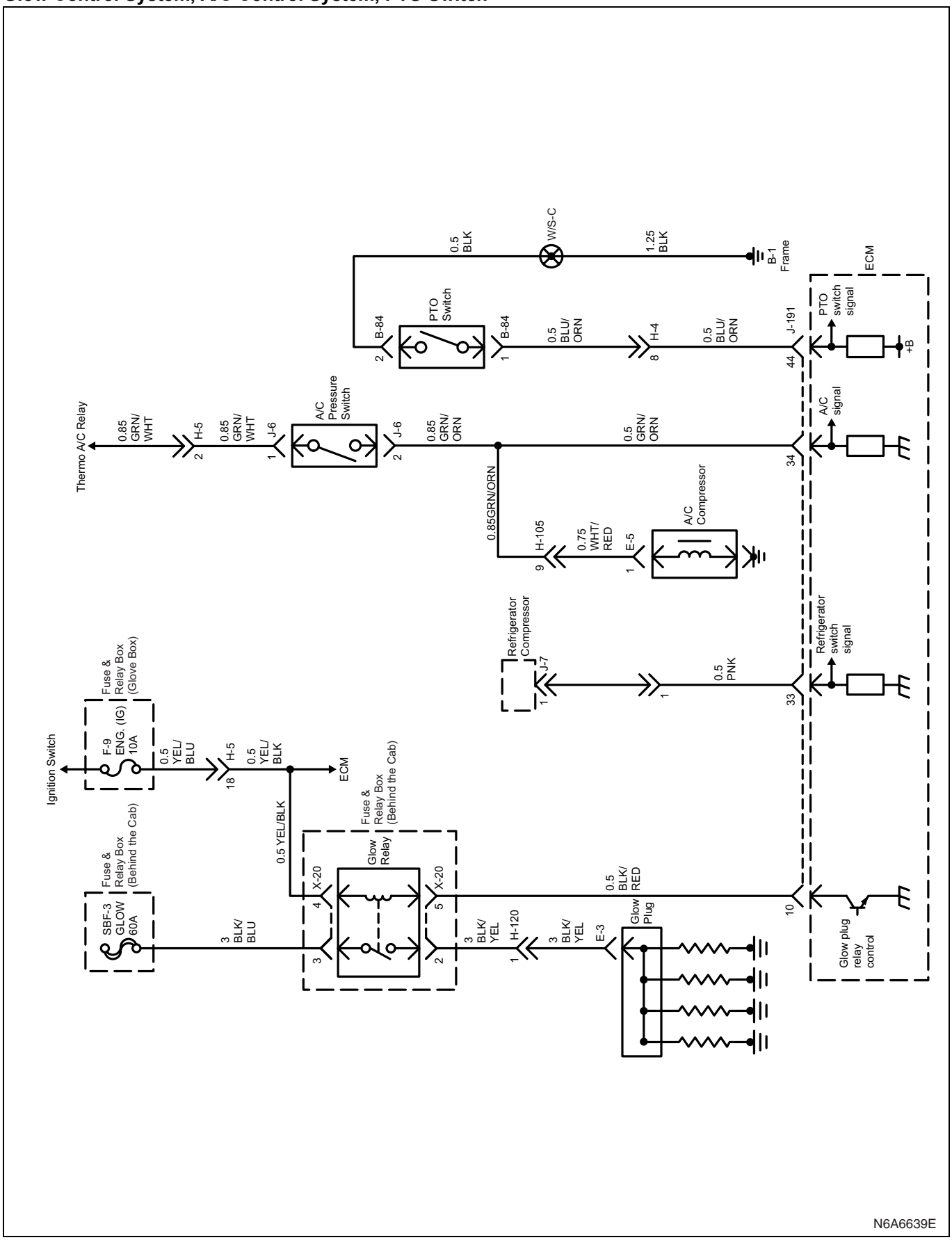
CKP and CMP Sensors



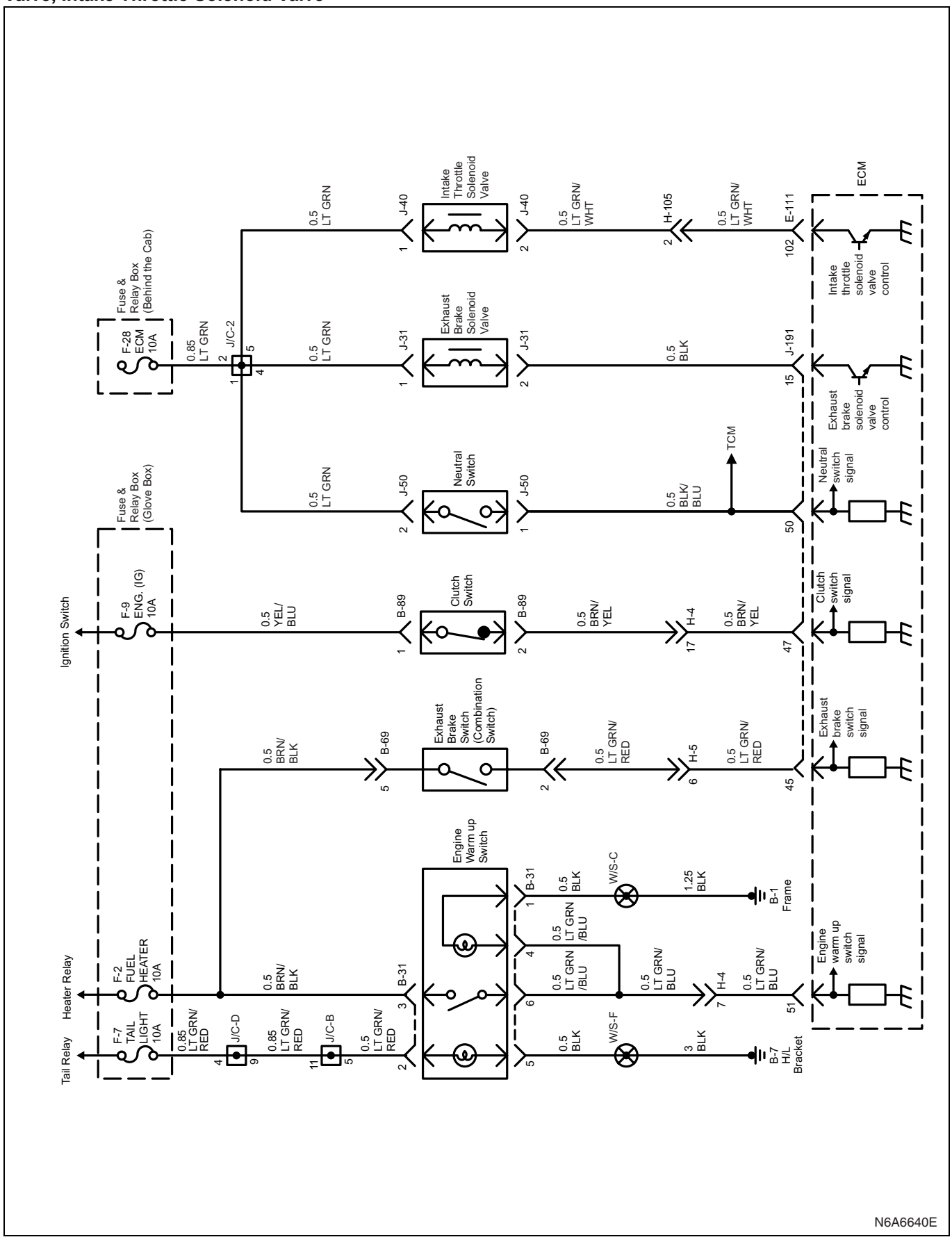
Injectors


ECM
Charge voltage (Common 2)
Charge voltage (Common 1)
116
121
2 RED
2 WHT
H-125
H-126
E-139
E-140
E-141
E-138
0.75 RED
0.75 WHT
Cylinder #2 Fuel Injector
Cylinder #3 Fuel Injector
Cylinder #4 Fuel Injector
Cylinder #1 Fuel Injector
0.75 BLU
0.75 YEL
0.75 BLK
0.75 GRN
0.75 BLK/ BLU
0.75 WHT/ YEL
0.75 GRN/ WHT
118
120
117
119
Cylinder #2 fuel injector control
Cylinder #3 fuel injector control
Cylinder #4 fuel injector control
Cylinder #1 fuel injector control
N6A6638E

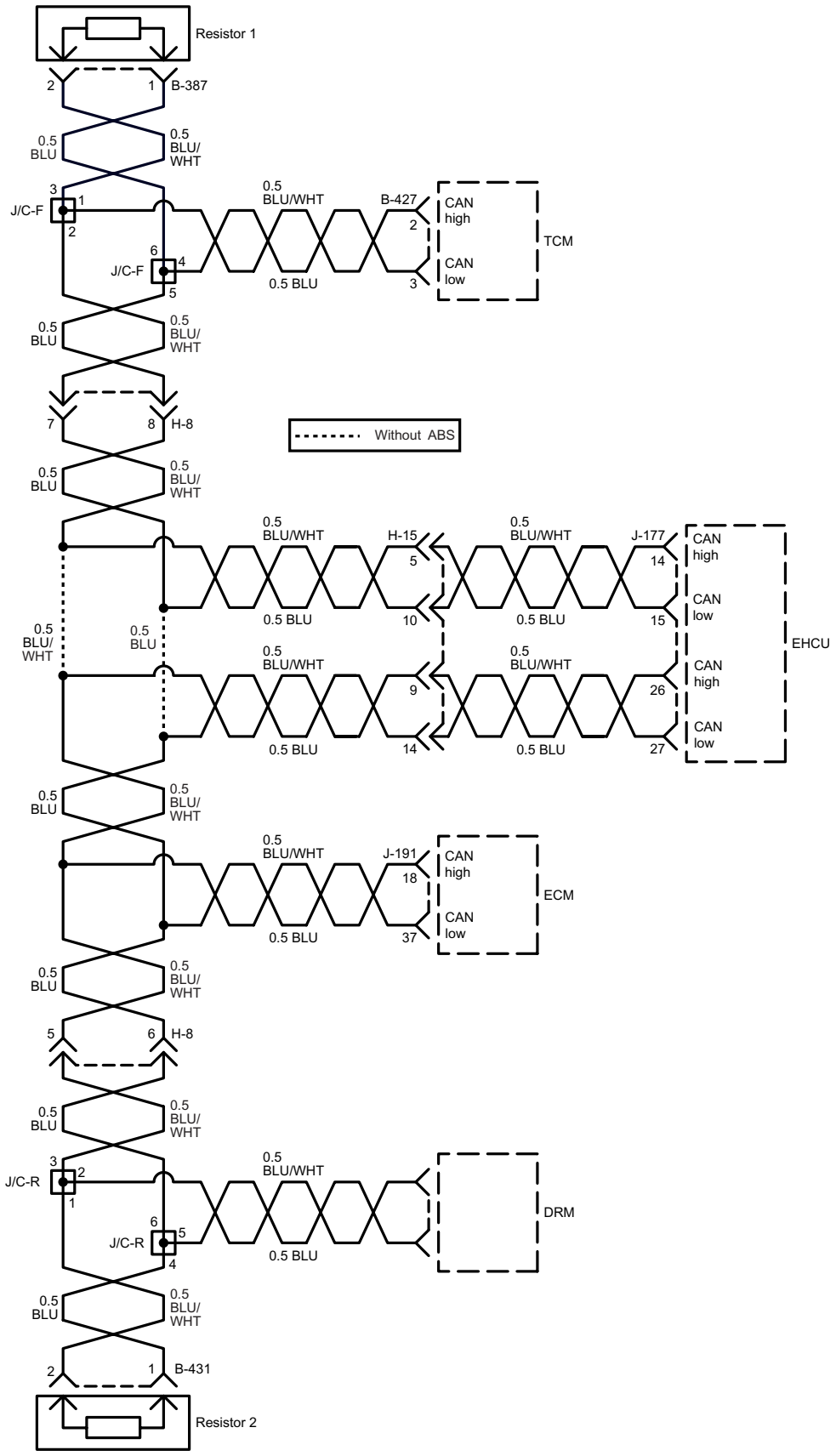
Glow Control System, A/C Control System, PTO Switch



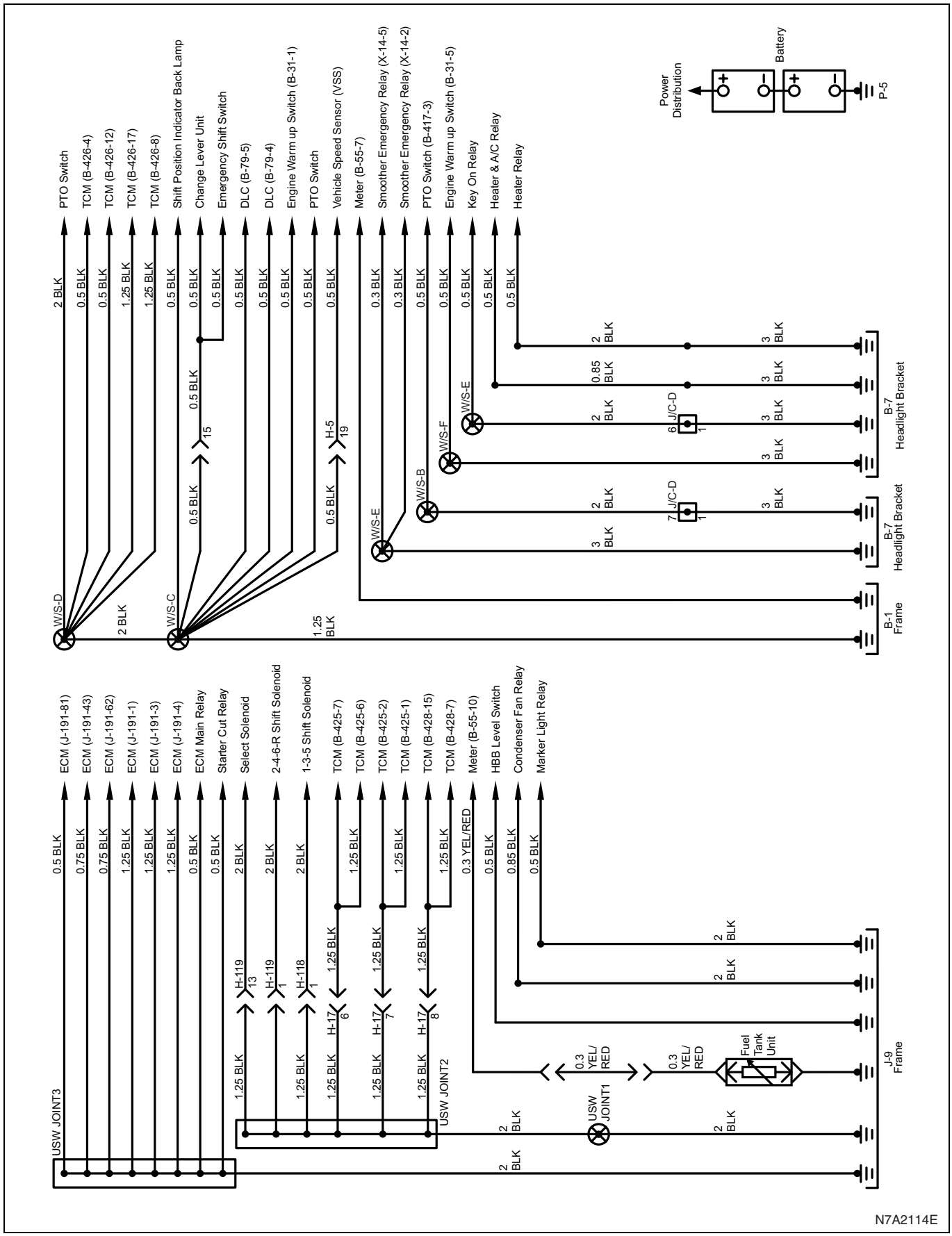
Clutch Switch, Neutral Switch, Exhaust Brake Switch, Engine Warm Up Switch, Exhaust Brake Solenoid Valve, Intake Throttle Solenoid Valve



CAN


Resistor 1
2
1
B-387
0.5 BLU
0.5 BLU/ WHT
3
J/C-F
1
2
6
J/C-F
4
5
0.5 BLU/WHT
B-427
2
3
CAN high
CAN low
TCM
0.5 BLU
7
8
H-8
Without ABS
H-15
5
10
J-177
14
15
CAN high
CAN low
EHCU
9
14
26
27
J-191
18
37
ECM
5
6
H-8
J/C-R
DRM
B-431
Resistor 2
N6A6641E

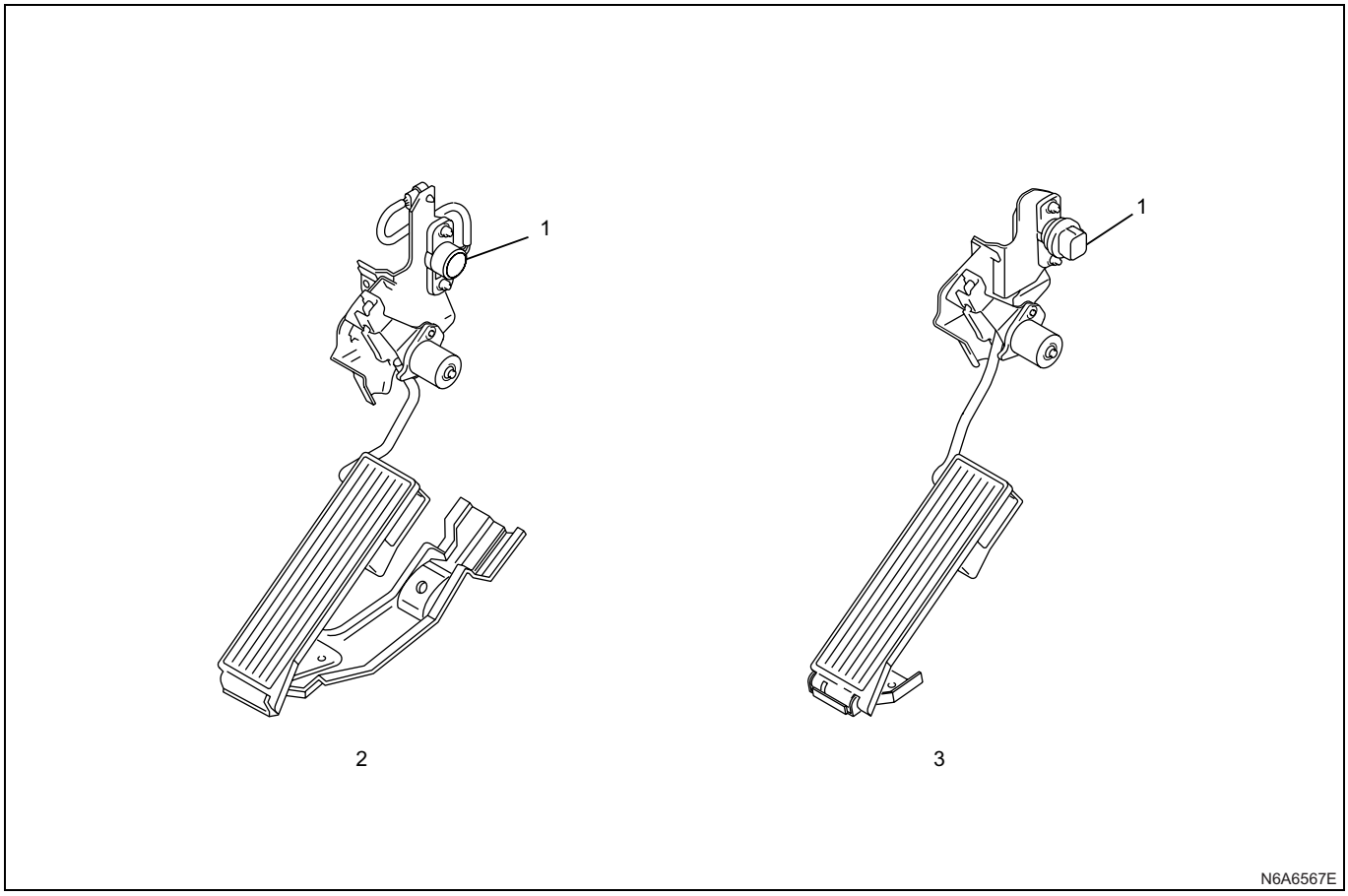
Ground Distributions



Component Locator

Engine Controls Component Views

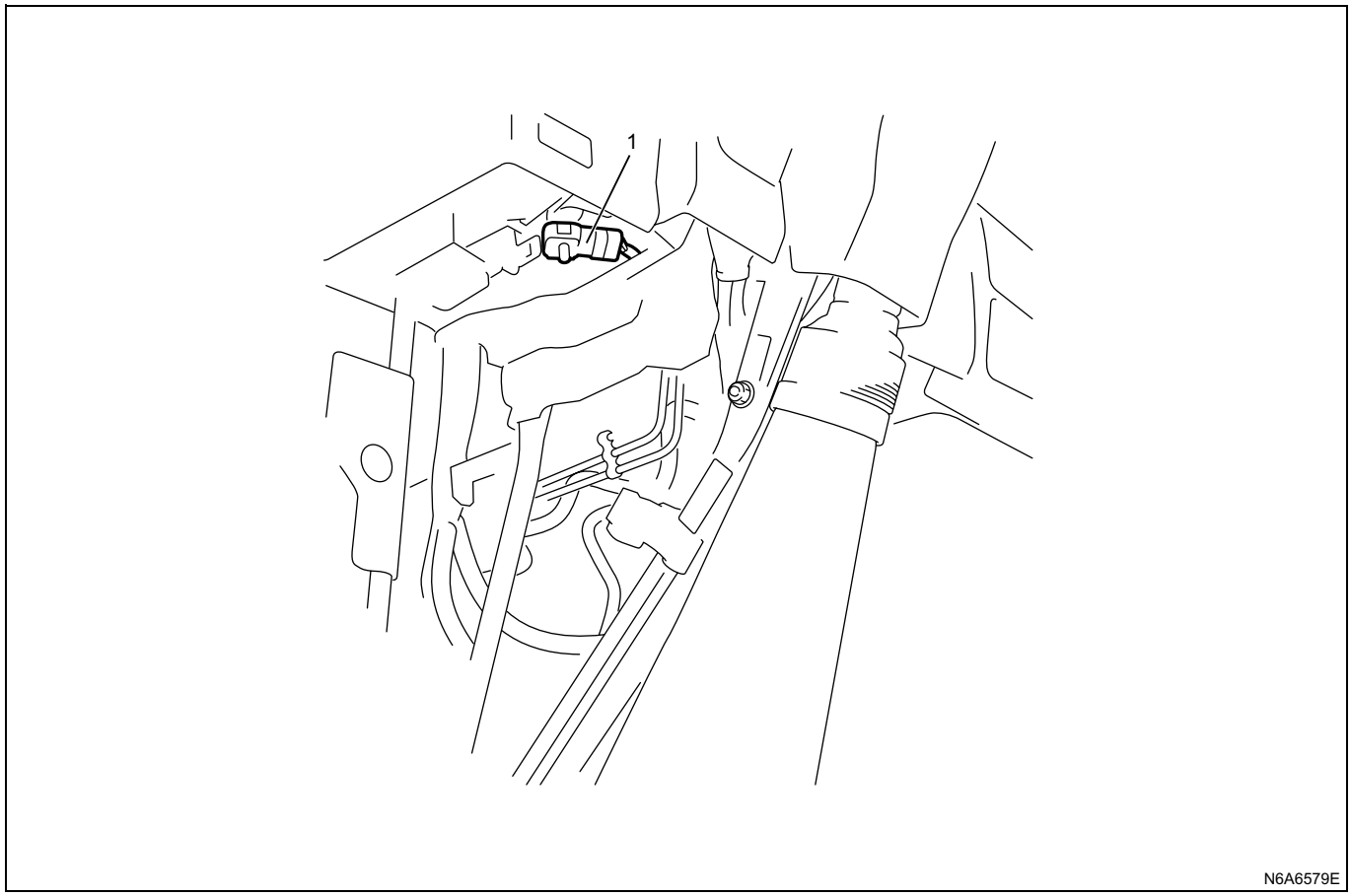
Accelerator Pedal Position (APP) Sensor



Legend

1. Accelerator Pedal Position (APP) Sensor Assembly
2. LHD Model
3. RHD Model

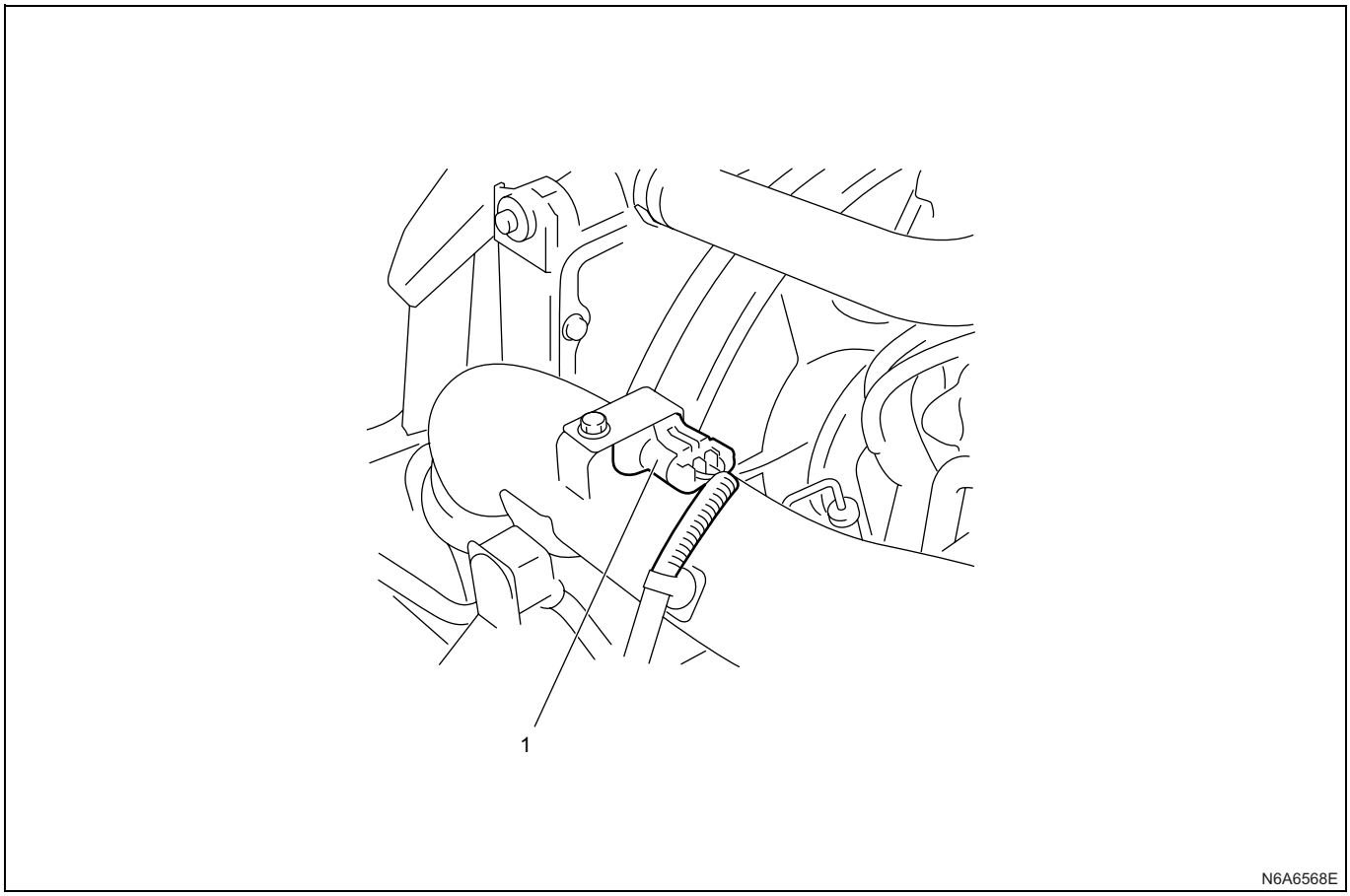
Barometric Pressure (BARO) Sensor



Legend

1. Barometric Pressure (BARO) Sensor

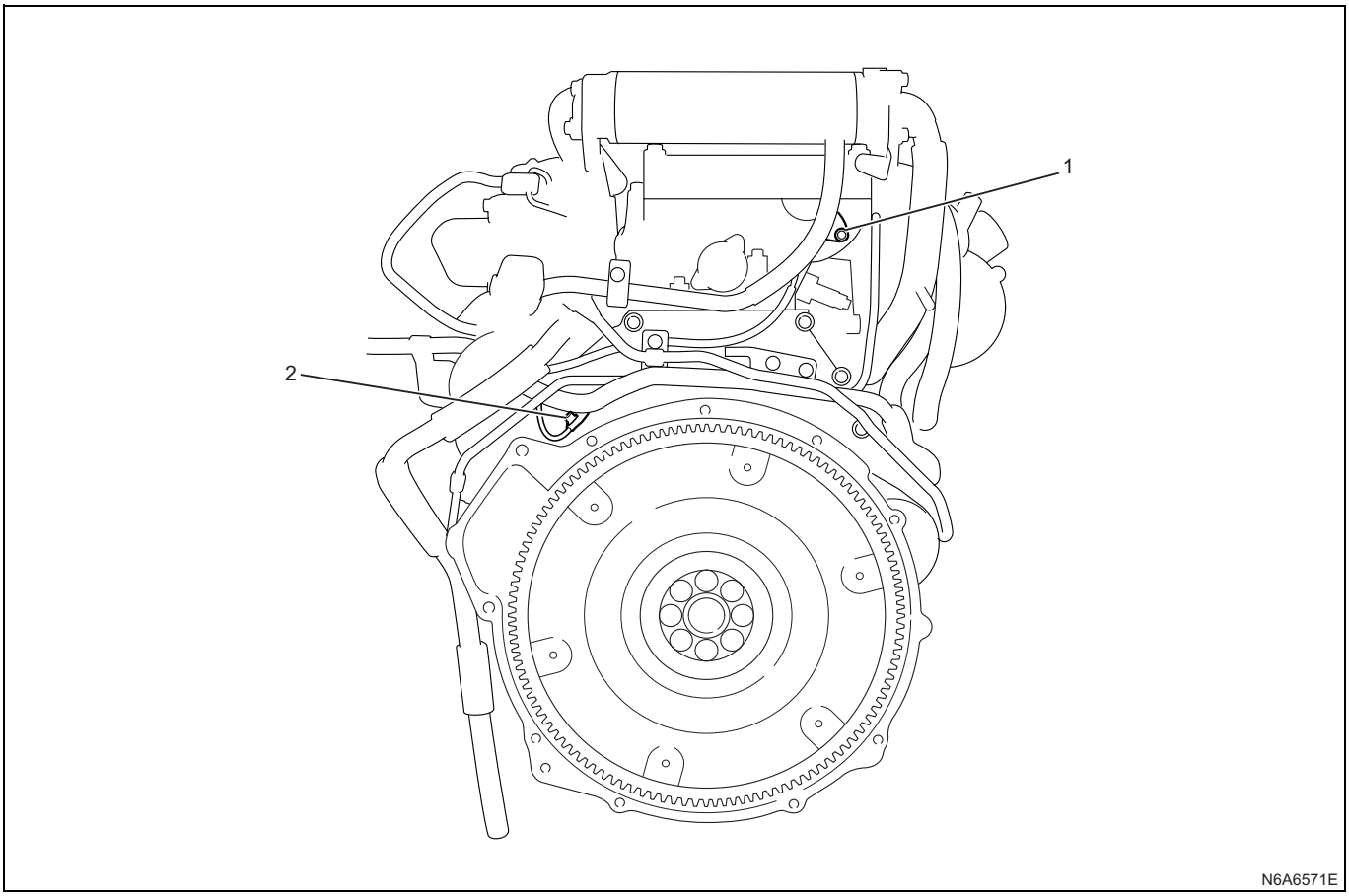
Boost Pressure Sensor



Legend

1. Boost Pressure Sensor

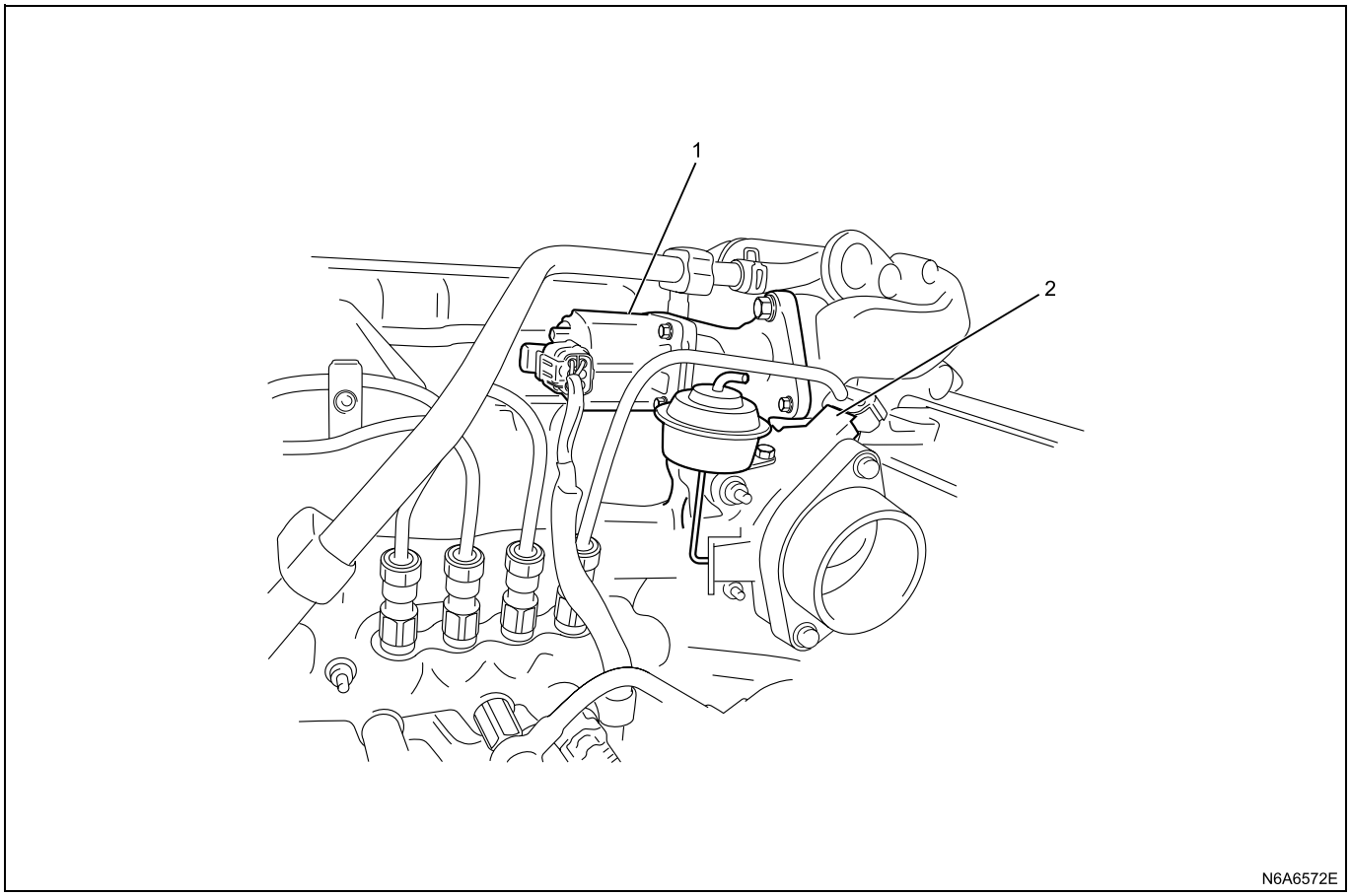
Camshaft Position (CMP), Crankshaft Position (CKP) Sensors



Legend

1. Camshaft Position (CMP) Sensor
2. Crankshaft Position (CKP) Sensor

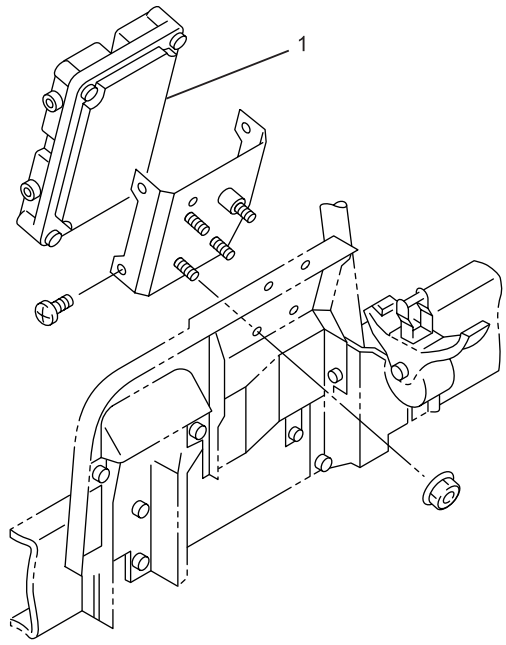
Exhaust Gas Recirculation (EGR) Valve and Intake Throttle Valve



Legend

1. Exhaust Gas Recirculation (EGR) Valve
2. Intake Throttle Valve

Engine Control Module (ECM)

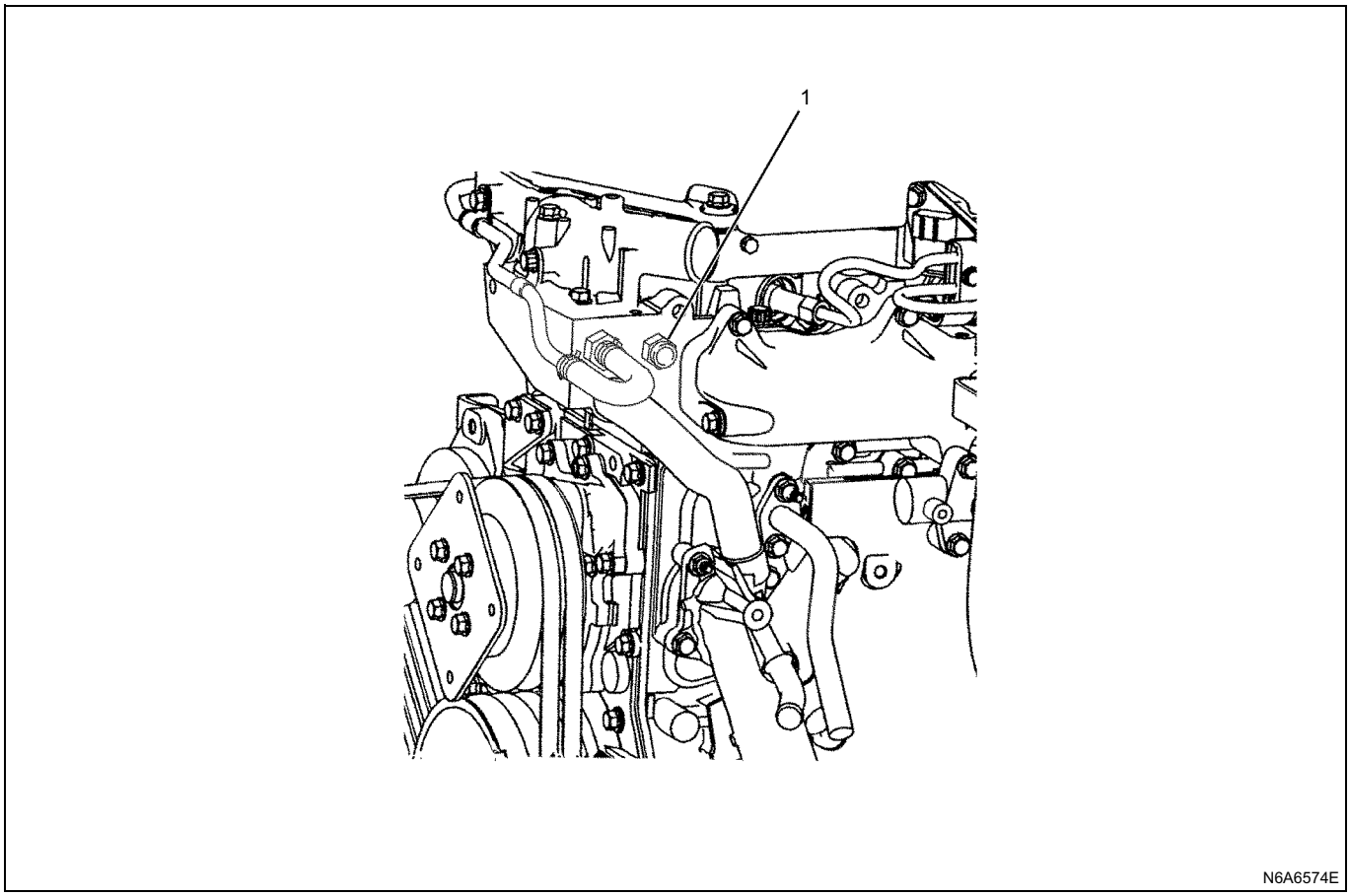


N6A6626E

Legend

1. Engine Control Module (ECM)

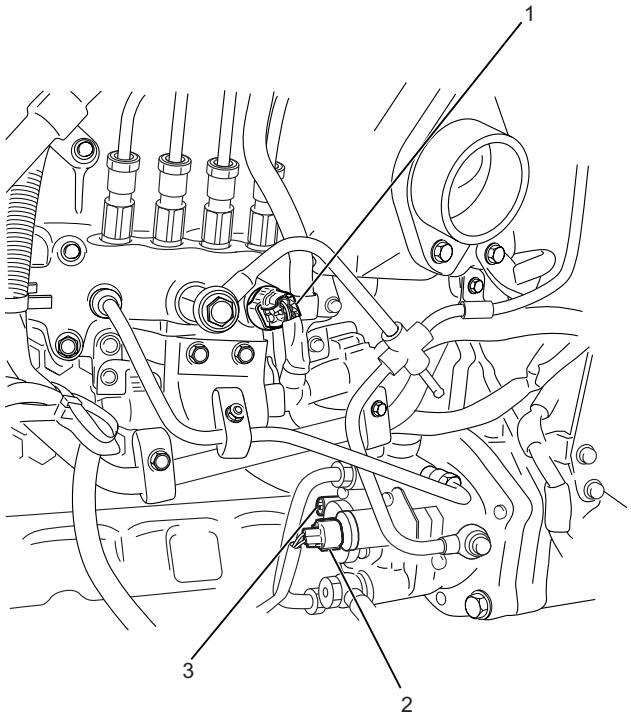
Engine Coolant Temperature (ECT) Sensor



Legend

1. Engine Coolant Temperature (ECT) Sensor

Fuel Rail Pressure (FRP) Sensor, Fuel Temperature (FT) Sensor and Fuel Rail Pressure (FRP) Regulator

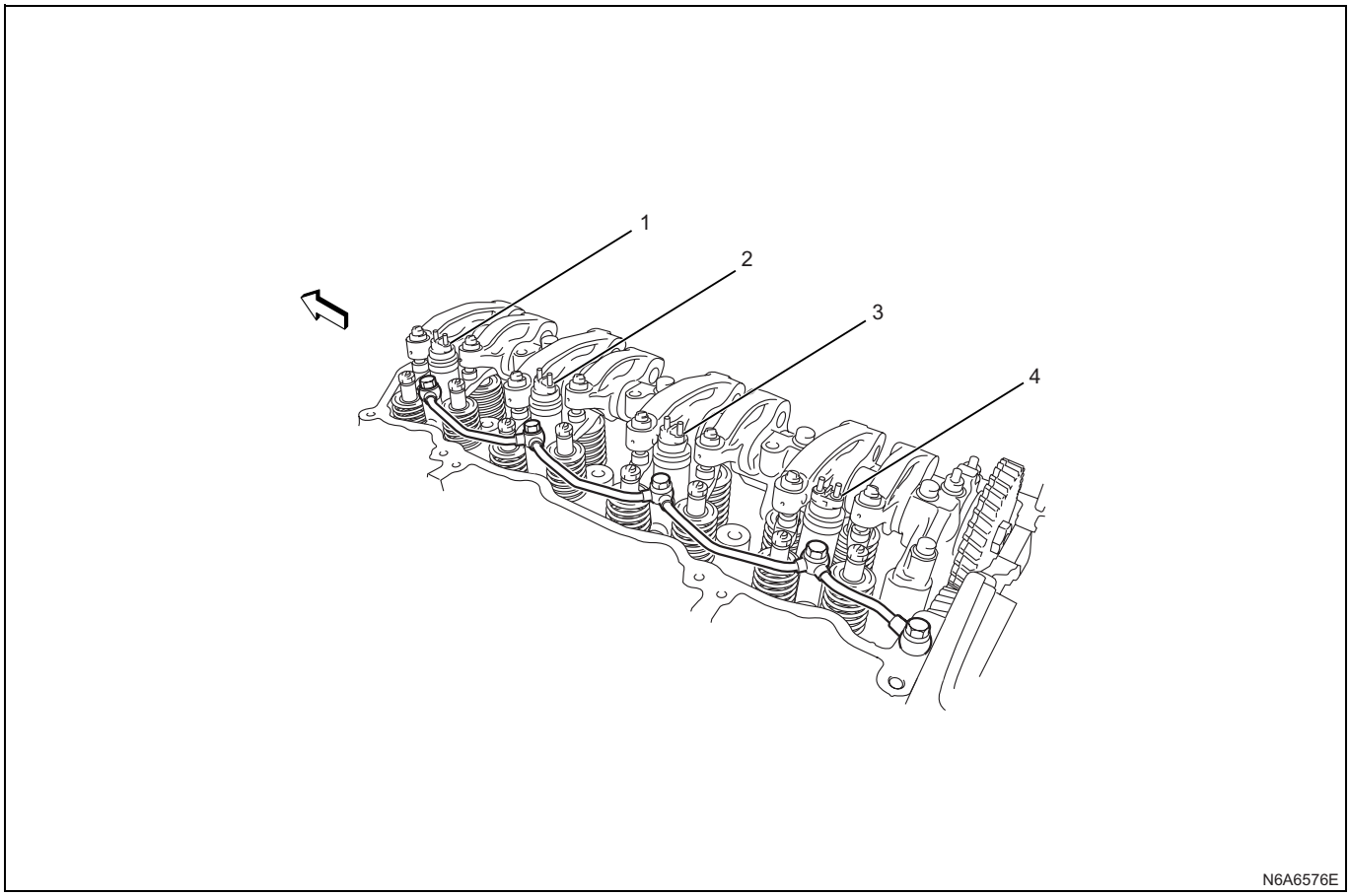


N6A6575E

Legend

1. Fuel Rail Pressure (FRP) Sensor
2. Fuel Rail Pressure (FRP) Regulator
3. Fuel Temperature (FT) Sensor

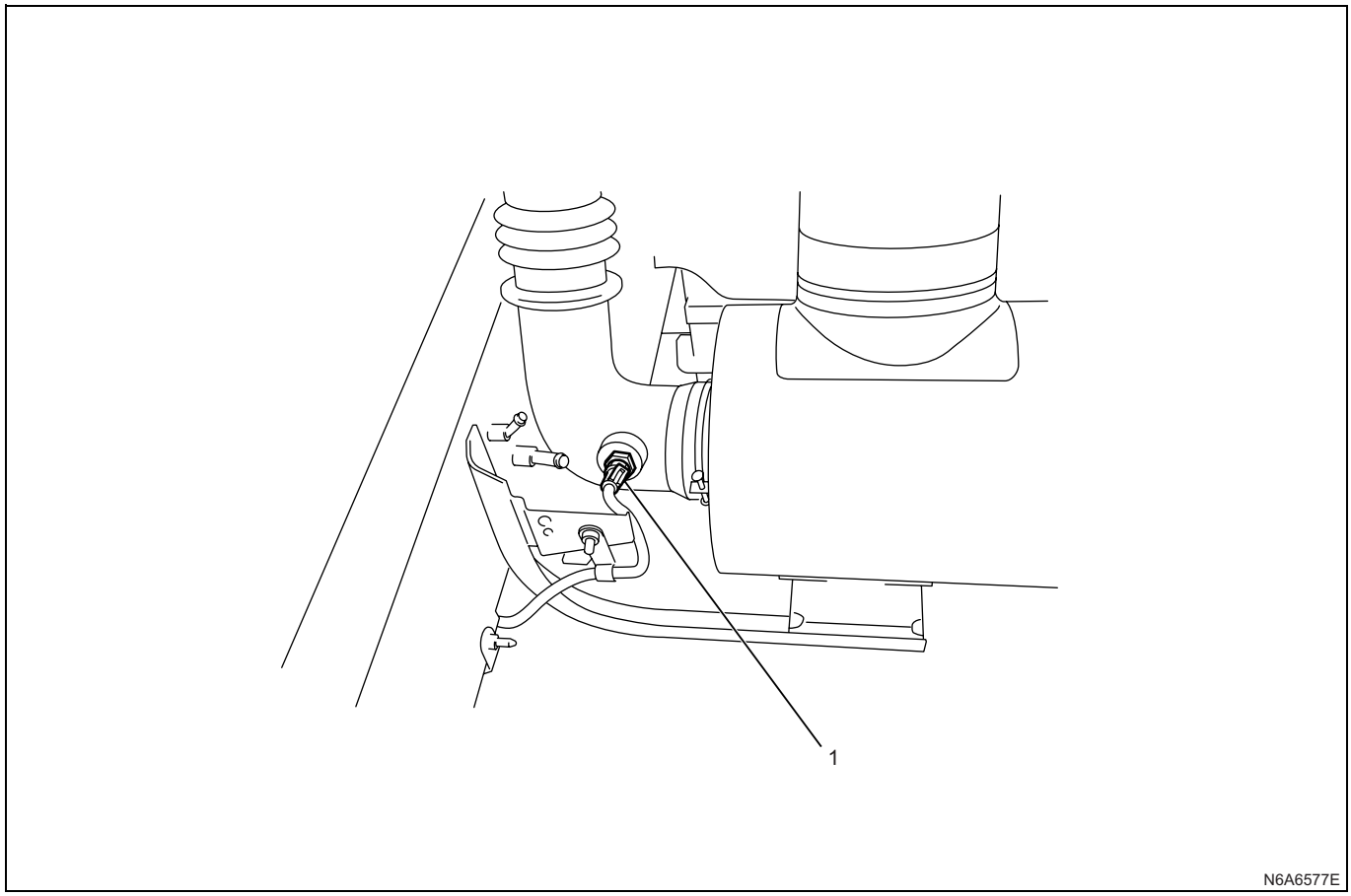
Fuel Injector



Legend

1. Cylinder #1 Injector
2. Cylinder #2 Injector
3. Cylinder #3 Injector
4. Cylinder #4 Injector

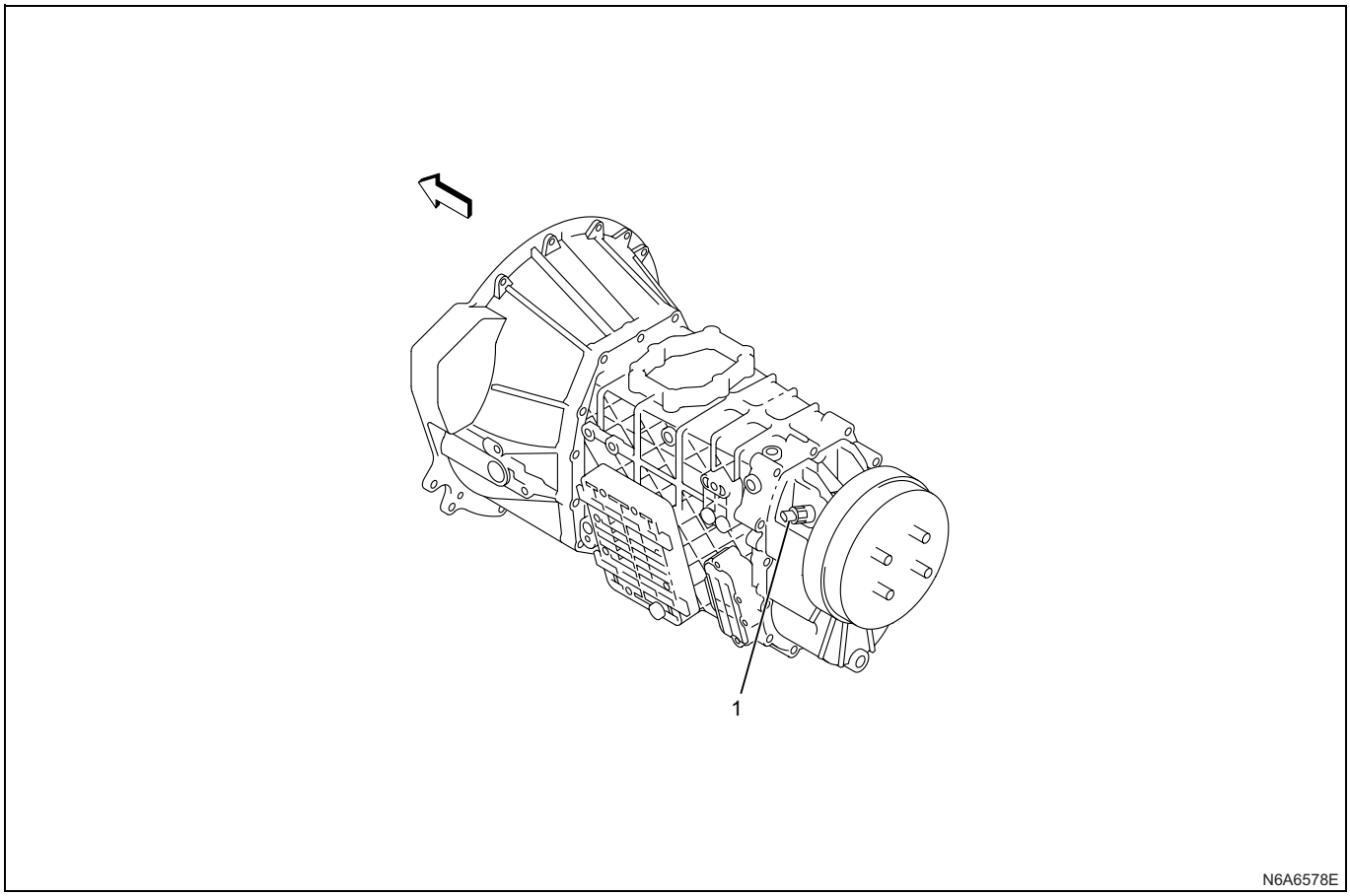
Intake Air Temperature (IAT) Sensor



Legend

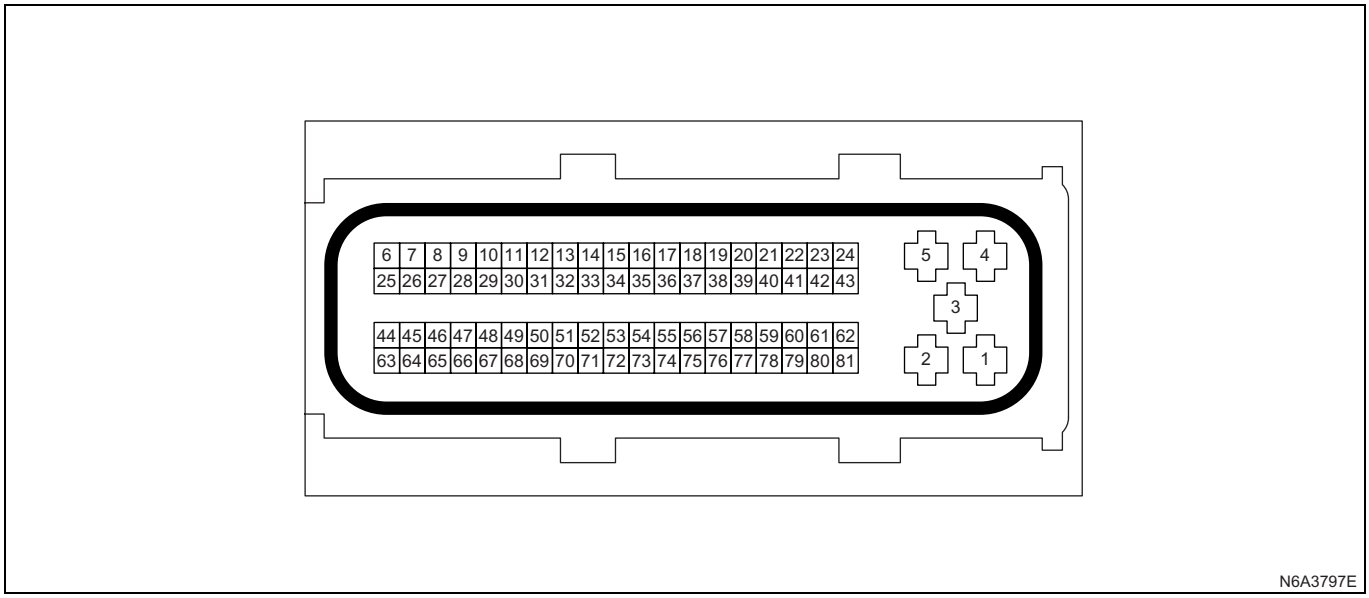
1. Intake Air Temperature (IAT) Sensor

Vehicle Speed Sensor (VSS)



Legend
1. Vehicle Speed Sensor (VSS)

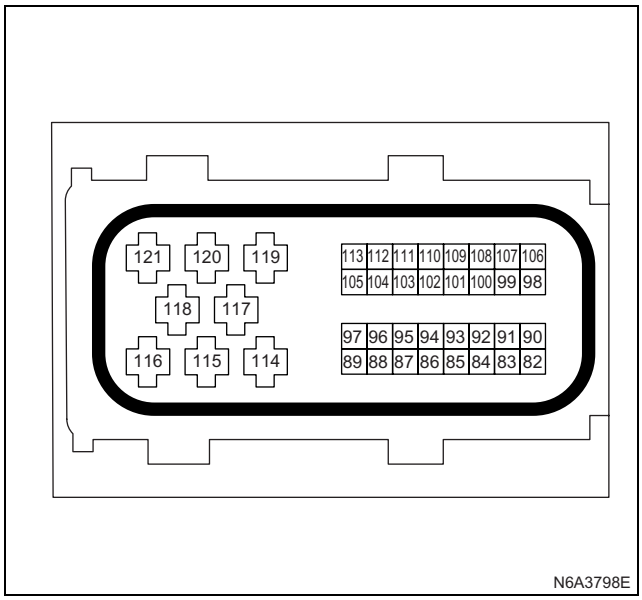
Engine Control Module (ECM) Connector End Views



Connector No.		J-191
Connector Color		Black
Test Adapter No.		J-35616-4A (Pin 1 – 5) J-35616-64A (Pin 6 – 81)
Pin	Wire Color	Pin Function
1	BLK	ECM Power Ground
2	RED	ECM Main Relay Voltage
3	BLK	ECM Power Ground
4	BLK	ECM Power Ground
5	RED	ECM Main Relay Voltage
6	BLU/RED	MIL Control
7	BLU/PNK	Exhaust Brake Lamp Control
8	LT GRN	Engine Speed Signal Output to Tachometer
9	—	Not Used
10	BLK/RED	Glow Plug Relay Control
11	ORN/BLU	Glow Indicator Lamp Control
12	—	Not Used
13	—	Not Used
14	WHT/BLU	Starter Cut Relay Control
15	BLK	Exhaust Brake Solenoid Valve Control
16	—	Not Used
17	—	Not Used
18	BLU/WHT	CAN High Signal
19	YEL/GRN	VSS Signal
20	BLK	APP Sensor 1 Shield Ground
21	BLU/BLK	ECM Main Relay Control
22	—	Not Used
23	—	Not Used
24	YEL/BLK	Ignition ON Switch Input Signal
25	—	Not Used
26	—	Not Used
27	—	Not Used
28	—	Not Used
29	—	Not Used
30	—	Not Used
31	—	Not Used
32	—	Not Used
33	PNK	Refrigerator Switch Input Signal
34	GRN/ORN	A/C Input Signal
35	—	Not Used
36	—	Not Used

Connector No.		J-191
Connector Color		Black
Test Adapter No.		J-35616-4A (Pin 1 – 5) J-35616-64A (Pin 6 – 81)
Pin	Wire Color	Pin Function
37	BLU	CAN Low Signal
38	LT BLU	Keyword 2000 Serial Data
39	BLK	APP Sensor 2 Shield Ground
40	BLU/BLK	ECM Main Relay Control
41	PNK/BLK	APP Sensor 1, Idle Up Sensor & PTO Throttle Sensor Low Reference
42	RED	APP Sensor 1, Idle Up Sensor & PTO Throttle Sensor 5 Volts Reference
43	BLK	ECM Signal Ground
44	BLU/ORN	PTO Mode Switch Input Signal
45	LT GRN/RED	Exhaust Brake Switch Input Signal
46	RED/WHT	Start Switch Input Signal
47	BRN/YEL	Clutch Switch Input Signal (M/T Only)
48	WHT/BLK	Park Brake Switch Input Signal
49	—	Not Used
50	BLK/BLU	Neutral Switch Input Signal
51	LT GRN/BLU	Engine Warm Up Switch Input Signal
52	YEL	Diagnostic Request Switch
53	—	Not Used
54	—	Not Used
55	—	Not Used
56	—	Not Used
57	—	Not Used
58	—	Not Used
59	—	Not Used
60	BLK	APP Sensor 2, BARO Sensor & IAT Sensor Low Reference
61	RED	APP Sensor 2 & BARO Sensor 5 Volts Reference
62	BLK	ECM Signal Ground
63	WHT	APP Sensor 1 Signal
64	WHT	APP Sensor 2 Signal
65	—	Not Used
66	BLU/YEL	Idle Up Sensor Signal
67	—	Not Used
68	—	Not Used

Connector No.		J-191
Connector Color		Black
Test Adapter No.		J-35616-4A (Pin 1 – 5) J-35616-64A (Pin 6 – 81)
Pin	Wire Color	Pin Function
69	—	Not Used
70	BRN	PTO Throttle Sensor Signal
71	BRN/GRN	BARO Sensor Signal
72	RED/GRN	IAT Sensor Signal
73	—	Not Used
74	—	Not Used
75	—	Not Used
76	—	Not Used
77	—	Not Used
78	—	Not Used
79	—	Not Used
80	—	Not Used
81	BLK	ECM Case Ground



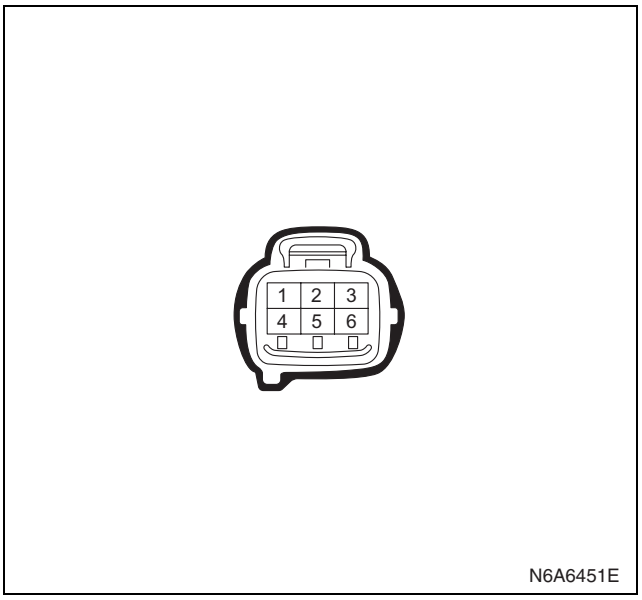
Connector No.		E-111
Connector Color		Black
Test Adapter No.		J-35616-4A (Pin 82 – 113) J-35616-64A (Pin 114 – 121)
Pin	Wire Color	Pin Function
82	WHT	FRP Sensor Signal
83	LT GRN/ WHT	FT Sensor Signal
84	GRN/YEL	ECT Sensor Signal
85	—	Not Used

Connector No.		E-111
Connector Color		Black
Test Adapter No.		J-35616-4A (Pin 82 – 113) J-35616-64A (Pin 114 – 121)
Pin	Wire Color	Pin Function
86	WHT/ORN	EGR Valve Position Sensor Signal
87	GRN/BLU	FRP Sensor & EGR Valve Position Sensor 5 Volts Reference
88	—	Not Used
89	GRN/RED	FRP Regulator Low Side
90	WHT	FRP Sensor Signal
91	RED	Boost Pressure Sensor Signal
92	—	Not Used
93	—	Not Used
94	—	Not Used
95	WHT	Boost Pressure Sensor 5 Volts Reference
96	—	Not Used
97	GRN/RED	FRP Regulator Low Side
98	BLU/WHT	CMP Sensor Signal
99	BLU/BLK	CMP Sensor 12 Volts Reference
100	BLK	FRP Sensor & CMP Sensor Shield Ground
101	BRN	FRP Sensor & EGR Valve Position Sensor Low Reference
102	LT GRN/ WHT	Intake Throttle Solenoid Valve Control
103	ORN	EGR Valve Motor Control Low Side
104	—	Not Used
105	WHT/RED	FRP Regulator High Control
106	ORN	CKP Sensor Low Signal
107	YEL	CKP Sensor High Signal
108	BLK	Boost Pressure Sensor & CKP Sensor Shield Ground
109	BLK	Boost Pressure Sensor, ECT Sensor & FT Sensor Low Reference
110	—	Not Used
111	BLK/ORN	EGR Valve Motor Control High Side
112	—	Not Used
113	WHT/RED	FRP Regulator High Control
114	—	Not Used
115	—	Not Used

Connector No.		E-111
Connector Color		Black
Test Adapter No.		J-35616-4A (Pin 82 – 113) J-35616-64A (Pin 114 – 121)
Pin	Wire Color	Pin Function
116	RED	Common 2 (Cylinder #2 & #3) Fuel Injector Drive
117	WHT/YEL	Cylinder #4 Fuel Injector Solenoid Control
118	BLK	Cylinder #2 Fuel Injector Solenoid Control
119	GRN/WHT	Cylinder #1 Fuel Injector Solenoid Control
120	BLK/BLU	Cylinder #3 Fuel Injector Solenoid Control
121	WHT	Common 1 (Cylinder #1 & #4) Fuel Injector Drive

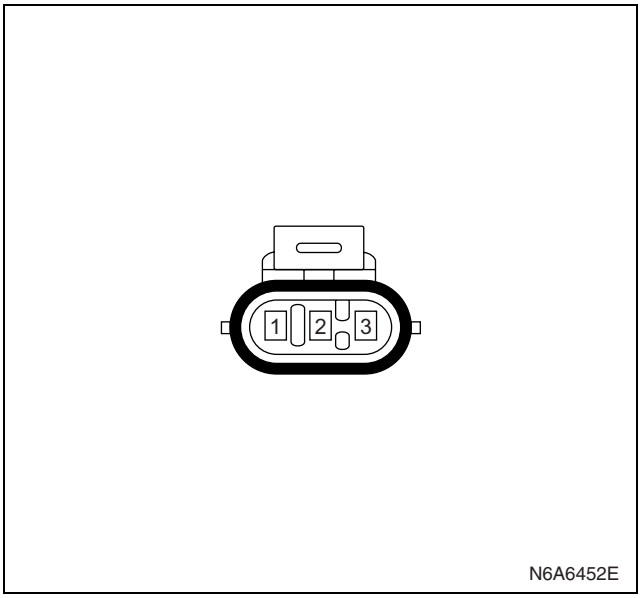
Engine Controls Connector End Views

Accelerator Pedal Position (APP) Sensor



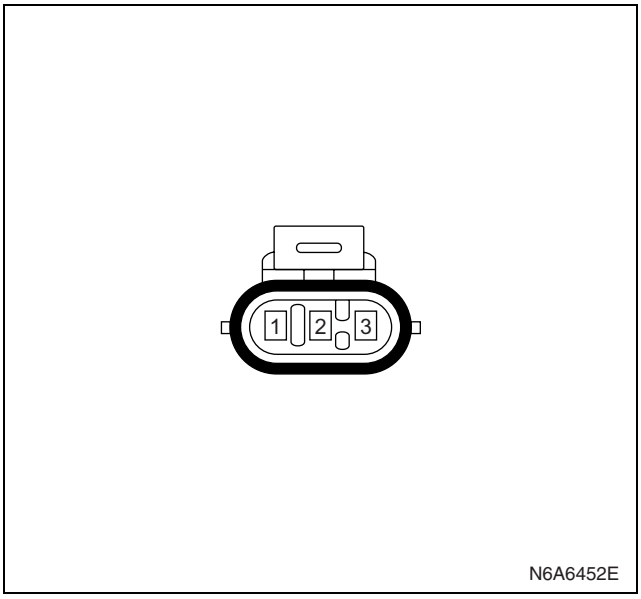
Connector No.		B-280
Connector Color		Gray
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	RED	APP Sensor 2 5 Volts Reference
2	WHT	APP Sensor 2 Signal
3	BLK	APP Sensor 2 Low Reference
4	BLU	APP Sensor 1 5 Volts Reference
5	BLU/WHT	APP Sensor 1 Signal
6	BLU/RED	APP Sensor 1 Low Reference

Barometric Pressure (BARO) Sensor



Connector No.		B-422
Connector Color		Gray
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	BLK	BARO Sensor Low Reference
2	BRN/GRN	BARO Sensor Signal
3	RED	BARO Sensor 5 Volts Reference

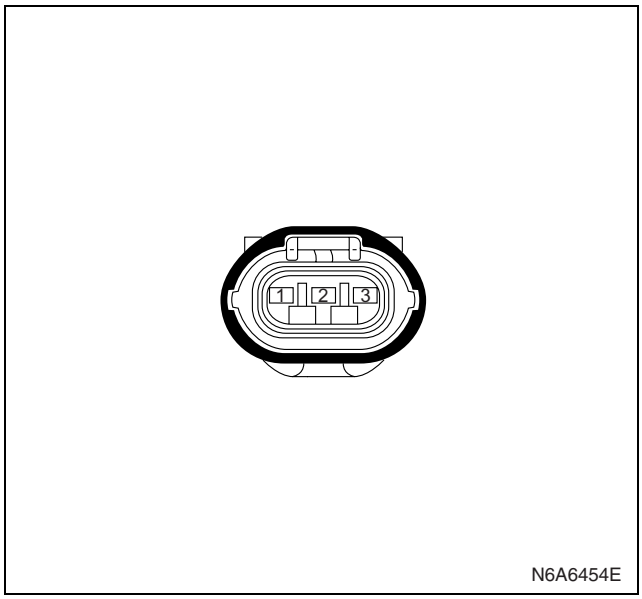
Boost Pressure Sensor



Connector No.		J-216
Connector Color		Gray
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	BLK	Boost Pressure Sensor Low Reference

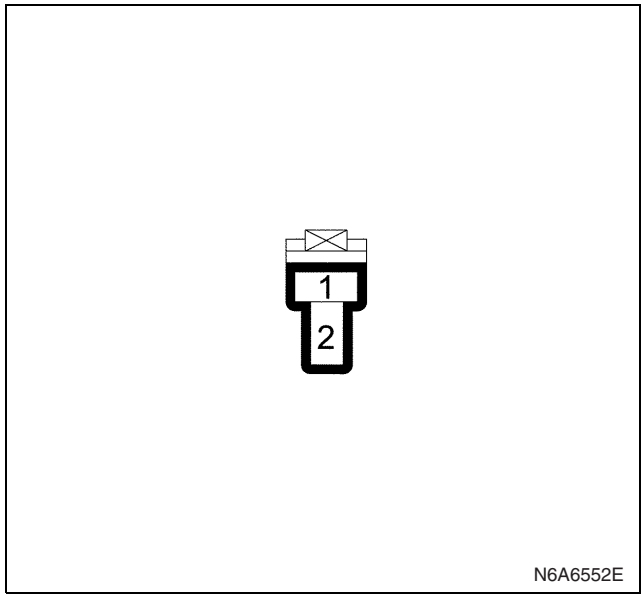
Connector No.		J-216
Connector Color		Gray
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
2	WHT	Boost Pressure Sensor Signal
3	RED	Boost Pressure Sensor 5 Volts Reference

Camshaft Position (CMP) Sensor



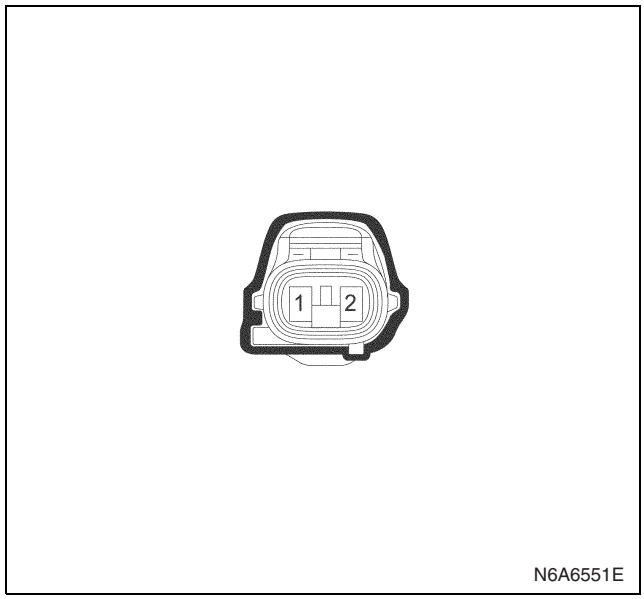
Connector No.		E-112
Connector Color		Black
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	BLK	CMP Sensor Shield Ground
2	BLU/WHT	CMP Sensor Signal
3	BLU/BLK	CMP Sensor 12 Volts Reference

Clutch Switch



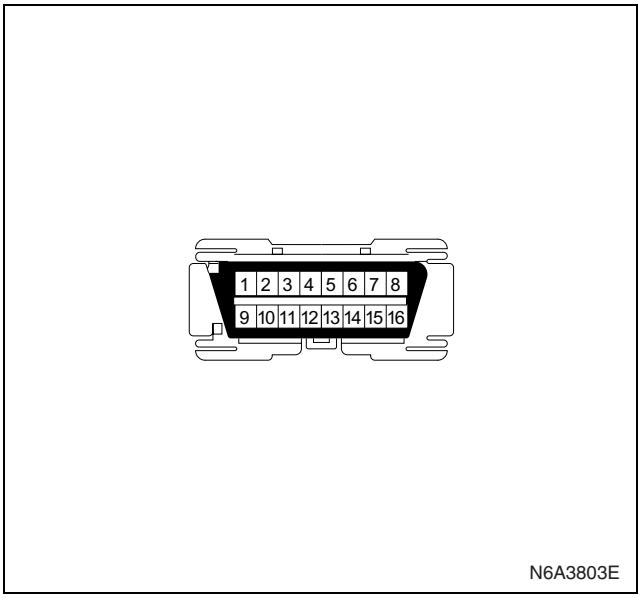
Connector No.		B-89
Connector Color		White
Test Adapter No.		J-35616-42
Pin	Wire Color	Pin Function
1	YEL/BLK	Clutch Pedal Switch Voltage Feed
2	BRN/YEL	Clutch Pedal Switch Signal

Crankshaft Position (CKP) Sensor



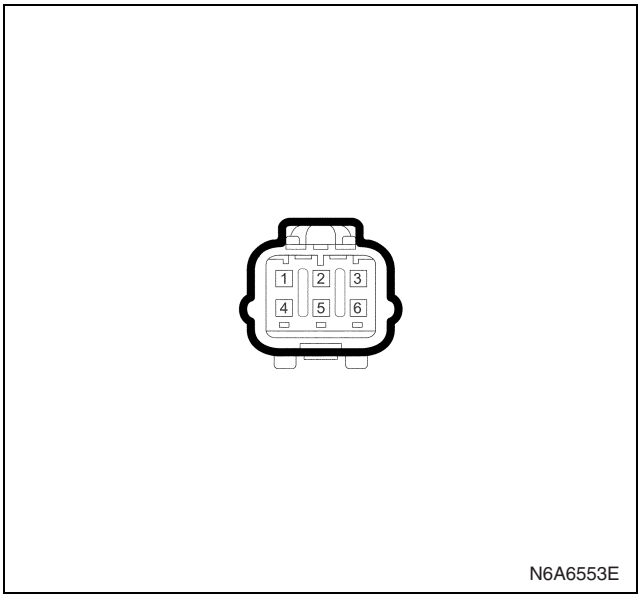
Connector No.		E-98
Connector Color		Gray
Test Adapter No.		J-35616-64A
Pin	Wire Color	Pin Function
1	YEL	CKP Sensor High Signal
2	ORN	CKP Sensor Low Signal

Data Link Connector (DLC)



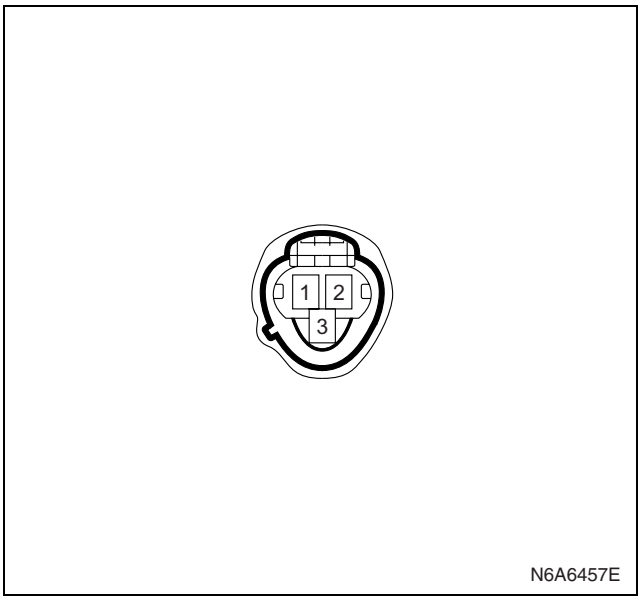
Connector No.		B-79
Connector Color		Black
Test Adapter No.		J-35616-2A
Pin	Wire Color	Pin Function
1	YEL	Diagnostic Request (ECM)
2	WHT/BLK	Class 2 Serial Communication (EHCU)
3	—	Not Used
4	BLK	Ground
5	BLK	Ground
6	—	Not Used
7	LT BLU	Keyword Serial Communication (ECM, TCM or HSA & SRS)
8	—	Not Used
9	—	Not Used
10	—	Not Used
11	BLK/WHT	Diagnostic Request (TCM or HSA)
12	WHT/GRN	Diagnostic Request (EHCU)
13	GRY	Diagnostic Request (SRS)
14	—	Not Used
15	—	Not Used
16	—	Not Used

EGR Valve



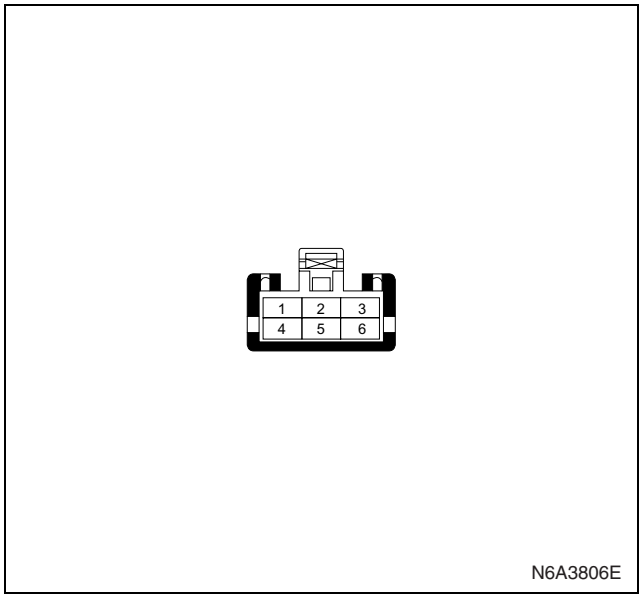
Connector No.		E-94
Connector Color		Gray
Test Adapter No.		J-35616-64A
Pin	Wire Color	Pin Function
1	GRN/BLU	EGR Valve Position Sensor 5 Volts Reference
2	BRN	EGR Valve Position Sensor Low Reference
3	WHT/ORN	EGR Valve Position Sensor Signal
4	BLK/ORN	EGR Valve Motor Control High Side
5	—	Not Used
6	ORN	EGR Valve Motor Control Low Side

Engine Coolant Temperature (ECT) Sensor



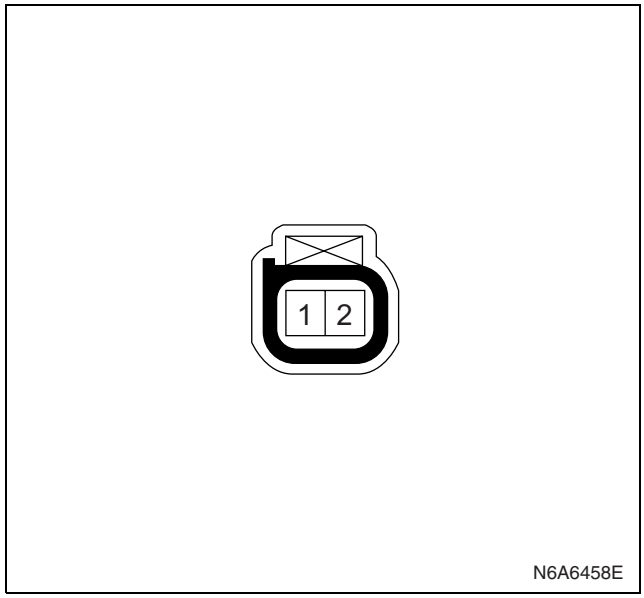
Connector No.		E-90
Connector Color		Gray
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	GRN/YEL	ECT Sensor Signal
2	BLK	ECT Sensor Low Reference
3	LT BLUK	ECT Gauge Signal

Engine Warm Up Switch



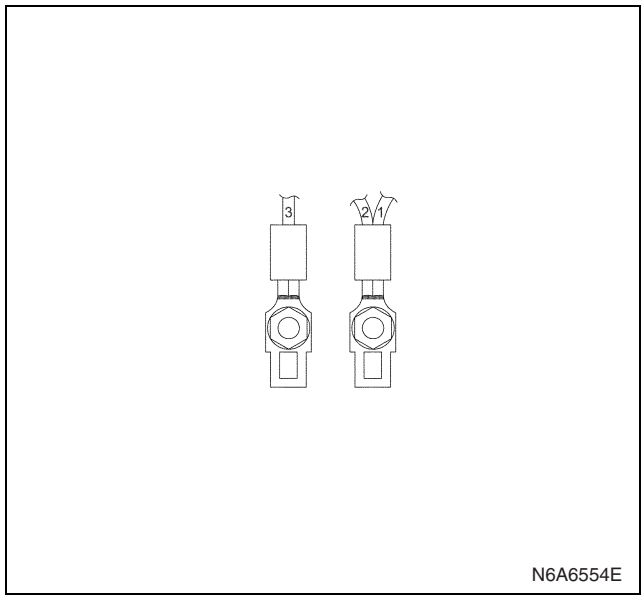
Connector No.		B-31
Connector Color		Gray
Test Adapter No.		J-35616-42
Pin	Wire Color	Pin Function
1	BLK	Indicator Lamp Ground
2	LT GRN/RED	Illumination Lamp Voltage Feed
3	BRN/BLK	Engine Warm Up Switch Voltage Feed
4	LT GRN/BLU	Indicator Lamp Voltage Feed From Engine Warm Up Switch Signal
5	BLK	Illumination Lamp Ground
6	LT GRN/BLU	Engine Warm Up Switch Signal

Exhaust Brake Solenoid Valve



Connector No.		J-31
Connector Color		Black
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	LT GRN	Exhaust Brake Solenoid Valve Voltage Feed
2	BLK	Exhaust Brake Solenoid Valve Control

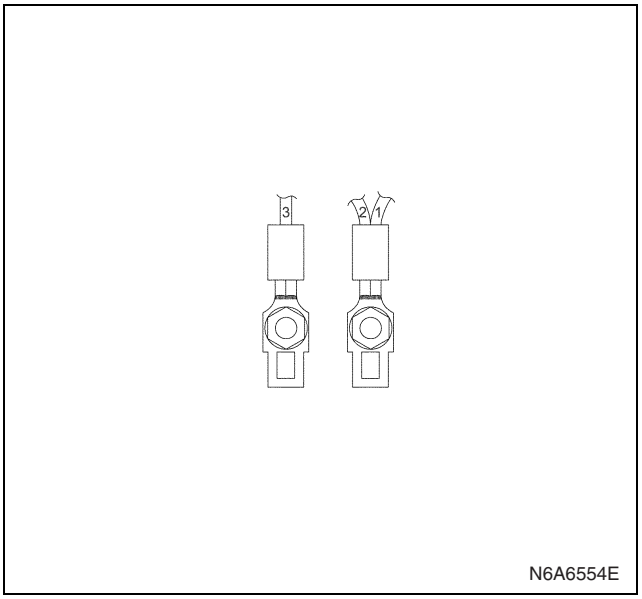
Fuel Injector Cylinder No. 1



Connector No.		E-138
Connector Color		Silver
Pin	Wire Color	Pin Function
1	WHT	Common 1 Fuel Injector Drive
2	WHT	Common 1 Fuel Injector Drive

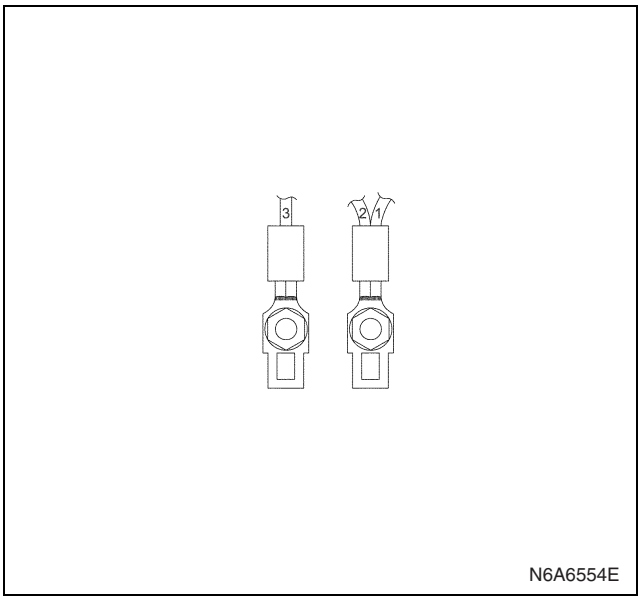
Connector No.		E-138
Connector Color		Silver
Pin	Wire Color	Pin Function
3	GRN	Cylinder #1 Fuel Injector Solenoid Control

Fuel Injector Cylinder No. 2



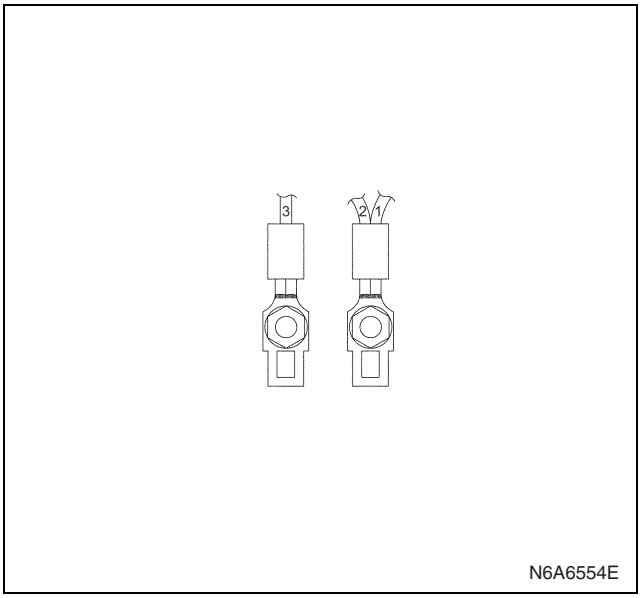
Connector No.		E-139
Connector Color		Silver
Pin	Wire Color	Pin Function
1	RED	Common 2 Fuel Injector Drive
2	RED	Common 2 Fuel Injector Drive
3	BLU	Cylinder #2 Fuel Injector Solenoid Control

Fuel Injector Cylinder No. 3



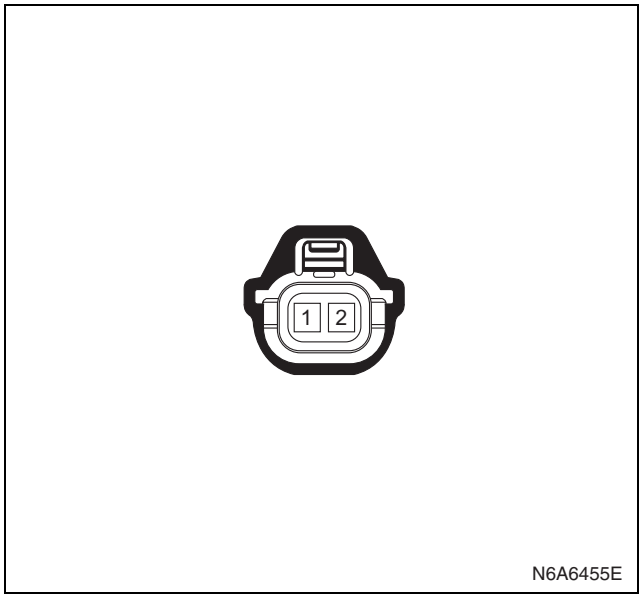
Connector No.		E-140
Connector Color		Silver
Pin	Wire Color	Pin Function
1	RED	Common 2 Fuel Injector Drive
2	RED	Common 2 Fuel Injector Drive
3	YEL	Cylinder #3 Fuel Injector Solenoid Control

Fuel Injector Cylinder No. 4



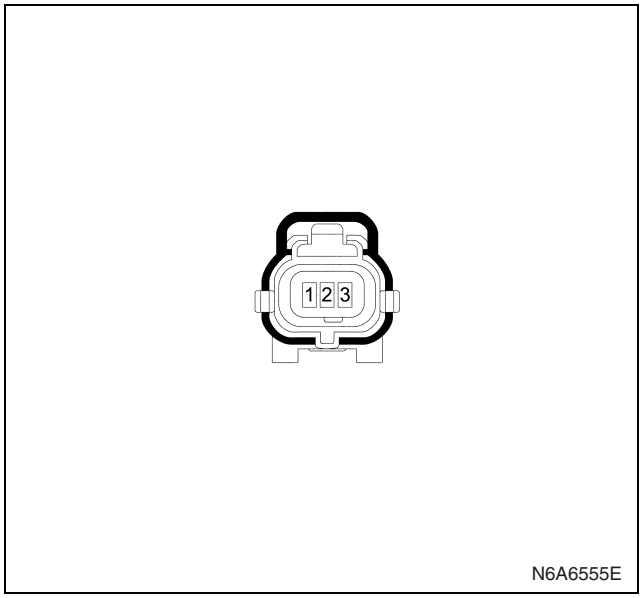
Connector No.		E-141
Connector Color		Silver
Pin	Wire Color	Pin Function
1	WHT	Common 1 Fuel Injector Drive
2	WHT	Common 1 Fuel Injector Drive
3	BLK	Cylinder #4 Fuel Injector Solenoid Control

Fuel Rail Pressure (FRP) Regulator



Connector No.		E-116
Connector Color		Gray
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	WHT/RED	FRP Regulator High Control
2	GRN/RED	FRP Regulator Low Control

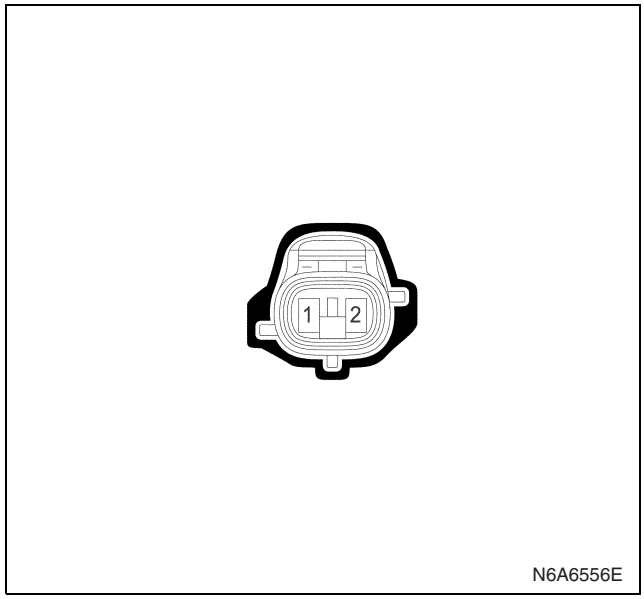
Fuel Rail Pressure (FRP) Sensor



Connector No.		E-113
Connector Color		Black
Test Adapter No.		J-35616-64A
Pin	Wire Color	Pin Function
1	BRN	FRP Sensor Low Reference
2	WHT	FRP Sensor Signal

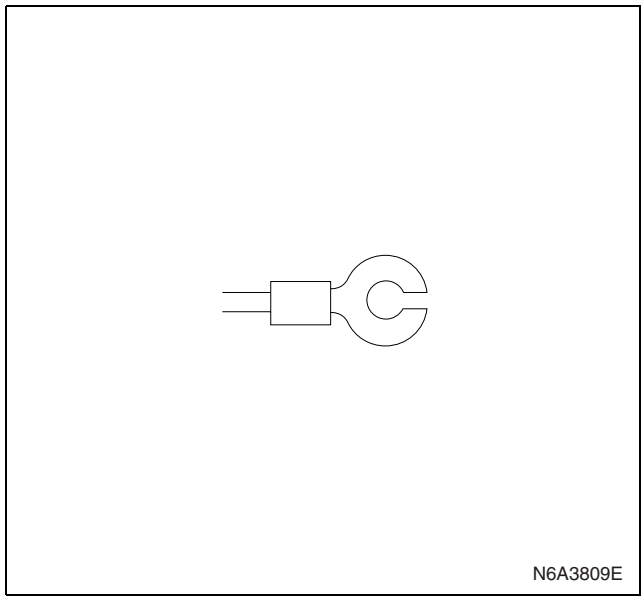
Connector No.		E-113
Connector Color		Black
Test Adapter No.		J-35616-64A
Pin	Wire Color	Pin Function
3	GRN/BLU	FRP Sensor 5 Volts Reference

Fuel Temperature (FT) Sensor



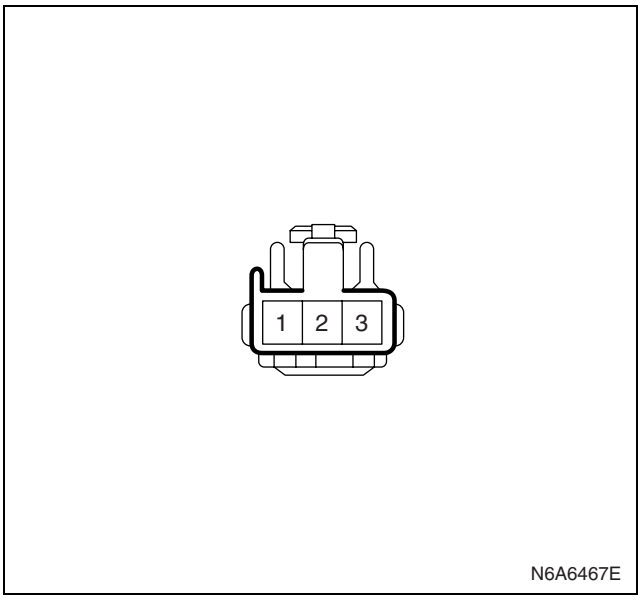
Connector No.		E-93
Connector Color		Green
Test Adapter No.		J-35616-64A
Pin	Wire Color	Pin Function
1	BLK	FT Sensor Low Reference
2	LT GRN/ WHT	FT Sensor Signal

Glow Plug



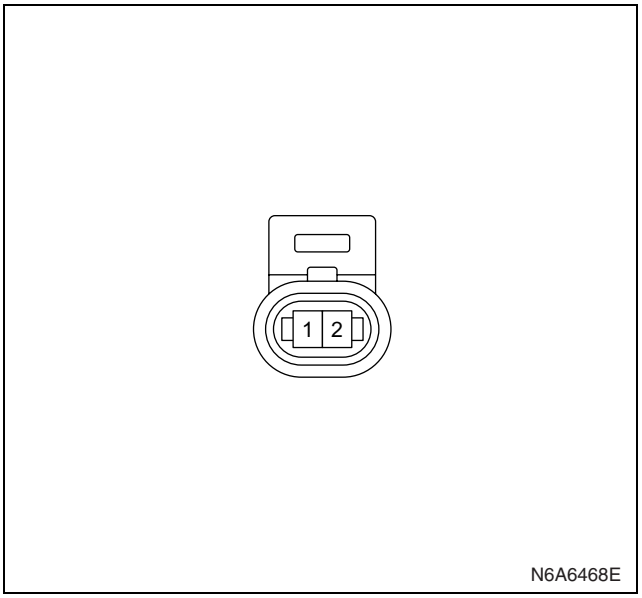
Connector No.		E-3
Connector Color		Silver
Pin	Wire Color	Pin Function
1	BLK/YEL	Power Supply

Idle Up Sensor



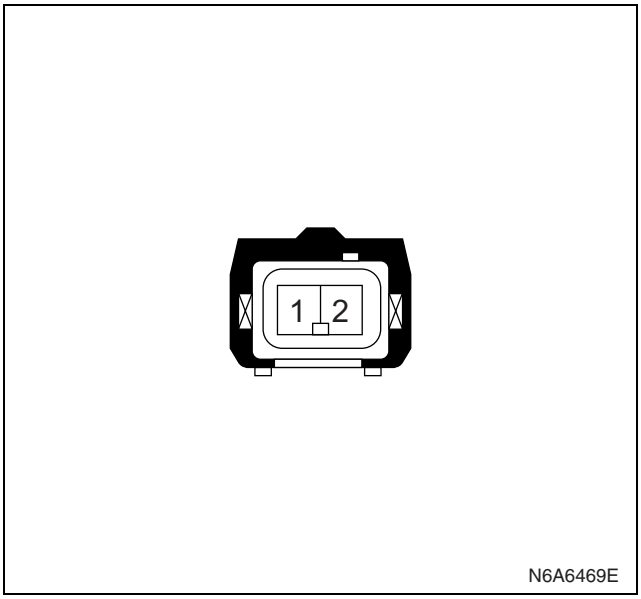
Connector No.		B-281
Connector Color		White
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	BLU/RED	Idle Up Sensor Low Reference
2	BLU/YEL	Idle Up Sensor Signal
3	BLU	Idle Up Sensor 5 Volts Reference

Intake Air Temperature (IAT) Sensor



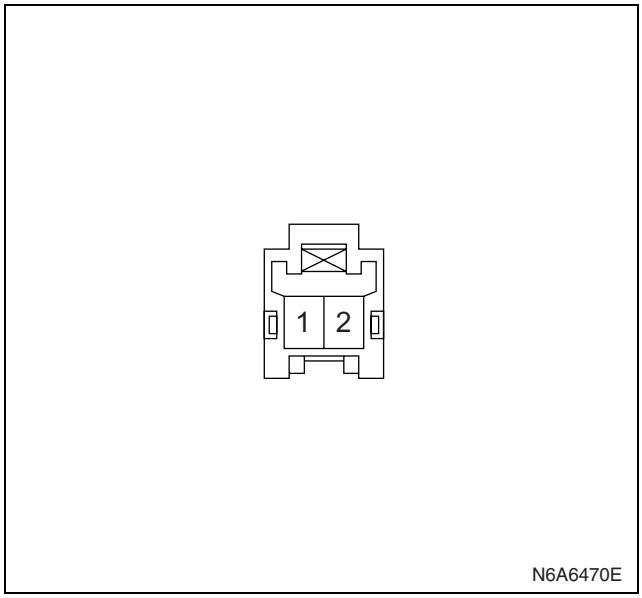
Connector No.		J-190
Connector Color		Gray
Test Adapter No.		J-35616-16
Pin	Wire Color	Pin Function
1	RED/GRN	IAT Sensor Signal
2	BLK	IAT Sensor Low Reference

Intake Throttle Solenoid Valve



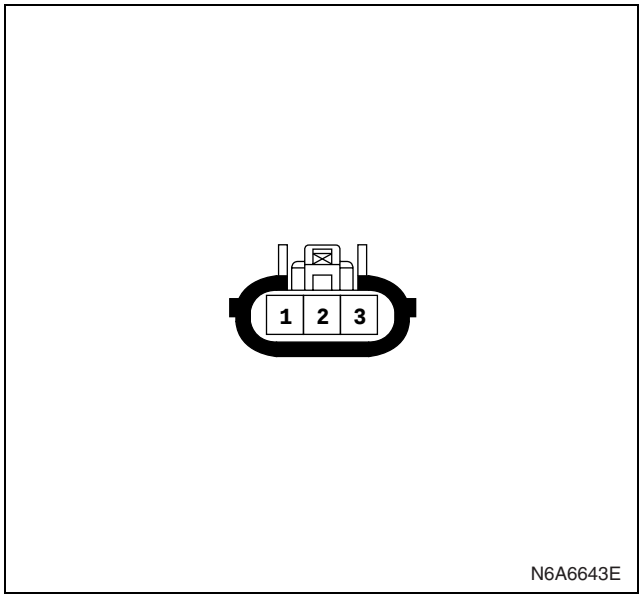
Connector No.		J-40
Connector Color		Black
Test Adapter No.		J-35616-4A
Pin	Wire Color	Pin Function
1	LT GRN	Intake Throttle Solenoid Valve Voltage Feed
2	LT GRN/ WHT	Intake Throttle Solenoid Valve Control

PTO Switch



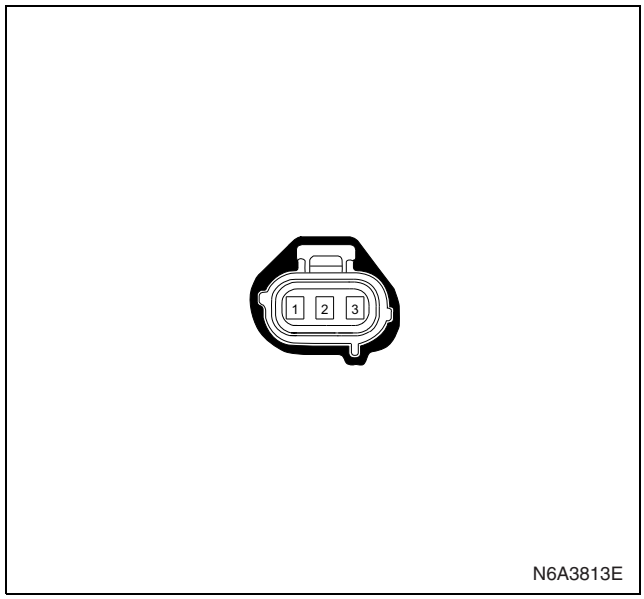
Connector No.		B-84
Connector Color		White
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	BLU/ORG	PTO Switch Signal
2	BLK	PTO Switch Ground

PTO Throttle Sensor



Connector No.		J-166
Connector Color		White
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	RED	PTO Throttle Sensor 5 Volts Reference
2	BRN	PTO Throttle Sensor Signal
3	PNK/BLK	PTO Throttle Sensor Low Reference

Vehicle Speed Sensor (VSS)



Connector No.		J-32
Connector Color		Gray
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	BLK/YEL	VSS Ignition Voltage
2	BLK	VSS Low Reference
3	YEL/GRN	VSS Signal

Diagnostic Information and Procedures

General Service Information

Non-OEM Parts

All of the on-board diagnostic (OBD) has been calibrated to run with original equipment manufacturer (OEM) parts. Accordingly, if commercially sold sensor or switch is installed, it makes a wrong diagnosis and turn on the malfunction indicator lamp (MIL). Aftermarket electronics, such as cellular phones, stereos, and anti-theft devices, may indicate electromagnetic interference (EMI) into the control system if they are improperly installed. This may cause a false sensor reading and turn on the MIL.

Poor Vehicle Maintenance

The sensitivity of OBD will cause the MIL turn on if the vehicle is not maintained properly. Restricted oil filters, fuel filters, and crankcase deposits due to lack of oil changes or improper oil viscosity can trigger actual vehicle faults that were not previously monitored prior to OBD. Poor vehicle maintenance cannot be classified as a “non-vehicle fault”, but with the sensitivity of OBD diagnostics, vehicle maintenance schedules must be more closely followed.

Visual / Physical Engine Compartment Inspection

Perform a careful visual and physical engine compartment inspection when performing any diagnostic procedure or diagnosing the cause of an emission test failure. This can often lead to repairing a problem without further steps. Use the following guidelines when performing a visual / physical inspection:

- Inspect all vacuum hoses for punches, cuts, disconnects, and correct routing.
- Inspect hoses that are difficult to see behind other components.
- Inspect all wires in the engine compartment for proper connections, burned or chafed spots, pinched wires, contact with sharp edges or contact with hot exhaust manifolds or pipes.

Basic Knowledge of Tools Required

Lack of basic knowledge of this powertrain when performing diagnostic procedures could result in an incorrect diagnosis or damage to powertrain components. Do not attempt to diagnose a powertrain problem without this basic knowledge. A basic understanding of hand tools is necessary to effectively use this section of the service manual.

Malfunction Indicator Lamp (MIL)

Basically, the MIL is turned on when the ECM detects a DTC that will impact the vehicle emission or performance. When the MIL remains “ON” while the engine is running, or when a malfunction is suspected due to a driveability or emissions problem, a Diagnostic System Check must be performed. The procedures for these checks are given in Diagnostic System Check - Engine Controls.

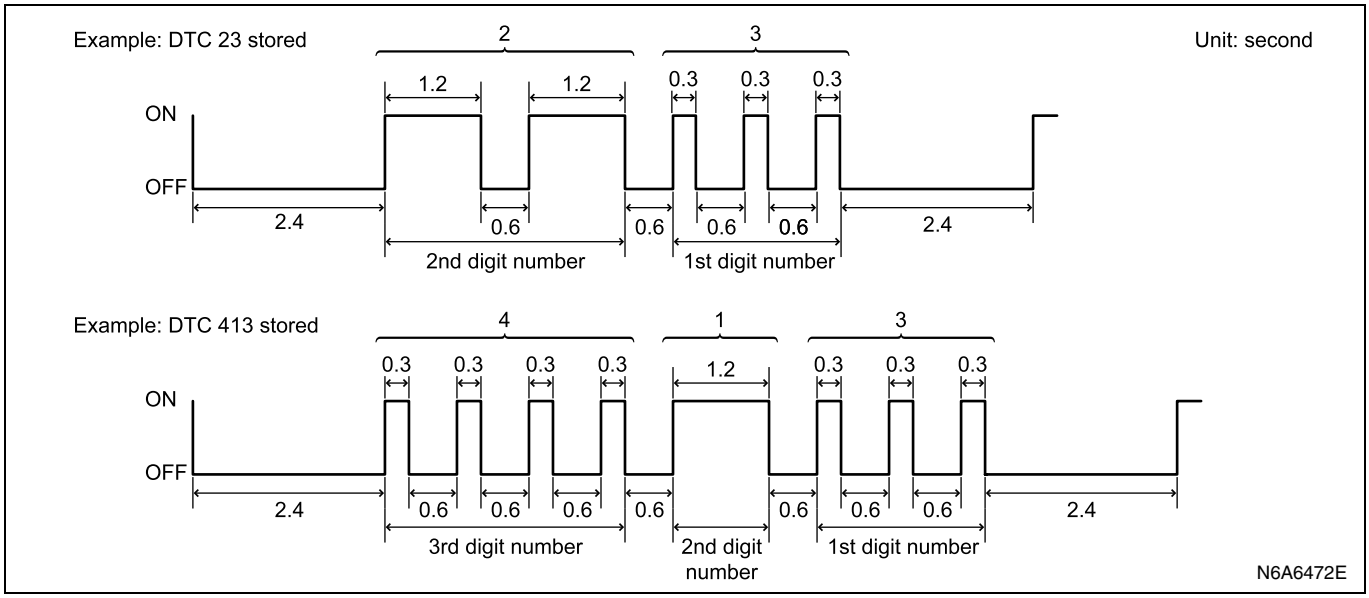
DTC Types

Characteristic of Code

- Stores a DTC on the first trip with a fail
- Dose not request illumination of any lamp

Reading Flash Diagnostic Trouble Codes (DTC)

The provision for communicating with the ECM is the Data Link Connector (DLC). The DTCs stored in the ECM memory can be read either through a hand-held diagnostic scanner such as Tech 2 plugged into the DLC or by counting the number of flashes of the MIL when the diagnostic test terminal of the DLC is grounded. The DLC terminal “1” (diagnostic request) is pulled “Low” (grounded) by jumped to DLC terminal “4”, which is a ground wire. Once terminals “1” and “4” have been connected, the ignition switch must be moved to the “ON” position, with the engine not running. The MIL will indicate a DTC three times is a DTC is present and history. If more than one DTC has been stored in the ECM’s memory, the DTCs will be output numerical order with each DTC being displayed three times. The flash DTC display will continue as long as the DLC is shorted.



Reading Diagnostic Trouble Codes (DTCs) with The Tech 2

The procedure for reading DTC(s) is used a diagnostic Tech 2. To read DTCs, use the Tech 2 “Read DTC Info As Stored By ECU”.

Clearing Diagnostic Trouble Codes (DTCs) with The Tech 2 or without Tech 2

Do not clear DTCs unless directed to do so by the service information provided for each diagnostic procedure. To clear DTCs, use with the Tech 2 “Clear DTC Information”. If there is no Tech 2, clear with accelerator pedal operation.

Notice:
A history DTC clears after 20 consecutive driving cycles without a fault.

DTC Clear Method with Accelerator Pedal Operation

1. Turn ON the ignition, with the engine OFF.
2. Use a jumper wire and the DLC terminal “1” (diagnostic request) is pulled “Low” (grounded) by jumped to DLC terminal “4”.
3. Depress accelerator pedal within 1 – 3 seconds.
4. Release accelerator pedal within 1 – 3 seconds.
5. Depress accelerator pedal within 1 – 3 seconds.
6. Release accelerator pedal within 1 – 3 seconds.
7. Depress accelerator pedal within 1 – 3 seconds.
8. Release accelerator pedal within 1 – 3 seconds.

Notice:
DO NOT touch the accelerator pedal when it is released.

Operating Procedure

1. Press Enter at start screen.
2. Select Diagnostic > appropriate vehicle identification > Engine > 4HK1(Common Rail).
3. The following table shows, which functions are used the available equipment versions.

- F0: Diagnostic Trouble Codes
  - F0: Read DTC Info As Stored By ECU
  - F1: Clear DTC Information
- F1: Data Display
- F2: Snapshot
- F3: Actuator Test
  - F0: Fuel System
    - F0: Rail Pressure Control
    - F1: Injector Balancing
    - F2: Injection Timing
    - F3: Pre Injection Stop
    - F4: Injector Forced Drive
  - F1: Device Controls
    - F0: Glow Plug Relay
    - F1: Exhaust Brake Control
    - F2: EGR Control
- F4: Programming
  - F0: Injector ID Code
    - F0: Injector ID Code
    - F1: ID Code Registration
    - F2: Upload ID Code
    - F3: Download ID Code

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Tech 2 Scan Tool

Isuzu recommend using Tech 2. Refer to the Tech 2 Users Guide for proper start up procedures.

F0: Diagnostic Trouble Codes

The purpose of this mode is to display stored trouble code in the ECM. When “Clear DTC Information” is selected, “Clear DTC Information”, warning screen appears. This screen informs you that by cleaning DTCs “all stored DTC information in the ECM will be erased”.

F1: Data Display

The purpose of this mode is to continuously monitor data parameters. The current actual values of all important sensors and signals, solenoid commands in the system are display through this mode.
Refer to the Tech 2 Data List in this section.

F2: Snapshot

“Snapshot” allow you to focus on making the condition occur, rather than trying to view all of the data in anticipation of the fault. The snapshot will collect parameter information around a trigger point that you select.
Refer to the Tech 2 user instructions for more information.

F3: Actuator Test

The purpose of this mode is to check for correct operation of electronic system actuators. Using actuator test menus can test the state of each actuator and related sensors. Especially when DTC cannot be detected, a faulty circuit can be diagnosed by testing. Even DTC has been detected, the circuit tests using these menus could help discriminate between a mechanical trouble and an electrical trouble.
Refer to the Tech 2 Output Controls in this section.

F4: Programming

The purpose of this mode is to program the fuel injector ID code into the ECM if the fuel injector or ECM is to be replaced.

Tech 2 Data List

The Tech 2 Data List contains all engine related parameters that are available on the Tech 2. Use the Tech 2 Data List only after the following is determined:

- The Diagnostic System Check – Engine Controls is completed.
- No diagnostic trouble codes (DTCs) are present.
- On-board diagnostics are functioning properly.

Tech 2 values from a properly running engine may be used for comparison with the engine you are diagnosing. The Tech 2 Data List represents values that would be seen on a normal running engine.

Important:
A Tech 2 that displays faulty data should not be used. The Tech 2 problem should be reported to the manufacturer. Use of a faulty Tech 2 can result in misdiagnosis and unnecessary parts replacement. Only the parameters listed below are referenced in this service manual for use in diagnosis.

Tech 2 Parameter	Units Displayed	Typical Data Value at Engine Idle	Typical Data Value at 1600 RPM
Operating Conditions: Engine Idling or 1600 RPM / Engine Coolant Temperature is between 75-85°C (167-185°F) / Accelerator Pedal is Constant / Neutral / Accessories OFF / Vehicle Located at Sea Level			
Ignition Voltage	V	22.0 – 30.0	22.0 – 30.0
Battery Voltage	V	22.0 – 30.0	22.0 – 30.0
Desired Idle Speed	RPM	650	650
Engine Speed	RPM	600 – 700	1550 – 1650
APP Sensor 1 (Accelerator Pedal Position)	V	0.3 – 0.7	1.2 – 1.6
APP Sensor 2 (Accelerator Pedal Position)	V	4.1 – 4.5	3.4 – 3.8
Accelerator Pedal Position (APP) Angle	%	0	20 – 26
Differential Fuel Rail Pressure	MPa / psi	-5 – 5 MPa / -725 – 725 psi	-5 – 5 MPa / -725 – 725 psi
Fuel Rail Pressure Sensor	V	1.4 – 1.6	More than 2.0 volts
Rail Pressure Feedback	Shutoff Mode / Wait Mode / Feedback Mode	Feedback Mode	Feedback Mode
Fuel Rail Pressure (FRP) Regulator Command	%	35 – 45	30 – 40
FRP Regulator Feedback	mA	900 – 1300	800 – 1200
Coolant Temperature Sensor	V	0.4 – 0.6	0.4 – 0.6

Tech 2 Parameter	Units Displayed	Typical Data Value at Engine Idle	Typical Data Value at 1600 RPM
Coolant Temperature	°C / °F	75 – 85°C / 167 – 185°F	75 – 85°C / 167 – 185°F
Intake Air Temperature Sensor	V	1.1 – 2.1	1.1 – 2.1
Intake Air Temperature	°C / °F	20 – 40°C / 68 – 104°F	20 – 40°C / 68 – 104°F
Fuel Temperature Sensor	V	2.4 – 2.8	2.4 – 2.8
Fuel Temperature	°C / °F	20 – 50°C / 50 – 122°F	20 – 50°C / 50 – 122°F
Barometric Pressure Sensor	V	Nearly 2.3 volts at sea level	Nearly 2.3 volts at sea level
Barometric Pressure	KPa / psi	Nearly 100 KPa / 14.5 psi at sea level	Nearly 100 KPa / 14.5 psi at sea level
EGR Position Sensor	V	Less than 1.5 volts	Less than 2.0 volts
EGR Position Variance	%	-5 – 5%	-5 – 5%
EGR Solenoid Command	%	Less than 20%	Less than 30%
Boost Pressure Sensor	V	Nearly 1.0 volt at sea level	Less than 1.3 volts at sea level
Boost Pressure	KPa / psi	Nearly 100 KPa / 14.5 psi at sea level	Less than 115 KPa / 16.7 psi at sea level
ASR System Command APP Angle	%	100	100
Vehicle Speed	Km/h / MPH	0	0
Cylinder 1 Compensation	mm^3/st	-5.0 – 5.0 (Varies)	0.0
Cylinder 2 Compensation	mm^3/st	-5.0 – 5.0 (Varies)	0.0
Cylinder 3 Compensation	mm^3/st	-5.0 – 5.0 (Varies)	0.0
Cylinder 4 Compensation	mm^3/st	-5.0 – 5.0 (Varies)	0.0
Engine Mode	Halt Mode / Wait Mode / Crank Mode / Fuel Mode	Fuel Mode	Fuel Mode
Engine Warm Up Switch	On / Off	Off	Off
Ignition Switch	On / Off	On	On
Starter Switch	On / Off	Off	Off
Clutch Pedal Switch	Applied / Release	Released	Released
Park / Neutral Switch	On / Off	On	On
Parking Brake Switch	Applied / Released	Applied	Applied
Exhaust Brake Switch	On / Off	Off	Off
Exhaust Brake Solenoid Valve Command	On / Off	Off	Off
PTO Switch	On / Off	Off	Off
PTO Remote Throttle Angle	%	0	0
PTO Remote Throttle Sensor	V	Less than 0.4 volts	Less than 0.4 volts
Idle Up Sensor	V	0.3 – 0.6	0.3 – 0.6
A/C Clutch Switch (Air Conditioning)	On / Off	Off	Off
ABS Exh. Brake Cut Request	Yes / No	No	No
TCM Exh. Brake Cut Request	Yes / No	No	No
Refrigerator Switch	On / Off	Off	Off
Glow Relay Command	On / Off	Off	Off
Glow Indicator Lamp Command	On / Off	Off	Off

Tech 2 Data Definitions

A list of each message displayed on the Tech 2 will be explained in Engine Controls. This information will assist in emission or driveability problems. The displays can be viewed while the vehicle is being driven. Always perform the Diagnosis System Check – Engine Controls first. The Diagnostic System Check will confirm proper system operation.

Ignition Voltage
This parameter displays the ignition voltage measured at the ignition feed circuit of the ECM. Voltage is applied to the ECM when the ignition switch is ON position.

Battery Voltage
This parameter displays the battery voltage measured at the ECM main relay switched voltage feed circuit of the ECM. Voltage is applied to the ECM when the ECM main relay is energized.

Desired Idle Speed
This parameter displays the idle speed requested by the ECM. The ECM will change desired idle speed based on engine coolant temperature (ECT) and Idle up sensor status.

Engine Speed
This parameter displays the speed of the crankshaft as calculated by the ECM based on inputs from the crankshaft position (CKP) sensor or camshaft position (CMP) sensor. The Tech 2 will display the engine speed in revolution per minute (RPM).

APP Sensor 1 (Accelerator Pedal Position)
This parameter displays the voltage signal sent to the ECM from the accelerator pedal position (APP) sensor 1 of the APP sensor assembly. APP sensor 1 is a range of values indicating a low voltage when the accelerator pedal is not depressed to a high voltage when the accelerator pedal is fully depressed.

APP Sensor 2 (Accelerator Pedal Position)
This parameter displays the voltage signal sent to the ECM from the accelerator pedal position (APP) sensor 2 of the APP sensor assembly. APP sensor 2 is a range of values indicating a high voltage when the accelerator pedal is not depressed to a low voltage when the accelerator pedal is fully depressed.

Accelerator Pedal Position (APP) Angle
This parameter displays the angle of the accelerator pedal as calculated by the ECM using the signals from the accelerator pedal position sensors. The APP indicated angle is a range of values indicating a low percentage when the accelerator pedal is not depressed to a high percentage when the accelerator pedal is fully depressed.

Differential Fuel Rail Pressure
This parameter displays the difference of actual and desired fuel rail pressure (actual value – desired value) as calculated by the ECM using the signal from the fuel rail pressure (FRP) sensor. The negative value is indicating a lower actual fuel rail pressure. The positive value is indicating a higher actual fuel rail pressure.

Fuel Rail Pressure Sensor
This parameter displays the voltage signal sent to the ECM from the fuel rail pressure (FRP) sensor. FRP sensor is a range of values indicating a low voltage when the fuel rail pressure is low to a high voltage when the fuel rail pressure is high.

Rail Pressure Feedback
This parameter displays the state of the fuel rail pressure feedback to the ECM. Wait Mode indicates the ignition switch is turned ON position. Feedback Mode indicates the engine is during crank or run. Shutoff Mode indicates the ignition switch is turned OFF position.

Fuel Rail Pressure (FRP) Regulator Command
This parameter displays the fuel rail pressure (FRP) regulator control duty ratio signal based on inputs to the ECM from various engine sensors. The Tech 2 will display a low percentage when the FRP regulator is controlled to open (fuel supply quantity to the fuel rail is increased). The Tech 2 will display a high percentage when the FRP regulator is controlled to close (fuel supply quantity to the fuel rail is reduced).

FRP Regulator Feedback
This parameter displays the fuel rail pressure (FRP) regulator control feedback current as calculated by the ECM. The Tech 2 will display a low current when the FRP regulator is controlled to open (fuel supply quantity to the fuel rail is increased). The Tech 2 will display a high current when the FRP regulator is controlled to close (fuel supply quantity to the fuel rail is reduced).

Coolant Temperature Sensor
This parameter displays the voltage signal sent to the ECM from the engine coolant temperature (ECT) sensor. Coolant temperature sensor is a range of value indicating a low voltage when the temperature is high and a high voltage when the temperature is low.

Coolant Temperature
This parameter displays the temperature of the engine coolant as calculated by the ECM using the signal from the engine coolant temperature (ECT) sensor. The Tech 2 will display a low temperature when the ECT sensor signal voltage is high, and a high temperature when the ECT sensor signal voltage is low.

Intake Air Temperature Sensor
This parameter displays the voltage signal sent to the ECM from the intake air temperature (IAT) sensor. IAT is a range of value indicating a low voltage when the temperature is high and a high voltage when the temperature is low.

Intake Air Temperature
This parameter displays the temperature of the intake air as calculated by the ECM using the signal from the intake air temperature (IAT) sensor. The Tech 2 will display a low temperature when the IAT sensor signal voltage is high, and a high temperature when the IAT sensor signal voltage is low.

Fuel Temperature Sensor
This parameter displays the voltage signal sent to the ECM from the fuel temperature (FT) sensor. FT sensor is a range of value indicating a low voltage when the temperature is high and a high voltage when the temperature is low.

Fuel Temperature
This parameter displays the temperature of the fuel as calculated by the ECM using the signal from the fuel temperature (FT) sensor. The Tech 2 will display a low temperature when the FT sensor signal voltage is high, and a high temperature when the FT sensor signal voltage is low.

Barometric Pressure Sensor
This parameter displays the voltage signal sent to the ECM from the barometric pressure (BARO) sensor. BARO sensor is a range of values indicating a low voltage in high altitude area to a high voltage in low altitude area.

Barometric Pressure
This parameter displays the barometric pressure (BARO) as calculated by the ECM using the signal from the barometric pressure (BARO) sensor. The Tech 2 will display a low barometric pressure in high altitude area to a high barometric pressure in low altitude area.

EGR Position Sensor
This parameter displays the voltage signal sent to the ECM from the EGR position sensor of the EGR valve. EGR position sensor is a range of values indicating a low voltage when the EGR valve is closed to a high voltage when the EGR valve is opened.

EGR Position Variance
This parameter displays the difference of actual and desired EGR valve position (actual value – desired value) as calculated by the ECM using the signal from the EGR position sensor. The negative value is indicating a lower actual valve position (more closed). The positive value is indicating a higher actual valve position (more opened).

EGR Solenoid Command
This parameter displays the EGR valve control duty ratio signal based on inputs to the ECM from various engine sensors. The Tech 2 will display a low percentage when the EGR valve is controlled to close. The Tech 2 will display a high percentage when the EGR valve is controlled to open.

Boost Pressure Sensor
This parameter displays the voltage signal sent to the ECM from the boost pressure sensor. Boost pressure sensor is a range of values indicating a low voltage when the boost pressure is low (idle or lower engine load) and a high voltage when the boost pressure is high (higher engine load).

Boost Pressure
This parameter displays the boost pressure in the intake duct as calculated by the ECM using the signal from the boost pressure sensor. The Tech 2 will display a low boost pressure when the low engine load to a high boost pressure when the high engine load. Note that the true boost pressure is determined by subtracting barometric pressure from the actual reading.

ASR System Command APP Angle
This parameter displays the controlled angle of the accelerator pedal calculated by the electric hydraulic control module (EHCU) (ABS module) when anti slip regulator (ASR) system operated. The Tech 2 will display 100% when the ECM is not controlled to reduce fuel injection quantity. The Tech 2 will display a low percentage when the ECM is controlled to reduce fuel injection quantity to reduce drive wheels spinning.

Vehicle Speed
This parameter indicates the vehicle speed calculated by the ECM using the signal from the vehicle speed sensor (VSS). The Tech 2 will display a low value at lower vehicle speeds, and a high value at higher vehicle speeds.

Cylinder 1 Compensation
This parameter displays the adjustment of fuel volume for cylinder 1 at low engine speed area as calculated by the ECM. The Tech 2 will display a negative value if the fuel volume is lowered. The Tech 2 will display a positive value if the fuel volume is increased. If there is a cylinder that is excessively high or low value, it may indicate faulty fuel injector, weak or slightly seized cylinder or an incorrectly programmed fuel injector ID code.

Cylinder 2 Compensation
This parameter displays the adjustment of fuel volume for cylinder 2 at low engine speed area as calculated by the ECM. The Tech 2 will display a negative value if the fuel volume is lowered. The Tech 2 will display a positive value if the fuel volume is increased. If there is a cylinder that is excessively high or low value, it may indicate faulty fuel injector, weak or slightly seized cylinder or an incorrectly programmed fuel injector ID code.

Cylinder 3 Compensation
This parameter displays the adjustment of fuel volume for cylinder 3 at low engine speed area as calculated by the ECM. The Tech 2 will display a negative value if the fuel volume is lowered. The Tech 2 will display a positive value if the fuel volume is increased. If there is a cylinder that is excessively high or low value, it may indicate faulty fuel injector, weak or slightly seized cylinder or an incorrectly programmed fuel injector ID code.

Cylinder 4 Compensation
This parameter displays the adjustment of fuel volume for cylinder 4 at low engine speed area as calculated by the ECM. The Tech 2 will display a negative value if the fuel volume is lowered. The Tech 2 will display a positive value if the fuel volume is increased. If there is a cylinder that is excessively high or low value, it may indicate faulty fuel injector, weak or slightly seized cylinder or an incorrectly programmed fuel injector ID code.

Engine Mode
This parameter displays the state of engine. Wait Mode indicates the ignition switch is turned ON position. Crank Mode indicates the engine is during crank. Fuel Mode indicates the engine is run. Halt Mode indicates the ignition switch is tuned OFF position.

Engine Warm Up Switch
This parameter displays the input state of the engine warm up switch to the ECM. The Tech 2 will display On or Off. On indicates the engine warm up switch is closing the engine warm up request circuit to the ECM and allowing to energize the exhaust brake solenoid valve and intake throttle solenoid valve depending on engine condition. Off indicates the engine warm up switch is open.

Ignition Switch
This parameter displays the input state of the ignition switch to the ECM. The Tech 2 will display On or Off. On indicates the ignition switch is turned ON position.

Starter Switch
This parameter displays the input state of the starter switch to the ECM. The Tech 2 will display On or Off. On indicates the ignition switch is turned at START position.

Clutch Pedal Switch
This parameter displays the state of the clutch pedal switch to the ECM. The Tech 2 will display Applied or Released. Released indicates the clutch pedal is not being push down. Applied indicates the clutch switch is being depressed.

Park / Neutral Switch
This parameter displays the input state of the neutral switch to the ECM. The Tech 2 will display On or Off. On indicates the neutral switch is ON position (actual position).

Parking Brake Switch
This parameter displays the input state of the parking brake switch to the ECM. The Tech 2 will display Applied or Released. Applied indicates the parking brake lever is pulled position.

Exhaust Brake Switch
This parameter displays the input state of the exhaust brake switch to the ECM. The Tech 2 will display On or Off. On indicates the exhaust brake switch is closing the exhaust brake request circuit to the ECM and allowing to energize the exhaust brake solenoid valve and intake throttle solenoid valve depending on driving condition. Off indicates the exhaust brake switch is open and exhaust brake will not engage.

Exhaust Brake Solenoid Valve Command
This parameter displays the commanded state of the exhaust brake solenoid valve control circuit. The Tech 2 will display On or Off. On indicates the exhaust brake solenoid valve is being energized by the ECM. Off indicates the exhaust brake solenoid valve is not being commanded On by the ECM.

PTO Switch
This parameter displays the state of the PTO switch to the ECM. The Tech 2 will display On or Off. On indicates the PTO switch is being pressed by controlling the PTO lever or button.

PTO Remote Throttle Angle
This parameter displays the angle of the PTO remote throttle sensor as calculated by the ECM using the signal from the PTO remote throttle sensor. The PTO remote throttle angle is a range of values indicating a low percentage when the throttle sensor is not operated to a high percentage when the throttle sensor is operated.

PTO Remote Throttle Sensor
This parameter displays the voltage signal sent to the ECM from the PTO remote throttle sensor. The PTO remote throttle sensor is a range of values indicating a low voltage when the throttle sensor is not operated to a high voltage when the throttle sensor is operated.

Idle Up Sensor
This parameter displays the voltage signal sent to the ECM from the idle up sensor. The idle up sensor is a range of values indicating a low voltage when the idle up sensor rotates in a counterclockwise direction to a high voltage when the idle up sensor rotates in a clockwise direction.

A/C Clutch Switch (Air Conditioning)
This parameter displays the state of the air conditioning (A/C) compressor engage. On indicates the ECM receiving an A/C compressor On signal. Off indicates the ECM is not receiving an A/C compressor On signal.

ABS Exh. Brake Cut Request
This parameter displays the state of the exhaust brake cut request to the ECM from the electric hydraulic control module (EHCU) (ABS module). The Tech 2 will display Yes or No. Yes indicates the EHCU is commanding to release the exhaust brake. No indicates the EHCU is not being commanded to the ECM.

TCM Exh. Brake Cut Request
This parameter displays the state of the exhaust brake cut request to the ECM from the transmission control module (TCM). The Tech 2 will display Yes or No. Yes indicates the TCM is commanding to release the exhaust brake. No indicate the TCM is not being commanded to the ECM.

Refrigerator Switch
This parameter displays the state of the refrigerator compressor engage. On indicates the ECM receiving a refrigerator compressor On signal. Off indicates the ECM is not receiving a refrigerator compressor On signal.

Glow Replay Command
This parameter displays the commanded state of the glow relay control circuit. The Tech 2 will display On or Off. On indicates the glow relay control circuit is being grounded by the ECM, allowing voltage to the glow plugs. Off indicates the glow relay is not being commanded On by the ECM.

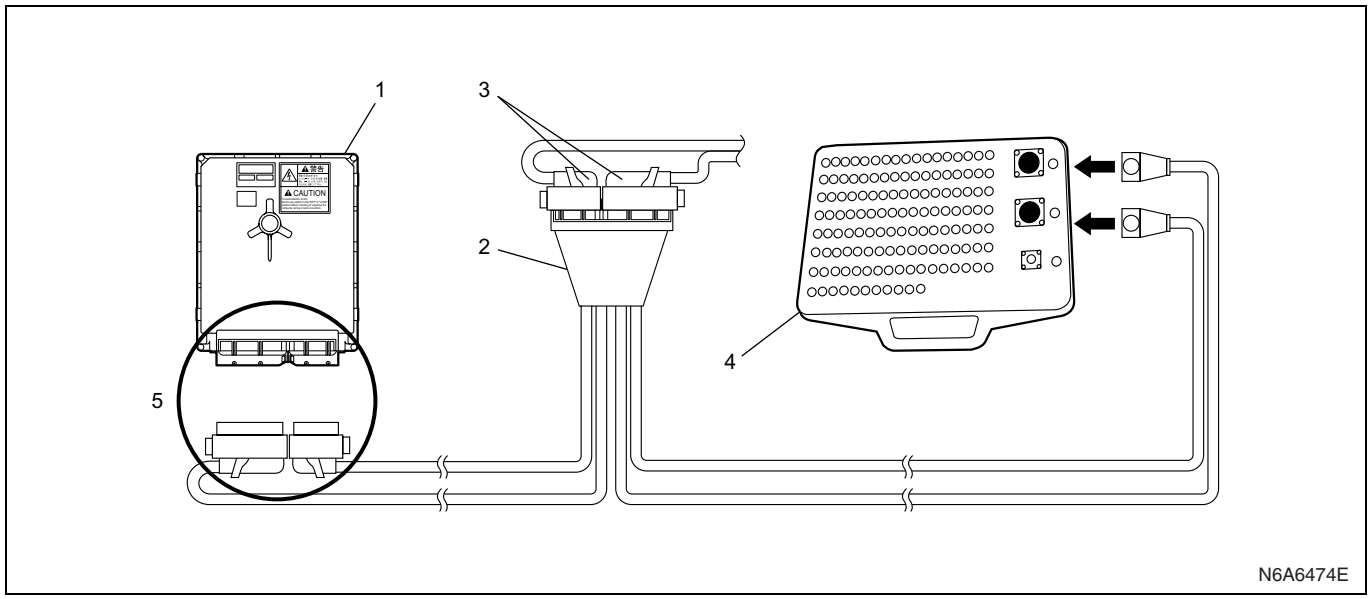
Glow Indicator Lamp Command
This parameter displays the commanded state of the glow indicator lamp control circuit. The glow indicator lamp should be On when the Tech 2 indicates the glow indicator lamp command is On. The glow indicator lamp should be Off when the Tech 2 indicates the glow indicator lamp command is Off.

Tech 2 Output Controls

Tech 2 Output Control	Additional Menu Selection(s)	Descriptions
Rail Pressure Control	Fuel System	The purpose of this test is for checking whether the fuel rail pressure is changing when commanded within 30 – 80 MPa (4,350 – 11,600 psi) when commanded. Faulty fuel supply pump, fuel rail pressure (FRP) regulator solenoid, pressure limiter valve or other fuel lines could be considered if the Differential Fuel Rail Pressure is large.
Injector Balancing	Fuel System	The purpose of this test is for checking whether the fuel injector is operating when commanded OFF. Faulty injector(s) could be considered if engine does not change speed when commanded OFF.
Injection Timing	Fuel System	The purpose of this test is for checking whether the main injection timing is changing when commanded Retard / Advance within -4 – 5°CA.
Pre Injection Stop	Fuel System	The purpose of this test is for checking whether the pilot fuel injection is operated when it is commanded to Off. Faulty injector(s) could be considered if engine noise does not change when commanded Stop.
Injector Forced Drive	Fuel System	The purpose of this test is for checking whether the fuel injector is correctly operating when commanded ON. Faulty injector(s) could be considered if it does not create a clicking noise (solenoid operating noise), contains an interrupted noise or has abnormal noise when commanded ON.
Glow Plug Relay	Device Controls	The purpose of this test is for checking whether the glow relay is operating when commanded ON. Faulty circuit(s) or a faulty glow relay could be considered if not energizing when commanded ON.
Exhaust Brake Control	Device Controls	The purpose of this test is for checking whether the exhaust brake solenoid valve and intake throttle solenoid valve are operating when commanded ON. Faulty circuit(s) or a solenoid valve(s) could be considered if not energizing when commanded ON.
EGR Control	Device Controls	The purpose of this test is for checking whether the EGR valve is correctly moved with command. Restricted valve movement by foreign materials, excessive deposits or a faulty valve could be considered if the EGR Position Variance is large.

Breaker Box

Breaker Box Connection Type A

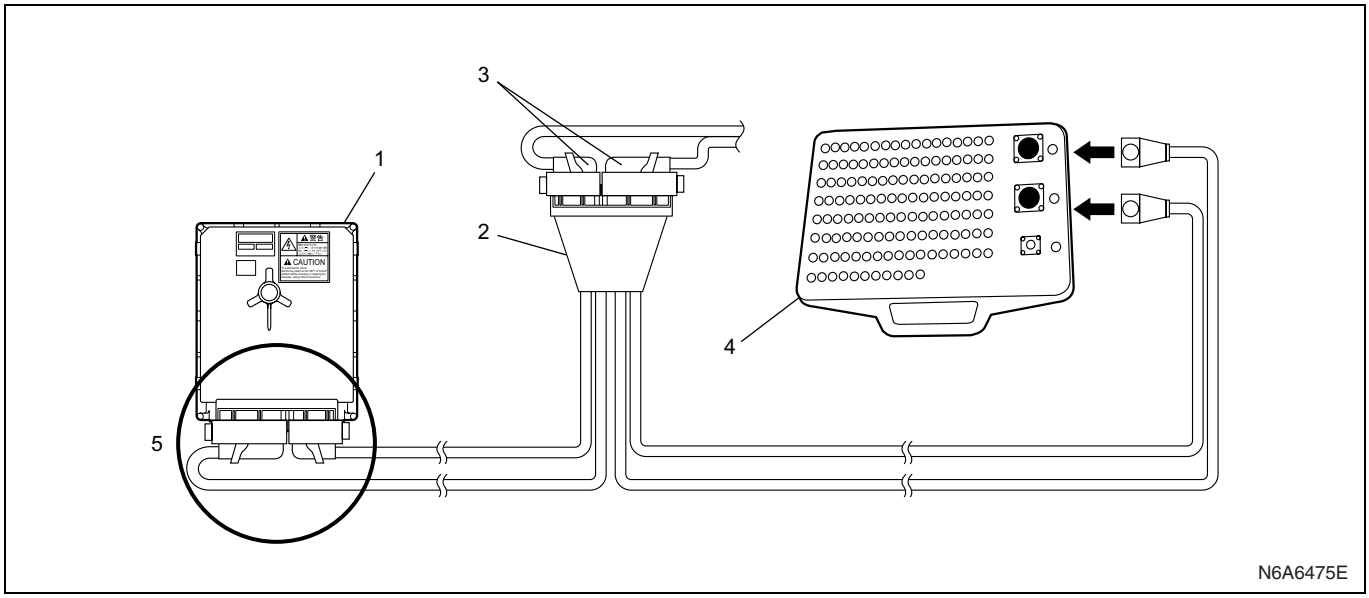


Legend

1. Engine Control Module (ECM)
2. Adapter Harness
3. ECM – Harness Connector
4. Breaker Box
5. ECM disconnected

Although probe to the engine control module (ECM) harness connector is possible by Test Adapter, Breaker Box Connection Type A is suitable usage to prevent misprobe and damage of female terminals when test open circuit or short to ground between the ECM and electrical components, since the terminals where the harness connector of the ECM is thin have gathered.

Breaker Box Connection Type B



Legend

1. Engine Control Module (ECM)
2. Adapter Harness
3. ECM – Harness Connector
4. Breaker Box
5. ECM connected

The ECM and other connectors have water proof terminal that is not allowed to back probe. Breaker Box Connection Type B is suitable usage to test short to voltage circuit or signal check between the ECM and electrical components.

Engine Control System Check Sheet

ENGINE CONTROL SYSTEM CHECK SHEET		Inspectors Name	
Customer's Name		Model & Model Year	
Driver's Name		Chassis No.	
Date Vehicle Brought In		Engine No.	
License No.		Odometer Reading	Km/miles

Problem Symptoms	☐ Engine Does Not Run	☐ Engine does not crank	☐ No initial combustion	☐ No complete combustion	
	☐ Hard Start	☐ Engine cranks slowly	☐ Other ( )		
	☐ Incorrect Idle	☐ Abnormal idling speed ☐ Rough idling ☐ Other ( )	☐ High idling speed (RPM)	☐ Low idling speed (RPM)	
	☐ Poor Driveability	☐ Hesitation, sag, stumble ☐ Lack of power, sluggishness, sponginess ☐ Other ( )	☐ Surge, chuggles	☐ Cut out, misses	
	☐ Engine Stall	☐ Soon after starting ☐ During A/C operation ☐ Other ( )	☐ After accelerator pedal depressed ☐ After accelerator pedal released	☐ Shifting from N to D	
	☐ Others	☐ Black smoke ☐ Fuel knock, combustion noise ☐ Other ( )	☐ White smoke	☐ Poor fuel economy	

Dates problem occurred					
Problem frequency		☐ Constant ☐ Other ( )	☐ Intermittently (times per day/month)		☐ Once only
Condition When Problem Occurs	Weather	☐ Fine ☐ Various/Other ( )	☐ Cloudy	☐ Rainy	☐ Snow
	Outside Temperature	☐ Hot (approx.) ☐ Any temperature	☐ Warm	☐ Cool	☐ Cold (approx.)
	Place	☐ Highway ☐ Downhill	☐ Suburbs ☐ Rough road	☐ City area ☐ Other ( )	☐ Uphill
	Load Condition	☐ Over (approx. tons) ☐ Other (approx. tons)		☐ No load	
	Engine Temperature	☐ Cold ☐ Other ( )	☐ Warming up	☐ After warming up	☐ Any temperature
	Engine Operation	☐ Starting ☐ Racing ☐ Deceleration ☐ Other ( )	☐ Just after starting (Min.) ☐ Driving ☐ A/C switch On/Off	☐ Constant speed	☐ Idling ☐ Acceleration
	Fuel Amount	☐ Full	☐ Above 1/2	☐ Below 1/2	☐ Near empty
	Fuel Bland				

Condition of MIL		☐ Remains On	☐ Intermittently turns On	☐ Does not turn On
Diagnostic Trouble Code (DTC) or Flash Code	Present Code	☐ Nothing	☐ P or U Code No. ( )	
	History Code	☐ Nothing	☐ P or U Code Code No. ( )	
Other Additional Condition				

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Diagnostic Starting Point – Engine Controls

Begin the system diagnosis with Diagnostic System Check – Engine Controls. The Diagnostic System Check – Engine Controls will provide the following information:

- The identification of the control modules which command the system.
- The ability of the control modules to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTCs) and the their statuses.

The use of the Diagnostic System Check – Engine Controls will identify the correct procedure for diagnosing the system and where the procedure is located.

Important:
Engine Control System Check Sheet must be used to verify the customer complaint, you need to know the correct (normal) operating behavior of the system and verify that the customer complaint is a valid failure of the system.

Diagnostic System Check – Engine Controls

Description

The Diagnostic System Check – Engine Controls is an organized approach to identifying a condition that is created by a malfunction in the electronic engine control system. The Diagnostic System Check must be the starting point for any driveability concern. The Diagnostic System Check directs the service technician to the next logical step in order to diagnose the concern. Understanding and correctly using the diagnostic table reduces diagnostic time, and prevents the replacement of good parts.

Test Description

The numbers below refer to the step numbers on the diagnostic table.
1. Lack of communication may be because of a partial or a total malfunction of the Keyword 2000 serial data circuit. The specified procedure determines the particular condition.
4. The presence of DTCs which begin with U, indicate that some other module is not communicating.
10. If there are other modules with DTCs set, refer to the DTC list. The DTC list directs you to the appropriate diagnostic procedure. If the control module stores multiple DTCs, diagnose the DTCs in the following order.

- Component level DTCs, such as sensor DTCs, solenoid DTCs, actuator DTCs, and relay DTCs. Diagnose the multiple DTCs within this category in numerical order. Begin with the lowest numbered DTC, unless the diagnostic table directs you otherwise.

Diagnostic System Check – Engine Controls

Important:

- DO NOT perform this diagnostic if there is not a driveability concern, unless another procedure directs you to this diagnostic.
- Before you proceed with diagnosis, search for applicable service bulletins.
- Unless a diagnostic procedure instructs you, DO NOT clear the DTCs.
- If there is a condition with the starting system, refer to the starting system section in the engine mechanical.
- Ensure the battery has a full charge.
- Ensure the battery cables (+) (–) are clean and tight.
- Ensure the ECM grounds are clean, tight, and in the correct location.
- Ensure the ECM harness connectors are clean and correctly connected.
- Ensure the ECM terminals are clean and correctly mating.
- Ensure the vehicle maintenance has been done enough.
- Ensure the Fuel Injector ID Code Data is correctly programmed.
- If there are fuel system DTC's (P0087, P0088, P0089, P1093, P1094 or P1095), diagnose sensor DTCs, solenoid DTCs, actuator DTCs and relay DTCs FIRST.

Step	Action	Value(s)	Yes	No
1	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Attempt to establish communication with the listed control modules. • Engine control module (ECM) • Transmission control module (TCM) (Smoother only) • Hill start aid (HSA) control module (If so equipped) • Supplemental restraint system (SRS) control module (If so equipped) Does the Tech 2 communicate with all the listed control modules?	—	Go to Step 2	Go to Tech 2 Does Not Communicate with Keyword Device
2	Attempt to start the engine. Does the engine start and idle?	—	Go to Step 3	Go to Engine Cranks but Does Not Run
3	Select the DTC display function for the following control modules: • ECM • TCM (Smoother only) • HSA control module (If so equipped) • SRS control module (If so equipped) Does the Tech 2 display any DTCs?	—	Go to Step 4	Go to Step 11
4	Does the Tech 2 display DTCs which begin with a U or other control module communication fault DTCs?	—	Go to Applicable DTC	Go to Step 5
5	Does the Tech 2 display ECM DTCs P0601, P0603, P0606, P0611, P0612 or P1630?	—	Go to Applicable DTC	Go to Step 6
6	Does the Tech 2 display ECM DTC P1625?	—	Go to Applicable DTC	Go to Step 7
7	Does the Tech 2 display ECM DTCs P1631, P1632, P1633, P1634 or P1635?	—	Go to Applicable DTC	Go to Step 8
8	Does the Tech 2 display ECM DTCs P0219, P0335, P0336, P0340, P0341 or P1345?	—	Go to Applicable DTC	Go to Step 9
9	Does the Tech 2 display ECM DTCs P0090, P0201, P0202, P0203, P0204, P1261 or P1262?	—	Go to Applicable DTC	Go to Step 10
10	Is there any other code in any controller that has not been diagnosed?	—	Go to Applicable DTC	Go to Step 11
11	Is the customer's concern with the transmission?	—	Go to Diagnostic System Check – Transmission Controls	Go to Step 12
12	Is the customer's concern with the HSA system?	—	Go to Diagnostic System Check – HSA Controls	Go to Step 13
13	Is the customer's concern with the SRS airbag system?	—	Go to Diagnostic System Check – SRS Controls	Go to Step 14

Step	Action	Value(s)	Yes	No
14	1. Review the following symptoms. 2. Refer to the applicable symptom diagnostic table: • Hard Start • Rough, Unstable, or Incorrect Idle and Stalling • High Idle • Cuts Out, Misses • Surge / Chuggles • Lack of Power, Sluggishness, or Sponginess • Hesitation, Sag, Stumble • Fuel Knock / Combustion Noise • Poor Fuel Economy • Excessive Smoke (Black Smoke) • Excessive Smoke (White Smoke) Did you find and correct the condition?	—	System OK	Go to Intermittent Conditions

Tech 2 Does Not Communicate with Keyword Device

Circuit Description

The engine control module (ECM), transmission control module (TCM) and supplemental restraint system (SRS) control module communicates with the Tech 2 over the Keyword 2000 serial data link. The hill start aid (HSA) control module communicates with the Keyword 82 serial data link. However, the ECM, TCM, electric hydraulic control module (EHCU) (ABS module) and the data recording module (DRM) communicate with each other over the controller area network (CAN) link. The CAN link is not used for communication with the Tech 2 and is shared only among each module.

Diagnostic Aids

The following conditions will cause a loss of Keyword serial data communication between the TCM, SRS control module and HSA control module or between the Tech 2 and any control module:

- A Keyword serial data circuit open.
- A Keyword serial data circuit shorted to ground.
- A Keyword serial data circuit shorted to voltage.
- An internal condition within a module or connector on the Keyword serial data circuit, that causes a short to voltage or ground to the Keyword serial data circuit.

Tech 2 Does Not Communicate with Keyword 2000 Device

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Attempt to communicate with the listed control modules. • Engine control module (ECM) • Transmission control module (TCM) (Smoother only) • Hill start aid (HSA) control module (If so equipped) • Supplemental restraint system (SRS) control module (If so equipped) Does the Tech 2 communicate with all the listed control modules?	—	Go to Step 3	Go to Step 8
3	Does the Tech 2 communicate with the ECM?	—	Go to Step 4	Go to Lost Communication with The ECM
4	Does the Tech 2 communicate with the TCM?	—	Go to Step 5	Go to Diagnostic System Check – Transmission Controls
5	Does the Tech 2 communicate with the HSA control module?	—	Go to Step 6	Go to Diagnostic System Check – HSA Controls
6	Does the Tech 2 communicate with the SRS control module?	—	Go to Step 7	Go to Diagnostic System Check – SRS Controls
7	Test the Keyword serial data circuit for an intermittently short to ground or intermittently short to voltage. Then, test the Keyword serial data circuit for an intermittently open (based on which control module did not communicate) at the connection in the circuit. Did you find and correct the condition?	—	Go to Step 17	System OK

Step	Action	Value(s)	Yes	No
8	1. Turn OFF the ignition. 2. Disconnect the ECM E-111 and J-191 harness connectors. 3. Turn ON the ignition, with the engine OFF. 4. Attempt to communicate with the TCM, HSA control module and SRS control module. Does the Tech 2 communicate with the TCM, HSA control module and SRS control module?	—	Go to Step 13	Go to Step 9
9	1. Turn OFF the ignition. 2. Reconnect the ECM E-111 and J-191 harness connectors. 3. Disconnect the TCM B-425, B-426, B-427 and B-428 harness connectors. 4. Turn ON the ignition, with the engine OFF. 5. Attempt to communicate with the ECM, HSA control module and SRS control module. Does the Tech 2 communicate with the ECM, HSA control module and SRS control module?	—	Go to Step 14	Go to Step 10
10	1. Turn OFF the ignition. 2. Reconnect the TCM B-425, B-426, B-427 and B-428 harness connectors. 3. Disconnect the HSA control module B-285 harness connectors. 4. Turn ON the ignition, with the engine OFF. 5. Attempt to communicate with the ECM, TCM and SRS control module. Does the Tech 2 communicate with the ECM, TCM and SRS control module?	—	Go to Step 15	Go to Step 11
11	1. Turn OFF the ignition. 2. Reconnect the HSA control module B-285 harness connectors. 3. Disconnect the SRS B-243 control module harness connector. 4. Turn ON the ignition, with the engine OFF. 5. Attempt to communicate with the ECM, TCM and HSA control module. Does the Tech 2 communicate with the ECM TCM and HSA control module?	—	Go to Step 16	Go to Step 12
12	Repair the short to ground or short to voltage on the Keyword serial data circuit between the DLC and ECM, TCM, HSA control module and SRS control module. Did you complete the repair?	—	Go to Step 17	—
13	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 17	—

Step	Action	Value(s)	Yes	No
14	Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in the transmission section. Did you complete the replacement?	—	Go to Step 17	—
15	Replace the HSA control module. Refer to Hill Start Aid (HSA) Control Module Replacement in the brake section. Did you complete the replacement?	—	Go to Step 17	—
16	Replace the SRS control module. Refer to Supplemental Restraint System (SRS) control module Replacement in the restraint system section. Did you complete the replacement?	—	Go to Step 17	—
17	Attempt to communicate with the ECM, TCM, HSA control module and SRS control module. Does the Tech 2 communicate with the ECM, TCM, HSA control module and SRS control module?	—	System OK	Go to Step 2

Lost Communication with The Engine Control Module (ECM)

Circuit Description

The engine control module (ECM), transmission control module (TCM) and supplemental restraint system (SRS) control module communicates with the Tech 2 over the Keyword 2000 serial data link. The hill start aid (HSA) control module communicates with the Keyword 82 serial data link. However, the ECM, TCM, electric hydraulic control module (EHCU) (ABS module) and the data recording module (DRM) communicate with each other over the controller area network (CAN) link. The CAN link is not used for communication with the Tech 2 and is shared only among each module.

Lost Communication with The Engine Control Module (ECM)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	Attempt to establish engine control module (ECM) communications with the Tech 2. Does the ECM communicate with the Tech 2?	—	Go to Intermittent Conditions	Go to Step 3
3	Check the ECM E-111 and J-191 connectors for poor connections. Did you find and correct the condition?	—	Go to Step 15	Go to Step 4
4	1. Turn ON the ignition, with the engine OFF. 2. Check the ECM (40A) slow blow fuse, ECM (10A) fuse and Engine (IG) (10A) fuse. Replace and retest if open. If any fuse continues to open, check for a short to ground on each circuit fed by that fuse. 3. Turn OFF the ignition. 4. Disconnect the ECM J-191 harness connector. 5. Turn ON the ignition, with the engine OFF. 6. Connect a test lamp to ground and check for voltage at the ignition voltage supply circuit at the ECM (pin 24 of J-191 connector). Does the test lamp illuminate?	—	Go to Step 5	Go to Step 12
5	1. Turn OFF the ignition. 2. Connect a DMM between the Keyword serial data circuit at the ECM (pin 38 of J-191 connector) and the data link connector (DLC) (pin 7 of B-79 connector). 3. Test the circuits for an open circuit or high resistance. 4. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 6
6	**Important:** An open in a ground circuit at the ECM will not cause a loss of communication. 1. Check ECM ground for corrosion and tightness. 2. Clean or tighten grounds as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Turn OFF the ignition. 2. Reconnect the ECM harness connector if previously disconnected. 3. Turn ON the ignition, with the engine OFF. 4. Replace the ECM main relay with the glow relay or replace with a known good relay. 5. Attempt to establish Tech 2 communications with the ECM. Does the ECM communicate with the Tech 2?	—	Go to Step 13	Go to Step 8
8	1. Turn OFF the ignition. 2. Remove the ECM main relay. 3. Turn ON the ignition, with the engine OFF. 4. Using a test lamp, check for battery voltage at both of the battery voltage supply circuits to the ECM main relay (pins 3 and 4 of X-18 connector). 5. Repair the open in the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 9
9	1. Reinstall the ECM main relay. 2. Turn the ignition ON and OFF while listening or feeling for the ECM main relay click. Wait 7 seconds between transitions. Does the ECM main relay click when the ignition is turned ON or OFF?	—	Go to Step 11	Go to Step 10
10	Repair the ECM main relay ground circuit between the ECM main relay (pin 5 of X-18 connector) and chassis ground terminal (J-9) for the following conditions: • An open circuit • High resistance or a poor connection at ECM main relay and ground terminal Did you complete the repair?	—	Go to Step 15	—
11	1. Test the ECM main relay voltage feed circuit to the ECM (pins 2 and 5 of J-191 connector) for the following conditions: • An open circuit • High resistance or a poor connection at ECM and ECM main relay 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
12	Repair the open in the ignition voltage circuit to the ECM. Did you complete the repair?	—	Go to Step 15	—
13	Replace the ECM main relay. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—

Step	Action	Value(s)	Yes	No
15	1. Turn OFF the ignition. 2. Reconnect all previously disconnected fuse, relay and harness connector(s). 3. Turn the ignition ON with the engine OFF. 4. Attempt to establish Tech 2 communications with the ECM. Does the Tech 2 communicate with the ECM?	—	System OK	Go to Step 3

Engine Cranks but Does Not Run

Description

The Engine Cranks but Does Not Run diagnostic table is an organized approach to identifying a condition that causes an engine to not start. The diagnostic table directs the service technician to the appropriate system diagnosis. The diagnostic table assumes the following conditions are met:

- The battery is completely charged and terminals are cleaned and tight.
- The engine cranking speed is normal.
- There is adequate fuel in the fuel tank.
- There is no fuel leak in the fuel line.
- There is no air in the fuel line.
- Filters (Air, Fuel) are clean.
- Fuse and slow blow fuse are normal.

Notice:

- The engine will start even if exhuast brake is fully engage.

Diagnostic Aid

If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The numbers below refers to the step number on the diagnostic table.
5. If the fuel rail pressure (FRP) regulator low control circuits between the ECM and the FRP regulator are shorted to ground, FRP Regulator Feedback will be approximately 300 mA or more low as compared with normal.

Engine Cranks but Does Not Run

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Crank the engine for specified amount of time. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the Tech 2 display any DTCs that failed this ignition?	15 seconds	Go to Diagnostic Trouble Code (DTC) List	Go to Step 3
3	1. Turn OFF the ignition. 2. Wait 2 minutes for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition, with the engine OFF. DO NOT start the engine. 4. Observe the Fuel Rail Pressure (FRP) Sensor parameter with a Tech 2. Is the FRP Sensor parameter the specified value?	0.9 – 1.0 Volts	Go to Step 4	Go to Step 6
4	**Notice:** If the vehicle has run out of fuel, air may be trapped in the fuel system. 1. Make sure the fuel tank(s) have adequate fuel and the fuel quality is good (take a sample). 2. Observe the FRP Sensor parameter on the Tech 2 while cranking over the engine for 5 seconds. Does the FRP Sensor reach the specified value during crank?	1.4 Volts	Go to Step 9	Go to Step 5

Step	Action	Value(s)	Yes	No
5	Observe the FRP Regulator Feedback parameter on the Tech 2 while cranking over the engine for 5 seconds. Does the SCV Feedback parameter more than the specified value during crank?	800 mA	Go to Fuel System Check in the Fuel System Section	Go to Step 8
6	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins 1, 2 and 3 of E-113 connector). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each FRP sensor circuit at the harness connector of the ECM (pins 82, 87, 90 and 101 of E-111 connector). 6. Test for high resistance on each FRP sensor circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 7
7	Replace the FRP sensor. Refer to Fuel Rail Pressure (FRP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 12	—
8	1. Test the FRP regulator low control circuits between the engine control module (ECM) (pins 89 and 97 of E-111 connector) and the FRP regulator (pin 2 of E-116 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
9	1. Check for normal readings at key up for the following sensor inputs: Use the Tech 2 Data List or a known good vehicle to determine nominal values. • Coolant Temperature • Barometric Pressure (BARO) • Boost Pressure Sensor • EGR Valve Position Sensor 2. Repair the circuit(s) or replace the sensor as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10

Step	Action	Value(s)	Yes	No
10	1. Other possible causes for the no-start condition: • Engine mechanical timing • Flywheel installed incorrectly causing the crankshaft position (CKP) sensor to be incorrectly timed to the engine. Disconnect sensor and attempt to start engine to verify. • Heavily restricted intake or exhaust plugged solid. • Poor engine compression. • Water or gasoline contamination in fuel. 2. Repair as necessary. Did you find and correct the condition?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Turn OFF the ignition for 30 seconds. 3. Attempt to start the engine. Does the engine start and continue to run?	—	Go to Step 13	Go to Step 2
13	Observe the DTC information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

Engine Starts and Stalls

Description

The engine control module (ECM) constantly monitors the information from various sensors. The ECM controls the systems that affect engine performance. The ECM performs the diagnostic function of the system. The ECM can recognize operational conditions, alert the driver through the malfunction indicator lamp (MIL), and store diagnostic trouble codes (DTCs). DTCs identify the faulty areas to aid the technician in making repairs.
The main relay supplies power to external output devices.

Diagnostic Aid

- Poor connection at the main relay
  Inspect harness connectors for backed-out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal-to-wire connection.
- Damaged harness
  Inspect the wiring harness for damage, shorts to ground, shorts to battery, and open circuits. If the harness appears to be OK, observe the power supply or data list display on the Tech 2 while moving connectors and wiring harnesses related to the main relay. A change in the scan tool display will indicate the location of the fault.
- Air / water or gasoline contamination in the fuel system.

Engine Starts and Stalls

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	Does the engine fail to start?	—	Go to Engine Cranks but Does Not Run	Go to Step 3
3	1. Perform the following checks before proceeding with this chart. • Make sure the idle up control knob to the lowest position. (Full counterclockwise direction) • Check for an adequate supply of fuel in the fuel tank(s) and the quality of the fuel (water or gasoline contamination). If the outside temperature is very cold, the fuel may be gelled. • Check the battery cables for corrosion and for tightness. • Make an under cab visual inspection for obvious fuel leaks and for fuel system line problems. • Make a vehicle inspection for obvious intake or exhaust restrictions (collapsed induction tubing or crushed exhaust). • Check the engine control module (ECM) connectors and ring terminal grounds for tightness. • Check the engine oil level viscosity and quality. 2. Repair as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn ON the ignition with the engine OFF. 2. Install the Tech 2 if not installed. 3. Observe the following parameters for skewed sensor readings: • Fuel Rail Pressure (FRP) Sensor with the engine OFF. The FRP Sensor should read 0.9 – 1.0 volt with the key ON and engine OFF. After the engine has stopped running for a minimum 2 minutes. • Boost Pressure and Barometric Pressure (BARO) with the engine OFF. The Boost Pressure and BARO parameters should be within 7.0 kPa (1.0 psi) each other. • Coolant Temperature with the engine OFF and a cold engine. The Coolant Temperature, Intake Air Temperature and Fuel Temperature parameters should be within 5°C (9°F) each other. 4. Refer to the Tech 2 Data List for nominal values. 5. Refer to appropriate DTC or schematic if a problem was found and repair as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Step 5
5	1. Other possible causes of engine stall: • Incorrect crankshaft to camshaft timing or sensor tooth / gear surface damage / incorrect machining • Poor fuel quality (water or gasoline contamination) • Fuel supply pump problem. Perform the Rail Pressure Control test with the Tech 2. The Differential Fuel Rail Pressure parameter should be within ± 5 MPa (± 725 psi) when commanded pressure range. • Fuel injector(s) problem. Perform the Injector Balancing test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not change engine speed when commanded OFF. Perform the Injector Forced Drive test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not create a clicking noise (solenoid operating noise). • ECM main relay circuit malfunction • ECM power / grounding problem 2. Repair as necessary. Did you find and correct the condition?	—	Go to Step 6	Possible fuel related. Refer to Fuel System Check in the Fuel System Section
6	1. Turn OFF the ignition for 30 seconds. 2. Start the engine and accelerate up and down the RPM band. Does the engine continue to run?	—	System OK	Go to Step 2

Diagnostic Trouble Code (DTC) List

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0087	227	ON	Fuel Rail Pressure (FRP) Too Low	• DTCs P0090, P0192, P0193, P0201 – P0204, P0611, P0612, P1095, P1261, P1262, P1630 and P1635 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	Either of following condition is met: • The ECM detects that the FRP sensor signal voltage is 1.0 volt for 10 seconds when the engine speed is between 0 – 600 RPM. • The ECM detects that the FRP sensor signal voltage is less than 1.2 volts for 10 seconds when the engine speed is higher than 900 RPM.	• Fuel leaking at high pressure side. • Loss fuel or less fuel in the fuel tank. • Pressure limiter valve opening pressure drop. • Faulty fuel injector. • Fuel suction side looseness, kinks or blocked. • Faulty or clogged fuel filter. • FRP sensor circuit is intermittently open circuit, poor connection or corrosion. • FRP sensor circuit high resistance. • FRP regulator circuit is intermittently open circuit, poor connection or corrosion. • FRP regulator circuit high resistance. • Faulty FRP sensor. • Faulty FRP regulator. • Faulty fuel supply pump.
P0088	118	ON	Fuel Rail Pressure (FRP) Too High	• DTCs P0192, P0193, P1630 and P1635 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts. • The engine is running.	First Stage DTC • The ECM detects that the FRP sensor signal voltage is more than 3.9 volts for longer than 10 second. Second Stage DTC • The ECM detects that the FRP sensor signal voltage is more than 4.0 volts for longer than 10 second during the ignition cycle after first stage has occurred.	• Loss fuel or less fuel in the fuel tank. • Faulty fuel injector. • Fuel suction side looseness, kinks or blocked. • Faulty or clogged fuel filter. • FRP sensor circuit is intermittently open circuit, poor connection or corrosion. • FRP sensor circuit high resistance. • FRP regulator circuit is intermittently open circuit, poor connection or corrosion. • FRP regulator circuit high resistance. • Faulty FRP sensor. • Faulty FRP regulator. • Faulty fuel supply pump.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0089	151	ON	Fuel Rail Regulator Performance	• DTCs P0090, P0192, P0193, P0201 – P0204, P0611, P0612, P1261, P1262, P1630 and P1635 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts. • The engine is running. • The FRP regulator command is more than 40% or commanded fuel supply is less than a predetermined value.	Either of following condition is met: • The ECM detects that the deferential fuel rail pressure is higher than 20 MPa (2,900 psi) for longer than 10 seconds when the engine speed is between 0 – 600 RPM. • The ECM detects that the differential fuel rail pressure is higher than 40 MPa (5,800 psi) for longer than 10 seconds when the engine speed is higher than 900 RPM.	• Faulty or clogged fuel filter. • FRP sensor circuit is intermittently open circuit, poor connection or corrosion. • FRP sensor circuit high resistance. • FRP regulator circuit is intermittently open circuit, poor connection or corrosion. • FRP regulator circuit high resistance. • Faulty FRP sensor. • Faulty FRP regulator. • Faulty fuel supply pump.
P0090	247	ON	Fuel Pressure Regulator Solenoid Control Circuit	• DTC P1630 is not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts. • The FRP regulator command duty cycle is between 10 – 90%.	Either of following condition is met: • The ECM detects that the FRP regulator solenoid feedback current is less than 50 mA. • The ECM detects that the FRP regulator solenoid feedback current is more than 2400 mA. • The ECM detects that the difference of commanded FRP regulator solenoid current and feedback current is more than 1000 mA.	• FRP regulator low control circuit is short to battery, ignition voltage, short to ground, short to the high control circuit, open circuit or high resistance. • FRP regulator high control circuit is short to battery, ignition voltage, short to ground, open circuit or high resistance. • Poor harness connector connection. • Faulty FRP regulator. • Faulty ECM.
P0107	71	ON	Barometric Pressure Sensor Circuit Low Voltage	• DTCs P1630 and P1632 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the BARO sensor signal voltage is less than 0.5 volts for 10 seconds.	• Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1632 may also set.) • Sensor 5V reference circuit is open circuit, high resistance. • Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0108	71	ON	Barometric Pressure Sensor Circuit High Voltage	• DTCs P1630 and P1632 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the BARO sensor signal voltage is more than 4.9 volts for 10 seconds.	• Sensor 5V reference circuit is short to battery or ignition voltage. (P1632 may also set.) • Sensor signal circuit is short to battery, ignition voltage or short to any 5V reference circuit. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.
P0112	22	ON	Intake Air Temperature (IAT) Sensor Circuit Low Voltage	• DTCs P1630 and P1632 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the IAT sensor signal voltage is less than 0.1 volts for 10 seconds.	• Sensor signal circuit is short to ground or short to the low reference circuit. • Faulty sensor. • Faulty ECM.
P0113	22	ON	Intake Air Temperature (IAT) Sensor Circuit High Voltage	• DTCs P1630 and P1632 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts. • The engine run time is longer than 3 minutes.	• The ECM detects that the IAT sensor signal voltage is more than 4.8 volts for 10 seconds.	• Sensor signal circuit is short to battery, ignition voltage, short to any 5V reference circuit, open circuit, high resistance. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.
P0117	23	ON	Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage	• DTCs P1630 and P1634 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the ECT sensor signal voltage is less than 0.1 volts for 10 seconds.	• Sensor signal circuit is short to ground or short to the low reference circuit. • Faulty sensor. • Faulty ECM.
P0118	23	ON	Engine Coolant Temperature (ECT) Sensor Circuit High Voltage	• DTCs P1630 and P1634 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts. • The engine run time is longer than 3 minutes.	• The ECM detects that the ECT sensor signal voltage is more than 4.8 volts for 10 seconds.	• Sensor signal circuit is short to battery, ignition voltage, short to any 5V reference circuit, open circuit, high resistance. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0182	221	ON	Fuel Temperature Sensor Circuit Low Voltage	• DTCs P1630 and P1634 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the FT sensor signal voltage is less than 0.1 volts for 10 seconds.	• Sensor signal circuit is short to ground or short to the low reference circuit. • Faulty sensor. • Faulty ECM.
P0183	211	ON	Fuel Temperature Sensor Circuit High Voltage	• DTCs P1630 and P1634 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts. • The engine run time is longer than 3 minutes.	• The ECM detects that the FT sensor signal voltage is more than 4.8 volts for 10 seconds.	• Sensor signal circuit is short to battery, ignition voltage, short to any 5V reference circuit, open circuit, high resistance. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.
P0192	245	ON	Fuel Rail Pressure (FRP) Sensor Circuit Low Voltage	• DTCs P1630 and P1635 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the FRP sensor signal voltage is less than 0.7 volts.	• Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1635 may also set.) • Sensor 5V reference circuit is open circuit or high resistance. • Sensor signal circuit is short to ground or short to the low reference circuit. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.
P0193	245	ON	Fuel Rail Pressure (FRP) Sensor Circuit High Voltage	• DTCs P1630 and P1635 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the FRP sensor signal voltage is more than 4.5 volts.	• Sensor 5V reference circuit is short to battery, ignition voltage. (P1635 may also set.) • Sensor signal circuit is short to battery, ignition voltage, short to any 5V reference circuit, open circuit or high resistance. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0201	271	ON	Injector 1 Control Circuit	• DTCs P0204, P0611 and P1261 are not set. • The ignition switch is ON. • The battery voltage is more than 18 volts. • The engine is running.	• The ECM detects that the cylinder #1 fuel injector solenoid coil control circuit is open circuit, shorted to voltage or shorted to common 1 fuel injector drive circuit during engine rotations.	• Cylinder #1 fuel injector solenoid coil control circuit is open circuit, high resistance. • Cylinder #1 fuel injector solenoid coil control circuit is short to battery, ignition voltage or short to common 1 fuel injector drive circuit. • Faulty fuel injector. • Faulty ECM.
P0202	272	ON	Injector 2 Control Circuit	• DTCs P0203, P0612 and P1262 are not set. • The ignition switch is ON. • The battery voltage is more than 18 volts. • The engine is running.	• The ECM detects that the cylinder #2 fuel injector solenoid coil control circuit is open circuit, shorted to voltage or shorted to common 2 fuel injector drive circuit during engine rotations.	• Cylinder #2 fuel injector solenoid coil control circuit is open circuit, high resistance. • Cylinder #2 fuel injector solenoid coil control circuit is short to battery, ignition voltage or short to common 2 fuel injector drive circuit. • Faulty fuel injector. • Faulty ECM.
P0203	273	ON	Injector 3 Control Circuit	• DTCs P0202, P0612 and P1262 are not set. • The ignition switch is ON. • The battery voltage is more than 18 volts. • The engine is running.	• The ECM detects that the cylinder #3 fuel injector solenoid coil control circuit is open circuit, shorted to voltage or shorted to common 2 fuel injector drive circuit during engine rotations.	• Cylinder #3 fuel injector solenoid coil control circuit is open circuit, high resistance. • Cylinder #3 fuel injector solenoid coil control circuit is short to battery, ignition voltage or short to common 2 fuel injector drive circuit. • Faulty fuel injector. • Faulty ECM.
P0204	274	ON	Injector 4 Control Circuit	• DTCs P0201, P0611 and P1261 are not set. • The ignition switch is ON. • The battery voltage is more than 18 volts. • The engine is running.	• The ECM detects that the cylinder #4 fuel injector solenoid coil control circuit is open circuit, shorted to voltage or shorted to common 1 fuel injector drive circuit during engine rotations.	• Cylinder #4 fuel injector solenoid coil control circuit is open circuit, high resistance. • Cylinder #4 fuel injector solenoid coil control circuit is short to battery, ignition voltage or short to common 1 fuel injector drive circuit. • Faulty fuel injector. • Faulty ECM.
P0219	543	OFF	Engine Overspeed	• The ignition switch is ON.	• The ECM detects that the engine speed is higher than 4300 RPM.	• Engine over-running. • Faulty CKP sensor. • Faulty ECM. • Electromagnetic interference and electrical noise.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0234	42	ON	Turbocharger Engine Overboost	• DTCs P0237, P0238, P1630 and P1634 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts. • The engine is running. • The fuel injection quantity is lower than a predetermined value.	• The ECM detects that the boost pressure is higher than 228 kPa (33 psi) for 3 seconds.	• Faulty turbocharger wastegate valve. • Faulty boost pressure sensor. • Faulty BARO sensor.
P0236	65	ON	Turbocharger Engine Underboost	• DTCs P0107, P0108, P0237, P0238, P1630 and P1634 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts. • The engine is running. • The fuel injection quantity is higher than a predetermined value.	Either of following condition is met: • The ECM detects that the boost pressure is lower than 78 kPa (11 psi) for 20 seconds when the engine speed is lower than 900 RPM. • The ECM detects that the boost pressure is lower than 82 – 151 kPa (12 – 22 psi) for 20 seconds when the engine speed is between 1200 – 3000 RPM. • The ECM detect that the boost pressure is lower than 100 – 158 kPa (15 – 23 psi) for 20 seconds when the engine speed is between 3300 – 3600 RPM.	• Air leakage. • Intake duct is disconnected. • Intake system is obstructed. • Intake throttle plate sticking in the closed position. • Faulty turbocharger wastegate valve. • Faulty turbocharger. (Shaft stick) • Faulty boost pressure sensor. • Faulty BARO sensor. • Faulty fuel system. (Low fuel pressure)

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0237	32	ON	Turbocharger Boost Sensor Circuit Low Voltage	• DTCs P1630 and P1634 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the boost pressure sensor signal voltage is less than 0.1 volts for 5 seconds.	• Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1634 may also set.) • Sensor 5V reference circuit is open circuit, high resistance. • Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.
P0238	32	ON	Turbocharger Boost Sensor Circuit High Voltage	• DTCs P1630 and P1634 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the boost pressure sensor signal voltage is more than 4.9 volts for 5 seconds.	• Sensor 5V reference circuit is short to battery or ignition voltage. (P1634 may also set.) • Sensor signal circuit is short to battery, ignition voltage or short to any 5V reference circuit. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.
P0335	15	ON	Crankshaft Position (CKP) Sensor Circuit	• DTCs P0336, P0340, P0341 and P1345 are not set. • The ignition switch is ON. • The CMP sensor signal pulse is detected.	• The ECM detects that the CKP sensor pulses are not generated during engine rotations.	• Sensor installation is poor condition. • Faulty sensor wheel. • Sensor high circuit is short to battery, ignition voltage, short to any 5V reference circuit, short to ground, open circuit or high resistance. • Sensor low circuit is short to battery, ignition voltage, short to any 5V reference circuit, short to ground, open circuit or high resistance. • Sensor circuits short to each other. • Poor harness connector connection. • Faulty sensor. • Faulty ECM. • Electromagnetic interference and electrical noise.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0336	15	ON	Crankshaft Position (CKP) Sensor Performance	• DTCs P0335, P0340, P0341 and P1345 are not set. • The ignition switch is ON. • The CKP sensor signal is detected.	• The ECM detects extra or missing CKP sensor pulses during engine rotations.	• Sensor installation is poor condition. • Faulty sensor wheel. • Sensor circuit is intermittently open circuit or poor connection. • Faulty sensor. • Electromagnetic interference and electrical noise.
P0340	14	ON	Camshaft Position (CMP) Sensor Circuit	• DTCs P0335, P0336, P0341 and P1345 are not set. • The ignition switch is ON. • The crankshaft position (CKP) sensor signal pulse is detected.	• The ECM detects that the CMP sensor pulses are not generated during engine rotations.	• Sensor installation is poor condition. • Faulty sensor wheel. • Sensor 12V reference circuit is short to battery, ignition voltage, short to any 5V reference circuit, short to ground, open circuit or high resistance. • Sensor signal circuit is short to battery, ignition voltage, short to any 5V reference circuit, short to ground, open circuit or high resistance. • Sensor circuits short to each other. • Poor harness connector connection. • Faulty sensor. • Faulty ECM. • Electromagnetic interference and electrical noise.
P0341	14	ON	Camshaft Position (CMP) Sensor Circuit Performance	• DTCs P0335, P0336, P0340 and P1345 are not set. • The ignition switch is ON. • The CMP sensor signal pulse is detected.	• The ECM detects extra or missing CMP sensor pulses during engine rotations.	• Sensor installation is poor condition. • Faulty sensor wheel. • Sensor circuit is intermittently open circuit or poor connection. • Faulty sensor. • Electromagnetic interference and electrical noise.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0380	66	ON	Glow Plug Relay Control Circuit	• The ignition switch is ON. • The battery voltage is between 16 – 32 volts.	Either of following condition is met: • The ECM detects a low voltage condition on the glow relay control circuit when the relay is commanded OFF for longer than 5 seconds. • The ECM detects a high voltage condition on the glow relay control circuit when the relay is commanded ON for longer than 5 seconds.	• Relay voltage feed circuit is open circuit or high resistance. • Relay control circuit is short to battery, ignition voltage, short to ground, open circuit or high resistance. • Poor harness connector connection. • Faulty relay. • Faulty ECM.
P0381	67	OFF	Glow Plug Lamp Control Circuit	• The ignition switch is ON. • The ignition voltage is more than 18 volts.	Either of following condition is met: • The ECM detects a low voltage condition on the glow indicator lamp control circuit when the indicator is commanded OFF for longer than 5 seconds. • The ECM detects a high voltage condition on the glow indicator lamp control circuit when the indicator is commanded ON for longer than 5 seconds.	• Lamp voltage feed circuit is open circuit or high resistance. • Lamp control circuit is short to battery, ignition voltage, short to ground, open circuit or high resistance. • Poor harness connector connection. • Faulty instrument panel cluster. • Faulty lamp. • Faulty ECM.
P0485	44	ON	EGR Valve Position Sensor Circuit Low Voltage	• DTCs P1630 and P1635 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the EGR valve position sensor signal voltage is less than 0.1 volts for 5 seconds.	• Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1635 may also set.) • Sensor 5V reference circuit is open circuit, high resistance. • Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. • Poor harness connector connection. • Faulty sensor. (EGR valve) • Faulty ECM.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0486	44	ON	EGR Valve Position Sensor Circuit High Voltage	• DTCs P1630 and P1635 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the EGR valve position sensor signal voltage is more than 4.9 volts for 5 seconds.	• Sensor 5V reference circuit is short to battery or ignition voltage. (P1635 may also set.) • Sensor signal circuit is short to battery, ignition voltage or short to any 5V reference circuit. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor. (EGR valve) • Faulty ECM.
P0488	45	ON	Exhaust Gas Recirculation (EGR) Valve Performance	• DTCs P0485, P0486, P1630 and P1635 are not set. • The ignition switch is ON. • The battery voltage is between 20 – 32 volts. • The ignition voltage is more than 18 volts. • The desired EGR valve position is stable.	• The ECM detects a variance between the actual EGR valve position and desired valve position is more than 20% for longer than 20 seconds when the EGR solenoid command duty is more than 90%.	• Valve stick. • Motor voltage feed circuit is short to battery, ignition voltage, short to ground, short to the sensor low reference circuit, open circuit or high resistance. • Duty signal circuit is short to battery, ignition voltage, short to ground, short to the sensor low reference circuit, open circuit or high resistance. • Poor harness connector connection. • Faulty EGR valve. • Faulty ECM.
P0500	25	ON	Vehicle Speed Sensor (VSS) Circuit	• The ignition switch is ON. • The ignition voltage is more than 18 volts. • The engine speed is more than 2000 RPM. • The commanded fuel is OFF (accelerator pedal is released).	• The ECM detects that the VSS signals are not generated for 5 seconds.	• Faulty sensor installation. • Sensor voltage feed circuit is open circuit or high resistance. • Sensor signal circuit is short to battery, ignition voltage, short to ground, open circuit or high resistance. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor. • Faulty ECM. • Electromagnetic interference and electrical noise.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0501	25	ON	Vehicle Speed Sensor (VSS) Performance	• The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the VSS signal are changed larger than a predetermined vehicle speed.	• Sensor installation is poor condition. • Sensor circuit is intermittently open circuit or poor connection. • Faulty sensor. • Electromagnetic interference and electrical noise.
P0601	53	ON	Control Module Read Only Memory (ROM)	—	• The ECM detects a malfunction in its internal flash read memory (ROM).	• Faulty ECM.
P0603	54	ON	Control Module Read Only Memory (ROM)	—	Either of following condition is met: • The ECM detects a malfunction in its internal electrically erasable & programmable read only memory (EEPROM). • The ECM detects that the calculated checksum does not agree with the ECM internal registered checksum.	• Faulty ECM.
P0606	51/52	ON	Control Module Internal Performance	• The ignition switch is ON. • The battery voltage is more than 16 volts.	Either of following condition is met: • The ECM detects a malfunction in its internal main central processing unit (CPU). (Flash Code 51) • The ECM detects a malfunction in its internal sub CPU. (Flash Code 52)	• ECM voltage feed circuit is high resistance. • ECM ground circuit is open circuit or high resistance. • Faulty ECM.
P0611	34	ON	Fuel Injector Control Module Performance Group 1	• The ignition switch is ON. • The battery voltage is more than 18 volts.	• The ECM detects that the common 1 fuel injector charge up circuit is insufficient charge.	• ECM voltage feed circuit is high resistance. • ECM ground circuit is open circuit or high resistance. • Faulty ECM.
P0612	34	ON	Fuel Injector Control Module Performance Group 2	• The ignition switch is ON. • The battery voltage is more than 18 volts.	• The ECM detects that the common 2 fuel injector charge up circuit is insufficient charge.	• ECM voltage feed circuit is high resistance. • ECM ground circuit is open circuit or high resistance. • Faulty ECM.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0615	19	ON	Starter Relay Control Circuit	• The ignition switch is ON. • The battery voltage is between 16 – 32 volts.	Either of following condition is met: • The ECM detects a low voltage condition on the starter cut relay control circuit when the relay is commanded OFF for longer than 10 seconds. • The ECM detects a high voltage condition on the starter cut relay control circuit when the relay is commanded ON for longer than 10 seconds.	• Relay voltage feed circuit is open circuit or high resistance. • Relay control circuit is short to battery, ignition voltage, short to ground, open circuit or high resistance. • Poor harness connector connection. • Faulty relay. • Faulty ECM.
P0650	77	OFF	Malfunction Indicator Lamp (MIL) Control Circuit	• The ignition switch is ON. • The ignition voltage is more than 18 volts.	Either of following condition is met: • The ECM detects a low voltage condition on the MIL control circuit when the indicator is commanded OFF for longer than 3 seconds. • The ECM detects a high voltage condition on the MIL control circuit when the indicator is commanded ON for longer than 3 seconds.	• Lamp voltage feed circuit is open circuit or high resistance. • Lamp control circuit is short to battery, ignition voltage, short to ground, open circuit or high resistance. • Poor harness connector connection. • Faulty instrument panel cluster. • Faulty lamp. • Faulty ECM.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1093	227	ON	Fuel Rail Pressure (FRP) Too Low	• DTCs P0090, P0192, P0193, P0201 – P0204, P0611, P0612, P1095, P1261, P1262, P1630 and P1635 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts. • The FRP regulator command is less than 33% or commanded fuel supply is more than a predetermined value.	Either of following condition is met: • The ECM detects that the differential fuel rail pressure is -10 MPa (-1,450 psi) for longer than 15 seconds when the engine speed is between 0 – 900 RPM. • The ECM detects that the deferential fuel rail pressure is -15 MPa (-2,170 psi) for longer than 15 seconds when the engine speed is higher than 1200 RPM.	• Loss fuel or less fuel in the fuel tank. • Pressure limiter valve opening pressure drop. • Faulty fuel injector. • Fuel suction side looseness, kinks or blocked. • Faulty or clogged fuel filter. • FRP sensor circuit is intermittently open circuit, poor connection or corrosion. • FRP sensor circuit high resistance. • FRP regulator circuit is intermittently open circuit, poor connection or corrosion. • FRP regulator circuit high resistance. • Faulty FRP sensor. • Faulty FRP regulator. • Faulty fuel supply pump.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1094	226	ON	Fuel Rail Pressure (FRP) Too Low	FRP Regulator Command High DTC • DTCs P0090, P0117, P0118, P0192, P0193, P0201 – P0204, P0500, P0501, P0611, P0612, P1095, P1261, P1262, P1630 and P1635 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts. • The engine is running. • The accelerator pedal position is 0%. • The engine coolant temperature is more than 50°C (122°F). • The vehicle speed is less than 5 km/h (4 MPH). • The engine speed does not vary more than 50 RPM. FRP Drop DTC • DTCs P0090, P0192, P0193, P0201 – P0204, P0611, P0612, P1095, P1261, P1262, P1630 and P1635 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts. • The engine is running. • The accelerator pedal position is 0%. • The engine coolant temperature is more than 50°C (122°F). • The vehicle speed is more than 50 km/h (30 MPH). • The commanded fuel injection quantity is OFF.	FRP Regulator Command High DTC • The ECM detects that the FRP regulator commanded fuel is more than a predetermined range for longer than 15 seconds when the engine speed is between 600 – 1500 RPM. FRP Drop DTC • The ECM detects that the FRP sensor signal voltage is shapely dropped more than 0.2 volts when the engine cuts fuel.	• Fuel leaking at high pressure side. • Loss fuel or less fuel in the fuel tank. • Pressure limiter valve opening pressure drop. • Faulty fuel injector. • Fuel suction side looseness, kinks or blocked. • Faulty or clogged fuel filter. • FRP sensor circuit is intermittently open circuit, poor connection or corrosion. • FRP sensor circuit high resistance. • FRP regulator circuit is intermittently open circuit, poor connection or corrosion. • FRP regulator circuit high resistance. • Faulty FRP sensor. • Faulty FRP regulator. • Faulty fuel supply pump.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1095	225	ON	Fuel Pressure Limiter Activation	• DTCs P0192, P0193, P1630 and P1635 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the FRP sensor signal voltage drops quickly from more than 3.7 volts to less than 2.3 volts, and then the differential fuel rail pressure is more than -30 MPa (4,350 psi).	• Loss fuel or less fuel in the fuel tank. • Faulty fuel injector. • Fuel suction side looseness, kinks or blocked. • Faulty or clogged fuel filter. • FRP sensor circuit is intermittently open circuit, poor connection or corrosion. • FRP sensor circuit high resistance. • FRP regulator circuit is intermittently open circuit, poor connection or corrosion. • FRP regulator circuit high resistance. • Faulty FRP sensor. • Faulty FRP regulator. • Faulty fuel supply pump.
P1173	542	OFF	Engine Overheat	• DTCs P0117, P0118, P1630 and P1634 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts. • The engine is running.	• The ECM detects that the engine coolant temperature is more than 110°C (230°F) for 15 seconds.	• Engine overheat. • Faulty engine cooling system. • Faulty engine coolant temperature sensor.
P1220	28	ON	PTO Engine Speed Selector Sensor Circuit High Voltage	• DTCs P1630 and P1631 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the PTO throttle sensor signal voltage is more than 4.8 volts.	• Sensor 5V reference circuit is short to battery or ignition voltage. (P1631 may also set.) • Sensor signal circuit is short to battery, ignition voltage or short to any 5V reference circuit. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1225	31	ON	Engine Idle Speed Selector Sensor Circuit	• DTCs P1630 and P1631 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	Either of following condition is met: • The ECM detects that the idle up sensor signal voltage is less than 0.1 volts for 5 second. • The ECM detects that the idle up sensor signal voltage is more than 4.9 volts for 5 second.	• Sensor 5V reference circuit is short to battery or ignition voltage, short to ground or short to the low reference circuit. (P1631 may also set.) • Sensor 5V reference circuit is open circuit, high resistance. • Sensor signal circuit is short to battery, ignition voltage or short to any 5V reference circuit, short to ground, short to the low reference circuit, open circuit or high resistance. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.
P1261	158	ON	Injector Positive Voltage Control Circuit Group 1	• DTC P0611 is not set. • The ignition switch is ON. • The battery voltage is more than 18 volts. • The engine is running.	Either of following condition is met: • The ECM detects that the common 1 fuel injector drive circuit is open circuit, shorted to ground or shorted to voltage during engine rotations. • The ECM detects that the cylinder #1 or #4 fuel injector solenoid coil control circuit is shorted to ground during engine rotations.	• Cylinder #1 or #4 fuel injector solenoid coil control circuit is short to ground. • Common 1 fuel injector drive circuit is short to battery, ignition voltage, short to ground, open circuit or high resistance. • Faulty fuel injector. • Faulty ECM.
P1262	159	ON	Injector Positive Voltage Control Circuit Group 2	• DTC P0612 is not set. • The ignition switch is ON. • The battery voltage is more than 18 volts. • The engine is running.	Either of following condition is met: • The ECM detects that the common 2 fuel injector drive circuit is open circuit, shorted to ground or shorted to voltage during engine rotations. • The ECM detects that the cylinder number 2 or number 3 fuel injector solenoid coil control circuit is shorted to ground during engine rotations.	• Cylinder #2 or #3 fuel injector solenoid coil control circuit is short to ground. • Common 2 fuel injector drive circuit is short to battery, ignition voltage, short to ground, open circuit or high resistance. • Faulty fuel injector. • Faulty ECM.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1271	24	ON	Accelerator Pedal Position (APP) Sensor 1-2 Correlation	• DTCs P1630, P1631 and P1632 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the APP sensor 1 and sensor 2 are more than 45% out of range of each other.	• Sensor 5V reference circuit is high resistance. • Sensor signal circuit is high resistance. • Sensor low reference circuit is high resistance. • Faulty sensor. • Faulty ECM. • Electromagnetic interference and electrical noise.
P1277	24	ON	Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage	• DTCs P1630 and P1631 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the APP sensor 1 signal voltage is less than 0.2 volts.	• Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1631 may also set.) • Sensor 5V reference circuit is open circuit, high resistance. • Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.
P1278	24	ON	Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage	• DTCs P1630 and P1631 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the APP sensor 1 signal voltage is more than 4.9 volts.	• Sensor 5V reference circuit is short to battery or ignition voltage. (P1631 may also set.) • Sensor signal circuit is short to battery, ignition voltage or short to any 5V reference circuit. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1282	24	ON	Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage	• DTCs P1630 and P1632 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the APP sensor 2 signal voltage is less than 0.2 volts.	• Sensor 5V reference circuit is short to ground or short to the low reference circuit. (P1632 may also set.) • Sensor 5V reference circuit is open circuit, high resistance. • Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.
P1283	24	ON	Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage	• DTCs P1630 and P1632 are not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts.	• The ECM detects that the APP sensor 2 signal voltage is more than 4.9 volts.	• Sensor 5V reference circuit is short to battery or ignition voltage. (P1632 may also set.) • Sensor signal circuit is short to battery, ignition voltage or short to any 5V reference circuit. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor. • Faulty ECM.
P1345	16	ON	Crankshaft Position (CKP) – Camshaft Position (CMP) Correlation	• DTCs P0335, P0336, P0340 and P0341 are not set. • The ignition switch is ON • The CKP sensor signal is detected. • The CMP sensor signal is detected.	• The ECM detects that the CKP sensor signals and CMP sensor signals are out of synchronization during engine rotations.	• Incorrect engine mechanical timing.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1625	416	ON	Main Relay System Error	ECM main relay open stuck DTC • DTC P1630 is not set. • The ignition switch is ON. • The ignition voltage is more than 18 volts. • The ignition ON time is longer than 3 seconds.	ECM Main Relay Open Stuck DTC • The ECM detects a low voltage condition on the ECM main relay voltage feed circuit when the relay is commanded ON for longer than 5 seconds. ECM Main Relay Close Stuck DTC • The ECM detects that the ECM has been ON when the relay is commanded OFF for longer than 10 seconds.	• Relay switch side voltage feed circuit is open circuit or high resistance. • Relay switched voltage feed circuit is short to battery or high resistance. • Relay coil side voltage supply circuit is short to battery or high resistance. • Relay coil side ground circuit is open circuit or high resistance. • Faulty relay. • Faulty ECM
P1630	36	ON	Control Module A/D Converter Error	—	• The ECM detects a malfunction in its internal analog / digital (A/D) converter.	• Faulty ECM.
P1631	55	ON	5V Reference Circuit 1	• DTC P1630 is not set. • The ignition switch is ON. • The battery voltage is between 16 – 32 volts.	Either of following condition is met: • The ECM detects that the 5 volts reference circuit 1 voltage is less than 4.5 volts. • The ECM detects that the 5 volts reference circuit 1 voltage is more than 5.5 volts.	• APP sensor 1 5V reference circuit is short to battery, ignition voltage or short to ground. • Idle up sensor 5V reference circuit is short to battery, ignition voltage or short to ground. • PTO throttle sensor 5V reference circuit is short to battery, ignition voltage or short to ground. • Faulty APP sensor. • Faulty idle up sensor. • Faulty PTO throttle sensor. • Faulty ECM.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1632	55	ON	5V Reference Circuit 2	• DTC P1630 is not set. • The ignition switch is ON. • The battery voltage is between 16 – 32 volts.	Either of following condition is met: • The ECM detects that the 5 volts reference circuit 2 or 5 voltage is less than 4.5 volts. • The ECM detects that the 5 volts reference circuit 2 or 5 voltage is more than 5.5 volts.	• APP sensor 2 5V reference circuit is short to battery, ignition voltage or short to ground. • FRP sensor 5V reference circuit is short to battery, ignition voltage or short to ground. • EGR valve position sensor 5V reference circuit is short to battery, ignition voltage or short to ground. • BARO sensor 5V reference circuit is short to battery, ignition voltage or short to ground. • Faulty APP sensor. • Faulty FRP sensor. • Faulty EGR valve. • Faulty BARO sensor. • Faulty ECM.
P1633	55	ON	5V Reference Circuit 3	• DTC P1630 is not set. • The ignition switch is ON. • The battery voltage is between 16 – 32 volts.	Either of following condition is met: • The ECM detects that the 5 volts reference circuit 3 or 4 voltage is less than 4.5 volts. • The ECM detects that the 5 volts reference circuit 3 or 4 voltage is more than 5.5 volts.	• Same as DTC P1634.
P1634	55	ON	5V Reference Circuit 4	• DTC P1630 is not set. • The ignition switch is ON. • The battery voltage is between 16 – 32 volts.	Either of following condition is met: • The ECM detects that the 5 volts reference circuit 3 or 4 voltage is less than 4.5 volts. • The ECM detects that the 5 volts reference circuit 3 or 4 voltage is more than 5.5 volts.	• Boost pressure sensor 5V reference circuit is short to battery, ignition voltage or short to ground. • Faulty boost pressure sensor. • Faulty ECM.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1635	55	ON	5V Reference Circuit 5	• DTC P1630 is not set. • The ignition switch is ON. • The battery voltage is between 16 – 32 volts.	Either of following condition is met: • The ECM detects that the 5 volts reference circuit 2 or 5 voltage is less than 4.5 volts. • The ECM detects that the 5 volts reference circuit 2 or 5 voltage is more than 5.5 volts.	• Same as DTC P1632.
P1681	46	ON	Exhaust Brake Valve Circuit Low Voltage	• The ignition switch is ON. • The battery voltage is between 16 – 32 volts. • The engine is running.	• The ECM detects a low voltage condition on the exhaust brake solenoid valve control circuit for longer than 10 seconds when the solenoid valve is commanded OFF.	• Exhaust brake solenoid valve voltage feed circuit is open circuit or high resistance. • Exhaust brake solenoid valve control circuit is short to ground, open circuit or high resistance. • Poor harness connector connection. • Faulty exhaust brake solenoid valve. • Faulty ECM.
P1682	46	ON	Exhaust Brake Valve Circuit High Voltage	• The ignition switch is ON. • The battery voltage is between 16 – 32 volts. • The engine is running.	• The ECM detects a high voltage condition on the exhaust brake solenoid valve control circuit for longer than 10 seconds when the solenoid valve is commanded ON.	• Exhaust brake solenoid valve control circuit is short to battery or ignition voltage. • Faulty exhaust brake solenoid valve. • Faulty ECM.
U2104	84	ON	CAN Bus Reset Counter Overrun	• The ignition switch is ON.	• The ECM detects that the CAN Bus OFF status.	• CAN Low circuit is short to battery, ignition voltage, short to ground, open circuit or high resistance. • CAN High circuit is short to battery, ignition voltage, short to ground, open circuit or high resistance. • Faulty resistor 1. • Faulty resistor 2. • Faulty ECM. • Faulty DRM. • Faulty TCM. • Faulty EHCU. • Electromagnetic interference and electrical noise.

DTC	Flash Code	MIL Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
U2106	85	ON	Lost CAN Communications With Transmission Control System	• The ignition switch is ON.	• The ECM detects that the CAN Bus messages from the TCM are not being received.	• CAN Low circuit to the TCM is open circuit. • CAN High circuit to the TCM is open circuit. • Faulty resistor 1. • Faulty resistor 2. • Faulty ECM. • Faulty TCM. • Electromagnetic interference and electrical noise.

P0087 (Flash Code 227)

Description

The common rail fuel system is comprised of two fuel pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the engine control module (ECM) using the fuel rail pressure (FRP) regulator dependant upon values from the FRP sensor attached to the fuel rail. In case of fuel rail overpressure, a pressure limiter valve threaded into the fuel rail will open to release overpressure and return fuel back to the fuel tank.
If the ECM detects that the fuel rail pressure is certain pressure low as compared with engine speed, this DTC will set.

Condition for Running the DTC

- DTCs P0090, P0192, P0193, P0201 – P0204, P0611, P0612, P1095, P1261, P1262, P1630 and P1635 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the FRP sensor signal voltage is 1.0 volt for 10 seconds when the engine speed is between 0 – 600 RPM.
- The ECM detects that the FRP sensor signal voltage is less than 1.2 volts for 10 seconds when the engine speed is higher than 900 RPM.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- An intermittently sticking FRP regulator may have allowed the fuel pressure to become low enough to set this DTC.
- Normal FRP Sensor readings on the Tech 2 with the engine running in neutral at idle is around 1.4 – 1.6 volts.
- An intermittently sticking fuel injector may have allowed the fuel pressure to drop too much. Use the Tech 2 to perform the Injector Balancing test for each injector. Verify a consistent engine speed change when commanding each fuel injector ON and OFF.
- A skewed FRP sensor value (shifted to a lower pressure) can set this DTC. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes.

Notice:

- This DTC most likely indicates a loss of fuel pressure by a fuel leak from the high pressure side. Inspect the high pressure side fuel leakage between the fuel supply pump and fuel injector FIRST.

Notice:

- The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight or if there is a crack in one of the fuel hoses. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load, which may set this DTC.

Notice:

- If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted and this DTC may set. Perform bleeding of fuel system after refilling.

Test Description

The numbers below refers to the step number on the diagnostic table.
7. This step checks for a fuel restriction by determining if a high vacuum is being pulled on the fuel system during normal operation.
8. This step checks for an air leak on the suction side of the fuel system by determining if a vacuum can be pulled when a fuel line is plugged.

DTC P0087 (Flash Code 227)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Inspect the high pressure side between the fuel supply pump and the fuel injectors for fuel leakage. The following components may contain an external leak. • Fuel supply pump • Fuel rail • Pressure limiter valve • Flow damper valve • Fuel rail pressure (FRP) sensor • Fuel pipe between the fuel supply pump and fuel rail • Fuel pipe between the fuel rail and fuel injectors • Each fuel pipe sleeve nuts **Notice:** Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel leakage into the engine oil. **Notice:** Remove and inspect the inlet high pressure joint to the fuel injectors for fuel leaking from the sleeve nut(s). Replace the fuel injector and injection pipe when foreign material was in contact. 2. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 3
3	1. Remove each glow plug from the cylinder head. 2. Inspect the tip of the plugs for wet fuel. **Notice:** Use the engine compression gauge (5-8840-2675-0 / J-26999-12) and gauge adapter (5-8840-2815-0 / EN-46722) to inspect the damage of engine. If poor engine compression (less than 1960 kPa [284 psi]) or variation of each cylinder (more than 294 kPa [43 psi]) is found, inspect the engine mechanical. Refer to the Engine Mechanical section. Repair as necessary. Did you find wet fuel on the glow plug(s)?	—	Go to Step 16	Go to Step 4
4	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0090, P0192, P0193, P0201 – P0204, P1094, P1095, P1261 or P1262 set?	—	Go to Applicable DTC	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Wait 2 minutes for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition with the engine OFF. DO NOT start the engine. 4. Observe the FRP Sensor parameter with the Tech 2. Is the FRP Sensor parameter the specified value?	0.9 – 1.0 volt	Go to Step 6	Go to Step 13
6	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load, which may set this DTC. 3. Pump the priming pump on the fuel filter until it becomes firm. If there is a leak on the suction side of the fuel system between the priming pump and the fuel supply pump, the priming pump will not build up sufficient firmness and fuel leakage may occur. 4. Start the engine and check for high side fuel system leaks at the fuel supply pump and fuel rail. **Notice:** Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel leakage into the engine oil. 5. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Turn OFF the ignition. 2. Remove the rubber fuel hose from the fuel filter housing (fuel supply pump side). Use a pan to catch the fuel leakage from the removed fuel line. **Important:** The fuel vacuum pump / pressure gauge connector and the adapter hose must be cleaned before connecting to the fuel line. Otherwise, foreign material internal to the tools line may damage the fuel supply pump. 3. Connect the suction side fuel pressure / vacuum gauge adapter (5-8840-2844-0 / EN-47667) with fuel pressure / vacuum gauge assembly (5-8840-2844-0 / J-44638) in series with the filter housing and the disconnected fuel hose. Ensure the service tool and fuel line connections are tight. 4. Bleed the fuel system by priming the priming pump until it becomes firm, then crank over the engine for a maximum of 5 seconds. Repeat as necessary until the engine starts. 5. Let the engine run at idle for at least 1 minute. 6. Monitor the fuel pressure / vacuum gauge while holding the engine speed higher than 2500 RPM for a minimum of 1 minute. Does the fuel pressure / vacuum gauge ever indicate a larger vacuum than the specified amount during the test?	5 inHg	Go to Step 9	Go to Step 8
8	1. Fully clamp off a fuel hose as close to the fuel tank as possible (this will draw vacuum on the fuel system). You can also disconnect a fuel line and plug it. 2. Start the engine and turn the idle up control knob to the highest position. (Full clockwise direction. The idle speed is increased up to 1600 RPM.) 3. Monitor the fuel pressure / vacuum gauge. **Notice:** Release the clamp or open the plug when the gauge is likely to be more than 8 inHg during the test. Can a vacuum of at least the specified amount be pulled on the fuel system?	8 inHg	Go to Step 11	Go to Step 10
9	1. Inspect the fuel lines between the fuel supply pump and fuel tank for being crushed or kinked. 2. Inspect for a plugged fuel tank vent hose. 3. Inspect inside the fuel tank (if possible) for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. 4. Repair as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 14

Step	Action	Value(s)	Yes	No
10	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. 3. Repair as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 12
11	1. Turn OFF the ignition. 2. Unclamp or unplug the fuel line from the previous step and reconnect the fuel line (if disconnected). 3. Start the engine and allow it to run for at least 1 minute. 4. Perform the Injector Balancing test with the Tech 2. 5. Command each injector OFF and verify an engine speed change for each injector. Is there an injector that does not change engine speed when commanded OFF?	—	Go to Step 17	Go to Step 19
12	1. Turn OFF the ignition. 2. Disconnect the FRP regulator harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP regulator (pins 1 and 2 of E-116). 4. Disconnect the engine control module (ECM) harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each FRP regulator circuit at the harness connector of the ECM (pins 89, 97, 105 and 113 of E-111 connector). 6. Test for high resistance on each FRP regulator circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 18
13	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins 1, 2 and 3 of E-113 connector). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each FRP sensor circuit at the harness connector of the ECM (pins 82, 87, 90 and 101 of E-111 connector). 6. Test for high resistance on each FRP circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 15

Step	Action	Value(s)	Yes	No
14	Replace the fuel filter cartridge. Refer to Fuel Filter Cartridge Replacement in the Fuel System Section. Did you complete the replacement?	—	Go to Step 20	—
15	Replace the FRP sensor. Refer to Fuel Rail Pressure (FRP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 20	—
16	**Important:** Replacement injector must be programmed. Replace the appropriate injector that was leaking fuel found at Step 3. Refer to Fuel Injector Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 20	—
17	**Important:** Replacement injector must be programmed. Replace the appropriate fuel injector that does not change engine speed when commanded OFF. Refer to Fuel Injector Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 20	—
18	**Important:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. **Notice:** Always replace the fuel filter cartridge when a fuel supply pump is replaced. Replace the fuel supply pump and fuel filter cartridge. Refer to Fuel Supply Pump Replacement in this section and Fuel Filter Cartridge Replacement in Fuel System section. Did you complete the replacement?	—	Go to Step 20	—
19	**Notice:** There is a possibility that the pressure limiter valve stuck open or opening pressure has fallen. Replace the pressure limiter valve. Refer to Fuel Rail Replacement in this section. Did you complete the replacement?	—	Go to Step 20	—
20	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 21
21	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0088 (Flash Code 118)

Description

The common rail fuel system is comprised of two fuel pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the engine control module (ECM) using the fuel rail pressure (FRP) regulator dependant upon values from the FRP sensor attached to the fuel rail. In case of fuel rail overpressure, a pressure limiter valve threaded into the fuel rail will open to release overpressure and return fuel back to the fuel tank.
If the ECM detects that the fuel pressure went excessively high for a certain length of time, this DTC will set (First Stage DTC).
If the ECM detects that during the same ignition cycle the fuel pressure rose even higher than the amount to set DTC P0088 (Second Stage DTC) for a certain length of time, this DTC will also set.

Condition for Running the DTC

- DTCs P0192, P0193, P1630 and P1635 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.
- The engine is running.

Condition for Setting the DTC

First Stage DTC

- The ECM detects that the FRP sensor signal voltage is more than 3.9 volts for longer than 10 second.

Second Stage DTC

- The ECM detects that the FRP sensor signal voltage is more than 4.0 volts for longer than 10 second during the ignition cycle after first stage has occurred.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- An intermittently sticking FRP regulator may have allowed the fuel pressure to become high enough to set this DTC.
- Normal FRP Sensor readings on the Tech 2 with the engine running in neutral at idle is around 1.4 – 1.6 volts.
- A skewed FRP sensor value (shifted to a higher pressure) can set this DTC. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes.

Test Description

The numbers below refer to the step number on the diagnostic table.
6. This step checks for a fuel restriction by determining if a high vacuum is being pulled on the fuel system during normal operation.
7. This step checks for an air leak on the suction side of the fuel system by determining if a vacuum can be pulled when a fuel line is plugged.

DTC P0088 (Flash Code 118)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls

Step	Action	Value(s)	Yes	No
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0089, P0090, P0192, P0193, P0201 – P0204, P1095, P1261 or P1262 set?	—	Go to Applicable DTC	Go to Step 3
3	1. Turn OFF the ignition for 30 seconds. 2. Place the transmission in Neutral and set the park brake. 3. Start the engine. 4. Observe the Fuel Rail Pressure (FRP) Sensor parameter with the Tech 2. 5. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the Tech 2. Does the FRP Sensor parameter ever exceed the specified value?	3.9 volts	Go to Step 4	An intermittent problem by foreign material in the fuel is suspected. Go to Step 13
4	1. Turn OFF the ignition. 2. Wait 2 minutes for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition with the engine OFF. DO NOT start the engine. 4. Observe the FRP Sensor parameter with the Tech 2. Is the FRP Sensor parameter the specified value?	0.9 – 1.0 volt	Go to Step 5	Go to Step 12
5	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load, which may set this DTC. 3. Pump the priming pump on the fuel filter until it becomes firm. If there is a leak on the suction side of the fuel system between the priming pump and the fuel supply pump, the priming pump will not build up sufficient firmness and fuel leakage may occur. 4. Start the engine and check for high side fuel system leaks at the fuel supply pump and fuel rail. **Notice:** Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel leakage into the engine oil. 5. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Remove the rubber fuel hose from the fuel filter housing (fuel supply pump side). Use a pan to catch the fuel leakage from the removed fuel line. **Important:** The fuel vacuum pump / pressure gauge connector and the adapter hose must be cleaned before connecting to the fuel line. Otherwise, foreign material internal to the tools line may damage the fuel supply pump. 3. Connect the suction side fuel pressure / vacuum gauge adapter (5-8840-2844-0 / EN-47667) with fuel pressure / vacuum gauge assembly (5-8840-2844-0 / J-44638) in series with the filter housing and the disconnected fuel hose. Ensure the service tool and fuel line connections are tight. 4. Bleed the fuel system by priming the priming pump until it becomes firm, then crank over the engine for a maximum of 5 seconds. Repeat as necessary until the engine starts. 5. Let the engine run at idle for at least 1 minute. 6. Monitor the fuel pressure / vacuum gauge while holding the engine speed higher than 2500 RPM for a minimum of 1 minute. Does the fuel pressure / vacuum gauge ever indicate a larger vacuum than the specified amount during the test?	5 inHg	Go to Step 8	Go to Step 7
7	1. Fully clamp off a fuel hose as close to the fuel tank as possible (this will draw vacuum on the fuel system). You can also disconnect a fuel line and plug it. 2. Start the engine and turn the idle up control knob to the highest position. (Full clockwise direction. The idle speed is increased up to 1600 RPM.) 3. Monitor the fuel pressure / vacuum gauge. **Notice:** Release the clamp or open the plug when the gauge is likely to be more than 8 inHg during the test. Can a vacuum of at least the specified amount be pulled on the fuel system?	8 inHg	Go to Step 10	Go to Step 9
8	1. Inspect the fuel lines between the fuel supply pump and fuel tank for being crushed or kinked. 2. Inspect for a plugged fuel tank vent hose. 3. Inspect inside the fuel tank (if possible) for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. 4. Repair as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 13

Step	Action	Value(s)	Yes	No
9	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. 3. Repair as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 11
10	1. Turn OFF the ignition. 2. Unclamp or unplug the fuel line from the previous step and reconnect the fuel line (if disconnected). 3. Start the engine and allow it to run for at least 1 minute. 4. Perform the Injector Balancing test with the Tech 2. 5. Command each injector OFF and verify an engine speed change for each injector. Is there an injector that does not change engine speed when commanded OFF?	—	Go to Step 15	Go to Step 11
11	1. Turn OFF the ignition. 2. Disconnect the FRP regulator harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP regulator (pins 1 and 2 of E-116). 4. Disconnect the engine control module (ECM) harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each FRP regulator circuit at the harness connector of the ECM (pins 89, 97, 105 and 113 of E-111 connector). 6. Test for high resistance on each FRP regulator circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 16
12	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins 1, 2 and 3 of E-113 connector). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each FRP sensor circuit at the harness connector of the ECM (pins 82, 87, 90 and 101 of E-111 connector). 6. Test for high resistance on each FRP circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 14

Step	Action	Value(s)	Yes	No
13	Replace the fuel filter cartridge. Refer to Fuel Filter Cartridge Replacement in the Fuel System Section. Did you complete the replacement?	—	Go to Step 17	—
14	Replace the FRP sensor. Refer to Fuel Rail Pressure (FRP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 17	—
15	**Important:** Replacement injector must be programmed. Replace the appropriate fuel injector that does not change engine speed when commanded OFF. Refer to Fuel Injector Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 17	—
16	**Important:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. **Notice:** Always replace the fuel filter cartridge when a fuel supply pump is replaced. Replace the fuel supply pump and fuel filter cartridge. Refer to Fuel Supply Pump Replacement in this section and Fuel Filter Cartridge Replacement in Fuel System section. Did you complete the replacement?	—	Go to Step 17	—
17	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 18
18	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0089 (Flash Code 151)

Description

The common rail fuel system is comprised of two fuel pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the engine control module (ECM) using the fuel rail pressure (FRP) regulator dependant upon values from the FRP sensor attached to the fuel rail. In case of fuel rail overpressure, a pressure limiter valve threaded into the fuel rail will open to release overpressure and return fuel back to the fuel tank.
If the ECM detects that fuel pressure is a certain pressure higher than the desired fuel pressure for a certain length of time, this DTC will set.

Condition for Running the DTC

- DTCs P0090, P0192, P0193, P0201 – P0204, P0611, P0612, P1261, P1262, P1630 and P1635 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.
- The engine is running.
- The FRP regulator command is more than 40% or commanded fuel supply is less than a predetermined value.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the deferential fuel rail pressure is higher than 20 MPa (2,900 psi) for longer than 10 seconds when the engine speed is between 0 – 600 RPM.
- The ECM detects that the differential fuel rail pressure is higher than 40 MPa (5,800 psi) for longer than 10 seconds when the engine speed is higher than 900 RPM.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- An intermittently sticking FRP regulator may have allowed the fuel pressure to become high enough to set this DTC.
- Normal FRP Sensor readings on the Tech 2 with the engine running in neutral at idle is around 1.4 – 1.6 volts.
- A skewed FRP sensor value (shifted to a higher pressure) can set this DTC. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes.

DTC P0089 (Flash Code 151)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0090, P0192, P0193, P0201 – P0204, P1261 or P1262 set?	—	Go to Applicable DTC	Go to Step 3

Step	Action	Value(s)	Yes	No
3	1. Turn OFF the ignition. 2. Wait 2 minutes for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition with the engine OFF. DO NOT start the engine. 4. Observe the Fuel Rail Pressure (FRP) Sensor parameter with the Tech 2. Is the FRP Sensor parameter the specified value?	0.9 – 1.0 volt	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Disconnect the FRP regulator harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP regulator (pins 1 and 2 of E-116). 4. Disconnect the engine control module (ECM) harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each FRP regulator circuit at the harness connector of the ECM (pins 89, 97, 105 and 113 of E-111 connector). 6. Test for high resistance on each FRP regulator circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 6
5	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins 1, 2 and 3 of E-113 connector). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each FRP sensor circuit at the harness connector of the ECM (pins 82, 87, 90 and 101 of E-111 connector). 6. Test for high resistance on each FRP circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
6	1. Turn OFF the ignition for 30 seconds. 2. Place the transmission in Neutral and set the Park brake. 3. Start the engine. 4. Let the engine idle with the engine coolant temperature between 60 – 85°C (140 – 185°F) and accessories OFF while observing the Differential Fuel Rail Pressure parameter with the Tech 2. Is the Differential Fuel Rail Pressures parameter with the specified value?	± 5 MPa (± 725 psi)	Go to Step 7	Go to Step 9

Step	Action	Value(s)	Yes	No
7	**Notice:** An intermittent problem by foreign material in the fuel is suspected. Replace the fuel filter cartridge. Refer to Fuel Filter Cartridge Replacement in the Fuel System Section. Did you complete the replacement?	—	Go to Step 10	—
8	Replace the FRP sensor. Refer to Fuel Rail Pressure (FRP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 10	—
9	**Important:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. **Notice:** Always replace the fuel filter cartridge when a fuel supply pump is replaced. Replace the fuel supply pump and fuel filter cartridge. Refer to Fuel Supply Pump Replacement in this section and Fuel Filter Cartridge Replacement in Fuel System section. Did you complete the replacement?	—	Go to Step 10	—
10	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 11
11	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0090 (Flash Code 247)

Circuit Description

The fuel rail pressure (FRP) regulator is installed to the fuel supply pump and controls the suction fuel quantity into the fuel rail. The FRP regulator is fully opened in the normal state and larger drive current results in smaller opening. The engine control module (ECM) calculates desired fuel rail pressure and fuel flow rate and it compares the calculated desired fuel rail pressure to the actual value to determine the FRP regulator position. When the actual fuel rail pressure is higher than the desired value, the FRP regulator is closed to decease the flow rate. If the ECM detects an excessively low or high FRP regulator solenoid feedback current, this DTC will set.

Condition for Running the DTC

- DTC P1630 is not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.
- The FRP regulator command duty cycle is between 10 – 90%.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the FRP regulator solenoid feedback current is less than 50 mA.
- The ECM detects that the FRP regulator solenoid feedback current is more than 2400 mA.
- The ECM detects that the difference of commanded FRP regulator solenoid current and feedback current is more than 1000 mA.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The numbers below refers to the step number on the diagnostic table.
7. If the FRP regulator high control circuits between the ECM and the FRP regulator are shorted to voltage, engine stalls and will not start.
8. If the FRP regulator low control circuits between the ECM and the FRP regulator are shorted to ground, this DTC may not set. This condition will cause engine stall or no engine start.

DTC P0090 (Flash Code 247)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn ON the ignition, with the engine OFF. 2. Observe the Fuel Rail Pressure (FRP) Regulator Feedback parameter with the Tech 2. Is the FRP Regulator Feedback parameter more than the specified value?	300 mA	Go to Step 4	Go to Step 5
4	Is the FRP Regulator Feedback parameter more than the specified value at Step 3?	900 mA	Go to Step 7	Go to Step 8

Step	Action	Value(s)	Yes	No
5	1. Turn ON the ignition, with the engine OFF. 2. Disconnect the FRP regulator harness connector. 3. Connect a test lamp between the FRP regulator high control circuit (pin 1 of E-116 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. DO NOT start the engine. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 9
6	1. Turn OFF the ignition. 2. Connect a test lamp between the FRP regulator low control circuit (pin 2 of E-116 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. DO NOT start the engine. Does the test lamp illuminate?	—	Go to Step 11	Go to Step 10
7	1. Test the FRP regulator high control circuits between the engine control module (ECM) (pins 105 and 113 of E-111 connector) and the FRP regulator (pin 1 of E-116 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
8	1. Test the FRP regulator low control circuits between the ECM (pins 89 and 97 of E-111 connector) and the FRP regulator (pin 2 of E-116 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
9	1. Test the FRP regulator high control circuits between the ECM (pins 105 and 113 of E-111 connector) and the FRP regulator (pin 1 of E-116 connector) for the following conditions: • An open circuit • A short to ground • A short to the low control circuits • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12
10	**Important:** The ECM may be damaged if the FRP regulator low control circuit is shorted to a voltage source. 1. Test the FRP regulator low control circuits between the ECM (pins 89 and 97 of E-111 connector) and the FRP regulator (pin 2 of E-116 connector) for the following conditions: • An open circuit • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12

Step	Action	Value(s)	Yes	No
11	1. Turn OFF the ignition. 2. Disconnect the FRP regulator harness connector. 3. Inspect for an intermittent and for poor connections at the FRP regulator harness connector. 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the FRP regulator circuits at the harness connector of the ECM (pins 89, 97, 105 and 113 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
13	**Important:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. Replace the fuel supply pump. Refer to Fuel Supply Pump Replacement in this section. (FRP regulator is part of the fuel supply pump assembly) Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0107 (Flash Code 71)

Circuit Description

The barometric pressure (BARO) sensor is located under the instrument panel cluster (IPC) near the pedal bracket. The BARO sensor is a transducer that varies voltage according to the barometric pressure changes and the generated voltage is input to the engine control module (ECM) for the BARO signal. The BARO sensor has the following circuits.

- 5 volts reference circuit.
- Low reference circuit.
- BARO sensor signal circuit.

The ECM supplies 5 volts to the BARO sensor on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The BARO sensor provides a signal to the ECM on the BARO signal circuit, which is relative to the pressure changes barometric pressure. The ECM should detect a low signal voltage at a low barometric pressure, such as high altitude place. The ECM should detect high signal voltage at a high barometric pressure. The ECM uses this voltage signal to calibrate the fuel injection quantity and injection timing for altitude compensation. If the ECM detects an excessively low BARO sensor signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1632 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the BARO sensor signal voltage is less than 0.5 volts for 10 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses a BARO substitution of 75 kPa (11 psi) for engine control.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0107 (Flash Code 71)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1632 also set?	—	Go to DTC P1632	Go to Step 3
3	1. Turn ON the ignition, with the engine OFF. 2. Observe the Barometric Pressure (BARO) Sensor parameter with the Tech 2. Is the BARO Sensor parameter less than the specified value?	0.5 volts	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the BARO sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit of the BARO sensor harness (pin 3 of B-422 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 5	Go to Step 6

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the 5 volts reference circuit and the signal circuit of the BARO sensor harness (pins 3 and 2 of B-422 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the BARO Sensor parameter with the Tech 2. Is the BARO Sensor parameter more than specified value?	4.5 volts	Go to Step 8	Go to Step 7
6	1. Test the 5 volts reference circuit between the engine control module (ECM) (pin 61 of J-191 connector) and the BARO sensor (pin 3 of B-422 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
7	1. Test the signal circuit between the ECM (pin 71 of J-191 connector) and the BARO sensor (pin 2 of B-422 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the BARO sensor (pins 2 and 3 of B-422 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the BARO sensor circuits at the harness connector of the ECM (pins 61 and 71 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
10	Replace the BARO sensor. Refer to Barometric Pressure (BARO) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 12	—

Step	Action	Value(s)	Yes	No
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 13
13	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0108 (Flash Code 71)

Circuit Description

The barometric pressure (BARO) sensor is located under the instrument panel cluster (IPC) near the pedal bracket. The BARO sensor is a transducer that varies voltage according to the barometric pressure changes and the generated voltage is input to the engine control module (ECM) for the BARO signal. The BARO sensor has the following circuits.

- 5 volts reference circuit.
- Low reference circuit.
- BARO sensor signal circuit.

The ECM supplies 5 volts to the BARO sensor on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The BARO sensor provides a signal to the ECM on the BARO signal circuit, which is relative to the pressure changes barometric pressure. The ECM should detect a low signal voltage at a low barometric pressure, such as high altitude place. The ECM should detect high signal voltage at a high barometric pressure. The ECM uses this voltage signal to calibrate the fuel injection quantity and injection timing for altitude compensation. If the ECM detects an excessively high BARO sensor signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1632 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the BARO sensor signal voltage is more than 4.9 volts for 10 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses a BARO substitution of 75 kPa (11 psi) for engine control.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0108 (Flash Code 71)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Barometric Pressure (BARO) Sensor parameter with the Tech 2. Is the BARO Sensor parameter more than the specified value?	4.9 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Turn ON the ignition, with the engine OFF. 2. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1632 also set?	—	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Disconnect the BARO sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the BARO Sensor parameter with the Tech 2. Is the BARO Sensor parameter less than the specified value?	0.5 volts	Go to DTC P1632	Go to Step 7

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Disconnect the BARO sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the BARO Sensor parameter with the Tech 2. Is the BARO Sensor parameter less than the specified value?	0.5 volts	Go to Step 6	Go to Step 7
6	1. Turn OFF the ignition. 2. Connect a test lamp between the low reference circuit of the BARO sensor harness (pin 1 of B-422 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 8
7	**Important:** The BARO sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the engine control module (ECM) (pin 71 of J-191 connector) and the BARO sensor (pin 2 of B-422 connector) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the low reference circuit between the ECM (pin 60 of J-191 connector) and the BARO sensor (pin 1 of B-422 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
9	1. Turn OFF the ignition. 2. Inspect for an intermittent and for a poor connection at the harness connector of the BARO sensor (pin 1 of B-422 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the BARO sensor circuit at the harness connector of the ECM (pin 60 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the BARO sensor. Refer to Barometric Pressure (BARO) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—

Step	Action	Value(s)	Yes	No
12	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0112 (Flash Code 22)

Circuit Description

The intake air temperature (IAT) sensor is fitted between the air cleaner and turbocharger. The IAT sensor is a variable resistor. The IAT sensor has a signal circuit and a low reference circuit. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 volts to the IAT signal circuit and a ground for the IAT low reference circuit. When the IAT sensor is cold, the sensor resistance is high. When the air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the IAT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the IAT signal circuit. If the ECM detects an excessively low IAT signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1632 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the IAT sensor signal voltage is less than 0.1 volts for 10 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses an IAT substitution of -10°C (14°F) for engine control.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Use the Temperature vs. Resistance table to test the IAT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

DTC P0112 (Flash Code 22)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Intake Air Temperature (IAT) Sensor parameter with the Tech 2. Is the IAT Sensor parameter less than the specified value?	0.1 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the IAT sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the IAT Sensor parameter with the Tech 2. Is the IAT Sensor parameter more than the specified value?	4.8 volts	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the signal circuit between the engine control module (ECM) (pin 72 of J-191 connector) and the IAT sensor (pin 1 of J-190 connector) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
5	Replace the IAT sensor. Refer to Intake Air Temperature (IAT) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 8	—
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect connections on the IAT sensor circuits at the harness connector of the ECM (pins 60 and 72 of J-191 connector) for corrosion. 4. Repair or clean the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 9
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0113 (Flash Code 22)

Circuit Description

The intake air temperature (IAT) sensor is fitted between the air cleaner and turbocharger. The IAT sensor is a variable resistor. The IAT sensor has a signal circuit and a low reference circuit. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 volts to the IAT signal circuit and a ground for the IAT low reference circuit. When the IAT sensor is cold, the sensor resistance is high. When the air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the IAT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the IAT signal circuit. If the ECM detects an excessively high IAT signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1632 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.
- The engine run time is longer than 3 minutes.

Condition for Setting the DTC

- The ECM detects that the IAT sensor signal voltage is more than 4.8 volts for 10 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses an IAT substitution of -10°C (14°F) for engine control.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Use the Temperature vs. Resistance table to test the IAT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

DTC P0113 (Flash Code 22)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Intake Air Temperature (IAT) Sensor parameter with the Tech 2. Is the IAT Sensor parameter more than the specified value?	4.8 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the IAT sensor harness connector. 3. Connect a DMM between the signal circuit of the IAT sensor harness (pin 1 of J-190 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	5.5 volts	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	**Important:** The IAT sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the engine control module (ECM) (pin 72 of J-191 connector) and the IAT sensor (pin 1 of J-190 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
5	1. Turn OFF the ignition. 2. Connect a test lamp between the signal circuit of the IAT sensor harness (pin 1 of J-190 connector) and a known good ground. 3. Connect a DMM between the probe of the test lamp and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 9	Go to Step 6
6	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the signal circuit and low reference circuit of the IAT sensor harness (pins 1 and 2 of J-190 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the IAT Sensor parameter with the Tech 2. Is the IAT Sensor parameter less than the specified value?	0.1 volts	Go to Step 10	Go to Step 7
7	1. Test the signal circuit between the ECM (pin 72 of J-191 connector) and the IAT sensor (pin 1 of J-190 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 8
8	1. Test the low reference circuit between the ECM (pin 60 of J-191 connector) and the IAT sensor (pin 2 of J-190 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
9	1. Test the signal circuit between the ECM (pin 72 of J-191 connector) and the IAT sensor (pin 1 of J-190 connector) for a short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
10	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the IAT sensor (pins 1 and 2 of J-190 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 12

Step	Action	Value(s)	Yes	No
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the IAT sensor circuits at the harness connector of the ECM (pins 60 and 72 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
12	Replace the IAT sensor. Refer to Intake Air Temperature (IAT) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 14	—
13	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 14	—
14	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 15
15	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0117 (Flash Code 23)

Circuit Description

The engine coolant temperature (ECT) sensor is installed to the thermostat housing. The ECT sensor is a variable resistor. The ECT sensor has a signal circuit and a low reference circuit. The ECT sensor measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and a ground for the ECT low reference circuit. When the ECT sensor is cold, the sensor resistance is high. When the engine coolant temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the ECT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the ECT signal circuit. If the ECM detects an excessively low ECT signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1634 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the ECT sensor signal voltage is less than 0.1 volts for 10 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses an ECT substitution of -20°C (-4°F) for engine starting control.
- The ECM uses an ECT substitution of 110°C (230°F) for engine control.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Use the Temperature vs. Resistance table to test the ECT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

DTC P0117 (Flash Code 23)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Coolant Temperature Sensor parameter with the Tech 2. Is the Coolant Temperature Sensor parameter less than the specified value?	0.1 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the engine coolant temperature (ECT) sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Coolant Temperature Sensor parameter with the Tech 2. Is the Coolant Temperature Sensor parameter more than the specified value?	4.8 volts	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the signal circuit between the engine control module (ECM) (pin 84 of E-111 connector) and the ECT sensor (pin 1 of E-90 connector) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
5	Replace the ECT sensor. Refer to Engine Coolant Temperature (ECT) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 8	—
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect connections on the ECT sensor circuits at the harness connector of the ECM (pins 84 and 109 of E-111 connector) for corrosion. 4. Repair or clean the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 9
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0118 (Flash Code 23)

Circuit Description

The engine coolant temperature (ECT) sensor is installed to the thermostat housing. The ECT sensor is a variable resistor. The ECT sensor has a signal circuit and a low reference circuit. The ECT sensor measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and a ground for the ECT low reference circuit. When the ECT sensor is cold, the sensor resistance is high. When the engine coolant temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the ECT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the ECT signal circuit. If the ECM detects an excessively high ECT signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1634 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.
- The engine run time is longer than 3 minutes.

Condition for Setting the DTC

- The ECM detects that the ECT sensor signal voltage is more than 4.8 volts for 10 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses an ECT substitution of -20°C (-4°F) for engine starting control.
- The ECM uses an ECT substitution of 110°C (230°F) for engine control.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Use the Temperature vs. Resistance table to test the ECT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

DTC P0118 (Flash Code 23)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Coolant Temperature Sensor parameter with the Tech 2. Is the Coolant Temperature Sensor parameter more than the specified value?	4.8 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the engine coolant temperature (ECT) sensor harness connector. 3. Connect a DMM between the signal circuit of the ECT sensor harness (pin 1 of E-90 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	5.5 volts	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	**Important:** The ECT sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the engine control module (ECM) (pin 84 of E-111 connector) and the ECT sensor (pin 1 of E-90 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
5	1. Turn OFF the ignition. 2. Connect a test lamp between the signal circuit of the ECT sensor harness (pin 1 of E-90 connector) and a known good ground. 3. Connect a DMM between the probe of the test lamp and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 9	Go to Step 6
6	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the signal circuit and low reference circuit of the ECT sensor harness (pins 1 and 2 of E-90 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the Coolant Temperature Sensor parameter with the Tech 2. Is the Coolant Temperature Sensor parameter less than the specified value?	0.1 volts	Go to Step 10	Go to Step 7
7	1. Test the signal circuit between the ECM (pin 84 of E-111 connector) and the ECT sensor (pin 1 of E-90 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 8
8	1. Test the low reference circuit between the ECM (pin 109 of E-111 connector) and the ECT sensor (pin 2 of E-90 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
9	1. Test the signal circuit between the ECM (pin 84 of E-111 connector) and the ECT sensor (pin 1 of E-90 connector) for a short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
10	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the ECT sensor (pins 1 and 2 of E-90 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 12

Step	Action	Value(s)	Yes	No
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the ECT sensor circuits at the harness connector of the ECM (pins 84 and 109 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
12	Replace the ECT sensor. Refer to Engine Coolant Temperature (ECT) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 14	—
13	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 14	—
14	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 15
15	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0182 (Flash Code 211)

Circuit Description

The fuel temperature (FT) sensor is installed to the fuel supply pump. The FT sensor is a variable resistor. The FT sensor has a signal circuit and a low reference circuit. The FT sensor measures the fuel temperature of the fuel. The engine control module (ECM) supplies 5 volts to the FT signal circuit and a ground for the FT low reference circuit. When the FT sensor is cold, the sensor resistance is high. When the fuel temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the FT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the FT signal circuit. If the ECM detects an excessively low FT signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1634 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the FT sensor signal voltage is less than 0.1 volts for 10 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses a FT substitution of -20°C (-4°F) for engine starting control.
- The ECM uses a FT substitution of 70°C (158°F) for engine control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- Before starting a cold engine, FT sensor and engine coolant temperature (ECT) sensor temperature should be relatively close to each other.
- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Use the Temperature vs. Resistance table to test the ECT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

DTC P0182 (Flash Code 211)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Fuel Temperature (FT) Sensor parameter with the Tech 2. Is the FT Sensor parameter less than the specified value?	0.1 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the FT sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the FT Sensor parameter with the Tech 2. Is the FT Sensor parameter more than the specified value?	4.8 volts	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the signal circuit between the engine control module (ECM) (pin 83 of E-111 connector) and the FT sensor (pin 2 of E-93 connector) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
5	Replace the FT sensor. Refer to Fuel Temperature (FT) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 8	—
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect connections on the FT sensor circuits at the harness connector of the ECM (pins 83 and 109 of E-111 connector) for corrosion. 4. Repair or clean the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 9
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0183 (Flash Code 211)

Circuit Description

The fuel temperature (FT) sensor is installed to the fuel supply pump. The FT sensor is a variable resistor. The FT sensor has a signal circuit and a low reference circuit. The FT sensor measures the fuel temperature of the fuel. The engine control module (ECM) supplies 5 volts to the FT signal circuit and a ground for the FT low reference circuit. When the FT sensor is cold, the sensor resistance is high. When the fuel temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the FT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the FT signal circuit. If the ECM detects an excessively high FT signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1634 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.
- The engine run time is longer than 3 minutes.

Condition for Setting the DTC

- The ECM detects that the FT sensor signal voltage is more than 4.8 volts for 10 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses a FT substitution of -20°C (-4°F) for engine starting control.
- The ECM uses a FT substitution of 70°C (158°F) for engine control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- Before starting a cold engine, FT sensor and engine coolant temperature (ECT) sensor temperature should be relatively close to each other.
- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Use the Temperature vs. Resistance table to test the ECT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

DTC P0183 (Flash Code 211)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Fuel Temperature (FT) Sensor parameter with the Tech 2. Is the FT Sensor parameter more than the specified value?	4.8 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the FT sensor harness connector. 3. Connect a DMM between the signal circuit of the FT sensor harness (pin 2 of E-93 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	5.5 volts	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	**Important:** The FT sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the engine control module (ECM) (pin 83 of E-111 connector) and the FT sensor (pin 2 of E-93 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
5	1. Turn OFF the ignition. 2. Connect a test lamp between the signal circuit of the FT sensor harness (pin 2 of E-93 connector) and a known good ground. 3. Connect a DMM between the probe of the test lamp and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 9	Go to Step 6
6	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the signal circuit and low reference circuit of the FT sensor harness (pins 1 and 2 of E-93 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the FT Sensor parameter with the Tech 2. Is the FT Sensor parameter less than the specified value?	0.1 volts	Go to Step 10	Go to Step 7
7	1. Test the signal circuit between the ECM (pin 83 of E-111 connector) and the FT sensor (pin 2 of E-93 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 8
8	1. Test the low reference circuit between the ECM (pin 109 of E-111 connector) and the FT sensor (pin 1 of E-93 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
9	1. Test the signal circuit between the ECM (pin 83 of E-111 connector) and the FT sensor (pin 2 of E-93 connector) for a short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
10	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the FT sensor (pins 1 and 2 of E-93 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 12

Step	Action	Value(s)	Yes	No
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the FT sensor circuits at the harness connector of the ECM (pins 83 and 109 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
12	Replace the FT sensor. Refer to Fuel Temperature (FT) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 14	—
13	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 14	—
14	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 15
15	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0192 (Flash Code 245)

Circuit Description

The fuel rail pressure (FRP) sensor is installed to the fuel rail and it detects the fuel pressure in the fuel rail, converts the pressure into a voltage signal, and sends the signal to the engine control module (ECM). The FRP sensor has the following circuits.

- 5 volts reference circuit.
- Low reference circuit.
- FRP sensor signal circuit.

The ECM supplies 5 volts to the FRP sensor on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. Higher fuel rail pressure provides higher FRP sensor voltage while lower pressure provides lower FRP sensor voltage. The ECM calculates actual fuel rail pressure (fuel pressure) from the voltage signal and uses the result in fuel injection control and other control tasks. The ECM monitors the FRP sensor signal for voltage outside the normal range. If the ECM detects an excessively low FRP sensor signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1635 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the FRP sensor signal voltage is less than 0.7 volts.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- Electrical or magnetic interference may affect intermittent condition.
- The Differential Fuel Rail Pressure parameter on the Tech 2 will be fixed at 0 MPa (0 psi) when this DTC is set.

DTC P0192 (Flash Code 245)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1635 also set?	—	Go to DTC P1635	Go to Step 3
3	1. Start the engine. 2. Observe the Fuel Rail Pressure (FRP) Sensor parameter with the Tech 2. Is the FRP Sensor parameter less than the specified value?	0.7 volts	Go to Step 4	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Fuel Rail Pressure (FRP) Sensor parameter with the Tech 2. Is the FRP Sensor parameter more than the specified value?	4.5 volts	Go to Step 5	Go to Step 6
5	1. Turn OFF the ignition. 2. Connect a DMM between the 5 volts reference circuit of the FRP sensor harness (pin 3 of E-113 connector) and a known good ground. 3. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 8	Go to Step 7
6	1. Test the signal circuits between the engine control module (ECM) (pins 82 and 90 of E-111 connector) and the FRP sensor (pin 2 of E-113 connector) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
7	1. Test the 5 volts reference circuit between the ECM (pin 87 of E-111 connector) and the FRP sensor (pin 3 of E-113 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Turn OFF the ignition. 2. Inspect for an intermittent and for a poor connection at the harness connector of the FRP sensor (pin 3 of E-113 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the FRP sensor circuit at the harness connector of the ECM (pin 87 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
10	Replace the FRP sensor. Refer to Fuel Rail Pressure (FRP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 12	—

Step	Action	Value(s)	Yes	No
11	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 13
13	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0193 (Flash Code 245)

Circuit Description

The fuel rail pressure (FRP) sensor is installed to the fuel rail and it detects the fuel pressure in the fuel rail, converts the pressure into a voltage signal, and sends the signal to the engine control module (ECM). The FRP sensor has the following circuits.

- 5 volts reference circuit.
- Low reference circuit.
- FRP sensor signal circuit.

The ECM supplies 5 volts to the FRP sensor on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. Higher fuel rail pressure provides higher FRP sensor voltage while lower pressure provides lower FRP sensor voltage. The ECM calculates actual fuel rail pressure (fuel pressure) from the voltage signal and uses the result in fuel injection control and other control tasks. The ECM monitors the FRP sensor signal for voltage outside the normal range. If the ECM detects an excessively high FRP sensor signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1635 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the FRP sensor signal voltage is more than 4.5 volts.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- Electrical or magnetic interference may affect intermittent condition.
- The Differential Fuel Rail Pressure parameter on the Tech 2 will be fixed at 0 MPa (0 psi) when this DTC is set.

DTC P0193 (Flash Code 245)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check-Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1635 also set?	—	Go to DTC P1635	Go to Step 3
3	1. Start the engine. 2. Observe the Fuel Rail Pressure (FRP) Sensor parameter with the Tech 2. Is the FRP Sensor parameter more than the specified value?	4.5 volts	Go to Step 4	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Connect a DMM between the signal circuit of the FRP sensor harness (pin 2 of E-113 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than specified value?	5.5 volts	Go to Step 10	Go to Step 5
5	1. Turn OFF the ignition. 2. Connect a test lamp between the signal circuit of the FRP sensor harness (pin 2 of E-113 connector) and a known good ground. 3. Connect a DMM between the probe of the test lamp and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 9	Go to Step 6
6	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the signal circuit and the low reference circuit of the FRP sensor harness (pins 1 and 2 of E-113 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the FRP Sensor parameter with the Tech 2. Is the FRP Sensor parameter less than the specified value?	0.7 volts	Go to Step 11	Go to Step 7
7	1. Test the low reference circuit between the engine control module (ECM) (pin 101 of E-111 connector) and the FRP sensor (pin 1 of E-113 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 8
8	1. Test the signal circuit between the ECM (pins 82 and 90 of E-111 connector) and the FRP sensor (pin 2 of E-113 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12
9	1. Test the signal circuits between the ECM (pins 82 and 90 of E-111 connector) and the FRP sensor (pin 2 of E-113 connector) for a short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14

Step	Action	Value(s)	Yes	No
10	**Important:** The FRP sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuits between ECM (pins 82 and 90 of E-111 connector) and the FRP sensor (pin 2 of E-113 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
11	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the FRP sensor (pins 1 and 2 of E-113 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the FRP sensor circuits at the harness connector of the ECM (pins 82, 90 and 101 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
13	Replace the FRP sensor. Refer to Fuel Rail Pressure (FRP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0201 (Flash Code 271)

Circuit Description

The engine control module (ECM) calculates the optimum fuel injection ON time using data sent from various engine sensors. The ECM supplies a high voltage along with grounding the fuel injector control circuit when it needs to energize the fuel injector (turn it ON). The ECM also supplies battery voltage to the fuel injector solenoid control circuit to allow for fault detection. If the cylinder number 1 fuel injector solenoid control circuit is open circuit, shorted to voltage or shorted to the common 1 fuel injector drive circuit, this DTC will set.

Condition for Running the DTC

- DTCs P0204, P0611 and P1261 are not set.
- The ignition switch is ON.
- The battery voltage is more than 18 volts.
- The engine is running.

Condition for Setting the DTC

- The ECM detects that the cylinder number 1 fuel injector solenoid coil control circuit is open circuit, shorted to voltage or shorted to common 1 fuel injector drive circuit during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0201 (Flash Code 271)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the in-line harness connector (H-125) from the cylinder head cover case. 3. Connect a DMM between the common 1 fuel injector drive circuit (pin 1 of H-125 female side connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage less than the specified value?	1.0 volt	Go to Step 4	Go to Step 9
4	Connect a DMM between the cylinder number 1 fuel injector control circuit (pin 5 of H-125 female side connector) and a known good ground. Is the DMM voltage less than the specified value?	16.0 volts	Go to Step 5	Go to Step 10
5	Is the DMM voltage more than the specified value at Step 4?	12.0 volts	Go to Step 6	Go to Step 11

Step	Action	Value(s)	Yes	No
6	1. Inspect for an intermittent and for a poor connection at the in-line harness connector (pin 5 of H-125 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 7
7	1. Remove the cylinder head cover. Refer to Fuel Injector Replacement in this section. 2. Inspect the fuel injector harness for loose injector terminal nuts, objects touching injector terminals. 3. Inspect for an intermittent and for a poor connection at the in-line harness connector (pin 5 of H-126 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 8
8	1. Test the cylinder number 1 fuel injector solenoid control circuit between the fuel injector terminal (pins 1, 2 and 3 of E-138 connector) and the in-line harness connector (pins 1, 4 and 5 of H-126 connector) for the following conditions: • An open circuit • A short to the common 1 fuel injector drive circuit • High resistance 2. Repair or replace the injector harness as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
9	1. Test the cylinder number 1 fuel injector solenoid control circuit and common 1 fuel injector drive circuit for a short to each other between the engine control module (ECM) (pins 119 and 121 of E-111 connector) and the in-line harness connector (pins 1 or 4 and 5 of H-125 connector). 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
10	1. Test the cylinder number 1 fuel injector solenoid control circuit between the ECM (pin 119 of E-111 connector) and the in-line harness connector (pin 5 of H-125 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
11	1. Test the cylinder number 1 fuel injector solenoid control circuit between the ECM (pin 119 of E-111 connector) and the in-line harness connector (pin 5 of H-125 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12

Step	Action	Value(s)	Yes	No
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the cylinder number 1 fuel injector control circuit at the harness connector of the ECM (pin 119 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
13	**Important:** Replacement injector must be programmed. Replace the cylinder number 1 fuel injector. Refer to Fuel Injector Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0202 (Flash Code 272)

Circuit Description

The engine control module (ECM) calculates the optimum fuel injection ON time using data sent from various engine sensors. The ECM supplies a high voltage along with grounding the fuel injector control circuit when it needs to energize the fuel injector (turn it ON). The ECM also supplies battery voltage to the fuel injector solenoid control circuit to allow for fault detection. If the cylinder number 2 fuel injector solenoid control circuit is open circuit, shorted to voltage or shorted to the common 2 fuel injector drive circuit, this DTC will set.

Condition for Running the DTC

- DTCs P0203, P0612 and P1262 are not set.
- The ignition switch is ON.
- The battery voltage is more than 18 volts.
- The engine is running.

Condition for Setting the DTC

- The ECM detects that the cylinder number 2 fuel injector solenoid coil control circuit is open circuit, shorted to voltage or shorted to common 2 fuel injector drive circuit during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0202 (Flash Code 272)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the in-line harness connector (H-125) from the cylinder head cover case. 3. Connect a DMM between the common 2 fuel injector drive circuit (pin 2 of H-125 female side connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage less than the specified value?	1.0 volt	Go to Step 4	Go to Step 9
4	Connect a DMM between the cylinder number 2 fuel injector control circuit (pin 6 of H-125 female side connector) and a known good ground. Is the DMM voltage less than the specified value?	16.0 volts	Go to Step 5	Go to Step 10
5	Is the DMM voltage more than the specified value at Step 4?	12.0 volts	Go to Step 6	Go to Step 11

Step	Action	Value(s)	Yes	No
6	1. Inspect for an intermittent and for a poor connection at the in-line harness connector (pin 6 of H-125 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 7
7	1. Remove the cylinder head cover. Refer to Fuel Injector Replacement in this section. 2. Inspect the fuel injector harness for loose injector terminal nuts, objects touching injector terminals. 3. Inspect for an intermittent and for a poor connection at the in-line harness connector (pin 6 of H-126 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 8
8	1. Test the cylinder number 2 fuel injector solenoid control circuit between the fuel injector terminal (pins 1, 2 and 3 of E-139 connector) and the in-line harness connector (pins 2, 3 and 6 of H-126 connector) for the following conditions: • An open circuit • A short to the common 2 fuel injector drive circuit • High resistance 2. Repair or replace the injector harness as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
9	1. Test the cylinder number 2 fuel injector solenoid control circuit and common 2 fuel injector drive circuit for a short to each other between the engine control module (ECM) (pins 116 and 118 of E-111 connector) and the in-line harness connector (pins 2 or 3 and 6 of H-125 connector). 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
10	1. Test the cylinder number 2 fuel injector solenoid control circuit between the ECM (pin 118 of E-111 connector) and the in-line harness connector (pin 6 of H-125 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
11	1. Test the cylinder number 2 fuel injector solenoid control circuit between the ECM (pin 118 of E-111 connector) and the in-line harness connector (pin 6 of H-125 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12

Step	Action	Value(s)	Yes	No
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the cylinder number 2 fuel injector control circuit at the harness connector of the ECM (pin 118 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
13	**Important:** Replacement injector must be programmed. Replace the cylinder number 2 fuel injector. Refer to Fuel Injector Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0203 (Flash Code 273)

Circuit Description

The engine control module (ECM) calculates the optimum fuel injection ON time using data sent from various engine sensors. The ECM supplies a high voltage along with grounding the fuel injector control circuit when it needs to energize the fuel injector (turn it ON). The ECM also supplies battery voltage to the fuel injector solenoid control circuit to allow for fault detection. If the cylinder number 3 fuel injector solenoid control circuit is open circuit, shorted to voltage or shorted to the common 2 fuel injector drive circuit, this DTC will set.

Condition for Running the DTC

- DTCs P0202, P0612 and P1262 are not set.
- The ignition switch is ON.
- The battery voltage is more than 18 volts.
- The engine is running.

Condition for Setting the DTC

- The ECM detects that the cylinder number 3 fuel injector solenoid coil control circuit is open circuit, shorted to voltage or shorted to common 2 fuel injector drive circuit during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0203 (Flash Code 273)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the in-line harness connector (H-125) from the cylinder head cover case. 3. Connect a DMM between the common 2 fuel injector drive circuit (pin 3 of H-125 female side connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage less than the specified value?	1.0 volt	Go to Step 4	Go to Step 9
4	Connect a DMM between the cylinder number 3 fuel injector control circuit (pin 7 of H-125 female side connector) and a known good ground. Is the DMM voltage less than the specified value?	16.0 volts	Go to Step 5	Go to Step 10
5	Is the DMM voltage more than the specified value at Step 4?	12.0 volts	Go to Step 6	Go to Step 11

Step	Action	Value(s)	Yes	No
6	1. Inspect for an intermittent and for a poor connection at the in-line harness connector (pin 7 of H-125 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 7
7	1. Remove the cylinder head cover. Refer to Fuel Injector Replacement in this section. 2. Inspect the fuel injector harness for loose injector terminal nuts, objects touching injector terminals. 3. Inspect for an intermittent and for a poor connection at the in-line harness connector (pin 7 of H-126 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 8
8	1. Test the cylinder number 3 fuel injector solenoid control circuit between the fuel injector terminal (pins 1, 2 and 3 of E-140 connector) and the in-line harness connector (pins 2, 3 and 7 of H-126 connector) for the following conditions: • An open circuit • A short to the common 2 fuel injector drive circuit • High resistance 2. Repair or replace the injector harness as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
9	1. Test the cylinder number 3 fuel injector solenoid control circuit and common 2 fuel injector drive circuit for a short to each other between the engine control module (ECM) (pins 116 and 120 of E-111 connector) and the in-line harness connector (pins 2 or 3 and 7 of H-125 connector). 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
10	1. Test the cylinder number 3 fuel injector solenoid control circuit between the ECM (pin 120 of E-111 connector) and the in-line harness connector (pin 7 of H-125 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
11	1. Test the cylinder number 3 fuel injector solenoid control circuit between the ECM (pin 120 of E-111 connector) and the in-line harness connector (pin 7 of H-125 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12

Step	Action	Value(s)	Yes	No
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the cylinder number 3 fuel injector control circuit at the harness connector of the ECM (pin 120 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
13	**Important:** Replacement injector must be programmed. Replace the cylinder number 3 fuel injector. Refer to Fuel Injector Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0204 (Flash Code 274)

Circuit Description

The engine control module (ECM) calculates the optimum fuel injection ON time using data sent from various engine sensors. The ECM supplies a high voltage along with grounding the fuel injector control circuit when it needs to energize the fuel injector (turn it ON). The ECM also supplies battery voltage to the fuel injector solenoid control circuit to allow for fault detection. If the cylinder number 4 fuel injector solenoid control circuit is open circuit, shorted to voltage or shorted to the common 1 fuel injector drive circuit, this DTC will set.

Condition for Running the DTC

- DTCs P0201, P0611 and P1261 are not set.
- The ignition switch is ON.
- The battery voltage is more than 18 volts.
- The engine is running.

Condition for Setting the DTC

- The ECM detects that the cylinder number 4 fuel injector solenoid coil control circuit is open circuit, shorted to voltage or shorted to common 1 fuel injector drive circuit during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0204 (Flash Code 274)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the in-line harness connector (H-125) from the cylinder head cover case. 3. Connect a DMM between the common 1 fuel injector drive circuit (pin 4 of H-125 female side connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage less than the specified value?	1.0 volt	Go to Step 4	Go to Step 9
4	Connect a DMM between the cylinder number 4 fuel injector control circuit (pin 8 of H-125 female side connector) and a known good ground. Is the DMM voltage less than the specified value?	16.0 volts	Go to Step 5	Go to Step 10
5	Is the DMM voltage more than the specified value at Step 4?	12.0 volts	Go to Step 6	Go to Step 11

Step	Action	Value(s)	Yes	No
6	1. Inspect for an intermittent and for a poor connection at the in-line harness connector (pin 8 of H-125 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 7
7	1. Remove the cylinder head cover. Refer to Fuel Injector Replacement in this section. 2. Inspect the fuel injector harness for loose injector terminal nuts, objects touching injector terminals. 3. Inspect for an intermittent and for a poor connection at the in-line harness connector (pin 8 of H-126 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 8
8	1. Test the cylinder number 4 fuel injector solenoid control circuit between the fuel injector terminal (pins 1, 2 and 3 of E-141 connector) and the in-line harness connector (pins 1, 4 and 8 of H-126 connector) for the following conditions: • An open circuit • A short to the common 1 fuel injector drive circuit • High resistance 2. Repair or replace the injector harness as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
9	1. Test the cylinder number 4 fuel injector solenoid control circuit and common 1 fuel injector drive circuit for a short to each other between the engine control module (ECM) (pins 117 and 121 of E-111 connector) and the in-line harness connector (pins 1 or 4 and 8 of H-125 connector). 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
10	1. Test the cylinder number 4 fuel injector solenoid control circuit between the ECM (pin 117 of E-111 connector) and the in-line harness connector (pin 8 of H-125 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
11	1. Test the cylinder number 4 fuel injector solenoid control circuit between the ECM (pin 117 of E-111 connector) and the in-line harness connector (pin 8 of H-125 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12

Step	Action	Value(s)	Yes	No
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the cylinder number 4 fuel injector control circuit at the harness connector of the ECM (pin 117 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
13	**Important:** Replacement injector must be programmed. Replace the cylinder number 4 fuel injector. Refer to Fuel Injector Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0219 (Flash Code 543)

Circuit Description

The crankshaft position (CKP) sensor is located on top of the flywheel housing. The engine control module (ECM) calculates the engine speed and exact position of the crankshaft based on the signal from the CKP sensor. If the ECM detects an engine overrun condition, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the engine speed is higher than 4300 RPM.

Action Taken When the DTC Sets

- The ECM does not illuminate the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the DTC

- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- This DTC is caused by an engine overspeed condition, which was most likely caused by driver error (i.e. downshifting a manual transmission on a steep grade). Since this DTC does not illuminate any lamps, clear the DTC and ensure there are no signs of engine damage. Excessive engine overspeed may damage internal engine components.
- Make sure the CKP sensor is tight and the sensor wheel teeth are not damaged.

DTC P0219 (Flash Code 543)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	**Important:** If DTC P0335, P0336, P0340 or P0341 is also set, diagnose that DTC first. 1. Install the Tech 2. 2. Start the engine. 3. Observe the Engine Speed parameter with the Tech 2. 4. Accelerate the engine as necessary. Does the Engine Speed parameter ever exceed the specified value?	3700 RPM	Go to Step 4	Go to Step 3
3	Ask the driver if overrun is caused by gear slip-out, shift error, down-slope driving, etc. If engine overrun has experienced, the engine must be inspected and repaired as necessary. Did you complete the action?	—	Go to Step 17	—
4	1. Remove the crankshaft position (CKP) sensor. Refer to CKP Sensor replacement in this section. 2. Visually inspect the CKP sensor for the following conditions: • For physical damage • For being loose • For improper installation Did you find and correct the condition?	—	Go to Step 17	Go to Step 5

Step	Action	Value(s)	Yes	No
5	Visually inspect for damage, metal particles on magnet and for flywheel teeth damage. Did you find and correct the condition?	—	Go to Step 17	Go to Step 6
6	1. Turn OFF the ignition. 2. Disconnect the crankshaft position (CKP) sensor harness connector. 3. Connect a DMM across the CKP sensor terminals. 4. Measure the resistance across the CKP sensor. Does the CKP sensor resistance measure within the specified range?	105 – 145 Ω	Go to Step 7	Go to Step 15
7	1. Connect a DMM across the CKP sensor terminals (measure sensor output voltage). 2. Place the DMM on the AC volt scale. 3. Start the engine. 4. Monitor the DMM while accelerating the engine between idle and W.O.T. (accelerator pedal full travel). Does the DMM indicate an AC voltage increase in accordance with an engine speed increase?	—	Go to Step 8	Go to Step 15
8	1. Turn ON the ignition, with the engine OFF. 2. Connect a DMM between the CKP sensor harness (pin 1 of E-98 connector) and a known good ground. 3. Connect a DMM between the CKP sensor harness (pin 2 of E-98 connector) and a known good ground. Is each DMM voltage within the specified value?	0.4 – 1.4 volts	Go to Step 10	Go to Step 9
9	Is the DMM voltage more than the specified value at Step 8?	—	Go to Step 12	Go to Step 11
10	1. Test the CKP sensor circuits between the engine control module (ECM) (pins 106 and 107 of E-111 connector) and CKP sensor (pins 1 and 2 of E-98 connector) for a short to each other. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 13
11	1. Test the CKP sensor circuits between the ECM (pins 106 and 107 of E-111 connector) and CKP sensor (pins 1 and 2 of E-98 connector) for the following conditions: • An open circuit • A short to ground • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 14

Step	Action	Value(s)	Yes	No
12	1. Test the CKP sensor circuits between the ECM (pins 106 and 107 of E-111 connector) and CKP sensor (pins 1 and 2 of E-98 connector) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 16
13	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the CKP sensor (pins 1 and 2 of E-98 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 16
14	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the CKP sensor circuits at the harness connector of the ECM (pins 106 and 107 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 16
15	Replace the CKP sensor. Refer to Crankshaft Position (CKP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 17	—
16	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 17	—
17	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Accelerate the Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the Engine Speed parameter with Tech 2. Does the Engine Speed parameter ever exceed the specified value?	3700 RPM	Go to Step 4	Go to Step 18
18	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0234 (Flash Code 42)

Circuit Description

The boost pressure sensor is located in the air induction tubing. The sensor is a transducer that varies voltage according to changes in the air pressure inside the air tubing. The engine control module (ECM) monitors the boost pressure sensor signal for abnormal values. If the ECM detects that the boost pressure sensor signal is excessively high, this DTC will set.

Condition for Running the DTC

- DTCs P0237, P0238, P1630 and P1634 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.
- The engine is running.
- The fuel injection quantity is lower than a predetermined value.

Condition for Setting the DTC

- The ECM detects that the boost pressure is higher than 228 kPa (33 psi) for 3 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- An open circuit or high resistance in the boost pressure low reference circuit may set this DTC.
- Check the turbocharger wastegate valve for a sticking or close stuck condition.
- Use the Tech 2 to verify the integrity of the boost pressure sensor signal. Compare the sensor values under all load conditions for an excessively high value. Use the Tech 2 data list values for nominal sensor readings.
- The fuel with which gasoline was mixed may set this DTC.

Test Description

The numbers below refer to the step number on the diagnostic table.
2. A skewed boost pressure sensor value (shifted to a higher pressure) can set this DTC. The Boost Pressure on the Tech 2 should read near Barometric Pressure (BARO) with the key ON and engine OFF.
3. A skewed BARO sensor value (shifted to a lower pressure) may indicate a wrong boost pressure sensor reading. The BARO on the Tech 2 should read near surrounding barometric pressure.

DTC P0234 (Flash Code 42)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Boost Pressure and Barometric Pressure (BARO) with the Tech 2. Does the Tech 2 indicate that the difference between the Boost Pressure and BARO is more than the specified value?	7.0 kPa (1.0 psi)	Go to Step 3	Go to Step 4
3	1. Observe the BARO parameter with the Tech 2. 2. Compare the BARO value to the range specified in the altitude vs. barometric pressure table. Refer to Altitude vs Barometric Pressure. Is the BARO parameter within the range specified?	—	Go to Step 5	Go to Step 8

Step	Action	Value(s)	Yes	No
4	1. Inspect the following for possible causes of high boost pressure. • Wastegate for a stuck closed condition. Refer to the Turbocharger in Engine Mechanical section for diagnosis. • Oil in the air induction tubing causing an incorrect boost pressure sensor signal. When there is adhesion of oil inside of the tubing, intercooler or turbocharger it needs to be wiped off. 2. Repair the condition as necessary. Did you find and correction the condition?	—	Go to Step 11	Go to Diagnostic Aids
5	1. Turn OFF the ignition. 2. Disconnect the boost pressure sensor harness connector. 3. Inspect for an intermittent and for a poor connection at the boost pressure sensor harness connector (pin 1 of J-216 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 6
6	1. Turn ON the ignition, with the engine OFF. 2. Connect a test lamp between the boost pressure sensor low reference circuit (pin 1 of J-216 connector) and battery voltage. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 7
7	Repair the high resistance in low reference circuit between the engine control module (ECM) (pin 109 of E-111 connector) and boost pressure sensor (pin 1 of J-216 connector). Did you complete the repair?	—	Go to Step 11	—
8	1. Turn OFF the ignition. 2. Disconnect the BARO sensor harness connector. 3. Inspect for an intermittent and for poor connections at the BARO sensor harness connector (pins 2 and 3 of B-422 connector). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each BARO sensor circuit at the harness connector of the ECM (pins 61 and 71 of J-191 connector). 6. Test for high resistance on each BARO sensor circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	Replace the boost pressure sensor. Refer to Boost Pressure Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 11	—
10	Replace the BARO sensor. Refer to Barometric Pressure (BARO) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 11	—

Step	Action	Value(s)	Yes	No
11	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 12
12	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0236 (Flash Code 65)

Circuit Description

The boost pressure sensor is located in the air induction tubing. The sensor is a transducer that varies voltage according to changes in the air pressure inside the air tubing. The engine control module (ECM) monitors the boost pressure sensor signal for abnormal values. If the ECM detects that the boost pressure sensor signal is excessively low, this DTC will set.

Condition for Running the DTC

- DTCs P0107, P0108, P0237, P0238, P1630 and P1634 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.
- The engine is running.
- The fuel injection quantity is higher than a predetermined value.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the boost pressure is lower than 78 kPa (11 psi) for 20 seconds when the engine speed is lower than 900 RPM.
- The ECM detects that the boost pressure is lower than 82 – 151 kPa (12 – 22 psi) for 20 seconds when the engine speed is between 1200 – 3000 RPM.
- The ECM detect that the boost pressure is lower than 100 – 158 kPa (15 – 23 psi) for 20 seconds when the engine speed is between 3300 – 3600 RPM.

Notice:

- If the barometric pressure (BARO) is lower than 100 kPa (15 psi), a compensated value (100 kPa – BARO) is added to the above thresholds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- Induction air leakage can cause a low boost pressure condition. A whistling noise may be heard if a component is allowing air to enter the induction system. Close the throttle plate, remove the boost pressure sensor and introduce shop air into the line. Feel around the air tubing for leaks.
- Check for cracked air tubing that may only open during certain engine movement conditions.
- Check the turbocharger wastegate valve for a sticking or stuck open condition.
- Use the Tech 2 to verify the integrity of the boost pressure sensor signal. Compare the sensor values under all load conditions for an excessively low value. Use the Tech 2 data list values for nominal sensor readings.
- Fuel system problem (low fuel pressure condition) may set this DTC.

Test Description

The numbers below refer to the step number on the diagnostic table.
3. A skewed boost pressure sensor value (shifted to a low pressure) can set this DTC. The Boost Pressure on the Tech 2 should read near barometric pressure (BARO) with the key ON and engine OFF.
4. A BARO sensor value (shifted to a higher pressure) may indicate a wrong boost pressure sensor reading. The BARO on the Tech 2 should read near surrounding barometric pressure.

DTC P0236 (Flash Code 65)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls

Step	Action	Value(s)	Yes	No
2	1. Inspect the following for possible causes of low boost pressure. • Air leakage around the boost pressure sensor or debris in the sensor hole. • Air leaking around any of the air induction tubing between the turbocharger and intake manifold. Check for damaged components and for loose clamps. • Turbine shaft binding causing lower turbocharger shaft spinning speeds. Refer to the Turbocharger in Engine Mechanical section for diagnosis. • Turbocharger wastegate valve for a stuck open condition. Refer to the Turbocharger in Engine Mechanical section for diagnosis. • Restricted air cleaner element, restricted or collapsed air tubing between the air cleaner and the intake throttle. • Intake throttle plate sticking in the closed position. Move intake throttle plate rod by hand to verify smooth operation. • Oil in the air induction tubing causing an incorrect boost pressure sensor signal. When there is adhesion of oil inside of the tubing, intercooler or turbocharger it needs to be wiped off. 2. Repair the condition as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 3
3	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Boost Pressure and Barometric Pressure (BARO) with the Tech 2. Does the Tech 2 indicate that the difference between the Boost Pressure and BARO is more than the specified value?	7.0 kPa (1.0 psi)	Go to Step 4	Go to Diagnostic Aids
4	1. Observe the BARO parameter with the Tech 2. 2. Compare the BARO value to the range specified in the altitude vs. barometric pressure table. Refer to Altitude vs Barometric Pressure. Is the BARO parameter within the range specified?	—	Go to Step 5	Go to Step 6

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Disconnect the boost pressure sensor harness connector. 3. Inspect for an intermittent and for poor connections at the boost pressure sensor harness connector (pins 2 and 3 of J-216 connector). 4. Disconnect the engine control module (ECM) harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each boost pressure sensor circuit at the harness connector of the ECM (pins 91 and 95 of E-111 connector). 6. Test for high resistance on each boost pressure sensor circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 9
6	1. Turn OFF the ignition. 2. Disconnect the BARO sensor harness connector. 3. Inspect for an intermittent and for a poor connection at the BARO sensor harness connector (pin 1 of B-422 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 7
7	1. Turn ON the ignition, with the engine OFF. 2. Connect a test lamp between the BARO sensor low reference circuit (pin 1 of B-422 connector) and battery voltage. Does the test lamp illuminate?	—	Go to Step 10	Go to Step 8
8	Repair the high resistance in low reference circuit between the ECM (pin 60 of J-191 connector) and BARO sensor (pin 1 of B-422 connector). Did you complete the repair?	—	Go to Step 11	—
9	Replace the boost pressure sensor. Refer to Boost Pressure Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 11	—
10	Replace the BARO sensor. Refer to Barometric Pressure (BARO) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 11	—
11	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 12

Step	Action	Value(s)	Yes	No
12	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0237 (Flash Code 32)

Circuit Description

The boost pressure sensor is located in the air induction tubing. The boost pressure sensor is a transducer that varies voltage according to changes in the air pressure inside the air tubing. The boost pressure sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- Boost pressure sensor signal circuit

The engine control module (ECM) supplies 5 volts to the boost pressure sensor on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The boost pressure sensor provides a signal to the ECM on the boost pressure signal circuit which is relative to the pressure changes in the manifold. The ECM should detect a low signal voltage at a low boost pressure, such as low engine load. The ECM should detect high signal voltage at a high boost pressure, such as high engine load. The ECM monitors the boost pressure sensor signal for voltage outside the normal range of the boost pressure sensor. If the ECM detects an excessively low boost pressure sensor signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1634 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the boost pressure sensor signal voltage is less than 0.1 volts for 5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses a boost pressure substitution of 100 kPa (14.5 psi) for engine control.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0237 (Flash Code 32)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1634 also set?	—	Go to DTC P1634	Go to Step 3
3	1. Start the engine. 2. Observe the Boost Pressure Sensor parameter with the Tech 2. Is the Boost Pressure Sensor parameter less than the specified value?	0.1 volts	Go to Step 4	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the boost pressure sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit of the boost pressure sensor harness (pin 3 of J-216 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 5	Go to Step 6
5	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the 5 volts reference circuit and the signal circuit of the boost pressure sensor harness (pins 3 and 2 of J-216 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the Boost Pressure Sensor parameter with the Tech 2. Is the Boost Pressure Sensor parameter more than specified value?	4.5 volts	Go to Step 8	Go to Step 7
6	1. Test the 5 volts reference circuit between the engine control module (ECM) (pin 95 of E-111 connector) and the boost pressure sensor (pin 3 of J-216 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
7	1. Test the signal circuit between the ECM (pin 91 of E-111 connector) and the boost pressure sensor (pin 2 of J-216 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the boost pressure sensor (pins 2 and 3 of J-216 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the boost pressure sensor circuits at the harness connector of the ECM (pins 91 and 95 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11

Step	Action	Value(s)	Yes	No
10	Replace the boost pressure sensor. Refer to Boost Pressure Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 13
13	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0238 (Flash Code 32)

Circuit Description

The boost pressure sensor is located in the air induction tubing. The boost pressure sensor is a transducer that varies voltage according to changes in the air pressure inside the air tubing. The boost pressure sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- Boost pressure sensor signal circuit

The engine control module (ECM) supplies 5 volts to the boost pressure sensor on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The boost pressure sensor provides a signal to the ECM on the boost pressure signal circuit which is relative to the pressure changes in the manifold. The ECM should detect a low signal voltage at a low boost pressure, such as low engine load. The ECM should detect high signal voltage at a high boost pressure, such as high engine load. The ECM monitors the boost pressure sensor signal for voltage outside the normal range of the boost pressure sensor. If the ECM detects an excessively high boost pressure sensor signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1634 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the boost pressure sensor signal voltage is more than 4.9 volts for 5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses a boost pressure substitution of 100 kPa (14.5 psi) for engine control.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0238 (Flash Code 32)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Observe the Boost Pressure Sensor parameter with the Tech 2. Is the Boost Pressure Sensor parameter more than the specified value?	4.9 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Start the engine. 2. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1634 also set?	—	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Disconnect the boost pressure sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Boost Pressure Sensor parameter with the Tech 2. Is the Boost Pressure Sensor parameter less than the specified value?	0.1 volts	Go to DTC P1634	Go to Step 7

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Disconnect the boost pressure sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Boost Pressure Sensor parameter with the Tech 2. Is the Boost Pressure Sensor parameter less than the specified value?	0.1 volts	Go to Step 6	Go to Step 7
6	1. Turn OFF the ignition. 2. Connect a test lamp between the low reference circuit of the boost pressure sensor harness (pin 1 of J-216 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 8
7	**Important:** The boost pressure sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the engine control module (ECM) (pin 91 of E-111 connector) and the boost pressure sensor (pin 2 of J-216 connector) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the low reference circuit between the ECM (pin 109 of E-111 connector) and the boost pressure sensor (pin 1 of J-216 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
9	1. Turn OFF the ignition. 2. Inspect for an intermittent and for a poor connection at the harness connector of the boost pressure sensor (pin 1 of J-216 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the boost pressure sensor circuit at the harness connector of the ECM (pin 109 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the boost pressure sensor. Refer to Boost Pressure Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—

Step	Action	Value(s)	Yes	No
12	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0335 (Flash Code 15)

Circuit Description

The crankshaft position (CKP) sensor is located on top of the flywheel housing. There are 56 notches spaced 6° apart and a 30° section that is open span. This open span portion allows for the detection of cylinder #1 top dead center (TDC). The CKP sensor is a magnetic coil type sensor, which generates an AC signal voltage based on the crankshaft rotational speed. The engine control module (ECM) monitors both the CKP sensor and camshaft position (CMP) sensor signals to ensure they correlate with each other. If the ECM receives a certain amount of CMP sensor signal pulses without a CKP sensor signal, this DTC will set.

Condition for Running the DTC

- DTCs P0336, P0340, P0341 and P1345 are not set.
- The ignition switch is ON.
- The CMP sensor signal pulse is detected.

Condition for Setting the DTC

- The ECM detects that the CKP sensor pulses are not generated during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Ensure the sensor is tight and the flywheel teeth are not damaged.

DTC P0335 (Flash Code 15)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine (Note a slight start delay may be noticed). 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the crankshaft position (CKP) sensor harness connector. 3. Connect a DMM across the CKP sensor terminals. 4. Measure the resistance across the CKP sensor. Does the CKP sensor resistance measure within the specified range?	105 – 145 Ω	Go to Step 4	Go to Step 13
4	1. Connect a DMM across the CKP sensor terminals (measure sensor output voltage). 2. Place the DMM on the AC volt scale. 3. Start the engine. 4. Monitor the DMM while accelerating the engine between idle and W.O.T. (accelerator pedal full travel). Does the DMM indicate an AC voltage increase in accordance with an engine speed increase?	—	Go to Step 5	Go to Step 10

Step	Action	Value(s)	Yes	No
5	1. Turn ON the ignition, with the engine OFF. 2. Connect a DMM between the CKP sensor harness (pin 1 of E-98 connector) and a known good ground. 3. Connect a DMM between the CKP sensor harness (pin 2 of E-98 connector) and a known good ground. Is each DMM voltage within the specified value?	0.4 – 1.4 volts	Go to Step 7	Go to Step 6
6	Is the DMM voltage more than the specified value at Step 5?	—	Go to Step 9	Go to Step 8
7	1. Test the CKP sensor circuits between the engine control module (ECM) (pins 106 and 107 of E-111 connector) and CKP sensor (pins 1 and 2 of E-98 connector) for a short to each other. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 11
8	1. Test the CKP sensor circuits between the ECM (pins 106 and 107 of E-111 connector) and CKP sensor (pins 1 and 2 of E-98 connector) for the following conditions: • An open circuit • A short to ground • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12
9	1. Test the CKP sensor circuits between the ECM (pins 106 and 107 of E-111 connector) and CKP sensor (pins 1 and 2 of E-98 connector) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
10	1. Inspect the CKP sensor for tightness. Retest if the sensor was loose. 2. Remove the CKP sensor and check for damage, metal particles on magnet and for flywheel teeth damage. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
11	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the CKP sensor (pins 1 and 2 of E-98 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14

Step	Action	Value(s)	Yes	No
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the CKP sensor circuits at the harness connector of the ECM (pins 106 and 107 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
13	Replace the CKP sensor. Refer to Crankshaft Position (CKP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0336 (Flash Code 15)

Circuit Description

The crankshaft position (CKP) sensor is located on top of the flywheel housing. There are 56 notches spaced 6° apart and a 30° section that is open span. This open span portion allows for the detection of cylinder #1 top dead center (TDC). The CKP sensor is a magnetic coil type sensor, which generates an AC signal voltage based on the crankshaft rotational speed. The engine control module (ECM) monitors both the CKP sensor and camshaft position (CMP) sensor signals to ensure they correlate with each other. If the ECM receives extra or missing CKP sensor signal pulses, this DTC will set.

Condition for Running the DTC

- DTCs P0335, P0340, P0341 and P1345 are not set.
- The ignition switch is ON.
- The CKP sensor signal is detected.

Condition for Setting the DTC

- The ECM detects extra or missing CKP sensor pulses during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- An intermittent CKP sensor signal may set this DTC.
- Ensure the sensor is tight and the flywheel teeth are not damaged.

DTC P0336 (Flash Code 15)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0335 also set?	—	Go to DTC P0335	Go to Step 3
3	1. Inspect all of the circuits going to the crankshaft position (CKP) sensor for the following: • Routed too closely to fuel injection wiring or components • Routed too closely to after-market add-on electrical equipment • Routed too closely to solenoids, relays, and motors 2. If you find incorrect routing, correct the harness routing. Did you find and correct the condition?	—	Go to Step 9	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the CKP sensor harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the CKP sensor (pins 1 and 2 of E-98 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) harness connector. 3. Inspect for an intermittent and for a poor connection on these CKP sensor circuits at the harness connector of the ECM (pins 106, 107 and 108 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 6
6	1. Remove the CKP sensor. Refer to Crankshaft Position (CKP) Sensor Replacement in this section. 2. Visually inspect the CKP sensor for the following conditions: • Physical damage • Loose or improper installation 3. The following conditions may cause this DTC to set: • Excessive air gap between the CKP sensor and the sensor rotor • Electromagnetic interference in the CKP sensor circuits • Foreign material passing between the CKP sensor and the sensor rotor Did you find and correct the condition?	—	Go to Step 9	Go to Step 7
7	Inspect the CKP sensor rotor for the following conditions: • Physical damage • Improper installation Refer to Flywheel Replacement in Engine Mechanical section. Did you find and correct the condition?	—	Go to Step 9	Go to Step 8
8	Replace the CKP sensor. Refer to Crankshaft Position (CKP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 9	—
9	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 10
10	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0340 (Flash Code 14)

Circuit Description

The camshaft position (CMP) sensor is installed on the cylinder head at the rear of the camshaft gear. The CMP sensor has the following circuits.

- 12 volts reference circuit
- CMP sensor signal circuit
- CMP sensor shield circuit

The engine control module (ECM) supplies 12 volts to the CMP sensor on the 12 volts reference circuit. The CMP sensor provides a signal to the ECM on the CMP signal circuit. The CMP sensor detects a total of five through holes (four holes arranged equally every 90° and one reference hole on the camshaft gear flange surface) and sends signals to the engine control module (ECM). Receiving these signals, the ECM determines cylinder #1 compression top dead center (TDC). If the ECM detects that CMP sensor signals are not generated, this DTC will set.

Condition for Running the DTC

- DTCs P0335, P0336, P0341 and P1345 are not set.
- The ignition switch is ON.
- The crankshaft position (CKP) sensor signal pulse is detected.

Condition for Setting the DTC

- The ECM detects that the CMP sensor pulses are not generated during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Ensure the sensor is tight and the camshaft gear flange surface is not damaged.

Notice:

- If this DTC is set, the engine cranks but does not start.

Test Description

The numbers below refers to the step number on the diagnostic table.
6. If the CMP sensor signal circuit between the ECM and the sensor is shorted to ground or shield circuit, the voltage reading on the DMM indicates same level as battery.

DTC P0340 (Flash Code 14)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. If engine does not start, crank over the engine for 10 seconds. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the camshaft position (CMP) sensor harness connector. 3. Connect a DMM between the 12 volts reference circuit (pin 3 of E-112 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the DMM voltage indicate within the specified value?	11 – 13 volts	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	Is the DMM voltage more than the specified value at Step 3?	—	Go to Step 9	Go to Step 8
5	1. Turn OFF the ignition. 2. Connect a DMM between the signal circuit (pin 2 of E-112 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	22 volts	Go to Step 6	Go to Step 10
6	1. Turn OFF the ignition. 2. Connect a test lamp between the signal circuit (pin 2 of E-112 connector) and battery voltage. 3. Connect a DMM between the probe of the test lamp and battery voltage. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	22 volts	Go to Step 11	Go to Step 7
7	1. Turn OFF the ignition. 2. Connect a test lamp between the shield circuit (pin 1 of E-112 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 13	Go to Step 12
8	1. Test the CMP sensor 12 reference circuit between the engine control module (ECM) (pin 99 of E-111 connector) and the CMP sensor (pin 3 of E-112 connector) for the following conditions: • An open circuit • A short to ground • A short to any 5 volts reference • A short to the signal circuit • A short to the shield circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 14
9	1. Test the CMP sensor 12 volts reference circuit between the ECM (pin 99 of E-111 connector) and the CMP sensor (pin 3 of E-112 connector) for short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18

Step	Action	Value(s)	Yes	No
10	**Important:** The CMP sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the CMP sensor signal circuit between the ECM (pin 98 of E-111 connector) and the CMP sensor (pin 2 of E-112 connector) for the following conditions: • An open circuit • A short to battery or ignition voltage • A short to any 5 volts reference • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 14
11	1. Test the CMP sensor signal circuit between the ECM (pin 98 of E-111 connector) and the CMP sensor (pin 2 of E-112 connector) for a short to ground or short to the shield circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
12	**Important:** The ECM may be damaged if the sensor shield circuit is shorted to a voltage source. 1. Test the CMP sensor shield circuit between the ECM (pin 100 of E-111 connector) and the CMP sensor (pin 1 of E-112 connector) for the following conditions: • An open circuit • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 14
13	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the CMP sensor (pins 1, 2 and 3 of E-112 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 15
14	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on these CMP sensor circuits at the harness connector of the ECM (pins 98, 99 and 100 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18

Step	Action	Value(s)	Yes	No
15	1. Remove the CMP sensor. Refer to Camshaft Position (CMP) Sensor Replacement in this section. 2. Visually inspect the CMP sensor for the following conditions: • For physical damage • For being loose • For improper installation Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
16	Visually inspect the camshaft gear surface for damage. Did you find and correct the condition?	—	Go to Step 19	Go to Step 17
17	Replace the CMP sensor. Refer to Camshaft Position (CMP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 19	—
18	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 19	—
19	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. If engine does not start, crank over the engine for 10 seconds. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 20
20	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0341 (Flash Code 14)

Circuit Description

The camshaft position (CMP) sensor is installed on the cylinder head at the rear of the camshaft gear. The CMP sensor has the following circuits.

- 12 volts reference circuit
- CMP sensor signal circuit
- CMP sensor shield circuit

The engine control module (ECM) supplies 12 volts to the CMP sensor on the 12 volts reference circuit. The CMP sensor provides a signal to the ECM on the CMP signal circuit. The CMP sensor detects a total of five through holes (four holes arranged equally every 90° and one reference hole on the camshaft gear flange surface) and sends signals to the engine control module (ECM). Receiving these signals, the ECM determines cylinder #1 compression top dead center (TDC). If the ECM receives extra or missing CMP sensor signal pulses, this DTC will set.

Condition for Running the DTC

- DTCs P0335, P0336, P0340 and P1345 are not set.
- The ignition switch is ON.
- The CMP sensor signal pulse is detected.

Condition for Setting the DTC

- The ECM detects extra or missing CMP sensor pulses during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- An intermittent CMP sensor signal may set this DTC.
- Ensure the sensor is tight and the camshaft gear flange surface is not damaged.

Notice:

- If this DTC is set, the engine cranks but does not start.

DTC P0341 (Flash Code 14)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. If engine does not start, crank over the engine for 10 seconds. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0340 also set?	—	Go to DTC P0340	Go to Step 3
3	1. Inspect all of the circuits going to the camshaft position (CMP) sensor for the following: • Routed too closely to fuel injection wiring or components • Routed too closely to after-market add-on electrical equipment • Routed too closely to solenoids, relays, and motors 2. If you find incorrect routing, correct the harness routing. Did you find and correct the condition?	—	Go to Step 9	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the CMP sensor harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the CMP sensor (pins 1, 2 and 3 of E-112 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) harness connector. 3. Inspect for an intermittent and for a poor connection on these CMP sensor circuit at the harness connector of the ECM (pins 98, 99 and 100 of E-111 connector). Did you find and correct the condition?	—	Go to Step 9	Go to Step 6
6	1. Remove the CMP sensor. Refer to Camshaft Position (CMP) Sensor Replacement in this section. 2. Visually inspect the CMP sensor for the following conditions: • Physical damage • Loose or improper installation 3. The following conditions may cause this DTC to set: • Excessive air gap between the CMP sensor and the camshaft gear surface (sensor rotor) • Electromagnetic interference in the CMP sensor circuits • Foreign material passing between the CMP sensor and the camshaft gear surface (sensor rotor) Did you find and correct the condition?	—	Go to Step 9	Go to Step 7
7	Inspect the camshaft gear surface (CMP sensor rotor) for physical damage. Did you find and correct the condition?	—	Go to Step 9	Go to Step 8
8	Replace the CMP sensor. Refer to Camshaft Position (CMP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 9	—
9	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. If engine does not start, crank over the engine for 10 seconds. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 10
10	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0380 (Flash Code 66)

Circuit Description

The engine control module (ECM) controls the glow relay which supplies power to the glow plugs based on engine coolant temperature. In the after glow phase, the glow indicator light is not illuminated but glow plugs remain active for a certain period. If the ECM detects an open circuit or short circuit on the glow relay control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The battery voltage is between 16 – 32 volts.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects a low voltage condition on the glow relay control circuit when the relay is commanded OFF for longer than 5 seconds.
- The ECM detects a high voltage condition on the glow relay control circuit when the relay is commanded ON for longer than 5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The numbers below refers to the step number on the diagnostic table.
2. Listen for an audible click when the glow relay operates. Command both the ON and OFF states.
6. Tests if ground is constantly being applied to the glow relay.

DTC P0380 (Flash Code 66)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Perform the Glow Relay Test with the Tech 2. 4. Command the Glow Relay ON with the Tech 2. Does the glow relay click when commanded ON with the Tech 2?	—	Go to Step 3	Go to Step 4
3	1. Turn OFF the ignition for 30 seconds. 2. Turn ON the ignition, with the engine OFF. 3. Disconnect the engine coolant temperature (ECT) sensor harness connector in order to gain glow ON time long enough. 4. Turn ON the ignition for 30 seconds while observing the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 11	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Replace the glow relay with the starter relay or replace with a known good relay. 3. Turn ON the ignition, with the engine OFF. 4. Perform the Glow Relay Test with the Tech 2. 5. Command the Glow Relay ON with the Tech 2. Does the glow relay click when commanded ON with the Tech 2?	—	Go to Step 8	Go to Step 5
5	1. Turn OFF the ignition. 2. Remove the glow relay. 3. Turn ON the ignition, with the engine OFF. 4. Probe the voltage feed circuit of the glow relay coil side (pin 4 of X-20 connector) with a test lamp that is connected to a known good ground. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 7
6	1. Test the control circuit of glow relay between the engine control module (ECM) (pin 10 of J-191 connector) and the glow relay (pin 5 of X-20 connector) for the following conditions: • An open circuit • A short to ground • A short to battery or ignition voltage 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
7	Repair the open circuit or high resistance on the voltage feed circuit between the ENG (10A) fuse and the glow relay coil side (pin 4 of X-20 connector). Check the ENG (IG) (10 A) fuse first. Did you complete the repair?	—	Go to Step 12	—
8	1. Turn OFF the ignition. 2. Remove the glow relay. 3. Inspect for an intermittent and for a poor connection on each glow plug relay terminal. 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the glow relay circuit at the harness connector of the ECM (pin 10 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
10	Replace the glow relay. Did you complete the replacement?	—	Go to Step 12	—

Step	Action	Value(s)	Yes	No
11	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected fuse, relay or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Disconnect the ECT sensor harness connector in order to gain glow ON time long enough. 5. Turn ON the ignition for 30 seconds while observing the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 13
13	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0381 (Flash Code 67)

Circuit Description

The glow indicator lamp is located on the instrument panel cluster (IPC). The glow control system is operated when the engine coolant temperature is low, which allows easier engine starting. If the ignition switch is turned ON when the engine coolant temperature is low, the engine control module (ECM) illuminates the glow indicator lamp and turns ON the glow plugs. After a fixed time passes, the ECM turns OFF the glow indicator lamp and the glow plugs. The ECM monitors the glow indicator lamp control circuit for conditions that are incorrect for the commanded state of the glow indicator lamp. For example, a failure condition exists if the ECM detects low voltage when the glow indicator lamp is commanded OFF, or high voltage when the glow indicator lamp is commanded ON. If the ECM detects an improper voltage on the glow indicator control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects a low voltage condition on the glow indicator lamp control circuit when the indicator is commanded OFF for longer than 5 seconds.
- The ECM detects a high voltage condition on the glow indicator lamp control circuit when the indicator is commanded ON for longer than 5 seconds.

Action Taken When the DTC Sets

- The ECM does not illuminate the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the DTC

- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0381 (Flash Code 67)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Verify whether the instrument cluster is operational. If the instrument panel cluster (IPC) is completely inoperative, refer to Diagnostic System Check. 2. Turn OFF the ignition for 30 seconds. 3. Disconnect the engine coolant temperature (ECT) sensor harness connector in order to gain glow ON time long enough. 4. Turn ON the ignition for 20 seconds while observing the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Inspect the Meter (10A) fuse in the glove box. Is the Meter (10A) fuse open?	—	Go to Step 4	Go to Step 5
4	Replace the Meter (10A) fuse. If the fuse continues to open, repair the short to ground on one of the circuits that is fed by the Meter (10A) fuse or replace the shorted attached component fed by the Meter (10A) fuse. Did you complete the repair?	—	Go to Step 19	—

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) J-191 harness connector. 3. Turn ON the ignition, with the engine OFF. Is the glow indicator lamp OFF?	—	Go to Step 6	Go to Step 13
6	1. Remove the Meter (10A) fuse that supplies voltage to the glow indicator lamp. 2. Turn ON the ignition, with the engine OFF. 3. Measure the voltage from the glow indicator lamp control circuit in the ECM harness connector (pin 11 of J-191 connector) to a good ground. Is the voltage less than the specified value?	1 volt	Go to Step 7	Go to Step 14
7	1. Turn OFF the ignition. 2. Install the Meter (10A) fuse that supplies ignition voltage to the glow indicator lamp. 3. Turn ON the ignition, with the engine OFF. 4. Connect a 3-amp fused jumper wire between the glow indicator lamp control circuit of the ECM harness connector (pin 11 of J-191 connector) and a known good ground. Is the glow indicator lamp illuminated?	—	Go to Step 12	Go to Step 8
8	1. Turn OFF the ignition. 2. Remove the IPC. 3. Remove the glow indicator lamp bulb from the IPC. Is the glow indicator bulb burned out?	—	Go to Step 16	Go to Step 9
9	1. Connect a test lamp between the glow indicator lamp ignition voltage circuit of the IPC harness connector (pin 18 of B-51 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 10	Go to Step 15
10	1. Test the glow indicator lamp control circuit between the ECM (pin 11 of J-191 connector) and the IPC (pin 15 of B-52 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 11
11	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the IPC (pins 18 of B-51 and 15 of B-52 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 17

Step	Action	Value(s)	Yes	No
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the glow indicator lamp control circuit at the harness connector of the ECM (pin 11 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
13	Repair the short to ground on the control circuit of the glow indicator lamp between the ECM (pin 11 of J-191 connector) and the IPC (pin 15 of B-52 connector). Did you complete the repair?	—	Go to Step 19	—
14	Repair the short to battery or ignition voltage on the control circuit of the glow indicator lamp between the ECM (pin 11 of J-191 connector) and the IPC (pin 15 of B-52 connector). Did you complete the repair?	—	Go to Step 19	—
15	Repair the open or high resistance on the ignition voltage circuit of the glow indicator lamp between the Meter (10A) fuse and the IPC (pin 18 of B-51 connector). Did you complete the repair?	—	Go to Step 19	—
16	Replace the glow indicator lamp bulb. Did you compete the replacement?	—	Go to Step 19	—
17	Repair or replace the IPC. Did you complete the repair or replacement?	—	Go to Step 19	—
18	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 19	—
19	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Disconnect the ECT sensor harness connector in order to gain glow ON time long enough. 5. Turn ON the ignition for 20 seconds while observing the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 20
20	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0485 (Flash Code 44)

Circuit Description

The exhaust gas recirculation (EGR) valve position sensor is installed on the EGR valve body together with the EGR valve control motor. The EGR valve position sensor changes output voltage according to EGR valve position. The EGR position sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- EGR valve position sensor signal circuit

The engine control module (ECM) supplies 5 volts to the EGR valve position sensor on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The EGR valve position sensor provides a signal to the ECM on the EGR valve position signal circuit, which is relative to the position changes of the EGR valve. The ECM monitors the EGR position sensor signals for voltage outside the normal range of the EGR position. If the ECM detects an excessively low EGR valve position signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1635 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the EGR valve position sensor signal voltage is less than 0.1 volts for 5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0485 (Flash Code 44)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1635 also set?	—	Go to DTC P1635	Go to Step 3
3	1. Start the engine. 2. Observe the EGR Position Sensor parameter with the Tech 2. Is the EGR Position Sensor parameter less than the specified value?	0.1 volts	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the EGR valve harness connector. 3. Connect a DMM between the 5 volts reference circuit of the EGR position sensor harness (pin 1 of E-94 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 5	Go to Step 6

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the 5 volts reference circuit and the signal circuit of the EGR valve position sensor harness (pins 1 and 3 of E-94 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the EGR Position Sensor parameter with the Tech 2. Is the EGR Position Sensor parameter more than specified value?	4.5 volts	Go to Step 8	Go to Step 7
6	1. Test the 5 volts reference circuit between the engine control module (ECM) (pin 87 of E-111 connector) and the EGR valve position sensor (pin 1 of E-94 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
7	1. Test the signal circuit between the ECM (pin 86 of E-111 connector) and the EGR valve position sensor (pin 3 of E-94 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Turn OFF the ignition. 2. Disconnect the EGR valve harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the EGR valve (pins 1 and 3 of E-94 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the EGR valve position sensor circuits at the harness connector of the ECM (pins 86 and 87 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
10	Replace the EGR valve. Refer to EGR Valve Replacement in this section. (EGR valve position sensor is internal to EGR valve) Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 12	—

Step	Action	Value(s)	Yes	No
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 13
13	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0486 (Flash Code 44)

Circuit Description

The exhaust gas recirculation (EGR) valve position sensor is installed on the EGR valve body together with the EGR valve control motor. The EGR valve position sensor changes output voltage according to EGR valve position. The EGR position sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- EGR valve position sensor signal circuit

The engine control module (ECM) supplies 5 volts to the EGR valve position sensor on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The EGR valve position sensor provides a signal to the ECM on the EGR valve position signal circuit, which is relative to the position changes of the EGR valve. The ECM monitors the EGR position sensor signals for voltage outside the normal range of the EGR position. If the ECM detects an excessively high EGR valve position signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1635 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the EGR valve position sensor signal voltage is more than 4.9 volts for 5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0486 (Flash Code 44)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Observe the EGR Position Sensor parameter with the Tech 2. Is the EGR Position Sensor parameter more than the specified valve?	4.9 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Start the engine. 2. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1635 also set?	—	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Disconnect the EGR valve harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the EGR Position Sensor parameter with the Tech 2. Is the DMM voltage less than the specified value?	0.1 volts	Go to DTC P1635	Go to Step 7

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Disconnect the EGR valve harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the EGR Position Sensor parameter with the Tech 2. Is the DMM voltage less than the specified value?	0.1 volts	Go to Step 6	Go to Step 7
6	1. Turn OFF the ignition. 2. Connect a test lamp between the low reference circuit of the EGR position sensor harness (pin 2 of E-94 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 8
7	**Important:** The EGR position sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the engine control module (ECM) (pin 86 of E-111 connector) and the EGR position sensor (pin 3 of E-94 connector) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the low reference circuit between the ECM (pin 101 of E-111 connector) and the EGR position sensor (pin 2 of E-94 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the EGR position sensor connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the EGR position sensor (pin 2 of E-94 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the EGR position sensor circuit at the harness connector of the ECM (pin 101 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the EGR valve. Refer to EGR Valve Replacement in this section. (EGR valve position sensor is internal to EGR valve) Did you complete the replacement?	—	Go to Step 13	—

Step	Action	Value(s)	Yes	No
12	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0488 (Flash Code 45)

Circuit Description

The engine control module (ECM) controls the EGR valve opening based on the barometric pressure, engine speed, engine coolant temperature and fuel injection quantity. The ECM controls the EGR valve by controlling the EGR motor. The EGR valve position is detected by the EGR valve position sensor, and relayed to ECM. If the ECM detects a variance between the actual EGR position and desired EGR position for a calibrated amount of time while the EGR valve is commanded open, this DTC will set.

Condition for Running the DTC

- DTCs P0485, P0486, P1630 and P1635 are not set.
- The ignition switch is ON.
- The battery voltage is between 20 – 32 volts.
- The ignition voltage is more than 18 volts.
- The desired EGR valve position is stable.

Condition for Setting the DTC

- The ECM detects a variance between the actual EGR valve position and desired valve position is more than 20% for longer than 20 seconds when the EGR solenoid command duty is more than 90%.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- A sticking or intermittently sticking EGR valve may set this DTC.

DTC P0488 (Flash Code 45)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0485 or P0486 set?	—	Go to Applicable DTC	Go to Step 3
3	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Perform the EGR Control test with the Tech 2 several times. 5. Command the Desired EGR Position “Increase” and “Decrease” with the Tech 2 while observing the EGR Position Variance. Does the EGR Position Variance parameter follow within the specified value?	± 5%	Go to Diagnostic Aids	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition for 30 seconds. 2. Disconnect the EGR valve harness connector. 3. Connect a test lamp between the EGR valve motor voltage feed circuit (pin 4 of E-94 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp blink then go out?	—	Go to Step 6	Go to Step 5
5	Does the test lamp continuously illuminate at Step 4?	—	Go to Step 10	Go to Step 9
6	1. Turn OFF the ignition for 30 seconds. 2. Connect a test lamp between the EGR valve duty signal circuit (pin 6 of E-94 connector) and a known good ground. 3. Turn ON the ignition, with the engine OFF. Does the test lamp blink then go out (note that the test lamp will not blink normally)?	—	Go to Step 14	Go to Step 7
7	Does the test lamp continuously illuminate at Step 6?	—	Go to Step 11	Go to Step 8
8	1. Turn OFF the ignition. 2. Connect a test lamp between the EGR valve duty signal circuit (pin 6 of E-94 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 12	Go to Step 13
9	1. Test the EGR valve motor voltage feed circuit between the engine control module (ECM) (pin 111 of E-111 connector) and the EGR valve (pin 4 of E-94 connector) for the following conditions: • An open circuit • A short to ground • A short to the EGR valve position sensor low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 16
10	1. Test the EGR valve motor voltage feed circuit between the ECM (pin 111 of E-111 connector) and the EGR valve (pin 4 of E-94 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 19
11	1. Test the EGR valve motor duty signal circuit between the ECM (pin 103 of E-111 connector) and the EGR valve (pin 6 of E-94 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 19

Step	Action	Value(s)	Yes	No
12	1. Test the EGR valve motor duty signal circuit between the ECM (pin 103 of E-111 connector) and the EGR valve (pin 6 of E-94 connector) for the following conditions: • A short to ground • A short to the EGR valve position sensor low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 19
13	1. Test the EGR valve motor duty signal circuit between the ECM (pin 103 of E-111 connector) and the EGR valve (pin 6 of E-94 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 15
14	1. Test the EGR valve motor voltage feed circuit and motor duty signal circuit between the ECM (pins 103 and 111 of E-111 connector) and the EGR valve (pins 4 and 6 of E-94 connector) for a short circuit each other. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 19
15	1. Turn OFF the ignition. 2. Disconnect the EGR valve harness connector. 3. Inspect for an intermittent and for poor connections at the EGR valve harness connector (pins 4 and 6 of E-94 connector). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent and for a poor connection on the EGR valve motor duty signal circuit at the harness connector of the ECM (pin 103 of E-111 connector). 6. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 17
16	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the EGR valve motor voltage feed circuit at the harness connector of the ECM (pin 111 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 19
17	Replace the EGR valve. Refer to EGR Valve Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—

Step	Action	Value(s)	Yes	No
18	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Perform the EGR Control test with the Tech 2 several times. 6. Command the Desired EGR Position “Increase” and “Decrease” with the Tech 2 while observing the EGR Position Variance. Does the EGR Position Variance parameter follow within the specified value?	± 5%	Go to Step 20	Go to Step 19
19	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 20	—
20	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 21
21	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0500 (Flash Code 25)

Circuit Description

The vehicle speed sensor (VSS) is used by the engine control module (ECM) and speedometer, which generates a speed signal from the transmission output shaft. The VSS has the following circuits.

- Ignition voltage feed circuit
- VSS signal circuit
- VSS low reference circuit

The VSS uses a hall effect element. It interacts with the magnetic field created by the rotating magnet and outputs square wave pulse signal. The ECM calculates the vehicle speed by the VSS. If the ECM detects VSS signals are not generated, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 18 volts.
- The engine speed is more than 2000 RPM.
- The commanded fuel is OFF (accelerator pedal is released).

Condition for Setting the DTC

- The ECM detects that the VSS signals are not generated for 5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Electrical or magnetic interference may affect intermittent condition.

DTC P0500 (Flash Code 25)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Drive the vehicle. 3. Observe the Vehicle Speed parameter with the Tech 2. Does the Vehicle Speed parameter indicate correct vehicle speed?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Inspect the Meter (10A) fuse in the glove box fuse block. Is the Meter (10A) fuse open?	—	Go to Step 4	Go to Step 5
4	Replace the Meter (10A) fuse. If the fuse continues to open, repair the short to ground on one of the circuits that fed by the Meter (10A) fuse or replace the shorted attached component fed by the Meter (10A) fuse. Did you complete the repair?	—	Go to Step 16	—

Step	Action	Value(s)	Yes	No
5	1. Remove the vehicle speed sensor (VSS). Refer to Vehicle Speed Sensor (VSS) replacement in this section. 2. Visually inspect the VSS for the following conditions: • Physical damage • Being loose • Improper installation • For transmission output shaft teeth damage 3. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 6
6	1. Turn OFF the ignition. 2. Disconnect the VSS harness connector. 3. Connect a test lamp between the ignition voltage feed circuit of the VSS harness (pin 1 of J-32 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 7	Go to Step 9
7	1. Keep the ignition switch ON. 2. Connect a test lamp between the low reference circuit of the VSS harness (pin 2 of J-32 connector) and battery voltage. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 10
8	1. Turn ON the ignition, with the engine OFF. 2. Intermittently jump the signal circuit of the VSS (pin 3 of J-32 connector) with a test lamp that is connected to 12 volts (apply from a battery) while monitoring the Vehicle Speed parameter with the Tech 2. Does the Tech 2 indicate any vehicle speed when the circuit is intermittently pulled to 12 volts?	—	Go to Step 12	Go to Step 11
9	Repair the open circuit or high resistance on the VSS ignition voltage feed circuit between the VSS (pin 1 of J-32 connector) and the Meter (10A) fuse. Did you complete the repair?	—	Go to Step 16	—
10	Repair the open or high resistance in the VSS low reference circuit between the VSS (pin 2 of J-32 connector) and ground terminal (B-1). Did you complete the repair?	—	Go to Step 16	—

Step	Action	Value(s)	Yes	No
11	1. Test the VSS signal circuit between the engine control module (ECM) (pin 19 of J-191 connector) and the VSS (pin 3 of J-32 connector), then between the instrument panel cluster (IPC) (pin 17 of B-52 connector) and the VSS (pin 3 of J-32 connector) for the following conditions: • An open circuit • A short to ground • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 13
12	1. Turn OFF the ignition. 2. Disconnect the VSS harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the VSS (pins 1, 2 and 3 of J-32 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 14
13	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the VSS signal circuit at the harness connector of the ECM (pin 19 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 15
14	Replace the VSS. Refer to Vehicle Speed Sensor (VSS) Replacement in this section. Did you complete the replacement?	—	Go to Step 16	—
15	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 16	—
16	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Drive the vehicle. 5. Observe the Vehicle Speed parameter with the Tech 2. Does the Vehicle Speed parameter indicate correct vehicle speed?	—	Go to Step 17	Go to Step 3
17	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0501 (Flash Code 25)

Circuit Description

The vehicle speed sensor (VSS) is used by the engine control module (ECM) and speedometer, which generates a speed signal from the transmission output shaft. The VSS has the following circuits.

- Ignition voltage feed circuit
- VSS signal circuit
- VSS low reference circuit

The VSS uses a hall effect element. It interacts with the magnetic field created by the rotating magnet and outputs square wave pulse signal. The ECM calculates the vehicle speed by the VSS. If the ECM detects VSS signals are changed sharply, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the VSS signal are changed larger than a predetermined vehicle speed.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Electrical or magnetic interference may affect intermittent condition.

DTC P0501 (Flash Code 25)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Inspect all of the circuits going to the vehicle speed sensor (VSS) for the following: • Routed too closely to fuel injection wiring or components • Routed too closely to after-market add-on electrical equipment • Routed too closely to solenoids, relays, and motors 2. If you find incorrect routing, correct the harness routing. Did you find and correct the condition?	—	Go to Step 7	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the VSS harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the VSS (pins 1, 2 and 3 of J-32 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) harness connector. 3. Inspect for an intermittent and for a poor connection on VSS circuit at the harness connector of the ECM (pin 19 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 5
5	1. Remove the VSS. Refer to Vehicle Speed Sensor (VSS) Replacement in this section. 2. Visually inspect the VSS for the following conditions: • Physical damage • Being loose • Improper installation 3. The following conditions may cause this DTC to set: • Electromagnetic interference in the VSS circuits 4. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
6	Replace the VSS. Refer to Vehicle Speed Sensor (VSS) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Drive the vehicle. 5. Observe the Vehicle Speed parameter with the Tech 2. Does the Vehicle Speed parameter indicate correct vehicle speed?	—	Go to Step 8	Go to Step 2
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0601 (Flash Code 53)

Circuit Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM).

Condition for Setting the MIL / DTC

- The ECM detects a malfunction in its internal flash read only memory (ROM).

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM stops engine running.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail at next ignition cycle.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If this DTC is present, the engine cranks but does not start.

DTC P0601 (Flash Code 53)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. If engine does not start, crank over the engine for 10 seconds. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0603 (Flash Code 54)

Circuit Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM).

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects a malfunction in its internal electrically erasable & programmable read only memory (EEPROM).
- The ECM detects that the calculated checksum does not agree with the ECM internal registered checksum.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

DTC P0603 (Flash Code 54)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0606 (Flash Code 51, 52)

Circuit Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM).

Condition for Running the DTC

- The ignition switch is ON.
- The battery voltage is more than 16 volts.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects a malfunction in its internal main central processing unit (CPU). (Flash Code 51)
- The ECM detects a malfunction in its internal sub CPU. (Flash Code 52)

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

DTC P0606 (Flash Code 51, 52)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
3	1. Test each ground circuit between the engine control module (ECM) (pins 1, 3, 4, 43, 62 and 81 of J-191 connector) and the chassis ground terminal (J-9) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 4
4	1. Turn OFF the ignition. 2. Inspect for an intermittent, for poor tightening and corrosion at the chassis ground terminal (J-9). 3. Repair the tightening or clean the corrosion as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 5
5	1. Test each ECM main relay voltage feed circuit between the ECM (pins 2 and 5 of J-191 connector) and the ECM main relay (pin 2 of X-18 connector) for high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM 1, 2, 3, 4, 5, 43, 62 and 81 of J-191 connector. 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected relay or harness connector(s). 2. Clear the DTCs with he Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 9
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0611 (Flash Code 34)

Circuit Description

The charge up circuit in the engine control module (ECM) steps up the voltage for fuel injectors and is divided into two banks, common 1 and 2. The common 1 covers fuel injectors in cylinders 1 and 4, and the common 2 covers fuel injectors in cylinders 2 and 3. If the common 1 fuel injector charge up voltage circuit in the ECM is excessively low, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The battery voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the common 1 fuel injector charge up circuit is insufficient charge.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0611 (Flash Code 34)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
3	1. Test each ground circuit between the engine control module (ECM) (pins 1, 3, 4, 43, 62 and 81 of J-191 connector) and the chassis ground terminal (J-9) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 4
4	1. Turn OFF the ignition. 2. Inspect for an intermittent, for poor tightening and corrosion at the chassis ground terminal (J-9). 3. Repair the tightening or clean the corrosion as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 5
5	1. Test each ECM main relay voltage feed circuit between the ECM (pins 2 and 5 of J-191 connector) and the ECM main relay (pin 2 of X-18 connector) for high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM 1, 2, 3, 4, 5, 43, 62 and 81 of J-191 connector. 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected relay or harness connector(s). 2. Clear the DTCs with he Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 9
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0612 (Flash Code 34)

Circuit Description

The charge up circuit in the engine control module (ECM) steps up the voltage for fuel injectors and is divided into two banks, common 1 and 2. The common 1 covers fuel injectors in cylinders 1 and 4, and the common 2 covers fuel injectors in cylinders 2 and 3. If the common 2 fuel injector charge up voltage circuit in the ECM is excessively low, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The battery voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the common 2 fuel injector charge up circuit is insufficient charge.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0612 (Flash Code 34)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
3	1. Test each ground circuit between the engine control module (ECM) (pins 1, 3, 4, 43, 62 and 81 of J-191 connector) and the chassis ground terminal (J-9) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 4
4	1. Turn OFF the ignition. 2. Inspect for an intermittent, for poor tightening and corrosion at the chassis ground terminal (J-9). 3. Repair the tightening or clean the corrosion as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 5
5	1. Test each ECM main relay voltage feed circuit between the ECM (pins 2 and 5 of J-191 connector) and the ECM main relay (pin 2 of X-18 connector) for high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM 1, 2, 3, 4, 5, 43, 62 and 81 of J-191 connector. 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected relay or harness connector(s). 2. Clear the DTCs with he Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 9
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0615 (Flash Code 19)

Circuit Description

The engine control module (ECM) controls the starter cut relay which de-energizes the starter relay based on engine speed inputs. The starter cut relay uses normally close type relay. During engine stopping, the relay is closed to allow grounding the starter relay. Once engine run, the ECM energizes the starter cut relay to open the starter relay circuit and starter motor is cut even the ignition is positioned at START. If the ECM detects an improper voltage on the starter cut relay control circuit, this DTC will set. This diagnostic only applies manual transmission model.

Condition for Running the DTC

- The ignition switch is ON.
- The battery voltage is between 16 – 32 volts.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects a low voltage condition on the starter cut relay control circuit when the relay is commanded OFF for longer than 10 seconds.
- The ECM detects a high voltage condition on the starter cut relay control circuit when the relay is commanded ON for longer than 10 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0615 (Flash Code 19)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. DO NOT start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 4	Go to Step 3
3	1. Start the engine. 2. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 8	Go to Diagnostic Aids
4	Start the engine. Does the engine start?	—	Go to Step 6	Go to Step 5
5	1. Turn OFF the ignition. 2. Replace the starter cut relay with the marker lamp relay or replace with a known good relay. 3. Start the engine. Does the engine start?	—	Go to Step 14	Go to Step 9

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Remove the starter cut relay. 3. Connect a test lamp between the starter cut relay voltage feed circuit (pin 3 of X-26 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 7	Go to Step 10
7	1. Reinstall the starter cut relay. 2. Start the engine. 3. Disconnect the starter cut relay. 4. Connect a test lamp between the starter cut relay control circuit (pin 5 of X-26 connector) and battery voltage. Does the test lamp illuminate?	—	Go to Step 12	Go to Step 11
8	1. Test the starter cut relay control circuit between the engine control module (ECM) (pin 14 of J-191 connector) and the starter cut relay (pin 5 of X-26 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 15
9	1. Test the starter cut relay control circuit between the ECM (pin 14 of J-191 connector) and the starter cut relay (pin 5 of X-26 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 15
10	Repair the open circuit or high resistance on the voltage feed circuit between the ECM (10A) fuse and the starter cut relay (pin 3 of X-26 connector). Check the ECM (10A) fuse first. Did you complete the repair?	—	Go to Step 16	—
11	1. Test the starter cut relay control circuit between the ECM (pin 14 of J-191 connector) and the starter cut relay (pin 5 of X-26 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 13
12	1. Turn OFF the ignition. 2. Remove the starter cut relay. 3. Inspect for an intermittent and for a poor connection on each starter cut relay terminal. 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 14

Step	Action	Value(s)	Yes	No
13	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the starter cut relay circuit at the harness connector of the ECM (pin 14 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 15
14	Replace the starter cut relay. Did you complete the replacement?	—	Go to Step 16	—
15	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 16	—
16	1. Reconnect all previously disconnected fuse, relay or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition for 5 seconds. 5. Start the engine. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 17
17	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0650 (Flash Code 77)

Circuit Description

The malfunction indicator lamp (MIL) is located on the instrument panel cluster (IPC). The MIL informs the driver that an emission system or a performance related fault has occurred and that the engine control system requires service. The engine control module (ECM) monitors the MIL control circuit for conditions that are incorrect for the commanded state of the MIL. For example, a failure condition exists if the ECM detects low voltage when the MIL is commanded OFF, or high voltage when the MIL is commanded ON. If the ECM detects an improper voltage on the MIL control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects a low voltage condition on the MIL control circuit when the indicator is commanded OFF for longer than 3 seconds.
- The ECM detects a high voltage condition on the MIL control circuit when the indicator is commanded ON for longer than 3 seconds.

Action Taken When the DTC Sets

- The ECM does not illuminate the MIL when the diagnostic runs and fails.

Condition for Clearing the DTC

- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0650 (Flash Code 77)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Verify whether the instrument cluster is operational. If the instrument panel cluster (IPC) is completely inoperative, refer to Diagnostic System Check. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition for 30 seconds while observing the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Inspect the Meter (10A) fuse in the glove box. Is the Meter (10A) fuse open?	—	Go to Step 4	Go to Step 5
4	Replace the Meter (10A) fuse. If the fuse continues to open, repair the short to ground on one of the circuits that is fed by the Meter (10A) fuse or replace the shorted attached component fed by the Meter (10A) fuse. Did you complete the repair?	—	Go to Step 19	—
5	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) J-191 harness connector. 3. Turn ON the ignition, with the engine OFF. Is the malfunction indicator lamp (MIL) OFF?	—	Go to Step 6	Go to Step 13

Step	Action	Value(s)	Yes	No
6	1. Remove the Meter (10A) fuse that supplies voltage to the MIL. 2. Turn ON the ignition, with the engine OFF. 3. Measure the voltage from the MIL control circuit in the ECM harness connector (pin 6 of J-191 connector) to a good ground. Is the voltage less than the specified value?	1 volt	Go to Step 7	Go to Step 14
7	1. Turn OFF the ignition. 2. Install the Meter (10A) fuse that supplies ignition voltage to the MIL. 3. Turn ON the ignition, with the engine OFF. 4. Connect a 3-amp fused jumper wire between the MIL control circuit of the ECM harness connector (pin 6 of J-191 connector) and a known good ground. Is the MIL illuminated?	—	Go to Step 12	Go to Step 8
8	1. Turn OFF the ignition. 2. Remove the IPC. 3. Remove the MIL bulb from the IPC. Is the MIL bulb burned out?	—	Go to Step 16	Go to Step 9
9	1. Connect a test lamp between the MIL ignition voltage circuit of the IPC harness connector (pin 18 of B-51 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 10	Go to Step 15
10	1. Test the MIL control circuit between the ECM (pin 6 of J-191 connector) and the IPC (pin 5 or 13 of B-51 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 11
11	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the IPC (pins 5 or 13 and 18 of B-51 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 17
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the MIL control circuit at the harness connector of the ECM (pin 6 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
13	Repair the short to ground on the control circuit of the MIL between the ECM (pin 6 of J-191 connector) and the IPC (pin 5 or 13 of B-51 connector). Did you complete the repair?	—	Go to Step 19	—

Step	Action	Value(s)	Yes	No
14	Repair the short to battery or ignition voltage on the control circuit of the MIL between the ECM (pin 6 of J-191 connector) and the IPC (pin 5 or 13 of B-51 connector). Did you complete the repair?	—	Go to Step 19	—
15	Repair the open or high resistance on the ignition voltage circuit of the MIL between the Meter (10A) fuse and the IPC (pin 18 of B-51 connector). Did you complete the repair?	—	Go to Step 19	—
16	Replace the MIL bulb. Did you compete the replacement?	—	Go to Step 19	—
17	Repair or replace the IPC. Did you complete the repair or replacement?	—	Go to Step 19	—
18	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 19	—
19	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition for 30 seconds while observing the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 20
20	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1093 (Flash Code 227)

Description

The common rail fuel system is comprised of two fuel pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the engine control module (ECM) using the fuel rail pressure (FRP) regulator dependant upon values from the FRP sensor attached to the fuel rail. In case of fuel rail overpressure, a pressure limiter valve threaded into the fuel rail will open to release overpressure and return fuel back to the fuel tank.
If the ECM detects that the fuel pressure is a certain pressure lower than the desired fuel rail pressure for a certain length of time, this DTC will set.

Condition for Running the DTC

- DTCs P0090, P0192, P0193, P0201 – P0204, P0611, P0612, P1095, P1261, P1262, P1630 and P1635 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.
- The FRP regulator command is less than 33% or commanded fuel supply is more than a predetermined value.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the differential fuel rail pressure is -10 MPa (-1,450 psi) for longer than 15 seconds when the engine speed is between 0 – 900 RPM.
- The ECM detects that the differential fuel rail pressure is -15 MPa (-2,170 psi) for longer than 15 seconds when the engine speed is higher than 1200 RPM.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- An intermittently sticking FRP regulator may have allowed the fuel pressure to become low enough to set this DTC.
- Normal FRP Sensor readings on the Tech 2 with the engine running in neutral at idle is around 1.4 – 1.6 volts.
- An intermittently sticking fuel injector may have allowed the fuel pressure to drop too much. Use the Tech 2 to perform the Injector Balancing test for each injector. Verify a consistent engine speed change when commanding each fuel injector ON and OFF.
- A skewed FRP sensor value (shifted to a lower pressure) can set this DTC. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes.

Notice:

- This DTC most likely indicates a loss of fuel pressure by a fuel leak from the high pressure side. Inspect the high pressure side fuel leakage between the fuel supply pump and fuel injector FIRST.

Notice:

- The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight or if there is a crack in one of the fuel hoses. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load, which may set this DTC.

Notice:

- If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted and this DTC may set. Perform bleeding of fuel system after refilling.

Test Description

The numbers below refers to the step number on the diagnostic table.
5. This step checks for a fuel restriction by determining if a high vacuum is being pulled on the fuel system during normal operation.
6. This step checks for an air leak on the suction side of the fuel system by determining if a vacuum can be pulled when a fuel line is plugged.

DTC P1093 (Flash Code 227)

Schematic Reference: Engine Controls Schematics

Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0090, P0192, P0193, P0201 – P0204, P1094, P1095, P1261 or P1262 set?	—	Go to Applicable DTC	Go to Step 3
3	1. Turn OFF the ignition. 2. Wait 2 minutes for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition with the engine OFF. DO NOT start the engine. 4. Observe the Fuel Rail Pressure (FRP) Sensor parameter with the Tech 2. Is the FRP Sensor parameter the specified value?	0.9 – 1.0 volt	Go to Step 4	Go to Step 11
4	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load, which may set this DTC. 3. Pump the priming pump on the fuel filter until it becomes firm. If there is a leak on the suction side of the fuel system between the priming pump and the fuel supply pump, the priming pump will not build up sufficient firmness and fuel leakage may occur. 4. Start the engine and check for high side fuel system leaks at the fuel supply pump and fuel rail. **Notice:** Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel leakage into the engine oil. 5. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Remove the rubber fuel hose from the fuel filter housing (fuel supply pump side). Use a pan to catch the fuel leakage from the removed fuel line. **Important:** The fuel vacuum pump / pressure gauge connector and the adapter hose must be cleaned before connecting to the fuel line. Otherwise, foreign material internal to the tools line may damage the fuel supply pump. 3. Connect the suction side fuel pressure / vacuum gauge adapter (5-8840-2844-0 / EN-47667) with fuel pressure / vacuum gauge assembly (5-8840-2844-0 / J-44638) in series with the filter housing and the disconnected fuel hose. Ensure the service tool and fuel line connections are tight. 4. Bleed the fuel system by priming the priming pump until it becomes firm, then crank over the engine for a maximum of 5 seconds. Repeat as necessary until the engine starts. 5. Let the engine run at idle for at least 1 minute. 6. Monitor the fuel pressure / vacuum gauge while holding the engine speed higher than 2500 RPM for a minimum of 1 minute. Does the fuel pressure / vacuum gauge indicate a larger vacuum than the specified amount during the test?	5 inHg	Go to Step 7	Go to Step 6
6	1. Fully clamp off a fuel hose as close to the fuel tank as possible (this will draw vacuum on the fuel system). You can also disconnect a fuel line and plug it. 2. Start the engine and turn the idle up control knob to the highest position. (Full clockwise direction. The idle speed is increased up to 1600 RPM.) 3. Monitor the fuel pressure / vacuum gauge. **Notice:** Release the clamp or open the plug when the gauge is likely to be more than 8 inHg during the test. Can a vacuum of at least the specified amount be pulled on the fuel system?	8 inHg	Go to Step 9	Go to Step 8
7	1. Inspect the fuel lines between the fuel supply pump and fuel tank for being crushed or kinked. 2. Inspect for a plugged fuel tank vent hose. 3. Inspect inside the fuel tank (if possible) for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. 4. Repair as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 12

Step	Action	Value(s)	Yes	No
8	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. 3. Repair as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 10
9	1. Turn OFF the ignition. 2. Unclamp or unplug the fuel line from the previous step and reconnect the fuel line (if disconnected). 3. Start the engine and allow it to run for at least 1 minute. 4. Perform the Injector Balancing test with the Tech 2. 5. Command each injector OFF and verify an engine speed change for each injector. Is there an injector that does not change engine speed when commanded OFF?	—	Go to Step 14	Go to Step 16
10	1. Turn OFF the ignition. 2. Disconnect the FRP regulator harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP regulator (pins 1 and 2 of E-116). 4. Disconnect the engine control module (ECM) harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each FRP regulator circuit at the harness connector of the ECM (pins 89, 97, 105 and 113 of E-111 connector). 6. Test for high resistance on each FRP regulator circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 15
11	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins 1, 2 and 3 of E-113 connector). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each FRP sensor circuit at the harness connector of the ECM (pins 82, 87, 90 and 101 of E-111 connector). 6. Test for high resistance on each FRP circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 13

Step	Action	Value(s)	Yes	No
12	Replace the fuel filter cartridge. Refer to Fuel Filter Cartridge Replacement in the Fuel System Section. Did you complete the replacement?	—	Go to Step 17	—
13	Replace the FRP sensor. Refer to Fuel Rail Pressure (FRP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 17	—
14	**Important:** Replacement injector must be programmed. Replace the appropriate fuel injector that does not change engine speed when commanded OFF. Refer to Fuel Injector Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 17	—
15	**Important:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. **Notice:** Always replace the fuel filter cartridge when a fuel supply pump is replaced. Replace the fuel supply pump and fuel filter cartridge. Refer to Fuel Supply Pump Replacement in this section and Fuel Filter Cartridge Replacement in Fuel System section. Did you complete the replacement?	—	Go to Step 17	—
16	**Notice:** There is a possibility that the pressure limiter valve stuck open or opening pressure has fallen. Replace the pressure limiter valve. Refer to Fuel Rail Replacement in this section. Did you complete the replacement?	—	Go to Step 17	—
17	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 18
18	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1094 (Flash Code 226)

Description

The common rail fuel system is comprised of two fuel pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the engine control module (ECM) using the fuel rail pressure (FRP) regulator dependant upon values from the FRP sensor attached to the fuel rail. In case of fuel rail overpressure, a pressure limiter valve threaded into the fuel rail will open to release overpressure and return fuel back to the fuel tank.
If the ECM detects that the differential fuel rail pressure is small at low engine speed but the FRP regulator commanded fuel is certain amount high for a certain length of time, this DTC will set. (FRP Regulator Command High DTC)
If the ECM detects that the fuel rail pressure sensor signal voltage is certain amount low for a certain length of time when fuel cut, DTC will also set. (FRP Drop DTC)

Condition for Running the DTC

FRP Regulator Command High DTC

- DTCs P0090, P0117, P0118, P0192, P0193, P0201 – P0204, P0500, P0501, P0611, P0612, P1095, P1261, P1262, P1630 and P1635 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.
- The engine is running.
- The accelerator pedal position is 0%.
- The engine coolant temperature is more than 50°C (122°F).
- The vehicle speed is less than 5 km/h (4 MPH).
- The engine speed does not vary more than 50 RPM.

FRP Drop DTC

- DTCs P0090, P0192, P0193, P0201 – P0204, P0611, P0612, P1095, P1261, P1262, P1630 and P1635 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.
- The engine is running.
- The accelerator pedal position is 0%.
- The engine coolant temperature is more than 50°C (122°F).
- The vehicle speed is more than 50 km/h (30 MPH).
- The commanded fuel injection quantity is OFF.

Condition for Setting the DTC

FRP Regulator Command High DTC

- The ECM detects that the FRP regulator commanded fuel is more than a predetermined range for longer than 15 seconds when the engine speed is between 600 – 1500 RPM.

FRP Drop DTC

- The ECM detects that the FRP sensor signal voltage is shapely dropped more than 0.2 volts when the engine cuts fuel.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- An intermittently sticking FRP regulator may have allowed the fuel pressure to become low enough to set this DTC.
- Normal FRP Sensor readings on the Tech 2 with the engine running in neutral at idle is around 1.4 – 1.6 volts.
- An intermittently sticking fuel injector may have allowed the fuel pressure to drop too much. Use the Tech 2 to perform the Injector Balancing test for each injector. Verify a consistent engine speed change when commanding each fuel injector ON and OFF.
- A skewed FRP sensor value (shifted to a lower pressure) can set this DTC. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes.

Notice:

- This DTC most likely indicates a loss of fuel pressure by a fuel leak from the high pressure side. Inspect the high pressure side fuel leakage between the fuel supply pump and fuel injector FIRST.

Notice:

- The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight or if there is a crack in one of the fuel hoses. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load, which may set this DTC.

Notice:

- If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted and this DTC may set. Perform bleeding of fuel system after refilling.

Test Description

The numbers below refers to the step number on the diagnostic table.
7. This step checks for a fuel restriction by determining if a high vacuum is being pulled on the fuel system during normal operation.
8. This step checks for an air leak on the suction side of the fuel system by determining if a vacuum can be pulled when a fuel line is plugged.

DTC P1094 (Flash Code 226)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Inspect the high pressure side between the fuel supply pump and the fuel injectors for fuel leakage. The following components may contain an external leak. • Fuel supply pump • Fuel rail • Pressure limiter valve • Flow damper valve • Fuel rail pressure (FRP) sensor • Fuel pipe between the fuel supply pump and fuel rail • Fuel pipe between the fuel rail and fuel injectors • Each fuel pipe sleeve nuts **Notice:** Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel leakage into the engine oil. **Notice:** Remove and inspect the inlet high pressure joint to the fuel injectors for fuel leaking from the sleeve nut(s). Replace the fuel injector and injection pipe when foreign material was in contact. 2. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 3

Step	Action	Value(s)	Yes	No
3	1. Remove each glow plug from the cylinder head. 2. Inspect the tip of the plugs for wet fuel. **Notice:** Use the engine compression gauge (5-8840-2675-0 / J-26999-12) and gauge adapter (5-8840-2815-0 / EN-46722) to inspect the damage of engine. If poor engine compression (less than 1960 kPa [284 psi]) or variation of each cylinder (more than 294 kPa [43 psi]) is found, inspect the engine mechanical. Refer to the Engine Mechanical section. Repair as necessary. Did you find wet fuel on the glow plug(s)?	—	Go to Step 16	Go to Step 4
4	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0090, P0192, P0193, P0201 – P0204, P1094, P1095, P1261 or P1262 set?	—	Go to Applicable DTC	Go to Step 5
5	1. Turn OFF the ignition. 2. Wait 2 minutes for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition with the engine OFF. DO NOT start the engine. 4. Observe the FRP Sensor parameter with the Tech 2. Is the FRP Sensor parameter the specified value?	0.9 – 1.0 volt	Go to Step 6	Go to Step 13

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load, which may set this DTC. 3. Pump the priming pump on the fuel filter until it becomes firm. If there is a leak on the suction side of the fuel system between the priming pump and the fuel supply pump, the priming pump will not build up sufficient firmness and fuel leakage may occur. 4. Start the engine and check for high side fuel system leaks at the fuel supply pump and fuel rail. **Notice:** Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel leakage into the engine oil. 5. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 7
7	1. Turn OFF the ignition. 2. Remove the rubber fuel hose from the fuel filter housing (fuel supply pump side). Use a pan to catch the fuel leakage from the removed fuel line. **Important:** The fuel vacuum pump / pressure gauge connector and the adapter hose must be cleaned before connecting to the fuel line. Otherwise, foreign material internal to the tools line may damage the fuel supply pump. 3. Connect the suction side fuel pressure / vacuum gauge adapter (5-8840-2844-0 / EN-47667) with fuel pressure / vacuum gauge assembly (5-8840-2844-0 / J-44638) in series with the filter housing and the disconnected fuel hose. Ensure the service tool and fuel line connections are tight. 4. Bleed the fuel system by priming the priming pump until it becomes firm, then crank over the engine for a maximum of 5 seconds. Repeat as necessary until the engine starts. 5. Let the engine run at idle for at least 1 minute. 6. Monitor the fuel pressure / vacuum gauge while holding the engine speed higher than 2500 RPM for a minimum of 1 minute. Does the fuel pressure / vacuum gauge ever indicate a larger vacuum than the specified amount during the test?	5 inHg	Go to Step 9	Go to Step 8

Step	Action	Value(s)	Yes	No
8	1. Fully clamp off a fuel hose as close to the fuel tank as possible (this will draw vacuum on the fuel system). You can also disconnect a fuel line and plug it. 2. Start the engine and turn the idle up control knob to the highest position. (Full clockwise direction. The idle speed is increased up to 1600 RPM.) 3. Monitor the fuel pressure / vacuum gauge. **Notice:** Release the clamp or open the plug when the gauge is likely to be more than 8 inHg during the test. Can a vacuum of at least the specified amount be pulled on the fuel system?	8 inHg	Go to Step 11	Go to Step 10
9	1. Inspect the fuel lines between the fuel supply pump and fuel tank for being crushed or kinked. 2. Inspect for a plugged fuel tank vent hose. 3. Inspect inside the fuel tank (if possible) for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. 4. Repair as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 14
10	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. 3. Repair as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 12
11	1. Turn OFF the ignition. 2. Unclamp or unplug the fuel line from the previous step and reconnect the fuel line (if disconnected). 3. Start the engine and allow it to run for at least 1 minute. 4. Perform the Injector Balancing test with the Tech 2. 5. Command each injector OFF and verify an engine speed change for each injector. Is there an injector that does not change engine speed when commanded OFF?	—	Go to Step 17	Go to Step 19

Step	Action	Value(s)	Yes	No
12	1. Turn OFF the ignition. 2. Disconnect the FRP regulator harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP regulator (pins 1 and 2 of E-116). 4. Disconnect the engine control module (ECM) harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each FRP regulator circuit at the harness connector of the ECM (pins 89, 97, 105 and 113 of E-111 connector). 6. Test for high resistance on each FRP regulator circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 18
13	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins 1, 2 and 3 of E-113 connector). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each FRP sensor circuit at the harness connector of the ECM (pins 82, 87, 90 and 101 of E-111 connector). 6. Test for high resistance on each FRP circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 15
14	Replace the fuel filter cartridge. Refer to Fuel Filter Cartridge Replacement in the Fuel System Section. Did you complete the replacement?	—	Go to Step 20	—
15	Replace the FRP sensor. Refer to Fuel Rail Pressure (FRP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 20	—
16	**Important:** Replacement injector must be programmed. Replace the appropriate injector that was leaking fuel found at Step 3. Refer to Fuel Injector Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 20	—

Step	Action	Value(s)	Yes	No
17	**Important:** Replacement injector must be programmed. Replace the appropriate fuel injector that does not change engine speed when commanded OFF. Refer to Fuel Injector Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 20	—
18	**Important:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. **Notice:** Always replace the fuel filter cartridge when a fuel supply pump is replaced. Replace the fuel supply pump and fuel filter cartridge. Refer to Fuel Supply Pump Replacement in this section and Fuel Filter Cartridge Replacement in Fuel System section. Did you complete the replacement?	—	Go to Step 20	—
19	**Notice:** There is a possibility that the pressure limiter valve stuck open or opening pressure has fallen. Replace the pressure limiter valve. Refer to Fuel Rail Replacement in this section. Did you complete the replacement?	—	Go to Step 20	—
20	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 21
21	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1095 (Flash Code 225)

Description

The common rail fuel system is comprised of two fuel pressure sections: a suction side between the fuel tank and the fuel supply pump and a high-pressure side between the fuel supply pump and the fuel injectors. Fuel is drawn from the fuel tank via a feed pump and then pumped into the fuel rail by two plungers, all of which are internal to the fuel supply pump. This high pressure is regulated by the engine control module (ECM) using the fuel rail pressure (FRP) regulator dependant upon values from the FRP sensor attached to the fuel rail. In case of fuel rail overpressure, a pressure limiter valve threaded into the fuel rail will open to release overpressure and return fuel back to the fuel tank.
If the ECM detects that the fuel rail pressure went excessively high, then sharply decreased, this DTC will set indicating high fuel pressure, which activated the pressure limiter valve.

Condition for Running the DTC

- DTCs P0192, P0193, P1630 and P1635 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the FRP sensor signal voltage drops quickly from more than 3.7 volts to less than 2.3 volts, and then the differential fuel rail pressure is more than -30 MPa (4,350 psi).

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- An intermittently sticking FRP regulator may have allowed the fuel pressure to become high enough to open the pressure limiter valve.
- Normal FRP Sensor readings on the Tech 2 with the engine running in neutral at idle is around 1.4 – 1.6 volts.
- A skewed FRP sensor value (shifted to a higher pressure) can set this DTC. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes.

Notice:

- The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight or if there is a crack in one of the fuel hoses. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load, which may set this DTC.

Notice:

- If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the supply pump is interrupted and this DTC may set. Perform bleeding of fuel system after refilling.

Test Description

The numbers below refers to the step number on the diagnostic table.
6. This step checks for a fuel restriction by determining if a high vacuum is being pulled on the fuel system during normal operation.
7. This step checks for an air leak on the suction side of the fuel system by determining if a vacuum can be pulled when a fuel line is plugged.

DTC P1095 (Flash Code 225)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls

Step	Action	Value(s)	Yes	No
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0089, P0090, P0192, P0193, P0201 – P0204, P1261 or P1262 set?	—	Go to Applicable DTC	Go to Step 3
3	1. Turn OFF the ignition for 30 seconds. 2. Place the transmission in Neutral and set the park brake. 3. Start the engine. 4. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Wait 2 minutes for the fuel pressure to bleed down from the fuel rail. 3. Turn ON the ignition with the engine OFF. DO NOT start the engine. 4. Observe the Fuel Rail Pressure (FRP) Sensor parameter with the Tech 2. Is the FRP Sensor parameter the specified value?	0.9 – 1.0 volt	Go to Step 5	Go to Step 12
5	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** The fuel system from the fuel tank(s) to the fuel supply pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel rail pressure fluctuations especially at high engine speed and load, which may set this DTC. 3. Pump the priming pump on the fuel filter until it becomes firm. If there is a leak on the suction side of the fuel system between the priming pump and the fuel supply pump, the priming pump will not build up sufficient firmness and fuel leakage may occur. 4. Start the engine and check for high side fuel system leaks at the fuel supply pump and fuel rail. **Notice:** Fuel may leak under the cylinder head cover from the inlet high pressure line. In such case, the engine oil level will rise. Inspect for fuel leakage into the engine oil. 5. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Remove the rubber fuel hose from the fuel filter housing (fuel supply pump side). Use a pan to catch the fuel leakage from the removed fuel line. **Important:** The fuel vacuum pump / pressure gauge connector and the adapter hose must be cleaned before connecting to the fuel line. Otherwise, foreign material internal to the tools line may damage the fuel supply pump. 3. Connect the suction side fuel pressure / vacuum gauge adapter (5-8840-2844-0 / EN-47667) with fuel pressure / vacuum gauge assembly (5-8840-2844-0 / J-44638) in series with the filter housing and the disconnected fuel hose. Ensure the service tool and fuel line connections are tight. 4. Bleed the fuel system by priming the priming pump until it becomes firm, then crank over the engine for a maximum of 5 seconds. Repeat as necessary until the engine starts. 5. Let the engine run at idle for at least 1 minute. 6. Monitor the fuel pressure / vacuum gauge while holding the engine speed higher than 2500 RPM for a minimum of 1 minute. Does the fuel pressure / vacuum gauge ever indicate a larger vacuum than the specified amount during the test?	5 inHg	Go to Step 8	Go to Step 7
7	1. Fully clamp off a fuel hose as close to the fuel tank as possible (this will draw vacuum on the fuel system). You can also disconnect a fuel line and plug it. 2. Start the engine and turn the idle up control knob to the highest position. (Full clockwise direction. The idle speed is increased up to 1600 RPM.) 3. Monitor the fuel pressure / vacuum gauge. **Notice:** Release the clamp or open the plug when the gauge is likely to be more than 8 inHg during the test. Can a vacuum of at least the specified amount be pulled on the fuel system?	8 inHg	Go to Step 10	Go to Step 9
8	1. Inspect the fuel lines between the fuel supply pump and fuel tank for being crushed or kinked. 2. Inspect for a plugged fuel tank vent hose. 3. Inspect inside the fuel tank (if possible) for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. 4. Repair as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 13

Step	Action	Value(s)	Yes	No
9	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. 3. Repair as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 11
10	1. Turn OFF the ignition. 2. Unclamp or unplug the fuel line from the previous step and reconnect the fuel line (if disconnected). 3. Start the engine and allow it to run for at least 1 minute. 4. Perform the Injector Balancing test with the Tech 2. 5. Command each injector OFF and verify an engine speed change for each injector. Is there an injector that does not change engine speed when commanded OFF?	—	Go to Step 15	Go to Step 11
11	1. Turn OFF the ignition. 2. Disconnect the FRP regulator harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP regulator (pins 1 and 2 of E-116). 4. Disconnect the engine control module (ECM) harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each FRP regulator circuit at the harness connector of the ECM (pins 89, 97, 105 and 113 of E-111 connector). 6. Test for high resistance on each FRP regulator circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 16
12	1. Turn OFF the ignition. 2. Disconnect the FRP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the FRP sensor (pins 1, 2 and 3 of E-113 connector). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each FRP sensor circuit at the harness connector of the ECM (pins 82, 87, 90 and 101 of E-111 connector). 6. Test for high resistance on each FRP circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 14

Step	Action	Value(s)	Yes	No
13	Replace the fuel filter cartridge. Refer to Fuel Filter Cartridge Replacement in the Fuel System Section. Did you complete the replacement?	—	Go to Step 17	—
14	Replace the FRP sensor. Refer to Fuel Rail Pressure (FRP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 17	—
15	**Important:** Replacement injector must be programmed. Replace the appropriate fuel injector that does not change engine speed when commanded OFF. Refer to Fuel Injector Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 17	—
16	**Important:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. **Notice:** Always replace the fuel filter cartridge when a fuel supply pump is replaced. Replace the fuel supply pump and fuel filter cartridge. Refer to Fuel Supply Pump Replacement in this section and Fuel Filter Cartridge Replacement in Fuel System section. Did you complete the replacement?	—	Go to Step 17	—
17	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 18
18	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1173 (Flash Code 542)

Circuit Description

The engine coolant temperature (ECT) sensor is installed to the thermostat housing. The ECT sensor is a variable resistor. The ECT sensor has a signal circuit and a low reference circuit. The ECT sensor measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and a ground for the ECT low reference circuit. When the ECT sensor is cold, the sensor resistance is high. When the engine coolant temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the ECT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the ECT signal circuit. If the ECM detects an excessive high coolant temperature, this DTC will set.

Condition for Running the DTC

- DTCs P0117, P0118, P1630 and P1634 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.
- The engine is running.

Condition for Setting the DTC

- The ECM detects that the engine coolant temperature is more than 110°C (230°F) for 15 seconds.

Action Taken When the DTC Sets

- The ECM does not illuminate the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the DTC

- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- After starting the engine, the ECT should rise steadily to about 80°C – 85°C (176°F – 185°F) then stabilize when the thermostat opens.
- Use the Temperature vs. Resistance table to test the ECT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

Notice:

- This DTC is caused by an engine overheat condition (i.e. low engine coolant level). Since this DTC does not illuminate any lamps, clear the DTC and ensure there are no signs of engine damage. Excessive engine overheat may damage internal engine components.

DTC P1173 (Flash Code 542)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0117 also set?	—	Go to DTC P0117	Go to Step 3
3	1. Start the engine and wait until engine is fully warms upped. 2. Observe the Coolant Temperature parameter with the Tech 2. Is the Coolant Temperature parameter more than the specified value?	110°C (230°F)	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	Ask the driver if overheat is caused by low engine coolant level, etc. If engine overheat has experienced, the engine must be inspected and repaired as necessary. Did you complete the action?	—	Go to Step 7	—
5	1. Test the engine coolant temperature (ECT) sensor at various temperature levels to evaluate the possibility if a skewed sensor. 2. Replace the ECT sensor as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
6	1. Test the engine cooling system for the following condition. Refer to diagnosis of the engine cooling system section for testing. • Engine coolant level • Engine coolant leakage • Cooling fan belt slippage • Cooling fan clutch working • Thermostat working • Water pump working • Radiator clogging 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Diagnostic Aids
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine and wait until engine is fully warms upped. 5. Observe the Coolant Temperature parameter with the Tech 2. Is the Coolant Temperature parameter more than the specified value?	110°C (230°F)	Go to Step 2	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1220 (Flash Code 28)

Circuit Description

The power take off (PTO) throttle sensor (body builder installed) detects the PTO control throttle angle. The engine control module (ECM) receives the PTO control throttle angle from the throttle sensor and controls the fuel injection quantity (engine speed) during PTO. The PTO throttle sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- PTO throttle sensor signal circuit

The ECM supplies 5 volts to the PTO throttle sensor on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The ECM monitors the PTO throttle sensor signal for voltages outside the normal range of the PTO throttle sensor. If the ECM detects an excessively high PTO throttle sensor signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1631 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the PTO throttle sensor signal voltage is more than 4.8 volts.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM disables PTO throttle sensor control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- PTO throttle sensor may have an intermittent open somewhere in the operating range.

DTC P1220 (Flash Code 28)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Observe the PTO Remote Throttle Sensor parameter with the Tech 2 while turning the PTO throttle sensor. Does the PTO Remote Throttle Sensor parameter ever exceed specified value?	4.8 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Start the engine. 2. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1631 also set?	—	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Disconnect the PTO throttle sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the PTO Remote Throttle Sensor parameter with the Tech 2. Is the PTO Remote Throttle Sensor parameter less than the specified value?	0.2 volts	Go to DTC P1631	Go to Step 7

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Disconnect the PTO throttle sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the PTO Remote Throttle Sensor parameter with the Tech 2. Is the PTO Remote Throttle Sensor parameter less than the specified value?	0.2 volts	Go to Step 6	Go to Step 7
6	1. Turn OFF the ignition. 2. Connect a test lamp between the low reference circuit of the PTO throttle sensor harness (pin 3 of J-166 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 8
7	**Important:** The PTO throttle sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the engine control module (ECM) (pin 70 of J-191 connector) and the PTO throttle sensor (pin 2 of J-166 connector) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the low reference circuit between the ECM (pin 41 of J-191 connector) and the PTO throttle sensor (pin 3 of J-166 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
9	1. Turn OFF the ignition. 2. Inspect for an intermittent and for a poor connection at the harness connector of the PTO throttle sensor (pin 3 of J-166 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the PTO throttle sensor circuit at the harness connector of the ECM (pin 41 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the PTO throttle sensor. Did you complete the replacement?	—	Go to Step 13	—

Step	Action	Value(s)	Yes	No
12	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Observe the PTO Remote Throttle Sensor parameter with the Tech 2 while turning the PTO throttle sensor. Is the PTO Remote Throttle Sensor parameter more than the specified value?	4.8 volts	Go to Step 3	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1225 (Flash Code 31)

Circuit Description

The idle up sensor controls the idle speed during warm-up and it is installed in the driver's side instrument panel. This sensor is active only when the gear position is in the neutral position. When the selector lever is moved to another position, the signal is ignored. The engine control module (ECM) receives the idle up signal from the idle up sensor and controls the fuel injection quantity. The idle up sensor has following circuits.

- 5 volts reference circuit
- Low reference circuit
- Idle up sensor signal circuit

The ECM monitors the idle up sensor signals for voltages outside the normal range of the idle up sensor. If the ECM detects an excessively low or high idle up sensor voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1631 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the idle up sensor signal voltage is less than 0.1 volts for 5 second.
- The ECM detects that the idle up sensor signal voltage is more than 4.9 volts for 5 second.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM disables idle up sensor control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Idle up sensor may have an intermittent open somewhere in the operating range.

DTC P1225 (Flash Code 31)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Fully turn the idle up sensor to lowest position (full counterclockwise direction) and highest position (full clock wise direction) while observing the Idle Up Sensor parameter with the Tech 2. Is the Idle Up Sensor parameter within the specified valve?	0.2 – 4.8 volts	Go to Diagnostic Aids	Go to Step 3
3	1. Start the engine. 2. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1631 also set?	—	Go to Step 4	Go to Step 5
4	Is the Idle Up Sensor parameter less than the specified value at Step 2?	0.1 volts	Go to DTC P1631	Go to Step 8

Step	Action	Value(s)	Yes	No
5	1. Turn ON the ignition, with the engine OFF. 2. Turn the idle up sensor to lowest position (full counterclockwise direction). 3. Observe the Idle Up Sensor parameter with the Tech 2. Is the Idle Up Sensor parameter less than the specified value?	0.1 volts	Go to Step 6	Go to Step 9
6	1. Turn OFF the ignition. 2. Disconnect the idle up sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit of the idle up sensor harness (pin 3 of B-281 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 7	Go to Step 11
7	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the 5 volts reference circuit and the signal circuit of the idle up sensor harness (pin 2 and 3 of B-281 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the Idle Up Sensor parameter with the Tech 2. Is the Idle Up Sensor parameter more than the specified value?	4.5 volts	Go to Step 15	Go to Step 12
8	1. Turn OFF the ignition. 2. Disconnect the idle up sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Idle Up Sensor parameter with the Tech 2. Is the Idle Up Sensor parameter less than the specified value?	0.1 volts	Go to DTC P0631	Go to Step 13
9	1. Turn OFF the ignition. 2. Disconnect the idle up sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Idle Up Sensor parameter with the Tech 2. Is the Idle Up Sensor parameter less than the specified value?	0.1 volts	Go to Step 10	Go to Step 13
10	1. Turn OFF the ignition. 2. Connect a test lamp between the low reference circuit of the idle up sensor harness (pin 1 of B-281 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 15	Go to Step 14

Step	Action	Value(s)	Yes	No
11	1. Test the 5 volts reference circuit between the engine control module (ECM) (pin 42 of J-191 connector) and the idle up sensor harness (pin 3 of B-281 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
12	1. Test the signal circuit between the ECM (pin 66 of J-191 connector) and the idle up sensor (pin 2 of B-281 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
13	**Important:** The idle up sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the ECM (pin 66 of J-191 connector) and the idle up sensor (pin 2 of B-281 connector) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
14	1. Test the low reference circuit between the ECM (pin 41 of J-191 connector) and the idle up sensor (pin 1 of B-281 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
15	1. Turn OFF the ignition. 2. Disconnect the idle up sensor harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the idle up sensor (pins 1, 2 and 3 of B-281 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 17
16	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the idle up sensor circuits at the harness connector of the ECM (pins 41, 42 and 66 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18

Step	Action	Value(s)	Yes	No
17	Replace the idle up sensor. Refer to Idle Up Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 19	—
18	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 19	—
19	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully turn the idle up sensor to lowest position (full counterclockwise direction) and highest position (full clock wise direction) while observing the Idle Up Sensor parameter with the Tech 2. Is the Idle Up Sensor parameter within the specified valve?	0.2 – 4.8 volts	Go to Step 20	Go to Step 3
20	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1261 (Flash Code 158)

Circuit Description

The common 1 fuel injector drive circuit is a high-voltage supply which drives injectors for cylinder number 1 and 4 in conjunction with the engine control module (ECM) grounding the fuel injector control circuit. The ECM also supplies battery voltage to the fuel injector solenoid control circuit to allow for fault detection. If the common 1 fuel injector drive circuit is open circuit, short to ground or short to voltage, this DTC will set. Or, if the cylinder number 1 or number 4 fuel injector solenoid control circuit is shorted to ground, this DTC will also set.

Condition for Running the DTC

- DTC P0611 is not set.
- The ignition switch is ON.
- The battery voltage is more than 18 volts.
- The engine is running.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the common 1 fuel injector drive circuit is open circuit, shorted to ground or shorted to voltage during engine rotations.
- The ECM detects that the cylinder number 1 or number 4 fuel injector solenoid coil control circuit is shorted to ground during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL and exhaust brake indicator lamp when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1261 (Flash Code 158)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	**Important:** If DTC P0201 or P0204 is also set, diagnose that DTC first. 1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the in-line harness connector (H-125) from the cylinder head cover case. 3. Connect a DMM between the cylinder number 1 fuel injector control circuit (pin 5 of H-125 female side connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	12.0 volt	Go to Step 4	Go to Step 6

Step	Action	Value(s)	Yes	No
4	1. Connect a test lamp between the common 1 fuel injector drive circuit (pin 1 or 4 of H-125 female side connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 7	Go to Step 5
5	1. Connect a test lamp between the common 1 fuel injector drive circuit (pins 1 or 4 of H-125 female side connector) and battery voltage. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 9
6	1. Test the cylinder number 1 or number 4 fuel injector solenoid control circuit between the engine control module (ECM) and the in-line harness connector (H-125 connector) for a short to ground. • Cylinder #1: Between pin 119 of E-111 connector and 5 of H-125 connector • Cylinder #4: Between pin 117 of E-111 connector and 8 of H-125 connector 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
7	1. Test the common 1 fuel injector drive circuit between the ECM (pin 121 of E-111 connector) and the in-line harness connector (pins 1 and 4 of H-125 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
8	1. Test the common 1 fuel injector drive circuit between the ECM (pin 121 of E-111 connector) and the in-line harness connector (pins 1 and 4 of H-125 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
9	1. Inspect for an intermittent and for a poor connection at the in-line harness connector (pins 1 and 4 of H-125 connector). 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the common 1 fuel injector drive circuit at the harness connector of the ECM (pin 121 of E-111 connector). 4. Inspect for an open circuit or high resistance on the common 1 fuel injector drive circuit between the ECM (pin 121 of E-111 connector) and the in-line harness connector (pins 1 and 4 of H-125 connector). 5. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 10

Step	Action	Value(s)	Yes	No
10	1. Remove the cylinder head cover. Refer to Fuel Injector Replacement in this section. 2. Inspect the fuel injector harness for loose injector terminal nuts, objects touching injector terminals. 3. Inspect for an intermittent and for a poor connection at the in-line harness connector (pins 1 and 4 of H-126 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 11
11	1. Disconnect the fuel injector harness from the cylinder number 1 and number 4 fuel injectors (E-138 and E-141 connector). 2. Measure the insulation resistance between cylinder number 1 fuel injector terminals and a known good ground. 3. Measure the insulation resistance between cylinder number 4 fuel injector terminals and a known good ground. Is the insulation resistance more than the specified value on each measurement?	1 MΩ	Go to Step 12	Go to Step 13
12	Repair or replace the injector harness. Refer to Fuel Injector Replacement in this section. Did you complete the repair or replace?	—	Go to Step 15	—
13	**Important:** Replacement injector must be programmed. Replace the appropriate fuel injector that was less insulation resistance found at Step 11. Refer to Fuel Injector Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1262 (Flash Code 159)

Circuit Description

The common 2 fuel injector drive circuit is a high-voltage supply which drives injectors for cylinder number 2 and 3 in conjunction with the engine control module (ECM) grounding the fuel injector control circuit. The ECM also supplies battery voltage to the fuel injector solenoid control circuit to allow for fault detection. If the common 2 fuel injector drive circuit is open circuit, short to ground or short to voltage, this DTC will set. Or, if the cylinder number 2 or number 3 fuel injector solenoid control circuit is shorted to ground, this DTC will also set.

Condition for Running the DTC

- DTC P0612 is not set.
- The ignition switch is ON.
- The battery voltage is more than 18 volts.
- The engine is running.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the common 2 fuel injector drive circuit is open circuit, shorted to ground or shorted to voltage during engine rotations.
- The ECM detects that the cylinder number 2 or number 3 fuel injector solenoid coil control circuit is shorted to ground during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL and exhaust brake indicator lamp when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1262 (Flash Code 159)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	**Important:** If DTC P0202 or P0203 is also set, diagnose that DTC first. 1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the in-line harness connector (H-125) from the cylinder head cover case. 3. Connect a DMM between the cylinder number 2 fuel injector control circuit (pin 6 of H-125 female side connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	12.0 volt	Go to Step 4	Go to Step 6

Step	Action	Value(s)	Yes	No
4	1. Connect a test lamp between the common 2 fuel injector drive circuit (pin 2 or 3 of H-125 female side connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 7	Go to Step 5
5	1. Connect a test lamp between the common 2 fuel injector drive circuit (pins 2 or 3 of H-125 female side connector) and battery voltage. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 9
6	1. Test the cylinder number 2 or number 3 fuel injector solenoid control circuit between the engine control module (ECM) and the in-line harness connector (H-125 connector) for a short to ground. • Cylinder #2: Between pin 118 of E-111 connector and 6 of H-125 connector • Cylinder #3: Between pin 120 of E-111 connector and 7 of H-125 connector 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
7	1. Test the common 2 fuel injector drive circuit between the ECM (pin 116 of E-111 connector) and the in-line harness connector (pins 2 and 3 of H-125 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
8	1. Test the common 2 fuel injector drive circuit between the ECM (pin 116 of E-111 connector) and the in-line harness connector (pins 2 and 3 of H-125 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
9	1. Inspect for an intermittent and for a poor connection at the in-line harness connector (pins 2 and 3 of H-125 connector). 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the common 2 fuel injector drive circuit at the harness connector of the ECM (pin 116 of E-111 connector). 4. Inspect for an open circuit or high resistance on the common 2 fuel injector drive circuit between the ECM (pin 116 of E-111 connector) and the in-line harness connector (pins 2 and 3 of H-125 connector). 5. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 10

Step	Action	Value(s)	Yes	No
10	1. Remove the cylinder head cover. Refer to Fuel Injector Replacement in this section. 2. Inspect the fuel injector harness for loose injector terminal nuts, objects touching injector terminals. 3. Inspect for an intermittent and for a poor connection at the in-line harness connector (pins 2 and 3 of H-126 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 11
11	1. Disconnect the fuel injector harness from the cylinder number 2 and number 3 fuel injectors (E-139 and E-140 connector). 2. Measure the insulation resistance between cylinder number 2 fuel injector terminals and a known good ground. 3. Measure the insulation resistance between cylinder number 3 fuel injector terminals and a known good ground. Is the insulation resistance more than the specified value on each measurement?	1 MΩ	Go to Step 12	Go to Step 13
12	Repair or replace the injector harness. Refer to Fuel Injector Replacement in this section. Did you complete the repair or replace?	—	Go to Step 15	—
13	**Important:** Replacement injector must be programmed. Replace the appropriate fuel injector that was less insulation resistance found at Step 11. Refer to Fuel Injector Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1271 (Flash Code 24)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of two individual sensors within one housing. The APP sensor 1 and APP sensor 2 are potentiometer type sensors, each with the following circuits.

- 5 volts reference circuit
- Low reference circuit
- Signal circuit

The engine control module (ECM) supplies 5 volts to the APP sensor on the 5 volts reference circuits. The ECM also provides a ground on the low reference circuits. The APP sensor provides a signal to the ECM on the APP sensor signal circuits, which is relative to the position changes of the accelerator pedal angle. The APP sensor 1 signal voltage is low at rest and increases as the pedal is depressed. The APP sensor 2 signal voltage is high at rest and decreases as the pedal is depressed. If the ECM detects that the APP sensor 1 signal and the APP sensor 2 signal are out of the correlation, this DTC will set.

Condition for Running the DTC

- DTCs P1630, P1631 and P1632 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the APP sensor 1 and sensor 2 are more than 45% out of range of each other.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM blinks the exhaust brake indicator lamp when the diagnostic runs and fails.
- The ECM inhibits exhaust brake control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL and exhaust brake indicator lamp when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1271 (Flash Code 24)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1277, P1278, P1282, P1283, P1631 or P1632 set?	—	Go to Applicable DTC	Go to Step 3
3	1. Turn OFF the ignition for 30 seconds. 2. Start the engine. 3. Monitor the DTC Information with the Tech 2. 4. Fully depress and release the accelerator pedal. Does the DTC fail this ignition?	—	Go to Step 4	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the accelerator pedal position (APP) sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the APP sensor (pins 1, 2, 3, 4, 5 and 6 of B-280 connector). 4. Disconnect the engine control module (ECM) harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each APP sensor circuit at the harness connector of the ECM (pins 41, 42, 60, 61, 63 and 64 of J-191 connector). 6. Test for high resistance on each APP sensor circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 5
5	1. Test the APP sensor 1 and sensor 2 signal circuit between the ECM (pin 63 and 64 of J-191 connector) and the APP sensor (pin 2 and 5 of B-280 connector) for a short circuit each other. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 6
6	Replace the APP sensor. Refer to Accelerator Pedal Position (APP) Sensor Replacement in this section. (APP sensor 1 and sensor 2 is internal to APP sensor assembly) Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal. Does the DTC fail this ignition?	—	Go to Step 8	Go to Step 10
8	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 9	—
9	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal. Does the DTC fail this ignition?	—	Go to Step 2	Go to Step 10

Step	Action	Value(s)	Yes	No
10	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1277 (Flash Code 24)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of two individual sensors within one housing. The engine control module (ECM) uses the APP sensors to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injector control. The APP sensor 1 has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- APP sensor 1 signal circuit

The ECM supplies 5 volts to the APP sensor 1 on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The APP sensor 1 provides a signal to the ECM on the APP sensor 1 signal circuit, which is relative to the position changes of the accelerator pedal angle. The ECM monitors the APP sensor 1 signal for voltages outside the normal range of the APP sensor 1. If the ECM detects an excessively low APP sensor 1 signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1631 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the APP sensor 1 signal voltage is less than 0.2 volts.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM blinks the exhaust brake indicator lamp when the diagnostic runs and fails.
- The ECM inhibits exhaust brake control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL and exhaust brake indicator lamp when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- APP sensor 1 may have an intermittent open somewhere in the pedal range.

DTC P1277 (Flash Code 24)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1631 also set?	—	Go to DTC P1631	Go to Step 3
3	1. Turn ON the ignition, with the engine OFF. 2. Observe the Accelerator Pedal Position (APP) Sensor 1 parameter with the Tech 2. Is the APP Sensor 1 parameter less than the specified value?	0.2 volts	Go to Step 4	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit of the APP sensor 1 harness (pin 4 of B-280 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 5	Go to Step 6
5	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the 5 volts reference circuit and the signal circuit of the APP sensor 1 harness (pins 4 and 5 of B-280 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the APP Sensor 1 parameter with the Tech 2. Is the APP Sensor 1 parameter more than specified value?	4.5 volts	Go to Step 8	Go to Step 7
6	1. Test the 5 volts reference circuit between the engine control module (ECM) (pin 42 of J-191 connector) and the APP sensor 1 (pin 4 of B-280 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
7	1. Test the signal circuit between the ECM (pin 63 of J-191 connector) and the APP sensor 1 (pin 5 of B-280 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the APP sensor (pins 4 and 5 of B-280 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the APP sensor 1 circuits at the harness connector of the ECM (pins 42 and 63 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11

Step	Action	Value(s)	Yes	No
10	Replace the APP sensor. Refer to Accelerator Pedal Position (APP) Sensor Replacement in this section. (APP sensor 1 is internal to APP sensor assembly) Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the APP Sensor 1 parameter with the Tech 2. Is the APP Sensor 1 parameter less than the specified value?	0.2 volts	Go to Step 3	Go to Step 13
13	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1278 (Flash Code 24)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of two individual sensors within one housing. The engine control module (ECM) uses the APP sensors to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injector control. The APP sensor 1 has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- APP sensor 1 signal circuit

The ECM supplies 5 volts to the APP sensor 1 on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The APP sensor 1 provides a signal to the ECM on the APP sensor 1 signal circuit, which is relative to the position changes of the accelerator pedal angle. The ECM monitors the APP sensor 1 signal for voltages outside the normal range of the APP sensor 1. If the ECM detects an excessively high APP sensor 1 signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1631 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the APP sensor 1 signal voltage is more than 4.9 volts.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM blinks the exhaust brake indicator lamp when the diagnostic runs and fails.
- The ECM inhibits exhaust brake control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL and exhaust brake indicator lamp when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- APP sensor 1 may have an intermittent open somewhere in the pedal range.

DTC P1278 (Flash Code 24)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Fully depress and release the accelerator pedal while observing the Accelerator Pedal Position (APP) Sensor 1 parameter with the Tech 2. Does the APP Sensor 1 parameter ever exceed the specified value?	4.8 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Start the engine. 2. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is the DTC P1631 also set?	—	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the APP Sensor 1 parameter with the Tech 2. Is the APP Sensor 1 parameter less than the specified value?	0.2 volts	Go to DTC P1631	Go to Step 7
5	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the APP Sensor 1 parameter with the Tech 2. Is the APP Sensor 1 parameter less than the specified value?	0.2 volts	Go to Step 6	Go to Step 7
6	1. Turn OFF the ignition. 2. Connect a test lamp between the low reference circuit of the APP sensor 1 harness (pin 6 of B-280 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 8
7	**Important:** The APP sensor 1 may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the engine control module (ECM) (pin 63 of J-191 connector) and the APP sensor 1 (pin 5 of B-280 connector) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the low reference circuit between the ECM (pin 41 of J-191 connector) and the APP sensor 1 (pin 6 of B-280 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
9	1. Turn OFF the ignition. 2. Inspect for an intermittent and for a poor connection at the harness connector of the APP sensor (pin 6 of B-280 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11

Step	Action	Value(s)	Yes	No
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the APP sensor 1 circuit at the harness connector of the ECM (pin 41 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the APP sensor. Refer to Accelerator Pedal Position (APP) Sensor Replacement in this section. (APP sensor 1 is internal to APP sensor assembly) Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the APP Sensor 1 parameter with the Tech 2. Does the APP Sensor 1 parameter ever exceed the specified value?	4.8 volts	Go to Step 3	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1282 (Flash Code 24)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of two individual sensors within one housing. The engine control module (ECM) uses the APP sensors to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injector control. The APP sensor 2 has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- APP sensor 2 signal circuit

The ECM supplies 5 volts to the APP sensor 2 on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The APP sensor 2 provides a signal to the ECM on the APP sensor 2 signal circuit, which is relative to the position changes of the accelerator pedal angle. The ECM monitors the APP sensor 2 signal for voltages outside the normal range of the APP sensor 2. If the ECM detects an excessively low APP sensor 2 signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1632 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the APP sensor 2 signal voltage is less than 0.2 volts.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM blinks the exhaust brake indicator lamp when the diagnostic runs and fails.
- The ECM inhibits exhaust brake control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL and exhaust brake indicator lamp when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- APP sensor 2 may have an intermittent open somewhere in the pedal range.

DTC P1282 (Flash Code 24)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1632 also set?	—	Go to DTC P1632	Go to Step 3
3	1. Turn ON the ignition, with the engine OFF. 2. Observe the Accelerator Pedal Position (APP) Sensor 2 parameter with the Tech 2. Is the APP Sensor 2 parameter less than the specified value?	0.2 volts	Go to Step 4	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit of the APP sensor 2 harness (pin 1 of B-280 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 5	Go to Step 6
5	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the 5 volts reference circuit and the signal circuit of the APP sensor 2 harness (pins 1 and 2 of B-280 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the APP Sensor 2 parameter with the Tech 2. Is the APP Sensor 2 parameter more than specified value?	4.5 volts	Go to Step 8	Go to Step 7
6	1. Test the 5 volts reference circuit between the engine control module (ECM) (pin 61 of J-191 connector) and the APP sensor 2 (pin 1 of B-280 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
7	1. Test the signal circuit between the ECM (pin 64 of J-191 connector) and the APP sensor 2 (pin 2 of B-280 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the APP sensor (pins 1 and 2 of B-280 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the APP sensor 1 circuits at the harness connector of the ECM (pins 61 and 64 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11

Step	Action	Value(s)	Yes	No
10	Replace the APP sensor. Refer to Accelerator Pedal Position (APP) Sensor Replacement in this section. (APP sensor 2 is internal to APP sensor assembly) Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the APP Sensor 2 parameter with the Tech 2. Is the APP Sensor 2 parameter less than the specified value?	0.2 volts	Go to Step 3	Go to Step 13
13	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1283 (Flash Code 24)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of two individual sensors within one housing. The engine control module (ECM) uses the APP sensors to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injector control. The APP sensor 2 has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- APP sensor 2 signal circuit

The ECM supplies 5 volts to the APP sensor 2 on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The APP sensor 2 provides a signal to the ECM on the APP sensor 2 signal circuit, which is relative to the position changes of the accelerator pedal angle. The ECM monitors the APP sensor 2 signal for voltages outside the normal range of the APP sensor 2. If the ECM detects an excessively high APP sensor 2 signal voltage, this DTC will set.

Condition for Running the DTC

- DTCs P1630 and P1632 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.

Condition for Setting the DTC

- The ECM detects that the APP sensor 2 signal voltage is more than 4.9 volts.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM blinks the exhaust brake indicator lamp when the diagnostic runs and fails.
- The ECM inhibits exhaust brake control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL and exhaust brake indicator lamp when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- APP sensor 2 may have an intermittent open somewhere in the pedal range.

DTC P1283 (Flash Code 24)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Fully depress and release the accelerator pedal while observing the Accelerator Pedal Position (APP) Sensor 2 parameter with the Tech 2. Does the APP Sensor 2 parameter ever exceed the specified value?	4.8 volts	Go to Step 3	Go to Diagnostic Aids
3	1. Start the engine. 2. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is the DTC P1632 also set?	—	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the APP Sensor 2 parameter with the Tech 2. Is the APP Sensor 2 parameter less than the specified value?	0.2 volts	Go to DTC P1632	Go to Step 7
5	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the APP Sensor 2 parameter with the Tech 2. Is the APP Sensor 2 parameter less than the specified value?	0.2 volts	Go to Step 6	Go to Step 7
6	1. Turn OFF the ignition. 2. Connect a test lamp between the low reference circuit of the APP sensor 2 harness (pin 3 of B-280 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 8
7	**Important:** The APP sensor 2 may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the engine control module (ECM) (pin 64 of J-191 connector) and the APP sensor 2 (pin 2 of B-280 connector) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the low reference circuit between the ECM (pin 60 of J-191 connector) and the APP sensor 2 (pin 3 of B-280 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
9	1. Turn OFF the ignition. 2. Inspect for an intermittent and for a poor connection at the harness connector of the APP sensor (pin 3 of B-280 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11

Step	Action	Value(s)	Yes	No
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the APP sensor 2 circuit at the harness connector of the ECM (pin 60 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the APP sensor. Refer to Accelerator Pedal Position (APP) Sensor Replacement in this section. (APP sensor 2 is internal to APP sensor assembly) Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Fully depress and release the accelerator pedal while observing the APP Sensor 2 parameter with the Tech 2. Does the APP Sensor 2 parameter ever exceed the specified value?	4.8 volts	Go to Step 3	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1345 (Flash Code 16)

Circuit Description

The crankshaft position (CKP) sensor is located on top of the flywheel housing. There are 56 notches spaced 6° apart and a 30° section that is open span. This open span portion allows for the detection of cylinder #1 top dead center (TDC).
The camshaft position (CMP) sensor is installed on the cylinder head at the rear of the camshaft gear. The CMP sensor detects a total of five through holes (four holes arranged equally every 90° and one reference hole on the camshaft gear flange surface).
Detecting the open span portion from the CKP sensor and one reference hole from the CMP sensor, the engine control module (ECM) determines cylinder #1 compression top dead center (TDC) to ensure they correlate with each other. If the ECM detects both signals are out of synchronization, this DTC will set.

Condition for Running the DTC

- DTCs P0335, P0336, P0340 and P0341 are not set.
- The ignition switch is ON.
- The CKP sensor signal is detected.
- The CMP sensor signal is detected.

Condition for Setting the DTC

- The ECM detects that the CKP sensor signals and CMP sensor signals are out of synchronization during engine rotations.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail at next driving cycle.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- This DTC is caused by an incorrect mechanical timing condition, which was most likely cased by wrong installation of timing gear, flywheel or camshaft.

DTC P1345 (Flash Code 16)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. If engine does not start, crank over the engine for 10 seconds. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is the DTC P0335, P0336, P0340 or P0341 also set?	—	Go to Applicable DTC	Go to Step 3
3	Inspect the engine mechanical timing. Refer to the Engine Mechanical section. Repair as necessary. **Notice:** If the flywheel dowel pin is missing or pushed in and the flywheel is incorrectly installed, this DTC may set. Did you complete the repair?	—	Go to Step 4	—
4	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. If engine does not start, crank over the engine for 10 seconds. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 5

Step	Action	Value(s)	Yes	No
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1625 (Flash Code 416)

Circuit Description

The engine control module (ECM) main relay is energized to feed the battery voltage to the ECM through the relay switch side when the ECM receives an ignition voltage switch ON signal. When the ignition switch is OFF, the ECM main relay is de-energized after a certain length of time passed.
If the ECM detects the ECM main relay is turned OFF before ECM commanded OFF, this DTC will set. (ECM main relay open stuck DTC)
If the ECM detects the ECM has been ON when the relay is commanded OFF, this DTC will also set. (ECM main relay close stuck DTC)

Condition for Running the DTC

ECM main relay open stuck DTC

- DTC P1630 is not set.
- The ignition switch is ON.
- The ignition voltage is more than 18 volts.
- The ignition ON time is longer than 3 seconds.

Condition for Setting the DTC

ECM main relay open stuck DTC

- The ECM detects a low voltage condition on the ECM main relay voltage feed circuit when the relay is commanded ON for longer than 5 seconds.

ECM main relay close stuck DTC

- The ECM detects that the ECM has been ON when the relay is commanded OFF for longer than 10 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Faulty or sticking ECM main relay will set this DTC.

DTC P1625 (Flash Code 416)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	Does the engine start?	—	Go to Step 4	Go to Step 8
4	1. Turn OFF the ignition. 2. Disconnect the ECM main relay. Does the engine start?	—	Go to Step 5	Go to Step 6
5	Repair the short to battery on the voltage feed circuits to the engine control module (ECM) between the ECM (pins 2 and 5 of J-191 connector) and the ECM main relay (pin 2 of X-18 connector). Did you complete the repair?	—	Go to Step 13	—

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition for 30 seconds. 2. Replace the ECM main relay with the glow relay or replace with a known good relay. 3. Turn ON the ignition, with the engine OFF. 4. Turn ON the ignition. 5. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 7	Go to Step 11
7	1. Test the voltage supply circuits to the ECM main relay between the ECM (pins 21 and 40 of J-191 connector) and the ECM main relay (pin 4 of X-18 connector) for a short to battery. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Turn OFF the ignition for 30 seconds. 2. Replace the ECM main relay with the glow relay or replace with a known good relay. 3. Start the engine. Does the engine start?	—	Go to Step 11	Go to Step 9
9	1. Turn OFF the ignition. 2. Inspect for an intermittent, for poor tightening and corrosion at the chassis ground terminal (J-9). 3. Repair the tightening or clean the corrosion as necessary. 4. Inspect the ECM (40A) slow blow fuse for open. 5. Replace the ECM (40A) slow blow fuse if open. If it continues to open, repair the short to ground on one of the circuits that is fed by the ECM (40A) slow blow fuse. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10

Step	Action	Value(s)	Yes	No
10	1. Turn OFF the ignition. 2. Disconnect the ECM main relay. 3. Inspect for an intermittent and for poor connections and corrosion on each ECM main relay terminal (pins 2, 3, 4 and 5 of X-18 connector). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on the ECM main relay voltage supply and feed circuits at the harness connector of the ECM (pins 2, 5, 21 and 40 of J-191 connector). 6. Test for high resistance on each ECM main relay circuit. • Between pins 2 and 5 of J-191 and pin 2 of X-18 connector • Between pins 21 and 40 of J-191 connector and pin 4 of X-18 connector • Between ECM (40A) slow blow fuse and pin 3 of X-18 connector • Between pin 5 of X-18 connector and chassis ground (J-9) 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the ECM main relay. Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected relay or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1630 (Flash Code 36)

Circuit Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM).

Condition for Setting the DTC

- The ECM detects a malfunction in its internal analog / digital (A/D) converter.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

DTC P1630 (Flash Code 36)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1631 (Flash Code 55)

Circuit Description

The engine control module (ECM) provides 5 volts reference voltage through the reference circuit 1 to the following sensors:

- Accelerator pedal position (APP) sensor 1
- PTO throttle sensor
- Idle up sensor

The 5 volts reference circuits are bussed together outside the ECM. Therefore, a short circuit condition on one sensor 5 volts reference circuit may affect the entire 5 volt reference circuit 1. The ECM monitors the voltage on the 5 volts reference circuit 1. If the ECM detects the voltage is excessively low or high, this DTC will set.

Condition for Running the DTC

- DTC P1630 is not set.
- The ignition switch is ON.
- The battery voltage is between 16 – 32 volts.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the 5 volts reference circuit 1 voltage is less than 4.5 volts.
- The ECM detects that the 5 volts reference circuit 1 voltage is more than 5.5 volts.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM blinks the exhaust brake indicator lamp when the diagnostic runs and fails.
- The ECM inhibits exhaust brake control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- The ECM turns OFF the exhaust brake indicator lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1631 (Flash Code 55)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the idle up sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit of the idle up sensor harness (pin 3 of B-281 connector) and a known good ground. 4. Turn ON the ignition, with engine OFF. Is the DMM voltage less than the specified value?	5.5 volts	Go to Step 4	Go to Step 7
4	Is the DMM voltage more than the specified value at Step 3?	4.5 volts	Go to Step 9	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Keep the DMM with connected to the idle up sensor harness connector. 2. Turn OFF the ignition. 3. Disconnect the accelerator pedal position (APP) sensor harness connector. 4. Turn ON the ignition, with the engine OFF. Does the DMM voltage change to more than the specified value when the APP harness connector is disconnected?	4.5 volts	Go to Step 10	Go to Step 6
6	**Notice:** If no PTO throttle sensor is installed, skip to Step 8. 1. Keep the DMM with connected to the idle up sensor harness connector. 2. Turn OFF the ignition. 3. Disconnect the PTO throttle sensor harness connector. 4. Turn ON the ignition, with the engine OFF. Does the DMM voltage change to more than the specified value when the PTO throttle sensor harness connector is disconnected?	4.5 volts	Go to Step 11	Go to Step 8
7	1. Test the 5 volts reference circuit 1 between the engine control module (ECM) (pin 42 of J-191 connector) and the following components for a short to battery or ignition voltage: • APP sensor 1 (pin 4 of B-280 connector) • PTO throttle sensor (pin 1 of J-166 connector) • Idle up sensor (pin 3 of B-281 connector) 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the 5 volts reference circuit 1 between the ECM (pin 42 of J-191 connector) and the following components for a short to ground or short to the low reference circuit: • APP sensor 1 (pin 4 of B-280 connector) • PTO throttle sensor (pin 1 of J-166 connector) • Idle up sensor (pin 3 of B-281 connector) 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
9	Replace the idle up sensor. Refer to Idle Up Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—
10	Replace the APP sensor. Refer to Accelerator Pedal Position (APP) Sensor Replacement in this section. (APP sensor 1 is internal to APP sensor assembly) Did you complete the replacement?	—	Go to Step 13	—
11	Replace the PTO throttle sensor. Did you complete the replacement?	—	Go to Step 13	—

Step	Action	Value(s)	Yes	No
12	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1632 (Flash Code 55)

Circuit Description

The engine control module (ECM) provides 5 volts reference voltage through the reference circuit 2 to the following sensors:

- Accelerator pedal position (APP) sensor 2
- Barometric pressure (BARO) sensor

The ECM also provides 5 volts reference voltage through the reference circuit 5 to the following sensors:

- Fuel rail pressure (FRP) sensor
- EGR valve position sensor

The 5 volts reference circuits 2 and 5 are independent of each other outside of the ECM, but are bussed together inside the ECM. Therefore, a short circuit condition on one sensor 5 volts reference circuit may affect the entire 5 volt reference circuit 2 and 5. The ECM monitors the voltage on the 5 volts reference circuit 2 and 5. If the ECM detects the voltage is excessively low or high, this DTC and DTC P1635 will also set.

Condition for Running the DTC

- DTC P1630 is not set.
- The ignition switch is ON.
- The battery voltage is between 16 – 32 volts.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the 5 volts reference circuit 2 or 5 voltage is less than 4.5 volts.
- The ECM detects that the 5 volts reference circuit 2 or 5 voltage is more than 5.5 volts.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM blinks the exhaust brake indicator lamp when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.
- The ECM inhibits EGR valve control.
- The ECM inhibits exhaust brake control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL and exhaust brake indicator lamp when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1632 (Flash Code 55)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the EGR valve harness connector. 3. Connect a DMM between the 5 volts reference circuit of the EGR valve position sensor harness (pin 1 of E-94 connector) and a known good ground. 4. Turn ON the ignition, with engine OFF. Is the DMM voltage less than the specified value?	5.5 volts	Go to Step 4	Go to Step 8
4	Is the DMM voltage more than the specified value at Step 3?	4.5 volts	Go to Step 10	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Keep the DMM with connected to the EGR valve position sensor harness connector. 2. Turn OFF the ignition. 3. Disconnect the fuel rail pressure (FRP) sensor harness connector. 4. Turn ON the ignition, with the engine OFF. Does the DMM voltage change to more than the specified value when the FRP sensor harness connector is disconnected?	4.5 volts	Go to Step 11	Go to Step 6
6	1. Keep the DMM with connected to the EGR valve position sensor harness connector. 2. Turn OFF the ignition. 3. Disconnect the barometric pressure (BARO) sensor harness connector. 4. Turn ON the ignition, with the engine OFF. Does the DMM voltage change to more than the specified value when the BARO sensor harness connector is disconnected?	4.5 volts	Go to Step 13	Go to Step 7
7	1. Keep the DMM with connected to the EGR valve position sensor harness connector. 2. Turn OFF the ignition. 3. Disconnect the accelerator pedal position (APP) sensor harness connector. 4. Turn ON the ignition, with the engine OFF. Does the DMM voltage change to more than the specified value when the APP sensor harness connector is disconnected?	4.5 volts	Go to Step 12	Go to Step 9
8	1. Test the 5 volts reference circuit 2 between the engine control module (ECM) (pin 61 of J-191 connector) and the following components for a short to battery or ignition voltage: • APP sensor 2 (pin 1 of B-280 connector) • BARO sensor (pin 3 of B-422 connector) 2. Test the 5 volts reference circuit 5 between the ECM (pin 87 of E-111 connector) and the following components for a short to battery or ignition voltage: • FRP sensor (pin 3 of E-113 connector) • EGR position sensor (pin 1 of E-94 connector) 3. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14

Step	Action	Value(s)	Yes	No
9	1. Test the 5 volts reference circuit 2 between the ECM (pin 61 of J-191 connector) and the following components for a short to ground or short to the low reference circuit: • APP sensor 2 (pin 1 of B-280 connector) • BARO sensor (pin 3 of B-422 connector) 2. Test the 5 volts reference circuit 5 between the ECM (pin 87 of E-111 connector) and the following components for a short to ground or short to the low reference circuit: • FRP sensor (pin 3 of E-113 connector) • EGR position sensor (pin 1 of E-94 connector) 3. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
10	Replace the EGR valve. Refer to EGR Valve Replacement in this section. (EGR valve position sensor is internal to EGR valve) Did you complete the replacement?	—	Go to Step 15	—
11	Replace the FRP sensor. Refer to Fuel Rail Pressure (FRP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 15	—
12	Replace the APP sensor. Refer to Accelerator Pedal Position (APP) Sensor Replacement in this section. (APP sensor 2 is internal to APP sensor assembly) Did you complete the replacement?	—	Go to Step 15	—
13	Replace the BARO sensor. Refer to Barometric Pressure (BARO) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1633 (Flash Code 55)

Circuit Description

The engine control module (ECM) has ability to provide 5 volts reference voltage through the reference circuit 3. But it is not used. The ECM provides 5 volts reference voltage through the reference circuit 4 to the boost pressure sensor. The 5 volts reference circuits 3 and 4 are independent of each other outside of the ECM, but are bussed together inside the ECM. Therefore, a short circuit condition on one sensor 5 volts reference circuit may affect the entire 5 volt reference circuit 3 and 4. The ECM monitors the voltage on the 5 volts reference circuit 3 and 4. If the ECM detects the voltage is excessively low or high, this DTC and DTC P1634 will also set.

Condition for Running the DTC

- DTC P1630 is not set.
- The ignition switch is ON.
- The battery voltage is between 16 – 32 volts.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the 5 volts reference circuit 3 or 4 voltage is less than 4.5 volts.
- The ECM detects that the 5 volts reference circuit 3 or 4 voltage is more than 5.5 volts.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1633 (Flash Code 55)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to DTC P1634	Go to Diagnostic Aids

P1634 (Flash Code 55)

Circuit Description

The engine control module (ECM) provides 5 volts reference voltage through the reference circuit 4 to the boost pressure sensor. The ECM also has ability to provide 5 volts reference voltage through the reference circuit 3. But it is not used. The 5 volts reference circuits 3 and 4 are independent of each other outside of the ECM, but are bussed together inside the ECM. Therefore, a short circuit condition on one sensor 5 volts reference circuit may affect the entire 5 volt reference circuit 3 and 4. The ECM monitors the voltage on the 5 volts reference circuit 3 and 4. If the ECM detects the voltage is excessively low or high, this DTC and DTC P1633 will also set.

Condition for Running the DTC

- DTC P1630 is not set.
- The ignition switch is ON.
- The battery voltage is between 16 – 32 volts.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the 5 volts reference circuit 3 or 4 voltage is less than 4.5 volts.
- The ECM detects that the 5 volts reference circuit 3 or 4 voltage is more than 5.5 volts.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.
- The ECM inhibits EGR valve control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1634 (Flash Code 55)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the boost pressure sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit of the boost pressure sensor harness (pin 3 of J-216 connector) and a known good ground. 4. Turn ON the ignition, with engine OFF. Is the DMM voltage less than the specified value?	5.5 volts	Go to Step 4	Go to Step 5
4	Is the DMM voltage more than the specified value at Step 3?	4.5 volts	Go to Step 7	Go to Step 6

Step	Action	Value(s)	Yes	No
5	1. Test the 5 volts reference circuit 3 between the engine control module (ECM) (pin 95 of E-111 connector) and the boost pressure sensor (pin 3 of J-216 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 8
6	1. Test the 5 volts reference circuit 3 between the ECM (pin 95 of E-111 connector) and the boost pressure sensor (pin 3 of J-216 connector) for a short to ground or short to the low reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 8
7	Replace the boost pressure sensor. Refer to Boost Pressure Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 9	Go to Step 8
8	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 9	Go to Step 8
9	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 10
10	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1635 (Flash Code 55)

Circuit Description

The engine control module (ECM) provides 5 volts reference voltage through the reference circuit 5 to the following sensors:

- Fuel rail pressure (FRP) sensor
- EGR valve position sensor

The ECM also provides 5 volts reference voltage through the reference circuit 2 to the following sensors:

- Accelerator pedal position (APP) sensor 2
- Barometric pressure (BARO) sensor

The 5 volts reference circuits 2 and 5 are independent of each other outside of the ECM, but are bussed together inside the ECM. Therefore, a short circuit condition on one sensor 5 volts reference circuit may affect the entire 5 volt reference circuit 2 and 5. The ECM monitors the voltage on the 5 volts reference circuit 2 and 5. If the ECM detects the voltage is excessively low or high, this DTC and DTC P1632 will also set.

Condition for Running the DTC

- DTC P1630 is not set.
- The ignition switch is ON.
- The battery voltage is between 16 – 32 volts.

Condition for Setting the DTC

Either of following condition is met:

- The ECM detects that the 5 volts reference circuit 2 or 5 voltage is less than 4.5 volts.
- The ECM detects that the 5 volts reference circuit 2 or 5 voltage is more than 5.5 volts.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM blinks the exhaust brake indicator lamp when the diagnostic runs and fails.
- The ECM limits accelerator control range.
- The ECM inhibits pilot injection.
- The ECM inhibits EGR valve control.
- The ECM inhibits exhaust brake control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL and exhaust brake indicator lamp when the key is cycled after a current DTC clears.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1635 (Flash Code 55)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to DTC P1632	Go to Diagnostic Aids

P1681 (Flash Code 46)

Circuit Description

The engine control module (ECM) controls the exhaust brake which energizes the intake throttle solenoid valve and exhaust brake solenoid valve based on vehicle running condition. The ECM commands each solenoid valve to close each throttle valve by applying vacuum. If the ECM detects that an open circuit or short to ground on the exhaust brake solenoid valve control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The battery voltage is between 16 – 32 volts.
- The engine is running.

Condition for Setting the DTC

- The ECM detects a low voltage condition on the exhaust brake solenoid valve control circuit for longer than 10 seconds when the solenoid valve is commanded OFF.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM blinks the exhaust brake indicator lamp when the diagnostic runs and fails.
- The ECM inhibits exhaust brake control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- The ECM turns OFF the exhaust brake indicator lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1681 (Flash Code 46)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Perform the Exhaust Brake Control test with the Tech 2. 5. Command the Exhaust Brake ON with the Tech 2. Does the exhaust brake solenoid valve click when commanded ON with the Tech 2 (note that intake throttle solenoid valve also click when commanded ON)?	—	Go to Step 3	Go to Step 4
3	1. Turn OFF the ignition for 30 seconds. 2. Start the engine. 3. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 13	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the exhaust brake solenoid valve harness connector. 3. Connect a test lamp between the voltage feed circuit of the exhaust brake solenoid valve harness (pin 1 of J-31 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 7

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Connect a test lamp between the control circuit of the exhaust brake solenoid valve harness (pin 2 of J-31 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 6
6	1. Keep the test lamp with connected. 2. Perform the Exhaust Brake Control test with the Tech 2. 3. Command the Exhaust Brake ON with the Tech 2. Does the test lamp illuminate?	—	Go to Step 10	Go to Step 8
7	Repair the open circuit or high resistance on the voltage feed circuit between the ECM (10A) fuse and the exhaust brake solenoid valve (pin 1 of J-31 connector). Check the ECM (10A) fuse first. Did you complete the repair?	—	Go to Step 14	—
8	1. Test the control circuit between the engine control module (ECM) (pin 15 of J-191 connector) and the exhaust brake solenoid valve (pin 2 of J-31 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
9	1. Test the control circuit between the ECM (pin 15 of J-191 connector) and the exhaust brake solenoid valve (pin 2 of J-31 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
10	1. Turn OFF the ignition. 2. Disconnect the exhaust brake solenoid valve harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the exhaust brake solenoid valve (pins 1 and 2 of J-31 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 12
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the exhaust brake solenoid valve control circuit at the harness connector of the ECM (pin 15 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
12	Replace the exhaust brake solenoid valve. Refer to Exhaust Brake Solenoid Valve Replacement in Exhaust System section. Did you complete the replacement?	—	Go to Step 14	—

Step	Action	Value(s)	Yes	No
13	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 14	—
14	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 15
15	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1682 (Flash Code 46)

Circuit Description

The engine control module (ECM) controls the exhaust brake which energizes the intake throttle solenoid valve and exhaust brake solenoid valve based on vehicle running condition. The ECM commands each solenoid valve to close each throttle valve by applying vacuum. If the ECM detects that a short to battery or ignition voltage on the exhaust brake solenoid valve control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The battery voltage is between 16 – 32 volts.
- The engine is running.

Condition for Setting the DTC

- The ECM detects a high voltage condition on the exhaust brake solenoid valve control circuit for longer than 10 seconds when the solenoid valve is commanded ON.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM blinks the exhaust brake indicator lamp when the diagnostic runs and fails.
- The ECM inhibits exhaust brake control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- The ECM turns OFF the exhaust brake indicator lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The number below refers to the step number on the diagnostic table.
3. If the exhaust brake solenoid valve control circuit between the ECM and the solenoid valve is normal, voltage level low DTC P1681 will set.

DTC P1682 (Flash Code 46)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Perform the Exhaust Brake Control test with the Tech 2. 5. Command the Exhaust Brake ON with the Tech 2. Does the exhaust brake solenoid valve click when commanded ON with the Tech 2 (note that intake throttle solenoid valve also click when commanded ON)?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the exhaust brake solenoid valve harness connector. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does DTC P1681 set, but not DTC P1682?	—	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the control circuit between the engine control module (ECM) (pin 15 of J-191 connector) and the exhaust brake solenoid valve (pin 2 of J-31 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Replace the exhaust brake solenoid valve. Refer to Exhaust Brake Solenoid Valve Replacement in Exhaust System section. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Lift the driving wheels or drive the vehicle. 5. Let the vehicle run so that the exhaust brake may operate enough time (longer than 3 seconds). Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

U2104, U2106 (Flash Code 84, 85)

Circuit Description

The engine control module (ECM), the transmission control module (TCM), the electric hydraulic control module (EHCU) (ABS module) and the data recording module (DRM) communicate control and diagnostic information via a controller area network (CAN) communication bus. The ECM monitors CAN operational status by expecting a constant flow of messages from the TCM, EHCU and DRM. If the ECM fails to receive an expected message from the TCM, EHCU and DRM, DTC U2104 or U2106 will set depending on what communication is lost.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

U2104

- The ECM detects that the CAN Bus OFF status.

U2106

- The ECM detects that the CAN Bus messages from the TCM are not being received.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM blinks the exhaust brake indicator lamp when the diagnostic runs and fails.
- The ECM inhibits exhaust brake control.

Condition for Clearing the MIL / DTC

- The ECM turns OFF the MIL when the key is cycled after a current DTC clears.
- The ECM turns OFF the exhaust brake indicator lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears after 20 consecutive driving cycles without a fault. Or clear with the Tech 2 or accelerator pedal operation.

Diagnostic Aid

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- Diagnostic charts are different depending on the specification of the vehicle.

DTC U2104, U2106 (Flash Code 84, 85)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Chart for without Smoother and ABS

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Monitor the engine control module (ECM) Diagnostic Trouble Code (DTC) Information with the Tech 2. 4. Start the engine. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Measure the resistance across the controller area network (CAN) Low and High circuits by back probing the resistor 1 (pins 1 and 2 of B-387 connector) (resistor 1 is located near the driver's side dash panel. It is blue connector). Is the resistance within the specified value (parallel resistance of the 120 Ω resister 1 and the 120 Ω resistor 2 should be 60 Ω)?	50 – 70 Ω	Go to Step 9	Go to Step 4
4	Is the resistance less than the specified value at Step 3?	—	Go to Step 5	Go to Step 7

Step	Action	Value(s)	Yes	No
5	1. Keep the DMM with connected. 2. Disconnect the engine control module (ECM) harness connectors. Is the resistance within the specified value?	50 – 70 Ω	Go to Step 23	Go to Step 6
6	1. Keep the DMM with connected. 2. Disconnect the data recording module (DRM) harness connector (DRM is located behind the glove box). Is the resistance within the specified value?	50 – 70 Ω	Go to Step 22	Go to Step 16
7	1. Disconnect the resistor 1 harness connector. 2. Measure the resistance of the resistor 1. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 8	Go to Step 20
8	1. Disconnect the resister 2 harness connector (resistor 2 is located behind the radio and above the heater unit. It is blue connector). 2. Measure the resistance of the resistor 2. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 17	Go to Step 21
9	1. Disconnect the resistor 1 and resistor 2 harness connector. 2. Turn ON the ignition, with the engine OFF. 3. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 4. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 10	Go to Step 12
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connectors. 3. Turn ON the ignition, with the engine OFF. 4. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 5. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 11	Go to Step 14

Step	Action	Value(s)	Yes	No
11	1. Turn OFF the ignition. 2. Reconnect the ECM harness connectors. 3. Disconnect the DRM harness connector. 4. Turn ON the ignition, with the engine OFF. 5. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 6. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Diagnostic Aids	Go to Step 15
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connectors. 3. Disconnect the DRM harness connector. 4. Turn ON the ignition, with the engine OFF. 5. Test the CAN Low and CAN High circuits among the resistor 1, resistor 2, ECM and DRM for a short to ground and short to voltage. Did you find and correct the condition?	—	Go to Step 24	Go to Step 13
13	1. Turn OFF the ignition. 2. Reconnect the ECM harness connectors. 3. Turn ON the ignition, with the engine OFF. 4. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 5. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 22	Go to Step 23
14	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 – 3.7 volts in Step 10) between the DRM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 24	Go to Step 18
15	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 – 3.7 volts in Step 11) between the ECM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 24	Go to Step 19

Step	Action	Value(s)	Yes	No
16	Repair the short circuit each other across the CAN Low and High circuits among the resistor 1, resistor 2, ECM and DRM. Did you complete the repair?	—	Go to Step 24	—
17	1. Repair the open circuit or high resistance on the CAN Low and High circuits between the resistor 1 (pins 1 and 2 of B-387 connector) and the resistor 2 (pins 1 and 2 of B-431 connector). 2. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the each resistor. Did you complete the repair?	—	Go to Step 24	—
18	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the DRM (pins 2 and 8 of B-429 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 24	Go to Step 22
19	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the ECM (pins 18 and 37 of J-191 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 24	Go to Step 23
20	Replace the resistor 1. Did you complete the replacement?	—	Go to Step 24	—
21	Replace the resistor 2. Did you complete the replacement?	—	Go to Step 24	—
22	Replace the DRM. Refer to Data Recording Module (DRM) Replacement. Did you complete the replacement?	—	Go to Step 24	—
23	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 24	—
24	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 25
25	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

Chart for with Soother but without ABS

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Monitor the engine control module (ECM) Diagnostic Trouble Code (DTC) Information with the Tech 2. 4. Start the engine. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	Attempt to communicate with the transmission control module (TCM) via the Transmission Data table. Does the Tech 2 communicate with the TCM?	—	Go to Step 4	Go to Diagnostic System Check – Transmission Controls
4	1. Turn OFF the ignition. 2. Measure the resistance across the controller area network (CAN) Low and High circuits by back probing the resistor 1 (pins 1 and 2 of B-387 connector) (resistor 1 is located near the driver's side dash panel. It is blue connector). Is the resistance within the specified value (parallel resistance of the 120 Ω resister 1 and the 120 Ω resistor 2 should be 60 Ω)?	50 – 70 Ω	Go to Step 11	Go to Step 5
5	Is the resistance less than the specified value at Step 4?	—	Go to Step 6	Go to Step 9
6	1. Keep the DMM with connected. 2. Disconnect the TCM harness connectors. Is the resistance within the specified value?	50 – 70 Ω	Go to Step 29	Go to Step 7
7	1. Keep the DMM with connected. 2. Disconnect the engine control module (ECM) harness connectors. Is the resistance within the specified value?	50 – 70 Ω	Go to Step 30	Go to Step 8
8	1. Keep the DMM with connected. 2. Disconnect the data recording module (DRM) harness connector (DRM is located behind the glove box). Is the resistance within the specified value?	50 – 70 Ω	Go to Step 28	Go to Step 21
9	1. Disconnect the resistor 1 harness connector. 2. Measure the resistance of the resistor 1. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 10	Go to Step 26
10	1. Disconnect the resister 2 harness connector (resistor 2 is located behind the radio and above the heater unit. It is blue connector). 2. Measure the resistance of the resistor 2. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 22	Go to Step 27

Step	Action	Value(s)	Yes	No
11	1. Disconnect the resistor 1 and resistor 2 harness connector. 2. Turn ON the ignition, with the engine OFF. 3. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 4. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 12	Go to Step 15
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connectors. 3. Disconnect the TCM harness connectors. 4. Turn ON the ignition, with the engine OFF. 5. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 6. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 13	Go to Step 18
13	1. Turn OFF the ignition. 2. Reconnect the TCM harness connectors. 3. Disconnect the DRM harness connectors. 4. Turn ON the ignition, with the engine OFF. 5. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 6. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 14	Go to Step 19
14	1. Turn OFF the ignition. 2. Reconnect the ECM harness connectors. 3. Disconnect the TCM harness connectors. 4. Turn ON the ignition, with the engine OFF. 5. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 6. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Diagnostic Aids	Go to Step 20

Step	Action	Value(s)	Yes	No
15	1. Turn OFF the ignition. 2. Disconnect the ECM harness connectors. 3. Disconnect the TCM harness connectors. 4. Disconnect the DRM harness connector. 5. Turn ON the ignition, with the engine OFF. 6. Test the CAN Low and CAN High circuits among the resistor 1, resistor 2, ECM, TCM and DRM for a short to ground and short to voltage. Did you find and correct the condition?	—	Go to Step 31	Go to Step 16
16	1. Turn OFF the ignition. 2. Reconnect the ECM harness connectors. 3. Turn ON the ignition, with the engine OFF. 4. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 5. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 17	Go to Step 30
17	1. Turn OFF the ignition. 2. Reconnect the TCM harness connectors. 3. Turn ON the ignition, with the engine OFF. 4. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 5. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 28	Go to Step 29
18	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 – 3.7 volts in Step 12) between the DRM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 23
19	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 – 3.7 volts in Step 13) between the TCM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 24

Step	Action	Value(s)	Yes	No
20	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 – 3.7 volts in Step 14) between the ECM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 25
21	Repair the short circuit each other across the CAN Low and High circuits among the resistor 1, resistor 2, ECM, TCM and DRM. Did you complete the repair?	—	Go to Step 31	—
22	1. Repair the open circuit or high resistance on the CAN Low and High circuits between the resistor 1 (pins 1 and 2 of B-387 connector) and the resistor 2 (pins 1 and 2 of B-431 connector). 2. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the each resistor. Did you complete the repair?	—	Go to Step 31	—
23	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the DRM (pins 2 and 8 of B-429 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 28
24	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the TCM (pins 2 and 3 of B-427 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 29
25	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the ECM (pins 18 and 37 of J-191 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 30
26	Replace the resistor 1. Did you complete the replacement?	—	Go to Step 31	—
27	Replace the resistor 2. Did you complete the replacement?	—	Go to Step 31	—
28	Replace the DRM. Refer to Data Recording Module (DRM) Replacement. Did you complete the replacement?	—	Go to Step 31	—
29	Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in the transmission section. Did you complete the replacement?	—	Go to Step 31	—

Step	Action	Value(s)	Yes	No
30	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 31	—
31	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 32
32	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

Chart for with ABS but without Smoother

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Monitor the engine control module (ECM) Diagnostic Trouble Code (DTC) Information with the Tech 2. 4. Start the engine. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	Attempt to communicate with the electrical hydraulic control unit (EHCU) (ABS module) via the ABS Data table. Does the Tech 2 communicate with the EHCU?	—	Go to Step 4	Go to Diagnostic System Check – Anti-lock Brake System Controls
4	1. Turn OFF the ignition. 2. Measure the resistance across the controller area network (CAN) Low and High circuits by back probing the resistor 1 (pins 1 and 2 of B-387 connector) (resistor 1 is located near the driver's side dash panel. It is blue connector). Is the resistance within the specified value (parallel resistance of the 120 Ω resister 1 and the 120 Ω resistor 2 should be 60 Ω)?	50 – 70 Ω	Go to Step 12	Go to Step 5
5	Is the resistance less than the specified value at Step 4?	—	Go to Step 6	Go to Step 10
6	1. Keep the DMM with connected. 2. Disconnect the EHCU harness connector. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 7	Go to Step 20
7	Measure the resistance across the CAN Low and High circuits by back probing the resistor 2 (pins 1 and 2 of B-431 connector) (resistor 2 is located behind the radio and above the heater unit. It is blue connector). Is the resistance within the specified value?	110 – 130 Ω	Go to Step 29	Go to Step 8

Step	Action	Value(s)	Yes	No
8	1. Keep the DMM with connected. 2. Disconnect the engine control module (ECM) harness connectors. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 30	Go to Step 9
9	1. Keep the DMM with connected. 2. Disconnect the data recording module (DRM) harness connector (DRM is located behind the glove box). Is the resistance within the specified value?	110 – 130 Ω	Go to Step 28	Go to Step 21
10	1. Disconnect the resistor 1 harness connector. 2. Measure the resistance of the resistor 1. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 11	Go to Step 26
11	1. Disconnect the resister 2 harness connector (resistor 2 is located behind the radio and above the heater unit. It is blue connector). 2. Measure the resistance of the resistor 2. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 22	Go to Step 27
12	1. Disconnect the resistor 1 and resistor 2 harness connector. 2. Turn ON the ignition, with the engine OFF. 3. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 4. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 13	Go to Step 15
13	1. Turn OFF the ignition. 2. Disconnect the ECM harness connectors. 3. Disconnect the EHCU harness connector. 4. Turn ON the ignition, with the engine OFF. 5. Connect a DMM between the CAN Low circuit (pin 1 of B-431 connector) and a known good ground at the resistor 2 harness connector. Record the voltage reading. 6. Connect a DMM between the CAN High circuit (pin 2 of B-431 connector) and a known good ground at the resistor 2 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 14	Go to Step 18

Step	Action	Value(s)	Yes	No
14	1. Turn OFF the ignition. 2. Reconnect the ECM harness connectors. 3. Disconnect the DRM harness connectors. 4. Turn ON the ignition, with the engine OFF. 5. Connect a DMM between the CAN Low circuit (pin 1 of B-431 connector) and a known good ground at the resistor 2 harness connector. Record the voltage reading. 6. Connect a DMM between the CAN High circuit (pin 2 of B-431 connector) and a known good ground at the resistor 2 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Diagnostic Aids	Go to Step 19
15	1. Turn OFF the ignition. 2. Disconnect the ECM harness connectors. 3. Disconnect the EHCU harness connector. 4. Disconnect the DRM harness connector. 5. Turn ON the ignition, with the engine OFF. 6. Test the CAN Low and CAN High circuits among the resistor 1, resistor 2, ECM, EHCU and DRM for a short to ground and short to voltage. Did you find and correct the condition?	—	Go to Step 31	Go to Step 16
16	1. Turn OFF the ignition. 2. Keep the ECM and DRM harness connectors with disconnect. 3. Reconnect the EHCU harness connector. 4. Turn ON the ignition, with the engine OFF. 5. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 6. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 17	Go to Step 29
17	1. Turn OFF the ignition. 2. Reconnect the ECM harness connectors. 3. Turn ON the ignition, with the engine OFF. 4. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 5. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 28	Go to Step 30

Step	Action	Value(s)	Yes	No
18	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 – 3.7 volts in Step 13) between the DRM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 23
19	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 – 3.7 volts in Step 14) between the ECM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 25
20	Repair the short circuit each other across the CAN Low and High circuits between the resistor 1 and EHCU. Did you complete the repair?	—	Go to Step 31	—
21	Repair the short circuit each other across the CAN Low and High circuits among the resistor 2, ECM, DRM and EHCU. Did you complete the repair?	—	Go to Step 31	—
22	1. Test the CAN Low and High circuits between the resistor 1 (pins 1 and 2 of B-387 connector) and the EHCU (pins 14 and 15 of J-177 connector) for an open circuit or high resistance. 2. Test the CAN Low and High circuits between the resistor 2 (pins 1 and 2 of B-431 connector) and the EHCU (pins 26 and 27 of J-177 connector) for an open circuit or high resistance. 3. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the each resistor. 4. Repair the circuit(s) or connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 24
23	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the DRM (pins 2 and 8 of B-429 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 28
24	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the EHCU (pins 14, 15, 26 and 27 of J-177 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 29

Step	Action	Value(s)	Yes	No
25	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the ECM (pins 18 and 37 of J-191 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 30
26	Replace the resistor 1. Did you complete the replacement?	—	Go to Step 31	—
27	Replace the resistor 2. Did you complete the replacement?	—	Go to Step 31	—
28	Replace the DRM. Refer to Data Recording Module (DRM) Replacement. Did you complete the replacement?	—	Go to Step 31	—
29	Replace the EHCU. Refer to Electric Hydraulic Control Unit (EHCU Replacement in the Anti-lock Brake section). Did you complete the replacement?	—	Go to Step 31	—
30	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 31	—
31	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 32
32	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

Chart for with Smoother and ABS

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Monitor the engine control module (ECM) Diagnostic Trouble Code (DTC) Information with the Tech 2. 4. Start the engine. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	Attempt to communicate with the transmission control module (TCM) via the Transmission Data table. Does the Tech 2 communicate with the TCM?	—	Go to Step 4	Go to Diagnostic System Check – Transmission Controls

Step	Action	Value(s)	Yes	No
4	Attempt to communicate with the electrical hydraulic control unit (EHCU) (ABS module) via the ABS Data table. Does the Tech 2 communicate with the EHCU?	—	Go to Step 5	Go to Diagnostic System Check – Anti-lock Brake System Controls
5	1. Turn OFF the ignition. 2. Measure the resistance across the controller area network (CAN) Low and High circuits by back probing the resistor 1 (pins 1 and 2 of B-387 connector) (resistor 1 is located near the driver's side dash panel. It is blue connector). Is the resistance within the specified value (parallel resistance of the 120 Ω resister 1 and the 120 Ω resistor 2 should be 60 Ω)?	50 – 70 Ω	Go to Step 14	Go to Step 6
6	Is the resistance less than the specified value at Step 5?	—	Go to Step 7	Go to Step 12
7	1. Keep the DMM with connected. 2. Disconnect the EHCU harness connector. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 9	Go to Step 8
8	1. Keep the DMM with connected. 2. Disconnect the TCM harness connectors. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 35	Go to Step 25
9	Measure the resistance across the CAN Low and High circuits by back probing the resistor 2 (pins 1 and 2 of B-431 connector) (resistor 2 is located behind the radio and above the heater unit. It is blue connector). Is the resistance within the specified value?	110 – 130 Ω	Go to Step 36	Go to Step 10
10	1. Keep the DMM with connected. 2. Disconnect the engine control module (ECM) harness connectors. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 37	Go to Step 11
11	1. Keep the DMM with connected. 2. Disconnect the data recording module (DRM) harness connector (DRM is located behind the glove box). Is the resistance within the specified value?	110 – 130 Ω	Go to Step 34	Go to Step 26
12	1. Disconnect the resistor 1 harness connector. 2. Measure the resistance of the resistor 1. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 13	Go to Step 32
13	1. Disconnect the resister 2 harness connector (resistor 2 is located behind the radio and above the heater unit. It is blue connector). 2. Measure the resistance of the resistor 2. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 27	Go to Step 33

Step	Action	Value(s)	Yes	No
14	1. Disconnect the resistor 1 and resistor 2 harness connector. 2. Turn ON the ignition, with the engine OFF. 3. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 4. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 15	Go to Step 18
15	1. Turn OFF the ignition. 2. Disconnect the ECM harness connectors. 3. Disconnect the EHCU harness connectors. 4. Disconnect the DRM harness connector. 5. Turn ON the ignition, with the engine OFF. 6. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 7. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 16	Go to Step 23
16	1. Turn OFF the ignition. 2. Reconnect the DRM harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Connect a DMM between the CAN Low circuit (pin 1 of B-431 connector) and a known good ground at the resistor 2 harness connector. Record the voltage reading. 5. Connect a DMM between the CAN High circuit (pin 2 of B-431 connector) and a known good ground at the resistor 2 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 17	Go to Step 22
17	1. Turn OFF the ignition. 2. Reconnect the ECM harness connectors. 3. Disconnect the DRM harness connectors. 4. Turn ON the ignition, with the engine OFF. 5. Connect a DMM between the CAN Low circuit (pin 1 of B-431 connector) and a known good ground at the resistor 2 harness connector. Record the voltage reading. 6. Connect a DMM between the CAN High circuit (pin 2 of B-431 connector) and a known good ground at the resistor 2 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Diagnostic Aids	Go to Step 24

Step	Action	Value(s)	Yes	No
18	1. Turn OFF the ignition. 2. Disconnect the ECM harness connectors. 3. Disconnect the TCM harness connectors. 4. Disconnect the EHCU harness connector. 5. Disconnect the DRM harness connector. 6. Turn ON the ignition, with the engine OFF. 7. Test the CAN Low and CAN High circuits among the resistor 1, resistor 2, ECM, EHCU and DRM for a short to ground and short to voltage. Did you find and correct the condition?	—	Go to Step 38	Go to Step 19
19	1. Turn OFF the ignition. 2. Keep the ECM, TCM and DRM harness connectors with disconnect. 3. Reconnect the EHCU harness connector. 4. Turn ON the ignition, with the engine OFF. 5. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 6. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 20	Go to Step 36
20	1. Turn OFF the ignition. 2. Reconnect the TCM harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 5. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 21	Go to Step 35
21	1. Turn OFF the ignition. 2. Reconnect the ECM harness connectors. 3. Turn ON the ignition, with the engine OFF. 4. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 5. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 – 3.7 volts	Go to Step 34	Go to Step 37

Step	Action	Value(s)	Yes	No
22	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 – 3.7 volts in Step 16) between the DRM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 28
23	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 – 3.7 volts in Step 15) between the TCM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 29
24	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 – 3.7 volts in Step 17) between the ECM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 31
25	Repair the short circuit each other across the CAN Low and High circuits among the resistor 1, TCM and EHCU. Did you complete the repair?	—	Go to Step 38	—
26	Repair the short circuit each other across the CAN Low and High circuits among the resistor 2, ECM, DRM and EHCU. Did you complete the repair?	—	Go to Step 38	—
27	1. Test the CAN Low and High circuits between the resistor 1 (pins 1 and 2 of B-387 connector) and the EHCU (pins 14 and 15 of J-177 connector) for an open circuit or high resistance. 2. Test the CAN Low and High circuits between the resistor 2 (pins 1 and 2 of B-431 connector) and the EHCU (pins 26 and 27 of J-177 connector) for an open circuit or high resistance. 3. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the each resistor. 4. Repair the circuit(s) or connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 30
28	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the DRM (pins 2 and 8 of B-429 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 34

Step	Action	Value(s)	Yes	No
29	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the TCM (pins 2 and 3 of B-427 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 35
30	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the EHCU (pins 14, 15, 26 and 27 of J-177 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 36
31	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the ECM (pins 18 and 37 of J-191 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 37
32	Replace the resistor 1. Did you complete the replacement?	—	Go to Step 38	—
33	Replace the resistor 2. Did you complete the replacement?	—	Go to Step 38	—
34	Replace the DRM. Refer to Data Recording Module (DRM) Replacement. Did you complete the replacement?	—	Go to Step 38	—
35	Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in the transmission section. Did you complete the replacement?	—	Go to Step 38	—
36	Replace the EHCU. Refer to Electric Hydraulic Control Unit (EHCU Replacement in the Anti-lock Brake section). Did you complete the replacement?	—	Go to Step 38	—
37	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 38	—
38	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 39
39	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

EGR Control System Check

Description

The engine control module (ECM) controls the EGR valve opening based on the barometric pressure, engine speed, engine coolant temperature and fuel injection quantity. The ECM controls the EGR valve by controlling the EGR motor. The EGR valve position is detected by the EGR valve position sensor, and relayed to ECM.

Condition for Running the EGR Control

- The engine coolant temperature is between 65°C (149°F) and 95°C (198°F).
- The barometric pressure (BARO) is more than 90 kPa (13 psi).

EGR Control System Check

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Are any DTCs set in which the “Action Taken When the DTC Sets” under that particular code states, “The ECM inhibits EGR valve control”?	—	Refer to Applicable DTC	Go to Step 3
3	1. Turn OFF the ignition. 2. Inspect for the following conditions: • An EGR valve gasket that is missing or damaged. • EGR gas leakage any of the EGR passages between the exhaust manifold and intake manifold. • Restricted or collapsed EGR passage between the exhaust manifold and the EGR valve. • Any type of restriction in the exhaust system. • Restrict air cleaner element, restrict or collapsed air tubing between the air cleaner and the intake manifold. • Skewed engine coolant temperature (ECT) sensor. Refer to Temperature vs Resistance table to test the ECT sensor at various temperature levels to evaluate the possibility of a skewed sensor. • Skewed barometric pressure (BARO) sensor. Determine the outside barometric pressure from your location specified in the altitude vs barometric pressure table. Refer to Altitude vs Barometric Pressure. • Any water intrusion in the induction system. • Air leaking around any of the air induction tubing between the air cleaner and the intake manifold. 3. Repair the condition as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition for 30 seconds. 2. Start the engine and warm up (allow engine coolant temperature to reach at least 70°C [158°F]). 3. Observe the EGR Position Variance parameter with the Tech 2. Does the EGR Position Variance parameter within the specified value?	± 5%	Go to Step 5	Go to Step 6
5	1. Perform the EGR Control test with the Tech 2 several times. 2. Command the Desired EGR Position “Increase” and “Decrease” with the Tech 2 while observing the EGR Position Variance. Does the EGR Position Variance parameter follow within the specified value?	± 5%	System OK	Go to Step 6
6	1. Turn OFF the ignition. 2. Remove the EGR valve assembly from the engine. Refer to EGR Valve Replacement in this section. 3. Inspect the following for possible causes of EGR valve sticking. • Restricted EGR valve by foreign materials • Excessive deposits at valve Did you find and correct the condition?	—	Go to Step 10	Go to Step 7
7	1. Turn OFF the ignition. 2. Disconnect the EGR valve harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the EGR valve (pins 1, 2, 3, 4 and 6 of E-94 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
8	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) harness connector. 3. Inspect for an intermittent, for poor connections and corrosion on the EGR valve circuits at the harness connector of the ECM (pins 86, 87, 101, 103 and 111 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 9
9	Replace the EGR valve. Refer to EGR Valve Replacement in this section. Did you complete the replacement?	—	Go to Step 10	—
10	Reconnect all previously disconnected components or harness connector(s). Is the action complete?	—	Go to Step 2	—

Glow Control System Check

Description

The glow control system consists of the engine control module (ECM), the glow relay, the glow indicator lamp and glow plugs. The glow control system is operated when the engine coolant temperature is low, which allows easier engine starting. The ECM commands the glow relay ON for a certain length of time at ignition switch is ON with engine OFF. In after glow phase, the glow plugs remain energized for a certain period with engine run.

Glow Control Operation

- The glow control system operates when the engine coolant temperature is less than 10°C (50°F).
- The glow indicator lamp is illuminated between 0.5 seconds and 15 seconds according to the engine coolant temperature. It illuminates 0.5 seconds at 10°C (50°F) or more.
- The glow relay is energized between 1 second and 30 seconds according to the engine coolant temperature. It energizes 1 second at 10°C (50°F) or more.

Glow Control System Check

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0117, P0118, P0380 or P0381 set?	—	Refer to Applicable DTC	Go to Step 3
3	1. Turn OFF the ignition. 2. Make sure the metal bus bar that connects switched battery voltage supply terminal (E-3) and all glow plugs is secured tightly. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the metal bus bar (glow plug power supply E-3 terminal) and a known good ground. 5. Perform the Glow Relay Test with the Tech 2. 6. Command the Glow Relay ON with the Tech 2 while observing the test lamp. Does the test lamp turn ON only when commanded ON with the Tech 2?	—	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Remove the metal bus bar from the glow plugs. 3. Measure resistance of each glow plug between the glow plug terminals and a known good ground. Make sure to record all measurements and take them quickly as to not allow engine temperature changes between measurements. Are the resistances within the specified value each other?	1 Ω	System OK	Go to Step 15

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Replace the glow relay with the starter relay or replace with a known good relay. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the metal bus bar (glow plug power supply E-3 connector) and a known good ground. 5. Perform the Glow Relay Test with the Tech 2. 6. Command the Glow Relay ON with the Tech 2 while observing the test lamp. Does the test lamp turn ON only when commanded ON with the Tech 2?	—	Go to Step 9	Go to Step 6
6	Inspect the Glow (60A) slow blow fuse in the chassis side fuse & relay box. Is the Glow (60A) slow blow fuse open?	—	Go to Step 10	Go to Step 7
7	1. Turn OFF the ignition. 2. Remove the glow relay in the chassis side fuse & relay box. 3. Connect a test lamp between the voltage feed circuit of the glow relay terminal (pin 3 of X-20 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 11
8	1. Turn ON the ignition, with the engine OFF. 2. Connect a test lamp between the power supply circuit to the glow plugs (pin 2 of X-20 connector) and a known good ground. Does the test lamp illuminate?	—	Go to Step 13	Go to Step 12
9	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the glow relay terminals (pins 2 and 3 of X-20 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 14
10	1. Replace the Glow (60A) slow blow fuse. If the slow blow fuse continues to open, repair the short to ground on a circuit fed by the slow blow fuse or check for a shorted attached component. 2. Repair the short to ground or replace the component as necessary. Did you complete the repair?	—	Go to Step 16	—
11	Repair the open circuit in the battery voltage supply circuit between the Glow (60A) slow blow fuse and the glow relay (pin 3 of X-20 connector). Did you complete the repair?	—	Go to Step 16	—
12	Repair the open circuit in the switched battery voltage supply circuit between the glow relay (pin 2 of X-20 connector) and the glow plugs (E-3 terminal). Did you complete the repair?	—	Go to Step 16	—

Step	Action	Value(s)	Yes	No
13	**Important:** The glow plugs may be burnt out if the battery voltage supply circuit is shorted to a voltage source. Repair the short to battery or ignition voltage on the switched battery voltage supply circuit between the glow relay (pin 2 of X-20 connector) and the glow plugs (E-3 terminal). Did you complete the repair?	—	Go to Step 16	—
14	Replace the glow relay. Did you complete the replacement?	—	Go to Step 16	—
15	Replace the appropriate glow plug. Did you complete the replacement?	—	Go to Step 16	—
16	1. Reconnect all previously disconnected components, relay, fuse or harness connector(s). 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the metal bus bar (glow plug power supply E-3 connector) and a known good ground. 5. Perform the Glow Relay Test with the Tech 2. 6. Command the Glow Relay ON with the Tech 2 while observing the test lamp. Does the test lamp turn ON only when commanded ON with the Tech 2?	—	Go to Step 4	Go to Step 5

Engine Warm Up Control System Check

Description

The engine warm up system consists of the engine control module (ECM), the intake throttle valve, the intake throttle solenoid valve, the exhaust brake valve, the exhaust brake solenoid valve and the engine warm up switch. The engine warm up system is operated when the engine coolant temperature is low, which promotes engine warm up. The ECM commands the both intake throttle solenoid valve and the exhaust brake solenoid valve to close each valve by applying vacuum pressure based on engine coolant temperature and warm up request switch input signal.

Condition for Running the Engine Warm Up Control

- The engine warm up switch is ON.
- The accelerator pedal is not depressed.
- The engine coolant temperature is less than 65°C (149°F).
- The vehicle is stationary.

Test Description

The number below refers to the step number on the diagnostic table.
7. Use the Tech 2 to observe the Accelerator Pedal Position (APP) Angle. The APP Angle parameter should change linearly from 0% to 100% according to the accelerator pedal operation.
8. Use the Tech 2 to observe the Vehicle Speed. The Vehicle Speed parameter should indicate correct vehicle speed.

Engine Warm Up Control System Check

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	Does the exhaust brake operate correctly?	—	Go to Step 3	Go to Exhaust Brake Control System Check
3	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0117, P0118, P1271, P1277, P1278, P1282, P1283, P1631, P1632, P1635, P1681 or P1682 set?	—	Refer to Applicable DTC	Go to Step 4
4	1. Park the vehicle. 2. Make sure the idle up control knob to the lowest position. (Full counterclockwise direction) 3. Cool down the engine as necessary (allow engine coolant temperature to cool down at least 60°C [140°F]). 4. Start the engine. 5. Turn ON the engine warm up switch. Are the intake throttle valve and the exhaust brake valve closed when switched ON?	—	Go to Step 5	Go to Step 9
5	Does the engine warm up switch indicator lamp illuminate?	—	Go to Step 6	Go to Step 15
6	Turn OFF the engine warm up switch. Does the engine warm up system cancel?	—	Go to Step 7	Go to Step 19

Step	Action	Value(s)	Yes	No
7	1. Turn ON the engine warm up switch. 2. Press the accelerator pedal. Does the engine warm up system cancel?	—	Go to Step 8	Observe the Accelerator Pedal Position (APP) Angle parameter and refer to APP sensor DTC
8	1. Lift the driving wheels or drive the vehicle. 2. Turn ON the engine warm up switch. Does the engine warm up system cancel?	—	System OK	Observe the Vehicle Speed parameter and refer to DTC P0500
9	1. Start the engine. 2. Turn ON the engine warm up switch. 3. Observe the Engine Warm Up Switch parameter with the Tech 2. Does the Engine Warm Up Switch parameter indicate ON?	—	Go to Step 10	Go to Step 11
10	Observe the Exhaust Brake Solenoid Command parameter with the Tech 2. Does the Exhaust Brake Solenoid Command parameter indicate ON when engine warm up switch is ON?	—	Problem is relating to either solenoid valves, throttle valves and vacuum pressure lines. Refer to applicable diagnostic chart in the Exhaust System Section or refer to Exhaust Brake Control System Check	The ECM is not allowing engine warm up control. Refer to Condition for Running the Engine Warm Up Control
11	1. Turn OFF the ignition. 2. Remove the bezel surrounding the instrument panel cluster (IPC) enough to disconnect the engine warm up switch. 3. Disconnect the engine warm up switch. 4. Connect a test lamp between the voltage feed circuit of the engine warm up switch harness (pin 3 of B-31 connector) and a known good ground. 5. Start the engine. Does the test lamp illuminate?	—	Go to Step 12	Go to Step 13
12	1. Start the engine. 2. Observe the Engine Warm Up Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the engine warm up switch harness connector between pins 3 and 6 of B-31 connector. Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 21	Go to Step 14
13	Repair the open circuit or high resistance on the voltage feed circuit between the Fuel Heater (10A) fuse and the engine warm up switch (pin 3 of B-31 connector). Did you complete the repair?	—	Go to Step 25	—

Step	Action	Value(s)	Yes	No
14	1. Test the engine warm up switch signal circuit between the engine control module (ECM) (pin 51 of J-191 connector) and the engine warm up switch (pin 6 of B-31 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 22
15	1. Turn OFF the ignition. 2. Remove the bezel surrounding the IPC enough to disconnect the engine warm up switch. 3. Connect the engine warm up switch if disconnected. 4. Probe a test lamp between the engine warm up switch indicator lamp harness (pin 4 of B-31 connector) and a known good ground. 5. Start the engine. 6. Turn ON the engine warm up switch. Does the test lamp illuminate?	—	Go to Step 16	Go to Step 17
16	1. Probe a test lamp across the engine warm up switch indicator lamp harness (pins 1 and 4 of B-31 connector). 2. Start the engine. 3. Turn ON the engine warm up switch. Does the test lamp illuminate?	—	Go to Step 21	Go to Step 18
17	Repair the open circuit between the engine warm up switch signal circuit and the indicator lamp circuit (pins 4 and 6 of B-31 connector). Did you compete the repair?	—	Go to Step 25	—
18	Repair the open circuit or high resistance on the engine warm up switch indicator lamp ground circuit between the engine warm up switch (pin 1 of B-31 connector) and ground terminal (B-1). Did you complete the repair?	—	Go to Step 25	—
19	1. Turn OFF the ignition. 2. Remove the bezel surrounding the IPC enough to disconnect the engine warm up switch. 3. Disconnect the engine warm up switch if disconnected. 4. Start the engine. Does the engine warm up system cancel?	—	Go to Step 23	Go to Step 20
20	1. Test the engine warm up switch signal circuit between the ECM (pin 51 of J-191 connector) and the engine warm up switch (pin 6 of B-31 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 24

Step	Action	Value(s)	Yes	No
21	1. Turn OFF the ignition. 2. Disconnect the engine warm up switch harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the engine warm up switch (pins 1, 3, 4 and 6 of B-31 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 23
22	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the engine warm up switch signal circuit at the harness connector of the ECM (pin 51 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 24
23	Replace the engine warm up switch. Did you complete the replacement?	—	Go to Step 25	—
24	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 25	—
25	Reconnect all previously disconnected fuse or harness connector(s). Is the action complete?	—	Go to Step 2	—

Exhaust Brake Control System Check

Description

The exhaust brake control system consists of the engine control module (ECM), the intake throttle valve, the intake throttle solenoid valve, the exhaust brake valve, the exhaust brake solenoid valve and the exhaust brake switch. The ECM commands the both intake throttle solenoid valve and the exhaust brake solenoid valve to close each valve by applying vacuum pressure based on vehicle running conditions and exhaust brake switch input signal.

Condition for Running the Exhaust Brake Control

- The exhaust brake switch is ON.
- The accelerator pedal is not depressed.
- The clutch pedal is not depressed.
- The neutral switch is OFF (other than neutral).
- The vehicle speed is higher than predetermined range.

Test Description

The number below refers to the step number on the diagnostic table.
7. Use the Tech 2 to observe the Accelerator Pedal Position (APP) Angle. The APP Angle parameter should change linearly from 0% to 100% according to the accelerator pedal operation.
10. If the Exhaust Brake Solenoid Command parameter indicates OFF, use the Tech 2 to observe the Vehicle Speed, APP Angle, Clutch Switch and Neutral Switch parameters which allows the exhaust brake control. Refer to Engine Controls Schematic for each input.

Exhaust Brake Control System Check

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Chart 1 of 2

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Are any DTCs set in which the “Action Taken When the DTC Sets” under that particular code states, “The ECM inhibits exhaust brake control”?	—	Refer to Applicable DTC	Go to Step 3
3	1. Start the engine. 2. Turn ON the exhaust brake switch. Does the exhaust brake indicator lamp in the instrument panel cluster (IPC) illuminate?	—	Go to Step 4	Go to Chart 2 of 2 Step 1
4	Turn OFF the exhaust brake switch. Does the exhaust brake indicator lamp in the IPC go out?	—	Go to Step 5	Go to Chart 2 of 2 Step 2
5	1. Turn ON the ignition, with the engine OFF. 2. Perform the Exhaust Brake Control test with the Tech 2. 3. Command the Exhaust Brake ON with the Tech 2. Does the exhaust brake solenoid valve and intake throttle solenoid valve click when commanded ON with the Tech 2 (note that intake throttle solenoid valve and exhaust brake solenoid valve energized at the same time)?	—	Go to Step 6	If both solenoid valves or only exhaust brake solenoid valve is not operated, refer to DTC P1681 or P1682. If only intake throttle solenoid valve is not operated, Go to Step 11

Step	Action	Value(s)	Yes	No
6	1. Lift the driving wheels or drive the vehicle. 2. Turn ON the exhaust brake. 3. Let the vehicle run so that the exhaust brake may operate enough. Does the exhaust brake operate (note that if the vehicle speed is reduced but engine valve noise is heard, intake throttle valve may not be operated)?	—	Go to Step 7	Go to Step 10
7	1. Turn ON the exhaust brake switch. 2. Let the vehicle run so that the exhaust brake may operate enough. 3. Press the accelerator pedal during the exhaust brake is operating. Does the exhaust brake cancel?	—	Go to Step 8	Observe the Accelerator Pedal Position (APP) Angle parameter and refer to APP sensor DTC
8	**Notice:** If the vehicle fitted with Smoother, skip to Step 9. 1. Turn ON the exhaust brake switch. 2. Let the vehicle run so that the exhaust brake may operate enough. 3. Press the clutch pedal during the exhaust brake is operating. Does the exhaust brake cancel?	—	System OK	Go to Step 18
9	1. Turn ON the exhaust brake switch. 2. Let the vehicle run so that the exhaust brake may operate enough. 3. Operate the selector lever during the exhaust brake is operating. Does the exhaust brake cancel?	—	System OK	Refer to Diagnostic System Check – Transmission Controls
10	1. Turn ON the exhaust brake switch. 2. Trigger the Snapshot function in order to capture and store engine parameters while the vehicle is running. 3. Let the vehicle run so that the exhaust brake may operate enough. 4. Review the Exhaust Brake Solenoid Command parameter with the Tech 2 in order to see the specific running conditions. Does the Exhaust Brake Solenoid Command parameter indicate ON when the exhaust brake may operate enough?	—	Problem is relating to either solenoid valves, throttle valves and vacuum pressure lines. Refer to applicable diagnostic chart in the Exhaust System Section	The ECM is not allowing exhaust brake control. Refer to Condition for Running the Exhaust Brake Control
11	1. Turn OFF the ignition. 2. Disconnect the intake throttle solenoid valve harness connector. 3. Connect a test lamp between the voltage feed circuit of the intake throttle solenoid valve harness (pin 1 of J-40 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 12	Go to Step 14

Step	Action	Value(s)	Yes	No
12	1. Connect a test lamp across the intake throttle solenoid valve harness (pin 1 and 2 of J-40 connector). 2. Turn ON the ignition, with the engine OFF. 3. Perform the Exhaust Brake Control test with the Tech 2. 4. Command the Exhaust Brake ON with the Tech 2. Does the test lamp illuminate when commanded ON with the Tech 2, then goes out?	—	Go to Step 15	Go to Step 13
13	1. Test the control circuit of the intake throttle solenoid valve between the engine control module (ECM) (pin 102 of E-111 connector) and the intake throttle solenoid valve (pin 2 of J-40 connector) for the following conditions: • An open circuit • A short to ground • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 16
14	Repair the open circuit or high resistance on the voltage feed circuit between the ECM (10A) fuse and the intake throttle solenoid valve (pin 1 of J-40 connector). Did you complete the repair?	—	Go to Step 30	—
15	1. Turn OFF the ignition. 2. Disconnect the intake throttle valve. 3. Inspect for an intermittent and for poor connections at the harness connector of the intake throttle solenoid valve (pins 1 and 2 of J-40 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 17
16	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the intake throttle solenoid valve control circuit at the harness connector of the ECM (pin 102 of E-111 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 29
17	Replace the intake throttle solenoid valve. Did you complete the replacement?	—	Go to Step 30	—
18	1. Turn ON the ignition, with the engine OFF. 2. Observe the Clutch Pedal Switch parameter with the Tech 2 while fully depressing and releasing the clutch pedal. Does the Tech 2 indicate Applied when the clutch pedal is applied and Released when the clutch pedal is released?	—	Problem is intermittent. Refer to Condition for Running the Exhaust Brake Control	Go to Step 19

Step	Action	Value(s)	Yes	No
19	1. Check to ensure the clutch pedal switch is adjusted correctly. The plunger should be all the way in when the pedal is released, yet should not impede with the clutch pedal full upward travel. 2. Adjust the clutch pedal switch as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 20
20	1. Turn OFF the ignition. 2. Disconnect the clutch pedal switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Clutch Pedal Switch parameter with the Tech 2 while momentarily jumping across the clutch pedal switch harness connector between pins 1 and 2 of B-89 connector. Does the Tech 2 indicate Applied when the circuit is jumpered and Released when the circuit is not jumpered?	—	Go to Step 26	Go to Step 21
21	1. Connect a test lamp between the ignition voltage feed circuit of the clutch pedal switch harness (pin 1 of B-89 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 22	Go to Step 23
22	1. Connect a test lamp between the signal circuit of the clutch pedal switch harness (pin 2 of B-89 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 24	Go to Step 25
23	Repair the open circuit or high resistance on the ignition voltage feed circuit between the ENG (IG) (10A) fuse and the clutch pedal switch (pin 1 of B-89 connector). Check the ENG (IG) (10A) fuse is first. Did you complete the repair?	—	Go to Step 30	—
24	1. Test the clutch pedal switch signal circuit between the ECM (pin 47 of J-191 connector) and the clutch pedal switch (pin 2 of B-89 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 29
25	1. Test the clutch pedal switch signal circuit between the ECM (pin 47 of J-191 connector) and the clutch pedal switch (pin 2 of B-89 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 27

Step	Action	Value(s)	Yes	No
26	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the clutch pedal switch (pins 1 and 2 of B-89 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 28
27	1. Turn OFF the ignition. 2. Disconnect for an intermittent and for a poor connection on the clutch pedal switch signal circuit at the harness connector of the ECM (pin 47 of J-191 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 29
28	Replace the clutch pedal switch. Refer to Clutch Pedal Switch Replacement. Did you complete the replacement?	—	Go to Step 30	—
29	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 30	—
30	Reconnect all previously disconnected fuse or harness connector(s). Is the action complete?	—	Go to Step 2	—

Chart 2 of 2

Step	Action	Value(s)	Yes	No
1	1. Start the engine, if stopped. 2. Turn ON the exhaust brake switch. 3. Observe the Exhaust Brake Switch parameter with the Tech 2. Does the Exhaust Brake Switch parameter indicate ON?	—	Go to Step 14	Go to Step 5
2	1. Start the engine, if stopped. 2. Turn OFF the exhaust brake switch. 3. Observe the Exhaust Brake Switch parameter with the Tech 2. Does the Exhaust Brake Switch parameter indicate OFF?	—	Go to Step 16	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the exhaust brake switch B-69 harness connector (located on the steering column support bracket). 3. Start the engine. 4. Observe the Exhaust Brake Switch parameter with the Tech 2. Does the Exhaust Brake Switch parameter indicate OFF?	—	Go to Step 13	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the exhaust brake switch signal circuit between the engine control module (ECM) (pin 45 of J-191 connector) and the exhaust brake switch (pin 2 of B-69 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 29
5	1. Turn OFF the ignition. 2. Inspect the Fuel Heater (10A) fuse in the glove box fuse block. Is the Fuel Heater (10A) fuse open?	—	Go to Step 6	Go to Step 7
6	Replace the Fuel Heater (10A) fuse. If the fuse continues to open, repair the short to ground on one of the circuits that fed by the Fuel Heater (10A) fuse or replace the shorted attached component fed by the Fuel Heater (10A) fuse. Did you complete the repair?	—	Go to Step 30	—
7	1. Turn OFF the ignition. 2. Disconnect the exhaust brake switch B-69 harness connector (located on the steering column support bracket). 3. Connect a test lamp between the voltage feed circuit of the exhaust brake switch harness (pin 5 of B-69 male side connector) and a known good ground. 4. Start the engine. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 9
8	1. Observe the Exhaust Brake Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the exhaust brake switch harness connector between pins 2 and 5 of the B-69 connector. Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 11	Go to Step 10
9	Repair the open circuit or high resistance on the voltage feed circuit between the Fuel Heater (10A) fuse and the exhaust brake switch (pin 5 of B-69 connector). Did you complete the repair?	—	Go to Step 30	—
10	1. Test the exhaust brake switch signal circuit between the ECM (pin 45 of J-191 connector) and the exhaust brake switch (pin 2 of B-69 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 12

Step	Action	Value(s)	Yes	No
11	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the exhaust brake switch (pins 2 and 5 of B-69 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 13
12	1. Turn OFF the ignition. 2. Disconnect for an intermittent and for a poor connection on the exhaust brake switch signal circuit at the harness connector of the ECM (pin 45 of J-191 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 29
13	Repair or Replace the exhaust brake switch. Did you complete the replacement?	—	Go to Step 30	—
14	1. Turn OFF the ignition. 2. Inspect the Meter (10A) fuse in the glove box. Is the Meter (10A) fuse open?	—	Go to Step 15	Go to Step 17
15	Replace the Meter (10A) fuse. If the fuse continues to open, repair the short to ground on one of the circuits that is fed by the Meter (10A) fuse or replace the shorted attached component fed by the Meter (10A) fuse. Did you complete the repair?	—	Go to Step 30	—
16	1. Turn OFF the ignition. 2. Disconnect the ECM J-191 harness connector. 3. Turn ON the ignition, with the engine OFF. Is the exhaust brake indicator lamp OFF?	—	Go to Step 29	Go to Step 24
17	1. Turn OFF the ignition. 2. Remove the Meter (10A) fuse that supplies voltage to the exhaust brake indicator lamp. 3. Disconnect the ECM J-191 harness connector. 4. Turn ON the ignition, with the engine OFF. 5. Measure the voltage from the exhaust brake indicator lamp control circuit in the ECM harness connector (pin 7 of J-191 connector) to a good ground. Is the voltage less than the specified value?	1 volt	Go to Step 18	Go to Step 25
18	1. Turn OFF the ignition. 2. Install the Meter (10A) fuse that supplies ignition voltage to the exhaust brake indicator lamp. 3. Turn ON the ignition, with the engine OFF. 4. Connect a 3-amp fused jumper wire between the exhaust brake indicator lamp control circuit of the ECM harness connector (pin 7 of J-191 connector) and a known good ground. Is the exhaust brake indicator lamp illuminated?	—	Go to Step 23	Go to Step 19

Step	Action	Value(s)	Yes	No
19	1. Turn OFF the ignition. 2. Remove the instrument panel cluster (IPC). 3. Remove the exhaust brake indicator lamp bulb from the IPC. Is the exhaust brake indicator lamp bulb burned out?	—	Go to Step 27	Go to Step 20
20	1. Connect a test lamp between the exhaust brake indicator lamp ignition voltage circuit of the IPC harness connector (pin 18 of B-51 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 21	Go to Step 26
21	1. Test the exhaust brake indicator lamp control circuit between the ECM (pin 7 of J-191 connector) and the IPC (pin 6 of B-51 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 22
22	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the IPC (pins 6 and 18 of B-51 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 28
23	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the exhaust brake indicator lamp control circuit at the harness connector of the ECM (pin 7 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 30	Go to Step 29
24	Repair the short to ground on the control circuit of the exhaust brake indicator lamp between the ECM (pin 7 of J-191 connector) and the IPC (pin 6 of B-51 connector). Did you complete the repair?	—	Go to Step 30	—
25	Repair the short to battery or ignition voltage on the control circuit of the exhaust brake indicator lamp between the ECM (pin 7 of J-191 connector) and the IPC (pin 6 of B-51 connector). Did you complete the repair?	—	Go to Step 30	—
26	Repair the open or high resistance on the voltage feed circuit of the exhaust brake indicator lamp between the Meter (10A) fuse and the IPC (pin 6 of B-51 connector). Did you complete the repair?	—	Go to Step 30	—
27	Replace the exhaust brake indicator lamp bulb. Did you compete the replacement?	—	Go to Step 30	—

Step	Action	Value(s)	Yes	No
28	Repair or replace the IPC. Did you complete the repair or replacement?	—	Go to Step 30	—
29	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming in this section. Did you complete the replacement?	—	Go to Step 30	—
30	Reconnect all previously disconnected fuse or harness connector(s). Is the action complete?	—	Go to Chart 1 of 2 Step 2	—

Symptoms – Engine Controls

Symptoms – Engine Controls

Important Preliminary Inspections Before Starting

Perform Diagnostic System Check – Engine Controls before using the symptom tables, and verify that all of the following are true:

- The engine control module (ECM) and malfunction indicator lamp (MIL) are operating correctly.
- There are no diagnostic trouble codes (DTCs) stored, or a DTC exists but without the MIL.
- The Tech 2 data is within the normal operating range. Refer to Tech 2 Data List in this section.
- Verify the customer concern and locate the correct symptom in the table of contents. Inspect the items indicated under that symptom.

Visual and Physical Inspection

Several of the symptom procedures ask for careful visual and physical inspection. This step is extremely important. The visual and physical inspection can lead to correcting a problem without further inspections, and can save valuable time. Ensure that:

- The ECM grounds are clean, tight, and in their proper location.
- The vacuum hoses are not split or kinked, and properly connected. Inspect throughly for any type of leak or restriction.
- The air intake ducts are not collapsed or damaged.
- The engine harness wiring and terminals are properly connected and are not pinched or cut.

Intermittent

Important:
Inspect for improper installation of electrical components if an intermittent condition exists. Inspect for aftermarket add-on electrical equipment devices, lights, and cellular phones. Verify that no aftermarket equipment is connected to the keyword 2000 serial data circuit. If you cannot locate an intermittent condition, a cellular phone communication signal may cause the condition.

Important:
The problem may or may not turn ON the MIL or store a DTC.

Faulty electrical connections or wiring cause most intermittent problems. Perform a careful visual and physical inspection of the suspect connectors for the following conditions:

- Improperly mated connector halves
- Terminals that are not seated
- Terminals that are damaged or improperly formed

Reform or replace connector terminals in the problem circuit in order to ensure proper contact tension. Remove the terminal from the connector body in order to inspect for poor terminal wire connection.
Road test the vehicle with the DMM connected to the suspected circuit. An abnormal reading that occurs when the malfunction occurs is a good indication that there is a malfunction in the circuit being monitored.
Use the Tech 2 in order to help detect intermittent conditions. Useful features of the Tech 2 include the following:

- Trigger the Snapshot feature in order to capture and store engine parameters when the malfunction occurs. Review this stored information in order to see the specific running conditions that caused the malfunction.
- Use the Plot Function on the Tech 2 in order to plot selected data parameters. Review this stored information to aid in locating an intermittent problem. Refer to the Tech 2 Users Guide for more information.

Important:
If the intermittent condition exists as a start and then stall, test for DTCs relating to the vehicle theft deterrent system. Test for improper installation of electrical options such as lights, cellular phones, etc.

Any of the following may cause an intermittent MIL with no stored DTC:

- The ECM grounds are loose or dirty. Refer to Engine Controls Schematics.
- The MIL circuit intermittently shorted to ground.
- Electrical system interference caused by a malfunctioning relay, ECM driven solenoid, or switch. The electrical component can cause a sharp electrical surge. Normally, the problem will occur when the malfunctioning component is operating.
- There are any open diodes.

Important:
The following symptom tables contain groups of possible causes for each symptom. The order of these procedures is not important. If the Tech 2 readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause first. In order to determine if a specific vehicle is using a particular system or component, refer to Engine Controls Schematics for an application.

Use the following tables when diagnosing a symptom complaint:

- Intermittent Conditions
- Hard Start
- Rough, Unstable, or Incorrect Idle and Stalling

- High Idle
- Cuts Out, Misses
- Surge / Chuggles
- Lack of Power, Sluggishness, or Sponginess
- Hesitation, Sag, Stumble
- Fuel Knock / Combustion Noise
- Poor Fuel Economy
- Excessive Smoke (Black Smoke)
- Excessive Smoke (White Smoke)

Intermittent Conditions

Checks	Action
DEFINITION: The problem is not currently present but is indicated in DTC History. OR There is a customer complaint, but the symptom cannot currently be duplicated, if the problem is not DTC related.	
Preliminary Checks	• Refer to Symptoms – Engine Controls before starting.
Harness / Connector	Many intermittent open or shorted circuits are affected by harness / connector movement that is caused by vibration, engine torque, bumps / rough pavement, etc. Test for this type of condition by performing the applicable procedure from the following list: • Move related connectors and wiring while monitoring the appropriate Tech 2 data. • Move related connectors and wiring with the component commanded ON, and OFF, with the Tech 2. Observe the component operation. • With the engine running, move related connectors and wiring while monitoring engine operation. If harness or connector movement affects the data displayed, component / system operation, or engine operation, inspect and repair the harness / connections as necessary. Refer to Electrical Connections or Wiring.
Electrical Connections or Wiring	Poor electrical connections, terminal tension or wiring problems cause most intermittent. To perform the following inspections: • Inspect for poor mating of the connector halves, or terminals improperly seated in the connector body. • Inspect for improperly formed or damaged terminals. Test for poor terminal tension. • Inspect for poor terminal to wire connections including terminals crimped over insulation. This requires removing the terminal from the connector body. • Inspect for corrosion / water intrusion. Pierced or damaged insulation can allow moisture to enter the wiring. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits. • Inspect for wires that are broken inside the insulation. • Inspect the harness for pinched, cut or rubbed through wiring. • Ensure that the wiring does not come in contact with hot exhaust components.
Control Module Power and Grounds Component Power and Grounds	Poor power or ground connections can cause widely varying symptoms. • Test all control module power supply circuits. Many vehicles have multiple circuits supplying power to the control module. Other components in the system may have separate power supply circuits that may also need to be tested. Inspect connections at the module / component connectors, fuses, and any intermediate connections between the power source and the module / component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Ensure that the circuit can carry the current necessary to operate the component. • Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point. Inspect the connections at the component and in splice packs, where applicable. Ensure that the circuit can carry the current necessary to operate the component.

Checks	Action
Temperature Sensitivity	• An intermittent condition may occur when a component / connection reaches normal operating temperature. The condition may occur only when the component / connection is cold, or only when the component / connection is hot. • If the intermittent is related to heat, review the data for a relationship with the following: - High ambient temperatures - Underhood / engine generated heat - Circuit generated heat due to a poor connection, or high electrical load - Higher than normal load conditions, towing, etc. • If the intermittent is related to cold, review the data for the following: - Low ambient temperatures-In extremely low temperatures, ice may form in a connection or component. Test for water intrusion. - The condition only occurs on a cold start. - The condition goes away when the vehicle warms up. • Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
Electromagnetic Interference (EMI) and Electrical Noise	Some electrical components / circuits are sensitive to EMI or other types of electrical noise. Inspect for the following conditions: • A misrouted harness that is too close to high voltage / high current devices such as injection components, motors, generator etc. These components may induce electrical noise on a circuit that could interfere with normal circuit operation. • Electrical system interference caused by a malfunctioning relay, or the engine control module (ECM) driven solenoid or switch. These conditions can cause a sharp electrical surge. Normally, the problem will occur when the malfunctioning component is operating. • Improper installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc. These accessories may lead to an emission related failure while in use, but do not fail when the accessories are not in use. • Test for any open diodes. Some relays may contain a clamping diode. • Test the generator for a bad rectifier bridge that may be allowing AC noise into the electrical system.
Duplicating Failure Conditions	• If none of the previous tests are successful, attempt to duplicate and/or capture the failure conditions. • An alternate method is to drive the vehicle with the DMM connected to a suspected circuit. An abnormal reading on the DMM when the problem occurs, may help you locate the problem.
Tech 2 Snapshot	The Tech 2 can be set up to take a Snapshot of the parameters available via serial data. The Snapshot function records live data over a period of time. The recorded data can be played back and analyzed. The Tech 2 can also graph parameters singly or in combinations of parameters for comparison. The Snapshot can be triggered manually at the time the symptom is noticed, or set up in advance to trigger when a DTC sets. An abnormal value captured in the recorded data may point to a system or component that needs to be investigated further. Refer to the Tech 2 user instructions for more information on the Snapshot function.

Hard Start

Checks	Action
DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.	

Checks	Action
Preliminary Checks	• Diagnostic System Check – Engine Controls. • Ensure the driver is using the correct starting procedure. • Inspect the engine control module (ECM) grounds for being clean, tight, and in their proper locations. • Inspect that the harness connectors are correctly connected. • Inspect the fuel type and quality. • Inspect the programmed fuel injector ID code for each cylinder. • Inspect the Tech 2 Data List in this section.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. • Use the Tech 2 to observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes. If not, check for high resistance in the 5 volts reference circuit, low reference circuit, signal circuits or for a skewed sensor. • Inspect the crankshaft position (CKP) sensor is tight and the flywheel teeth are not damaged. • Inspect the camshaft position (CMP) sensor is tight and the camshaft gear flange surface is not damaged.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to Fuel System Check Chart and appropriate procedure in the Fuel System section. • Inspect for air in the fuel system. • Inspect for water contamination in the fuel. • Inspect for external fuel leaks or high engine oil level. • Measure the fuel return rate from the fuel injectors. • Inspect the fuel lines between the fuel tank and fuel supply pump for being crushed or kinked. • Inspect for a plugged fuel tank vent hose. • Inspect inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. • Inspect the fuel lines between the fuel tank and fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. • Inspect the fuel supply pump operation. **Notice:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. • Perform the Injector Balancing test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not change engine speed when commanded OFF. • Perform the Injector Forced Drive test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not create a clicking noise (solenoid operating noise), contents an interrupted noise or has abnormal nose when commanded ON. • Inspect the fuel rail pressure (FRP) regulator feedback current on the Tech 2.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction in the turbocharger inlet duct. • Inspect the intake throttle valve for a stuck closed position. • Inspect for a restriction or leak in the intake manifold.

Checks	Action
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section. • Inspect the exhaust brake valve for a stuck closed position. • Inspect for a restriction in the exhaust pipes.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 1960 kPa (284 psi) and variation of each cylinder is less than 294 kPa (43 psi). • Improper mechanical timing (timing gear) • Improper valve gap • Broken or weak valve springs • Worn camshaft lobes
Electrical System Checks	Inspect the engine electrical for the following conditions. Refer to the Engine Electrical section. • Inspect the glow plug control (preheating) system operation. Refer to Glow Control System Check in this section. • Inspect the fuel heater operation. • Inspect for slow cranking speed. • Inspect for weakened batteries.

Rough, Unstable, or Incorrect Idle And Stalling

Checks	Action
DEFINITION: Engine runs unevenly at idle. If severe, the engine or vehicle may shake. Engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.	
Preliminary Checks	• Diagnostic System Check – Engine Controls. • Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary. • Inspect the Engine Control Module (ECM) grounds for being clean, tight, and in their proper locations. • Inspect that the harness connectors are correctly connected. • Inspect the fuel type and quality. • Inspect the programmed fuel injector ID code for each cylinder. • Inspect the Tech 2 Data List in this section.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. • Use the Tech 2 to observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes. If not, check for high resistance in the 5 volts reference circuit, low reference circuit, signal circuits or for a skewed sensor. • Use the Tech 2 to observe the Differential Fuel Rail Pressure parameter at idle in Neutral. Differential Fuel Rail Pressure parameter should always be within ± 5 MPa (± 725 psi). • Inspect the crankshaft position (CKP) sensor is tight and the flywheel teeth are not damaged. • Inspect the camshaft position (CMP) sensor is tight and the camshaft gear flange surface is not damaged.

Checks	Action
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to Fuel System Check Chart and appropriate procedure in the Fuel System section. • Inspect for air in the fuel system. • Inspect for water contamination in the fuel. • Inspect for external fuel leaks or high engine oil level. • Measure the fuel return rate from the fuel injectors. • Inspect the fuel lines between the fuel tank and fuel supply pump for being crushed or kinked. • Inspect for a plugged fuel tank vent hose. • Inspect inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. • Inspect the fuel lines between the fuel tank and fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. • Inspect the fuel supply pump operation. **Notice:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. • Perform the Injector Balancing test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not change engine speed when commanded OFF. • Perform the Injector Forced Drive test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not create a clicking noise (solenoid operating noise), contents an interrupted noise or has abnormal nose when commanded ON. • Use the Tech 2 to observe the Cylinder Compensation for each cylinder at idle. If there is a cylinder that is excessively high or low value, it may indicate faulty fuel injector, weak or slightly seized cylinder or an incorrectly programmed fuel injector ID code. • Inspect the fuel rail pressure (FRP) regulator feedback current on the Tech 2.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction in the turbocharger inlet duct. • Inspect the intake throttle valve for a stuck closed position. • Inspect for a restriction or leak in the intake manifold.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section. • Inspect the exhaust brake valve for a stuck closed position. • Inspect for a restriction in the exhaust pipes.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 1960 kPa (284 psi) and variation of each cylinder is less than 294 kPa (43 psi). • Improper mechanical timing (timing gear) • Improper valve gap • Broken or weak valve springs • Worn camshaft lobes • Inspect for incorrect basic engine parts such as camshaft, cylinder head, pistons, etc.

Checks	Action
Additional Checks	• Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. The Tech 2 can usually detect EMI by monitoring the engine speed. A sudden increase in speed with little change in actual engine speed change indicates that EMI is present. If a problem exists, check routing of high voltage components, such as fuel injector solenoid valve wiring, near the sensor circuits. • Inspect for faulty engine mounts. • Inspect faulty crank pulley. • Inspect faulty generator & A/C compressor. • Inspect the generator output voltage. • Inspect the EGR system operating correctly. Refer to EGR Control System Check in this section. • Inspect the A/C operation.

High Idle

Checks	Action
DEFINITION: Engine idle speed is higher than normal in regardless of engine coolant temperature.	
Preliminary Checks	• Diagnostic System Check – Engine Controls. • Inspect that the harness connectors are correctly connected. • Inspect the idle up control knob turned fully counterclockwise. • Use the Tech 2 to compare the engine speed and tachometer on the instrument panel cluster (IPC). • Inspect the fuel type and quality. • Inspect the engine oil level. • Inspect the Tech 2 Data List in this section.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. • Use the Tech 2 to observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes. If not, check for high resistance in the 5 volts reference circuit, low reference circuit, signal circuits or for a skewed sensor. • Use the Tech 2 to observe the Differential Fuel Rail Pressure parameter at idle in Neutral. Differential Fuel Rail Pressure parameter should always be within ± 5 MPa (± 725 psi). • Use the Tech 2 to observe the Idle Up Sensor parameter. Idle Up Sensor parameter should be less than 0.7 volts at full turned counterclockwise. If not, check for high resistance in low reference circuit or skewed sensor. • Use the Tech 2 to observe the Accelerator Pedal Position (APP) Angle. APP Angle parameter should change linearly from 0% to 100% according to the accelerator pedal operation.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Inspect the fuel injectors. Remove the injectors and visually inspect. (Injector tip(s) may be damaged) • Measure the fuel return from the fuel injectors. See Fuel System Check Chart in the Fuel System section.

Cut Out, Misses

Checks	Action
DEFINITION: A constant jerking that follows the engine speed, usually more pronounced as the engine load increase. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.	
Preliminary Check	• Diagnostic System Check – Engine Controls. • Inspect that the harness connectors are correctly connected. • Inspect the engine control module (ECM) grounds for being clean, tight, and in their proper locations. • Inspect the Tech 2 Data List in this section.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to observe the Accelerator Pedal Position (APP) Angle. APP Angle parameter should change linearly from 0% to 100% according to the accelerator pedal operation. • Use the Tech 2 to observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes. If not, check for high resistance in the 5 volts reference circuit, low reference circuit, signal circuits or for a skewed sensor. • Use the Tech 2 to observe the Differential Fuel Rail Pressure parameter at idle and W.O.T. (accelerator pedal full travel) in Neutral. Differential Fuel Rail Pressure parameter should always be within ± 5 MPa (± 725 psi). • Inspect the crankshaft position (CKP) sensor is tight and the flywheel teeth are not damaged. • Inspect the camshaft position (CMP) sensor is tight and the camshaft gear flange surface is not damaged.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to Fuel System Check Chart and appropriate procedure in the Fuel System section. • Inspect for air in the fuel system. • Inspect for water contamination in the fuel. • Inspect the fuel lines between the fuel tank and fuel supply pump for being crushed or kinked. • Inspect for a plugged fuel tank vent hose. • Inspect inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. • Inspect the fuel lines between the fuel tank and fuel supply pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. • Perform the Injector Balancing test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not change engine speed when commanded OFF. • Perform the Injector Forced Drive test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not create a clicking noise (solenoid operating noise), contents an interrupted noise or has abnormal nose when commanded ON. • Use the Tech 2 to observe the Cylinder Compensation for each cylinder at idle. If there is a cylinder that is excessively high or low value, it may indicate faulty fuel injector, weak or slightly seized cylinder or an incorrectly programmed fuel injector ID code.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction in the turbocharger inlet duct. • Inspect the intake throttle valve for a stuck closed position. • Inspect for a restriction or leak in the intake manifold.

Checks	Action
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section. • Inspect the exhaust brake valve for a stuck closed position. • Inspect for a restriction in the exhaust pipes.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 1960 kPa (284 psi) and variation of each cylinder is less than 294 kPa (43 psi). • Improper valve timing • Improper valve gap • Broken or weak valve springs • Worn camshaft lobes
Additional Checks	• Inspect the generator output voltage. • Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. The Tech 2 can usually detect EMI by monitoring the engine speed. A sudden increase in speed with little change in actual engine speed change indicates that EMI is present. If a problem exists, check routing of high voltage components, such as fuel injector solenoid wiring, near the sensor circuits.

Surges / Chuggles

Checks	Action
DEFINITION: The engine has a power variation under a steady throttle or cruise. The vehicle seems to speed up and slow down with no change in the accelerator pedal.	
Preliminary Checks	• Diagnostic System Check – Engine Controls. • Ensure the driver understands the A/C compressor operation. • Use the Tech 2 in order to make sure the Vehicle Speed parameter reading matches the vehicle speedometer. • Inspect the engine control module (ECM) grounds for being clean, tight, and in their proper locations. • Inspect that the harness connectors are correctly connected. • Inspect the fuel type and quality. • Inspect the programmed fuel injector ID code for each cylinder. • Inspect the Tech 2 Data List in this section.

Checks	Action
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes. If not, check for high resistance in the 5 volts reference circuit, low reference circuit, signal circuits or for a skewed sensor. • Use the Tech 2 to observe the Differential Fuel Rail Pressure parameter at idle and W.O.T. (accelerator pedal full travel) in Neutral. Differential Fuel Rail Pressure parameter should always be within ± 5 MPa (± 725 psi). • Use the Tech 2 to observe the Accelerator Pedal Position (APP) Angle. APP Angle parameter should change linearly from 0% to 100% according to the accelerator pedal operation. Also inspect the APP Angle when the accelerator pedal is steady. If the indicating angle fluctuates, check for an intermittent open, high resistance in the circuits or for a skewed sensor. • Inspect the crankshaft position (CKP) sensor is tight and the flywheel circumference is not damaged. • Inspect the crankshaft position (CKP) sensor is tight and the flywheel teeth are not damaged. • Inspect the camshaft position (CMP) sensor is tight and the camshaft gear flange surface is not damaged.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to Fuel System Check Chart and appropriate procedure in the Fuel System section. • Install a fuel pressure / vacuum gauge (5-8840-2844-0 / J-44638) between the fuel filter and fuel tank to check the fuel pressure. If the fuel pressure at any engine speed is a larger vacuum than 5 inHg, a restriction exists in the fuel supply lines between the fuel tank and the fuel supply pump. • Inspect the fuel supply pump operation. **Notice:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. • Perform the Injector Balancing test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not change engine speed when commanded OFF. • Perform the Injector Forced Drive test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not create a clicking noise (solenoid operating noise), contents an interrupted noise or has abnormal nose when commanded ON.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction in the turbocharger inlet duct. • Inspect the intake throttle valve for a stuck closed position. • Inspect for a restriction or leak in the intake manifold.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section. • Inspect the exhaust brake valve for a stuck closed position. • Inspect for a restriction in the exhaust pipes.
Additional Checks	• Inspect the generator output voltage. • Inspect the EGR system operating correctly. Refer to EGR Control System Check in this section. • Inspect the A/C operation.

Lack of Power, Sluggishness, Sponginess

Checks	Action
DEFINITION: The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.	
Preliminary Checks	• Diagnostic System Check – Engine Controls. • Compare the vehicle with a similar unit. Ensure the vehicle has an actual problem. • Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary. • Have the tire sizes changed • Are excessively heavy loads being carried? • Inspect for clutch slip. • Inspect brake drag. • Inspect for a proper transmission shift pattern and down shift operation. • Inspect the fuel quality (cetane index). • Inspect the engine oil level and quality. • Use the Tech 2 in order to make sure the Vehicle Speed parameter reading matches the vehicle speedometer. • Inspect the engine control module (ECM) grounds for being clean, tight, and in their proper locations. • Inspect the programmed fuel injector ID code for each cylinder. • Inspect the Tech 2 Data List in this section.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. • Use the Tech 2 to observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes. If not, check for high resistance in the 5 volts reference circuit, low reference circuit, signal circuits or for a skewed sensor. • Use the Tech 2 to observe the Differential Fuel Rail Pressure parameter at idle and W.O.T. (accelerator pedal full travel) in Neutral. Differential Fuel Rail Pressure parameter should always be within ± 5 MPa (± 725 psi). • Use the Tech 2 to observe the Boost Pressure and Barometric Pressure (BARO) with ignition ON and engine OFF. Boost Pressure and BARO parameters should be within the 1.0 psi (7.0 kPa) each other. • Use the Tech 2 to observe the Accelerator Pedal Position (APP) Angle. APP Angle parameter should change linearly from 0% to 100% according to the accelerator pedal operation.

Checks	Action
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to Fuel System Check Chart and appropriate procedure in the Fuel System section. • Install a fuel pressure / vacuum gauge (5-8840-2844-0 / J-44638) between the fuel filter and fuel tank to check the fuel pressure. If the fuel pressure at any engine speed is a larger vacuum than 5 inHg, a restriction exists in the fuel supply lines between the fuel tank and the fuel supply pump. • Inspect the fuel supply pump operation. **Notice:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. • Perform the Injector Balancing test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not change engine speed when commanded OFF. • Perform the Injector Forced Drive test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not create a clicking noise (solenoid operating noise), contents an interrupted noise or has abnormal nose when commanded ON.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction in the turbocharger inlet duct. • Inspect the intake throttle valve for a stuck closed position. • Inspect for a restriction or leak in the intake manifold. • Inspect for a worn or damaged turbocharger turbine wheel, shaft or compressor wheel. Refer to turbocharger inspection in the Engine Mechanical section. • Inspect for turbocharger wastegate valve operation. Refer to wastegate valve inspection in the Engine Mechanical section.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section. • Inspect the exhaust brake valve for a stuck closed position. • Inspect for a restriction in the exhaust pipes.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 1960 kPa (284 psi) and variation of each cylinder is less than 294 kPa (43 psi). • Improper valve timing • Improper valve gap • Broken or weak valve springs • Worn camshaft lobes
Additional Checks	• Inspect the generator output voltage. • Inspect the EGR system operating correctly. Refer to EGR Control System Check in this section. • Inspect the engine overheat condition. Refer to the Engine Cooling section. • Inspect the A/C operation.

Hesitation, Sag, Stumble

Checks	Action
DEFINITION: The vehicle has a momentary lack of response when pushing down on the accelerator. The condition can occur at any vehicle speed. The condition is usually most severe when trying to make the vehicle move from a stop. If severe enough, the condition may cause the engine to stall.	

Checks	Action
Preliminary Checks	• Diagnostic System Check – Engine Controls. • Compare the vehicle with a similar unit. Ensure the vehicle has an actual problem. • Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary. • Inspect for a proper transmission shift pattern and down shift operation. • Inspect the fuel quality (cetane index). • Inspect the engine oil level and quality. • Inspect the engine control module (ECM) grounds for being clean, tight, and in their proper locations. • Inspect the programmed fuel injector ID code for each cylinder. • Inspect the Tech 2 Data List in this section.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. • Use the Tech 2 to observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes. If not, check for high resistance in the 5 volts reference circuit, low reference circuit, signal circuits or for a skewed sensor. • Use the Tech 2 to observe the Differential Fuel Rail Pressure parameter at idle and W.O.T. (accelerator pedal full travel) in Neutral. Differential Fuel Rail Pressure parameter should always be within ± 5 MPa (± 725 psi). • Use the Tech 2 to observe the Boost Pressure and Barometric Pressure (BARO) with ignition ON and engine OFF. Boost Pressure and BARO parameters should be within the 1.0 psi (7.0 kPa) each other. • Use the Tech 2 to observe the Accelerator Pedal Position (APP) Angle. APP Angle parameter should change linearly from 0% to 100% according to the accelerator pedal operation. • Inspect the crankshaft position (CKP) sensor is tight and the flywheel teeth are not damaged. • Inspect the camshaft position (CMP) sensor is tight and the camshaft gear flange surface is not damaged.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to Fuel System Check Chart and appropriate procedure in the Fuel System section. • Install a fuel pressure / vacuum gauge (5-8840-2844-0 / J-44638) between the fuel filter and fuel tank to check the fuel pressure. If the fuel pressure at any engine speed is a larger vacuum than 5 inHg, a restriction exists in the fuel supply lines between the fuel tank and the fuel supply pump. • Inspect the fuel supply pump operation. **Notice:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. • Perform the Injector Balancing test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not change engine speed when commanded OFF. • Perform the Injector Forced Drive test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not create a clicking noise (solenoid operating noise), contents an interrupted noise or has abnormal nose when commanded ON.

Checks	Action
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction in the turbocharger inlet duct. • Inspect the intake throttle valve for a stuck closed position. • Inspect for a restriction or leak in the intake manifold. • Inspect for a worn or damaged turbocharger turbine wheel, shaft or compressor wheel. Refer to turbocharger inspection in the Engine Mechanical section. • Inspect for turbocharger wastegate valve operation. Refer to wastegate valve inspection in the Engine Mechanical section.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section. • Inspect for a restriction in the exhaust pipes.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 1960 kPa (284 psi) and variation of each cylinder is less than 294 kPa (43 psi). • Improper valve timing • Improper valve gap • Broken or weak valve springs • Worn camshaft lobes
Additional Checks	• Inspect the generator output voltage. • Inspect the EGR system operating correctly. Refer to EGR Control System Check in this section. • Inspect the engine overheat condition. Refer to the Engine Cooling section. • Inspect the A/C operation.

Fuel Knock / Combustion Noise

Checks	Action
DEFINITION: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with the throttle opening.	
Preliminary Checks	• Diagnostic System Check – Engine Controls. • Ensure the vehicle has an actual problem. • Inspect for smoke associated with the combustion noise. • Inspect the fuel quality (cetane index). • Inspect the programmed fuel injector ID code for each cylinder. • Inspect the Tech 2 Data List in this section.

Checks	Action
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. • Use the Tech 2 to observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes. If not, check for high resistance in the 5 volts reference circuit, low reference circuit, signal circuits or for a skewed sensor. • Use the Tech 2 to observe the Differential Fuel Rail Pressure parameter at idle and W.O.T. (accelerator pedal full travel) in Neutral. Differential Fuel Rail Pressure parameter should always be within ± 5 MPa (± 725 psi). • Inspect the crankshaft position (CKP) sensor is tight and the flywheel teeth are not damaged. • Inspect the camshaft position (CMP) sensor is tight and the camshaft gear flange surface is not damaged.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to Fuel System Check Chart and appropriate procedure in the Fuel System section. • Install a fuel pressure / vacuum gauge (5-8840-2844-0 / J-44638) between the fuel filter and fuel tank to check the fuel pressure. If the fuel pressure at any engine speed is a larger vacuum than 5 inHg, a restriction exists in the fuel supply lines between the fuel tank and the fuel supply pump. • Inspect the fuel supply pump operation. **Notice:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. • Inspect the fuel injectors. Remove the injectors and visually inspect. • Perform the Injector Balancing test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not change engine speed when commanded OFF. • Perform the Injector Forced Drive test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not create a clicking noise (solenoid operating noise), contents an interrupted noise or has abnormal nose when commanded ON. • Perform the Pre Injection Stop test with the Tech 2. Replace the injectors if engine noise does not change when commanded Stop. • Use the Tech 2 to observe the Cylinder Compensation for each cylinder at idle. If there is a cylinder that is excessively high or low value, it may indicate faulty fuel injector, weak or slightly seized cylinder or an incorrectly programmed fuel injector ID code.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 1960 kPa (284 psi) and variation of each cylinder is less than 294 kPa (43 psi). • Inspect for incorrect basic engine parts such as camshaft, cylinder head, pistons, etc. • Inspect for any excessive oil entering combustion chamber.
Additional Checks	• Inspect the EGR system operating correctly. Refer to EGR Control System Check in this section. • Inspect other possible causes that can make similar noise such as loose component parts, bracket, mount and weak clutch damper spring.

Poor Fuel Economy

Checks	Action
DEFINITION: Fuel economy, as measured by actual road tests and several tanks of fuel, is noticeably lower than expected. Also, the economy is noticeably lower than it was on this vehicle at one time, as previously shown by actual road tests.	
Preliminary Checks	• Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary. • Inspect the driving habits of the owner. • Is the A/C ON full time, defroster mode ON? • Are the tires at the correct pressure? • Are the tire sizes changed • Are excessively heavy loads being carried? • Is the acceleration too much, too often? • Inspect for clutch slip. • Inspect brake drag. • Inspect dive belt tension. • Inspect for a proper transmission shift pattern and down shift operation. • Inspect the fuel quality (cetane index). • Inspect the engine oil level and quality. • Suggest to the owner to fill the fuel tank and recheck the fuel economy. • Suggest to the driver to read the Important Facts on Fuel Economy in the Owner Manual. • Inspect the odometer is correctly operated. • Inspect the programmed fuel injector ID code for each cylinder.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Inspect the fuel type and quality. • Check fuel leak.
Cooling System Checks	Inspect the cooling system for the following conditions. Refer to the Cooling System Section. • Inspect the engine coolant level. • Inspect the engine thermostat for always being open or for the wrong heat range. • Inspect the engine cooling fan for always being ON.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction in the turbocharger inlet duct. • Inspect the intake throttle valve for a stuck closed position. • Inspect for a restriction or leak in the intake manifold.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section. • Inspect the exhaust brake valve for a stuck closed position. • Inspect for a restriction in the exhaust pipes.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 1960 kPa (284 psi) and variation of each cylinder is less than 294 kPa (43 psi).

Excessive Smoke (Black Smoke)

Checks	Action
DEFINITION: Black smoke under load, idle or start up hot or cold.	
Preliminary Check	• Ensure the vehicle has an actual problem. • Inspect the engine control module (ECM) grounds for being clean, tight, and in their proper locations. • Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary. • Inspect the fuel quality (cetane index). • Inspect the engine oil level and quality. • Inspect the programmed fuel injector ID code for each cylinder.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. • Use the Tech 2 to observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes. If not, check for high resistance in the 5 volts reference circuit, low reference circuit, signal circuits or for a skewed sensor. • Use the Tech 2 to observe the Differential Fuel Rail Pressure parameter at idle and W.O.T. (accelerator pedal full travel) in Neutral. Differential Fuel Rail Pressure parameter should always be within ± 5 MPa (± 725 psi). • Use the Tech 2 to observe the Boost Pressure and Barometric Pressure (BARO) with ignition ON and engine OFF. Boost Pressure and BARO parameters should be within the 1.0 psi (7.0 kPa) each other. • Use the Tech 2 to observe the Accelerator Pedal Position (APP) Angle. APP Angle parameter should change linearly from 0% to 100% according to the accelerator pedal operation.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Inspect the fuel supply pump operation. **Notice:** The fuel supply pump must be timed to the engine and adjustment value must be learned to the ECM. • Perform the Injector Balancing test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not change engine speed when commanded OFF. • Perform the Injector Forced Drive test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not create a clicking noise (solenoid operating noise), contents an interrupted noise or has abnormal nose when commanded ON. • Use the Tech 2 to observe the Cylinder Compensation for each cylinder at idle. If there is a cylinder that is excessively high or low value, it may indicate faulty fuel injector, weak or slightly seized cylinder or an incorrectly programmed fuel injector ID code. • Inspect the fuel injectors. Remove the injectors and visually inspect.

Checks	Action
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction in the turbocharger inlet duct. • Inspect the intake throttle valve for a stuck closed position. • Inspect for a restriction or leak in the intake manifold. • Inspect for a worn or damaged turbocharger turbine wheel, shaft or compressor wheel. Refer to turbocharger inspection in the Engine Mechanical section.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section. • Inspect the exhaust brake valve for a stuck closed position. • Inspect for a restriction in the exhaust pipes.
Engine Mechanical Check	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 1960 kPa (284 psi) and variation of each cylinder is less than 294 kPa (43 psi). • Inspect for incorrect basic engine parts such as camshaft, cylinder head, pistons, etc. • Inspect for any excessive oil entering combustion chamber. • Improper valve timing • Improper valve gap • Broken or weak valve springs • Worn camshaft lobes
Additional Checks	• Inspect the EGR system operating correctly. Refer to EGR Control System Check in this section. • Inspect the excessive blow-by gasses. • Inspect the Tech 2 Data List in this section.

Excessive Smoke (White Smoke)

Checks	Action
DEFINITION: White smoke under load, idle or start up hot or cold.	
Preliminary Check	• Ensure the vehicle has an actual problem. • Inspect the engine control module (ECM) grounds for being clean, tight, and in their proper locations. • Inspect the fuel quality (cetane index). • Inspect the programmed fuel injector ID code for each cylinder.

Checks	Action
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Coolant Temperature with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. • Use the Tech 2 to observe the Fuel Rail Pressure (FRP) Sensor parameter with the engine OFF. The FRP Sensor on the Tech 2 should read 0.9 – 1.0 volt with the key ON and engine OFF after the engine has stopped running for a minimum of 2 minutes. If not, check for high resistance in the 5 volts reference circuit, low reference circuit, signal circuits or for a skewed sensor. • Use the Tech 2 to observe the Differential Fuel Rail Pressure parameter at idle and W.O.T. (accelerator pedal full travel) in Neutral. Differential Fuel Rail Pressure parameter should always be within ± 5 MPa (± 725 psi). • Use the Tech 2 to observe the Boost Pressure and Barometric Pressure (BARO) with ignition ON and engine OFF. Boost Pressure and BARO parameters should be within the 1.0 psi (7.0 kPa) each other. • Use the Tech 2 to observe the Accelerator Pedal Position (APP) Angle. APP Angle parameter should change linearly from 0% to 100% according to the accelerator pedal operation. • Inspect the crankshaft position (CKP) sensor is tight and the flywheel teeth are not damaged. • Inspect the camshaft position (CMP) sensor is tight and the camshaft gear flange surface is not damaged.
Fuel System Checks	• Check for a stuck open fuel injector. Remove each glow plug from the cylinder head and inspect the tip of the glow plugs for wet fuel. Use the cylinder compression gauge. Proper compression is more than 1960 kPa (284 psi) and variation of each cylinder is less than 294 kPa (43 psi). If poor compression is observed, inspect the engine mechanical. • Perform the Injector Balancing test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not change engine speed when commanded OFF. • Perform the Injector Forced Drive test with the Tech 2. Repair the wire or replace the appropriate fuel injector that does not create a clicking noise (solenoid operating noise), contents an interrupted noise or has abnormal nose when commanded ON. • Use the Tech 2 to observe the Cylinder Compensation for each cylinder at idle. If there is a cylinder that is excessively high or low value, it may indicate faulty fuel injector, weak or slightly seized cylinder or an incorrectly programmed fuel injector ID code. • Inspect the fuel injectors. Remove the injectors and visually inspect.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction in the turbocharger inlet duct. • Inspect the intake throttle valve for a stuck closed position. • Inspect for a restriction or leak in the intake manifold. • Inspect for a worn or damaged turbocharger turbine wheel, shaft or compressor wheel. Refer to turbocharger inspection in the Engine Mechanical section.

Checks	Action
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 1960 kPa (284 psi) and variation of each cylinder is less than 294 kPa (43 psi). • Inspect for incorrect basic engine parts such as camshaft, cylinder head, pistons, etc. • Improper valve timing • Improper valve gap • Broken or weak valve springs • Worn camshaft lobes • Inspect for any excessive fuel entering combustion chamber. • Inspect for coolant entering the combustion chamber.
Electrical System Checks	Inspect the engine electrical for the following conditions. • Inspect the glow plug control (preheating) system operation. Refer to Glow Control System Check in this section.

Repair Instructions

Engine Control Module (ECM) Replacement / Fuel Injector ID Code Data Programming

If the ECM is replaced the Fuel Injector ID Code Data (24, 0-9 or A-F characters for each fuel injector) MUST be reprogrammed into the new ECM.

Uploading the Fuel Injector ID Code Data from the ECM

Important:
Only perform this procedure if the ECM is being replaced. The current fuel injector ID code data can be determined with the Tech 2. If the ECM does not communicate with the Tech 2, go to the next procedure.

1. Install the Tech 2.
2. Turn ON the ignition, with the engine OFF.
3. Select Diagnostics > appropriate vehicle identification > 4HK1 (Common Rail) > Programming > Injector ID Code > Upload ID Code.
4. After complete the upload, turn OFF the Tech 2.
5. Turn OFF the ignition.

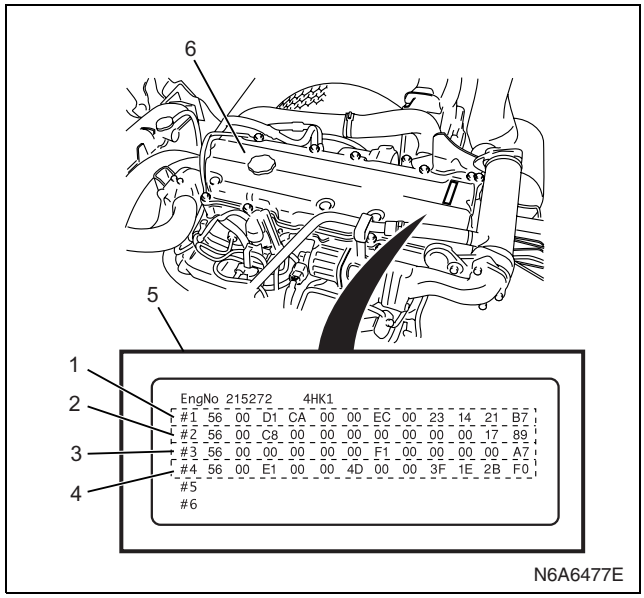
Retrieving the Fuel Injector ID Code Data with a Non-communicating ECM

Important:
Only perform following procedure if the ECM is being replaced and the Tech 2 does not communicate. The current fuel injector ID code data can not be determined with the Tech 2, the fuel injector numbers must be recorded from the factory affixed label on the cylinder head cover or each fuel injector ID plate.

Recording from the label on cylinder head cover;

Important:
Only perform this procedure if the fuel injectors are not being replaced in the past.

1. Record all numbers of each cylinder on the label.

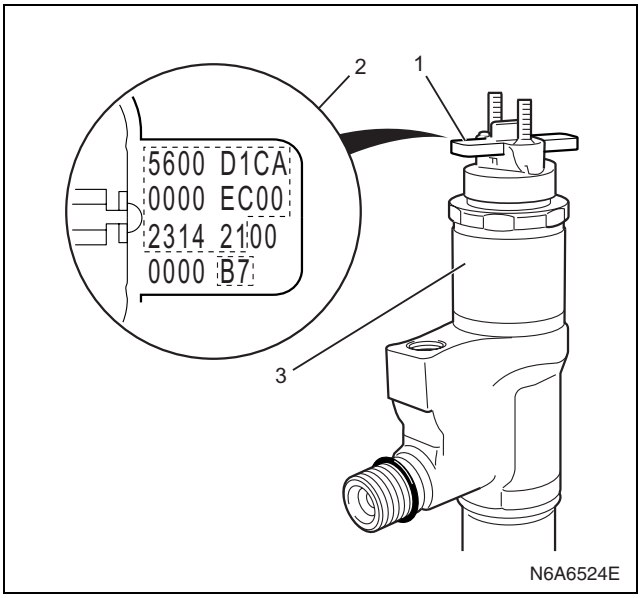


Legend

1. Cylinder Number 1 Fuel Injector ID Code
2. Cylinder Number 2 Fuel Injector ID Code
3. Cylinder Number 3 Fuel Injector ID Code
4. Cylinder Number 4 Fuel Injector ID Code
5. Injector ID Code Label
6. Cylinder Head Cover

Recording from the each fuel injector ID plate

1. Remove the cylinder head cover. Refer to Fuel Injector replacement in this section.
2. Record 24 figures of each fuel injector ID plate. The correct order for the fuel injector ID code for the following illustration is as follows:
   56 00 D1 CA 00 00 EC 00 23 14 21 B7

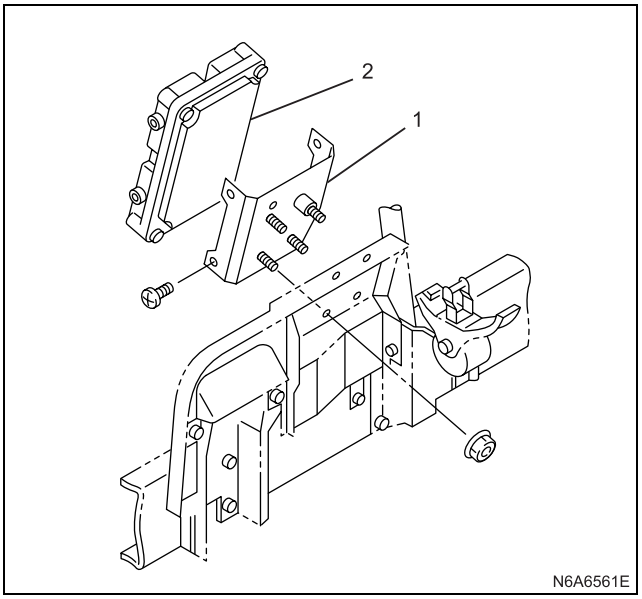


Legend
1. Fuel Injector ID Plate
2. Fuel Injector ID Code
3. Fuel Injector

Removal Procedure

Important:
Take care not to give a strong impact to the ECM.

1. Turn OFF the ignition.
2. Disconnect the negative battery cable.
3. Disconnect the ECM connectors.
4. Remove the ECM bracket fixing nuts.
5. Remove the ECM bracket with the ECM.
6. Remove the ECM fixing bolts.
7. Remove the ECM.



Legend
1. ECM Bracket
2. ECM

Installation Procedure

Important:
Do not use a fallen ECM or the ECM that received a strong impact.

1. Install the ECM on the ECM bracket.

   Tighten:
   Bolts to 8.6 — 13.5 N·m (0.88 — 1.38 kg·m / 6.4 — 10.0 lb·ft)
2. Install the ECM bracket with the ECM.
3. Tighten the ECM bracket fixing nuts.
4. Connect the ECM connectors.
5. Connect the negative battery cable.

Fuel Injector ID Code Data Programming Procedure

Important:
Only perform this procedure if the fuel injector ID code data can be uploaded with the Tech 2. If the ECM can not be uploaded with the Tech 2, go to the next procedure.

1. Install the Tech 2.
2. Turn ON the ignition, with the engine OFF.
3. Select Diagnostics > appropriate vehicle identification > 4HK1 (Common Rail) > Programming > Injector ID Code > Download ID Code.
4. After complete the download, turn OFF the ignition for 30 second.
5. Turn ON the ignition.
6. Select Diagnostics > appropriate vehicle identification > 4HK1 (Common Rail) > Programming > Injector ID Code > Injector ID Code. At this point, all downloaded fuel injector ID code data can be verified. Compare the ID code values downloaded into the ECM and each fuel injector.
7. Start the engine and let idle.

Important:
In order to make the fuel supply pump characteristic learn into the replaced ECM, let the engine idle until warm-up. If the fuel system DTC's stored in the meantime, once clear DTC and warm-up the engine again.

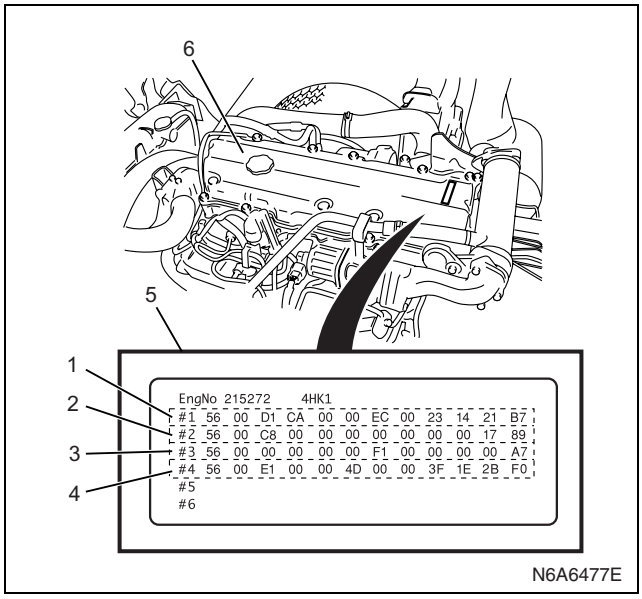
8. Inspect for a proper engine running condition and for no DTC's. Refer to the Diagnostic System Check-Engine Controls if needed.

Important:
If the current injector ID code data can not be uploaded with the Tech 2, the recorded all numbers must be entered into the Tech 2.

1. Install the Tech 2.
2. Turn ON the ignition, with the engine OFF.

3. Select Diagnostics > appropriate vehicle identification > 4HK1 (Common Rail) > Programming > Injector ID Code > ID Code Registration.
4. Select the cylinder 1 to 4 and press Change. If the ID code data are recorded from the label on cylinder head cover, go to a..
   If the ID code data are recorded from the each fuel injector ID plate, go to b..
   a. Input 22 figures. The correct order for the cylinder number 1 fuel injector ID code for the following illustration is as follows:
      56 00 D1 CA 00 00 EC 00 23 14 21

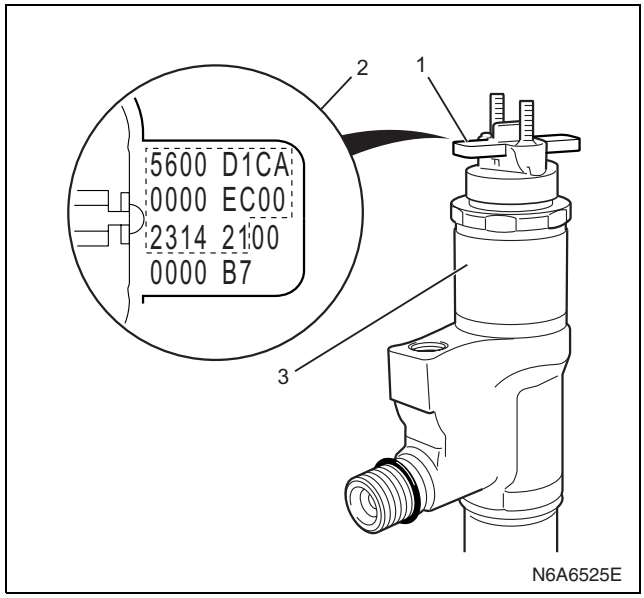
Important:
The number of places required for input is 22 figures except last 2 figures.



Legend
1. Cylinder Number 1 Fuel Injector ID Code
2. Cylinder Number 2 Fuel Injector ID Code
3. Cylinder Number 3 Fuel Injector ID Code
4. Cylinder Number 4 Fuel Injector ID Code
5. Injector ID Code Label
6. Cylinder Head Cover

   b. Input 22 figures. Then, input in order from the left edge of upper sequence to the right edge of lower sequence. The correct order for the fuel injector ID code for the following illustration is as follows:
      56 00 D1 CA 00 00 EC 00 23 14 21

Important:
The number of places required for input is 22 figures except last 2 figures.



Legend
1. Fuel Injector ID Plate
2. Fuel Injector ID Code
3. Fuel Injector

5. After complete the registration, turn OFF the ignition for 30 second.
6. Turn ON the ignition.
7. Select Diagnostics > appropriate vehicle identification > 4HK1 (Common Rail) > Programming > Injector ID Code > Injector ID Code. At this point, all registered fuel injector ID code data can be verified. Compare the ID code values registered into the ECM and each fuel injector including the last 2 figures. If the registered ID code is incorrect, go back to Step 4 ID Code Registration.
8. Start the engine and let idle.

Important:
In order to make the fuel supply pump characteristic learn into the replaced ECM, let the engine idle until warm-up. If the fuel system DTC's stored in the meantime, once clear DTC and warm-up the engine again.

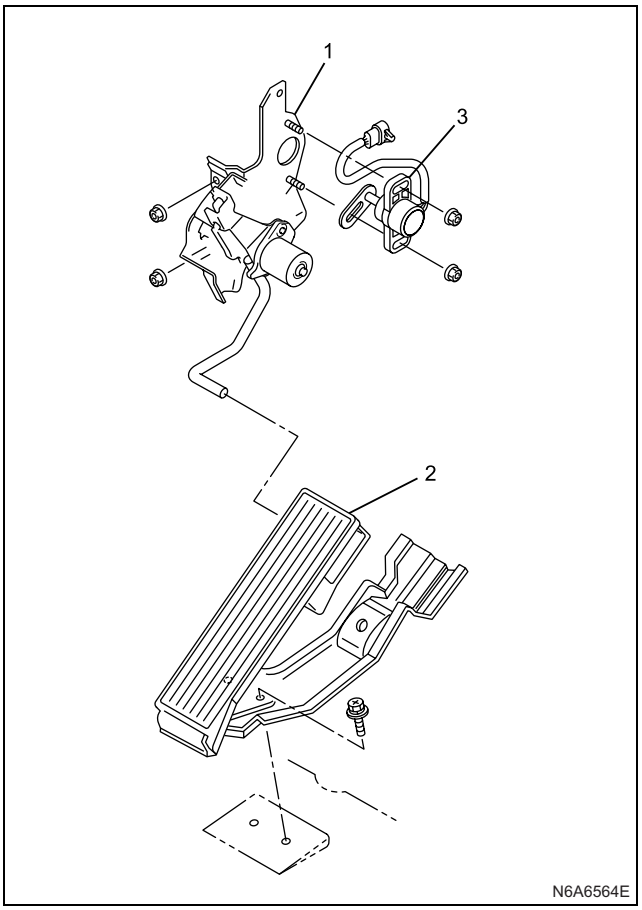
9. Inspect for a proper engine running condition and for no DTC's. Refer to the Diagnostic System Check-Engine Controls if needed.

Accelerator Pedal Position (APP) Sensor Replacement

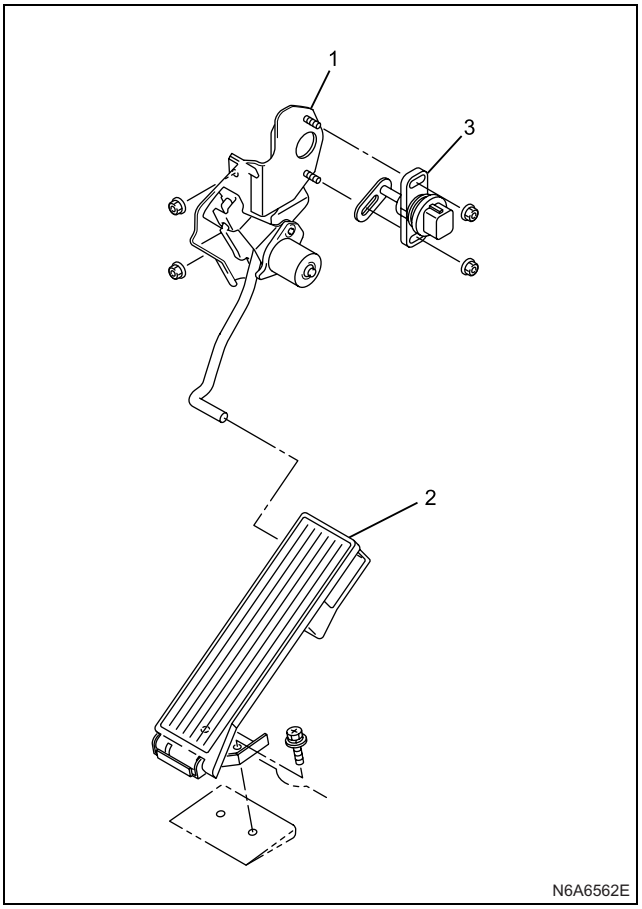
Removal Procedure

1. Turn off the ignition.
2. Disconnect the negative battery cable.
3. Remove the control link bracket assembly (1) fixing nuts.

• LHD Model



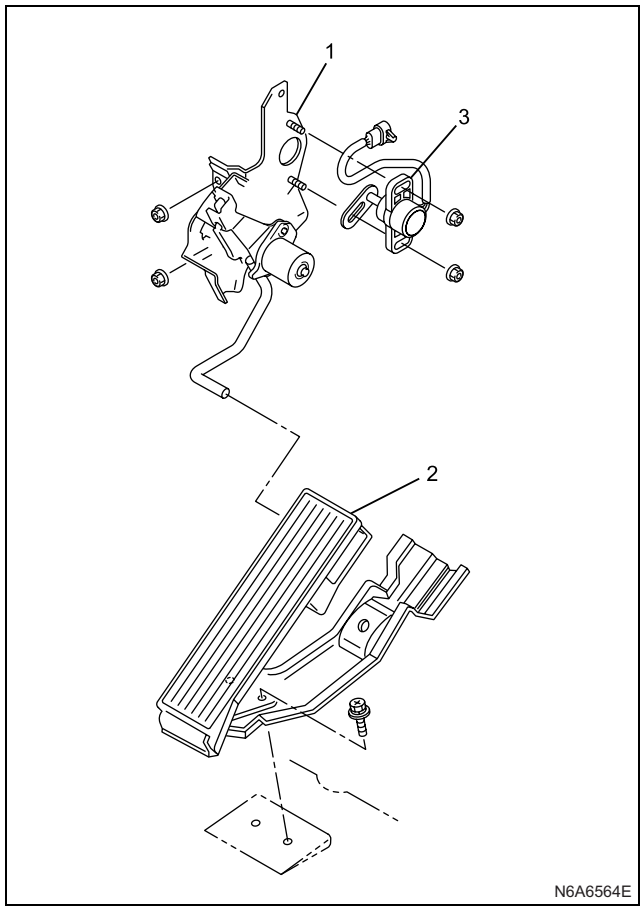
• RHD Model



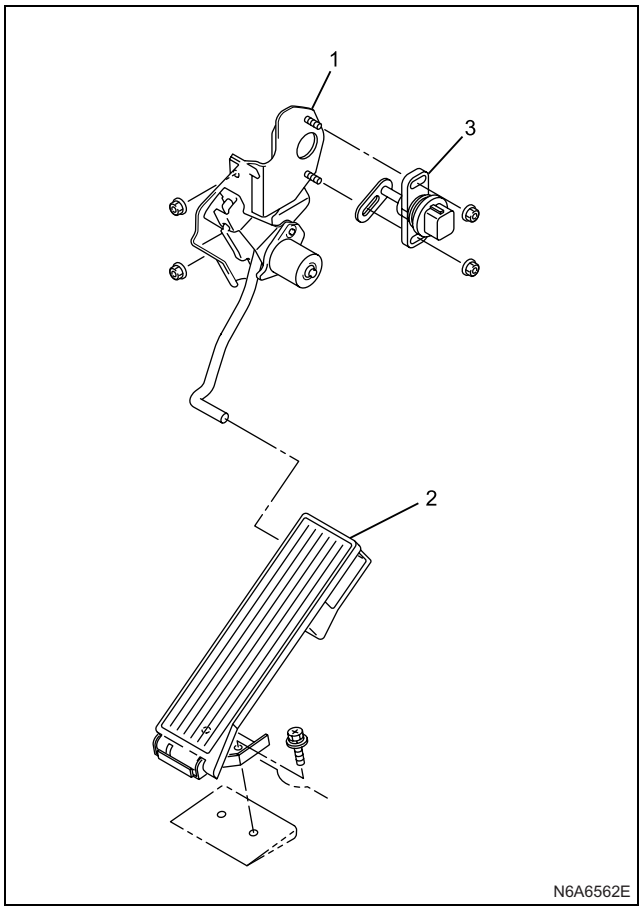
4. Remove the pedal assembly (2) fixing bolts.
5. Disconnect the accelerator pedal position (APP) sensor (3) connector.
6. Remove the APP sensor (3) fixing nuts.

Installation Procedure

• LHD Model



- RHD Model

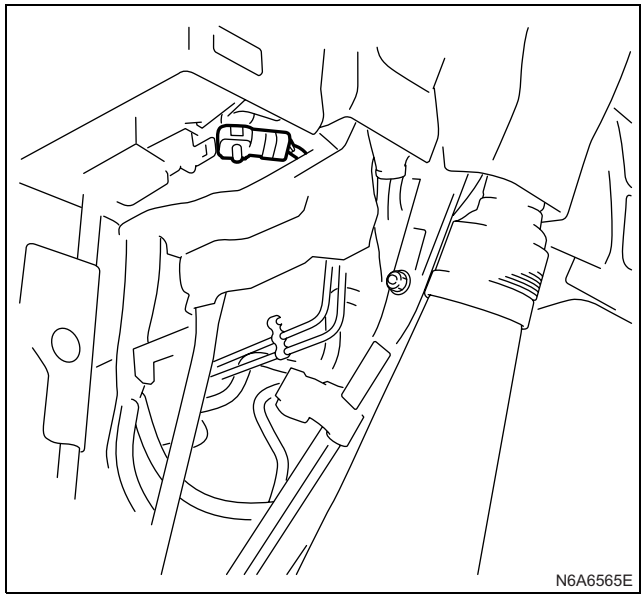


1. Install the APP sensor (3) on the control link bracket assembly (1).
2. Connect the APP sensor (3) connector.
3. Install the pedal assembly (2).
4. Install the control link bracket assembly (1).
5. Connect the nagative battery cable.

Barometric Pressure (BARO) Sensor Replacement

Removal Procedure

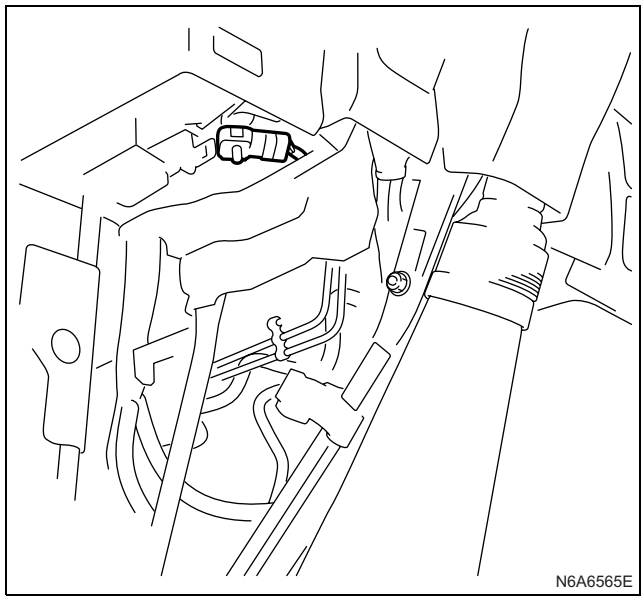
1. Turn off the ignition.
2. Disconnect the negative battery cable.
3. Disconnect the barometric pressure (BARO) sensor connector that is located under the instrument panel cluster (IPC).



4. Remove the BARO sensor.

Installation Procedure

1. Install the BARO sensor on the installation bracket.

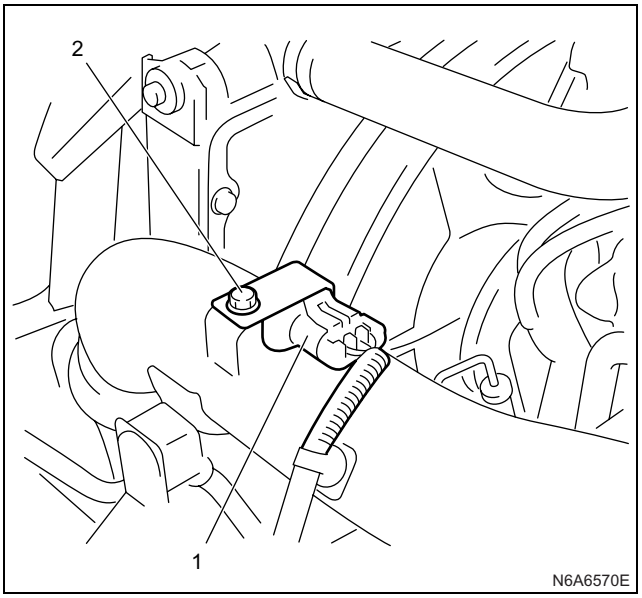


2. Connect the BARO sensor connector.
3. Connect the nagative battery cable.

Boost Pressure Sensor Replacement

Removal Procedure

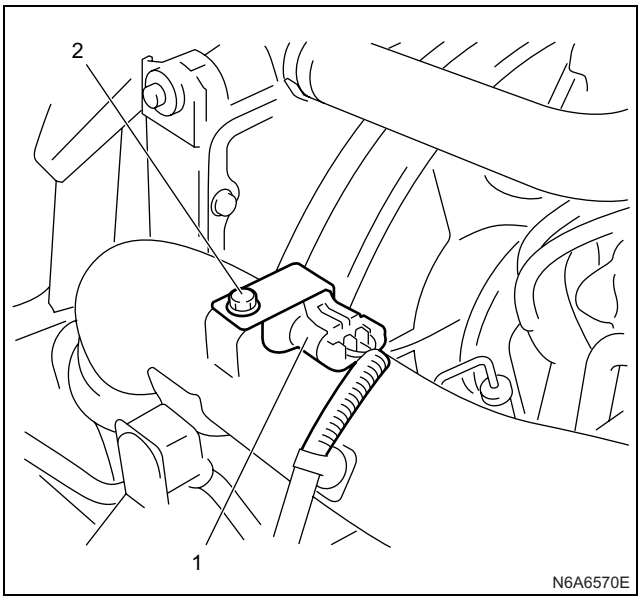
1. Turn off the ignition.
2. Loosen the boost pressure sensor bolt (2).
3. Disconnect the boost pressure sensor connector.
4. Remove the boost pressure sensor (1).



Installation Procedure

1. Install the boost pressure sensor (1).
2. Tighten the boost pressure sensor bolt (2).

   Tighten:
   Bolt to 8 N·m (0.8 kg·m / 69 lb·in)

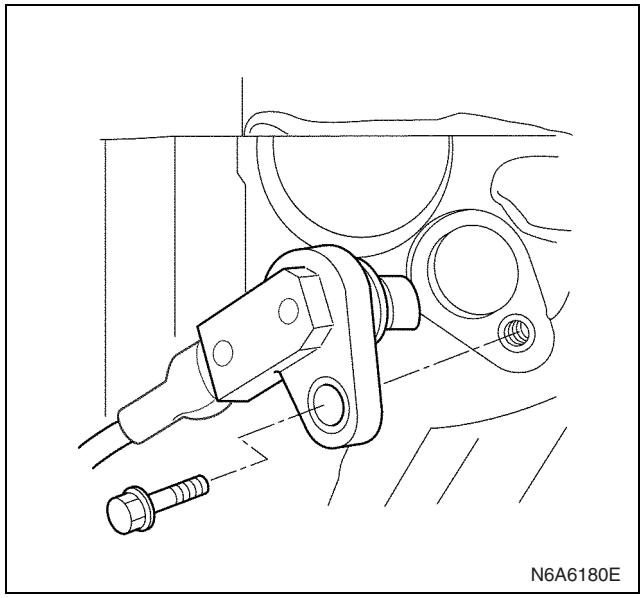


3. Connect the boost pressure sensor connector.

Camshaft Position (CMP) Sensor Replacement

Removal Procedure

1. Turn off the ignition.
2. Loosen the camshaft position (CMP) sensor retaining bolt.

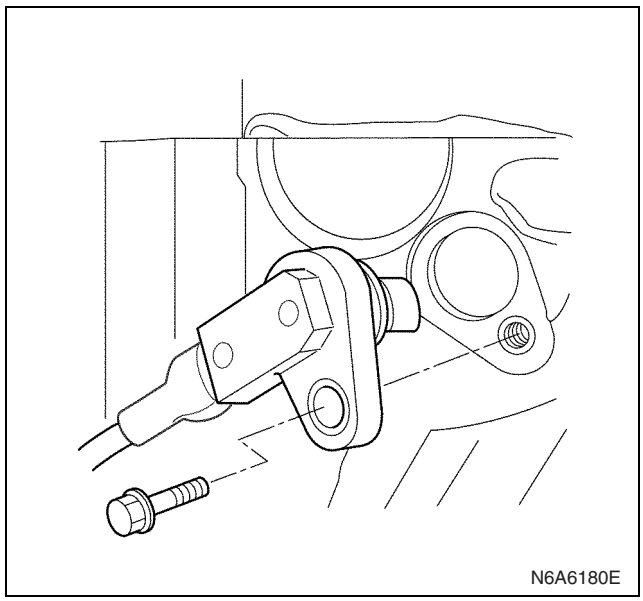


3. Remove the CMP sensor.

Installation Procedure

1. Install the CMP sensor.
   - Apply engine oil over the O-ring nice and thin and install it.
2. Tighten the CMP sensor retaining bolt.

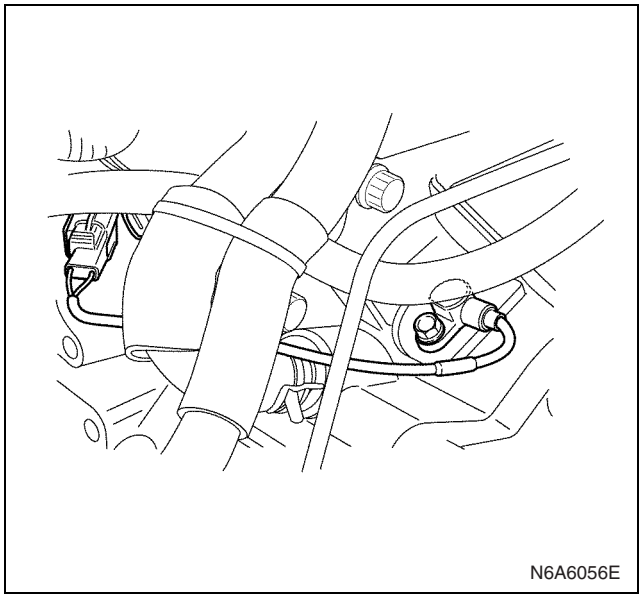
   Tighten:
   Bolt to 8 N·m (0.8 kg·m / 69 lb·in)



Crankshaft Position (CKP) Sensor Replacement

Removal Procedure

1. Disconnect the negative battery cable.
2. Loosen the crankshaft position (CKP) sensor retaining bolt.

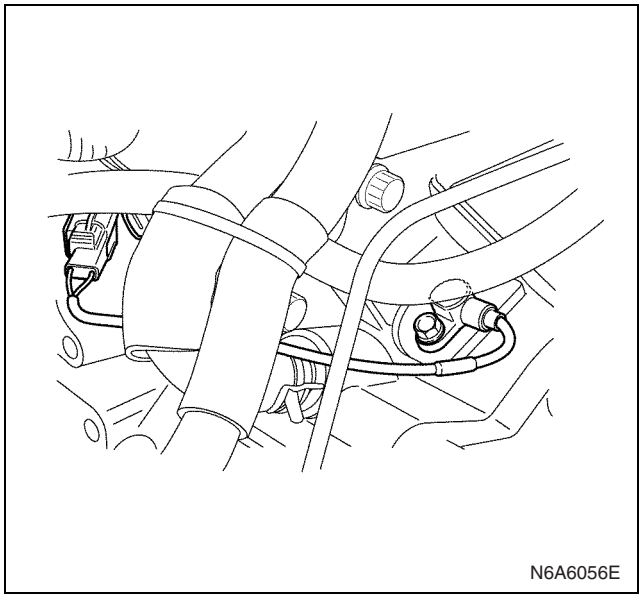

N6A6056E

3. Remove the CKP sensor.

Installation Procedure

1. Install the CKP sensor.
2. Tighten the CKP sensor retaining bolt.

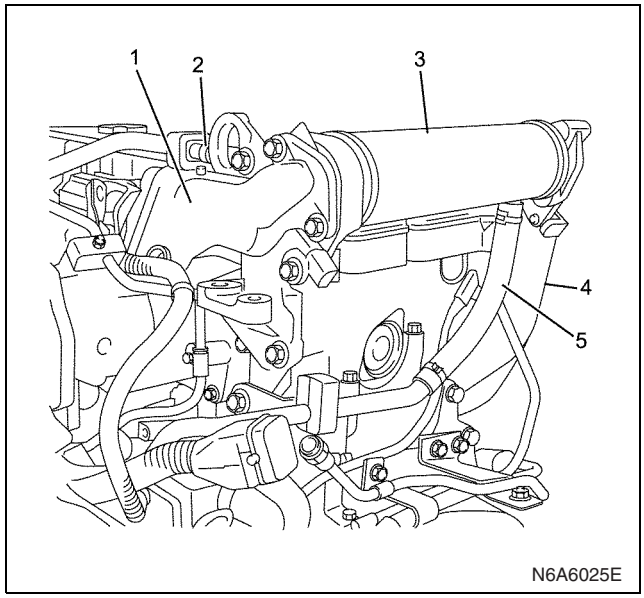
   Tighten:
   Bolt to 8 N·m (0.8 kg·m / 69 lb·in)


N6A6056E

EGR Valve Replacement

Removal Procedure

1. Drain engine coolant. Refer to Engine Cooling System section.
2. Remove the EGR valve connector.
3. Remove the EGR pipe.



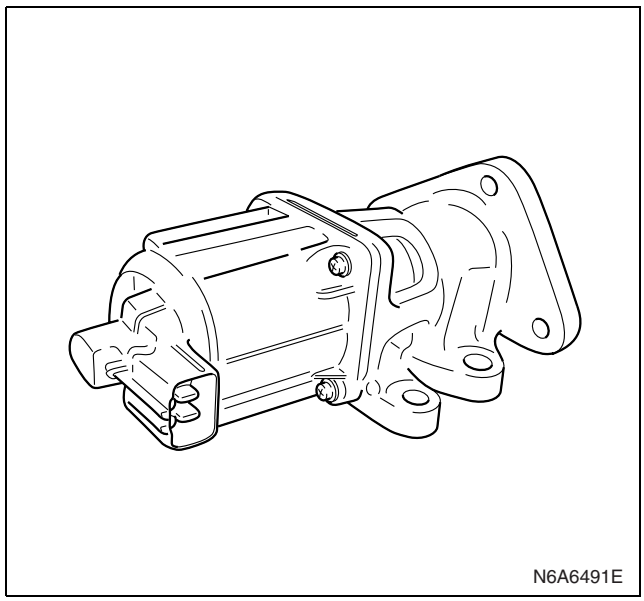
N6A6025E

Legend

1. EGR Adapter
2. Water Return Pipe
3. EGR Cooler
4. EGR Pipe
5. Water Feed Pipe

4. Remove the cooling water pipes.
5. Remove the EGR adapter.
6. Remove the EGR cooler.
7. Remove the EGR valve.

Caution:
After removing the EGR valve and EGR adapter, seal the opening so that foreign matter does not enter.


N6A6491E

Inspection Procedure

- **Gas leak check**
  - Check for gas leak in various parts of the EGR gas line.

If the results of the check show abnormalities, repair or replace the defective parts.

- **EGR valve check**

Installation Procedure

1. Mount the EGR valve.
   - Insert the gasket and temporarily fit the EGR valve.

Notice:
Temporarily tighten the bolts.

2. Install the EGR cooler.
   - Temporarily fit the EGR cooler to the bracket.

Notice:
Temporarily tighten the bolts.

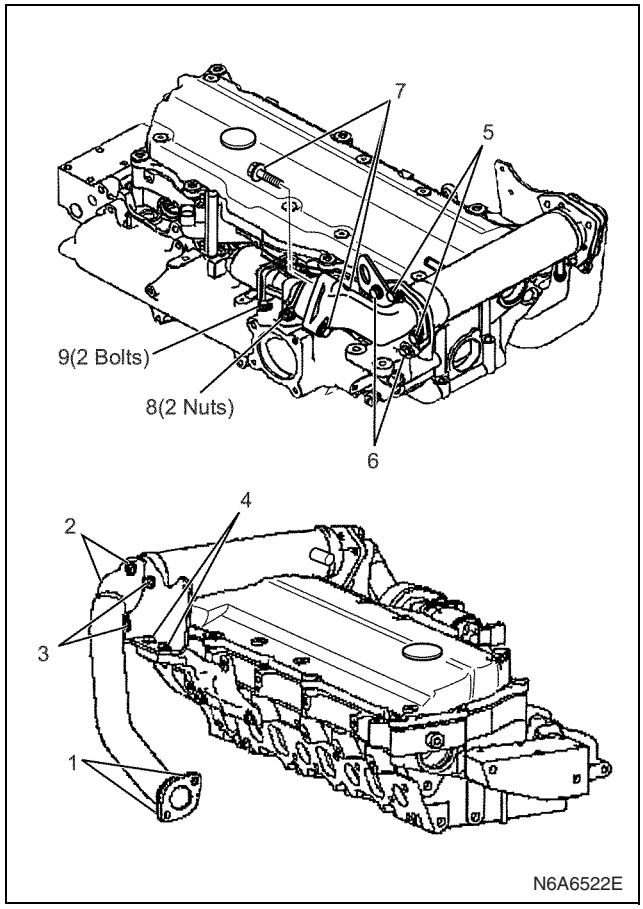
3. Install the EGR adapter.
   - Temporarily fit the EGR adapter between the EGR cooler and exhaust manifold.

Notice:
Temporarily tighten the bolts.

4. Install the EGR pipe.
   - Insert the gasket between the two ends of the EGR pipe and temporarily fit it.

Notice:
Temporarily tighten the bolts.

During temporary assembly, tighten the nuts and bolts to the specified torque in the order shown in the illustration.



Legend

1 ~ 9 Show The Order of Tighten Bolts and Nuts.

Tighten:

1 : 31 N·m (3.2 kg·m / 23 lb·ft)

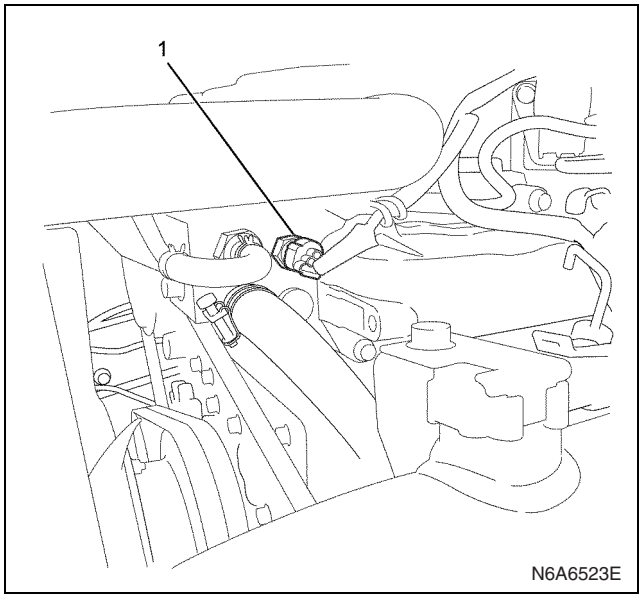
2, 4 : 28 N·m (2.9 kg·m / 21 lb·ft)

3, 5, 6, 7, 8, 9 : 24 N·m (2.4 kg·m / 17 lb·ft)

Engine Coolant Temperature (ECT) Sensor Replacement

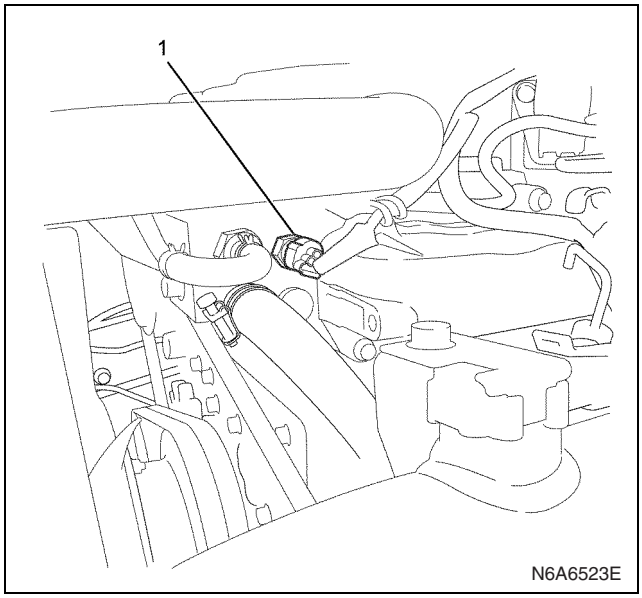
Removal Procedure

1. Turn off the ignition.
2. Disconnect the engine coolant temperature (ECT) sensor connector.
3. Remove the ECT sensor (1).



Installation Procedure

1. Install the ECT sensor (1).



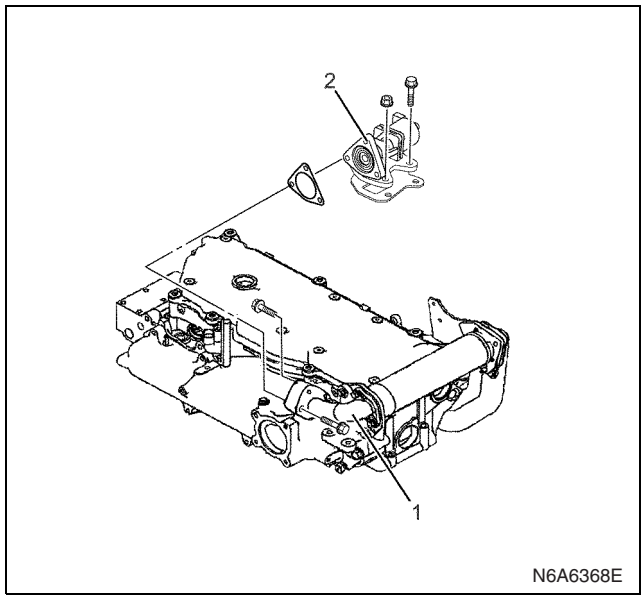
2. Connect the ECT sensor connector.
3. Replenish any lost engine coolant.

Fuel Injector Replacement / Fuel Injector ID Code Data Programming

Important:
The Fuel Injector ID Code Data Programming MUST be done when the fuel injector is being replaced. The Fuel Injector ID Code information MUST be recorded before assembling the cylinder head cover.

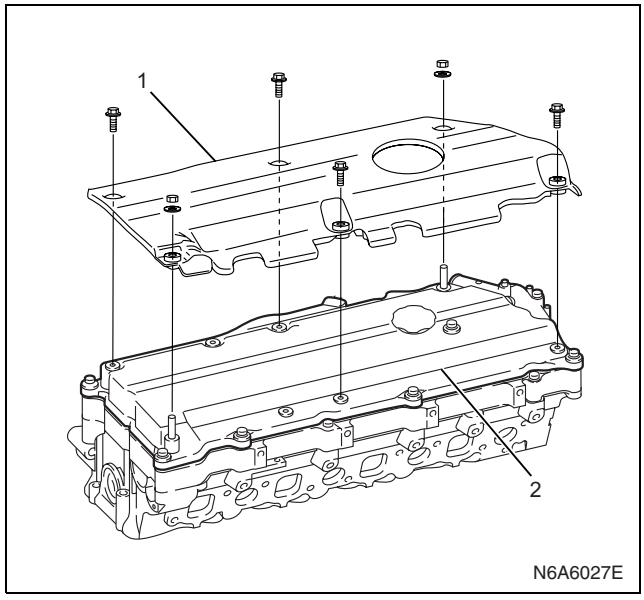
Removal Procedure

1. Remove the engine harness, the throttle position sensor, the EGR valve, the pressure sensor, and all of the fuel injector connectors.
2. Remove the EGR valve and the EGR adapter.
3. Tape the EGR case holes shut to prevent the entry of foreign material.



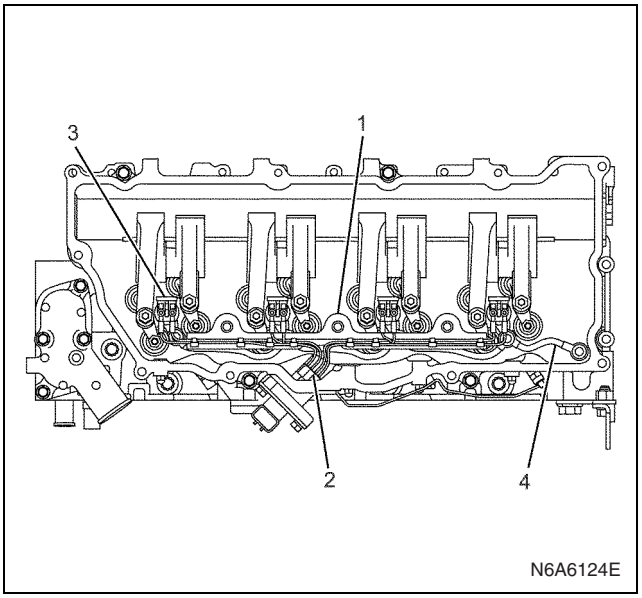
Legend
1. EGR Adapter
2. EGR Valve

4. Remove the sound insulation cover.
5. Remove the head cover.



Legend
1. Sound Insulation Cover (For Europe)
2. Head Cover

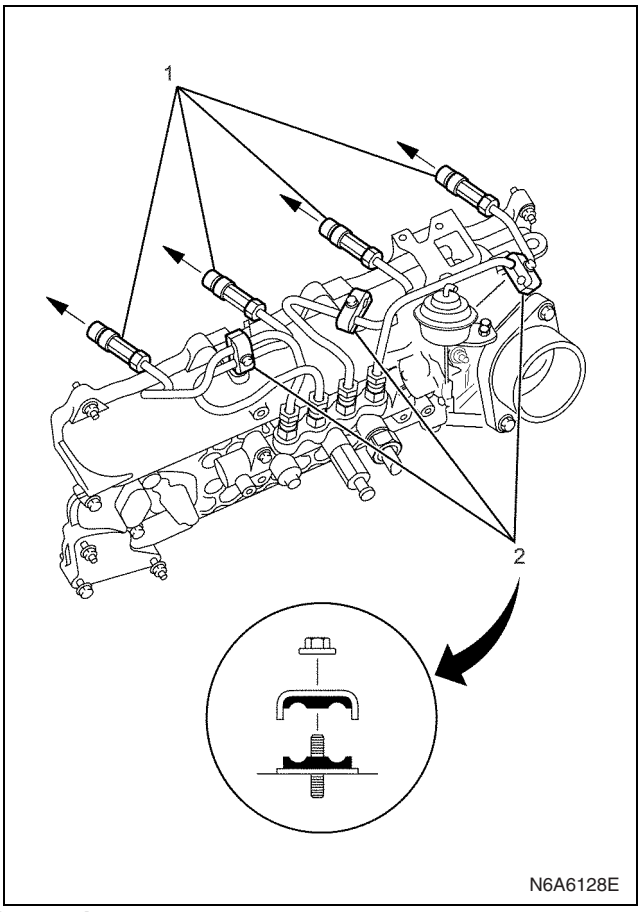
6. Loosen the fuel injector terminal nuts.
7. Loosen the fuel injector harness bracket bolts. Remove the inside connector and the harness bracket.
8. Remove the fuel injector leak-off pipe.
9. Remove the lower cover.



Legend

1. Harness Bracket
2. Harness Connector
3. Fuel Injector Terminal
4. Fuel Leak-Off Pipe

10. Remove the fuel injection pipe clips and the injection pipes.



Legend

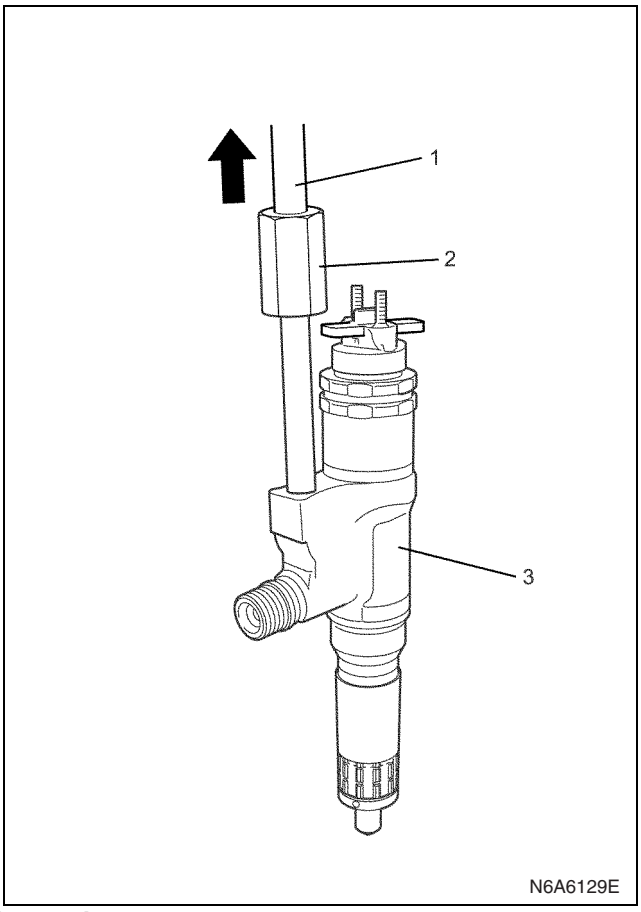
1. Fuel Injection Pipe
2. Pipe Clip

11. Loosen the fuel injector clamp fixing bolts and remove the fuel injectors.

If the fuel injectors are difficult to remove, use the fuel injector remover. Install the fuel injector remover to the leak-off pipe attachment part on the fuel injector. Use a sliding hammer to force the fuel injector clamp off the fuel injector.

Caution:
Do not remove the fuel injector sleeve.

Special tools
Fuel injector remover: 5-8840-2826-0 (EN-46720)
Sliding hammer: 5-8840-0019-0 (J-23907)



Legend

1. Sliding Hammer
2. Remover
3. Fuel Injector Assembly

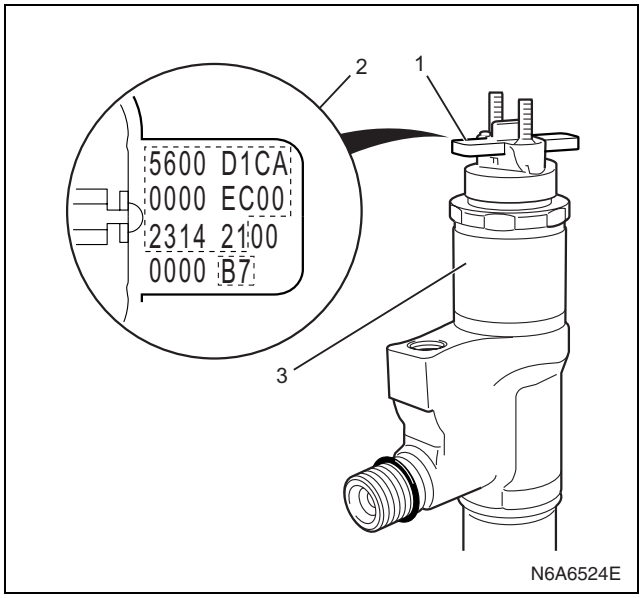
12. Mark each fuel injector with the number of the cylinder from which it was removed. Store the fuel injectors in a safe place. Position the fuel injector so that the nozzle is protected.

Caution:

- Do not tamper with the electromagnetic portion of the fuel injector. Reduced electromagnetic function will result in injector failure.

Recording from the each fuel injector ID plate

Record 24 figures of each fuel injector ID plate. The correct order for the fuel injector ID code for the following illustration is as follows:
56 00 D1 CA 00 00 EC 00 23 14 21 B7

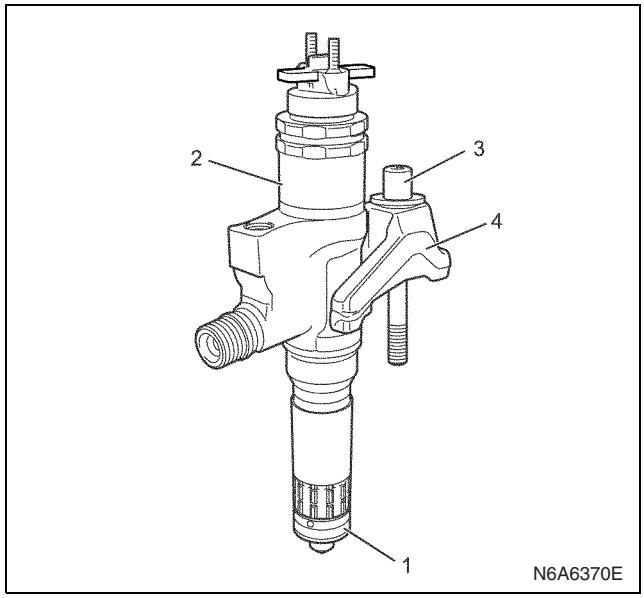


Legend
1. Fuel Injector ID Plate
2. Fuel Injector ID Code
3. Fuel Injector

Installation Procedure

Important:
Install each of the fuel injectors on its original position. (the cylinder from which it was removed)

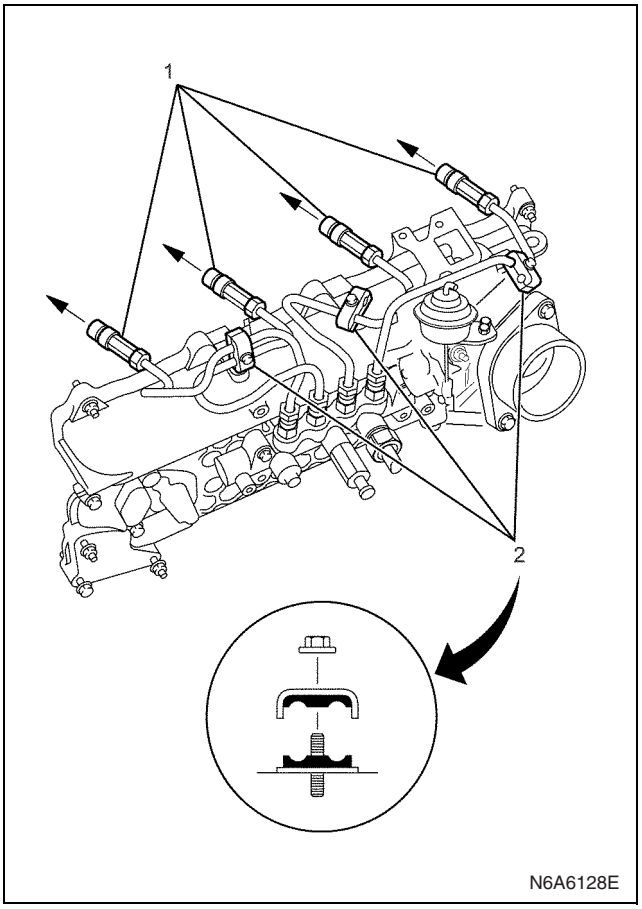
1. Install a new gasket and O-ring to each of the fuel injector clamps. Refer to the illustration.



Legend
1. Gasket
2. Fuel Injector
3. Bolt
4. Fuel Injector Clamp

2. Apply molybdenum to the threads and seating surfaces of the clamp bolts.
3. Install the fuel injector clamps to the cylinder head.
4. Temporarily tighten the clamp bolts.
5. Apply a thin coat of engine oil to the outer surface of the fuel injector side sleeve nuts.
6. Install the fuel injection pipes to the position shown in the illustration.
7. Use a spanner to carefully the sleeve nuts until the fuel injection pipes contact the fuel injector and common rail.
8. Tighten the fuel injection pipe clips to the specified torque.

   Tighten:
   Clips to 6 N·m (0.6 kg·m / 52 lb·in)



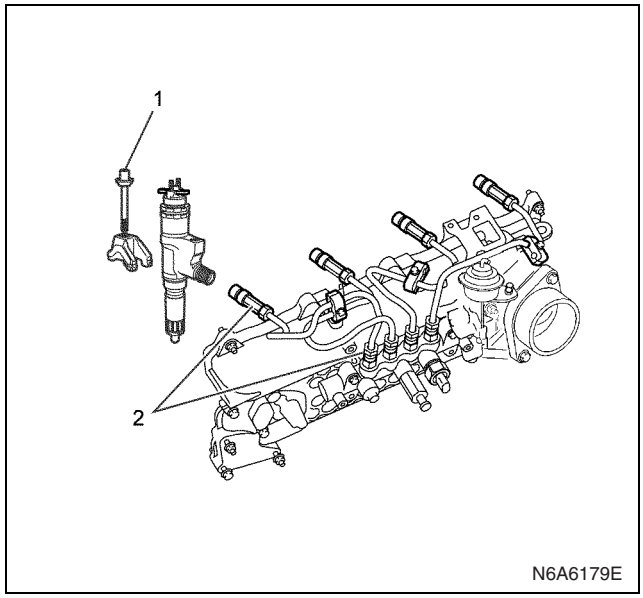
Legend
1. Fuel Injection Pipe
2. Pipe Clip

9. Final tighten the injection clamp bolts to the specified torque.

   Tighten:
   Bolts to 30 N·m (3.1 kg·m / 22 lb·ft)

10. Tighten the injection pipes to the specified torque.

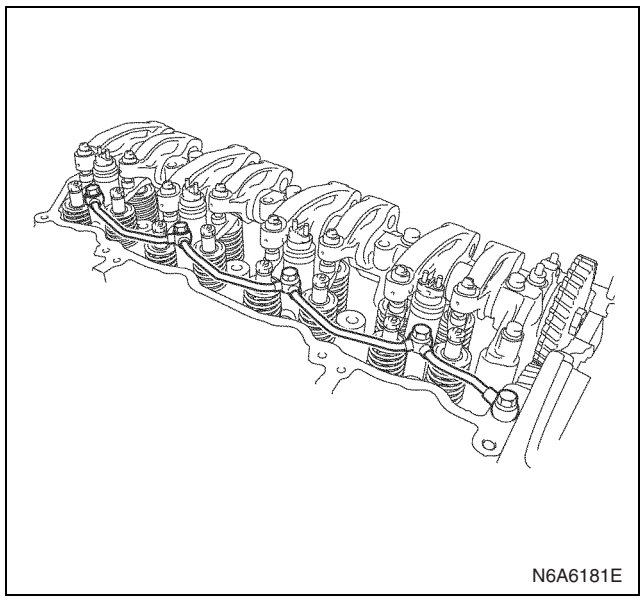
    Tighten:
    Injection pipes to 44 N·m (4.5 kg·m / 33 lb·ft)



Legend
1. Clamp Bolt
2. Sleeve Nut

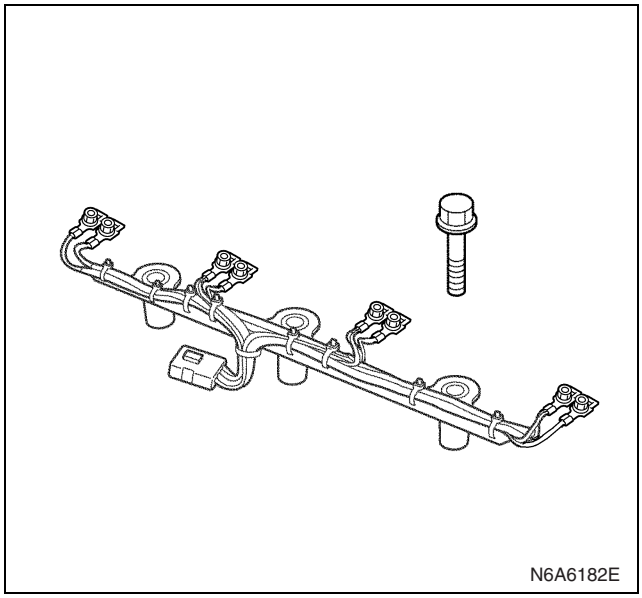
11. Install the nozzle leak off pipes together with the new gaskets. Tighten the pipes to the specified torque.

    Tighten:
    Pipes to 12 N·m (1.2 kg·m / 104 lb·in)



12. Install the fuel injector harness connectors. Work from the inside out.
13. Install the harness bracket and tighten the bolts to the specified torque.

    Tighten:
    Bolts to 48 N·m (4.9 kg·m / 35 lb·ft)

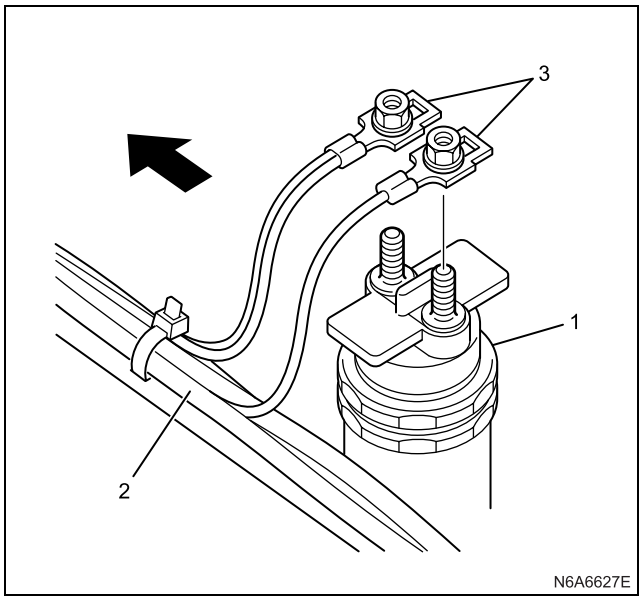


14. Install the fuel injector terminal nuts to the injector.

    Tighten:
    Nut to 2 N·m (0.2 kg·m / 17 lb·in)

Caution:

- Do not overtighten the nuts. Damage to the terminal studs will result.
- The terminal nut with two wires is engine front side.

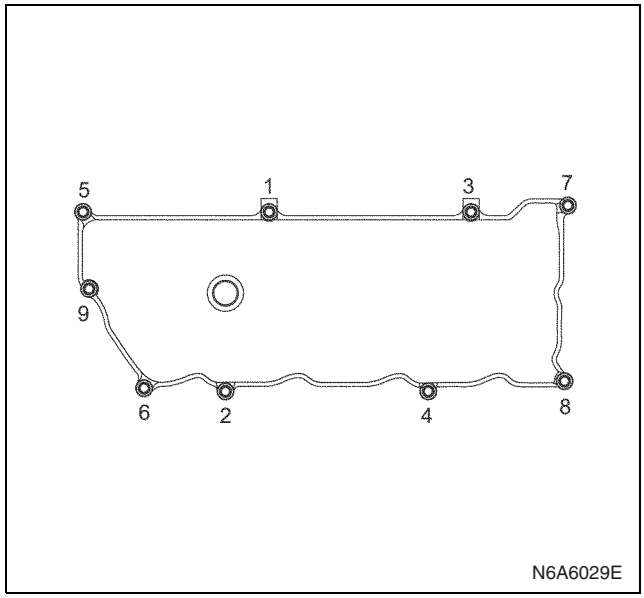


Legend

1. Fuel Injector
2. Harness
3. Terminal Nut

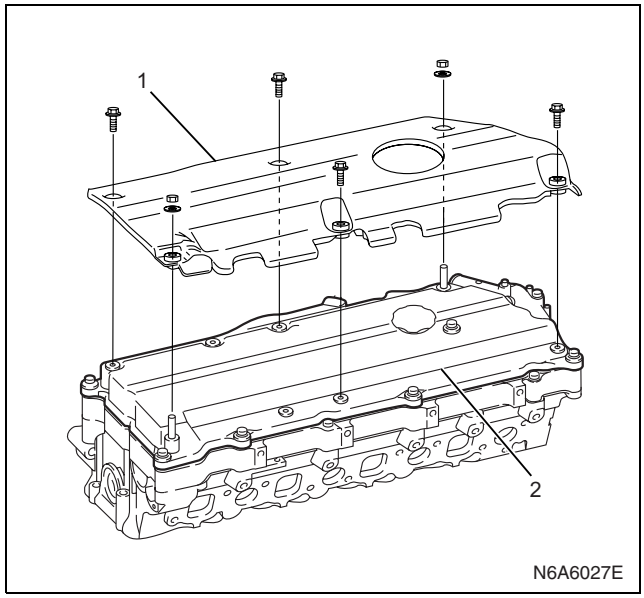
15. Install the gasket to the cylinder head cover.
16. Install the cylinder head cover and tighten up according to the order.

    Tighten:
    Bolts to 18 N·m (1.8 kg·m / 13 lb·ft)



17. Install the sound insulation cover (For Europe)

    Tighten:
    Bolts to 8 N·m (0.8 kg·m / 6 lb·ft)



Legend

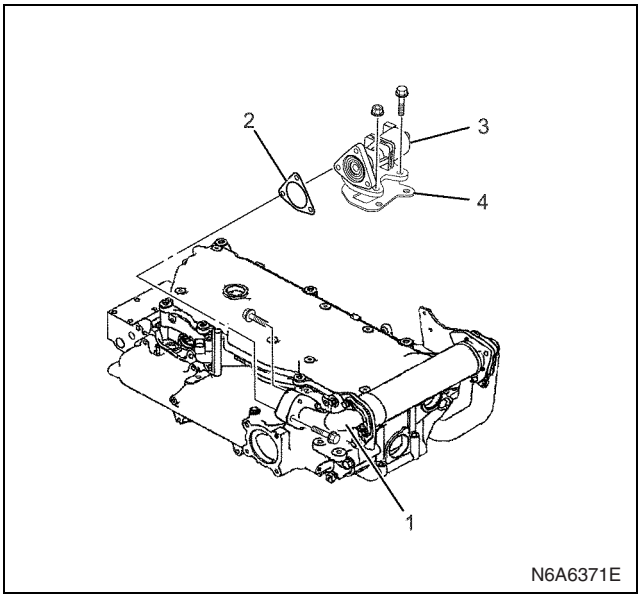
1. Sound Insulation Cover (For Europe)
2. Head Cover

18. Install the gasket to the EGR valve and tighten the bolts to the specified torque.

    Tighten:
    Bolts to 24 N·m (2.4 kg·m / 17 lb·ft)

19. Install the gasket to the EGR adapter and tighten the bolts to the specified torque.

    Tighten:
    Bolts to 24 N·m (2.4 kg·m / 17 lb·ft)



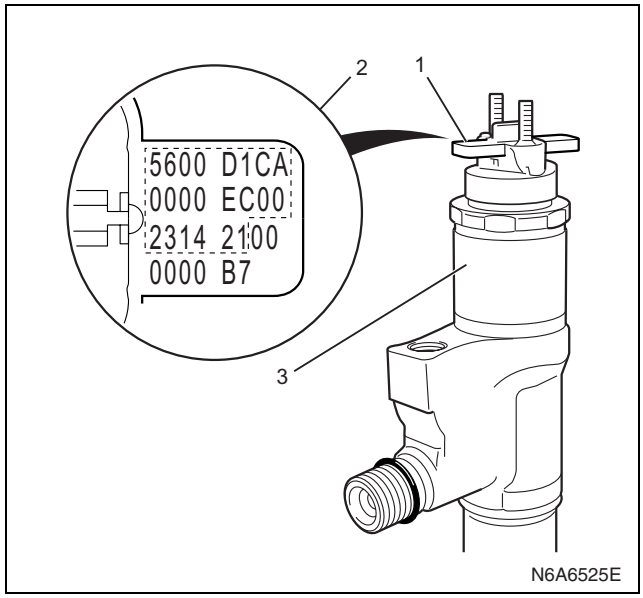
Legend
1. EGR Adapter
2. EGR Valve Gasket
3. EGR Valve
4. EGR Valve Gasket

20. Attach the engine harness connectors. Each composite connector should make a loud click when it is securely attached.

Fuel Injector ID Code Data Programming Procedure

1. Install the Tech 2.
2. Turn ON the ignition, with the engine OFF.
3. Select Diagnostics > appropriate vehicle identification > 4HK1 (Common Rail) > Programming > Injector ID Code > ID Code Registration.
4. Select replaced cylinder and press Change. Input 22 figures. Then, input in order from the left edge of upper sequence to the right sequence. The correct order for the fuel injector ID code for the following illustration is as follows:
   56 00 D1 CA 00 00 EC 00 23 14 21

Important:
The number of places required for input is 22 figures except last 2 figures.



Legend
1. Fuel Injector ID Plate
2. Fuel Injector ID Code
3. Fuel Injector

5. After complete the registration, turn OFF the ignition for 30 second.
6. Turn ON the ignition.
7. Select Diagnostics > appropriate vehicle identification > 4HK1 (Common Rail) > Programming > Injector ID Code > Injector ID Code. At this point, all registered fuel injector ID code data can be verified. Compare the ID code values registered into the ECM and each fuel injector including the last 2 figures. If the registered ID code is incorrect, go back to Step 4 ID Code Registration.
8. Start the engine and let idle.
9. Inspect for a proper engine running condition and for no DTC's. Refer to the Diagnostic System Check-Engine Controls if needed.

Notice:
After replacement of the fuel injector, perform the following procedure.
All fuel injectors are replaced:
Remove the fuel injector ID code label on the cylinder head cover.
Any fuel injector(s) is replaced:
Blackout the replaced cylinder fuel injector ID code on the cylinder head cover with a marking pen or equivalent.

Fuel Rail Pressure (FRP) Sensor Replacement

Removal Procedure

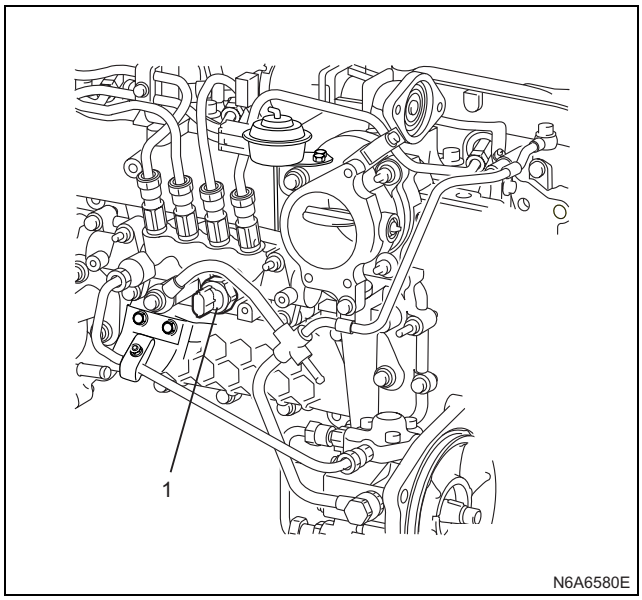
WARNING:
TO PREVENT LEAKED FUEL FROM CATCHING FIRE, DO NOT WORK WHILE THE ENGINE IS HOT.

Preparation:

- Pour detergent into a steam cleaner, and throughly wash around the sensor and the fuel rail.
- Remove water completely using air blow.

Notice:
Make sure that foreign matter will be prevented from getting in.

1. Remove the air intake pipe.
2. Disconnect the fuel rail pressure (FRP) sensor connector.
3. Remove the FRP sensor.



Legend
1. Fuel Rail Pressure (FRP) Sensor

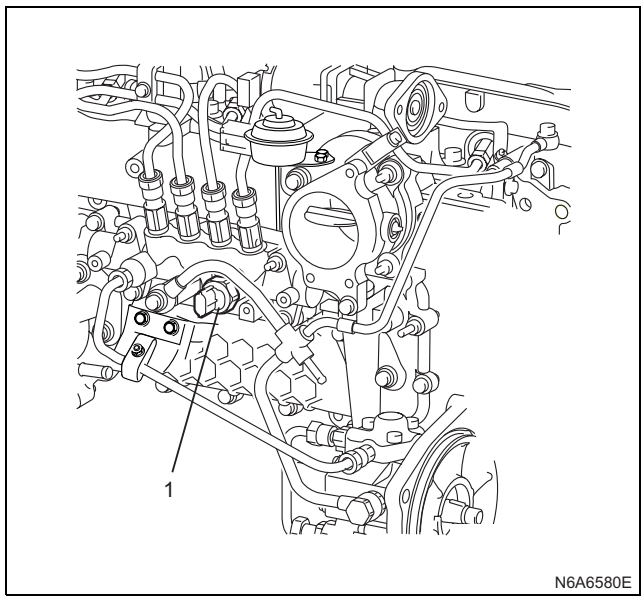
Installation Procedure

Important:

- FRP sensor cannot be reused after assembly. (The seal is deformed after tightening. This may result in defective seal if reused.)
- Keep the protective cap attached until assembly.
- Take care not to allow water or foreign matter to get inside the connector.
- Do not let foreign matter attach to the threaded portion. Also, make sure the installation part is free of foreign matter before installation.

1. Apply grease to the threads of the FRP sensor.
2. Install the FRP sensor.

   Tighten:
   FRP sensor to 98 N·m (10 kg·m / 72 lb·ft)



Legend
1. Fuel Rail Pressure (FRP) Sensor

3. Connect the FRP sensor connector.
4. Install the air intake pipe.

Notice:

- Carefully check for fuel leak after starting the engine.
- After the sensor is replaced, clear the trouble code and make sure the sensor operates normally using a scan tool.

Fuel Pressure Limiter Replacement

Removal Procedure

WARNING:
TO PREVENT LEAKED FUEL FROM CATCHING FIRE, DO NOT WORK WHILE THE ENGINE IS HOT.

Preparation:

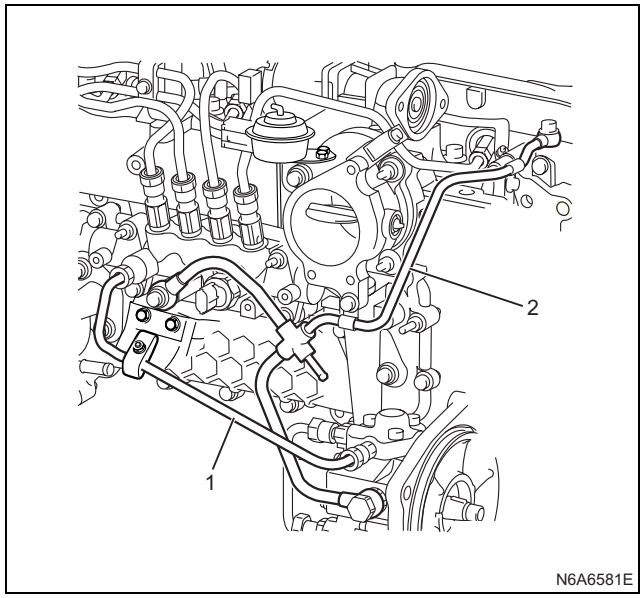
- Pour detergent into a steam cleaner, and throughly wash around the sensor and the fuel rail.
- Remove water completely using air blow.

Notice:
Make sure that foreign matter will be prevented from getting in.

1. Remove the air intake pipe.
2. Remove the fuel leak off hose from the leak off pipe.
   - Cover the removed fuel hose, keep it facing upward and secure it using wire, etc.
3. Remove the fuel pipe.

Important:
Loosen the fuel pipe gradually not to scatter high pressure fuel.

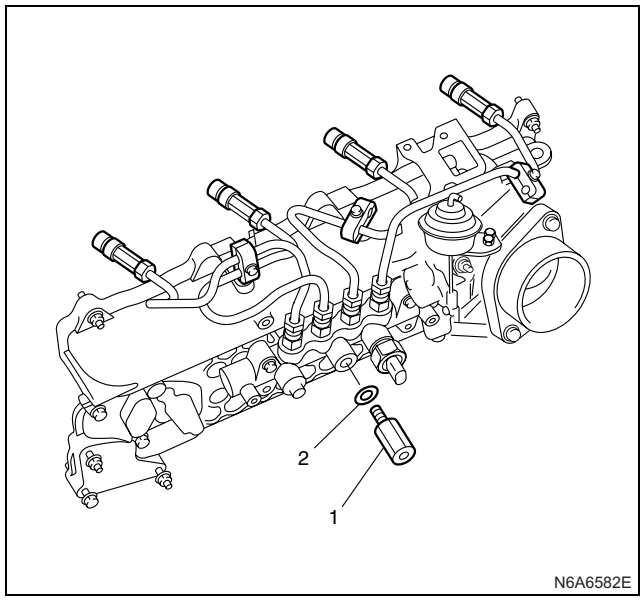
4. Remove the clips and the fuel leak off pipe.



Legend
1. Fuel Pipe
2. Fuel Leak Off Pipe

5. Remove the fuel pressure limiter.

Important:
Do not damage the seat surface when removing the gasket.



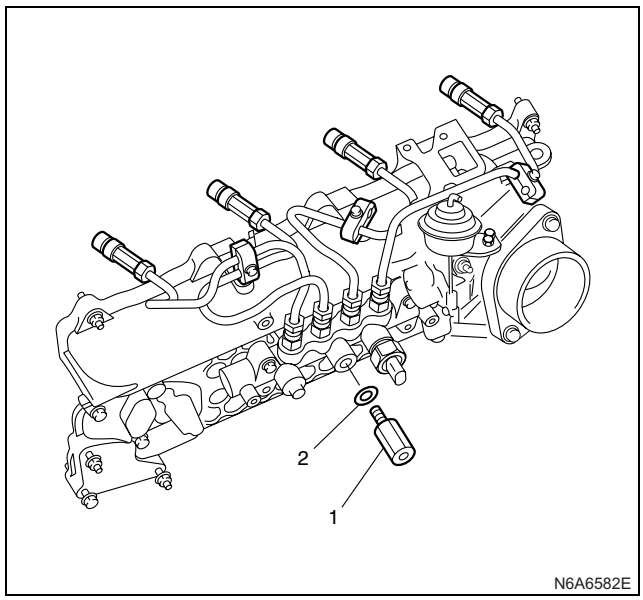
Legend
1. Fuel Pressure Limiter
2. Gasket

Installation Procedure

Important:
- Do not reuse the removed fuel pressure limiter and gaskets.
- Do not let foreign matter attach to the threaded portion. Also, make sure the installation part is free of foreign matter before installation.

1. Install the fuel pressure limiter.

   Tighten:
   Fuel pressure limiter to 172 N·m (17.5 kg·m / 127 lb·ft)



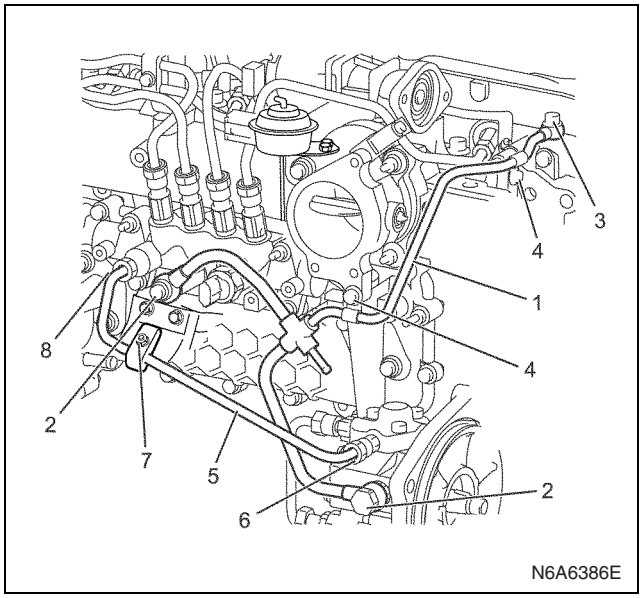
Legend
1. Fuel Pressure Limiter
2. Gasket

2. Tighten the fuel leak off pipe (1) using the mounting eyebolt and the clips using the specified torque.

   Tighten:
   (2): 18 N·m (1.8 kg·m / 13 lb·ft)
   (3): 12 N·m (1.2 kg·m / 9 lb·ft)
   (4): 8 N·m (0.8 kg·m / 69 lb·in)

3. Tighten the fuel pipe (5) using the mounting sleeve nut and the clip using the specified torque.

   Tighten:
   (6): 44 N·m (4.5 kg·m / 33 lb·ft)
   (7): 6 N·m (0.6 kg·m / 52 lb·in)
   (8): 44 N·m (4.5 kg·m / 33 lb·ft)



4. Install the fuel leak off hose to the fuel leak off pipe.
5. Install the air intake pipe.

Notice:

- Carefully check for fuel leak after starting the engine.
- After the fuel pressure limiter is replaced, clear the trouble code and make sure the fuel pressure limiter operates normally using a scan tool.

Fuel Rail Replacement

Removal Procedure

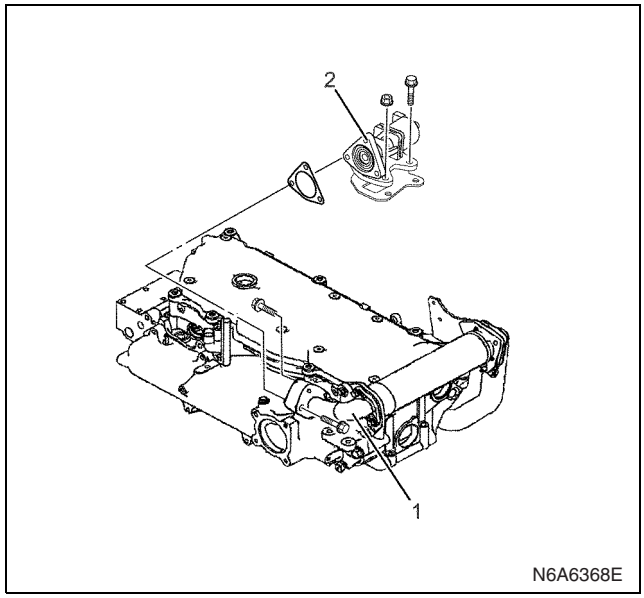
WARNING:
TO PREVENT LEAKED FUEL FROM CATCHING FIRE, DO NOT WORK WHILE THE ENGINE IS HOT.

Preparation:

- Pour detergent into a steam cleaner, and throughly wash around the sensor and the fuel rail.
- Remove water completely using air blow.

Notice:
Make sure that foreign matter will be prevented from getting in.

1. Remove the air intake pipe.
   - Disconnect the connector for the intake air temperature sensor.
2. Remove the fuel leak off hose from the leak off pipe.
   - Cover the removed fuel hose, keep it facing upward and secure it using wire, etc.
3. Disconnect the fuel rail pressure sensor harness connector.
4. Remove the EGR valve and the EGR adapter.
5. Tape the EGR case holes shut to prevent the entry of foreign material.

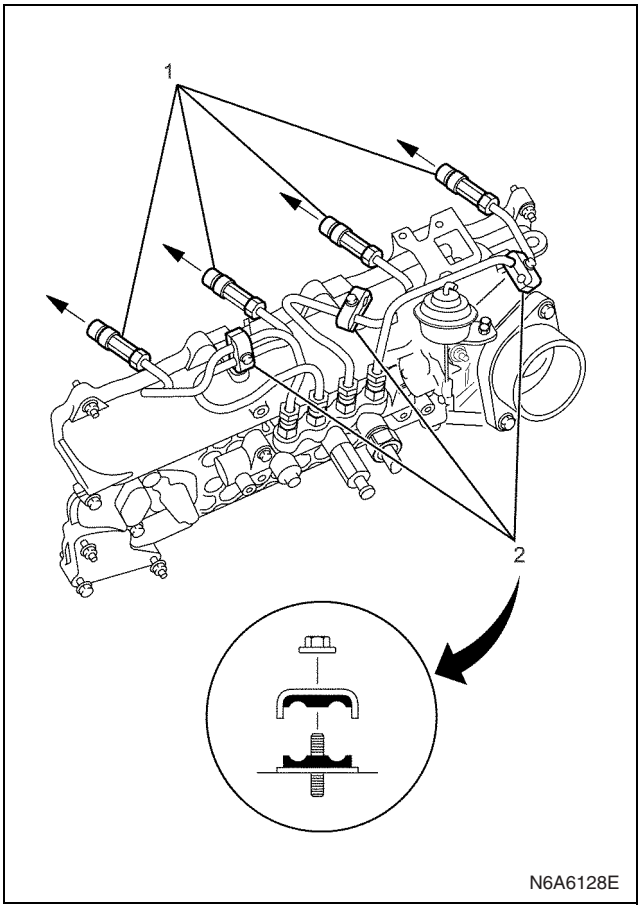


Legend

1. EGR Adapter
2. EGR Valve

6. Remove the injection pipe clip and remove the injection pipes.

Important:
Loosen the injection pipes gradually not to scatter high pressure fuel.

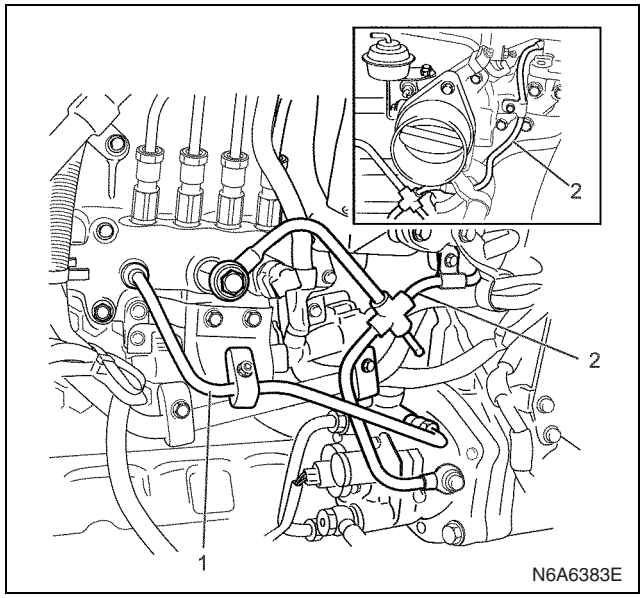


Legend
1. Fuel Injection Pipe
2. Fuel Injection Pipe Clip

7. Remove the fuel pipe.

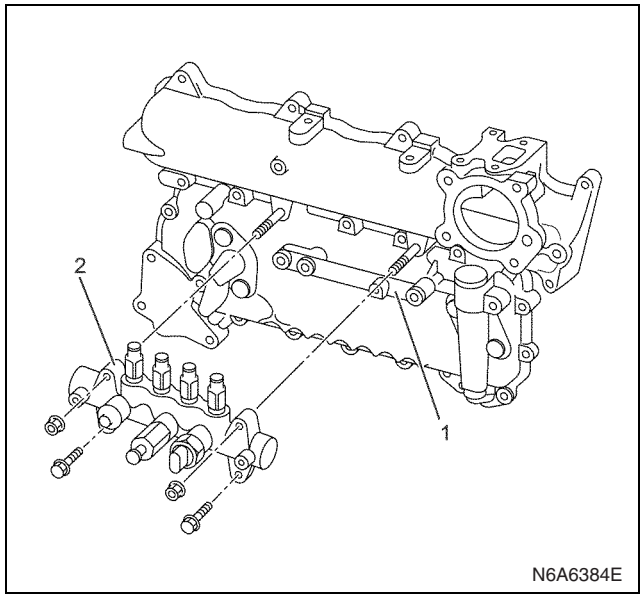
Important:
Loosen the fuel pipe gradually not to scatter high pressure fuel.

8. Remove the clips and the fuel leak off pipe.



Legend
1. Fuel Pipe
2. Fuel Leak-Off Pipe

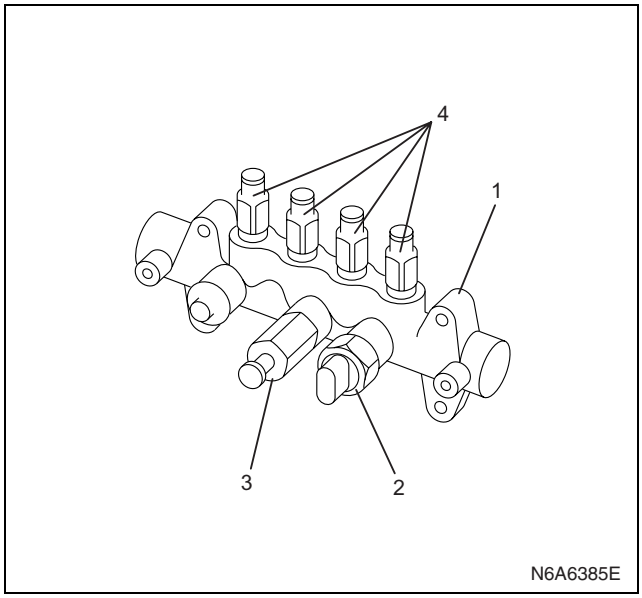
9. Remove the fuel rail and the fuel rail bracket.
   - Do not remove the flow damper. The dampers should always remain in the fuel rail.
   - Take care not to damage the connector unit of the pressure sensor.



Legend
1. Fuel Rail Bracket
2. Fuel Rail

Disassembly

1. Remove the fuel pressure limiter.
2. Remove the fuel rail pressure sensor.



Legend
1. Fuel Rail
2. Fuel Rail Pressure Sensor
3. Fuel Pressure Limiter
4. Flow Damper

Reassembly

1. Install the fuel pressure limiter.

   Tighten:
   Fuel pressure limiter to 172 N·m (17.5 kg·m / 127 lb·ft)

2. Install the fuel rail pressure sensor.

   Tighten:
   Fuel rail pressure sensor to 98 N·m (10 kg·m / 72 lb·ft)

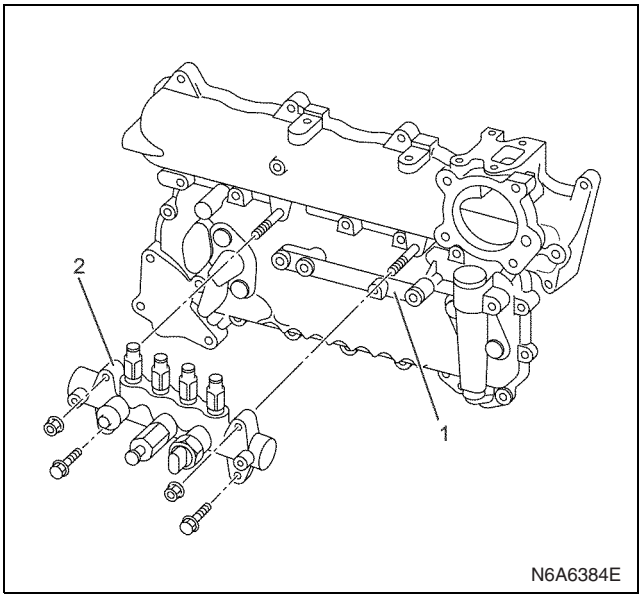
Installation Procedure

1. Tighten the fuel rail bracket using the specified mounting torque.

   Tighten:
   Nuts to 19 N·m (1.9 kg·m / 14 lb·ft)

2. Tighten the fuel rail using the specified mounting torque.

   Tighten:
   Bolts to 19 N·m (1.9 kg·m / 14 lb·ft)



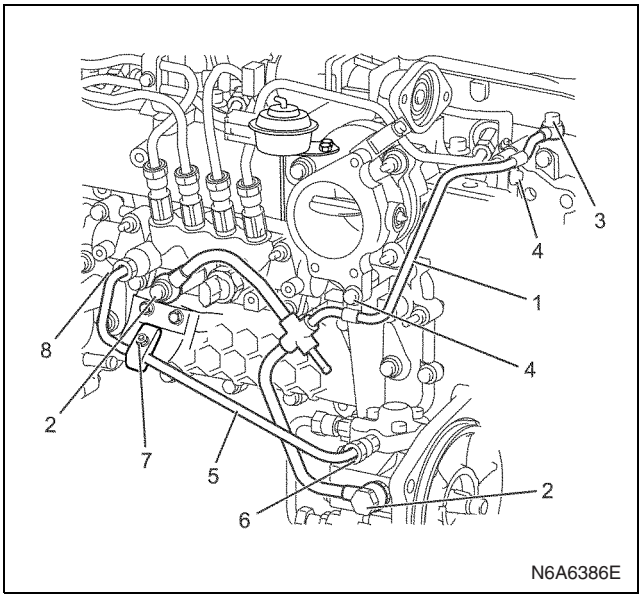
Legend
1. Fuel Rail Bracket
2. Fuel Rail

3. Tighten the fuel leak off pipe (1) using the mounting eyebolt and the clips using the specified torque.

   Tighten:
   (2): 18 N·m (1.8 kg·m / 13 lb·ft)
   (3): 12 N·m (1.2 kg·m / 9 lb·ft)
   (4): 8 N·m (0.8 kg·m / 69 lb·in)

4. Tighten the fuel pipe (5) using the mounting sleeve nut and the clip using the specified torque.

   Tighten:
   (6): 44 N·m (4.5 kg·m / 33 lb·ft)
   (7): 6 N·m (0.6 kg·m / 52 lb·in)
   (8): 44 N·m (4.5 kg·m / 33 lb·ft)



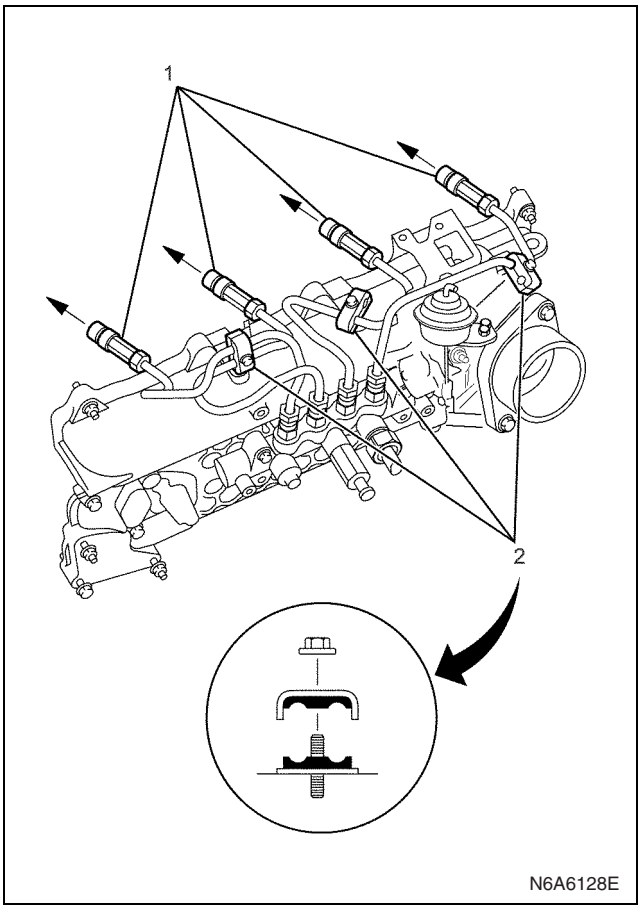
5. Install the fuel leak off hose to the fuel leak off pipe.

6. Tighten the injection pipe and the clip using the specified mounting torque.

   Tighten:
   Injection pipe sleeve nut to 44 N·m (4.5 kg·m / 33 lb·ft)

   Injection pipe clip to 6 N·m (0.6 kg·m / 52 lb·in)

   - Apply a thin coat of engine oil on the periphery of the sleeve nut on the injector side and assemble.



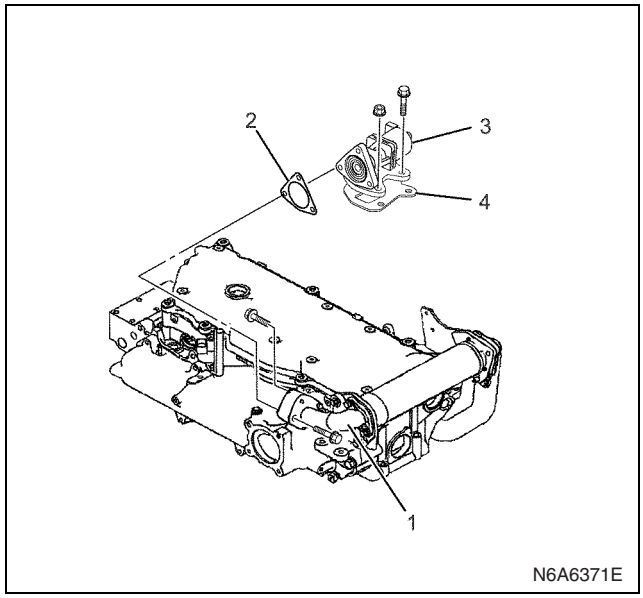
Legend
1. Fuel Injection Pipe
2. Fuel Injection Pipe Clip

7. Connect the fuel rail pressure (FRP) sensor connector.
8. Install the gasket to the EGR valve and tighten the bolts to the specified torque.

   Tighten:
   Bolts to 24 N·m (2.4 kg·m / 17 lb·ft)

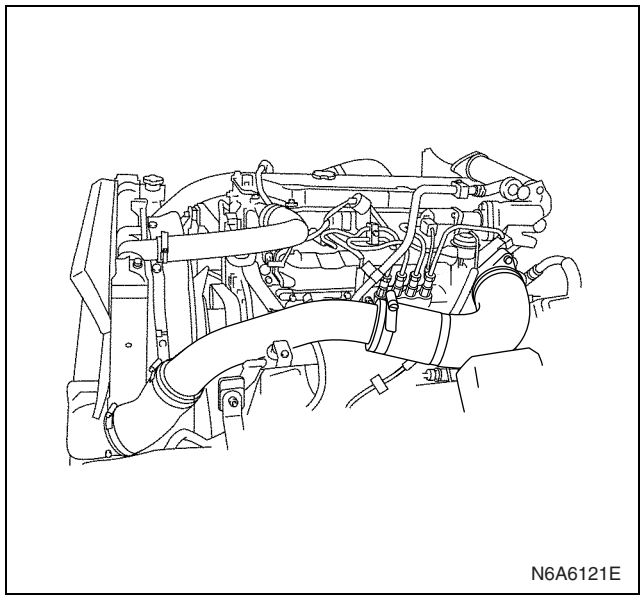
9. Install the gasket to the EGR adapter and tighten the bolts to the specified torque.

   Tighten:
   Bolts to 24 N·m (2.4 kg·m / 17 lb·ft)



Legend
1. EGR Adapter
2. EGR Valve Gasket
3. EGR Valve
4. EGR Valve Gasket

10. Install the air intake duct.
    - Connect the connector for the intake air temperature sensor.

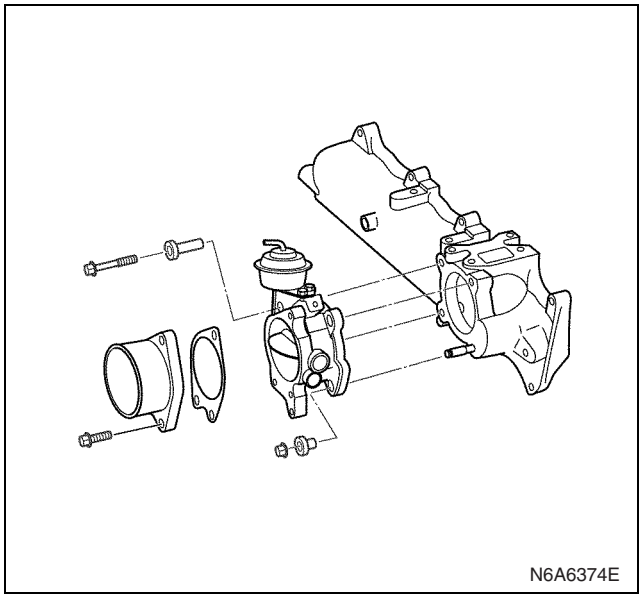


Fuel Supply Pump Replacement

Removal Procedure

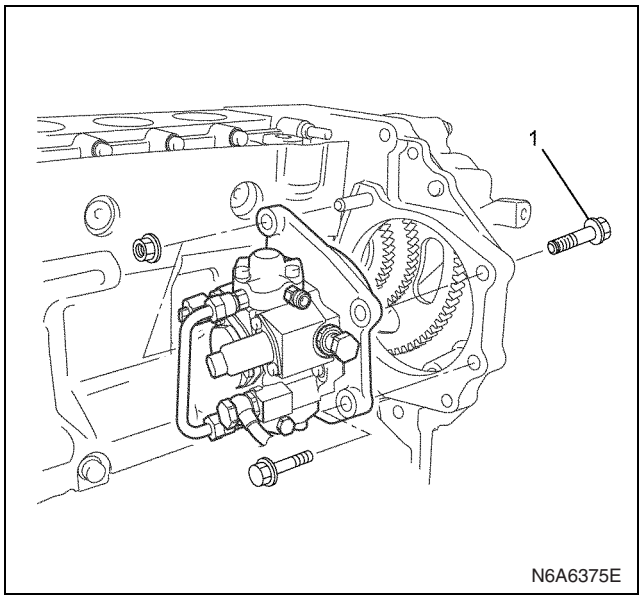
Important:
The fuel supply pump must be timed to the engine.

1. Remove the intake pipe and the intake throttle valve.
2. Remove the fuel pipe and fuel leak-off pipe.


N6A6374E

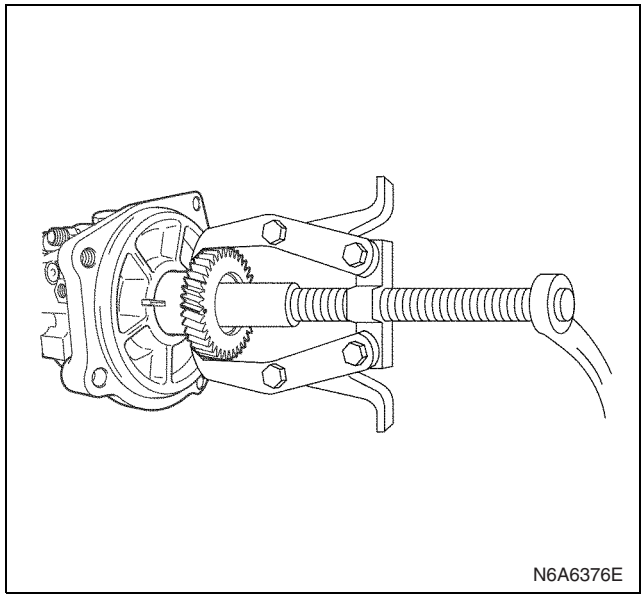
3. Remove the fuel feed hose.
4. Disconnect the fuel temperature sensor and the fuel rail pressure regulator harness connector from the fuel supply pump.
5. Remove the fuel supply pump attachment bolts and nuts, then remove the fuel supply pump.

Notice:
One of the attachment bolt (1) secures the fuel supply pump to the flywheel housing as denoted in the picture below.

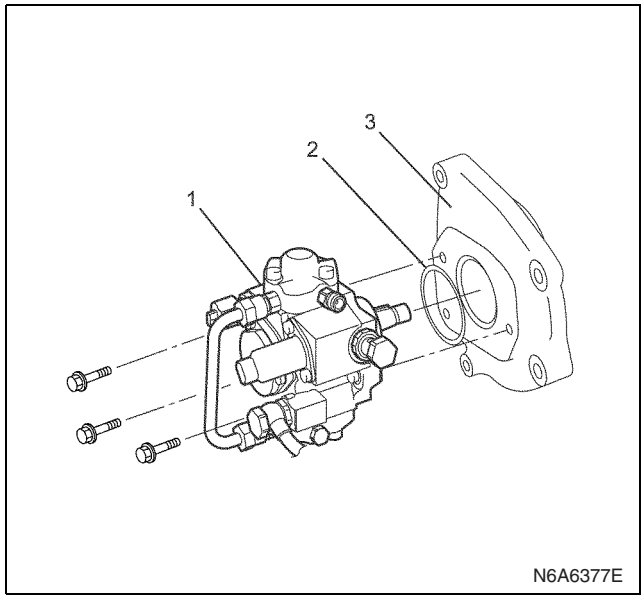


N6A6375E

6. Use a gear puller to remove the fuel supply pump gear and the O-ring.


N6A6376E

7. Loosen the 3 bolts holding the fuel supply pump bracket. Remove the bracket and the O-ring.



N6A6377E

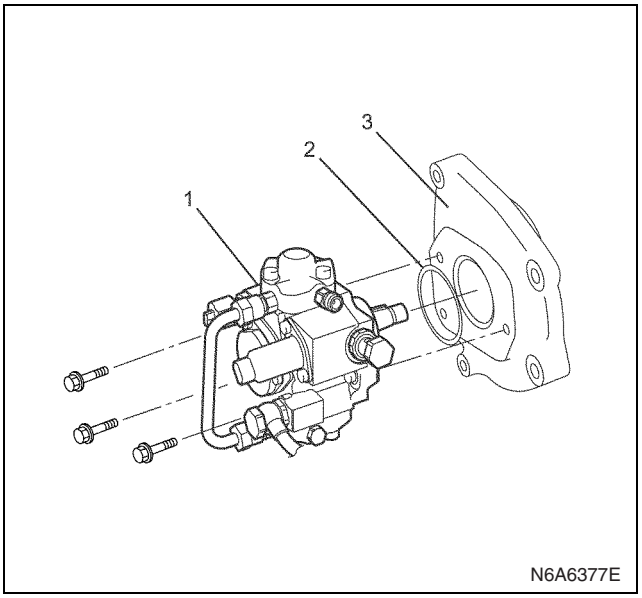
Legend
1. Fuel Supply Pump
2. O-Ring
3. Fuel Supply Pump Bracket

Installation Procedure

1. Install the O-ring to the fuel supply pump.
2. Install the pump to the bracket and tighten the 3 bolts to the specified torque.

   Tighten:
   Bolts to 19 N·m (1.9 kg·m / 14 lb·ft)

Caution:
Take care not to twist the O-ring.

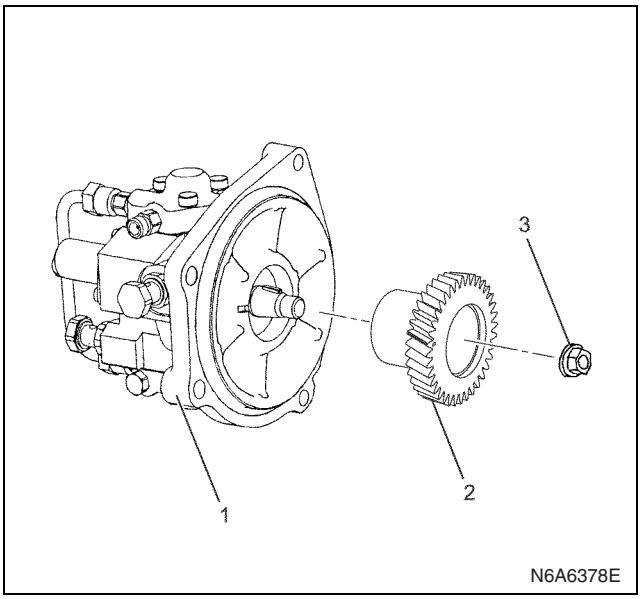


Legend

1. Fuel Supply Pump
2. O-Ring
3. Fuel Supply Pump Bracket

3. Align the fuel supply pump shaft key and gear. Install the gear and tighten the nut to the specified torque.
   There is a round alignment mark on the gear (white paint).

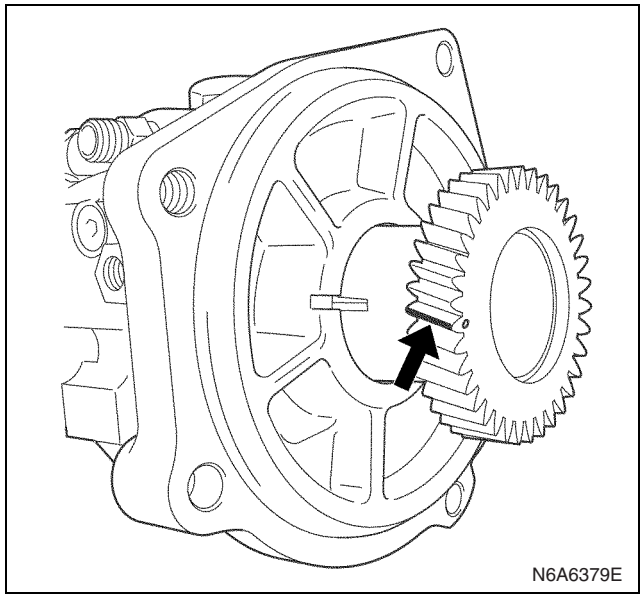
   Tighten:
   Nut to 64 N·m (6.5 kg·m / 47 lb·ft)



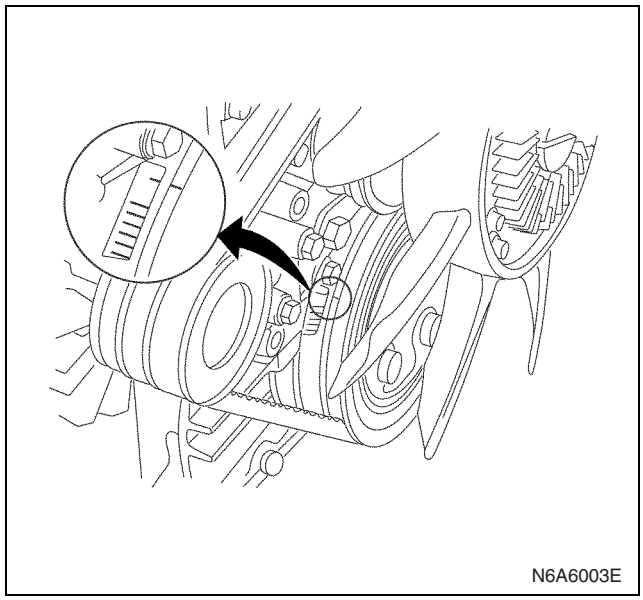
Legend

1. Fuel Supply Pump
2. Fuel Supply Gear
3. Nut

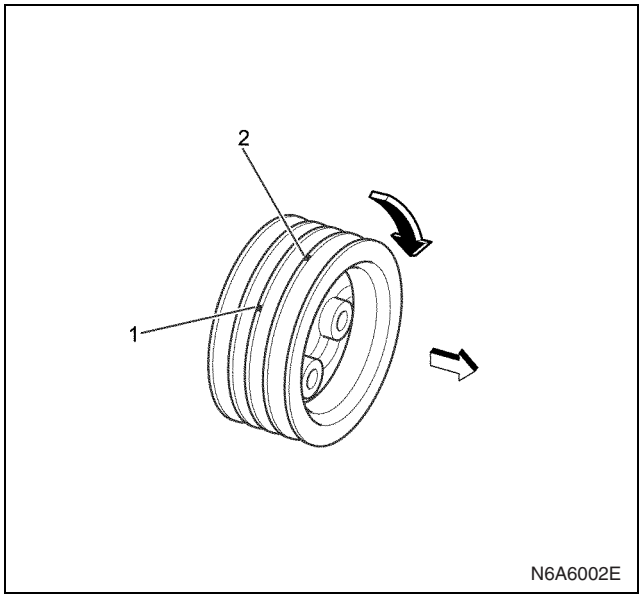
4. Apply white paint to the top of the fuel supply pump gear tooth directly above the stamped ‘O’ mark. Refer to the illustration.



5. Turn the crankshaft in the normal direction of engine rotation until the No.1 or No.4 cylinder is at TDC on the compression stroke.
   Refer to illustration.



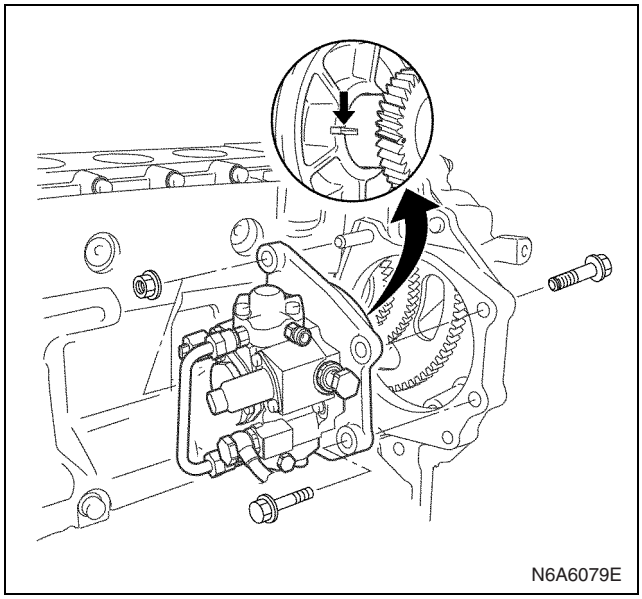
Notice:
There are 2 timing marks on the crankshaft pulley.
Mark (1) is near the front cover and is used to bring the 4HK1-TC engine to TDC.
Mark (2) is not applicable to this engine.
Be sure to use mark (1) when bringing the engine to TDC.



6. Remove the oil drain adapter.
7. Install the O-ring to the fuel supply pump.
8. Align the slits as shown in the illustration.
9. Insert the stud bolts into the guides and temporarily tighten them.

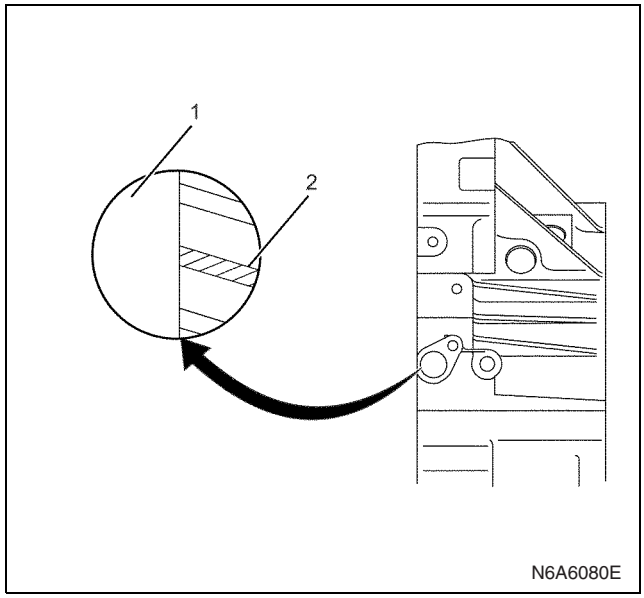
Caution:

- If the stud bolts (cylinder block side) have been loosened or replaced, apply Locktite No. 262 to the recessed portion of the bolts.



- Check that the round alignment mark (white paint) is positioned as shown in the illustration when viewed from the plug hole. If necessary, reposition the gear.
- Tighten the stud bolts and the nuts to the specified torque.

  Tighten:
  Nuts to 50 N·m (5.1 kg·m / 37 lb·ft)
  Bolts to 76 N·m (7.7 kg·m / 56 lb·ft)

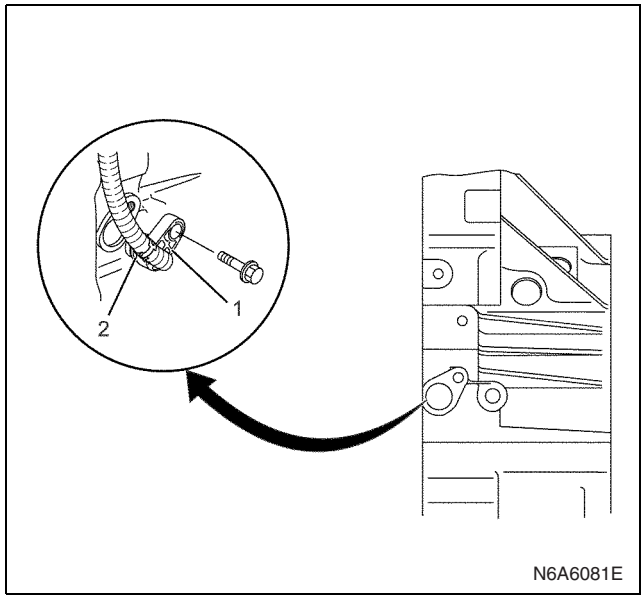


Legend

1. Plug Hole
2. Alignment Mark

10. Apply a light coat of engine oil to the O-ring.
11. Install the oil drain adapter to the plug hole. Tighten the bolt to the specified torque.

    Tighten:
    Bolt to 8 N·m (0.8 kg·m / 69 lb·in)



Legend

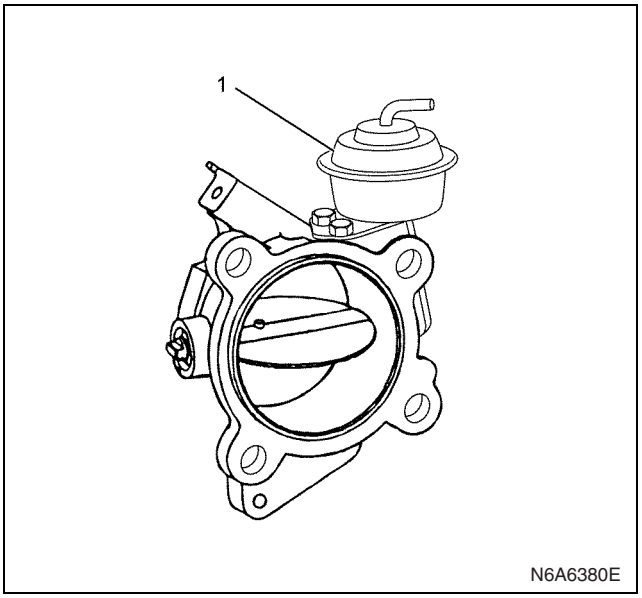
1. Oil Drain Adapter
2. O-Ring

12. Connect the fuel temperature sensor and the suction control valve connectors to the fuel supply pump.
13. Install the fuel feed hose.
14. Install the throttle assembly.

- Coat the fluid gasket and mount within 7 minutes.

  Tighten:
  Throttle assembly to 24 N·m (2.4 kg·m / 17 lb·ft)

- Install the intake throttle valve chamber hose.



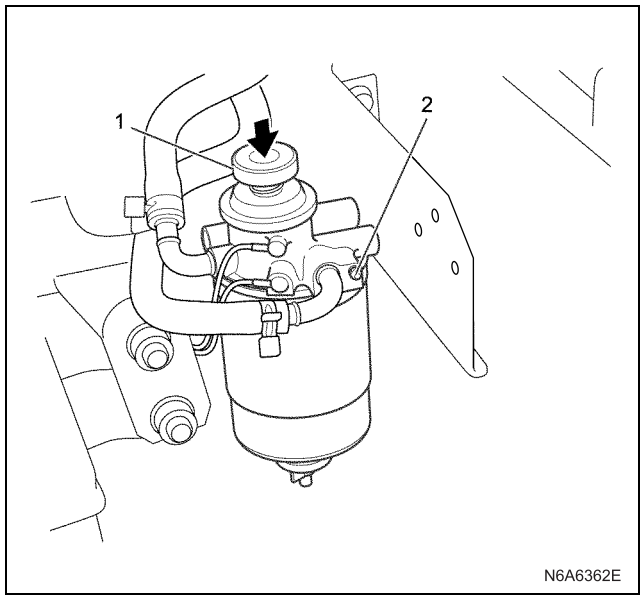
Legend
1. Intake throttle Valve Chamber

15. Install the fuel pipe and fuel leak-off pipe.

Important:
In order to make the fuel supply pump characteristic learn into the ECM, let the engine idle until warm-up. If the fuel system DTC's stored in the meantime, once clear DTC and warm-up the engine again.

16. Inspect for a proper engine running condition and for no DTC's. Refer to the Diagnostic System Check-Engine Controls if needed.

Fuel System Air Bleeding



Legend
1. Priming Pump
2. Air Bleed Plug

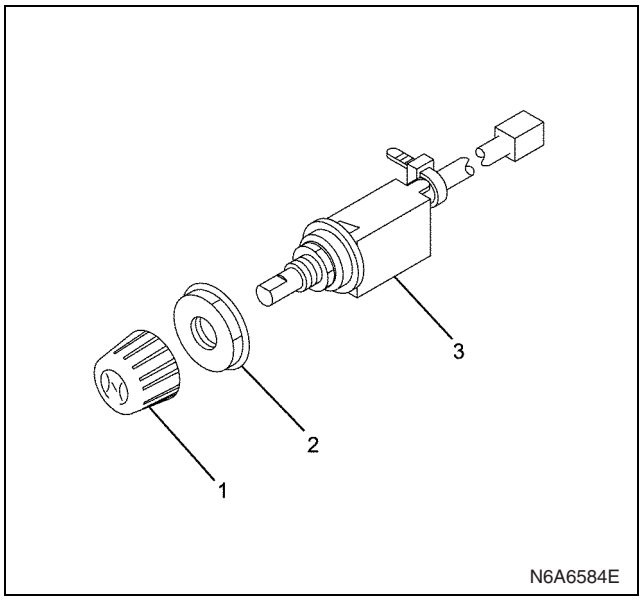
1. Before starting the engine
   a. Fit a tray below the fuel filter (below the air bleed plug).
   b. Loosen the plug adequately and operate the priming pump more than 20 times until the fuel overflows from plug hole.
   c. Tighten the plug, and operate the priming pump more than 10 times until it is filled with fuel. After waiting for approximately a minute, loosen the plug and bleed off the air in the fuel filter. (This work must be repeated a minimum of three times until no more air comes out from the plug.)
   d. Tighten the plug firmly and wipe the fuel in the surrounding area. Operate the priming pump (10 to 15 times) till it is filled with fuel and then send fuel to the engine.
2. After starting the engine
   a. Start the engine by rotating the starter without depressing the accelerator pedal.
   b. After starting, maintain the idling rotation for 5 seconds.
   c. Slowly rotate the idling control knob clockwise and maintain it for 3 minutes.
   d. Fully depress the accelerator pedal and increase the rotations to maximum. (Repeat this operation several times)
   e. Rotate the idling knob counterclockwise and return to idling mode.

Caution:
If the air bleeding work is insufficient then it could lead to faults in the engine. Therefore, the procedures after starting the engine should always be implemented.

Idle Up Sensor Replacement

Removal Procedure

1. Turn off the ignition.
2. Remove the idle up sensor knob (1).
3. Disconnect the idle up sensor connector.
4. Remove the idle up sensor holder (2).



5. Remove the idle up sensor (3).

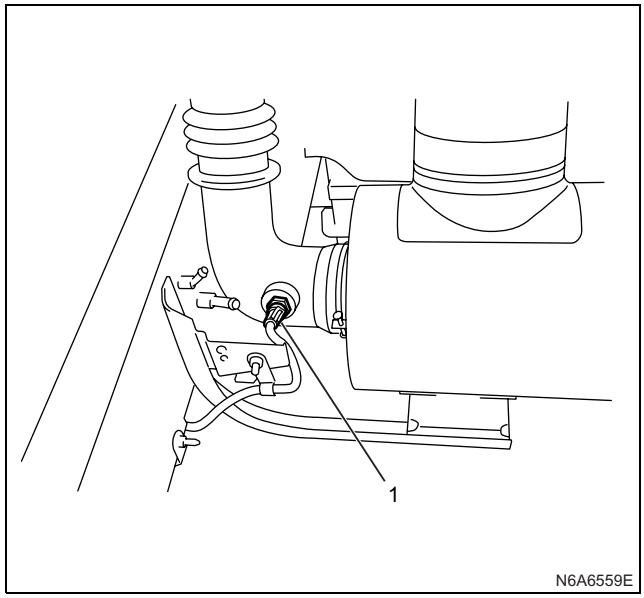
Installation Procedure

1. Install the idle up sensor (3).
2. Install the idle up sensor holder (2).
3. Install the idle up sensor knob (1).
4. Connect the idle up sensor connector.

Intake Air Temperature (IAT) Sensor Replacement

Removal Procedure

1. Turn off the ignition.
2. Disconnect the intake air temperature (IAT) sensor connector (1).
3. Remove the IAT sensor.



Installation Procedure

1. Coat threads of the IAT sensor with sealer (9985490) in full circumference.
2. Tighten the IAT sensor.

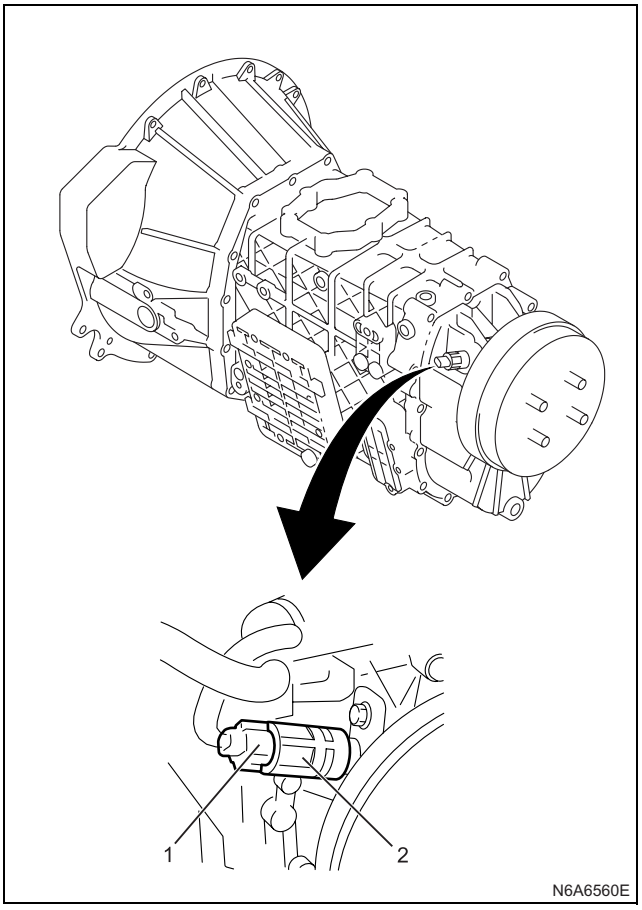
   Tighten:
   IAT sensor to 10.8 — 16.3 N·m (1.1 — 1.7 kg·m / 8.0 — 12.0 lb·ft)

3. Connect the IAT sensor connector.

Vehicle Speed Sensor (VSS) Replacement

Removal procedure

1. Turn off the ignition.
2. Disconnect the vehicle speed sensor connector (1).
3. Remove the vehicle speed sensor (2).



Installation procedure

1. Tighten the vehicle speed sensor (2).

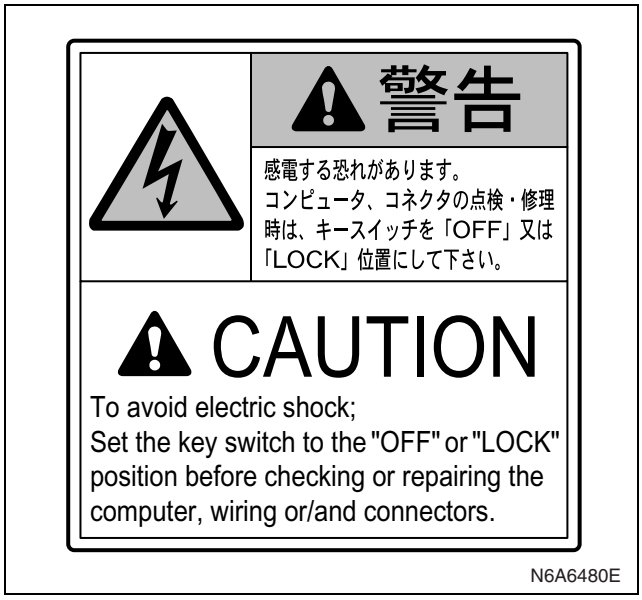
   Tighten:
   Vehicle speed sensor to 27 N·m (2.8 kg·m / 20 lb·ft)

2. Connect the vehicle speed sensor connector (1).

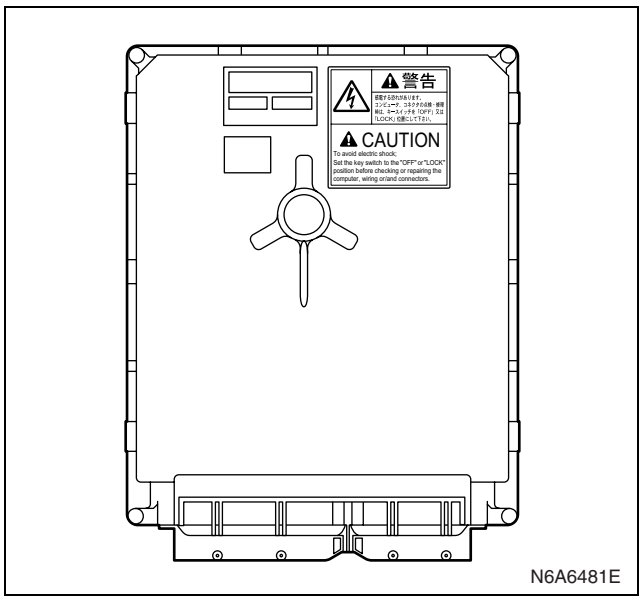
Description and Operation

Engine Control Module (ECM) Description

Engine Control Module (ECM) Service Precautions



Important:
Symbol warns you of an electric shock hazard. To avoid shock and possible serious injury, DO NOT touch the terminals. When disconnecting the harness connectors, always turn OFF the ignition switch or disconnect the battery cable.



The engine control module (ECM) is designed to withstand normal current draws associated with vehicle operation. Avoid overloading any circuit. When testing for opens and shorts, do not ground or apply voltage to any of the ECM circuits unless instructed to do so. In some cases, these circuits should only be tested using a digital multimeter (DMM). The ECM should remain connected to the ECM harness.

The engine control module (ECM) is located inside of engine side cover on the left via mounting bracket and is beside the engine. The ECM mainly controls the following:

- The fuel system control
- The exhaust gas recirculation (EGR) system control
- The preheating (glow) system control
- On-board diagnostics for engine control

The ECM constantly observes the information from various sensors. The ECM controls the systems that affect vehicle performance. The ECM performs the diagnostic function of the system. The ECM can recognize operational problems, alert the driver through the malfunction indicator lamp (MIL), and store diagnostic trouble codes (DTCs). DTCs identify the system faults to aid the technician in making repairs.

ECM Voltage Description

The ECM supplies a buffered voltage to various switches and sensors. The ECM can do this because resistance in the ECM is so high in value that a test lamp may not illuminate when connected to the circuit. An ordinary shop voltmeter may not give an accurate reading because the voltmeter input impedance is too low. Use a 10-megaohm input impedance DMM, to ensure accurate voltage readings. The input and/or output devices in the ECM include analog-to-digital converters, signal buffers, counters, and special drivers. The ECM controls most components with electronic switches which complete a ground circuit when turned ON.

Aftermarket Electrical and Vacuum Equipment

Aftermarket or add-on electrical and vacuum equipment is defined as any equipment which connects to the vehicle's electrical or vacuum systems that is installed on a vehicle after the vehicle leaves the factory. No allowances have been made in the vehicle design for this type of equipment. No add-on vacuum equipment should be added to this vehicle. Add-on electrical equipment must only be connected to the vehicle's electrical system at the battery power and ground. Add-on electrical equipment, even when installed to these guidelines, may still cause the powertrain system to malfunction. This may also include equipment not connected to the vehicle electrical system such as portable telephones and audios. Therefore, the first step in diagnosing any powertrain fault is to eliminate all aftermarket electrical equipment from the vehicle. After this is done, if the fault still exists, the fault may be diagnosed in the normal manner.

Electrostatic Discharge Damage

Electronic components used in the ECM are often designed to carry very low voltage. Electronic components are susceptible to damage caused by electrostatic discharge. By comparison, as much as 4,000 volts may be needed for a person to feel even the zap of a static discharge. There are several ways for a person to become statically charged. The most common methods of charging are by friction and induction.

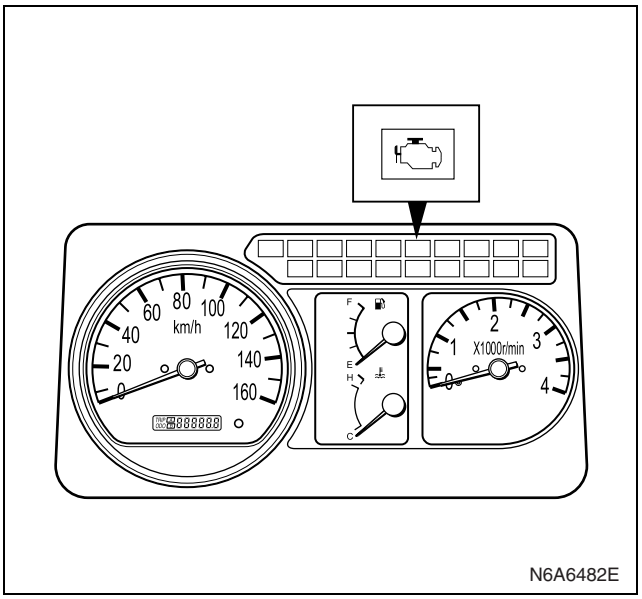
- An example of charging by friction is a person sliding across a vehicle seat.

Important:
To prevent possible electrostatic discharge damage, follow these guidelines:

- Do not touch the ECM connector pins or soldered components on the ECM circuit board.
- Do not open the replacement part package until the part is ready to be installed.
- Before removing the part from the package, ground the package to a known good ground on the vehicle.
- If the part has been handled while sliding across the seat, while sitting down from a standing position, or while walking a distance, touch a known good ground before installing the part.
- Charge by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off leaving the person highly charged with opposite polarity.

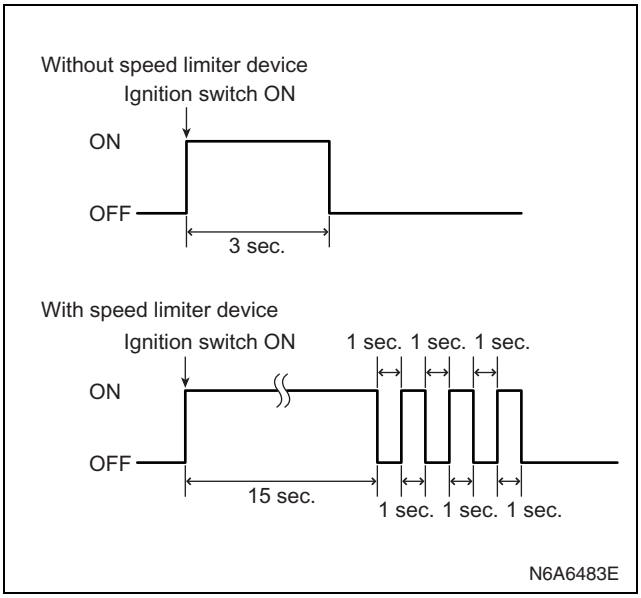
Malfunction Indicator Lamp (MIL) Operation

The malfunction indicator lamp (MIL) is located in the instrument panel cluster. The MIL will display the following symbols when commanded ON:



The MIL indicates that an emission or performance related fault has occurred and vehicle service is required. The following is a list of the modes of operation for the MIL:

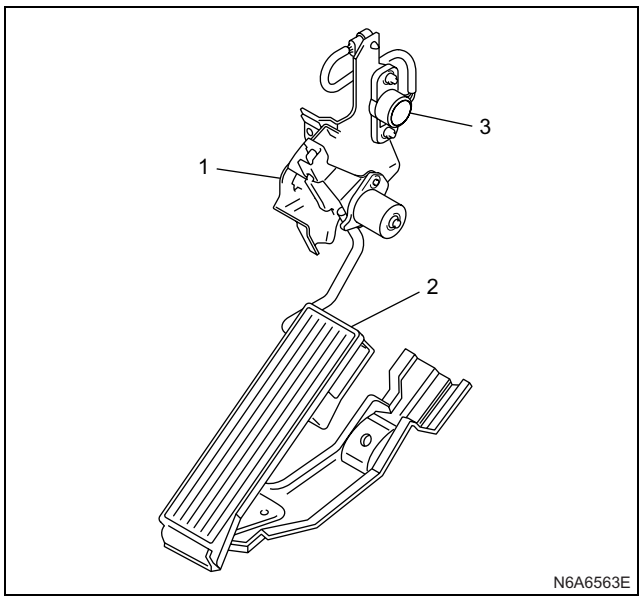
- The MIL illuminates for approximately 3 seconds when the ignition switch is turned ON, with the engine OFF. This is a bulb test to ensure the MIL is able to illuminate. (Without speed limiter device)
- The MIL illuminates for approximately 15 seconds and blinks 3 times when the ignition switch is turned ON, with the engine OFF. This is a bulb test to ensure the MIL is able to illuminate and a speed limiter device installation check. (With speed limiter device)
- The MIL remains illuminated if the engine control module (ECM) detects a fault. A diagnostic trouble code (DTC) is stored any time the ECM illuminates the MIL due to an emission or performance related fault.



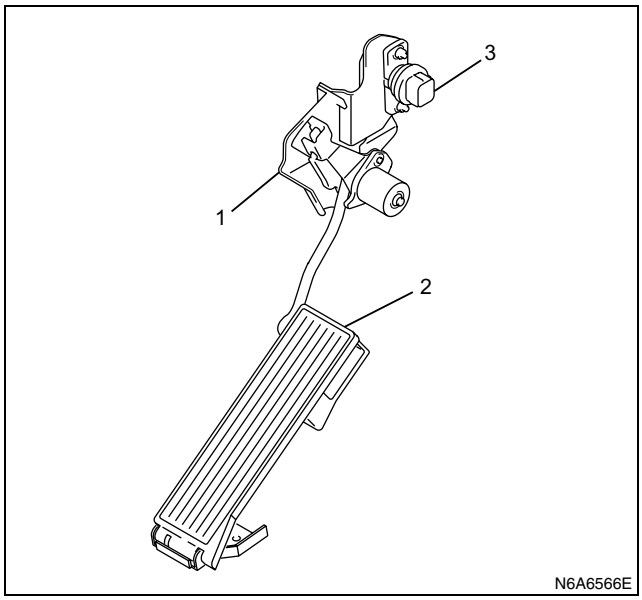
Engine Control Component Description

Accelerator Pedal Position (APP) Sensor

- LHD Model



- RHD Model

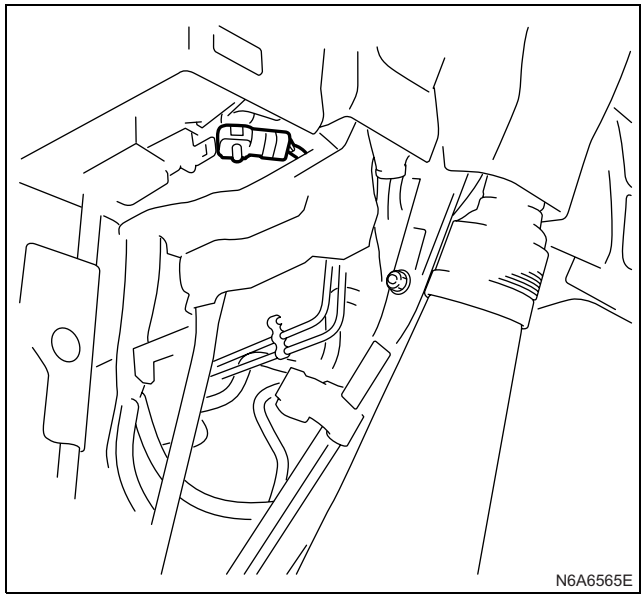


Legend

1. Control Link Bracket Assembly
2. Pedal Assembly
3. Accelerator Pedal Position (APP) Sensor

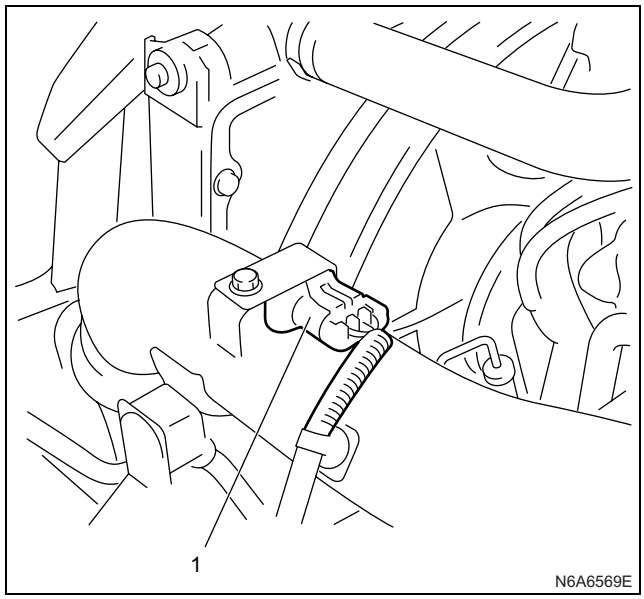
The accelerator pedal position (APP) sensor is mounted on the control link bracket assembly. The sensor is made up of two individual sensors within one housing. The engine control module (ECM) uses the APP sensor to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injector control.

Barometric Pressure (BARO) Sensor



The barometric pressure (BARO) sensor is located under the instrument panel cluster (IPC) near the pedal bracket. The BARO sensor is a transducer that varies voltage according to the barometric pressure changes and the generated voltage is input to the engine control module (ECM) for the BARO signal. The ECM should detect a low signal voltage at a low barometric pressure, such as high altitude place. The ECM should detect high signal voltage at a high barometric pressure. The ECM uses this voltage signal to calibrate the fuel injection quantity and injection timing for altitude compensation.

Boost Pressure Sensor

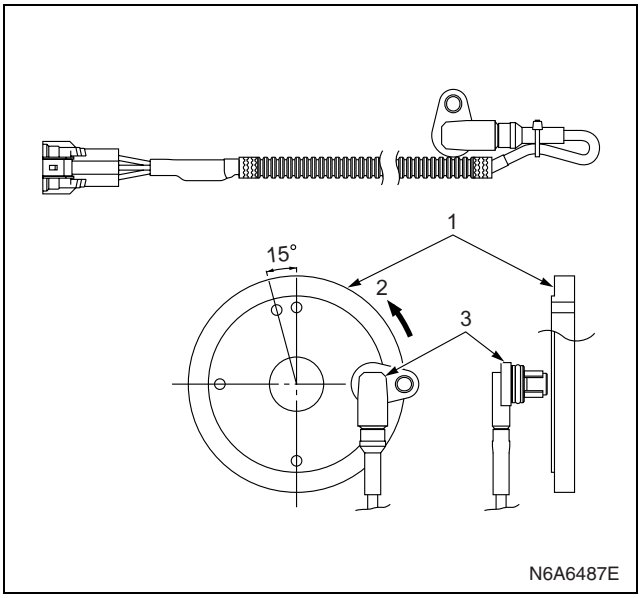


Legend

1. Boost Pressure Sensor

The boost pressure sensor is located in the air induction tubing. The boost pressure sensor is a transducer that varies voltage according to changes in the air pressure inside the air tubing. The boost pressure sensor provides a signal to the engine control module (ECM) on the boost pressure signal circuit which is relative to the pressure changes in the induction tubing. The ECM should detect a low signal voltage at a low boost pressure, such as low engine load. The ECM should detect high signal voltage at a high boost pressure, such as high engine load.

Camshaft Position (CMP) Sensor

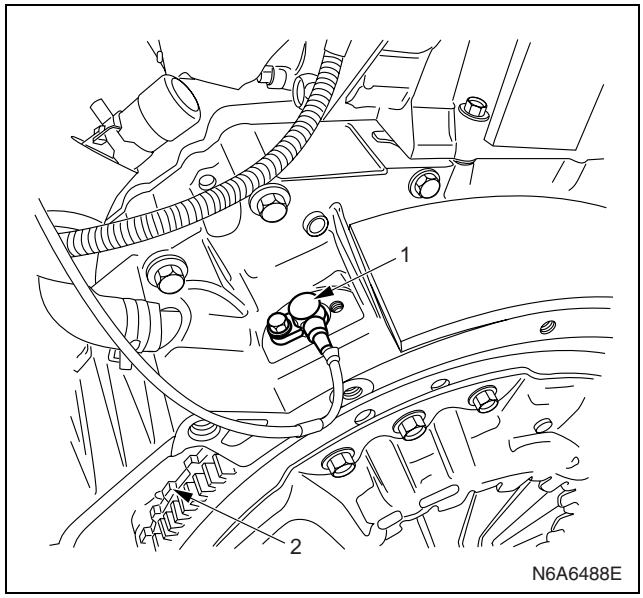


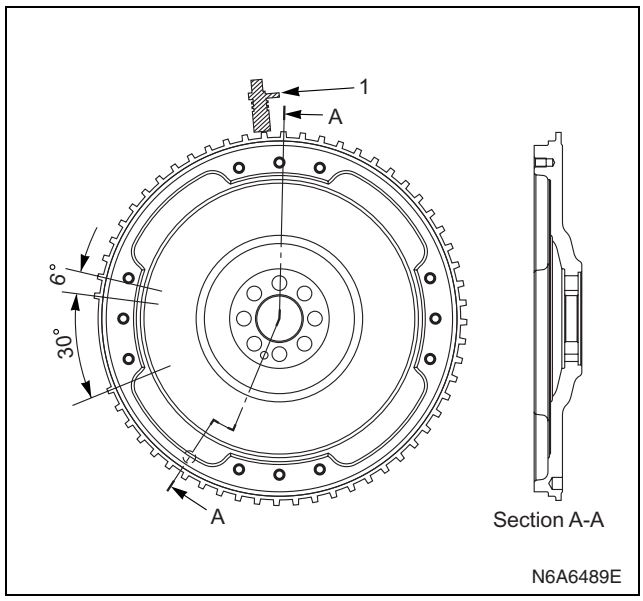
Legend

1. Camshaft Gear
2. Gear Rotating Direction
3. Camshaft Position (CMP) Sensor

The camshaft position (CMP) sensor is installed on the cylinder head at the rear of the camshaft gear. The CMP sensor detects a total of five through holes (four holes arranged equally every 90° and one reference hole on the camshaft gear flange surface) and sends signals to the engine control module (ECM). Receiving these signals, the ECM determines cylinder #1 compression top dead center (TDC).

Crankshaft Position (CKP) Sensor



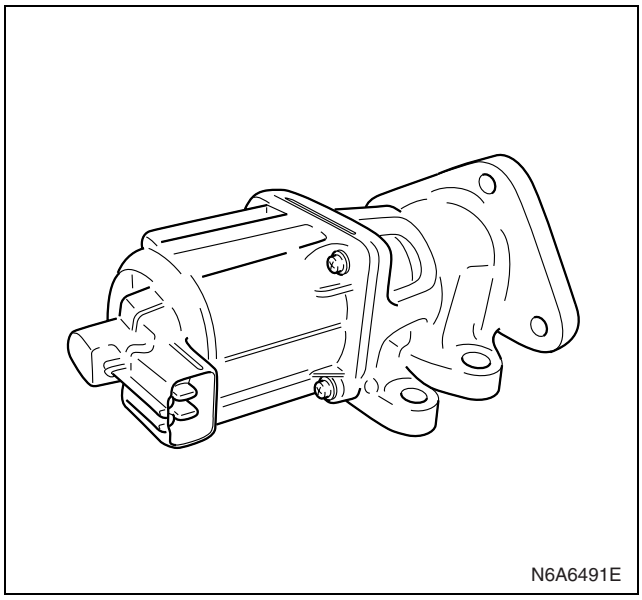


Legend

1. Crankshaft Position (CKP) Sensor
2. Flywheel hollow

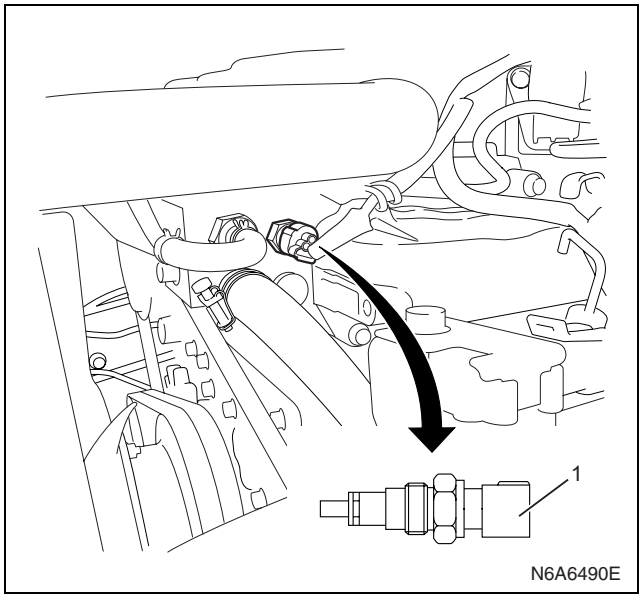
The crankshaft position (CKP) sensor is located on top of the flywheel housing. There are 56 notches spaced 6° apart and a 30° section that is open span. This open span portion allows for the detection of cylinder #1 top dead center (TDC). The CKP sensor is a magnetic coil type sensor, which generates an AC signal voltage based on the crankshaft rotational speed. The engine control module (ECM) monitors both the CKP sensor and camshaft position (CMP) sensor signals to ensure they correlate with each other.

Exhaust Gas Recirculation (EGR) Valve and Position Sensor



The control current from the engine control module (ECM) operates the EGR motor to control the lift amount of EGR valve. Also, a valve position sensor is provided at the rear of the motor to feed actual valve lift amount back to the ECM for more precision control of the EGR amount. The EGR valve position sensor is applied with reference voltage (5 volts) at all times from the ECM to detect the EGR valve lift amount in the form of voltage change and sends its signal to the ECM.

Engine Coolant Temperature (ECT) Sensor

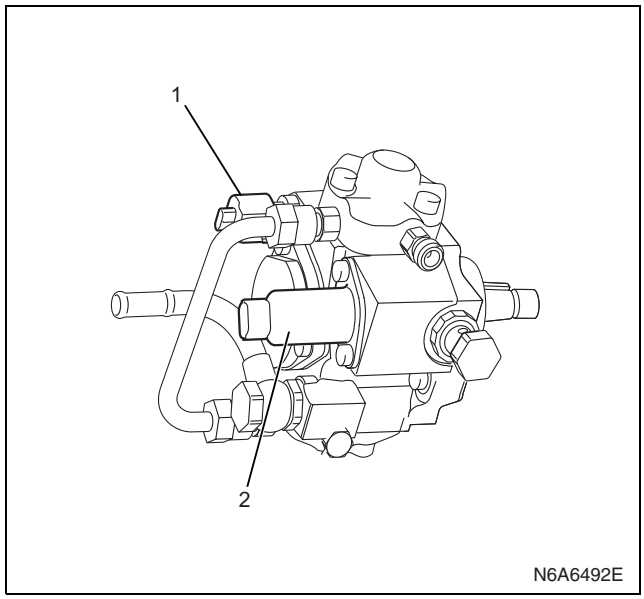


Legend

1. Engine Coolant Temperature (ECT) Sensor

The engine coolant temperature (ECT) sensor is installed to the thermostat housing. The ECT sensor is a variable resistor. The ECT sensor measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and a ground for the ECT low reference circuit. When the ECT sensor is cold, the sensor resistance is high. When the engine coolant temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the ECT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the ECT signal circuit.

Fuel Rail Pressure (FRP) Regulator

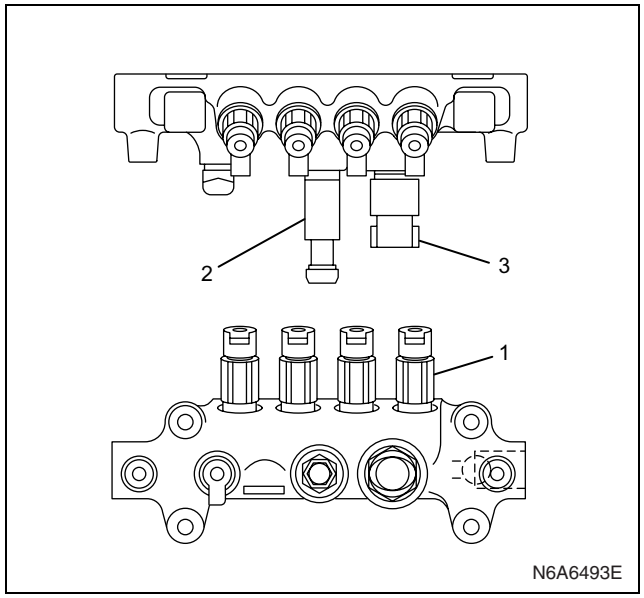


Legend

1. Fuel Temperature (FT) Sensor
2. Fuel Rail Pressure (FRP) Regulator

The fuel rail pressure (FRP) regulator is installed to the fuel supply pump and controls the suction fuel quantity into the fuel rail. The FRP regulator is fully opened in the normal state and larger drive current results in smaller opening. The engine control module (ECM) calculates desired fuel rail pressure and fuel flow rate and it compares the calculated desired fuel rail pressure to the actual value to determine the FRP regulator position. When the actual fuel rail pressure is higher than the desired value, the FRP regulator is closed to decease the flow rate.

Fuel Rail Pressure (FRP) Sensor

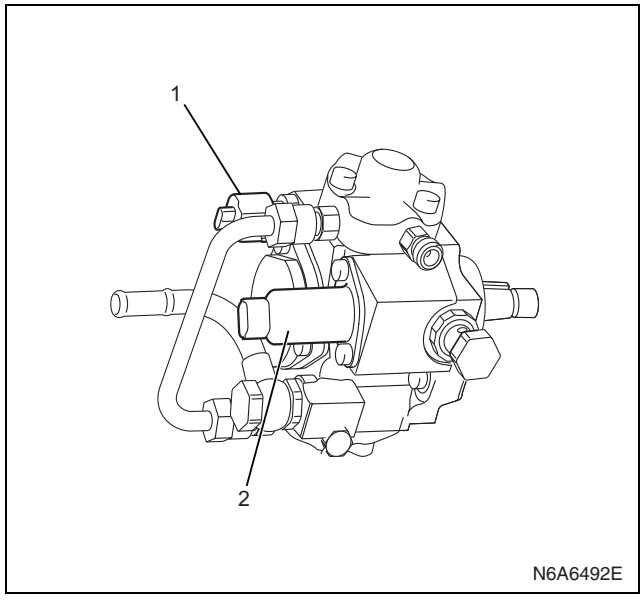


Legend

1. Flow Damper
2. Pressure Limiter
3. Fuel Rail Pressure (FRP) Sensor

The fuel rail pressure (FRP) sensor is installed to the fuel rail and it detects the fuel pressure in the fuel rail, converts the pressure into a voltage signal, and sends the signal to the engine control module (ECM). Higher fuel rail pressure provides higher FRP sensor voltage while lower pressure provides lower FRP sensor voltage. The ECM calculates actual fuel rail pressure (fuel pressure) from the voltage signal and uses the result in fuel injection control and other control tasks.

Fuel Temperature (FT) Sensor

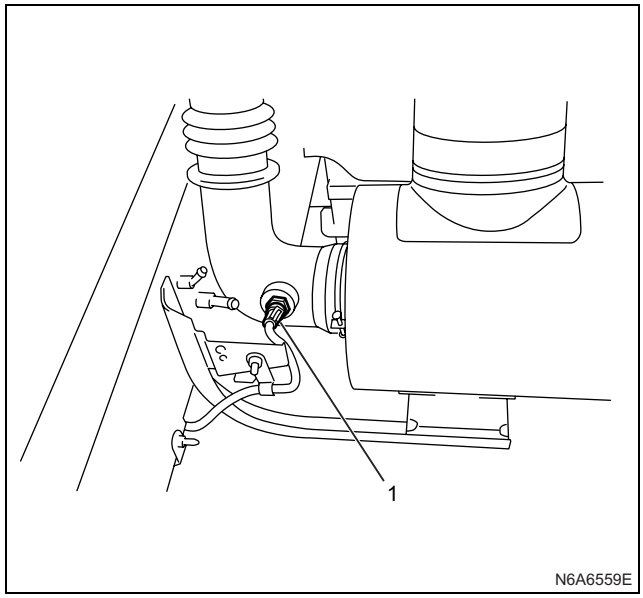


Legend

1. Fuel Temperature (FT) Sensor
2. Fuel Rail Pressure (FRP) Regulator

The fuel temperature (FT) sensor is installed to the fuel supply pump. The FT sensor is a variable resistor. The FT sensor measures the fuel temperature of the fuel. The engine control module (ECM) supplies 5 volts to the FT signal circuit and a ground for the FT low reference circuit. When the FT sensor is cold, the sensor resistance is high. When the fuel temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the FT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the FT signal circuit.

Intake Air Temperature (IAT) Sensor

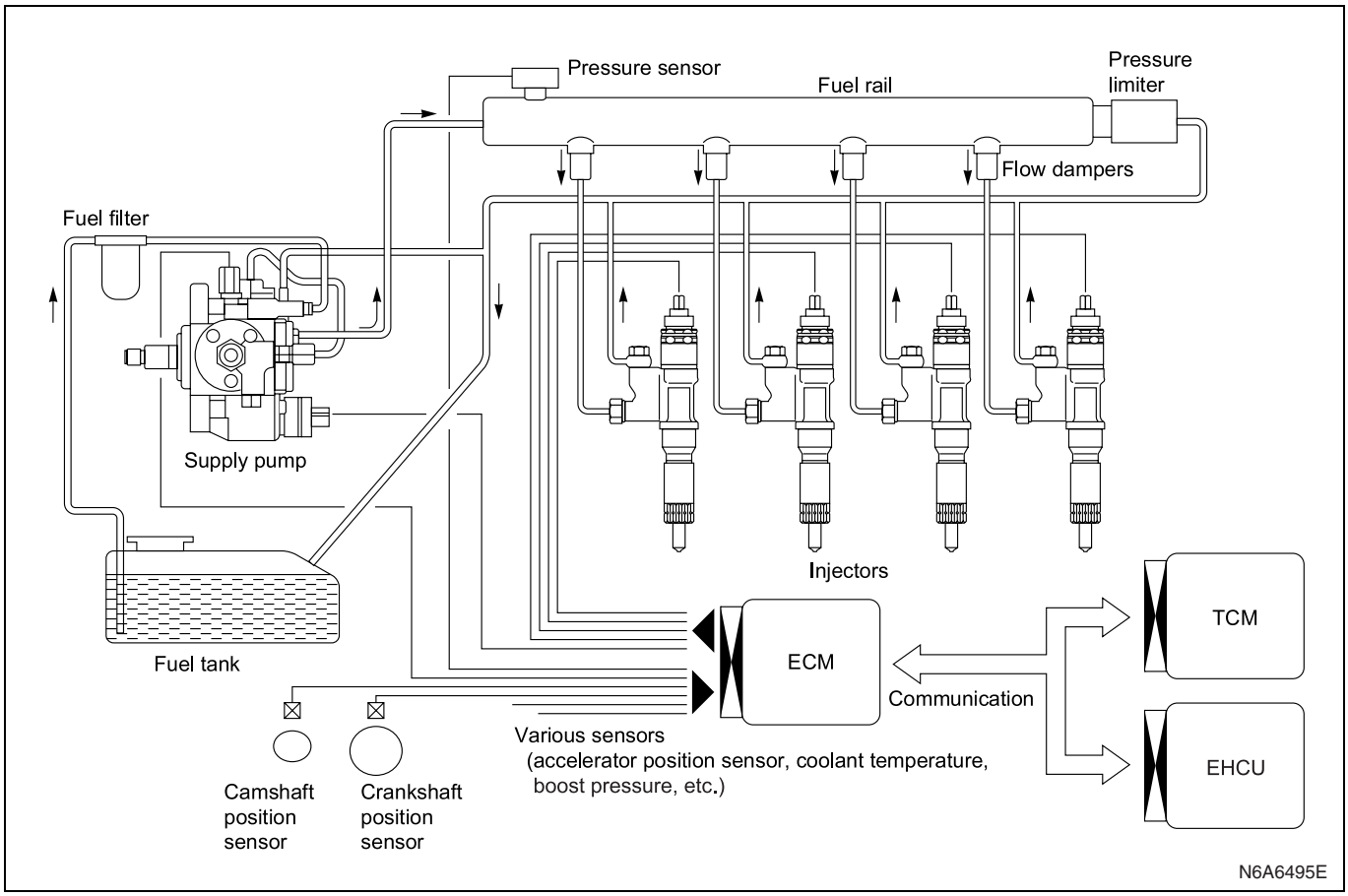


Legend

1. Intake Air Temperature (IAT) Sensor

The intake air temperature (IAT) sensor is fitted between the air cleaner and turbocharger. The IAT sensor is a variable resistor. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 volts to the IAT signal circuit and a ground for the IAT low reference circuit. When the IAT sensor is cold, the sensor resistance is high. When the air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the IAT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the IAT signal circuit.

Fuel System Description



The common rail system uses a type of accumulator chamber called the fuel rail to store pressurized fuel, and injectors that contain electronically controlled solenoid valves to spray the pressurized fuel in the combustion chambers. The injection system (injection pressure, injection rate, and injection timing) is controlled by the engine control module (ECM), and therefore the common rail system can be controlled independently, free from the influence of engine speed and load. This ensures a stable injection pressure at all time, particularly in the low engine speed range, so that black smoke specific to diesel engines generated during vehicle starting or acceleration can be reduced dramatically. As a result, exhaust gas emissions are clear and reduced, and higher output is achieved.

1. High Pressure Control

- Enables high pressure injection from low engine speed range.
- Optimizes control to minimize particulate matter and NOx emissions.

2. Injection Timing Control

- Enables finely tuned optimized control in accordance with running conditions.

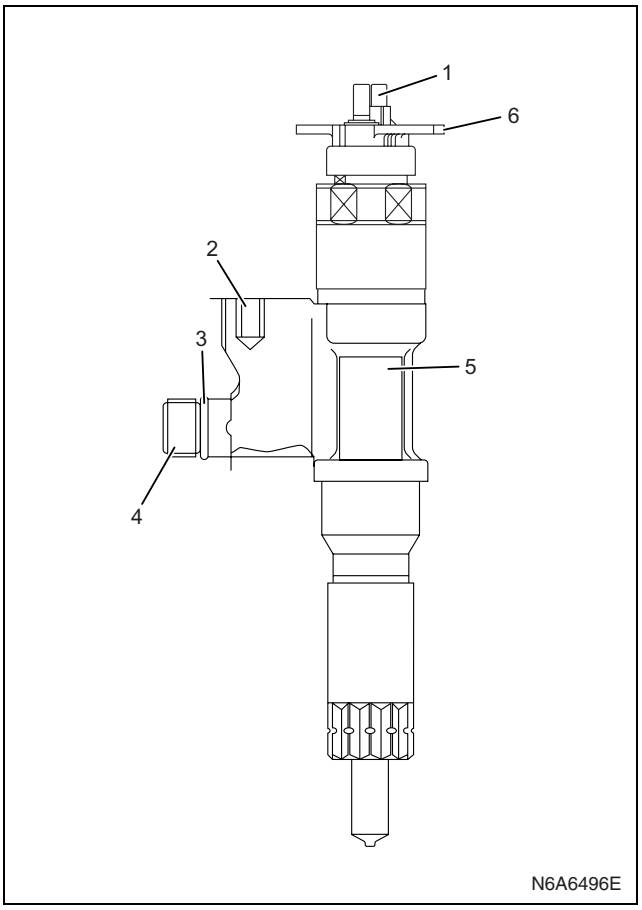
3. Injection Rate Control

- Pilot injection control that performs a small amount of injection before main injection.

The fuel rail system consists primarily of a fuel supply pump, fuel rail, injectors, and ECM.

Fuel System Component Description

Injector



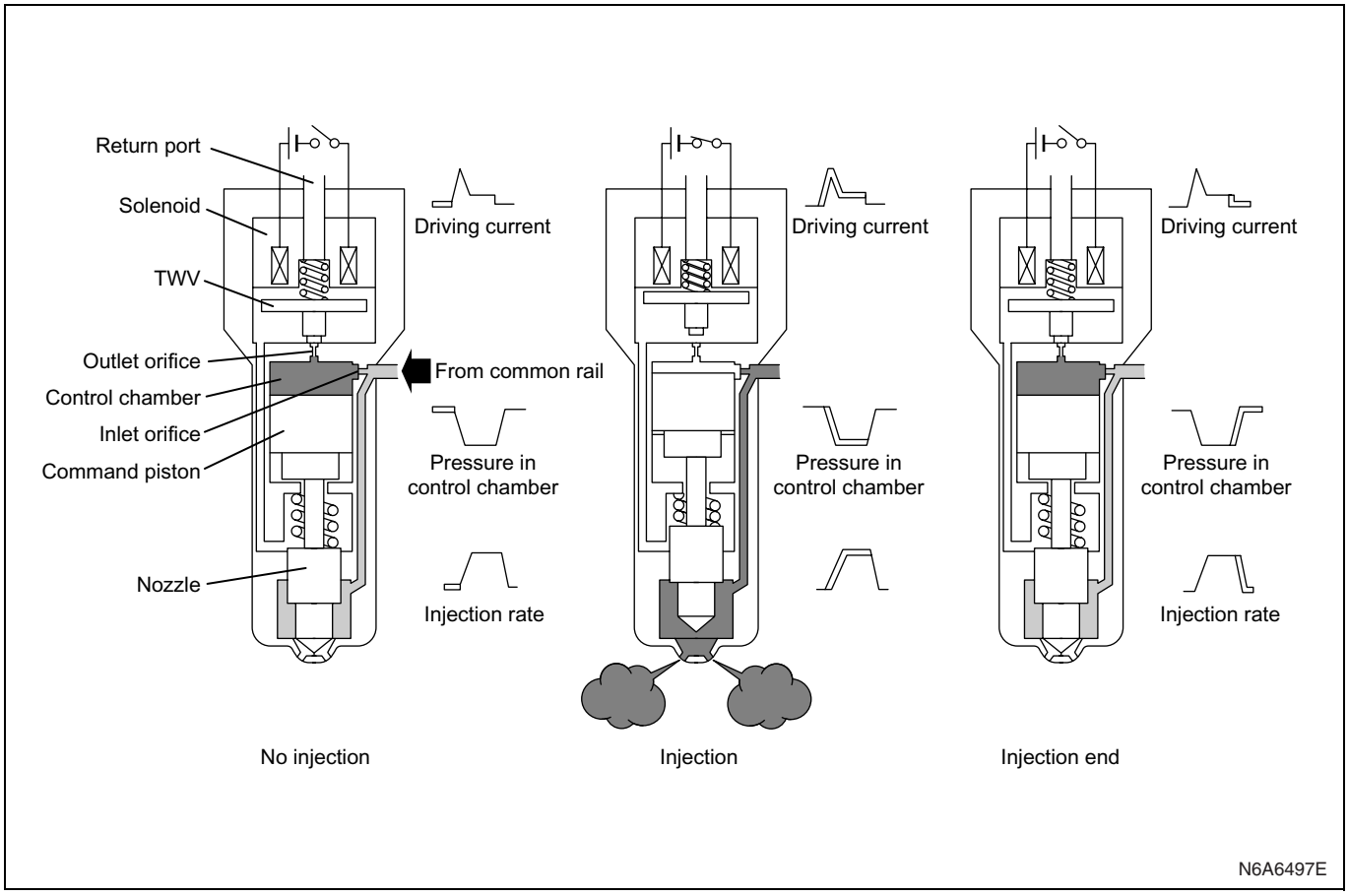
Legend

1. Terminal Stud
2. Fuel Leak Off Port
3. O-ring
4. Fuel Inlet Port
5. Injector Parts Number Marking
6. Fuel Injector ID Plate

Electronic control type injectors controlled by the engine control module (ECM) are used. Compared with conventional injection nozzles, a command piston, solenoid valve, etc. are added.

ID codes displaying various injector characteristic are laser marked in the plate, and ID codes showing these in numeric form (30 alphanumeric figures are displayed and only 24 are used) are laser marked in the plate. This system uses fuel injector flow rate information (ID codes) to optimize injection quantity control. When an injector is newly installed in a vehicle, it is necessary to input the ID codes in the ECM.

QR (Quick Response) codes or fuel injector flow rate (ID codes) have been adopted to enhance the injection quantity precision of the injectors. The adoption of codes enables injection quantity dispersion control throughout all pressure ranges, contributing to improvement in combustion efficiency, reduction in exhaust gas emissions and consistent horsepower throughout the vehicle built.



1) Non-injection state

The two way valve (TWV) closes the outlet orifice by means of a spring force, when no current is supplied from the engine control module (ECM) to the solenoid. At this time, the fuel pressure applied to the nozzle leading end is equal to the fuel pressure applied to the control chamber through the inlet orifice. As for the force competition in this state, the pressure on the command piston upper surface + nozzle spring force defeat the pressure on the nozzle leading end, and consequently the nozzle is pushed downward to close the injection holes.

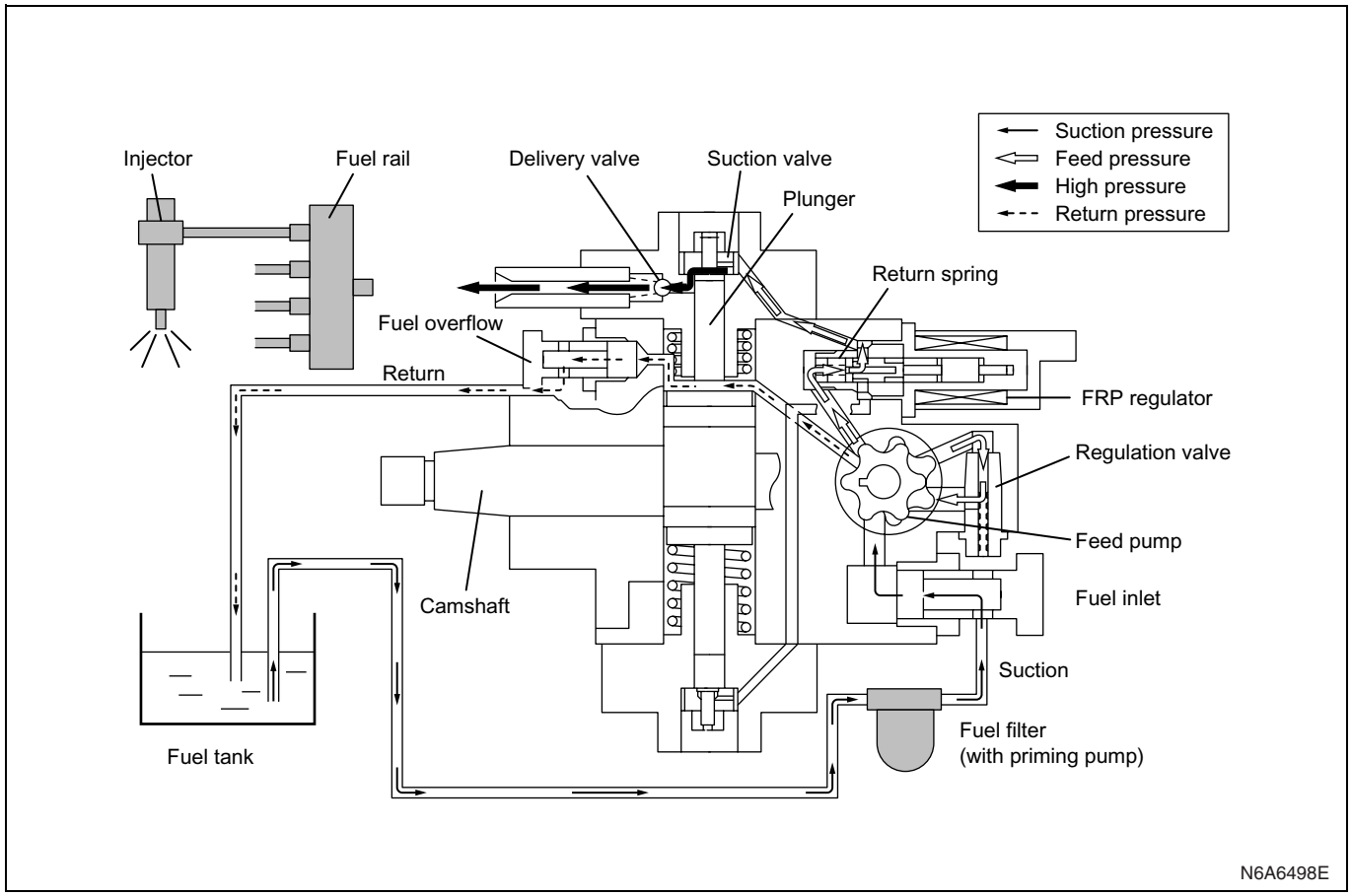
2) Injection start

The TWV is pulled up to open the outlet orifice, and thus the fuel leaks toward the return port, when the current is supplied from the ECM to the solenoid. As a result, the nozzle is pushed up together with the command piston by the fuel pressure applied to the nozzle leading end, and then the nozzle injection holes open to inject the fuel.

3) Injection end

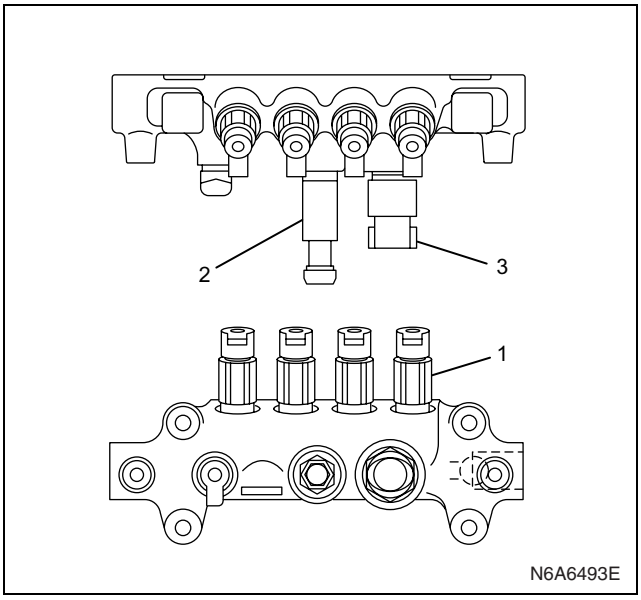
The TWV lowers to close the outlet orifice, when the ECM shuts off a current supply to the solenoid. As a result, the fuel cannot leak from the control chamber, and thus the fuel pressure in the control chamber rises abruptly and then the nozzle is pushed down by the command piston to close the nozzle injection holes, resulting in the end of fuel injection.

Fuel Supply Pump



The fuel supply pump is the heart of the common rail type electronic fuel injection system. The fuel supply pump is installed at the same location as the conventional injection type pump, which spins at a 1 to 1 ratio of fuel supply pump to crankshaft speed. A fuel rail pressure (FRP) regulator and fuel temperature sensor are part of the fuel supply pump assembly.
Fuel is drawn from the fuel tank via the fuel supply pump by the use of an internal feed pump (trochoid type). This feed pump pumps fuel into a 2-plunger chamber also internal to the fuel supply pump. Fuel into this chamber is regulated by the FRP regulator solely controlled by current supplied from the engine control module (ECM). No current to the solenoid results in maximum fuel flow whereas full current to the solenoid produces no fuel flow. As the engine spins, these two plungers produce high pressure in the fuel rail. Since the ECM controls the flow of fuel into this 2-plunger chamber, it therefore controls the quantity and pressure of the fuel supply to the fuel rail. This optimizes performance, improves economy and reduces NOx emissions.

Fuel Rail (Common Rail)

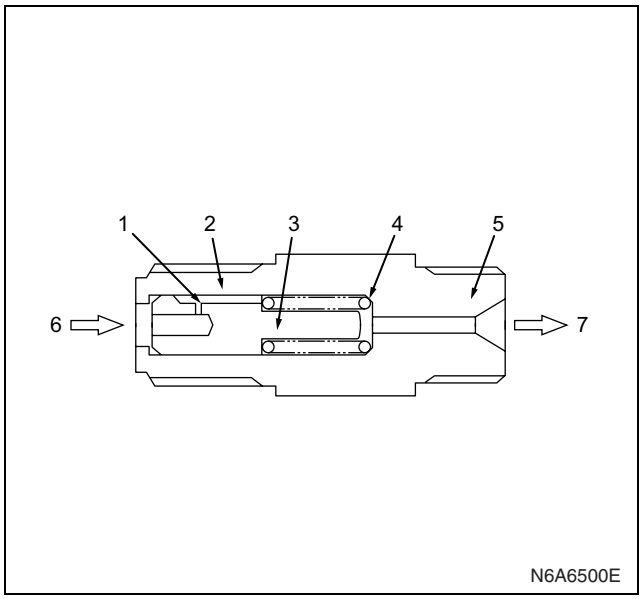


Legend

1. Flow Damper
2. Pressure Limiter
3. Fuel Rail Pressure (FRP) Sensor

Along with the employment of a common rail type electronic control fuel injection system, the fuel rail is provided to store high pressure fuel between supply pump and injectors. A pressure sensor and a pressure limiter are installed on the fuel rail. The pressure sensor detects the fuel pressure inside the fuel rail and sends its signal to the engine control module (ECM). Based on this signal, the ECM controls the fuel pressure inside the fuel rail via the fuel rail pressure (FRP) regulator of the supply pump. The pressure limiter opens the valve mechanically to relieve the pressure when the fuel pressure inside the fuel rail is excessive.

Flow Damper



Legend

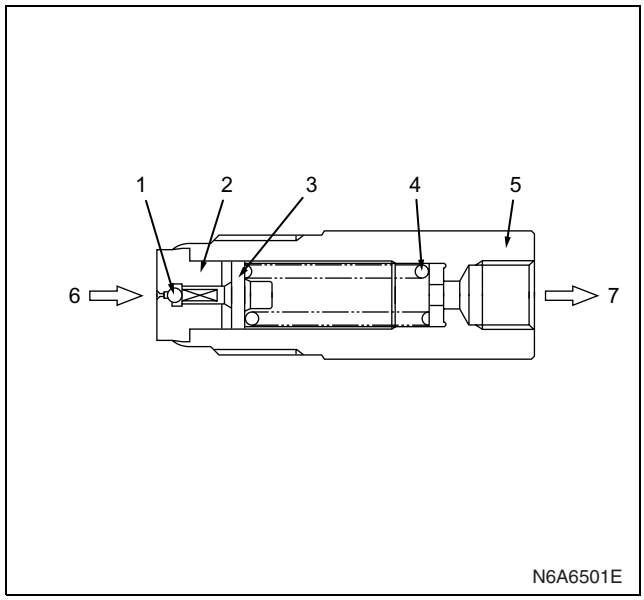
1. Orifice
2. Slit
3. Piston
4. Return Spring
5. Housing
6. Fuel Rail
7. Injector

The flow dampers are installed at the outlet of fuel rail to damp a pulsation of fuel pressure inside the fuel rail or to cut off the fuel supply when the fuel leaks downstream of flow damper. The fuel is supplied to the injectors through an orifice of the piston. The pressure pulsation occurring in the fuel rail is dampered by a resistive force of the return spring and a passing resistance of the orifice, wherein the piston acts as a damper. Also, the leading end of piston closes the fuel supply port to cut off the fuel supply, if the fuel leak occurs in the injection pipe or injectors. Since fuel pressure on the downstream side of flow damper supplied through an orifice + resistive force of return spring do not balance, the fuel pressure applied on the piston surface prior to the orifice will allow the fuel to be cut off. The piston will return when the fuel pressure inside the fuel rail is less than 1.0 MPa (145 psi).

Fuel Rail Pressure Sensor

Refer to Engine Control Component Description.

Pressure Limiter

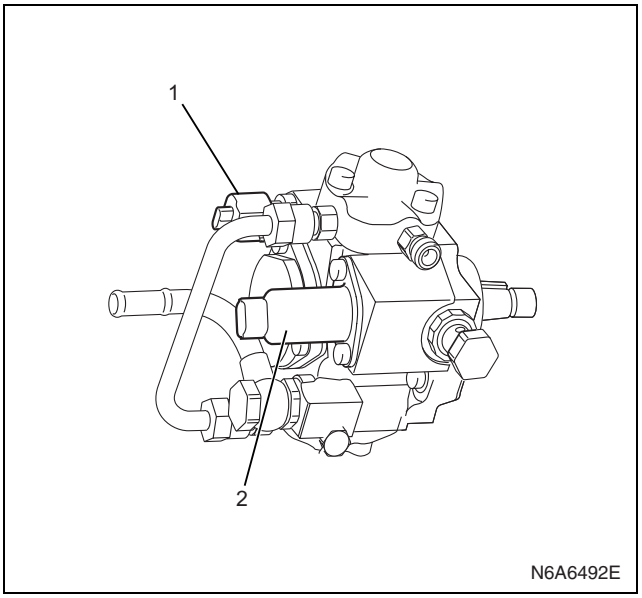


Legend

1. Valve
2. Valve Body
3. Valve Guide
4. Spring
5. Housing
6. Fuel Rail
7. Fuel Return Pipe

The pressure limiter relieves pressure by opening the valve if abnormally high pressure is generated. The valve opens when pressure in rail reaches approximately 200 MPa (29,000 psi), and closes when pressure falls to approximately 50 MPa (7,250 psi). Fuel leakage through the pressure limiter re-turns to the fuel tank.

Fuel Rail Pressure (FRP) Regulator



Legend

1. Fuel Temperature (FT) Sensor
2. Fuel Rail Pressure (FRP) Regulator

The engine control module (ECM) controls the duty ratio of the linear type fuel rail pressure (FRP) regulator (the length of time that the current is applied to the FRP regulator), in order to control the quantity of fuel that is supplied to the high-pressure plungers. Since only the quantity of fuel that is required for achieving the target rail pressure is drawn in, the drive load of the supply pump is decreased.

When current flows to the FRP regulator, variable electromotive force is created in accordance with the duty ratio, moving the armature to the left side. The armature moves the cylinder to the left side, changing the opening of the fuel passage and thus regulating the fuel quantity. With the FRP regulator OFF, the return spring contracts, completely opening the fuel passage and supplying fuel to the plungers (Full quantity intake and full quantity discharge). When the FRP regulator is ON, the force of the return spring moves the cylinder to the right, closing the fuel passage (normally opened).

By turning the FRP regulator ON/OFF, fuel is supplied in an amount corresponding to the actuation duty ratio, and fuel is discharged by the plungers.

Fuel Injection Quantity Control Description

Fuel Injection Quantity Control

This control determines the fuel injection quantity by adding coolant temperature, fuel temperature, intake air temperature, barometric pressure, vehicle speed and some switch inputs information corrections to the basic injection quantity is calculated by the engine control module (ECM) based on the engine operating conditions (engine speed, accelerator pedal pressing amount and boost pressure sensor). More fuel rate indicates if the engine load is increased as the accelerator pedal is stepped on at constant engine speed.

Combined with high pressure injection of atomized fuel, this control improves exhaust gas and ensures proper fuel consumption. Compared with conventional mechanical governors, an electronic control system provides higher degree of freedom of fuel injection quantity control, thereby presenting high accelerator response (acceleration feeling and pressing feeling).

Starting Injection Quantity Control

At the engine starting (after the key switch is turned to the START position to start the engine, up to return of key switch to the ON position), optimum fuel injection quantity is controlled based on the information on the engine speed and coolant temperature. At low temperature, the fuel injection quantity increases. When the engine started completely, this boosted quantity mode at the starting is cancelled and normal running mode is restored.

Idle Speed Control

A control is made so as to achieve stable idling speed at all time regardless of engine secular changes or engine condition variations. The ECM sets target idling speed and controls the fuel injection quantity according to the engine conditions (actual engine speed, coolant temperature and engine load) to follow actual engine speed to the target idling speed so as to ensure stable idling speed.

Idle Vibration Control

A control is made so as to reduce the engine vibration caused by torque variations between cylinders due to variations in fuel injection quantity of each cylinder or injector performance. The ECM corrects the injection quantity between cylinders based on the revolution signals from the crankshaft position (CKP) sensor. Normal range of correction quantity between cylinders is within $\pm$ 5 mm^3.

Fuel Injection Timing Control Description

The injection timing suitable for the vehicle conditions is controlled based on the inputs from respective sensors. The injection timing is determined by comparing actually measured values of pulse signals from the CKP sensor with the target injection timing stored in the map of the ECM.

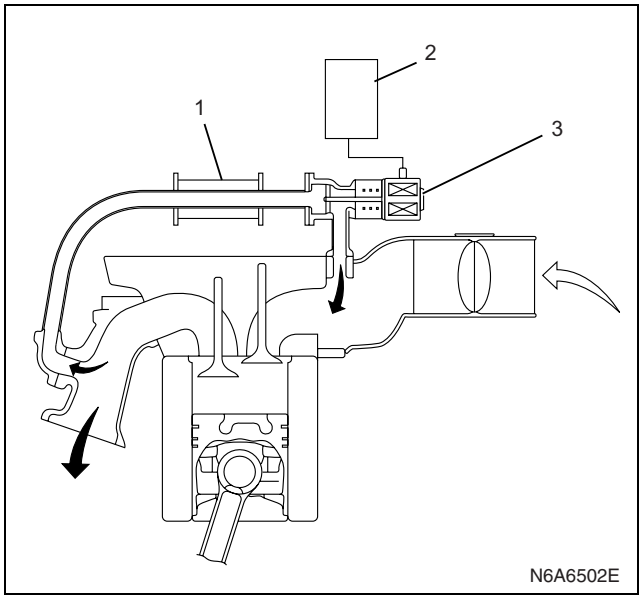
Coolant Temperature Compensation

At the engine starting when the engine coolant temperature is low, the coolant temperature is detected to advance the injection timing for reduction of white smoke emission.

High Altitude Compensation

During running at a highland where air density is low, the atmospheric pressure is detected to advance the injection timing for reduction of white smoke emission.

Exhaust Gas Recirculation (EGR) System Description



Legend

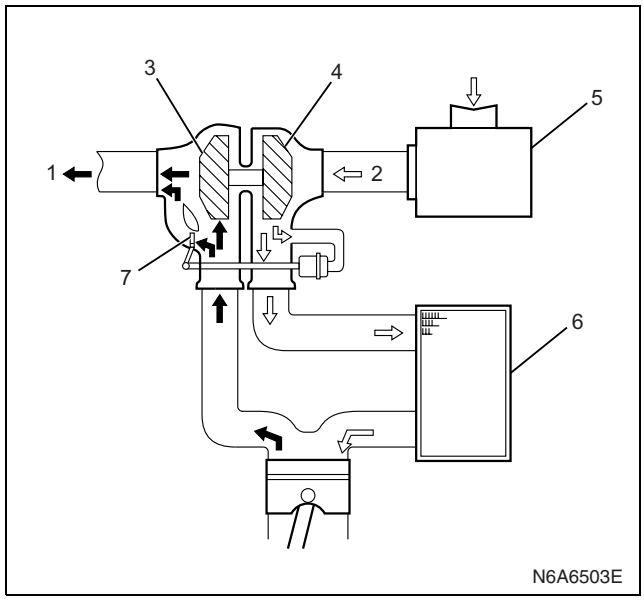
1. EGR Cooler
2. ECM
3. EGR Valve

The EGR system recirculates a part of exhaust gas back into the intake manifold, which results in reducing nitrogen oxide (NOx) emissions. The EGR control system uses an electronic control system to ensure both driveability and low emission. The control current from the engine control module (ECM) operates the motor to control the lift amount of EGR valve. Also, an EGR position sensor is provided at the rear of the motor to feed actual valve lift amount back to the ECM for more precision control of the EGR amount.

The EGR control starts when the conditions for engine speed, engine coolant temperature and barometric pressure are satisfied. Then, the valve opening is calculated according to the engine speed, and target fuel injection quantity. Based on this valve opening, the drive duty of the motor is determined and the motor is driven accordingly.

A potentiometer type EGR valve position sensor is employed and installed on the EGR valve body. The EGR valve position sensor is supplied with reference voltage (5V) and ground at all times from the ECM. The ECM reads the EGR position sensor voltage input and determines the EGR lift position.

Turbocharger Description



Legend

1. Exhaust Gas
2. Clean Air
3. Turbine Wheel
4. Compressor Wheel
5. Air Cleaner
6. Charge Air Cooler (Intercooler)
7. Wastegate Valve

The turbocharger is used to increase the amount of air that enters the engine cylinders. This allows a proportional increase of fuel to be injected into the cylinders, resulting in increased power output, more complete combustion of fuel, and increased cooling of the cylinder heads, pistons, valves, and exhaust gas. This cooling effect helps extend engine life.

Heat energy and pressures in the engine exhaust gas are utilized to drive the turbine. Exhaust gas is directed to the turbine housing. The turbine housing acts as a nozzle to direct the shaft wheel assembly. Since the compressor wheel is attached directly to the shaft, the compressor wheel rotates at the same speed as the turbine wheel. Clean air from the air cleaner is drawn into the compressor housing and wheel. The air is compressed and delivered through a crossover pipe to

the engine air intake manifold, then into the cylinders. The amount of air pressure rise and air volume delivered to the engine from the compressor outlet is regulated by a waste gate valve in the exhaust housing. The position of the waste gate valve is controlled by the amount of pressure built up on the intake side of the turbocharger. The diaphragm on the inside of the waste gate is pressure sensitive, and controls the position of the valve inside the turbocharger. The position of the valve will increase or decrease the amount of boost to the turbocharger.

The charge air cooler also helps the performance of the diesel. Intake air is drawn through the air cleaner and into the turbocharger compressor housing. Pressurized air from the turbocharger then flows forward through the charge air cooler located in the front of the radiator. From the charge air cooler, the air flows back into the intake manifold.

The charge air cooler is a heat exchanger that uses air flow to dissipate heat from the intake air. As the turbocharger increases air pressure, the air temperature increases. Lowering the intake air temperature increases the engine efficiency and power by packing more air molecules into the same space.

Special Tools and Equipment

Special Tools and Equipment

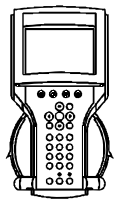
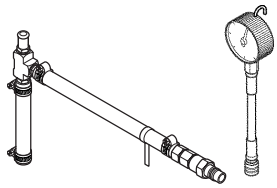
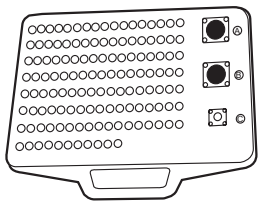
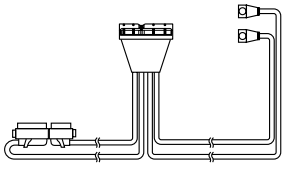
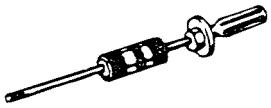
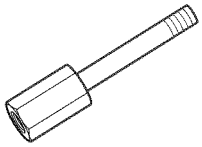
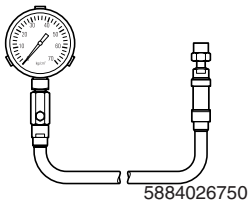
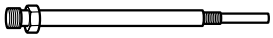
Illustration	Tool Number / Description
5884028350	5-8840-2835-0 (J-35616-C) Connector Test Adapter Kit (With Test Lamp)
5884002850	5-8840-0285-0 (J-39200) Digital Multimeter
	Tech 2 Kit
 5884028440	5-8840-2844-0 Fuel Pressure / Vacuum Gauge Set (J-44638 / Fuel Pressure / Vacuum Gauge Assembly) (EN-47667 / Suction Side Fuel Pressure / Vacuum Gauge Adapter)
	Breaker Box
	Adapter Harness

Illustration	Tool Number / Description
 5884000190	5-8840-0019-0 (J-23907) Sliding Hammer
 EN46720	5-8840-2826-0 (EN-46720) Fuel Injector Remover
 5884026750	5-8840-2675-0 (J-26999-12) Compression Gauge
 5884028150	5-8840-2815-0 (EN-46722) Gauge Adapter

4HKED-WE-0551N

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.4HKED-WE-0551N PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

ENGINE

SECTION 6E

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

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ENGINE

Engine Control System (4JH1)

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P1625 (Symptom Code B) (Flash Code 76) 6E-202
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Specifications

Temperature vs Resistance

Engine Coolant Temperature vs. Resistance

°C	°F	Ω
Temperature vs. Resistance Value (Approximately)		
120	248	120
110	230	160
100	212	200
90	194	260
80	176	350
70	158	470
60	140	640
50	122	880
40	104	1250
30	86	1800
20	68	2650
10	50	4000
0	32	6180
-10	14	9810
-20	-4	16000
-30	-22	27000

Intake Air Temperature vs. Resistance

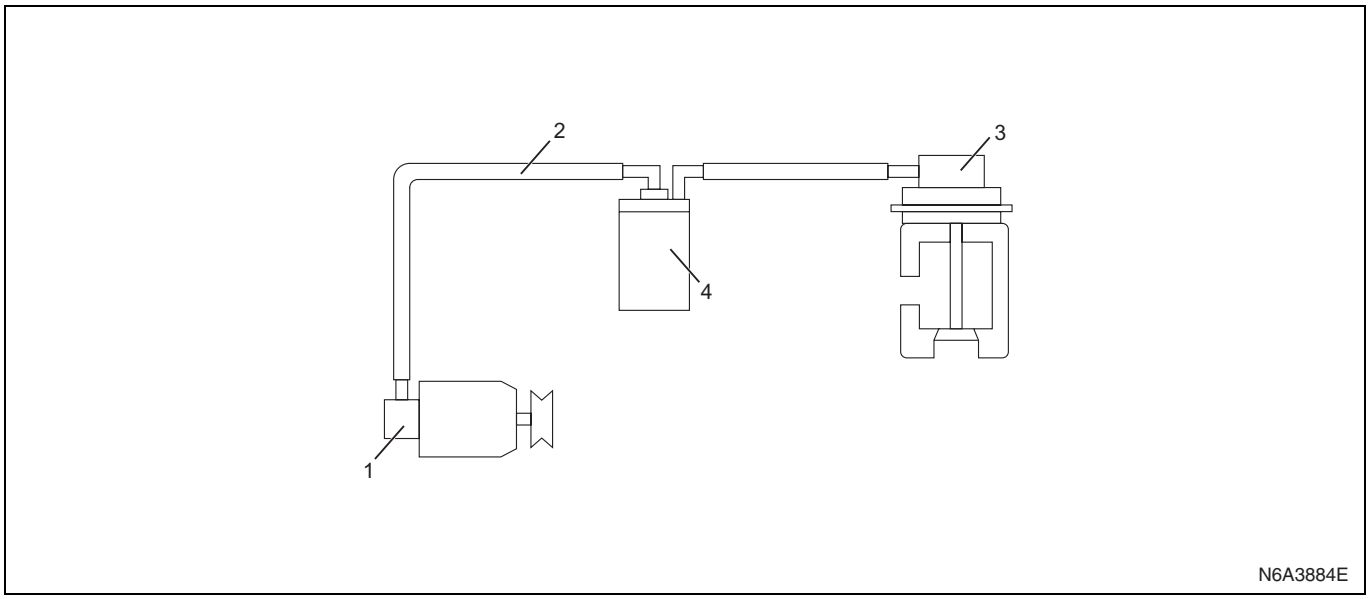
°C	°F	Ω
Temperature vs. Resistance Value (Approximately)		
100	212	190
90	194	240
80	176	320
70	158	430
60	140	590
50	122	810
40	104	1150
30	86	1650
25	77	2000
20	68	2430
10	50	3660
0	32	5650
-10	14	8970
-20	-4	14700

Altitude vs Barometric Pressure

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)
Determine your altitude by contacting a local weather station or by using another reference source.		
4267	14000	56-64
3962	13000	58-66
3658	12000	61-69
3353	11000	64-72
3048	10000	66-74
2743	9000	69-77
2438	8000	71-79
2134	7000	74-82
1829	6000	77-85
1524	5000	80-88
1219	4000	83-91
914	3000	87-98
610	2000	90-98
305	1000	94-102
0	0 Sea Level	96-104
-305	-1000	101-105

Schematic and Routing Diagrams

Vacuum Hose Routing Diagram

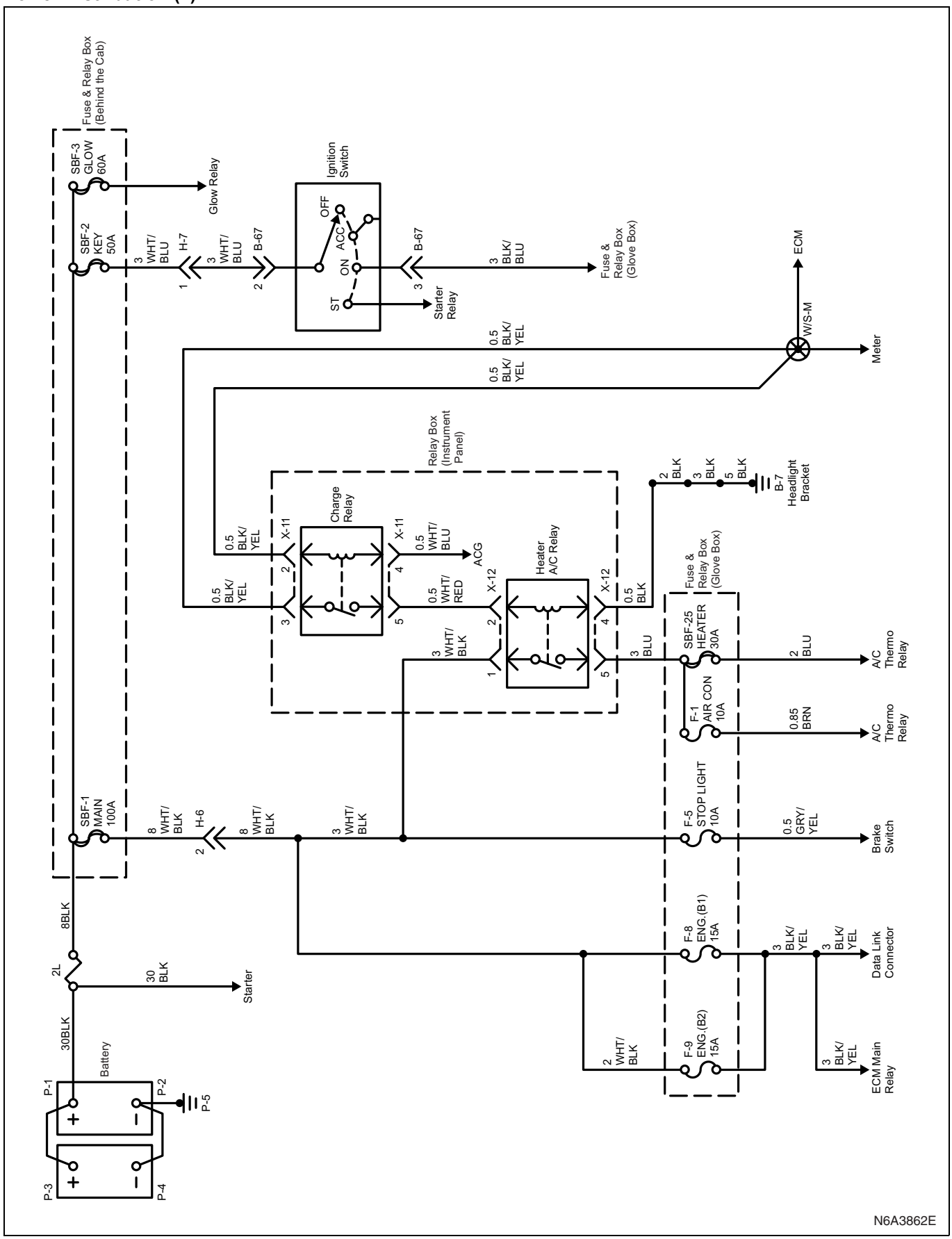


Legend

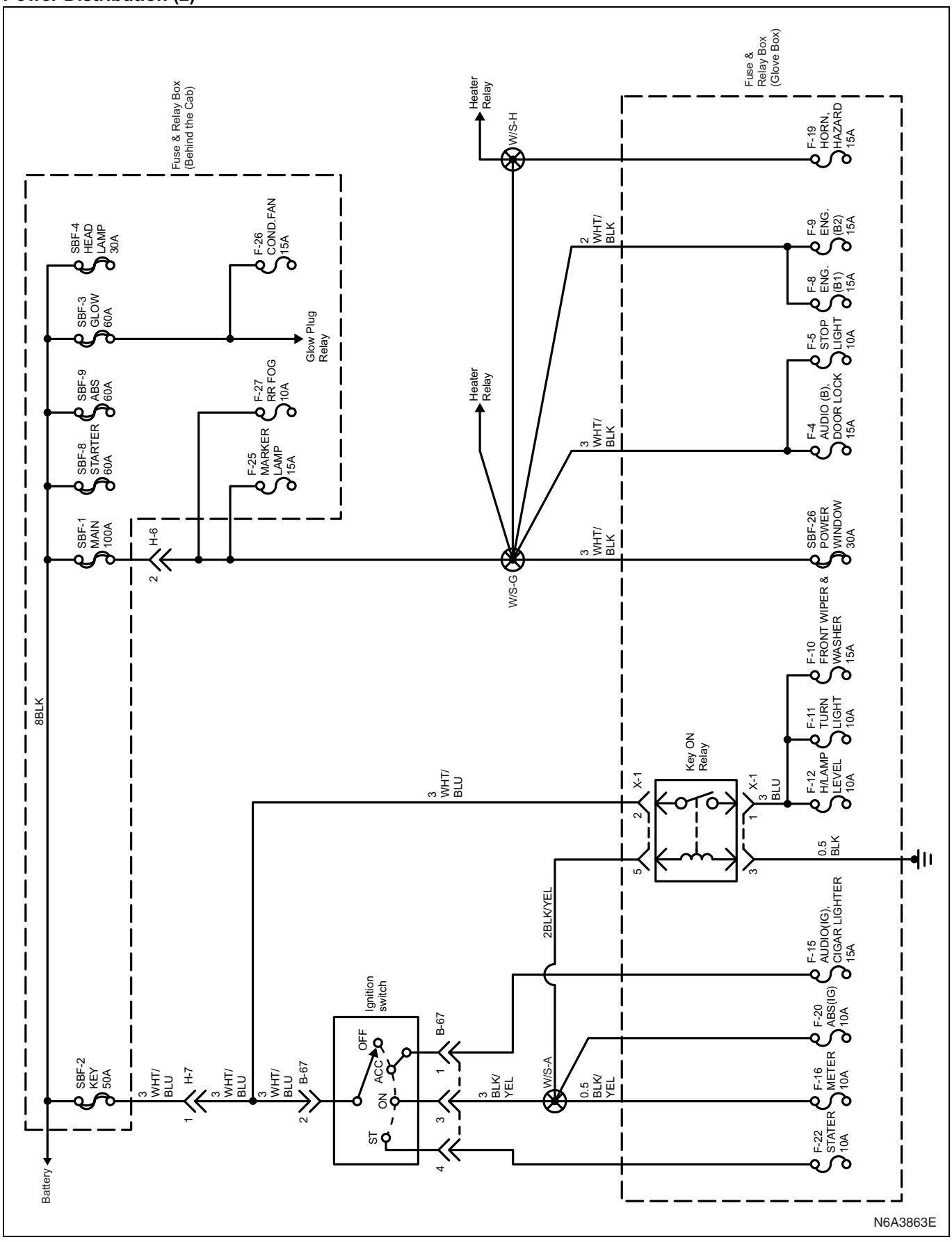
1. Vacuum Pump (part of ACG)
2. Vacuum Hose
3. EGR Valve
4. EGR Solenoid Valve

Engine Controls Schematics

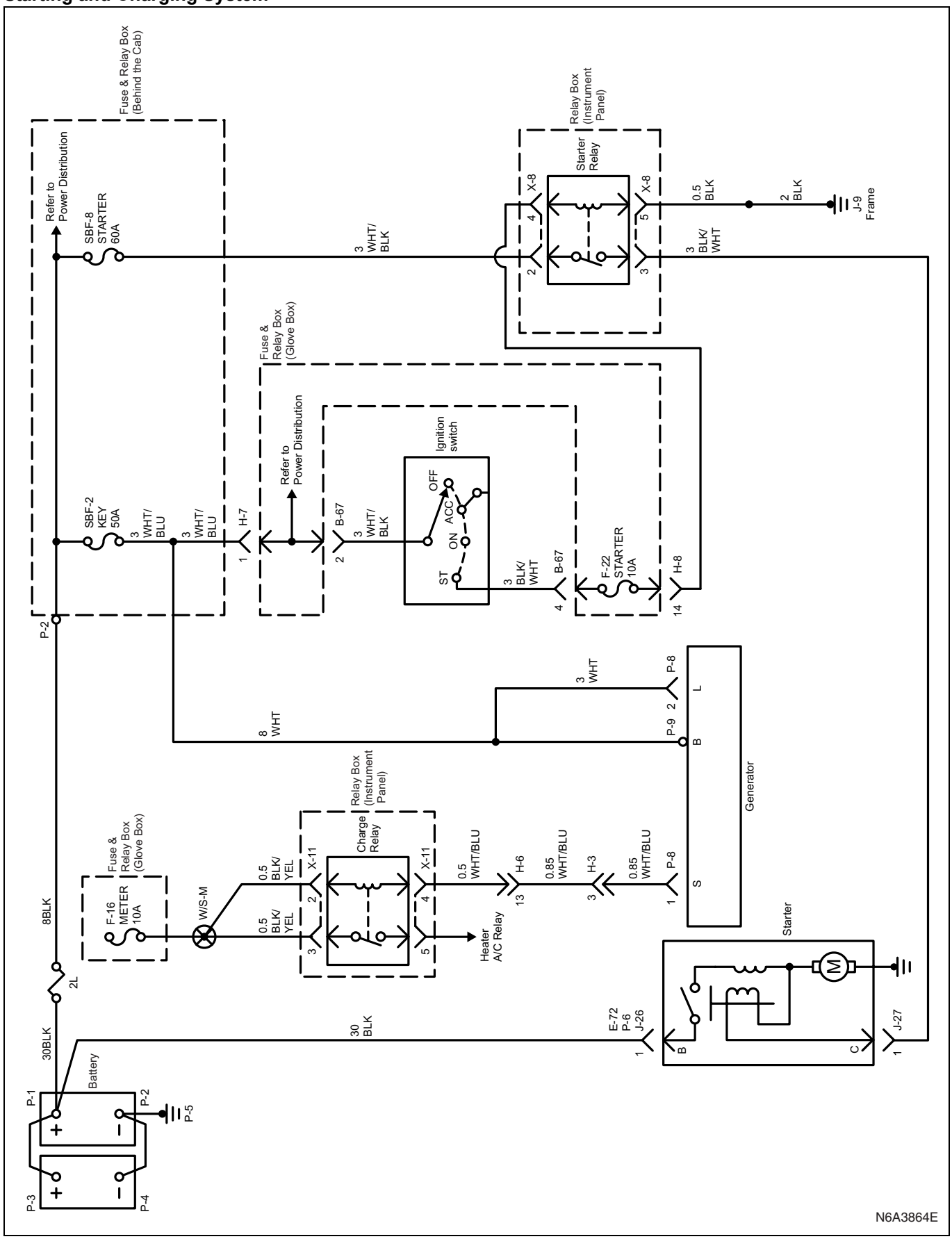
Power Distribution (1)



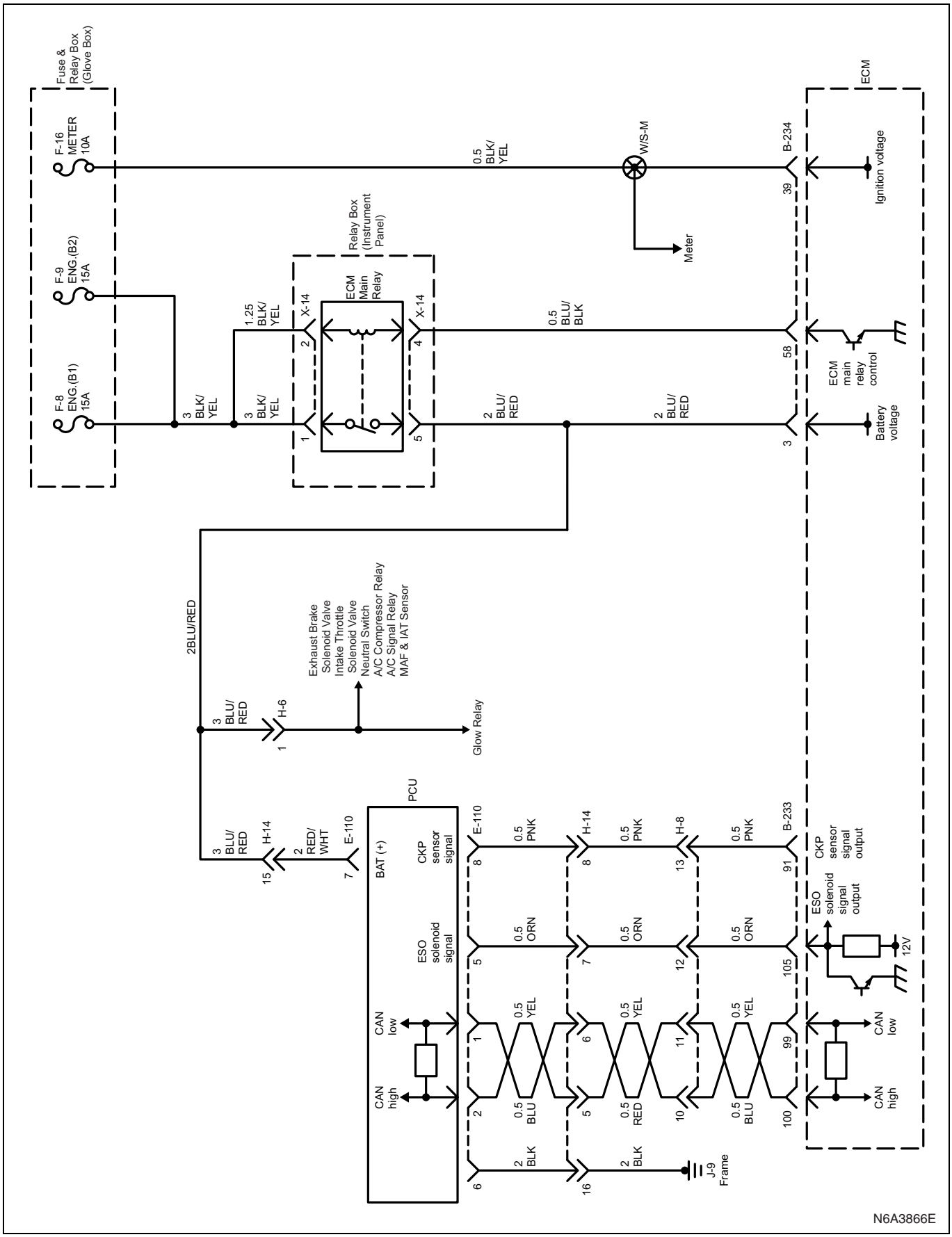
Power Distribution (2)



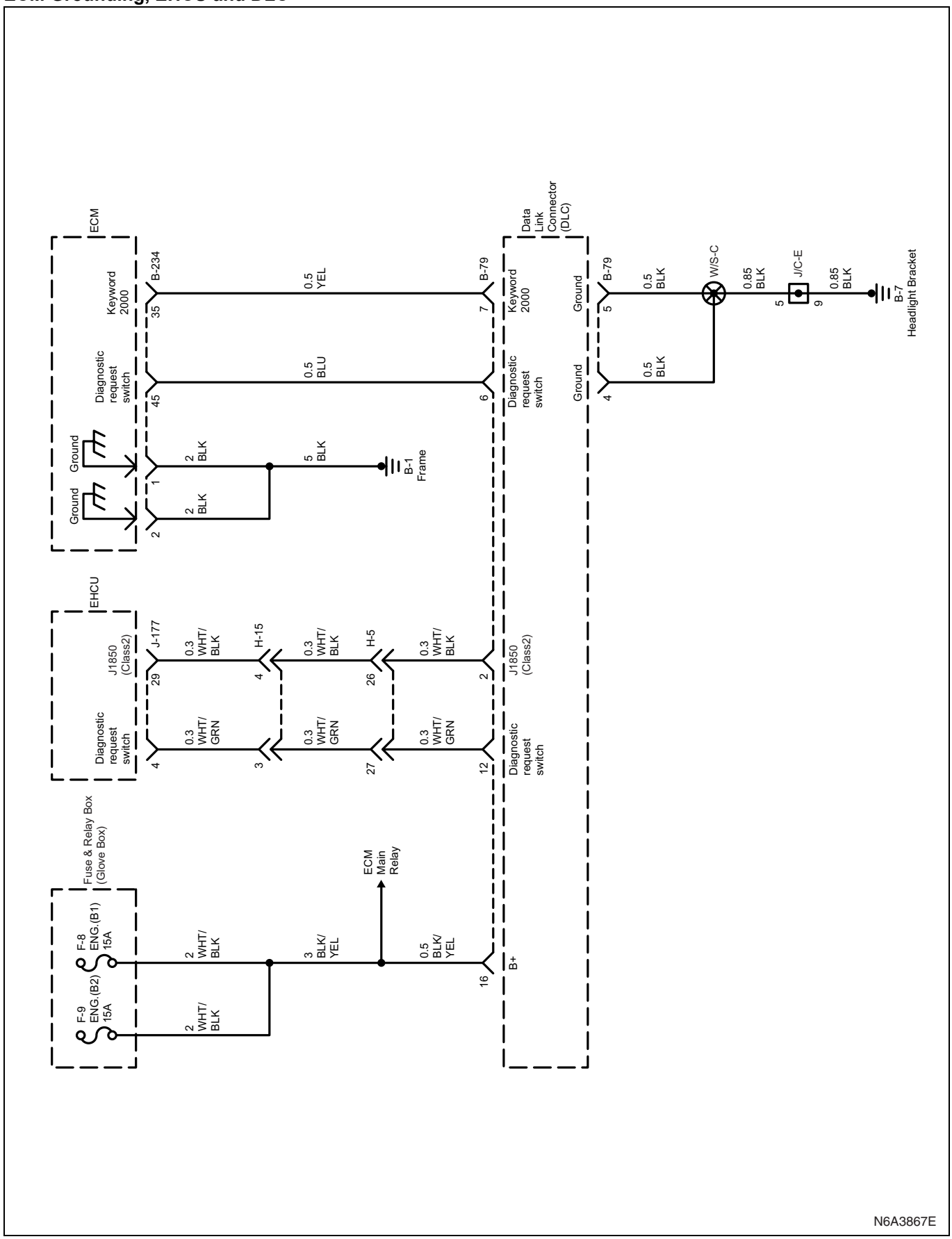
Starting and Charging System



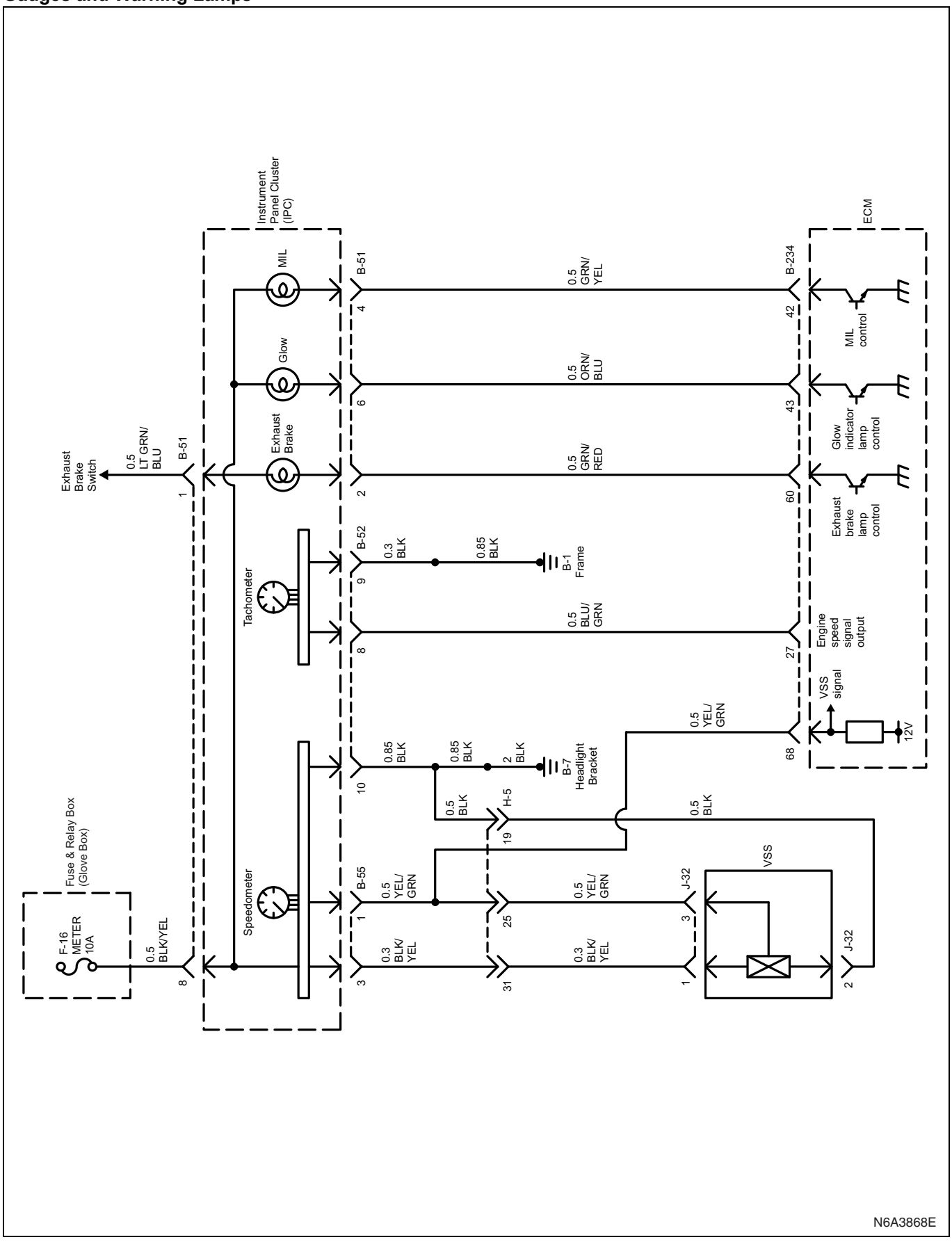
ECM Power and PCU



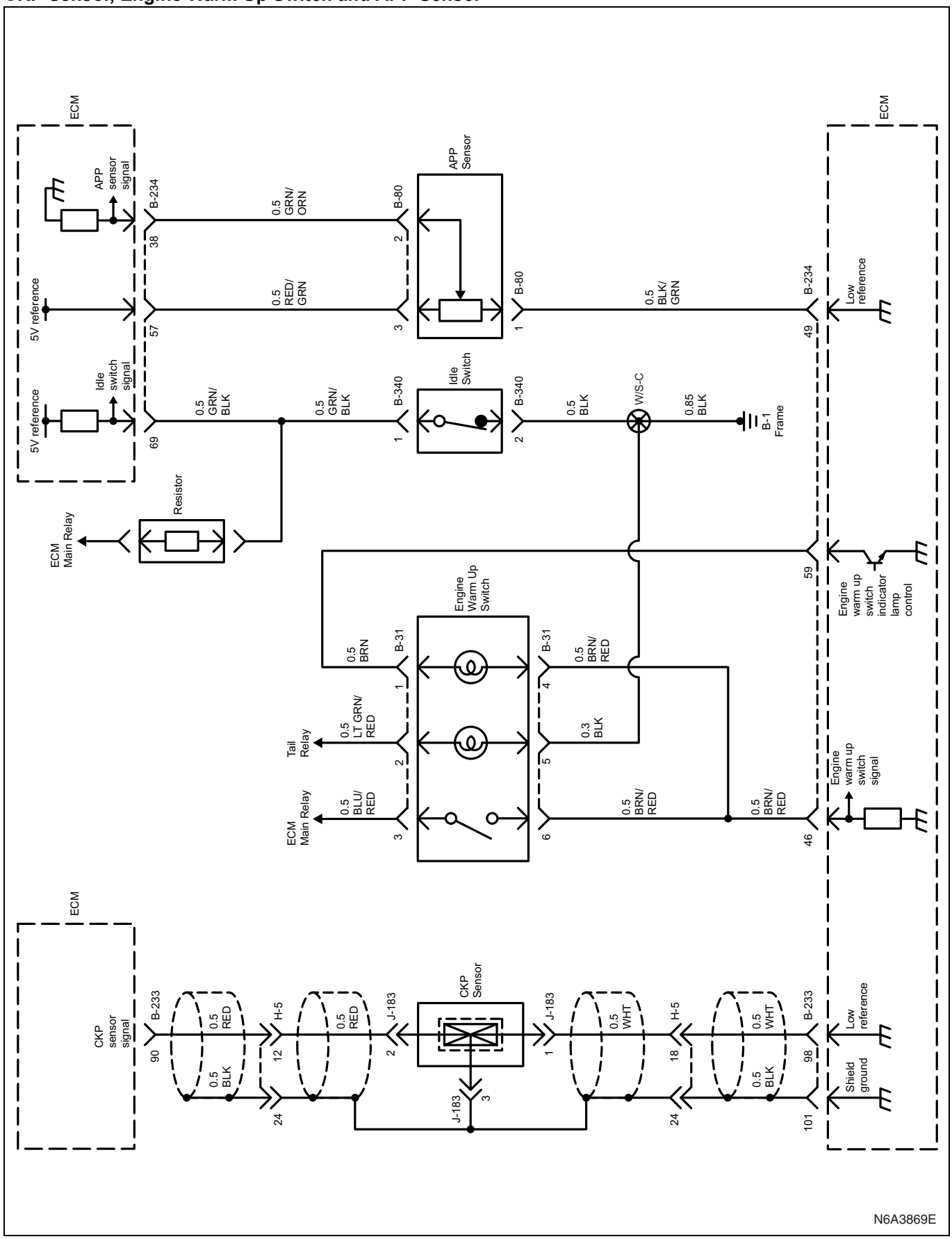
ECM Grounding, EHCU and DLC



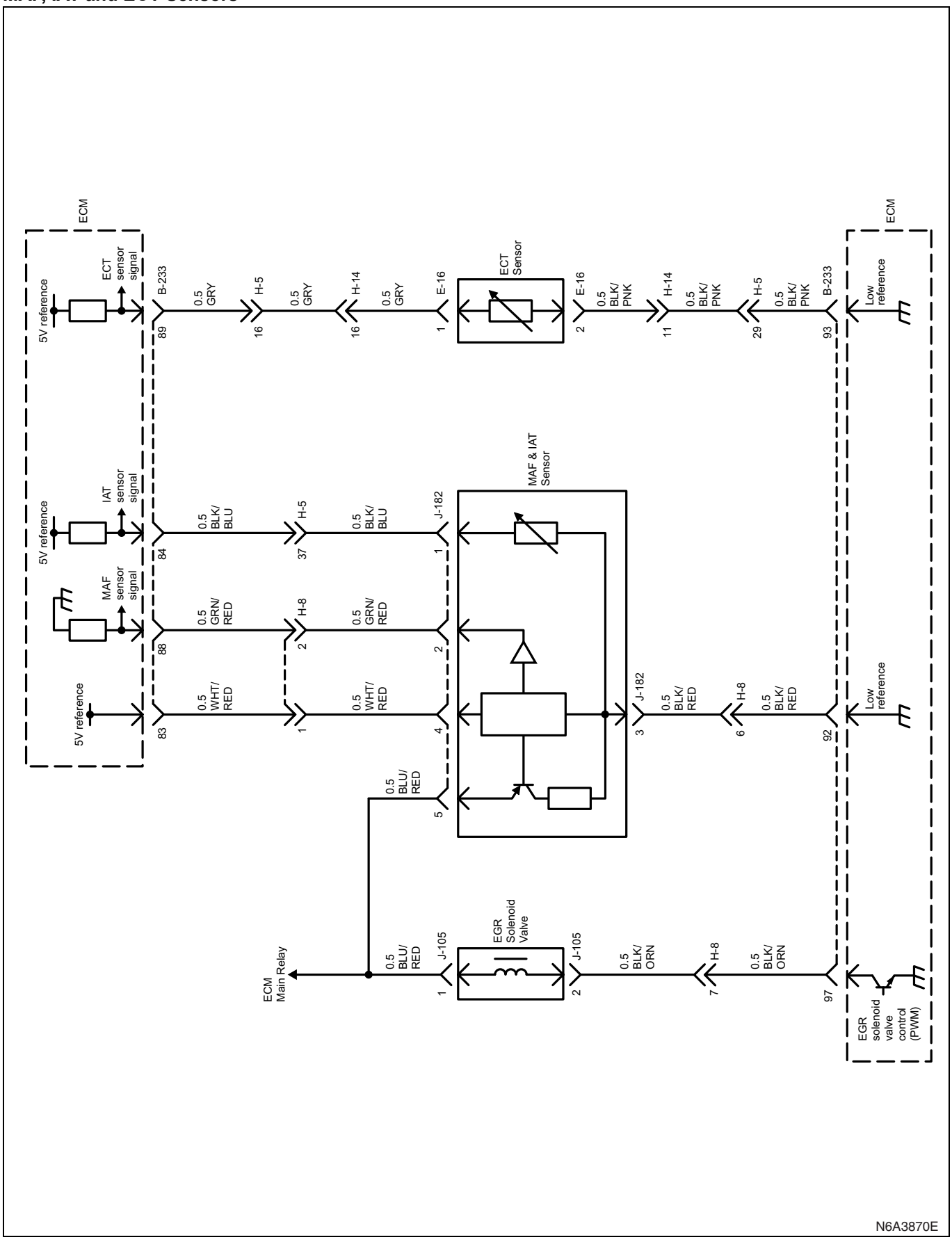
Gauges and Warning Lamps



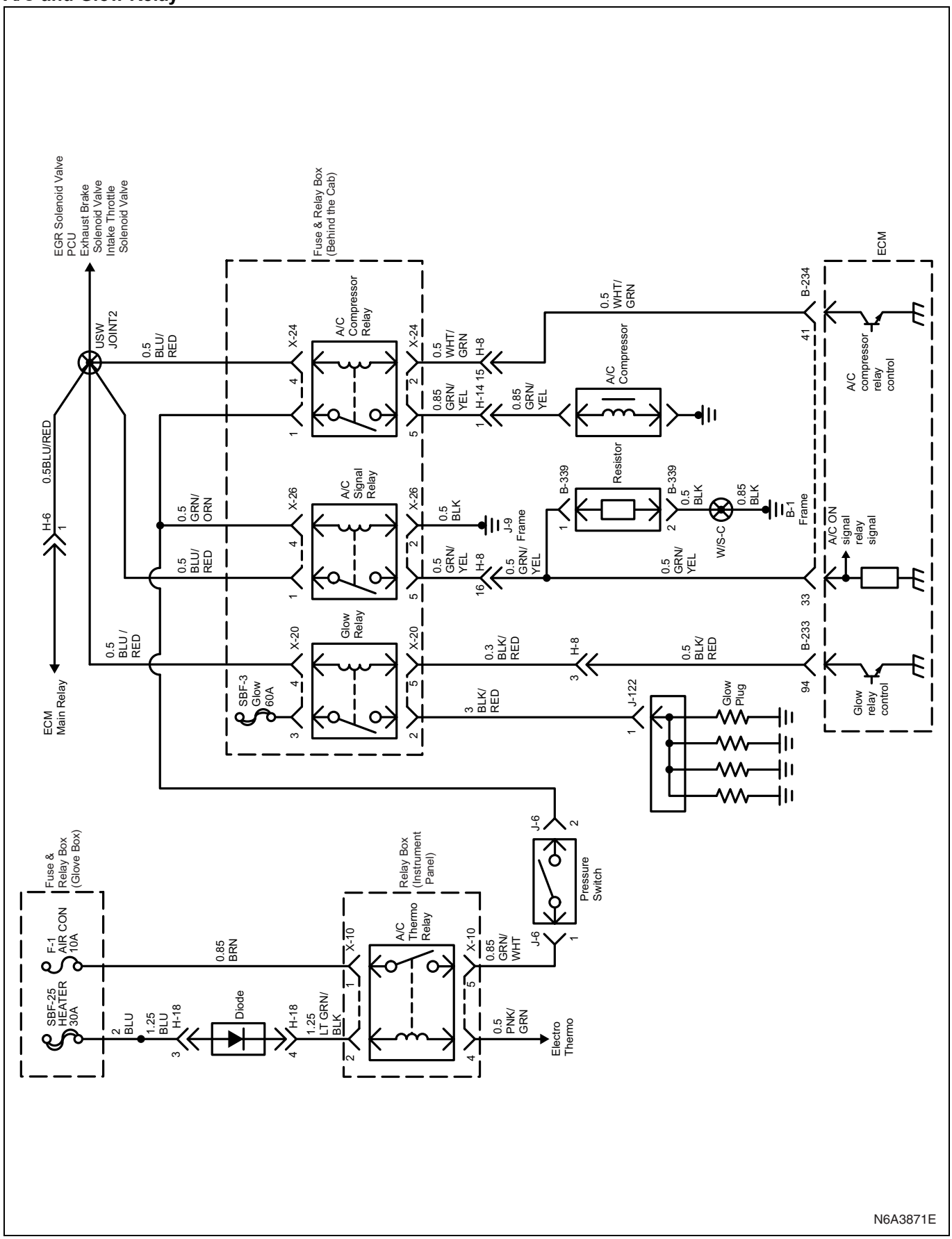
CKP Sensor, Engine Warm Up Switch and APP Sensor



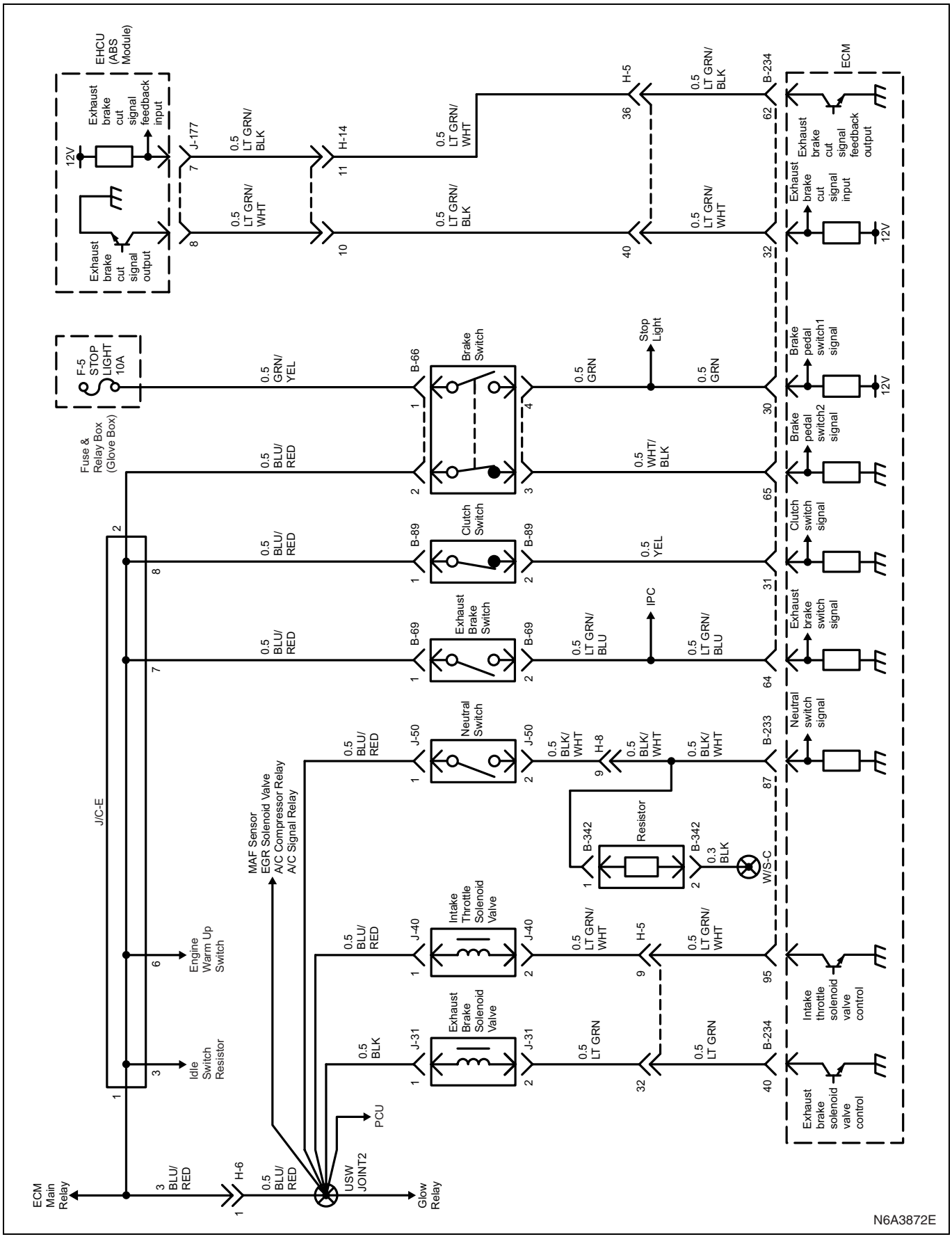
MAF, IAT and ECT Sensors



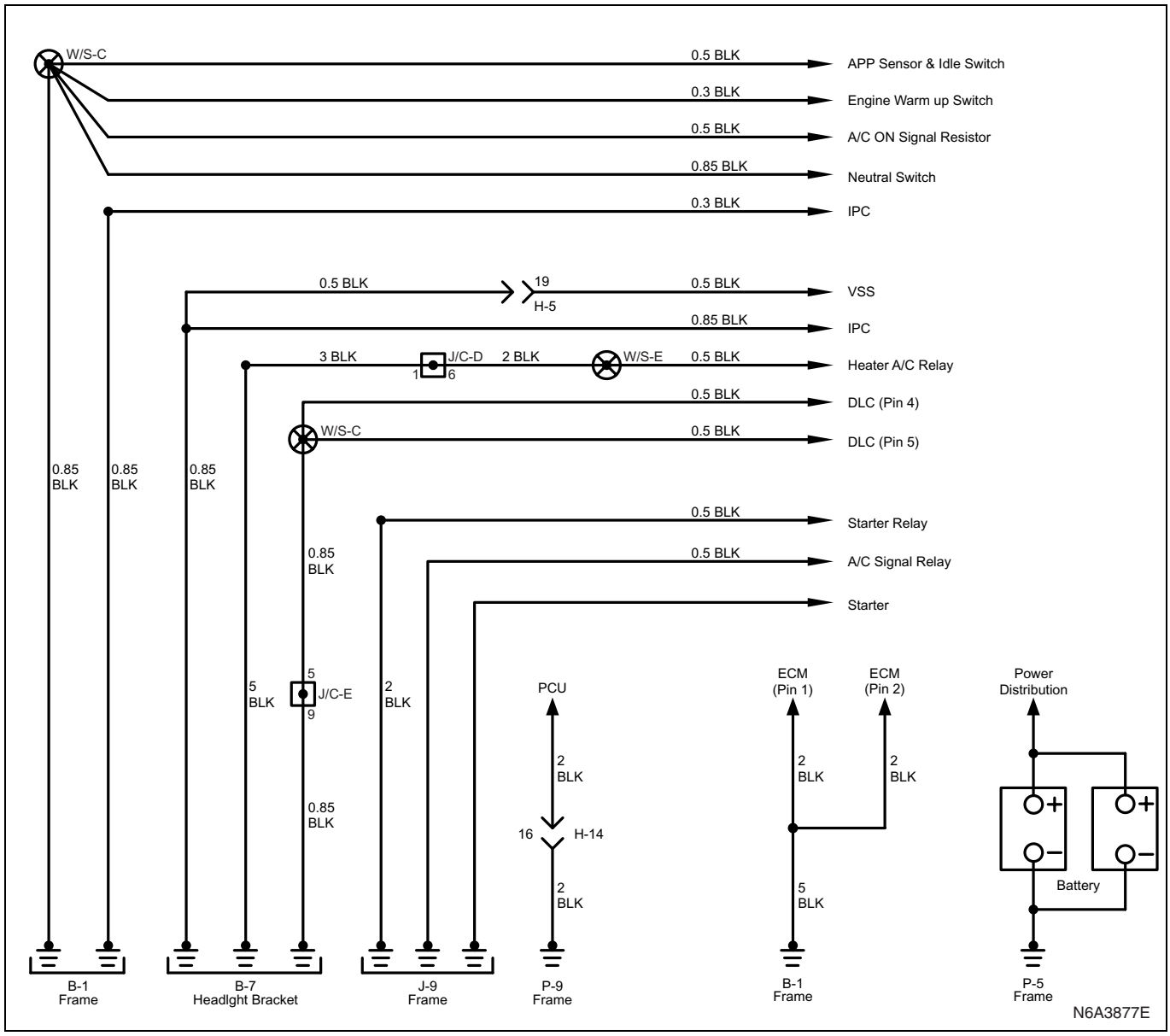
A/C and Glow Relay



EGR Solenoid Valve, Exhaust Brake Solenoid Valve, Intake Throttle Solenoid Valve, Exhaust Brake Switch, Clutch Switch and Brake Switch



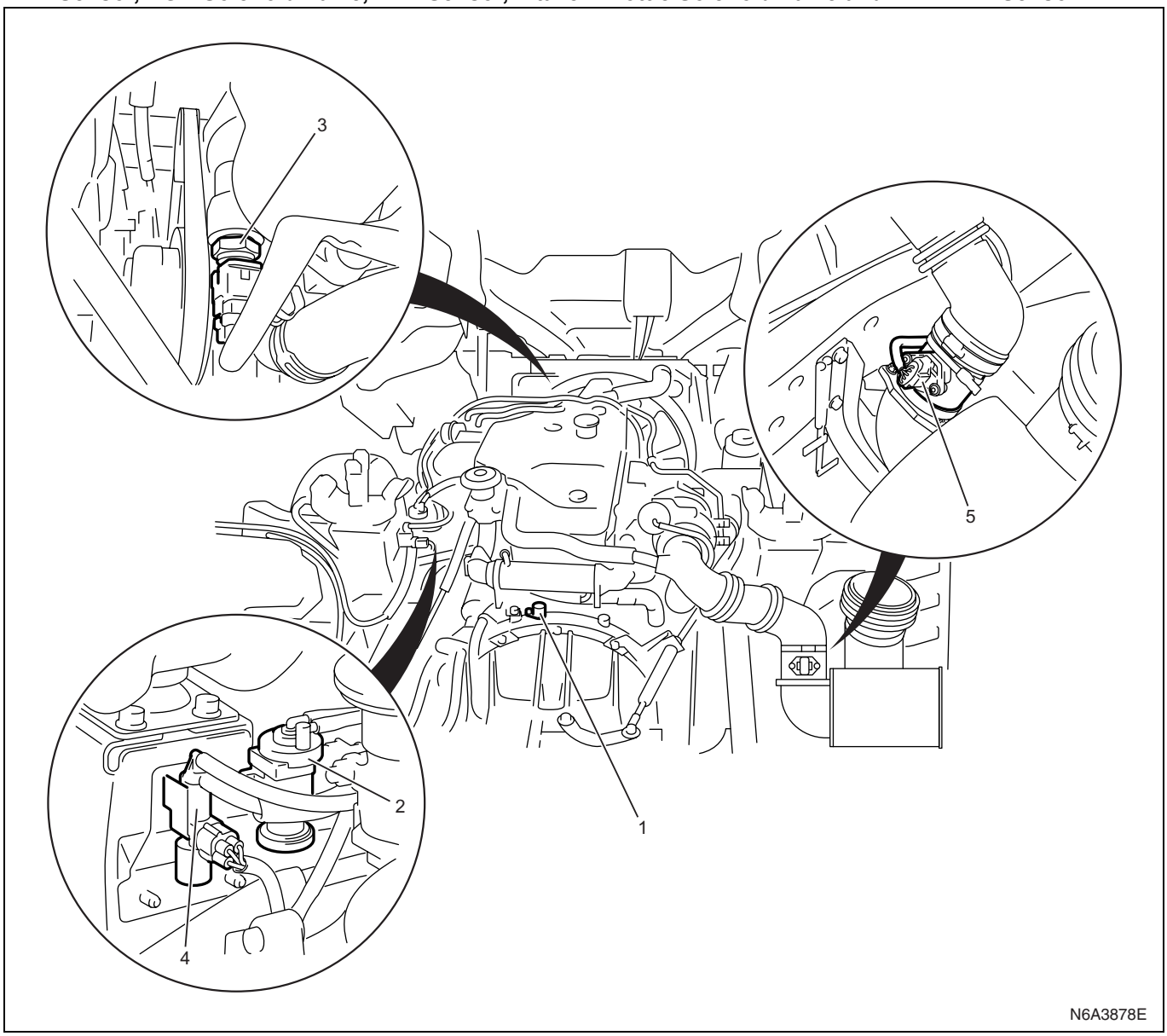
Ground Distributions



Component Locator

Engine Controls Component Views

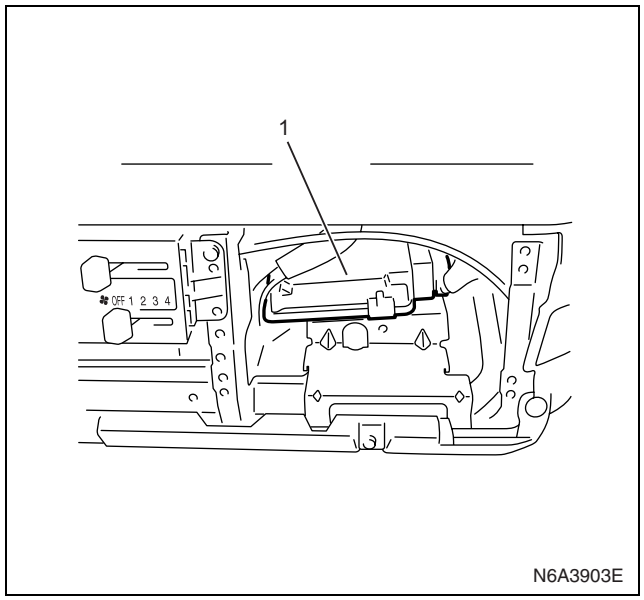
CKP Sensor, EGR Solenoid Valve, ECT Sensor, Intake Throttle Solenoid Valve and MAF / IAT Sensor



Legend

1. Crankshaft Position (CKP) Sensor
2. EGR Solenoid Valve
3. Engine Coolant Temperature (ECT) Sensor
4. Intake Throttle Solenoid Valve
5. Mass Air Flow (MAF) / Intake Air Temperature (IAT) Sensor

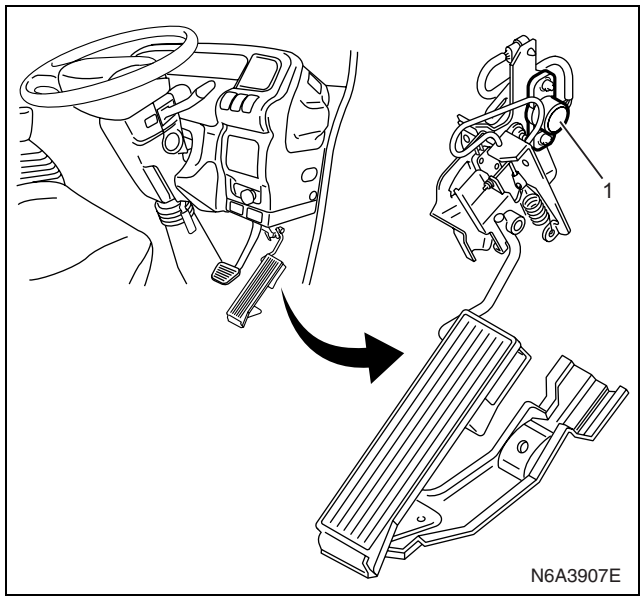
ECM



Legend

1. Engine Control Module (ECM)

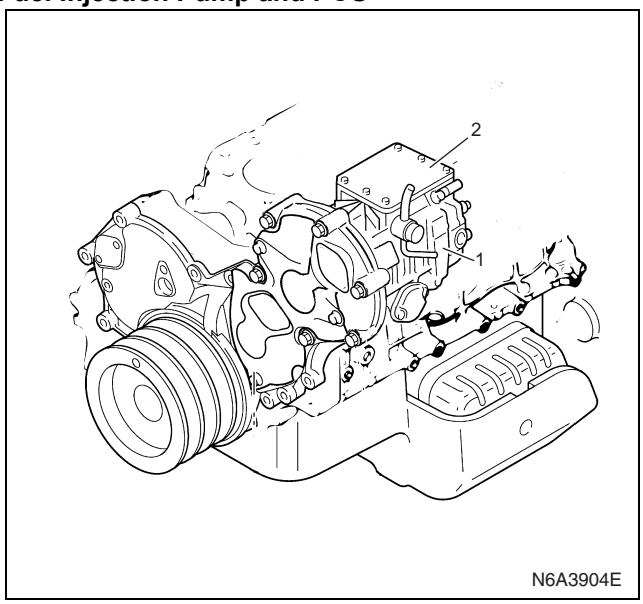
APP Sensor



Legend

1. Accelerator Pedal Position (APP) Sensor

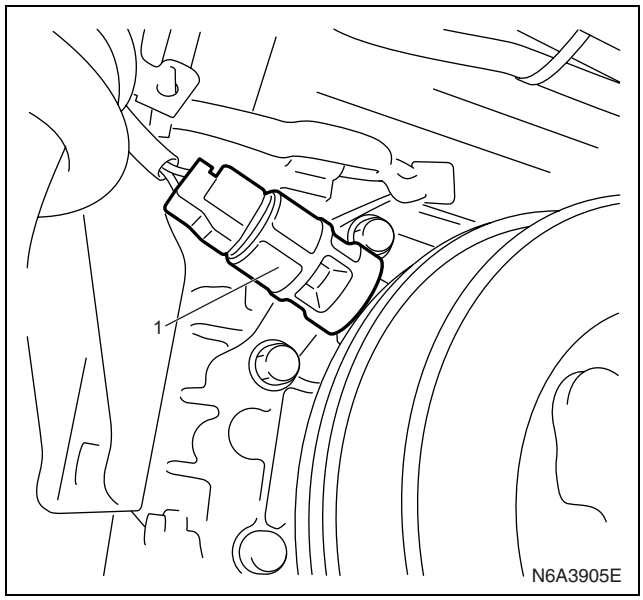
Fuel Injection Pump and PCU



Legend

1. Fuel Injection Pump
2. Pump Control Unit (PCU)

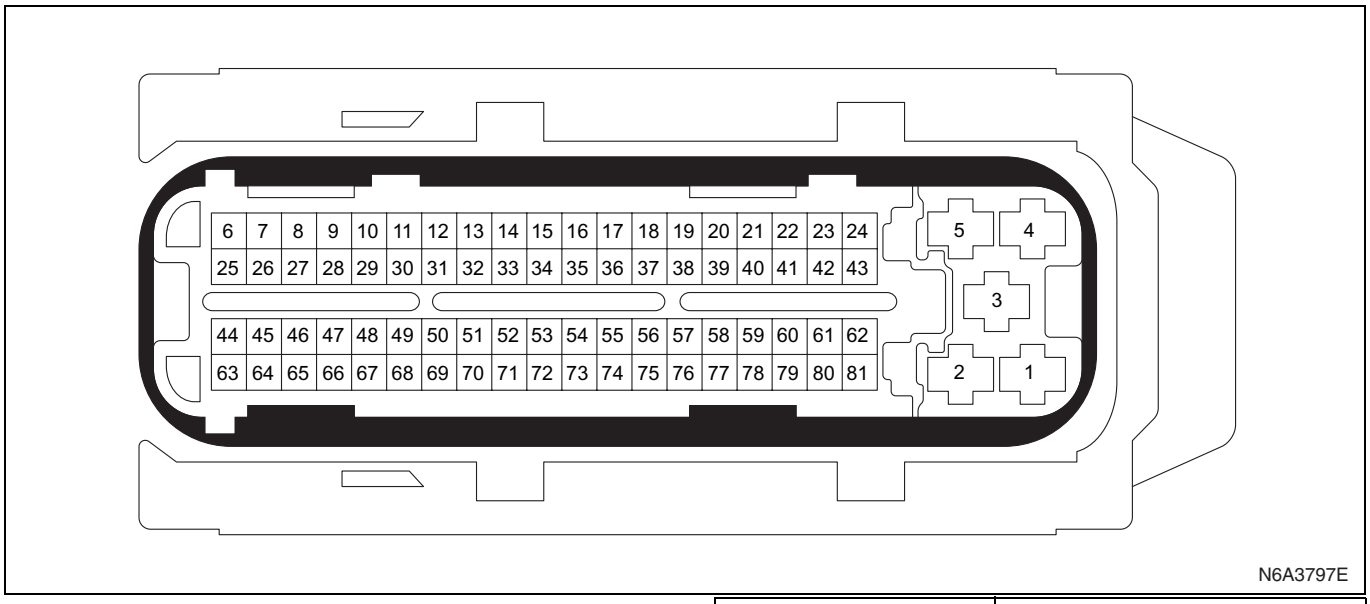
VSS



Legend

1. Vehicle Speed Sensor (VSS)

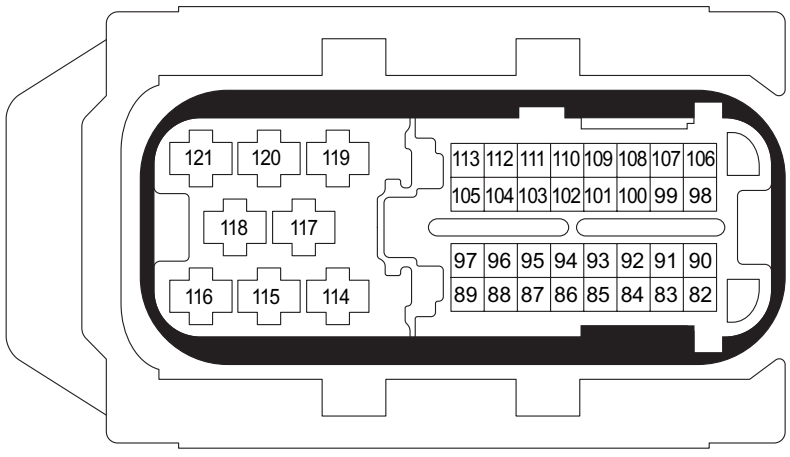
Engine Control Module (ECM) Connector End Views



Connector No.		B-234
Connector Color		Black
Test Adapter No.		J-35616-4A (Pin 1 – 5) J-35616-64A (Pin 6 – 81)
Pin	Wire Color	Pin Function
1	BLK	ECM Ground
2	BLK	ECM Ground
3	BLU/RED	ECM Battery Voltage
4	—	Not Used
5	—	Not Used
6-24	—	Not Used
25	—	Not Used
26	—	Not Used
27	BLU/GRN	Engine Speed Signal Output to Tachometer
28	—	Not Used
29	—	Not Used
30	GRN	Brake Pedal 1 Switch (Stoplamp Pedal Switch) Signal
31	YEL	Clutch Pedal Switch
32	LT GRN/ WHT	Exhaust Brake Cut Signal Input from EHCU (ABS Module)
33	GRN/YEL	A/C ON Signal Relay Input
34	—	Not Used
35	YEL	Keyword 2000
36	—	Not Used
37	—	Not Used
38	GRN/ORN	APP Sensor Signal
39	WHT	Ignition Voltage Feed

Connector No.		B-234
Connector Color		Black
Test Adapter No.		J-35616-4A (Pin 1 – 5) J-35616-64A (Pin 6 – 81)
Pin	Wire Color	Pin Function
40	LT GRN	Exhaust Brake Solenoid Valve
41	WHT/GRN	A/C Compressor Relay Control
42	GRN/YEL	MIL Control
43	ORN/BLU	Glow Indicator Lamp Control
44	—	Not Used
45	BLU	Diag Switch
46	BRN/RED	Engine Warm Up Switch Input
47	—	Not Used
48	—	Not Used
49	BLK/GRN	APP Sensor Low Reference
50	—	Not Used
51	—	Not Used
52	—	Not Used
53	—	Not Used
54	—	Not Used
55	—	Not Used
56	—	Not Used
57	RED/GRN	APP Sensor 5 Volts reference
58	BLU/BLK	ECM Main Relay Control
59	BRN	Engine Warm Up Indicator Lamp Control
60	GRN/RED	Exhaust Brake Lamp Control
61	—	Not Used

Connector No.		B-234
Connector Color		Black
Test Adapter No.		J-35616-4A (Pin 1 – 5) J-35616-64A (Pin 6 – 81)
Pin	Wire Color	Pin Function
62	LT GRN/ BLK	Exhaust Brake Cut Signal Output to EHCU (ABS Module)
63	—	Not Used
64	LT GRN/ BLU	Exhaust Brake Switch Signal
65	WHT/BLK	Brake Pedal 2 Switch Signal
66	—	Not Used
67	—	Not Used
68	YEL/GRN	VSS Signal
69	GRN/BLK	Idle Switch Signal
70	—	Not Used
71	—	Not Used
72	—	Not Used
73	—	Not Used
77	—	Not Used
78	—	Not Used
79	—	Not Used
80	—	Not Used
81	—	Not Used



N6A3798E

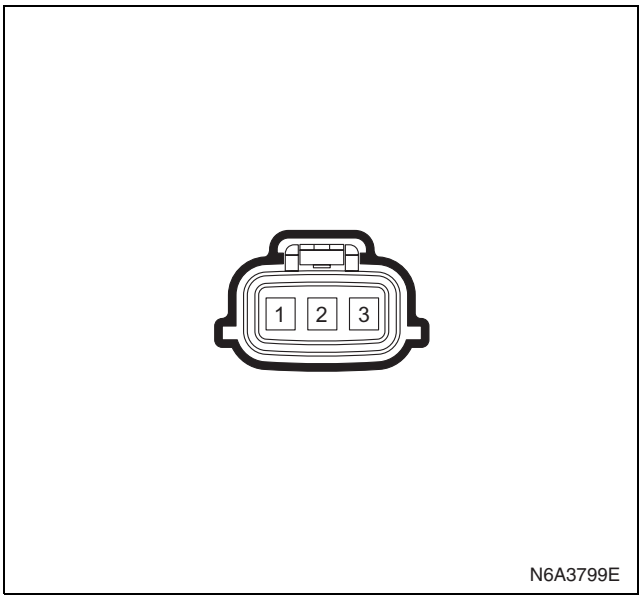
Connector No.		B-233
Connector Color		Black
Test Adapter No.		J-35616-64A
Pin	Wire Color	Pin Function
82	—	Not Used
83	WHT/RED	MAF Sensor 5 Volts Reference

Connector No.		B-233
Connector Color		Black
Test Adapter No.		J-35616-64A
Pin	Wire Color	Pin Function
84	BLK/BLU	IAT Sensor Signal
85	—	Not Used

Connector No.		B-233
Connector Color		Black
Test Adapter No.		J-35616-64A
Pin	Wire Color	Pin Function
86	—	Not Used
87	BLK/WHT	Neutral Switch Input
88	GRN/RED	MAF Sensor Signal
89	GRY	ECT Sensor Signal
90	RED	CKP Sensor Signal
91	PNK	CKP Sensor Signal Output
92	BLK/RED	MAF Sensor & IAT Sensor Low Reference
93	BLK/PNK	ECT Sensor Low Reference
94	BLK/RED	Glow Relay Control
95	LT GRN/ WHT	Intake Throttle Solenoid Control
96	—	Not Used
97	BLK/ORN	EGR Solenoid Valve Control
98	WHT	CKP Sensor Low Reference
99	BLU	CAN Low Signal
100	YEL	CAN High Signal
101	BLK	CKP Sensor Shield Ground
102	—	Not Used
102	—	Not Used
103	—	Not Used
105	ORN	Engine Shutoff (ESO) Solenoid Valve Control Signal Output
106-121	—	Not Used

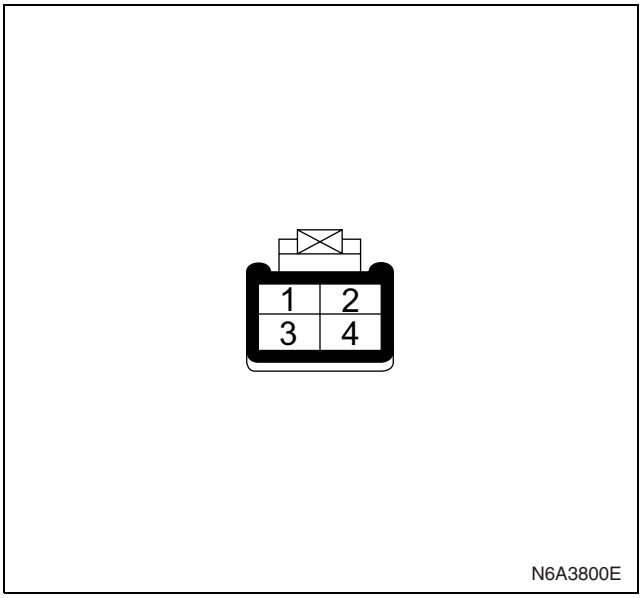
Engine Controls Connector End Views

Accelerator Pedal Position (APP) Sensor



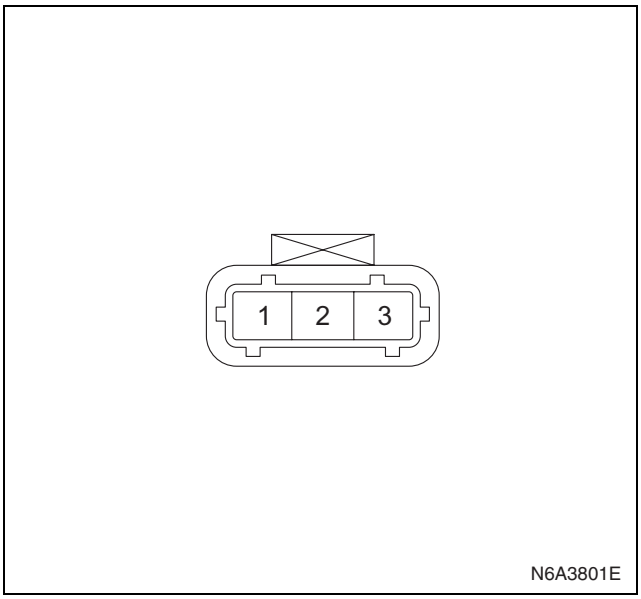
Connector No.		B-80
Connector Color		Gray
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	BLK/GRN	APP Sensor Low Reference
2	GRN/ORN	APP Sensor Signal
3	RED/GRN	APP Sensor 5 Volts Reference

Brake Switch



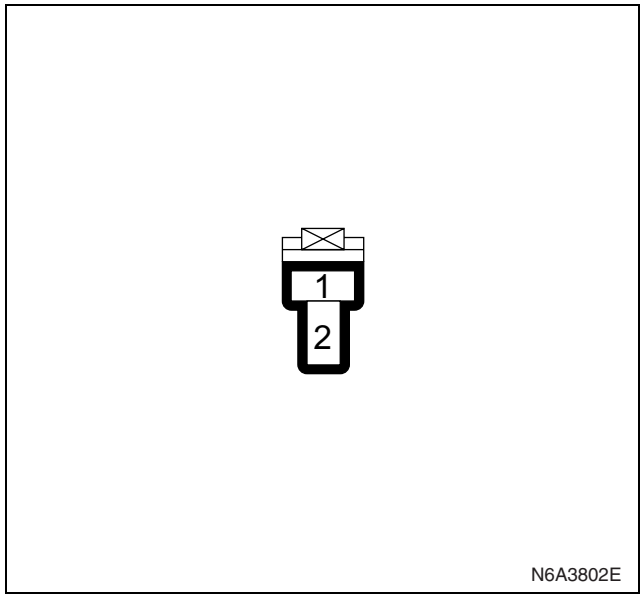
Connector No.		B-66
Connector Color		Brown
Test Adapter No.		J-35616-42
Pin	Wire Color	Pin Function
1	GRN/YEL	Brake Pedal 1 Switch (Stoplamp Pedal Switch) 12 Volts Feed
2	BLU/RED	Brake Pedal 2 Switch Ignition Voltage
3	WHT/BLK	Brake Pedal 2 Switch Signal
4	GRN	Brake Pedal 1 Switch (Stoplamp Pedal Switch) Signal

Crankshaft Position (CKP) Sensor



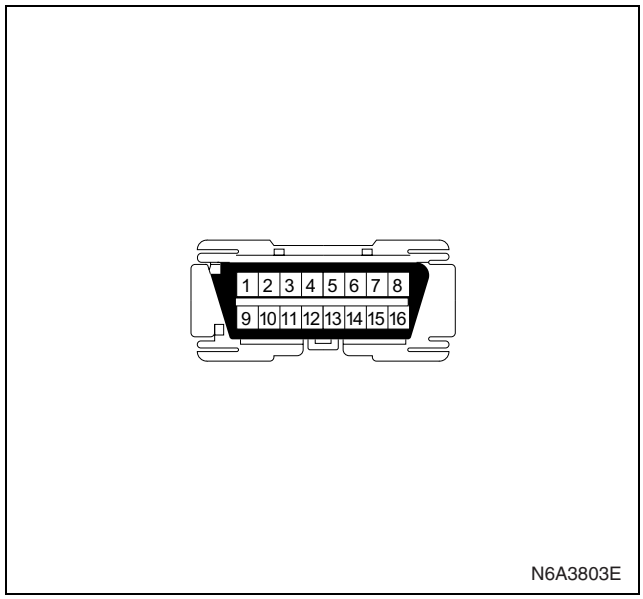
Connector No.		J-183
Connector Color		Black
Test Adapter No.		J-35616-4A
Pin	Wire Color	Pin Function
1	WHT	CKP Sensor Low Reference
2	RED	CKP Sensor Signal
3	BLK	CKP Sensor Shield Ground

Clutch Switch



Connector No.		B-89
Connector Color		White
Test Adapter No.		J-35616-42
Pin	Wire Color	Pin Function
1	BLU/RED	Clutch Pedal Switch Ignition Voltage
2	YEL	Clutch Pedal Switch Signal

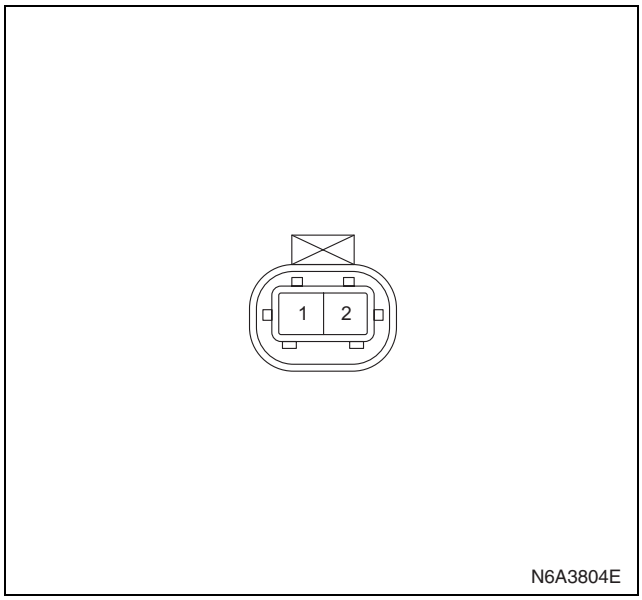
Data Link Connector (DLC)



Connector No.		B-79
Connector Color		Black
Test Adapter No.		J-35616-2A
Pin	Wire Color	Pin Function
1	—	Not Used
2	WHT/BLK	J1850 (Class 2)

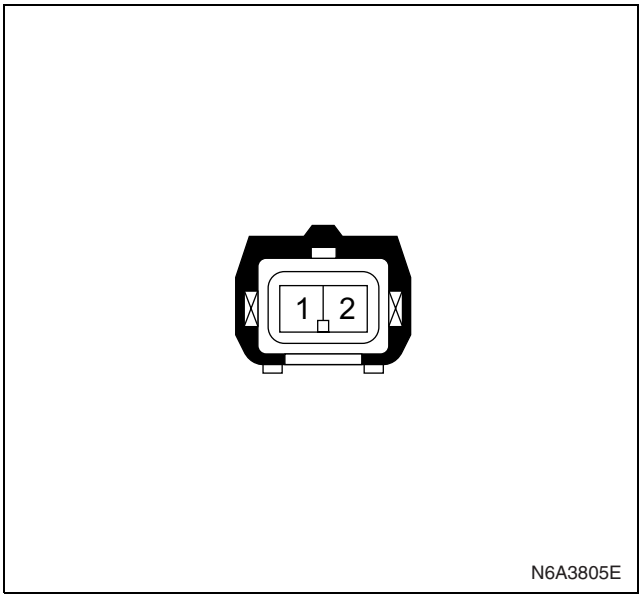
Connector No.		B-79
Connector Color		Black
Test Adapter No.		J-35616-2A
Pin	Wire Color	Pin Function
3	—	Not Used
4	BLK	Ground
5	BLK	Ground
6	BLU	Diagnostic Request Switch (ECM)
7	YEL/BLU	Keyword 2000
8	—	Not Used
9	—	Not Used
10	—	Not Used
11	—	Not Used
12	WHT/GRN	Diagnostic Request Switch (EHCU [ABS Module])
13	—	Not Used
14	—	Not Used
15	—	Not Used
16	BLK/YEL	Power Supply

EGR Solenoid Valve



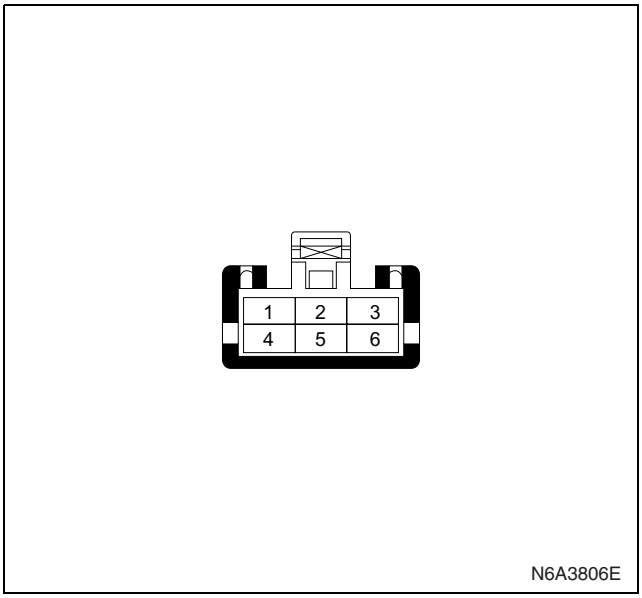
Connector No.		J-105
Connector Color		Black
Test Adapter No.		J-35616-4A
Pin	Wire Color	Pin Function
1	BLU/RED	Solenoid Valve 12 Volts Feed
2	BLK/ORN	Solenoid Valve Control

Engine Coolant Temperature (ECT) Sensor



Connector No.		E-16
Connector Color		Gray
Test Adapter No.		J-35616-4A
Pin	Wire Color	Pin Function
1	GRY	ECT Sensor Signal
2	BLK/PNK	ECT Sensor Low Reference

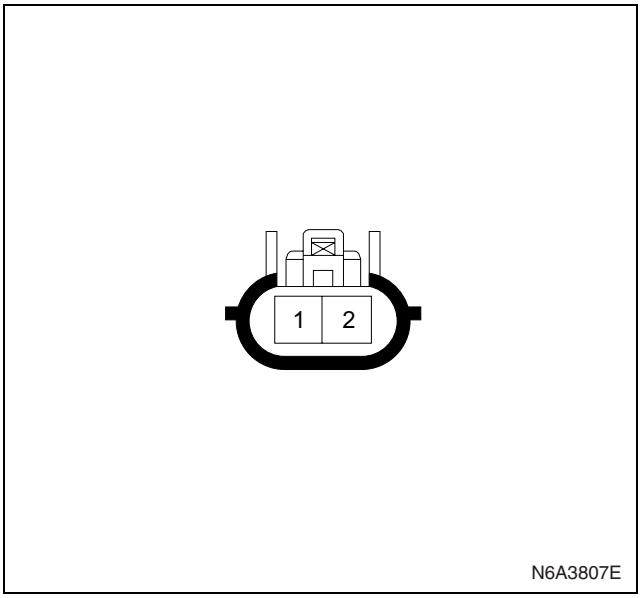
Engine Warm Up Switch



Connector No.		B-31
Connector Color		Gray
Test Adapter No.		J-35616-42
Pin	Wire Color	Pin Function
1	BRN	Indicator Lamp Control
2	GRN/RED	Illumination Lamp 12V Feed

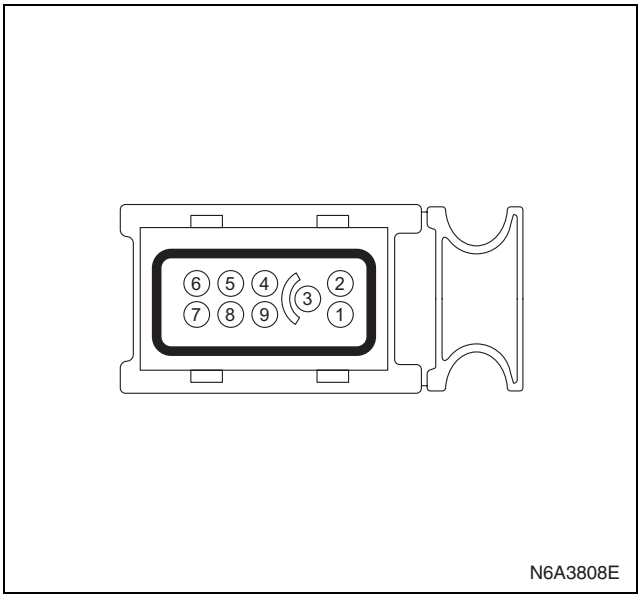
Connector No.		B-31
Connector Color		Gray
Test Adapter No.		J-35616-42
Pin	Wire Color	Pin Function
3	BLU/RED	Engine Warm Up Switch 12V Feed
4	BRN/RED	Indicator Lamp Voltage Feed From Switch Signal
5	BLK	Illumination Lamp Ground
6	BRN/RED	Engine Warm Up Switch Signal

Exhaust Brake Solenoid Valve



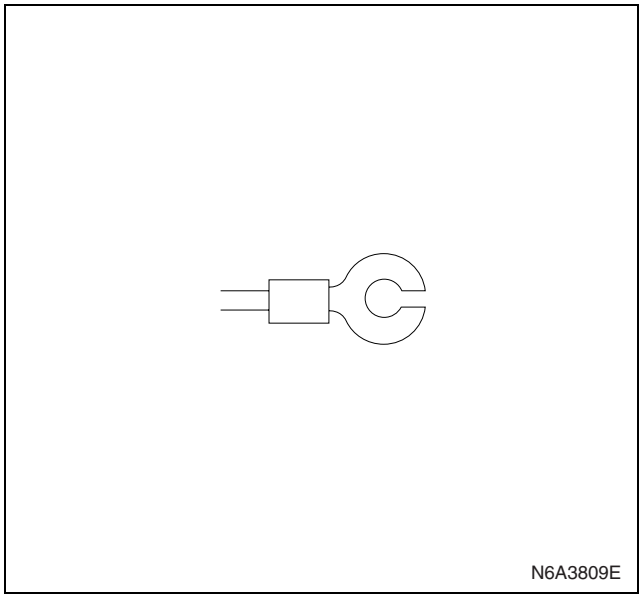
Connector No.		J-31
Connector Color		Black
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	BLK	Ignition Voltage
2	LT GRN	Exhaust Brake Solenoid Control

Fuel Injection Pump Control Unit (PCU)



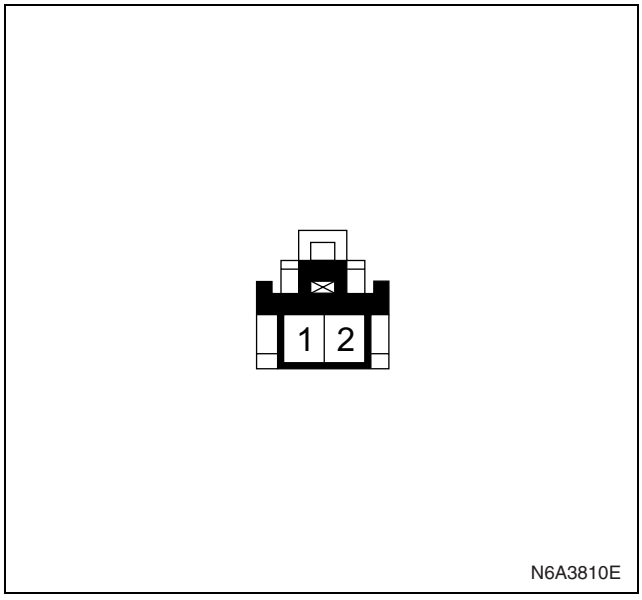
Connector No.		E-110
Connector Color		Black
Test Adapter No.		J-35616-8
Pin	Wire Color	Pin Function
1	BLU	CAN Low Signal
2	YEL	CAN High Signal
3	—	Not Used
4	—	Not Used
5	ORN	Engine Shutoff (ESO) Solenoid Valve Control Signal Input
6	BLK	Ground
7	RED/WHT	Battery voltage
8	PNK	CKP Sensor Signal Input
9	—	Not Used

Glow Plug



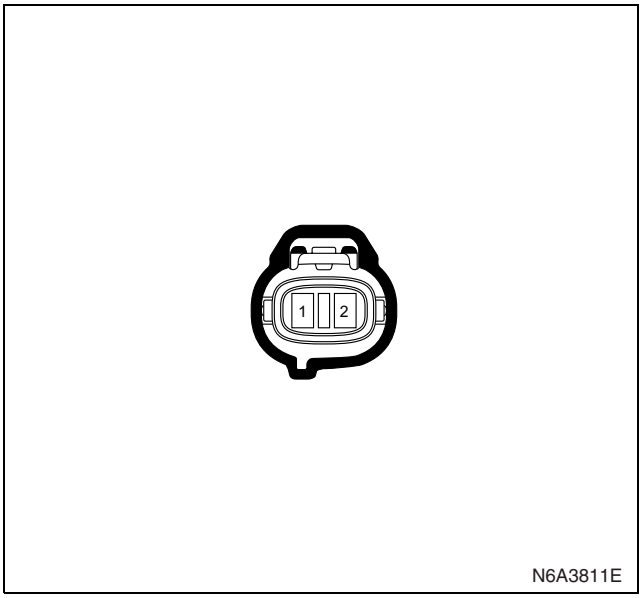
Connector No.		J-122
Connector Color		Silver
Pin	Wire Color	Pin Function
1	BLK/YEL	Power Supply

Idle Switch



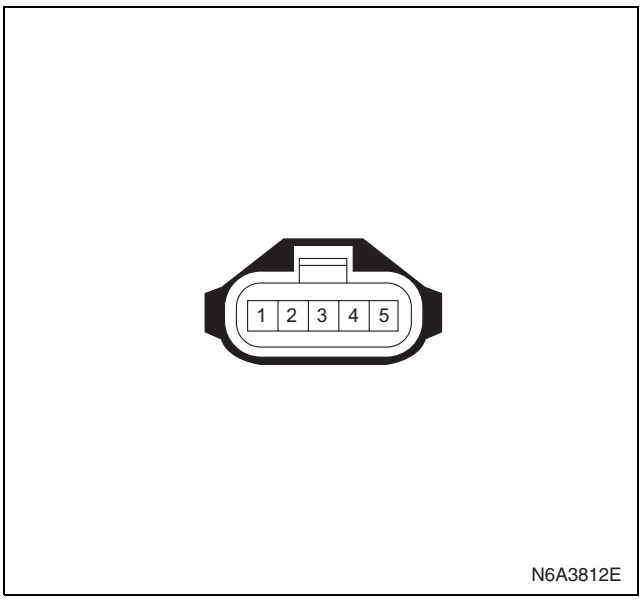
Connector No.		B-340
Connector Color		Black
Test Adapter No.		J-35616
Pin	Wire Color	Pin Function
1	GRN/BLK	Idle Switch Signal
2	BLK	Idle Switch Ground

Intake Throttle Solenoid Valve



Connector No.		J-40
Connector Color		Brown
Test Adapter No.		J-35616-4A
Pin	Wire Color	Pin Function
1	BLU/RED	Ignition Voltage
2	LT GRN/ WHT	Intake Throttle Solenoid Control

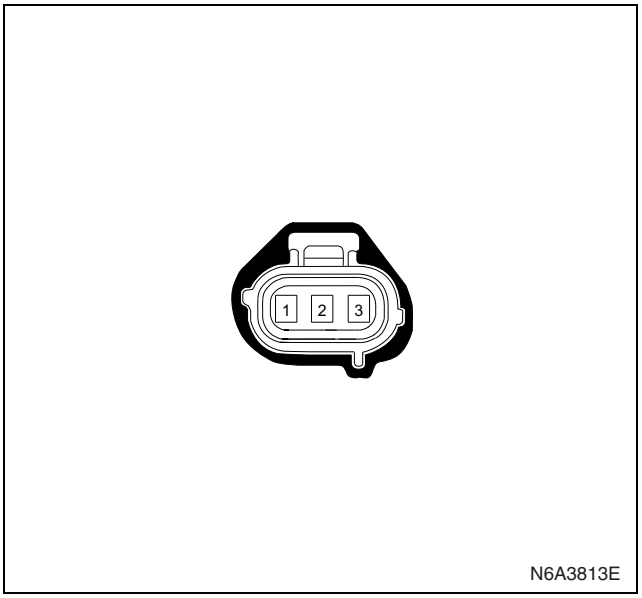
Mass Air Flow (MAF) / Intake Air Temperature Sensor



Connector No.		J-182
Connector Color		Black
Test Adapter No.		J-35616-4A
Pin	Wire Color	Pin Function
1	BLK/BLU	IAT Sensor Signal

Connector No.		J-182
Connector Color		Black
Test Adapter No.		J-35616-4A
Pin	Wire Color	Pin Function
2	BLU/RED	MAF Sensor Ignition Voltage Feed
3	BLK/RED	MAF Sensor & IAT Sensor Low Reference
4	WHT/RED	MAF Sensor 5 Volts Reference
5	GRN/RED	MAF Sensor Signal

Vehicle Speed Sensor (VSS)



Connector No.		J-32
Connector Color		Gray
Test Adapter No.		J-35616-64A
Pin	Wire Color	Pin Function
1	BLK/YEL	VSS 12 Volts Feed
2	BLK	VSS Low Reference
3	YEL/GRN	VSS Signal

Diagnostic Information and Procedures

General Service Information

Non-OEM Parts

All of the on-board diagnostic (OBD) has been calibrated to run with original equipment manufacturer (OEM) parts. Accordingly, if commercially sold sensor or switch is installed, it makes a wrong diagnosis and turn on the malfunction indicator lamp (MIL). Aftermarket electronics, such as cellular phones, stereos, and anti-theft devices, may indicate electromagnetic interference (EMI) into the control system if they are improperly installed. This may cause a false sensor reading and turn on the MIL.

Poor Vehicle Maintenance

The sensitivity of OBD will cause the MIL turn on if the vehicle is not maintained properly. Restricted oil filters, fuel filters, and crankcase deposits due to lack of oil changes or improper oil viscosity can trigger actual vehicle faults that were not previously monitored prior to OBD. Poor vehicle maintenance cannot be classified as a “non-vehicle fault”, but with the sensitivity of OBD diagnostics, vehicle maintenance schedules must be more closely followed.

Visual/Physical Engine Compartment Inspection

Perform a careful visual and physical engine compartment inspection when performing any diagnostic procedure or diagnosing the cause of an emission test failure. This can often lead to repairing a problem without further steps. Use the following guidelines when performing a visual/physical inspection:

- Inspect all vacuum hoses for punches, cuts, disconnects, and correct routing.
- Inspect hoses that are difficult to see behind other components.
- Inspect all wires in the engine compartment for proper connections, burned or chafed spots, pinched wires, contact with sharp edges or contact with hot exhaust manifolds or pipes.

Basic Knowledge of Tools Required

Lack of basic knowledge of this powertrain when performing diagnostic procedures could result in an incorrect diagnosis or damage to powertrain components. Do not attempt to diagnose a powertrain problem without this basic knowledge. A basic understanding of hand tools is necessary to effectively use this section of the service manual.

Malfunction Indicator Lamp (MIL)

Basically, the MIL is turned on when the ECM detects a DTC that will impact the vehicle emissions. When the MIL remains “ON” while the engine is running, or when a malfunction is suspected due to a driveability or emissions problem, a Diagnostic System Check must be performed. The procedures for these checks are given in Diagnostic System Check – Engine Controls.

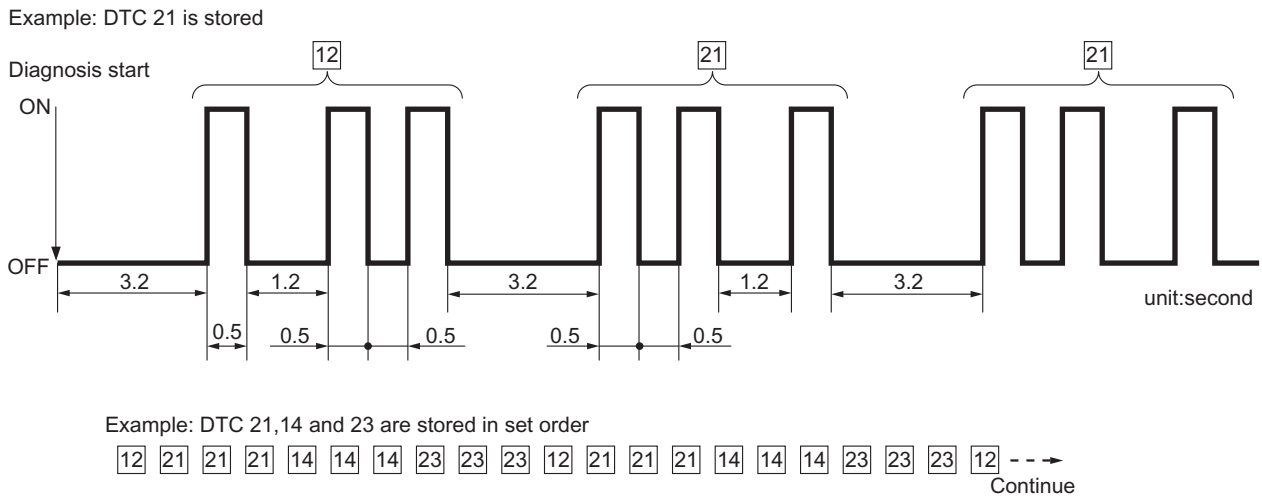
DTC Types

Characteristic of Code

- Non-Emissions related
- Dose not request illumination of any lamp
- Stores a DTC on the first trip with a fail

Reading Flash Diagnostic Trouble Codes

The provision for communicating with the ECM is the Data Link Connector (DLC). The DTCs stored in the ECM memory can be read either through a hand-held diagnostic scanner such as Tech 2 plugged into the DLC or by counting the number of flashes of the MIL when the diagnostic test terminal of the DLC is grounded. The DLC terminal “6” (diagnostic request switch) is pulled “Low” (grounded) by jumped to DLC terminal “4”, which is a ground wire.
Once terminals “4” and “6” have been connected, the ignition switch must be moved to the “ON” position, with the engine not running. The MIL will initially flash 12. Then, the MIL will flash the first stored DTC three times, second stored DTC three times and so on. All the stored DTCs are flashed, then return 12 and continue to flash the DTC. If no DTC exists, the MIL flashes 12 continuously. The flash DTC display will continue as long as the DLC is shorted.



Reading Diagnostic Trouble Codes (DTCs) with The Tech 2

The procedure for reading DTC(s) is used a diagnostic Tech 2. To read DTCs, use the Tech 2 “Read DTC Info As Stored By ECU”.

Clearing Diagnostic Trouble Codes (DTCs) with The Tech 2 or without Tech 2

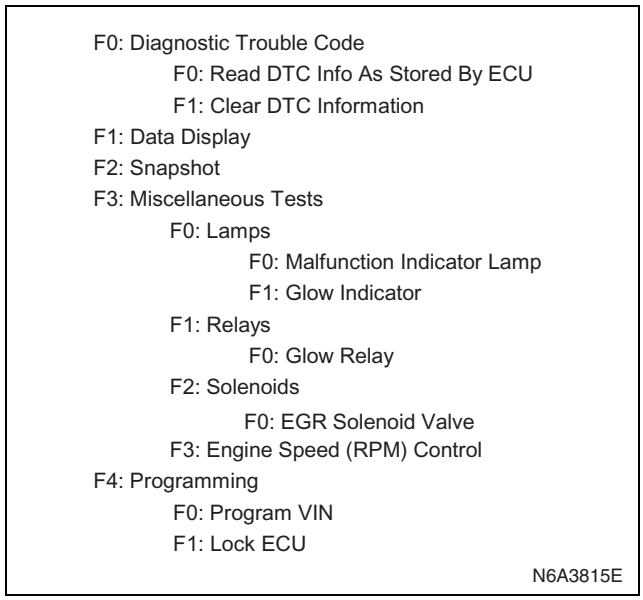
Do not clear DTCs unless directed to do so by the service information provided for each diagnostic procedure. To clear DTCs, use the Tech 2 “Clear DTC Information”. If there is no Tech 2, history DTCs can also be cleared after 40 consecutive driving cycles without a fault.

Tech 2 Scan Tool

Isuzu recommend using Tech 2. Refer to the Tech 2 Users Guide for proper start up procedures.

Operating Procedure

1. Press Enter at start screen.
2. Select Diagnostic > appropriate vehicle identification > Powertrain > 4JH1-TC.
3. The following table shows, which functions are used the available equipment versions.

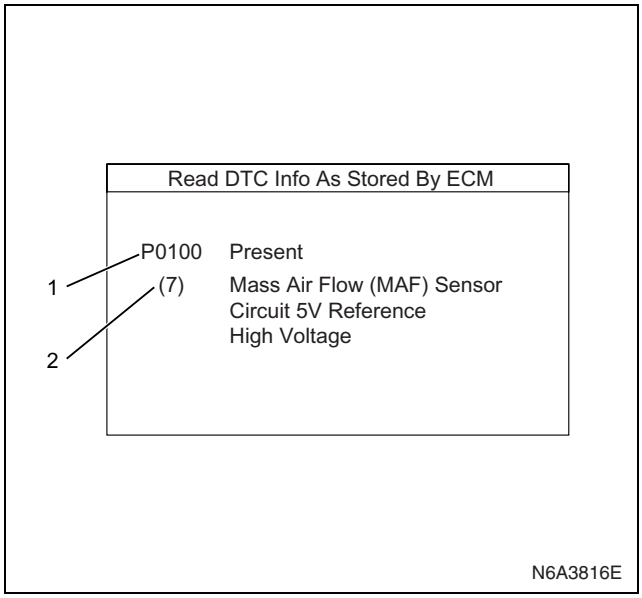


F0: Diagnostic Trouble Code

The purpose of this mode is to display stored trouble code in the ECM. When “Clear DTC Information” is selected, “Clear DTC Information”, warning screen appears. This screen informs you that by cleaning DTCs “all stored DTC information in the ECM will be erased”.

Symptom Code

Symptom Code is located under the DTC column. A parenthetic alphabet or number means identification of the malfunction. Each DTC includes individual symptoms, such as DTC P0100 has four symptom codes (7), (9), (B) and (C). DTC chart is separated depending on this symptom code.



Legend

1. Diagnostic Trouble Code (DTC)
2. Symptom Code

F1: Data Display

The purpose of this mode is to continuously monitor data parameters. The current actual values of all important sensors and signals in the system are display through this mode. Refer to the Tech 2 Data List in this section.

F2: Snapshot

"Snapshot" allow you to focus on making the condition occur, rather than trying to view all of the data in anticipation of the fault. The snapshot will collect parameter information around a trigger point that you select. Refer to the Tech 2 user instructions for more information.

F3: Miscellaneous Test

The purpose of this mode is to check for correct operation of electronic system actuators. Using miscellaneous test menus can test the state of each actuator and related sensors. Especially when DTC cannot be detected, a faulty circuit can be diagnosed by testing. Even DTC has been detected, the circuit tests using these menus could help discriminate between a mechanical trouble and an electrical trouble. Refer to the Tech 2 Output Controls in this section.

F4: Programming

The purpose of this mode is to program the vehicle identification number (VIN) into the ECM and lock the programmed VIN. Refer to Engine Control Module (ECM) Replacement in this section.

Tech 2 Data List

The Tech 2 Data List contains all engine related parameters that are available on the Tech 2. Use the Tech 2 Data List only after the following is determined:

- The Diagnostic System Check – Engine Controls is completed.
- No diagnostic trouble codes (DTCs) are present.
- On-board diagnostics are functioning properly.

Tech 2 values from a properly running engine may be used for comparison with the engine you are diagnosing. The Tech 2 Data List represents values that would be seen on a normal running engine.

Important:
A Tech 2 that displays faulty data should not be used. The Tech 2 problem should be reported to the manufacturer. Use of a faulty Tech 2 can result in misdiagnosis and unnecessary parts replacement. Only the parameters listed below are referenced in this service manual for use in diagnosis.

Tech 2 Parameter	Units Displayed	Typical Data Value at Engine Idle	Typical Data Value at 2000 RPM
Operating Conditions: Engine Idling or 2000 RPM / Engine Coolant Temperature is between 75-85°C (167-185°F) / Accelerator Pedal is Constant / Park or Neutral / Accessories OFF / Vehicle Located at Sea Level			
Ignition Switch	On/Off	On	On
System Voltage	V	11.0 – 15.0	11.0 – 15.0
ECM Main Relay	On/Off	On	On
Engine Speed	RPM	650 – 750	1950 – 2050
Desired Idle Speed	RPM	700	700
Injection Pump Speed	RPM	325 – 375	975 – 1025
Accelerator Pedal Position	%	0.0	19.0 – 23.0
Idle Switch	On/Off	On	Off
Intake Air Temperature	°C/°F	20 – 40°C / 68 – 104°F	20 – 40°C / 68 – 104°F
Engine Coolant Temperature	°C/°F	75 – 85°C / 167 – 185°F	75 – 85°C / 167 – 185°F

Tech 2 Parameter	Units Displayed	Typical Data Value at Engine Idle	Typical Data Value at 2000 RPM
Fuel Temperature	°C/°F	20 – 60°C / 68 – 140°F	20 – 60°C / 68 – 140°F
Barometric Pressure	hPa	Nearly 1010 hPa at sea level	Nearly 1010 hPa at sea level
EGR Solenoid Command	%	Nearly 70%	Nearly 30%
Mass Air Flow Sensor	mg/strk	More than 480 mg/strk at sea level	More than 1200 mg/strk at sea level
Desired Mass Air Flow	mg/strk	More than 480 mg/strk at sea level	More than 1200 mg/strk at sea level
Actual Injection Quantity	mg/strk	7.0 – 10.0	8.0 – 12.0
Desired Injection Quantity	mg/strk	7.0 – 10.0	8.0 – 12.0
Actual Injection Timing	°CA	3.0 – 5.0	5.0 – 7.0
Desired Injection Timing	°CA	3.0 – 5.0	5.0 – 7.0
Neutral Switch	On/Off	On	On
Brake Pedal 1 Switch	Applied/ Released	Released	Released
Brake Pedal 2 Switch	Applied/ Released	Released	Released
Clutch Pedal Switch	Applied/ Released	Released	Released
Engine Warm Up Switch	On/Off	Off	Off
Exhaust Brake Switch	On/Off	Off	Off
Intake Throttle Solenoid Command	On/Off	Off	Off
Exhaust Brake Solenoid Command	On/Off	Off	Off
ABS Input Signal	On/Off	Off	Off
ABS Output Signal	On/Off	Off	Off
Vehicle Speed	km/h / MPH	0	0
Glow Relay Command	On/Off	Off	Off
Glow Indicator Lamp Command	On/Off	Off	Off
Malfunction Indicator Lamp (MIL) Command	On/Off	Off	Off
A/C Request Signal	On/Off	Off	Off
A/C Relay Command	On/Off	Off	Off

Tech 2 Data Definitions

A list of each message displayed on the Tech 2 will be explained in Engine Controls. This information will assist in emission or driveability problems. The displays can be viewed while the vehicle is being driven. Always perform the Diagnosis System Check – Engine Controls first. The Diagnostic System Check will confirm proper system operation.

Ignition Switch
This parameter displays the input status of the ignition switch to the ECM terminal (pin 39). The Tech 2 will display On or Off. On indicates the ignition switch is turned ON position.

System Voltage
This parameter displays the system voltage measured by the ECM terminal (pin 3) at the voltage feed from the ECM main relay.

ECM Main Relay
This parameter displays the commanded state of the ECM main relay control circuit (pin 58). The Tech 2 will display On or Off. On indicates the ECM main relay control circuit is being grounded by the ECM, allowing the main relay to supply voltage to the other circuits of the ECM. Off indicates the main relay is not being commanded On by the ECM.

Engine Speed
This parameter displays the speed of the crankshaft as calculated by the ECM based on input from the crankshaft position (CKP) sensor or camshaft position (CMP) sensor. The Tech 2 will display the engine speed in revolution per minute (RPM).

Desired Idle Speed
This parameter displays the idle speed requested by the ECM. The ECM will compensate for various engine loads based on engine coolant temperature (ECT) and A/C system status. If the A/C system is activated, the ECM sets 50 RPM higher than normal idle speed.

Injection Pump Speed
This parameter displays the speed of the injection pump as calculated by the fuel injection pump control unit (PCU) based on the input from the fuel injection pump camshaft position (CMP) sensor. The Tech 2 will display the injection pump speed in revolution per minute (RPM).

Accelerator Pedal Position
This parameter displays the angle of the accelerator pedal as calculated by the ECM using the signal from the accelerator pedal position (APP) sensor. The accelerator pedal position indicated angle is a range of values indicating a low percentage when the accelerator pedal is not depressed to a high percentage when the accelerator pedal is fully depressed.

Idle Switch
This parameter displays the input status of the idle switch to the ECM terminal (pin 69). The Tech will display On or Off. On indicates the accelerator pedal is not being pushed down. Off indicates the accelerator pedal is being depressed.

Intake Air Temperature
This parameter displays the temperature of the intake air based on a voltage input from the intake air temperature (IAT) sensor to the ECM. The Tech 2 will display a low temperature when signal voltage is high, and high temperature when the signal voltage is low. Note that the IAT sensor is internal to the mass air flow (MAF) sensor and the MAF sensor is heated.

Engine Coolant Temperature
This parameter displays the temperature of the engine coolant based on a voltage input from the engine coolant temperature (ECT) sensor to the ECM. The Tech 2 will display a low temperature when the signal voltage is high, and a high temperature when the signal voltage is low.

Fuel Temperature
This parameter displays the temperature of the fuel as calculated by the fuel injection pump control unit (PCU) using the signal from the fuel temperature sensor inside of the PCU.

Barometric Pressure
This parameter displays the barometric pressure as calculated by the ECM using the signal from the barometric pressure (BARO) sensor inside of the ECM.

EGR Solenoid Command
This parameter displays the EGR solenoid valve control duty ratio commanded by the ECM terminal (pin 97) using the signal from engine speed, and injection volume and various sensor inputs. When a small duty ratio, the EGR valve is controlled to close. When a large duty ratio, the EGR valve is controlled to open.

Mass Air Flow Sensor
This parameter displays the air flow into the engine as calculated by the ECM based on the mass air flow (MAF) sensor input. The Tech 2 will display a high value at higher engine speeds, and a low value at idle. This can be compared to the Desired Mass Air Flow to determine MAF sensor accuracy, EGR problem or intake problem. Note that the MAF on the Tech 2 will only update with the engine running.

Desired Mass Air Flow
This parameter displays a mass air flow desired by the ECM based on current driving condition.

Actual Injection Quantity
This parameter displays the injection quantity calculated by the PCU based on the fuel injection solenoid valve On time which compensated from the timing device position and fuel temperature inputs. This can be compared to the Desired Injection Quantity to determine fuel system problem.

Desired Injection Quantity
This parameter displays an injection quantity desired by the ECM based on current driving condition using target injection maps.

Actual Injection Timing
This parameter displays the injection timing calculated by the PCU based on the timing device position which determined from the crankshaft position sensor and camshaft position sensor inputs. This can be compared to the Desired Injection Timing to determine timing device problem or fuel system problem.

Desired Injection Timing
This parameter displays injection timing desired by the ECM based on current driving condition using target injection timing maps. This timing is compensated by engine coolant temperature, altitude and intake air temperature, etc.

Neutral Switch
This parameter displays the state of the neutral switch as determined by the ECM terminal (pin 87) based on an input from the neutral switch.

Brake Pedal 1 Switch
This parameter displays the state of the brake pedal as determined by the ECM terminal (pin 30) based on an input from the brake pedal 1 switch. This switch turns On the stop lamps when the brake pedal is depressed. The Tech 2 will display Applied when the brake pedal is depressed.

Brake Pedal 2 Switch
This parameter displays the state of the brake pedal 2 switch as determined by the ECM terminal (pin 65). The Tech 2 will display Released or Applied. Released indicates the brake pedal is not being pushed down. Applied indicates the brake switch is being depressed.

Clutch Pedal Switch
This parameter displays the state of the clutch pedal as determined by the ECM terminal (pin 31) based on an input from the clutch pedal switch. The Tech 2 will display Release or Applied. Release indicates the clutch pedal is not being push down. Applied indicates the clutch switch is being depressed.

Engine Warm Up Switch
This parameter displays the input status of the engine warm up switch to the ECM terminal (pin 46). The Tech 2 will display On or Off. On indicates the engine warm up switch is closing the engine quick warm up system request circuit to the ECM. Off indicates the engine warm up switch is open.

Exhaust Brake Switch
This parameter displays the input status of the exhaust brake switch to the ECM terminal (pin 64). The Tech 2 will display On or Off. On indicates the exhaust brake switch is closing the exhaust brake request circuit to the ECM and allowing to energize the intake throttle solenoid and exhaust brake solenoid depending on driving condition. Off indicates the exhaust brake switch is open and exhaust brake will not engage.

Intake Throttle Solenoid Command
This parameter displays the commanded state of the intake throttle solenoid valve control circuit (pin 95). The Tech 2 will display On or Off. On indicates the intake throttle solenoid valve circuit is being energized by the ECM. Off indicates the intake throttle solenoid valve is not being commanded On by the ECM.

Exhaust Brake Solenoid Command
This parameter displays the commanded state of the exhaust brake solenoid valve control circuit (pin 40). The Tech 2 will display On or Off. On indicates the exhaust brake solenoid valve circuit is being energized by the ECM. Off indicates the exhaust brake solenoid valve is not being commanded On by the ECM.

ABS Input Signal
This parameter displays the input status of the exhaust brake cut request from the EHCU (ABS unit) to the ECM terminal (pin 32). The Tech 2 will display On or Off. On indicates the EHCU is commanding to the ECM to release the exhaust brake. Off indicates the EHCU is not being commanded.

ABS Output Signal
This parameter displays a feedback (output) signal of exhaust brake cut request from the ECM terminal (pin 62) to the EHCU (ABS unit). On indicates the ECM is commanding to the EHCU to return a feedback signal. Off indicates the ECM is not being commanded.

Vehicle Speed
This parameter displays the vehicle speed calculated by the ECM based on an input from the vehicle speed sensor (VSS). The Tech 2 will display a high value at higher vehicle speeds, and low value at lower vehicle speeds.

Glow Relay Command
This parameter displays the commanded state of the glow plug relay control circuit (pin 94). The Tech 2 will display On or Off. On indicates the glow plug relay control circuit is being grounded by the ECM, allowing voltage to the glow plugs. Off indicates the glow plug relay is not being commanded On by the ECM.

Glow Indicator Lamp Command
This parameter displays the commanded state of the glow indicator lamp control circuit (pin 43). The glow indicator lamp should be On when the Tech 2 indicates On. The glow indicator should be Off when the Tech 2 indicates Off.

Malfunction Indicator Lamp (MIL) Command
This parameter displays the commanded state of the malfunction indicator lamp (MIL) control circuit (pin 42). The MIL should be On when the Tech 2 indicates On. The MIL should be Off when the Tech 2 indicates Off. The ECM will command the MIL On for a certain length of time when the ignition is On with the engine Off in order to perform a bulb check.

A/C Request Signal
This parameter displays the state of the air conditioning (A/C) request input to the ECM terminal (pin 33) from the heating, ventilation, and air conditioning (HVAC) controls. The Tech 2 will display On or Off. On indicates the ECM is receiving a request from the HVAC system to ground the A/C compressor relay control circuit, engaging the A/C compressor clutch. Off indicates the ECM is not receiving a request from the HVAC system.

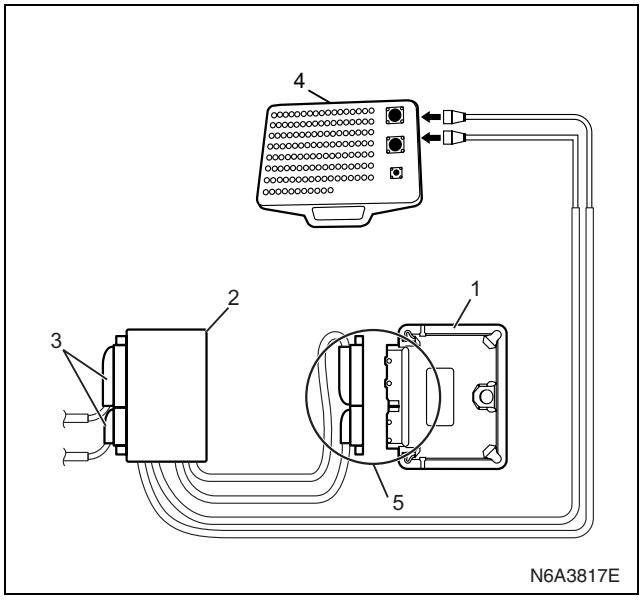
A/C Relay Command
This parameter displays the commanded state of the A/C compressor relay control circuit (pin 41). The Tech 2 will display On or Off. On indicates the A/C compressor relay control circuit is being grounded by the ECM, allowing voltage to the A/C compressor clutch. Off indicates the A/C compressor relay is not being commanded On by the ECM.

Tech 2 Output Controls

Tech 2 Output Control	Additional Menu Selection(s)	Descriptions
EGR Solenoid Valve	Solenoids	The purpose of this test is for checking whether the EGR valve is correctly moved with command. Restricted valve movement by foreign materials, excessive deposits, a faulty vacuum hose routing, a faulty EGR valve or a faulty EGR solenoid could be considered if the mass air flow (MAF) sensor is not changed when commanded ON or OFF.
Engine Speed (RPM) Control	—	The purpose of this test is for checking whether the actual engine idle speed can change to match the commanded RPM.
Glow Indicator	Lamps	The purpose of this test is for checking whether the glow indicator lamp is operating when commanded ON. Faulty circuit(s) or an open bulb could be considered if not operating when commanded ON.
Glow Relay	Relays	The purpose of this test is for checking whether the glow relay is operating when commanded ON. Faulty circuit(s) or a faulty glow relay could be considered if not energizing when commanded ON.
Malfunction Indicator Lamp	Lamps	The purpose of this test is for checking whether the malfunction indicator lamp (MIL) is operating when commanded ON. Faulty circuit(s) or an open bulb could be considered if not operating when commanded ON.

Breaker Box

Breaker Box Connection Type A

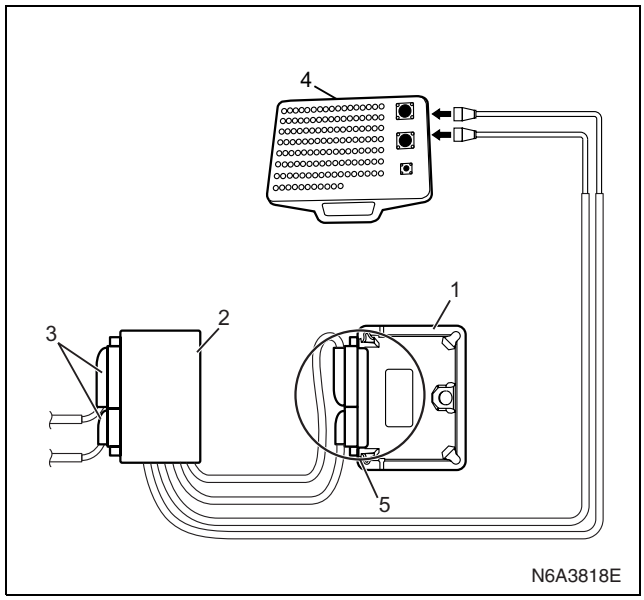


Legend

1. Engine Control Module (ECM)
2. Harness Adapter
3. ECM – Harness Connector
4. Breaker Box
5. ECM disconnected

Although probe to the engine control module (ECM) harness connector is possible by Test Adapter, Breaker Box Connection Type A is suitable usage to prevent misprobe and damage of female terminals when test open circuit or short to ground between the ECM and electrical components, since the terminals where the harness connector of the ECM is thin have gathered.

Breaker Box Connection Type B



Legend

1. Engine Control Module (ECM)
2. Harness Adapter
3. ECM – Harness Connector
4. Breaker Box
5. ECM connected

The ECM and other connectors have water proof terminal that is not allowed to back probe. Breaker Box Connection Type B is suitable usage to test short to voltage circuit or signal check between the ECM and electrical components.

Engine Control System Check Sheet

ENGINE CONTROL SYSTEM CHECK SHEET		Inspectors Name	
Customer's Name		Model & Model Year	
Driver's Name		Chassis No.	
Date Vehicle Brought In		Engine No.	
License No.		Odometer Reading	Km/miles

Problem Symptoms	☐ Engine Does Not Run	☐ Engine does not crank ☐ No initial combustion ☐ No complete combustion
	☐ Hard Start	☐ Engine cranks slowly ☐ Other ( )
	☐ Incorrect Idle	☐ Abnormal idling speed ☐ High idling speed (RPM) ☐ Low idling speed (RPM) ☐ Rough idling ☐ Other ( )
	☐ Poor Driveability	☐ Hesitation, sag, stumble ☐ Surge, chuggles ☐ Cut out, misses ☐ Lack of power, sluggishness, sponginess ☐ Other ( )
	☐ Engine Stall	☐ Soon after starting ☐ After accelerator pedal depressed ☐ During A/C operation ☐ After accelerator pedal released ☐ Shifting from N to D ☐ Other ( )
	☐ Others	☐ Black smoke ☐ White smoke ☐ Poor fuel economy ☐ Fuel knock, combustion noise ☐ Other ( )

Dates problem occurred		
Problem frequency		☐ Constant ☐ Intermittently (times per day/month) ☐ Once only ☐ Other ( )
Condition When Problem Occurs	Weather	☐ Fine ☐ Cloudy ☐ Rainy ☐ Snow ☐ Various/Other ( )
	Outside Temperature	☐ Hot (approx.) ☐ Warm ☐ Cool ☐ Cold (approx.) ☐ Any temperature
	Place	☐ Highway ☐ Suburbs ☐ City area ☐ Uphill ☐ Downhill ☐ Rough road ☐ Other ( )
	Load Condition	☐ Over (approx. tons) ☐ No load ☐ Other (approx. tons)
	Engine Temperature	☐ Cold ☐ Warming up ☐ After warming up ☐ Any temperature ☐ Other ( )
	Engine Operation	☐ Starting ☐ Just after starting (Min.) ☐ Idling ☐ Racing ☐ Driving ☐ Constant speed ☐ Acceleration ☐ Deceleration ☐ A/C switch On/Off ☐ Other ( )
	Fuel Amount	☐ Full ☐ Above 1/2 ☐ Below 1/2 ☐ Near empty
	Fuel Bland	

Condition of MIL		☐ Remains On ☐ Intermittently turns On ☐ Does not turn On	
Diagnostic Trouble Code (DTC) or Flash Code	Present Code	☐ Nothing	☐ P Code & Symptom Code No. ( )
	History Code	☐ Nothing	☐ P Code & Symptom Code No. ( )
Other Additional Condition			

N6A3819E

Diagnostic Starting Point – Engine Controls

Begin the system diagnosis with Diagnostic System Check – Engine Controls. The Diagnostic System Check – Engine Controls will provide the following information:

- The identification of the control modules which command the system.
- The ability of the control modules to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTCs) and their statuses.

The use of the Diagnostic System Check – Engine Controls will identify the correct procedure for diagnosing the system and where the procedure is located.

Important:
Engine Control System Check Sheet must be used to verify the customer complaint, you need to know the correct (normal) operating behavior of the system and verify that the customer complaint is a valid failure of the system.

Diagnostic System Check – Engine Controls

Description

The Diagnostic System Check – Engine Controls is an organized approach to identifying a condition that is created by a malfunction in the electronic engine control system. The Diagnostic System Check must be the starting point for any driveability concern. The Diagnostic System Check directs the service technician to the next logical step in order to diagnose the concern. Understanding and correctly using the diagnostic table reduces diagnostic time, and prevents the replacement of good parts.

Test Description

The numbers below refer to the step numbers on the diagnostic table.
2. Lack of communication may be because of a partial or a total malfunction of the Keyword 2000 serial data circuit. The specified procedure determines the particular condition.
11. If there are other modules with DTCs set, refer to the DTC list. The DTC list directs you to the appropriate diagnostic procedure. If the control module stores multiple DTCs, diagnose the DTCs in the following order.

- Component level DTCs, such as sensor DTCs, solenoid DTCs, actuator DTCs, and relay DTCs. Diagnose the multiple DTCs within this category in numerical order. Begin with the lowest numbered DTC, unless the diagnostic table directs you otherwise.

Diagnostic System Check – Engine Controls

Important:

- DO NOT perform this diagnostic if there is not a driveability concern, unless another procedure directs you to this diagnostic.
- Before you proceed with diagnosis, search for applicable service bulletins.
- Unless a diagnostic procedure instructs you, DO NOT clear the DTCs.
- If there is a condition with the starting system, refer to the starting system section in the engine mechanical.
- Ensure the battery has a full charge.
- Ensure the battery cables (+) (-) are clean and tight.
- Ensure the ECM grounds are clean, tight, and in the correct location.
- Ensure the ECM harness connectors are clean and correctly connected.
- Ensure the ECM terminals are clean and correctly mating.
- Ensure the fuel injection pump control unit (PCU) ground is clean, tight, and in the correct location.
- Ensure the PCU harness connectors are clean and correctly connected.
- Ensure the PCU terminals are clean and correctly mating.
- Ensure the vehicle maintenance has been done enough.

Step	Action	Value(s)	Yes	No
1	Install the Tech 2. Does the Tech 2 turn ON?	—	Go to Step 2	Go to Tech 2 Does Not Power Up
2	1. Turn ON the ignition, with the engine OFF. 2. Attempt to establish communication with the engine control module (ECM). Does the Tech 2 communicate with the ECM?	—	Go to Step 3	Go to Lost Communication with The Engine Control Module (ECM)

Step	Action	Value(s)	Yes	No
3	Attempt to start the engine. Does the engine start and idle?	—	Go to Step 4	Go to Engine Cranks but Does Not Run
4	Select the DTC display function of the ECM. Does the Tech 2 display any DTCs?	—	Go to Step 5	Go to Step 12
5	1. Turn OFF the ignition for 30 seconds. 2. Start the engine. 3. Monitor the DTC Information with the Tech 2. Did you complete the action?	—	Go to Step 6	—
6	Does the Tech 2 display ECM DTC P0602?	—	Go to Applicable DTC	Go to Step 7
7	Does the Tech 2 display ECM DTC P0251 (Symptom Code 9 or A), P0606 (Symptom Code A or B) or P1605 (Symptom Code C, D or E)?	—	Go to Applicable DTC	Go to Step 8
8	Does the Tech 2 display ECM DTC P0560 (Symptom Code 1, 2 or A)?	—	Go to Applicable DTC	Go to Step 9
9	Does the Tech 2 display ECM DTC P0561 (Symptom Code A or B) or P1625 (Symptom Code A or B)?	—	Go to Applicable DTC	Go to Step 10
10	Does the Tech 2 display ECM DTC P1650 (Symptom Code A or B) or P1651 (Symptom Code A or B)?	—	Go to Applicable DTC	Go to Step 11
11	Is there any other code in any controller that has not been diagnosed?	—	Go to Applicable DTC	Go to Step 12
12	1. Review the following symptoms. 2. Refer to the applicable symptom diagnostic table: • Hard Start • Rough, Unstable, or Incorrect Idle and Stalling • Cuts Out, Misses • Surge/Chuggles • Lack of Power, Sluggishness, or Sponginess • Hesitation, Sag, Stumble • Fuel Knock/Combustion Noise • Poor Fuel Economy • Excessive Smoke (Black Smoke) • Excessive Smoke (White Smoke) Did you find and correct the condition?	—	System OK	Go to Intermittent Conditions

Tech 2 Does Not Power Up

Circuit Description

The data link connector (DLC) is a standardized 16–cavity connector. Connector design and location is dictated by an industry wide standard, and is required to provide the following:

- Tech 2 power battery positive voltage at terminal 16.
- Tech 2 power ground at terminal 4.
- Common signal ground at terminal 5.

The Tech 2 will power up with the ignition OFF. Some modules however, will not communicate unless the ignition is ON.

Tech 2 Does Not Power Up

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views

Step	Action	Value(s)	Yes	No
1	**Important:** Make sure the Tech 2 works properly on another vehicle before using this chart. 1. Turn OFF the ignition. 2. Inspect the ENG(B1)(B2) (15A) fuse (F-8 & F-9) in the glove box fuse block. Is the ENG(B1)(B2) (15A) fuse (F-8 & F-9) open?	—	Go to Step 2	Go to Step 3
2	Replace the ENG(B1)(B2) (15A) fuse (F-8 & F-9). If the fuse continues to open, repair the short to ground on one of the circuits that is fed by the ENG(B1)(B2) (15A) fuse (F-8 & F-9) or replace the shorted attached component fed by the ENG(B1)(B2) (15A) fuse (F-8 & F-9). Did you complete the repair?	—	Go to Step 7	—
3	1. Check each circuit at the data link connector (DLC) (B-79 connector) for a backed out, spread or missing terminal. 2. Repair the terminal as necessary. Did you find and complete the repair?	—	Go to Step 7	Go to Step 4
4	Connect a test lamp between the B+ circuit (pin 16 of B-79 connector) at the DLC and a known ground. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 5
5	Repair the open in the battery voltage circuit to the DLC. Did you complete the repair?	—	Go to Step 7	—
6	1. Test each ground circuit at the DLC (pins 4 and 5 of B-79 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Intermittent Conditions
7	1. Connect the Tech 2 to the DLC. 2. Attempt to turn ON the Tech 2. Does the Tech 2 ON?	—	System OK	Go to Step 1

Lost Communication with The Engine Control Module (ECM)

Circuit Description

The engine control module (ECM) communicates with the Tech 2 over the Keyword 2000 serial data link. However, the ECM and fuel injection pump control unit (PCU) communicates with each other over the controller area network (CAN) link. The CAN link is not used for communication with the Tech 2 and is shared only between the ECM and PCU.

Diagnostic Aids

The following conditions will cause a loss of Keyword 2000 serial data communication between the Tech 2 and any control module:

- A Keyword 2000 serial data circuit open.
- A Keyword 2000 serial data circuit shorted to ground.
- A Keyword 2000 serial data circuit shorted to voltage.
- An internal condition within a module or connector on the Keyword 2000 serial data circuit, that causes a short to voltage or ground to the Keyword 2000 serial data circuit.
- Open ground circuit (pin 5) at the DLC.

Lost Communication with The Engine Control Module (ECM)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	Attempt to establish engine control module (ECM) communications with the Tech 2. Does the ECM communicate with the Tech 2?	—	Go to Step 3	Go to Step 4
3	Test the Keyword 2000 serial data circuit for an intermittently short to ground or intermittently short to voltage. Did you find and correct the condition?	—	Go to Step 17	System OK
4	Check the ECM B-234 and B-233 connectors for poor connections. Did you find and correct the condition?	—	Go to Step 17	Go to Step 5
5	1. Turn ON the ignition, with the engine OFF. 2. Check the Main (100A) (SBF-1), Key (50A) (SBF-2) and ENG(B1)(B2) (15A) fuse (F-8 & F-9). Replace and retest if open. If any fuse continues to open, check for a short to ground on each circuit fed by that fuse. 3. Turn OFF the ignition. 4. Disconnect the ECM B-234 harness connector. 5. Turn ON the ignition, with the engine OFF. 6. Connect a test lamp to ground and check for voltage at the ignition voltage supply circuit at the ECM (pin 39 of B-234 connector). Does the test lamp illuminate?	—	Go to Step 6	Go to Step 14
6	Test the data link connector (DLC) ground circuit at terminal 5 for an open circuit or poor connection. Did you find and correct the condition?	—	Go to Step 17	Go to Step 7
7	Test the Keyword 2000 serial data circuit between the ECM (pin 35 of B-234 connector) and the DLC (pin 7 of B-79 connector) for a short to ground or voltage. Did you find and correct the condition?	—	Go to Step 17	Go to Step 8

Step	Action	Value(s)	Yes	No
8	**Important:** An open in a ground circuit at the ECM will not cause a loss of communication. 1. Check ECM ground for corrosion and tightness. 2. Clean or tighten grounds as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 9
9	1. Turn OFF the ignition. 2. Reconnect the ECM harness connector if previously disconnected. 3. Turn ON the ignition, with the engine OFF. 4. Replace the ECM main relay with the horn relay or replace with a known good relay. 5. Attempt to establish Tech 2 communications with the ECM. Does the ECM communicate with the Tech 2?	—	Go to Step 15	Go to Step 10
10	1. Turn OFF the ignition. 2. Remove the ECM main relay. 3. Turn ON the ignition, with the engine OFF. 4. Using a test lamp, check for battery voltage at both of the battery voltage supply circuits to the ECM main relay (pins 1 and 2 of X-14 connector). 5. Repair the open in the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 11
11	1. Reinstall the ECM main relay. 2. Turn the ignition ON and OFF while listening or feeling for the ECM main relay click. Wait 2 seconds between transitions. Does the ECM main relay click when the ignition is turned ON or OFF?	—	Go to Step 13	Go to Step 12
12	Repair the ECM main relay control circuit between the ECM main relay (pin 4 of X-14 connector) and the ECM (pin 58 of B-234 connector) for the following conditions: • An open circuit • A short to battery or ignition voltage • High resistance or a poor connection at both the ECM and ECM main relay Did you find and correct the condition?	—	Go to Step 17	Go to Step 16
13	1. Check ECM main relay voltage supply circuit to the ECM between the ECM main relay (pin 5 of X-14 connector) and the ECM (pin 3 of B-234 connector) for the following conditions: • An open circuit • High resistance or a poor connection at the ECM and ECM main relay 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 16
14	Repair the open in the ignition voltage circuit to the ECM. Did you complete the repair?	—	Go to Step 17	—

Step	Action	Value(s)	Yes	No
15	Replace the ECM main relay. Did you complete the replacement?	—	Go to Step 17	—
16	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 17	—
17	1. Turn OFF the ignition. 2. Reconnect all disconnected connectors. 3. Turn ON the ignition, with the engine OFF. 4. Attempt to establish Tech 2 communications with the ECM. Does the Tech 2 communicate with the ECM?	—	System OK	Go to Step 3

Engine Cranks but Does Not Run

Description

The Engine Cranks but Does Not Run diagnostic table is an organized approach to identifying a condition that causes an engine to not start. The diagnostic table directs the service technician to the appropriate system diagnosis. The diagnostic table assumes the following conditions are met:

- The battery is completely charged and terminals are cleaned and tight.
- The engine cranking speed is normal.
- There is adequate fuel in the fuel tank.
- There is no fuel leak in the fuel line.
- There is no air in the fuel line.
- Filters (Air, Fuel) are clean.
- Fuse and slow blow fuse are normal.

Diagnostic Aids

If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Engine Cranks but Does Not Run

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Crank the engine for specified amount of time. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the Tech 2 display any DTCs that failed this ignition?	15 seconds	Go to Diagnostic Trouble Code (DTC) List	Go to Step 3
3	1. Check for normal readings at key up for the following inputs and output: Refer to the Tech 2 Data List or a known good vehicle to determine normal values. • System Voltage • Engine Coolant Temperature (ECT) • Intake Air Temperature (IAT) • Mass Air Flow (MAF) Sensor • Barometric Pressure 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Inspect the high pressure side between the fuel injection pump and the fuel injection nozzles for fuel leakage. The following components may contain an external leak. • Fuel injection pump • Fuel injection pump control unit (PCU) • Fuel injection solenoid valve • Timing control valve (TCV) • Constant pressure valve (CPV) • Fuel pipe between the fuel injection pump and fuel injection nozzles • Each fuel pipe sleeve nuts • Each fuel pipe connectors • Each gaskets **Notice:** Fuel may leak into the engine from the fuel injection pump. In such case, the engine oil level will rise. Inspect for fuel leakage into the engine oil. 2. Repair any fuel system leaks as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 5
5	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. 3. Pump the priming pump on the fuel filter until it becomes firm. If there is a leak on the suction side of the fuel system between the priming pump and the fuel injection pump, the priming pump will not build up sufficient firmness and fuel leakage may occur. 4. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 6
6	1. Remove the fuel hose that connects to the fuel injection pump suction side. 2. Remove the fuel pipe connector that connects to the fuel injection pump suction side. 3. Inspect the eye bolt for any type of restriction or collapsed gauze filter. **Notice:** If any type of restriction found, check for a condition that causes contaminated fuel, such as the customer is using an aftermarket fuel filter or extended maintenance interval. Also inspect fuel waxing or icing that is caused by an incorrect fuel type used in winter season or water intrusion in the fuel system. 4. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Disconnect the fuel hose that connects to the fuel injection pump suction side. In order to measure the discharged fuel amount, put the hose into a bottle or a container. 2. Pump the priming pump on the fuel filter. **Notice:** If there is a leak on the suction side of the fuel system, the fuel from the disconnected hose will not flow out sufficiently and fuel leakage may occur. Also if there is a restriction on the suction side of the fuel system, the fuel from the disconnected hose will not flow out sufficiently that is most likely caused by clogged fuel filter or kinked fuel hose or pipe. 3. Draw fuel from the fuel tank at the fuel line (as close to the fuel tank as possible) going to the fuel pickup tube to verify a clean stream of fuel comes out (use the hand-held vacuum pump 5-8840-0279-0/J-23738-A with a clear hose or equivalent). This will ensure the fuel pickup tube is not cracked drawing air into the fuel line. 4. Repair any fuel system leaks and restrictions as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
8	1. Other possible causes for the no-start condition: • Fuel injection pump mechanical timing incorrect • Flywheel installed incorrectly causing the crankshaft position (CKP) sensor to be incorrectly timed to the engine. Disconnect sensor and attempt to start engine to verify. • Heavily restricted intake, exhaust or catalytic converter plugged solid • Poor engine compression • Water or gasoline contamination in fuel 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 9
9	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. Did you complete the replacement?	—	Go to Step 10	—
10	1. Reconnect all previously disconnected harness connector(s). 2. Turn OFF the ignition for 30 seconds. 3. Attempt to start the engine. Does the engine start and continue to run?	—	Go to Step 11	Go to Step 2
11	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

Diagnostic Trouble Code (DTC) List

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0100 (7)	65	ON	Mass Air Flow (MAF) Sensor Circuit 5V Reference High Voltage	• The ignition switch is ON.	• The ECM detects that the MAF sensor 5 volts reference circuit voltage is more than 5.2 volts for 0.5 seconds.	• Sensor 5V reference circuit is short to battery or ignition voltage. • Sensor 5V reference circuit is short to the sensor ignition voltage circuit. • Faulty MAF sensor. • Faulty ECM.
P0100 (9)	65	ON	Mass Air Flow (MAF) Sensor Voltage 5V Reference Circuit Low Voltage	• The ignition switch is ON.	• The ECM detects that the MAF sensor 5 volts reference circuit voltage is less than 4.6 volts for 0.5 seconds.	• Sensor 5V reference circuit is short to ground. • Sensor 5V reference circuit is short to the low reference circuit. • Faulty MAF sensor. • Faulty ECM.
P0100 (B)	65	ON	Mass Air Flow (MAF) Sensor Circuit Low Voltage	• The ignition switch is ON. • The engine is running.	• The ECM calculated MAF is lower than -18.6 kg/h for 5 seconds.	• Sensor ignition voltage feed circuit is open circuit or high resistance. • Sensor 5V reference circuit is open circuit, high resistance, short to ground or short to the low reference circuit. • Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. • Poor harness connector connection. • Faulty MAF sensor installation. • Faulty MAF sensor. • Faulty ECM.
P0100 (C)	65	ON	Mass Air Flow (MAF) Sensor Circuit High Voltage	• The ignition switch is ON. • The engine is running.	• The ECM calculated MAF is higher than 806 kg/h for 10 seconds.	• Sensor signal circuit is short to any 5V reference circuit, short to battery or ignition voltage circuit. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty MAF sensor. • Faulty ECM.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0110 (1)	23	ON	Intake Air Temperature (IAT) Sensor Circuit High Voltage	• The ignition switch is ON.	• The ECM detects that the IAT sensor signal voltage is more than 4.7 volts for 3 seconds.	• Sensor signal circuit is open circuit, high resistance, short to any 5V reference circuit, short to battery or ignition voltage. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty IAT sensor. • Faulty ECM.
P0110 (2)	23	ON	Intake Air Temperature (IAT) Sensor Circuit Low Voltage	• The ignition switch is ON.	• The ECM detects that the IAT sensor signal voltage is less than 0.3 volts for 3 seconds.	• Sensor signal circuit is short to ground or short to the low reference circuit. • Faulty IAT sensor. • Faulty ECM.
P0115 (1)	14	ON	Engine Coolant Temperature (ECT) Sensor Circuit High Voltage	• The ignition switch is ON.	• The ECM detects that the ECT sensor signal voltage is more than 4.7 volts for 3 seconds.	• Sensor signal circuit is open circuit, high resistance, short to any 5V reference circuit, short to battery or ignition voltage. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty ECT sensor. • Faulty ECM.
P0115 (2)	14	ON	Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage	• The ignition switch is ON.	• The ECM detects that the ECT sensor signal voltage is less than 0.3 volts for 3 seconds.	• Sensor signal circuit is short to ground or short to the low reference circuit. • Faulty ECT sensor. • Faulty ECM.
P0180 (B)	15	ON	Fuel Temperature Sensor Circuit	• The ignition switch is ON.	• The PCU internal FT sensor output is lower than -40°C (-40°F) for 3 seconds or higher than 150°C (302°F) for 3 seconds.	• Faulty PCU.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0215 (A)	52	ON at next ignition cycle	Engine Shutoff (ESO) Solenoid Control Circuit	• The ignition switch is OFF. • The engine speed is lower than 1500 RPM. • The vehicle speed is lower than 1.5 km/h (1 MPH).	• After the condition for running the DTC for 2 seconds, the engine speed is higher than 200 RPM when the ESO solenoid valve is commanded shutoff from the PCU.	• Faulty fuel injection pump.
P0215 (B)	52	ON	Engine Shutoff (ESO) Solenoid Control Circuit	• The ignition switch is ON.	• The PCU detects high voltage condition on the ESO solenoid valve control circuit for longer than 1 second when the ECM does not command shutoff.	• ESO solenoid valve control circuit is short to battery or ignition voltage. • Faulty PCU. • Faulty ECM.
P0215 (C)	52	ON	Engine Shutoff (ESO) Solenoid Control Circuit	• The ignition switch is OFF. • The engine speed is lower than 1500 RPM. • The vehicle speed is lower than 1.5 km/h (1 MPH).	• The engine speed is higher than 200 RPM within 2 seconds after the condition for running the DTC are met.	• ESO solenoid valve control circuit is open circuit, high resistance or short to ground. • Faulty PCU. • Faulty ECM.
P0215 (D)	52	ON	Engine Shutoff (ESO) Solenoid Control Circuit	• The ignition switch is OFF.	• The ECM detects internal CAN controller does not Bus OFF mode.	• Faulty ECM.
P0216 (A)	54	ON	Injection Timing Control Circuit	• The engine speed is higher than 700 RPM. • The fuel injection quantity is higher than 4 mg/strk.	• The PCU monitored actual fuel injection timing is advanced more than desired by 3°CA for longer than 12 seconds or retarded more than desired by 6°CA for longer than 12 seconds.	• Excessive air in the fuel system. • Loss fuel. • Fuel suction side looseness, kinks or blocked. • Faulty or clogged fuel filter. • Contaminated fuel. • Faulty timing device. • Faulty fuel injection pump CMP sensor.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0216 (B)	54	ON	Injection Timing Control Circuit	• The engine speed is higher than 2014 RPM.	• The PCU monitored actual fuel injection timing is oscillated higher than desired by 5.2°CA.	• Excessive air in the fuel system. • Loss fuel. • Fuel suction side looseness, kinks or blocked. • Faulty or clogged fuel filter. • Contaminated fuel. • Faulty timing device. • Faulty fuel injection pump CMP sensor.
P0251 (6)	53	ON	Injection Pump Fuel Metering Control	• The fuel injection pump CMP sensor signal is generated. • The CAN communication between the ECM and PCU is normal.	• The PCU detects that the fuel injection solenoid valve is operated when the desired fuel injection quantity is commanded 0 mg/strk.	• Faulty fuel injection pump. • Faulty PCU.
P0251 (7)	53	ON	Injection Pump Fuel Metering Control	• The fuel injection pump CMP sensor signal is generated. • The CKP sensor signal is generated. • The engine speed is higher than 500 RPM.	• The PCU detects that the doubled fuel injection pump speed is lower than engine speed by 800 RPM for longer than 0.2 seconds.	• Faulty CKP sensor signal. • Faulty fuel injection pump CMP sensor signal. • Electrical interference. • Magnetic interference. • Faulty PCU.
P0251 (9)	53	ON	Injection Pump Fuel Metering Control	• The ignition switch is ON.	• The PCU detects internal fuel injection pump control maps are not programmed during self-test.	• Faulty PCU.
P0251 (A)	53	ON	Injection Pump Fuel Metering Control	• The ignition switch is ON.	• The PCU detects internal EEPROM or A/D converter is failed during self-test.	• Faulty PCU.
P0251 (B)	53	ON	Injection Pump Fuel Metering Control	• The ignition switch is ON.	• The PCU detects that the fuel injection solenoid valve drive circuit is failed during self-test.	• Faulty fuel injection pump. • Faulty PCU.
P0251 (D)	53	ON	Injection Pump Fuel Metering Control	• The ignition switch is ON.	• The PCU detects that the fuel injection solenoid valve drive circuit voltage level is abnormal during self-test.	• Faulty fuel injection pump. • Faulty PCU.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0251 (E)	53	ON	Injection Pump Fuel Metering Control	• The ignition switch is ON.	• The ECM detects communication message from the PCU is not received for longer than 1 second.	• CAN high circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage. • CAN low circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage. • Electrical interference. • Magnetic interference. • Faulty PCU. • Faulty ECM.
P0335 (B)	43	ON	Crankshaft Position (CKP) Sensor Circuit	• The ignition switch is ON. • The engine speed is higher than 665 RPM.	• The ECM detects extra or missing CKP sensor signals while engine is running.	• Sensor signal circuit is open circuit, high resistance, short to ground, short to battery or short to ignition voltage. • Sensor low reference circuit is open circuit, high resistance, short to ground, short to battery or short to ignition voltage. • Sensor shield ground is open circuit, high resistance, short to ground, short to battery or short to ignition voltage. • Faulty CKP sensor. • Faulty ECM. • Electrical interference. • Magnetic interference. • Faulty sensor installation. • Faulty flywheel circumference.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0335 (D)	43	ON	Crankshaft Position (CKP) Sensor Circuit	• DTC P0335 (Symptom Code B) is not set. • The ignition switch is ON. • The fuel injection pump CMP sensor signal is generated. • The CAN communication between the ECM and PCU is normal.	• The ECM detects that the CKP sensor signals are not generated when doubled fuel injection pump rotation speed is higher than 50 RPM.	• Sensor signal circuit is open circuit, high resistance, short to ground, short to battery or short to ignition voltage. • Sensor low reference circuit is open circuit, high resistance, short to ground, short to battery or short to ignition voltage. • Sensor shield ground is open circuit, high resistance, short to ground, short to battery or short to ignition voltage. • Faulty CKP sensor. • Faulty ECM. • Electrical interference. • Magnetic interference. • Faulty sensor installation. • Faulty flywheel circumference.
P0335 (E)	43	ON	Crankshaft Position (CKP) Sensor Circuit	• The ignition switch is ON.	• The ECM detects that the engine speed is higher than 5700 RPM for 0.2 seconds.	• Engine overrun. • Faulty CKP sensor. • Faulty ECM. • Electrical interference. • Magnetic interference. • Faulty flywheel circumference.
P0380 (4)	66	ON	Glow Plug Relay Control Circuit Low Voltage	• The ignition switch is ON.	• The ECM detects that the low voltage condition on the glow relay control circuit for longer than 3 seconds when the relay is commanded OFF.	• Glow relay ignition voltage feed circuit on coil side is open circuit or high resistance. • Glow relay control circuit is open circuit, high resistance or short to ground. • Glow relay is poor installation. • Faulty glow relay. • Faulty ECM.
P0380 (8)	66	ON	Glow Plug Relay Control Circuit High Voltage	• The ignition switch is ON.	• The ECM detect that the high voltage condition on the glow relay control circuit for longer than 1 second when the relay is commanded ON.	• Glow relay control circuit is short to battery or ignition voltage circuit. • Faulty glow relay. • Faulty ECM.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0381 (4)	67	ON	Glow Plug Indicator Circuit Low Voltage	• The ignition switch is ON.	• The ECM detects that the low voltage condition on the glow indicator lamp control circuit for longer than 3 seconds when the indicator lamp is commanded OFF.	• Meter (10A) fuse (F-16) open. • Glow indicator lamp ignition voltage feed circuit is open circuit or high resistance. • Glow indicator lamp control circuit is open circuit, high resistance or short to ground. • Poor harness connector connection. • Glow indicator lamp bulb burned out. • Faulty instrument panel cluster (meter assembly). • Faulty ECM.
P0381 (8)	67	ON	Glow Plug Indicator Circuit High Voltage	• The ignition switch is ON.	• The ECM detects that the high voltage condition on the glow indicator lamp control circuit for longer than 1 second when the indicator lamp is commanded ON.	• Glow indicator lamp control circuit is short to battery or ignition voltage circuit. • Faulty instrument panel cluster (meter assembly). • Faulty ECM.
P0400 (3)	32	ON	Exhaust Gas Recirculation (EGR) System Performance	• The ignition switch is ON. • The engine is running. • The BARO is between 880 hPa and 1100 hPa. • The IAT is between 16°C (61°F) and 34°C (93°F). • The ECT is between 70°C (158°F) and 100°C (212°F).	• The ECM detects that the MAF amount is 150 mg/strk lower than the desired MAF for 60 seconds.	• MAF sensor circuits are high resistance. • MAF sensor signal circuit is short to IAT sensor signal circuit. • Intake air leakage. • Intake duct disconnected. • Intake system is obstructed. • Faulty turbocharger. • Faulty exhaust system. • Faulty EGR valve vacuum control system. • Faulty EGR valve. • Faulty EGR solenoid valve. • Faulty EGR solenoid valve vacuum hose routing. • Faulty MAF sensor.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0400 (4)	32	ON	Exhaust Gas Recirculation (EGR) Solenoid Circuit Low Voltage	• The ignition switch is ON.	• The ECM detects that the low voltage condition on the EGR solenoid valve control circuit for longer than 3 seconds when the solenoid valve is commanded OFF.	• EGR solenoid valve ignition voltage feed circuit is open circuit or high resistance. • EGR solenoid valve control circuit is open circuit, high resistance or short to ground. • Poor harness connector connection. • Faulty EGR solenoid valve. • Faulty ECM.
P0400 (5)	32	ON	Exhaust Gas Recirculation (EGR) System Performance	• The ignition switch is ON. • The engine is running. • The BARO is between 880 hPa and 1100 hPa. • The IAT is between 16°C (61°F) and 34°C (93°F). • The ECT is between 70°C (158°F) and 100°C (212°F).	• The ECM detects that the MAF amount is 150 mg/strk higher than the desired MAF for 60 seconds.	• MAF sensor low reference circuit is high resistance. • Faulty EGR valve vacuum control system. • Faulty EGR valve. • Faulty vacuum pump. • Faulty EGR solenoid valve. • Faulty EGR solenoid valve vacuum hose routing. • Faulty MAF sensor. • Faulty ECM.
P0400 (8)	32	ON	Exhaust Gas Recirculation (EGR) Solenoid Circuit High Voltage	• The ignition switch is ON.	• The ECM detects that the high voltage condition on the EGR solenoid valve control circuit for longer than 3 seconds when the solenoid valve is commanded ON.	• EGR solenoid valve control circuit is short to battery or ignition voltage circuit. • Faulty EGR solenoid valve. • Faulty ECM.
P0500 (1)	24	OFF	Vehicle Speed Sensor (VSS) Circuit	• The ignition switch is ON.	• The ECM detects that the vehicle speed is higher than 190 km/h (119 MPH) for 5 seconds.	• Vehicle speed too high. • Electrical interference. • Magnetic interference. • Faulty VSS. • Faulty ECM.
P0500 (A)	24	OFF	Vehicle Speed Sensor (VSS) Circuit	• The ignition switch is ON.	• The ECM detects that the vehicle speed sensor signal frequency is too high for 0.6 seconds.	• Electrical interference. • Magnetic interference. • Faulty VSS. • Faulty ECM.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0500 (B)	24	OFF	Vehicle Speed Sensor (VSS) Circuit	• The ignition switch is ON. • The engine speed is higher than 3600 RPM. • The fuel injection quantity is more than 41 mg/strk.	• The ECM detects that the vehicle speed is lower than 1.5 km/h (1 MPH) for 60 seconds.	• Meter (10A) fuse (F-16) open. • Sensor ignition voltage circuit is open circuit or high resistance. • Sensor signal circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty instrument panel cluster (meter assembly). • Faulty VSS. • Faulty ECM.
P0560 (1)	35	OFF	System Voltage	—	• The ECM detects that the battery voltage feed circuit voltage is more than 20 volts.	• Incorrect “Jump Starting”. • Faulty charging system. • Faulty ECM.
P0560 (2)	35	OFF	System Voltage	—	• The ECM detects that the battery voltage feed circuit voltage is less than 7 volts.	• Faulty charging system. • Battery voltage feed circuit is high resistance. • Faulty ECM.
P0560 (A)	35	OFF	System Voltage	—	• The PCU battery voltage feed circuit voltage is less than 4.5 volts or more than 27 volts.	• Incorrect “Jump Starting”. • Faulty charging system. • Battery voltage feed or ground circuit is high resistance. • Faulty PCU.
P0561 (A)	18	OFF	Ignition Switch Circuit	—	• The ECM detects that the ignition voltage circuit is changed ON to OFF during initialization.	• ECM main relay control circuit is short to ground. • Ignition voltage feed circuit is intermittently open circuit or high resistance. • Faulty ignition switch.
P0561 (B)	18	OFF	Ignition Switch Circuit	—	• The ECM detects internal ignition voltage feed circuit is failed after initialization.	• Faulty ECM.
P0602 (25)	–	ON	Control Module Not Programmed	—	• VIN in the ECM is not programmed.	• VIN is not programmed.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0606 (A)	28	ON	Control Module Internal Performance	—	• The ECM detects that the internal CPU does not react.	• Faulty ECM.
P0606 (B)	28	ON	Control Module Internal Performance	• The accelerator pedal position is less than 1%. • The desired fuel injection quantity is 0 mg/strk.	• The ECM detects that the engine speed is higher than 2000 RPM.	• Faulty ECM.
P0645 (4)	46	ON	Air Conditioning (A/C) Clutch Relay Control Circuit Low Voltage	• The ignition switch is ON. • The A/C compressor relay is once commanded ON.	• The ECM detects that the low voltage condition on the A/C compressor relay control circuit for longer than 3 seconds when the relay is commanded OFF.	• A/C compressor relay ignition voltage feed circuit on coil side is open circuit or high resistance. • A/C compressor relay control circuit is open circuit, high resistance or short to ground. • A/C compressor relay is poor installation. • Faulty A/C compressor relay. • Faulty ECM.
P0645 (8)	46	ON	Air Conditioning (A/C) Clutch Relay Control Circuit High Voltage	• The ignition switch is ON. • The A/C compressor relay is once commanded ON.	• The ECM detects that the high voltage condition on the A/C compressor relay control circuit for longer than 3 seconds when the relay is commanded ON.	• A/C compressor relay control circuit is short to battery or ignition voltage circuit. • Faulty A/C compressor relay. • Faulty ECM.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0703 (A)	25	ON	Brake Switch Circuit	• The ignition switch is ON. • The engine speed is higher than 1500 RPM. • The accelerator pedal position is more than 10%. • The vehicle speed is higher than 15 km/h (9 MPH).	• The ECM detects that the brake pedal 1 switch is ON (Applied) when the brake pedal 2 switch is OFF (Released) for longer than 30 seconds within the enabling conditions ever since ignition switch is ON.	• Stop (15A) fuse (F-5) open. • Brake pedal 1 switch battery voltage feed circuit is open circuit or high resistance. • Brake pedal 1 switch signal circuit is open circuit, high resistance, short to battery or ignition voltage. • Brake pedal 2 switch ignition voltage feed circuit is open circuit or high resistance. • Brake pedal 2 switch signal circuit is open circuit, high resistance, short to battery or ignition voltage. • Misadjusted brake pedal switch. • Brake pedal switch is poor connection. • Faulty brake pedal switch. • Faulty ECM.
P0703 (B)	25	ON	Brake Switch Circuit	• The ignition switch is ON. • The engine speed is higher than 1500 RPM. • The accelerator pedal position is more than 10%. • The vehicle speed is higher than 15 km/h (9MPH).	• The ECM detects that the brake pedal 1 switch is OFF (Released) when the brake pedal 2 switch is ON (Applied) for longer than 30 seconds.	• Stop (15A) fuse (F-5) open. • Brake pedal 1 switch battery voltage feed circuit is open circuit or high resistance. • Brake pedal 1 switch signal circuit is open circuit, high resistance, short to battery or ignition voltage. • Brake pedal 2 switch ignition voltage feed circuit is open circuit or high resistance. • Brake pedal 2 switch signal circuit is open circuit, high resistance, short to battery or ignition voltage. • Misadjusted brake pedal switch. • Brake pedal switch is poor connection. • Faulty brake pedal switch. • Faulty ECM.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0704 (6)	57	ON	Clutch Switch Input Circuit	• The ignition switch is ON.	• The ECM detects that the clutch pedal switch signal does not change during the vehicle speed changes between 5 km/h (3MPH) and 80 km/h (50MPH).	• Clutch pedal switch ignition voltage feed circuit is open circuit or high resistance. • Clutch pedal switch signal circuit is open circuit, high resistance, short to battery or ignition voltage. • Misadjusted clutch pedal switch. • Clutch pedal switch is poor connection. • Faulty clutch pedal switch. • Faulty ECM.
P1105 (2)	86	ON	Barometric Pressure (BARO) Sensor Circuit High Voltage	• The ignition switch is ON.	• The ECM detects that the BARO sensor signal voltage is more than 4.4 volts for 1 second.	• Faulty ECM.
P1105 (2)	86	ON	Barometric Pressure (BARO) Sensor Circuit Low Voltage	• The ignition switch is ON.	• The ECM detects that the BARO sensor signal voltage is less than 1.5 volts for 1 second.	• Faulty ECM.
P1110 (4)	72	ON	Intake Throttle Solenoid Circuit Low Voltage	• The ignition switch is ON.	• The ECM detects that the low voltage condition on the intake throttle solenoid valve control circuit for longer than 3 seconds when the solenoid valve is commanded OFF.	• Intake throttle solenoid valve ignition voltage feed circuit is open circuit or high resistance. • Intake throttle solenoid valve control circuit is open circuit, high resistance or short to ground. • Poor harness connector connection. • Faulty intake throttle solenoid valve. • Faulty ECM.
P1110 (8)	72	ON	Intake Throttle Solenoid Circuit High Voltage	• The ignition switch is ON.	• The ECM detects that the high voltage condition on the intake throttle solenoid valve control circuit for longer than 3 seconds when the solenoid valve is commanded ON.	• Intake throttle solenoid valve control circuit is short to battery or ignition voltage circuit. • Faulty intake throttle solenoid valve. • Faulty ECM.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1120 (1)	21	ON	Accelerator Pedal Position (APP) Sensor Circuit High Voltage	• The ignition switch is ON.	• The ECM detects that the APP sensor signal voltage is more than 4.9 volts for 0.5 seconds.	• Sensor 5V reference circuit is short to battery or ignition voltage. • Sensor 5V reference circuit is short to ground or short to the low reference circuit. • Sensor signal circuit is short to any 5V reference circuit, short to battery or ignition voltage circuit. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty APP sensor. • Faulty ECM.
P1120 (2)	21	ON	Accelerator Pedal Position (APP) Sensor Circuit Low Voltage	• The ignition switch is ON.	• The ECM detects that the APP sensor signal voltage is less than 0.3 volts for 0.5 seconds.	• Sensor 5V reference circuit is open circuit, high resistance, short to ground or short to the low reference circuit. • Sensor signal circuit is open circuit, high resistance, short to ground or short to the low reference circuit. • Poor harness connector connection. • Faulty APP sensor. • Faulty ECM.
P1120 (7)	21	ON	Accelerator Pedal Position (APP) Sensor Circuit 5V Reference High Voltage	• The ignition switch is ON.	• The ECM detects that the APP sensor voltage supply circuit is more than 5.2 volts for 0.5 seconds.	• Sensor 5V reference circuit is short to battery or ignition voltage circuit. • Faulty ECM.
P1120 (9)	21	ON	Accelerator Pedal Position (APP) Sensor Circuit 5V Reference Low Voltage	• The ignition switch is ON.	• The ECM detects that the APP sensor voltage supply circuit is less than 4.6 volts for 0.5 seconds.	• Sensor 5V reference circuit is short to ground or short to the low reference circuit. • Faulty APP sensor. • Faulty ECM.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1120 (D)	21	ON	Accelerator Pedal Position (APP) Sensor Circuit Correlation	• The ignition switch is ON. • The engine speed is higher than 1700 RPM. • The vehicle speed is higher than 1.5 km/h (1MPH).	• The ECM detects APP sensor angle is stationary more than 18%, then brake pedal is depressed for longer than 2 seconds.	• Brake pedal 1 switch signal circuit is open circuit, high resistance, short to battery or ignition voltage. • Accelerator pedal stuck. • Intake throttle valve stuck. • Intake throttle valve control cable damaged, stuck or no free play. • Misadjusted APP sensor. • Faulty APP sensor. • Misadjusted brake pedal switch. • Faulty brake pedal switch. • Faulty ECM.
P1120 (E)	21	ON	Accelerator Pedal Position (APP) Sensor Circuit Correlation	• The ignition switch is ON.	• The ECM detects APP sensor angle is more than 18%, then idle switch is ON for longer than 0.6 seconds.	• APP sensor low reference circuit is high resistance. • Idle switch signal circuit is short to ground. • Poor harness connector connection. • Faulty APP sensor. • Faulty idle switch. • Faulty ECM.
P1173 (3)	22	OFF	Limitation of Injection Quantity	• The ignition switch is ON.	• The ECM detects an excessive high coolant temperature for longer than 30 seconds.	• Engine overheat. • Faulty engine cooling system. • Faulty ECT sensor.
P1173 (7)	22	OFF	Limitation of Injection Quantity	• The ignition switch is ON.	• The ECM detects an excessive high FT for longer than 30 seconds.	• Faulty PCU.
P1173 (A)	22	OFF	Limitation of Injection Quantity	• The ignition switch is ON.	• The ECM detects an excessive low FT for longer than 30 seconds.	• Faulty PCU.
P1335 (A)	43	ON	Crankshaft Position (CKP) Sensor Circuit	• The ignition switch is ON.	• The PCU detects CKP sensor signal from the ECM is faulty.	• CKP sensor signal output circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage. • Poor harness connector connection. • Faulty PCU. • Faulty ECM.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1345 (A)	41	ON	Crankshaft Position (CKP) – Camshaft Position (CMP) Correlation	—	• The PCU received faulty fuel injection pump CMP sensor signal for 1 second.	• Faulty fuel injection pump. • Faulty PCU.
P1520 (A)	47	ON	Park/Neutral Position Switch Circuit	• The ignition switch is ON. • The engine speed is higher than 1500 RPM. • The vehicle speed is higher than 64 km/h (40MPH). • The clutch pedal is released.	• The ECM detects that the neutral switch signal is continuously ON (neutral) during three consecutive driving cycles.	• Neutral switch signal circuit is short to battery or ignition voltage. • Faulty neutral switch. • Faulty ECM.
P1520 (B)	47	ON	Park/Neutral Position Switch Circuit	• The ignition switch is ON. • The engine speed is higher than 665 RPM. • The vehicle speed is lower than 2 km/h (3MPH). • The clutch pedal is released after once depressed.	• The ECM detects that the neutral switch signal is continuously OFF (other than neutral) during three consecutive driving cycles.	• Neutral switch ignition voltage feed circuit is open circuit or high resistance. • Neutral switch signal circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty neutral switch. • Faulty ECM.
P1576 (4)	71	ON	Exhaust Brake Solenoid Circuit Low Voltage	• The ignition switch is ON.	• The ECM detects that the low voltage condition on the exhaust brake solenoid valve control circuit for longer than 3 seconds when the solenoid valve is commanded OFF.	• Exhaust brake solenoid valve ignition voltage feed circuit is open circuit or high resistance. • Exhaust brake solenoid valve control circuit is open circuit, high resistance or short to ground. • Poor harness connector connection. • Faulty exhaust brake solenoid valve. • Faulty ECM.
P1576 (8)	71	ON	Exhaust Brake Solenoid Circuit High Voltage	• The ignition switch is ON.	• The ECM detects that the high voltage condition on the exhaust brake solenoid valve control circuit for longer than 3 seconds when the solenoid valve is commanded ON.	• Exhaust brake solenoid valve control circuit is short to battery or ignition voltage circuit. • Faulty exhaust brake solenoid valve. • Faulty ECM.
P1605 (C)	55	ON	Control Module Internal Performance	—	• The ECM detects internal seed or key file in EEPROM data is destroyed.	• Faulty ECM.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1605 (D)	55	ON	Control Module Internal Performance	—	• The ECM detects reading or writing from the EEPROM data is failed during initialization.	• Faulty ECM.
P1605 (E)	55	ON	Control Module Internal Performance	—	• The ECM detects total sum of EEPROM data is not equal to registered value during initialization.	• Faulty ECM.
P1625 (A)	76	OFF	ECM Main Relay Circuit	—	• The ECM detects that the ECM main relay is turned OFF before commanded turned OFF.	• ECM main relay control circuit is intermittently open circuit or high resistance. • ECM battery voltage feed circuit is intermittently open or high resistance. • Faulty ECM main relay.
P1625 (B)	76	OFF	ECM Main Relay Circuit	• The ignition switch is OFF.	• The ECM detects that the ECM main relay is turned ON for longer than 2 seconds.	• ECM main relay control circuit is short to ground. • ECM battery voltage circuit is short to battery. • Faulty ECM main relay. • Faulty ECM.
P1630 (A)	51	ON	Injection Pump Fuel Metering Control	—	• The ECM detects that the PCU monitored fuel injection solenoid valve control current is too high.	• Faulty fuel injection pump. • Faulty PCU.
P1630 (B)	51	ON	Injection Pump Fuel Metering Control	—	• The ECM detects that the PCU continuously flow the control current to the fuel injection solenoid valve.	• Faulty fuel injection pump. • Faulty PCU.
P1650 (A)	44	ON	CAN Device Offline	—	• The ECM detects that the PCU receives from the CAN controller reset or Bus Offline.	• CAN high circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage. • CAN low circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage. • Electrical interference. • Magnetic interference. • Faulty PCU. • Faulty ECM.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1650 (B)	44	ON	CAN Device Hang-up	—	• The ECM detects internal CAN controller does not react.	• Faulty ECM.
P1651 (A)	45	ON	CAN Malfunction	—	• The ECM detects that the PCU does not receive the CAN messages from the ECM.	• CAN high circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage. • CAN low circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage. • Electrical interference. • Magnetic interference. • Faulty PCU. • Faulty ECM.
P1651 (B)	45	ON	CAN Malfunction	—	• The ECM does not receive the CAN messages from the PCU.	• CAN high circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage. • CAN low circuit is open circuit, high resistance, short to ground, short to battery or ignition voltage. • Electrical interference. • Magnetic interference. • Faulty PCU. • Faulty ECM.
P1690 (4)	77	OFF	Malfunction Indicator Lamp (MIL) Control Circuit Low Voltage	• The ignition switch is ON.	• The ECM detects a low voltage condition on the MIL control circuit for longer than 3 seconds when the MIL is commanded OFF.	• Meter (10A) fuse (F-16) open. • MIL ignition voltage feed circuit is open circuit or high resistance. • MIL control circuit is open circuit, high resistance or short to ground. • Poor harness connector connection. • MIL bulb burned out. • Faulty instrument panel cluster (meter assembly). • Faulty ECM.

DTC (Symptom Code)	Flash Code	MIL Status	DTC Name on Tech 2	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1690 (8)	77	OFF	Malfunction Indicator Lamp (MIL) Circuit High Voltage	• The ignition switch is ON.	• The ECM detects a high voltage condition on the MIL control circuit for longer than 1 second when the MIL is commanded ON.	• MIL control circuit is short to battery or ignition voltage circuit. • Faulty instrument panel cluster (meter assembly). • Faulty ECM.

P0100 (Symptom Code 7) (Flash Code 65)

Circuit Description

The mass air flow (MAF) sensor is an air flow meter that measures the amount of air that enters the engine. It is fitted between the air cleaner and turbocharger. A small quantity of air that enters the engine indicates deceleration or idle speed. A large quantity of air that enters the engine indicates acceleration or a high load condition. The MAF sensor has the following circuits.

- Ignition voltage circuit
- 5 volts reference circuit
- Low reference circuit
- MAF sensor signal circuit

The engine control module (ECM) provides 5 volts reference voltage through the reference circuit to the MAF sensor. The ECM monitors the voltage on the 5 volts reference circuit. If the ECM detects an excessively high MAF sensor 5 volts reference voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the MAF sensor 5 volts reference circuit voltage is more than 5.2 volts for 0.5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses a MAF substitution of 1600 mg/strk for engine control.
- The ECM uses an EGR solenoid valve control substitution of 10%.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- The MAF Sensor parameter on the Tech 2 will only update with engine running.

Test Description

The number below refers to the step number on the diagnostic table.
3. If the MAF sensor 5 volts reference circuit between the ECM and the sensor is normal, the sensor signal voltage low DTC P0100 (Symptom Code B) will set.

DTC P0100 (Symptom Code 7) (Flash Code 65)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the mass air flow (MAF) sensor harness connector. 3. Start the engine and let idle for 30 seconds. 4. Monitor the DTC Information with the Tech 2. Does DTC P0100 (Symptom Code B) set, but not DTC P0100 (Symptom Code 7)?	—	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the 5 volts reference circuit between the engine control module (ECM) (pin 83 of B-233 connector) and the MAF sensor (pin 4 of J-182 connector) for the following conditions: • A short to battery or ignition voltage • A short to the sensor ignition voltage 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Replace the MAF sensor. Refer to Mass Air Flow Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0100 (Symptom Code 9) (Flash Code 65)

Circuit Description

The mass air flow (MAF) sensor is an air flow meter that measures the amount of air that enters the engine. It is fitted between the air cleaner and turbocharger. A small quantity of air that enters the engine indicates deceleration or idle speed. A large quantity of air that enters the engine indicates acceleration or a high load condition. The MAF sensor has the following circuits.

- Ignition voltage circuit
- 5 volts reference circuit
- Low reference circuit
- MAF sensor signal circuit

The engine control module (ECM) provides 5 volts reference voltage through the reference circuit to the MAF sensor. The ECM monitors the voltage on the 5 volts reference circuit. If the ECM detects an excessively low MAF sensor 5 volts reference voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the MAF sensor 5 volts reference circuit voltage is less than 4.6 volts for 0.5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses a MAF substitution of 1600 mg/strk for engine control.
- The ECM uses an EGR solenoid valve control substitution of 10%.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- The MAF Sensor parameter on the Tech 2 will only update with engine running.

Test Description

The number below refers to the step number on the diagnostic table.
3. If the MAF sensor 5 volts reference circuit between the ECM and the sensor is normal, the sensor signal voltage low DTC P0100 (Symptom Code B) will set.

DTC P0100 (Symptom Code 9) (Flash Code 65)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the mass air flow (MAF) sensor harness connector. 3. Start the engine and let idle for 30 seconds. 4. Monitor the DTC Information with the Tech 2. Does DTC P0100 (Symptom Code B) set, but not DTC P0100 (Symptom Code 9)?	—	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the 5 volts reference circuit between the engine control module (ECM) (pin 83 of B-233 connector) and the MAF sensor (pin 4 of J-182 connector) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Replace the MAF sensor. Refer to Mass Air Flow Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0100 (Symptom Code B) (Flash Code 65)

Circuit Description

The mass air flow (MAF) sensor is an air flow meter that measures the amount of air that enters the engine. It is fitted between the air cleaner and turbocharger. A small quantity of air that enters the engine indicates deceleration or idle speed. A large quantity of air that enters the engine indicates acceleration or a high load condition. The MAF sensor has the following circuits.

- Ignition voltage circuit
- 5 volts reference circuit
- Low reference circuit
- MAF sensor signal circuit

The engine control module (ECM) monitors the MAF sensor signal for voltage outside the normal range of the MAF sensor. If the ECM detects an excessively low MAF sensor signal voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

- The ECM calculated MAF is lower than -18.6 kg/h for 5 seconds. This indicates the ECM detects that the MAF sensor signal voltage is smaller than a predetermined range during engine run.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses a MAF substitution of 1600 mg/strk for engine control.
- The ECM uses an EGR solenoid valve control substitution of 10%.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL that the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- Wrong direction of MAF sensor installation will cause this DTC to set.
- Contaminated or restricted MAF sensor will cause this DTC to set.
- The MAF Sensor parameter on the Tech 2 will only update with engine running.

Test Description

The number below refers to the step number on the diagnostic table.
5. If the MAF sensor signal circuit between the ECM and the sensor is short to ground or any low reference circuits, the sensor 5 volts reference voltage low DTC P0100 (Symptom Code 9) will set.
6. If the MAF sensor signal circuit between the ECM and the sensor is normal, the sensor signal voltage high DTC P0100 (Symptom Code C) will set.

DTC P0100 (Symptom Code B) (Flash Code 65)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and let idle for 30 seconds. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
3	1. Turn OFF the ignition. 2. Disconnect the mass air flow (MAF) sensor harness connector. 3. Connect a test lamp between the ignition voltage feed circuit of the MAF sensor harness (pin 2 of J-182 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 4	Go to Step 7
4	1. Keep the ignition ON, with the engine OFF. 2. Connect a DMM between the 5 volts reference circuit of the MAF sensor harness (pin 4 of J-182 connector) and a known good ground. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 5	Go to Step 8
5	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the 5 volts reference circuit and the signal circuit of the MAF sensor harness (pins 4 and 5 of J-182 connector). 3. Turn ON the ignition, with the engine OFF. DO NOT start the engine. 4. Monitor the DTC Information with the Tech 2. Does DTC P0100 (Symptom Code 9) set, but not DTC P0100 (Symptom Code B)?	—	Go to Step 9	Go to Step 6
6	1. Keep the 3-amp fused jumper wire with connected. 2. Start the engine and let idle for 30 seconds. Does DTC P0100 (Symptom Code C) set, but not DTC P0100 (Symptom Code B)?	—	Go to Step 11	Go to Step 10
7	Repair the open circuit or high resistance on the ignition voltage feed circuit between the ECM main relay (pin 5 of X-14 connector) and the MAF sensor (pin 2 of J-182 connector). Did you complete the repair?	—	Go to Step 15	—
8	1. Test the 5 volts reference circuit between the engine control module (ECM) (pin 83 of B-233 connector) and the MAF sensor (pin 4 of J-182 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12
9	1. Test the signal circuit between the ECM (pin 88 of B-233 connector) and the MAF sensor (pin 5 of J-182 connector) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14

Step	Action	Value(s)	Yes	No
10	1. Test the signal circuit between the ECM (pin 88 of B-233 connector) and the MAF sensor (pin 5 of J-182 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12
11	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the MAF sensor (pins 2, 4 and 5 of J-182 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the MAF sensor circuits at the harness connector of the ECM (pins 83 and 88 of B-233 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
13	Replace the MAF sensor. Refer to Mass Air Flow Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0100 (Symptom Code C) (Flash Code 65)

Circuit Description

The mass air flow (MAF) sensor is an air flow meter that measures the amount of air that enters the engine. It is fitted between the air cleaner and turbocharger. A small quantity of air that enters the engine indicates deceleration or idle speed. A large quantity of air that enters the engine indicates acceleration or a high load condition. The MAF sensor has the following circuits.

- Ignition voltage circuit
- 5 volts reference circuit
- Low reference circuit
- MAF sensor signal circuit

The engine control module (ECM) monitors the MAF sensor signal for voltage outside the normal range of the MAF sensor. If the ECM detects an excessively high MAF sensor signal voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The engine is running.

Condition for Setting the DTC

- The ECM calculated MAF is higher than 806 kg/h for 10 seconds. This indicates the ECM detects that the MAF sensor signal voltage is higher than a predetermined range during engine run.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses a MAF substitution of 1600 mg/strk for engine control.
- The ECM uses an EGR solenoid valve control substitution of 10%.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- The MAF Sensor parameter on the Tech 2 will only update with engine running.

Test Description

The number below refers to the step number on the diagnostic table.
3. If the MAF sensor signal circuit between the ECM and the sensor is normal, the sensor signal voltage low DTC P0100 (Symptom Code B) will set.

DTC P0100 (Symptom Code C) (Flash Code 65)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and let idle for 30 seconds. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the mass air flow (MAF) sensor harness connector. 3. Start the engine and let idle for 30 seconds. 4. Monitor the DTC Information with the Tech 2. Does DTC P0100 (Symptom Code B) set, but not DTC P0100 (Symptom Code C)?	—	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Connect a test lamp between the low reference circuit of the MAF sensor harness (pin 3 of J-182 connector) and a battery voltage. Does the test lamp illuminate?	—	Go to Step 7	Go to Step 6
5	**Important:** The MAF sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the engine control module (ECM) (pin 88 of B-233 connector) and the MAF sensor (pin 5 of J-182 connector) for the following conditions: • A short to battery or ignition voltage • A short to 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
6	1. Test the low reference circuit between the ECM (pin 92 of B-233 connector) and the MAF sensor (pin 3 of J-182 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
7	1. Turn OFF the ignition. 2. Inspect for an intermittent and for a poor connection at the harness connector of the MAF sensor (pin 3 of J-182 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 9
8	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the MAF sensor circuit at the harness connector of the ECM (pin 92 of B-233 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	Replace the MAF sensor. Refer to Mass Air Flow Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 11	—
10	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 11	—

Step	Action	Value(s)	Yes	No
11	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 12
12	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0110 (Symptom Code 1) (Flash Code 23)

Circuit Description

The intake air temperature (IAT) sensor is fitted between the air cleaner and turbocharger internal to the mass air flow (MAF) sensor. The IAT sensor is a variable resistor. The IAT sensor has a signal circuit and a low reference circuit. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 volts to the IAT signal circuit and a ground for the IAT low reference circuit. When the IAT sensor is cold, the sensor resistance is high. When the air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the IAT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the IAT signal circuit. If the ECM detects an excessively high IAT signal voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the IAT sensor signal voltage is more than 4.7 volts for 3 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses an IAT substitution of 0°C (32°F) for engine control.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Use the Temperature vs. Resistance table to test the IAT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

Notice:

- The mass air flow (MAF) sensor is heated and as a result the IAT sensor may indicate a higher than normal intake temperature if the ignition switch is being ON.

DTC P0110 (Symptom Code 1) (Flash Code 23)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Intake Air Temperature (IAT) parameter with the Tech 2. Is the IAT parameter less than the specified value?	-38°C (-36°F)	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the mass air flow/intake air temperature (MAF/IAT) sensor harness connector. 3. Connect a DMM between the signal circuit of the IAT sensor harness (pin 1 of J-182 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	5.3 volts	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	**Important:** The IAT sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the engine control module (ECM) (pin 84 of B-233 connector) and the IAT sensor (pin 1 of J-182 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
5	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the signal circuit and the low reference circuit of the IAT sensor harness (pins 1 and 3 of J-182 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the IAT parameter with the Tech 2. Is the IAT parameter more than the specified value?	110°C (230°F)	Go to Step 9	Go to Step 6
6	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the signal circuit of the IAT sensor harness (pin 1 of J-182 connector) and a known good ground. 3. Turn ON the ignition, with the engine OFF. 4. Observe the IAT parameter with the Tech 2. Is the IAT parameter more than the specified value?	110°C (230°F)	Go to Step 8	Go to Step 7
7	1. Test the signal circuit between the ECM (pin 84 of B-233 connector) and the IAT sensor (pin 1 of J-182 connector) for an open circuit high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
8	1. Test the low reference circuit between the ECM (pin 92 of B-233 connector) and the IAT sensor (pin 3 of J-182 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
9	1. Test the signal circuit between the ECM (pin 84 of B-233 connector) and the IAT sensor (pin 1 of J-182 connector) for a short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 10
10	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the IAT sensor (pins 1 and 3 of J-182 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 12

Step	Action	Value(s)	Yes	No
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the IAT sensor circuits at the harness connector of the ECM (pins 84 and 92 of B-233 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
12	Replace the IAT sensor. Refer to Mass Air Flow Sensor Replacement in this section. (IAT sensor is internal to MAF sensor) Did you complete the replacement?	—	Go to Step 14	—
13	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 14	—
14	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 15
15	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0110 (Symptom Code 2) (Flash Code 23)

Circuit Description

The intake air temperature (IAT) sensor is fitted between the air cleaner and turbocharger internal to the mass air flow (MAF) sensor. The IAT sensor is a variable resistor. The IAT sensor has a signal circuit and a low reference circuit. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 volts to the IAT signal circuit and a ground for the IAT low reference circuit. When the IAT sensor is cold, the sensor resistance is high. When the air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the IAT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the IAT signal circuit. If the ECM detects an excessively low IAT signal voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the IAT sensor signal voltage is less than 0.3 volts for 3 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses an IAT substitution of 0°C (32°F) for engine control.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Use the Temperature vs. Resistance table to test the IAT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

Notice:

- The mass air flow (MAF) sensor is heated and as a result the IAT sensor may indicate a higher than normal intake temperature if the ignition switch is being ON.

DTC P0110 (Symptom Code 2) (Flash Code 23)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Intake Air Temperature (IAT) parameter with the Tech 2. Is the IAT parameter more than the specified value?	110°C (230°F)	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the mass air flow/intake air temperature (MAF/IAT) sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the IAT parameter with the Tech 2. Is the IAT parameter less than the specified value?	-38°C (-36°F)	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the signal circuit between the engine control module (ECM) (pin 84 of B-233 connector) and the IAT sensor (pin 1 of J-182 connector) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
5	Replace the IAT sensor. Refer to Mass Air Flow Sensor Replacement in this section. (IAT sensor is internal to MAF sensor) Did you complete the replacement?	—	Go to Step 8	—
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect connections on the IAT sensor circuits at the harness connector of the ECM (pins 84 and 92 of B-233 connector) for corrosion. 4. Repair or clean the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 9
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0115 (Symptom Code 1) (Flash Code 14)

Circuit Description

The engine coolant temperature (ECT) sensor is installed to the thermostat housing. The ECT sensor is a variable resistor. The ECT sensor has a signal circuit and a low reference circuit. The ECT sensor measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and a ground for the ECT low reference circuit. When the ECT sensor is cold, the sensor resistance is high. When the engine coolant temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the ECT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the ECT signal circuit. If the ECM detects an excessively high ECT signal voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the ECT sensor signal voltage is more than 4.7 volts for 3 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses an ECT substitution of fuel temperature for engine control.
- The ECM uses an ECT substitution of 60°C (120°F) for injection timing control.
- The ECM uses an ECT substitution of -25°C (-13°F) for glow control.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- After starting the engine, the ECT should rise steadily to about 80°C – 85°C (176°F – 185°F) then stabilize when the thermostat opens.
- Use the Temperature vs. Resistance table to test the ECT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

DTC P0115 (Symptom Code 1) (Flash Code 14)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Engine Coolant Temperature (ECT) parameter with the Tech 2. Is the ECT parameter less than the specified value?	-35°C (-31°F)	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the ECT sensor harness connector. 3. Connect a DMM between the signal circuit of the ECT sensor harness (pin 1 of E-16 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	5.3 volts	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	**Important:** The ECT sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the engine control module (ECM) (pin 89 of B-233 connector) and the ECT sensor (pin 1 of E-16 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
5	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the signal circuit and the low reference circuit of the ECT sensor harness (pins 1 and 2 of E-16 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the ECT parameter with the Tech 2. Is the ECT parameter more than the specified value?	135°C (275°F)	Go to Step 9	Go to Step 6
6	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the signal circuit of the ECT sensor harness (pin 1 of E-16 connector) and a known good ground. 3. Turn ON the ignition, with the engine OFF. 4. Observe the ECT parameter with the Tech 2. Is the ECT parameter more than the specified value?	135°C (275°F)	Go to Step 8	Go to Step 7
7	1. Test the signal circuit between the ECM (pin 89 of B-233 connector) and the ECT sensor (pin 1 of E-16 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
8	1. Test the low reference circuit between the ECM (pin 93 of B-233 connector) and the ECT sensor (pin 2 of E-16 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
9	1. Test the signal circuit between the ECM (pin 89 of B-233 connector) and the ECT sensor (pin 1 of E-16 connector) for a short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 10
10	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the ECT sensor (pins 1 and 2 of E-16 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 12

Step	Action	Value(s)	Yes	No
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the ECT sensor circuits at the harness connector of the ECM (pins 89 and 93 of B-233 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
12	Replace the ECT sensor. Refer to Engine Coolant Temperature Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 14	—
13	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 14	—
14	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 15
15	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0115 (Symptom Code 2) (Flash Code 14)

Circuit Description

The engine coolant temperature (ECT) sensor is installed to the thermostat housing. The ECT sensor is a variable resistor. The ECT sensor has a signal circuit and a low reference circuit. The ECT sensor measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and a ground for the ECT low reference circuit. When the ECT sensor is cold, the sensor resistance is high. When the engine coolant temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the ECT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the ECT signal circuit. If the ECM detects an excessively low ECT signal voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the ECT sensor signal voltage is less than 0.3 volts for 3 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses an ECT substitution of fuel temperature for engine control.
- The ECM uses an ECT substitution of 60°C (120°F) for injection timing control.
- The ECM uses an ECT substitution of -25°C (-13°F) for glow control.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- After starting the engine, the ECT should rise steadily to about 80°C – 85°C (176°F – 185°F) then stabilize when the thermostat opens.
- Use the Temperature vs. Resistance table to test the ECT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

DTC P0115 (Symptom Code 2) (Flash Code 14)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Engine Coolant Temperature (ECT) parameter with the Tech 2. Is the ECT parameter more than the specified value?	135°C (275°F)	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the ECT sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Coolant Temperature parameter with the Tech 2. Is the ECT parameter less than the specified value?	-35°C (-31°F)	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the signal circuit between the engine control module (ECM) (pin 89 of B-233 connector) and the ECT sensor (pin 1 of E-16 connector) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
5	Replace the ECT sensor. Refer to Engine Coolant Temperature Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 8	—
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect connections on the ECT sensor circuits at the harness connector of the ECM (pins 89 and 93 of B-233 connector) for corrosion. 4. Repair or clean the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 9
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0180 (Symptom Code B) (Flash Code 15)

Circuit Description

The fuel temperature (FT) sensor is internal to the fuel injection pump control unit (PCU). It detects fuel temperature in the fuel injection pump. The engine control module (ECM) and PCU communicates with each other over the controller area network (CAN) link. If the PCU internal FT sensor output is an excessively high or low, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The PCU internal FT sensor output is lower than -40°C (-40°F) for 3 seconds or higher than 150°C (302°F).

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses a default FT substitution for engine control.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- FT sensor is internal to the PCU and it is part of the fuel injection pump assembly.

DTC P0180 (Symptom Code B) (Flash Code 15)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. (Fuel temperature (FT) sensor is internal to the fuel injection pump control unit (PCU) and it is part of the fuel injection pump assembly.) Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0215 (Symptom Code A) (Flash Code 52)

Circuit Description

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.
The fuel injection solenoid valve is installed to the fuel injection pump rear side. The fuel injection event is determined by this solenoid ON/OFF command. The fuel injection solenoid valve cuts the fuel when the engine shutoff (ESO) solenoid valve is commanded shutoff from the PCU. (The fuel injection solenoid valve and engine shutoff (ESO) solenoid valve is same part. It calls ESO solenoid valve when fuel is shutoff.) When the ignition switch is turned OFF or commanded from fail-safe action, the ESO solenoid valve is commanded shutoff to stop the engine running. If the ECM detects that the engine is continuously run after the ignition switch is OFF, this DTC will set.

Condition for Running the DTC

- The ignition switch is OFF.
- The engine speed is lower than 1500 RPM.
- The vehicle speed is lower than 1.5 km/h (1MPH).

Condition for Setting the DTC

- After the condition for running this DTC for 2 seconds, the engine speed is higher than 200 RPM when the ESO solenoid valve is commanded shutoff from the PCU. This indicates the PCU reacts to the command from the ECM but ESO solenoid valve does not react to the command from the PCU and fuel cannot shutoff.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) at next ignition cycle.
- The ECM cuts fuel injection.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- Fuel injection solenoid valve is internal to the fuel injection pump assembly.
- PCU is part of the fuel injection pump assembly.

DTC P0215 (Symptom Code A) (Flash Code 52)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and let idle for 30 seconds. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. 5. Turn OFF the engine. Does the DTC fail this ignition before the engine control module (ECM) turned OFF?	—	Go to Step 3	Go to Step 4
3	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. Did you complete the replacement?	—	Go to Step 4	—

Step	Action	Value(s)	Yes	No
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. 5. Turn OFF the engine. Does the DTC fail this ignition before the ECM turns OFF?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0215 (Symptom Code B) (Flash Code 52)

Circuit Description

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.
The fuel injection solenoid valve is installed to the fuel injection pump rear side. The fuel injection event is determined by this solenoid ON/OFF command. The fuel injection solenoid valve cuts the fuel when the engine shutoff (ESO) solenoid valve is commanded shutoff from the PCU. (The fuel injection solenoid valve and engine shutoff (ESO) solenoid valve is same part. It calls ESO solenoid valve when fuel is shutoff.) When the ignition switch is turned OFF or commanded from fail-safe action, the ESO solenoid valve is commanded shutoff to stop the engine running. If the PCU detects that the ESO solenoid valve control circuit voltage level from the ECM to PCU is high, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The PCU detects high voltage condition on the ESO solenoid valve control circuit for longer than 1 second when the ECM does not command shutoff.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- Fuel injection solenoid valve is internal to the fuel injection pump assembly.
- PCU is part of the fuel injection pump assembly.
- If this DTC is present, engine will not start.

DTC P0215 (Symptom Code B) (Flash Code 52)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. If the engine does not start, crank over the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the fuel injection pump control unit (PCU) harness connector. 3. Connect a test lamp between the engine shutoff (ESO) solenoid valve control signal circuit (pin 5 of E-110 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Reconnect the PCU harness connector. 3. Disconnect the engine control module (ECM) B-233 harness connector. Keep the B-234 harness connector with connected. 4. Connect a test lamp between the ESO solenoid valve control signal circuit (pin 105 of B-233 connector) and a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 6	Go to Diagnostic Aids
5	1. Test the ESO solenoid valve control signal circuit between the ECM (pin 105 of B-233 connector) and the PCU (pin 5 of E-110 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
6	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. Did you complete the replacement?	—	Go to Step 8	—
7	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 9
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0215 (Symptom Code C) (Flash Code 52)

Circuit Description

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.
The fuel injection solenoid valve is installed to the fuel injection pump rear side. The fuel injection event is determined by this solenoid ON/OFF command. The fuel injection solenoid valve cuts the fuel when the engine shutoff (ESO) solenoid valve is commanded shutoff from the PCU. (The fuel injection solenoid valve and engine shutoff (ESO) solenoid valve is same part. It calls ESO solenoid valve when fuel is shutoff.) When the ignition switch is turned OFF or commanded from fail-safe action, the ESO solenoid valve is commanded shutoff to stop the engine running. If the ECM detects that the engine is continuously run after the ignition switch is OFF, this DTC will set.

Condition for Running the DTC

- The ignition switch is OFF.
- The engine speed is lower than 1500 RPM.
- The vehicle speed is lower than 1.5 km/h (1MPH).

Condition for Setting the DTC

- The engine speed is higher than 200 RPM within 2 seconds after the condition for running the DTC are met. This indicates the PCU does not react to the command from the ECM and fuel cannot shutoff.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM cuts fuel injection.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- Fuel injection solenoid valve is internal to the fuel injection pump assembly.
- PCU is part of the fuel injection pump assembly.

DTC P0215 (Symptom Code C) (Flash Code 52)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and let idle for 30 seconds. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. 5. Turn OFF the engine. Does the DTC fail this ignition before the engine control module (ECM) turns OFF?	—	Go to Step 3	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
3	1. Turn OFF the ignition. 2. Disconnect the fuel injection pump control unit (PCU) harness connector. 3. Connect a test lamp between the engine shutoff (ESO) solenoid valve control signal circuit (pin 5 of E-110 connector) and battery voltage. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 4
4	1. Turn OFF the ignition. 2. Connect a DMM between the ESO solenoid valve control signal circuit (pin 5 of E-110 connector) and a known good ground. 3. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	10 volts	Go to Step 7	Go to Step 6
5	1. Test the ESO solenoid valve control signal circuit between the ECM (pin 105 of B-233 connector) and the PCU (pin 5 of E-110 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
6	1. Test the ESO solenoid valve control signal circuit between the ECM (pin 105 of B-233 connector) and the PCU (pin 5 of E-110 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
7	1. Turn OFF the ignition. 2. Inspect for an intermittent, for a poor connection and corrosion on the ESO solenoid valve control signal circuit at the harness connector of the PCU (pin 5 of E-110 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 9
8	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the ESO solenoid valve control signal circuit at the harness connector of the ECM (pin 105 of B-233 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. Did you complete the replacement?	—	Go to Step 11	—

Step	Action	Value(s)	Yes	No
10	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 11	—
11	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. 6. Turn OFF the engine. Does the DTC fail this ignition before the ECM turns OFF?	—	Go to Step 3	Go to Step 12
12	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0215 (Symptom Code D) (Flash Code 52)

Circuit Description

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.
The ECM monitors CAN operational status by expecting a constant flow of messages from the PCU. If the ECM detects that the internal CAN controller does not Bus OFF when the ignition switch is OFF, this DTC will set.

Condition for Running the DTC

- The ignition switch is OFF.

Condition for Setting the DTC

- The ECM detects internal CAN controller does not Bus OFF mode.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- CAN controller is internal to the ECM.

DTC P0215 (Symptom Code D) (Flash Code 52)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and let idle for 30 seconds. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. 5. Turn OFF the engine. Does the DTC fail this ignition before the engine control module (ECM) turns OFF?	—	Go to Step 3	Go to Step 4
3	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and let idle for 30 seconds. 4. Monitor the DTC Information with the Tech 2. 5. Turn OFF the engine. Does the DTC fail this ignition before the ECM turns OFF?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0216 (Symptom Code A,B) (Flash Code 54)

Description

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.
The timing device changes the optimum injection timing against various engine conditions. The pressure of the fuel fed from the feed pump is adjusted and it acts to the timing plunger by TCV controlled fuel pressure. (The TCV is installed to the fuel injection pump rear side and it is controlled by duty ratio cycle from the PCU.) The timing plunger is connected to the cam ring by a ball pin. Axial movement of the timing plunger is transferred to the cam ring in the form of rotational movement. Movement to the right of the timing plunger advances injection timing. If the PCU detects an excessive difference between actual and desired fuel injection timing, this DTC will set.

Condition for Running the DTC

Symptom Code A

- The engine speed is higher than 700 RPM.
- The fuel injection quantity is higher than 4 mg/strk.

Symptom Code B

- The engine speed is higher than 2014 RPM.

Condition for Setting the DTC

Symptom Code A

- The PCU monitored actual fuel injection timing is advanced more than desired by 3°CA for longer than 12 seconds or retarded more than desired by 6°CA for longer than 12 seconds.

Symptom Code B

- The PCU monitored actual fuel injection timing is oscillated higher than desired by 5.2°CA.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits fuel injection quantity.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- The fuel injection pump installation with incorrect mechanical timing may set this DTC.
- This DTC most likely indicate loss fuel pressure by restricted fuel line. Inspect the fuel line restriction between the fuel injection pump and fuel tank.
- The fuel system from the fuel tank(s) to the fuel injection pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight or if there is a crack in one of the fuel hoses. Air in the fuel system will cause fuel injection pump internal pressure fluctuations especially at high engine speed and load, which may set this DTC.
- Improper fuel will cause this DTC to set. Inspect fuel waxing or icing that is caused by an incorrect fuel type used in winter season or water intrusion in the fuel system.
- Contaminated fuel will cause this DTC to set. Inspect the pipe connector fixing bolt (eye bolt) on the fuel injection pump suction side.

Important:
If the fuel tank is empty or near empty, air might be allowed to go into the fuel system. With air in the fuel system, smooth flow of fuel into the fuel injection pump is interrupted and this DTC may set. Refer to air bleeding procedure in Fuel System Section.

DTC P0216 (Symptom Code A,B) (Flash Code 54)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls

Step	Action	Value(s)	Yes	No
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and let idle for 30 seconds. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0335 (Symptom Code B or D), P1335 (Symptom Code A) or P1345 (Symptom Code A) set?	—	Go to Applicable DTC	Go to Step 3
3	1. Turn OFF the engine. 2. Place the transmission in neutral and set the park brake. 3. Start the engine and let engine idle for 30 seconds while observing the Actual Injection Timing parameter with the Tech 2. 4. Accelerate the engine and keep the constant engine speed around 2000 RPM while observing the Actual Injection Timing parameter with the Tech 2. 5. Accelerate the engine and keep the constant engine speed around 3000 RPM while observing the Actual Injection Timing parameter with the Tech 2. Does the Actual Injection Timing parameter follow the Desired Injection Timing within 2°CA on each engine speed?	—	Go to Diagnostic Aids	Go to Step 4
4	1. Turn OFF the ignition. 2. Check the fuel system line connections between the fuel tank and the fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** The fuel system from the fuel tank(s) to the fuel injection pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel injection pump internal pressure fluctuations especially at high engine speed and load, which may set this DTC. 3. Pump the priming pump on the fuel filter until it becomes firm. If there is a leak on the suction side of the fuel system between the priming pump and the fuel injection pump, the priming pump will not build up sufficient firmness and fuel leakage may occur. 4. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Remove the fuel hose that connects to the fuel injection pump suction side. 2. Remove the fuel pipe connector that connects to the fuel injection pump suction side. 3. Inspect the eye bolt for any type of restriction or collapsed gauze filter. **Notice:** If any type of restriction found, check for a condition that causes contaminated fuel, such as the customer is using an aftermarket fuel filter or extended maintenance interval. Also inspect fuel waxing or icing that is caused by an incorrect fuel type used in winter season or water intrusion in the fuel system. 4. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 6
6	1. Disconnect the fuel hose that connects to the fuel injection pump suction side. In order to measure the discharged fuel amount, put the hose into a bottle or a container. 2. Pump the priming pump on the fuel filter. **Notice:** If there is a leak on the suction side of the fuel system, the fuel from the disconnected hose will not flow out sufficiently and fuel leakage may occur. Also if there is a restriction on the suction side of the fuel system, the fuel from the disconnected hose will not flow out sufficiently that is most likely caused by clogged fuel filter or kinked fuel hose or pipe. 3. Draw fuel from the fuel tank at the fuel line (as close to the fuel tank as possible) going to the fuel pickup tube to verify a clean stream of fuel comes out (use the hand-held vacuum pump 5-8840-0279-0/J-23738-A with a clear hose or equivalent). This will ensure the fuel pickup tube is not cracked drawing air into the fuel line. 4. Repair any fuel system leaks and restrictions as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Reconnect the fuel pipe connector that connects to the fuel injection pump suction side. 2. Remove the fuel hose that connects to the fuel injection pump suction side. 3. Substitute a clear hose. **Notice:** A hose must be cleaned. 4. Connect the clear hose to the fuel injection pump. 5. Bleed the fuel system. Refer to the Diagnostic Aids. 6. Let the engine run at idle for at least 2 minutes. 7. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the clear hose. **Notice:** If many air bubbles appear in the fuel, check the fuel system line connections between the fuel tank and the fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. 8. Repair as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 8
8	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. Did you complete the replacement?	—	Go to Step 9	—
9	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Place the transmission in neutral and set the park brake. 4. Start the engine and let engine idle for 30 seconds while observing the Actual Injection Timing parameter with the Tech 2. 5. Accelerate the engine and keep the constant engine speed around 2000 RPM while observing the Actual Injection Timing parameter with the Tech 2. 6. Accelerate the engine and keep the constant engine speed around 3000 RPM while observing the Actual Injection Timing parameter with the Tech 2. Does the Actual Injection Timing parameter follow the Desired Injection Timing within 2°CA on each engine speed?	—	Go to Step 10	Go to Step 2
10	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0251 (Symptom Code 6) (Flash Code 53)

Circuit Description

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.
The fuel injection solenoid valve is installed to the fuel injection pump rear side. The fuel injection event is determined by this solenoid ON/OFF command. The fuel injection solenoid valve cuts the fuel when the engine shutoff (ESO) solenoid valve is commanded shutoff from the PCU. (The fuel injection solenoid valve and engine shutoff (ESO) solenoid valve is same part. It calls ESO solenoid valve when fuel is shutoff.) When the ignition switch is turned OFF or commanded from fail-safe action, the ESO solenoid valve is commanded shutoff to stop the engine running. If the PCU detects that the fuel injection solenoid valve is operated when the desired injection quantity from the ECM is 0 mg/strk, this DTC will set.

Condition for Running the DTC

- The fuel injection pump CMP sensor signal is generated.
- The CAN communication between the ECM and PCU is normal.

Condition for Setting the DTC

- The PCU detects that the fuel injection solenoid valve is operated when the desired fuel injection quantity is commanded 0 mg/strk.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM cuts fuel injection.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- Fuel injection solenoid valve is internal to the fuel injection pump assembly.
- PCU is part of the fuel injection pump assembly.

DTC P0251 (Symptom Code 6) (Flash Code 53)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and let idle for 30 seconds. 4. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. Did you complete the replacement?	—	Go to Step 4	—

Step	Action	Value(s)	Yes	No
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and let idle for 30 seconds. 4. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0251 (Symptom Code 7) (Flash Code 53)

Circuit Description

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU. The PCU also compares the engine speed signal sent from the ECM and the fuel injection pump speed. If the PCU detects that the doubled fuel injection pump speed is excessively lower than engine speed, this DTC will set.

Condition for Running the DTC

- The fuel injection pump CMP sensor signal is generated.
- The crankshaft position (CKP) sensor signal is generated.
- The engine speed is higher than 500 RPM.

Condition for Setting the DTC

- The PCU detects that the doubled fuel injection pump speed is lower than engine speed by 800 RPM for longer than 0.2 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM cuts fuel injection.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- Electrical or magnetic interference may affect intermittent condition.
- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- Fuel injection pump CMP sensor is internal to the fuel injection pump assembly.
- PCU is part of the fuel injection pump assembly.

DTC P0251 (Symptom Code 7) (Flash Code 53)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. If the engine does not start, crank over the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0335 (Symptom Code B, D or E), P1335 (Symptom Code A) or P1345 (Symptom Code A) set?	—	Go to Applicable DTC	Go to Step 3
3	1. Start the engine. 2. Monitor the DTC Information with the Tech 2. 3. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times. Does the DTC fail this ignition?	—	Go to Step 4	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
4	1. Observe the Engine Speed parameter with the Tech 2. 2. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the Tech 2. Does the Engine Speed parameter indicate correct engine speed?	—	Go to Step 9	Go to Step 5
5	1. Inspect the crankshaft position (CKP) sensor for tightness. 2. Remove the CKP sensor and check for damage, metal particles on magnet and for flywheel circumference damage. Did you find and correct the condition?	—	Go to Step 10	Go to Step 6
6	1. Turn OFF the ignition. 2. Disconnect the CKP sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion on the CKP sensor terminal (pins 1, 2 and 3 of J-183 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 7
7	1. Turn OFF the ignition. 2. Disconnect the fuel injection pump control unit (PCU) harness connector. 3. Inspect for an intermittent, for a poor connection and corrosion on the CKP sensor signal input at the harness connector of the PCU (pin 8 of E-110 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
8	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) harness connector. 3. Inspect for an intermittent, for poor connections and corrosion on at the harness connector of the ECM (pins 90, 91, 98 and 101 of B-233 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 9
9	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. Did you complete the replacement?	—	Go to Step 10	—

Step	Action	Value(s)	Yes	No
10	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 2	Go to Step 11
11	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0251 (Symptom Code 9, A, B, D) (Flash Code 53)

Circuit Description

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.
The fuel injection solenoid valve is installed to the fuel injection pump rear side. The fuel injection event is determined by this solenoid ON/OFF command. The fuel injection solenoid valve cuts the fuel when the engine shutoff (ESO) solenoid valve is commanded shutoff from the PCU. (The fuel injection solenoid valve and engine shutoff (ESO) solenoid valve is same part. It calls ESO solenoid valve when fuel is shutoff.) When the ignition switch is turned OFF or commanded from fail-safe action, the ESO solenoid valve is commanded shutoff to stop the engine running.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The PCU detects internal fuel injection pump control maps are not programmed during self-test. (Symptom Code 9)
- The PCU detects internal EEPROM or A/D converter is failed during self-test. (Symptom Code A)
- The PCU detects that the fuel injection solenoid valve drive circuit is failed during self-test. (Symptom Code B)
- The PCU detects that the fuel injection solenoid valve drive circuit voltage level is abnormal during self-test. (Symptom Code D)

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM cuts fuel injection. (Symptom Code 9)
- The ECM limits fuel injection quantity. (Symptom Code A)

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- Fuel injection solenoid valve is internal to the fuel injection pump assembly.
- PCU is part of the fuel injection pump assembly.

DTC P0251 (Symptom Code 9, A, B, D) (Flash Code 53)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the igniton, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. Did you complete the replacement?	—	Go to Step 4	—

Step	Action	Value(s)	Yes	No
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0251 (Symptom Code E) (Flash Code 53)

Circuit Description

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.
The ECM monitors CAN operational status by expecting a constant flow of messages from the PCU. If the ECM detects that the communication message from the PCU is not received, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects communication message from the PCU is not received for longer than 1 second.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM cuts fuel injection.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- PCU is part of the fuel injection pump assembly.

DTC P0251 (Symptom Code E) (Flash Code 53)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. If the engine does not start, crank over the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1650 (Symptom Code A or B) or P1651 (Symptom Code A or B) set?	—	Go to Applicable DTC	Go to Step 3
3	1. Turn ON the ignition, with the engine OFF. 2. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 4	Go to Step 5
4	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 5	—
5	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 2	Go to Step 6

Step	Action	Value(s)	Yes	No
6	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0335 (Symptom Code B, D) (Flash Code 43)

Circuit Description

The crankshaft position (CKP) sensor is located on top of the flywheel housing. There are 4 slits spaced 90° on the flywheel circumference. The CKP sensor is a magnetic coil type sensor, which generates an AC signal voltage based on the crankshaft rotational speed. The engine control module (ECM) monitors both the CKP sensor and injection pump camshaft position (CMP) sensor signals to ensure they correlate with each other.
If the ECM receives extra or missing CKP sensor signal pulses, this DTC will set. (Symptom Code B)
If the ECM receives a certain amount of injection pump CMP sensor signal pulses without a CKP sensor signal, this DTC will set. (Symptom Code D)

Condition for Running the DTC

Symptom Code B

- The ignition switch is ON.
- The engine speed is higher than 665 RPM.

Symptom Code D

- DTC P0335 (Symptom Code B) is not set.
- The ignition switch is ON.
- The fuel injection pump CMP sensor signal is generated.
- The controller area network (CAN) communication between the ECM and PCU is normal.

Condition for Setting the DTC

Symptom Code B

- The ECM detects extra or missing CKP sensor signals while engine is running.

Symptom Code D

- The ECM detects that the CKP sensor signals are not generated when doubled fuel injection pump rotation speed is higher than 50 RPM.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails. The ECM uses an engine speed substitution of doubled fuel injection pump speed for engine control.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Ensure the sensor is tight and the flywheel circumference is not damaged.

DTC P0335 (Symptom Code B, D) (Flash Code 43)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine (Note a slight start delay may be noticed). 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the crankshaft position (CKP) sensor harness connector. 3. Connect a DMM across the CKP sensor terminals (pins 1 and 2 of J-183 connector). 4. Measure the resistance across the CKP sensor. Is the CKP sensor resistance within the specified value?	870 – 930 Ω	Go to Step 4	Go to Step 20

Step	Action	Value(s)	Yes	No
4	1. Connect a DMM across the CKP sensor terminals (measure the sensor output voltage). 2. Place the DMM on the AC volt scale. 3. Start the engine. 4. Monitor the DMM while accelerating the engine between idle and W.O.T. (accelerator pedal full travel). Does the DMM indicate an AC voltage increase in accordance with an engine speed increase (the range of approximately 1.4 volts is indicated from approximately 0.7 volts)?	—	Go to Step 5	Go to Step 19
5	1. Turn ON the ignition, with the engine OFF. 2. Connect a test lamp between the low reference circuit of the CKP sensor harness (pin 1 of J-183 connector) and a known good ground. Does the test lamp illuminate?	—	Go to Step 11	Go to Step 6
6	1. Keep the ignition switch ON, with the engine OFF. 2. Connect a test lamp between the low reference circuit of the CKP sensor harness (pin 1 of J-183 connector) and battery voltage. Does the test lamp illuminate?	—	Go to Step 7	Go to Step 12
7	1. Keep the ignition switch ON, with the engine OFF. 2. Connect a test lamp between the shield ground circuit of the CKP sensor harness (pin 3 of J-183 connector) and a known good ground. Does the test lamp illuminate?	—	Go to Step 13	Go to Step 8
8	1. Keep the ignition switch ON, with the engine OFF. 2. Connect a test lamp between the shield ground circuit of the CKP sensor harness (pin 1 of J-183 connector) and battery voltage. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 14
9	1. Keep the ignition switch ON, with the engine OFF. 2. Connect a test lamp between the signal circuit of the CKP sensor harness (pin 2 of J-183 connector) and battery voltage. Does the test lamp illuminate?	—	Go to Step 15	Go to Step 10
10	1. Keep the ignition switch ON, with the engine OFF. 2. Connect a DMM between the signal circuit of the CKP sensor harness (pin 2 of J-183 connector) and a known good ground. Is the DMM voltage more than the specified value?	1 volt	Go to Step 16	Go to Step 17

Step	Action	Value(s)	Yes	No
11	**Important:** The ECM may be damaged if the sensor low reference circuit is shorted to a voltage source. 1. Test the low reference circuit of the CKP sensor between the engine control module (ECM) (pin 98 of B-233 connector) and the CKP sensor (pin 1 of J-183 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 21
12	1. Test the low reference circuit of the CKP sensor between the ECM (pin 98 of B-233 connector) and the CKP sensor (pin 1 of J-183 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 18
13	**Important:** The ECM may be damaged if the sensor shield ground circuit is shorted to a voltage source. 1. Test the shield ground circuit of the CKP sensor between the ECM (pin 101 of B-233 connector) and the CKP sensor (pin 3 of J-183 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 21
14	1. Test the shield ground circuit of the CKP sensor between the ECM (pin 101 of B-233 connector) and the CKP sensor (pin 3 of J-183 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 18
15	1. Test the signal circuit of the CKP sensor between the ECM (pin 90 of B-233 connector) and the CKP sensor (pin 2 of J-183 connector) for the following conditions: • A short to ground • A short to the low reference circuit • A short to the shield ground 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 21

Step	Action	Value(s)	Yes	No
16	**Important:** The CKP sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit of the CKP sensor between the ECM (pin 90 of B-233 connector) and the CKP sensor (pin 2 of J-183 connector) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 21
17	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the CKP sensor (pins 1, 2 and 3 of J-183 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 20
18	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the CKP sensor circuits at the harness connector of the ECM (pins 90, 98 and 101 of B-233 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 21
19	1. Inspect the CKP sensor for tightness. Retest if the sensor was loose. 2. Remove the CKP sensor and check for damage, metal particles on magnet and for flywheel circumference damage. Did you find and correct the condition?	—	Go to Step 22	Go to Step 20
20	Replace the CKP sensor. Refer to Crankshaft Position Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 22	—
21	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 22	—
22	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 23
23	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0335 (Symptom Code E) (Flash Code 43)

Circuit Description

The crankshaft position (CKP) sensor is located on top of the flywheel housing. The engine control module (ECM) calculates the engine speed and exact position of the crankshaft based on the signal from the CKP sensor. If the ECM detects an engine overrun condition, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the engine speed is higher than 5700 RPM for 0.2 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM cuts fuel injection.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- Ensure the sensor is tight and the flywheel circumference is not damaged.

Notice:

- This DTC is caused by an engine overspeed condition, which was most likely caused by driver error (i.e. downshifting a manual transmission on a steep grade). Ensure there are no signs of engine damage. Excessive engine overspeed may damage internal engine components.

DTC P0335 (Symptom Code E) (Flash Code 43)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Start the engine. 3. Observe the Engine Speed parameter with the Tech 2. 4. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the Tech 2. Does the Engine Speed parameter ever exceed the specified value?	5000 RPM	Go to Step 4	Go to Step 3
3	Ask the driver if overrun is caused by gear slip-out, shift error, down-slope diving, etc. If engine overrun has experienced, the engine must be inspected and repaired as necessary. Did you complete the action?	—	Go to Step 7	—
4	1. Remove the crankshaft position (CKP) sensor. Refer to CKP Sensor replacement in this section. 2. Visually inspect the CKP sensor for the following conditions: • For physical damage • For being loose • For improper installation Did you find and correct the condition?	—	Go to Step 7	Go to Step 5
5	Visually inspect the flywheel circumference for damage. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6

Step	Action	Value(s)	Yes	No
6	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Observe the Engine Speed parameter with the Tech 2. 6. Accelerate the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the Tech 2. Does the Engine Speed parameter ever exceed the specified value?	5000 RPM	Go to Step 4	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0380 (Symptom Code 4) (Flash Code 66)

Circuit Description

The engine control module (ECM) controls the glow relay which supplies power to the glow plugs based on engine coolant temperature. In the after glow phase, the glow indicator light is not illuminated but glow plugs remain active for a certain period. If the ECM detects an open circuit or short to ground on the glow relay control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the low voltage condition on the glow relay control circuit for longer than 3 seconds when the relay is commanded OFF.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Notice:

- The glow relay is commanded OFF with ignition ON and engine OFF when the engine coolant temperature is reached at 30°C (86°F).
- The glow relay is commanded OFF with engine run when the engine coolant temperature is reached at 30°C (86°F).

DTC P0380 (Symptom Code 4) (Flash Code 66)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Perform the Glow Relay test with the Tech 2. 4. Command the Glow Relay ON with the Tech 2. Does the glow relay click when commanded ON with the Tech 2?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Replace the glow relay with the starter relay or replace with a known good relay. 3. Turn ON the ignition, with the engine OFF. 4. Command the Glow Relay ON with the Tech 2. Does the glow relay click when commanded ON with the Tech 2?	—	Go to Step 10	Go to Step 4
4	1. Turn OFF the ignition. 2. Remove the glow relay. 3. Connect a test lamp between the voltage feed circuit of the glow relay coil side (pin 4 of X-20 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 7

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Connect a test lamp between the control circuit of the glow relay (pin 5 of X-20 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp continuously illuminate (the test lamp blinks then goes out normally if the engine coolant temperature lower than 30°C [86°F])?	—	Go to Step 8	Go to Step 6
6	1. Keep the test lamp with connected. 2. Command the Glow Relay ON with the Tech 2. Does the test lamp illuminate when commanded ON with the Tech 2?	—	Go to Step 10	Go to Step 9
7	Repair the voltage feed circuit between the ECM main relay (pin 5 of X-14 connector) and the glow relay (pin 4 of X-20 connector) for an open circuit or high resistance. Did you complete the repair?	—	Go to Step 14	—
8	1. Test the control circuit of the glow relay between the engine control module (ECM) (pin 94 of B-233 connector) and the glow relay (pin 5 of X-20 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
9	1. Test the control circuit of the glow relay between the ECM (pin 94 of B-233 connector) and the glow relay (pin 5 of X-20 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
10	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections on the glow relay terminals (pins 4 and 5 of X-20 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 12
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the glow relay control circuit at the harness connector of the ECM (pin 94 of B-233 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
12	Replace the glow relay. Did you complete the replacement?	—	Go to Step 14	—
13	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 14	—

Step	Action	Value(s)	Yes	No
14	1. Reconnect all previously disconnected relay or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine and warm up (allow engine coolant temperature to reach at least 35°C [95°F]). 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 15
15	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0380 (Symptom Code 8) (Flash Code 66)

Circuit Description

The engine control module (ECM) controls the glow relay which supplies power to the glow plugs based on engine coolant temperature. In the after glow phase, the glow indicator light is not illuminated but glow plugs remain active for a certain period. If the ECM detects a short to battery or ignition voltage on the glow relay control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the high voltage condition on the glow relay control circuit for longer than 1 second when the relay is commanded ON.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Notice:

- The glow relay is commanded OFF with ignition ON and engine OFF when the engine coolant temperature is reached at 30°C (86°F).
- The glow relay is commanded OFF with engine run when the engine coolant temperature is reached at 30°C (86°F).

DTC P0380 (Symptom Code 8) (Flash Code 66)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Perform the Glow Relay test with the Tech 2. 4. Command the Glow Relay ON with the Tech 2. Does the glow relay click when commanded ON with the Tech 2?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Replace the glow relay with the starter relay or replace with a known good relay. 3. Turn ON the ignition, with the engine OFF. 4. Command the Glow Relay ON with the Tech 2. Does the glow relay click when commanded ON with the Tech 2?	—	Go to Step 5	Go to Step 4
4	1. Test the control circuit of the glow relay between the engine control module (ECM) (pin 94 of B-233 connector) and the glow relay (pin 5 of X-20 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Replace the glow relay. Did you complete the replacement?	—	Go to Step 7	—

Step	Action	Value(s)	Yes	No
6	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected relay or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Cool down the engine as necessary (allow engine coolant temperature to cool down at least 25°C [77°F]). 5. Start the engine. 6. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0381 (Symptom Code 4) (Flash Code 67)

Circuit Description

The glow indicator lamp is located on the instrument panel cluster (IPC). The glow control system is operated when the engine coolant temperature is low, which allows easier engine starting. If the ignition switch is turned ON when the engine coolant temperature is low, the engine control module (ECM) illuminates the glow indicator lamp and turns ON the glow plugs. After a fixed time passes, the ECM turns OFF the glow indicator lamp and the glow plugs. The ECM monitors the glow indicator lamp control circuit for conditions that are incorrect for the commanded state of the glow indicator lamp. If the ECM detects an open circuit or short to ground on the glow indicator control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the low voltage condition on the glow indicator lamp control circuit for longer than 3 seconds when the lamp is commanded OFF.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- The glow indicator lamp is commanded OFF with the ignition ON and engine OFF when the engine coolant temperature is reached at 30°C (86°F).

DTC P0381 (Symptom Code 4) (Flash Code 67)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Perform the Glow Indicator test with the Tech 2. 4. Command the Glow Indicator ON with the Tech 2. Does the glow indicator lamp turn ON when commanded ON with the Tech 2?	—	Go to Step 3	Go to Step 4
3	Command the Glow Indicator OFF with the Tech 2. Does the glow indicator lamp OFF?	—	Go to Step 17	Go to Step 10
4	1. Turn OFF the ignition. 2. Inspect the Meter (10A) fuse (F-16) in the glove box fuse block. Is the Meter (10A) fuse (F-16) open?	—	Go to Step 5	Go to Step 6
5	Replace the Meter (10A) fuse (F-16). If the fuse continues to open, repair the short to ground on one of the circuits that fed by the Meter (10A) fuse (F-16) or replace the shorted attached component fed by the Meter (10A) fuse (F-16). Did you complete the repair?	—	Go to Step 19	—

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Connect a 3-amp fused jumper wire between the glow indicator lamp control circuit of the ECM harness connector (pin 43 of B-234 connector) and a known good ground. Does the glow indicator lamp illuminate?	—	Go to Step 11	Go to Step 7
7	1. Turn OFF the ignition. 2. Remove the instrument panel cluster (IPC). 3. Remove the glow indicator bulb from the IPC (meter assembly). Is the glow indicator bulb burned out?	—	Go to Step 15	Go to Step 8
8	1. Disconnect the IPC harness B-51 connector. 2. Connect a test lamp between the voltage feed circuit of the glow indicator lamp (pin 8 of B-51 connector) and a known good ground. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 12
9	1. Turn OFF the ignition. 2. Reconnect the ECM harness connector. 3. Connect a test lamp between the voltage feed circuit and control circuit of the glow indicator lamp (pins 6 and 8 of B-51 connector). 4. Turn ON the ignition, with the engine OFF. 5. Perform the Glow Indicator test with the Tech 2. 6. Command the Glow Indicator ON with the Tech 2. Does the test lamp turn ON when commanded ON with the Tech 2?	—	Go to Step 14	Go to Step 13
10	1. Test the control circuit of the glow indicator lamp between the ECM (pin 43 of B-234 connector) and the IPC (pin 6 of B-51 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the glow indicator lamp control circuit at the harness connector of the ECM (pin 43 of B-234 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
12	Repair the open circuit or high resistance on the voltage feed circuit of the glow indicator lamp between the IPC (pin 8 of B-51 connector) and Meter (10A) fuse (F-16). Did you complete the repair?	—	Go to Step 19	—

Step	Action	Value(s)	Yes	No
13	1. Repair the open circuit or high resistance on the control circuit of the glow indicator lamp between the ECM (pin 43 of B-234 connector) and the IPC (pin 6 of B-51 connector). 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	—
14	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections on the glow indicator lamp circuits at the IPC (pins 6 and 8 of B-51 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
15	Replace the glow indicator bulb. Did you complete the replacement?	—	Go to Step 19	—
16	Repair or replace the IPC (meter assembly). Did you complete the repair or replacement?	—	Go to Step 19	—
17	1. Turn OFF the ignition for 30 seconds. 2. Turn ON the ignition for 30 seconds, with the engine OFF. 3. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 18	Go to Diagnostic Aids
18	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 19	—
19	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 20
20	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0381 (Symptom Code 8) (Flash Code 67)

Circuit Description

The glow indicator lamp is located on the instrument panel cluster (IPC). The glow control system is operated when the engine coolant temperature is low, which allows easier engine starting. If the ignition switch is turned ON when the engine coolant temperature is low, the engine control module (ECM) illuminates the glow indicator lamp and turns ON the glow plugs. After a fixed time passes, the ECM turns OFF the glow indicator lamp and the glow plugs. The ECM monitors the glow indicator lamp control circuit for conditions that are incorrect for the commanded state of the glow indicator lamp. If the ECM detects a short to battery or ignition voltage on the glow indicator control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the high voltage condition on the glow indicator lamp control circuit for longer than 1 second when the lamp is commanded ON.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- The glow indicator lamp is commanded OFF with the ignition ON and engine OFF when the engine coolant temperature is reached at 30°C (86°F).

Test Description

The number below refers to the step number on the diagnostic table.
3. If the control circuit of the glow indicator lamp between the ECM and the IPC is normal, the control circuit voltage low DTC P0381 (Symptom Code 4) will set.

DTC P0381 (Symptom Code 8) (Flash Code 67)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Perform the Glow Indicator test with the Tech 2. 4. Command the Glow Indicator ON with the Tech 2. Does the glow indicator lamp turn ON when commanded ON with the Tech 2?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Remove the instrument panel cluster (IPC) in order to disconnect the IPC harness B-51 connector. 3. Disconnect the IPC harness B-51 connector. 4. Turn ON the ignition for 30 seconds, with the engine OFF. 5. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does DTC P0381 (Symptom Code 4) set, but not DTC P0381 (Symptom Code 8)?	—	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the control circuit of the glow indicator lamp between the engine control module (ECM) (pin 43 of B-234 connector) and the IPC (pin 6 of B-51 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Repair or replace the IPC (meter assembly). Did you complete the repair or replacement?	—	Go to Step 7	—
6	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Cool down the engine as necessary (allow engine coolant temperature to cool down at least 25°C [77°F]). 5. Turn ON the ignition, with the engine OFF. 6. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0400 (Symptom Code 3) (Flash Code 32)

Circuit Description

The engine control module (ECM) controls the exhaust gas recirculation (EGR) flow amount based on the engine speed, engine coolant temperature, intake air temperature, barometric pressure and fuel injection quantity. The ECM controls the EGR valve by controlling the EGR solenoid valve. The mass air flow (MAF) sensor monitors EGR gas flow amount. An expected MAF amount should be detected while the engine running. If the ECM detects the actual MAF amount is lower than desired MAF amount, this DTC will set. This indicates excessive amount of EGR gas flow.

Condition for Running the DTC

- The ignition switch is ON.
- The engine is running.
- The barometric pressure (BARO) is between 880 hPa and 1100 hPa.
- The intake air temperature (IAT) is between 16°C (61°F) and 34°C (93°F).
- The ECT is between 70°C (158°F) and 100°C (211°F).

Condition for Setting the DTC

- The ECM detects that the MAF amount is 150 mg/strk lower than the desired MAF for 60 seconds. This indicates excessive amount of EGR flow.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits fuel injection quantity.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- A sticking or intermittently sticking the EGR valve will cause this DTC to set.
- Misrouted vacuum hoses will cause this DTC to set.

DTC P0400 (Symptom Code 3) (Flash Code 32)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and let idle for 30 seconds. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0100 (Symptom Code 7, 9, B or C) or P0400 (Symptom Code 4 or 8) set?	—	Go to Applicable DTC	Go to Step 3
3	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and warm up (allow engine coolant temperature to reach at least 75°C [167°F]). 4. Perform the EGR Solenoid Valve test with the Tech 2. 5. Command the EGR Solenoid Valve ON and OFF with the Tech 2 while observing the Mass Air Flow (MAF) Sensor parameter. Does the MAF Sensor parameter decrease by at least 200 mg/strk within 2 seconds when the EGR Solenoid Valve is commanded ON?	—	Go to Diagnostic Aids	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Inspect for the following conditions: • An EGR valve control vacuum hose is damaged or kinked. • An EGR solenoid valve vacuum hose and ventilation hose that is damaged or kinked. • An EGR valve is stuck open. • Any type of restriction in the exhaust system. • Air leakage around the MAF sensor or debris in the sensor housing. • Air leaking around any of the air induction tubing between the MAF sensor and intake manifold. • Turbine shaft binding causing lower turbocharger shaft spinning speeds. Refer to the Turbocharger in Engine Mechanical section for diagnosis. • Restricted air cleaner element, restricted or collapsed air tubing between the air cleaner and the turbocharger. • Oil in the air tubing causing an incorrect MAF sensor signal. When there is adhesion of oil, inside of the tubing, intercooler and turbocharger needs to be wiped off. • Contaminated, skewed or slow MAF sensor. 3. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the EGR valve control vacuum hose from the EGR valve. 3. Connect a hand-held vacuum pump (5-8840-0279-0/J-23738-A) to the disconnected vacuum hose. 4. Start the engine and let engine idle. 5. Perform the EGR Solenoid Valve test with the Tech 2. 6. Command the EGR Solenoid Valve ON and OFF with the Tech 2. Does the hand-held vacuum pump indicate more than 50 cmHg (20 inHg) when commanding the ON and less than 10 cmHg (4 inHg) when commanding OFF?	—	Go to Step 6	Go to Step 9

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Disconnect the hand-held vacuum pump from the vacuum hose. 3. Connect the hand-held vacuum pump to the vacuum port of EGR valve. 4. Start the engine and let engine idle. 5. Apply vacuum pressure to the EGR valve while observing the MAF Sensor parameter. Does the MAF Sensor parameter decrease by at least 200 mg/strk when the vacuum pressure is applied?	—	Go to Diagnostic Aids	Go to Step 7
7	1. Turn OFF the ignition. 2. Disconnect the MAF sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the MAF sensor (pins 2, 4 and 5 of J-182 connector). 4. Disconnect the engine control module (ECM) harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each MAF sensor circuit at the harness connector of the ECM (pins 83 and 88 of B-233 connector). 6. Test for high resistance on each MAF sensor circuit. 7. Test the MAF sensor signal circuit short to intake air temperature (IAT) sensor signal. 8. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
8	Replace the EGR valve. Refer to EGR Valve Replacement in engine mechanical section. Did you complete the replacement?	—	Go to Step 10	—
9	Replace the EGR solenoid valve. Refer to EGR Solenoid Valve Replacement in this section. Did you complete the replacement?	—	Go to Step 10	—
10	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine and warm up (allow engine coolant temperature to reach at least 75°C [167°F]) while observing the MAF Sensor parameter with the Tech 2. Does the MAF Sensor parameter follow the Desired MAF parameter within 50 mg/strk?	—	Go to Step 11	Go to Step 2
11	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0400 (Symptom Code 4) (Flash Code 32)

Circuit Description

The engine control module (ECM) controls the exhaust gas recirculation (EGR) flow amount based on the engine speed, engine coolant temperature, intake air temperature, barometric pressure and fuel injection quantity. The ECM controls the EGR valve by controlling the EGR solenoid valve. The mass air flow (MAF) sensor monitors EGR gas flow amount. An expected MAF amount should be detected while the engine running. If the ECM detects that an open circuit or short to ground on the EGR solenoid valve control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the low voltage condition on the EGR solenoid valve control circuit for longer than 3 seconds when the solenoid valve is commanded OFF.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits fuel injection quantity.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0400 (Symptom Code 4) (Flash Code 32)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the EGR control solenoid valve harness connector. 3. Connect a test lamp between the voltage feed circuit of the EGR control solenoid valve harness (pin 1 of J-105 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 4	Go to Step 6
4	1. Connect a test lamp between the control circuit of the EGR solenoid valve harness (pin 2 of J-105 connector) and battery voltage. 2. Perform the EGR Solenoid Valve test with the Tech 2. 3. Command the EGR Solenoid Valve ON with the Tech 2. Does the test lamp illuminate when commanded ON with the Tech 2?	—	Go to Step 5	Go to Step 7

Step	Action	Value(s)	Yes	No
5	Command the EGR Solenoid Valve OFF with the Tech 2. Does the test lamp continuously illuminate same as Step 4 when commanded OFF with the Tech 2 (the test lamp slightly illuminates if the circuit is normal when commanded OFF)?	—	Go to Step 8	Go to Step 9
6	Repair the open circuit or high resistance on the voltage feed circuit between the ECM main relay (pin 5 of X-14 connector) and the EGR solenoid valve (pin 1 of J-105 connector). Did you complete the repair?	—	Go to Step 13	—
7	1. Test the control circuit between the engine control module (ECM) (pin 97 of B-233 connector) and the EGR solenoid valve (pin 2 of J-105 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
8	1. Test the control circuit between the ECM (pin 97 of B-233 connector) and the EGR solenoid valve (pin 2 of J-105 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
9	1. Turn OFF the ignition. 2. Disconnect the EGR solenoid valve harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the EGR solenoid valve (pins 1 and 2 of J-105 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the EGR solenoid valve control circuit at the harness connector of the ECM (pin 97 of B-233 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the EGR solenoid valve. Refer to EGR Solenoid Valve Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—

Step	Action	Value(s)	Yes	No
13	1. Reconnect all previously disconnected or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0400 (Symptom Code 5) (Flash Code 32)

Circuit Description

The engine control module (ECM) controls the exhaust gas recirculation (EGR) flow amount based on the engine speed, engine coolant temperature, intake air temperature, barometric pressure and fuel injection quantity. The ECM controls the EGR valve by controlling the EGR solenoid valve. The mass air flow (MAF) sensor monitors EGR gas flow amount. An expected MAF amount should be detected while the engine running. If the ECM detects the actual MAF amount is higher than desired MAF amount, this DTC will set. This indicates insufficient amount of EGR gas flow.

Condition for Running the DTC

- The ignition switch is ON.
- The engine is running.
- The barometric pressure (BARO) is between 880 hPa and 1100 hPa.
- The intake air temperature (IAT) is between 16°C (61°F) and 34°C (93°F).
- The ECT is between 70°C (158°F) and 100°C (211°F).

Condition for Setting the DTC

- The ECM detects that the MAF amount is 150 mg/strk higher than the desired MAF for 60 seconds. This indicates insufficient amount of EGR flow.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits fuel injection quantity.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- A sticking or intermittently sticking the EGR valve will cause this DTC to set.
- Misrouted vacuum hoses will cause this DTC to set.
- A vacuum pump problem will cause this DTC to set.

DTC P0400 (Symptom Code 5) (Flash Code 32)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and let idle for 30 seconds. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0100 (Symptom Code 7, 9, B or C) or P0400 (Symptom Code 4 or 8) set?	—	Go to Applicable DTC	Go to Step 3
3	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and warm up (allow engine coolant temperature to reach at least 75°C [167°F]). 4. Perform the EGR Solenoid Valve test with the Tech 2. 5. Command the EGR Solenoid Valve ON and OFF with the Tech 2 while observing the Mass Air Flow (MAF) Sensor parameter. Does the MAF Sensor parameter decrease by at least 200 mg/strk within 2 seconds when the EGR Solenoid Valve is commanded ON?	—	Go to Diagnostic Aids	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Inspect for the following conditions: • An EGR valve control vacuum hose is damaged or kinked. • An EGR solenoid valve control vacuum hose and ventilation hose that is damaged or kinked. • An EGR valve is stuck close. • Restricted or collapsed EGR passage between the exhaust manifold and EGR valve. • A vacuum hose from the vacuum pump is damaged or kinked. • A vacuum pump is damaged. • Oil in the air tubing causing an incorrect MAF sensor signal. When there is adhesion of oil, inside of the tubing, intercooler and turbocharger needs to be wiped off. • Contaminated or skewed MAF sensor. 3. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the EGR valve control vacuum hose from the EGR valve. 3. Connect a hand-held vacuum pump (5-8840-0279-0/J-23738-A) to the disconnected vacuum hose. 4. Start the engine and let engine idle. 5. Perform the EGR Solenoid Valve test with the Tech 2. 6. Command the EGR Solenoid Valve ON and OFF with the Tech 2. Does the hand-held vacuum pump indicate more than 50 cmHg (20 inHg) when commanding the ON and less than 10 cmHg (4 inHg) when commanding OFF?	—	Go to Step 6	Go to Step 9
6	1. Turn OFF the ignition. 2. Disconnect the hand-held vacuum pump from the vacuum hose. 3. Connect the hand-held vacuum pump to the vacuum port of EGR valve. 4. Start the engine and let engine idle. 5. Apply vacuum pressure to the EGR valve while observing the MAF Sensor parameter. Does the MAF Sensor parameter decrease by at least 200 mg/strk when the vacuum pressure is applied?	—	Go to Diagnostic Aids	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Turn OFF the ignition. 2. Disconnect the MAF sensor harness connector. 3. Inspect for an intermittent, for a poor connection and corrosion at the harness connector of the MAF sensor (pin 3 of J-182 connector). 4. Disconnect the engine control module (ECM) harness connector. 5. Inspect for an intermittent, for a poor connection and corrosion on each MAF sensor circuit at the harness connector of the ECM (pin 92 of B-233 connector). 6. Test for high resistance on each MAF sensor circuit. 7. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
8	Replace the EGR valve. Refer to EGR Valve Replacement in engine mechanical section. Did you complete the replacement?	—	Go to Step 10	—
9	Replace the EGR solenoid valve. Refer to EGR Solenoid Valve Replacement in this section. Did you complete the replacement?	—	Go to Step 10	—
10	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine and warm up (allow engine coolant temperature to reach at least 75°C [167°F]) while observing the MAF Sensor parameter with the Tech 2. Does the MAF Sensor parameter follow the Desired MAF parameter within 50 mg/strk?	—	Go to Step 11	Go to Step 2
11	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0400 (Symptom Code 8) (Flash Code 32)

Circuit Description

The engine control module (ECM) controls the exhaust gas recirculation (EGR) flow amount based on the engine speed, engine coolant temperature, intake air temperature, barometric pressure and fuel injection quantity. The ECM controls the EGR valve by controlling the EGR solenoid valve. The mass air flow (MAF) sensor monitors EGR gas flow amount. An expected MAF amount should be detected while the engine running. If the ECM detects a short to battery or ignition voltage on the EGR solenoid valve control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the high voltage condition on the EGR solenoid valve control circuit for longer than 3 seconds when the solenoid valve is commanded ON.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits fuel injection quantity.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The number below refers to the step number on the diagnostic table.
3. If the control circuit of the EGR solenoid valve between the ECM and the solenoid valve is normal, the control circuit voltage low DTC P0400 (Symptom Code 4) will set.

DTC P0400 (Symptom Code 8) (Flash Code 32)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and warm up (allow engine coolant temperature to reach at least 75°C [167°F]). 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the EGR control solenoid valve harness connector. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. Does the DTC P0400 (Symptom Code 4) set, but not DTC P0400 (Symptom Code 8)?	—	Go to Step 5	Go to Step 4
4	1. Test the control circuit between the engine control module (ECM) (pin 97 of B-233 connector) and the EGR solenoid valve (pin 2 of J-105 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6

Step	Action	Value(s)	Yes	No
5	Replace the EGR solenoid valve. Refer to EGR Solenoid Valve Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine and warm up (allow engine coolant temperature to reach at least 75°C [167°F]). 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0500 (Symptom Code 1, A) (Flash Code 24)

Circuit Description

The vehicle speed sensor (VSS) is used by the engine control module (ECM) and speedometer, which generates a speed signal from the transmission output shaft. The VSS has the following circuits.

- Ignition voltage feed circuit
- VSS signal circuit
- VSS low reference circuit

The VSS uses a hall effect element. It interacts with the magnetic field created by the rotating magnet and outputs square wave pulse signal. The ECM calculates the vehicle speed by the VSS. If the ECM detects VSS signals are generated with high frequencies, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the vehicle speed is higher than 190 km/h (119 MPH) for 5 seconds. (Symptom Code 1)
- The ECM detects that the vehicle speed sensor signal frequency is too high for 0.6 seconds. (Symptom Code A)

Action Taken When the DTC Sets

- The ECM does not illuminate the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses a vehicle speed substitution of 5 km/h (3 MPH) for engine control.

Condition for Clearing the DTC

- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- Electrical or magnetic interference may affect intermittent condition.
- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0500 (Symptom Code 1, A) (Flash Code 24)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Inspect all of the circuits going to the vehicle speed sensor (VSS) for the following: • Routed too closely to fuel injection solenoid wiring or components • Routed too closely to after-market add-on electrical equipment • Routed too closely to solenoids, relays, and motors 2. If you find incorrect routing, correct the harness routing. Did you find and correct the condition?	—	Go to Step 7	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the VSS harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the VSS (pins 1, 2 and 3 of J-32 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) harness connector. 3. Inspect for an intermittent and for a poor connection on VSS circuit at the harness connector of the ECM (pin 68 of B-234 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 5
5	1. Remove the VSS. Refer to Vehicle Speed Sensor (VSS) Replacement in this section. 2. Visually inspect the VSS for the following conditions: • Physical damage • Being loose • Improper installation 3. The following conditions may cause this DTC to set: • Electromagnetic interference in the VSS circuits 4. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
6	Replace the VSS. Refer to Vehicle Speed Sensor (VSS) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Drive the vehicle. 5. Observe the Vehicle Speed parameter with the Tech 2. Does the Vehicle Speed parameter indicate correct vehicle speed?	—	Go to Step 8	Go to Step 2
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0500 (Symptom Code B) (Flash Code 24)

Circuit Description

The vehicle speed sensor (VSS) is used by the engine control module (ECM) and speedometer, which generates a speed signal from the transmission output shaft. The VSS has the following circuits.

- Ignition voltage feed circuit
- VSS signal circuit
- VSS low reference circuit

The VSS uses a hall effect element. It interacts with the magnetic field created by the rotating magnet and outputs square wave pulse signal. The ECM calculates the vehicle speed by the VSS. If the ECM detects VSS signals are not generated, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The engine speed is higher than 3600 RPM.
- The fuel injection quantity is more than 41 mg/strk.

Condition for Setting the DTC

- The ECM detects that the vehicle speed is lower than 1.5 km/h (1 MPH) for 60 seconds.

Action Taken When the DTC Sets

- The ECM does not illuminate the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the DTC

- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- Electrical or magnetic interference may affect intermittent condition.
- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0500 (Symptom Code B) (Flash Code 24)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Drive the vehicle. 3. Observe the Vehicle Speed parameter with the Tech 2. Does the Vehicle Speed parameter indicate correct vehicle speed?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Inspect the Meter (10A) fuse (F-16) in the glove box fuse block. Is the Meter (10A) fuse (F-16) open?	—	Go to Step 4	Go to Step 5
4	Replace the Meter (10A) fuse (F-16). If the fuse continues to open, repair the short to ground on one of the circuits that fed by the Meter (10A) fuse (F-16) or replace the shorted attached component fed by the Meter (10A) fuse (F-16). Did you complete the repair?	—	Go to Step 18	—

Step	Action	Value(s)	Yes	No
5	1. Remove the vehicle speed sensor (VSS). Refer to Vehicle Speed Sensor (VSS) Replacement in this section. 2. Visually inspect the VSS for the following conditions: • Physical damage • Being loose • Improper installation • For transmission output shaft teeth damage 3. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 6
6	1. Turn OFF the ignition. 2. Disconnect the VSS harness connector. 3. Connect a test lamp between the ignition voltage feed circuit of the VSS harness (pin 1 of J-32 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 7	Go to Step 9
7	1. Keep the ignition switch ON. 2. Connect a test lamp between the ignition voltage feed circuit and low reference circuit of the VSS harness (pins 1 and 2 of J-32 connector). Does the test lamp illuminate?	—	Go to Step 8	Go to Step 10
8	1. Turn ON the ignition, with the engine OFF. 2. Intermittently jump the signal circuit of the VSS (pin 3 of J-32 connector) with a test lamp that is connected to a known good ground while monitoring the Vehicle Speed parameter with the Tech 2. Does the Tech 2 indicate any vehicle speed when the circuit is intermittently pulled to ground?	—	Go to Step 12	Go to Step 11
9	1. Test the VSS ignition voltage feed circuit between the VSS (pin 1 of J-32 connector) and the instrument panel cluster (IPC) (pin 3 of B-55 connector) for an open circuit or high resistance, then between the IPC (pin 8 of B-51 connector) and the Meter (10A) fuse (F-16) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 13
10	Repair the open or high resistance in the VSS low reference circuit between the VSS (pin 2 of J-32 connector) and ground terminal (B-7 terminal). Did you complete the repair?	—	Go to Step 18	—

Step	Action	Value(s)	Yes	No
11	1. Test the VSS signal circuit between the engine control module (ECM) (pin 68 of B-234 connector) and the VSS (pin 3 of J-32 connector). • An open circuit • A short to ground • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 14
12	1. Turn OFF the ignition. 2. Disconnect the VSS harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the VSS (pins 1, 2 and 3 of J-32 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 15
13	1. Turn OFF the ignition. 2. Disconnect the IPC B-51 and B-55 harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the IPC (pin 8 of B-51 and pin 3 of B-55 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 16
14	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the VSS signal circuit at the harness connector of the ECM (pin 68 of B-234 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 17
15	Replace the VSS. Refer to Vehicle Speed Sensor (VSS) Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—
16	Replace the IPC (meter assembly). Refer to Meter Replacement in electrical section. Did you complete the replacement?	—	Go to Step 18	—
17	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—

Step	Action	Value(s)	Yes	No
18	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Drive the vehicle. 5. Observe the Vehicle Speed parameter with the Tech 2. Does the Vehicle Speed parameter indicate correct vehicle speed?	—	Go to Step 19	Go to Step 3
19	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0560 (Symptom Code 1) (Flash Code 35)

Circuit Description

The engine control module (ECM) monitors the system voltage on the ECM main relay load supply voltage terminal to make sure that the voltage stays within the proper range. If the ECM detects an excessively high system voltage, this DTC will set.

Condition for Setting the DTC

- The ECM detects that the battery voltage feed circuit voltage is more than 20 volts.

Action Taken When the DTC Sets

- The ECM does not illuminate the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the DTC

- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- A charging system problem may set this DTC.
- Jump starting the vehicle or a battery charger may have set this DTC.

DTC P0560 (Symptom Code 1) (Flash Code 35)

Schematic Reference: Engine Controls Schematics & Starting and Charging Schematics

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	Was the vehicle recently jump started from 24 volts system?	—	Go to Step 8	Go to Step 4
4	1. Start the engine and let idle for 30 seconds. 2. Observe the System Voltage parameter with the Tech 2. Is the System Voltage parameter less than the specified value?	16 volts	Go to Diagnostic Aids	Go to Step 5
5	Test the charging system. Refer to Diagnosis of The Charging System in the Charging System Section. Did you find a charging system problem?	—	Go to Step 6	Go to Step 7
6	Repair the charging system. Refer to Diagnosis of The Charging System in the Charging System Section. Did you complete the repair?	—	Go to Step 8	—
7	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 8	—

Step	Action	Value(s)	Yes	No
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Observe the System Voltage parameter with the Tech 2. Is the System Voltage parameter less than the specified value?	16 volts	Go to Step 9	Go to Step 5
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0560 (Symptom Code 2) (Flash Code 35)

Circuit Description

The engine control module (ECM) monitors the system voltage on the ECM main relay load supply voltage terminal to make sure that the voltage stays within the proper range. If the ECM detects an excessively low system voltage, this DTC will set.

Condition for Setting the DTC

- The ECM detects that the battery voltage feed circuit voltage is less than 7 volts.

Action Taken When the DTC Sets

- The ECM does not illuminate the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the DTC

- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- A charging system problem may set this DTC.

DTC P0560 (Symptom Code 2) (Flash Code 35)

Schematic Reference: Engine Controls Schematics & Starting and Charging Schematics
Connector End View Reference: Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Start the engine and let idle for 30 seconds. 2. Load the electrical system by turning ON the headlights, A/C, etc. 3. Observe the System Voltage parameter with the Tech 2. Is the System Voltage parameter more than the specified value?	10 volts	Go to Diagnostic Aids	Go to Step 4
4	Test the charging system. Refer to Diagnosis of The Charging System in the Charging System Section. Did you find a charging system problem?	—	Go to Step 5	Go to Step 6
5	Repair the charging system. Refer to Diagnosis of The Charging System in the Charging System Section. Did you complete the repair?	—	Go to Step 8	—
6	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent, for a poor connection and corrosion on the battery voltage feed at the harness connector of the ECM (pin 3 of B-234 connector). 4. Repair or clean the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7

Step	Action	Value(s)	Yes	No
7	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Load the electrical system by turning ON the headlights, A/C, etc. 6. Observe the System Voltage parameter with the Tech 2. Is the System Voltage parameter more than the specified value?	10 volts	Go to Step 9	Go to Step 4
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0560 (Symptom Code A) (Flash Code 35)

Circuit Description

The fuel injection pump control unit (PCU) monitors the system voltage on the engine control module (ECM) main relay load supply voltage terminal to make sure that the voltage stays within the proper range. If the ECM detects an excessively high or low system voltage, this DTC will set.

Condition for Setting the DTC

- The PCU detects that the battery voltage feed circuit voltage is less than 4.5 volts or more than 27 volts.

Action Taken When the DTC Sets

- The ECM does not illuminate the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the DTC

- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- A charging system problem may set this DTC.
- Jump starting the vehicle or a battery charger may have set this DTC.

Notice:

- PCU is part of the fuel injection pump assembly.

DTC P0560 (Symptom Code A) (Flash Code 35)

Schematic Reference: Engine Controls Schematics & Starting and Charging Schematics
Connector End View Reference: Engine Controls Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0560 (Symptom Code 1 or 2) set?	—	Go to Applicable DTC	Go to Step 3
3	1. Start the engine and let idle for 30 seconds. 2. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the fuel injection pump control unit (PCU) harness connector. 3. Inspect for an intermittent, for poor connections and corrosion on the voltage feed or ground at the harness connector of the PCU (pins 6 and 7 of E-110 connector). 4. Repair or clean the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Step 5
5	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. Did you complete the replacement?	—	Go to Step 6	—

Step	Action	Value(s)	Yes	No
6	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine and let idle for 30 seconds. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 7
7	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0561 (Symptom Code A) (Flash Code 18)

Circuit Description

The engine control module (ECM) main relay is energized when the ECM receives an ignition voltage switch ON signal. When the ignition switch is OFF, the ECM main relay is de-energized after a certain length of time passed. If the ECM detects the ignition voltage switch signal is changed to OFF during the ECM is energized, this DTC will set.

Condition for Setting the DTC

- The ECM detects that the ignition voltage circuit is changed ON to OFF during initialization.

Action Taken When the DTC Sets

- The ECM does not illuminate the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM turns OFF the ECM if the ignition voltage circuit is OFF even 1 second passes from the judgement.
- The ECM limits fuel injection quantity if the ignition voltage circuit is returned ON within 1 second from the judgement.

Condition for Clearing the DTC

- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Faulty or sticking ECM main relay may set this DTC.

Notice:

- Quick repetition ON and OFF of ignition switch may set this DTC.

Test Description

The numbers below refer to the step number on the diagnostic table.
2. If DTC P1625 (Symptom Code B) is present, Tech 2 can communicate with the ECM when the ignition switch is OFF.

DTC P0561 (Symptom Code A) (Flash Code 18)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1625 (Symptom Code B) set?	—	Go to Applicable DTC	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the ignition switch harness connector (B-67) to the ignition switch (behind the steering column). 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ignition switch (pins 2 and 3 of B-67 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) harness connector. 3. Inspect for an intermittent, for a poor connection and corrosion on ignition voltage feed circuit at the harness connector of the ECM (pin 39 of B-234 connector). 4. Test for high resistance on ignition voltage feed circuit. 5. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Step 5
5	Replace the ignition switch. Did you complete the replacement?	—	Go to Step 6	—
6	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Observe the DTC Information with the Tech 2. 6. Turn OFF the ignition. Does the DTC fail this ignition before the ECM turns OFF?	—	Go to Step 2	Go to Step 7
7	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0561 (Symptom Code B) (Flash Code 18)

Circuit Description

The engine control module (ECM) main relay is energized when the ECM receives an ignition voltage switch ON signal. When the ignition switch is OFF, the ECM main relay is de-energized after a certain length of time passed. If the ECM detects the ignition voltage switch signal is changed to OFF during the ECM is energized, this DTC will set.

Condition for Setting the DTC

- The ECM detects internal ignition voltage feed circuit is failed after initialization.

Action Taken When the DTC Sets

- The ECM does not illuminate the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM turns OFF the ECM.

Condition for Clearing the DTC

- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0561 (Symptom Code B) (Flash Code 18)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0602

Description

The engine control module (ECM) has the ability to set a diagnostic trouble code (DTC) if it detects that there is no vehicle identification (VIN) programmed.

Diagnostic Aids

Notice:

- Production and service ECM does not require software programming when it is replaced except calibration software update. This DTC indicates that a production or service ECM does not program VIN.

DTC P0602

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 6
3	**Important:** Blank engine control module (ECM) must be programmed. Program the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the programming?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 5	Go to Step 7
5	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 6	—
6	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 7
7	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0606 (Symptom Code A, B) (Flash Code 28)

Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM).

Condition for Running the DTC

Symptom Code B

- The accelerator pedal position is less than 1%.
- The desired fuel injection quantity is 0 mg/strk.

Condition for Setting the DTC

Symptom Code A

- The ECM detects that the internal CPU does not react.

Symptom Code B

- The ECM detects that the engine speed is higher than 2000 RPM.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM cuts fuel injection.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

DTC P0606 (Symptom Code A, B) (Flash Code 28)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0645 (Symptom Code 4) (Flash Code 46)

Circuit Description

The engine control module (ECM) controls the air conditioning (A/C) compressor relay, which supplies power to the A/C compressor clutch based on A/C request input to the ECM from the heating, ventilation and air conditioning (HVAC) controls. The ECM commands the A/C compressor relay ON at engine run. If the ECM detects an open circuit or short to ground on the A/C compressor relay control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The A/C compressor relay is once commanded ON.

Condition for Setting the DTC

- The ECM detects a low voltage condition on the A/C compressor relay control circuit for longer than 3 seconds when the relay is commanded OFF.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- The A/C compressor relay is commanded OFF when the engine coolant temperature is reached around 115°C (239°F) and it commanded ON again below 110°C (230°F).

DTC P0645 (Symptom Code 4) (Flash Code 46)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and let idle. 4. Turn ON the blower motor switch and the A/C compressor switch. 5. Turn OFF the A/C compressor switch. 6. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Replace the A/C compressor relay with the marker light relay or replace with a known good relay. 3. Start the engine and let idle. 4. Turn ON the blower motor switch and the A/C compressor switch. 5. Turn OFF the A/C compressor switch. 6. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 4	Go to Step 12

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Remove the A/C compressor relay. 3. Connect a test lamp between the voltage feed circuit of the A/C compressor relay coil side (pin 4 of X-24 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 7
5	1. Turn OFF the ignition. 2. Connect a test lamp between the A/C compressor relay control circuit (pin 2 of X-24 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 6
6	1. Keep the test lamp with connected. 2. Start the engine. 3. Turn ON the blower motor switch and the A/C compressor switch. Does the test lamp illuminate when the A/C Compressor Relay parameter is ON?	—	Go to Step 10	Go to Step 9
7	Repair the open circuit or high resistance on the voltage feed circuit between the ECM main relay (pin 5 of X-14 connector) and the A/C compressor relay (pin 4 of X-24 connector). Did you complete the repair?	—	Go to Step 14	—
8	1. Test the control circuit of the A/C compressor relay between the ECM (pin 41 of B-234 connector) and the A/C compressor relay (pin 2 of X-24 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
9	1. Test the control circuit of the A/C compressor relay between the engine control module (ECM) (pin 41 of B-234 connector) and the A/C compressor relay (pin 2 of X-24 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
10	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections on the A/C compressor relay terminal (pins 2 and 4 of X-24 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 12
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the A/C compressor relay control circuit at the harness connector of the ECM (pin 41 of B-234 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13

Step	Action	Value(s)	Yes	No
12	Replace the A/C compressor relay. Did you complete the replacement?	—	Go to Step 14	—
13	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 14	—
14	1. Reconnect all previously disconnected fuse, relay or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine and let idle. 5. Turn ON the blower motor switch and the A/C compressor switch. 6. Turn OFF the A/C compressor switch. 7. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 15
15	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0645 (Symptom Code 8) (Flash Code 46)

Circuit Description

The engine control module (ECM) controls the air conditioning (A/C) compressor relay, which supplies power to the A/C compressor clutch based on A/C request input to the ECM from the heating, ventilation and air conditioning (HVAC) controls. The ECM commands the A/C compressor relay ON at engine run. If the ECM detects a short to battery or ignition voltage on the A/C compressor relay control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The A/C compressor relay is once commanded ON.

Condition for Setting the DTC

- The ECM detects a high voltage condition on the A/C compressor relay control circuit for longer than 3 seconds when the relay is commanded ON.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- The A/C compressor relay is commanded OFF when the engine coolant temperature is reached around 115°C (239°F) and it commanded ON again below 110°C (230°F).

DTC P0645 (Symptom Code 8) (Flash Code 46)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Turn ON the blower motor switch and the A/C compressor switch. 5. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2 when the A/C Relay Command parameter is ON. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Replace the A/C compressor relay with the marker light relay or replace with a known good relay. 3. Start the engine. 4. Turn ON the blower motor switch and the A/C compressor switch. 5. Monitor the DTC Information with the Tech 2 when the A/C Relay Command parameter is ON. Does the DTC fail this ignition?	—	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	1. Test the control circuit of the A/C compressor relay between the ECM (pin 41 of B-234 connector) and the A/C compressor relay (pin 2 of X-24 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Replace the A/C compressor relay. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected relay or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Turn ON the blower motor switch and the A/C compressor switch. 6. Monitor the DTC Information with the Tech 2 when the A/C Relay Command parameter is ON. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0703 (Symptom Code A, B) (Flash Code 25)

Circuit Description

The brake pedal switch is installed on the brake pedal bracket. The brake pedal 1 switch is a normally open type switch and the brake pedal 2 switch is a normally closed type switch. When the brake pedal is pressed, the brake pedal 1 switch signal is provided to the engine control module (ECM) and the stoplights are turned ON. Then, the brake pedal 2 switch signal to the ECM is stopped (low voltage). If the ECM detects the brake switch signals out of correlation, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The engine speed is higher than 1500 RPM.
- The accelerator pedal position is more than 10%.
- The vehicle speed is higher than 15 km/h (9 MPH).

Condition for Setting the DTC

- The ECM detects that the brake pedal 1 switch (normally open type switch) signal and brake pedal 2 switch (normally closed type switch) signal correlation error for longer than 30 seconds within the enabling conditions ever since ignition switch is ON. (Symptom Code A)
- The ECM detects that the brake pedal 1 switch (normally open type switch) signal and brake pedal 2 switch (normally closed type switch) signal correlation error for longer than 30 seconds. (Symptom Code B)

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Misadjusted brake pedal switch will cause this DTC to set.

DTC P0703 (Symptom Code A, B) (Flash Code 25)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Brake Pedal 1 Switch parameter with the Tech 2 while fully depressing and releasing the brake pedal. Does the Tech 2 indicate Applied when the brake pedal is applied and Released when the brake pedal is released?	—	Go to Step 10	Go to Step 3
3	1. Check to ensure the brake pedal switch is adjusted correctly. The plunger should be all the way in when the pedal is released, yet should not impede with the brake pedal full upward travel. 2. Adjust the brake pedal switch as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 4
4	1. Turn OFF the ignition. 2. Inspect the Stop Light (10A) fuse (F-5) in the glove box fuse block. Is the Stop Light (10A) fuse (F-5) open?	—	Go to Step 5	Go to Step 6

Step	Action	Value(s)	Yes	No
5	Replace the Stop Light (10A) fuse (F-5). If the fuse continues to open, repair the short to ground on one of the circuits that is fed by the Stop Light (10A) fuse (F-5) or replace the shorted attached component fed by the Stop Light (10A) fuse (F-5). Did you complete the repair?	—	Go to Step 20	—
6	1. Turn OFF the ignition. 2. Disconnect the brake pedal switch harness connector. 3. Connect a test lamp between the voltage feed circuit of the brake pedal 1 switch harness (pin 1 of B-66 connector) and a known good ground. Does the test lamp illuminate?	—	Go to Step 7	Go to Step 8
7	1. Turn ON the ignition, with the engine OFF. 2. Observe the Brake Pedal 1 Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the brake pedal 1 switch harness connector between pins 1 and 4 of the B-66 connector. Does the Tech 2 indicate Applied when the circuit is jumpered and Released when the circuit is not jumpered?	—	Go to Step 16	Go to Step 9
8	Repair the open circuit or high resistance on the voltage feed circuit between the Stop Light (10A) fuse (F-5) and the brake pedal 1 switch (pin 1 of B-66 connector). Did you complete the repair?	—	Go to Step 20	—
9	1. Test the brake pedal 1 switch signal circuit between the ECM (pin 30 of B-234 connector) and the brake pedal 1 switch (pin 4 of B-66 connector) for the following conditions: • An open circuit • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 17
10	Observe the Brake Pedal 2 Switch parameter with the Tech 2 while fully depressing and releasing the brake pedal. Does the Tech 2 indicate Applied when the brake pedal is applied and Released when the brake pedal is released?	—	Go to Diagnostic Aids	Go to Step 11
11	1. Check to ensure the brake pedal switch is adjusted correctly. The plunger should be all the way in when the pedal is released, yet should not impede with the brake pedal full upward travel. 2. Adjust the brake pedal switch as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 12

Step	Action	Value(s)	Yes	No
12	1. Turn OFF the ignition. 2. Disconnect the brake pedal switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the voltage feed circuit of the brake pedal 2 switch harness (pin 2 of B-66 connector) and a known good ground. Does the test lamp illuminate?	—	Go to Step 13	Go to Step 14
13	1. Turn ON the ignition, with the engine OFF. 2. Observe the Brake Pedal 2 Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the brake pedal 2 switch harness connector between pins 2 and 3 of the B-66 connector. Does the Tech 2 indicate Released when the circuit is jumpered and Applied when the circuit is not jumpered?	—	Go to Step 16	Go to Step 15
14	Repair the open circuit or high resistance on the voltage feed circuit between the ECM main relay (pin 5 of X-14 connector) and the brake pedal 2 switch (pin 2 of B-66 connector). Did you complete the repair?	—	Go to Step 20	—
15	1. Test the brake pedal 2 switch signal circuit between the ECM (pin 65 of B-234 connector) and the brake pedal 2 switch (pin 3 of B-66 connector) for the following conditions: • An open circuit • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 17
16	1. Turn OFF the ignition. 2. Disconnect the brake pedal switch harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the brake pedal switch (pins 1, 2, 3 and 4 of B-66 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 18
17	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the brake switch circuits at the harness connector of the ECM (pins 30 and 65 of B-234 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 20	Go to Step 19
18	Replace brake pedal switch. Refer to Brake Switch Replacement in this section. Did you complete the replacement?	—	Go to Step 20	—

Step	Action	Value(s)	Yes	No
19	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 20	—
20	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Brake Pedal 1 Switch and the Brake Pedal 2 Switch with the Tech 2 while fully depressing and releasing the brake pedal. Does the Tech 2 indicate Applied when the brake pedal is applied and Released when the brake pedal is released?	—	Go to Step 21	Go to Step 2
21	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0704 (Symptom Code 6) (Flash Code 57)

Circuit Description

The clutch pedal switch is installed on the clutch pedal bracket. The clutch pedal switch is a normally closed type switch. When the clutch pedal is pressed, the clutch pedal switch signal to the engine control module (ECM) is stopped (low voltage). If the ECM detects the clutch pedal switch signal does not change during a predetermined vehicle speed range, this DTC will set. This DTC will only run once per ignition cycle within the enabling condition.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the clutch pedal switch signal does not change during the vehicle speed changes between 5 km/h (3 MPH) and 80 km/h (50 MPH). This DTC will only run once per ignition cycle within the enabling condition.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Misadjusted clutch pedal switch will cause this DTC to set.

DTC P0704 (Symptom Code 6) (Flash Code 57)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Clutch Pedal Switch parameter with the Tech 2 while fully depressing and releasing the clutch pedal. Does the Tech 2 indicate Applied when the clutch pedal is applied and Released when the clutch pedal is released?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Check to ensure the clutch pedal switch is adjusted correctly. The plunger should be all the way in when the pedal is released, yet should not impede with the clutch pedal full upward travel. 2. Adjust the clutch pedal switch as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the clutch pedal switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Clutch Pedal Switch parameter with the Tech 2 while momentarily jumping across the clutch pedal switch harness connector between pins 1 and 2 of B-89 connector. Does the Tech 2 indicate Applied when the circuit is jumped and Released when the circuit is not jumped?	—	Go to Step 10	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Connect a test lamp between the ignition voltage feed circuit of the clutch pedal switch harness (pin 1 of B-89 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 7
6	1. Connect a test lamp between the signal circuit of the clutch pedal switch harness (pin 2 of B-89 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 9
7	Repair the open circuit or high resistance on the ignition voltage feed circuit between the ECM main relay (pin 5 of X-14 connector) and the clutch pedal switch (pin 1 of B-89 connector). Did you complete the repair?	—	Go to Step 14	—
8	1. Test the clutch pedal switch signal circuit between the engine control module (ECM) (pin 31 of B-234 connector) and the clutch pedal switch (pin 2 of B-89 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
9	1. Test the clutch pedal switch signal circuit between the ECM (pin 31 of B-234 connector) and the clutch pedal switch (pin 2 of B-89 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 11
10	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the clutch pedal switch (pins 1 and 2 of B-89 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 12
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the clutch pedal switch circuit at the harness connector of the ECM (pin 31 of B-234 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
12	Replace the clutch pedal switch. Refer to Clutch Pedal Switch Replacement in this section. Did you complete the replacement?	—	Go to Step 14	—

Step	Action	Value(s)	Yes	No
13	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 14	—
14	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Clutch Pedal Switch parameter with the Tech 2 while fully depressing and releasing the clutch pedal. Does the Tech 2 indicate Applied when the clutch pedal is applied and Released when the clutch pedal is released?	—	Go to Step 15	Go to Step 3
15	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1105 (Symptom Code 1) (Flash Code 86)

Circuit Description

The barometric pressure (BARO) sensor is installed inside of the engine control module (ECM) and converts the BARO into a voltage signal. The ECM uses this voltage signal to calibrate the fuel injection quantity and injection timing for altitude compensation. If the ECM detects an excessively high BARO sensor signal voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the BARO sensor signal voltage is more than 4.4 volts for 1 second.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses a BARO substitution of 1013 hPa.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

DTC P1105 (Symptom Code 1) (Flash Code 86)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1105 (Symptom Code 2) (Flash Code 86)

Circuit Description

The barometric pressure (BARO) sensor is installed inside of the engine control module (ECM) and converts the BARO into a voltage signal. The ECM uses this voltage signal to calibrate the fuel injection quantity and injection timing for altitude compensation. If the ECM detects an excessively low BARO sensor signal voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the BARO sensor signal voltage is less than 1.5 volts for 1 second.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses a BARO substitution of 1013 hPa.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

DTC P1105 (Symptom Code 2) (Flash Code 86)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1110 (Symptom Code 4) (Flash Code 72)

Circuit Description

The engine control module (ECM) controls the exhaust brake which energizes the intake throttle solenoid valve and exhaust brake solenoid valve based on vehicle running condition. The ECM commands each solenoid valve to close each throttle valve by applying vacuum. If the ECM detects that an open circuit or short to ground on the intake throttle solenoid valve control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects a low voltage condition on the intake throttle solenoid valve control circuit for longer than 3 seconds when the solenoid valve is commanded OFF.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The number below refers to the step number on the diagnostic table.
5. If the intake throttle solenoid valve control circuit between the ECM and the solenoid valve is normal, voltage level high DTC P1110 (Symptom Code 8) will set.

DTC P1110 (Symptom Code 4) (Flash Code 72)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the intake throttle solenoid valve harness connector. 3. Connect a test lamp between the voltage feed circuit of the intake throttle solenoid valve harness (pin 1 of J-40 connector) and a known good ground. Does the test lamp illuminate?	—	Go to Step 4	Go to Step 6
4	1. Turn OFF the ignition. 2. Connect a test lamp between the control circuit of the intake throttle solenoid valve harness (pin 2 of J-40 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Connect a 3-amp fused jumper wire across the intake throttle solenoid valve harness connector between pins 1 and 2 of the J-40 connector. 2. Lift the driving wheels or drive the vehicle. 3. Let the vehicle run so that the exhaust brake may operate while observing the Intake Throttle Solenoid Command parameter with the Tech 2. Does DTC P1110 (Symptom Code 8) set when the exhaust brake is operating, but not DTC P1110 (Symptom Code 4)?	—	Go to Step 9	Go to Step 7
6	Repair the open circuit or high resistance on the voltage feed circuit between the ECM main relay (pin 5 of X-14 connector) and the intake throttle solenoid valve (pin 1 of J-40 connector). Did you complete the repair?	—	Go to Step 13	—
7	1. Test the control circuit between the engine control module (ECM) (pin 95 of B-233 connector) and the intake throttle solenoid valve (pin 2 of J-40 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
8	1. Test the control circuit between the ECM (pin 95 of B-233 connector) and the intake throttle solenoid valve (pin 2 of J-40 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
9	1. Turn OFF the ignition. 2. Disconnect the intake throttle solenoid valve harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the intake throttle solenoid valve (pins 1 and 2 of J-40 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the intake throttle solenoid valve control circuit at the harness connector of the ECM (pin 95 of B-233 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the intake throttle solenoid valve. Refer to Intake Throttle Solenoid Valve Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—

Step	Action	Value(s)	Yes	No
12	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1110 (Symptom Code 8) (Flash Code 72)

Circuit Description

The engine control module (ECM) controls the exhaust brake which energizes the intake throttle solenoid valve and exhaust brake solenoid valve based on vehicle running condition. The ECM commands each solenoid valve to close each throttle valve by applying vacuum. If the ECM detects that a short to battery or ignition voltage on the intake throttle solenoid valve control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects a high voltage condition on the intake throttle solenoid valve control circuit for longer than 3 seconds when the solenoid valve is commanded ON.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The number below refers to the step number on the diagnostic table.
3. If the intake throttle solenoid valve control circuit between the ECM and the solenoid valve is normal, voltage level low DTC P1110 (Symptom Code 4) will set.

DTC P1110 (Symptom Code 8) (Flash Code 72)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Lift the driving wheels or drive the vehicle. 4. Let the vehicle run so that the exhaust brake may operate while observing the Intake Throttle Solenoid Command with the Tech 2. Does the Diagnostic Trouble Code (DTC) fail this ignition when the exhaust brake is operating?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the intake throttle solenoid valve harness connector. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. Does DTC P1110 (Symptom Code 4) set, but not DTC P1110 (Symptom Code 8)?	—	Go to Step 5	Go to Step 4
4	1. Test the control circuit between the engine control module (ECM) (pin 95 of B-233 connector) and the intake throttle solenoid valve (pin 2 of J-40 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Replace the intake throttle solenoid valve. Refer to Intake Throttle Solenoid Valve Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—

Step	Action	Value(s)	Yes	No
6	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Lift the driving wheels or drive the vehicle. 5. Let the vehicle run so that the exhaust brake may operate while observing the Intake Throttle Solenoid Command with the Tech 2. Does the DTC fail this ignition when the exhaust brake is operating?	—	Go to Step 3	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1120 (Symptom Code 1) (Flash Code 21)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal bracket. The engine control module (ECM) uses the APP sensors to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injection control. The APP sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- APP sensor signal circuit

The ECM supplies 5 volts to the APP sensor on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The APP sensor provides a signal to the ECM on the APP sensor signal circuit, which is relative to the position changes of the accelerator pedal angle. The ECM monitors the APP sensor signal for voltages outside the normal range of the APP sensor. If the ECM detects an excessively high APP sensor signal voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the APP sensor signal voltage is more than 4.9 volts for 0.5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses an engine speed substitution of 1400 RPM.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1120 (Symptom Code 1) (Flash Code 21)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the accelerator pedal position (APP) sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Accelerator Pedal Position (APP) parameter with the Tech 2. Does the APP parameter less than the specified value?	1%	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Connect a test lamp between the low reference circuit of the APP sensor harness (pin 1 of B-80 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 11	Go to Step 8

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Connect a DMM between the 5 volts reference circuit of the APP sensor harness (pin 3 of B-80 connector) and a known good ground. 3. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 6	Go to Step 9
6	Is the DMM voltage less than the specified value at step 5?	5.3 volts	Go to Step 7	Go to Step 10
7	**Important:** The APP sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the engine control module (ECM) (pin 38 of E-234 connector) and the APP sensor (pin 2 of B- 80 connector) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
8	1. Test the low reference circuit between the ECM (pin 49 of B-234 connector) and the APP sensor (pin 1 of B-80 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 12
9	1. Test the 5 volts reference circuit between the ECM (pin 57 of B-234 connector) and the APP sensor (pin 3 of B-80 connector) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
10	1. Test the 5 volts reference circuit between the ECM (pin 57 of B-234 connector) and the APP sensor (pin 3 of B-80 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
11	1. Turn OFF the ignition. 2. Inspect for an intermittent and for a poor connection at the harness connector of the APP sensor (pin 1 of B-80 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13

Step	Action	Value(s)	Yes	No
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the APP sensor circuit at the harness connector of the ECM (pin 49 of B-234 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
13	Replace APP sensor. Refer to Accelerator Pedal Position (APP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 15	—
15	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Fully depress and release the accelerator pedal many times. 6. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 16
16	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1120 (Symptom Code 2) (Flash Code 21)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal bracket. The engine control module (ECM) uses the APP sensors to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injection control. The APP sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- APP sensor signal circuit

The ECM supplies 5 volts to the APP sensor on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The APP sensor provides a signal to the ECM on the APP sensor signal circuit, which is relative to the position changes of the accelerator pedal angle. The ECM monitors the APP sensor signal for voltages outside the normal range of the APP sensor. If the ECM detects an excessively low APP sensor signal voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the APP sensor signal voltage is less than 0.3 volts for 0.5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses an engine speed substitution of 1400 RPM.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The number below refers to the step number on the diagnostic table.
4. If the APP sensor signal circuit between the ECM and the sensor is normal, the sensor signal voltage high DTC P1120 (Symptom Code 1) will set.

DTC P1120 (Symptom Code 2) (Flash Code 21)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the accelerator pedal position (APP) sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit of the APP sensor harness (pin 3 of B-80 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.7 volts	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire across the APP sensor connector between pins 2 and 3 of the B-80 connector. 3. Turn ON the ignition, with the engine OFF. Does DTC P1120 (Symptom Code 1) set, but not P1120 (Symptom Code 2)?	—	Go to Step 7	Go to Step 6
5	1. Test the 5 volts reference circuit between the engine control module (ECM) (pin 57 of B-234 connector) and the APP sensor (pin 3 of B-80 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
6	1. Test the signal circuit between the ECM (pin 38 of E-234 connector) and the APP sensor (pin 2 of B-80 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
7	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the APP sensor (pins 2 and 3 of B-80 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 9
8	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connection on the APP sensor circuit at the harness connector of the ECM (pins 38 and 57 of B-234 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	Replace APP sensor. Refer to Accelerator Pedal Position (APP) Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 11	—
10	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 11	—

Step	Action	Value(s)	Yes	No
11	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Fully depress and release the accelerator pedal many times. 6. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 12
12	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1120 (Symptom Code 7) (Flash Code 21)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal bracket. The engine control module (ECM) uses the APP sensors to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injection control. The APP sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- APP sensor signal circuit

The ECM provides 5 volts reference voltage through the reference circuit to the APP sensor. The ECM monitors the voltage on the 5 volts reference circuit. If the ECM detects an excessively high APP sensor 5 volts reference voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

The ECM detects that the APP sensor voltage supply circuit is more than 5.2 volts for 0.5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses an engine speed substitution of 1400 RPM.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1120 (Symptom Code 7) (Flash Code 21)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Test the 5 volts reference circuit between the engine control module (ECM) (pin 57 of B-234 connector) and the accelerator pedal position (APP) sensor (pin 3 of B-80 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 5	Go to Step 4
4	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 5	—

Step	Action	Value(s)	Yes	No
5	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Fully depress and release the accelerator pedal many times. 6. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 6
6	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1120 (Symptom Code 9) (Flash Code 21)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal bracket. The engine control module (ECM) uses the APP sensors to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injection control. The APP sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- APP sensor signal circuit

The ECM provides 5 volts reference voltage through the reference circuit to the APP sensor. The ECM monitors the voltage on the 5 volts reference circuit. If the ECM detects an excessively high APP sensor 5 volts reference voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects that the APP sensor voltage supply circuit is less than 4.6 volts for 0.5 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses an engine speed substitution of 1400 RPM.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The number below refers to the step number on the diagnostic table.
3. If the APP sensor 5 volts reference circuit between the ECM and the sensor is normal, the sensor signal low DTC P1120 (Symptom Code 2) will set.

DTC P1120 (Symptom Code 9) (Flash Code 21)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the accelerator pedal position (APP) sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Depress and release the accelerator pedal. 5. Monitor the DTC Information with the Tech 2. Does DTC P1120 (Symptom Code 2) set, but not DTC P1120 (Symptom Code 9)?	—	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the 5 volts reference circuit between the engine control module (ECM) (pin 57 of B-234 connector) and the APP sensor (pin 3 of B-80 connector) for the following conditions: • A short to ground • A short to the low reference circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Replace the accelerator pedal position sensor. Refer to Accelerator Pedal Position Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Fully depress and release the accelerator pedal many times. 6. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1120 (Symptom Code D) (Flash Code 21)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal bracket. The engine control module (ECM) uses the APP sensors to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injection control. The APP sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- APP sensor signal circuit

The ECM supplies 5 volts to the APP sensor on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The APP sensor provides a signal to the ECM on the APP sensor signal circuit, which is relative to the position changes of the accelerator pedal angle.
The brake pedal switch is installed on the brake pedal bracket. The brake pedal 1 switch is a normally open type switch and the brake pedal 2 switch is a normally closed type switch. When the brake pedal is pressed, the brake pedal 1 switch signal is provided to the ECM and the stoplights are turned ON. Then, the brake pedal 2 switch signal to the ECM is stopped (low voltage).
If the ECM detects accelerator pedal or APP sensor signal is stuck while brake pedal is depressed, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The engine speed is higher than 1700 RPM.
- The vehicle speed is higher than 1.5 km/h (1 MPH).

Condition for Setting the DTC

- The ECM detects APP sensor angle is stationary more than 18%, then brake pedal is depressed for longer than 2 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses an engine speed substitution of 1400 RPM.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Misadjusted brake pedal switch may set this DTC.
- Misadjusted APP sensor may set this DTC.
- A sticking or intermittently sticking the pedal may set this DTC.

DTC P1120 (Symptom Code D) (Flash Code 21)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Was DTC P0703 (Symptom Code A or B) or P1120 (Symptom Code 1, 7, 9 or E) set?	—	Go to Applicable DTC	Go to Step 3
3	1. Turn ON the ignition, with the engine OFF. 2. Observe the Brake Pedal 1 Switch parameter with the Tech 2 while fully depressing and releasing the brake pedal. Does the Tech 2 indicate Applied when the brake pedal is applied and Released when the brake pedal is released?	—	Go to Step 9	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Check to ensure the brake pedal switch is adjusted correctly. The plunger should be all the way in when the pedal is released, yet should not impede with the brake pedal full upward travel. 2. Adjust the brake pedal switch as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the brake pedal switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Brake Pedal 1 Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the brake pedal 1 switch harness connector between pins 1 and 4 of the B-66 connector. Does the Tech 2 indicate Applied when the circuit is jumpered and Released when the circuit is not jumpered?	—	Go to Step 8	Go to Step 6
6	1. Test the brake pedal 1 switch signal circuit between the ECM (pin 30 of B-234 connector) and the brake pedal 1 switch (pin 4 of B-66 connector) for the following conditions: • An open circuit • A short to battery or ignition voltage • High resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 7
7	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the brake switch circuit at the harness connector of the ECM (pin 30 of B-234 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	Replace the brake pedal switch. Refer to Brake Pedal Switch Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—
9	1. Turn ON the ignition, with the engine OFF. 2. Fully depress and release the accelerator pedal many times while observing the Accelerator Pedal Position (APP) parameter with the Tech 2. Is the APP parameter smoothly changed within 0 to 100% when the accelerator pedal is depressed and released?	—	Go to Diagnostic Aids	Go to Step 10

Step	Action	Value(s)	Yes	No
10	1. Turn OFF the ignition. 2. Inspect for the following conditions: • APP sensor is misadjusted. • An accelerator pedal that is stuck depressed. 3. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
11	Replace the accelerator pedal position sensor. Refer to Accelerator Pedal Position Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Observe the APP parameter while fully depressing and releasing the accelerator pedal many times. 6. Also observe the Brake Pedal 1 Switch parameter with the Tech 2 while depressing and releasing the brake pedal. Does the Tech 2 indicate the APP parameter smoothly changed within 0 to 100% when the accelerator pedal is depressed and released, then Tech 2 indicate the Brake Pedal 1 Switch parameter Applied when the brake pedal is depressed and Released when the brake pedal is released?	—	Go to Step 14	Go to Step 2
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1120 (Symptom Code E) (Flash Code 21)

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal bracket. The engine control module (ECM) uses the APP sensors to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injection control. The APP sensor has the following circuits.

- 5 volts reference circuit
- Low reference circuit
- APP sensor signal circuit

The ECM supplies 5 volts to the APP sensor on the 5 volts reference circuit. The ECM also provides a ground on the low reference circuit. The APP sensor provides a signal to the ECM on the APP sensor signal circuit, which is relative to the position changes of the accelerator pedal angle.
The idle switch is also mounted on the accelerator pedal bracket. The idle switch is a normally closed type switch. When the accelerator pedal is released, the idle switch signal to the ECM is low voltage.
If the ECM detects the APP sensor signal and the idle switch out of correlation, this DTC will set.

Condition for Running the DTC

The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects APP sensor angle is more than 18%, then the idle switch is ON for longer than 0.6 seconds.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses an engine speed substitution of 1400 RPM.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1120 (Symptom Code E) (Flash Code 21)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Turn ON the ignition, with the engine OFF. 2. Observe the Idle Switch parameter with the Tech 2 while depressing and releasing the accelerator pedal. Does the Tech 2 indicate OFF when the accelerator pedal is depressed and ON when the accelerator pedal is released?	—	Go to Step 5	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the idle switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Idle Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the idle switch harness connector between pins 1 and 2 of the B-340 connector. Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 7	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the switch signal circuit between the engine control module (ECM) (pin 69 of B-234 connector) and the idle switch (pin 1 of B-340 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 9
5	1. Turn ON the ignition, with the engine OFF. 2. Fully depress and release the accelerator pedal many times while observing the Accelerator Pedal Position (APP) parameter with the Tech 2. Is the APP parameter smoothly changed within 0 to 100% when the accelerator pedal is depressed and released?	—	Go to Diagnostic Aids	Go to Step 6
6	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Inspect for an intermittent, for poor connection and corrosion at the harness connector of the APP sensor (pin 1 of B-80 connector). 4. Disconnect the ECM harness connector. 5. Inspect for an intermittent, for a poor connection and corrosion on the APP sensor circuit at the harness connector of the ECM (pin 49 of B-234 connector). 6. Test for high resistance on the APP sensor low reference circuit. 7. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
7	Replace the idle switch. Refer to Idle Switch Replacement in this section. Did you complete the replacement?	—	Go to Step 10	—
8	Replace the accelerator pedal position sensor. Refer to Accelerator Pedal Position Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 10	—
9	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 10	—

Step	Action	Value(s)	Yes	No
10	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Observe the Idle Switch and APP parameter while fully depressing and releasing the accelerator pedal many times. Does the Tech 2 indicate the APP parameter smoothly changed within 0 to 100% when the accelerator pedal is depressed and released, then Tech 2 indicate the Idle Switch parameter OFF when the accelerator pedal is depressed and ON when the accelerator pedal is released?	—	Go to Step 11	Go to Step 2
11	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1173 (Symptom Code 3) (Flash Code 22)

Circuit Description

The engine coolant temperature (ECT) sensor is installed to the thermostat housing. The ECT sensor is a variable resistor. The ECT sensor has a signal circuit and a low reference circuit. The ECT sensor measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and a ground for the ECT low reference circuit. When the ECT sensor is cold, the sensor resistance is high. When the engine coolant temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the ECT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the ECT signal circuit. If the ECM detects an excessive high coolant temperature, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects an excessive high coolant temperature for longer than 30 seconds.

Action Taken When the DTC Sets

- The ECM does not illuminate the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the DTC

- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- After starting the engine, the ECT should rise steadily to about 80°C – 85°C (176°F – 185°F) then stabilize when the thermostat opens.
- Use the Temperature vs. Resistance table to test the ECT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

Notice:

- This DTC is caused by an engine overheat condition (i.e. low engine coolant level). Since this DTC does not illuminate any lamps, clear the DTC and ensure there are no signs of engine damage. Excessive engine overheat may damage internal engine components.

DTC P1173 (Symptom Code 3) (Flash Code 22)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine and wait until engine is fully warms upped. 4. Observe the Engine Coolant Temperature (ECT) parameter with the Tech 2. Is the ECT parameter more than the specified value?	100°C (212°F)	Go to Step 4	Go to Step 3
3	Ask the driver if overheat is caused by low engine coolant level, etc. If engine overheat has experienced, the engine must be inspected and repaired as necessary. Did you complete the action?	—	Go to Step 6	—
4	1. Test the ECT sensor at various temperature levels to evaluate the possibility if a skewed sensor. 2. Replace the ECT sensor as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Test the engine cooling system for the following condition. Refer to diagnosis of the engine cooling system section for testing. • Engine coolant level • Engine coolant leakage • Cooling fan belt slippage • Cooling fan clutch working • Thermostat working • Water pump working • Radiator clogging 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 6	Go to Diagnostic Aids
6	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine and wait until engine is fully warms upped. 5. Observe the ECT parameter with the Tech 2. Is the ECT parameter more than the specified value?	100°C (212°F)	Go to Step 4	Go to Step 7
7	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1173 (Symptom Code 7, A) (Flash Code 22)

Circuit Description

The fuel temperature (FT) sensor is internal to the fuel injection pump control unit (PCU). It detects fuel temperature in the fuel injection pump. If the PCU detects an excessively high or low fuel temperature, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects an excessive high FT for longer than 30 seconds. (Symptom Code 7)
- The ECM detects an excessive low FT for longer than 30 seconds. (Symptom Code A)

Action Taken When the DTC Sets

- The ECM does not illuminate the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The PCU limits fuel injection quantity. (Symptom Code 7)

Condition for Clearing the DTC

- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- FT sensor is internal to the PCU and it is part of the fuel injection pump assembly.

DTC P1173 (Symptom Code 7, A) (Flash Code 22)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. (Fuel temperature [FT] sensor is internal to the fuel injection pump control unit [PCU] and it is part of the fuel injection pump assembly.) Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1335 (Symptom Code A) (Flash Code 43)

Circuit Description

The crankshaft position (CKP) sensor is located on top of the flywheel housing. There are 4 slits spaced 90° on the flywheel circumference. The CKP sensor is a magnetic coil type sensor, which generates an AC signal voltage based on the crankshaft rotational speed. The engine control module (ECM) monitors both the CKP sensor and injection pump camshaft position (CMP) sensor signals to ensure they correlate with each other. If the fuel injection pump control unit (PCU) receives faulty CKP sensor signal pulses, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The PCU detects CKP sensor signal from the ECM is faulty.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits fuel injection quantity.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- PCU is part of the fuel injection pump assembly.

DTC P1335 (Symptom Code A) (Flash Code 43)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine (Note a slight start delay may be noticed). 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0335 (Symptom Code B or D) set?	—	Go to Applicable DTC	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) B-233 harness connector. Keep the B-234 harness connector with connected. 3. Connect a DMM between the crankshaft position (CKP) sensor signal output circuit (pin 91 of B-233 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the DMM voltage more than the specified value?	10 volts	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the CKP sensor signal output circuit between the ECM (pin 91 of B-233 connector) and the fuel injection pump (pin 8 of E-110 connector) for the following conditions: • An open circuit • A short to ground • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 6
5	1. Test the CKP sensor signal output circuit between the ECM (pin 91 of B-233 connector) and the fuel injection pump control unit (PCU) (pin 8 of E-110 connector) for a short to battery or ignition voltage. **Notice:** Perform this by connecting a test lamp between the ECM harness connector (pin 91 of B-233 connector) and a known good ground. If the test lamp illuminates, circuit is short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 7
6	1. Turn OFF the ignition. 2. Disconnect the PCU harness connector. 3. Inspect for an intermittent and for a poor connection on the CKP sensor signal circuit at the harness connector of the PCU (pin 8 of E-110 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
7	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the CKP sensor signal output circuit at the harness connector of the ECM (pin 92 of B-233 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 9
8	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. Did you complete the replacement?	—	Go to Step 10	—
9	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 10	—

Step	Action	Value(s)	Yes	No
10	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 11
11	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1345 (Symptom Code A) (Flash Code 41)

Circuit Description

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU. The PCU also compares the engine speed signal sent from the ECM and the fuel injection pump speed. If the PCU received faulty fuel injection pump CMP sensor signal, this DTC will set.

Condition for Setting the DTC

- The PCU received faulty fuel injection pump CMP sensor signal for 1 second.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits fuel injection quantity.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- Fuel injection pump CMP sensor is internal to the fuel injection pump assembly.
- PCU is part of the fuel injection pump assembly.

DTC P1345 (Symptom Code A) (Flash Code 41)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1520 (Symptom Code A) (Flash Code 47)

Circuit Description

The neutral switch is installed on the transmission gear control box. When the gear position is neutral, the switch is closed and the switch signal is provided to the engine control module (ECM). If the ECM detects the neutral switch signal is not changed from neutral during the predetermined engine speed and vehicle speed range, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The engine speed is higher than 1500 RPM.
- The vehicle speed is higher than 64 km/h (40 MPH).
- The clutch pedal is released.

Condition for Setting the DTC

- The ECM detects that the neutral switch signal is continuously ON (neutral) during three consecutive driving cycles.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

Important:

- Following conditions must be met two consecutive driving cycles. (One driving cycle: Ignition switch ON > Engine run > Vehicle run > Ignition switch OFF for 10 seconds)
  - The engine speed is higher than 1500 RPM
  - The vehicle speed is higher than 64 km/h (40 MPH)
  - The clutch pedal is released
  - Other than neutral
- After the above procedure is done, a history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1520 (Symptom Code A) (Flash Code 47)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Neutral Switch parameter with the Tech 2 while shift to neutral and other positions. Does the Tech 2 indicate ON when the position is neutral and OFF when other than the neutral?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the neutral switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Neutral Switch parameter with the Tech 2. Does the Tech 2 indicate ON?	—	Go to Step 4	Go to Step 5
4	1. Test the neutral switch input signal circuit between the engine control module (ECM) (pin 87 of B-233 connector) and the neutral switch (pin 2 of J-50 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Replace the neutral switch. Refer to Neutral Switch Replacement in Transmission Section. Did you complete the replacement?	—	Go to Step 7	—

Step	Action	Value(s)	Yes	No
6	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. **Important:** Following conditions must be met two consecutive driving cycles before clear with the Tech 2. (One driving cycle: Ignition switch ON > Engine run > Vehicle run > Ignition switch OFF for 10 seconds) • The engine speed is higher than 1500 RPM • The vehicle speed is higher than 64 km/h (40 MPH) • The clutch pedal is released • Other than neutral 3. Turn ON the ignition, with the engine OFF. 4. Observe the Neutral Switch parameter with the Tech 2 while shift to neutral and other positions. Does the Tech 2 indicate ON when the position is neutral and OFF when other than the neutral?	—	Go to Step 8	Go to Step 3
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1520 (Symptom Code B) (Flash Code 47)

Circuit Description

The neutral switch is installed on the transmission gear control box. When the gear position is neutral, the switch is closed and the switch signal is provided to the engine control module (ECM). If the ECM detects the neutral switch signal is not changed from other than neutral during the predetermined engine speed and vehicle speed range, this DTC will set. This DTC runs only manual transmission.

Condition for Running the DTC

- The ignition switch is ON.
- The engine speed is higher than 665 RPM.
- The vehicle speed is lower than 2 km/h (3 MPH).
- The clutch pedal is released after once depressed.

Condition for Setting the DTC

- The ECM detects that the neutral switch signal is continuously OFF (other than neutral) during three consecutive driving cycles.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

Important:

- Following conditions must be met two consecutive driving cycles. (One driving cycle: Ignition switch ON > Engine run > Ignition switch OFF for 10 seconds)
  - The engine speed is higher than 665 RPM
  - The vehicle speed is lower than 2 km/h (3 MPH)
  - The clutch pedal is released after once depressed
  - Neutral position
- After the above procedure is done, a history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1520 (Symptom Code B) (Flash Code 47)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Neutral Switch parameter with the Tech 2 while shift to neutral and other positions. Does the Tech 2 indicate ON when the position is neutral and OFF when other than the neutral?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the neutral switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Neutral Switch parameter with the Tech 2 while momentarily jumping across the neutral switch harness connectors between pins 1 and 2 of J-50 connector. Does the Tech 2 indicate ON when the circuit is jumped and OFF when the circuit is not jumped?	—	Go to Step 7	Go to Step 4
4	1. Connect a test lamp between the ignition voltage feed circuit of the neutral switch harness (pin 1 of J-50 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 5

Step	Action	Value(s)	Yes	No
5	Repair the open circuit or high resistance on the ignition voltage feed circuit between the ECM main relay (pin 5 of X-14 connector) and the neutral switch (pin 1 of J-50 connector). Did you complete the repair?	—	Go to Step 11	—
6	1. Test the neutral switch signal circuit between the engine control module (ECM) (pin 87 of B-233 connector) and the neutral switch (pin 2 of J-50 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 8
7	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connectors of the neutral switch (pins 1 and 2 of J-50 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 9
8	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the neutral switch circuit at the harness connector of the ECM (pin 87 of B-233 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 11	Go to Step 10
9	Replace the neutral switch. Refer to Neutral Switch Replacement in Transmission Section. Did you complete the replacement?	—	Go to Step 11	—
10	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 11	—

Step	Action	Value(s)	Yes	No
11	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. **Important:** Following conditions must be met two consecutive driving cycles before clear with the Tech 2. (One driving cycle: Ignition switch ON > Engine run > Ignition switch OFF for 10 seconds) • The engine speed is higher than 665 RPM • The vehicle speed is lower than 2 km/h (3 MPH) • The clutch pedal is released after once depressed • Neutral position 3. Turn ON the ignition, with the engine OFF. 4. Observe the Neutral Switch parameter with the Tech 2 while shift to neutral and other positions. Does the Tech 2 indicate ON when the position is neutral and OFF when other than the neutral?	—	Go to Step 12	Go to Step 3
12	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1576 (Symptom Code 4) (Flash Code 71)

Circuit Description

The engine control module (ECM) controls the exhaust brake which energizes the intake throttle solenoid valve and exhaust brake solenoid valve based on vehicle running condition. The ECM commands each solenoid valve to close each throttle valve by applying vacuum. If the ECM detects that an open circuit or short to ground on the exhaust brake solenoid valve control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects a low voltage condition on the exhaust brake solenoid valve control circuit for longer than 3 seconds when the solenoid valve is commanded OFF.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The number below refers to the step number on the diagnostic table.
5. If the exhaust brake solenoid valve control circuit between the ECM and the solenoid valve is normal, voltage level high DTC P1576 (Symptom Code 8) will set.

DTC P1576 (Symptom Code 4) (Flash Code 71)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the exhaust brake solenoid valve harness connector. 3. Connect a test lamp between the voltage feed circuit of the exhaust brake solenoid valve harness (pin 1 of J-31 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 4	Go to Step 6
4	1. Turn OFF the ignition. 2. Connect a test lamp between the control circuit of the exhaust brake solenoid valve harness (pin 2 of J-31 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Connect a 3-amp fused jumper wire across the exhaust brake solenoid valve harness connector between pins 1 and 2 of the J-31 connector. 2. Lift the driving wheels or drive the vehicle. 3. Let the vehicle run so that the exhaust brake may operate while observing the Exhaust Brake Solenoid Command parameter with the Tech 2. Does DTC P1576 (Symptom Code 8) set when the exhaust brake is operating, but not DTC P1576 (Symptom Code 4)?	—	Go to Step 9	Go to Step 7
6	Repair the open circuit or high resistance on the voltage feed circuit between the ECM main relay (pin 5 of X-14 connector) and the exhaust brake solenoid valve (pin 1 of J-31 connector). Did you complete the repair?	—	Go to Step 13	—
7	1. Test the control circuit between the engine control module (ECM) (pin 40 of B-234 connector) and the exhaust brake solenoid valve (pin 2 of J-31 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
8	1. Test the control circuit between the ECM (pin 40 of B-234 connector) and the exhaust brake solenoid valve (pin 2 of J-31 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
9	1. Turn OFF the ignition. 2. Disconnect the exhaust brake solenoid valve harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the exhaust brake solenoid valve (pins 1 and 2 of J-31 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the exhaust brake solenoid valve control circuit at the harness connector of the ECM (pin 40 of B-234 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the exhaust brake solenoid valve. Refer to Exhaust Brake Solenoid Valve Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—

Step	Action	Value(s)	Yes	No
12	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1576 (Symptom Code 8) (Flash Code 71)

Circuit Description

The engine control module (ECM) controls the exhaust brake which energizes the intake throttle solenoid valve and exhaust brake solenoid valve based on vehicle running condition. The ECM commands each solenoid valve to close each throttle valve by applying vacuum. If the ECM detects that a short to battery or ignition voltage on the exhaust brake solenoid valve control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects a high voltage condition on the exhaust brake solenoid valve control circuit for longer than 3 seconds when the solenoid valve is commanded ON.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The number below refers to the step number on the diagnostic table.
3. If the exhaust brake solenoid valve control circuit between the ECM and the solenoid valve is normal, voltage level low DTC P1576 (Symptom Code 4) will set.

DTC P1576 (Symptom Code 8) (Flash Code 71)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Lift the driving wheels or drive the vehicle. 4. Let the vehicle run so that the exhaust brake may operate while observing the Exhaust Brake Solenoid Command with the Tech 2. Does the Diagnostic Trouble Code (DTC) fail this ignition when the exhaust brake is operating?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the exhaust brake solenoid valve harness connector. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. Does DTC P1576 (Symptom Code 4) set, but not DTC P1576 (Symptom Code 8)?	—	Go to Step 5	Go to Step 4
4	1. Test the control circuit between the engine control module (ECM) (pin 40 of B-234 connector) and the exhaust brake solenoid valve (pin 2 of J-31 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Replace the exhaust brake solenoid valve. Refer to Exhaust Brake Solenoid Valve Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—

Step	Action	Value(s)	Yes	No
6	Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Lift the driving wheels or drive the vehicle. 5. Let the vehicle run so that the exhaust brake may operate while observing the Exhaust Brake Solenoid Command with the Tech 2. Does the DTC fail this ignition when the exhaust brake is operating?	—	Go to Step 3	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1605 (Symptom Code C, D, E) (Flash Code 55)

Circuit Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM). The electronically erasable programmable read only memory (EEPROM) memorize some data for engine control and communication with other control module. If the ECM detects memory area malfunction inside of the ECM, this DTC will set.

Condition for Setting the DTC

- The ECM detects internal seed or key file in EEPROM data is destroyed (Symptom Code C).
- The ECM detects reading or writing from the EEPROM data is failed during initialization (Symptom Code D).
- The ECM detects total sum of EEPROM data is not equal to registered value during initialization (Symptom Code E).

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM uses default EEPROM data substitution of faulty EEPROM. (Symptom Code D & E).

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

DTC P1605 (Symptom Code C, D, E) (Flash Code 55)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1625 (Symptom Code A) (Flash Code 76)

Circuit Description

The engine control module (ECM) main relay is energized when the ECM receives an ignition voltage switch ON signal. When the ignition switch is OFF, the ECM main relay is de-energized after a certain length of time passed. If the ECM detects the ECM main relay is turned OFF before ECM commanded OFF, this DTC will set.

Condition for Setting the DTC

- The ECM detects that the ECM main relay is turned OFF before commanded turned OFF.

Action Taken When the DTC Sets

- The ECM does not illuminate the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the DTC

- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Faulty ECM main relay may set this DTC.

DTC P1625 (Symptom Code A) (Flash Code 76)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. 5. Turn OFF the ignition. 6. Turn ON the ignition, with the engine OFF. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the ECM main relay. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the ECM main relay (pins 1, 2, 4 and 5 of X-14 connector). 4. Disconnect the engine control module (ECM) harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on ECM main relay control and battery voltage feed circuit at the harness connector of the ECM (pins 3 and 58 of B-234 connector). 6. Test for high resistance on each ECM main relay circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 5	Go to Step 4
4	Replace the ECM main relay. Did you complete the replacement?	—	Go to Step 5	—

Step	Action	Value(s)	Yes	No
5	1. Reconnect all previously disconnected relay or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Observe the DTC Information with the Tech 2. 6. Turn OFF the ignition. 7. Turn ON the ignition, with the engine OFF. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 6
6	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1625 (Symptom Code B) (Flash Code 76)

Circuit Description

The engine control module (ECM) main relay is energized when the ECM receives an ignition voltage switch ON signal. When the ignition switch is OFF, the ECM main relay is de-energized after a certain length of time passed. If the ECM detects the ECM main relay has been ON since the ignition switch was turned OFF, this DTC will set.

Condition for Running the DTC

- The ignition switch is OFF.

Condition for Setting the DTC

- The ECM detects that the ECM main relay is turned ON for longer than 2 seconds.

Action Taken When the DTC Sets

- The ECM does not illuminate the malfunction indicator lamp (MIL) when the diagnostic runs and fails.

Condition for Clearing the DTC

- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Faulty or sticking ECM main relay may set this DTC.

Test Description

The numbers below refer to the step number on the diagnostic table.
2. If this DTC is present, Tech 2 can communicate with the ECM when the ignition switch is OFF.

DTC P1625 (Symptom Code B) (Flash Code 76)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail with the ignition switch OFF?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Disconnect the ECM main relay. 2. Monitor the DTC Information with the Tech 2. Does the DTC fail with the ignition switch OFF?	—	Go to Step 6	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the ECM main relay. 3. Connect a test lamp between the control circuit of the ECM main relay harness (pin 4 of X-14 connector) and battery voltage. 4. Keep the ignition switch OFF. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 7
5	1. Test the control circuit of the ECM main relay between the engine control module (ECM) (pin 58 of B-234 connector) and the ECM main relay (pin 4 of X-14 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 8
6	Repair the short to battery on the voltage feed supply circuit to the ECM between the ECM (pin 3 of B-234 connector) and the ECM main relay (pin 5 of X-14 connector). Did you complete the repair?	—	Go to Step 9	—

Step	Action	Value(s)	Yes	No
7	Replace the ECM main relay. Did you complete the replacement?	—	Go to Step 9	—
8	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 9	—
9	1. Reconnect all previously disconnected relay or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Monitor the DTC Information with the Tech 2. Does the DTC with the ignition switch OFF?	—	Go to Step 3	Go to Step 10
10	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1630 (Symptom Code A, B) (Flash Code 51)

Circuit Description

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.
The fuel injection solenoid valve is installed to the fuel injection pump rear side. The fuel injection event is determined by this solenoid ON/OFF command. The fuel injection solenoid valve cuts the fuel when the engine shutoff (ESO) solenoid valve is commanded shutoff from the PCU. (The fuel injection solenoid valve and engine shutoff (ESO) solenoid valve is same part. It calls ESO solenoid valve when fuel is shutoff.) When the ignition switch is turned OFF or commanded from fail-safe action, the ESO solenoid valve is commanded shutoff to stop the engine running. If the ECM detects that the fuel injection solenoid valve control current problem, this DTC will set.

Condition for Setting the DTC

- The ECM detects that the PCU monitored fuel injection solenoid valve control current is too high. (Symptom Code A)
- The ECM detects that the PCU continuously flow the control current to the fuel injection solenoid valve. (Symptom Code B)

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM limits fuel injection quantity. (Symptom Code A)
- The ECM cuts fuel injection. (Symptom Code B)

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- Fuel injection solenoid valve is internal to the fuel injection pump assembly.
- PCU is part of the fuel injection pump assembly.

DTC P1630 (Symptom Code A, B) (Flash Code 51)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. Did you complete the replacement?	—	Go to Step 4	—

Step	Action	Value(s)	Yes	No
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1650 (Symptom Code A) (Flash Code 44)

Circuit Description

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.
The ECM monitors CAN operational status by expecting a constant flow of messages from the PCU. If the ECM detects that the PCU receives from the CAN controller rest or Bus Offline, this DTC will set.

Condition for Setting the DTC

- The ECM detects that the PCU receives from the CAN controller reset or Bus Offline.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM cuts the fuel injection.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1650 (Symptom Code A) (Flash Code 44)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P1651 (Symptom Code A or B) set?	—	Go to Applicable DTC	Go to Step 3
3	Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the fuel injection pump control unit (PCU) harness connector. 3. Connect a DMM across the controller area network (CAN) harness (pins 1 and 2 of E-110 connector). 4. Measure the resistance across the CAN terminals. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 5	Go to Step 10
5	1. Connect a DMM between the CAN Low signal circuit (pin 1 of E-110 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Is the DMM voltage within the specified value?	1.5 – 2.5 volts	Go to Step 6	Go to Step 11

Step	Action	Value(s)	Yes	No
6	1. Keep the ignition switch ON, with the engine OFF. 2. Connect a DMM between the CAN High signal circuit (pin 2 of E-110 connector) and a known good ground. Is the DMM voltage within the specified value?	3.0 – 4.0 volts	Go to Step 7	Go to Step 12
7	1. Turn OFF the ignition. 2. Reconnect the PCU harness connector. 3. Disconnect the engine control module (ECM) B-233 harness connector. Keep the ECM B-234 harness connector with connected. 4. Connect a DMM across the CAN harness (pins 99 and 100 of B-233 connector). 5. Measure the resistance across the CAN terminals. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 8	Go to Step 14
8	1. Connect a DMM between the CAN Low signal circuit of the ECM harness (pin 99 of B-233 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Is the DMM voltage within the specified value?	1.5 – 2.5 volts	Go to Step 9	Go to Step 16
9	1. Keep the ignition switch ON, with the engine OFF. 2. Connect a DMM between the CAN High signal circuit of the ECM harness (pin 100 of B-233 connector) and a known good ground. Is the DMM voltage within the specified value?	3.0 – 4.0 volts	Go to Step 13	Go to Step 16
10	1. Test the CAN Low and High circuit between the ECM (pins 99 and 100 of B-233 connector) and the PCU (pins 1 and 2 of E-110 connector) for the following conditions: • An open circuit • A short each other • High resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 15
11	1. Test the CAN Low circuit between the ECM (pin 99 of B-233 connector) and the PCU (pin 1 of E-110 connector) for the following conditions: • A short to ground • A short to battery or ignition voltage 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 17
12	1. Test the CAN Low circuit between the ECM (pin 100 of B-233 connector) and the PCU (pin 2 of E-110 connector) for the following conditions: • A short to ground • A short to battery or ignition voltage 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 17

Step	Action	Value(s)	Yes	No
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Monitor the DTC Information with the Tech 2. Is DTC P0251 (Symptom Code E) set?	—	Go to Step 16	Go to Diagnostic Aids
14	1. Turn OFF the ignition. 2. Disconnect the PCU harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the PCU (pins 1 and 2 of E-110 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 16
15	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the CAN Low or High circuits at the harness connector of the ECM (pins 99 and 100 of B-233 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 17
16	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. (PCU is part of the fuel injection pump assembly) Did you complete the replacement?	—	Go to Step 18	—
17	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—
18	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 2	Go to Step 19
19	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1650 (Symptom Code B) (Flash Code 44)

Circuit Description

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.
The ECM monitors CAN operational status by expecting a constant flow of messages from the PCU. If the ECM detects internal CAN controller does not react, this DTC will set.

Condition for Setting the DTC

- The ECM detects internal CAN controller does not react.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM cuts the fuel injection.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Notice:

- CAN controller is internal to the ECM.

DTC P1650 (Symptom Code B) (Flash Code 44)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1651 (Symptom Code A, B) (Flash Code 45)

Circuit Description

The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.
The ECM monitors CAN operational status by expecting a constant flow of messages from the PCU. If the ECM fails to receive an expected message from the PCU, this will set depending on what communication is lost.

Condition for Setting the DTC

- The ECM detects that the PCU does not receive the CAN messages from the ECM. (Symptom Code A)
- The ECM does not receive the CAN messages from the PCU. (Symptom Code B)

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The ECM cuts the fuel injection.

Condition for Clearing the MIL/DTC

- The ECM turns OFF the MIL when the diagnostic runs and does not fail.
- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1651 (Symptom Code A, B) (Flash Code 45)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	1. Turn OFF the ignition. 2. Disconnect the fuel injection pump control unit (PCU) harness connector. 3. Connect a DMM across the controller area network (CAN) harness (pins 1 and 2 of E-110 connector). 4. Measure the resistance across the CAN terminals. Is the resistance within the specified value?	110 – 130 Ω	Go to Step 4	Go to Step 9
4	1. Connect a DMM between the CAN Low signal circuit (pin 1 of E-110 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Is the DMM voltage within the specified value?	1.5 – 2.5 volts	Go to Step 5	Go to Step 10

Step	Action	Value(s)	Yes	No
5	1. Keep the ignition switch ON, with the engine OFF. 2. Connect a DMM between the CAN High signal circuit (pin 2 of E-110 connector) and a known good ground. Is the DMM voltage within the specified value?	3.0 – 4.0 volts	Go to Step 6	Go to Step 11
6	1. Turn OFF the ignition. 2. Reconnect the PCU harness connector. 3. Disconnect the engine control module (ECM) B-233 harness connector. Keep the ECM B-234 harness connector with connected. 4. Connect a DMM across the CAN harness (pins 99 and 100 of B-233 connector). 5. Measure the resistance across the CAN terminals Is the resistance within the specified value?	110 – 130 Ω	Go to Step 7	Go to Step 13
7	1. Connect a DMM between the CAN Low signal circuit of the ECM harness (pin 99 of B-233 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Is the DMM voltage within the specified value?	1.5 – 2.5 volts	Go to Step 8	Go to Step 15
8	1. Keep the ignition switch ON, with the engine OFF. 2. Connect a DMM between the CAN High signal circuit of the ECM harness (pin 100 of B-233 connector) and a known good ground. Is the DMM voltage within the specified value?	3.0 – 4.0 volts	Go to Step 12	Go to Step 15
9	1. Test the CAN Low and High circuit between the ECM (pins 99 and 100 of B-233 connector) and the PCU (pins 1 and 2 of E-110 connector) for the following conditions: • An open circuit • A short each other • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 14
10	1. Test the CAN Low circuit between the ECM (pin 99 of B-233 connector) and the PCU (pin 1 of E-110 connector) for the following conditions: • A short to ground • A short to battery or ignition voltage 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 16
11	1. Test the CAN Low circuit between the ECM (pin 100 of B-233 connector) and the PCU (pin 2 of E-110 connector) for the following conditions: • A short to ground • A short to battery or ignition voltage 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 16

Step	Action	Value(s)	Yes	No
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Monitor the DTC Information with the Tech 2. Is DTC P0251 (Symptom Code E) set?	—	Go to Step 15	Go to Diagnostic Aids
13	1. Turn OFF the ignition. 2. Disconnect the PCU harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the PCU (pins 1 and 2 of E-110 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 15
14	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for poor connections on the CAN Low or High circuits at the harness connector of the ECM (pins 99 and 100 of B-233 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 17	Go to Step 16
15	**Important:** The fuel injection pump must be timed to the engine. Replace the fuel injection pump. Refer to Fuel Injection Pump Replacement in engine mechanical section. (PCU is part of the fuel injection pump assembly) Did you complete the replacement?	—	Go to Step 17	—
16	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 17	—
17	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 18
18	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1690 (Symptom Code 4) (Flash Code 77)

Circuit Description

The malfunction indicator lamp (MIL) is located on the instrument panel cluster (IPC). The battery voltage is supplied to the MIL. The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit. After a fixed time passes, the ECM turns OFF the MIL with the ignition ON and the engine OFF. The MIL has the following functions:

- The MIL informs the driver that a malfunction has occurred and the vehicle should be taken in for service as soon as possible.
- The MIL illuminates during a bulb test and a system test.
- A DTC will be stored if a MIL is requested by the ECM.

If the ECM detects an open circuit or short circuit on the MIL control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects a low voltage condition on the MIL control circuit for longer than 3 seconds when the MIL is commanded OFF.

Action Taken When the DTC Sets

- The ECM does not illuminates the MIL when the diagnostic runs and fails.

Condition for Clearing the DTC

- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1690 (Symptom Code 4) (Flash Code 77)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Perform the Malfunction Indicator Lamp (MIL) test with the Tech 2. 4. Command the MIL ON with the Tech 2. Does the MIL turn ON when commanded ON with the Tech 2?	—	Go to Step 3	Go to Step 4
3	Command the MIL OFF with the Tech 2. Does the MIL OFF?	—	Go to Step 17	Go to Step 10
4	1. Turn OFF the ignition. 2. Inspect the Meter (10A) fuse (F-16) in the glove box fuse block. Is the Meter (10A) fuse (F-16) open?	—	Go to Step 5	Go to Step 6
5	Replace the Meter (10A) fuse (F-16). If the fuse continues to open, repair the short to ground on one of the circuits that fed by the Meter (10A) fuse (F-16) or replace the shorted attached component fed by the Meter (10A) fuse (F-16). Did you complete the repair?	—	Go to Step 19	—

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Connect a 3-amp fused jumper wire between the MIL control circuit of the ECM harness connector (pin 42 of B-234 connector) and a known good ground. Does the MIL illuminate?	—	Go to Step 11	Go to Step 7
7	1. Turn OFF the ignition. 2. Remove the instrument panel cluster (IPC). 3. Remove the MIL bulb from the IPC (meter assembly). Is the MIL bulb burned out?	—	Go to Step 15	Go to Step 8
8	1. Disconnect the IPC harness B-51 connector. 2. Connect a test lamp between the voltage feed circuit of the MIL (pin 8 of B-51 connector) and a known good ground. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 12
9	1. Turn OFF the ignition. 2. Reconnect the ECM harness connector. 3. Connect a test lamp between the voltage feed circuit and control circuit of the MIL (pins 4 and 8 of B-51 connector). 4. Turn ON the ignition, with the engine OFF. 5. Perform the MIL test with the Tech 2. 6. Command the MIL ON with the Tech 2. Does the test lamp turn ON when commanded ON with the Tech 2?	—	Go to Step 14	Go to Step 13
10	1. Test the control circuit of the MIL between the ECM (pin 42 of B-234 connector) and the IPC (pin 4 of B-51 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
11	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the MIL control circuit at the harness connector of the ECM (pin 42 of B-234 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
12	Repair the open circuit or high resistance on the voltage feed circuit of the MIL between the IPC (pin 8 of B-51 connector) and Meter (10A) fuse (F-16). Did you complete the repair?	—	Go to Step 19	—

Step	Action	Value(s)	Yes	No
13	Repair the open circuit or high resistance on the control circuit of the MIL between the ECM (pin 42 of B-234 connector) and the IPC (pin 4 of B-51 connector). Did you complete the repair?	—	Go to Step 19	—
14	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections on the MIL circuits at the IPC (pins 4 and 8 of B-51 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
15	Replace the MIL bulb. Did you complete the replacement?	—	Go to Step 19	—
16	Repair or replace the IPC (meter assembly). Did you complete the repair or replacement?	—	Go to Step 19	—
17	1. Turn OFF the ignition for 30 seconds. 2. Turn ON the ignition for 10 seconds, with the engine OFF. 3. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 18	Go to Diagnostic Aids
18	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 19	—
19	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 20
20	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1690 (Symptom Code 8) (Flash Code 77)

Circuit Description

The malfunction indicator lamp (MIL) is located on the instrument panel cluster (IPC). The battery voltage is supplied to the MIL. The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit. After a fixed time passes, the ECM turns OFF the MIL with the ignition ON and the engine OFF. The MIL has the following functions:

- The MIL informs the driver that a malfunction has occurred and the vehicle should be taken in for service as soon as possible.
- The MIL illuminates during a bulb test and a system test.
- A DTC will be stored if a MIL is requested by the ECM.

If the ECM detects a short to battery or ignition voltage on the MIL control circuit, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.

Condition for Setting the DTC

- The ECM detects a high voltage condition on the MIL control circuit for longer than 1 second when the MIL is commanded ON.

Action Taken When the DTC Sets

- The ECM does not illuminates the MIL when the diagnostic runs and fails.

Condition for Clearing the DTC

- A history DTC clears after 40 consecutive driving cycles without a fault. Or clear with the Tech 2.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The number below refers to the step number on the diagnostic table.
3. If the control circuit of the MIL between the ECM and the IPC is normal, the control circuit voltage low DTC P1690 (Symptom Code 4) will set.

DTC P1690 (Symptom Code 8) (Flash Code 77)

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views or Engine Control Module (ECM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Perform the Malfunction Indicator Lamp (MIL) test with the Tech 2. 4. Command the MIL ON with the Tech 2. Does the MIL turn ON when commanded ON with the Tech 2?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Remove the instrument panel cluster (IPC) in order to disconnect the IPC harness B-51 connector. 3. Disconnect the IPC harness B-51 connector. 4. Turn ON the ignition, with the engine OFF. 5. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does DTC P1690 (Symptom Code 4) set, but not DTC P1690 (Symptom Code 8)?	—	Go to Step 5	Go to Step 4
4	1. Test the control circuit of the MIL between the engine control module (ECM) (pin 42 of B-234 connector) and the IPC (pin 4 of B-51 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6

Step	Action	Value(s)	Yes	No
5	Repair or replace the IPC (meter assembly). Did you complete the repair or replacement?	—	Go to Step 7	—
6	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

Glow Control System Check

Description

The glow control system consists of the engine control module (ECM), the glow relay and glow plugs. The glow control system is operated when the engine coolant temperature is low, which allows easier engine starting. The ECM commands the glow relay ON for a certain length of time at ignition switch is ON with engine OFF. In after glow phase, the glow plugs remain energized for a certain period with engine run.

Glow Control Operation

- The pre glow control system operates when the engine coolant temperature is less than 30°C (86°F).
- The after glow control system operates when the engine coolant temperature is less than 30°C (86°F).

Glow Control System Check

Schematic Reference: Engine Controls Schematics
Connector End View Reference: Engine Controls Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check – Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check – Engine Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information of the engine control system with the Tech 2 and check whether following DTC(s) is set: • P0115 (Symptom Code 1 & 2) • P0380 (Symptom Code 4 & 8) • P0381 (Symptom Code 4 & 8) Are any of the above DTC(s) set?	—	Refer to Applicable DTC	Go to Step 3
3	1. Turn OFF the ignition. 2. Make sure the metal bus bar that connects switched battery voltage supply terminal (J-122) and all glow plugs is secured tightly. 3. Turn ON the ignition, with the engine OFF 4. Connect a test lamp between the metal bus bar (glow plug power supply J-122 terminal) and a known good ground. 5. Perform the Glow Relay test with the Tech 2. 6. Command the Glow Relay ON with the Tech 2 while observing the test lamp. Does the test lamp turn ON only when commanded ON with the Tech 2?	—	Go to Step 4	Go to Step 5
4	1. Turn OFF the ignition. 2. Remove the metal bus bar from the glow plugs. 3. Measure resistance of each glow plug between the glow plug terminals and a known good ground. Make sure to record all measurements and take them quickly as to not allow engine temperature changes between measurements. Are the resistances within the specified value each other?	1 Ω	System OK	Go to Step 15

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Replace the glow relay with the starter relay or replace with a known good relay. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the metal bus bar (glow plug power supply J-122 connector) and a known good ground. 5. Perform the Glow Relay test with the Tech 2. 6. Command the Glow Relay ON with the Tech 2 while observing the test lamp. Does the test lamp turn ON only when commanded ON with the Tech 2?	—	Go to Step 9	Go to Step 6
6	Inspect the Glow (60A) slow blow fuse (SBF-3) in the fuse & relay box. Is the Glow (60A) slow blow fuse (SBF-3) open?	—	Go to Step 10	Go to Step 7
7	1. Turn OFF the ignition. 2. Remove the glow relay in the fuse & relay box. 3. Connect a test lamp between the voltage feed circuit of the glow relay terminal (pin 3 of X-20 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 11
8	1. Turn ON the ignition, with the engine OFF. 2. Connect a test lamp between the power supply circuit of glow plugs (pin 2 of X-20 connector) and a known good ground. Does the test lamp illuminate?	—	Go to Step 13	Go to Step 12
9	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the glow relay terminals (pins 2 and 3 of X-20 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 14
10	1. Replace the Glow (60A) slow blow fuse (SBF-3). If the slow blow fuse continues to open, repair the short to ground on a circuit fed by the slow blow fuse or check for a shorted attached component. 2. Repair the short to ground or replace the component as necessary. Did you complete the repair?	—	Go to Step 16	—
11	Repair the open circuit in the battery voltage supply circuit between the Glow (60A) slow blow fuse (SBF-3) and the glow relay (pin 3 of X-20 connector). Did you complete the repair?	—	Go to Step 16	—
12	Repair the open circuit in the switched battery voltage supply circuit between the glow relay (pin 2 of X-20 connector) and the glow plugs (J-122 terminal). Did you complete the repair?	—	Go to Step 16	—

Step	Action	Value(s)	Yes	No
13	**Important:** The glow plugs may be burnt out if the battery voltage supply circuit is shorted to a voltage source. Repair the short to battery or ignition voltage on the switched battery voltage supply circuit between the glow relay (pin 2 of X-20 connector) and the glow plugs (J-122 terminal). Did you complete the repair?	—	Go to Step 16	—
14	Replace the glow relay. Did you complete the replacement?	—	Go to Step 16	—
15	Replace the appropriate glow plug. Did you complete the replacement?	—	Go to Step 16	—
16	1. Reconnect all previously disconnected components, relay, fuse or harness connector(s). 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the metal bus bar (glow plug power supply J-122 connector) and a known good ground. 5. Perform the Glow Relay test with the Tech 2. 6. Command the Glow Relay ON with the Tech 2 while observing the test lamp. Does the test lamp turn ON only when commanded ON with the Tech 2?	—	Go to Step 4	Go to Step 2

Symptoms – Engine Controls

Symptoms – Engine Controls

Important Preliminary Inspections Before Starting

Perform Diagnostic System Check – Engine Controls before using the symptom tables, and verify that all of the following are true:

- The engine control module (ECM) and malfunction indicator lamp (MIL) are operating correctly.
- There are no diagnostic trouble codes (DTCs) stored, or a DTC exists but without the MIL.
- The Tech 2 data is within the normal operating range. Refer to the Tech 2 Data List in this section.
- Verify the customer concern and locate the correct symptom in the table of contents. Inspect the items indicated under that symptom.

Visual and Physical Inspection

Several of the symptom procedures ask for careful visual and physical inspection. This step is extremely important. The visual and physical inspection can lead to correcting a problem without further inspections, and can save valuable time. Ensure that:

- The ECM grounds are clean, tight, and in their proper location.
- The vacuum hoses are not split or kinked, and properly connected. Inspect thoroughly for any type of leak or restriction.
- The mass air flow (MAF) sensor is properly installed. The arrows on the plastic portion of the sensor must point toward the engine.
- The air intake ducts are not collapsed or damaged.
- There are no leaks at the MAF sensor, any connections or intake manifold sealing surfaces.
- The engine harness wiring and terminals are properly connected and are not pinched or cut.

Intermittent

Important:
Inspect for improper installation of electrical components if an intermittent condition exists. Inspect for aftermarket add-on electrical equipment devices, lights, and cellular phones. Verify that no aftermarket equipment is connected to the keyword 2000 serial data circuit. If you cannot locate an intermittent condition, a cellular phone communication signal may cause the condition.

Important:
The problem may or may not turn ON the MIL or store a DTC.

Faulty electrical connections or wiring cause most intermittent problems. Perform a careful visual and physical inspection of the suspect connectors for the following conditions:

- Improperly mated connector halves
- Terminals that are not seated
- Terminals that are damaged or improperly formed

Reform or replace connector terminals in the problem circuit in order to ensure proper contact tension. Remove the terminal from the connector body in order to inspect for poor terminal wire connection.
Road test the vehicle with the DMM connected to the suspected circuit. An abnormal reading that occurs when the malfunction occurs is a good indication that there is a malfunction in the circuit being monitored.
Use the Tech 2 in order to help detect intermittent conditions. Useful features of the Tech 2 include the following:

- Trigger the Snapshot feature in order to capture and store engine parameters when the malfunction occurs. Review this stored information in order to see the specific running conditions that caused the malfunction.
- Use the Plot Function on the Tech 2 in order to plot selected data parameters. Review this stored information to aid in locating an intermittent problem. Refer to the Tech 2 Users Guide for more information.

Important:
If the intermittent condition exists as a start and then stall, test for DTCs relating to the vehicle theft deterrent system. Test for improper installation of electrical options such as lights, cellular phones, etc.

Any of the following may cause an intermittent MIL with no stored DTC:

- The ECM grounds are loose or dirty. Refer to Engine Controls Schematics.
- The MIL circuit intermittently shorted to ground.
- Electrical system interference caused by a malfunctioning relay, ECM driven solenoid, or switch. The electrical component can cause a sharp electrical surge. Normally, the problem will occur when the malfunctioning component is operating.
- There is an open diode across the A/C compressor clutch or any other open diodes.

Important:
The following symptom tables contain groups of possible causes for each symptom. The order of these procedures is not important. If the Tech 2 readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause first. In order to determine if a specific vehicle is using a particular system or component, refer to Engine Controls Schematics for an application.
Use the following tables when diagnosing a symptom complaint:

- Intermittent Conditions
- Hard Start
- Rough, Unstable, or Incorrect Idle and Stalling
- Cuts Out, Misses
- Surge/Chuggles
- Lack of Power, Sluggishness, or Sponginess
- Hesitation, Sag, Stumble
- Fuel Knock/Combustion Noise
- Poor Fuel Economy
- Excessive Smoke (Black Smoke)
- Excessive Smoke (White Smoke)

Intermittent Conditions

Checks	Action
DEFINITION: The problem is not currently present but is indicated in DTC History. OR There is a customer complaint, but the symptom cannot currently be duplicated, if the problem is not DTC related.	
Preliminary Checks	• Refer to Symptoms – Engine Controls before starting.
Harness/Connector	Many intermittent open or shorted circuits are affected by harness/connector movement that is caused by vibration, engine torque, bumps/rough pavement, etc. Test for this type of condition by performing the applicable procedure from the following list: • Move related connectors and wiring while monitoring the appropriate Tech 2 data. • Move related connectors and wiring with the component commanded ON, and OFF, with the Tech 2. Observe the component operation. • With the engine running, move related connectors and wiring while monitoring engine operation. If harness or connector movement affects the data displayed, component/system operation, or engine operation, inspect and repair the harness/connections as necessary. Refer to Electrical Connections or Wiring.
Electrical Connections or Wiring	Poor electrical connections, terminal tension or wiring problems cause most intermittent. To perform the following inspections: • Inspect for poor mating of the connector halves, or terminals improperly seated in the connector body. • Inspect for improperly formed or damaged terminals. Test for poor terminal tension. • Inspect for poor terminal to wire connections including terminals crimped over insulation. This requires removing the terminal from the connector body. • Inspect for corrosion/water intrusion. Pierced or damaged insulation can allow moisture to enter the wiring. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits. • Inspect for wires that are broken inside the insulation. • Inspect the harness for pinched, cut or rubbed through wiring. • Ensure that the wiring does not come in contact with hot exhaust components.
Control Module Power and Grounds Component Power and Grounds	Poor power or ground connections can cause widely varying symptoms. • Test all control module power supply circuits. Many vehicles have multiple circuits supplying power to the control module. Other components in the system may have separate power supply circuits that may also need to be tested. Inspect connections at the module/component connectors, fuses, and any intermediate connections between the power source and the module/component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Ensure that the circuit can carry the current necessary to operate the component. • Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point. Inspect the connections at the component and in splice packs, where applicable. Ensure that the circuit can carry the current necessary to operate the component.

Checks	Action
Temperature Sensitivity	• An intermittent condition may occur when a component/connection reaches normal operating temperature. The condition may occur only when the component/ connection is cold, or only when the component/connection is hot. • If the intermittent is related to heat, review the data for a relationship with the following: - High ambient temperatures - Underhood/engine generated heat - Circuit generated heat due to a poor connection, or high electrical load - Higher than normal load conditions, towing, etc. • If the intermittent is related to cold, review the data for the following: - Low ambient temperatures – In extremely low temperatures, ice may form in a connection or component. Test for water intrusion. - The condition only occurs on a cold start. - The condition goes away when the vehicle warms up. • Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
Electromagnetic Interference (EMI) and Electrical Noise	Some electrical components/circuits are sensitive to EMI or other types of electrical noise. Inspect for the following conditions: • A misrouted harness that is too close to high voltage/high current devices such as injection components, motors, generator etc. These components may induce electrical noise on a circuit that could interfere with normal circuit operation. • Electrical system interference caused by a malfunctioning relay, or the engine control module (ECM) driven solenoid or switch. These conditions can cause a sharp electrical surge. Normally, the problem will occur when the malfunctioning component is operating. • Improper installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc. These accessories may lead to an emission related failure while in use, but do not fail when the accessories are not in use. • Test for an open diode across the A/C compressor clutch and for other open diodes. Some relays may contain a clamping diode. • Test the generator for a bad rectifier bridge that may be allowing AC noise into the electrical system.
Incorrect ECM Programming	• There are only a few situations where reprogramming a ECM is appropriate: **Important:** DO NOT reprogram the ECM with the SAME software/calibration files that are already present in the ECM. This is not an effective repair for any type of driveability problem. - A ECM from another vehicle is installed. - Revised software/calibration files have been released for this vehicle. • Verify that the ECM contains the correct software/calibration. If incorrect programming is found, reprogram the ECM with the most current software/ calibration.
Duplicating Failure Conditions	• If none of the previous tests are successful, attempt to duplicate and/or capture the failure conditions. • An alternate method is to drive the vehicle with the DMM connected to a suspected circuit. An abnormal reading on the DMM when the problem occurs, may help you locate the problem.
Tech 2 Snapshot	The Tech 2 can be set up to take a Snapshot of the parameters available via serial data. The Snapshot function records live data over a period of time. The recorded data can be played back and analyzed. The Tech 2 can also graph parameters singly or in combinations of parameters for comparison. The Snapshot can be triggered manually at the time the symptom is noticed, or set up in advance to trigger when a DTC sets. An abnormal value captured in the recorded data may point to a system or component that needs to be investigated further. Refer to the Tech 2 user instructions for more information on the Snapshot function.

Hard Start

Checks	Action
DEFINITION: The engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately dies.	
Preliminary Checks	• Diagnostic System Check – Engine Controls. • Ensure the driver is using the correct starting procedure. • Inspect the engine control module (ECM) and fuel injection pump control unit (PCU) grounds for being clean, tight, and in their proper locations. • Inspect that the harness connectors are correctly connected. • Inspect the fuel type and quality. • Inspect the Tech 2 Data List in this section. • Inspect the Service Bulletins for ECM software updates.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Engine Coolant Temperature (ECT) with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT sensor may indicate a higher than normal intake air temperature if the ignition switch is being ON. FT sensor is internal to the PCU and it is part of the fuel injection pump assembly. • Inspect the crankshaft position (CKP) sensor is tight and the flywheel circumference is not damaged.

Checks	Action
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Inspect for water contamination in the fuel. • Inspect for external fuel leaks or fuel leakage into the engine oil. • Inspect the fuel lines between the fuel tank and fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** The fuel system from the fuel tank(s) to the fuel injection pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel injection pump internal pressure fluctuations especially at high engine speed and load. • Inspect for air in the fuel system. **Notice:** If many air bubbles appear in the fuel, check the fuel system line connections between the fuel tank and the fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. a. Remove the fuel hose that connects to the fuel injection pump suction side. b. Substitute a clear hose. **Notice:** A hose must be cleaned. c. Connect the clear hose to the fuel injection pump. d. Bleed the fuel system. e. Let the engine run at idle for at least 2 minutes. f. Accelerator the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the clear hose. • Inspect the fuel tank vent hose for a plugged or kinked. • Inspect inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. Draw fuel from the fuel tank at the fuel line (as close to the fuel tank as possible) going to the fuel pickup tube to verify a clean stream of fuel comes out (use the hand-held vacuum pump 5-8840-0279-0/ J-23738-A with a clear hose or equivalent). This will ensure the fuel pickup tube is not cracked drawing air into the fuel line. • Inspect the fuel injection pump operation. **Notice:** The fuel injection pump must be timed to the engine. • Inspect the eye bolt for any type of restriction or collapsed gauze filter. **Notice:** If any type of restriction found, check for a condition that causes contaminated fuel, such as the customer is using an aftermarket fuel filter or extended maintenance interval. Also inspect fuel waxing or icing that is caused by an incorrect fuel type used in winter season or water intrusion in the fuel system. • Inspect the fuel injection nozzle(s) for proper splay condition or operating pressure. **Notice:** Only first stage of operating pressure can be checked.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction in the turbocharger inlet duct. • Inspect for a restriction or deposit in the intake throttle bore. • Inspect for a restriction or leak in the intake manifold.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section. • Inspect for a restriction in the catalytic converter or exhaust pipes.

Checks	Action
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 2100 kPa (309 psi). • Improper mechanical timing (timing gear) • Improper valve gap • Broken or weak valve springs • Worn camshaft lobes
Electrical System Checks	Inspect the engine electrical for the following conditions. Refer to the Engine Electrical section. • Inspect the glow plug control (preheating) system operation. • Inspect for slow cranking speed. • Inspect for weakened batteries.

Rough, Unstable, or Incorrect Idle And Stalling

Checks	Action
DEFINITION: Engine runs unevenly at idle. If severe, the engine or vehicle may shake. Engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.	
Preliminary Checks	• Diagnostic System Check – Engine Controls. • Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary. • Inspect the Engine Control Module (ECM) and fuel injection pump control unit (PCU) grounds for being clean, tight, and in their proper locations. • Inspect that the harness connectors are correctly connected. • Inspect the fuel type and quality. • Inspect the Tech 2 Data List in this section. • Inspect the Service Bulletins for ECM software updates.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Engine Coolant Temperature (ECT) with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT sensor may indicate a higher than normal intake air temperature if the ignition switch is being ON. FT sensor is internal to the PCU and it is part of the fuel injection pump assembly. • Use the Tech 2 to compare the MAF Sensor parameter with the Desired MAF parameter. Start the engine and warm up (allow engine coolant temperature to reach at least 60°C [140°F]). The MAF Sensor parameter must follow the Desired MAF parameter within 100mg/strk. If not, inspect the air intake system, EGR system components and contaminated, skewed or slow MAF sensor. • Inspect the crankshaft position (CKP) sensor is tight and the flywheel circumference is not damaged.

Checks	Action
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Inspect for water contamination in the fuel. • Inspect for external fuel leaks or fuel leakage into the engine oil. • Inspect the fuel lines between the fuel tank and fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** The fuel system from the fuel tank(s) to the fuel injection pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel injection pump internal pressure fluctuations especially at high engine speed and load. • Inspect for air in the fuel system. **Notice:** If many air bubbles appear in the fuel, check the fuel system line connections between the fuel tank and the fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. a. Remove the fuel hose that connects to the fuel injection pump suction side. b. Substitute a clear hose. **Notice:** A hose must be cleaned. c. Connect the clear hose to the fuel injection pump. d. Bleed the fuel system. e. Let the engine run at idle for at least 2 minutes. f. Accelerator the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the clear hose. • Inspect the fuel tank vent hose for a plugged or kinked. • Inspect inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. Draw fuel from the fuel tank at the fuel line (as close to the fuel tank as possible) going to the fuel pickup tube to verify a clean stream of fuel comes out (use the hand-held vacuum pump 5-8840-0279-0/ J-23738-A with a clear hose or equivalent). This will ensure the fuel pickup tube is not cracked drawing air into the fuel line. • Inspect the fuel injection pump operation. **Notice:** The fuel injection pump must be timed to the engine. • Inspect the eye bolt for any type of restriction or collapsed gauze filter. **Notice:** If any type of restriction found, check for a condition that causes contaminated fuel, such as the customer is using an aftermarket fuel filter or extended maintenance interval. Also inspect fuel waxing or icing that is caused by an incorrect fuel type used in winter season or water intrusion in the fuel system. • Inspect the fuel injection nozzle(s) for proper splay condition or operating pressure. **Notice:** Only first stage of operating pressure can be checked.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction in the turbocharger inlet duct. • Inspect for a restriction or deposit in the intake throttle bore. • Inspect for a restriction or leak in the intake manifold. • Inspect for a restriction or damage at MAF sensor.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section. • Inspect for a restriction in the catalytic converter or exhaust pipes.

Checks	Action
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 2100 kPa (309 psi). • Improper mechanical timing • Improper valve gap • Broken or weak valve springs • Worn camshaft lobes • Inspect for incorrect basic engine parts.
Additional Checks	• Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. The Tech 2 can usually detect EMI by monitoring the engine speed. A sudden increase in speed with little change in actual engine speed change indicates that EMI is present. If a problem exists, check routing of high voltage components, such as fuel injection solenoid valve wiring, near the sensor circuits. • Inspect for faulty engine mounts. • Inspect faulty crank pulley. • Inspect faulty generator & A/C compressor. • Inspect the generator output voltage. Repair if less than 9 volts or more than 16 volts. • Inspect the EGR system operating correctly. • Inspect the A/C operation.

Cut Out, Misses

Checks	Action
DEFINITION: A constant jerking that follows the engine speed, usually more pronounced as the engine load increase. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.	
Preliminary Check	• Diagnostic System Check — Engine Controls. • Inspect that the harness connectors are correctly connected. • Inspect the engine control module (ECM) and fuel injection pump control unit (PCU) grounds for being clean, tight, and in their proper locations. • Inspect the Tech 2 Data List in this section. • Inspect the Service Bulletins for ECM software updates.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to observe the Accelerator Pedal Position. Accelerator Pedal Position indicating angle parameter should change linearly from 0% to 100% according to the accelerator pedal operation. • Inspect the crankshaft position (CKP) sensor is tight and the flywheel circumference is not damaged.

Checks	Action
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Inspect for water contamination in the fuel. • Inspect for external fuel leaks or fuel leakage into the engine oil. • Inspect the fuel lines between the fuel tank and fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** The fuel system from the fuel tank(s) to the fuel injection pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel injection pump internal pressure fluctuations especially at high engine speed and load. • Inspect for air in the fuel system. **Notice:** If many air bubbles appear in the fuel, check the fuel system line connections between the fuel tank and the fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. a. Remove the fuel hose that connects to the fuel injection pump suction side. b. Substitute a clear hose. **Notice:** A hose must be cleaned. c. Connect the clear hose to the fuel injection pump. d. Bleed the fuel system. e. Let the engine run at idle for at least 2 minutes. f. Accelerator the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the clear hose. • Inspect the fuel tank vent hose for a plugged or kinked. • Inspect inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. Draw fuel from the fuel tank at the fuel line (as close to the fuel tank as possible) going to the fuel pickup tube to verify a clean stream of fuel comes out (use the hand-held vacuum pump 5-8840-0279-0/ J-23738-A with a clear hose or equivalent). This will ensure the fuel pickup tube is not cracked drawing air into the fuel line. • Inspect the fuel injection pump operation. **Notice:** The fuel injection pump must be timed to the engine. • Inspect the eye bolt for any type of restriction or collapsed gauze filter. **Notice:** If any type of restriction found, check for a condition that causes contaminated fuel, such as the customer is using an aftermarket fuel filter or extended maintenance interval. Also inspect fuel waxing or icing that is caused by an incorrect fuel type used in winter season or water intrusion in the fuel system.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction in the turbocharger inlet duct. • Inspect for a restriction or deposit in the intake throttle bore. • Inspect for a restriction or leak in the intake manifold. • Inspect for a restriction or damage at mass air flow (MAF) sensor.
Additional Checks	• Inspect the generator output voltage. Repair if less than 9 volts or more than 16 volts. • Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. The Tech 2 can usually detect EMI by monitoring the engine speed. A sudden increase in speed with little change in actual engine speed change indicates that EMI is present. If a problem exists, check routing of high voltage components, such as fuel injection solenoid wiring, near the sensor circuits.

Surges/Chuggles

Checks	Action
DIFINITION: The engine has a power variation under a steady throttle or cruise. The vehicle seems to speed up and slow down with no change in the accelerator pedal.	
Preliminary Checks	• Diagnostic System Check — Engine Controls. • Ensure the driver understands the A/C compressor operation. • Use the Tech 2 in order to make sure the Vehicle Speed parameter reading matches the vehicle speedometer. • Inspect the engine control module (ECM) and fuel injection pump control unit (PCU) grounds for being clean, tight, and in their proper locations. • Inspect that the harness connectors are correctly connected. • Inspect the fuel type and quality. • Inspect the Tech 2 Data List in this section. • Inspect the Service Bulletins for ECM software updates.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Mass Air Flow (MAF) Sensor parameter with the Desired MAF parameter. Start the engine and warm up (allow engine coolant temperature to reach at least 60°C [140°F]). The MAF Sensor parameter must follow the Desired MAF parameter within 100mg/strk. If not, inspect the air intake system, EGR system components and contaminated, skewed or slow MAF sensor. • Use the Tech 2 to observe the Accelerator Pedal Position. Accelerator Pedal Position parameter should change linearly from 0% to 100% according to the accelerator pedal operation. Also inspect the Accelerator Pedal Position indicating angle when the accelerator pedal is steady. If the indicating angle fluctuates, check for an intermittent open, high resistance in the circuits or for a skewed sensor. • Inspect the crankshaft position (CKP) sensor is tight and the flywheel circumference is not damaged.

Checks	Action
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Inspect for water contamination in the fuel. • Inspect for external fuel leaks or fuel leakage into the engine oil. • Inspect the fuel lines between the fuel tank and fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** The fuel system from the fuel tank(s) to the fuel injection pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel injection pump internal pressure fluctuations especially at high engine speed and load. • Inspect for air in the fuel system. **Notice:** If many air bubbles appear in the fuel, check the fuel system line connections between the fuel tank and the fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. a. Remove the fuel hose that connects to the fuel injection pump suction side. b. Substitute a clear hose. **Notice:** A hose must be cleaned. c. Connect the clear hose to the fuel injection pump. d. Bleed the fuel system. e. Let the engine run at idle for at least 2 minutes. f. Accelerator the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the clear hose. • Inspect the fuel tank vent hose for a plugged or kinked. • Inspect inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. Draw fuel from the fuel tank at the fuel line (as close to the fuel tank as possible) going to the fuel pickup tube to verify a clean stream of fuel comes out (use the hand-held vacuum pump 5-8840-0279-0/ J-23738-A with a clear hose or equivalent). This will ensure the fuel pickup tube is not cracked drawing air into the fuel line. • Inspect the fuel injection pump operation. **Notice:** The fuel injection pump must be timed to the engine. • Inspect the eye bolt for any type of restriction or collapsed gauze filter. **Notice:** If any type of restriction found, check for a condition that causes contaminated fuel, such as the customer is using an aftermarket fuel filter or extended maintenance interval. Also inspect fuel waxing or icing that is caused by an incorrect fuel type used in winter season or water intrusion in the fuel system. • Inspect the fuel injection nozzle(s) for proper splay condition or operating pressure. **Notice:** Only first stage of operating pressure can be checked. • Inspect the timing device operating correctly. Observe the Actual Injection Timing parameter with the Tech 2 while running the engine. The Actual Injection Timing parameter must follow the Desired Injection Timing within 2°CA on each engine speed. Engine idle > around 2000 RPM > around 3000 RPM. If not, inspect the fuel system restriction, air in the fuel or fuel injection pump operation.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction in the turbocharger inlet duct. • Inspect for a restriction or deposit in the intake throttle bore. • Inspect for a restriction or leak in the intake manifold. • Inspect for a restriction or damage at MAF sensor.

Checks	Action
Additional Checks	• Inspect the generator output voltage. Repair if less than 9 volts or more than 16 volts. • Inspect the EGR system operating correctly. • Inspect the A/C operation.

Lack of Power, Sluggishness, Sponginess

Checks	Action
DEFINITION: The engine delivers less than expected power. There is little or no increase in speed when partially applying the accelerator pedal.	
Preliminary Checks	• Diagnostic System Check — Engine Controls. • Compare the vehicle with a similar unit. Ensure the vehicle has an actual problem. • Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary. • Are the tire sizes changed? • Are excessively heavy loads being carried? • Inspect for clutch slip. • Inspect brake drag. • Inspect the fuel quality (cetane index). • Inspect the engine oil level and quality. • Use the Tech 2 in order to make sure the Vehicle Speed parameter reading matches the vehicle speedometer. • Inspect the engine control module (ECM) and fuel injection pump control unit (PCU) grounds for being clean, tight, and in their proper locations. • Inspect the Tech 2 Data List in this section. • Inspect the Service Bulletins for ECM software updates.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Engine Coolant Temperature (ECT) with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT sensor may indicate a higher than normal intake air temperature if the ignition switch is being ON. FT sensor is internal to the PCU and it is part of the fuel injection pump assembly. • Use the Tech 2 to compare the MAF Sensor parameter with the Desired MAF parameter. Start the engine and warm up (allow engine coolant temperature to reach at least 60°C [140°F]). The MAF sensor parameter must follow the Desired MAF parameter within 100 mg/strk. If not, inspect the air intake system, EGR system components and contaminated, skewed or slow MAF sensor. • Use the Tech 2 to observe the Accelerator Pedal Position. Accelerator Pedal Position parameter should change linearly from 0% to 100% according to the accelerator pedal operation.

Checks	Action
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Inspect for water contamination in the fuel. • Inspect for external fuel leaks or fuel leakage into the engine oil. • Inspect the fuel lines between the fuel tank and fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** The fuel system from the fuel tank(s) to the fuel injection pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel injection pump internal pressure fluctuations especially at high engine speed and load. • Inspect for air in the fuel system. **Notice:** If many air bubbles appear in the fuel, check the fuel system line connections between the fuel tank and the fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. a. Remove the fuel hose that connects to the fuel injection pump suction side. b. Substitute a clear hose. **Notice:** A hose must be cleaned. c. Connect the clear hose to the fuel injection pump. d. Bleed the fuel system. e. Let the engine run at idle for at least 2 minutes. f. Accelerator the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the clear hose. • Inspect the fuel tank vent hose for a plugged or kinked. • Inspect inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. Draw fuel from the fuel tank at the fuel line (as close to the fuel tank as possible) going to the fuel pickup tube to verify a clean stream of fuel comes out (use the hand-held vacuum pump 5-8840-0279-0/ J-23738-A with a clear hose or equivalent). This will ensure the fuel pickup tube is not cracked drawing air into the fuel line. • Inspect the fuel injection pump operation. **Notice:** The fuel injection pump must be timed to the engine. • Inspect the eye bolt for any type of restriction or collapsed gauze filter. **Notice:** If any type of restriction found, check for a condition that causes contaminated fuel, such as the customer is using an aftermarket fuel filter or extended maintenance interval. Also inspect fuel waxing or icing that is caused by an incorrect fuel type used in winter season or water intrusion in the fuel system. • Inspect the fuel injection nozzle(s) for proper splay condition or operating pressure. **Notice:** Only first stage of operating pressure can be checked. • Inspect the timing device operating correctly. Observe the Actual Injection Timing parameter with the Tech 2 while running the engine. The Actual Injection Timing parameter must follow the Desired Injection Timing within 2°CA on each engine speed. Engine idle > around 2000 RPM > around 3000 RPM. If not, inspect the fuel system restriction, air in the fuel or fuel injection pump operation.

Checks	Action
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction or leak in the intercooler. • Inspect for a restriction in the turbocharger inlet duct. • Inspect for a restriction or deposit in the intake throttle bore. • Inspect for a restriction or leak in the intake manifold. • Inspect for a restriction or damage at MAF sensor. • Inspect for a worn or damaged turbocharger turbine wheel, shaft or compressor wheel. Refer to turbocharger inspection in the Engine Mechanical section. • Inspect for turbocharger wastegate valve operation. Refer to wastegate valve inspection in the Engine Mechanical section.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section. • Inspect for a restriction in the catalytic converter or exhaust pipes.
Engine Mechanical Check	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 2100 kPa (309 psi). • Improper mechanical timing • Improper valve gap • Broken or weak valve springs • Worn camshaft lobes
Additional Checks	• Inspect the generator output voltage. Repair if less than 9 volts or more than 16 volts. • Inspect the EGR system operating correctly. • Inspect the engine overheat condition. Refer to the Engine Cooling section. • Inspect the A/C operation.

Hesitation, Sag, Stumble

Checks	Action
DEFINITION: The vehicle has a momentary lack of response when pushing down on the accelerator. The condition can occur at any vehicle speed. The condition is usually most severe when trying to make the vehicle move from a stop. If severe enough, the condition may cause the engine to stall.	
Preliminary Checks	• Diagnostic System Check — Engine Controls. • Compare the vehicle with a similar unit. Ensure the vehicle has an actual problem. • Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary. • Inspect the fuel quality (cetane index). • Inspect the engine oil level and quality. • Inspect the Tech 2 Data List in this section. • Inspect the engine control module (ECM) and fuel injection pump control unit (PCU) grounds for being clean, tight, and in their proper locations. • Inspect the Service Bulletins for ECM software updates.

Checks	Action
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Engine Coolant Temperature (ECT) with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT sensor may indicate a higher than normal intake air temperature if the ignition switch is being ON. FT sensor is internal to the PCU and it is part of the fuel injection pump assembly. • Use the Tech 2 to compare the MAF Sensor parameter with the Desired MAF parameter. Start the engine and warm up (allow engine coolant temperature to reach at least 60°C [140°F]). The MAF Sensor parameter must follow the Desired MAF parameter within 100mg/strk. If not, inspect the air intake system, EGR system components and contaminated, skewed or slow MAF sensor • Use the Tech 2 to observe the Accelerator Pedal Position. Accelerator Pedal Position parameter should change linearly from 0% to 100% according to the accelerator pedal operation.

Checks	Action
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Inspect for water contamination in the fuel. • Inspect for external fuel leaks or fuel leakage into the engine oil. • Inspect the fuel lines between the fuel tank and fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. **Notice:** The fuel system from the fuel tank(s) to the fuel injection pump is under a slight vacuum with the engine running. As a result, air can enter the fuel system if these connections are not tight. Air in the fuel system will cause fuel injection pump internal pressure fluctuations especially at high engine speed and load. • Inspect for air in the fuel system. **Notice:** If many air bubbles appear in the fuel, check the fuel system line connections between the fuel tank and the fuel injection pump for tightness and all fuel hoses for cuts, cracks and for the use of proper clamps. a. Remove the fuel hose that connects to the fuel injection pump suction side. b. Substitute a clear hose. **Notice:** A hose must be cleaned. c. Connect the clear hose to the fuel injection pump. d. Bleed the fuel system. e. Let the engine run at idle for at least 2 minutes. f. Accelerator the engine between idle and W.O.T. (accelerator pedal full travel) many times while observing the clear hose. • Inspect the fuel tank vent hose for a plugged or kinked. • Inspect inside the fuel tank for any foreign material that may be getting drawn into the fuel line pickup causing a blocked condition. Draw fuel from the fuel tank at the fuel line (as close to the fuel tank as possible) going to the fuel pickup tube to verify a clean stream of fuel comes out (use the hand-held vacuum pump 5-8840-0279-0/ J-23738-A with a clear hose or equivalent). This will ensure the fuel pickup tube is not cracked drawing air into the fuel line. • Inspect the fuel injection pump operation. **Notice:** The fuel injection pump must be timed to the engine. • Inspect the eye bolt for any type of restriction or collapsed gauze filter. **Notice:** If any type of restriction found, check for a condition that causes contaminated fuel, such as the customer is using an aftermarket fuel filter or extended maintenance interval. Also inspect fuel waxing or icing that is caused by an incorrect fuel type used in winter season or water intrusion in the fuel system. • Inspect the fuel injection nozzle(s) for proper splay condition or operating pressure. **Notice:** Only first stage of operating pressure can be checked. • Inspect the timing device operating correctly. Observe the Actual Injection Timing parameter with the Tech 2 while running the engine. The Actual Injection Timing parameter must follow the Desired Injection Timing within 2°CA on each engine speed. Engine idle > around 2000 RPM > around 3000 RPM. If not, inspect the fuel system restriction, air in the fuel or fuel injection pump operation.

Checks	Action
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction or leak in the intercooler. • Inspect for a restriction in the turbocharger inlet duct. • Inspect for a restriction or deposit in the intake throttle bore. • Inspect for a restriction or leak in the intake manifold. • Inspect for a restriction or damage at MAF sensor. • Inspect for a worn or damaged turbocharger turbine wheel, shaft or compressor wheel. Refer to turbocharger inspection in the Engine Mechanical section. • Inspect for turbocharger wastegate valve operation. Refer to wastegate valve inspection in the Engine Mechanical section.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section. • Inspect for a restriction in the catalytic converter or exhaust pipes.
Engine Mechanical Check	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 2100 kPa (309 psi). • Improper mechanical timing • Improper valve gap • Broken or weak valve springs • Worn camshaft lobes
Additional Checks	• Inspect the generator output voltage. Repair if less than 9 volts or more than 16 volts. • Inspect the EGR system operating correctly. • Inspect the A/C operation.

Fuel Knock/Combustion Noise

Checks	Action
DEFINITION: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with the throttle opening.	
Preliminary Checks	• Diagnostic System Check — Engine Controls. • Ensure the vehicle has an actual problem. • Inspect for smoke associated with the combustion noise. • Inspect the fuel quality (cetane index). • Inspect the Tech 2 Data List in this section. • Inspect the Service Bulletins for ECM software updates.

Checks	Action
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Engine Coolant Temperature (ECT) with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT sensor may indicate a higher than normal intake air temperature if the ignition switch is being ON. FT sensor is internal to the PCU and it is part of the fuel injection pump assembly. • Use the Tech 2 to compare the MAF Sensor parameter with the Desired MAF parameter. Start the engine and warm up (allow engine coolant temperature to reach at least 60°C [140°F]). The MAF Sensor paramater must follow the Desired MAF parameter within 100mg/strk. If not, inspect the air intake system, EGR system components and contaminated, skewed or slow MAF sensor. • Inspect the crankshaft position (CKP) sensor is tight and the flywheel circumference is not damaged.
Fuel System Checks	• If excessive smoke is present, check for an injection nozzle(s). Remove each glow plug from the cylinder head and inspect the tip of the glow plugs for wet by fuel. Use the cylinder compression gauge. Proper compression is more than 2100 kPa (309 psi). If poor compression is observed, inspect the engine mechanical. • Inspect the fuel injection nozzle(s) for proper splay condition or operating pressure. **Notice:** Only first stage of operating pressure can be checked. • Inspect the timing device operating correctly. Observe the Actual Injection Timing parameter with the Tech 2 while running the engine. The Actual Injection Timing parameter must follow the Desired Injection Timing within 2°CA on each engine speed. Engine idle > around 2000 RPM > around 3000 RPM. If not, inspect the fuel system restriction, air in the fuel or fuel injection pump operation.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 2100 kPa (309 psi). • Inspect for incorrect basic engine parts such as camshaft, cylinder head, pistons, etc. • Inspect for any excessive oil entering combustion chamber.
Additional Checks	• Inspect the EGR system operating correctly. • Inspect other possible causes that can make similar noise such as loose component parts, bracket, mount and weak clutch damper spring.

Poor Fuel Economy

Checks	Action
DEFINITION: Fuel economy, as measured by actual road tests and several tanks of fuel, is noticeably lower than expected. Also, the economy is noticeably lower than it was on this vehicle at one time, as previously shown by actual road tests.	

Checks	Action
Preliminary Checks	• Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary. • Inspect the driving habits of the owner. • Is the A/C ON full time, defroster mode ON? • Are the tires at the correct pressure? • Have the tire sizes changed? • Are excessively heavy loads being carried? • Is the acceleration too much, too often? • Inspect for clutch slip. • Inspect brake drag. • Inspect dive belt tension. • Inspect the fuel quality (cetane index). • Inspect the engine oil level and quality. • Suggest to the owner to fill the fuel tank and recheck the fuel economy. • Suggest to the driver to read the Important Facts on Fuel Economy in the Owner Manual. • Inspect the odometer is correctly operated. • Inspect the Service Bulletins for ECM software updates.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Engine Coolant Temperature (ECT) with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT sensor may indicate a higher than normal intake air temperature if the ignition switch is being ON. FT sensor is internal to the PCU and it is part of the fuel injection pump assembly.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Inspect the fuel type and quality. • Check fuel leak.
Cooling System Checks	Inspect the cooling system for the following conditions. Refer to the Cooling System Section. • Inspect the engine coolant level. • Inspect the engine thermostat for always being open or for the wrong heat range. • Inspect the engine cooling fan for always being ON.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction or leak in the intercooler. • Inspect for a restriction in the turbocharger inlet duct. • Inspect for a restriction or deposit in the intake throttle bore. • Inspect for a restriction or leak in the intake manifold. • Inspect for a restriction or damage at MAF sensor.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section. • Inspect for a restriction in the catalytic converter or exhaust pipes.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 2100 kPa (309 psi).

Excessive Smoke (Black Smoke)

Checks	Action
DEFINITION: Black smoke under load, idle or start up hot or cold.	
Preliminary Check	• Ensure the vehicle has an actual problem. • Inspect the engine control module (ECM) and fuel injection pump control unit (PCU) grounds for being clean, tight, and in their proper locations. • Remove the air cleaner and check for dirt, or for air ducts being plugged or restricted. Replace as necessary. • Inspect the fuel quality (cetane index). • Inspect the engine oil level and quality. • Inspect the Service Bulletins for ECM software updates.
Sensor Checks	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Engine Coolant Temperature (ECT) with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT sensor may indicate a higher than normal intake air temperature if the ignition switch is being ON. FT sensor is internal to the PCU and it is part of the fuel injection pump assembly. • Use the Tech 2 to compare the MAF Sensor parameter with the Desired MAF parameter. Start the engine and warm up (allow engine coolant temperature to reach at least 60°C [140°F]). The MAF Sensor parameter must follow the Desired MAF parameter within 100mg/strk. If not, inspect the air intake system, EGR system components and contaminated, skewed or slow MAF sensor • Use the Tech 2 to observe the Accelerator Pedal Position. Accelerator Pedal Position indicating angle parameter should change linearly from 0% to 100% according to the accelerator pedal operation.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Inspect the fuel injection nozzle(s) for proper splay condition or operating pressure. **Notice:** Only first stage of operating pressure can be checked. • Inspect the timing device operating correctly. Observe the Actual Injection Timing parameter with the Tech 2 while running the engine. The Actual Injection Timing parameter must follow the Desired Injection Timing within 2°CA on each engine speed. Engine idle > around 2000 RPM > around 3000 RPM. If not, inspect the fuel system restriction, air in the fuel or fuel injection pump operation.
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction or leak in the intercooler. • Inspect for a restriction in the turbocharger inlet duct. • Inspect for a restriction or deposit in the intake throttle bore. • Inspect for a restriction or leak in the intake manifold. • Inspect for a restriction or damage at MAF sensor. • Inspect for a worn or damaged turbocharger turbine wheel, shaft or compressor wheel. Refer to turbocharger inspection in the Engine Mechanical section.
Exhaust System Checks	Inspect the exhaust system for a possible restriction. Refer to the Exhaust System section. • Inspect for a restriction in the catalytic converter or exhaust pipes.

Checks	Action
Engine Mechanical Check	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 2100 kPa (309 psi). • Inspect for incorrect basic engine parts such as camshaft, cylinder head, pistons, etc. • Inspect for any excessive oil entering combustion chamber. • Improper mechanical timing • Improper valve gap • Broken or weak valve springs • Worn camshaft lobes
Additional Checks	• Inspect the EGR system operating correctly. • Inspect the excessive blow-by gasses. • Inspect the Tech 2 Data List in this section.

Excessive Smoke (White Smoke)

Checks	Action
DIFINITION: White smoke under load, idle or start up hot or cold.	
Preliminary Check	• Ensure the vehicle has an actual problem. • Inspect the engine control module (ECM) and fuel injection pump control unit (PCU) grounds for being clean, tight, and in their proper locations. • Inspect the fuel quality (cetane index). • Inspect the Service Bulletins for ECM software updates.
Sensor Check	Inspect the engine control sensors for the following conditions. Refer to the Tech 2 Data List in this section. • Use the Tech 2 to compare the Engine Coolant Temperature (ECT) with the Intake Air Temperature (IAT) and Fuel Temperature (FT) on a cold engine condition. If the difference among temperature reading is more than 5°C (9°F) on a cold engine, check for high resistance on the low reference circuit and signal circuit or for a skewed sensor. **Notice:** The mass air flow (MAF) sensor is heated and as a result the IAT sensor may indicate a higher than normal intake air temperature if the ignition switch is being ON. FT sensor is internal to the PCU and it is part of the fuel injection pump assembly. • Inspect the crankshaft position (CKP) sensor is tight and the flywheel circumference is not damaged.
Fuel System Checks	Inspect the fuel system for the following conditions. Refer to the Fuel System section. • Inspect the fuel injection nozzle(s) for proper splay condition or operating pressure. **Notice:** Only first stage of operating pressure can be checked. • Inspect the timing device operating correctly. Observe the Actual Injection Timing parameter with the Tech 2 while running the engine. The Actual Injection Timing parameter must follow the Desired Injection Timing within 2°CA on each engine speed. Engine idle > around 2000 RPM > around 3000 RPM. If not, inspect the fuel system restriction, air in the fuel or fuel injection pump operation.

Checks	Action
Air Intake System Checks	Inspect the air intake system for the following conditions. • Inspect the air cleaner and air intake ducts for a restriction, holes, or leaks. • Inspect for a restriction or leak in the intercooler. • Inspect for a restriction in the turbocharger inlet duct. • Inspect for a restriction or leak in the intake manifold. • Inspect for a restriction or damage at MAF sensor. • Inspect for a worn or damaged turbocharger turbine wheel, shaft or compressor wheel. Refer to turbocharger inspection in the Engine Mechanical section.
Engine Mechanical Checks	Inspect the engine mechanical for the following conditions. Refer to the Engine Mechanical section. • Inspect for poor cylinder compression. Proper compression is more than 2100 kPa (309 psi). • Inspect for incorrect basic engine parts such as camshaft, cylinder head, pistons, etc. • Improper mechanical timing • Improper valve gap • Broken or weak valve springs • Worn camshaft lobes • Inspect for any excessive fuel entering combustion chamber. • Inspect for coolant entering the combustion chamber.
Electrical System Checks	Inspect the engine electrical for the following conditions. Refer to the Engine Electrical section. • Inspect the glow plug control (preheating) system operation.

Repair Instructions

Engine Control Module (ECM) Replacement

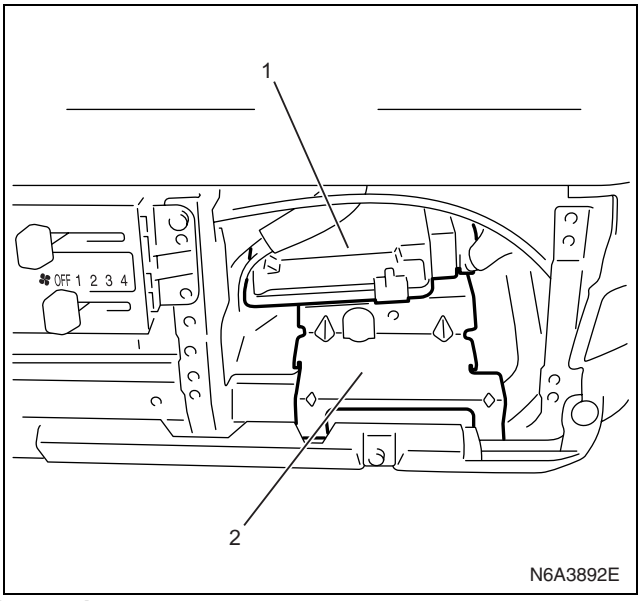
Engine Control Module (ECM) Replacement Procedure

Important:
If the ECM is to be replaced the following programmed contents MUST be reprogrammed into the new ECM.

- Vehicle identification number (VIN).
- Latest software/calibrations if released. Refer to Service Programming System (SPS) Description and Service Programming System (SPS) (Remote Procedure) or Service Programming System (SPS) (Pass-Thru Procedure) in this section.

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the instrument cover.
3. Remove a bolt from the ECM bracket.
4. Disconnect the two connectors from the ECM.



Legend
1. ECM
2. Bracket

Installation Procedure

1. Connect the two connectors to the ECM.
2. Put on the ECM to the bracket and tighten by a bolt.
3. Refit the instrument cover by four screws.
4. Connect the negative battery cable.

Vehicle Identification Number (VIN) Programming Procedure

Important:
If the ECM from another vehicle is installed, VIN is not programmed by the Tech 2. Use the SPS to change the original VIN. Refer to Service Programming System (SPS) Description and Service Programming System (SPS) (Remote Procedure) or Service Programming System (SPS) (Pass-Thru Procedure) in this section.

Important:
If an updated software/calibrations is released, DO NOT program the VIN now. The VIN is programmed at SPS procedure. Refer to Service Programming System (SPS) Description and Service Programming System (SPS) (Remote Procedure) or Service Programming System (SPS) (Pass-Thru Procedure) in this section.

1. Connect the Tech 2 to the vehicle DLC, with the engine and the Tech 2 OFF.
2. Turn ON the Tech 2.
3. Select Diagnostic > appropriate vehicle identification > Powertrain > 4JH1-TC > Programming > Program VIN.
4. Input correct VIN reading from stamped VIN or affixed VIN plate on the vehicle.
5. Select Lock ECU and lock the programmed VIN.

Service Programming System (SPS) Description

The service programming system (SPS) allows a technician to program a control module through the data link connector (DLC). The information transfer circuit that is used at the DLC is the same serial data circuit used be the Tech 2 for retrieving diagnostic trouble codes (DTCs), displaying data, clearing DTCs etc. This procedure offers the ability to install software/ calibrations matched to a particular vehicle.
Most control modules have two types of memory. The software/calibrations reside in the flash memory. The two types of memory are listed below:

- Electrically Erasable Programmable Read Only Memory (EEPROM).
  This type of memory allows selected portions of memory to be programmed while other portions remain unchanged.
  Certain learned values reside in the EEPROM, such as:
  - The vehicle identification number (VIN)
  - The software/calibrations identification numbers
  - The control module security information

- Flash Read Only Memory-Flash MemoryFlash memory has increased memory storage capacity. During programming, all information within this type of memory is erased, and then replaced with entirely new information.

Service Programming Methods

The two methods of programming an engine control module (ECM) are listed below:

- Remote Programming
- Pass Thru Programming

For information on programming an ECM using one of the methods listed above, refer to Service Programming System (SPS) (Remote Procedure) or Service Programming System (SPS) (Pass-Thru Procedure).

Before Programming a Control Module

Important:
DO NOT program an existing ECM with the identical software/calibration package. This procedure is not a short cut to correct the driveability condition. This is an ineffective repair. An ECM should only be programmed when the following occurs:

- When a service procedure instructs you to replace the ECM. When the ECM from another vehicle is installed, VIN must be changed. And change vehicle information as necessary such as type of transmission.
- An updated software/calibrations is released.

Ensure that the following conditions are met before programming an ECM:

- The Tech 2 PCMCIA card is programmed with the latest software.
- The TIS 2000 is installed with the latest software.
- The hardware key is plugged into the computer port.
- Vehicle system voltage:
  - There are no charging system concerns. All charging system concerns must be repaired before programming the ECM.
  - The battery voltage is greater than 12 volts but less than 16 volts. The battery must be fully charged before programming the ECM.
  - A battery charger is NOT connected to the vehicles battery. Incorrect system voltage or voltage fluctuations from a battery charger may cause programming failure or ECM damage.
  - Turn OFF or disable any system that may put a load on the vehicles battery. Turn OFF or disable systems such as:
    - ◊ Heating, ventilation, and air conditioning (HVAC) systems
    - ◊ Headlights
    - ◊ Room lights
    - ◊ Accessory equipment
- The ignition switch is in the proper position. The Tech 2 prompts you to turn ON the ignition, with the engine OFF. DO NOT change the position of the ignition switch during the programming procedure unless instructed to do so.
- All tool connections are secure:
  - The RS-232 cable
  - The connection at the DLC
  - The voltage supply circuits
- DO NOT disturb the tool harnesses while programming. If an interruption occurs during the programming procedure, programming failure or ECM damage may occur.
- If you are performing the Pass-Thru programming procedure using a notebook computer without the power cord, ensure that the internal battery is fully charged.

Service Programming System (SPS) (Remote Procedure)

The Remote Service Programming System (SPS) method is a three-step process that involves the following procedures:

1. Connecting the Tech 2 to the vehicle and obtaining the information from the engine control module (ECM).
2. Connecting the Tech 2 to the terminal and downloading a new calibration file from the terminal into the Tech 2 memory.
3. Reconnecting the Tech 2 to the vehicle and uploading the new calibration file into the ECM.

Performing the Remote Procedure

1. Connect the Tech 2 to the vehicle and obtain the ECM information using the following procedure:

Important:
Ensure the ECM is installed in the vehicle and the battery is fully charged before programming.

   a. Connect the Tech 2 to the vehicle data link connector (DLC), with the engine and the Tech 2 OFF.
   b. Turn ON the Tech 2.
   c. Press Enter at the title screen.
   d. Turn ON the ignition, with the engine OFF.
   e. Select Service Programming System at the Main Menu.
   f. Select Request Info.

g. If there is already stored in the Tech 2, the existing data is displayed on the screen. The Tech 2 asks user to keep existing data Keep Data or Continue to request new vehicle information from the ECM. If there is no data in the Tech 2, it will immediately start vehicle identification.
h. Enter the vehicle description by following the on-screen instructions based on stamped VIN or affixed VIN plate on the vehicle.
i. During obtaining information, the Tech 2 is receiving information from any modules at the same time. But only ECM information is displayed on the screen.
j. Turn OFF all accessories and select Continue.
k. Verify that the correct VIN is entered on the Tech 2. If the VIN is incorrect, write down the correct VIN.

2. Turn OFF the Tech 2.
3. Disconnect the Tech 2 from the vehicle.
4. Turn OFF the ignition.
5. Transfer the data from the terminal to the Tech 2 using the following procedure:

Important:
The TIS supports service programming with the Tech 2 scan tool only.

a. Connect the Tech 2 to the terminal.
b. Launch the TIS application at the terminal.
c. Select the Service Programming System at the main screen.
d. Highlight the following information on the Select Diagnostic Tool and Programming Process screen:
   - Select Diagnostic Tool-Select Tech 2.
   - Select Programming Process-Identify whether an existing ECM is being reprogrammed or an ECM is being replaced with a new one.
   - Select ECU Location-Select Vehicle.
e. Select Next.
f. Verify the connections on the Preparing for Communication screen and select Next.
g. Verify the VIN on the Validate Vehicle Identification Number (VIN) screen and select Next.

Important:
If the ECM is replaced to new one, VIN does not displayed. Input correct VIN reading from stamped VIN or affixed VIN plate on the vehicle. If the ECM from another vehicle is installed, input correct VIN by same way.

h. Highlight Engine on the System Type screen and select Next, if requested.
i. Complete the following information based on the service ID plate on the Validate Vehicle Data screen until Next is highlighted:
   - Model
   - Model Year
   - Engine
   - Type of Transmission
   - Destination Code
j. Select Next.
k. Verify your selection on the Summary screen.

Important:
Refer to Service Bulletins before service programming is performed if the bulletins are listed along with the calibration files.

Important:
Select Cancel if you receive a message stating that the calibration selected is already the current calibration in the ECM and reprogramming with the same download is not allowed.

l. Select Reprog.
m. The Transfer Data screen will appear until the progress bar reaches 100%.

6. Close the application and return to the TIS application selection screen after the download is complete.
7. Turn OFF the Tech 2.
8. Disconnect the Tech 2 from the terminal.
9. Transfer the data from the Tech 2 to the ECM using the following procedure:
   a. Connect the Tech 2 to the vehicle DLC, with the engine and the Tech 2 OFF.
   b. Turn ON the Tech 2.
   c. Press Enter at the Title screen.
   d. Turn ON the ignition, with the engine OFF.
   e. Select Service Programming System.
   f. Select the Program ECU on the Tech 2.
   g. Follow the on-screen instructions and select Continue.
   h. Programming in Process will appear until the progress bar reaches 100%.

Important:
The vehicle fitted with automatic transmission, Check Trans lamp may blink while programming the ECM since communication between the ECM and TCM is interrupted. Clear DTC in any module after programming.

   i. Select Continue and exit the program after the Tech 2 displays Programming Was Successful.

10. Turn OFF the ignition.
11. Turn OFF the Tech 2.
12. Disconnect the Tech 2 from the vehicle.

Service Programming System (SPS) (Pass-Thru Procedure)

Pass-Thru programming allows the Tech 2 to remain connected to the terminal and to the vehicle throughout the programming process. The vehicle must be in close proximity to the terminal while using Pass-Thru.

Important:
The TIS supports service programming with the Tech 2 scan tool only.

1. Launch the TIS application at the terminal application at the terminal.
2. Select the Service Programming System at the main screen.
3. Highlight the following information on the Select Diagnostic Tool and Programming Process screen:
   - Select Diagnostic Tool-Select Pass-Thru
   - Select Programming Process-Identify whether as existing engine control module (ECM) is being reprogrammed or an ECM is being replaced with a new one.
   - Select ECU Location-Select Vehicle.
4. Select Next.
5. Complete all vehicle data on the Preparing for Communication/Determine Vehicle screen until Next is highlighted.
6. Select Next.
7. Follow the instruction on the Preparing for Communication screen.

Important:
In order to reduce the potential for signal loss, the RS-232 cable should not be more than 25 feet long.

8. Select Next.
9. Verify the VIN on the Validate Vehicle Identification Number (VIN) screen and select Next.

Important:
If the ECM is replaced to new one, VIN does not displayed. Input correct VIN reading from stamped VIN or affixed VIN plate on the vehicle. If the ECM from another vehicle is installed, input correct VIN by same way.

10. Highlight Engine on the System Type screen and select Next, if requested.
11. Complete the following information based on the service ID plate on the Validate Vehicle Data screen until Next is highlighted:
    - Model
    - Model Year
    - Engine
    - Type of Transmission
    - Destination Code
12. Select Next.
13. Verify your selection on the Summary screen.

Important:
Refer to Service Bulletins before service programming is performed if the bulletins are listed along with the calibration files.

Important:
Select Cancel if you receive a message stating that the calibration selected is already the current calibration in the Tech 2 and reprogramming with the same download is not allowed.

14. Select Reprog.
15. The Transfer Data screen will appear until the progress bar reaches 100%.

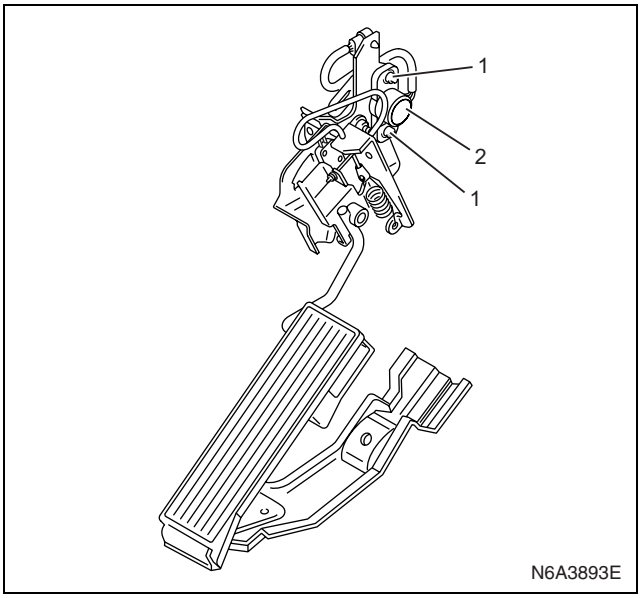
Important:
The vehicle fitted with automatic transmission, Check Trans lamp may blink while programming the ECM since communication between the ECM and TCM is interrupted. Clear DTC in any module after programming.

16. Select Close on the Programming Complete screen.
17. Turn OFF the Tech 2.
18. Disconnect the Tech 2 from the vehicle.

Accelerator Pedal Position (APP) Sensor Replacement

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the APP and idle switch connector.
3. Remove the accelerator pedal assembly from the bracket.
4. Loosen two nuts and remove APP from the accelerator pedal bracket.



Legend
1. Accelerator Pedal Position (APP) Sensor
2. Nut

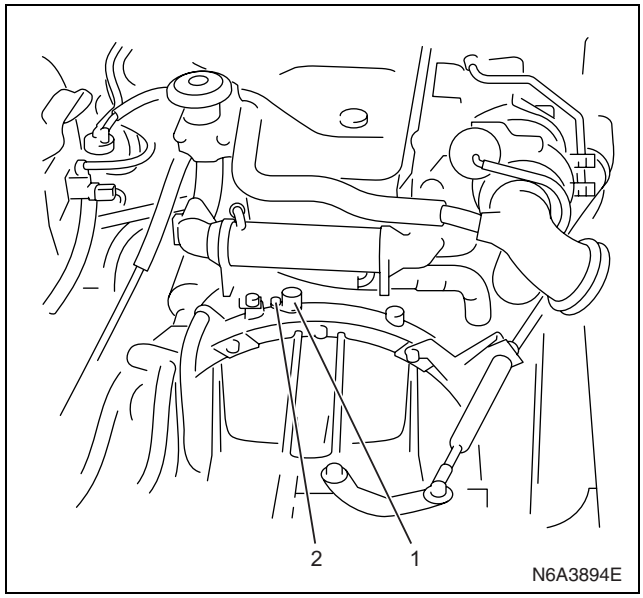
Installation Procedure

1. Temporary tighten the APP by two nuts.
2. Refit the accelerator pedal bracket to the body.
3. Connect the idle switch and APP connector.
4. Connect the Tech 2 to the vehicle.
5. Connect the negative battery cable.
6. Select “Data Display” with the Tech 2.
7. Check the accelerator pedal position data and adjust the APP position.
8. Tighten two nuts.

Crankshaft Position (CKP) Sensor Replacement

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect connector from the CKP sensor.
3. Loosen a bolt and remove the CKP sensor from the clutch housing.



Legend
1. Crankshaft Position (CKP) Sensor
2. Bolt

Installation Procedure

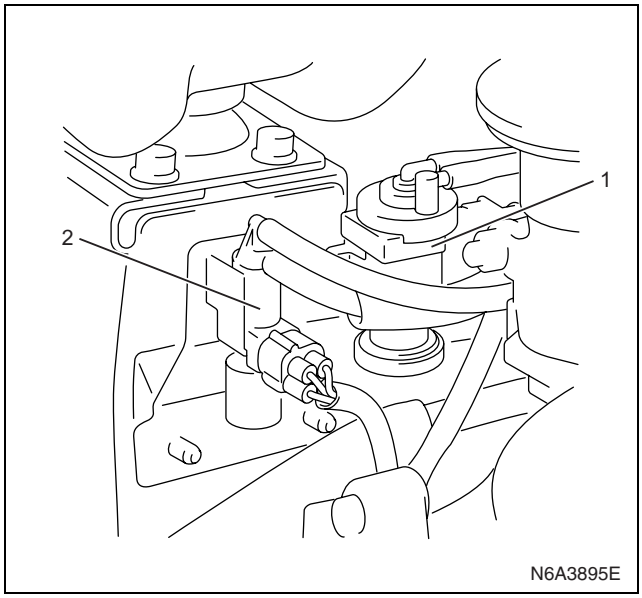
1. Install the CKP sensor to the clutch housing.
2. Tighten CKP sensor by a bolt with specified tightening torque.

   Tighten:
   Bolts to 8.0 – 12.0 N·m (0.8 – 1.2 kg·m / 5.9 – 8.9 lb·ft)
3. Connect a CKP sensor connector to the CKP sensor.
4. Connect the negative battery cable.

EGR Solenoid Valve Replacement

Removal Procedure

1. Disconenct the negative battery cable.
2. Disconnect a EGR solenoid valve connector from the EGR solenoid valve.
3. Disconnect two hoses from the EGR solenoid valve.
4. Loosen two bolts and remove the EGR solenoid valve from the bracket.



Legend
1. EGR Solenoid Valve
2. Intake Throttle Solenoid Valve

Installation Procedure

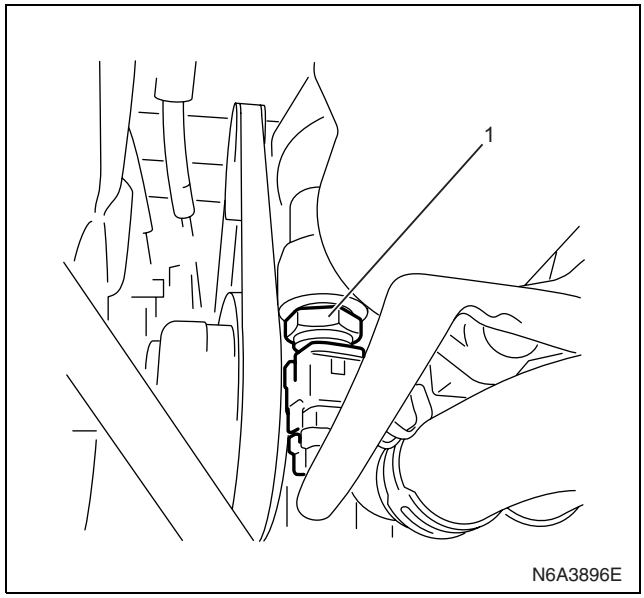
1. Tighten the purge solenoid by tow bolts.
2. Connect a connector to the EGR solenoid valve.
3. Connect two hoses to the EGR solenoid valve.
4. Connect the negative battery cable.

Engine Coolant Temperature (ECT) Sensor Replacement

Removal Procedure

1. Disconnect the negative battery cable.
2. Drain enough engine coolant so that the coolant level will be below the ECT sensor.
3. Disconnect connector from the ECT sensor.
4. Loosen and remove the ECT sensor from the thermostat housing.

Notice:
Cool down the engine before above procedures are carried out.



Legend
1. Engine Coolant Temperature (ECT) Sensor

Installation Procedure

1. Apply sealer to threads of screw at the ECT sensor.
2. Tighten the ECT sensor with specified tightening torque.

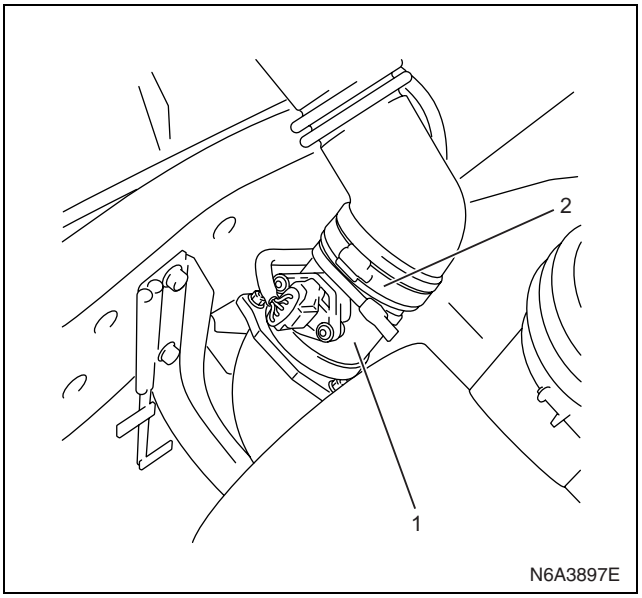
   Tighten:
   Bolt to 13 N·m (1.3 kg·m / 9.6 lb·ft)
3. Connect a ECT sensor connector to the ECT sensor.
4. Fill the engine coolant.
5. Connect the negative battery cable.

Notice:
Verify any DTCs (diagnosis Trouble Code) are not stored after replacement.
Verify no engine coolant leaking from the sensor threads after replacement.

Mass Air Flow (MAF) / Intake Air Temperature (IAT) Sensor Replacement

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect a MAF & IAT sensor connector from the MAF & IAT sensor assembly.
3. Loosen the clips and remove the MAF & IAT sensor assembly from the intake duct housing.



Legend

1. Mass Air Flow (MAF) and Intake Air Temperature (IAT) Sensor
2. Clip

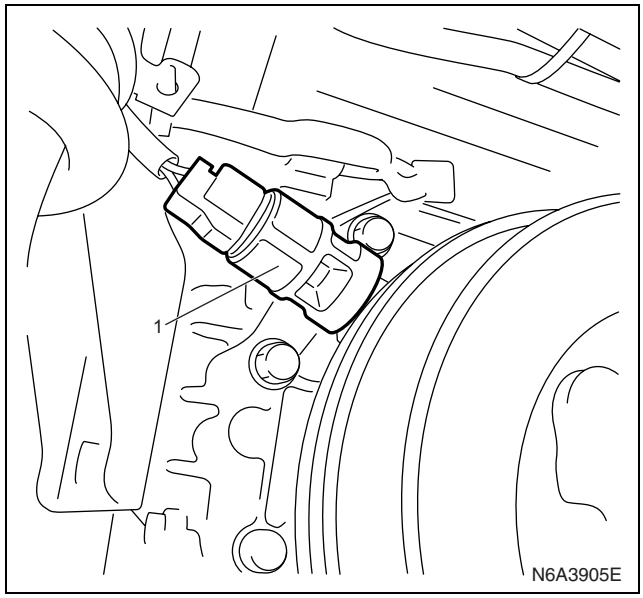
Installation Procedure

1. Install the MAF & IAT sensor assembly into intake air duct.
2. Tighten the clips.
3. Connect a MAF & IAT sensor connector to the MAF & IAT sensor assembly.
4. Connect the negative battery cable.

Vehicle Speed Sensor (VSS) Replacement

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the vehicle speed sensor connector.
3. Loosen and remove the vehicle speed sensor.



Legend

1. Vehicle Speed Sensor (VSS)

Installation Procedure

1. Tighten the vehicle speed sensor to the specified tightening torque.

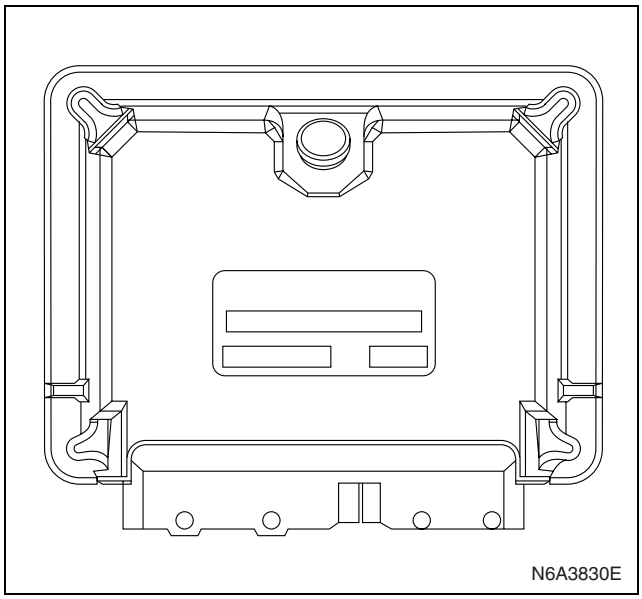
   Tighten:
   Hexagonal part of the sensor: 25 N·m (2.5 kg·m / 18 lb·ft)

Caution:
Tightening must be made at the hexagonal part of the sensor. To tighten the connector itself would cause damage.

2. Connect the vehicle speed sensor connector to the vehicle speed sensor.
3. Connect the negative battery cable.

Description and Operation

Engine Control Module (ECM) Description



The engine control module (ECM) is designed to withstand normal current draws associated with vehicle operation. Avoid overloading any circuit. When testing for opens and shorts, do not ground or apply voltage to any of the ECM circuits unless instructed to do so. In some cases, these circuits should only be tested using a digital multimeter (DMM). The ECM should remain connected to the ECM harness.
The ECM is located behind the radio via mounting bracket. The ECM mainly controls the following.

- The fuel system control
- The exhaust gas recirculation (EGR) system control
- The preheating (glow) system control
- A/C compressor control
- Exhaust brake control
- On-board diagnostics for engine control

The ECM constantly observes the information from various sensors. The ECM controls the systems that affect vehicle performance. The ECM performs the diagnostic function of the system. The ECM can recognize operational problems, alert the driver through the malfunction indicator lamp (MIL), and store diagnostic trouble codes (DTCs). DTCs identify the system faults to aid the technician in making repairs.

ECM Voltage Description

The ECM supplies a buffered voltage to various switches and sensors. The ECM can do this because resistance in the ECM is so high in value that a test lamp may not illuminate when connected to the circuit. An ordinary shop voltmeter may not give an accurate reading because the voltmeter input impedance is too low. Use a 10-megaohm input impedance DMM, to ensure accurate voltage readings. The input and/or output devices in the ECM include analog-to-digital converters, signal buffers, counters, and special drivers. The ECM controls most components with electronic switches which complete a ground circuit when turned ON.

Aftermarket Electrical and Vacuum Equipment

Aftermarket or add-on electrical and vacuum equipment is defined as any equipment which connects to the vehicle's electrical or vacuum systems that is installed on a vehicle after the vehicle leaves the factory. No allowances have been made in the vehicle design for this type of equipment. No add-on vacuum equipment should be added to this vehicle. Add-on electrical equipment must only be connected to the vehicle's electrical system at the battery power and ground. Add-on electrical equipment, even when installed to these guidelines, may still cause the powertrain system to malfunction. This may also include equipment not connected to the vehicle electrical system such as portable telephones and audios. Therefore, the first step in diagnosing any powertrain fault is to eliminate all aftermarket electrical equipment from the vehicle. After this is done, if the fault still exists, the fault may be diagnosed in the normal manner.

Electrostatic Discharge Damage

Electronic components used in the ECM are often designed to carry very low voltage. Electronic components are susceptible to damage caused by electrostatic discharge. By comparison, as much as 4,000 volts may be needed for a person to feel even the zap of a static discharge. There are several ways for a person to become statically charged. The most common methods of charging are by friction and induction.

- An example of charging by friction is a person sliding across a vehicle seat.

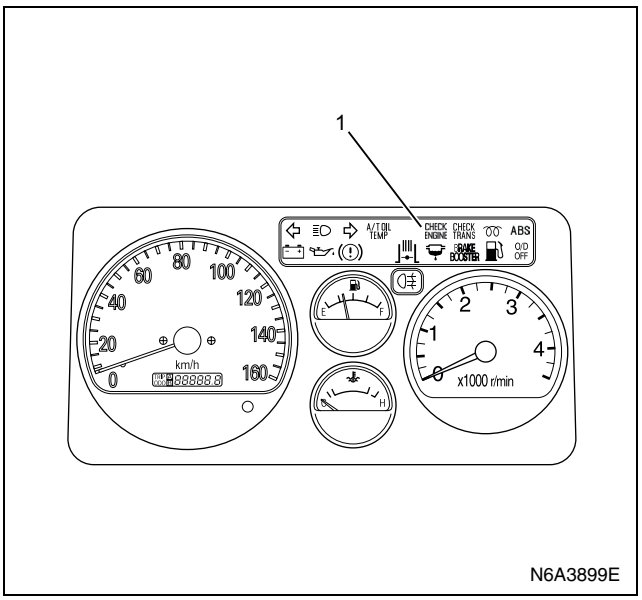
Important:
To prevent possible electrostatic discharge damage, follow these guidelines:

- Do not touch the ECM connector pins or soldered components on the ECM circuit board.
- Do not open the replacement part package until the part is ready to be installed.

- Before removing the part from the package, ground the package to a known good ground on the vehicle.
- If the part has been handled while sliding across the seat, while sitting down from a standing position, or while walking a distance, touch a known good ground before installing the part.
- Charge by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off leaving the person highly charged with opposite polarity.

Malfunction Indicator Lamp (MIL) Operation

The malfunction indicator lamp (MIL) is located in the instrument panel cluster (IPC). The MIL will display the CHECK ENGINE when commanded ON:



Legend

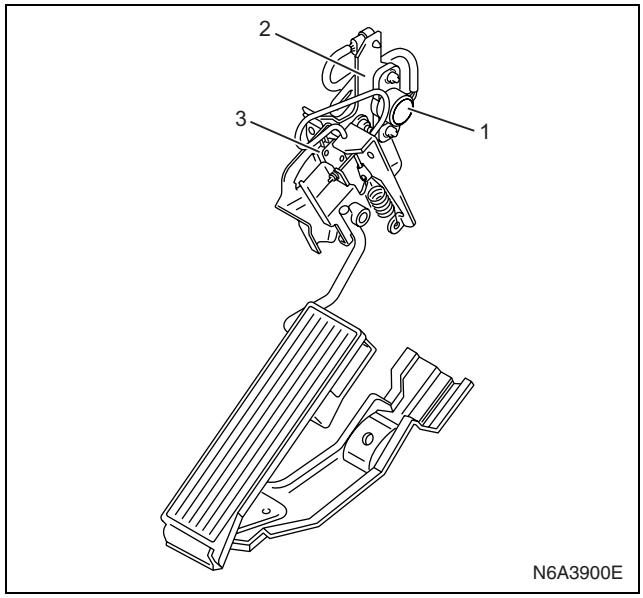
1. Malfunction Indicator Lamp (MIL)

The MIL indicates that an emission or performance related fault has occurred and vehicle service is required. The following is a list of the modes of operation for the MIL:

- The MIL illuminates for approximately 2 seconds when the ignition switch is turned ON, with the engine OFF. This is a bulb test to ensure the MIL is able to illuminate.
- The MIL remains illuminated after the engine is started if the engine control module (ECM) detects a fault. A DTC is stored any time the ECM illuminates the MIL due to an emission or performance related fault.

Engine Control Component Description

Accelerator Pedal Position (APP) Sensor & Idle Switch



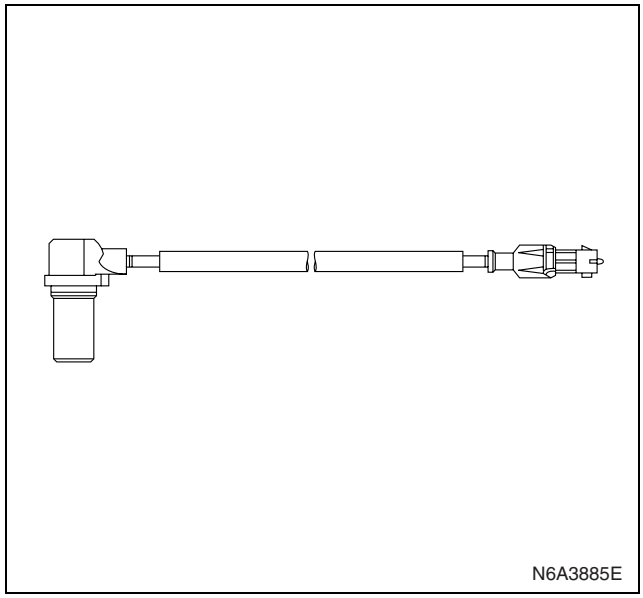
Legend

1. Accelerator Pedal Position (APP) Sensor
2. Accelerator Pedal Bracket
3. Idle Switch

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal bracket. The engine control module (ECM) uses the APP sensors to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injection control.

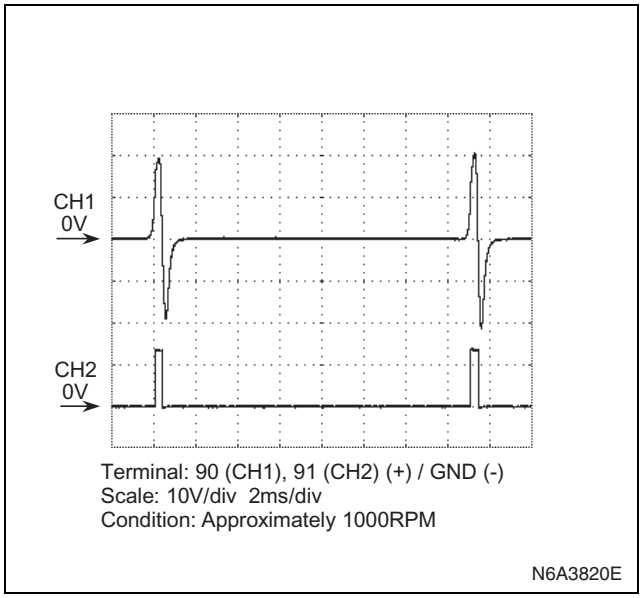
The idle switch is also mounted on the accelerator pedal bracket. The idle switch is a normally closed type switch. When the accelerator pedal is released, the idle switch signal to the ECM is low voltage.

Crankshaft Position (CKP) Sensor

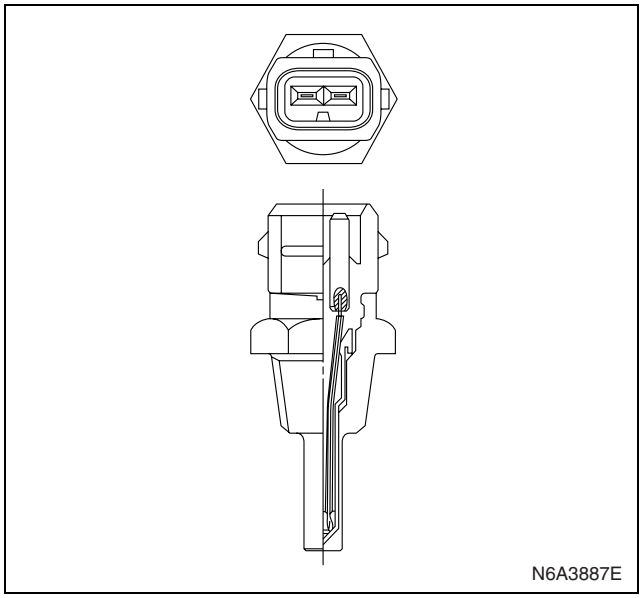


The crankshaft position (CKP) sensor is located on top of the flywheel housing. There are 4 slits spaced 90° on the flywheel circumference. The CKP sensor is a magnetic coil type sensor, which generates an AC signal voltage based on the crankshaft rotational speed. The ECM monitors both the CKP sensor and injection pump camshaft position (CMP) sensor signals to ensure they correlate with each other.
The following waveform aids to diagnose when there is an oscilloscope or equivalent.

- Amplitudes of CKP sensor signal (CH1) increase as engine speed increases.
- Each waveform cycle shorten as the engine speed increases.



Engine Coolant Temperature (ECT) Sensor

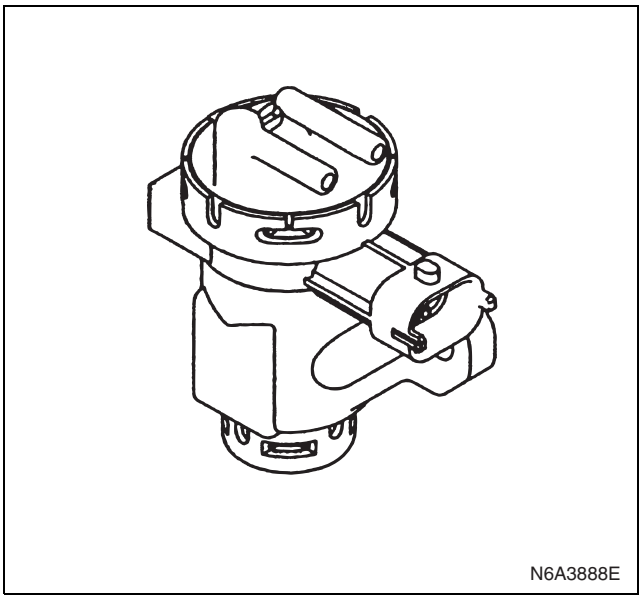


Legend

1. Engine Coolant Temperature (ECT) Sensor

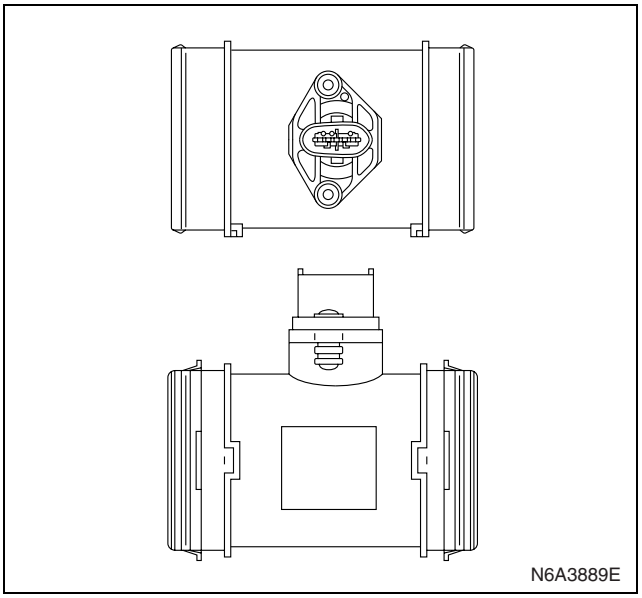
The engine coolant temperature (ECT) sensor is installed to the thermostat housing. The ECT sensor is a variable resistor. The ECT sensor measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and a ground for the ECT low reference circuit. When the ECT sensor is cold, the sensor resistance is high. When the engine coolant temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the ECT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the ECT signal circuit.

Exhaust Gas Recirculation (EGR) Solenoid Valve



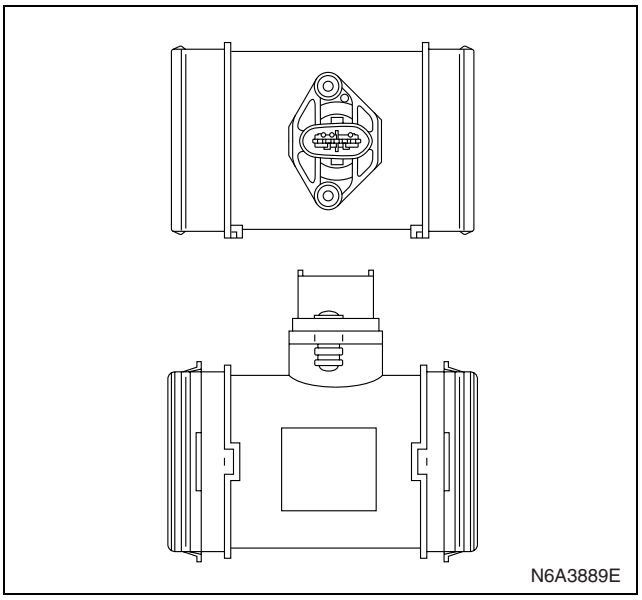
The engine control module (ECM) controls the exhaust gas recirculation (EGR) flow amount based on the engine speed, engine coolant temperature, intake air temperature, barometric pressure and fuel injection quantity. The ECM controls the EGR valve by controlling the EGR solenoid valve. The mass air flow (MAF) sensor monitors EGR gas flow amount. An expected MAF amount should be detected while the engine running.

Intake Air Temperature (IAT) Sensor



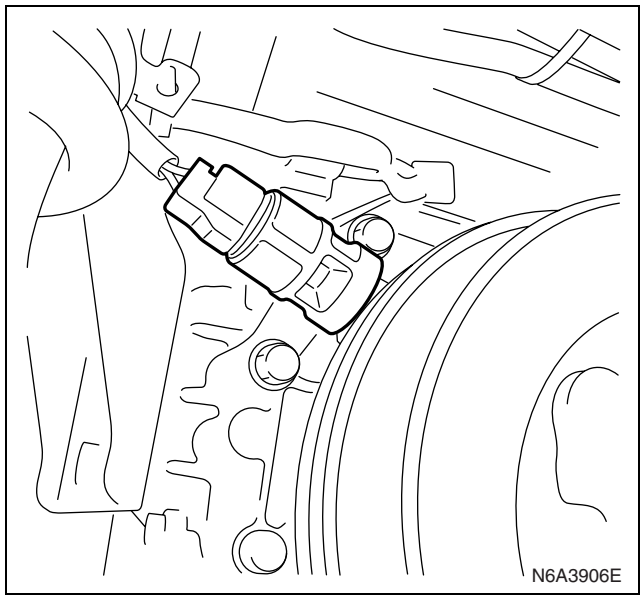
The intake air temperature (IAT) sensor is fitted between the air cleaner and turbocharger internal to the mass air flow (MAF) sensor. The IAT sensor is a variable resistor. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 volts to the IAT signal circuit and a ground for the IAT low reference circuit. When the IAT sensor is cold, the sensor resistance is high. When the air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the IAT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the IAT signal circuit.

Mass Air Flow (MAF) Sensor

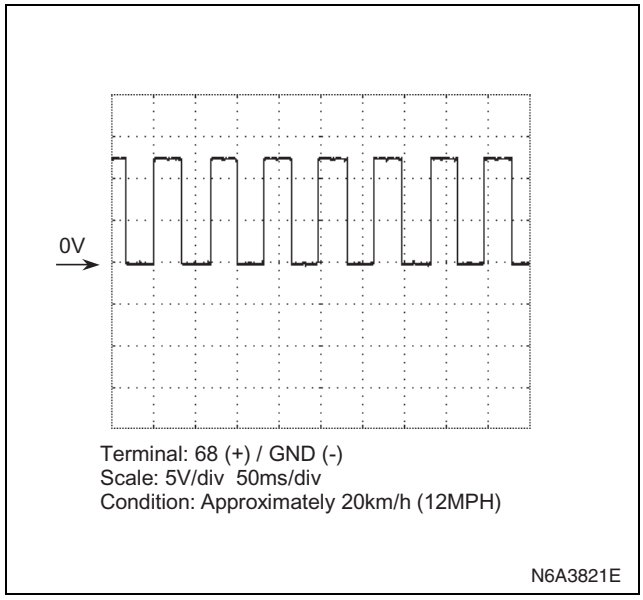


The mass air flow (MAF) sensor is an air flow meter that measures the amount of air that enters the engine. It is fitted between the air cleaner and turbocharger. A small quantity of air that enters the engine indicates deceleration or idle. A large quantity of air that enters the engine indicates acceleration or a high load condition. The MAF sensor assembly consists of a MAF sensor element and an intake air temperature sensor that are both exposed to the air flow to be measured. The MAF sensor element measures the partial air mass through a measurement duct on the sensor housing.

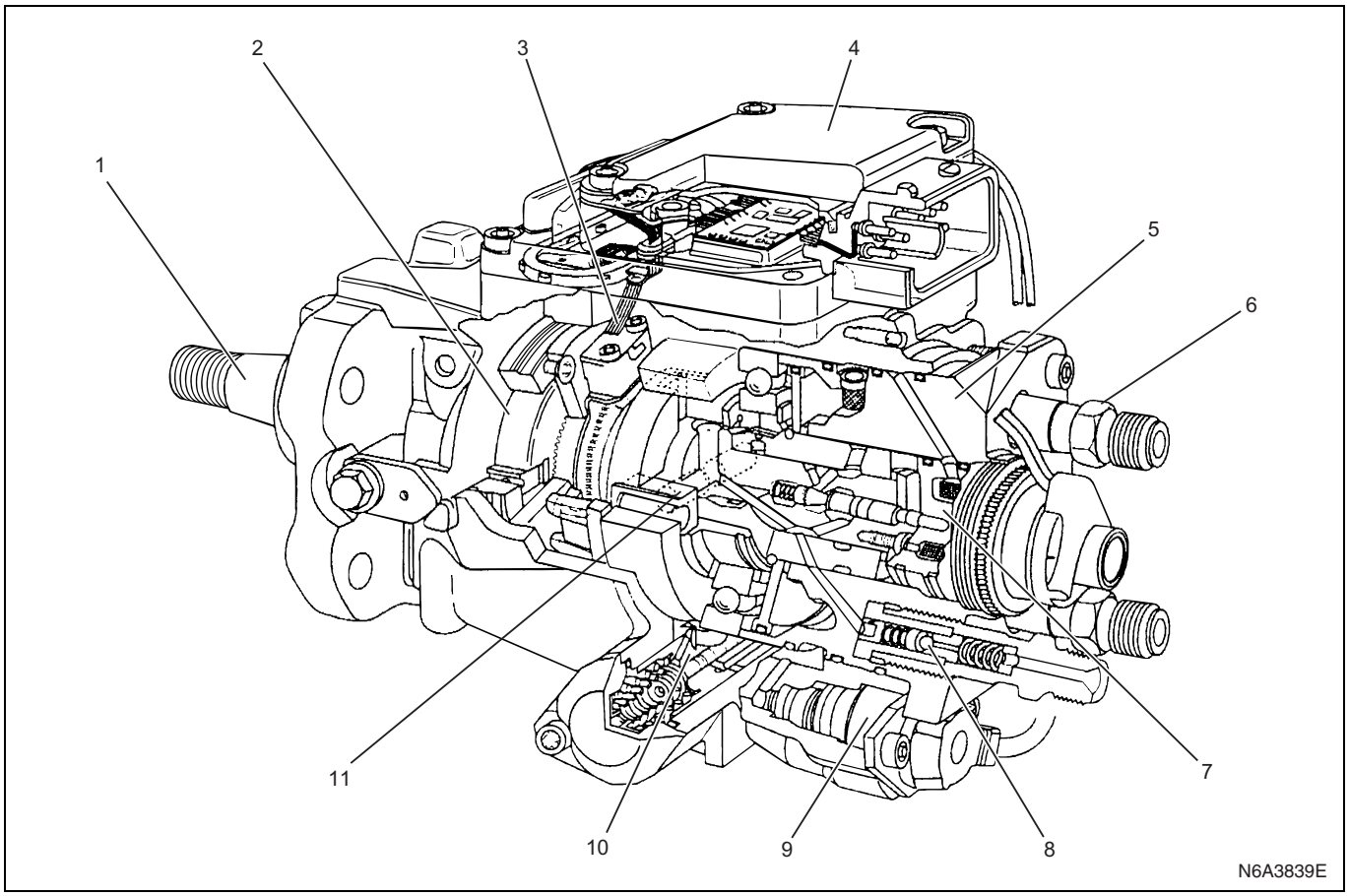
Vehicle Speed Sensor (VSS)



The vehicle speed sensor (VSS) is used by the engine control module (ECM) and speedometer, which generates a speed signal from the transmission output shaft. The VSS uses a hall effect element. It interacts with the magnetic field created by the rotating magnet and outputs square wave pulse signal. The ECM calculates the vehicle speed by the VSS.



Fuel Injection System Description



Legend

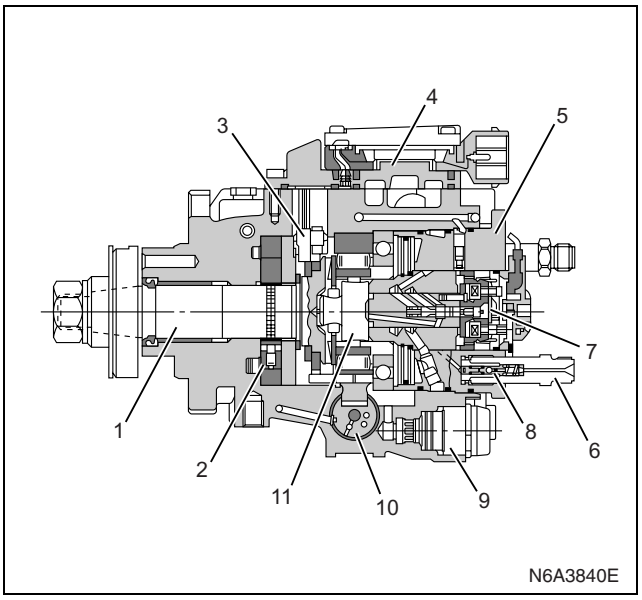
1. Drive Shaft
2. Fuel Feed Pump
3. Pump Camshaft Position (CMP) Sensor
4. Fuel Injection Pump Control Unit (PCU)
5. Distributor Head
6. Constant Pressure Valve (CPV) Holder
7. Fuel Injection Solenoid Valve
8. Constant Pressure Valve (CPV)
9. Timing Control Valve (TCV)
10. Timer
11. Radial Plunger

Bosch VP44 Fuel Injection Pump

Instead of the previous face cam type, the radial plunger distributor type injection pump utilizes a cam ring to enable fuel injection at high-pressures, marking it suitable for small, high-speed direct injection diesel engines. This pump was developed to provide the most suitable fuel injection quantity and injection timing to satisfy the demand for engine reliability, driveability, low smoke, low noise, high output and low exhaust emissions.

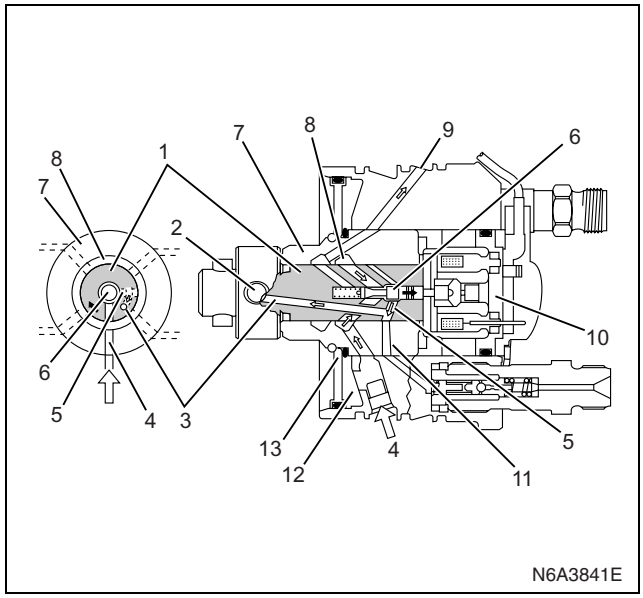
The engine control module (ECM) calculates the desired fuel injection quantity and timing using data sent from various sensors. These desired data are sent to the fuel injection pump control unit (PCU) via a controller area network (CAN) communication bus. The PCU also receives signals from the internal inputs: pump camshaft position (CMP) sensor that is located inside the fuel injection pump to determine the cam ring rotation angle and the fuel injection pump speed. The fuel temperature (FT) sensor is internal the PCU. These values are used to compare the desired values sent from the ECM then PCU determines the injection timer piston position and fuel injection quantity, and actuates timing control valve (TCV) & fuel injection solenoid valve based on control maps in the PCU.

The timing device changes the optimum injection timing against various engine conditions. The pressure of the fuel fed from the feed pump is adjusted and it acts to the timing plunger by TCV controlled fuel pressure. (The TCV is installed to the fuel injection pump rear side and it is controlled by duty ratio cycle from the PCU.) The timing plunger is connected to the cam ring by a ball pin. Axial movement of the timing plunger is transferred to the cam ring in the form of rotational movement.



Legend

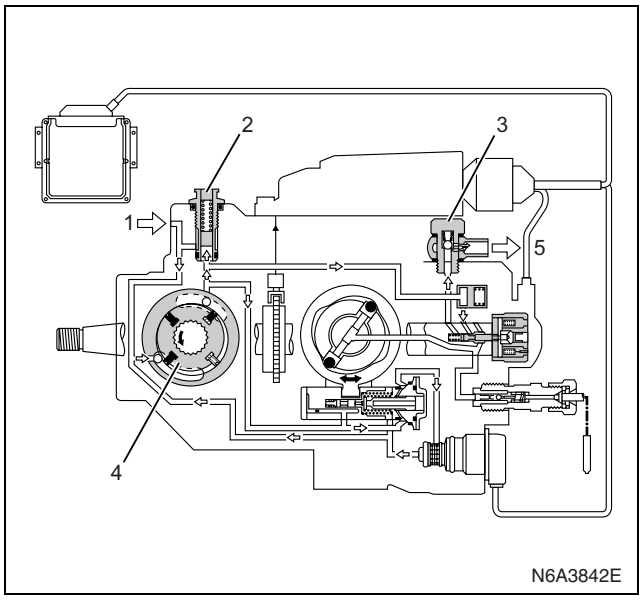
1. Drive Shaft
2. Feed Pump
3. Pump Camshaft Position (CMP) Sensor
4. Fuel Injection Pump Control Unit (PCU)
5. Distributor Head
6. Constant Pressure Valve (CPV) Holder
7. Fuel Injection Solenoid Valve
8. Constant Pressure Valve (CPV)
9. Timing Control Valve (TCV)
10. Timer
11. Radial Plunger



Legend

1. Rotor Shaft
2. Radial Plunger
3. High Pressure Passage
4. Low Pressure Inlet
5. Distribution Slit
6. Valve Needle
7. Barrel
8. Annular Passage
9. Fuel Return
10. Fuel Injection Solenoid Valve
11. High Pressure Outlet
12. Diaphragm Chamber
13. Accumulator Diaphragm

Low Pressure Fuel Circuit Description

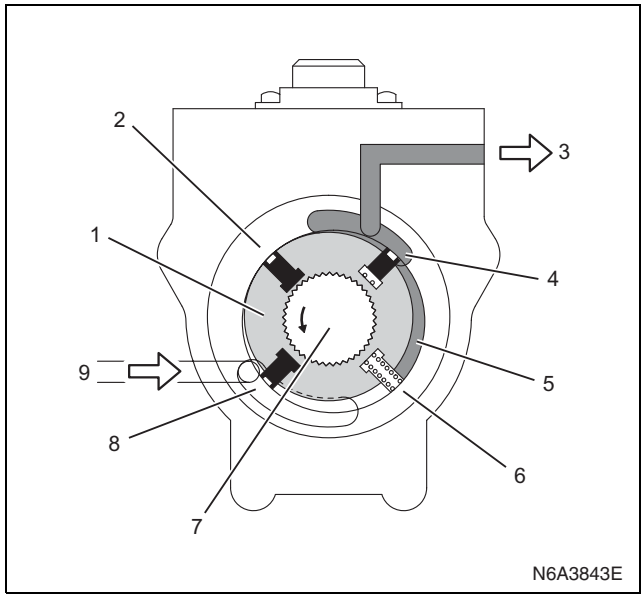


Legend

1. Fuel Suction
2. Regulating Valve
3. Overflow Valve
4. Feed Pump
5. To Fuel Tank

The low pressure fuel circuit must supply sufficient fuel to the high pressure fuel circuit. The main components are the feed pump, the regulating valve and the overflow valve.

Feed Pump

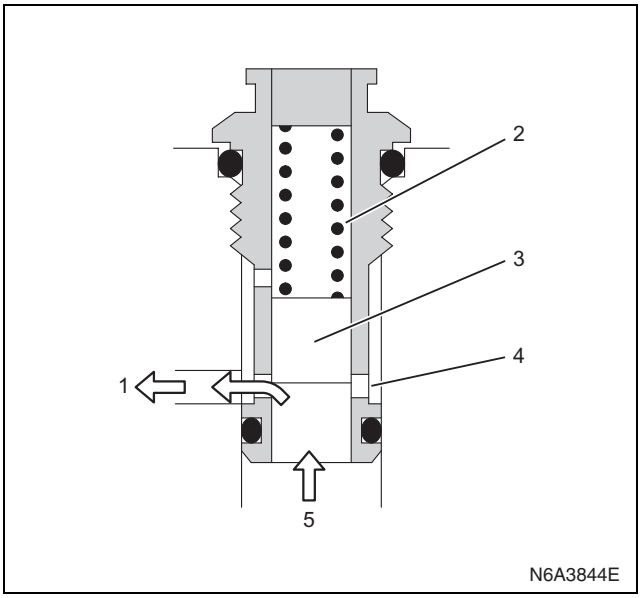


Legend

1. Rotor
2. Casing Ring
3. Fuel Supply
4. Outlet
5. Chamber
6. Vane
7. Driveshaft
8. Inlet
9. Fuel Suction

The feed pump is driven by the drive shaft, performs suction and supply of fuel. The vanes assembled in the rotor are pressed against the inside of the casing ring by spring forces and centrifugal force during rotation to form chambers. When the vanes rotate, the volume of these chambers increase when they reach recesses the casing ring connected to the inlet port. Pressure then decreases and fuel is drawn in. When the chambers have passed the inlets and recesses, the volume decreases and the fuel is compressed. Fuel pressure increases until the chamber reaches the outlet, where the fuel passes through the regulating valve to the high pressure fuel circuit.

Regulating Valve

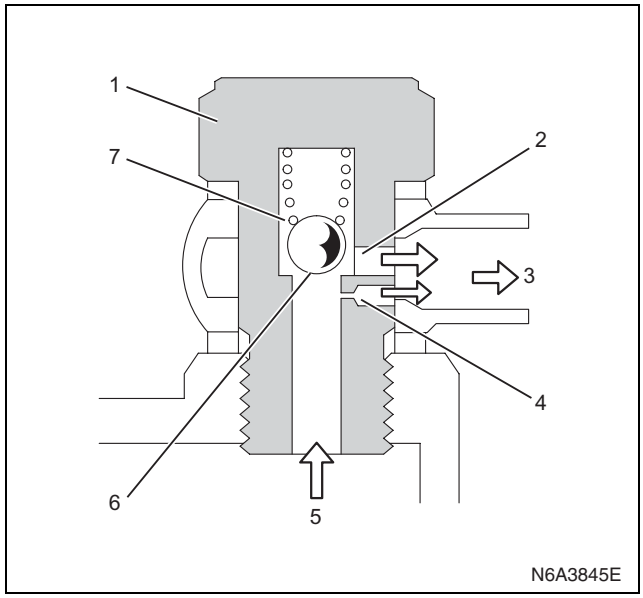


Legend

1. To Inlet
2. Spring
3. Valve Piston
4. Port
5. From Outlet

When feed pump speed increases so that the delivery pressure of the fuel delivered from the outlet exceeds the regulating valve spring force, the plunger is pushed upwards. Excess fuel passes through the ports and returns to the inlet side, and the delivery pressure is maintained within a specified range. When feed pump speed decreases so that the delivery pressure decreases, the plunger is pushed downwards by spring force to close the port.

Overflow Valve

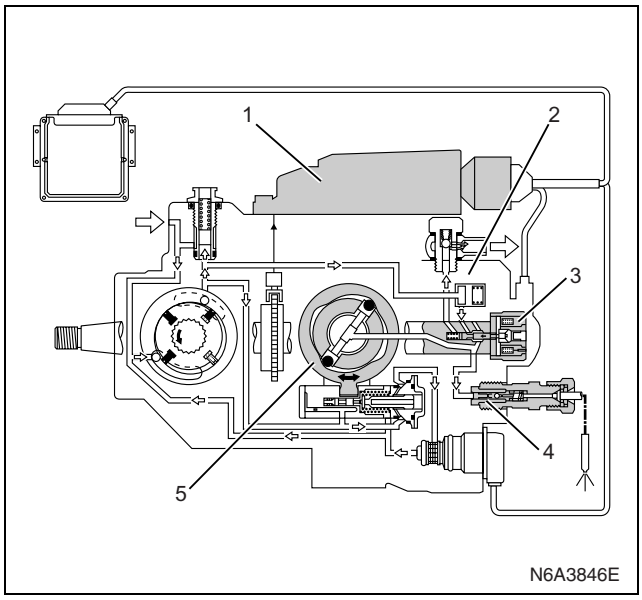


Legend

1. Valve Holder
2. Port
3. To Fuel Tank
4. Orifice Port
5. From Fuel Tank
6. Ball Valve
7. Spring

When the pressure of the fuel, returned from the distributor head, exceeds the spring force, the overflow valve's ball valve is pushed up. Excess fuel presses through the port and returns to the tank, and fuel pressure inside the pump chamber does not exceed a specified pressure. The flow of excess fuel serves cooling and automatic bleeding of the fuel pump during operation. Also the orifice port is installed to assist in automatic air bleeding.

High Pressure Fuel Circuit Description



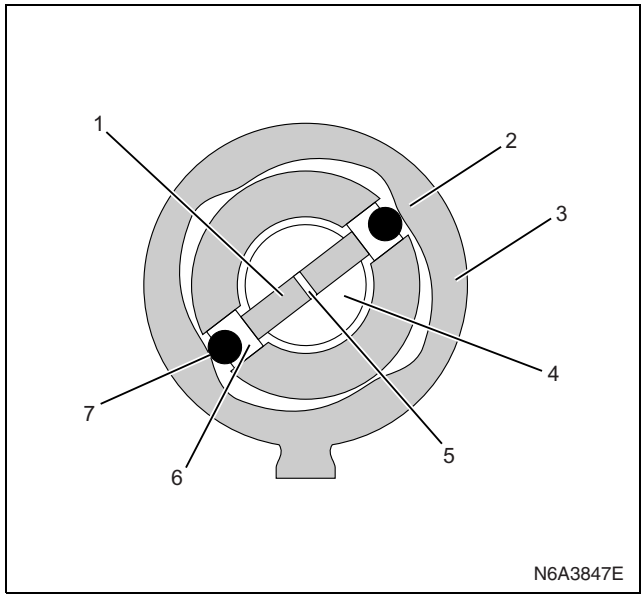
Legend

1. Fuel Injection Pump Control Unit (PCU)
2. Distributor Head
3. Fuel Injection Solenoid Valve
4. Constant Pressure Valve (CPV)
5. Radial Plunger

In addition high pressure generating device, the high pressure circuit also consists of fuel piping, and devices to set the beginning of injection and fuel injection quantity. The main components are as follows:

- High pressure generation: Radial Plunger
- Fuel distribution: Distributor Head
- Beginning of injection timing: Timing Device
- Prevention of secondary injection: Constant Pressure Valve (CPV)

Radial Plunger

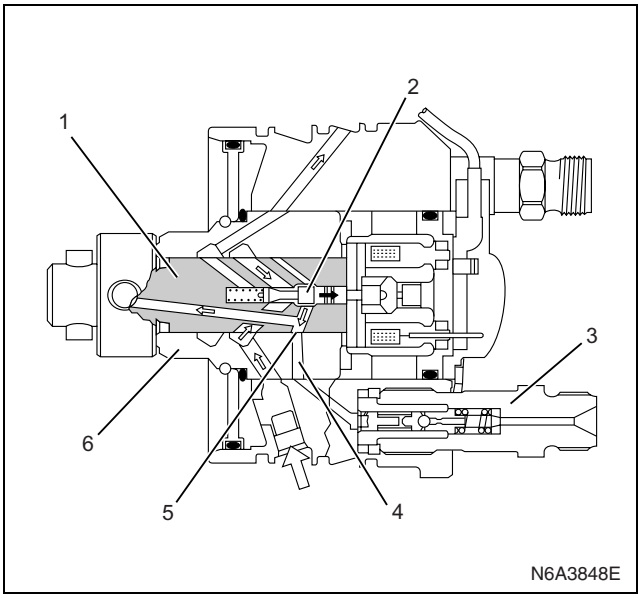


Legend

1. Radial Plunger
2. Internal Cam
3. Cam Ring
4. Rotor Shaft
5. Plunger Chamber
6. Roller Shoe
7. Roller

While the radial plungers assembled to the rotor shaft rotate, they are held against the inside of the cam ring (via the roller shoes and rollers) by fuel delivery pressure from the feed pump and centrifugal force. The radial plungers perform rotational movement as well as internal cam induced reciprocating movement to suck in and compress the fuel in the plunger chamber.

Distributor Head

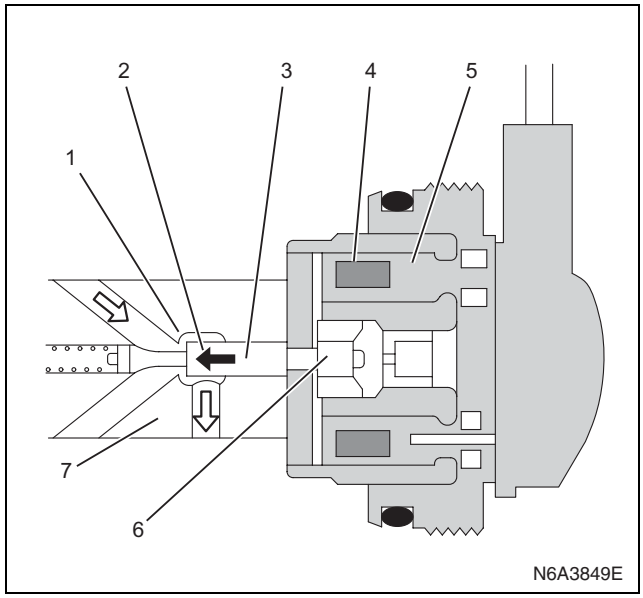


Legend

1. Rotor Shaft
2. Valve Needle
3. Constant Pressure Valve (CPV) Holder
4. High Pressure Outlet
5. Distributor Shaft
6. Barrel

The distributor head distribute the high pressure fuel that has flowed through the rotating rotor shaft's distributor slits and the barrel's high pressure outlets (4 cylinders) to the engine cylinders via the constant pressure valve (CPV) and the nozzle holder assemblies. The fuel injection solenoid valve needle changes the passage to the radial plunger high pressure pump between fuel suction and fuel compression.

Fuel Injection Solenoid Valve

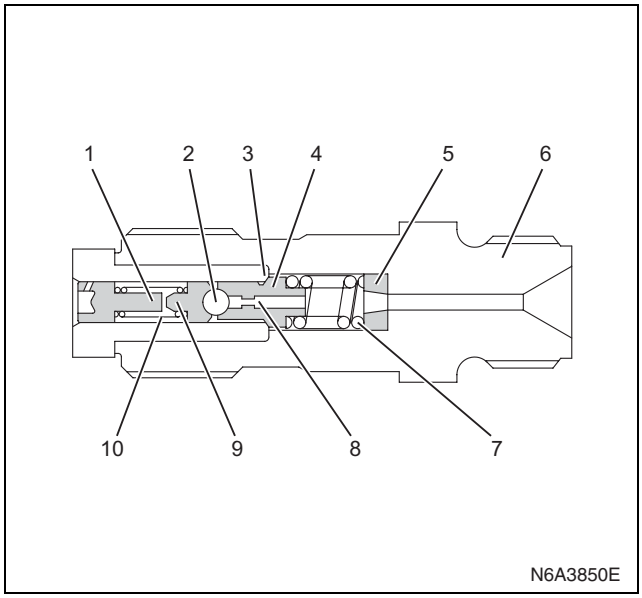


Legend

1. Valve Seat
2. Valve Closing Direction
3. Valve Needle
4. Coil
5. Magnet
6. Magnet Anchor
7. Rotor Shaft

The fuel injection solenoid valve consists of a valve seat, a valve needle, and a magnet anchor (a movable iron core), a coil and a magnet. The valve needle rotates together with the rotor shaft. When current controlled by the fuel injection pump control unit (PCU) flows to the coil, the magnet anchor and the valve needle are pushed towards the valve seat. When the valve seat is completely closed by the valve needle, the fuel in the high pressure passage is isolated from the low pressure passage, is compressed by the radial plunger high pressure pump, and injected into the engine cylinder through the nozzle holder assembly. When the required injection quantity is reached, the current to the coil is cut, the valve seat opens and injection of fuel is completed.

Constant Pressure Valve (CPV)

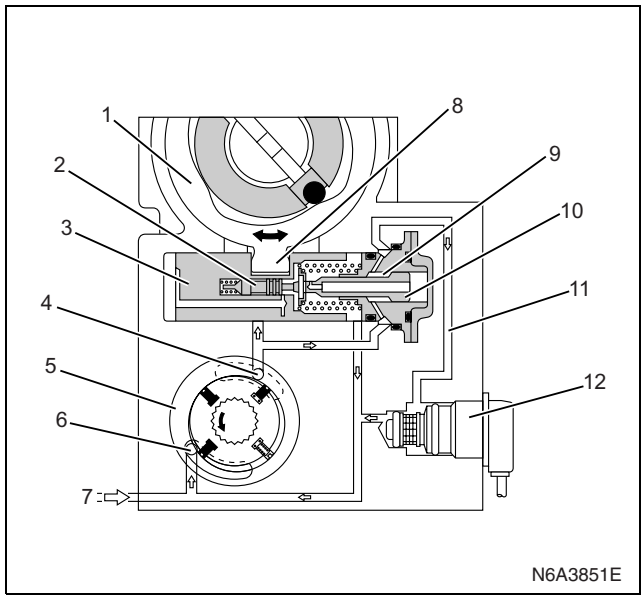


Legend

1. Plug
2. Ball
3. Seat
4. Valve
5. Spacer
6. Holder
7. Valve Spring
8. Oriffice
9. Ball Support
10. Spring

The constant pressure valve (CPV) consists of a holder, a spacer, a valve spring, a valve, a seat, a ball, a ball support, a spring and a plug. The valve is equipped with an orifice to suppress the reflected pressure wave (the cause of secondary injection) caused by nozzle closing at the end of the injection and maintains a stable pressure in the injection pipe (residual pressure) to ensure stabilized injection timing for subsequent injection. The valve is opened by pressurized fuel and this high pressure fuel is delivered to the nozzle holder assembly.

Timing Control Device Description

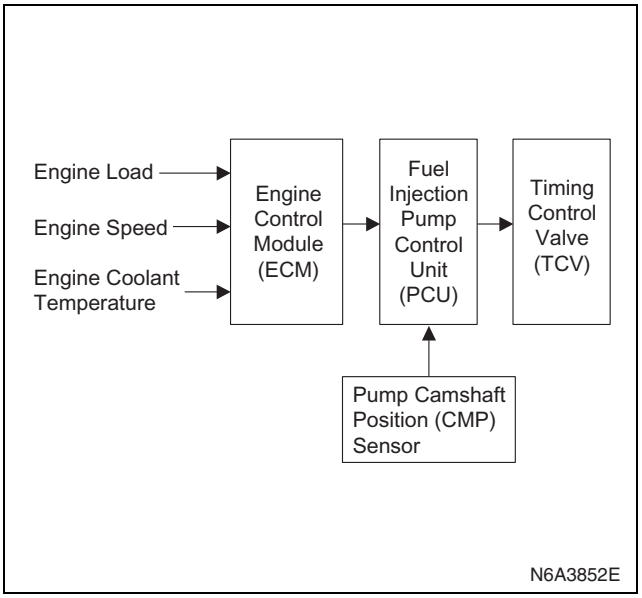


Legend

1. Cam Ring
2. Servo Valve
3. Timer Piston
4. Outlet
5. Feed Pump
6. Inlet
7. Fuel Suction
8. Ball Pin
9. Annular Chamber
10. Hydraulic Stopper
11. Return Passage
12. Timing Control Valve (TCV)

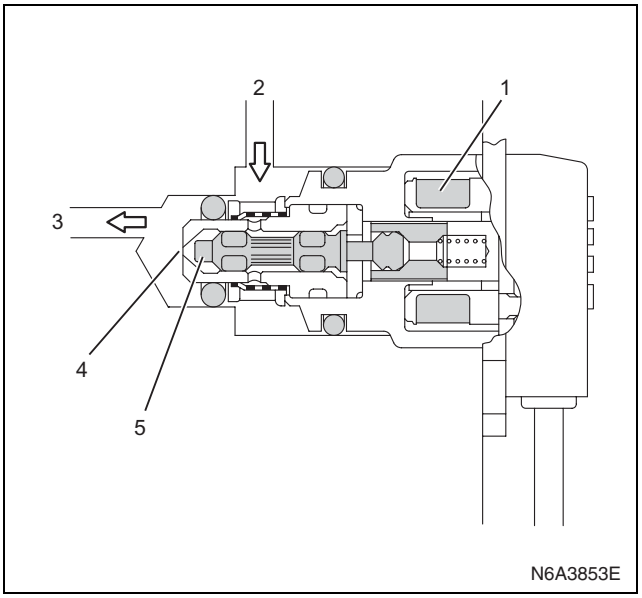
The timing device determines the optimum injection timing against variations in engine speed. The pressure of the fuel fed from the feed pump is adjusted in accordance with speed by the regulating valve. This delivery pressure acts on the hydraulic stopper's annular chamber as control pressure. The chamber pressure of the annular chamber is controlled by the timing control valve (TCV). The timing plunger is connected to the cam ring by a ball pin. Axial movement of the timing plunger is transferred to the cam ring in the form of rotational movement. Movement to the right of the timing plunger (to the spring side) advances injection timing. The main components are timing plunger, the TCV and pump camshaft position (CMP) sensor.

Beginning of Injection Staring



The engine control module (ECM) contains characteristic maps of the beginning of injection, corresponding to engine operating conditions (engine load, engine speed and engine coolant temperature). The fuel injection pump control unit (PCU) is constantly comparing the set beginning of injection timing and the actual beginning of injection timing. If there is a difference, the timing control valve (TCV) is controlled by the duty ratio. (The actual beginning of injection timing is determined from the pump camshaft position (CMP) sensor.)

Timing Control Valve



Legend

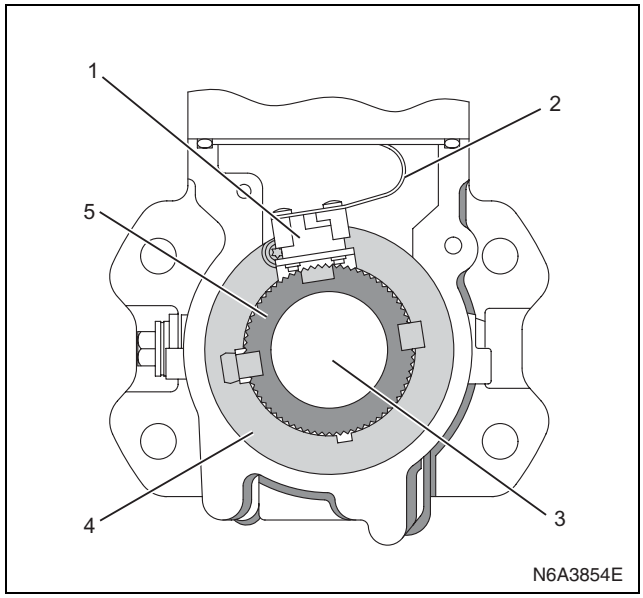
1. Coil
2. From Annular Chamber
3. To Feed Pump
4. Orifice
5. Valve Needle

The timing control valve (TCV) acts as a variable throttle, using the rapid opening and closing (cycling) of the valve needle in the TCV. At normal operation, the TCV controls the pressure acting on the annular chamber so that the hydraulic stopper cam move to any position, from the retard position to the advance position. At this time, the duty ratio is set by the fuel injection pump control unit (PCU).

When control current flows to the TCV coil, the valve needle opens and the fuel annular chamber flows through the orifice to the feed pump inlet. Consequently, the pressure of the annular chamber decreases and the hydraulic stopper is moved to the retard side.

When control current to the TCV coil is cut, the valve needle closes and the return passage is closed. Consequently, the pressure of the annular chamber increases and the hydraulic stopper is moved to the advance side.

Pump Camshaft Position (CMP) Sensor

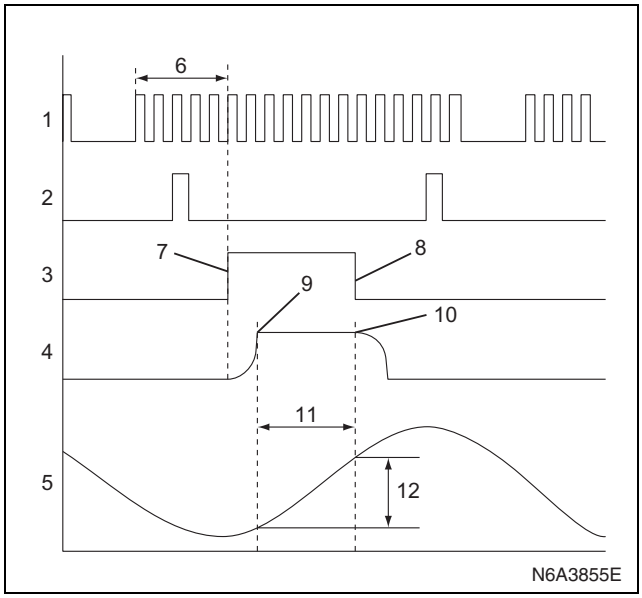


Legend

1. Pump Camshaft Position (CMP) Sensor
2. Flexible Connecting Harness
3. Drive Shaft
4. Pump Camshaft Position (CMP) Sensor Retaining Ring
5. Sensor Wheel

When the drive shaft rotates, the pump camshaft position (CMP) sensor receives signal from the sensor wheel, and an electric pulse is sent through the flexible connecting harness to the fuel injection pump control unit (PCU). From these signals the PCU can determine the average pump speed and the momentary pump speed. The pump CMP sensor is mounted to the cam ring. Thus, the relationship between the cam ring and the pump CMP sensor signal is constant. The pump CMP sensor signal is utilized for the following purposes:

- To determine the momentary angular position of the cam ring.
- To calculate the actual speed of the fuel injection pump.
- To determine the actual timing plunger position.

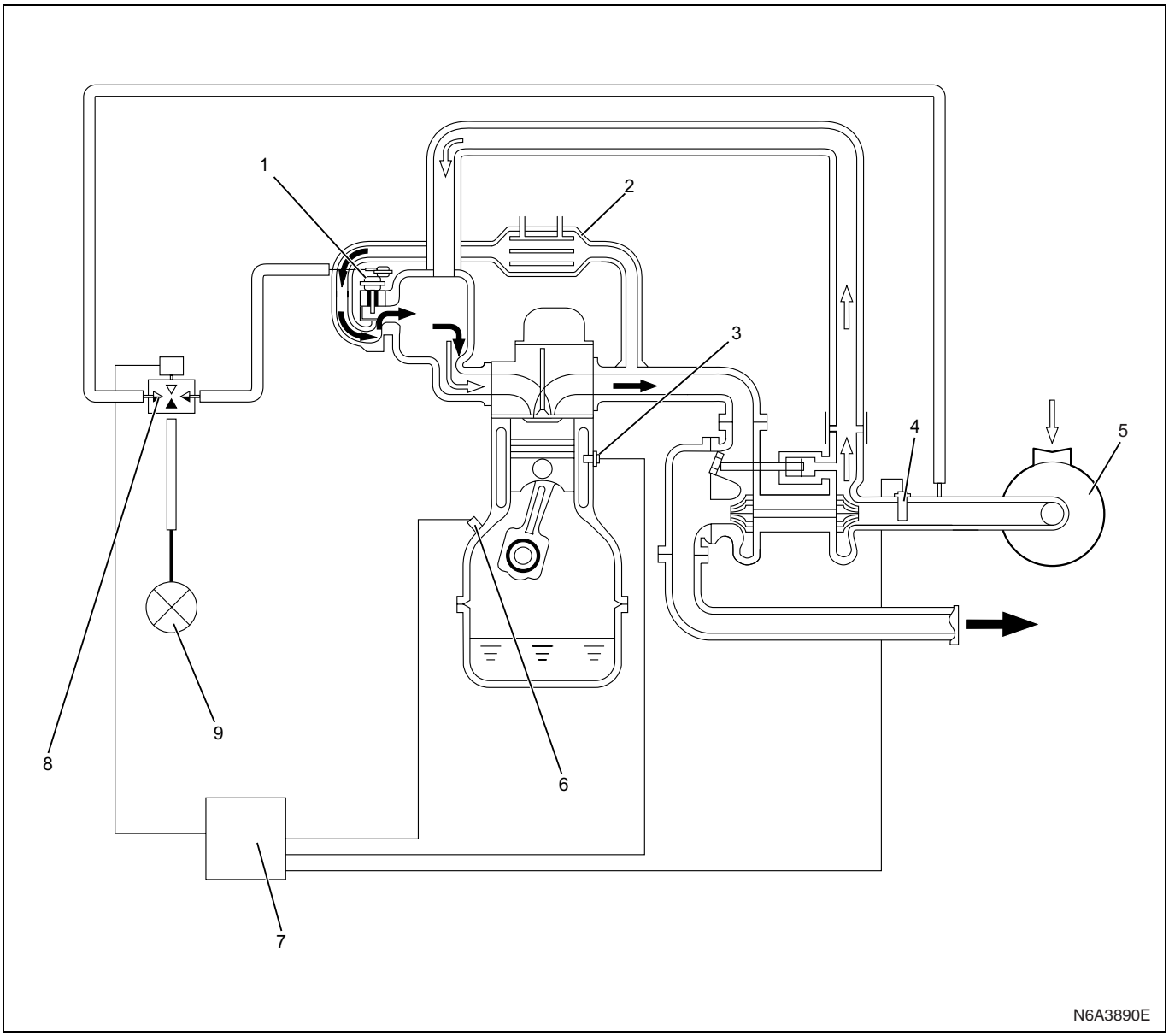


Legend

1. Pump Camshaft Position (CMP) Sensor Signal
2. Crankshaft Position (CKP) Sensor Signal
3. Fuel Injection Solenoid Valve Control Pulse
4. Fuel Injection Solenoid Needle Valve Lift
5. Cam Lift (Cam Profile)
6. Pulse Count
7. Fuel Injection Solenoid Valve Close
8. Fuel Injection Solenoid Valve Open
9. Start of Pressure Delivery
10. End of Pressure Delivery
11. Pressure Delivery Angle
12. Effective Stroke

- Momentary Cam Ring Angular Position
  The momentary angular position of the cam ring is input into the fuel injection PCU as a fuel injection solenoid valve control signal. From momentary input of angular position for fluctuations in running conditions, the fuel injection solenoid valve open and close intervals corresponding to the cam ring's cam lift can be accurately determined.
- Actual Injection Pump Speed
  When the crankshaft speed (CKP) sensor is faulty, the engine control module (ECM) uses the pump CMP signal as a replacement signal.
- Actual Timing Plunger Position
  The actual timing plunger position can be determined by comparing the CKP sensor signal with the pump CMP sensor angle. This position is used for timer control.

Exhaust Gas Recirculation (EGR) System Description

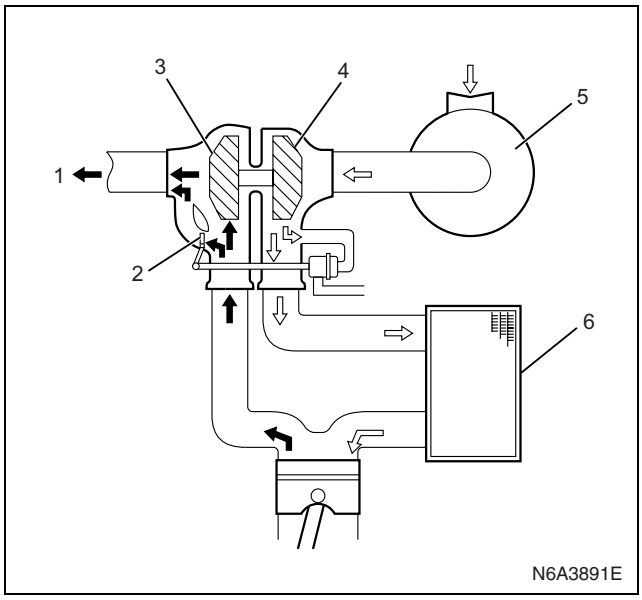


Legend

1. EGR Valve
2. EGR Cooler
3. ECT Sensor
4. MAF & IAT Sensor
5. Air Cleaner
6. CKP Sensor
7. ECM
8. EGR Solenoid Valve
9. Vacuum Pump

The EGR system recirculates a part of exhaust gas back into the intake manifold, which results in reducing nitrogen oxide (NOx) emissions. The EGR control system uses an electronic control system solenoid valve and vacuum control EGR valve to ensure both driveability and low emission. The engine control module (ECM) controls the EGR flow amount based on the engine speed, engine coolant temperature, intake air temperature, barometric pressure and fuel injection quantity. The ECM controls the EGR valve opening by controlling the EGR solenoid valve drive duty. The mass air flow (MAF) sensor monitors EGR gas flow amount. An expected MAF amount should be detected while the engine running.

Turbocharger Description



Legend

1. Exhaust Gas
2. Waste Gate Valve
3. Turbine Wheel
4. Compressor Wheel
5. Air Cleaner
6. Charge Air Cooler (Intercooler)

The turbocharger is used to increase the amount of air that enters the engine cylinders. This allows a proportional increase of fuel to be injected into the cylinders, resulting in increased power output, more complete combustion of fuel, and increased cooling of the cylinder heads, pistons, valves, and exhaust gas. This cooling effect helps extend engine life.

Heat energy and pressures in the engine exhaust gas are utilized to drive the turbine. Exhaust gas is directed to the turbine housing. The turbine housing acts as a nozzle to direct the shaft wheel assembly. Since the compressor wheel is attached directly to the shaft, the compressor wheel rotates at the same speed as the turbine wheel. Clean air from the air cleaner is drawn into the compressor housing and wheel. The air is compressed and delivered through a crossover pipe to the engine air intake manifold, then into the cylinders. The amount of air pressure rise and air volume delivered to the engine from the compressor outlet is regulated by a waste gate valve in the exhaust housing. The position of the waste gate valve is controlled by the amount of pressure built up on the intake side of the turbocharger. The diaphragm on the inside of the waste gate is pressure sensitive, and controls the position of the valve inside the turbocharger. The position of the valve will increase or decrease the amount of boost to the turbocharger.

The charge air cooler also helps the performance of the diesel. Intake air is drawn through the air cleaner and into the turbocharger compressor housing. Pressurized air from the turbocharger then flows forward through the charge air cooler located in the front of the radiator.

From the charge air cooler, the air flows back into the intake manifold.

The charge air cooler is a heat exchanger that uses air flow to dissipate heat from the intake air. As the turbocharger increases air pressure, the air temperature increases. Lowering the intake air temperature increases the engine efficiency and power by packing more air molecules into the same space.

Special Tools and Equipment

Special Tools and Equipment

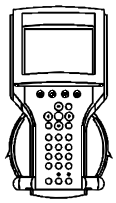
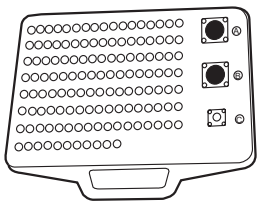
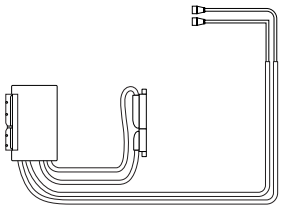
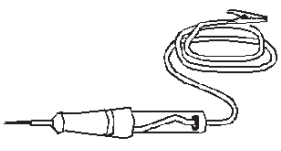
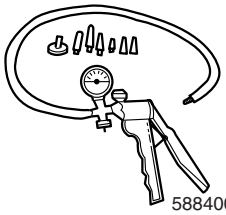
Illustration	Tool Number / Description
5884028350	5-8840-2835-0 (J-35616-A) Connector Test Adapter Kit (With Test Lamp)
5884002850	5-8840-0285-0 (J-39200) Digital Multimeter
 7000081	Tech 2 Kit
	Breaker Box
	Adapter Harness
 5884006070	5-8840-0607-0 (J-34142-B) Test Lamp

Illustration	Tool Number / Description
 5884002790	5-8840-0279-0 (J-23738-A) Vacuum Pump

4JHED-WE-0551N

You are requested to order this manual using the manual number that is shown above.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.4JHED-WE-0551N PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

ENGINE

SECTION 6E

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

SECTION No.	CONTENTS
6E	ENGINE CONTROL SYSTEM

LGMSB-WE-0552

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WORKSHOP MANUAL

N-SERIES

MANUAL TRANSMISSION AND CLUTCH MSB SERIES

SECTION 7

ISUZU

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SECTION No.	CONTENTS
00	SERVICE INFORMATION
7B	MANUAL TRANSMISSION (MSB)
7C	CLUTCH

MANUAL TRANSMISSION AND CLUTCH MSB SERIES

SECTION 00
SERVICE INFORMATION

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TROUBLESHOOTING

Transmission

PROBLEM	POSSIBLE CAUSE	CORRECTION
Abnormal Noise	1. Flywheel pilot bearing worn.	1. Replace.
	2. Bearing worn or broken (Main shaft or counter shaft).	2. Repair or replace.
	3. Anti-lash plate malfunction.	3. Repair or replace.
	4. Gear tooth contact surface worn or scuffed (Main shaft, counter shaft and/or reverse idle gear).	4. Repair or replace.
	5. Spline worn (Synchronizer clutch hub).	5. Replace.
	6. Gear, clutch hub or thrust washer thrust face seized.	6. Replace.
	7. Lack of backlash between mating gears.	7. Replace.
Hard Shifting	1. Improper church pedal free play.	1. Readjust.
	2. Wrong oil in use.	2. Replace with recommended oil.
	3. Gear control linkage misadjust.	3. Readjust.
	4. Change lever sliding portions worn.	4. Repair or replace.
	5. Shift block, shift rod and/or control box sliding faces worn.	5. Repair or replace.
	6. Shift arm and/or synchronizer sleeve groove worn.	6. Replace.
	7. Synchronizer parts worn or weakened.	7. Replace.
	8. Thrust washer, collar, and/or gear thrust faces worn (Main shaft and/or counter shaft thrust play).	8. Replace.
Walking or Jumping out of Gear	1. Gear control linkage misadjust.	1. Readjust.
	2. Detent spring weakened or broken.	2. Replace.
	3. Detent ball worn.	3. Replace.
	4. Change lever sliding portions worn.	4. Repair or replace.
	5. Shift block, shift rod and/or control box sliding faces worn.	5. Repair or replace.
	6. Shift arm and/or synchronizer sleeve groove worn.	6. Replace.
	7. Synchronizer parts worn or weakened.	7. Replace.
	8. Thrust washer, collar, and/or gear thrust faces worn (Main shaft and/or counter shaft thrust play).	8. Replace.
	9. Spline worn (Synchronizer hub).	9. Replace.
	10. Bearings worn or broken.	10. Replace.

Clutch

PROBLEM	POSSIBLE CAUSE	CORRECTION
Dragging	1. Hydraulic line leakage.	1. Repair.
	2. Air in line.	2. Bleed and check for damage.
	3. Master cylinder and/or slave cylinder piston cup worn.	3. Replace.
	4. Driven plate worn or warped.	4. Replace driven plate.
	5. Diaphragm spring weak or tip of finger worn.	5. Replace pressure plate assembly.
	6. Driven plate sticking on spline.	6. Clean and free spline and lubricate with grease.
	7. Release bearing worn or damaged.	7. Replace release bearing.
	8. Clutch pedal excessive free play.	8. Readjust.
Slipping	1. Driven plate facing worn or oil soaked.	1. Replace driven plate and check for leaks as needed.
	2. Diaphragm spring weak.	2. Replace pressure plate assembly.
	3. Pressure plate and/or flywheel warped.	3. Repair or replace.
	4. Clutch pedal lack of free play.	4. Readjust.
Shudder (Chattering)	1. Engine mounting loose or broken.	1. Tighten or replace.
	2. Driven plate facing warped.	2. Replace driven plate.
	3. Driven plate surface of facing hardened.	3. Replace driven plate.
	4. Driven plate facing oil soaked.	4. Replace driven plate and check for leaks.
	5. Driven plate damper spring weakened or broken.	5. Replace driven plate.
	6. Pressure plate and/or flywheel warped.	6. Repair or replace.
Noisy	1. Release bearing binding.	1. Clean or replace if damaged, and lubricate.
	2. Release bearing worn or broken.	2. Replace.
	3. Release bearing insufficiently lubricate.	3. Lubricate with grease or replace.
	4. Driven plate damper springs weakened or broken.	4. Replace driven plate.
	5. Pilot bearing worn or broken.	5. Replace.
	6. Driven plate rivet loosen.	6. Replace driven plate.
	7. Ball stud insufficiently lubricate.	7. Lubricate with grease.
	8. Clutch pedal lack of free play.	8. Readjust.
	9. Clutch pedal shaft insufficiently lubricate.	9. Lubricate with grease.
	10. Pilot bearing loose or broken.	10. Replace.
Pedal is Hard to Push	1. hydraulic line blocked or crimped.	1. Clean out or replace.
	2. Clutch pedal shaft insufficiently lubricate.	2. Lubricate with grease.

MAIN DATA AND SPECIFICATIONS

Transmission

Type		MSB-5 5 Speed	
Gear Mesh Type		1st to 5th:	Synchro-mesh
		Reverse:	Constant-mesh
Control Type		Floor remote control	
Gear Ratio		MSB-5S	MSB-5M
	1st:	5.016	5.594
	2nd:	2.672	2.814
	3rd:	1.585	1.660
	4th:	1.000	1.000
	5th:	0.770	0.794
	Reverse:	4.783	5.334
Lubricating Oil		Engine Oil SAE 5W-30	
Oil Capacity	L (US qt/Imp qt)	Approx. 2.7 (2.9/2.4)	

Power Take Off

Allowable Maximum Torque	N·m (kg·m / lb·ft)	147 (15/108.4) / at output shaft 1000 RPM
Gear Ratio (to Engine)		1.8214
Revolution Direction		Clockwise (viewed from rear)

Clutch

Pressure Plate		NKR55	NHR55 / NKR55 / NHR69
Spring Type		Diaphragm	Diaphragm
Outside Diameter	mm (in)	240 (9.4)	250 (9.8)
Clamping Force	N (kg/lb)	4,119 (420/926)	6,276 (640/1,411)
Spring Finger Height	mm (in)	40.7 — 42.7 (1.60 — 1.68)	39.0 — 41.0 (1.54 — 1.61)
Driven Plate			
Inside × Outside Diameter	mm (in)	240 × 160 (9.4 × 6.3)	250 × 160 (9.8 × 6.3)
Free Thickness	mm (in)	7.5 — 8.1 (0.295 — 0.319)	8.1 — 8.7 (0.319 — 0.343)
Clamping Thickness	mm (in)	7.1 — 7.7 (0.280 — 0.303)	7.7 — 8.3 (0.303 — 0.327)
Clutch Pedal			
Height	mm (in)	160 — 170 (6.3 — 6.7)	
Stroke	mm (in)	159 — 169 (6.3 — 6.7)	
Free Play	mm (in)	15 — 25 (0.6 — 1.0)	
Master Cylinder			
Bore Diameter	mm (in)	ϕ 19.050 — 19.102 (0.7500 — 0.7520)	
Slave Cylinder			
Bore Diameter	mm (in)	ϕ 26.990 — 27.042 (1.0626 — 1.0646)	

SERVICE STANDARD

Transmission

Items		Service Standard	Service Limit
Gear Shift Position between Center of Shift Lever Play and Instrument Center Cluster	mm (in)	Standard Cab: 247±15 (9.7±0.6) Wide Cab: 283±15 (11.1±0.6)	
Ball Bearing Run-out	mm (in)		0.2 (0.01)
Gear Inside Diameter	mm (in)	1st Gear: 61 (2.402)	61.1 (2.406)
		2nd Gear: 54 (2.126)	54.1 (2.130)
		3rd Gear: 42 (1.654)	42.1 (1.657)
		Reverse Gear: 54 (2.126)	54.1 (2.130)
Clearance between 5th Gear and Main Shaft	mm (in)	0.05 — 0.09 (0.002 — 0.004)	0.2 (0.01)
Clearance between Reverse Idle Gear and Idle Gear Shaft	mm (in)	0.04 — 0.08 (0.002 — 0.003)	0.2 (0.01)
Spline Play between 5th Counter Gear and Counter Shaft at 5th Counter Gear Outer Circumference	mm (in)	0.18 — 0.43 (0.007 — 0.017)	0.45 (0.018)
Thrust Washer Thickness	mm (in)	2nd: 3.0 (0.12)	2.8 (0.11)
		5th: 3.8 (0.15)	3.6 (0.14)
Main Shaft Run-out	mm (in)	Less than 0.025 (0.0010)	0.1 (0.004)
Clearance between Block Ring and Dog Gear	mm (in)	3rd/4th: 1.0 (0.04)	0.5 (0.02)
		1st/2nd: 1.5 (0.06)	0.5 (0.02)
		5th: 1.5 (0.06)	0.5 (0.02)
Spline Play between Clutch Hub and Main Shaft at Clutch Hub Outer Circumference	mm (in)	Less than 0.05 (0.002)	0.3 (0.01)
Clearance between Block Ring and Insert	mm (in)	3.59 — 3.91 (0.141 — 0.154)	4.1 (0.16)
Clearance between Clutch Hub and Insert	mm (in)	0.09 — 0.31 (0.004 — 0.012)	0.4 (0.02)
Shift Arm Thickness	mm (in)	10.0 (0.39)	9.0 (0.35)
Detent Spring Free Length	mm (in)	31.6 (1.24)	30.1 (1.19)

Clutch

Items		Service Standard	Service Limit
Pressure Plate Distortion	mm (in)		0.3 (0.01)
Pressure Plate Clamping Force	N (kg/lb)		
NKR55 Clutch Size ϕ 240		4,116 (420/926)	3,785 (386/851)
NHR55 / NKR55 / NHR69 Clutch Size ϕ 250		6,276 (640/1,411)	5,776 (589/1,299)
Diaphragm Spring Finger Height	mm (in)		
NKR55 Clutch Size ϕ 240		40.7 — 42.7 (1.60 — 1.68)	
NHR55 / NKR55 / NHR69 Clutch Size ϕ 250		39.0 — 41.0 (1.54 — 1.61)	
Driven Plate Warpage	mm (in)	Less than 0.7 (0.03)	1.0 (0.04)
Spline Play between Top Gear Shaft and Driven Plate at Driven Plate Outer Circumference	mm (in)	Less than 0.5 (0.02)	1.0 (0.04)
Driven Plate Rivet Head Depression	mm (in)		
NKR55 Clutch Size ϕ 240		1.1 — 1.7 (0.04 — 0.01)	0.2 (0.01)
NHR55 / NKR55 / NHR69 Clutch Size ϕ 250		1.65 — 2.25 (0.06 — 0.09)	0.2 (0.01)
Clutch Pedal Height	mm (in)	160 — 170 (6.3 — 6.7)	
Clutch Pedal Stroke	mm (in)	159 — 169 (6.3 — 6.7)	
Clutch Pedal Free Play	mm (in)	15 — 25 (0.6 — 1.0)	
Clearance between Pedal Stopper and Clutch Switch Thread End or Stopper Bolt	mm (in)	0.5 — 1.0 (0.02 — 0.04)	
Master Cylinder Bore Diameter	mm (in)	19.050 — 19.102 (0.7500 — 0.7520)	
Clearance between Master Cylinder Bore and Piston	mm (in)	0.03 — 0.11 (0.001 — 0.004)	0.12 (0.005)
Slave Cylinder Bore Diameter	mm (in)	26.990 — 27.042 (1.0626 — 1.0646)	
Clearance between Slave Cylinder Bore and Piston	mm (in)	0.02 — 0.10 (0.0008 — 0.0039)	0.11 (0.0043)

SERVICING

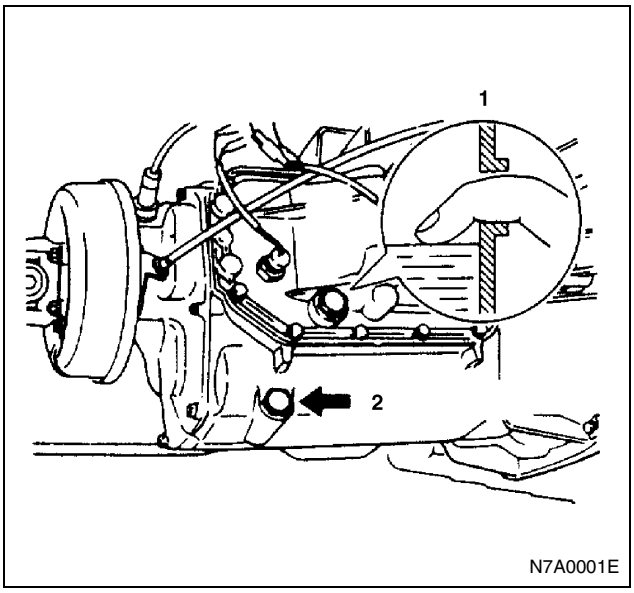
Transmission Oil Level Check

1. Remove Filler Plug.
2. Check Oil Level.
   - Add lubricant to within 0 to10 mm (0 to 0.4 in) of bottom edge of the filler hole if necessary.

Caution:
Use ENGINE OIL SAE 5W-30 for transmission case.

3. Install Filler Plug.

Tighten:
Filler plug to 49 N·m (5.0 kg·m / 36 lb·ft)



Legend
1. Filler plug
2. Drain plug

Transmission Oil Change

1. Drain Oil.
   - Remove the drain plug from the transmission case and drain the oil.
2. Install Drain Plug.

Tighten:
Drain plug to 49 N·m (5.0 kg·m / 36 lb·ft)

3. Remove Filler Plug.
4. Fill Oil.
   - Fill the transmission case from the filler plug hole with new oil of specified grade.

Oil Capacity	Liters (US·qt/Imp·qt)
2.7 (2.9/2.4)	

Caution:
Use ENGINE OIL SAE 5W-30 for transmission case.

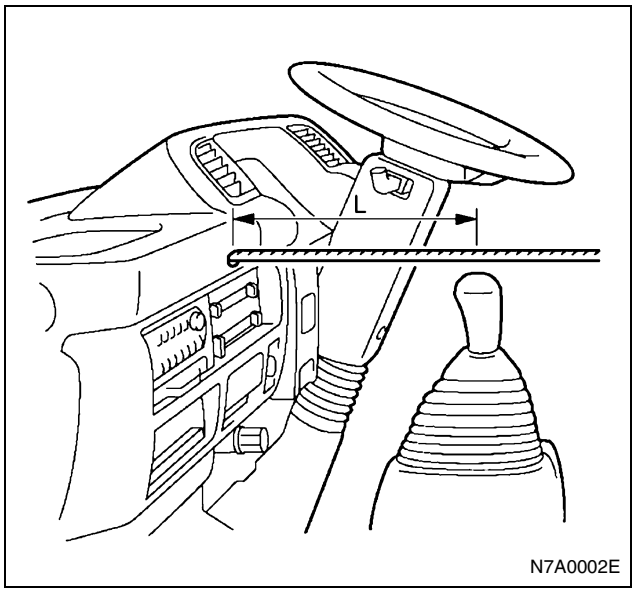
5. Install Filler Plug.

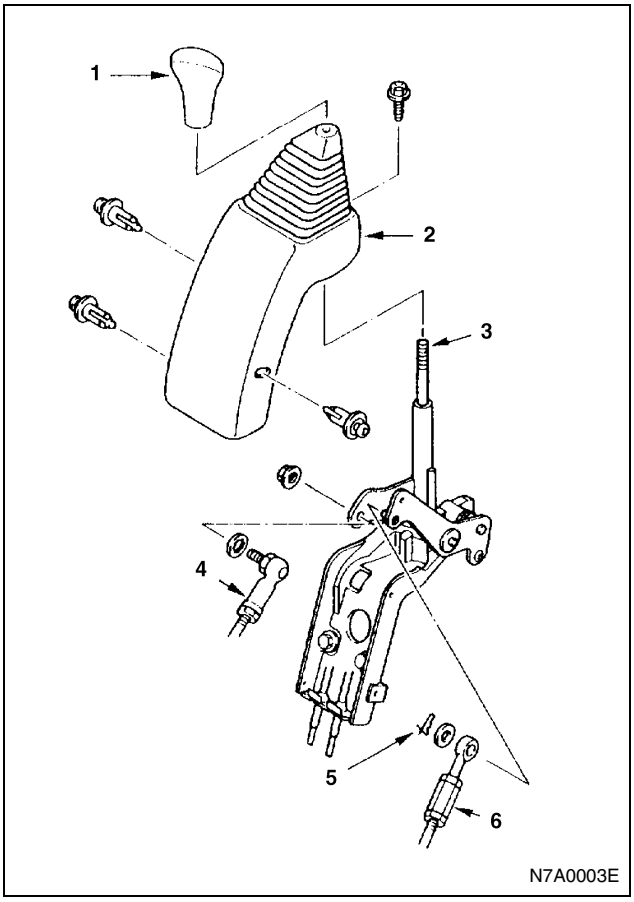
Tighten:
Filler plug to 49 N·m (5.0 kg·m / 36 lb·ft)

Gear Control Cable Adjustment

1. Measure
   - Set the change lever in the neutral position, then confirm if the dimension (L) between the center of the change lever play and the instrument center cluster is within the reference value.

Change Lever Position	mm (in)
Standard Cab: 247±15 (9.7±0.6) Wide Cab: 238±15 (11.1±0.6)	





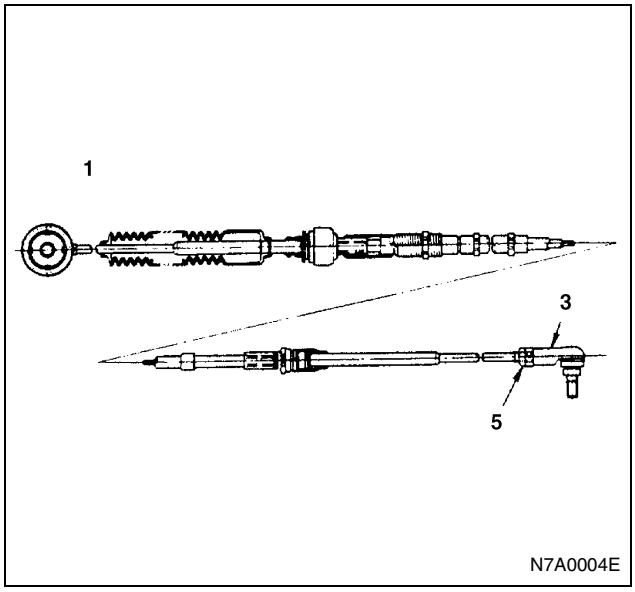
Legend

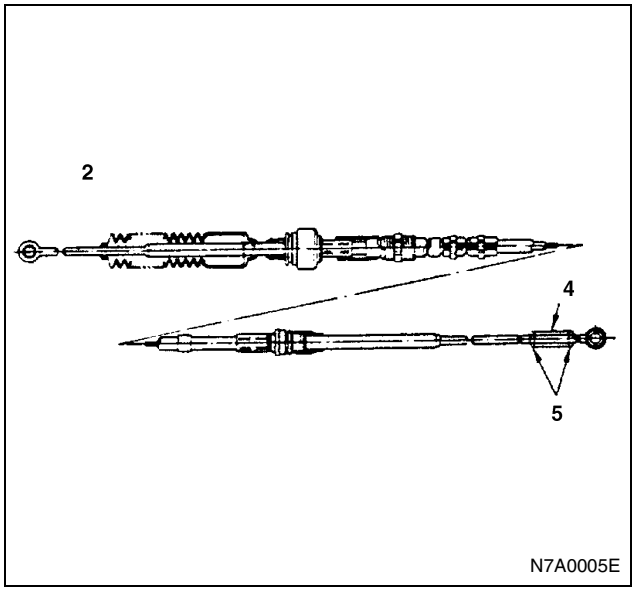
1. Knob
2. Cover assembly
3. Change lever
4. Shift cable
5. Snap pin
6. Select cable

2. Adjust
   - If the dimension is out of the reference, adjust as required.
   1) Remove the change lever knob.
   2) Remove the cover assembly.
   3) Disconnect the shift cable from the change lever.
   4) Set the transmission in the neutral position.
   5) Loosen the lock nut of the shift cable ball joint and the select cable turnbuckle, then turn the ball joint and turnbuckle as necessary for hole and pin.
   6) Tighten the lock nuts and install the shift cable to the change lever.

Tighten:
Lock nut to 6 N·m (0.6 kg·m / 4.4 lb·ft)

   7) Install the cover assembly and the change lever knob.





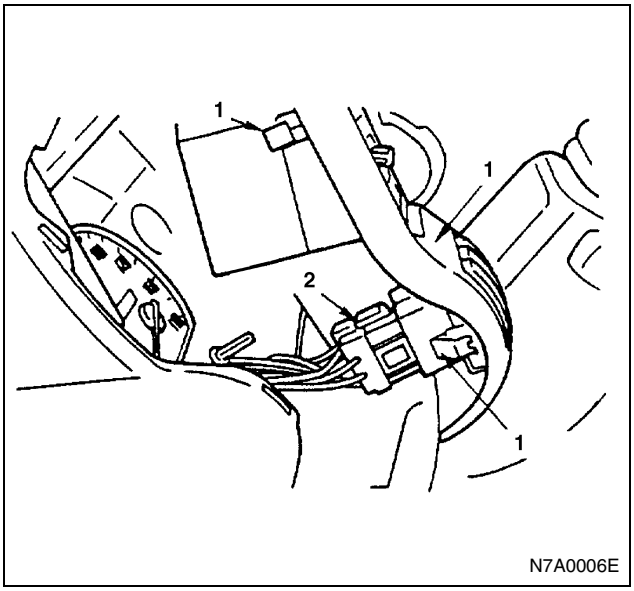
Legend

1. Shift cable (transmission side)
2. Select cable (transmission side)
3. Ball joint
4. Turnbuckle
5. Lock nut (change lever side)

Clutch Pedal Travel and Free Play Adjustment

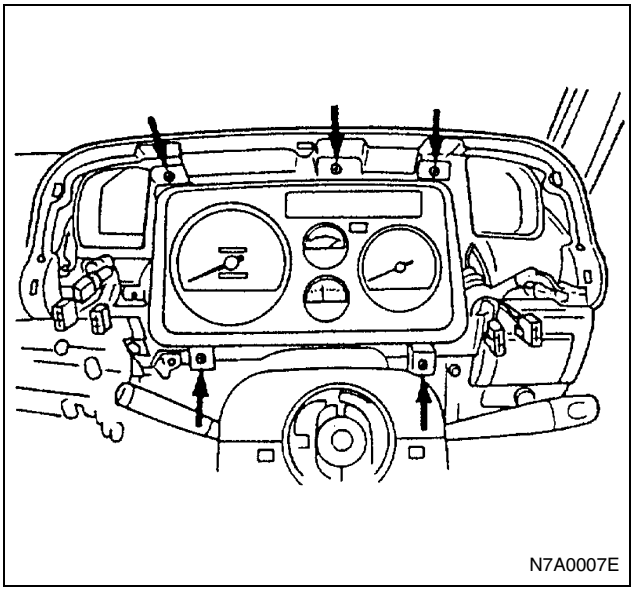
Clutch Pedal Height and Stroke

1. Remove Meter Cluster.
   - Pull out the meter cluster and disconnect the harness connectors.

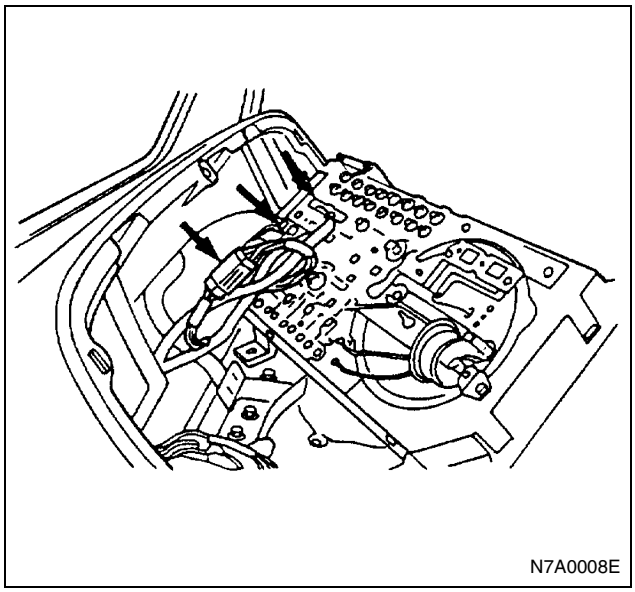


Legend
1. Clip
2. Connector

2. Remove Meter Assembly.
   - Remove the 5 fixing screws.



   - Disconnect the harness connectors.

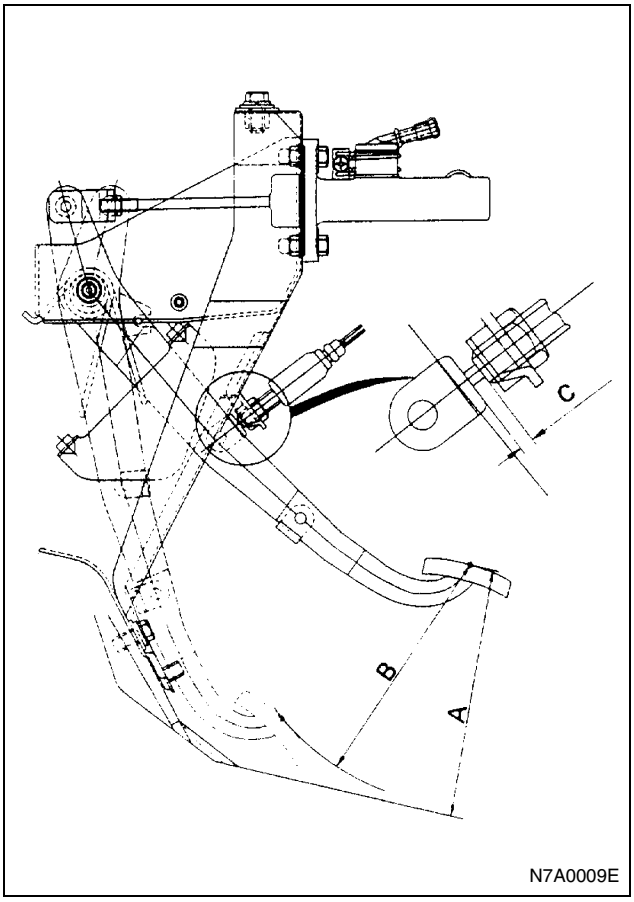


3. Adjust
   - Loosen the lock nut of the clutch master cylinder push rod.
   - Adjust the pedal height by turning the push rod.

Clutch Pedal Height and Stroke	mm (in)
Height (A): 160 — 170 (6.3 — 6.7) Stroke (B): 159 — 169 (6.3 — 6.7)	

4. Tighten Lock Nut.

Tighten:
Lock nut to 20 N·m (2.0 kg·m / 14 lb·ft)



5. Install Meter Assembly and Meter Cluster.

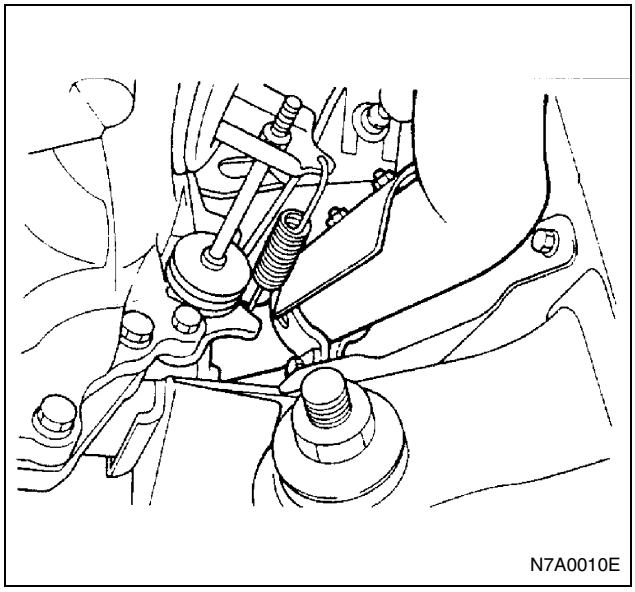
Clutch Pedal Free Play

Slave Cylinder

1) Remove the slave cylinder return spring.
2) Loosen the lock nut of the push rod.
3) Turn the adjust nut until it reaches the shift fork.
4) Back off the adjust nut 1.5 turns (shift fork free play approximately 2 mm/0.1 in.).
5) Tighten the lock nut.

Tighten:
Lock nut to 16 N·m (1.6 kg·m / 12 lb·ft)

6) Install the return spring.



Clutch Switch or Stopper Bolt

After completion of clutch pedal height adjustment, adjust the clutch switch or stopper bolt clearance.

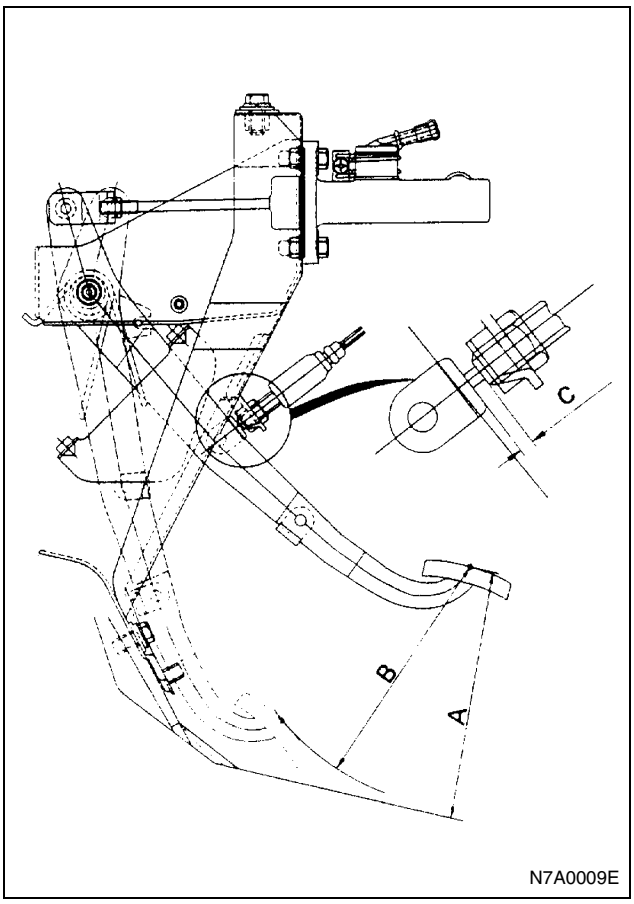
1) Loosen the lock nut of clutch switch or stopper bolt.
2) Adjust the clutch switch or stopper bolt clearance by turning clutch switch or stopper bolt.

Clutch Switch or Stopper Bolt Clearance (C)	mm (in)
0.5 — 1.0 (0.02 — 0.04)	

Clutch Pedal Free Play	mm (in)
15 — 25 (0.6 — 1.0)	

3) Tighten the lock nut.

Tighten:
Lock nut to 19 N·m (1.9 kg·m / 14 lb·ft)

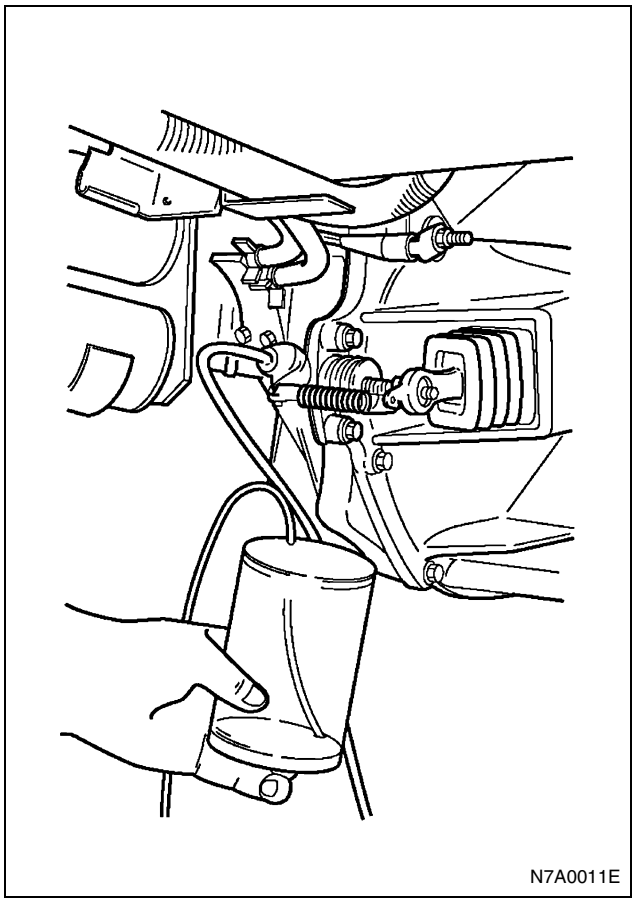


Clutch Hydraulic Circuits Bleeding

If air enters the clutch circuit, it will cause clutch dragging. Therefore, bleeding operation should be performed if the clutch fluid reservoir has been emptied due to failure to mal-replenishment or if the hydraulic circuit has been disassembled. Bleeding operation calls for cooperative action of two men.

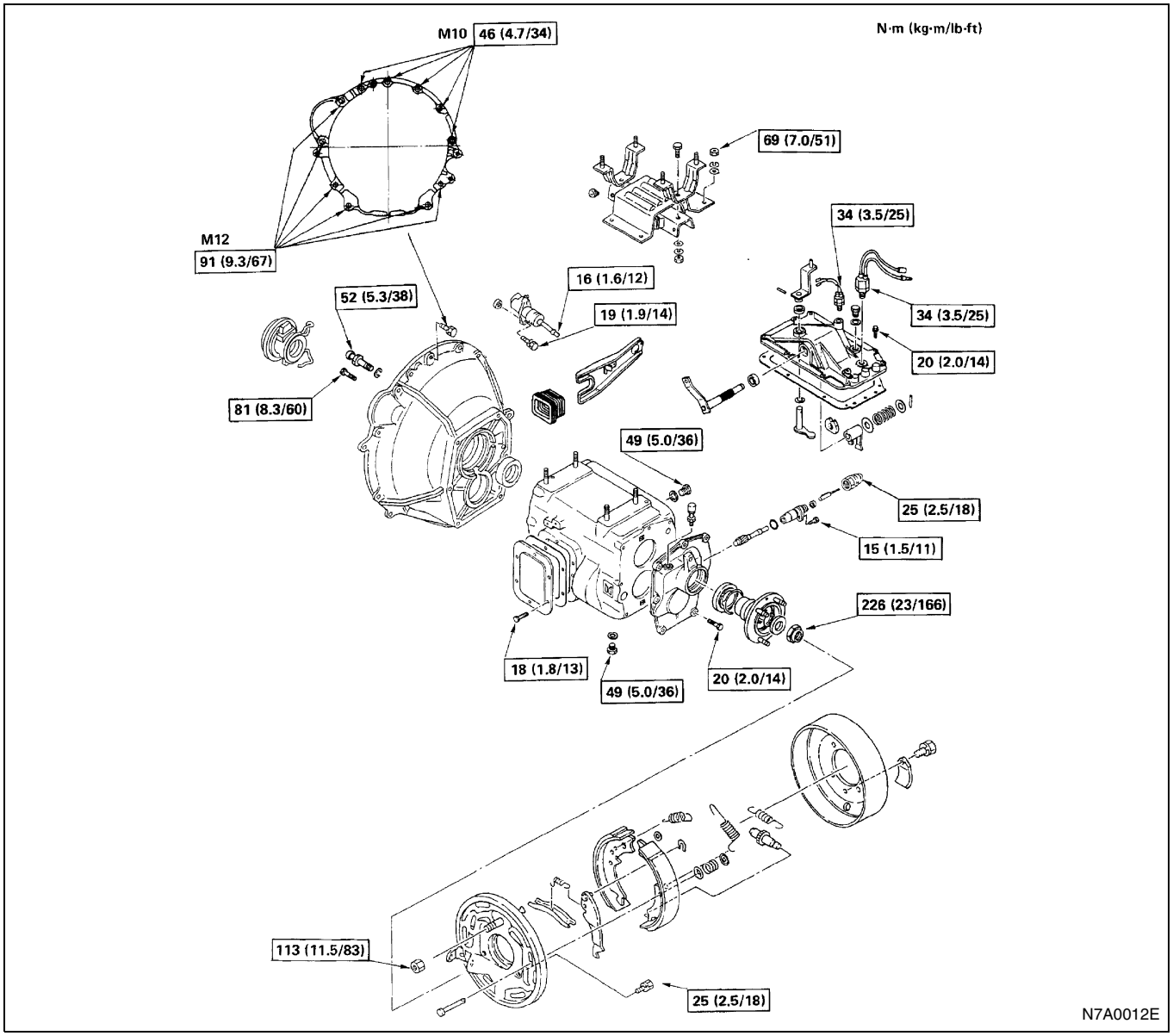
1) Check the level of clutch fluid in the reservoir and replenish if necessary.
2) Remove the rubber cap from the bleeder screw and wipe clean the bleeder screw.
   Connect a vinyl tube to the bleeder screw and insert the other end of the vinyl tube into a transparent container.
3) Pump the clutch pedal repeatedly and hold it depressed.
4) Loosen the bleeder screw on the clutch slave cylinder to release clutch fluid with air bubbles into the container and tighten the bleeder screw immediately.
5) Release the clutch pedal carefully. Repeat the above operation until air bubbles disappear from the clutch fluid being pumped out into the container. During the bleeding operation, keep the clutch fluid reservoir filled to the specified level.
   Reinstall the rubber cap.

Caution:
Do not let clutch fluid remain on a painted surface. Wash it off immediately.

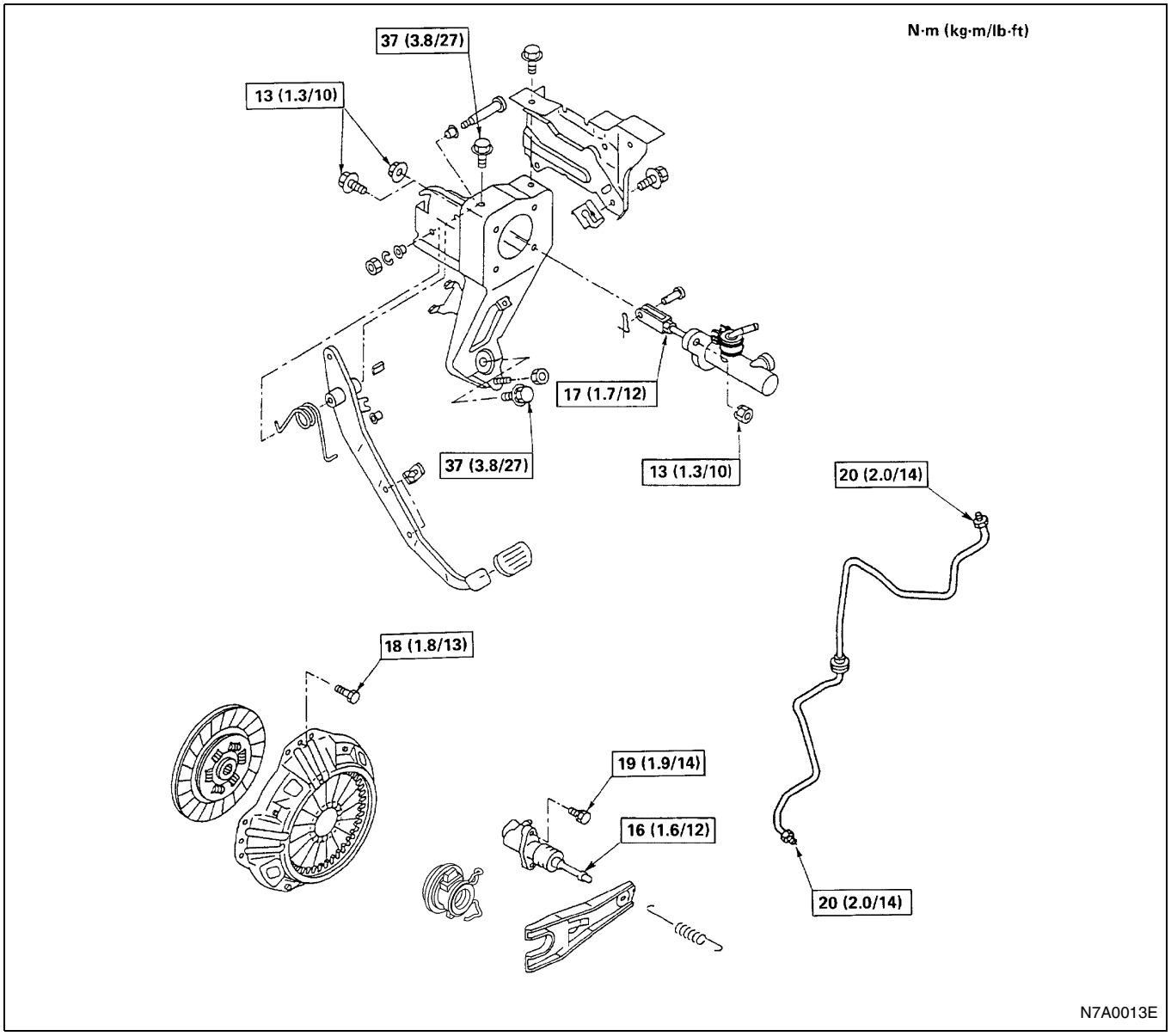


FIXING TORQUE

Transmission



Clutch


N·m (kg·m/lb·ft)
37 (3.8/27)
13 (1.3/10)
17 (1.7/12)
37 (3.8/27)
13 (1.3/10)
20 (2.0/14)
18 (1.8/13)
19 (1.9/14)
16 (1.6/12)
20 (2.0/14)
N7A0013E

SPECIAL TOOLS

Transmission

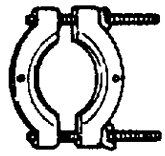
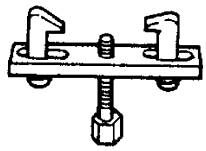
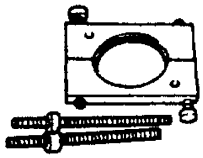
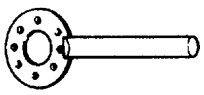
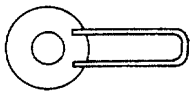
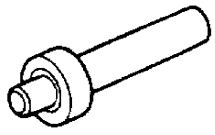
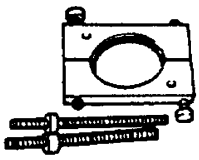
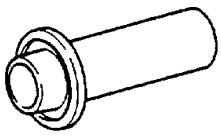
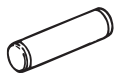
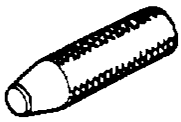
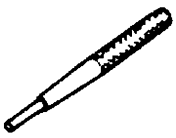
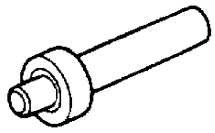
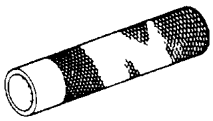
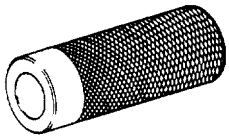
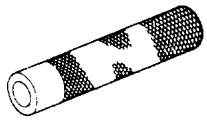
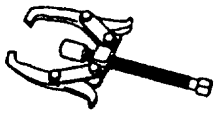
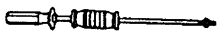
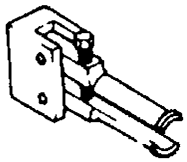
Illustration	Part Number / Description / Remarks
 5884005870	5-8840-0587-0 / Bearing Remover
 5884020270	5-8840-2027-0 / Universal Puller
 5884020420	5-8840-2042-0 / Bearing Remover
 5884020430	5-8840-2043-0 / Handle
 5884020440	5-8840-2044-0 / Anti-lash Plate Installer
 5884020640	5-8840-2064-0 / Oil Seal Installer / For front cover oil seal install

Illustration	Part Number / Description / Remarks
 5884020780	5-8840-2078-0 / Bearing Remover
 5884022420	5-8840-2242-0 / Oil Seal Installer / For rear cover oil seal install
 5884022440	5-8840-2244-0 / Bearing Installer
 9852216150	9-8522-1615-0 / Bearing Installer
 9852922010	9-8529-2201-0 / Spring Pin Remover

Power Take Off

Illustration	Part Number / Description / Remarks
 5884020640	5-8840-2064-0 / Oil Seal Installer / For output shaft oil seal
 5884020650	5-8840-2065-0 / Oil Seal Installer / For shift rod oil seal
 5884020660	5-8840-2066-0 / Bearing Installer / For output shaft bearing
 5884020670	5-8840-2067-0 / Plug Installer / For shift rod cap
9825922010	9-8529-2201-0 / Spring Pin Remover

Clutch

Illustration	Part Number / Description / Remarks
5852530010	5-8525-3001-0 / Pilot Aligner
 5884000130	5-8840-0013-0 / Bearing Remover
 5884000840	5-8840-0084-0 / Sliding Hammer
 5884020000	5-8840-2000-0 / Pilot Bearing Remover
5852200240	5-8522-0024-0 / Pilot Bearing Installer

MANUAL TRANSMISSION AND CLUTCH MSB SERIES

SECTION 7B

MANUAL TRANSMISSION (MSB)

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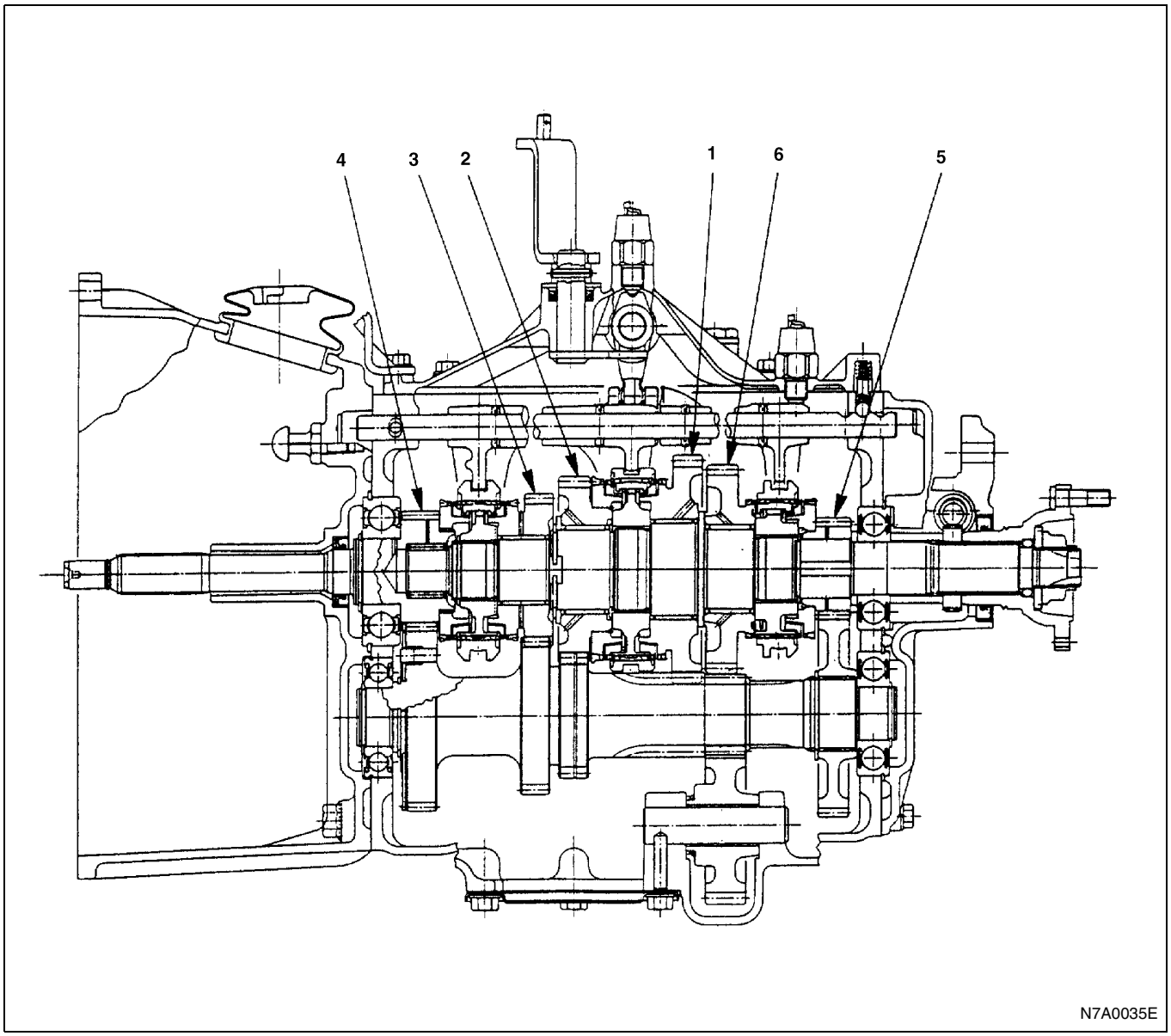
GENERAL DESCRIPTION



Legend

1. 1st
2. 2nd
3. 3rd
4. 4th
5. 5th
6. Rev.

For MSB model transmission, a forward 5-shift all synchromesh type and a backward 1-shift constant mesh type transmission are employed.

The transmission case is made of a high rigidity cast iron, and the front cover integral with the clutch housing is made of aluminum die-cast. An aluminum die-cast control box containing a gear shift and gear select mechanism is installed on the right side of the transmission case. A window for power take-off is also provided on the left side.

For all the gears, helical gears are employed to reduce noises.

The synchromesh mechanism that employs balking rings use block rings of special brass to obtain improved synchromesh performance.

With the main shaft screwed up at the rear, ball bearings are employed for the bearings on both sides of the main shaft and the counter shaft, and needle roller bearings employed for the bearings at the tip end of the main shaft and also for those of the 1st gear, 2nd gear, 3rd gear and reverse gear to secure improved durability and reduced noises.

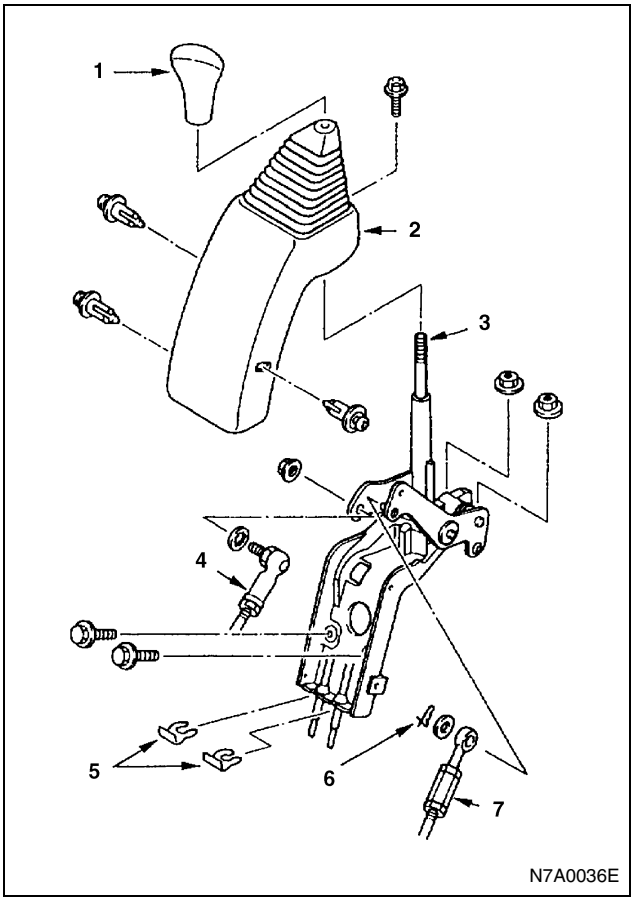
Furthermore, with the anti-lash mechanism employed for the engagement of the top gear with the counter gear, fine-pitch gears are also employed for the 4th gear and the 5th gear to reduce noises.

ON-VEHICLE SERVICE

Change Lever Assembly Replacement

Removal

1. Change Lever Knob
2. Cover Assembly
   - Remove the fixing screw and three clips.
3. Shift Cable and Select Cable
   - Disconnect the cables from the change lever.
   - Remove the clips and disconnect the cables from bracket.
4. Change Lever Assembly



Legend

1. Knob
2. Cover assembly
3. Change lever
4. Shift cable
5. Clip
6. Snap pin
7. Select cable

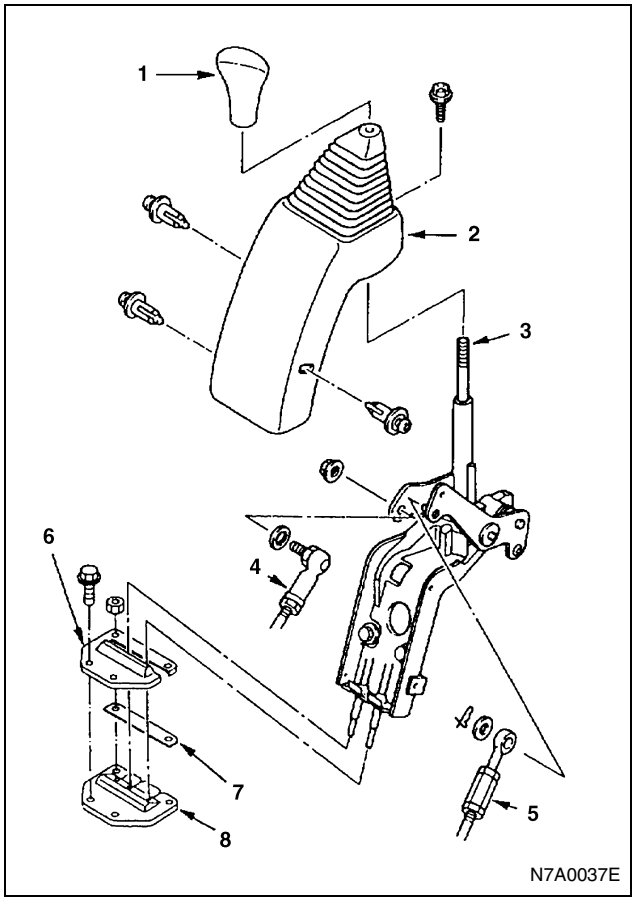
Installation

1. Change Lever Assembly
2. Shift Cable and Select Cable
   When connecting the shift cable and the select cable to the change lever, adjust the cable.
   Refer to “SERVICING: GEAR CONTROL CABLE ADJUSTMENT” given previously in this section.
3. Cover Assembly
4. Change Lever Knob

Gear Control Cable Replacement

Removal

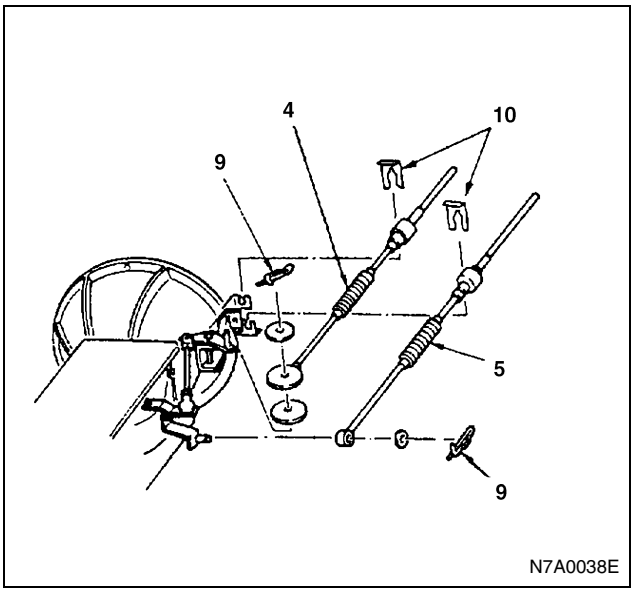
1. Change Lever Knob
2. Cover Assembly
3. Shift Cable and Select Cable
   1) Disconnect the shift and select cables from change lever.
   2) Remove the clips and disconnect the cables from change lever bracket.
   3) Remove the grommet retainer, grommet seal and grommet.
   4) Tilt the cab.



Legend

1. Knob
2. Cover assembly
3. Change lever
4. Shift cable
5. Select cable
6. Grommet retainer
7. Grommet seal
8. Grommet

5) Disconnect the shift cable and the select cable on the transmission side.
6) Remove the clips and disconnect the shift cable and the select cable from the bracket.
7) Remove the clips that fix the cables to the frames.
8) Remove the shift and select cable assemblies.



Legend

4. Shift cable
5. Select cable
9. Snap pin
10. Clip

Inspection and Repair

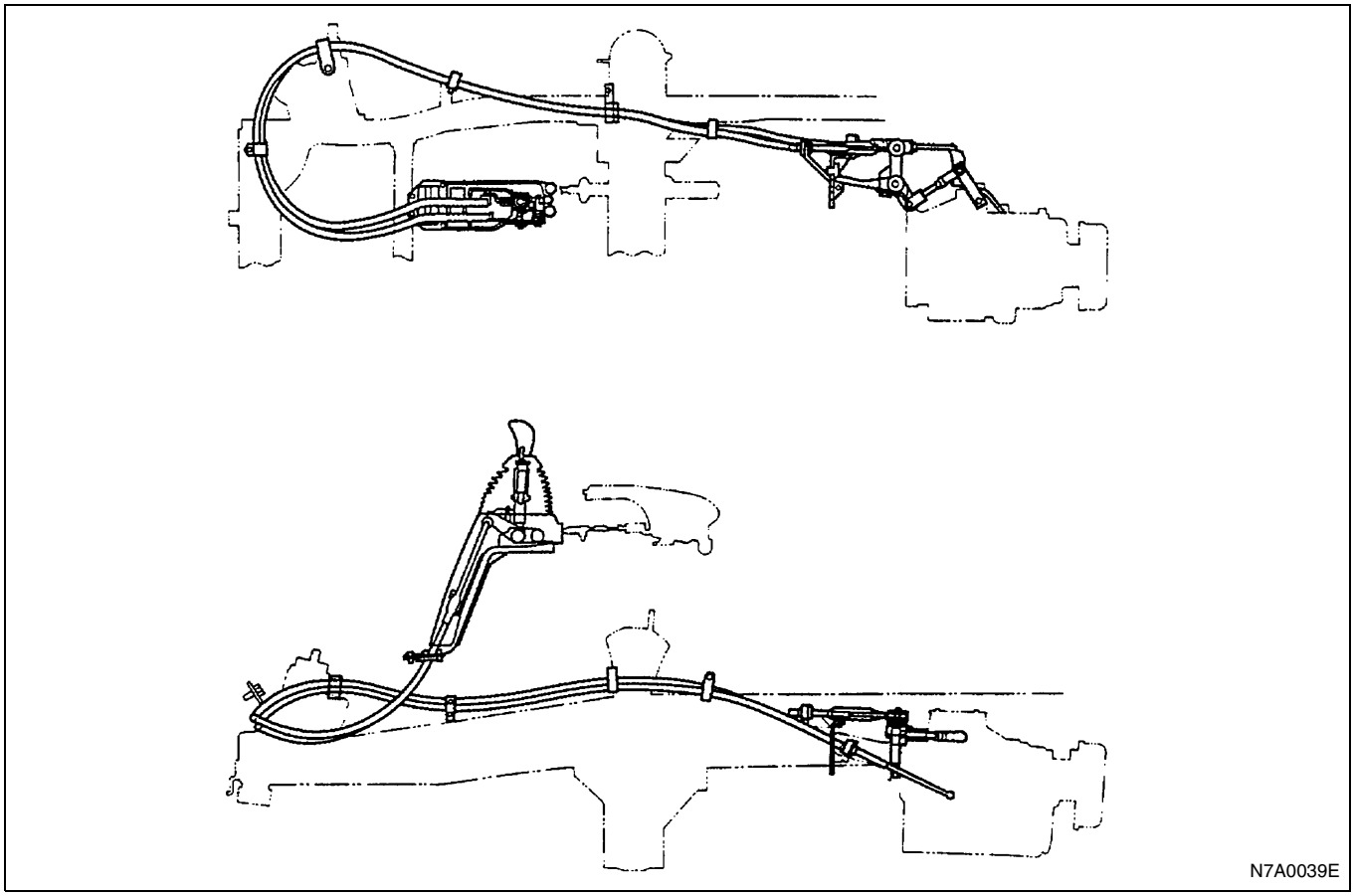
Check the cables for any deformation, damage or rust, and also check the sliding portion for any abnormal condition.
When there is any abnormal condition, replace it with a new one.

Installation

1. Shift Cable and Select Cable
   1) Install the shift cable and the select cable temporarily.

Caution:
Never bend the cables to radius less than 450 mm (18 in) unless it is necessary to do so for wiring purposes. And never bend the cables to radius less than 180 mm (7 in) even during wiring. Install the cables carefully without unnecessary twisting the cable boots.

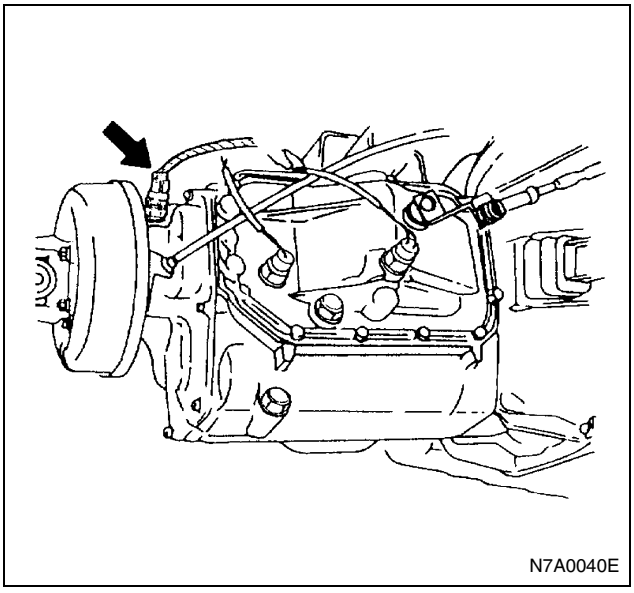
   2) Connect the shift cable and the select cable to the transmission.
   3) Fasten the cables with clips to the brackets on the transmission side.
   4) Fasten the cables with clips to the change lever bracket.
   5) Fasten the cables with clips to the frames. At this time, take care that the select cable comes above the shift cable.
   6) Install the grommet, grommet seal and grommet retainer.
   7) When connecting the shift cable and the select cable to the change lever, adjust the cables. Refer to “SERVICING: GEAR CONTROL CABLE ADJUSTMENT” given previously in this section.
2. Cover Assembly
3. Change Lever Knob


N7A0039E

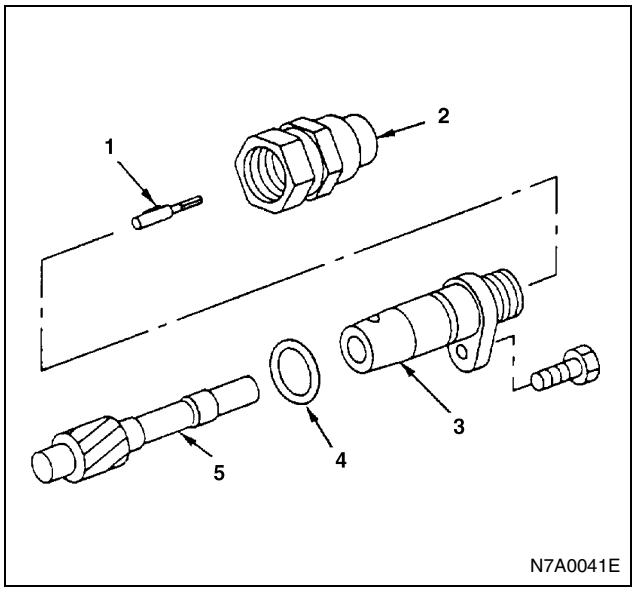
Vehicle Speed Sensor Driven Gear Replacement

Removal

1. Wiring Connector


N7A0040E

2. Vehicle Speed Sensor with Key Rod
3. Vehicle Speed Sensor Driven Gear Assembly
   - Remove the fixing bolt.
   - Remove the driven gear assembly.



N7A0041E

Legend

1. Key rod
2. Vehicle speed sensor
3. Bushing
4. O-ring
5. Driven gear

Installation

1. Vehicle Speed Sensor Driven Gear Assembly

Tighten:
Fixing bolt to 15 N·m (1.5 kg·m / 11 lb·ft)

2. Vehicle Speed Sensor with Key Rod

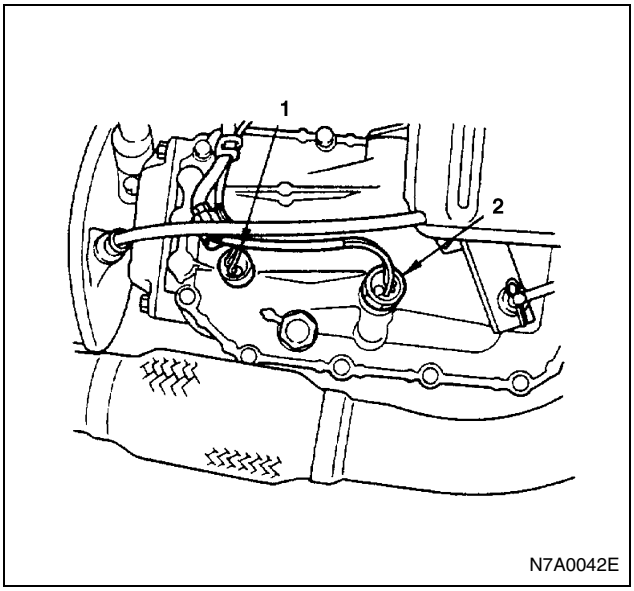
Tighten:
Fixing bolt to 25 N·m (2.5 kg·m / 18 lb·ft)

3. Wiring Connector

Back-up Light Switch and Neutral Switch Replacement

Removal

1. Wiring Connector
2. Switch

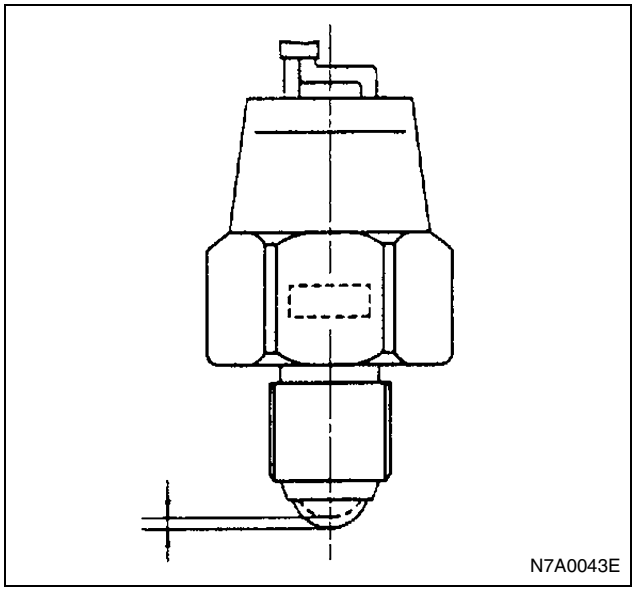


Legend
1. Back-up light switch
2. Neutral switch

Inspection and Repair

- When there is continuity between the terminals in the condition as it is, and when the continuity between the terminals is turned off by pressing the ball of the switch, the switch is normal.

Switch Operating Stroke	mm (in)
0.93 (0.037)	



Installation

1. Switch
   - Apply liquid gasket (Three Bond 1141 or equivalent) to the switch's threaded portion to prevent oil leakage, and install the switch to the control box.
   - Color of connector
     Back-up Light Switch: Brown
     Neutral Switch: Gray

Tighten:
Switch to 34 N·m (3.5 kg·m / 25 lb·ft)

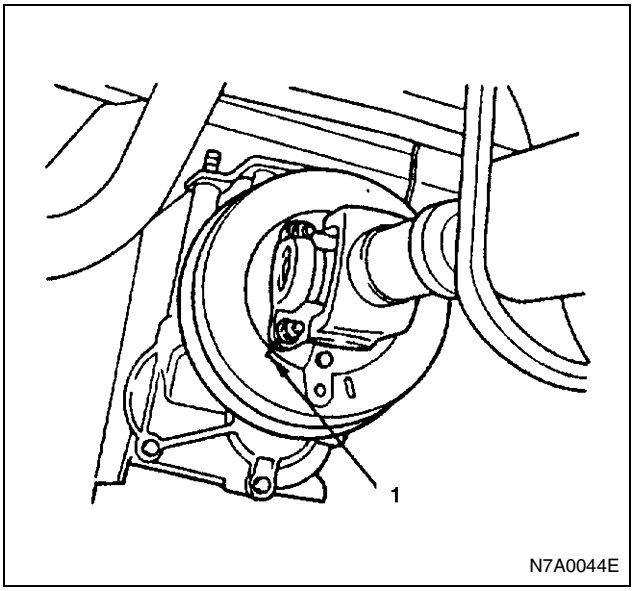
2. Wiring Connector

Rear Oil Seal Replacement

Removal

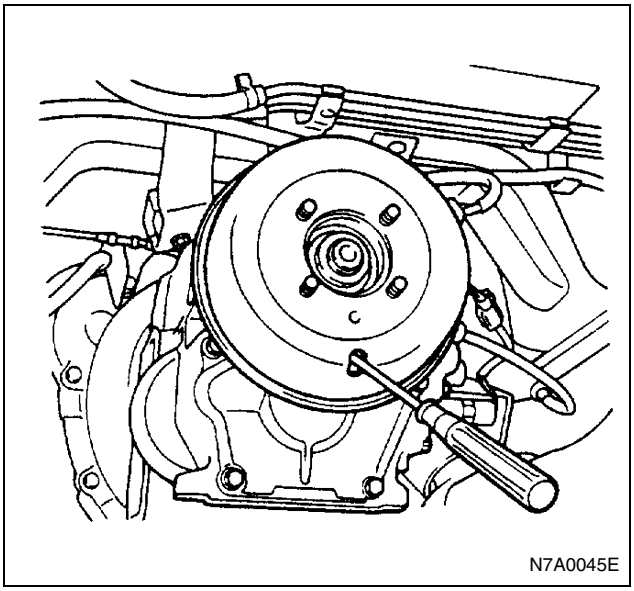
- Raise vehicle and support with suitable safety stands.

1. Propeller Shaft
   - Put a reference mark (1) on the flange yoke and the parking brake drum.

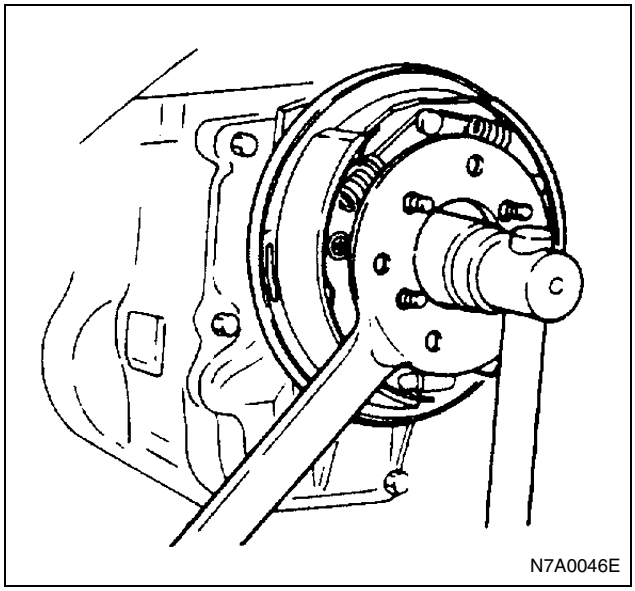


- Disconnect the propeller shaft at flange yoke.
- Put aside the propeller shaft and tie it to the frame so it does not interfere with servicing work.

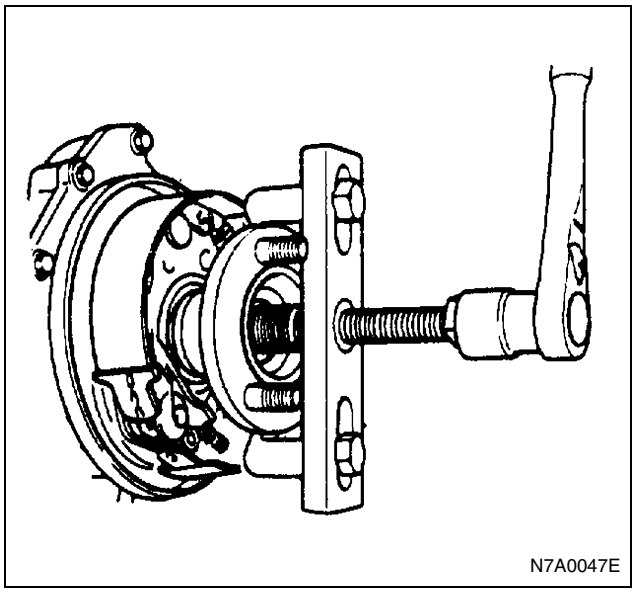
2. Parking Brake Drum
   - Remove the screw and the adjust hole cover.
   - It may be necessary to back off the shoe adjuster.



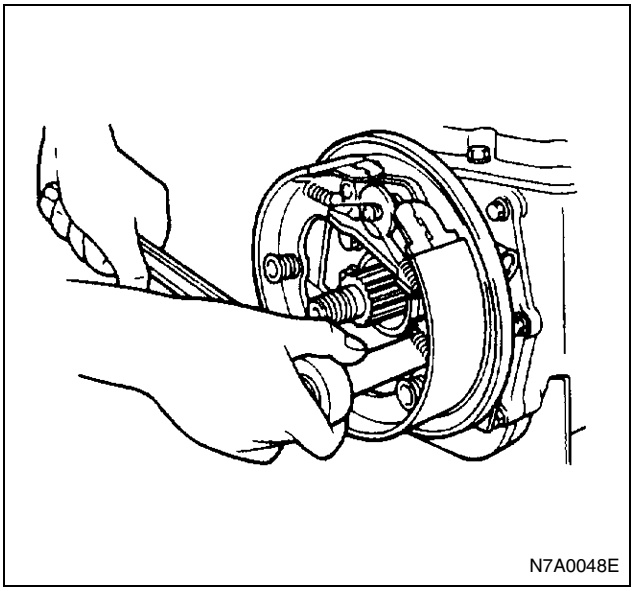
3. Lock Nut
   - Make sure to raise the caulking of the coupling driver lock nut, then remove the lock nut.
   - Use the handle to remove the lock nut.
     Handle: 5-8840-2043-0



4. Coupling Driver
   - Remove the coupling driver using the universal puller.
     Universal Puller: 5-8840-2027-0
   - Remove the conical washer and the O-ring.



5. Parking Brake Assembly

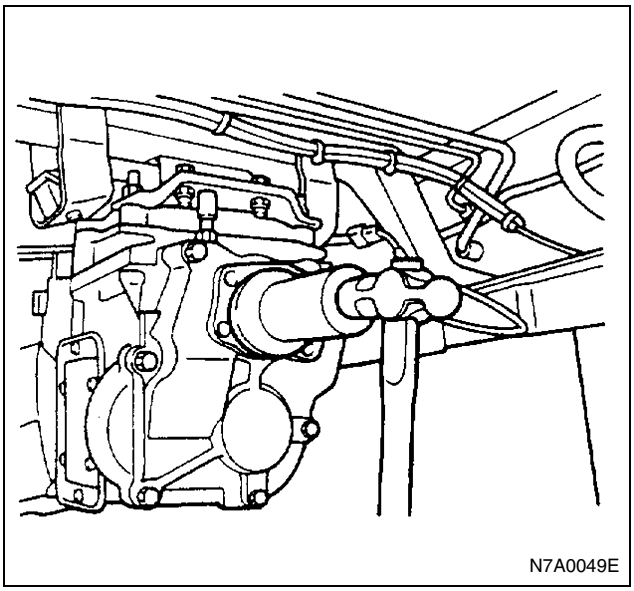

N7A0048E

6. Oil Seal
   - Use the screwdriver to remove the oil seal from the rear cover.

Caution:
Take care not to damage the sealing seat of the rear cover.

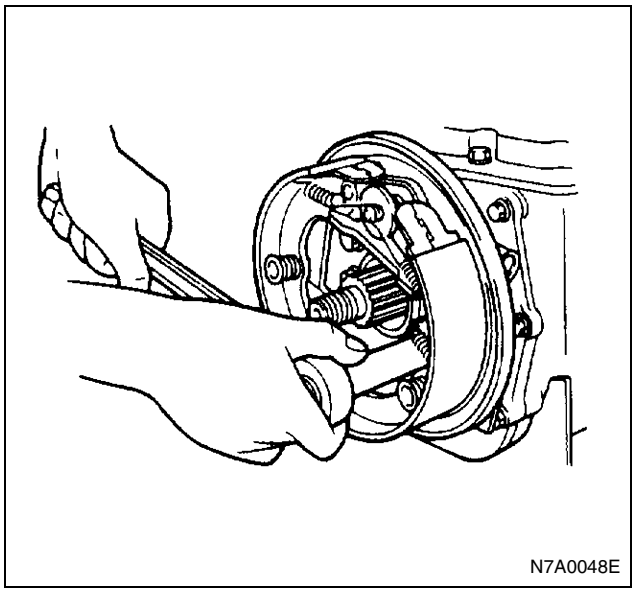
Installation

1. Oil Seal
   - Apply engine oil to the new oil seal outer circumference and apply multi-purpose grease to the oil seal lip.
   - Use the oil seal installer to install the oil seal to the rear cover.
     Oil Seal Installer: 5-8840-2242-0


N7A0049E

2. Parking Brake Assembly

Tighten:
- Parking brake bolts to 25 N·m (2.5 kg·m / 18 lb·ft)
- Parking brake nut to 113 N·m (11.5 kg·m / 83 lb·ft)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3. Coupling Driver
4. Lock Nut
   - Install the O-ring and the conical washer.
     The conical washer is to be set up with its identification groove to the nut side.

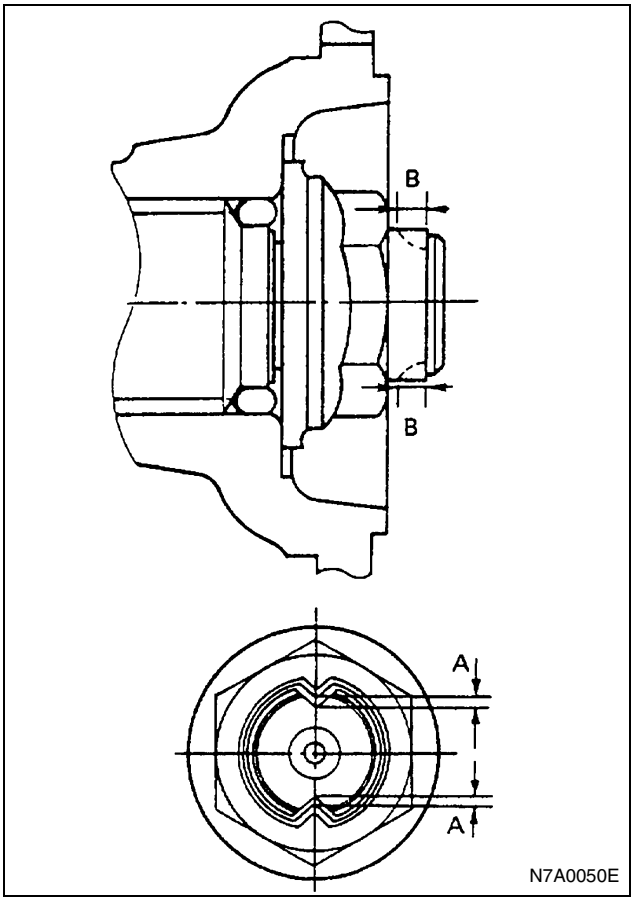
Caution:
Do not reuse the lock nut.

   - Apply the engine oil to the setting face of the new lock nut and tighten it up to the specified torque.
     Handle: 5-8840-2043-0

Tighten:
Lock nut to 226 N·m (23.0 kg·m / 166 lb·ft)

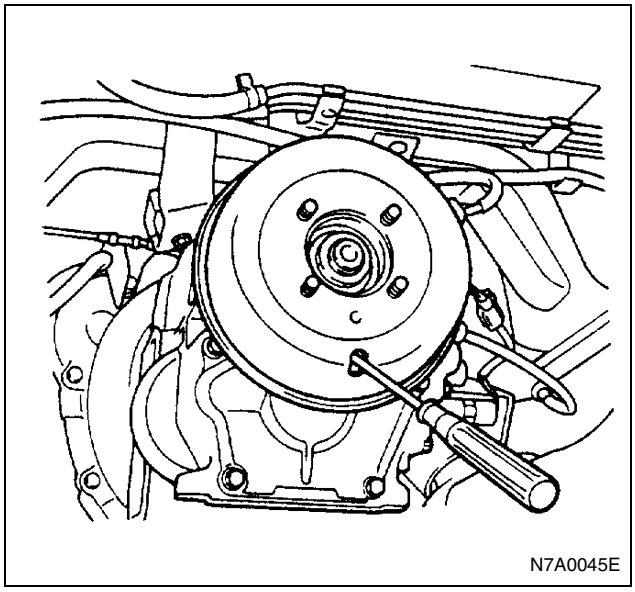
   - Align the lock nut with the V-shaped groove at the tip of the main shaft, and caulk the nut lip portion by using a chisel.
     (Round edge approximately 1 mm (0.04 in) × 60°).
   - As shown in the illustration, be sure to caulk the nut lip so that the clearance between the V-shaped groove portion at the tip of the main shaft and the caulked up lip (A) is less than 1.5 mm (0.06 in), and the caulking length (B) is 5 mm (0.2 in) or more.

Caution:
Be sure to confirm that there is no crack at the caulked portion of the end nut after caulking.

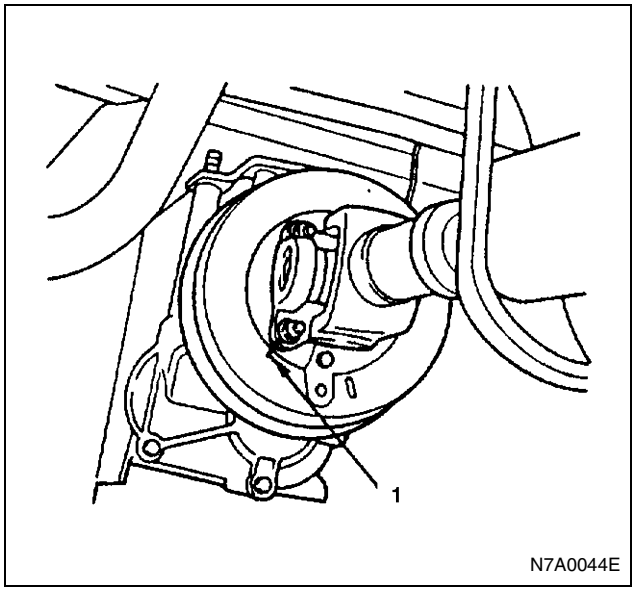


5. Parking Brake Drum
   - Adjust the parking brake after installation.
   1) Rotate the brake drum to align the adjust hole with the adjuster.
   2) Move the camshaft lever from side to side several times to center the brake shoes.
   3) Insert a screwdriver into the hole and rotate the adjuster by pushing it upward until the shoes drag on the drum.
   4) Back off the adjuster 30 notches.
   - Install the adjust hole cover.

Tighten:
Adjust hole cover bolt to 8 N·m (0.8 kg·m / 69 lb·in)



6. Propeller Shaft
   - Line up reference mark (1).



Tighten:
Propeller shaft bolt to 66 N·m (6.7 kg·m / 48 lb·ft)

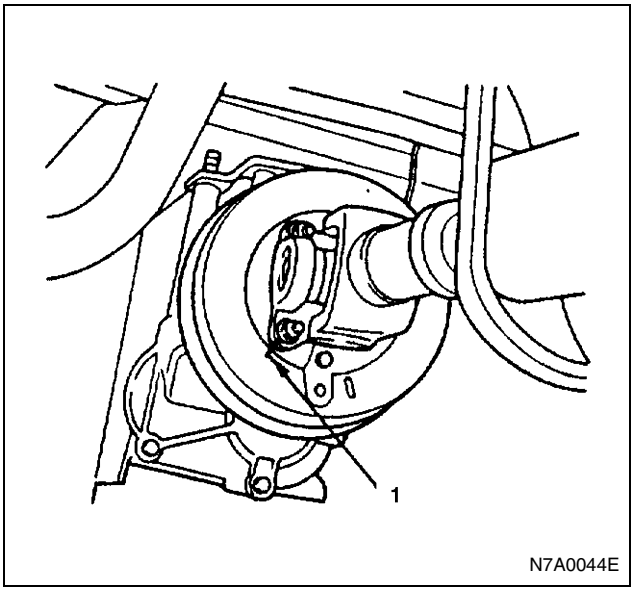
- Remove the safety stands.

Transmission Assembly Replacement

Removal

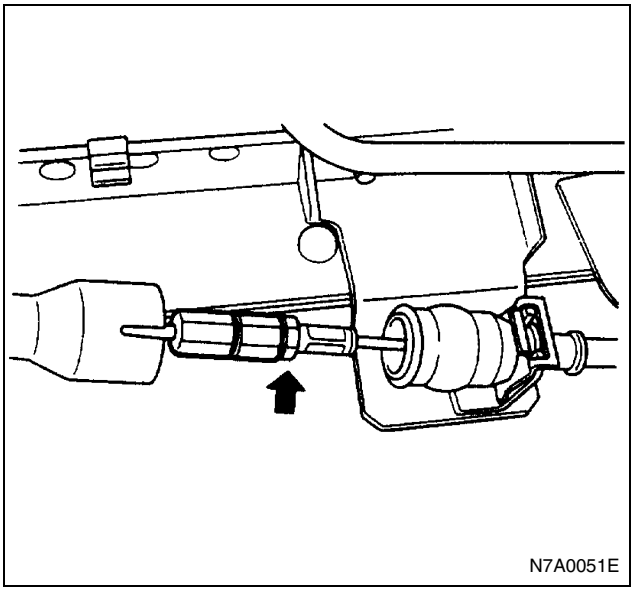
- Raise vehicle and support with suitable safety stands.

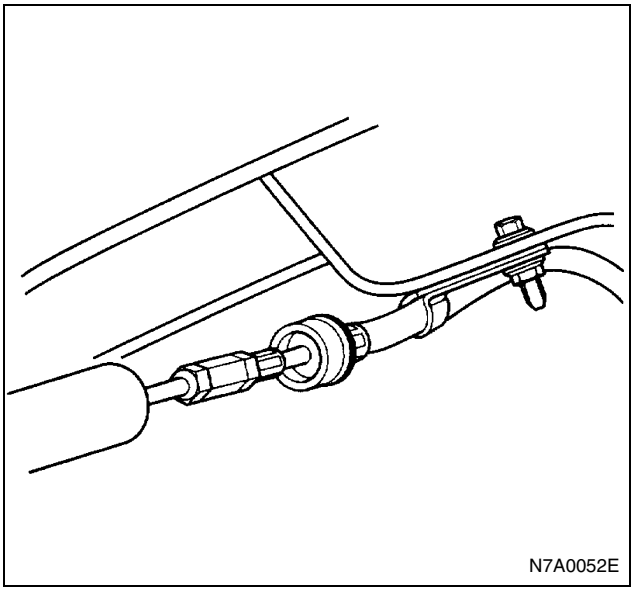
1. Propeller Shaft
   - Put a reference mark (1) on the flange yoke and the parking brake drum.



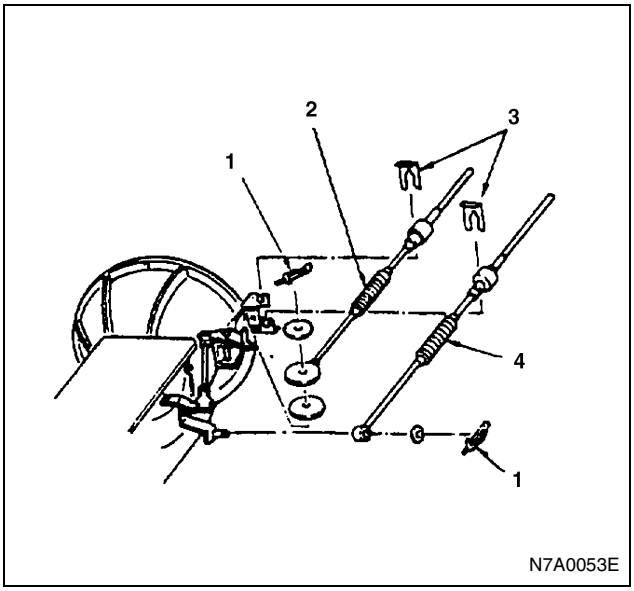
- Disconnect the propeller shaft at flange yoke.
- Put aside the propeller shaft and tie it to the frame so that it does not interfere with servicing work.

2. Parking Brake Cable
   - Move the joint cover.
   - Disconnect the joint bolt.
   - Remove the clip, and then disconnect the cable from the bracket.





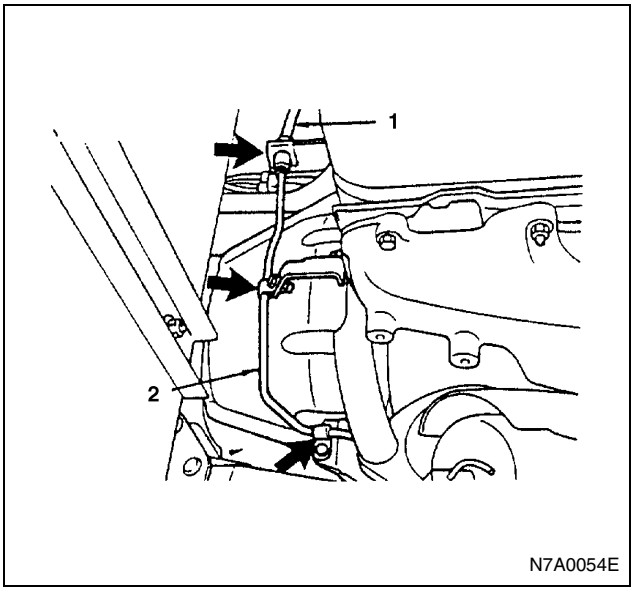
3. Wiring Connector
   - Disconnect the wiring connectors from the vehicle speed sensor, the neutral switch and the back-up light switch.
4. Shift Cable and Select Cable
   - Disconnect the shift cable and select cable on the transmission side.



Legend

1. Snap pin
2. Shift cable
3. Clip
4. Select cable

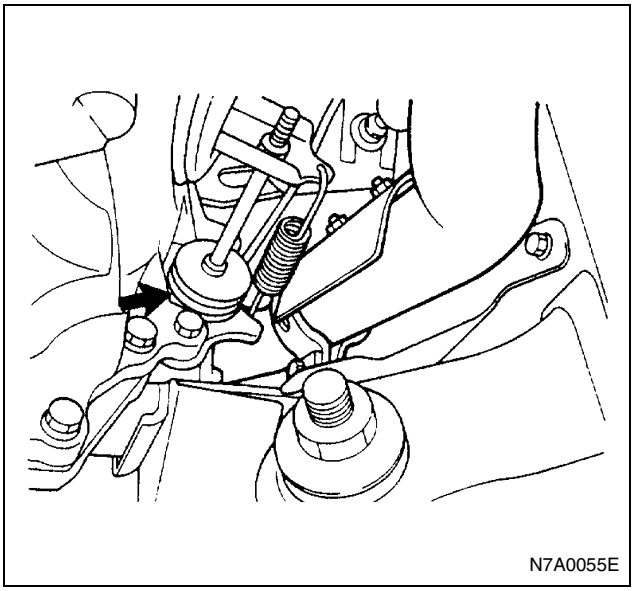
5. Clutch Slave Cylinder
   - Remove the clutch pipe fixing clips and the clip bracket (Right hand drive models only).



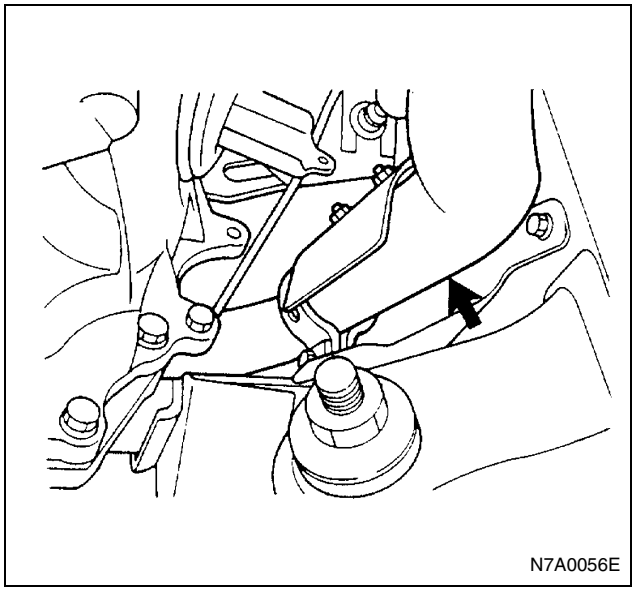
Legend

1. Flexible hose
2. Shift cable

- Remove the slave cylinder assembly with the flexible hose attached, and then tie it to the frame so that it does not interfere with servicing work.



6. Exhaust Brake Assembly
7. Front Exhaust Pipe



8. Transmission Assembly

Notice:

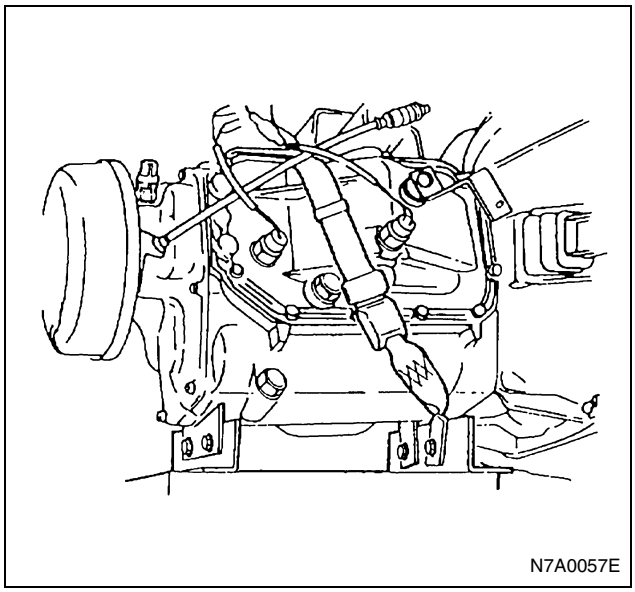
The exhaust pipe bracket, the gear control bracket and the clips are sometimes installed in the wrong position or direction confusedly. To prevent incorrect installation of these parts, put a correct installation mark on them.

- Support the transmission with mission jack.

Caution:

To prevent the falling of the transmission, tie it firmly to the jack with a chain or belt.

Do not allow transmission to hang unsupported from clutch. Damage to the clutch assembly will result.



- Remove the nuts of the transmission mounting bracket on the crossmember side.
- Engine and transmission angles may need to be adjusted for removal.
- Hold the rear section of the engine by the jack or hoist.

Caution:
When lifting the engine by the jack, use wood blocks to prevent any possible damage to the oil pan.

- Remove transmission fastening bolts.
- Pull out the transmission assembly rearward.

9. Mounting Bracket

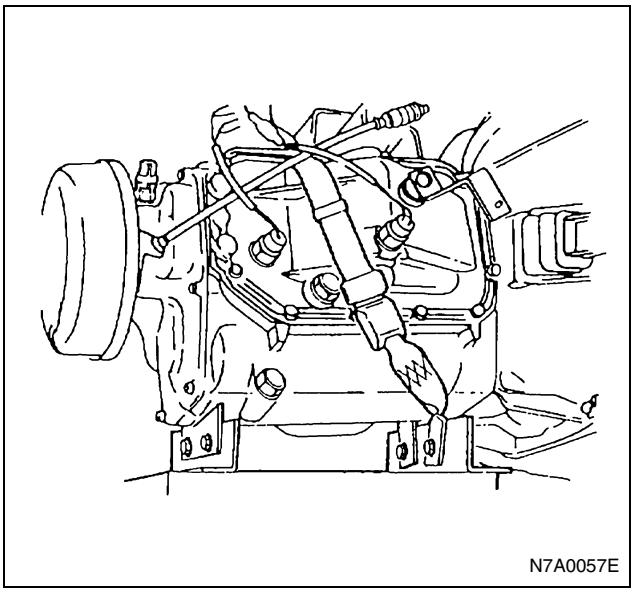
Installation

1. Mounting Bracket

Tighten:
Mounting bracket nuts to 69 N·m (7.0 kg·m / 51 lb·ft)

2. Transmission Assembly
   - Support the transmission with mission jack.

Caution:
To prevent the falling of the transmission, tie it securely to the jack with a chain or belt.

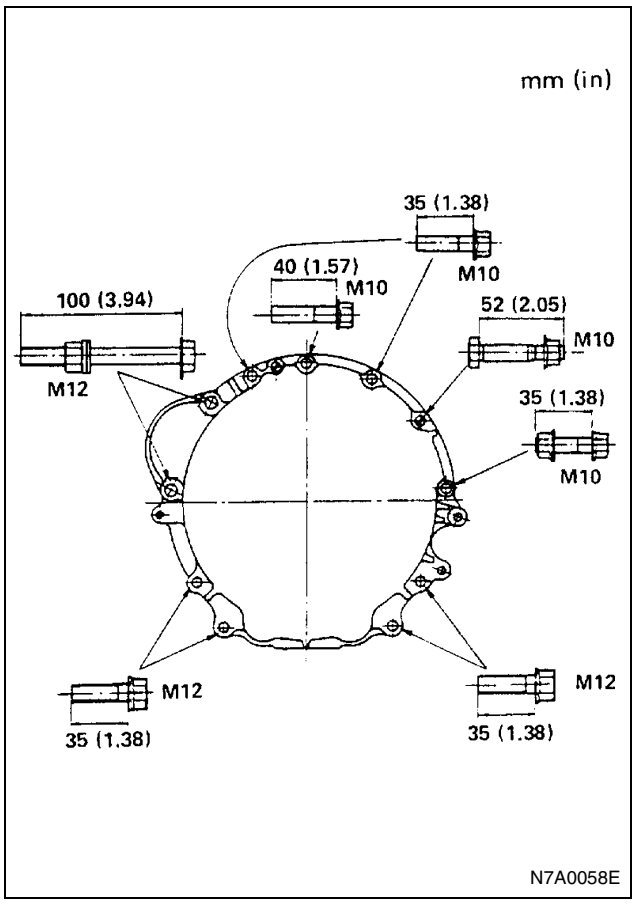

N7A0057E

- Shift transmission into high gear.
- Align transmission with engine slope.
- Turn output parking brake drum to aid clutch spline engagement.

Tighten:
Clutch housing to flywheel housing bolts to
- M10: 46 N·m (4.7 kg·m / 34 lb·ft)
- M12: 91 N·m (9.3 kg·m / 67 lb·ft)

- Raise engine and transmission up into rear transmission mount.

Tighten:
Engine rear mounting nuts and bolts to
- M10: 40 N·m (4.1 kg·m / 30 lb·ft)
- M12: 69 N·m (7.0 kg·m / 51 lb·ft)



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3. Front Exhaust Pipe

Tighten:
Front exhaust pipe bolts to 37 N·m (3.8 kg·m / 27 lb·ft)

4. Exhaust Brake Assembly

Tighten:
Exhaust brake bolts to 17 N·m (1.8 kg·m / 12 lb·ft)

5. Clutch Slave Cylinder

Tighten:
Slave cylinder bolts to 19 N·m (1.9 kg·m / 14 lb·ft)

- Perform slave cylinder adjustment before installation of the return spring.

1) Loosen the lock nut of the push rod.
2) Turn the adjust nut until it reaches the shift fork.
3) Back off the adjust nut 1.5 turns. (shift fork free play Approximately 2 mm/0.1 in).
4) Tighten the lock nut.

Tighten:
Push rod lock nut to 16 N·m (1.6 kg·m / 12 lb·ft)

6. Shift Cable and Select Cable
7. Wiring Connector
   - Color of Connector
     Back-up Light Switch: Brown
     Neutral Switch: Gray
8. Parking Brake Cable
9. Propeller Shaft
   - Line up reference mark.

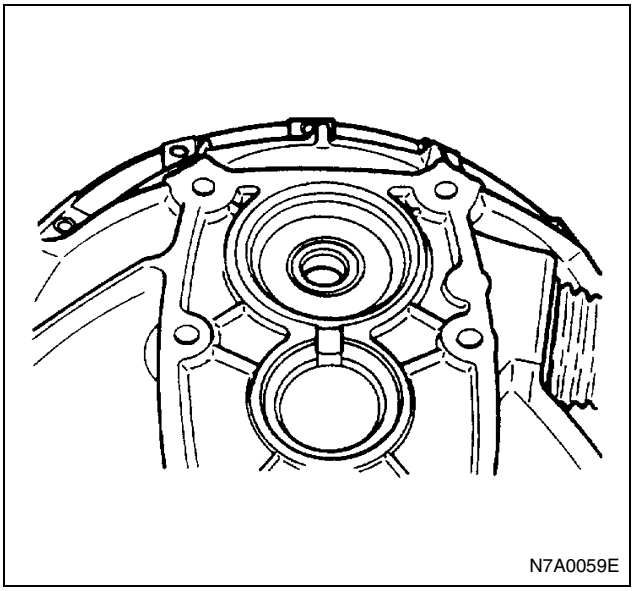
Tighten:
Propeller shaft nuts to 66 N·m (6.7 kg·m / 48 lb·ft)

Front Oil Seal Replacement

Removal

1. Transmission Assembly
   Refer to "ON-VEHICLE SERVICE: TRANSMISSION ASSEMBLY REPLACEMENT" previously in this section.
2. Clutch Housing
3. Oil Seal
   - Use the screwdriver to remove the oil seal from the clutch housing.

Caution:
Take care not to damage the sealing seat of the clutch housing.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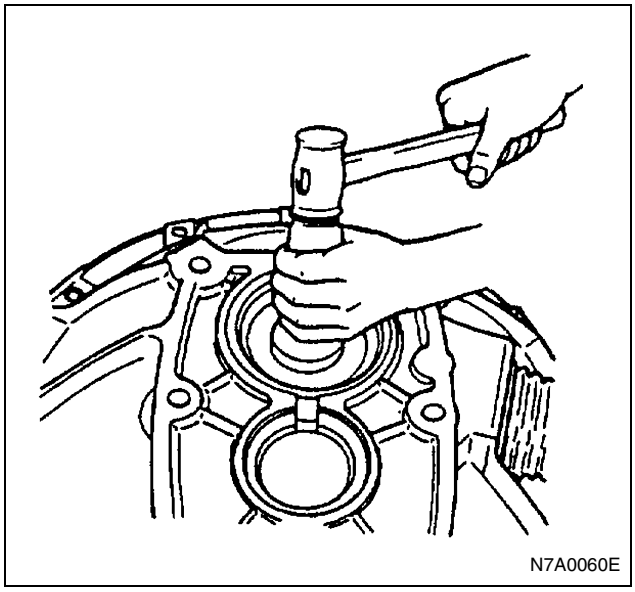
Installation

1. Oil Seal
   - Apply engine oil to the new oil seal outer circumference and apply multi-purpose grease to the oil seal lip.
   - Use the oil seal installer to install the oil seal to the clutch housing.
     Oil Seal Installer: 5-8840-2064-0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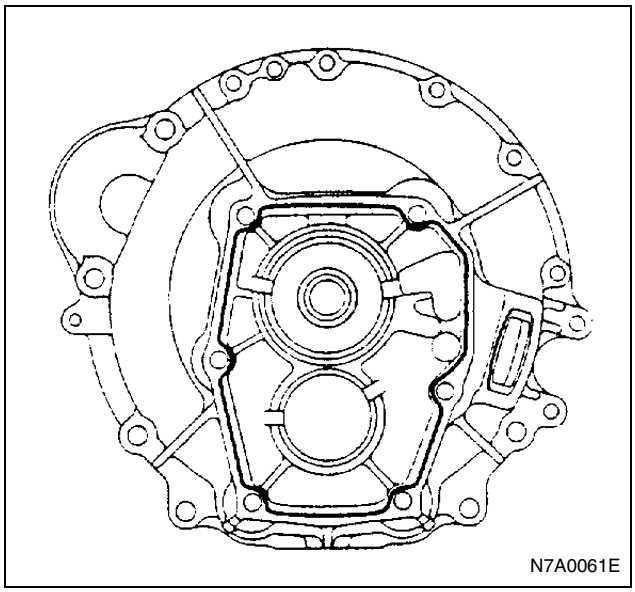
2. Clutch Housing
   - Remove water and oil on the mating face before applying the liquid gasket.
   - Apply ϕ2 mm (0.1 in) bead of the liquid gasket (Three Bond 1215 or equivalent) to the clutch housing surface shown in the illustration.

Notice:
Install the clutch housing on the transmission case within 30 minutes after liquid gasket application.

Tighten:
Clutch housing to transmission case bolts to 81 N·m (8.3 kg·m / 60 lb·ft)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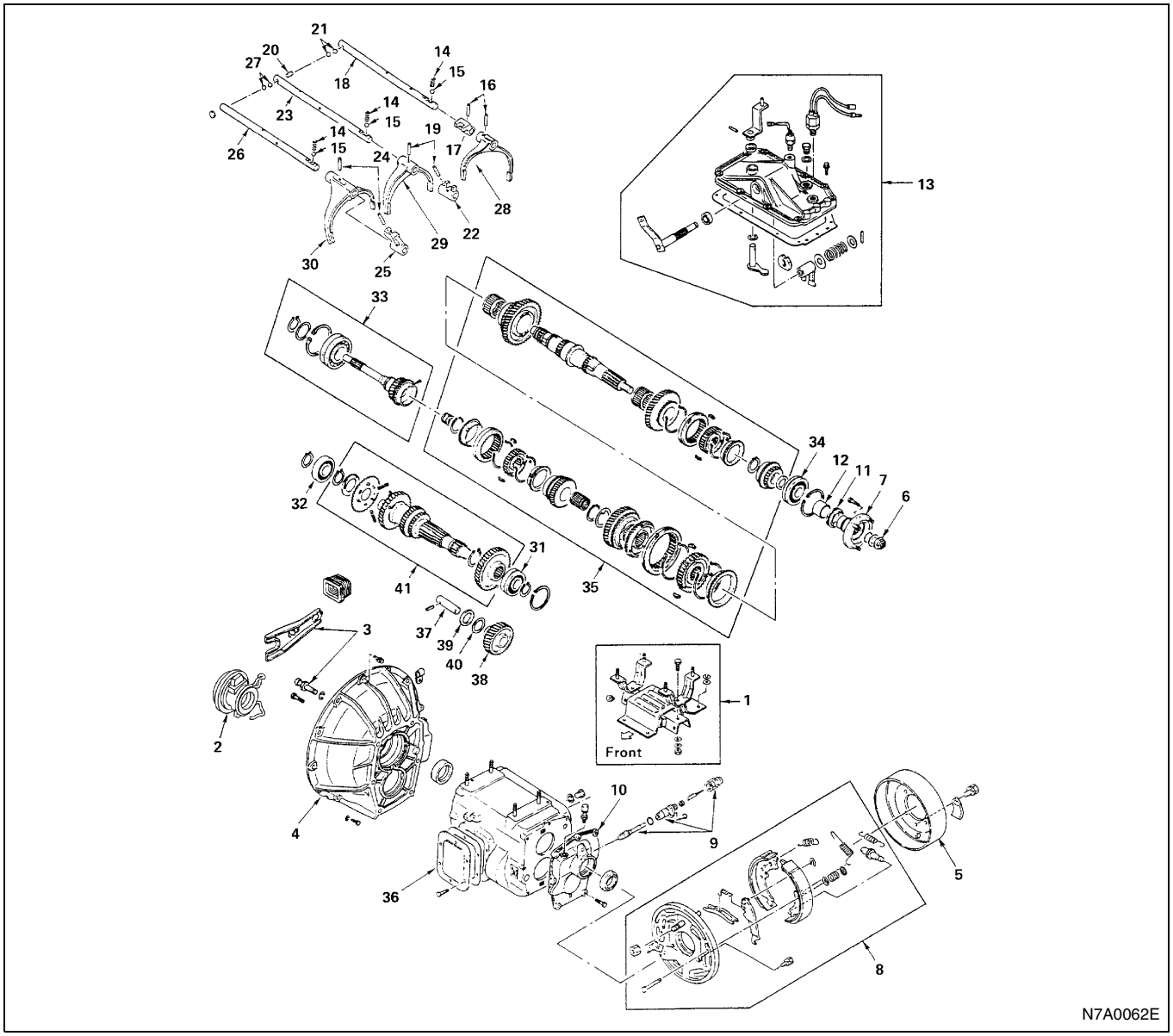
3. Transmission Assembly
   Refer to "ON-VEHICLE SERVICE: TRANSMISSION ASSEMBLY REPLACEMENT" previously in this section.

Tighten:
Clutch housing to flywheel housing bolts to
- M10: 46 N·m (4.7 kg·m / 34 lb·ft)
- M12: 91 N·m (9.3 kg·m / 67 lb·ft)

UNIT REPAIR

Major Components



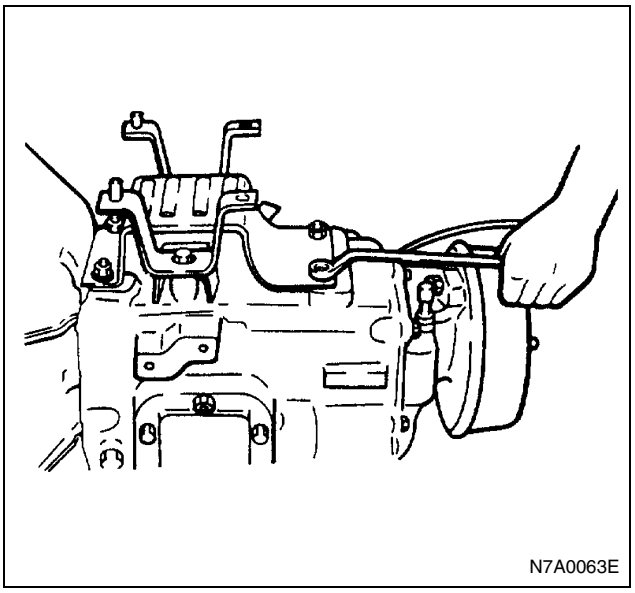
Legend

1. Mission mounting assembly
2. Release bearing assembly
3. Shift fork and support bolt
4. Clutch housing
5. Parking brake drum
6. Lock nut
7. Coupling driver
8. Parking brake assembly
9. Vehicle speed sensor driven gear assembly
10. Rear cover
11. Vehicle speed sensor drive gear
12. Spacer
13. Control box assembly
14. Detent spring
15. Detent ball
22. 3rd/4th shift block
23. 3rd/4th shift rod
24. Spring pin
25. 1st/2nd shift block
26. 1st/2nd shift rod
27. Interlock ball
28. 5th/Reverse shift arm
29. 3rd/4th shift arm
30. 1st/2nd shift arm
31. Counter shaft rear bearing
32. Counter shaft front bearing
33. Top gear shaft assembly
34. Main shaft rear bearing
35. Main shaft assembly
36. Side cover

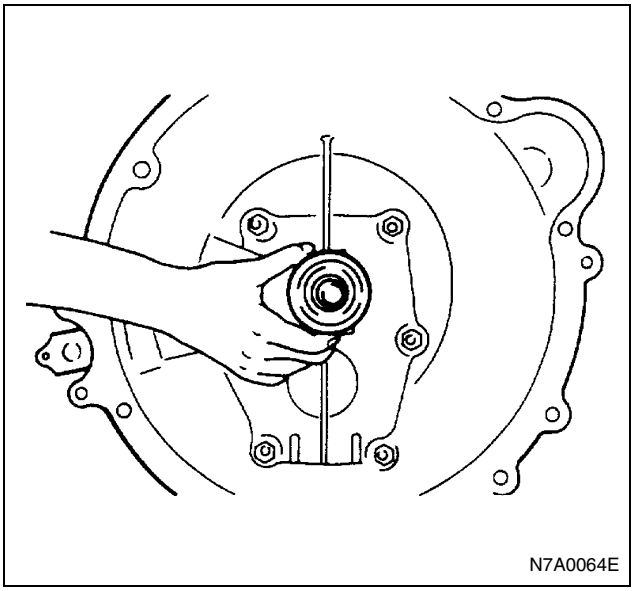
16. Spring pin
17. 5th/Reverse shift block
18. 5th/Reverse shift rod
19. Spring pin
20. Interlock pin
21. Interlock ball
37. Reverse idle gear shaft
38. Reverse idle gear
39. Thrust washer
40. Conical washer
41. Counter shaft assembly

Disassembly

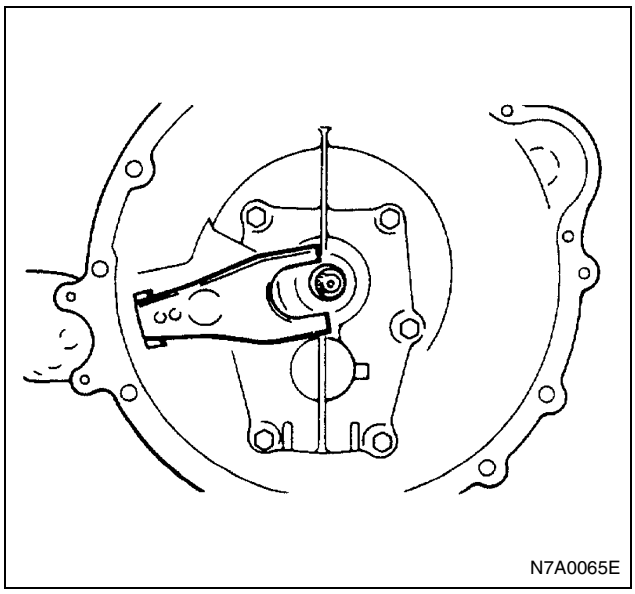
1. Mission Mounting Assembly


N7A0063E

2. Release Bearing Assembly

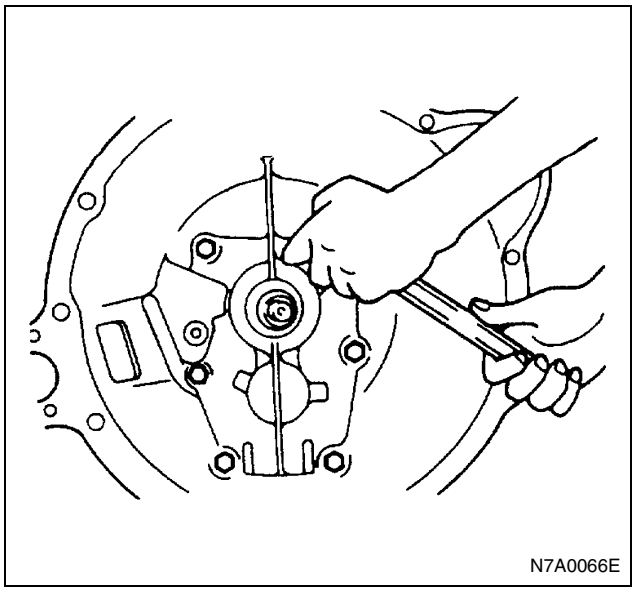

N7A0064E

3. Shift Fork and Support Bolt


N7A0065E

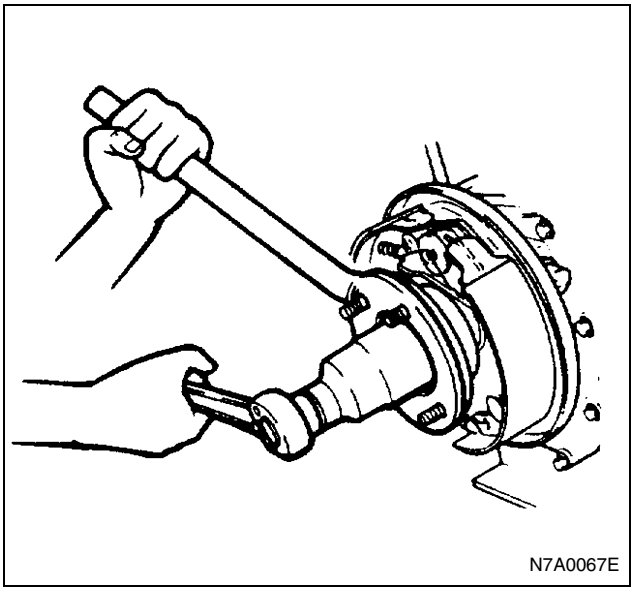
4. Clutch Housing
   - Remove the clutch housing from the transmission case.
   - Use the screwdriver to remove the oil seal from the clutch housing.

Caution:
Take care not to damage the sealing seat of the clutch housing.

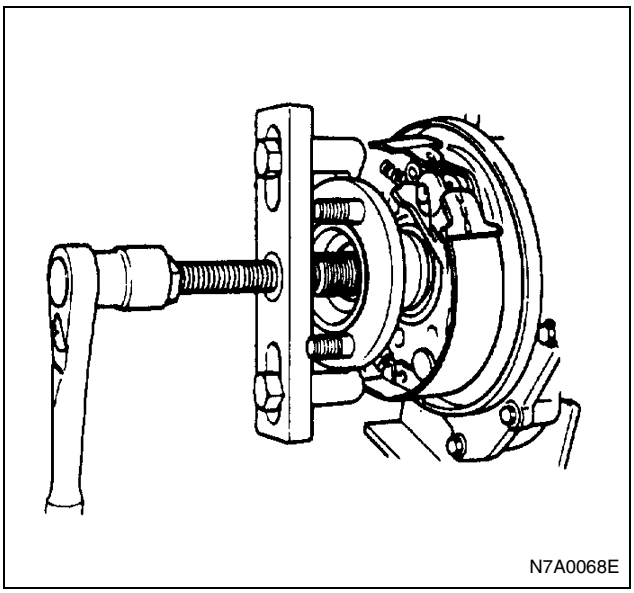

N7A0066E

5. Parking Brake Drum
   - Remove the screw and the adjust hole cover.
   - It may be necessary to back off the shoe adjuster.

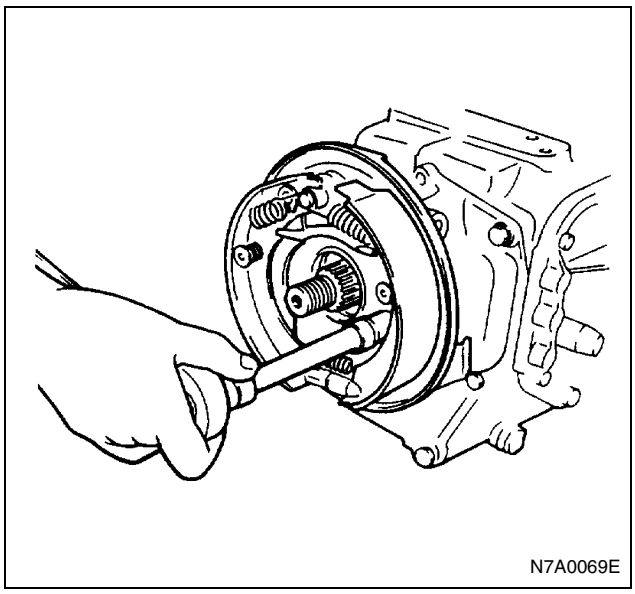
6. Lock Nut
   - Make sure to raise the caulking of the coupling driver lock nut.
   - Use the handle to remove the lock nut.
     Handle: 5-8840-2043-0

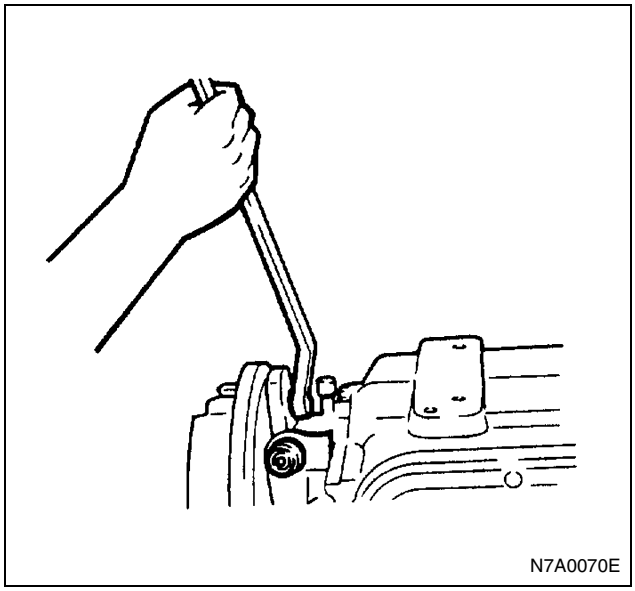

N7A0067E

7. Coupling Driver
   - Remove coupling driver using the universal puller.
     Universal Puller: 5-8840-2027-0
   - Remove the conical washer and the O-ring.

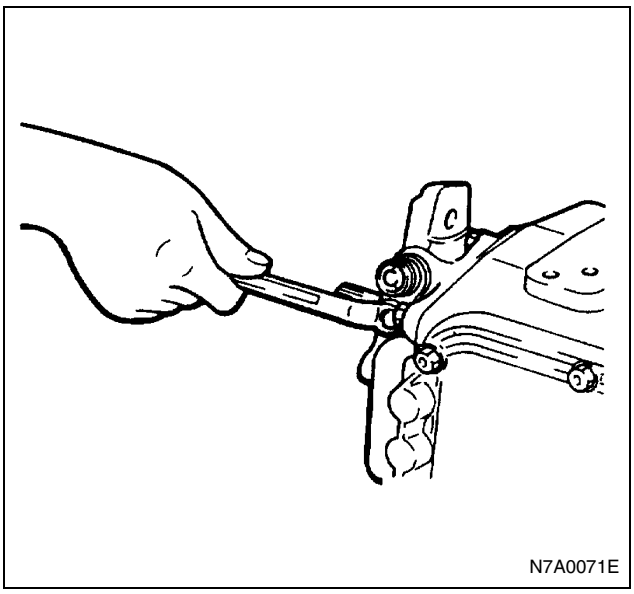

N7A0068E

8. Parking Brake Assembly

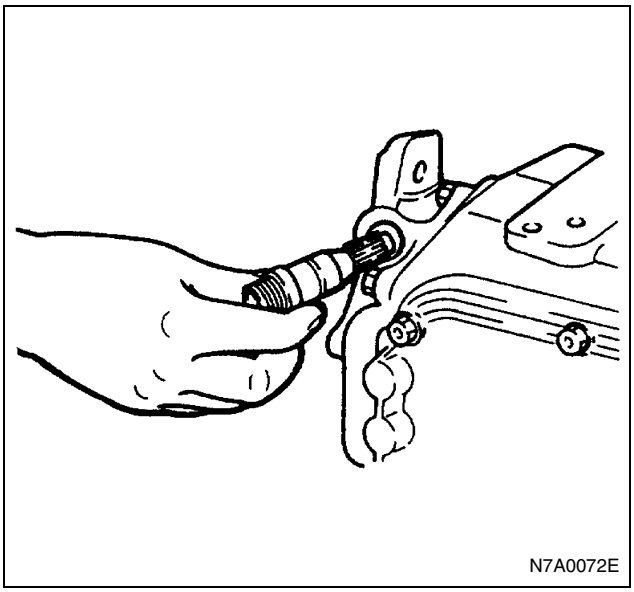

N7A0069E


N7A0070E

9. Vehicle Speed Sensor Driven Gear Assembly
   - Remove the vehicle speed sensor with the key rod.
   - Remove the fixing bolt.

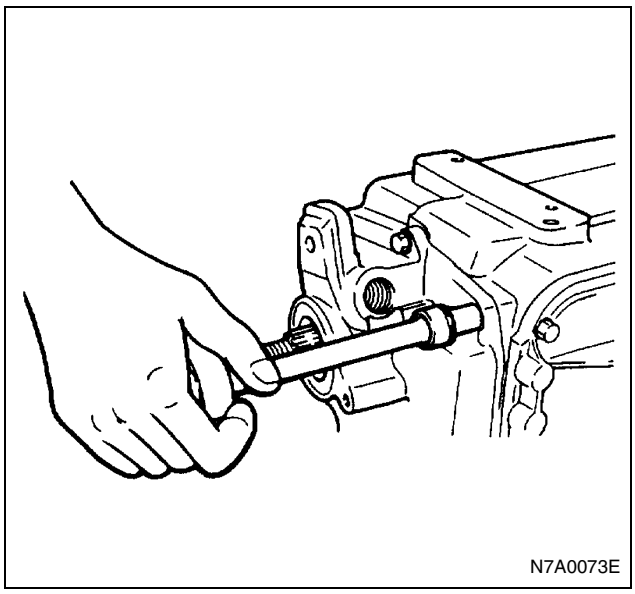


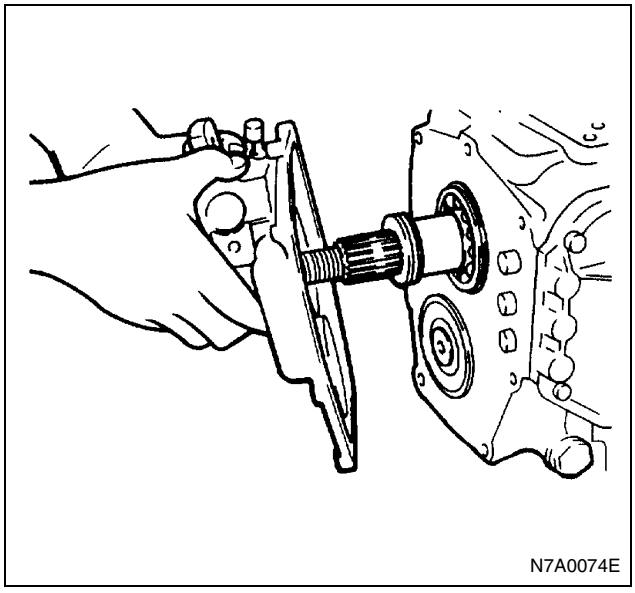
- Remove the driven gear assembly.



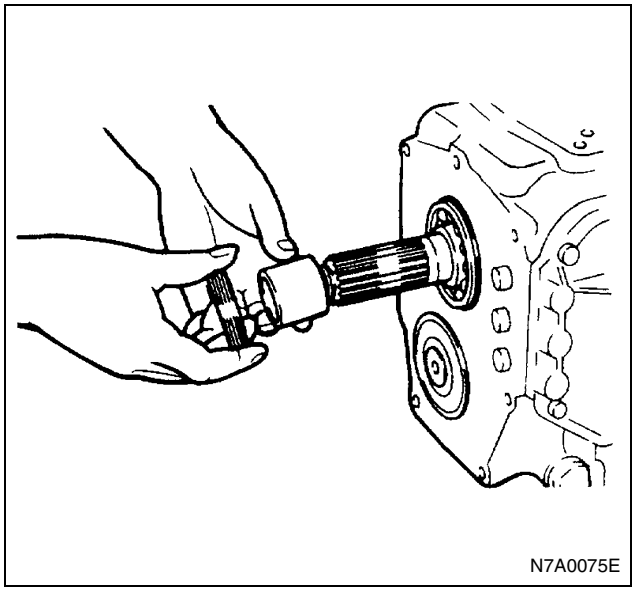
10. Rear Cover
    - Remove 7 fixing bolts. Tap the rear cover with a copper or plastic hammer to remove it. The rear cover is provided with lugs for hammering both side.
    - Remove the oil seal using the screwdriver.

Caution:
Take care not to damage the sealing seat of the rear cover with the screwdriver.



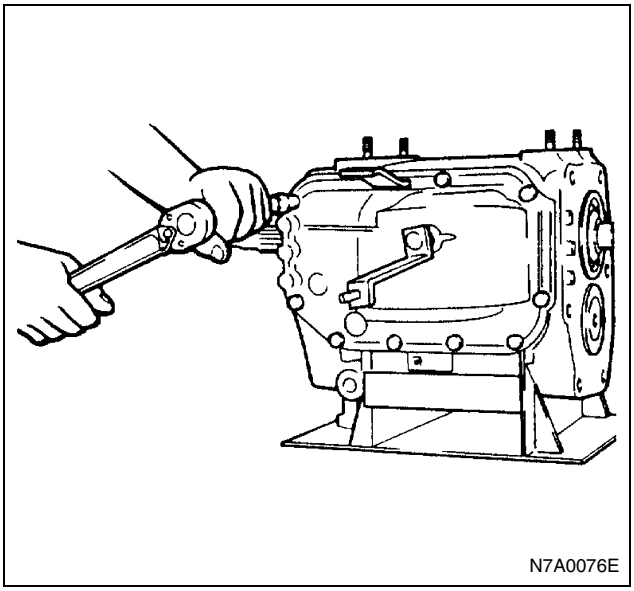


11. Vehicle Speed Sensor Drive Gear
12. Spacer

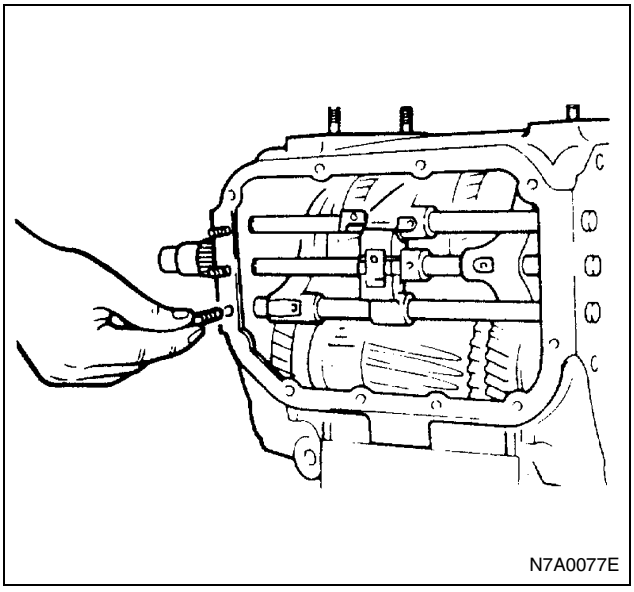


13. Control Box Assembly
    - Remove 10 control box fixing bolts, and then prize open the four corners of the control box with a screwdriver to remove the control box assembly.

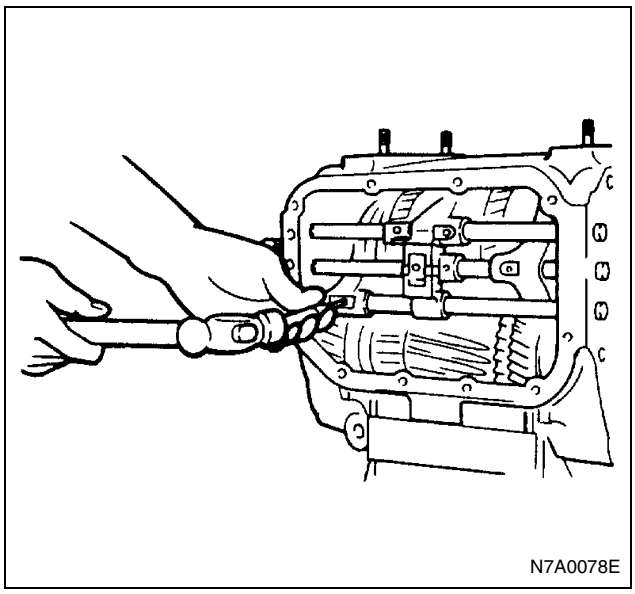
Notice:
Be careful not to lose the detent springs and balls of the transmission case.


N7A0076E

14. Detent Spring
15. Detent Ball
    - Take out the three detent springs and the three detent balls from the transmission case.

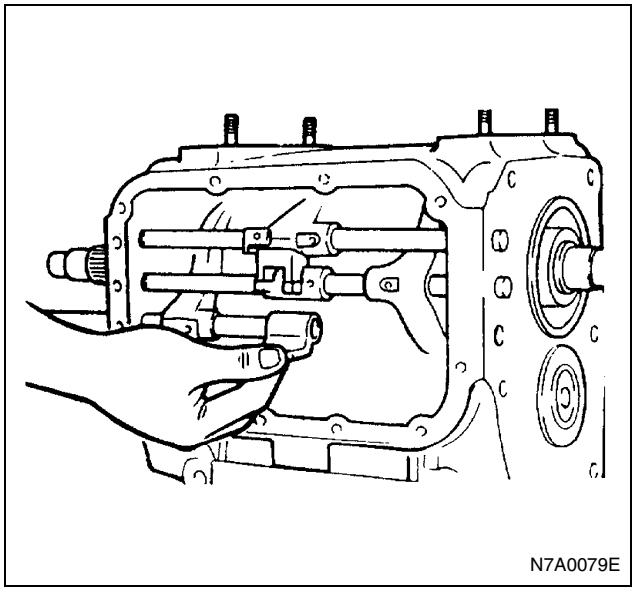

N7A0077E

16. Spring Pin
    - Before removal, set all shift rods in neutral position.
      Spring Pin Remover: 9-8529-2201-0

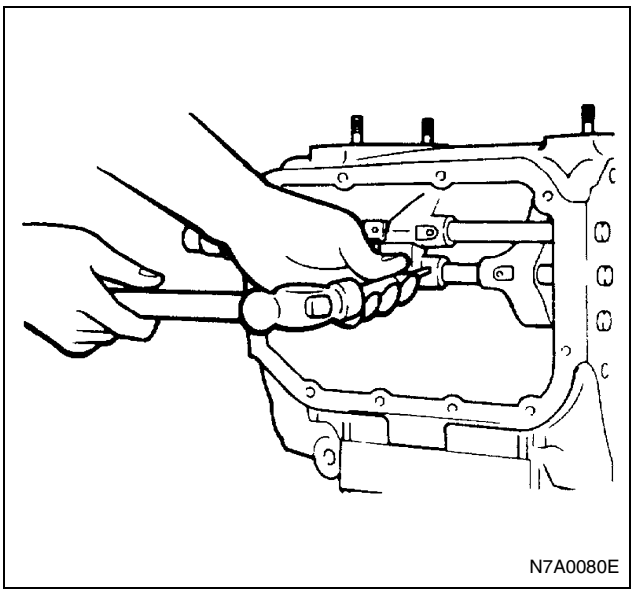

N7A0078E

17. 5th/Reverse Shift Block
18. 5th/Reverse Shift Rod
    - Move the 5th/reverse shift rod rearward and remove the shift block and shift rod.

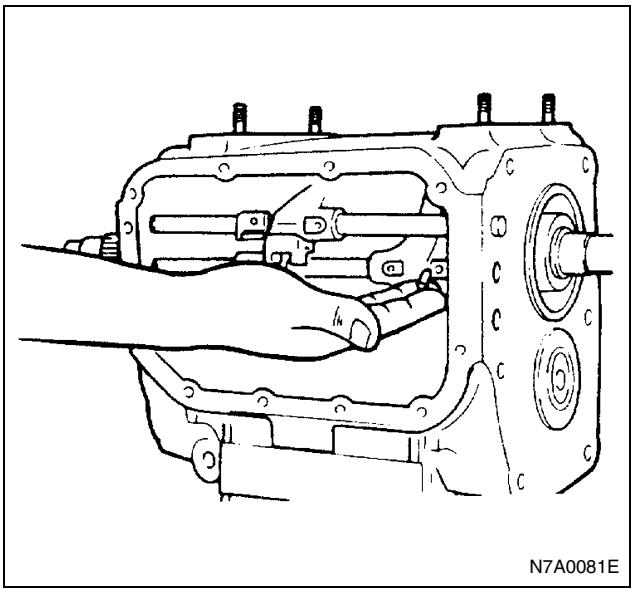
Notice:
When removing the parts, exercise care to prevent the interlock balls and pin fitted to the front part from falling apart.


N7A0079E

19. Spring Pin
    - Spring Pin Remover: 9-8529-2201-0


N7A0080E

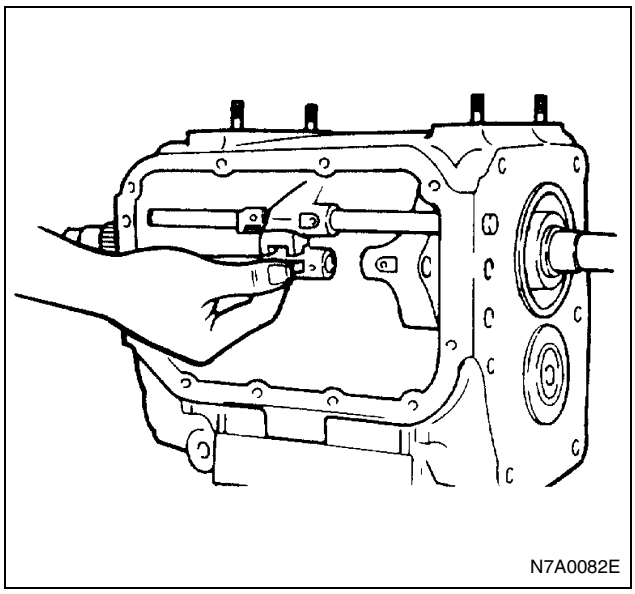
20. Interlock Pin
    - Move the 3rd/4th shift rod rearward by pushing its front end.
      Then take out the interlock pin from the 3rd/4th shift rod.
21. Interlock Ball
    - Take out the 2 interlock balls from the transmission case.


N7A0081E

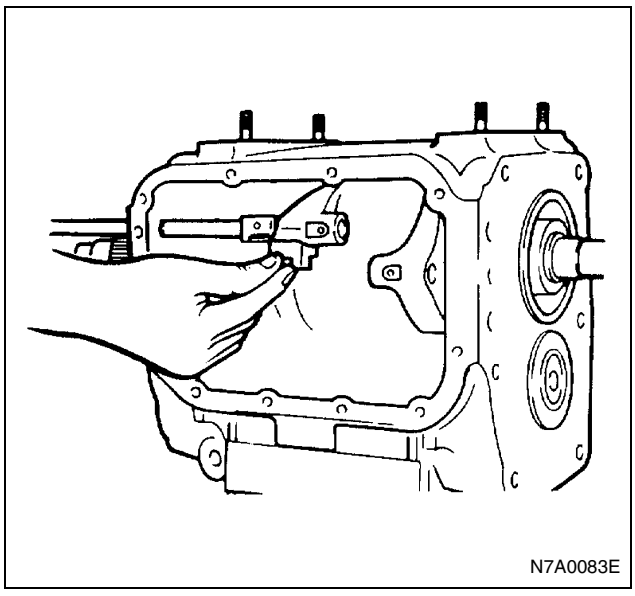
22. 3rd/4th Shift Block
23. 3rd/4th Shift Rod
    - Move the shift rod rearward and remove the shift block and shift rod.

Notice:
When removing the parts, exercise care to prevent the interlock balls fitted to the front part from falling apart.

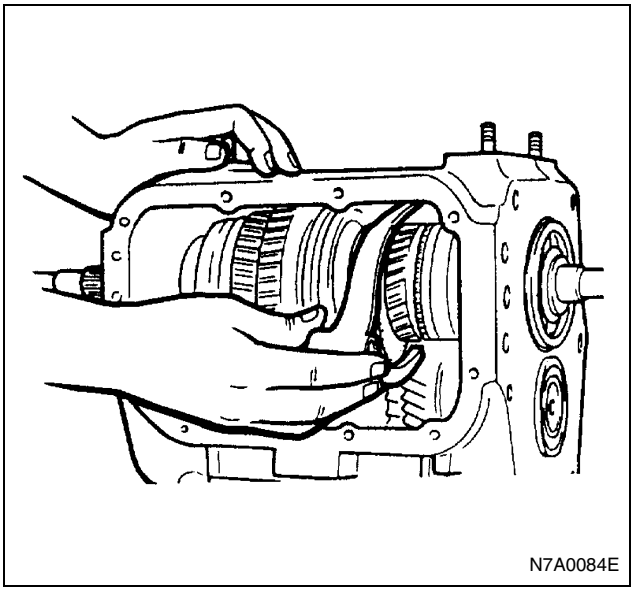
24. Spring Pin
    Spring Pin Remover: 9-8529-2201-0


N7A0082E

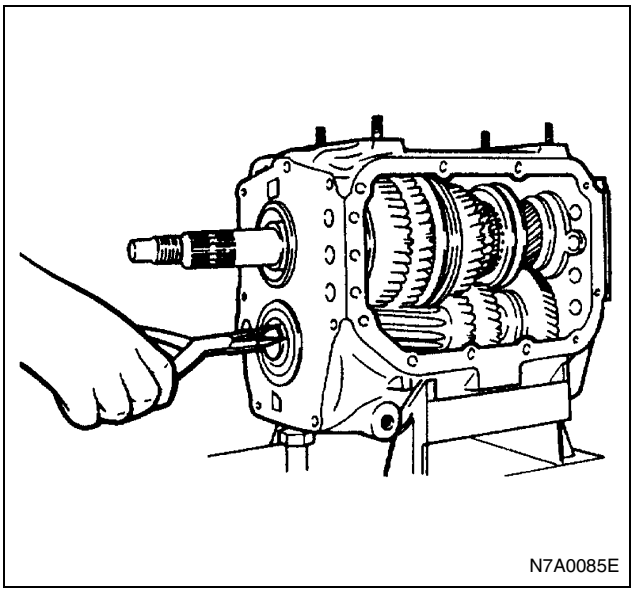
25. 1st/2nd Shift Block
26. 1st/2nd Shift Rod
    - Move the shift rod rearward and remove the shift block and shift rod.
27. Interlock Ball
    - Take out the 2 interlock balls from the transmission case.


N7A0083E

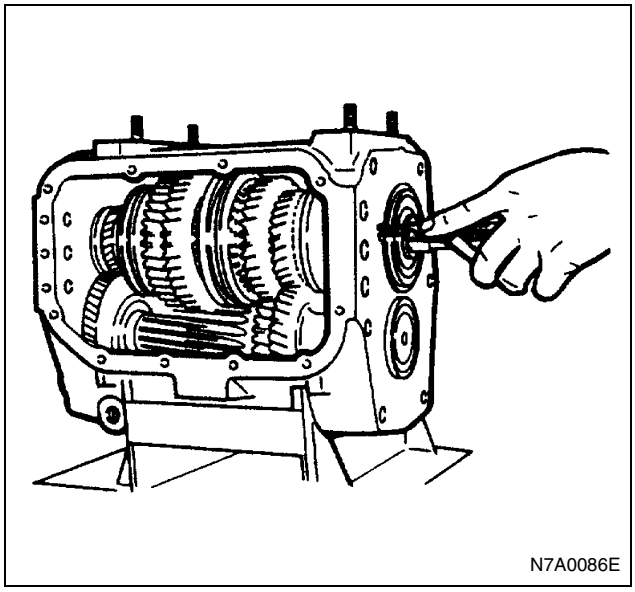
28. 5th/Reverse Shift Arm
29. 3rd/4th Shift Arm
30. 1st/2nd Shift Arm


N7A0084E

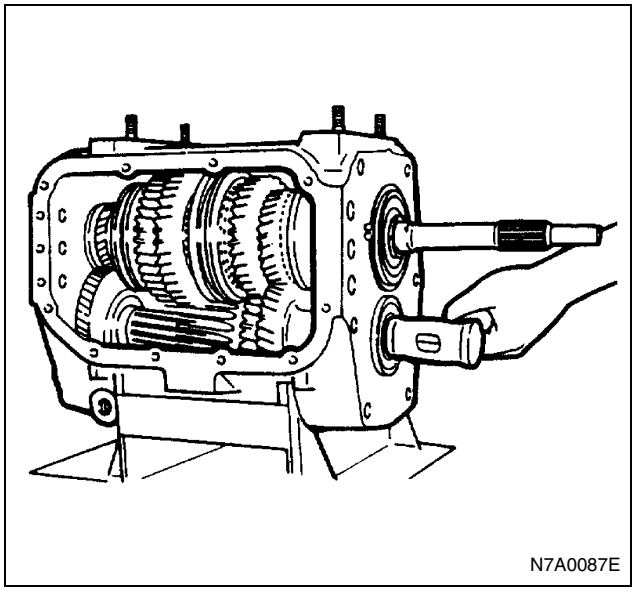
31. Counter Shaft Rear Bearing
    - Remove the snap ring from the counter shaft rear end.


N7A0085E

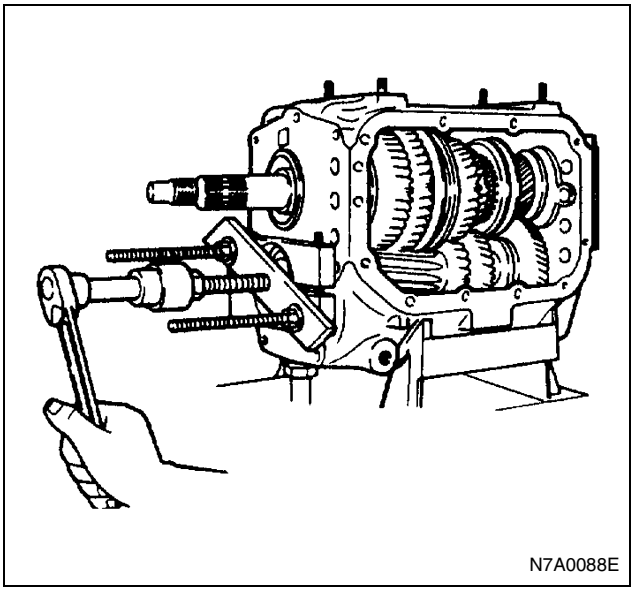
- Remove the snap ring from the top gear shaft bearing outer circumference.


N7A0086E

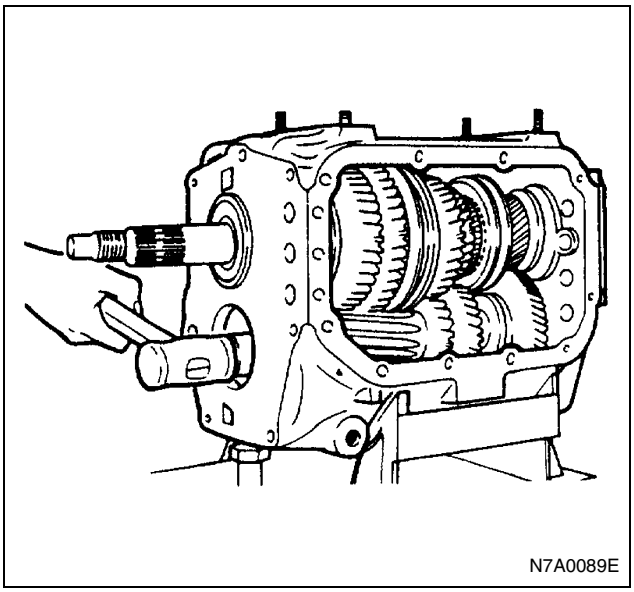
- Move the counter shaft approximately 3 mm (0.1 in) rearward by tapping on its front end with brass or plastic hammer.
- Remove the snap ring from the rear bearing outer circumference.


N7A0087E

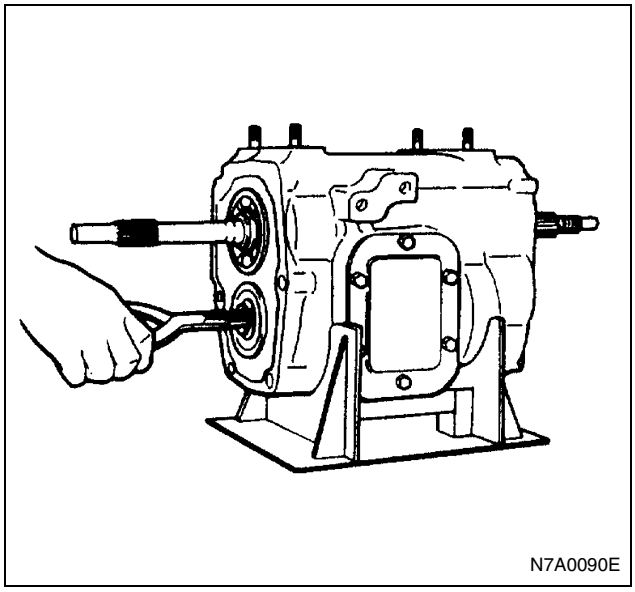
- Set the bearing remover to the snap ring groove to remove the rear bearing.
  Bearing Remover: 5-8840-2042-0
  Universal Puller: 5-8840-2027-0


N7A0088E

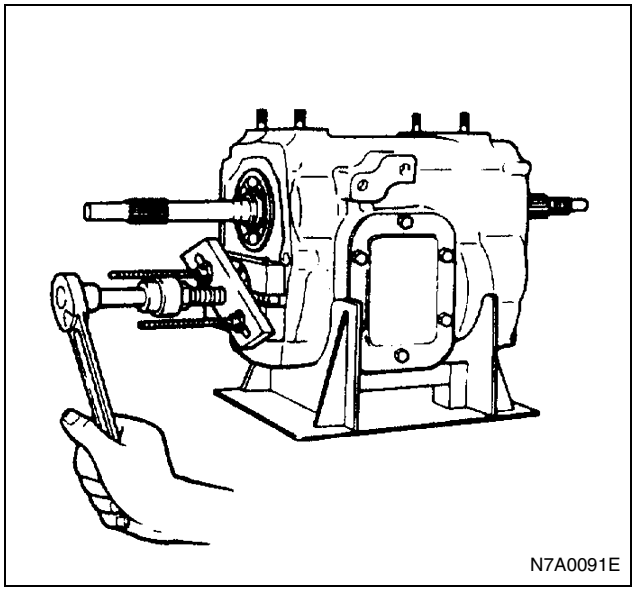
32. Counter Shaft Front Bearing
    - Move the counter shaft approximately 3 mm (0.1 in) forward by tapping on its rear end with brass or plastic hammer.


N7A0089E

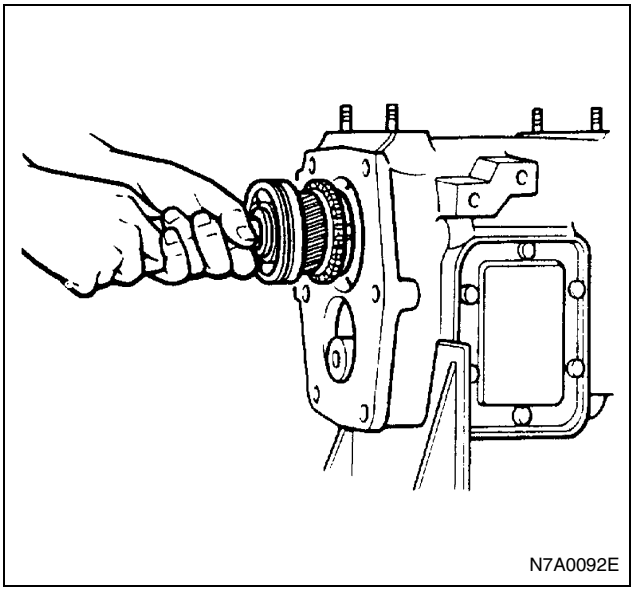
- Remove the snap ring from the counter shaft front end.


N7A0090E

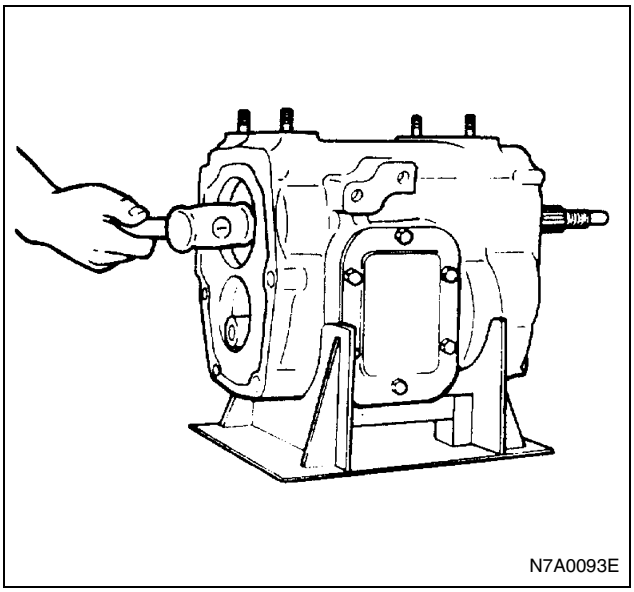
- Set the bearing remover to the snap ring groove to remove the front bearing.
  Bearing Remover: 5-8840-2078-0
  Universal Puller: 5-8840-2027-0


N7A0091E

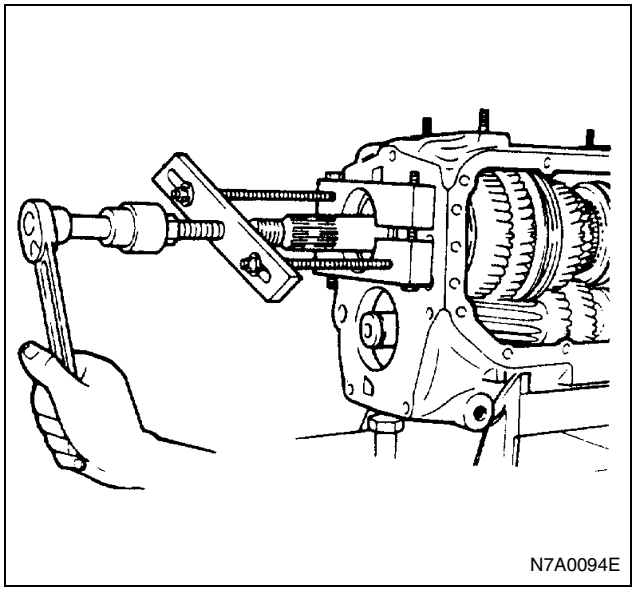
33. Top Gear Shaft Assembly
    - Remove the top gear shaft bearing outer race toward front end using a hammer and soft metal bar.
    - Remove the block ring and needle bearing.



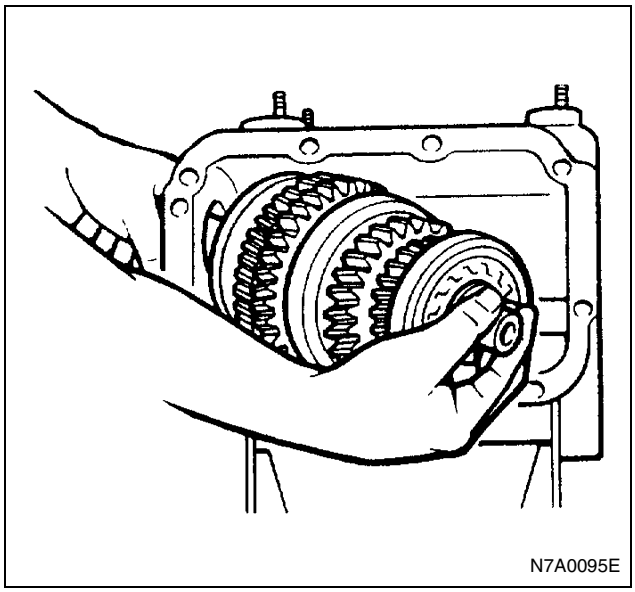
34. Main Shaft Rear Bearing
    - Move the main shaft approximately 3 mm (0.1 in) rearward by tapping on its front end with brass or plastic hammer.



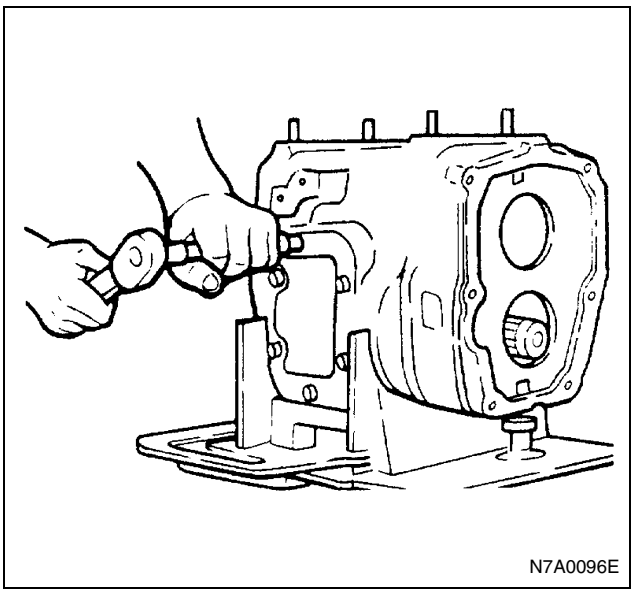
    - Remove the snap ring and set the bearing remover to the snap ring groove to remove the bearing.
      Bearing Remover: 5-8840-2078-0
      Universal Puller: 5-8840-2027-0



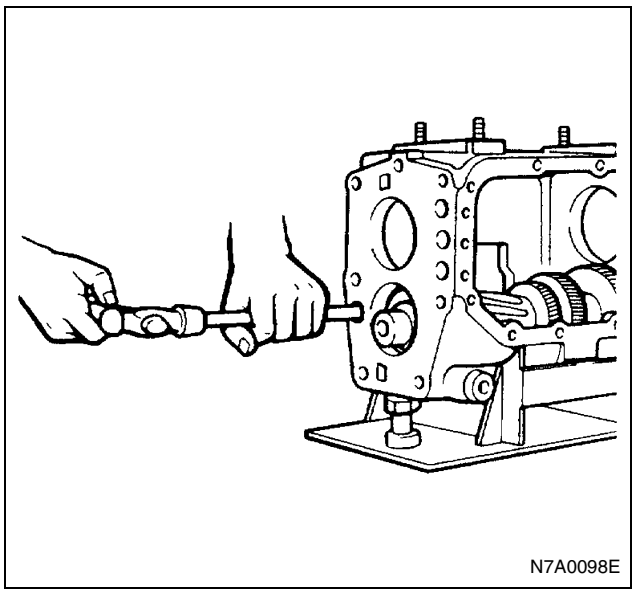
35. Main Shaft Assembly
    - Take main shaft assembly out from the transmission case.



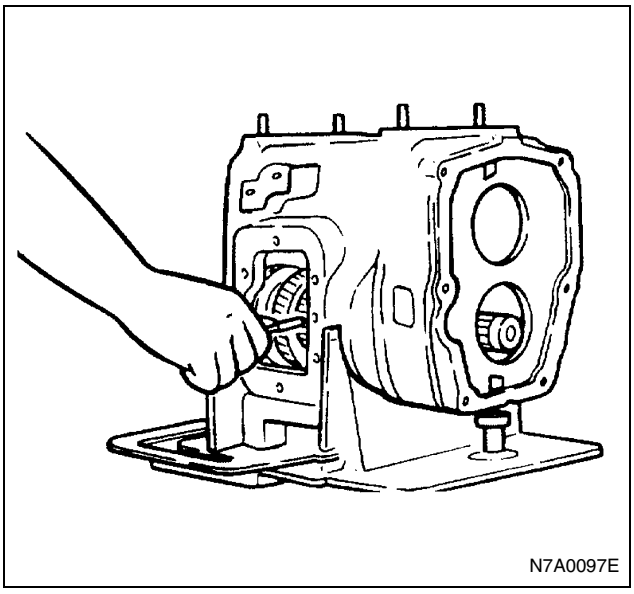
36. Side Cover



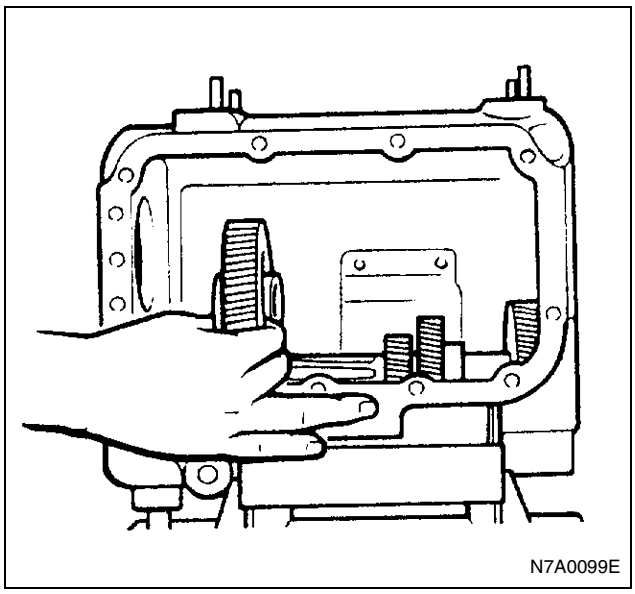
37. Reverse Idle Gear Shaft
    - Take out the pin of reverse idle gear shaft from the transmission case.



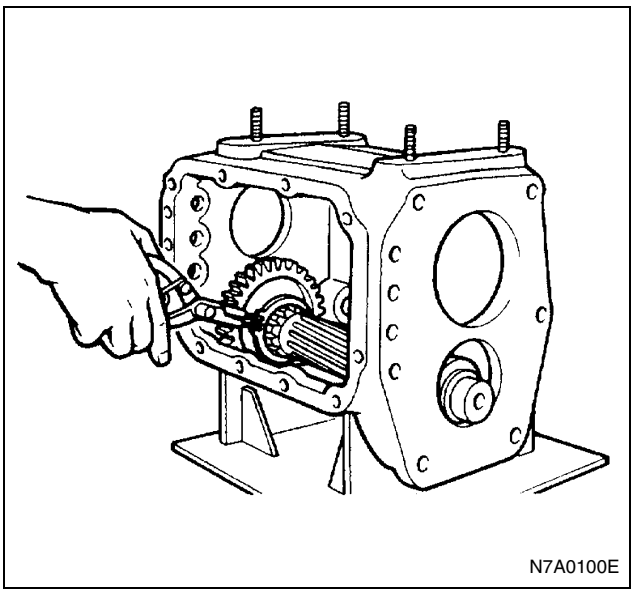
38. Reverse Idle Gear
39. Thrust Washer
40. Conical Spring



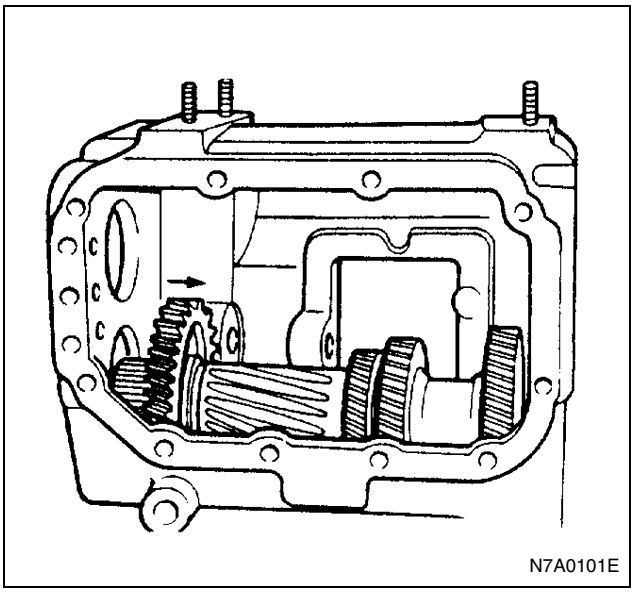
- Drive out the reverse idle gear shaft inward the transmission case, with a suitable bar at the end of reverse gear shaft.



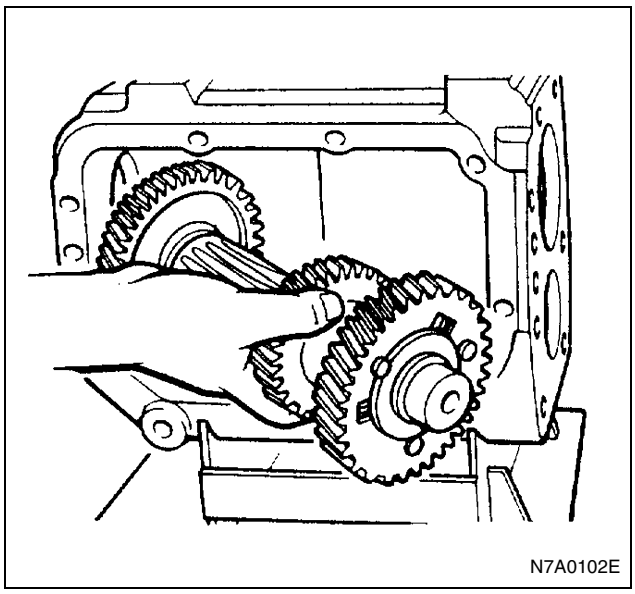
41. Counter Shaft Assembly
    - Remove the snap ring of the counter 5th gear and place aside inward temporarily.


N7A0100E

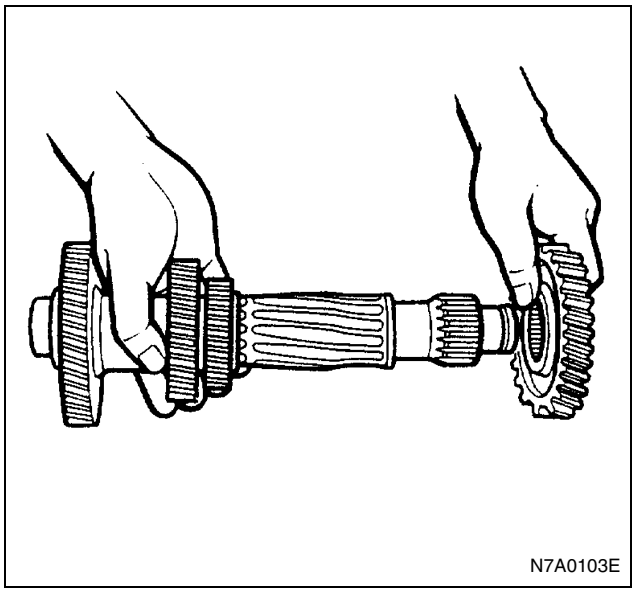
- Move the counter 5th gear inward and take it out together with the counter shaft assembly.


N7A0101E

- Remove the counter shaft assembly from the transmission case.


N7A0102E

- Remove the counter 5th gear and the snap ring from the counter shaft.


N7A0103E

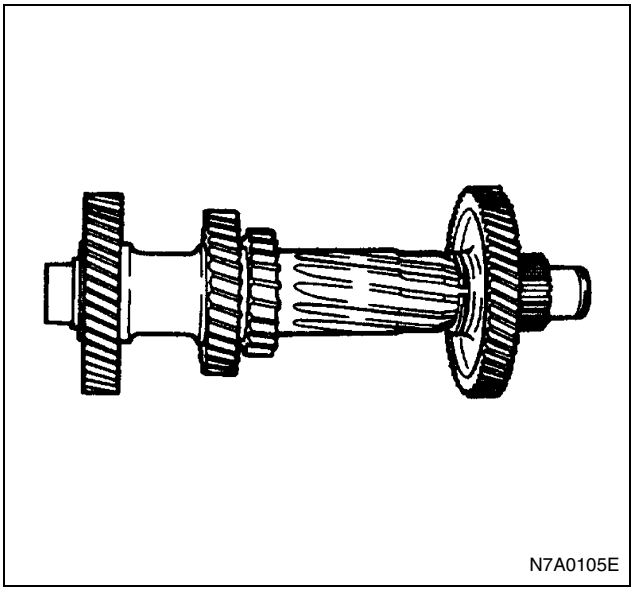
Reassembly

Notice:

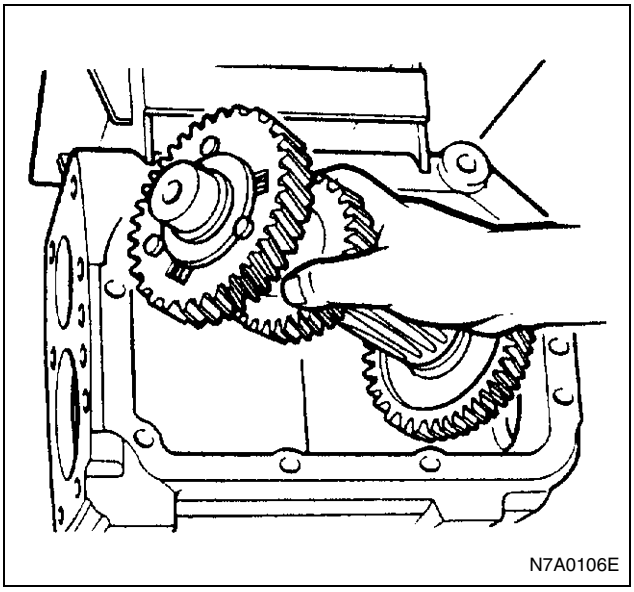
Clean each part thoroughly.

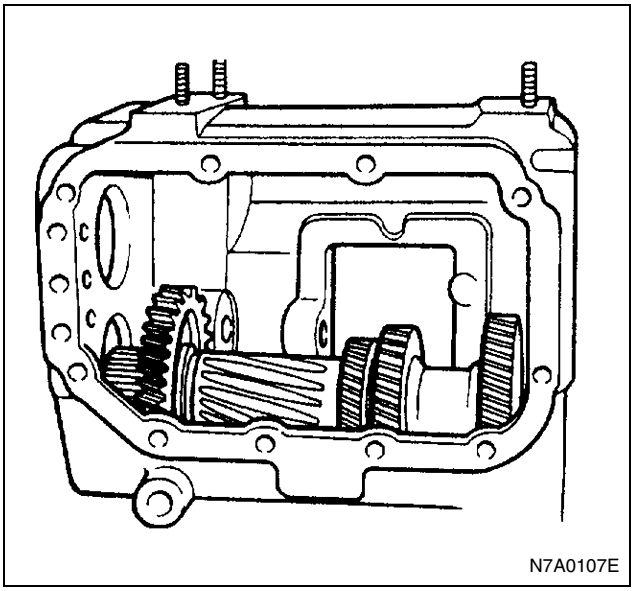
When assembling parts, apply clean engine oil (SAE 5W-30) to their sliding and mating sections.

1. Counter Shaft Assembly
   - Install the snap ring to the counter shaft and place it aside inward temporarily.
   - Then install the counter 5th gear and move it inward.

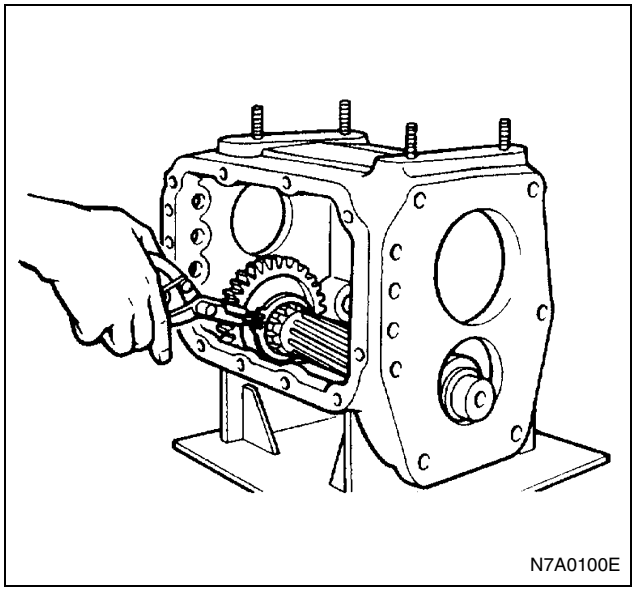

N7A0105E

- Install the counter shaft assembly in the transmission case.

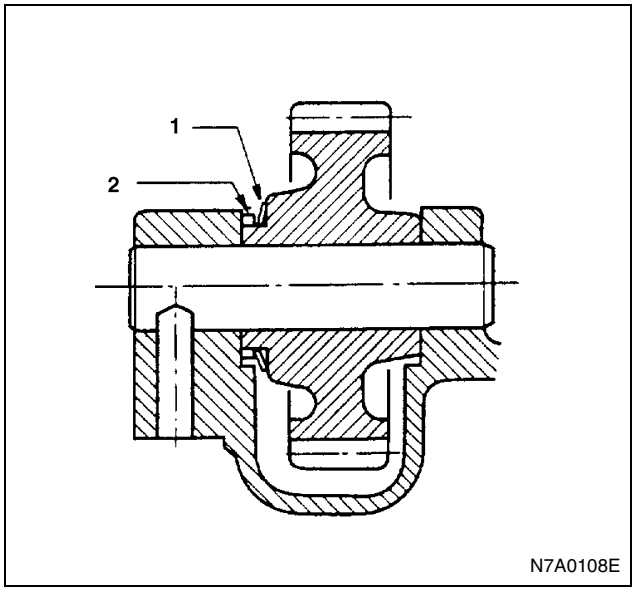

N7A0106E


N7A0107E

- Install the snap ring to fix the counter 5th gear.

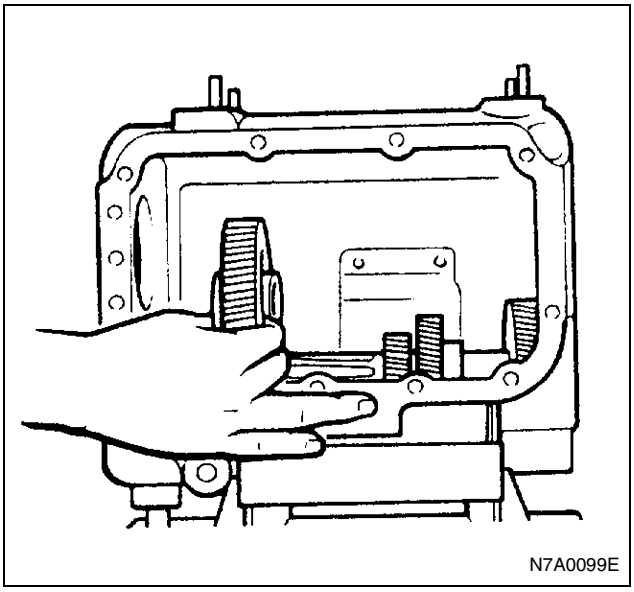

N7A0100E

2. Reverse Idle Gear
3. Conical Spring
4. Thrust Washer
   - Install the conical spring (1) and the thrust washer (2) to the reverse idle gear.
   - The conical spring is to be set up with its concave face to the gear side shown in the illustration.

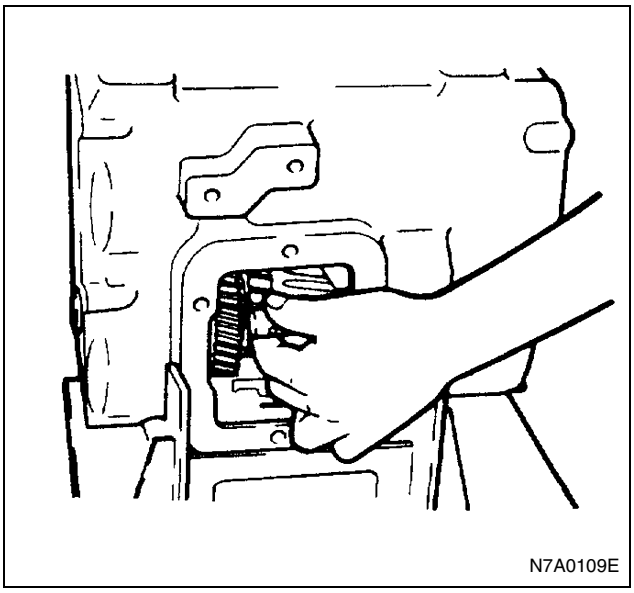


N7A0108E

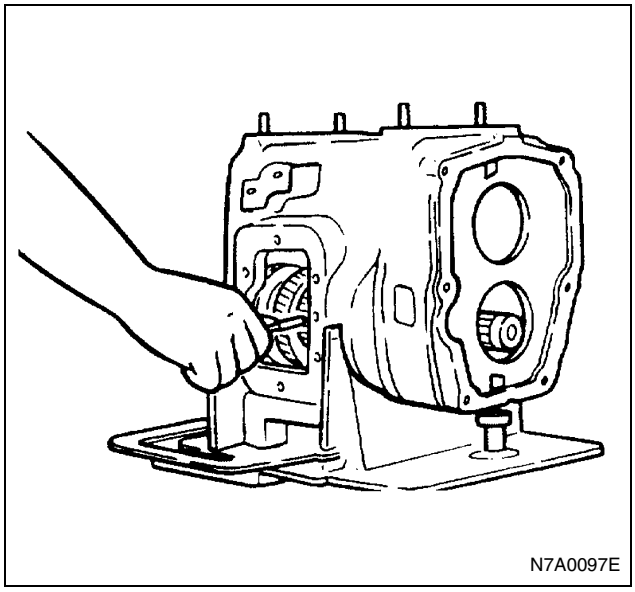
- The reverse idle gear should be installed with the thrust washer side turned to the forward.


N7A0099E

5. Reverse Idle Gear Shaft
   - Aligning the knock pin hole on the reverse idle gear shaft with its hole of the transmission case.

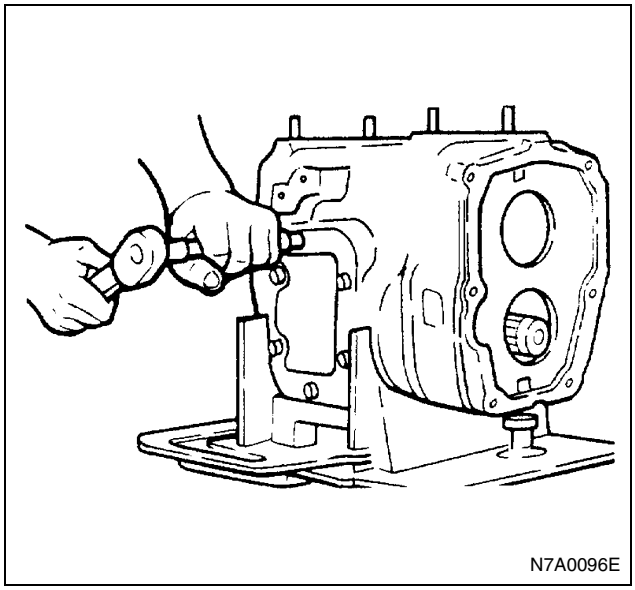

N7A0109E

- Then insert the knock pin.


N7A0097E

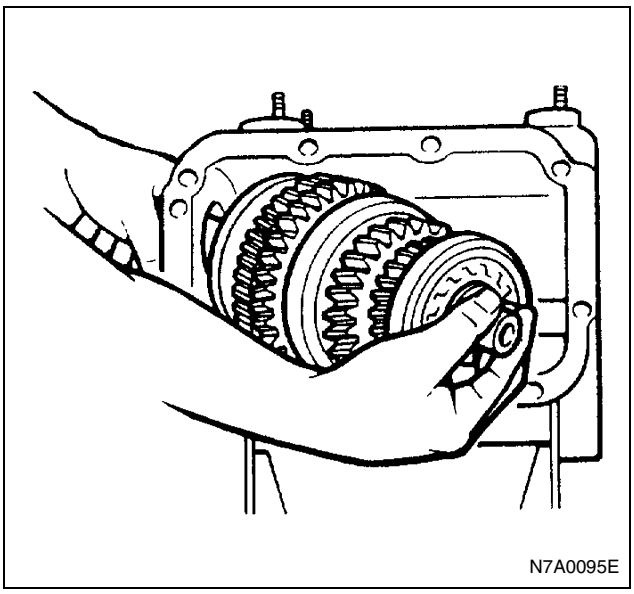
6. Side Cover
   - Install the side cover with new gasket.

Tighten:
Side cover bolt to 18 N·m (1.8 kg·m / 13 lb·ft)

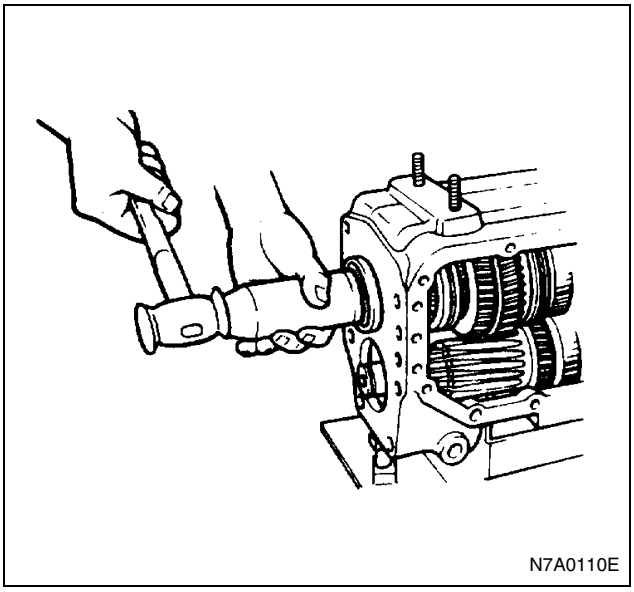

N7A0096E

7. Main Shaft Assembly

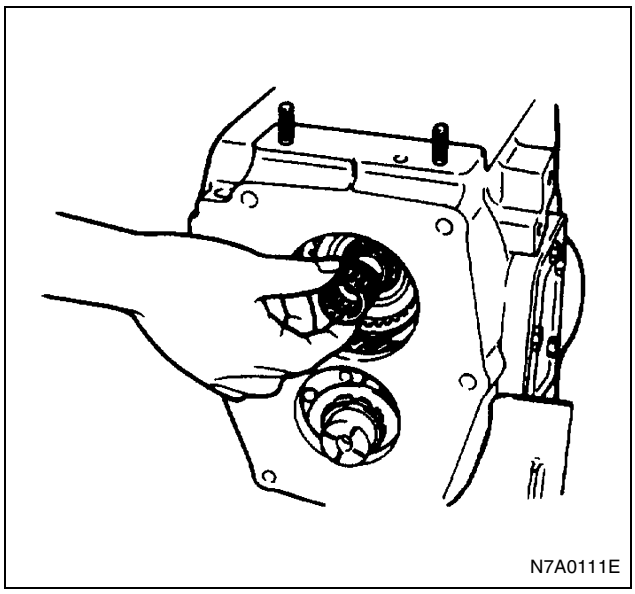
Notice:
Take care that the thrust washer of the reverse gear does not drop off.


N7A0095E

8. Main Shaft Rear Bearing
   - Install the snap ring to the rear bearing outer circumference.
   - Install the rear bearing using the bearing installer.
     Bearing Installer: 9-8522-1615-0
   - Check to be certain the block ring on the 5th gear side fitted properly to the inserts.


N7A0110E

9. Top Gear Shaft Assembly
   - Install the needle bearing to the top gear shaft.
   - Install the top gear shaft assembly into the transmission case.
   - Check to be certain the block ring on the 4th gear side fitted properly to the inserts.
   - Press in the bearing until the snap ring of the bearing outer circumference comes into contact with the transmission case.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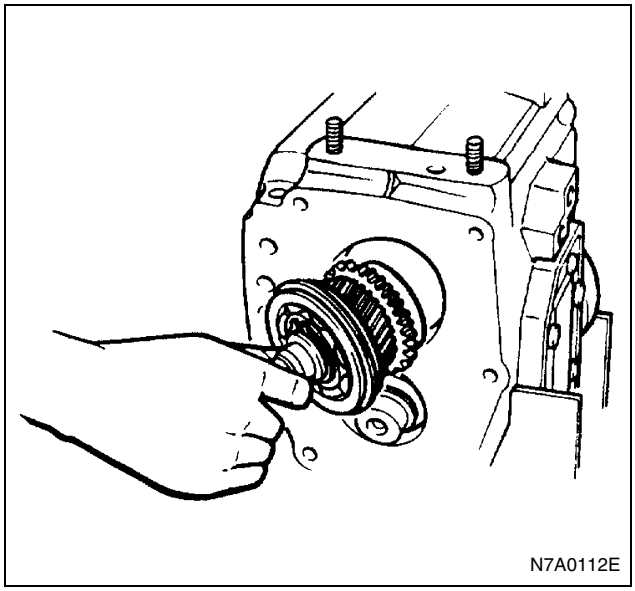
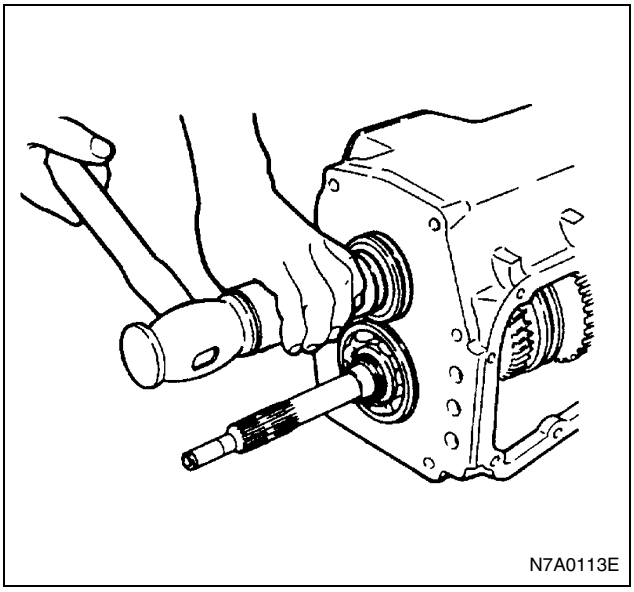

N7A0112E

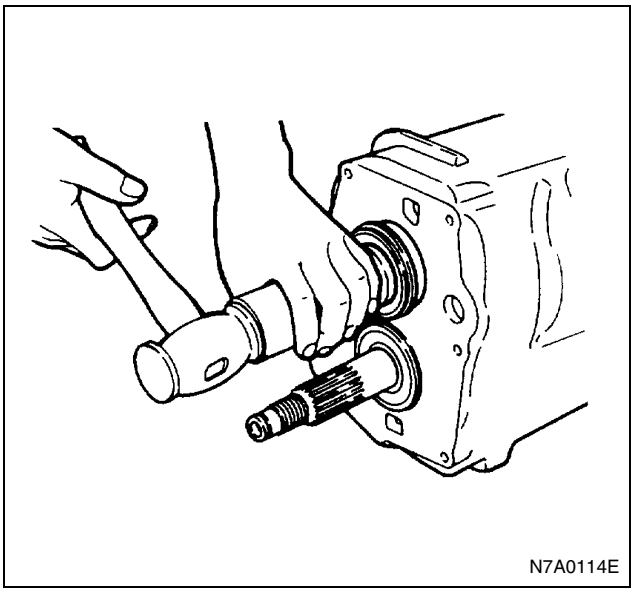
10. Counter Shaft Front Bearing
    - Use the bearing installer to install the front bearing.
      Bearing installer: 5-8840-2244-0
    - Install the counter shaft snap ring.

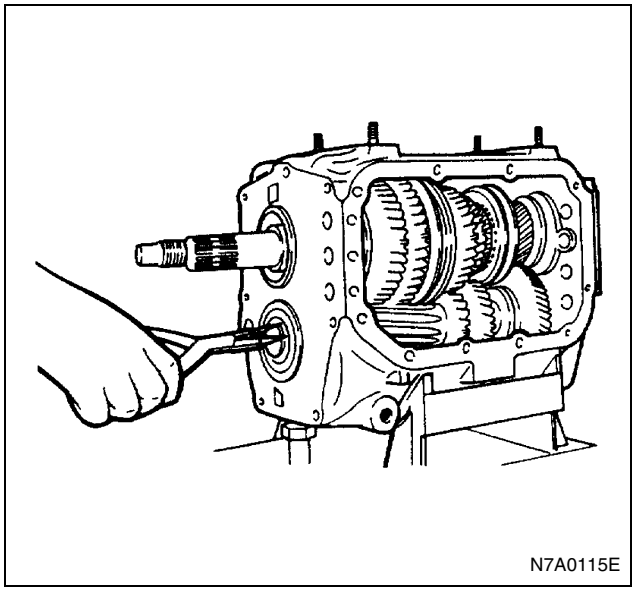

N7A0113E

11. Counter Shaft Rear Bearing
    - Install the snap ring to the rear bearing outer circumference.
    - Install the rear bearing using bearing installer and install the snap ring.
      Bearing Installer: 5-8840-2244-0

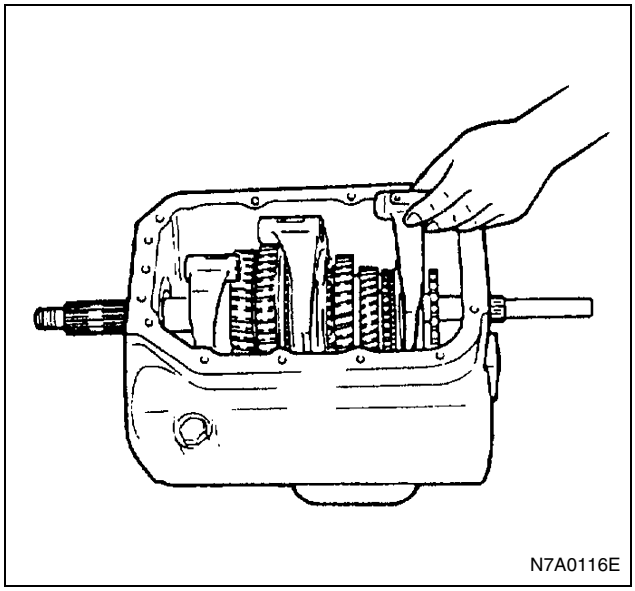
Notice:
With each gear set to the neutral position, check to see if the shaft and each gear rotate smoothly.

Check to see if each block ring is free. When it gets caught and stuck in the taper cone, use a screwdriver to make it free.

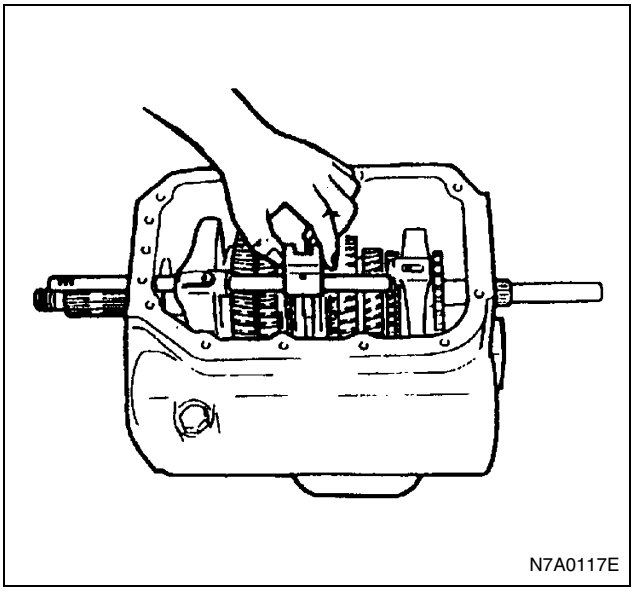

N7A0114E


N7A0115E

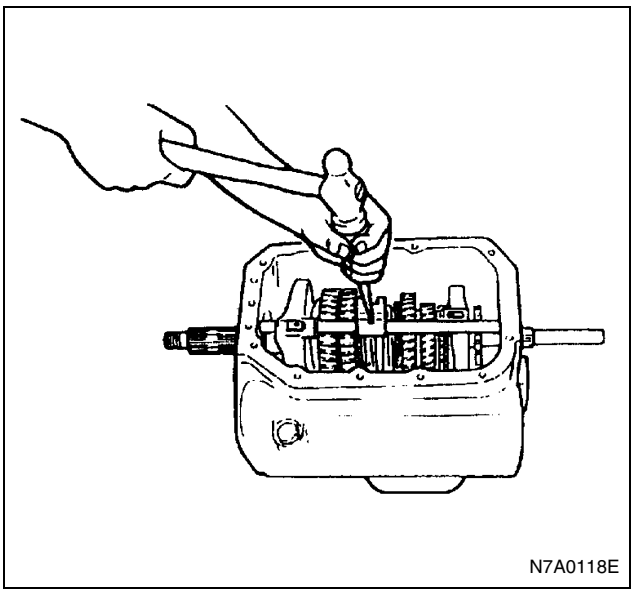
12. 1st/2nd Shift Arm
    - With the longer boss side set to the front.
13. 3rd/4th Shift Arm
    - With the longer boss side set to the rear.
14. 5th/Reverse Shift arm
    - With the longer boss side set to the front.


N7A0116E

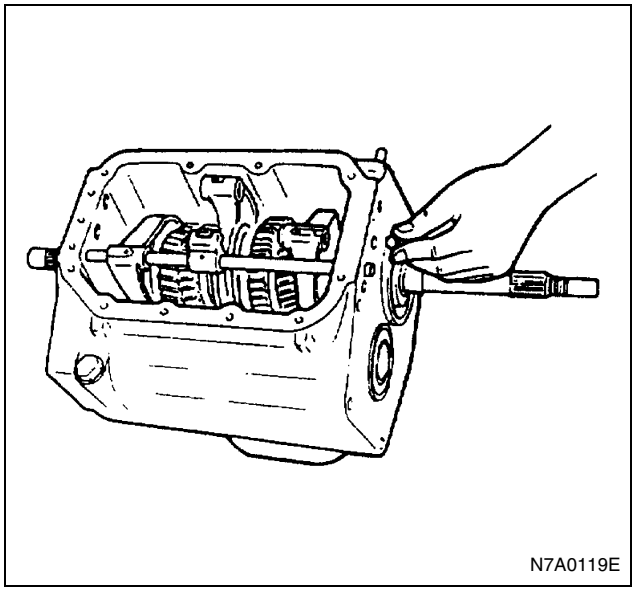
15. 5th/Reverse Shift Rod
16. 5th/Reverse Shift Block
    - Turning the detent groove to the outside (detent ball side), insert the shift rod from the rear side with the detent groove side at the rear.


N7A0117E

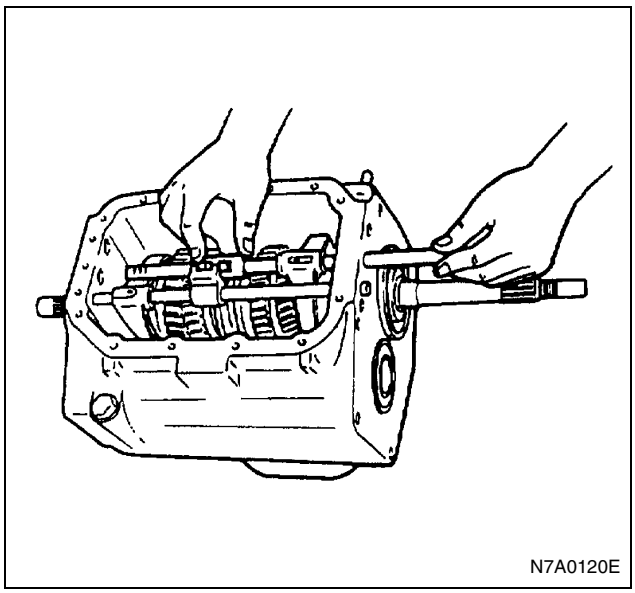
17. Spring Pin
    - Setting the hole of the shift arm and shift block to that of the shift rod, fix them with a new spring pin.
    - Install spring pin properly with the slit in line with the shaft center line.


N7A0118E

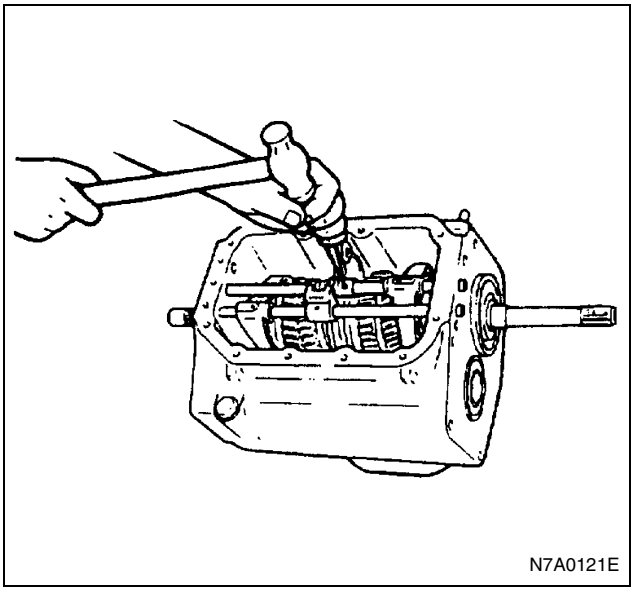
18. Interlock Ball
    - Apply small amount of multi-purpose grease to the interlock balls.
    - Install the 2 interlock balls in position between the 5th/reverse shift rod and 3rd/4th shift rod.


N7A0119E

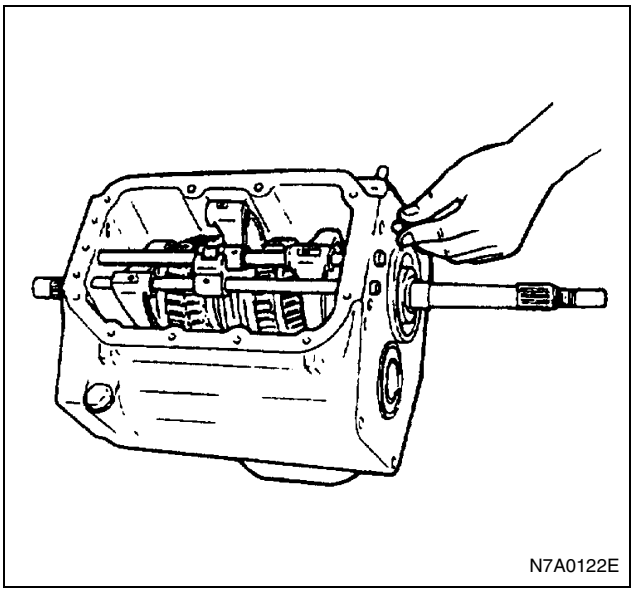
19. Interlock Pin
20. 3rd/4th Shift Rod
21. 3rd/4th Shift Block
    - Apply small amount of multi-purpose grease to the interlock pin.
    - Insert an interlock pin into the 3rd/4th shift rod.
    - Turning the detent groove to the outside (detent ball side), insert the shift rod from the front side with the detent groove side at the front.


N7A0120E

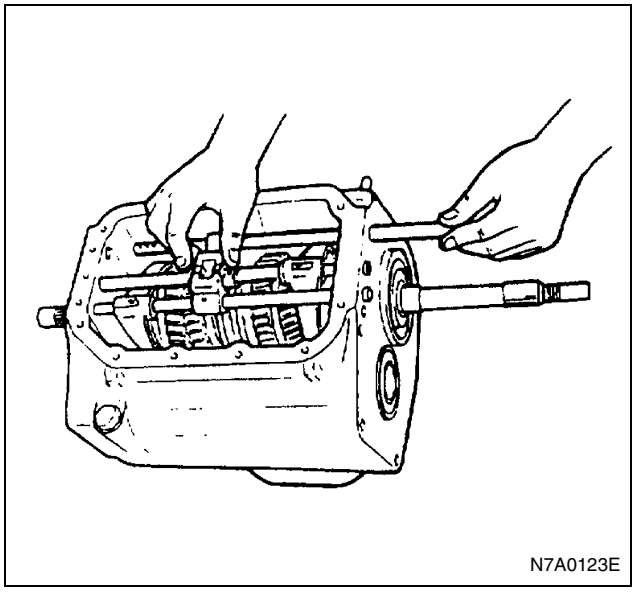
22. Spring Pin
    - Setting the hole of the shift arm and shift block to that of the shift rod, fix them with a new spring pin.
    - Install spring pin properly with the slit in line with the shaft center line.


N7A0121E

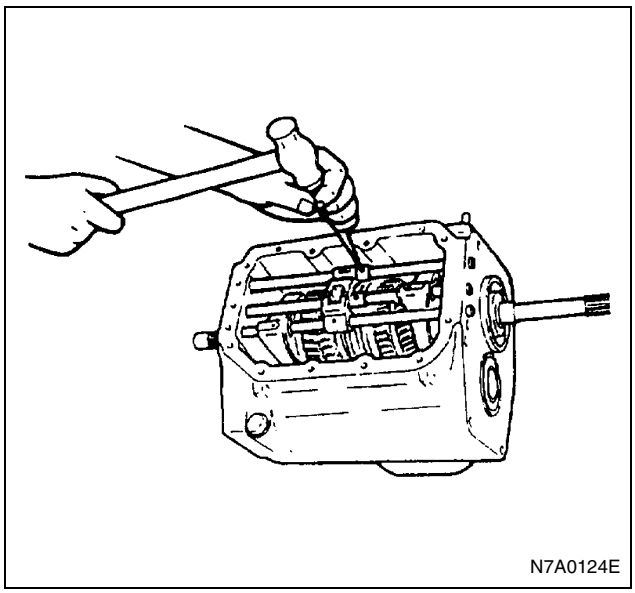
23. Interlock Ball
    - Apply small amount of multi-purpose grease to the interlock balls.
    - Install the 2 interlock balls in position between the 3rd/4th shift rod and 1st/2nd shift rod.


N7A0122E

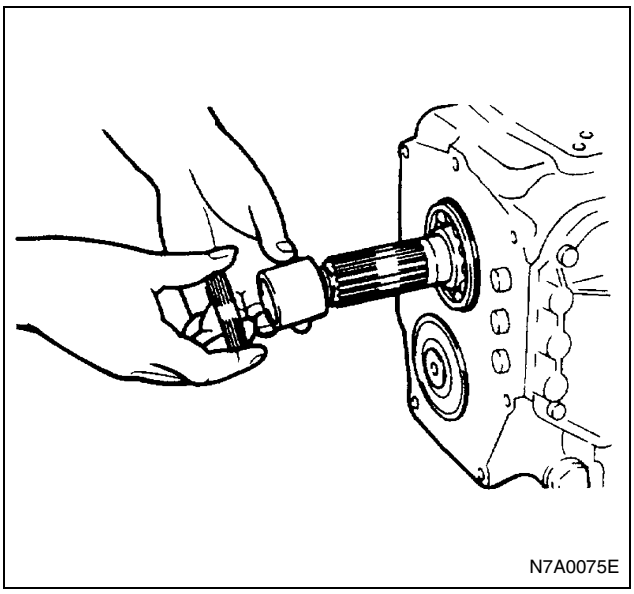
24. 1st/2nd Shift Rod
25. 1st/2nd Shift Block
    - Before reassembly, set the 5th/reverse and 3rd/4th shift rods already reassembled in neutral position.
    - Turning the detent groove to the outside (detent ball side), insert the shift rod from the front side with the detent groove side at the front.


N7A0123E

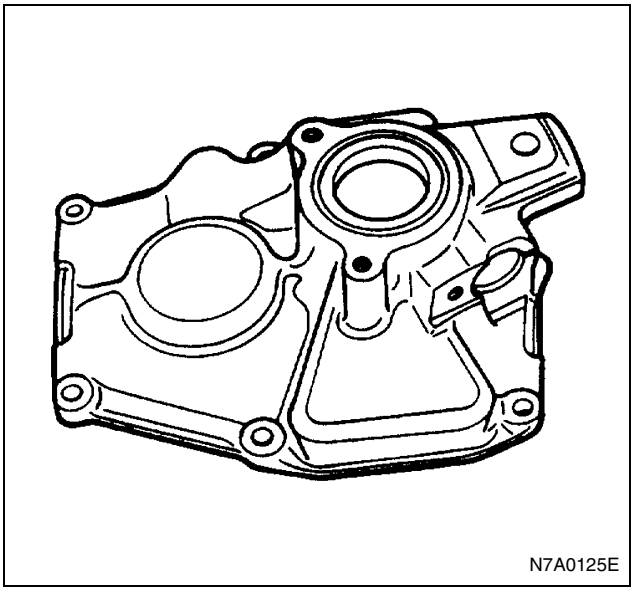
26. Spring Pin
    - Setting the hole of the shift arm and shift block to that of the shift rod, fix them with a new spring pin.
    - Install spring pin properly with the slit in line with the shaft center line.


N7A0124E

27. Spacer
28. Vehicle Speed Sensor Drive Gear

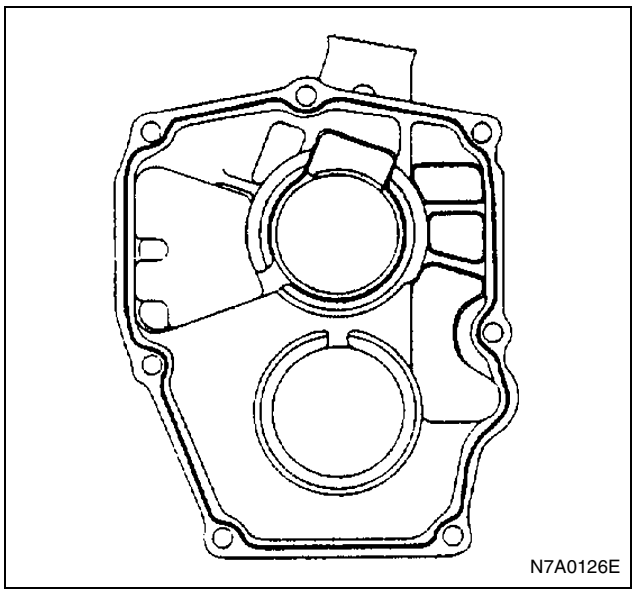

N7A0075E

29. Rear Cover
    - Apply engine oil to the new oil seal outer circumference and apply multi-purpose grease to the oil seal lip.
    - Use the oil seal installer to install oil seal to the rear cover.
      Oil Seal Installer: 5-8840-2242-0


N7A0125E

- Remove water and oil on the mating face before applying the liquid gasket.
- Apply a ϕ2 mm (0.1 in) bead of the liquid gasket (Three Bond 1215 or equivalent) to the rear cover surface shown in the illustration.

Caution:
Install the rear cover on the transmission case within 30 minutes after liquid gasket application.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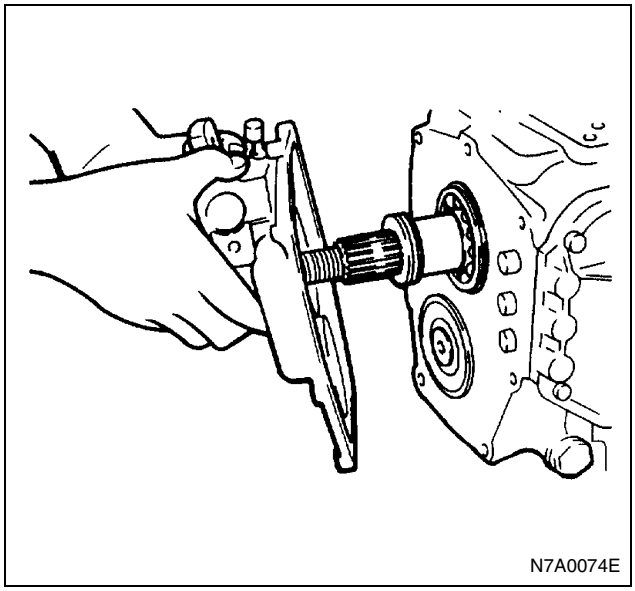
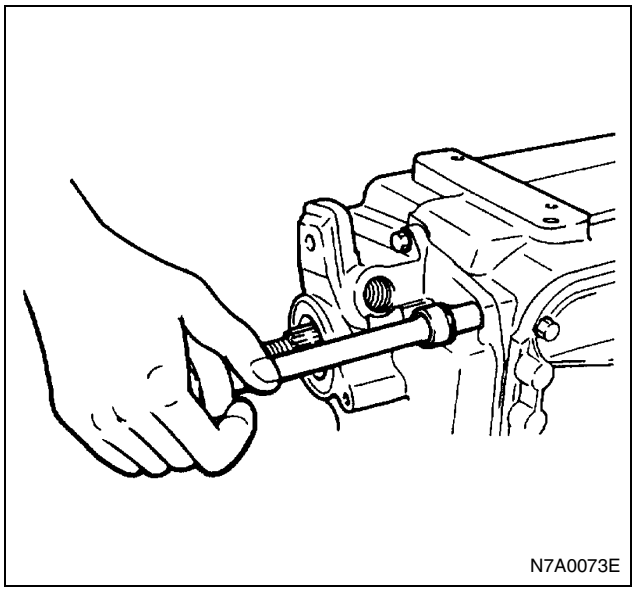
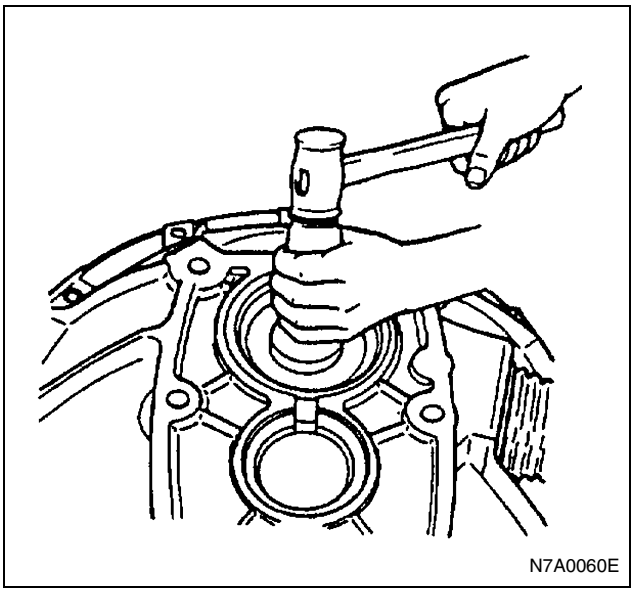

N7A0074E

Tighten:
Rear cover bolts to 20 N·m (2.0 kg·m / 14 lb·ft)

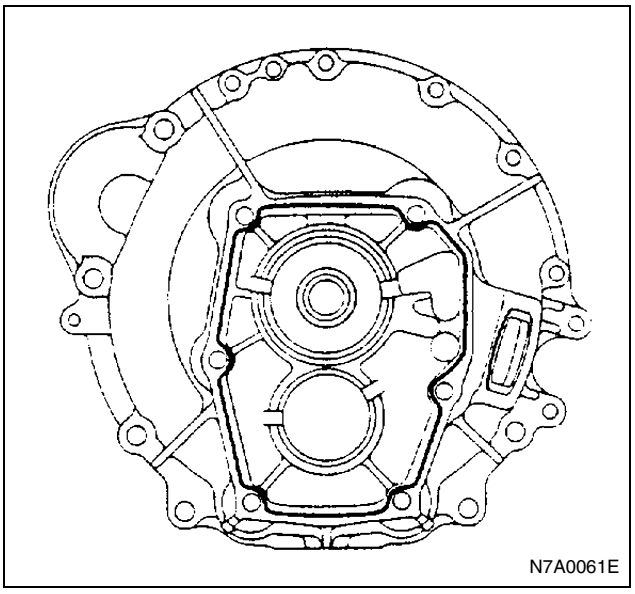

N7A0073E

30. Clutch Housing
    - Apply engine oil to the new oil seal outer circumference and apply multi-purpose grease to the oil seal lip.
    - Use the oil seal installer to install the oil seal to the clutch housing.
      Oil Seal Installer: 5-8840-2064-0

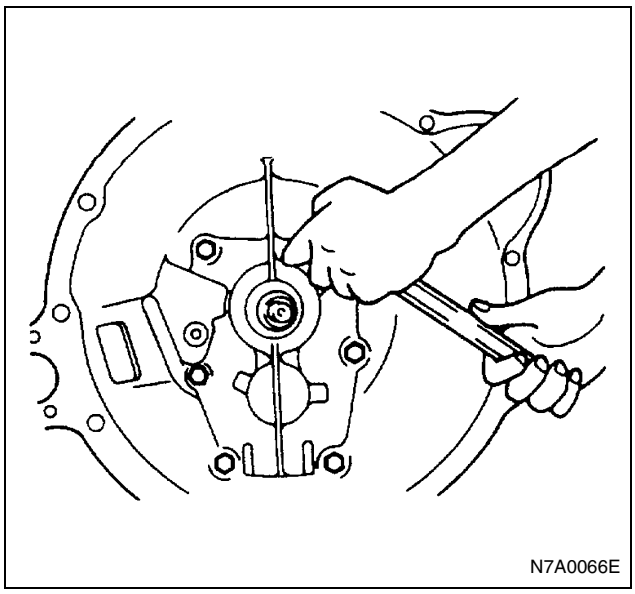

N7A0060E

- Remove water and oil on the mating face before applying the liquid gasket.
- Apply a ϕ2 mm (0.1 in) bead of the liquid gasket (Three Bond 1215 or equivalent) to the clutch housing surface shown in the illustration.

Caution:
Install the clutch housing on the transmission case within 30 minutes after liquid gasket application.


N7A0061E

Tighten:
Clutch housing to transmission case bolts to 81 N·m (8.3 kg·m / 60 lb·ft)

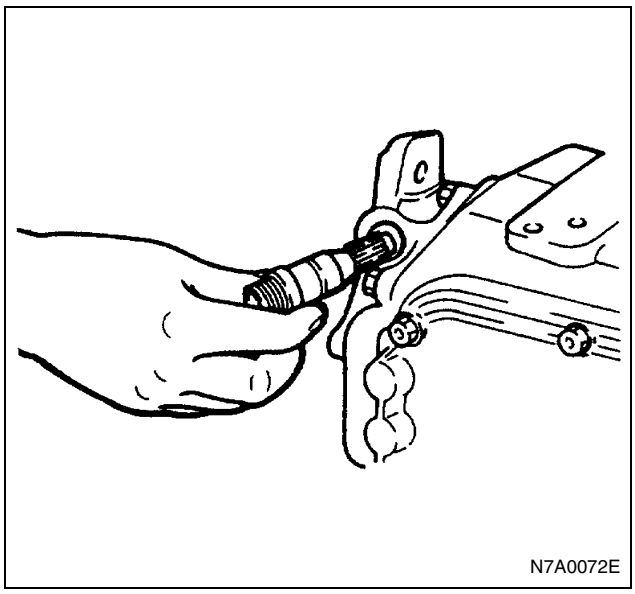

N7A0066E

31. Vehicle Speed Sensor Driven Gear Assembly

Tighten:
Driven gear lock plate bolt to 15 N·m (1.5 kg·m / 11 lb·ft)

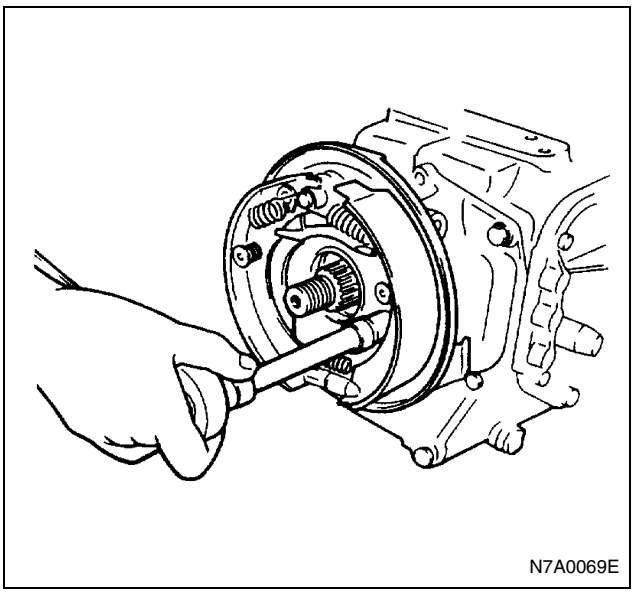
- Install the vehicle speed sensor with key rod.

Tighten:
Vehicle speed sensor to 25 N·m (2.5 kg·m / 18 lb·ft)

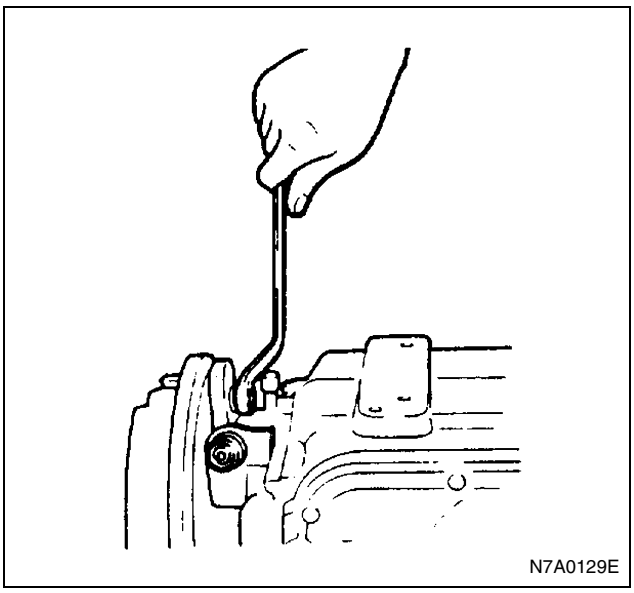

N7A0072E

32. Parking Brake Assembly

Tighten:
Parking brake bolts M8 to 25 N·m (2.6 kg·m / 19 lb·ft)


N7A0069E

Tighten:
Parking brake nut M12 to 113 N·m (11.5 kg·m / 83 lb·ft)

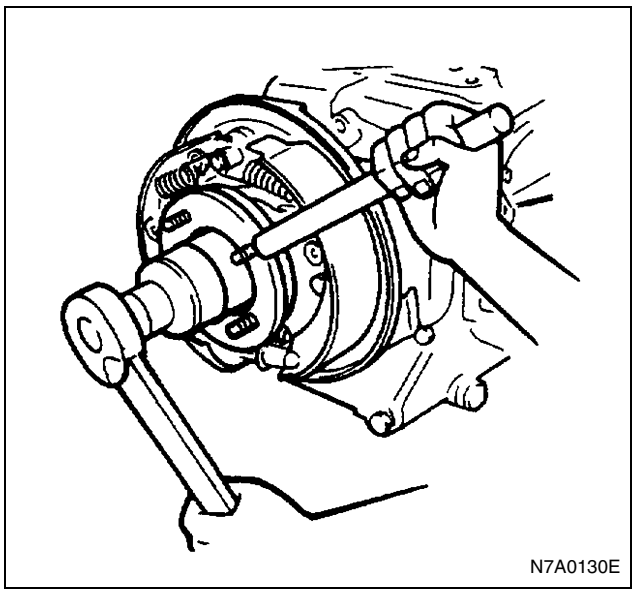

N7A0129E

33. Coupling Driver
34. Lock Nut
    - Install the O-ring and conical washer. The conical washer is to be set up with its identification groove to the nut side.
    - Apply the engine oil to the setting face of the new lock nut and tighten it up to the specified torque.

Caution:
Do not reuse the lock nut.

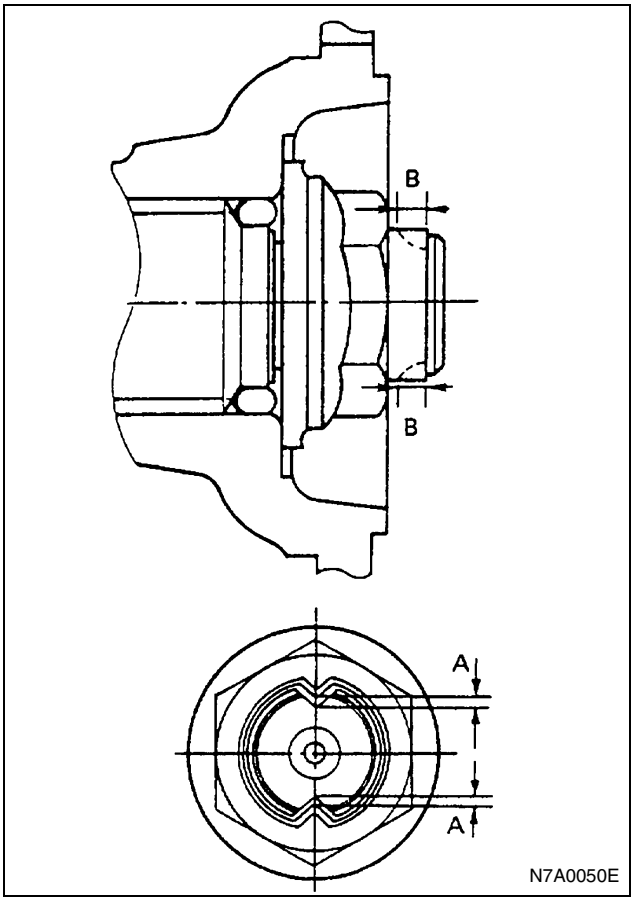
Handle: 5-8840-2043-0

Tighten:
Lock nut to 226 N·m (23.0 kg·m / 166 lb·ft)


N7A0130E

- Align the lock nut with the V-shaped groove at the tip of the main shaft, and caulk the nut lip portion by using a chisel. (Round edge approximately 1 mm (0.04 in) × 60°).
- As shown in the illustration, be sure to caulk the nut lip so that the clearance between the V-shaped groove portion at the tip of the main shaft and the caulked up lip (A) is less than 1.5 mm (0.06 in), and the caulking length (B) is 5 mm (0.2 in) or more.

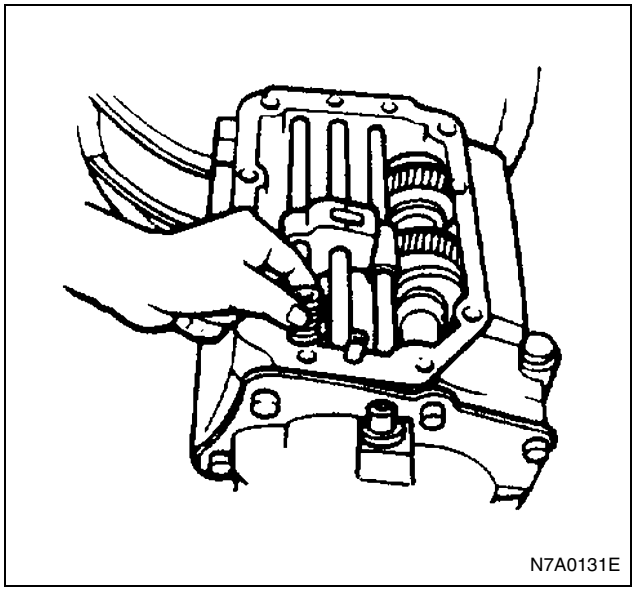
Caution:
Be sure to confirm that there is no crack at the caulked portion of the lock nut after caulking.



35. Parking Brake Drum
    - Adjust the parking brake after installation.
    1) Rotate the brake drum to align the adjust hole with the adjuster.
    2) Move the camshaft lever from side to side several times to center the brake shoes.
    3) Insert a screwdriver into the hole and rotate the adjuster by pushing it upward until the shoes drag on the drum.
    4) Back off the adjuster 30 notches.
    - Install the adjust hole cover.

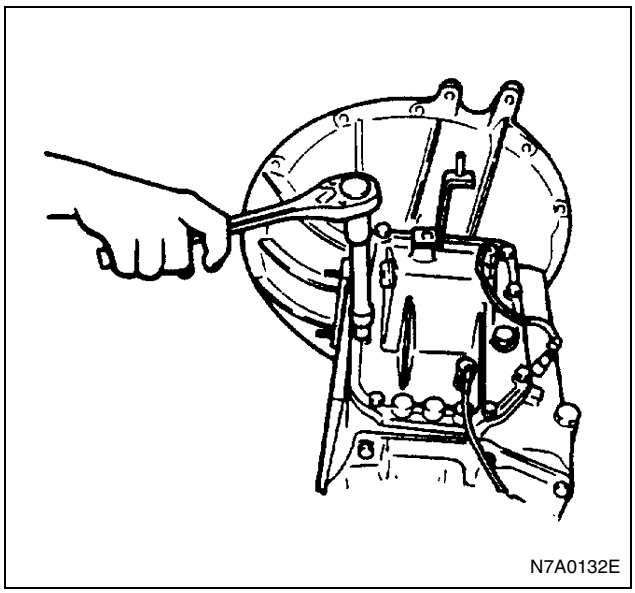
Tighten:
Adjust hole cover bolt to 8 N·m (0.8 kg·m / 69 lb·in)

36. Detent Ball
37. Detent Spring
38. Control Box Assembly
    - Apply small amount of multi-purpose grease to the detent balls.
    - Install the 3 detent balls and the 3 detent springs to the transmission case.
    - Install the control box assembly with new gasket.



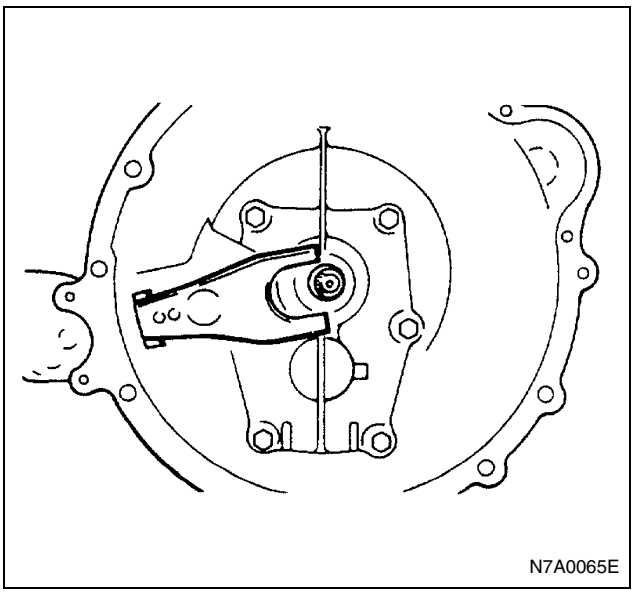
Tighten:
Control box to transmission case bolts to 20 N·m (2.0 kg·m / 14 lb·ft)

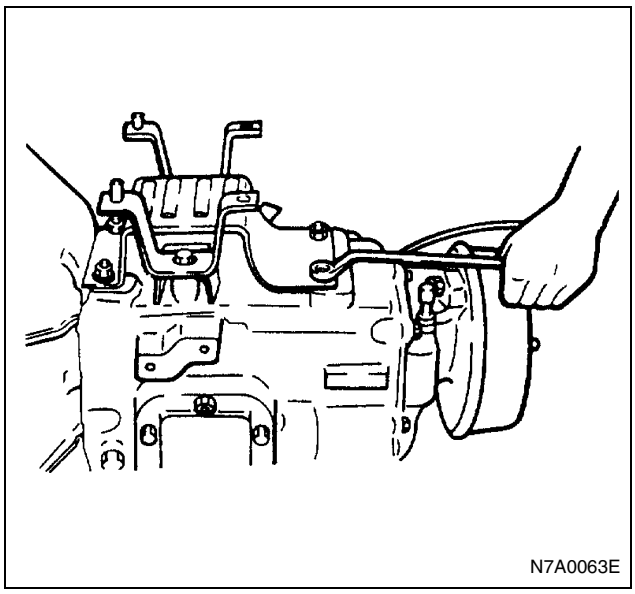
Notice:
Operating the shift lever and the select lever, make sure that they shift to each position smoothly.



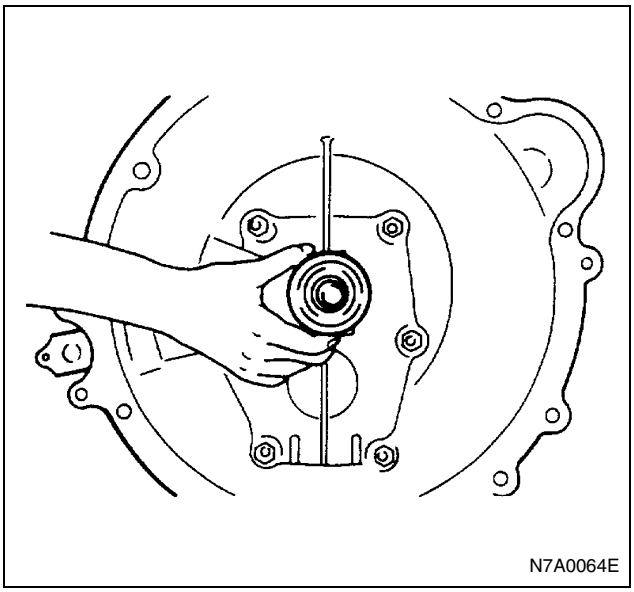
39. Shift Fork and Support Bolt

Tighten:
Support bolt to 52 N·m (5.3 kg·m / 38 lb·ft)





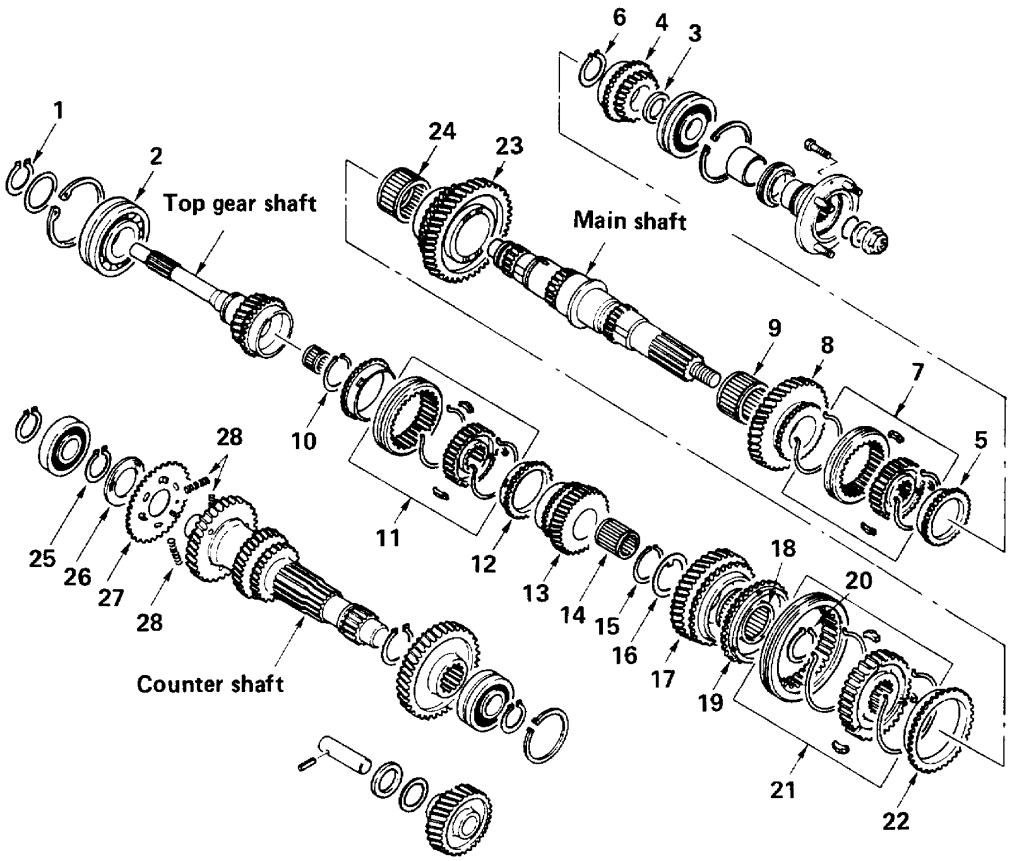
40. Release Bearing Assembly



41. Mission Mounting Assembly

Tighten:
Mission mounting bolt to 69 N·m (7.0 kg·m / 51 lb·ft)

Top Gear Shaft Assembly, Main Shaft Assembly and Counter Shaft Assembly



N7A0014E

Legend

Top gear shaft assembly
1. Snap ring
2. Ball bearing

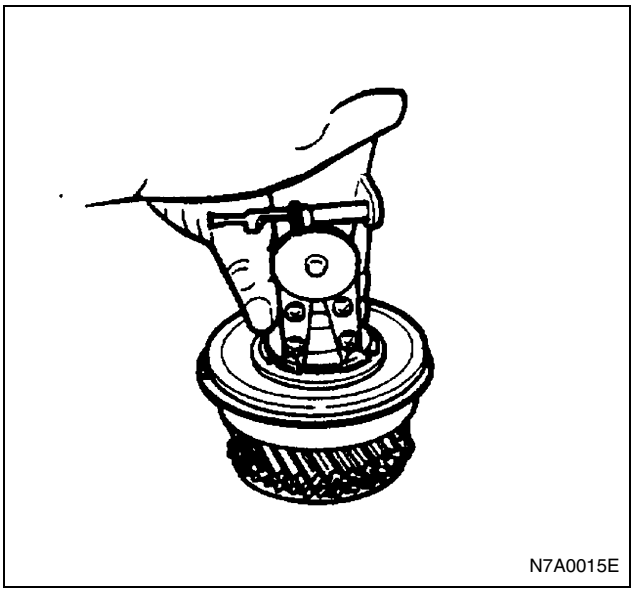
Main shaft assembly
3. Thrust washer
4. 5th gear
5. Block ring
6. Snap ring
7. 5th/reverse synchronizer assembly
8. Reverse gear
9. Needle bearing
10. Snap ring
11. 3rd/4th synchronizer assembly
12. Block ring
13. 3rd gear
14. Needle bearing
15. Snap ring
16. Thrust washer
17. 2nd gear
18. Needle bearing
19. Block ring
20. Snap ring
21. 1st/2nd synchronizer assembly
22. Block ring
23. 1st gear
24. Needle bearing

Counter shaft assembly
25. Snap ring
26. Conical washer
27. Anti-lash plate
28. Spring

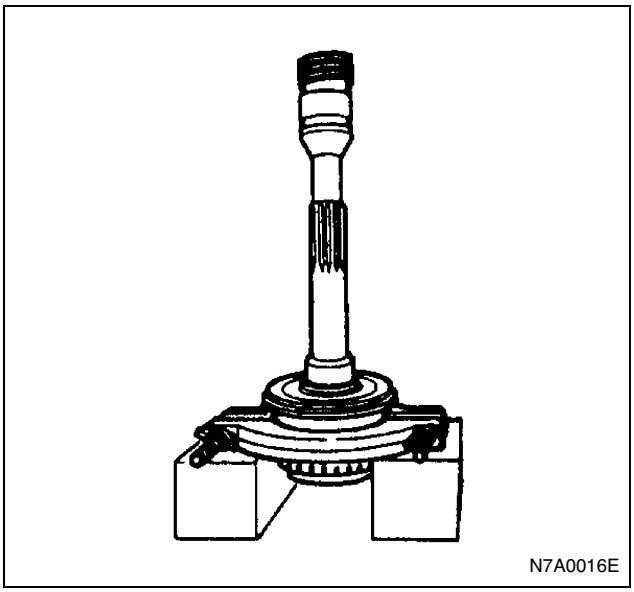
Disassembly

Top Gear Shaft Assembly

1. Snap Ring

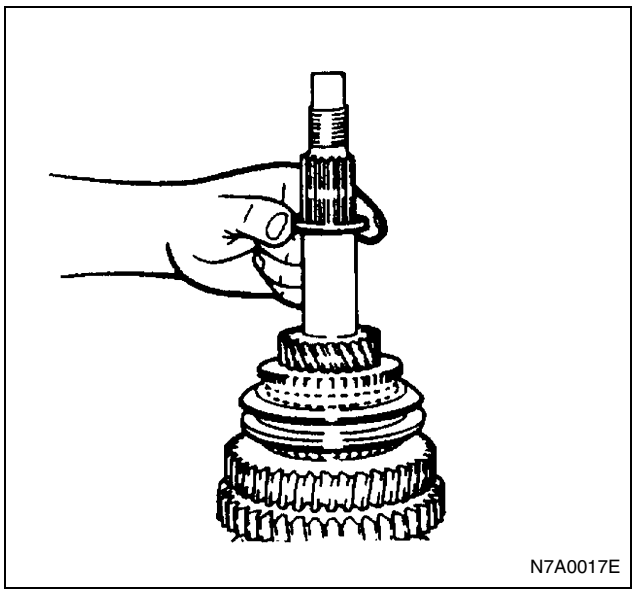

N7A0015E

2. Ball Bearing
   - Use the bearing remover to remove the bearing from top gear shaft.
     Bearing Remover: 5-8840-0587-0

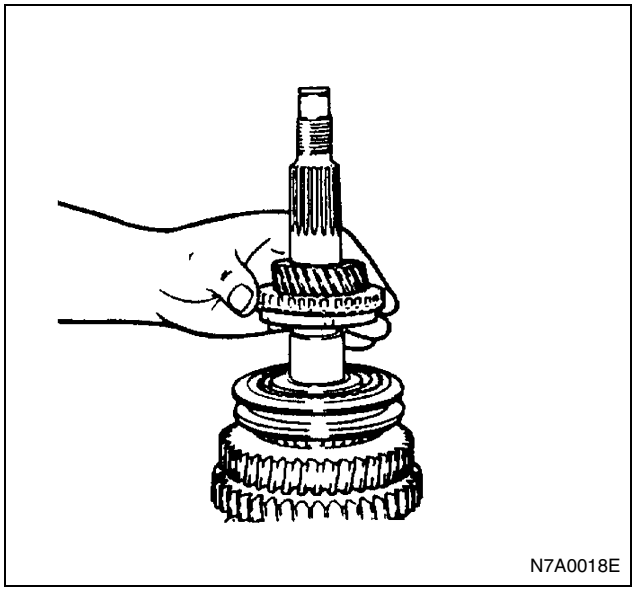

N7A0016E

Main Shaft Assembly

3. Thrust Washer

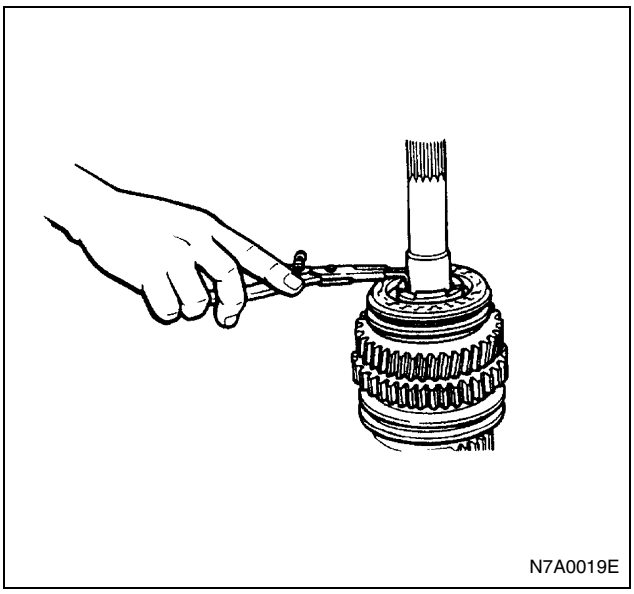

N7A0017E

4. 5th Gear
5. Block Ring
   - Attach a backing plate to the vise, secure the main shaft at the top end, and remove the 5th gear and block ring.

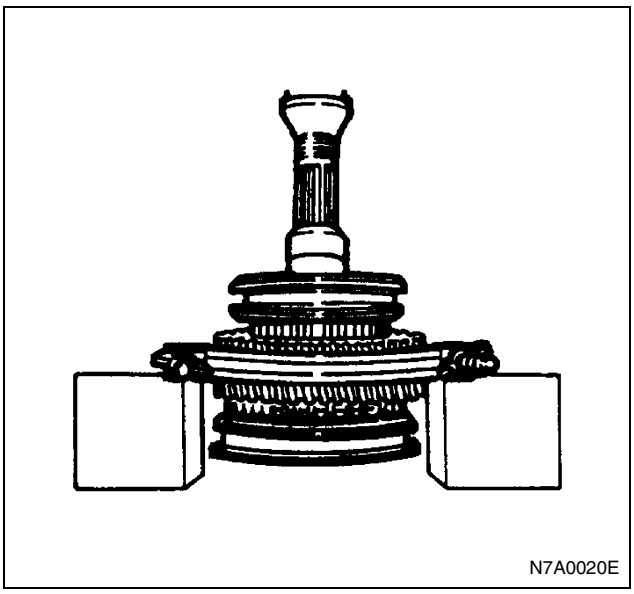

N7A0018E

6. Snap Ring

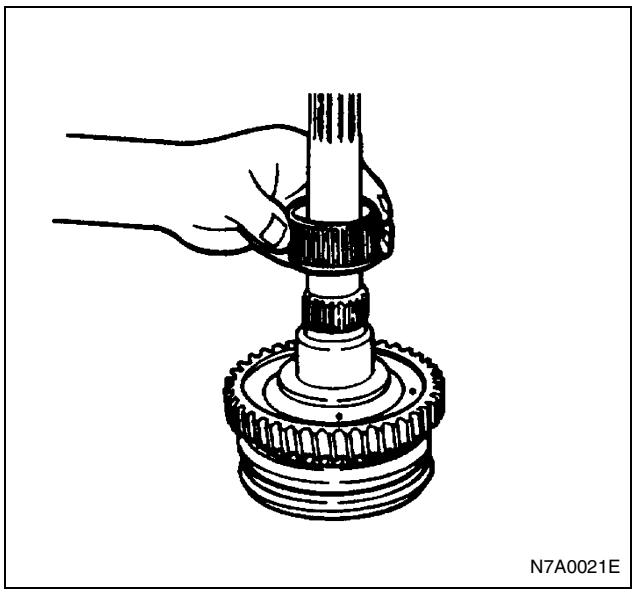
Notice:
Snap ring of appropriate sizes are combined to fill the gap to the clutch hub. Never mix them with other snap rings.


N7A0019E

7. 5th/Reverse Synchronizer Assembly
8. Reverse Gear
   - Use a bench press and the bearing remover to remove the reverse gear together with the 5th/ reverse synchronizer assembly.
     Bearing Remover: 5-8840-0587-0
   - Disassemble synchronizer assemblies into the clutch hub, sleeve, inserts (3 pieces) and insert springs (2 pieces).

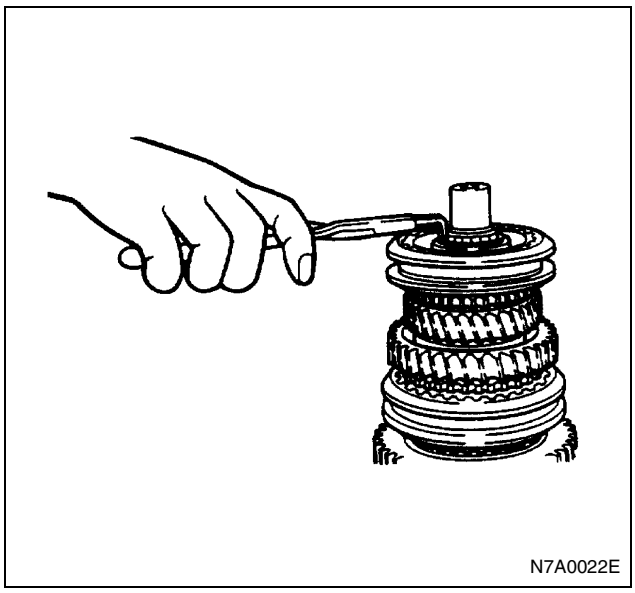

N7A0020E

9. Needle Bearing

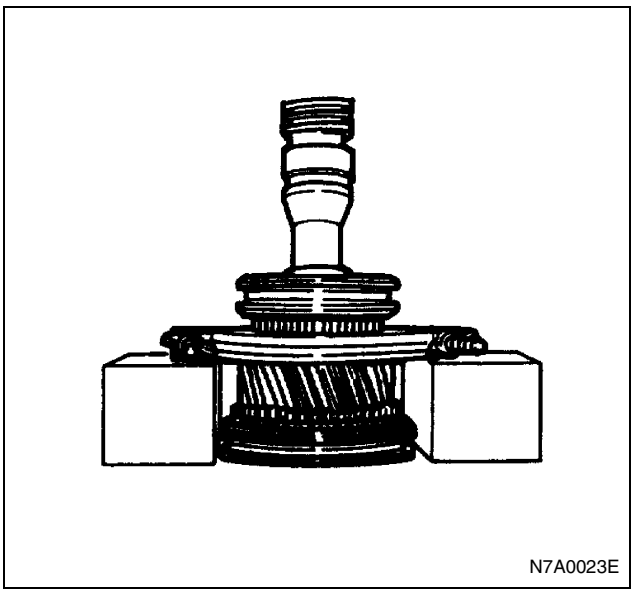

N7A0021E

10. Snap Ring
    - Attach a backing plate to the vise, secure the main shaft at the spline end, and remove the snap ring at the end.

Notice:
Snap ring of appropriate sizes are combined to fill the gap to the clutch hub. Never mix them with other snap rings.

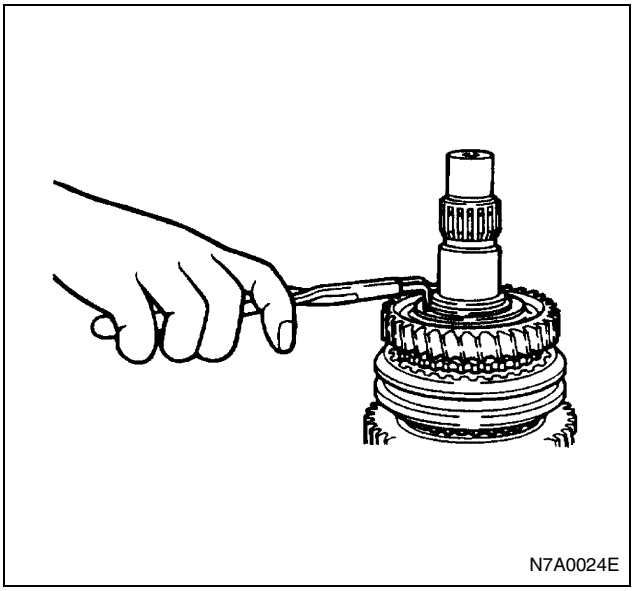

N7A0022E

11. 3rd/4th Synchronizer Assembly
12. Block Ring
13. 3rd Gear
    - Use a bench press and the bearing remover to remove the 3rd gear together with the 3rd/4th synchronizer assembly and the block ring.
      Bearing Remover: 5-8840-0587-0
    - Disassemble synchronizer assemblies into the clutch hub, sleeve, inserts (3 pieces) and insert springs (2 pieces).

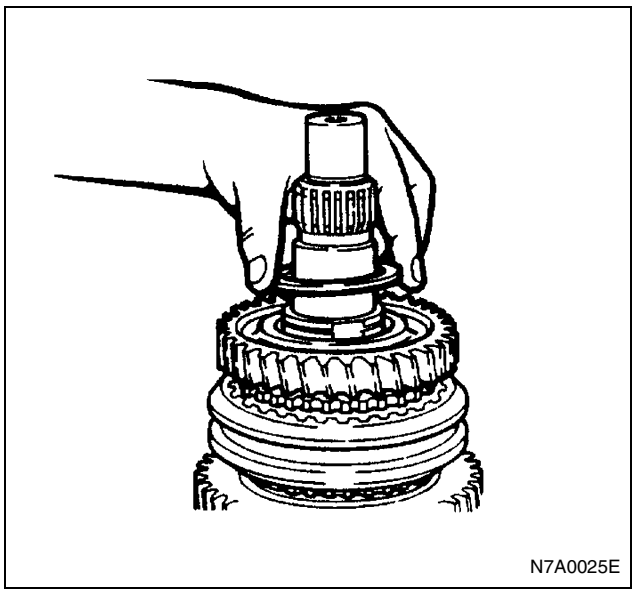

N7A0023E

14. Needle Bearing
15. Snap Ring

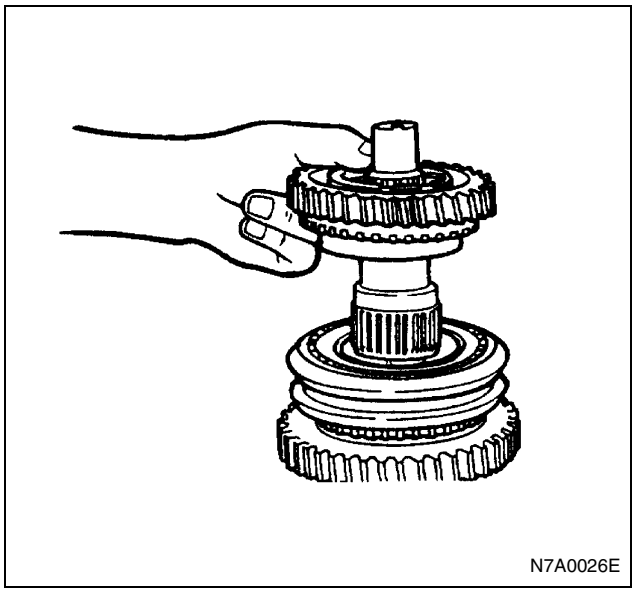
Notice:
Snap ring of appropriate sizes are combined to fill the gap to the clutch hub. Never mix them with other snap rings.


N7A0024E

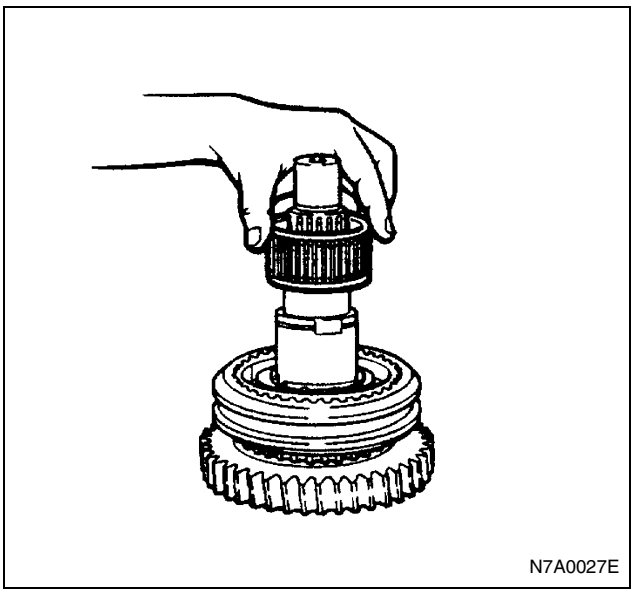
16. Thrust Washer


N7A0025E

17. 2nd Gear

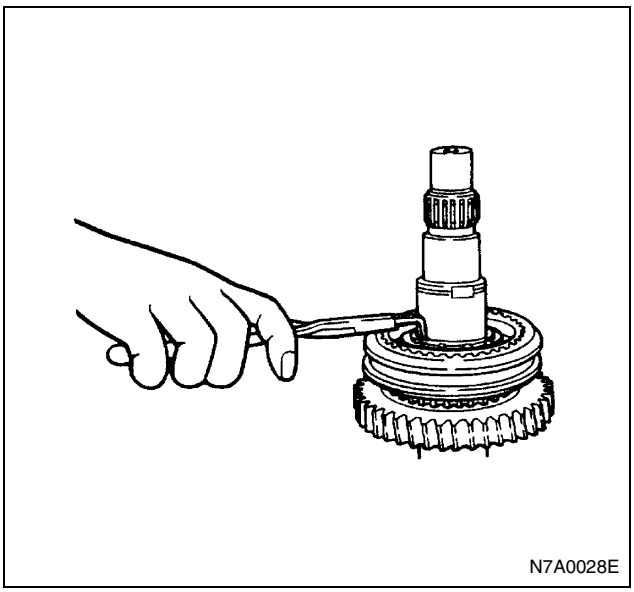

N7A0026E

18. Needle Bearing
19. Block Ring

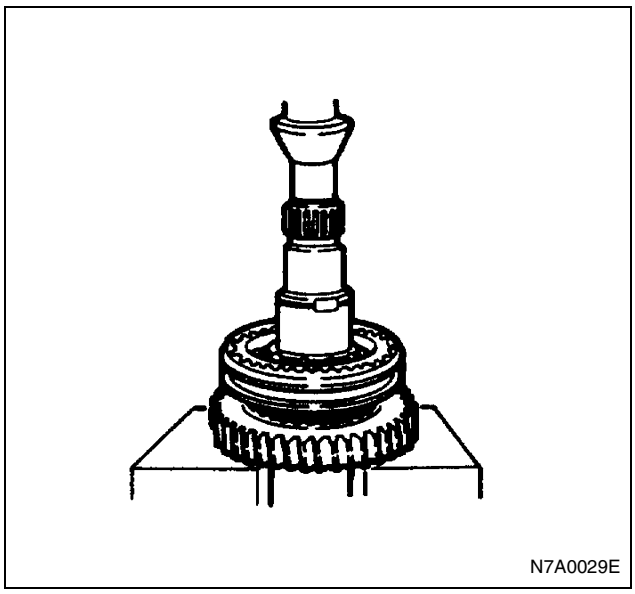

N7A0027E

20. Snap Ring

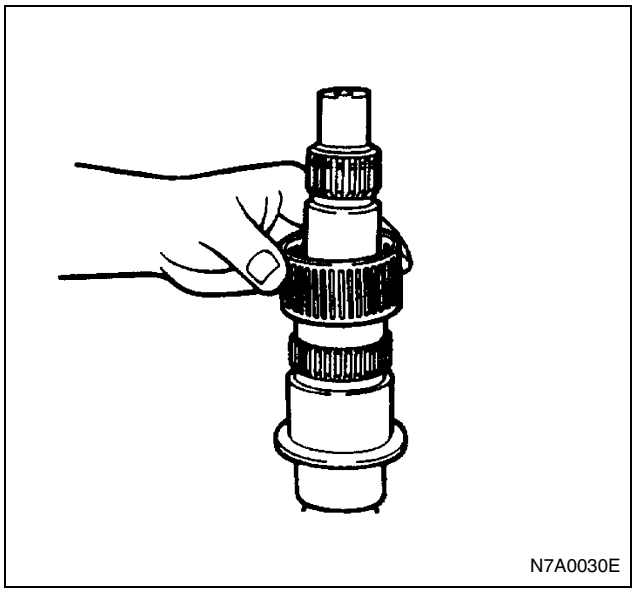
Notice:
Snap ring of appropriate sizes are combined to fill the gap to the clutch hub. Never mix them with other snap rings.


N7A0028E

21. 1st/2nd Synchronizer Assembly
22. Block Ring
23. 1st Gear
    - Use a bench press to remove the 1st gear together with the 1st/2nd synchronizer assembly and the block ring.
    - Disassemble synchronizer assemblies into the clutch hub, sleeve, inserts (3 pieces) and insert springs (2 pieces).

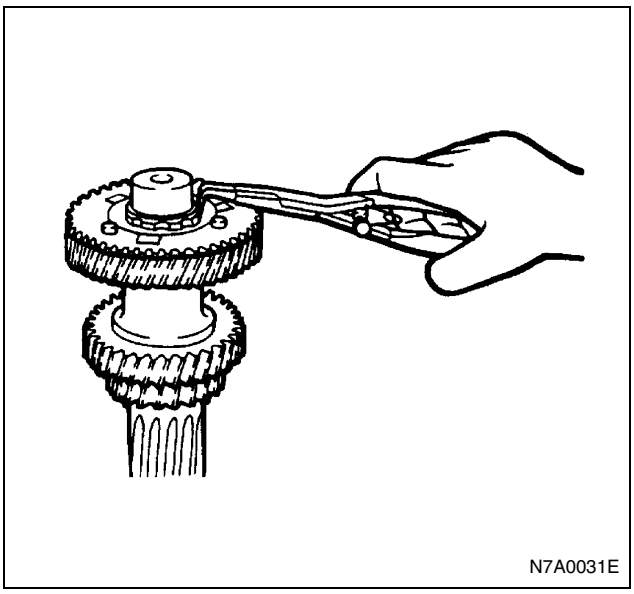

N7A0029E

24. Needle Bearing

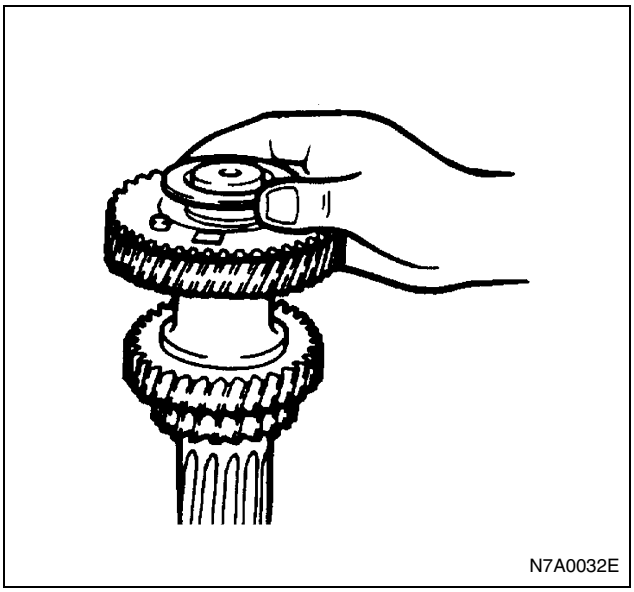

N7A0030E

Counter Shaft Assembly

25. Snap Ring

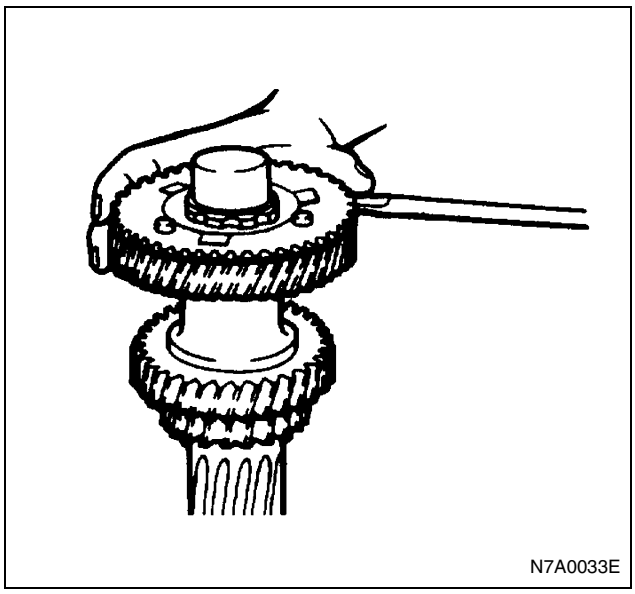

N7A0031E

26. Conical Washer

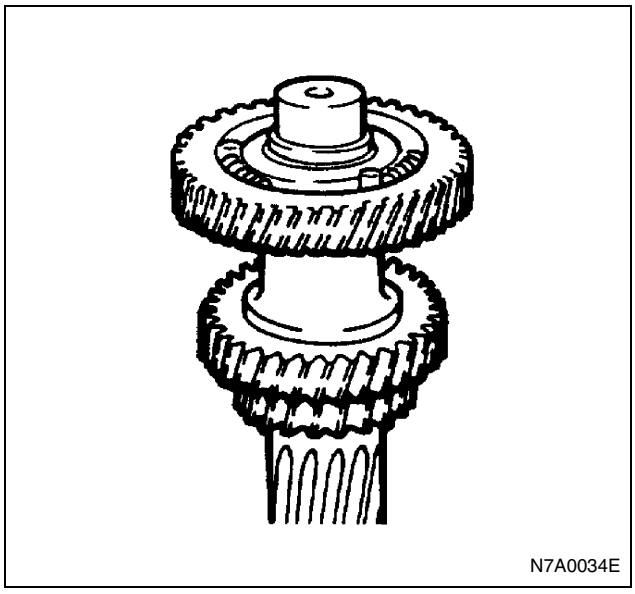

N7A0032E

27. Anti-lash Plate
    - Insert a flat-end screwdriver between the anti-lash plate and the counter drive gear, and remove the anti-lash plate.

WARNING:
THE ANTI-LASH PLATE SHOULD BE REMOVED VERY SLOWLY WITH SPECIAL CARE OTHERWISE SOME SPRINGS INSTALLED INSIDE THE PLATE COULD POP OUT AND CAUSE INJURY.


N7A0033E

28. Spring
    - Remove the 3 springs that are assembled to the counter drive gear side.


N7A0034E

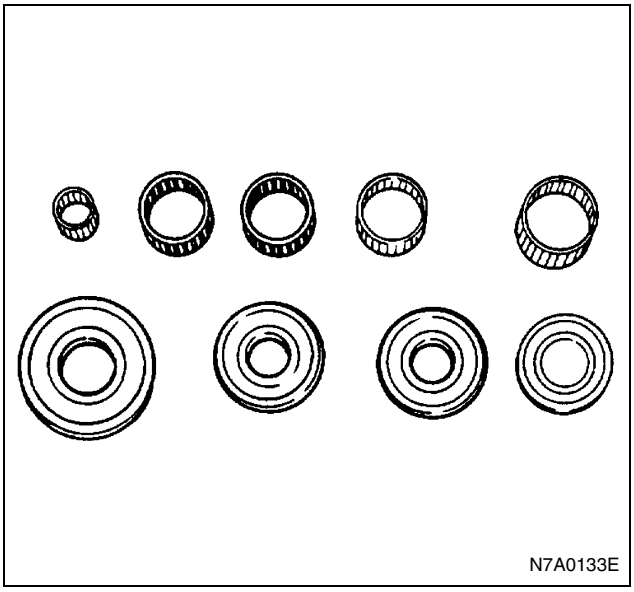
Inspection and Repair

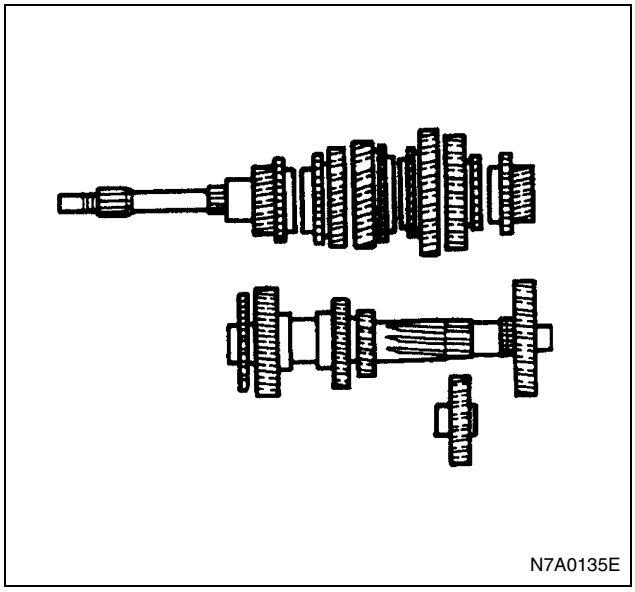
Make the necessary adjustment, repairs, and part replacements if excessive wear or damage is discovered during inspection.

Bearings

Check each bearing, and replace in either of the following cases.

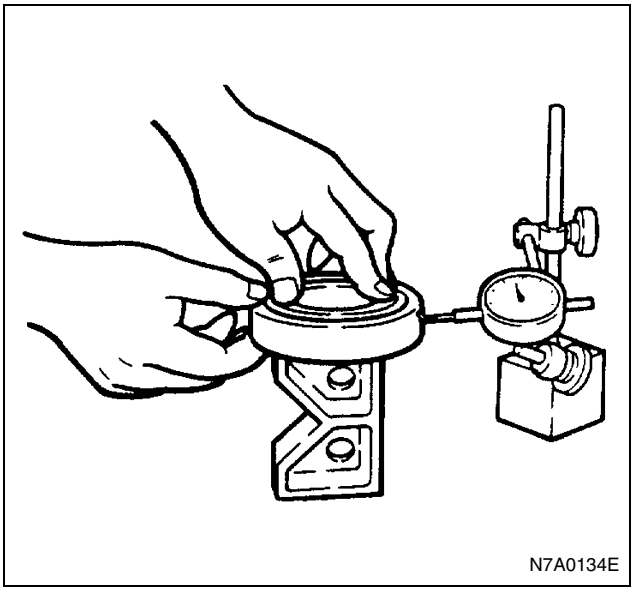
- Rotation is not smooth.
- Abnormal sound is generated.
- There is extreme damage or rust.
- Rolling element or rolling contact surface of needle roller bearing is discolored, extremely worn or pitted.

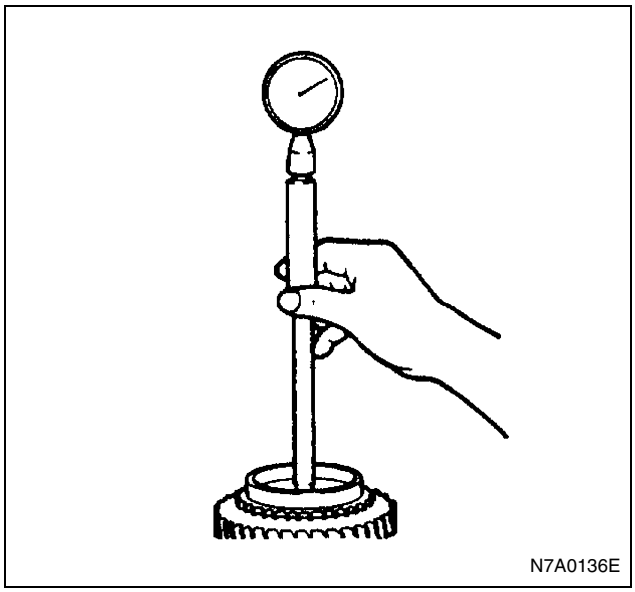

N7A0133E


N7A0135E

Ball Bearing Run-out	mm (in)
Limit	
0.2 (0.01)	

Gear Inside Diameter		mm (in)
Gear	Standard	Limit
3rd Gear	42.0 (1.654)	42.1 (1.657)
2nd Gear	54.0 (2.126)	54.1 (2.130)
1st Gear	61.0 (2.402)	61.1 (2.406)
Reverse Gear	54.0 (2.126)	54.1 (2.130)

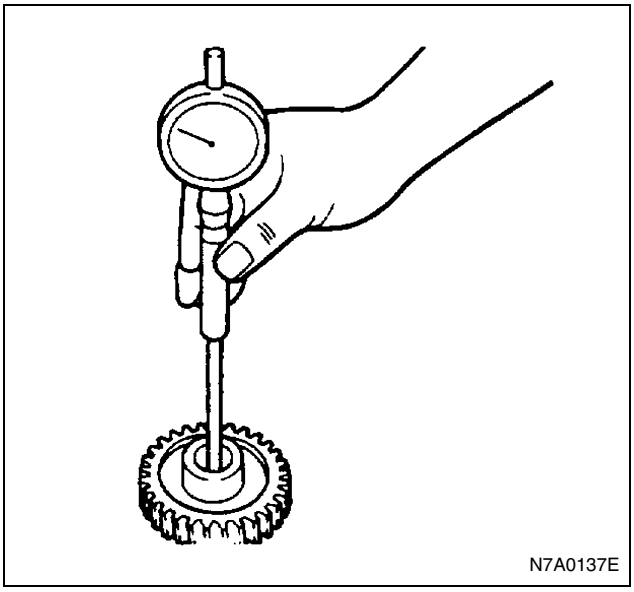

N7A0134E

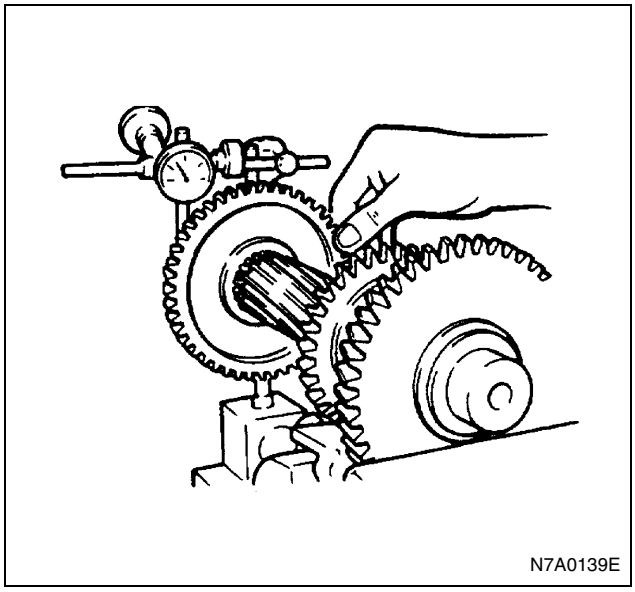

N7A0136E

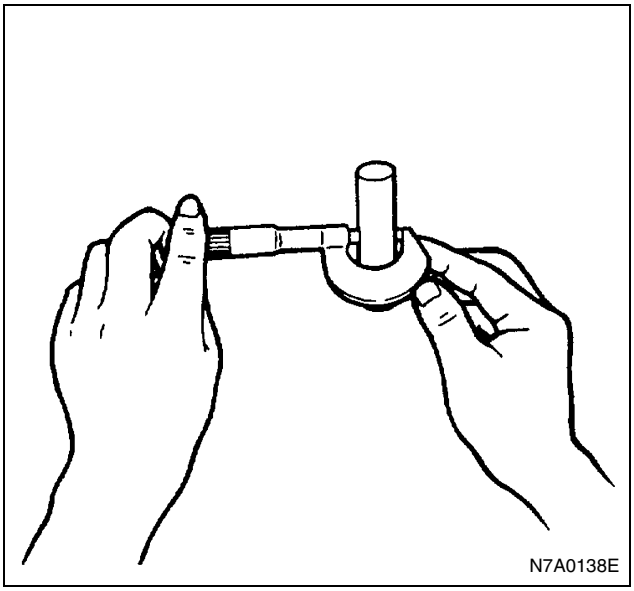
Gears

Check each gear for the following points. Correct a slight stepped wear or surface roughness with an oil stone or pencil grinder, or replace the gear if unrecoverable damage is found.

- Break or damage of tooth.
- Roughness or damage of taper cone (contact surface with block ring).
- Extreme wear of tooth.
- Inspect the dog gear teeth, and replace if hard contact is found on the force receive side (coast side) during engine braking.

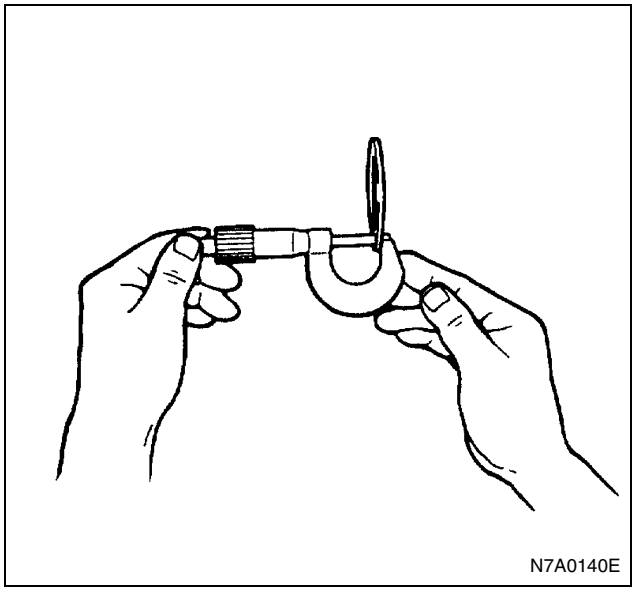

N7A0137E


N7A0139E

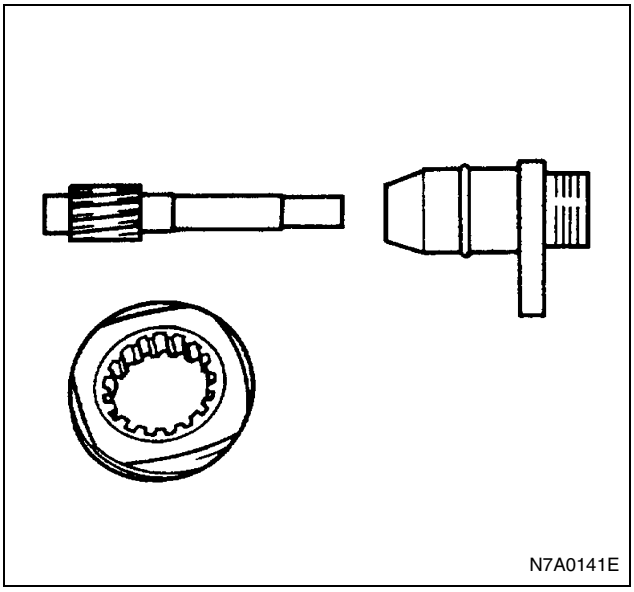

N7A0138E

Thrust Washer Thickness		mm (in)
Gear	Standard	Limit
For 2nd Gear	3.0 (0.12)	2.8 (0.11)
For 5th Gear	3.8 (0.15)	3.6 (0.14)

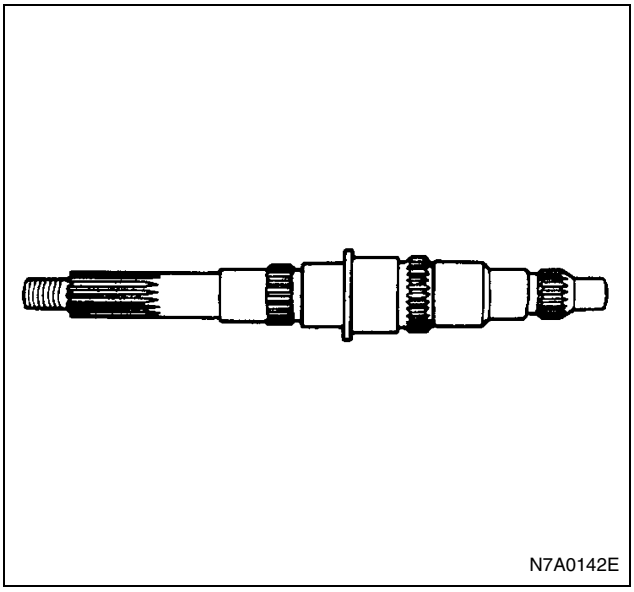
Counter 5th Gear Spline Play (At counter 5th gear outer circumference)	mm (in)
Standard	Limit
0.18 — 0.43 (0.007 — 0.017)	0.45 (0.018)


N7A0140E

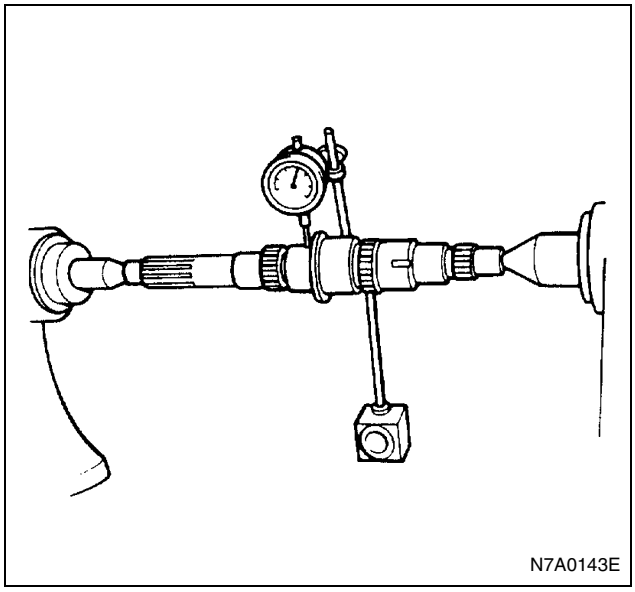
- Wear or damage of the vehicle speed sensor drive gear and driven gear bushing.


N7A0141E

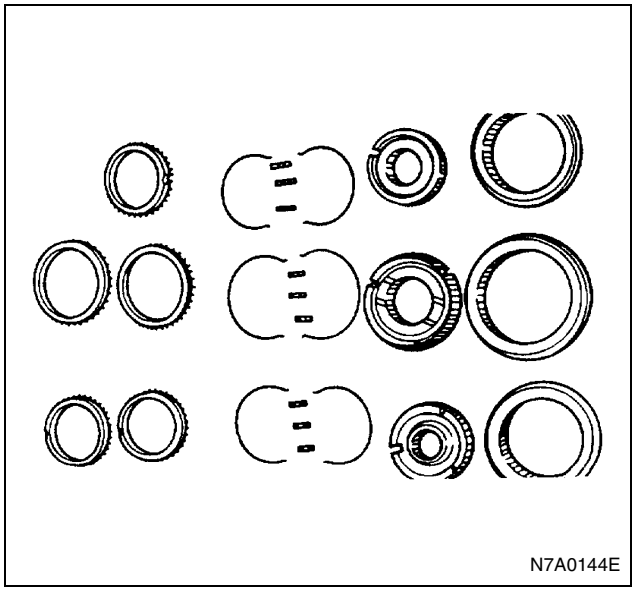
Main Shaft
Check the main shaft external surface for any damage or wear, and its spline sections for wear, damage or bent.
When there is any abnormal condition, or when it is used excessively beyond a proper use limit, replace it with new one.


N7A0142E

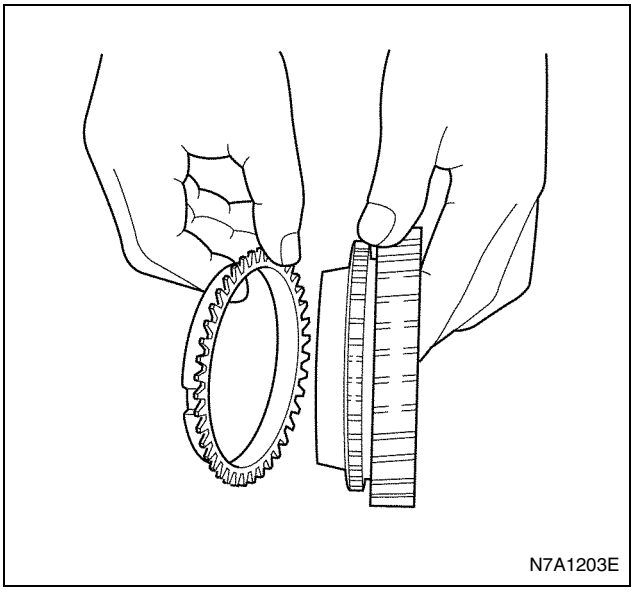
Main Shaft Run-out	mm (in)
Standard	Limit
0.025 (0.0010) or Less	0.1 (0.004)


N7A0143E

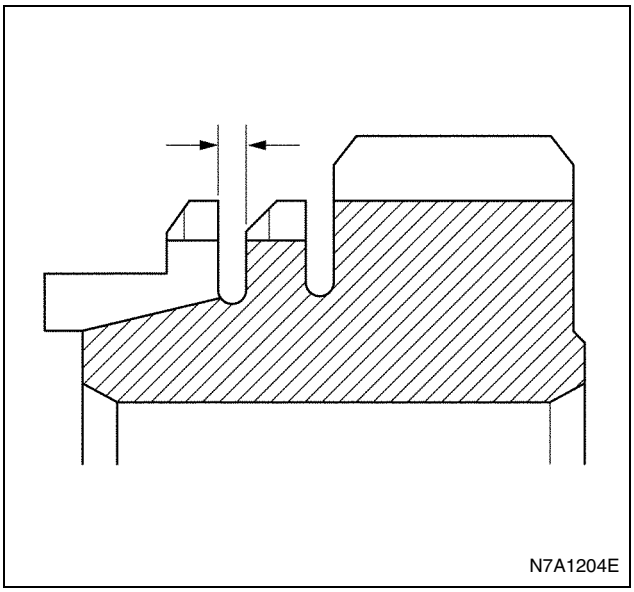
Synchromesh
Check the components of the synchronizer for any abnormal conditions. When there are uneven slight wears or rough surfaces, improve them with an oil stone or pencil grinder.
When they are abnormally damaged, or when they are used excessively beyond a proper use limit, replace them with new one.


N7A0144E

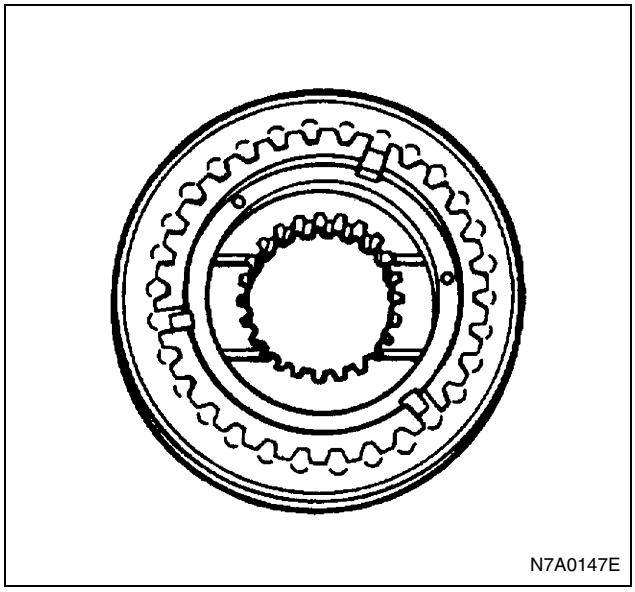
- Damages or wears found on the taper, gear and insert groove sections of the block ring.


N7A1203E

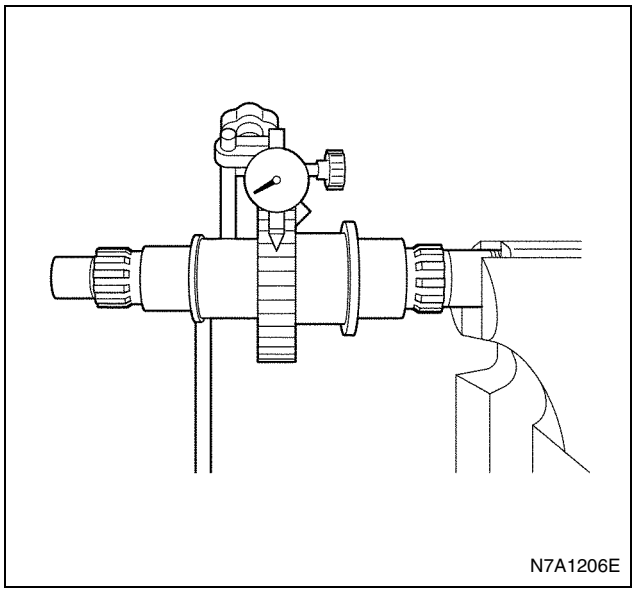
Block Ring and Dog Gear Teeth Clearance		mm (in)
Gear	Standard	Limit
3rd/4th	1.0 (0.04)	0.5 (0.02)
1st/2nd	1.5 (0.06)	0.5 (0.02)
5th	1.5 (0.06)	0.5 (0.02)


N7A1204E

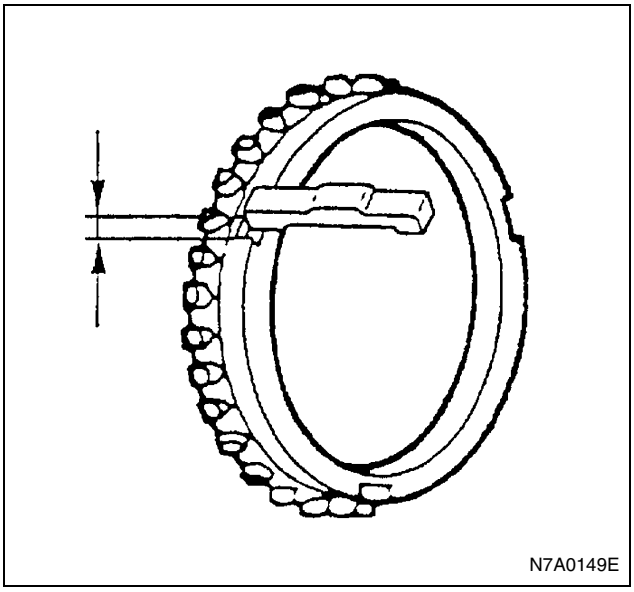
- Wears or damages found on the clutch hub, the sliding sections of the sleeve, the spline sections and insert grooves.


N7A0147E

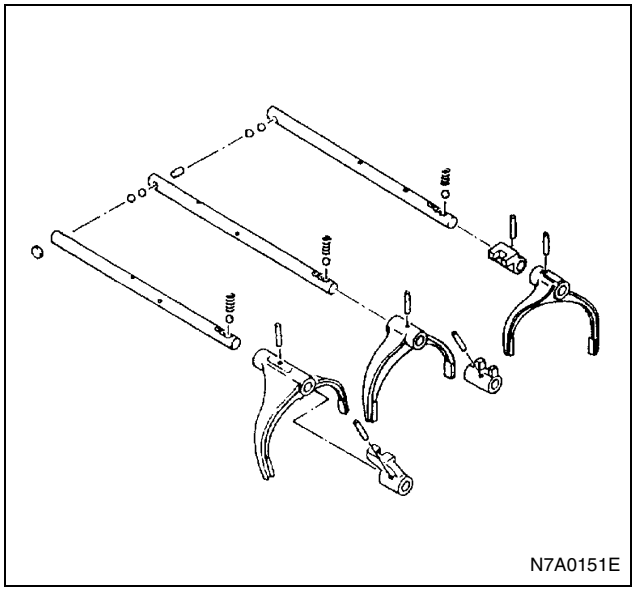
Clutch Hub Spline Play (At clutch hub outer circumference)	mm (in)
Standard	Limit
0 — 0.05 (0 — 0.002)	0.3 (0.01)


N7A1206E

Block Ring Groove and Insert Clearance	mm (in)
Standard	Limit
3.59 — 3.91 (0.141 — 0.154)	4.1 (0.16)

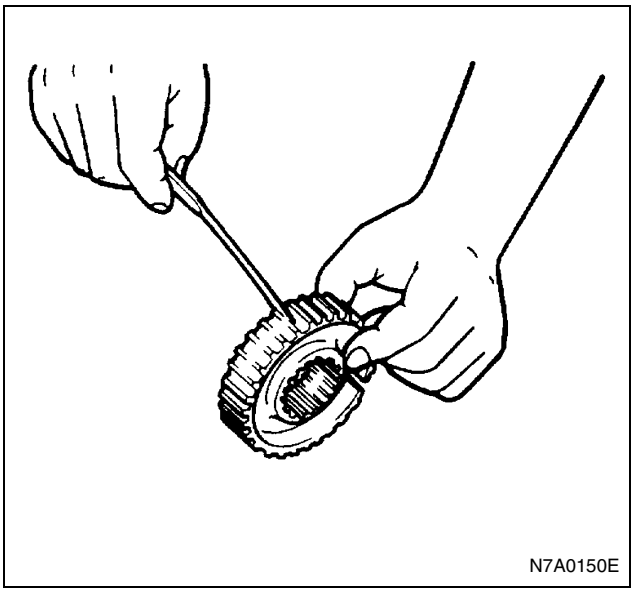

N7A0149E

Clutch Hub Groove and Insert Clearance	mm (in)
Standard	Limit
0.09 — 0.31 (0.004 — 0.012)	0.4 (0.02)


N7A0151E

- Check the shift arm and shift block groove for wear or deformation.

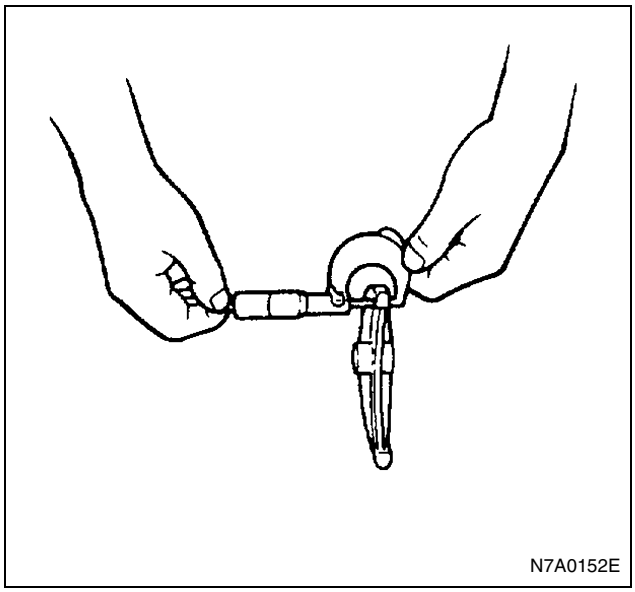
Shift Arm Thickness	mm (in)
Standard	Limit
10.0 (0.39)	9.0 (0.35)


N7A0150E

Shift Mechanism

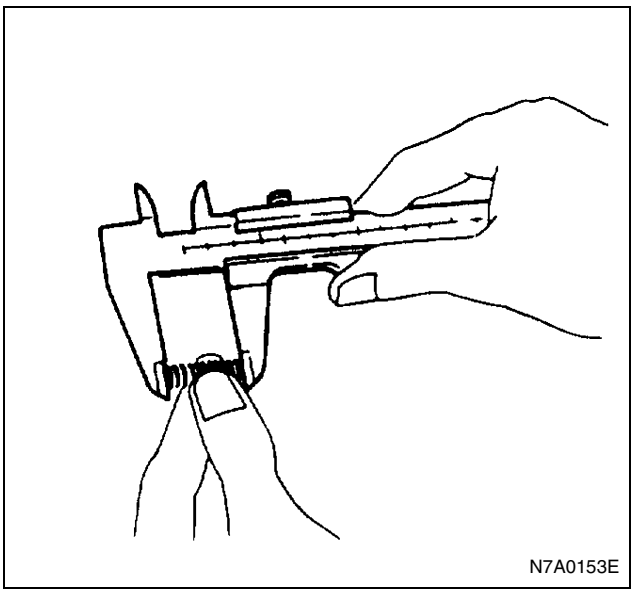
Inspect all disassembled parts for wear, damage or other abnormal conditions.

- Check the shift rod for wear, bent and damage.

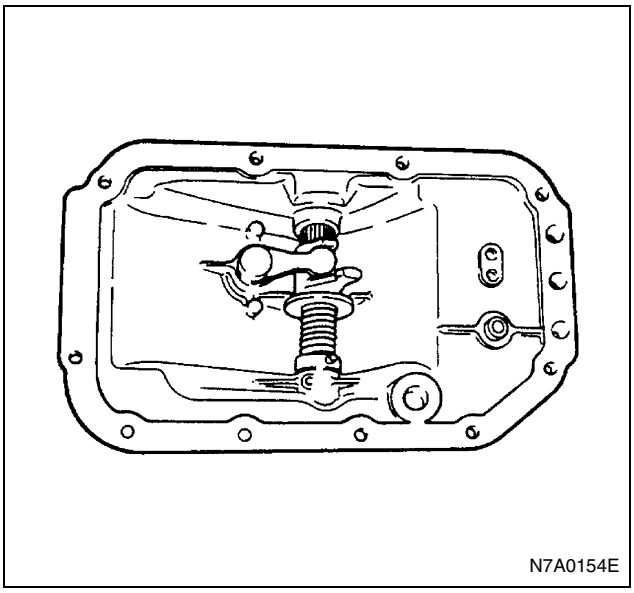

N7A0152E

- Check the detent spring for weakening and deformation.

Free Length of Detent Spring	mm (in)
Standard	Limit
31.6 (1.24)	30.1 (1.19)


N7A0153E

- The wear of the select lever, and the backlash and awkward operation of the control box.


N7A0154E

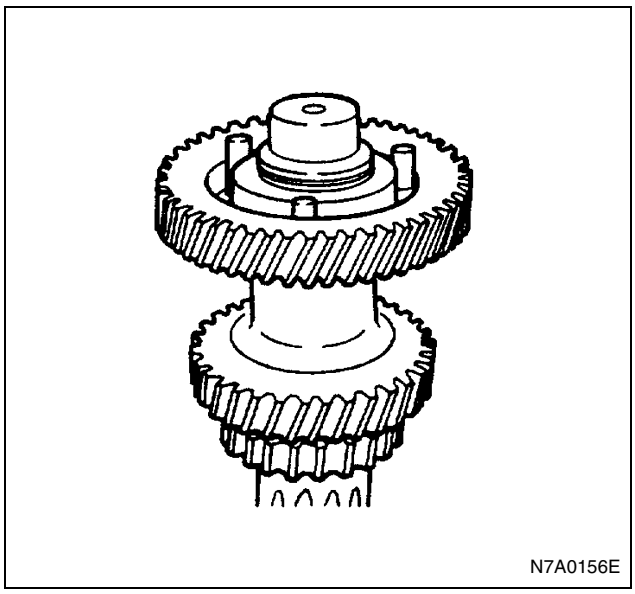
Reassembly

Notice:
Clean each part thoroughly.

When assembling parts, apply clean engine oil (SAE 5W-30) to their sliding and mating sections.

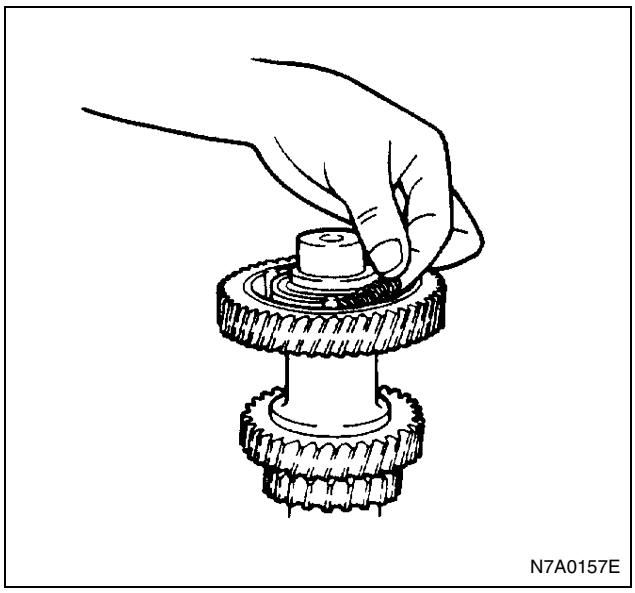
Counter Shaft Assembly

1. Spring
   - Attach a backing plate to the vise, secure the counter shaft rear end, and install the springs.

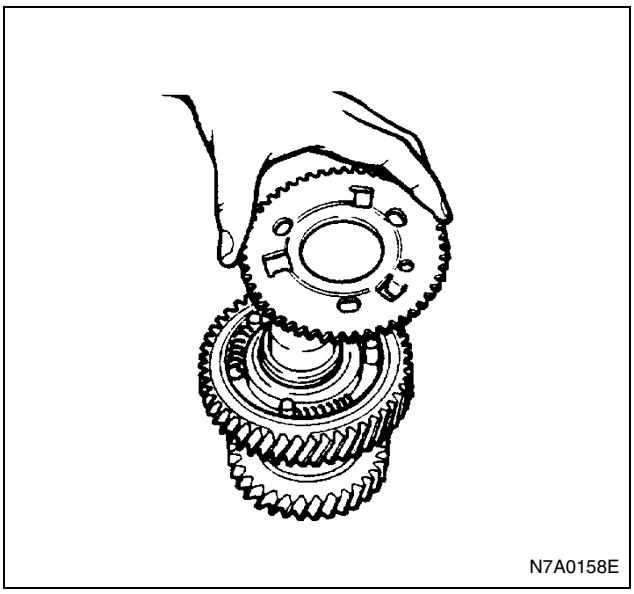

N7A0156E

- The spring should be installed to the left of the inside counter drive gear pin.

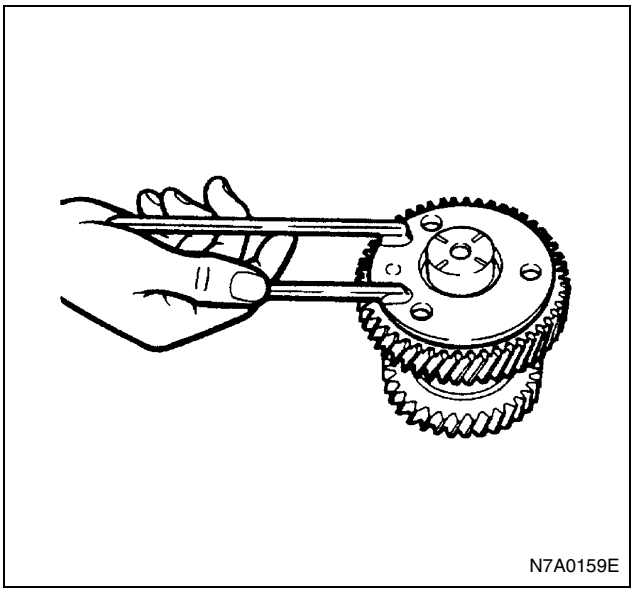
Notice:
When replacing the pin with a new one, hammer it in until its height becomes 3 mm (0.12 in) from the gear end face.


N7A0157E

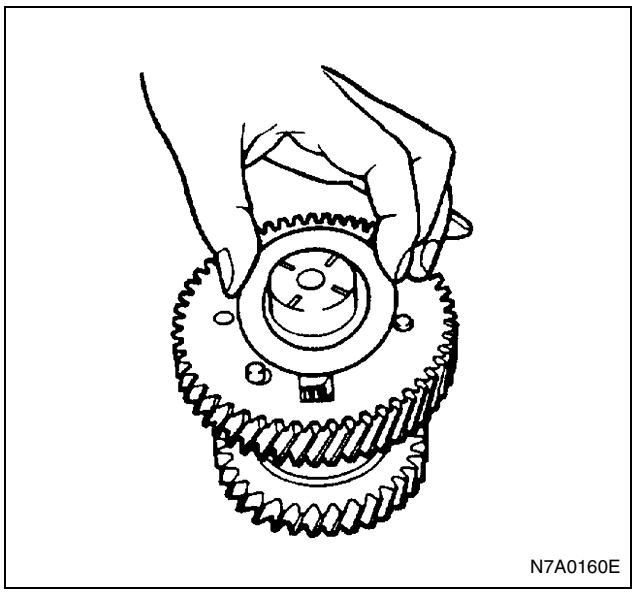
2. Anti-lash Plate
   - Assemble the anti-lash plate to the drive gear so that the drive gear hole (ϕ7.7 mm/0.3 in) comes roughly in line with the hole (ϕ7.7 mm/0.3 in) of the anti-lash plate.


N7A0158E

- With the guide pin aligned with the drive gear hole (ϕ7.7 mm/0.3 in), set the installer to the guide pin.
  Anti-lash Plate Installer: 5-8840-2044-0
- Turn the installer clockwise. When the drive gear pin comes to the position where it can be seen fully, put the installer into the drive gear side to fix the anti-lash plate to the drive gear.

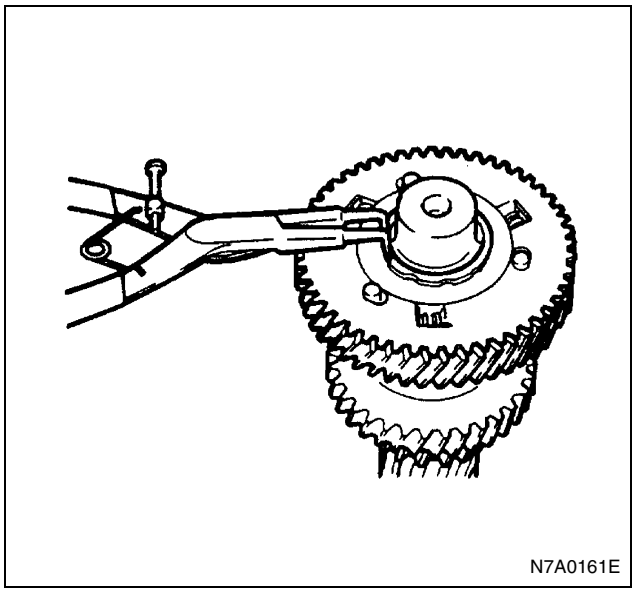

N7A0159E

3. Conical Washer
   - Install the conical washer above the anti-lash plate with the convex side (front side) up.


N7A0160E

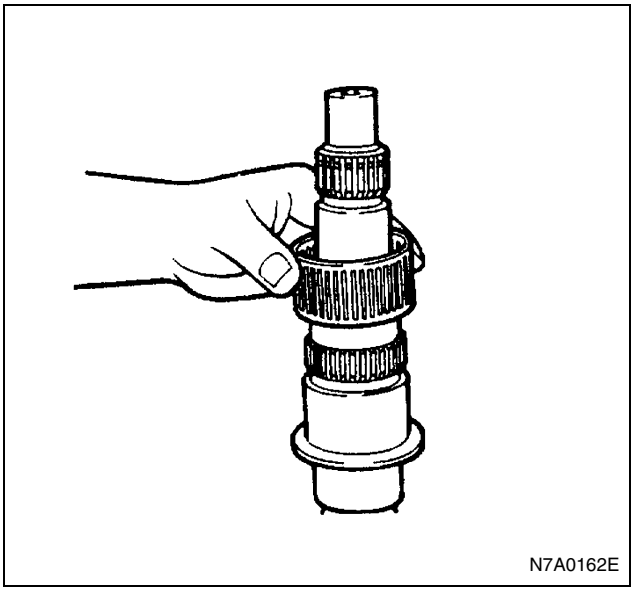
4. Snap Ring
   - Use a new snap ring to fix the conical washer.

Notice:
Avoid the reuse of snap ring.
Check visually the anti-lash plate for a warp or curve after assembly.

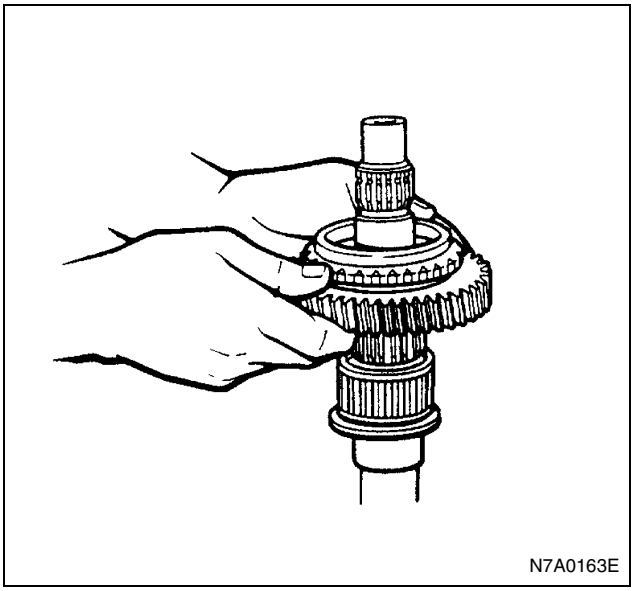

N7A0161E

Main Shaft Assembly

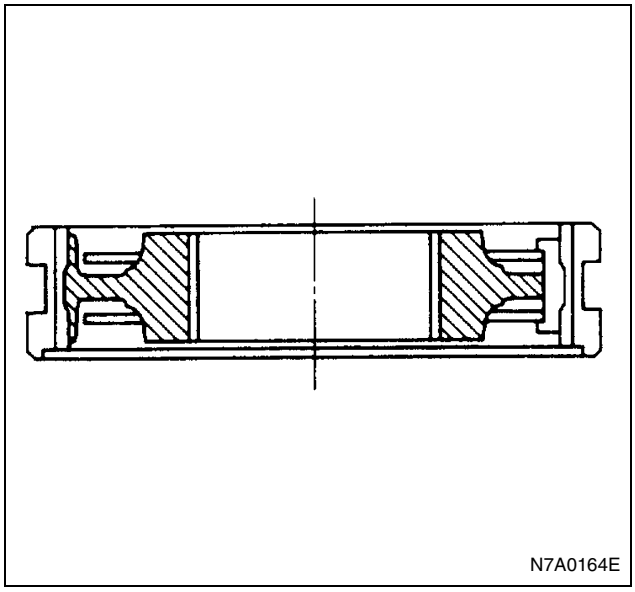
5. Needle Bearing
   - Attach a backing plate to the vise, secure the main shaft at the spline end.


N7A0162E

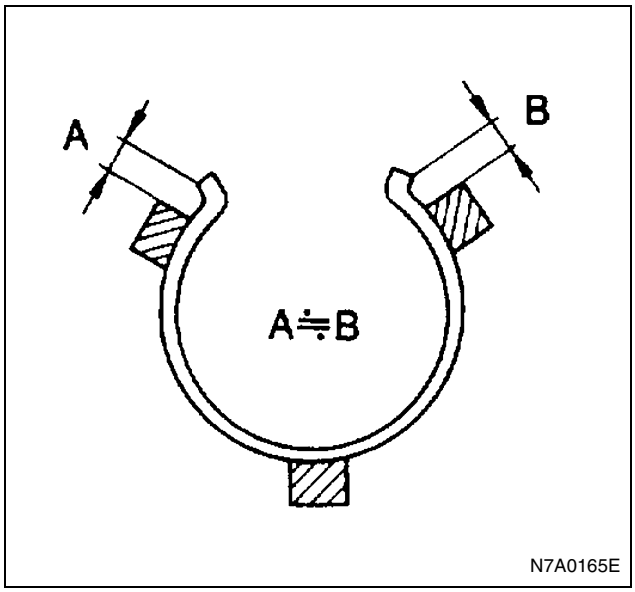
6. 1st Gear
   - Install the 1st gear with its taper cone side upward (front of transmission).
7. Block Ring
   - Align the insert groove of the block ring with the insert.


N7A0163E

8. 1st/2nd Synchronizer Assembly
   - Assemble the sleeve to the clutch hub. The clutch hub has no specific directionality.
   - Put the inserts into the clutch hub groove, and install the insert spring.

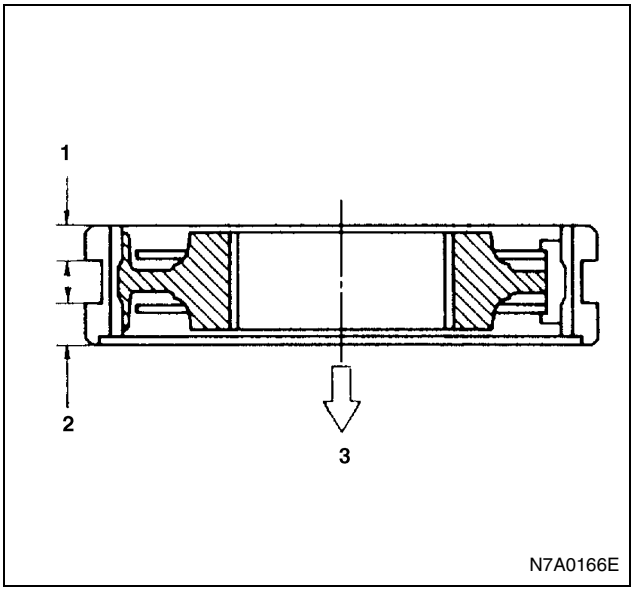

N7A0164E

   - Assemble the insert springs so that the distances (A and B) between inserts and the opening of the spring can be nearly equal, and also this opening may not be the same direction on both side.



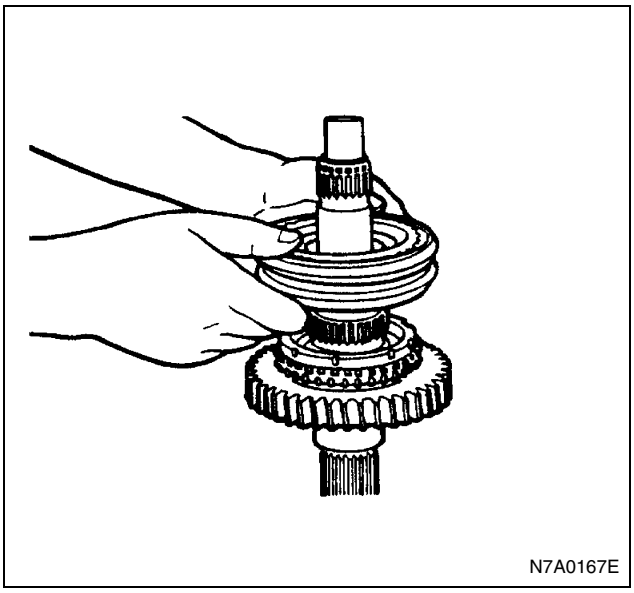
N7A0165E

   - Larger width side of the sleeve outer circumference should be positioned toward the 1st gear side (rear of transmission).
   - Align the insert with the insert groove of the block ring.



Legend
1. Smaller
2. Larger
3. 1st gear

- Tap the clutch hub boss section with a plastic hammer to press it in until it contacts closely with the main shaft stepped section.
- When it is difficult to engage the clutch hub boss with the main shaft spline, heat the clutch hub boss section to a temperature between 80 and 120°C (176 and 248°F) with the piston heater before assembling.
- Check to see if the 1st gear rotates smoothly.

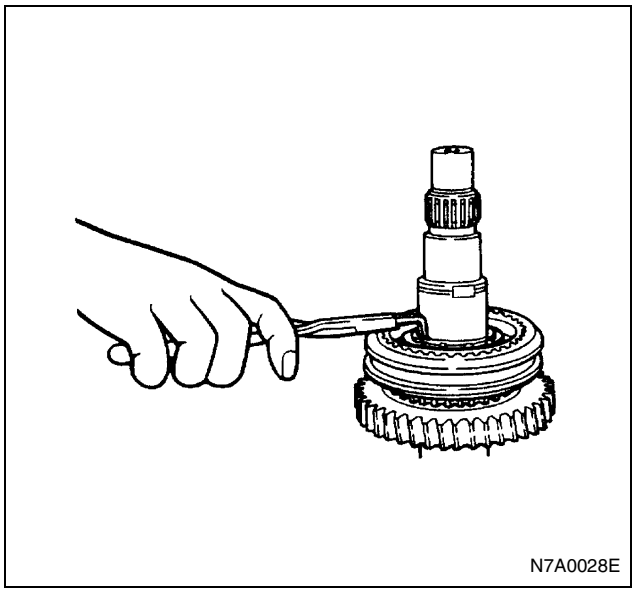


9. Snap Ring
   - Install the built-in snap ring and measure the clearance between the snap ring and the clutch hub.

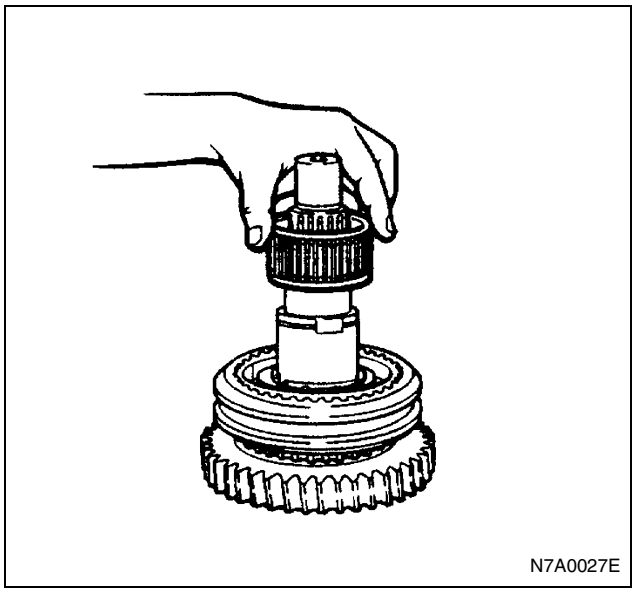
Clutch Hub and Snap Ring Clearance	mm (in)
0 — 0.09 (0 — 0.004)	

- When the clearance is out of the reference value, select a snap ring with the maximum thickness that can be inserted from among the following three types, and built it in.

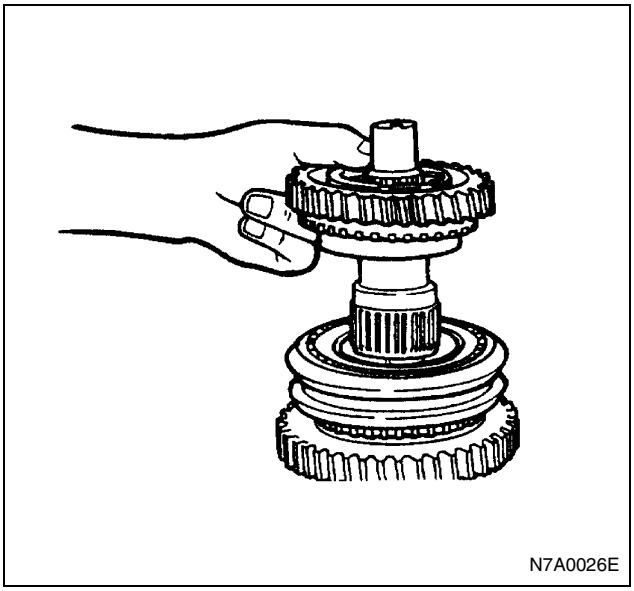
Snap Ring	mm (in)
Color	Thickness (Reference)
Pink	1.75 — 1.80 (0.069 — 0.071)
White	1.80 — 1.85 (0.071 — 0.073)
Yellow	1.85 — 1.90 (0.073 — 0.075)



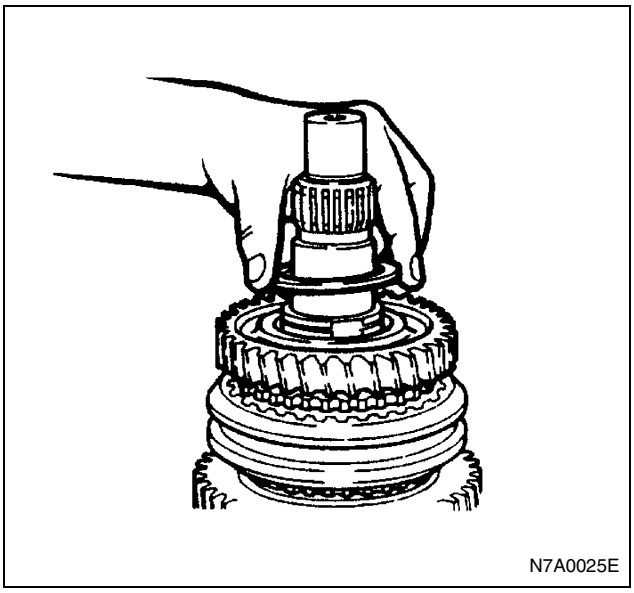
10. Block Ring
    - Align the insert groove of the block ring with the insert.
11. Needle Bearing



12. 2nd Gear
    - Install the 2nd gear with the taper cone side turned to the 1st gear side (to the bottom).

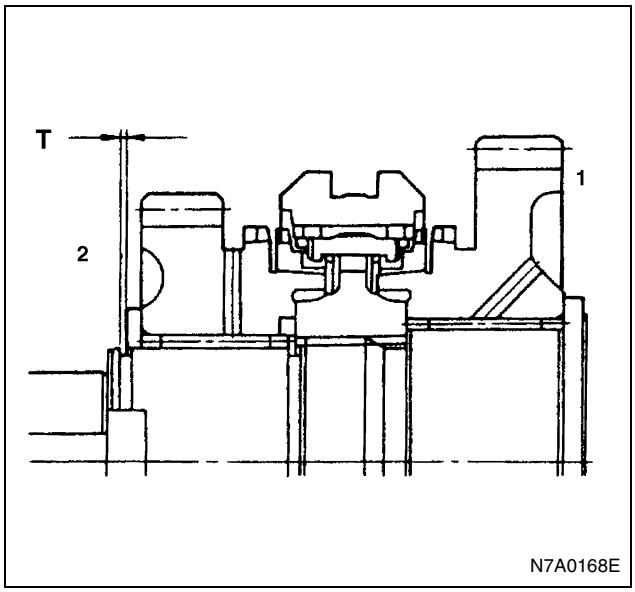

N7A0026E

13. Thrust Washer
    - With the thrust washer set to main shaft groove, assemble it.


N7A0025E

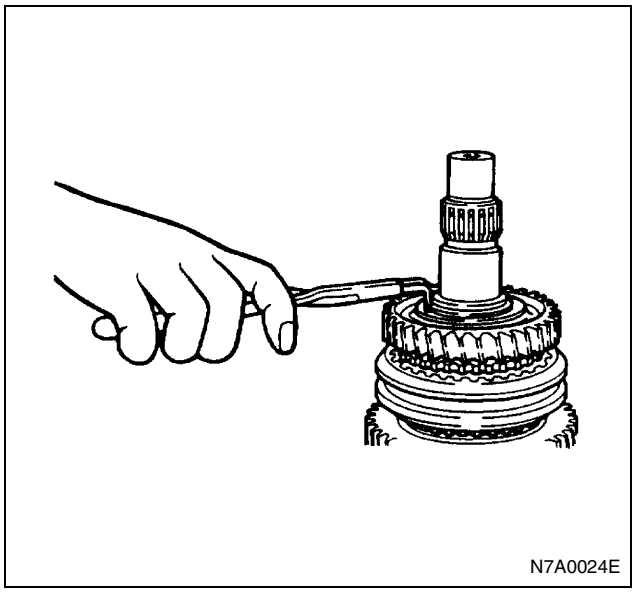
14. Snap Ring
    - After installation, measure distance (T) and select the optimum snap ring from the table.

Snap Ring		mm (in)
Distance (T)	Color	Thickness (Reference)
2.20 — 2.27 (0.087 — 0.089)	Yellow	1.85 — 1.90 (0.073 — 0.075)
2.27 — 2.32 (0.089 — 0.091)	Blue	1.90 — 1.95 (0.075 — 0.077)
2.32 — 2.37 (0.091 — 0.093)	Brown	1.95 — 2.00 (0.077 — 0.079)
2.37 — 2.43 (0.093 — 0.096)	Green	2.00 — 2.05 (0.079 — 0.081)



N7A0168E

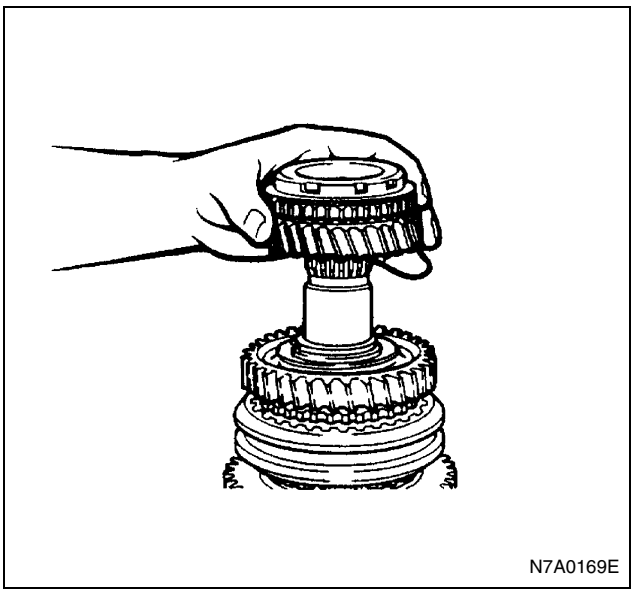
Legend
1. 1st
2. 2nd


N7A0024E

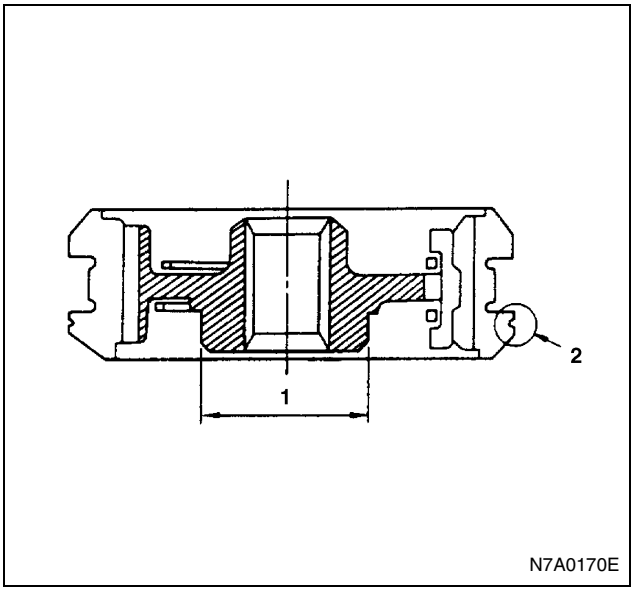
15. Needle Bearing
16. 3rd Gear

- Install with the taper cone side turned upward (front of transmission).

17. Block Ring


N7A0169E

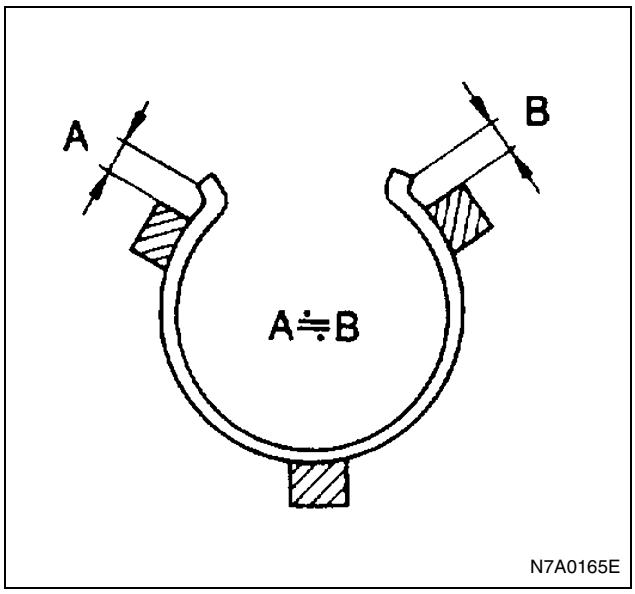
18. 3rd/4th Synchronizer Assembly
    - Mate the clutch hub and the sleeve so that the larger diameter side of the clutch hub boss and the identification groove of the sleeve outer circumference point to the same direction.
    - Put the inserts into the clutch hub groove, and install the insert spring.



N7A0170E

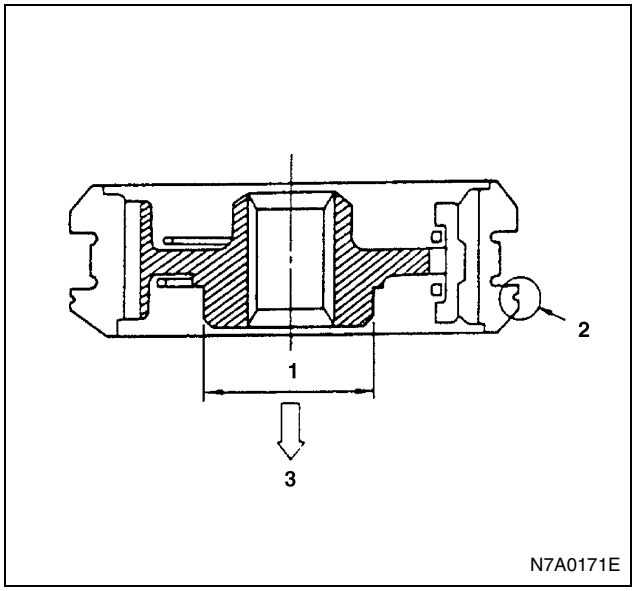
Legend
1. Larger
2. Groove

- Assemble the insert springs so that the distances (A and B) between inserts and the opening of the spring can be nearly equal, and also this opening may not be the same direction on both side.



N7A0165E

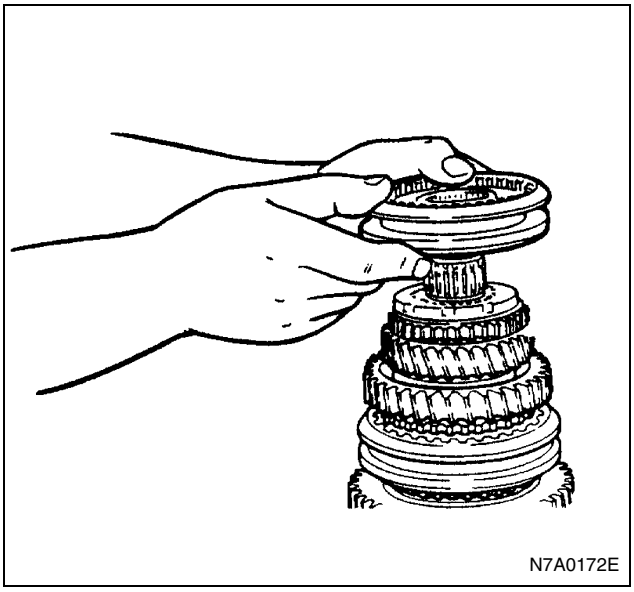
- Grooved face of the sleeve and the larger boss of clutch hub should be positioned toward the 3rd gear (rear of transmission).
- Align the insert groove of the block ring with the insert.



N7A0171E

Legend
1. Larger
2. Groove
3. 3rd gear

- Tap the clutch hub boss section with a plastic hammer to press it in until it contacts closely with the main shaft stepped section.
- When it is difficult to engage the clutch hub boss with the main shaft spline, heat the clutch hub boss section to a temperature between 80 and 120°C (176 and 248°F) with the piston heater before assembling.
- Check to see if the 3rd gear rotates smoothly.

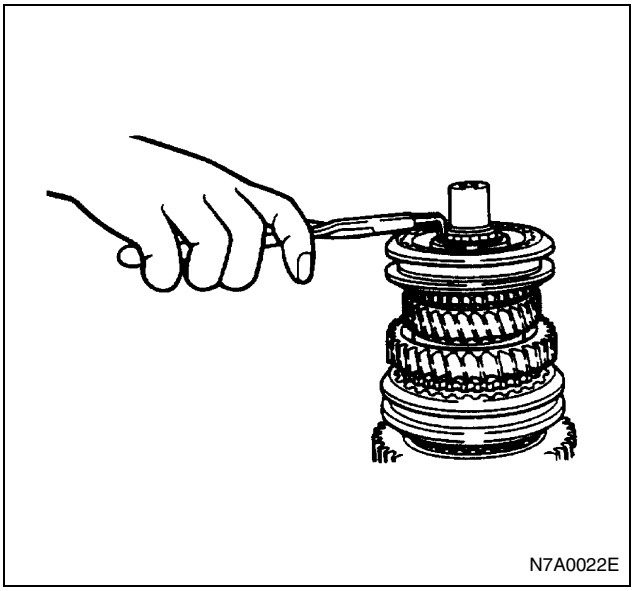

N7A0172E

19. Snap Ring
    - Install the built-in snap ring and measure the clearance between the snap ring and the clutch hub.

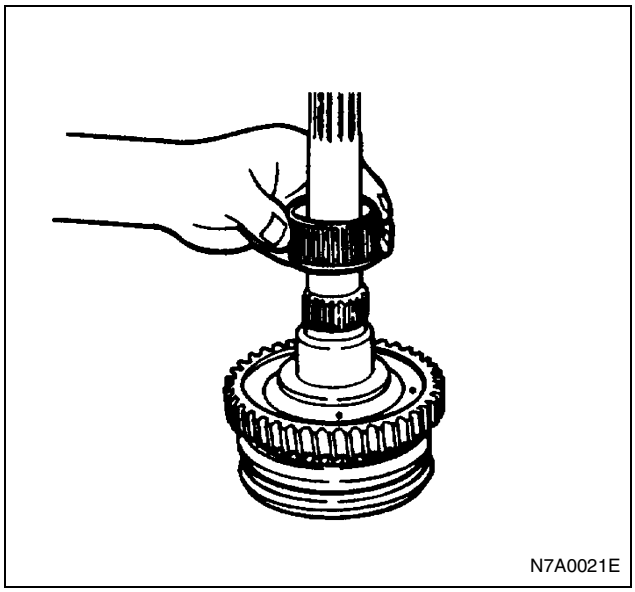
Clutch Hub and Snap Ring Clearance	mm (in)
0 — 0.09 (0 — 0.004)	

- When the clearance is out of the reference value, select a snap ring with the maximum thickness that can be inserted from among the following three types, and built it in.

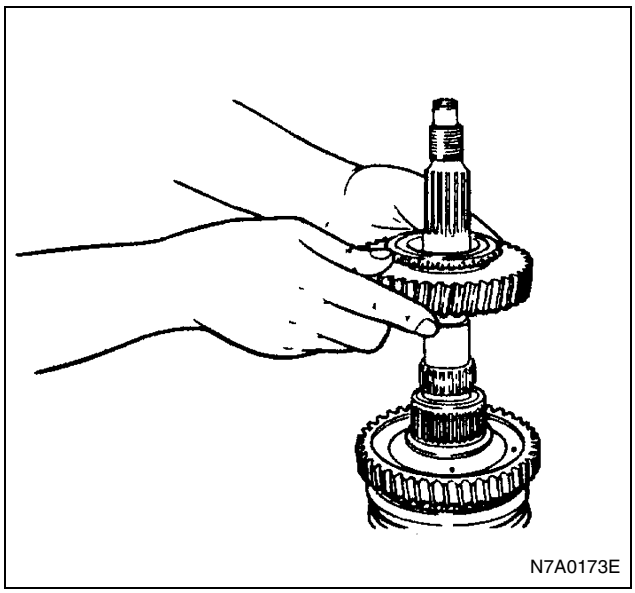
Snap Ring	mm (in)
Color	Thickness (Reference)
Pink	1.75 — 1.80 (0.069 — 0.071)
White	1.80 — 1.85 (0.071 — 0.073)
Yellow	1.85 — 1.90 (0.073 — 0.075)


N7A0022E

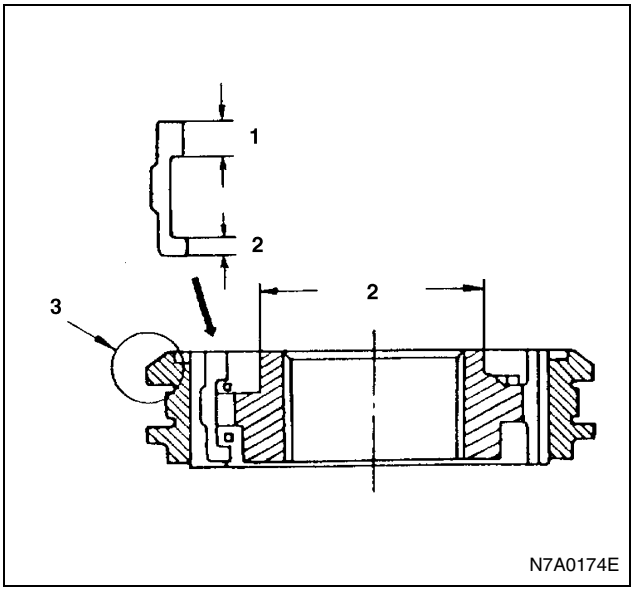
20. Needle Bearing
    - Attach a backing plate to the vise, secure the main shaft at the top end.


N7A0021E

21. Reverse Gear
    - Install with the taper cone side turned upward (rear of transmission).

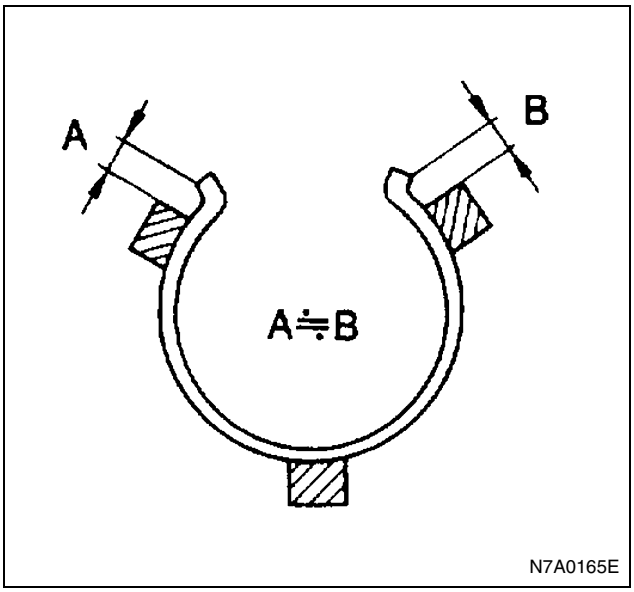

N7A0173E

22. 5th/Reverse Synchronizer Assembly
    - Mate the clutch hub and the sleeve so that the smaller diameter side of the clutch hub boss and the chamfer of the sleeve outer circumference point to the same direction.
    - Put the inserts into the clutch hub groove so that the smaller catch of the insert should be positioned toward the reverse gear (larger diameter side of the clutch hub boss), and install the insert spring.

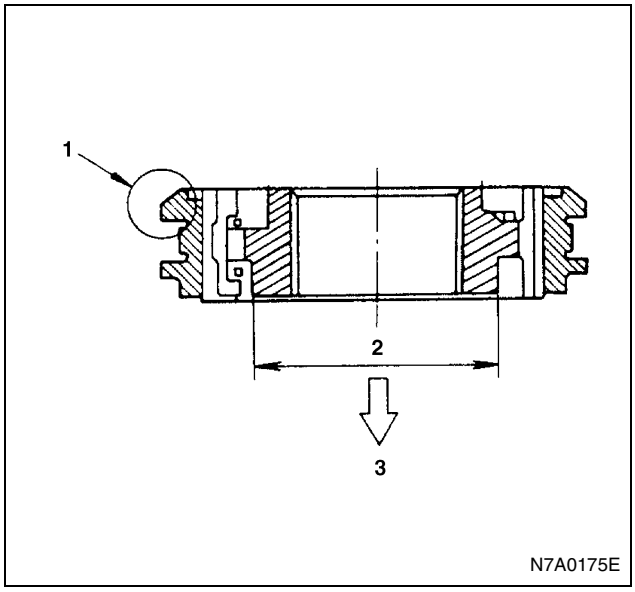


Legend
1. Larger
2. Smaller
3. Chamfer

- Assemble the insert springs so that the distances (A and B) between inserts and the opening of the spring can be nearly equal, and also this opening may not be the same direction on both side.

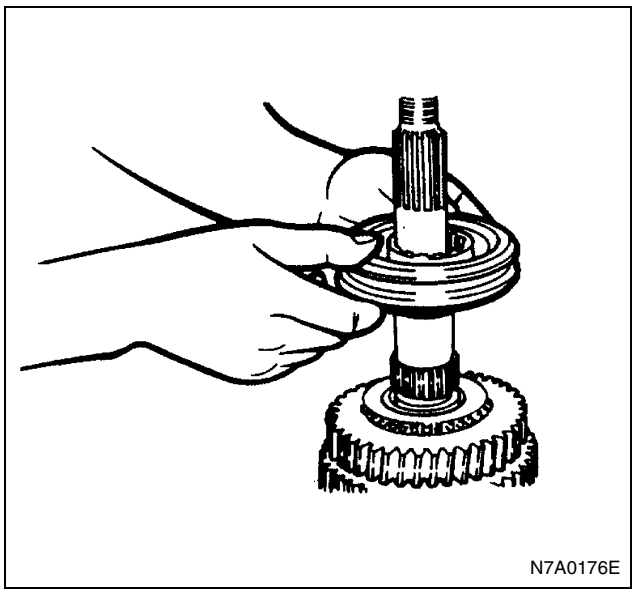


- Face of the clutch hub with larger boss should be positioned toward reverse gear (front of transmission).
- Align the insert with the insert groove of the block ring.



Legend
1. Chamfer
2. Larger
3. Reverse gear

- Tap the clutch hub boss section with a plastic hammer to press it in until it contacts closely with the main shaft stepped section.
- When it is difficult to engage the clutch hub boss with the main shaft spline, heat the clutch hub boss section to a temperature between 80 and 120°C (176 and 248°F) with the piston heater before assembling.
- Check to see if the reverse gear rotates smoothly.

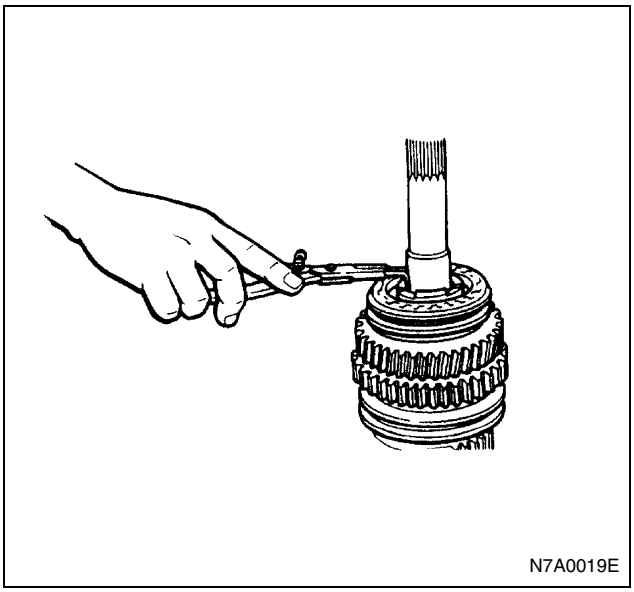


23. Snap Ring
    - Install the built-in snap ring and measure the clearance between the snap ring and the clutch hub.

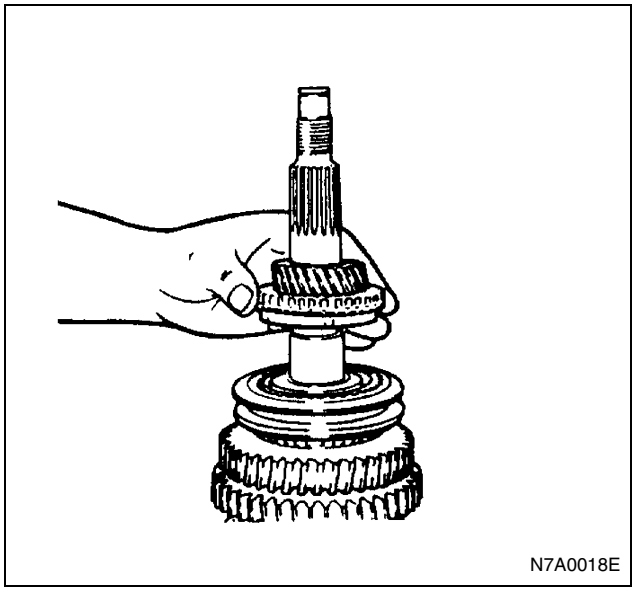
Clutch Hub and Snap Ring Clearance	mm (in)
0 — 0.09 (0 — 0.004)	

- When the clearance is out of the reference value, select a snap ring with the maximum thickness that can be inserted from among the following three types, and built it in.

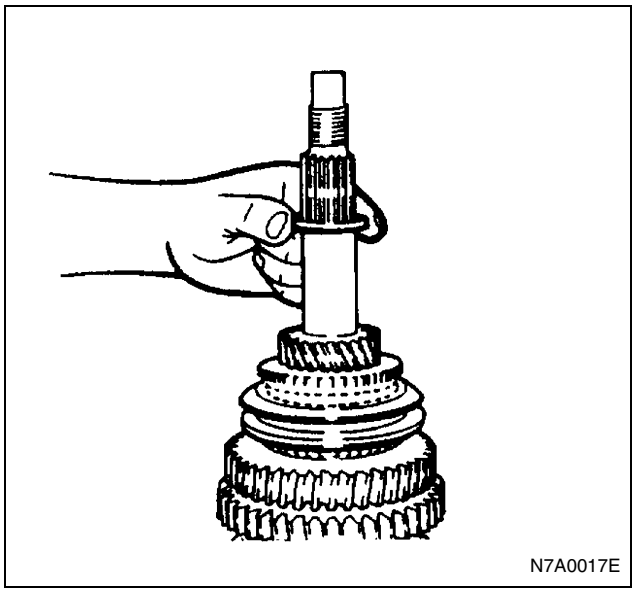
Snap Ring	mm (in)
Color	Thickness (Reference)
Pink	1.75 — 1.80 (0.069 — 0.071)
White	1.80 — 1.85 (0.071 — 0.073)
Yellow	1.85 — 1.90 (0.073 — 0.075)



24. Block Ring
    - Align the insert groove of the block ring with the insert.
25. 5th Gear
    - Install with the taper cone side turned reverse gear side (front of transmission).

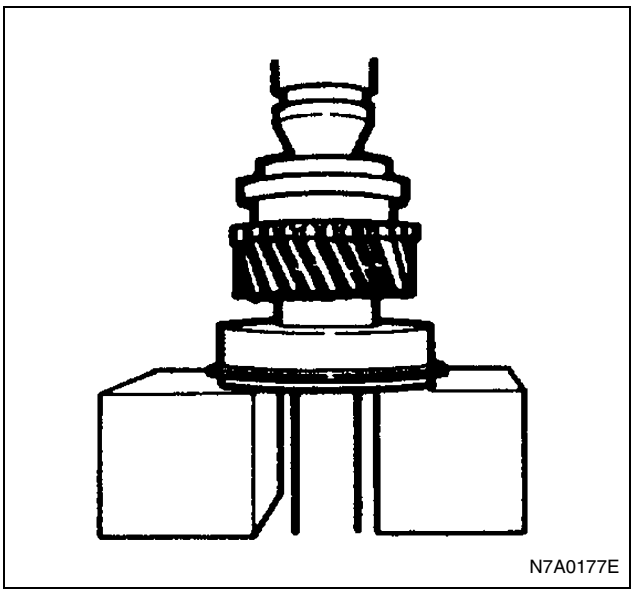


26. Thrust Washer

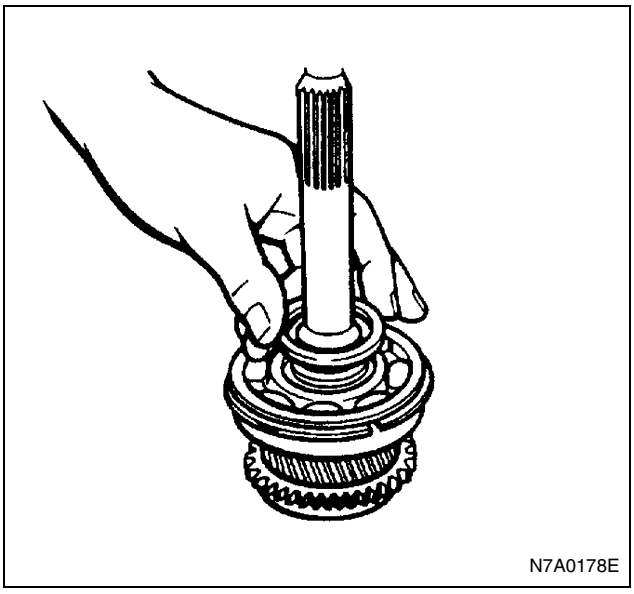


Top Gear Shaft Assembly

27. Ball Bearing
    - Install the ball bearing to the top gear shaft and press it in so that the outer circumference snap ring side turns to the outside (in the direction opposite to the gear).

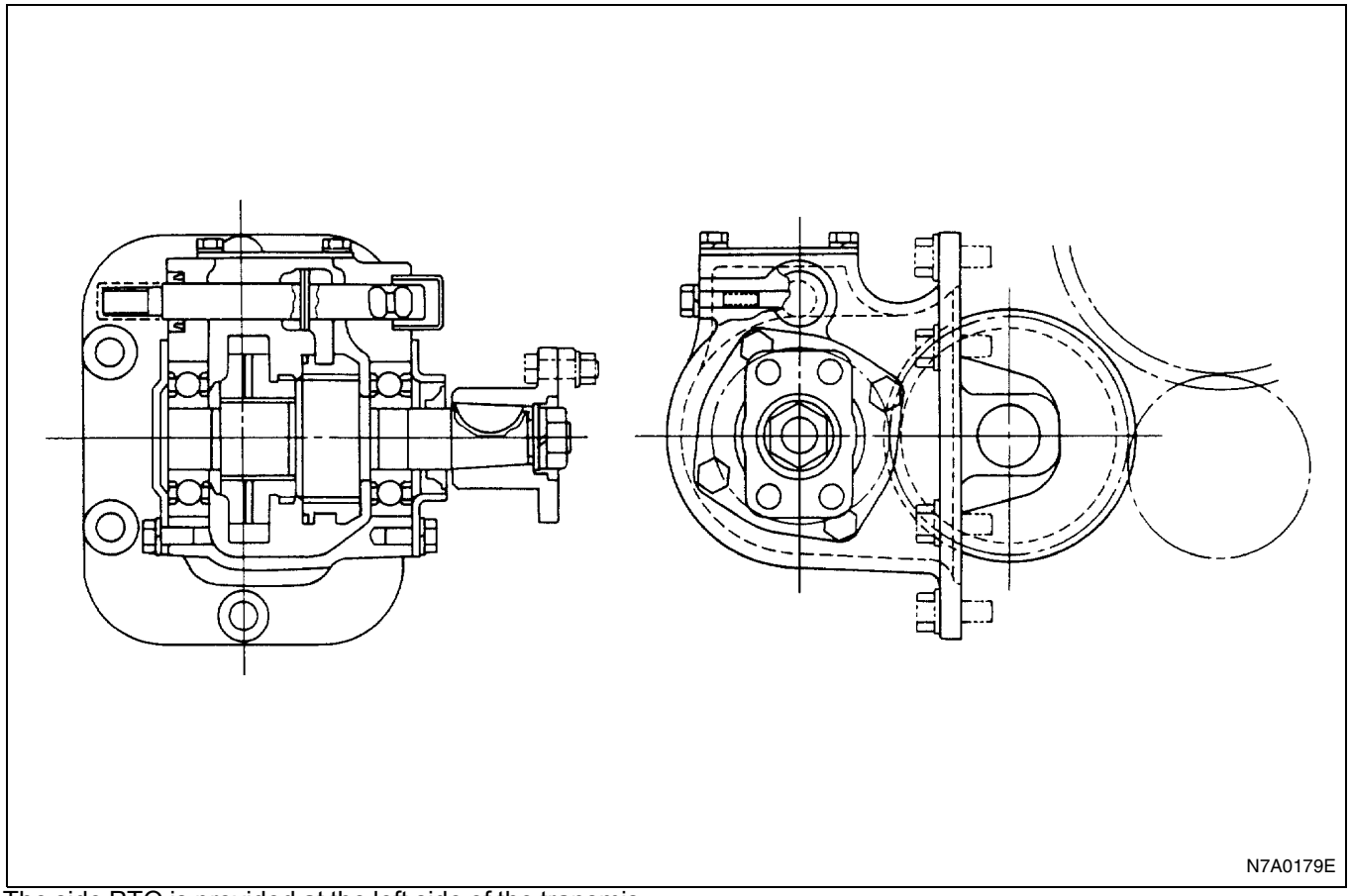

N7A0177E

28. Snap Ring


N7A0178E

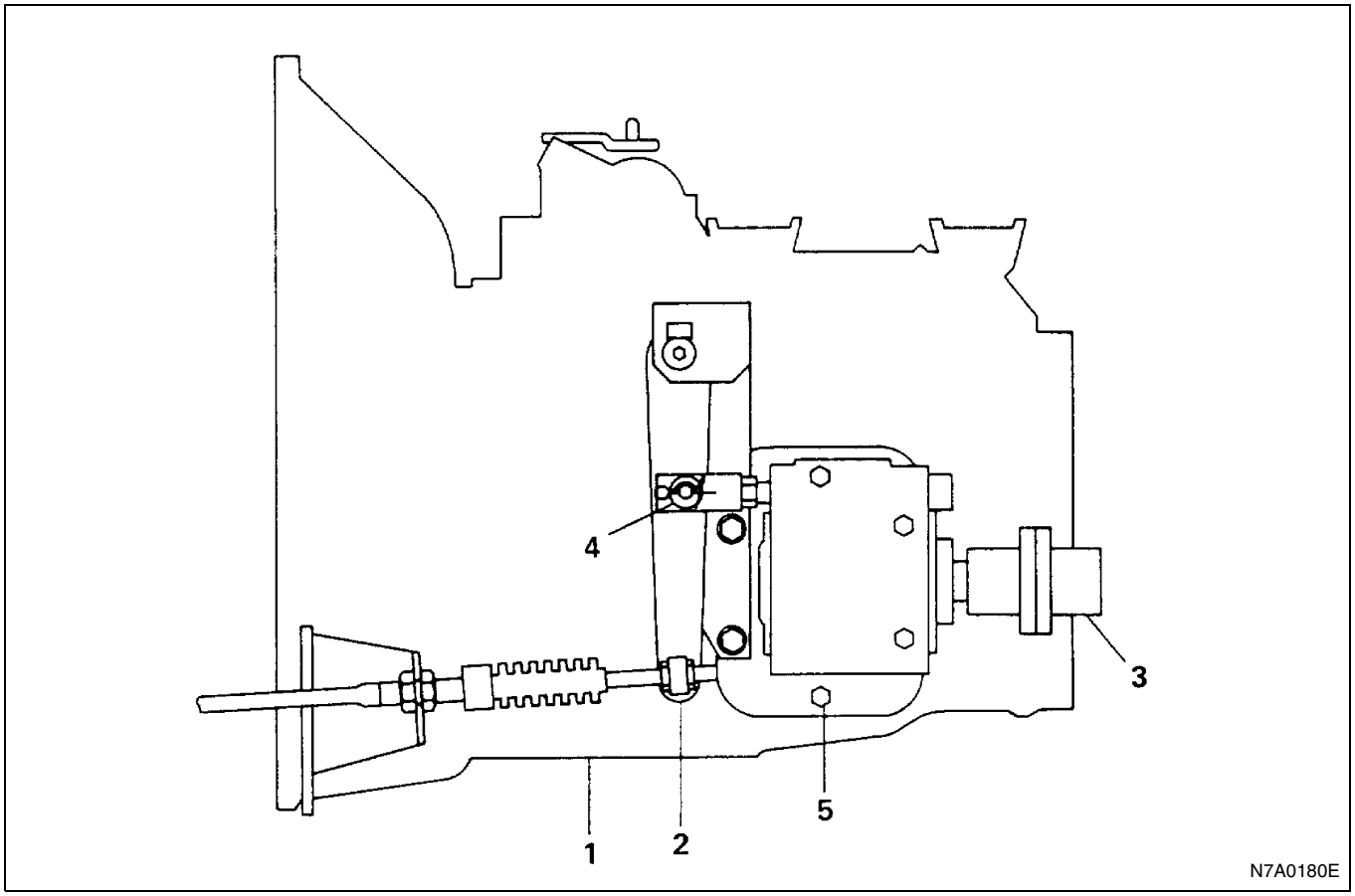
POWER TAKE OFF (PTO)

General Description



The side PTO is provided at the left side of the transmission.
For the gear, the same helical gear as the one used for the transmission is employed to reduce noises.
The roller type needle bearing is employed for the idle shaft and the ball bearing for the output shaft to obtain the increased durability and quietness.
The gear employed is of a constant-mesh type. The gear engagement control (ON/OFF) by a cable is made by the shift rod provided at the upper section of the case, which slides the sleeve on the output shaft through the shaft arm.

Power Take Off (PTO) Replacement



Legend

1. Transmission oil
2. Control cable
3. PTO output propeller shaft
4. Connecting pin
5. PTO assembly

Removal

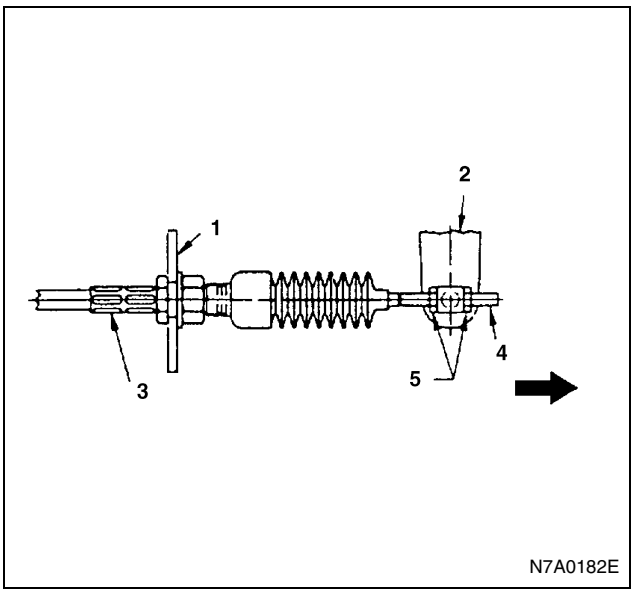
1. Transmission Oil
   - Remove the drain plug from the transmission case and drain the oil.
2. Control Cable
   - Disconnect the control cable from the PTO shift lever.
3. PTO Output Propeller Shaft
   - Disconnect the propeller shaft from the PTO output flange.
4. Connecting Pin
   - Remove the snap pin, washer and the connecting pin from the shift rod and the shift lever.
5. PTO Assembly
   - Remove the 6 PTO fixing bolts, and the PTO assembly.

Installation

1. PTO Assembly
   - Clean and dry on the mating faces before applying the liquid gasket.
   - Apply liquid gasket (Three Bond 1141E or equivalent) to the PTO and transmission surfaces, and both sides of the distance plate (if installed).
   - Install the distance plate (if installed) and PTO with new gasket(s).

Tighten:
PTO bolt to 37 N·m (3.8 kg·m / 27 lb·ft)

2. Connecting Pin
   - Install the connecting pin to the shift rod and shift lever and install the snap pin with washer.
3. PTO Output Propeller Shaft
4. Control Cable
   Inner Cable Adjudtment Type
   1) Fix the outer cable.
   2) Set the PTO shift lever in the OFF position. Be sure to confirm the PTO control lever is in the OFF position (PTO indicator light turned off).
   3) Remove slack from the inner cable by pulling the inner cable in the direction of the arrow.
   4) Tighten the lock nuts.

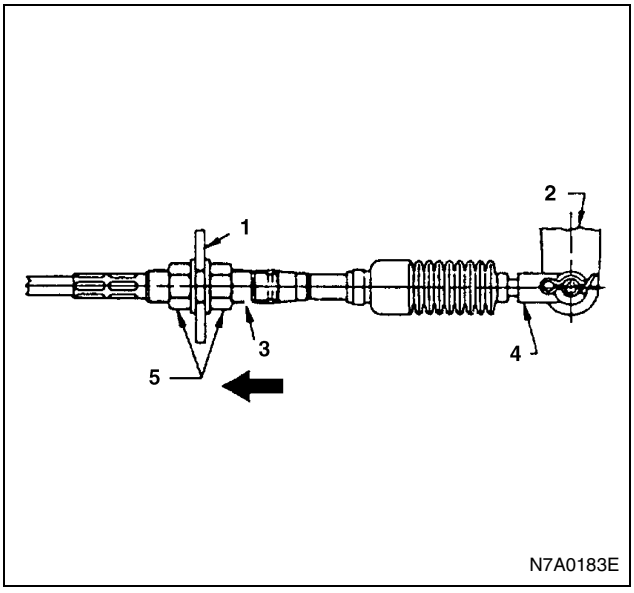


Legend

1. Bracket
2. Shift lever
3. Outer cable
4. Inner cable
5. Lock nut

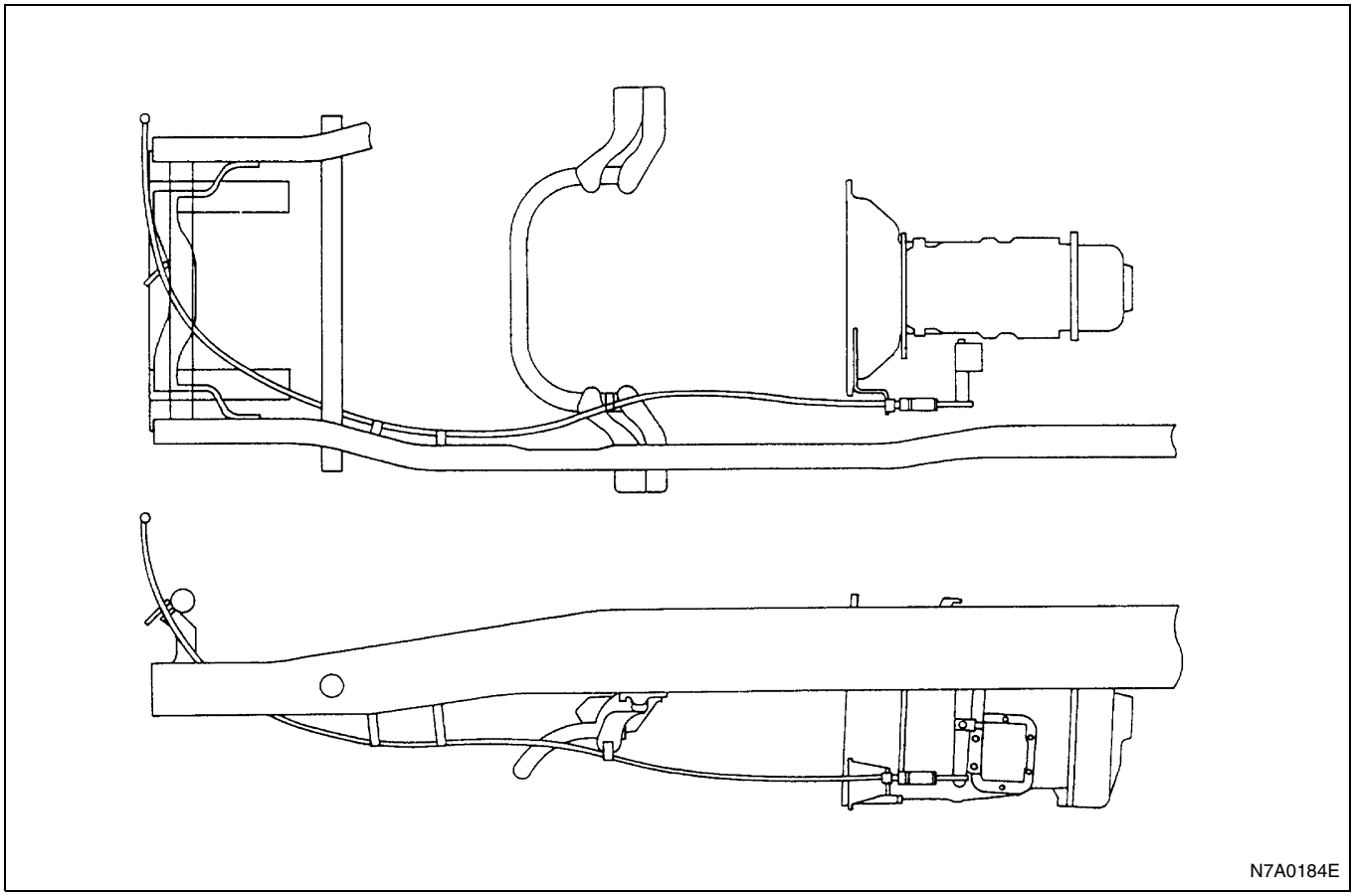
Outer Cable Adjustment Type

1) Set the PTO shift lever in the OFF position. Be sure to confirm the PTO control lever is in the OFF position (PTO indicator light turned off).
2) Connect the inner cable to the PTO shift lever.
3) Remove slack from the inner cable by pulling the outer cable in the direction of the arrow.
4) Tighten the lock nuts.



Legend

1. Bracket
2. Shift lever
3. Outer cable
4. Inner cable
5. Lock nut



5. Transmission Oil
   1) Install the drain plug.

Tighten:
Drain plug to 49 N·m (5.0 kg·m / 36 lb·ft)

   2) Remove the filler plug and fill the transmission case with the specified engine oil through the filler plug hole.

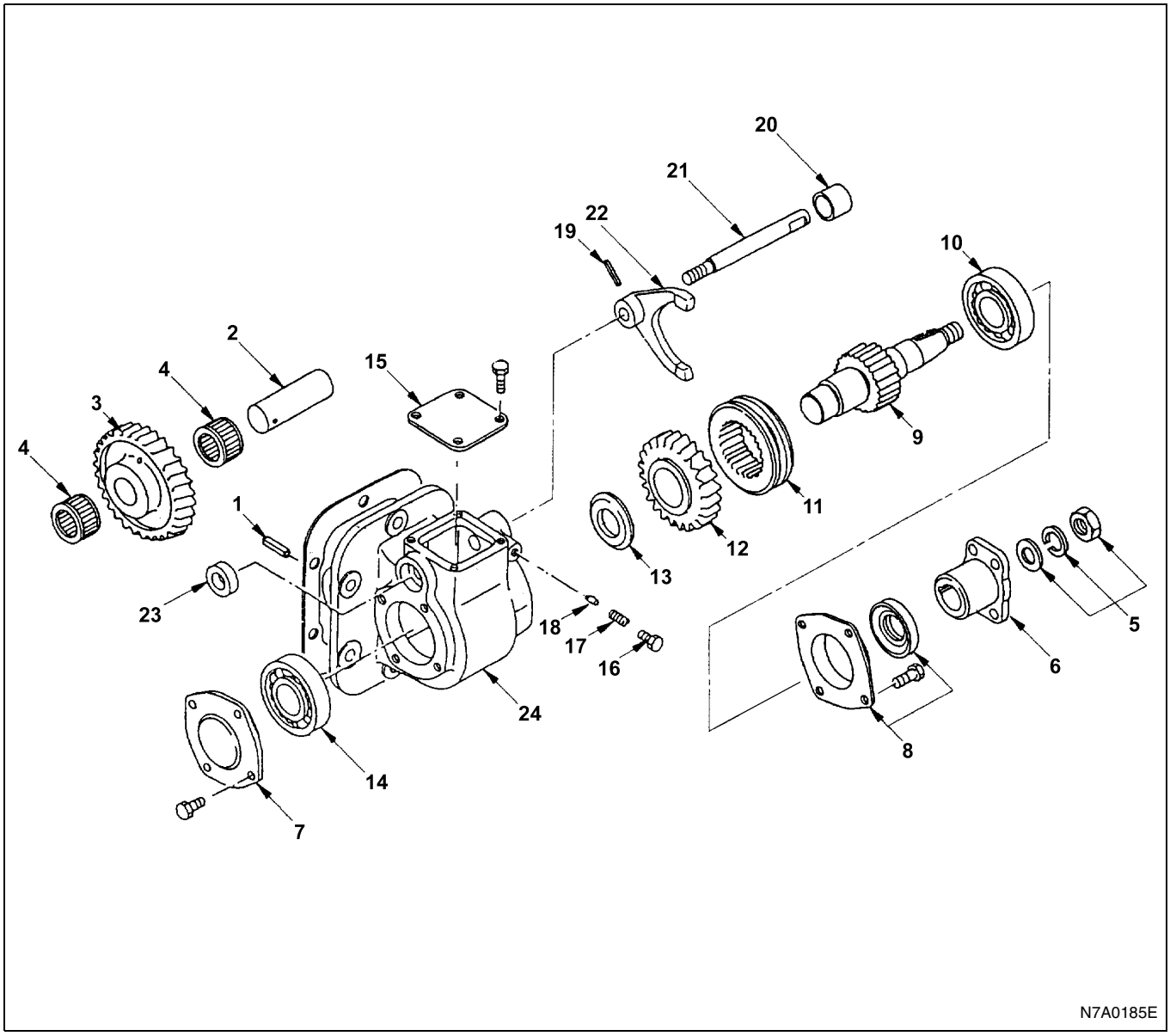
Oil Capacity	Liters (US·qt/Imp·qt)
2.7 (2.9/2.4)	

Caution:
Use ENGINE OIL SAE 5W-30 for transmission case.

   3) Install the filler plug.

Tighten:
Filler plug to 49 N·m (5.0 kg·m / 36 lb·ft)

Unit Repair

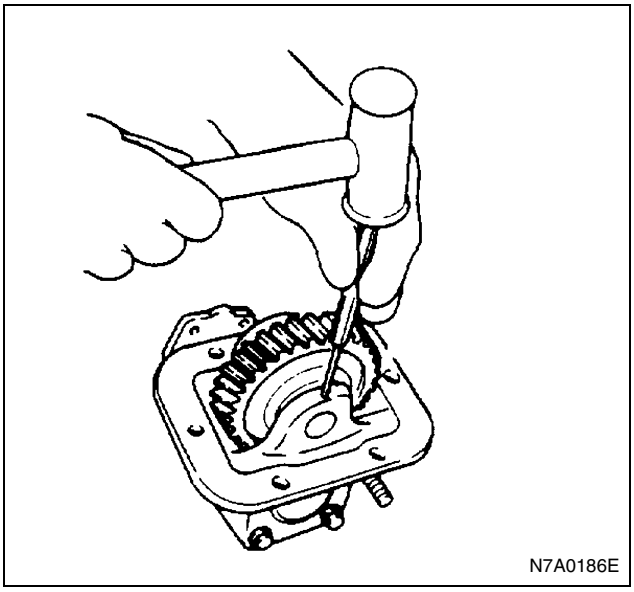


Legend

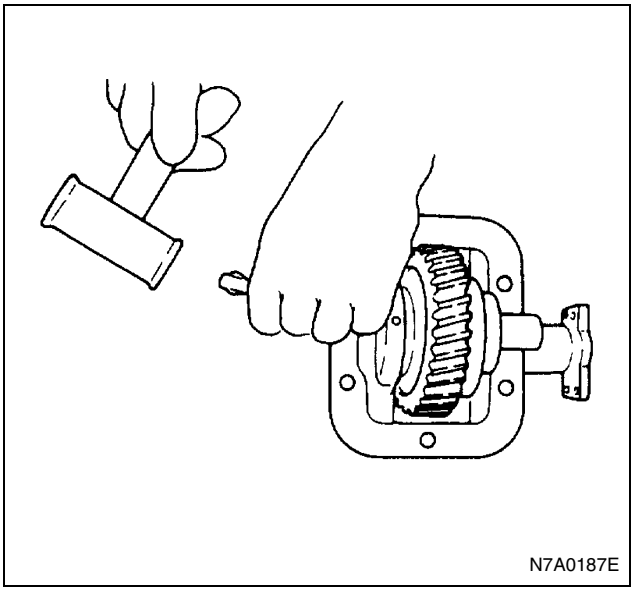
1. Spring pin
2. Idle gear shaft
3. Idle gear
4. Needle bearing
5. Lock nut and washer
6. Coupling driver
7. Front cover
8. Rear cover with oil seal
9. Output shaft
10. Rear bearing
11. Sleeve
12. Output gear with bushing
13. Thrust collar
14. Front bearing
15. Upper cover
16. Plug
17. Detent spring
18. Detent pin
19. Spring pin
20. Shift rod plug
21. Shift rod
22. Shift arm
23. Shift rod oil seal
24. Gear case

Disassembly

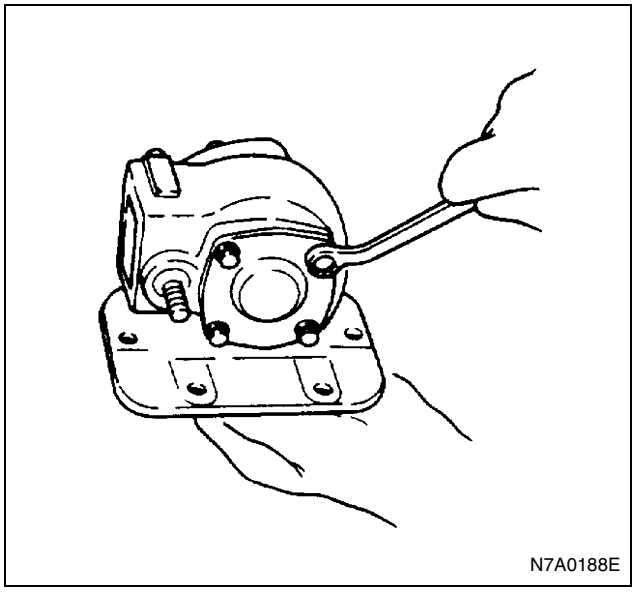
1. Spring Pin
   - Tap the spring pin into the idle shaft.
     Spring Pin Remover: 9-8529-2201-0



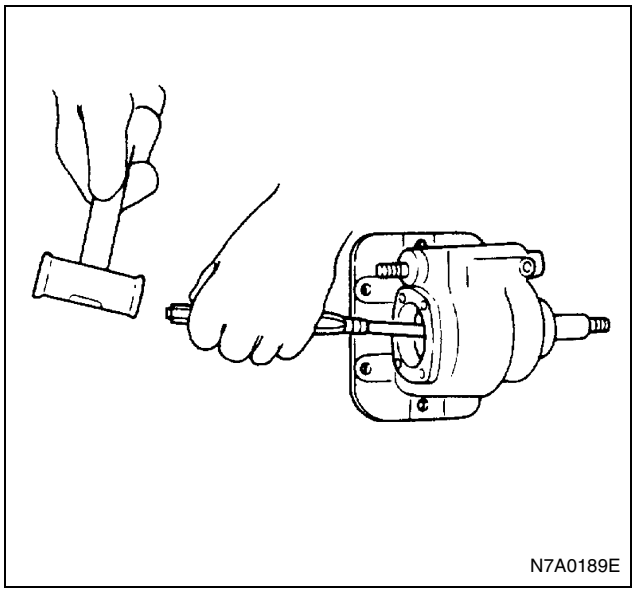
2. Idle Gear Shaft
   - Drive out the idle gear shaft by tapping on its front end with a suitable bar and hammer.
   - Remove the spring pin from the idle gear shaft.
     Spring Pin Remover: 9-8529-2201-0
3. Idle Gear
4. Needle Bearing



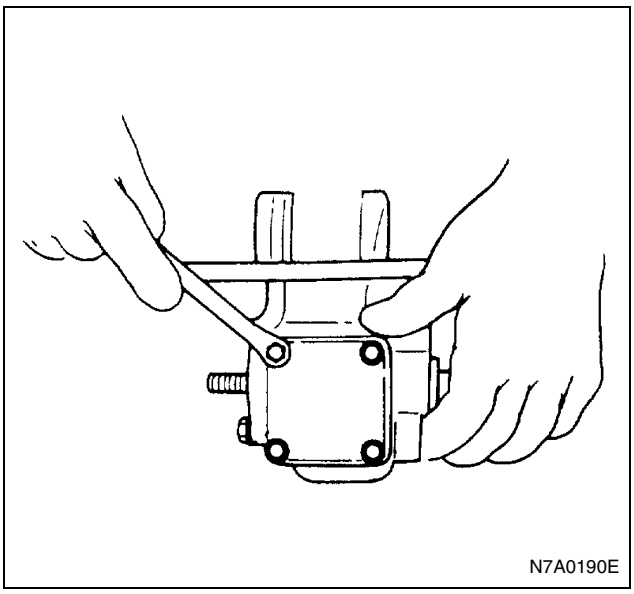
5. Lock Nut and Washer
   - Attach a backing plate to the vice, secure the coupling driver, and remove the lock nut, spring washer and plain washer.
6. Coupling Driver
7. Front Cover



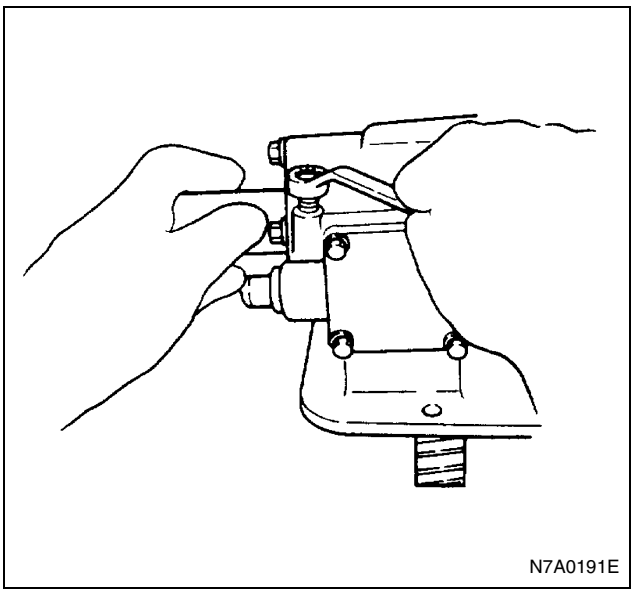
8. Rear Cover (with Oil Seal)
   - Remove the oil seal from the rear cover.
9. Output Shaft
10. Rear Bearing
    - Drive out the output shaft by tapping on its front end with a suitable bar and hammer.
    - Remove the rear bearing from the output shaft.



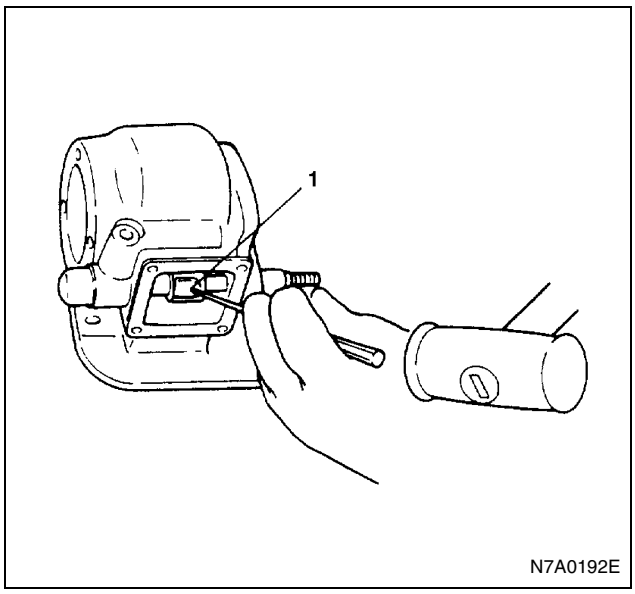
11. Sleeve
12. Output Gear with Bushing
13. Thrust Collar
14. Front Bearing
15. Upper Cover


N7A0190E

16. Plug
17. Detent Spring
18. Detent Pin


N7A0191E

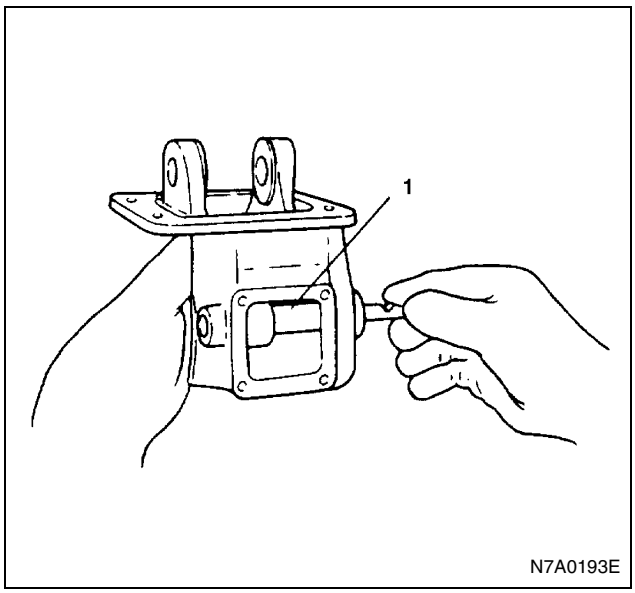
19. Spring Pin
    Spring Pin Remover: 9-8529-2201-0



N7A0192E

Legend
1. Spring pin

20. Shift Rod Plug
21. Shift Rod
22. Shift Arm
    - Move the shift rod (1) rearward by tapping on its front end. Then, remove the each parts.



N7A0193E

23. Shift Rod Oil Seal
24. Gear Case

Inspection and Repair

Make the necessary adjustments, repairs and part replacement if excessive wear or damage is discovered during inspection.

Bearings

Check the each bearing, and replace in either of the following cases.

- Rotation is not smooth.
- Abnormal sound is generated.

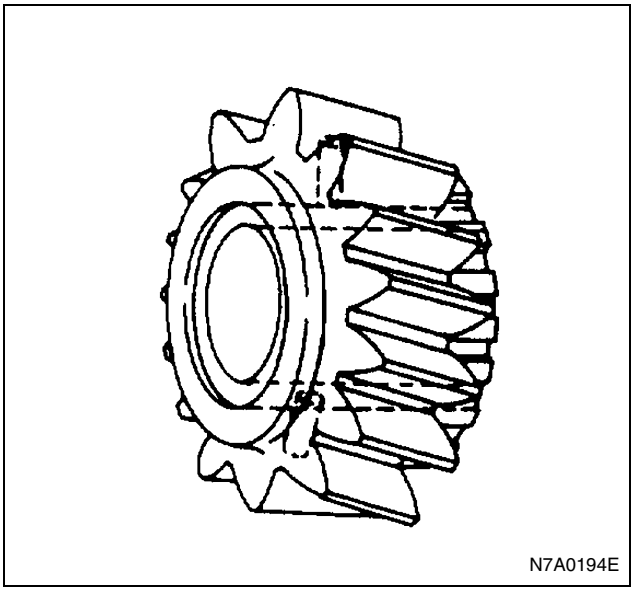
- There is extreme damage or rust.
- Rolling element or rolling contact surface of needle roller bearing is discolored, extremely worn or pitted.

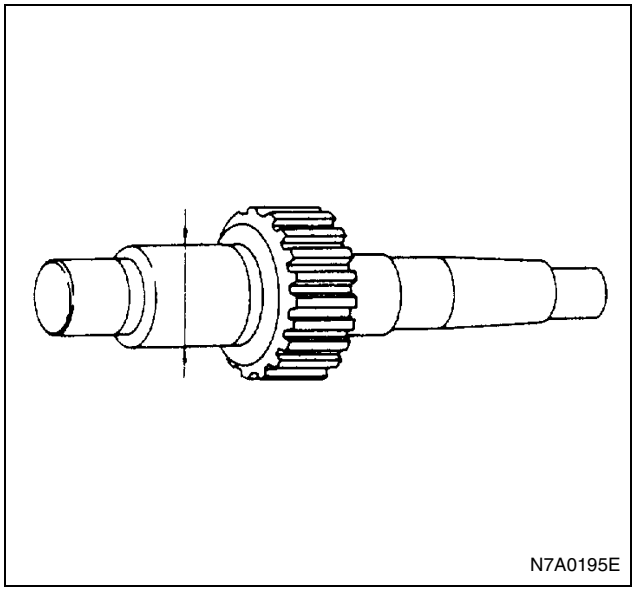
Ball Bearing Run-out	mm (in)
Limit	
0.2 (0.01)	

Gears
Check each gear for the following points. Correct a slight stepped wear or surface roughness with an oil stone or pencil grinder, or replace the gear if unrecoverable damage is found.

- Break or damage of tooth.
- Extreme wear of tooth.

Output Shaft and Output Gear Bushing Clearance	mm (in)
Limit	
0.2 (0.01)	


N7A0194E


N7A0195E

Idle Gear Shaft and Output Shaft
Check the shaft external surface for any damage or wear, and its spline section for wear, damage or bent.
When there is any abnormal condition, or when it is used excessively beyond a proper use limit, replace it with new one.

Shift Mechanism
Inspect all disassembled parts for wear, damage or other abnormal conditions.

- Check the shift rod for wear, bent and damage.
- Check the shift arm for wear or deformation.

Shift Arm Thickness	mm (in)
Standard	Limit
9.0 (0.35)	8.0 (0.31)

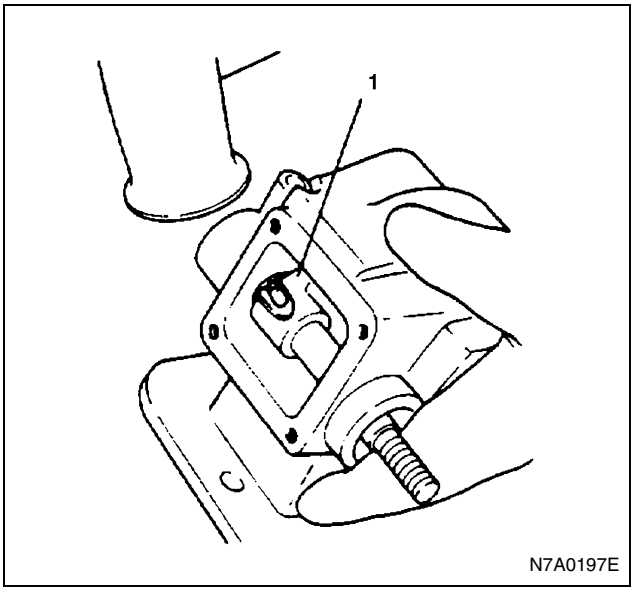
- Check the detent spring and detent pin for wear, weakening and deformation.
- The wear of the shift rod, and the awkward operation of the gear case.

Sleeve
Check the sleeve for any abnormal conditions.
Correct a slight stepped wear or surface roughness with an oil stone or pencil grinder, or replace the sleeve if unrecoverable damage is found.

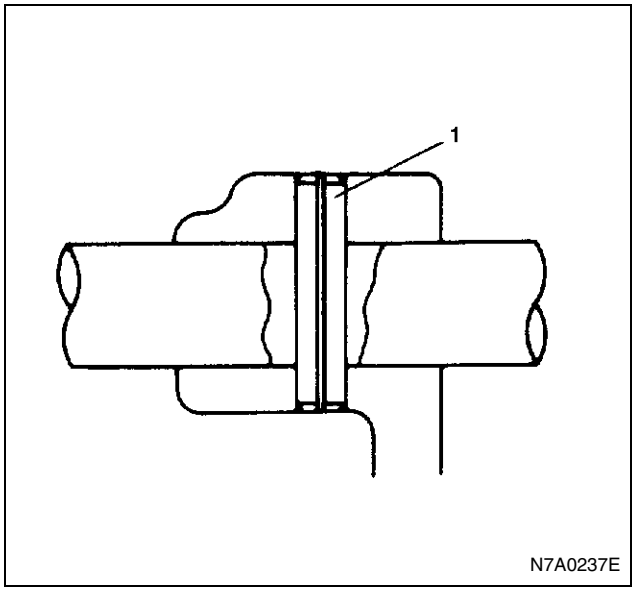
Reassembly

Notice:
Clean each part thoroughly.
When assembling parts, apply clean engine oil (SAE 5W-30) to their sliding and mating sections.

1. Gear Case
2. Shift Rod Oil Seal
   - Clean and dry on the mating faces before applying the liquid gasket.
   - Apply liquid gasket (Three Bond 1141E or equivalent) to the new oil seal outer circumference and apply multi-purpose grease to the oil seal lip.
   - Use the oil seal installer to install the oil seal.
     Oil Seal Installer: 5-8840-2065-0
3. Shift Arm
   - With the boss side of the shift arm (1) set to the rear.



4. Shift Rod
   - Turning the detent groove to the outside (detent pin side), insert the shift rod from the front side with the detent groove side at the front.
5. Spring Pin
   - Setting the hole of the shift arm to that of the shift rod, fix them with a new spring pin (1).

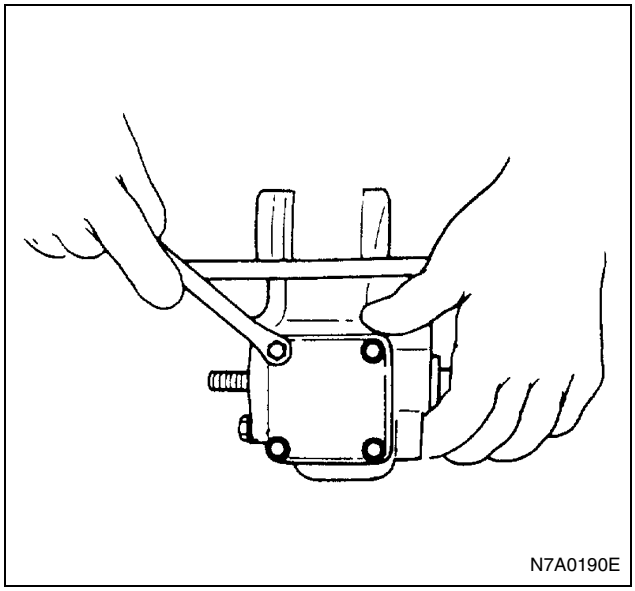


6. Shift Rod Plug
   - Clean and dry on the mating faces before applying the liquid gasket.
   - Apply liquid gasket (LOCTITE 962T or equivalent) to the cap outer circumference.
   - Use the plug installer to install the shift rod cap.
     Plug Installer: 5-8840-2067-0

Notice:
When there is any warp or flaw found with the shift rod cap, replace it with new one.

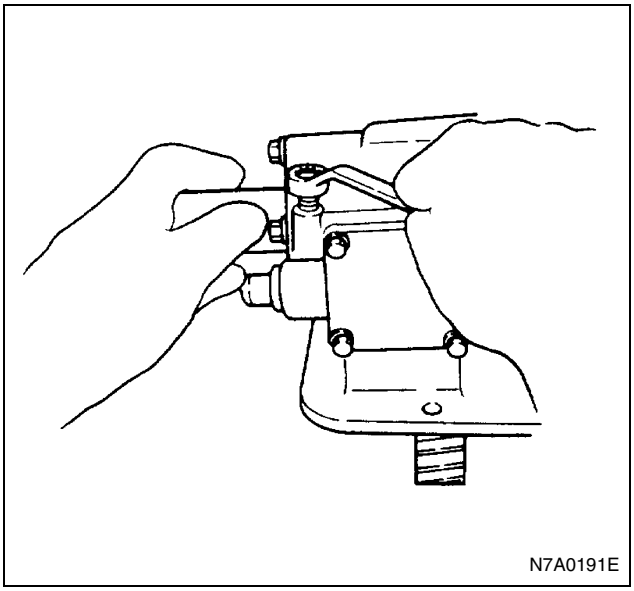
7. Upper Cover
   - Clean and dry on the mating faces before applying the liquid gasket.
   - Apply liquid gasket (FMD-127 or equivalent) to the gear case and upper cover surfaces.
   - Install the upper cover with new gasket.

Tighten:
Upper cover bolt to 25 N·m (2.5 kg·m / 18 lb·ft)

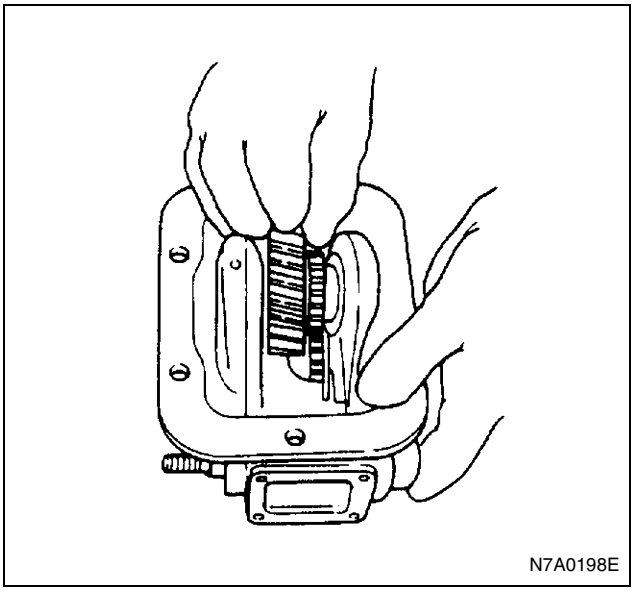


8. Detent Pin
9. Detent Spring
10. Plug
    - Remove sealant from the plug and female threaded surfaces and the surfaces must be perfectly dry.
    - Apply liquid gasket (LOCTITE 242 or equivalent) to the plug's threaded portion.

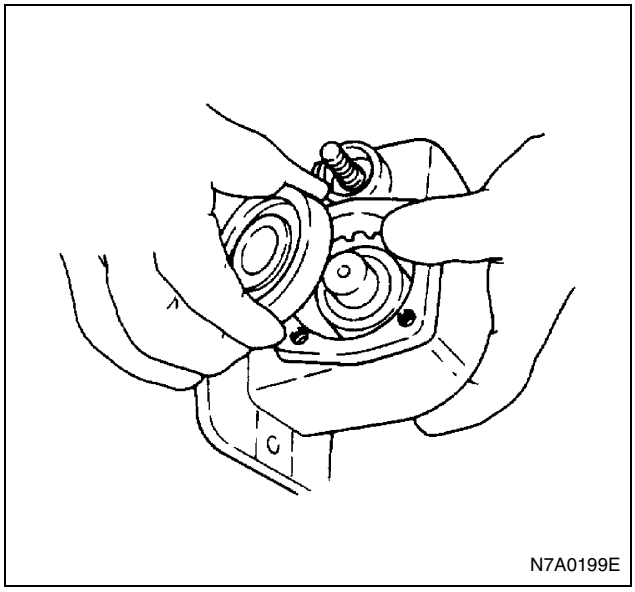
Tighten:
Detent pin plug to 25 N·m (2.5 kg·m / 18 lb·ft)


N7A0191E

11. Output Gear with Bushing
    - Install with the dog gear side turned to the coupling driver side (to the rear).


N7A0198E

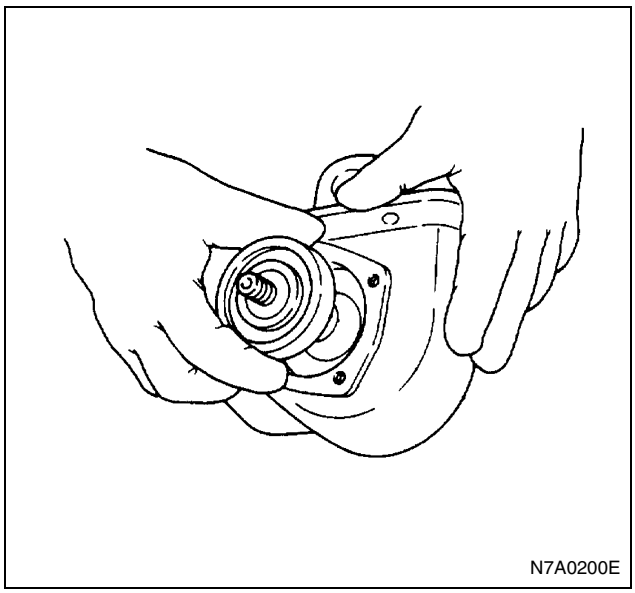
12. Sleeve
    - Chamfer face of the sleeve outer circumference should be positioned toward the coupling driver and assemble the sleeve groove to the shift arm.
13. Output Shaft
14. Thrust Collar
15. Front Bearing
    - Install the thrust collar and front bearing using bearing installer.
      Bearing Installer: 5-8840-2066-0


N7A0199E

16. Front Cover
    - Clean and dry on the mating faces before applying the liquid gasket.
    - Apply liquid gasket (FMD-127 or equivalent) to the gear case and front cover surfaces.
    - Install the front cover with new gasket.
    - Apply liquid gasket (LOCTITE 242 or equivalent) to the fixing bolt's threaded portion.

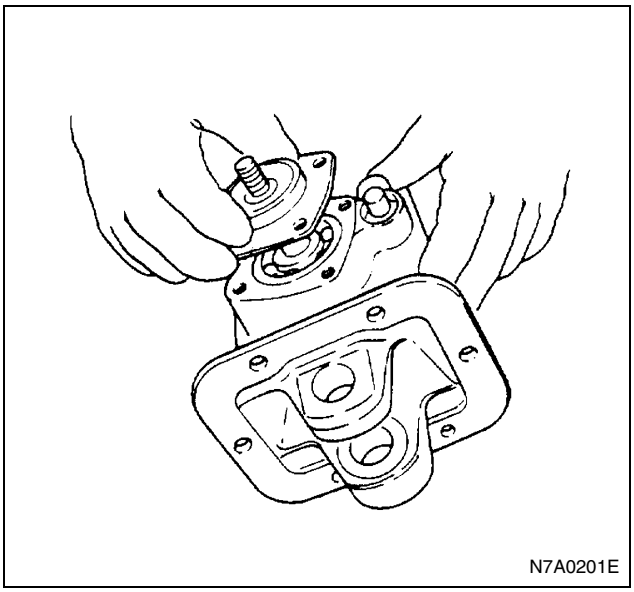
Tighten:
Upper cover bolt to 25 N·m (2.5 kg·m / 18 lb·ft)

17. Rear Bearing
    - Use the bearing installer to install the rear bearing.
      Bearing Installer: 5-8840-2066-0


N7A0200E

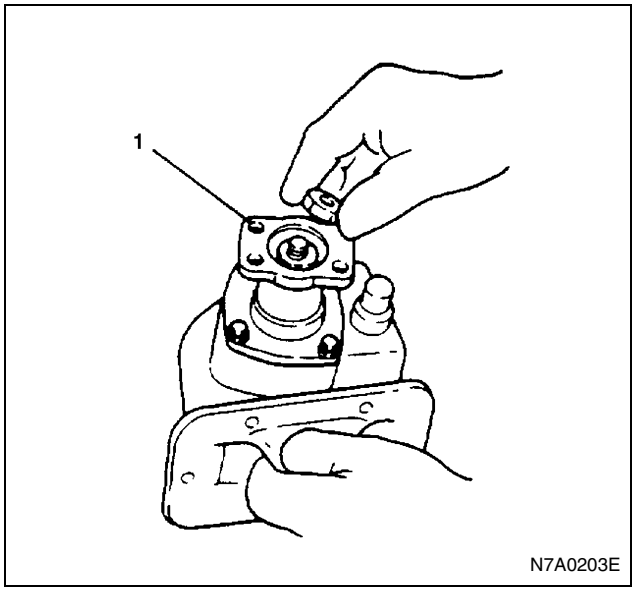
18. Rear Cover
    - Apply liquid gasket (FMD-127 or equivalent) to the new oil seal outer circumference and apply multi-purpose grease to the oil seal lip.
    - Use oil seal installer to install the oil seal to the rear cover.
      Oil Seal Installer: 5-8840-2064-0
    - Apply approx. 3 grams (0.1 ounce) of the Multi-purpose with MOS_2 type grease to the inside of rear cover.
    - Clean and dry on the mating faces before applying the liquid gasket.
    - Apply liquid gasket (Three Bond 1141E or equivalent) to the rear cover and gear case surfaces.
    - Install the rear cover with new gasket.

Tighten:
Rear cover bolt to 25 N·m (2.5 kg·m / 18 lb·ft)


N7A0201E

19. Coupling Driver
20. Lock Nut and Washer
    - Attach a backing plate to the vice, secure the coupling driver, and tighten the lock nut.

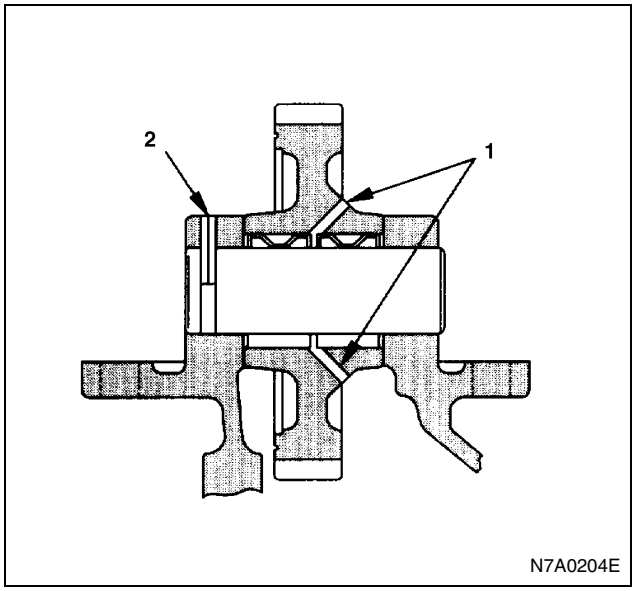
Tighten:
Lock nut to 105 N·m (10.7 kg·m / 77 lb·ft)



N7A0203E

Legend
1. Flange

21. Needle Bearing
22. Idle Gear
    - Install with the oil holes side turned to the rear.
23. Idle Gear Shaft
24. Spring Pin



N7A0204E

Legend
1. Oil hole
2. Spring pin

MANUAL TRANSMISSION AND CLUTCH MSB SERIES

SECTION 7C
CLUTCH

Contents

GENERAL DESCRIPTION 7C-2
Clutch Assembly.....7C-2
Pressure Plate Assembly and Driven Plate Assembly ...7C-2
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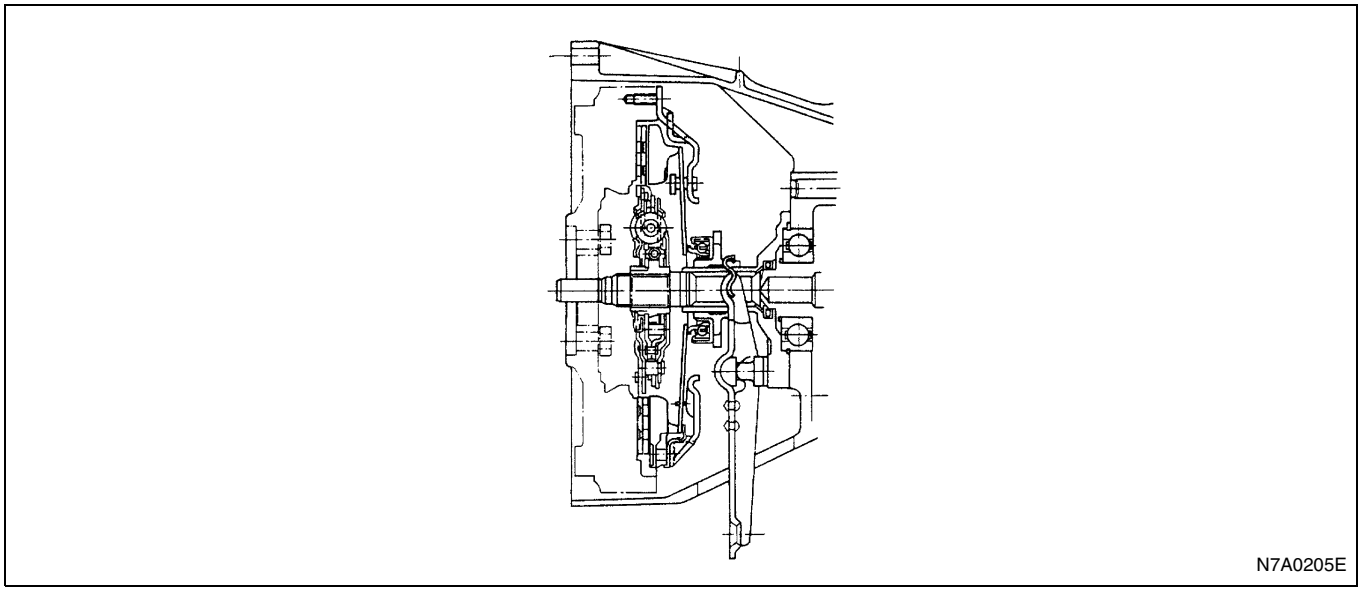
ON-VEHICLE SERVICE 7C-4
Clutch Assembly.....7C-4
Clutch Control.....7C-11
UNIT REPAIR 7C-14
Master Cylinder 7C-14
Slave Cylinder 7C-15

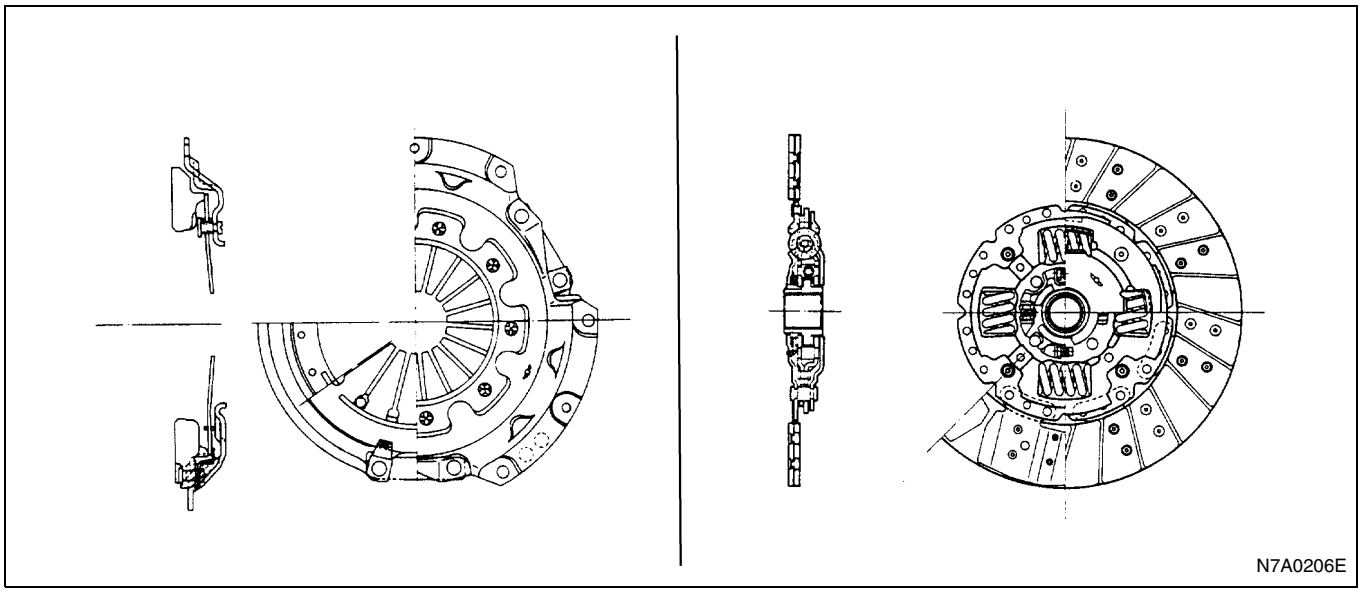
GENERAL DESCRIPTION

Clutch Assembly



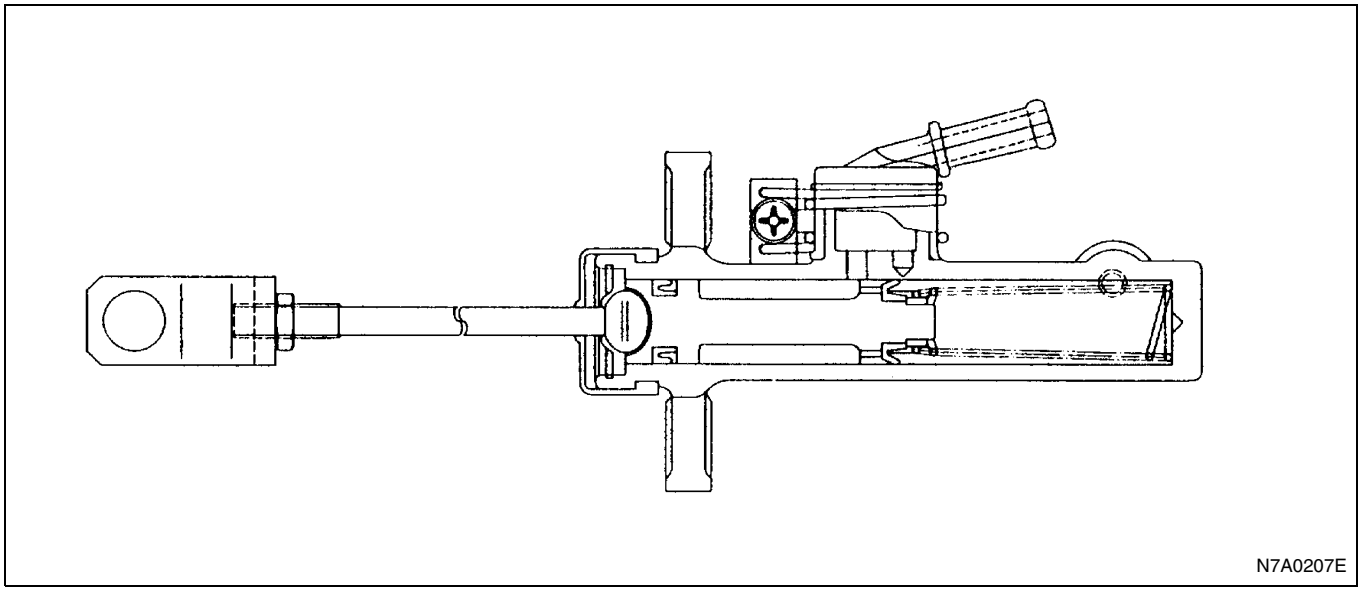
N7A0205E

Pressure Plate Assembly and Driven Plate Assembly

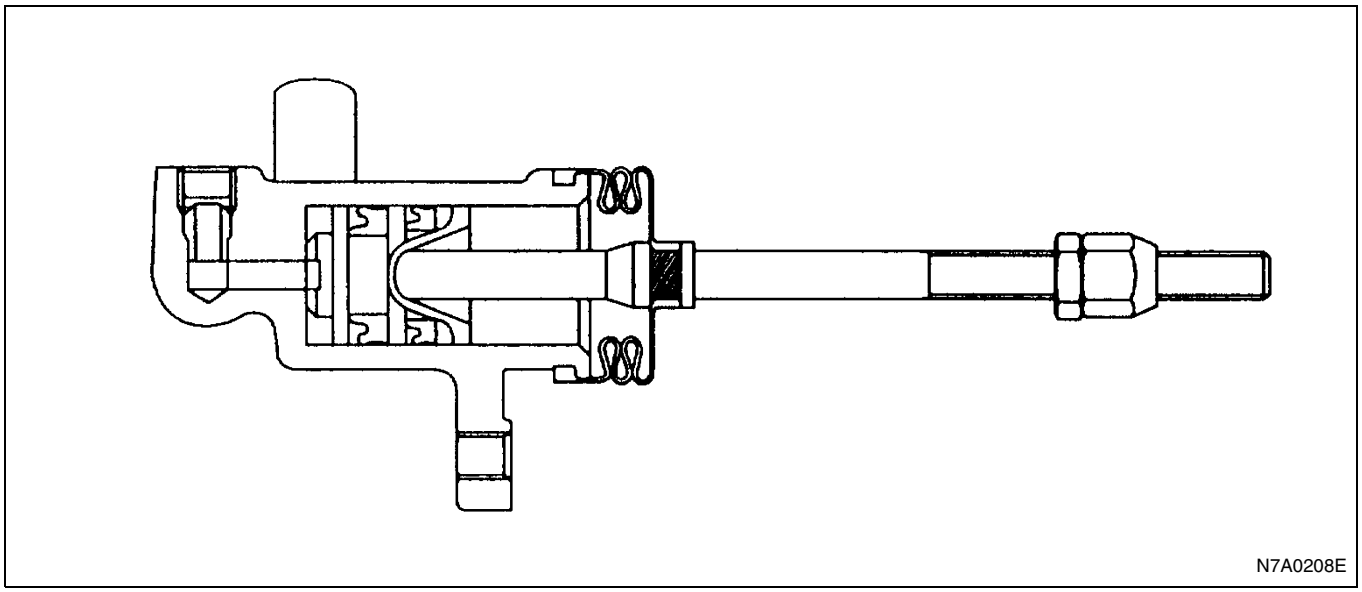


N7A0206E

Master Cylinder

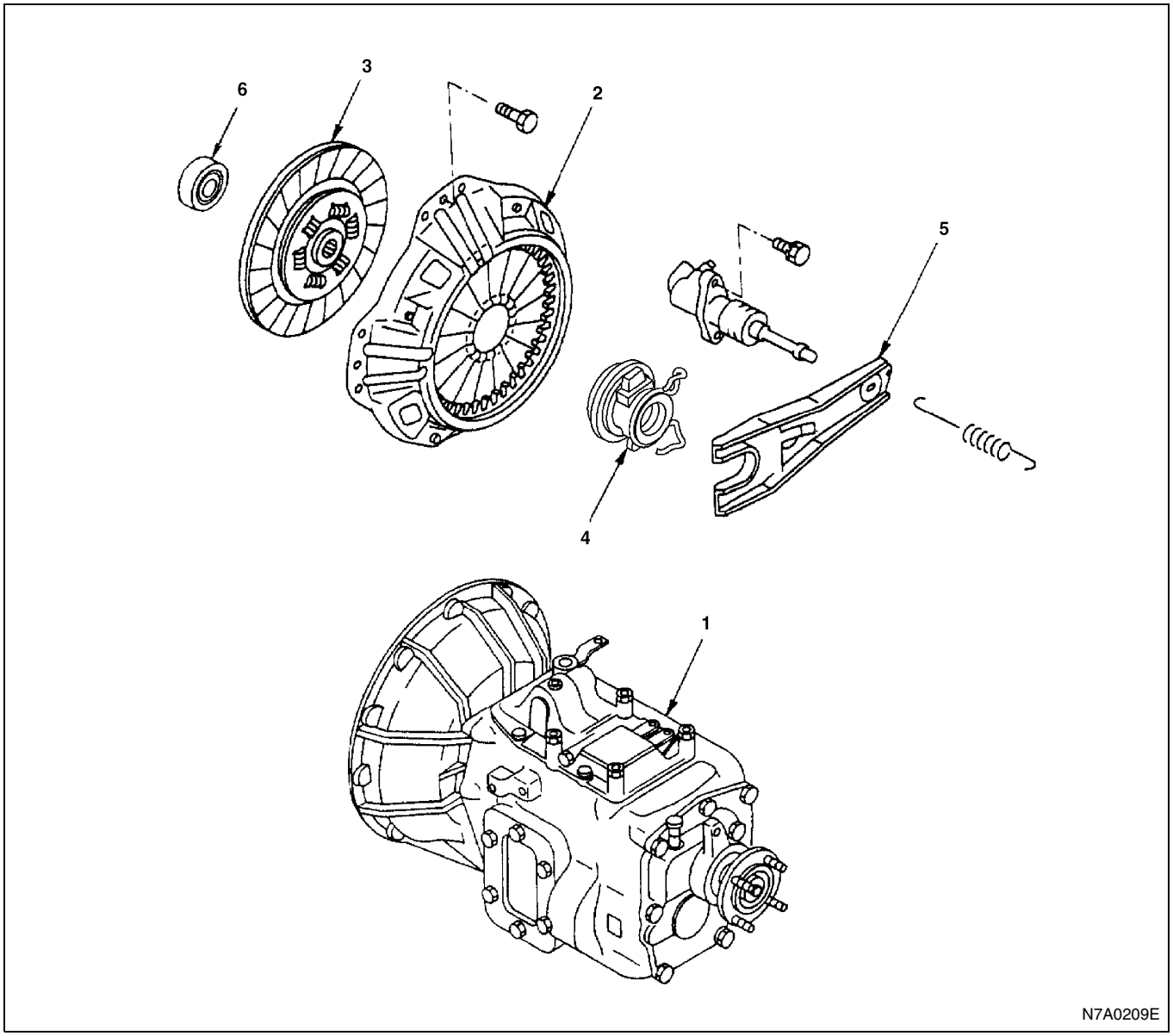


Slave Cylinder



ON-VEHICLE SERVICE

Clutch Assembly



Legend

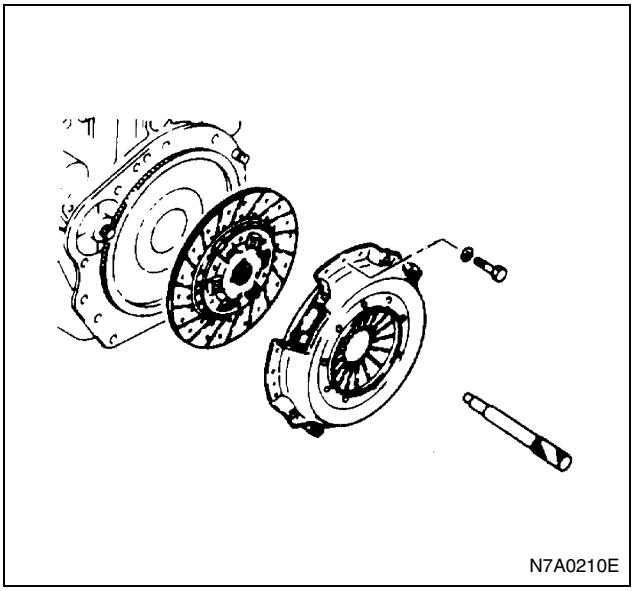
1. Transmission assembly
2. Pressure plate assembly
3. Driven plate assembly
4. Release bearing assembly
5. Shift fork
6. Pilot bearing

Removal

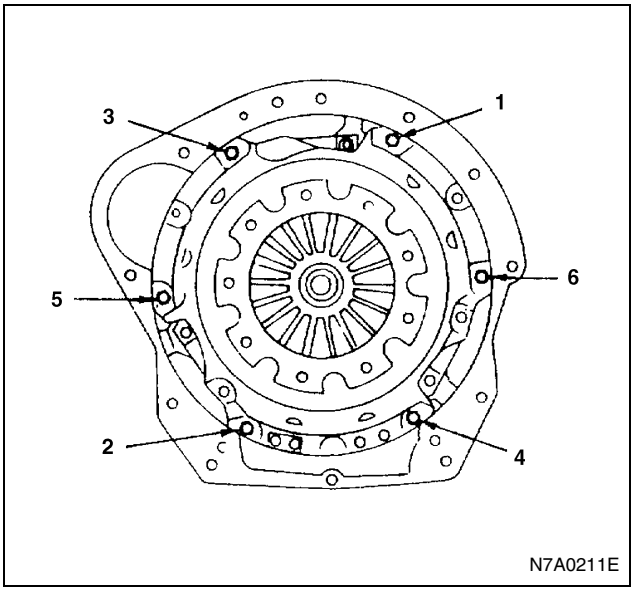
- Raise vehicle and support with suitable safety stands.

Caution:
Do not let clutch fluid remain on a painted surface. Wash it off immediately.

1. Transmission Assembly
   Refer to “SECTION 7B ON-VEHICLE SERVICE: TRANSMISSION ASSEMBLY REPLACEMENT” in this manual.
2. Pressure Plate Assembly
3. Driven Plate Assembly
   - Use the pilot aligner to prevent the driven plate assembly from falling free.
     Pilot Aligner: 5-8525-3001-0
   - Mark the flywheel and pressure plate lug for alignment when installing.


N7A0210E

- Loosen the pressure plate assembly fixing bolts in the numerical order shown in the illustration.

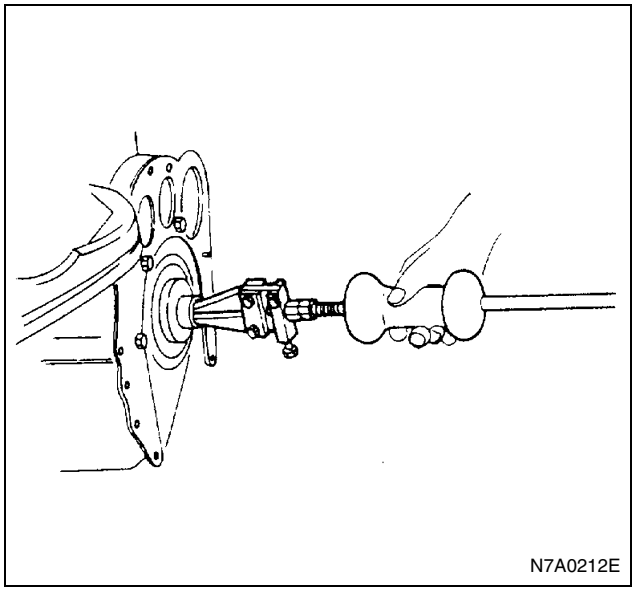


N7A0211E

4. Release Bearing Assembly
5. Shift Fork
6. Pilot Bearing

Notice:
Do not remove pilot bearing unless absolutely necessary.

- Use the pilot bearing remover to remove the pilot bearing.
  Pilot Bearing Remover: 5-8840-2000-0
  Sliding Hammer: 5-8840-0084-0

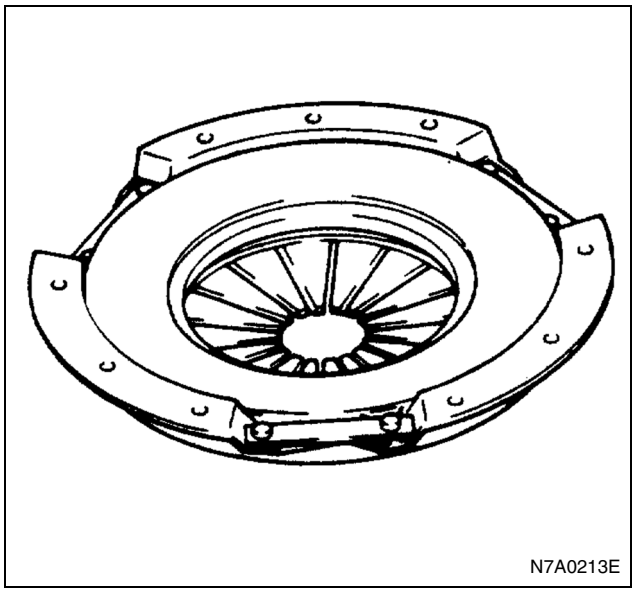

N7A0212E

Inspection and Repair

Make the necessary adjustments, repairs, and part replacement if excessive wear or damage is discovered during inspection.

Pressure Plate Assembly

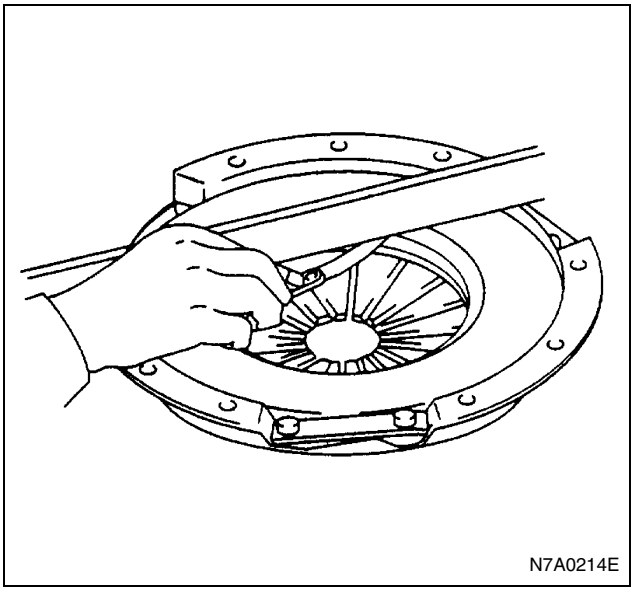
- Visually inspect the pressure plate friction surface for excessive wear and heat cracks. If excessive wear or deep heat cracks are present, the pressure plate assembly must be replaced.


N7A0213E

Pressure Plate Warpage

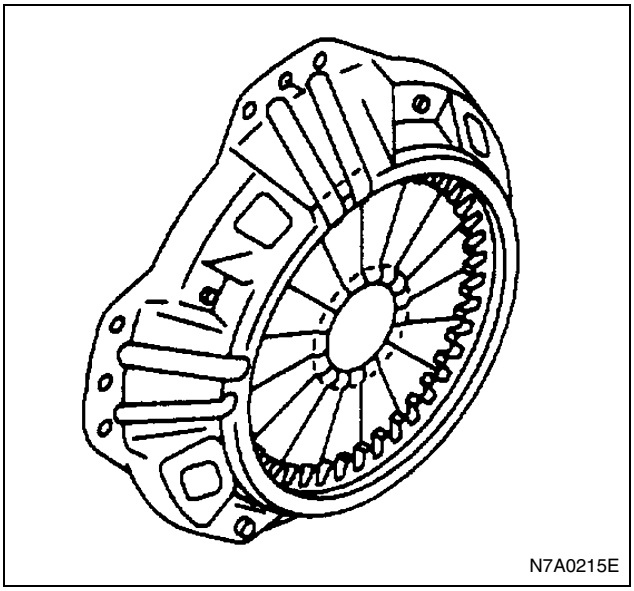
- Use a straight edge and a feeler gauge to measure the pressure plate friction surface flatness in four directions.
  If any of the measured values exceed the specified limit, the pressure plate assembly must be replaced.

Pressure Plate Warpage	mm (in)
Limit	
0.3 (0.01)	



Clutch Cover

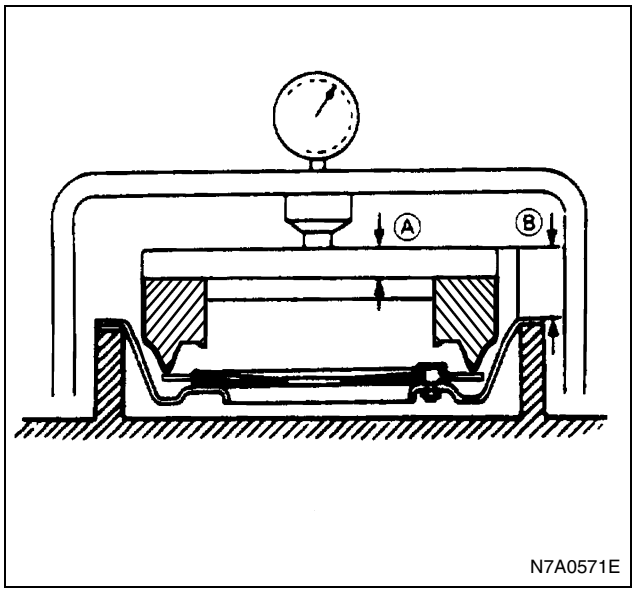
- Visually inspect the entire clutch cover for excessive wear, cracking, and other damage. The pressure plate assembly must be replaced if any of these conditions are present.



Clutch Set Force

1) Invert the pressure plate assembly.
2) Place a metal sheet with thickness “A” on the pressure plate.
3) Compress the pressure plate assembly until the distance “B” becomes specified.

Thickness and Distance		mm (in)
	A	B
NKR55 Clutch Size ϕ 240	7.4 (0.29)	18 (0.71)
NHR55/NKR55/NHR69 Clutch Size ϕ 250	8.0 (0.31)	18 (0.71)



4) Note the pressure plate gauge reading.

Clutch Set Force		N (kg/lb)
	Standard	Limit
NKR55 Clutch Size ϕ 240	4,116 (420/926)	3,785 (386/851)
NHR55/NKR55/NHR69 Clutch Size ϕ 250	6,276 (640/1,411)	5,776 (589/1,299)

Diaphragm Spring Finger Height

1) Place distance pieces beneath the pressure plate and clutch cover.

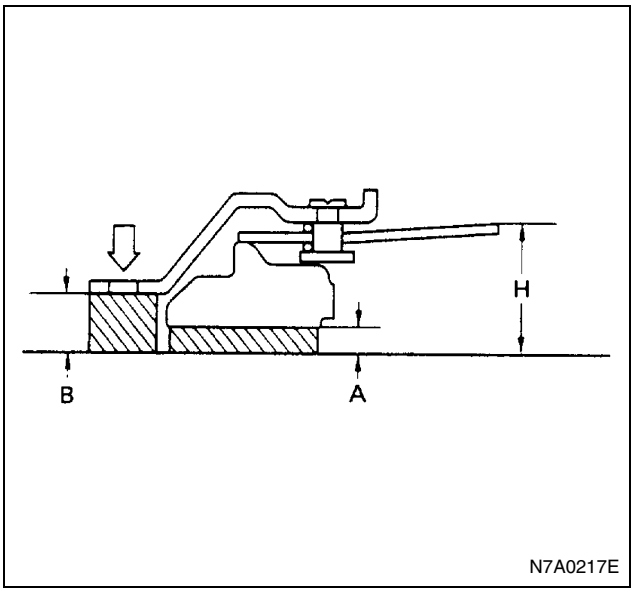
Distance Piece		mm (in)
	A	B
NKR55 Clutch Size ϕ 240	7.4 (0.29)	18 (0.71)
NHR55/NKR55/NHR69 Clutch Size ϕ 250	8.0 (0.31)	18 (0.71)

2) Fully compress the pressure plate assembly. There are two ways to do this.

a. Use a bench press to press down on the pressure plate assembly from the top.
b. Tighten the pressure plate assembly fixing bolts.

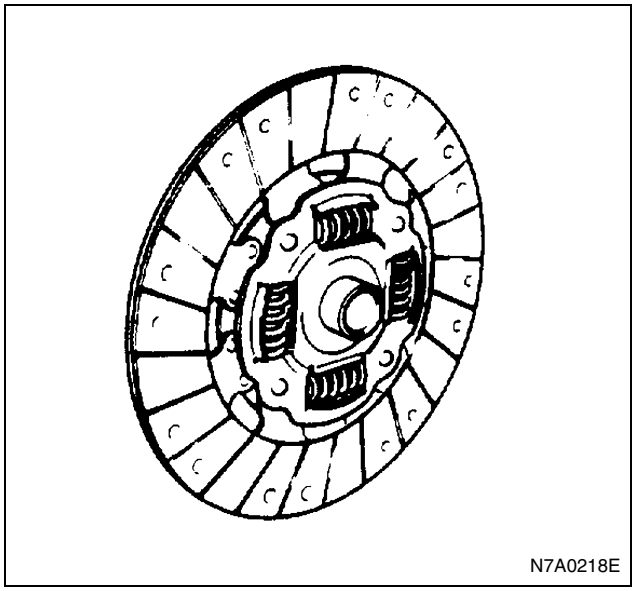
3) Measure the spring finger height from base to spring tip.

Spring Finger Height (H)	mm (in)
	Standard
NKR55 Clutch Size ϕ 240	40.7 — 42.7 (1.60 — 1.68)
NHR55/NKR55/NHR69 Clutch Size ϕ 250	39.0 — 41.0 (1.54 — 1.61)



Driven Plate Assembly

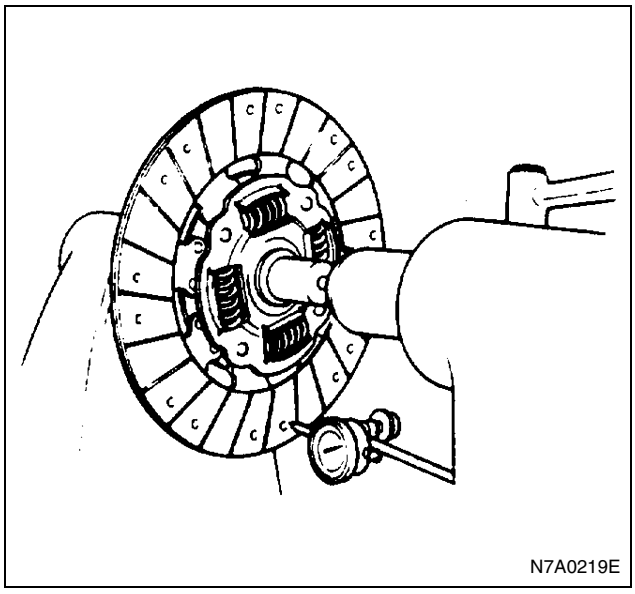
- Visually inspect the torsion spring for looseness, breakage, and weakening.
  If any of these conditions are discovered, the driven plate assembly must be replaced.
- Visually inspect the facing surfaces for cracking and excessive scorching.
  Visually inspect the facing surfaces for the presence of oil or grease.
  If any of these conditions are discovered, the facing must be cleaned or the driven plate assembly replaced.
- Check that the driven plate moves smoothly on the transmission top gear shaft spline.
  Minor ridges on the top gear shaft spline may be removed with an oil stone or pencil grinder.



Driven Plate Warpage

- Insert the pilot aligner into the driven plate spline hub.
  The pilot aligner must be held perfectly horizontal.
  Pilot Aligner: 5-8525-3001-0
- Set a dial indicator to the driven plate outside circumference.
- Slowly turn the driven plate.
  Read the dial indicator as you turn the driven plate.
  If the measured value exceeds the specified limit, the driven plate assembly must be replaced.

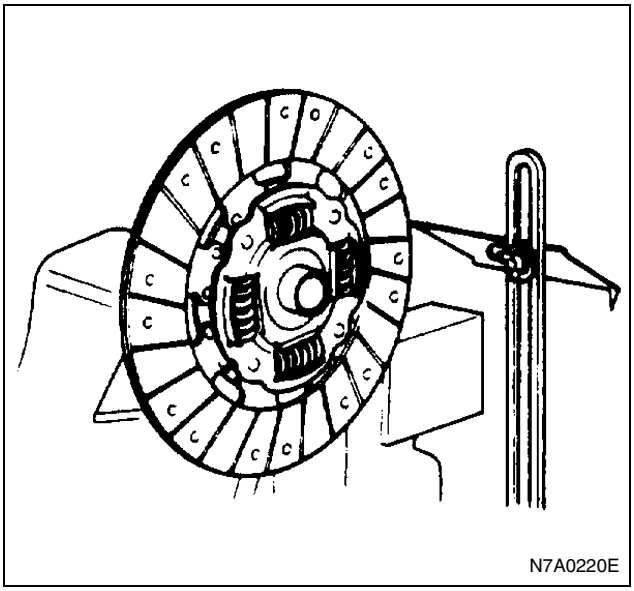
Driven Plate Warpage	mm (in)
Standard	Limit
Less than 0.7 (0.03)	1.0 (0.04)



Driven Plate Splined Hub Spline Wear

- Clean the driven plate splined hub.
- Install the driven plate to the transmission top gear shaft spline.
- Set a surface gauge to the driven plate outside circumference.
- Slowly turn the driven plate. Measure the spline rotation play as you turn the driven plate.
  If the measured value exceeds the specified limit, the driven plate assembly must be replaced.

Driven Plate Splined Hub Spline Wear	mm (in)
Standard	Limit
Less then 0.5 (0.02)	1.0 (0.04)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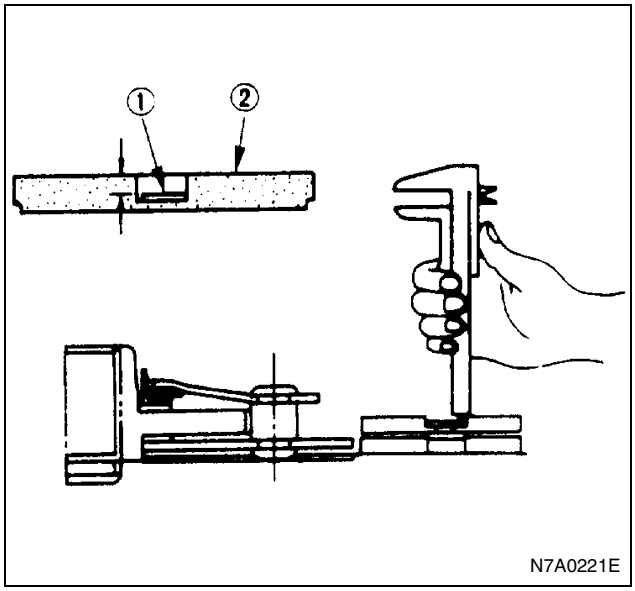
Driven Plate Rivet Head Depression

- Use the depth gauge or a straight edge with steel rule to measure the rivet head depression (1) from the facing surface (2).
  Be sure to measure the rivet head depression (1) on both sides of the driven plate (2).
  If the measured value is less than the specified limit, the driven plate must be replaced.

Rivet Head Depression		mm (in)
	Standard	Limit
NKR55 Clutch Size ϕ 240	1.1 — 1.7 (0.04 — 0.07)	0.2 (0.01)
NHR55/NKR55/NHR69 Clutch Size ϕ 250	1.65 — 2.25 (0.06 — 0.09)	0.2 (0.01)



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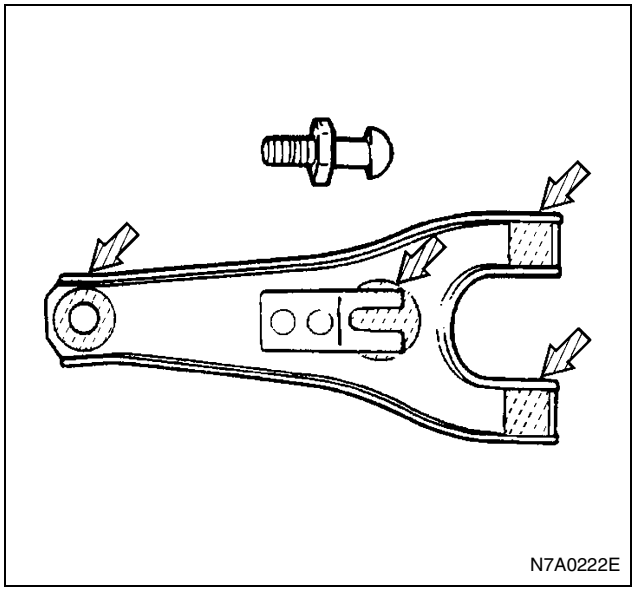
Shift Fork and Support Bolt

- Visually inspect the surfaces of the shift fork making contact with the shift block (release bearing) and support bolt.
- Correct a slight stepped wear or surface roughness with an oil stone or pencil grinder, or replace the shift fork and/or support bolt if unrecoverable damage is found.
- Apply multi-purpose with MOS_2 type grease.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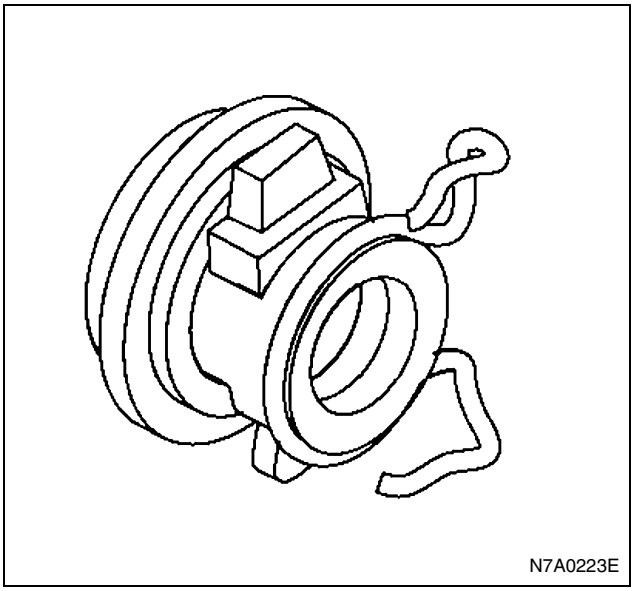
Release Bearing Assembly

- Visually inspect the release bearing assembly for breakage and weakening.
- If any of these conditions are discovered, release bearing assembly must be replaced.

Caution:
The release bearing is permanently packed with lubricant and should not be soaked in cleaning solvent, as this will dissolve the lubricant.

Notice:
Do not disassemble the shift block assembly if no fault is apparent.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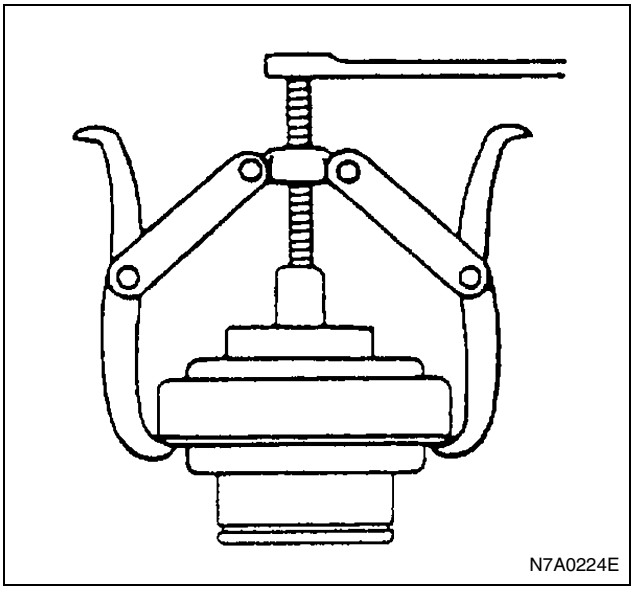
- Use the bearing remover and bench press to remove the release bearing.
  Bearing Remover: 5-8840-0013-0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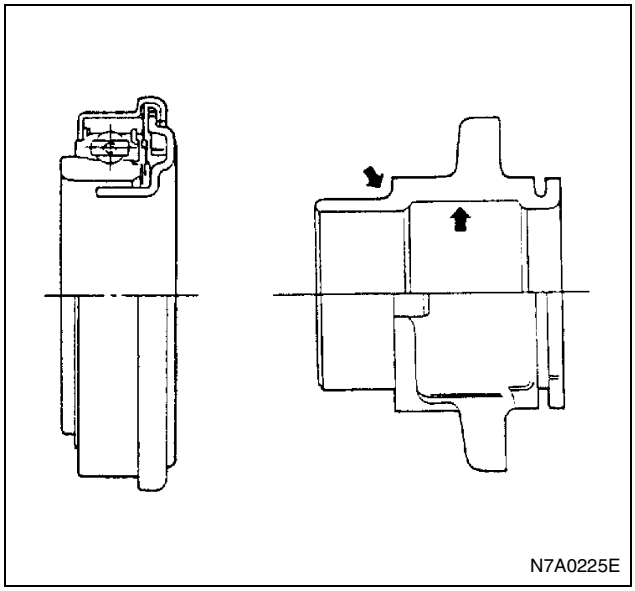
- Install the parts as shown after applying multi-purpose with MOS_2 type grease.
  Use a bench press.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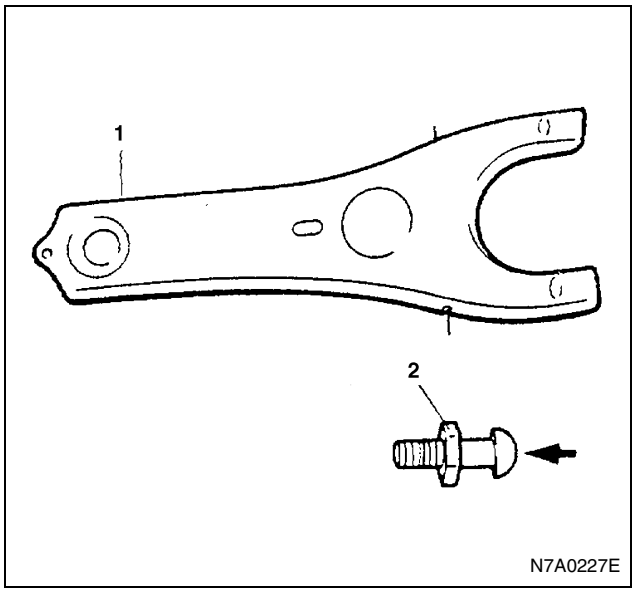
Support Spring

- Visually inspect the support spring for breakage and weakening.
- If any of these condition are discovered, parts must be replaced.

Installation

1. Pilot Bearing
   - Use the pilot bearing installer to install the clutch pilot bearing.
     Pilot Bearing Installer: 5-8522-0024-0
2. Shift Fork
   - Apply multi-purpose with MOS_2 type grease to the contact surfaces with the shift block and support bolt head.



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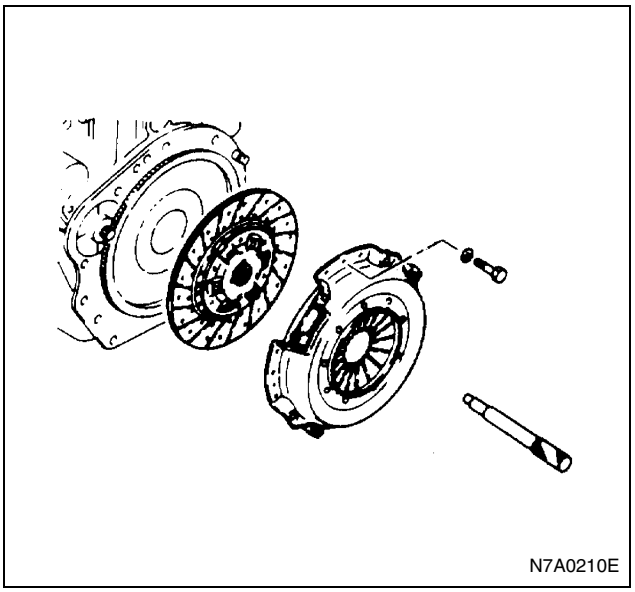
Legend
1. Shift fork
2. Support bolt

3. Release Bearing Assembly
4. Driven Plate Assembly
   - Apply multi-purpose with MOS_2 type grease to the driven plate hub spline.
   - Use the pilot aligner to install the driven plate assembly.
     Pilot Aligner: 5-8525-3001-0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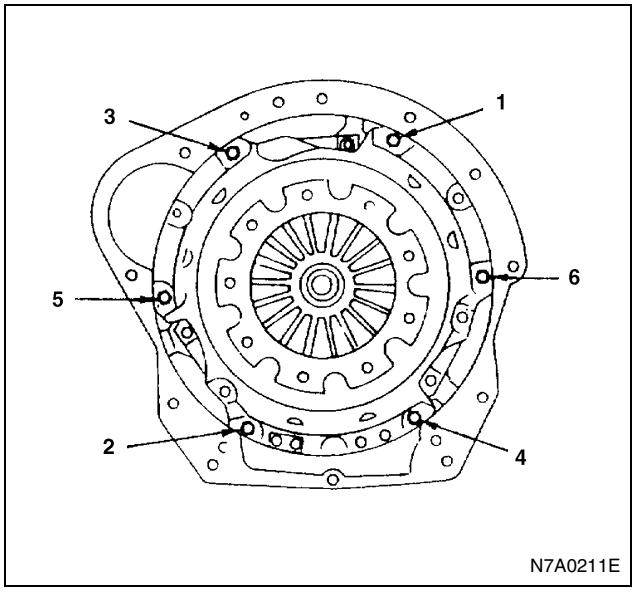
5. Pressure Plate Assembly
   - Tighten pressure plate assembly fixing bolts in numerical order.

Tighten:
Pressure plate fixing bolt to 18 N·m (1.8 kg·m / 13 lb·ft)

   - Remove the pilot aligner.

Notice:
In case a new pressure plate assembly is mounted, after tightening a pressure plate to the specified torque, be sure to remove the wire for protection of a diaphragm spring.



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6. Transmission Assembly
   Refer to "SECTION 7B ON-VEHICLE SERVICE: TRANSMISSION ASSEMBLY REPLACEMENT" in this manual.

Tighten:
Clutch housing to flywheel housing bolts to
- M10: 46 N·m (4.7 kg·m / 34 lb·ft)
- M12: 91 N·m (9.3 kg·m / 67 lb·ft)

Tighten:
Engine rear mounting nuts and bolts to
- M10: 40 N·m (4.1 kg·m / 30 lb·ft)
- M12: 69 N·m (7.0 kg·m / 51 lb·ft)

Tighten:
Front exhaust pipe bolts to 37 N·m (3.8 kg·m / 27 lb·ft)

Tighten:
Exhaust brake bolts to 17 N·m (1.7 kg·m / 12 lb·ft)

Tighten:
Slave cylinder bolts to 16 N·m (1.6 kg·m / 12 lb·ft)

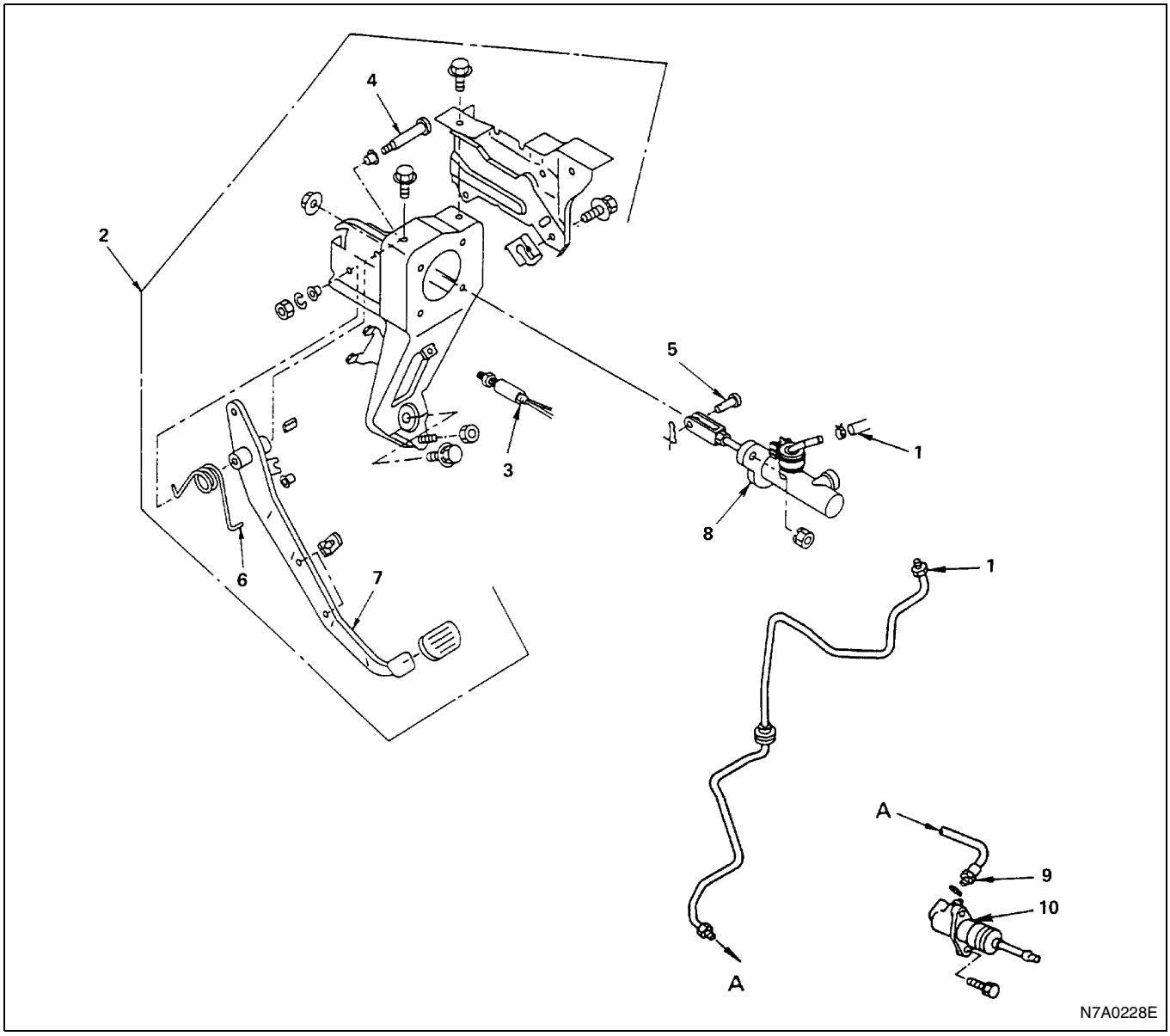
Perform slave cylinder adjustment before installation of the return spring.
1) Loosen the lock nut of the push rod.
2) Turn the adjust nut until it reaches the shift fork.
3) Back off the adjust nut 1.5 turns (shift fork free play Approximately 2 mm/0.1 in).
4) Tighten the lock nut.

Tighten:
Push rod lock nut to 19 N·m (1.9 kg·m / 14 lb·ft)

Wiring Connector Color
Back-up Light Switch: Brown
Neutral Switch: Gray

Tighten:
Propeller shaft nuts to 66 N·m (6.7 kg·m / 48 lb·ft)

Clutch Control



Legend

1. Clutch pipe and hose
2. Clutch pedal and bracket assembly
3. Clutch switch or stopper bolt
4. Shaft
5. Clevis pin
6. Return spring
7. Clutch pedal
8. Master cylinder
9. Flexible hose
10. Slave cylinder

Preparation

1. Meter Cluster
   - Pull out the meter cluster and disconnect the harness connectors.
2. Meter Assembly
   - Remove the 5 fixing screws, then remove the meter assembly and disconnect the harness connector.

Removal

- Drain the clutch fluid from the clutch hydraulic line.

Caution:
Do not let clutch fluid remain on a painted surface. Wash it off immediately.

1. Clutch Pipe and Hose
2. Clutch Pedal and Bracket Assembly
3. Clutch Switch or Stopper Bolt
4. Shaft

5. Clevis Pin
6. Return Spring
7. Clutch Pedal
8. Master Cylinder
9. Flexible Hose
10. Slave Cylinder

Inspection and Repair

Make the necessary adjustment, repairs, and part replacement if excessive wear or damage is discovered during inspection.

Installation

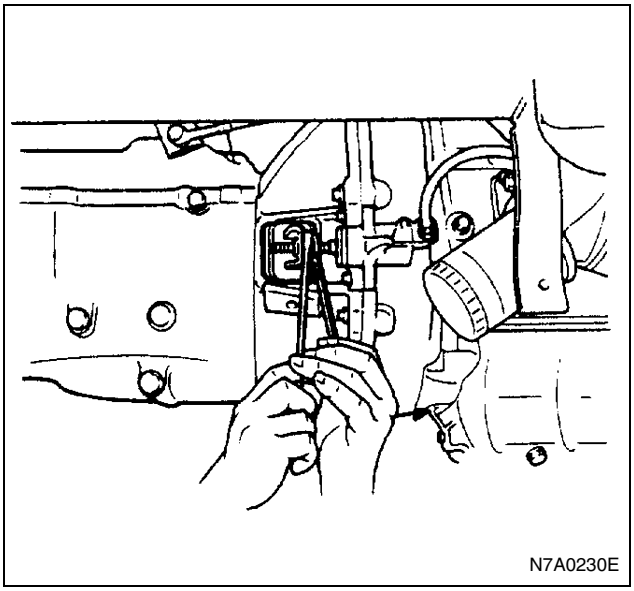
1. Slave Cylinder

Tighten:
Slave cylinder bolt to 19 N·m (1.9 kg·m / 14 lb·ft)

- Perform slave cylinder adjustment before installation of the return spring.

1) Loosen the lock nut of the push rod.
2) Turn the adjust nut until it reaches the shift fork.
3) Back off the adjust nut 1.5 turns. (shift fork free play approximately 2 mm/0.1 in).
4) Tighten the lock nut.

Tighten:
Push rod lock nut to 16 N·m (1.6 kg·m / 12 lb·ft)



2. Flexible Hose
3. Master Cylinder

- Install the master cylinder assembly to the clutch pedal bracket.

Tighten:
Fixing nuts to 13 N·m (1.3 kg·m / 113 lb·in)

4. Clutch Pedal
5. Return Spring
6. Clevis Pin
7. Shaft
8. Clutch Switch or Stopper Bolt
9. Clutch Pedal and Bracket Assembly

Tighten:
Clutch bracket bolts to 37 N·m (3.8 kg·m / 27 lb·ft)

- Perform the clutch pedal adjustment after installation of clutch control.

Clutch Pedal Height and Stroke

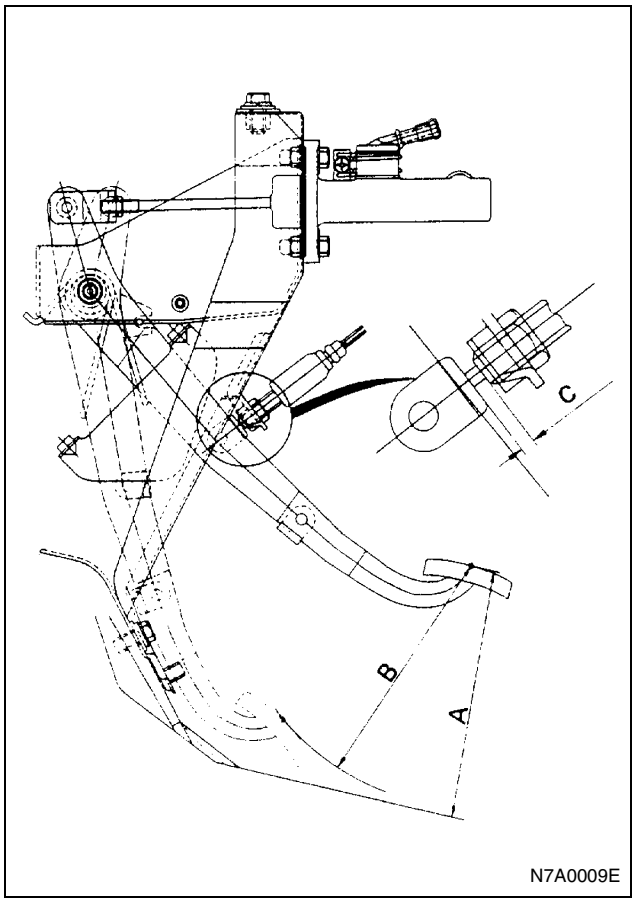
1) Loosen the lock nut of the master cylinder push rod.
2) Adjust the pedal height by turning the push rod.

Clutch Pedal Height and Stroke	mm (in)
Height (A): 160 — 170 (6.3 — 6.7) Stroke (B): 159 — 169 (6.2 — 6.7)	

3) Tighten the lock nut.

Tighten:
Lock nut to 17 N·m (1.7 kg·m / 12 lb·ft)

4) Install the meter assembly and meter cluster.



Clutch Pedal Free Play

Clutch Switch or Stopper Bolt

After completion of clutch pedal height and slave cylinder adjustment, adjust the clutch switch or stopper bolt clearance.

1) Loosen the lock nut of clutch switch or stopper bolt.

2) Adjust the clutch switch or stopper bolt clearance by turning clutch switch or stopper bolt.

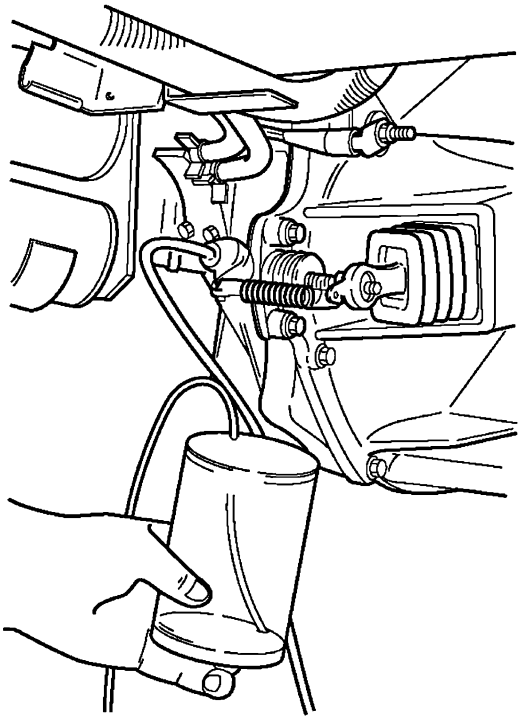
Clutch Switch or Stopper Bolt Clearance (C)	mm (in)
0.5 — 1.0 (0.02 — 0.04)	

Clutch Pedal Free Play	mm (in)
15 — 25 (0.6 — 1.0)	

3) Tighten the lock nut.

Tighten:
Lock nut to 19 N·m (1.9 kg·m / 14 lb·ft)

10. Clutch Pipe and Hose
    - Perform the clutch hydraulic circuit bleeding after installation of the clutch control.
      Bleeding operation calls for cooperative action of two men.
    1) Check the level of clutch fluid in the reservoir and replenish if necessary.
    2) Remove the rubber cap from the bleeder screw and wipe clean the bleeder screw.
       Connect a vinyl tube to the bleeder screw and insert the other end of the vinyl tube into transparent container.
    3) Pump the clutch pedal repeatedly and hold it depressed.
    4) Loosen the bleeder screw on the clutch slave cylinder to release clutch to release clutch fluid with air bubbles into the container and tighten the bleeder screw immediately.
    5) Release the clutch pedal carefully. Repeat the above operation until air bubbles disappear from the clutch fluid being pumped out into the container. During the bleeding operation, keep the clutch fluid reservoir filled to the specified level.
       Reinstall the rubber cap.



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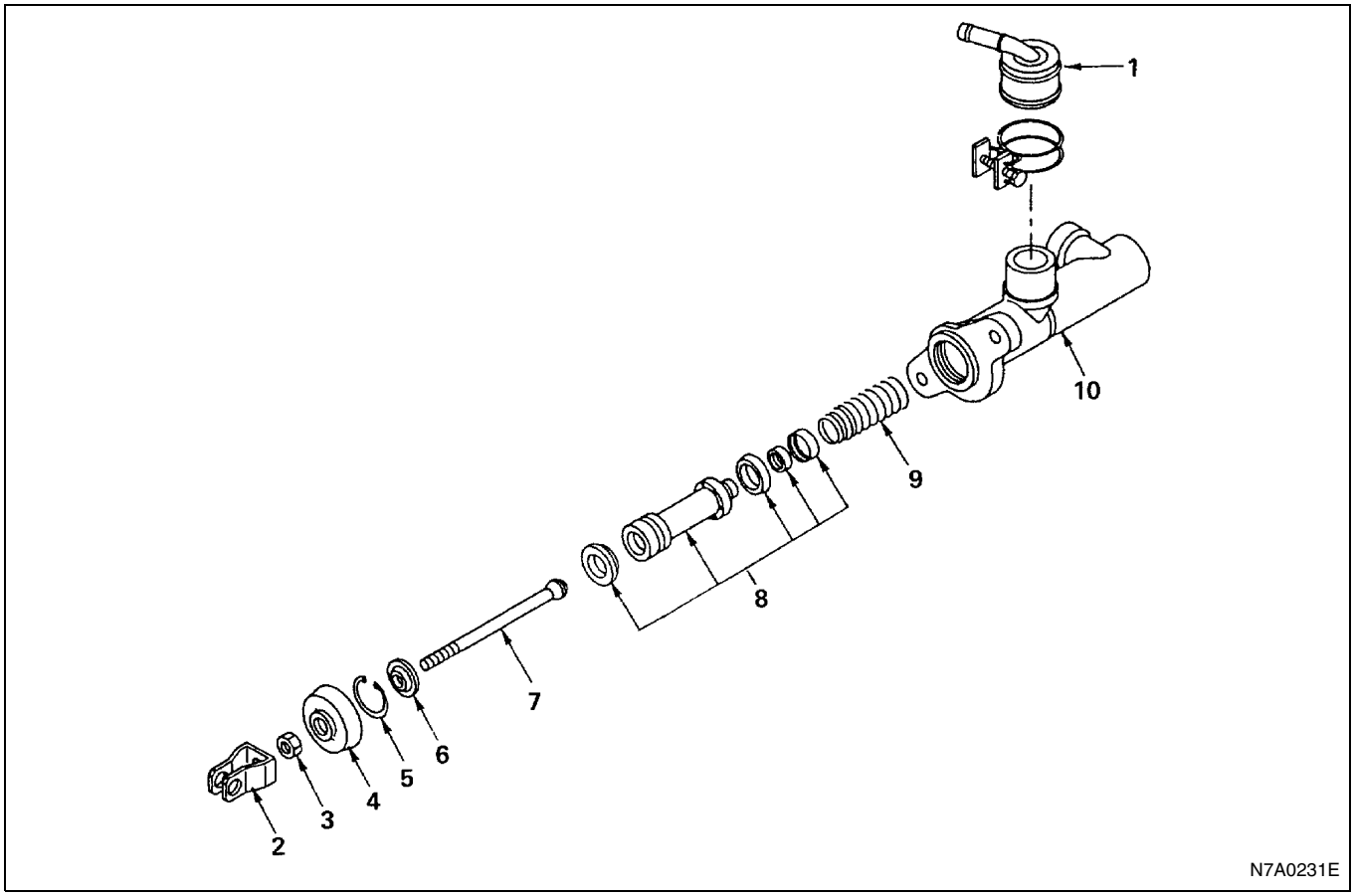
UNIT REPAIR

Master Cylinder



Legend

1. Pipe joint
2. Clevis yoke
3. Lock nut
4. Dust cover
5. Snap ring
6. Stopper
7. Push rod
8. Piston assembly
9. Return spring
10. Cylinder body

Disassembly

1. Pipe Joint
2. Clevis Yoke
3. Lock Nut
4. Dust Cover
5. Snap Ring
   - Press down the piston with your finger to prevent it from jumping out.
6. Stopper
7. Push Rod
8. Piston Assembly
9. Return Spring
10. Cylinder Body

Inspection and Repair

Make the necessary adjustments, repairs, and parts replacements if excessive wear or damage is discovered during inspection.

Cylinder Body

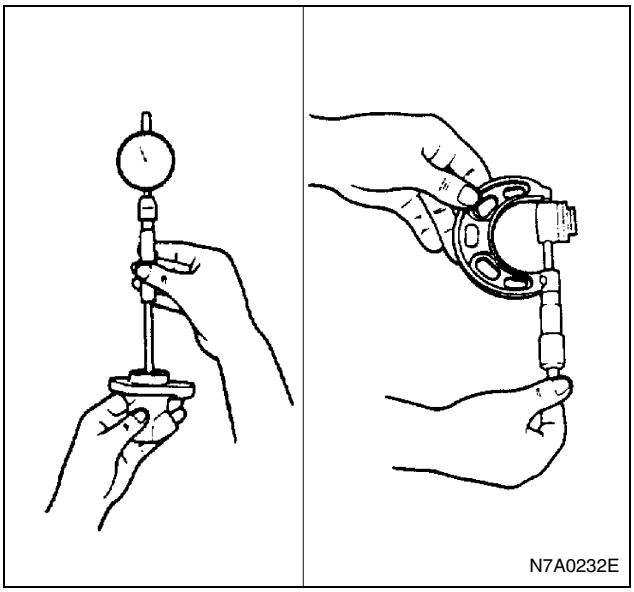
- Wash clean the cylinder body in brake fluid.
- Check the fluid return port for restrictions and clean it if necessary.
- Measure the cylinder bore diameter.

Master Cylinder Bore Diameter	mm (in)
Standard	
ϕ19.050 — 19.102 (0.7500 — 0.7520)	

Clearance between Cylinder Bore and Piston Clearance	mm (in)
Standard	Limit
0.03 — 0.11 (0.001 — 0.004)	0.12 (0.005)

- If excessive wear or any abnormal conditions are present, the master cylinder assembly must be replaced with new one.

Caution:
If the master cylinder has been disassembled, the repair kit must be replaced with new one.



Reassembly

1. Cylinder Body
   - Immerse the cylinder body in clean brake fluid.
2. Return Spring
   - Install the return spring to the piston assembly.
3. Piston Assembly
   - Before installing, apply a thin coat of rubber grease to the piston.

Caution:
Use care to prevent damaging the lip of the piston cup.

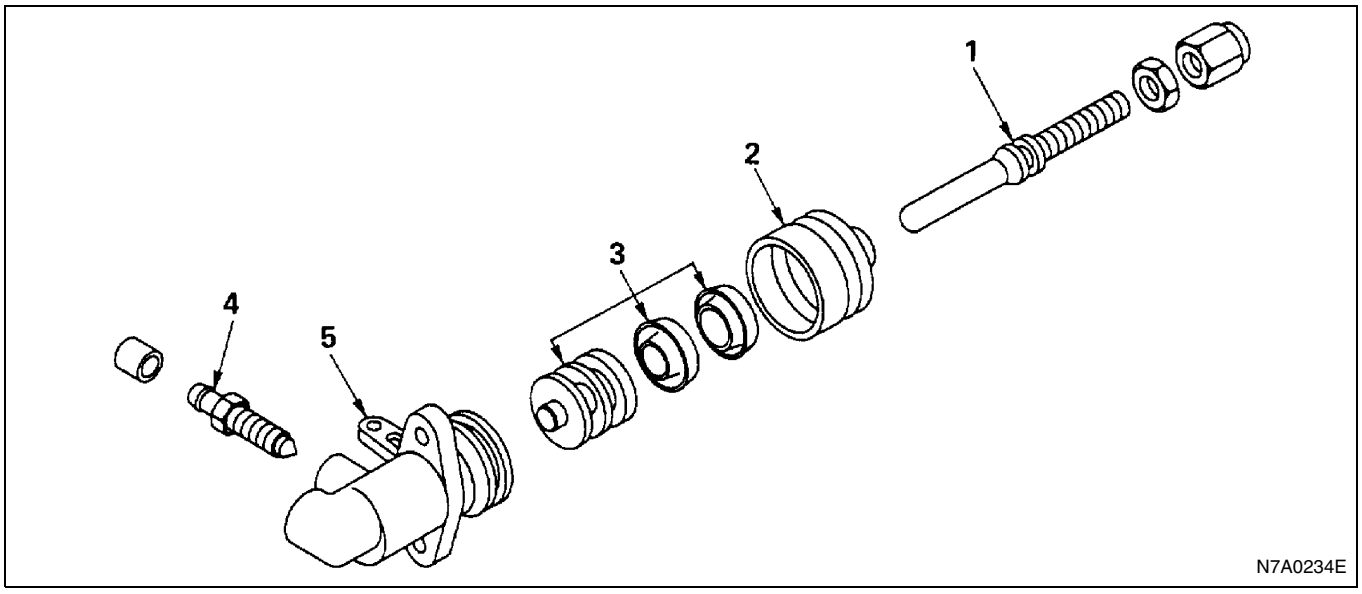
4. Push Rod
5. Stopper
6. Snap Ring
7. Dust Cover
8. Lock Nut

Tighten:
Lock nut to 17 N·m (1.7 kg·m / 12 lb·ft)

9. Clevis Yoke
10. Pipe Joint

Tighten:
Pipe joint to 5 N·m (0.5 kg·m / 43 lb·in)

Slave Cylinder



Legend

1. Push rod
2. Boot
3. Piston assembly
4. Bleeder screw
5. Cylinder body

Disassembly

1. Push Rod
2. Boot
3. Piston Assembly
4. Bleeder Screw
5. Cylinder Body

Inspection and Repair

Make the necessary adjustments, repairs, and parts replacements if excessive wear or damage is discovered during inspection.

Cylinder Body

- Wash clean the cylinder body in brake fluid.
- Measure the cylinder bore diameter.

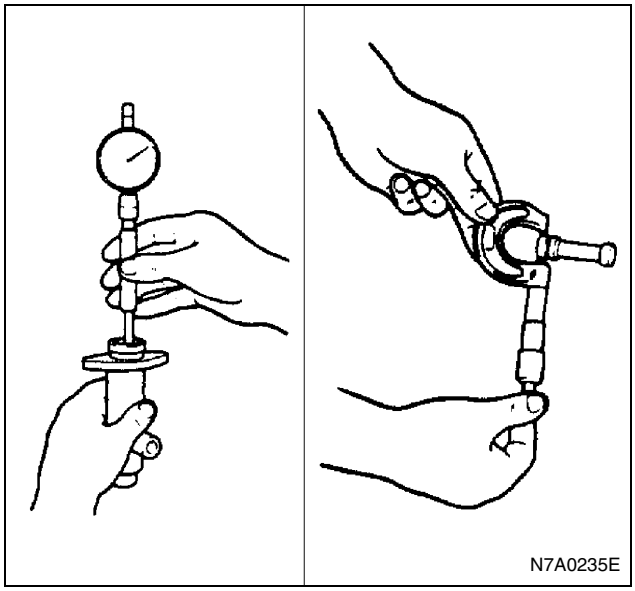
Cylinder Bore Diameter	mm (in)
Standard	
ϕ26.990 — 27.042 (1.0626 — 1.0646)	

Clearance between Cylinder Bore and Piston Clearance	mm (in)
Standard	Limit
0.02 — 0.10 (0.0008 — 0.0039)	0.11 (0.0043)

- If excessive wear or any abnormal conditions are present, the slave cylinder assembly must be replaced with new one.

Caution:

If the slave cylinder has been disassembled, the repair kit must be replaced with new one.



Reassembly

1. Cylinder Body
2. Bleeder Screw
3. Piston Assembly
   - Before installing, apply a thin coat of rubber grease to the piston.

Caution:

Use care to prevent damaging the lip of the piston cup.

4. Boot
5. Push Rod

LGMYY-WE-0552

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LGMYY-WE-0552 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

MANUAL TRANSMISSION AND CLUTCH MYY SERIES

SECTION 7

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

SECTION No.	CONTENTS
0A	GENERAL INFORMATION
7B	MANUAL TRANSMISSION
7C	CLUTCH

MANUAL TRANSMISSION AND CLUTCH MYY SERIES

SECTION 0A
GENERAL INFORMATION

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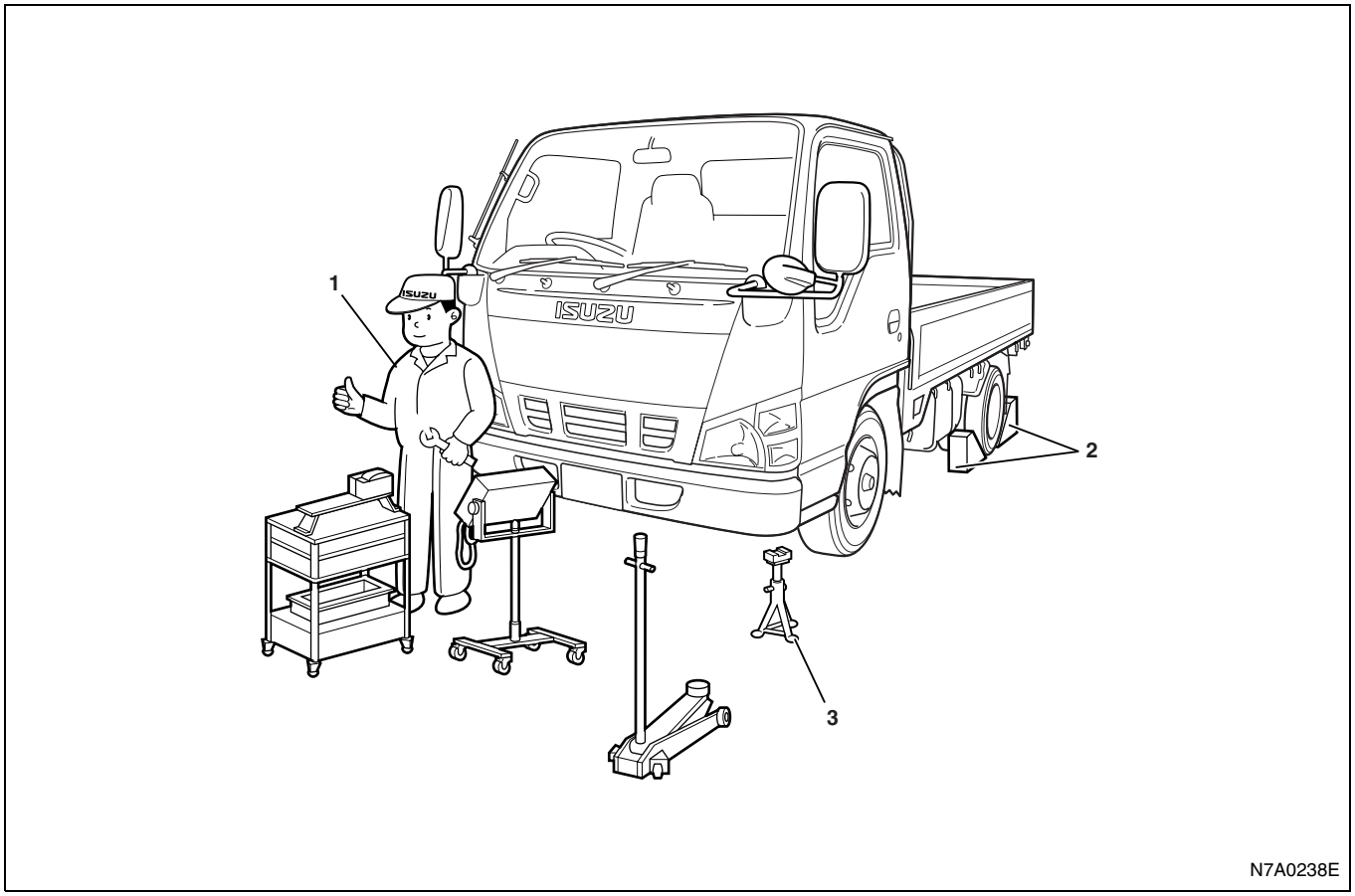
GENERAL REPAIR INSTRUCTIONS

General Precautions



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Preparation

- Prepare all the necessary tools, gauges and special tools before performing service operations.
- Prepare beforehand alternative parts which must be replaced or cannot be reused.

Work Clothes

- Make sure to wear a clean service uniform, cap and safety shoes (1).

Damage Prevention

- Make sure to use a cover on the vehicle body.
- Disconnect the ground cable from the battery before carrying out service operations.

Safety First

- Make sure to set chocks (2) before raising the vehicle using a jack set.
- After completing jacking-up the vehicle, make sure to set a safety stand (3) at the specified point to support the vehicle.
- Make sure to apply safety lock after raising the vehicle using a lift.
- If service operations are to be carried out by two persons or more, make sure to confirm safety of each other before performing service operations.

Precautions During Operations

- Keep the disassembled parts in good order to prevent them from confusing with unusable parts.
- When performing installation and assembly, clean or wash the relevant parts.
- Also, remove grease from the parts on which liquid packing etc. are applied.

Check After Operations

- When service operation is completed, make a final check that the service has been done properly and problem has been corrected.
- Check that there is no leakage of fuel, oil or coolant.

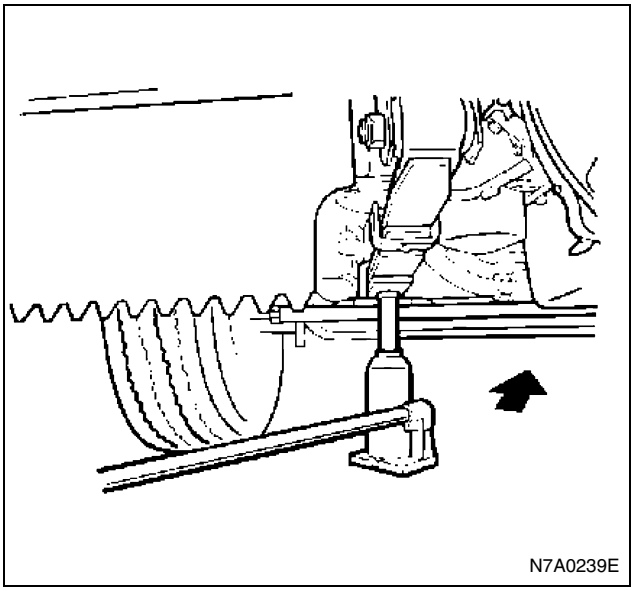
LIFTING POINTS

Lifting Points for Originally Equipped Jack

- The arrow indicates the front side of the vehicle.

Front wheels of front wheel leaf spring type suspension vehicle (NHR, NKR, NPR, NQR)

- Set the jack at the leaf spring.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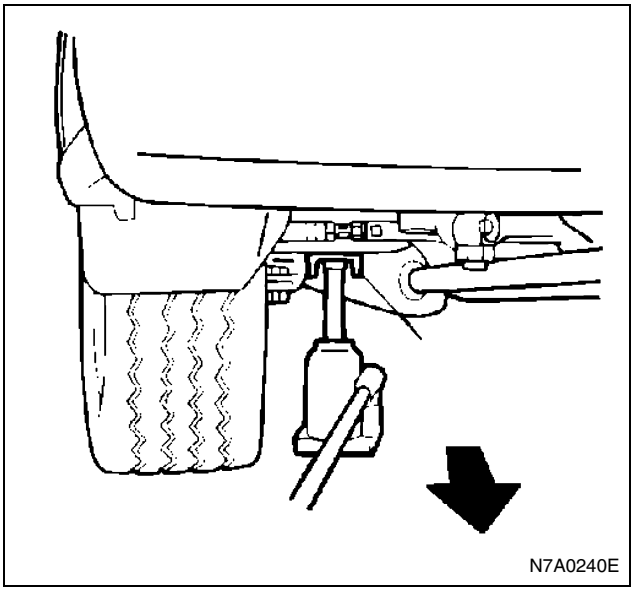
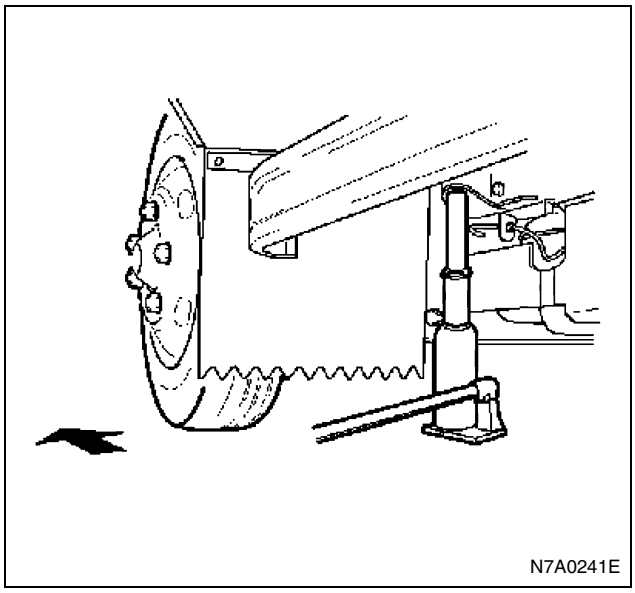
Front wheels of front wheel wishbone type suspension vehicle (NHR, NKR)

- Set the jack at the jack-up bracket on the front side of the lower link.


N7A0240E

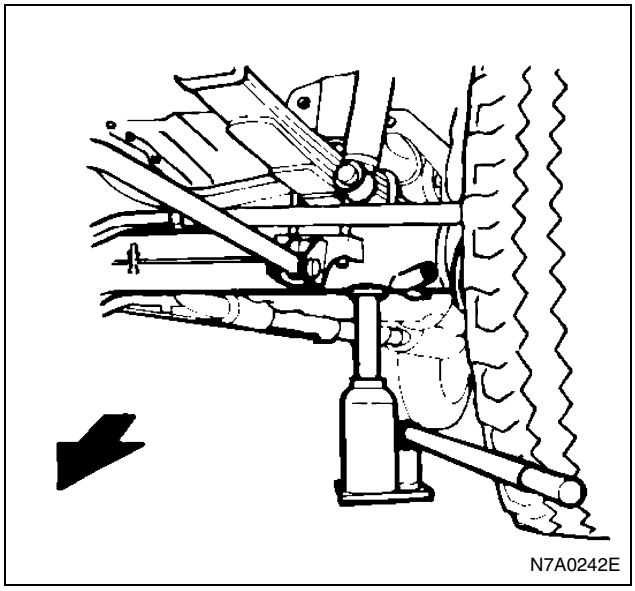
Front wheels of front wheel wishbone type suspension vehicle (NHR, NKR, NPR)
Set the jack at the lower side of the jack-up bracket.


N7A0241E

Caution:
Jack-up points for the vehicles of independent front suspension differ according to vehicle types. Make sure to check the jack-up bracket before jacking up the vehicle.

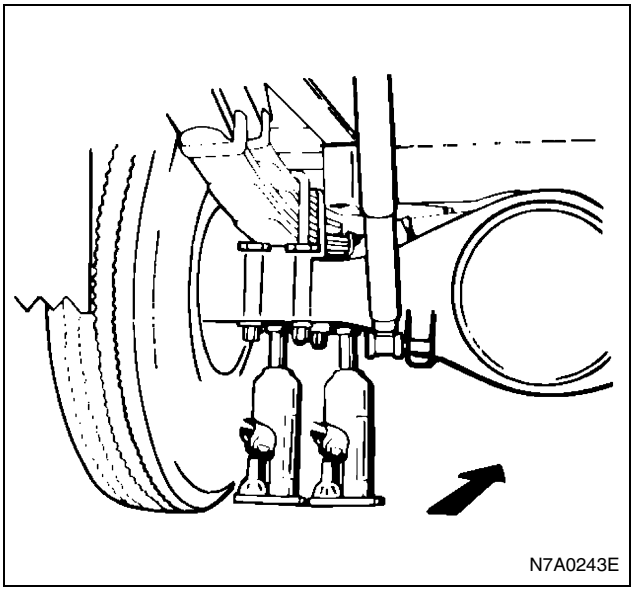
Front wheels (NPS)

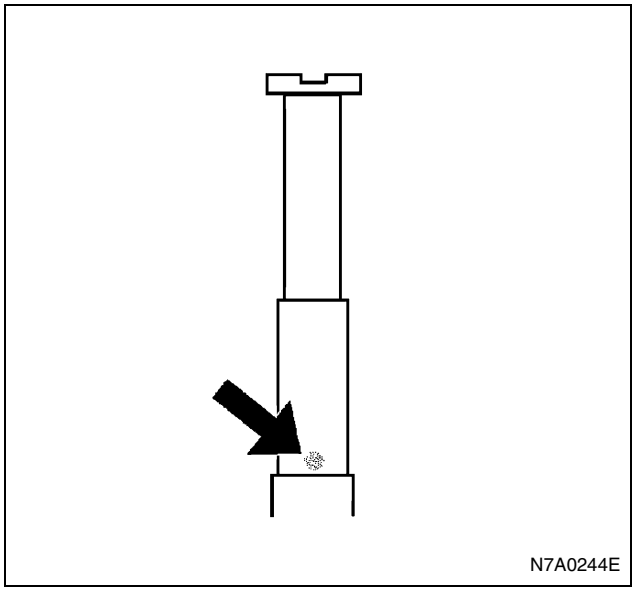
- Set the jack at the lower side of the axle.


N7A0242E

Rear wheels

- Set the jack at the lower side of the leaf spring or axle case.


N7A0243E

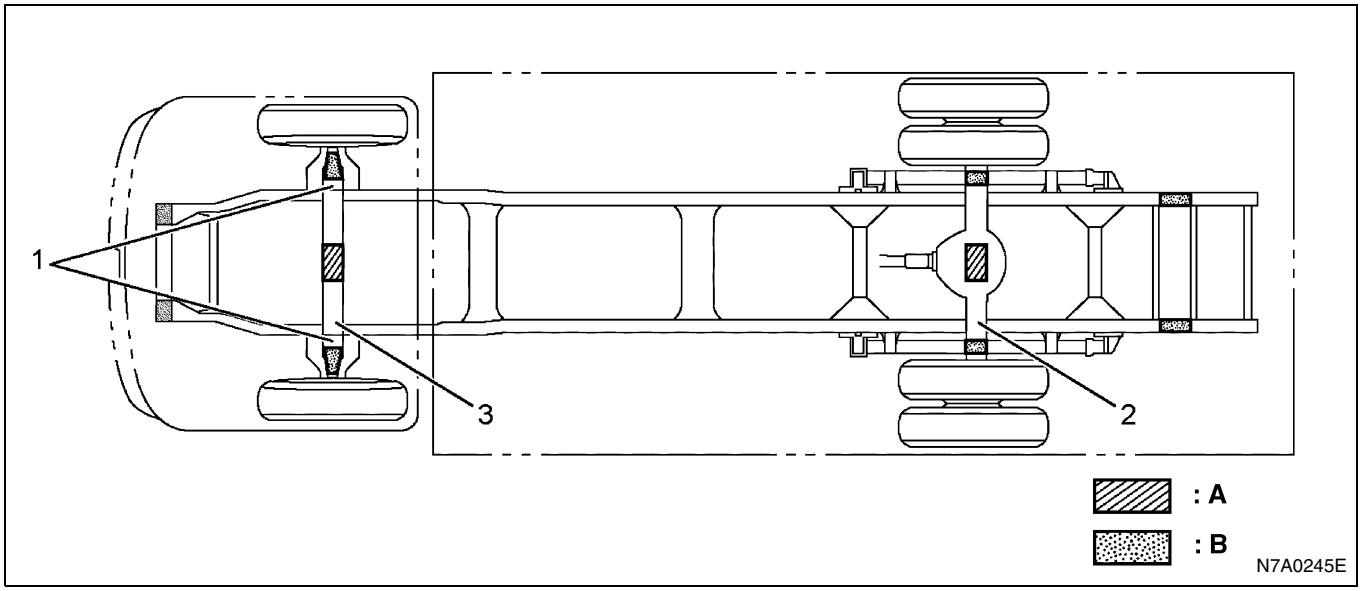

N7A0244E

Caution:
If a yellow mark appears when lifting the vehicle using the originally equipped jack, stop lifting. Continuing lifting may damage the jack.

Front wheel wishbone type (NHR, NKR, NPR)

Floor Jack Lifting Points and Chassis Stand Position

- Make sure to set the floor jack and the chassis stand properly at the specified positions.

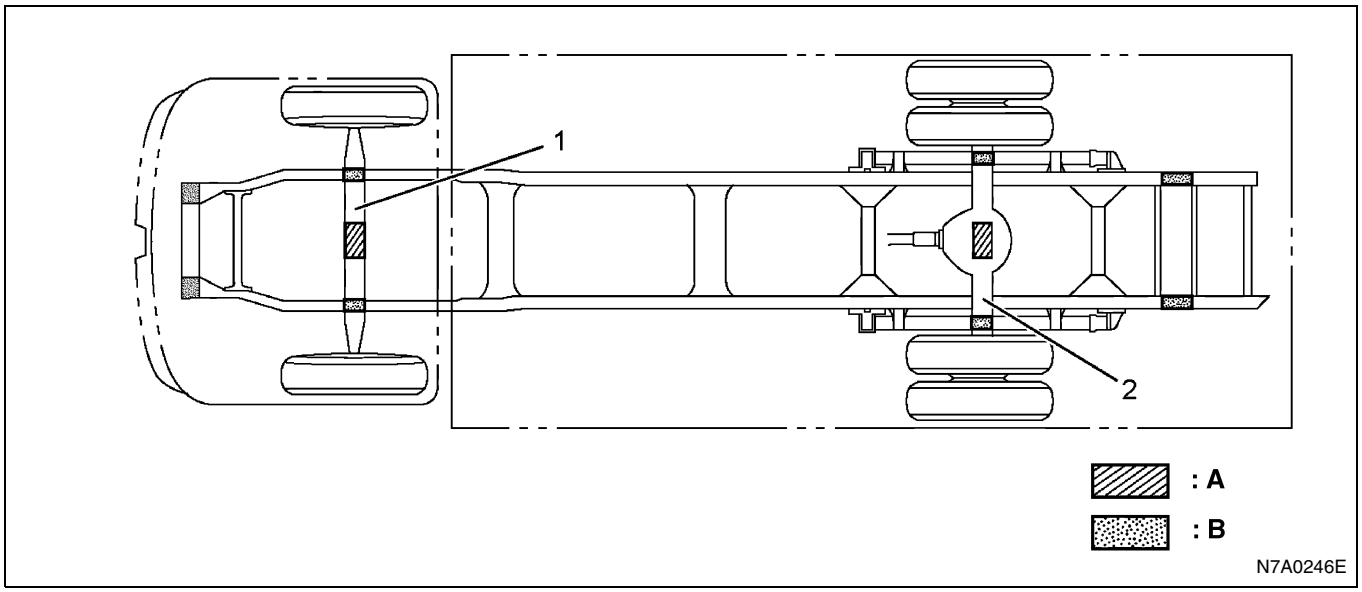


N7A0245E

Legend

A: Floor jack point
B: Chassis stand lifting position
1. Lower link (except NPR independent suspension vehicles)
2. Rear axle
3. Front suspension crossmember

Front wheel leaf spring type (NHR, NKR, NPR, NQR)

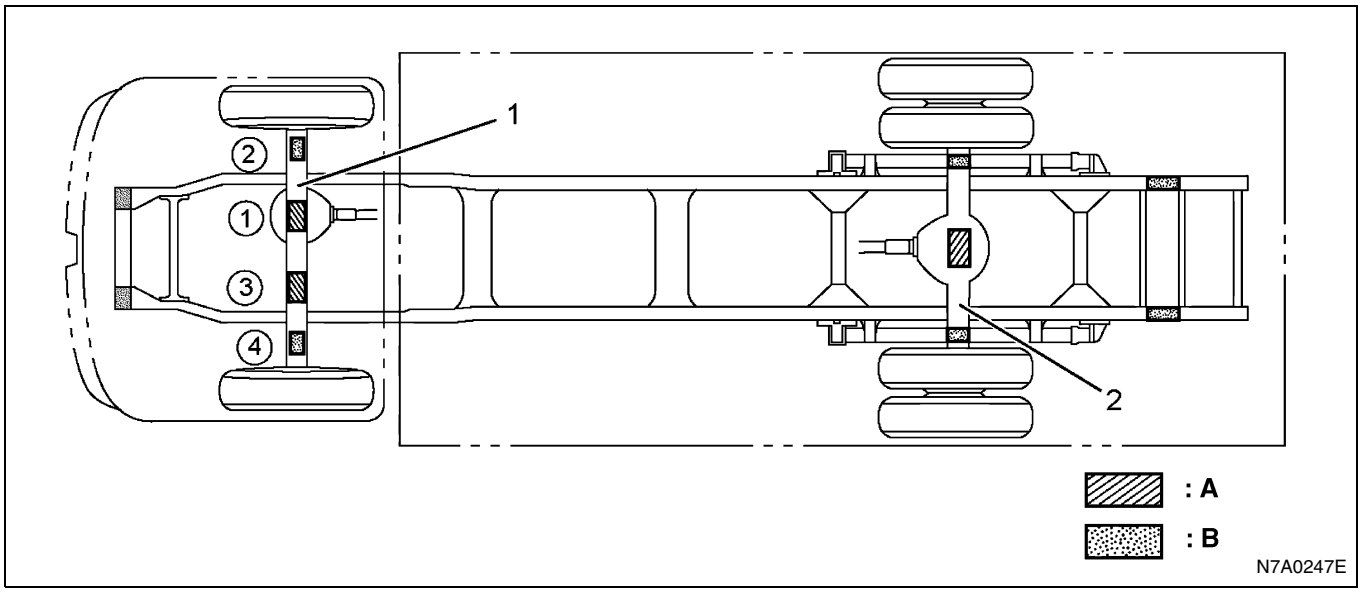


Legend

A: Floor jack point
B: Chassis stand lifting position
1. Front axle
2. Rear axle

Front wheel leaf spring type (NPS)

- Follow the numbers in circle when jacking up the front wheel side.



Legend

A. Floor jack point
B. Chassis stand lifting position
1. Front axle
2. Rear axle

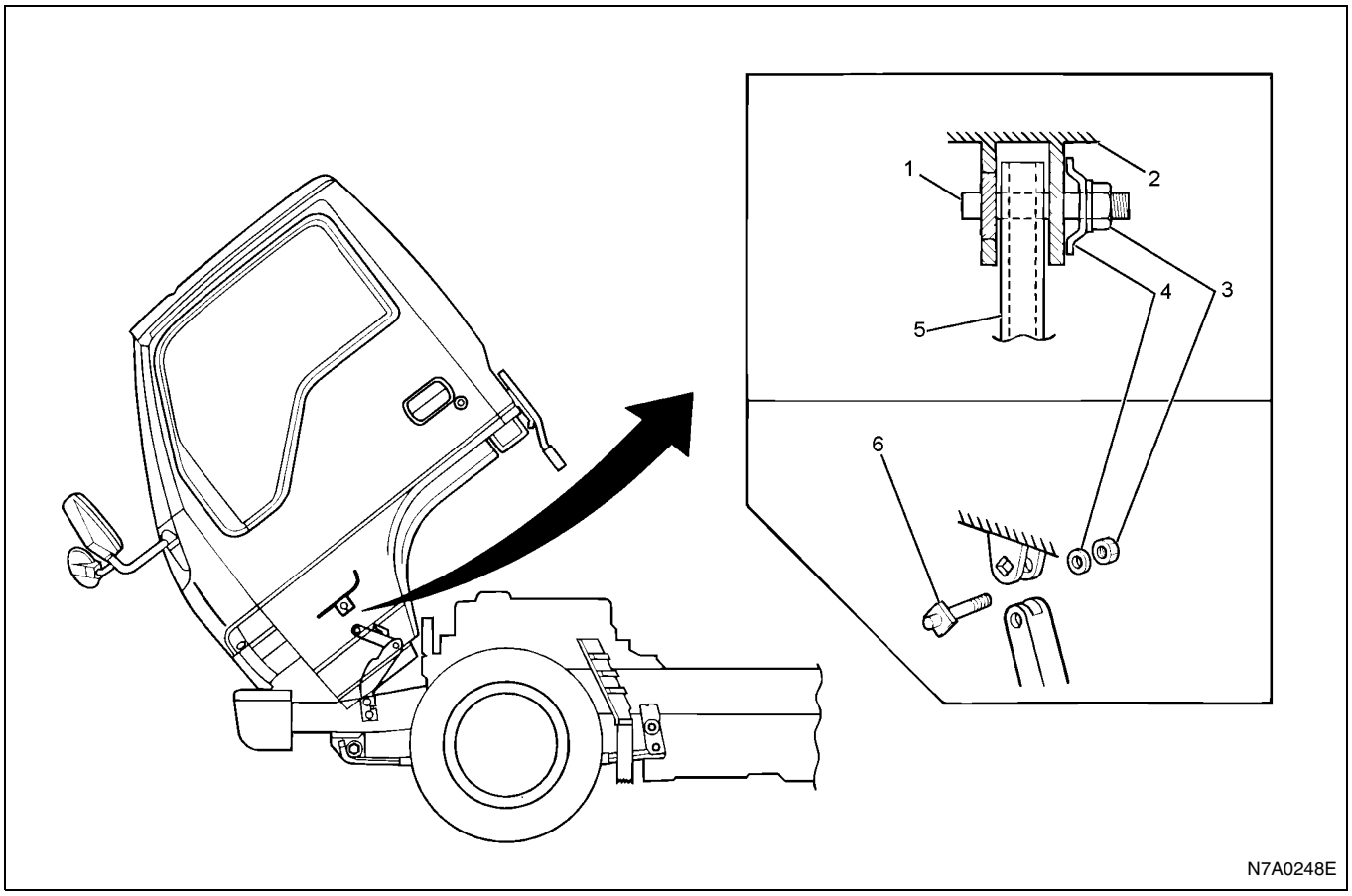
CAB TILTING

Notes for Tilting of the Cab

Make sure to observe the precautions below when removing the cab tilt stay assembly to tilt the cab in order to carry out service operations.

- When lifting the cab by tilting, use shop cloth to prevent damage to the cab.
- When tilting, the maximum tilt angle of the cab is 50 degrees. If the cab is tilted at an angle of more than 50 degrees, the torsion bar supporting the cab may be damaged.
- When tilting the cab, pay special attention not to let the cab come into contact with peripheral parts.
- The nut securing the cab tilt stay assembly is tightened with its thread deformed. Do not reuse the nut because the specified fixing torque is not obtained when reused.
- Strictly observe the specified fixing torques when tightening the nut.

Tighten:
Nut to 22±5 N·m (2.2±0.5 kg·m / 16±3.7 lb·ft)



Legend

1. Cab tilt stay pin
2. Cab side bracket
3. Nut
4. Washer
5. Cab tilt stay
6. Cab tilt stay pin

NOTES FOR WORKING ON ELECTRIC EQUIPMENT

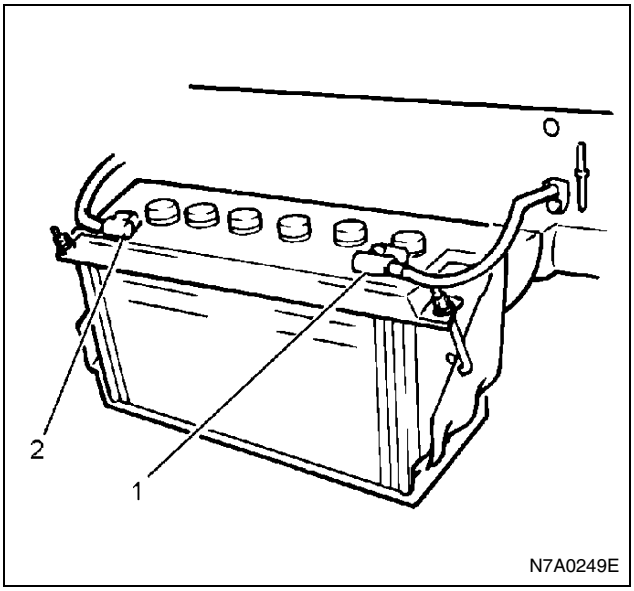
Battery Cable

Disconnecting The Battery Cable

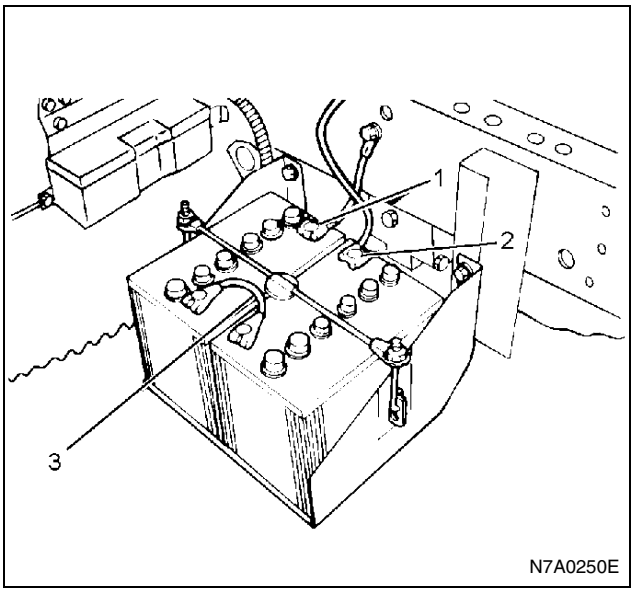
1. Turn all the switches to “OFF” positions.
2. Disconnect the battery ground cable (1).
3. Disconnect the battery positive cable (2).
4. Disconnect the battery cable (3) (Only 24V model).

Caution:
It is important that the battery ground cable should be disconnected first.
Disconnecting the battery positive cable first may result in a short circuit.

- For 12V model



- For 24V model



Connecting The Battery Cable

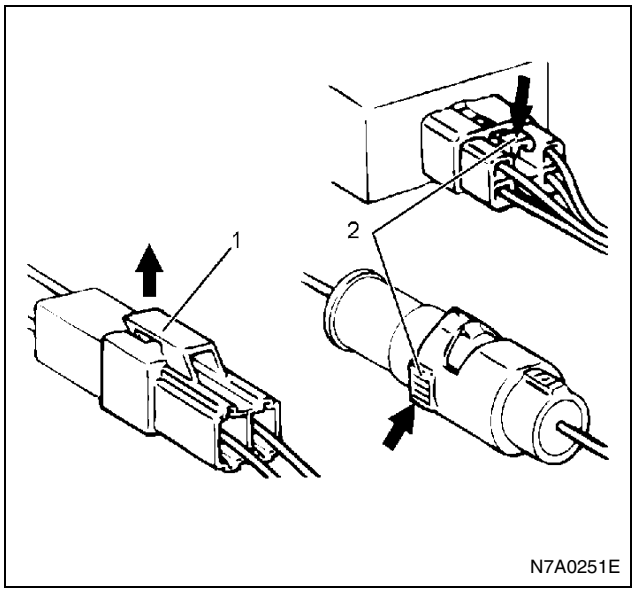
Connect in the reverse order of removal.

Caution:
Clean the battery terminal and apply a light coat of grease to prevent terminal corrosion.

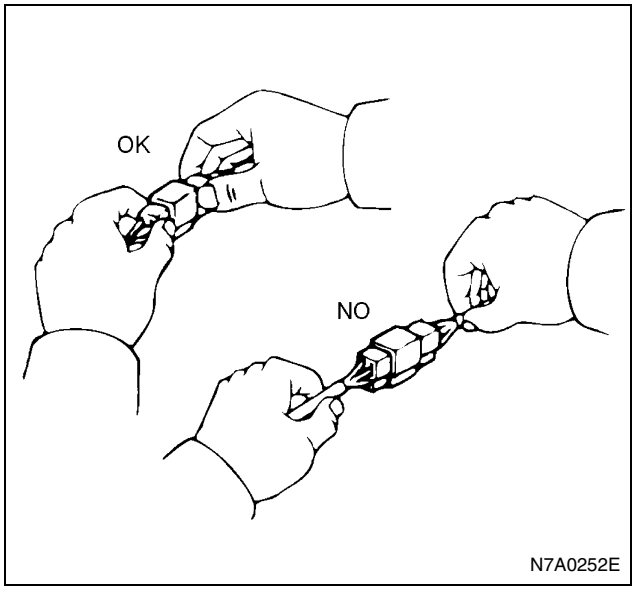
Connector Handling

Disconnecting The Connectors

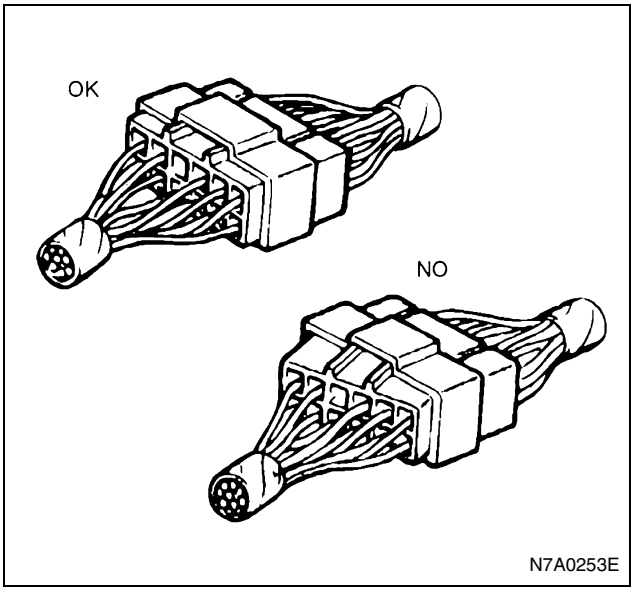
Most of the connectors have a tang lock to hold the connectors together.
Some tang locks are released by pulling them up (1).
Other tang locks are released by pressing them forward (2).
Determine which type of tang lock is adopted on the connector when disconnecting.



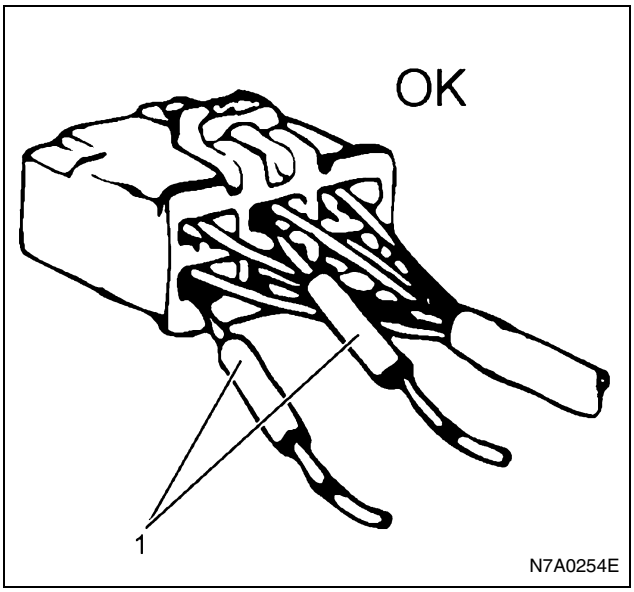
Firmly grasp both sides (male and female) of the connector.
Release the tang lock and carefully pull the two halves of the connector apart.
Never pull on the harness to separate the connectors. This will result in wire breakage.



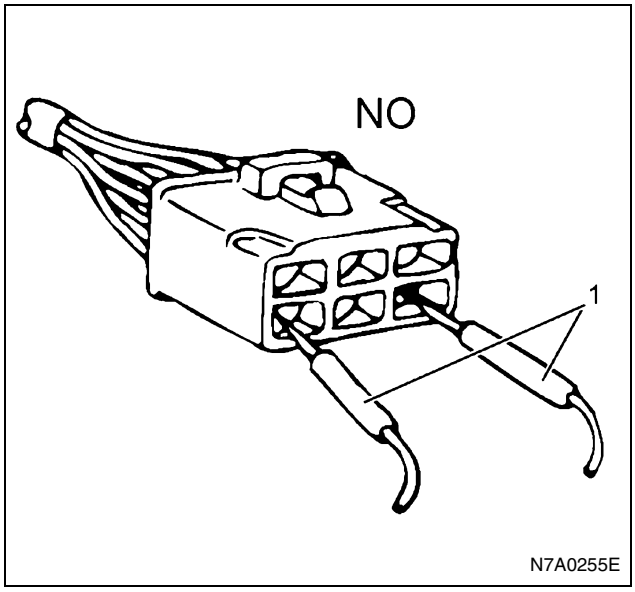
Connecting The Connector
Firmly grasp both sides (male and female) of the connector.
Firmly but carefully push the two sides of the connector together until a distinct click is heard.



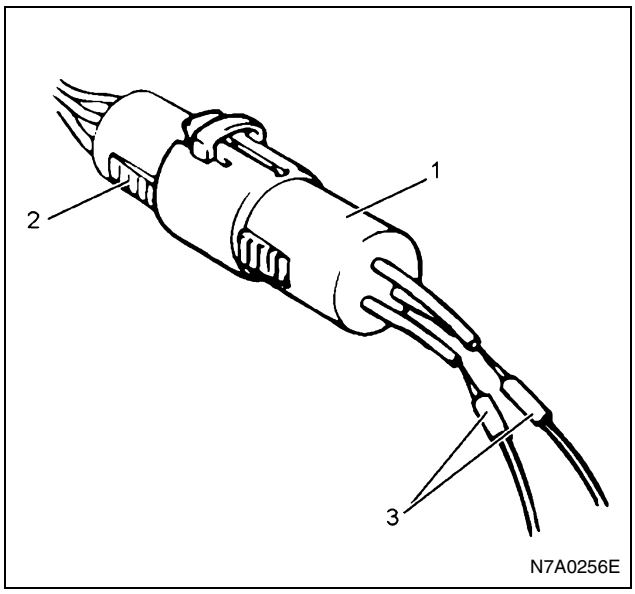
Connector Inspection
Use a circuit tester to check the connector for continuity. Insert the test probes (1) from the connector harness side.



Never insert the circuit tester test probes (1) into the connector open end to test the continuity. Broken connector terminals will result.

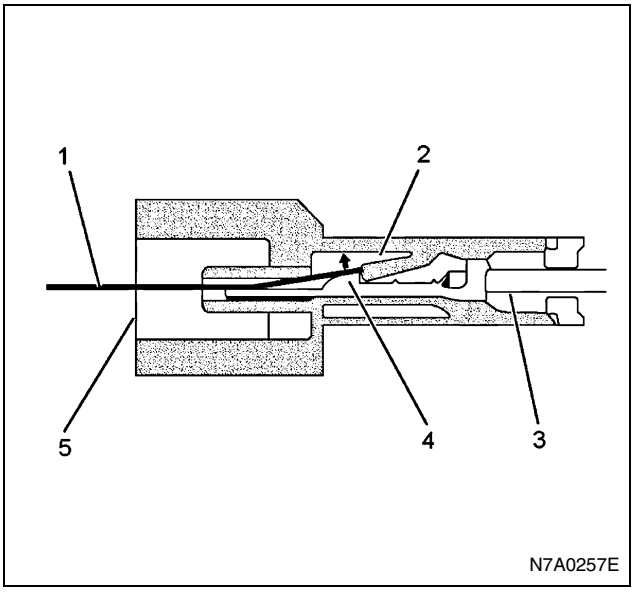


Waterproof Connector Inspection
It is not possible to insert the test probes into the connector wire side of a waterproof connector. Use a previously made connector (1) with its wires cut to carry out the test. Connect the test connector (2) to the connector to be tested. Connect the test probes (3) to the cut wires to check the connector continuity.



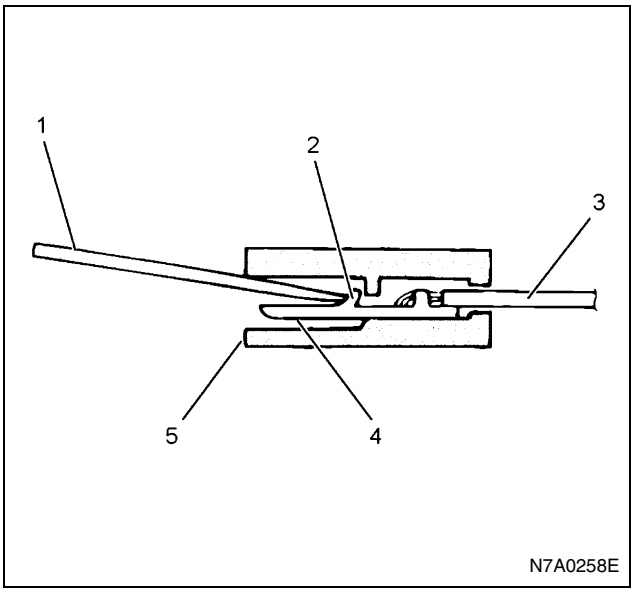
Connector Pin Removal
Connector Housing Tang Lock Type

1. Insert a thin flat-tip screwdriver or equivalent (1) into the connector housing open end (5).
2. Push the tang lock (2) up (in the direction of the arrow in the figure). Pull the wire (3) with pin (4) free from the wire side of the connector.



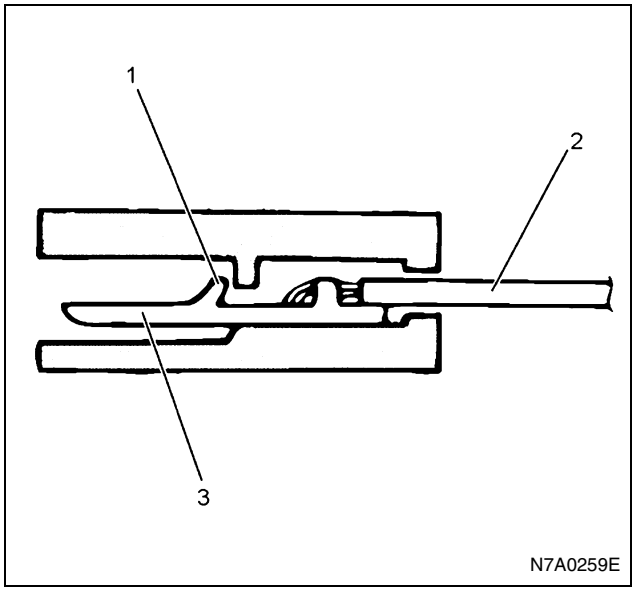
Pin Tang Lock Type

1. Insert a thin flat-tip screwdriver or equivalent (1) into the connector housing open end (5).
2. Push the tang lock (2) flat (toward the wire side of the connector). Pull the wire (3) with pin (4) free from the wire side of the connector.



Connector Pin Insertion

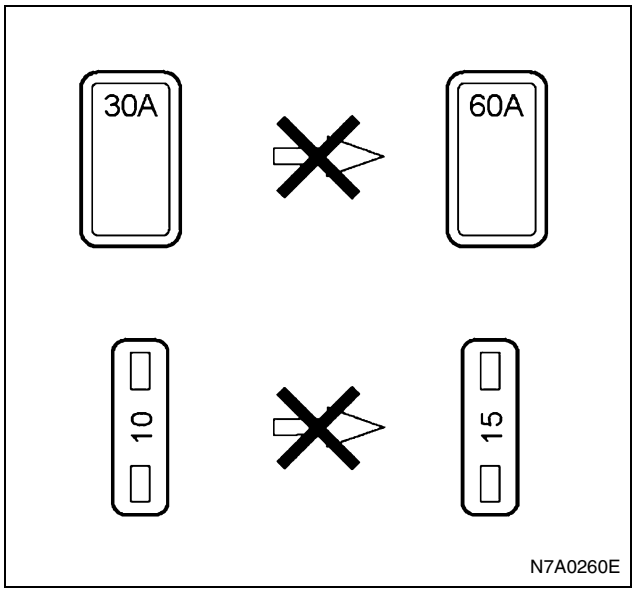
1. Check that the tang lock (1) is fully up.
2. Insert the pin (3) from the connector wire (2) side. Push the pin in until the tang lock closes firmly.
3. Gently pull on the wires to make sure that the connector pin is firmly set in place.



Fuse Replacement

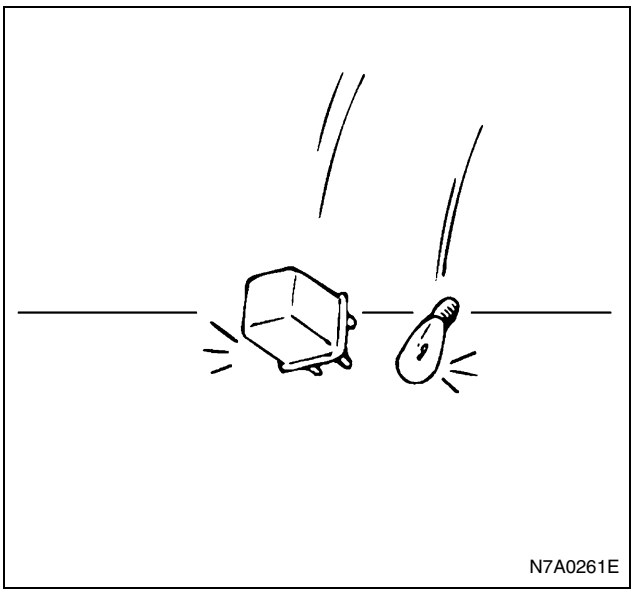
WARNING:
WHEN A FUSE IS BLOWN OUT, REPLACE IT WITH A NEW ONE OF THE SAME CAPACITY AFTER FINDING THE CAUSE.

IF A FUSE OF TOO LARGE CAPACITY IS USED, IT RESULTS TO BE MEANINGLESS WHEN AN OVER CURRENT FLOWS. THEREFORE, A WIRE MAY BE BURNED RESULTING IN A FIRE.



Electric Equipment Handling

Be careful when handling electrical parts. They should not be dropped or thrown, because short circuit or other damage may result.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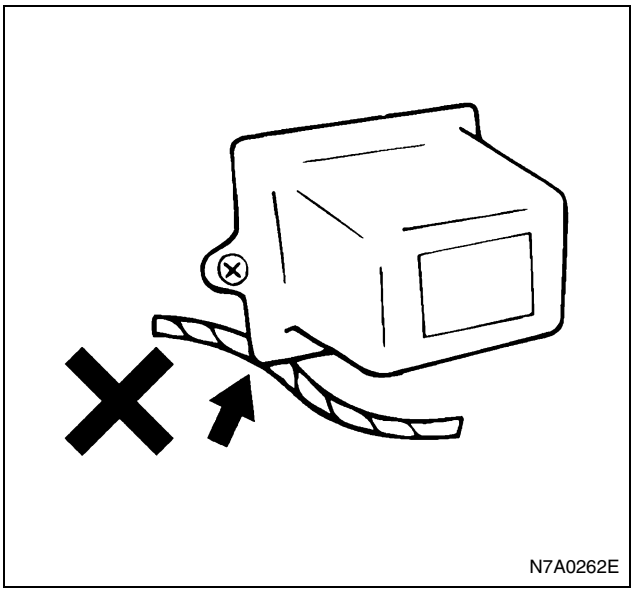
Cable Harness

1. When installing the parts, be careful not to pinch or wedge the wiring harness.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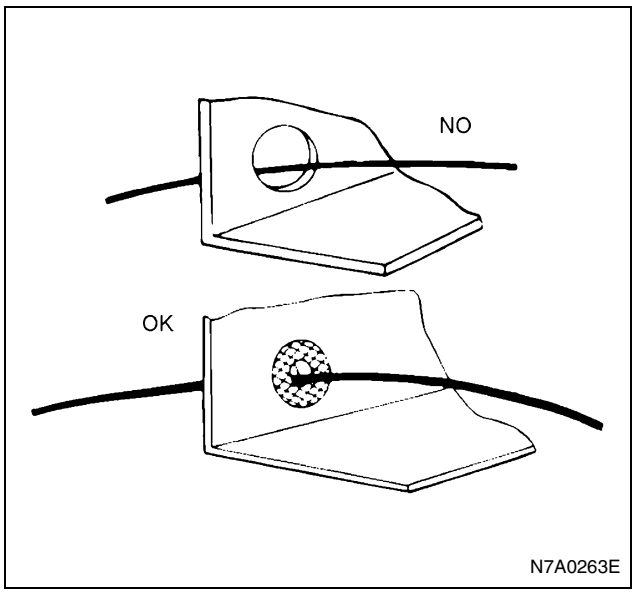
2. All electrical connections must be kept clean and tight.
3. Use a grommet or guard tube to protect the wiring harness from contacting a sharp edge or surface.



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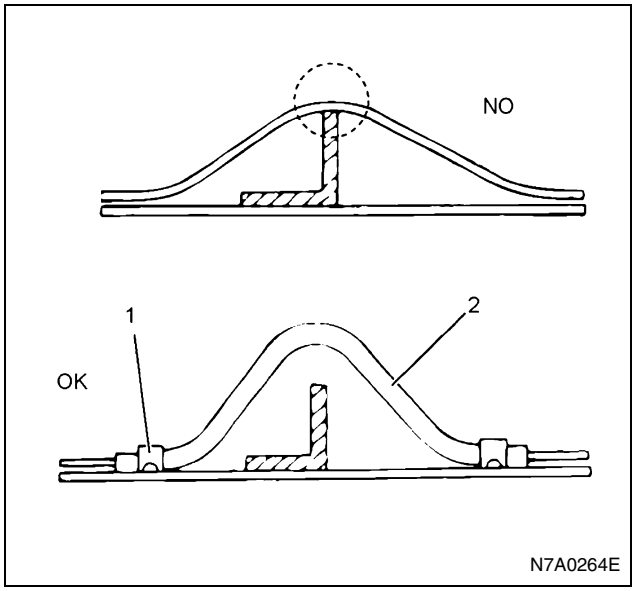
4. Position the wiring harness with an enough clearance from the other parts, and guard the wiring harness with a vinyl tube (2) and clips (1) to avoid direct contact.



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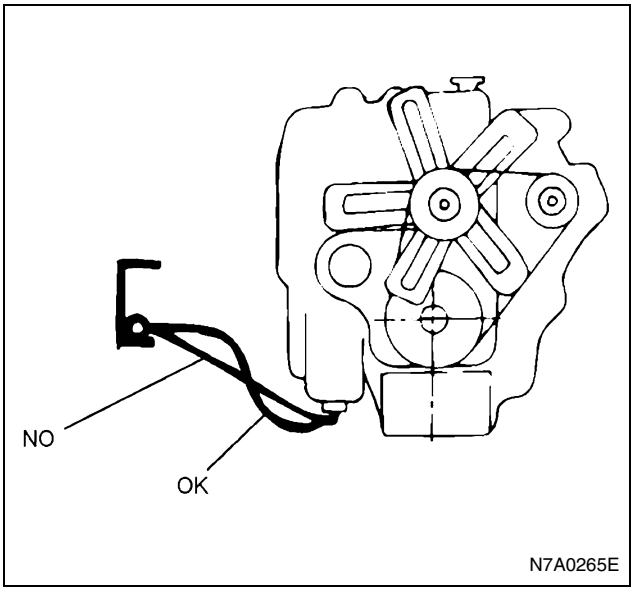
5. The wiring harness between engine and chassis should be long enough to prevent chafing or damage due to various vibrations.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VEHICLES WITH SRS AIRBAG SYSTEM

Notes for Handling SRS Airbag System

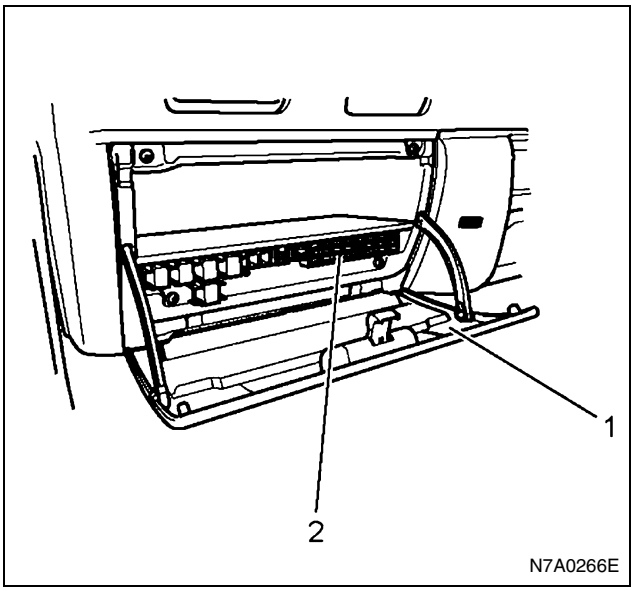
All the information necessary to securely and properly carry out service operations for SRS airbag system is provided in the section “Seat Belt, SRS Airbag.” In this section, notes related to the SRS airbag system are provided, which are to be observed when carrying out service operations for items other than SRS airbag system. When doing an inspection work, make sure to set the ignition switch to “LOCK”.

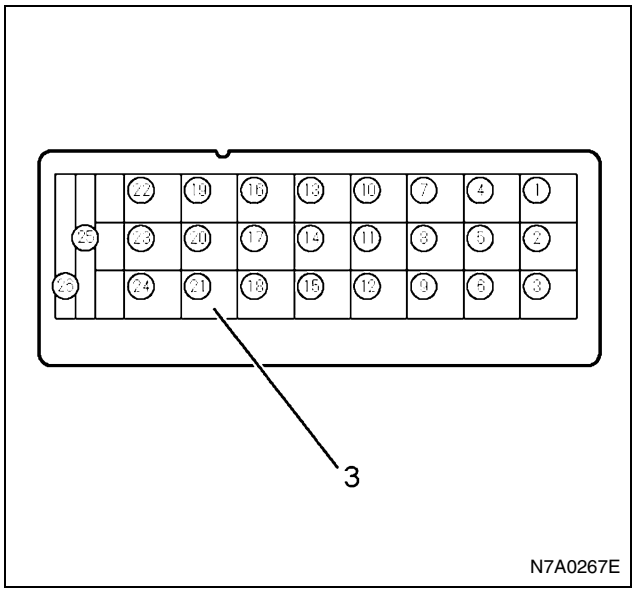
Be careful not to impact the SRS airbag system and its peripheral parts to prevent the deployment of the airbag. Also, before carrying out service operations for SRS parts, SRS harnesses and other service operations as shown below, make sure to temporarily deactivate the SRS airbag system. Not observing the following procedure may result in an injury because of sudden deployment of the airbag, or damage to the SRS airbag system.

1. Repairs around the steering wheel
2. Repairs around the instrument panel, glove box and fuse box.
3. Repairs around the dashboard and center console.
4. Installation of car stereo etc.
5. Sheet metal coating on the right side of the cab

Deactivation of SRS Airbag System

- Turn the ignition key to “LOCK”, and release the key.
- Remove the SRS fuse (3) from the fuse box (2) located in the lower part of the glove box (1), or disconnect the ground cable from the battery. And leave all these parts untouched for about 15 seconds or more.
- In 15 seconds or more after removing the fuse and the ground cable of the battery, remove the two yellow connectors located in the lower part of the steering column.





Reactivation of SRS Airbag System

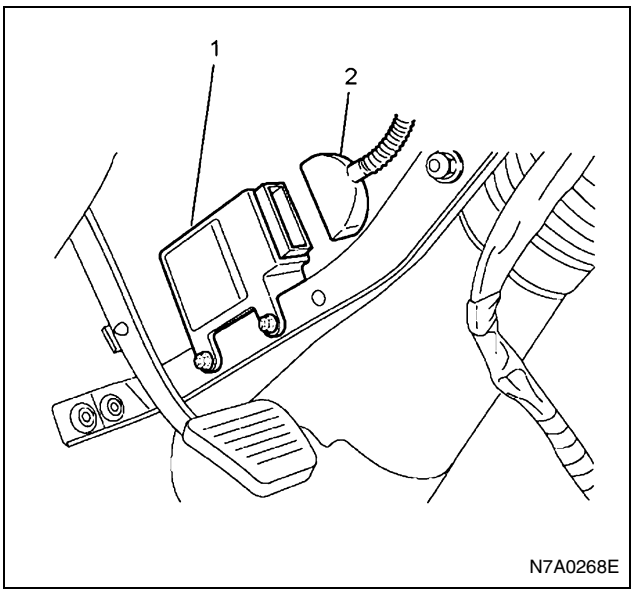
- Carry out the operation in the reverse order of deactivation.
- Turn the ignition switch to “ON.”
- Check that the AIRBAG warning lamp turns off after blinking seven times. (If the warning lamp is not activated correctly, refer to “SRS Control System.”)

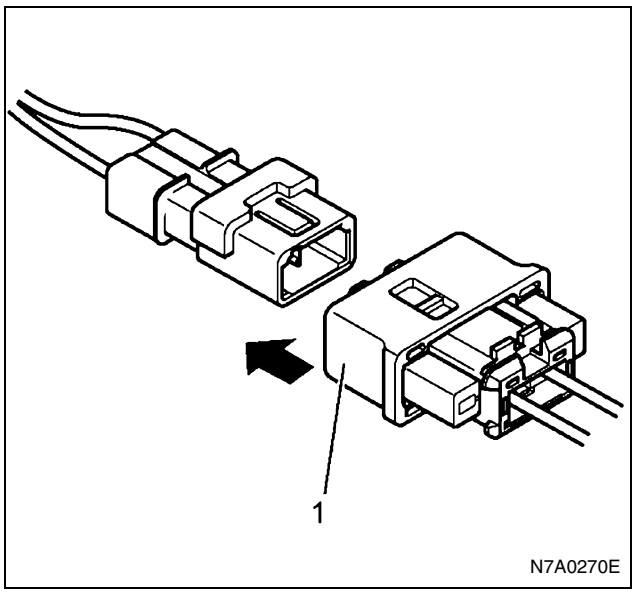
Caution:

- Do not expose the airbag assembly to the temperature of 93°C (199°F) or more. Accidental airbag deployment may result.
- If the airbag assembly and controller are dropped from a height of about one meter or more, do not use the airbag assembly.
- Check the part number before installing the airbag assembly. If a not applicable item is installed, malfunction may result.
- When disposing of the airbag assembly, make sure to deploy the airbag. If the airbag is discarded without being deployed, secondary accident may result.

Handling of Airbag Controller Connector

- Removal of connector (2)
  Remove the connector from controller (1) by pressing the arrow mark on the connector.

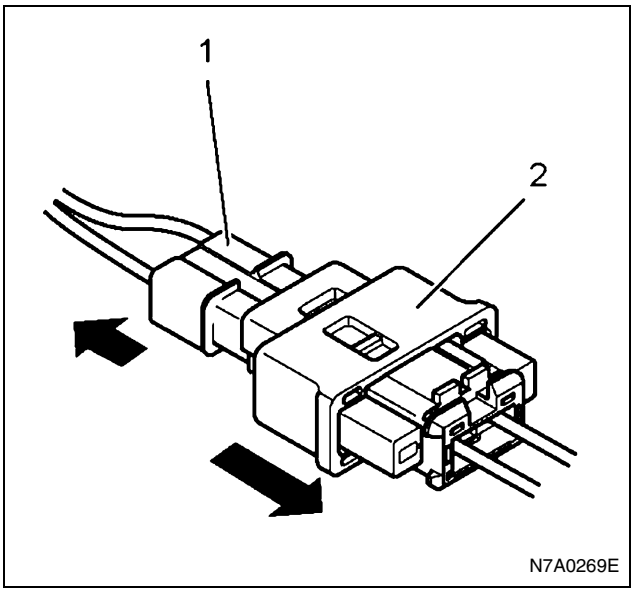




- Connection of connector
  Push connector (2) inside, and check that the connector is installed securely.

Handling of Inflator Connector

- Removal of connector
  Remove connector (1) on the pin side (male side) by pulling cover insulator (2) in the direction indicated by an arrow.



- Connecting of connector
  Hold socket insulator (1) and push it inside until a click is heard.

NOTES FOR ELECTRONIC CONTROL SYSTEM INSPECTION AND SERVICE

Scan Tool (External Diagnosis Device)

Use the specified scan tool in order to carry out fast and correct inspection of parts.
Make sure to refer to detailed description in the repair manual because the type and connection of a scan tool to be used differ according to vehicles and devices.

Circuit Tester

When using a circuit tester, observe the procedure indicated in the repair manual. If the procedure is not observed, other relevant parts may be damaged. If a specific type of circuit tester is specified, do not use any circuit tester of other type. If a circuit tester, which is not of the specified type, is used, other relevant parts may be damaged, and measurement may not be done correctly.

Caution:
If any circuit tester, which is not of the specified type, is used, the SRS and other electronic control system may malfunction.

Failure due to Static Electricity Discharge

When static electricity is discharged, relevant parts are charged with high voltage, and may be damaged. Observe the following items and take a proper action.

- Repair staff may be charged with static electricity through work place and clothes. Touch any normal grounding before inspecting and replacing relevant parts.
- Do not directly touch the connector pins of relevant parts. Do not rub them with other parts or cover.
- Connect the replacement parts to the normal grounding without unwrapping them. And then, take them out without letting them come into contact with the connector pins.

Additional Electric Equipment

If the vehicle is equipped with additional electric parts including lights, audio and radio devices, the electronic control system may be adversely affected by electric noises including radio wave emitted by those devices, depending on the installing condition. Turn off the additional electric parts beforehand, or carry out removal inspection and service.

Notes for Welding

Take the following actions before carrying out welding operation to protect the relevant parts.

- Remove the battery cable.
- Remove harnesses from all the control units.
- Turn all the switches to “OFF”.
- Install the grounding of the welding machine in a place as close to the welding point as possible.

Repetition of Trouble

If the same trouble is generated repeatedly or momentarily, or the trouble does not repeat whereas the trouble display is indicated, check whether the trouble repeats by taking following actions.

- Shake by hand the relevant parts, including control units, sensors, relays and harnesses.
  The trouble may repeat in case of connection failure.
- Heat the relevant parts using a dryer, or cool these parts using a refrigerant. The trouble may repeat if it is caused by temperature change.

Caution:
Do not heat the parts excessively to the level that cannot be touched.

- Sprinkle the vehicle with water. The trouble may repeat if it is caused by humidity change.

Caution:
Do not sprinkle water directly on the electric parts.

RECOMMENDED LIQUID GASKET AND LOCTITE

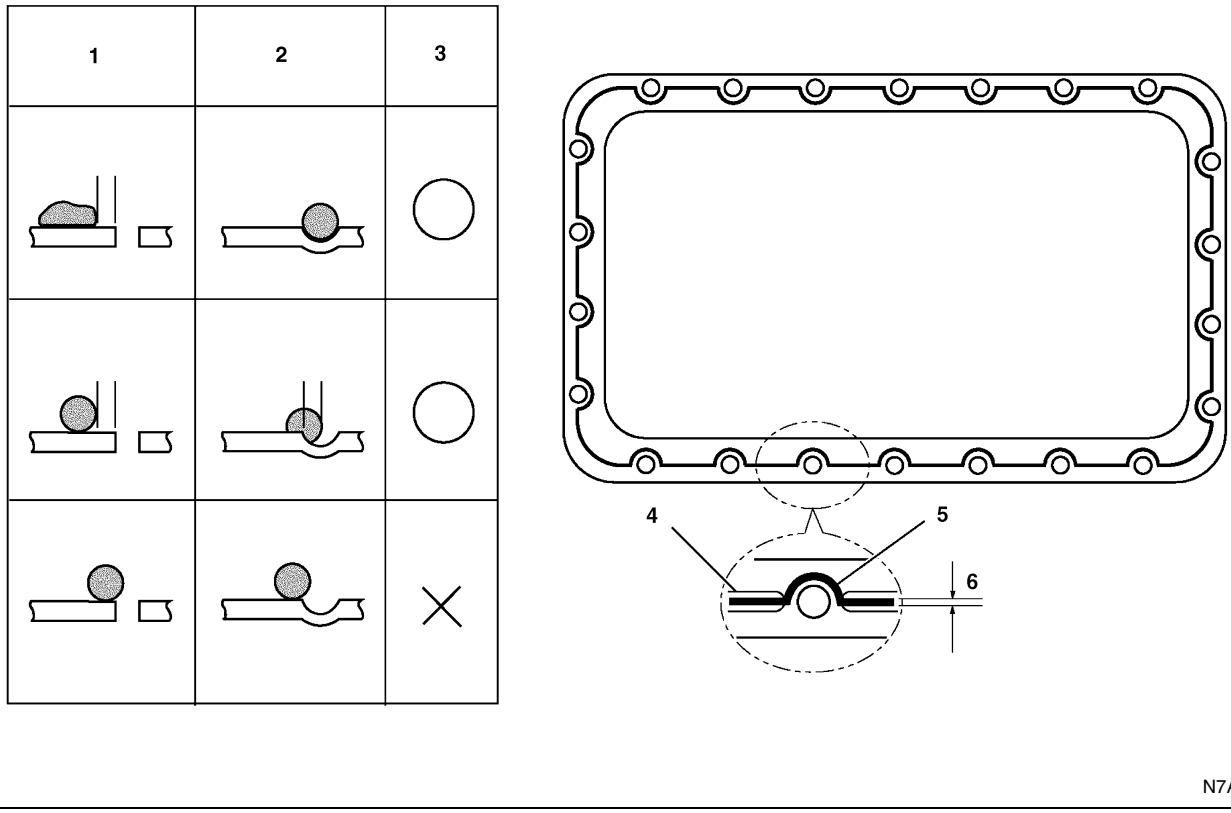
Liquid Gasket

TYPE	PRODUCT NAME	MANUFACTURER	APPLICATION PARTS (EXAMPLE)
Silicon Base (Room Temperature Vulcanizer)	ThreeBond 1207B ThreeBond 1207C ThreeBond 1215 ThreeBond 1216	ThreeBond ThreeBond ThreeBond ThreeBond	Engine Oil Seal Retainer Engine Oil Pan Timing Gear Case Cylinder Head Cover
Water Base	ThreeBond 1141	ThreeBond	Fuel Pump
Solvent	ThreeBond 1104 BelcoBond 4 BelcoBond 401 BelcoBond 402	ThreeBond ISUZU ISUZU ISUZU	Water Pump Rear Axle etc.
Anaerobic	LOCTITE 515 LOCTITE 518 FMD127	LOCTITE LOCTITE LOCTITE	Engine Oil Seal Retainer Water Pump Transaxle etc.

- It is very important that the liquid gasket listed above or their exact equivalent be used on the vehicle.
- LOCTITE 515, LOCTITE 518 and FMD127 harden upon contact with a metal surface. Do not apply LOCTITE 515, LOCTITE 518 or FMD127 between two metal surfaces having a clearance of greater than 0.25 mm (0.001 in). Poor adhesion will result.
- Use a proper amount of the liquid gasket. Observe the precautions for each product.

Application Procedure

1. Completely remove lubricant and moisture from the connecting surfaces. The surfaces must be perfectly dry.
2. Apply specified bead width 2 — 3 mm (0.08 — 0.12 in) of liquid gasket to one of the connecting surfaces. And the bead should be continuous.



Legend

1. BOLT HOLE
2. DEPRESSION
3. JUDGEMENT
4. Depression
5. Apply liquid gasket to the bolt hole interior.
6. Specified bead width: 2 — 3 mm (0.08 — 0.12 in)

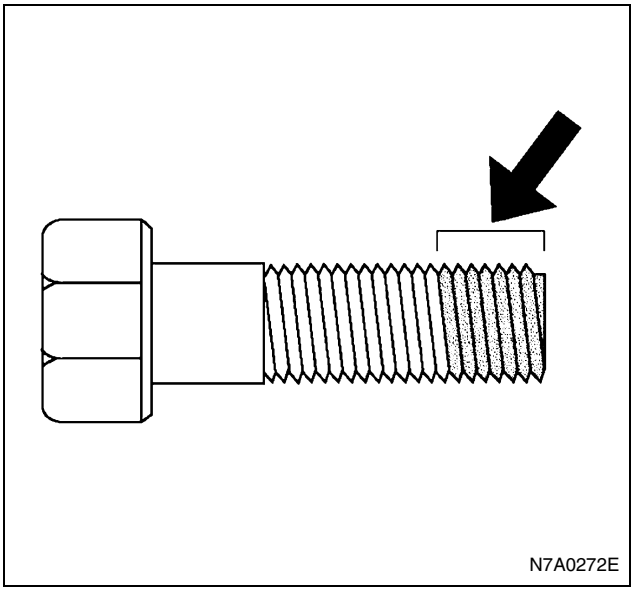
Notice:
When the application procedures are specified in this workshop manual, follow them.

Recommended Loctite (Thread Locking Agent)

TYPE	COLOR
LOCTITE242	Blue
LOCTITE262	Red
LOCTITE271	Red

Application Steps

1. Completely wipe all lubricant and moisture from the bolts and bolt holes, and the female thread connecting surfaces. The surfaces must be perfectly dry.
2. Apply LOCTITE to the 1/3 tip of the bolt's threaded area.



3. Tighten the bolts to the specified torque.

Important:
After tightening, be sure to keep the bolts free from vibration and torque for at least an hour until LOCTITE hardens.

TERMS AND ABBREVIATIONS

Term Definition

TERM	DESCRIPTION
DIMENSION	The standard dimension values to be observed when manufacturing.
STANDARD	The standard values to be observed when carrying out service operations, including inspection, adjustment, assembly and installation.
LIMIT	The maximum or minimum values, which must not be exceeded when service operations are carried out. If this value is exceeded, replacement or repair is required.
WARNING:	If not observed, danger of death or serious injury will result.
CAUTION:	If not observed, danger of injury or accident will result.
IMPORTANT:	If not observed, normal performance of relevant parts and system is not guaranteed, and failure of the vehicle may result.
NOTE:	Matters, which should be specially mentioned.

Abbreviations Charts

ABBREVIATION	DESCRIPTION
2L	2L Shoe Brake
2WD, 4×2	Two Wheel Drive
4WD, 4×4	Four Wheel Drive
A/C	Air Conditioning
A/F	Air Fuel Ratio
A/T, AT	Automatic Transmission
ABDC	After Bottom Dead Center
ABS	Antilock Brake System
AC	Alternating Current
ACC	Accessory
ACG	Alternating Current Generator
ACL	Air Cleaner
ACT	Actuator
ANT	Antenna
AP	Accelerator Position
API	American Petroleum Institute
ASM (Assy)	Assembly
ASR	Anti-slip Regulator
ASSIT	Assistant / Assist
ATDC	After Top Dead Center
ATF	Automatic Transmission Fluid
B/K	Brake
B+	Battery Positive Voltage
BAL	Balance
BAT, BATT	Battery
BBDC	Before Bottom Dead Center

ABBREVIATION	DESCRIPTION
BJ	Birfield Joint
BKT, BRKT	Bracket
BRG, Brg	Bearing
BTDC	Before Top Dead Center
C/B	Circuit Braker
C/U	Control Unit
CAM	Camshaft
CAN	Control Unit Communication Type
CFS	Clutch Free System
CKP	Crankshaft Position
CMP	Camshaft Position
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CONN	Connector
CPU	Central Processing Unit
CSD	Cold Starting Device
D2L	D2L Shoe Brake
DC	Direct Current
DD	Direct Drive
DFI	Diesel Fuel Injection
DI	Direct Injection
DLC	Data Link Connector
DMM	Digital Multi-meter
DOJ	Double Offset Joint
DPF	Diesel Particulate Filter

ABBREVIATION	DESCRIPTION
DTC	Diagnostic Trouble Code
DVM	Digital Voltage Meter
E/B	Exhaust Brake
ECM	Engine Control Module
ECT	Engine Coolant Temperature
ECU	Engine Control Unit
EDU	Engine Driver Unit
EEPROM	Electrically Erasable and Programmable Read Only Memory
EGR	Exhaust Gas Recirculation
EHCU	Electronic Hydraulic Control Unit
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
EVAP	Evaporation
EVRV	Electric Vacuum Regulating Valve
Exh, EXH	Exhaust
F/B	Feedback
F/C	Fuel Cut
F/L, FL	Fusible Link
FCS	Fuel Cut System
FICD	Fast Idle Control Device
FIO	Fast Idle Open
FLW	Fusible Link Wire
FRZ	Freezer
FT	Fuel Temperature
Ft, FRT	Front
FWD	Front Wheel Drive
GEN	Generator
GND	Ground
GVW	Gross Vehicle Weight
GVM	Gross Vehicle Mass
H/L	Head Lamp
HAB	Hydraulic Assist Brake
HC	Hydrocarbons
HD	Heavy Duty
HID	High Intensity Discharge Headlamp
HO 2 S	Heated Oxygen Sensor
HAS	Hill Start Aid
HT	Hypoid Tandem
HUD	Head-Up Display

ABBREVIATION	DESCRIPTION
HVAC	Heater Ventilation Air Conditioner
I/PUMP, I/P	Injection Pump
IAC	Idle Air Control
IAT	Intake Air Temperature
IC	Integrated Circuit
ID Plate	Identification Plate
IGN / IG	Ignition
IN	Intake
INJ	Injection
ISC	Idle Speed Control
ISM	Intake Step Motor
ISO	International Standardization Organization
ISP	Intake Shutter Position
ITP	Intake Throttle Position
J/B	Junction Block
J/C	Joint Connector
JIS	Japan Industrial Standards
L/H, LH	Left-Hand
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LEV	Low Emission Vehicle
LPG	Liquefied Petroleum Gas
LSD	Limited Slip Differential
LSPV	Load Sensing Proportioning Valve
LT	LT Shoe Brake
LWB	Long Wheel Base
M/T, MT	Manual Transmission
M/V	Electromagnetic Valve
MAP	Manifold Absolute Pressure
Max	Maximum
MIL	Malfunction Indicator Lamp
Min	Minimum
MPU	Micro Processing Unit
NC	Normally Closed
NE	Engine RPM
NO	Normally Open
Nox	Nitrogen Oxides
O/D	Over Drive
O2S	O2 Sensor

ABBREVIATION	DESCRIPTION
OBD	Onboard Diagnosis
ODM	Output Driver Module
OEM	Original Equipment Manufacturing
OHC	Overhead Camshaft
OHV	Overhead Valve
OPT	Option
OT	Oil Temperature
P	Poles
P/L, PL	Pilot Lamp
P/S	Power Steering
PCM	Power Train Control Module
PCV	Positive Crankcase Ventilation
P-I	Proportion / Integration
PID	Control Type
PM	Particulate Matter
POS	Position
PTO	Power Take Off
PWM	Pulse Width Modulation
Q	Quantity (Fuel Injection Quantity)
QDM	Quad Driver Module
QOS	Quick On Start Module
QWS	Quick Warming Up System
R/H, RH	Right-Hand
R/L	Relay
RAM	Random Access Memory
REF	Reference
RET	Retarder
REV	Reverse
ROM	Read Only Memory
RP	Rail Pressure
Rr, RR	Rear
RWD	Rear Wheel Drive Vehicle
S/M	Step Motor
SAE	Society of Automotive Engineers
SBF	Slow Blow Fuse
SCV	Suction Control Valve
SIG	Signal
SLD	Shield
SPV	Spill Control Valve
SRS	Supplemental Restraint System
ST	Starter / Start
STD	Standard
STRG	Steering
SW	Switch
SWB	Short Wheel Base
T/F	Transfer
TCC	Torque Converter Clutch
TCM	Transmission Control Module
TCV	Timing Control Valve
TDC	Top Dead Center
TEMP	Temperature
TFT	Transmission Fluid Temperature
TP	Throttle Position
TWV	Two Way Valve
V/P	Vacuum Pump
VB	Battery Voltage
Vcc	Collector Voltage
VCI	Vehicle Communication Interface
VIM	Vehicle Interface Module
VIN	Vehicle Identification Number
VOL, Vol.	Volume
VSS	Vehicle Speed Sensor
VSV	Vacuum Switching Valve
W/B, WB	Wheel Base
W/H	Wire / Harness
W/L	Warning Lamp
WOT	Wide Open Throttle

Introduction of SI (International System of Unit)

The SI was founded with an aim to standardize various unit systems, e.g. the metric system, pound system etc., and to get rid of complicated conversion of units using calculators.
Introduction of the SI in Japan is standardized in JIS-Z-8203.
In this manual, all the units are indicated based on the International System of Units, along with conventional units in ( ).

- SI is the abbreviation of “Le Systeme Internationale d’Unites.”

STANDARD BOLTS TIGHTENING

Isuzu Standard Fixing Torque Specifications

The torque values given in the following table should be applied where a particular torque is not specified.

N·m (kg·m/lb·ft)

Strength Class	4.8 4T		7T	
Bolt Identification	Hexagon Head Bolt	Flange Bolt	Hexagon Head Bolt	Flange Bolt
M6 × 1	3.9 — 7.8 (0.4 — 0.8/2.9 — 5.8)	4.6 — 8.5 (0.5 — 0.9/3.4 — 6.3)	4.9 — 9.8 (0.5 — 1.0/3.6 — 7.2)	5.7 — 10.6 (0.6 — 1.1/4.2 — 7.8)
M8 × 1.25	7.8 — 17.7 (0.8 — 1.8/5.8 — 13.1)	10.5 — 19.6 (1.1 — 2.0/7.7 — 14.5)	11.8 — 22.6 (1.2 — 2.3/8.7 — 16.7)	13.5 — 25.0 (1.4 — 2.5/10 — 18.4)
M10 × 1.25	20.6 — 34.3 (2.1 — 3.5/15.2 — 25.3)	23.1 — 38.5 (2.4 — 3.9/17 — 28.4)	27.5 — 46.1 (2.8 — 4.7/20.3 — 34)	31.0 — 51.7 (3.2 — 5.3/22.9 — 38.1)
*M10 × 1.5	19.6 — 33.3 (2.0 — 3.4/14.5 — 24.6)	22.3 — 37.2 (2.3 — 3.8/16.4 — 27.4)	27.5 — 45.1 (2.8 — 4.6/20.3 — 33.3)	30.3 — 50.4 (3.1 — 5.1/22.3 — 37.2)
M12 × 1.25	49.0 — 73.5 (5.0 — 7.5/36.1 — 54.2)	54.9 — 82.3 (5.6 — 8.4/40.5 — 60.7)	60.8 — 91.2 (6.2 — 9.3/44.8 — 67.3)	68.1 — 102.1 (6.9 — 10.4/50.2 — 75.3)
*M12 × 1.75	45.1 — 68.6 (4.6 — 7.0/33.3 — 50.6)	51.0 — 76.5 (5.2 — 7.8/37.6 — 56.4)	56.9 — 84.3 (5.8 — 8.6/42 — 62.2)	62.7 — 94.0 (6.4 — 9.6/46.2 — 69.3)
M14 × 1.5	76.5 — 114.7 (7.8 — 11.7/56.4 — 84.6)	83.0 — 124.5 (8.5 — 12.7/61.2 — 91.8)	93.2 — 139.3 (9.5 — 14.2/68.7 — 102.7)	100.8 — 151.1 (10.3 — 15.4/74.3 — 111.4)
*M14 × 2	71.6 — 106.9 (7.3 — 10.9/52.8 — 78.8)	77.2 — 115.8 (7.9 — 11.8/56.9 — 85.4)	88.3 — 131.4 (9.0 — 13.4/65.5 — 96.9)	94.9 — 142.3 (9.7 — 14.5/70 — 105)
M16 × 1.5	104.0 — 157.0 (10.6 — 16.0/76.7 — 115.8)	115.6 — 173.3 (11.8 — 17.7/85.3 — 127.8)	135.3 — 204.0 (13.8 — 20.8/99.8 — 150.5)	150.1 — 225.2 (15.3 — 23.0/110.7 — 166.1)
*M16 × 2	100.0 — 149.1 (10.2 — 15.2/73.8 — 110)	109.4 — 164.2 (11.2 — 16.7/80.7 — 121.1)	129.4 — 194.2 (13.2 — 19.8/95.4 — 143.2)	142.5 — 213.8 (14.5 — 21.8/105.1 — 157.7)
M18 × 1.5	151.0 — 225.6 (15.4 — 23.0/111.4 — 166.4)	—	195.2 — 293.2 (19.9 — 29.9/144 — 216.3)	—
*M18 × 2.5	151.0 — 225.6 (15.4 — 23.0/111.4 — 166.4)	—	196.1 — 294.2 (20.0 — 30.0/144.6 — 217)	—
M20 × 1.5	206.0 — 310.0 (21.0 — 31.6/151.9 — 228.6)	—	269.7 — 405.0 (27.5 — 41.3/198.9 — 298.7)	—
*M20 × 2.5	190.2 — 286.4 (19.4 — 29.2/140.3 — 211.2)	—	249.1 — 374.6 (25.4 — 38.2/183.7 — 276.3)	—

				N·m (kg·m/lb·ft)
Strength Class	4.8 4T		7T	
Bolt Identification	Hexagon Head Bolt	Flange Bolt	Hexagon Head Bolt	Flange Bolt
M22 × 1.5	251.1 — 413.8 (25.6 — 42.2/185.2 — 305.2)	—	362.8 — 544.3 (37.0 — 55.5/267.6 — 401.5)	—
*M22 × 2.5	217.7 — 327.5 (22.2 — 33.4/160.6 — 241.6)	—	338.3 — 507.0 (34.5 — 51.7/249.5 — 373.9)	—
M24 × 2	358.9 — 539.4 (36.6 — 55.0/264.7 — 397.8)	—	430.0 — 711.0 (43.9 — 72.5/317.2 — 524.4)	—
*M24 × 3	338.3 — 507.0 (34.5 — 51.7/249.5 — 373.7)	—	406.0 — 608.0 (41.4 — 62.0/299.5 — 448.4)	—

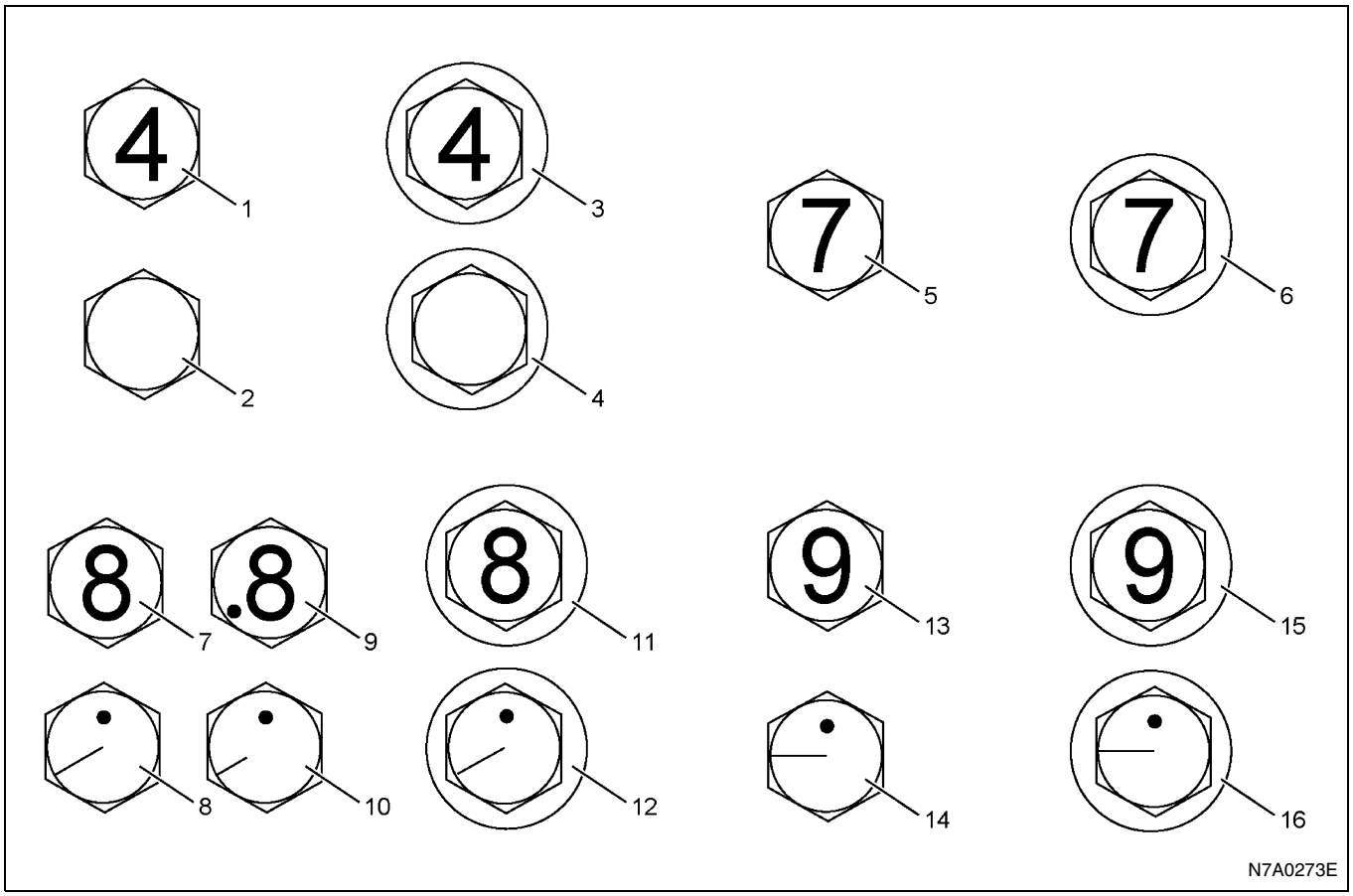
The asterisk * indicates that the bolts are used for female-threaded parts that are made of soft materials such as casting, etc.

				N·m (kg·m/lb·ft)
Strength Class	8.8		9.8 9T	
Bolt Identification	Hexagon Head Bolt	Flange Bolt	Hexagon Head Bolt	Flange Bolt
M6 × 1	5.6 — 11.2 (0.6 — 1.1/4.1 — 8.3)	6.6 — 12.2 (0.6 — 1.2/4.9 — 9)	—	—
M8 × 1.25	13.4 — 25.7 (1.4 — 2.6/9.9 — 19)	15.3 — 28.4 (1.6 — 2.9/11.3 — 20.9)	16.7 — 30.4 (1.7 — 3.1/12.3 — 22.4)	18.1 — 33.6 (1.9 — 3.4/13.3 — 24.8)
M10 × 1.25	31.3 — 52.5 (3.2 — 5.4/23.1 — 38.7)	35.4 — 58.9 (3.6 — 6.1/26.1 — 43.4)	37.3 — 62.8 (3.8 — 6.4/27.5 — 46.3)	42.3 — 70.5 (4.3 — 7.2/31.2 — 52)
*M10 × 1.5	31.3 — 51.4 (3.2 — 5.2/23.1 — 37.9)	34.5 — 57.5 (3.5 — 5.8/34.5 — 42.4)	36.3 — 59.8 (3.7 — 6.1/26.8 — 44.1)	40.1 — 66.9 (4.1 — 6.8/29.6 — 49.3)
M12 × 1.25	69.3 — 104.0 (7.1 — 10.6/51.1 — 76.7)	77.7 — 116.5 (7.9 — 11.9/57.3 — 85.9)	75.5 — 113.8 (7.7 — 11.6/55.7 — 83.9)	85.0 — 127.5 (8.7 — 13.0/62.7 — 94)
*M12 × 1.75	64.8 — 96.1 (6.6 — 9.8/47.8 — 70.9)	71.4 — 107.2 (7.3 — 10.9/52.7 — 79.1)	71.6 — 106.9 (7.3 — 10.9/52.8 — 78.8)	79.5 — 119.2 (8.1 — 12.2/58.6 — 87.9)
M14 × 1.5	106.2 — 158.8 (10.8 — 16.2/78.3 — 117.1)	114.9 — 172.3 (11.7 — 17.6/84.7 — 127.1)	113.8 — 170.6 (11.6 — 17.4/83.9 — 125.8)	123.4 — 185.1 (12.6 — 18.9/91 — 136.5)
*M14 × 2	100.6 — 149.8 (10.3 — 15.3/74.2 — 110.5)	108.2 — 162.2 (11.1 — 16.6/79.8 — 119.6)	106.9 — 160.0 (10.9 — 16.3/78.8 — 118)	115.5 — 173.3 (11.8 — 17.7/85.2 — 127.8)
M16 × 1.5	154.3 — 232.5 (15.7 — 23.7/113.8 — 171.5)	171.1 — 256.7 (17.4 — 26.2/126.2 — 189.3)	160.0 — 240.3 (16.3 — 24.5/118 — 177.2)	176.9 — 265.3 (18.0 — 27.1/130.5 — 195.7)

				N·m (kg·m/lb·ft)
Strength Class	8.8		9.8 9T	
Bolt Identification	Hexagon Head Bolt	Flange Bolt	Hexagon Head Bolt	Flange Bolt
*M16 × 2	147.6 — 221.4 (15.0 — 22.6/108.9 — 163.3)	162.5 — 243.8 (16.6 — 24.9/119.9 — 179.8)	153.0 — 229.5 (15.6 — 23.4/112.8 — 169.3)	168.5 — 252.7 (17.2 — 25.8/124.3 — 186.4)
M18 × 1.5	222.5 — 334.3 (22.7 — 34.1/164.1 — 246.6)	—	229.5 — 345.2 (23.4 — 35.2/169.3 — 254.6)	—
*M18 × 2.5	223.6 — 335.4 (22.8 — 34.2/164.9 — 247.4)	—	230.5 — 346.2 (23.6 — 35.3/170 — 255.3)	—
M20 × 1.5	307.4 — 461.7 (31.4 — 47.1/226.7 — 340.5)	—	316.8 — 475.6 (32.3 — 48.5/233.7 — 350.8)	—
*M20 × 2.5	284.0 — 472.1 (29.0 — 43.5/209.5 — 348.2)	—	293.2 — 440.3 (29.2 — 44.9/216.3 — 324.7)	—
M22 × 1.5	413.6 — 620.5 (42.2 — 63.3/305.1 — 457.7)	—	424.6 — 636.5 (43.3 — 64.9/313.2 — 469.5)	—
*M22 × 2.5	385.7 — 578.0 (39.3 — 58.9/284.5 — 426.3)	—	394.2 — 592.3 (40.0 — 60.4/290.7 — 436.9)	—
M24 × 2	490.8 — 810.5 (50.0 — 82.7/362 — 597.8)	—	554.1 — 830.6 (56.5 — 84.7/408.7 — 612.6)	—
*M24 × 3	462.8 — 693.1 (47.2 — 70.7/341.3 — 511.2)	—	520.7 — 781.6 (53.1 — 79.7/384 — 576.5)	—

The asterisk * indicates that the bolts are used for female-threaded parts that are made of soft materials such as casting, etc.

Isuzu Standard Bolt Head Marks

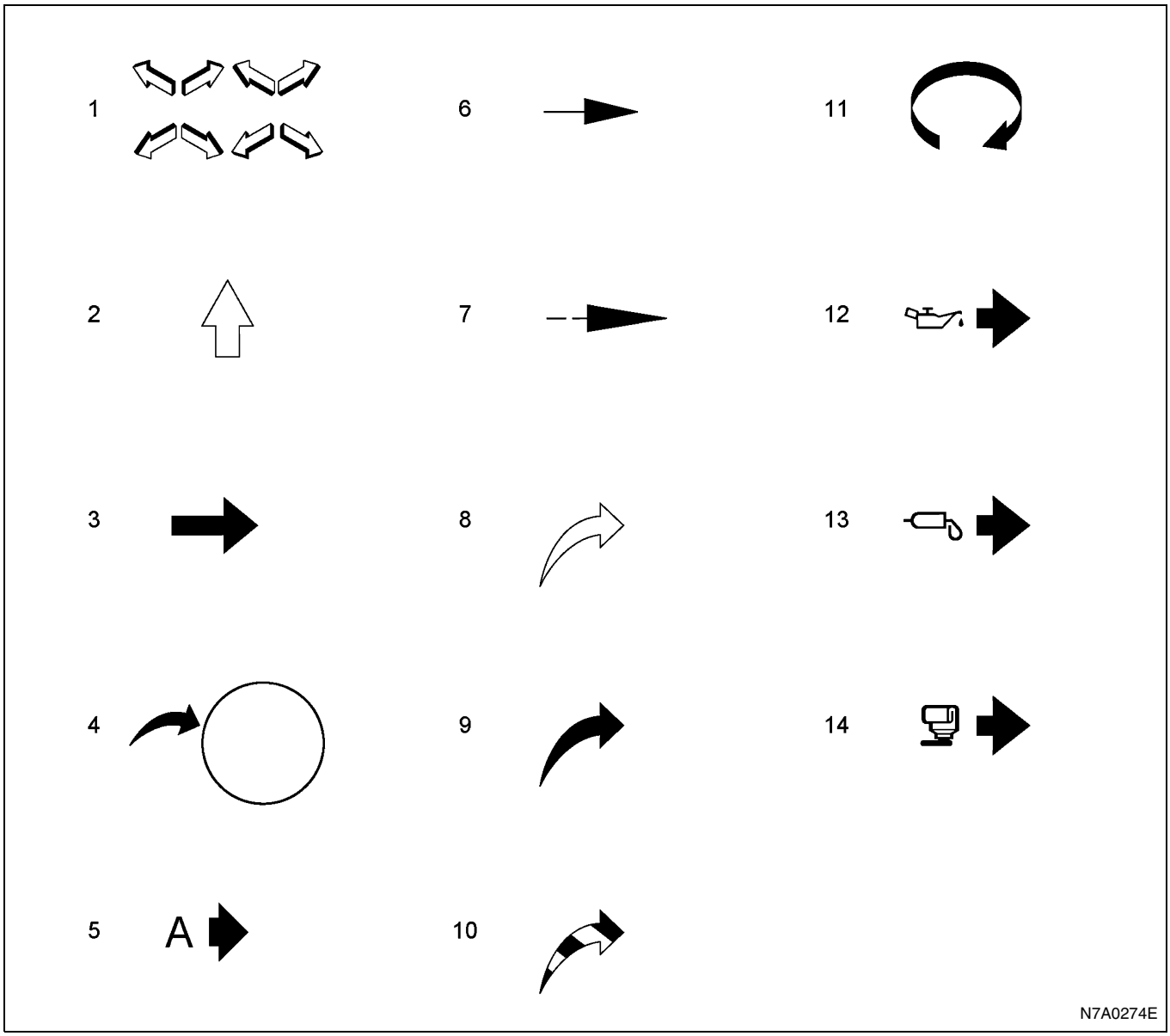


Legend

1. Hexagon Head Bolt (4.8, 4T)
2. Hexagon Head Bolt (4.8, 4T)
3. Flange Bolt (4.8, 4T)
4. Flange Bolt (4.8, 4T)
5. Hexagon Head Bolt (7T)
6. Flange Bolt (7T)
7. Hexagon Bolt (Heat-Treated 8.8)
8. Hexagon Bolt (Heat-Treated 8.8)
9. Hexagon Bolt (Non Heat-Treated 8.8)
10. Hexagon Bolt (Non Heat-Treated 8.8)
11. Flange Bolt (8.8)
12. Flange Bolt (8.8)
13. Hexagon Bolt (9.8, 9T)
14. Hexagon Bolt (9.8, 9T)
15. Flange Bolt (9.8, 9T)
16. Flange Bolt (9.8, 9T)

ARROWS USED IN FIGURES

Arrows Descriptions



Legend

1. Front side of the vehicle
2. Upper side
3. Servicing part, or servicing direction
4. Detail of a part
5. Detail from the point of view A
6. Arrow meaning dimension
7. Arrow meaning a cross section
8. External air or cool air flow (Used to indicate an air flow)
9. Gas or warm air flow
10. Mixture of air and gas, or mixture of cool air and warm air flow
11. Rotation direction
12. Fuel supply
13. Lubrication supply
14. Application of liquid gasket

MANUAL TRANSMISSION AND CLUTCH MYY SERIES

SECTION 7B

MANUAL TRANSMISSION

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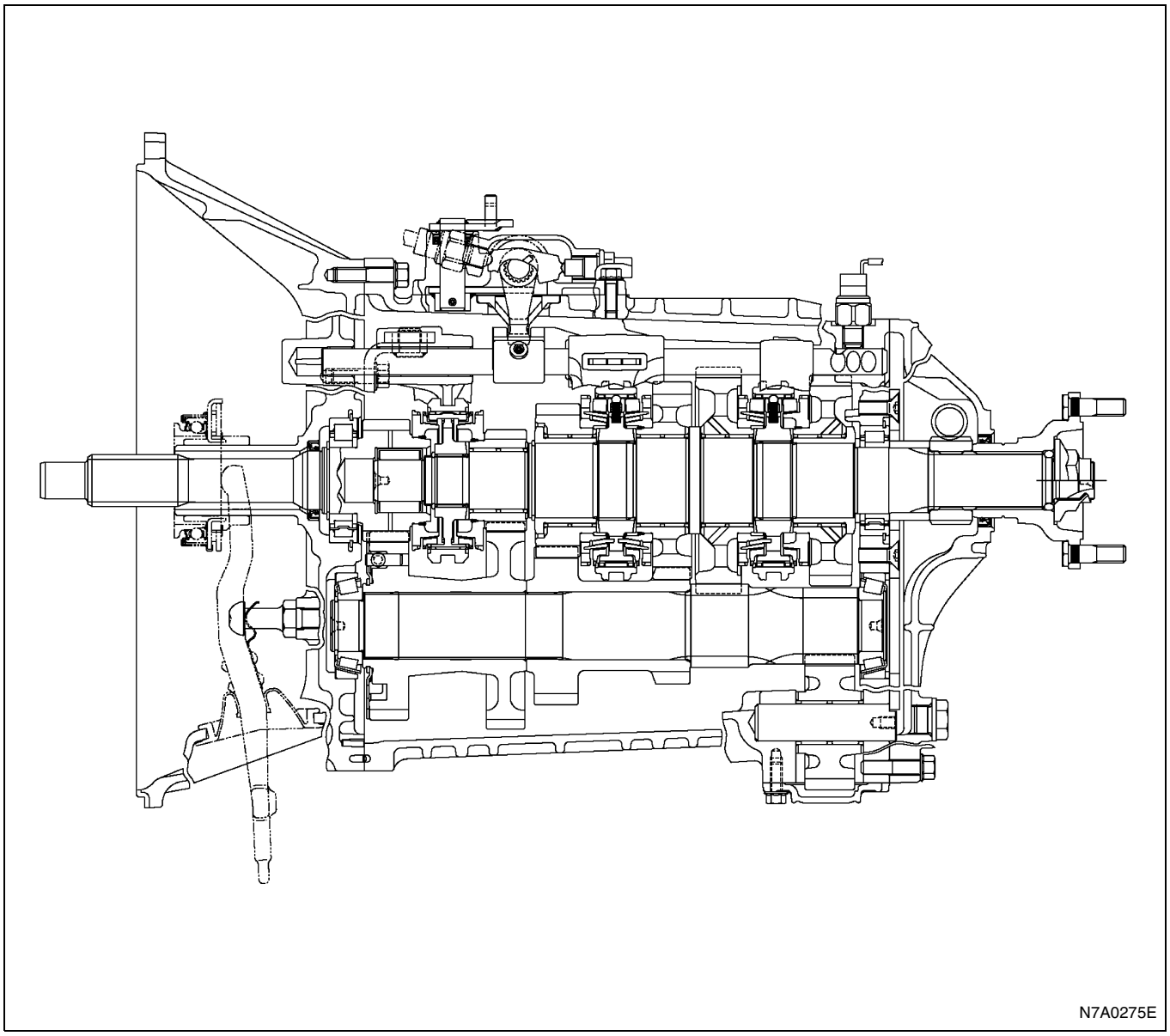
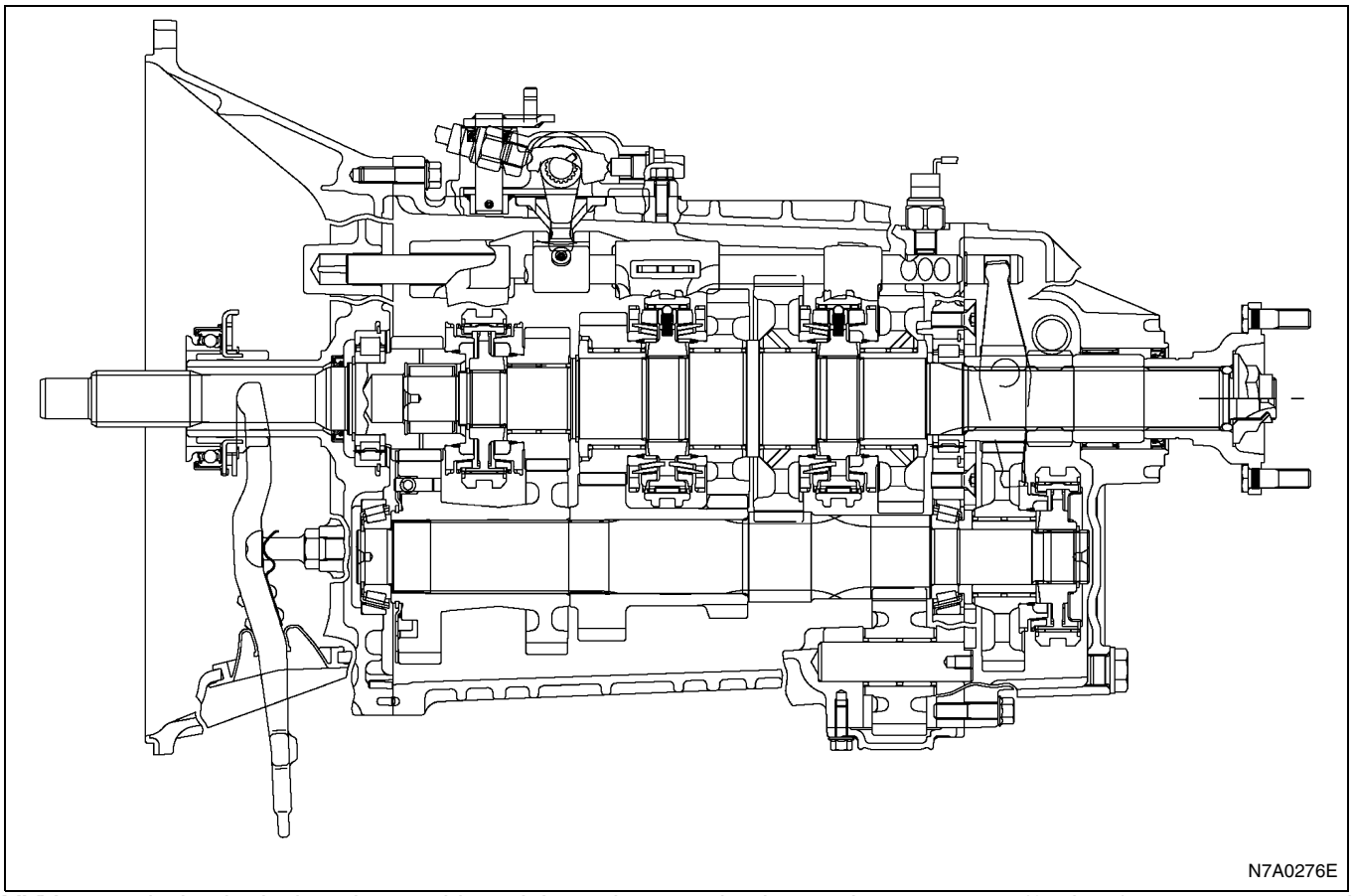
MANUAL TRANSMISSION MECHANISM

Function and Operation

- 5MT



• 6MT



MYY transmission is designed to enable weight saving and to adapt larger available torque input 392 N·m (40 kg·m/289.3 lb·ft). New technology is adopted such as aluminum-tube type case (3 piece) structure, tapered roller bearing (main shaft front and rear, counter shaft front and rear) and twin-rod type shift control layout.

Inspection

Diagnostic chart for troubleshooting

Trouble	Cause	Treatment
Noise	Wear of flywheel pilot bearing	Replace
	Wear or damage of bearing (main shaft, counter shaft)	Replace
	Wear, crack and damage of gear (main shaft, counter shaft, reverse idle gear)	Replace
	Wear of spline (main shaft, synchronizer clutch hub)	Replace
	Seizure of gear or bearing thrust surface	Replace
	Backlash shortage of mesh gear	Replace
Shift difficulty	Clutch pedal play inaccuracy	Adjust
	Wear of change lever sliding portion	Repair or replace, lubricate grease
	Wear of shift block, shift rod or control box sliding portion	Replace
	Wear of shift arm or synchronizer sleeve groove	Replace the worn parts
	Wear of thrust washer, collar or gear thrust surface (main shaft and counter shaft thrust play)	Replace the worn parts
	Wear of synchronizer parts	Replace

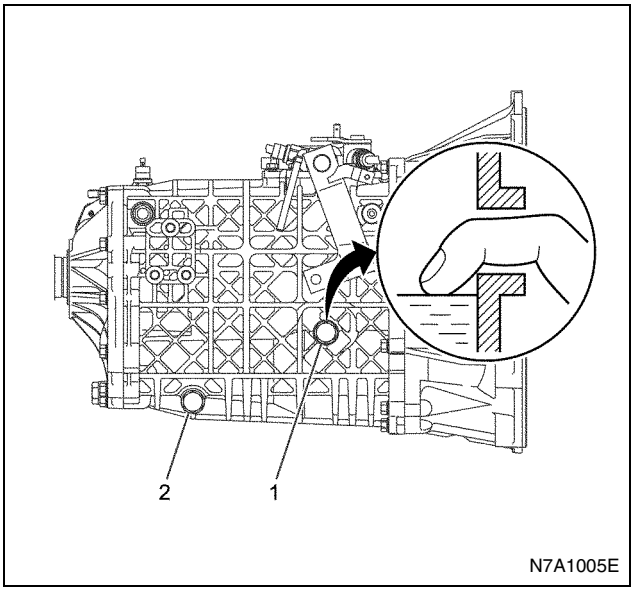
Trouble	Cause	Treatment
Out of gear	Wear of detent ball	Replace
	Wear of shift rod or control box sliding portion	Replace
	Wear of shift arm or synchronizer sleeve groove	Replace the worn parts
	Wear of thrust washer, collar or gear thrust surface (main shaft and counter shaft thrust play)	Replace the worn parts
	Wear or damage of bearing	Replace
	Wear of spline (main shaft, synchronizer hub)	Replace
	Fatigue or damage of synchronizer spring	Replace
Oil leakage	Looseness of drain plug or filler plug	Tighten the plug or refill oil
	Damaged gasket	Replace
	Wear or damage of oil seal	Replace

Oil Inspection

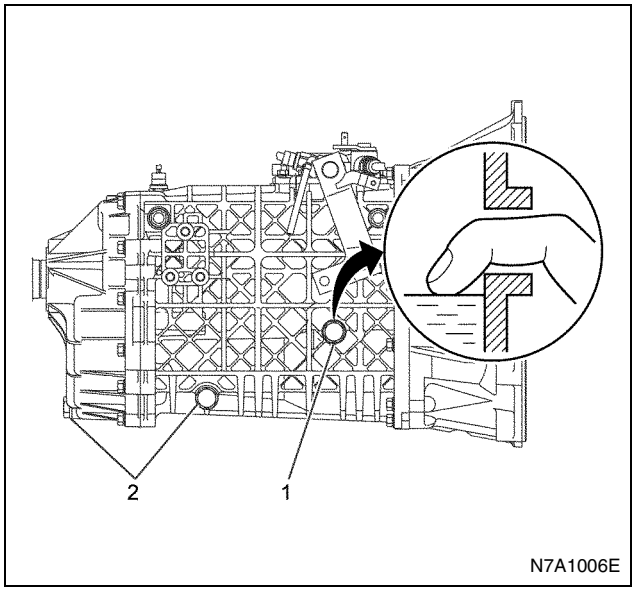
1. Remove the filler plug.
2. Check the oil level by inserting a finger to the filler plug hole.
3. Refill oil when the oil level is out of the specified amount.
   - Applicable oil = Besco gear oil transaxle (5W-30)
4. Fix the filler plug to the specified torque.

Tighten:
Filler plug to 39 N·m (4.0 kg·m / 29 lb·ft)

- 5MT



- 6MT



Legend
1. Filler plug
2. Drain plug

Oil Replacement

1. Start the engine and idle the transmission sufficiently.
2. Stop the engine, remove the drain plug, and then drain oil.
3. Fix the drain plug.

Tighten:
Drain plug to 39 N·m (4.0 kg·m / 29 lb·ft)

4. Remove the filler plug.
5. Fill oil through the filler plug hole to the lower edge of the hole.
   - Applicable oil = Besco gear oil transaxle (5W-30)

Oil Capacity		L (US qt/Imp qt)
	6MT	5MT
Normal	3.5 (3.7 / 3.1)	2.8 (3.0 / 2.5)
4WD	—	3.5 (3.7 / 3.1)
With front PTO	—	5.5 — 6.0 (5.8 — 6.3 / 4.8 — 5.3)
With side PTO	3.8 (4.0 / 3.3)	3.1 (3.3 / 2.7)
With side PTO (4WD)	—	3.8 (4.0 / 3.3)

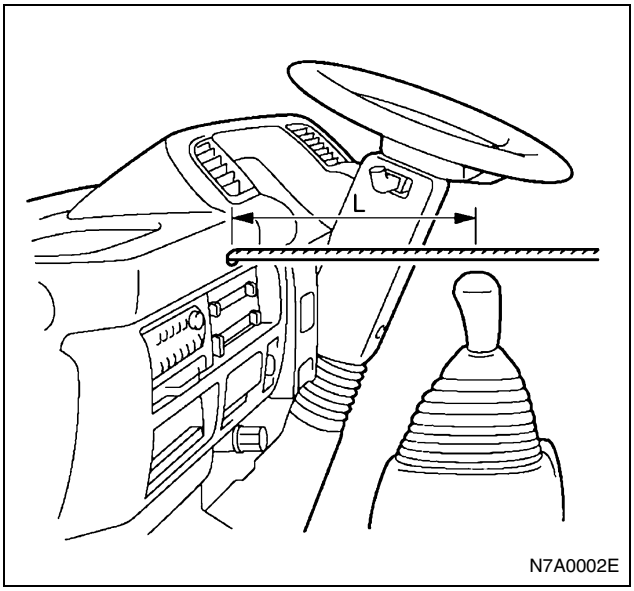
6. Fix the filler plug to the specified torque.

Tighten:
Filler plug to 39 N·m (4.0 kg·m / 29 lb·ft)

Inspection and Adjustment of The Gear Control

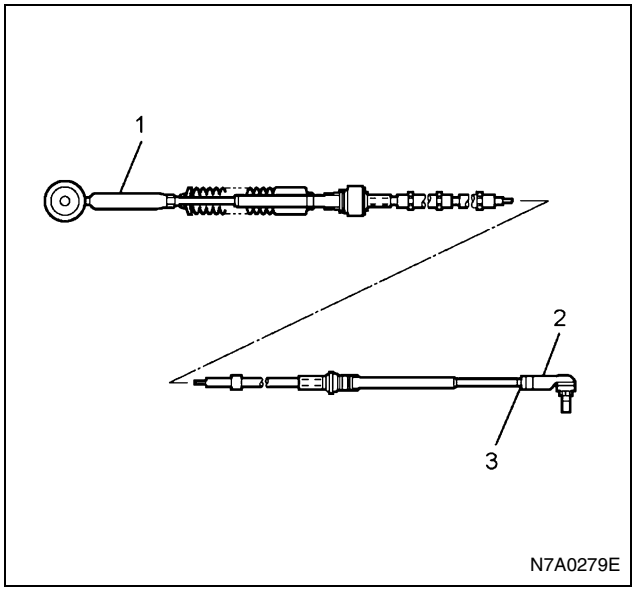
1. Shift the shift select external lever of the transmission side to neutral.
2. Measure the dimension (L) between the center of the change lever play and the instrument panel.
   L dimension

Standard cab model = 247 ± 15 mm (9.72 ± 0.6 in)
Wide cab model = 283 ± 15 mm (11.1 ± 0.6 in)



3. When the L dimension is out of specification, adjust it by the following:
   - Remove the change lever knob.
   - Remove the boot.
   - Remove the console box assembly.
   - Remove the shift select cable at the change lever side.
   - Shift the shift select external lever of the transmission side to neutral.
   - Loosen the lock nut of the shift cable, and install it by adjusting the cable length and making the L dimension become within specification.
   - Fix the lock nut.

Tighten:
Lock nut to 6 N·m (0.6 kg·m / 4 lb·ft)

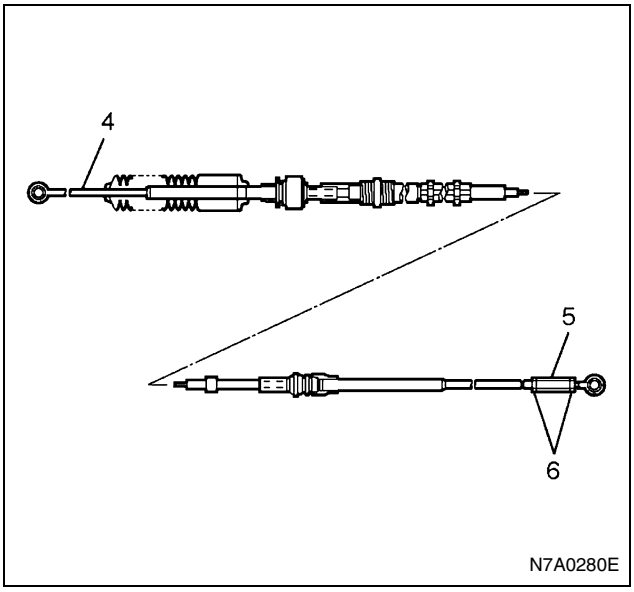


Legend
1. Transmission side
2. Joint ball
3. Change lever side

   - Loosen the lock nut of the select cable joint, adjust the select cable length to make the change lever select direction (right and left direction) tilt a little (2.7°) to the left against the vertical direction, and then joint the change lever.
   - Fix the lock nut.

Tighten:
Lock nut to 6 N·m (0.6 kg·m / 4 lb·ft)

   - Install the console box, the boot and the change lever knob.



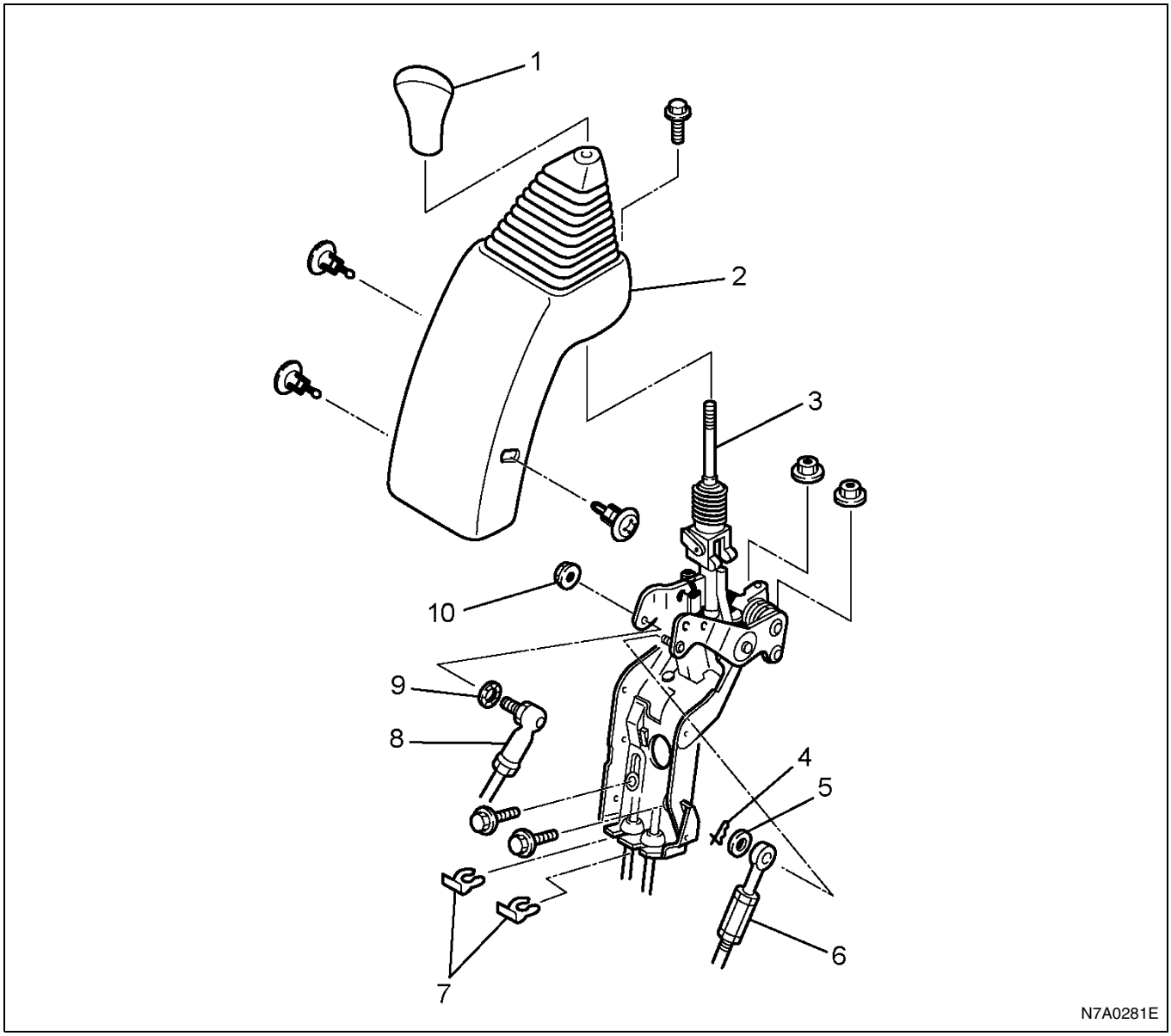
Legend

4. Transmission side
5. Turn buckle
6. Lock nut

ON-VEHICLE SERVICE

Change Lever

Components



Legend

1. Change lever knob
2. Gear control cover
3. Change lever assembly
4. Snap pin
5. Plain washer
6. Shift & select cable
7. Clip
8. Shift & select cable
9. Lock washer
10. Nut

Removal

1. Remove the change lever knob.
2. Remove the gear control cover.
3. Disconnect the change lever and cable from the shift & select cable.
4. Remove the change lever assembly.
   - Remove the parking brake cable from the bracket and put it aside, remove the bracket securing bolt and nut, and then remove the change lever assembly with the bracket.

Installation

1. Install the change lever assembly.
2. Install the shift & select cable.

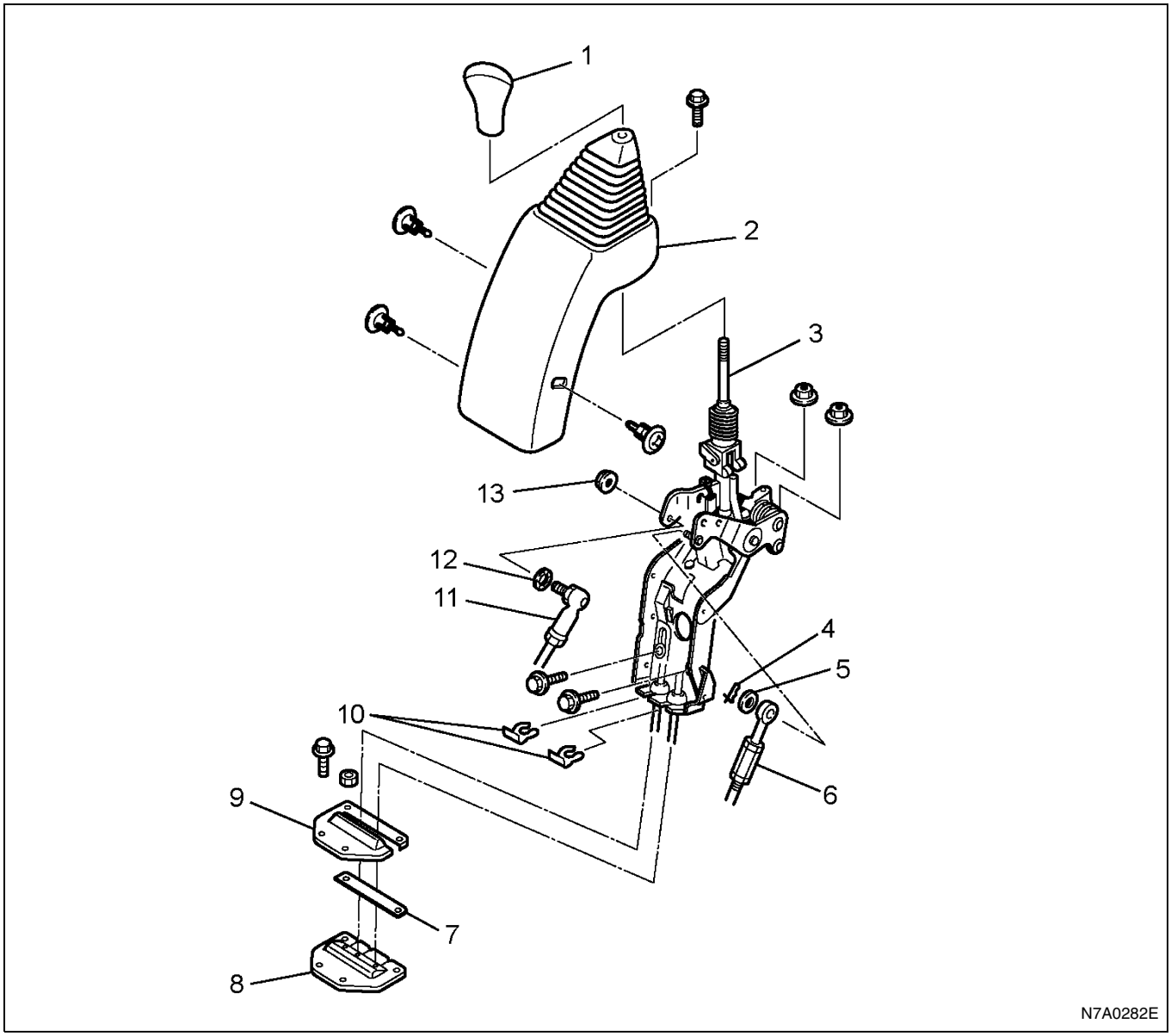
- Adjustment should be done after fixing the shift cable securing nut to the specified torque.
- Install the parking brake cable to the bracket.
- For adjustment, refer to MANUAL TRANSMISSION MECHANISM.

Tighten:
Shift cable securing nut to 21 N·m (2.1 kg·m / 15 lb·ft)

3. Install the gear control cover.
4. Install the change lever knob.

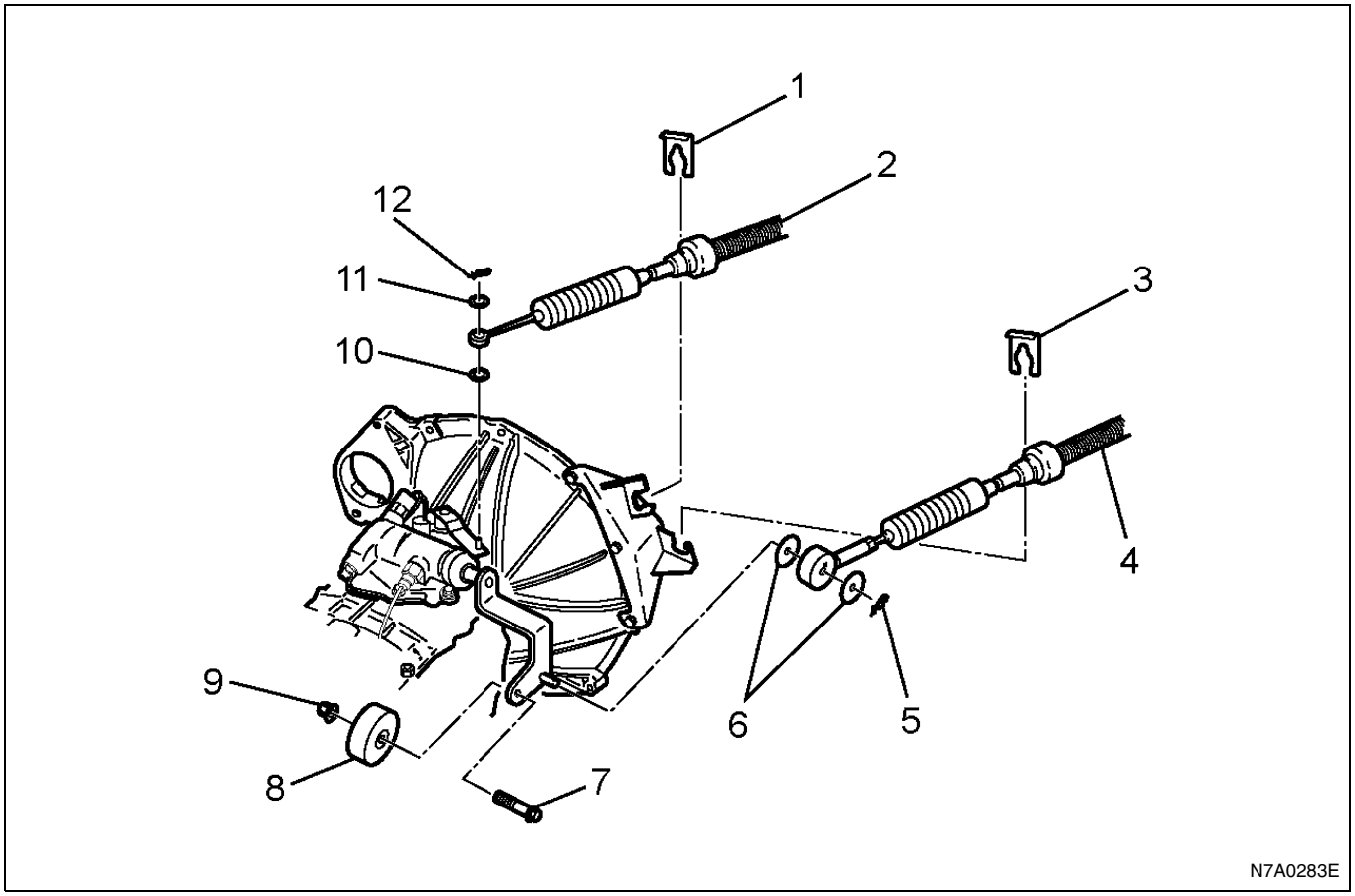
Gear Control Cable

Components



Legend

1. Change lever knob
2. Gear control cover
3. Change lever assembly
4. Snap pin
5. Plain washer
6. Shift & select cable
7. Grommet seat
8. Grommet
9. Grommet retainer
10. Clip
11. Shift & select cable
12. Lock washer
13. Nut

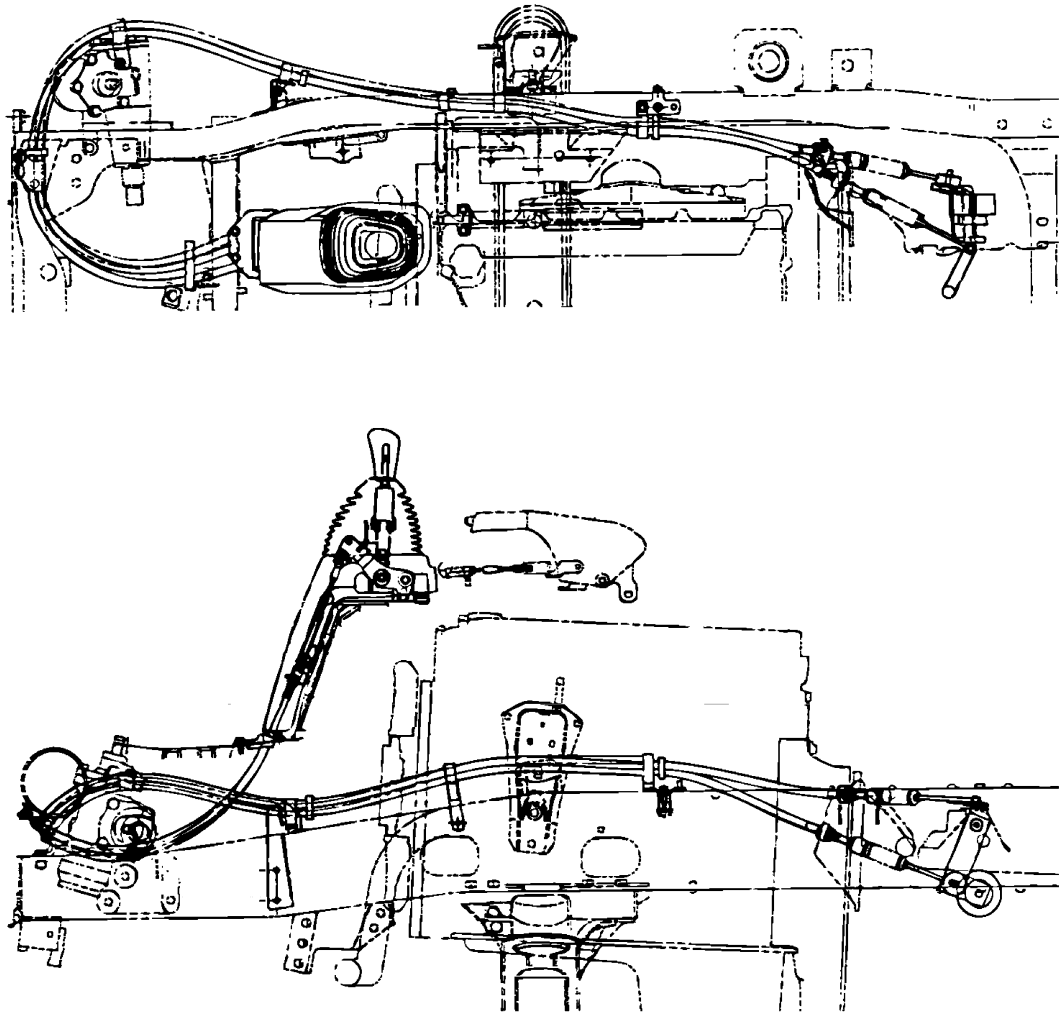


Legend

1. Clip
2. Select cable
3. Clip
4. Shift cable
5. Snap pin
6. Plain washer
7. Bolt
8. Weight
9. Nut
10. Wave washer
11. Plain washer
12. Snap pin

Gear Control Cable Layout

NKR



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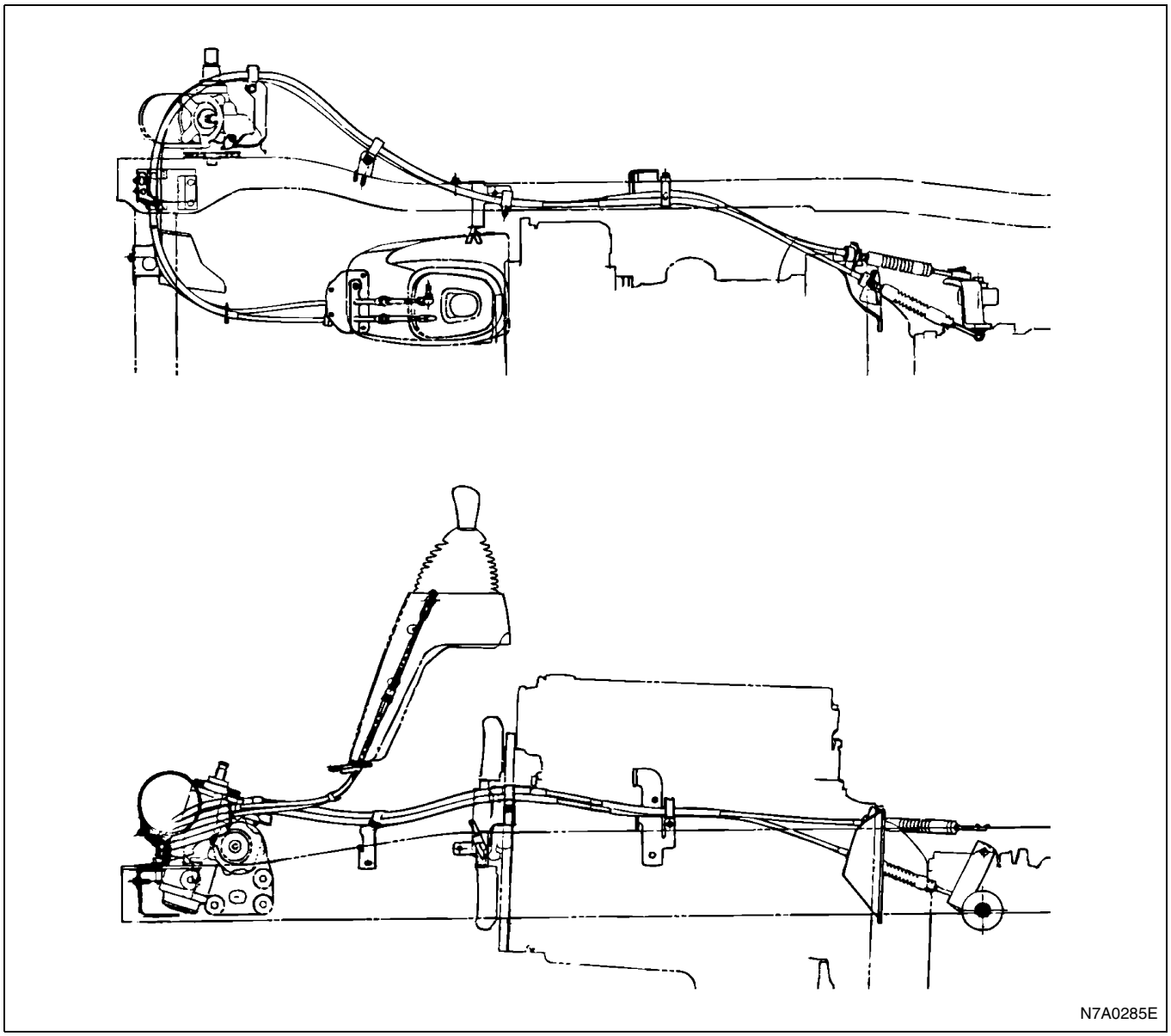
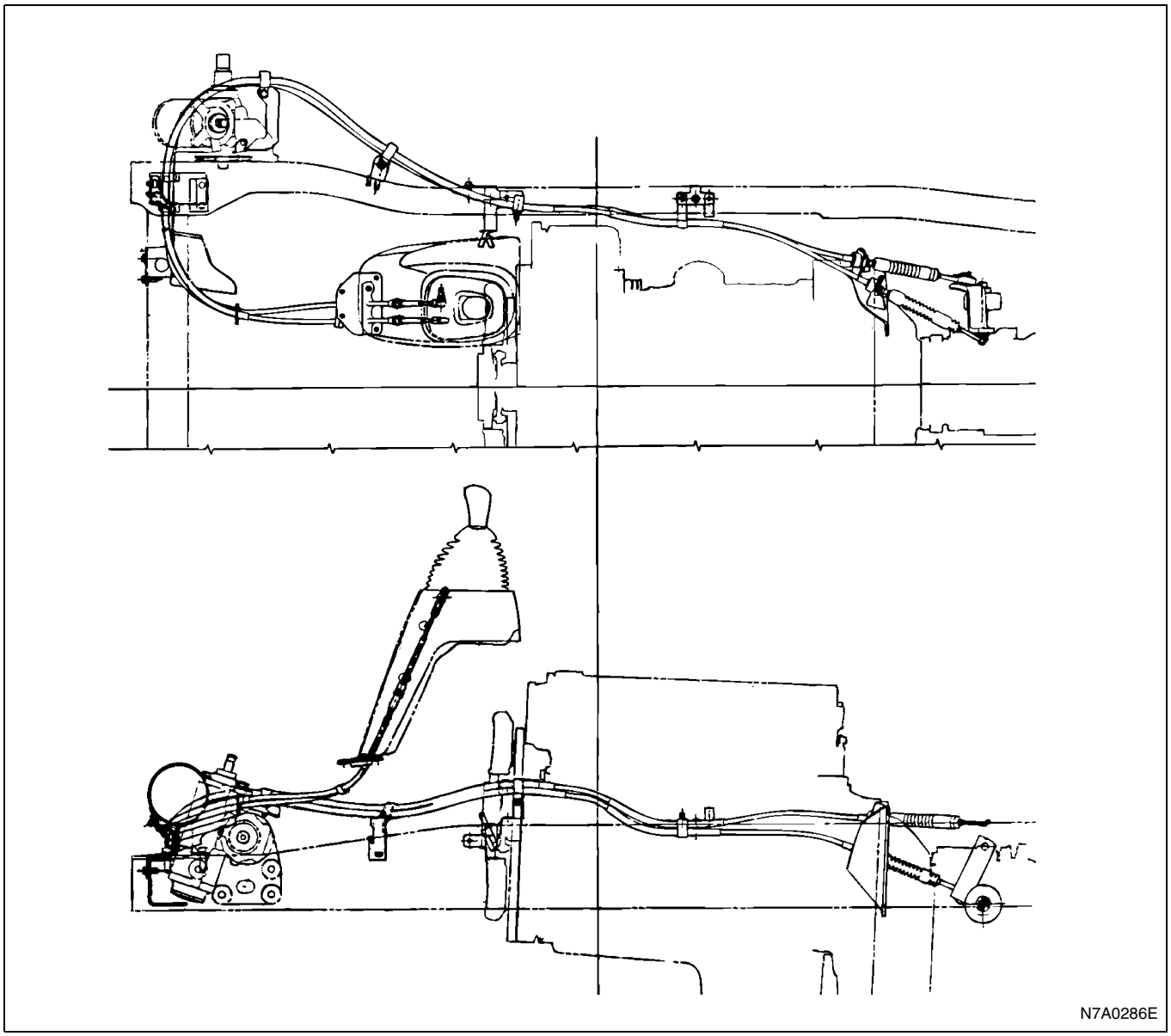
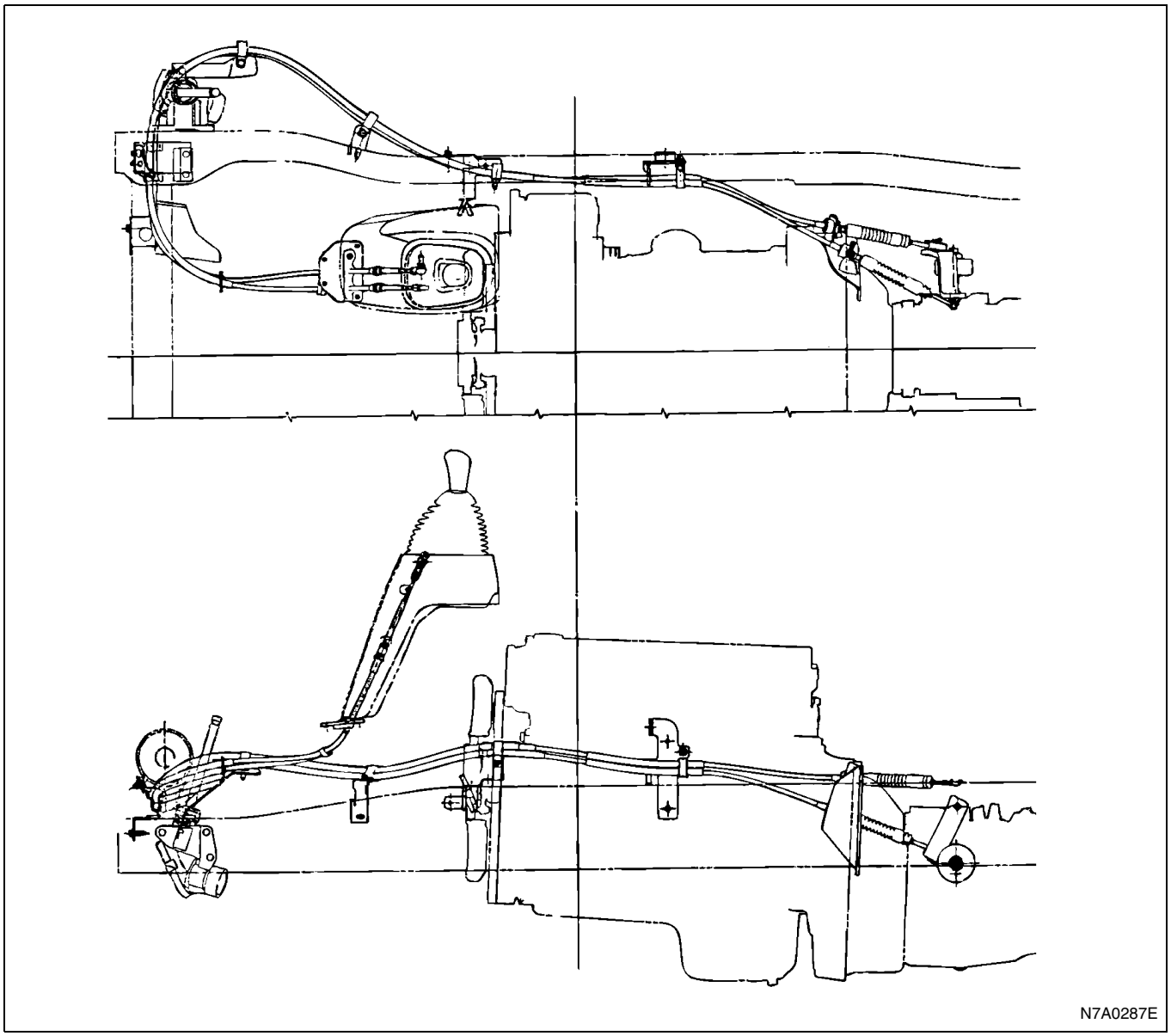
NPR



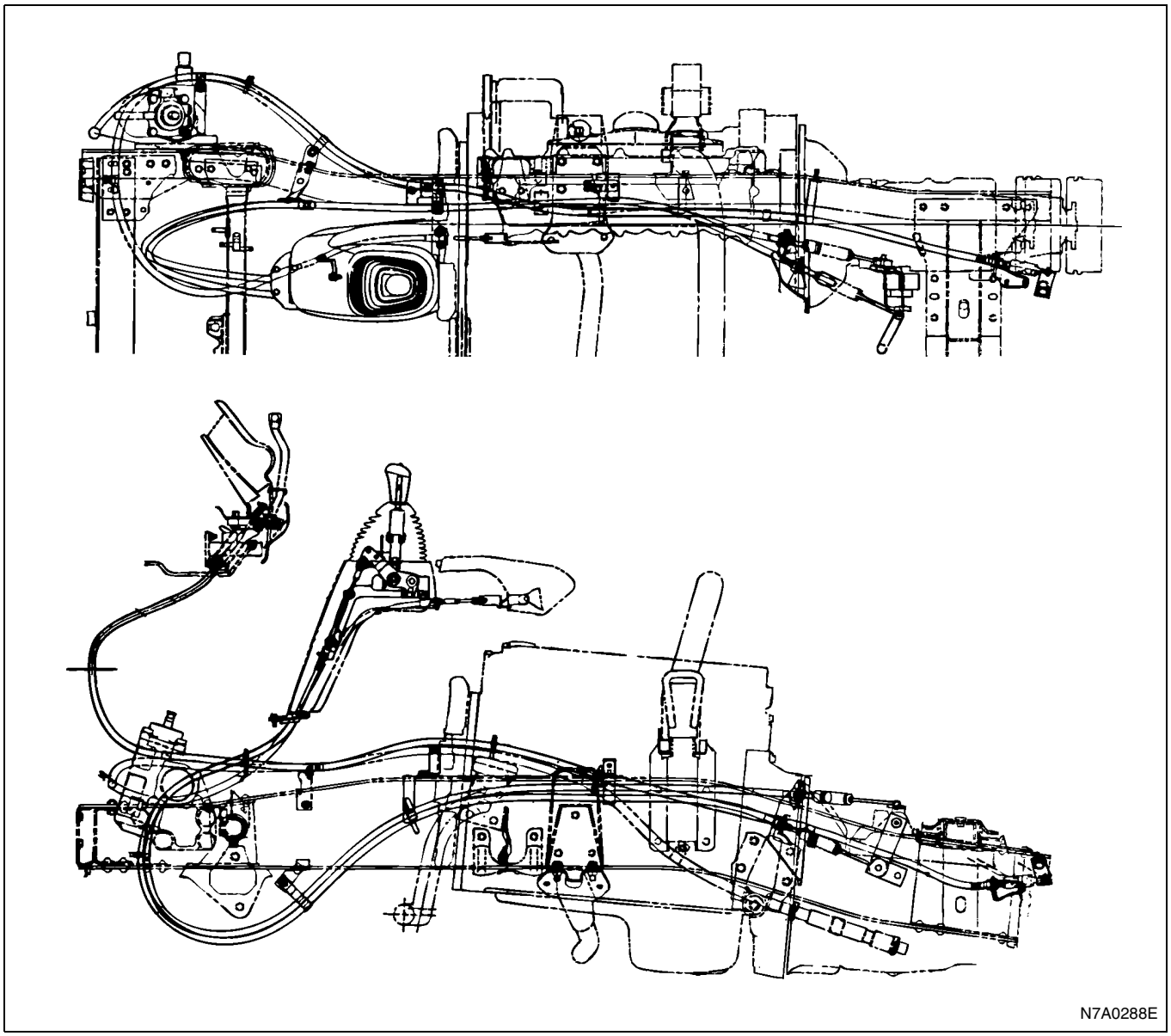
NPR (Bottle Car)



NPR/S (Double Wishbone Suspension)



NPS



Removal

1. Remove the change lever knob.
2. Remove the gear control cover.
   - Remove the screw and clip, and then remove the cover.
3. Remove the shift & select cable from the change lever side.
   - Disconnect the cable from the change lever.
   - Remove the clip securing the cable.
4. Remove the grommet retainer and the grommet seat.
   - Remove the securing bolt and nut, and then remove the grommet retainer and the seal.
5. Remove the grommet.
6. Remove the shift & select cable of the transmission side.
7. Remove all the clips and clamps.
   - Remove all the clips and clamps securing the cable to the frame, etc.
8. Remove the shift & select cable.

Inspection

- Check whether the cable is deformed, damaged, corroded or not, and whether the boot is damaged, poor-slid or not, and then replace abnormal parts found by the check.

Installation

1. Install the shift & select cable.
2. Secure the cable with a clip and clamp.
3. Fix the shift & select cable nut of the transmission side.

Tighten:

- Select cable nut to 21 N·m (2.1 kg·m / 15 lb·ft)
- Shift weight nut to 103 N·m (10.5 kg·m / 76 lb·ft)

4. Install the grommet.

5. Install the grommet retainer.

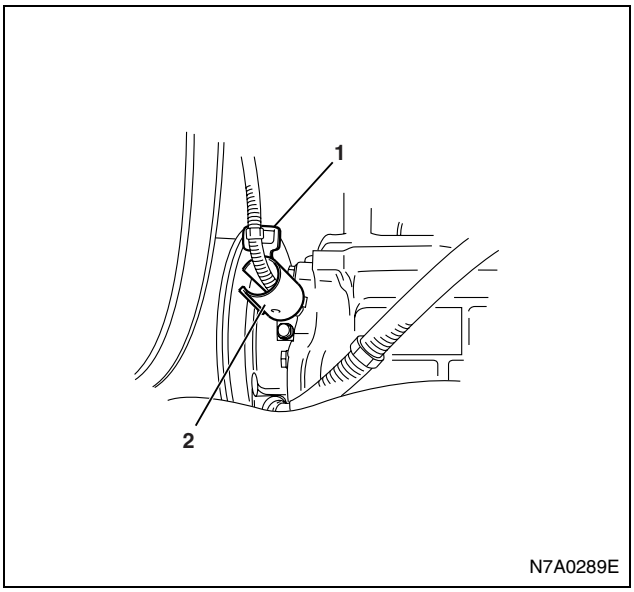
Tighten:
Securing bolt & nut to 11 N·m (1.1 kg·m / 8 lb·ft)

6. Install the shift & select cable joint portion (change lever side).
   - Adjust it after fixing the shift cable securing nut to the specified torque.
   - For adjustment, refer to MANUAL TRANSMISSION MECHANISM.
7. Install the gear control cable cover.
8. Install the change lever knob.
9. Install the seal behind the cab.

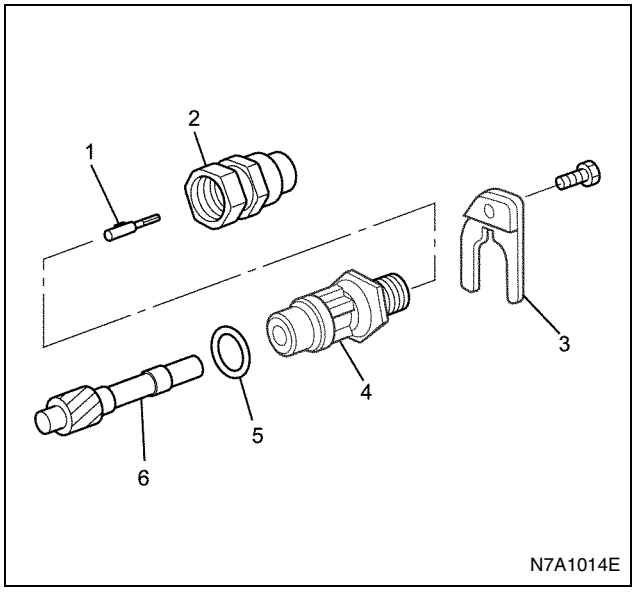
Vehicle Speed Sensor

Removal

1. Remove the clip (1), and then remove the protector (2).
2. Remove the wiring connector.



3. Remove the securing screw, and then remove the vehicle speed sensor.



Legend
1. Plug sensor
2. Vehicle speed sensor
3. Plate
4. Bush
5. O-ring
6. Driven gear

Installation

1. Install the vehicle speed sensor with a securing screw.

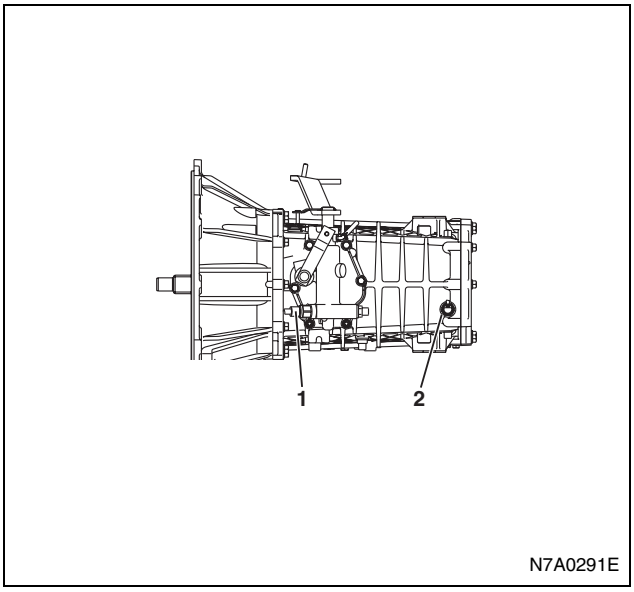
Tighten:
- Securing screw to 20 N·m (2.0 kg·m / 15 lb·ft)
- Bush and vehicle speed sensor to 25 N·m (2.5 kg·m / 18 lb·ft)

2. Connect the wiring connector.
3. Secure the protector with a clip.

Reverse and Neutral Switch

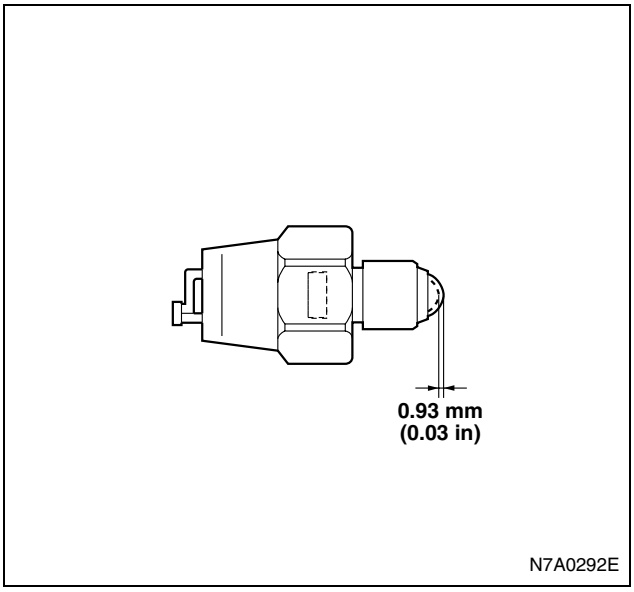
Removal

1. Remove the wiring connector.
2. Remove the reverse switch (2) (black connector).
3. Remove the neutral switch (1) (black connector).



Inspection

- It is normal if there is continuity between the switch terminals when the ball is not pushed, and no continuity when pushing in the ball.
- Switch operating stroke = 0.93 mm (0.03 in)



Installation

1. Install the neutral switch.

Liquid gasket: Three Bond 1141

Tighten:
Neutral switch to 34 N·m (3.5 kg·m / 25 lb·ft)

2. Install the reverse switch.
   - Apply liquid gasket to the switch thread before installation.

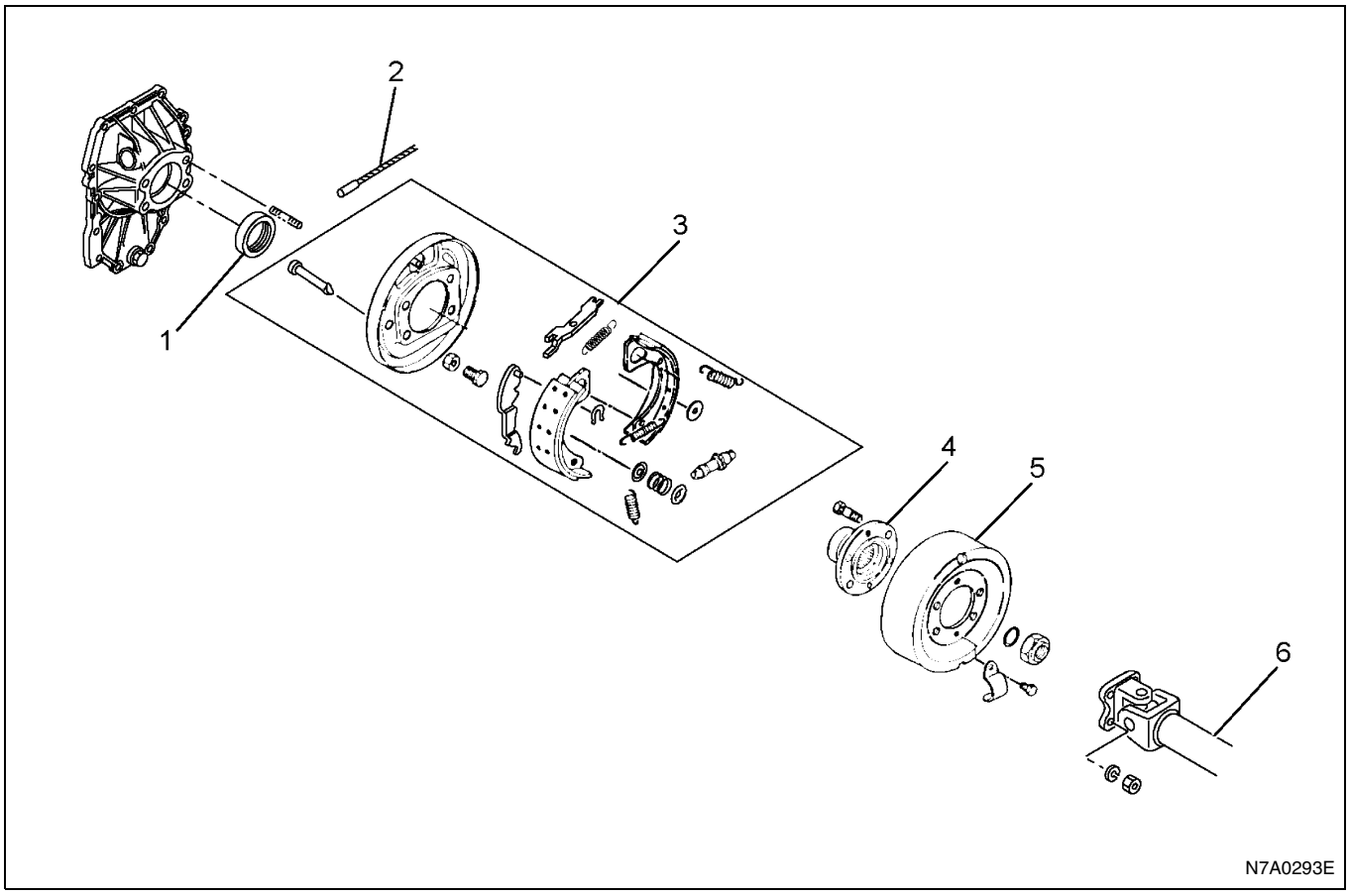
Liquid gasket: Three Bond 1141

Tighten:
Reverse switch to 39 N·m (4.0 kg·m / 29 lb·ft)

3. Connect the wiring connector.

Rear Oil Seal (5MT)

Components

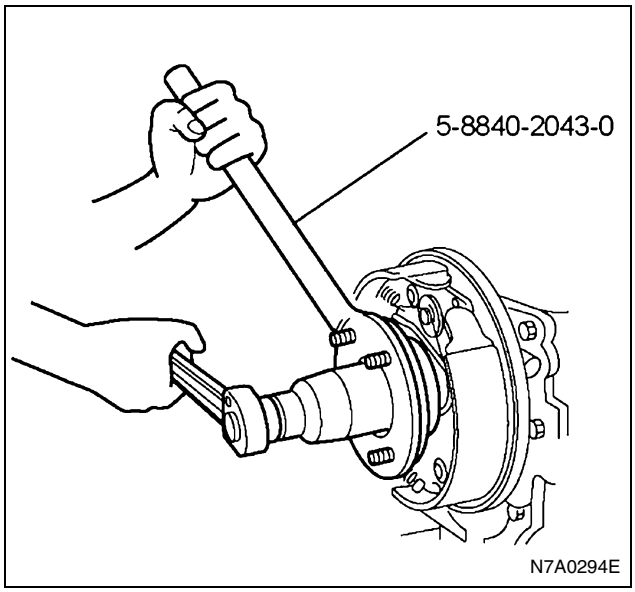


Legend

1. Oil seal
2. Parking brake cable
3. Parking brake assembly
4. Coupling driver
5. Parking brake drum
6. Rear propeller shaft assembly

Removal

1. Remove the rear propeller shaft assembly.
   - Refer to REAR PROPELLER SHAFT ASSEMBLY.
2. Remove the parking brake cable.
   - Refer to PARKING BRAKE CABLE.
3. Remove the parking brake drum.
   - Refer to PARKING BRAKE ASSEMBLY.
4. Remove the coupling driver and O-ring.
   - Raise the lock nut caulking portion (two parts) securely, and then remove the lock nut using the flange holder 5-8840-2043-0.



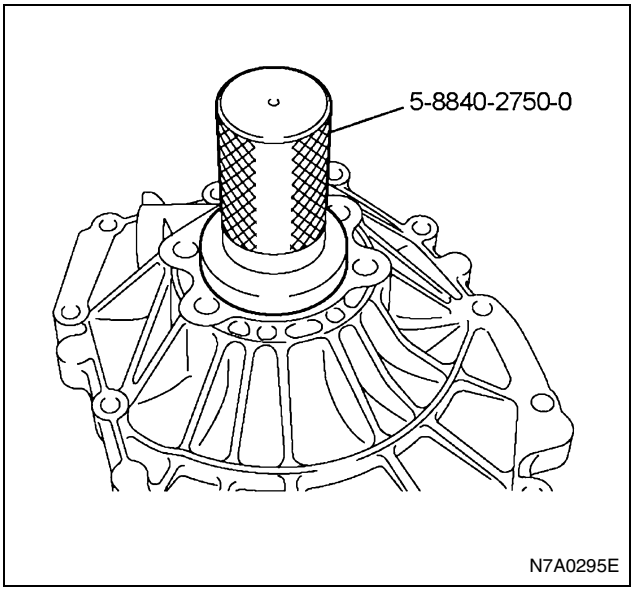
5. Remove the parking brake assembly.
   - Refer to PARKING BRAKE ASSEMBLY.

6. Remove the rear oil seal using the flat-tip screwdriver.

Installation

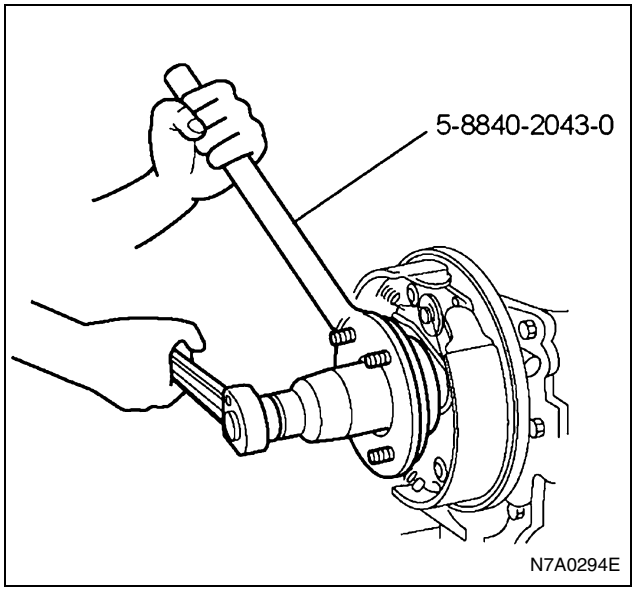
1. Apply engine oil 5W-30 around a new oil seal, and then press in the oil seal to the rear cover using the installer 5-8840-2750-0.
   - Apply Besco L2 grease on the lip of the oil seal.

Caution:
Be careful not to damage the lip of the oil seal.



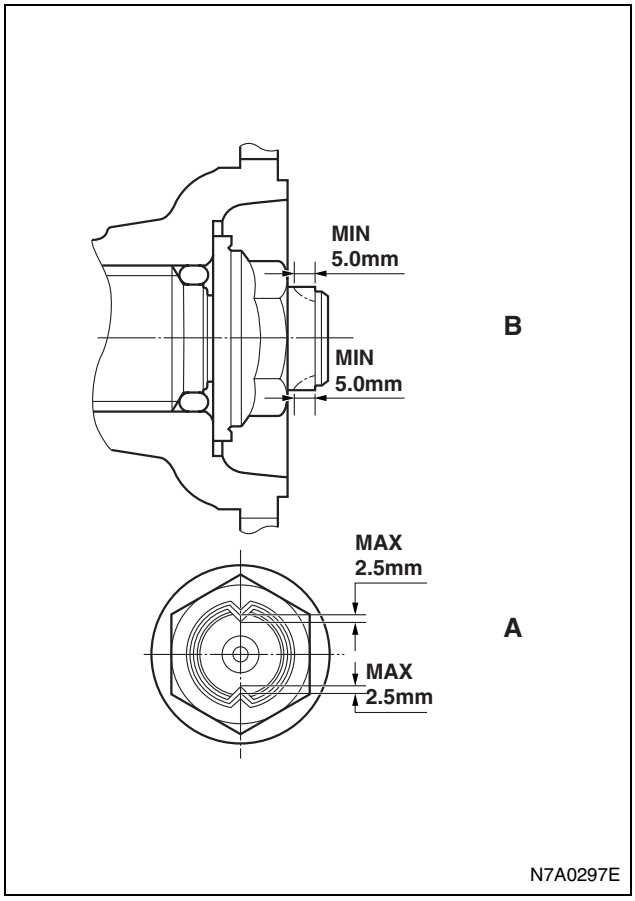
2. Install the parking brake assembly.
   - Refer to PARKING BRAKE ASSEMBLY.
3. Install the coupling driver.
   a. Apply engine oil 5W-30 to the O-ring, and then install the coupling driver and the O-ring.
   b. Use a new lock nut and apply engine oil 5W-30 on its seat, and then fix the lock nut using the flange holder 5-8840-2043-0.

Tighten:
Lock nut to 289 N·m (29.5 kg·m / 213 lb·ft)



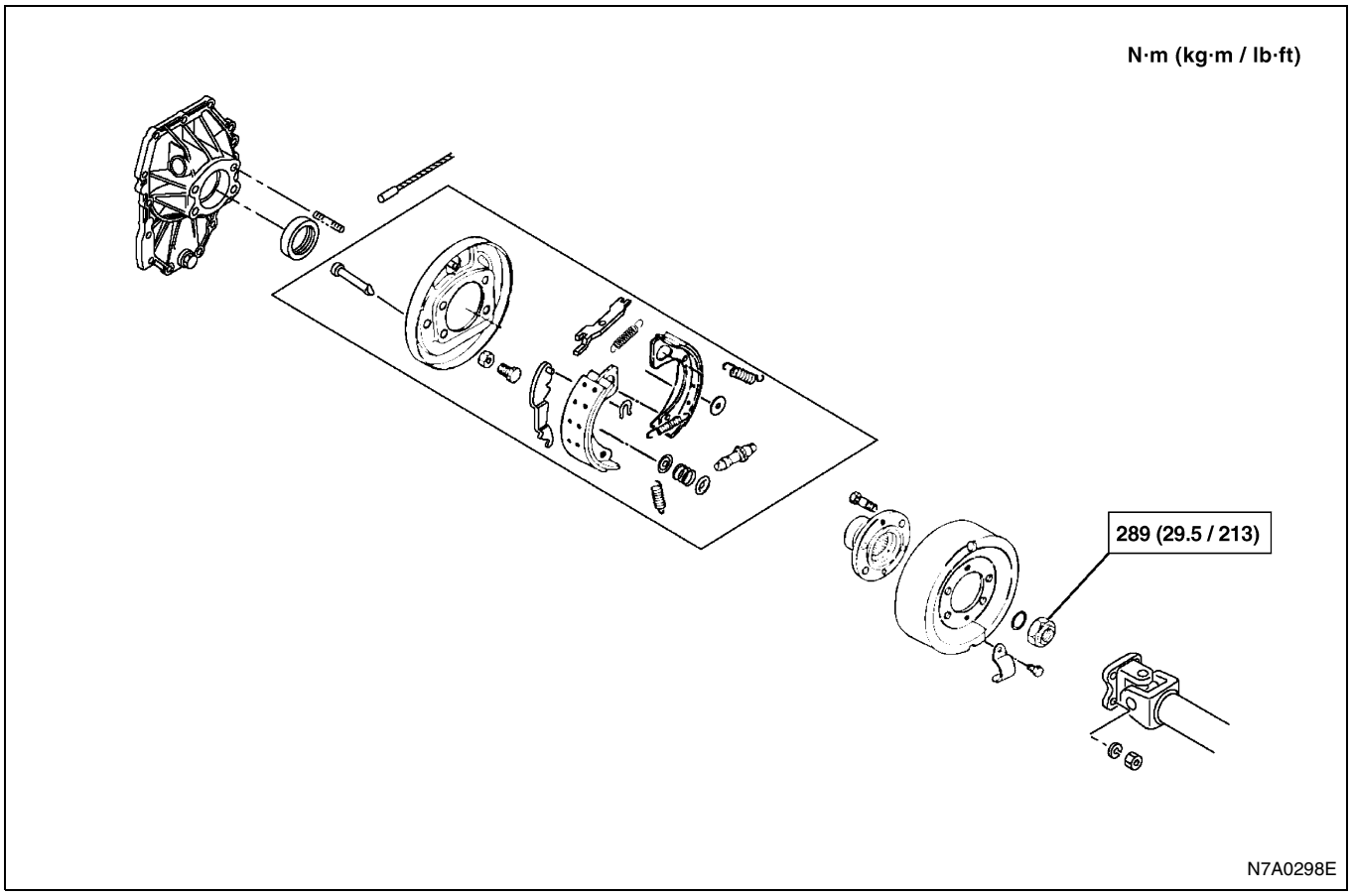
   - After fixing it to the specified torque, align the lip part of the nut to the V-groove of the shaft edge. Securely caulk the two parts of the nut lip using a chisel whose tip form is approx. 1 mm (0.04 in) radius by 60°, to make a length (B) of 5 mm (0.2 in) or more, and a clearance between the bottom of the shaft and the nut lip (A) of 1.5 mm (0.06 in) or less.

Caution:
If any crack is found on the caulking portions of the nut after the check, replace the lock nut and caulk it again.

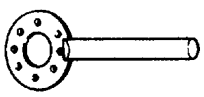
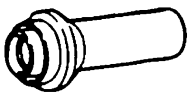


4. Install the parking brake drum.
   - Refer to PARKING BRAKE ASSEMBLY.
5. Install the parking brake cable.
   - Refer to PARKING BRAKE CABLE.
6. Install the rear propeller shaft assembly.
   - Refer to REAR PROPELLER SHAFT ASSEMBLY.

Fixing Torque

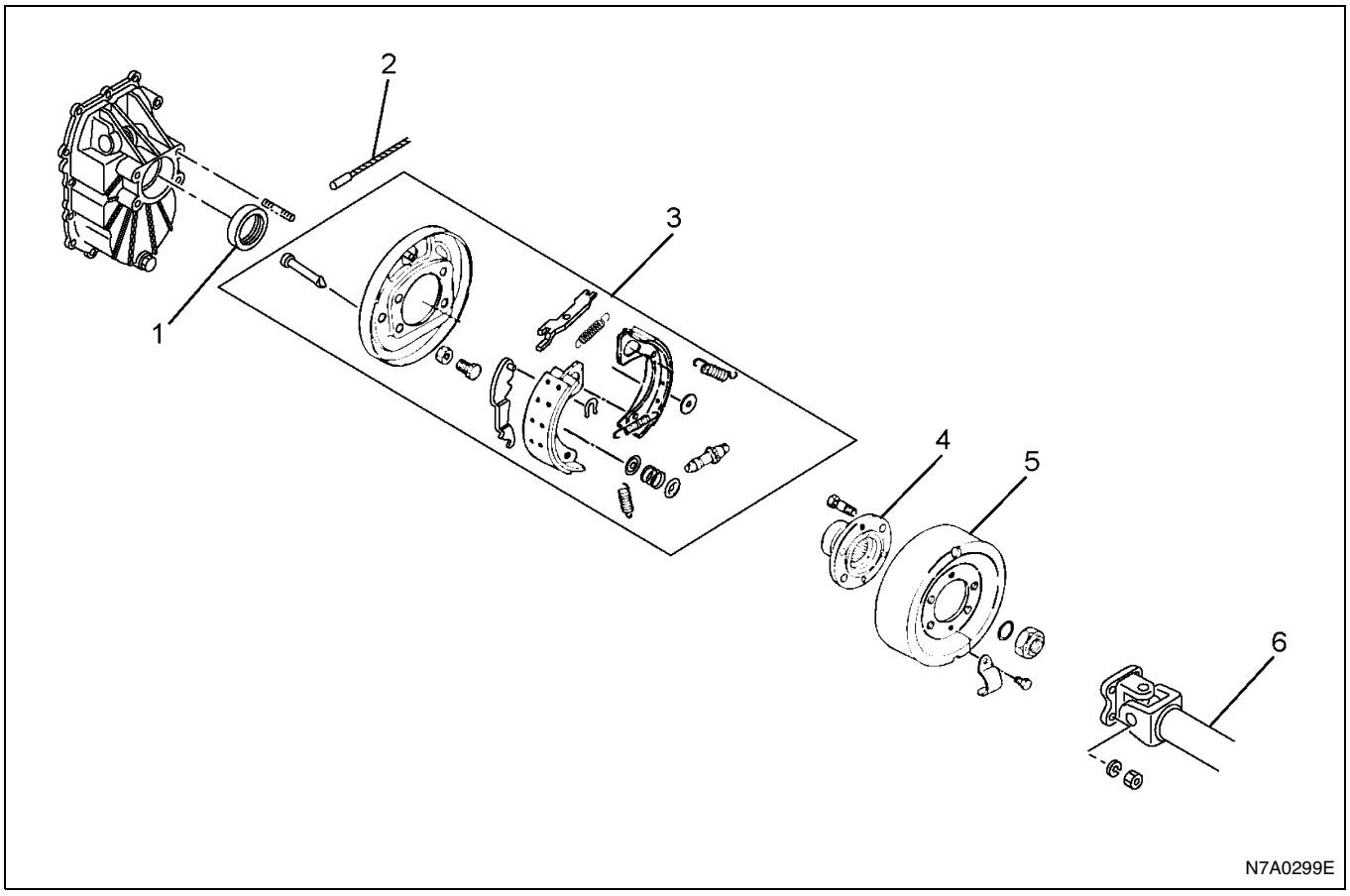


Special Tools

Illustration	Tool Number / Description / Remarks
 5884020430	5-8840-2043-0 / Flange Holder
 5884027500	5-8840-2750-0 / Oil Seal Installer

Rear Oil Seal (6MT)

Components

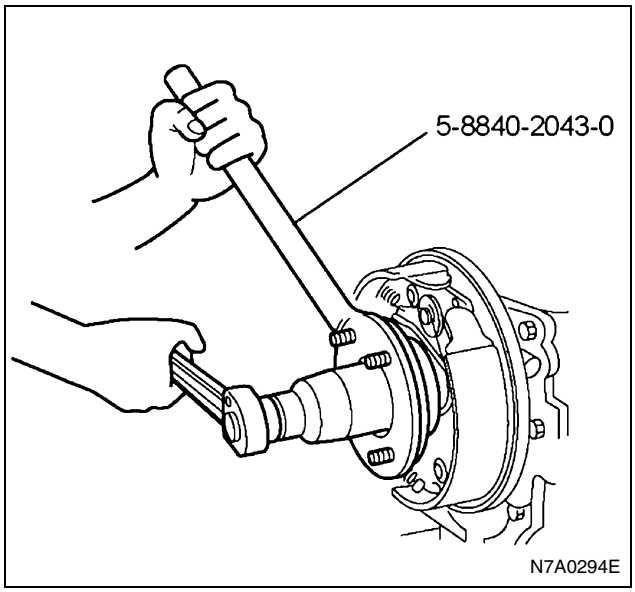


Legend

1. Oil seal
2. Parking brake cable
3. Parking brake assembly
4. Coupling driver
5. Parking brake drum
6. Rear propeller shaft assembly

Removal

1. Remove the rear propeller shaft assembly.
   - Refer to REAR PROPELLER SHAFT ASSEMBLY.
2. Remove the parking brake cable.
   - Refer to PARKING BRAKE CABLE.
3. Remove the parking brake drum.
   - Refer to PARKING BRAKE ASSEMBLY.
4. Remove the coupling driver and O-ring.
   - Raise the caulking portion (2 parts) of the lock nut securely, and remove it using the flange holder 5-8840-2043-0.



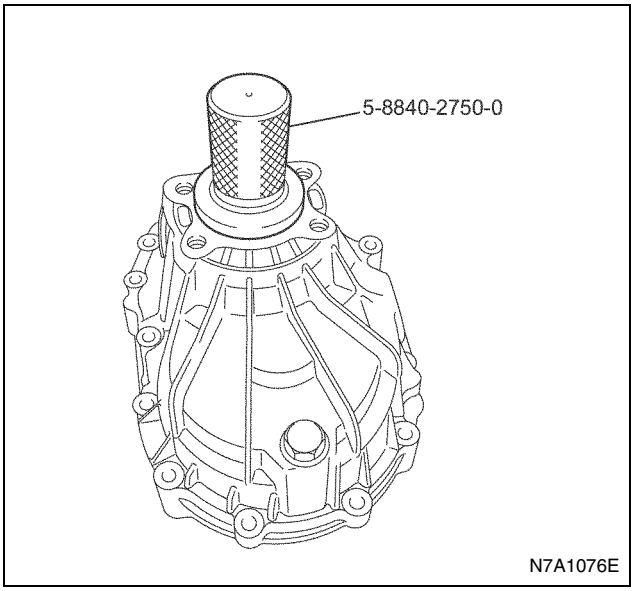
5. Remove the parking brake assembly.
   - Refer to PARKING BRAKE ASSEMBLY.

6. Remove the rear oil seal using the flat-tip screwdriver.

Installation

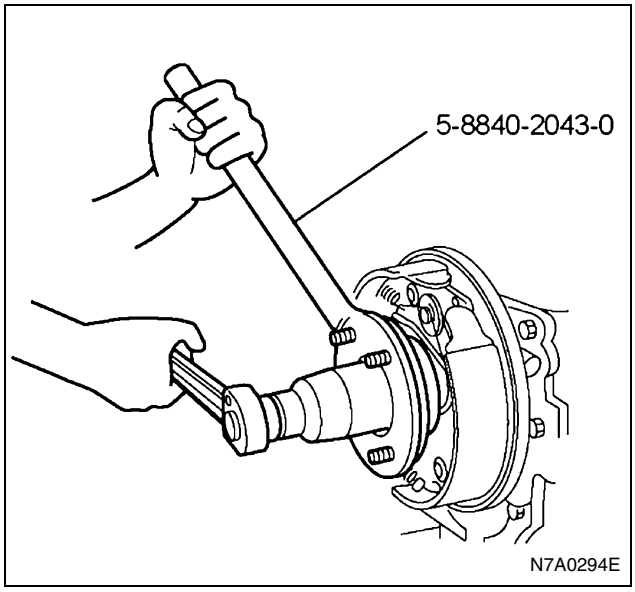
1. Apply engine oil 5W-30 around a new oil seal, and then press in the oil seal to the rear cover using the installer 5-8840-2750-0.
   - Apply Besco L2 grease to the lip portion of the oil seal.

Caution:
Be careful not to damage the oil seal lip portion.



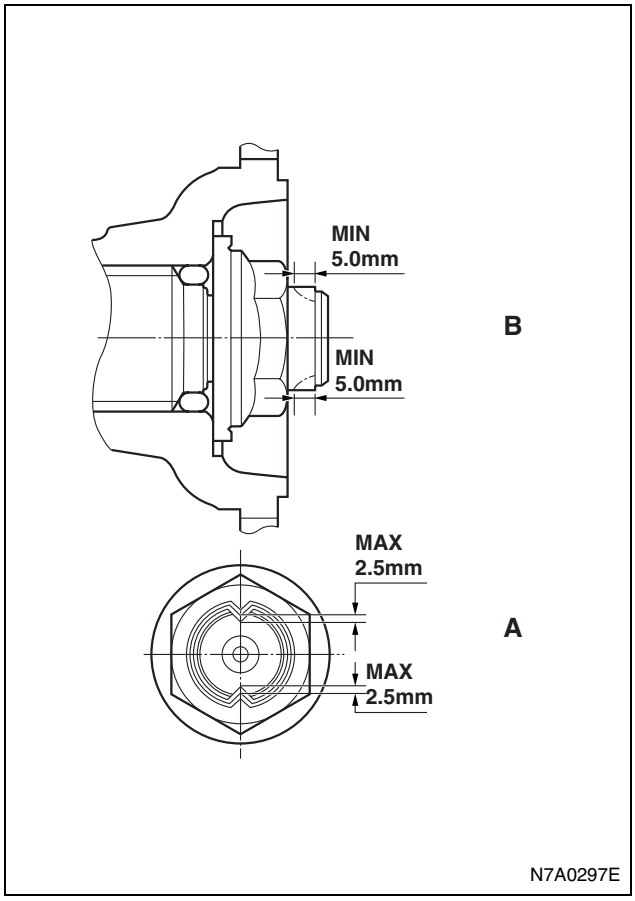
2. Install the parking brake assembly.
   - Refer to PARKING BRAKE ASSEMBLY.
3. Install the coupling driver.
   a. Apply engine oil 5W-30 to the O-ring, and then install the coupling driver and the O-ring.
   b. Use a new lock nut and apply engine oil 5W-30 on its seat, and then fix the lock nut using the flange holder 5-8840-2043-0.

Tighten:
Lock nut to 289 N·m (29.5 kg·m / 213 lb·ft)



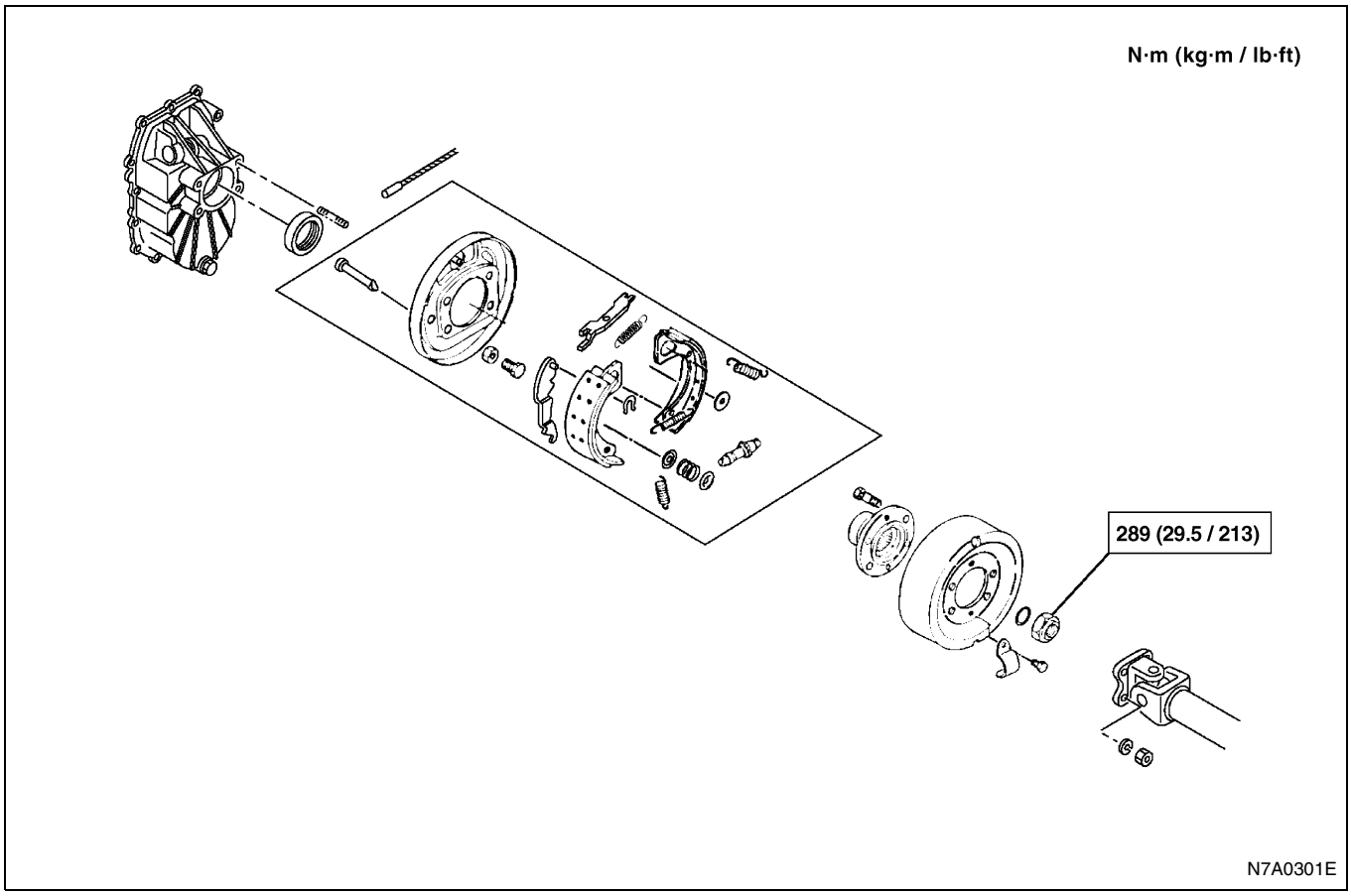
   - After fixing it to the specified torque, align the lip part of the nut to the V-groove of the shaft edge. Securely caulk the two parts of the nut lip using a chisel whose tip form is approx. 1 mm (0.04 in) radius by 60°, to make a length (B) of 5 mm (0.2 in) or more, and a clearance between the bottom of the shaft and the nut lip (A) of 1.5 mm (0.06 in) or less.

Caution:
If any crack is found on the caulking portions of the nut after the check, replace the lock nut and caulk it again.

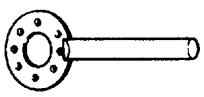
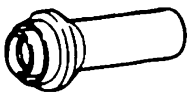


4. Install the parking brake drum.
   - Refer to PARKING BRAKE ASSEMBLY.
5. Install the parking brake cable.
   - Refer to PARKING BRAKE CABLE.
6. Install the rear propeller shaft assembly.
   - Refer to REAR PROPELLER SHAFT ASSEMBLY.

Fixing Torque



Special Tools

Illustration	Tool Number / Description / Remarks
 5884020430	5-8840-2043-0 / Flange Holder
 5884027500	5-8840-2750-0 / Oil Seal Installer

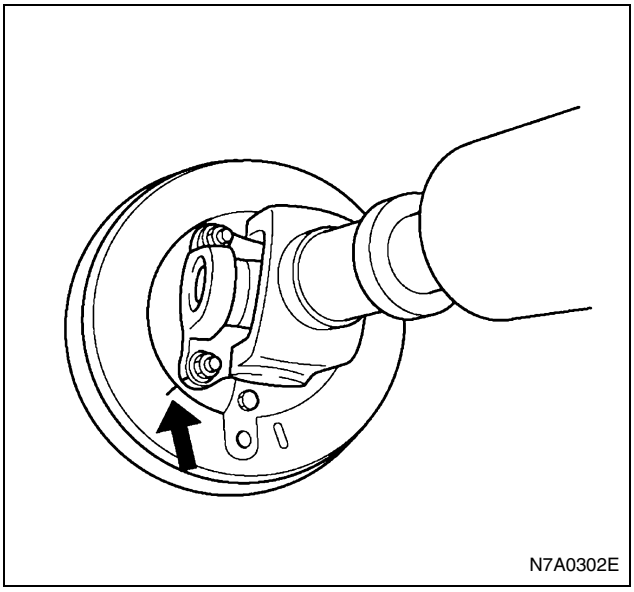
Transmission Assembly

Removal

Preparation: Jack up the vehicle, and support it with rigid racks.

1. Remove the rear propeller shaft assembly.

Caution:
Put an alignment mark on the drum and the flange yoke. Put them aside and hang them up using a wire or something to prevent them from interrupting the work.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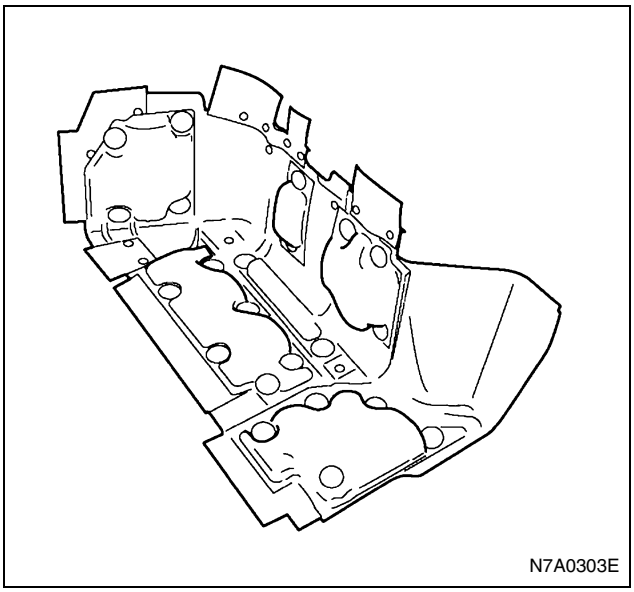
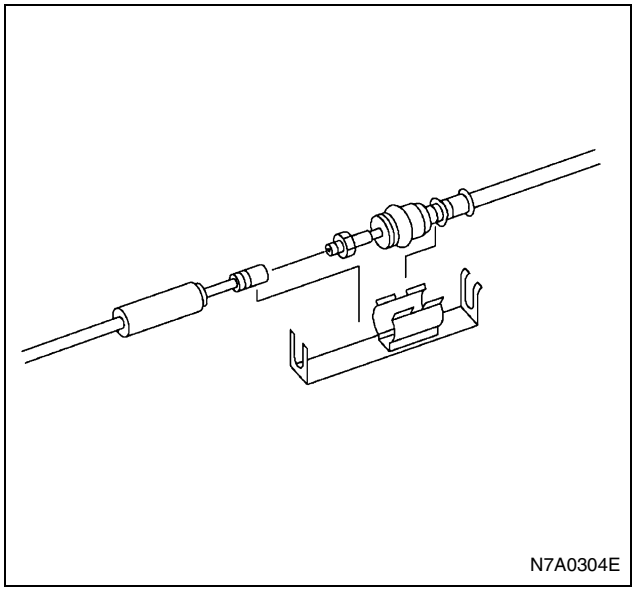
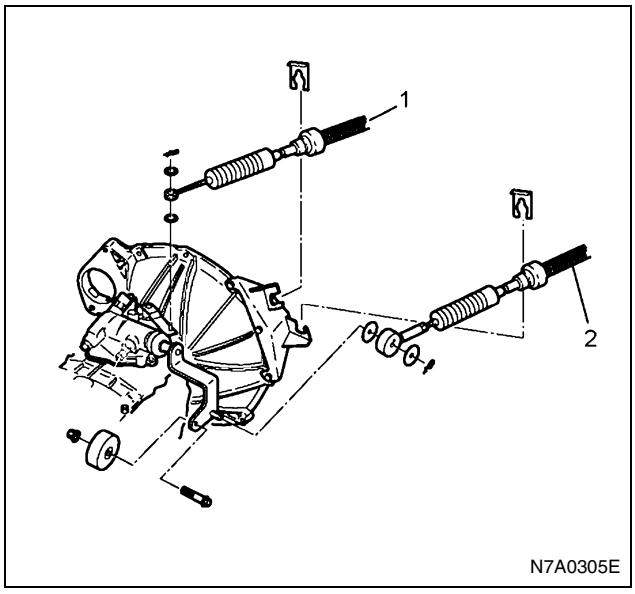
2. Remove the transmission side cover.


N7A0303E

3. Remove the connection of the vehicle speed sensor connector.
4. Remove the connection of the neutral switch connector.
5. Remove the connection of the reverse switch connector.
6. Remove the connector from the harness bracket taking care not to damage the clip portion.
7. Disconnect the parking cable.
   - Remove the cable bracket and move the cover, and then disconnect the cable by loosening the longer nut located to the vehicle front side.


N7A0304E

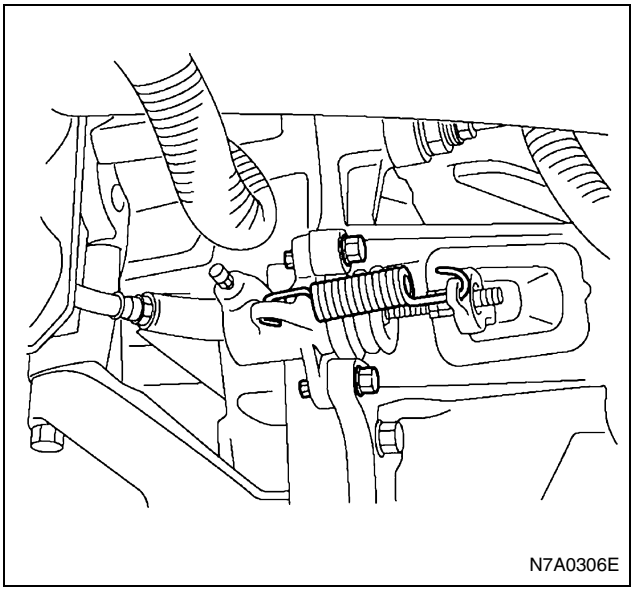
8. Remove the shift cable split pin and disconnect the shift cable.
9. Remove the select cable split pin and disconnect the select cable.



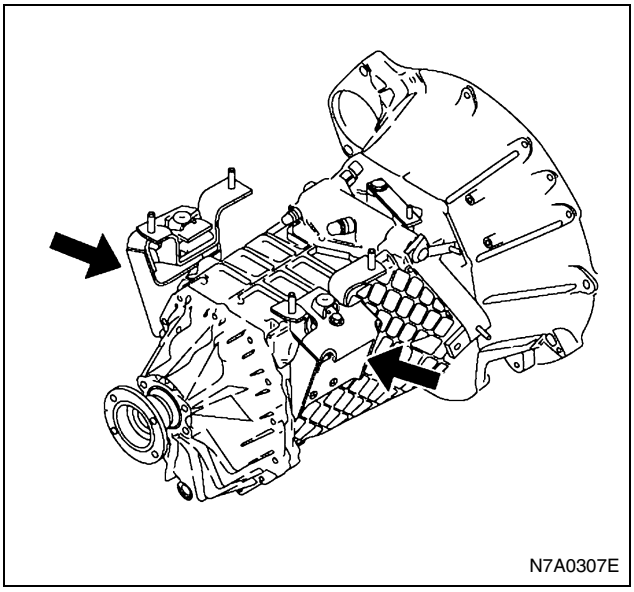
N7A0305E

Legend
1. Select cable
2. Shift cable

10. Remove the clutch slave cylinder assembly.
    - Remove the return spring and the securing bolt, and then hang them up using a wire or something to prevent them from interrupting the work.


N7A0306E

11. Remove the starter ground cable.
12. Remove the starter motor assembly.
    - Hang them up using a wire or something to prevent them from interrupting the work.
13. Remove the nut securing the transmission and the frame (crossmember).
    - Support the engine using a garage jack or a wire, and then set the transmission jack under the transmission and secure it with a chain not to fall down.
    - For the vehicles with a double wishbone type suspension, remove the mounting bracket bolt on the transmission side, if necessary, and remove the mounting bracket.
14. Remove the transmission assembly.
    - Remove the bolt securing the clutch housing, and then remove the transmission assembly by operating the transmission jack.
15. Remove the mounting bracket assembly bolt, and then remove the bracket.


N7A0307E

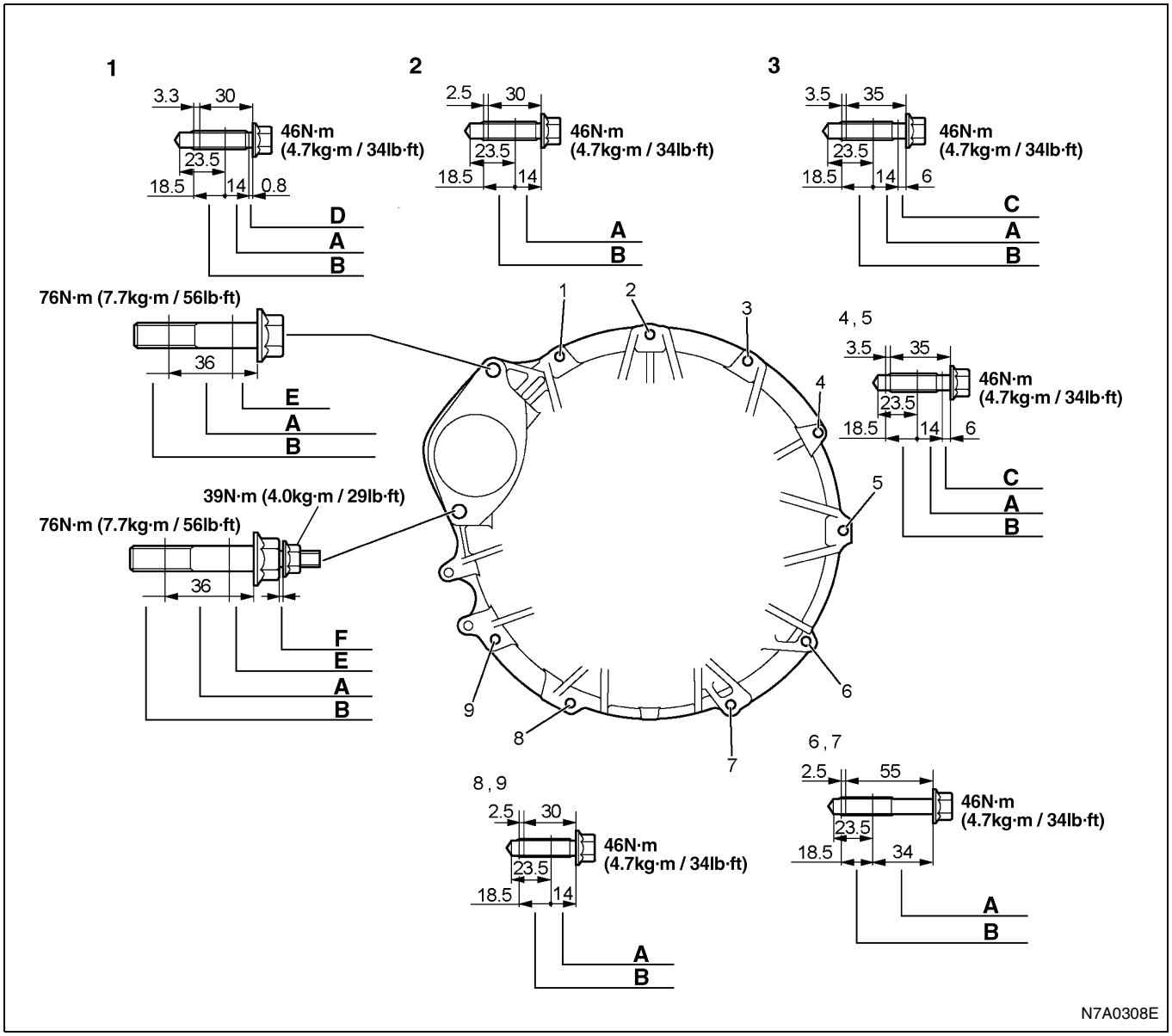
Installation

1. Install the mounting bracket assembly.

Tighten:
Mounting bracket to 97 N·m (9.9 kg·m / 72 lb·ft)

2. Install the transmission assembly.
    - Fix and secure the transmission in the same way of removal.

Tighten:
Transmission assembly to 46 N·m (4.7 kg·m / 34 lb·ft)



Legend

A: Clutch housing
B: Fly wheel housing
C: Gear control bracket
D: Harness clip
E: Starter
F: Engine ground cable

3. Fix the nut securing the transmission and the frame (crossmember).

Tighten:
Nut to 40 N·m (4.1 kg·m / 30 lb·ft)

- For the vehicles with a double wishbone type suspension, install the mounting bracket on the transmission after installing the transmission.

Tighten:
Mounting bracket on the transmission to 46 N·m (4.7 kg·m / 34 lb·ft)

4. Install the starter motor assembly.

Tighten:
Starter motor assembly to 76 N·m (7.7 kg·m / 56 lb·ft)

5. Install the starter ground cable.

Tighten:
Starter ground cable to 39 N·m (4.0 kg·m / 29 lb·ft)

6. Install the clutch slave cylinder assembly.

Tighten:
Clutch slave cylinder assembly 16 N·m (1.6 kg·m / 12 lb·ft)

7. Install the select cable.
   - For installation, refer to GEAR CONTROL CABLE.
8. Install the shift cable.
   - For installation, refer to GEAR CONTROL CABLE.

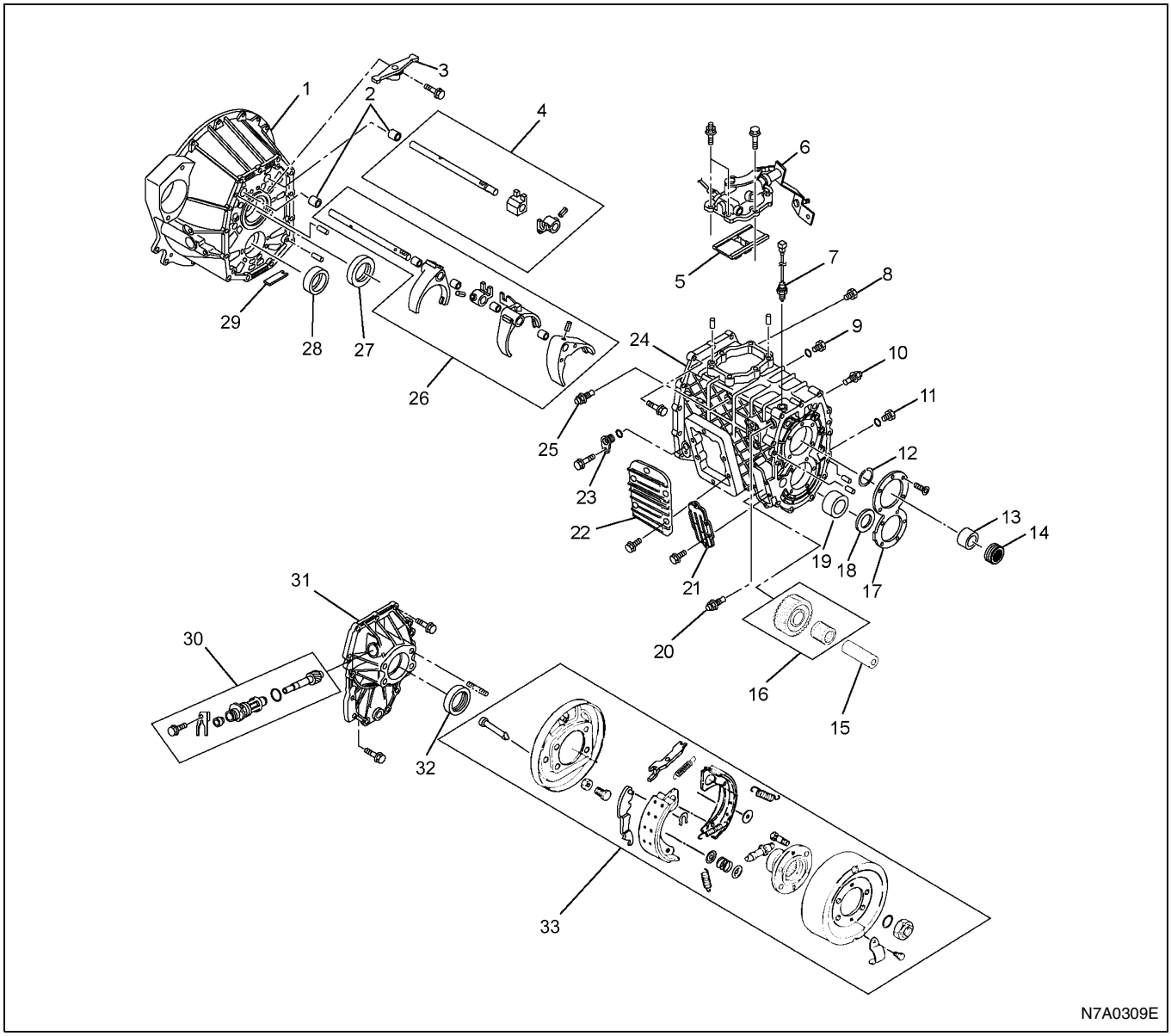
9. Install the parking brake cable.
10. Install the harness connector.
11. Install the reverse switch connector.
12. Install the neutral switch connector.
13. Install the vehicle speed sensor connector.
14. Install the transmission side cover.
15. Install the rear propeller shaft assembly aligning it to the alignment mark.

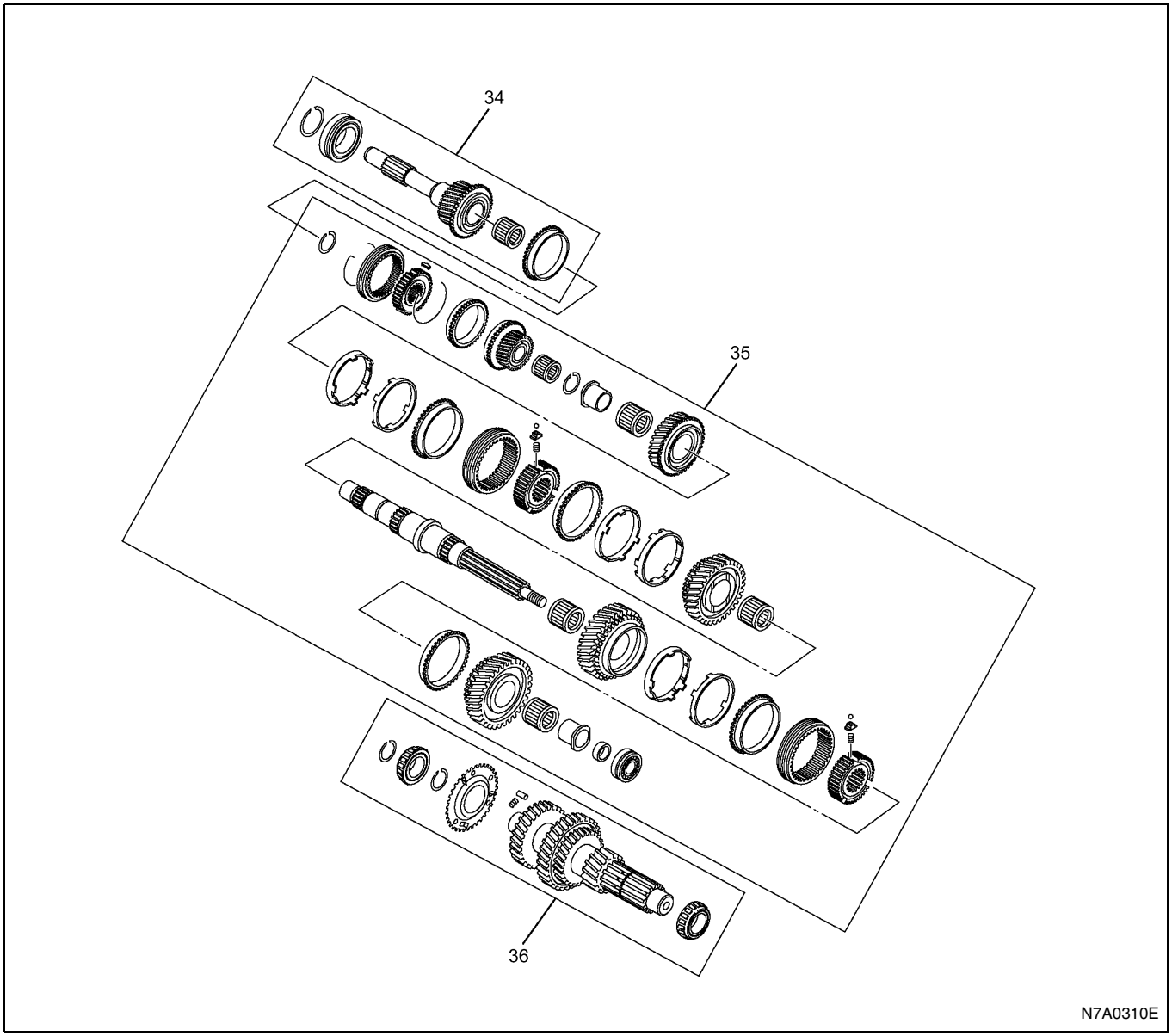
Tighten:
Rear propeller shaft assembly to 102 N·m (10.5 kg·m / 75 lb·ft)

UNIT REPAIR

Transmission (5MT)

Components





Legend

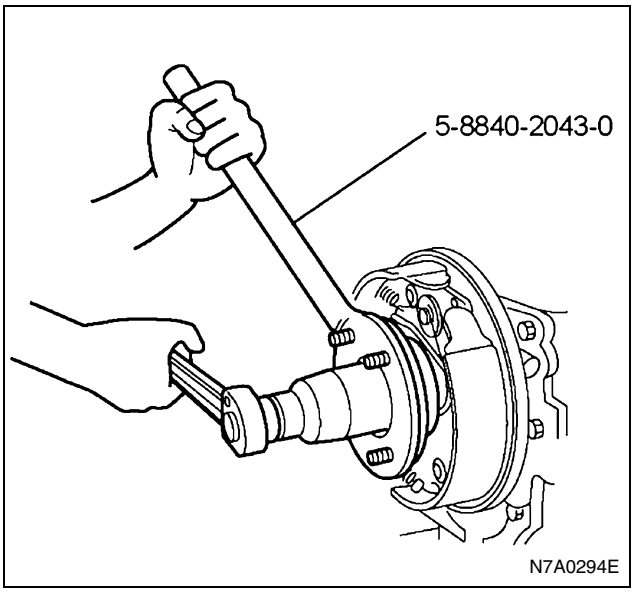
1. Clutch housing
2. Bush; Clutch housing
3. 5th relay lever
4. 4th-5th shift block
5. Interlock plate
6. Control box
7. Reverse switch
8. Detent plug
9. Filler plug
10. Detent assembly
11. Drain plug
12. Snap ring
13. Collar
14. Speedometer gear
15. Reverse idle shaft
16. Reverse idle gear and needle bearing
17. Retainer
18. Shim; Counter
19. Counter rear bearing
20. Detent assembly
21. Reverse idle cover
22. PTO cover
23. Sensor dummy plug
24. Transmission case
25. Detent assembly
26. 1st reverse, 2nd-3rd and 4th-5th shift arm
27. Front oil seal
28. Bearing outer race
29. Magnet
30. Speedometer driven gear
31. Rear cover
32. Rear oil seal
33. Parking brake assembly
34. Top gear shaft assembly
35. Main shaft assembly
36. Counter shaft assembly

Disassembly

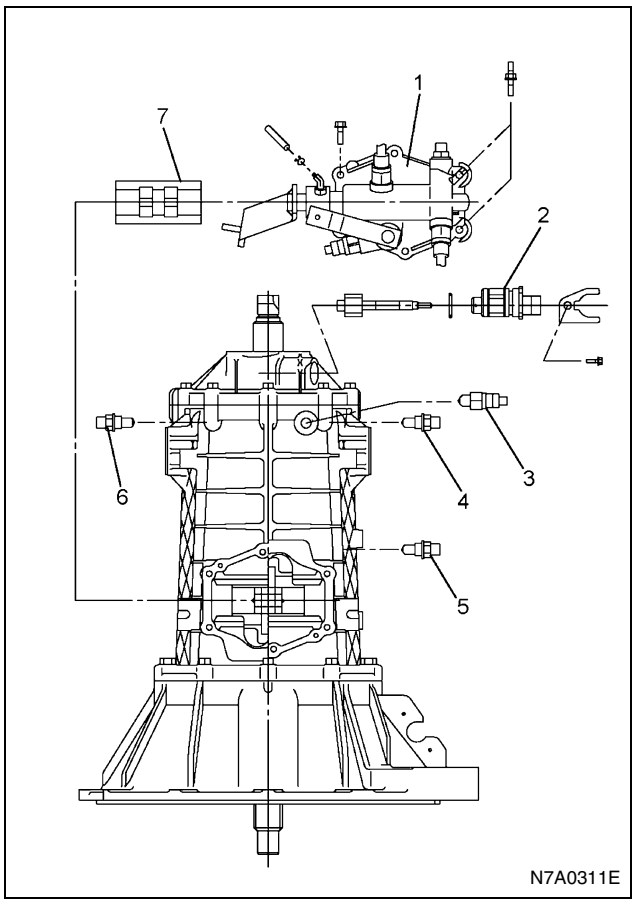
Caution:
Be careful not to damage the transmission case and the clutch housing because they are made of aluminum. Further attention should be paid to the rib because its damage weakens hardness of the case.

Do not hurt yourself when working on something heavy such as cases and gears.

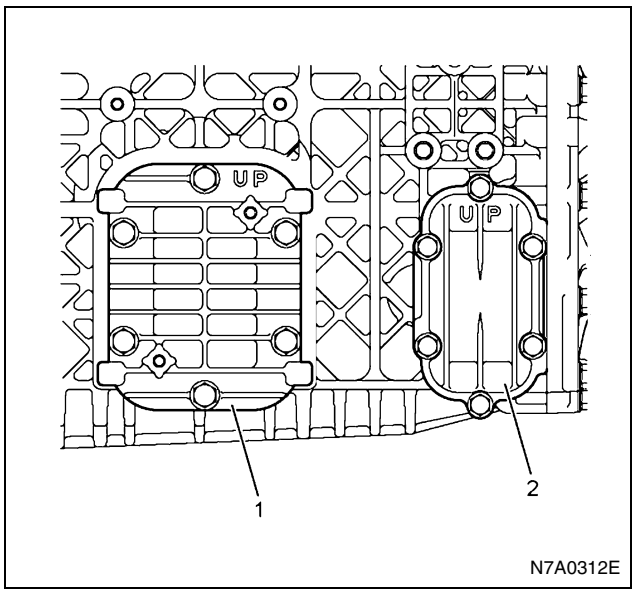
1. Remove the shift block assembly.
   - Refer to CLUTCH.
2. Remove the shift fork and the support bolt.
   - Refer to CLUTCH.
3. Remove the bolt securing the adjust hole cover and remove the parking brake drum.
   - Refer to PARKING BRAKE ASSEMBLY.
4. Raise the caulking portion (2 parts) of the coupling driver lock nut securely, and then remove the lock nut using the flange holder 5-8840-2043-0.



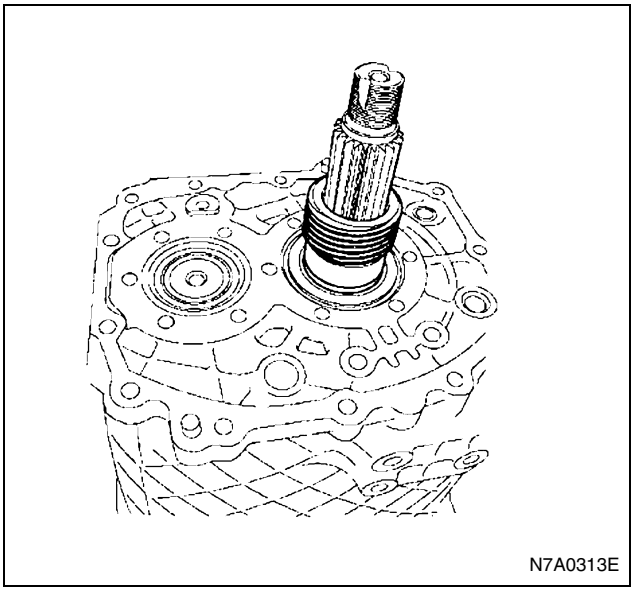
5. Remove the coupling driver and O-ring.
6. Remove the parking brake assembly.
   - Refer to PARKING BRAKE ASSEMBLY.
7. Remove the filler plug and O-ring.
8. Remove the drain plug and O-ring.
   - Drain the transmission oil. Check the amount of oil and the existence of metal particles and foreign matters while draining oil.
9. Remove the speedometer driven gear (2).
10. Remove the reverse switch (3).
11. Remove the detent assembly (4)(5)(6).
12. Remove the control box (1) and the interlock plate (7).



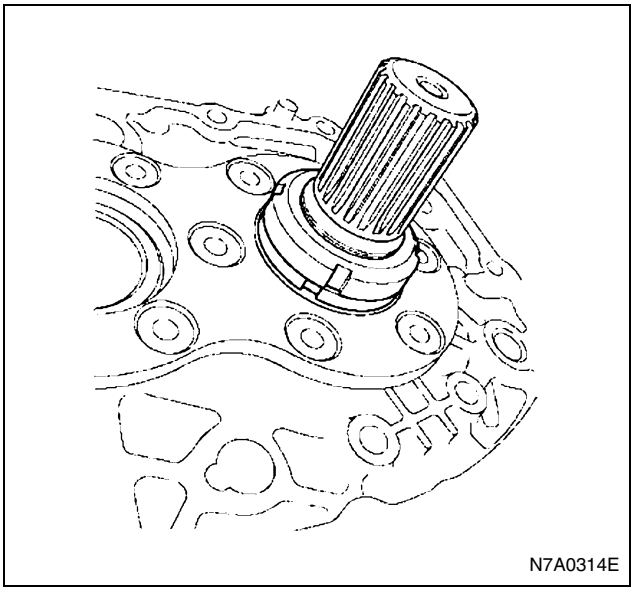
13. Remove the PTO cover (1).
14. Remove the reverse idle cover (2).



15. Remove the rear cover assembly.
16. If worn or damaged parts are found after checking the rear cover oil seal, remove the oil seal from rear cover using the flat-tip screwdriver.
17. Remove the speedometer gear and collar.


N7A0313E

18. Remove the main shaft end lock nut using the wrench 5-8840-2798-0. (4WD model)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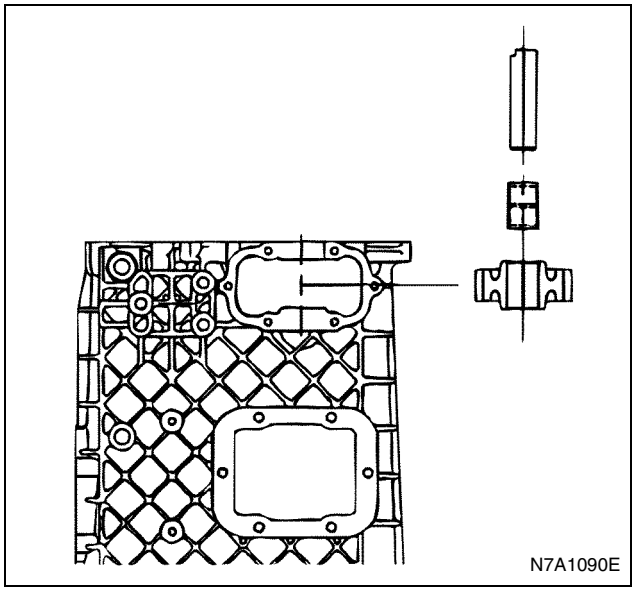
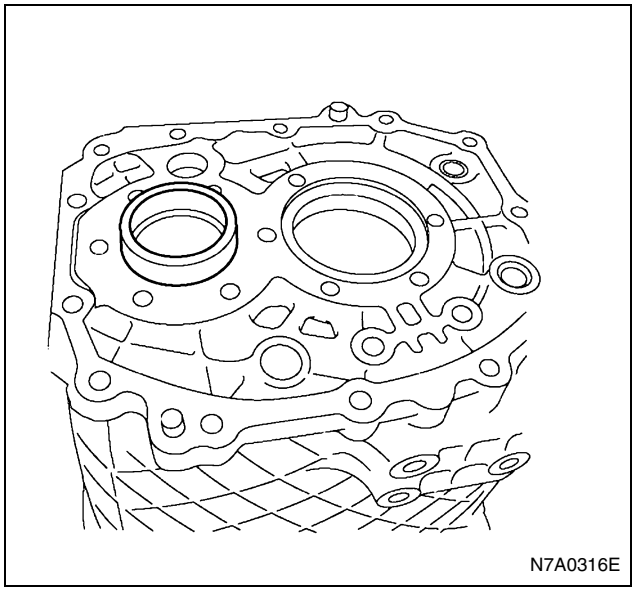
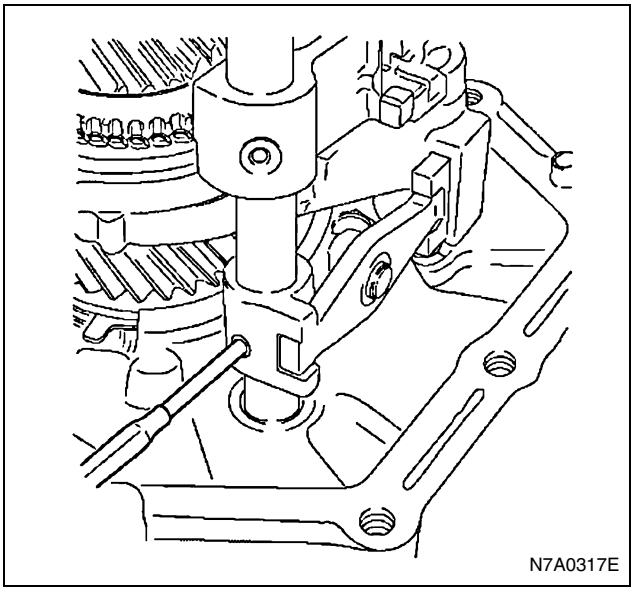
19. Remove the retainer from the transmission case.
20. Pull out the reverse idle shaft, and then remove the reverse idle gear and the needle bearing.


N7A1090E

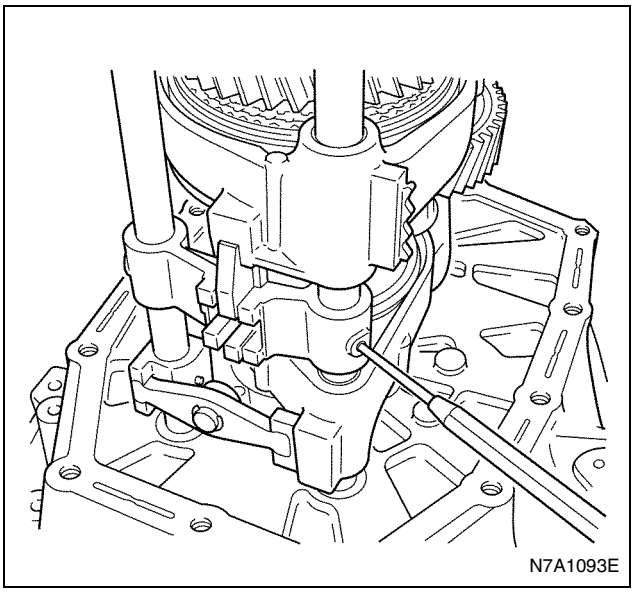
21. Remove the snap ring from the main shaft rear bearing.
22. Remove the shim from the counter shaft rear bearing.
23. Remove the transmission case from the clutch housing.
24. Remove the bearing rear outer race from the transmission case.


N7A0316E

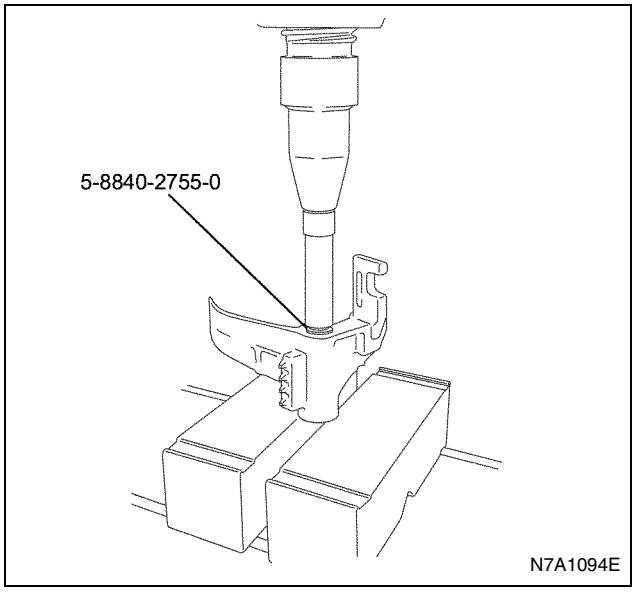
25. Remove the 4th-5th shift rod, 4th-5th main shift block and 4th-5th sub shift block.
    - When driving out the spring pin, put a round pole on the opposite side of the shift rod not to damage other parts, and then remove the spring pin using the spring pin remover.


N7A0317E

26. Remove the 1st-reverse and 2nd-3rd shift rod, 1st-reverse shift arm, 2nd-3rd shift arm, 1st-reverse shift block, and 4th-5th shift arm.
    - When driving out the spring pin, put a round pole on the opposite side of the shift rod not to damage other parts, and then remove the spring pin using the spring pin remover.

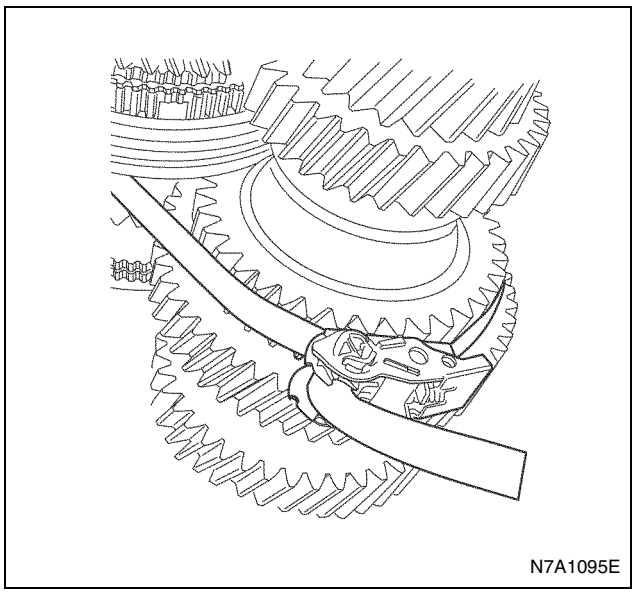

N7A1093E

27. Remove the bush from the 2nd-3rd shift arm using the remover 5-8840-2755-0.
28. Remove the bush from the 4th-5th shift arm using the remover 5-8840-2755-0.
    - Use the remover with a round pole whose length is enough to push the remover to the end.

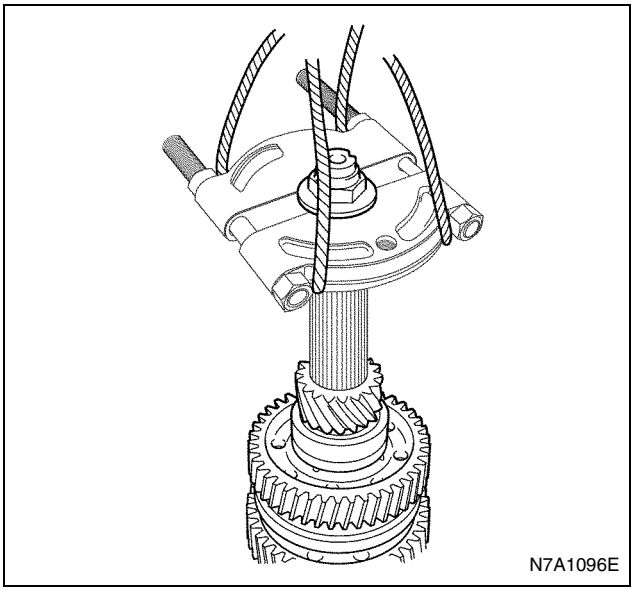


N7A1094E

29. Remove the 5th relay lever from the clutch housing.
30. Remove the magnet from the clutch housing.
31. Remove the main shaft assembly, the top gear shaft assembly and counter shaft assembly.
    a. Tie the main shaft assembly, the counter shaft assembly and the top gear shaft assembly at the two positions not to let them come apart using a lashing belt or other belts with a fixing function, and then fix them securely.


N7A1095E

    b. Install the bearing remover to the main shaft and secure it with a lock nut, hang them with a hoist and a wire, and then remove the top gear shaft assembly, the main shaft assembly, the counter shaft assembly from the clutch housing as a unit while spreading the top gear shaft bearing outer snap ring installed to the clutch housing.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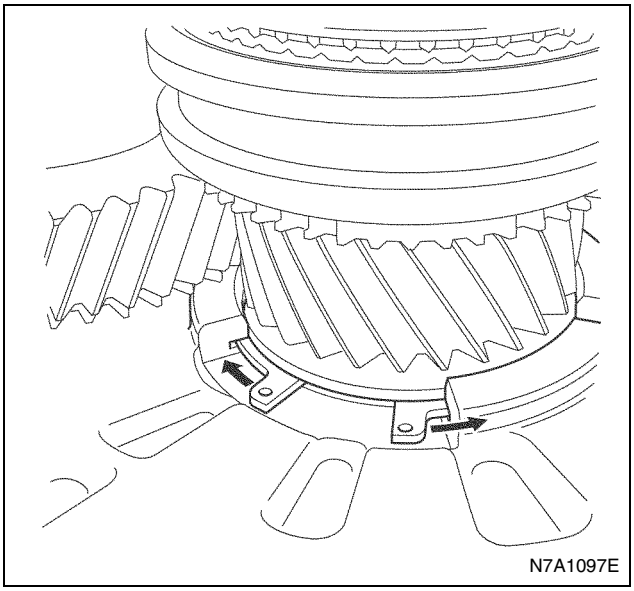
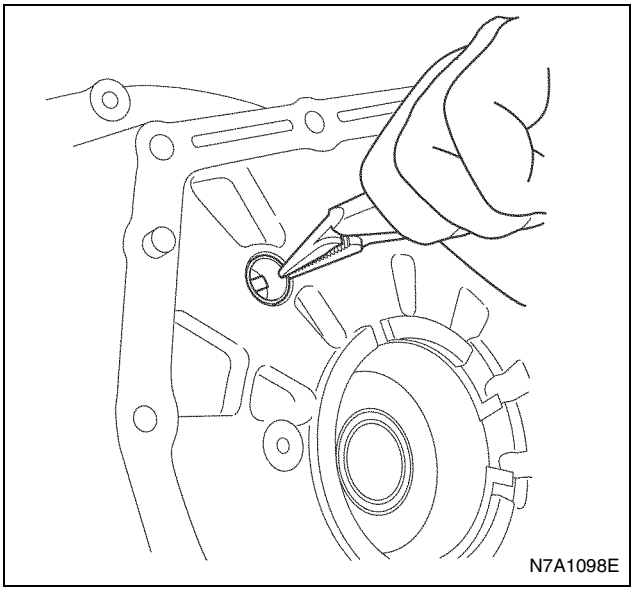
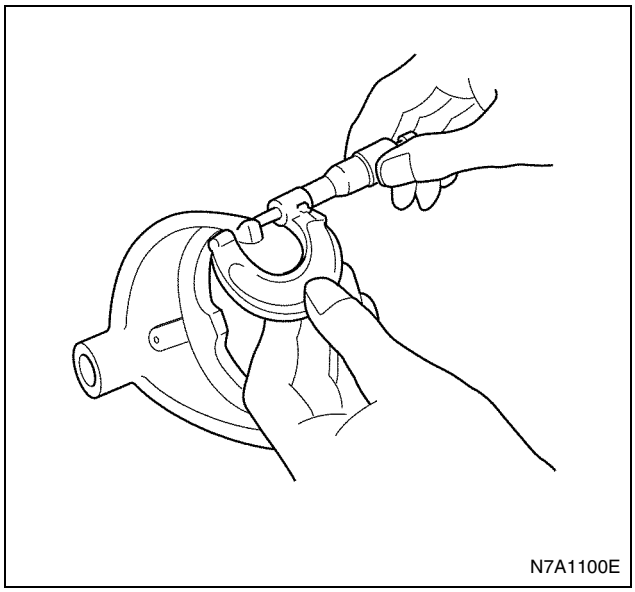

N7A1097E

32. Check the clutch housing bush, and then remove it from the clutch housing using a pliers if it is worn or damaged.

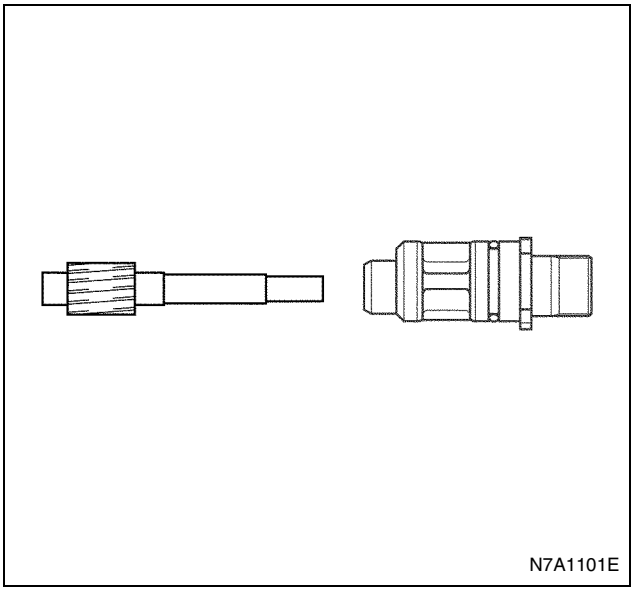

N7A1098E

33. Check the front oil seal, and then remove it from the clutch housing using a flat-tip screwdriver if it is worn or damaged.
34. Check each part, and then correct and replace it if some worn, damaged or faulty parts are found.
    Check each part of the shift mechanism, and then correct light damage, deflection or stepped wear. Replace it when it is heavily damaged or its usage limit is over.
    - Deflection, wear and damage of the shift rod and the shift arm
    - Shift arm thickness
      – Measure the thickness of the shift arm tip using the micrometer.

Shift arm thickness, mm (in)		
	Standard	Limit
1st-reverse 3rd-2nd 5th-4th	9.60 — 9.85 (0.377 — 0.387)	9.0 (0.354)


N7A1100E

35. Check the wear of the speedometer driven gear and the driven gear bush.
    - Replace them if they are heavily worn.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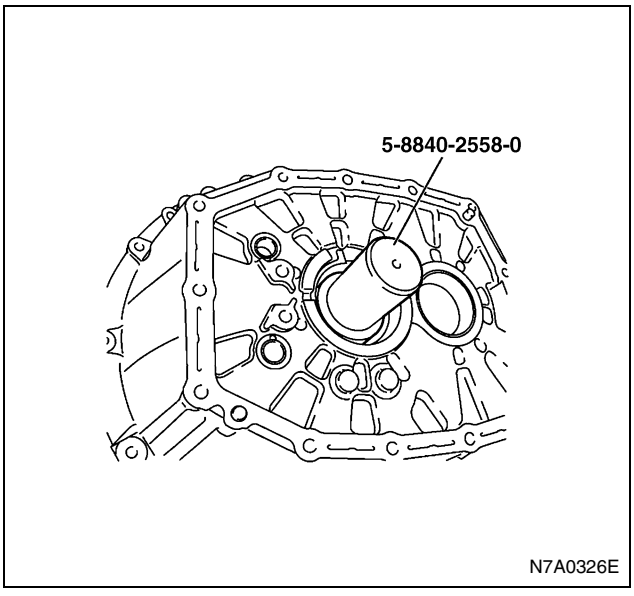
Assembly

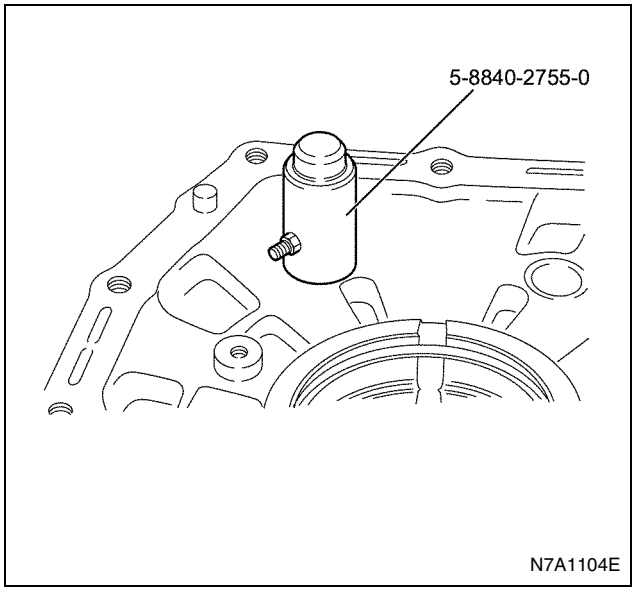
1. When finding the oil seal worn and damaged after the check and replacing it with a new one, apply engine oil 5W-30 around the oil seal, and then press in the oil seal into the clutch housing using the installer 5-8840-2558-0, or when the front PTO is equipped, using the installer 5-8840-2754-0 and the grip 5-8840-0007-0.
   - Apply Besco L2 grease on the oil seal lip portion.

Caution:
Be careful not to damage the oil seal lip portion.



N7A0326E

2. When the clutch housing bush is replaced with a new one after checking it for wear and damage, press it in using the installer 5-8840-2755-0.
   - During installation, caulk three portions securely except older caulking portions and grooves.



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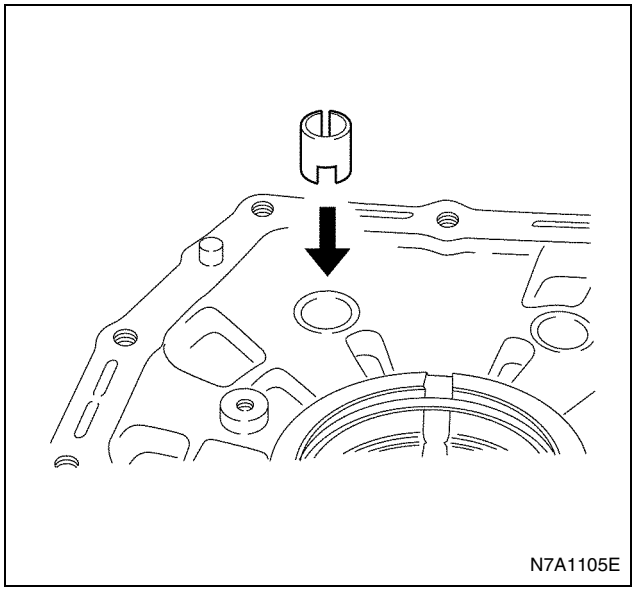
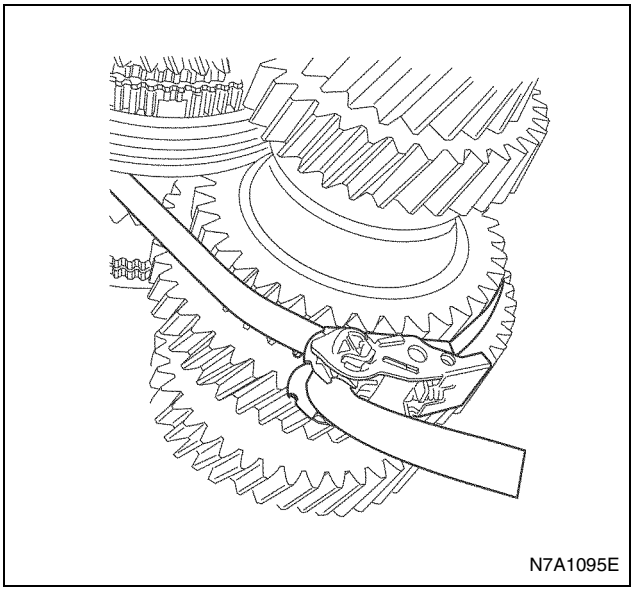
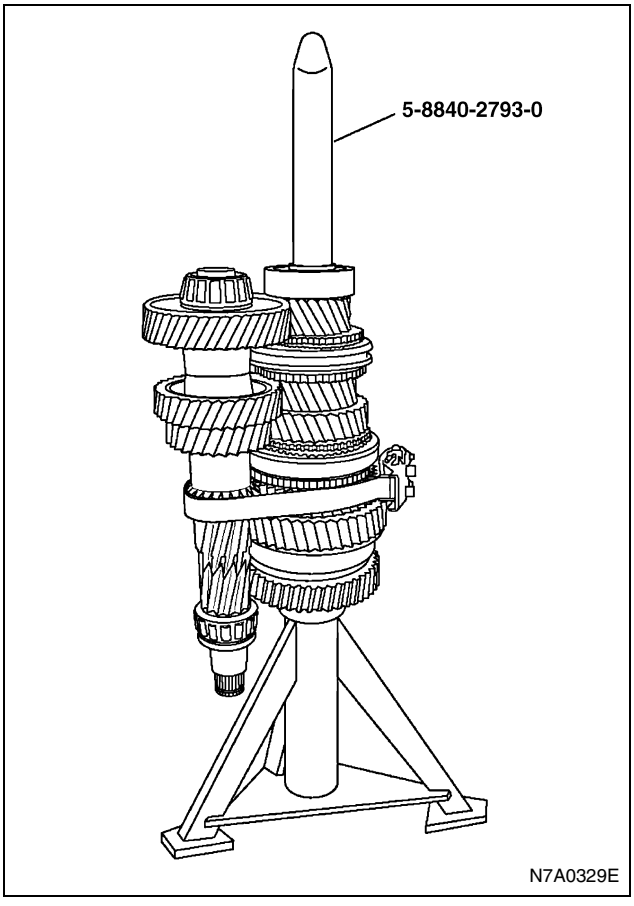
   - For the bush pressing in for the second time and onwards, press in the bush facing its notched portion to the clutch housing.


N7A1105E

3. Install the main shaft assembly, the top gear shaft assembly and the counter shaft assembly.
   a. Tie the main shaft assembly, the counter shaft assembly and the top gear shaft at the two positions not to let them come apart using a lashing belt or other belts with a fixing function, and then fix them securely. Be careful not to drop the top gear shaft while lifting up.

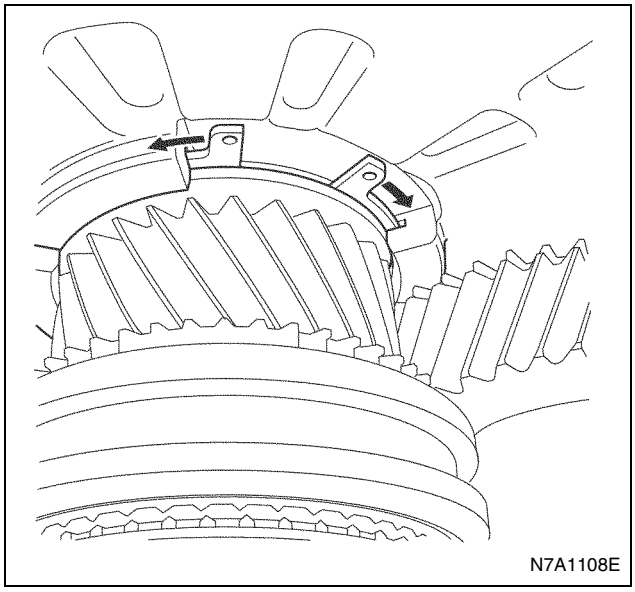

N7A1095E

b. Stick up the three of the top gear shaft assembly, the main gear shaft assembly and the counter shaft assembly on the support stand as the top gear shaft assembly is put on the top.
c. Install the oil seal protector 5-8840-2793-0 to the main shaft.



N7A0329E

d. Set the top gear shaft bearing outer snap ring to the clutch housing, spread it using a snap ring pliers, and then insert it to the clutch housing after aligning the top gear shaft, the counter shaft and the shift rod positions.

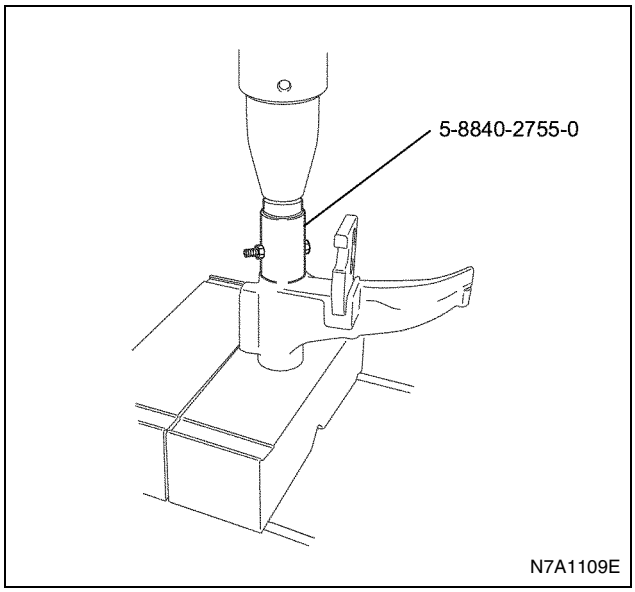

N7A1108E

Caution:
- Make sure the snap ring is installed securely.
- Work carefully not to damage the front oil seal.

4. Install the magnet to the clutch housing.
5. Install the 5th relay lever to the clutch housing.

Tighten:
5th relay lever to 44 N·m (4.5 kg·m / 34 lb·ft)

6. When replacing the 4th-5th shift arm bush with a new one after checking it for wear or damage, press fit the bush using the installer 5-8840-2755-0.
7. When replacing the 2nd-3rd shift arm bush with a new one after checking it for wear or damage, press in the bush using the installer 5-8840-2755-0.



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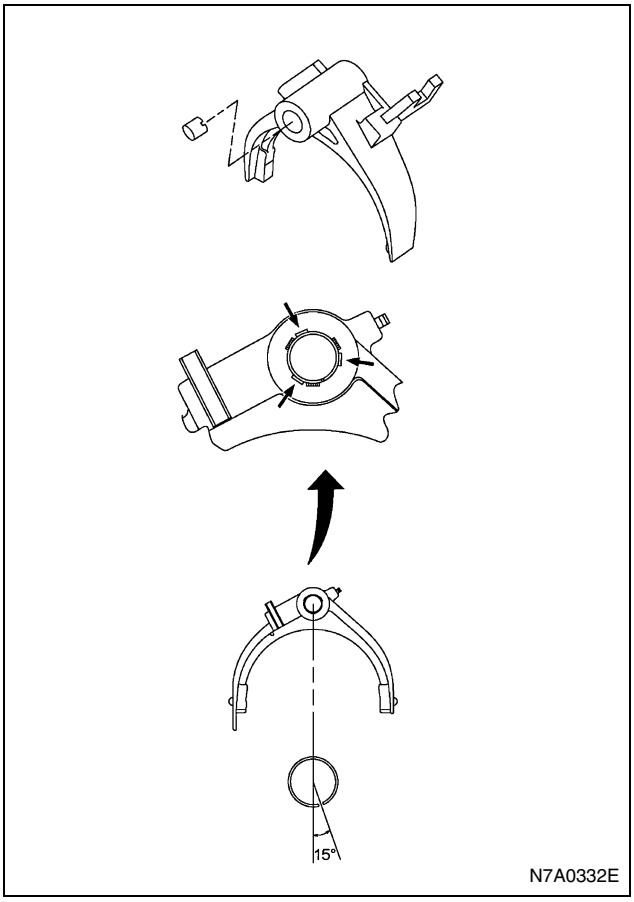
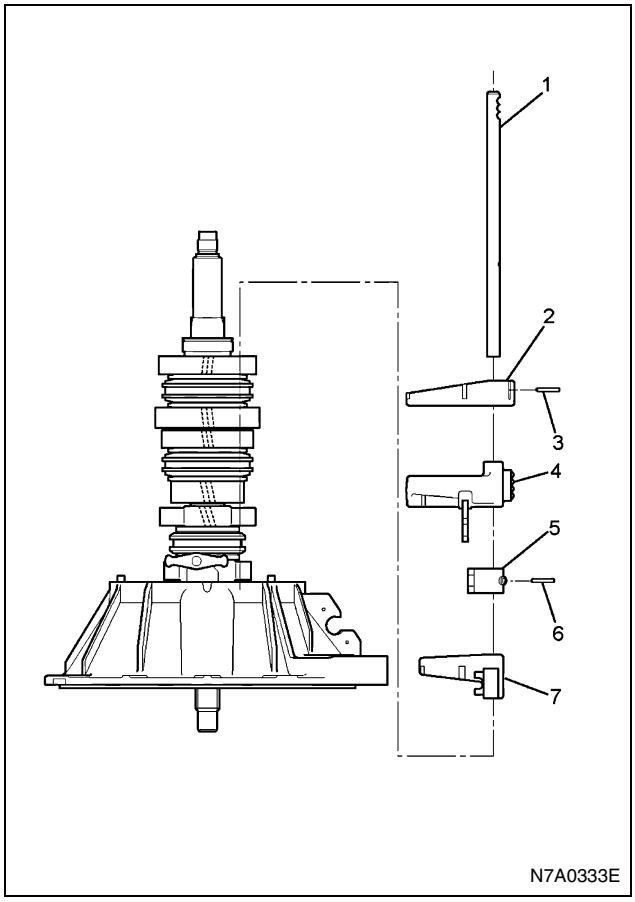
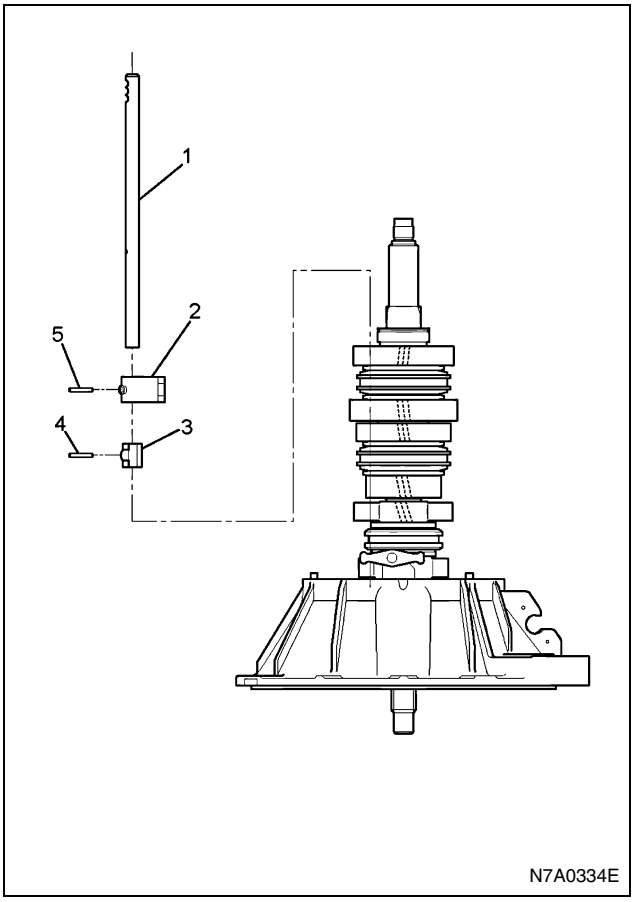
- Press it taking care of the direction and angle of the shift arm bush, caulk the three portions except the bush cut and older caulking portions.



8. Install the 4th-5th shift arm (7), the 1st-reverse shift block (5), the 2nd-3rd shift arm (4), the 1st-reverse shift arm (2), and the 1st-reverse and 2nd-3rd shift rod (1).
   - Drive the spring pin (3) and (6) using a hammer after aligning the spring pin hole.
   - When pressing in the spring pin, put a round pole on the opposite side of the shift rod not to damage other parts, and then press in the spring pin.

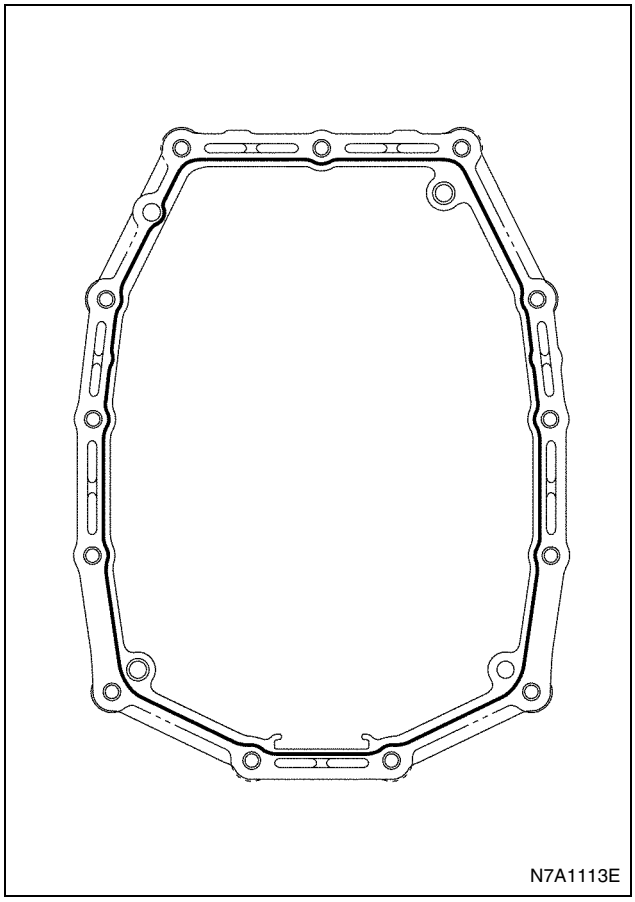


9. Install the 4th-5th sub shift block (3), 4th-5th main shift block (2), 4th-5th shift rod (1).
   - Drive in the spring pin (4) and (5) using a hammer after aligning the spring pin hole.
   - When pressing in the spring pin, put a round pole on the opposite side of the shift rod not to damage other parts, and then press in the spring pin.

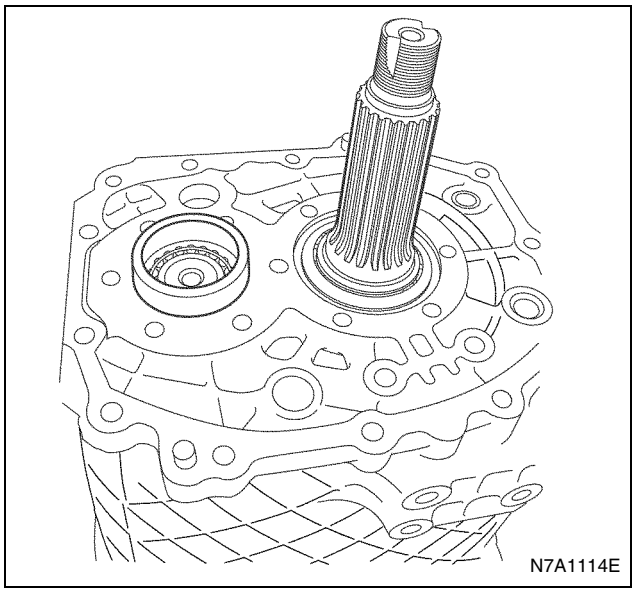


10. Apply ThreeBond 1215 to the mating surface of the transmission case and the clutch housing, and then install the clutch housing.
    - Wipe off moisture and lubricant from the mating surface, and then apply the bond continuously with a diameter of 2 mm (0.079 in) or more.

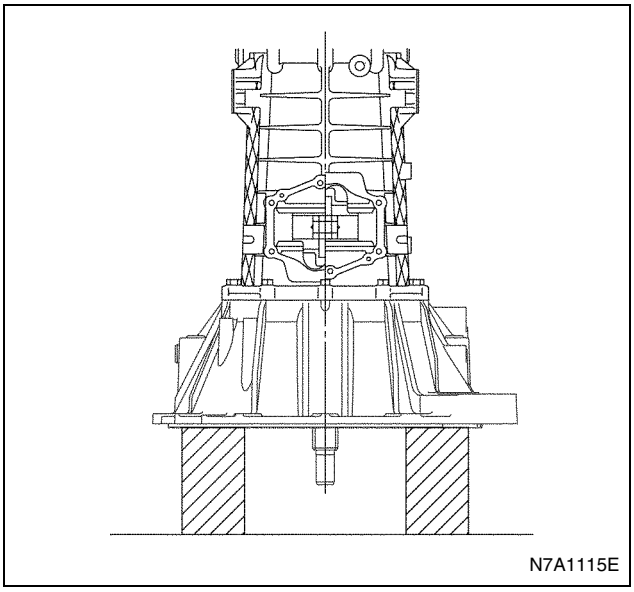
Tighten:
Clutch housing to 46 N·m (4.7 kg·m / 34 lb·ft)



11. Install the bearing rear outer race to the transmission case.



12. Install the shim to the counter shaft rear bearing.
    a. Shift the position to the neutral.
    b. Set the transmission assembly with the clutch housing faced down.


N7A1115E

c. Revolve the counter shaft more then 30 times and smooth the taper roller bearing.

d. Select the counter shim.

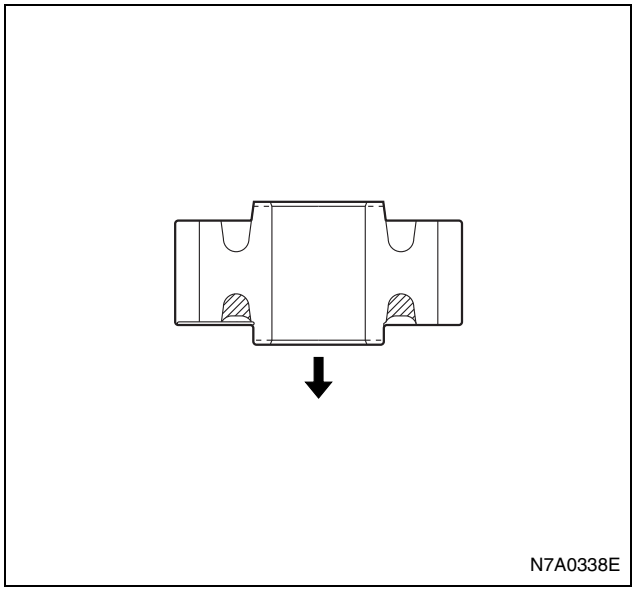
- Measure the depth at the points equally divided into three from the end surface of the transmission case to the outer ring edge surface of the counter shaft rear bearing, and then take an average of them.
- Select the shim whose thickness agrees with the list below.

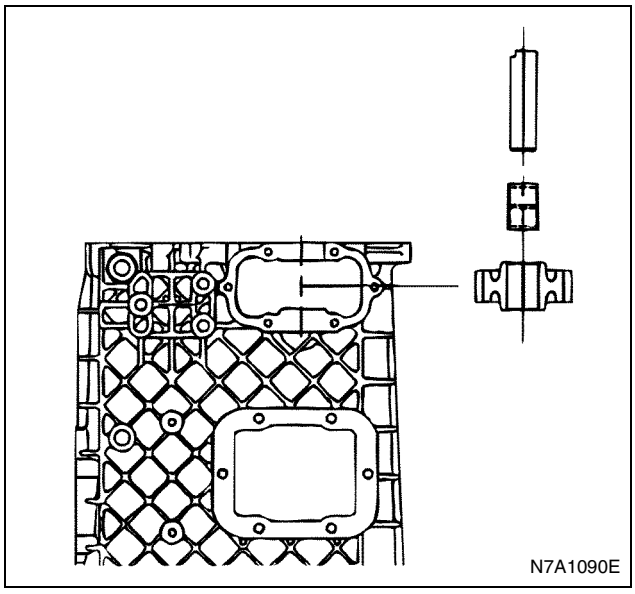
Measured value, mm (in)	Thickness of applicable shim
more than — less than	
3.34 — 3.40 (0.132 — 0.133)	3.19 (0.125)
3.28 — 3.34 (0.130 — 0.131)	3.13 (0.123)
3.22 — 3.28 (0.127 — 0.129)	3.70 (0.120)
3.16 — 3.22 (0.125 — 0.126)	3.01 (0.118)
3.10 — 3.16 (0.122 — 0.124)	2.95 (0.116)
3.04 — 3.10 (0.120 — 0.122)	2.89 (0.113)
2.98 — 3.04 (0.118 — 0.119)	2.83 (0.111)
2.92 — 2.98 (0.115 — 0.117)	2.77 (0.109)
2.86 — 2.92 (0.113 — 0.114)	2.71 (0.106)
2.80 — 2.86 (0.110 — 0.112)	2.65 (0.104)
2.74 — 2.80 (0.108 — 0.110)	2.59 (0.101)
2.68 — 2.74 (0.106 — 0.107)	2.53 (0.099)
2.62 — 2.68 (0.104 — 0.105)	2.47 (0.097)
2.56 — 2.62 (0.101 — 0.103)	2.41 (0.094)
2.50 — 2.56 (0.099 — 0.100)	2.35 (0.092)
2.44 — 2.50 (0.096 — 0.098)	2.29 (0.090)
2.38 — 2.44 (0.094 — 0.096)	2.23 (0.087)
2.32 — 2.38 (0.092 — 0.093)	2.17 (0.085)
2.26 — 2.32 (0.089 — 0.091)	2.11 (0.083)

13. Install the snap ring to the main shaft rear bearing.

14. Apply engine oil 5W-30 to the needle bearing, install the reverse idle gear and needle bearing, and then insert the reverse idle shaft.

- The arrow mark shows the direction of the transmission front side.


N7A0338E


N7A1090E

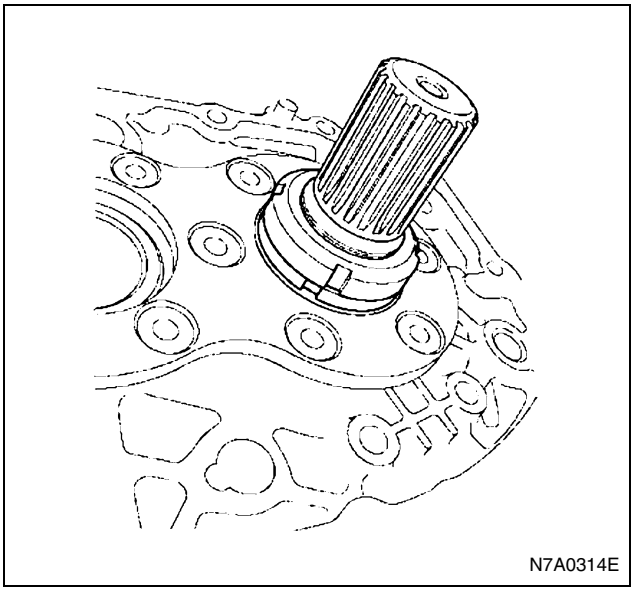
15. Install the retainer to the transmission case.

Tighten:
Retainer to 26 N·m (2.7 kg·m / 19 lb·ft)

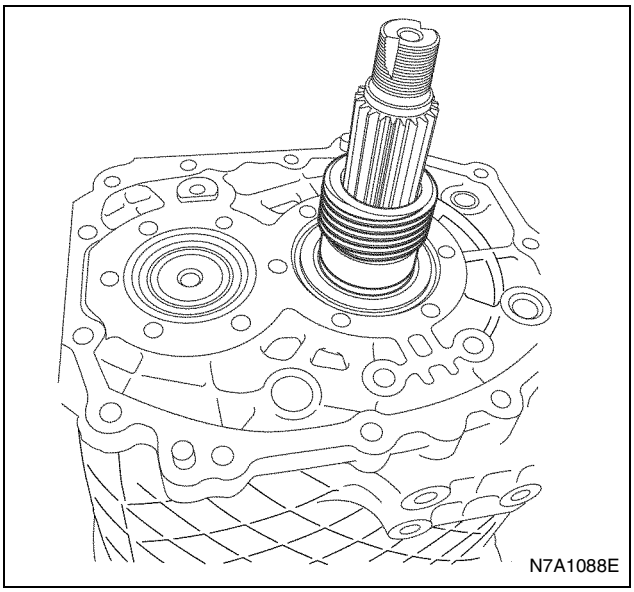
Caution:
Clean up the sealing agent on the screw thread of the transmission case and replace all screws with new ones.

16. Fix the main shaft end lock nut using the wrench 5-8840-2798-0. (4WD model)

Tighten:
Main shaft end lock nut to 359 N·m (36.6 kg·m / 265 lb·ft)

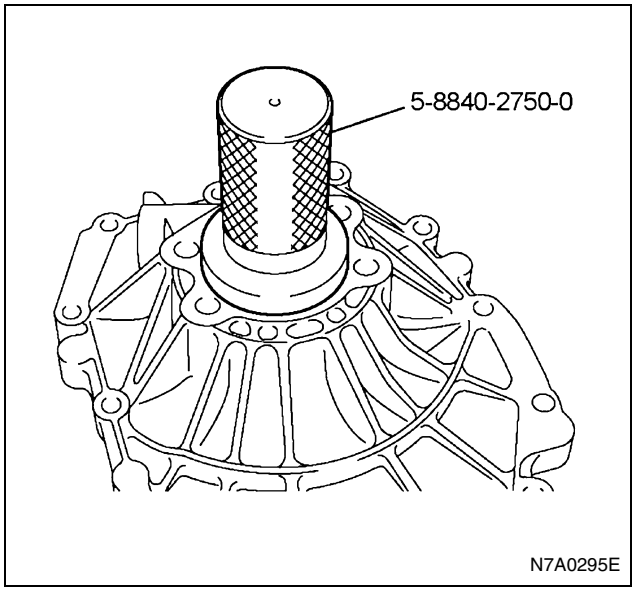

N7A0314E

17. Install the collar and speedometer gear.


N7A1088E

18. When replacing the oil seal of the rear cover with a new one after checking it for wear or damage, apply engine oil 5W-30 around the oil seal, and then press it in to the rear cover using the installer 5-8840-2750-0.
    - Apply Besco L2 grease to the oil seal lip.

Caution:
Be careful not to damage the lip portion of the oil seal.

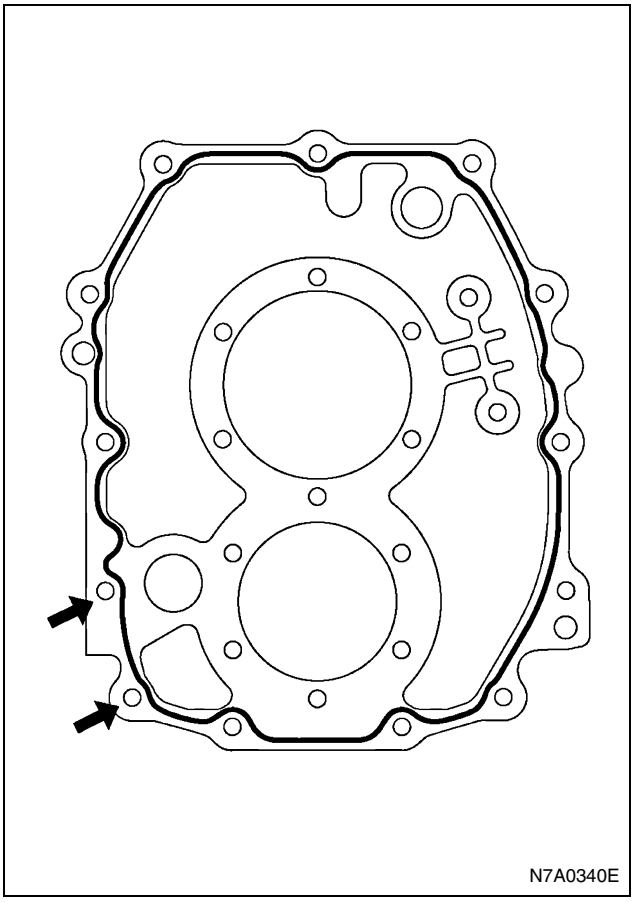


N7A0295E

19. Apply ThreeBond 1215 to the mating surface of the transmission case rear cover, and then install the rear cover.
    Wipe off moisture and lubricant from the connecting surface, and then apply the gasket continuously with a diameter of 2 mm (0.079 in) or more.

Caution:
Since the two bolts with arrow marks are installed with LOCTITE sealing agent, clean up the sealing agent remaining on the screw thread of the transmission case, and then use new bolts with LOCTITE sealing agent.

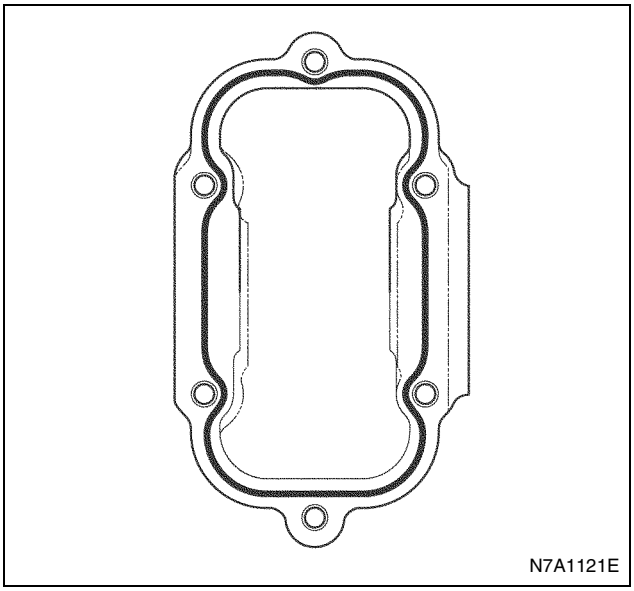
Tighten:
Rear cover to 46 N·m (4.7 kg·m / 34 lb·ft)



20. Apply ThreeBond 1215 to the mating surface of the transmission case reverse idle cover, and then install the reverse idle cover.

Tighten:
Reverse idle cover to 20 N·m (2.0 kg·m / 15 lb·ft)

- Wipe off moisture water and lubricant from the mating surface, and then apply the gasket continuously with a diameter of 2 mm (0.079 in) or more.

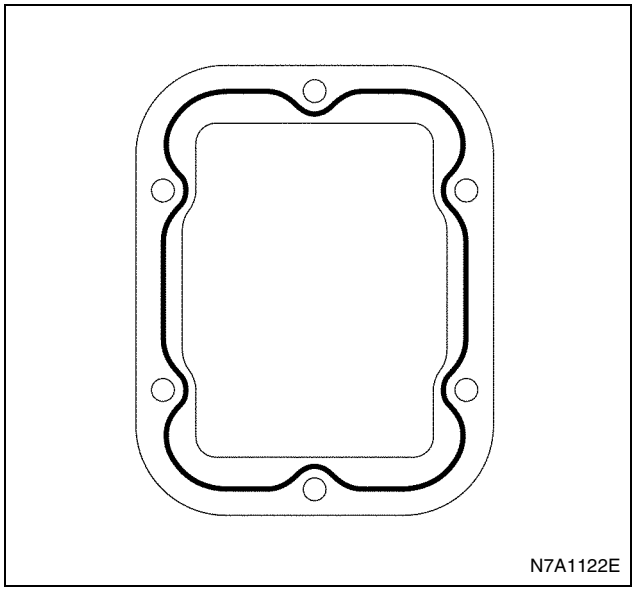


21. Apply ThreeBond 1215 to the mating surface of the transmission case front side cover, and then install the PTO cover.

- Wipe off moisture and lubricant from the mating surface, and then apply the gasket continuously with a diameter of 2 mm (0.079 in) or more.

Tighten:
PTO cover to 37 N·m (3.8 kg·m / 27 lb·ft)

Caution:
Since the bolt is installed with LOCTITE sealing agent, clean up the sealing agent remaining on the screw thread of the transmission case, and then use a new bolt with LOCTITE sealing agent.

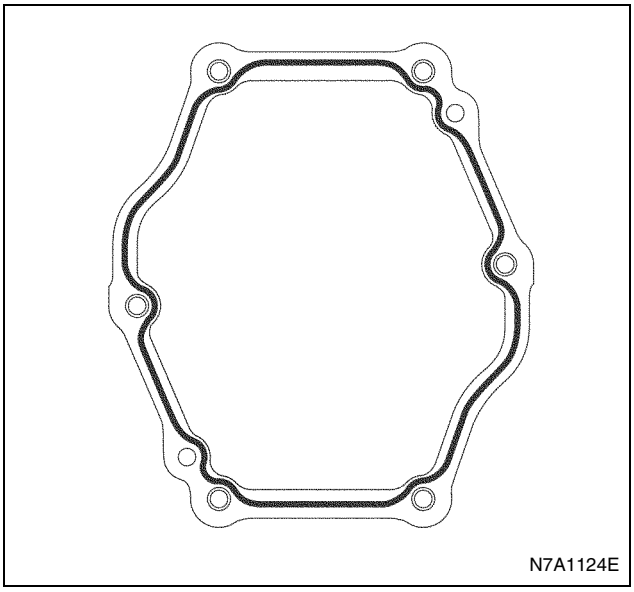


22. Shift the position to the neutral, apply ThreeBond 1215 to the mating surface of the transmission case control box, and then install the interlock plate (7) and the control box (1).

- Wipe off moisture and lubricant from the mating surface, and then apply the gasket continuously with a diameter of 2 mm (0.079 in) or more.

Tighten:
Control box (1) to 27 N·m (2.8 kg·m / 20 lb·ft)

Caution:
Since the bolt is installed with LOCTITE sealing agent, clean up the sealing agent remaining on the screw thread of the transmission case, and then use a new bolt with LOCTITE sealing agent.



23. Install the detent assembly (6) (5) (4).

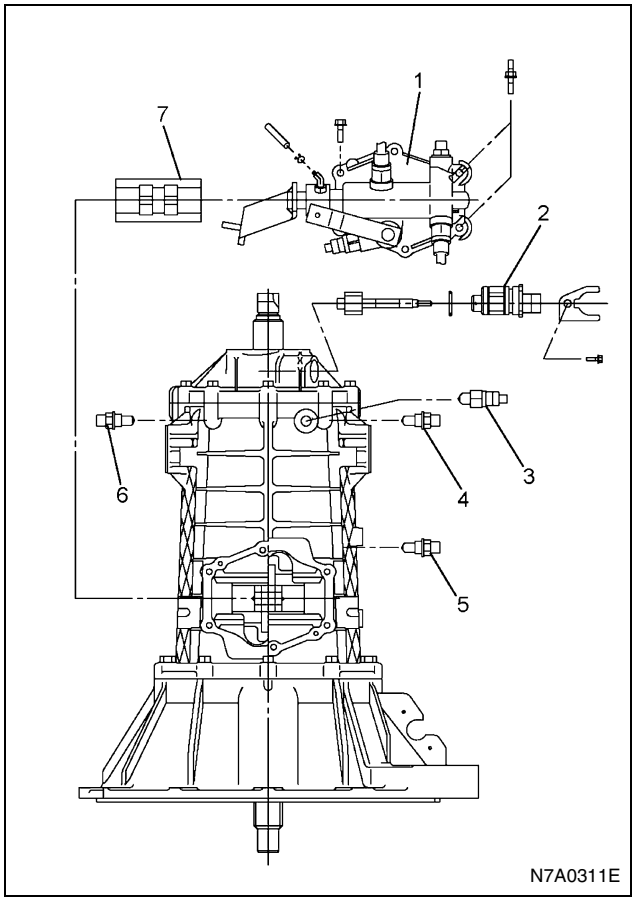
Tighten:
Detent assembly (6) (5) (4) to 27 N·m (2.8 kg·m / 20 lb·ft)

24. Apply Three Bond 1141 to the reverse switch thread portion, and then install the reverse switch (3).

Tighten:
Reverse switch (3) to 39 N·m (4.0 kg·m / 29 lb·ft)

25. Apply engine oil 5W-30 to the speedometer driven gear and the O-ring, and then install the speedometer driven gear (2).

Tighten:
Speedometer driven gear (2) to 20 N·m (2.0 kg·m / 15 lb·ft)



26. Apply engine oil 5W-30 to the O-ring, and then install the drain plug and the O-ring.

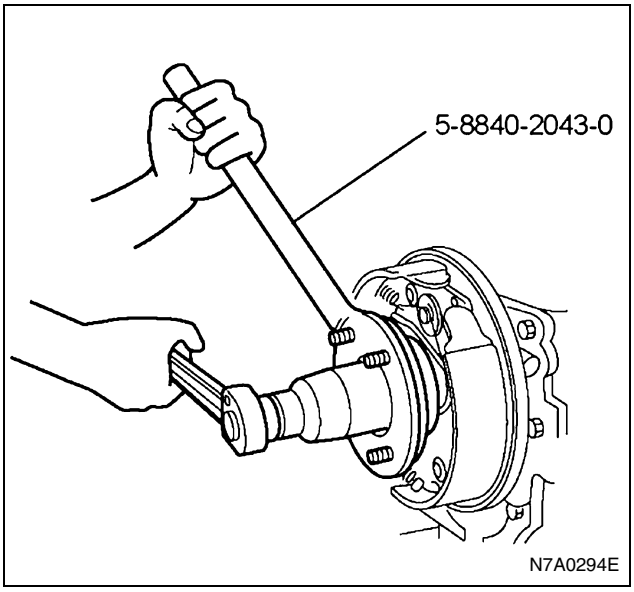
Tighten:
Drain plug to 39 N·m (4.0 kg·m / 29 lb·ft)

27. Apply engine oil 5W-30 to the O-ring, and then install the filler plug and the O-ring.

Tighten:
Filler plug to 39 N·m (4.0 kg·m / 29 lb·ft)

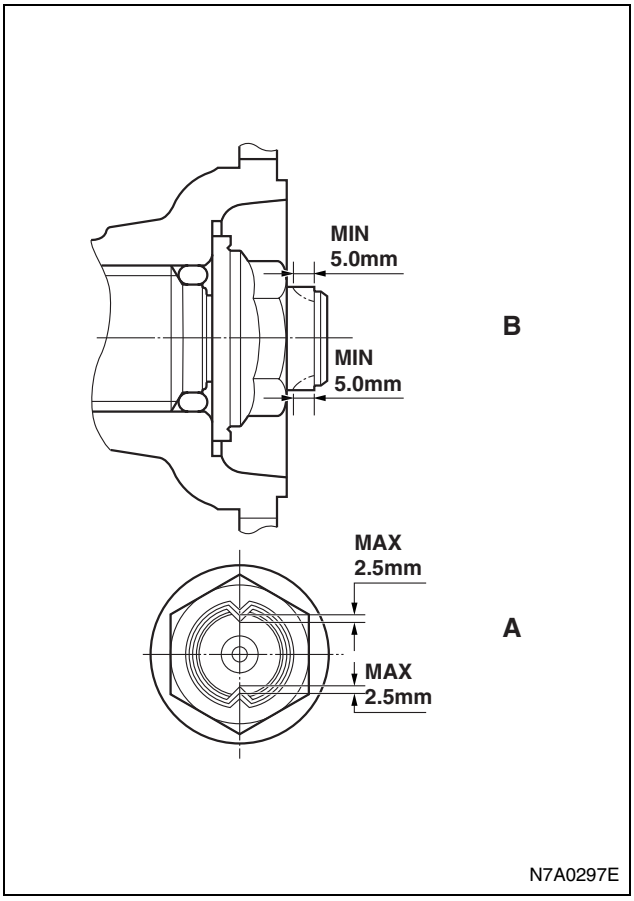
28. Install the parking brake assembly.
    - Refer to PARKING BRAKE ASSEMBLY.
29. Apply engine oil 5W-30 to the O-ring, and then install the coupling driver and the O-ring.
30. Use a new lock nut, apply engine oil 5W-30 to the seat, and then fix the lock nut using the flange holder 5-8840-2043-0.

Tighten:
Lock nut to 289 N·m (29.5 kg·m / 213 lb·ft)



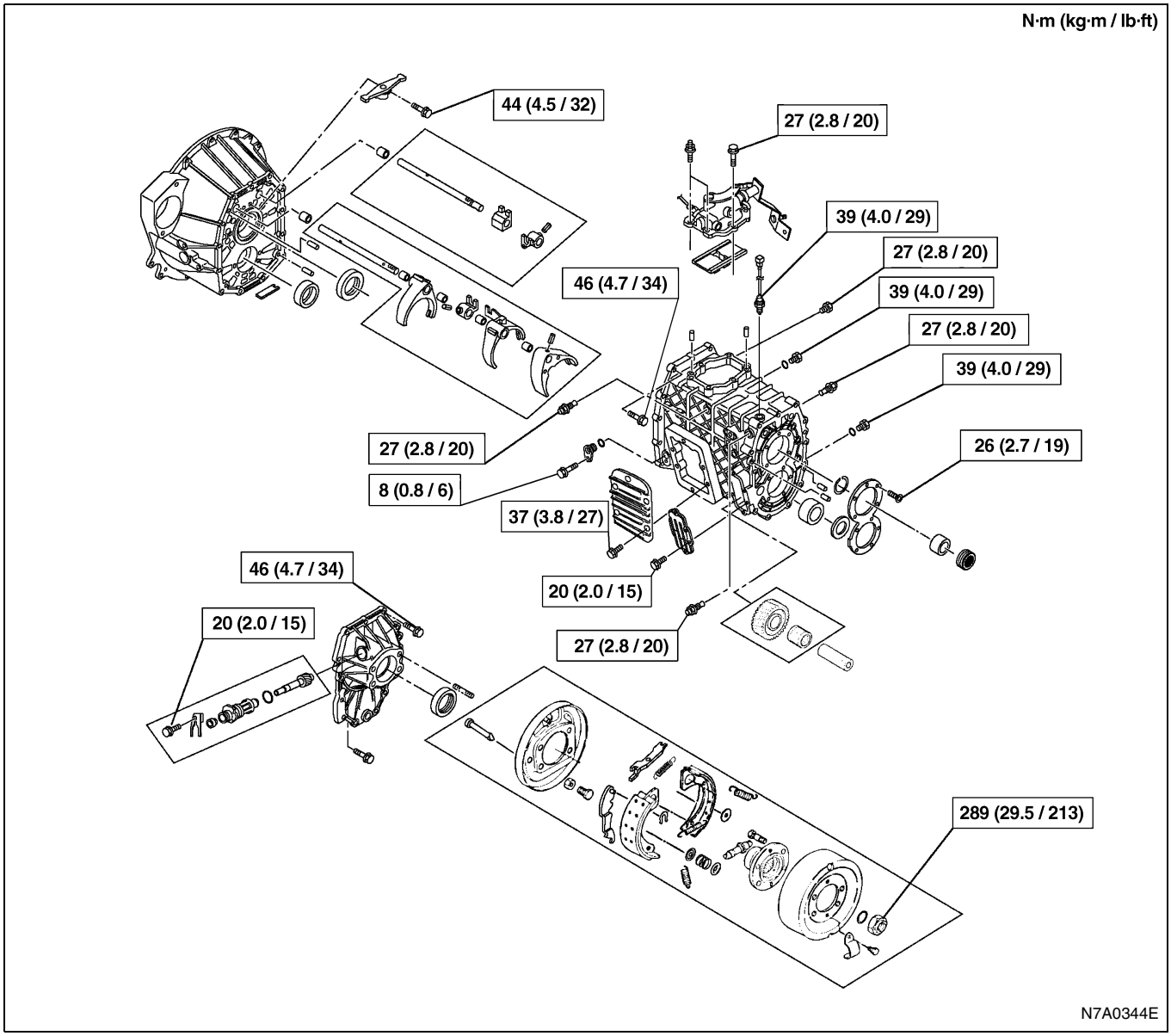
- After fixing it to the specified torque, align the lip part of the nut to the V-groove of the shaft edge. Securely caulk the two parts of the nut lip using a chisel whose tip form is approx. 1 mm (0.04 in) radius by 60°, to make a length (B) of 5 mm (0.2 in) or more, and a clearance between the bottom of the shaft and the nut lip (A) of 2.5 mm (0.06 in) or less.

Caution:
If any crack is found on the caulking portions of the nut after the check, replace the lock nut and caulk it again.



31. Install the parking brake dram and the adjust hole cover securing bolt.
    - Refer to PARKING BRAKE ASSEMBLY.
32. Install the shift fork and the support bolt.
    - Refer to CLUTCH.
33. Install the shift block assembly.
    - Refer to CLUTCH.

Fixing Torque



Special Tools

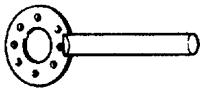
Illustration	Tool Number / Description / Remarks
5884000070	5-8840-0007-0 / Grip
 5884020430	5-8840-2043-0 / Flange Holder

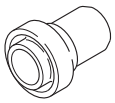
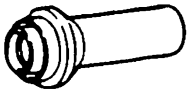
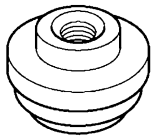
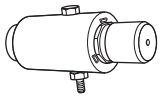
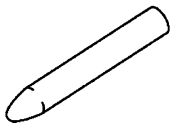
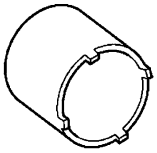
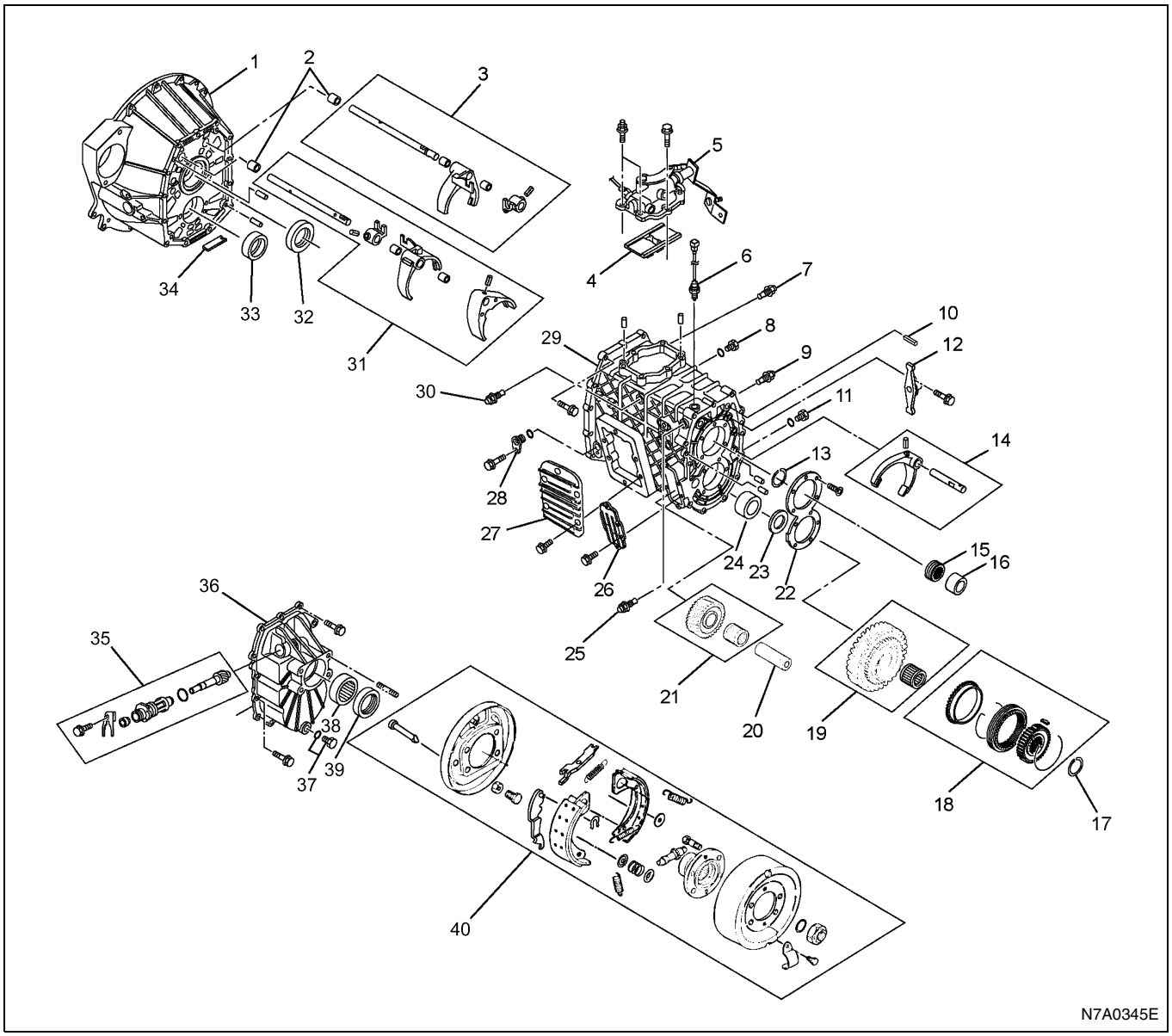
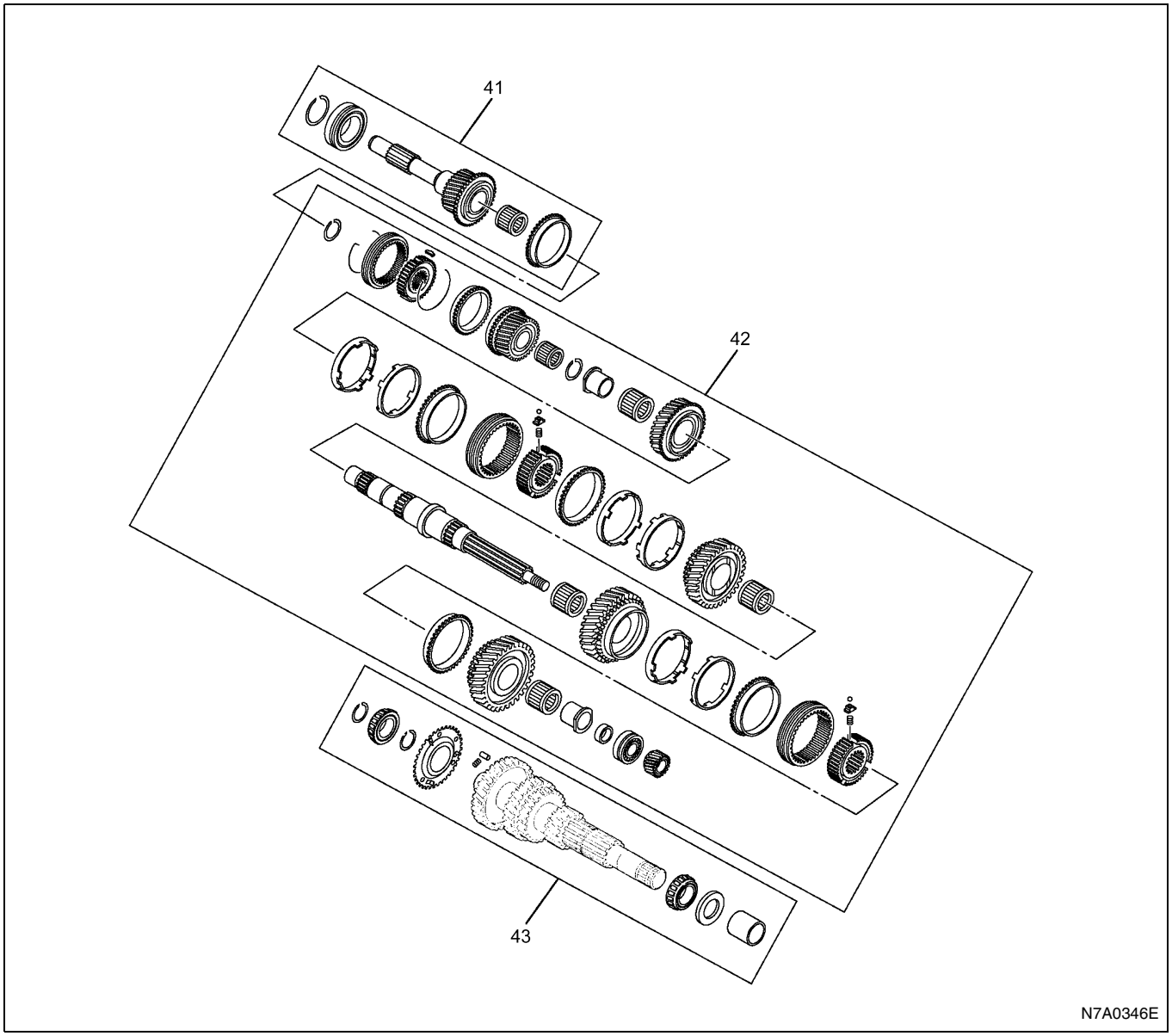
Illustration	Tool Number / Description / Remarks
 5884025580	5-8840-2558-0 / Oil Seal Installer
 5884027500	5-8840-2750-0 / Oil Seal Installer

Illustration	Tool Number / Description / Remarks
 5884027540	5-8840-2754-0 / Oil Seal Installer
 5884027550	5-8840-2755-0 / Bush Remover & Installer
 5884027930	5-8840-2793-0 / Oil Seal Protector
 5884027980	5-8840-2798-0 / Wrench

Transmission (6MT)

Components





Legend

1. Clutch housing
2. Bush; Clutch housing
3. 4th-5th, 6th shift arm
4. Interlock plate
5. Control box
6. Reverse switch
7. Detent assembly
8. Filler plug
9. Detent assembly
10. Spring pin
11. Drain plug
12. 6th relay lever
13. Snap ring
14. 6th shift arm and shift rod
15. Speedometer gear
16. Collar
17. Snap ring
18. 6th clutch hub assembly and sleeve
23. Shim; counter
24. Counter rear bearing
25. Detent assembly
26. Reverse idle cover
27. PTO cover
28. Sensor dummy plug
29. Transmission case
30. Detent assembly
31. 1st-reverse and 2nd-3rd shift arm
32. Front oil seal
33. Bearing outer race
34. Magnet
35. Speedometer driven gear
36. Rear cover
37. Drain plug
38. Needle bearing; main end
39. Rear oil seal
40. Parking brake assembly

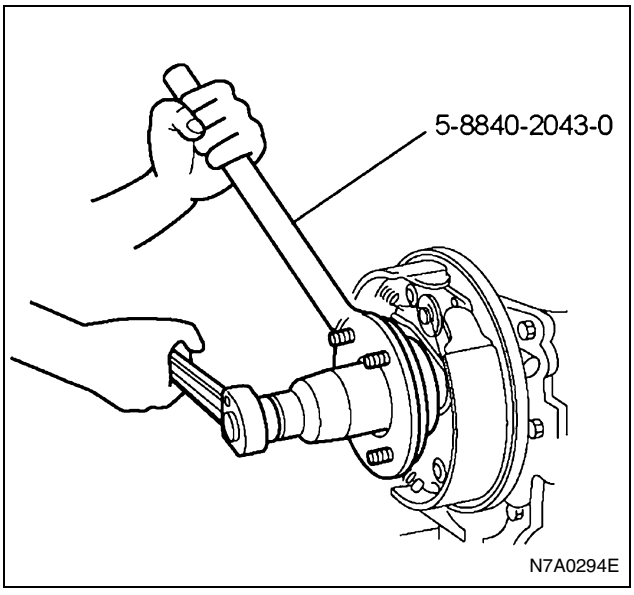
19. 6th gear and needle bearing
20. Reverse idle shaft
21. Reverse idle gear and needle bearing
22. Retainer
41. Top gear shaft assembly
42. Main shaft assembly
43. Counter shaft assembly

Disassembly

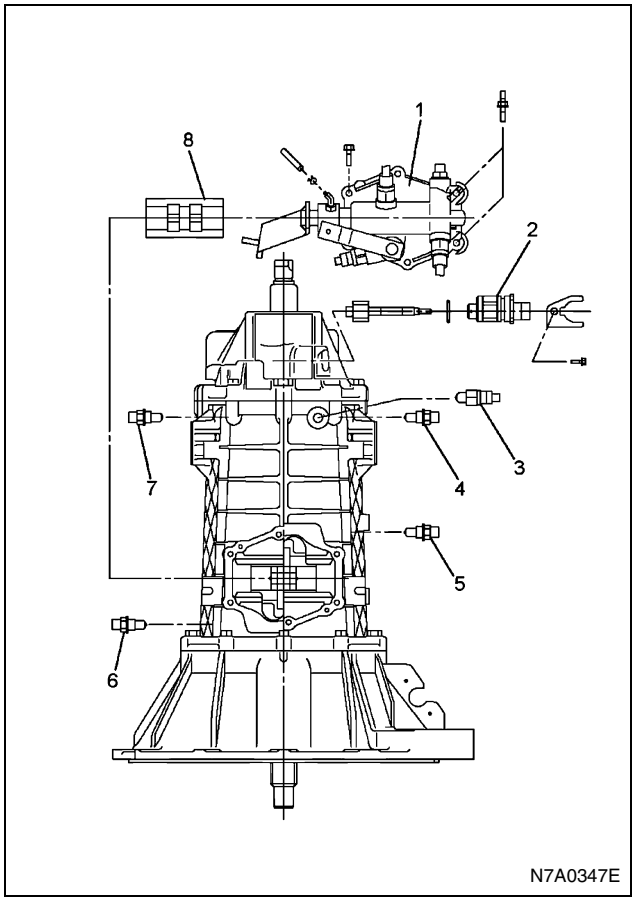
Caution:
Be careful not to damage the transmission case and the clutch housing because they are made of aluminum. Further attention should be paid to the rib because its damage weakens hardness of the case.

Do not hurt yourself when working on something heavy such as cases and gears.

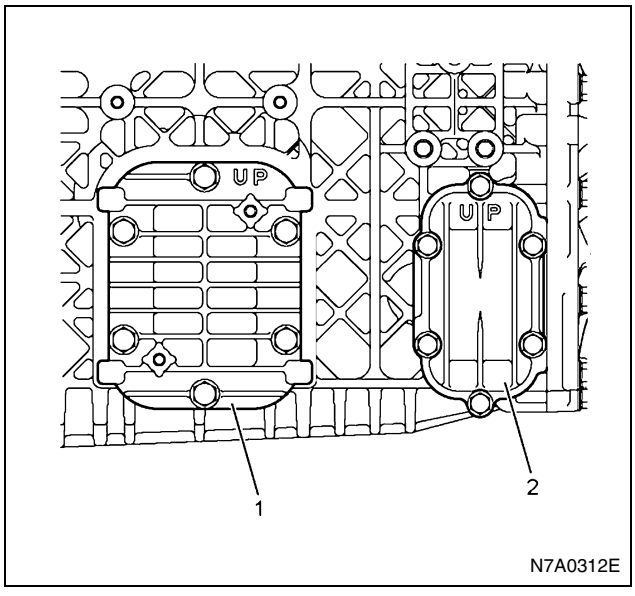
1. Remove the shift block assembly.
   - Refer to CLUTCH.
2. Remove the shift fork and the support bolt.
   - Refer to CLUTCH.
3. Remove the adjust hole cover securing bolt, and then remove the parking brake drum.
   - Refer to PARKING BRAKE ASSEMBLY.
4. Raise the caulking portions (two parts) of the coupling driver lock nut securely, and then remove the lock nut using the flange holder 5-8840-2043-0.



5. Remove the coupling driver and the O-ring.
6. Remove the parking brake assembly.
   - Refer to PARKING BRAKE ASSEMBLY.
7. Remove the filler plug and the O-ring.
8. Remove the drain plug and the O-ring.
   - Drain transmission oil. Check the amount of oil and the existence of metal particles and foreign matters while draining oil.
9. Remove the noise cover.
10. Remove the speedometer driven gear (2).
11. Remove the reverse switch (3).
12. Remove the detent assembly (4) (5) (6) (7).
13. Remove the control box (1) and the interlock plate (8).

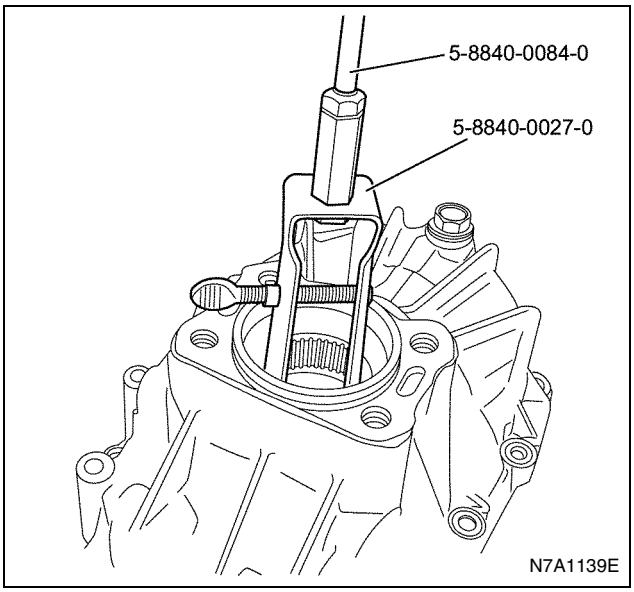


14. Remove the front side cover (1).
15. Remove the reverse idle cover (2).

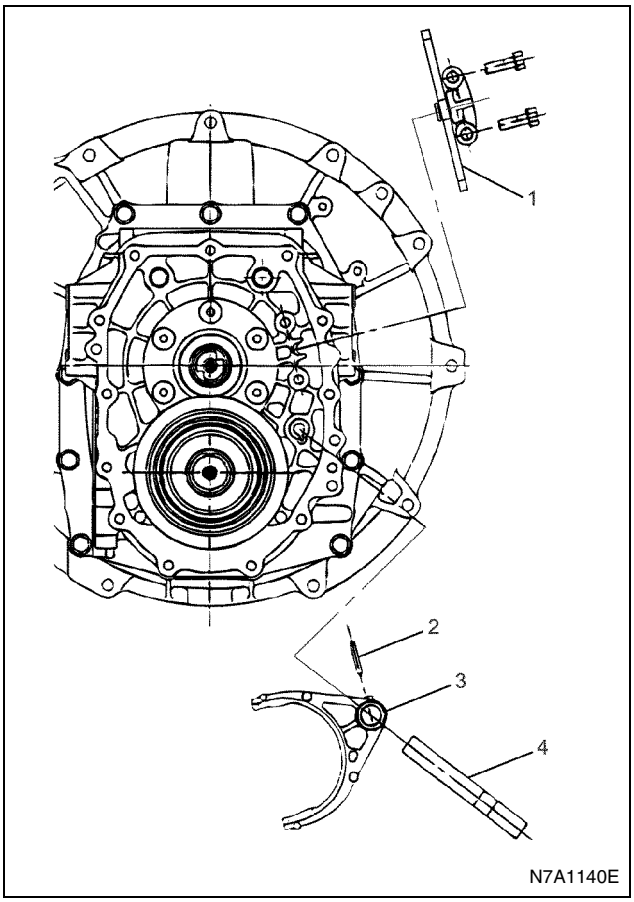


16. Remove the rear cover assembly.

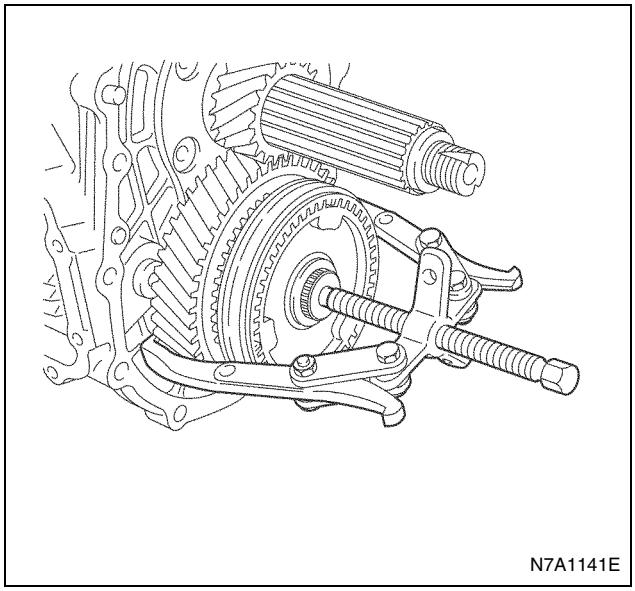
17. When worn or damaged parts are found after checking the rear cover oil seal, remove it from the rear cover using the flat-tip screwdriver.
18. Remove the needle bearing; main end from the rear cover using the remover 5-8840-0027-0 and the sliding hammer 5-8840-0084-0.



19. Remove the 6th relay lever (1).
20. Remove the 6th shift arm (3) and 6th shift rod (4).
    - Using the spring remover, drive out the spring pin (2).

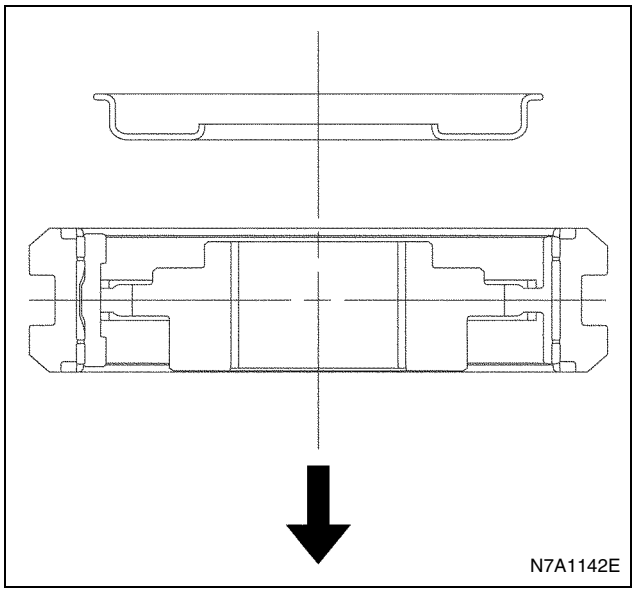


21. Using the snap ring pliers, remove the snap ring; 6th clutch hub.
22. Using the puller, remove the 6th clutch hub assembly and sleeve, the 6th block ring, the 6th gear and the needle bearing from the counter shaft.

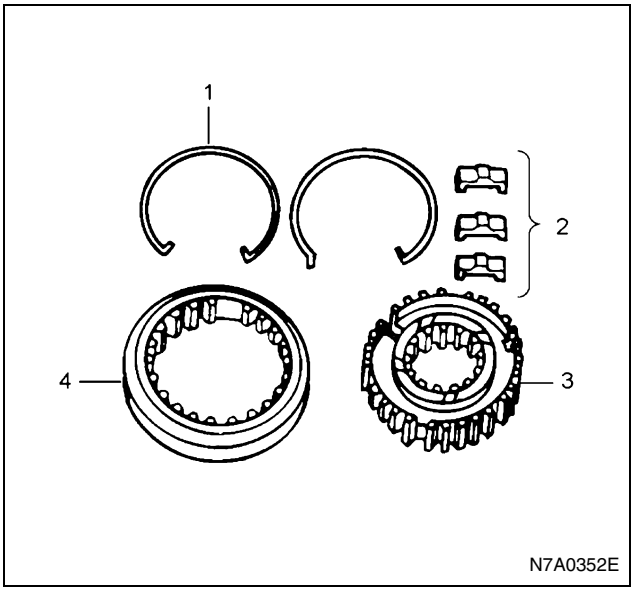


23. Disassemble the 6th clutch hub assembly and sleeve.
    a. Remove the stopper from the clutch hub.
       - The arrow mark shows the direction of the transmission front side.

Caution:
When removing the stopper plate, replace it with a new one on installation.



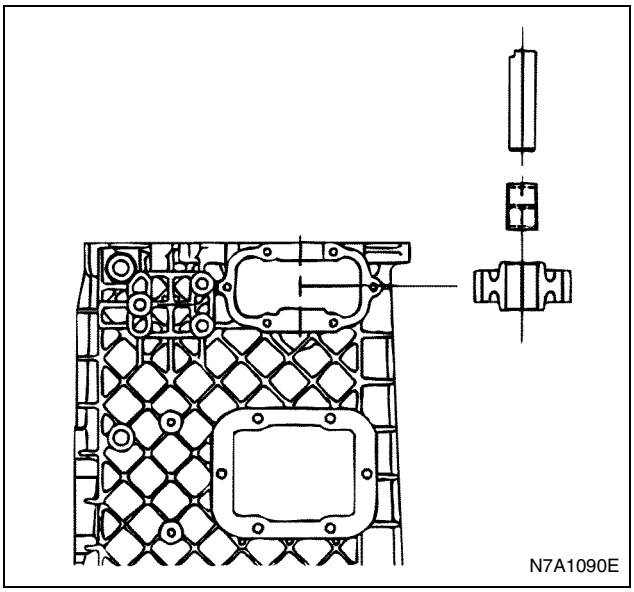
    b. Disassemble the clutch hub assembly and sleeve.



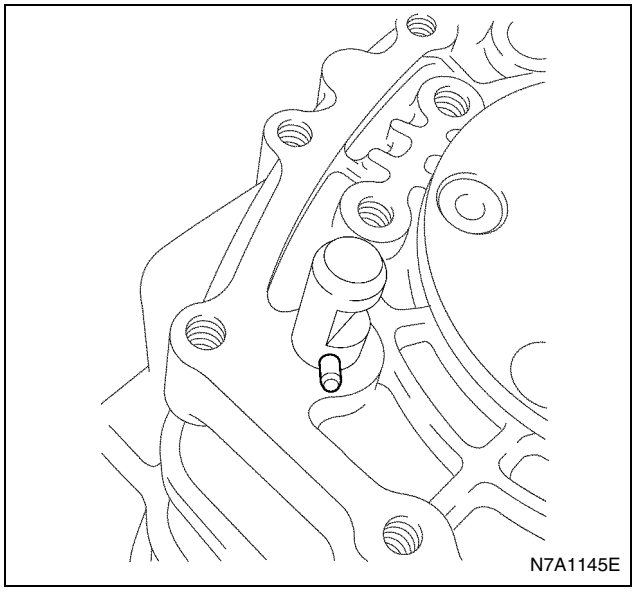
Legend

1. Spring
2. Insert
3. Clutch hub
4. Sleeve

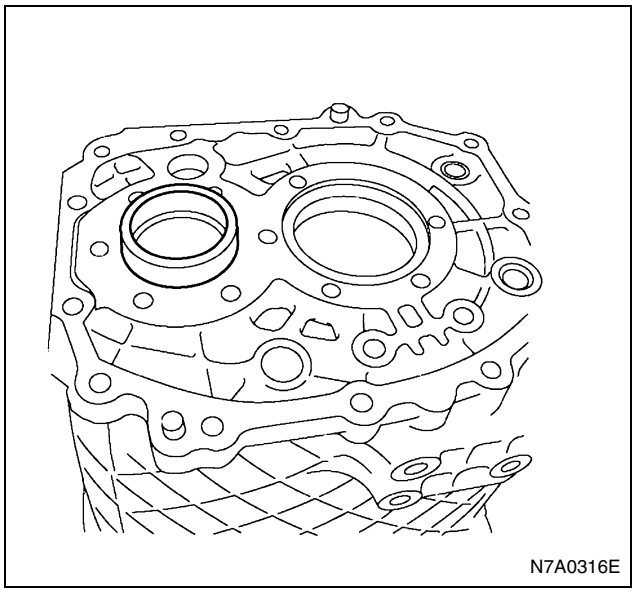
24. Remove the collar and the speedometer gear.
25. Remove the retainer from the transmission case.
26. Pull out the reverse idle shaft, and then remove the reverse idle gear and the needle bearing.



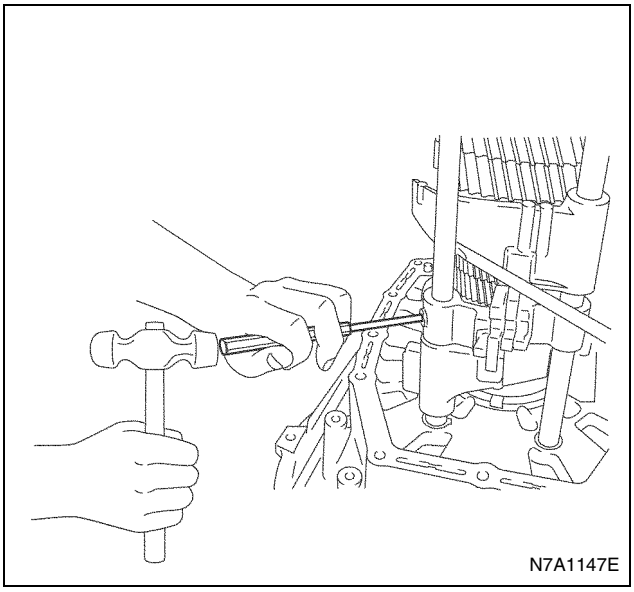
27. Remove the snap ring from the main shaft rear bearing.
28. Remove the shim from the counter shaft rear bearing.
29. Remove the spring pin; 4th-5th and 6th shift rod.



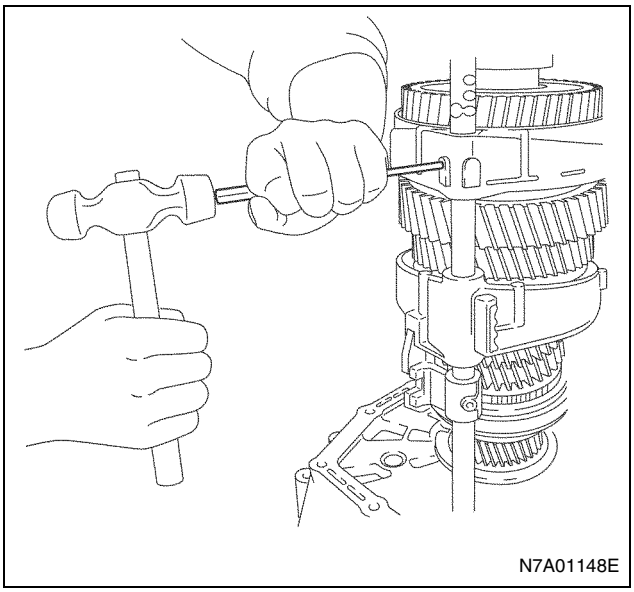
30. Remove the transmission case from the clutch housing.
31. Remove the bearing rear outer race from the transmission case.



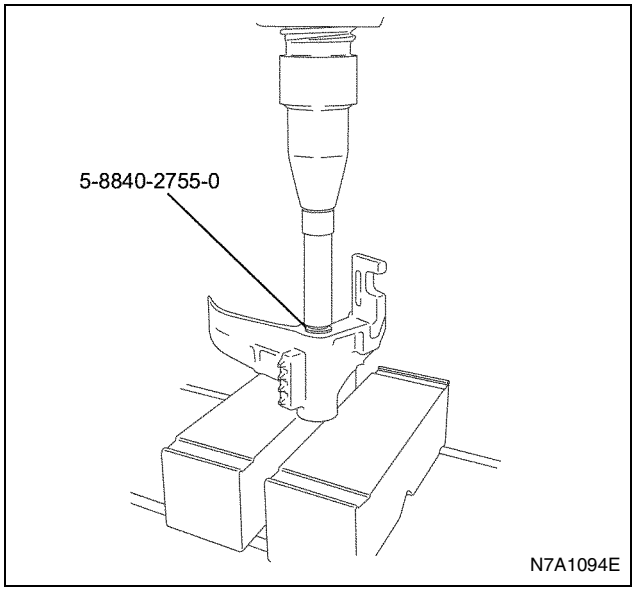
32. Remove the 4th-5th and 6th shift rod, the 1st-reverse and 6th shift block and the 4th - 5th shift arm.
    - When driving out the spring pin, put a round pole on the opposite side of the shift rod not to damage other parts, and then remove the spring pin using the spring pin remover.


N7A1147E

33. Remove the 1st-reverse and 2nd-3rd shift rod, the 1st-reverse shift arm, the 3rd-2nd shift arm, the 1st-reverse and 6th shift block.
    - When driving out the spring pin, put a round pole on the opposite side of the shift rod not to damage other parts, and then remove the spring pin using the spring pin remover.

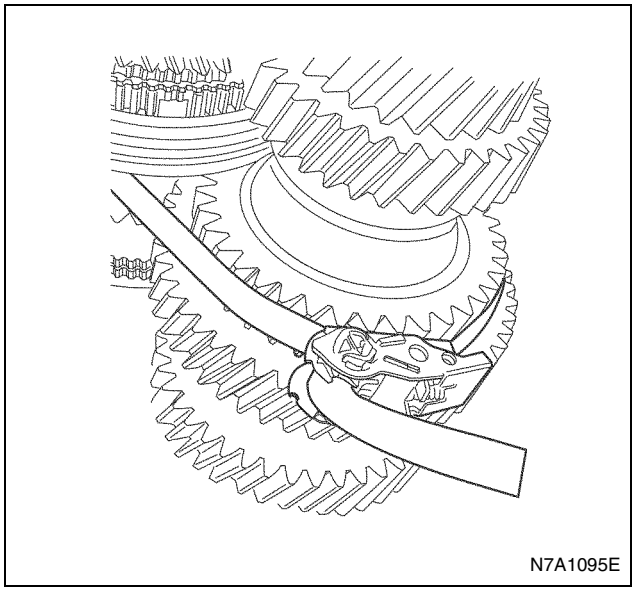

N7A01148E

34. Remove the bush from the 4th-5th shift arm using the remover 5-8840-2755-0.
35. Remove the bush from the 1st-reverse shift arm using the remover 5-8840-2755-0.
36. Remove the bush from the 3rd-2nd shift arm using the remover 5-8840-2755-0.
    - Use a round pole whose length is enough to push the remover to the end.

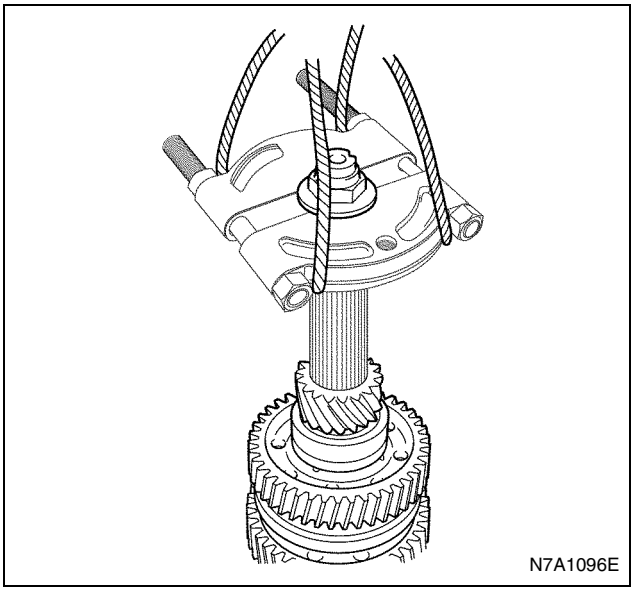


N7A1094E

37. Remove the magnet from the clutch housing.
38. Remove the mail shaft assembly, the top gear shaft assembly and the counter shaft assembly.
    a. Tie the main shaft assembly, the counter shaft assembly and the top gear shaft assembly at the two positions not to let them come apart using a lashing belt or other belts with a fixing function, and then fix them securely.


N7A1095E

    b. Install the bearing remover to the main shaft and secure it with a lock nut, hang them with a hoist and a wire, and then remove the top gear shaft assembly, the main shaft assembly, the counter shaft assembly from the clutch housing as a unit while spreading the top gear shaft bearing outer snap ring installed to the clutch housing.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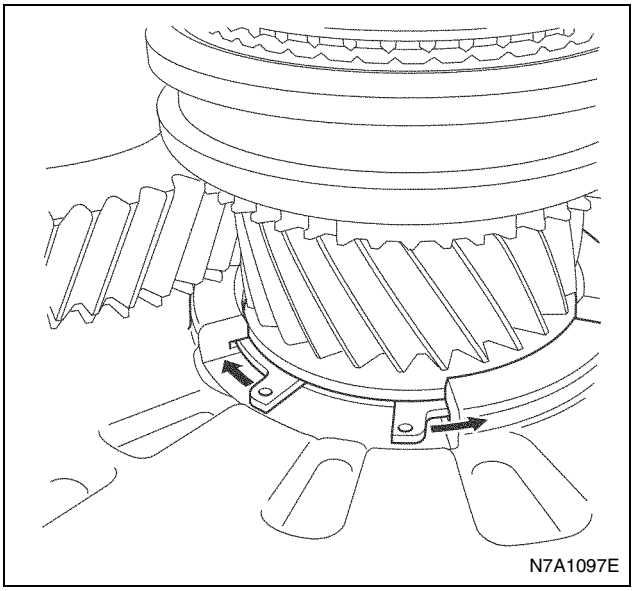
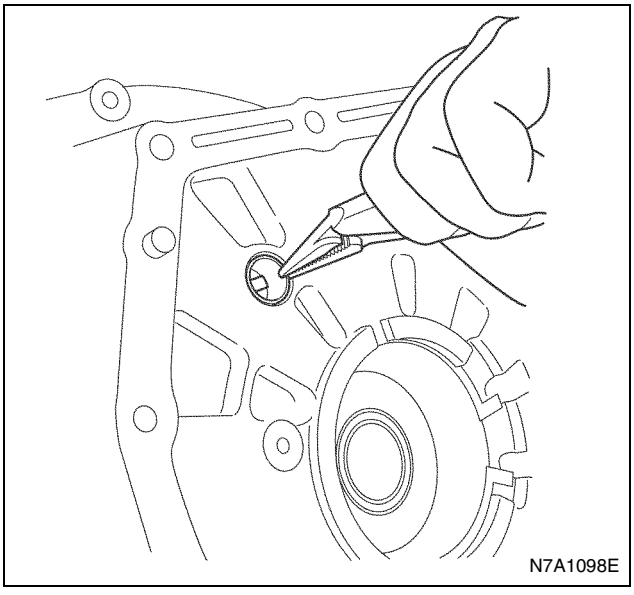
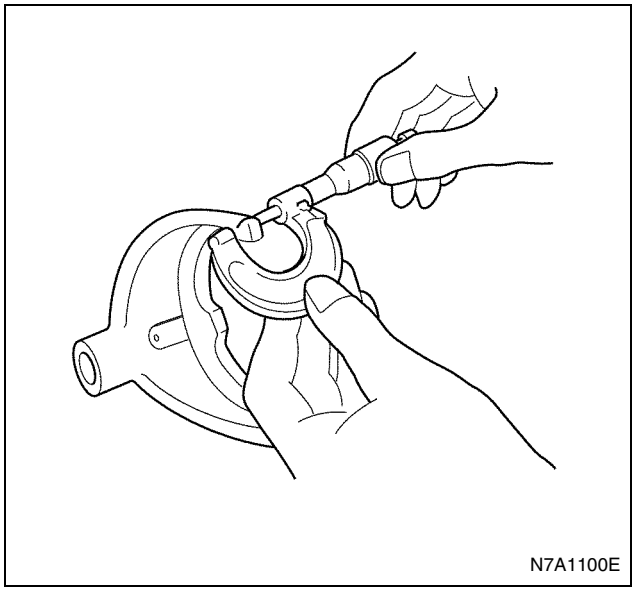

N7A1097E

39. Check the clutch housing bush, and then remove it from the clutch housing using a pliers if it is worn or damaged.

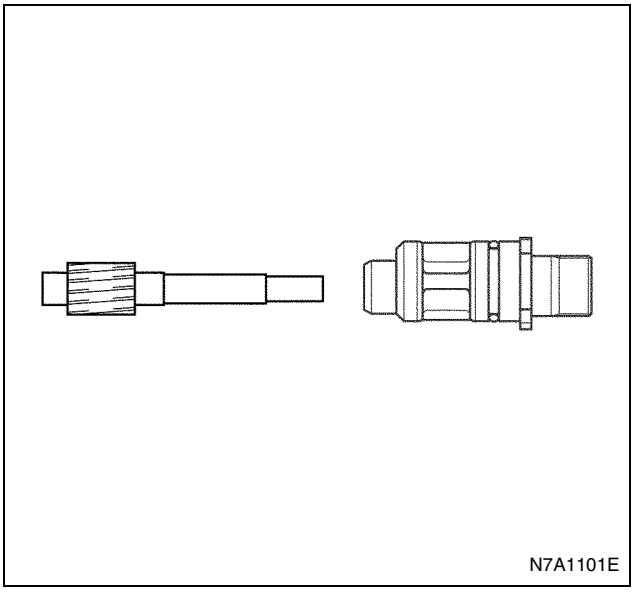

N7A1098E

40. Check the front oil seal, and then remove it from the clutch housing using a flat-tip screwdriver if it is worn or damaged.
    Check each part, and then correct and replace it if some worn, damaged or faulty parts are found.
41. Check each part of the shift mechanism, and then correct light damage, deflection or stepped wear. Replace it when it is heavily damaged or its usage limit is over.
    - Deflection, wear and damage of the shift rod and the shift arm
    - Shift arm thickness
      – Measure the thickness of the shift arm tip using the micrometer.

Shift arm thickness, mm (in)		
	Standard	Limit
1st-reverse 3rd-2nd 5th-4th	9.60 — 9.85 (0.378 — 0.387)	9.0 (0.354)
6th	9.60 — 9.85 (0.378 — 0.387)	9.3 (0.366)


N7A1100E

42. Check whether the speedometer driven gear and the driven gear bush are worn.
    - Replace them if they are worn heavily.


N7A1101E

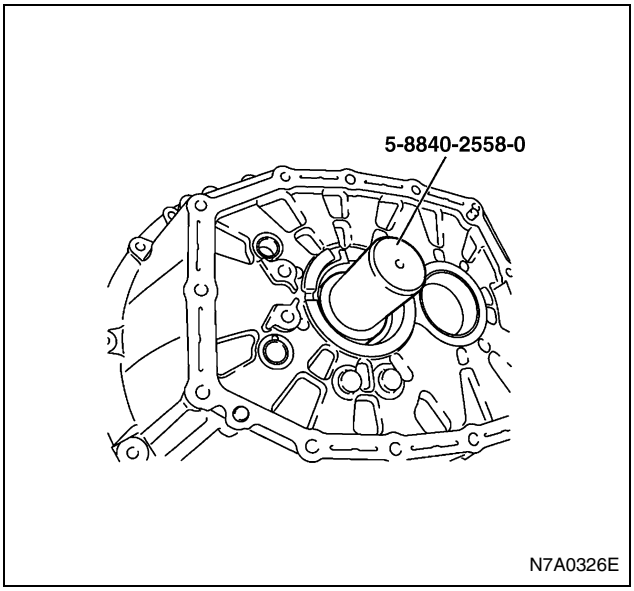
43. Measure the clearance between the insert and the block ring groove.
    - Measure the clearance using a caliper.
    - Replace the insert and the block ring if their measured values are out of the limit.

Clearance between insert and block ring, mm (in)	
	Standard
6th	3.46 — 3.76 (0.136 — 0.148)

Assembly

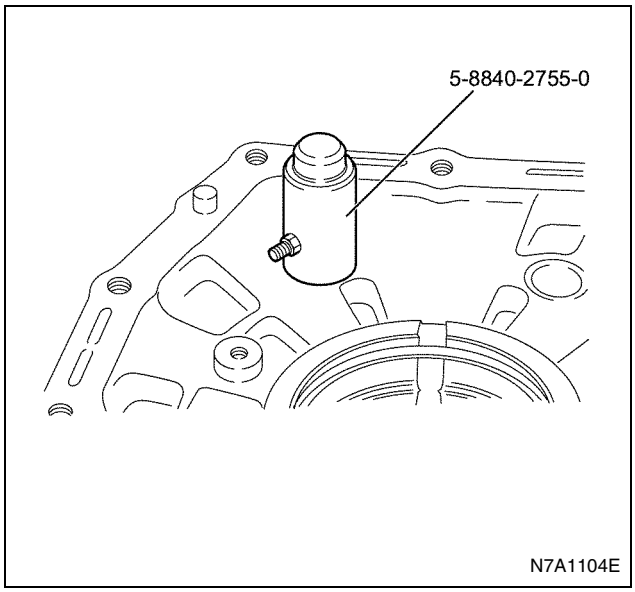
1. When finding the oil seal worn and damaged after the check and replacing it with a new one, apply engine oil 5W-30 around the oil seal, and then press in the oil seal into the clutch housing using the installer 5-8840-2558-0.
    - Apply Besco L2 grease on the oil seal lip portion.

Caution:
Be careful not to damage the oil seal lip portion.



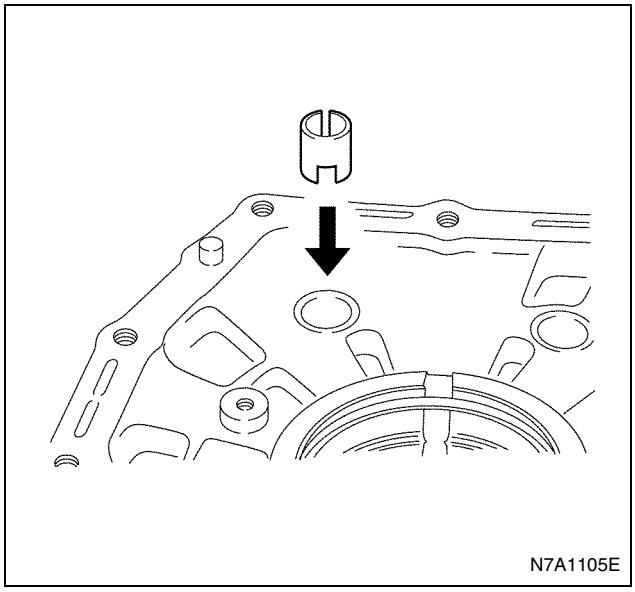
N7A0326E

2. When the clutch housing bush is replaced with a new one after checking it for wear and damage, press it in using the installer 5-8840-2755-0.

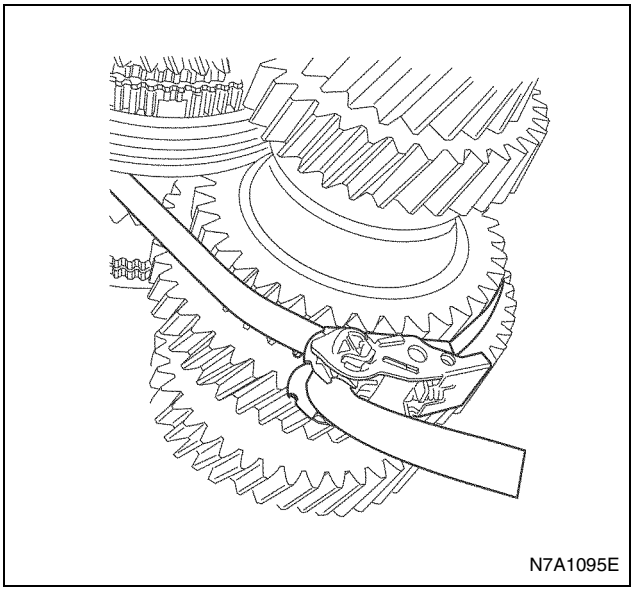


N7A1104E

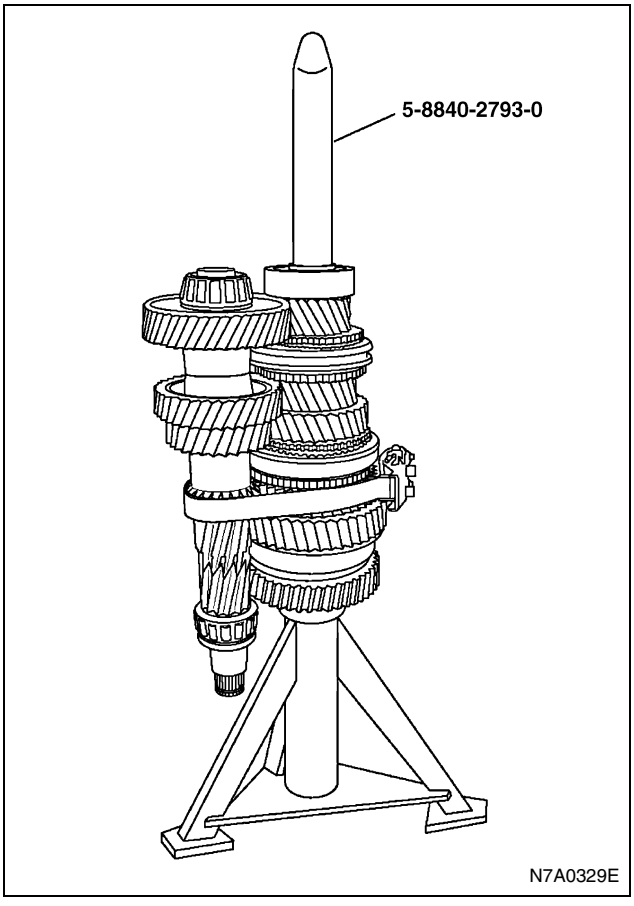
- During installation, the direction of the bush and the position of the caulking should be set as indicated in the figure.
- For the bush pressing in for the second time and onwards, press in the bush facing its notched portion to the clutch housing.


N7A1105E

3. Install the main shaft assembly, the top gear shaft assembly and the counter shaft assembly.
    a. Tie the main shaft assembly, the counter shaft assembly and the top gear shaft assembly at the two positions not to let them come apart using a lashing belt or other belts with a fixing function, and then fix them securely. Be careful not to drop the top gear shaft while lifting up.


N7A1095E

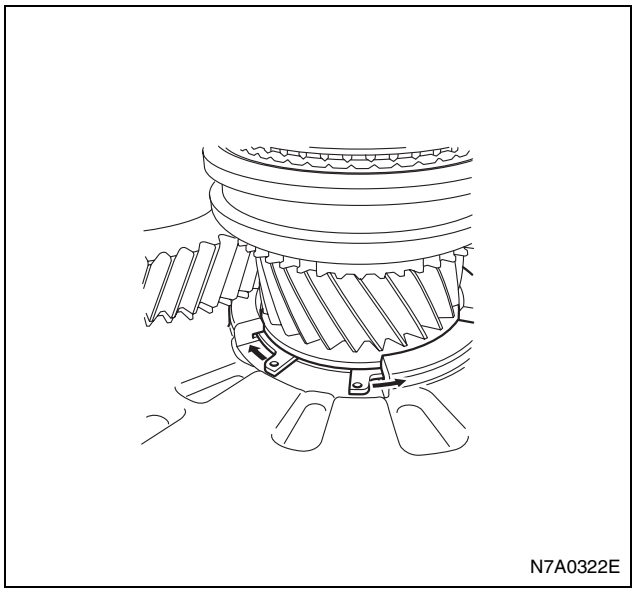
b. Stick up the three of the top gear shaft assembly, the main gear shaft assembly and the counter shaft assembly on the support stand as the top gear shaft assembly is put on the top.
c. Install the oil seal protector 5-8840-2793-0 to the main shaft.



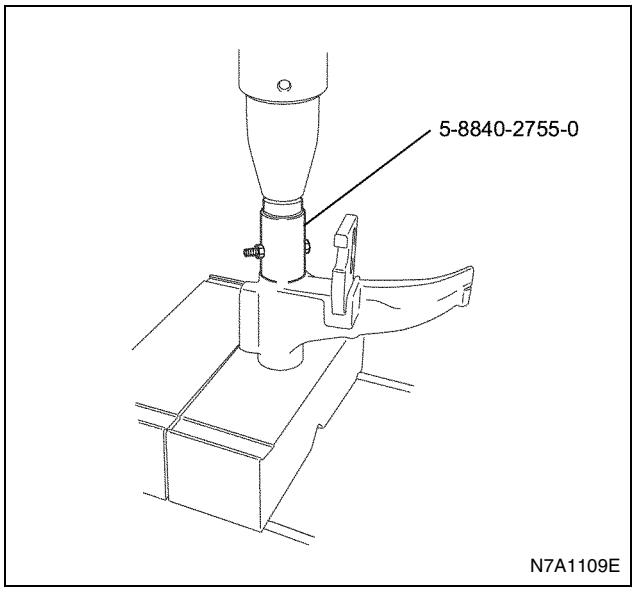
N7A0329E

d. Set the top gear shaft bearing outer snap ring to the clutch housing, spread it using a snap ring pliers, and then insert it to the clutch housing after aligning the top gear shaft, the counter shaft and the shift rod positions.

Caution:
- Make sure the snap ring is installed securely.
- Work carefully not to damage the front oil seal.

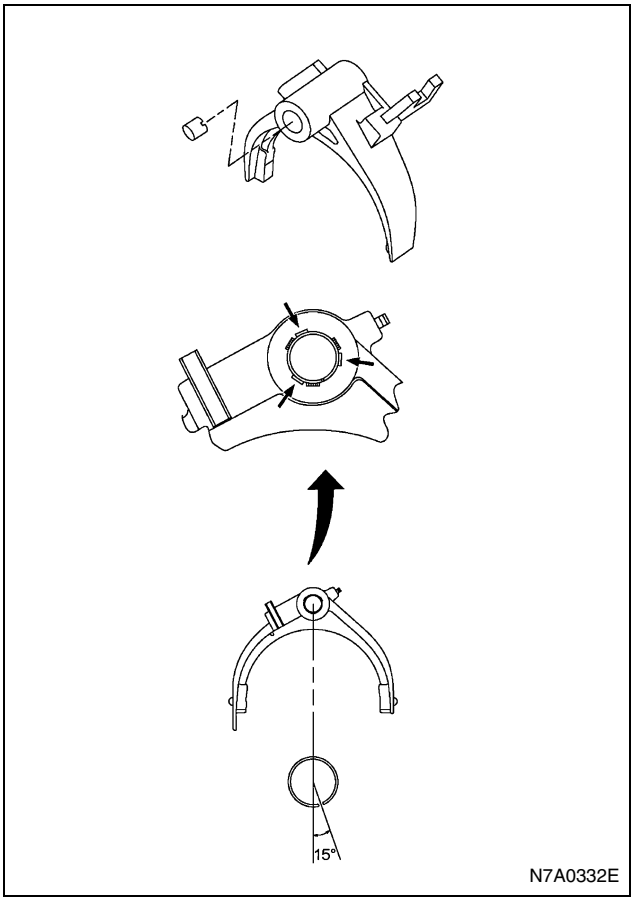

N7A0322E

4. Install the magnet to the clutch housing.
5. When replacing the 3rd-2nd shift arm bush with a new one after checking it for wear or damage, press in the bush using the installer 5-8840-2755-0.
6. When replacing the 4th-5th shift arm bush with a new one after checking it for wear or damage, press in the bush using the installer 5-8840-2755-0.
7. When replacing the 4th-5th shift arm bush with a new one after checking it for wear or damage, press in the bush using the installer 5-8840-2755-0.

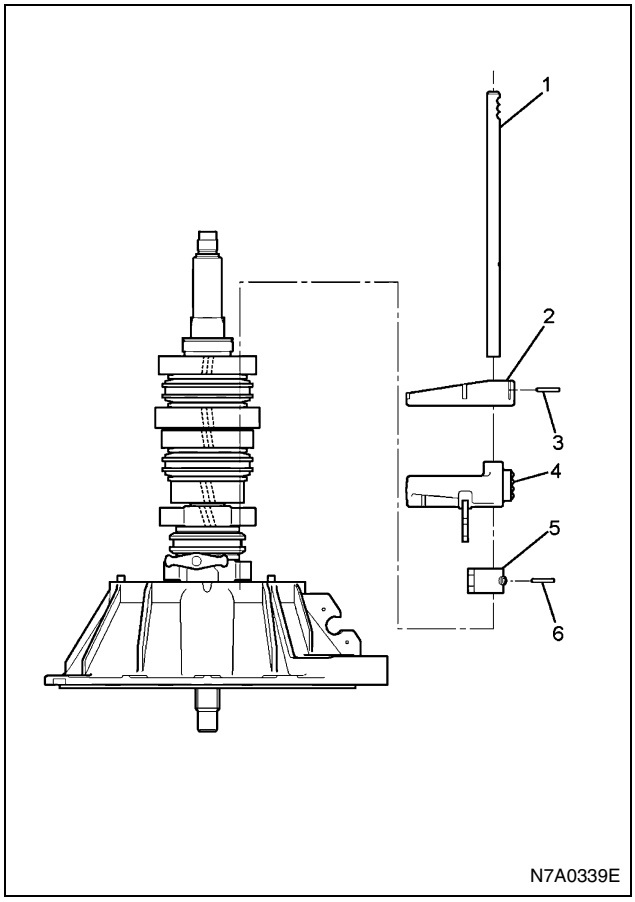


N7A1109E

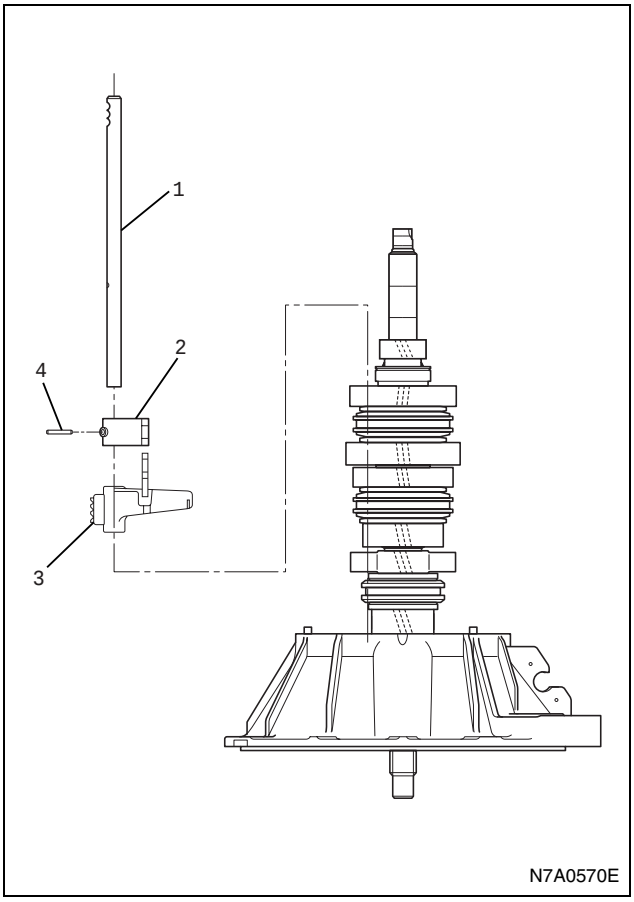
- Press it in taking care of the direction and angle of the shift arm bush, and then caulk the three portions except the bush cut and older caulking portions.



8. Install the 1st-reverse and 2nd-3rd shift rod (1) to the 1st-reverse and 6th shift block (5), the 2nd-3rd shift arm (4), the 1st-reverse shift arm (2).
   - Drive in the spring pin (3) and (6) using a hammer after aligning the spring pin hole.
   - When pressing in the spring pin, put a round pole on the opposite side of the shift rod not to damage other parts, and then press in the spring pin.

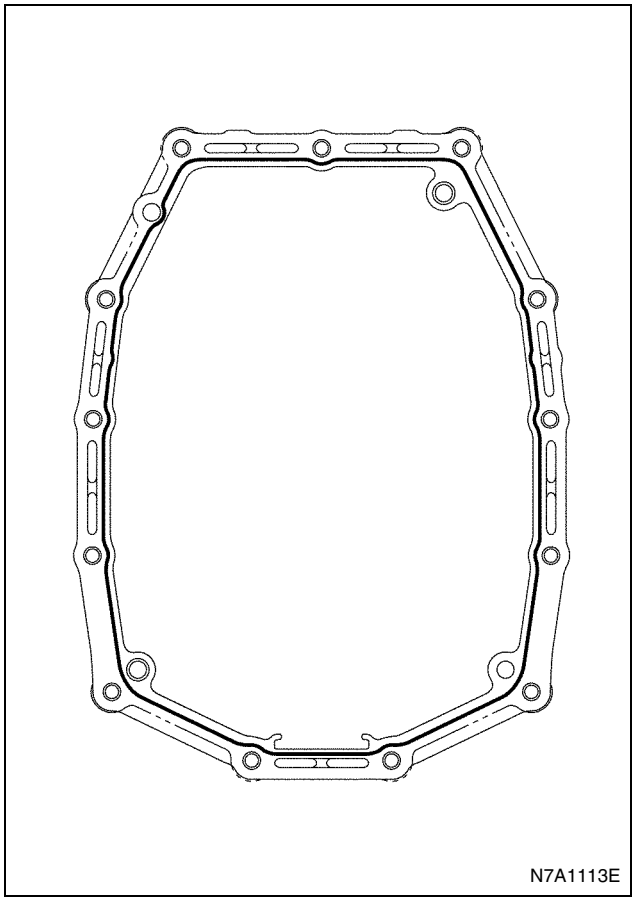


9. Install the 4th-5th and 6th shift rod (1) to the 4th-5th shift arm (3), 1st-reverse and 6th shift block (2).
   - Drive in the spring pin (4) using a hammer after aligning the spring pin hole.
   - When pressing in the spring pin, put a round pole on the opposite side of the shift rod not to damage other parts, and then press in the spring pin.



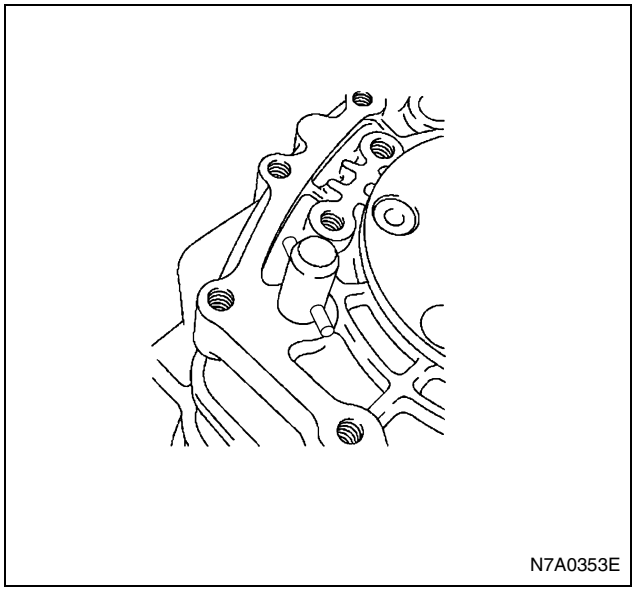
10. Apply ThreeBond 1215 to the mating surface of the transmission case and the clutch housing, and then install the clutch housing.
    - Wipe off moisture and lubricant from the mating surface, and then apply the gasket continuously with a diameter of 2 mm (0.079 in) or more.

Tighten:
Clutch housing to 46 N·m (4.7 kg·m / 34 lb·ft)

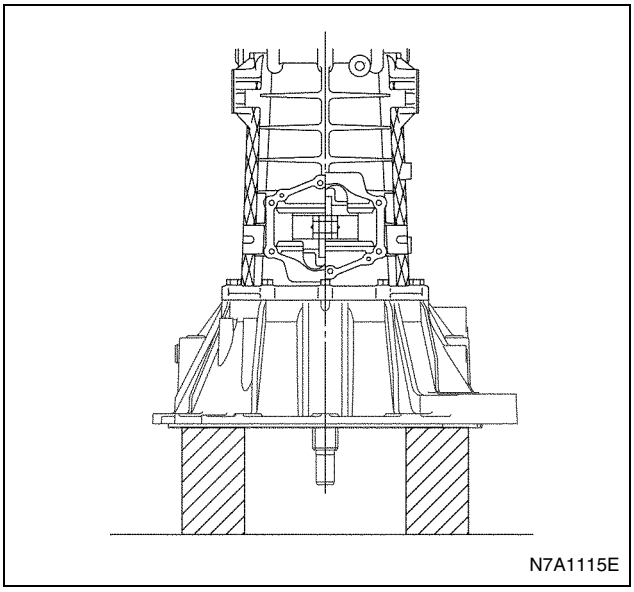


11. Install the bearing rear outer race to the transmission case.
12. Install the spring pin; 4th-5th and 6th shift rod.

Caution:
When the snap ring is deformed or damaged, replace it with a new one, and make sure it is completely installed.



13. Install the shim to the counter shaft rear bearing.
    a. Shift the position to the neutral.
    b. Set the transmission assembly with the clutch housing faced down.


N7A1115E

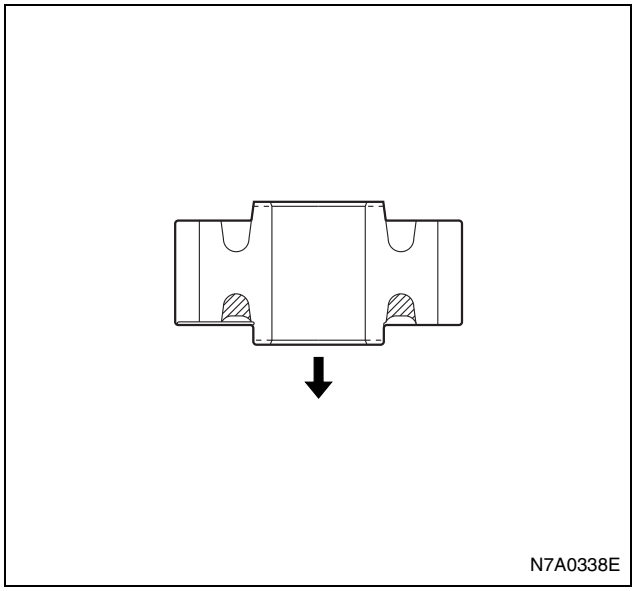
c. Revolve the counter shaft more then 30 times and smooth the taper roller bearing.

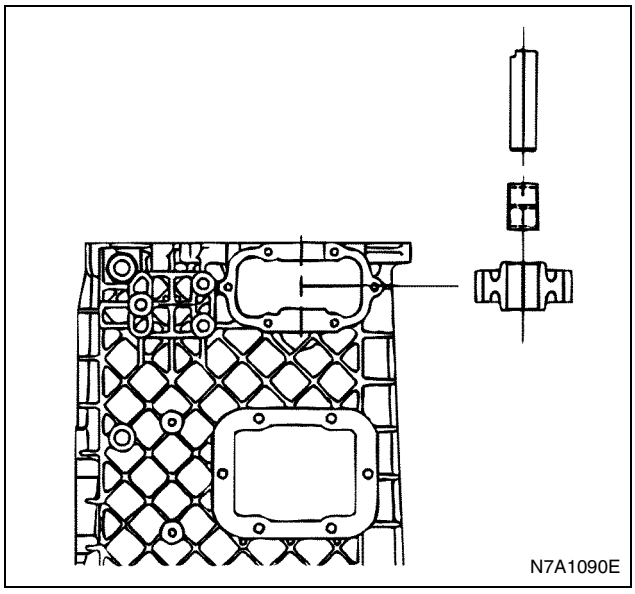
d. Select the counter shim.

- Measure the depth at the points equally divided into three from the end surface of the transmission case to the outer ring edge surface of the counter shaft rear bearing, and then take an average of them.
- Select the shim whose thickness agrees with the list below.

Measured value, mm (in)	Thickness of applicable shim
more than — less than	
3.34 — 3.40 (0.132 — 0.133)	3.19 (0.125)
3.28 — 3.34 (0.130 — 0.131)	3.13 (0.123)
3.22 — 3.28 (0.127 — 0.129)	3.70 (0.120)
3.16 — 3.22 (0.125 — 0.126)	3.01 (0.118)
3.10 — 3.16 (0.122 — 0.124)	2.95 (0.116)
3.04 — 3.10 (0.120 — 0.122)	2.89 (0.113)
2.98 — 3.04 (0.118 — 0.119)	2.83 (0.111)
2.92 — 2.98 (0.115 — 0.117)	2.77 (0.109)
2.86 — 2.92 (0.113 — 0.114)	2.71 (0.106)
2.80 — 2.86 (0.110 — 0.112)	2.65 (0.104)
2.74 — 2.80 (0.108 — 0.110)	2.59 (0.101)
2.68 — 2.74 (0.106 — 0.107)	2.53 (0.099)
2.62 — 2.68 (0.104 — 0.105)	2.47 (0.097)
2.56 — 2.62 (0.101 — 0.103)	2.41 (0.094)
2.50 — 2.56 (0.099 — 0.100)	2.35 (0.092)
2.44 — 2.50 (0.096 — 0.098)	2.29 (0.090)
2.38 — 2.44 (0.094 — 0.096)	2.23 (0.087)
2.32 — 2.38 (0.092 — 0.093)	2.17 (0.085)
2.26 — 2.32 (0.089 — 0.091)	2.11 (0.083)

14. Install the snap ring to the main shaft rear bearing.
15. Apply engine oil 5W-30 to the needle bearing, install the reverse idle gear and needle bearing, and then insert the reverse idle shaft.
    - The arrow mark shows the direction of the transmission front side.


N7A0338E


N7A1090E

16. Install the retainer to the transmission case.

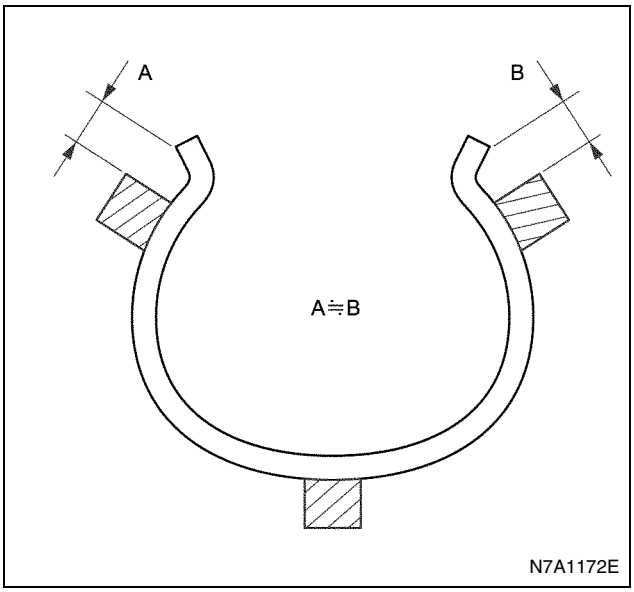
Tighten:
Retainer to 26 N·m (2.7 kg·m / 19 lb·ft)

Caution:
Clean up the sealing agent on the screw thread of the transmission case and replace all screws with new ones.

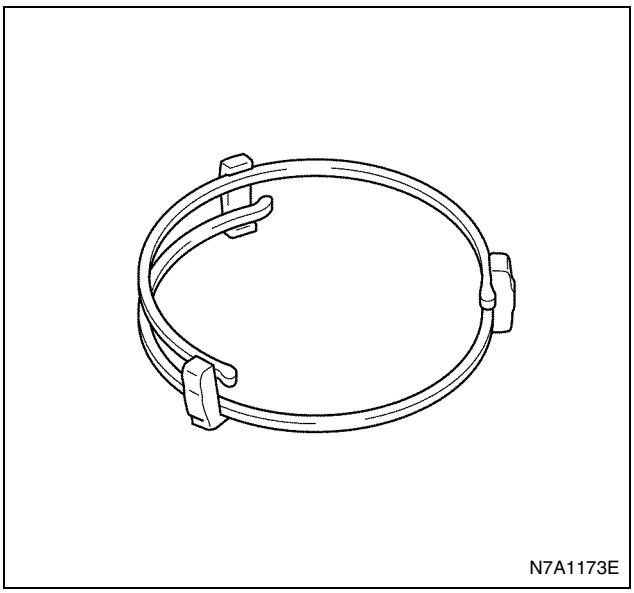
17. Install the collar and the speedometer gear.
18. Assemble the 6th clutch hub assembly (2) and the sleeve (1) following the procedure below.
    a. Assemble the insert (3) securely to the block ring insert groove.
    b. Install the insert spring (4) to the insert.

Caution:

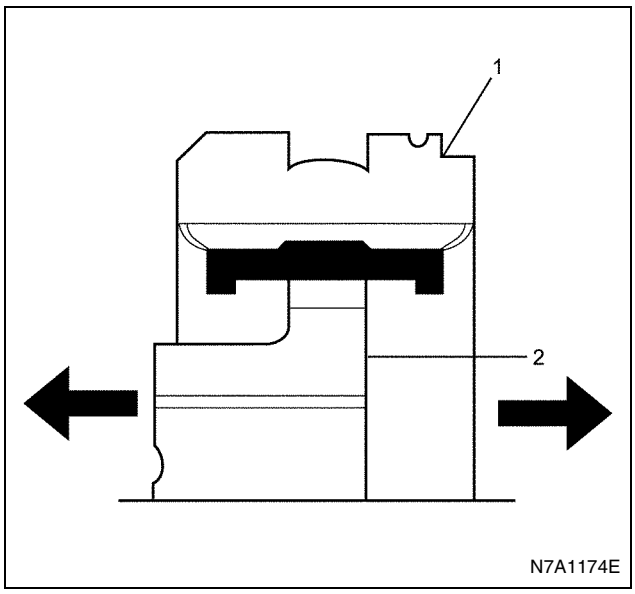
- When assembling the insert spring, equalize the length of the both edges of the spring not to adversely interfere with the inside diameter of the hub.

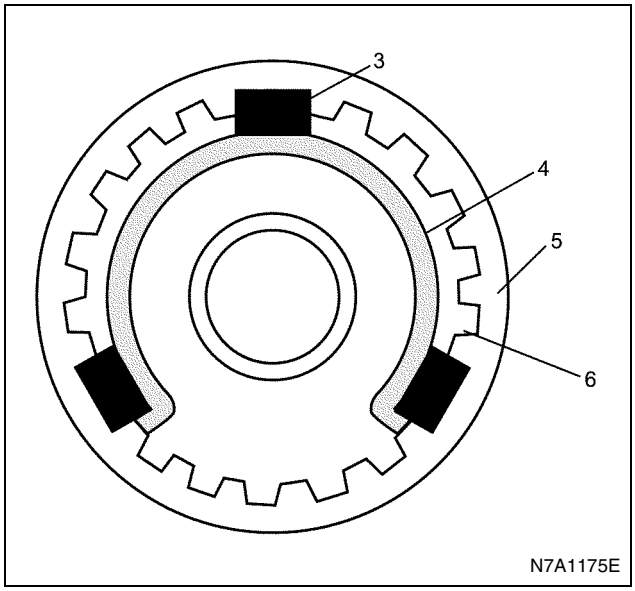


- Make sure that the open part of the insert spring assembled on the reverse side, is not aligned with the open part of the front side.



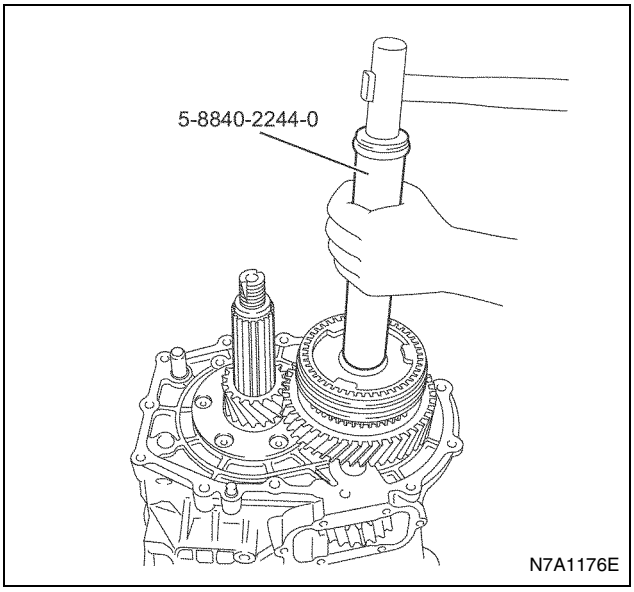
c. Make sure the clutch hub (5) and the sleeve (6) slide smoothly.





d. Install a new stopper plate to the clutch hub.

19. Apply engine oil 5W-30 to the needle bearing and the block ring bore, assemble the 6th gear, the needle bearing and the 6th block ring, align the aspect of the clutch hub block ring groove, assemble the 6th clutch hub assembly and the sleeve, and then press in them using the installer 5-8840-2244-0 and a hammer.



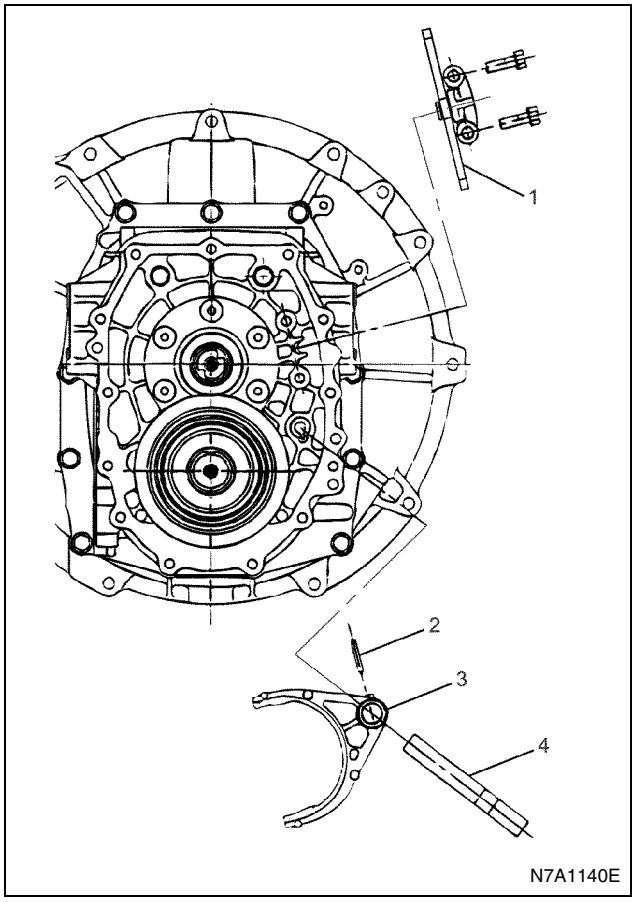
20. Using the snap ring pliers, install the snap ring and the 6th clutch hub.
    - Select the thickest snap ring of the available three.

Thickness, mm (in)	Identification Color
1.7 (0.066)	White
1.8 (0.070)	No color
1.9 (0.074)	Blue

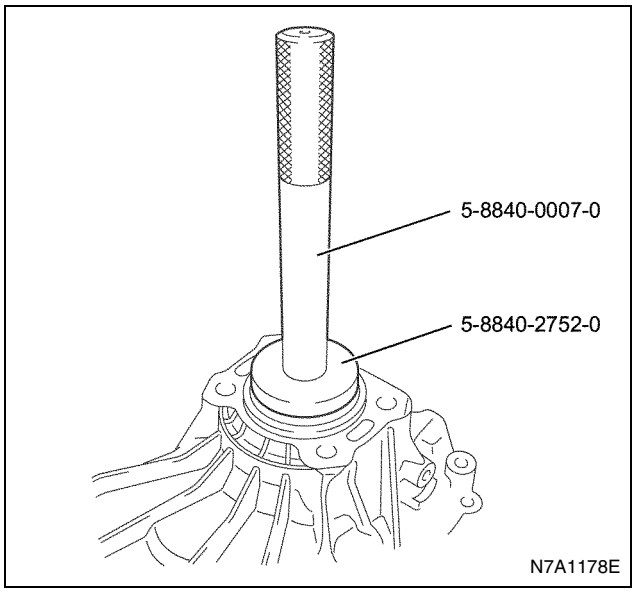
Caution:
When the snap ring is deformed or damaged on installation, replace it with a new one, and make sure it is completely installed.

21. Apply engine oil 5W-30 to the shift rod hole of the transmission case, install the 6th shift arm (3) and 6th shift rod (4), and then press in the spring pin (2) aligning its hole.
22. Install the 6th relay lever (1).

Tighten:
6th relay lever (1) to 44 N·m (4.5 kg·m / 32 lb·ft)



23. Install the needle bearing; main end.
    - Apply Besco L2 grease inside the needle bearing, and apply engine oil 5W-30 to the bearing connecting bore of the rear cover.
    - Press in the needle bearing to the rear cover from outside by turning the bearing stamped surface out and using the installer 5-8840-2752-0 and the grip 5-8840-0007-0.

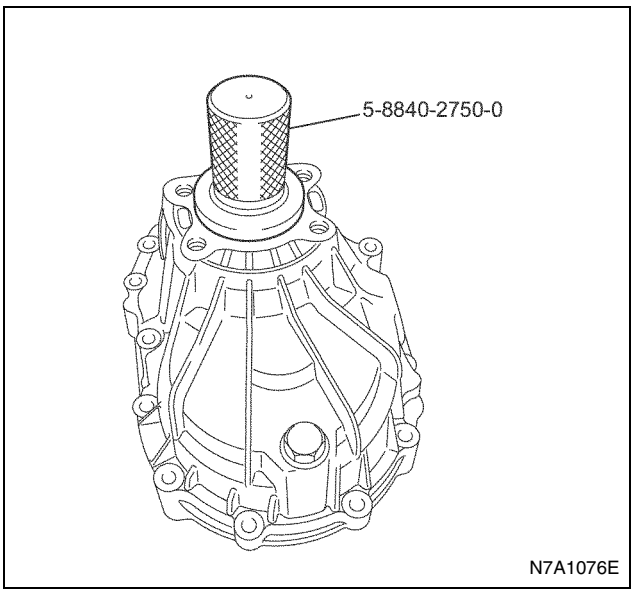


24. When replacing the rear cover oil seal with a new one after checking for wear and damage or when replacing the needle bearing, apply engine oil 5W-

30 around the oil seal, and then press in the oil seal to the rear cover using the installer 5-8840-2750-0.

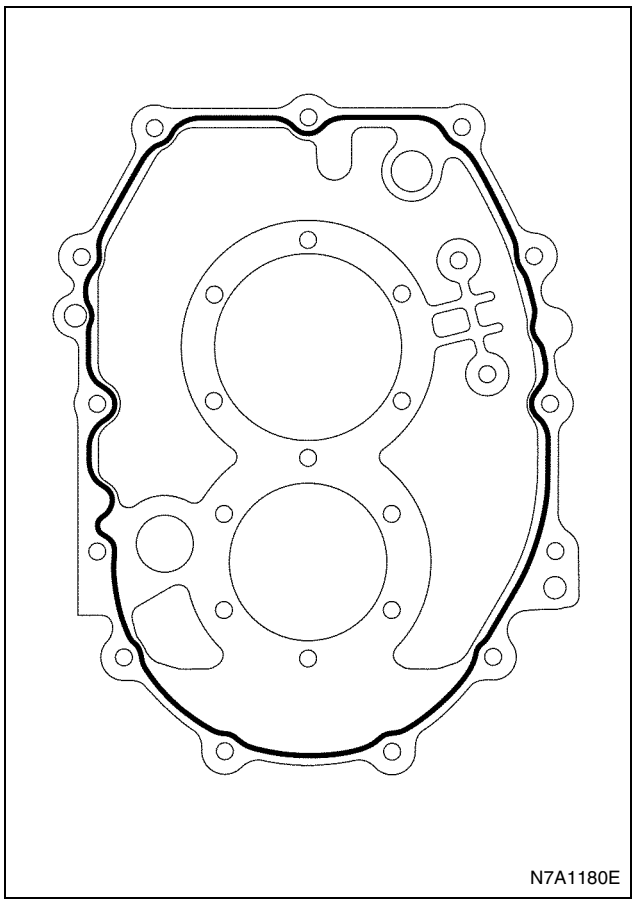
- Apply Besco L2 grease to the lip portion of the oil seal.

Caution:
Be careful not to damage the oil seal lip portion.

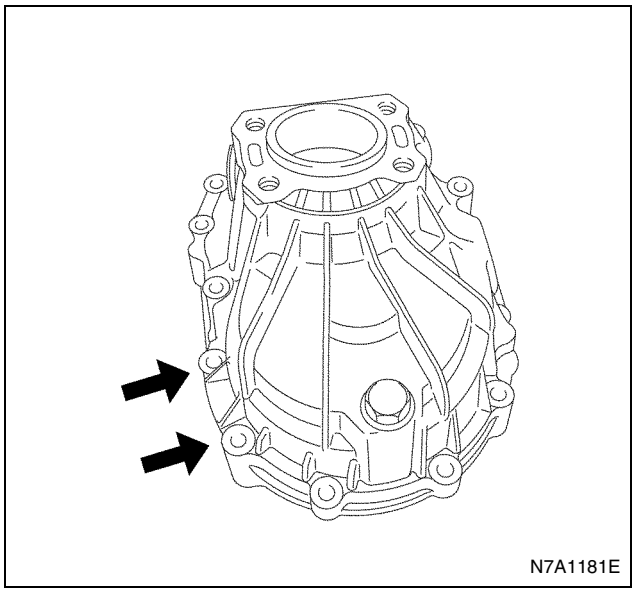


25. Apply ThreeBond 1215 to the mating surface of the transmission case rear cover, and then install the rear cover.
    - Wipe off moisture and lubricant from the connecting surface. And then apply the bond continuously with a diameter of 2 mm (0.079 in).

Tighten:
Rear cover to 46 N·m (4.7 kg·m / 34 lb·ft)

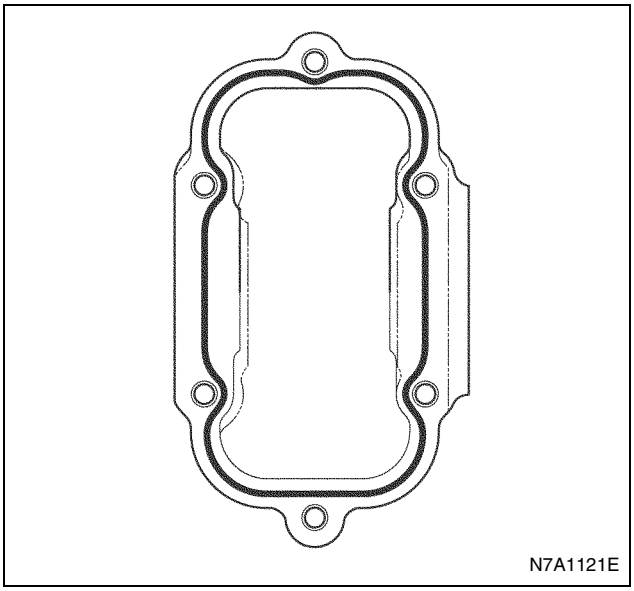


Caution:
Since the two bolts with arrow marks are installed with LOCTITE sealing agent, clean up the sealing agent remaining on the screw thread of the transmission case, and then use new bolts with LOCTITE sealing agent.



26. Apply ThreeBond 1215 to the mating surface of the transmission case reverse idle cover, and then install the reverse idle cover.
    - Wipe off moisture and lubricant from the mating surface. And then apply the bond continuously with a diameter of 2 mm (0.079 in) or more.

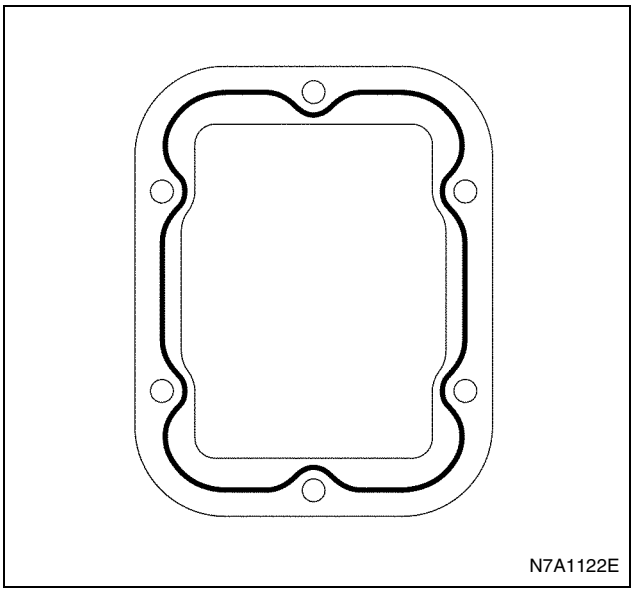
Tighten:
Reverse idle cover to 20 N·m (2.0 kg·m / 15 lb·ft)


N7A1121E

27. Apply ThreeBond 1215 to the mating surface of the transmission case PTO cover, and then install the PTO cover.
    - Wipe off moisture and lubricant from the connecting surface before applying it as a more than 2 mm (0.079 in) diameter solid line.

Tighten:
PTO cover to 37 N·m (3.8 kg·m / 27 lb·ft)

Caution:
Since the bolt is installed with LOCTITE sealing agent, clean up the sealing agent remaining on the screw thread of the transmission case, and then use a new bolt with LOCTITE sealing agent.

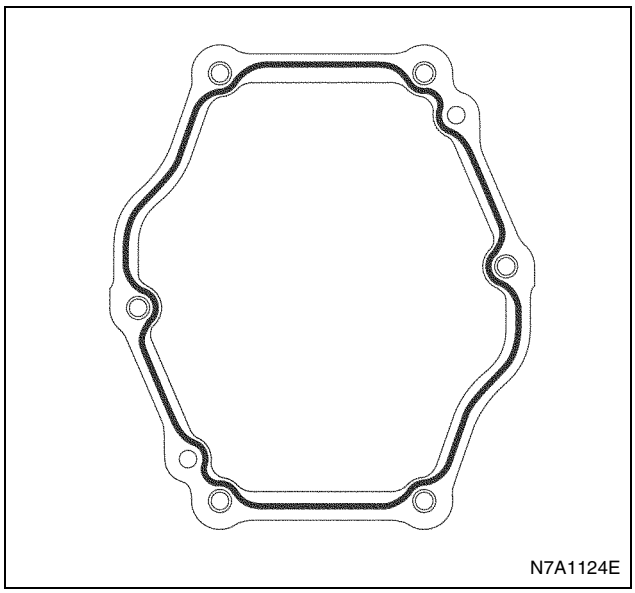

N7A1122E

28. Shift the position to the neutral, apply ThreeBond 1215 to the mating surface of the transmission case control box, and then install the interlock plate (8) and the control box (1).

Tighten:
Control box (1) to 27 N·m (2.8 kg·m / 20 lb·ft)

- Wipe off moisture and lubricant from the mating surface. And then apply the bond continuously with a diameter of 2 mm (0.079 in) or more.

Caution:
Since the bolt is installed with LOCTITE sealing agent, clean up the sealing agent remaining on the screw thread of the transmission case, and then use a new bolt with LOCTITE sealing agent.


N7A1124E

29. Install the detent assembly (7) (6) (5) (4) after cleaning up the sealing on the thread and applying the LOCTITE 242.

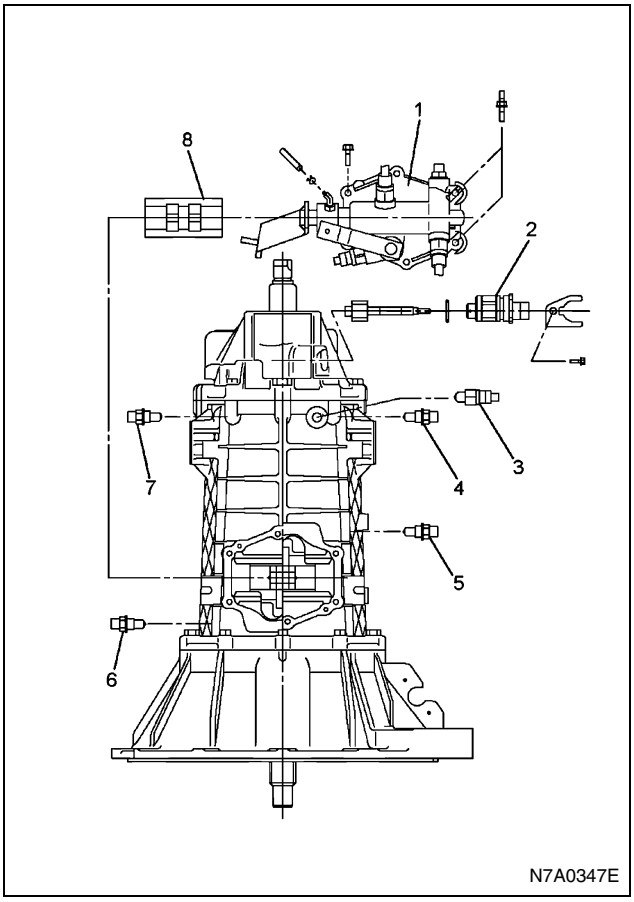
Tighten:
Detent assembly (7) (6) (5) (4) to 27 N·m (2.8 kg·m / 20 lb·ft)

30. Apply LOCTITE 242 to the reverse switch thread portion, and then install the reverse switch (3).

Tighten:
Reverse switch (3) to 39 N·m (4.0 kg·m / 29 lb·ft)

31. Apply engine oil 5W-30 to the speedometer driven gear and the O-ring, and then install the speedometer driven gear (2).

Tighten:
Speedometer driven gear (2) to 20 N·m (2.0 kg·m / 15 lb·ft)



32. Apply engine oil 5W-30 to the O-ring, and then install the drain plug and the O-ring.

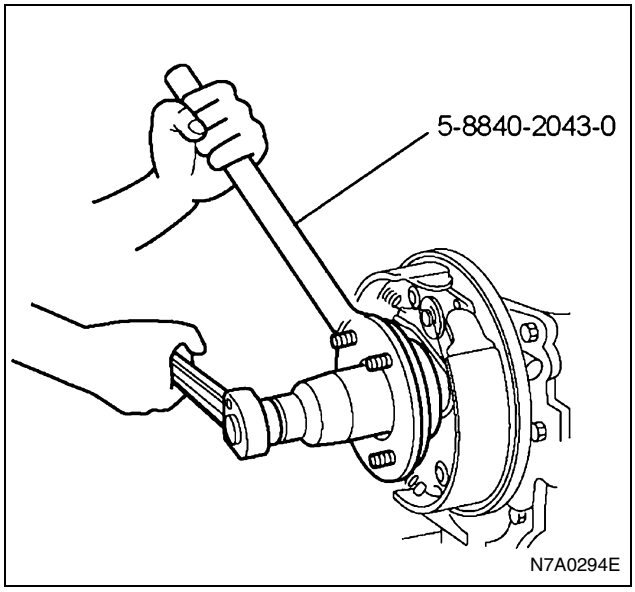
Tighten:
Drain plug to 39 N·m (4.0 kg·m / 29 lb·ft)

33. Apply engine oil 5W-30 to the O-ring, and then install the filler plug and the O-ring.

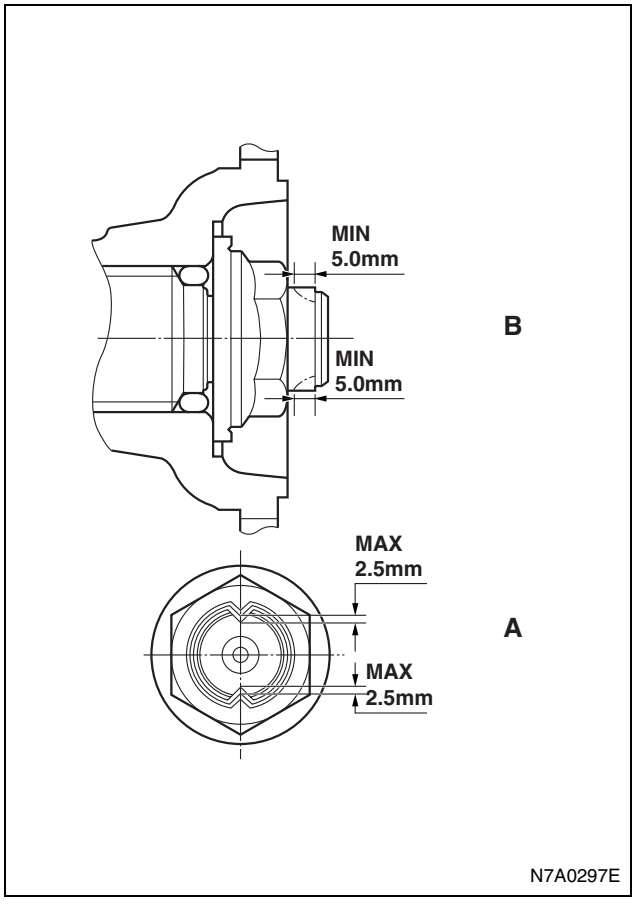
Tighten:
Filler plug to 39 N·m (4.0 kg·m / 29 lb·ft)

34. Install the parking brake assembly.
    - Refer to PARKING BRAKE ASSEMBLY.
35. Apply engine oil 5W-30 to the O-ring, and then install the coupling driver and the O-ring.
36. Use a new lock nut, apply engine oil 5W-30 to the seat, and then fix the lock nut using the flange holder 5-8840-2043-0.

Tighten:
Lock nut to 289 N·m (29.5 kg·m / 213 lb·ft)



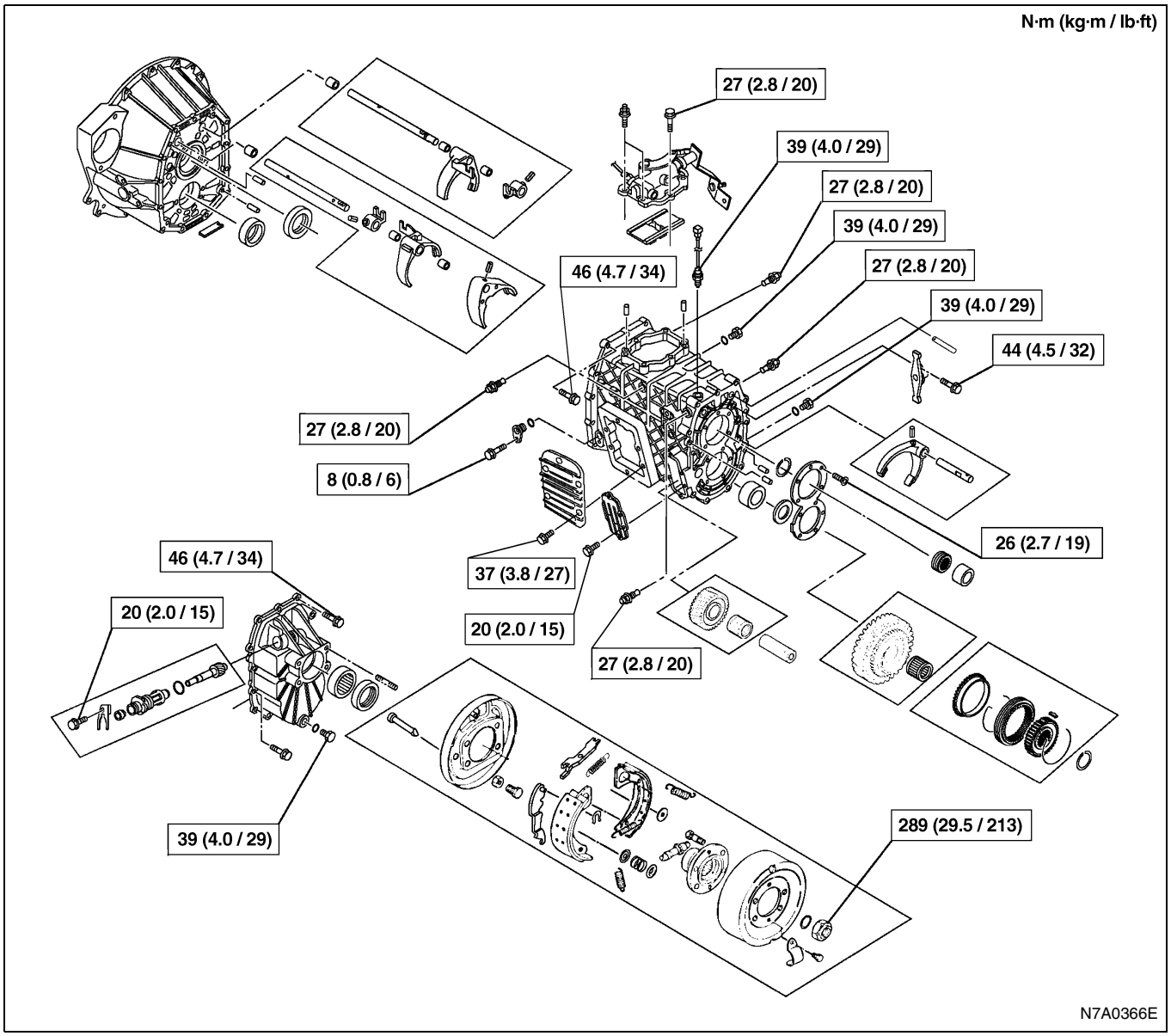
- After fixing it to the specified torque, align the lip part of the nut to the V-groove of the shaft edge. Securely caulk the two parts of the nut lip using a chisel whose tip form is approx. 1 mm (0.04 in) radius by 60°, to make a length (B) of 5 mm (0.2 in) or more, and a clearance between the bottom of the shaft and the nut lip (A) of 2.5 mm (0.06 in) or less.



37. Install the parking brake drum and adjust hole cover fixing bolt.
    - Refer to PARKING BRAKE ASSEMBLY.

38. Install the shift fork and the support bolt.
    - Refer to CLUTCH.
39. Install the shift block assembly.
    - Refer to CLUTCH.

Fixing Torque



Special Tools

Illustration	Tool Number / Description / Remarks
5884000070	5-8840-0007-0 / Grip

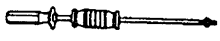
Illustration	Tool Number / Description / Remarks
 5884000840	5-8840-0084-0 / Sliding Hammer

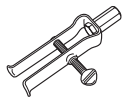
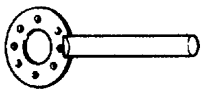
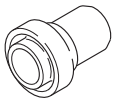
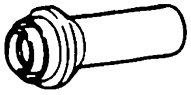
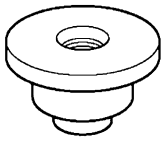
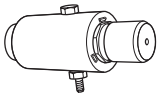
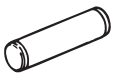
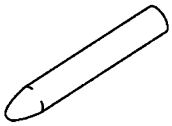
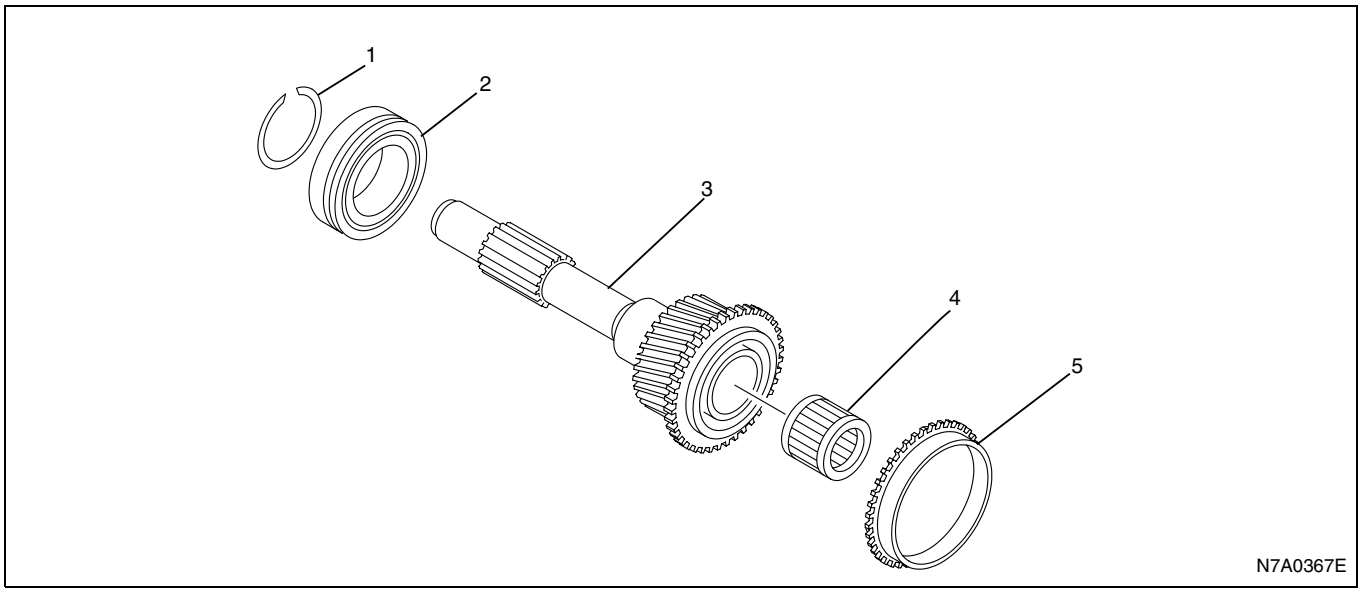
Illustration	Tool Number / Description / Remarks
 5884000270	5-8840-0027-0 / Bearing Remover
 5884020430	5-8840-2043-0 / Flange Holder
 5884025580	5-8840-2558-0 / Oil Seal Installer
 5884027500	5-8840-2750-0 / Oil Seal Installer
 5884027520	5-8840-2752-0 / Bearing Installer
 5884027550	5-8840-2755-0 / Bush Remover & Installer
 5884022440	5-8840-2244-0 / Bearing Installer

Illustration	Tool Number / Description / Remarks
 5884027930	5-8840-2793-0 / Oil Seal Protector

Top Gear Shaft

Components



Legend

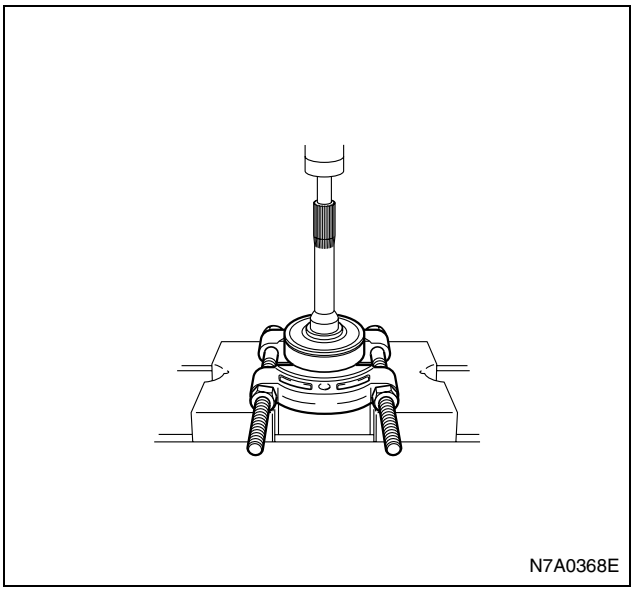
1. Snap ring
2. Bearing
3. Top gear shaft
4. Needle bearing
5. Block ring

Disassembly

1. Remove the block ring from the top gear shaft.
2. Remove the needle bearing from the top gear shaft.

Caution:
As the needle bearing is of separation type, make sure not to drop and damage the roller.

3. Remove the snap ring using snap ring pliers.
4. Remove the bearing by a press using a bearing remover.

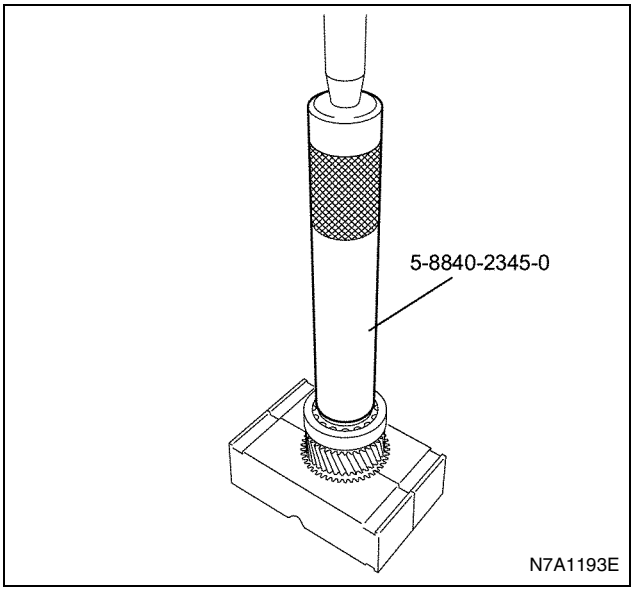


Inspect each part. If any wear, damage or other abnormality is found, repair or replace the part.

5. Inspect the gear tooth, spline part and the sliding part of the top for damage and wear. If any abnormality is found, replace them with new ones.
6. Inspect each bearing regarding the following items. If any abnormality is found, replace it with a new one.
   - Smoothness of rotation
   - Noise
   - Abnormal external appearance, including damage, rust, etc.
   - Abnormal free play in thrust direction
   - Discoloration, excessive wear and pitching of the rolling body and surface of the needle bearing

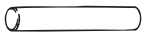
Assembly

1. Press the bearing using the installer 5-8840-2345-0.



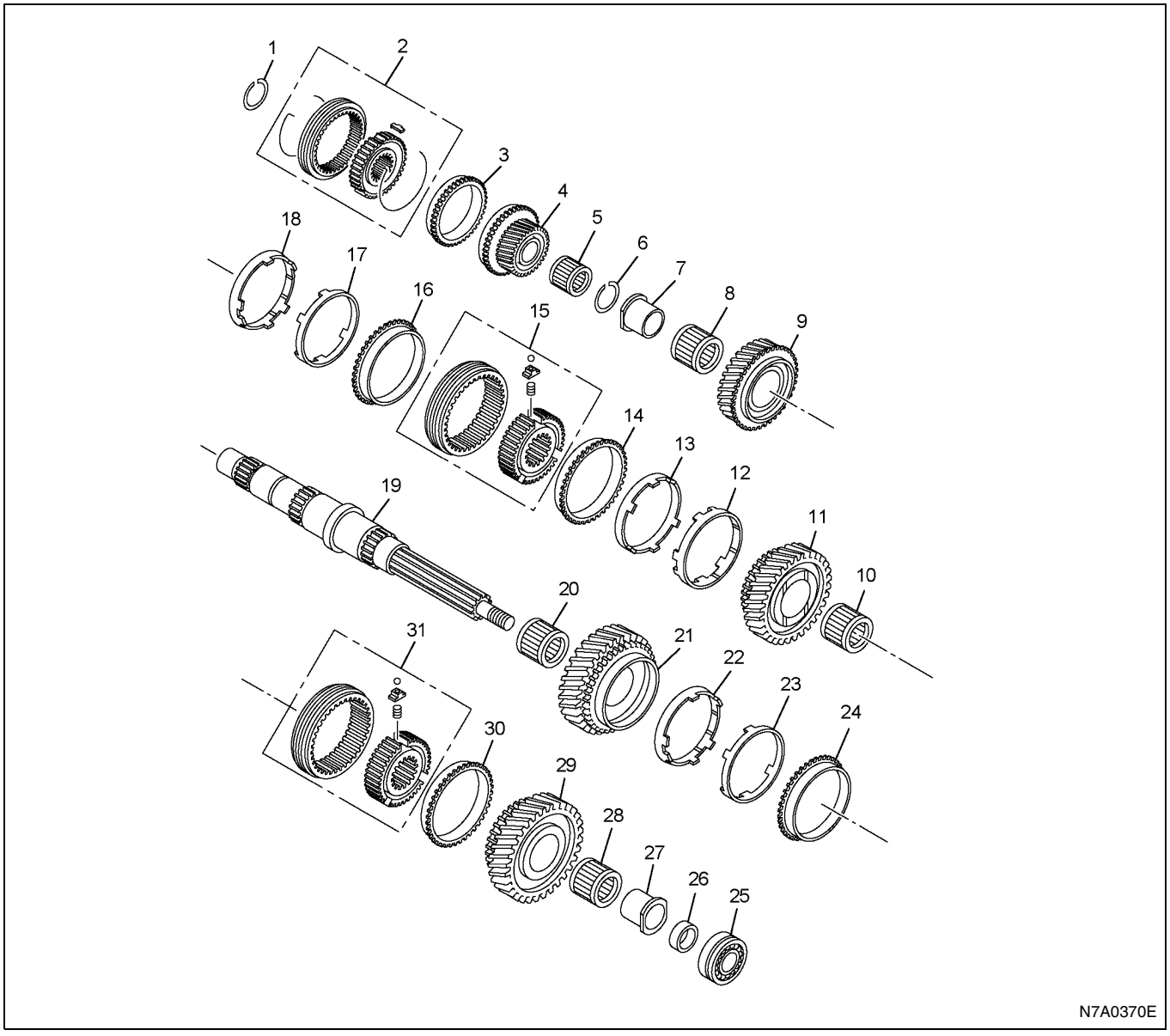
2. Install the snap ring using snap ring pliers.
3. Install the needle bearing to the top gear shaft.
4. Apply engine oil 5W-30 sufficiently to the internal surface of the block ring, and install the block ring to the top gear shaft.

Special Tools

Illustration	Tool Number / Description / Remarks
 5884023450	5-8840-2345-0 / Clutch Hub & Collar Installer

Main Shaft (5MT)

Components

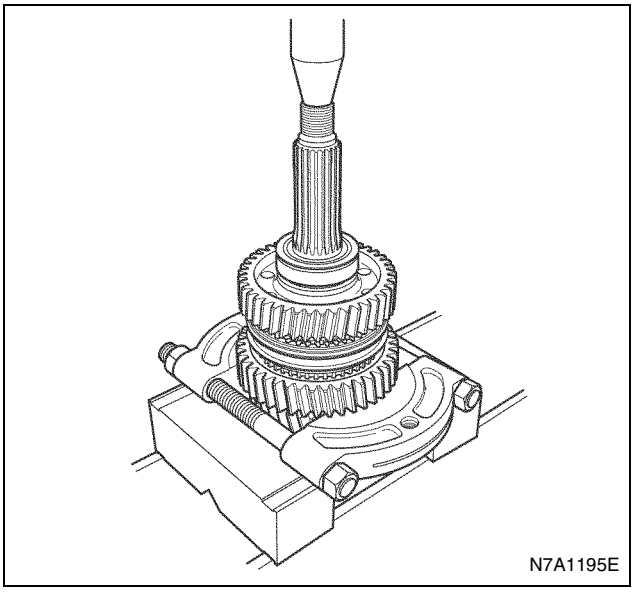


Legend

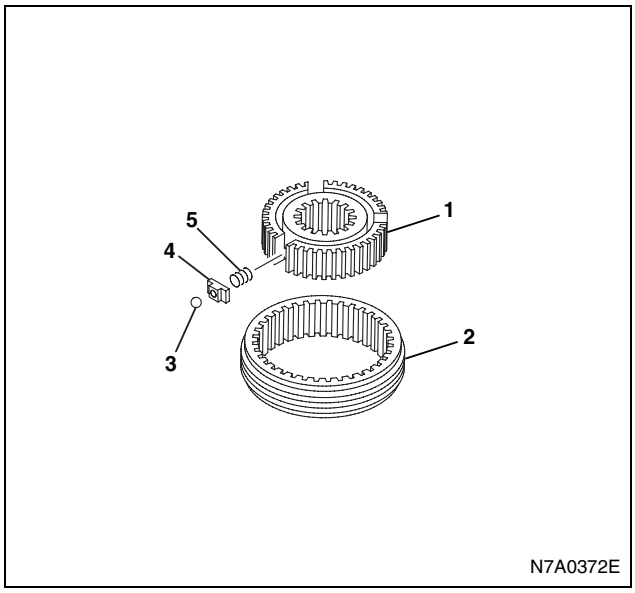
1. Snap ring
2. 4th-5th clutch hub assembly and sleeve
3. 5th block ring
4. 5th gear
5. Needle bearing
6. Snap ring
7. Collar
8. Needle bearing
9. 3rd gear
10. Needle bearing
11. 2nd gear
12. 2nd inside ring
13. 2nd outside ring
14. 2nd block ring
15. 2nd-3rd clutch hub assembly and sleeve
16. 3rd block ring
17. 3rd outside ring
18. 3rd inside ring
19. Main shaft
20. Needle bearing
21. 1st gear
22. 1st inside ring
23. 1st outside ring
24. 1st block ring
25. Bearing
26. Spacer
27. Collar
28. Needle bearing
29. Reverse gear
20. Reverse block ring
31. 1st-reverse clutch hub assembly & sleeve

Disassembly

1. Remove simultaneously the following parts with a press using a bearing remover; the bearing, spacer, collar, reverse gear, needle bearing, reverse block ring, 1st-reverse clutch hub assembly & sleeve, 1st block ring, 1st outside ring, 1st inside ring, 1st gear, and needle bearing.


N7A1195E

2. Disassemble the 1st-reverse clutch hub & sleeve.

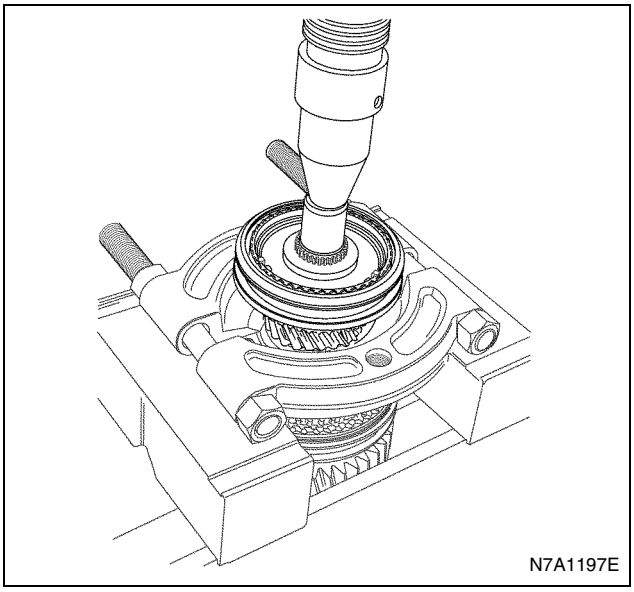


N7A0372E

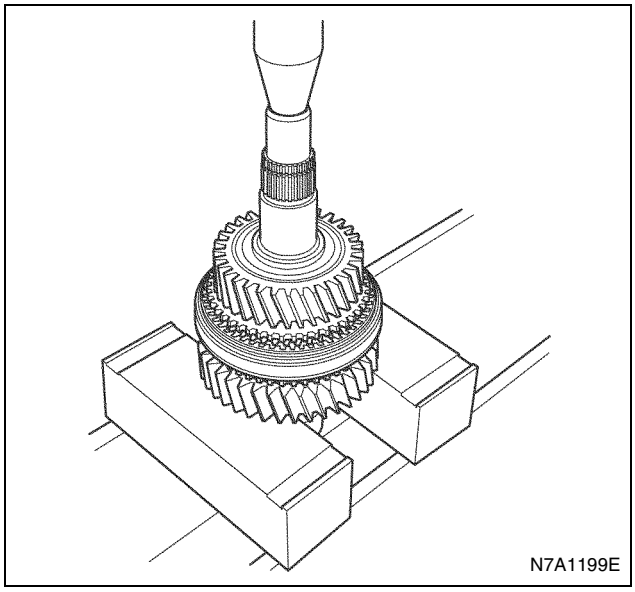
Legend

1. Clutch hub
2. Sleeve
3. Ball
4. Block
5. Spring

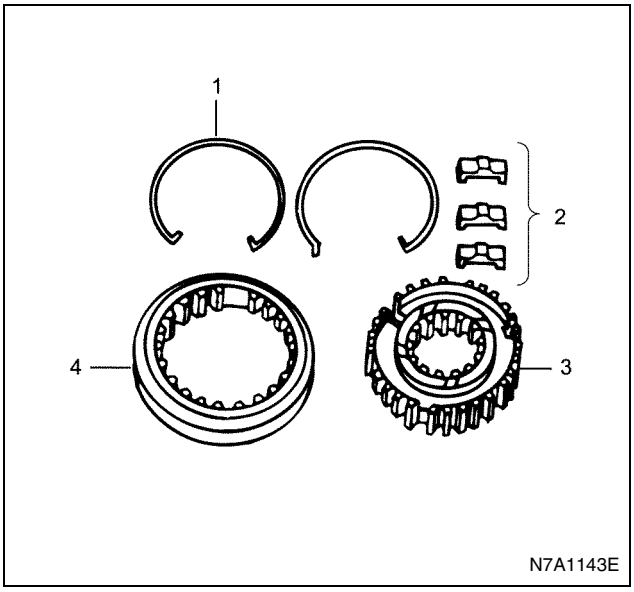
3. Remove the 4th-5the clutch hub assembly fixing snap ring using snap ring pliers.
4. Remove simultaneously the following parts with a press using a bearing remover; the 4th-5th clutch hub assembly & sleeve, 5th block ring, 5th gear, needle bearing.



5. Disassemble the 4th-5th clutch hub assembly & sleeve.



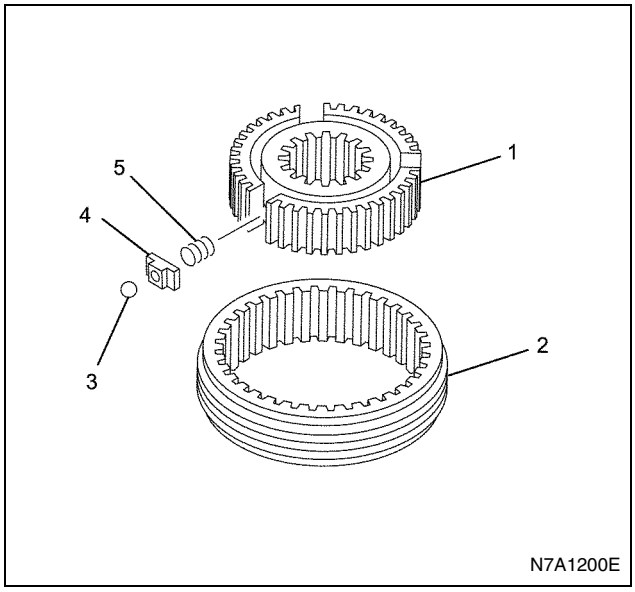
8. Disassemble the 2nd-3rd clutch hub assembly & sleeve.



Legend

1. Spring
2. Insert
3. Clutch hub
4. Sleeve

6. Remove the 3rd gear collar fixing snap ring using snap ring pliers.
7. Remove simultaneously from the main shaft the following parts with a press using a bearing remover; the collar, 3rd gear, needle bearing, 3rd inside ring, 3rd outside ring, 3rd block ring, 2nd-3rd clutch hub assembly & sleeve, 2nd block ring, 2nd outside ring, 2nd inside ring, 2nd gear, and needle bearing.



Legend

1. Clutch hub
2. Sleeve
3. Ball
4. Block
5. Spring

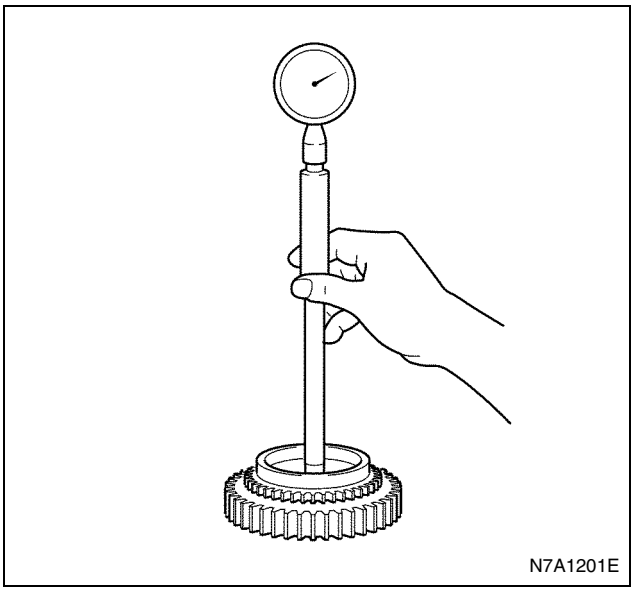
Inspect each part, and if any wear, damage and other abnormality is found, repair or replace the item.

9. Inspect each bearing with respect to the following items, and if any abnormality is found, replace the part.
   - Smoothness of rotation
   - Noise
   - Abnormal external appearance, including damage, rust, etc.

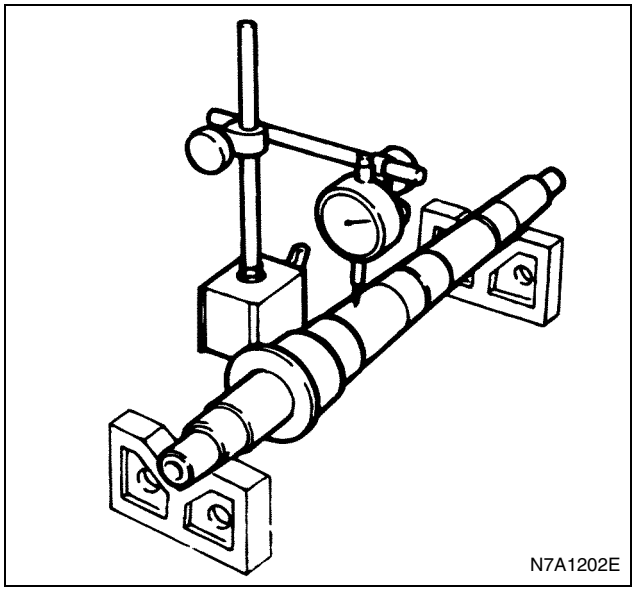
- Abnormal free play in thrust direction

10. Inspect the internal diameter of the gear.
    - Measure the inside diameter of each gear using an inside dial gauge.
    - If the measured value exceeds the limit, replace the gear.

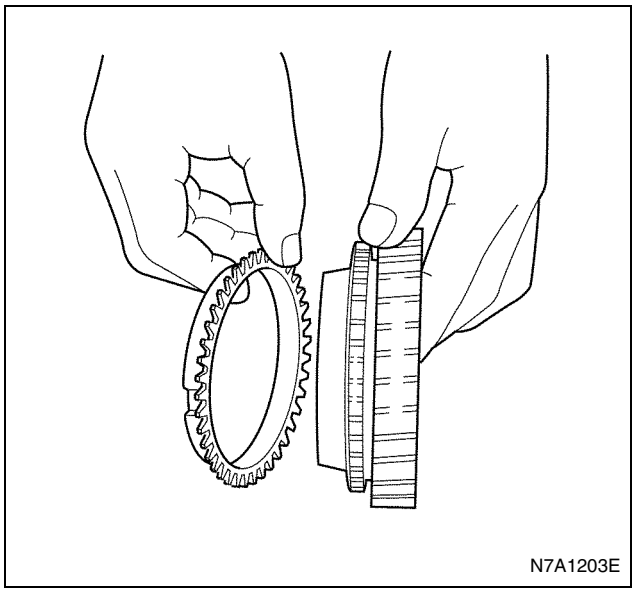
Gear Internal Diameter, mm (in)		
	Standard	Limit
5th gear	44.009 — 44.025 (1.732 — 1.733)	44.065 (1.734)
3rd gear	63.010 — 63.029 (2.480 — 2.481)	63.069 (2.483)
2nd gear	63.010 — 63.029 (2.480 — 2.481)	63.069 (2.483)
1st gear	63.010 — 63.029 (2.480 — 2.481)	63.069 (2.483)
Reverse Gear	63.010 — 63.029 (2.480 — 2.481)	63.069 (2.483)


N7A1201E

11. Main shaft deflection
    - Measure the deflection of the main shaft using a dial gauge.
    - If the measured value exceeds the limit, replace the main shaft.
      Standard: 0.015 mm (0.000059 in)
      Limit: 0.1 mm (0.00393 in)

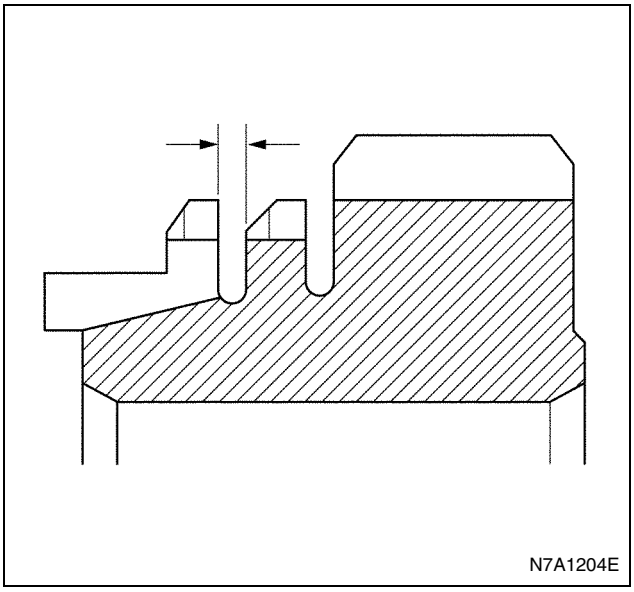

N7A1202E

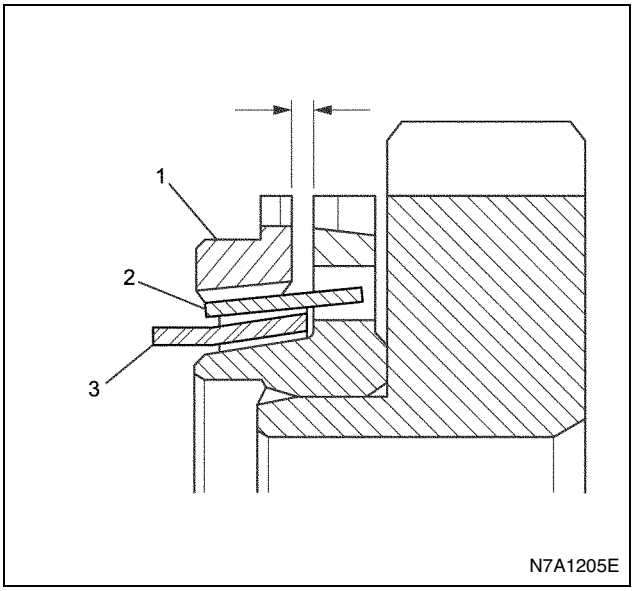
12. Inspect the synchromesh system.
    - Inspect the components, and repair light stepped wear and damage using an oil stone or a pencil grinder.


N7A1203E

13. Clearance between block ring and dog gear
    - Measure the clearance using a thickness gauge.
    - If the measured value exceeds the limit, replace the block gear.

Clearance between Block Ring and Dog Gear, mm (in)		
	Standard	Limit
4th / 5th / Reverse	1.30 — 2.60 (0.051 — 0.102)	0.5 (0.019)
2nd / 3rd	1.00 — 2.50 (0.039 — 0.098)	0.5 (0.019)
1st	1.00 — 2.50 (0.039 — 0.098)	0.5 (0.019)


N7A1204E



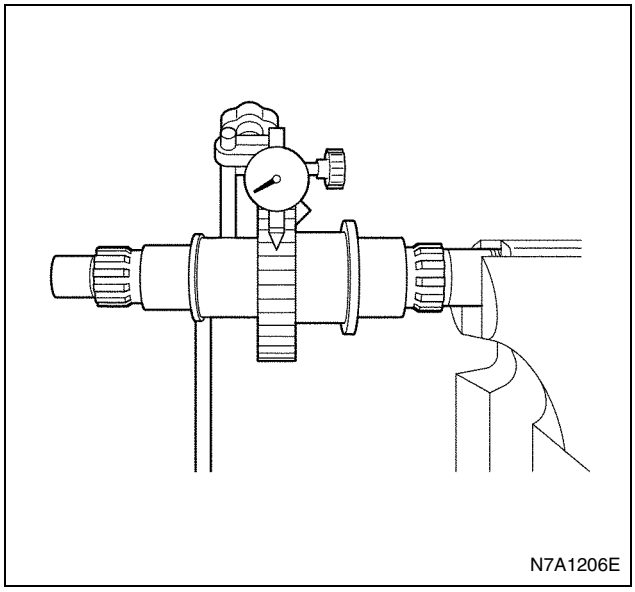
N7A1205E

Legend

1. Block ring
2. Outside ring
3. Inside ring

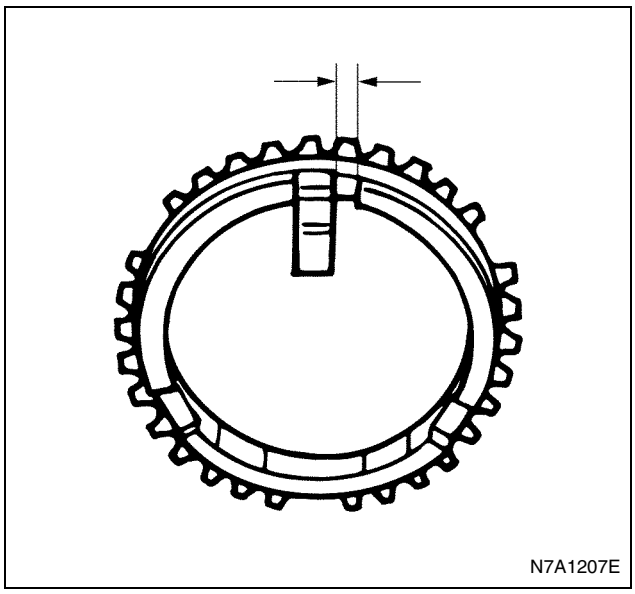
14. Inspect the sliding part, spline part, inserting part and insert groove of the clutch hub and sliding sleeve for wear and damage.
15. Measure the free play in the direction of spline rotation on the clutch hub external circumference.
    - If the measured value exceed the limit, replace the part.

Spline Free Play, mm (in)	
Standard	Limit
0 — 0.05 (0 — 0.0019)	0.3 (0.0118)


N7A1206E

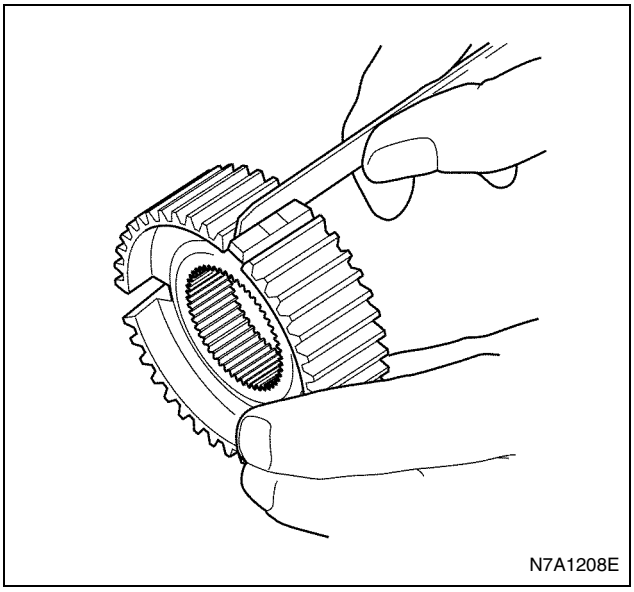
16. Measure the clearance between the insert and block ring groove using a caliper.
    - If the measured value exceeds the limit, replace the insert and block ring.

Clearance between Insert and Block Ring Groove, mm (in)	
	Standard
4th / 5th	3.46 — 3.76 (0.136 — 0.148)


N7A1207E

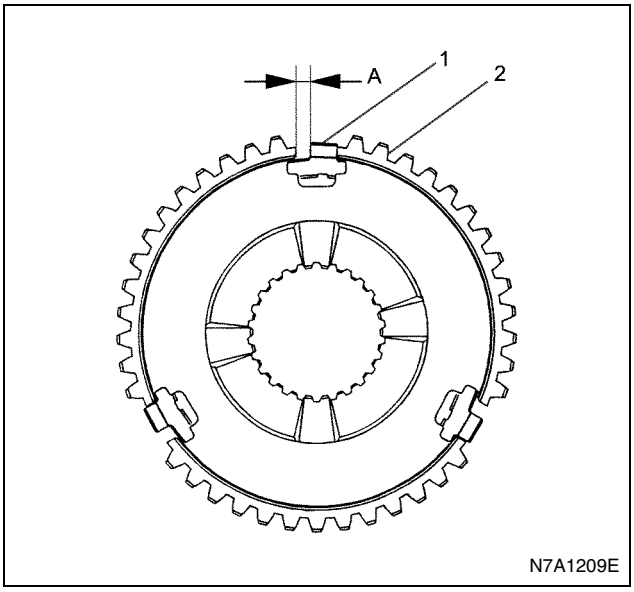
17. Measure the clearance between the insert and clutch hub using a thickness gauge.
    - If the measured value exceeds the limit, replace the insert and clutch hub.

Clearance between Insert and Clutch Hub, mm (in)	
	Standard
4th / 5th	0.01 — 0.21 (0.00039 — 0.00826)


N7A1208E

18. Measure the clearance A between the block ring and the clutch hub using a thickness gauge.
    - If the measured value exceeds the limit, replace the block and clutch hub.

Clearance between Block Ring and Clutch Hub, mm (in)	
	Standard
2nd / 3rd	4.30 — 4.70 (0.16929 — 0.18503)
1st / Reverse	4.30 — 4.70 (0.16929 — 0.18503)



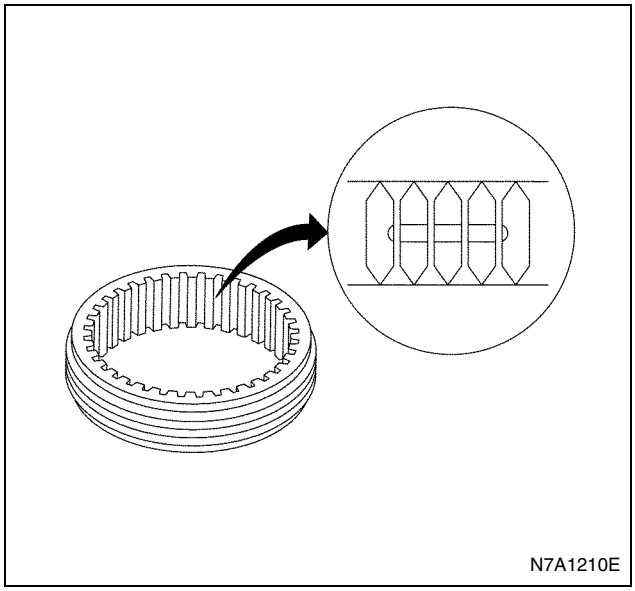
N7A1209E

Legend
1. Block ring
2. Clutch hub

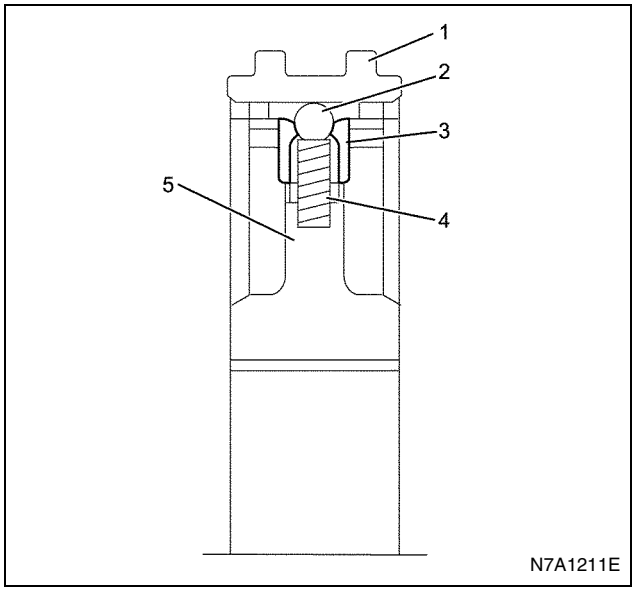
Assembly

- Clean up each part.
- Set the main shaft in a vise, with the long spline part at the bottom. When setting the main shaft, make sure not to damage the grind surface.

1. Assemble the 2nd-3rd clutch hub assembly & sleeve following the procedure below.
   a. Install the block and sleeve to the clutch hub.
   b. Inside the sleeve, there are three ball grooves. Align the phase to let the ball enter the center of the ball grooves.


N7A1210E

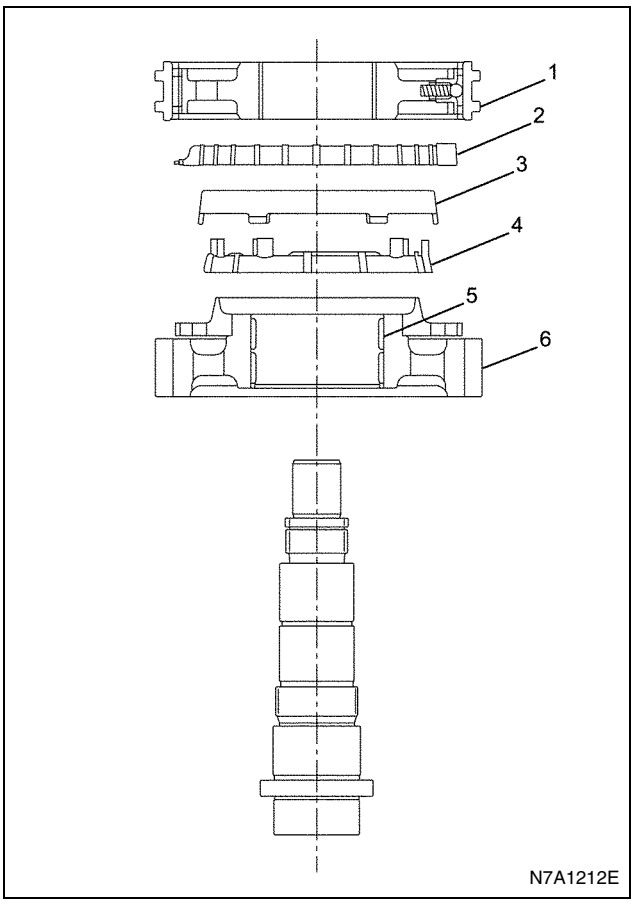
   c. Insert sleeve (1) until the clutch hub (5) slightly overlaps the block.
   d. Securely insert the sleeve until the ball enters the ball groove of the sleeve by pushing the ball (2), block (3) and spring (4).



N7A1211E

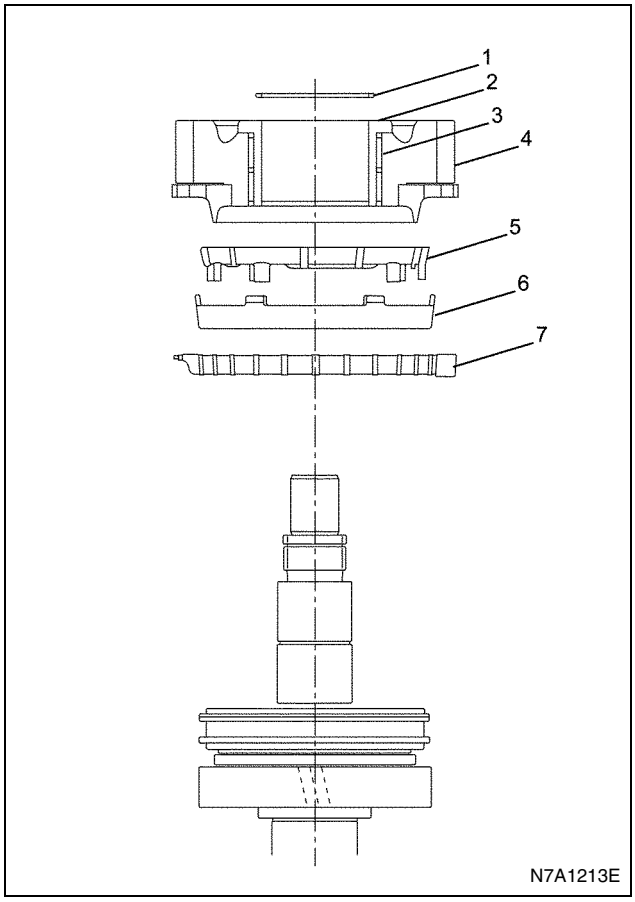
2. Apply engine oil 5W-30 to the needle bearing, 2nd gear thrust surface and synchro cone taper surface. And install the 2nd gear (6) and needle bearing (5) to the main shaft with the dog gear turned upward.

3. Install the 2nd inside ring (4), 2nd outside ring (3) and 2nd block ring (2) inserting the nail of the outside ring into the gear hole of the 2nd gear. At this time, make sure to apply engine oil 5W-30 sufficiently to the both sides of the inside ring and outside ring, and inside diameter surface of the block ring.
4. Insert the 2nd-3rd clutch hub assembly & sleeve with a press using the installer 5-8840-2345-0, setting the six nails of the inside ring to enter the six holes of the hub.



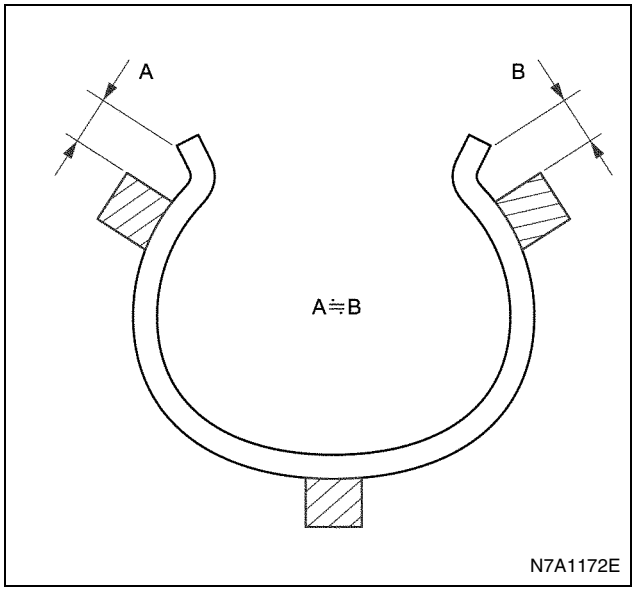
5. During installation, set the six nails of the inside ring of the 3rd block ring (7), 3rd outside ring (6) and 3rd inside ring (5) to enter the six hub holes respectively. At this time, apply engine oil 5W-30 sufficiently to the inside surface of the outside ring and the inside diameter surface of the block ring.
6. Apply engine oil 5W-30 to the needle bearing, 3rd gear thrust surface and synchro cone taper. Turn the dog gear downward, and insert the 3rd gear (4), needle bearing (3) and collar (2) with a press using the installer 5-8840-2345-0, setting the nail of the outer ring to enter the dog gear hole of the 3rd gear.
7. Install the snap ring (1) using snap ring pliers.

Caution:
Replace deformed or damaged snap rings with new ones. Check that the parts are securely installed.

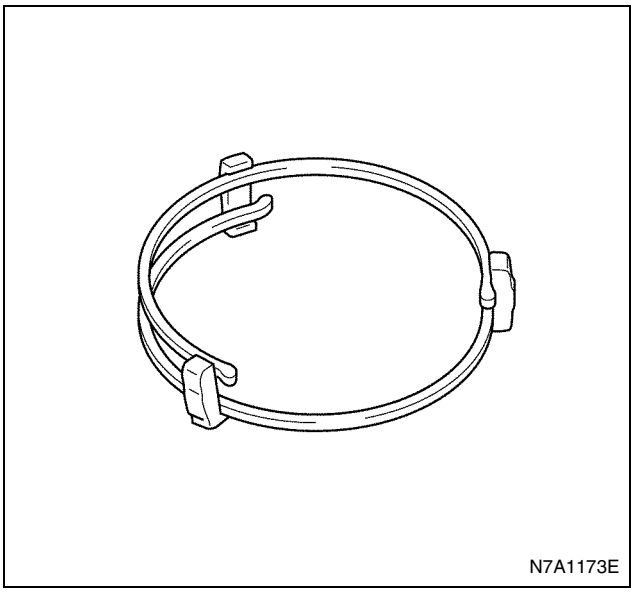


8. Assemble the 4th-5th clutch hub assembly & sleeve following the procedure below.
   a. Assemble securely the insert (2) to the insert groove of the block ring.
   b. Install the insert spring (3) to the insert.

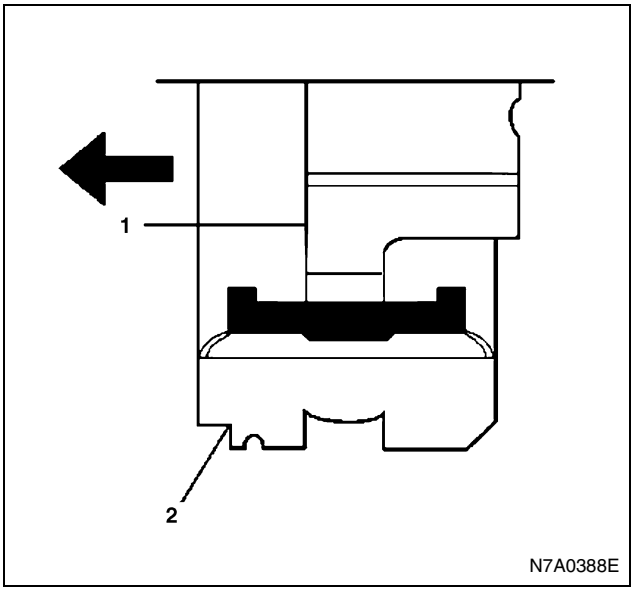
Caution:
- When assembling the insert spring, equalize the length of the both edges of the spring not to adversely interfere with the inside diameter of the hub.



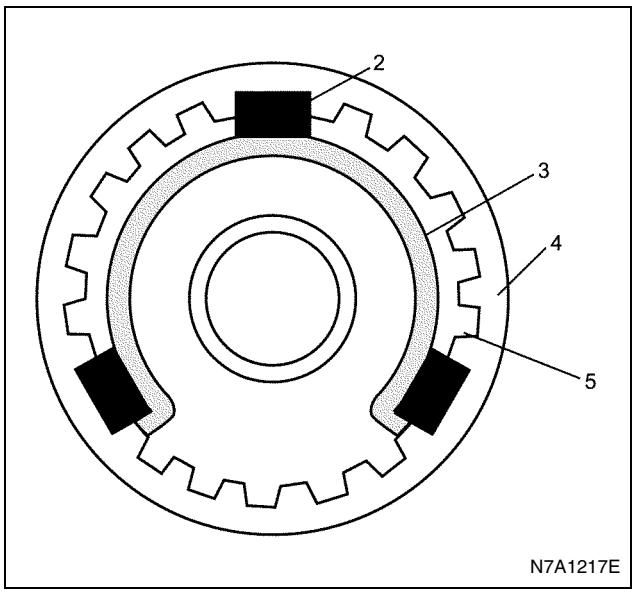
- Make sure that the open part of the insert spring assembled on the reverse side, is not aligned with the open part of the front side.


N7A1173E

c. Check that the clutch hub (5) and sleeve (4) are smoothly sliding.
   - The arrow (1) indicates the front side of the transmission.



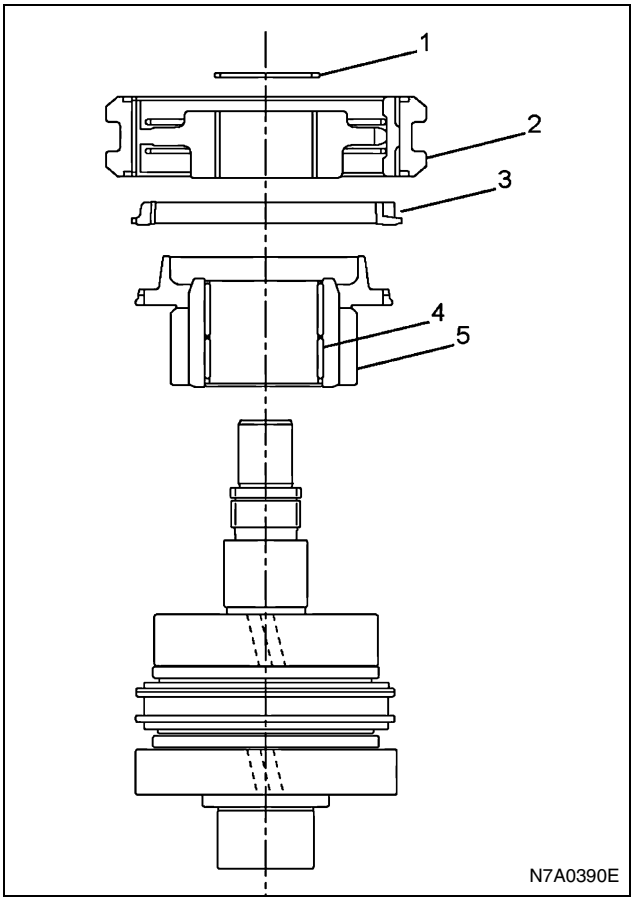
N7A0388E



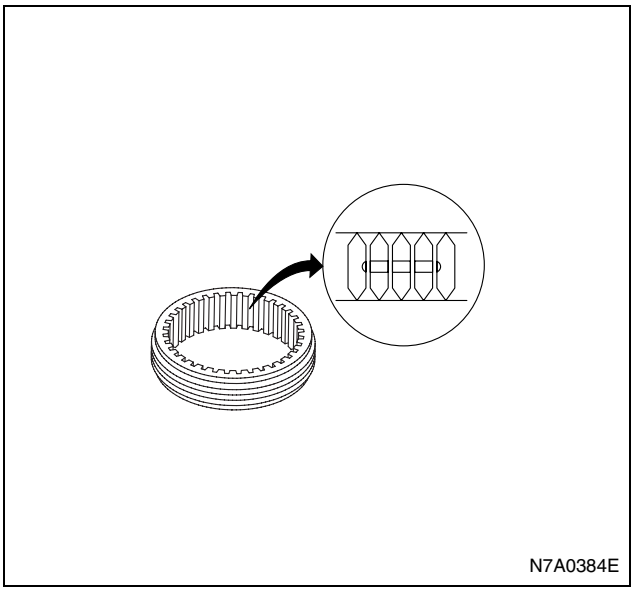
N7A1217E

9. Apply engine oil 5W-30 sufficiently to the needle bearing, 5th gear thrust surface and synchro cone taper, and install the 5th gear (5) and needle bearing (4) with the dog gear turned upward.
10. Apply engine oil 5W-30 to the 5th block ring (3), and install.
11. Turning the surface with oil groove downward, align the 4th-5th clutch hub assembly and sleeve (2) to the groove of the 4th-5th block ring, and then insert with a press using the installer 5-8840-2345-0.
12. Install the snap ring (1) using snap ring pliers.

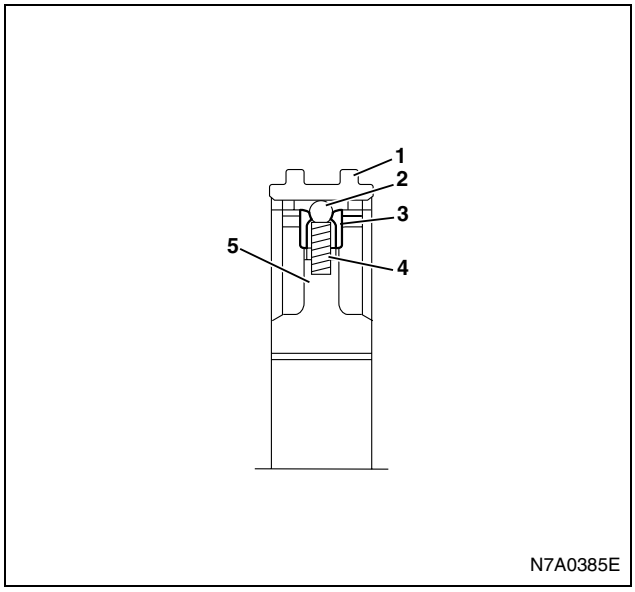
Caution:
Replace deformed or damaged snap rings with new ones. Check that the parts are securely installed.



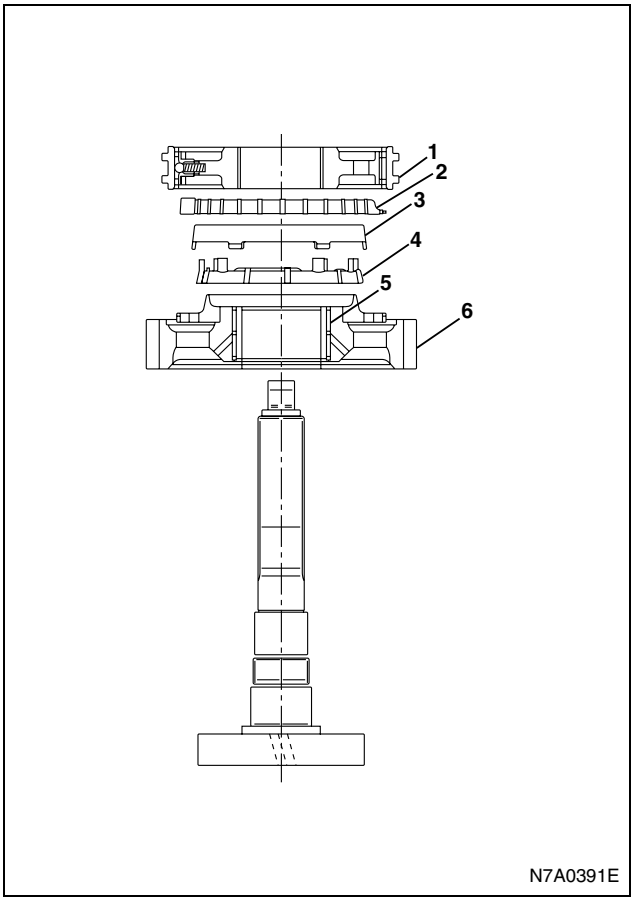
13. Assemble the 1st-reverse clutch hub assembly and sleeve following the procedure below.
    a. Install the block and spring to the clutch hub.
    b. Inside the sleeve, there are three ball grooves. Align the phase to let the ball enter the ball groove.



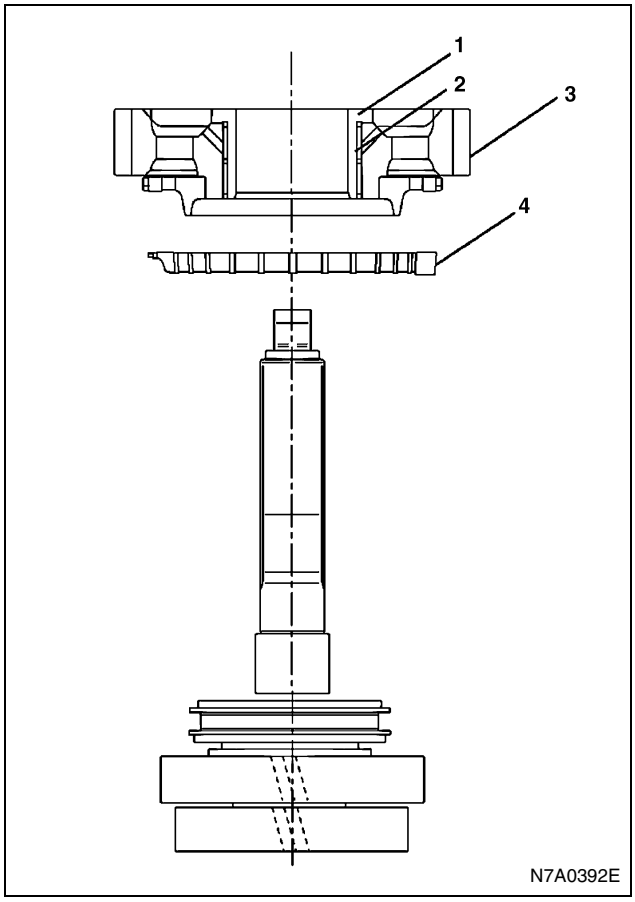
    c. Insert the sleeve (1) until the block slightly overlaps the clutch hub (5).
    d. Securely insert the sleeve until the ball enters the ball groove of the sleeve by pushing the ball (2), block (3) and spring (4).



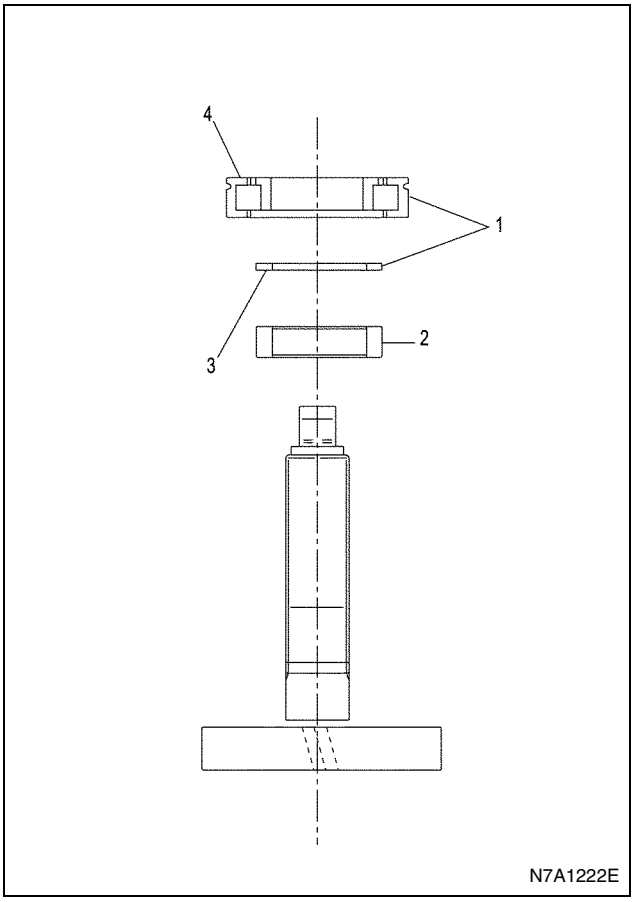
14. Apply engine oil 5W-30 to the needle bearing, 1st gear thrust surface and synchro cone taper surface. And install the 1st gear (6) and needle bearing (5), turning the dog gear upward.
15. Assemble the 1st inside ring (4), 1st outside ring (3) and 1st block ring (2), inserting the nail of the outer ring into the dog gear hole of the 1st gear. At this time, make sure to apply engine oil 5W-30 sufficiently to the both sides of the inside ring and outside ring, and inside diameter surface of the block ring.
16. Insert the 1st-reverse clutch hub assembly & sleeve (1) with a press using the installer 5-8840-2345-0, setting the six nails of the inside ring to enter the six holes of the hub.



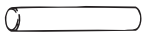
17. Apply engine oil 5W-30 sufficiently to the reverse block ring (4), and then align the phase of the block ring groove to the 1st-reverse clutch hub assembly and sleeve, and install.
18. Apply engine oil 5W-30 to the needle bearing, the reverse gear thrust surface and the synchro cone taper. Turning the dog gear downward, align the phase of the synchro cone phase of the reverse gear to the nail of the outer ring, and insert the reverse gear (3), needle bearing (2), and collar (1) with a press using the installer 5-8840-2345-0.



19. Install the spacer (2).
20. Insert the bearing (1) with a press using the installer 5-8840-2345-0, turning the stamped surface (4) upward and the stamped surface (3) downward.

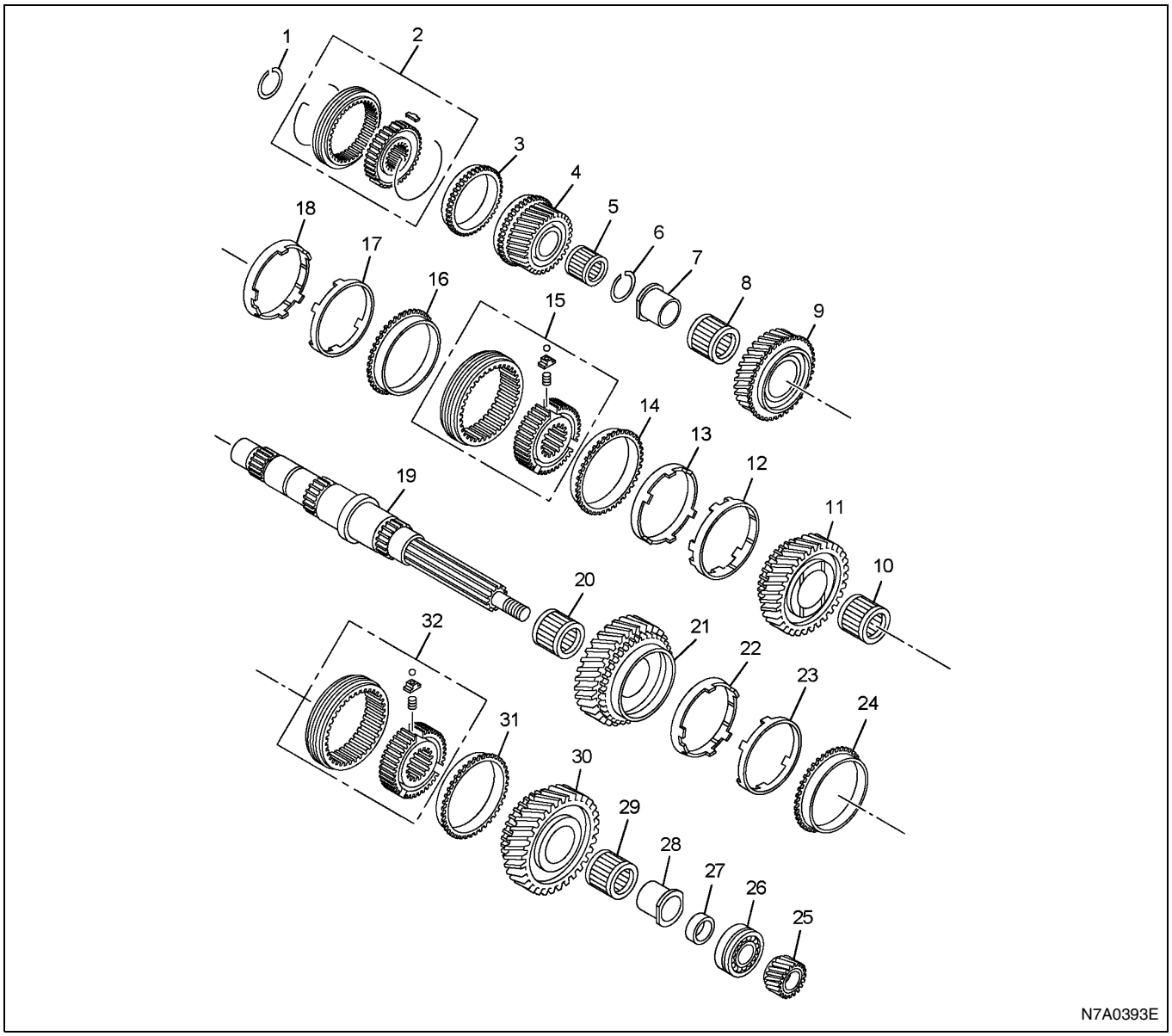


Special Tools

Illustration	Tool Number / Description / Remarks
 5884023450	5-8840-2345-0 / Clutch Hub & Collar Installer

Main Shaft (6MT)

Components



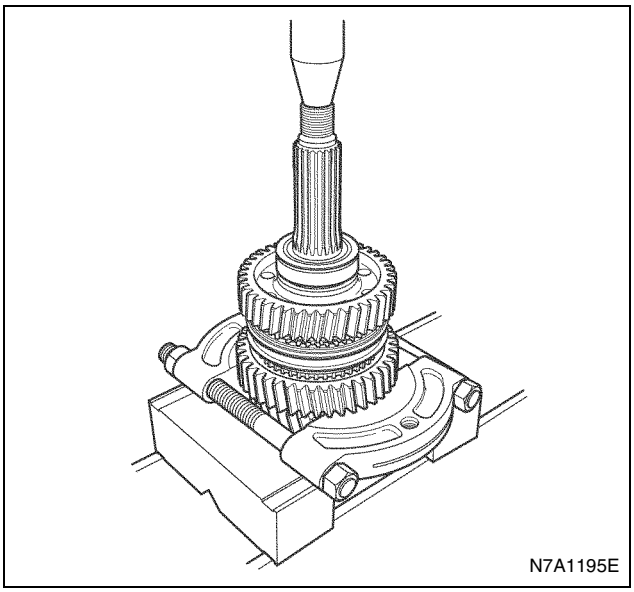
Legend

1. Snap ring
2. 4th-5th clutch hub assembly & sleeve
3. 4th block ring
4. 4th gear
5. Needle bearing
6. Snap ring
7. Collar
8. Needle bearing
9. 3rd bearing
10. Needle bearing
11. 2nd bearing
12. 2nd inside ring
13. 2nd outside ring
14. 2nd block ring
15. 2nd-3rd clutch hub assembly & sleeve
17. 3rd outside ring
18. 3rd inside ring
19. Main shaft
20. Needle bearing
21. 1st gear
22. 1st inside ring
23. 1st outside ring
24. 1st block ring
25. 6th gear
26. Bearing
27. Spacer
28. Collar
29. Needle bearing
30. Reverse gear
31. Reverse block ring

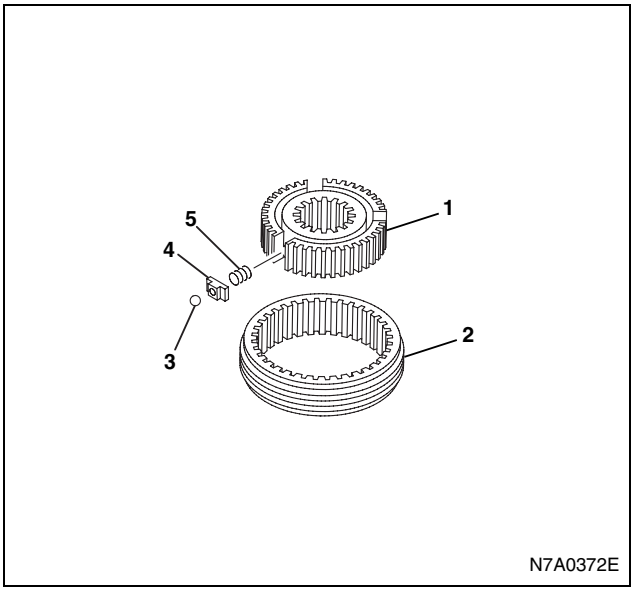
16. 3rd block ring
32. 1st-reverse clutch hub assembly & sleeve

Disassembly

1. Remove the 6th gear.
2. Remove simultaneously the following parts using a bearing remover with a press; the bearing, spacer, collar, reverse gear, needle bearing, 2nd-3rd, reverse block ring, 1st-reverse clutch hub assembly & sleeve, 1st block ring, 1st outside ring, 1st inside ring, 1st gear, needle bearing.


N7A1195E

3. Disassemble the 1st-reverse clutch hub assembly & sleeve.

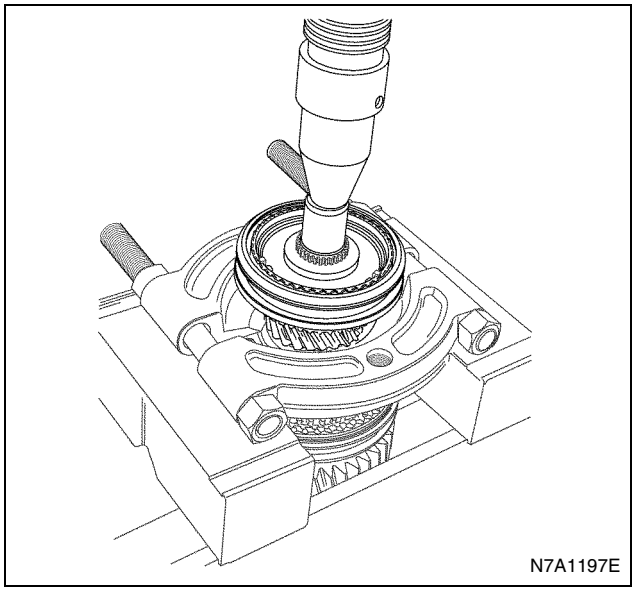


N7A0372E

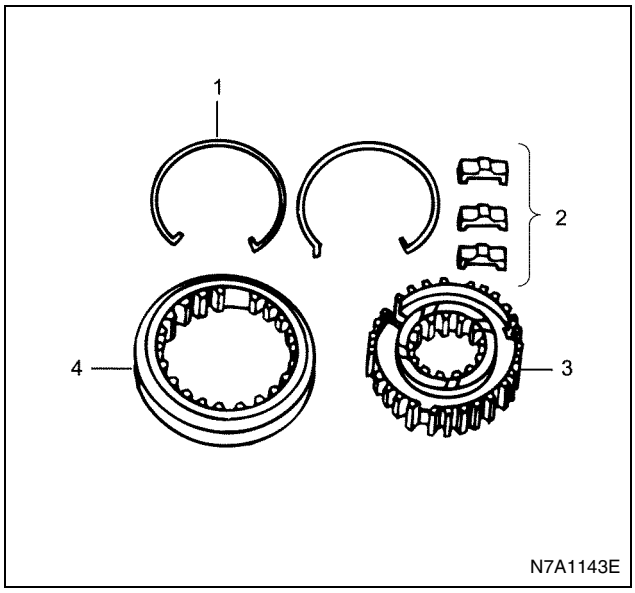
Legend

1. Clutch hub
2. Sleeve
3. Ball
4. Block
5. Spring

4. Remove the 4th-5th clutch hub assembly fixing snap ring using snap ring pliers.
5. Remove simultaneously the following parts, using a bearing remover with a press; 4th-5th clutch hub assembly & sleeve, 4th block ring 4th gear and needle bearing.


N7A1197E

6. Disassemble the 4th-5th clutch hub assembly & sleeve.



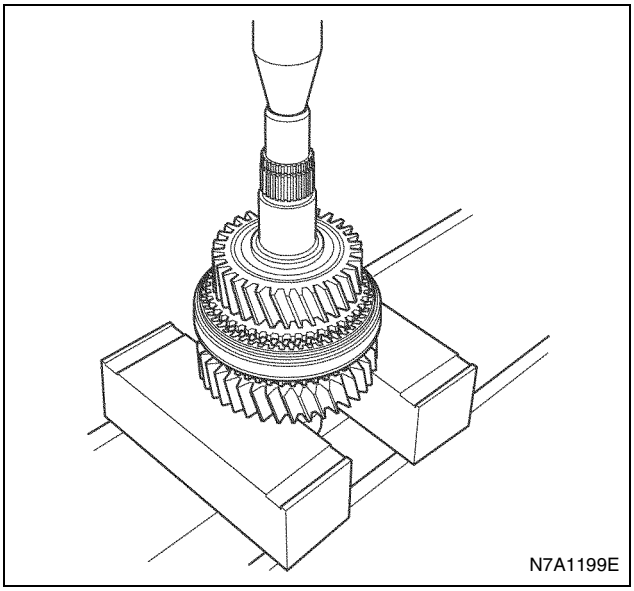
N7A1143E

Legend

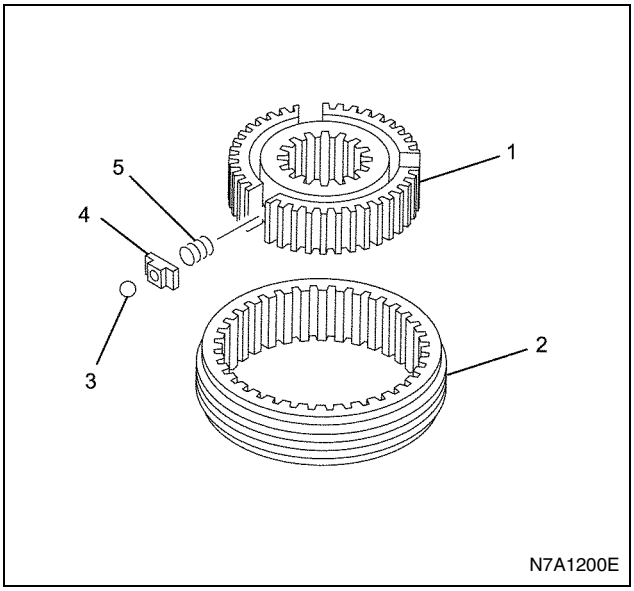
1. Spring
2. Insert
3. Clutch hub
4. Sleeve

7. Remove the 3rd gear collar fixing snap ring, using snap ring pliers.

8. Remove from the main shaft the following parts using a bearing remover with a press; the collar, 3rd gear, needle bearing, 3rd inside ring, 3rd outside ring, 3rd block ring, 2nd-3rd clutch hub assembly & sleeve, 2nd block ring, 2nd outside ring, 2nd inside ring, 2nd gear, needle bearing.


N7A1199E

9. Disassemble the 2nd-3rd clutch hub assembly & sleeve.



N7A1200E

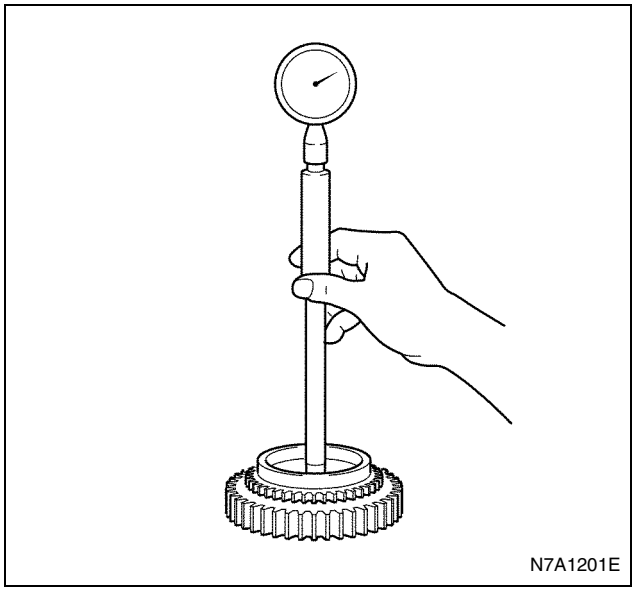
Legend

1. Clutch hub
2. Sleeve
3. Ball
4. Block
5. Spring

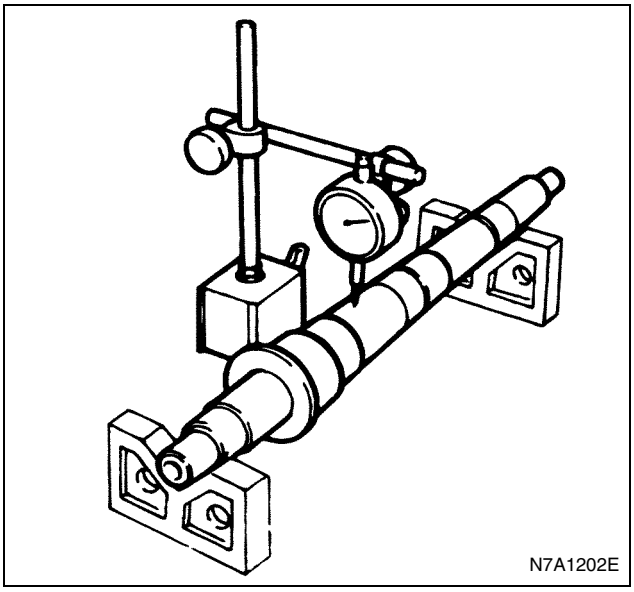
Inspect each part. If any wear, damage or other abnormality is found, repair or replace the part.

10. Inspect each bearing with respect to the following items. If any abnormality is found, replace the item.
    - Smoothness of rotation
    - Noise
    - Abnormal external appearance, including damage, rust, etc.
11. Inspect the inside diameter of the gear.
    - Measure the inside diameter of each gear using an inside dial gauge.
    - If the measured value exceeds the limit, replace the gear.

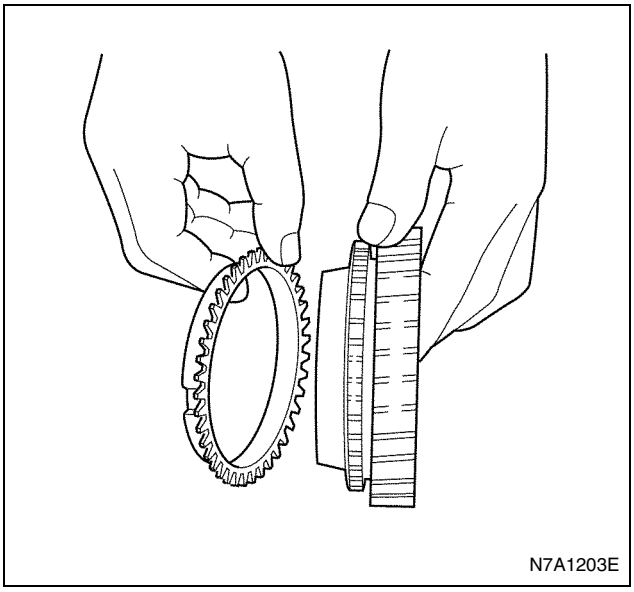
Gear Inside Diameter, mm (in)		
	Standard	Limit
6th gear	50.009 — 50.025 (1.968 — 1.969)	50.065 (1.971)
4th gear	44.009 — 44.025 (1.732 — 1.733)	44.065 (1.734)
3rd gear	63.010 — 63.029 (2.480 — 2.481)	63.069 (2.483)
2nd gear	63.010 — 63.029 (2.480 — 2.481)	63.069 (2.483)
1st gear	63.010 — 63.029 (2.480 — 2.481)	63.069 (2.483)
Reverse Gear	63.010 — 63.029 (2.480 — 2.481)	63.069 (2.483)


N7A1201E

12. Inspect the deflection of the main shaft.
    - Measure the deflection of the main shaft using a dial gauge.
    - If the measured value exceeds the limit, replace the main shaft.
      Standard: 0.015 mm (0.00059 in)
      Limit: 0.1 mm (0.00393 in)

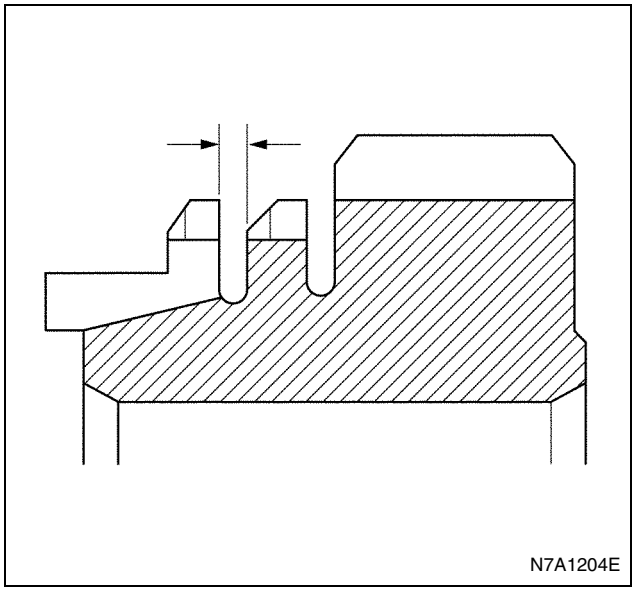

N7A1202E

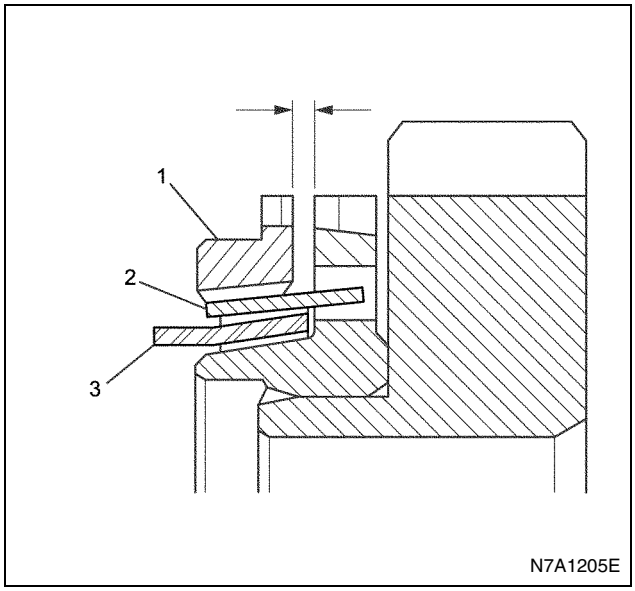
13. Inspect the synchromesh system.
    - Inspect the components. Repair the slight stepped wear and damage using an oil stone or a pencil grinder.


N7A1203E

14. Measure the clearance between the block ring and the dog gear using a thickness gauge.
    - If the measured value exceeds the limit, replace the block gear.

Clearance between Block Ring and Dog Gear, mm (in)		
	Standard	Limit
4th / 5th / 6th / Reverse	1.30 — 2.60 (0.051 — 0.102)	0.5 (0.019)
2nd / 3rd	1.00 — 2.50 (0.039 — 0.098)	0.5 (0.019)
1st	1.00 — 2.50 (0.039 — 0.098)	0.5 (0.019)


N7A1204E

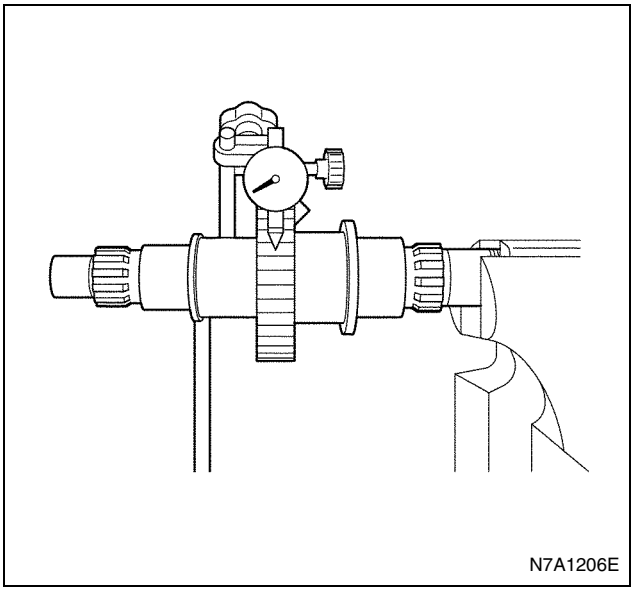


N7A1205E

Legend
1. Block ring
2. Outside ring
3. Inside ring

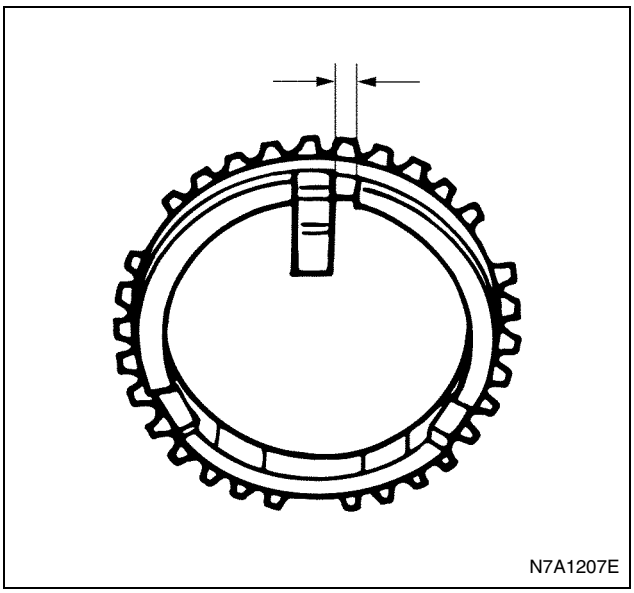
15. Inspect the sliding part, spline part, inserting part and insert groove of the clutch hub and sliding sleeve for wear and damage.
16. Measure the free play in the direction of spline rotation on the clutch hub external circumference.
    - If the measured value exceeds the limit, replace the part.

Spline Free Play, mm (in)	
Standard	Limit
0 — 0.05 (0 — 0.0019)	0.3 (0.0118)


N7A1206E

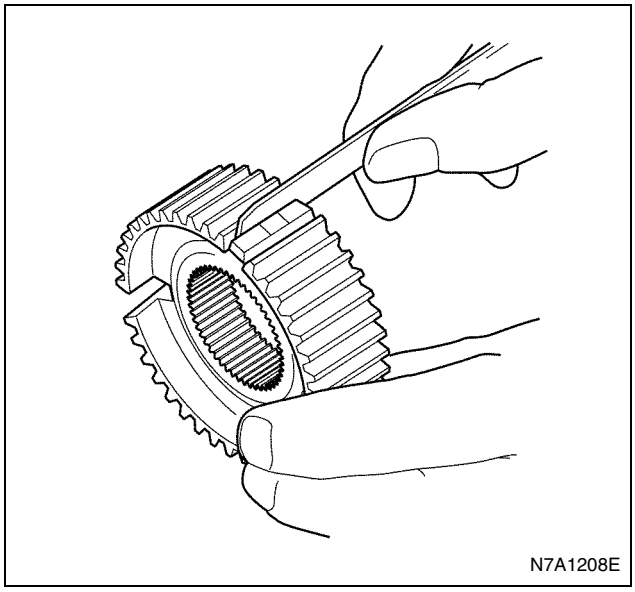
17. Measure the clearance between the insert and block ring groove using a caliper.
    - If the measured value exceeds the limit, replace the insert and block ring.

Clearance between Insert and Block Ring Groove, mm (in)	
	Standard
4th / 5th / 6th	3.46 — 3.76 (0.136 — 0.148)


N7A1207E

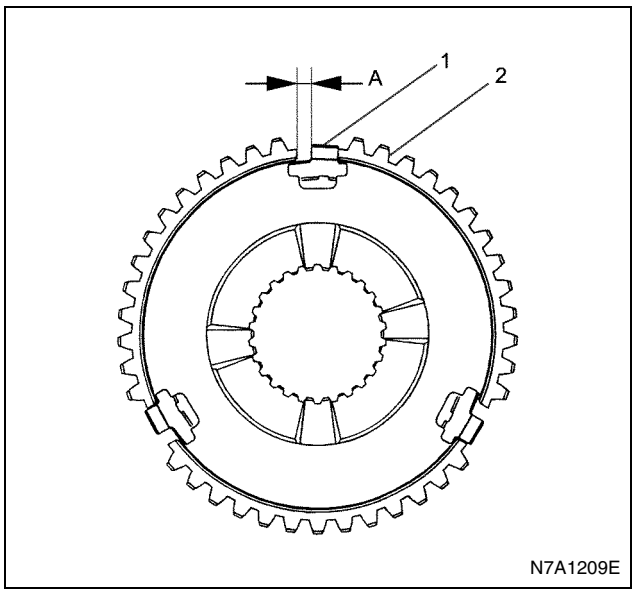
18. Measure the clearance between the insert and clutch hub using a thickness gauge.
    - If the measured value exceeds the limit, replace the insert and clutch hub.

Clearance between Insert and Clutch Hub, mm (in)	
	Standard
4th / 5th / 6th	0.01 — 0.21 (0.00039 — 0.00826)


N7A1208E

19. Measure the clearance between the block ring and the clutch hub using a thickness gauge.
    - If the measured value exceeds the limit, replace the block and clutch hub.

Clearance between Block Ring and Clutch Hub, mm (in)	
	Standard
2nd / 3rd	4.30 — 4.70 (0.16929 — 0.18503)
1st / Reverse	4.30 — 4.70 (0.16929 — 0.18503)



N7A1209E

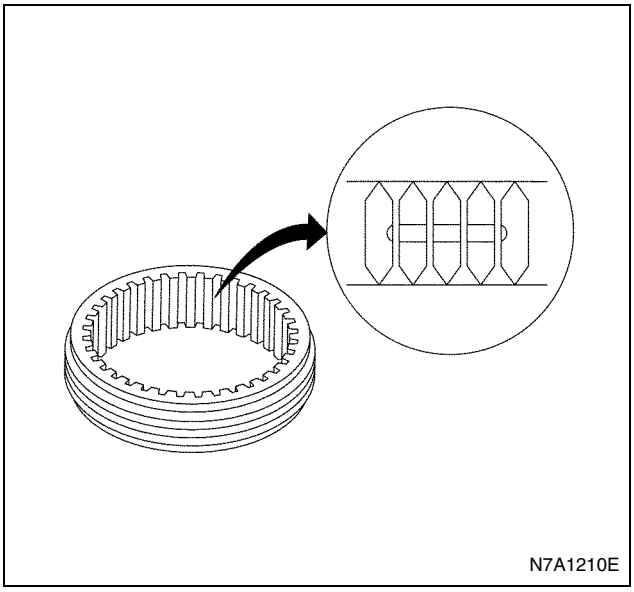
Legend
1. Block ring
2. Clutch hub

Assembly

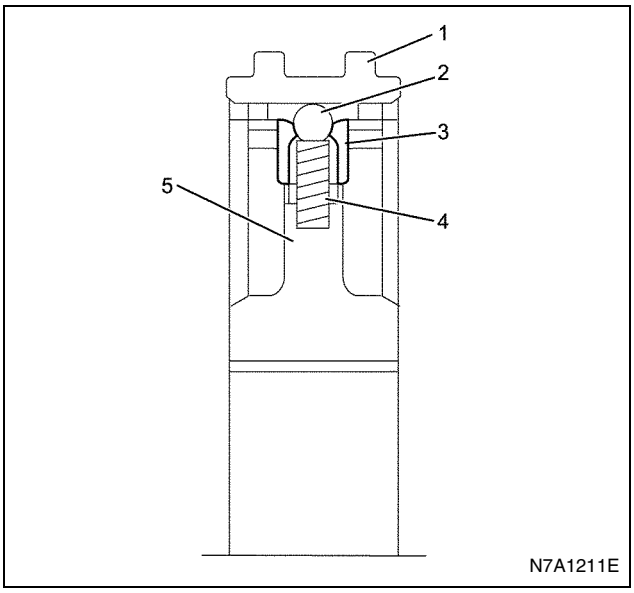
- Clean up each part.
- Set the main shaft in a vise, with the long spline part at the bottom.

When setting the main shaft, make sure not to damage the grind surface.

1. Assemble the 2nd-3rd clutch hub assembly & sleeve following the procedure below.
   a. Install the block and sleeve to the clutch hub.
   b. Inside the sleeve, there are three ball grooves. Align the phase to let the ball enter the center of the ball grooves.

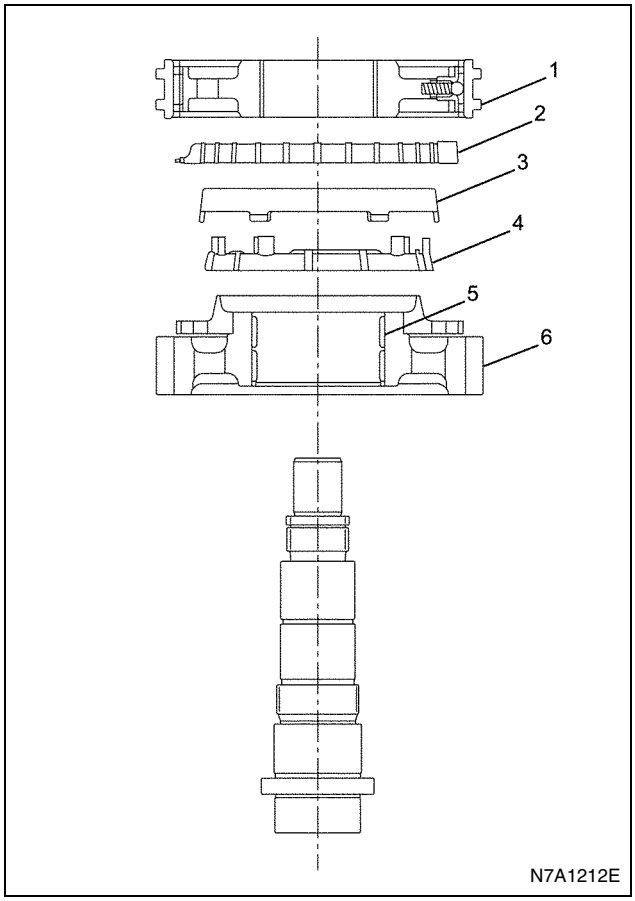

N7A1210E

   c. Insert sleeve (1) until the clutch hub (5) slightly overlaps the block.
   d. Securely insert the sleeve until the ball enters the ball groove of the sleeve by pushing the ball (2), block (3) and spring (4).



N7A1211E

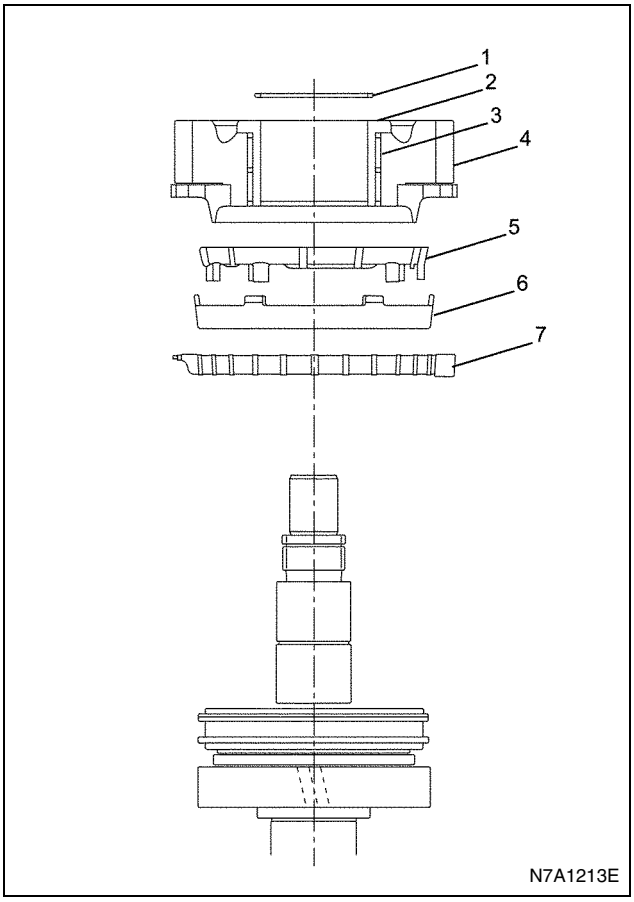
2. Apply engine oil 5W-30 to the needle bearing, 2nd gear thrust surface and synchro cone taper surface. And install the 2nd gear (6) and needle bearing (5) to the main shaft with the dog gear turned upward.
3. Install the 2nd inside ring (4), 2nd outside ring (3) and 2nd block ring (2) inserting the nail of the outside ring into the gear hole of the 2nd gear. At this time, make sure to apply engine oil 5W-30 sufficiently to the both sides of the inside ring and outside ring, and inside diameter surface of the block ring.
4. Insert the 2nd-3rd clutch hub assembly & sleeve with a press using the installer 5-8840-2345-0, setting the six nails of the inside ring to enter the six holes of the hub.



N7A1212E

5. During installation, set the six nails of the inside ring of the 3rd block ring (7), 3rd outside ring (6) and 3rd inside ring (5) to enter the six hub holes, respectively. At this time, apply engine oil 5W-30 sufficiently to the inside surface of the outside ring and the inside diameter surface of the block ring.
6. Apply engine oil 5W-30 to the needle bearing, 3rd gear thrust surface and synchro cone taper. Turn the dog gear downward, and insert the 3rd gear (4), needle bearing (3) and collar (2) using the installer 5-8840-2345-0 with a press, setting the nail of the outer ring to enter the dog gear hole of the 3rd gear.
7. Install the snap ring (1) using snap ring pliers.

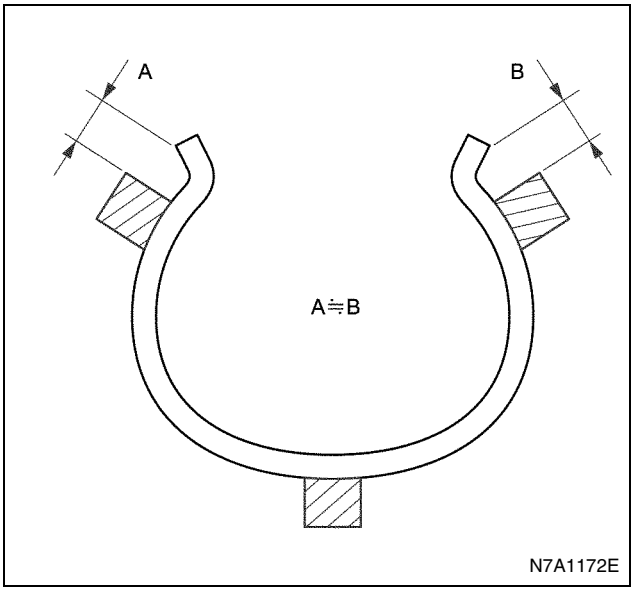
Caution:
Replace deformed or damaged snap rings with new ones. Check that the parts are securely installed.



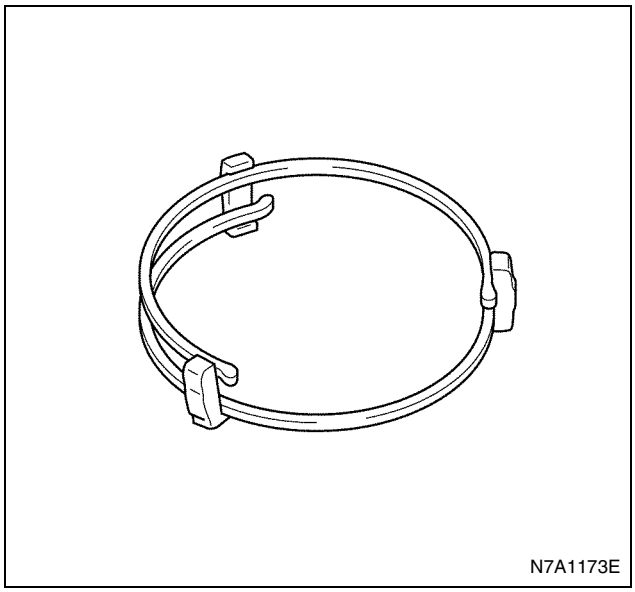
8. Assemble the 4th-5th clutch hub assembly & sleeve following the procedure below.
   a. Assemble securely the insert (2) to the insert groove of the block ring.
   b. Install the insert spring (3) to the insert.

Caution:

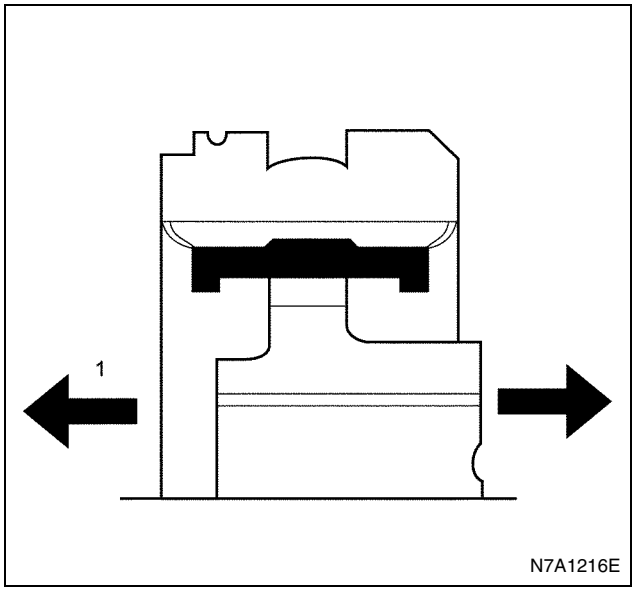
- When assembling the insert spring, equalize the length of the both edges of the spring not to adversely interfere with the inside diameter of the hub.

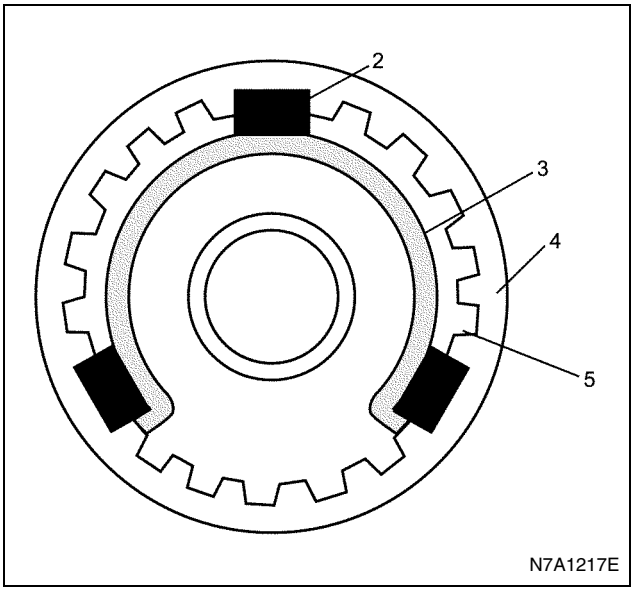


- Make sure that the open part of the insert spring assembled on the reverse side, is not aligned with the open part of the front side.



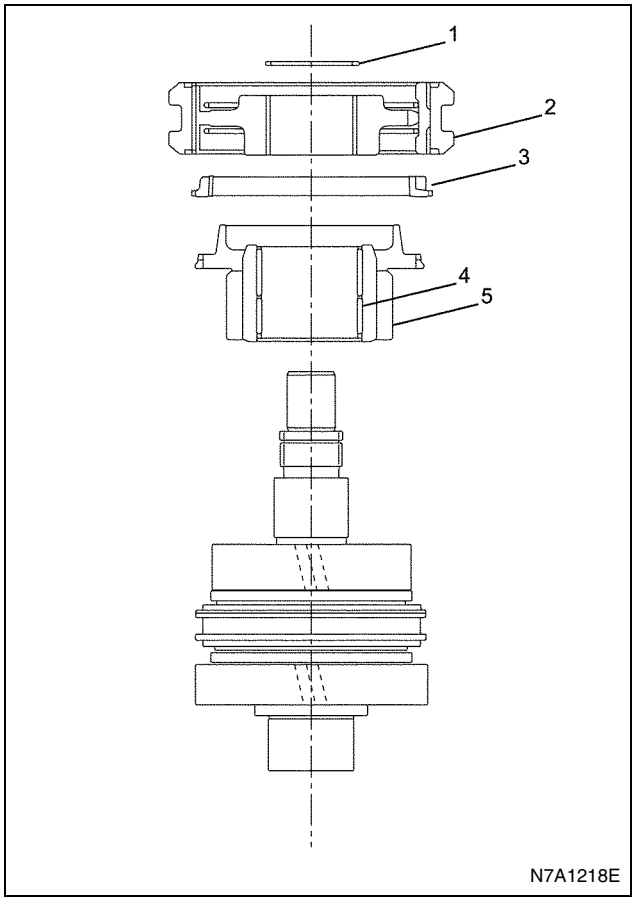
   c. Check that the clutch hub (5) and sleeve (4) are smoothly sliding.
      - The arrow (1) indicates the front side of the transmission.



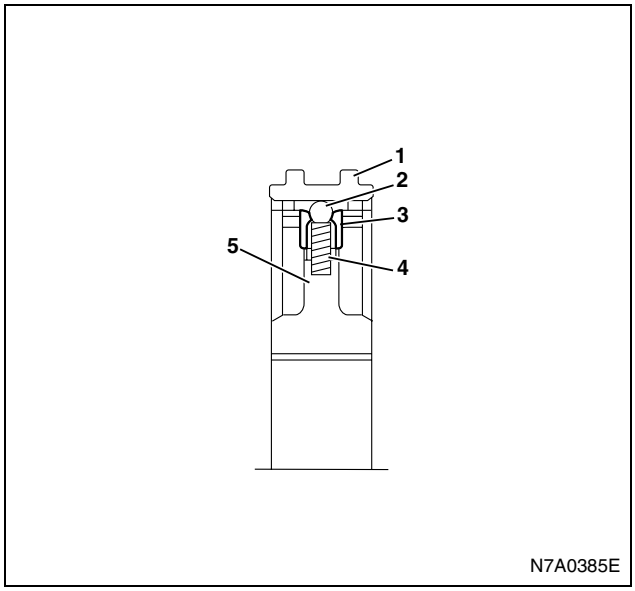


9. Apply engine oil 5W-30 sufficiently to the needle bearing, 4th gear thrust surface and synchro cone taper, and install the 4th gear (5) and needle bearing (4) with the dog gear turned upward.
10. Apply engine oil 5W-30 to the 4th block ring (3), and install.
11. Turning the surface with oil groove downward, align the 4th-5th clutch hub assembly and sleeve (2) to the groove of the 4th-5th block ring, and then insert with a press using the installer 5-8840-2345-0.
12. Install the snap ring (1) using snap ring pliers.

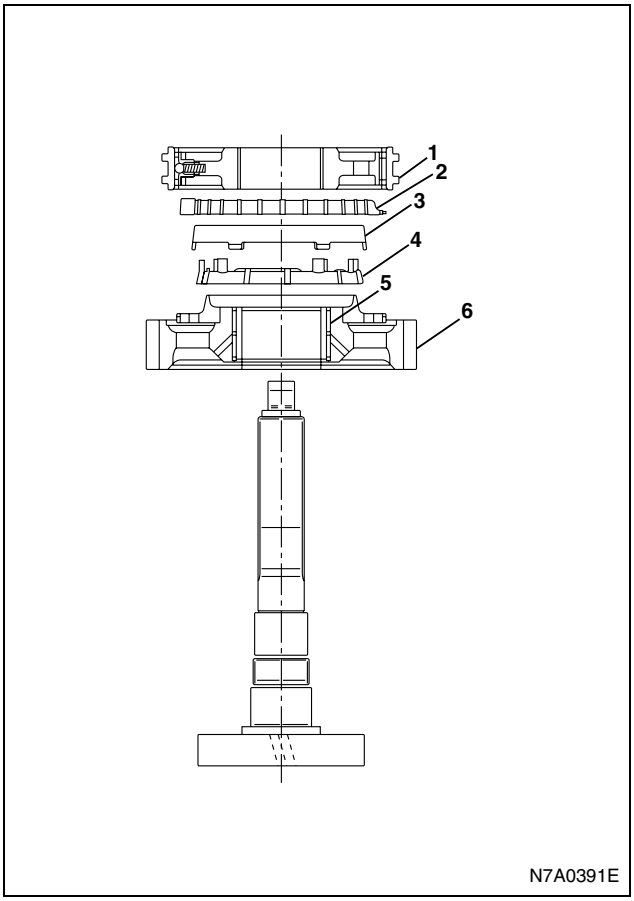
Caution:
Replace deformed or damaged snap rings with new ones. Check that the parts are securely installed.



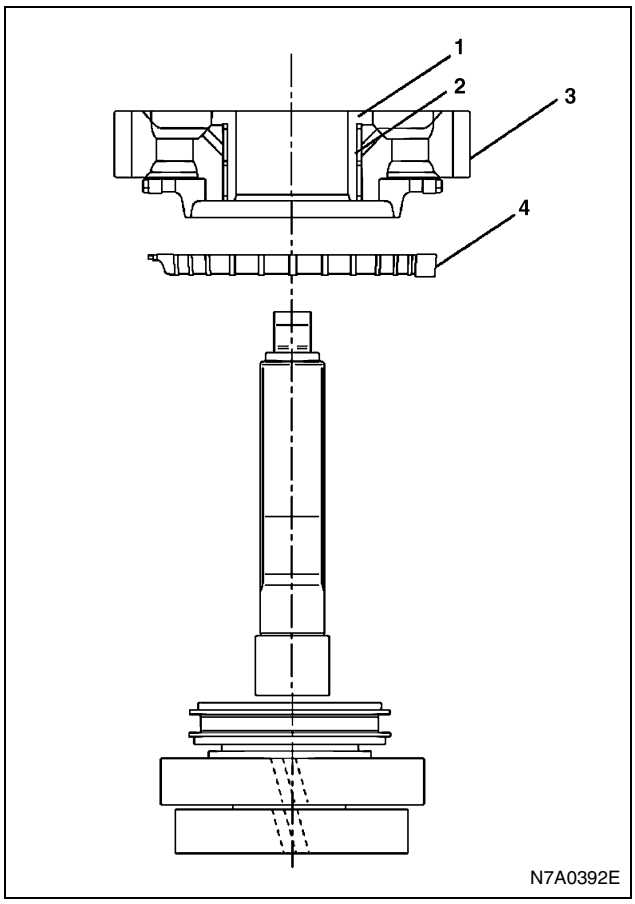
13. Assemble the 1st-reverse clutch hub assembly and sleeve following the procedure below.
    a. Install the block and spring to the clutch hub.
    b. Inside the sleeve, there are three ball grooves. Align the phase to let the ball enter the ball groove.
    c. Insert the sleeve (1) until the block slightly overlaps the clutch hub (5).
    d. Securely insert the sleeve until the ball enters the ball groove of the sleeve by pushing the ball (2), block (3) and spring (4).



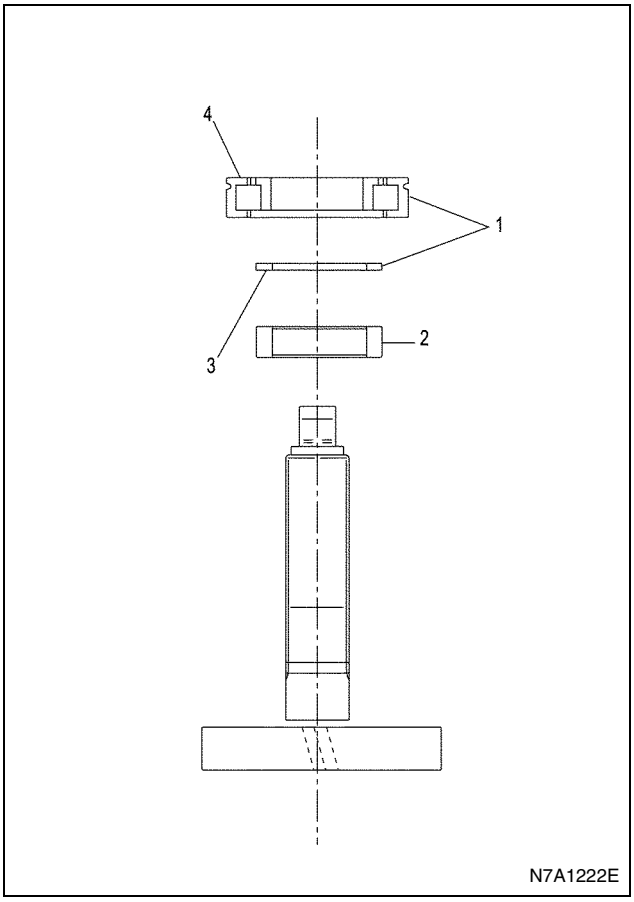
14. Apply engine oil 5W-30 to the needle bearing, 1st gear thrust surface and synchro cone taper surface, and then install the 1st gear (6) and needle bearing (5), turning the dog gear upward.
15. Assemble the 1st inside ring (4), 1st outside ring (3) and 1st block ring (2), inserting the nail of the outer ring into the dog gear hole of the 1st gear. At this time, make sure to apply engine oil 5W-30 sufficiently to the both sides of the inside ring and outside ring, and inside diameter surface of the block ring.
16. Insert the 1st-reverse clutch hub assembly & sleeve (1) with a press using the installer 5-8840-2345-0, setting the six nails of the inside ring to enter the six holes of the hub.



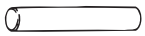
17. Apply engine oil 5W-30 sufficiently to the reverse block ring (4), and then align the phase of the block ring groove to the 1st-reverse clutch hub assembly and sleeve, and install.
18. Apply engine oil 5W-30 to the needle bearing, the reverse gear thrust surface and the synchro cone taper. Turning the dog gear downward, align the phase of the synchro cone phase of the reverse gear to the nail of the outer ring, and then insert the reverse gear (3), needle bearing (2), and collar (1) with a press using the installer 5-8840-2345-0.



19. Install the spacer (2).
20. Insert the bearing (1) with a press using the installer 5-8840-2345-0, turning the stamped surface (4) upward and the stamped surface (3) downward.
21. Install the 6th gear.
    - Install with the convex part at the bottom.

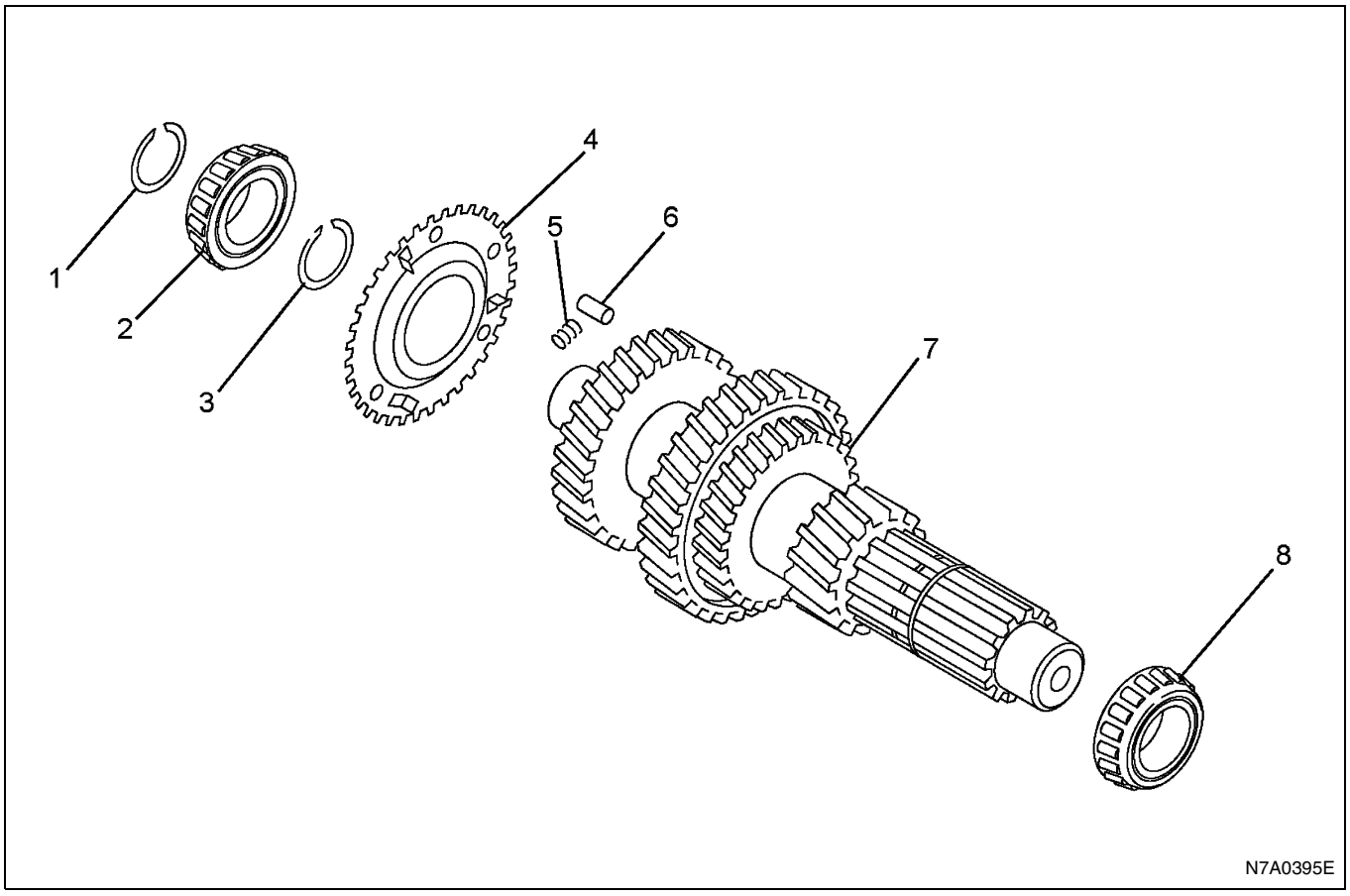


Special Tools

Illustration	Tool Number / Description / Remarks
 5884023450	5-8840-2345-0 / Clutch Hub & Collar Installer

Counter Shaft (5MT)

Components

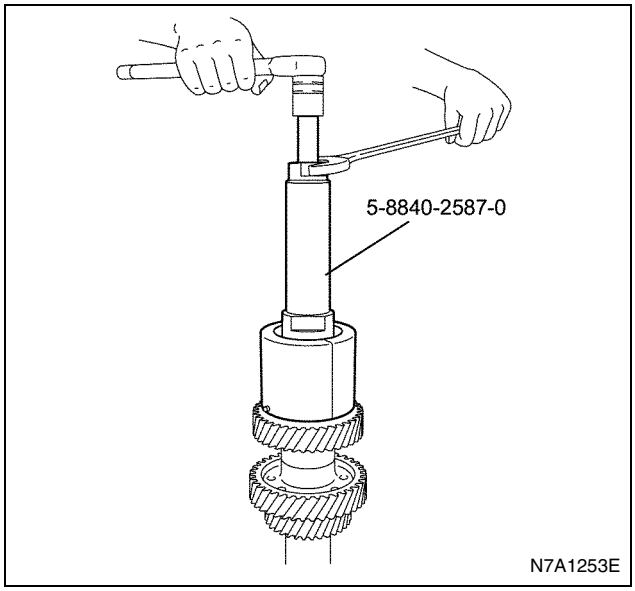


Legend

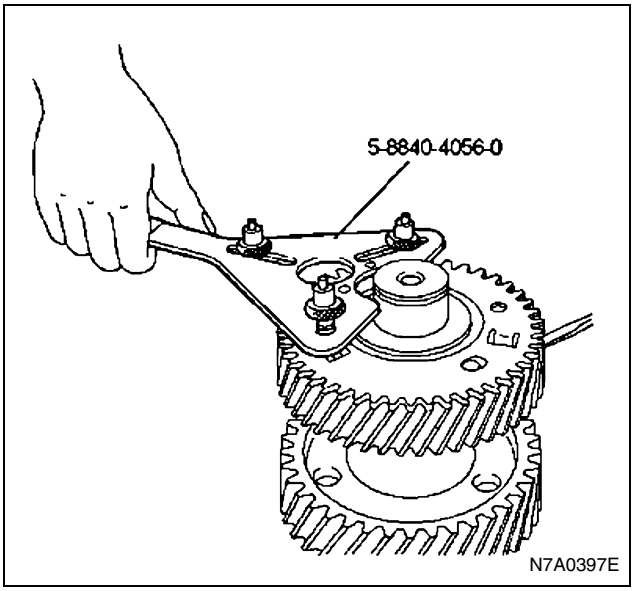
1. Snap ring
2. Bearing; Counter front
3. Snap ring
4. Anti-lash plate
5. Coil spring
6. Straight pin
7. Counter shaft assembly
8. Bearing; Counter rear

Disassembly

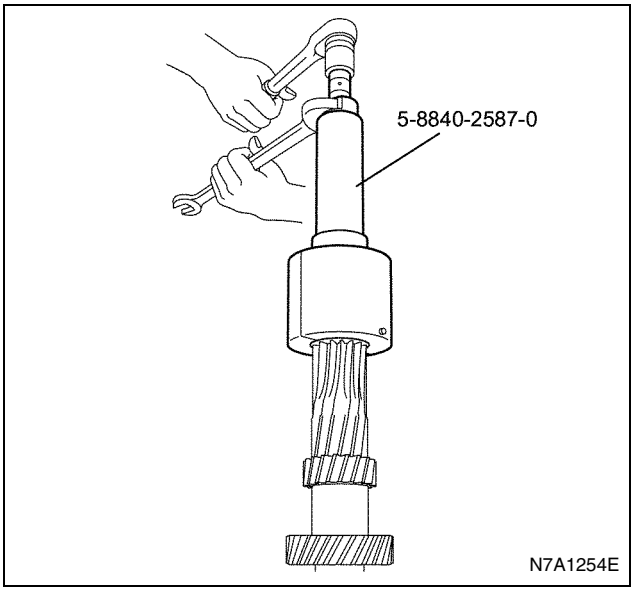
1. Remove the bearing fixing snap ring using snap ring pliers.
2. Remove the bearing; counter front using the bearing remover 5-8840-2587-0.



3. Remove the anti-lash plate fixing snap ring using snap ring pliers.
4. Remove the anti-lash plate using the flange holder 5-8840-4056-0.



5. Remove the three coil springs from the 5th gear.
6. Remove the straight pin from the 5th gear.
7. Remove the bearing; counter rear using the bearing remover 5-8840-2587-0.

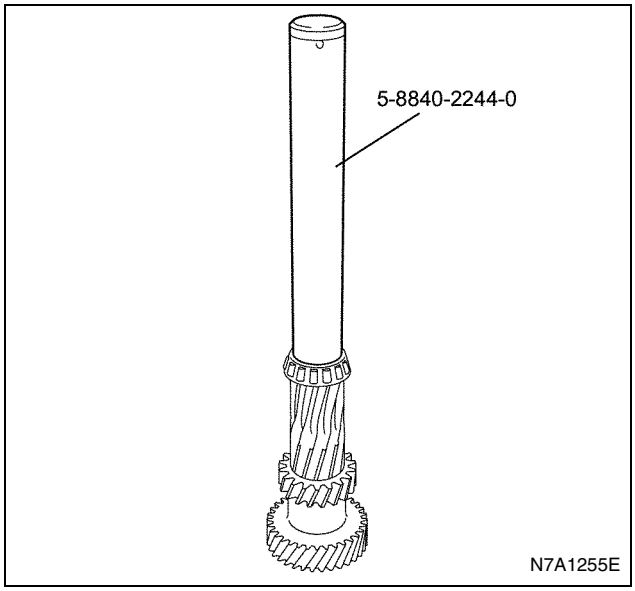


If any wear, damage or other abnormality is found on the disassembled parts, repair or replace the parts.

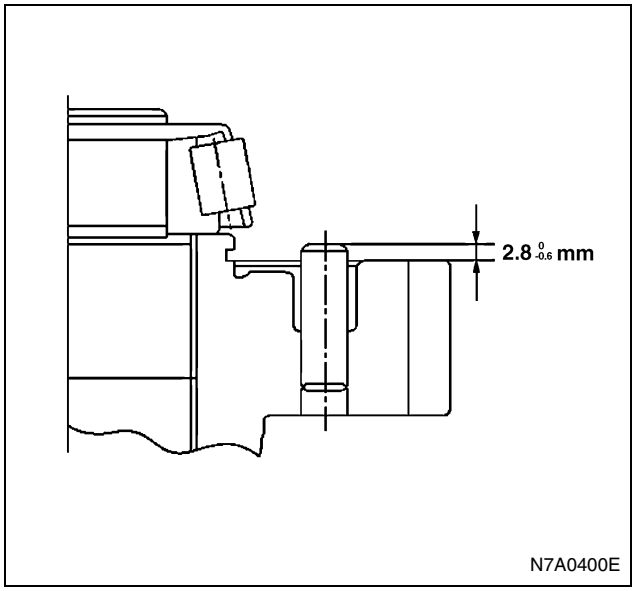
8. Inspect the surface of each gear for damage or wear. If any abnormality is found, replace the gear.
9. Inspect each bearing with respect to the following items. If any abnormality is found, replace with a new one.
   - Smoothness of rotation
   - Noise
   - Abnormal external appearance, including damage, rust, etc.
   - Abnormal free play in thrust direction

Assembly

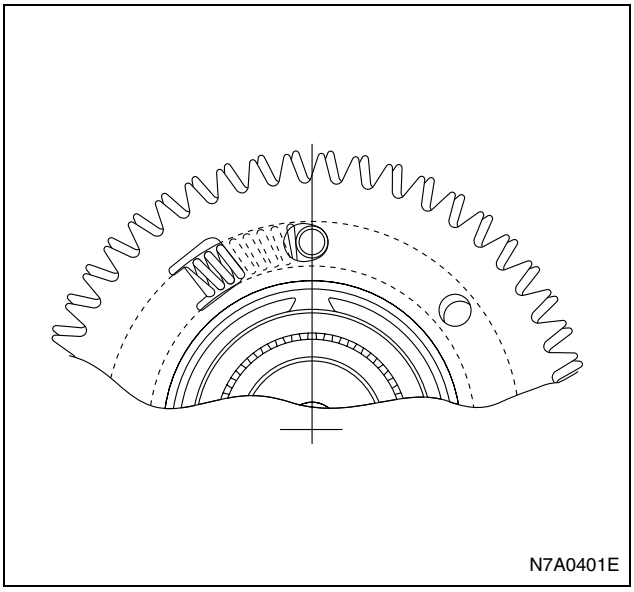
1. Insert the bearing counter rear with a press using the installer 5-8840-2244-0.



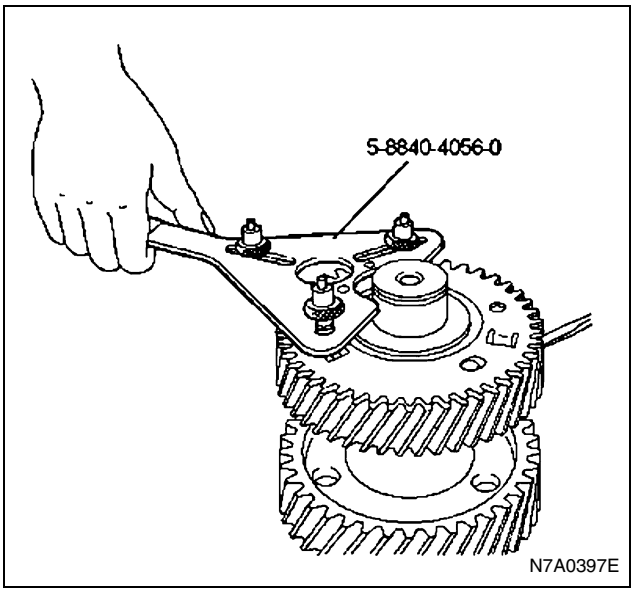
2. Install the straight pin within the range of protrusion.



3. Assemble the three coil springs to the groove on the side of the 5th gear, while these springs have to touch the left side of the pin viewing from the center of the gear.



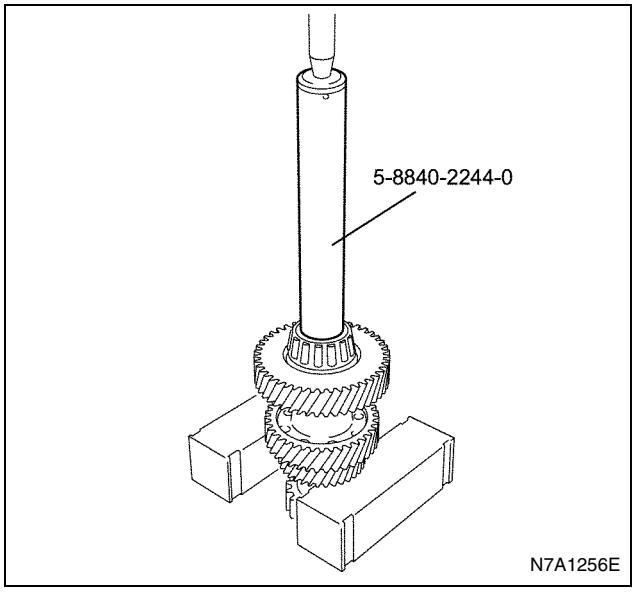
4. Set the springs between the folded protrusion of the anti-lash plate and the straight pin. Using the flange holder 5-8840-4056-0, align the set hole of the anti-lash plate with the set hole of the 5th gear, and install.



5. Install the anti-lash plate fixing snap ring using snap ring pliers.

Caution:
Replace deformed or damaged snap rings with new ones. Check that the parts are securely installed.

6. Install the bearing: counter front with a press using the installer 5-8840-2244-0.



7. Install the bearing fixing snap ring using snap ring pliers.
   - Select the thickest snap ring installable from the following three types.

Thickness, mm (in)	Color
1.9 (0.0748)	Blue
2.1 (0.0826)	Yellow
2.3 (0.0905)	Pink

Caution:
Replace deformed or damaged snap rings with new ones. Check that the parts are securely installed.

Special Tools

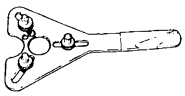
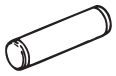
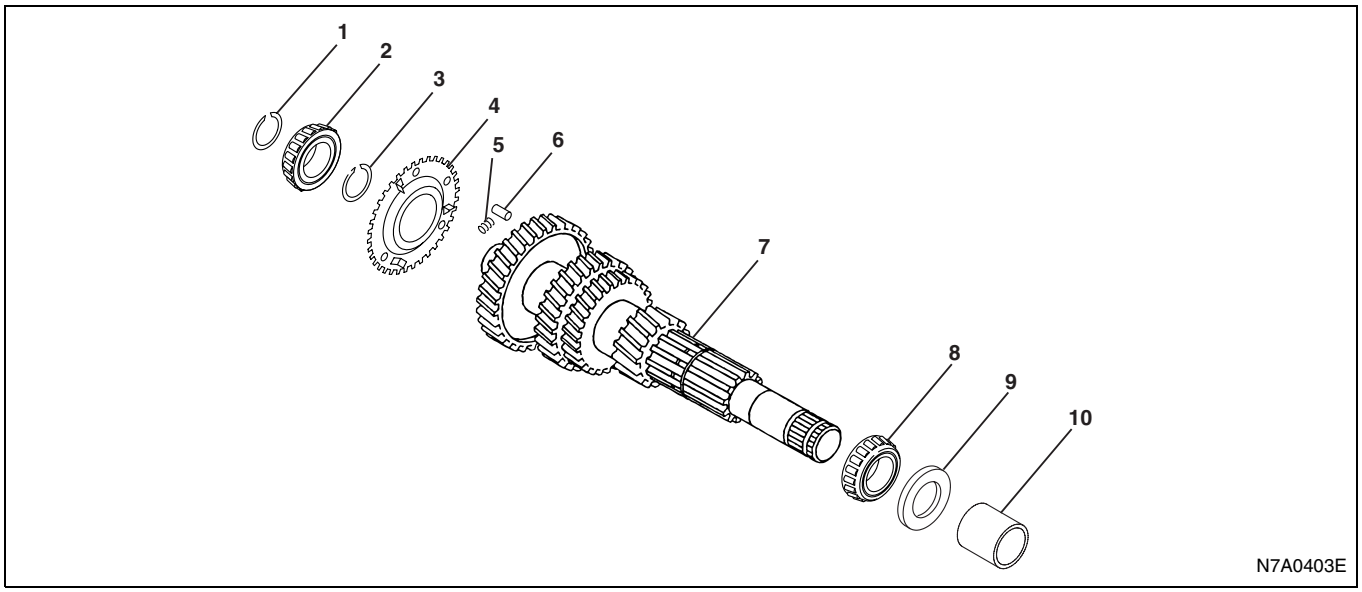
Illustration	Tool Number / Description / Remarks
5884025870	5-8840-2587-0 / Bearing Remover
 5884040560	5-8840-4056-0 / Flange Holder

Illustration	Tool Number / Description / Remarks
 5884022440	5-8840-2244-0 / Bearing Installer

Counter Shaft (6MT)

Components

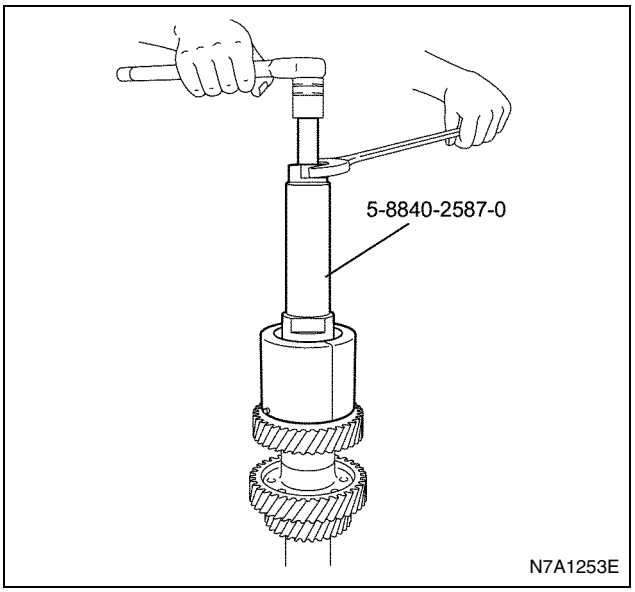


Legend

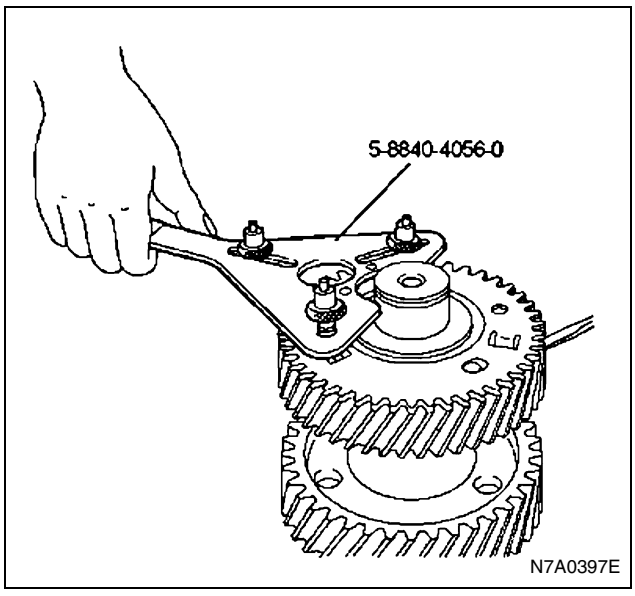
1. Snap ring
2. Bearing; Counter front
3. Snap ring
4. Anti-lash plate
5. Coil spring
6. Straight pin
7. Counter shaft assembly
8. Bearing; Counter rear
9. Thrust washer
10. Collar

Disassembly

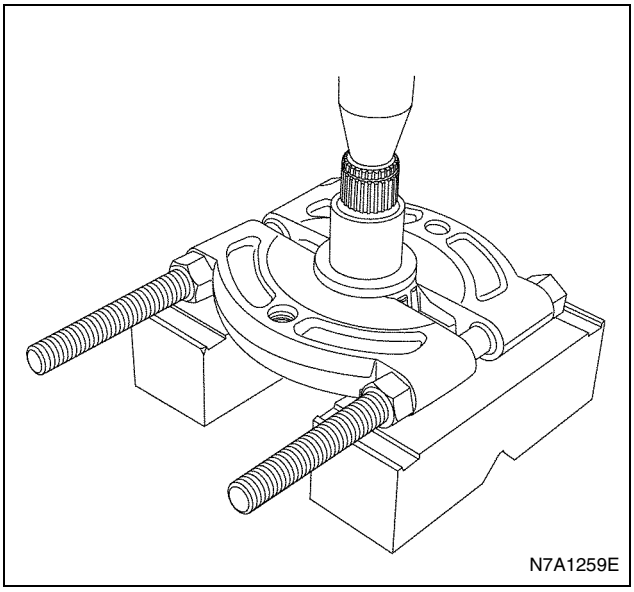
1. Remove the bearing fixing snap ring using snap ring pliers.
2. Remove the bearing; counter front using the bearing remover 5-8840-2587-0.



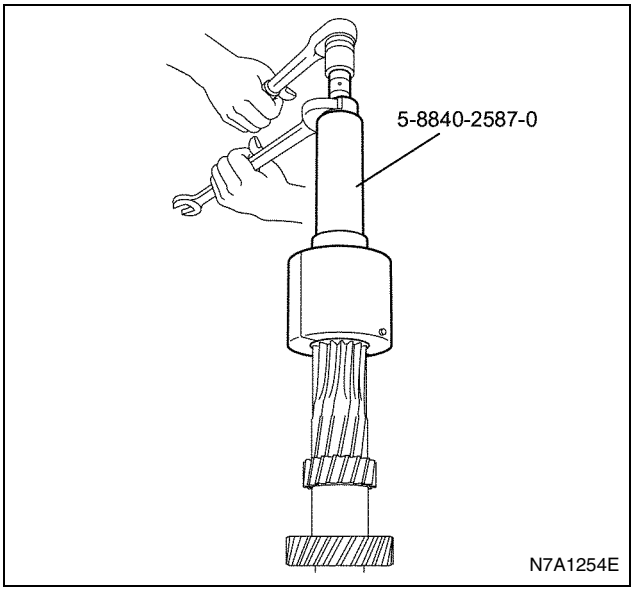
3. Remove the anti-lash plate fixing snap ring using snap ring pliers.
4. Remove the anti-lash plate using the flange holder 5-8840-4056-0.



5. Remove the three coil springs from the 5th gear.
6. Remove the straight pin from the 5th gear.
7. Remove the collar and thrust washer with a press using a bearing remover.



8. Remove the bearing; counter rear using the bearing remover 5-8840-2587-0.

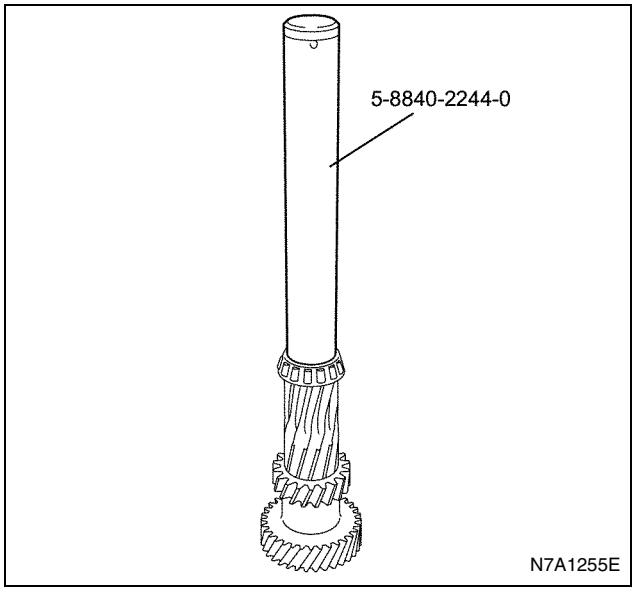


If any wear, damage or other abnormality is found on the disassembled parts, repair or replace the parts.

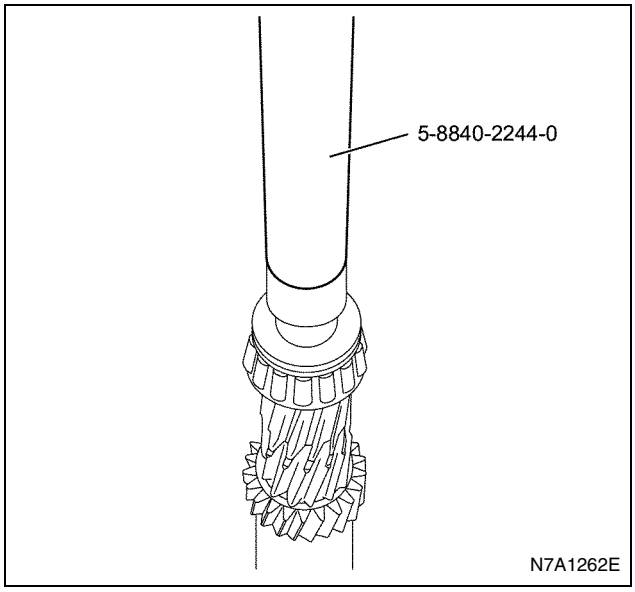
9. Inspect the surface of each gear for damage or wear. If any abnormality is found, replace the gear.
10. Inspect each bearing with respect to the following items. If any abnormality is found, replace with a new one.
    - Smoothness of rotation
    - Noise
    - Abnormal external appearance, including damage, rust, etc.
    - Abnormal free play in thrust direction

Assembly

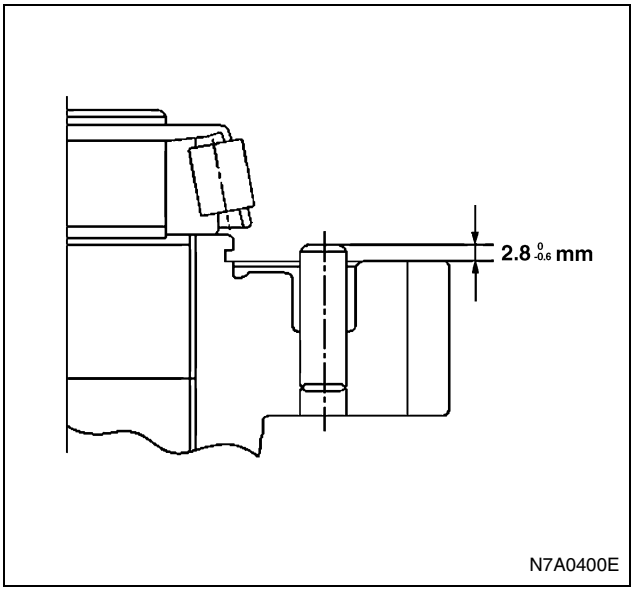
1. Insert the bearing; counter rear with a press using the installer 5-8840-2244-0.



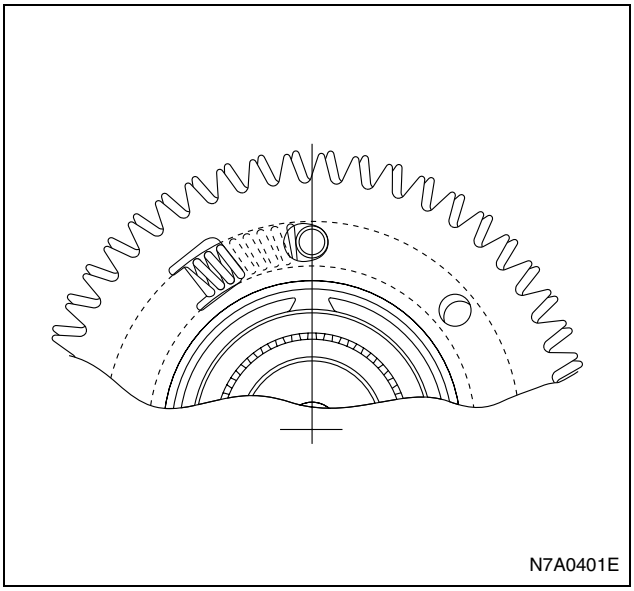
2. Insert the collar and thrust washer with a press using the installer 5-8840-2244-0.



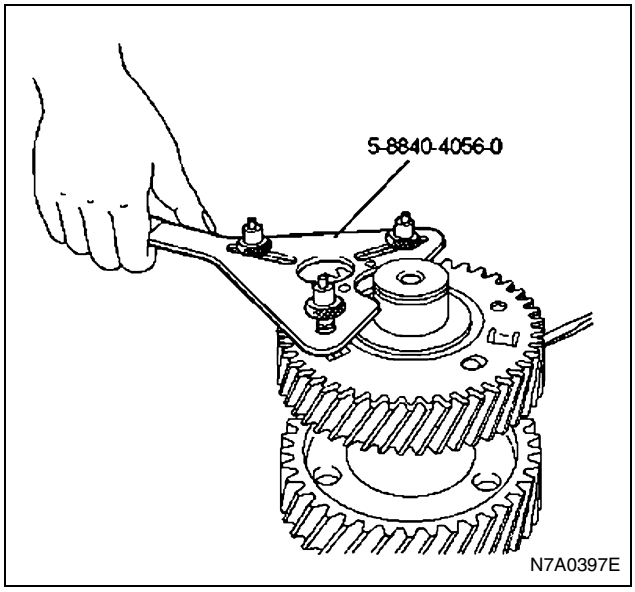
3. Install the straight pin within the range of protrusion.



4. Assemble the three coil springs to the groove on the side of the 5th gear, while these springs have to touch the left side of the pin viewing from the center of the gear.



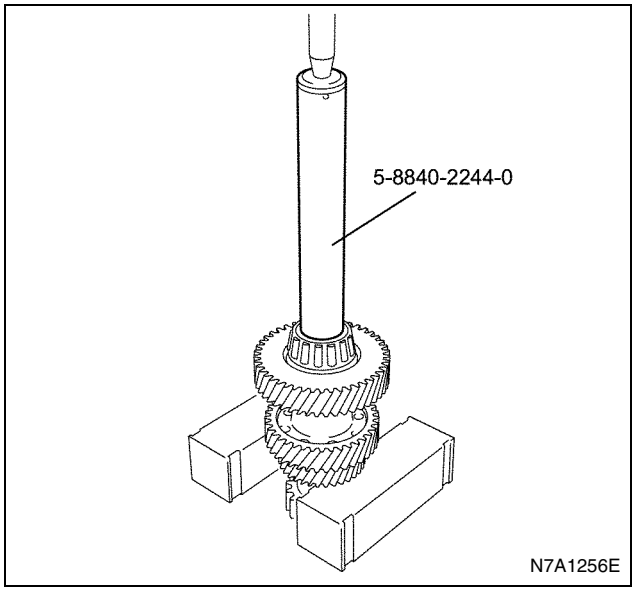
5. Set the springs between the folded protrusion of the anti-lash plate and the straight pin. Using the flange holder 5-8840-4056-0, align the set hole of the anti-lash plate with the set hole of the 5th gear, and install.



6. Install the anti-lash plate fixing snap ring using snap ring pliers.

Caution:
Replace deformed or damaged snap rings with new ones. Check that the parts are securely installed.

7. Install the bearing: counter front with a press using the installer 5-8840-2244-0.

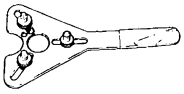
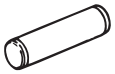


8. Install the bearing fixing snap ring using snap ring pliers.
   - Select the thickest snap ring installable from the following three types.

Thickness, mm (in)	Color
1.9 (0.0748)	Blue
2.1 (0.0826)	Yellow
2.3 (0.0905)	Pink

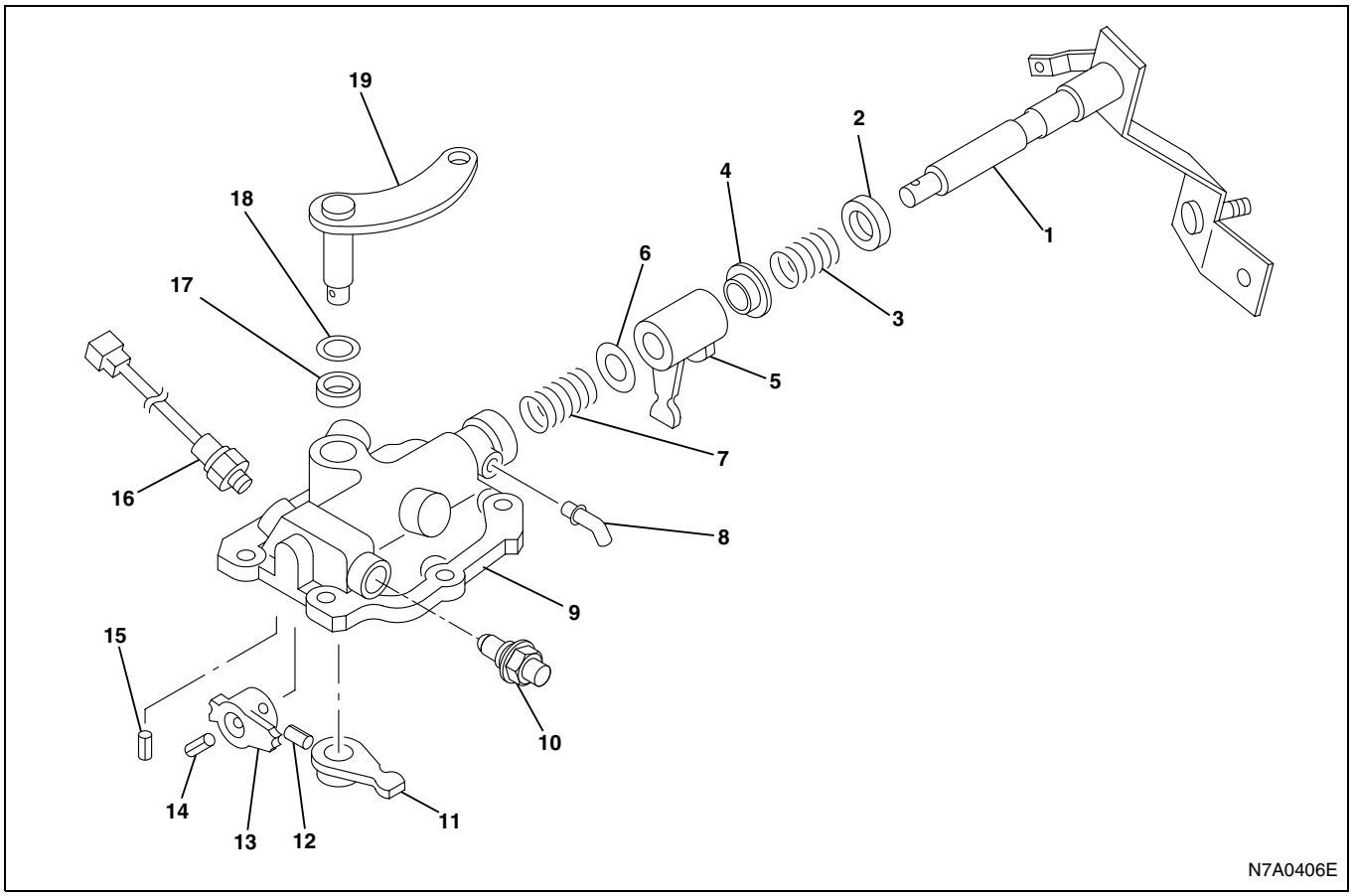
Caution:
Replace deformed or damaged snap rings with new ones. Check that the parts are securely installed.

Special Tools

Illustration	Tool Number / Description / Remarks
5884025870	5-8840-2587-0 / Bearing Remover
 5884040560	5-8840-4056-0 / Flange Holder
 5884022440	5-8840-2244-0 / Bearing Installer

Control Box

Components

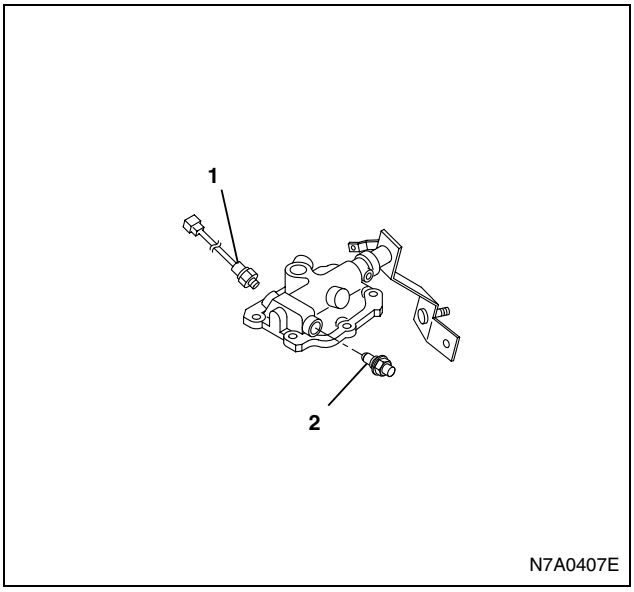


Legend

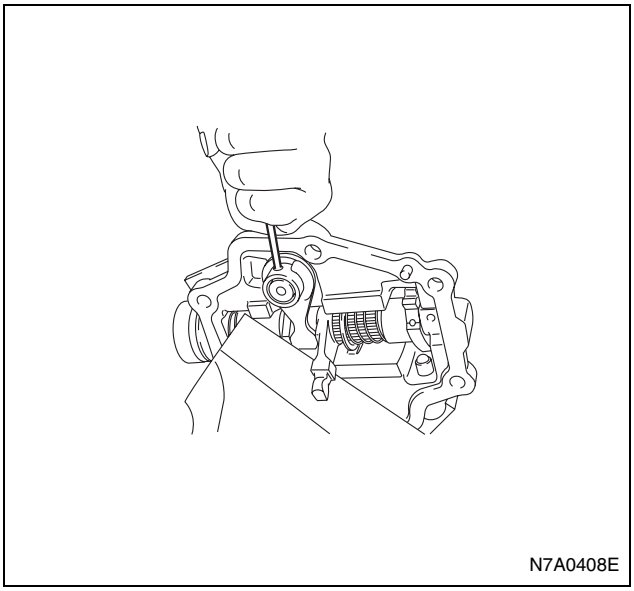
1. Shift lever shaft
2. Shift lever shaft oil seal
3. Spring
4. Washer
5. Shift internal lever
6. Spring sheet
7. Spring
8. Pipe
9. Control box
10. Detent
11. Select internal lever
12. Spring pin; Select internal lever
13. Stopper ring
14. Spring pin; Stopper ring
15. Spring pin; Shift lever shaft
16. Neutral switch
17. Select lever shaft oil seal
18. Washer
19. Select external lever

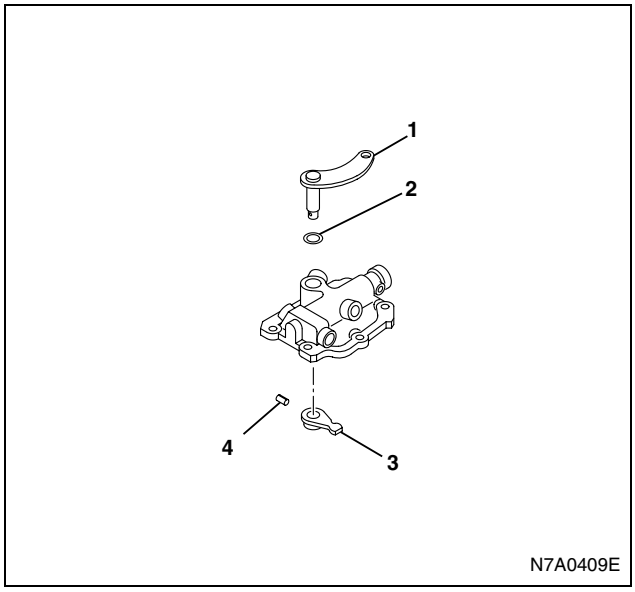
Disassembly

1. Remove the neutral switch (1) and detent (2).

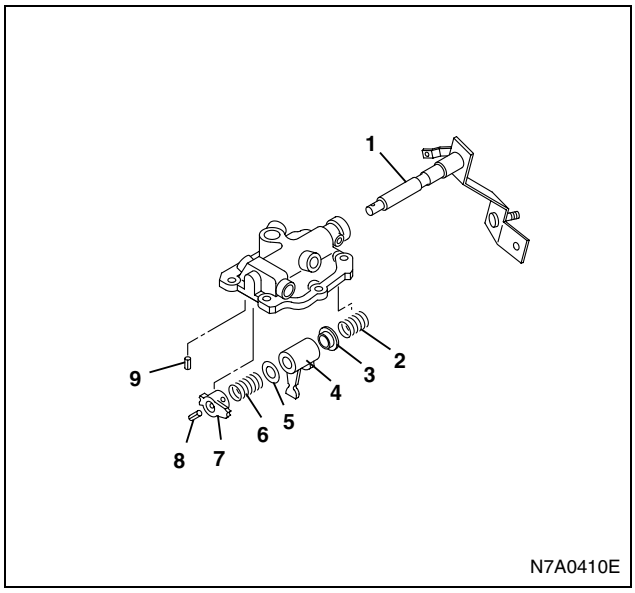


2. Remove the spring pin; select internal lever (4) using the spring pin remover, and then remove the select internal lever (3), select external lever (1) and washer (2).





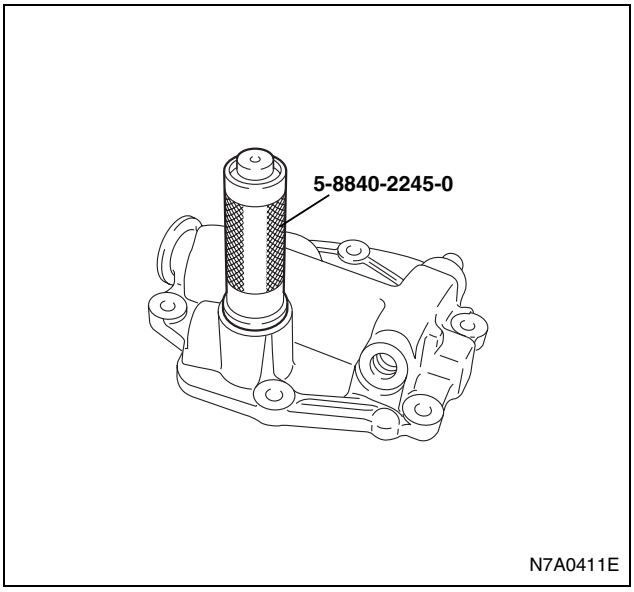
3. Remove the spring pin; stopper ring (8) and the spring pin; shift lever shaft (9).
4. Pull out the shift lever shaft (1), and remove the stopper ring (7), spring (6), spring sheet (5), shift internal lever (4), washer (3) and spring (2).



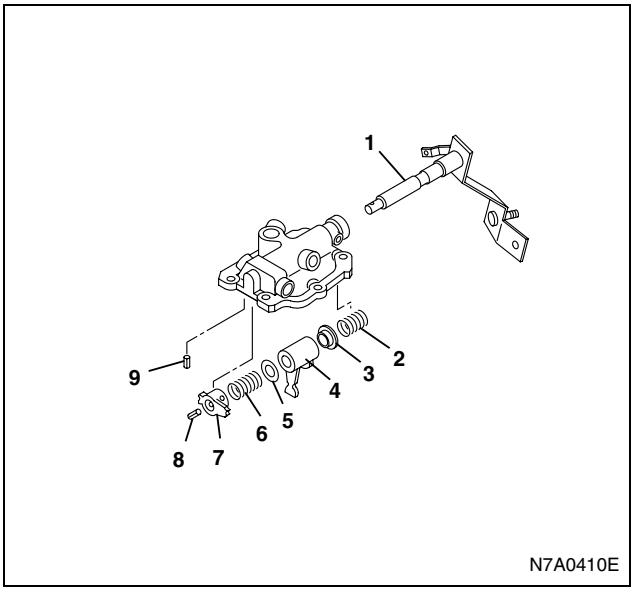
5. Pry and remove with a driver the select lever shaft oil seal and shift lever shaft oil seal from the control box.
   If any wear, damage or other abnormality is found on the disassembled parts, repair or replace them.
6. Inspect wear of the shift shaft, free play of the control box and roughness of the manipulation. If any abnormality is found, replace the part.

Assembly

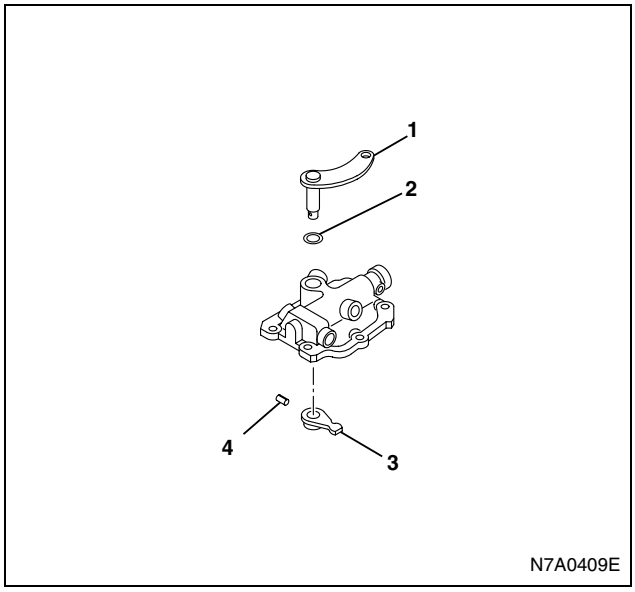
1. Using the installer 5-8840-2245-0 for the control box, install the shift lever shaft oil seal and select lever shaft oil seal.



2. Assemble the spring (2), washer (3), shift internal lever (4), spring sheet (5), spring (6) and stopper ring (7) to the control box. Insert the shift lever shaft (1). Align the pin hole of the shift lever shaft with the pin hole of the stopper ring, and then drive in a new spring pin; stopper ring (8) and spring pin; shift lever shaft (9).



3. Insert the select external lever (1) and washer (2) into the control box. Install the select internal lever (3), and then drive in a new spring pin; select internal lever (4).

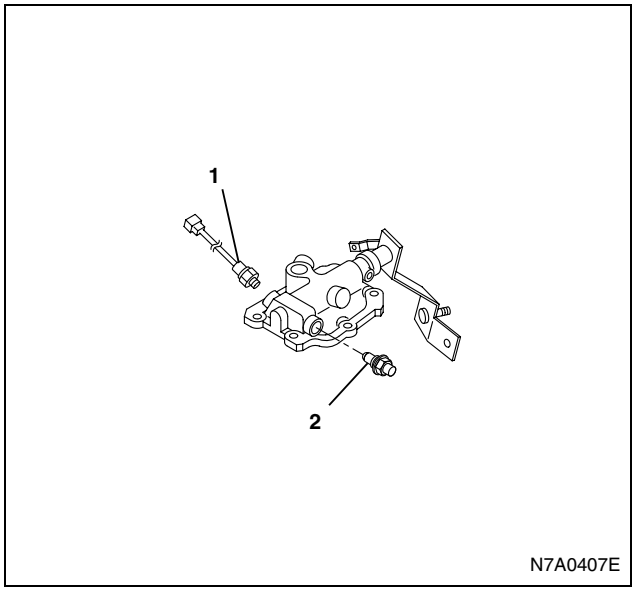


4. Install the detent (2).
   - The detent contains pre-coating agent. Remove completely the seal agent on the screw of the case side before using new detent.

Tighten:
Detent (2) to 28 N·m (2.9 kg·m / 21 lb·ft)

5. Fix the neutral switch (1) to the specified torque.

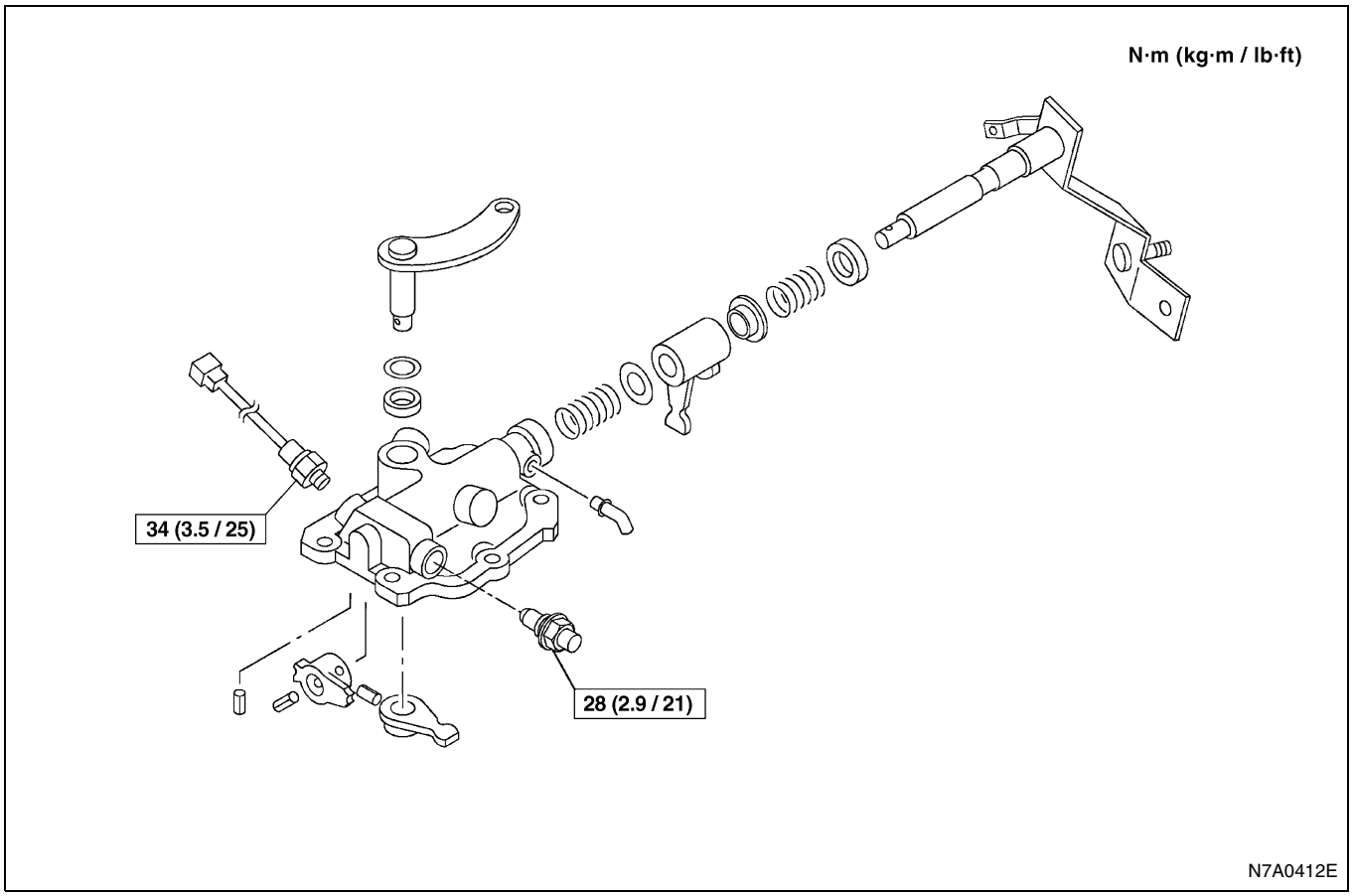
Tighten:
Neutral switch (1) to 34 N·m (3.5 kg·m / 25 lb·ft)



Specifications

Transmission Type			MYY6P	MYY5T
Control System			Floor Remote Control	Floor Remote Control
Gear Ratio				
	Transmission	1st	5.979	5.315
		2nd	3.434	3.053
		3rd	1.862	1.655
		4th	1.297	1
		5th	1	0.721
		6th	0.774	—
		Reverse	5.701	5.068
Oil Capacity	L (US qt / Imp qt)	Standard	3.5 (3.7 / 3.1)	2.8 (3.0 / 2.5)
		4 × 4 Vehicle	—	3.5 (3.7 / 3.1)
		With Front PTO	—	5.5 — 6.0 (5.8 — 6.3 / 4.8 — 5.3)
		With Side PTO	3.8 (4.0 / 3.3)	3.1 (3.3 / 2.7)
		With Side PTO (4 × 4 Vehicle)	—	3.8 (4.0 / 3.3)
Oil			Besco Transaxle Oil 5W-30	

Fixing Torque

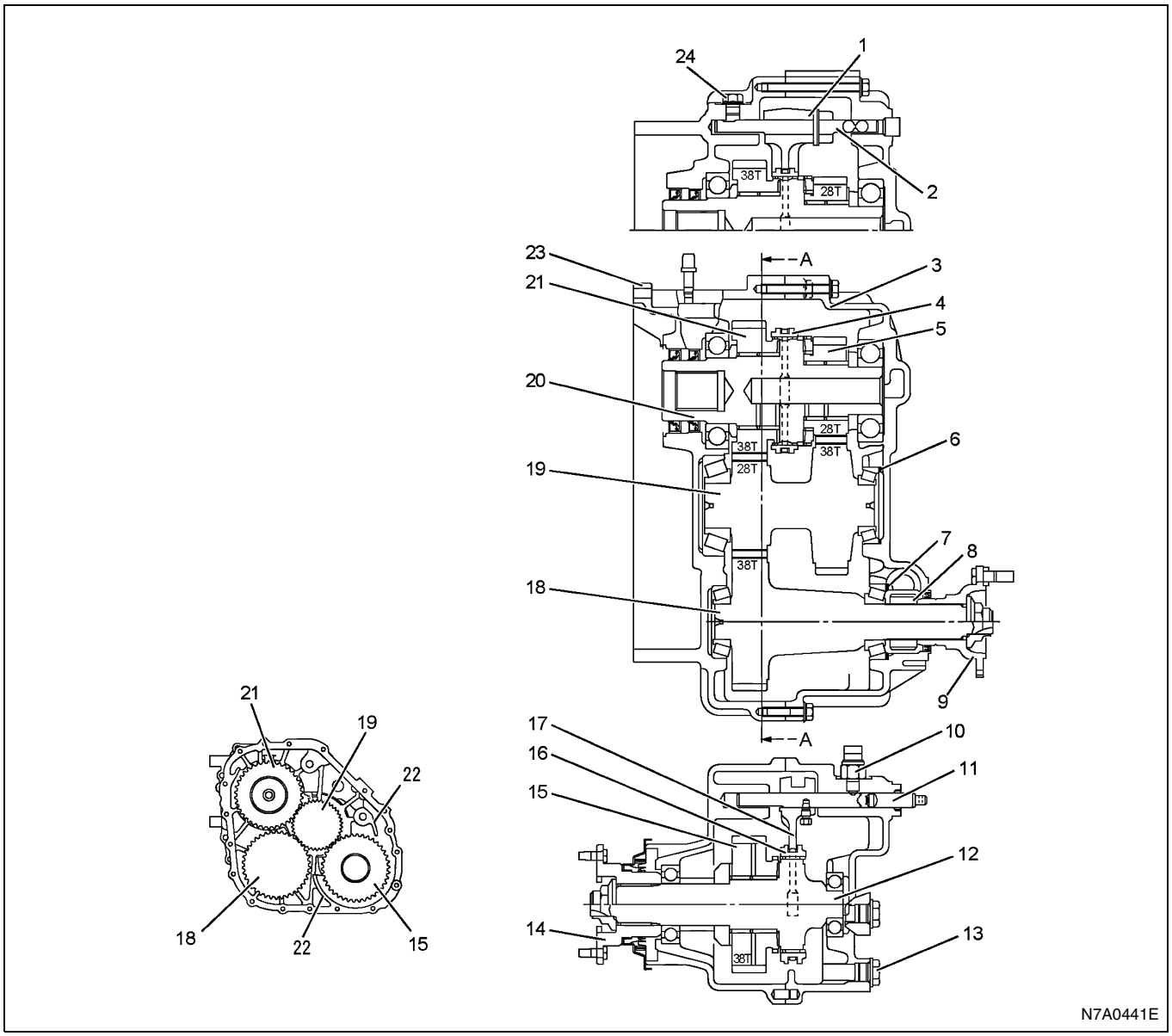


Special Tools

Illustration	Tool Number / Description / Remarks
5884022450	5-8840-2245-0 / Control Box Oil Seal Installer

Transfer System (MYY Rigid Type)

Function and Operation



Legend

1. Low / high shift arm
2. Low / high shift rod
3. Transfer rear case
4. Sleeve; Low / high
5. Transfer low gear
6. Shim; Counter shaft bearing
7. Shim; Rear output shaft bearing
8. Speedometer drive gear
9. Driver coupling; Rear output
10. 2WD / 4WD sensor switch
11. 2WD / 4WD shift rod
12. Front output shaft
13. Drain plug
14. Driver coupling; Front output
15. Front output drive gear
16. Sleeve; 2WD / 4WD
17. 2WD / 4WD shift arm
18. Rear output shaft
19. Idle gear shaft
20. Input shaft
21. Transfer high gear
22. Current plate
23. Transfer front case
24. Low / high sensor switch

Specifications

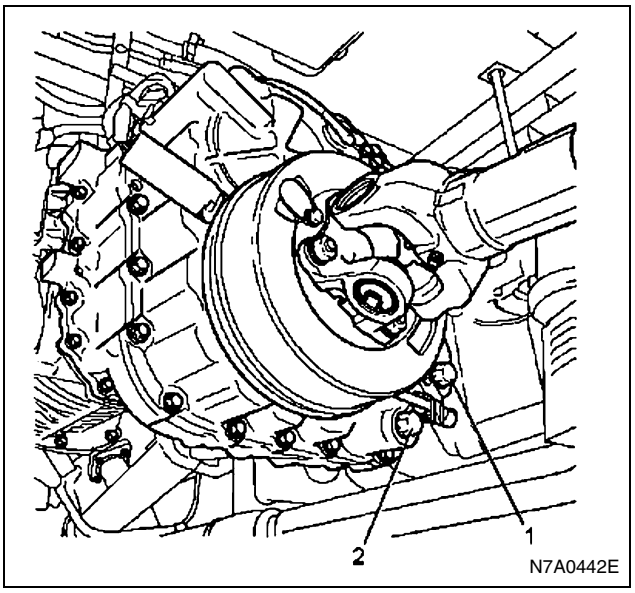
Type		2nd, helical gear type
Gear Ratio	High Range	1.000 (28/38 × 38/28)
	Low Range	1.842 (38/28 × 38/28)
Specified Oil		Besco Gear Oil Transaxle (5W-30)
Oil Capacity L (US qt/Imp qt)		1.8 (1.9 / 1.6)

Transfer Assembly (MYY Rigid Type)

Removal

Preparation

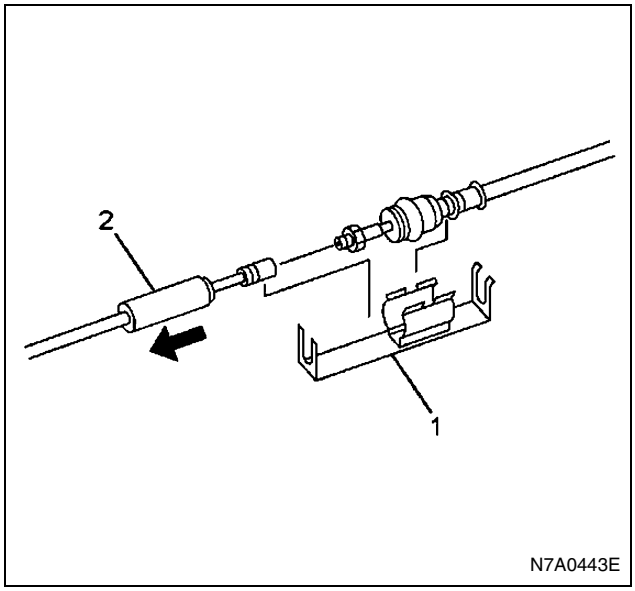
- Jack up the vehicle, and support with a rigid rack.
- Remove the drain plug, and drain the oil.



Legend

1. Filler plug
2. Drain plug

1. Remove the propeller shaft guard.
2. Remove the transfer side of the rear propeller shaft.
   - Before removing the propeller shaft, put alignment marks on the transfer flange and the propeller shaft flange yoke.
   - The removed propeller shaft must be put aside not to interfere with the operation, and fix securely with wire.
3. Disconnect the parking brake cable.
   - Remove the cable bracket (1) and slide the cover (2) in the direction indicated by an arrow.
   - Loosen the lock nut, and remove the front cable and the rear cable.



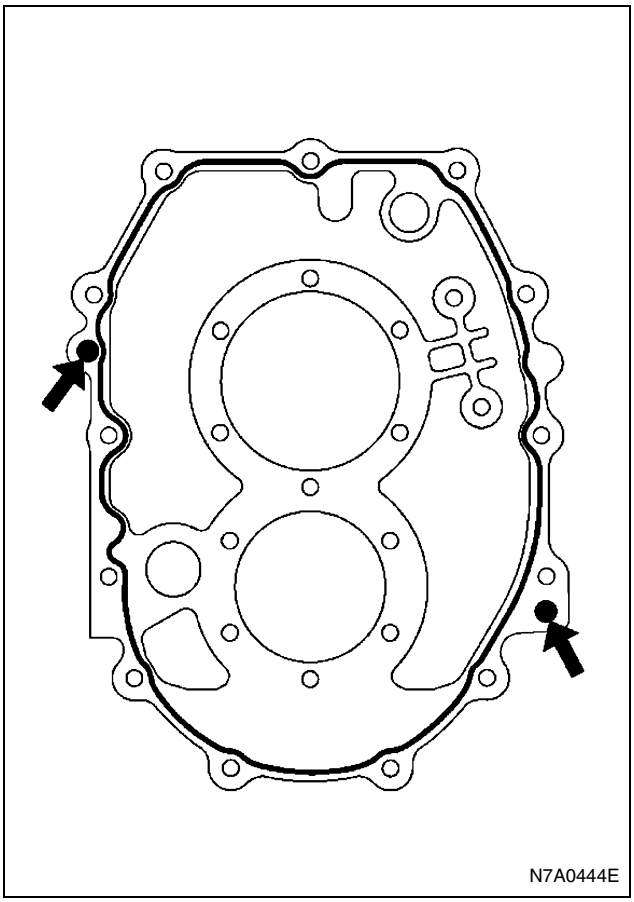
   - Remove the cable clip of the rear cable.
4. Remove the front propeller shaft.
   - Before removing the propeller shaft, put alignment marks on the transfer flange and the propeller shaft flange yoke.
5. Remove the low / high shift cable installation bracket.
6. Remove the vehicle speed sensor connector.
7. Remove the 2WD / 4WD change warning lamp switch connector.
8. Remove the 2 parts of the vacuum hose.
9. Remove the harness and nut on the transfer side.
10. Remove the transfer assembly from the transmission.
    - Set securely the transmission jack to the transfer assembly.
    - Remove 11 bolts and 2 nuts for transfer installation.
    - Remove the transfer assembly by operating the transmission jack.

Installation

Install in the reverse order of removal, observing the following items.

- Apply liquid packing (ThreeBond 1215) on the transfer mating surface of the transmission case.

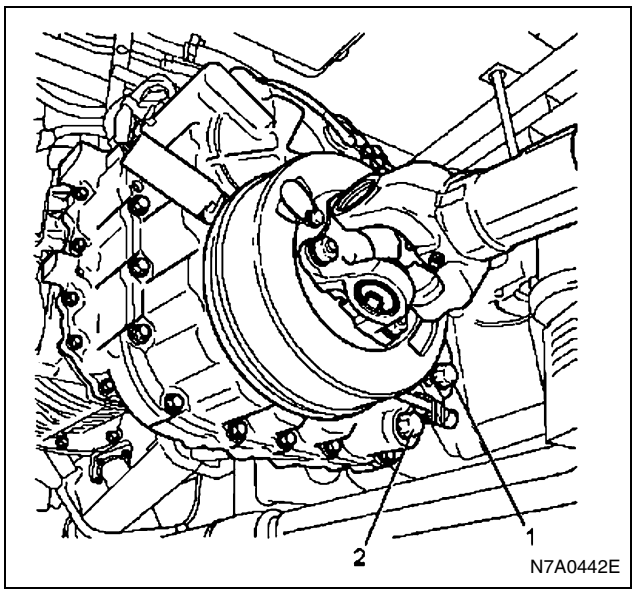
- Liquid packing (ThreeBond 1215) must be applied continuously with a diameter of 2 mm (0.079 in).
- Align the transfer assembly with the stud bolts indicated by arrows, and install it to the transmission.



- Transfer assembly to transmission assembly fixing torque

Tighten:
Transfer assembly to transmission assembly to 46 N·m (4.7 kg·m / 34 lb·ft)

- Inject gear oil into the transfer assembly.
  Product Name: Besco Gear Oil Transaxle (5W-30)
  Capacity: 1.8L (1.9 US qt / 1.6 Imp qt)



Legend
1. Filler plug
2. Drain plug

- Fixing torque of the oil filler and drain plug

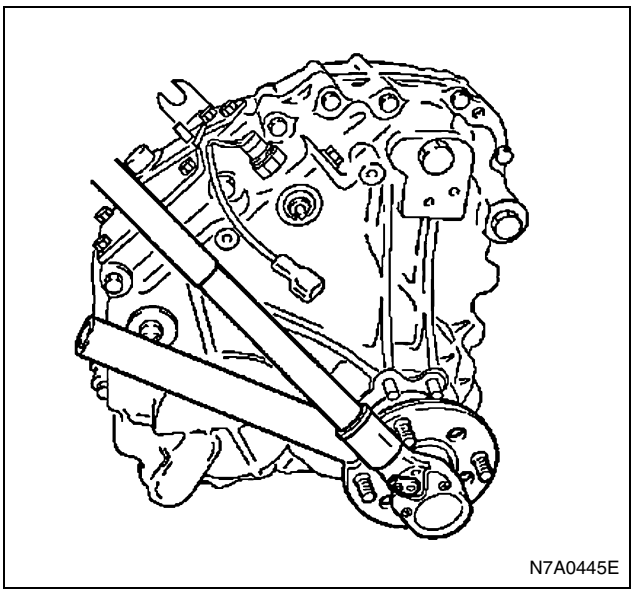
Tighten:
Oil filler and drain plug to 39 N·m (4.0 kg·m / 29 lb·ft)

Transfer (MYY Rigid Type)

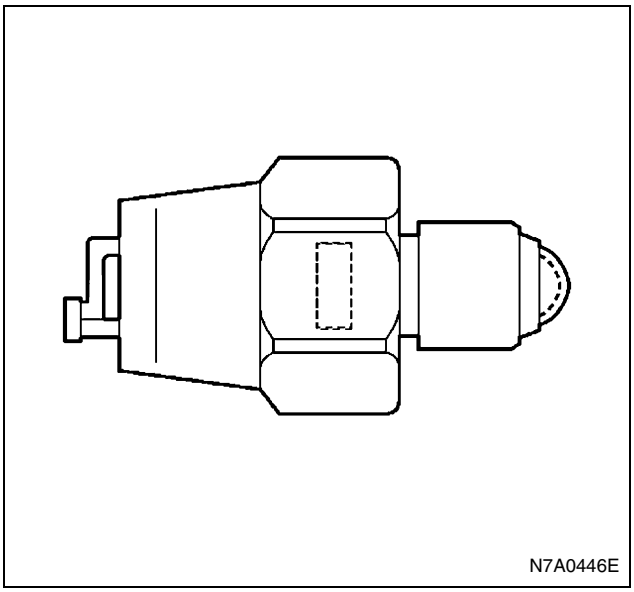
Disassembly

Caution:
Make sure to shift the gear to 4H before disassembling the front & rear transfer case.

1. Securely raise the caulking parts of the lock nut of the coupling driver.
2. Fix the rear coupling driver using the flange holder 5-8840-2043-0, and remove the lock nut.
3. Fix the front coupling driver using the flange holder 5-8840-0133-0, and remove the lock nut.
   - The rear coupling driver is shown in the figure below.


N7A0445E

4. Remove the 2WD/4WD change warning lamp switch.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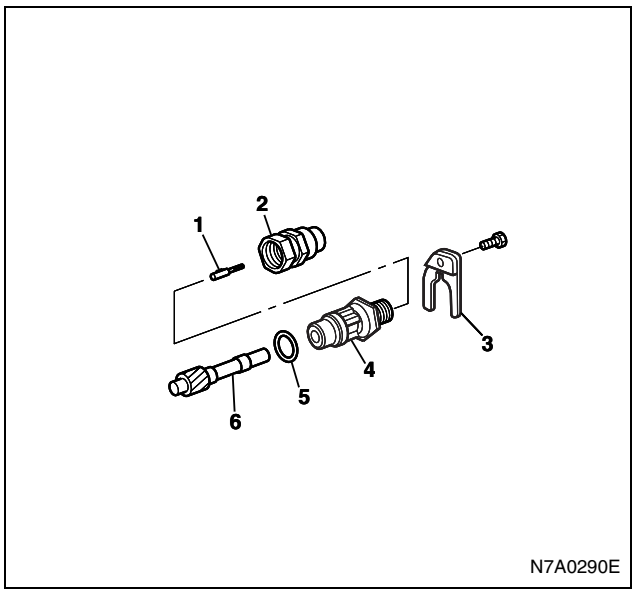
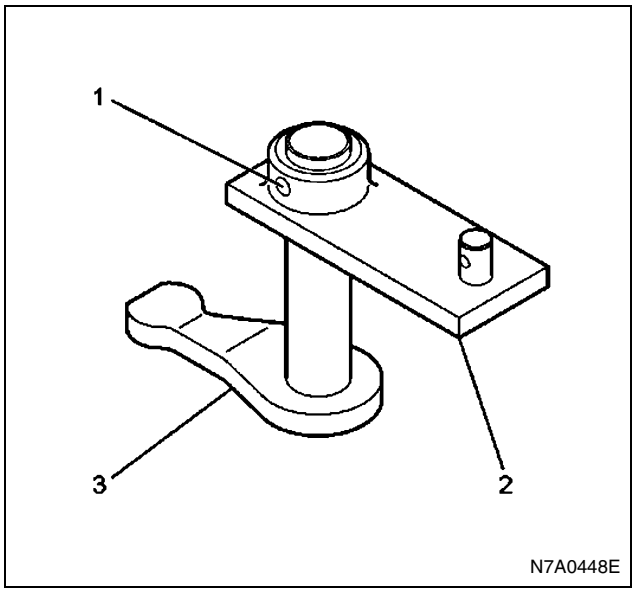
5. Remove the breather.
6. Remove the speed sensor driven gear.



N7A0290E

Legend
1. Insertion key
2. Vehicle speed sensor
3. Plate
4. Bush
5. O-ring
6. Driven gear

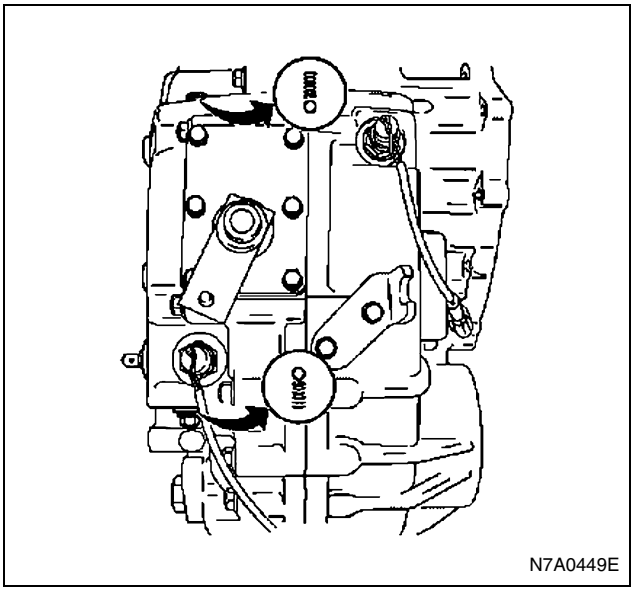
7. Remove the low / high change lever.



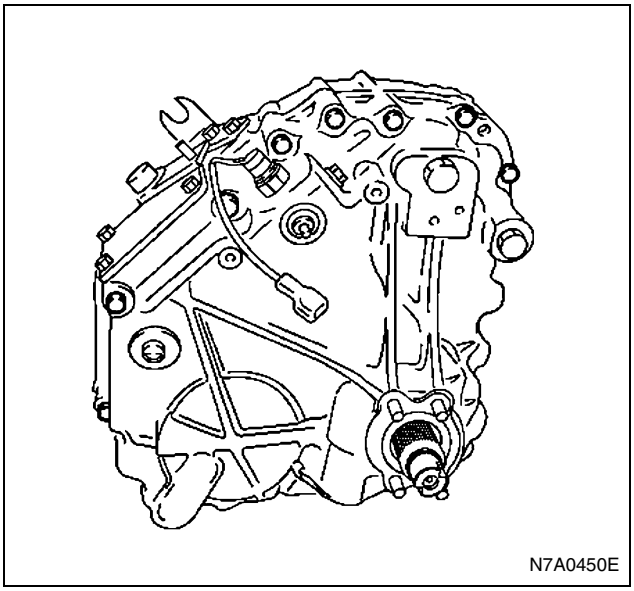
N7A0448E

Legend
1. Spring pin
2. Select external lever
3. Select internal lever

8. Remove the control cable bracket.
9. Remove the detent ball and detent spring.
   - Two parts


N7A0449E

10. Remove the transfer rear case.
    - Remove the 18 bolts.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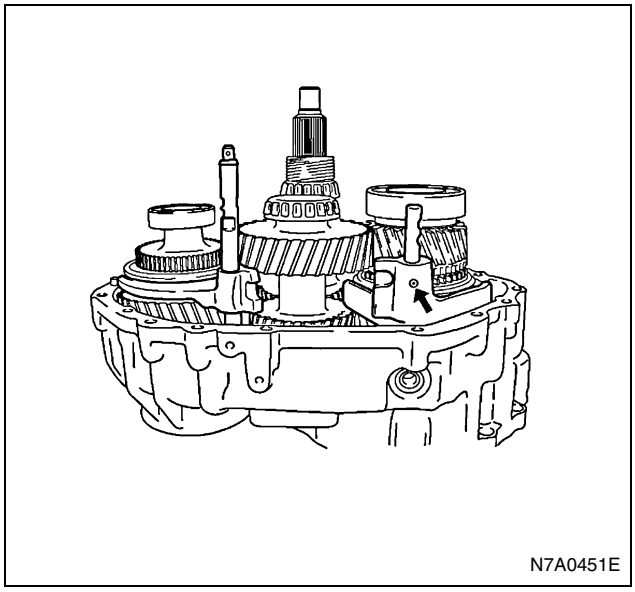
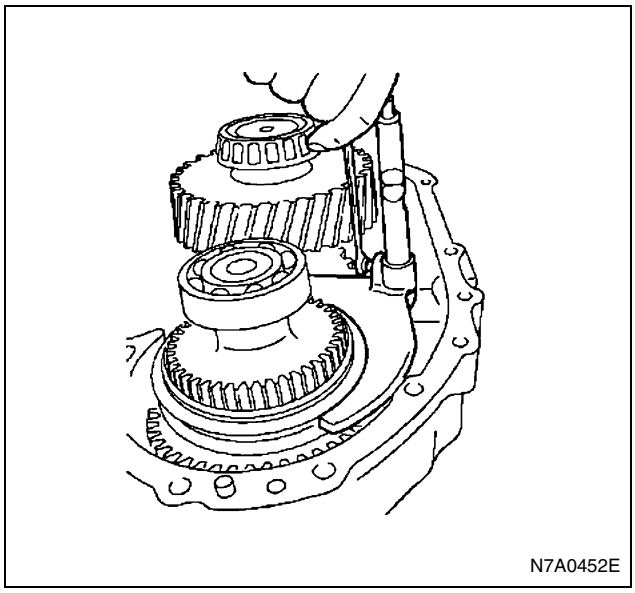
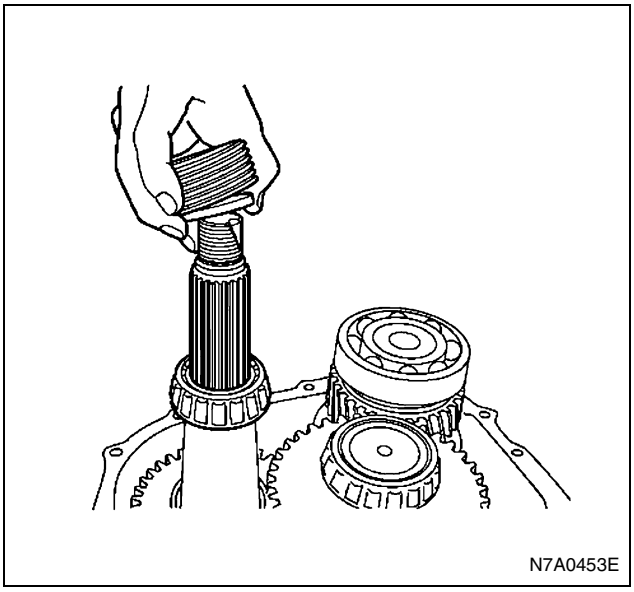
11. Remove the low / high change shift arm and the shift lock.
    - Drive out the spring pin, and then remove the shift arm and the shift rod.


N7A0451E

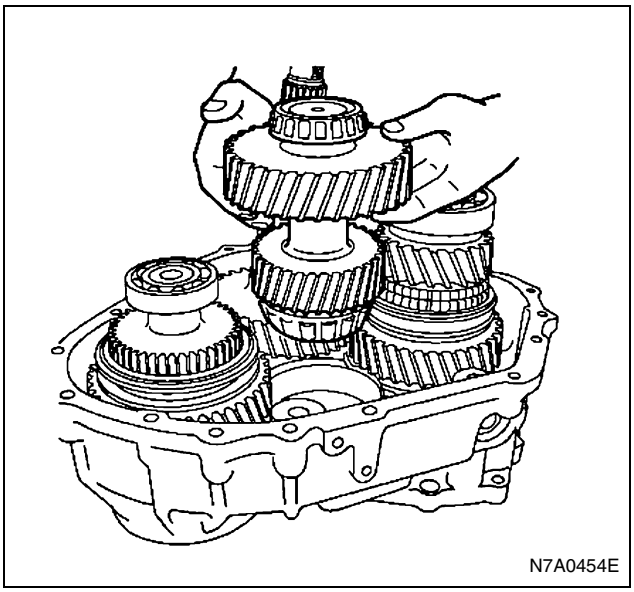
12. Remove the 2WD / 4WD change shift arm and shift rod.
    - Loosen the shift arm fixing bolt, and remove the shift arm and the shift rod.


N7A0452E

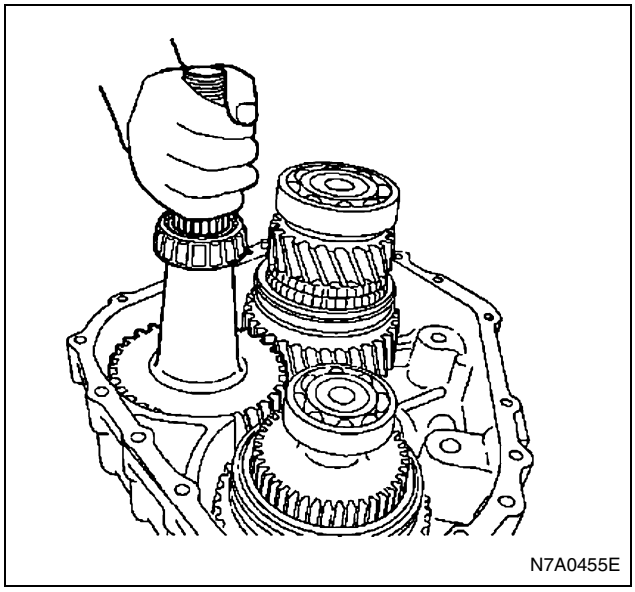
13. Remove the speedometer driven gear and the thrust washer.



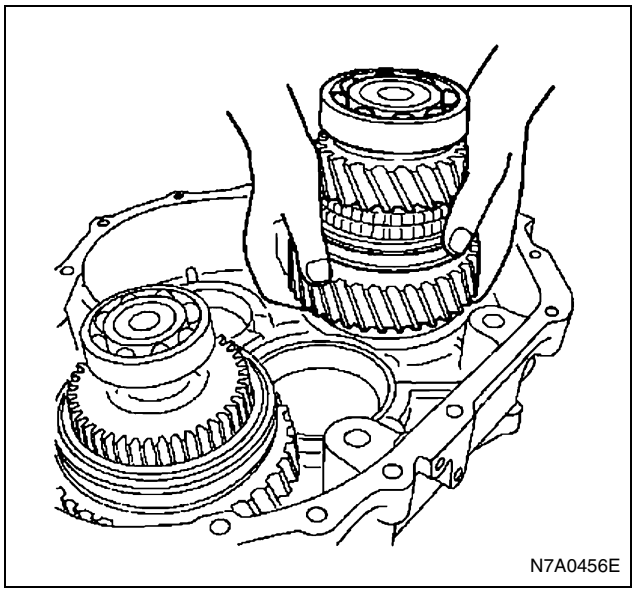
14. Remove the idle gear shaft from the transfer case.



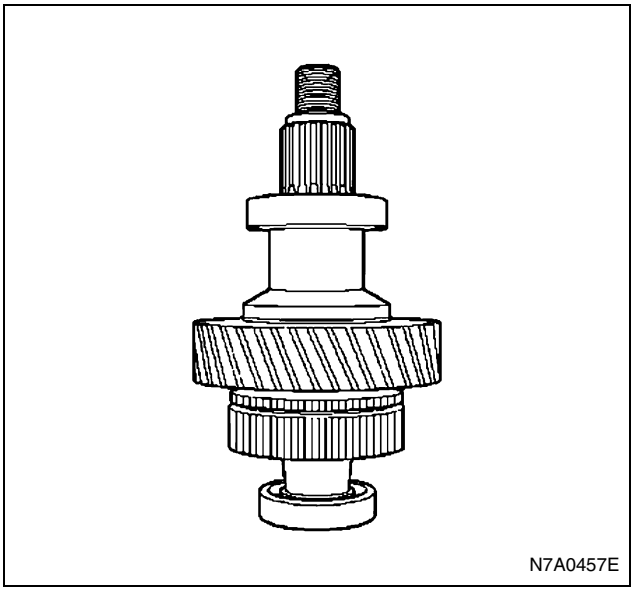
15. Remove the rear output gear shaft from the transfer case.



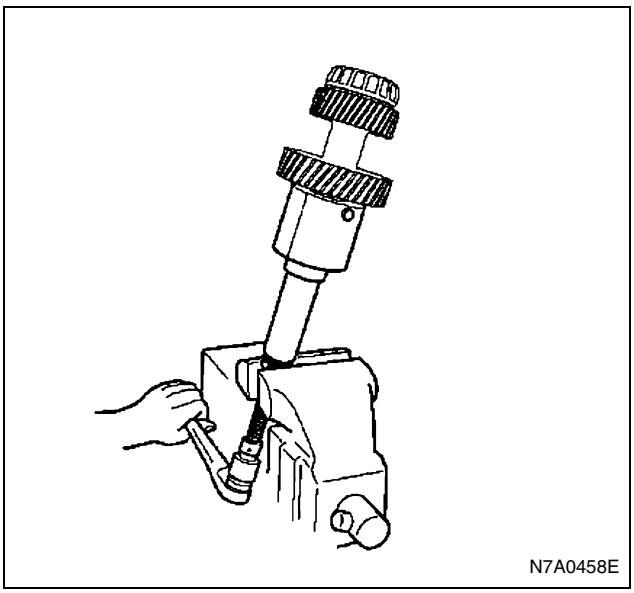
16. Remove the input gear shaft from the transfer case.



17. Remove the front output gear shaft from the transfer case.


N7A0457E

18. Remove the front & rear bearing from the idle shaft.
    - Remove the front bearing using a general-purpose bearing remover.
    - Remove the rear bearing using the insert 303173 and the collet 44801 from among the parts of the bearing remover 5-8840-2587-0.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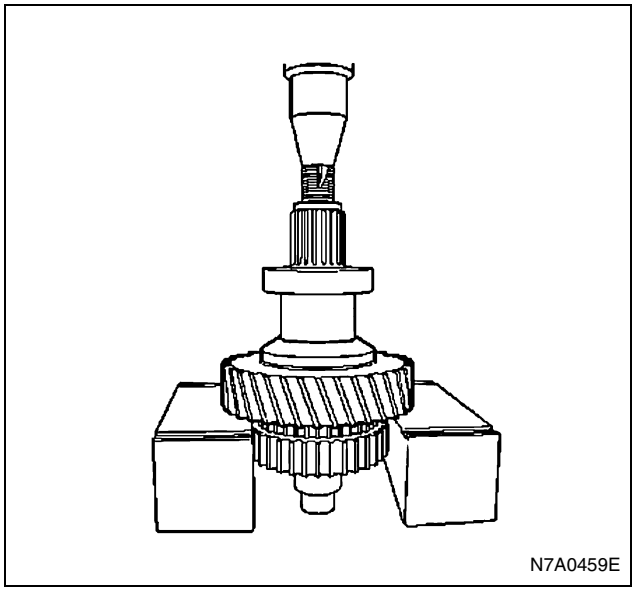
19. Disassemble the front output gear shaft.
    - Before removing the ball bearing, put a mark which indicates the installation direction.
    - Remove the front & rear bearing using a general-purpose bearing remover.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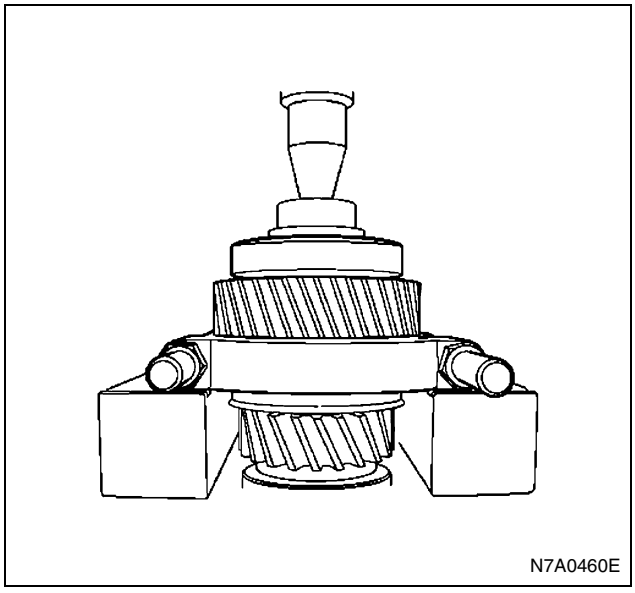
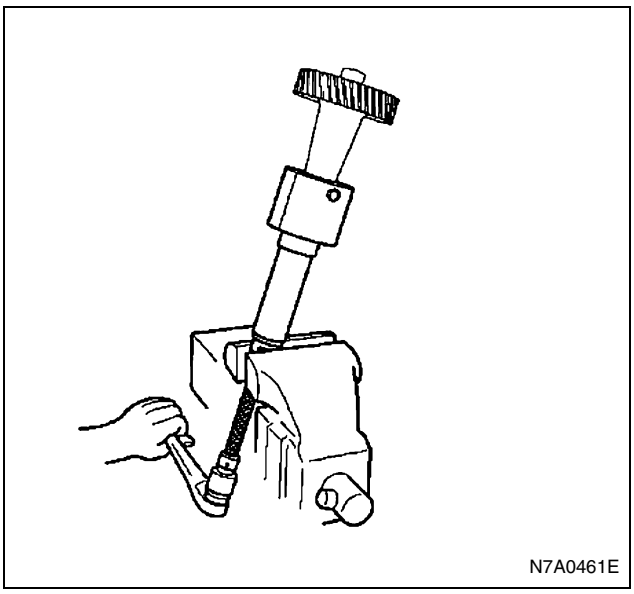
    - After removing the ball bearing, remove the collar, thrust washer, front output drive gear and needle bearing.
20. Disassemble the input gear shaft.
    - Remove the front & rear bearing using a general-purpose bearing remover.


N7A0460E

    - After removing the front bearing, remove the thrust washer, transfer high gear, needle bearing and sleeve.
    - After removing the rear bearing, remove the thrust washer, transfer low gear and needle bearing.
21. Remove the front & rear bearing from the rear output gear shaft.
    - Remove using the bearing remover 5-8840-2587-0.
    - Remove using the insert 303173 and the collet 44801 from among the parts of the bearing remover.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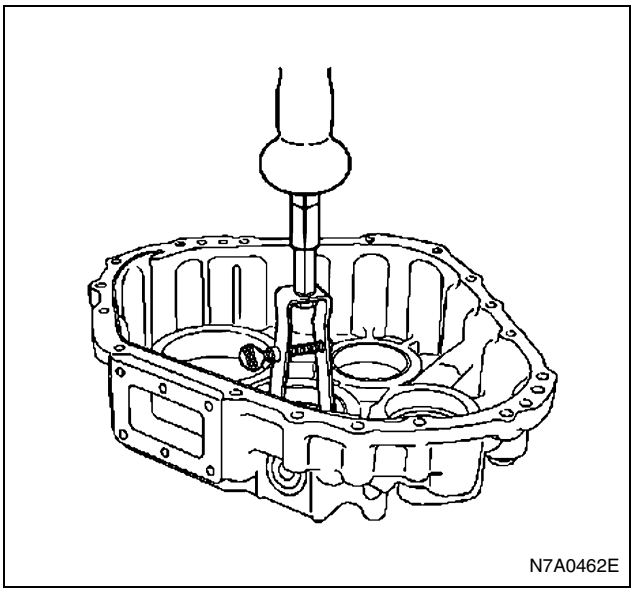
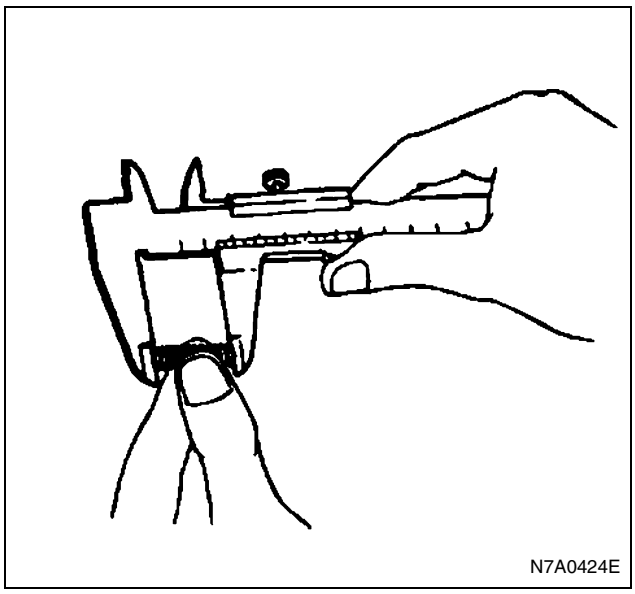
22. Remove the bearing outer race of the idle gear shaft.
    - Remove using the bearing race remover 5-8840-0027-0.


N7A0462E

Assembly

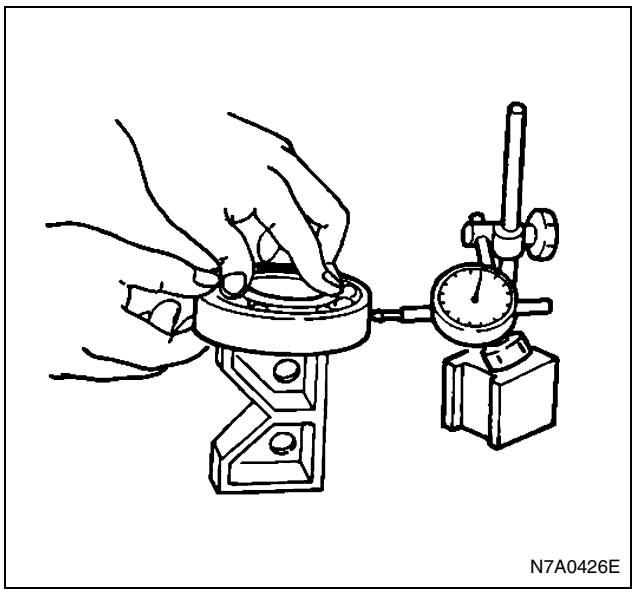
1. Clean and inspect the disassembled parts. If any abnormality including wear, damage or corrosion is found, repair or replace the part.
    - Measure the free length of the detent spring.

Free Length of Detent Spring
Standard: 31.6 mm (1.244 in) Limit: 30.1 mm (1.185 in)


N7A0424E

- Inspect each bearing. If any abnormality is found, replace the bearing.
  - Smoothness of rotation
  - Noise
  - Abnormal external appearance, including damage or rust
  - Abnormal free play in thrust direction
  - Discoloration, excessive wear and pitching of rotating body and rotating surface of needle bearing
- Measure the free play in the radial direction of the ball bearing.

Free play in the radial direction of the ball bearing
Limit: 0.2 mm (0.0079 in)

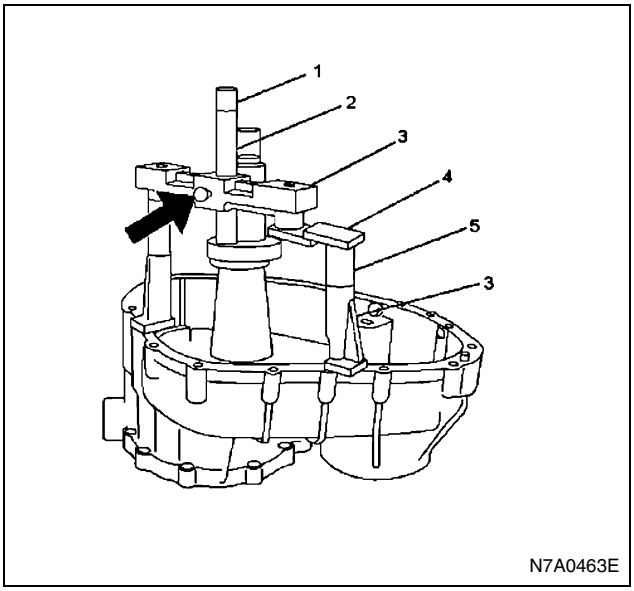

N7A0426E

- Inspect the sleeve sliding surface of the shift arm. Check that there is no excessive wear or damage.
- Inspect the gear. Repair slight stepped surface or roughness using an oil stone or pencil grinder.

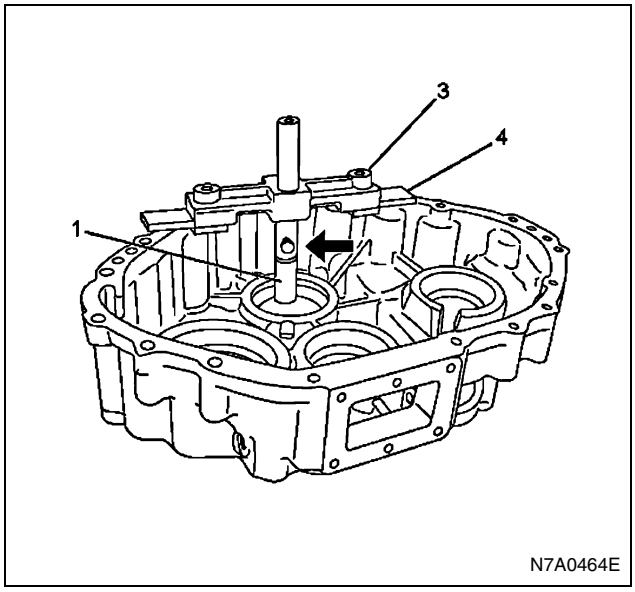
– Damage on tooth surfaces
– Excessive wear of tooth surfaces
– If excessive wear or damage is found on the tooth surfaces of the dog clutch, replace the part.

• Oil seal
– Replace the removed oil seal with a new one.

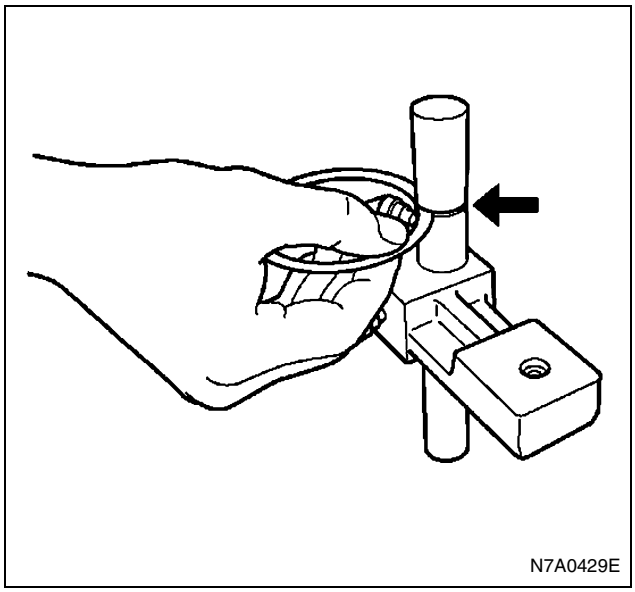
2. Bearing shim adjustment
• Adjust the thickness of the shim of the rear output shaft rear bearing, using the shim selector 5-8840-0194-0 and shim selector adaptor 5-8840-2794-0.
• Measure the thickness of the shim, using the gauge pin J-35824-8 (1), gauge cylinder J-35824-31(2), bridge assembly J-35824-1(3), extension J-35824-19(4) and spacer J-35824-30(5) included in the shim selector gauge and the shim selector set.



a. Loosen the screw, put the gauge cylinder on the rear bearing edge surface of the output shaft, and fix with the screw.
b. Remove the leg and spacer from the bridge. Install the extension (4) to the bridge to enable the bridge to connect to the rear transfer case mating surface.



c. Turn the bridge assembly upside down, and then set the bearing assembly to the installation hole surface of the output shaft rear bearing of the mating side rear transfer case.
d. Loosen the screw, put the gauge pin (1) on the bearing installation surface, and fix the screw.
e. Measure the clearance between the gauge cylinder and the gauge pin, and select the size of the shim. Adjustment to the standard end plate 0 — 0.05 mm (0 — 0.002 in) becomes possible.



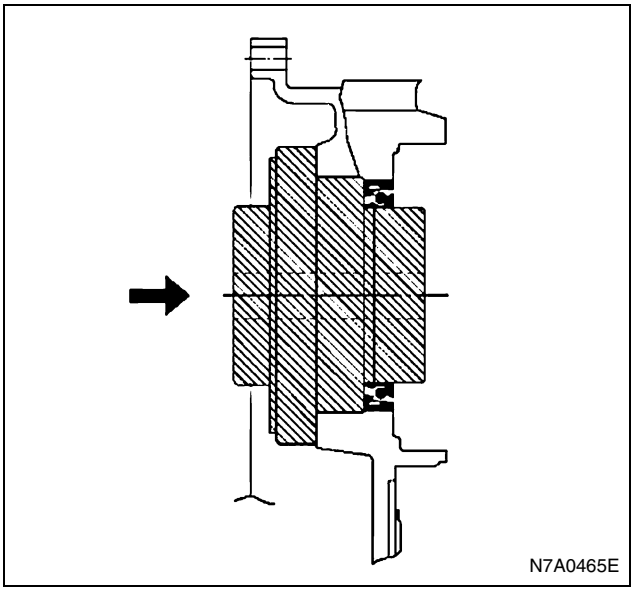
• Set the selected shim on the bearing surface of the bearing race, and press in the race.
• Adjust the shim for the bearing outer of the idle shaft in the same manner.

Shims, which can be selected, mm (in)	
Idle gear shaft	0.18 (0.0070)
Rear output gear shaft	0.25 (0.0098)
	0.30 (0.0118)
	0.35 (0.0137)
	0.40 (0.0157)
	0.50 (0.0196)

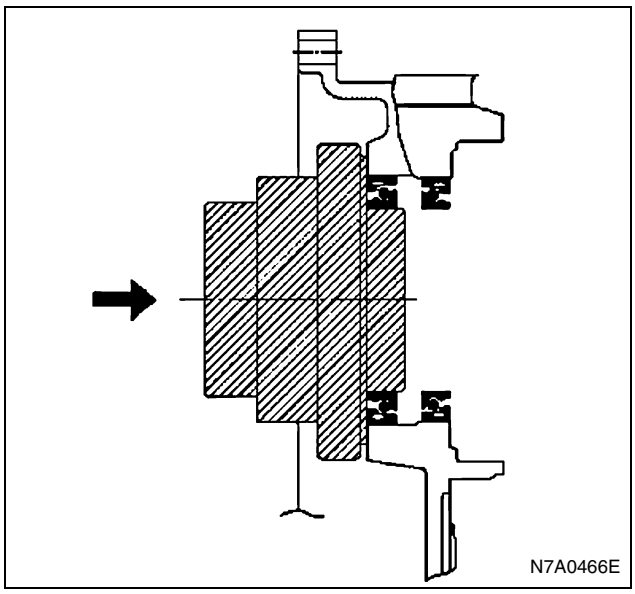
3. Install the oil seals of the rear output shaft, front output shaft and input shaft.
   - Apply engine oil on the outer circumference of a new oil seal, and apply grease (Besco L2 or equivalent) to the lip part.
   - Install the rear output oil seal using the installer 5-8840-2775-0.
   - Install the front output oil seal using the installer 5-8840-2774-0.
   - Install the input oil seal using the installer 5-8840-2776-0.

Caution:
Make sure to install the inner side and outer side of the input shaft oil seal from the transmission side.

- Installation direction of the inner side oil seal of the input shaft is indicated.

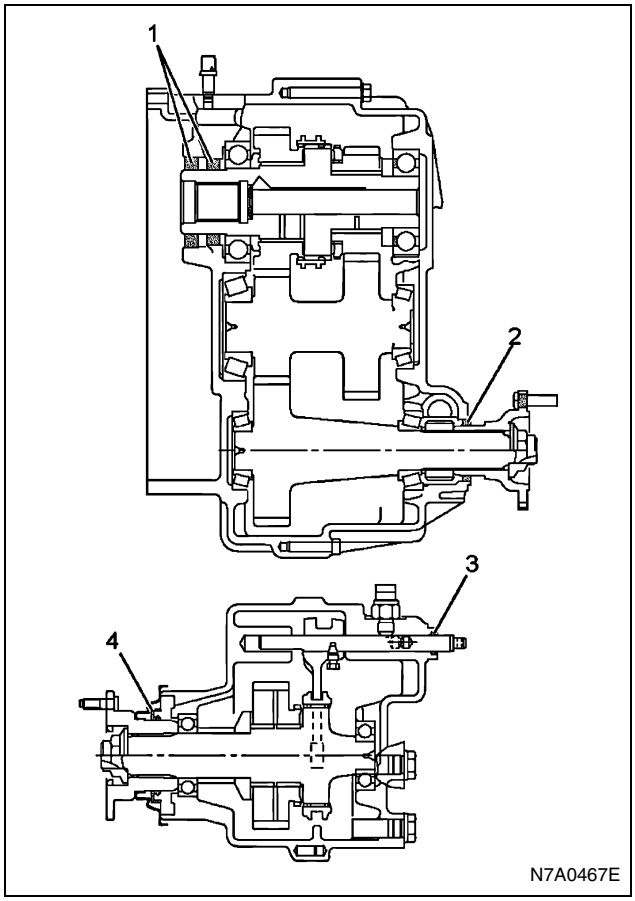


- Installation direction of the outer side oil seal of the input shaft is indicated.



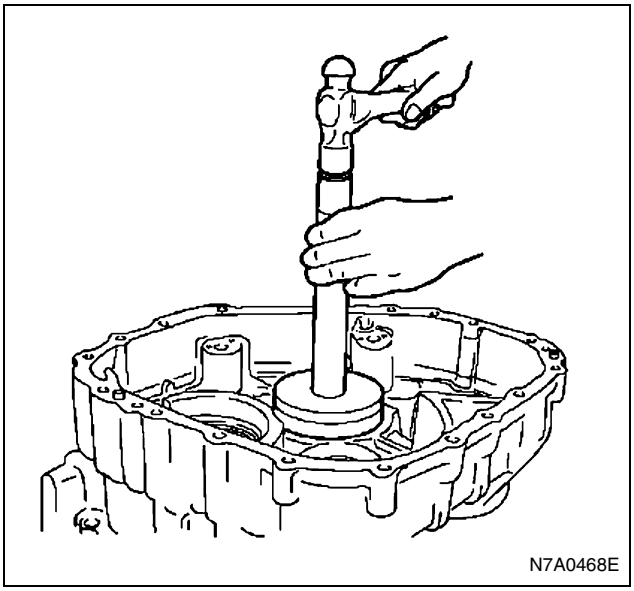
- Install the oil seal of the 2WD / 4WD change shift rod part of the rear transfer case.
- Install the front output shaft oil seal to the front transfer case.

Installation Position

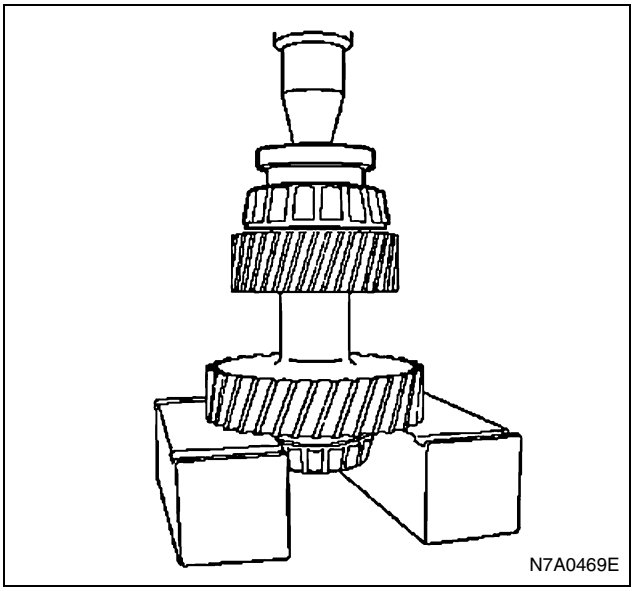


Legend
1. Input shaft oil seal
2. Rear output shaft oil seal
3. Shift rod oil seal
4. Front output shaft oil seal

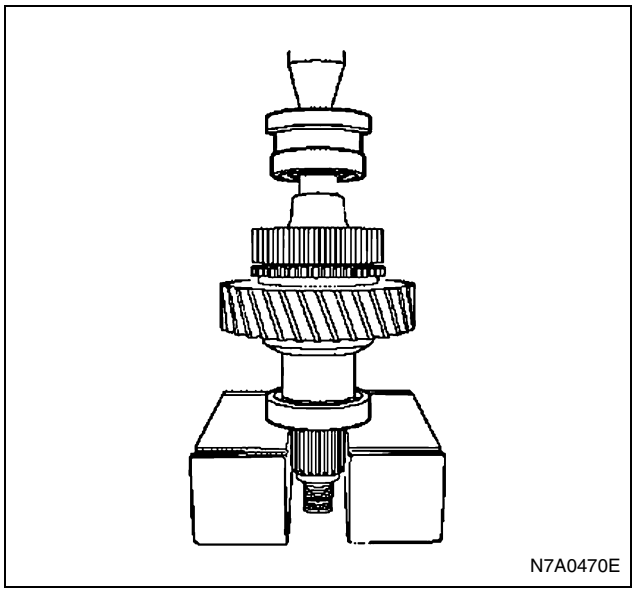
4. Press in the bearing outer race of the idle gear shaft and rear output gear shaft.
   - Use the installer 5-8840-2773-0 and the grip 5-8840-0007-0 to press in the front side outer race of the idle gear shaft.
   - Use the installer 5-8840-2235-0 and the grip 5-8840-0007-0 to press in the rear side outer race of the idle gear shaft.
   - Use the installer 5-8840-2772-0 and the grip 5-8840-0007-0 to press in the front & rear side outer race of the rear output gear shaft.


N7A0468E

5. Install the front & rear bearing inner race of the idle gear shaft.
   - Use a press machine to press in the roller bearing.


N7A0469E

6. Assemble the front output gear shaft.
   - Before installing the ball bearing, install the needle bearing, front output drive gear, thrust washer and collar.
   - Use a press machine to press in the ball bearing.


N7A0470E

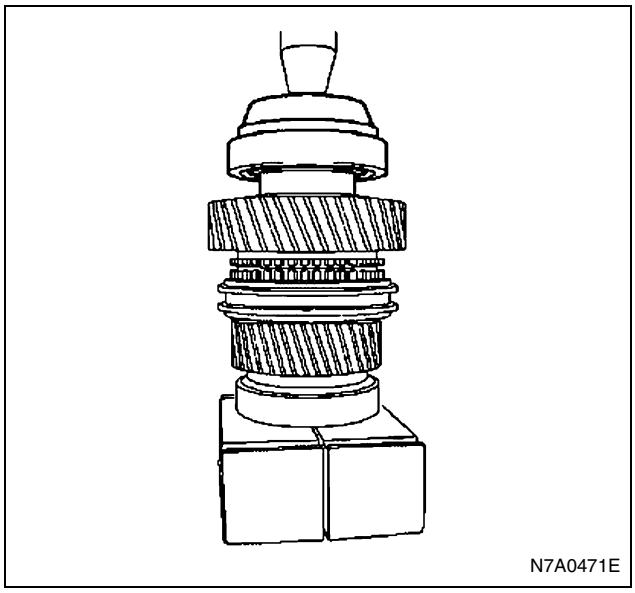
   - After installing the ball bearing, install the sleeve in accordance with the marked direction.

Caution:
Make sure to install in the correct direction.

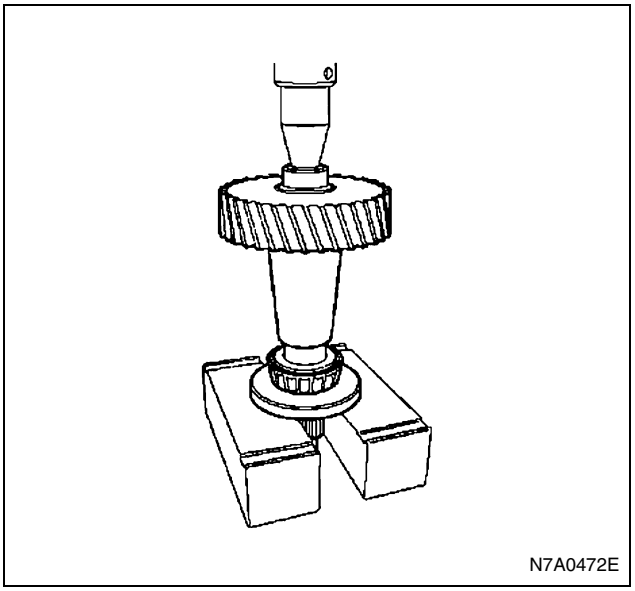
7. Assemble the input gear shaft.
   - Before installing the front side ball bearing, install the needle bearing, transfer low gear and thrust washer.
   - Before installing the rear side ball bearing, install the sleeve, needle bearing, transfer high gear and thrust washer.

Caution:
Install the sleeve by turning the side, which has a groove along its outer circumference, toward the front side.

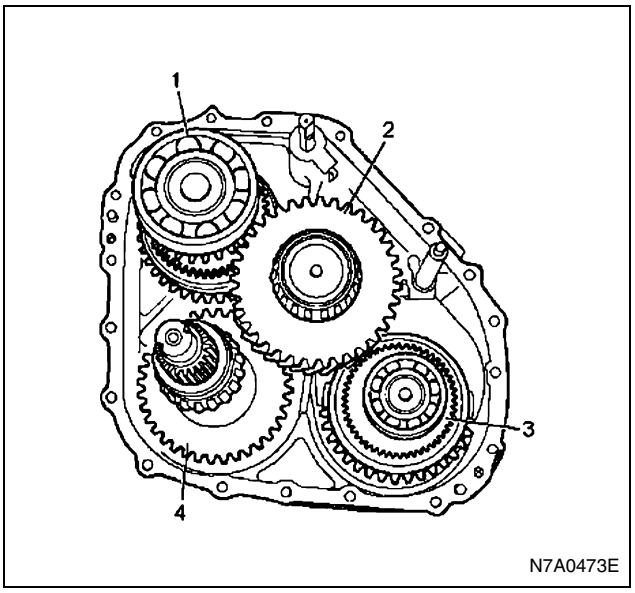
   - Use a press machine to press in the ball bearing.


N7A0471E

8. Install the bearing of the rear output gear shaft.
   - Use a press machine to press in the ball bearing.


N7A0472E

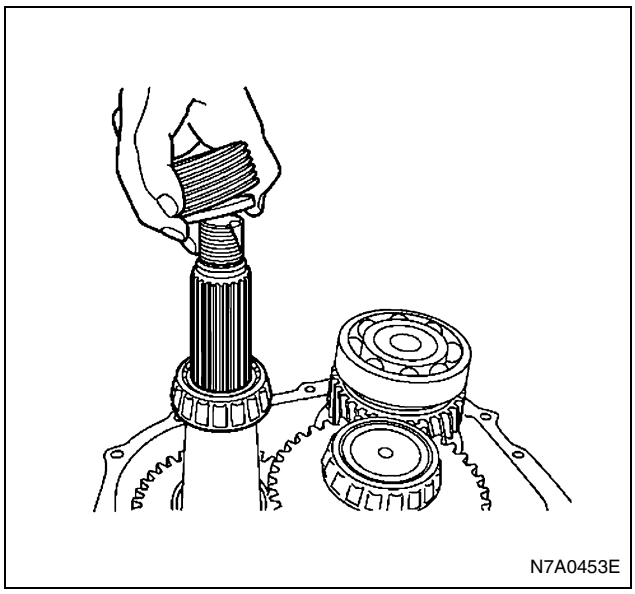
9. Install the front output gear shaft to the front transfer case.
10. Install the input gear shaft.
11. Install the rear output gear shaft.
12. Install the idle gear shaft.
    - Install in the order of 9, 10, 11 and 12.



N7A0473E

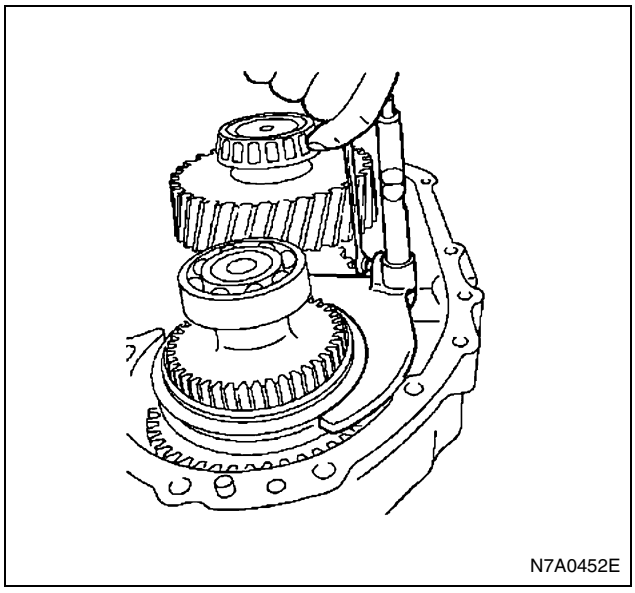
Legend
1. Input gear shaft
2. Idle gear shaft
3. Front output gear shaft
4. Rear output gear shaft

13. Install the thrust washer and speedometer drive gear.

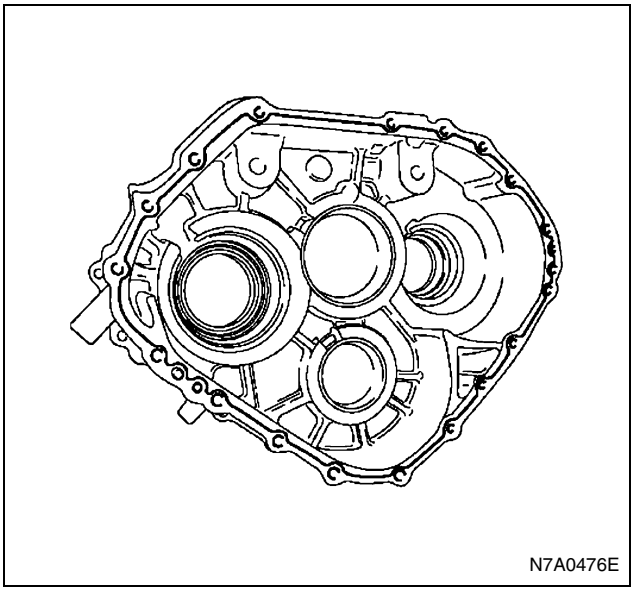

N7A0453E

14. Install the shift arm and shift rod.
    - Use a spring pin to install the shift arm of the low / high change side.
    - Use a bolt to fix the shift arm of the 2WD / 4WD change side. Apply LOCTITE 242 to the threaded part of the bolt.

Tighten:
Shift arm and shift rod to 23 N·m (2.3 kg·m / 17 lb·ft)

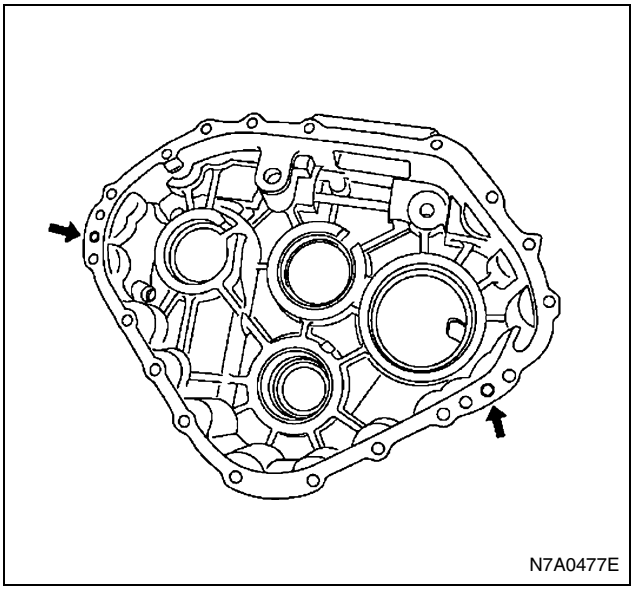

N7A0452E

15. Install the rear transfer case.
    - Apply liquid packing (ThreeBond 1215) to the mating surface of the front transfer case. Liquid packing must be applied to the inside of the bolt hole continuously with a diameter of 2 mm (0.079 in).


N7A0476E

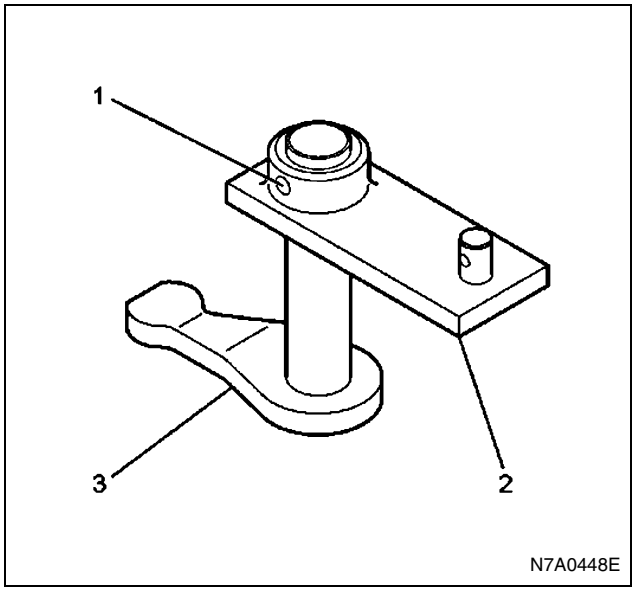
- Do not drop the detent shaft.
- Align with the 2 knock pins.
- Set the 18 bolts on the fixing holes, and fix them diagonally and equally.

Tighten:
Transfer case to 33 N·m (3.4 kg·m / 24 lb·ft)


N7A0477E

16. Install the shift lever.
    - Check that the internal lever is securely put in the groove of the shift arm.
    - Apply liquid packing (ThreeBond 1215) to the mating surfaces of the shift cover and transfer case, and fix it with a bolt.

Tighten:
Shift lever to 17 N·m (1.7 kg·m / 13 lb·ft)



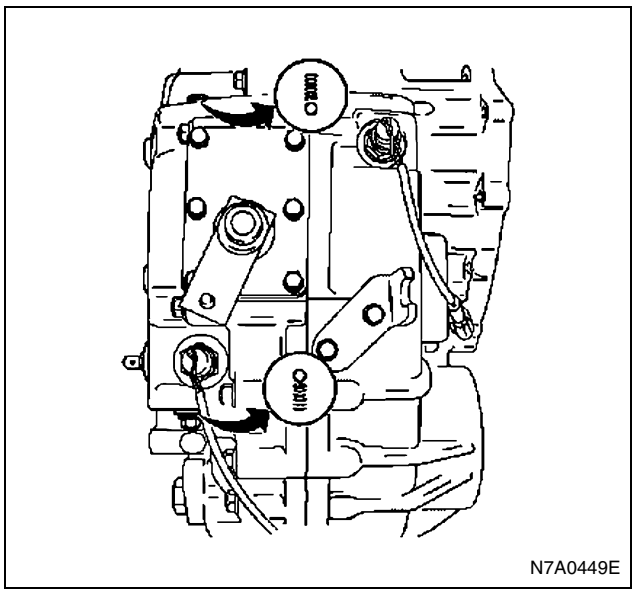
N7A0448E

Legend
1. Spring pin
2. Select external lever
3. Select internal lever

17. Install the detent balls and springs in two parts.
    - Install the detent balls and springs for 4H & 4L and 2WD & 4WD to the rear transfer case.
    - Apply liquid gasket (ThreeBond 1105) to the thread of the plug, and fix it to the specified torque.

Tighten:
Plug to 25 N·m (2.5 kg·m / 18 lb·ft)

Caution:
Do not drop the parts.


N7A0449E

18. Install the low / high shift lever cable installation bracket.

- Apply liquid gasket (ThreeBond 1215) only to the thread of the bolt, which is to be fixed through the bore hole of the case side.

Tighten:
Bolt to 17 N·m (1.7 kg·m / 13 lb·ft)

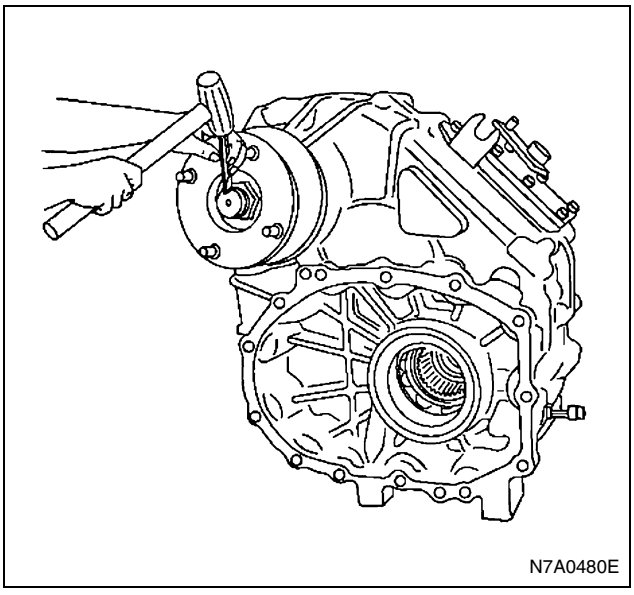
19. Install the 2WD / 4WD change warning lamp switch.
    - Apply liquid gasket (ThreeBond 1105) to the switch thread.

Tighten:
2WD / 4WD change warning lamp switch to 33 N·m (3.4 kg·m / 25 lb·ft)

20. Install the rear & front coupling driver.
    - Use the flange holder 5-8840-0133-0 to fix the front coupling driver, and tighten it with a lock nut.
    - After installing the parking brake assembly, use the coupling driver and lock nut to install the rear output shaft.
      Tighten the lock nut by fixing the coupling driver using the flange holder 5-88470-2043-0.

Tighten:
- Parking brake to 83 N·m (8.5 kg·m / 61 lb·ft)
- Front output shaft to 290 N·m (29 kg·m / 214 lb·ft)
- Rear output shaft to 226 N·m (23 kg·m / 167 lb·ft)
    - After tightening to the specified torque, align the lip part of the nut to the V-groove of the shaft edge. Caulk the nut lip with a chisel to make a length (B) of 5 mm (0.2 in) or more, and a clearance between the bottom of the shaft and the nut lip (A) of 2.5 mm (0.06 in) or less.

Caution:
When caulking, be careful not to crack the nut.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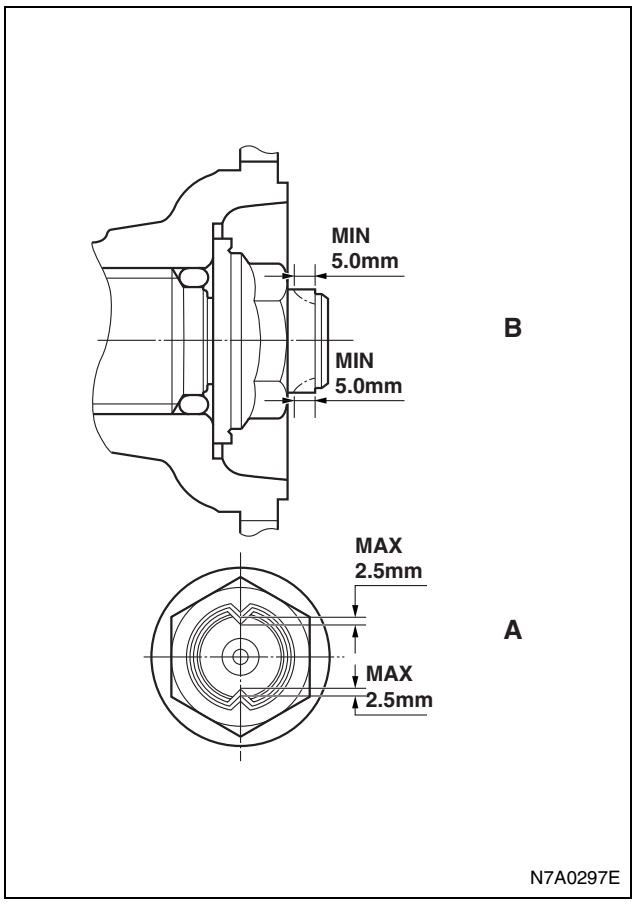


N7A0297E

21. Install the parking brake drum.
    - Tighten the adjustment hole cover fixing bolt.

Special Tools

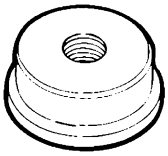
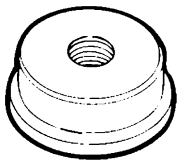
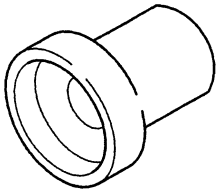
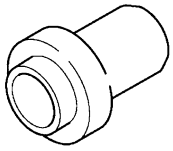
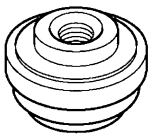
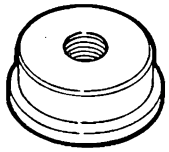
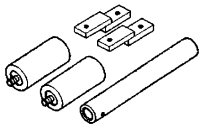
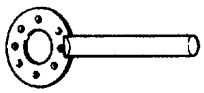
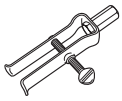
Illustration	Tool Number / Description / Remarks
 5884027720	5-8840-2772-0 / Bearing Installer
 5884027730	5-8840-2773-0 / Bearing Installer
 5884027740	5-8840-2774-0 / Bearing Installer
 5884027750	5-8840-2775-0 / Oil Seal Installer
 5884027760	5-8840-2776-0 / Oil Seal Installer
5884001940	5-8840-0194-0 / Shim Selector

Illustration	Tool Number / Description / Remarks
 5884022350	5-8840-2235-0 / Bearing Installer
 5884027940	5-8840-2794-0 / Shim Selector Adapter Kit
5884000070	5-8840-0007-0 / Grip
 5884020430	5-8840-2043-0 / Flange Holder
5884025870	5-8840-2587-0 / Bearing Remover
 5884000270	5-8840-0027-0 / Remover

MANUAL TRANSMISSION AND CLUTCH MYY SERIES

SECTION 7C
CLUTCH

Contents

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Clutch System 7C-2
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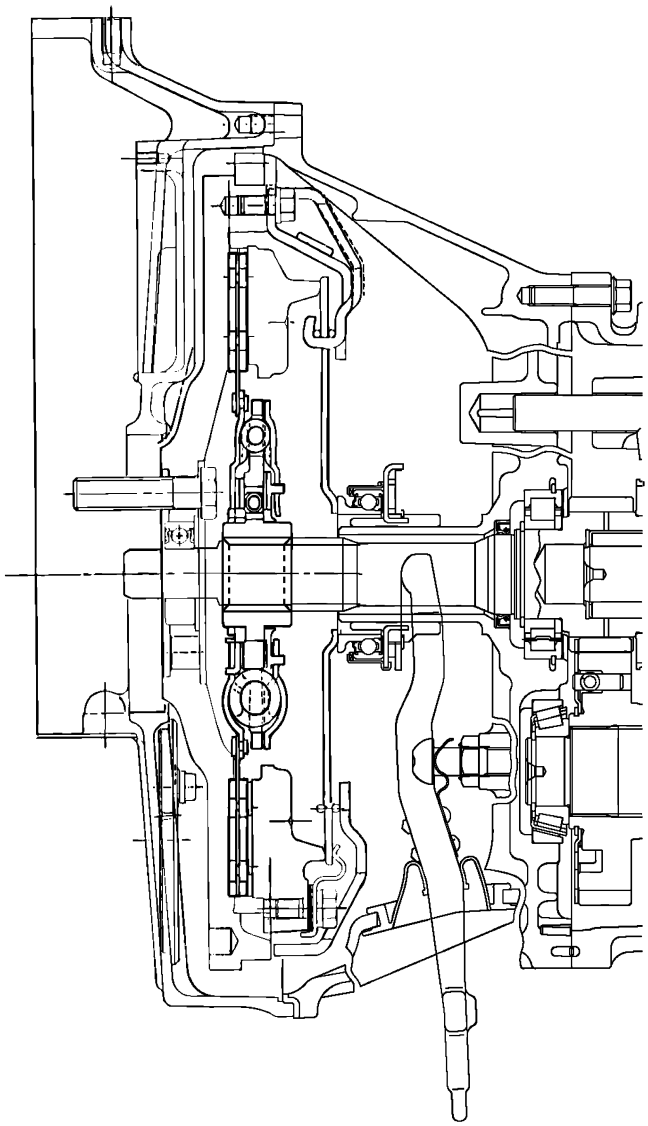
Clutch Assembly 7C-6
Clutch Control 7C-12
UNIT REPAIR 7C-15
Master Cylinder 7C-15
Clutch Booster 7C-17
Slave Cylinder 7C-20

GENERAL DESCRIPTION

Clutch System

Clutch



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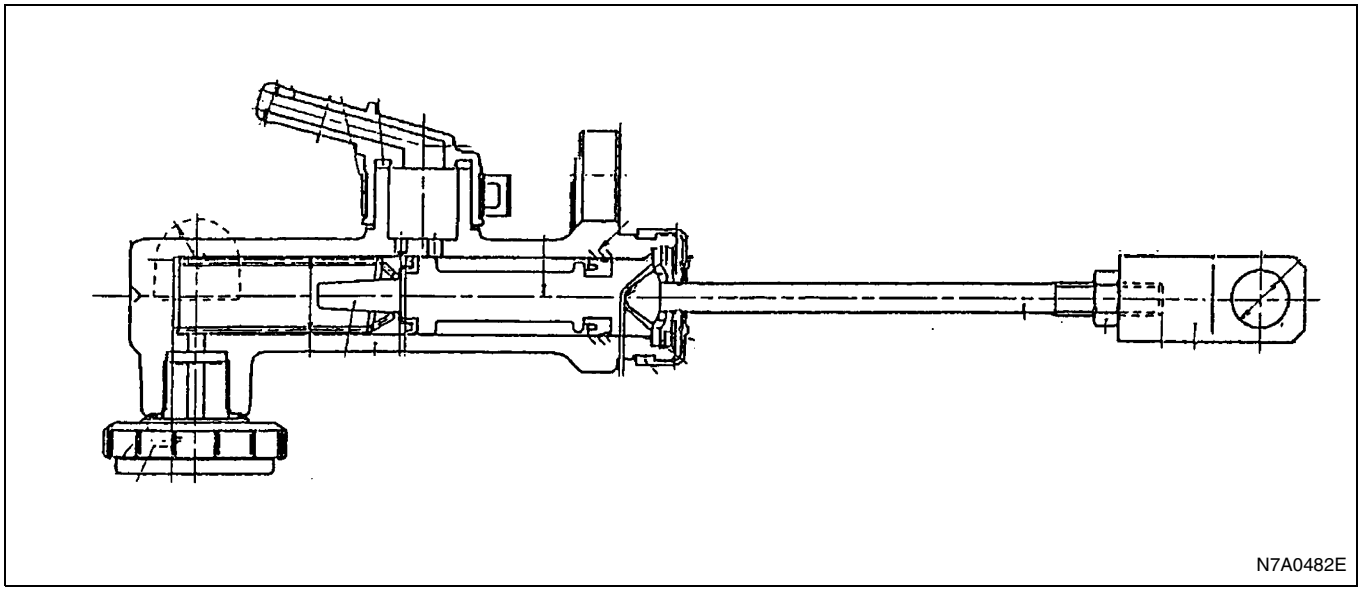
Master Cylinder



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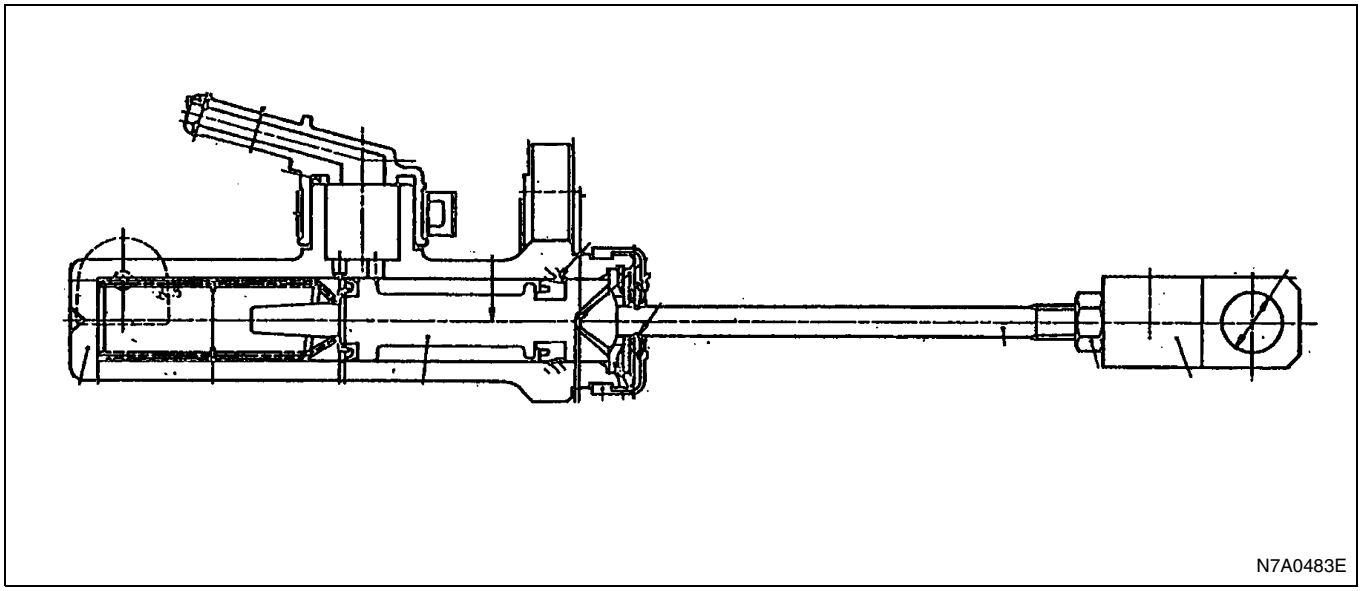
Master Cylinder (without Booster)



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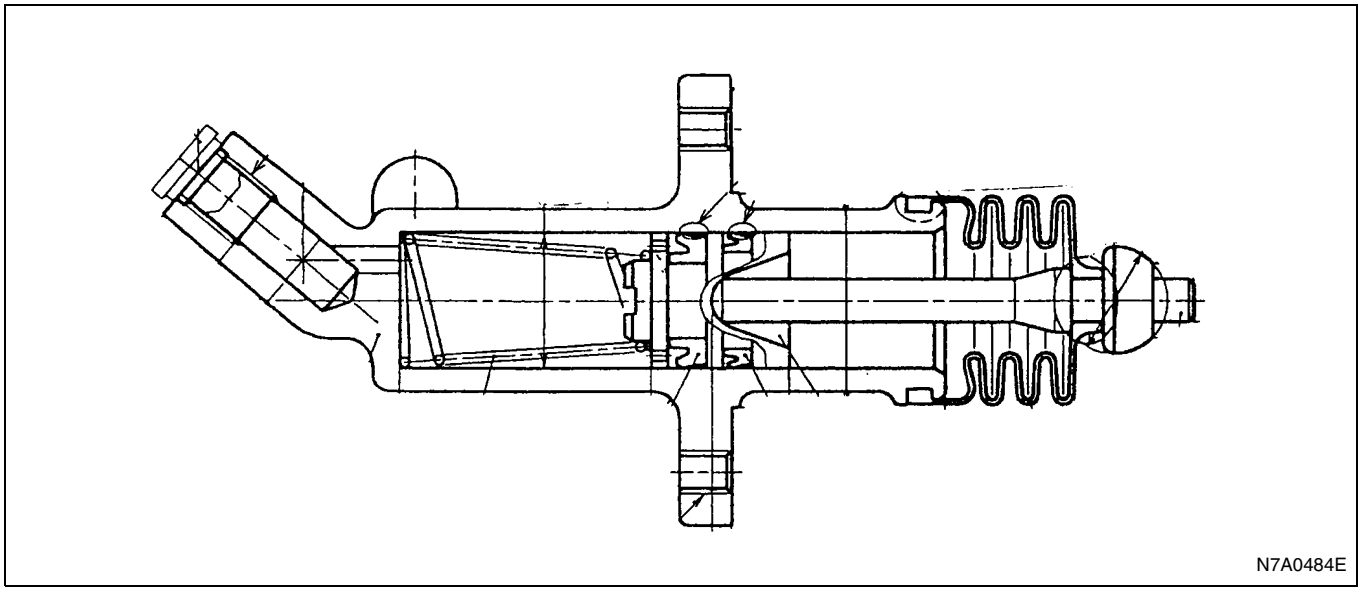
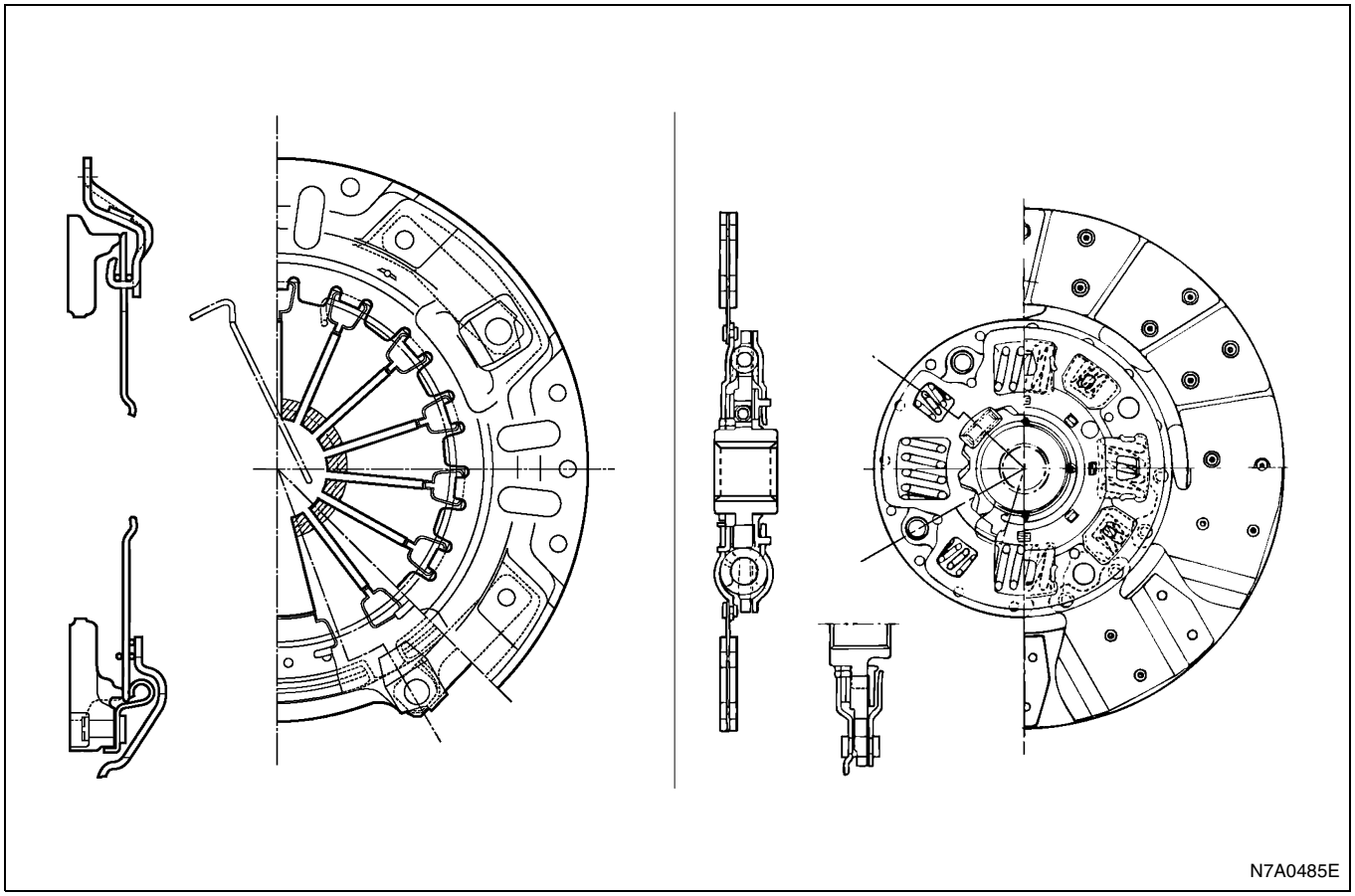
Slave Cylinder (Auto Adjustment Type)



Pressure Plate Assembly and Clutch Disk Assembly



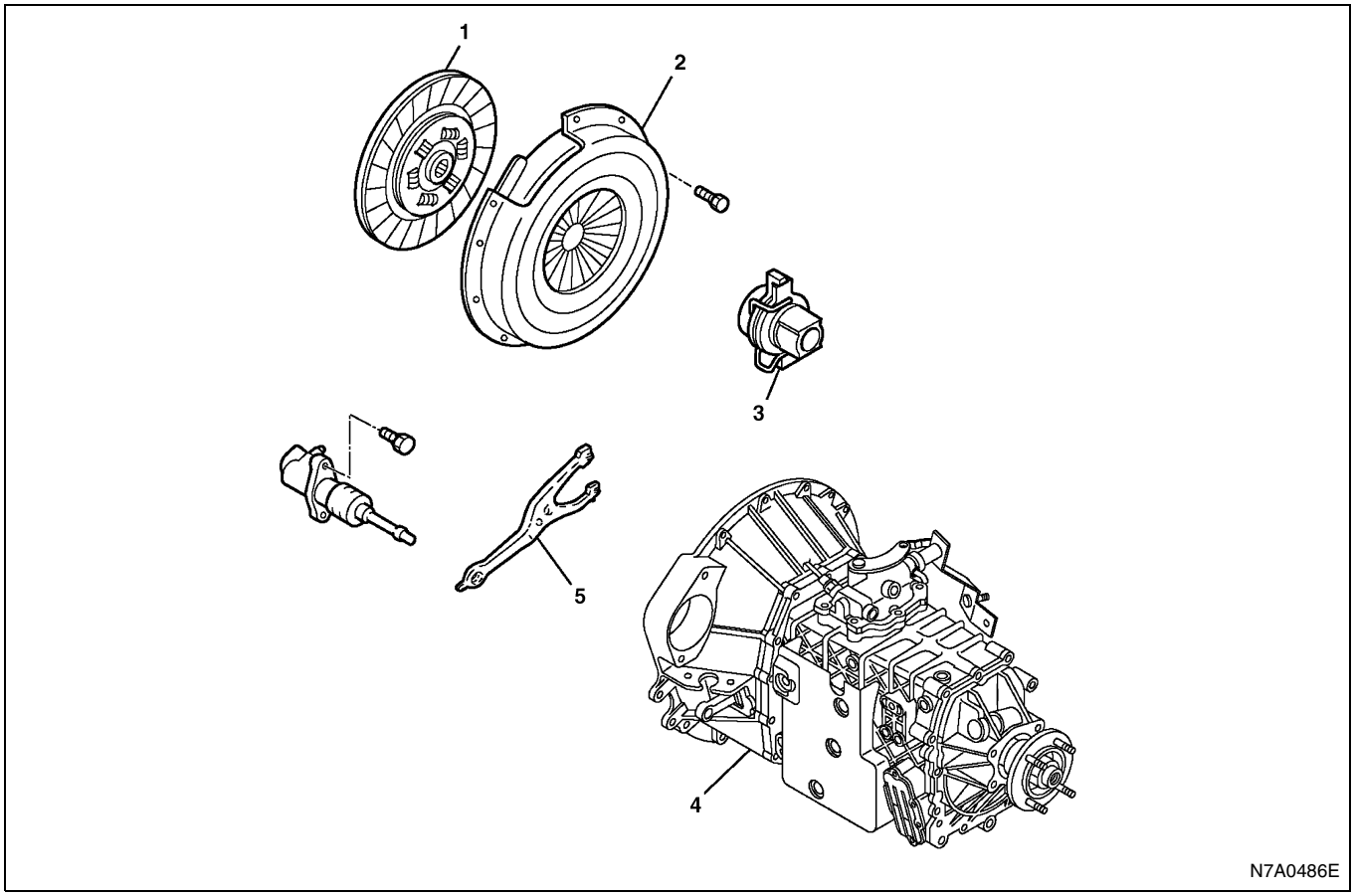
Troubleshooting

Trouble	Cause	Treatment
Dragging	Hydraulic line leakage.	Repair.
	Air in line.	Bleed air.
	Master cylinder and/or slave cylinder seals worn.	Replace seals.
	Driven plate worn or warped.	Replace.
	Diaphragm spring weak or tip of finger worn.	Replace.
	Driven plate sticking on spline.	Apply grease or replace.
	Release bearing worn or damaged.	Replace.
	Clutch pedal excessive free play.	Readjust.
Slippage	Driven plate facing worn or oil soaked.	Replace.
	Diaphragm spring weak.	Replace.
	Pressure plate and/or flywheel warped.	Repair or replace.
	Clutch pedal lack of free play.	Readjust.
Shudder (Chattering)	Engine mounting loose or broken.	Tighten or replace.
	Driven plate facing warped.	Replace.
	Driven plate surface of facing hardened.	Replace.
	Driven plate facing oil soaked.	Replace and check oil leakage.
	Driven plate damper spring weakened or broken.	Replace.
	Pressure plate and/or flywheel warped.	Repair or replace.
Noisy	Release bearing binding.	Repair or replace, apply grease.
	Release bearing worn or broken.	Replace.
	Release bearing insufficiently lubricated.	Replace.
	Driven plate damper springs weakened or broken.	Replace driven plate.
	Pilot bearing worn or broken.	Replace.
	Driven plate rivet loosened.	Replace driven plate.
	Ball stud insufficiently lubricated.	Lubricate with grease.
	Clutch pedal lack of free play.	Readjust.
	Clutch pedal shaft insufficiently lubricated.	Repair or replace.
Pedal is Hard to Push	Hydraulic line blocked or crimped.	Clean out or replace.
	Clutch booster malfunction.	Repair or replace.
	Clutch pedal shaft insufficiently lubricated.	Repair or replace.

ON-VEHICLE SERVICE

Clutch Assembly

Components

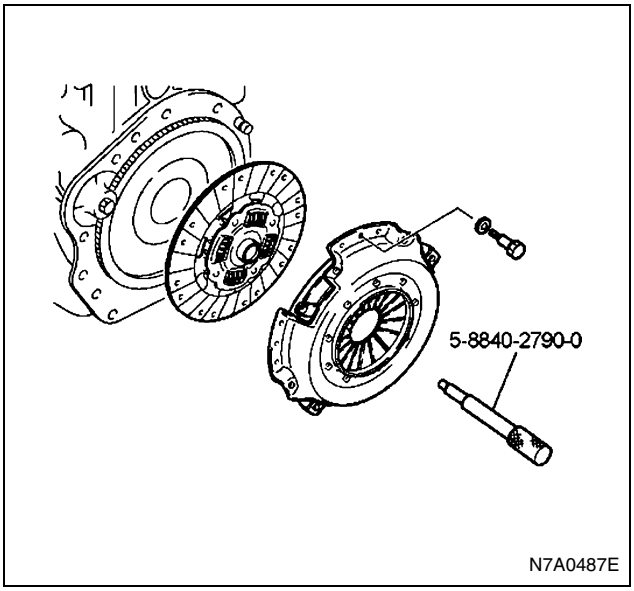


Legend

1. Driven plate assembly
2. Pressure plate assembly
3. Release bearing assembly
4. Transmission assembly
5. Shift fork

Removal

1. Remove the transmission assembly from the vehicle.
   - Refer to TRANSMISSION ASSEMBLY.
2. Remove the pressure plate assembly.
3. Remove the driven plate assembly.
   - Use pilot aligner 5-8840-2790-0 to prevent the driven plate assembly from falling.
   - Mark the flywheel and clutch cover for alignment when installing.



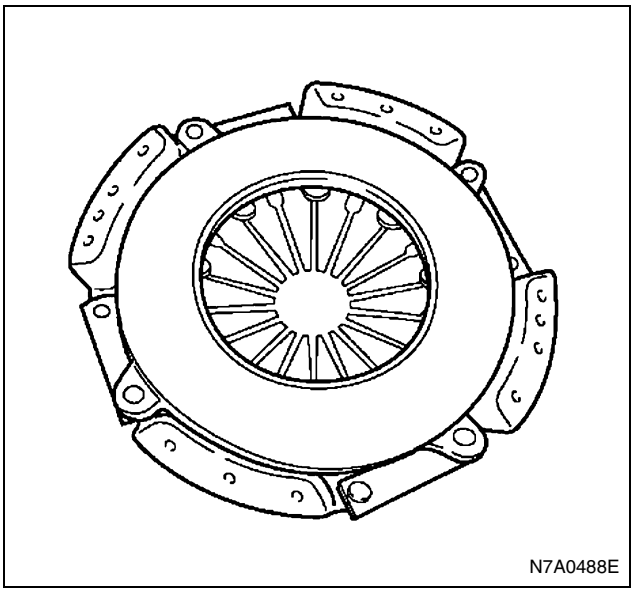
4. Remove the release bearing.
5. Remove the shift fork.

Inspection

Make the necessary adjustment, repairs, and part replacement if excessive wear or damage is found during inspection.

Pressure Plate Assembly

- Visually inspect the pressure plate friction surface for excessive wear and heat cracks. If excessive wear or deep heat cracks are present, the pressure plate assembly must be replaced.



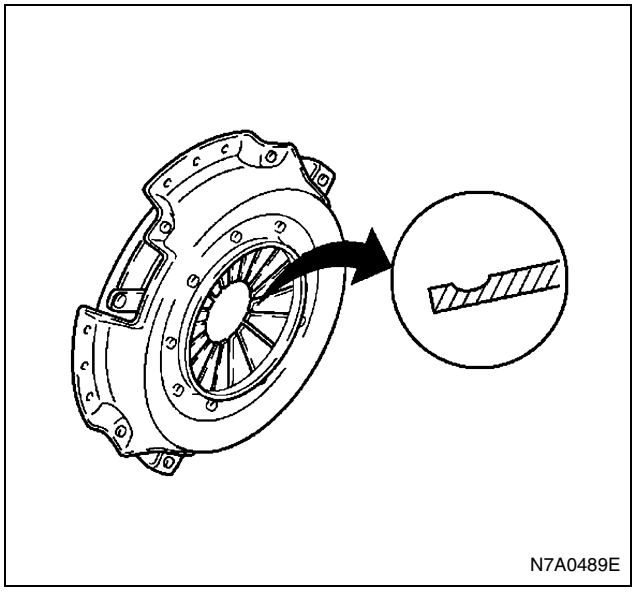
Pressure Plate Warpage

- Use a straight gauge and a filler gauge to measure the pressure plate friction surface flatness in four directions.
  If any of the measured values exceed the specified limit, the pressure plate assembly must be replaced.

Pressure Plate Warpage
Limit : 0.3 mm (0.012 in)

Clutch Cover

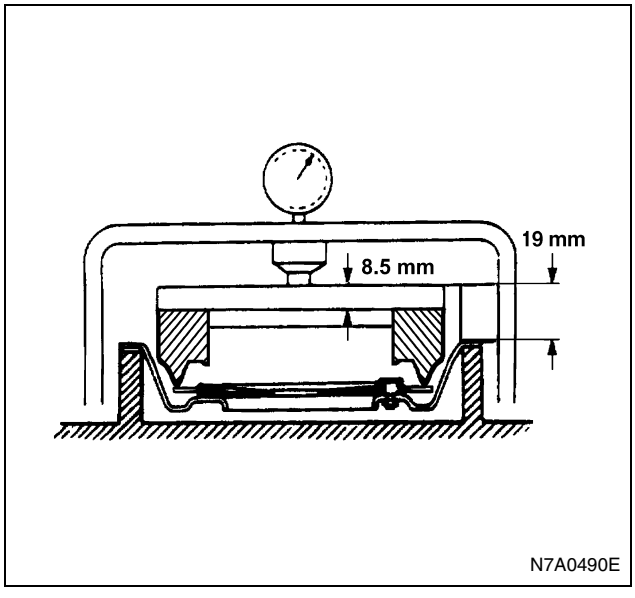
- Visually inspect the entire clutch cover for excessive wear, cracking, and other damage. The pressure plate assembly must be replaced if any of these conditions are present.



Clutch Set Force

1. Invert the pressure plate.
2. Place on the pressure plate, a new clutch disk, or a spacer of 8.5 mm (0.33 in) in place of the clutch disk.
3. Compress the pressure plate assembly until the dimension becomes 19 mm (0.748 in).
4. Note the pressure plate gauge reading.

Clutch Set Force :	
Set Force	Engine Model
8,340 N (850 kg / 1,874 lb)	4HF1, 4HG1, 4HF1-II
9,500 N (970 kg / 2,139 lb)	4HG1-T, 4HE1-TC-N, 4HK1-TC
6,200 N (633 kg / 1,396 lb)	4JH1-TC-S

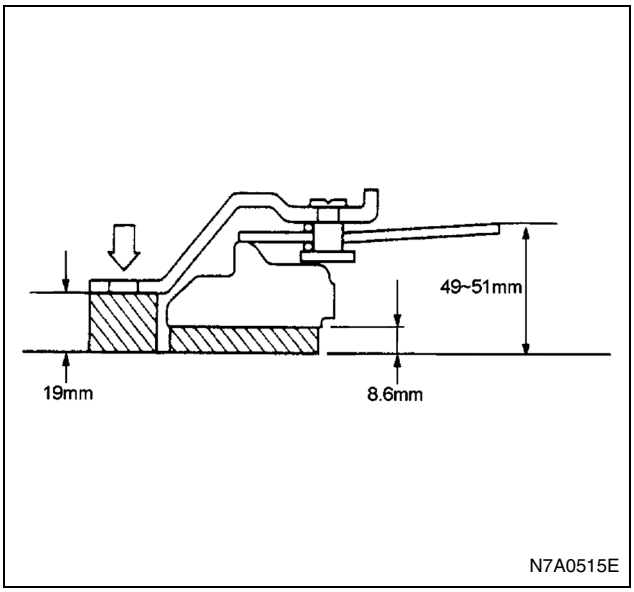


Diaphragm Spring Finger Height

1. Place a spacer of 8.5 mm (0.33 in) under the pressure plate.

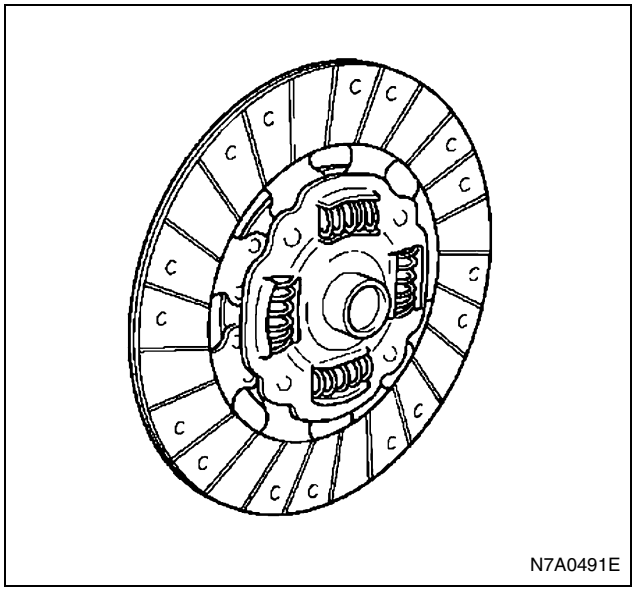
2. Compress the pressure plate assembly and the diaphragm spring until the distance “B” becomes specified. There are two ways to do this.
   a. Use a bench press to press down on the pressure plate assembly from the top.
   b. Tighten the pressure plate assembly fixing bolts.
3. Measure the distance between the base and the top of the diaphragm spring.

Spring Finger Height
Standard : 49.0 — 51.0 mm (1.929 — 2.008 in)



Driven Plate Assembly

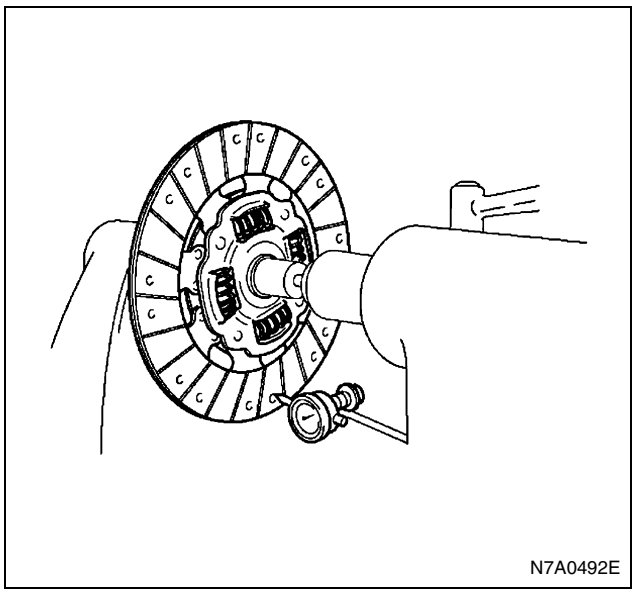
- Visually inspect the torsion spring for looseness, breakage, and weakening. If any of these conditions are found, the driven plate assembly must be replaced.
- Visually inspect the facing surfaces for cracking and excessive scorching.
- Visually inspect the facing surfaces for the presence of oil or grease. If any of these conditions are found, the facing must be cleaned or the driven plate assembly replaced.
- Check that the driven plate moves smoothly on the transmission top gear shaft spline. Minor ridges on the top gear shaft spline may be removed with an oil stone.



Driven Plate Warpage

1. Insert pilot aligner 5-8840-2790-0 into the driven plate spline hub. The pilot aligner must be held perfectly horizontal.
2. Set a dial indicator to the driven plate outside circumference.
3. Slowly turn the driven plate, and read the dial indicator.
4. If the measured value exceeds the specified limit, replace the driven plate assembly.

Driven Plate Warpage
Standard : 0.7 mm (0.028 in) or less
Limit : 1.0 mm (0.039 in)

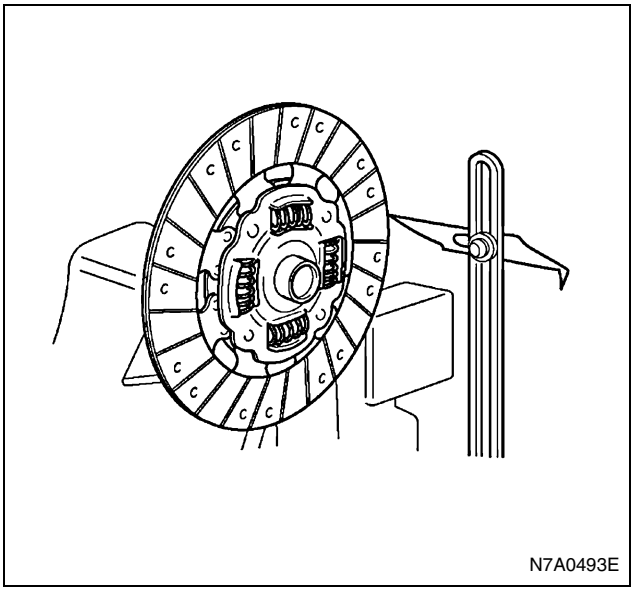


Driven Plate Spline Free Play

1. Install the driven plate to the transmission top gear shaft spline.
2. Set a surface gauge to the driven plate outside circumference.
3. Slowly turn the driven plate. Measure the spline rotation free play.

If the measured value exceeds the specified limit, replace the driven plate assembly.

Driven Plate Spline Free Play
Standard : 0.5 mm (0.020 in) or less
Limit : 1.0 mm (0.039 in)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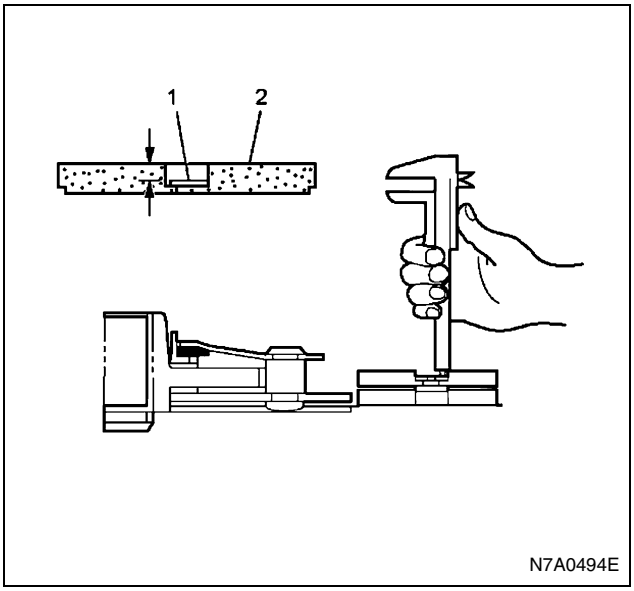
Driven Plate Rivet Head Depression

- Use the depth gauge to measure the rivet head depression (1) from the facing surface (2).
- Be sure to measure the rivet head depression (1) on both sides of the driven plate (2).
- If the measured value exceeds the specified limit, replace the driven plate assembly.

Facing Rivet Head Depression
Standard : 1.4 — 2.0 mm (0.055 — 0.078 in) (Flywheel side)
1.7 — 2.3 mm (0.067 — 0.090 in) (Transmission side)
Limit : 0.2 mm (0.008 in)



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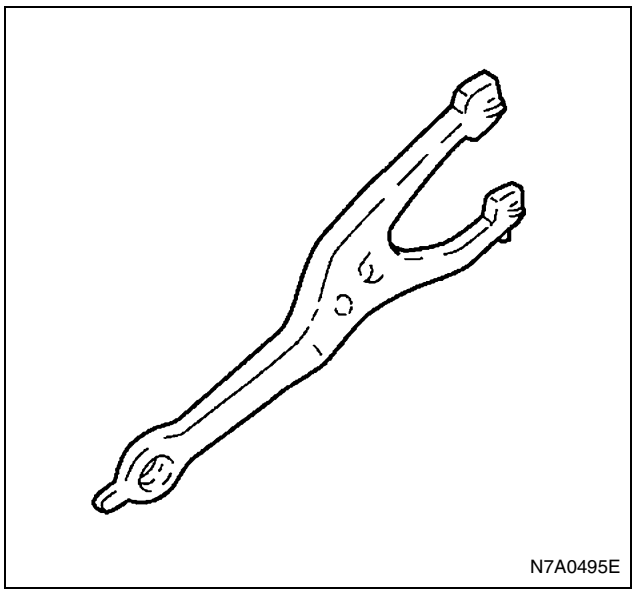
Shift Fork

- Inspect the wear and damage on the release bearing and facing surface.
- Correct a slight stepped wear or surface roughness with an oil stone.
  Replace the shift fork if unrecoverable damage is found.
- Inspect the wear and damage on the surface of the support bolt.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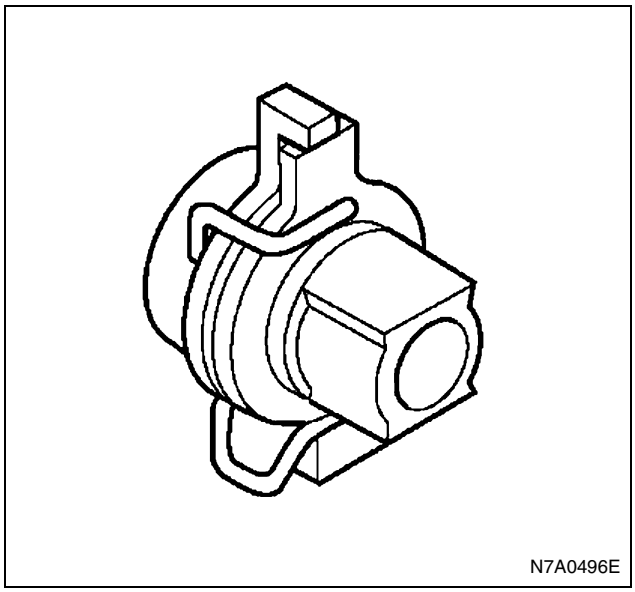
Release Bearing

- Inspect the looseness, noise, damage, etc. or wear of the inside diameter. If any abnormality is found, replace the part.

Caution:
Never wash the release bearing because this part is sealed with grease.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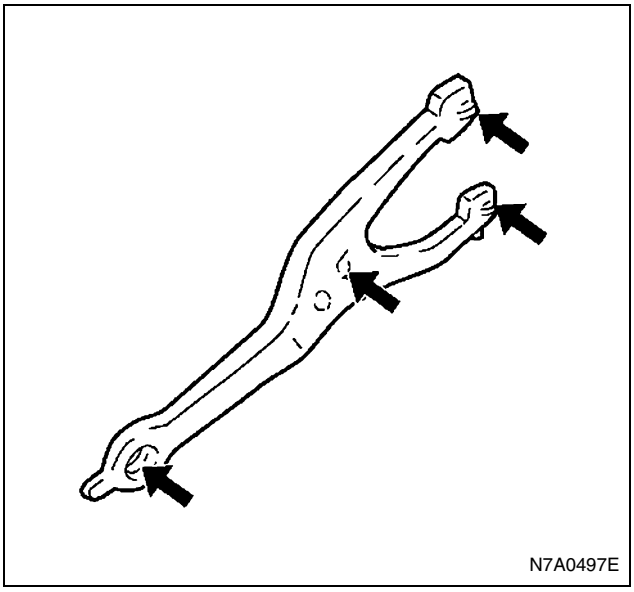
Installation

1. Install the shift fork after applying the MO-NO2 type grease to the contact surfaces of the shift fork.
2. Install the release bearing to the transmission front part.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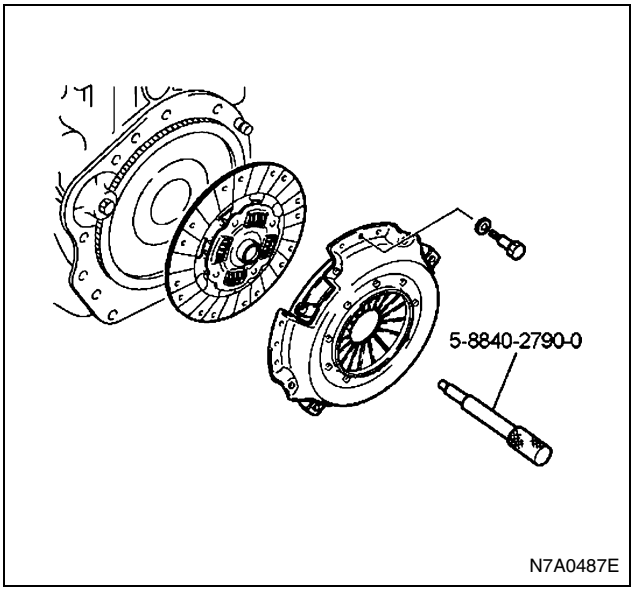
3. Install the clutch disk assembly.
4. Install the pressure plate assembly.
   - Clean the facing surfaces and pressure plate surface of the flywheel and the driven plate.
   - Install the driven plate assembly to the flywheel using pilot aligner 5-8840-2790-0.



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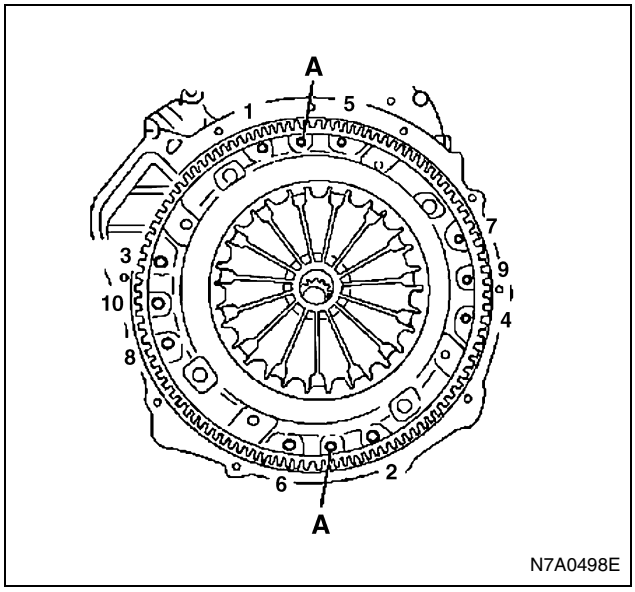
   - Install the pressure plate assembly, adjusting to knock pins (A) of the flywheel. And tighten the pins slowly and equally in numerical order.

Tighten:
Pressure plate to 40 N·m (4.1 kg·m / 30 lb·ft)

   - When installing a new pressure plate assembly, make sure to remove the wiring after the tightening.

Caution:
Do not beat with hammer when removing the aligner.



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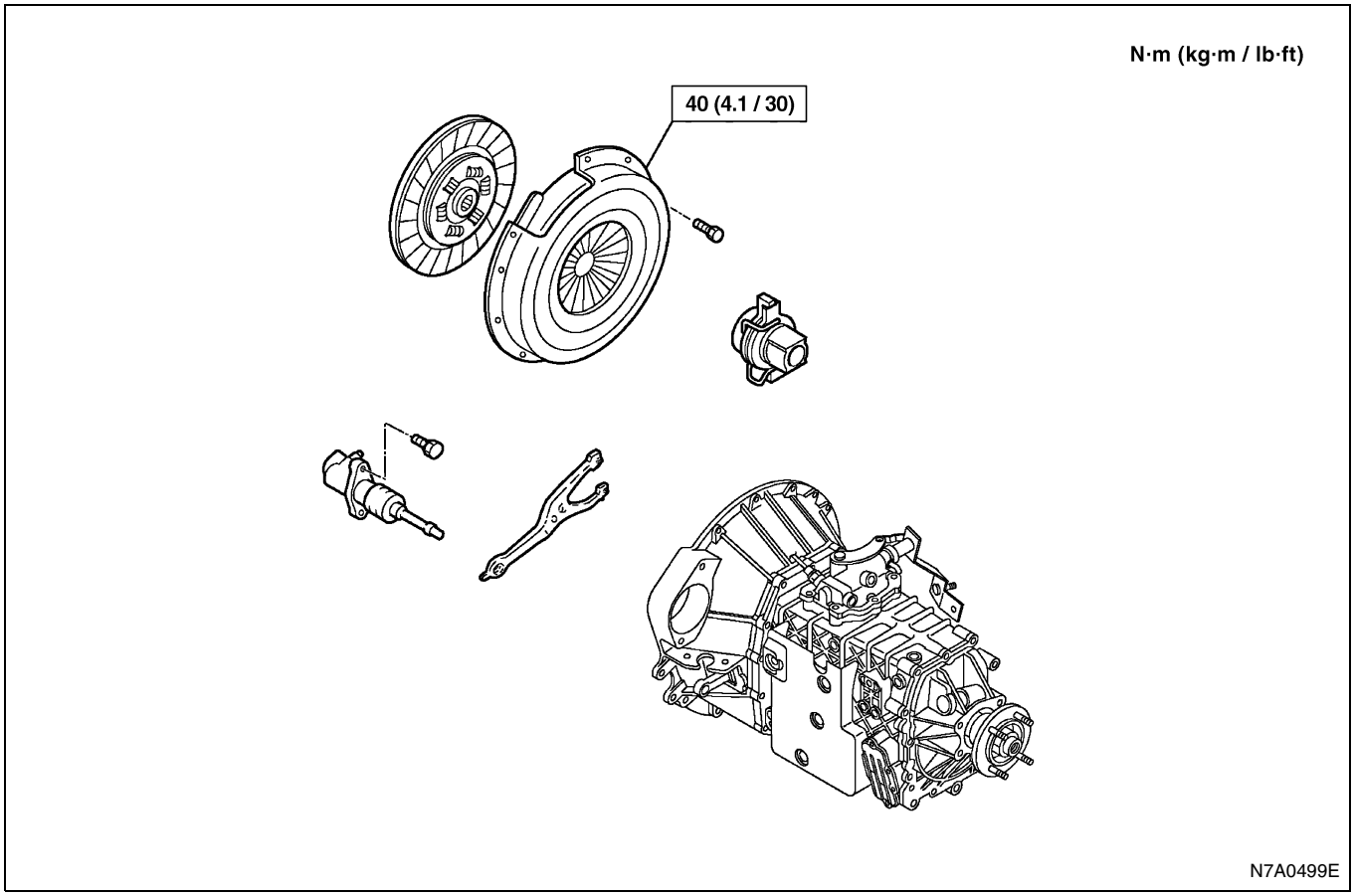
5. Install the transmission assembly.
   - Refer to TRANSMISSION ASSEMBLY.

Fixing Torque

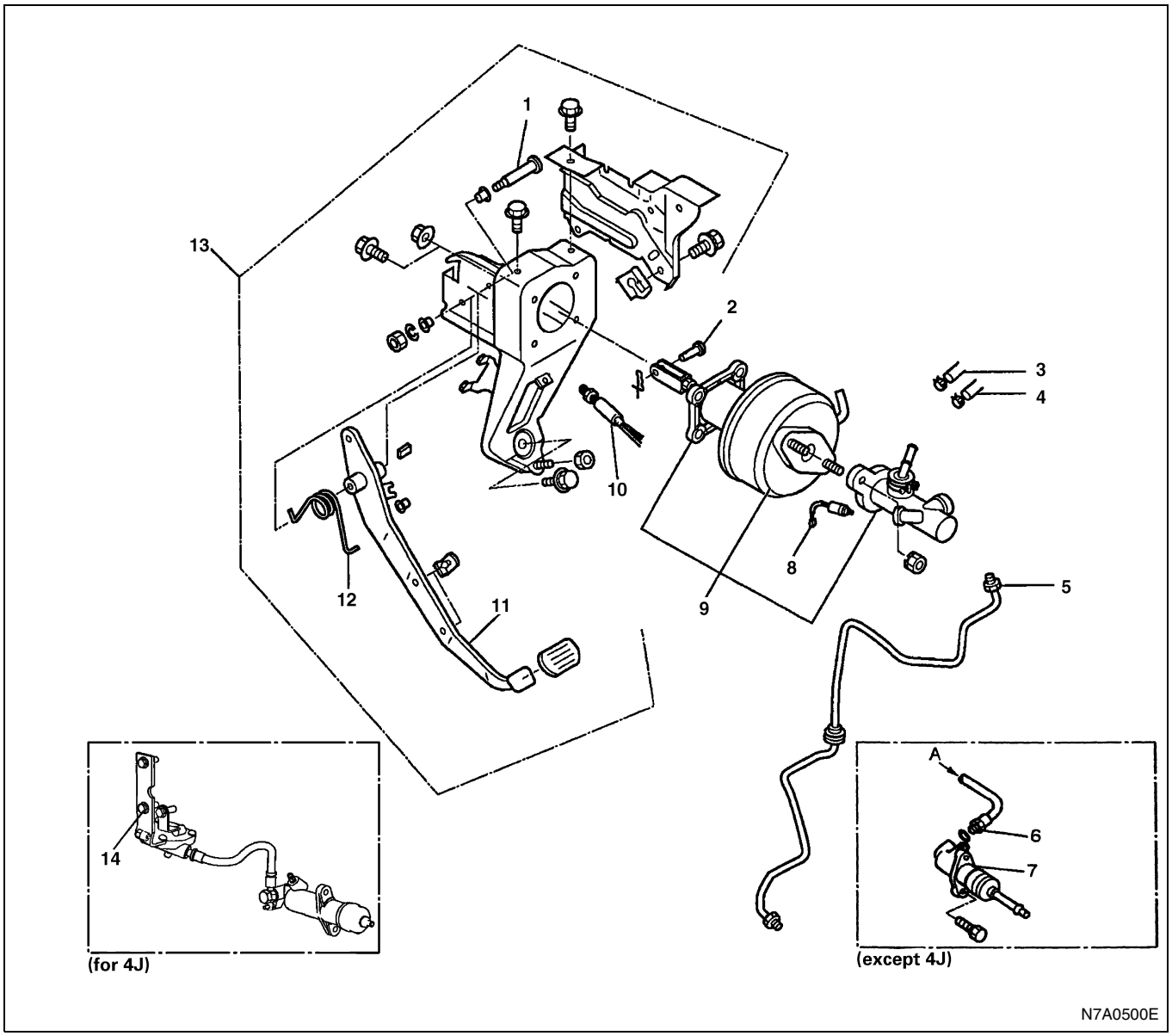


Special Tools

Illustration	Tool Number / Description / Remarks
5884027900	5-8840-2790-0 / Clutch Pilot Aligner

Clutch Control

Components



Legend

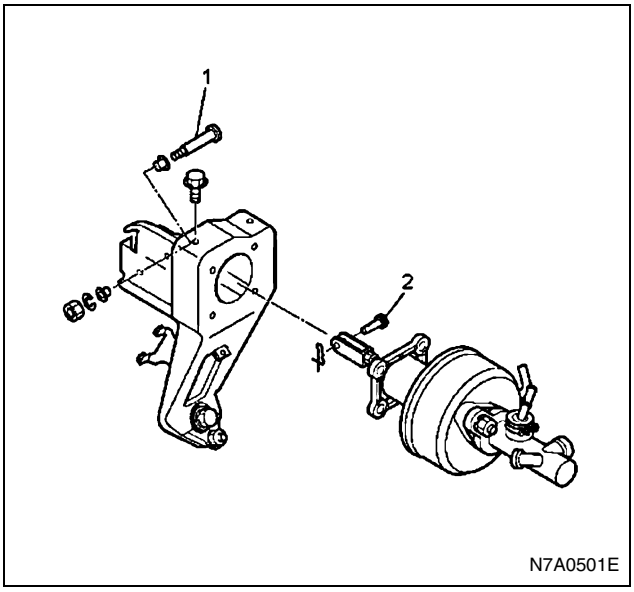
1. Pin
2. Clevis pin
3. Vacuum hose
4. Oil hose
5. Clutch pipe
6. Flexible hose
7. Slave cylinder
8. Pressure switch connector
9. Clutch booster and master cylinder assembly
10. Clutch switch
11. Clutch pedal
12. Return spring
13. Clutch pedal and bracket assembly
14. Damper cylinder

Removal

- Drain the brake fluid before removal.

Caution:
Do not let brake fluid contact painted surface. Wash it off immediately.

1. Remove the oil hose and clutch pipe.
2. Remove the vacuum hose.
3. Remove the clutch pedal and bracket assembly.
4. Remove the clutch switch.
5. Remove pin (1).
6. Remove clevis pin (2).



7. Remove the return spring.
8. Remove the clutch pedal.
9. Remove the clutch booster & spacer, and master cylinder assembly.
   - Removal of the master cylinder can be done only by removing the meter cluster.

Inspection

Make necessary adjustment, repairs, and part replacement if excessive wear or damage is found during inspection.

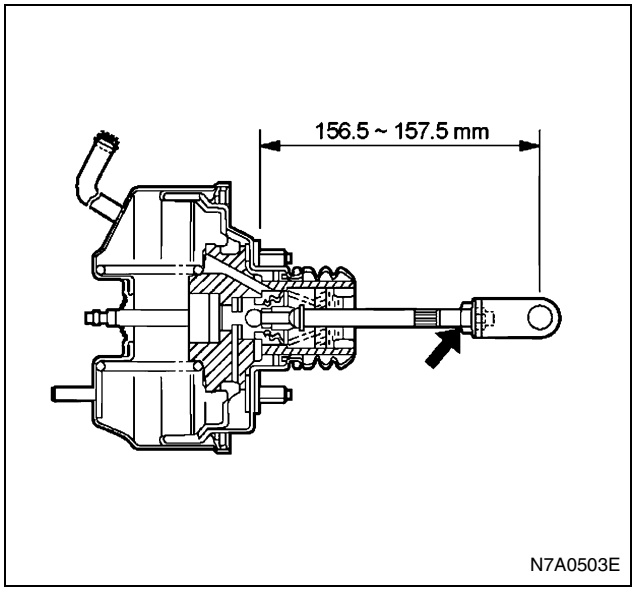
Installation

1. Install the clutch booster, spacer and master cylinder assembly.
   - Tighten the lock nut where the distance between the center of the clevis pin hole and the installation surface is 156.5 — 157.5 mm (6.161 — 6.201 in).

Tighten:
Lock nut to 26 N·m (2.6 kg·m / 19 lb·ft)

   - Install the clutch booster, spacer and master cylinder assembly to the clutch pedal bracket.

Tighten:
Nut to 13 N·m (1.3 kg·m / 10 lb·ft)

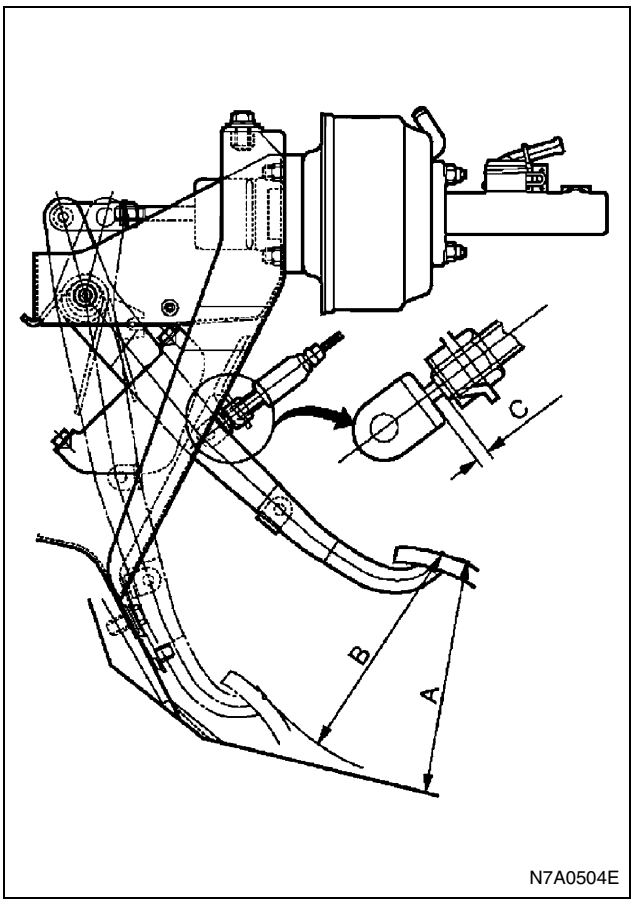


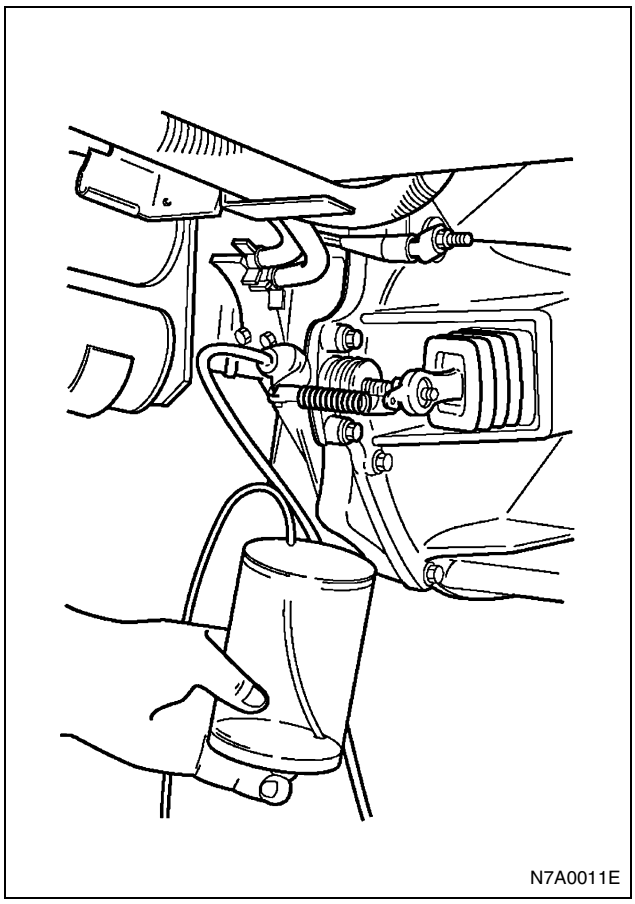
2. Install the pressure switch connector.
3. Install the clutch pedal.
4. Install the return spring.
5. Install the clevis pin.
6. Install the pin.
7. Install the clutch switch.
8. Install the clutch pedal and bracket assembly.

Tighten:
Clutch bracket bolts to 37 N·m (3.8 kg·m / 27 lb·ft)

   - The clutch pedal adjustment is not necessary if the length of the clutch booster operation rod is adjusted when installing the clutch booster.
     The length of the clutch booster operation rod:
     The distance between the installation surface and the center of the clevis pin hole is 156.5 — 157.5 mm (6.161 — 6.200 in).
   - Check the clutch pedal play.
   - Adjust the clearance between the pedal and the clutch switch bolt, to the measured value.

Clutch Pedal Height (A)
160 — 170 mm (6.299 — 6.693 in) (Reference value)
Pedal Stroke (B)
159 — 169 mm (6.260 — 6.653 in) (Reference value)
Clutch Pedal Play
15 — 25 mm (0.590 — 0.984 in) (Reference value)
Pedal and Clutch Switch
Bolt Clearance (C)
0.5 — 1.0 mm (0.020 — 0.039 in)





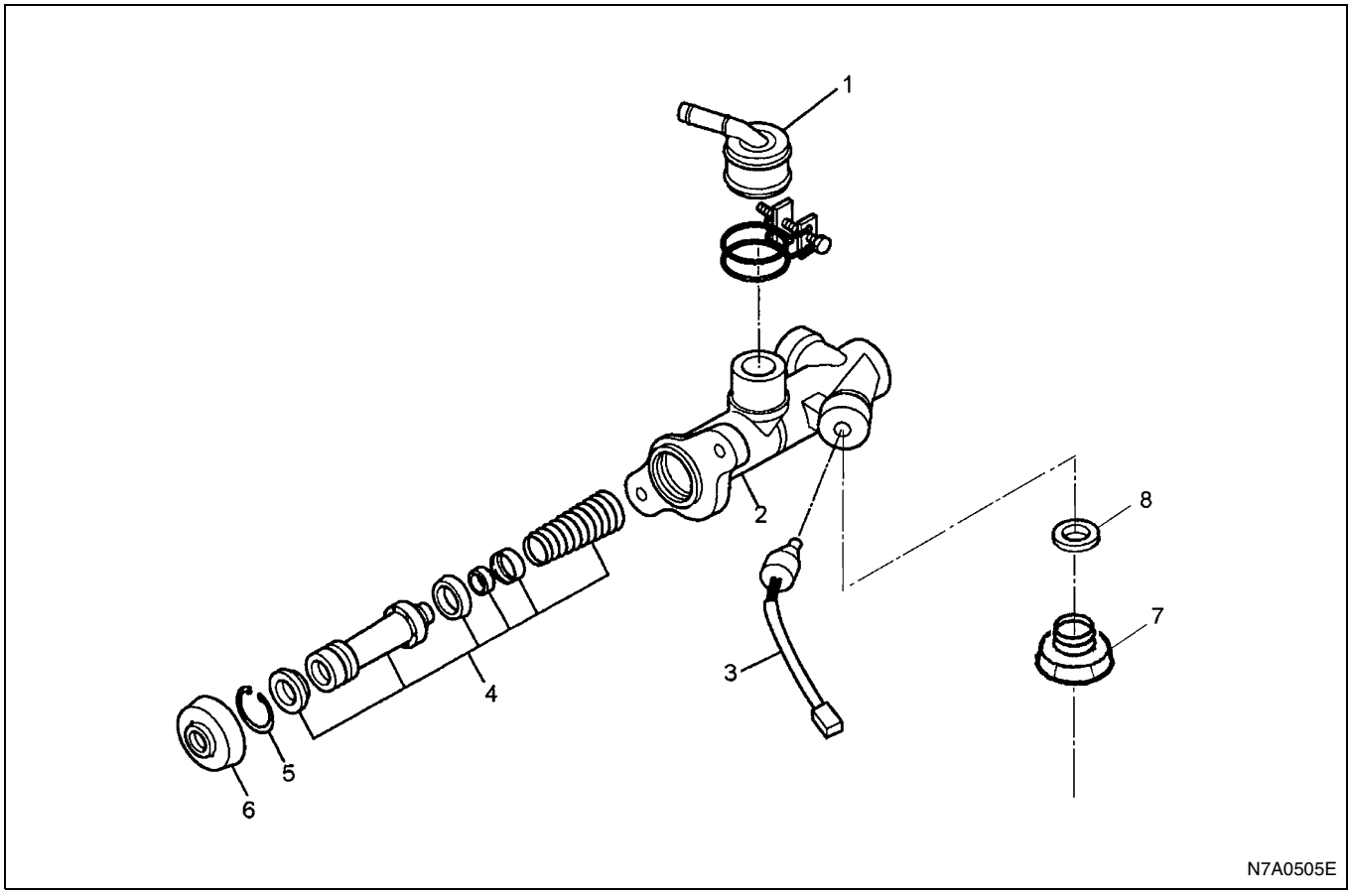
9. Install the vacuum hose.
10. Install the oil hose and clutch pipe.
    Bleeding of Slave Cylinder
    - After the installation, make sure to perform the bleeding of the slave cylinder conforming to the following procedure.

    a. Refill brake fluid to the maximum level of the reservoir.
    b. Connect a vinyl tube to the bleeder screw, and insert the other end of the vinyl tube into a transparent container.
    c. Pump the clutch pedal several times and hold it depressed.
    d. Loosen the bleeder screw on the clutch slave cylinder to bleed air in the fluid. Tightening the bleeder screw, slowly return the clutch pedal.
    e. Repeat steps (c) and (d) until the air in the fluid is completely bled.
    f. After bleeding the air, securely tighten the bleeder screw and install the bleeder cap.
    g. Refill brake fluid to the maximum level of the reservoir.

UNIT REPAIR

Master Cylinder

Components



Legend

1. Hose joint
2. Cylinder body
3. Pressure switch
4. Piston assembly
5. Snap ring
6. Dust cover
7. Damper Cylinder
8. Washer

Removal

Caution:
Press down the piston with your fingers or shop cloth to prevent it from jumping out.

1. Remove the pressure switch (3).
2. Remove the hose joint (1).
3. Remove the dust cover (6).
4. Remove the snap ring (5).
5. Remove the piston assembly (4).
6. Remove the cylinder body (2).

Inspection

Make the necessary adjustments, repairs, and parts replacements if excessive wear or damage is found during inspection.
Cylinder body

- Check the fluid return port for clogging.

Internal parts

- Replace the parts indicated in the figure with new ones.

Clearance of cylinder body and piston

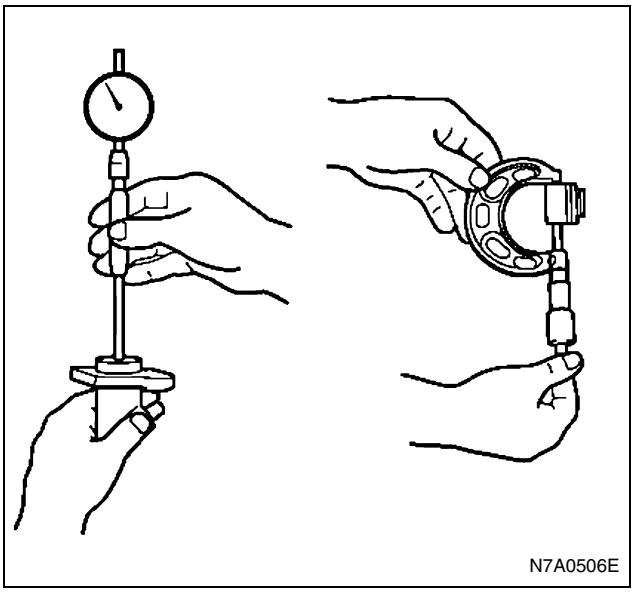
- Check the cylinder body for stepped wear, corrosion and damage, and measure the inside diameter.

Cylinder body inside diameter
Standard : Limit ϕ20.64 mm (0.8126 in)

- Check the piston for damage, rust and wear.
- Measure the clearance between the cylinder body and the piston.

Clearance between cylinder body and piston
Standard : 0.03 — 0.11 mm (0.0012 — 0.0043 in)
Limit : 0.12 mm (0.0047 in)

- If the wear limit is exceeded, replace the master cylinder assembly with a new one.



Installation

1. Cylinder body
   - Immerse the cylinder body in clean brake fluid.
2. Install the piston of the piston assembly after applying rubber grease.

Caution:
Do not damage the piston assembly when installing.

3. Install the snap ring.
4. Install the dust cover.
5. Install the hose joint.

Tighten:
Hose joint to 4.5 N·m (0.45 kg·m / 3.25 lb·ft)

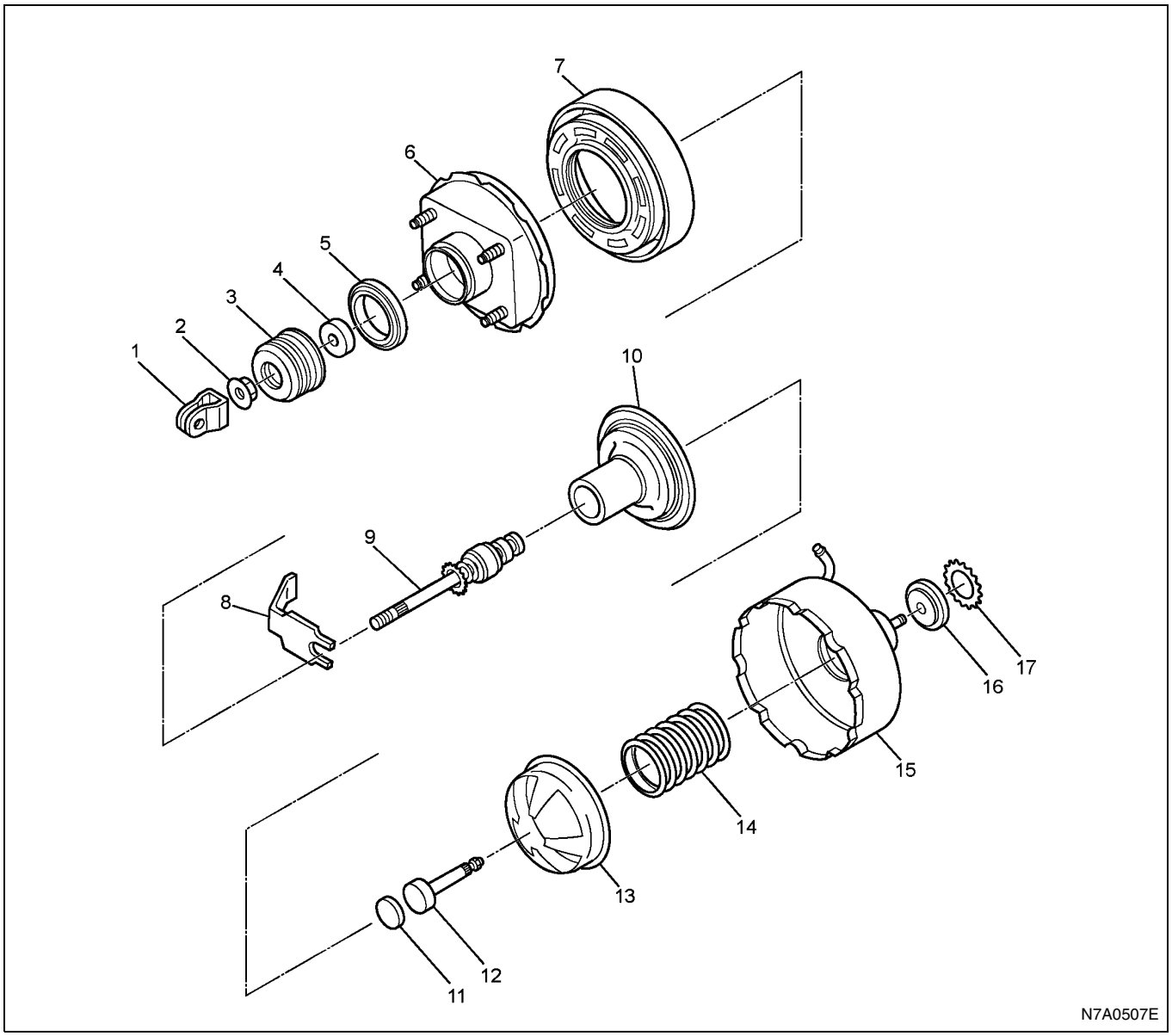
6. Install the pressure switch.
   - Apply liquid gasket to the switch screw, and install to the master cylinder.

Liquid Gasket : LOCTITE 575

Tighten:
Pressure switch to 2.5 N·m (0.25 kg·m / 1.81 lb·ft)

Clutch Booster

Components



Legend

1. Clevis master cylinder push rod
2. Nut
3. Boots
4. Separator air cleaner
5. Seal booster body No. 2
6. Body assembly booster No. 2
7. Diaphragm booster
8. Key valve stopper
9. Valve sub assembly booster air
10. Piston sub assembly booster
11. Disk reaction
12. Rod sub assembly booster piston
13. Retainer rod
14. Spring booster piston return
15. Body assembly booster No. 1
16. Seal booster body No. 1
17. Ring circular

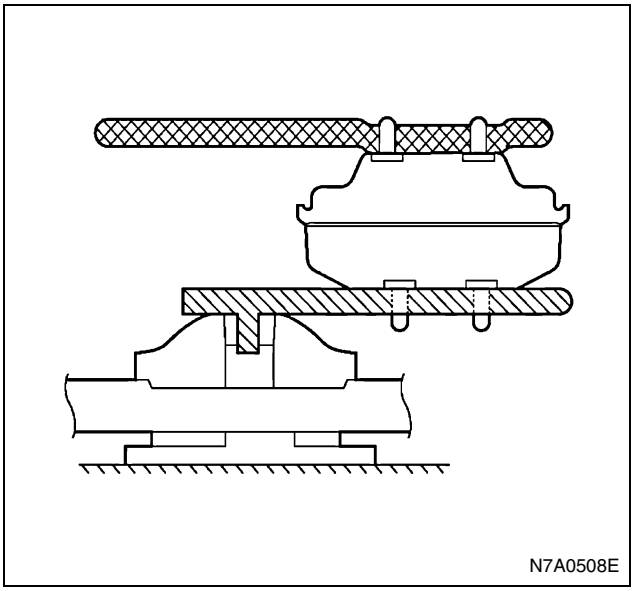
Removal

Before disassembling, mark the front shell and rear shell for alignment.

1. Remove the clevis master cylinder push rod.
2. Remove the nut.
3. Remove the boots.
4. Remove the separator air cleaner.
5. Remove the body assembly booster No. 2 (rear shell).

- Separate the rear shell from the front shell using handle 9-8523-1733-0 and support plate 5-8840-2056-0.

Caution:
Make sure to prevent the diaphragm spring from jumping out.



6. Remove the body assembly booster No. 1 (front shell).
7. Remove the spring booster piston return.
8. Remove the retainer rod.
9. Remove the rod sub assembly booster piston.
10. Remove the disk reaction.
11. Remove the diaphragm booster.
12. Remove the key valve stopper.
13. Remove the valve sub assembly booster air.
14. Remove the piston sub assembly booster.
15. Remove the link circular.
16. Remove the seal booster body No. 2.
17. Remove the seal booster body No. 1.

Inspection

Inspect the parts by washing and drying. Replace the damaged parts with new ones.

Caution:
Use trichlene or metachlene (commercial product) for metal parts, and clean alcohol for rubber and resin parts, respectively.

Installation

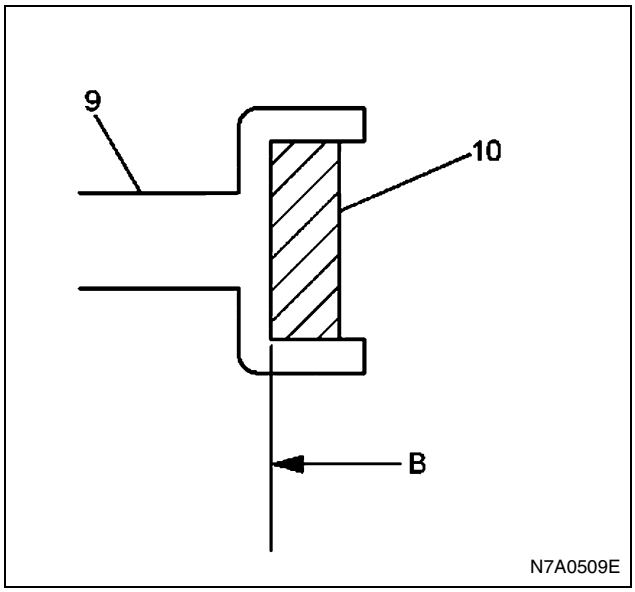
Apply silicone grease to each sliding part.

- Seal mating part and lip part of the rear shell
- Internal & external surface of the diaphragm plate, and outer circumference of the valve body
- Seal of the front shell, sliding surface of the push rod and outer circumference of the valve booster control

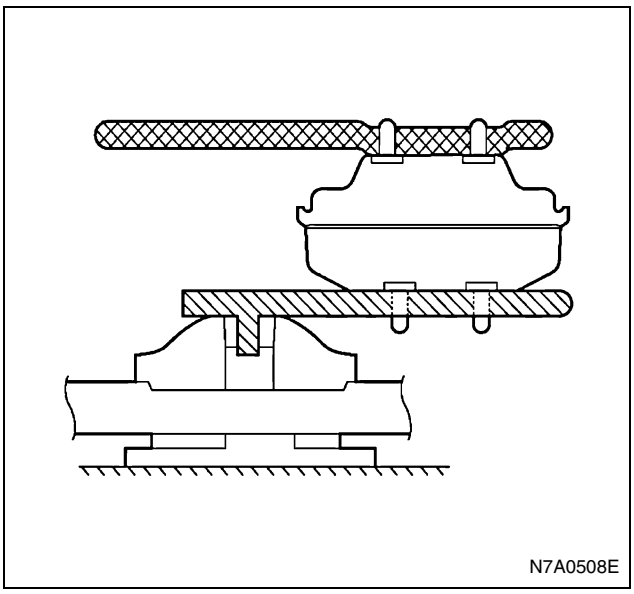
1. Install seal booster body No. 1.
2. Install body assembly booster No. 2.
3. Install the piston sub assembly booster.
4. Install the valve sub assembly booster air.
5. Install the key valve stopper.
6. Install the diaphragm booster.

Caution:
Never tear the diaphragm. Make sure that the reaction disk is securely inserted to the surface B. (Bleed the air from the outer circumference.)

7. Install the disk reaction (10).



8. Install the rod sub assembly booster piston (9).
9. Install the retainer rod.
10. Install the spring booster piston return.
11. Install seal booster body No. 1.
12. Install the link circular.
13. Install body assembly booster No. 1 (front shell).
    - Installation has to be done using handle 9-8523-1733-0 and support plate 5-8840-2056-0.
    - When installing, the marks on the rear shell and the front shell, which were put when disassembling, has to mate with each other.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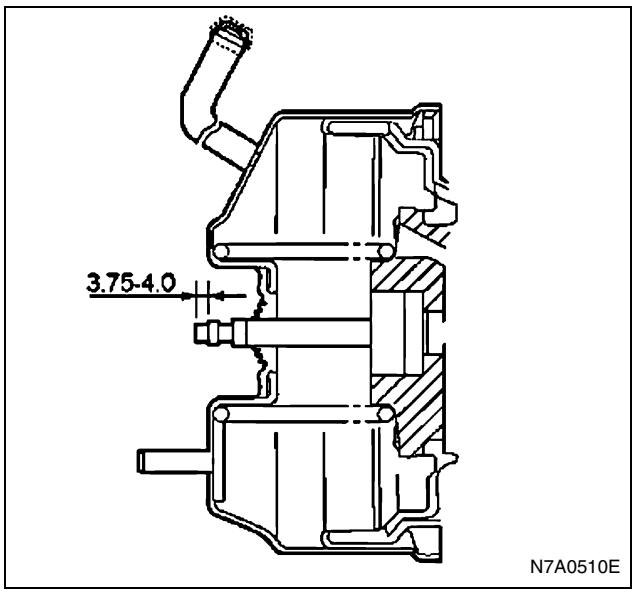

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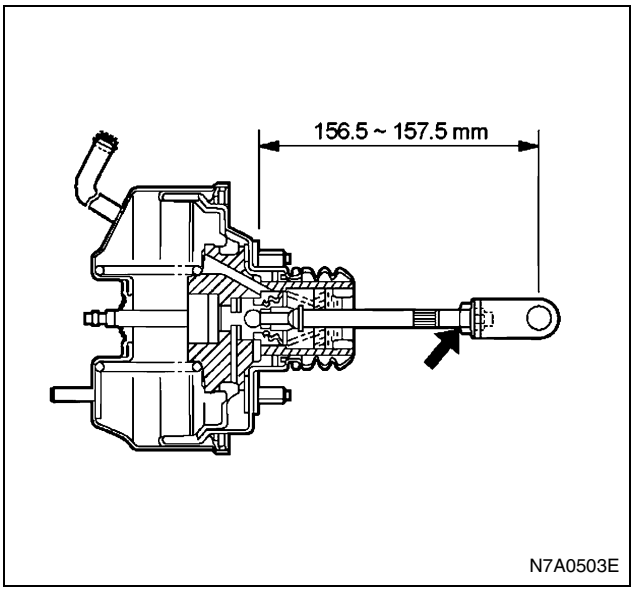
14. Install the separator air cleaner.
15. Install the boots.
16. Install the nut.
17. Install and adjust the clevis master cylinder push rod.
    - Adjust the distance between the center of the pin hole of the clevis yoke and the installation surface, and tighten the lock nut.

Dimension between the center of the pin hole of the clevis yoke and the rear shell.
156.5 — 157.5 mm (6.161 — 6.201 in)

Tighten:
Lock nut to 26 N·m (2.6 kg·m / 19 lb·ft)



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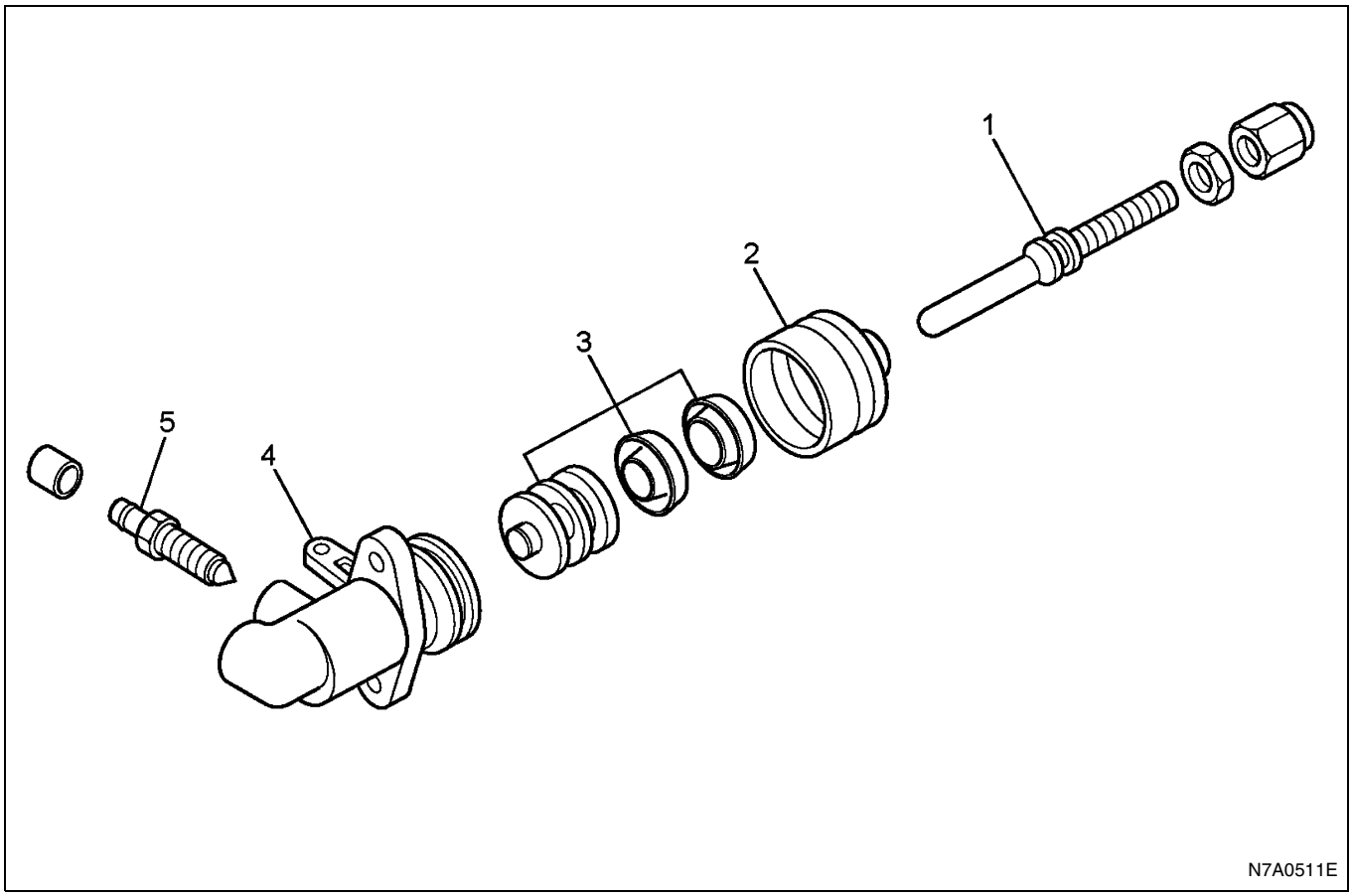
Adjustment of the rod sub assembly booster piston

- After assembling the clutch booster, adjust the length between the top of the push rod and the surface of the rear shell.

Dimension between the top of the push rod and the rear shell
3.75 — 4.0 mm (0.15 — 0.16 in)

Slave Cylinder

Components



Legend

1. Push rod
2. Boots
3. Piston assembly
4. Cylinder body
5. Bleeder screw

Removal

1. Remove the push rod (1).
2. Remove the boots (2).
3. Remove the piston assembly (3).
4. Remove the bleeder screw (5)
5. Remove the cylinder (4).

Inspection

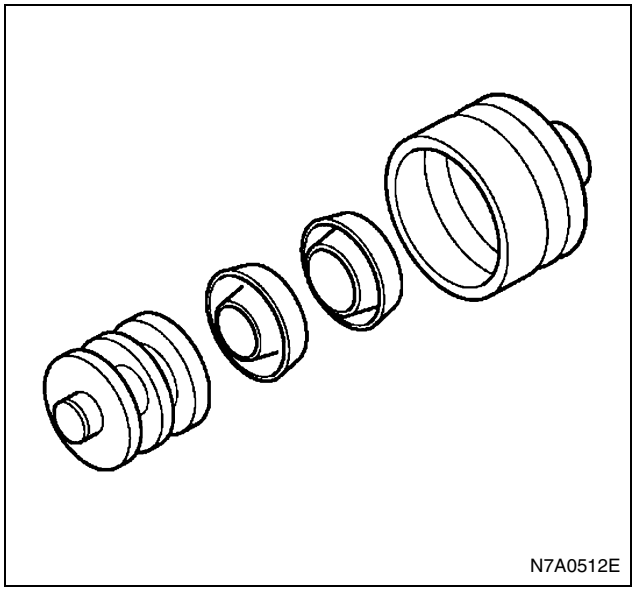
Inspect the removed parts by washing. Replace the damaged parts with new ones.

Cylinder body

- Check the fluid return port for clogging.

Internal parts

- Replace the parts indicated in the figure with new ones.



Clearance between the cylinder body and the piston

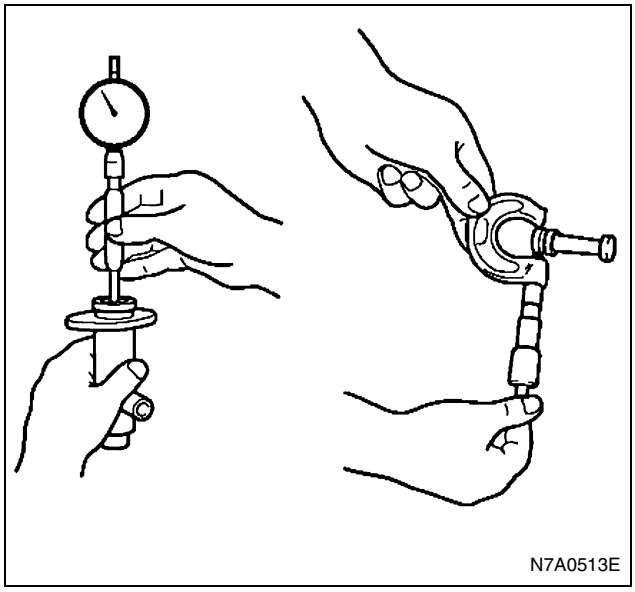
- Check the internal surface of the cylinder body for stepped wear, corrosion and damage, and measure the inside diameter.

Inside diameter of the cylinder body.
Standard inside diameter : ϕ25.4 mm (1.0 in)

- Check the piston for damage, rust and wear.
- Measure the clearance between the cylinder body and the piston.

Standard inside diameter : 0.02 — 0.10 mm (0.00078 — 0.0039 in)
Limit : 0.11 mm (0.0043 in)

- If the limit value is exceeded, replace the slave cylinder assembly.



Installation

1. Assemble the cylinder body.
2. Assemble the bleeder screw.
3. Assemble the piston assembly.
   - Before assembling, apply a thin coat of rubber grease to the piston.

Caution:
Make sure not to damage the piston assembly when assembling.

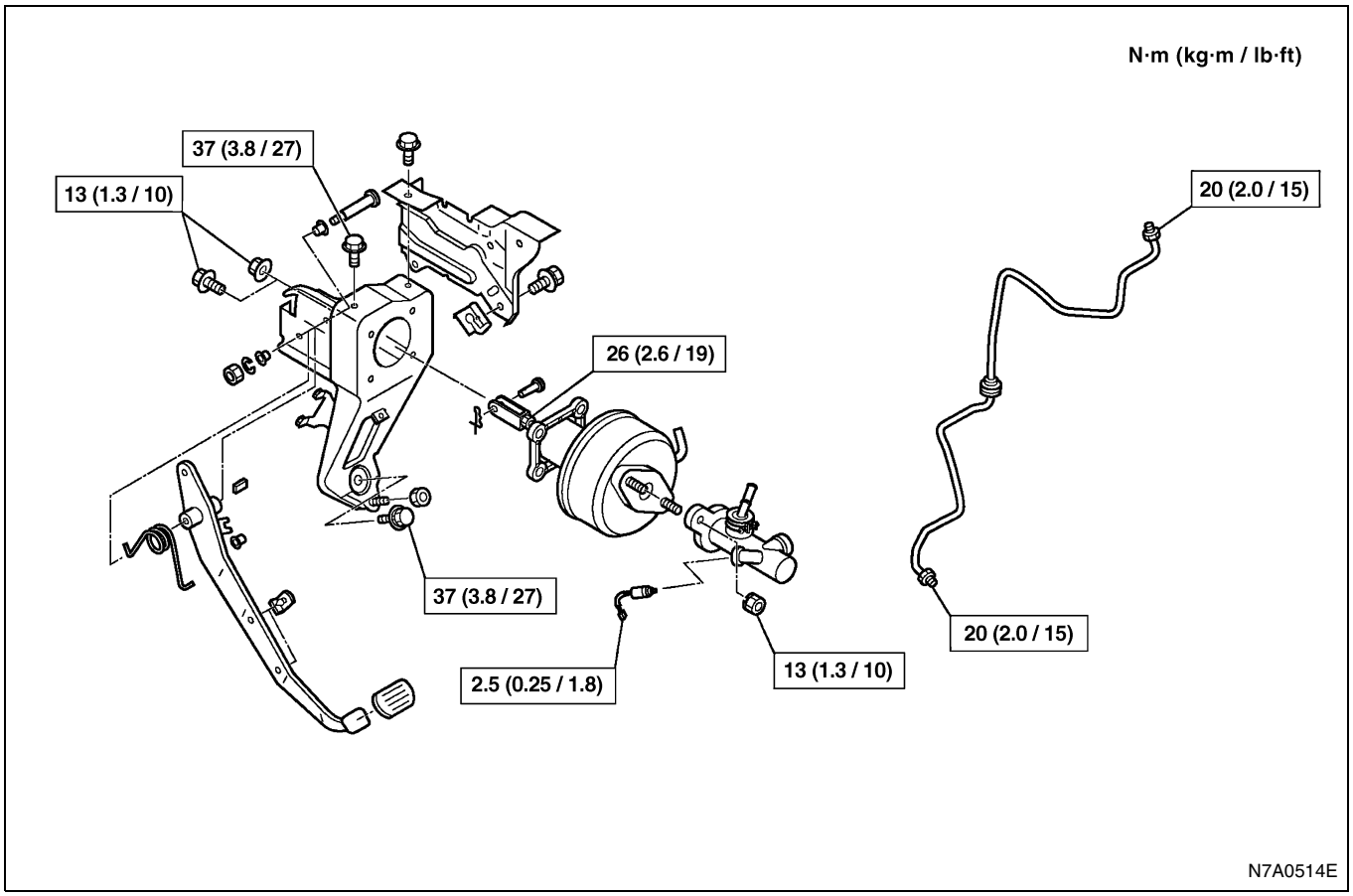
4. Assemble the boots.
5. Assemble the push rod.

Specifications

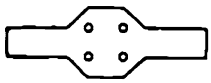
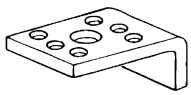
PRESSURE PLATE	Spring Shape	Diaphragm Spring	
	Outer Circumference	373 mm (14.685 in)	
	Installation Force	Set Force	Engine Model
		8,340 N (850 kg / 1,874 lb)	4HF1, 4HG1, 4HF1-II
		9,500 N (970 kg / 2,139 lb)	4HG1-T, 4HE1-TC-N, 4HK1-TC
		6,200 N (633 kg / 1,396 lb)	4JH1-TC-S
	Spring Finger Installation Height	49 — 51 mm (1.93 — 2.01 in)	
CLUTCH DISK	Outside Diameter × Inside Diameter	300 × 190 mm (11.81 × 7.48 in)	
	Assembly Thickness: When free	8.9 mm (0.35 in)	
	Assembly Thickness: When compressed	8.5 mm (0.33 in)	
CLUTCH PEDAL	Clutch Pedal Height	160 — 170 mm (6.29 — 6.69 in)	
	Clutch Pedal Stroke	159 — 169 mm (6.25 — 6.65 in)	
	Clutch Pedal Free Play	15 — 25 mm (0.59 — 0.98 in)	
MASTER CYLINDER	Inside Diameter	ϕ20.64 mm (0.81 in) (with Booster)	
		ϕ19.05 mm (0.74 in) (without Booster)	

CLUTCH BOOSTER	Diaphragm Valid Diameter	ϕ130 mm (5.11 in)
SLAVE CYLINDER	Inside Diameter	ϕ25.4 mm (1.00 in)

Fixing Torque



Special Tools

Illustration	Tool Number / Description / Remarks
 9852317330	9-8523-1733-0 / Handle
 5884020560	5-8840-2056-0 / Support Plate

LGMZZ-WE-0552

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LGMZZ-WE-0552 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

MANUAL TRANSMISSION AND CLUTCH MZZ SERIES

SECTION 7

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

SECTION No.	CONTENTS
7B1	MANUAL TRANSMISSION (MZZ)
7C	CLUTCH (FOR MZZ TRANSMISSION)

MANUAL TRANSMISSION AND CLUTCH MZZ SERIES

SECTION 7B1

MANUAL TRANSMISSION (MZZ)

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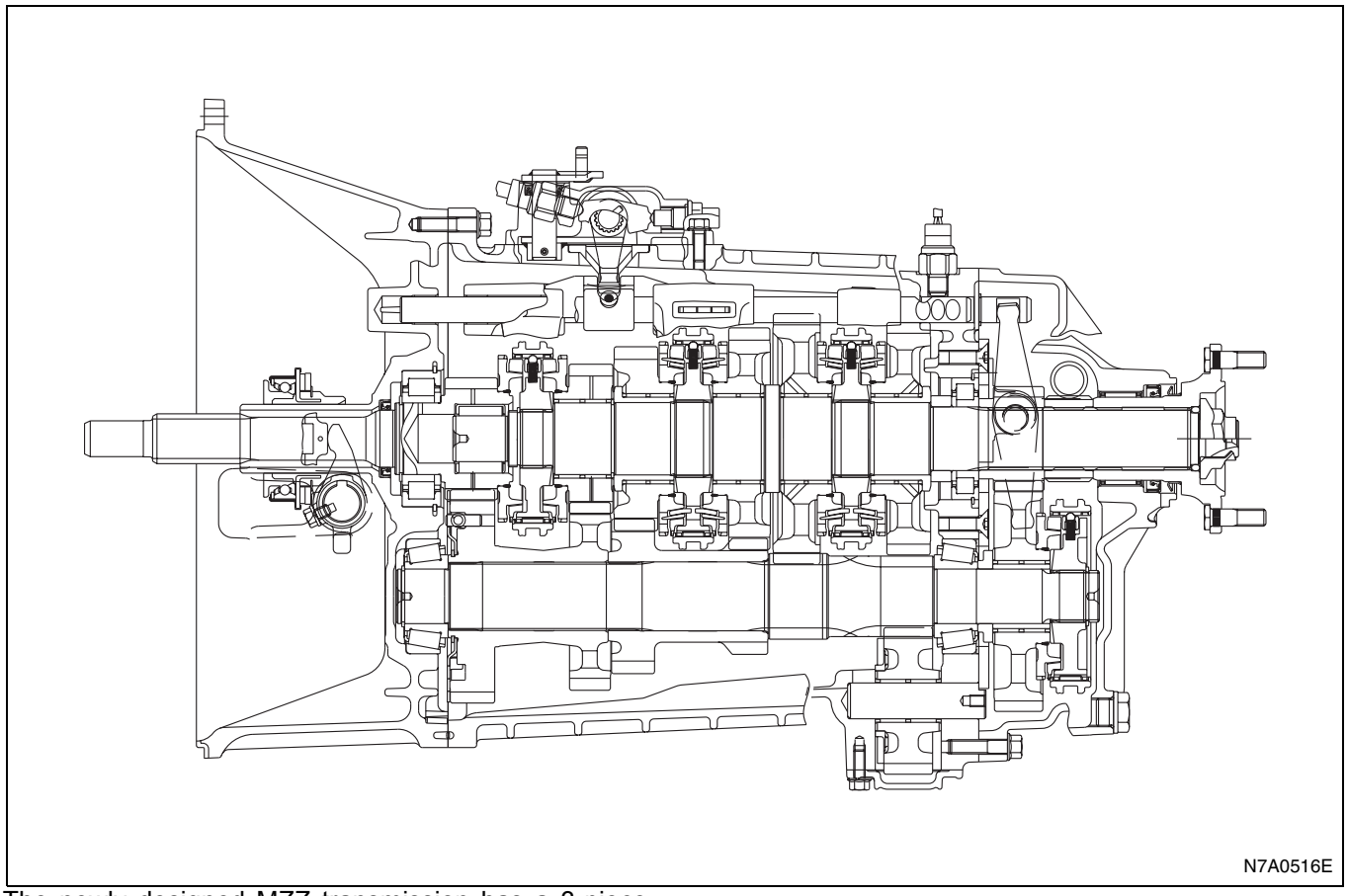
DESCRIPTION

6-speed Transmission

Notice:
When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.



The newly designed MZZ transmission has a 3-piece aluminum case to greatly reduce weight.
Taper roller bearings are used for both ends of the countershaft (front and rear).
The transmission features a twin-rod shift control.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Abnormal noise	1. Flywheel pilot bearing wear	1. Replace the bearing.
	2. Main shaft or countershaft bearing wear or other damage	2. Replace the bearing(s).
	3. Main shaft gear, countershaft gear, and/or reverse idle gear wear or other damage	3. Replace the gear(s).
	4. Main shaft spline and/or synchronizer hub spline wear	4. Replace the spline(s).
	5. Gear or bearing thrust surface scoring	5. Replace the gear(s) and/or bearing(s).
	6. Insufficient backlash between mating gears	6. Replace the gears.
Difficult shifting	1. Insufficient clutch pedal play	1. Adjust the play.
	2. Change lever contact surface wear	2. Repair or replace the change lever and apply grease.
	3. Shift block, shift rod, and/or control box contact surface wear	3. Replace the worn components.
	4. Shift arm and/or synchronizer sleeve wear	4. Replace the worn parts.
	5. Thrust washer and collar and/or gear thrust surface wear (Main shaft and countershaft thrust play)	5. Replace the worn parts.
	6. Synchronizer wear	6. Replace the synchronizer.
Gear slippage	1. Detent ball wear	1. Replace the detent ball.
	2. Shift rod and/or control box contact surface wear	2. Replace the worn components.
	3. Shift arm and/or synchronizer sleeve wear	3. Replace the worn parts.
	4. Thrust washer and collar and/or gear thrust surface wear (Main shaft and countershaft thrust play)	4. Replace the worn parts.
	5. Bearing wear or other damage	5. Replace the worn or damaged bearings.
	6. Main shaft spline and synchronizer hub spline wear	6. Replace the worn parts.
	7. Synchronizer spring weak or broken	7. Replace the spring.
Oil leakage	1. Drain plug and/or filler plug loose	1. Tighten the plug(s).
	2. Broken gasket	2. Replace the gasket.
	3. il seal wear or damage	3. Replace the oil seal.

ON-VEHICLE SERVICE

Transmission Oil Level Check

Measure

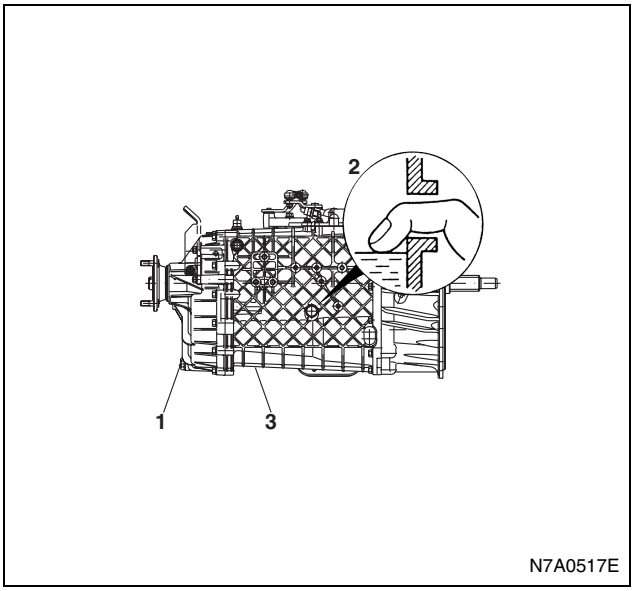
- Block the vehicle so it cannot move.
- Disconnect the ground cable from the battery negative (–) post.

1. Remove the filler plug (2) from the transmission case (3).
2. Check oil level.
   - Add lubricant to within 0 — 10 mm (0 — 0.4 in) of bottom edge of the filler hole if necessary.

Caution:
Use ENGINE OIL SAE 5W-30 for the transmission case.

3. Install the filler plug.

Tighten:
- Filler plug to 39 N·m (4 kg·m / 29 lb·ft)
- Connect the battery ground cable and remove the wheel blocks.



Legend
1. Drain plug
2. Filler plug
3. Transmission case

Changing Transmission Oil

Drain the transmission oil after driving the vehicle. The oil will drain more completely.

- Block the vehicle so it cannot move.
- Disconnect the ground cable from the battery negative (–) post.

1. Remove the drain plug (1). Provide a pan to catch oil.
2. Install the drain plug and tighten.

Tighten:
Drain plug to 39 N·m (4 kg·m / 29 lb·ft)

3. Remove the filler plug (2).
4. Fill the transmission case to level of the filler plug opening.

Caution:
Use ENGINE OIL SAE 5W-30 for the transmission case.

5. Install filler plug and tighten.

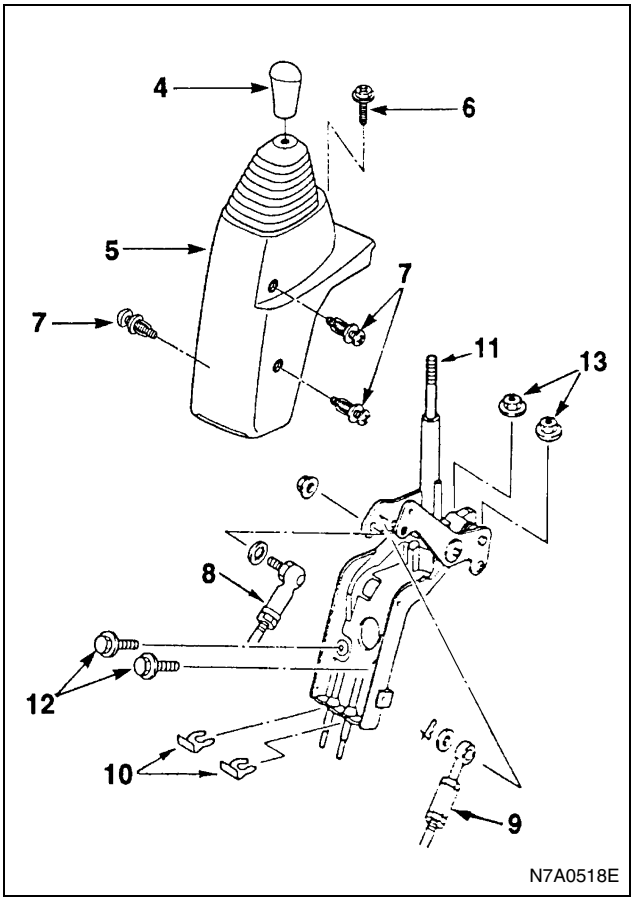
Tighten:
- Filler plug to 39 N·m (4 kg·m / 29 lb·ft)
- Connect the battery negative cable and remove the wheel blocks.

Gearshift Lever

Remove or Disconnect

- Block the vehicle so it cannot move.
- Disconnect the ground cable from the battery negative (–) post.

1. Gearshift lever knob (4).
2. Cover assembly (5).
   - Remove the fixing screw (6) and 3 clips (7).
3. Shift cable (8) and select cable (9).
   - Disconnect the cables from the gearshift lever.
   - Remove the C-clips (10) and disconnect the cables from bracket.
4. Gearshift lever assembly (11).
   - Remove 2 screws (12) and 2 nuts (13).



Legend

4. Gearshift lever knob
5. Cover assembly
6. Screw
7. Clip
8. Shift cable
9. Select cable
10. C-clip
11. Gearshift lever assembly
12. Screw
13. Nut

Install or Connect

1. Gearshift lever assembly (11).
2. Shift cable (8) and select cable (9).
   - Connect the cables to the gearshift lever.
   - Install the C-clips (10) to the bracket.

Adjust:

- When connecting the shift cable and select cable to the gearshift lever, adjust the cable. Refer to GEARSHIFT CABLE in this section.

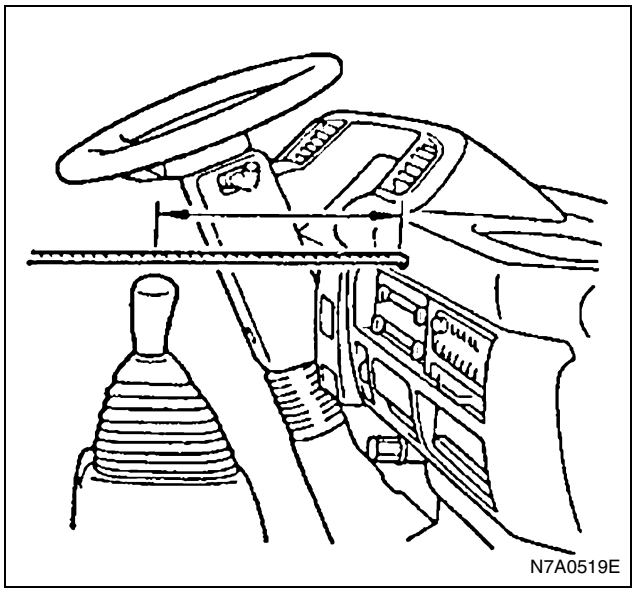
3. Cover assembly (5).
4. Gearshift lever knob (4).
   - Connect the battery negative cable and remove the wheel blocks.

Gearshift Cable

After connection of the select cable and the shift cable, confirm if shift operation is performed smoothly. If any dragging or improper stroke is present, check and adjust in accordance with the procedures shown below.

Measure

Set the transmission in the neutral position, then confirm if the dimension between the center of the shift lever play and the instrument center cluster is within the 283 ± 15 mm (11.1 ± 0.6 in). If the dimension is out of the reference value, adjust as required.



Adjust

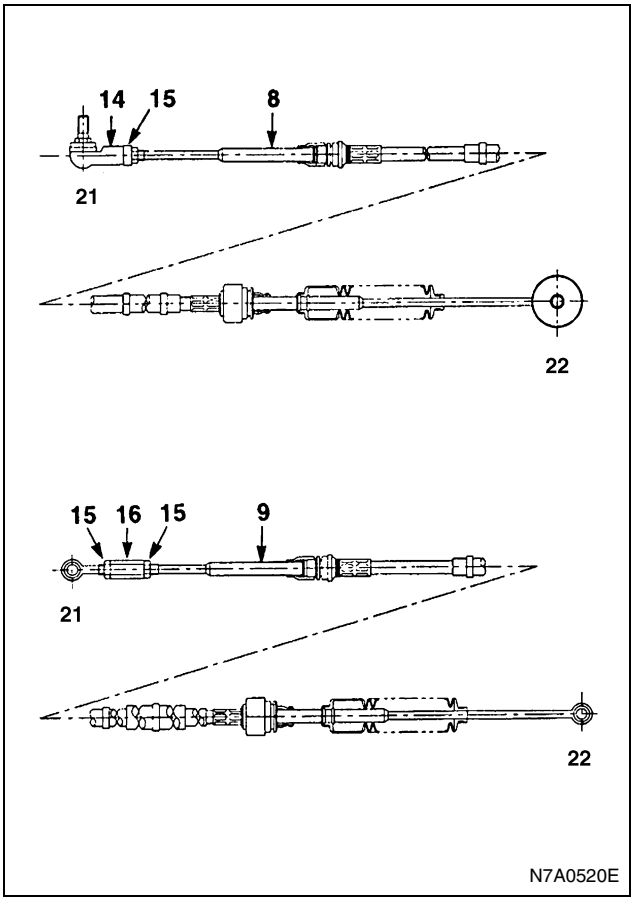
- Block the vehicle so it cannot move.
- Disconnect the ground cable from the battery negative (-) post.

1. Remove the gearshift lever knob (4).
2. Remove the cover assembly (5).
3. Disconnect the shift cable (8) and the select cable (9) on the gearshift lever side.
4. Set the transmission in the neutral position, then adjust the dimension between the center of the shift lever play and the instrument center cluster to the 283 ± 15 mm (11.1 ± 0.6 in).
5. Loosen the lock nut (15) of the shift cable (8) and the select cable (9), then turn the ball joint (14) or turnbuckle (16) as necessary for respective pins.
6. Fasten the lock nut (15) with specific torque.

Tighten:

Lock nut (15) to 6 N·m (0.6 kg·m / 52 lb·in)

7. Install the cover assembly (5).
8. Install the gearshift lever knob (4).
   - Connect the battery ground cable and remove the wheel blocks.



Legend

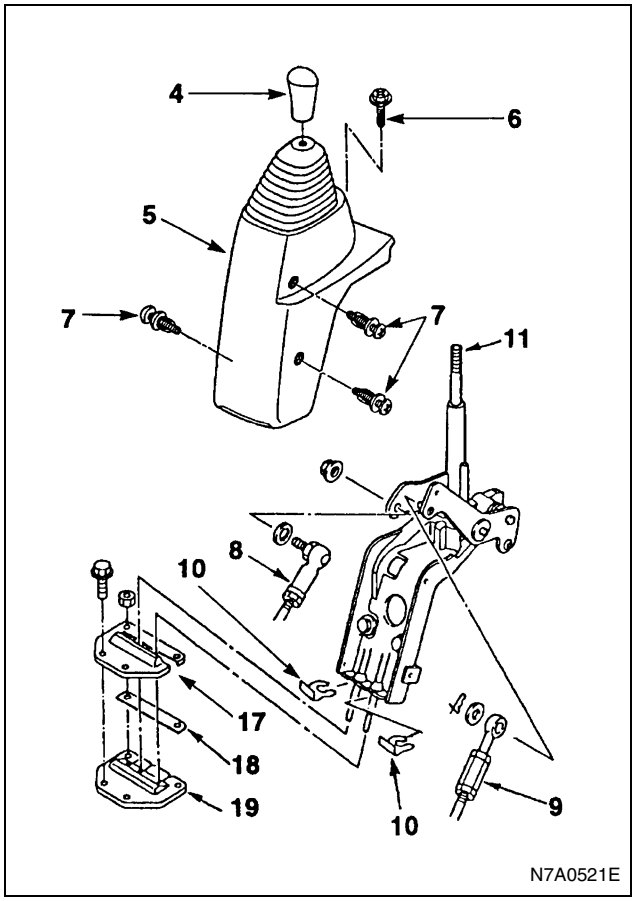
8. Shift cable
9. Select cable
14. Ball joint
15. Lock nut
16. Turnbuckle
21. Shift lever side
22. Transmission side

Remove or Disconnect

- Block the vehicle so it cannot move.
- Disconnect the ground cable from the battery negative (-) post.

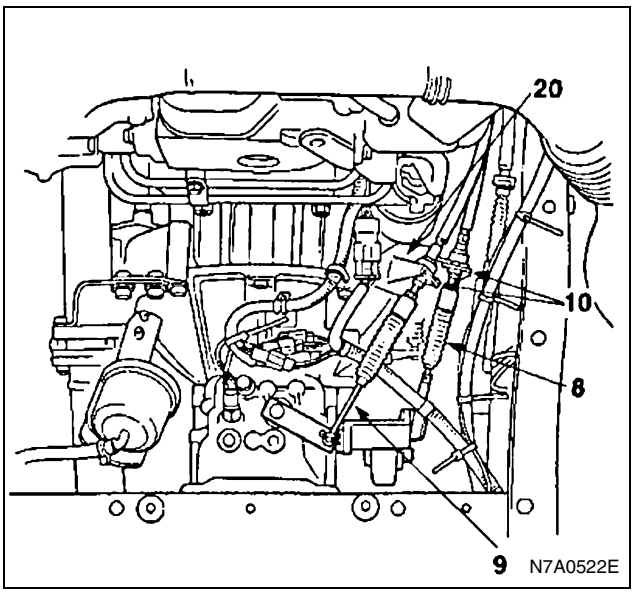
1. Gearshift lever knob (4).
2. Cover assembly (5).
3. Shift cable (8) and select cable (9).

- Disconnect the shift cable and select cable from gearshift lever.
- Remove the C-clips (10) and disconnect the cables from gearshift lever bracket.
- Remove the grommet retainer (17), grommet seal (18) and grommet (19).
- Tilt the cab.
- Disconnect the shift cable and the select cable on the transmission side.
- Remove the C-clips (10) and disconnect the shift cable and the select cable from the bracket (20).
- Remove the clips that fix the cables to the frames or brackets.
- Remove the shift and select cable assemblies.



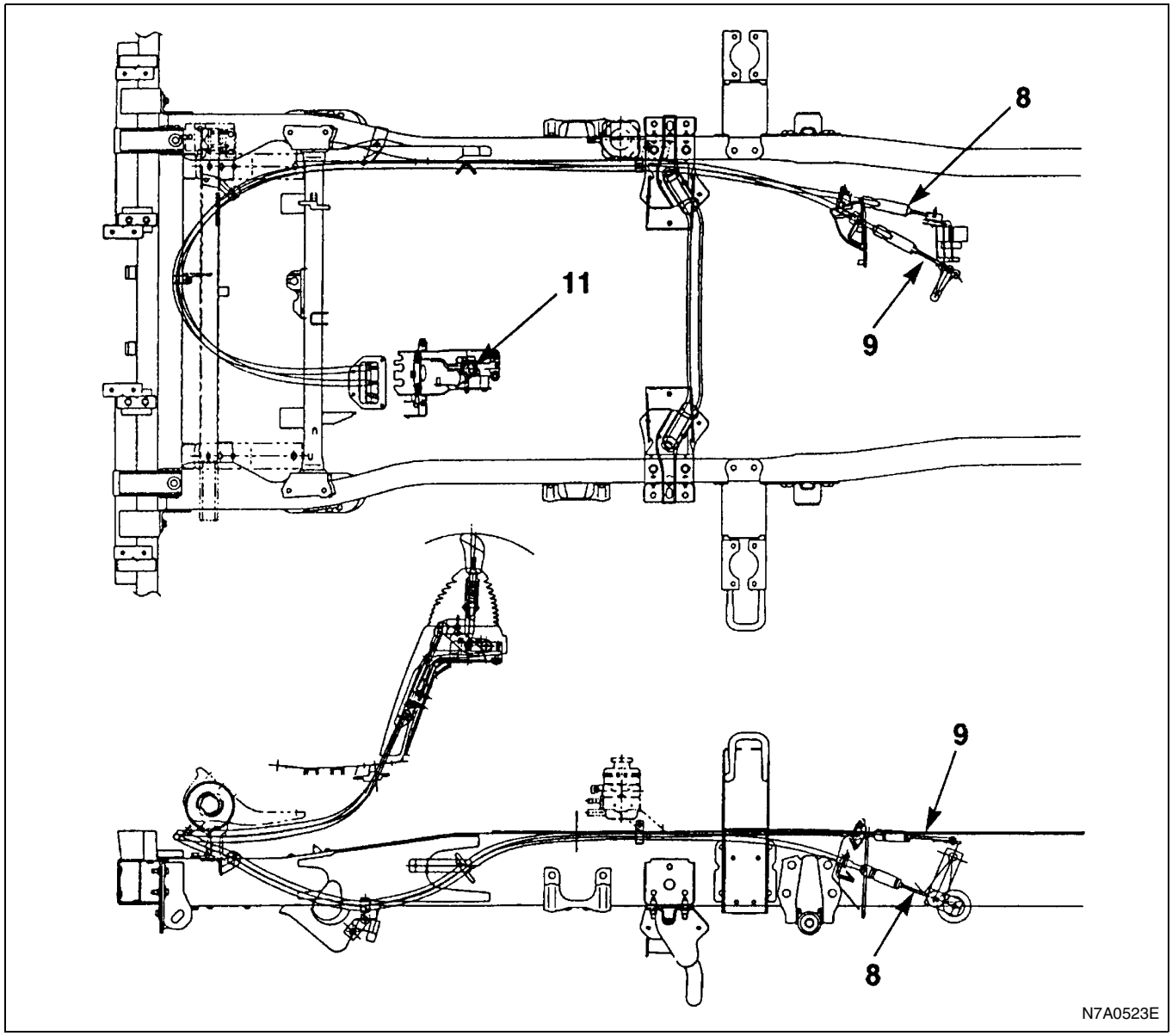
Legend

4. Gearshift lever knob
5. Cover assembly
6. Screw
7. Clip
8. Shift cable
9. Select cable
10. C-clip
11. Gearshift lever
17. Grommet retainer
18. Grommet seal
19. Grommet



Legend

8. Shift cable
9. Select cable
10. C-clip
20. Bracket



Legend

8. Shift cable
9. Select cable
11. Gearshift lever

Inspect

Check the cables for any deformation, damage or rust, and also check the sliding portion for any abnormal condition.
When there is any abnormal condition found, replace it with new one.

Install or Connect

1. Shift cable (8) and select cable(9).
   - Install temporarily the shift cable and select cable.

Important:

- Never bend the cables to radius less than 450 mm (18 in) unless it is necessary to do so for wiring purposes. And never bend the cables to radius less than 180 mm (7 in) even during wiring.
- Install the cables carefully without unnecessary twisting the cable boots.
- Fasten the cables with C-clips to the brackets on the transmission side.
- Fasten the cables with C-clips to the gearshift lever bracket.
- Fasten the cables with clips to the frames and brackets.
- Connect the cables to the transmission.
- Install the grommet (19), grommet seal (18) and grommet retainer (17).

Adjust:

- When connecting the shift cable (8) and the select cable (9) to the gearshift lever, adjust the cables. Refer to GEARSHIFT CABLE given previously in this section.

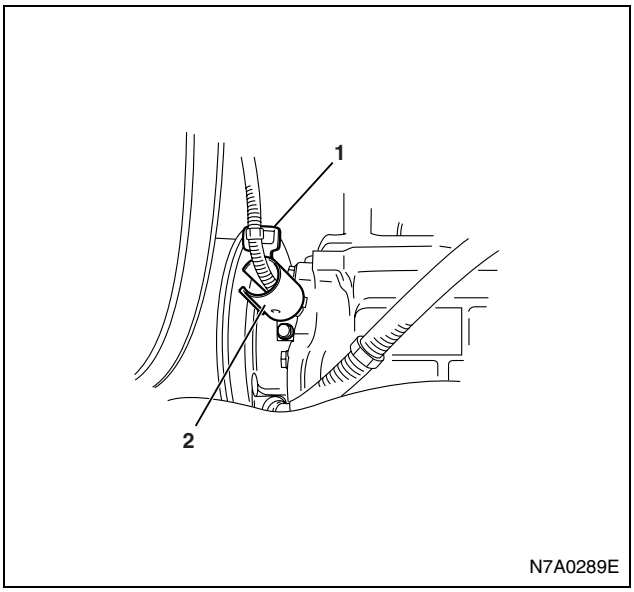
2. Cover assembly (5).
3. Gearshift lever knob (4).

- Connect the battery negative cable and remove the wheel blocks.

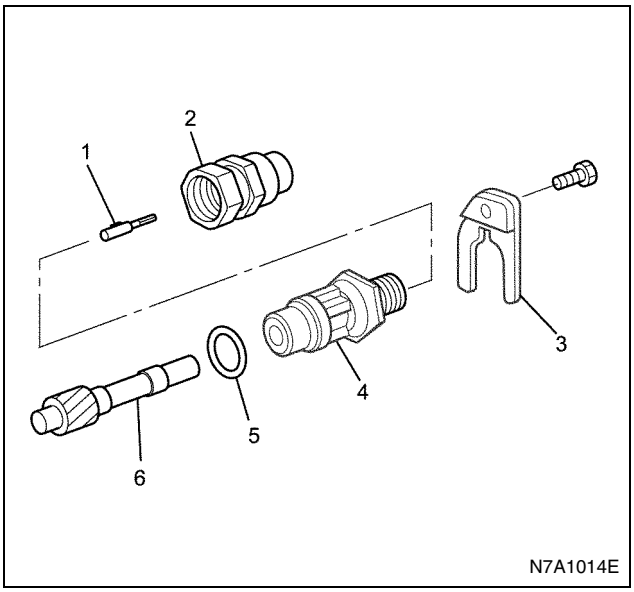
Vehicle Speed Sensor

Removal

1. Remove the clips (1) and the protector (2).
2. Remove the wiring connectors.



3. Loosen the fixing screw and remove the vehicle speed sensor (2).



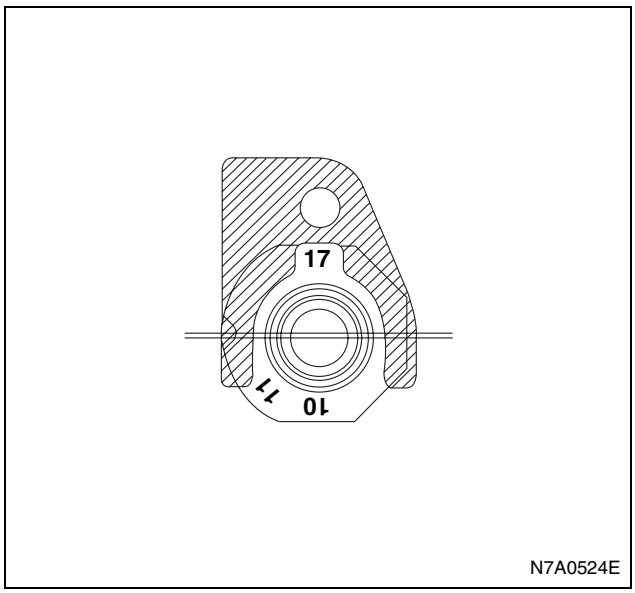
Legend

1. Sensor insert
2. Vehicle speed sensor
3. Plate
4. Bush
5. O-ring
6. Driven gear

Installation

1. Install the vehicle speed sensor and secure it with the fixing screw.

- Align the gear tooth marked 17 of the speedometer's driven gear (17 teeth) with the opening in the plate.



2. Tighten the fixing screw to the specified torque.

Tighten:
Screw to 20 N·m (2.0 kg·m / 15 lb·ft)

3. Install the sensor insert and the vehicle speed sensor. Tighten the vehicle speed sensor to the specified torque.

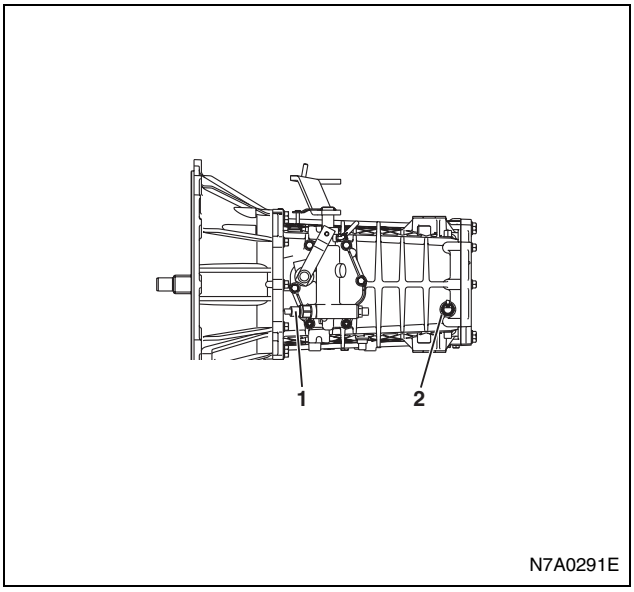
Tighten:
Vehicle speed sensor to 25 N·m (2.5 kg·m / 18 lb·ft)

4. Connect the wiring connectors.
5. Install the protector and secure it with the clips.

Reverse, Neutral and Selector Switches

Removal

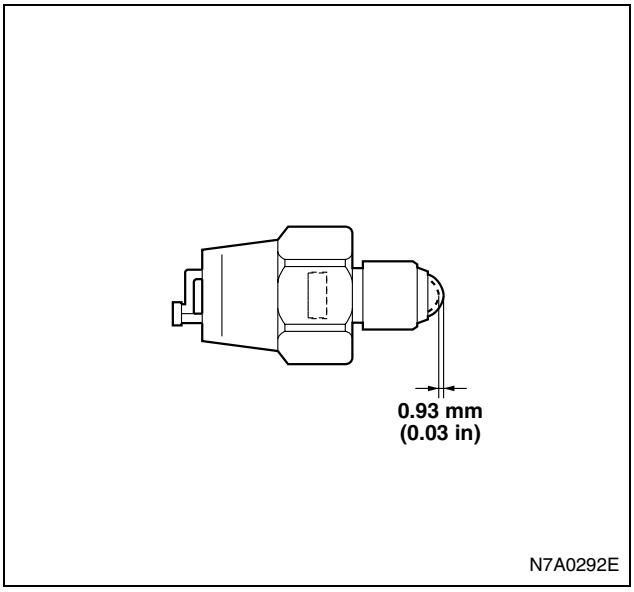
1. Remove the wiring connectors.
2. Remove the reverse switch (2). The switch has a black connector.
3. Remove the neutral switch (1). The switch has a black connector.



Inspection

1. Check for continuity between the switch terminals when the ball is pressed. If there is no continuity, the switch is bad.
2. Measure the switch travel.

Switch travel: 0.93 mm (0.03 in)



Installation

1. Apply liquid gasket (Three Bond 1141) to the threaded portion of the neutral switch.
2. Install the neutral switch. Tighten the switch to the specified torque.

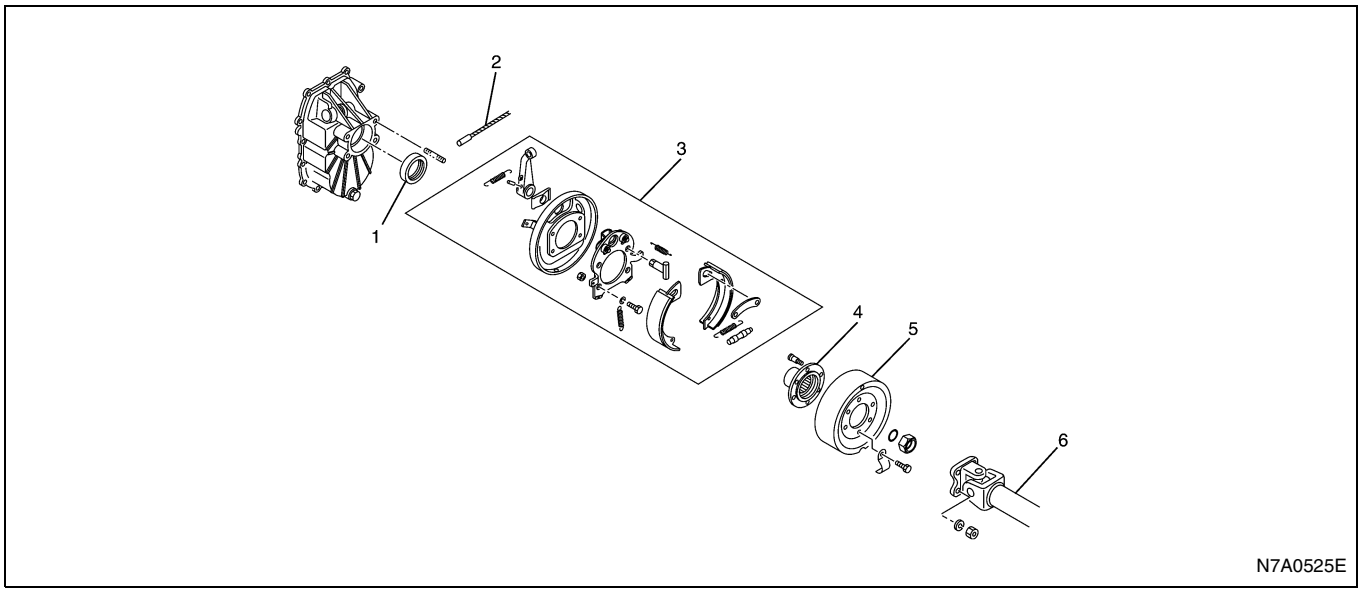
Tighten:
Switch to 34 N·m (3.5 kg·m / 25 lb·ft)

3. Apply liquid gasket (Three Bond 1141) to the threaded portion of the reverse switch.
4. Install the reverse switch. Tighten the switch to the specified torque.

Tighten:
Switch to 39 N·m (4 kg·m / 29 lb·ft)

Rear Oil Seal

Parts



Legend

1. Oil seal
2. Parking brake cable
3. Parking brake assembly
4. Coupling driver
5. Parking brake drum
6. Rear propeller shaft assembly

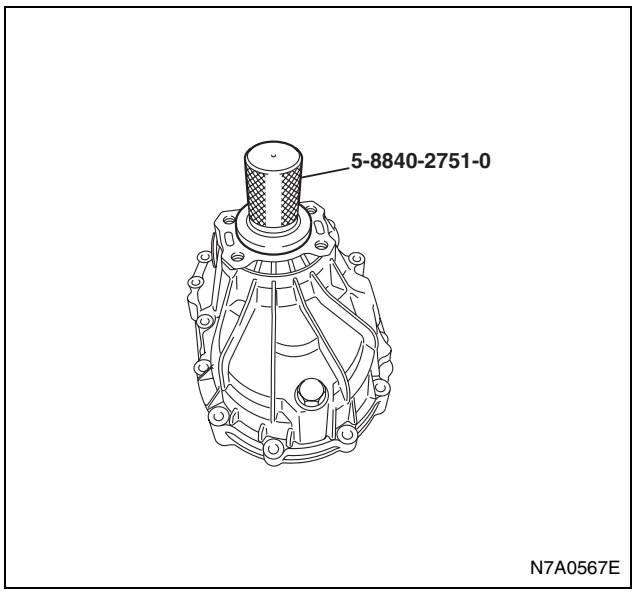
Removal

1. Remove the rear propeller shaft assembly.
   - Refer to PROPELLER SHAFT.
2. Remove the parking brake cable.
   - Refer to PARKING BRAKES.
3. Remove the parking brake drum.
   - Refer to PARKING BRAKES.
4. Use the special tool (9-8529-2101-0) to break the coupler driver lock nut caulking (2 locations) and remove the nut.
5. Remove the coupling driver together with the O-ring.
6. Remove the parking brake assembly.
   - Refer to PARKING BRAKES.
7. Use an ordinary screwdriver to remove the rear oil seal.

Installation

1. Apply engine oil (5W-30) to the new oil seal outer circumference.
2. Apply multi-purpose type grease to the lipped portion of the oil seal.
3. Use the installer (5-8840-2751-0) to press the oil seal into the rear cover.

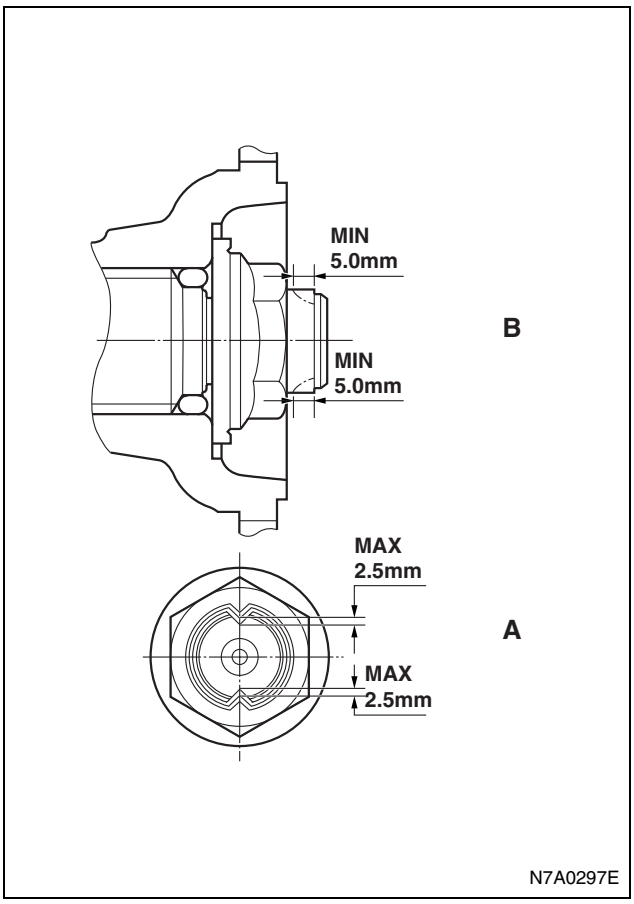
Caution:
The lipped portion of the oil seal is easily broken. Exercise care during the installation procedure.



4. Install the parking brake assembly.
   - Refer to PARKING BRAKES.
5. Apply engine oil (5W-30) to the new O-ring.
6. Install the coupling driver together with the O-ring.
7. Apply engine oil (5W-30) to the seating surface of the new lock nut.
8. Use the special tool (9-8529-2101-0) to tighten the lock nut to the specified torque.

Tighten:
Lock nut to 382 N·m (39 kg·m / 282 lb·ft)

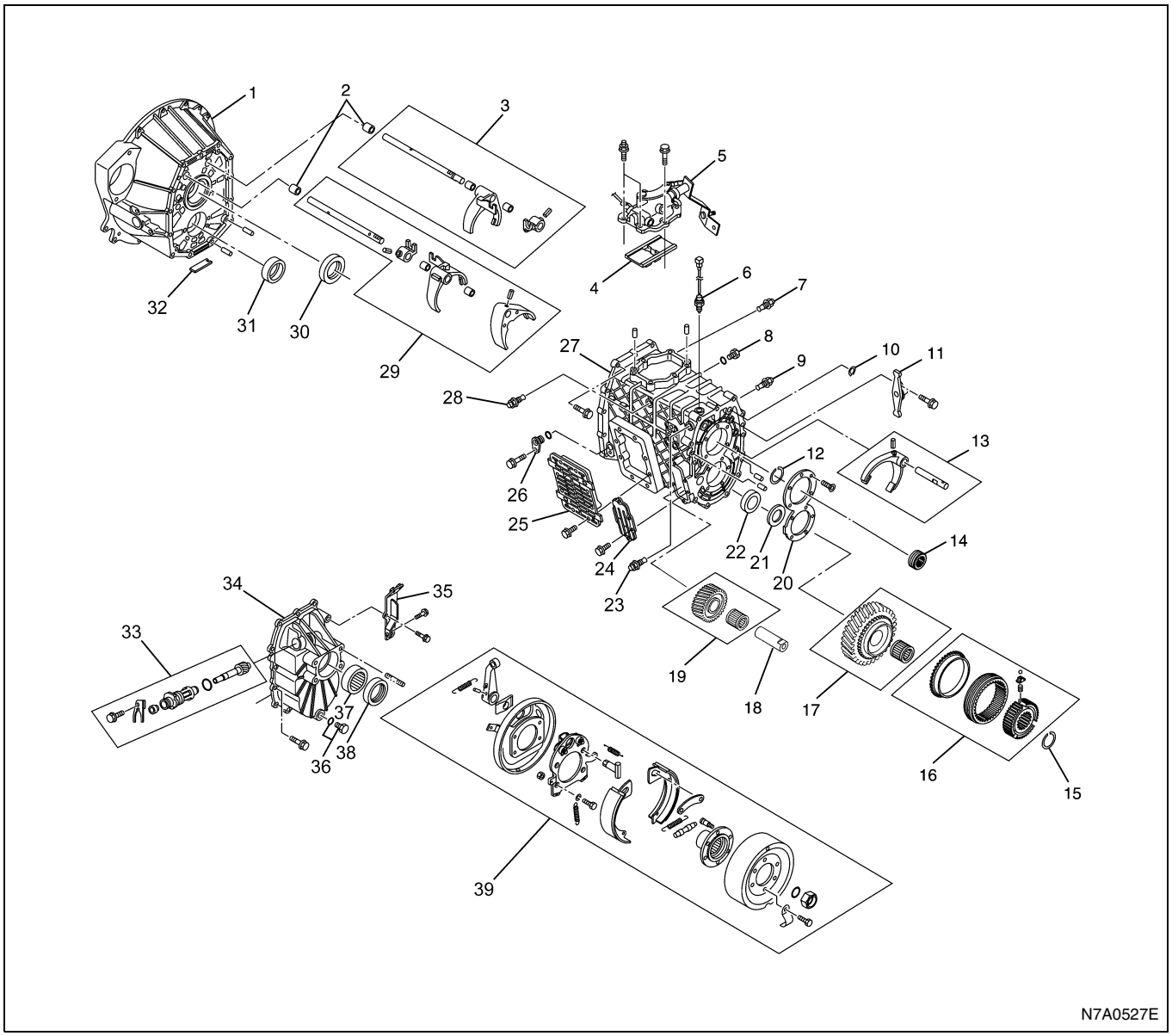
9. Align the lip portion of the lock nut with the V-groove at the end of the shaft (length (B) must be at least 5 mm (0.2 in)). Wedge the lipped portion of the nut into the V-groove so that the gap between the nut and the bottom of the V-groove (A) is less than 2.5 mm (0.1 in).
10. Caulk the lock nut at two places.

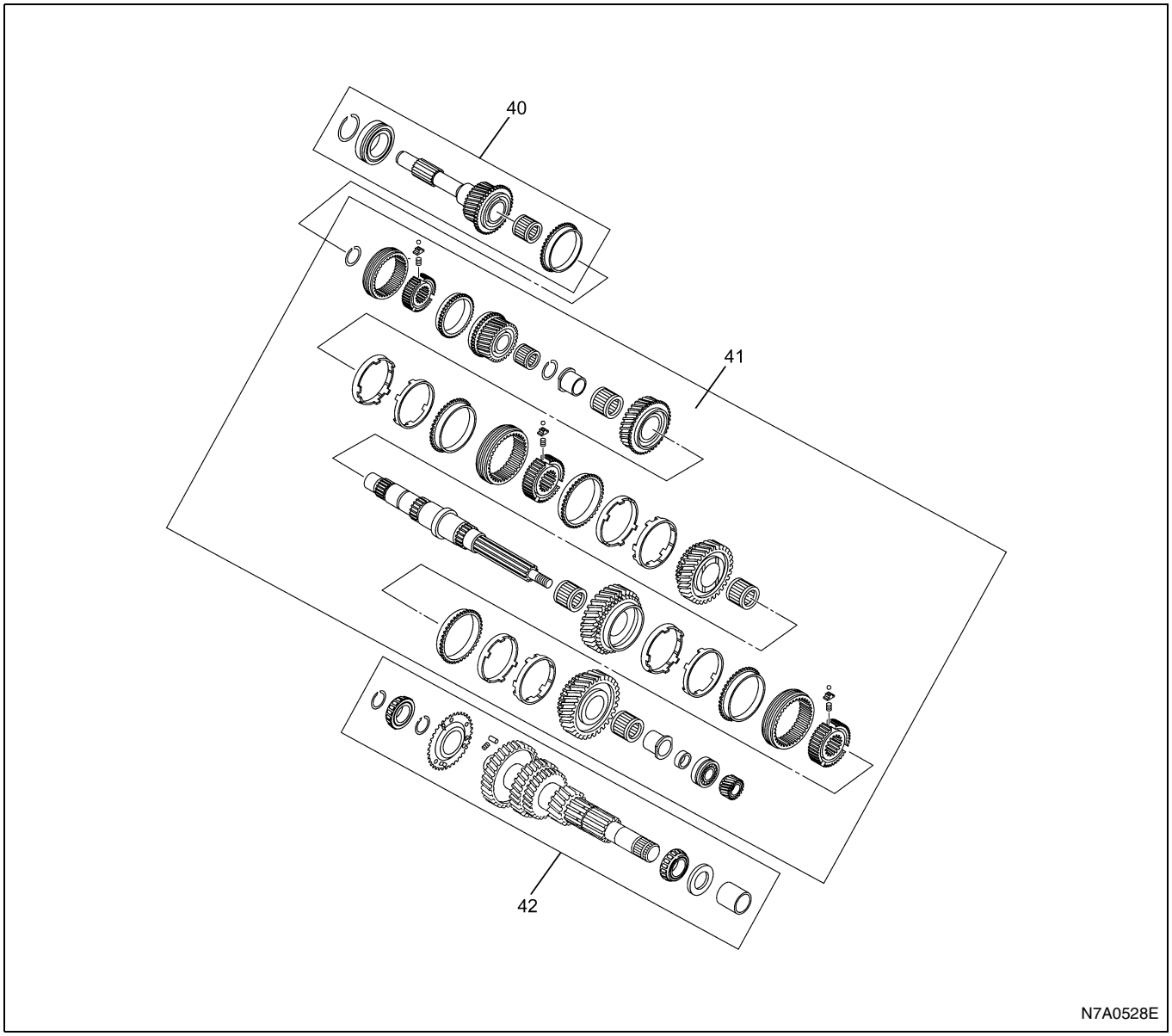


11. Install the parking brake drum.
    - Refer to PARKING BRAKES.
12. Install the parking brake cable.
    - Refer to PARKING BRAKES.
13. Install the rear propeller shaft assembly.
    - Refer to PROPELLER SHAFT.

Transmission

Parts





Legend

1. Clutch housing
2. Bush (Clutch housing)
3. 4th / 5th, 6th shift arm
4. Interlock plate
5. Control box
6. Reverse switch
7. Detent assembly
8. Filler plug
9. Detent assembly
10. Snap ring
11. 6th relay lever
12. Snap ring
13. 6th shift arm and shift rod
14. Speedometer gear
15. Snap ring
16. 6th clutch hub assembly and sleeve
17. 6th gear and needle bearing
18. Reverse idle shaft
22. Counter rear bearing
23. Detent assembly
24. Reverse gear idle cover
25. PTO cover
26. Sensor dummy plug
27. Transmission case
28. Detent assembly
29. 1st / reverse and 2nd/ 3rd shift arm
30. Front oil seal
31. Bearing outer race
32. Magnet
33. Speedometer driven gear
34. Rear cover
35. Parking brake cable bracket
36. Drain plug
37. Needle bearing (Main end)
38. Rear oil seal
39. Parking brake assembly

19. Reverse idle gear and needle bearing
20. Retainer
21. Counter shim
40. Top gear shaft assembly
41. Main shaft assembly
42. Countershaft assembly

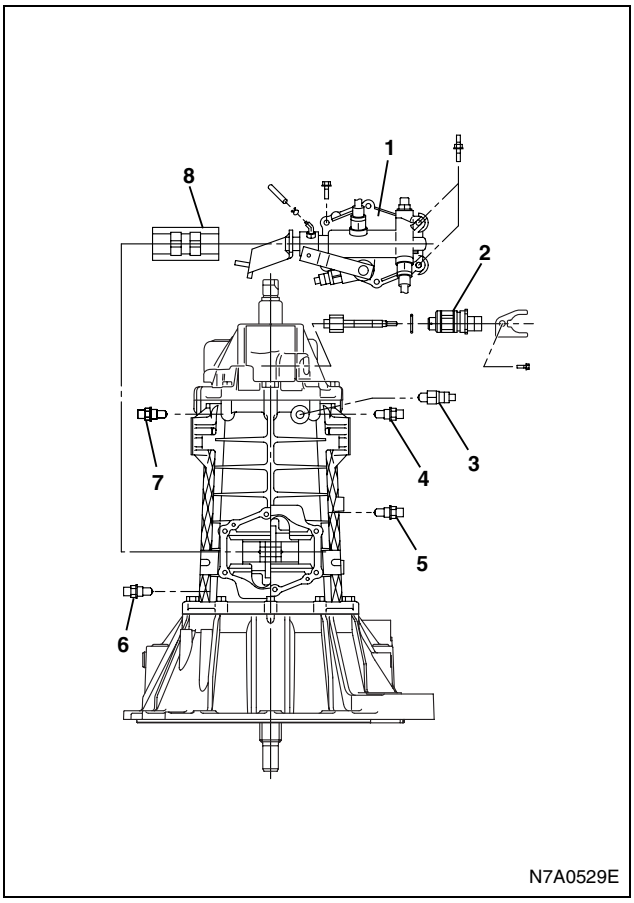
Disassembly

Caution:
The transmission case and clutch housing are made of aluminum. They are easily damaged. Exercise care during the disassembly and reassembly procedure.

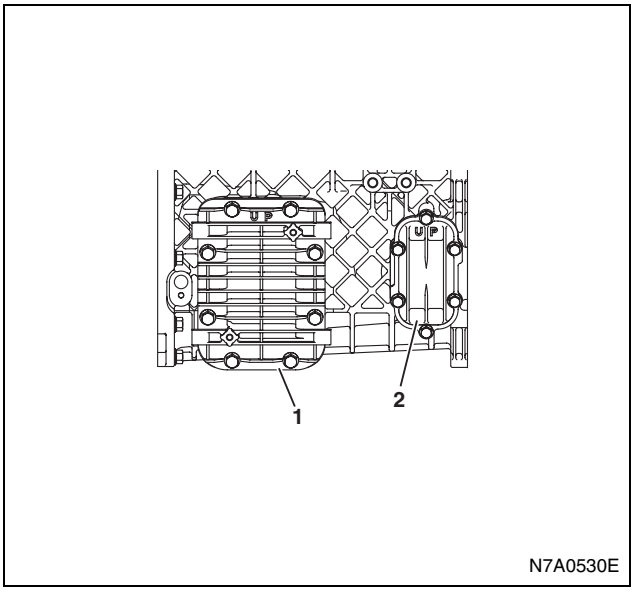
Caution:
Be especially careful not to damage the transmission case ribs. A damaged rib greatly weakens the case.

Caution:
Remember that transmission and clutch parts are heavy and must be handled with great care to avoid serious injury to yourself and others around you.

1. Remove the shift block together with the release bearing, the clutch shaft, and the shaft fork.
   - Refer to CLUTCH.
2. Remove the parking brake drum.
   - Refer to PARKING BRAKES.
3. Use the special tool (9-8529-2101-0) to break the coupler driver lock nut caulking (2 locations) and remove the nut.
4. Remove the coupling driver together with the O-ring.
5. Remove the parking brake assembly.
   - Refer to PARKING BRAKES.
6. Remove the parking brake cable bracket from the transmission case.
7. Remove the filler plug and O-ring.
8. Remove the drain plug and the O-ring.
   - Allow time for the transmission oil to drain into a suitable container. Check the oil volume. Look for metallic particles and other foreign material in the oil.
9. Remove the speedometer driven gear (2).
10. Remove the reverse switch (3).
11. Remove the 4 detent assemblies ((4), (5), (6) and (7)).
12. Remove the control box (1) together with the interlock plate (8).

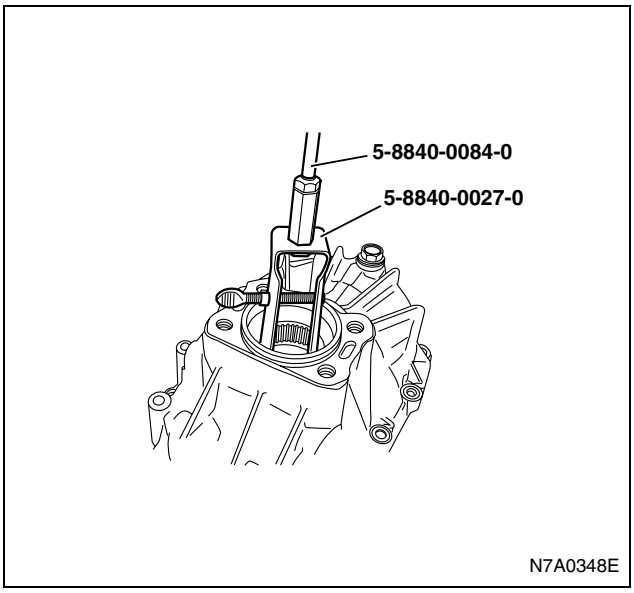


13. Remove the PTO cover (1).
14. Remove the reverse idle cover (2).

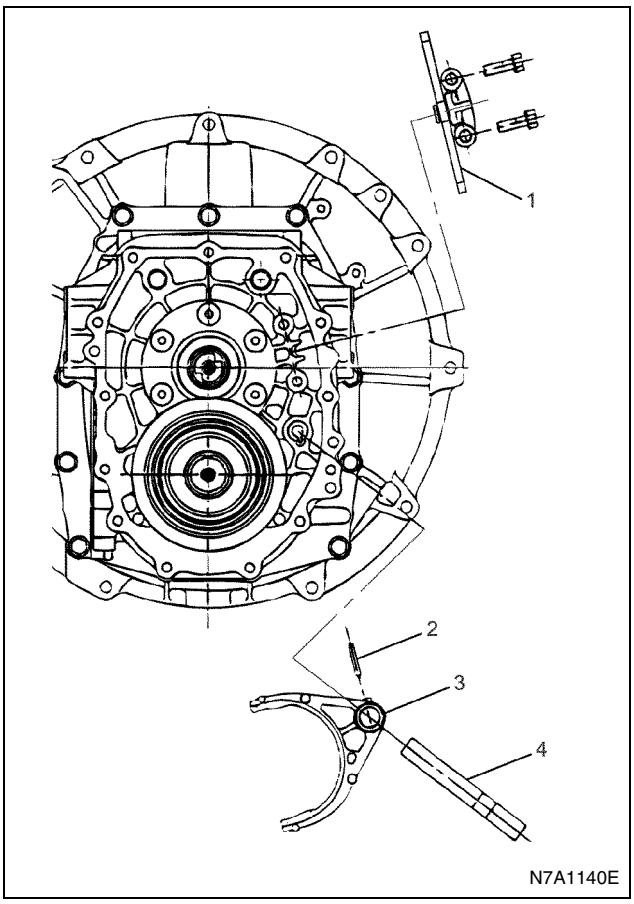


15. Remove the rear cover assembly.
16. Inspect the rear cover oil seal for wear and other damage. If wear or damage is present, the oil seal must be replaced. Use an ordinary screwdriver to remove it from the rear cover.

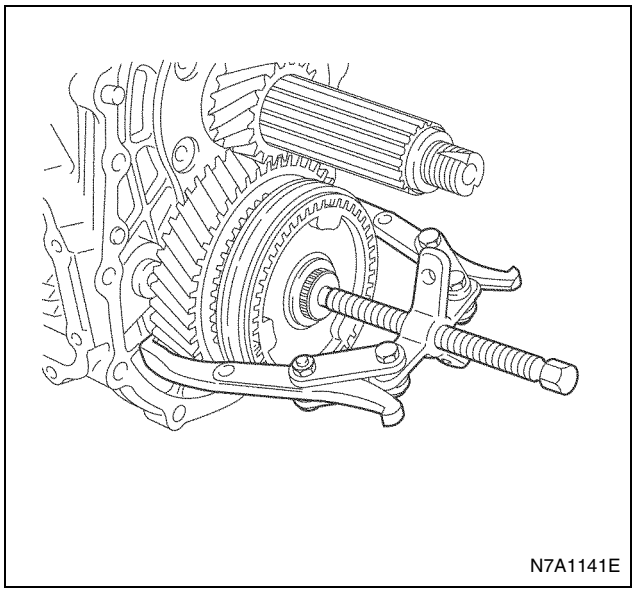
17. Use the remover (5-8840-0027-0) and the sliding hammer (5-8840-0084-0) to remove the neutral bearing (main end) from the rear cover.



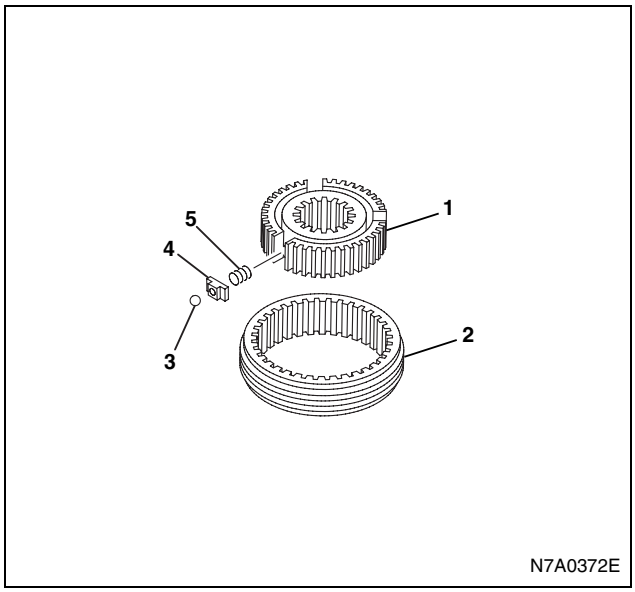
18. Remove the relay lever 6th gear (1).
19. Use a spring remover to force out the spring pins (2) from the 6th gear shift arm (3) and the 6th gear shift rod (4).
20. Remove the 6th gear shift arm and the 6th gear shift rod.



21. Use a pair of snap ring pliers to remove the snap ring from the 6th gear clutch hub.
22. Use a puller to remove the 6th gear clutch hub assembly, the sleeve, the block ring, the gear, and the needle bearing from the counter shaft.



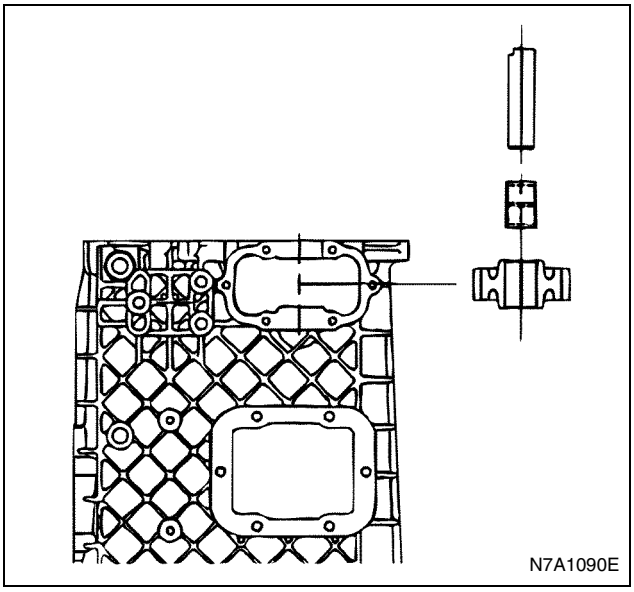
23. Disassemble the 6th gear clutch hub assembly and the sleeve.



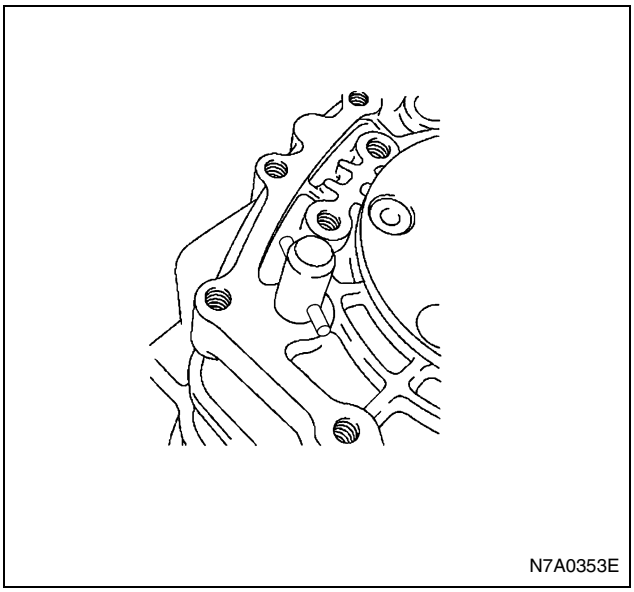
Legend

1. Clutch hub
2. Sleeve
3. Ball
4. Block
5. Spring

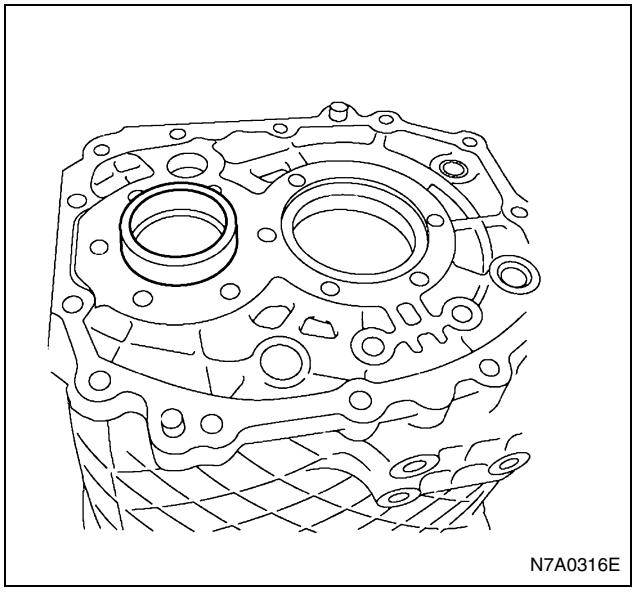
24. Remove the speedometer gear.
25. Remove the retainer from the transmission case.
26. Pull out the reverse idle shaft.
27. Remove the reverse idle gear together with the needle bearing.


N7A1090E

28. Remove the snap ring (rear outer) from the main shaft rear bearing.
29. Remove the shim from the counter shaft rear bearing.
30. Remove the snap rings (4th / 5th and 6th shift rods).

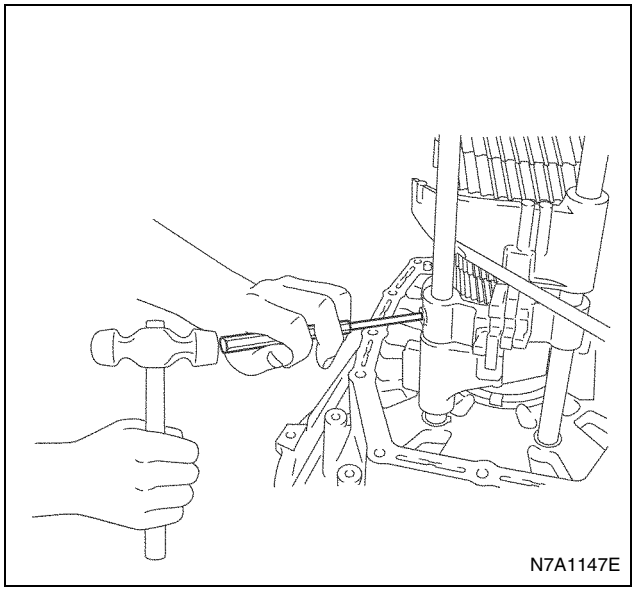

N7A0353E

31. Remove the transmission case from the clutch housing.
32. Remove the bearing rear outer race from the transmission case.


N7A0316E

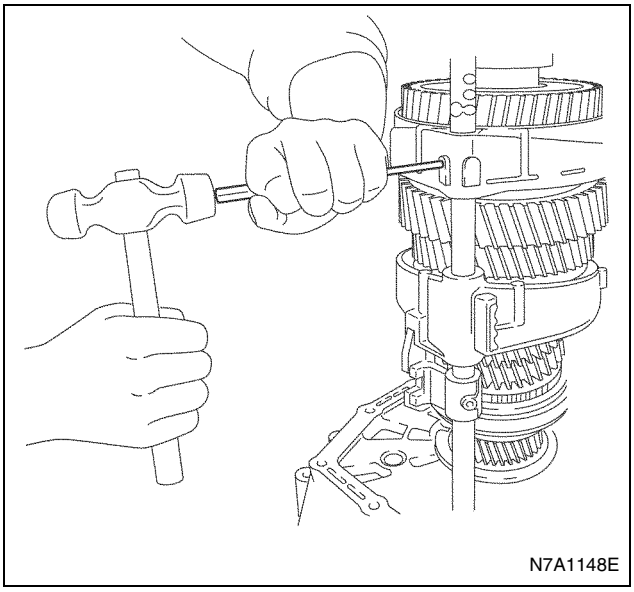
33. Use a spring pin remover to remove the spring pins from the 4th / 5th shift rod, the 1st / reverse shift block, the 6th shift block, and 4th / 5th shift arm.
34. Remove the 4th / 5th shift rod, the 1st / reverse shift block, the 6th shift block, and 4th / 5th shift arm.

Caution:
To avoid damaging other parts, place a round shaft at the opposite end of the shift rod when removing the spring pins.


N7A1147E

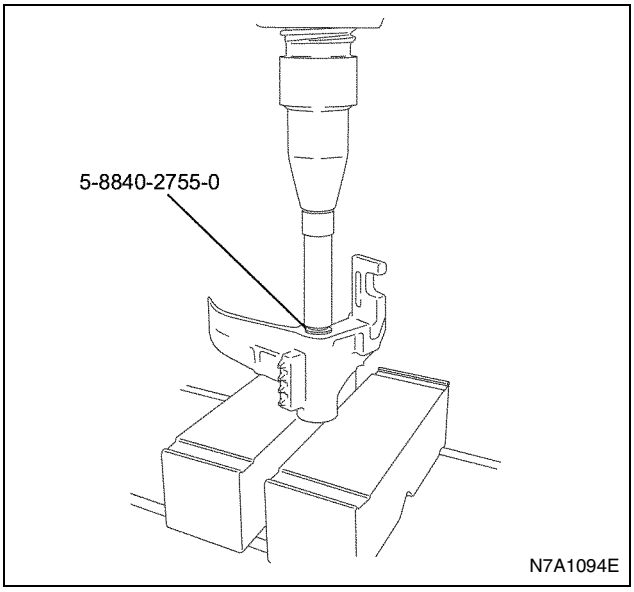
35. Remove the 1st / reverse and the 2nd / 3rd shift rod, the 1st / reverse shift arm, the 2nd / 3rd shift arm, the 1st / reverse, and the 6th shift block.

Caution:
To avoid damaging other parts, place a round shaft at the opposite end of the shift rod when removing the spring pins.


N7A1148E

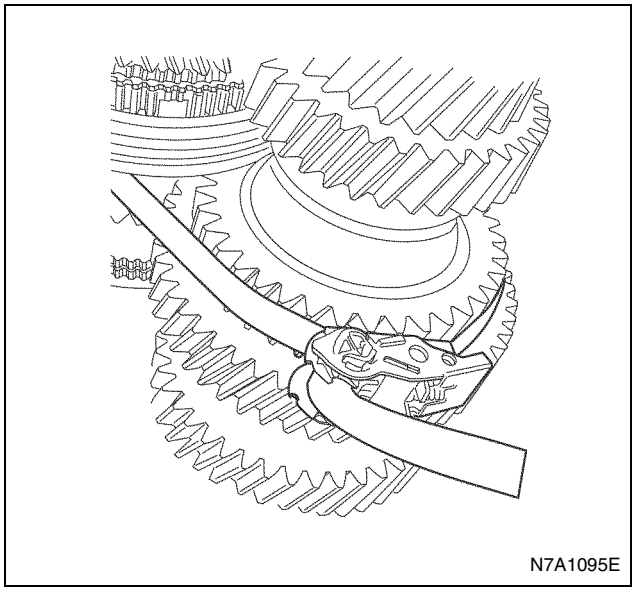
36. Use the remover (5-8840-2755-0) to remove the bush from the 4th / 5th shift arm.
37. Use the remover (5-8840-2755-0) to remove the bush from the 1st / reverse shift arm.
38. Use the remover (5-8840-2755-0) to remove the bush from the 2nd / 3rd shift arm. from the 1st / reverse shift arm.

Caution:
To avoid damaging other parts, place a round shaft at the opposite end of the shift arm (same length as the remover) when removing the bushes.

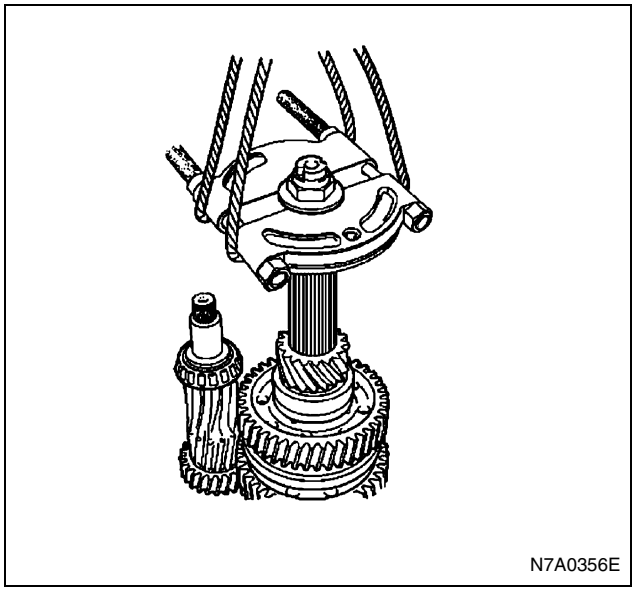


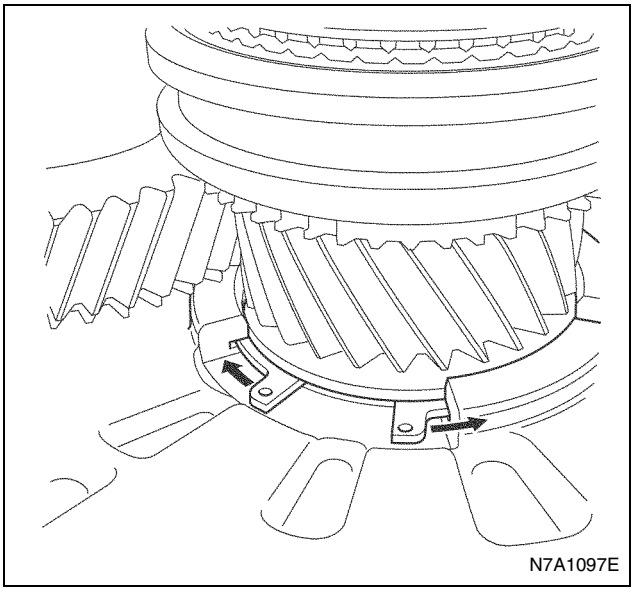
N7A1094E

39. Remove the magnet from the clutch housing.
40. Remove the main shaft assembly, upper gear shaft assembly, and the countershaft assembly.
    a. Tightly wrap belts such as lashing belts around the main shaft assembly, upper gear shaft assembly, and the countershaft assembly in two or more places to prevent the assemblies from separating.

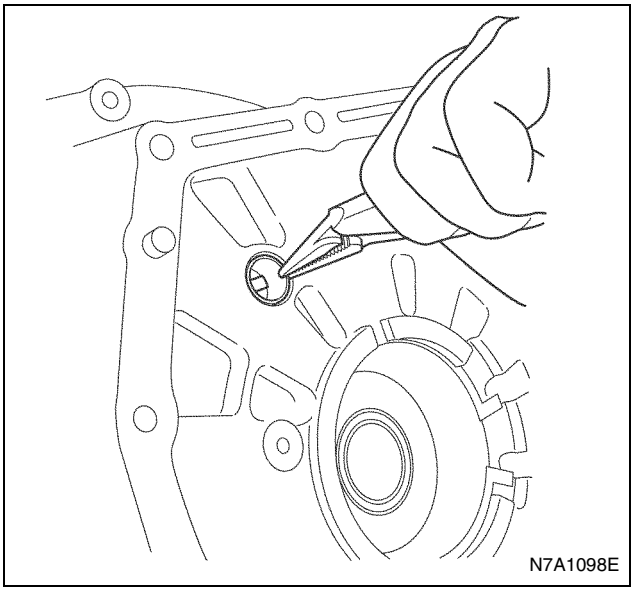

N7A1095E

    b. Secure the bearing remover to the main shaft with the lock nut, then raise it with a hoisting cable. Spread the outer snap ring of the upper gear shaft bearing, which is attached to the clutch housing, and simultaneously remove upper gear shaft assembly, main shaft assembly, and countershaft assembly from the clutch housing.


N7A0356E

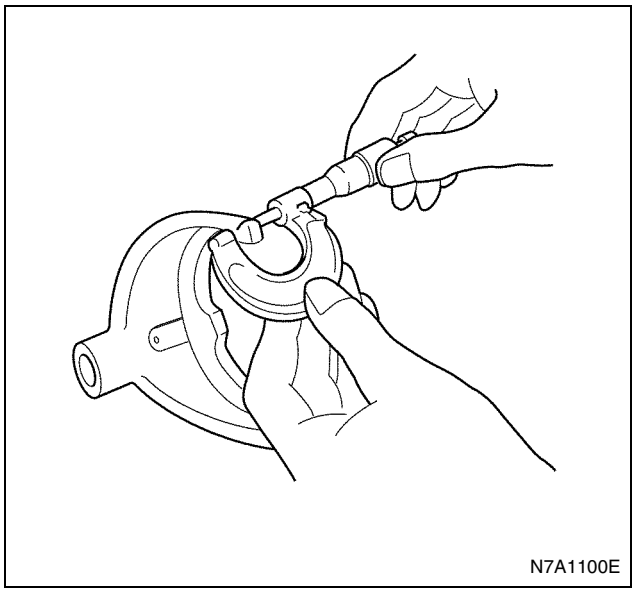

N7A1097E

41. Inspect the clutch housing bush for wear and damage. If wear or damage is present, the bush must be replaced. Remove the old bush from the clutch housing with a pair of pliers.

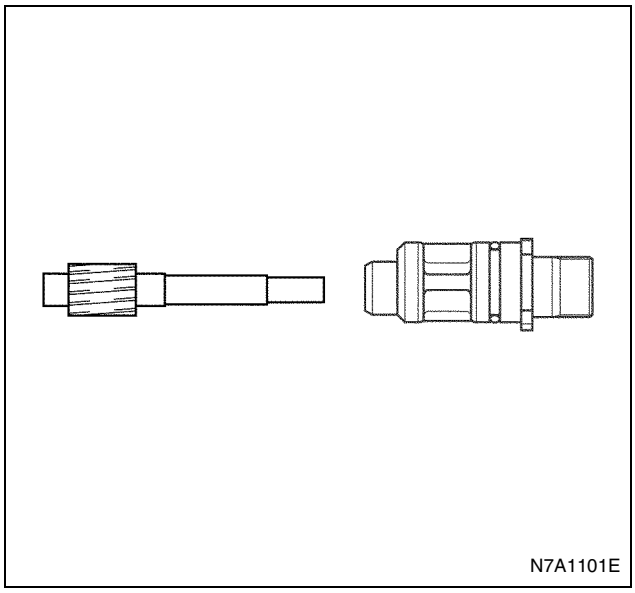

N7A1098E

42. Inspect the front oil seal for wear and damage. If wear or damage is present, the seal must be replaced. Remove the old seal from the clutch housing with an ordinary screwdriver.
43. Inspect the other parts for wear and damage. If wear or damage is present, make the necessary repairs or replace the part(s).
44. Inspect the shift rod and the shift arm (shift mechanism) for bending, wear, and other damage. If minor wear or damage is present, make the necessary repairs. If major wear or damage is present, the part(s) must be replaced.
45. Use a micrometer to measure the shift arm end thickness. If the thickness exceeds the specified limit, the shift arm must be replaced.

Shift arm end thickness		mm (in)
Gear	Standard	Limit
1st / reverse 3rd / 2nd 5th / 4th	9.60 — 9.85 (0.378 — 0.388)	9.00 (0.354)
6th	9.60 — 9.85 (0.378 — 0.388)	9.30 (0.366)


N7A1100E

46. Inspect the speedometer driven gear and the driven gear bush for wear and other damage. Replace the driven gear and bush if significant wear is present.

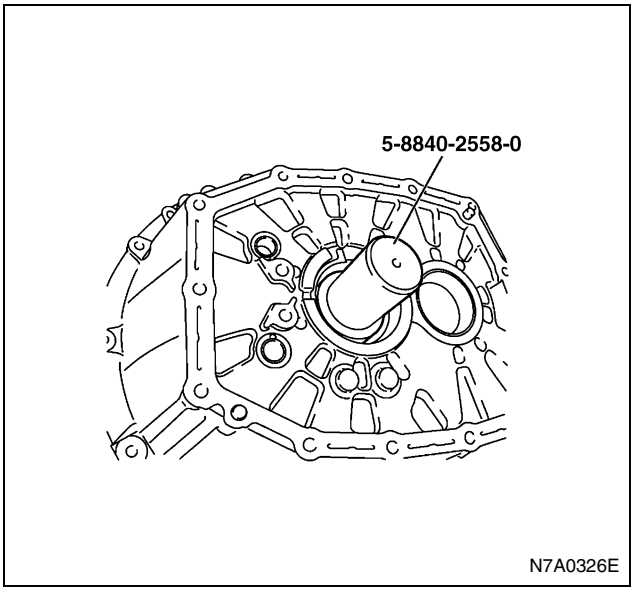

N7A1101E

Reassembly

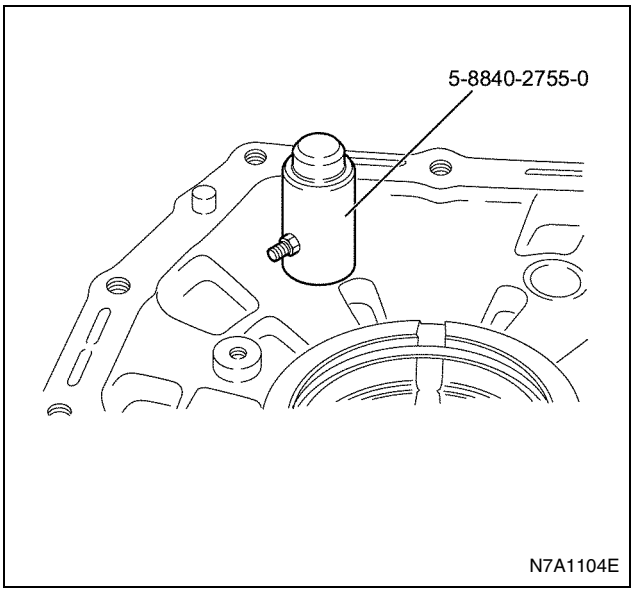
1. Inspect the oil seal for wear and damage. If damage or wear is present, the seal must be replaced.
2. Apply engine oil (5W-30) to the outside circumference of the oil seal.
3. Apply multi-purpose type grease to the lipped portion of the oil seal.

4. Use the installer (5-8840-2558-0) to press the oil seal into the clutch housing.

Caution:
The lipped portion of the oil seal is easily broken. Exercise care during the installation procedure.

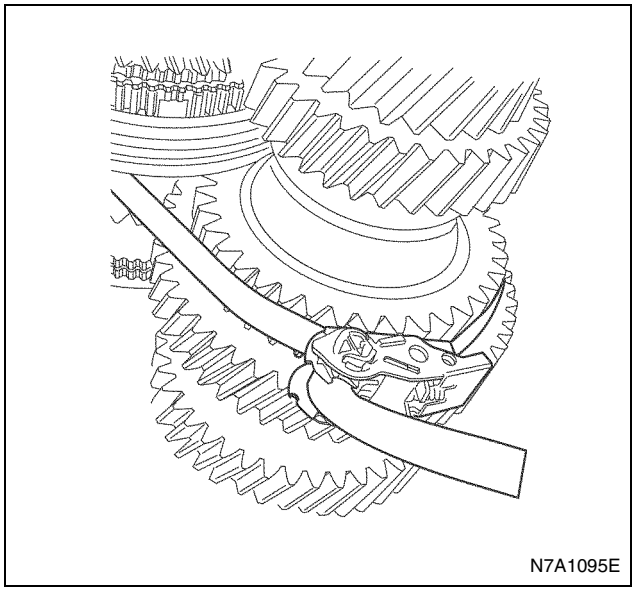


5. Inspect the bearing outer race for wear and damage. If wear or damage is present, the race must be replaced.
6. Inspect the clutch housing bush for wear and damage. If wear or damage is present, the bush must be replaced.
7. Use the installer (5-8840-2755-0) to press the bush into the clutch housing. Pay close attention to the bush installation direction (refer to the illustration).

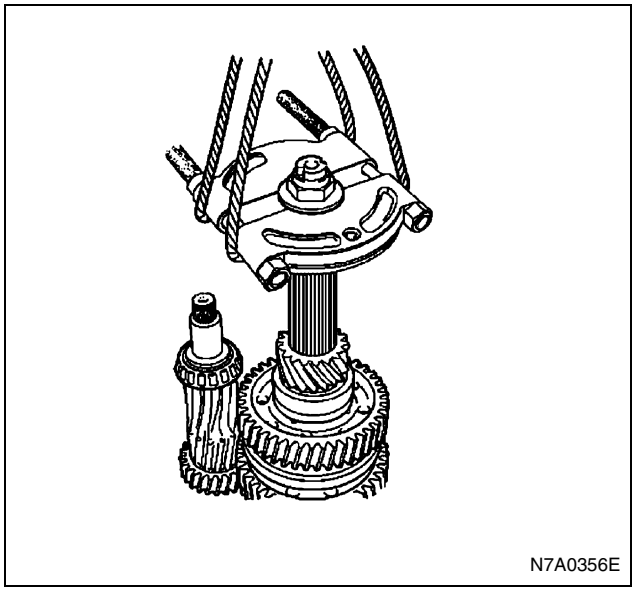


- Attach by crimping to secure at three points, but avoid the grooved area and previous crimping spots.
- Apply the second and subsequent bushing presses with the notch facing the clutch housing.

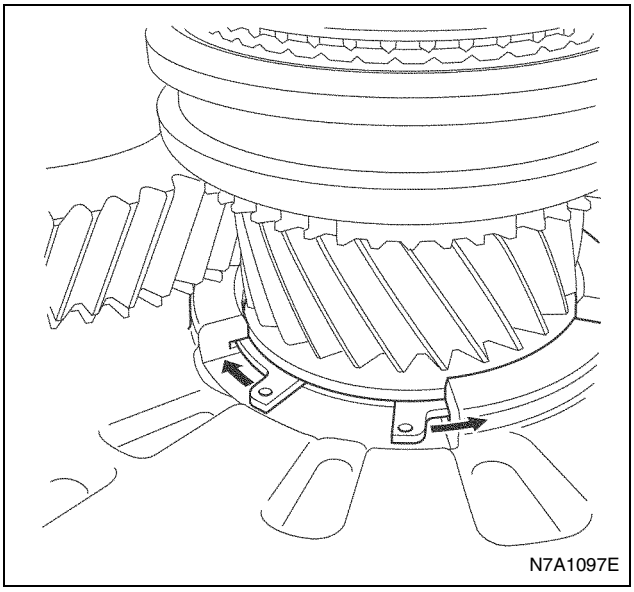
8. Attach the main shaft assembly, upper gear shaft assembly, and countershaft assembly.
   a. Tightly wrap belts such as lashing belts around the main shaft assembly, countershaft assembly, and upper gear shaft assembly at two or more places to prevent the assemblies from separating. Make sure that the upper gear shaft does not fall when the assembly is suspended.

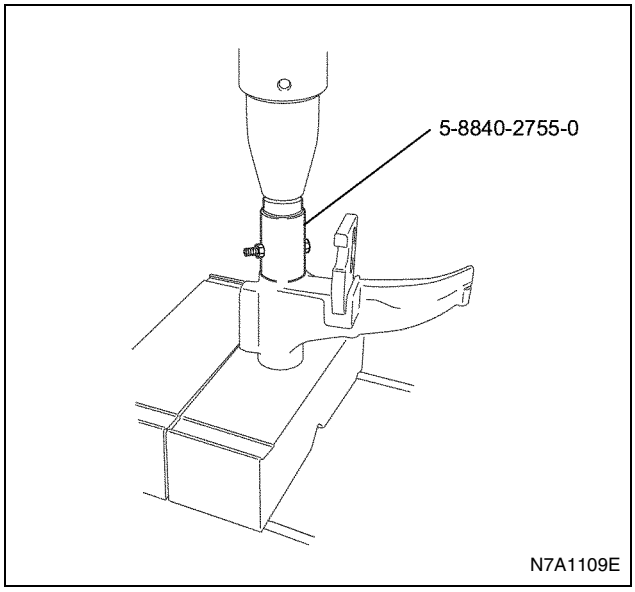


   b. Secure the bearing remover to the main shaft with a lock nut, then raise it with a hoisting cable. Spread the outer snap ring of the upper gear shaft bearing, which is attached to the clutch housing, and simultaneously install the upper gear shaft assembly, main shaft assembly, and countershaft assembly into the clutch housing.



   c. Set the outer snap ring of the upper gear shaft bearing onto the clutch housing, spread it using snap-ring pliers, and insert the upper gear shaft bearing.


N7A1097E

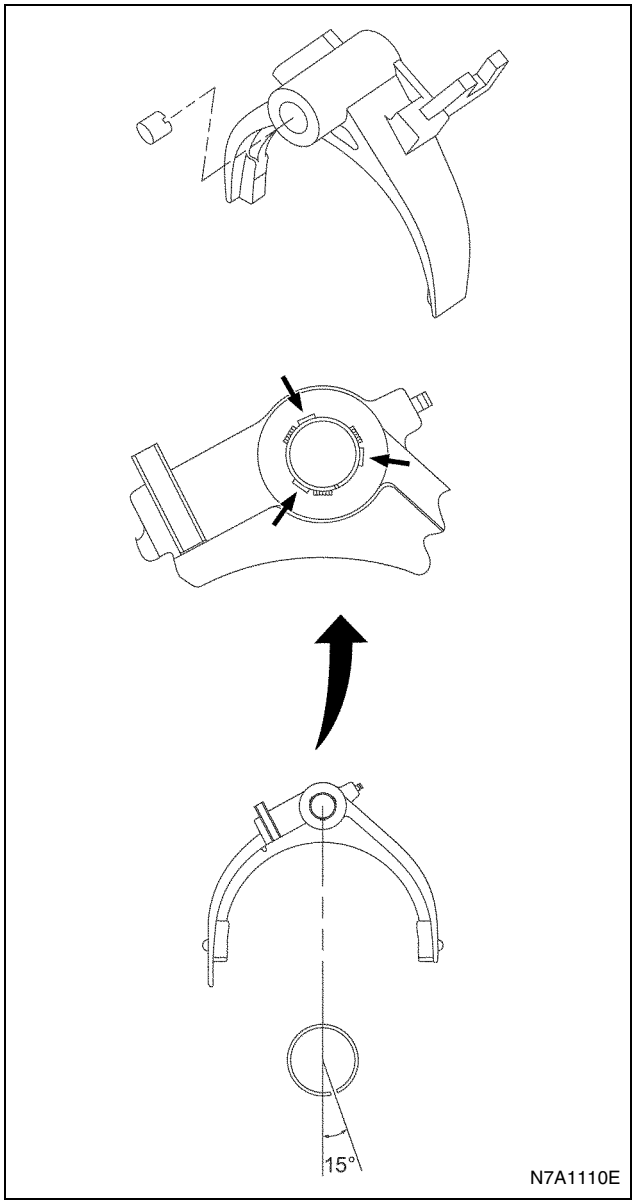


N7A1109E

Notice:

- Be sure to verify that the snap ring is properly attached.
- When suspending the shaft, maintain vertical alignment to prevent the front oil seal from being damaged, and work with care.

9. Install the magnet to the clutch housing.
10. Inspect the 3rd / 2nd shift arm bush for wear and damage. If wear or damage is present, the bush must be replaced.
11. Use the installer (5-8840-2755-0) to press the bush into the clutch housing. Pay careful attention to direction of installation and installation angle.
12. Caulk the bush at 3 locations (do not caulk near the bush grooves).
13. Inspect the 1st / reverse shift arm bush for wear and damage. If wear or damage is present, the bush must be replaced.
14. Use the installer (5-8840-2755-0) to press the bush into the clutch housing. Pay careful attention to direction of installation and installation angle.
15. Caulk the bush at 3 locations (do not caulk near the bush grooves).
16. Inspect the 4th / 5th shift arm bush for wear and damage. If wear or damage is present, the bush must be replaced.
17. Use the installer (5-8840-2755-0) to press the bush into the clutch housing.
18. Caulk the bush at 3 locations (do not caulk near the bush grooves). Pay careful attention to direction of installation and installation angle.

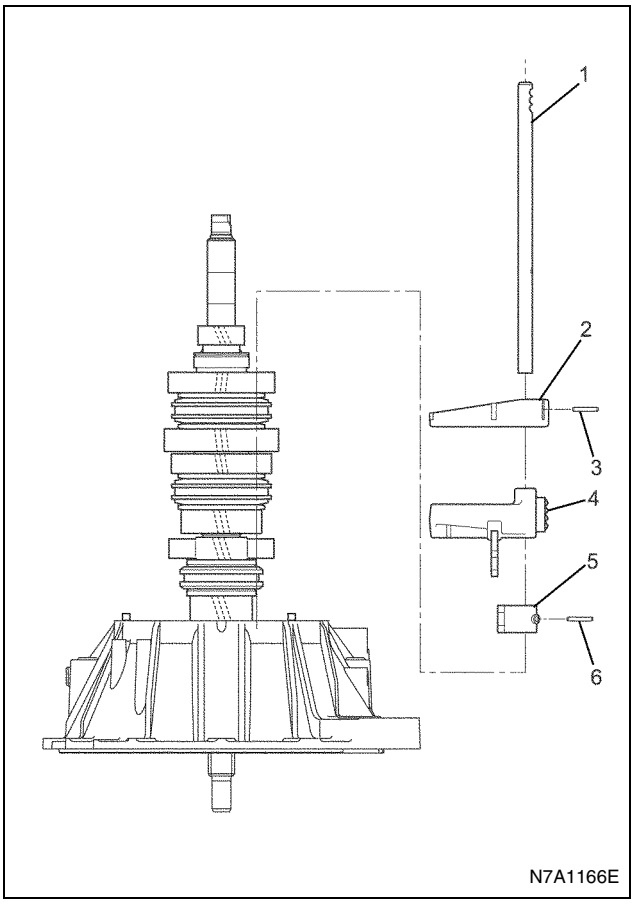


N7A1110E

19. Align the spring pin holes.

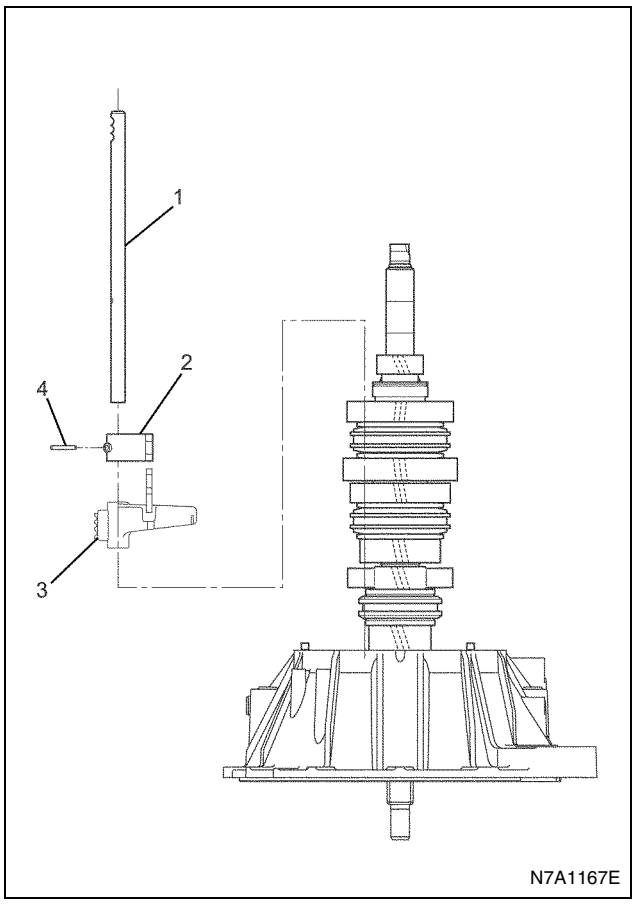
20. Install the 1st / reverse and the 2nd / 3rd shift rod (1) to the 1st / reverse and the 6th shift block (5), the 2nd / 3rd shift arm (4), and the 1st / reverse shift arm (2).
21. Use a hammer to drive the spring pins (3) (6) into the holes.

Caution:
To avoid damaging other parts, place a round shaft at the opposite end of the shift rod when installing the spring pins.



22. Align the spring pin holes.
23. Install the 4th / 5th and the 6th shift rod (1) to the 4th / 5th shift arm (3), the 1st / reverse and the 6th shift block (2).
24. Use a hammer to drive the spring pins (4) into the holes.

Caution:
To avoid damaging other parts, place a round shaft at the opposite end of the shift rod when installing the spring pins.

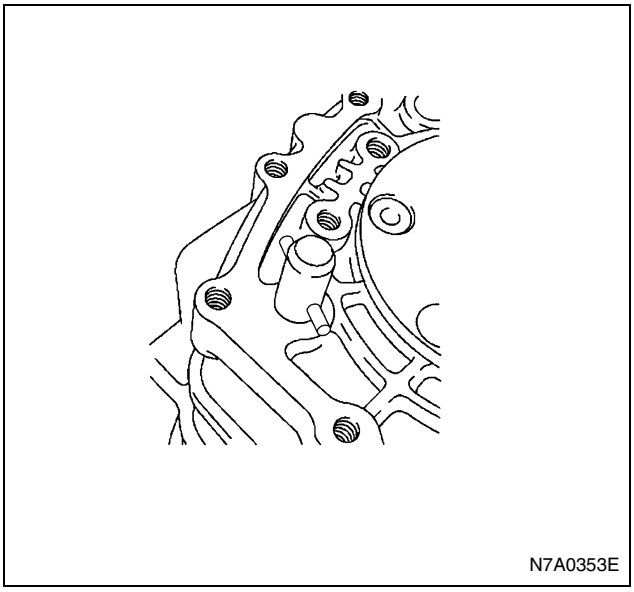


25. Apply Three Bond 1215 to the fitting surfaces of the transmission case and the clutch housing.
    - Remove moisture and oil from the fitting surface prior to application. Set the bead diameter to greater than 2 mm (0.078 in) and make it even all around.
26. Install the clutch housing to the transmission case. Tighten the bolts to the specified torque.

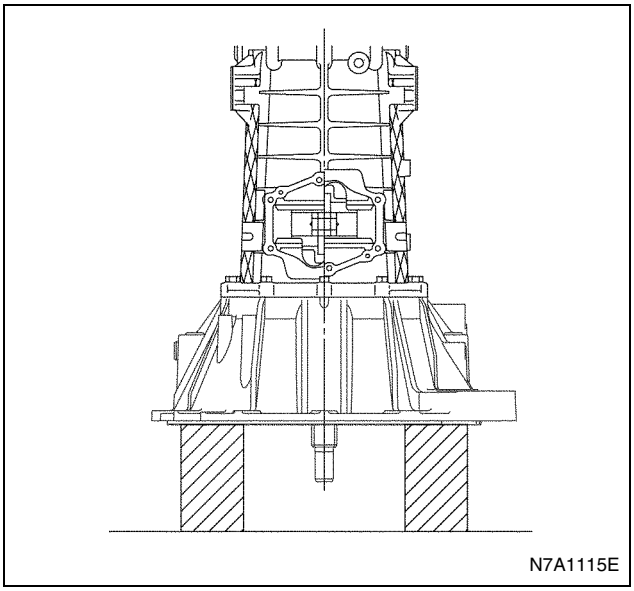
Tighten:
Bolts to 46 N·m (4.7 kg·m / 34 lb·ft)

27. Install the bearing rear outer race to the transmission case.
28. Install the snap ring to the 4th / 5th and the 6th gear shift rod.

Notice:
If a snap ring is deformed or damaged, replace it with a new one and verify that it is attached properly.


N7A0353E

29. Attaching the countershim
    a. Put the gear into neutral.
    b. Set the transmission assembly with the housing at the bottom.

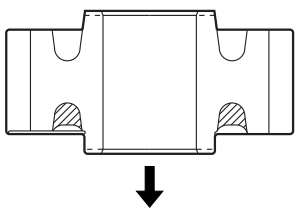

N7A1115E

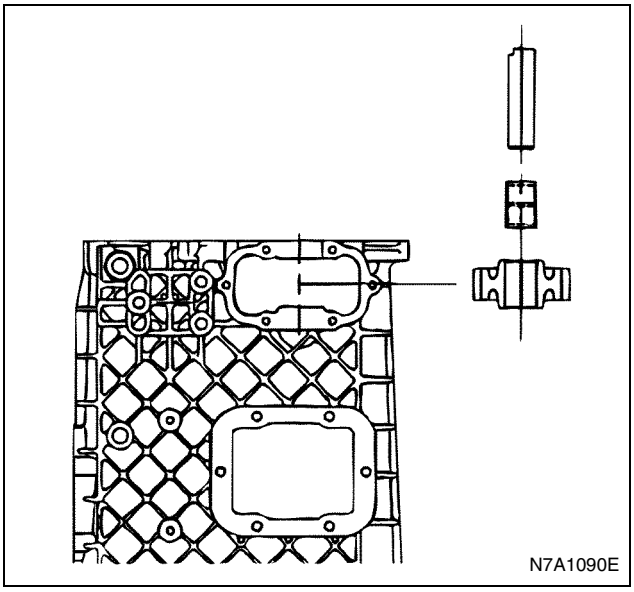
    c. Break in the taper roller bearing by rotating the countershaft at least 30 times.
    d. Selecting a countershim
        • Measure the depth between the rear most surface of the transmission housing and the outer wheel surfaces of the countershaft rear bearing. Take three measurements at 120-degree intervals, and calculate the average.
        • Select the shim with the appropriate thickness from the table below.

Measured depth mm (in)	Shim thickness mm (in)
2.13 — 2.19 (0.084 — 0.086)	1.98 (0.078)

Measured depth mm (in)	Shim thickness mm (in)
2.07 — 2.13 (0.081 — 0.084)	1.92 (0.076)
2.01 — 2.07 (0.079 — 0.081)	1.88 (0.074)
1.95 — 2.01 (0.077 — 0.079)	1.80 (0.071)
1.89 — 1.95 (0.074 — 0.077)	1.74 (0.069)
1.83 — 1.89 (0.072 — 0.074)	1.68 (0.066)
1.77 — 1.83 (0.070 — 0.072)	1.62 (0.064)
1.71 — 1.77 (0.067 — 0.070)	1.58 (0.062)
1.65 — 1.71 (0.065 — 0.067)	1.50 (0.059)
1.59 — 1.65 (0.063 — 0.065)	1.44 (0.057)
1.53 — 1.59 (0.060 — 0.063)	1.38 (0.054)
1.47 — 1.53 (0.058 — 0.060)	1.32 (0.052)
1.41 — 1.47 (0.056 — 0.058)	1.26 (0.050)
1.35 — 1.41 (0.053 — 0.056)	1.20 (0.047)

30. Install the snap ring (rear outer) to the main shaft rear bearing.
31. Apply engine oil (5W-30) to the needle bearing.
32. Install the reverse idle gear together with the needle bearing and the oil slinger.
33. Install the reverse idle shaft.
    • The arrow indicates the front of the transmission.


N7A0338E

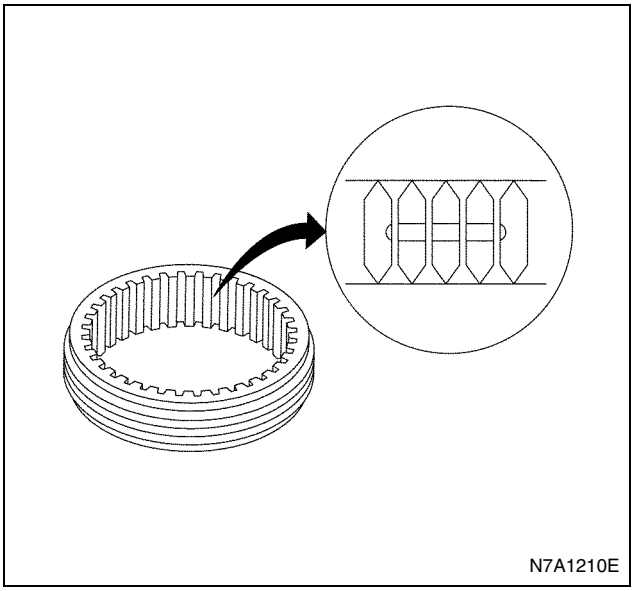

N7A1090E

34. Install the retainer to the transmission case. Tighten the bolts to the specified torque.

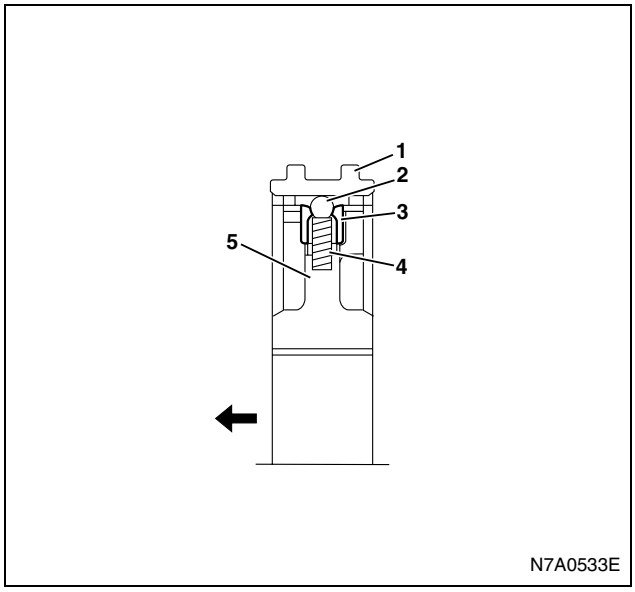
Tighten:
Bolts to 26 N·m (2.7 kg·m / 20 lb·ft)

Notice:
Be sure to thoroughly remove sealing material from the screw threads of the transmission housing, and to use a set of new screws.

35. Install the speedometer gear.
36. Install the block and spring to the clutch hub.
37. Adjust the phase so that the three balls fit into the three ball grooves inside the sleeve.

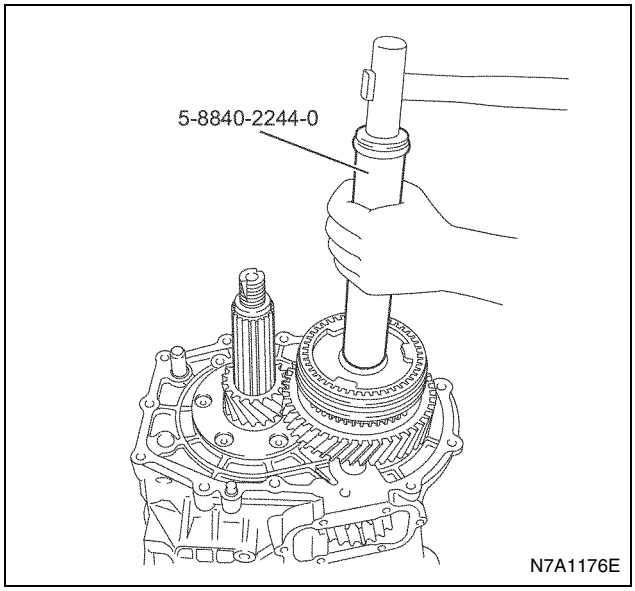

N7A1210E

38. Insert the sleeve (1) into the clutch hub (5) until resistance is felt.
39. Insert the ball (2), the block (3), and the spring (4) into the clutch hub. Be sure that the ball enters the ball groove.
    - The arrow indicates the front of the transmission.



N7A0533E

40. Apply engine oil (5W-30) to the neutral bearing and the inside of the block ring.
41. Assemble the 6th gear the needle bearing, and the 6th gear block ring.
42. Align the above assembly with the clutch hub block ring.
43. Assemble the 6th gear clutch hub assembly and the sleeve.
44. Use the installer (5-8840-2244-0) and a hammer to install the assembled parts.



N7A1176E

45. Use a pair of snap ring pliers to install the 6th gear clutch hub snap ring.
    - From the mountable snap rings, select the thickest one of the three types.

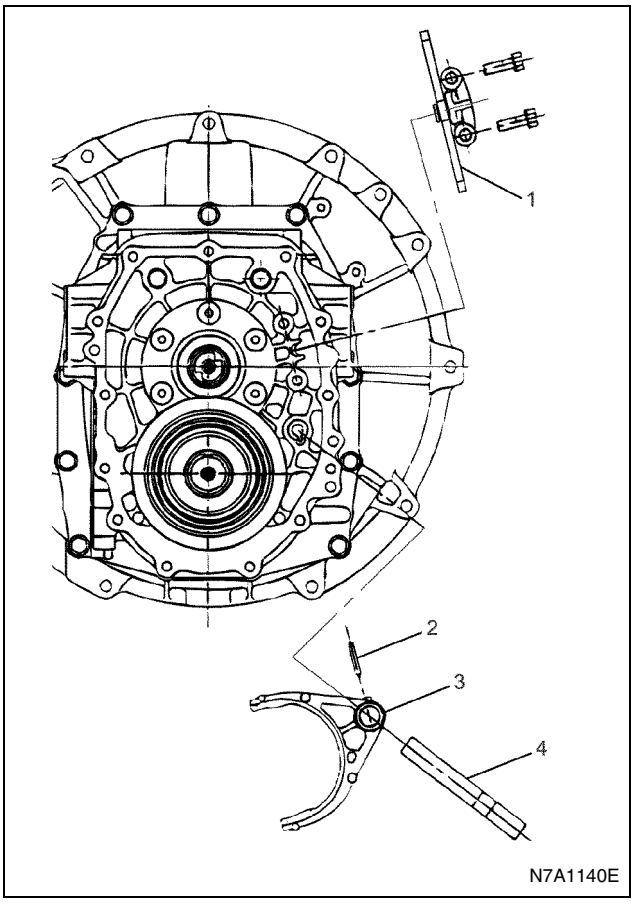
Shim thickness mm (in)	Discernment color
1.6 (0.063)	Pink
1.7 (0.067)	Light blue
1.8 (0.071)	Orange

Shim thickness mm (in)	Discernment color
1.9 (0.075)	Purple

Notice:
If a snap ring is deformed or damaged, replace it with a new one and verify that it is attached properly.

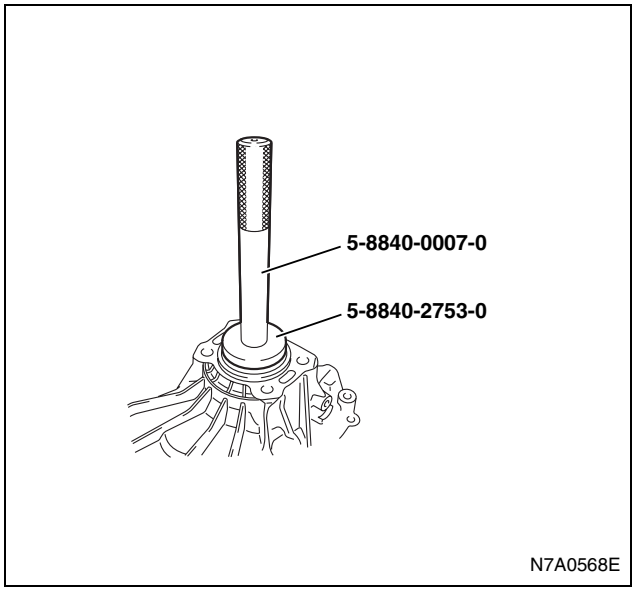
46. Apply engine oil (5W-30) to the shift rod holes in the transmission case.
47. Install the 6th gear shift arm (3) and the 6th gear shift rod (4).
48. Align the spring pin holes.
49. Insert the spring pins (2).
50. Install the relay lever 6th gear (1). Tighten the bolts to the specified torque.

Tighten:
Bolts to 44 N·m (4.5 kg·m / 34 lb·ft)

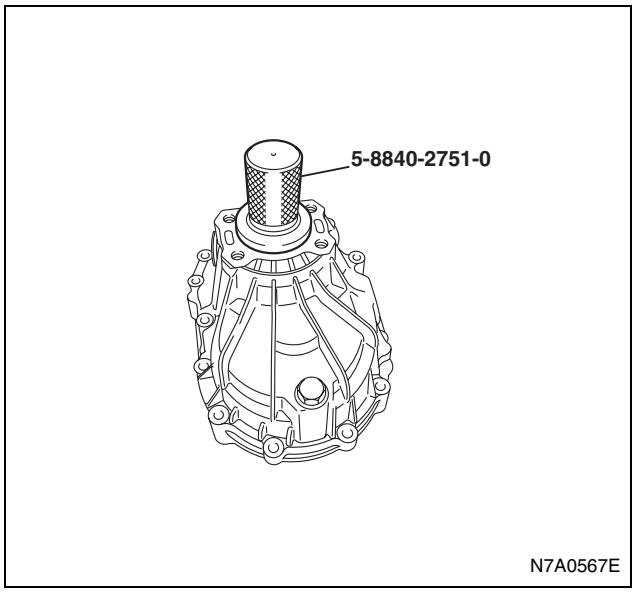


51. Apply multi-purpose type grease to the inside of the main end needle bearing.
52. Apply engine oil (5W-30) to the inside contact surfaces of the rear cover bearing.
53. Use the installer (5-8840-2753-0) and the handle (5-8840-0007-0) to press the needle bearing into the rear cover from the outside. The inscribed mark on the bearing must be facing out.

Caution:
The lipped portion of the oil seal is easily broken. Exercise care during the installation procedure.

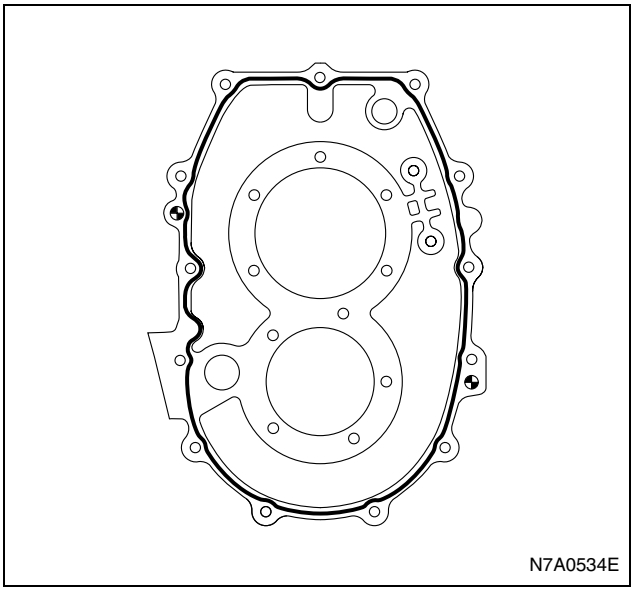


54. Inspect the rear cover oil seal for wear and damage. If wear or damage is present, the oil seal must be replaced.
55. Apply multi-purpose type grease to the lip portion of the oil seal.
56. Apply engine oil (5W-30) to the outer circumference of the oil seal.
57. Use the installer (5-8840-2751-0) to press the oil seal into the rear cover.

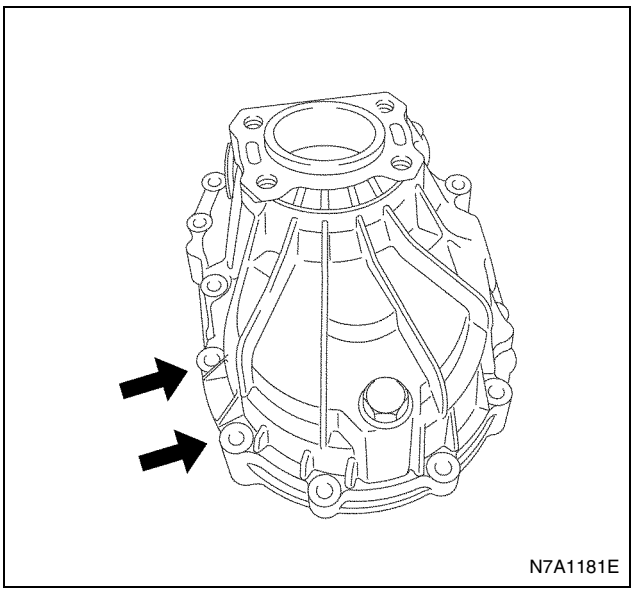


58. Apply Three Bond 1215 to the contact surfaces of the transmission case and the rear cover.
59. Install the rear cover to the transmission case. Tighten the bolts to the specified torque.
    - Remove moisture and oil from the fitting surface prior to application. Set the bead diameter to greater than 2 mm (0.078 in) and make it even all around.

Tighten:
Bolts to 46 N·m (4.7 kg·m / 34 lb·ft)

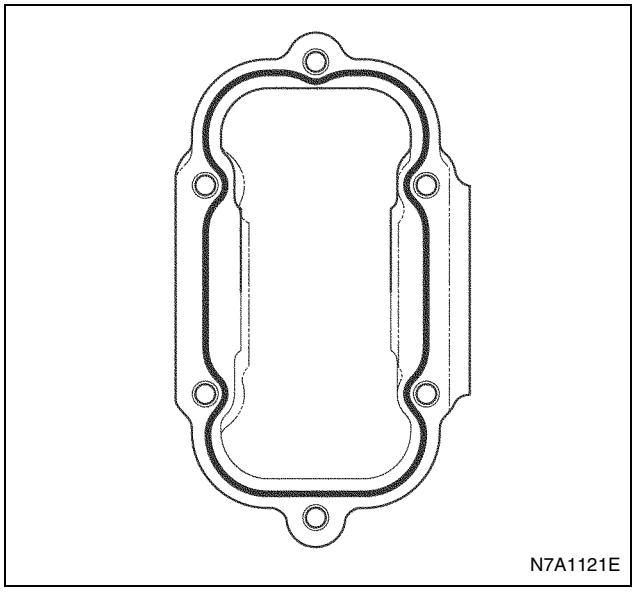

N7A0534E

Notice:
The two bolts, indicated by the arrows, have lock-tight material applied to them. Be sure to thoroughly remove sealing material from the threads and to use new bolts with lock-tight material.


N7A1181E

60. Align the contact surfaces of the transmission case reverse gear side cover.
61. Apply Three Bond 1215 to the contact surfaces.
62. Install the reverse gear side cover. Tighten the bolts to the specified torque.

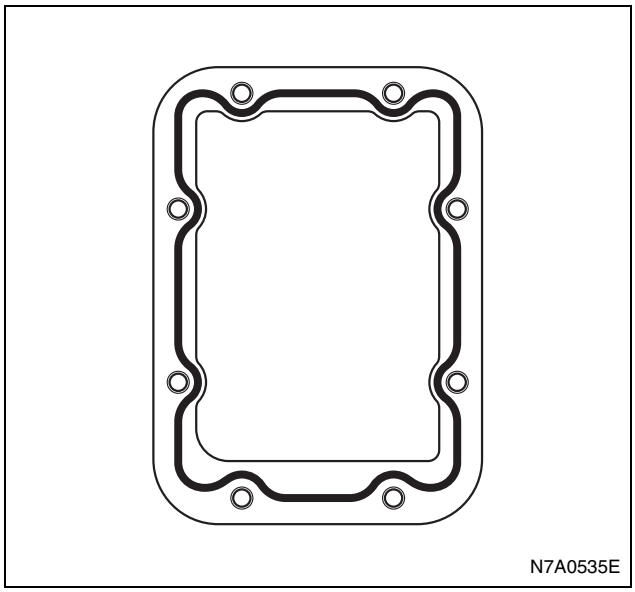
Tighten:
Bolts to 20 N·m (2.0 kg·m / 15 lb·ft)


N7A1121E

63. Align the contact surfaces of the transmission case PTO cover.
64. Apply Three Bond 1215 to the contact surfaces.
65. Install the PTO cover. Tighten the bolts to the specified torque.

Tighten:
Bolts to 37 N·m (3.8 kg·m / 27 lb·ft)

Notice:
The bolts have lock-tight material applied to them. Be sure to thoroughly remove sealing material from the threads and to use new bolts with lock-tight material.


N7A0535E

66. Place the transmission in the neutral position.
67. Align the contact surfaces of the transmission case control box (1).
68. Apply Three Bond 1215 to the contact surfaces.
69. Install the interlock plate (8) and the control box. Tighten the bolts to the specified torque.

Tighten:
Bolts to 27 N·m (2.8 kg·m / 20 lb·ft)

Notice:
The bolts have lock-tight material applied to them. Be sure to thoroughly remove sealing material from the threads and to use new bolts with lock-tight material.

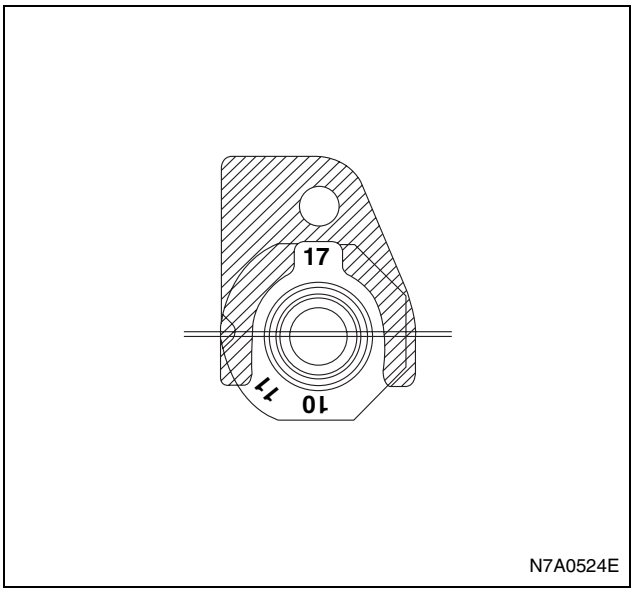
70. Install the 4 detent assemblies (7), (6), (5) and (4). Tighten the bolts to the specified torque.

Tighten:
Bolts to 27 N·m (2.8 kg·m / 20 lb·ft)

71. Apply liquid gasket (Three Bond 1141) to the threaded portion of the reverse switch.
72. Install the reverse switch (3). Tighten the bolt to the specified torque.

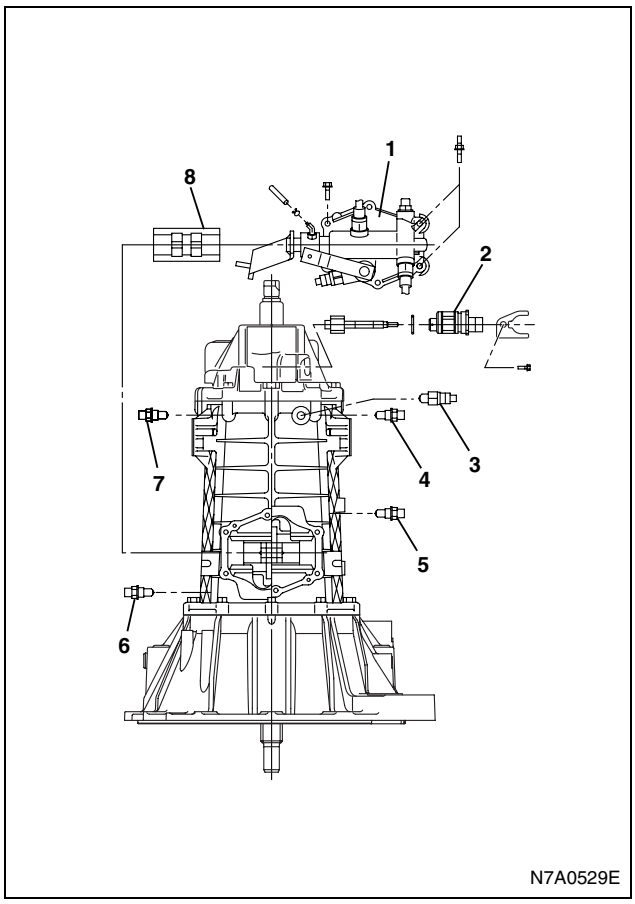
Tighten:
Bolt to 39 N·m (4 kg·m / 29 lb·ft)

73. Apply engine oil (5W-30) to the speedometer driven gear (2) and the O-ring.
    - Align the gear tooth marked 17 of the speedometer's driven gear (17 teeth) with the opening in the plate.



74. Install the driven gear together with the O-ring. Tighten the bolts to the specified torque.

Tighten:
Bolts to 20 N·m (2 kg·m / 15 lb·ft)



75. Apply engine oil (5W-30) to the drain plug and the O-ring.
76. Install the drain plug together with the O-ring. Tighten the bolts to the specified torque.

Tighten:
Bolts to 39 N·m (4 kg·m / 29 lb·ft)

77. Apply engine oil (5W-30) to the filler plug and the O-ring.
78. Install the filler plug together with the O-ring. Tighten the bolts to the specified torque.

Tighten:
Bolt to 39 N·m (4 kg·m / 29 lb·ft)

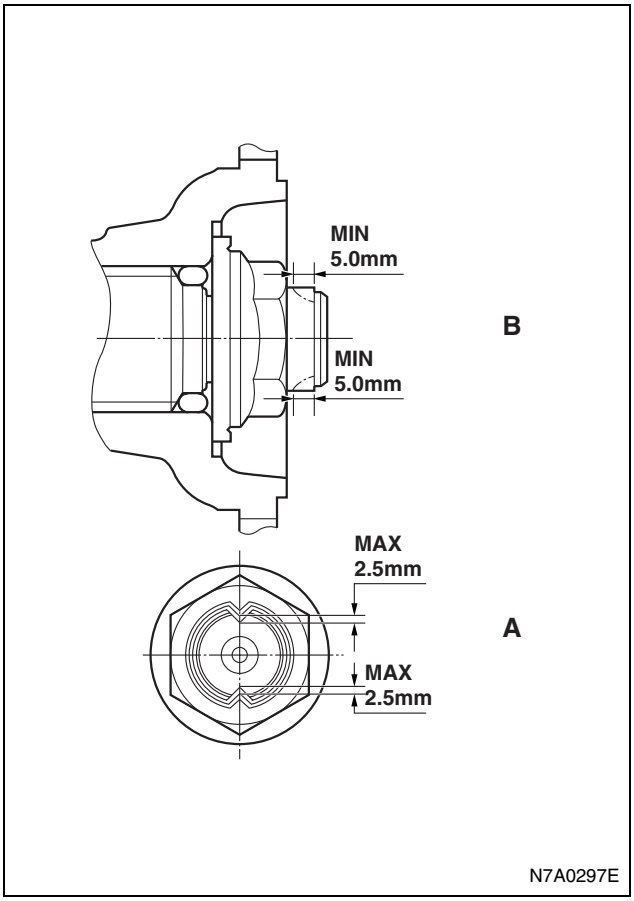
79. Install the parking brake assembly.
    - Refer to PARKING BRAKES.
80. Install the parking brake bracket to the transmission case. Tighten the bolts to the specified torque.

Tighten:
Bolts to 48 N·m (4.9 kg·m / 35 lb·ft)

81. Apply engine oil (5W-30) to the coupling driver and the O-ring.
82. Install the coupling driver together with the O-ring.
83. Apply engine oil (5W-30) to the seating surface of the new coupling driver lock nut.
84. Use the special tool (9-8529-2101-0) to tighten the lock nut to the specified torque.

Tighten:
Lock nut to 382 N·m (39 kg·m / 282 lb·ft)

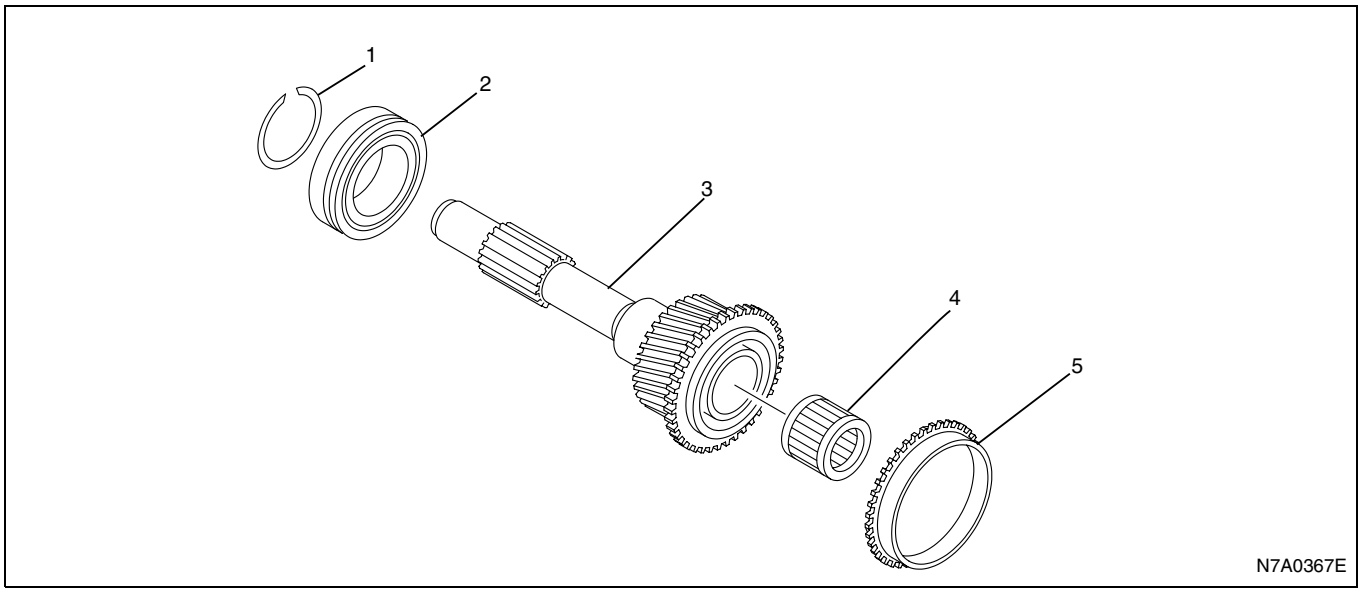
85. Align the lip portion of the lock nut with the V-groove at the end of the shaft (length (B) must be at least 5 mm (0.2 in)). Wedge the lipped portion of the nut into the V-groove so that the gap between the nut and the bottom of the V-groove (A) is less than 2.5 mm (0.1 in).
86. Caulk the lock nut at two places (caulking form: tip radius approximately 1 mm with caulking sites 60 degrees away form each other).



87. Install the parking brake drum.
    - Refer to PARKING BRAKES.
88. Install the shift block together with the release bearing, the clutch shaft, and the shift fork.
    - Refer to CLUTCH.

Top Gear Shaft

Parts



Legend

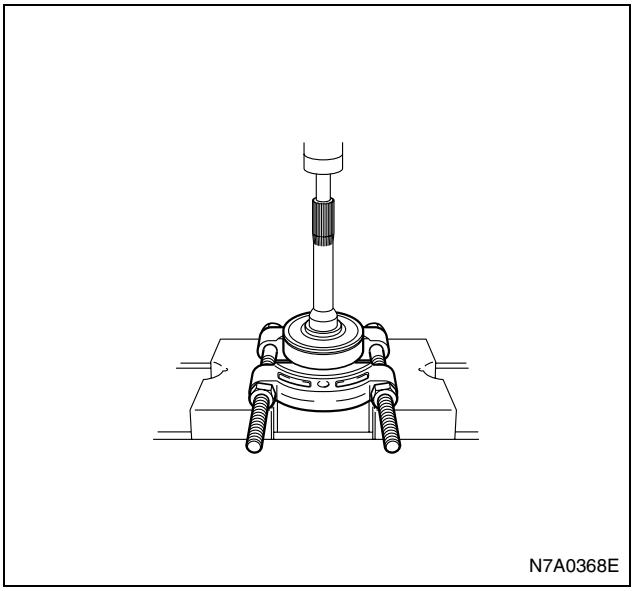
1. Snap ring
2. Bearing
3. Top gear shaft
4. Needle bearing
5. Block ring

Disassembly

1. Remove the block ring from the top gear shaft.
2. Remove the needle bearing from the top gear shaft.

Notice:
The needle bearing is of a separator type. Be careful not to drop the roller when dissembling.

3. Use a pair of snap ring pliers to remove the snap ring from the top gear shaft.
4. Use a press and a bearing remover to remove the bearing from the top gear shaft.

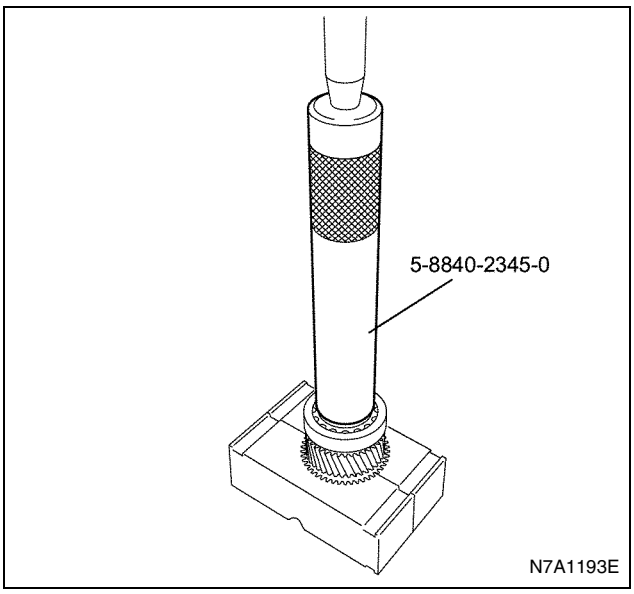


5. Inspect each of the disassembled parts for wear and damage. If wear or damage is present, make the necessary repairs or replace the part(s).
6. Inspect the gear teeth, the spline, and the end contact surfaces for wear and damage. If wear or damage is present, the part(s) must be replaced.
7. Inspect each of the bearings. The bearings must rotate smoothly and quietly. There must be no corrosion. Play in the thrust direction must be normal. Replace the bearing(s) if these conditions are not met.

8. Inspect the needle bearing rolling surface and roller for discoloration, excessive wear, and pitching. Replace the bearing if any of these conditions are present.

Reassembly

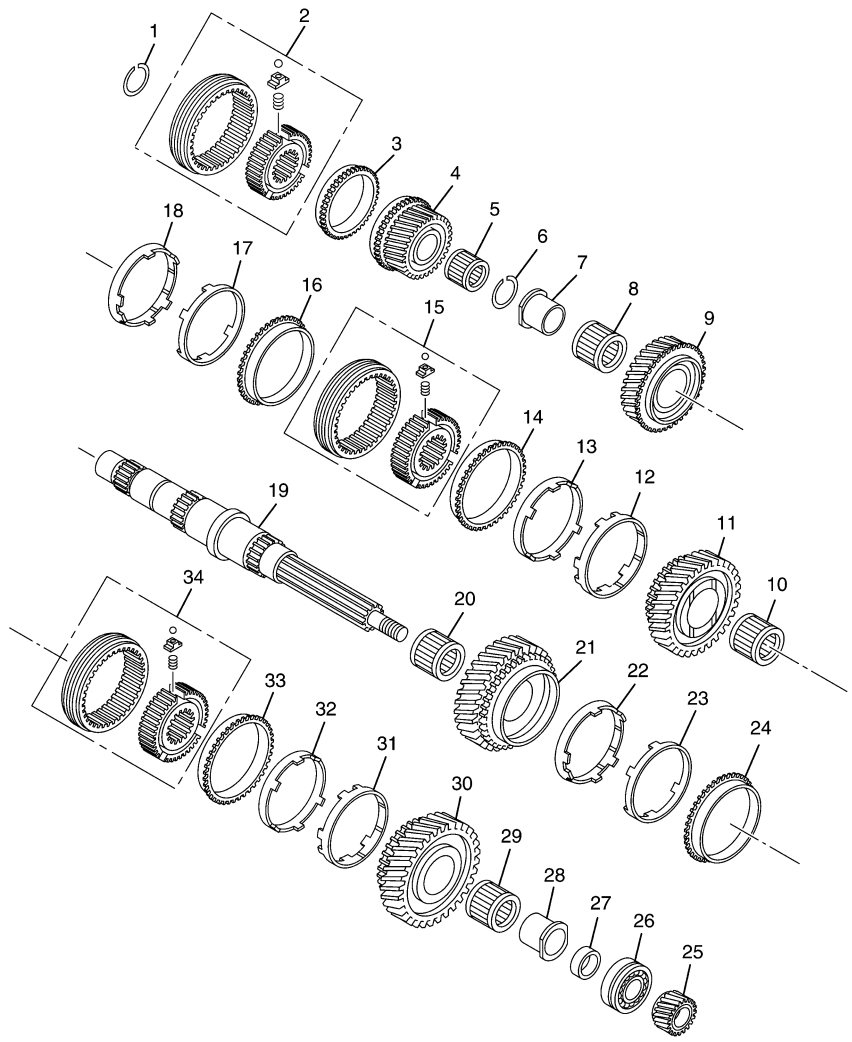
1. Use the installer (5-8840-2345-0) and a press to install the bearing to the top gear shaft.



2. Use a pair of snap ring pliers to install the snap ring to the top gear shaft.
3. Install the needle bearing to the top gear shaft.
4. Thoroughly apply 5W-30 engine oil to the inner surface of the block ring, then attach the block ring to the upper gear shaft.

Main Shaft

Parts



N7A0536E

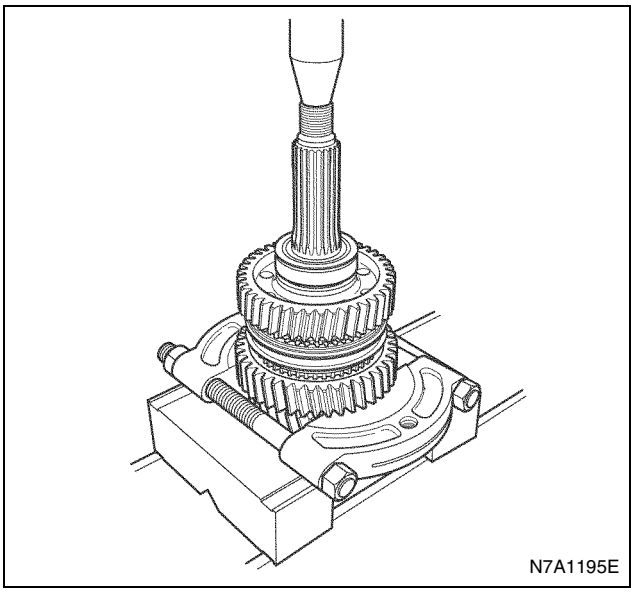
Legend

1. Snap ring
2. 4th / 5th clutch hub assembly and sleeve
3. 4th block ring
4. 4th gear
5. Needle bearing
6. Snap ring
7. Collar
8. Needle bearing
9. 3rd gear
10. Needle bearing
11. 2nd gear
12. 2nd gear inside ring
13. 2nd gear outside ring
14. 2nd gear block ring
15. 2nd / 3rd clutch hub assembly and sleeve
18. 3rd gear inside ring
19. Main shaft
20. Needle bearing
21. 1st gear
22. 1st gear inside ring
23. 1st gear outside ring
24. 1st gear block ring
25. 6th gear
26. Bearing
27. Spacer
28. Collar
29. Needle bearing
30. Reverse gear
31. Reverse gear inside ring
32. Reverse gear outside ring

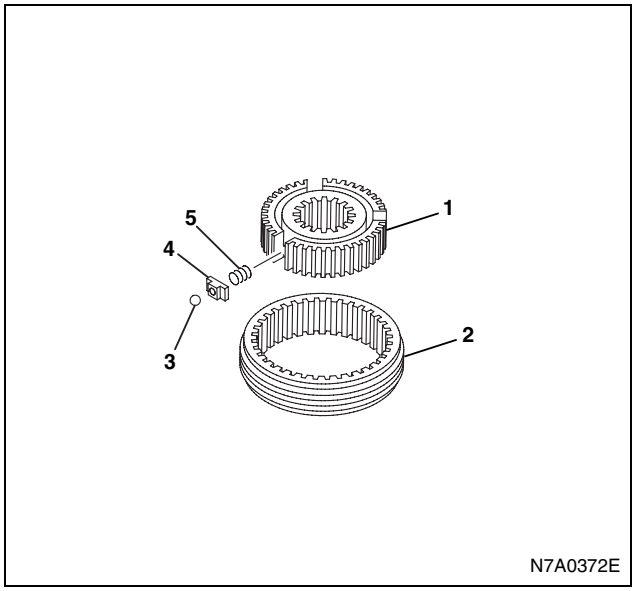
16. 3rd gear block ring
17. 3rd gear outside ring
33. Reverse gear block ring
34. 1st / reverse clutch assembly and sleeve

Disassembly

1. Remove the 6th gear.
2. Use a bearing remover and a press to simultaneously remove the following parts.
   - Bearing
   - Spacer
   - Collar
   - Reverse gear
   - Needle bearing
   - Reverse gear inside ring
   - Reverse gear outside ring
   - Reverse gear block ring
   - 1st / reverse clutch hub assembly and sleeve
   - 1st gear block ring
   - 1st gear outside ring
   - 1st gear inside ring
   - 1st gear
   - Needle bearing


N7A1195E

3. Disassemble the 1st / reverse clutch hub assembly and sleeve.

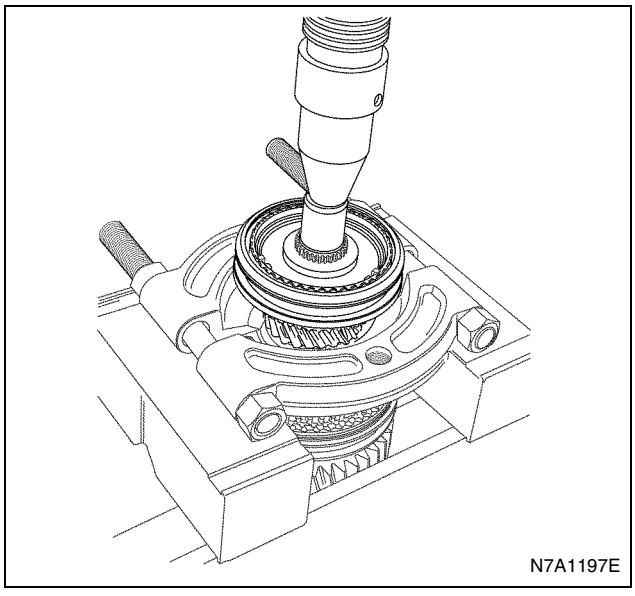


N7A0372E

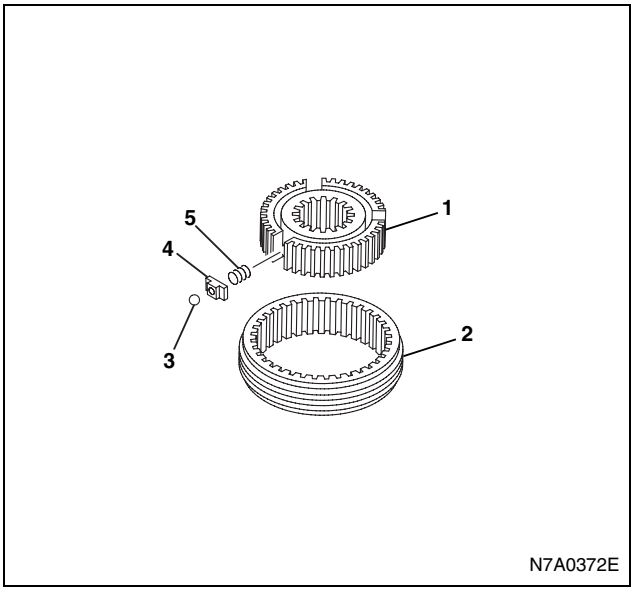
Legend

1. Clutch hub
2. Sleeve
3. Ball
4. Block
5. Spring

4. Use a pair of snap ring pliers to remove the snap ring securing the 4th / 5th clutch hub assembly.
5. Use a bearing remover to simultaneously remove the 4th / 5th clutch hub assembly, the sleeve, the 4th / 5th block ring, and the 4th gear needle bearing.


N7A1197E

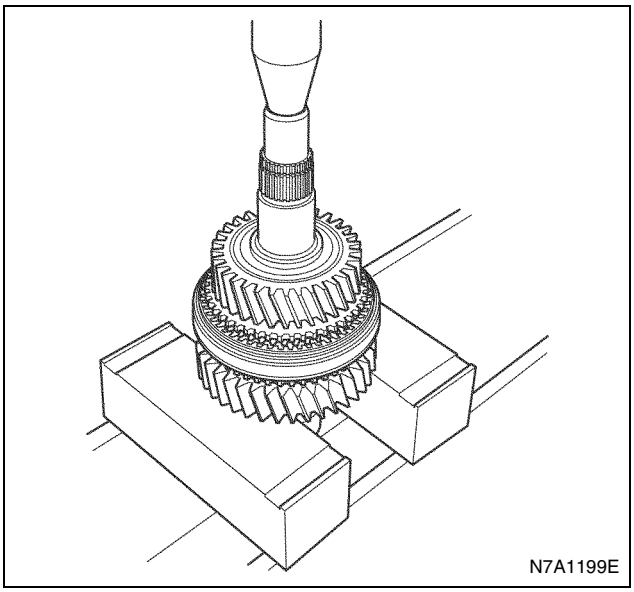
6. Disassemble the 4th / 5th clutch hub assembly and the sleeve.



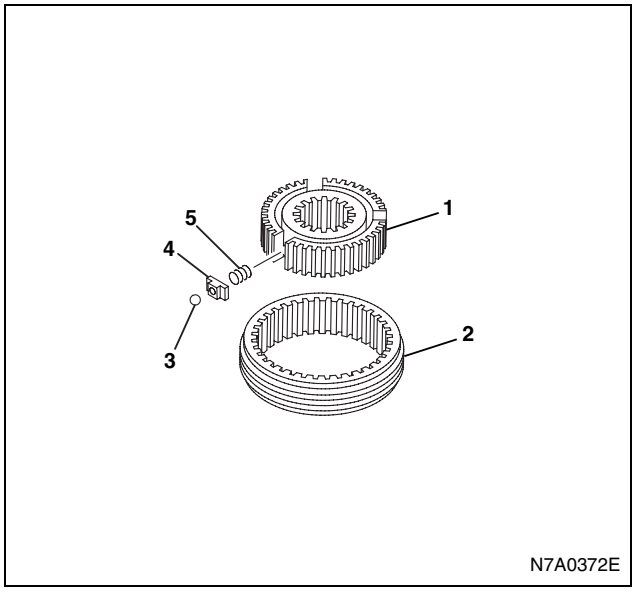
Legend

1. Clutch hub
2. Sleeve
3. Ball
4. Block
5. Spring

7. Use a pair of snap ring pliers to remove the snap ring securing the 3rd gear collar.
8. Use a bearing remover to simultaneously remove the 3rd gear collar, the 3rd gear needle bearing, the 3rd gear inside ring, the 3rd gear outside ring, the 3rd gear block ring, the 2nd / 3rd clutch hub assembly, the sleeve, the 2nd gear block ring, the 2nd gear inside ring, the 2nd gear outside ring, and the 2nd gear needle bearing from the main shaft.



9. Disassemble the 2nd / 3rd clutch hub assembly and the sleeve.

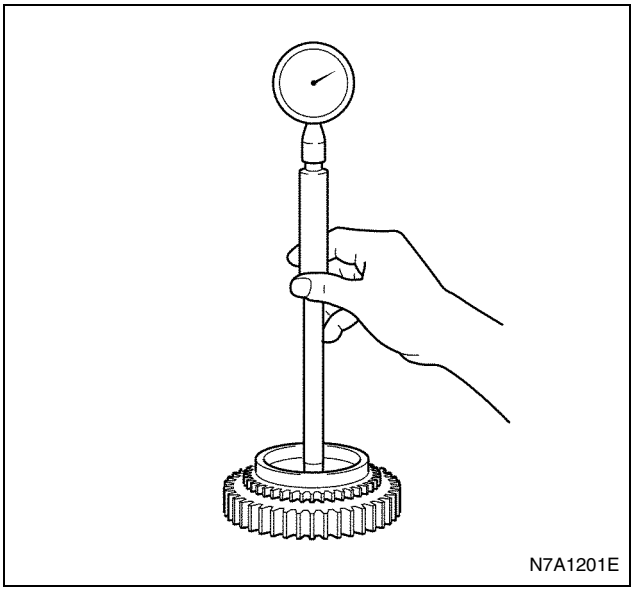


Legend

1. Clutch hub
2. Sleeve
3. Ball
4. Block
5. Spring

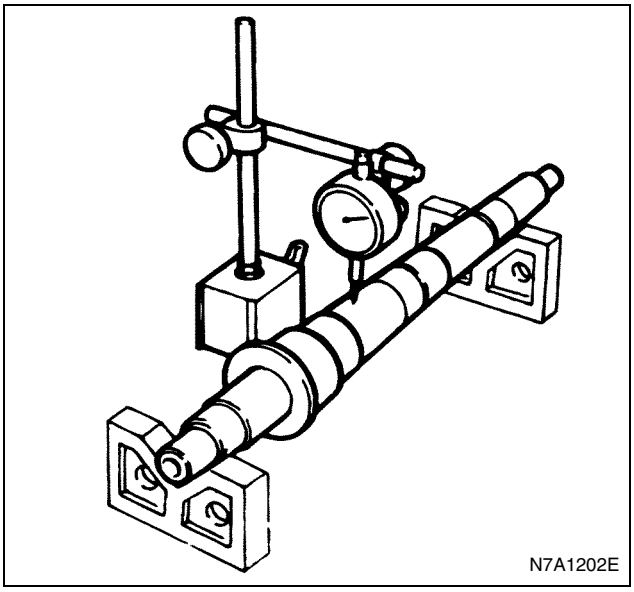
10. Inspect each of the bearings for roughness, abnormal operating noise, corrosion, internal and external damage, and excessive play (in the direction of the slide). Repair or replace the bearings as required.
11. Use an inside dial gauge to measure the inside diameter of each of the gears. If the measured diameter exceeds the specified limit, the gear must be replaced.

Gear inside diameter		mm (in)
Gear	Standard range	Limit
6th	50.009 — 50.025 (1.968 — 1.969)	50.065 (1.971)
5th	48.009 — 48.025 (1.890 — 1.890)	48.065 (1.892)
4th	55.010 — 55.029 (2.165 — 2.166)	55.069 (2.168)
3rd	63.010 — 63.029 (2.480 — 2.481)	63.069 (2.483)
2nd	63.010 — 63.029 (2.480 — 2.481)	63.069 (2.483)
1st	63.010 — 63.029 (2.480 — 2.481)	63.069 (2.483)
Reverse	63.010 — 63.029 (2.480 — 2.481)	63.069 (2.483)

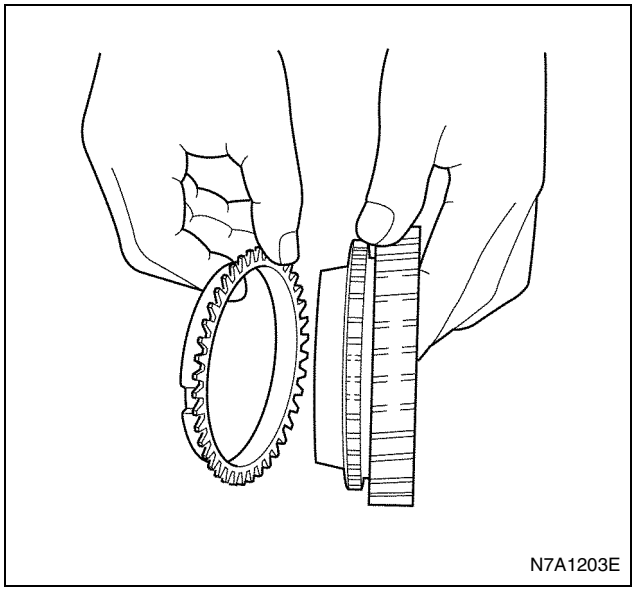


12. Use a dial gauge to measure the main shaft deflection (curvature). If the deflection exceeds the specified limit, the shaft must be replaced.

Main shaft deflection	mm (in)
Standard	Limit
0.015 (0.001)	0.1 (0.004)

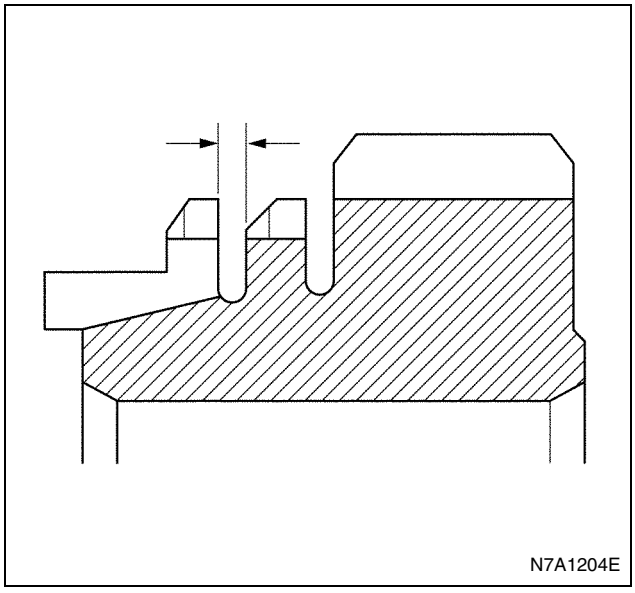


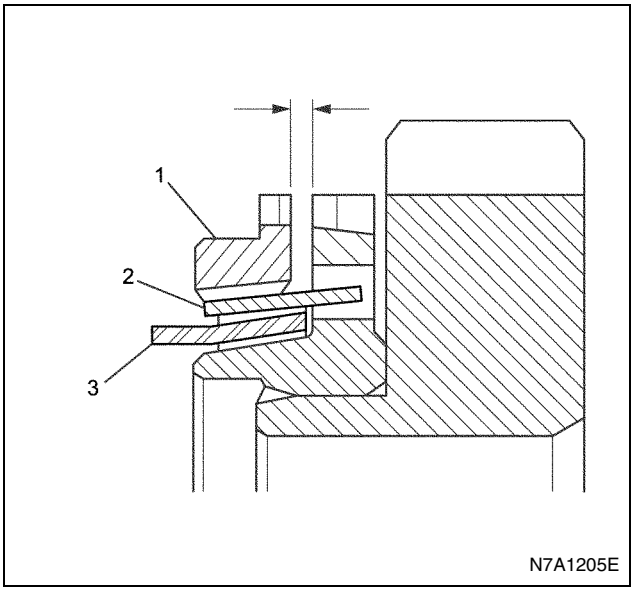
13. Inspect the synchromesh mechanism. Use an oil stone or a pencil grinder to correct light stepping and other minor imperfections.



14. Use a thickness gauge to measure the gaps between the block ring and the dog gear. If the gap exceeds the specified limit, the block ring must be replaced.

Block ring and dog gear gap		mm (in)
Gear	Standard range	Limit
4th / 5th / 6th	1.03 — 2.60 (0.04 — 0.10)	0.50 (0.02)
2nd / 3rd	1.00 — 2.50 (0.04 — 0.10)	0.50 (0.02)
1st / Reverse	1.00 — 2.50 (0.04 — 0.10)	0.50 (0.02)



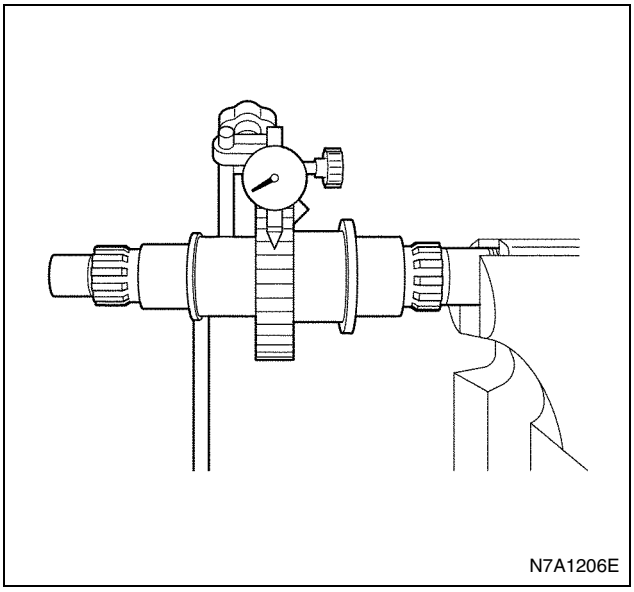


Legend

1. Block ring
2. Outside ring
3. Inside ring

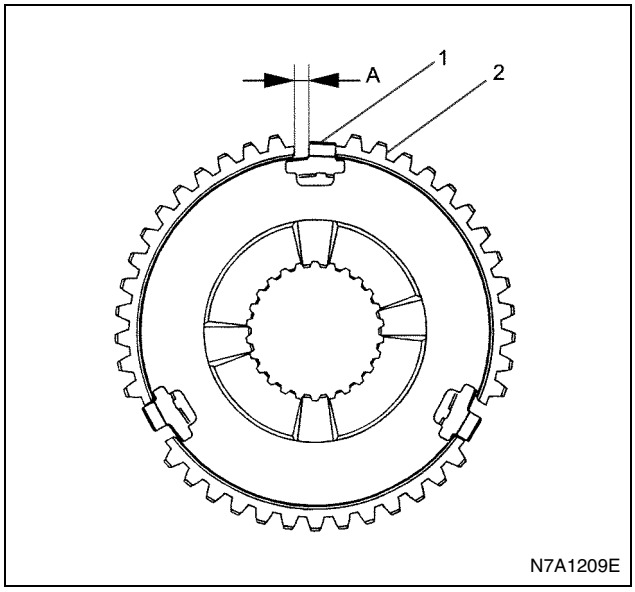
15. Inspect the clutch hub and sliding sleeve contact surfaces for wear and/or damage.
16. Inspect the spline interior and groove for wear and/or damage.
17. Measure the spline play in the direction of rotation (above the clutch hub outside circumference). If the play exceeds the specified limit, the spline must be replaced.

Spline play	mm (in)
Standard	
0 — 0.16 (0 — 0.01)	



18. Measure the gaps (A) at the clutch hub and the protrusion of the block ring using a thickness gauge.
    - If the measurements exceed the limits, replace the block and clutch hub.

Block and clutch hub gap	mm (in)
Gear	Limit
5th / 4th 6th	4.30 — 4.70 (0.17 — 0.19)
1st / Reverse 3rd / 2nd	3.30 — 3.70 (0.13 — 0.15)

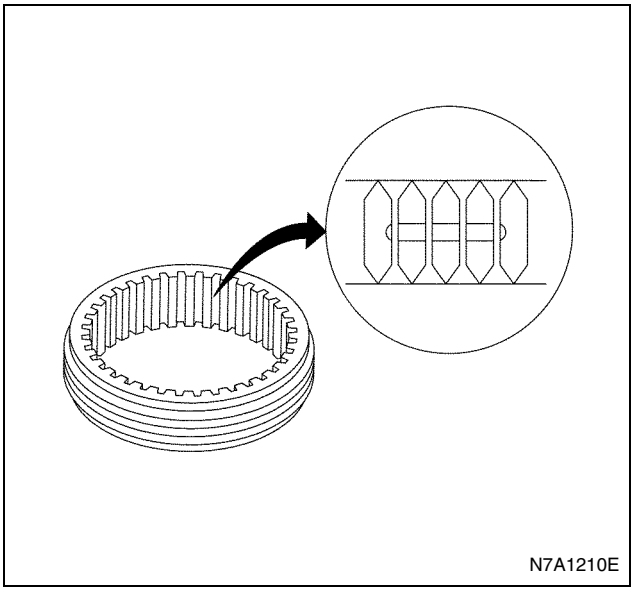


Legend

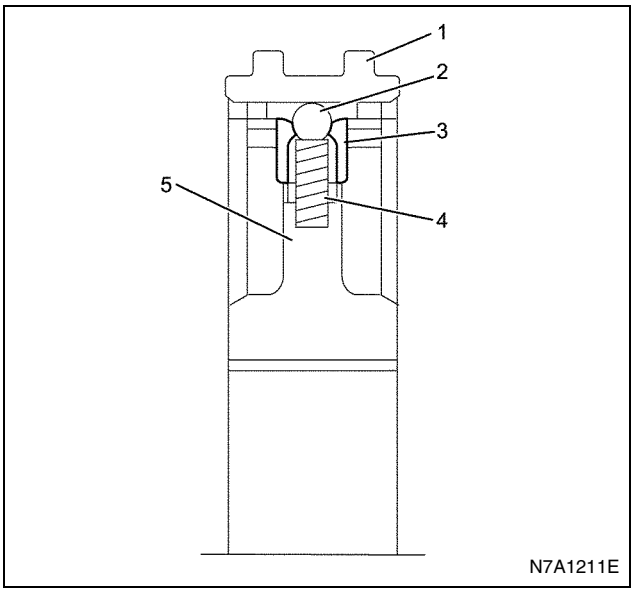
1. Block ring
2. Clutch hub

Reassembly

1. Clean all the parts.
2. Place the main shaft in a vise. The long end of the spline must be facing down.
3. Install the block and spring to the 2nd / 3rd clutch hub.
4. Insert the 3 balls into the 3 insert grooves inside the sleeve. Position the balls carefully to set the phase.

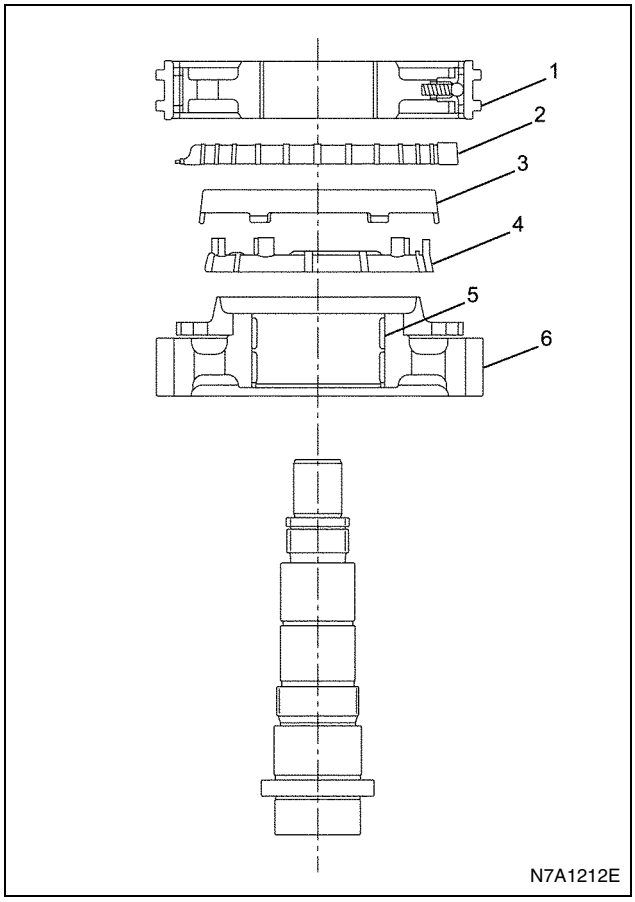

N7A1210E

5. Install the sleeve (1) to the clutch hub (5). The sleeve should press slightly against the block.
6. Press on the ball (2), the block (3), and the spring (4). Insert the sleeve into the ball groove until it touches the ball.



N7A1211E

7. Apply 5W-30 engine oil to the needle bearing, 2nd gear thrust surface, and the tapered surface of the synchronization cone. Face the dog gear upward and attach the 2nd gear (6) and needle bearing (5) to the main shaft.
8. Attach the 2nd-gear inside ring (4), 2nd-gear outside ring (3), and 2nd-gear block ring (2) so that the teeth of the outside ring mesh with those of the dog gear.
9. Insert the 6 pawls on the inside ring into the holes in the hub.
10. Use the installer (5-8840-2345-0) to press the 2nd / 3rd clutch hub assembly and sleeve (1) into place.

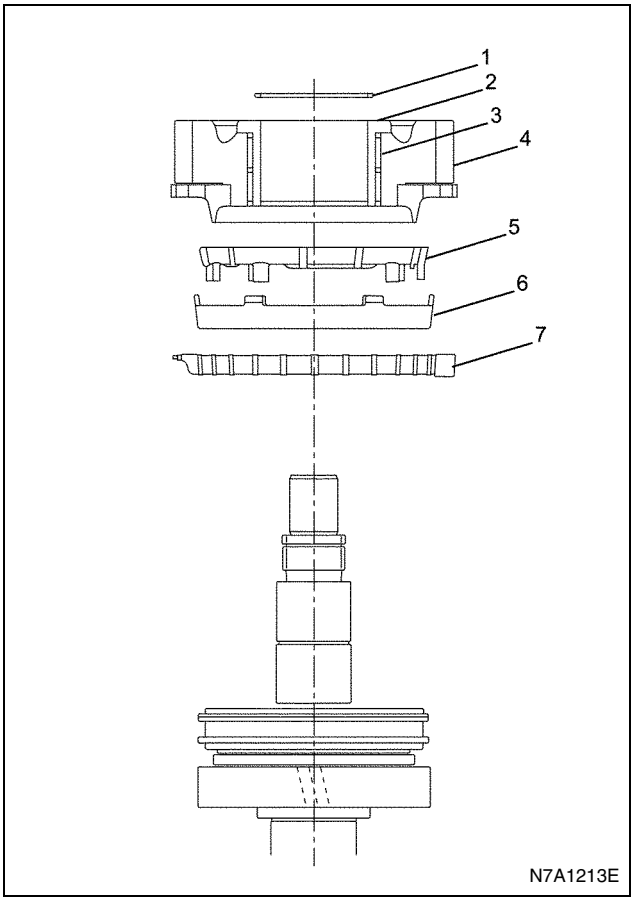


N7A1212E

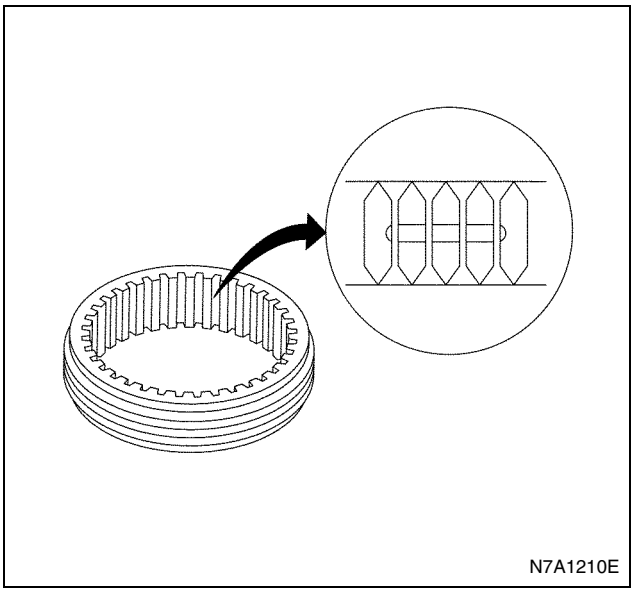
11. Attach the 3rd-gear block ring (7), 3rd-gear outside ring (6), 3rd-gear inside ring (5) so that the six teeth mesh with those of the hub. Make sure to thoroughly apply 5W-30 engine oil to both sides of the inside ring and outside ring as well as the inside surface of the block ring.
12. Apply 5W-30 engine oil to the needle bearing, 3rd-gear thrust surface, and the tapered surface of the synchronization cone. Face the dog gear downward and press-fit the 3rd gear (4), needle bearing (3), and collar (2) using the installer (5-8840-2345-0) so that the teeth of the outer ring mesh with those of the dog gear of the 3rd gear.
13. Use a pair of pliers to install the snap ring (1).

Caution:

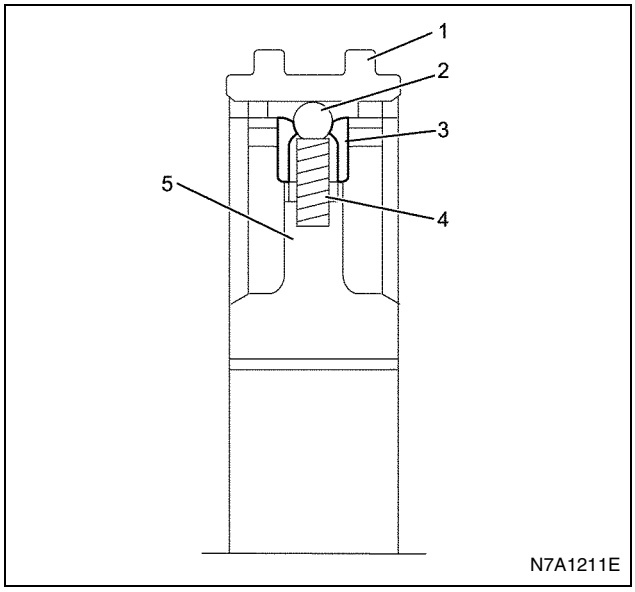
- If the snap ring is bent or otherwise damaged, it must be replaced with a new one.
- Be sure that the snap ring is completely installed to the snap ring groove.



14. Install the block and spring to the 4th / 5th clutch hub.
15. Insert the 3 balls into the 3 insert grooves inside the sleeve. Position the balls carefully to set the phase.



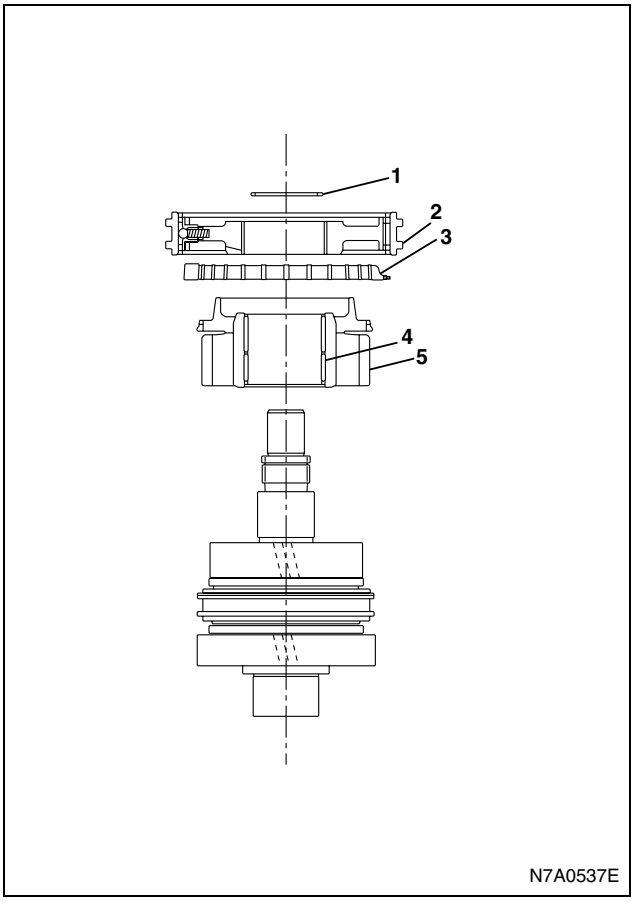
16. Install the sleeve (1) to the clutch hub (5). The sleeve should press slightly against the block.
17. Press on the ball (2), the block (3), and the spring (4). Insert the sleeve into the ball groove until it touches the ball.



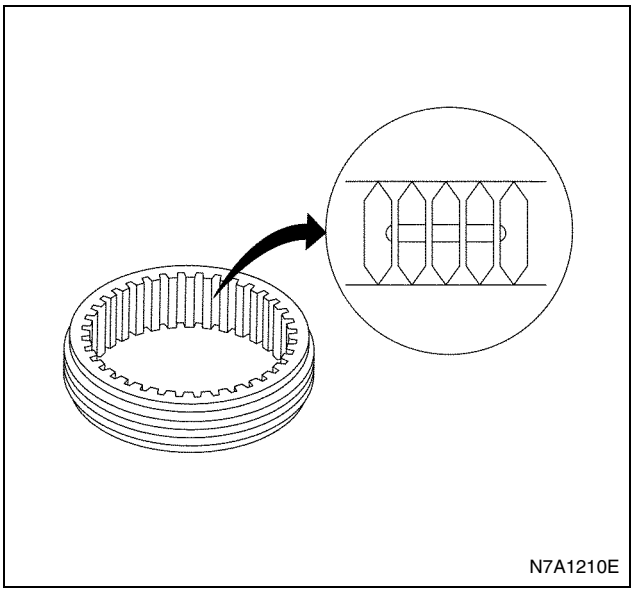
18. Apply engine oil (5W-30) to the needle bearing, the 4th gear thrust surfaces, and the synchrotron taper.
19. Install the 4th gear (5) and the needle bearing (4) to the main shaft. The dog gear must be facing up.
20. Apply engine oil (5W-30) to the 4th block ring (3).
21. Use the installer (5-8840-2345-0) to press the 4th / 5th clutch hub assembly and sleeve (2) into the groove in the 4th / 5th block ring.
22. Use a pair of pliers to install the snap ring (1).

Caution:

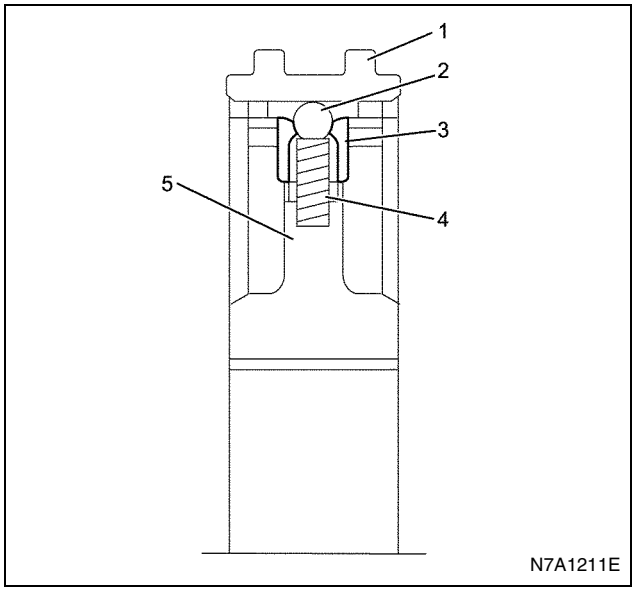
- If the snap ring is bent or otherwise damaged, it must be replaced with a new one.
- Be sure that the snap ring is completely installed to the snap ring groove.



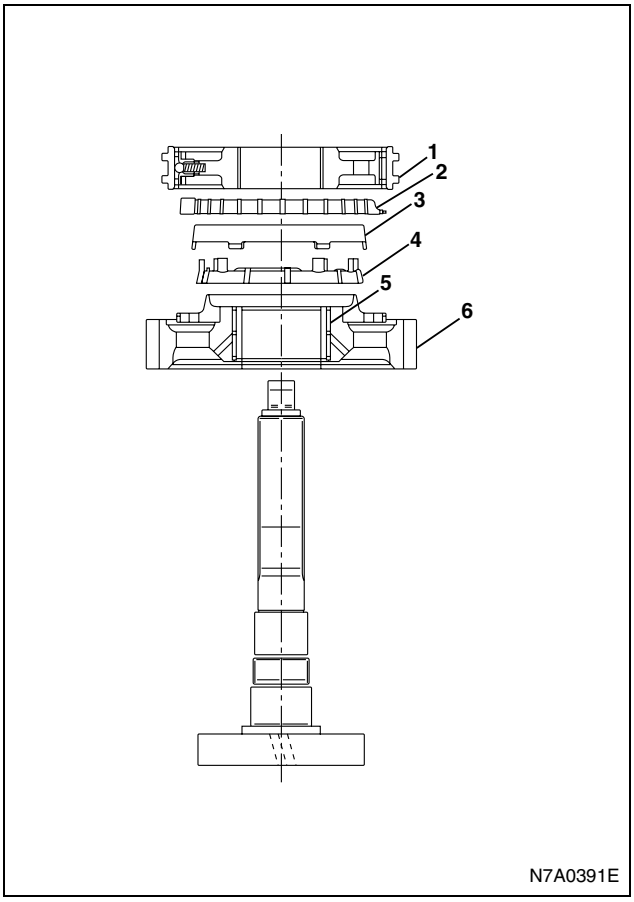
23. Install the block and spring to the 1st / reverse clutch hub.
24. Insert the 3 balls into the 3 insert grooves inside the sleeve. Position the balls carefully to set the phase.



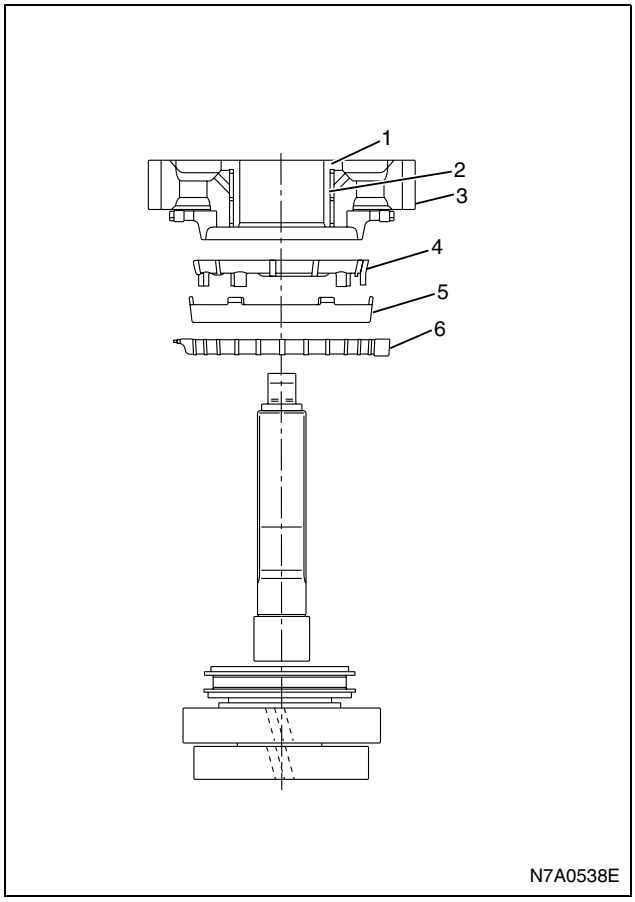
25. Install the sleeve (1) to the clutch hub (5). The sleeve should press slightly against the block.
26. Press on the ball (2), the block (3), and the spring (4). Insert the sleeve into the ball groove until it touches the ball.



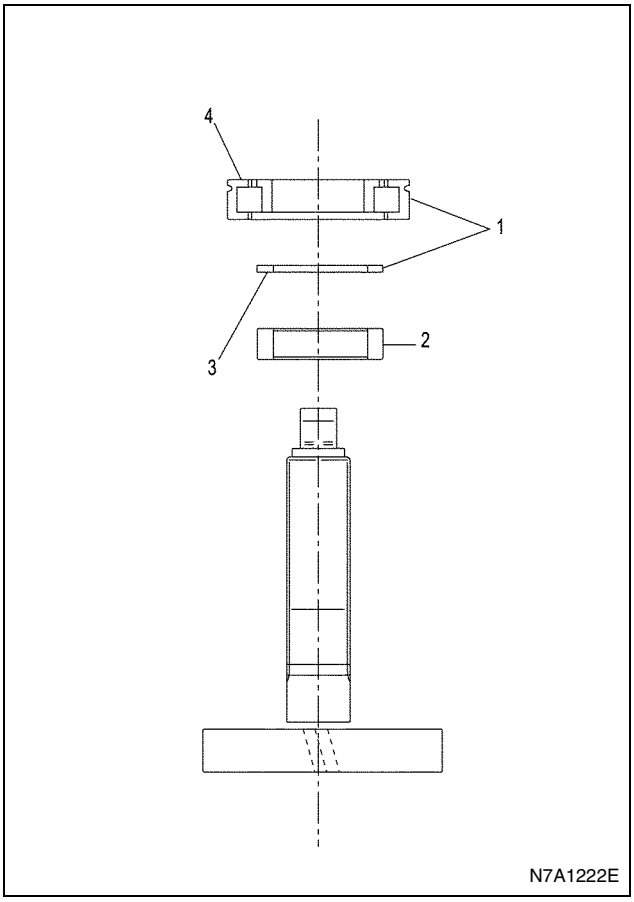
27. Apply engine oil (5W-30) to the needle bearing, the 1st gear thrust surfaces, and the synchrotron taper.
28. Install the 1st gear (6) and the needle bearing (5) to the main shaft. The dog gear must be facing up.
29. Assemble the 1st-gear inside ring (4), 1st-gear outside ring (3), and 1st-gear block ring (2) in that order. Then attach them so that the teeth of the outer ring mesh with those of the dog gear of the 1st gear. Be sure to thoroughly apply 5W-30 engine oil to both sides of the inside ring and outside ring as well as the inside surface of the block ring.
30. Insert the 6 pawls on the 1st gear inside ring into the 6 hub holes.
31. Use the installer (5-8840-2345-0) to press the 1st / reverse clutch hub assembly and sleeve (1) into place.



32. Apply engine oil (5W-30) to the reverse gear block ring (6), the reverse outside ring (5), and the reverse inside ring (4).
33. Align the block ring groove phase with the 1st / reverse clutch hub assembly and sleeve.
34. Install the block ring.
35. Apply engine oil (5W-30) to the needle bearing and the reverse gear thrust surfaces.
36. Align the reverse gear with the pawl on the outer ring to set the synchrotron phase.
37. Use the installer (5-8840-2345-0) to press the reverse gear (3), the needle bearing (2), and the collar (1) into place.



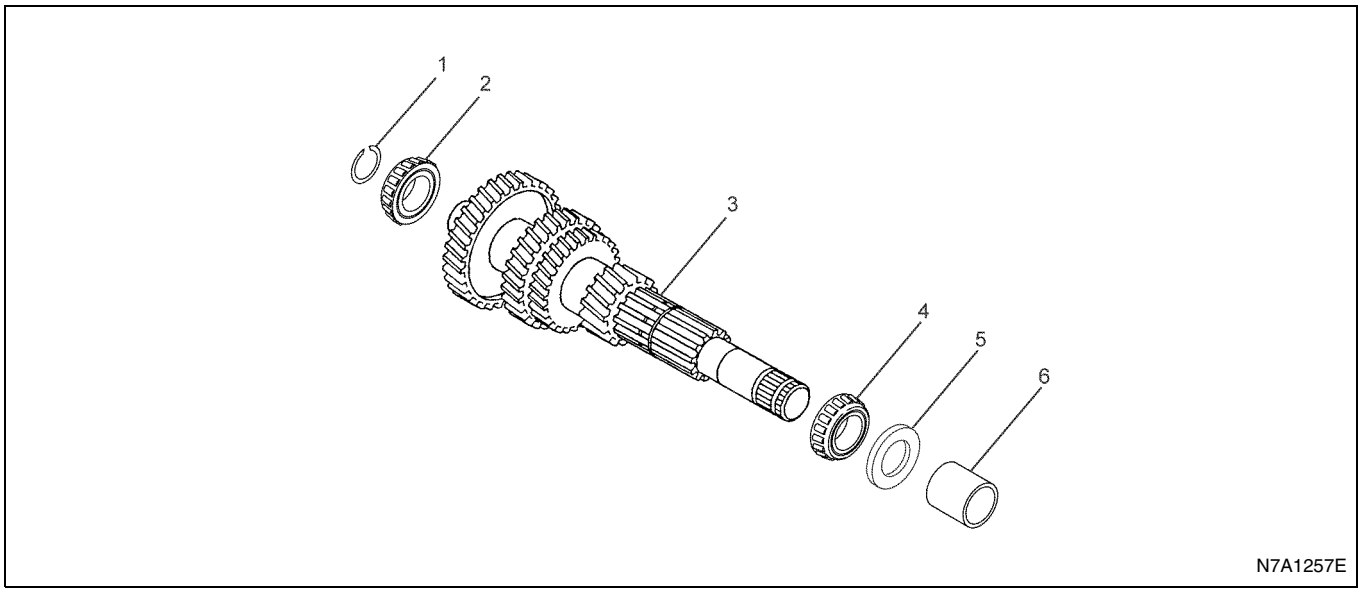
38. Install the spacer (2).
39. Use the installer (5-8840-2345-0) to press the bearing (1) into place. The bearing surface 'A' mark (4) must be facing up. The bearing surface 'B' mark (3) must be facing down.



40. Install the 6th gear. The projecting portion of the gear must be facing down.

Countershaft

Parts



Legend

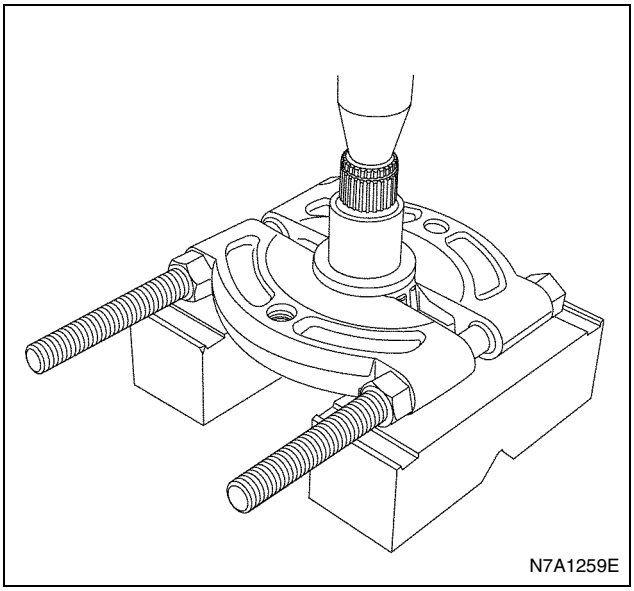
1. Snap ring
2. Bearing (Front of countershaft)
3. Countershaft assembly
4. Bearing (Back of countershaft)
5. Thrust washer
6. Collar

Disassembly

1. Use a pair of snap ring pliers to remove the snap ring holding the bearings in place.
2. Use a bearing separator or the like to remove the bearing from the front of the countershaft.

Caution:
Replace the bearing with inner race and outer race to new one.

3. Use a bearing remover and a press to remove the collar and the thrust washer.



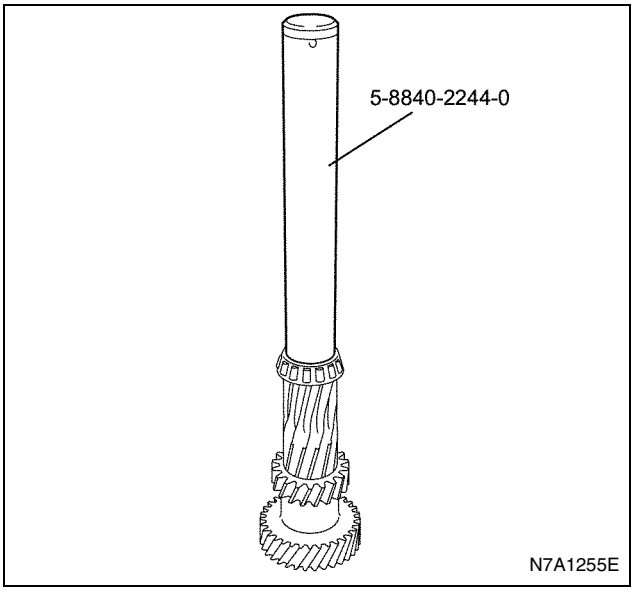
4. Use a bearing separator or the like to remove the bearing from the rear of the countershaft.

Caution:
Replace the bearing with inner race and outer race to new one.

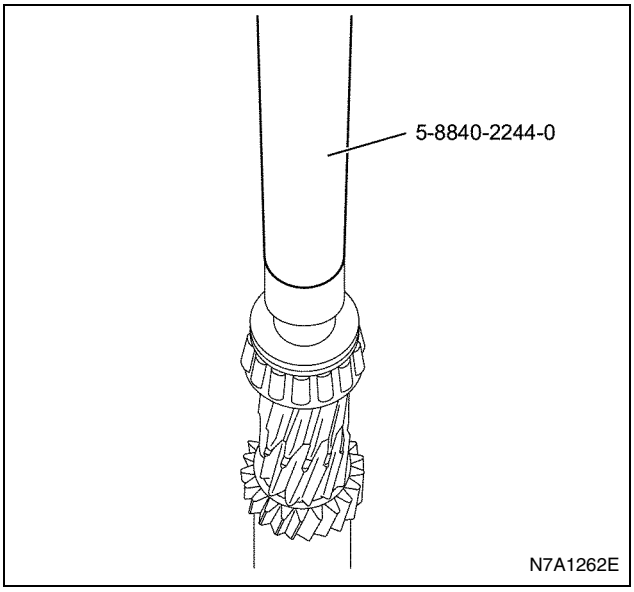
5. Inspect the disassembled parts for wear and/or other damage. Repair or replace damaged parts as required.
6. Check the cross-sectional area of each gear for significant wear and/or damage. If wear of damage is present, the gear must be replaced.
7. Inspect each of the bearings for roughness, abnormal operating noise, corrosion, internal and external damage, and excessive play (in the direction of the slide). Repair or replace the bearings as required.

Reassembly

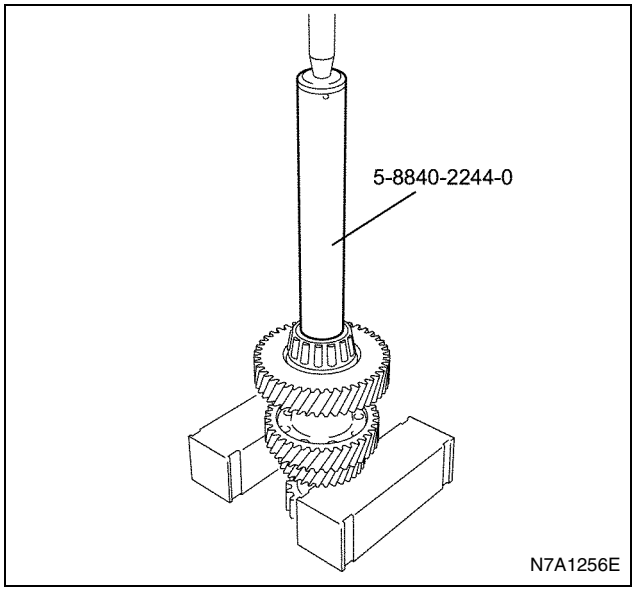
1. Use the installer (5-8840-2244-0) and a press to force the rear countershaft bearing into place.



2. Use the installer (5-8840-2244-0) and a press to force the collar and thrust washer into place.



3. Use the installer (5-8840-2244-0) and a press to force the bearing on to the front of the countershaft.

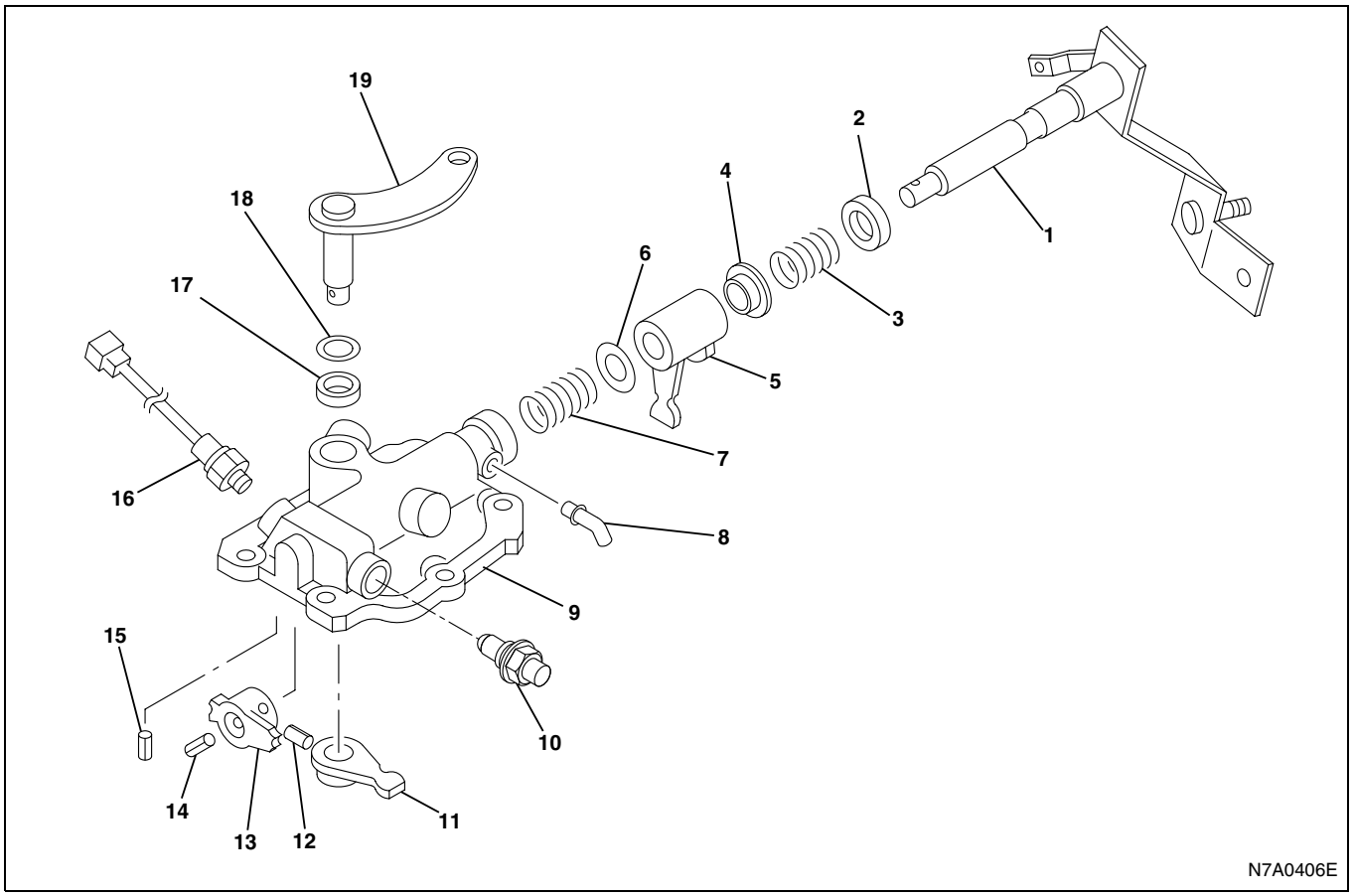


4. Use a pair of snap ring pliers to install the snap ring securing the front countershaft bearing.
   - From the mountable snap rings, select the thickest one of the three types.

Shim thickness mm (in)	Discernment color
1.9 (0.075)	Colorless
2.1 (0.083)	Yellow
2.3 (0.091)	Pink

Control Box

Parts

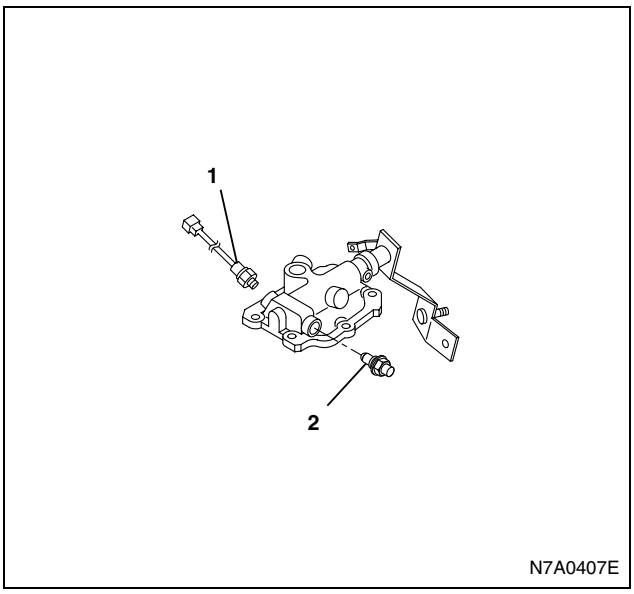


Legend

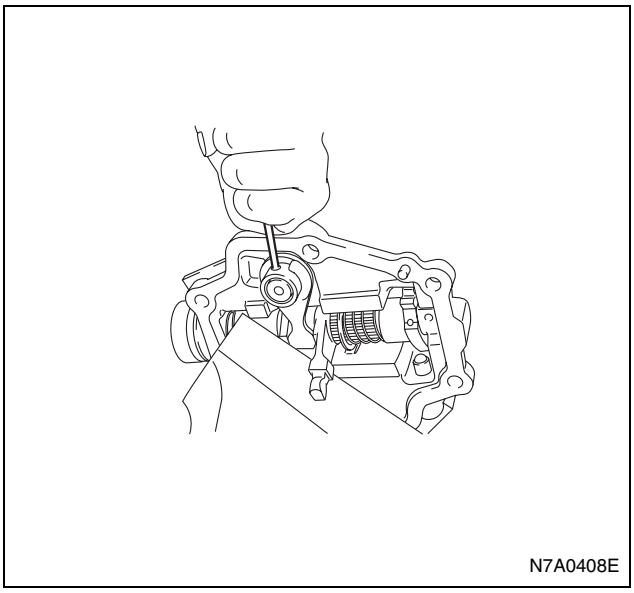
1. Shift lever shaft
2. Shift lever shaft oil seal
3. Spring
4. Washer
5. Shift internal lever
6. Spring seat
7. Spring
8. Pipe
9. Control box
10. Detent
11. Selector internal lever
12. Spring pin (Selector internal lever)
13. Stopper ring
14. Spring pin (Stopper ring)
15. Spring pin (Shift lever shaft)
16. Neutral switch
17. Selector lever shaft oil seal
18. Washer
19. Selector external lever

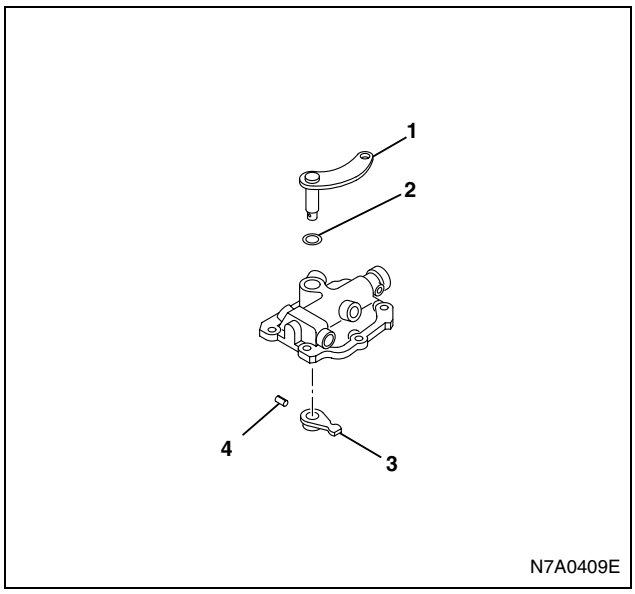
Disassembly

1. Remove the neutral switch (1), the detent (2).

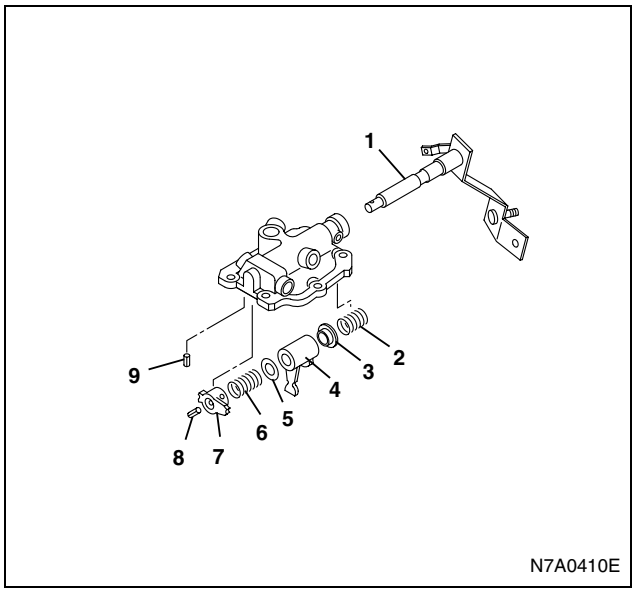


2. Use a spring pin remover to remove the selector internal bar spring pin (4).
3. Remove the selector internal lever (3), the selector external bar (1), and the washer (2).





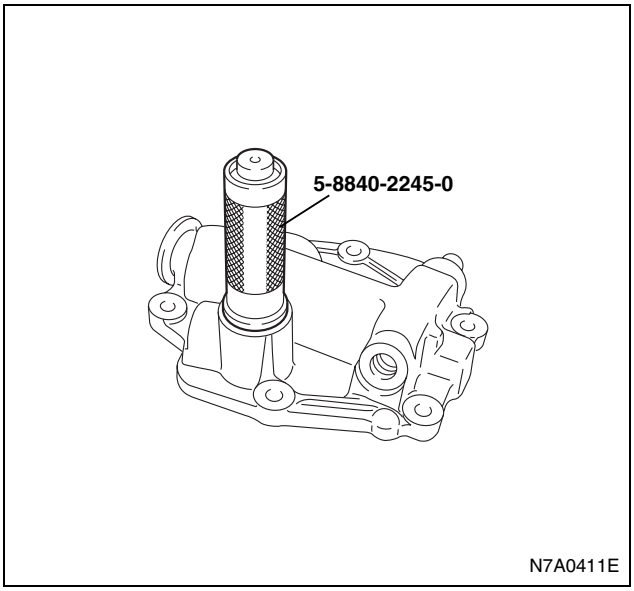
4. Use a pair of pliers to remove the stopper ring spring pin (8) and the shift lever shaft spring pin (9).
5. Pull the shift lever shaft (1) from the assembly.
6. Remove the stopper ring (7), the spring (6), the spring seat (5), the shift internal lever (4), the washer (3), and the spring (2).



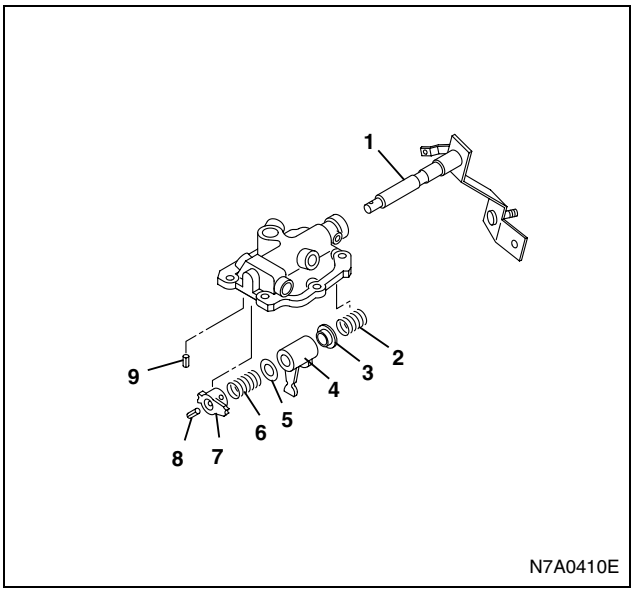
7. Use a screwdriver or similar prying tool to remove the selector lever shaft oil seal and the shift lever shaft oil seal from the control box.
8. Inspect the disassembled parts for wear and/or damage. Make the necessary repairs or replace the part as appropriate.
9. Inspect the shift lever shaft for significant wear. Replace the shaft if significant wear is present.
10. Inspect the control box for excessive play and rough or restricted movement. Replace the control box if either of these conditions is present.

Reassembly

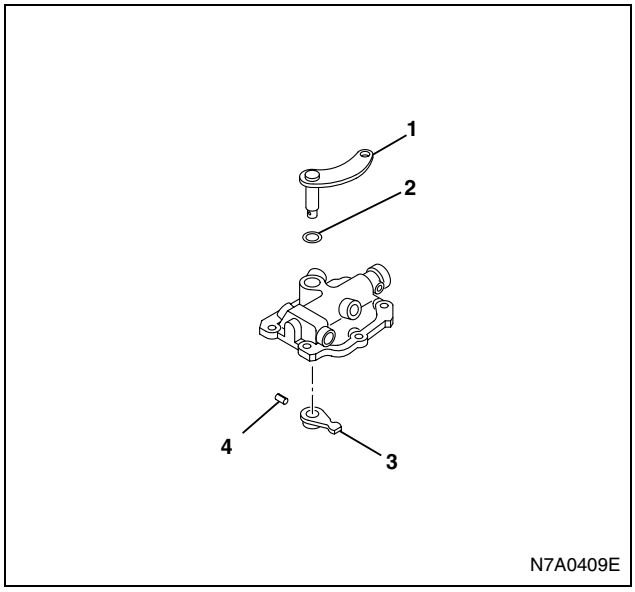
1. Use the installer (5-8840-2245-0) to install the shift lever shaft oil seal and the selector lever shaft oil seal to the control box.



2. Install the spring (2), the washer (3), the shift internal lever (4), the spring seat (5), the spring (6), and the stopper ring (7) to the control box.
3. Insert the shift lever shaft (1).
4. Align the pin holes in the shift lever shaft and the stopper ring.
5. Drive the new stopper ring spring pin (8) and the new shift lever shaft spring pin (9) into place.



6. Install the selector external lever (1) and the washer (2) to the control box.
7. Install the selector internal lever (3).
8. Drive the new selector internal lever spring pin (4) into place.



9. Install the detent (2).

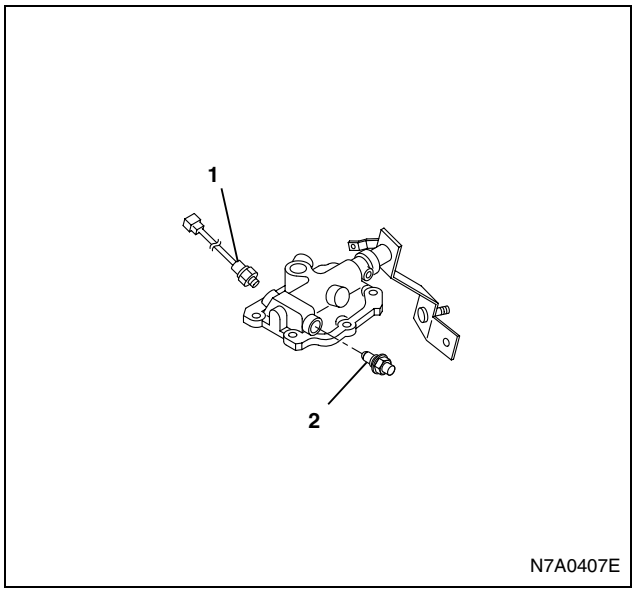
Tighten:
Detent (2) to 28 N·m (2.9 kg·m / 21 lb·ft)

- Detents are precoated. Be sure to thoroughly remove sealing material around the threads of the case, and use new detents.

10. Tighten the neutral switch (1) to the specified torque.

- Thoroughly remove sealing material from the threads, apply Three Bond 1141 to them, and then assemble.

Tighten:
Neutral switch (1) to 34 N·m (3.5 kg·m / 25 lb·ft)



SPECIFICATIONS

Specifications

Transmission Type	MZZ6U Direct Drive 6-Speed
Gear Mesh Type	1st, 2nd, 3rd, Reverse: Synchro-mesh
Gear Ratio	1st 6.389
	2nd 3.767
	3rd 2.234
	4th 1.442
	5th 1.000
	6th 0.782
	Reverse 6.369
Lubricating Oil	Engine Oil SAE 5W-30
Oil Capacity	Approx. 4.4 Liters (4.7 US qt/3.9 Imp qt)
Weight without Lubricating Oil	100 kg (221 lb)
Distance between Center of Shift Lever Play and Center Cluster	283 ± 15 mm (11.1 ± 0.6 in)
Spline Play between Clutch Hub and Mainshaft	0 — 0.16 mm (0 — 0.01 in)
Shift Arm Thickness (Min.)	1st / Reverse, 3rd / 2nd, 5th / 4th 9.0 mm (0.354 in)
	6th 9.3 mm (0.366 in)
Gear Inside Diameter (Max.)	1st, 2nd, 3rd, Reverse 63.069 mm (2.483 in)
	4th 55.069 mm (2.168 in)
	5th 48.065 mm (1.892 in)
	6th 50.065 mm (1.971 in)
Main Shaft Deflection (Max.)	0.1 mm (0.004 in)
Block Ring and Dog Gear Gap (Min.)	0.5 mm (0.020 in)
Block and Clutch Hub Gap	1st / Reverse, 3rd / 2nd 3.3 — 3.7 mm (0.130 — 0.150 in)
	5th / 4th, 6th 4.3 — 4.7 mm (0.17 — 0.19 in)

Fixing Torque

Clutch Housing to Transmission Case Bolt	46 N·m (4.7 kg·m / 34 lb·ft)
Rear Cover Bolt	46 N·m (4.7 kg·m / 34 lb·ft)
Control Box Bolt	27 N·m (2.8 kg·m / 20 lb·ft)
Filler Plug	39 N·m (4 kg·m / 29 lb·ft)
Drain Plug	39 N·m (4 kg·m / 29 lb·ft)
Lock Nut to Coupling Driver	382 N·m (39 kg·m / 282 lb·ft)
Reverse Switch	39 N·m (4 kg·m / 29 lb·ft)
Neutral Switch	34 N·m (3.5 kg·m / 25 lb·ft)
Vehicle Speed Sensor Driven Gear Mounting Bolt	20 N·m (2 kg·m / 15 lb·ft)
Vehicle Speed Sensor	25 N·m (2.5 kg·m / 18 lb·ft)
Retainer Bolt	26 N·m (2.7 kg·m / 20 lb·ft)
6th Relay Lever Bolt	44 N·m (4.5 kg·m / 33 lb·ft)

Reverse Gear Side Cover Bolt	20 N·m (2.0 kg·m / 15 lb·ft)
PTO Cover Bolt	37 N·m (3.8 kg·m / 27 lb·ft)
Detent Plug	27 N·m (2.8 kg·m / 20 lb·ft)
Parking Brake Bracket Bolt	48 N·m (4.9 kg·m / 35 lb·ft)

SPECIAL TOOLS

Special Tools

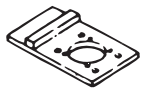
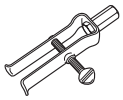
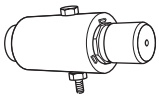
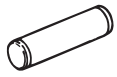
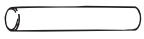
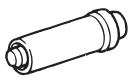
Illustration	Tool Number / Description / Remarks
 9852921010	9-8529-2101-0 / Drive Pinion Flange Bracket
5884027510	5-8840-2751-0 / Oil Seal Installer
 5884000270	5-8840-0027-0 / Bearing Remover
5884000840	5-8840-0084-0 / Sliding Hammer
 5884027550	5-8840-2755-0 / Bush Remover & Installer
5884025580	5-8840-2558-0 / Oil Seal Installer

Illustration	Tool Number / Description / Remarks
 5884022440	5-8840-2244-0 / Bearing Installer
5884000070	5-8840-0007-0 / Driver Handle
5884027530	5-8840-2753-0 / Bearing Installer
 5884023450	5-8840-2345-0 / Clutch Hub & Collar Installer
 5884022450	5-8840-2245-0 / Oil Seal Installer

MANUAL TRANSMISSION AND CLUTCH MZZ SERIES

SECTION 7C

CLUTCH (FOR MZZ TRANSMISSION)

Contents

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DESCRIPTION

Clutch System

Notice:
When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread locking compound will be called out. The correct torque value must be used when installing fasteners that require it. If the above conditions are not followed, parts or system damage could result.

Driving Members

The driving members of a clutch usually consist of two flat surfaces machined to a smooth finish.
One of these surfaces is usually the rear face of the engine flywheel, and the other is a comparatively heavy flat ring with one side machined. This part is known as the pressure plate. It is fitted into a steel cover, which also contains some of the operating members, and is bolted to the flywheel.

Driven Member

The driven member is a clutch disc with a splined hub which is free to slide lengthwise along the splines of the clutch shaft, but which drives the shaft through these same splines. Suitable frictional facings are attached to each side of the clutch disc by means of rivets. These facings must be heat resistant since friction produces heat.

Operating Members

The driving and driven members are held in contact by spring pressure.
The throwout (clutch release) bearing is a ballthrust bearing contained in the clutch housing, mounted on a sleeve attached to the front of the transmission case. The throwout bearing is moved by the clutch release yoke to contact the release levers and move the pressure plate to the rear, thus separating the clutch driving members from the driven member when the clutch pedal is depressed by the driver.

Clutch Controls

This system utilizes hydraulic pressure as a means of transmitting clutch pedal movement to the clutch release mechanism. The system consists of a pedal-operated master cylinder and a slave cylinder, interconnected with hydraulic lines. The clutch pedal is connected to the master cylinder push rod, and the slave cylinder push rod is connected to the clutch release fork.

DIAGNOSIS OF CLUTCH

PROBLEM	POSSIBLE CAUSE	CORRECTION
Clutch Slips	1. Binding of release levers in the pressure plate and cover assembly.	1. Replace the clutch cover assembly.
	2. Clutch release levers improperly adjusted.	2. If levers are in place, adjust free pedal.
	3. Facings loose on the clutch disc.	3. Replace the driven disc assembly.
	4. Improper clutch release bearing adjustment.	4. Adjust for proper clearance (free pedal).
	5. Binding or sticking clutch pedal assembly.	5. Repair or replace faulty parts. Check linkage for proper adjustment.
	6. Weak or broken clutch pressure springs.	6. Replace the clutch cover assembly.
	7. Burned clutch facings.	7. Replace clutch driven disc assembly and check flywheel and pressure plate friction surfaces for damage replace parts as necessary.
	8. Binding or sticking of the clutch disc hub on the transmission drive gear.	8. Lubricate splines with high temperature grease (if dry). Replace driven discs if splined hubs are worn.
	9. Release bearing binding on bearing retainer.	9. Replace release bearing or lubricate.
	10. Warped pressure plate or engine flywheel.	10. Replace defective parts. Check transmission, clutch, and engine alignment.
	11. No free pedal.	11. Adjust for free pedal, check clutch driven disc wear and replace parts as required.
Clutch Chatters During Engagement	1. Loose engine mounts.	1. Tighten engine mount bolts to specifications.
	2. Grease or oil on facings.	2. Replace driven disc assembly and repair oil leak.
	3. Slight binding in linkage during engagement.	3. Check linkage for wear or damage. Replace parts as required.
	4. Weak pressure springs.	4. Replace clutch cover assembly.
	5. Clutch release levers binding during engagement.	5. Repair or replace clutch cover assembly.
	6. Worn or broken pilot bearing.	6. Replace and lubricate pilot bearing.
	7. Rough engine idle.	7. Tune engine to manufacturer's specifications.
	8. Bent or out of plane pressure plate fingers.	8. Replace clutch cover assembly if release fingers are more than 2 mm (0.079 in) out of plane.
	9. Driven disc warped, cracked, or loose friction material.	9. Replace driven disc assembly.
	10. Pressure plate warped or hot spots.	10. Replace pressure plate or clutch cover assembly.
	11. Flywheel warpage or discoloration.	11. Replace flywheel.
	12. Flywheel housing bore and face not aligned.	12. Correct per alignment procedure.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Clutch Drags When Disengaged	1. Pedal cannot disengage clutch because of excessive free pedal travel.	1. Check pedal and linkage for wear, replace parts as required. Adjust clutch and linkage for proper free travel.
	2. Clutch release levers need adjustment.	2. Replace clutch cover assembly.
	3. High spots on clutch facings.	3. Replace driven disc assembly.
	4. Loose rivet in facings.	4. Replace driven disc assembly. Check for damaged flywheel and pressure plate, replace as necessary.
	5. Clutch disc wobbles because of broken springs in hub.	5. Replace driven disc assembly.
	6. Flange of clutch cover not in alignment with flywheel because of loose bolts or bent flange.	6. Torque bolts to specifications or replace cover assembly.
	7. Deteriorated or broken engine mounts.	7. Replace engine mountings.
	8. Worn clutch release bearing.	8. Replace release bearing and adjust clutch free pedal.
	9. Worn linkage components.	9. Check pedal and linkage for wear; replace parts as required.
	10. Clutch disc warped.	10. Replace driven disc assembly, also check flywheel for deep heat checks. Replace flywheel as necessary.
	11. Broken or loose facings.	11. Replace driven disc assembly.
	12. Misalignment of transmission.	12. Check engine mounts, wear on flywheel housing, and bolt torque.
	13. Main drive gear misaligned because of worn bearings.	13. Repair transmission if required and check flywheel pilot bearing; replace pilot bearing as required.
	14. Clutch pressure plate warped.	14. Replace clutch cover assembly; also check flywheel surface for dished out wear pattern. Replace flywheel as required.
	15. Loose flywheel housing bolts.	15. Torque bolts to specifications.
Clutch Grabs	1. Grease or oil on clutch facings.	1. Replace driven disc assembly and repair oil leak.
	2. Exposed rivet heads due to excessively worn facings or loose rivets.	2. Replace driven disc assembly and check for flywheel and pressure plate damage. Replace damaged parts.
	3. Loose engine mounts.	3. Tighten engine mount bolts to specifications.
	4. Clutch pressure springs too stiff.	4. Replace clutch cover assembly.
	5. Momentary binding in linkage while clutch is being engaged.	5. Check pedal and linkage for wear or damage. Replace parts as required.
	6. Warped pressure plate or flywheel.	6. Replace damaged parts. Check alignment.

PROBLEM	POSSIBLE CAUSE	CORRECTION
Clutch Noisy When Engaged	1. Improper clutch release bearing adjustment.	1. Adjust clutch linkage for pedal free play.
	2. Clutch disc damper springs weak or broken.	2. Replace driven disc assembly.
	3. Linkage binds.	3. Check pedal and linkage. Replace or repair as required.
	4. Clutch release bearing binding.	4. Check for alignment and release bearing lubricant. Replace bearing as required.
	5. Loose flywheel or clutch cover bolts.	5. Torque bolts to specifications.
	6. Misalignment of transmission.	6. Check engine mountings, wear on flywheel housing, and fixing torque.
	7. Worn splines on clutch disc or transmission main drive gear.	7. Replace parts as required. Lubricate with high temperature grease.
	8. Weak or missing clutch return springs.	8. Replace clutch cover assembly.
	9. Clutch pedal assembly binding.	9. Check pedal and linkage for wear or damage. Repair or replace parts as required.
Clutch Pedal Pulsates During Engagement	1. Misalignment of transmission.	1. Check engine mountings, wear on flywheel housing, and fixing torque.
	2. Loose or improperly installed engine mounts.	2. Refer to ENGINE for proper engine mount installation.
	3. Clutch release levers not adjusted to uniform height.	3. Replace clutch cover assembly.
Clutch Rattles When Disengaged with Engine Idling	1. Wear or looseness in linkage.	1. Check linkage for wear or damage. Replace parts as required.
	2. Retractor springs on release lever weak, broken, or disconnected.	2. Replace clutch cover assembly.
	3. Loose flywheel or clutch cover bolts.	3. Torque bolts to specifications.
	4. Rough engine idle.	4. Tune engine to manufacturer's specifications.
Clutch Noisy When Disengaged	1. Pilot bearing or bushing in crankshaft worn, damaged, broken, or inadequately lubricated.	1. Replace parts as required. Lubricate with high temperature grease.
	2. Release bearing worn, dirty, damaged, broken, or inadequately lubricated.	2. Replace release bearing. Lubricate with high temperature grease.
	3. Transmission main drive gear bearing worn, dirty or lacks lubricant.	3. Repair transmission. Check for rear bearing cap oil hole for restriction clearance.

ON-VEHICLE SERVICE

Clutch System Inspection

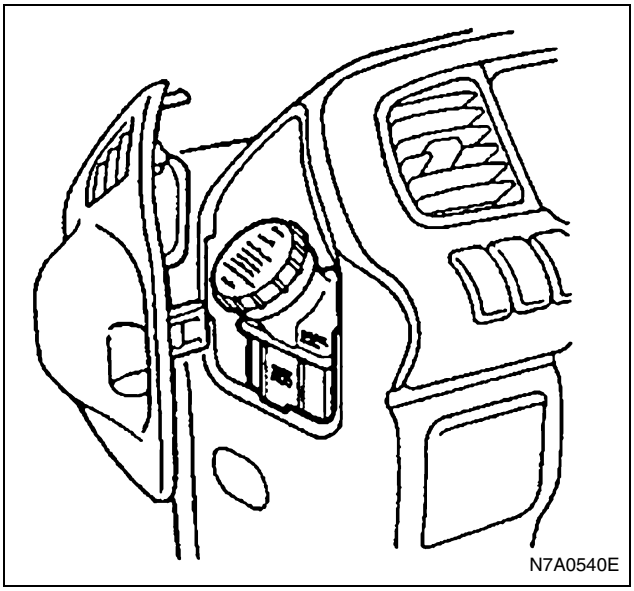
The system should be checked and serviced periodically as stated below.

- Maintain the proper level of hydraulic fluid in the master cylinder reservoir. Refer to MAINTENANCE AND LUBRICATION for recommended fluid and checking intervals.
- Inspect the entire clutch system regularly for fluid leakage. Leakage must be corrected immediately.
- Adjust the clutch linkage if necessary.
- If the clutch pedal action is springy or spongy, it is an indication that air needs to be bled from the hydraulic system.

A specified clearance in the hydraulic control linkage must exist between the end of the push rod and master cylinder piston. This clearance is measured as pedal free travel.

Before making the adjustment, make sure that the level of fluid in the master cylinder reservoir is 13 mm (0.5 in) below the top of the reservoir. The fluid system must be free of air.

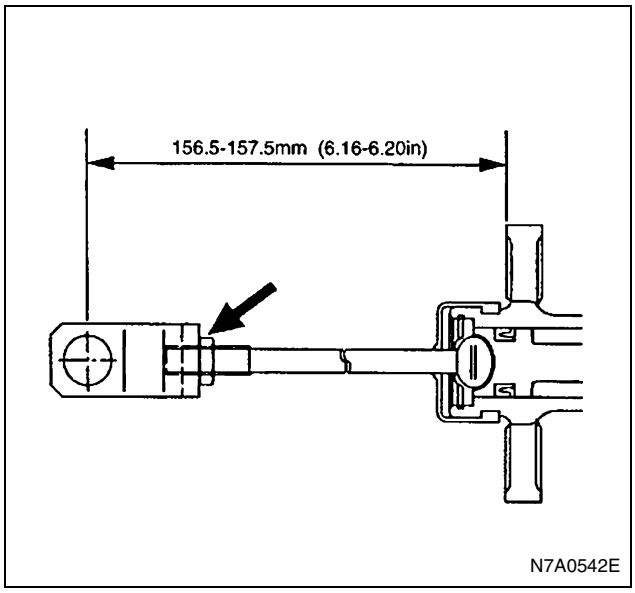
The dual brake/clutch master cylinder reservoir is in the left-upper portion of the dash panel. It can be accessed by opening the driver door.



Clutch Pedal Free Play, Height And Travel Adjustment

Adjust

1. Loosen the jam nut on the clutch switch.
2. Remove the master cylinder from the clutch pedal assembly.
3. Loosen the jam nut on the master cylinder push rod.
4. Turn the push rod until the distance from the center of clevis pin hole to mounting surface of clutch pedal bracket should be set at 156.5 — 157.5 mm (6.16 — 6.20 in).
   When fixed under this condition, there is no need to adjust the clutch pedal height and free play.



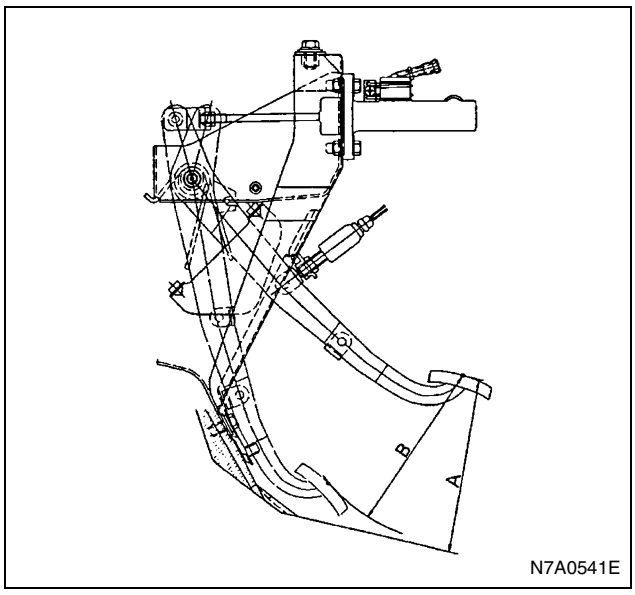
5. Install the master cylinder to the clutch pedal assembly.

Tighten:
Jam nut to 17 N·m (1.7 kg·m / 148 lb·in).

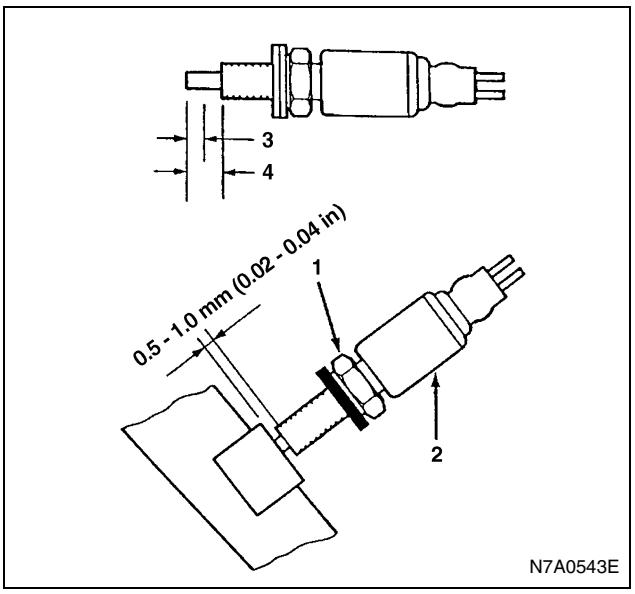
6. Install the master cylinder to the clutch pedal assembly.

Measurement

- Clutch pedal normal play is between 15 — 25 mm (0.6 — 1.0 in) (reference).
- Clutch pedal height “A” is between 160 — 170 mm (6.3 — 6.7 in) (reference).
- Clutch pedal travel “B” is between 159 — 169 mm (6.2 — 6.7 in) (reference).



7. Check clearance at the clutch switch. Turn the switch in its bracket until the clearance between the fully depressed plunger and the clutch pedal is 0.5 — 1.0 mm (0.02 — 0.04 in).



Legend

1. Jam nut
2. Clutch switch
3. OFF
4. Max. stroke

Caution:
Clutch switch must be adjusted so that when the clutch pedal is released, it closes the switch but does not completely depress the switch plunger (max stroke see figure). If the plunger is completely depressed by the pedal, switch damage may result.

8. Tighten the jam nut (1) at the clutch switch (2).

Tighten:
Jam nut to 15 N·m (1.5 kg·m / 133 lb·in).

9. Recheck the clutch switch clearance.

Bleeding The Clutch Hydraulic Circuits

If air enters the clutch circuit, it will cause the clutch to drag. It will be necessary to bleed the clutch fluid circuit if the reservoir has been emptied or the hydraulic circuit has been disassembled. To bleed the clutch circuit properly, an assistant will be needed.

Bleeding Procedure

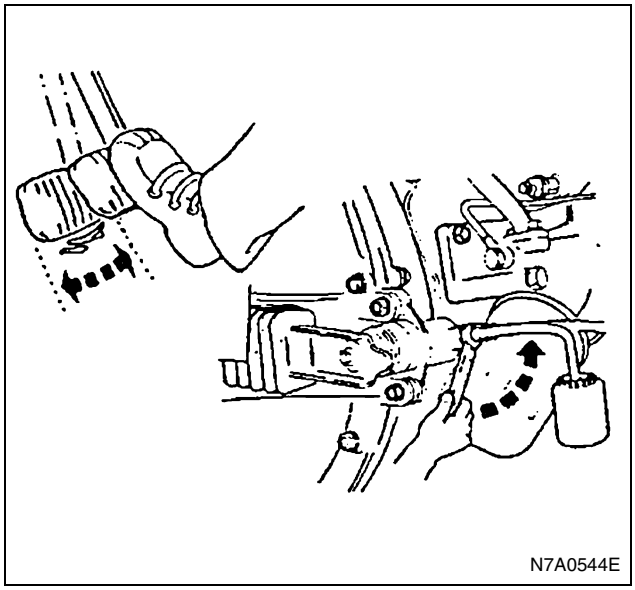
1. Check the level of the clutch fluid in the clutch reservoir and add clutch fluid if necessary.
2. Remove the rubber cap from the bleeder screw and wipe the bleeder screw clean. Connect a vinyl tube to the bleeder screw and insert the other end of the vinyl tube into a transparent container. Pump the clutch pedal repeatedly and hold the pedal in the depressed position.
3. Loosen the bleeder screw on the clutch slave cylinder to discharge clutch fluid and air bubbles into a container then tighten the bleeder screw immediately.
4. Release the clutch pedal slowly. Repeat step 3 until all air bubbles disappear from the clutch fluid being discharged into the container. During the bleeding operation, keep the clutch fluid reservoir filled to 13 mm (0.5 in) below the top of the reservoir.
5. Install the rubber cap onto the bleeder screw.

Optional Bleeding Method

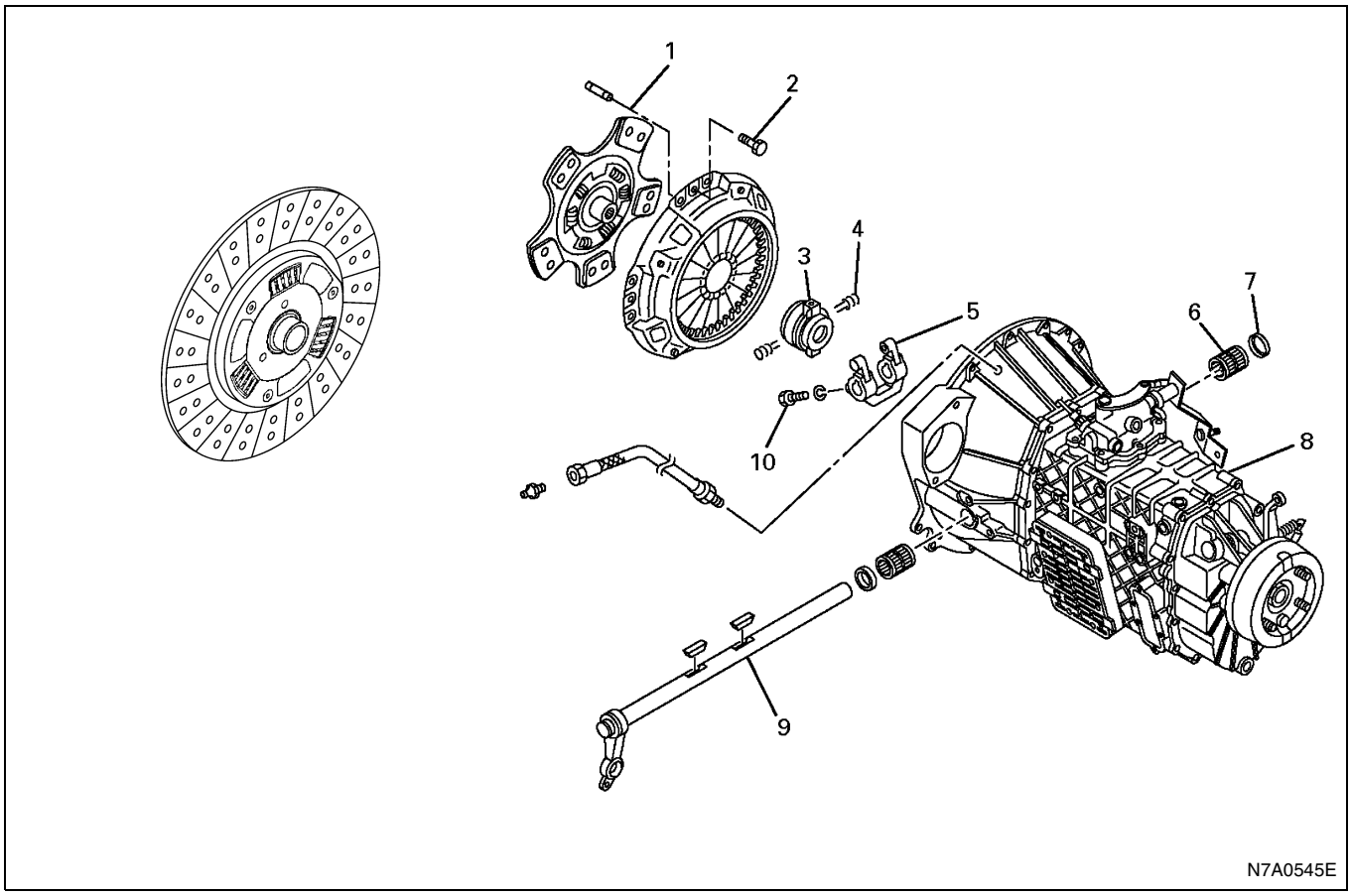
Tool Required:

J-35854 Power Bleeder Adapter or Equivalent

- Connect a power bleeding machine to the master cylinder with the use of adapter J-35854 or equivalent. Bleed until all air bubbles are out of the system and a solid pedal is obtained.



COMPONENT PARTS REPLACEMENT



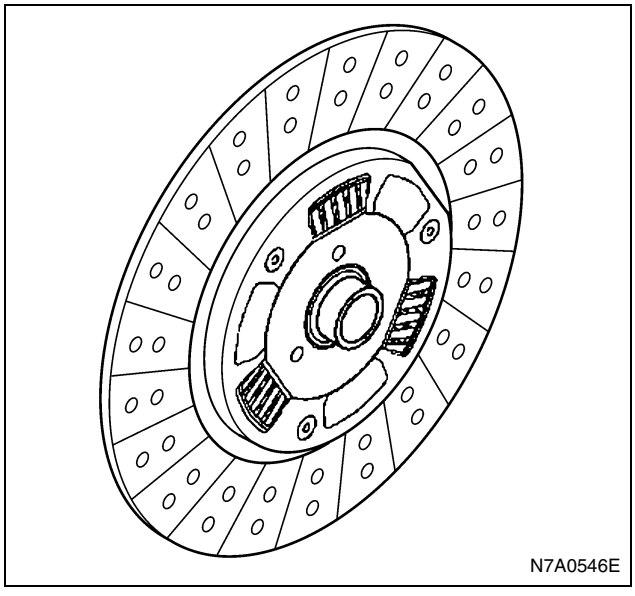
Legend

1. Clutch disc assembly
2. Pressure plate assembly
3. Shift block and release bearing
4. Return spring
5. Shift fork
6. Needle bearing
7. Dust cover
8. Transmission assembly
9. Clutch shaft
10. Set bolt

Clutch Assembly

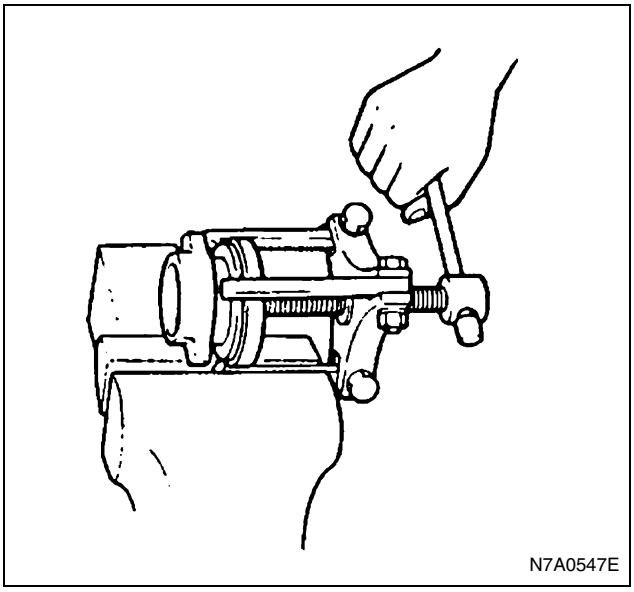
Remove or Disconnect

1. Transmission assembly.
   Refer to TRANSMISSION.
2. Pressure plate assembly.
3. Clutch disc assembly.



4. Return spring.

5. Shift block and release bearing.
   - Use suitable puller to remove the release bearing.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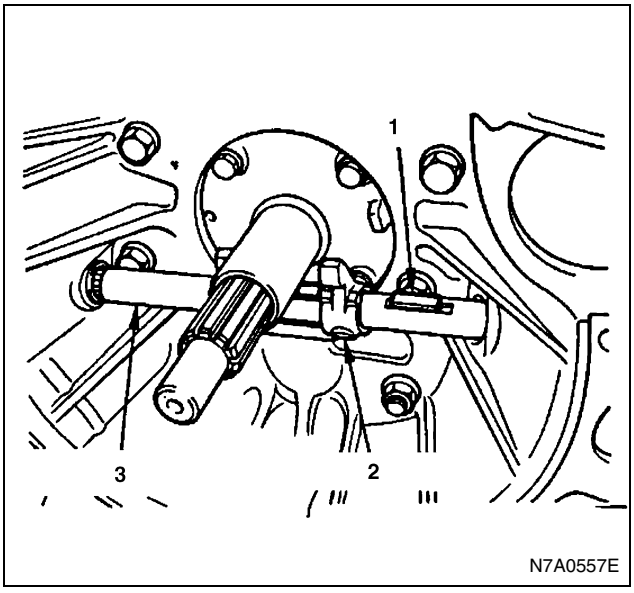
6. Set bolt.
7. Clutch shaft.
   - Use a brass bar to remove the clutch shaft.
8. Shift fork.



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Legend

1. Key
2. Shift fork
3. Clutch shaft

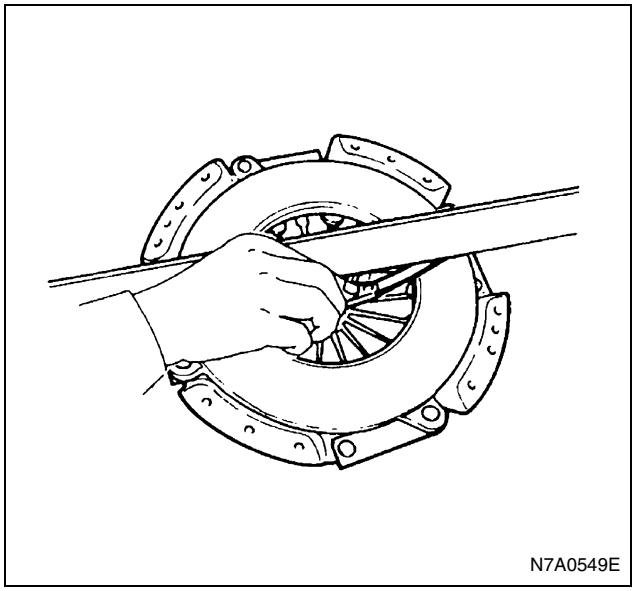
9. Dust cover.
10. Needle bearing.

Inspect

- Pressure plate cover for cracks or distortion.
- Diaphragm spring for heat distortion.
- For loose or bent rivets.
- Release bearing for roughness or noise by rotating the bearing race under light pressure.
- Shift fork for wear or damage.
- Pilot bearing on the crankshaft for roughness by rotating the bearing race under light pressure.
- Replace all parts that would effect proper operation of the clutch release assembly.
- Replace the flywheel, pressure plate assembly, or driven plate if found to be scored, burned, warped, or worn. Do not machine the flywheel or the pressure plate to eliminate these conditions.

Measure

- Pressure plate wear.
  If the wear exceeds the limit 0.3 mm (0.012 in), the pressure plate assembly must be replaced.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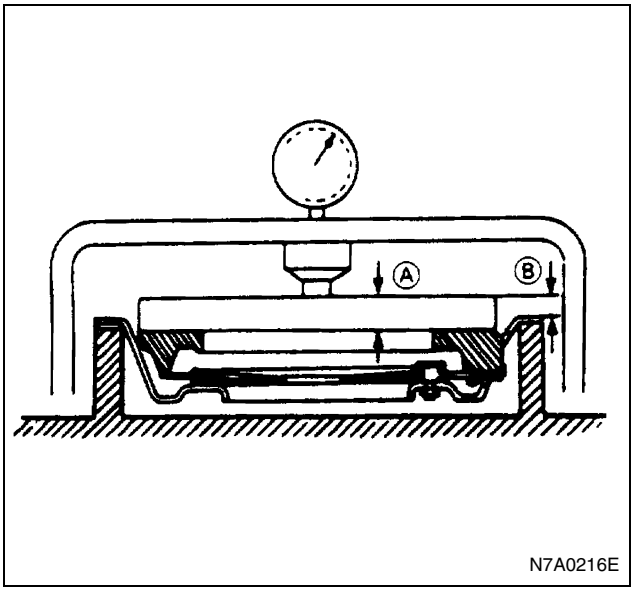
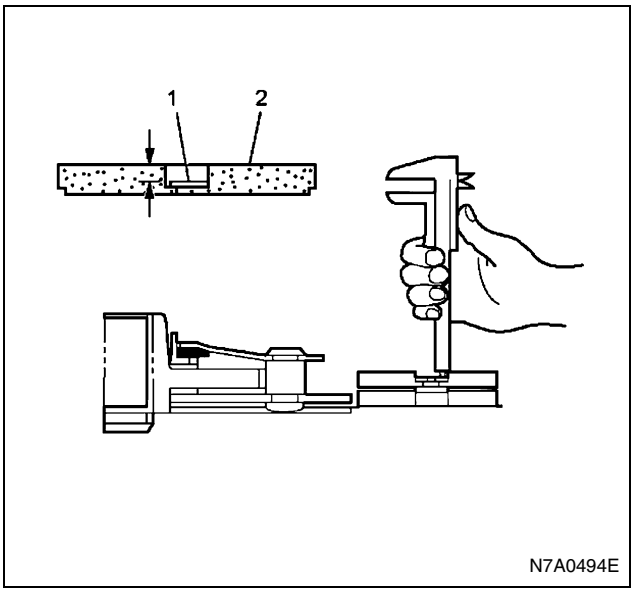
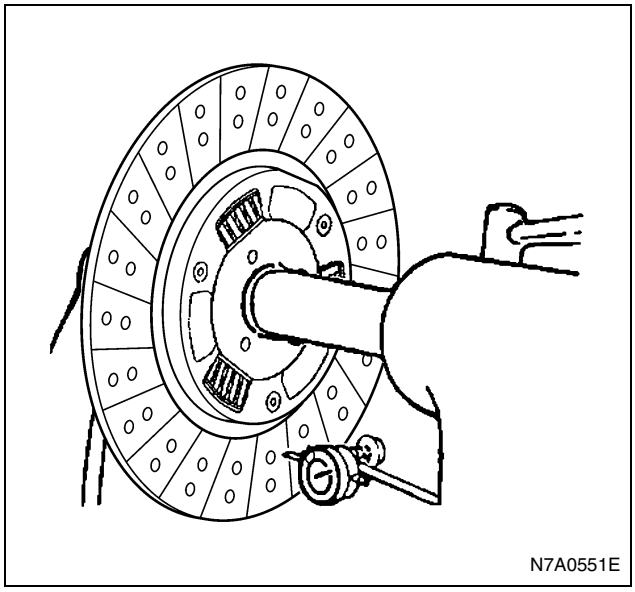
- Pressure plate clamping force. Invert the pressure plate and position an 9.2 mm (0.36 in) thick plate A over the pressure plate with hydraulic press. Then observe the load gauge reading when the dimension B becomes 19 mm (0.75 in) as indicated in the figure. Replace the pressure plate assembly if the clamping force is less than 970 kg (2,139 lb).



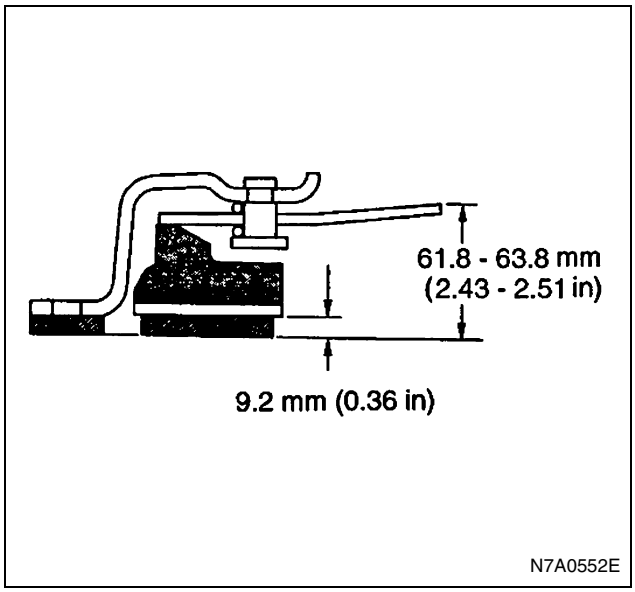
- The depression of the rivet head (1) on the driven plate (2).
  Replace the clutch disc assembly if the thickness of the friction material is less than 0.2 mm (0.008 in).



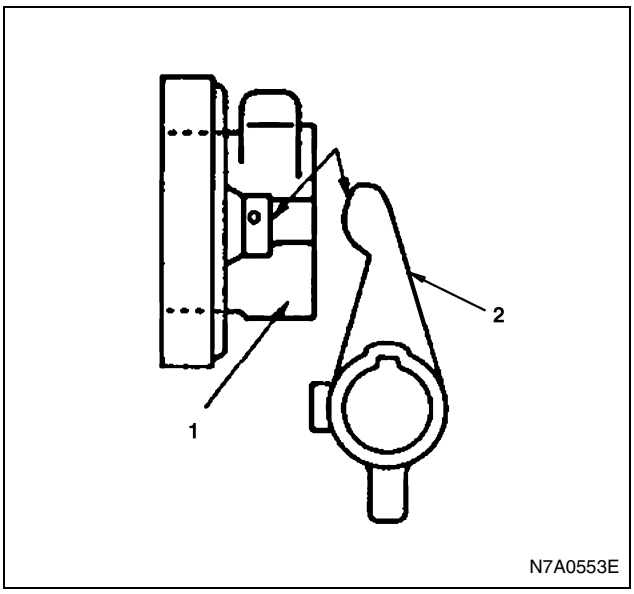
- Clutch Disc warpage.
  Limit: 0.6 mm (0.024 in).
  Clutch Size: 325 mm (12.80 in).



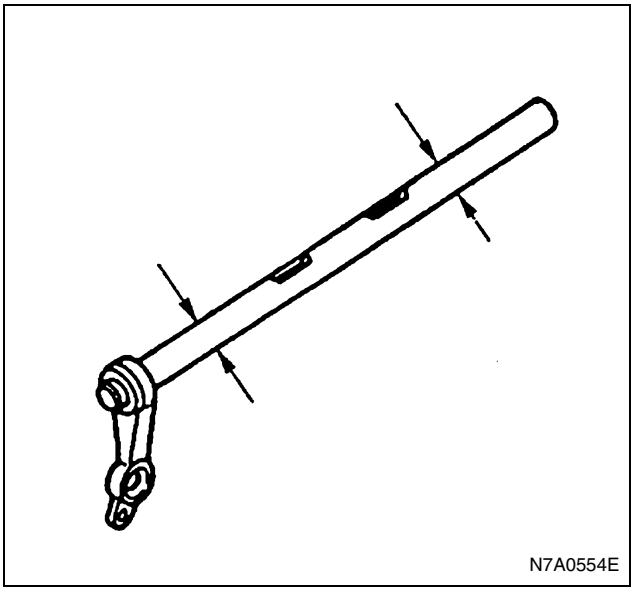
- Height of the diaphragm spring fingers. Position an 9.2 mm (0.36 in) thick plate under the pressure plate. Compress the diaphragm spring until the spring touches the table. Measure the height of the diaphragm spring fingers. They must be 61.8 — 63.8 mm (2.43 — 2.51 in) high.



- Check the surface of the shift block (1) for wear or damage.
- Check the surface of the shift fork (2) for wear or damage.

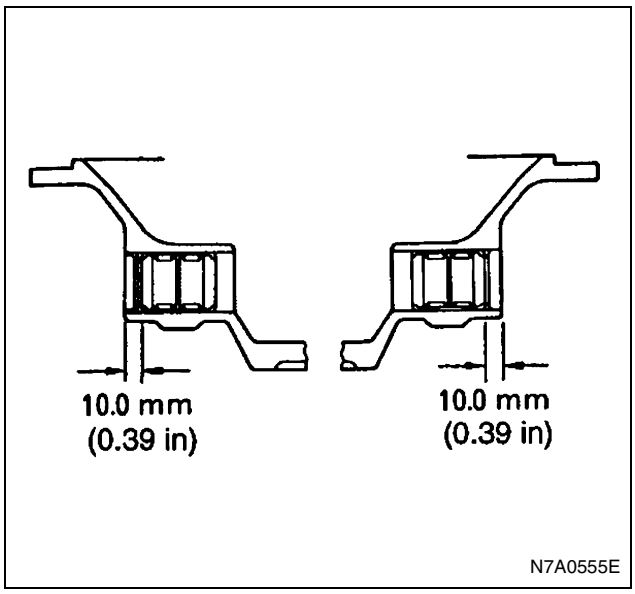


- Clutch shaft diameters as shown in the figure. If the diameter is less than 24.5 mm (0.96 in), replace the clutch shaft and needle bearing.

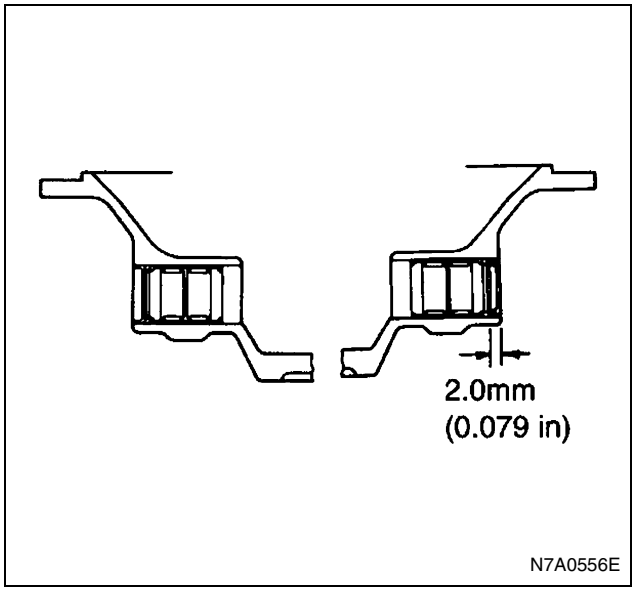


Install or connect

1. Needle bearing.
   - Use a 32 mm (1.26 in) diameter bar to drive the needle bearing from the marked side of bearing and install it specified depth as shown in illustration.

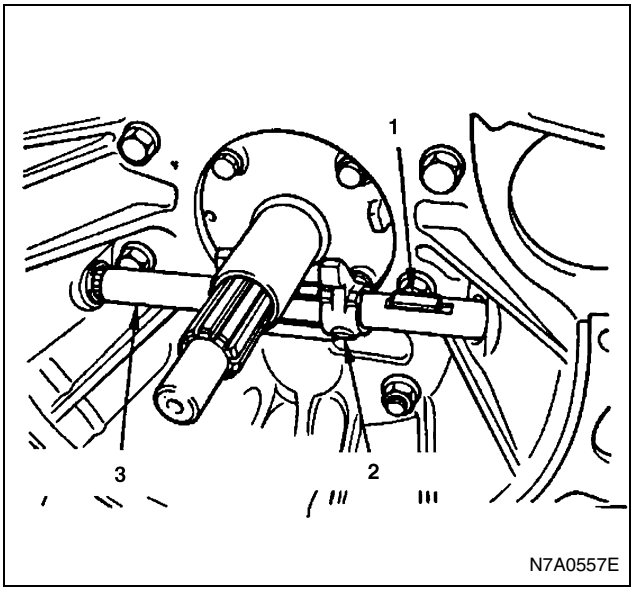


2. Dust seal.
   - Before installing the new bearing, apply MoS_2 contained type grease to the bearing surfaces and the clearance area between the bearing and the dust seal.



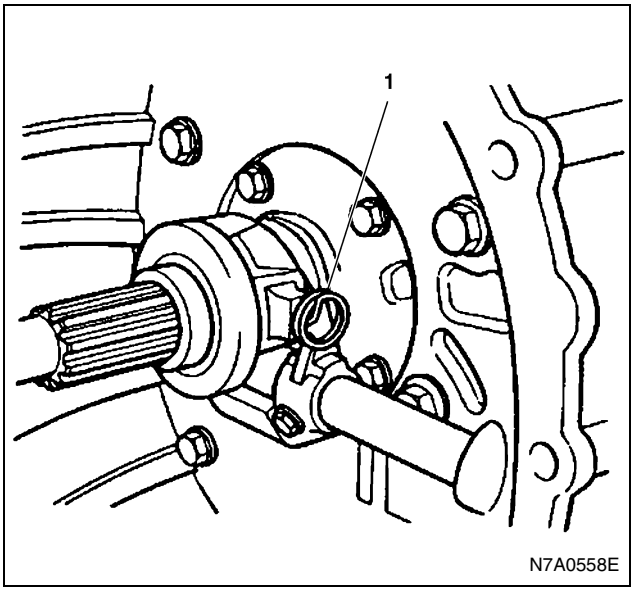
3. Shift fork.
4. Clutch shaft and key.
5. Set bolt.
   - Install the clutch shaft to the clutch housing.
   - Key and shift fork onto the clutch shaft assembly.
   - Tighten the set bolt.

Tighten:
Set bolt to 13 N·m (1.3 kg·m / 113 lb·in)

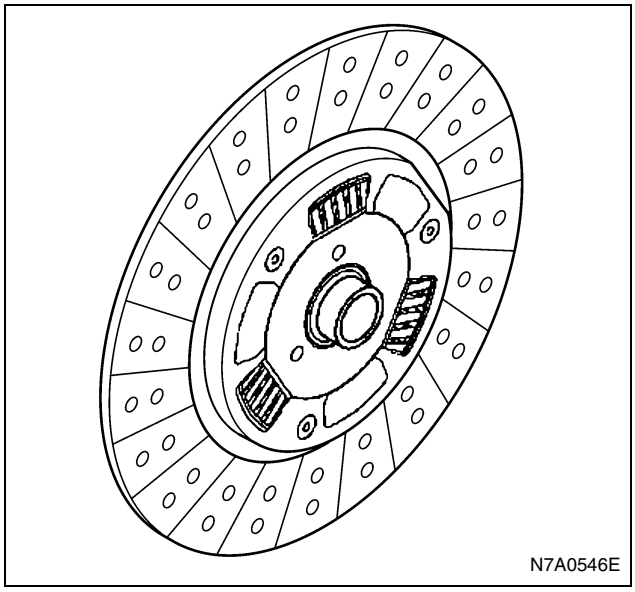


Legend
1. Key
2. Shift fork
3. Clutch shaft

6. Shift block and release bearing.
7. Return spring.
   - Apply the MoS_2 contained type grease to shift fork and shift block surfaces.
   - Install the return spring (1).

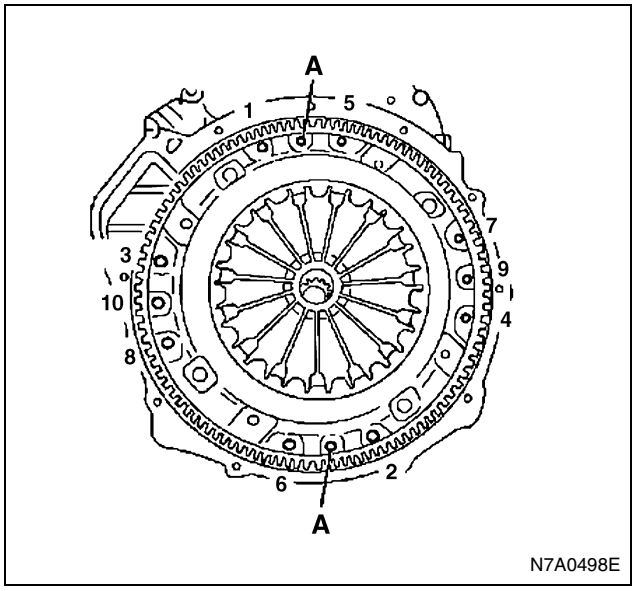


8. Clutch disc assembly.
   - Clutch pilot aligner 5-8840-2790-0 into the center of the clutch disc assembly.



9. Pressure plate assembly.
   - Install the pressure plate assembly to the flywheel. If the pressure plate was replaced to new parts, be sure to remove the ring which is installed to the diaphragm spring.

Tighten:
Pressure plate bolt to 40 N·m (4.1 kg·m / 30 lb·ft) in the sequence shown in the figure.

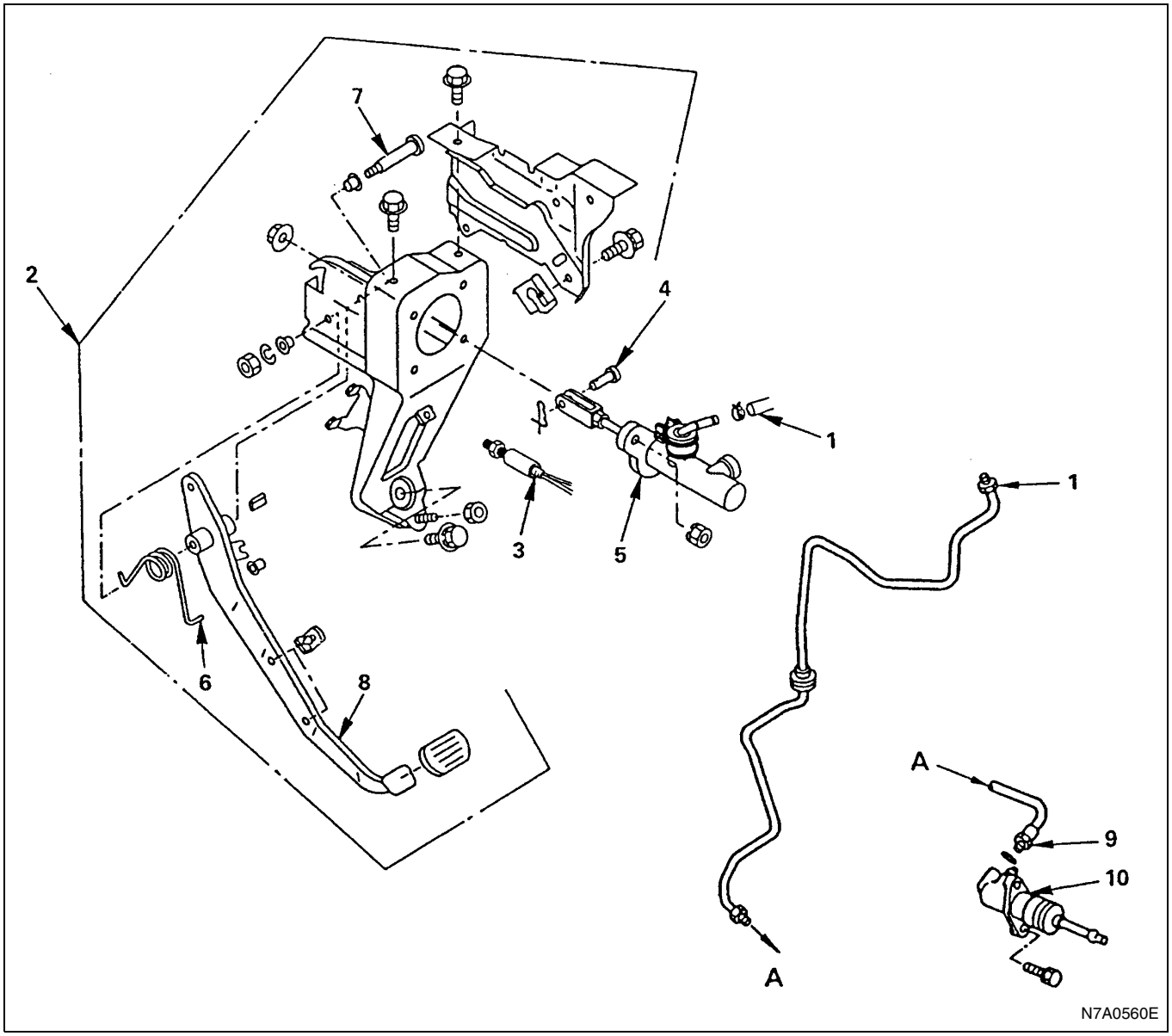


Legend
A. Dowel pin

   - Remove the pilot aligner.
10. Transmission assembly.
   - Refer to TRANSMISSION in this manual.

Clutch Controls

Clutch Control Assembly



Legend

1. Hose and pipe
2. Clutch pedal and bracket assembly
3. Clutch switch
4. Clevis pin
5. Master cylinder
6. Return spring
7. Fulcrum pin
8. Clutch pedal
9. Flexible hose
10. Slave cylinder

Remove or Disconnect

- Drain the clutch fluid from the clutch hydraulic line.

Notice:
Do not let clutch fluid remain on a painted surface. Wash it off immediately.

1. Meter cluster and meter assembly.
   - Pull out the meter cluster and disconnect harness connectors.
     Refer to INSTRUMENTAL PANEL.
2. Electric vacuum pump.
   - Remove the electric vacuum pump.
     Refer to ELECTRIC VACUUM PUMP.
3. Hose and pipe.
4. Clutch pedal and bracket assembly.
5. Clutch switch.
6. Clevis pin.
7. Master cylinder.
8. Return spring.

9. Fulcrum pin.
10. Clutch pedal.
11. Flexible hose.
12. Slave cylinder.

Inspect

- All parts for damage or wear.
- The clearance between the pedal shaft and bushings.
- Replace the clutch pedal assembly if the clearance is excessive.

Install or Connect

Notice:
For steps 1, 7 and 9 see “Notice” on page 7C-2 of this section.

1. Slave cylinder.

Tighten:
Slave cylinder bolt to 19 N·m (1.9 kg·m / 14 lb·ft).

2. Flexible hose.

Tighten:
Flexible hose tube nut to 20 N·m (2 kg·m / 14 lb·ft).

3. Clutch pedal.
4. Fulcrum pin.
5. Return spring.
6. Master cylinder.

Adjust:
- Loosen the jam nut on the master cylinder push rod.
- Adjust push rod length to 156.5 — 157.5mm (6.16 — 6.20 in), and tighten the jam nut.

Tighten:
Master cylinder jam nut to 17 N·m (1.7 kg·m / 148 lb·in).

7. Clutch switch.
8. Clutch pedal and bracket assembly.

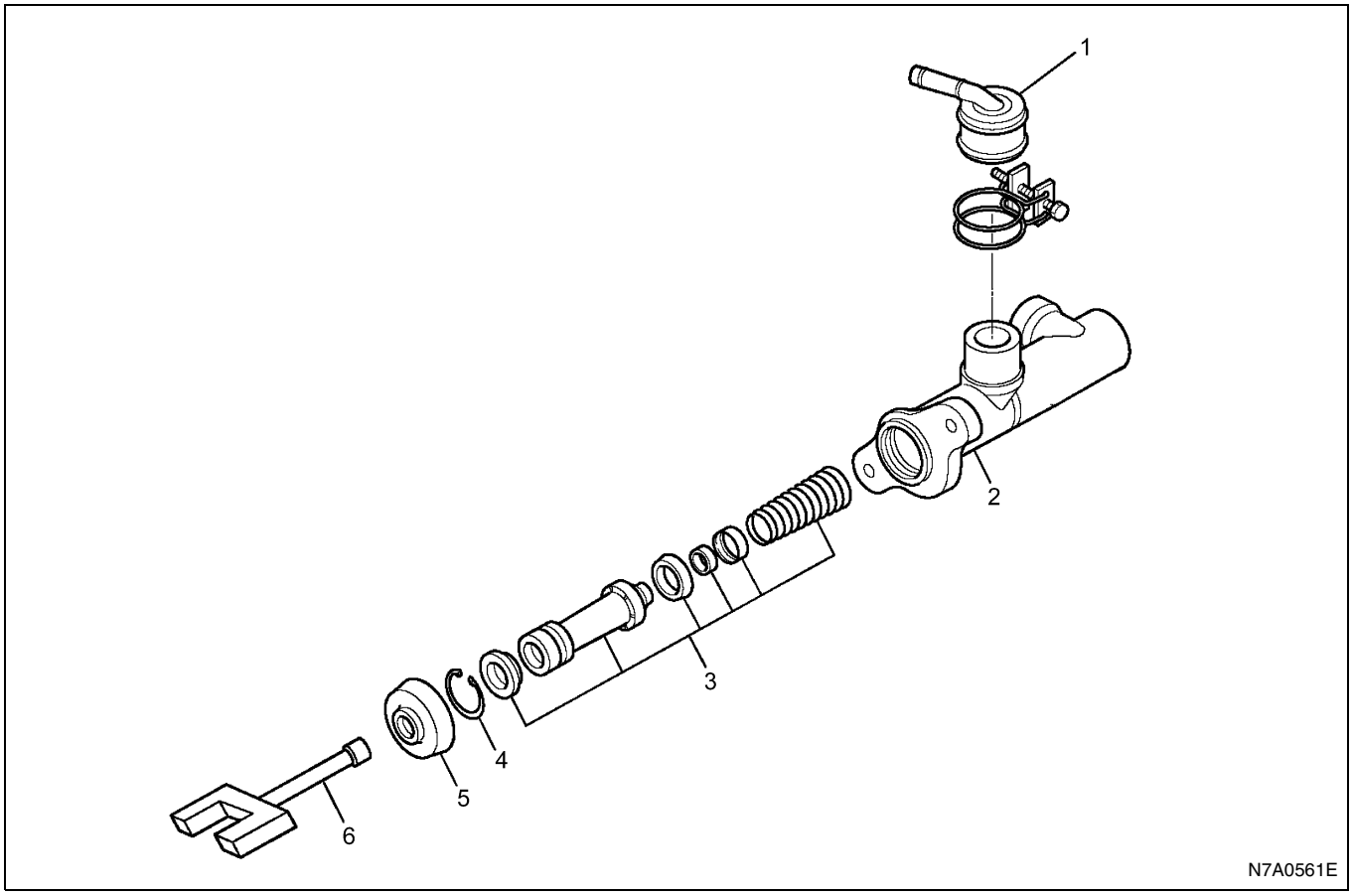
Tighten:
Clutch pedal and bracket bolt to 37 N·m (3.8 kg·m / 27 lb·ft).

9. Hose and pipe.
10. Electric vacuum pump.
    - Refer to ELECTRIC VACUUM PUMP.
11. Meter cluster and meter assembly.
    - Refer to INSTRUMENTAL PANEL.
12. Bleed the clutch hydraulic circuit. Refer to BLEEDING CLUTCH HYDRAULIC CIRCUITS previously in this section.

UNIT REPAIR

Master Cylinder

Master Cylinder Assembly



Legend

1. Hose joint
2. Cylinder body
3. Piston assembly
4. Snap ring
5. Dust cover
6. Push rod

Disassembly

1. Hose joint (1).
2. Dust cover (5).
3. Snap ring (4).
4. Piston assembly (3).
5. Cylinder body (2).

Clean

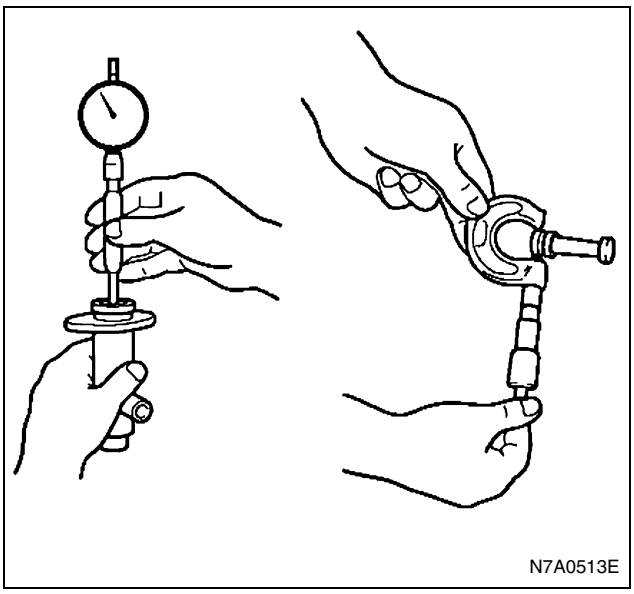
- All disassembled parts in brake fluid. Be sure to check the ports for restrictions. Use a metal wire to loosen the dirt.

Inspect

- Cylinder bore and piston for wear and rust formation.
- Spring for weakening.
- Replace any parts if wear, damage, or any other abnormal conditions are found during inspection.

Measure

- The bore inside the master cylinder body with a dial indicator. Use a micrometer to check the thickness of the piston. Replace the master cylinder body or piston if the clearance is less than 0.12 mm (0.0047 in).


N7A0513E

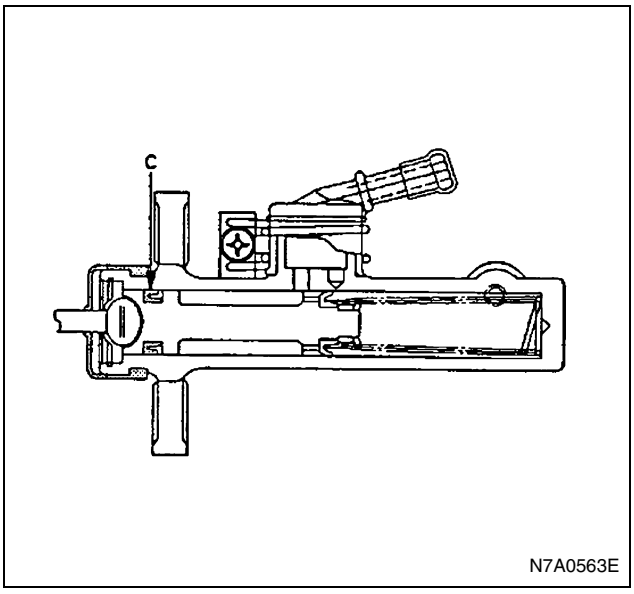
Reassembly

1. Cylinder body (2).

Important:

- Before installing the parts, apply a thin coat of brake fluid.

2. Piston assembly (3). Install new cup (C) in groove in piston with the lip turned toward the front of the cylinder body. Use care so as not to scratch the lipped portion of the cup.
3. Snap ring (4) to the cylinder body groove.
4. Dust cover (5).
5. Hose joint (1).



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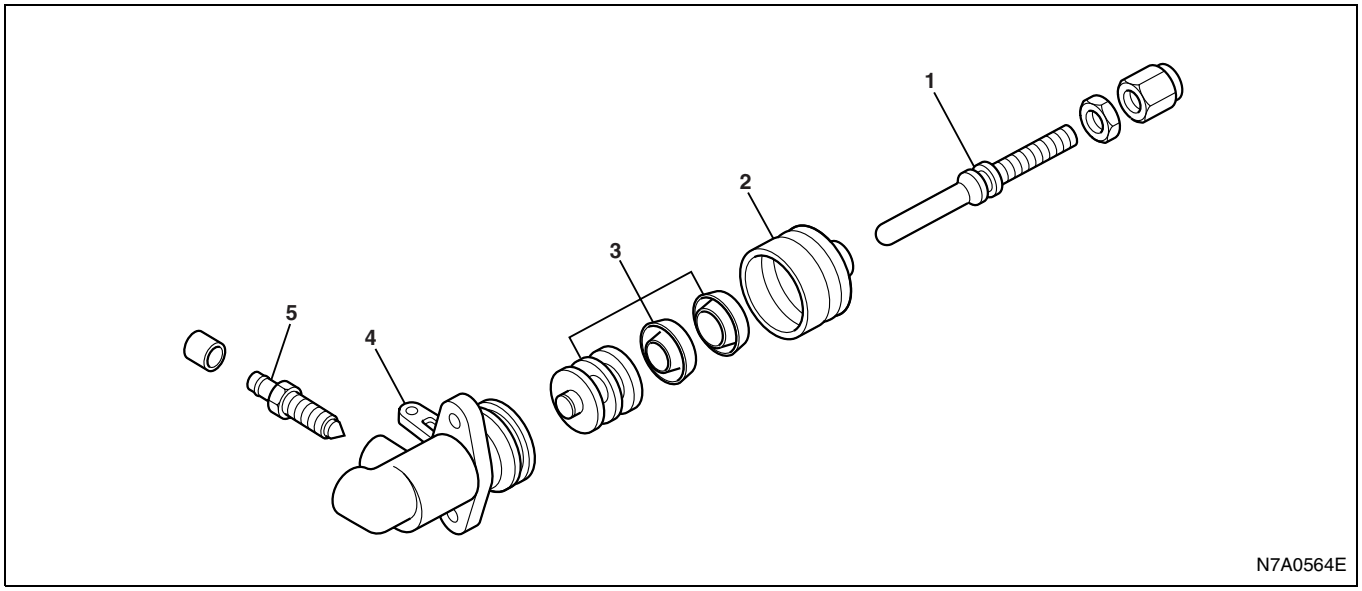
Slave Cylinder

Slave Cylinder Assembly



Legend

1. Push rod
2. Boot
3. Piston assembly
4. Slave cylinder body
5. Bleeder screw and cap

Disassembly

1. Push rod (1).
2. Boot (2).
3. Piston assembly (3).
4. Slave cylinder body (4).
5. Bleeder screw and cap (5).

Clean

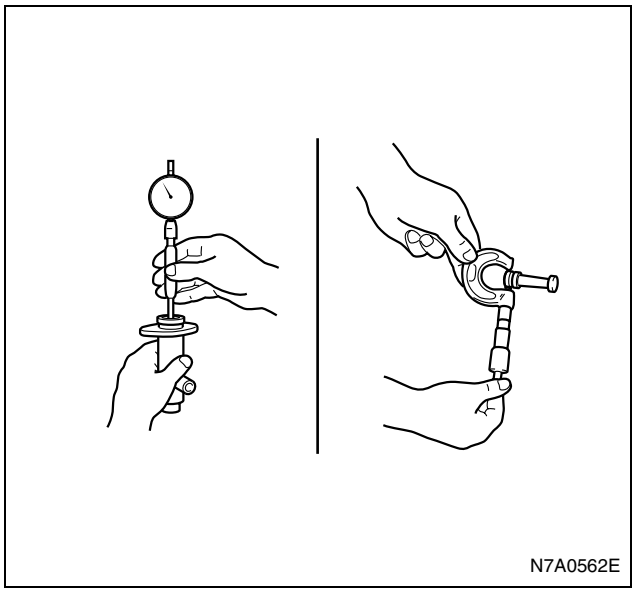
- All disassembled parts in brake fluid. Be sure to wipe excess brake fluid from the components.

Inspect

- Cylinder bore and piston for wear and rust formation.
- Spring for weakening.
- Piston cups for wear, deterioration and scratches.
- Replace any parts if wear, damage, or any other abnormal conditions are found during inspection.

Measure

- The clearance inside the slave cylinder body with a dial indicator. Use a micrometer to check the thickness of the piston. Replace the slave cylinder body or piston if the clearance is less than 0.11 mm (0.0043 in).



Reassembly

1. Slave cylinder body (4).

Notice:
See “Notice” on page 7C-2 of this section.

2. Bleeder screw and cap (5).

Tighten:
Bleeder screw to 8 N·m (0.8 kg·m / 69 lb·in).

Important:

- Before installing the parts, apply a thin coat of brake fluid.

- Be sure to install the piston cup in the piston groove with the lip turned toward the front of the cylinder body. Use care so as not to scratch the lip portion of the piston cup.

3. Piston assembly (3).
4. Boot (2).
5. Push rod (1).

SPECIFICATIONS

Specifications

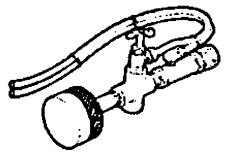
Pressure Plate Types	Dry Single Plate w/Cushioning Spring
Clearance Between Master Cylinder Body and Piston	0.12 mm (0.0047 in)
Clearance Between Slave Cylinder Body and Piston	0.11 mm (0.0043 in)
Driven Plate Warpage Maximum Limit	0.6 mm (0.024 in)
Clutch Size	325 mm (12.80 in)
Depression of Rivet Head Maximum Limit	0.2 mm (0.008 in)
Pressure Plate Clamping Force Maximum Limit	970 kg (2,139 lb)
Pressure Plate Finger Height	61.8 — 63.8 mm (2.43 — 2.51 in)
Master Cylinder Push Rod Length (From Center of Crevis Pin Hole to Mounting Surface)	156.5 — 157.5 mm (6.16 — 6.20 in)
Pedal Height (Reference)	160 — 170 mm (6.3 — 6.7 in)
Pedal Travel (Reference)	159 — 169 mm (6.2 — 6.7 in)
Free Play (Reference)	15 — 25 mm (0.6 — 1.0 in)
Clutch Switch Clearance	0.5 — 1.0 mm (0.020 — 0.039 in)

Fixing Torque

Master Cylinder Push Rod Jam Nut	17 N·m (1.7 kg·m / 148 lb·in)
Clutch Switch Jam Nut	15 N·m (1.5 kg·m / 133 lb·in)
Pressure Plate Bolts	40 N·m (4.1 kg·m / 30 lb·ft)
Master Cylinder Bolts	13 N·m (1.3 kg·m / 113 lb·in)
Slave Cylinder Bolts	19 N·m (1.9 kg·m / 14 lb·ft)
Flexible Hose Tube Nuts	20 N·m (2 kg·m / 14 lb·ft)
Slave Cylinder Bleeder Screw	8 N·m (0.8 kg·m / 69 lb·in)
Clutch Pedal and Bracket Assembly Mounting Bolt	37 N·m (3.8 kg·m / 27 lb·ft)

SPECIAL TOOLS

Special Tools

Illustration	Tool Number / Description / Remarks
 J35854	J-35854 / Power Bleeder Adapter
5884027900	5-8840-2790-0 / Clutch Pilot Aligner

LGSMT-WE-0551

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LGSMT-WE-0551 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

TRANSMISSION/TRANSAXLE

SECTION 7

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

SECTION No.	CONTENTS
7A	TRANSMISSION CONTROL SYSTEM (Smoother)
7B	AUTOMATIC TRANSMISSION (Smoother)

TRANSMISSION/TRANSAXLE

Transmission Control System (Smoother)

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Specifications

Temperature vs Resistance

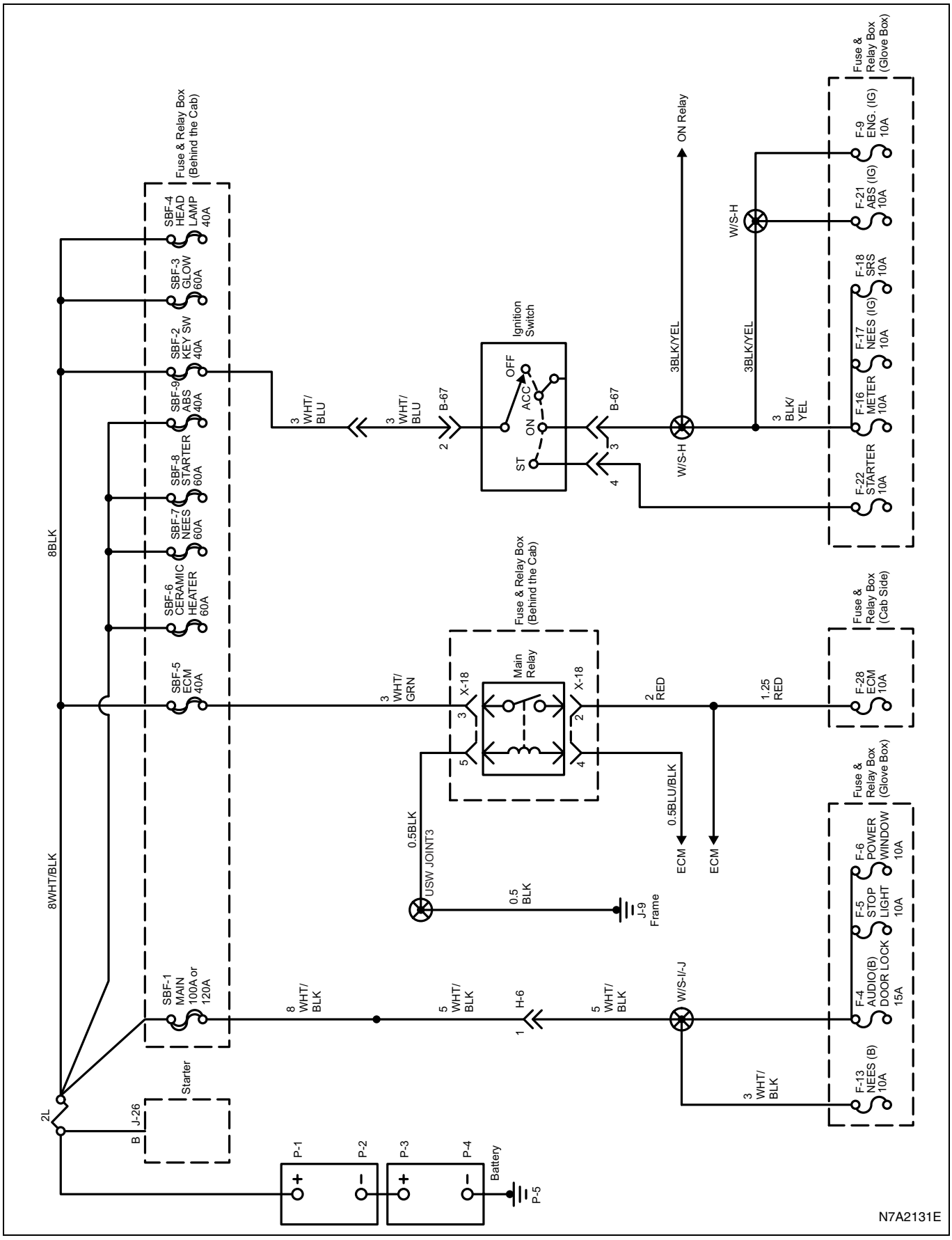
Transmission Fluid Temperature Sensor vs. Resistance

°C	°F	Ω
Temperature vs. Resistance Value (Approximately)		
150	302	60
140	284	80
130	266	90
120	248	120
110	230	150
100	212	190
90	194	250
80	176	320
70	158	430
60	140	590
50	122	820
40	104	1160
30	86	1680
20	68	2500
10	50	3820
0	32	6030
−10	14	9840
−20	−4	16700
−30	−22	29610

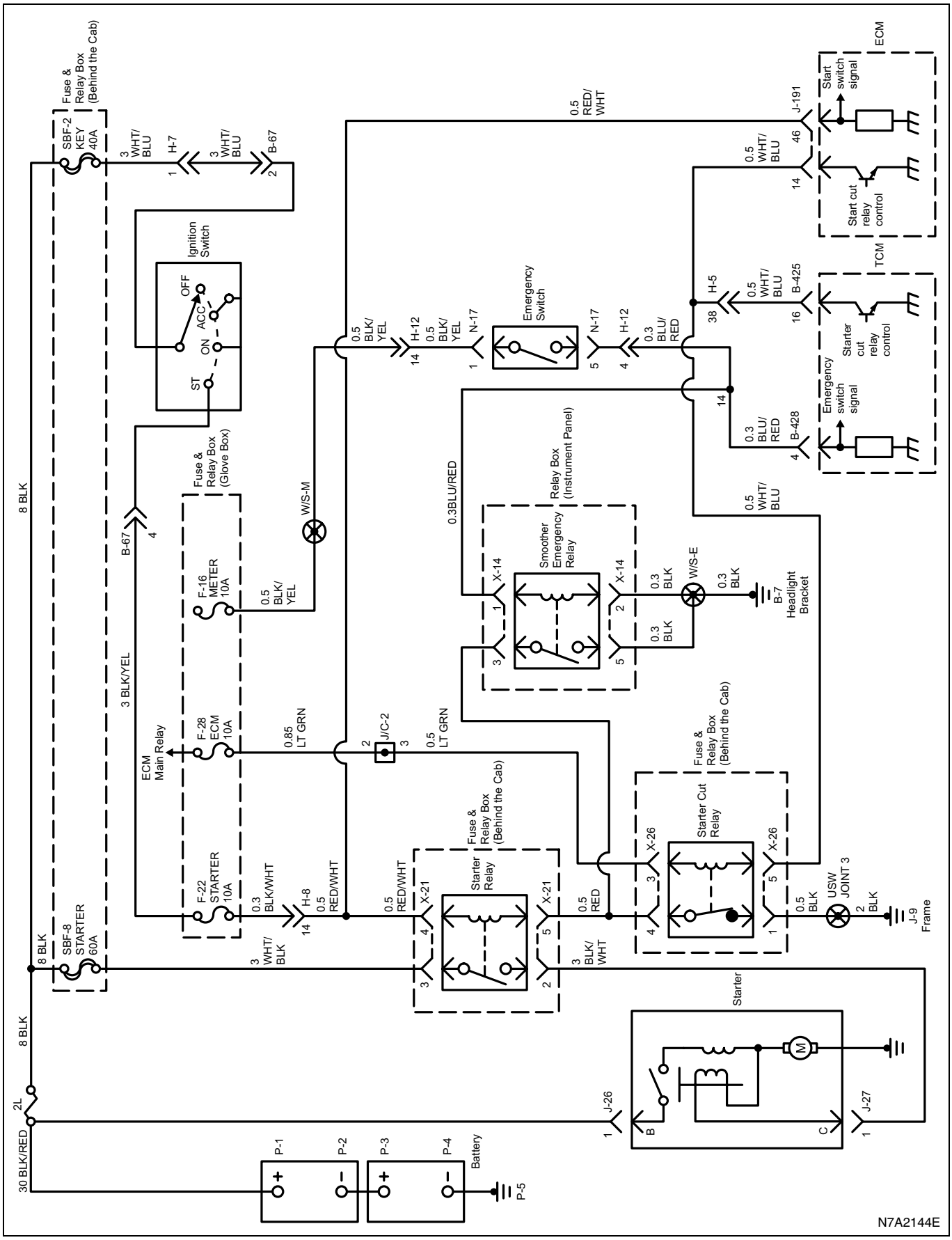
Schematic and Routing Diagrams

Transmission Controls Schematics

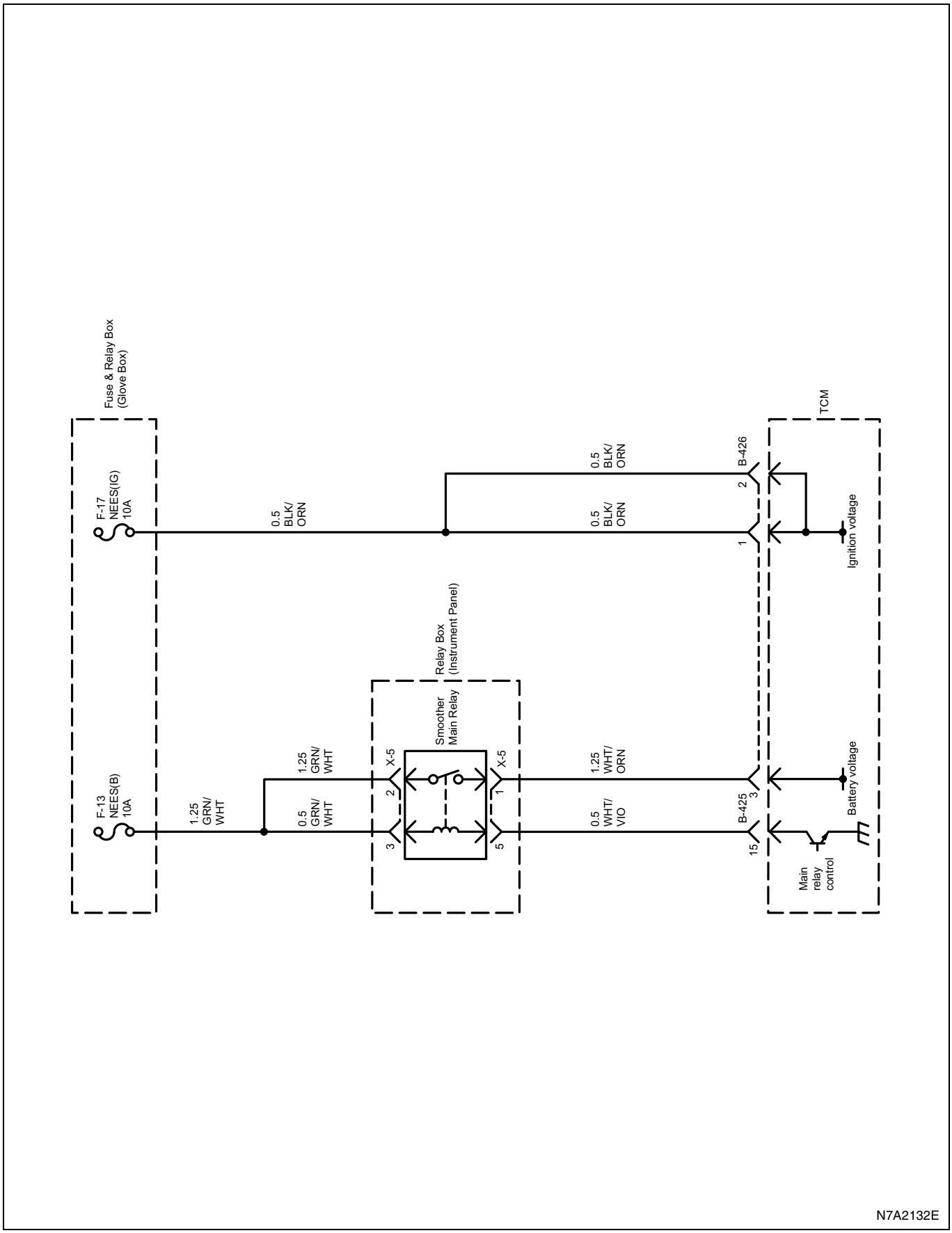
Power Distribution



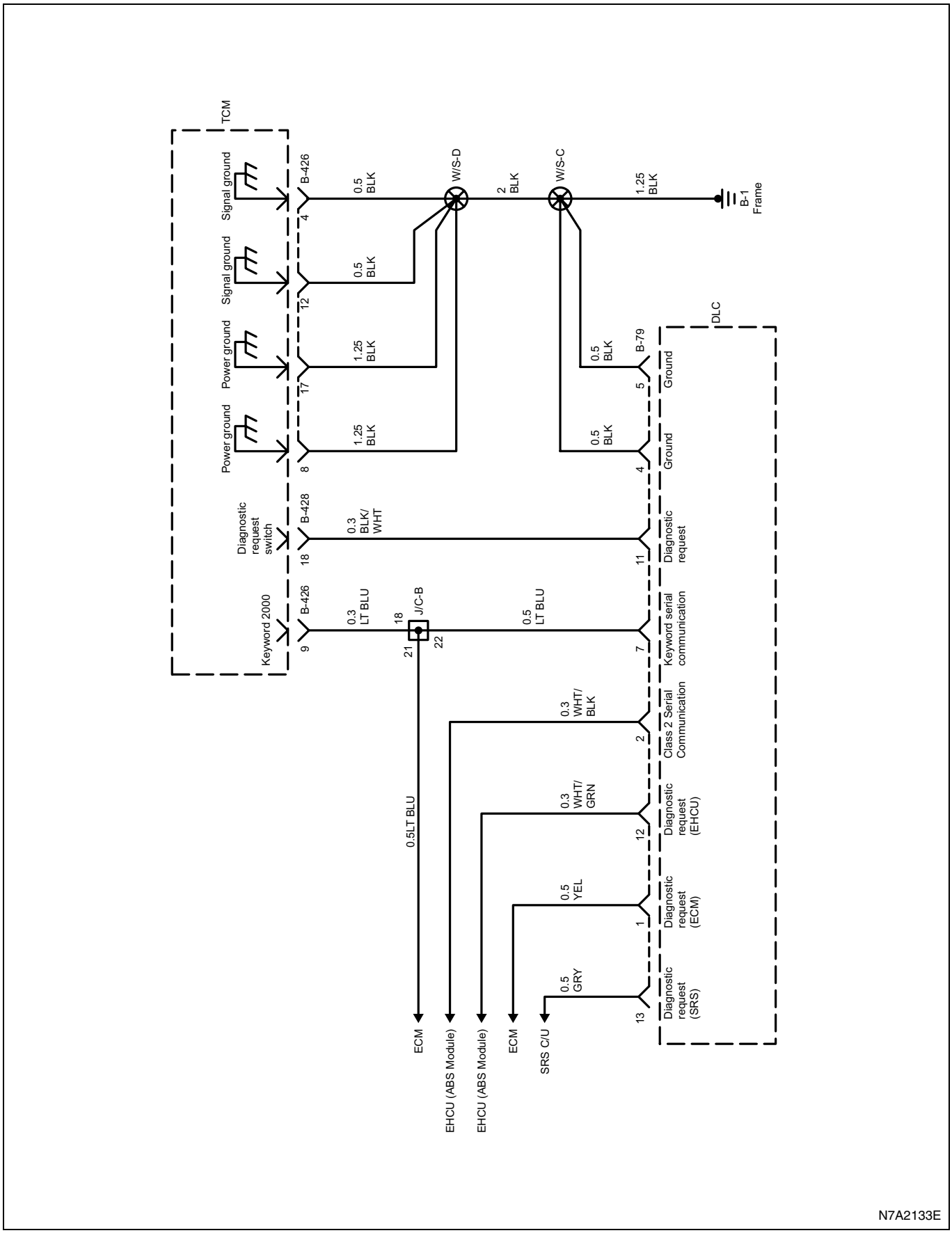
Starting System



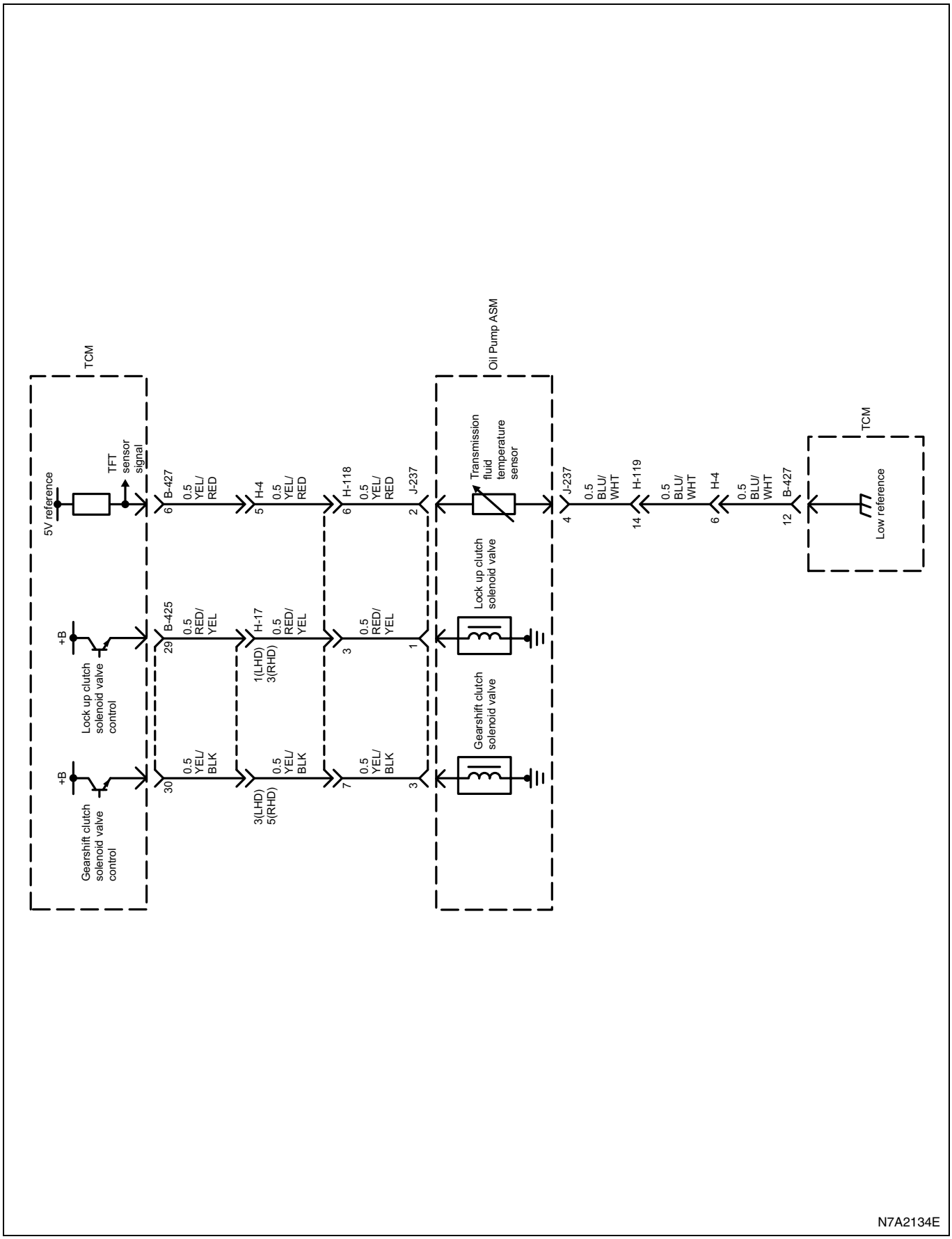
ECM and TCM Power



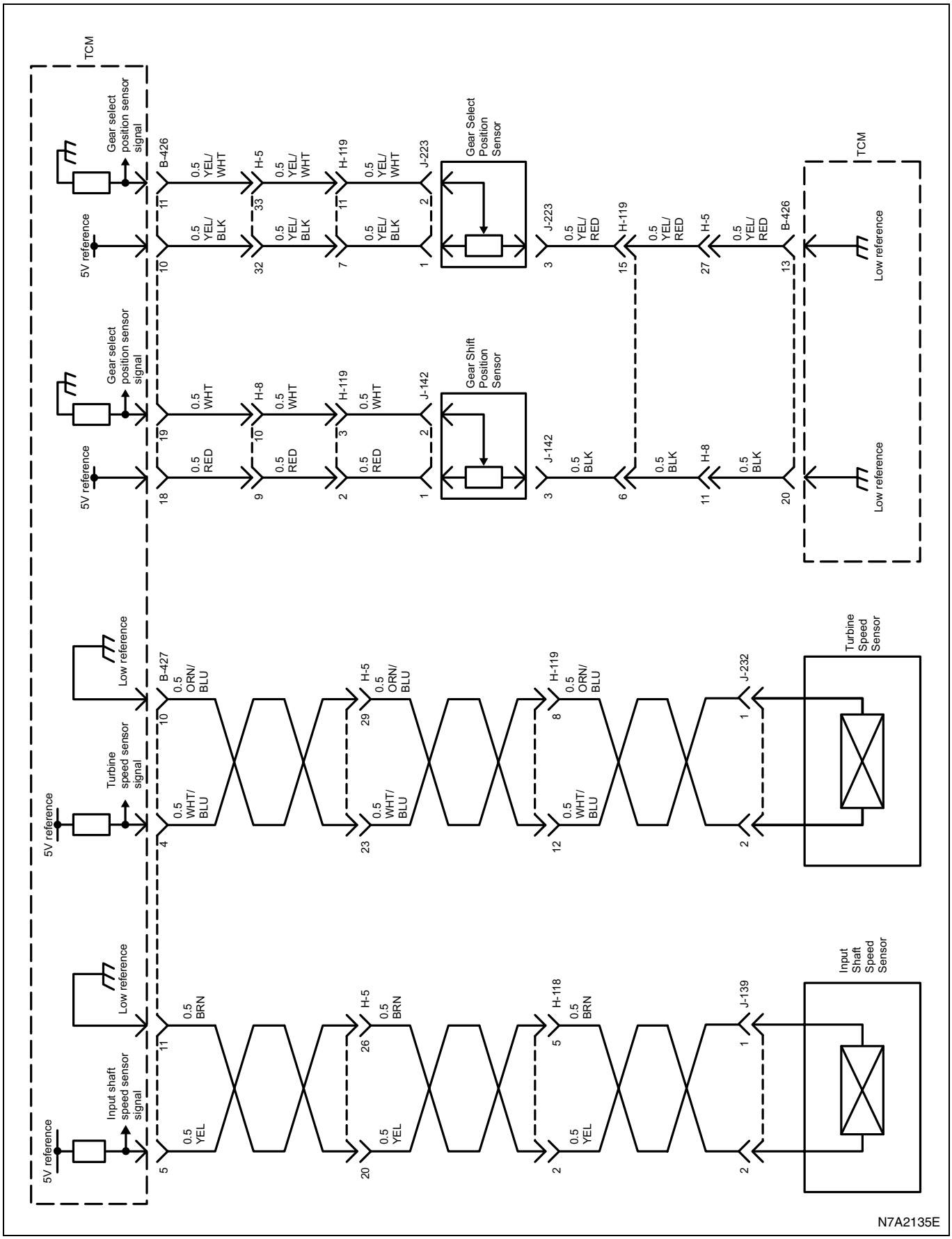
TCM Ground and DLC



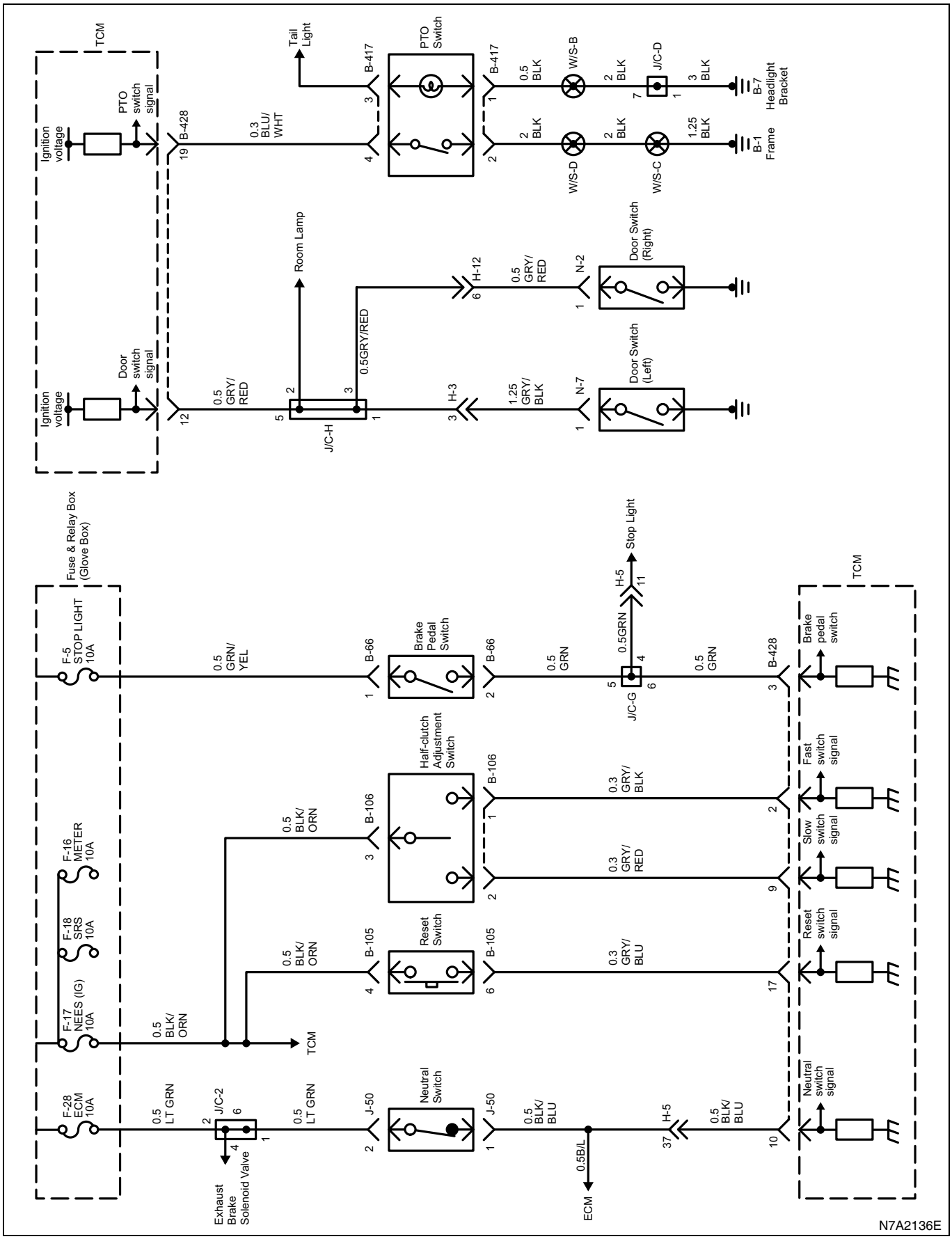
Clutch Control



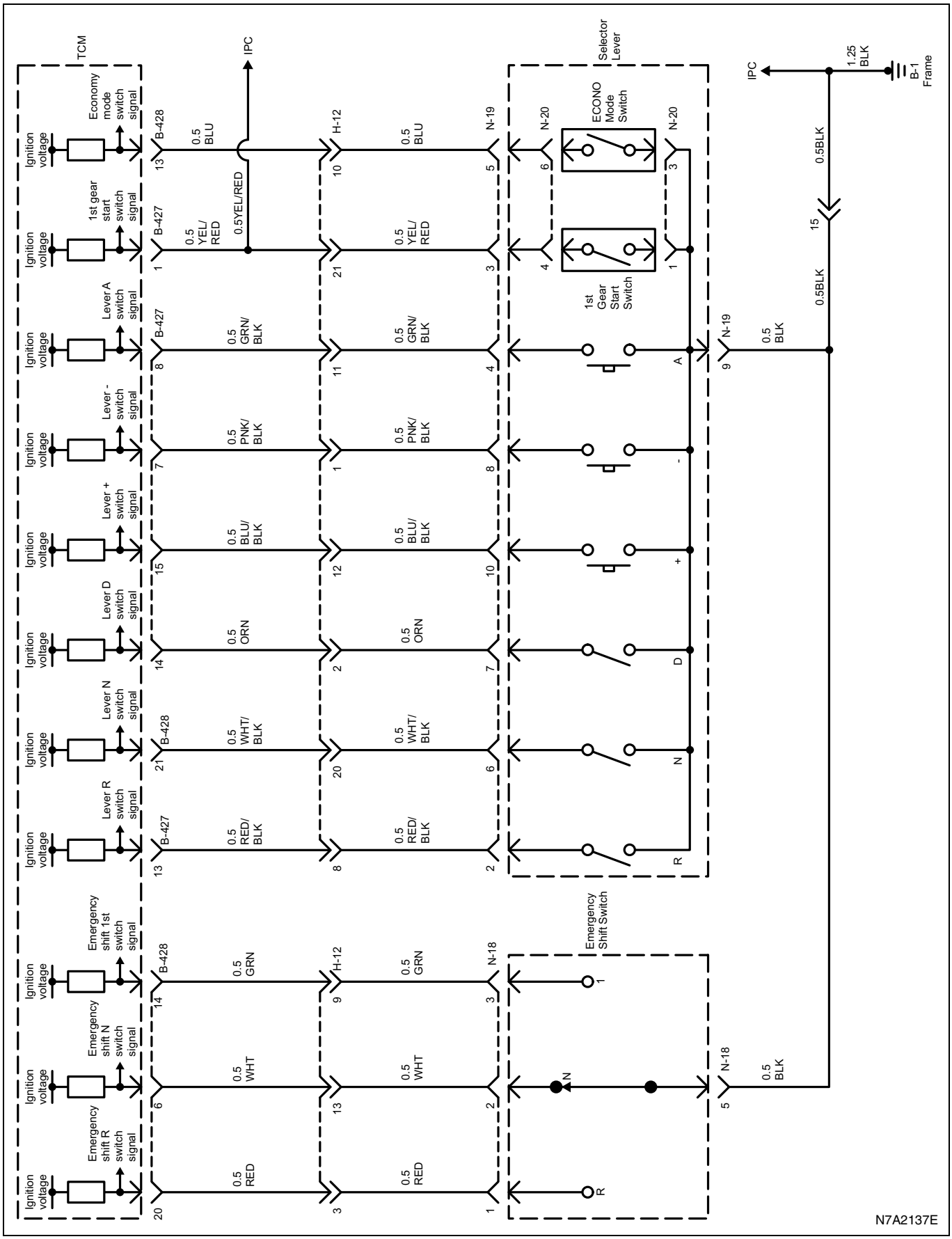
Input Shaft Speed Sensor, Turbine Sensor, Gearshift Position Sensor and Gear Select Position Sensor



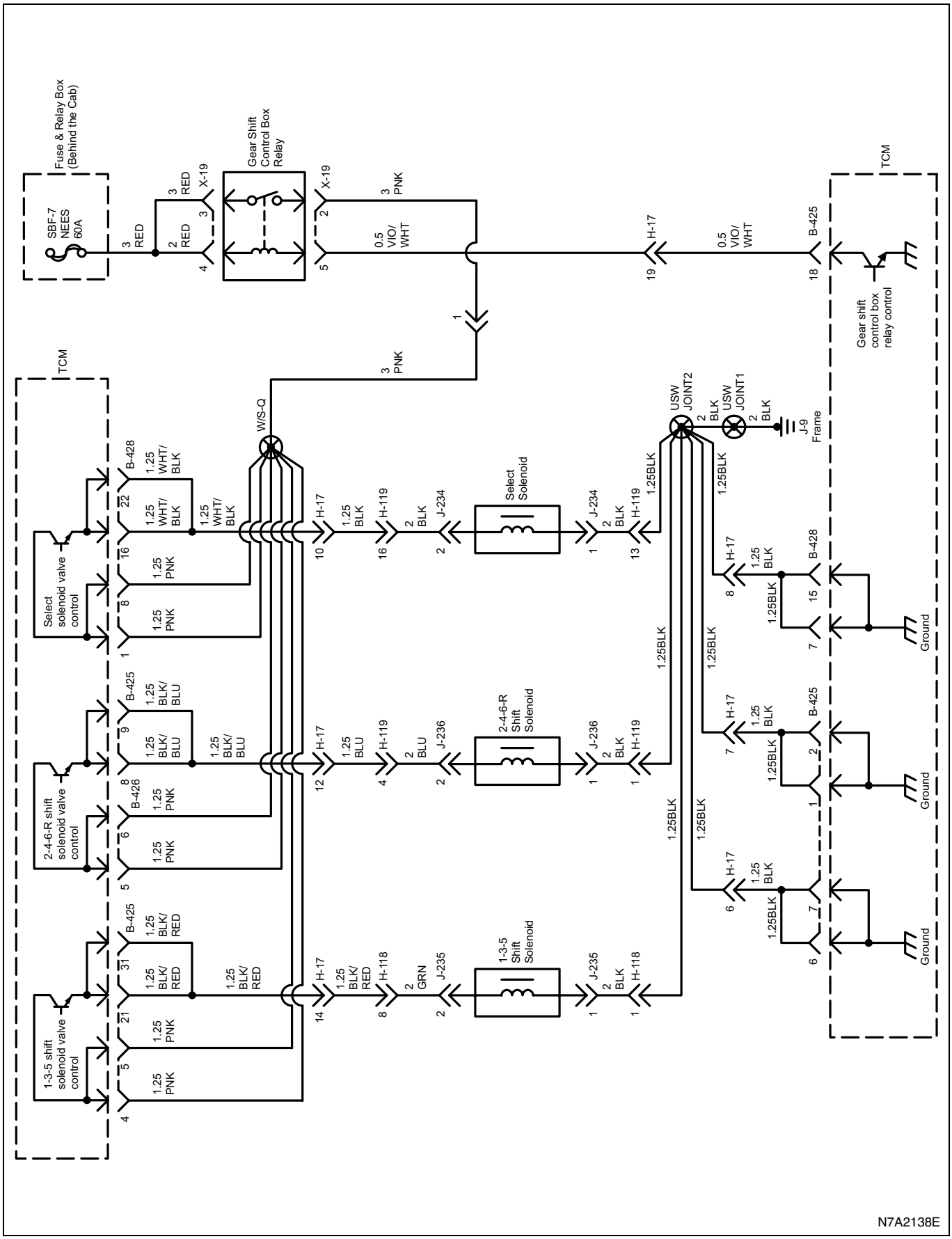
Neutral Switch, Reset Switch, Half-clutch adjustment Switch, Brake Pedal Switch, Door Switch, PTO Switch



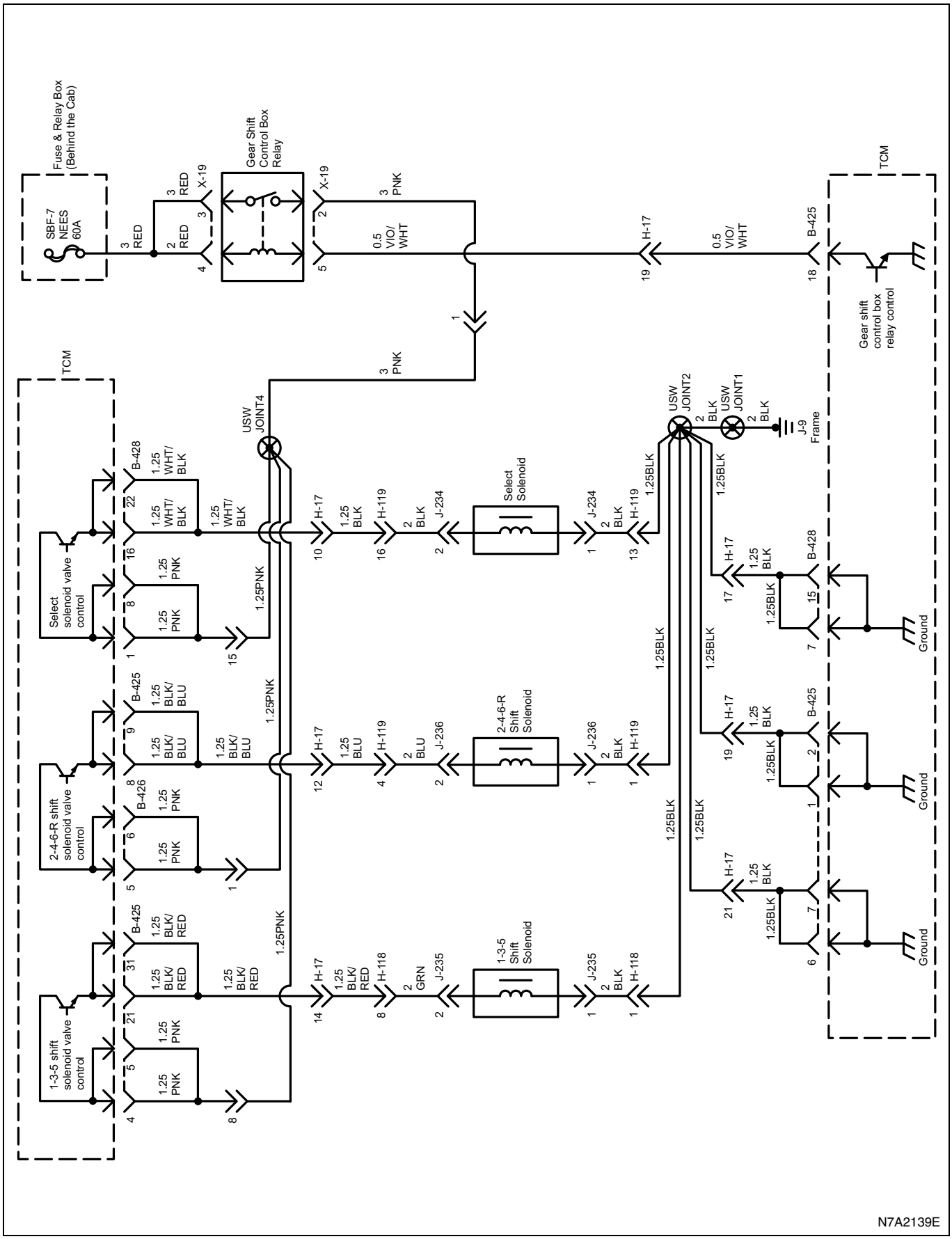
Change Lever Switch



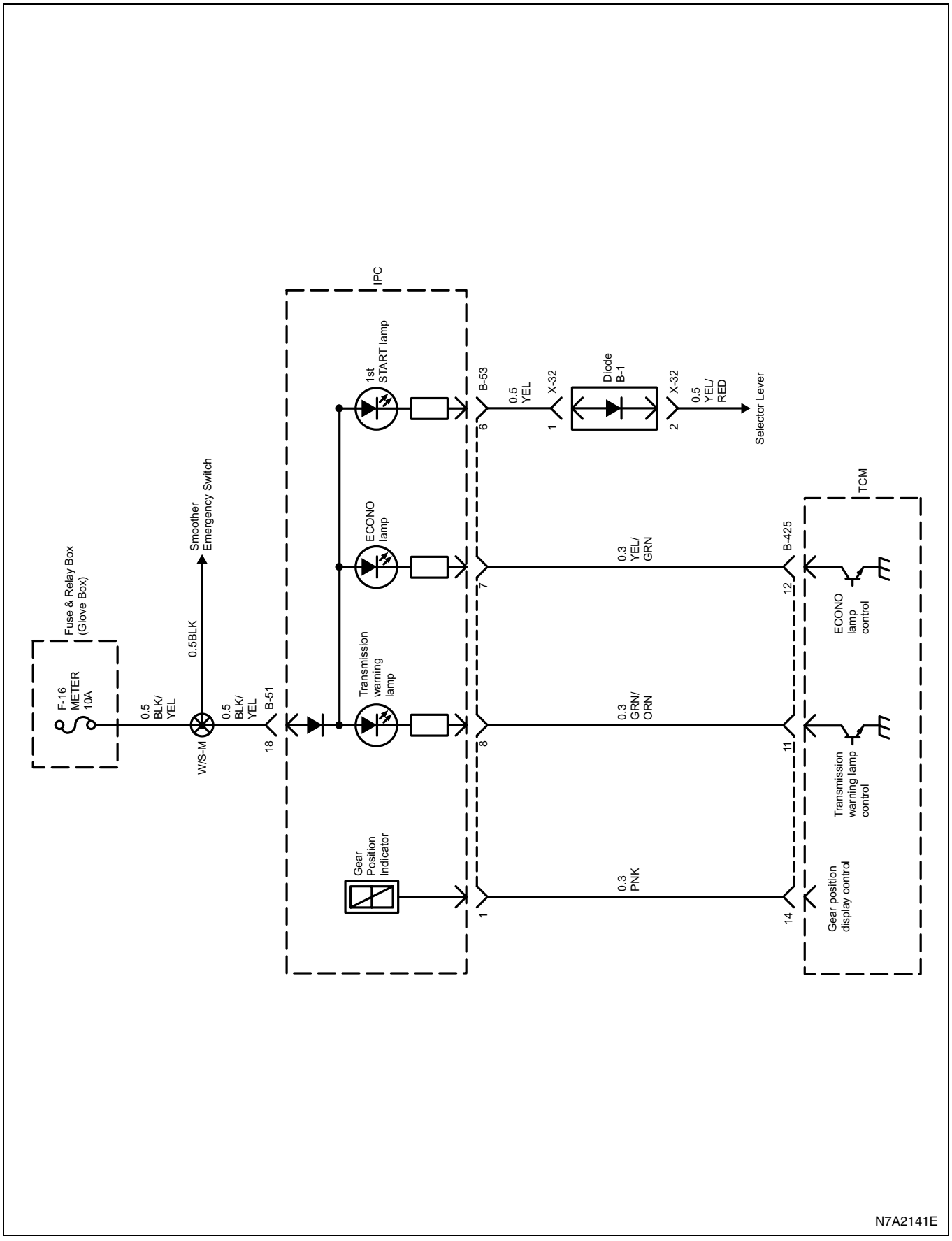
Shift System (LHD)



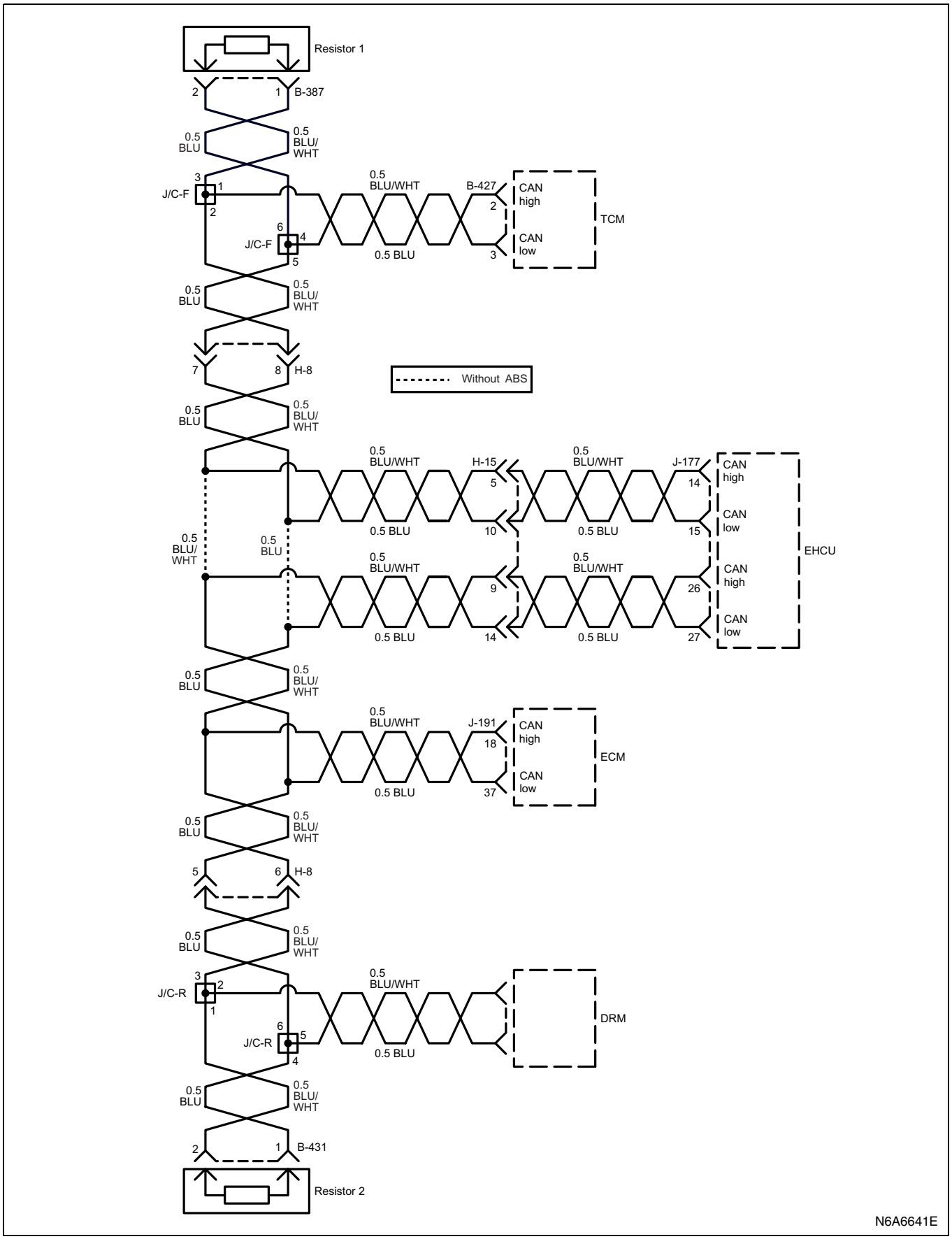
Shift System (RHD)



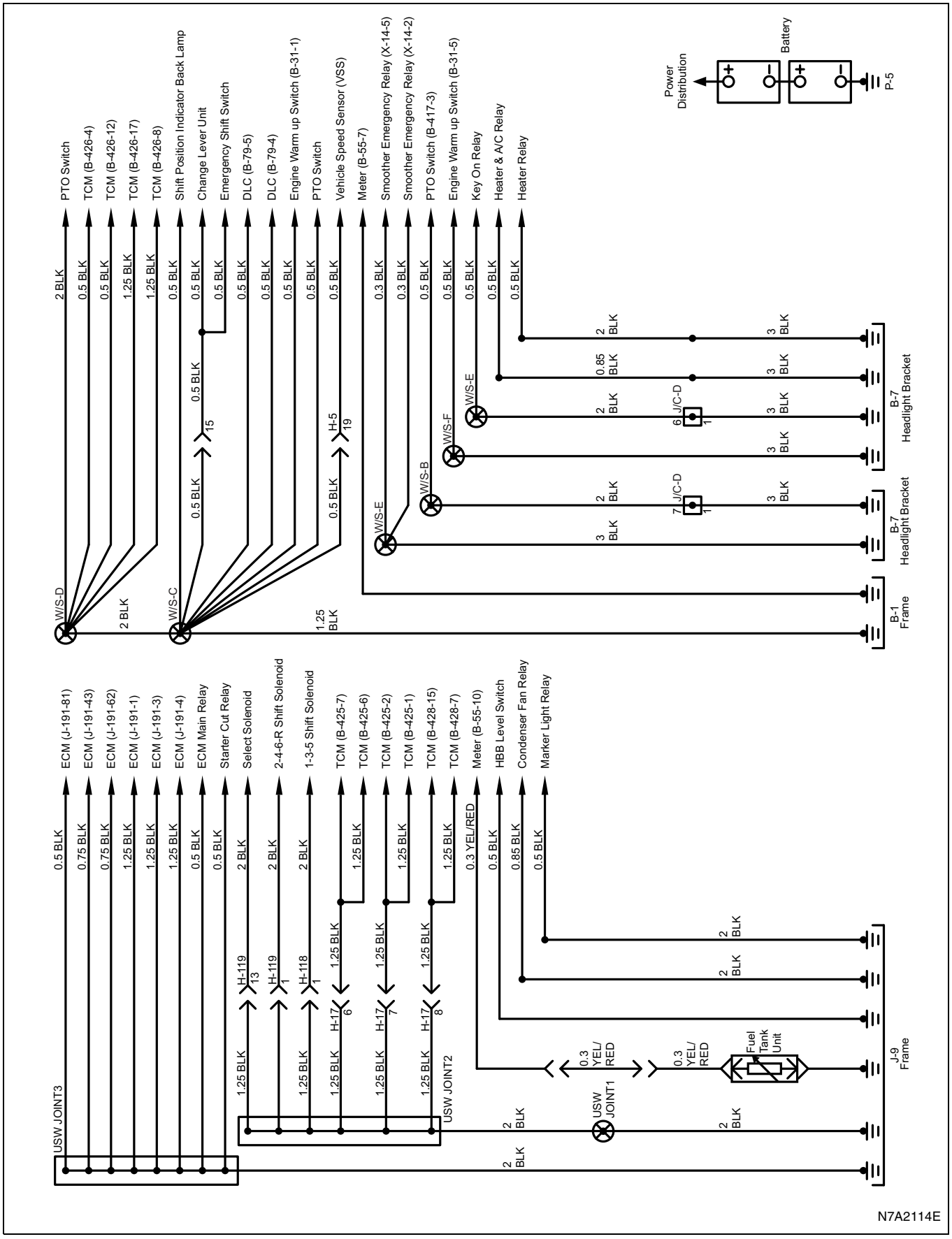
Indicator Lamp



Can System


Resistor 1
B-387
0.5 BLU
0.5 BLU/WHT
J/C-F
0.5 BLU/WHT
B-427
CAN high
CAN low
TCM
0.5 BLU
H-8
Without ABS
H-15
J-177
EHCU
J-191
ECM
J/C-R
DRM
B-431
Resistor 2
N6A6641E

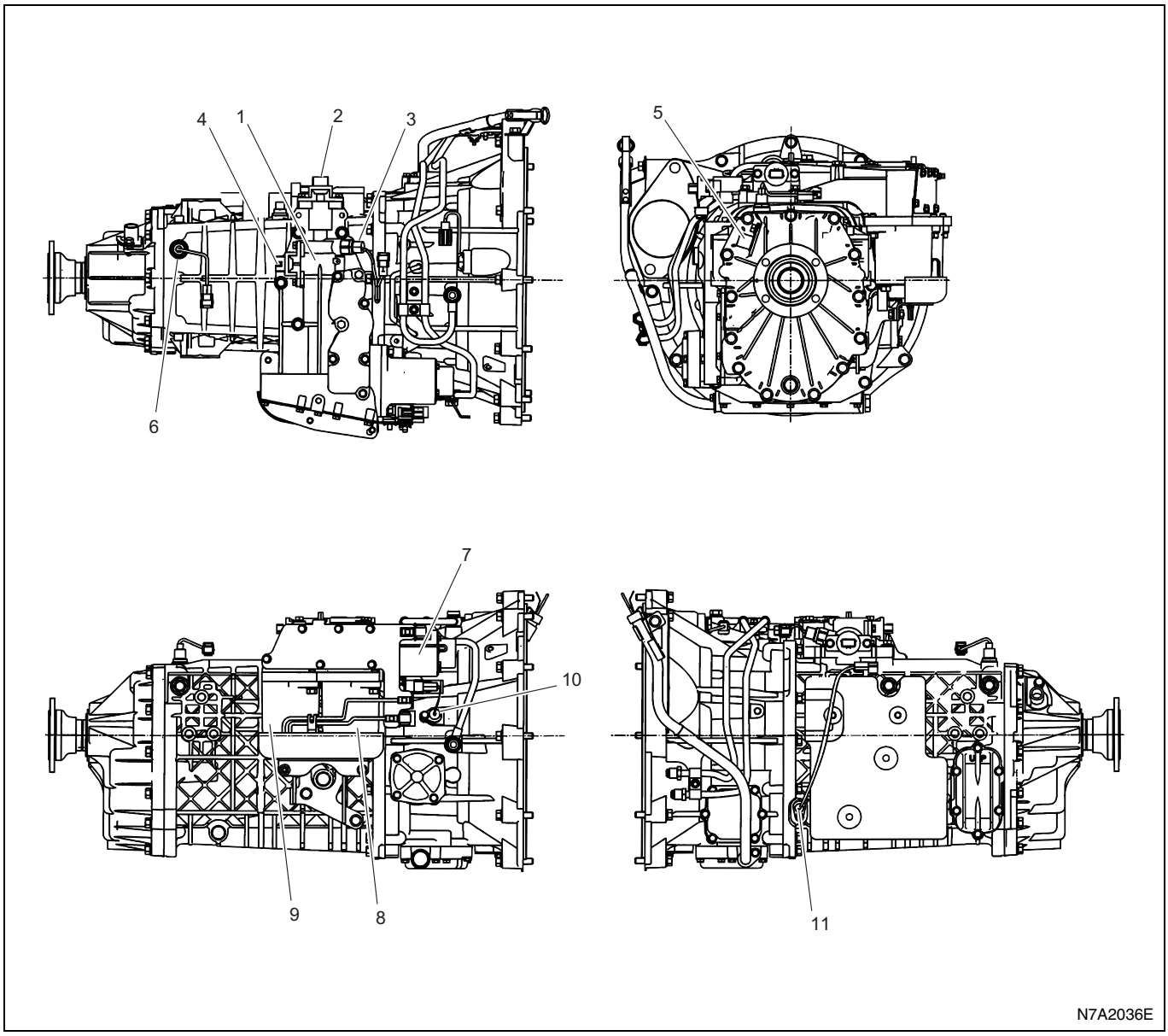
Ground Distributions



Component Locator

Transmission Controls Component Views

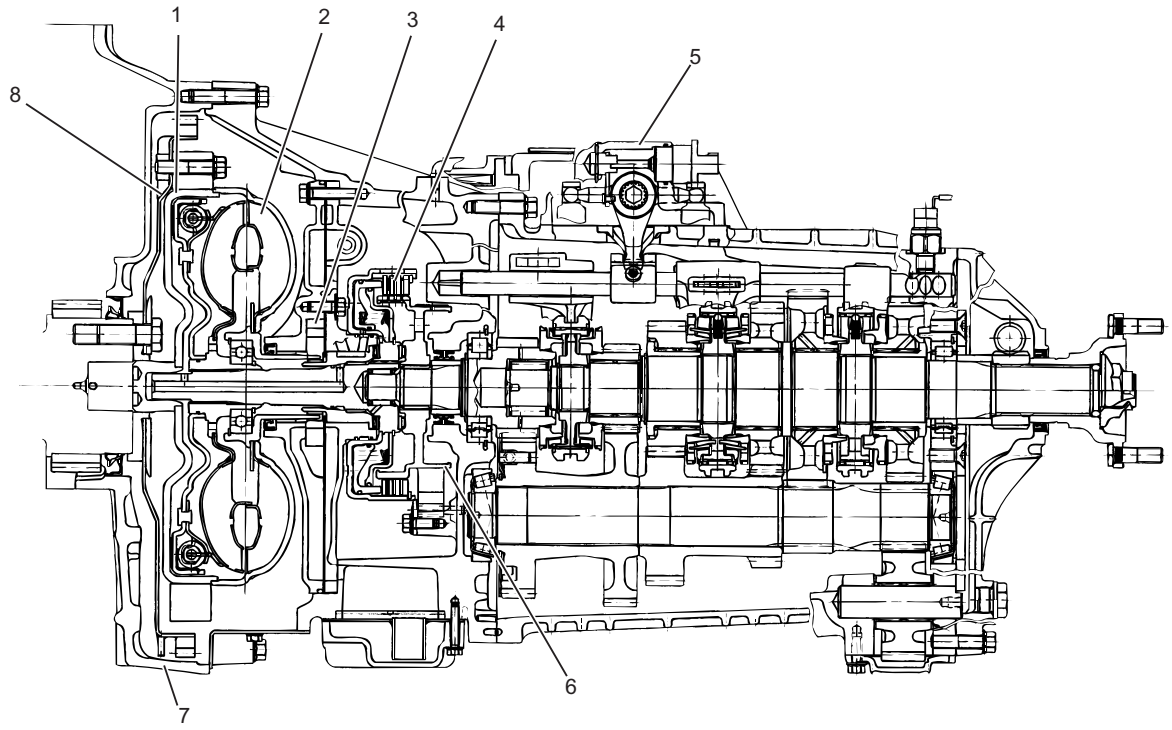
Transmission



Legend

1. Gearshift Control Box
2. Gear Shift Position Sensor
3. Neutral Switch
4. Gear Select Position Sensor
5. Vehicle Speed Sensor
6. Reverse Switch
7. Select Solenoid Valve
8. 1-3-5 Shift Solenoid Valve
9. 2-4-6-R Shift Solenoid Valve
10. Turbine Speed Sensor
11. Input Shaft Speed Sensor

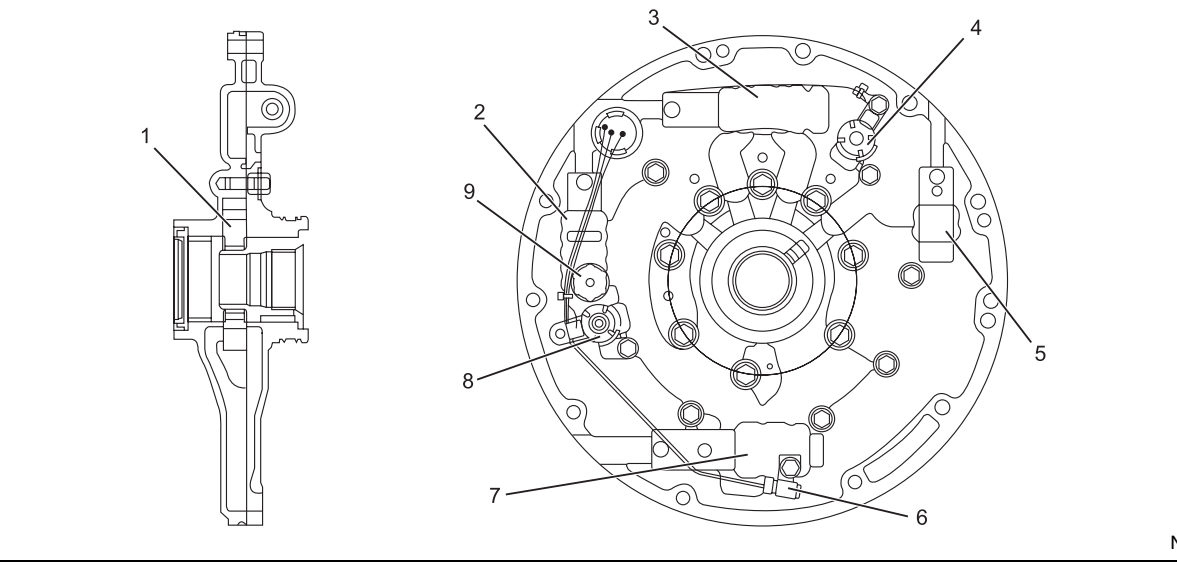
Cross Section



Legend

1. Lock Up Clutch
2. Fluid Coupling
3. Oil Pump
4. Gearshift Clutch
5. Gearshift Control Box
6. Brake Band
7. Flywheel Housing
8. Flexible Plate

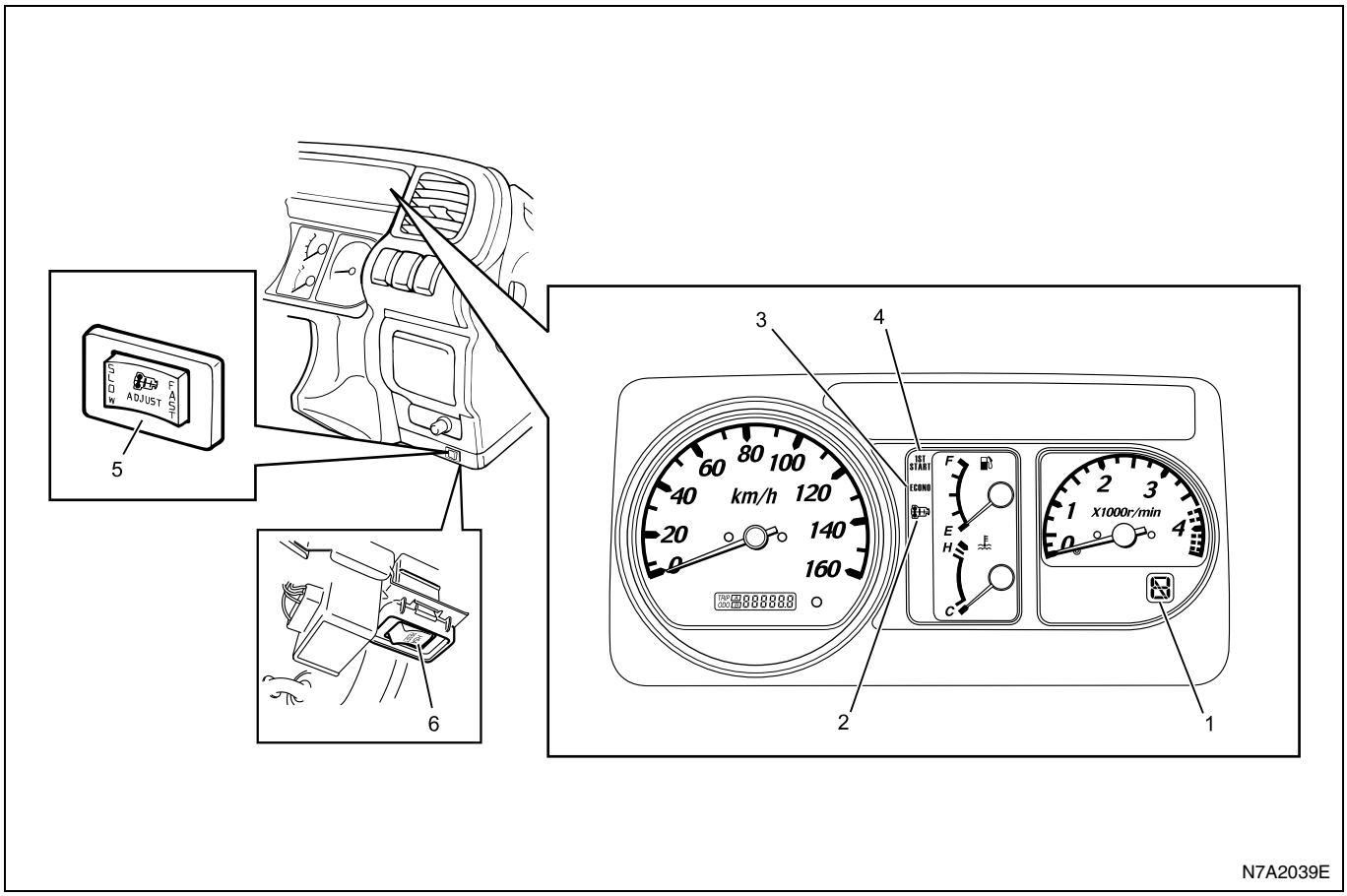
Oil Pump Assembly



Legend

1. Oil Pump
2. Gearshift Clutch Spool Valve
3. Lockup Clutch Spool Valve
4. Lock Up Clutch Solenoid Valve
5. Bypass Valve
6. Transmission Fluid Temperature (TFT) Sensor
7. Relief Valve
8. Gearshift Clutch Solenoid Valve
9. Accumulator

Cab

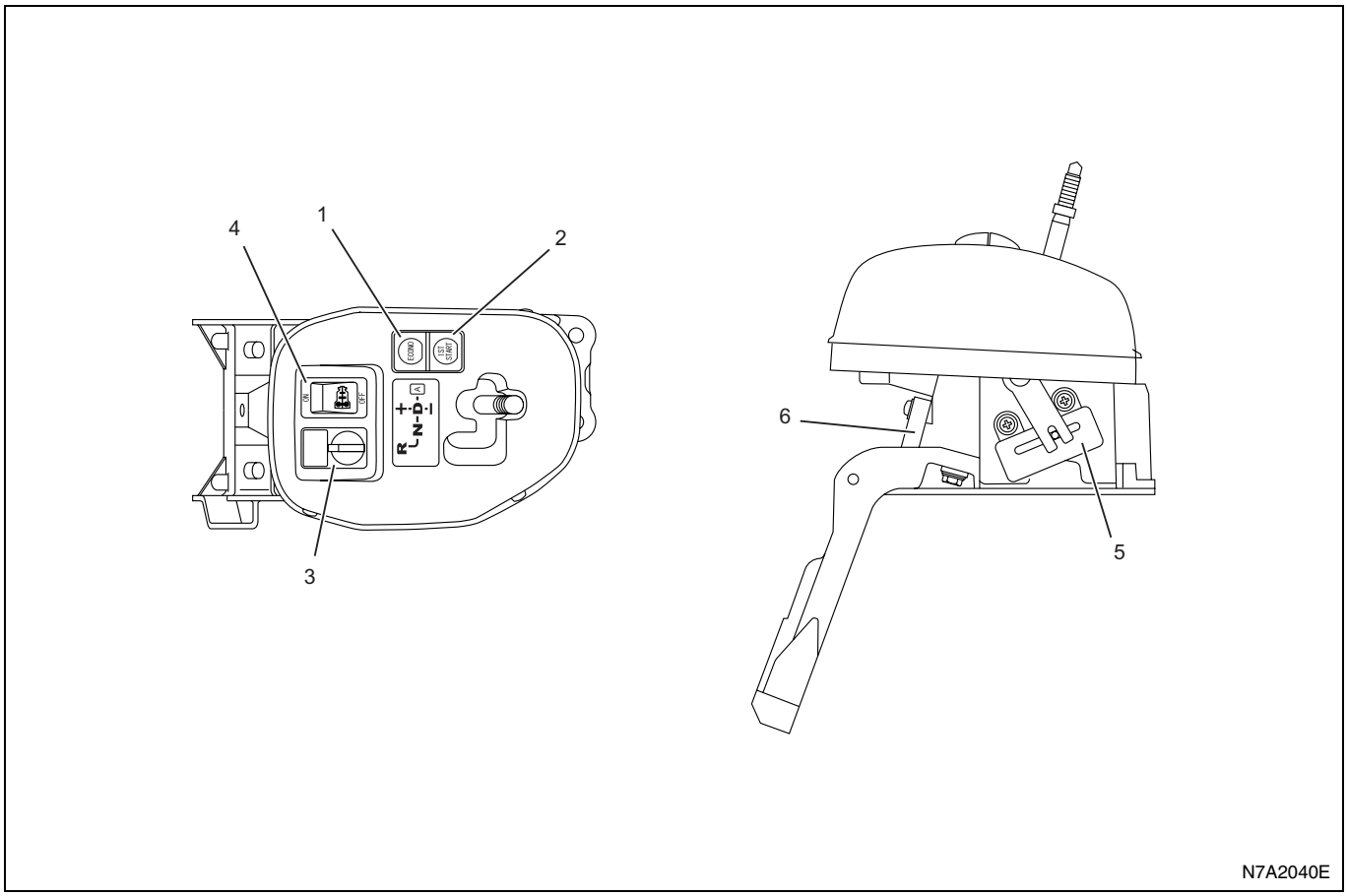


N7A2039E

Legend

1. Gear Position Indicator
2. Transmission Warning Lamp
3. Economy Mode Indicator Lamp
4. 1st Gear Start Indicator Lamp
5. Half-Clutch Adjustment Switch
6. Reset Switch

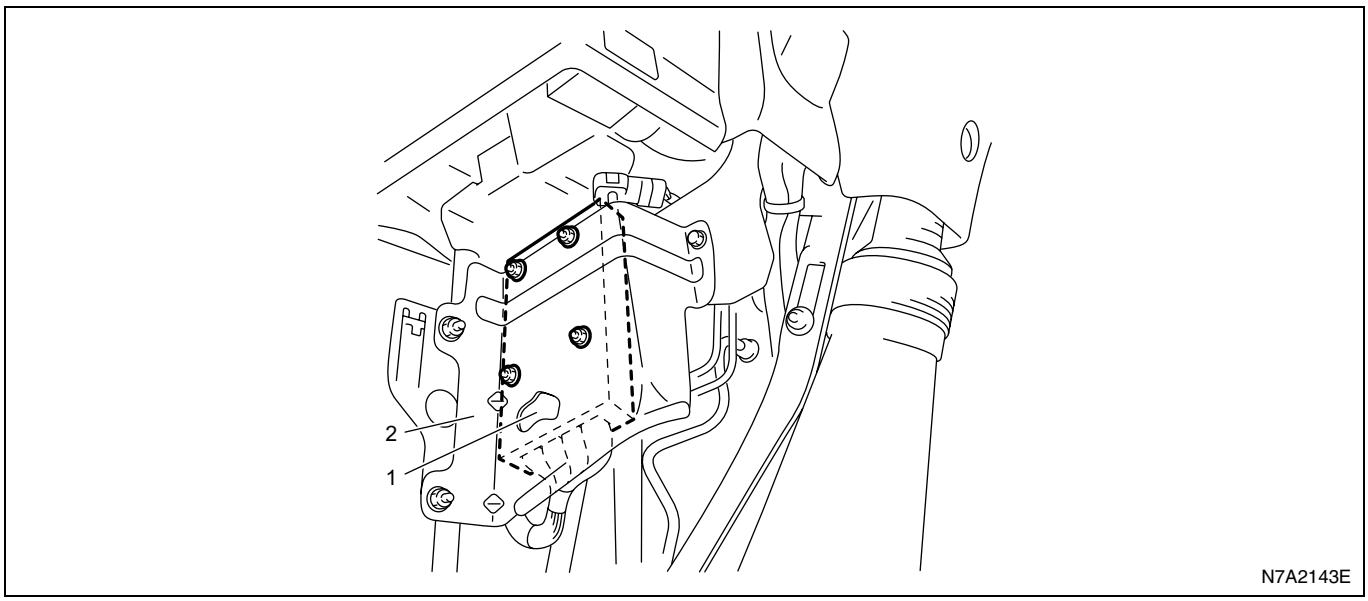
Selector Lever



Legend

1. Economy Mode Switch
2. 1st Gear Start Switch
3. Emergency Shift Switch
4. Emergency Switch
5. Selector Lever Switch (Shift Side)
6. Selector Lever Switch (Select Side)

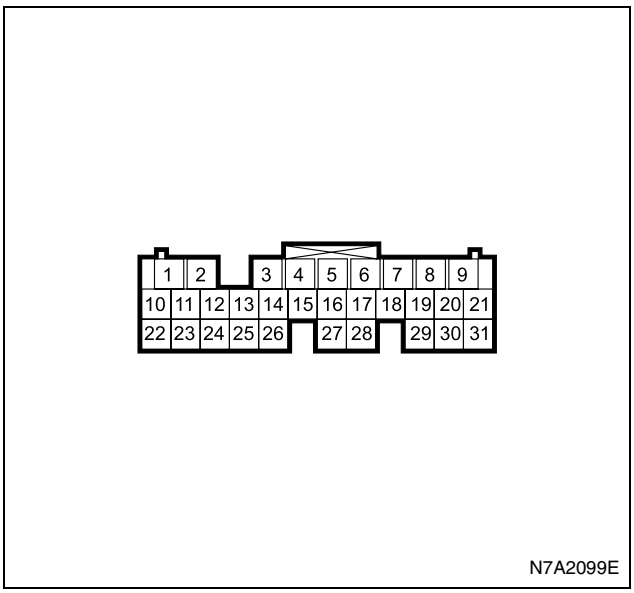
Transmission Control Module (TCM)



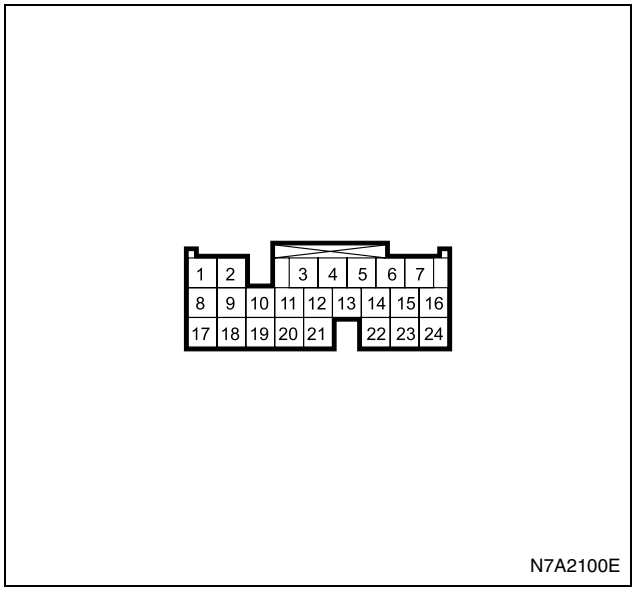
Legend

1. Transmission Control Module (TCM)
2. TCM Cover

Transmission Control Module (TCM) Connector End Views

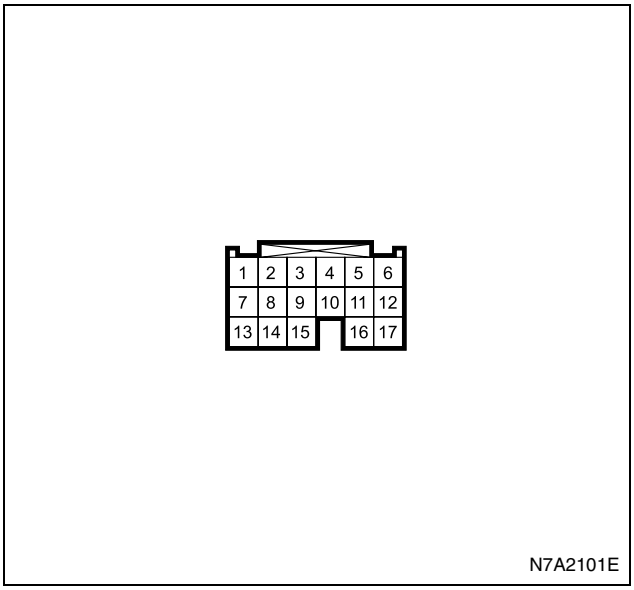


Connector No.		B-425
Connector Color		White
Test Adapter No.		J-35616-64A
Pin	Wire Color	Pin Function
1	BLK	2-4-6-R Shift Solenoid Valve Ground
2	BLK	2-4-6-R Shift Solenoid Valve Ground
3	—	Not Used
4	PNK	1-3-5 Shift Solenoid Valve Voltage Feed
5	PNK	1-3-5 Shift Solenoid Valve Voltage Feed
6	BLK	1-3-5 Shift Solenoid Valve Ground
7	BLK	1-3-5 Shift Solenoid Valve Ground
8	BLK/BLU	2-4-6-R Shift Solenoid Valve Control
9	BLK/BLU	2-4-6-R Shift Solenoid Valve Control
10	—	Not Used
11	GRN/ORN	Transmission Warning Lamp Control
12	YEL/GRN	Economy Mode Lamp Control
13	—	Not Used
14	PNK	Gear Position Display Control
15	WHT/VIO	Main Relay Control
16	WHT/BLU	Starter Cut Relay Control
17	—	Not Used
18	VIO/WHT	Gearshift Control Box Relay Control
19	—	Not Used
20	—	Not Used
21	BLK/RED	1-3-5 Shift Solenoid Valve Control
22	—	Not Used
23	—	Not Used
24	—	Not Used
25	—	Not Used
26	—	Not Used
27	—	Not Used
28	—	Not Used
29	RED/YEL	Lock Up Clutch Solenoid Valve Control
30	YEL/BLK	Gearshift Clutch Solenoid Valve Control
31	BLK/RED	1-3-5 Shift Solenoid Valve Control



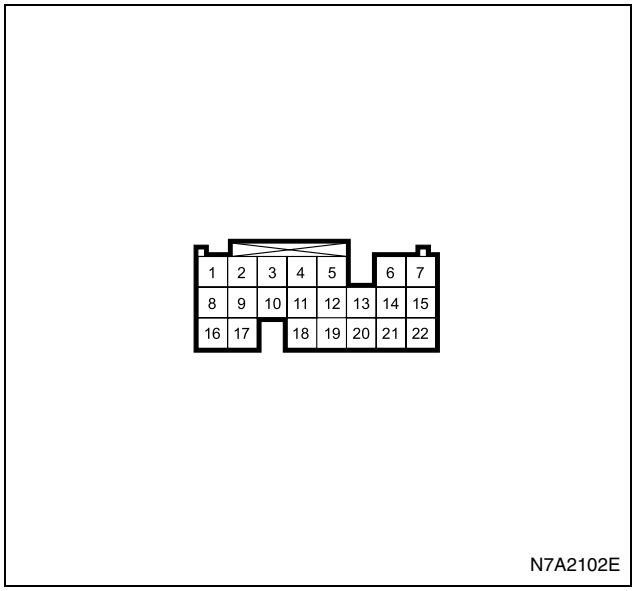
Connector No.		B-426
Connector Color		White
Test Adapter No.		J-35616-64A
Pin	Wire Color	Pin Function
1	BLK/ORN	Ignition Voltage Feed
2	BLK/ORN	Ignition Voltage Feed
3	WHT/ORN	Main Relay Voltage
4	BLK	TCM Signal Ground
5	PNK	2-4-6-R Shift Solenoid Valve Voltage Feed
6	PNK	2-4-6-R Shift Solenoid Valve Voltage Feed
7	—	Not Used
8	BLK	TCM Power Ground
9	LT BLU	Keyword 2000 Serial Data
10	YEL/BLK	Gear Select Position Sensor 5 Volts Reference
11	YEL/WHT	Gear Select Position Sensor Signal

12	BLK	TCM Signal Ground
13	YEL/RED	Gear Select Position Sensor Low Reference
14	—	Not Used
15	—	Not Used
16	—	Not Used
17	BLK	TCM Power Ground
18	RED	Gear Shift Position Sensor 5 Volts Reference
19	WHT	Gear Shift Position Sensor Signal
20	BLK	Gear Shift Position Sensor Low Reference
21	—	Not Used
22	—	Not Used
23	—	Not Used
24	—	Not Used



Connector No.		B-427
Connector Color		White
Test Adapter No.		J-35616-64A
Pin	Wire Color	Pin Function
1	YEL/RED	1st Gear Start Switch Input Signal
2	BLU/WHT	CAN High Signal
3	BLU	CAN Low Signal
4	WHT/BLU	Turbine Speed Sensor Signal
5	YEL	Input Shaft Speed Sensor Signal
6	YEL/RED	Transmission Fluid Temperature Sensor Signal
7	PNK/BLK	Selector Lever “–” Position Switch Input Signal
8	GRN/BLK	Selector Lever “A” Position Switch Input Signal

9	—	Not Used
10	ORN/BLU	Turbine Speed Sensor Low Reference
11	BRN	Input Shaft Speed Sensor Low Reference
12	BLU/WHT	Transmission Fluid Temperature Sensor Low Reference
13	RED/BLK	Selector Lever “R” Position Switch Input Signal
14	ORN	Selector Lever “D” Position Switch Input Signal
15	BLU/BLK	Selector Lever “+” Position Switch Input Signal
16	—	Not Used
17	—	Not Used

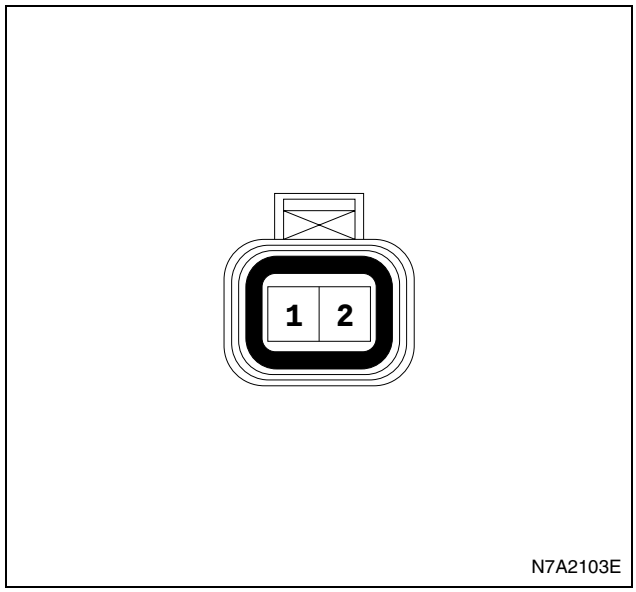


Connector No.		B-428
Connector Color		White
Test Adapter No.		J-35616-64A
Pin	Wire Color	Pin Function
1	PNK	Select Solenoid Valve Voltage Feed
2	GRY/BLK	Clutch Adjustment Fast Switch Input Signal
3	GRN	Brake Pedal Switch Input Signal
4	BLU/RED	Emergency Switch Input Signal
5	—	Not Used
6	WHT	Emergency Shift Switch “N” Position Input Signal
7	BLK	Select Solenoid Valve Ground
8	PNK	Select Solenoid Valve Voltage Feed
9	GRY/RED	Clutch Adjustment Slow Switch Input Signal
10	BLK/BLU	Neutral Switch Input Signal

11	—	Not Used
12	GRY/RED	Door Switch Input Signal
13	BLU	Economy Mode Switch Input Signal
14	BLU/WHT	Emergency Shift Switch “1” Position Input Signal
15	BLK	Select Solenoid Valve Ground
16	WHT/BLK	Select Solenoid Valve Control
17	GRY/BLU	Reset Switch Input Signal
18	BLK/WHT	Diagnostic Request Switch
19	BLU/WHT	PTO Switch Input Signal
20	RED	Emergency Shift Switch “R” Position Input Signal
21	WHT/BLK	Selector Lever “N” Position Switch Input Signal
22	WHT/BLK	Select Solenoid Valve Control

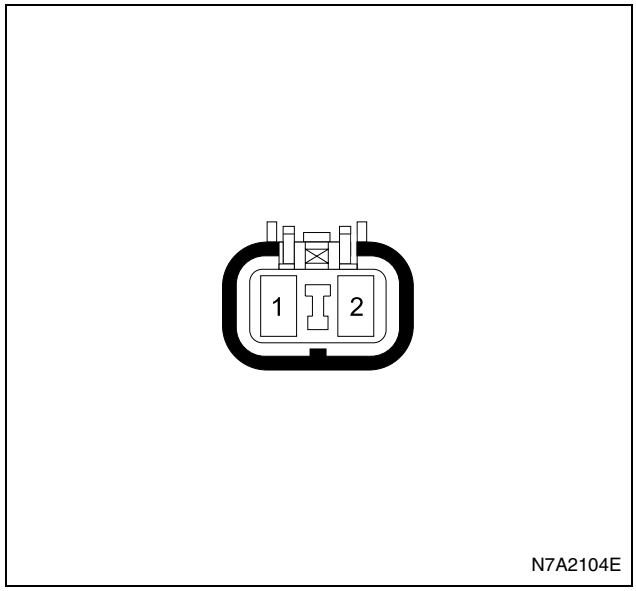
Transmission Controls Connector End Views

1-3-5 Shift Solenoid



Connector No.		J-235
Connector Color		Gray
Test Adapter No.		J-35616-42
Pin	Wire Color	Pin Function
1	BLK	1-3-5 Shift Solenoid Valve Ground
2	GRN	1-3-5 Shift Solenoid Valve Control

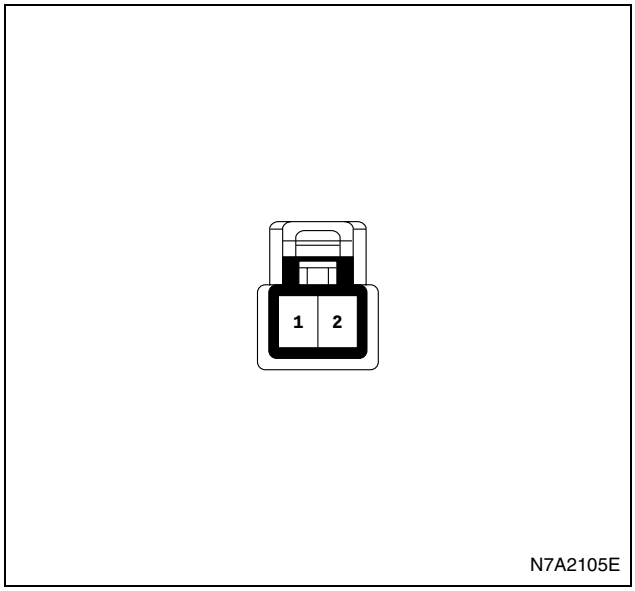
2-4-6-R Shift Solenoid



Connector No.	J-236
Connector Color	Black
Test Adapter No.	J-35616-42

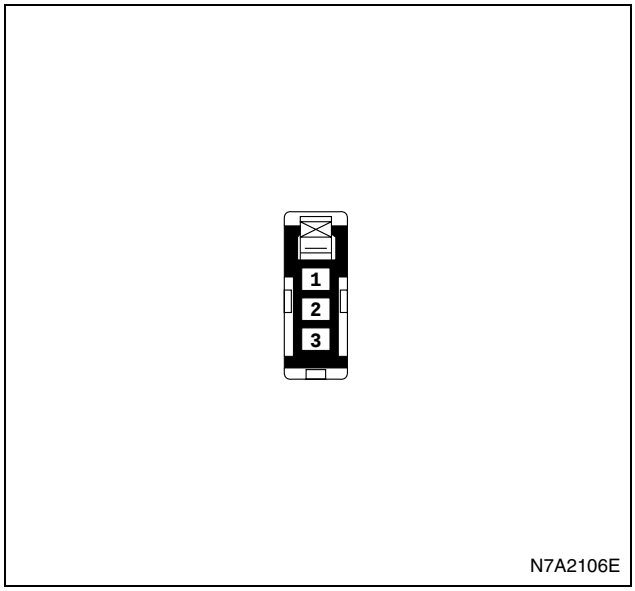
Pin	Wire Color	Pin Function
1	BLK	2-4-6-R Shift Solenoid Valve Ground
2	BLU	2-4-6-R Shift Solenoid Valve Control

Brake Pedal Switch



Connector No.		B-66
Connector Color		Black
Test Adapter No.		J-35616-42
Pin	Wire Color	Pin Function
1	GRN/YEL	Brake Pedal Switch Voltage Feed
2	GRN	Brake Pedal Switch Signal

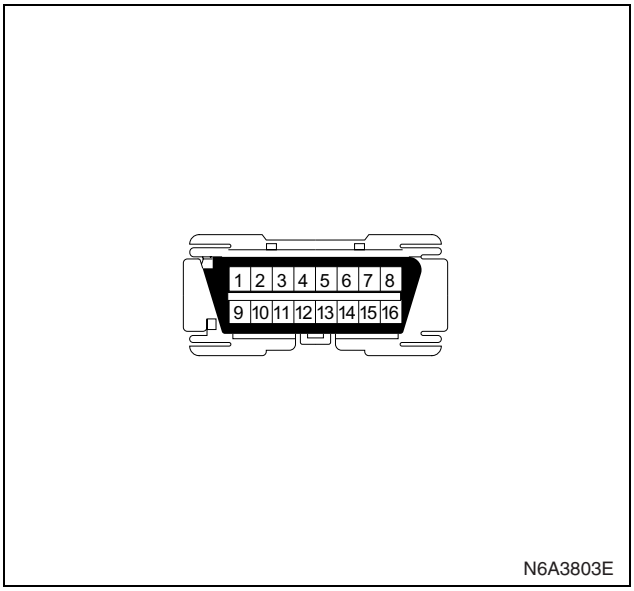
Half-clutch Adjustment Switch



Connector No.	B-106
Connector Color	White

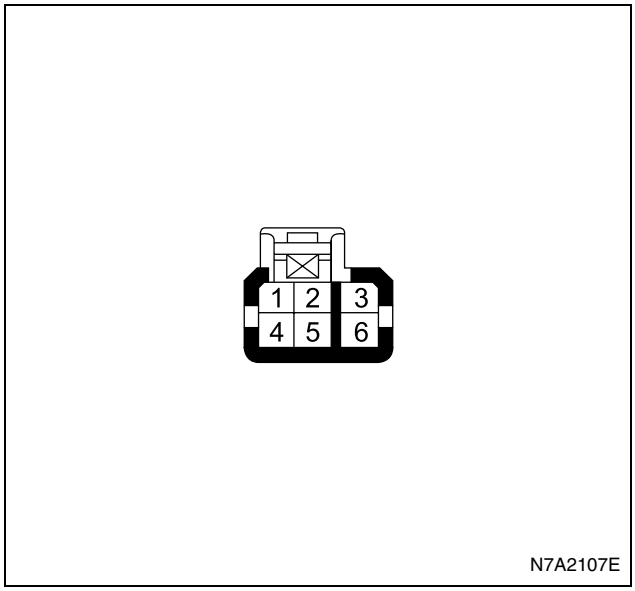
Test Adapter No.		J-35616-4A
Pin	Wire Color	Pin Function
1	GRY/BLK	Clutch Adjustment Fast Switch Signal
2	GRY/RED	Clutch Adjustment Slow Switch Signal
3	BLK/ORN	Clutch Adjustment Switch Voltage Feed

Data Link Connector (DLC)



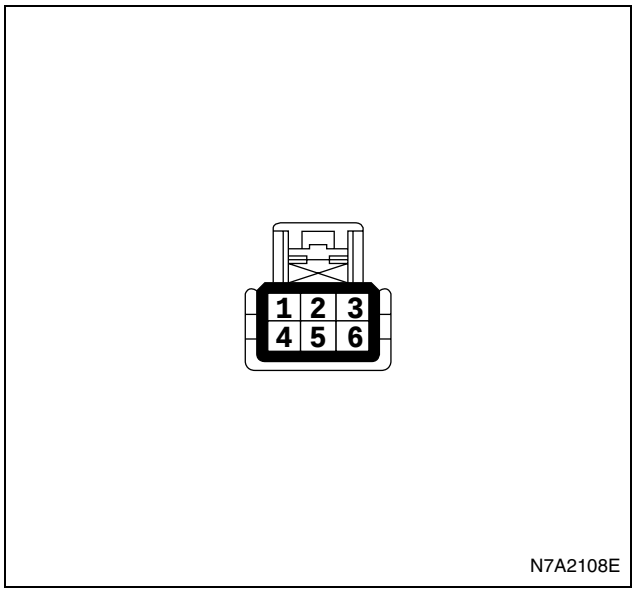
Connector No.		B-79
Connector Color		Black
Test Adapter No.		J-35616-2A
Pin	Wire Color	Pin Function
1	YEL	Diagnostic Request (ECM)
2	WHT/BLK	Class 2 Serial Communication (EHCU)
3	—	Not Used
4	BLK	Ground
5	BLK	Ground
6	—	Not Used
7	LT BLU	Keyword Serial Communication (ECM, TCM & SRS)
8	—	Not Used
9	—	Not Used
10	—	Not Used
11	BLK/WHT	Diagnostic Request (TCM)
12	WHT/GRN	Diagnostic Request (EHCU)
13	GRY	Diagnostic Request (SRS)
14	—	Not Used
15	—	Not Used
16	—	Not Used

Economy Mode Switch & 1st Gear Start Switch



Connector No.		N-20
Connector Color		Blue
Test Adapter No.		J-35616-4A
Pin	Wire Color	Pin Function
1	ORN	1st Gear Start Switch Ground
2	—	Not Used
3	ORN	Economy Mode Switch Ground
4	VIO	1st Gear Start Switch Signal
5	—	Not Used
6	GRN/ORN	Economy Mode Switch Signal

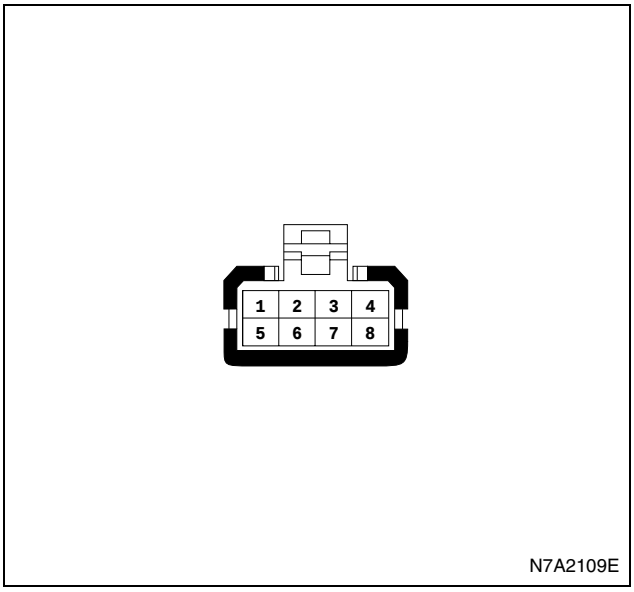
Emergency Shift Switch



Connector No.	N-18
Connector Color	White
Test Adapter No.	J-35616-4A

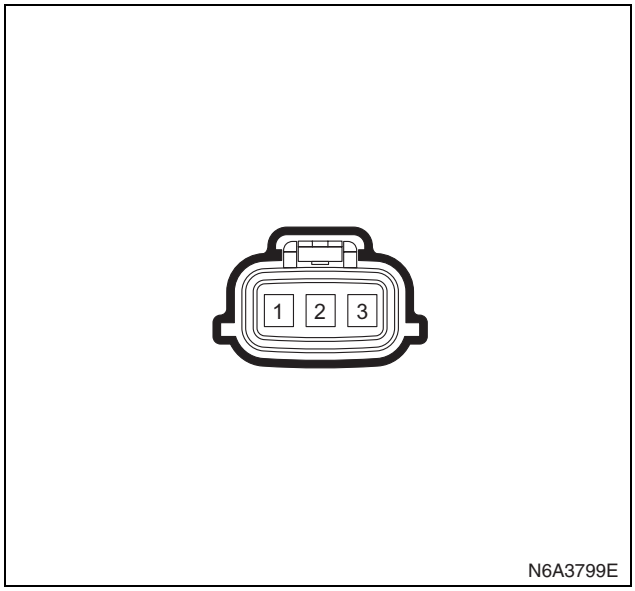
Pin	Wire Color	Pin Function
1	RED	Emergency Shift Switch “R” Position Signal
2	WHT	Emergency Shift Switch “N” Position Signal
3	GRN	Emergency Shift Switch “1” Position Signal
4	—	Not Used
5	BLK	Emergency Shift Switch Ground
6	—	Not Used

Emergency Switch



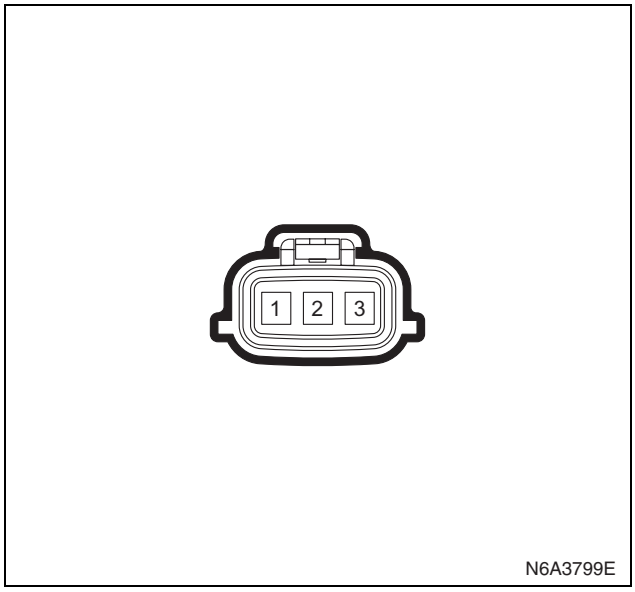
Connector No.		N-17
Connector Color		White
Test Adapter No.		J-35616-4A
Pin	Wire Color	Pin Function
1	BLK/YEL	Emergency Switch Voltage Feed
2	—	Not Used
3	—	Not Used
4	—	Not Used
5	BLU/RED	Emergency Switch Signal
6	—	Not Used
7	—	Not Used
8	—	Not Used

Gear Select Position Sensor



Connector No.		J-223
Connector Color		Brown
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	YEL/BLK	Gear Select Position Sensor 5 Volts Reference
2	YEL/WHT	Gear Select Position Sensor Signal
3	YEL/RED	Gear Select Position Sensor Low Reference

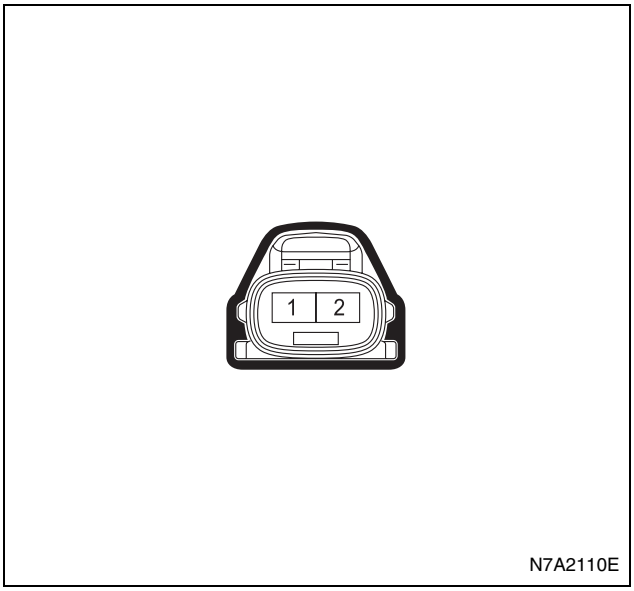
Gear Shift Position Sensor



Connector No.	J-142
Connector Color	Brown
Test Adapter No.	J-35616-33

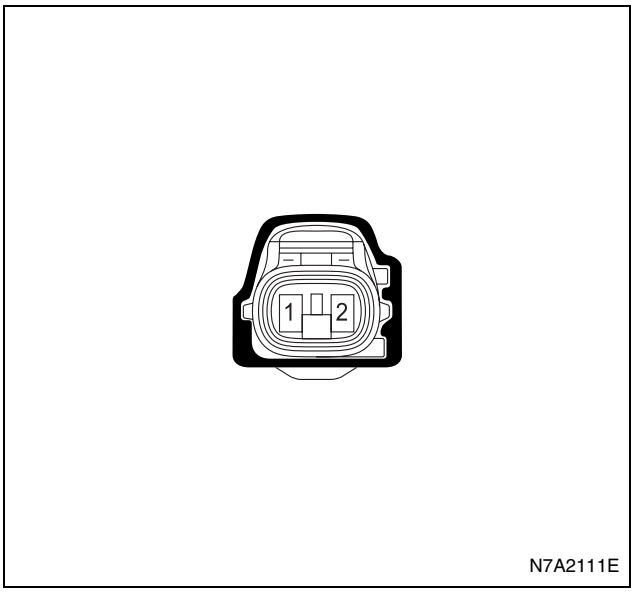
Pin	Wire Color	Pin Function
1	RED	Gear Shift Position Sensor 5 Volts Reference
2	WHT	Gear Shift Position Sensor Signal
3	BLK	Gear Shift Position Sensor Low Reference

Input Speed Sensor



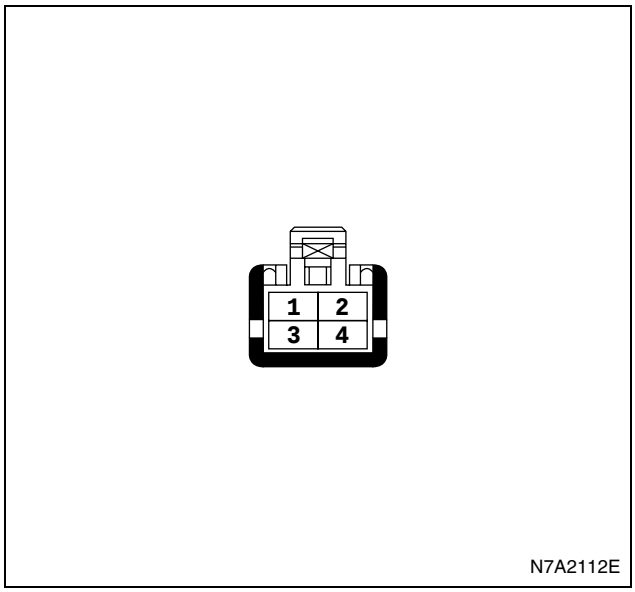
Connector No.		J-139
Connector Color		Gray
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	BRN	Input Shaft Speed Sensor Low Reference
2	YEL	Input Shaft Speed Sensor Signal

Neutral Switch



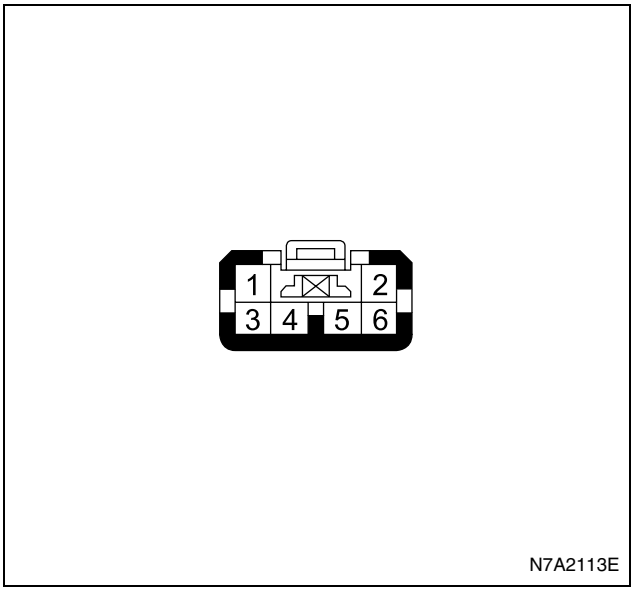
Connector No.		J-50
Connector Color		Black
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	BLK/BLU	Neutral Switch Signal
2	LT GRN	Neutral Switch Voltage Feed

PTO Switch



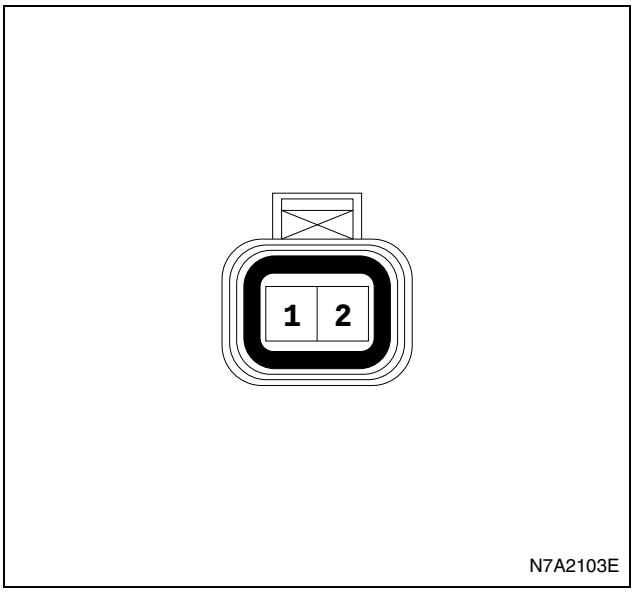
Connector No.		B-417
Connector Color		White
Test Adapter No.		J-35616-42
Pin	Wire Color	Pin Function
1	LT GRN/ RED	Illumination Lamp Voltage Feed
2	BLK	PTO Switch Ground
3	BLK	Illumination Lamp Ground
4	BLU/WHT	PTO Switch Signal

Reset Switch



Connector No.		B-105
Connector Color		Black
Test Adapter No.		J-35616-4A
Pin	Wire Color	Pin Function
1	—	Not Used
2	—	Not Used
3	—	Not Used
4	BLK/ORN	Reset Switch Voltage Feed
5	—	Not Used
6	GRY/BLU	Reset Switch Signal

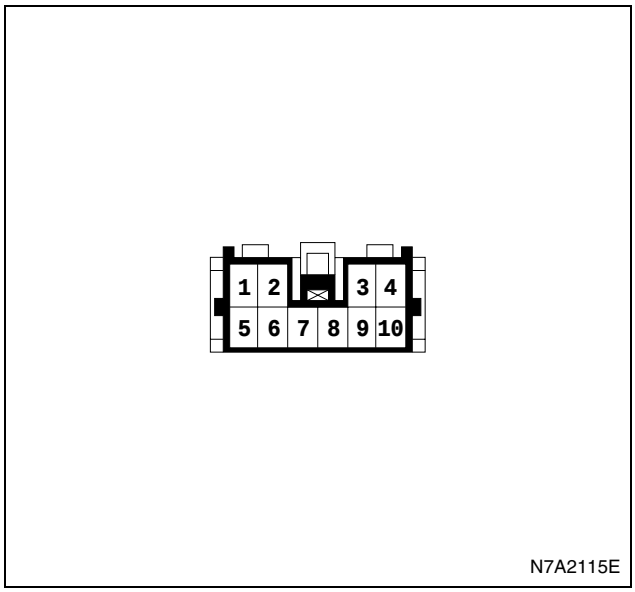
Select Solenoid



Connector No.	J-234
Connector Color	Green
Test Adapter No.	J-35616-42

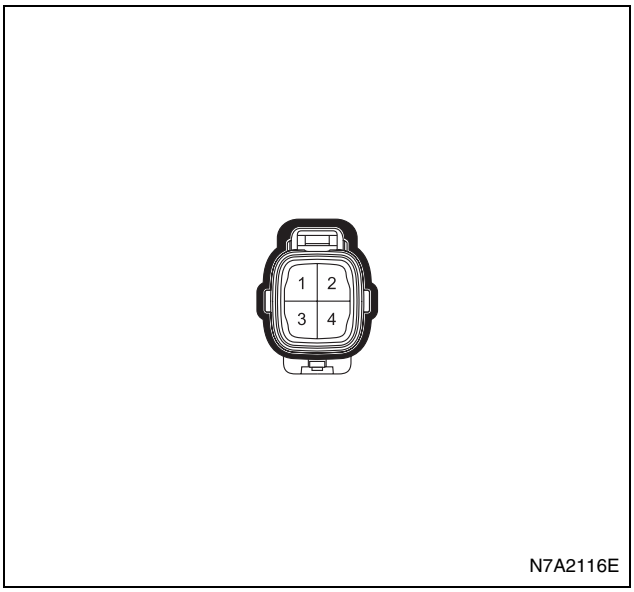
Pin	Wire Color	Pin Function
1	BLK	Select Solenoid Valve Ground
2	WHT/BLK	Select Solenoid Valve Control

Selector Lever



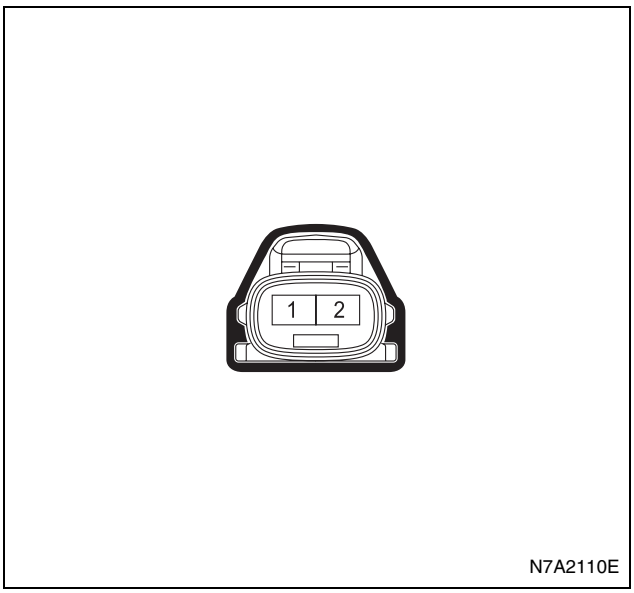
Connector No.		N-19
Connector Color		White
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	LT GRN/ RED	Illumination Lamp Voltage Feed
2	RED/BLK	Selector Lever “R” Position Switch Signal
3	YEL/RED	1st Gear Start Switch Signal
4	GRN/BLK	Selector Lever “A” Position Switch Signal
5	BLU	Economy Mode Switch Signal
6	WHT/BLK	Selector Lever “N” Position Switch Signal
7	ORN	Selector Lever “D” Position Switch Signal
8	PNK/BLK	Selector Lever “–” Position Switch Signal
9	BLK	Selector Lever Ground
10	BLU/BLK	Selector Lever “+” Position Switch Signal

Solenoid Valves & Transmission Fluid Temperature Sensor In-line Harness Connector



Connector No.		J-237
Connector Color		Gray
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	RED/YEL	Lock Up Clutch Solenoid Valve Control
2	YEL/RED	Transmission Fluid Temperature Sensor Signal
3	YEL/BLK	Gearshift Clutch Solenoid Valve Control
4	BLU/WHT	Transmission Fluid Temperature Sensor Low Reference

Turbine Speed Sensor



Connector No.		J-232
Connector Color		Gray
Test Adapter No.		J-35616-33
Pin	Wire Color	Pin Function
1	ORN/BLU	Turbine Speed Sensor Low Reference
2	WHT/BLU	Turbine Speed Sensor Signal

Diagnostic Information and Procedures

General Service Information

Non-OEM Parts

All of the on-board diagnostic (OBD) has been calibrated to run with original equipment manufacturer (OEM) parts. Accordingly, if commercially sold sensor or switch is installed, it makes a wrong diagnosis and turn on the transmission warning lamp. Aftermarket electronics, such as cellular phones, stereos, and anti-theft devices, may indicate electromagnetic interference (EMI) into the control system if they are improperly installed. This may cause a false sensor reading and turn on the transmission warning lamp.

Poor Vehicle Maintenance

The sensitivity of OBD will cause the transmission warning lamp turn on if the vehicle is not maintained properly. Restricted oil filters, fuel filters, and crankcase deposits due to lack of oil changes or improper oil viscosity can trigger actual vehicle faults that were not previously monitored prior to OBD. Poor vehicle maintenance cannot be classified as a “non-vehicle fault”, but with the sensitivity of OBD diagnostics, vehicle maintenance schedules must be more closely followed.

Visual/Physical Transmission Compartment Inspection

Perform a careful visual and physical transmission compartment inspection when performing any diagnostic procedure or diagnosing the cause of an emission test failure. This can often lead to repairing a problem without further steps. Use the following guidelines when performing a visual/physical inspection:

- Inspect all vacuum hoses for punches, cuts, disconnects, and correct routing.
- Inspect hoses that are difficult to see behind other components.
- Inspect all wires in the transmission compartment for proper connections, burned or chafed spots, pinched wires, contact with sharp edges or contact with hot exhaust manifolds or pipes.

Basic Knowledge of Tools Required

Lack of basic knowledge of this powertrain when performing diagnostic procedures could result in an incorrect diagnosis or damage to powertrain components. Do not attempt to diagnose a powertrain problem without this basic knowledge. A basic understanding of hand tools is necessary to effectively use this section of the service manual.

Transmission Warning Lamp

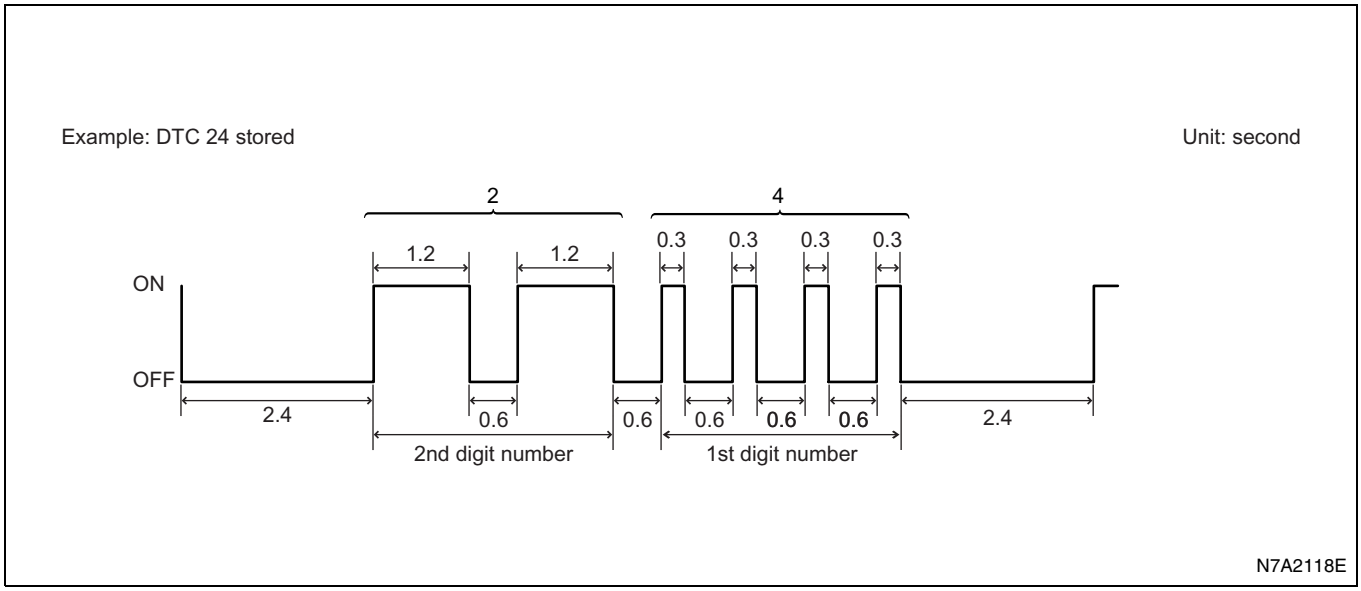
Basically, the transmission warning lamp is turned on when the transmission control module (TCM) detects a DTC that will impact the vehicle performance. When the transmission warning lamp remains “ON” while the engine is running, or when a malfunction is suspected due to a driveability problem, a Diagnostic System Check must be performed. The procedures for these checks are given in Diagnostic System Check - Transmission Controls.

Reading Flash Diagnostic Trouble Codes (DTC)

The provision for communicating with the TCM is the Data Link Connector (DLC). The DTCs stored in the TCM memory can be read either through a hand-held diagnostic scanner such as Tech 2 plugged into the DLC or by counting the number of flashes of the transmission warning lamp when the diagnostic test terminal of the DLC is grounded. The DLC terminal “11” (diagnostic request) is pulled “Low” (grounded) by jumped to DLC terminal “4”, which is a ground wire. Once terminals “11” and “4” have been connected, the ignition switch must be moved to the “ON” position, with the engine not running. The transmission warning lamp will indicate a DTC three times is a DTC is present and history. If more than one DTC has been stored in the TCM’s memory, the DTCs will be output numerical order with each DTC being displayed three times. The flash DTC display will continue as long as the DLC is shorted.

Notice:

- If DTC is present, buzzer also sounds with a lamp illumination.
- When present DTC and history DTC are mixed, present DTC is always output first, regardless of number of DTC.



Reading Diagnostic Trouble Codes (DTCs) with The Tech 2

The procedure for reading DTC(s) is used a diagnostic Tech 2. To read DTCs, use the Tech 2 “Read DTC Info As Stored By ECU”.

Clearing Diagnostic Trouble Codes (DTCs) with The Tech 2 or without Tech2

Do not clear DTCs unless directed to do so by the service information provided for each diagnostic procedure. To clear DTCs, use with the Tech 2 “Clear DTC Information”. If there is no Tech 2, clear with reset switch operation.

DTC Clear Method with Reset Switch Operation

1. Turn ON the ignition, with the engine OFF.
2. Use a jumper wire and the DLC terminal “11” (diagnostic request) is pulled “Low” (grounded) by jumped to DLC terminal “4”.
3. Press reset switch for at least 1 second and release it within 6 seconds.
4. If completed, buzzer will sound with a short beep.

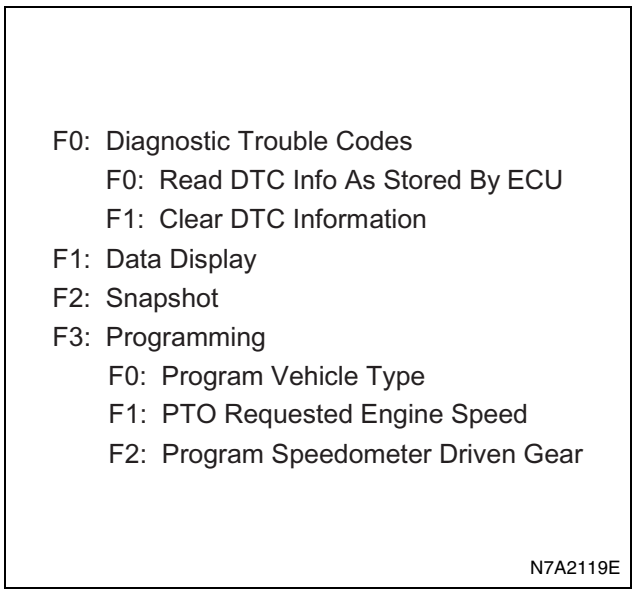
Notice:
If the buzzer does not sound, restart clear procedure from step 1.

Tech 2 Scan Tool

Isuzu recommend using Tech 2. Refer to the Tech 2 Users Guide for proper start up procedures.

Operating Procedure

1. Press Enter at start screen.
2. Select Diagnostic > appropriate vehicle identification > Transmission > Smoother.
3. The following table shows, which functions are used the available equipment versions.



F0: Diagnostic Trouble Codes

The purpose of this mode is to display stored trouble code in the TCM. When “Clear DTC Information” is selected, “Clear DTC Information”, warning screen appears. This screen informs you that by cleaning DTCs “all stored DTC information in the TCM will be erased”.

F1: Data Display

The purpose of this mode is to continuously monitor data parameters. The current actual values of all important sensors and signals, solenoid commands in the system are display through this mode.
Refer to the “Tech 2 Data List” in this section.

F2: Snapshot

“Snapshot” allow you to focus on making the condition occur, rather than trying to view all of the data in anticipation of the fault. The snapshot will collect parameter information around a trigger point that you select.
Refer to the Tech 2 user instructions for more information.

F3: Programming

The purpose of this mode is to program the vehicle information into the TCM if the vehicle specification or TCM is to be replaced.

Tech 2 Data List

Tech 2 data display items	Units	Typical Value (Key Switch ON)
Ignition Voltage	V	18V — 32V
Engine Speed	rpm	0 rpm
Turbine Speed	rpm	0 rpm
Input Shaft Speed	rpm	0 rpm
Engine and Input Shaft Speed Difference	rpm	0 rpm
Output Shaft Speed	rpm	0 rpm
Vehicle Speed	km/h / MPH	0 km/h
Accelerator Position Sensor Signal	%	0% *4
Transmission Fluid Temperature Sensor	V	Varies depending on conditions.
Transmission Fluid Temperature	°C / °F	–40 — 165 °C
Gearshift Clutch Solenoid Command	%	Varies depending on conditions.
Gearshift Clutch Output Signal	Engaged/Disengaged	Varies depending on conditions.
Lock up Clutch Solenoid Command	ON/OFF	Lockup solenoid valve active: ON
Lock up Clutch Solenoid Feedback	ON/OFF	Lockup solenoid valve active: ON
Desired Gear Select Position	V	Varies depending on conditions.
Gear Select Position Sensor	V	Varies depending on conditions.
Desired Gear Shift Position	V	Varies depending on conditions.
Gear Shift Position Sensor	V	Varies depending on conditions.
Select Solenoid Command	%	Varies depending on conditions.
1-3-5 Shift Solenoid Command	%	Varies depending on conditions.
2-4-6-R Shift Solenoid Command	%	Varies depending on conditions.
Neutral Switch	Neutral/In Gear	Neutral: Neutral
Selector Position	R/N/D/+/–/ --- /A/Don't know/Key Off/Emergency Control	Matches change lever operation (N)
Desired Gear Position	N1/N2/N3/N4/1st/2nd/ 3rd/4th/5th/6th	Varies depending on conditions.
Desired Gate Position	N1/N2/N3/N4/1st/2nd/ 3rd/4th/5th/6th	Varies depending on conditions.
Current Gear	During N1/N2/N3/N4/1st/ 2nd/3rd/4th/5th/6th/R shifting	Varies depending on conditions.
Control Phase	*1	Varies depending on conditions.
Gearshift Clutch Control Mode	*2	Varies depending on conditions.
Buzzer Mode	*3	Varies depending on conditions.
Main Relay Command	ON/OFF	ON
Main Relay Voltage Feed Circuit	ON/OFF	Battery voltage supplied to TCM: ON
Gearshift Control Box Relay Command	ON/OFF	ON
Starter Cut Relay Command	ON/OFF	Engine start prohibited: ON
Brake Pedal Switch	Applied/Released	Brake pedal depressed: Applied

Tech 2 data display items	Units	Typical Value (Key Switch ON)
Selector N Switch	ON/OFF	ON in accordance with the selector lever position.
Selector D Switch	ON/OFF	ON in accordance with the selector lever position.
Selector A Switch	ON/OFF	ON in accordance with the selector lever position.
Selector + Switch	ON/OFF	ON in accordance with the selector lever position.
Selector – Switch	ON/OFF	ON in accordance with the selector lever position.
Selector R Switch	ON/OFF	ON in accordance with the selector lever position.
Emergency Switch	ON/OFF	Emergency switch pressed: ON
Emergency N Switch	ON/OFF	Emergency shift switch position N: ON
Emergency 1st Switch	ON/OFF	Emergency switch position 1st: ON
Emergency R Switch	ON/OFF	Emergency shift switch position R: ON
1st Gear Start Switch	ON/OFF	1st gear start switch pressed: ON
Economy Switch	ON/OFF	Economy mode switch pressed: ON
Economy Lamp Command	ON/OFF	Economy mode is enabled: ON
Warning Lamp Command	ON/OFF	Key is ON, trouble is detected, etc.: ON
Buzzer Command	ON/OFF	Buzzer sounding: ON
Fast Switch	ON/OFF	FAST side of Half-clutch adjustment switch pressed: ON
Slow Switch	ON/OFF	SLOW side of Half-clutch adjustment switch pressed: ON
Reset Switch	ON/OFF	Reset switch pressed: ON
Door Switch	Open /Closed	Door open: Open
PTO Switch	ON/OFF	PTO switch pressed: ON
PTO Mode Start	Yes/No	Varies depending on conditions.
PTO Solenoid	—	—
PTO Request Engine Speed	rpm	Varies depending on conditions.
Aerial Platform Vehicle	Yes/No	Depends on vehicle condition.
Neutral Learned Shift Position	V	Varies depending on conditions.
1st Gear Learned Shift Position	V	Varies depending on conditions.
2nd Gear Learned Shift Position	V	Varies depending on conditions.
3rd Gear Learned Shift Position	V	Varies depending on conditions.
4th Gear Learned Shift Position	V	Varies depending on conditions.
5th Gear Learned Shift Position	V	Varies depending on conditions.
6th Gear Learned Shift Position	V	Varies depending on conditions.
Reverse Gear R Learned Shift Position	V	Varies depending on conditions.
N1 Learned Select Position	V	Varies depending on conditions.
N2 Learned Select Position	V	Varies depending on conditions.
N3 Learned Select Position	V	Varies depending on conditions.
N4 Learned Select Position	V	Varies depending on conditions.
N1 Learned Duty Ratio	%	Varies depending on conditions.
N2 Learned Duty Ratio	%	Varies depending on conditions.

Tech 2 data display items	Units	Typical Value (Key Switch ON)
N3 Learned Duty Ratio	%	Varies depending on conditions.
N4 Learned Duty Ratio	%	Varies depending on conditions.
Torque Learned Duty Ratio	%	Varies depending on conditions.
Half-Clutch Adjustment Duty Ratio	%	Varies depending on conditions.
Engine Type	Example: 4HK1	Varies depending on vehicle.
Engine Type Learning Status	Learned/Not Learned	Learned after learning is complete.
Transmission Type	Example: MYY	Varies depending on vehicle.
Transmission Type Learning Status	Learned/Not Learned	Learned after learning is complete.
Speedometer Driven Gear Teeth	—	10 — 17
Speedometer Driven Gear Learning Status	Learned/Not Learned	Learned
Gear Position Learning Status	Learned/Not Learned	Learned
Torque Learning Status	Learned/Not Learned	Learned

*1

Non-control	Not control being performed.
Immediate clutch disengage	Clutch immediate disengage control
Clutch slow disengage	Clutch slow disengage control
Clutch fully disengaged	Clutch fully disengaged
Full clutch engage	Clutch immediate engage control
Clutch slow engage	Clutch slow engage control
Clutch slow engage complete	Slow clutch engage control complete
Clutch full engage	Clutch fully engaged
Shift start	Shift control started.
Neutral gear	Neutral gear select control
Neutral select transition	Neutral select position transition control
Neutral select N1 transition	Neutral selection position transition to initial position
Gear in	Gear in control started.
Control stopped	Smoother system control stopped
Engine start, clutch disengaged	Clutch disengaged immediately after engine start.
Engine start, clutch engaged	Clutch engaged immediately after engine start.
PTO mode	PTO control mode
Initial learning mode	Initial learning mode
Manual learning mode	Manual learning mode
Key off	Key switch is OFF.
Torque learning clutch full disengage	Clutch is fully disengaged when torque learning.
Torque learning N2 shift	Neutral clutch position is N2 when torque learning.
Torque learning 2nd shift	Shifted to 2nd when torque learning.
Torque learning standby	Clutch engage control when torque learning
Torque learning clutch immediate disengage	Clutch immediately engaged when torque learning.
Torque learning clutch loose disengage	Clutch slowly engaged when torque learning.
Torque learning stop	Torque learning complete
N2 shift after torque learning	Neutral clutch position is N2 after torque learning.
N1 shift after torque learning	Neutral clutch position is initial position after torque learning.
Torque learning neutral shift	Gear is shifted to neutral when torque learning.

Gear learning full disengage	Clutch is fully disengaged when gear learning.
Gear learning TM learning	Gear learning (transmission type learning) performed.
Gear learning N1 learning	Gear learning (gear position) performed.
Gear learning N2 learning	Gear learning (gear position) performed.
Gear learning N3 learning	Gear learning (gear position) performed.
Gear learning N4 learning	Gear learning (gear position) performed.
Gear learning N1 standby	Standby in neutral select (N1) when gear learning.
Gear learning N2 standby	Standby in neutral select (N2) when gear learning.
Gear learning N3 standby	Standby in neutral select (N3) when gear learning.
Gear learning N4 standby	Standby in neutral select (N4) when gear learning.
Gear learning REV learning	Gear learning (gear position Rev learning) performed.
Gear learning 1st learning	Gear learning (gear position 1st learning) performed.
Gear learning 2nd learning	Gear learning (gear position 2nd learning) performed.
Gear learning 3rd learning	Gear learning (gear position 3rd learning) performed.
Gear learning 4th learning	Gear learning (gear position 4th learning) performed.
Gear learning 5th learning	Gear learning (gear position 5th learning) performed.
Gear learning 6th learning	Gear learning (gear position 6th learning) performed.
Gear learning complete	Gear position learning is complete.
Emergency control, non-control	System control stopped during non-control.
Non-control, N shift	Shift to neutral during non-control.
Non-control, 1st shift	Shift to 1st during non-control.
Non-control, Rev shift	Shift to Rev during non-control.

*2

Garage	Half-clutch control on a stopped vehicle
Engine plus	Half clutch control when engine speed is high due to input shaft speed, as when up-shifting is performed
Input shaft plus	Half clutch control when input shaft speed is high due to engine speed, as when down-shifting is performed
Synchro	Half-clutch control while running, when the engine speed and input shaft speed differential is very small.
Idle up-shift	Half-clutch control on a stopped vehicle, while idling

*3

Reset start	When the key switch is ON
Voltage drop	When battery voltage (system voltage) is low
Buzzer check	Buzzer check mode
Memory clear	When memory is cleared
Learning complete	When learning control is complete
Learning	When learning control is being performed
Self-diagnosis code output	When there is a short between DLC pins, and DTC is detected
Continuous buzzer trouble	When trouble that causes the buzzer to sound continuously is detected
Intermittent buzzer trouble	When trouble that causes the buzzer to sound on intermittently is detected
Gear in door open	When the door is open while the vehicle is in gear
Unlearned alarm	When learning is not being performed

Slip alarm	When the accelerator pedal is pressed while the parking brake is ON and the vehicle is in gear
Inclined stop alarm	When the vehicle is stopped on an incline, even though the accelerator pedal is depressed
Clutch pedal point adjustment	When torque learning (adjustment) is being performed
High-gear very low speed running	When vehicle speed is low while the gear position is very high
Overrun alarm	When the engine is over-running
Parking brake reminder	When the vehicle is running with the parking brake applied
Long-term gear in	When the vehicle is left in gear for a long time while stopped
Overrun shift prohibit	When there is an attempt to down-shift while the engine is over-running.
Underrun shift prohibit	When there is an attempt to up-shift while the engine is under-running.
N lock alarm	When the change lever position is change from N to D without pressing the brake
PTO idle up adjustment	When the idle speed is being adjusted while the PTO is active
PTO mode On	When the PTO mode is on
PTO mode Off	When the PTO mode is off
Buzzer OFF	When buzzer operation is prohibited

*4: The accelerator opening angle does not always match the operational feel of the pedal. Some difference between the two is not abnormal.

Tech 2 Data Definitions

A list of each message displayed on the Tech 2 will be explained in Transmission Controls. This information will assist in driveability problems. The displays can be viewed while the vehicle is being driven. Always perform the Diagnosis System Check - Transmission Controls first. The Diagnostic System Check will confirm proper system operation.

Ignition Voltage

This parameter displays the ignition voltage measured at the ignition feed circuit of the TCM. Voltage is applied to the TCM when the ignition switch is ON position.

Engine Speed

This parameter displays the rotational speed of the crankshaft as calculated by the engine control module (ECM) based on inputs from the crankshaft position (CKP) sensor or camshaft position (CMP) sensor. This data is sent over the CAN serial data link from the ECM to the TCM. The Tech 2 will display the engine speed in revolution per minute (RPM).

Turbine Speed

This parameter displays the rotational speed of the gearshift multi-plate clutch as calculated by the TCM based on an input from the turbine speed sensor. The Tech 2 will display the turbine speed in revolution per minute (RPM).

Input Shaft Speed

This parameter displays the rotational speed of the transmission counter shaft as calculated by the TCM based on an input from the input shaft speed sensor. The Tech 2 will display the turbine speed in revolution per minute (RPM).

Engine Speed and Input Shaft Speed Difference

This parameter display the difference of engine speed and input shaft speed (engine speed - input shaft speed) as calculated by the TCM using the signal from the input shaft speed sensor and crankshaft rotational speed that is sent over the CAN serial data link from the engine control module (ECM) to the TCM. The Tech 2 will display a low value when the gearshift clutch is engaged, and a high value when the gearshift clutch is disengaged.

Output Shaft Speed

This parameter displays the transmission output shaft speed calculated by the engine control module (ECM) using the signal from the output shaft speed sensor that is called vehicle speed sensor (VSS). This data is sent over the CAN serial data link from the ECM to the TCM. The Tech 2 will display the engine speed in revolution per minute (RPM).

Vehicle Speed

This parameter displays the vehicle speed calculated by the engine control module (ECM) using the signal from the vehicle speed sensor (VSS). This data is sent over the CAN serial data link from the ECM to the TCM. The Tech 2 will display a low value at lower vehicle speeds, and a high value at higher vehicle speeds.

Accelerator Pedal Position Sensor Signal

This parameter displays the angle of the accelerator pedal as calculated by the engine control module (ECM) using the signals from the accelerator pedal position (APP) sensors. This data is sent over the CAN serial data link from the ECM to the TCM. The APP sensor signal is a range of values indicating a low percentage when the accelerator pedal is not depressed to a high percentage when the accelerator pedal is fully depressed.

Transmission Fluid Temperature Sensor

This parameter displays the voltage signal sent to the TCM from the transmission fluid temperature (TFT) sensor. TFT sensor is a range of value indicating a low voltage when the temperature is high and a high voltage when the temperature is low.

Transmission Fluid Temperature

This parameter displays the temperature of the transmission fluid temperature (TFT) as calculated by the TCM using the signal from the TFT sensor. The Tech 2 will display a low temperature when the TFT sensor signal voltage is high, and a high temperature when the TFT sensor signal voltage is low.

Gearshift Clutch Solenoid Command

This parameter displays the gearshift clutch solenoid valve control duty ratio commanded by the TCM. The Tech 2 will display 0% when the gearshift clutch is controlled to engage. The Tech 2 will display a high percentage or 100% when the gearshift clutch is controlled to disengage.

Gearshift Clutch Output Signal

This parameter displays the state of the gearshift clutch output signal to the engine control module (ECM) from the TCM. The Tech 2 will display engage or disengage.

Lock Up Clutch Solenoid Command

This parameter displays the lock up clutch solenoid valve control signal commanded by the TCM. The Tech 2 will display On when the lock up clutch is controlled to engage. The Tech 2 will display Off when the lock up clutch is controlled to disengage.

Lock Up Clutch Solenoid Feedback

This parameter displays the feedback state of the lock up clutch solenoid valve control circuit. The Tech 2 will display On when the lock up clutch solenoid valve control circuit is a high voltage (commanded ON). The Tech 2 will display Off when the lock up clutch solenoid valve is a low voltage (commanded OFF).

Desired Gear Select Position

This parameter displays gear select side lever position desired by the TCM based on desired gear position.

Gear Select Position Sensor

This parameter displays the voltage signal sent to the TCM from the gear select position sensor. Gear select position sensor is a range of values indicating a low voltage when the select side lever is positioned near the N1 to a high voltage when the select side lever is positioned near the N3 or N4.

Desired Gear Shift Position

This parameter displays gear shift side lever position desired by the TCM based on desired gear position.

Gear Shift Position Sensor

This parameter displays the voltage signal sent to the TCM from the gear shift position sensor. Gear shift position sensor is a range of values indicating a low voltage when the shift side lever is positioned near the 2nd, 4th, 6th or reverse gear to a high voltage when the shift side lever is positioned near the 1st, 3rd or 5th gear. It indicates a middle voltage when the shift side lever is positioned near the neutral.

Select Solenoid Command

This parameter displays the select solenoid valve control duty ratio commanded by the TCM. The Tech 2 will display 0% when the select solenoid valve is not controlled. The Tech 2 will display any percentage when the select solenoid valve is commanded to move the select side lever.

1-3-5 Shift Solenoid Command

This parameter displays the 1-3-5 shift solenoid valve control duty ratio commanded by the TCM. The Tech 2 will display 0% when the 1-3-5 shift solenoid valve is not controlled. The Tech 2 will display any percentage when the 1-3-5 shift solenoid valve is commanded to move the shift side lever. (When engaging to 1st, 3rd and 5th gear or when disengaging from 2nd, 4th, 6th and reverse gear.)

2-4-6-R Shift Solenoid Command

This parameter displays the 2-4-6-R shift solenoid valve control duty ratio commanded by the TCM. The Tech 2 will display 0% when the 2-4-6-R shift solenoid valve is not controlled. The Tech 2 will display any percentage when the 2-4-6-R shift solenoid valve is commanded to move the shift side lever. (When engaging to 2nd, 4th, 6th and reverse gear or when disengaging from 1st, 3rd and 5th gear.)

Neutral Switch

This parameter displays the input state of the neutral switch to the TCM. The Tech 2 will display Neutral or In Gear. Neutral indicates the neutral switch is closed position (actual neutral position). In gear indicates the neutral switch is opened position (other than neutral).

Selector Position

This parameter displays the selector lever position based on the selector lever switch inputs to the TCM.

Desired Gear Position

This parameter displays the gear position commanded by the TCM based on engine speed, vehicle speed, selector lever position and other inputs.

Desired Gate Position

This parameter displays the controlled gear position is set by the TCM for shifting to the desired gear position.

Current Gear

This parameter displays the current gear position based on the gear select position sensor and gear shift position sensor inputs. N1 indicates the shift position is neutral between 1st and reverse gear. N2 indicates the shift position is neutral between 2nd and 3rd gear. N3 indicates the shift position is neutral between 4th and 5th gear. N4 indicates the shift position is neutral at 6th gear gate.

Control Phase

This parameter displays the control state of the transmission. The Tech 2 will display various control status for transmission control.

Gearshift Clutch Control Mode

This parameter displays the control state of the gearshift clutch. The Tech 2 will display various control status for gearshift clutch control.

Buzzer Mode

This parameter displays the control state of the buzzer. The Tech 2 will display various control status for buzzer control.

Main Relay Command

This parameter displays the commanded state of the main relay control circuit. On indicates the main relay control circuit is being grounded by the TCM, allowing the main relay to supply battery voltage to the TCM. Off indicates the main relay is not being commanded On by the TCM.

Main Relay Voltage Feed Circuit

This parameter displays the input state of the main relay voltage supply to the TCM. On indicates the main relay is closed and battery voltage is being supplied through the main relay.

Gearshift Control Box Relay Command

This parameter displays the commanded state of the gearshift control box relay control circuit. On indicates the gearshift control box relay control circuit is being grounded by the TCM, allowing the gearshift control box relay to supply voltage to the select and shift solenoid valves through the TCM. Off indicates the gearshift control box relay is not being commanded On by the TCM.

Starter Cut Relay Command

This parameter displays the commanded state of the starter cut relay control circuit. On indicates the starter cut relay control circuit is being grounded by the TCM, inhibiting the starter relay control circuit to connect to ground and the engine will not crank. Off indicates the starter cut relay is not being commanded On by the TCM, allowing the starter relay control circuit to connect to ground and the engine is possible to crank.

Brake Pedal Switch

This parameter displays the state of the brake pedal as determined by the TCM based on an input from the stop lamp pedal switch. This switch turns on the stop lamps when the brake pedal is depressed. The Tech 2 will display Applied when the brake pedal is depressed.

Selector N Switch

This parameter displays the state of the selector lever as determined by the TCM based on input from the selector lever switches. The Tech 2 will display On when the selector lever is positioned to N.

Selector D Switch

This parameter displays the state of the selector lever as determined by the TCM based on input from the selector lever switches. The Tech 2 will display On when the selector lever is positioned to D, A + or –.

Selector A Switch

This parameter displays the state of the selector lever as determined by the TCM based on input from the selector lever switches. The Tech 2 will display On when the selector lever is positioned to A.

Selector + Switch

This parameter displays the state of the selector lever as determined by the TCM based on input from the selector lever switches. The Tech 2 will display On when the selector lever is positioned to +.

Selector – Switch

This parameter displays the state of the selector lever as determined by the TCM based on input from the selector lever switches. The Tech 2 will display On when the selector lever is positioned to –.

Selector R Switch

This parameter displays the state of the selector lever as determined by the TCM based on input from the selector lever switches. The Tech 2 will display On when the selector lever is positioned to R.

Emergency Switch

This parameter displays the state of the emergency switch as determined by the TCM based on an input from the emergency switch. The Tech 2 will display On when the emergency switch is On, allowing the emergency mode to start.

Emergency N Switch

This parameter displays the state of the emergency shift switch as determined by the TCM based on an input from the emergency shift switch. The Tech 2 will display On when the emergency shift switch is positioned to N.

Emergency 1st Switch

This parameter displays the state of the emergency shift switch as determined by the TCM based on an input from the emergency shift switch. The Tech 2 will display On when the emergency shift switch is positioned to 1, allowing the emergency shifting to 1st gear when emergency switch is ON.

Emergency R Switch

This parameter displays the state of the emergency shift switch as determined by the TCM based on an input from the emergency shift switch. The Tech 2 will display On when the emergency shift switch is positioned to R, allowing the emergency shifting to reverse gear when emergency switch is ON.

1st Gear Start Switch

This parameter displays the state of the 1st gear start switch as determined by the TCM based on an input from the 1st gear start switch. The Tech 2 will display On when the 1st gear start switch is On.

Economy Switch

This parameter displays the state of the economy switch as determined by the TCM based on an input from the economy switch. The Tech 2 will display On when the economy switch is On, allowing the gearshift schedule to change at auto shift mode.

Economy Lamp Command

This parameter displays the commanded state of the economy indicator lamp control circuit. The ECONO indicator lamp should be On when the Tech 2 indicates the Economy Lamp Command is On. The ECONO

indicator lamp should be Off when the Tech 2 indicates the Economy Lamp Command is Off. The TCM will command the ECONO indicator lamp On approximately 3 seconds when the ignition is On with the engine Off in order to perform a bulb check.

Warning Lamp Command

This parameter displays the commanded state of the transmission warning lamp control circuit. The transmission warning lamp should be On when the Tech 2 indicates the Warning Lamp Command is On. The transmission warning lamp should be Off when the Tech 2 indicates the Warning Lamp Command is Off. The TCM will command the transmission warning lamp On approximately 3 seconds when the ignition is On with the engine Off in order to perform a bulb check.

Buzzer Command

This parameter displays the commanded state of the buzzer control circuit in the TCM. The buzzer should be sound when the Tech 2 indicates the Buzzer Command is On. The buzzer should be Off when the Tech 2 indicates the Buzzer Command is Off.

Fast Switch

This parameter displays the state of the half-clutch adjustment switch as determined by the TCM based on an input from the half-clutch adjustment switch. The Tech 2 will display On when the FAST side switch is depressed.

Slow Switch

This parameter displays the state of the half-clutch adjustment switch as determined by the TCM based on an input from the half-clutch adjustment switch. The Tech 2 will display On when the SLOW side switch is depressed.

Reset Switch

This parameter displays the state of the reset switch as determined by the TCM based on an input from the reset switch. The Tech 2 will display On when the reset switch is depressed.

Door Switch

This parameter displays the state of the door switch as determined by the TCM based on inputs from the door switches. The Tech 2 will display Open when the either of door open.

4L Switch

This parameter is not used.

PTO Switch

This parameter displays the state of the PTO switch as determined by the TCM based on an input from the PTO switch. The Tech 2 will display On when the PTO switch is depressed.

PTO Mode Start

This parameter displays the control state of the PTO mode. The Tech 2 will display Yes when the PTO mode is started.

PTO Solenoid

This parameter is not used.

PTO Request Engine Speed

This parameter displays the programmed PTO request engine speed when PTO mode is enabled. The PTO request engine speed can change by user request or PTO applications.

Aerial Platform Vehicle

This parameter is not used.

Neutral Learned Shift Position

This parameter displays the learned position at the neutral using the signal from the gear shift position sensor.

1st Gear Learned Shift Position

This parameter displays the learned position at the 1st gear using the signal from the gear shift position sensor.

2nd Gear Learned Shift Position

This parameter displays the learned position at the 2nd gear using the signal from the gear shift position sensor.

3rd Gear Learned Shift Position

This parameter displays the learned position at the 3rd gear using the signal from the gear shift position sensor.

4th Gear Learned Shift Position

This parameter displays the learned position at the 4th gear using the signal from the gear shift position sensor.

5th Gear Learned Shift Position

This parameter displays the learned position at the 5th gear using the signal from the gear shift position sensor.

6th Gear Learned Shift Position

This parameter displays the learned position at the 6th gear using the signal from the gear shift position sensor.

Reverse Gear Learned Shift Position

This parameter displays the learned position at the reverse gear using the signal from the gear shift position sensor.

N1 Learned Select Position

This parameter displays the learned position at the N1 using the signal from the gear select position sensor.

N2 Learned Select Position

This parameter displays the learned position at the N2 using the signal from the gear select position sensor.

N3 Learned Select Position

This parameter displays the learned position at the N3 using the signal from the gear select position sensor.

N4 Learned Select Position

This parameter displays the learned position at the N4 using the signal from the gear select position sensor.

N1 Learned Duty Ratio

This parameter displays the learned select solenoid valve control duty ratio at the N1.

N2 Learned Duty Ratio

This parameter displays the learned select solenoid valve control duty ratio at the N2.

N3 Learned Duty Ratio

This parameter displays the learned select solenoid valve control duty ratio at the N3.

N4 Learned Duty Ratio

This parameter displays the learned select solenoid valve control duty ratio at the N4.

Torque Learned Duty Ratio

This parameter displays the learned gearshift clutch solenoid valve control duty ratio when the half-clutch position is learned.

Half-Clutch Adjustment Duty Ratio

This parameter displays the adjustment value of the gearshift clutch solenoid valve control duty ratio when the gearshift clutch is engaged. The half-clutch adjustment switch is used to adjust the clutch engagement timing.

Engine Type

This parameter displays the programmed engine type.

Engine Type Learning Status

This parameter displays the learning state of the engine type. Not Learned indicates initialed state that is replaced to a new TCM. Learned indicates learning process is completed state.

Transmission Type

This parameter displays the programmed engine type.

Transmission Type Learning Status

This parameter displays the learning state of the transmission type. Not Learned indicates initialed state that is replaced to a new TCM. Learned indicates learning process is completed state.

Speedometer Driven Gear Teeth

This parameter displays the programmed speedometer driven gear teeth.

Speedometer Driven Gear Learning Status

This parameter displays the learning state of the speedometer driven gear teeth. Not Learned indicates initialed state that is replaced to a new TCM. Learned indicates learning process is completed state.

Gear Position Learning Status

This parameter displays the learning state of the half-clutch position. Not Learned indicates initialed state that is replaced to a new TCM. Learned indicates learning process is completed state.

Torque Learning Status

This parameter displays the learning state of the transmission gear select and shift position. Not Learned indicates initialed state that is replaced to a new TCM. Learned indicates learning process is completed state.

Transmission Contol System Check Sheet

Check list for Smoother control system Specific example Inspector's name _____

Customer's name		Model type and model year	
Driver's name		Vehicle No.	
Date vehicle brought in		Transmission type	
Registration No.		Transmission No.	
		Engine model	
		Odometer reading	km

Trouble symptom	☐ Engine does not start	☐ Engine does not crank ☐ At gear-in ☐ At neutral ☐ When emergency switch is ON
	☐ When gear is engaged while vehicle is stopped, engine stalls	☐ Idle speed is incorrect ☐ Abnormal idling ☐ High (rpm) ☐ Low (rpm) ☐ Others _____
	☐ Drivability is low	☐ Engagement/disengagement is felt at shift-up ☐ Body vibration ☐ Engine vibration ☐ Noise ☐ Large shock at gearshift ☐ Large shock at starting to move ☐ Others _____
	☐ Running not possible	☐ Immediately after starting to move ☐ When accelerator pedal is released ☐ When A/C is operated ☐ Immediately after replacing engine oil ☐ Immediately after replacing transmission oil ☐ When gear is shifted up ☐ Others _____
	☐ Gearshift	☐ Gear is shifted ☐ Gear is not shifted
	☐ Noise	☐ Gear clash ☐ Others
	☐ Accelerator pedal	☐ Blow up ☐ Slow response ☐ Rough
	☐ Engine stall	☐ Brake lamp does not come on ☐ Others _____

Trouble occurrence data		
Frequency of trouble		☐ Always ☐ Sometimes (How many times: per date/month) ☐ Once ☐ Others _____
Trouble condition	Weather	☐ Fine ☐ Cloudy ☐ Rain ☐ Snow ☐ Various/ others _____
	Ambient temperature	☐ 30℃ or more ☐ Around 20−30 ℃ ☐ Around 10−15 ℃ ☐ 0℃ or less (℃)
	Location	☐ Expressway ☐ Suburb ☐ Urban area ☐ Uphill ☐ Downhill ☐ Rough road ☐ Others _____
	Engine/ transmission temperature	☐ Cold ☐ Warming-up ☐ After warmed-up ☐ Engine coolant temperature ℃
	Operating condition	☐ When starting ☐ Immediately after starting (minutes) ☐ Idling ☐ Racing ☐ During operation ☐ At a constant speed ☐ At acceleration ☐ At deceleration ☐ A/C SW, other SW ON/OFF ☐ Others _____

Smoother warning lamp		☐ ON ☐ Sometimes comes on ☐ Not come on ☐ Not sure
DTC	Present	☐ ☐ ☐
* When was the transmission oil replaced last time? Were genuine transmission oil, filter, etc. used?		☐ When was the engine oil replaced last time? ☐ ☐
Buzzer		☐ Beeped ☐ Not beep ☐ Not sure
Lamp indication fault		☐ Economy mode ☐ Indicator display ☐ Others ☐ Not sure ☐ 1st gear start
Past trouble history		☐ (Year Month/Date) _____ ☐ (Year Month/Date)
About learning		Torque learning _____ Torque learning value _____ % Gear learning _____ Adjustment learning value _____ %
Trouble occurrence data		Phase _____ Shift mode _____ Target gear _____ Buzzer mode _____

N7A2073E

Diagnostic Starting Point - Transmission Controls

Begin the system diagnosis with Diagnostic System Check Transmission Controls. The Diagnostic System Check Transmission Controls will provide the following information:

- The identification of the control modules which command the system.
- The ability of the control modules to communicate through the serial data circuit.
- The identification of any stored diagnostic trouble codes (DTCs) and the their statuses.

The use of the Diagnostic System Check - Transmission Controls will identify the correct procedure for diagnosing the system and where the procedure is located.

Important:
Transmission Control System Check Sheet must be used to verify the customer complaint, you need to know the correct (normal) operating behavior of the system and verify that the customer complaint is a valid failure of the system.

Diagnostic System Check - Transmission Controls

Description

The Diagnostic System Check Transmission Controls is an organized approach to identifying a condition that is created by a malfunction in the electronic transmission control system. The Diagnostic System Check must be the starting point for any driveability concern. The Diagnostic System Check directs the service technician to the next logical step in order to diagnose the concern. Understanding and correctly using the diagnostic table reduces diagnostic time, and prevents the replacement of good parts.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

1.Lack of communication may be because of a partial or a total malfunction of the Keyword 2000 serial data circuit. The specified procedure determines the particular condition.

5. The presence of DTCs which begin with U, indicate that some other module is not communicating.

11.If there are other modules with DTCs set, refer to the DTC list. The DTC list directs you to the appropriate diagnostic procedure. If the control module stores multiple DTCs, diagnose the DTCs in the following order.

- Component level DTCs, such as sensor DTCs, solenoid DTCs, actuator DTCs, and relay DTCs. Diagnose the multiple DTCs within this category in numerical order. Begin with the lowest numbered DTC, unless the diagnostic table directs you otherwise.

Important:

- DO NOT perform this diagnostic if there is not a driveability concern, unless another procedure directs you to this diagnostic.
- Before you proceed with diagnosis, search for applicable service bulletins.
- Unless a diagnostic procedure instructs you, DO NOT clear the DTCs.
- Ensure the battery has a full charge.
- Ensure the battery cables (+) (–) are clean and tight.
- Ensure the TCM grounds are clean, tight, and in the correct location.
- Ensure the TCM harness connectors are clean and correctly connected.
- Ensure the TCM terminals are clean and correctly mating.
- Ensure the vehicle maintenance has been done enough.
- Ensure the vehicle information data is correctly programmed and transmission gear select & shift position and half-clutch position is correctly learned.
- If there are DTC's P0718, P0726, P0909, P0915 or P0919, diagnose sensor DTCs, solenoid DTCs, actuator DTCs and relay DTCs FIRST.

Step	Action	Value(s)	Yes	No
1	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Attempt to establish communication with the listed control modules. • Engine control module (ECM) • Transmission control module (TCM) • Supplemental restraint system (SRS) control module (If so equipped) Does the Tech 2 communicate with all the listed control modules?	—	Go to Step 2	Go to Tech 2 Does Not Communicate with Keyword Device

Step	Action	Value(s)	Yes	No
2	1. Turn OFF the ignition for 30 seconds. 2. Turn OFF the emergency switch. 3. Turn ON the ignition, with the engine OFF. Does the transmission warning lamp illuminate?	—	Go to Step 3	Go to Transmission Warning Lamp Inoperative
3	Attempt to crank the engine. Does the engine crank?	—	Go to Step 4	Go to Engine Does Not Crank
4	Attempt to start the engine. Does the engine start and idle?	—	Go to Step 5	Go to Engine Cranks But Does Not Run in Engine Control Section
5	Select the DTC display function for the following control modules: • ECM • TCM • SRS control module (If so equipped) Does the Tech 2 display any DTCs?	—	Go to Step 6	Go to Step 13
6	Does the Tech 2 display DTCs which begin with a U or other control module communication fault DTCs?	—	Go to Applicable DTC	Go to Step 7
7	Does the Tech 2 display TCM DTCs P0602, P0605 or P0613?	—	Go to Applicable DTC	Go to Step 8
8	Does the Tech 2 display TCM DTCs P0885 or P0889?	—	Go to Applicable DTC	Go to Step 9
9	Does the Tech 2 display TCM DTCs P0715, P0717, P0721, P0904 or P0914?	—	Go to Applicable DTC	Go to Step 10
10	Does the Tech 2 display TCM DTCs P0740, P0742, P0902 or P0903?	—	Go to Applicable DTC	Go to Step 11
11	Does the Tech 2 display TCM DTCs P0851, P0852, P0906 or P0907?	—	Go to Applicable DTC	Go to Step 12
12	Is there any other code in any controller that has not been diagnosed?	—	Go to Applicable DTC	Go to Step 13
13	Is the customer's concern with the engine?	—	Go to Diagnostic System Check - Engine Control	Go to Step 14
14	Is the customer's concern with the SRS airbag system?	—	Go to Diagnostic System Check SRS Control	Go to Step 15
15	Drive vehicle and verify if any engine or transmission related driveability concern exist. Perform Gearshift Control System Check as necessary. Refer to Gearshift Control System Check in this section. Does an engine or transmission driveability concern exist?	—	Go to Symptoms - Engine Controls in Engine Control Section or Diagnosis based on vehicle condition for Transmission	System OK

Tech 2 Does Not Communicate with Keyword Device

Circuit Description

The engine control module (ECM), transmission control module (TCM) and supplemental restraint system (SRS) control module communicates with the Tech 2 over the Keyword 2000 serial data link. However, the ECM, TCM, electric hydraulic control module (EHCU) (ABS module) and the data recording module (DRM) communicate with each other over the controller area network (CAN) link. The CAN link is not used for communication with the Tech 2 and is shared only among each module.

Diagnostic Aids

The following conditions will cause a loss of Keyword serial data communication between the ECM, TCM and SRS control module or between the Tech 2 and any control module:

- A Keyword serial data circuit open.
- A Keyword serial data circuit shorted to ground.
- A Keyword serial data circuit shorted to voltage.
- An internal condition within a module or connector on the Keyword serial data circuit, that causes a short to voltage or ground to the Keyword serial data circuit.

Tech 2 Does Not Communicate with Keyword Device

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Attempt to communicate with the listed control modules. • Engine control module (ECM) • Transmission control module (TCM) • Supplemental restraint system (SRS) control module (If so equipped) Does the Tech 2 communicate with all the listed control modules?	—	Go to Step 3	Go to Step 7
3	Does the Tech 2 communicate with the ECM?	—	Go to Step 4	Go to Diagnostic System Check - Engine Control
4	Does the Tech 2 communicate with the TCM?	—	Go to Step 5	Go to Lost Communication with The TCM
5	Does the Tech 2 communicate with the SRS control module?	—	Go to Step 6	Go to Diagnostic System Check -SRS Control
6	Test the Keyword serial data circuit for an intermittently short to ground or intermittently short to voltage. Then, test the Keyword serial data circuit for an intermittently open (based on which control module did not communicate) at the connection in the circuit. Did you find and correct the condition?	—	Go to Step 14	System OK
7	1. Turn OFF the ignition. 2. Disconnect the ECM E-111 and J-191 harness connectors. 3. Turn ON the ignition, with the engine OFF. 4. Attempt to communicate with the TCM and SRS control module. Does the Tech 2 communicate with the TCM and SRS control module?	—	Go to Step 11	Go to Step 8

Step	Action	Value(s)	Yes	No
8	1. Turn OFF the ignition. 2. Reconnect the ECM E-111 and J-191 harness connectors. 3. Disconnect the TCM B-425, B-426, B-427 and B-428 harness connectors. 4. Turn ON the ignition, with the engine OFF. 5. Attempt to communicate with the ECM and SRS control module. Does the Tech 2 communicate with the ECM and SRS control module?	—	Go to Step 12	Go to Step 9
9	1. Turn OFF the ignition. 2. Reconnect the TCM B-425, B-426, B-427 and B-428 harness connectors. 3. Disconnect the SRS B-243 control module harness connector. 4. Turn ON the ignition leaving the engine OFF. 5. Attempt to communicate with the ECM and TCM. Does the Tech 2 communicate with the ECM and TCM?	—	Go to Step 13	Go to Step 10
10	Repair the short to ground or short to voltage on the Keyword serial data circuit between the DLC and ECM, TCM and SRS control module. Did you complete the repair?	—	Go to Step 14	—
11	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement /Restore Fuel Injector ID Code Data in engine control section. Did you complete the replacement?	—	Go to Step 14	—
12	**Important:** Replacement TCM must be programmed. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 14	—
13	Replace the SRS control module. Refer to Supplemental Restraint System (SRS) control module Replacement in the restraint system section. Did you complete the replacement?	—	Go to Step 14	—
14	Attempt to communicate with the ECM, TCM and SRS control module. Does the Tech 2 communicate with the ECM, TCM and SRS control module?	—	System OK	Go to Step 2

Lost Communication with The Transmission Control Module (TCM)

Circuit Description

The engine control module (ECM), transmission control module (TCM) and supplemental restraint system (SRS) control module communicates with the Tech 2 over the Keyword 2000 serial data link. However, the ECM, TCM, electric hydraulic control module (EHCU) (ABS module) and the data recording module (DRM) communicate with each other over the controller area network (CAN) link. The CAN link is not used for communication with the Tech 2 and is shared only among each module.

Lost Communication with The Transmission Control Module (TCM)

Schematic Reference: Transmission Controls Schematics
Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	Attempt to establish transmission control module (TCM) communications with the Tech 2. Does the TCM communicate with the Tech 2?	—	Go to Intermittent Conditions	Go to Step 3
3	Check the TCM B-425, B-426, B-427 and B-428 connectors for poor connections. Did you find and correct the condition?	—	Go to Step 9	Go to Step 4
4	1. Turn ON the ignition, with the engine OFF. 2. Check the NEES (IG) (10A) fuse (F-17) in the glove box fuse block. Replace and retest if open. If any fuse continues to open, check for a short to ground on each circuit fed by that fuse. 3. Turn OFF the ignition. 4. Disconnect the TCM B-426 harness connector. 5. Turn ON the ignition, with the engine OFF. 6. Connect a test lamp to ground and check for voltage at the ignition voltage supply circuit at the ECM (pins 1 and 2 of B-426 connector). Does the test lamp illuminate?	—	Go to Step 5	Go to Step 7
5	1. Turn OFF the ignition. 2. Connect a DMM between the Keyword serial data circuit at the TCM (pin 9 of B-426 connector) and the data link connector (DLC) (pin 7 of B-79 connector). 3. Test the circuits for an open circuit or high resistance. 4. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 6
6	**Important:** An open in a ground circuit at the TCM will not cause a loss of communication. 1. Check TCM ground for corrosion and tightness. 2. Clean or tighten grounds as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 8

Step	Action	Value(s)	Yes	No
7	Repair the open in the ignition voltage circuit to the TCM. Did you complete the repair?	—	Go to Step 9	—
8	**Important:** Replacement TCM must be programmed. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 9	—
9	1. Turn OFF the ignition. 2. Reconnect all previously disconnected fuse or harness connector(s). 3. Turn the ignition ON with the engine OFF. 4. Attempt to establish Tech 2 communications with the ECM. Does the Tech 2 communicate with the TCM?	—	System OK	Go to Step 3

Engine Does Not Crank

Description

The Engine Does Not Crank diagnostic table is an organized approach to identifying a condition that causes an engine not crank. The diagnostic table directs the service technician to the appropriate system diagnosis. The diagnostic table assumes the following conditions are met:

- The battery is completely charged and terminals are cleaned and tight.
- Fuse and slow blow fuse are normal.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Test Description

The numbers below refers to the step number on the diagnostic table.

7. This step checks whether the starter cut relay command signal from TCM is canceled by the brake pedal signal.
8. This step checks whether the starter cut relay command signal from the TCM is canceled by the parking brake signal from the ECM.
9. This step checks whether the starter cut relay command signal from the TCM is canceled by the emergency switch signal.
10. If the vehicle parked in gear, the starter cut relay command is canceled by either of brake pedal, parking brake or emergency switch input. This step retests with the gear in neutral after engine is once started.

Engine Does Not Crank

Schematic Reference: Engine Controls Schematics and Transmission Controls Schematics
Connector End View Reference: Engine Controls Connector End Views, Engine Control Module (ECM) Connector End Views, Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Chart 1 of 3

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0602, P0605, P0613, P0851, P0852, P0906, P0907 or P0914 set?	—	Go to Applicable DTC	Go to Step 3
3	Operate the selector lever while observe the Selector Position parameter with the Tech 2. Does the Selector Position parameter indicate correct position?	—	Go to Step 4	Refer to DTC P0906 and P0907
4	1. Put the vehicle with the following conditions: • Selector lever N position • Release the brake pedal • Release the parking brake • Emergency switch OFF 2. Attempt to start the engine. Does the engine crank?	—	Go to Step 5	Go to Step 6
5	Does the engine start and idle?	—	System OK	Go to Engine Cranks But Does Not Run in Engine Control Section
6	1. Turn ON the ignition, with the engine OFF. 2. Observe the Starter Cut Relay Command parameter with the Tech 2. Does the Starter Cut Relay Command parameter indicate OFF?	—	Go to Chart 3 of 3 Step 1	Go to Step 7

Step	Action	Value(s)	Yes	No
7	Put the vehicle with the following conditions: • Selector lever N position • Apply the brake pedal • Release the parking brake • Emergency switch OFF Does the Starter Cut Relay Command parameter indicate OFF?	—	Go to Step 8	Go to Chart 2 of 3 Step 1
8	Put the vehicle with the following conditions: • Selector lever N position • Release the brake pedal • Apply the parking brake • Emergency switch OFF Does the Starter Cut Relay Command parameter indicate OFF?	—	Go to Step 9	Go to Chart 2 of 3 Step 11
9	Put the vehicle with the following conditions: • Selector lever N position • Release the brake pedal • Release the parking brake • Emergency switch ON Does the Starter Cut Relay Command parameter indicate OFF?	—	Go to Step 10	Go to Chart 2 of 3 Step 16
10	1. Put the vehicle with the following conditions: • Selector lever N position • Apply the brake pedal or parking brake • Emergency switch OFF 2. Start the engine. If the engine cranks but does not start, go to Engine Cranks But Does Not Run in the engine control section. 3. Set the gear position in neutral. 4. Stop the engine. 5. Put the vehicle with the following conditions: • Selector lever N position • Release the brake pedal • Release the park brake • Emergency switch OFF 6. Attempt to start the engine. Does the engine crank?	—	Go to Step 5	Go to Step 11

Step	Action	Value(s)	Yes	No
11	1. Visually inspect the gear shift position sensor for the following conditions: • Physical damage • Loose or improper installation 2. Inspect the gear shift position sensor output voltage. **Notice:** The gear shift position sensor voltage shifted to a lower or a higher voltage will cause no engine crank without DTC. 3. Remove the gear shift position sensor. Refer to Gear Shift Position Sensor Replacement in this section. 4. Visually inspect the gear shift position sensor for the following conditions: • Physical damage • Loose or improper installation • Shift lever damage that connects to the gear shift position sensor shaft. Did you find and correct the condition?	—	Go to Step 14	Go to Step 12
12	1. Turn OFF the ignition. 2. Disconnect the gear shift position sensor harness connector. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the gear shift position sensor (pins 1, 2 and 3 of J-142 connector). 4. Disconnect the TCM harness connector. 5. Inspect for an intermittent, for poor connections and corrosion on each gear shift position sensor circuit at the harness connector of the TCM (pins 18, 19 and 20 of B-426 connector). 6. Test for high resistance on each gearshift position sensor circuit. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 14	Go to Step 13
13	**Important:** Replacement gear shift position sensor must be relearned. Replace the gear shift position sensor. Refer to Gear Shift Position Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 14	—

Step	Action	Value(s)	Yes	No
14	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2 if stored. **Important:** Transmission Gear Select & Shift Position Learning must be done if the gear shift position sensor or transmission gearshift control box is replaced, removed or repaired. 3. Turn OFF the ignition for 30 seconds. 4. Put the vehicle with the following conditions: • Selector lever N position • Release the brake pedal • Release the parking brake • Emergency switch OFF 5. Attempt to start the engine. Does the engine crank?	—	Go to Step 5	Go to Step 2

Chart 2 of 3

Step	Action	Value(s)	Yes	No
1	1. Check to ensure the brake pedal switch is adjusted correctly. The plunger should be all the way in when the pedal is released, yet should not impede with the brake pedal full upward travel. 2. Adjust the brake pedal switch as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 2
2	1. Turn OFF the ignition. 2. Inspect the Stop Light (10A) fuse (F-5) in the glove box fuse block. Is the Stop Light (10A) fuse (F-5) open?	—	Go to Step 3	Go to Step 4
3	Replace the Stop Light (10A) fuse (F-5). If the fuse continues to open, repair the short to ground on one of the circuits that is fed by the Stop Light (10A) fuse (F-5) or replace the shorted attached component fed by the Stop Light (10A) fuse (F-5). Did you complete the repair?	—	Go to Step 25	—
4	1. Turn OFF the ignition. 2. Disconnect the brake pedal switch harness connector. 3. Connect a test lamp between the voltage feed circuit of the brake pedal switch harness (pin 1 of B-66 connector) and a known good ground. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 6
5	1. Turn ON the ignition, with the engine OFF. 2. Observe the Brake Pedal Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the brake pedal switch harness connector between pins 1 and 2 of the B-66 connector. Does the Tech 2 indicate Applied when the circuit is jumpered and Released when the circuit is not jumpered?	—	Go to Step 8	Go to Step 7

Step	Action	Value(s)	Yes	No
6	Repair the open circuit or high resistance on the voltage feed circuit between the Stop Light (10A) fuse (F-5) and the brake pedal switch (pin 1 of B-66 connector). Did you complete the repair?	—	Go to Step 25	—
7	1. Test the brake pedal switch signal circuit between the transmission control module (TCM) (pin 3 of B-428 connector) and the brake pedal switch (pin 2 of B-66 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 9
8	1. Turn OFF the ignition. 2. Disconnect the brake pedal switch harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the brake pedal switch (pins 1 and 2 of B-66 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for a poor connection on the brake switch circuit at the harness connector of the TCM (pin 3 of B-428 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 24
10	Replace brake pedal switch. Did you complete the replacement?	—	Go to Step 25	—
11	1. Turn OFF the ignition. 2. Disconnect the parking brake switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Parking Brake Switch parameter with the Tech 2 in the engine system menu while momentarily jumping 3-amp fused jumper wire between the parking brake pedal switch harness (pin 2 of N-6 connector) and a known good ground. Does the Tech 2 indicate Applied when the circuit is jumpered and Released when the circuit is not jumpered?	—	Go to Step 13	Go to Step 12
12	1. Test the parking brake switch signal circuit between the engine control module (ECM) (pin 48 of J-191 connector) and the parking brake switch (pin 2 of N-6 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 14

Step	Action	Value(s)	Yes	No
13	1. Turn OFF the ignition. 2. Disconnect the parking brake switch harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the parking brake switch (pin 2 of N-6 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 15
14	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector. 3. Inspect for an intermittent and for a poor connection on the parking brake switch circuit at the harness connector of the ECM (pin 48 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 23
15	Replace parking brake switch. Did you complete the replacement?	—	Go to Step 25	—
16	1. Turn OFF the ignition. 2. Disconnect the emergency switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the voltage feed circuit of the emergency switch harness (pin 1 of N-17 connector) and a known good ground. Does the test lamp illuminate?	—	Go to Step 17	Go to Step 18
17	1. Turn ON the ignition, with the engine OFF. 2. Observe the Emergency Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the emergency switch harness connector between pins 1 and 5 of the N-17 connector. Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 20	Go to Step 19
18	Repair the open circuit or high resistance on the voltage feed circuit between the Meter (10A) fuse (F-16) in the glove box fuse block and the emergency switch (pin 1 of N-17 connector). Did you complete the repair?	—	Go to Step 25	—
19	1. Test the emergency switch signal circuit between the TCM (pin 4 of B-428 connector) and the emergency switch (pin 5 of N-17 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 21

Step	Action	Value(s)	Yes	No
20	1. Turn OFF the ignition. 2. Disconnect the emergency switch harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the emergency switch (pins 1 and 5 of N-17 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 22
21	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for a poor connection on the emergency switch circuit at the harness connector of the TCM (pin 4 of B-428 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 25	Go to Step 24
22	Replace emergency switch. Did you complete the replacement?	—	Go to Step 25	—
23	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement /Restore Fuel Injector ID Code Data in engine control section. Did you complete the replacement?	—	Go to Step 25	—
24	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 25	—
25	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2 if stored. 3. Turn OFF the ignition for 30 seconds. 4. Put the vehicle with the following conditions: • Selector lever N position • Release the brake pedal • Release the parking brake • Emergency switch OFF 5. Attempt to start the engine. Does the engine crank?	—	Go to Chart 1 of 3 Step 5	Go to Chart 1 of 3 Step 6

Chart 3 of 3

Step	Action	Value(s)	Yes	No
1	1. Put the vehicle with the following conditions: • Selector lever N position • Release the brake pedal • Release the parking brake • Emergency switch ON 2. Attempt to start the engine. Does the engine crank?	—	Go to Step 3	Go to Step 2
2	1. Turn ON the ignition, with the engine OFF. 2. Observe the Emergency Switch parameter with the Tech 2. Does the Tech 2 indicate ON when the switch is ON and OFF when the switch is OFF?	—	Go to Step 13	Go to Step Chart 2 of 3 Step 16
3	1. Turn OFF the ignition. 2. Replace the starter cut relay with the marker lamp relay or replace with a known good relay. 3. Put the vehicle with the following conditions: • Selector lever N position • Release the brake pedal • Release the parking brake • Emergency switch OFF 4. Attempt to start the engine. Does the engine crank?	—	Go to Step 12	Go to Step 4
4	1. Turn OFF the ignition. 2. Remove the starter cut relay. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the starter cut relay (pins 1 and 4 of X-26 connector). Did you find and correct the condition?	—	Go to Step 33	Go to Step 5
5	1. Turn OFF the ignition. 2. Remove the starter cut relay. 3. Probe the ground circuit of the starter cut relay switch side (pin 1 of X-26 connector) with a test lamp that is connected to battery voltage. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 9
6	1. Probe the starter relay control circuit to the starter cut relay switch side (pin 4 of X-26 connector) with a DMM that is connected to a known good ground. 2. Make sure the emergency switch is OFF. 3. Turn Start the ignition while observing the DMM. Does the DMM voltage more than the specified value?	18.0 volts	Go to Step 7	Go to Step 10
7	1. Probe the control circuit of the starter cut relay (pin 5 of X-26 connector) with a test lamp that is connected to battery voltage. 2. Turn OFF the ignition for 30 seconds. 3. Disconnect the TCM harness connector (B-425 connector). 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 32

Step	Action	Value(s)	Yes	No
8	1. Turn OFF the ignition for 30 seconds. 2. Keep the test lamp with connected. 3. Disconnect the ECM harness connector (J-191 connector). 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 11	Go to Step 31
9	Repair the open circuit or high resistance on the ground circuit of the starter cut relay switch side between the starter cut relay (pin 1 of X-26 connector) and the chassis ground (J-9). Did you complete the repair?	—	Go to Step 33	—
10	Repair the open circuit or high resistance on the starter relay control circuit to the starter cut relay switch side between the starter relay (pin 5 of X-21 connector) and the starter cut relay (pin 4 of X-26 connector). Did you complete the repair?	—	Go to Step 33	—
11	Repair the short to ground on the starter cut relay control circuit between the TCM (pin 16 of B-425 connector) or ECM (pin 14 of J-191 connector) and the starter cut relay (pin 5 of X-26 connector). Did you complete the repair?	—	Go to Step 33	—
12	Replace the starter cut relay. Did you compete the replacement?	—	Go to Step 33	—
13	1. Turn OFF the ignition. 2. Replace the starter relay with the glow relay or replace with a known good relay. 3. Put the vehicle with the following conditions: • Selector lever N position • Release the brake pedal • Release the parking brake • Emergency switch OFF 4. Attempt to start the engine. Does the engine crank?	—	Go to Step 29	Go to Step 14
14	1. Turn OFF the ignition. 2. Remove the starter relay. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the starter relay (pins 1, 2, 4 and 5 of X-21 connector). Did you find and correct the condition?	—	Go to Step 33	Go to Step 15
15	Probe the starter relay battery voltage feed circuit (pin 2 of X-21 connector) with a test lamp that is connected to a known good ground. Does the test lamp illuminate?	—	Go to Step 16	Go to Step 23
16	1. Probe the starter relay ignition voltage feed circuit (pin 4 of X-21 connector) with a test lamp that is connected to a known ground. 2. Turn Start the ignition while observing the test lamp. Does the test lamp illuminate?	—	Go to Step 17	Go to Step 24

Step	Action	Value(s)	Yes	No
17	1. Test the starter C terminal circuit between the starter relay (pin 1 of X-21 connector) and the starter C terminal for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 33	Go to Step 18
18	1. Turn OFF the ignition. 2. Reinstall the starter relay. 3. Replace the emergency relay with the dimmer relay or replace with a known good relay. 4. Put the vehicle with the following conditions: • Selector lever N position • Release the brake pedal • Release the parking brake • Emergency switch OFF 5. Attempt to start the engine. Does the engine crank?		Go to Step 30	Go to Step 19
19	1. Turn OFF the ignition. 2. Remove the emergency relay. 3. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the emergency relay (pins 1, 2, 3 and 5 of X-14 connector). Did you find and correct the condition?	—	Go to Step 33	Go to Step 20
20	Probe the emergency relay ground circuits (pins 2 and 5 of X-14 connector) with a test lamp that is connected to battery voltage. Does the test lamp illuminate?	—	Go to Step 21	Go to Step 25
21	1. Probe the emergency relay voltage feed circuit (pin 3 of X-21 connector) with a test lamp that is connected to a known ground. 2. Turn ON the ignition, with the engine OFF. 3. Turn ON the emergency switch. Does the test lamp illuminate?	—	Go to Step 22	Go to Step 26
22	1. Probe the starter relay control circuit to the emergency relay switch side (pin 1 of X-14 connector) with a DMM that is connected to a known good ground. 2. Turn OFF the emergency switch. 3. Turn Start the ignition while observing the DMM. Does the DMM voltage more than the specified value?	18.0 volts	Go to Step 28	Go to Step 27
23	Repair the open circuit or high resistance on the battery voltage feed circuit between the starter relay (pin 2 of X-21 connector) and the battery terminal. Check the Starter (60A) slow blow fuse (SBF-8) is first. Did you complete the repair?	—	Go to Step 33	—

Step	Action	Value(s)	Yes	No
24	Repair the open circuit or high resistance on the ignition voltage feed circuit between the starter relay (pin 4 of X-21 connector) and the starter switch (pin 4 of B-67 connector). Check the Starter (10A) fuse (F-22) is first. Did you complete the repair?	—	Go to Step 33	—
25	Repair the open circuit or high resistance on the ground circuits of the emergency relay between the emergency relay (pins 2 and 5 of X-14 connector) and the ground (B-7). Did you complete the repair?	—	Go to Step 33	—
26	Repair the open circuit or high resistance on the emergency switch voltage feed circuit between the emergency relay (pin 3 of X-14 connector) and the emergency switch (pin 5 of N-17 connector). Did you complete the repair?	—	Go to Step 33	—
27	Repair the open circuit or high resistance on the starter relay control circuit to the emergency relay switch side between the starter relay (pin 5 of X-21 connector) and the emergency relay (pin 1 of X-14 connector). Did you complete the repair?	—	Go to Step 33	—
28	Repair or replace the starter motor. Refer to starting and charging system in the engine section. Did you complete the repair?	—	Go to Step 33	—
29	Replace the starter relay. Did you complete the replacement?	—	Go to Step 33	—
30	Replace the emergency relay. Did you compete the replacement?	—	Go to Step 33	—
31	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement /Restore Fuel Injector ID Code Data in engine control section. Did you complete the replacement?	—	Go to Step 33	—
32	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 33	—

Step	Action	Value(s)	Yes	No
33	1. Reconnect all previously disconnected fuse, relay or harness connector(s). 2. Clear the DTCs with the Tech 2 if stored. 3. Turn OFF the ignition for 30 seconds. 4. Put the vehicle with the following conditions: • Selector lever N position • Release the brake pedal • Release the parking brake • Emergency switch OFF 5. Attempt to start the engine. Does the engine crank?	—	Go to Chart 1 of 3 Step 5	Go to Chart 1 of 3 Step 6

Diagnostic Trouble Code (DTC) List

DTC	Flash Code	W/L Status	Buzzer Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0602	—	Blinks	Intermittently ON	Control Module Not Programmed	—	• Vehicle information is not programmed.	• Vehicle information is not programmed and learned.
P0605	33	ON	Continuity ON	Control Module Internal Performance	—	Either of following condition is met: • The TCM detects a malfunction in its internal Random Access Memory (RAM). • The TCM detects a calculated checksum does not agree with the TCM internal registered checksum.	• Faulty TCM.
P0613	33	ON	Continuity ON	Control Module EEPROM Error	—	• The TCM detects a faulty learning data in the Electronically Erasable Programmable Read Only Memory (EEPROM).	• Faulty TCM.
P0710	21	ON	OFF	Transmission Fluid Temperature Sensor Circuit	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	• The TCM detects that the TFT sensor signal voltage is less than 0.1 volts (more than 165°C [329°F]) or more than 4.9 volts (less than −50°C [−58°F]).	• Sensor signal circuit is short to battery or ignition voltage or short to any 5V reference circuit, short to ground, short to the low reference circuit, open circuit or high resistance. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor. • Faulty TCM.
P0715	3	ON	OFF	Turbine Speed Sensor Circuit	• DTCs P0721, P0726, U0400 and U0406 are not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The engine is running. • The lock up clutch is commanded engage.	• The TCM detects that the turbine speed sensor pulses are not generated during lock up control.	• Faulty sensor installation condition. • Faulty sensor wheel (gearshift clutch case). • Sensor signal circuit is short to battery or ignition voltage, short to any 5V reference circuit, short to ground, open circuit or high resistance. • Sensor low circuit is open circuit or high resistance. • Sensor circuits short to each other. • Poor harness connector connection. • Faulty sensor. • Faulty TCM. • Electromagnetic interference and electrical noise.

DTC	Flash Code	W/L Status	Buzzer Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0717	2	ON	OFF	Input Speed Sensor Circuit	• DTCs P0715, P0718, P0721, P0726, U0400 and U0406 are not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The engine is running. • The turbine speed is more than 500 RPM. • The vehicle speed is more than 10 km/h (6 MPH). • The gearshift clutch is commanded engage.	• The TCM detects that the input shaft speed sensor pulses are not generated during vehicle running.	• Faulty sensor installation condition. • Faulty sensor wheel (counter shaft). • Sensor signal circuit is short to battery or ignition voltage, short to any 5V reference circuit, short to ground, open circuit or high resistance. • Sensor low circuit is open circuit or high resistance. • Sensor circuits short to each other. • Poor harness connector connection. • Faulty sensor. • Faulty TCM. • Electromagnetic interference and electrical noise.
P0718	17	ON	OFF	Gearshift Clutch Slip Error	• DTCs P0715 and P0717 are not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	• The TCM detects that the input shaft speed is less than the turbine speed 300 RPM or more when the gearshift clutch is commanded engage.	• Faulty ATF amount. • Faulty line pressure (low). • Faulty oil pump. • Faulty gearshift clutch. • Faulty gearshift clutch solenoid valve. • Faulty gearshift clutch oil pressure circuits. • Faulty band brake. • Faulty input shaft speed sensor.
P0721	26	ON	OFF	Output Speed Sensor Performance	• DTCs P0717, P0904, P0914 and U0100 are not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The input shaft speed is more than 1500 RPM. • The current gear is other than neutral.	• The TCM detects that the output shaft speed is less than 30 RPM during the vehicle running.	• Faulty sensor installation. • Sensor voltage feed circuit is open circuit or high resistance. • Sensor signal circuit is short to battery or ignition voltage, short to ground, open circuit or high resistance. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor. • Faulty ECM. • Faulty TCM. • Electromagnetic interference and electrical noise.

DTC	Flash Code	W/L Status	Buzzer Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0726	16	ON	OFF	Lock Up Clutch Slip Error	• DTCs P0715, P0740, P0742 and U0400 are not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	• The TCM detects that the turbine speed is less than the engine speed 300 RPM or more when the lock up clutch is commanded engage.	• Faulty ATF amount. • Faulty line pressure (low). • Faulty oil pump. • Faulty fluid coupling. • Faulty lock up clutch solenoid valve. • Faulty lock up clutch oil pressure circuits. • Faulty turbine speed sensor.
P0740	67	ON	OFF	Lock Up Clutch Solenoid Circuit High Voltage	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The smoother main relay is commanded ON.	• The TCM detects a high voltage condition on the lock up clutch solenoid valve control circuit when the solenoid valve is commanded OFF.	• Solenoid valve control circuit is short to battery or ignition voltage, open circuit or high resistance. • Poor harness connector connection. • Faulty solenoid valve. • Faulty TCM.
P0742	67	ON	OFF	Lock Up Clutch Solenoid Circuit Low Voltage	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The smoother main relay is commanded ON.	• The TCM detects a low voltage condition on the lock up clutch solenoid valve control circuit when the solenoid valve is commanded ON.	• Solenoid valve control circuit is short ground. • Poor harness connector connection. • Faulty solenoid valve. • Faulty TCM.
P0851	6	OFF	OFF	Neutral Switch Circuit Low Voltage	• DTC P0914 is not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	• The TCM detects that the neutral switch signal is continuously OFF (other than neutral) when the current gear is neutral.	• Switch voltage feed circuit is open circuit or high resistance. • Switch signal circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty switch installation. • Faulty gearshift control box internal lever. • Faulty switch • Faulty gear shift position sensor. • Faulty 1-3-5 shift solenoid. • Faulty 2-4-6-R shift solenoid. • Faulty TCM.

DTC	Flash Code	W/L Status	Buzzer Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0852	7	OFF	OFF	Neutral Switch Circuit High Voltage	• DTC P0914 is not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	• The TCM detects that the neutral switch signal is continuously ON (neutral) when the current gear is other than neutral.	• Switch signal circuit is short to battery or ignition voltage. • Poor harness connector connection. • Faulty switch installation. • Faulty gearshift control box internal lever. • Faulty switch • Faulty gear shift position sensor. • Faulty 1-3-5 shift solenoid. • Faulty 2-4-6-R shift solenoid. • Faulty TCM.
P0885	38	ON	Continuity ON (Open Stuck DTC)/OFF (Close Stuck DTC)	TCM Power Relay Control Circuit	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	Open stuck DTC • The TCM detects a low voltage condition on the smoother main relay voltage feed circuit when the relay is commanded ON. Close stuck DTC • The TCM detects a high voltage condition on the smoother main relay voltage feed circuit when the relay is commanded OFF.	• Relay power feed circuit is open circuit or high resistance. • Relay control circuit is short to ground, open circuit or high resistance. • Relay voltage feed circuit is short to battery, open circuit or high resistance. • Poor harness connector connection. • Faulty relay. • Faulty TCM.
P0889	39	ON	Continuity ON (Open Stuck DTC)/OFF (Close Stuck DTC)	Gearshift Relay Control Circuit	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	Open stuck DTC • The TCM detects a low voltage condition on the 1-3-5 shift solenoid, 2-4-6-R shift solenoid and select solenoid voltage feed circuit when the gearshift control box relay is commanded ON. Close stuck DTC • The TCM detects a high voltage condition on the 1-3-5 shift solenoid, 2-4-6-R shift solenoid and select solenoid voltage feed circuit when the gearshift control box relay is commanded OFF.	• Relay power feed circuit is open circuit or high resistance. • Relay control circuit is short to ground, open circuit or high resistance. • Relay voltage feed circuit is short to battery, open circuit or high resistance. • Poor harness connector connection. • Faulty relay. • Faulty TCM.
P0902	65	ON	Intermittently ON	Clutch Actuator Circuit Low Voltage	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The smoother main relay is commanded ON.	• The TCM detects a low voltage condition on the gearshift clutch solenoid valve control circuit when the solenoid valve is commanded ON.	• Solenoid valve control circuit is short ground. • Poor harness connector connection. • Faulty solenoid valve. • Faulty TCM.

DTC	Flash Code	W/L Status	Buzzer Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0903	65	ON	Intermittently ON	Clutch Actuator Circuit High Voltage	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The smoother main relay is commanded ON.	• The TCM detects a high voltage condition on the gearshift clutch solenoid valve control circuit when the solenoid valve is commanded OFF.	• Solenoid valve control circuit is short to battery or ignition voltage, open circuit or high resistance. • Poor harness connector connection. • Faulty solenoid valve. • Faulty TCM.
P0904	58	ON	OFF	Gate Select Position Circuit	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	• The TCM detects that the gear select position sensor signal voltage is less than 0.5 volts or more than 4.5 volts.	• Sensor 5V reference circuit is short to battery or ignition voltage, short to ground, short to the low reference circuit, open circuit or high resistance. • Sensor signal circuit is short to battery or ignition voltage, short to any 5V reference circuit, short to ground, short to the low reference circuit, open circuit or high resistance. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor installation condition. • Faulty sensor. • Faulty TCM.
P0906	52	ON	OFF	Selector Lever Circuit	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	Either of following condition is met: • The TCM detects two or more selector lever N, D and R switch signal is ON (pulled to ground). • The TCM detects two or more selector lever A, + and – switch signal is ON (pulled to ground) when the selector lever N, D or R switch signal is ON (pulled to ground).	• Switch signal circuit is short to ground or short each other. • Faulty switch installation condition. • Faulty switch. • Faulty selector lever. • Faulty TCM.
P0907	51	OFF	OFF	Selector Lever Circuit	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	• The TCM detects that the selector lever N, D and R switch signals are OFF (open circuit) at the same time.	• Switch signal circuit is open circuit or high resistance. • Switch ground circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty switch installation condition. • Faulty switch. • Faulty selector lever. • Faulty TCM.

DTC	Flash Code	W/L Status	Buzzer Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0909	76	ON	OFF	Gate Select Control Error	• DTCs P0718, P0889, P0902, P0903, P0904, P0912, P0913, P0914, P0973, P0974, P0976 and P0977 are not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The gearshift control box relay is commanded ON. • The selector lever is other than N position.	• The TCM detects the gear select side lever position does not reach to a desired select position continuously when shifting to desired gear.	• Faulty gear select position sensor. • Faulty gear select position sensor installation condition. • Faulty select solenoid valve. • Faulty select solenoid valve installation condition. • Faulty gear select lever shaft. • Faulty gearshift control box. • Select lever stuck. • Incorrect vehicle information programming (transmission type).
P0912	75	ON	Intermittently ON	Select Solenoid Valve Circuit High Voltage	• DTC P0889 is not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The gearshift control box relay is commanded ON.	• The TCM detects a high voltage condition on the select solenoid valve monitor circuit when the solenoid valve is commanded OFF.	• Solenoid valve voltage feed circuit is open circuit or high resistance. • Solenoid valve control circuit is short to battery or ignition voltage, open circuit or high resistance. • Solenoid valve ground circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty solenoid valve. • Faulty TCM.
P0913	75	ON	Intermittently ON	Select Solenoid Valve Circuit Low Voltage	• DTC P0889 is not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The gearshift control box relay is commanded ON.	• The TCM detects a low voltage condition on the select solenoid valve monitor circuit when the solenoid valve is commanded ON.	• Solenoid valve control circuit is short to ground. • Faulty solenoid valve. • Faulty TCM.

DTC	Flash Code	W/L Status	Buzzer Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0914	57	ON	OFF	Gear Shift Position Circuit	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	• The TCM detects that the gear shift position sensor signal voltage is less than 0.5 volts or more than 4.5 volts.	• Sensor 5V reference circuit is short to battery or ignition voltage, short to ground, short to the low reference circuit, open circuit or high resistance. • Sensor signal circuit is short to battery or ignition voltage, short to any 5V reference circuit, short to ground, short to the low reference circuit, open circuit or high resistance. • Sensor low reference circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty sensor installation condition. • Faulty sensor. • Faulty TCM.
P0915	74	ON	OFF	Gear Shift Position Control Disengage Error	• DTCs P0718, P0889, P0902, P0903, P0904, P0912, P0913, P0914, P0973, P0974, P0976 and P0977 are not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The gearshift control box relay is commanded ON. • The selector lever is other than N position.	• The TCM detects the gear shift side lever position does not reach to a desired shift position and it keeping a previously engaged gear position continuously when shifting to desired gear. This indicates that the TCM detects gear stuck at an engaged position.	• Faulty gear shift position sensor. • Faulty gear shift position sensor installation condition. • Faulty 1-3-5 or 2-4-6-R shift solenoid valve. • Faulty 1-3-5- or 2-4-6-R shift solenoid valve installation condition. • Faulty gear shift lever shaft. • Faulty gearshift control box. • Shift lever stuck. • Faulty gearshift clutch (stuck engage). • Transmission stuck.
P0919	72	ON	OFF	Gear Shift Position Engage Error	• DTCs P0718, P0889, P0902, P0903, P0904, P0912, P0913, P0914, P0973, P0974, P0976 and P0977 are not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The gearshift control box relay is commanded ON. • The selector lever is other than N position.	• The TCM detects the gear shift side lever position does not reach to a desired shift position continuously when shifting to desired gear.	• Faulty gear shift position sensor. • Faulty gear shift position sensor installation condition. • Faulty 1-3-5 or 2-4-6-R shift solenoid valve. • Faulty 1-3-5- or 2-4-6-R shift solenoid valve installation condition. • Faulty gear shift lever shaft. • Faulty gearshift control box. • Shift lever stuck. • Faulty gearshift clutch (stuck engage). • Transmission stuck.

DTC	Flash Code	W/L Status	Buzzer Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P0973	71	ON	Intermittently ON	2-4-6-R Shift Solenoid Valve Circuit High Voltage	• DTC P0889 is not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The gearshift control box relay is commanded ON.	• The TCM detects a high voltage condition on the 2-4-6-R shift solenoid valve monitor circuit when the solenoid valve is commanded OFF.	• Solenoid valve voltage feed circuit is open circuit or high resistance. • Solenoid valve control circuit is open circuit or high resistance. • Solenoid valve ground circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty solenoid valve. • Faulty TCM.
P0974	71	ON	Intermittently ON	2-4-6-R Shift Solenoid Valve Circuit Low Voltage	• DTC P0889 is not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The gearshift control box relay is commanded ON.	• The TCM detects a low voltage condition on the 2-4-6-R shift solenoid valve monitor circuit when the solenoid valve is commanded ON.	• Solenoid valve control circuit is short to ground. • Faulty solenoid valve. • Faulty TCM.
P0976	73	ON	Intermittently ON	1-3-5 Shift Solenoid Valve Circuit High Voltage	• DTC P0889 is not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The gearshift control box relay is commanded ON.	• The TCM detects a high voltage condition on the 1-3-5 shift solenoid valve monitor circuit when the solenoid valve is commanded OFF.	• Solenoid valve voltage feed circuit is open circuit or high resistance. • Solenoid valve control circuit is short to battery or ignition voltage, open circuit or high resistance. • Solenoid valve ground circuit is open circuit or high resistance. • Poor harness connector connection. • Faulty solenoid valve. • Faulty TCM.
P0977	73	ON	Intermittently ON	1-3-5 Shift Solenoid Valve Circuit Low Voltage	• DTC P0889 is not set. • The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The gearshift control box relay is commanded ON.	• The TCM detects a low voltage condition on the 1-3-5 shift solenoid valve monitor circuit when the solenoid valve is commanded ON.	• Solenoid valve control circuit is short to ground. • Faulty solenoid valve. • Faulty TCM.

DTC	Flash Code	W/L Status	Buzzer Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
P1901	19	OFF	OFF	Clutch Adjustment Switch (Fast) Circuit	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The vehicle speed is more than 5 km/h (3 MPH).	• The TCM detects that the half-clutch adjustment fast switch signal is stuck at the ON position (high voltage).	• Switch signal circuit is short to battery or ignition voltage. • Faulty switch. • Faulty TCM.
P1902	19	OFF	OFF	Clutch Adjustment Switch (Slow) Circuit	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF. • The vehicle speed is more than 5 km/h (3 MPH).	• The TCM detects that the half-clutch adjustment slow switch signal is stuck at the ON position (high voltage).	• Switch signal circuit is short to battery or ignition voltage. • Faulty switch. • Faulty TCM.
U0100	42	ON	OFF	CAN-BUS Error	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	• The TCM detects that the CAN Bus messages are not being received.	• CAN Low circuit is short to battery or ignition voltage, short to ground, open circuit or high resistance. • CAN High circuit is short to battery or ignition voltage, short to ground, open circuit or high resistance. • Faulty resistor 1. • Faulty resistor 2. • Faulty ECM. • Faulty DRM. • Faulty TCM. • Faulty EHCU. • Electromagnetic interference and electrical noise.
U0121	68	OFF	OFF	ABS Signal Line Error	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	• The TCM detects that the CAN Bus messages from the EHCU are not being received.	• CAN Low circuit to the EHCU is open circuit. • CAN High circuit to the EHCU is open circuit. • Faulty resistor 1. • Faulty resistor 2. • Faulty ECM. • Faulty EHCU. • Electromagnetic interference and electrical noise.

DTC	Flash Code	W/L Status	Buzzer Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
U0400	23	ON	OFF	Engine Speed Signal Error	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	• The TCM detects that the engine speed CAN Bus messages from the ECM are not being received.	• Faulty crankshaft position sensor circuits. • Faulty camshaft position sensor circuits. • CAN Low circuit is short to battery or ignition voltage, short to ground, open circuit or high resistance. • CAN High circuit is short to battery or ignition voltage, short to ground, open circuit or high resistance. • Faulty resistor 1. • Faulty resistor 2. • Faulty ECM. • Faulty DRM. • Faulty TCM. • Faulty EHCU. • Electromagnetic interference and electrical noise.
U0401	24	ON	OFF	Accelerator Sensor Signal Malfunction	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	• The TCM detects that the accelerator pedal position CAN Bus messages from the ECM are not being received.	• Faulty accelerator pedal position sensor circuits. • CAN Low circuit is short to battery or ignition voltage, short to ground, open circuit or high resistance. • CAN High circuit is short to battery or ignition voltage, short to ground, open circuit or high resistance. • Faulty resistor 1. • Faulty resistor 2. • Faulty ECM. • Faulty DRM. • Faulty TCM. • Faulty EHCU. • Electromagnetic interference and electrical noise.

DTC	Flash Code	W/L Status	Buzzer Status	DTC Name	Condition for Running the DTC	Condition for Setting the DTC	Possible Cause
U0406	25	ON	OFF	Vehicle Speed Signal Error	• The ignition switch is ON. • The ignition voltage is more than 20 volts. • The emergency switch is OFF.	• The TCM detects that the vehicle speed CAN Bus messages from the ECM are not being received.	• Faulty vehicle speed sensor circuits. • CAN Low circuit is short to battery or ignition voltage, short to ground, open circuit or high resistance. • CAN High circuit is short to battery or ignition voltage, short to ground, open circuit or high resistance. • Faulty resistor 1. • Faulty resistor 2. • Faulty ECM. • Faulty DRM. • Faulty TCM. • Faulty EHCU. • Electromagnetic interference and electrical noise.

P0602

Description

The transmission control module (TCM) has the ability to set a diagnostic trouble code (DTC) if it detects that there is no vehicle information programmed.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM intermittently sounds buzzer when the diagnostic runs and fails.
- The TCM inhibits gearshift control under certain conditions.

Condition for Clearing the DTC

- The TCM blinks the transmission warning lamp when the diagnostic runs and does not fail, and turns OFF the transmission warning lamp when the initial learning is completed.
- The TCM stops the buzzer when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

Notice:

- Production and service TCM does not require software programming when it is replaced except calibration software update. This DTC indicates that a production or service TCM did not program vehicle information and learn.

DTC P0602

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	Program and learn the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the programming?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0605 (Flash Code 33)

Description

This diagnostic applies to internal microprocessor integrity conditions within the transmission control module (TCM).

Condition for Setting the DTC

Either of following condition is met:

- The TCM detects a malfunction in its internal Random Access Memory (RAM).
- The TCM detects a calculated checksum does not agree with the TCM internal registered checksum.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM continuously sounds buzzer when the diagnostic runs and fails.
- The TCM inhibits transmission control.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- The TCM stops the buzzer when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears with the Tech 2 or reset switch operation.

DTC P0605 (Flash Code 33)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0613 (Flash Code 33)

Description

This diagnostic applies to internal microprocessor integrity conditions within the transmission control module (TCM).

Condition for Setting the DTC

- The TCM detects a faulty learning data in the Electronically Erasable Programmable Read Only Memory (EEPROM).

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM continuously sounds buzzer when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- The TCM stops the buzzer when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

DTC P0613 (Flash Code 33)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 4
3	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 4	—
4	1. Clear the DTCs with the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 5
5	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0710 (Flash Code 21)

Circuit Description

The transmission fluid temperature (TFT) sensor is located on the oil pump assembly and soaked in the transmission fluid. The TFT sensor is a variable resistor. The TFT sensor has a signal circuit and a low reference circuit. The transmission control module (TCM) supplies 5 volts to the TFT sensor signal circuit and a ground for the TFT sensor low reference circuit. When the TFT is cold, the sensor resistance is high. When the TFT increases, the sensor resistance decreases. With high sensor resistance, the TCM detects a high voltage on the TFT sensor signal circuit. With lower sensor resistance, the TCM detects a lower voltage on the TFT sensor signal circuit. If the TCM detects an excessively low or high TFT signal voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

- The TCM detects that the TFT sensor signal voltage is less than 0.1 volts (more than 165°C [329°F]) or more than 4.9 volts (less than −50°C [−58°F]).

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM uses a TFT substitution of 50°C (122°F) for transmission control.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Use the Temperature vs. Resistance table to test the TFT sensor at various temperature levels to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.
- If this DTC is present, harsh garage shift appears when shifted from N to D or N to R.

DTC P0710 (Flash Code 21)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Transmission Fluid Temperature (TFT) Sensor parameter with the Tech 2. **Notice:** If the TFT sensor signal voltage is more than 4.9 volts, the TFT Sensor parameter on the Tech 2 indicates a default value when the ignition has been turned ON for longer than 5 seconds. Does the TFT Sensor parameter ever exceed the specified value within 5 seconds after the ignition switch is ON?	4.9 volts	Go to Step 4	Go to Step 3
3	**Notice:** If the TFT sensor signal is less than 0.1 volts, the TFT Sensor parameter on the Tech 2 indicates a default value when the ignition has been turned ON for longer than 5 seconds. Does the TFT Sensor parameter ever fall below the specified value within 5 seconds after the ignition switch is ON?	0.1 volts	Go to Step 14	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the in-line harness connector (J-237) near the starter motor. 3. Connect a DMM between the signal circuit of the TFT sensor harness (pin 2 of J-237 female connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	5.5 volts	Go to Step 5	Go to Step 6
5	**Important:** The TFT sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the transmission control module (TCM) (pin 6 of B-427 connector) and the in-line connector (pin 2 of J-237 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
6	1. Turn OFF the ignition. 2. Connect a test lamp between the signal circuit of the TFT sensor harness (pin 2 of J-237 female connector) and a known good ground. 3. Connect a DMM between the probe of the test lamp and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 10	Go to Step 7
7	1. Turn OFF the ignition. 2. Connect a DMM across the signal circuit and low reference circuit of the TFT sensor harness (pins 2 and 4 of J-237 female connector). 3. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 11	Go to Step 8
8	1. Test the signal circuit between the TCM (pin 6 of B-427 connector) and the in-line harness connector (pin 2 of J-237 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 9
9	1. Test the low reference circuit between the TCM (pin 12 of J-237 connector) and the in-line harness connector (pin 4 of J-237 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 12
10	1. Test the signal circuit between the TCM (pin 6 of B-427 connector) and the in-line harness connector (pin 2 of J-237 connector) for a short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18

Step	Action	Value(s)	Yes	No
11	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the in-line harness connector (pins 2 and 4 of J-237 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 13
12	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for poor connections on the TFT sensor circuits at the harness connector of the TCM (pins 6 and 12 of B-427 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
13	1. Remove the harness assembly from the oil pump. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. 2. Test the signal circuit between the TFT sensor and the in-line harness connector (pin 2 of J-237 connector) for the following conditions: • An open circuit • A short to the solenoid valve circuit • High resistance 3. Test the low reference circuit between the TFT sensor and the in-line harness connector (pin 4 of J-237 connector) for an open circuit or high resistance. 4. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 17
14	1. Turn OFF the ignition. 2. Disconnect the in-line harness connector (J-237) near the starter motor. 3. Connect a DMM between the signal circuit of the TFT sensor harness (pin 2 of J-237 female connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 16	Go to Step 15
15	1. Test the signal circuit between the TCM (pin 6 of B-427 connector) and the in-line harness connector (pin 2 of J-237 connector) for a short to ground or short to the low reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
16	1. Test the signal circuit between the TFT sensor and the in-line harness connector (pin 2 of J-237 connector) for a short to ground or short to the low reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 17
17	Replace the TFT sensor. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. (TFT sensor is part of the harness assembly) Did you complete the replacement?	—	Go to Step 19	—

Step	Action	Value(s)	Yes	No
18	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 19	—
19	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 20
20	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0715 (Flash Code 3)

Circuit Description

The turbine speed sensor is located on right-hand side of the fluid coupling housing. The turbine speed sensor is a magnetic coil type sensor, which generates an AC signal voltage based on the gearshift multi-plate clutch rotational speed that is part of the sub-hub assembly attached to the fluid coupling turbine by spline. (30 pulses per a rotation of the gearshift multi-plate clutch) If the transmission control module (TCM) detects no turbine speed sensor signal during the lock up clutch is engaged, this DTC will set.

Condition for Running the DTC

- DTCs P0721, P0726, U0400 and U0406 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The engine is running.
- The lock up clutch is commanded engage.

Condition for Setting the DTC

- The TCM detects that the turbine speed sensor pulses are not generated during lock up control.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Electrical or magnetic interference may affect intermittent condition.
- Ensure the sensor is tight and the gearshift multi-plate clutch case is not damaged.
- If this DTC is present, harsh garage shift appears when shifted from N to D or N to R.

DTC P0715 (Flash Code 3)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Place the transmission in neutral and set the parking brake. 4. Start the engine. 5. Observe the Turbine Speed parameter with the Tech 2 while accelerating the engine between idle and W.O.T. (accelerator pedal full travel). Does the Turbine Speed parameter increase in accordance with an engine speed increase?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the turbine speed sensor harness connector. 3. Connect a DMM across the turbine speed sensor terminals. 4. Measure the resistance across the turbine speed sensor. Does the turbine speed sensor resistance measure within the specified range?	1.0 - 2.5kΩ	Go to Step 4	Go to Step 16

Step	Action	Value(s)	Yes	No
4	1. Connect a DMM across the turbine speed sensor terminals (measure sensor output voltage). 2. Place the DMM on the AC volt scale. 3. Start the engine. 4. Monitor the DMM while accelerating the engine between idle and W.O.T. (accelerator pedal full travel). Does the DMM indicate an AC voltage increase in accordance with an engine speed increase?	—	Go to Step 5	Go to Step 15
5	1. Connect a DMM between the signal circuit of the turbine speed sensor harness (pin 2 of J-232 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	5.5 volts	Go to Step 9	Go to Step 6
6	Is the DMM voltage more than the specified value at Step 5?	4.5 volts	Go to Step 7	Go to Step 11
7	1. Connect a test lamp between the signal circuit of the turbine speed sensor harness (pin 2 of J-232 connector) and a known good ground. 2. Connect a DMM between the probe of the test lamp and a known good ground. 3. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 10	Go to Step 8
8	1. Connect a DMM across the signal circuit and the low reference circuit of the turbine speed sensor harness (pins 1 and 2 of J-232 connector). 2. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 13	Go to Step 12
9	**Important:** The turbine speed sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the transmission control module (TCM) (pin 4 of B-427 connector) and the turbine speed sensor connector (pin 2 of J-232 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 17
10	1. Test the signal circuit between the TCM (pin 4 of B-427 connector) and the turbine speed sensor harness connector (pin 2 of J-232 connector) for a short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 17

Step	Action	Value(s)	Yes	No
11	1. Test the signal circuit between the TCM (pin 4 of B-427 connector) and the turbine speed sensor harness connector (pin 2 of J-232 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 14
12	1. Test the low reference circuit between the TCM (pin 10 of B-427 connector) and the turbine speed sensor harness connector (pin 1 of J-232 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 14
13	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the turbine speed sensor (pins 1 and 2 of J-232 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 15
14	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for poor connections on the turbine speed sensor circuits at the harness connector of the TCM (pins 4 and 10 of B-427 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 17
15	1. Remove the turbine speed sensor. Refer to Turbine Speed Sensor Replacement in this section. 2. Visually inspect the turbine speed sensor for the following conditions: • Physical damage • Loose or improper installation 3. The following conditions may cause this DTC to set: • Excessive air gap between the turbine speed sensor and the gearshift multi-plate clutch case • Electromagnetic interference in the turbine speed sensor circuits • Foreign material passing between the turbine speed sensor and the gearshift multi-plate clutch case Did you find and correct the condition?	—	Go to Step 18	Go to Step 16
16	Replace the turbine speed sensor. Refer to Turbine Speed Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—

Step	Action	Value(s)	Yes	No
17	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—
18	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 19
19	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0717 (Flash Code 2)

Circuit Description

The input shaft speed sensor is located on left-hand side of the transmission housing. The input shaft speed sensor is a magnetic coil type sensor, which generates an AC signal voltage based on the counter shaft rotational speed. If the transmission control module (TCM) detects no input shaft speed sensor signal during the vehicle running, this DTC will set.

Condition for Running the DTC

- DTCs P0715, P0718, P0721, P0726, U0400 and U0406 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The engine is running.
- The turbine speed is more than 500 RPM.
- The vehicle speed is more than 10 km/h (6 MPH).
- The gearshift clutch is commanded engage.

Condition for Setting the DTC

- The TCM detects that the input shaft speed sensor pulses are not generated during vehicle running.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Electrical or magnetic interference may affect intermittent condition.
- Ensure the sensor is tight and the counter shaft is not damaged.
- If this DTC is present, poor shift quality (feel) will appear.

Notice:

- If this DTC is present, the Input Shaft Speed parameter on the Tech 2 will indicate estimated value based on other inputs.

DTC P0717 (Flash Code 2)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Lift the driving wheels or drive the vehicle. 4. Let the vehicle run within the Conditions for Running the DTC. 5. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the input shaft speed sensor harness connector. 3. Connect a DMM across the input shaft speed sensor terminals. 4. Measure the resistance across the turbine speed sensor. Does the input shaft speed sensor resistance measure within the specified range?	1.5 - 3.5kΩ	Go to Step 4	Go to Step 16

Step	Action	Value(s)	Yes	No
4	1. Connect a DMM across the input shaft speed sensor terminals (measure sensor output voltage). 2. Place the DMM on the AC volt scale. 3. Lift the driving wheels or drive the vehicle. 4. Let the vehicle run with a fixed gear. 5. Monitor the DMM while accelerating the engine. Does the DMM indicate an AC voltage increase in accordance with an engine speed increase?	—	Go to Step 5	Go to Step 15
5	1. Connect a DMM between the signal circuit of the input shaft speed sensor harness (pin 2 of J-139 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	5.5 volts	Go to Step 9	Go to Step 6
6	Is the DMM voltage more than the specified value at Step 5?	4.5 volts	Go to Step 7	Go to Step 11
7	1. Connect a test lamp between the signal circuit of the input shaft speed sensor harness (pin 2 of J-139 connector) and a known good ground. 2. Connect a DMM between the probe of the test lamp and a known good ground. 3. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 10	Go to Step 8
8	1. Connect a DMM across the signal circuit and the low reference circuit of the input shaft speed sensor harness (pins 1 and 2 of J-139 connector). 2. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 13	Go to Step 12
9	**Important:** The input shaft speed sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the transmission control module (TCM) (pin 5 of B-427 connector) and the input shaft speed sensor connector (pin 2 of J-139 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 17
10	1. Test the signal circuit between the TCM (pin 5 of B-427 connector) and the input shaft speed sensor harness connector (pin 2 of J-139 connector) for a short to any 5 volts reference circuit. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 17

Step	Action	Value(s)	Yes	No
11	1. Test the signal circuit between the TCM (pin 5 of B-427 connector) and the input shaft speed sensor harness connector (pin 2 of J-139 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 14
12	1. Test the low reference circuit between the TCM (pin 11 of B-427 connector) and the input shaft speed sensor harness connector (pin 1 of J-139 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 14
13	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the input shaft speed sensor (pins 1 and 2 of J-139 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 15
14	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for poor connections on the input shaft speed sensor circuits at the harness connector of the TCM (pins 5 and 11 of B-427 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 17
15	1. Remove the input shaft speed sensor. Refer to Input Shaft Speed Sensor Replacement in this section. 2. Visually inspect the input shaft speed sensor for the following conditions: • Physical damage • Loose or improper installation 3. The following conditions may cause this DTC to set: • Excessive air gap between the input shaft speed sensor and the counter shaft • Electromagnetic interference in the input shaft speed sensor circuits • Foreign material passing between the input shaft speed sensor and the counter shaft Did you find and correct the condition?	—	Go to Step 18	Go to Step 16
16	Replace the input shaft speed sensor. Refer to Input Shaft Speed Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—

Step	Action	Value(s)	Yes	No
17	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—
18	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Lift the driving wheels or drive the vehicle. 5. Let the vehicle run within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 19
19	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0718 (Flash Code 17)

Circuit Description

The gearshift clutch pulse width modulation (PWM) solenoid valve is located on the oil pump assembly. It controls the transmission fluid supply to the gearshift clutch control spool valve. The transmission control module (TCM) controls the gearshift clutch solenoid valve by duty cycle signal based on vehicle running condition. Since normally open type solenoid valve is used, the gearshift clutch control spool valve moves by the applied fluid pressure when the TCM turns OFF the gearshift clutch solenoid valve under the certain condition. Then the gearshift multi-plate clutch engagement pressure circuit connects with the line pressure circuit. At the same time, the gearshift multi-plate clutch is engaged. The TCM detects the actual state of the gearshift clutch solenoid valve by the slip speed of the gearshift clutch based on the turbine speed sensor signal and input shaft speed sensor signal inputs. If the TCM detects an excessively low input shaft speed in comparison to turbine speed, this DTC will set.

Condition for Running the DTC

- DTCs P0715 and P0717 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

- The TCM detects that the input shaft speed is less than the turbine speed 300 RPM or more when the gearshift clutch is commanded engage.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Ensure the input shaft speed sensor is tight and the counter shaft is not damaged.
- If this DTC is present, gearshift clutch slipping feel will appear.

DTC P0718 (Flash Code 17)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Inspect for correct ATF level. Refer to ATF inspection in this section. 2. Inspect for external leakage. Did you find and correct the condition?	—	Go to Step 10	Go to Step 3
3	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Lift the driving wheels or drive the vehicle. 4. Let the vehicle run within the Conditions for Running the DTC. 5. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0715, P0717, P0902 or P0903 set?	—	Go to Applicable DTC	Go to Step 4
4	Let the vehicle run while observing the Turbine Speed and Input Shaft Speed parameter with the Tech 2. Is the Input Shaft Speed parameter less than the Turbine Speed 300 RPM or more?	—	Go to Step 5	Go to Diagnostic Aids
5	Test the line pressure. Refer to line pressure test in this section. Does the line pressure within the specified value?	—	Go to Step 7	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Inspect oil strainer for clogging. Repair Instructions (Overhaul) - Oil Filter in this section. 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
7	1. Remove the input shaft speed sensor. Refer to Input Shaft Speed Sensor Replacement in this section. 2. Visually inspect the input shaft speed sensor for the following conditions: • Physical damage • Loose or improper installation 3. The following conditions may cause this DTC to set: • Excessive air gap between the input shaft speed sensor and the counter shaft • Electromagnetic interference in the input shaft speed sensor circuits • Foreign material passing between the input shaft speed sensor and the counter shaft 4. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
8	1. Remove the oil pump assembly. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. 2. Inspect the oil pump and gearshift clutch for the following conditions: • The oil pump for damage • The gearshift clutch solenoid valve for mechanically stuck or leaking • The clutch spool valve mechanically stuck or leaking • The gasket or seal leaking or worn • The band brake mechanically stuck 3. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 9
9	**Important:** Replacement gearshift clutch assembly must be learned. Replace the gearshift clutch assembly. Refer to Repair Instructions (Overhaul) - Gearshift Clutch Replacement in this section. Did you complete the replacement?	—	Go to Step 10	—
10	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Lift the driving wheels or drive the vehicle. 5. Let the vehicle run while observing the Turbine Speed and Input Shaft Speed parameter with the Tech 2. Is the Input Shaft Speed parameter less than the Turbine Speed 300 RPM or more?	—	Go to Step 2	Go to Step 11

Step	Action	Value(s)	Yes	No
11	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0721 (Flash Code 26)

Circuit Description

The output shaft speed sensor that is called vehicle speed sensor (VSS) is located on the transmission rear housing and is used by the engine control module (ECM), transmission control module (TCM) and speedometer, which generates a speed signal from the transmission output shaft. The output shaft speed sensor uses a hall effect element. It interacts with the magnetic field created by the rotating magnet and outputs square wave pulse signal. The ECM calculates the vehicle speed by the output shaft speed sensor and calculated vehicle speed sent to the TCM via a controller area network (CAN) communication bus. If the TCM detects no output shaft speed sensor signal from the ECM during the vehicle running, this DTC will set.

Condition for Running the DTC

- DTCs P0717, P0904, P0914 and U0100 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The input shaft speed is more than 1500 RPM.
- The current gear is other than neutral.

Condition for Setting the DTC

- The TCM detects that the output shaft speed is less than 30 RPM during the vehicle running.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits auto shift control.
- The TCM selects highest gear when shifted from N to D.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Electrical or magnetic interference may affect intermittent condition.

Notice:

- If this DTC is present, the Output Shaft Speed and Vehicle Speed parameters on the Tech 2 will indicate estimated value based on other inputs.

DTC P0721 (Flash Code 26)

Schematic Reference: Engine Controls Schematics and Transmission Controls Schematics
Connector End View Reference: Engine Controls Connector End Views, Engine Control Module (ECM) Connector End Views, Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC U0100, U0121 or U0406 set?	—	Go to Applicable DTC	Go to Step 3
3	1. Select the “4HK1” in the system selection menu. 2. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is the engine control module (ECM) DTC P0500 or P0501 set?	—	Go to Applicable DTC in Engine Control Section	Go to Step 4
4	1. Drive the vehicle. 2. Select the data display function of ECM. 3. Observe the Vehicle Speed parameter with the Tech 2. Does the Vehicle Speed parameter indicate correct vehicle speed?	—	Go to Diagnostic Aids	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Inspect the Meter (10A) fuse (F-16) in the glove box fuse block. Is the Meter (10A) fuse (F-16) open?	—	Go to Step 6	Go to Step 7
6	Replace the Meter (10A) fuse (F-16). If the fuse continues to open, repair the short to ground on one of the circuits that fed by the Meter (10A) fuse (F-16) or replace the shorted attached component fed by the Meter (10A) fuse (F-16). Did you complete the repair?	—	Go to Step 18	—
7	1. Remove the output shaft speed sensor. Refer to Output Shaft Speed Sensor replacement in the section. 2. Visually inspect the output shaft speed sensor for the following conditions: • Physical damage • Being loose • Improper installation • For transmission output shaft teeth damage 3. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 8
8	1. Turn OFF the ignition. 2. Disconnect the output shaft speed sensor harness connector. 3. Connect a test lamp between the ignition voltage feed circuit of the output shaft speed sensor harness (pin 1 of J-32 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 11
9	1. Keep the ignition switch ON. 2. Connect a test lamp between the low reference circuit of the output shaft speed sensor harness (pins 2 of J-32 connector) and battery voltage. Does the test lamp illuminate?	—	Go to Step 10	Go to Step 12
10	1. Turn ON the ignition, with the engine OFF. 2. Intermittently jump the signal circuit of the output shaft speed sensor (pin 3 of J-32 connector) with a test lamp that is connected to 12 volts (apply form a battery) while monitoring the Vehicle Speed parameter with the Tech 2. Does the Tech 2 indicate any vehicle speed when the circuit is intermittently pulled to 12 volts?	—	Go to Step 14	Go to Step 13
11	Repair the open circuit or high resistance on the output shaft speed sensor ignition voltage feed circuit between the output shaft speed sensor (pin 1 of J-32 connector) and the Meter (10A) fuse (F-16). Did you complete the repair?	—	Go to Step 18	—

Step	Action	Value(s)	Yes	No
12	Repair the open or high resistance in the output shaft speed sensor low reference circuit between the output shaft speed sensor (pin 2 of J-32 connector) and ground terminal. Did you complete the repair?	—	Go to Step 18	—
13	1. Test the output shaft speed sensor signal circuit between the engine control module (ECM) (pin 19 of J-191 connector) and the output shaft speed sensor (pin 3 of J-32 connector), then between the instrument panel cluster (IPC) (pin 17 of B-52 connector) and the output shaft speed sensor (pin 3 of J-32 connector) for the following conditions: • An open circuit • A short to ground • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 15
14	1. Turn OFF the ignition. 2. Disconnect the output shaft speed sensor harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the output shaft speed sensor (pin 1, 2 and 3 of J-32 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 16
15	1. Turn OFF the ignition. 2. Disconnect the ECM J-191 harness connector. 3. Inspect for an intermittent and for a poor connection on the output shaft speed sensor signal circuit at the harness connector of the ECM (pin 19 of J-191 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 18	Go to Step 17
16	Replace the output shaft speed sensor. Refer to Output Shaft Speed Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 18	—
17	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement /Restore Fuel Injector ID Code Data in engine control section. Did you complete the replacement?	—	Go to Step 18	—

Step	Action	Value(s)	Yes	No
18	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Drive the vehicle. 5. Select the data display function of ECM. 6. Observe the Vehicle Speed parameter with the Tech 2. Does the Vehicle Speed parameter indicate correct vehicle speed?	—	Go to Step 19	Go to Step 5
19	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0726 (Flash Code 16)

Circuit Description

The lock up clutch (ON/OFF) solenoid valve is located on the oil pump assembly. It controls the transmission fluid supply to the lock up clutch control spool valve. The transmission control module (TCM) controls the lock up solenoid valve by ON/OFF signal based on vehicle running condition. The TCM turns ON the lock up solenoid valve when the certain condition has been met. Then the lock up clutch control spool valve moves by the applied fluid pressure. The lock up engagement pressure circuit connects with the line pressure circuit, and the lock up clutch disengage pressure circuit connects to the drain circuit. The lock up clutch engagement pressure is nearly equal with the line pressure. At the same time, the lock up clutch is pressed to the fluid coupling front cover and then the fluid coupling is locked. The TCM detects the actual state of the lock up clutch solenoid valve by the slip speed of the lock up clutch based on the engine speed and turbine speed sensor signal inputs. If the TCM detects an excessively low turbine speed in comparison to engine speed, this DTC will set.

Condition for Running the DTC

- DTCs P0715, P0740, P0742 and U0400 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

- The TCM detects that the turbine speed is less than the engine speed 300 RPM or more when the lock up clutch is commanded engage.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Ensure the turbine speed sensor is tight and the gearshift multi-plate clutch case is not damaged.
- If this DTC is present, lock up clutch slipping feel will appear.

DTC P0726 (Flash Code 16)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Inspect for correct ATF level. Refer to ATF inspection in this section. 2. Inspect for external leakage. Did you find and correct the condition?	—	Go to Step 10	Go to Step 3
3	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Lift the driving wheels or drive the vehicle. 4. Let the vehicle run within the Conditions for Running the DTC. 5. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0715, P0740, P0742 or U0400 set?	—	Go to Applicable DTC	Go to Step 4
4	1. Let the vehicle run so that lock up may operate enough. 2. Observe the Engine Speed and Turbine Speed parameter with the Tech 2. Is the Turbine Speed parameter less than the Engine Speed 300 RPM or more?	—	Go to Step 5	Go to Diagnostic Aids

Step	Action	Value(s)	Yes	No
5	Test the line pressure. Refer to line pressure test in this section. Does the line pressure within the specified value?	—	Go to Step 7	Go to Step 6
6	1. Inspect oil strainer for clogging. Repair Instructions (Overhaul) - Oil Filter in this section. 2. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
7	1. Remove the turbine speed sensor. Refer to Turbine Speed Sensor Replacement in this section. 2. Visually inspect the turbine speed sensor for the following conditions: • Physical damage • Loose or improper installation 3. The following conditions may cause this DTC to set: • Excessive air gap between the turbine speed sensor and the gearshift multi-plate clutch case • Electromagnetic interference in the turbine speed sensor circuits • Foreign material passing between the turbine speed sensor and the gearshift multi-plate clutch case 4. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
8	1. Remove the oil pump assembly. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. 2. Inspect the oil pump and gearshift clutch for the following conditions: • The oil pump for damage • The lock up clutch solenoid valve for mechanically stuck or leaking • The lock up clutch spool valve mechanically stuck or leaking • The gasket or seal leaking or worn • The gearshift multi-plate clutch for damage 3. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 9
9	Replace the fluid coupling assembly. Refer to Repair Instructions (Overhaul) - Fluid Coupling Replacement in this section. Did you complete the replacement?	—	Go to Step 10	—

Step	Action	Value(s)	Yes	No
10	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Lift the driving wheels or drive the vehicle. 5. Let the vehicle run so that lock up may operate enough. 6. Observe the Engine Speed and Turbine Speed parameter with the Tech 2. Is the Turbine Speed parameter less than the Engine Speed 300 RPM or more?	—	Go to Step 2	Go to Step 11
11	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0740 (Flash Code 67)

Circuit Description

The lock up clutch (ON/OFF) solenoid valve is located on the oil pump assembly. It controls the transmission fluid supply to the lock up clutch control spool valve. The transmission control module (TCM) controls the lock up solenoid valve by ON/OFF signal based on vehicle running condition. The TCM turns ON the lock up solenoid valve when the certain condition has been met. Then the lock up clutch control spool valve moves by the applied fluid pressure. The lock up engagement pressure circuit connects with the line pressure circuit, and the lock up clutch disengage pressure circuit connects to the drain circuit. The lock up clutch engagement pressure is nearly equal with the line pressure. At the same time, the lock up clutch is pressed to the fluid coupling front cover and then the fluid coupling is locked. The TCM monitors the lock up clutch solenoid valve operating status through the feedback circuit. If the TCM detects a high voltage condition on the lock up clutch solenoid valve control circuit when the solenoid valve is commanded OFF, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The smoother main relay is commanded ON.

Condition for Setting the DTC

- The TCM detects a high voltage condition on the lock up clutch solenoid valve control circuit when the solenoid valve is commanded OFF.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- If this DTC is present, deteriorated vehicle starting feel will appear.

DTC P0740 (Flash Code 67)

Schematic Reference: Transmission Controls Schematics
Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the in-line harness connector (J-237) near the starter motor. 3. Connect a DMM between the control circuit of the lock up clutch solenoid valve harness (pin 1 of J-237 female connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	18.0 volts	Go to Step 4	Go to Step 5
4	1. Connect a test lamp between the control circuit of the lock up clutch solenoid valve harness (pin 1 of J-237 female connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 7

Step	Action	Value(s)	Yes	No
5	1. Test the control circuit of the lock up clutch solenoid valve between the transmission control module (TCM) (pin 29 of B-425 connector) and the in-line harness connector (pin 1 of J-237 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 8
6	1. Test the control circuit of the lock up clutch solenoid valve between the TCM (pin 29 of B-425 connector) and the in-line harness connector (pin 1 of J-237 connector) for the following conditions: • A short to battery or ignition voltage • A short to the gearshift clutch solenoid valve control circuit 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
7	1. Turn OFF the ignition. 2. Inspect for an intermittent and for a poor connection at the in-line harness connector (pin 1 of J-237 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for a poor connection on the lock up clutch solenoid valve circuit at the harness connector of the TCM (pin 29 of B-425 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
9	1. Remove the oil pump assembly. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. 2. Inspect for an intermittent and for a poor connection at the harness connector of the lock up clutch solenoid valve. 3. Inspect the lock up clutch solenoid valve for loose bolt. 4. Test the control circuit of the lock up clutch solenoid valve between the lock up clutch solenoid valve and the in-line harness connector (pin 1 of J-237 connector) for the following conditions: • An open circuit • A short to the gearshift clutch solenoid valve control circuit • High resistance 5. Repair the circuit(s), connection(s) or tightness as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10
10	Replace the lock up clutch solenoid valve. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. Did you complete the replacement?	—	Go to Step 12	—

Step	Action	Value(s)	Yes	No
11	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 13
13	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0742 (Flash Code 67)

Circuit Description

The lock up clutch (ON/OFF) solenoid valve is located on the oil pump assembly. It controls the transmission fluid supply to the lock up clutch control spool valve. The transmission control module (TCM) controls the lock up solenoid valve by ON/OFF signal based on vehicle running condition. The TCM turns ON the lock up solenoid valve when the certain condition has been met. Then the lock up clutch control spool valve moves by the applied fluid pressure. The lock up engagement pressure circuit connects with the line pressure circuit, and the lock up clutch disengage pressure circuit connects to the drain circuit. The lock up clutch engagement pressure is nearly equal with the line pressure. At the same time, the lock up clutch is pressed to the fluid coupling front cover and then the fluid coupling is locked. The TCM monitors the lock up clutch solenoid valve operating status through the feedback circuit. If the TCM detects a low voltage condition on the lock up clutch solenoid valve control circuit when the solenoid valve is commanded ON, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The smoother main relay is commanded ON.

Condition for Setting the DTC

- The TCM detects a low voltage condition on the lock up clutch solenoid valve control circuit when the solenoid valve is commanded ON.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM commands OFF the lock up clutch solenoid valve.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- If this DTC is present, lock up clutch does not engage and excessive slip feel will appear.

DTC P0742 (Flash Code 67)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Lift the driving wheels or drive the vehicle. 4. Let the vehicle run so that lock up may operate enough. 5. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the in-line harness connector (J-237) near the starter motor. 3. Connect a DMM between the control circuit of the lock up clutch solenoid valve harness (pin 1 of J-237 female connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	18.0 volts	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the control circuit of the lock up clutch solenoid valve between the transmission control module (TCM) (pin 29 of B-425 connector) and the in-line harness connector (pin 1 of J-237 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
5	1. Remove the oil pump assembly. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. 2. Test the control circuit of the lock up clutch solenoid valve between the lock up clutch solenoid valve and the in-line harness connector (pin 2 of J-237 connector) for the following conditions: • A short to ground • A short to the transmission fluid temperature (TFT) sensor low reference circuit 3. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
6	Replace the lock up clutch solenoid valve. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. Did you complete the replacement?	—	Go to Step 8	—
7	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Lift the driving wheels or drive the vehicle. 5. Let the vehicle run so that lock up may operate enough. 6. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 9
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0851 (Flash Code 6)

Circuit Description

The neutral switch is installed on the transmission gearshift control box. When the gear position is neutral, the switch is closed and the switch signal is provided to the transmission control module (TCM). If the TCM detects the neutral switch signal is stuck OFF (open) when the current gear is neutral based on the gear shift position sensor input.

Condition for Running the DTC

- DTC P0914 is not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

- The TCM detects that the neutral switch signal is continuously OFF (other than neutral) when the current gear is neutral.

Action Taken When the DTC Sets

- The TCM does not illuminate the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Ensure the gear shift position sensor is tight and the sensor shaft is not damaged.

Notice:

- If this DTC is present, engine will not crank except applying the brake pedal or parking brake.

DTC P0851 (Flash Code 6)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. **Notice:** If the engine does not crank, apply the brake pedal or parking brake. 4. Lift the driving wheels or drive the vehicle. 5. Let the vehicle run so that all gear may engage enough. 6. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0914, P0915 or P0919 also set?	—	Go to Applicable DTC	Go to Step 3
3	Observe the Neutral Switch parameter with the Tech 2 while changing the gear between neutral and other positions. Does the Tech 2 indicate Neutral when the current gear is neutral and In Gear when other than the neutral?	—	Go to Diagnostic Aids	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the neutral switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Neutral Switch parameter with the Tech 2 while momentarily jumping across the neutral switch harness connectors between pins 1 and 2 of J-50 connector. Does the Tech 2 indicate Neutral when the circuit is jumped and In Gear when the circuit is not jumped?	—	Go to Step 8	Go to Step 5
5	1. Connect a test lamp between the ignition voltage feed circuit of the neutral switch harness (pin 2 of J-50 connector) and a known good ground. 2. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 7	Go to Step 6
6	Repair the open circuit or high resistance on the voltage feed circuit between the ENG (IG) (10A) fuse (F-9) (in the glove box fuse block) and the neutral switch (pin 2 of J-50 connector). Check the ENG (IG) (10A) fuse (F-9) first. Did you complete the repair?	—	Go to Step 13	—
7	1. Test the neutral switch signal circuit between the transmission control module (TCM) (pin 10 of B-428 connector) and the neutral switch (pin 1 of J-50 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 9
8	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connectors of the neutral switch (pins 1 and 2 of J-50 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for a poor connection on the neutral switch circuit at the harness connector of the TCM (pin 10 of B-428 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12

Step	Action	Value(s)	Yes	No
10	1. Remove the neutral switch. Refer to Neutral Switch Replacement in this section. 2. Visually inspect the neutral switch for the following conditions: • Physical damage • Loose or improper installation 3. Remove the gear shift position sensor. Refer to Gear Shift Position Sensor Replacement in this section. 4. Visually inspect the gear shift position sensor for the following conditions: • Physical damage • Loose or improper installation 5. Visually inspect the shift lever shaft to the gear shift position sensor shaft for damage. 6. Remove the transmission gearshift control box assembly from the transmission main unit. Refer to Repair Instructions (Overhaul) - Control Box in this section. 7. Visually inspect the neutral position detection lever for damage that contacts to the neutral switch. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
11	Replace the neutral switch. Refer to Neutral Switch Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2. **Important:** Transmission Gear Select & Shift Position Learning must be done if the gear shift position sensor or transmission gearshift control box is replaced, removed or repaired. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Observe the Neutral Switch parameter with the Tech 2 while changing gear between neutral and other positions. Does the Tech 2 indicate Neutral when the current gear is neutral and In Gear when other than the neutral?	—	Go to Step 14	Go to Step 2
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0852 (Flash Code 7)

Circuit Description

The neutral switch is installed on the transmission gearshift control box. When the gear position is neutral, the switch is closed and the switch signal is provided to the transmission control module (TCM). If the TCM detects the neutral switch signal is stuck ON (closed) condition when the current gear is other than neutral based on the gear shift position sensor input.

Condition for Running the DTC

- DTC P0914 is not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

- The TCM detects that the neutral switch signal is continuously ON (neutral) when the current gear is other than neutral.

Action Taken When the DTC Sets

- The TCM does not illuminate the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Ensure the gear shift position sensor is tight and the sensor shaft is not damaged.

Notice:

- If this DTC is present, engine may not crank except applying the brake pedal or parking brake.

DTC P0852 (Flash Code 7)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. **Notice:** If the engine does not crank, apply the brake pedal or parking brake. 4. Lift the driving wheels or drive the vehicle. 5. Let the vehicle run so that all gear may engage enough. 6. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0914, P0915 or P0919 also set?	—	Go to Applicable DTC	Go to Step 3
3	Observe the Neutral Switch parameter with the Tech 2 while changing the gear between neutral and other positions. Does the Tech 2 indicate Neutral when the current gear is neutral and In Gear when other than the neutral?	—	Go to Diagnostic Aids	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the neutral switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Neutral Switch parameter with the Tech 2. Does the Tech 2 indicate In Gear?	—	Go to Step 6	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Test the neutral switch input signal circuit between the transmission control module (TCM) (pin 10 of B-428 connector) and the neutral switch (pin 1 of J-50 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 9	Go to Step 8
6	1. Remove the neutral switch. Refer to Neutral Switch Replacement in this section. 2. Visually inspect the neutral switch for the following conditions: • Physical damage • Loose or improper installation 3. Remove the gear shift position sensor. Refer to Gear Shift Position Sensor Replacement in this section. 4. Visually inspect the gear shift position sensor for the following conditions: • Physical damage • Loose or improper installation 5. Visually inspect the shift lever shaft to the gear shift position sensor shaft for damage. 6. Remove the transmission gearshift control box assembly from the transmission main unit. Refer to Repair Instructions (Overhaul) - Control Box in this section. 7. Visually inspect the neutral position detection lever for damage that contacts to the neutral switch. Did you find and correct the condition?	—	Go to Step 9	Go to Step 7
7	Replace the neutral switch. Refer to Neutral Switch Replacement in this section. Did you complete the replacement?	—	Go to Step 9	—
8	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 9	—
9	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2. **Important:** Transmission Gear Select & Shift Position Learning must be done if the gear shift position sensor or transmission gearshift control box is replaced, removed or repaired. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Observe the Neutral Switch parameter with the Tech 2 while changing gear between neutral and other positions. Does the Tech 2 indicate Neutral when the current gear is neutral and In Gear when other than the neutral?	—	Go to Step 10	Go to Step 2

Step	Action	Value(s)	Yes	No
10	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0885 (Flash Code 38)

Circuit Description

The smoother main relay is energized to feed the battery voltage to the TCM through the relay switch side when the TCM receives an ignition voltage switch ON signal. When the ignition switch is OFF, the smoother main relay is de-energized after a certain length of time passed.
If the TCM detects the smoother main relay is turned OFF when the relay is commanded ON, this DTC will set. (Open stuck DTC)
If the TCM detects the TCM has been ON when the relay is commanded OFF, this DTC will also set. (Close stuck DTC)

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

Open stuck DTC

- The TCM detects a low voltage condition on the smoother main relay voltage feed circuit when the relay is commanded ON.

Close stuck DTC

- The TCM detects a high voltage condition on the smoother main relay voltage feed circuit when the relay is commanded OFF.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM continuously sounds buzzer when the diagnostic runs and fails. (Open stuck DTC)
- The TCM inhibits gearshift control. (Open stuck DTC)
- The TCM holds gear position.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- The TCM stops the buzzer when the diagnostic runs and does not fail. (Open stuck DTC)
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Faulty or sticking smoother main relay will set this DTC.

DTC P0885 (Flash Code 38)

Schematic Reference: Transmission Controls Schematics
Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition for 30 seconds. 2. Replace the smoother main relay with the dimmer relay or replace with a known good relay. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 4	Go to Step 11
4	1. Turn ON the ignition, with the engine OFF. 2. Observe the Main Relay Voltage Feed Circuit parameter with the Tech 2. Does the Main Relay Voltage Feed Circuit parameter indicate ON?	—	Go to Step 8	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Remove the smoother main relay. 3. Probe the battery voltage feed circuit of the smoother main relay (pins 2 and 3 of X-5 connector) with a test lamp that is connected to a known good ground. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 7
6	1. Turn OFF the ignition. 2. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the smoother main relay (pins 1, 2, 3 and 5 of X-5 connector). 3. Disconnect the transmission control module (TCM) harness connector. 4. Inspect for an intermittent, for poor connections and corrosion on the smoother main relay control and voltage feed circuit at the harness connector of the TCM (pin 15 of B-425 and 3 of B-426 connector). 5. Test for high resistance on each smoother main relay circuit. 6. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
7	Repair the open circuit or high resistance on the battery voltage feed circuit between the NEES (B) (10A) fuse (F-13) in the glove box fuse block and the smoother main relay (pins 2 and 3 of X-5 connector) (which ever test lamp did not illuminate at Step 5). Check the NEES (B) (10 A) fuse (F-13) first. Did you complete the repair?	—	Go to Step 13	—
8	1. Turn OFF the ignition. Remove the smoother main relay. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Main Relay Voltage Feed Circuit parameter with the Tech 2. Does the Main Relay Voltage Feed Circuit parameter indicate ON?	—	Go to Step 10	Go to Step 9
9	1. Test the control circuit of the smoother main relay between the TCM (pin 15 of B-425 connector) and the smoother main relay (pin 5 of X-5 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
10	1. Test the voltage feed circuit between the TCM (pin 3 of B-426 connector) and the smoother main relay (pin 1 of X-5 connector) for a short to battery. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
11	Replace the smoother main relay. Did you complete the replacement?	—	Go to Step 13	—

Step	Action	Value(s)	Yes	No
12	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0889 (Flash Code 39)

Circuit Description

The gearshift control box relay is energized to feed a drive voltage of the each solenoid valve (1-3-5 shift solenoid, 2-4-6-R shift solenoid and select solenoid) when the transmission control module (TCM) commands ON.
If the TCM detects the gearshift control box relay is turned OFF when the relay is commanded ON, this DTC will set. (Open stuck DTC)
If the TCM detects the TCM has been ON when the relay is commanded OFF, this DTC will also set. (Close stuck DTC)

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

Open stuck DTC

- The TCM detects a low voltage condition on the 1-3-5 shift solenoid, 2-4-6-R shift solenoid and select solenoid voltage feed circuit when the gearshift control box relay is commanded ON.

Close stuck DTC

- The TCM detects a high voltage condition on the 1-3-5 shift solenoid, 2-4-6-R shift solenoid and select solenoid voltage feed circuit when the gearshift control box relay is commanded OFF.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM continuously sounds buzzer when the diagnostic runs and fails. (Open stuck DTC)
- The TCM inhibits gearshift control. (Open stuck DTC)
- The TCM holds gear position.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- The TCM stops the buzzer when the diagnostic runs and does not fail. (Open stuck DTC)
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- If this DTC is present, P0912, P0973 and P0976 may also set.
- Faulty or sticking gearshift control box relay will set this DTC.

DTC P0889 (Flash Code 39)

Schematic Reference: Transmission Controls Schematics
Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Replace the gearshift control box relay with the glow relay or replace with a known good relay. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 4	Go to Step 11
4	Does the buzzer continuously sound?	—	Go to Step 5	Go to Step 8

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Remove the gearshift control box relay. 3. Probe the battery voltage feed circuit of the gearshift control box relay (pins 3 and 4 of X-19 connector) with a test lamp that is connected to a known good ground. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 7
6	1. Turn OFF the ignition. 2. Inspect for an intermittent, for poor connections and corrosion at the harness connector of the gearshift control box relay (pins 2, 3, 4 and 5 of X-19 connector). 3. Disconnect the transmission control module (TCM) harness connector. 4. Inspect for an intermittent, for a poor connection and corrosion on gearshift control box relay control circuit at the harness connector of the TCM (pin 18 of B-425 connector). 5. Test the gearshift control box relay control circuit for an open circuit or high resistance. 6. Test the each solenoid valve voltage feed circuit between the gearshift control box relay and the TCM (pins 4 and 5 of B-425, pins 5 and 6 of B-426 and pins 1 and 8 of B-418 connector) for an open circuit or high resistance. 7. Repair the connection(s) or circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
7	Repair the open circuit or high resistance on the battery voltage feed circuit between the NEES (60A) slow blow fuse (SBF-7) and the gearshift control box relay (pins 3 and 4 of X-19 connector) (which ever test lamp did not illuminate at Step 5). Check the NEES (60 A) slow blow fuse (SBF-7) first. Did you complete the repair?	—	Go to Step 13	—
8	1. Turn OFF the ignition. 2. Remove the gearshift control box relay. 3. Turn ON the ignition, with the engine OFF. Does the buzzer continuously sound?	—	Go to Step 9	Go to Step10
9	1. Test the control circuit of the gearshift control box relay between the TCM (pin 18 of B-425 connector) and the gearshift control box relay (pin 5 of X-19 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
10	1. Test the voltage feed circuit between the TCM (pins 4 and 5 of B-425, pins 5 and 6 of B-426 and pins 1 and 8 of B-418 connector) and the gearshift control box relay (pin 2 of X-19 connector) for a short to battery. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12

Step	Action	Value(s)	Yes	No
11	Replace the gearshift control relay. Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected fuse or harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0902 (Flash Code 65)

Circuit Description

The gearshift clutch pulse width modulation (PWM) solenoid valve is located on the oil pump assembly. It controls the transmission fluid supply to the gearshift clutch control spool valve. The transmission control module (TCM) controls the gearshift clutch solenoid valve by duty cycle signal based on vehicle running condition. Since normally open type solenoid valve is used, the gearshift clutch control spool valve moves by the applied fluid pressure when the TCM turns OFF the gearshift clutch solenoid valve under the certain condition. Then the gearshift multi-plate clutch engagement pressure circuit connects with the line pressure circuit. At the same time, the gearshift multi-plate clutch is engaged. The TCM monitors the gearshift clutch solenoid valve operating status through the feedback circuit. If the TCM detects a low voltage condition on the gearshift clutch solenoid valve control circuit when the solenoid valve is commanded ON, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The smoother main relay is commanded ON.

Condition for Setting the DTC

- The TCM detects a low voltage condition on the gearshift clutch solenoid valve control circuit when the solenoid valve is commanded ON.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM intermittently sounds buzzer when the diagnostic runs and fails.
- The TCM inhibits gearshift control.
- The TCM inhibits emergency gearshift control.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- The TCM stops the buzzer when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0902 (Flash Code 65)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Place the transmission in neutral and set the parking brake. 4. Start the engine. 5. Operate the selector lever from N to D and D to N. 6. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the in-line harness connector (J-237) near the starter motor. 3. Connect a DMM between the control circuit of the gearshift clutch solenoid valve harness (pin 3 of J-237 female connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	18.0 volts	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the control circuit of the gearshift clutch solenoid valve between the transmission control module (TCM) (pin 30 of B-425 connector) and the in-line harness connector (pin 3 of J-237 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
5	1. Remove the oil pump assembly. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. 2. Test the control circuit of the gearshift clutch solenoid valve between the gearshift clutch solenoid valve and the in-line harness connector (pin 3 of J-237 connector) for the following conditions: • A short to ground • A short to the transmission fluid temperature (TFT) sensor low reference circuit 3. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
6	**Important:** Replacement gearshift clutch solenoid valve must be learned. Replace the gearshift clutch solenoid valve. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. Did you complete the replacement?	—	Go to Step 8	—
7	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Place the transmission in neutral and set the parking brake. 5. Start the engine. 6. Operate the selector lever from N to D and D to N. 7. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 9
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0903 (Flash Code 65)

Circuit Description

The gearshift clutch pulse width modulation (PWM) solenoid valve is located on the oil pump assembly. It controls the transmission fluid supply to the gearshift clutch control spool valve. The transmission control module (TCM) controls the gearshift clutch solenoid valve by duty cycle signal based on vehicle running condition. Since normally open type solenoid valve is used, the gearshift clutch control spool valve moves by the applied fluid pressure when the TCM turns OFF the gearshift clutch solenoid valve under the certain condition. Then the gearshift multi-plate clutch engagement pressure circuit connects with the line pressure circuit. At the same time, the gearshift multi-plate clutch is engaged. The TCM monitors the gearshift clutch solenoid valve operating status through the feedback circuit. If the TCM detects a high voltage condition on the gearshift clutch solenoid valve control circuit when the solenoid valve is commanded OFF, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The smoother main relay is commanded ON.

Condition for Setting the DTC

- The TCM detects a high voltage condition on the gearshift clutch solenoid valve control circuit when the solenoid valve is commanded OFF.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM intermittently sounds buzzer when the diagnostic runs and fails.
- The TCM inhibits gearshift control and holds gear position when the diagnostic runs and fails.
- The TCM inhibits emergency gearshift control.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- The TCM stops the buzzer when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0903 (Flash Code 65)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Place the transmission in neutral and set the parking brake. 4. Start the engine. 5. Operate the selector lever from N to D and D to N. 6. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition. 2. Disconnect the in-line harness connector (J-237) near the starter motor. 3. Connect a test lamp between the control circuit of the gearshift clutch solenoid valve harness (pin 3 of J-237 female connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	1. Keep the test lamp with connected. 2. Turn OFF the ignition for 30 second. 3. Start the engine while observing the test lamp. Does the test lamp blink after the engine start (note that the test lamp will blink then continuously illuminate normally)?	—	Go to Step 7	Go to Step 6
5	1. Test the control circuit of the gearshift clutch solenoid valve between the transmission control module (TCM) (pin 30 of B-425 connector) and the in-line harness connector (pin 3 of J-237 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 8
6	1. Test the control circuit of the gearshift clutch solenoid valve between the TCM (pin 30 of B-425 connector) and the in-line harness connector (pin 3 of J-237 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
7	1. Turn OFF the ignition. 2. Inspect for an intermittent and for a poor connection at the in-line harness connector (pin 3 of J-237 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 9
8	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for a poor connection on the gearshift clutch solenoid valve circuit at the harness connector of the TCM (pin 30 of B-425 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 11
9	1. Remove the oil pump assembly. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. 2. Inspect for an intermittent and for a poor connection at the harness connector of the gearshift clutch solenoid valve. 3. Inspect the gearshift clutch solenoid valve for loose bolt. 4. Test the control circuit of the gearshift clutch solenoid valve between the gearshift clutch solenoid valve and the in-line harness connector (pin 3 of J-237 connector) for the following conditions: • An open circuit • A short to the lock up clutch solenoid valve control circuit • High resistance 5. Repair the circuit(s), connection(s) or tightness as necessary. Did you find and correct the condition?	—	Go to Step 12	Go to Step 10

Step	Action	Value(s)	Yes	No
10	**Important:** Replacement gearshift clutch solenoid valve must be learned. Replace the gearshift clutch solenoid valve. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. Did you complete the replacement?	—	Go to Step 12	—
11	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 12	—
12	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Place the transmission in neutral and set the parking brake. 5. Start the engine. 6. Operate the selector lever from N to D and D to N. 7. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 13
13	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0904 (Flash Code 58)

Circuit Description

The gear select position sensor is used to detect the select side lever position feedback for the select solenoid valve on the transmission gearshift control box and it is installed to the transmission gearshift control box assembly. The transmission control module (TCM) uses the gear select position sensor to determine the current gear position with a combination of the gear shift position sensor. The gear select position sensor has following circuits.

- 5 volts reference circuit
- Low reference circuit
- Gear select position sensor signal circuit

The TCM supplies 5 volts to the gear select position sensor on the 5 volts reference circuit. The TCM also provides a ground on the low reference circuit. The gear select position sensor provides a signal to the TCM on the gear select position sensor signal circuit, which is relative to the position changes of the select side. The TCM monitors the gear select position sensor signal for voltages outside the normal range of the gear select position sensor. If the ECM detects an excessively low or high gear select position sensor voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

- The TCM detects that the gear select position sensor signal voltage is less than 0.5 volts or more than 4.5 volts.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits auto shift control.
- The TCM permits shifting to neutral, 1st or reverse gear.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Ensure the sensor is tight, the sensor shaft and sensor lever are not damaged.

Notice:

- If this DTC is present, the Gear Select Position Sensor parameters on the Tech 2 will indicate desired value.

DTC P0904 (Flash Code 58)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. **Notice:** If the gear select position sensor signal voltage is more than 4.5 volts, the Gear Select Position Sensor parameter on the Tech 2 indicates a desired value when the ignition has been turned ON for longer than 5 seconds. Does the Gear Select Position Sensor parameter ever exceed the specified value within 5 seconds after the ignition switch is ON?	4.5 volts	Go to Step 4	Go to Step 3

Step	Action	Value(s)	Yes	No
3	**Notice:** If the gear select position sensor signal is less than 0.5 volts, the Gear Select Position Sensor parameter on the Tech 2 indicates a desired value when the ignition has been turned ON for longer than 5 seconds. Does the Gear Select Position Sensor parameter ever fall below the specified value within 5 seconds after the ignition switch is ON?	0.5 volts	Go to Step 7	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the gear select position sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Gear Select Position Sensor parameter with the Tech 2. Is the Gear Select Position Sensor parameter less than the specified value within 5 seconds after the ignition switch is ON?	0.5 volts	Go to Step 5	Go to Step 9
5	1. Turn OFF the ignition. 2. Connect a DMM between the 5 volts reference circuit of the gear select position sensor harness (pin 1 of J-223 connector) and a known good ground. 3. Turn ON the ignition, with the engine OFF. Is the DMM voltage less than the specified value?	5.5 volts	Go to Step 6	Go to Step 10
6	1. Turn OFF the ignition. 2. Connect a test lamp between the low reference circuit of the gear select position sensor harness (pin 3 of J-223 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 14	Go to Step 11
7	1. Turn OFF the ignition. 2. Disconnect the gear select position sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit of the gear select position sensor harness (pin 1 of J-223 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 8	Go to Step 12
8	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the 5 volts reference circuit and the signal circuit of the gear select position sensor harness (pin 1 and 2 of J-223 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the Gear Select Position Sensor parameter with the Tech 2. Is the Gear Select Position Sensor parameter more than the specified value within 5 seconds after the ignition switch is ON?	4.5 volts	Go to Step 14	Go to Step 13

Step	Action	Value(s)	Yes	No
9	**Important:** The gear select position sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the transmission control module (TCM) (pin 11 of B-426 connector) and the gear select position sensor (pin 2 of J-223 connector) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
10	1. Test the 5 volts reference circuit between the TCM (pin 10 of B-426 connector) and the gear select position sensor (pin 1 of J-223 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
11	1. Test the low reference circuit between the TCM (pin 13 of B-426 connector) and the gear select position sensor (pin 3 of J-223 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 15
12	1. Test the 5 volts reference circuit between the TCM (pin 10 of B-426 connector) and the gear select position sensor (pin 1 of J-223 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 15
13	1. Test the signal circuit between the TCM (pin 11 of B-426 connector) and the gear select position sensor (pin 2 of J-223 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 15

Step	Action	Value(s)	Yes	No
14	1. Turn OFF the ignition. 2. Disconnect the gear select position sensor harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the gear select position sensor (pins 1, 2 and 3 of J-223 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
15	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for poor connections on the gear select position sensor circuits at the harness connector of the TCM (pins 10, 11 and 13 of B-426 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
16	1. Remove the gear select position sensor. Refer to Gear Select Position Sensor Replacement in this section. 2. Visually inspect the gear select position sensor for the following conditions: • Physical damage • Loose or improper installation 3. Remove the transmission gearshift control box assembly from the transmission main unit. Refer to Repair Instructions (Overhaul) - Control Box in this section. 4. Visually inspect the lever for damage that connects to the gear select position sensor shaft. Did you find and correct the condition?	—	Go to Step 19	Go to Step 17
17	**Important:** Replacement gear select position sensor must be learned. Replace the gear select position sensor. Refer to Gear Select Position Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 19	—
18	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 19	—
19	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Lift the driving wheels or drive the vehicle. 5. Let the vehicle run. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 20

Step	Action	Value(s)	Yes	No
20	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0906 (Flash Code 52)

Circuit Description

The selector lever switches are installed to the selector lever bracket and there are two switches. The forward and backward direction switch detects the selector lever forward and backward movement. The horizontal direction switch detects the selector lever horizontal movement. When the selector lever is positioned N, D or R, each selector lever switch is closed and the switch signal from the transmission control module (TCM) is pulled to ground. When the selector lever is positioned A, + or –, each selector lever switch and D switch are also closed and the switch signal from the TCM is pulled to ground. If the TCM detects the selector lever switch input signal is out of correlation, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

Either of following condition is met:

- The TCM detects two or more selector lever N, D and R switch signal is ON (pulled to ground).
- The TCM detects two or more selector lever A, + and – switch signal is ON (pulled to ground) when the selector lever N, D or R switch signal is ON (pulled to ground).

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits selector lever switch signal.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Ensure each selector lever switch is tight and not damaged.

DTC P0906 (Flash Code 52)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Operate the selector lever while observing the Selector N, R, D, A, + and – Switch parameter with the Tech 2. **Notice:** The Selector D Switch parameter indicates ON when the selector lever is A, + or – . Does each selector lever switch parameter display ON when it moved to its position and display OFF when it moved to other positions?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Remove the selector lever cover. 3. Disconnect the selector lever switch harness connector. 4. Turn ON the ignition, with the engine OFF. Does all selector position switch parameter display OFF?	—	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the signal circuit between the transmission control module (TCM) (pins 7, 8, 13, 14 & 15 of B-427 and pin 21 of B-428 connector) and the selector lever switch (pin 2, 4, 6, 7, 8 and 10 of N-19 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
5	1. Test the signal circuit on the selector lever switch (pin 2, 4, 6, 7, 8 and 10 of N-19 connector) and ground (pin 9 of N-19 connector) for a short each other. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
6	Repair or replace the selector lever. Refer to Selector Lever Replacement in this section. Did you complete the replacement?	—	Go to Step 8	—
7	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 8	—
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Operate the selector lever while observing the Selector N, R, D, A, + and – Switch parameter with the Tech 2. **Notice:** The Selector D Switch parameter indicates ON when the selector lever is A, + or –. Does each selector lever switch parameter display ON when it moved to its position and display OFF when it moved to other positions?	—	Go to Step 9	Go to Step 3
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0907 (Flash Code 51)

Circuit Description

The selector lever switches are installed to the selector lever bracket and there are two switches. The forward and backward direction switch detects the selector lever forward and backward movement. The horizontal direction switch detects the selector lever horizontal movement. When the selector lever is positioned N, D or R, each selector lever switch is closed and the switch signal from the transmission control module (TCM) is pulled to ground. When the selector lever is positioned A, + or –, each selector lever switch and D switch are also closed and the switch signal from the TCM is pulled to ground. If the TCM detects the selector lever N, D and R switch input signals are OFF (open circuit) at the same time, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

- The TCM detects that the selector lever N, D and R switch signals are OFF (open circuit) at the same time.

Action Taken When the DTC Sets

- The TCM does not illuminate the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Ensure each selector lever switch is tight and not damaged.

Notice:

- Engine will not crank if the selector lever N switch signal is OFF (open circuit).

DTC P0907 (Flash Code 51)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Operate the selector lever while observing the Selector N, R, D, A, + and – Switch parameter with the Tech 2. **Notice:** The Selector D Switch parameter indicates ON when the selector lever is A, + or –. Does each selector lever switch parameter display ON when it moved to its position and display OFF when it moved to other positions?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Remove the selector lever cover. 3. Disconnect the selector lever switch harness connector. 4. Connect a DMM between the signal circuit (pins 2, 6 and 7 of N-19 connector which ever parameter reading did not display ON at Step 2) and a known good ground. 5. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	18.0 volts	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the signal circuit between the transmission control module (TCM) (pin 13 & 14 of B-427 and pin 21 of B-428 connector) and the selector lever switch (pin 2, 6 and 7 of N-19 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 8
5	1. Turn OFF the ignition. 2. Disconnect the selector lever switch harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the selector lever (pins 2, 6, 7 and 9 of N-19 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 6
6	1. Test the ground circuit between the selector lever switch (pin 9 of N-19 connector) and the chassis ground (B-1) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 7
7	Repair or replace the selector lever. Refer to Selector Lever Replacement in this section. Did you complete the replacement?	—	Go to Step 10	—
8	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for poor connections on the selector lever switch circuits at the harness connector of the TCM (pins 13 & 14 of B-427 and pin 21 of B-428 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 10	Go to Step 9
9	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 10	—

Step	Action	Value(s)	Yes	No
10	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Operate the selector lever while observing the Selector N, R, D, A, + and – Switch parameter with the Tech 2. **Notice:** The Selector D Switch parameter indicates ON when the selector lever is A, + or –. Does each selector lever switch parameter display ON when it moved to its position and display OFF when it moved to other positions?	—	Go to Step 11	Go to Step 3
11	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0909 (Flash Code 76)

Circuit Description

The pulse width modulation (PWM) select solenoid valve is located on the gearshift control box. The transmission control module (TCM) controls the select solenoid valve by duty cycle signal based on commanded gear position. The select solenoid is only commanded ON when up-shifting. When downshifting, the force created by the return springs moves the internal select lever, but the select solenoid limits the amount of movement by generating force as required in the up-shift direction. The gear select position sensor is used to detect the select side lever position feedback for the select solenoid valve movement. The TCM uses the gear select position sensor to determine the current gear position with a combination of the gear shift position sensor. If the TCM detects the gear select side lever position does not reach to a desired select position when shifting to desired gear, this DTC will set.

Condition for Running the DTC

- DTCs P0718, P0889, P0902, P0903, P0904, P0912, P0913, P0914, P0973, P0974, P0976 and P0977 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The gearshift control box relay is commanded ON.
- The selector lever is other than N position.

Condition for Setting the DTC

- The TCM detects the gear select side lever position does not reach to a desired select position continuously when shifting to desired gear.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits gearshift control.
- The TCM commands OFF the gearshift clutch solenoid valve.
- The TCM commands OFF the lock up clutch solenoid valve.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0909 (Flash Code 76)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Lift the driving wheels or drive the vehicle. 4. Let the vehicle run so that all gear may engage enough. 5. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is P0902, P0903, P0904, P0912, P0913, P0914, P0973, P0974, P0976 or P0977 also set?	—	Go to Applicable DTC	Go to Step 3
3	Visually inspect the gear select position sensor and the select solenoid valve for the following conditions: • Physical damage • Loose or improper installation Did you find and correct the condition?	—	Go to Step 8	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Lift the driving wheels or drive the vehicle. 2. Let the vehicle run so that all gear may engage enough. 3. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 5	Go to Diagnostic Aids
5	If the DTC fail only when shifting from 5th to 6th with the 5th speed transmission, programmed transmission type is incorrect. Reprogram correct vehicle information and retest. Refer to Transmission Control Module (TCM) Replacement Procedure Description in this section. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
6	1. Remove the gear select position sensor. Refer to Gear Select Position Sensor Replacement in this section. 2. Visually inspect the gear select position sensor for the following conditions: • Physical damage • Loose or improper installation 3. Inspect the gear select position sensor output voltage in order to check an open circuit, short circuit and high resistance somewhere in the operating range. 4. Remove the transmission gearshift control box assembly from the transmission main unit. Refer to Repair Instructions (Overhaul) - Control Box in this section. 5. Visually inspect the select side lever for the following conditions: • Select lever damage that connects to the gear select position sensor shaft. • Select lever damage that connects to the interlock plate and shift rods. • Select relay lever damage that connects to the select solenoid valve. • Other damage that the select lever possible stuck. 6. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 7
7	**Important:** Replacement select solenoid valve must be learned. Replace the select solenoid valve. Refer to Repair Instructions (Overhaul) - Gearshift Control Box in this section. Did you complete the replacement?	—	Go to Step 8	—

Step	Action	Value(s)	Yes	No
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. **Important:** Transmission Gear Select & Shift Position Learning must be done if the gear select position sensor, select solenoid valve or transmission gearshift control box is replaced, removed or repaired. 3. Turn OFF the ignition for 30 seconds. 4. Lift the driving wheels or drive the vehicle. 5. Let the vehicle run so that all gear may engage enough. 6. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 9
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0912 (Flash Code 75)

Circuit Description

The pulse width modulation (PWM) select solenoid valve is located on the gearshift control box. The transmission control module (TCM) controls the select solenoid valve by duty cycle signal based on commanded gear position. The select solenoid is only commanded ON when up-shifting. When downshifting, the force created by the return springs moves the internal select lever, but the select solenoid limits the amount of movement by generating force as required in the up-shift direction. The gear select position sensor is used to detect the select side lever position feedback for the select solenoid valve movement. The TCM uses the gear select position sensor to determine the current gear position with a combination of the gear shift position sensor. If the TCM detects a high voltage condition on the select solenoid valve monitor circuit when the solenoid valve is commanded OFF, this DTC will set.

Condition for Running the DTC

- DTC P0889 is not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The gearshift control box relay is commanded ON.

Condition for Setting the DTC

- The TCM detects a high voltage condition on the select solenoid valve monitor circuit when the solenoid valve is commanded OFF.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM intermittently sounds buzzer when the diagnostic runs and fails.
- The TCM commands OFF gearshift control box relay.
- The TCM inhibits gearshift control and holds gear position when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail at next ignition cycle
- The TCM stops the buzzer when the diagnostic runs and does not fail at next ignition cycle.
- A current DTC clears when the diagnostic runs and does not fail at next ignition cycle.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0912 (Flash Code 75)

Schematic Reference: Transmission Controls Schematics
Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0889 also set?	—	Go to DTC P0889	Go to Step 3
3	1. Turn OFF the ignition for 30 seconds. 2. Disconnect the select solenoid valve harness connector. 3. Connect a DMM between the control circuit of the select solenoid valve harness (pin 2 of J-234 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value until this DTC fails?	18.0 volts	Go to Step 4	Go to Step 6
4	Is the DMM voltage more than the specified value after this DTC fails?	18.0 volts	Go to Step 7	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Connect a test lamp between the ground circuit of the select solenoid valve harness (pin 1 of J-234 connector) and battery voltage. 2. Turn ON the ignition. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 8
6	1. Test the voltage feed circuit between the transmission control module (TCM) (pins 1 and 8 of B-428 connector) and the gearshift control box relay (pin 2 of X-19 connector) for an open circuit or high resistance. 2. Test the control circuit between the TCM (pins 16 and 22 of B-428 connector) and the select solenoid (pin 2 of J-234 connector) for an open circuit or high resistance. 3. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
7	**Important:** The select solenoid valve may be damaged if the solenoid valve control circuit is shorted to a voltage source. 1. Test the control circuit between the TCM (pins 16 and 22 of B-428 connector) and the select solenoid (pin 2 of J-234 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the ground circuit between the select solenoid (pin 1 of J-234 connector) and chassis ground (J-9) for an open circuit or high resistance. 2. Test the ground circuit between the TCM (pins 7 and 15 of B-428 connector) and chassis ground (J-9) for an open circuit or high resistance. 3. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the select solenoid valve harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the select solenoid valve (pins 1 and 2 of J-234 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for poor connections on the select solenoid valve circuits at the harness connector of the TCM (pins 1, 7, 8, 15 16 and 22 of B-428 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12

Step	Action	Value(s)	Yes	No
11	**Important:** Replacement select solenoid valve must be learned. Replace the select solenoid valve. Refer to Repair Instructions (Overhaul) - Gearshift Control Box in this section. Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0913 (Flash Code 75)

Circuit Description

The pulse width modulation (PWM) select solenoid valve is located on the gearshift control box. The transmission control module (TCM) controls the select solenoid valve by duty cycle signal based on commanded gear position. The select solenoid is only commanded ON when up-shifting. When downshifting, the force created by the return springs moves the internal select lever, but the select solenoid limits the amount of movement by generating force as required in the up-shift direction. The gear select position sensor is used to detect the select side lever position feedback for the select solenoid valve movement. The TCM uses the gear select position sensor to determine the current gear position with a combination of the gear shift position sensor. If the TCM detects a low voltage condition on the select solenoid valve monitor circuit when the solenoid valve is commanded ON, this DTC will set.

Condition for Running the DTC

- DTC P0889 is not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The gearshift control box relay is commanded ON.

Condition for Setting the DTC

- The TCM detects a low voltage condition on the select solenoid valve monitor circuit when the solenoid valve is commanded ON.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM intermittently sounds buzzer when the diagnostic runs and fails.
- The TCM commands OFF gearshift control box relay.
- The TCM inhibits gearshift control and holds gear position when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail at next ignition cycle
- The TCM stops the buzzer when the diagnostic runs and does not fail at next ignition cycle.
- A current DTC clears when the diagnostic runs and does not fail at next ignition cycle.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0913 (Flash Code 75)

Schematic Reference: Transmission Controls Schematics
Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Place the transmission in neutral and set the parking brake. 4. Start the engine. 5. Operate the selector lever from N to D in order to shift to 2nd or higher gear. 6. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition for 30 seconds. 2. Disconnect the select solenoid valve harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with the Tech 2. Is DTC P0912 set?	—	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the control circuit between the transmission control module (TCM) (pins 16 and 22 of B-428 connector) and the select solenoid valve (pin 2 of J-234 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	**Important:** Replacement select solenoid valve must be learned. Replace the select solenoid valve. Refer to Repair Instructions (Overhaul) - Gearshift Control Box in this section. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Place the transmission in neutral and set the parking brake. 5. Start the engine. 6. Operate the selector lever from N to D in order to shift to 2nd or higher gear. 7. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0914 (Flash Code 57)

Circuit Description

The gear shift position sensor is used to detect the shift side lever position feedback for the shift solenoid valves on the transmission gearshift control box and it is installed to the transmission gearshift control box assembly. The transmission control module (TCM) uses the gear shift position sensor to determine the current gear position with a combination of the gear select position sensor. The gear shift position sensor has following circuits.

- 5 volts reference circuit
- Low reference circuit
- Gear shift position sensor signal circuit

The TCM supplies 5 volts to the gear shift position sensor on the 5 volts reference circuit. The TCM also provides a ground on the low reference circuit. The gear shift position sensor provides a signal to the TCM on the gear shift position sensor signal circuit, which is relative to the position changes of the select side. The TCM monitors the gear shift position sensor signal for voltages outside the normal range of the gear shift position sensor. If the ECM detects an excessively low or high gear shift position sensor voltage, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

- The TCM detects that the gear shift position sensor signal voltage is less than 0.5 volts or more than 4.5 volts.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits gearshift control and holds gear position when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- Ensure the sensor is tight and the sensor shaft are not damaged.

Notice:

- If this DTC is present, engine will not crank except applying the brake pedal or parking brake.

DTC P0914 (Flash Code 57)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Lift the driving wheels or drive the vehicle. 4. Let the vehicle run while observing the Gear Shift Position Sensor parameter with the Tech 2. Is the Gear Shift Position Sensor parameter within the specified valve?	0.6 - 4.4 volts	Go to Diagnostic Aids	Go to Step 3
3	Is the Gear Shift Position Sensor parameter less than the specified value at Step 2?	0.5 volts	Go to Step 7	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the gear shift position sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Gear Shift Position Sensor parameter with the Tech 2. Is the Gear Shift Position Sensor parameter less than the specified value?	0.5 volts	Go to Step 5	Go to Step 9
5	1. Turn OFF the ignition. 2. Connect a DMM between the 5 volts reference circuit of the gear shift position sensor harness (pin 1 of J-142 connector) and a known good ground. 3. Turn ON the ignition, with the engine OFF. Is the DMM voltage less than the specified value?	5.5 volts	Go to Step 6	Go to Step 10
6	1. Turn OFF the ignition. 2. Connect a test lamp between the low reference circuit of the gear shift position sensor harness (pin 3 of J-142 connector) and battery voltage. 3. Turn ON the ignition, with the engine OFF. Does the test lamp illuminate?	—	Go to Step 14	Go to Step 11
7	1. Turn OFF the ignition. 2. Disconnect the gear shift position sensor harness connector. 3. Connect a DMM between the 5 volts reference circuit of the gear select position sensor harness (pin 1 of J-142 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value?	4.5 volts	Go to Step 8	Go to Step 12
8	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the 5 volts reference circuit and the signal circuit of the gear shift position sensor harness (pin 1 and 2 of J-142 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the Gear Shift Position Sensor parameter with the Tech 2. Is the Gear Shift Position Sensor parameter more than the specified value?	4.5 volts	Go to Step 14	Go to Step 13
9	**Important:** The gear shift position sensor may be damaged if the sensor signal circuit is shorted to a voltage source. 1. Test the signal circuit between the transmission control module (TCM) (pin 19 of B-426 connector) and the gear shift position sensor (pin 2 of J-142 connector) for the following conditions: • A short to battery or ignition voltage • A short to any 5 volts reference 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18

Step	Action	Value(s)	Yes	No
10	1. Test the 5 volts reference circuit between the TCM (pin 18 of B-426 connector) and the gear shift position sensor (pin 1 of J-142 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
11	1. Test the low reference circuit between the TCM (pin 20 of B-426 connector) and the gear shift position sensor (pin 3 of J-142 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 15
12	1. Test the 5 volts reference circuit between the TCM (pin 18 of B-426 connector) and the gear shift position sensor (pin 1 of J-142 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 15
13	1. Test the signal circuit between the TCM (pin 19 of B-426 connector) and the gear shift position sensor (pin 2 of J-142 connector) for the following conditions: • An open circuit • A short to ground • A short to the low reference circuit • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 15
14	1. Turn OFF the ignition. 2. Disconnect the gear shift position sensor harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the gear shift position sensor (pins 1, 2 and 3 of J-142 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
15	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for poor connections on the gear shift position sensor circuits at the harness connector of the TCM (pins 18, 19 and 20 of B-426 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18

Step	Action	Value(s)	Yes	No
16	1. Remove the gear shift position sensor. Refer to Gear Shift Position Sensor Replacement in this section. 2. Visually inspect the gear shift position sensor for the following conditions: • Physical damage • Loose or improper installation 3. Visually inspect the lever shaft for damage that connects to the gear select position sensor shaft. Did you find and correct the condition?	—	Go to Step 19	Go to Step 17
17	**Important:** Replacement gear shift position sensor must be relearned. Replace the gear shift position sensor. Refer to Gear Shift Position Sensor Replacement in this section. Did you complete the replacement?	—	Go to Step 19	—
18	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 19	—
19	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Lift the driving wheels or drive the vehicle. 5. Let the vehicle run. 6. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 20
20	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0915 (Flash Code 74)

Circuit Description

The pulse width modulation (PWM) 1-3-5 and 2-4-6-R shift solenoid valves are located on the gearshift control box. The transmission control module (TCM) controls each shift solenoid valves by duty cycle signal based on commanded gear position. The 1-3-5 shift solenoid is commanded ON when the commanded gear is set to 1st, 3rd and 5th gear. When disengaging from 2nd, 4th, 6th and reverse gear, the 1-3-5 shift solenoid is also commanded ON. The 2-4-6-R shift solenoid is commanded ON when the commanded gear is set to 2nd, 4th, 6th and reverse gear. When disengaging from1st, 3rd and 5th gear, the 2-4-6-R shift solenoid is also commanded ON. The gear shift position sensor is used to detect the shift side lever position feedback for the shift solenoid valves movement. The TCM uses the gear shift position sensor to determine the current gear position with a combination of the gear select position sensor. If the TCM detects the gear shift side lever position does not reach to a desired shift position and it keeping a previous gear position when shifting to desired gear, this DTC will set.

Condition for Running the DTC

- DTCs P0718, P0889, P0902, P0903, P0904, P0912, P0913, P0914, P0973, P0974, P0976 and P0977 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The gearshift control box relay is commanded ON.
- The selector lever is other than N position.

Condition for Setting the DTC

- The TCM detects the gear shift side lever position does not reach to a desired shift position and it keeping a previously engaged gear position continuously when shifting to desired gear. This indicates that the TCM detects gear stuck at an engaged position.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits gearshift control.
- The TCM commands OFF the gearshift clutch solenoid valve.
- The TCM commands OFF the lock up clutch solenoid valve.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0915 (Flash Code 74)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Lift the driving wheels or drive the vehicle. 4. Let the vehicle run so that all gear may engage enough. 5. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is P0902, P0903, P0904, P0912, P0913, P0914, P0973, P0974, P0976 or P0977 also set?	—	Go to Applicable DTC	Go to Step 3
3	Visually inspect the gear shift position sensor, 1-3-5 and 2-4-6-R shift solenoid valves for the following conditions: • Physical damage • Loose or improper installation Did you find and correct the condition?	—	Go to Step 8	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Lift the driving wheels or drive the vehicle. 2. Let the vehicle run so that all gear may engage enough. 3. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 5	Go to Diagnostic Aids
5	1. Remove the gear shift position sensor. Refer to Gear Shift Position Sensor Replacement in this section. 2. Visually inspect the gear shift position sensor for the following conditions: • Physical damage • Loose or improper installation 3. Inspect the gear shift position sensor output voltage in order to check an open circuit, short circuit and high resistance somewhere in the operating range. 4. Remove the transmission gearshift control box assembly from the transmission main unit. Refer to Repair Instructions (Overhaul) - Control Box in this section. 5. Visually inspect the shift side lever for the following conditions: • Shift lever damage that connects to the gear shift position sensor shaft. • Shift lever damage that connects to the shift solenoid valves. • Shift lever damage that connects to the interlock plate and shift rods. • Other damage that the shift lever possible stuck. 6. Inspect the transmission main unit as necessary. Refer to Repair Instructions (Overhaul) in this section. 7. Repair or replace as necessary. 8. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
6	1. Remove the oil pump assembly. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. 2. Inspect the oil pump and gearshift clutch for the following conditions: • The gearshift clutch solenoid valve for mechanically stuck • The clutch spool valve mechanically stuck • The gearshift clutch mechanically stuck 3. Repair or replace as necessary. Did you find and correct the condition?		Go to Step 8	Go to Step 7
7	**Important:** Replacement 1-3-5 or 2-4-6-R shift solenoid valve must be relearned. Replace the 1-3-5 or 2-4-6-R shift solenoid valve. Refer to Repair Instructions (Overhaul) - Gearshift Control Box in this section. Did you complete the replacement?	—	Go to Step 8	—

Step	Action	Value(s)	Yes	No
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. **Important:** Transmission Gear Select & Shift Position Learning must be done if the gear shift position sensor, 1-3-5 shift solenoid valve, 2-4-6-R shift solenoid valve or transmission gearshift control box is replaced, removed or repaired. **Important:** Half-clutch Position Learning must be done if the gearshift clutch is replaced, removed or repaired. 3. Turn OFF the ignition for 30 seconds. 4. Lift the driving wheels or drive the vehicle. 5. Let the vehicle run so that all gear may engage enough. 6. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 9
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0919 (Flash Code 72)

Circuit Description

The pulse width modulation (PWM) 1-3-5 and 2-4-6-R shift solenoid valves are located on the gearshift control box. The transmission control module (TCM) controls each shift solenoid valves by duty cycle signal based on commanded gear position. The 1-3-5 shift solenoid is commanded ON when the commanded gear is set to 1st, 3rd and 5th gear. When disengaging from 2nd, 4th, 6th and reverse gear, the 1-3-5 shift solenoid is also commanded ON. The 2-4-6-R shift solenoid is commanded ON when the commanded gear is set to 2nd, 4th, 6th and reverse gear. When disengaging from1st, 3rd and 5th gear, the 2-4-6-R shift solenoid is also commanded ON. The gear shift position sensor is used to detect the shift side lever position feedback for the shift solenoid valves movement. The TCM uses the gear shift position sensor to determine the current gear position with a combination of the gear select position sensor. If the TCM detects the gear shift side lever position does not reach to a desired shift position when shifting to desired gear, this DTC will set.

Condition for Running the DTC

- DTCs P0718, P0889, P0902, P0903, P0904, P0912, P0913, P0914, P0973, P0974, P0976 and P0977 are not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The gearshift control box relay is commanded ON.
- The selector lever is other than N position.

Condition for Setting the DTC

- The TCM detects the gear shift side lever position does not reach to a desired shift position continuously when shifting to desired gear.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits gearshift control.
- The TCM commands OFF the gearshift clutch solenoid valve.
- The TCM commands OFF the lock up clutch solenoid valve.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0919 (Flash Code 72)

Schematic Reference: Transmission Controls Schematics
Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Lift the driving wheels or drive the vehicle. 4. Let the vehicle run so that all gear may engage enough. 5. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is P0902, P0903, P0904, P0912, P0913, P0914, P0973, P0974, P0976 or P0977 also set?	—	Go to Applicable DTC	Go to Step 3
3	Visually inspect the gear shift position sensor, 1-3-5 and 2-4-6-R shift solenoid valves for the following conditions: • Physical damage • Loose or improper installation Did you find and correct the condition?	—	Go to Step 8	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Lift the driving wheels or drive the vehicle. 2. Let the vehicle run so that all gear may engage enough. 3. Monitor the DTC Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 5	Go to Diagnostic Aids
5	1. Remove the gear shift position sensor. Refer to Gear Shift Position Sensor Replacement in this section. 2. Visually inspect the gear shift position sensor for the following conditions: • Physical damage • Loose or improper installation 3. Inspect the gear shift position sensor output voltage in order to check an open circuit, short circuit and high resistance somewhere in the operating range. 4. Remove the transmission gearshift control box assembly from the transmission main unit. Refer to Repair Instructions (Overhaul) - Control Box in this section. 5. Visually inspect the shift side lever for the following conditions: • Shift lever damage that connects to the gear shift position sensor shaft. • Shift lever damage that connects to the shift solenoid valves. • Shift lever damage that connects to the interlock plate and shift rods. • Other damage that the shift lever possible stuck. 6. Inspect the transmission main unit as necessary. Refer to Repair Instructions (Overhaul) in this section. 7. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 8	Go to Step 6
6	1. Remove the oil pump assembly. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. 2. Inspect the oil pump and gearshift clutch for the following conditions: • The gearshift clutch solenoid valve for mechanically stuck • The clutch spool valve mechanically stuck • The gearshift clutch mechanically stuck 3. Repair or replace as necessary. Did you find and correct the condition?		Go to Step 8	Go to Step 7
7	**Important:** Replacement 1-3-5 or 2-4-6-R shift solenoid valve must be relearned. Replace the 1-3-5 or 2-4-6-R shift solenoid valve. Refer to Repair Instructions (Overhaul) - Gearshift Control Box in this section. Did you complete the replacement?	—	Go to Step 8	—

Step	Action	Value(s)	Yes	No
8	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. **Important:** Transmission Gear Select & Shift Position Learning must be done if the gear shift position sensor, 1-3-5 shift solenoid valve, 2-4-6-R shift solenoid valve or transmission gearshift control box is replaced, removed or repaired. **Important:** Half-clutch Position Learning must be done if the gearshift clutch is replaced, removed or repaired. 3. Turn OFF the ignition for 30 seconds. 4. Lift the driving wheels or drive the vehicle. 5. Let the vehicle run so that all gear may engage enough. 6. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 9
9	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0973 (Flash Code 71)

Circuit Description

The pulse width modulation (PWM) 2-4-6-R shift solenoid valve is located on the gearshift control box. The transmission control module (TCM) controls the 2-4-6-R shift solenoid valve by duty cycle signal based on commanded gear position. The 2-4-6-R shift solenoid is commanded ON when the commanded gear is set to 2nd, 4th, 6th and reverse gear. When disengaging from1st, 3rd and 5th gear, the 2-4-6-R shift solenoid is also commanded ON. The gear shift position sensor is used to detect the shift side lever position feedback for the shift solenoid valves movement. The TCM uses the gear shift position sensor to determine the current gear position with a combination of the gear select position sensor. If the TCM detects a high voltage condition on the 2-4-6-R shift solenoid valve monitor circuit when the solenoid valve is commanded OFF, this DTC will set.

Condition for Running the DTC

- DTC P0889 is not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The gearshift control box relay is commanded ON.

Condition for Setting the DTC

- The TCM detects a high voltage condition on the 2-4-6-R shift solenoid valve monitor circuit when the solenoid valve is commanded OFF.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM intermittently sounds buzzer when the diagnostic runs and fails.
- The TCM commands OFF gearshift control box relay.
- The TCM inhibits gearshift control and holds gear position when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail at next ignition cycle
- The TCM stops the buzzer when the diagnostic runs and does not fail at next ignition cycle.
- A current DTC clears when the diagnostic runs and does not fail at next ignition cycle.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0973 (Flash Code 71)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0889 also set?	—	Go to DTC P0889	Go to Step 3
3	1. Turn OFF the ignition for 30 seconds. 2. Disconnect the 2-4-6-R shift solenoid valve harness connector. 3. Connect a DMM between the control circuit of the 2-4-6-R shift solenoid valve harness (pin 2 of J-236 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value until this DTC fails?	18.0 volts	Go to Step 4	Go to Step 6
4	Is the DMM voltage more than the specified value after this DTC fails?	18.0 volts	Go to Step 7	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Connect a test lamp between the ground circuit of the 2-4-6-R shift solenoid valve harness (pin 1 of J-236 connector) and battery voltage. 2. Turn ON the ignition. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 8
6	1. Test the voltage feed circuit between the transmission control module (TCM) (pins 5 and 6 of B-426 connector) and the gearshift control box relay (pin 2 of X-19 connector) for an open circuit or high resistance. 2. Test the control circuit between the TCM (pins 8 and 9 of B-425 connector) and the 2-4-6-R shift solenoid (pin 2 of J-236 connector) for an open circuit or high resistance. 3. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
7	**Important:** The 2-4-6-R shift solenoid valve may be damaged if the solenoid valve control circuit is shorted to a voltage source. 1. Test the control circuit between the TCM (pins 8 and 9 of B-425 connector) and the 2-4-6-R shift solenoid (pin 2 of J-236 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the ground circuit between 2-4-6-R shift solenoid (pin 1 of J-236 connector) and chassis ground (J-9) for an open circuit or high resistance. 2. Test the ground circuit between the TCM (pins 1 and 2 of B-425 connector) and chassis ground (J-9) for an open circuit or high resistance. 3. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the 2-4-6-R shift solenoid valve harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the 2-4-6-R shift solenoid valve (pins 1 and 2 of J-236 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for poor connections on the 2-4-6-R shift solenoid circuits at the harness connector of the TCM (pins 1, 2, 8 and 9 of B-425 and pins 5 and 6 of B-426 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12

Step	Action	Value(s)	Yes	No
11	**Important:** Replacement 2-4-6-R shift solenoid valve must be relearned. Replace the 2-4-6-R shift solenoid valve. Refer to Repair Instructions (Overhaul) - Gearshift Control Box in this section. Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0974 (Flash Code 71)

Circuit Description

The pulse width modulation (PWM) 2-4-6-R shift solenoid valve is located on the gearshift control box. The transmission control module (TCM) controls the 2-4-6-R shift solenoid valve by duty cycle signal based on commanded gear position. The 2-4-6-R shift solenoid is commanded ON when the commanded gear is set to 2nd, 4th, 6th and reverse gear. When disengaging from1st, 3rd and 5th gear, the 2-4-6-R shift solenoid is also commanded ON. The gear shift position sensor is used to detect the shift side lever position feedback for the shift solenoid valves movement. The TCM uses the gear shift position sensor to determine the current gear position with a combination of the gear select position sensor. If the TCM detects a low voltage condition on the 2-4-6-R shift solenoid valve monitor circuit when the solenoid valve is commanded ON, this DTC will set.

Condition for Running the DTC

- DTC P0889 is not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The gearshift control box relay is commanded ON.

Condition for Setting the DTC

- The TCM detects a low voltage condition on the 2-4-6-R shift solenoid valve monitor circuit when the solenoid valve is commanded ON.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM intermittently sounds buzzer when the diagnostic runs and fails.
- The TCM commands OFF gearshift control box relay.
- The TCM inhibits gearshift control and holds gear position when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail at next ignition cycle
- The TCM stops the buzzer when the diagnostic runs and does not fail at next ignition cycle.
- A current DTC clears when the diagnostic runs and does not fail at next ignition cycle.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0974 (Flash Code 71)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Place the transmission in neutral and set the parking brake. 4. Start the engine. 5. Operate the selector lever from N to D in order to energize the 2-4-6-R shift solenoid valve. 6. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition for 30 seconds. 2. Disconnect the 2-4-6-R shift solenoid valve harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with the Tech 2. Is DTC P0973 set?	—	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the control circuit between the transmission control module (TCM) (pins 8 and 9 of B-425 connector) and the 2-4-6-R shift solenoid (pin 2 of J-236 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	**Important:** Replacement 2-4-6-R shift solenoid valve must be learned. Replace the 2-4-6-R shift solenoid valve. Refer to Repair Instructions (Overhaul) - Gearshift Control Box in this section. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Place the transmission in neutral and set the parking brake. 5. Start the engine. 6. Operate the selector lever from N to D in order to energize the 2-4-6-R shift solenoid valve. 7. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0976 (Flash Code 73)

Circuit Description

The pulse width modulation (PWM) 1-3-5 shift solenoid valve is located on the gearshift control box. The transmission control module (TCM) controls the 1-3-5 shift solenoid valve by duty cycle signal based on commanded gear position. The 1-3-5 shift solenoid is commanded ON when the commanded gear is set to 1st, 3rd and 5th gear. When disengaging from 2nd, 4th, 6th and reverse gear, the 1-3-5 shift solenoid is also commanded ON. The gear shift position sensor is used to detect the shift side lever position feedback for the shift solenoid valves movement. The TCM uses the gear shift position sensor to determine the current gear position with a combination of the gear select position sensor. If the TCM detects a high voltage condition on the 1-3-5 shift solenoid valve monitor circuit when the solenoid valve is commanded OFF, this DTC will set.

Condition for Running the DTC

- DTC P0889 is not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The gearshift control box relay is commanded ON.

Condition for Setting the DTC

- The TCM detects a high voltage condition on the 1-3-5 shift solenoid valve monitor circuit when the solenoid valve is commanded OFF.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM intermittently sounds buzzer when the diagnostic runs and fails.
- The TCM commands OFF gearshift control box relay.
- The TCM inhibits gearshift control and holds gear position when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail at next ignition cycle
- The TCM stops the buzzer when the diagnostic runs and does not fail at next ignition cycle.
- A current DTC clears when the diagnostic runs and does not fail at next ignition cycle.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0976 (Flash Code 73)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC P0889 also set?	—	Go to DTC P0889	Go to Step 3
3	1. Turn OFF the ignition for 30 seconds. 2. Disconnect the 1-3-5 shift solenoid valve harness connector. 3. Connect a DMM between the control circuit of the 1-3-5 shift solenoid valve harness (pin 2 of J-235 connector) and a known good ground. 4. Turn ON the ignition, with the engine OFF. Is the DMM voltage more than the specified value until this DTC fails?	18.0 volts	Go to Step 4	Go to Step 6
4	Is the DMM voltage more than the specified value after this DTC fails?	18.0 volts	Go to Step 7	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Connect a test lamp between the ground circuit of the 1-3-5 shift solenoid valve harness (pin 1 of J-235 connector) and battery voltage. 2. Turn ON the ignition. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 8
6	1. Test the voltage feed circuit between the transmission control module (TCM) (pins 4 and 5 of B-425 connector) and the gearshift control box relay (pin 2 of X-19 connector) for an open circuit or high resistance. 2. Test the control circuit between the TCM (pins 21 and 31 of B-425 connector) and the 1-3-5 shift solenoid (pin 2 of J-235 connector) for an open circuit or high resistance. 3. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
7	**Important:** The 1-3-5 shift solenoid valve may be damaged if the solenoid valve control circuit is shorted to a voltage source. 1. Test the control circuit between the TCM (pins 21 and 31 of B-425 connector) and the 1-3-5 shift solenoid (pin 2 of J-235 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12
8	1. Test the ground circuit between the 1-3-5 shift solenoid (pin 1 of J-235 connector) and chassis ground (J-9) for an open circuit or high resistance. 2. Test the ground circuit between the TCM (pins 6 and 7 of B-425 connector) and chassis ground (J-9) for an open circuit or high resistance. 3. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the 1-3-5 shift solenoid valve harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the 1-3-5 shift solenoid valve (pins 1 and 2 of J-235 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for poor connections on the 1-3-5 shift solenoid circuits at the harness connector of the TCM (pins 4, 5, 6, 7, 21 and 31 of B-425 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 13	Go to Step 12

Step	Action	Value(s)	Yes	No
11	**Important:** Replacement 1-3-5 shift solenoid valve must be relearned. Replace the 1-3-5 shift solenoid valve. Refer to Repair Instructions (Overhaul) - Gearshift Control Box in this section. Did you complete the replacement?	—	Go to Step 13	—
12	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 13	—
13	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. Did the DTC fail this ignition?	—	Go to Step 2	Go to Step 14
14	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P0977 (Flash Code 73)

Circuit Description

The pulse width modulation (PWM) 1-3-5 shift solenoid valve is located on the gearshift control box. The transmission control module (TCM) controls the 1-3-5 shift solenoid valve by duty cycle signal based on commanded gear position. The 1-3-5 shift solenoid is commanded ON when the commanded gear is set to 1st, 3rd and 5th gear. When disengaging from 2nd, 4th, 6th and reverse gear, the 1-3-5 shift solenoid is also commanded ON. The gear shift position sensor is used to detect the shift side lever position feedback for the shift solenoid valves movement. The TCM uses the gear shift position sensor to determine the current gear position with a combination of the gear select position sensor. If the TCM detects a low voltage condition on the 1-3-5 shift solenoid valve monitor circuit when the solenoid valve is commanded ON, this DTC will set.

Condition for Running the DTC

- DTC P0889 is not set.
- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The gearshift control box relay is commanded ON.

Condition for Setting the DTC

- The TCM detects a low voltage condition on the 1-3-5 shift solenoid valve monitor circuit when the solenoid valve is commanded ON.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM intermittently sounds buzzer when the diagnostic runs and fails.
- The TCM commands OFF gearshift control box relay.
- The TCM inhibits gearshift control and holds gear position when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail at next ignition cycle
- The TCM stops the buzzer when the diagnostic runs and does not fail at next ignition cycle.
- A current DTC clears when the diagnostic runs and does not fail at next ignition cycle.
- A history DTC clears with the Tech 2 or reset switch operation.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P0977 (Flash Code 73)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Place the transmission in neutral and set the parking brake. 4. Start the engine. 5. Operate the selector lever from N to D and from D to N in order to energize the 1-3-5 shift solenoid valve. 6. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the ignition for 30 seconds. 2. Disconnect the 1-3-5 shift solenoid valve harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the DTC Information with the Tech 2. Is DTC P0976 set?	—	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Test the control circuit between the transmission control module (TCM) (pins 21 and 31 of B-425 connector) and the 1-3-5 shift solenoid (pin 2 of J-235 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	**Important:** Replacement 1-3-5 shift solenoid valve must be relearned. Replace the 1-3-5 shift solenoid valve. Refer to Repair Instructions (Overhaul) - Gearshift Control Box in this section. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Place the transmission in neutral and set the parking brake. 5. Start the engine. 6. Operate the selector lever from N to D and from D to N in order to energize the 1-3-5 shift solenoid valve. 7. Monitor the DTC Information with the Tech 2. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 8
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1901 (Flash Code 19)

Circuit Description

The half-clutch adjustment switch is used to adjust the clutch engagement timing. The clutch engages too fast/ slow when starting vehicle or the clutch engagement timing does not match with the driver preference when starting vehicle, the driver can select the timing by pressing either “FAST” or “SLOW” adjustment switch. If the TCM detects the half-clutch adjustment fast switch signal continuously “ON”, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The vehicle speed is more than 5 km/h (3 MPH)

Condition for Setting the DTC

- The TCM detects that the half-clutch adjustment fast switch signal is stuck at the ON position (high voltage).

Action Taken When the DTC Sets

- The TCM does not illuminate the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits half-clutch adjustment.

Condition for Clearing the DTC

- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1901 (Flash Code 19)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Fast Switch parameter with the Tech 2. Does the Fast Switch parameter indicate OFF?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the half-clutch adjustment switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Fast Switch parameter with the Tech 2. Does the Fast Switch parameter indicate OFF?	—	Go to Step 5	Go to Step 4
4	1. Test the half-clutch adjustment switch circuit between the transmission control module (TCM) (pin 2 of B-428 connector) and the half-clutch adjustment switch (pin 1 of B-106 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Replace the half-clutch adjustment switch. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—

Step	Action	Value(s)	Yes	No
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Observe the Fast Switch parameter with the Tech 2. Does the Fast Switch parameter indicate OFF?	—	Go to Step 8	Go to Step 3
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

P1902 (Flash Code 19)

Circuit Description

The half-clutch adjustment switch is used to adjust the clutch engagement timing. The clutch engages too fast/ slow when starting vehicle or the clutch engagement timing does not match with the driver preference when starting vehicle, the driver can select the timing by pressing either “FAST” or “SLOW” adjustment switch. If the TCM detects the half-clutch adjustment slow switch signal continuously “ON”, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.
- The vehicle speed is more than 5 km/h (3 MPH)

Condition for Setting the DTC

- The TCM detects that the half-clutch adjustment slow switch signal is stuck at the ON position (high voltage).

Action Taken When the DTC Sets

- The TCM does not illuminate the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits half-clutch adjustment.

Condition for Clearing the DTC

- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

DTC P1902 (Flash Code 19)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Slow Switch parameter with the Tech 2. Does the Slow Switch parameter indicate OFF?	—	Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the half-clutch adjustment switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Slow Switch parameter with the Tech 2. Does the Slow Switch parameter indicate OFF?	—	Go to Step 5	Go to Step 4
4	1. Test the half-clutch adjustment switch circuit between the transmission control module (TCM) (pin 9 of B-428 connector) and the half-clutch adjustment switch (pin 2 of B-106 connector) for a short to battery or ignition voltage. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 6
5	Replace the half-clutch adjustment switch. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—

Step	Action	Value(s)	Yes	No
7	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. 5. Observe the Slow Switch parameter with the Tech 2. Does the Slow Switch parameter indicate OFF?	—	Go to Step 8	Go to Step 3
8	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

U0100, U0121 (Flash Code 42, 68)

Circuit Description

The engine control module (ECM), the transmission control module (TCM), the electric hydraulic control module (EHCU) (ABS module) and the data recording module (DRM) communicate control and diagnostic information via a controller area network (CAN) communication bus. The TCM monitors CAN operational status by expecting a constant flow of messages from the ECM, EHCU and DRM. If the TCM fails to receive an expected message from the ECM, EHCU and DRM, DTC U0100 or U0121 will set depending on what communication is lost.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

U0100

- The TCM detects that the CAN Bus OFF Status.

U0121

- The TCM detects that the CAN Bus.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails. (U0100)
- The TCM does not illuminate the transmission warning lamp when the diagnostic runs and fails. (U0121)
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail. (U0100)
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- If DTC U0100 is present, auto shift control is inhibited and poor shift quality (feel) will appear.
- If DTC U0121 is present, lock up clutch may engage/disengage during an ABS event.

Notice:

- Diagnostic charts are different depending on the specification of the vehicle.

DTC U0100, U0121 (Flash Code 42, 68)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Chart for without ABS

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the transmission control module (TCM) Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	Attempt to communicate with the engine control module (ECM) via the Engine Data table. Does the Tech 2 communicate with the ECM?	—	Go to Step 4	Go to Diagnostic System Check - Engine Controls
4	1. Turn OFF the ignition. 2. Measure the resistance across the controller area network (CAN) Low and High circuits by back probing the resistor 1 (pins 1 and 2 of B-387 connector) (resistor 1 is located near the driver's side dash panel. It is blue connector). Is the resistance within the specified value (parallel resistance of the 120Ω resister 1 and the 120Ω resistor 2 should be 60Ω)?	50 - 70Ω	Go to Step 11	Go to Step 5

Step	Action	Value(s)	Yes	No
5	Is the resistance less than the specified value at Step 4?	—	Go to Step 6	Go to Step 9
6	1. Keep the DMM with connected. 2. Disconnect the TCM harness connectors. Is the resistance within the specified value?	50 - 70Ω	Go to Step 29	Go to Step 7
7	1. Keep the DMM with connected. 2. Disconnect the engine control module (ECM) harness connectors. Is the resistance within the specified value?	50 - 70Ω	Go to Step 30	Go to Step 8
8	1. Keep the DMM with connected. 2. Disconnect the data recording module (DRM) harness connector (DRM is located behind the glove box). Is the resistance within the specified value?	50 - 70Ω	Go to Step 28	Go to Step 21
9	1. Disconnect the resistor 1 harness connector. 2. Measure the resistance of the resistor 1. Is the resistance within the specified value?	110 - 130Ω	Go to Step 10	Go to Step 26
10	1. Disconnect the resister 2 harness connector (resistor 2 is located behind the radio and above the heater unit. It is blue connector). 2. Measure the resistance of the resistor 2. Is the resistance within the specified value?	110 - 130Ω	Go to Step 22	Go to Step 27
11	1. Disconnect the resistor 1 and resistor 2 harness connector. 2. Turn ON the ignition, with the engine OFF. 3. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 4. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 - 3.7 volts	Go to Step 12	Go to Step 15
12	1. Turn OFF the ignition. 2. Disconnect the ECM harness connectors. 3. Disconnect the TCM harness connectors. 4. Turn ON the ignition, with the engine OFF. 5. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 6. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 - 3.7 volts	Go to Step 13	Go to Step 18

Step	Action	Value(s)	Yes	No
13	1. Turn OFF the ignition. 2. Reconnect the TCM harness connectors. 3. Disconnect the DRM harness connectors. 4. Turn ON the ignition, with the engine OFF. 5. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 6. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 - 3.7 volts	Go to Step 14	Go to Step 19
14	1. Turn OFF the ignition. 2. Reconnect the ECM harness connectors. 3. Disconnect the TCM harness connectors. 4. Turn ON the ignition, with the engine OFF. 5. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 6. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading Are both voltage readings within the specified value?	1.3 - 3.7 volts	Go to Diagnostic Aids	Go to Step 20
15	1. Turn OFF the ignition. 2. Disconnect the ECM harness connectors. 3. Disconnect the TCM harness connectors. 4. Disconnect the DRM harness connector. 5. Turn ON the ignition, with the engine OFF. 6. Test the CAN Low and CAN High circuits among the resistor 1, resistor 2, ECM, TCM and DRM for a short to ground and short to voltage. Did you find and correct the condition?	—	Go to Step 31	Go to Step 16
16	1. Turn OFF the ignition. 2. Reconnect the ECM harness connectors. 3. Turn ON the ignition, with the engine OFF. 4. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 5. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading Are both voltage readings within the specified value?	1.3 - 3.7 volts	Go to Step 17	Go to Step 30

Step	Action	Value(s)	Yes	No
17	1. Turn OFF the ignition. 2. Reconnect the TCM harness connectors. 3. Turn ON the ignition, with the engine OFF. 4. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 5. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading Are both voltage readings within the specified value?	1.3 - 3.7 volts	Go to Step 28	Go to Step 29
18	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 — 3.7 volts in Step 12) between the DRM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 23
19	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 — 3.7 volts in Step 13) between the TCM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 24
20	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 — 3.7 volts in Step 14) between the ECM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 25
21	Repair the short circuit each other across the CAN Low and High circuits among the resistor 1, resistor 2, ECM, TCM and DRM. Did you complete the repair?	—	Go to Step 31	—
22	1. Repair the open circuit or high resistance on the CAN Low and High circuits between the resistor 1 (pins 1 and 2 of B-387 connector) and the resistor 2 (pins 1 and 2 of B-431 connector). 2. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the each resistor. Did you complete the repair?	—	Go to Step 31	—
23	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the DRM (pins 2 and 8 of B-429 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 28

Step	Action	Value(s)	Yes	No
24	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the TCM (pins 2 and 3 of B-427 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 29
25	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the ECM (pins 18 and 37 of J-191 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 31	Go to Step 30
26	Replace the resistor 1. Did you complete the replacement?	—	Go to Step 31	—
27	Replace the resistor 2. Did you complete the replacement?	—	Go to Step 31	—
28	Replace the DRM. Refer to Data Recording Module (DRM) Replacement. Did you complete the replacement?	—	Go to Step 31	—
29	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 31	—
30	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement /Restore Fuel Injector ID Code Data in engine control section. Did you complete the replacement?	—	Go to Step 31	—
31	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 32
32	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

Chart for with ABS

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls

Step	Action	Value(s)	Yes	No
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Monitor the transmission control module (TCM) Diagnostic Trouble Code (DTC) Information with the Tech 2. Does the DTC fail this ignition?	—	Go to Step 3	Go to Diagnostic Aids
3	Attempt to communicate with the engine control module (ECM) via the Engine Data table. Does the Tech 2 communicate with the ECM?	—	Go to Step 4	Go to Diagnostic System Check - Engine Controls
4	Attempt to communicate with the electrical hydraulic control unit (EHCU) (ABS module) via the ABS Data table. Does the Tech 2 communicate with the EHCU?	—	Go to Step 5	Go to Diagnostic System Check -Anti-lock Brake System Controls
5	1. Turn OFF the ignition. 2. Measure the resistance across the controller area network (CAN) Low and High circuits by back probing the resistor 1 (pins 1 and 2 of B-387 connector) (resistor 1 is located near the driver's side dash panel. It is blue connector). Is the resistance within the specified value (parallel resistance of the 120Ω resister 1 and the 120Ω resistor 2 should be 60Ω)?	50 - 70Ω	Go to Step 14	Go to Step 6
6	Is the resistance less than the specified value at Step 5?	—	Go to Step 7	Go to Step 12
7	1. Keep the DMM with connected. 2. Disconnect the EHCU harness connector. Is the resistance within the specified value?	110 - 130Ω	Go to Step 9	Go to Step 8
8	1. Keep the DMM with connected. 2. Disconnect the TCM harness connectors. Is the resistance within the specified value?	110 - 130Ω	Go to Step 35	Go to Step 25
9	Measure the resistance across the CAN Low and High circuits by back probing the resistor 2 (pins 1 and 2 of B-431 connector) (resistor 2 is located behind the radio and above the heater unit. It is blue connector). Is the resistance within the specified value?	110 - 130Ω	Go to Step 36	Go to Step 10
10	1. Keep the DMM with connected. 2. Disconnect the engine control module (ECM) harness connectors. Is the resistance within the specified value?	110 - 130Ω	Go to Step 37	Go to Step 11
11	1. Keep the DMM with connected. 2. Disconnect the data recording module (DRM) harness connector (DRM is located behind the glove box). Is the resistance within the specified value?	110 - 130Ω	Go to Step 34	Go to Step 26
12	1. Disconnect the resistor 1 harness connector. 2. Measure the resistance of the resistor 1. Is the resistance within the specified value?	110 — 130Ω	Go to Step 13	Go to Step 32

Step	Action	Value(s)	Yes	No
13	1. Disconnect the resister 2 harness connector (resistor 2 is located behind the radio and above the heater unit. It is blue connector). 2. Measure the resistance of the resistor 2. Is the resistance within the specified value?	110 - 130Ω	Go to Step 27	Go to Step 33
14	1. Disconnect the resistor 1 and resistor 2 harness connector. 2. Turn ON the ignition, with the engine OFF. 3. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 4. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 - 3.7 volts	Go to Step 15	Go to Step 18
15	1. Turn OFF the ignition. 2. Disconnect the ECM harness connectors. 3. Disconnect the EHCU harness connectors. 4. Disconnect the DRM harness connector. 5. Turn ON the ignition, with the engine OFF. 6. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 7. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 - 3.7 volts	Go to Step 16	Go to Step 23
16	1. Turn OFF the ignition. 2. Reconnect the DRM harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Connect a DMM between the CAN Low circuit (pin 1 of B-431 connector) and a known good ground at the resistor 2 harness connector. Record the voltage reading. 5. Connect a DMM between the CAN High circuit (pin 2 of B-431 connector) and a known good ground at the resistor 2 harness connector. Record the voltage reading. Are both voltage readings within the specified value?	1.3 - 3.7 volts	Go to Step 17	Go to Step 22

Step	Action	Value(s)	Yes	No
17	1. Turn OFF the ignition. 2. Reconnect the ECM harness connectors. 3. Disconnect the DRM harness connectors. 4. Turn ON the ignition, with the engine OFF. 5. Connect a DMM between the CAN Low circuit (pin 1 of B-431 connector) and a known good ground at the resistor 2 harness connector. Record the voltage reading. 6. Connect a DMM between the CAN High circuit (pin 2 of B-431 connector) and a known good ground at the resistor 2 harness connector. Record the voltage reading Are both voltage readings within the specified value?	1.3 - 3.7 volts	Go to Diagnostic Aids	Go to Step 24
18	1. Turn OFF the ignition. 2. Disconnect the ECM harness connectors. 3. Disconnect the TCM harness connectors. 4. Disconnect the EHCU harness connector. 5. Disconnect the DRM harness connector. 6. Turn ON the ignition, with the engine OFF. 7. Test the CAN Low and CAN High circuits among the resistor 1, resistor 2, ECM, EHCU and DRM for a short to ground and short to voltage. Did you find and correct the condition?	—	Go to Step 38	Go to Step 19
19	1. Turn OFF the ignition. 2. Keep the ECM, TCM and DRM harness connectors with disconnect. 3. Reconnect the EHCU harness connector. 4. Turn ON the ignition, with the engine OFF. 5. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 6. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading Are both voltage readings within the specified value?	1.3 - 3.7 volts	Go to Step 20	Go to Step 36
20	1. Turn OFF the ignition. 2. Reconnect the TCM harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 5. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading Are both voltage readings within the specified value?	1.3 - 3.7 volts	Go to Step 21	Go to Step 35

Step	Action	Value(s)	Yes	No
21	1. Turn OFF the ignition. 2. Reconnect the ECM harness connectors. 3. Turn ON the ignition, with the engine OFF. 4. Connect a DMM between the CAN Low circuit (pin 1 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading. 5. Connect a DMM between the CAN High circuit (pin 2 of B-387 connector) and a known good ground at the resistor 1 harness connector. Record the voltage reading Are both voltage readings within the specified value?	1.3 - 3.7 volts	Go to Step 34	Go to Step 37
22	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 — 3.7 volts in Step 16) between the DRM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 28
23	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 — 3.7 volts in Step 15) between the TCM and joint connection. 2. Repair the circuit(s) as necessary. 3. Did you find and correct the condition?	—	Go to Step 38	Go to Step 29
24	1. Test for an open or high resistance in the CAN Low or High circuit (which ever voltage reading did not read between 1.3 — 3.7 volts in Step 17) between the ECM and joint connection. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 31
25	Repair the short circuit each other across the CAN Low and High circuits among the resistor 1, TCM and EHCU. Did you complete the repair?	—	Go to Step 38	—
26	Repair the short circuit each other across the CAN Low and High circuits among the resistor 2, ECM, DRM and EHCU. Did you complete the repair?	—	Go to Step 38	—
27	1. Test the CAN Low and High circuits between the resistor 1 (pins 1 and 2 of B-387 connector) and the EHCU (pins 14 and 15 of J-177 connector) for an open circuit or high resistance. 2. Test the CAN Low and High circuits between the resistor 2 (pins 1 and 2 of B-431 connector) and the EHCU (pins 26 and 27 of J-177 connector) for an open circuit or high resistance. 3. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the each resistor. 4. Repair the circuit(s) or connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 30

Step	Action	Value(s)	Yes	No
28	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the DRM (pins 2 and 8 of B-429 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 34
29	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the TCM (pins 2 and 3 of B-427 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 35
30	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the EHCU (pins 14, 15, 26 and 27 of J-177 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 36
31	1. Inspect for an intermittent, for poor connections and corrosion on the CAN Low and High circuits at the harness connector of the ECM (pins 18 and 37 of J-191 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 38	Go to Step 37
32	Replace the resistor 1. Did you complete the replacement?	—	Go to Step 38	—
33	Replace the resistor 2. Did you complete the replacement?	—	Go to Step 38	—
34	Replace the DRM. Refer to Data Recording Module (DRM) Replacement. Did you complete the replacement?	—	Go to Step 38	—
35	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 38	—
36	Replace the EHCU. Refer to Electric Hydraulic Control Unit (EHCU Replacement in the Anti-lock Brake section. Did you complete the replacement?	—	Go to Step 38	—
37	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement /Restore Fuel Injector ID Code Data in engine control section. Did you complete the replacement?	—	Go to Step 38	—

Step	Action	Value(s)	Yes	No
38	1. Reconnect all previously disconnected harness connector(s). 2. Clear the DTCs with the Tech 2. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. Did the DTC fail this ignition?	—	Go to Step 3	Go to Step 39
39	Observe the DTC Information with the Tech 2. Are there any DTCs that you have not diagnosed?	—	Go to Diagnostic Trouble Code (DTC) List	System OK

U0400 (Flash Code 23)

Circuit Description

The engine speed signal to the transmission control module (TCM) is sent from the engine control module (ECM) via a controller area network (CAN) communication bus based on inputs from the crankshaft position (CKP) sensor and camshaft position (CMP) sensor. If the TCM detects no engine speed signal from the ECM during the engine running, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

- The TCM detects that the engine speed CAN Bus messages from the ECM are not being received.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- If this DTC is present, the Engine Speed parameter on the Tech 2 will indicate the turbine speed when the current gear is neutral or lock up clutch is engaged. Other condition, it indicates a default value.

DTC U0400 (Flash Code 23)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC U0100 or U0121 set?	—	Go to Applicable DTC	Go to Step 3
3	1. Select the “4HK1” in the system selection menu. 2. Monitor the DTC Information with the Tech 2. Is the engine control module (ECM) DTC P0335, P0336, P0340, P0341 or P1345 set?	—	Go to Applicable DTC in Engine Control Section	Go to Diagnostic Aids

U0401 (Flash Code 24)

Circuit Description

The accelerator pedal position (APP) signal to the transmission control module (TCM) is sent from the engine control module (ECM) via a controller area network (CAN) communication bus based on inputs from the APP sensor 1 and APP sensor 2. If the TCM detects no APP signal from the ECM, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

- The TCM detects that the accelerator pedal position CAN Bus messages from the ECM are not being received.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits auto shift control.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.
- If this DTC is present, poor shift quality (feel) will appear.

DTC U0401 (Flash Code 24)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC U0100 or U0121 set?	—	Go to Applicable DTC	Go to Step 3
3	1. Select the “4HK1” in the system selection menu. 2. Monitor the DTC Information with the Tech 2. Is the engine control module (ECM) DTC P1271, P1277, P1278, P1282 or P1283 set?	—	Go to Applicable DTC in Engine Control Section	Go to Diagnostic Aids

U0406 (Flash Code 25)

Circuit Description

The vehicle speed signal to the transmission control module (TCM) is sent from the engine control module (ECM) via a controller area network (CAN) communication bus based on input from the vehicle speed sensor (VSS). If the TCM detects no vehicle speed signal from the ECM, this DTC will set.

Condition for Running the DTC

- The ignition switch is ON.
- The ignition voltage is more than 20 volts.
- The emergency switch is OFF.

Condition for Setting the DTC

- The TCM detects that the vehicle speed CAN Bus messages from the ECM are not being received.

Action Taken When the DTC Sets

- The TCM illuminates the transmission warning lamp when the diagnostic runs and fails.
- The TCM inhibits auto shift control.
- The TCM selects highest gear when shifted from N to D.
- The TCM inhibits gear select & shift position learning and half-clutch learning.

Condition for Clearing the DTC

- The TCM turns OFF the transmission warning lamp when the diagnostic runs and does not fail.
- A current DTC clears when the diagnostic runs and does not fail.
- A history DTC clears when the diagnostic runs and does not fail.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Notice:

- If this DTC is present, the Output Shaft Speed and Vehicle Speed parameter on the Tech 2 will indicate estimated value based on other inputs.

DTC U0406 (Flash Code 25)

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Monitor the Diagnostic Trouble Code (DTC) Information with the Tech 2. Is DTC U0100 or U0121 set?	—	Go to Applicable DTC	Go to Step 3
3	1. Select the “4HK1” in the system selection menu. 2. Monitor the DTC Information with the Tech 2. Is the engine control module (ECM) DTC P0500 or P0501 set?	—	Go to Applicable DTC in Engine Control Section	Go to Diagnostic Aids

Transmission Warning Lamp Inoperative

Circuit Description

Ignition voltage is supplied to the transmission warning lamp via meter fuse. The transmission control module (TCM) turns the transmission warning lamp ON by grounding the lamp control circuit.

Transmission Warning Lamp Operation

The transmission warning lamp is located on the instrument panel cluster (IPC).

Transmission Warning Lamp Function

- The transmission warning lamp informs the driver that a malfunction has occurred and the vehicle should be taken in for service as soon as possible.
- The transmission warning lamp illuminates during a bulb test.
- A DTC will be stored if the transmission warning lamp is requested by the TCM.

Transmission Waning Lamp Illumination

- The transmission warning lamp illuminates for approximately 3 seconds when the ignition switch is turned ON, with the engine OFF.
- The transmission warning lamp remains illuminated if the transmission control module (TCM) detects a fault.

Transmission Warning Lamp Inoperative

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Verify whether the instrument panel cluster (IPC) is operational. 2. Turn OFF the ignition for 30 seconds. 3. Turn OFF the emergency switch. 4. Turn ON the ignition, with the engine OFF. Does the transmission warning lamp illuminate?	—	Go to Intermittent Conditions	Go to Step 3
3	Inspect the Meter (10 A) fuse (F-16) in the glove box fuse block that supplies ignition voltage to the transmission warning lamp. Is the fuse open?	—	Go to Step 10	Go to Step 4
4	1. Turn OFF the ignition. 2. Remove the Meter (10 A) fuse (F-16) that supplies voltage to the transmission warning lamp. 3. Disconnect the transmission control module (TCM) harness connector (B-425 connector). 4. Turn ON the ignition with the engine OFF. 5. Measure the voltage from the transmission warning lamp control circuit at the TCM (pin 11 of B-425 connector) to a known good ground. Is the voltage less than the specified value?	1 volt	Go to Step 5	Go to Step 11
5	1. Turn OFF the ignition. 2. Install the Meter (10 A) fuse (F-16) that supplies voltage to the transmission warning lamp. 3. Turn ON the ignition, with the engine OFF. 4. Connect a 3-amp fused jumper wire between the transmission warning lamp control circuit in the TCM harness connector and a known good ground. Is the transmission warning lamp illuminated?	—	Go to Step 9	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Turn ON the ignition. 2. Operate the 1st gear start switch while observing the 1st START indicator lamp in the IPC. Does the 1st START indicator lamp operate correctly?	—	Go to Step 7	Go to Step 12
7	1. Turn OFF the ignition. 2. Disconnect the IPC harness connector (B-53 connector). 3. Test the transmission warning lamp control circuit between the TCM (pin 11 of B-425 connector) and the IPC (pin 8 of B-53 connector) for an open or high resistance. 4. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 8
8	1. Test for an intermittent and for a poor connection at the IPC (pin 8 of B-53 connector). 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 13
9	1. Test for an intermittent and for a poor connection at the TCM harness connector (pin 11 of B-425 connector). 2. Repair the connector(s) as necessary. Did you find and correct the condition?	—	Go to Step 15	Go to Step 14
10	Replace the Meter (10 A) fuse (F-16). If the fuse continues to open, repair the short to ground on the ignition voltage circuit or check for a shorted component. Did you complete the repair?	—	Go to Step 15	—
11	Repair the short to voltage on the transmission warning lamp control circuit. Did you complete the repair?	—	Go to Step 15	—
12	Repair the open in the transmission warning lamp ignition voltage circuit. Did you complete the repair?	—	Go to Step 15	—
13	Replace the IPC. Refer to Instrument Panel Cluster (IPC) Replacement in the Cab and Chassis Electrical section. Did you complete the replacement?	—	Go to Step 15	—
14	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 15	—
15	1. Remove all test equipment. 2. Connect any disconnected components or any disconnected fuse. 3. Turn ON the ignition, with the engine OFF. Does the transmission warning lamp illuminate?	—	Go to Step 16	Go to Step 2

Step	Action	Value(s)	Yes	No
16	1. Turn OFF the ignition for 30 seconds. 2. Start the engine and operate the vehicle checking for acceptable performance and driveability. 3. Observe the transmission warning lamp, the vehicle performance and the driveability. Does the vehicle operate correctly, without any transmission warning lamp illumination and without any stored DTCs?	—	System OK	Go to Diagnostic Trouble Code (DTC) List or Symptom Charts

Transmission Warning Lamp Always On

Circuit Description

Ignition voltage is supplied to the transmission warning lamp via meter fuse. The transmission control module (TCM) turns the transmission warning lamp ON by grounding the lamp control circuit.

Transmission Warning Lamp Operation

The transmission warning lamp is located on the instrument panel cluster (IPC).

Transmission Warning Lamp Function

- The transmission warning lamp informs the driver that a malfunction has occurred and the vehicle should be taken in for service as soon as possible.
- The transmission warning lamp illuminates during a bulb test.
- A DTC will be stored if the transmission warning lamp is requested by the TCM.

Transmission Waning Lamp Illumination

- The transmission warning lamp illuminates for approximately 3 seconds when the ignition switch is turned ON, with the engine OFF.
- The transmission warning lamp remains illuminated if the transmission control module (TCM) detects a fault.

Transmission Warning Lamp Always On

Schematic Reference: Transmission Controls Schematics

Connector End View Reference: Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls
2	1. Turn OFF the ignition for 30 seconds. 2. Turn OFF the emergency switch. 3. Turn ON the ignition, with the engine OFF. Does the transmission warning lamp always remain ON after 3 seconds passed?	—	Go to Step 3	Check for DTCs and if none exist Go to Intermittent Conditions
3	1. Turn OFF the ignition. 2. Disconnect the transmission control module (TCM) harness connector (B-425 connector). 3. Turn ON the ignition, with the engine OFF. 4. Observe the transmission warning lamp. Is the transmission warning lamp illuminated?	—	Go to Step 4	Go to Step 6
4	1. Remove the instrument panel cluster (IPC). 2. Disconnect the IPC harness connector (B-53 connector). 3. Test the transmission warning lamp control circuit between the TCM (pin 11 of B-425 connector) and the IPC (pin 8 of B-53 connector) for a short to ground. 4. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 7	Go to Step 5
5	Replace the IPC. Refer to Instrument Panel Cluster (IPC) Replacement in the Cab and Chassis Electrical section. Did you complete the replacement?	—	Go to Step 7	—
6	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 7	—

Step	Action	Value(s)	Yes	No
7	1. Remove all test equipment. 2. Connect any disconnected components. 3. Turn ON the ignition, with the engine OFF. Does the transmission warning lamp always remain ON after 3 seconds passed?	—	Go to Step 2	Go to Step 8
8	1. Turn OFF the ignition for 30 seconds. 2. Start the engine and operate the vehicle checking for acceptable performance and driveability. 3. Observe the transmission warning lamp, the vehicle performance, and the driveability. Does the vehicle operate correctly, without any transmission warning lamp illumination and without any stored DTCs?	—	System OK	Go to Diagnostic Trouble Code (DTC) List or Symptom Charts

Gearshift Control System Check

Description

The pulse width modulation (PWM) select solenoid valve, 1-3-5 and 2-4-6-R shift solenoid valves are located on the gearshift control box. The transmission control module (TCM) controls each select and shift solenoid valves by duty cycle signal based on commanded gear position. The select solenoid is only commanded ON when up-shifting. When downshifting, the force created by the return springs moves the internal select lever, but the select solenoid limits the amount of movement by generating force as required in the up-shift direction. The 1-3-5 shift solenoid is commanded ON when the commanded gear is set to 1st, 3rd and 5th gear. When disengaging from 2nd, 4th, 6th and reverse gear, the 1-3-5 shift solenoid is also commanded ON. The 2-4-6-R shift solenoid is commanded ON when the commanded gear is set to 2nd, 4th, 6th and reverse gear. When disengaging from1st, 3rd and 5th gear, the 2-4-6-R shift solenoid is also commanded ON. The gear select position sensor is used to detect the select side lever position feedback for the select solenoid valve movement. The gear shift position sensor is used to detect the shift side lever position feedback for the shift solenoid valves movement. The TCM uses the gear shift position sensor to determine the current gear position with a combination of the gear select position sensor.

When the selector lever is in the N position, the transmission is in neutral. Operating the lever to the R position puts the vehicle into reverse. Operating the lever to the D position puts the vehicle into drive, and into auto shift mode. Operating the lever to the + direction from D, shifts the up-shifting. Operating it to the − direction, shifts the downshifting. This operation also switches to the manual mode. Operating the lever from the D position to the A position while in the manual mode switches to the auto mode. When the selector lever is moved to any of the A, + or − positions from the D position, it will automatically return to the D position.

The economy mode switch can be pressed during the auto mode if you want gear changes to be performed with the priority on efficient fuel consumption. The 1st gear start switch is used to control vehicle starting so that 1st gear is normally used to start vehicle. This is because the transmission is controlled to start in 2nd gear if the 1st gear start switch is not ON.

The emergency switch, which is used when the TCM or related switches or sensors fail and normal control is not possible, and the emergency shift switch are located in front of the selector lever. As these switches are only used in an emergency, they are usually protected with a cover.

The diagnostic table assumes the following conditions are met:

- The battery is completely charged and terminals are cleaned and tight.
- Fuse and slow blow fuse are normal.
- The vehicle information data is correctly programmed and transmission gear select & shift position is correctly learned.

Diagnostic Aids

- If an intermittent condition is suspected, refer to Intermittent Conditions in this section.

Gearshift Control System Check

Schematic Reference: Engine Controls Schematics and Transmission Controls Schematics

Connector End View Reference: Engine Controls Connector End Views, Engine Control Module (ECM) Connector End Views, Transmission Controls Connector End Views or Transmission Control Module (TCM) Connector End Views

Chart 1 of 4

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Transmission Controls?	—	Go to Step 2	Go to Diagnostic System Check - Transmission Controls

Step	Action	Value(s)	Yes	No
2	1. Install the Tech 2. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Observe the following transmission data with the Tech 2. Reprogram correct vehicle information if incorrect. Refer to Transmission Control Module (TCM) Replacement in this section. • Engine Type • Transmission Type • Speedometer Driven Gear Teeth 5. Observe the following transmission data with the Tech 2. Relearn if indicates Not Learned. Refer to Transmission Control Module (TCM) Replacement in this section. • Engine Type Learning Status • Transmission Type Learning Status • Speedometer Driven Gear Learning Status • Gear Position Learning Status • Torque Learning Status 6. Learning procedure must be done whenever any of the relating parts are replaced, removed or repaired. Refer to Programming & Learning Guideline in this section. Did you complete the action?	—	Go to Step 3	—
3	Operate the selector lever while observe the Selector Position parameter with the Tech 2. Does the Selector Position parameter indicate correct position?	—	Go to Step 4	Refer to DTC P0906 and P0907
4	1. Inspect for correct ATF level. Refer to ATF inspection in this section. 2. Inspect for external leakage. 3. Repair or add ATF as necessary. Did you complete the action?	—	Go to Step 5	—
5	1. Lift the driving wheels or drive the vehicle. 2. Start the engine. 3. Monitor the DTC Information with the Tech 2. Are any DTC(s) set?	—	Go to Applicable DTC	Go to Step 6
6	1. Start the engine if stopped. 2. Put the vehicle with the following conditions: • Selector lever N position • 1st gear start switch OFF • Economy mode switch OFF • Emergency switch OFF • Emergency shift switch N position • PTO switch(s) and/or lever OFF 3. Operate the selector lever from N to D while applying the brake pedal. Does the gear position display in the instrument panel cluster (IPC) indicate A?	—	Go to Step 7	Go to Step 20

Step	Action	Value(s)	Yes	No
7	Does the transmission warning lamp OFF in the IPC?	—	Go to Step 8	If DTC is set, refer to applicable DTC. If no DTC, Go to Transmission Warning Lamp Always ON
8	Does the ECONO indicator lamp OFF in the IPC?	—	Go to Step 9	Go to Chart 2 of 4 Step 13
9	Does the 1st START indicator lamp OFF in the IPC?	—	Go to Step 10	Go to Chart 2 of 4 Step 28
10	Let the vehicle run while observing the Current Gear and Desired Gear Position parameter with the Tech 2. Does all forward gear automatically engage or disengage except 1st gear, and Current Gear parameter follow the Desired Gear Position parameter?	—	Go to Step 11	If DTC is set, refer to applicable DTC. If no DTC, Go to Step 19
11	1. Stop the vehicle. 2. Economy mode switch ON. 3. Let the vehicle run while observing the Current Gear and Desired Gear Position parameter with the Tech 2. Does all forward gear automatically engage or disengage except 1st gear, and the timing of up-shifting earlier than normal auto shifting?	—	Go to Step 12	Go to Chart 2 of 4 Step 1
12	1. Stop the vehicle. 2. Operate the selector lever to + and −. Slightly move the vehicle as necessary. Does the gear position display in the IPC indicate 1, 2 or 3 when the selector lever is operated?	—	Go to Step 13	If DTC is set, refer to applicable DTC. If no DTC, Go to Step 19
13	1. Stop the vehicle. 2. Operate the selector lever to A. 3. 1st gear start switch ON 4. Let the vehicle run while observing the Current Gear and Desired Gear Position parameter with the Tech 2. Does the 1st gear automatically engage whenever vehicle starting?	—	Go to Step 14	Go to Chart 2 of 4 Step 18
14	1. Stop the vehicle. 2. Operate the selector lever to R. Slightly move the vehicle as necessary. Does the reverse gear engage?	—	Go to Step 15	If DTC is set, refer to applicable DTC. If no DTC, Go to Step 19
15	1. Stop the vehicle. 2. Put the vehicle with the following conditions: • Selector lever N position • Emergency switch ON • Emergency shift switch N position Does the transmission warning lamp blink in the IPC?	—	Go to Step 16	Go to Chart 3 of 4 Step 1
16	1. Apply the brake pedal firmly. 2. Turn the emergency shift switch to 1. Does the 1st gear engage?	—	Go to Step 17	Go to Chart 3 of 4 Step 13

Step	Action	Value(s)	Yes	No
17	1. Stop the vehicle. 2. Apply the brake pedal firmly. 3. Turn the emergency shift switch to R. Does the reverse gear engage?	—	Go to Step 18	Go to Chart 3 of 4 Step 24
18	1. Stop the vehicle. 2. Put the vehicle with the following conditions: • Selector lever N position • Emergency switch OFF • Emergency shift switch N position 3. Turn OFF the ignition for 30 seconds. 4. Turn ON the ignition, with the engine OFF. Does the gear position display in the IPC indicate N?	—	System OK	If DTC is set, refer to applicable DTC. If no DTC, Go to Step 19
19	1. Perform following checks which ever gear position did not engage or disengage. Use Tech 2 transmission data list normal reading or a known good vehicle to determine nominal values. 2. Visually inspect the gear select position sensor, gear shift position sensor, select solenoid valve, 1-3-5 shift solenoid valve, 2-4-6-R shift solenoid valve for the following conditions: • Physical damage • Loose or improper installation 3. Remove the transmission gearshift control box. Refer to Repair Instructions (Overhaul) - Control Box in this section. 4. Visually inspect the gearshift control box for the following conditions: • Internal lever damage that connects to the each position sensor. • Internal lever damage that connects to the each solenoid valve. • Shift lever damage that connects to the interlock plate and shift rods • Other damage that the shift lever possible to stuck. 5. Inspect the transmission main unit as necessary. Refer to Repair Instructions (Overhaul) in this section. 6. Remove the oil pump assembly. Refer to Repair Instructions (Overhaul) - Oil Pump in this section. 7. Inspect the oil pump assembly and gearshift clutch for the following conditions: • The gearshift clutch solenoid valve or lock up clutch solenoid valve for mechanically stuck or damage. • Each spool valve for damage. • The oil pump for damage. • ATF Internal leaking • The gearshift clutch mechanically stuck or damage. 8. Repair or replace as necessary. Did you find and correct the condition?	—	Go to Step 2	—

Step	Action	Value(s)	Yes	No
20	Does the gear position display in the IPC keep to indicate N?	—	Go to Step 21	Go to Step 22
21	Does the transmission warning lamp blink in the IPC?	—	Go to Chart 3 of 4 Step 9	Go to Step Chart 4 of 4 Step 1
22	Does the gear position display in the IPC indicate any gear?	—	If DTC is set, the TCM is not allowing auto shift control. Refer to applicable DTC. If no DTC, Go to Chart 4 of 4 Step 16	Go to Chart 4 of 4 Step 12

Chart 2 of 4

Step	Action	Value(s)	Yes	No
1	1. Turn ON the ignition switch, with the engine OFF. 2. Observe the Economy Switch parameter with the Tech 2. Does the Economy Switch parameter indicate ON when the switch is ON?	—	Go to Step 2	Go to Step 3
2	Does the ECONO indicator lamp illuminate at Step 1?	—	Go to Intermittent Conditions	Go to Step 9
3	1. Turn OFF the ignition. 2. Disconnect the economy mode and 1st gear start switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Economy Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire between the economy mode switch harness (pin 6 of N-20 connector) and a known good ground. Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 4	Go to Step 5
4	Observe the Economy Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the economy mode switch harness (pins 3 and 6 of N-20 connector). Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 7	Go to Step 6
5	1. Test the economy switch signal circuit between the transmission control module (TCM) (pin 13 of B-428 connector) and the economy mode switch (pin 6 of N-20 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 8
6	Repair the open circuit or high resistance on the ground circuit of the economy mode switch (pin 3 of N-20 connector) and the chassis ground (B-1). Did you complete the repair?	—	Go to Step 35	—

Step	Action	Value(s)	Yes	No
7	1. Turn OFF the ignition. Inspect for an intermittent and for poor connections at the harness connector of the economy mode switch (pins 3 and 6 of N-20 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 32
8	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for a poor connection on the economy mode switch signal circuit at the harness connector of the TCM (pin 13 of B-428 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 34
9	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector (B-425 connector). 3. Turn ON the ignition, with the engine OFF. 4. Connect a 3-amp fused jumper wire between the ECONO indicator lamp control circuit of the TCM harness connector (pin 12 of B-425 connector) and a known good ground. Does the ECONO indicator lamp illuminate?	—	Go to Step 12	Go to Step 10
10	1. Turn OFF the ignition. 2. Inspect for an intermittent and for a poor connection at the harness connector of the instrument panel cluster (IPC) (pin 7 of B-53 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 11
11	1. Test the ECONO indicator lamp control circuit between the TCM (pin 12 of B-425 connector) and the IPC (pin 7 of B-53 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 33
12	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for a poor connection on the ECONO indicator lamp control circuit at the harness connector of the TCM (pin 12 of B-425 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 34
13	1. Turn ON the ignition switch, with the engine OFF. 2. Observe the Economy Switch parameter with the Tech 2. Does the Economy Switch parameter indicate OFF when the switch is OFF?	—	Go to Step16	Go to Step 14

Step	Action	Value(s)	Yes	No
14	1. Turn OFF the ignition. 2. Disconnect the economy mode and 1st gear start switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Economy Switch parameter with the Tech 2. Does the Economy Switch parameter indicate OFF?	—	Go to Step 32	Go to Step 15
15	1. Test the economy switch circuit between the TCM (pin 13 of B-428 connector) and the economy mode switch (pin 6 of N-20 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 34
16	1. Turn OFF the ignition. 2. Disconnect the IPC B-53 connector harness connector. 3. Connect a test lamp between the ECONO indicator lamp control circuit (pin 7 of B-53 connector) and battery voltage. 4. Turn ON the ignition, with the engine OFF. Does the test lamp continuously illuminate (test lamp blink then go out normally)?	—	Go to Step 17	Go to Step 33
17	1. Test the ECONO indicator lamp control circuit between the TCM (pin 12 of B-425 connector) and the IPC (pin 7 of B-53 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 34
18	1. Turn ON the ignition switch, with the engine OFF. 2. Observe the 1st gear start switch parameter with the Tech 2. Does the 1st gear start switch parameter indicate ON when the switch is ON?	—	Go to Step 19	Go to Step 20
19	Does the 1st START indicator lamp illuminate at Step 18?	—	Go to Intermittent Conditions	Go to Step 26
20	1. Turn OFF the ignition switch. 2. Disconnect the economy mode and 1st gear start switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the 1st Gear Start Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire between the economy switch harness (pin 4 of N-20 connector) and a known good ground. Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 21	Go to Step22
21	Observe the 1st Gear Start Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the economy switch harness (pins 1 and 4 of N-20 connector). Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 24	Go to Step 23

Step	Action	Value(s)	Yes	No
22	1. Test the 1st gear start switch signal circuit between the TCM (pin 1 of B-427 connector) and the 1st gear start switch (pin 4 of N-20 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 25
23	Repair the open circuit or high resistance on the ground circuit of the 1st gear start switch (pin 1 of N-20 connector) and the chassis ground (B-1). Did you complete the repair?	—	Go to Step 35	—
24	1. Turn OFF the ignition. 2. Inspect for an intermittent and for poor connections at the harness connector of the 1st gear start switch (pins 1 and 4 of N-20 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 32
25	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for a poor connection on the 1st gear start switch signal circuit at the harness connector of the TCM (pin 1 of B-427 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 34
26	1. Turn OFF the ignition. 2. Inspect for an intermittent and for a poor connection at the harness connector of the IPC (pin 6 of B-53 connector). 3. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 27
27	1. Test the 1st START indicator lamp circuit between the 1st gear start switch (pin 4 of N-20 connector) and the IPC (pin 6 of B-53 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 33
28	1. Turn ON the ignition switch, with the engine OFF. 2. Observe the 1st Gear Start Switch parameter with the Tech 2. Does the 1st Gear Start Switch parameter indicate OFF when the switch is OFF?	—	Go to Step 31	Go to Step 29
29	1. Turn OFF the ignition. 2. Disconnect the economy mode and 1st gear start switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the 1st Gear Start Switch parameter with the Tech 2. Does the 1st Gear Start Switch parameter indicate OFF?	—	Go to Step 32	Go to Step 30

Step	Action	Value(s)	Yes	No
30	1. Test the 1st gear start switch circuit between the TCM (pin 1 of B-427 connector) and the 1st gear start switch (pin 4 of N-20 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 34
31	1. Test the 1st START indicator lamp circuit between the diode (pin 1 of X-32 connector) and the IPC (pin 6 of B-53 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 35	Go to Step 33
32	Replace the economy mode & 1st gear start switch. Did you complete the replacement?	—	Go to Step 35	—
33	Repair or replace the IPC. Refer to Instrument Panel Cluster (IPC) Replacement in the Cab and Chassis Electrical section. Did you complete the repair or replacement?	—	Go to Step 35	
34	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 35	—
35	Reconnect all previously disconnected fuse or harness connector(s). Is the action complete?	—	Go to Chart 1 of 4 Step 6	—

Chart 3 of 4

Step	Action	Value(s)	Yes	No
1	1. Turn ON the ignition switch, with the engine OFF. 2. Observe the Emergency Switch parameter with the Tech 2. Does the Emergency Switch parameter indicate ON when the switch is ON?	—	Go to Step 2	Go to Step 3
2	Does the transmission warning lamp blink at Step 1?	—	Go to Intermittent Conditions	Go to Transmission Warning Lamp Inoperative
3	1. Turn OFF the ignition. 2. Disconnect the emergency switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the voltage feed circuit of the emergency switch harness (pin 1 of N-17 connector) and a known good ground. Does the test lamp illuminate?	—	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	1. Turn ON the ignition, with the engine OFF. 2. Observe the Emergency Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the emergency switch harness connector between pins 1 and 5 of the N-17 connector. Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 7	Go to Step 6
5	Repair the open circuit or high resistance on the voltage feed circuit between the Meter (10A) fuse (F-16) in the glove box fuse block and the emergency switch (pin 1 of N-17 connector). Did you complete the repair?	—	Go to Step 36	—
6	1. Test the emergency switch signal circuit between the TCM (pin 4 of B-428 connector) and the emergency switch (pin 5 of N-17 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 36	Go to Step 8
7	1. Turn OFF the ignition. 2. Disconnect the emergency switch harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the emergency switch (pins 1 and 5 of N-17 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 36	Go to Step 12
8	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for a poor connection on the emergency switch circuit at the harness connector of the TCM (pin 4 of B-428 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 36	Go to Step 35
9	1. Turn ON the ignition switch, with the engine OFF. 2. Observe the Emergency Switch parameter with the Tech 2. Does the Emergency Switch parameter indicate OFF when the switch is OFF?	—	Go to Intermittent Conditions	Go to Step 10
10	1. Turn OFF the ignition. 2. Disconnect the emergency switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Emergency Switch parameter with the Tech 2. Does the Emergency Switch parameter indicate OFF?	—	Go to Step 12	Go to Step 11

Step	Action	Value(s)	Yes	No
11	1. Test the emergency switch circuit between the TCM (pin 4 of B-428 connector) and the emergency switch (pin 5 of N-17 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 36	Go to Step 35
12	Replace emergency switch. Did you complete the replacement?	—	Go to Step 36	—
13	1. Turn ON the ignition switch, with the engine OFF. 2. Observe the Emergency 1st Switch parameter with the Tech 2. Does the Emergency 1st Switch parameter indicate ON when the switch is 1?	—	Go to Step 14	Go to Step 16
14	Does the Emergency 1st Switch parameter indicate OFF when the switch is N?	—	Go to Step 15	Go to Step 19
15	Does the Emergency N Switch parameter indicate ON when the switch is N?	—	Go to Intermittent Conditions	Go to Step 21
16	1. Turn OFF the ignition switch. 2. Disconnect the emergency shift switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Emergency 1st Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire between the emergency shift switch harness (pin 3 of N-18 connector) and a known good ground. Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 17	Go to Step 18
17	Observe the Emergency 1st Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the emergency shift switch harness (pins 3 and 5 of N-18 connector). Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 29	Go to Step 33
18	1. Test the emergency 1st position switch signal circuit between the TCM (pin 14 of B-428 connector) and the emergency shift switch (pin 3 of N-18 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 36	Go to Step 30
19	1. Turn OFF the ignition. 2. Disconnect the switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Emergency 1st Switch parameter with the Tech 2. Does the Emergency 1st Switch parameter indicate OFF?	—	Go to Step 34	Go to Step 20

Step	Action	Value(s)	Yes	No
20	1. Test the emergency 1st position switch circuit between the TCM (pin 14 of B-429 connector) and the emergency shift switch (pin 3 of N-18 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 36	Go to Step 35
21	1. Turn OFF the ignition switch. 2. Disconnect the emergency shift switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Emergency N Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire between the emergency shift switch harness (pin 2 of N-18 connector) and a known good ground. Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 22	Go to Step 23
22	Observe the Emergency N Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the emergency shift switch harness (pins 2 and 5 of N-18 connector). Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 29	Go to Step 33
23	1. Test the emergency N position switch signal circuit between the TCM (pin 6 of B-428 connector) and the emergency shift switch (pin 2 of N-18 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 36	Go to Step 30
24	1. Turn ON the ignition switch, with the engine OFF. 2. Observe the Emergency R Switch parameter with the Tech 2. Does the Emergency R Switch parameter indicate ON when the switch is R?	—	Go to Step 25	Go to Step 26
25	Does the Emergency R Switch parameter indicate OFF when the switch is N?	—	Go to Intermittent Conditions	Go to Step 31
26	1. Turn OFF the ignition switch. 2. Disconnect the emergency shift switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Emergency R Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire between the emergency shift switch harness (pin 1 of N-18 connector) and a known good ground. Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 27	Go to Step 28

Step	Action	Value(s)	Yes	No
27	Observe the Emergency R Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the emergency shift switch harness (pins 1 and 5 of N-18 connector). Does the Tech 2 indicate ON when the circuit is jumpered and OFF when the circuit is not jumpered?	—	Go to Step 29	Go to Step 33
28	1. Test the emergency R position switch signal circuit between the TCM (pin 20 of B-428 connector) and the emergency shift switch (pin 1 of N-18 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 36	Go to Step 30
29	1. Turn OFF the ignition. Inspect for an intermittent and for poor connections at the harness connector of the emergency shift switch (pins 1, 2, 3 and 5 of N-18 connector). 2. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 36	Go to Step 34
30	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for poor connections on the emergency shift switch signal circuit at the harness connector of the TCM (pin 6, 14 and 20 of B-428 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 36	Go to Step 35
31	1. Turn OFF the ignition. 2. Disconnect the switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Emergency R Switch parameter with the Tech 2. Does the Emergency R Switch parameter indicate OFF?	—	Go to Step 34	Go to Step 32
32	1. Test the emergency R position switch circuit between the TCM (pin 20 of B-428 connector) and the emergency shift switch (pin 1 of N-18 connector) for a short to ground. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 36	Go to Step 35
33	Repair the open circuit or high resistance on the ground circuit of the emergency shift switch (pin 5 of N-18 connector) and the chassis ground (B-1). Did you complete the repair?		Go to Step 36	—
34	Replace emergency shift switch. Did you complete the replacement?	—	Go to Step 36	—
35	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 36	—

Step	Action	Value(s)	Yes	No
36	Reconnect all previously disconnected fuse or harness connector(s). Is the action complete?	—	Go to Chart 1 of 4 Step 6	—

Chart 4 of 4

Step	Action	Value(s)	Yes	No
1	1. Turn ON the ignition, with the engine OFF. 2. Observe the Brake Pedal Switch parameter with the Tech 2. Does the Brake Pedal Switch parameter indicate Applied when the pedal is applied and Released when the pedal is released?	—	Go to Intermittent Conditions	Go to Step 2
2	1. Check to ensure the brake pedal switch is adjusted correctly. The plunger should be all the way in when the pedal is released, yet should not impede with the brake pedal full upward travel. 2. Adjust the brake pedal switch as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 3
3	1. Turn OFF the ignition. 2. Inspect the Stop Light (10A) fuse (F-5) in the glove box fuse block. Is the Stop Light (10A) fuse (F-5) open?	—	Go to Step 4	Go to Step 5
4	Replace the Stop Light (10A) fuse (F-5). If the fuse continues to open, repair the short to ground on one of the circuits that is fed by the Stop Light (10A) fuse (F-5) or replace the shorted attached component fed by the Stop Light (10A) fuse (F-5). Did you complete the repair?	—	Go to Step 22	—
5	1. Turn OFF the ignition. 2. Disconnect the brake pedal switch harness connector. 3. Connect a test lamp between the voltage feed circuit of the brake pedal switch harness (pin 1 of B-66 connector) and a known good ground. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 7
6	1. Turn ON the ignition, with the engine OFF. 2. Observe the Brake Pedal Switch parameter with the Tech 2 while momentarily jumping 3-amp fused jumper wire across the brake pedal switch harness connector between pins 1 and 2 of the B-66 connector. Does the Tech 2 indicate Applied when the circuit is jumpered and Released when the circuit is not jumpered?	—	Go to Step 9	Go to Step 8
7	Repair the open circuit or high resistance on the voltage feed circuit between the Stop Light (10A) fuse (F-5) and the brake pedal switch (pin 1 of B-66 connector). Did you complete the repair?	—	Go to Step 22	—

Step	Action	Value(s)	Yes	No
8	1. Test the brake pedal switch signal circuit between the transmission control module (TCM) (pin 3 of B-428 connector) and the brake pedal switch (pin 2 of B-66 connector) for an open circuit or high resistance. 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 10
9	1. Turn OFF the ignition. 2. Disconnect the brake pedal switch harness connector. 3. Inspect for an intermittent and for poor connections at the harness connector of the brake pedal switch (pins 1 and 2 of B-66 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 11
10	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for a poor connection on the brake switch circuit at the harness connector of the TCM (pin 3 of B-428 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 21
11	Replace brake pedal switch. Did you complete the replacement?	—	Go to Step 22	—
12	1. Turn OFF the ignition. 2. Disconnect the instrument panel cluster (IPC) harness connector. 3. Inspect for an intermittent and for a poor connection at the harness connector of the IPC (pin 1 of B-53 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 13
13	1. Turn OFF the ignition. 2. Disconnect the TCM harness connector. 3. Inspect for an intermittent and for a poor connection on the gear position display control circuit at the harness connector of the TCM (pin 14 of B-425 connector). 4. Repair the connection(s) as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 14
14	1. Test the gear position display control circuit between the TCM (pin 14 of B-425 connector) and the IPC (pin 1 of B-53 connector) for the following conditions: • An open circuit • A short to ground • A short to battery or ignition voltage • High resistance 2. Repair the circuit(s) as necessary. Did you find and correct the condition?	—	Go to Step 22	Go to Step 15

Step	Action	Value(s)	Yes	No
15	Replace the IPC. Refer to Instrument Panel Cluster (IPC) Replacement in the Cab and Chassis Electrical section. Did you complete the replacement?	—	Go to Step 22	—
16	1. Turn ON the ignition, with the engine OFF. 2. Observe the PTO Switch parameter with the Tech 2 in the ENGINE system menu. Does the PTO Switch parameter OFF when the PTO switch or lever is released?	—	Go to Intermittent Conditions	Go to Step 17
17	1. Turn OFF the ignition. 2. Disconnect the PTO switch harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the PTO Switch parameter with the Tech 2. Does the PTO Switch parameter OFF?	—	Go to Step 19	Go to Step 18
18	1. Test the PTO switch circuit between the ECM (pin 44 of J-191 connector) and the PTO switch or lever (pin 1 of B-84 connector) for a short to ground. 2. Repair the circuit(s) as necessary. 3. Did you find and correct the condition?	—	Go to Step 22	Go to Step 20
19	Replace the PTO switch or lever. Did you complete the replacement?	—	Go to Step 22	—
20	**Important:** Replacement ECM must be programmed. Replace the ECM. Refer to Engine Control Module (ECM) Replacement /Restore Fuel Injector ID Code Data in engine control section. Did you complete the replacement?	—	Go to Step 22	—
21	**Important:** Replacement TCM must be programmed and learned. Replace the TCM. Refer to Transmission Control Module (TCM) Replacement in this section. Did you complete the replacement?	—	Go to Step 22	—
22	Reconnect all previously disconnected fuse or harness connector(s). Is the action complete?	—	Go to Chart 1 of 4 Step 6	—

Symptoms - Transmission Controls

Symptoms - Transmission Controls

Important Preliminary Inspections Before Starting

Perform Diagnostic System Check - Transmission Controls before using the symptom tables, and verify that all of the following are true:

- The transmission control module (TCM) and transmission warning lamp are operating correctly.
- There are no diagnostic trouble codes (DTCs) stored.
- The Tech 2 data is within the normal operating range. Refer to Tech 2 Data List in this section.
- Verify the customer concern and locate the correct symptom in the table of contents. Inspect the items indicated under that symptom.

Visual and Physical Inspection

Several of the symptom procedures ask for careful visual and physical inspection. This step is extremely important. The visual and physical inspection can lead to correcting a problem without further inspections, and can save valuable time. Ensure that:

- The TCM grounds are clean, tight, and in their proper location.
- The transmission harness wiring and terminals are properly connected and are not pinched or cut.

Intermittent

Important:
Inspect for improper installation of electrical components if an intermittent condition exists. Inspect for aftermarket add-on electrical equipment devices, lights, and cellular phones. Verify that no aftermarket equipment is connected to the keyword 2000 serial data circuit. If you cannot locate an intermittent condition, a cellular phone communication signal may cause the condition.

Important:
The problem may or may not turn ON the transmission warning lamp or store a DTC.

Faulty electrical connections or wiring cause most intermittent problems. Perform a careful visual and physical inspection of the suspect connectors for the following conditions:

- Improperly mated connector halves
- Terminals that are not seated
- Terminals that are damaged or improperly formed

Reform or replace connector terminals in the problem circuit in order to ensure proper contact tension. Remove the terminal from the connector body in order to inspect for poor terminal wire connection.
Road test the vehicle with the DMM connected to the suspected circuit. An abnormal reading that occurs when the malfunction occurs is a good indication that there is a malfunction in the circuit being monitored.

Use the Tech 2 in order to help detect intermittent conditions. Useful features of the Tech 2 include the following:

- Trigger the Snapshot feature in order to capture and store transmission parameters when the malfunction occurs. Review this stored information in order to see the specific running conditions that caused the malfunction.
- Use the Plot Function on the Tech 2 in order to plot selected data parameters. Review this stored information to aid in locating an intermittent problem. Refer to the Tech 2 Users Guide for more information.

Important:
If the intermittent condition exists as a start and then stall, test for DTCs relating to the vehicle theft deterrent system. Test for improper installation of electrical options such as lights, cellular phones, etc.

Any of the following may cause an intermittent transmission warning lamp with no stored DTC:

- The TCM grounds are loose or dirty. Refer to Transmission Controls Schematics.
- The transmission warning lamp circuit intermittently shorted to ground.
- Electrical system interference caused by a malfunctioning relay, TCM driven solenoid, or switch. The electrical component can cause a sharp electrical surge. Normally, the problem will occur when the malfunctioning component is operating.
- There are any open diodes.

Important:
The following symptom tables contain groups of possible causes for each symptom. The order of these procedures is not important. If the Tech 2 readings do not indicate the problems, then proceed in a logical order, easiest to check or most likely to cause first. In order to determine if a specific vehicle is using a particular system or component, refer to Transmission Controls Schematics for an application.

Use the following tables when diagnosing a symptom complaint:

Intermittent Conditions

Checks	Action
DEFINITION: The problem is not currently present but is indicated in DTC History. OR There is a customer complaint, but the symptom cannot currently be duplicated, if the problem is not DTC related.	
Preliminary Checks	• Refer to Symptoms - Transmission Controls before starting.
Harness/Connector	Many intermittent open or shorted circuits are affected by harness/connector movement that is caused by vibration, engine torque, bumps/rough pavement, etc. Test for this type of condition by performing the applicable procedure from the following list: • Move related connectors and wiring while monitoring the appropriate Tech 2 data. • Move related connectors and wiring with the component commanded ON, and OFF, with the Tech 2. Observe the component operation. • With the engine running, move related connectors and wiring while monitoring engine operation. If harness or connector movement affects the data displayed, component/system operation, or engine operation, inspect and repair the harness/connections as necessary. Refer to Electrical Connections or Wiring.
Electrical Connections or Wiring	Poor electrical connections, terminal tension or wiring problems cause most intermittent. To perform the following inspections: • Inspect for poor mating of the connector halves, or terminals improperly seated in the connector body. • Inspect for improperly formed or damaged terminals. Test for poor terminal tension. • Inspect for poor terminal to wire connections including terminals crimped over insulation. This requires removing the terminal from the connector body. • Inspect for corrosion/water intrusion. Pierced or damaged insulation can allow moisture to enter the wiring. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits. • Inspect for wires that are broken inside the insulation. • Inspect the harness for pinched, cut or rubbed through wiring. • Ensure that the wiring does not come in contact with hot exhaust components.
Control Module Power and Grounds Component Power and Grounds	Poor power or ground connections can cause widely varying symptoms. • Test all control module power supply circuits. Many vehicles have multiple circuits supplying power to the control module. Other components in the system may have separate power supply circuits that may also need to be tested. Inspect connections at the module/component connectors, fuses, and any intermediate connections between the power source and the module/component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Ensure that the circuit can carry the current necessary to operate the component. • Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point. Inspect the connections at the component and in splice packs, where applicable. Ensure that the circuit can carry the current necessary to operate the component.

Checks	Action
Temperature Sensitivity	• An intermittent condition may occur when a component/connection reaches normal operating temperature. The condition may occur only when the component/connection is cold, or only when the component/connection is hot. • If the intermittent is related to heat, review the data for a relationship with the following: - High ambient temperatures - Underhood/engine generated heat - Circuit generated heat due to a poor connection, or high electrical load - Higher than normal load conditions, towing, etc. • If the intermittent is related to cold, review the data for the following: - Low ambient temperatures - In extremely low temperatures, ice may form in a connection or component. Test for water intrusion. - The condition only occurs on a cold start. - The condition goes away when the vehicle warms up. • Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
Electromagnetic Interference (EMI) and Electrical Noise	Some electrical components/circuits are sensitive to EMI or other types of electrical noise. Inspect for the following conditions: • A misrouted harness that is too close to high voltage/high current devices such as injection components, motors, generator etc. These components may induce electrical noise on a circuit that could interfere with normal circuit operation. • Electrical system interference caused by a malfunctioning relay, or the transmission control module (TCM) driven solenoid or switch. These conditions can cause a sharp electrical surge. Normally, the problem will occur when the malfunctioning component is operating. • Improper installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc. These accessories may lead to an emission related failure while in use, but do not fail when the accessories are not in use. • Test for any open diodes. Some relays may contain a clamping diode. • Test the generator for a bad rectifier bridge that may be allowing AC noise into the electrical system.
Duplicating Failure Conditions	• If none of the previous tests are successful, attempt to duplicate and/or capture the failure conditions. • An alternate method is to drive the vehicle with the DMM connected to a suspected circuit. An abnormal reading on the DMM when the problem occurs, may help you locate the problem.
Tech 2 Snapshot	The Tech 2 can be set up to take a Snapshot of the parameters available via serial data. The Snapshot function records live data over a period of time. The recorded data can be played back and analyzed. The Tech 2 can also graph parameters singly or in combinations of parameters for comparison. The Snapshot can be triggered manually at the time the symptom is noticed, or set up in advance to trigger when a DTC sets. An abnormal value captured in the recorded data may point to a system or component that needs to be investigated further. Refer to the Tech 2 user instructions for more information on the Snapshot function.

Programming and Learning

Programming and Learning Guideline

Description

The vehicle information data must be programmed and the learning procedure must be done when the transmission control module (TCM) is replaced, sensors, actuators or internal parts are replaced or repaired. Programming with the wrong data or improper learning will cause a deterioration of the shift feeling, the poor vehicle performance and the diagnostic trouble code (DTC) to set.
Vehicle Information Programming and/or Initial Learning must be done whenever any of the following parts is replaced or specification changed. Refer to Transmission Control Module (TCM) Replacement - TCM Replacement Procedure Description in this section.

- TCM
- Transmission assembly
- Engine type
- Final gear and tire size change relating speedometer driven gear
- PTO request engine speed

Transmission Gear Select & Shift Position Learning must be done whenever any of the following parts are replaced, removed or repaired.

- 1-3-5 shift solenoid valve
- 2-4-6-R shift solenoid valve
- Select solenoid valve
- Gear shift position sensor
- Gear select position sensor
- Transmission gearshift control box
- Transmission unit internal

Half Clutch Position Learning must be done whenever any of the following parts are replaced, removed or repaired.

- Gearshift clutch assembly
- Gearshift clutch solenoid valve
- Oil pump assembly
- Clutch engagement point is shifted greatly (when difficult to adjust by the adjustment switch)

Transmission Gear Select & Shift Position Learning

1. Put the vehicle with the following conditions:
   - DTC is not present
   - Vehicle is stationary
   - Parking brake is pulled
   - Selector lever is Neutral
   - Emergency switch is OFF
   - Engine is idle speed
   - Idle up control knob to the lowest position (Full counterclockwise direction)
   - A/C switch is OFF
   - Use the Tech 2 and make sure clutch fluid temperature is 40°C (104°F) or higher
2. Depress and hold the brake pedal.

Notice:
DO NOT release the brake pedal until the transmission gear select & shift position learning is completed.

3. Press Reset switch for at least 7 seconds and release it within 17 seconds. This will enter the learning mode, which is indicated by a buzzer pattern that consists of a series of two short beeps.

Notice:
If the buzzer does not sound, restart the learning procedure from step 1.

4. With the brake pedal firmly depressed, operate the selector lever in the following sequence: N - D - N (Neutral - Drive - Neutral)
   This will change the buzzer pattern that consists of a series of two beeps, one short beep followed by one long beep. After the selector lever is operated, this buzzer pattern will continue for approximately 10 seconds and shift to each gear will be automatically performed.

Notice:
If the buzzer does not sound, operate the selector lever again.

5. Confirm that the buzzer stops.

Half Clutch Position Learning

1. Put the vehicle with the following conditions:
   - DTC is not present
   - Vehicle is stationary
   - Parking brake is pulled
   - Selector lever is Neutral
   - Emergency switch is OFF
   - Engine is warm upped
   - Engine is idle speed
   - Idle up control knob to the lowest position (Full counterclockwise direction)
   - A/C switch is OFF
   - Use the Tech 2 and make sure clutch fluid temperature is 40°C (104°F) or higher
2. Depress and hold the brake pedal.

Notice:
DO NOT release the brake pedal until the half clutch position learning is completed.

3. Press Reset switch for at least 7 seconds and release it within 17 seconds. This will enter the learning mode, which is indicated by a buzzer pattern that consists of a series of two short beeps.

Notice:
If the buzzer does not sound, restart the learning procedure from step 1.

4. With the brake pedal firmly depressed, operate the selector lever in the following sequence: N - D (Neutral - Drive)
   This will change the buzzer pattern that consists of a series of single short beeps. After the selector lever is operated, this buzzer pattern will continue for approximately 30 seconds and the clutch will be automatically engaged.

Notice:
If the buzzer does not sound, operate the selector lever again.

5. Confirm that the buzzer stops.

Repair Instructions

Transmission Control Module (TCM) Replacement

TCM Replacement Procedure Description

The following A-F steps provide an overview procedure to replace and reprogram a TCM. Each A-F step is explained further in this section.

A. Record the vehicle type information manually from the old TCM. The vehicle type information can be obtained using the Tech 2 Data Display function.
B. Replace the old TCM with the new TCM.
C. Program the latest software and calibrations into the new TCM using the Service Programming System (SPS).
D. Program the recorded vehicle information into the new TCM using the Tech 2 Programming function.
E. Perform the transmission gear position learning, half clutch learning and number of speedometer driven gear teeth learning by initial learning procedure.
F. Program the vehicle identification number (VIN). If the TCM from another vehicle is installed, VIN does not match with the vehicle. Use the SPS to change the original VIN.

A. Recording Vehicle Information

The following vehicle type information must be programmed into the TCM for correct vehicle performance.

- Engine Type
- Transmission Type
- Speedometer Driven Gear Teeth
- PTO Request Engine Speed (If so equipped)

Important:
If the communications cannot be established with the old TCM, the technician will need to follow the following ways.

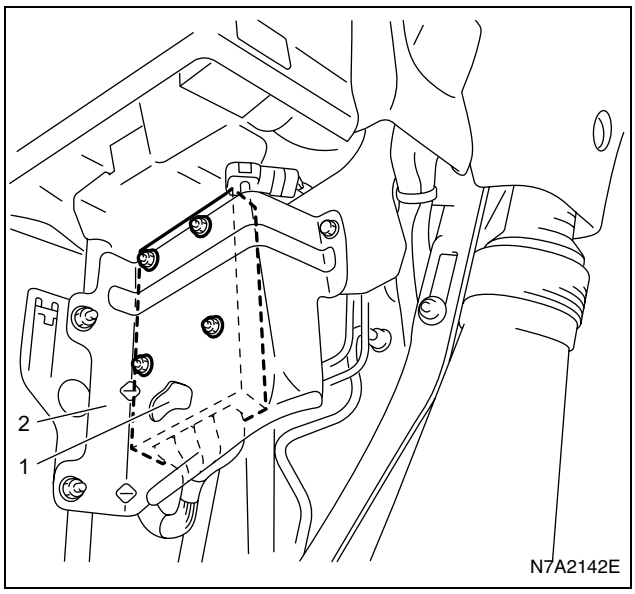
- Find out the correct engine type and transmission type from the service ID plate.
- Physically find out the correct number of speedometer driven gear teeth.
- Ask the customer which of the PTO request engine speed was previously being used.

B. Removal and Installation

Removal Procedure

Important:
Take care not to give a strong impact to the TCM.

1. Turn OFF the ignition.
2. Disconnect the negative battery cable.
3. Disconnect the TCM connectors.
4. Remove the TCM fixing nuts.
5. Remove the TCM.



Legend
1. TCM
2. TCM Cover

Installation Procedure

Important:
Do not use a fallen TCM or the TCM that received a strong impact.

1. Install the TCM on the TCM bracket.
2. Tighten the TCM fixing nuts.
3. Connect the TCM connectors.
4. Connect the negative battery cable.

C. Programming Software and Calibrations

Program latest software/calibrations if released. Refer to Service Programming System (SPS) Description and Service Programming System (SPS) (Remote Procedure) or Service Programming System (SPS) (Pass-Thru Procedure) in this section.

D. Programming Vehicle Information

Use the Tech 2 to program the previously recorded vehicle information.

Notice:
If the removed TCM from another vehicle is installed with same specification, this programming is not necessary.

1. Install the Tech 2.
2. Turn ON the ignition, with the engine OFF.
3. Select Diagnostics > appropriate vehicle identification > Smoother > Programming.
4. Select Program Vehicle Type and press Change.
5. Select previously recorded correct combination of engine type and transmission type.

6. Select PTO Request Engine Speed and press Change. (If PTO is not installed, skip to step 8.)
7. Select previously recorded correct PTO request engine speed.
8. Select Program Speedometer Driven Gear and press Change.
9. Select previously recorded correct number of speedometer driven gear teeth.
10. Select Diagnostics > appropriate vehicle identification > Smoother > Data Display. At this point, all programmed data can be verified. Compare the vehicle information programmed into the TCM with the recorded value. If the programmed vehicle information is incorrect, go back to appropriate step.

E. Initial Learning

As for initial learning, transmission gear select & shift position learning, half clutch position learning and speedometer driven gear learning will be performed at the same time.

1. Put the vehicle with the following conditions:
   - DTC is not present
   - Vehicle is stationary
   - Parking brake is pulled
   - Selector lever is Neutral
   - Emergency switch is OFF
   - Engine is warm upped
   - Engine is idle speed
   - Idle up control knob to the lowest position (Full counterclockwise direction)
   - A/C switch is OFF
   - Use the Tech 2 and make sure clutch fluid temperature is 40°C (104°F) or higher
2. Use a jumper wire and the DLC terminal “11” (diagnostic request) is pulled “Low” (grounded) by jumped to DLC terminal “4”. This will warning lamp blinks.
3. Depress and hold the brake pedal.

Notice:
DO NOT release the brake pedal until the transmission gear select & shift position learning and half clutch position learning is completed (until step 6).

4. Press Reset switch for at least 7 seconds and release it within 17 seconds. This will enter the learning mode, which is indicated by a buzzer pattern that consists of a series of two short beeps.

Notice:
If the buzzer does not sound, restart the learning procedure from step 1.

5. With the brake pedal firmly depressed, operate the selector lever in the following sequence: N - D - N (Neutral - Drive - Neutral)
   This will change the buzzer pattern that consists of a series of two beeps, one short beep followed by one long beep. After the selector lever is operated, this buzzer pattern will continue for approximately 10 seconds and shift to each gear will be automatically performed. And then, change automatically to single short beeps. This buzzer pattern will continue for approximately 30 seconds and the clutch will be automatically engaged.

Notice:
If the buzzer does not sound, operate the selector lever again.

Notice:
If the buzzer stops on the way of this step, restart the learning procedure from step 3.

6. Confirm that the buzzer stops. Remove the jumper wire from the DLC.

Notice:
If the buzzer sounds after removing the jumper wire from the DLC, restart the learning procedure from step 1.

7. Confirm that the warning lamp. The warning lamp will blink if the number of speed meter driven gear teeth leaning is not completed.

Notice:
If the TCM from another vehicle is installed, the warning lamp does not blink.

8. With the parking brake applied, the engine speed is idle, and the brake pedal is depressed, move the selector lever to D (Drive) position. Confirm that the gear position indicator is 2nd. If the gear position is not 2nd, operate the selector lever “+” or “–” to change 2nd.
9. Run the vehicle in 2nd gear at fixed vehicle speed of approximately 20km/h (12MPH) for 10 seconds.
10. Confirm that the warning lamp goes out.

Notice:
If the warning lamp does not go out, restart the learning procedure from step 8.

F. Programming VIN

If the TCM from another vehicle is installed, VIN does not match with the vehicle. Use the SPS to change the original VIN. Refer to Service Programming System (SPS) Description and Service Programming System (SPS) (Remote Procedure) or Service Programming System (SPS) (Pass-Thru Procedure) in this section.

Notice:
If an updated software/calibrations is released, DO NOT program the VIN now. The VIN is programmed at previously described C. Programming Software and Calibrations SPS procedure.

Service Programming System (SPS) Description

The service programming system (SPS) allows a technician to program a control module through the data link connector (DLC). The information transfer circuit that is used at the DLC is the same serial data circuit used be the Tech 2 for retrieving diagnostic trouble codes (DTCs), displaying data, clearing DTCs etc. This procedure offers the ability to install software/ calibrations matched to a particular vehicle.
Most control modules have two types of memory. The software/calibrations reside in the flash memory. The two types of memory are listed below:

- Electrically Erasable Programmable Read Only Memory (EEPROM).
  This type of memory allows selected portions of memory to be programmed while other portions remain unchanged.
  Certain learned values reside in the EEPROM, such as:
  - The vehicle identification number (VIN)
  - The vehicle type information
  - The gear position leaning and half clutch learning
- Flash Read Only Memory-Flash Memory
  Flash memory has increased memory storage capacity. During programming, all information within this type of memory is erased, and then replaced with entirely new information.

Service Programming Methods

The two methods of programming an transmission control module (TCM) are listed below:

- Remote Programming
- Pass Thru Programming

For information on programming a TCM using one of the methods listed above, refer to Service Programming System (SPS) (Remote Procedure) or Service Programming System (SPS) (Pass-Thru Procedure).

Before Programming a Control Module

Important:
DO NOT program an existing transmission control module (TCM) with the identical software/calibration package. This procedure is not a short cut to correct the driveability condition. This is an ineffective repair. A TCM should only be programmed when the following occurs:

- When a service procedure instructs you to replace the TCM. When the TCM from another vehicle is installed, VIN must be changed.
- An updated software/calibrations is released.

Ensure that the following conditions are met before programming a TCM:

- The Tech 2 PCMCIA card is programmed with the latest software.
- The TIS 2000 is installed with the latest software.
- The hardware key is plugged into the computer port.
- Vehicle system voltage:
  - There are no charging system concerns. All charging system concerns must be repaired before programming the TCM.
  - The battery voltage is greater than 24 volts but less than 30 volts. The battery must be fully charged before programming the TCM.
  - A battery charger is NOT connected to the vehicles battery. Incorrect system voltage or voltage fluctuations from a battery charger may cause programming failure or TCM damage.
  - Turn OFF or disable any system that may put a load on the vehicles battery. Turn OFF or disable systems such as:
    - Heating, ventilation, and air conditioning (HVAC) systems
    - Headlights
    - Room lights
    - Accessory equipment
- The ignition switch is in the proper position. The Tech 2 prompts you to turn ON the ignition, with the engine OFF. DO NOT change the position of the ignition switch during the programming procedure unless instructed to do so.
- All tool connections are secure:
  - The RS-232C cable
  - The connection at the DLC
  - The voltage supply circuits
- DO NOT disturb the tool harnesses while programming. If an interruption occurs during the programming procedure, programming failure or TCM damage may occur.
  If you are performing the Pass-Thru programming procedure using a notebook computer without the power cord, ensure that the internal battery is fully charged.

Service Programming System (SPS) (Remote Procedure)

The Remote Service Programming System (SPS) method is a three-step process that involves the following procedures:

1. Connecting the Tech 2 to the vehicle and obtaining the information from the transmission control module (TCM).
2. Connecting the Tech 2 to the terminal and downloading a new calibration file from the terminal into the Tech 2 memory.
3. Reconnecting the Tech 2 to the vehicle and uploading the new calibration file into the TCM.

Performing the Remote Procedure

1. Connect the Tech 2 to the vehicle and obtain the transmission control module (TCM) information using the following procedure:

Important:
Ensure the TCM is installed in the vehicle and the battery is fully charged before programming.

1.1. Connect the Tech 2 to the vehicle data link connector (DLC), with the engine and the Tech 2 OFF.
1.2. Turn ON the Tech 2.
1.3. Press Enter at the title screen.
1.4. Turn ON the ignition, with the engine OFF.
1.5. Select Service Programming System at the Main Menu.
1.6. Select Request Info.
1.7. If there is already stored in the Tech 2, the existing data is displayed on the screen. The Tech 2 asks user to keep existing data Keep Data or Continue to request new vehicle information from the TCM. If there is no data in the Tech 2, it will immediately start vehicle identification.
1.8. Enter the vehicle description by following the on-screen instructions based on stamped VIN or affixed VIN plate on the vehicle.
1.9. During obtaining information, the Tech 2 is receiving information from any modules at the same time. But only engine control module (ECM) information is displayed on the screen if ECM is programmable.
1.10. Turn OFF all accessories and select Continue.
1.11. Verify that the correct VIN is entered on the Tech 2. If the VIN is incorrect, write down the correct VIN.

2. Turn OFF the Tech 2.
3. Disconnect the Tech 2 from the vehicle.
4. Turn OFF the ignition.
5. Transfer the data from the terminal to the Tech 2 using the following procedure:

Important:
The TIS supports service programming with the Tech 2 scan tool only.

5.1. Connect the Tech 2 to the terminal.
5.2. Launch the TIS application at the terminal.
5.3. Select the Service Programming System at the main screen.
5.4. Highlight the following information on the Select Diagnostic Tool and Programming Process screen:
- Select Diagnostic Tool-Select Tech 2.
- Select Programming Process-Identify whether an existing TCM is being reprogrammed or a TCM is being replaced with a new one.
- Select TCM Location-Select Vehicle.

5.5. Select Next.
5.6. Verify the connections on the Preparing for Communication screen and select Next.
5.7. Verify the VIN on the Validate Vehicle Identification Number (VIN) screen and select Next.

Important:
If the TCM is replaced to new one, VIN does not displayed. Input correct VIN reading from stamped VIN or affixed VIN plate on the vehicle. If the TCM from another vehicle is installed, input correct VIN by same way.

5.8. Highlight Engine on the System Type screen and select Next, if requested.
5.9. Complete the following information based on the service ID plate on the Validate Vehicle Data screen until Next is highlighted:
- Model
- Model Year
- Engine
- System Type
- Model Designator

5.10. Select Next.
5.11. Verify your selection on the Summary screen.

Important:
Refer to Service Bulletins before service programming is performed if the bulletins are listed along with the calibration files.

Important:
Select Cancel if you receive a message stating that the calibration selected is already the current calibration in the TCM and reprogramming with the same download is not allowed.

5.12. Select Reprog.
5.13. The Transfer Data screen will appear until the progress bar reaches 100%.

6. Close the application and return to the TIS application selection screen after the download is complete.
7. Turn OFF the Tech 2.
8. Disconnect the Tech 2 from the terminal.
9. Transfer the data from the Tech 2 to the TCM using the following procedure:
9.1. Connect the Tech 2 to the vehicle DLC, with the engine and the Tech 2 OFF.
9.2. Turn ON the Tech 2.
9.3. Press Enter at the Title screen.
9.4. Turn ON the ignition, with the engine OFF.

9.5. Select Service Programming System.
9.6. Select the Program TCM on the Tech 2.
9.7. Follow the on-screen instructions and select Continue.
9.8. Programming in Process will appear until the progress bar reaches 100%.

Important:
Some warning lamp may turn ON or blink while programming the TCM since communication between the TCM and other modules are interrupted. Clear DTC in any module after programming.

9.9. Select Continue and exit the program after the Tech 2 displays Programming Was Successful.
10. Turn OFF the ignition.
11. Turn OFF the Tech 2.
12. Disconnect the Tech 2 from the vehicle.

Service Programming System (SPS) (Pass-Thru Procedure)

Pass-Thru programming allows the Tech 2 to remain connected to the terminal and to the vehicle throughout the programming process. The vehicle must be in close proximity to the terminal while using Pass-Thru.

Important:
The TIS supports service programming with the Tech 2 scan tool only.

1. Launch the TIS application at the terminal.
2. Select the Service Programming System at the main screen.
3. Highlight the following information on the Select Diagnostic Tool and Programming Process screen:
   - Select Diagnostic Tool-Select Pass-Thru
   - Select Programming Process-Identify whether as existing transmission control module (TCM) is being reprogrammed or a TCM is being replaced with a new one.
   - Select TCM Location-Select Vehicle.
4. Select Next.
5. Complete all vehicle data on the Preparing for Communication/Determine Vehicle screen until Next is highlighted.
6. Select Next.
7. Follow the instruction on the Preparing for Communication screen.

Important:
In order to reduce the potential for signal loss, the RS-232 cable should not be more than 25 feet long.

8. Select Next.
9. Verify the VIN on the Validate Vehicle Identification Number (VIN) screen and select Next.

Important:
If the TCM is replaced to new one, VIN does not displayed. Input correct VIN reading from stamped VIN or affixed VIN plate on the vehicle. If the TCM from another vehicle is installed, input correct VIN by same way.

10. Highlight Engine on the System Type screen and select Next, if requested.
11. Complete the following information based on the service ID plate on the Validate Vehicle Data screen until Next is highlighted:
    - Model
    - Model Year
    - Engine
    - System Type
    - Model Designator
12. Select Next.
13. Verify your selection on the Summary screen.

Important:
Refer to Service Bulletins before service programming is performed if the bulletins are listed along with the calibration files.

Important:
Select Cancel if you receive a message stating that the calibration selected is already the current calibration in the Tech 2 and reprogramming with the same download is not allowed.

14. Select Reprog.
15. The Transfer Data screen will appear until the progress bar reaches 100%.

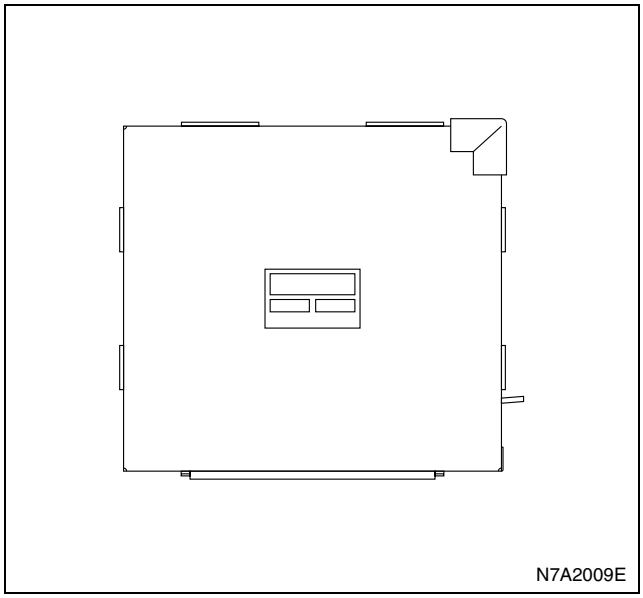
Important:
Some warning lamp may turn ON or blink while programming the TCM since communication between the TCM and other modules are interrupted. Clear DTC in any module after programming.

16. Select Close on the Programming Complete screen.
17. Turn OFF the Tech 2.
18. Disconnect the Tech 2 from the vehicle.

Description and Operation

Transmission Control Module (TCM) Description

The TCM constantly monitors the information sent from various sensors and controls the solenoid valves and other systems. The TCM controls the output circuits by controlling the ground or power supply circuit through a transistor and other devices. The TCM performs the diagnostic function of the system, detects operational problems of the system, warns the driver with a Smoother warning lamp and buzzer and memorizes DTC (diagnostic trouble codes). It also has a system backup function when trouble occurs.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TCM and Components

The TCM is designed to provide outstanding driveability and fuel efficiency. The TCM monitors the transmission and other vehicle functions using operational information it obtains via various speed sensors, switches, magnetic (solenoid) valves, etc.

TCM Voltage Descriprion

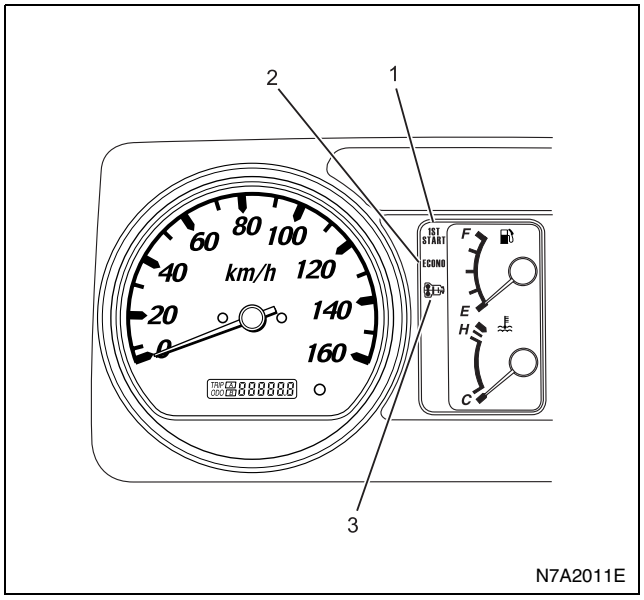
The TCM impresses reference voltage to various switches and sensors. The TCM is able to impress voltage like this because the TCM resistance value is very high, and the voltage actually applied to the circuit is low. The test light may not light, even when it is connected to the circuit. The voltmeter usually used in a service shop may not indicate a correct reading because its input impedance is too low. A digital voltmeter whose input impedance is at least 10 MΩ (e.g. 5-8840-2691-0) should be used to obtain a correct voltage reading. The input/output devices of the TCM have an analog-digital converter, a signal buffer, a counter, a special driver, etc. The TCM uses an electrical switch to control most of the components.

Important:
Replacement TCM must be programmed and learned.

Transmission Control Component Description

1st Gear Start Indicator Lamp

When the 1st gear start switch is “ON”, the lamp lights.



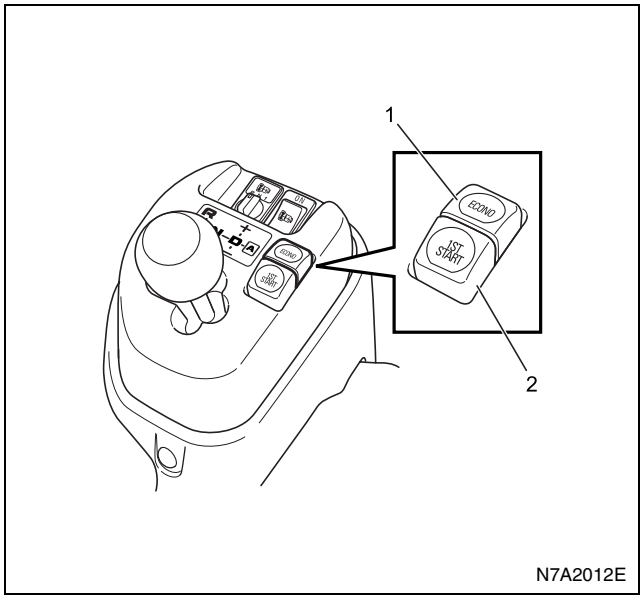
N7A2011E

Legend

1. 1st Gear Start Indicator Lamp
2. Economy Mode Indicator Lamp
3. Transmission Warning Lamp

1st Gear Start Switch

Turning on the 1st gear start switch causes the normal start gear (2nd) to change to 1st gear. This can be used when power is required due to payload and inclines.



Legend

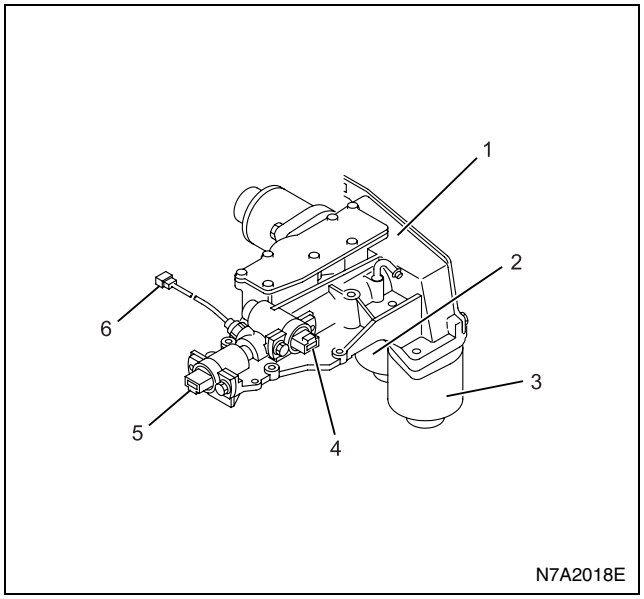
1. Economy Mode Switch
2. 1st Gear Start Switch

1-3-5 Shift Solenoid Valve

This shift solenoid valve is installed in the shift control box. The shaft inside the solenoid operates during shifting and the shift operation is performed.

2-4-6-R Shift Solenoid Valve

This shift solenoid valve is installed in the shift control box. The shaft inside the solenoid operates during shifting and the shift operation is performed.

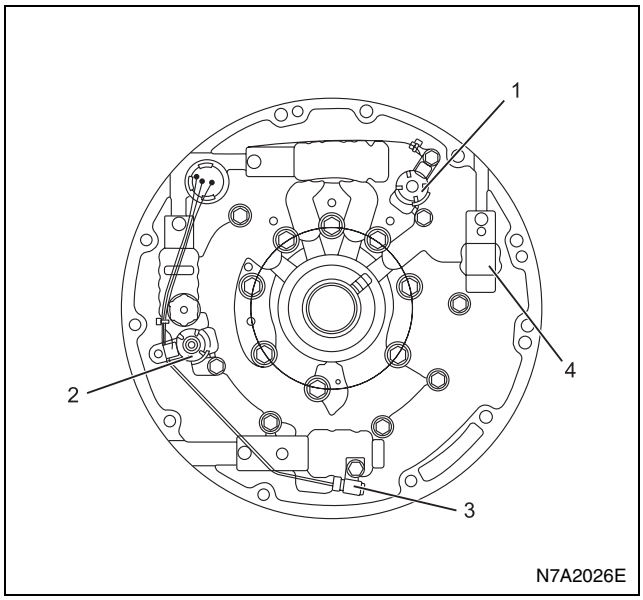


Legend

1. Gearshift Control Box
2. 1-3-5 Shift Solenoid Valve
3. 2-4-6-R Shift Solenoid Valve
4. Gear Select Positin Sensor
5. Gear Shift Position Sensor
6. Neutral Switch

Transmission Fluid Temperature (TFT) Sensor

The transmission fluid temperature (TFT) sensor is used to detect the clutch fluid temperature inside the transmission. Clutch fluid temperature is determined by detecting changes in thermistor resistance.

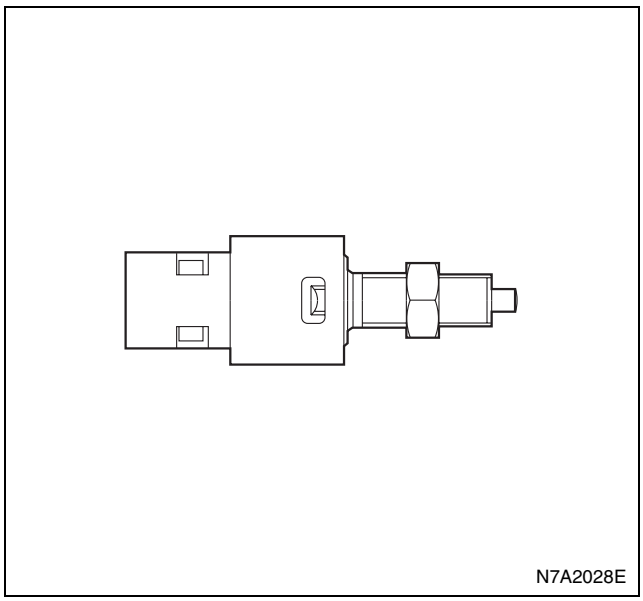


Legend

1. Lock Up Clutch Solenoid Valve
2. Gearshift Clutch Solenoid Valve
3. Transmission Fluid Temperature (TFT) Sensor
4. Bypass Valve

Brake Switch

The brake switch is used to detect brake pedal depression. The transmission control module (TCM) interprets the condition when the brake switch is on (contact closed) as the brake pedal being pressed.

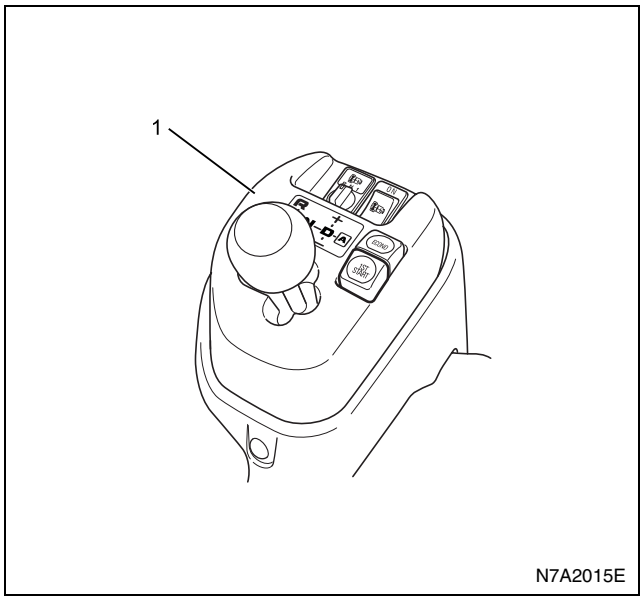


Buzzer

The buzzer sounds when trouble is detected in the Smoother system, when learning is being performed, when shift control is prohibited, etc.

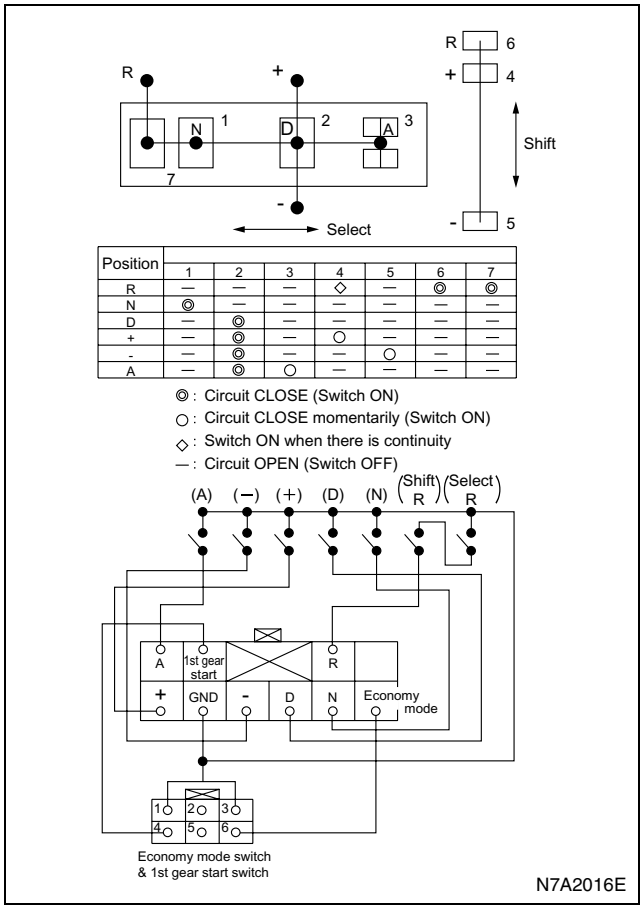
Selector Lever Unit

The selector lever unit is used during selector lever operation to communicate the lever position to the TCM, for shift control, etc. The change lever unit also has a position detection switch built in.



Legend

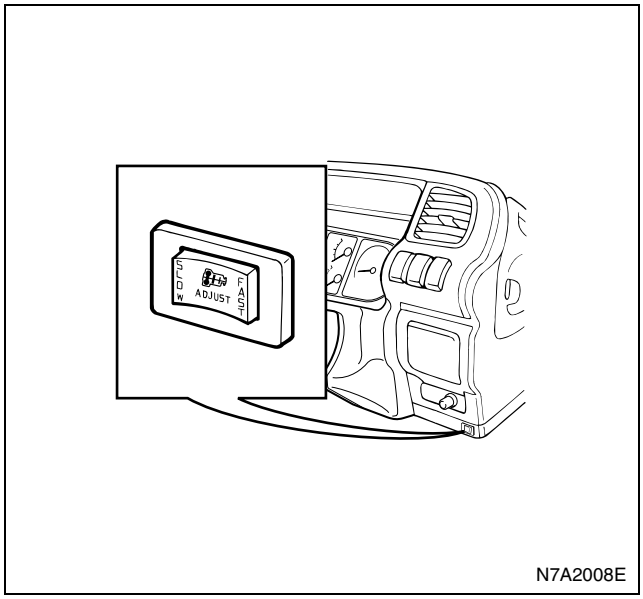
1. Selector Lever Unit



N7A2016E

Half-clutch Adjustment Switch

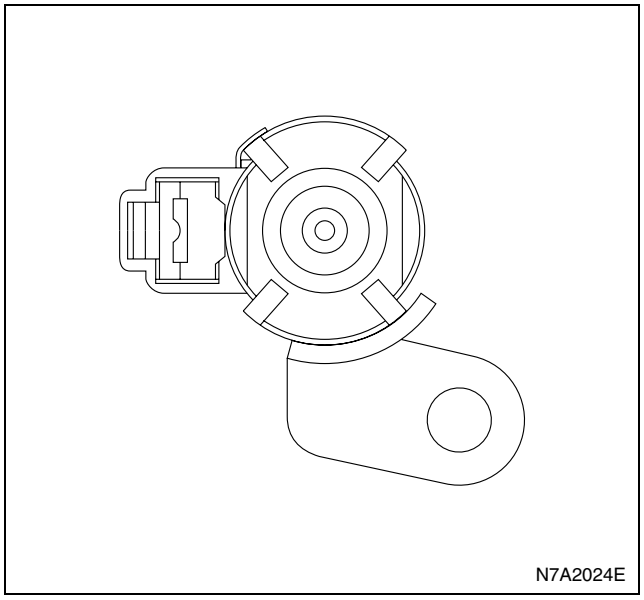
The half-clutch adjustment switch is used to adjust the half-clutch point.



N7A2008E

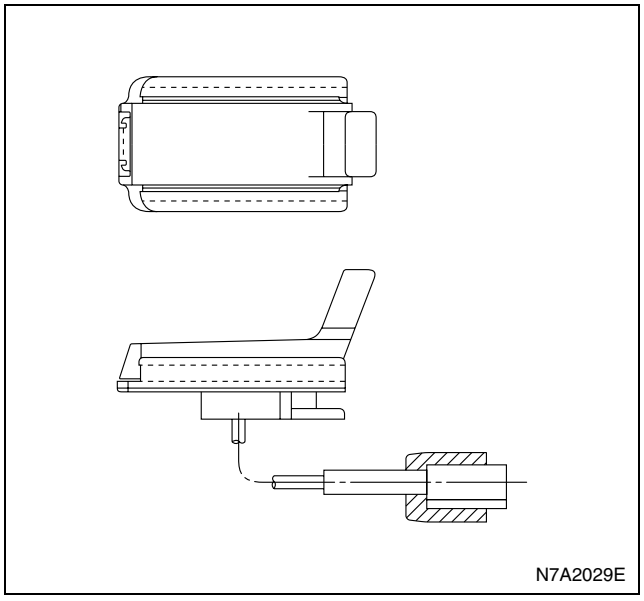
Geagshift clutch Solenoid Valve

The gearshift clutch solenoid valve is installed in the oil pump. It operates during shifting, and when the gearshift clutch is engaged or disengaged.


N7A2024E

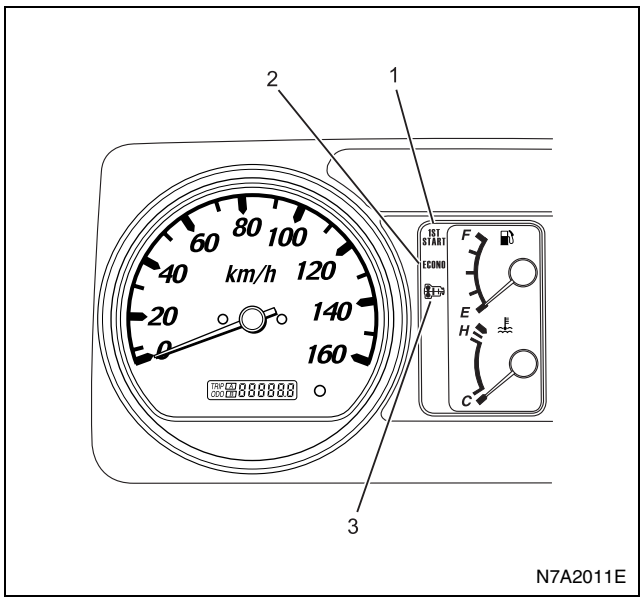
Door Switch

The door switch is used to detect the door open/closed condition. The transmission control module (TCM) interprets the condition when the door switch is on (contact closed) as door open.


N7A2029E

Economy Mode Indicator Lamp

When the economy mode switch is “ON” during automatic shifting, the lamp lights. The lamp is out in the normal mode.

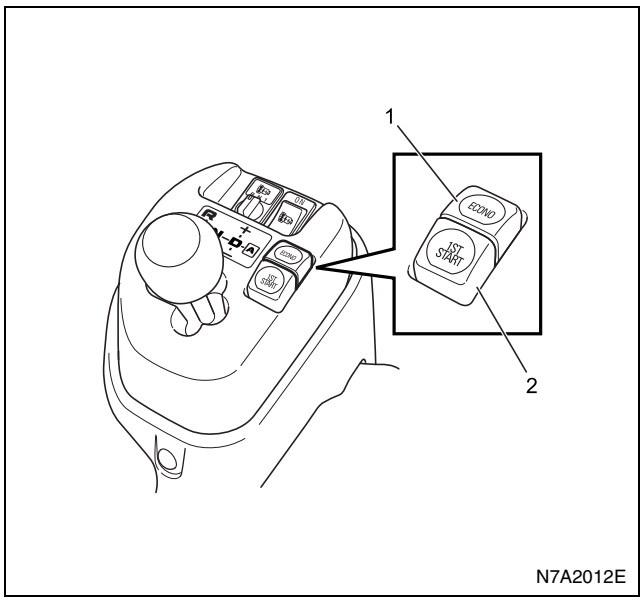


Legend

1. 1st Gear Start Indicator Lamp
2. Economy Mode Indicator Lamp
3. Transmission Warning Lamp

Economy Mode Switch

Automatic shift control characteristics are switched by the switch position. If you want to conserve fuel while running in the normal mode, press the switch to change to the economy mode. In the economy mode, the shift timing is earlier than in the normal mode.



Legend

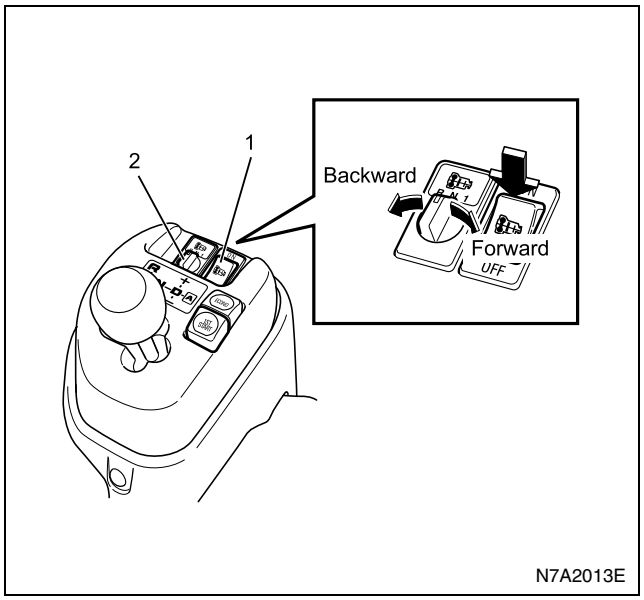
1. Economy Mode Switch
2. 1st Gear Start Switch

Emergency Shift Switch

The emergency switch is used when there is a problem with the Smoother system. When the emergency switch is ON, the emergency shift switch can be operated to shift gears to R, N, or 1.

Emergency Switch

The emergency switch is used when there is a problem with the Smoother system. Normally the emergency switch should be left in the OFF position. Turning on the emergency switch allows the engine to be started regardless of the transmission gear position, and enables the emergency shift switch.

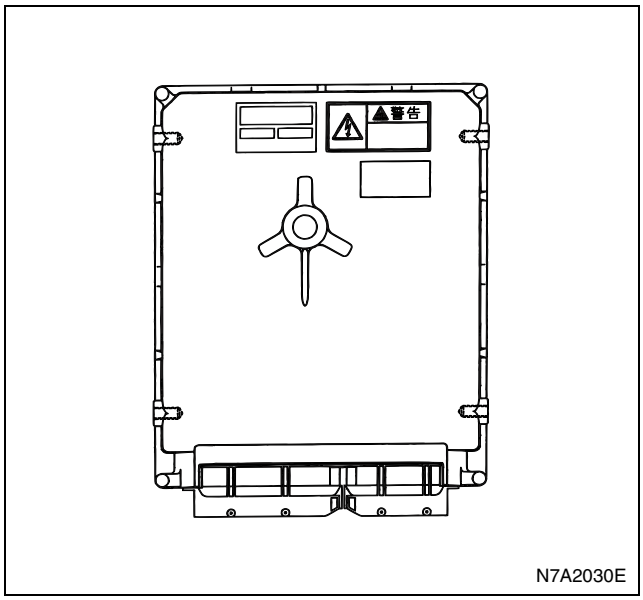


Legend

1. Emergency Switch
2. Emergency Shift Switch

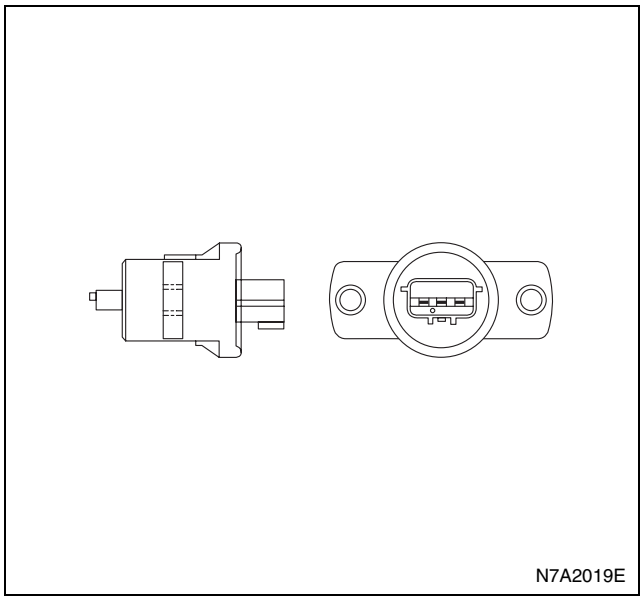
Engine Control Module (ECM)

The engine control module (ECM) uses CAN communication to send and receive engine speed, accelerator opening angle, vehicle speed, and switch signals.



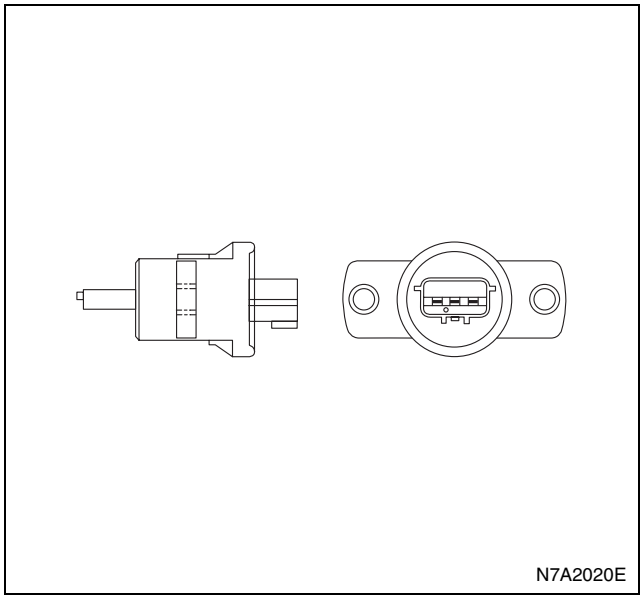
Gear Shift Position Sensor

The gear shift position sensor is the hall IC type sensor and is installed to shift control box. It detects the shift stroke amount of T/M and outputs to transmission control module (TCM).



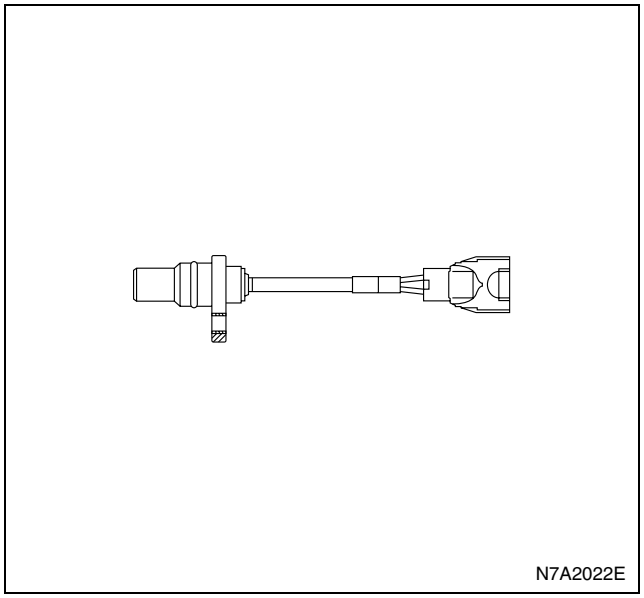
Gear Select Position Sensor

The gear select position sensor uses a hall IC type sensor to detect the shift stroke of the T/M installed in the shift control box, and outputs to the transmission control module (TCM).



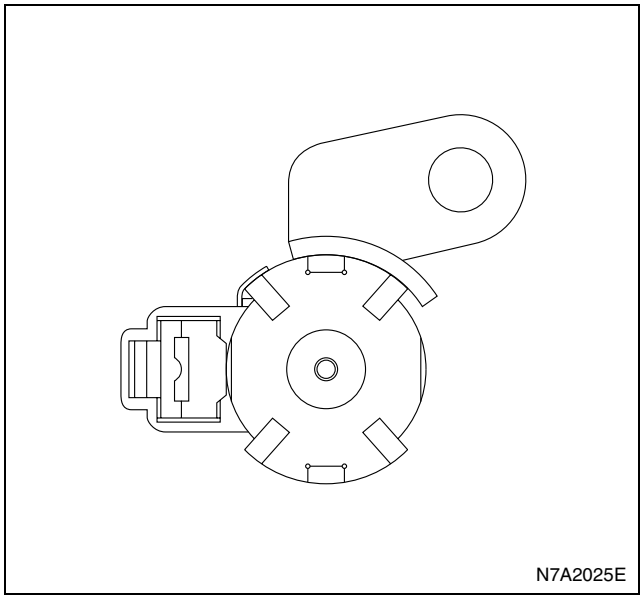
Input Shaft Speed Sensor

The input shaft speed sensor is a pickup type sensor installed in the transmission, which generates a signal when it is passed by the input shaft pulser. The input shaft speed sensor signal is used for gear shift control (lockup control, clutch control, etc.) based on signals input from the turbine speed sensor, vehicle speed sensor, etc.



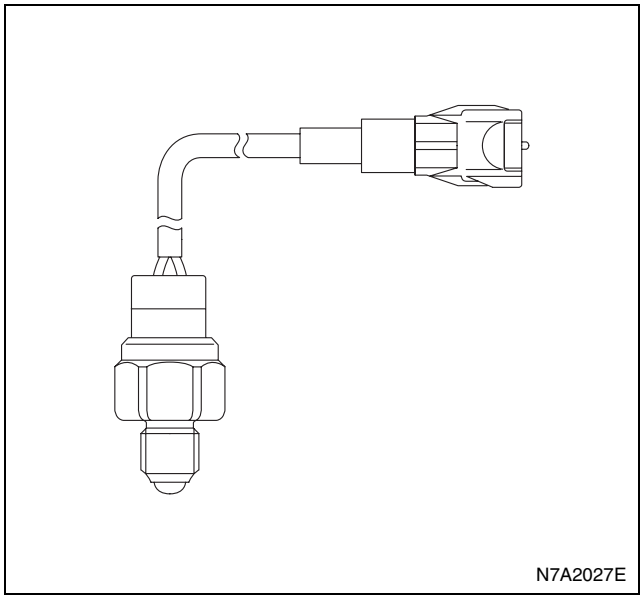
Lock up Clutch Solenoid Valve

The lock up clutch solenoid valve is installed in the oil pump. It operates in response to engine speed and fluid coupling operation.



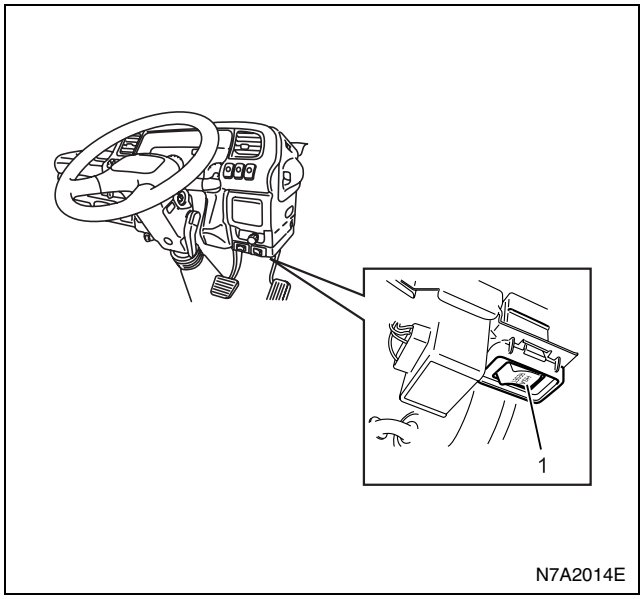
Neutral Switch

The neutral switch is installed in the gearshift control box, and it used to detect when the transmission is in neutral. The transmissin control module (TCM) interprets the condition when the neutral switch is on (contact closed) as neutral gear.



Reset Switch

The reset switch is used during transmission position learning and clutch position learning, or to clear DTC/ Smoother learning values.

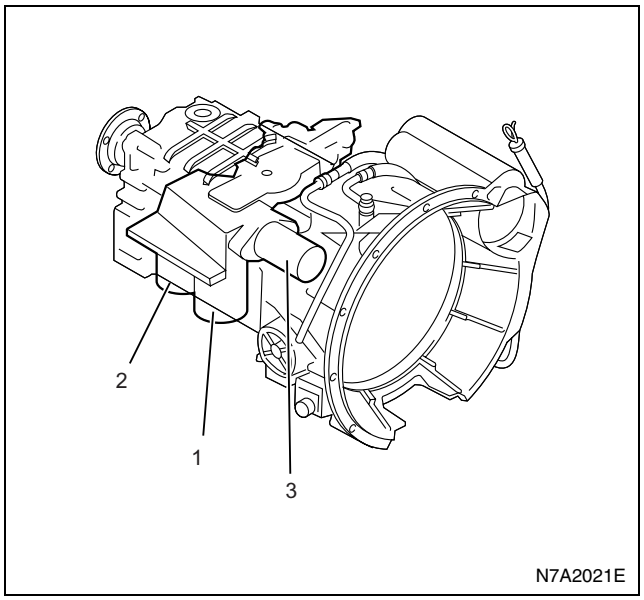


Legend

1. Reset Switch

Select Solenoid Valve

This select solenoid valve is installed in the gearshift control box. The shaft inside the solenoid operates during shifting and the select operation is performed.

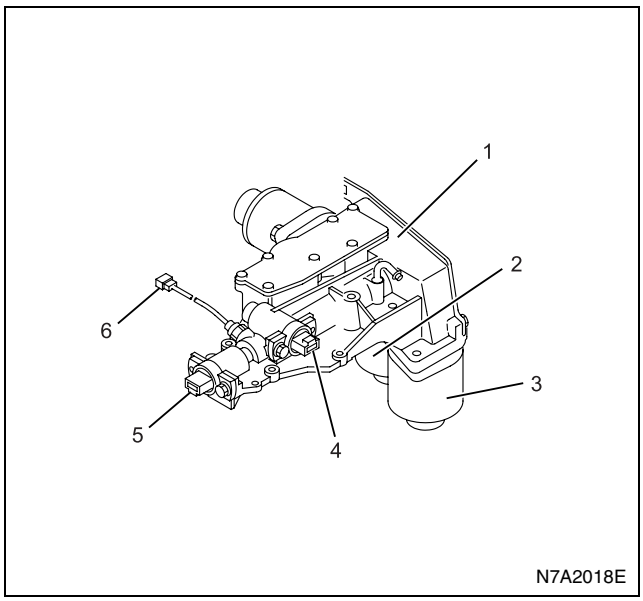


Legend

1. 1-3-5 Shift Solenoid Valve
2. 2-4-6-R Shift Solenoid Valve
3. Select Solenoid Valve

Gearshift Control Box

The gearshift control box has shift solenoids (two), a select solenoid (one), a gear shift position sensor, and a gear select position sensor, and performs shift operations (control) in accordance with signals from the transmission control module (TCM).

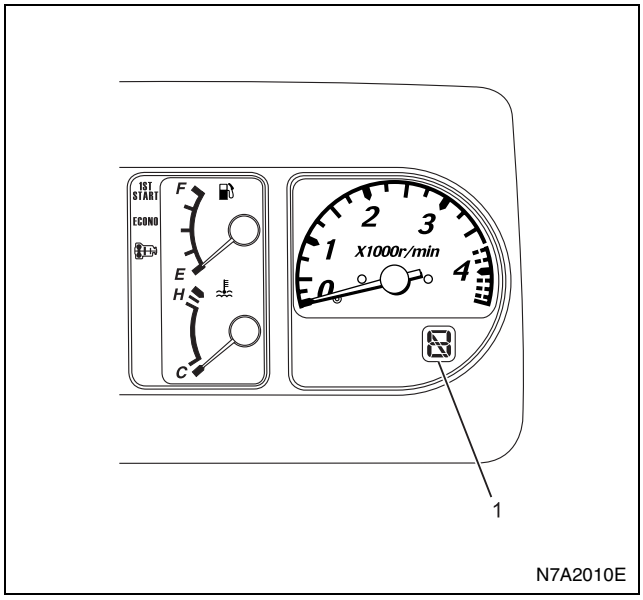


Legend

1. Gearshift Control Box
2. 1-3-5 Shift Solenoid Valve
3. 2-4-6-R Shift Solenoid Valve
4. Gear Select Positin Sensor
5. Gear Shift Position Sensor
6. Neutral Switch

Gear Position Indicator

The gear position indicator indicates the transmission gear position as detected by the TCM. The gear position indicator is installed within the instrument panel cluster (IPC).



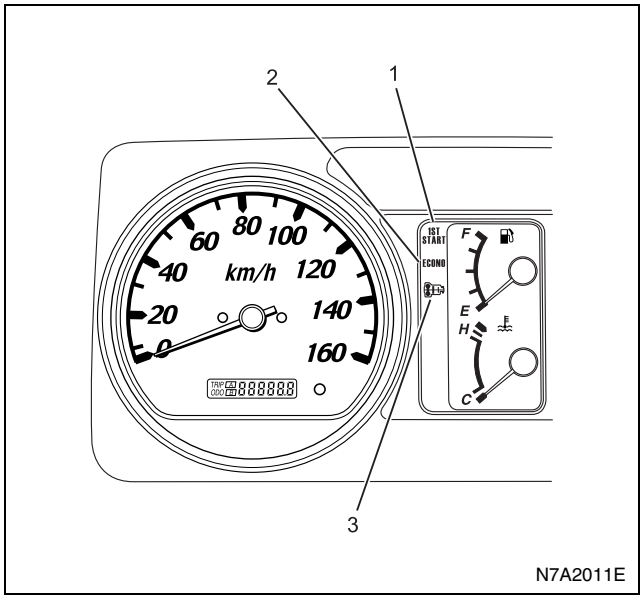
Legend

1. Gear Position Indicator

Transmission Warning Lamp

The transmission warning lamp lights or blinks when the following conditions occur.

- If trouble is detected by the system during normal running, the lamp lights or blinks.
- The warning lamp blinks when the emergency switch is on.
- If the Smoother system transmission fluid temperature rises to an abnormal level during normal running, the lamp blinks.
- The lamp blinks during learning.

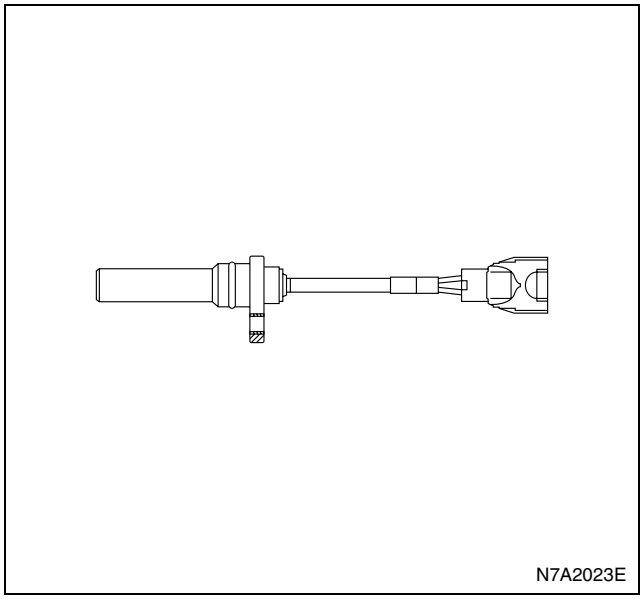


Legend

1. 1st Gear Start Indicator Lamp
2. Economy Mode Indicator Lamp
3. Transmission Warning Lamp

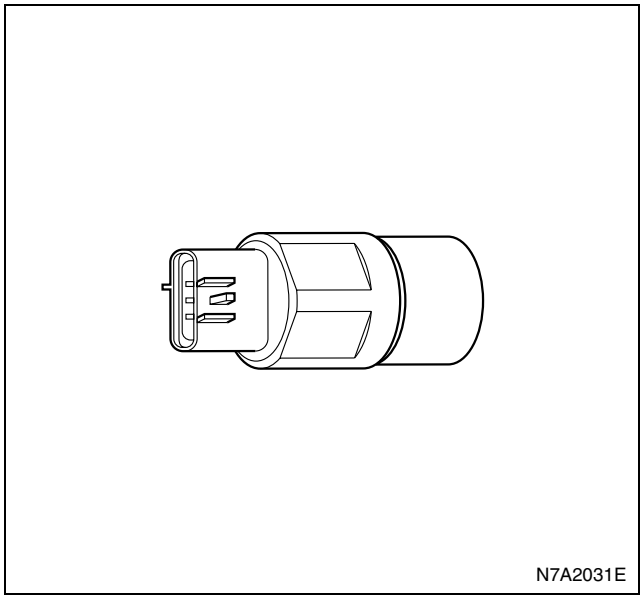
Turbine Speed Sensor

The turbine speed sensor is a pickup type sensor installed in the transmission, which generates a signal when it is passed by the turbine pulser. The turbine speed sensor signal is used for gear shift control (lockup control, clutch control, etc.) based on signals input from the input shaft speed sensor, vehicle speed sensor, etc.


N7A2023E

Vehicle Speed Sensor

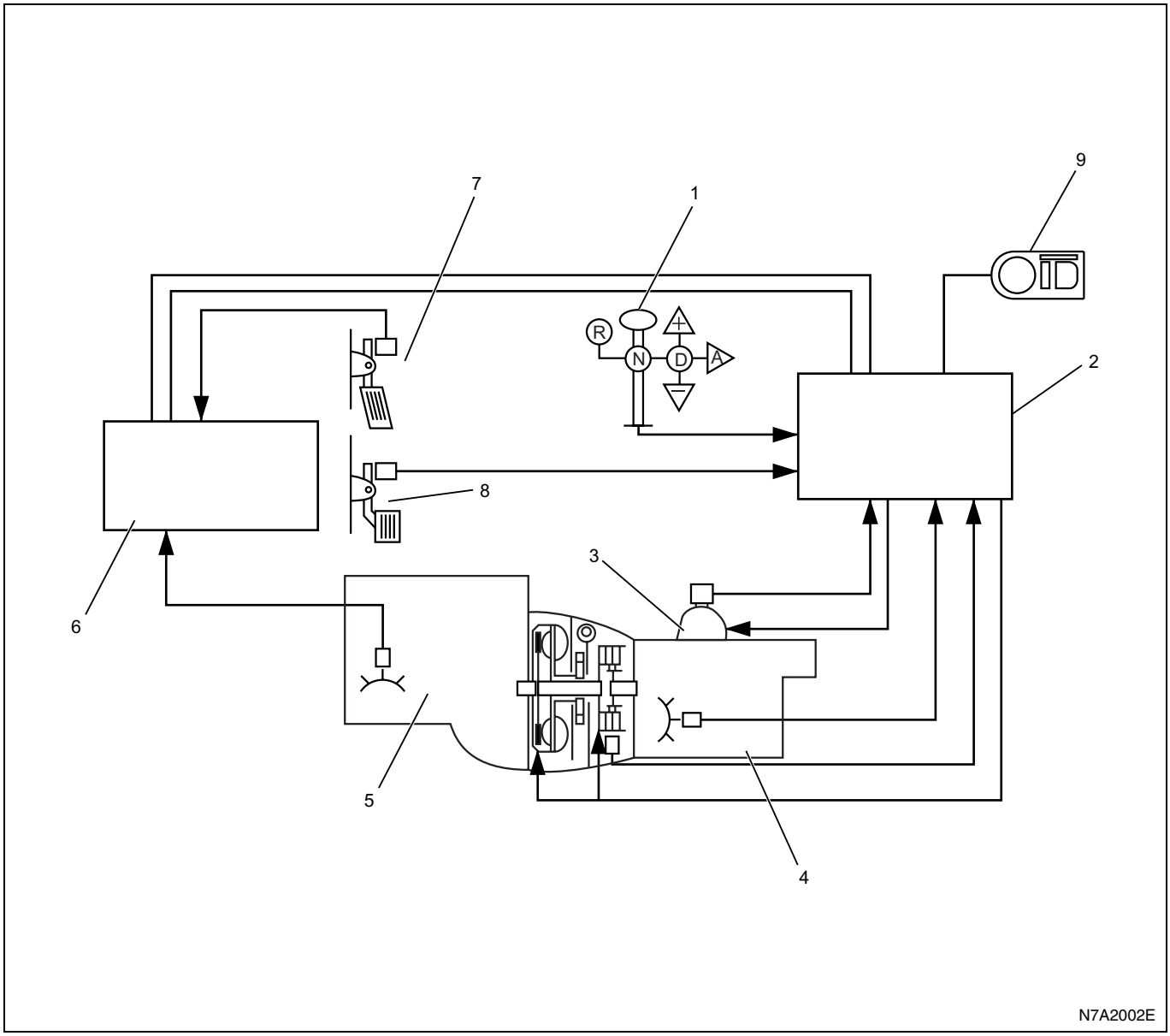
The vehicle speed sensor is installed in the transmission. The vehicle speed sensor signal is obtained from the ECM using CAN communication.


N7A2031E

Smoother System Description

Smoother System Overview

“Smoother” is the name of a new-generation drive train that provides benefits in terms of both life cycle costs (low initial cost and maintenance cost, lower fuel consumption, etc.) and easy driving. Smoother is a system that adds an automatic transmission to the existing Smoother, for even better fuel consumption and easier driving. This is accomplished by installing a solenoid system gearshift control box on the Smoother, which combines a manual transmission with fluid coupling, so all shifting is performed automatically in accordance with signals from the transmission control module (TCM). When starting moving the vehicle, depressing the brake pedal and operating the change lever as on an automatic vehicle causes a selector lever position signal to be detected by the TCM. This actuates the gearshift control box solenoid and shifts the gear into the starting position or the reverse position, and then engages the shift change clutch (gearshift). (After the shift clutch engages, creep force is generated the same as on an AT vehicle.) Releasing the foot from the brake pedal and pressing the accelerator pedal starts the vehicle moving forward. If there is an up-shift or down-shift while running, the control unit determines the vehicle status based on vehicle speed, accelerator opening angle, and other factors, and shifts to the optimal gear automatically. If the driver movers the change lever in the “+” or “–” direction, a gear change is indicated, so sequential manual shifting is also possible. (Even during sequential manual shifting, the transmission shifts to the starting position when the vehicle is stopped.)



Legend

1. Selector Lever
2. Transmission Control Module (TCM)
3. Gearshift Control Box Assembly
4. Transmission Main Unit
5. Engine
6. Engine Control Module (ECM)
7. Accelerator Opening Angle Signal
8. Brake Signal
9. Instrument Panel Cluster (Lamps, Indicators)

About Control

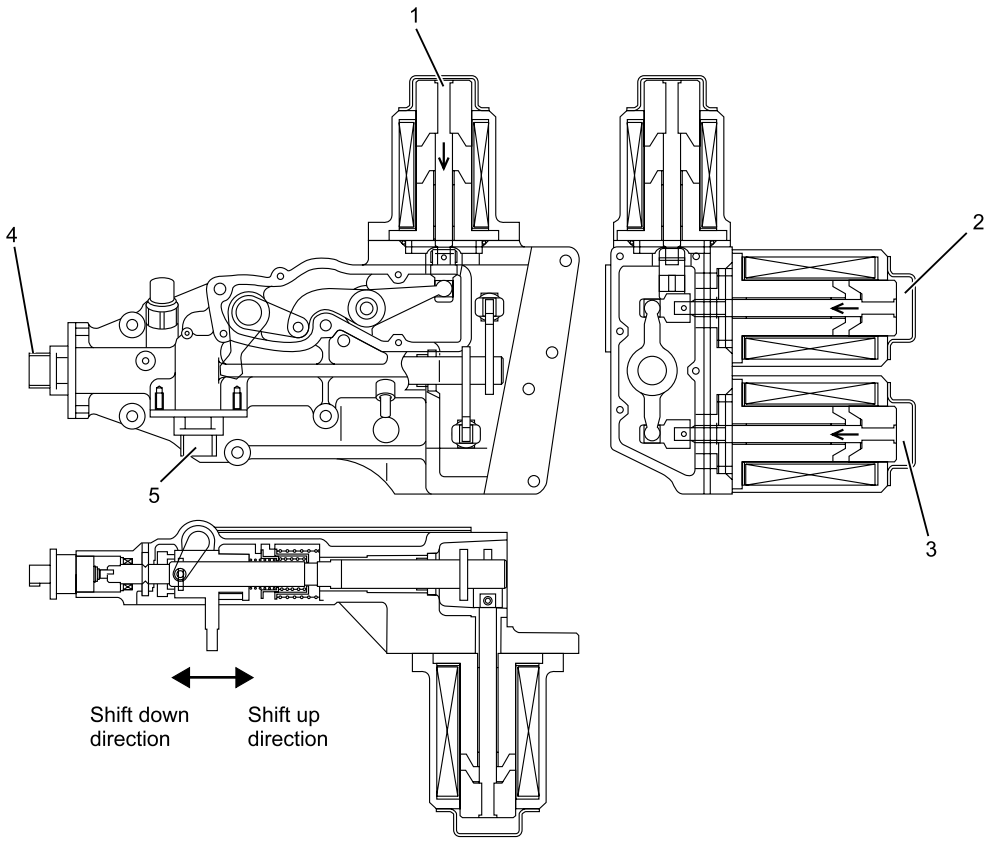
The transmission control module (TCM) has the following functions, which perform various types of control.

1. Transmission shift control
   Shift control is performed automatically as required by vehicle conditions, shift mode, 1st gear start, etc. Shift control is performed by controlling the change lever, shift control box assembly, etc. (Manual operation is also supported, and the driver's intentions are giving top priority.)
   - Shift up, shift down control
   - Shift clutch control
   - Lockup clutch control
   - Engine speed control
   - 1st gear start control
2. Running mode control
   Shift control is change automatically in accordance with the selected mode, and switches between fuel economy mode and normal mode. There are two modes: NORMAL mode and ECONO mode.

3. Starter inhibitor control
   Neutral control and other control are performed when the engine is being started.
4. PTO control
   Shift control is performed for PTO gear operation.
5. Emergency system control
   Control is performed to enable engine start and vehicle movement when system trouble is detected.
6. Inter-TCM communication
   Communication is performed with the engine control module (ECM) and other devices, and information transfer required for control is also performed.
7. Self-diagnosis function
   DTC are used to perform various tests to identify the location of trouble and communication is performed with scan tool, the DTC are confirmed, etc.
8. Information functions (indicator, lamp, buzzer control)
   Gear position indicators show the current gear position of the transmission, information lamps indicate operation of each function, and a buzzer alerts the driver to function operations, etc.
9. Half-clutch adjustment function
   The half-clutch position can be adjusted by operating a clutch adjustment switch.

Transmission Shift Control

Based on control signals from the selector lever unit, gearshift control box solenoids (shift, select) are controlled in accordance with engine speed, transmission turbine speed, input shaft speed, vehicle speed, accelerator opening angle, and other factors to perform the shift operation.

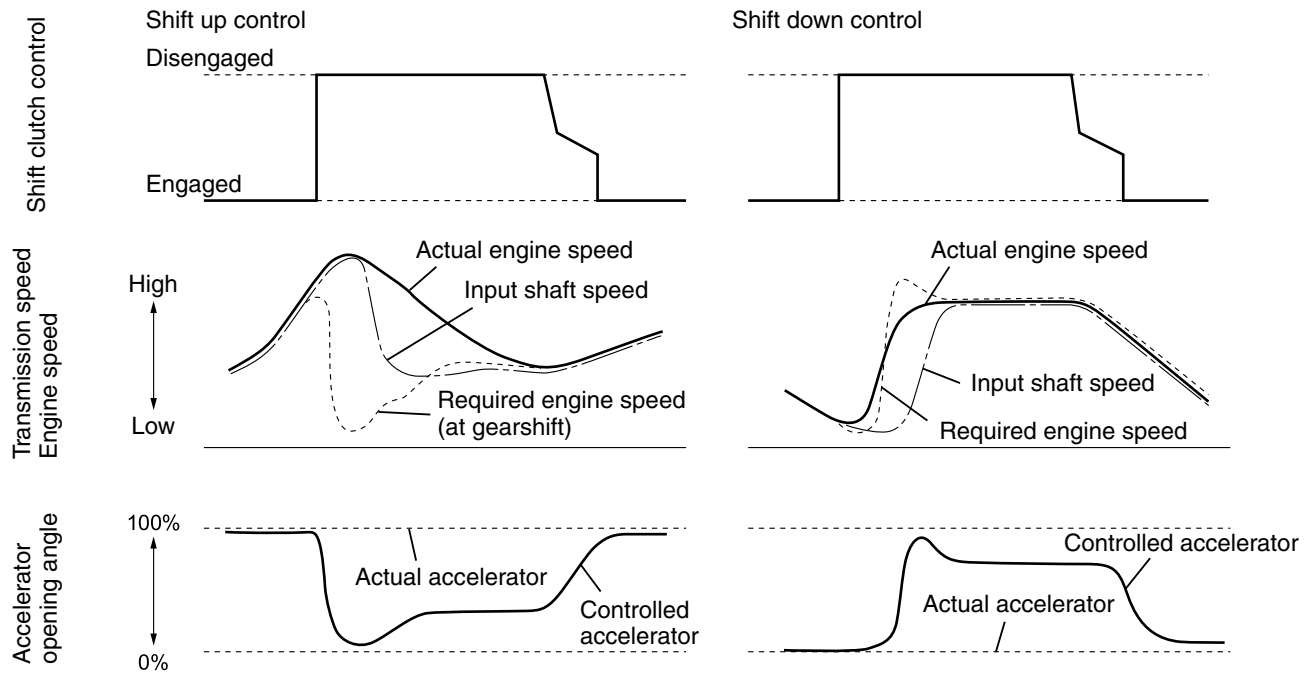


Legend

1. Select Solenoid Valve
2. 1-3-5 Shift Solenoid Valve
3. 2-4-6-R Shift Solenoid Valve
4. Gear Shift Position Sensor
5. Gear Select Position Sensor

About Shift Up, Shift Down Control

Shift up/shift down is performed when the selector lever position (mode) is “D”, and an automatic shift or selector lever operation is performed in the “+” direction or “–” direction. Basically, shift clutch control and shift control are performed based on engine speed, input shaft speed, accelerator opening angle, etc.



About Shift Clutch Control

Clutch solenoid valves are controlled so fluid pressure operates the clutch assembly piston, which operates the gearshift clutch to disengage and engage the clutch.
The clutch is disengaged while in neutral, and operates before shifting and after shift control is complete.
When ATF temperature is low (up to 20°C [68°F]), the clutch engages in order to warm up the engine.

About Lockup Clutch Control

While running at or above a preset speed, the lockup clutch engages in order to perform control that eliminates engine power transmission loss.

- Lockup clutch engagement control
  In 2nd and higher gears, the lockup clutch engages when the following conditions are satisfied: shift clutch is engaged, input shaft speed is 900 to 1500 rpm (vehicle speed depends on gear position), etc.
  In the case of Rev or 1st gear, the lockup clutch does not engage.
- Lockup clutch disengagement control
  The lockup clutch disengages when the following conditions are satisfied: input shaft speed is 900 to 1500 rpm (input shaft speed depends on gear position), etc.

About Engine Speed Control

When the clutch is released (for shifting, etc.), a request for engine speed change is sent to the engine control module (ECM), and engine blowup and deterioration of feeling (shift shock etc.) are prevented.

1st Gear Start Control

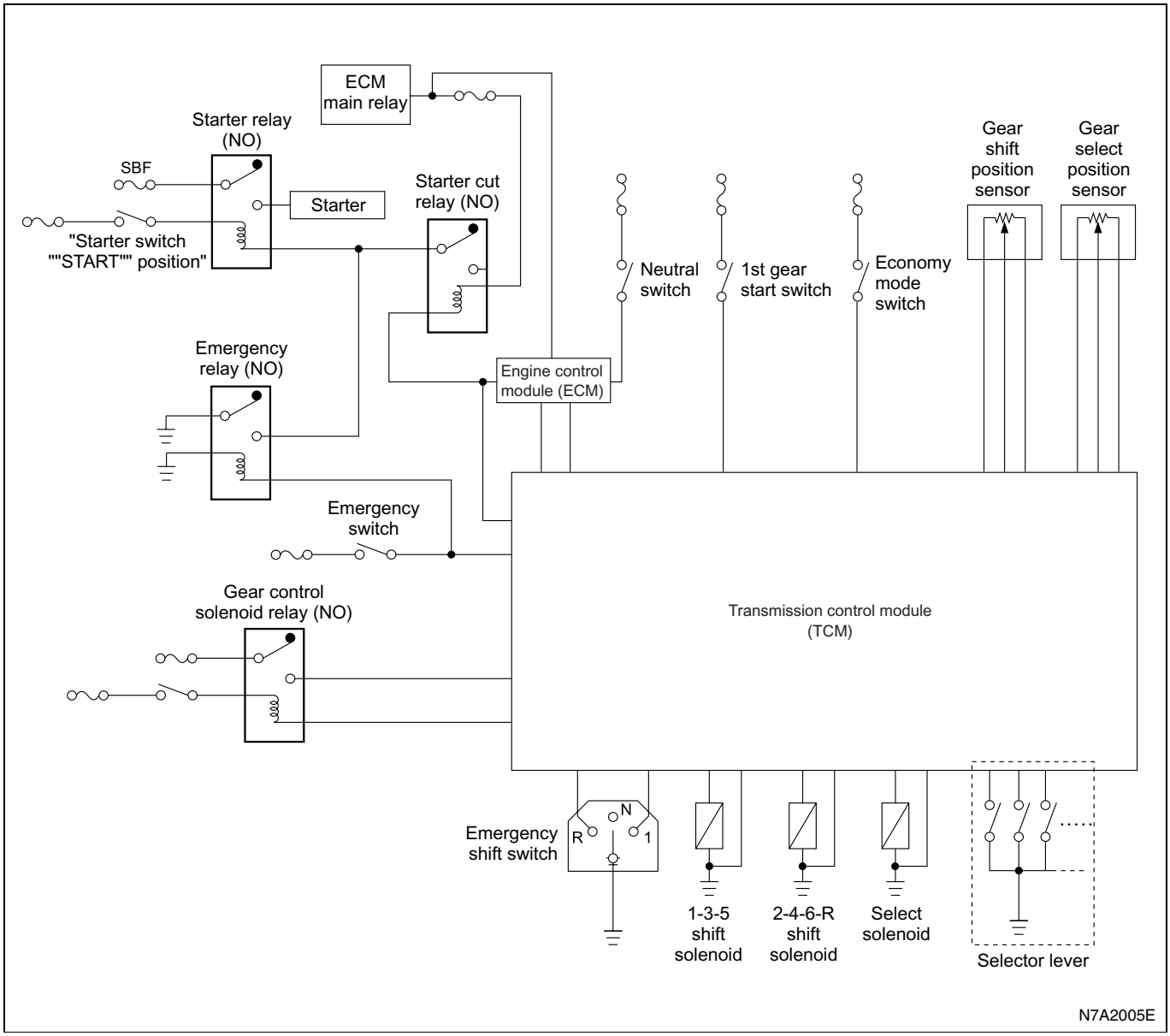
Turning on the 1st gear start switch causes the normal start gear (2nd) to change to 1st gear. This can be used when power is required due to payload and inclines.

Running Mode Control

Shift control is change automatically in accordance with the selected mode, and switches between fuel economy mode and normal mode. There are two modes: NORMAL mode and ECONO mode.

Starter Inhibitor Control

Starter inhibitor control makes it impossible to start the engine when the selector lever is in any position other than neutral.



PTO Control

PTO mode ON/OFF control is performed in accordance with the PTO switch input gear position, parking brake switch, and other inputs.

Determination of PTO control is possible

- Gear: Neutral
- Vehicle speed: Stopped
- PTO switch: ON
- Engine speed: Running (idling)
- Accelerator opening angle: OFF (idling)
- Parking brake: ON

Determination of PTO control is possible

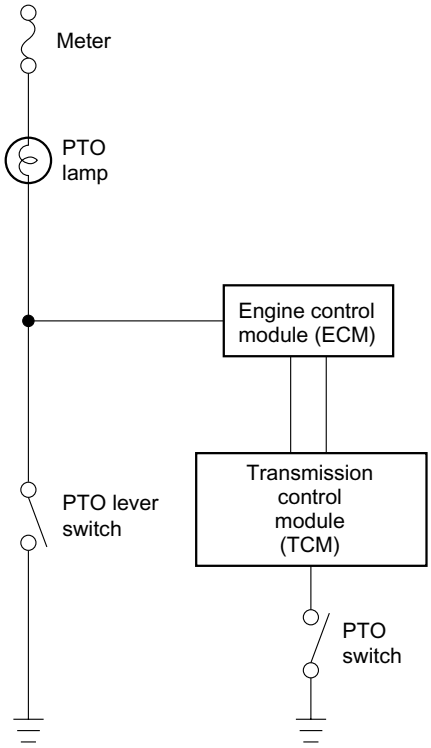
- PTO switch: OFF
- Engine stopped
- Selector lever operation during PTO operation
- In neutral, vehicle speed is greater than 20 km/h (12 MPH)
- Emergency switch: ON

Shift Control Limit

Automatic shifting prohibited while vehicle is running.

About The Starting Gear

The starting gear can be selected from among 1, 2 and Rev, and shifting from the starting gear is not possible. (The starting gear is fixed. However, shifting to neutral is possible.)

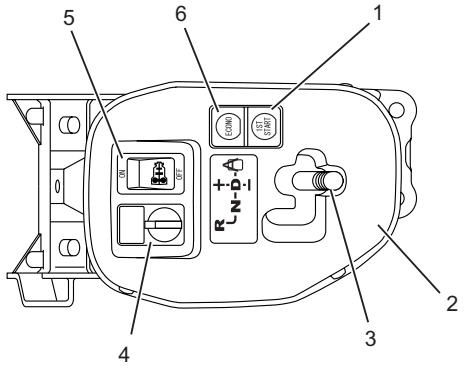


N7A2095E

Emergency System Control

Turning on the emergency switch operates the emergency relay and enables starter relay operation, which makes it possible to operate the starter. The emergency shift switch is also enabled, and switch operation can be used to shift to R, neutral, and 1st.

Notice:
Shifting with the selector lever is not possible when the emergency switch is turned on.



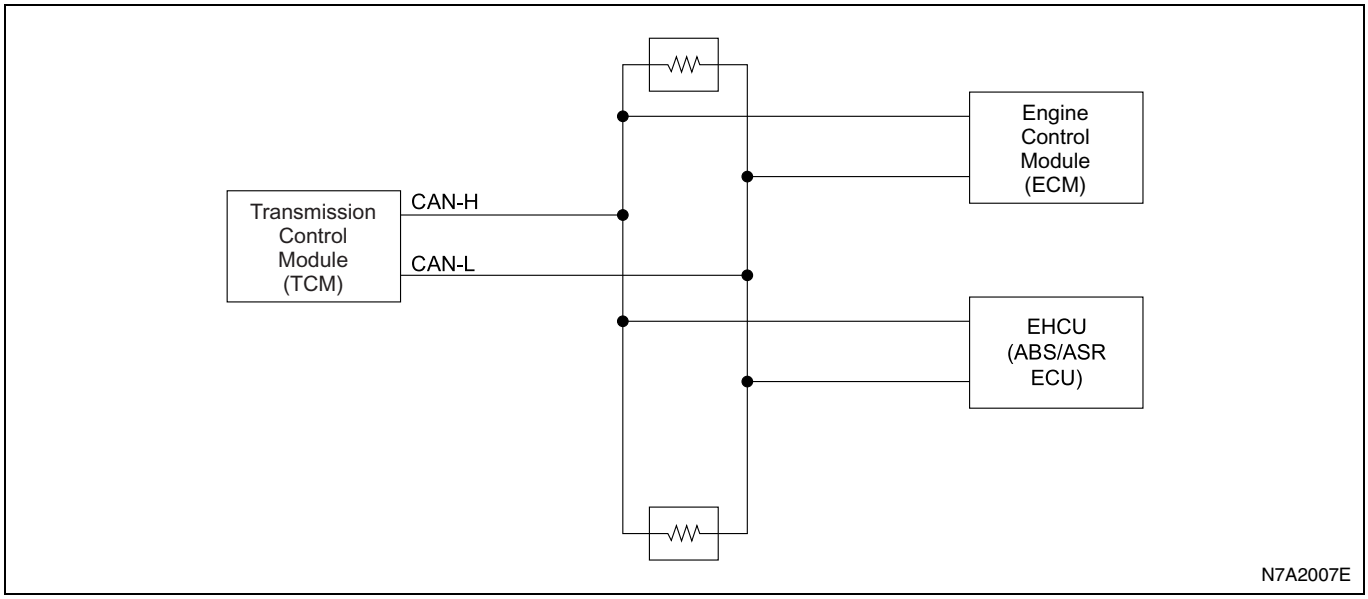
N7A2006E

Legend

1. 1st Gear Start Switch
2. Selector Lever Unit
3. Selector Lever
4. Emergency Shift Switch
5. Emergency Switch
6. Economy Mode Switch

Inter-TCM Communication

The transmission control module (TCM) communicates with the engine control module (ECM), EHCU (ABS/ASR control unit), etc., and transfers engine speed, vehicle speed, accelerator opening angle, ABS/ASR operation, and other signals. CAN communication is used for the communication system.



Half-Clutch Position Adjustment Function

The half-clutch point (gear engagement point) is adjusted by pressing the FAST side or SLOW side of the clutch adjustment switch. The procedure is: select the neutral gear, pull the parking brake, and then press “FAST” for fast clutch engagement or “SLOW” for slow engagement. Adjustment is possible to four levels on each side.

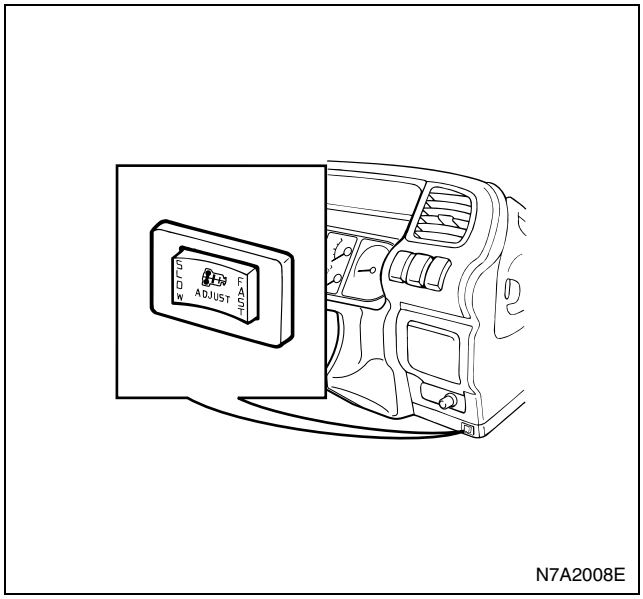
Important:

When ATF temperature is unstable, accurate learning is not possible for half-clutch position adjustment.

Perform the adjustment operation after warming up the engine sufficiently. If the half-clutch position does not feel right after adjustment, repeat half-clutch adjustment as required.

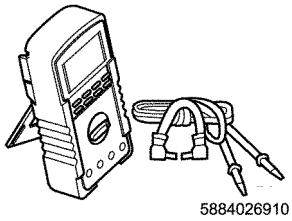
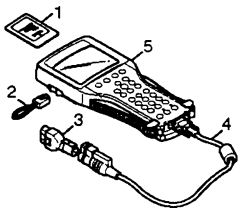
(In this case, it is not necessary to clear the current learned value. Half-clutch adjustment can be performed consecutively.)

It is easy to obtain a stable position at an ATF temperature of 40°C (104°F) or higher (directly after running), which can be checked using scan tool (Tech 2).



Special Tools and Equipment

Special Tools and Equipment

Illustration	Tool Number / Description / Remarks
	5-8840-2691-0/ Digital multimeter
	Tech 2/ Scan tool

TRANSMISSION/TRANSAXLE

Automatic Transmission (Smoother)

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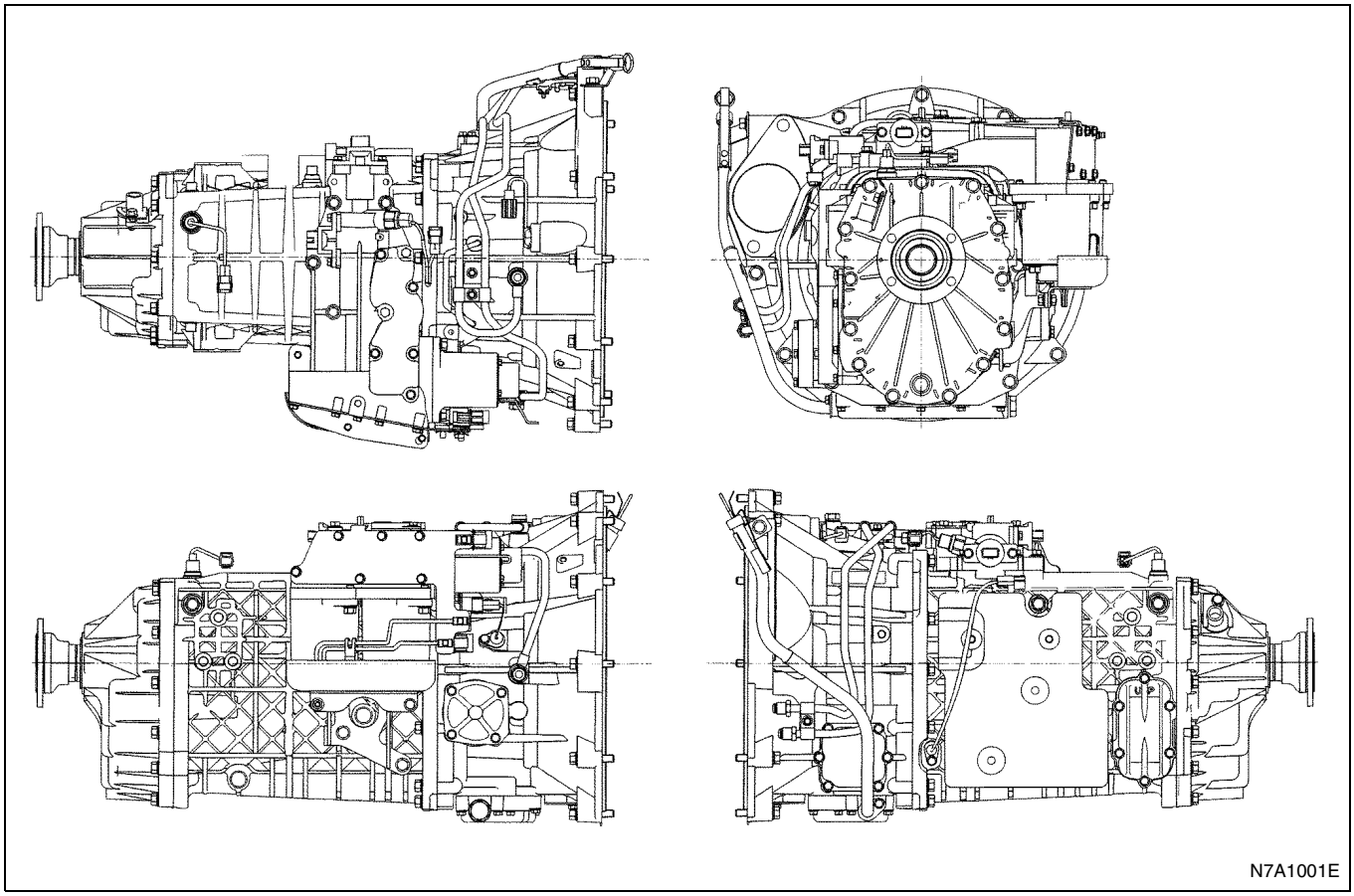
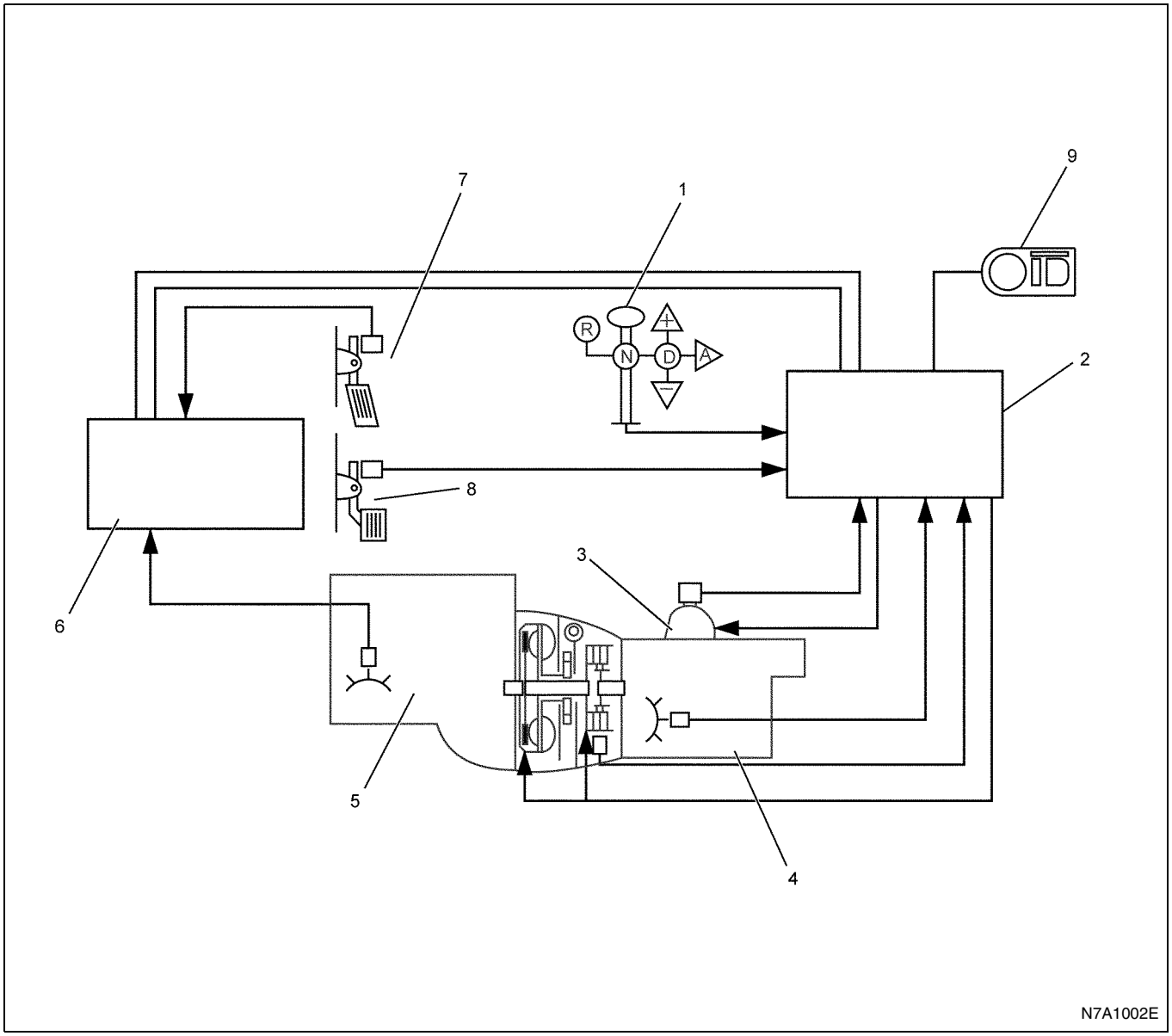
Smoother Mechanism

Description of Function and Operation

Smoother





Legend

1. Selector Lever Unit
2. Transmission Control Module (TCM)
3. Gearshift Control Box
4. Transmission
5. Engine
6. Engine Control Module (ECM)
7. Accelerator Opening Angle Signal
8. Brake Signal
9. Instrument Panel Cluster (Lamps, Indicators)

The Smoother transmission is based on the MYY type transmission, with the clutch system changed to the fluid coupling plus gearshift clutch, and the gearshift control box changed to a solenoid system. The transmission receives shift lever and accelerator operation signals and other data, and automatically engages and disengages the gearshift clutch (wet-type multi-disc clutch) and lock up clutch (inside the fluid coupling) to control gear shifting.
The following are the basic operation conditions.

1. Gearshift control box
   A new solenoid type control box enables electronic control of the gear shift/select operation. A selectable driving mode allows selection of manual mode shifting or auto shift mode (shift up and down) can be selected in accordance with the application using the + / – switch.
2. Gearshift clutch
   When shifting, the gearshift clutch releases (disengages) and gear shift control is enabled.

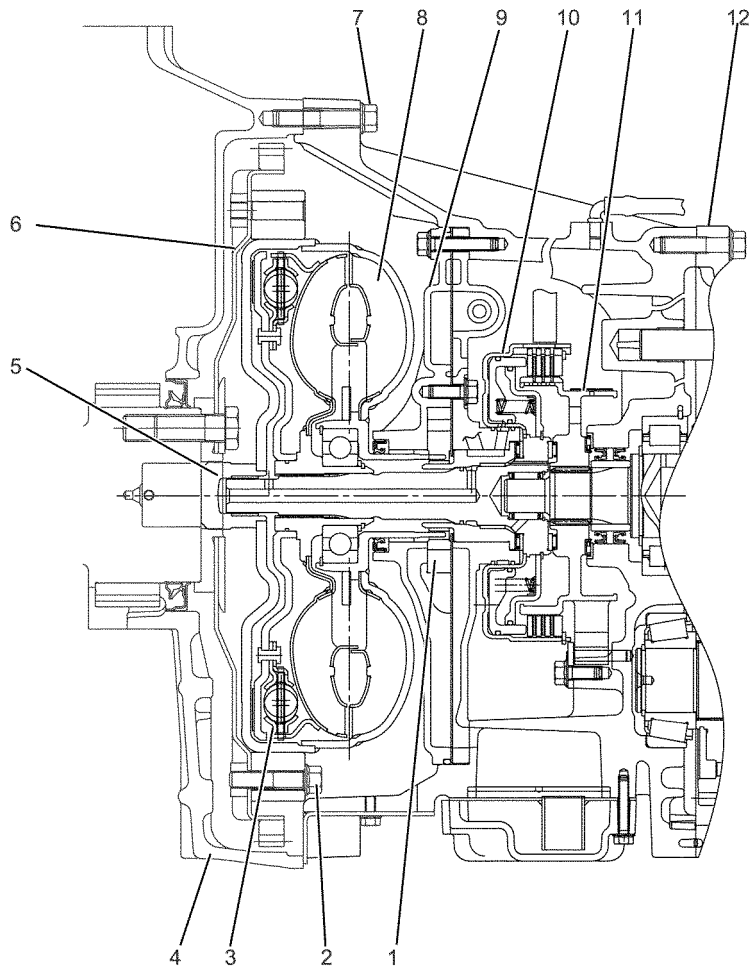
- Gearshift clutch release control
  The gearshift clutch is disengaged in neutral gear. However, at transmission fluid temperatures of 20°C or lower, the gearshift clutch is engaged even in neutral gear (in order to warm up the transmission).
- Gearshift clutch control engagement control
  The gearshift clutch engages after shift completion is detected (gear in determined).

3. Lock up clutch
   While running at or above a preset speed, the lock up clutch engages in order to eliminate engine power transmission loss (and increases fuel consumption).
   - Lock up clutch engagement control
     The lock up clutch disengages when the following conditions are satisfied: 2nd gear or higher, transmission speed above a prescribed value (vehicle speed depends on gear), etc. The lock up clutch does not engage in the case of reverse or 1st gear.
   - Lock up clutch control
     The lock up clutch disengages when the following conditions are satisfied: 2nd gear or higher, transmission speed below a prescribed value (vehicle speed depends on gear), etc.

MYY Transmission

There are two types of MYY transmission: MYY6P and MYY5T. The MYY transmission is designed for light weight and increased allowable input torque. New technology makes it possible to adopt aluminum cylinder case (3-piece) construction, taper roller bearings (counter shaft front and rear), a twin rod type shift control layout, and more.

Part Location Diagram



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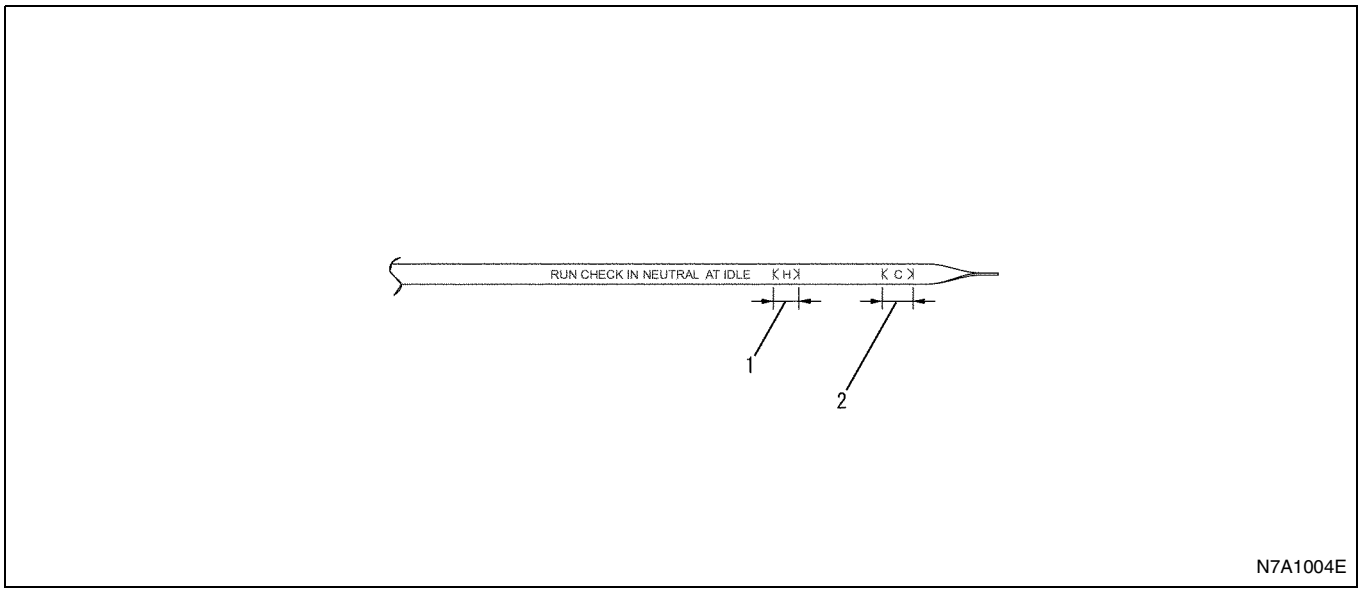
Legend

1. Oil Pump
2. Bolt
3. Lock Up Clutch
4. Flywheel Housing
5. Pilot Hub
6. Flex Plate
7. Bolt
8. Fluid Coupling
9. Oil Pump Assembly (Oil Control Unit)
10. Clutch Assembly
11. Brake Band
12. MYY Transmission

Function Check:

Transmission Fluid Level Check

Smoother

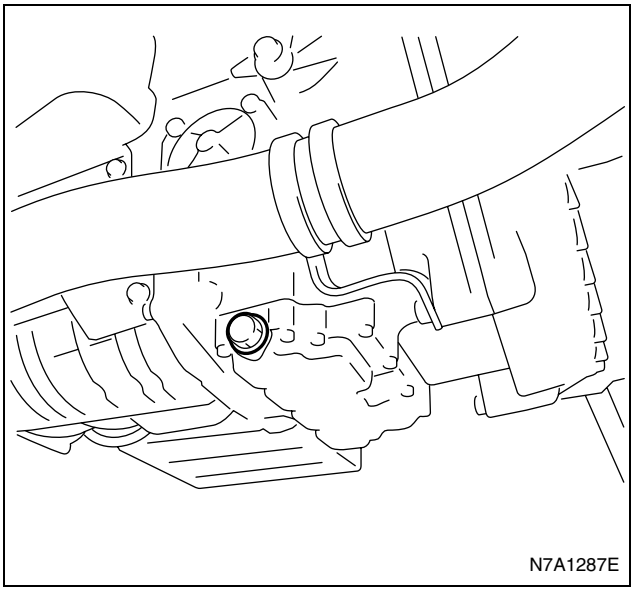


Legend

1. Oil level limit when oil temperature is 70 to 80°
2. Oil level limit when oil temperature is 20 to 30°

1. Inspection procedure
   a. Stop the vehicle on a level surface, select neutral gear, and engage the parking brake.
   b. With the engine idling, shift to 2nd gear for at least three seconds, and then return to neutral. Repeat this operation at least three times. (For the second and subsequent shifts, you can select another gear other than 2nd; also you can use gear in learning as a substitute for this.)
      It can be performed to stall the engine while gearshifts, but stop this immediately when the alarm bleeps. Even if the alarm does not bleep, finish this within five seconds. After oil temperature stabilizes, check the oil level.
   c. With the engine still idling, use the level gauge to confirm that the oil level is within the appropriate range for the oil temperature.
      If the oil level is low, replenish it with Besco ATF III through the level gauge guide tube.
2. Caution
   - Before pulling out the level gauge, clean the area around the gauge by wiping with a cloth.
   - Take care to ensure that the cloth is free of lint, dust, water, or any other foreign matter that can contaminate the oil.
   - When checking the oil level securely hook the level gauge to the clip, insert the level gauge into the guide tube, and hold it there for at least three seconds before pulling it out for reading. Insert the level gauge slowly in order to allow air to escape.
   - When inserting or pulling out the level gauge, take care to avoid letting any oil on the filler tube walls adhere to the level gauge.
   - Use the Tech 2 for an accurate reading of the oil temperature. For information about using the Tech 2, refer to “Transmission Control System Smoother.”
3. Changing transmission fluid procedure
   a. Prepare the container under drain plug for draining of transmission fluid.
   b. Pulling out the level gauge.
   c. Drain the transmission fluid by remove the drain plug and O-ring.
   d. Tighten the drain plug.
      The transmission case is made of aluminium. It is easily damaged. Be careful not to tighten a bolt too much.

Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)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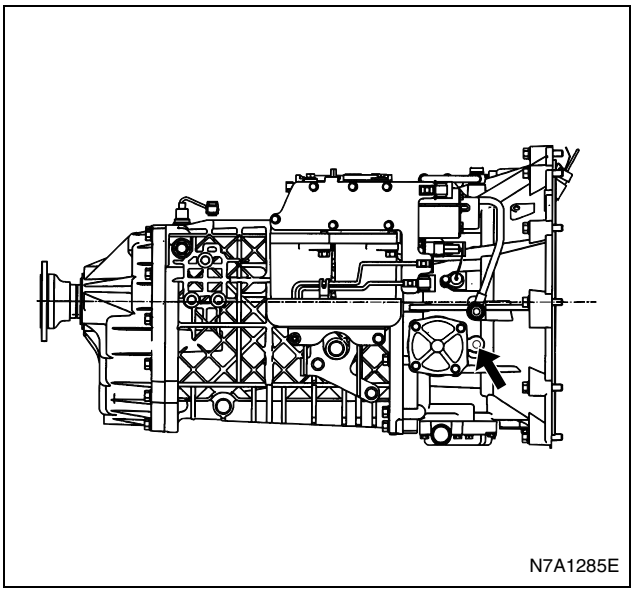
e. Fill it with Besco ATF III through the level gauge guide tube.
The amount of oil is used as a guide for change. After oil change, with reference to “Inspection procedure”, make sure that it is poured to the specified level.
Transmission fluid capacity at replacement: 2.0 L (2.1 US qt / 1.8 Imp qt)

Checking Line Oil Pressure

1. Stop the engine and wait long enough for line oil pressure to drop.
2. Remove the eye bolt on the right side and remove any seal material remaining in the bolt hole.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3. Attach an oil pressure gauge and then start the engine.
4. Measure the line oil pressure.
Line oil pressure reference value: 715 to 800 kPa {7.3 to 8.2 kg/cm^2}
5. Operate the shift lever and check if line oil pressure is within the prescribed values even during gear in.
6. If the line oil pressure is not within the prescribed values, check the transmission fluid level. If the level is normal, repair the transmission unit.
7. Stop the engine, wait long enough for line oil pressure to drop, and then remove the oil pressure gauge.
8. Using a new gasket, re-install the eye bolt and tighten it to its specified torque.

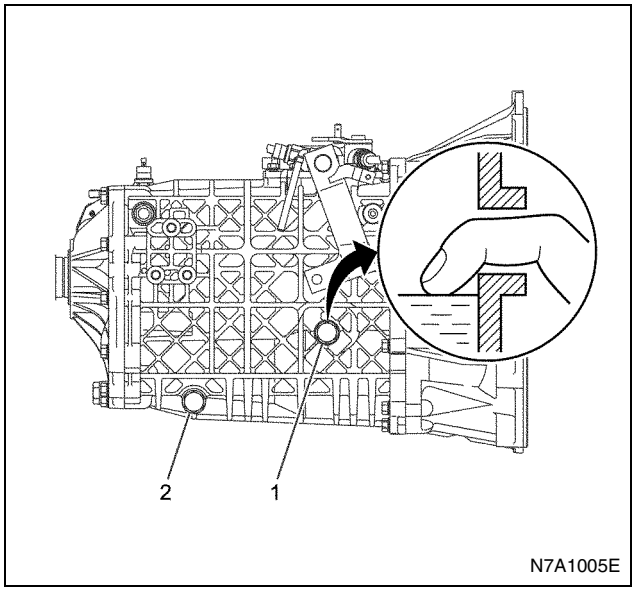
Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

Checking the Oil

1. Remove the filler plug.
2. From the filler plug hole, check that the oil is up to the bottom of the hole.
3. Replenish oil until it is within the prescribed level.
   - Oil: Besco gear oil transaxle (5W-30)
4. Tighten the filler plug to the specified torque.

Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

MYY 5-Speed



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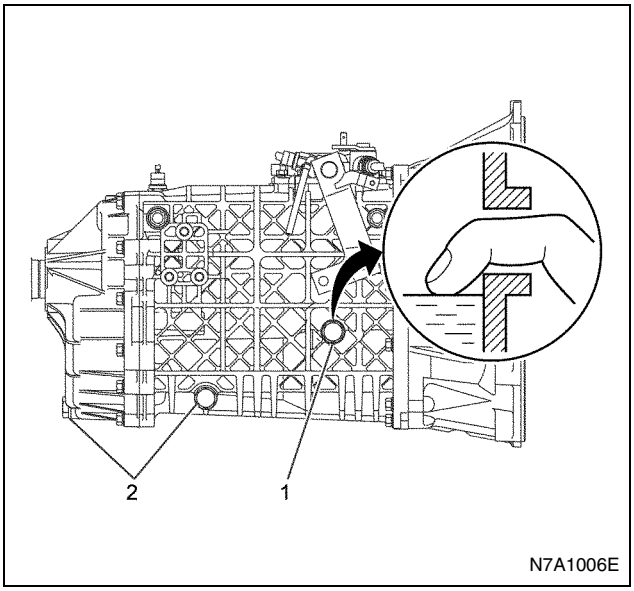
MYY 6-Speed



Legend
1. Filler Plug
2. Drain Plug

Changing Transmission Oil

1. Start the engine and allow it to run until the transmission is sufficiently warmed up.
2. Stop the engine and then remove the drain plug to drain the oil.
3. Tighten the drain plug.

Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

4. Remove the filler plug.
5. Fill oil from the filler plug hole until it reaches the rim of the hole.

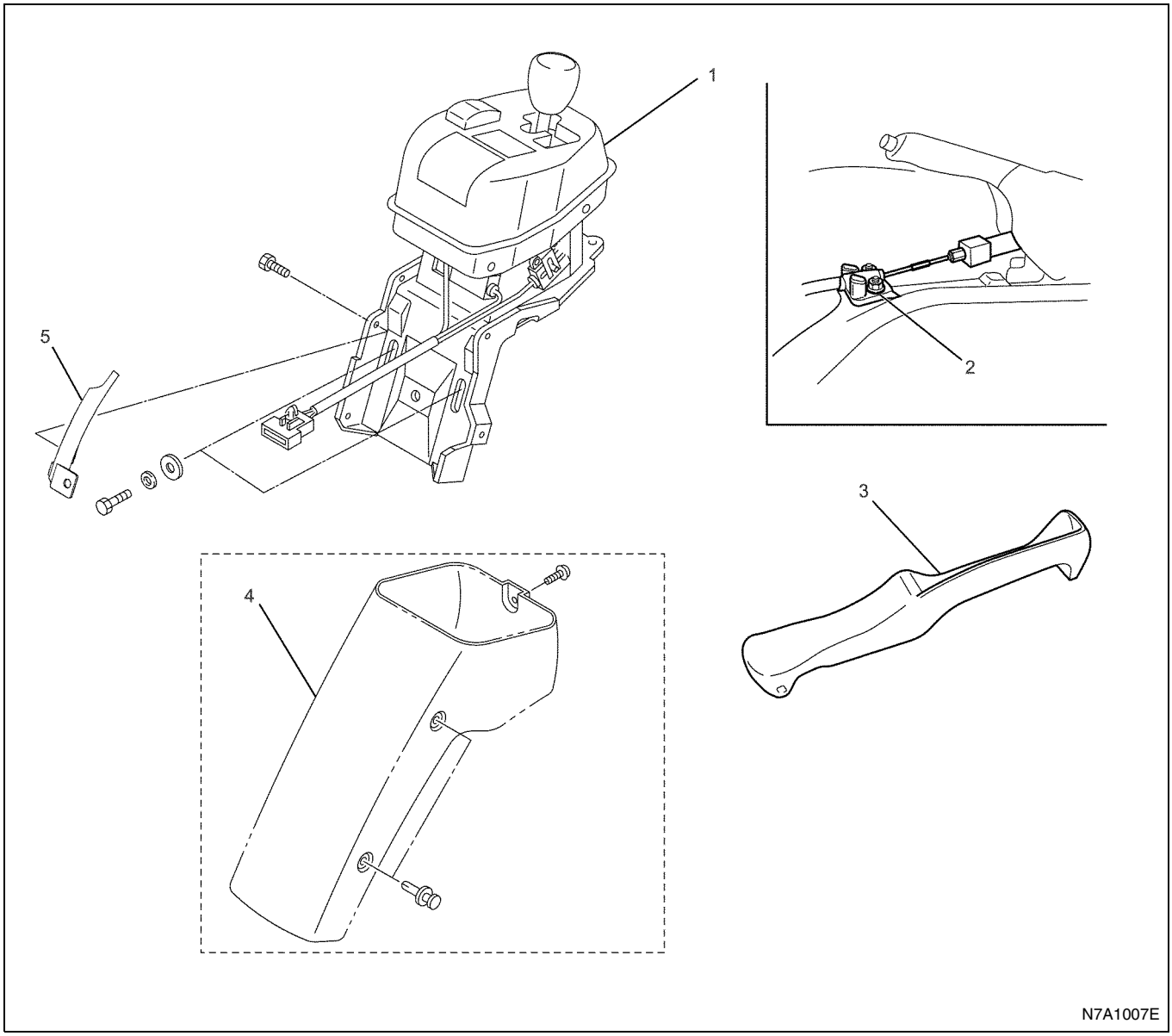
Oil Level (L)		
	MYY 5-Speed	MYY 6-Speed
Standard	2.8	3.5
With Side PTO	3.1	3.8

6. Tighten the filler plug to the specified torque.

Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

Selector Lever Assembly

Components



Legend

1. Selector Lever Assembly
2. Parking Brake Cable Bracket
3. Parking Brake Cable Cover
4. Gear Control Cover
5. Parking Brake Cable Bracket

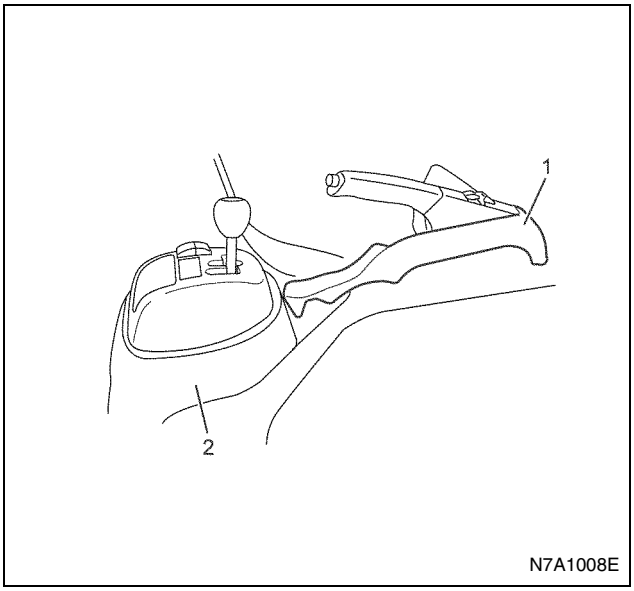
Removal

Preparation

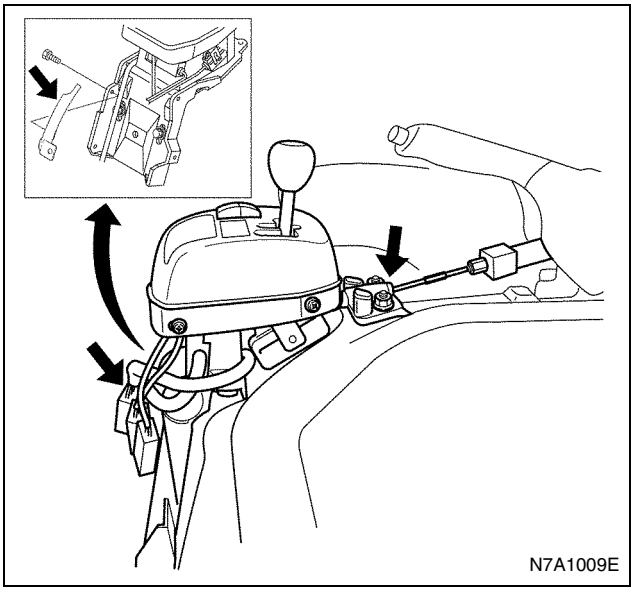
- Disconnect the battery (−) cable.

1. Remove the parking brake cable cover (1).

2. Remove the gear control cover (2).



3. Remove the two parking brake cable brackets.
4. Disconnect the harness connector.

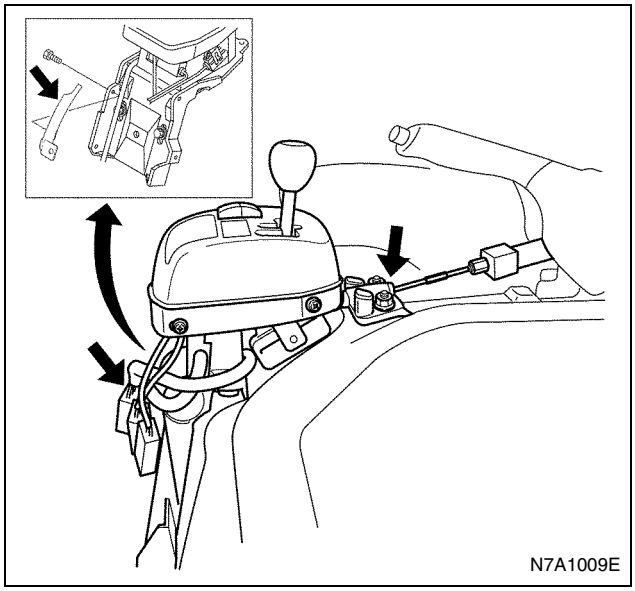


5. Remove the selector lever assembly.
   - Remove the two installation bolts and two nuts of the selector lever assembly.

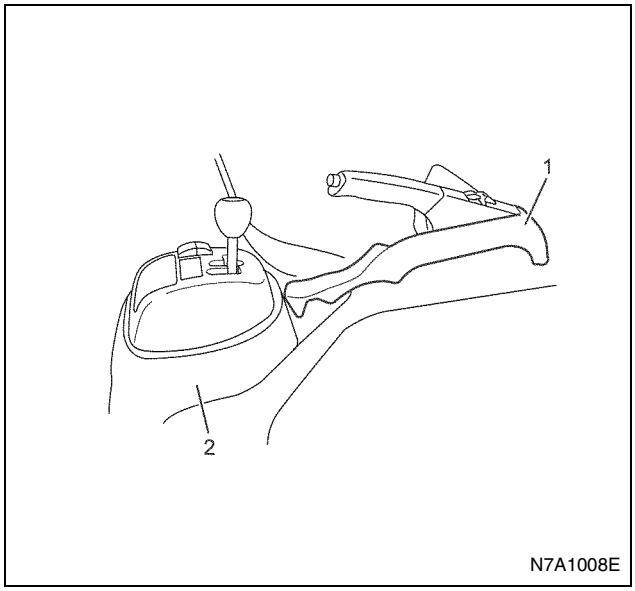
Installation

1. Install the selector lever assembly.
   - Install the two installation bolts and two nuts of the selector lever assembly.
2. Connect the harness connector.

3. Install the two parking brake cable brackets.

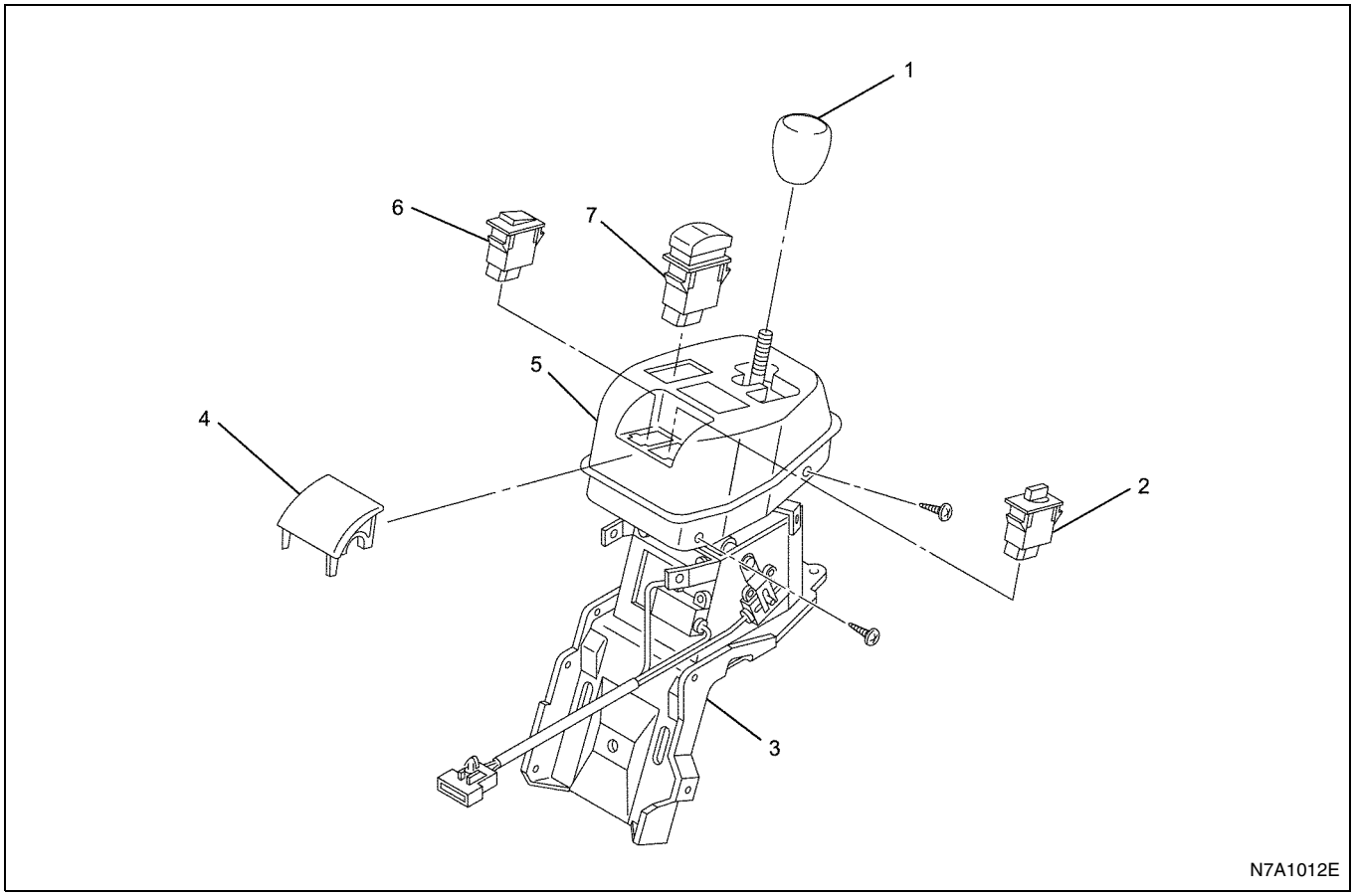


4. Install the gear control cover (2).
5. Install the parking brake cable cover (1).



Selector Lever

Components



Legend

1. Selector Lever Knob
2. Emergency Shift Switch
3. Selector Lever Assembly
4. Switch Cover
5. Selector Lever Cover
6. Emergency Switch
7. Mode Switch (Economy, 1st Gear Start)

Disassembly

1. Remove the selector lever knob.
2. Remove the selector lever cover.
   - Remove the fours screws that secure the selector lever cover in place, and remove the selector lever cover.
3. Remove the switch cover from the selector lever cover.
4. Remove the emergency shift switch, emergency switch, and mode switch from the selector lever cover.

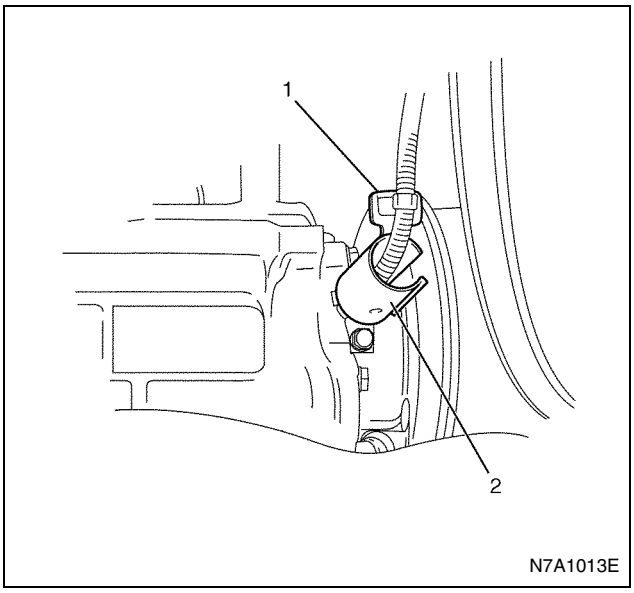
Assembly

1. Install the mode switch, emergency switch, and emergency shift switch on the selector lever cover.
2. Install the switch cover on the selector lever cover.
3. Install the selector lever cover.
   - Install the selector lever cover and secure it with the four selector lever cover screws.
4. Install the selector lever knob.

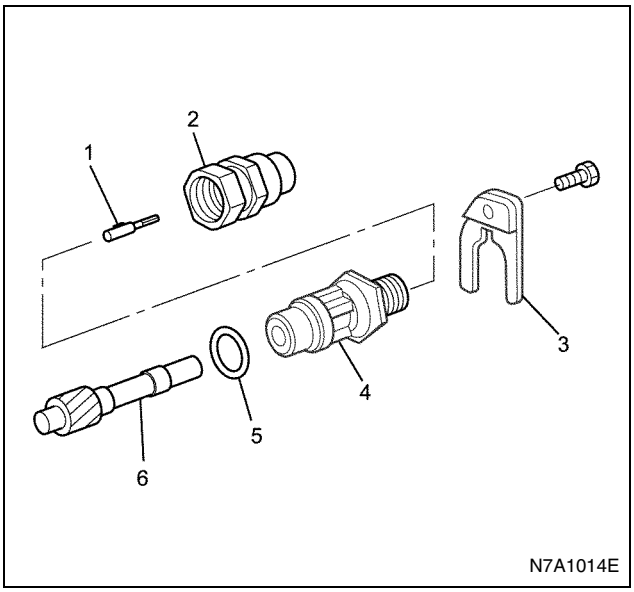
Vehicle Speed Sensor

Removal

1. Remove the clip (1) and remove the protector (2).
2. Disconnect the wire connector.



3. Remove the fixing screw and then remove the vehicle speed sensor (3).



Legend

1. Plug Sensor
2. Vehicle Speed Sensor
3. Plate
4. Bush
5. O-ring
6. Driven Gear

Installation

1. Use the fixing screw to install the vehicle speed sensor.

Fixing screw

Tighten:
20 N·m (2.0 kg·m / 14.8 lb·ft)

Bushing — Vehicle speed sensor

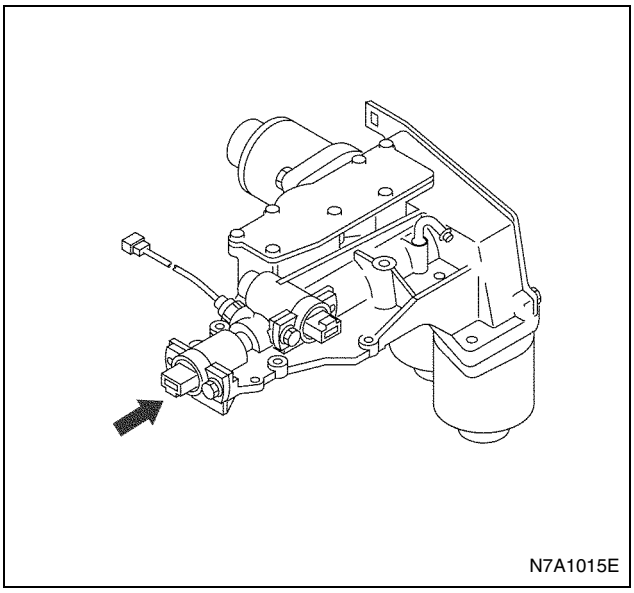
Tighten:
25 N·m (2.5 kg·m / 18.4 lb·ft)

2. Connect the wire connector.
3. Secure the protector with the clip.

Gear Shift Position Sensor

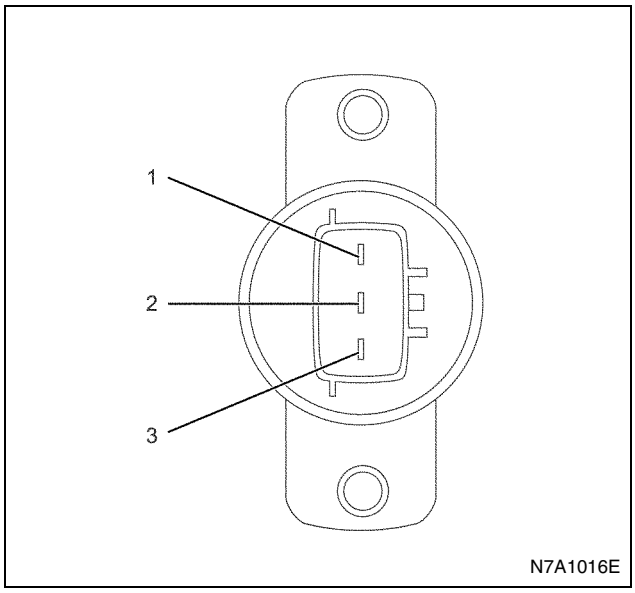
Removal

1. Connector
2. Remove the gear shift position sensor.



Inspection

Connect the gear shift position sensor terminal 3 (SFT.VCC) to 5 V and terminal 1 (SFT.GND) to ground. Record the voltage between terminals 2 (SFT.SIG) and 1 (SFT.GND) while rotating the sensor arm.
Replace if the voltage does not vary from approximately 0.1 to 4.8 V.



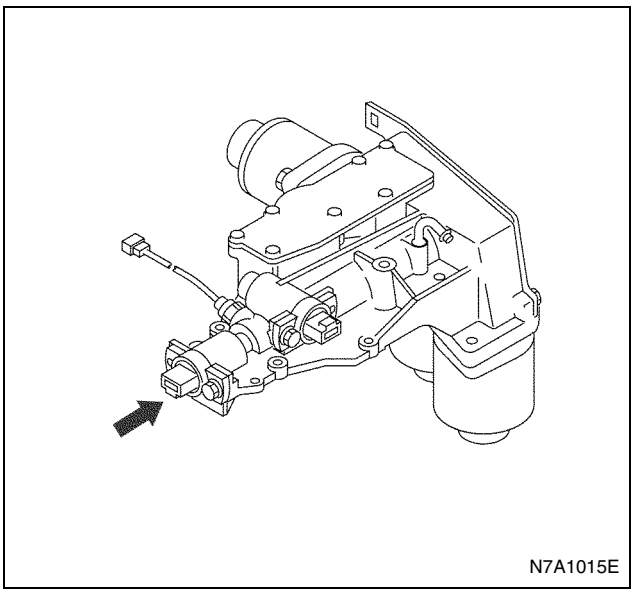
Legend

1. Gear Shift Position Sensor Terminal 1 (SFT.GND)
2. Gear Shift Position Sensor Terminal 2 (SFT.SIG)
3. Gear Shift Position Sensor Terminal 3 (SFT.VCC)

Installation

1. Apply Besco chassis grease to the sensor shaft tip and the sliding portion of the gearshift control box shaft tip groove, and install.
2. Install the gear shift position sensor.
   a. Aligning the angle of the sensor arm tip with connector part groove, carefully insert the gear shift position sensor.
   b. Install the gear shift position sensor using the bolt.

Tighten:
9 N·m (0.9 kg·m / 6.6 lb·ft)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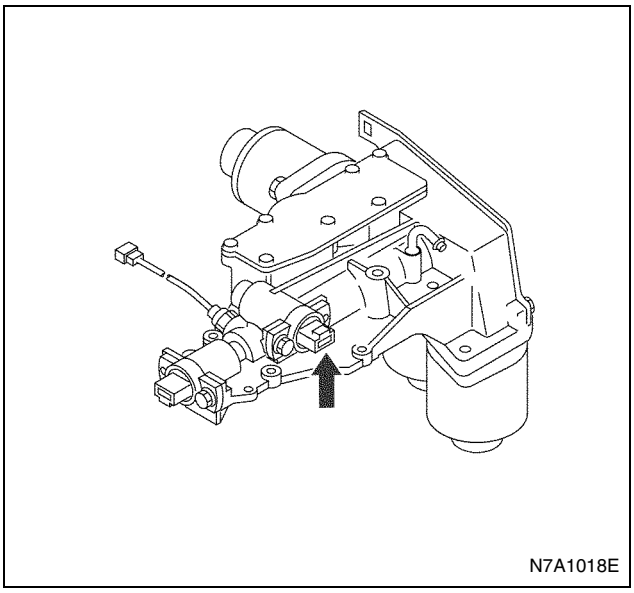
Gear Select Position Sensor

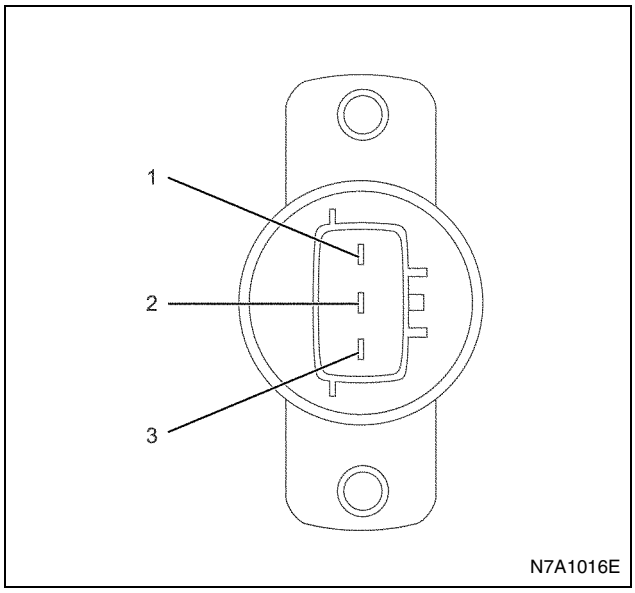
Removal

1. Connector
2. Remove the gear select position sensor.



Inspection

Connect the gear select position sensor terminal 3 (SEL.VCC) to 5 V and terminal 1 (SEL.GND) to ground. Record the voltage between terminals 2 (SEL.SIG) and 1 (SEL.GND) while rotating the sensor arm.
Replace if the voltage does not vary from approximate 0.1 to 4.8 V.



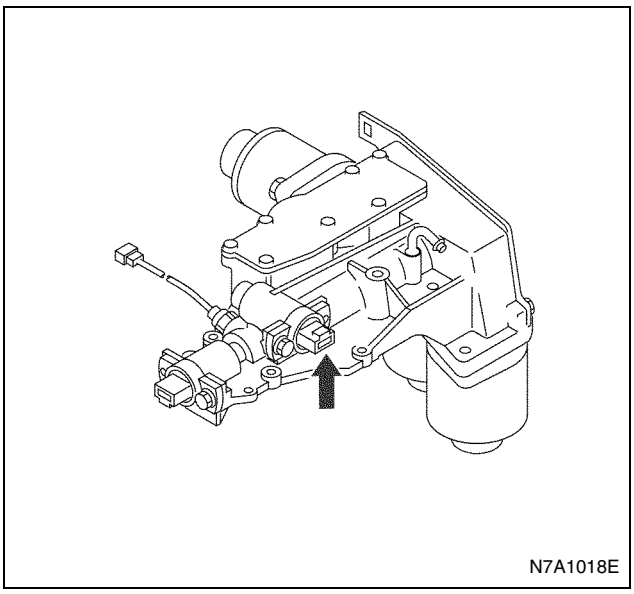
Legend

1. Gear Select Position Sensor Terminal 1 (SEL.GND)
2. Gear Select Position Sensor Terminal 2 (SEL.SIG)
3. Gear Select Position Sensor Terminal 3 (SEL.VCC)

Installation

1. Confirm there is an O-ring on the case side, apply Besco chassis grease to the sliding portion of the sensor shaft tip and install.
2. Install the gear select position sensor.
   a. Aligning the angle of the sensor arm tip with the connector part groove, carefully insert the gear select position sensor.
   b. Install the gear select position sensor using the bolt.

Tighten:
9 N·m (0.9 kg·m / 6.6 lb·ft)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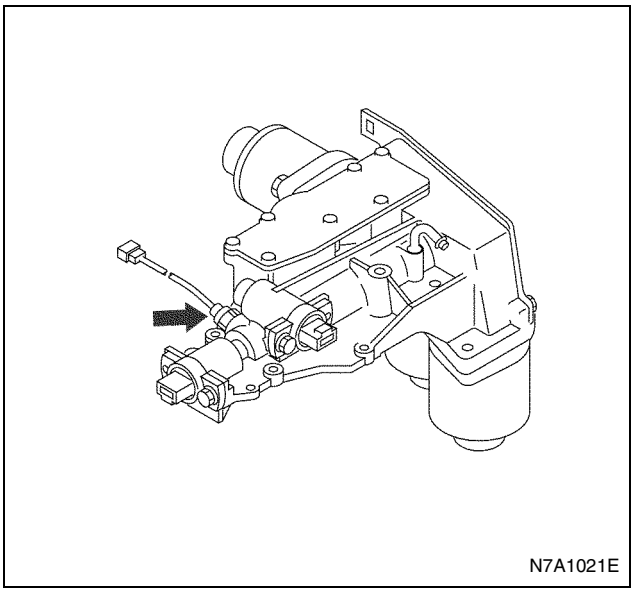
Neutral Switch

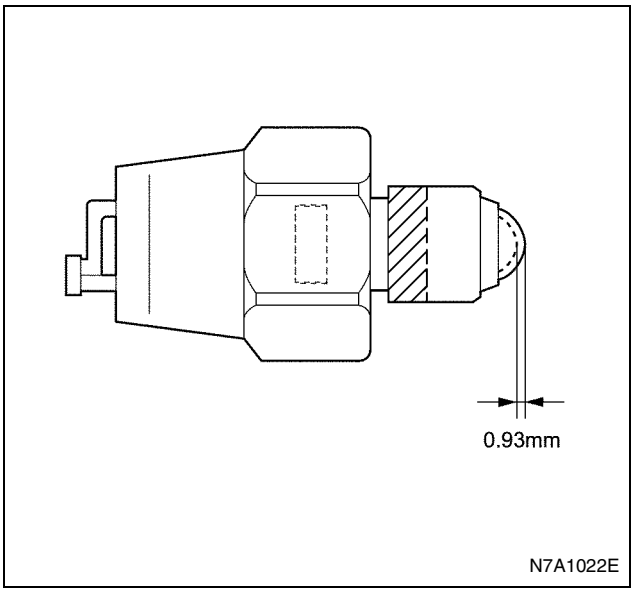
Removal

1. Connector
2. Neutral switch



Inspection

- Replace if the harness, the connector or the seal is damaged.
- Normal operation is indicated if there is continuity between switch terminals when measured as-is, and if there is no continuity between the terminals when the ball is pressed.
- The switch operation stroke is 0.93 mm.



Installation

1. Neutral switch
   - Apply Loctite 242 (or equivalent) to the threads of the switch and install.

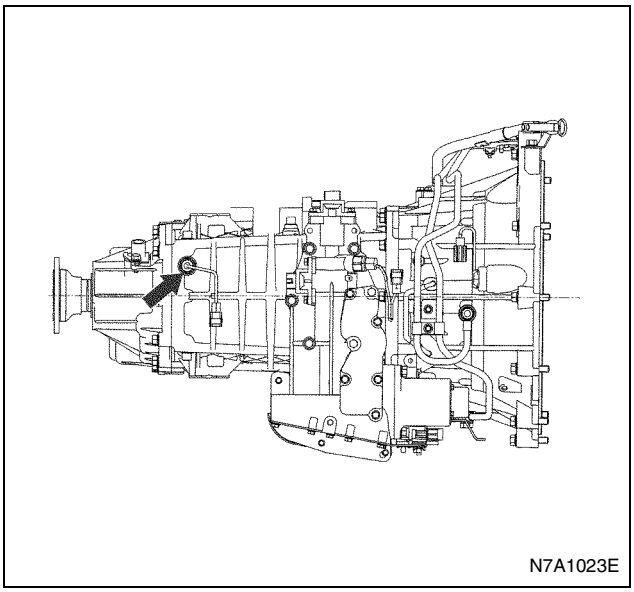
Tighten:
34 N·m (3.5 kg·m / 25.1 lb·ft)

2. Connector

Reverse Switch

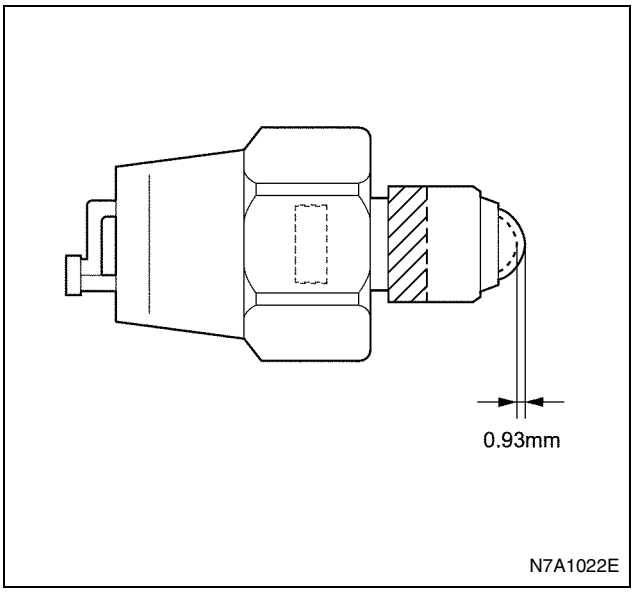
Removal

1. Connector
2. Reverse switch



Inspection

- Replace if the harness, the connector or the seal is damaged.
- Normal operation is indicated if there is continuity between switch terminals when measured as-is, and if there is no continuity between the terminals when the ball is pressed.
- The switch operation stroke is 0.93mm.



Installation

1. Reverse switch
   - Apply Loctite 242 (or equivalent) to the threads of the switch and install.

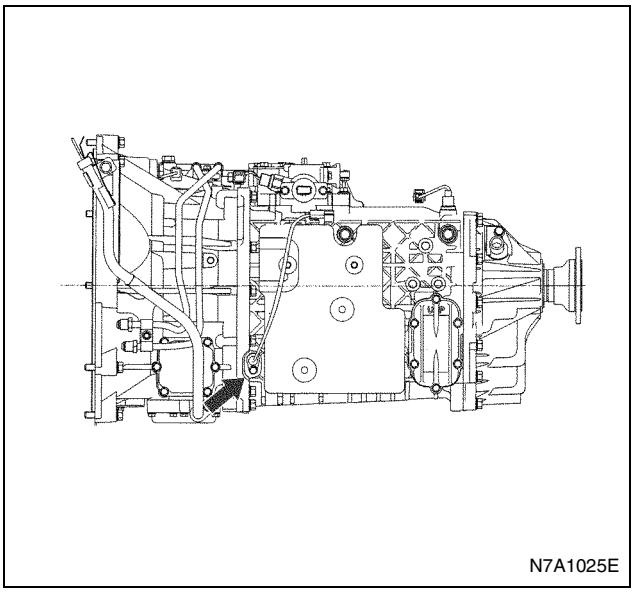
Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

2. Connector

Input Shaft Speed Sensor

Removal

1. Connector
2. Input shaft speed sensor



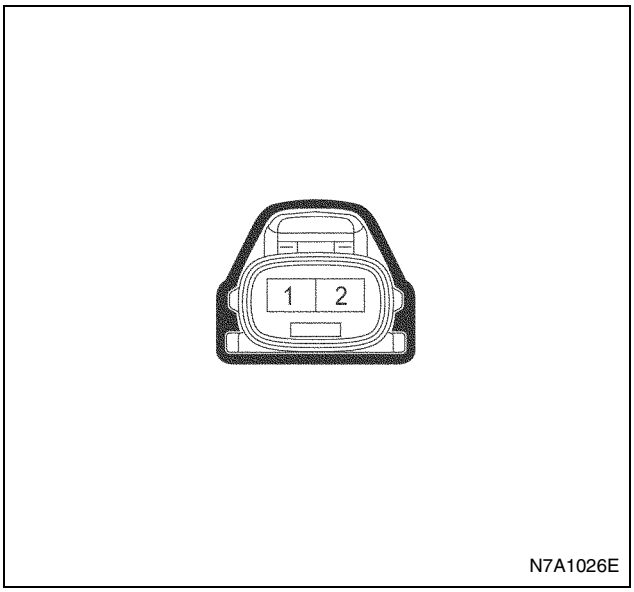
N7A1025E

Tighten:
9 N·m (0.9 kg·m / 6.6 lb·ft)

2. Connector

Inspection

- Replace if the harness, the connector or the seal is damaged.
- Measure the resistance between terminals. Replace if the resistance between 1 — 2 is not within 1.5 to 2.1 kΩ.



N7A1026E

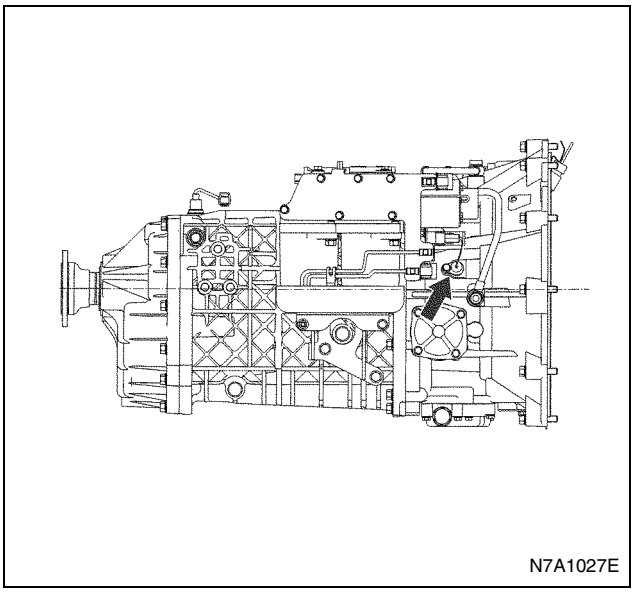
Installation

1. Input shaft speed sensor
   - Apply 5W-30 engine oil to the sensor O-ring, and install.

Turbine Speed Sensor

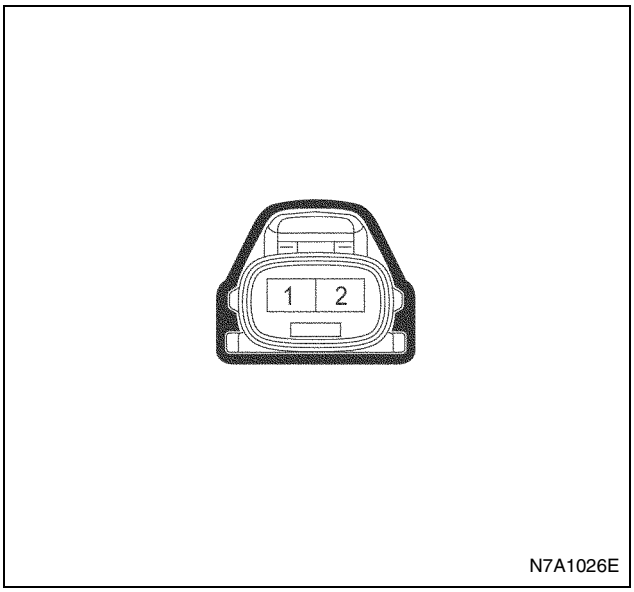
Removal

1. Connector
2. Turbine speed sensor



Inspection

- Replace if the harness, the connector or the seal is damaged.
- Measure the resistance between terminals. Replace if the resistance between 1 — 2 is not within 1.5 to 2.1 kΩ.



Installation

1. Turbine speed sensor
   - Apply oil (Besco ATF III) to the O-ring and clutch housing hole, and install.

Tighten:
9 N·m (0.9 kg·m / 6.6 lb·ft)

2. Connector

Transmission Fluid Cooler Circuit

Removal

1. Remove the Smoother oil pan drain plug and O-ring.
   - Drain the oil (Transmission fluid). When draining the oil, check the oil amount, and check for metal bits and foreign matter.
2. Disconnect the transmission fluid cooler pipe connection.
3. Remove the transmission fluid cooler pipe from the clutch housing.
4. Remove the clip, and remove the transmission fluid cooler pump.

Installation

1. Install the transmission fluid cooler pipe in the clutch housing.

Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

Caution:
Use a new gasket.

2. Connect the transmission fluid cooler pipe.

Tighten:
44 N·m (4.5 kg·m / 32.5 lb·ft)

3. Install the clip on the transmission fluid cooler pipe.

Tighten:
20 N·m (2.0 kg·m / 14.8 lb·ft)

4. Install the Smoother oil pan drain plug and O-ring.

Tighten:
40 N·m (4.1 kg·m / 29.5 lb·ft)

5. Supply transmission fluid (Besco ATF III) from the oil filler tube to the Smoother.

Flushing The Transmission Fluid Cooler Circuit

Inspection

In order to prevent trouble following Smoother repair, flushing of the cooler circuit is required when any of the following conditions exist.

- When a large volume of debris comes out of the cooler circuit
- When abnormal wear is discovered while disassembling the Smoother
- When abnormal wear is discovered in the clutch facing or when impurities are discovered in the oil

Procedure

1. Disconnect the transmission fluid cooler pipe from the clutch housing and oil cooler.
2. Use cleaning solvent and pressurized air to clean the oil cooler and pipes.

Caution:
The maximum air pressure should be 197kPa {2kg/ cm^2}.

3. After using the air to dry the cleaning solvent in the oil cooler and pipes, clean with transmission fluid.
4. Connect the cooler circuit, and then fill with transmission fluid.

Tighten:
44 N·m (4.5 kg·m / 32.5 lb·ft)

5. Start the engine and check for transmission fluid leaks from the cooler circuit.
6. Check the transmission fluid level and replenish if it is low.

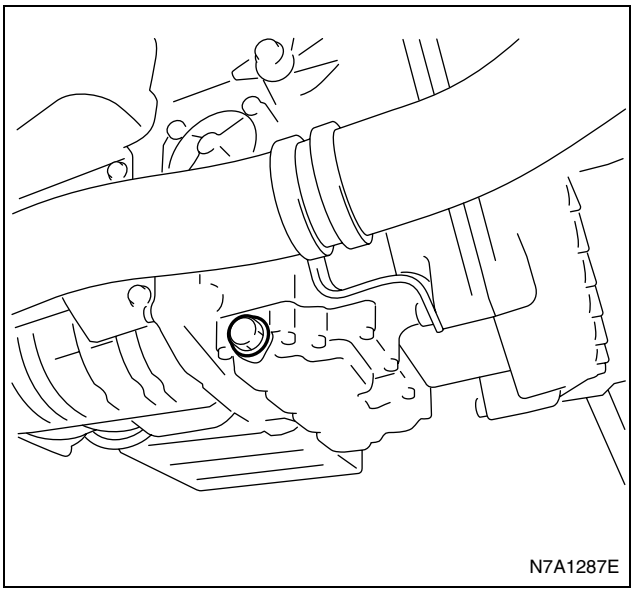
Smoother Transmission Assembly

Removal

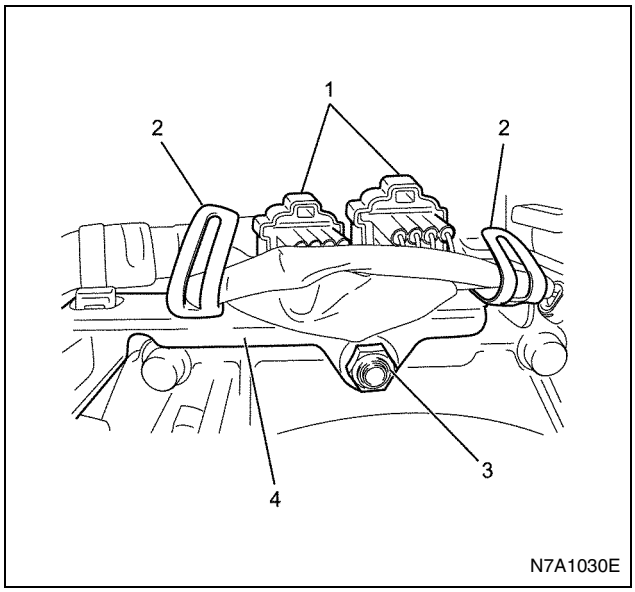
The transmission case and clutch housing are made of aluminum, to be sure to exercise sufficient care to ensure they are not damaged. A particularly high level of care is required to protect against rib damage, which can affect the strength of the case.
Also take care to avoid personal injury when working with cases and other heavy items.

- Chock the tires.
- Tilt the cab.
- Disconnect the battery (–) cable.
- Use a lifter to raise the vehicle.

1. Remove the transmission side cover and bracket.
2. Remove the Smoother oil pan drain plug and O-ring (if disassembling).
   - Drain the oil (transmission fluid). When draining the oil, check the oil amount, and check for metal bits and foreign matter.



3. Remove the transmission filler plug and O-ring (if disassembling).
4. Remove the transmission drain plug and O-ring (if disassembling).
   - Drain the transmission oil. When draining the oil, check the oil amount, and check for metal bits and foreign matter.
5. Remove the propeller shaft guard.
6. Disconnect the rear propeller shaft at the transmission, and fasten it at a point where it will not interfere with work.
   - Refer to “Rear Drive Propeller Shaft.”
7. Remove the parking brake cable.
   - Refer to “Parking Brake.”
8. Disconnect the two starter harness connectors.
9. Remove the starter ground cable.
10. Remove the upper oil filler tube.
11. Remove the starter motor assembly.
12. Disconnect the speed sensor connector.
13. Disconnect the two transmissions harness connectors from the frame harness.
    a. Remove the connector bracket nut, and remove the two transmission harness connectors from the connector bracket.
    b. Remove the two connector bracket frame harness clips and the one transmission harness clip.
    c. Disconnect the two transmissions harness connectors from the frame harness.

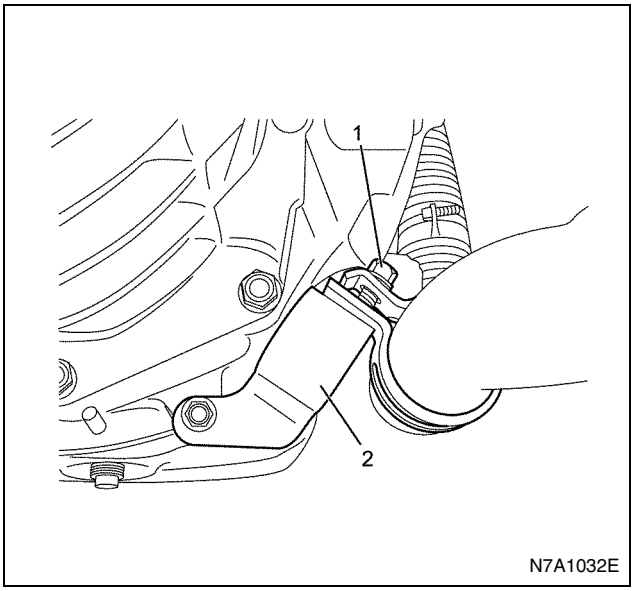


Legend

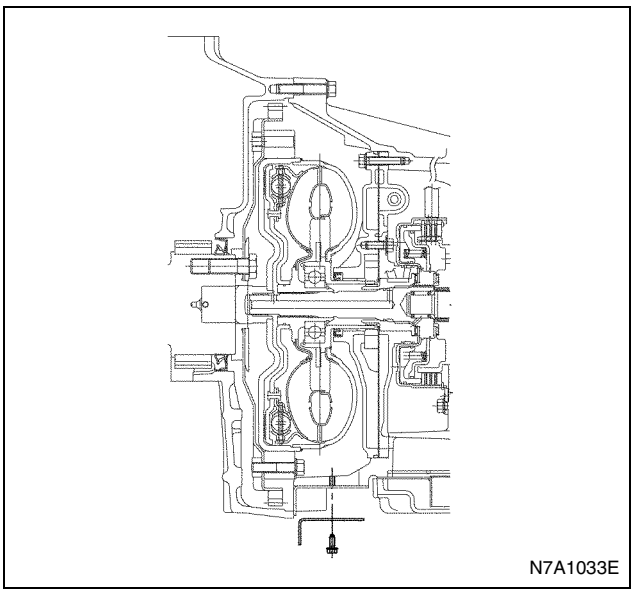
1. Transmission Harness Connector
2. Frame Harness Clips
3. Connector Bracket Nut
4. Connector Bracket

14. Remove the connector bracket.
    a. Remove the reverse switch connector from the connector bracket.
    b. Remove the frame harness clip from the connector bracket, and remove the connector bracket from the transmission.
15. Remove the battery cable clip, and disconnect the neutral switch connector.

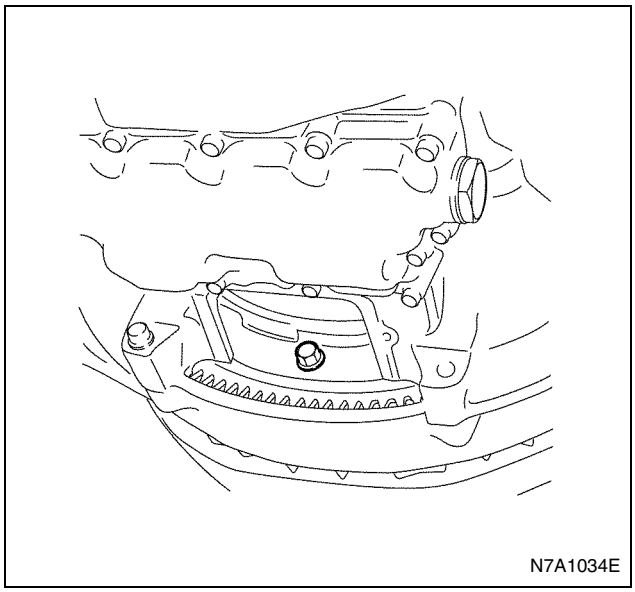
16. Remove the parking brake cable clip from the gearshift control box.
17. Remove the exhaust pipe clamp bolt (1) from the exhaust pipe bracket (2).
18. Remove the exhaust pipe bracket (2) from the clutch housing.



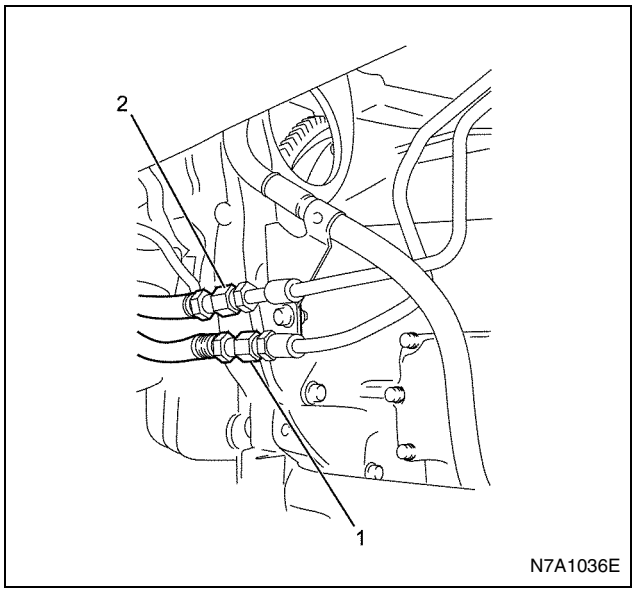
19. Remove the under cover of the work hole for the fluid coupling tightening bolt, which is located in the lower portion of the clutch housing.



20. From the hole under clutch housing rotate the flywheel as you remove the six bolts that links the flexible plate with fluid couplings.

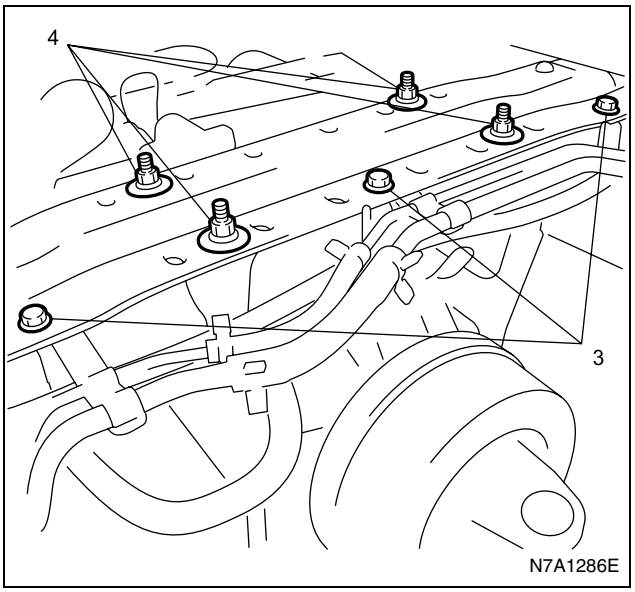


21. Disconnect the outlet (1) and inlet (2) transmission fluid cooler hose.



22. Set a transmission jack in place, and use a chain or some other means to secure the transmission.
23. Remove the three fuel pipe brackets (3) from the top of the cross member.

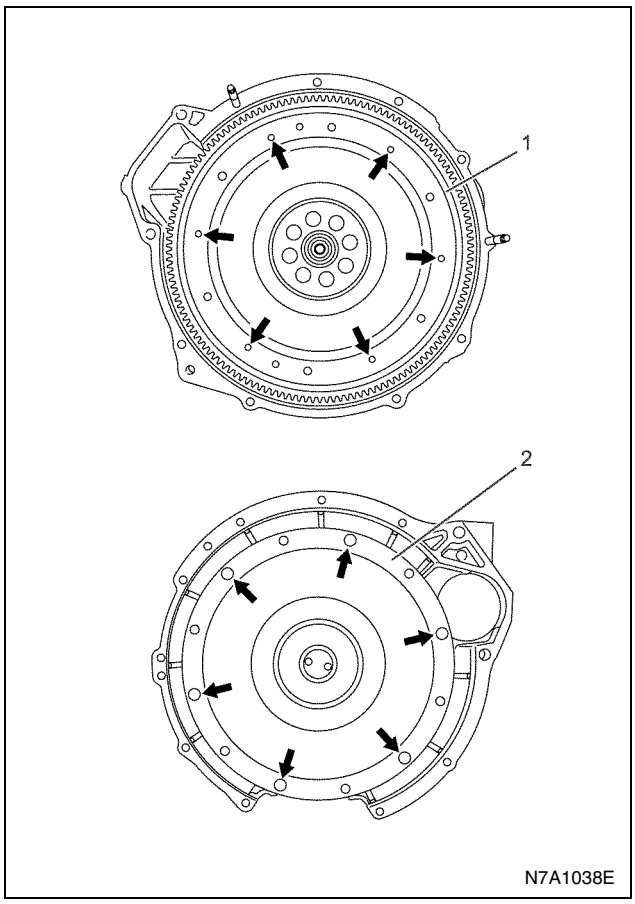
24. Remove the installation nuts (4) between the transmission mounting and the cross member.



25. Set an engine jack in place and support the engine.
26. Remove the bolt that links the transmission and engine.
27. Taking care that the fluid coupling does not fall out, pull out the Smoother transmission assembly.

Installation

1. After applying a light coating of grease around the entire circumference of the fluid coupling pilot hub, carefully operate the transmission jack to link the engine and the Smoother transmission assembly. At this time, match the phase of the engine's flexible plate (1) knock pin and the fluid coupling (2) groove.



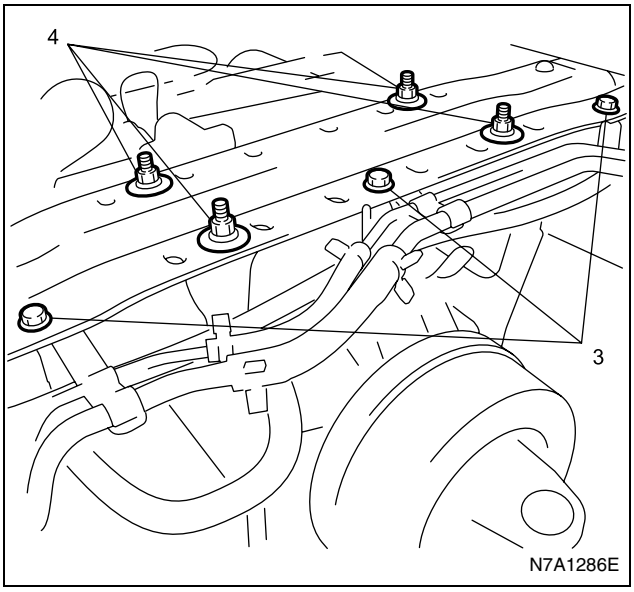
2. Tighten the engine and transmission installation bolts to their specified torque.

Tighten:
40 N·m (4.1 kg·m / 29.5 lb·ft)

3. Install the installation nuts (4) between the transmission mounting to the cross member.

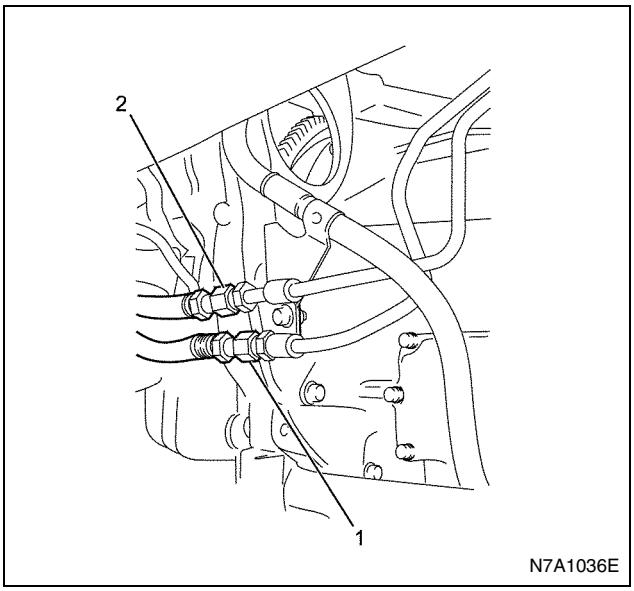
Tighten:
40 N·m (4.1 kg·m / 29.5 lb·ft)

4. Install the three fuel pipe brackets (3) on the top of the cross member to cross member.
   - Remove the transmission jack and engine jack.



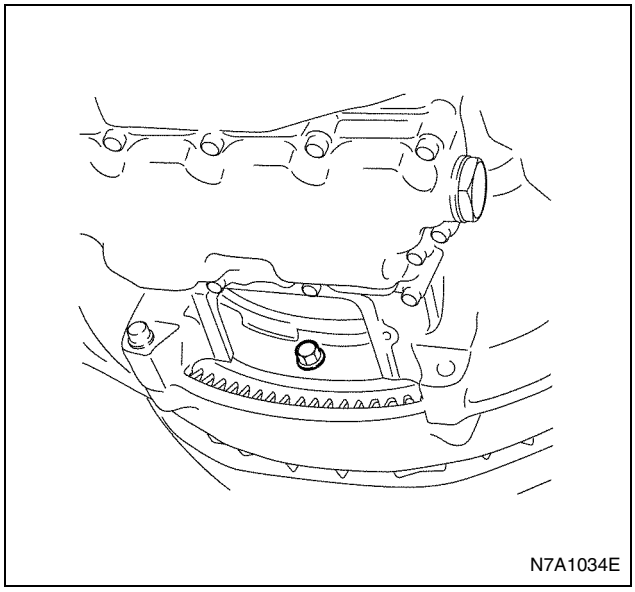
5. Connect the outlet (1) and inlet (2) transmission fluid cooler hose.

Tighten:
44 N·m (4.5 kg·m / 32.5 lb·ft)



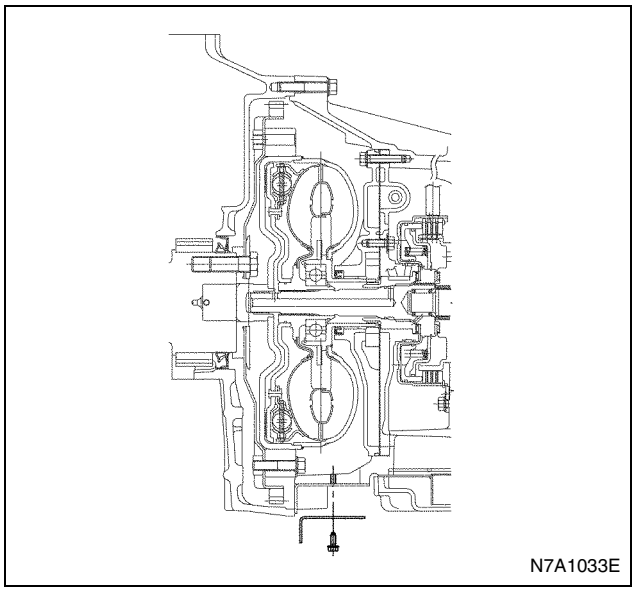
6. After temporarily assembling the six flexible plate and fluid coupling installation bolts, tighten them to their specified torque.

Tighten:
40 N·m (4.1 kg·m / 29.5 lb·ft)



7. Install the under cover of the work hole for the flexible coupling link bolt.

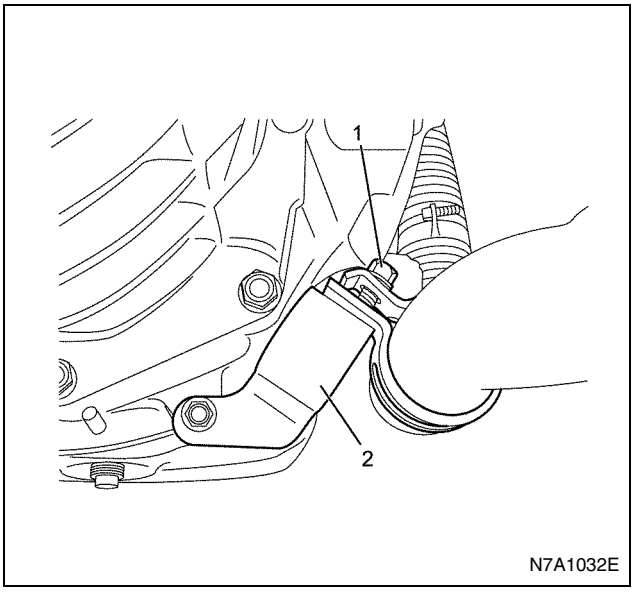
Tighten:
8 N·m (0.8 kg·m / 5.9 lb·ft)



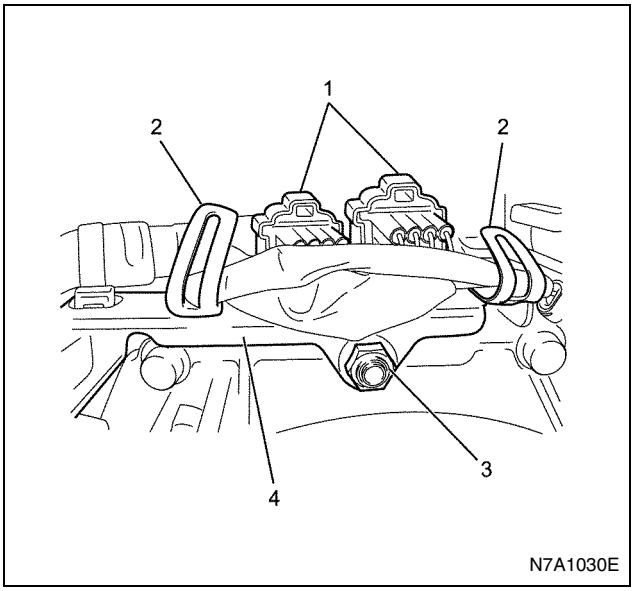
8. Install the exhaust pipe bracket (2) on the clutch housing.

Tighten:
46 N·m (4.7 kg·m / 33.9 lb·ft)

9. Install the exhaust pipe clamp bolt (1) on the exhaust pipe bracket.



10. Install the parking brake cable clip on the gearshift control box.
11. Connect the neutral switch connector, and install the battery cable clip.
12. Install the connector bracket.
    a. Install the frame harness clip on the connector bracket, and install the connector bracket on the transmission.
    b. Install the reverse switch connector on the connector bracket.
13. Connect the two transmission harness connectors to the frame harness.
    a. Connect the two transmission harness connectors to the frame harness.
    b. Install one transmission harness clip and two frame harness clips on the connector bracket.
    c. Install the transmission harness connectors at two points on the connector bracket, and install the connector bracket nut.



Legend

1. Transmission Harness Connector
2. Frame Harness Clips
3. Connector Bracket Nut
4. Connector Bracket

14. Connect the speed sensor connector.
15. Install the starter motor assembly.

Tighten:
76 N·m (7.7 kg·m / 56.1 lb·ft)

16. Install the upper oil filler tube. (Use a new O-ring.)

Tighten:
41 N·m (4.2 kg·m / 30.2 lb·ft)

17. Install the starter ground cable.

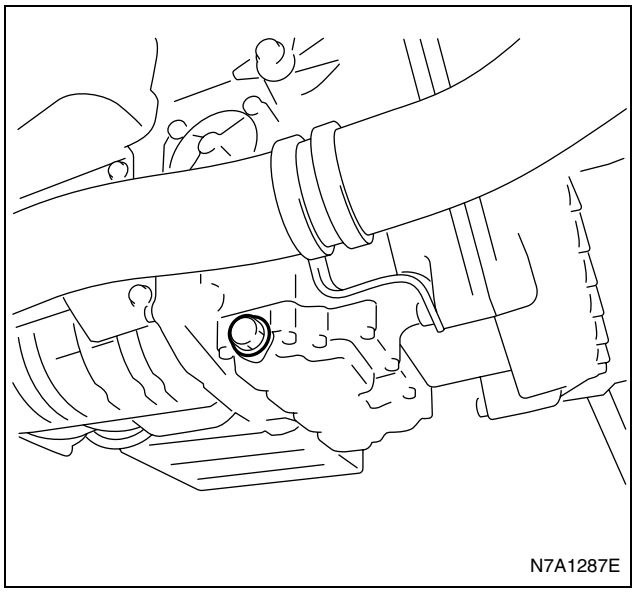
Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

18. Install the two starter harnesses.
19. Install the parking brake cable.
    - Refer to “Parking Brake.”
20. Install the rear propeller shaft.
    - Refer to “Rear Drive Propeller Shaft”.
21. Install the propeller shaft guard.
22. Apply engine oil to the O-ring, and then install the transmission drain plug and the O-ring (after disassembly).

Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

23. Apply oil (Besco ATF III) to the O-ring, and then install the Smoother oil pan drain plug and the O-ring (after disassembly).

Tighten:
40 N·m (4.1 kg·m / 29.5 lb·ft)



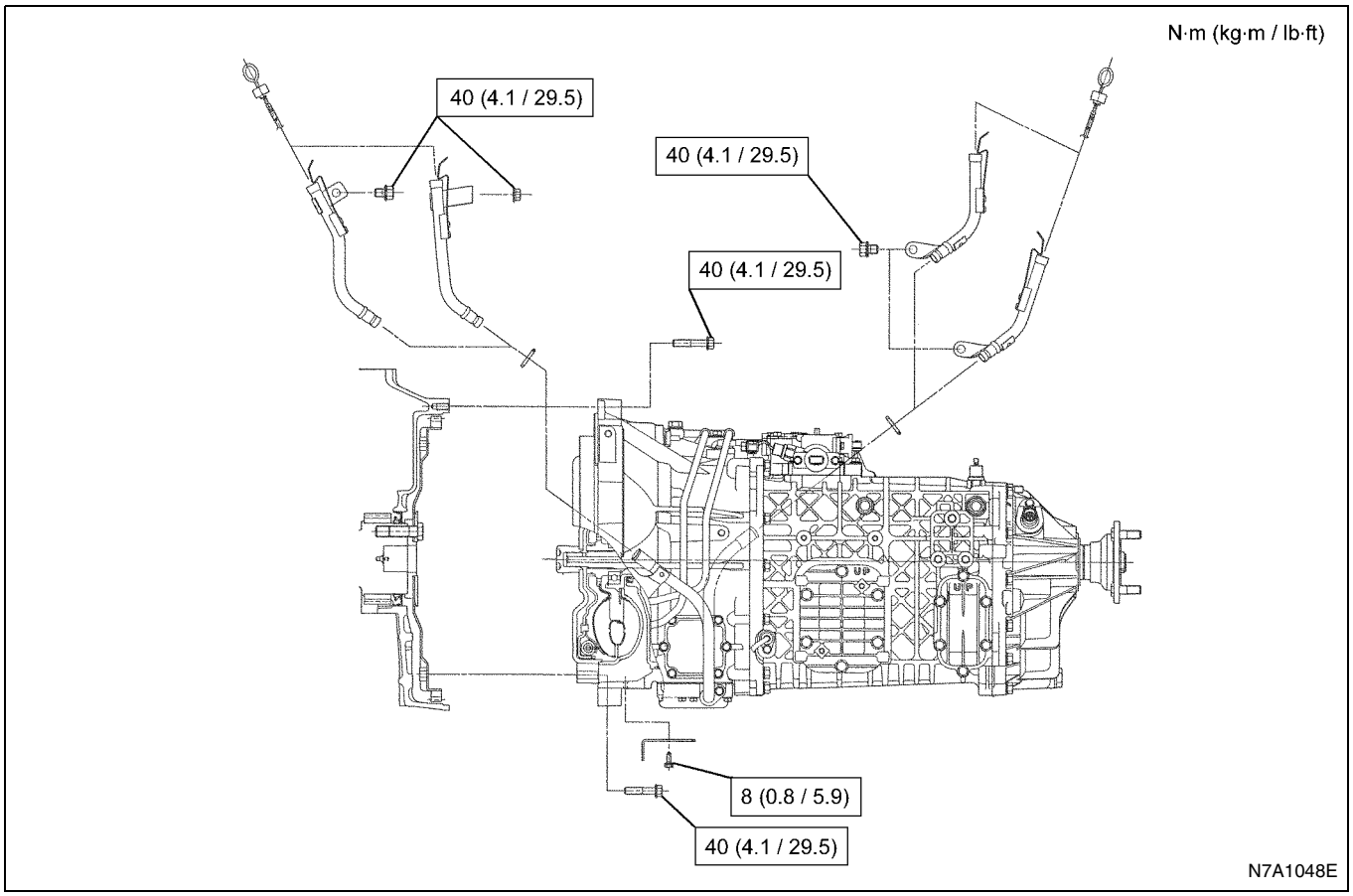
24. Supply transmission fluid (Besco ATF III) from the oil filler tube to the Smoother (after disassembly).

25. Fill transmission oil (5W-30) from the filler hole (after disassembly).
26. Apply engine oil to the O-ring, and then install the transmission filler plug and the O-ring (after disassembly).

Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

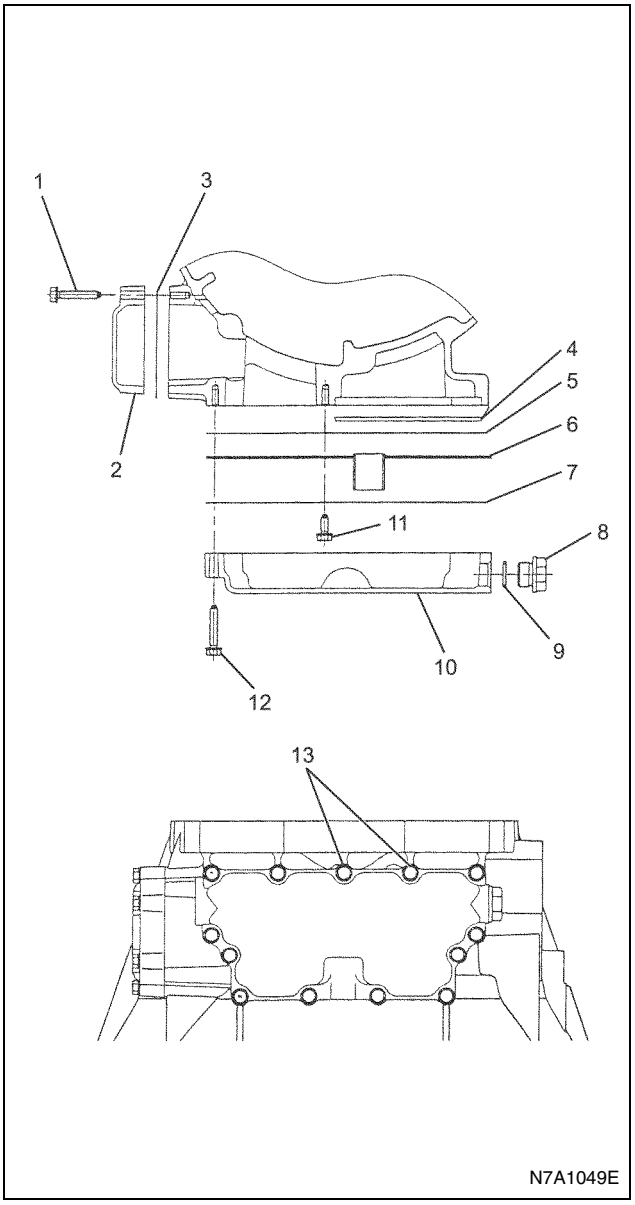
27. Install the transmission side cover and bracket.
28. Connect the battery (–) cable.
29. If you replaced switches, etc., perform gear shift position learning and half-clutch position learning.
    - For the learning procedure, refer to "Transmission Control System Smoother."
30. Start the engine and use the level gauge to check the transmission fluid level.

Tightening Torques



Oil Filter

Components



Legend

1. Bolt
2. Cover
3. Gasket
4. Oil Filter
5. Upper Gasket
6. Strainer Cover
7. Lower Gasket
8. Drain Plug
9. O-ring
10. Oil Pan
11. Bolt
12. Bolt
13. Gasket Tab

Removal

1. Remove the bolt, and then remove the filler tube and O-ring.
2. Remove the bolt and remove the cover and gascket. (Removal is not required if the filter is replaced.)
3. Remove the drain plug and remove the O-ring.
4. Remove the 13 bolts, and remove the oil pan and lower gasket.
5. Remove the one bolt, and remove the strainer cover, upper gasket, and oil filter.
6. If the filter is clogged, dirty, or otherwise abnormal, replace it.
   When re-assembling, clean and then assemble.

Installation

1. Apply oil (Besco ATF III) to the bottom of the clutch housing (except the oil pan installation surface).
2. Insert the oil filter in the clutch housing, install a new upper gasket, and then use the installation bolt to install the strainer cover.

Tighten:
10 N·m (1.0 kg·m / 7.4 lb·ft)

- Position the tab of the upper gasket as shown in the illustration, and take care that the top-bottom orientation is correct.

3. Install the oil pan with a new lower gasket, and tighten with the installation bolts. Check the tightening torque twice.

Tighten:
10 N·m (1.0 kg·m / 7.4 lb·ft)

- Position the tab of the lower gasket as shown in the illustration, and take care that the top-bottom orientation is correct.

4. Apply oil (Besco ATF III) to the O-ring, assemble the drain plug, and tighten it.

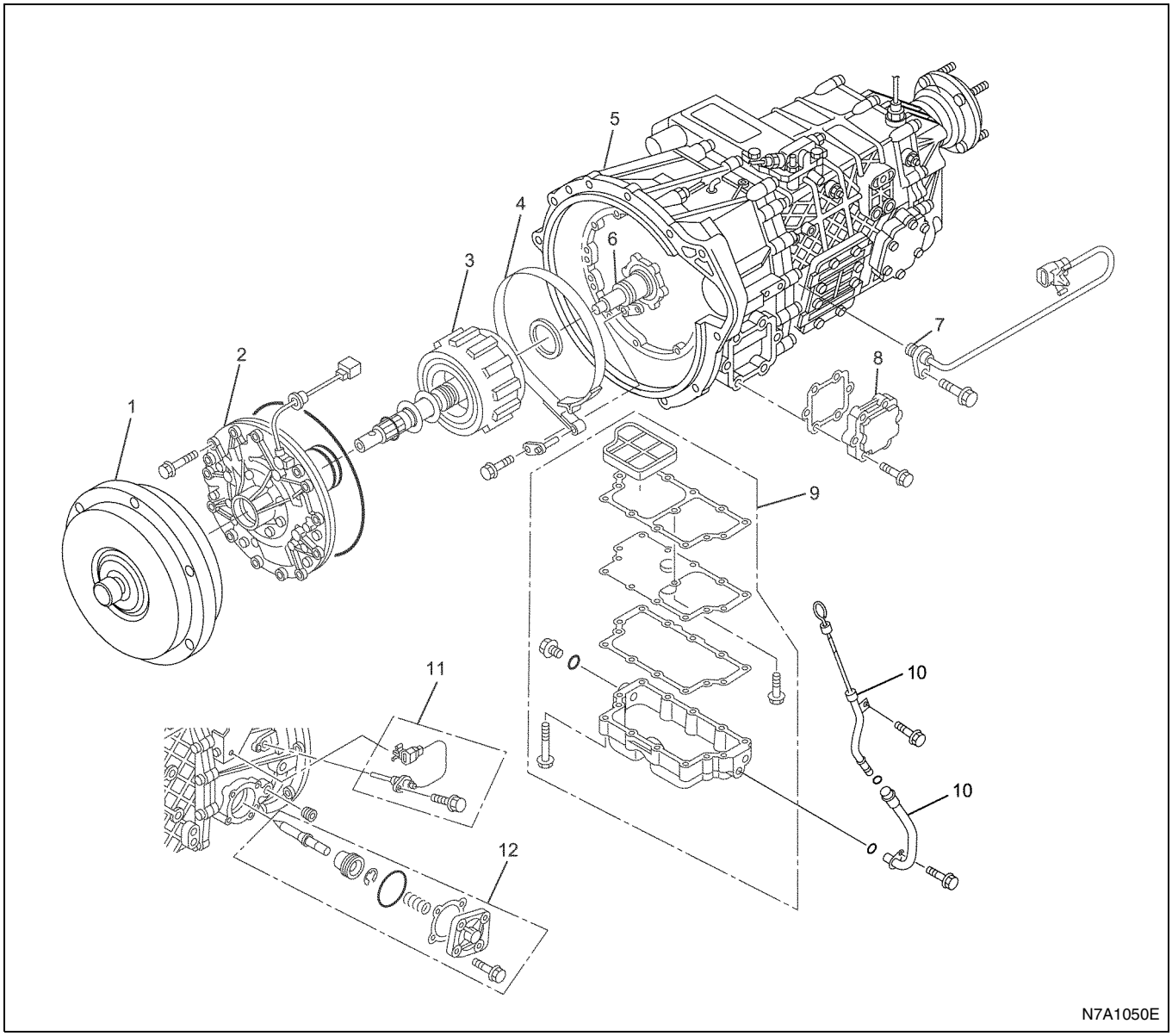
Tighten:
40 N·m (4.1 kg·m / 29.5 lb·ft)

5. Insert a new gasket, and tighten the cover with the bolt.

Tighten:
10 N·m (1.0 kg·m / 7.4 lb·ft)

Smoother

Components



Legend

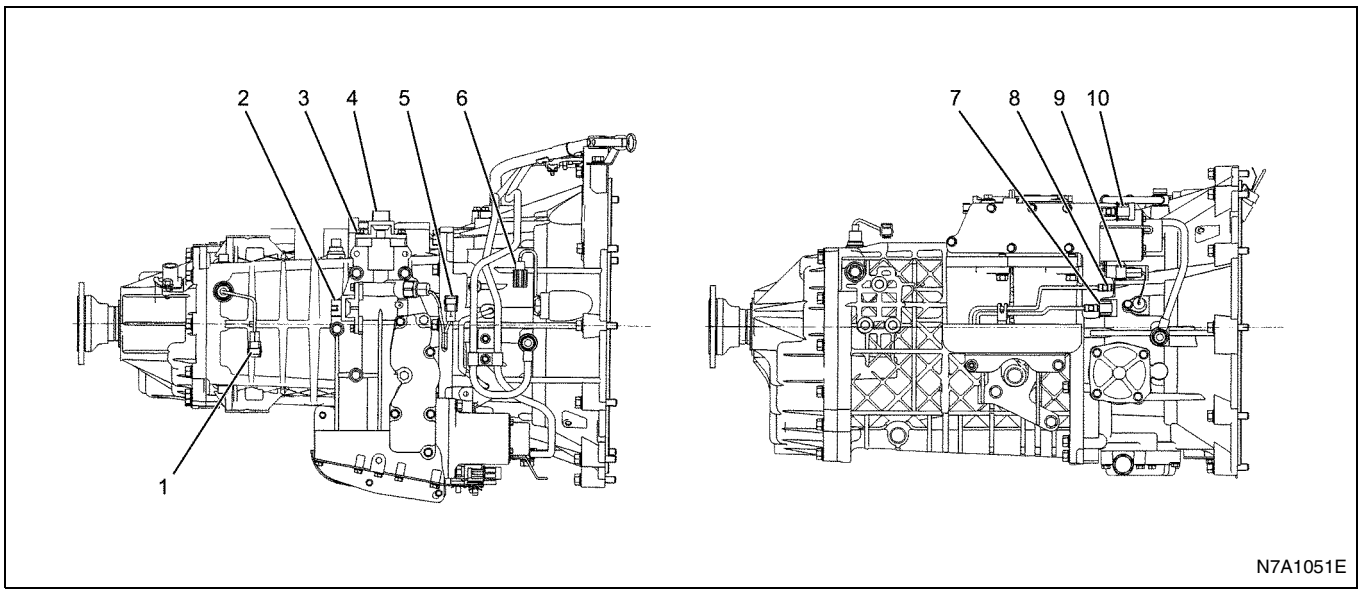
1. Fluid Coupling
2. Oil Pump Assembly
3. Clutch Assembly
4. Brake Band
5. Clutch Housing
6. Top Gear Shaft
7. Input Shaft Speed Sensor
8. Cover
9. Oil Pan Assembly
10. Oil Filler Tube Assembly
11. Turbine Speed Sensor
12. Plunger and Piston Assembly

Caution:

- The interior of the Smoother does not stand up to dust, so be sure to clean all components before assembly. In addition, never use cloth rags, knit gloves, or air tools during assembly. Do not apply any paint, etc.
- In the case of disassembly, re-assemble using new O-rings, D-rings, and seal rings.

Disassembly

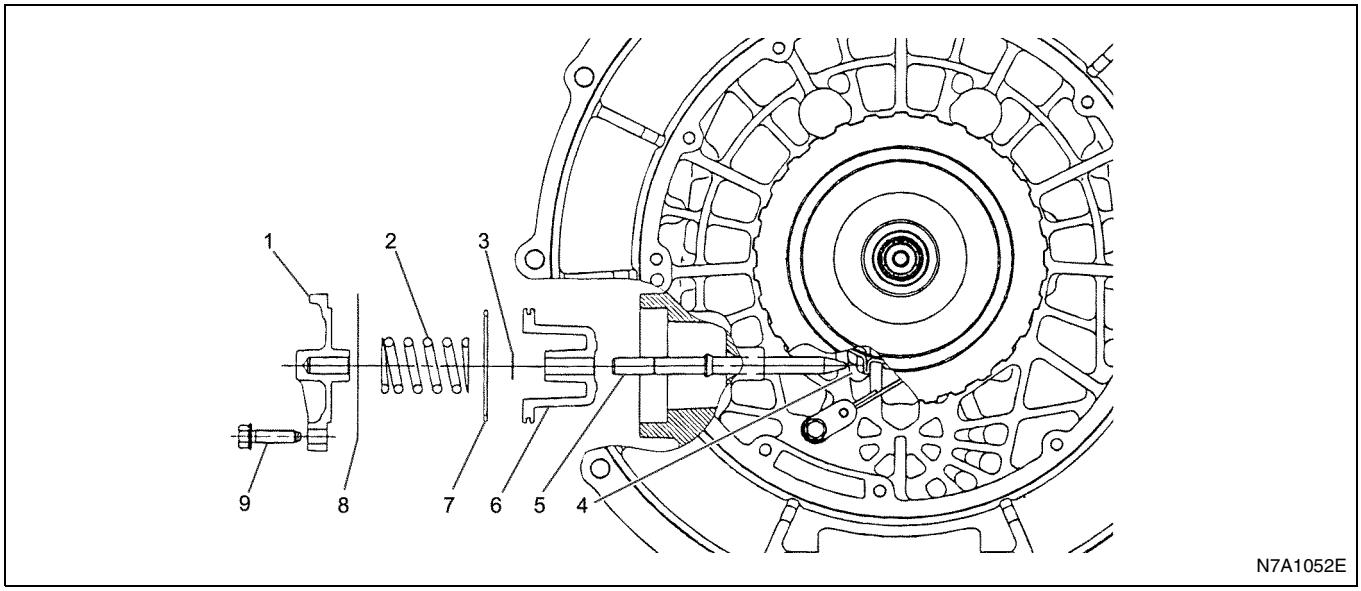
1. Remove the band clip, and disconnect the sensor connector from the transmission harness.



Legend

1. Reverse Switch
2. Gear Shift Select Sensor
3. Input Shaft Speed Sensor
4. Gear Shift Select Sensor
5. Neutral Switch
6. Solenoid & Transmission Fluid Temperature Sensor
7. 2-4-6-R Shift Solenoid
8. 1-3-5 Shift Solenoid
9. Turbine Speed Sensor
10. Select Solenoid

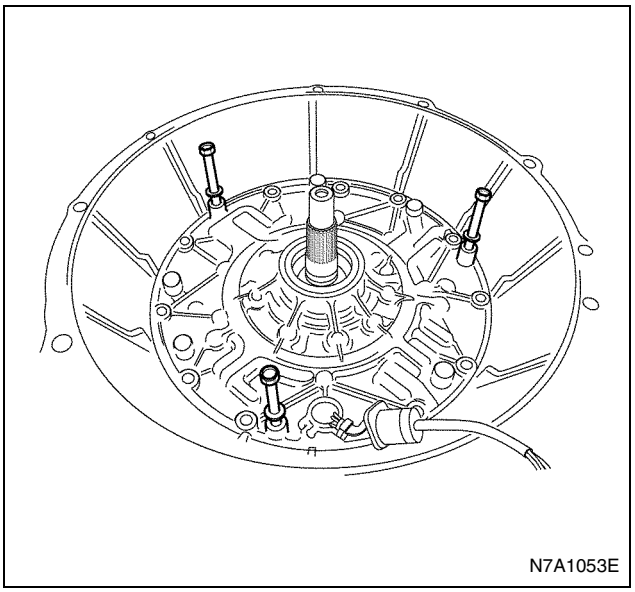
2. Drain the fluid coupling.
   - Any oil that is not drained can leak out later, so drain oil carefully.
3. To facilitate work, use a chain block, belt, or other means to secure the transmission with the front of the vehicle faced up.
4. Push in the grommet of the solenoid & transmission fluid temperature sensor harness located in the top of the clutch housing in order to put the both harness and connector inside the clutch housing.
5. Remove the bolt, and then remove the gasket, cover, spring, and piston and plunger sub assembly.
   - Tighten the four bolts equally.
6. Remove the snap ring of the piston and plunger sub assembly, and remove the piston, D-ring, and plunger.



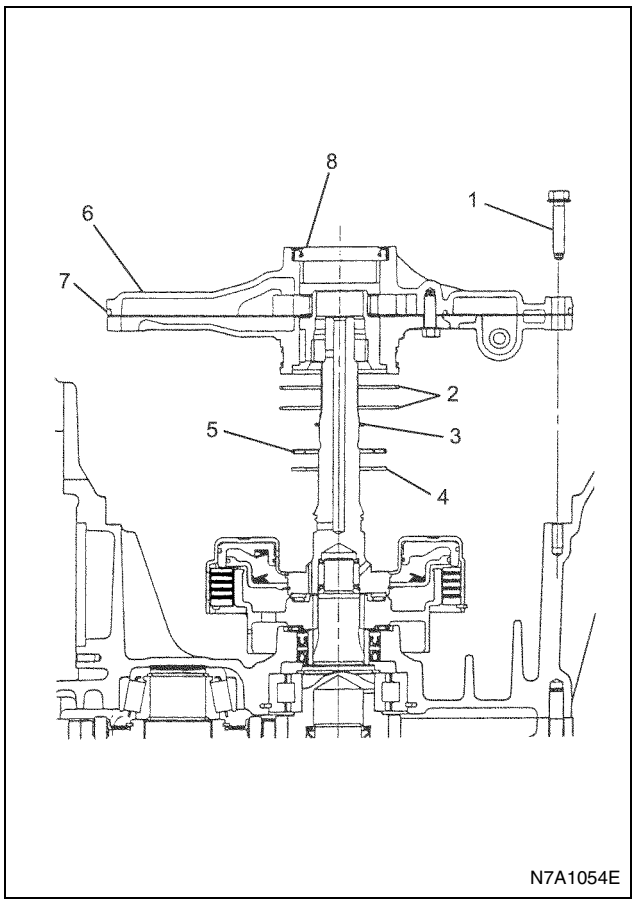
Legend

1. Cover
2. Spring
3. Snap Ring
4. Brake Band Support
5. Plunger
6. Piston
7. D-ring
8. Gasket
9. Bolt

7. Screw an M8 bolt onto the oil pump assembly work screw, and pull out the unit uniformly at three points.
   - When positioning the oil pump assembly, have the part that is towards the front of the vehicle facing downwards.



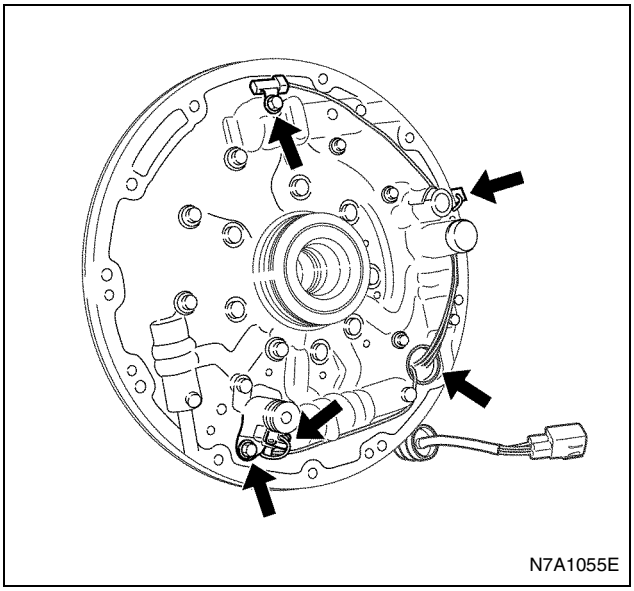
8. Remove the sealing at two points and the O-ring from the oil pump assembly.



Legend

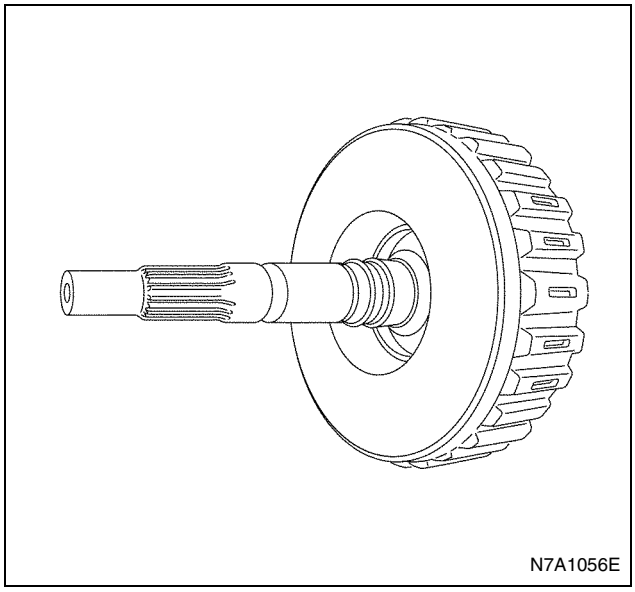
1. Bolt
2. Seal Ring
3. Seal Ring
4. Thrust Washer
5. Thrust Bearing
6. Oil Pump Assembly
7. O-ring
8. Oil Pump Oil Seal

9. Remove the thrust washer and thrust bearing. Check the thrust bearing for the following.
   - Smoothness of rotation
   - Noise
   - Damage, visible abnormality of rubber, etc.
   - Discoloration of rolling element
10. Disconnect the sealing from the clutch assembly turbine shaft
11. Remove the bolt, band clip, connector, and grommet indicated by the arrows from the oil pump assembly, and remove the solenoid and transmission fluid temperature sensor harness.

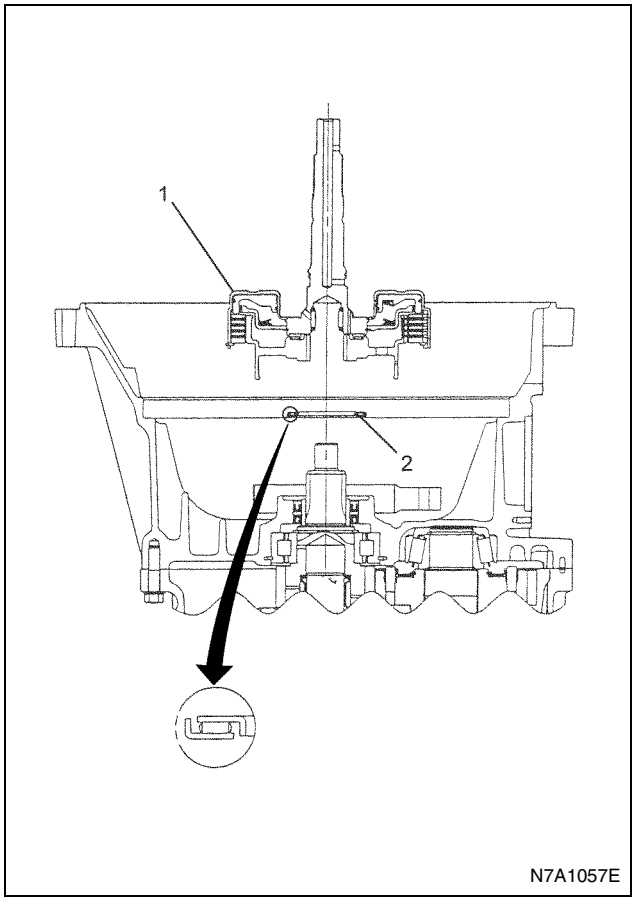


N7A1055E

12. Taking care not to damage the press-fit portion of the oil seal, remove the oil pump oil seal.
13. Remove the turbine speed sensor.
14. Remove the clutch assembly.
    - Holding the clutch hub so it is not pulled out, remove the assembly.



N7A1056E

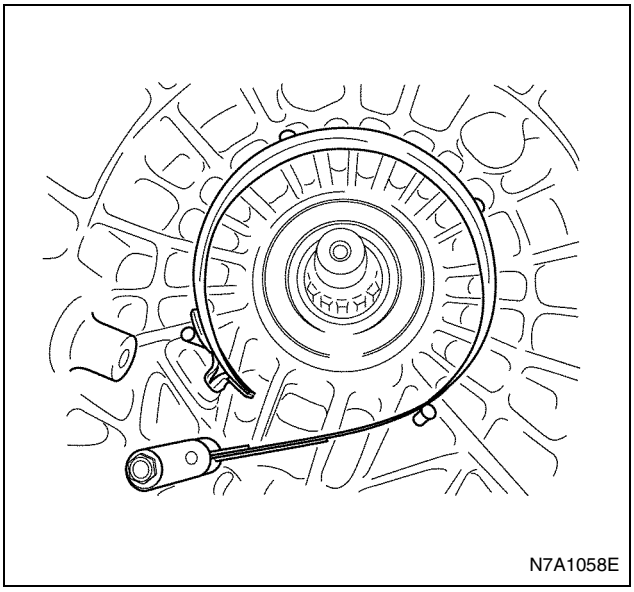


N7A1057E

Legend

1. Clutch Assembly
2. Thrust Bearing

15. Remove the bolt that holds the pin and remove the brake band.
    - If the brake band wear surface is cracked, burned, or otherwise abnormal, replace the brake band.

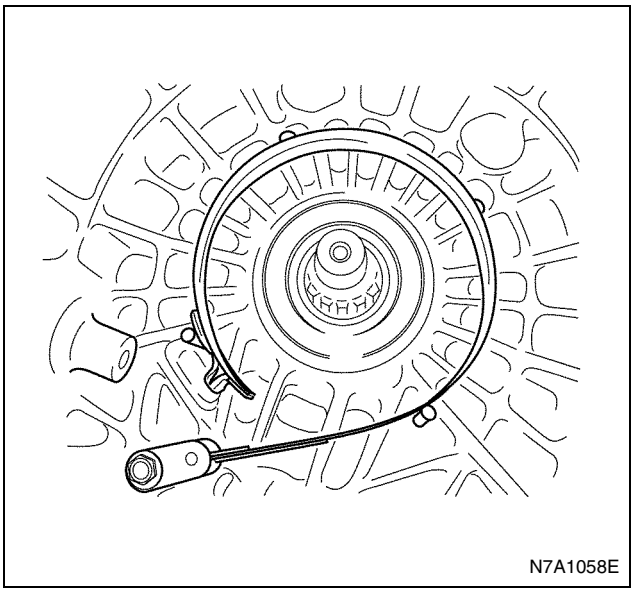

N7A1058E

16. Remove the input shaft speed sensor.

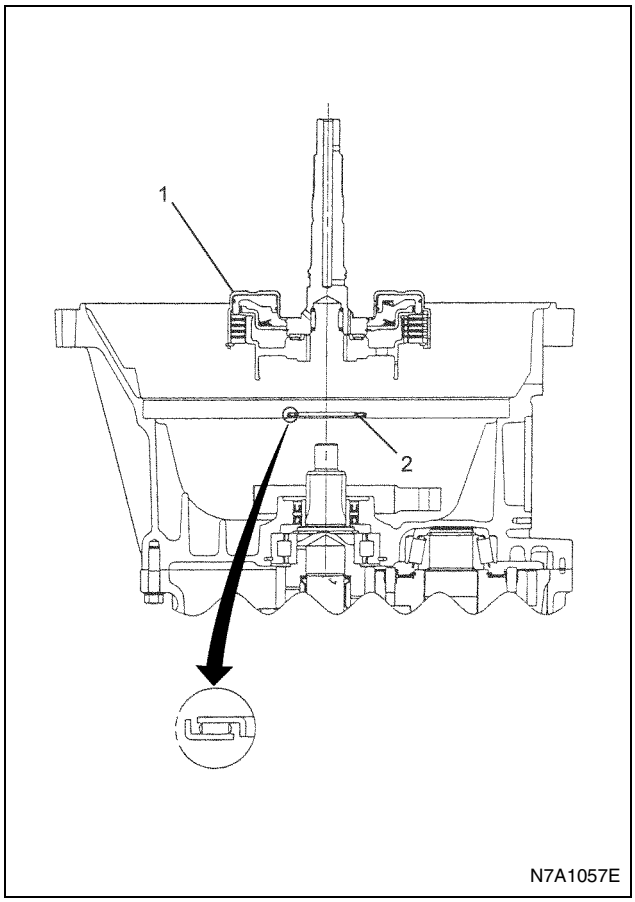
Assembly

1. Set the brake band inside of the four clutch housing pins, insert the pins into the brake band, and install the bolts.

Tighten:
23 N·m (2.3 kg·m / 17 lb·ft)


N7A1058E

2. Taking care of the assembly orientation, place the thrust bearing on the clutch housing.
   - At this time, apply oil (Besco ATF III) to the clutch housing contact surface and to the thrust bearing.
3. Apply oil (Besco ATF III) to the inner circumference of the brake band and the outer circumference of the clutch hub, and then insert the clutch assembly into the shaft so that it fits inside the brake band.
   - The drum part and the hub part of the clutch assembly can be separated, so take care that they are not separated when you assemble the clutch assembly.
   - Put the transmission in neutral, and confirm that the hub can be rotated by hand.

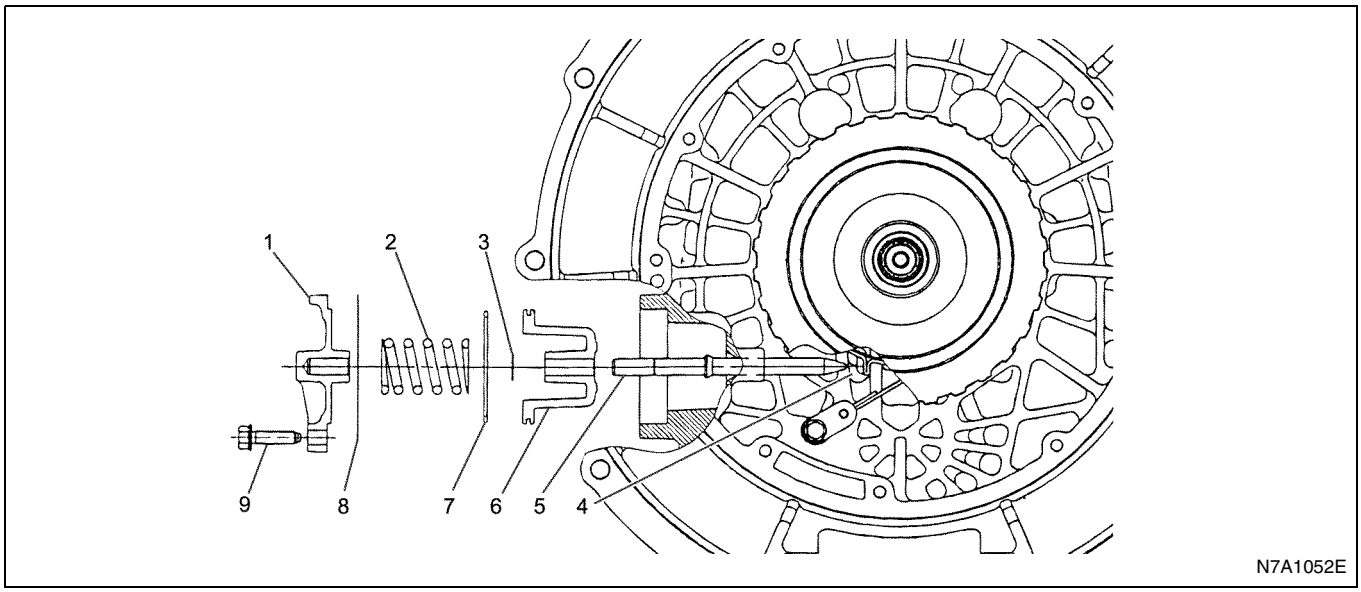


N7A1057E

Legend
1. Clutch Assembly
2. Thrust Bearing

4. Insert the plunger into the piston and secure it with the snap ring, install the D-ring, and install the piston and plunger sub assembly.

5. Apply oil (Besco ATF III) to the clutch housing hole and piston and plunger sub assembly, insert the piston and plunger sub assembly, and position the brake band so the plunger tip comes into contact with the brake band support.



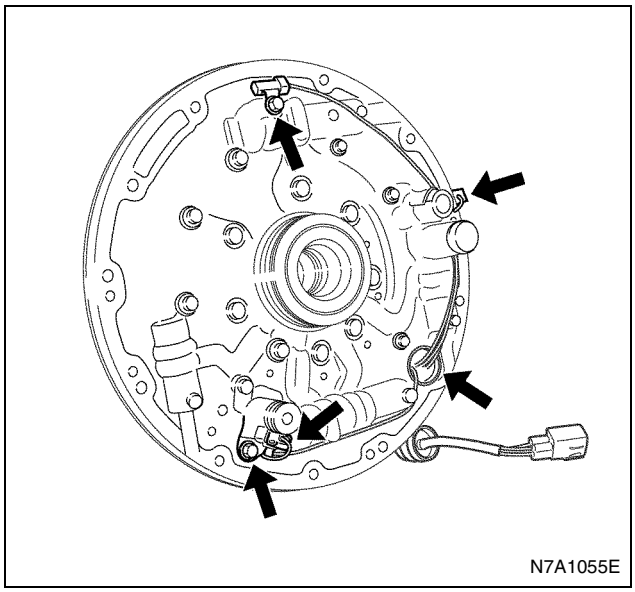
Legend

1. Cover
2. Spring
3. Snap Ring
4. Brake Band Support
5. Plunger
6. Piston
7. D-ring
8. Gasket
9. Bolt

6. Set the spring inside the piston, install a new gasket on the cover, and temporarily tighten the bolt so the spring is not compressed.
7. Apply oil (Besco ATF III) to the turbine speed sensor O-ring and clutch housing hole, and install using the bolts.

Tighten:
9 N·m (0.9 kg·m / 6.6 lb·ft)

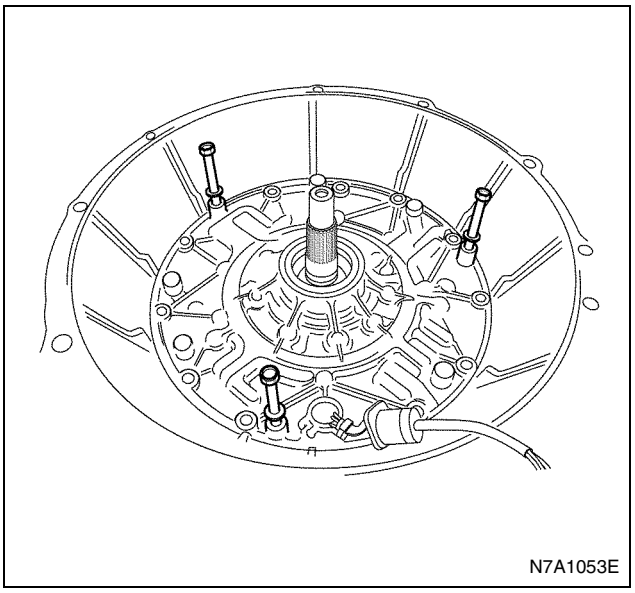
8. Apply Besco ATF III to the outer circumference of the oil seal and to the lip, and then use an installer (9-8522-1269-0) and grip (5-8840-0007-0) to press-fit the oil seal to the oil pump assembly.
9. Secure the solenoid and transmission fluid temperature sensor harness with a bolt and new band clip, and connect the solenoid connectors.
   Pass the harness grommet through the hole and install the solenoid and transmission fluid temperature sensor harness.
   - Make sure the solenoid and transmission fluid temperature sensor harness wiring is not loose, and appears as shown in the illustration below.

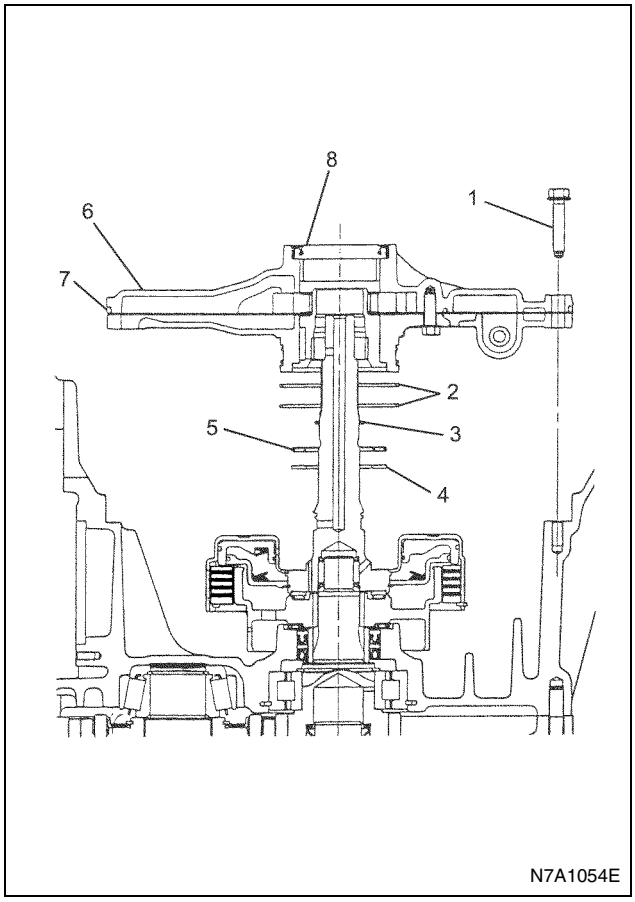


10. Apply Vaseline to the outer circumference of the shaft, open the slit in the sealing, and install the sealing.
    - Take care you do not damage the sealing by opening the slit too much. After assembly, push the slit part inside.
11. Perform the procedure in step 10 to install the oil pump assembly sealing at the other two points.

12. Apply oil (Besco ATF III) to the thrust washer and thrust bearing, install them in the clutch assembly.
    - Take care to orient the thrust bearing correctly (needle down, gauge up) when assembling it, and follow the correct sequence.
13. Apply oil (Besco ATF III) to the outer circumference of the oil pump assembly O-ring, and assemble.
14. Apply oil (Besco ATF III) to the bore of the clutch housing, insert a bolt into the work screw hole, assemble the hydraulic control unit, and tighten with the bolts.
    - Take care not to damage the O-ring when aligning the clutch housing bore with the center of the hydraulic control unit.
    - Align the phase of the oil pump assembly hole and clutch housing screw hole when assembling.
    - Take care that the solenoid and transmission fluid temperature sensor harness does not become pinched between components during assembly.

Tighten:
23 N·m (2.3 kg·m / 17 lb·ft)


N7A1053E



N7A1054E

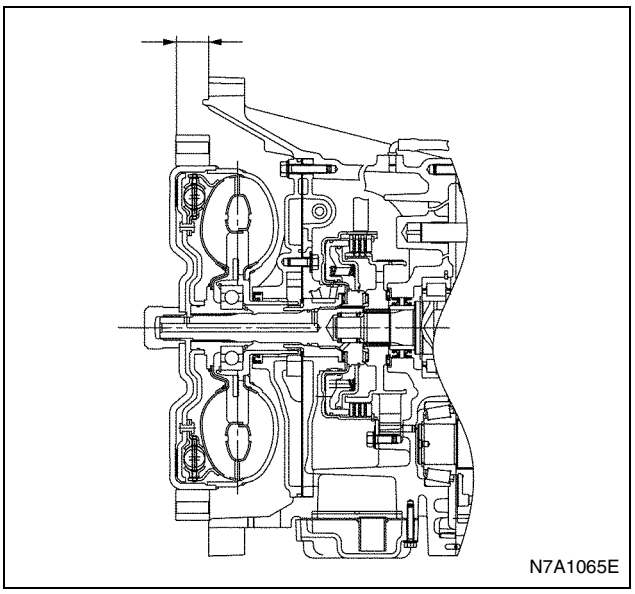
Legend
1. Bolt
2. Seal Ring
3. Seal Ring
4. Thrust Washer
5. Thrust Bearing
6. Oil Pump Assembly (Oil Control Unit)
7. O-ring
8. Oil Pump Oil Seal

15. Insert the solenoid and transmission fluid temperature sensor harness grommet into the clutch housing hole.
16. Check that the clutch assembly turbine shaft can rotate.
17. Uniformly tighten the four bolts you temporarily tightened in step 6.

Tighten:
23 N·m (2.3 kg·m / 17 lb·ft)

18. Position the Smoother so it is level and insert the fluid coupling tab so it engages wit the oil pump rotor.
    - Take care to avoid damage to the oil pump oil seal.

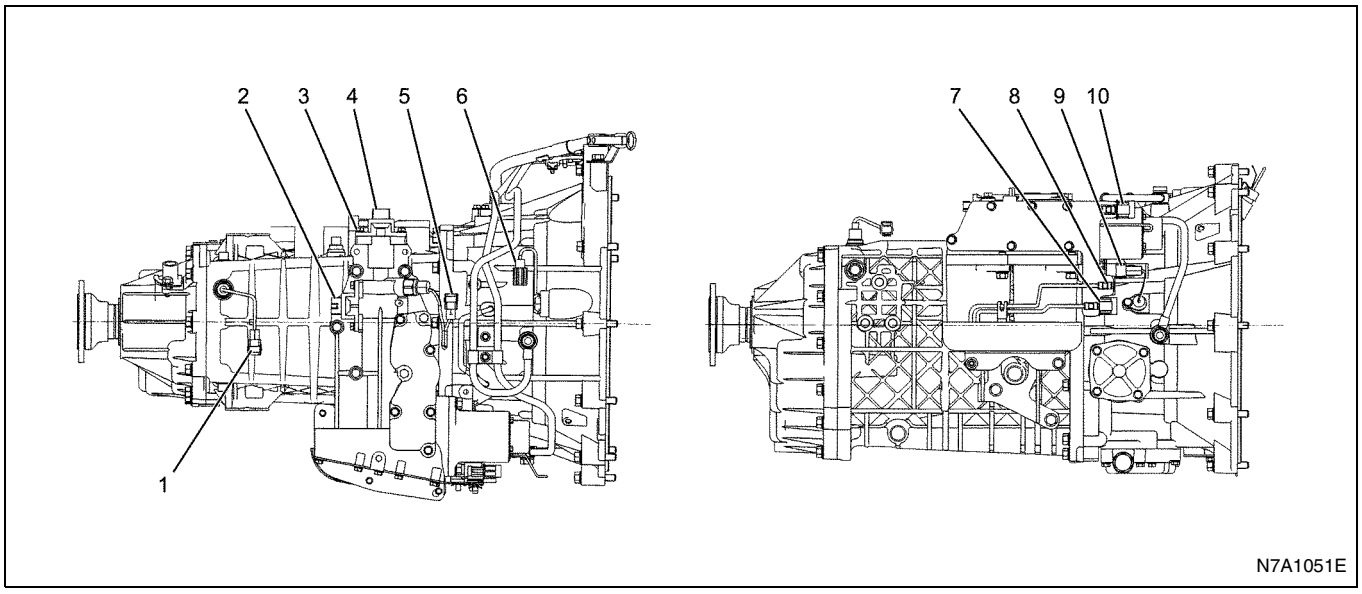
- Check to make sure that the gap between the clutch housing installation surface and the fluid coupling installation surface is no more than 31 mm.



19. Install the input shaft speed sensor.

Tighten:
9 N·m (0.9 kg·m / 6.6 lb·ft)

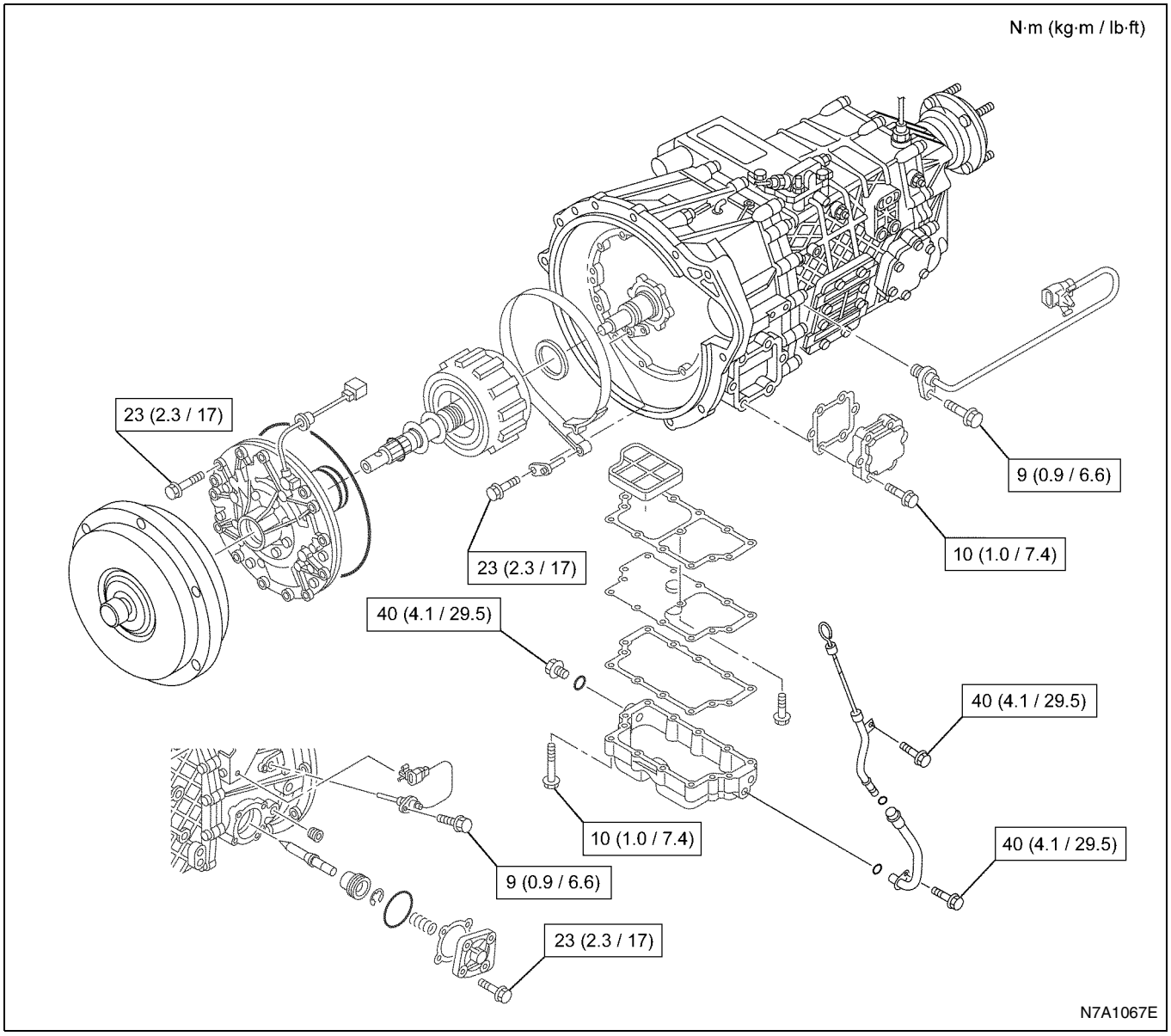
20. Connect the sensor harness connector to the transmission harness.
    - Install the band clip.



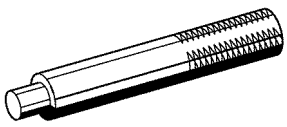
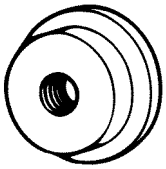
Legend

1. Reverse Switch
2. Gear Select Position Sensor
3. Input Shaft Speed Sensor
4. Gear Shift Position Sensor
5. Neutral Switch
6. Solenoid & Transmission Fluid Temperature Sensor
7. 1-3-5 Shift Solenoid
8. 2-4-6-R Shift Solenoid
9. Turbine Speed Sensor
10. Select Solenoid

Tightening Torques

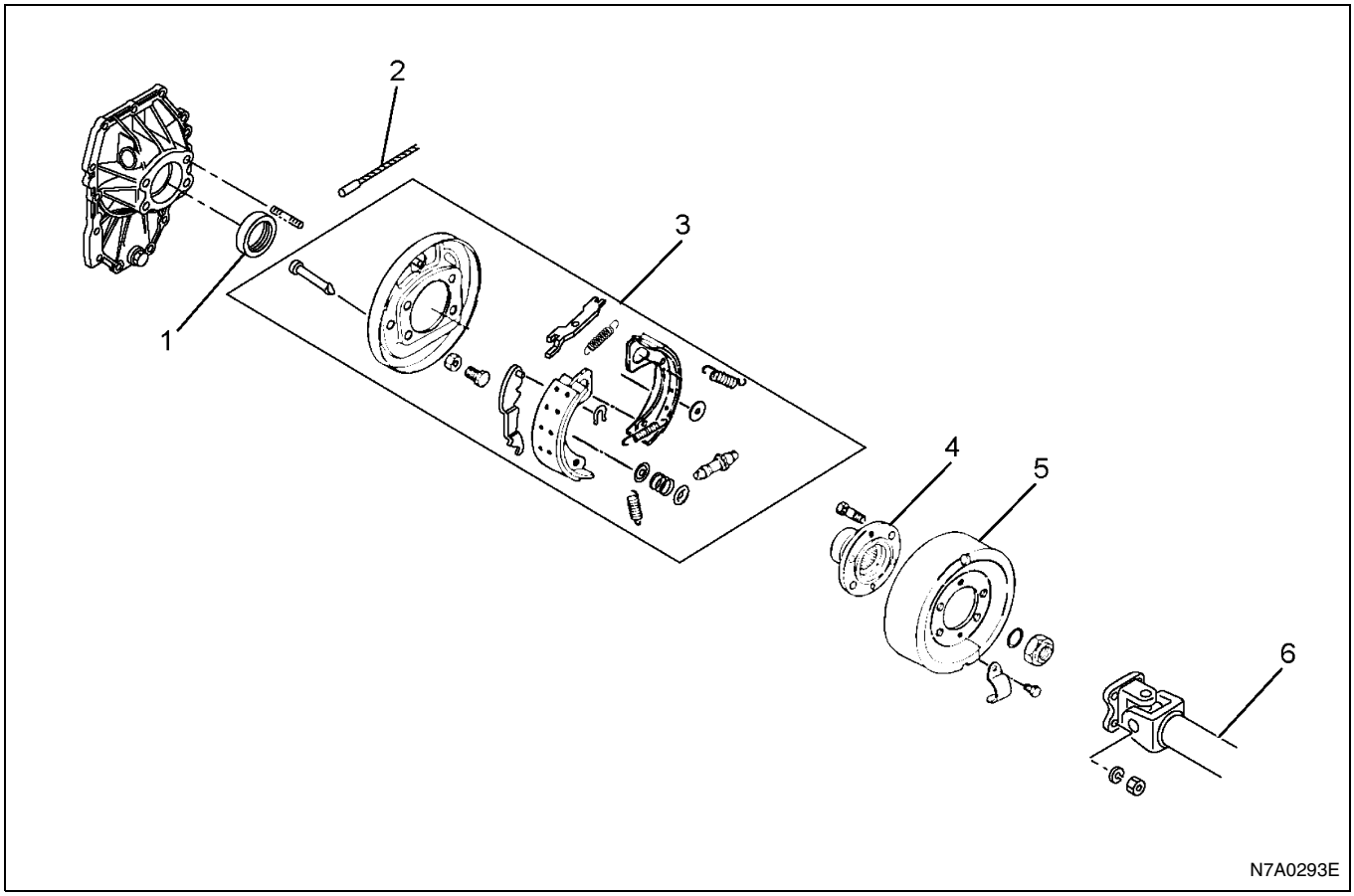


Special Tools

Illustration	Tool No. Tool Name
 5884000070	5-8840-0007-0 Grip
 9852212690	9-8522-1269-0 Oil Seal Installer

Rear Oil Seal (5-Speed)

Components

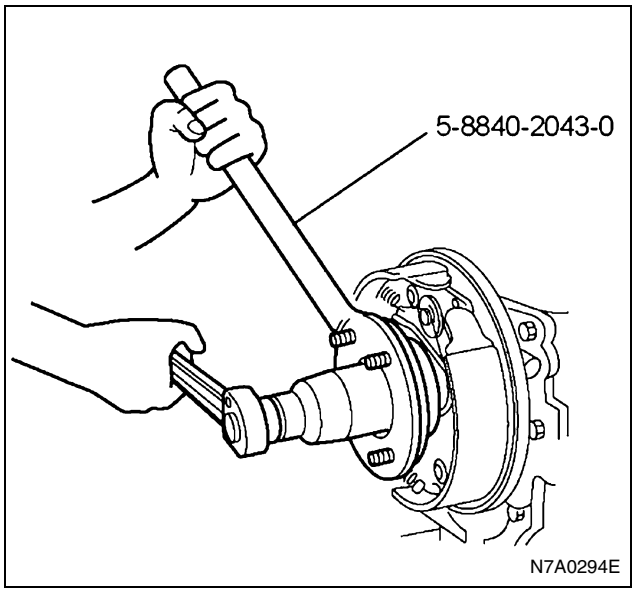


Legend

1. Oil Seal
2. Parking Brake Cable
3. Parking Brake Assembly
4. Coupling Driver
5. Parking Brake Drum
6. Rear Propeller Shaft Assembly

Removal

1. Remove the rear propeller shaft assembly.
   - Refer to “Rear Drive Propeller Shaft”.
2. Remove the parking brake cable.
   - Refer to “Parking Brake”.
3. Remove the parking brake drum.
   - Refer to “Parking Brake”.
4. Remove the coupling driver and O-ring.
   - Carefully release the caulking (two points) of the lock unit, and remove the lock nut by fixing it with the flange holder (5-8840-2043-0).



5. Remove the parking brake assembly.

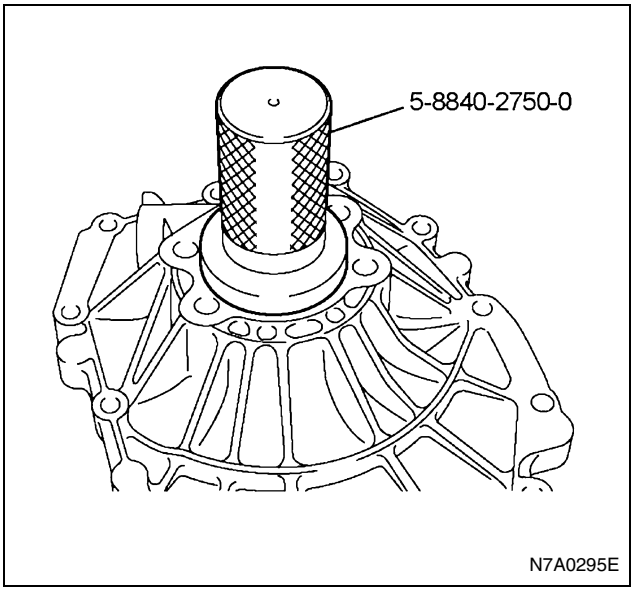
- Refer to “Parking Brake”.

6. Remove the rear oil seal.

Installation

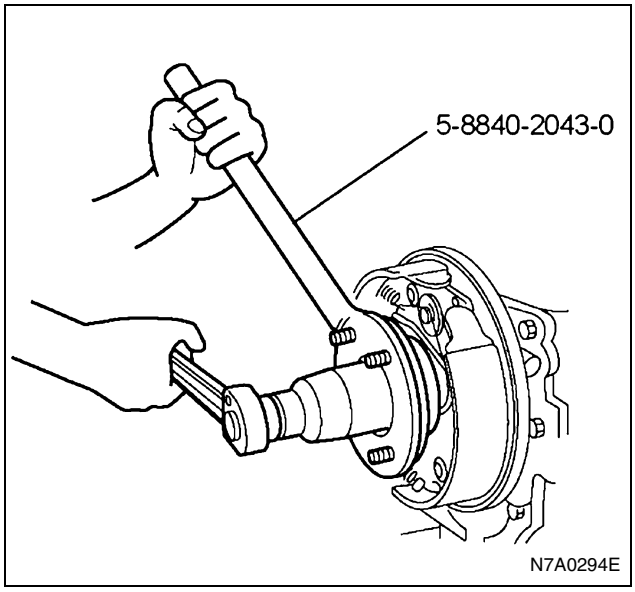
1. Apply engine oil to the outer circumference of a new oil seal, and then use the installer (5-8840-2750-0) to press-fit the oil seal to the rear cover.
   - Apply Besco L2 grease to the lip of the oil seal.

Caution:
Take care to avoid damaging the oil seal lip.



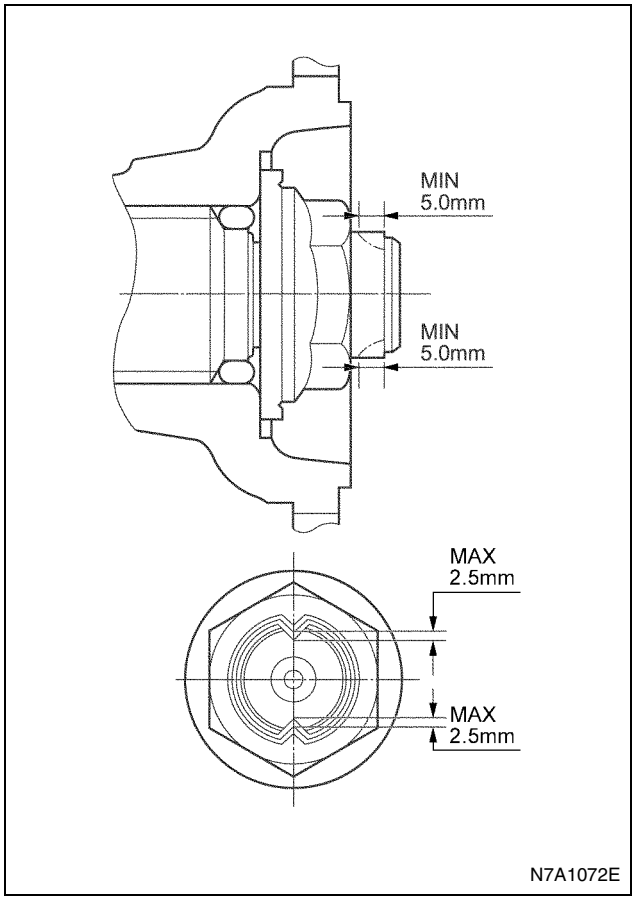
2. Install the parking brake assembly.
   - Refer to “Parking Brake.”
3. Install the coupling driver.
   a. Apply engine oil to the O-ring, and then install the coupling driver and O-ring.
   b. Using a new lock nut, use the flange holder (5-8840-2043-0) to tighten the lock nut.

Tighten:
289 N·m (29.5 kg·m / 213.2 lb·ft)



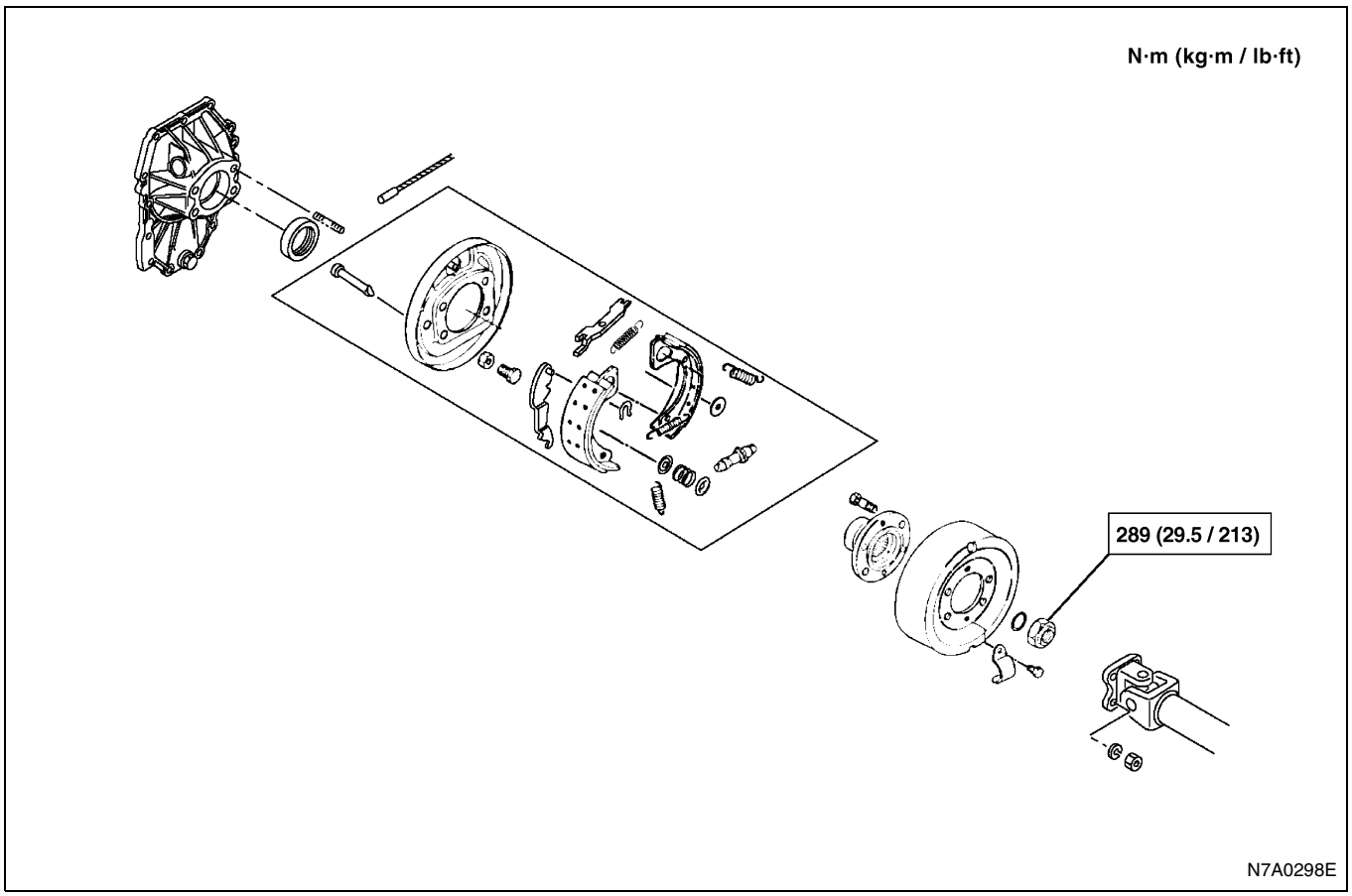
- After tightening the nut to the specified torque, align the nut lip with the V-groove of the shaft tip and caulk it (2 points) securely using a chisel (chisel tip shape: approx. 1 mm in radius × 60 degrees) so that the caulking is more than 5 mm in length and the lip gap is less than 2.5 mm.

Caution:
After caulking, check the caulking of the nut. If any cracks are discovered, replace the lock nut and re-caulk.

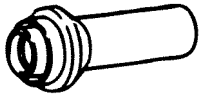


4. Install the parking brake drum.
   - Refer to “Parking Brake”.
5. Install the parking brake cable.
   - Refer to “Parking Brake”.
6. Install the rear propeller shaft assembly.
   - Refer to “Rear Drive Propeller Shaft”.

Tightening Torques

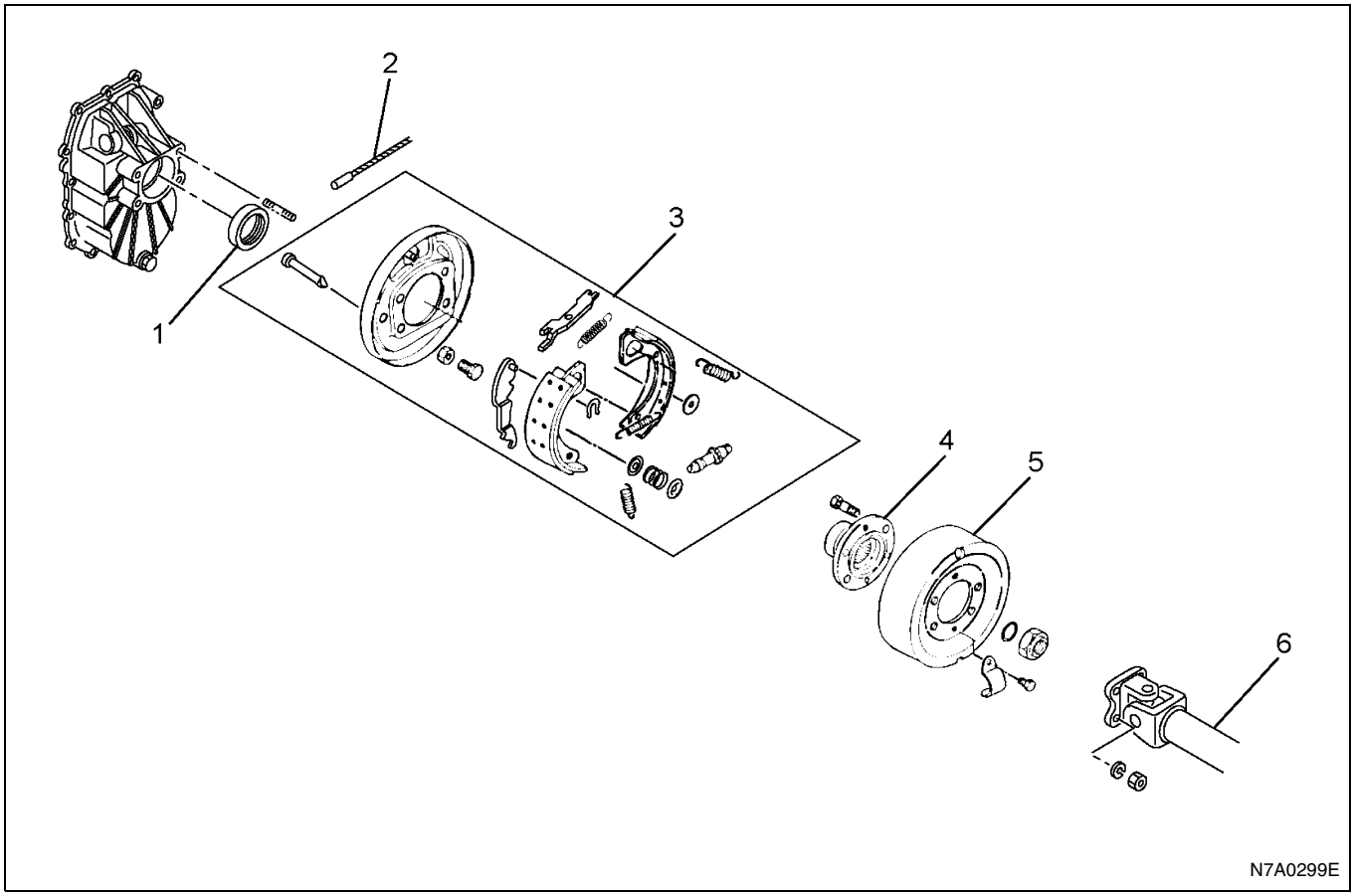


Special Tools

Illustration	Tool No. Tool Name
 5884020430	5-8840-2043-0 Flange Holder
 5884027500	5-8840-2750-0 Oil Seal Installer

Rear Oil Seal (6-Speed)

Components

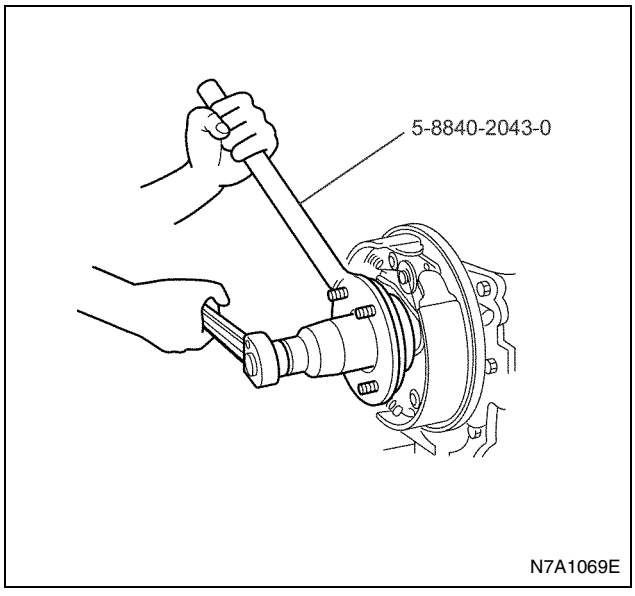


Legend

1. Oil Seal
2. Parking Brake Cable
3. Parking Brake Assembly
4. Coupling Driver
5. Parking Brake Drum
6. Rear Propeller Shaft Assembly

Removal

1. Remove the rear propeller shaft assembly.
   - Refer to “Propeller shaft”.
2. Remove the parking brake cable.
   - Refer to “Parking Brake”.
3. Remove the parking brake drum.
   - Refer to “Parking Brake”.
4. Remove the coupling driver and O-ring.
   - Carefully release the caulking (two points) of the lock unit, and remove the lock nut by fixing it with the flange holder (5-8840-2043-0).



5. Remove the parking brake assembly.

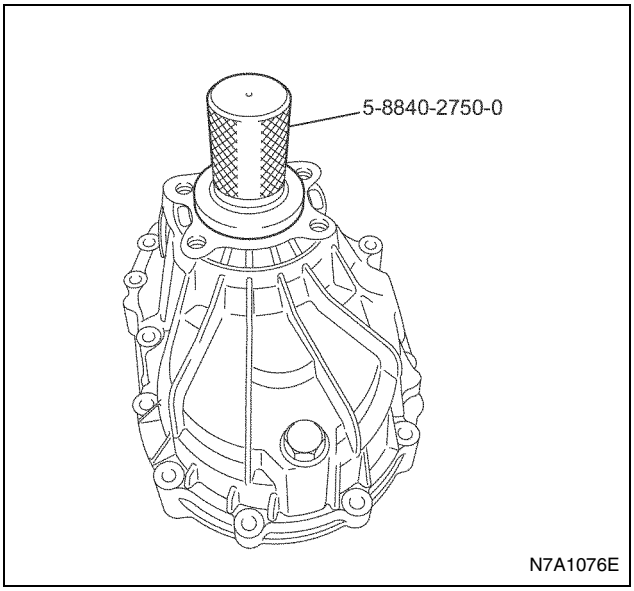
- Refer to “Parking Brake”.

6. Remove the rear oil seal.

Installation

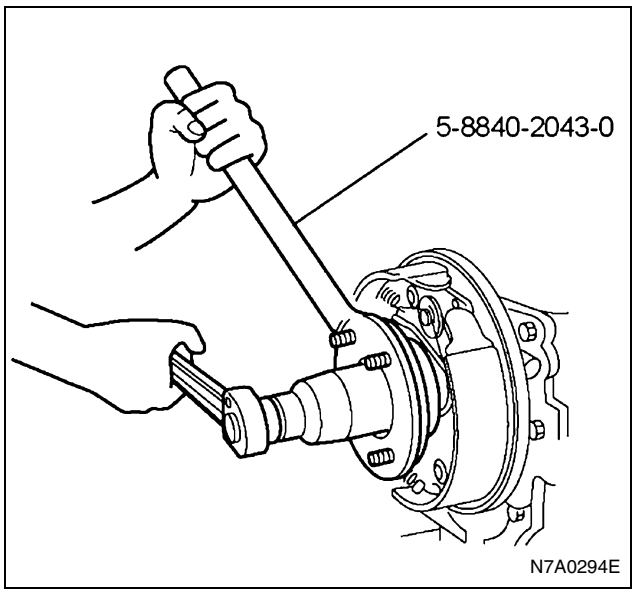
1. Apply engine oil to the outer circumference of a new seal, and then use the installer (5-8840-2750-0) to press-fit the oil seal to the rear cover.
   - Apply Besco L2 grease to the lip of the oil seal.

Caution:
Take care to avoid damaging the oil seal lip.



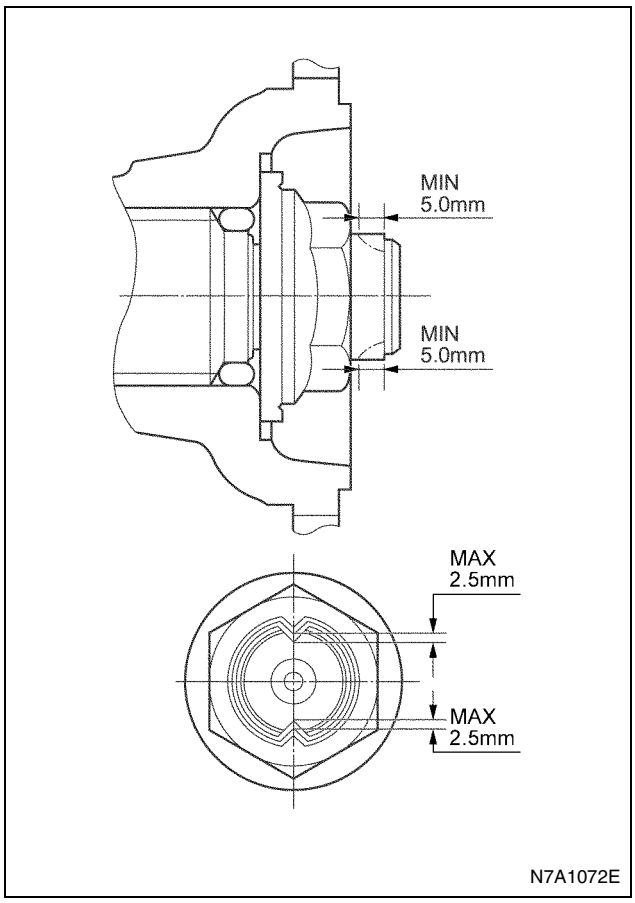
2. Install the parking brake assembly.
   - Refer to “Parking Brake”.
3. Install the coupling driver.
   a. Apply engine oil to the O-ring, and then install the coupling driver and O-ring.
   b. Using a new lock nut, use the flange holder (5-8840-2043-0) to tighten the lock nut.

Tighten:
289 N·m (29.5 kg·m / 213.2 lb·ft)



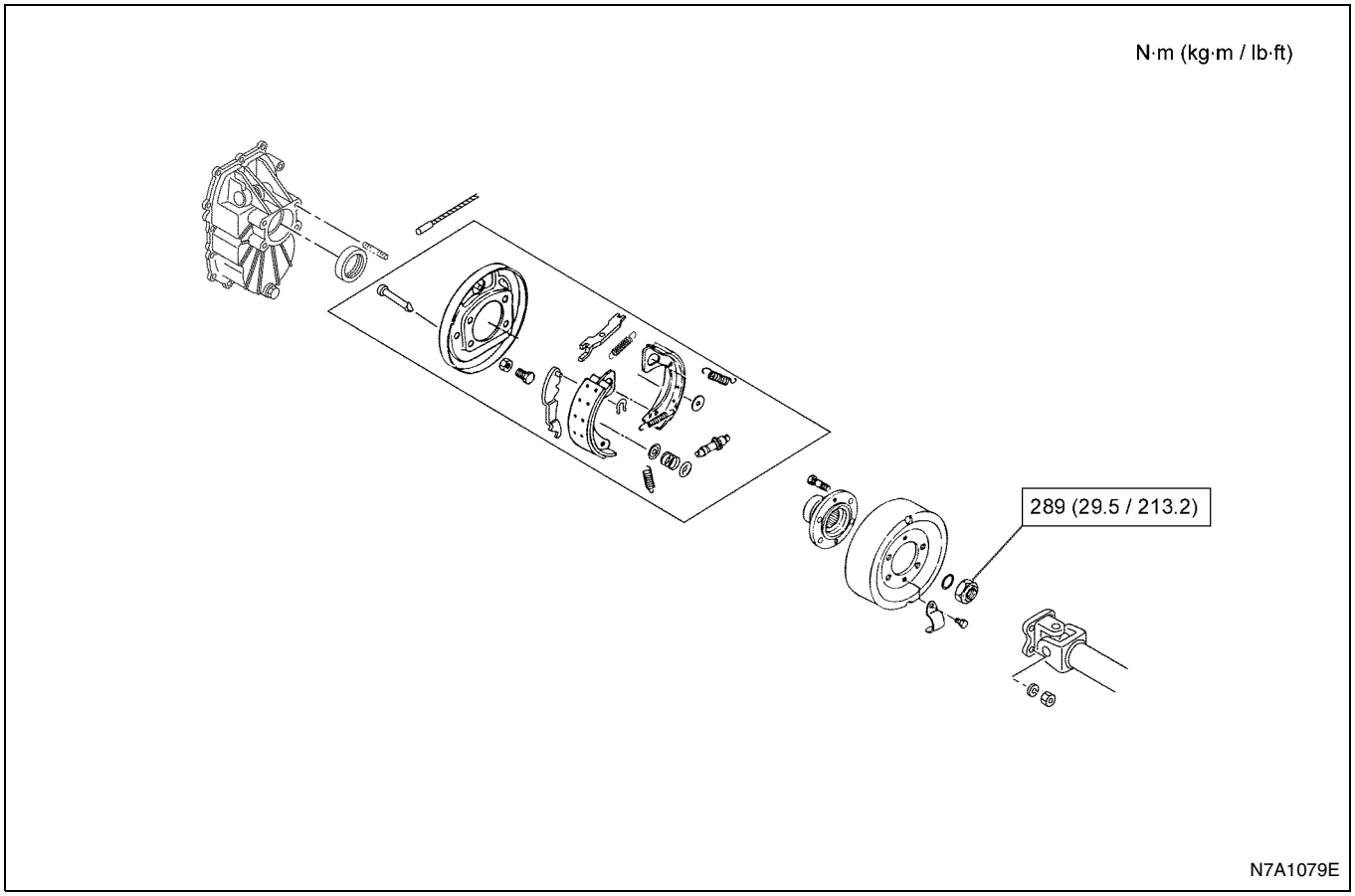
- After tightening the lock nut to the specified torque, stake it (2 points) securely using a chisel (chisel tip shape: approx. 1 mm in radius × 60 degrees) so the lock nut lip gap is aligned with the V-groove of the shaft and is at least 5 mm, and the clearance between the V-groove bottom and the nut lip is 2.5 mm or less.

Caution:
After caulking, check the caulking of the nut. If any cracks are discovered, replace the lock nut and re-caulk.



4. Install the parking brake drum.
   - Refer to “Parking Brake”.
5. Install the parking brake cable.
   - Refer to “Parking Brake”.
6. Install the rear propeller shaft assembly.
   - Refer to “Propeller shaft.”

Tightening Torques

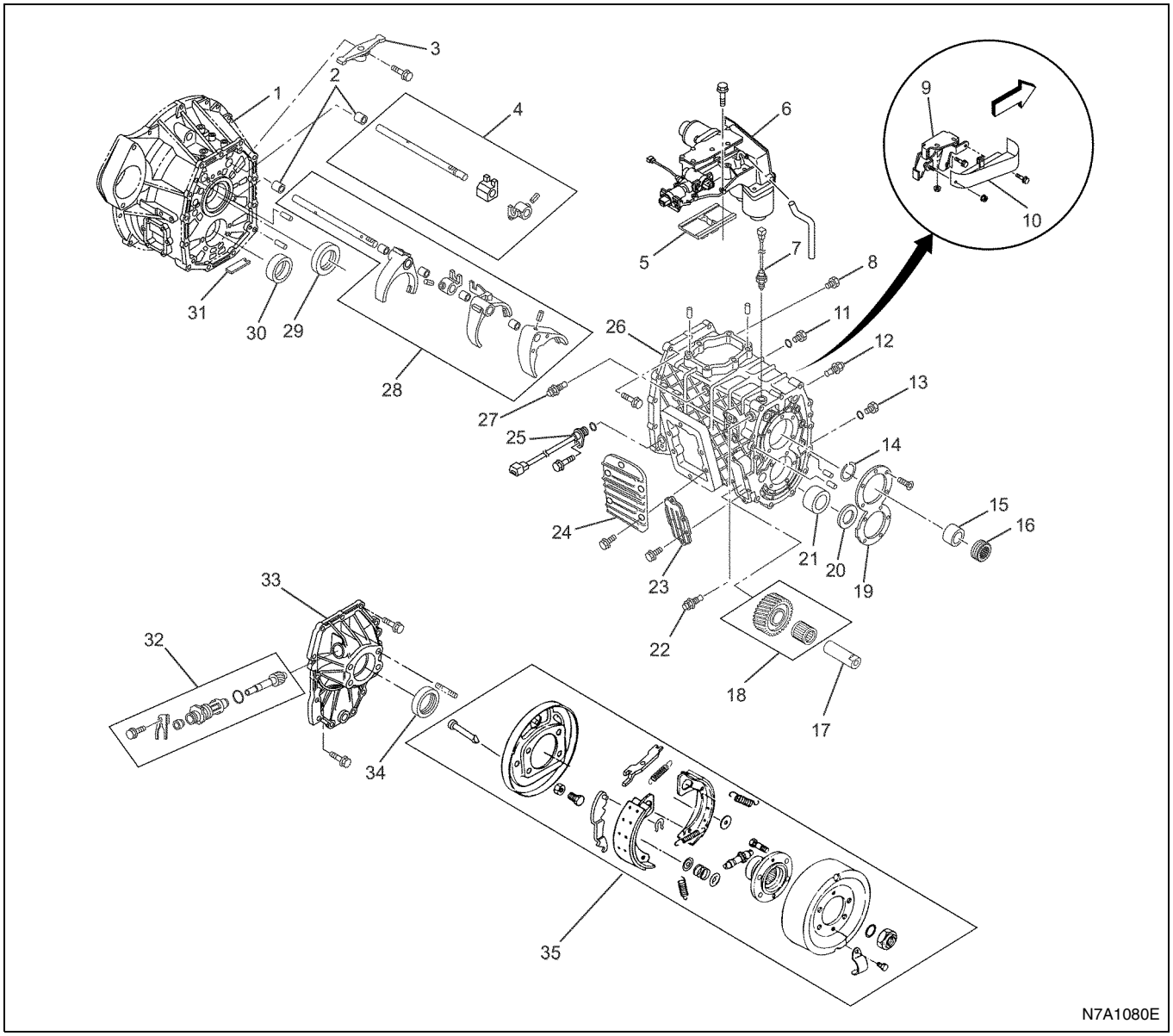


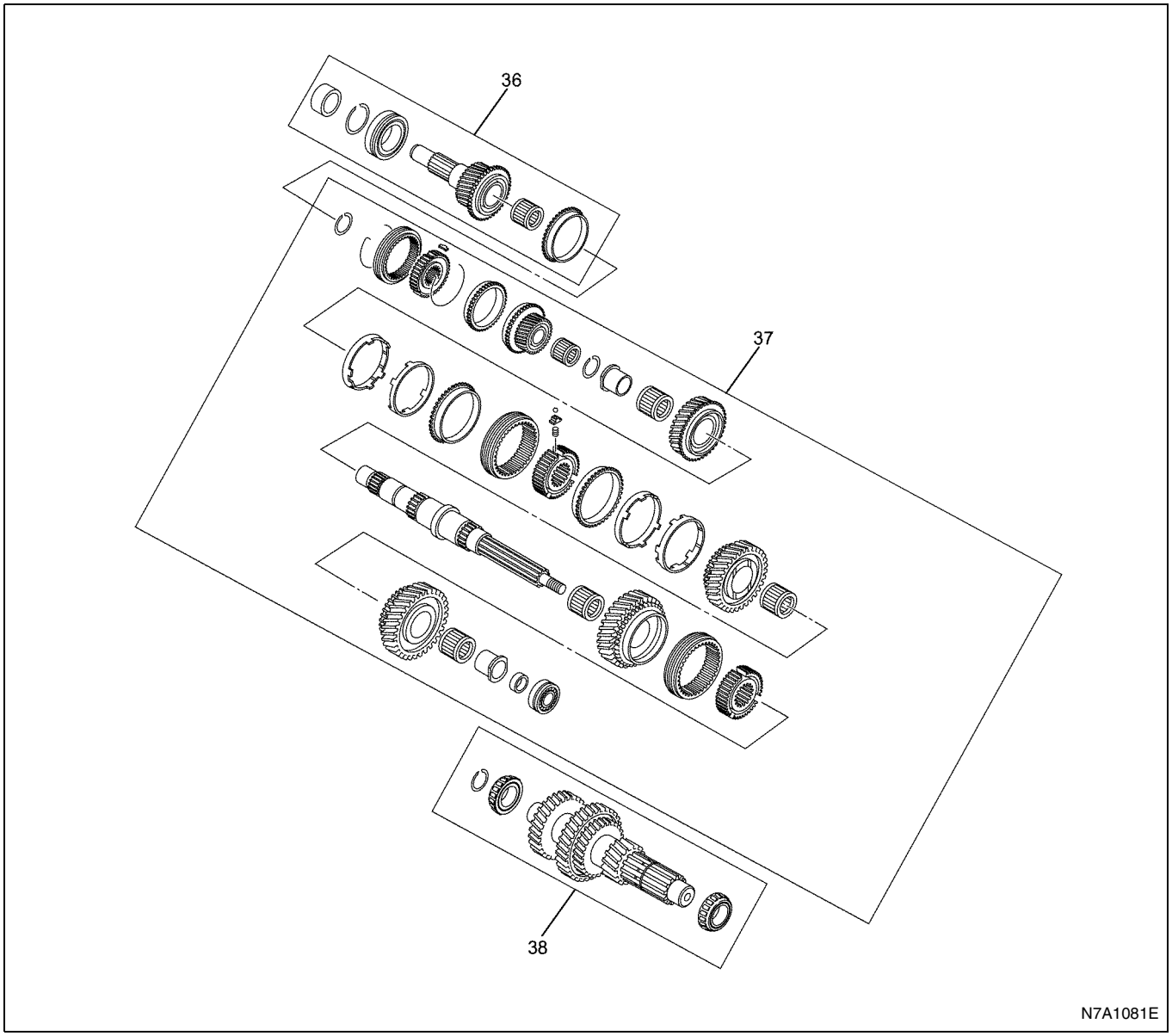
Special Tools

Illustration	Tool No. Tool Name
 5884020430	5-8840-2043-0 Flange Holder
 5884027500	5-8840-2750-0 Oil Seal Installer

MYY Transmission (5-Speed)

Components





Legend

1. Clutch Housing
2. Clutch Housing Bushing
3. 5th Gear Relay Lever
4. 4th — 5th Gear Shift Block
5. Interlock Plate
6. Control Box
7. Reverse Switch
8. Detent Plug
9. Heat Protector Bracket
10. Heat Protector
11. Filler Plug
12. Detent Assembly
13. Drain Plug
14. Snap Ring
15. Collar
16. Speedometer Gear
17. Reverse Idle Shaft
18. Reverse Idle Gear and Needle Bearing
19. Retainer
20. Counter Shim
21. Counter Rear Bearing
22. Detent Assembly
23. Reverse Idle Cover
24. PTO Cover
25. Input Shaft Speed Sensor
26. Transmission Case
27. Detent Assembly
28. 1st Gear — Reverse, 2nd — 3rd Gear and 4th — 5th Gear Shift Arm
29. Front Oil Seal
30. Bearing Outer Race
31. Magnet
32. Speedometer Driven Gear
33. Rear Cover

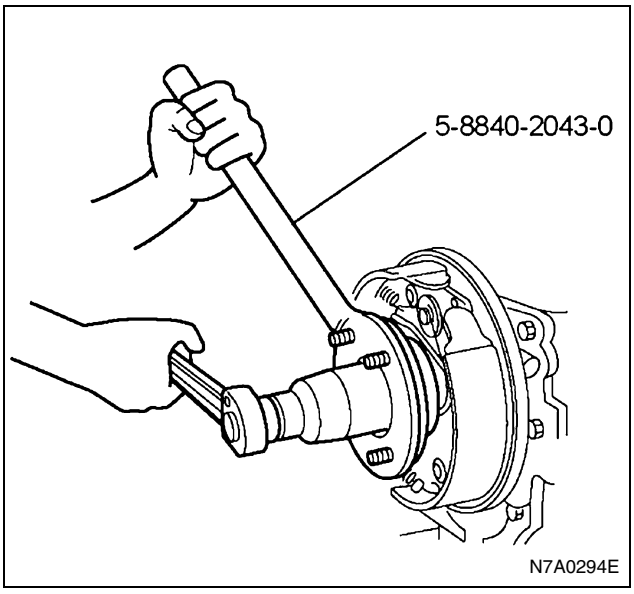
34. Rear Oil Seal
35. Parking Brake Assembly
36. Top Gear Shaft Assembly
37. Main Shaft Assembly
38. Counter Shaft Assembly

Disassembly

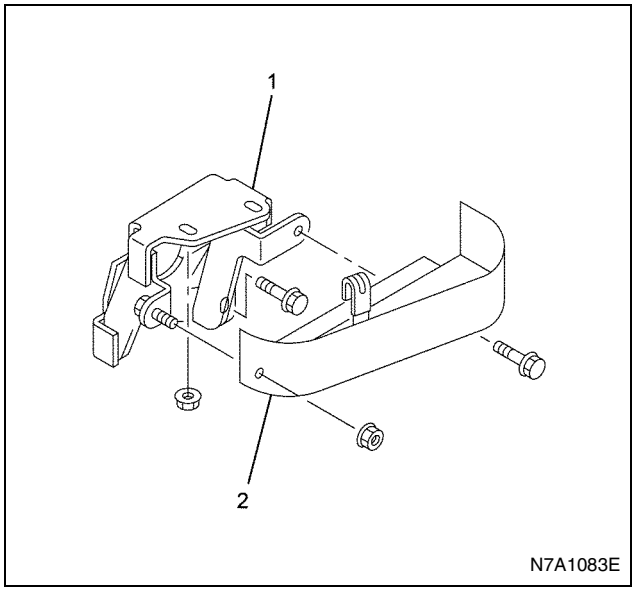
Caution:
The transmission case and clutch housing are made of aluminum, to be sure to exercise sufficient care to ensure they are not damaged. A particularly high level of care is required to protect against rib damage, which can affect the strength of the case.

Also take care to avoid personal injury when working with cases, gears, and other heavy items.

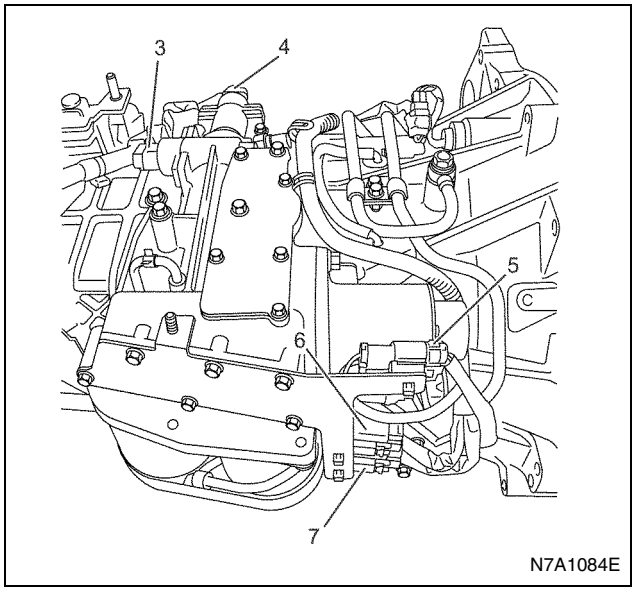
1. Remove the fixing bolt of the adjust hole cover, and remove the parking brake drum.
   - Refer to “Parking Brake.”
2. Carefully release the caulking (two points) of the coupling driver lock nut, and remove the lock nut by fixing it with the flange holder (5-8840-2043-0).



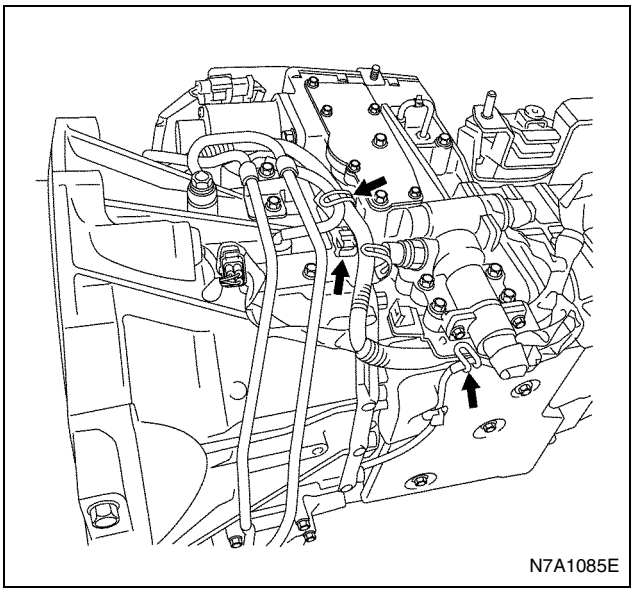
3. Remove the coupling driver and O-ring.
4. Remove the parking brake assembly.
   - Refer to “Parking Brake”.
5. Remove the filler plug and O-ring.
6. Remove the drain plug and O-ring.
   - Drain the transmission oil. When draining the oil, check the oil amount, and check for metal bits and foreign matter.
7. Remove the heat protector (2) and heat protector bracket (1).



8. Remove the gearshift control box.
   a. Disconnect the five connectors from the gearshift control box.
      - Disconnect the connectors of the select sensor (3), shift sensor (4), select solenoid (5), 2-4-6-R shift solenoid (6), and 1-3-5 shift solenoid (7).

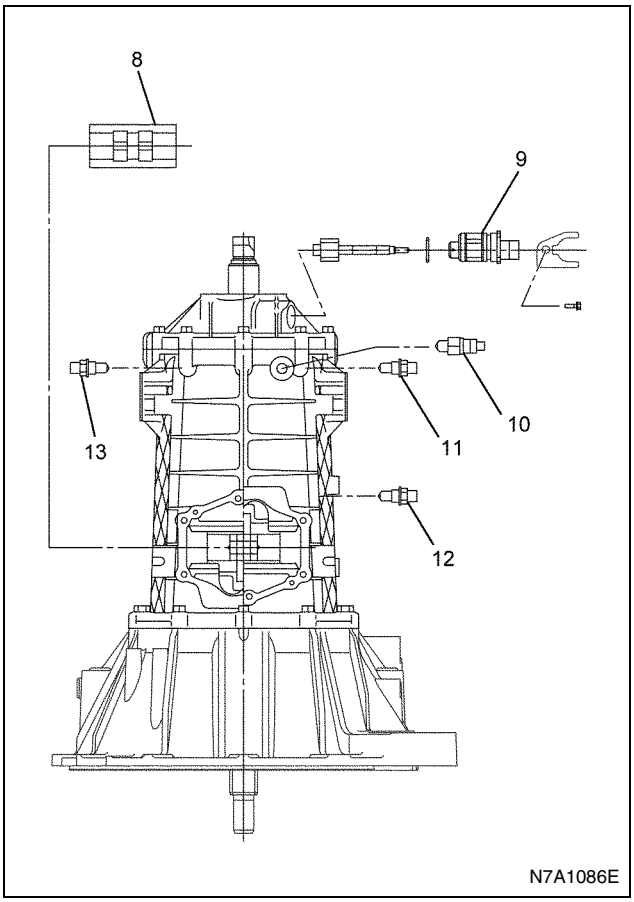


b. Remove the harness from the two clips, and remove the neutral switch connector from the bracket.


N7A1085E

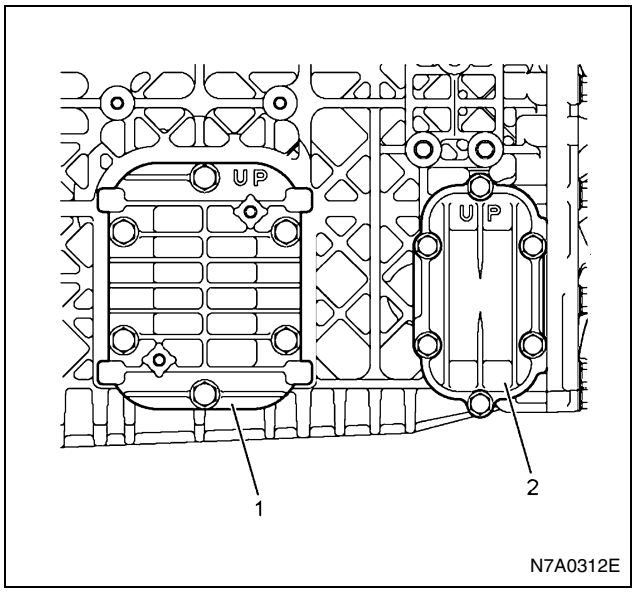
c. Remove the six bolts and the gearshift control box.

9. Remove the interlock plate (8).
10. Remove the speedometer driven gear (9).
11. Remove the reverse switch (10).
12. Remove the detent assembly (11), (12), (13).



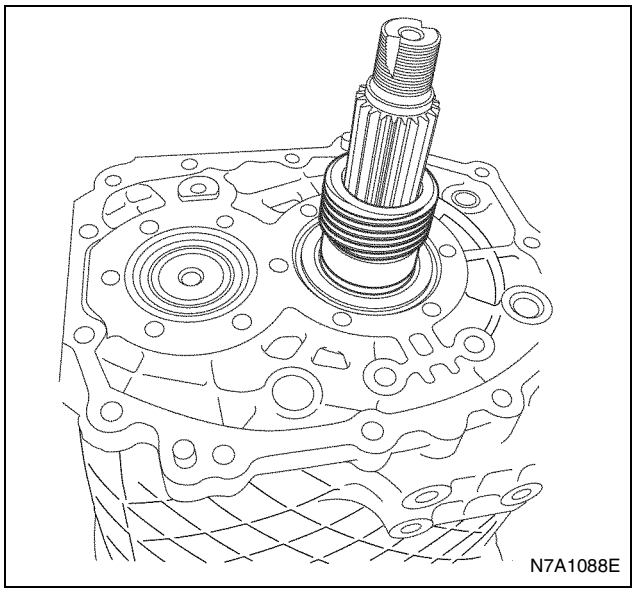
N7A1086E

13. Remove the input shaft speed sensor.
14. Remove the PTO cover (1).
15. Remove the reverse idle cover (2).



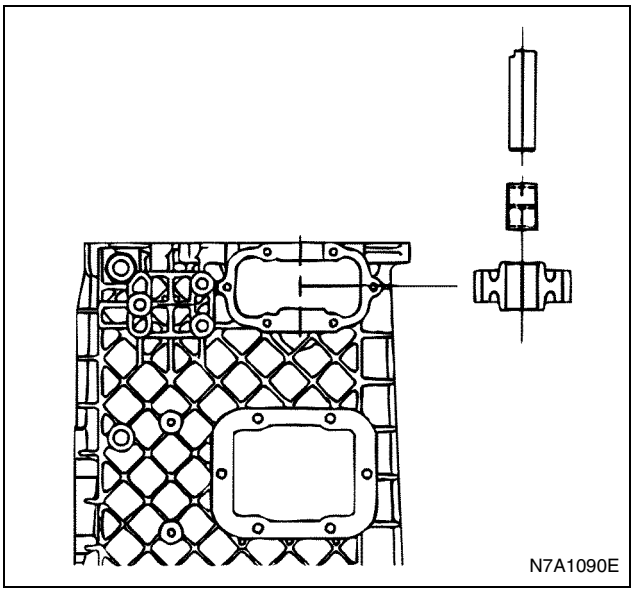
N7A0312E

16. Remove the rear cover assembly.
17. Inspect the rear cover oil seal. If it is worn or damaged, remove it from the rear cover.
18. Remove the speedometer gear and collar.

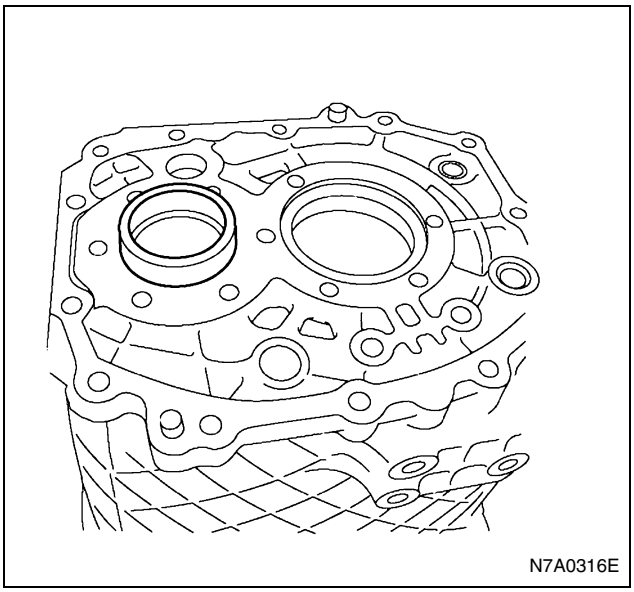

N7A1088E

19. Remove the retainer from the transmission case.

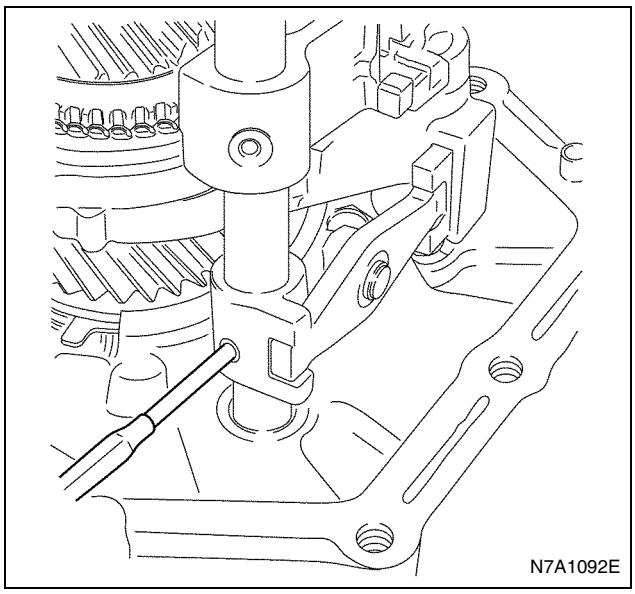
20. Pull out the reverse idle shaft, and remove the reverse idle gear and needle bearing.


N7A1090E

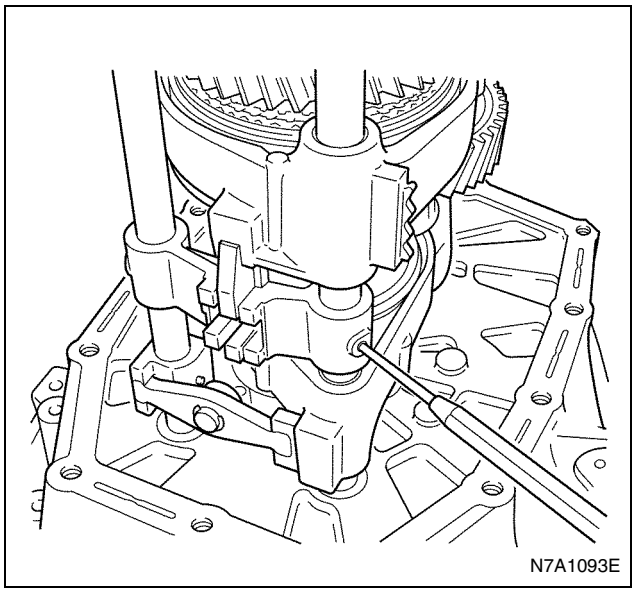
21. Remove the rear outer snap ring from the main shaft rear bearing.
22. Remover the counter shim.
23. Remove the transmission case from the clutch housing.
24. Remove the bearing rear outer race from the transmission case.


N7A0316E

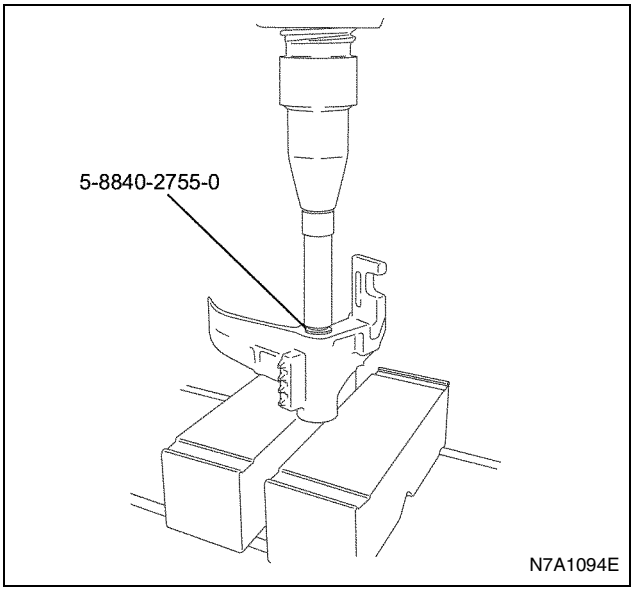
25. Remove the 3rd — 4th shift rod, 4th — 5th main shift rod block and 4th — 5th gear sub shaft block.
    - When driving out the spring pin, insert a round bar on the opposite side of the shift rod, and use a spring pin remover to remove the spring pin while taking care to avoid damage to other parts.


N7A1092E

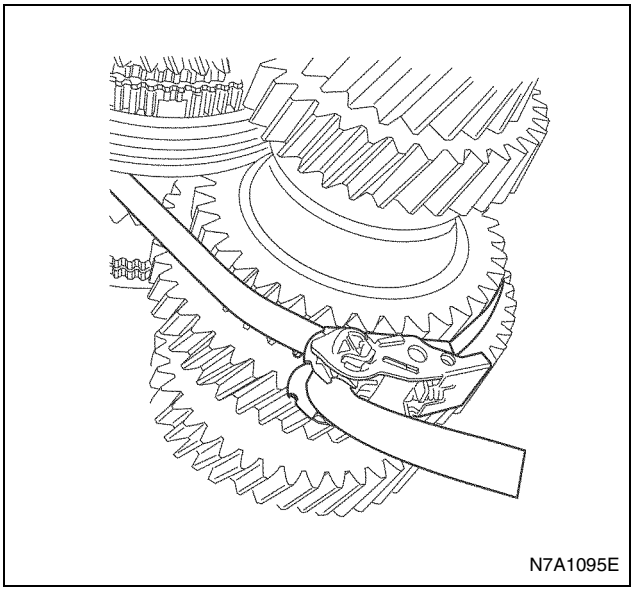
26. Remove the 1st — Reverse and 2nd — 3rd shift rod, 1st — Reverse shift arm, 2nd — 3rd shift arm, 1st — Reverse shift block, 4th — 5th shift arm.
    - When driving out the spring pin, insert a round bar on the opposite side of the shift rod, and use a spring pin remover to remove the spring pin while taking care to avoid damage to other parts.


N7A1093E

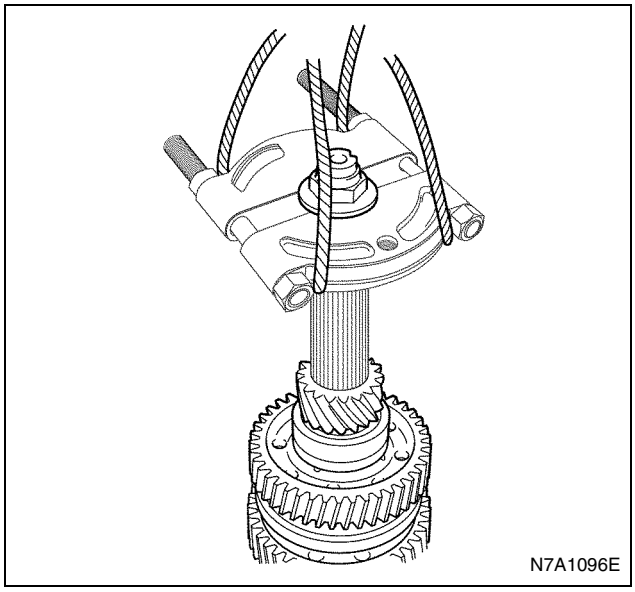
27. Use a remover (5-8840-2755-0) to remove the bushing from the 2nd — 3rd shift arm.
28. Use a remover (5-8840-2755-0) to remove the bushing from the 4th — 5th shift arm.
    - Use the remover in combination with a round bar of a length that makes it possible to push in as far as possible.

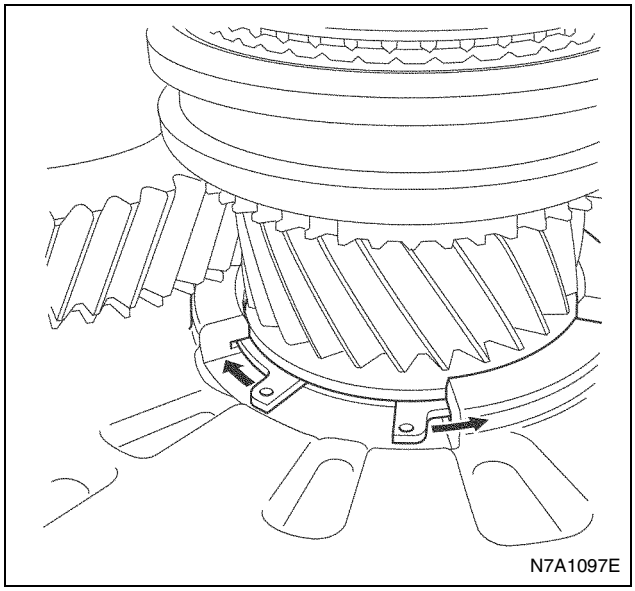


29. Remove the 5th relay lever from the clutch housing.
30. Remove the magnet case from the clutch housing.
31. Remove the main shaft assembly, top gear shaft assembly, and counter shaft assembly.
    a. Use a lashing belt or some other belt from a lashing device to bundle the main shaft assembly, counter shaft assembly, and top gear shaft assembly at two points so they cannot separate. Tighten the belt securely.

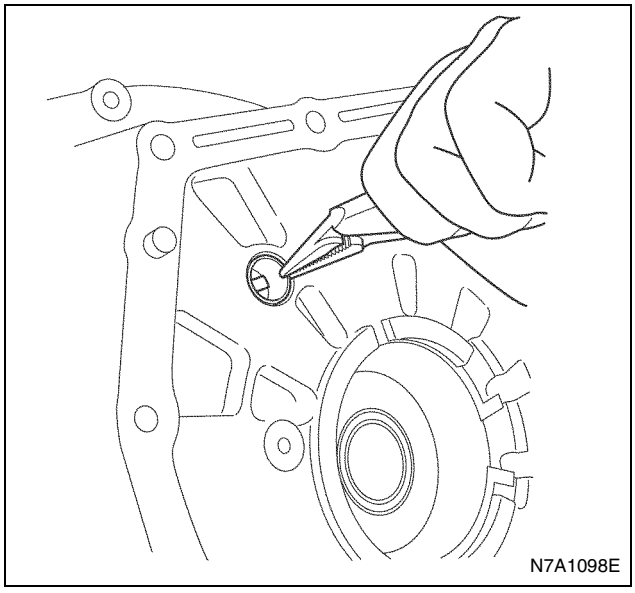


    b. Attach a bearing remover to the main shaft and secure with a lock nut, attach a wire, and raise it using a hoist. While opening the top gear shaft bearing outer snap ring attached to the clutching housing, simultaneously remove the top gear shaft assembly, main shaft assembly, and counter shaft assembly from the clutch housing.

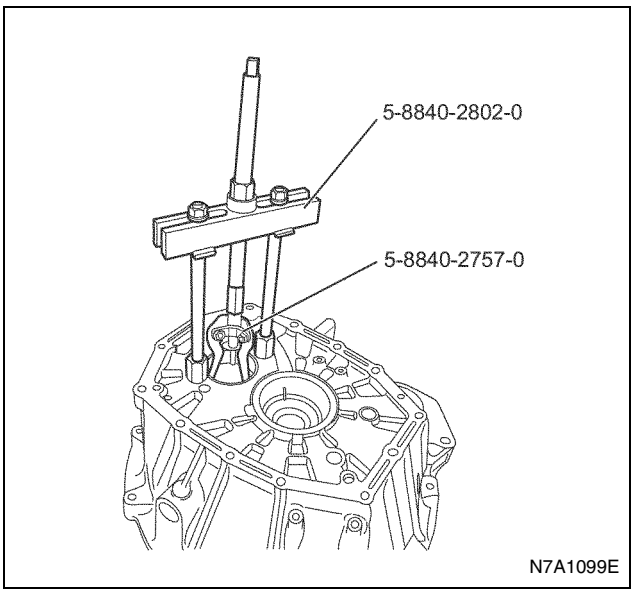




32. Inspect the clutch housing bushing. If it is worn or damaged, use pliers to remove it from the clutch housing.



33. Inspect the counter shaft front bearing. If it is worn or damaged, use a bearing remover (5-8840-2757-0) and bushing puller (5-8840-2802-0) to remove the bearing outer race from the clutch housing.

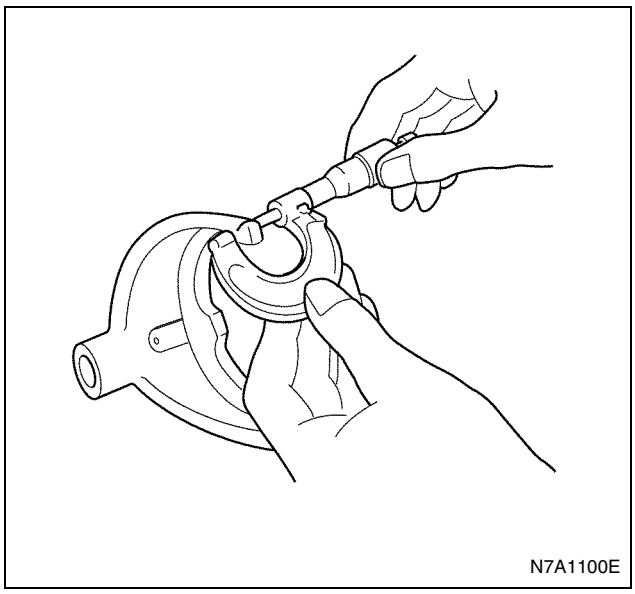


34. Inspect the front oil seal. If it is worn or damaged, remove it from the clutch housing.

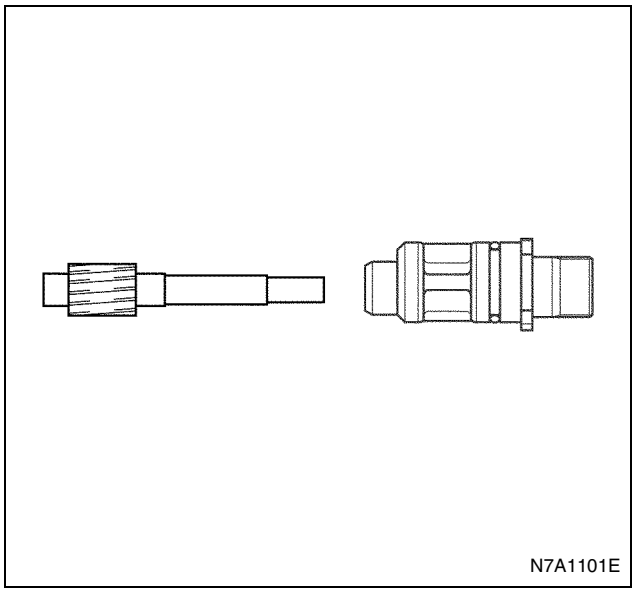
Inspect each part. Replace or repair as required if anything is worn or damaged or if any other defect is discovered.

35. Inspect each shift mechanism component. Repair any minor damage, bending, or stepped wear. Replace any component that is badly damaged or worn, and any component that exceeds the allowable limit.
    - Shift rod and shift arm bending, wear, damage
    - Shift arm thickness
      – Use a micrometer to measure the thickness of the shift arm tip.

Shift Arm Thickness (mm)		
	Specified Value	Limit
1st — Reverse 3rd — 2nd 5th — 4th	9.60 — 9.85	9.0



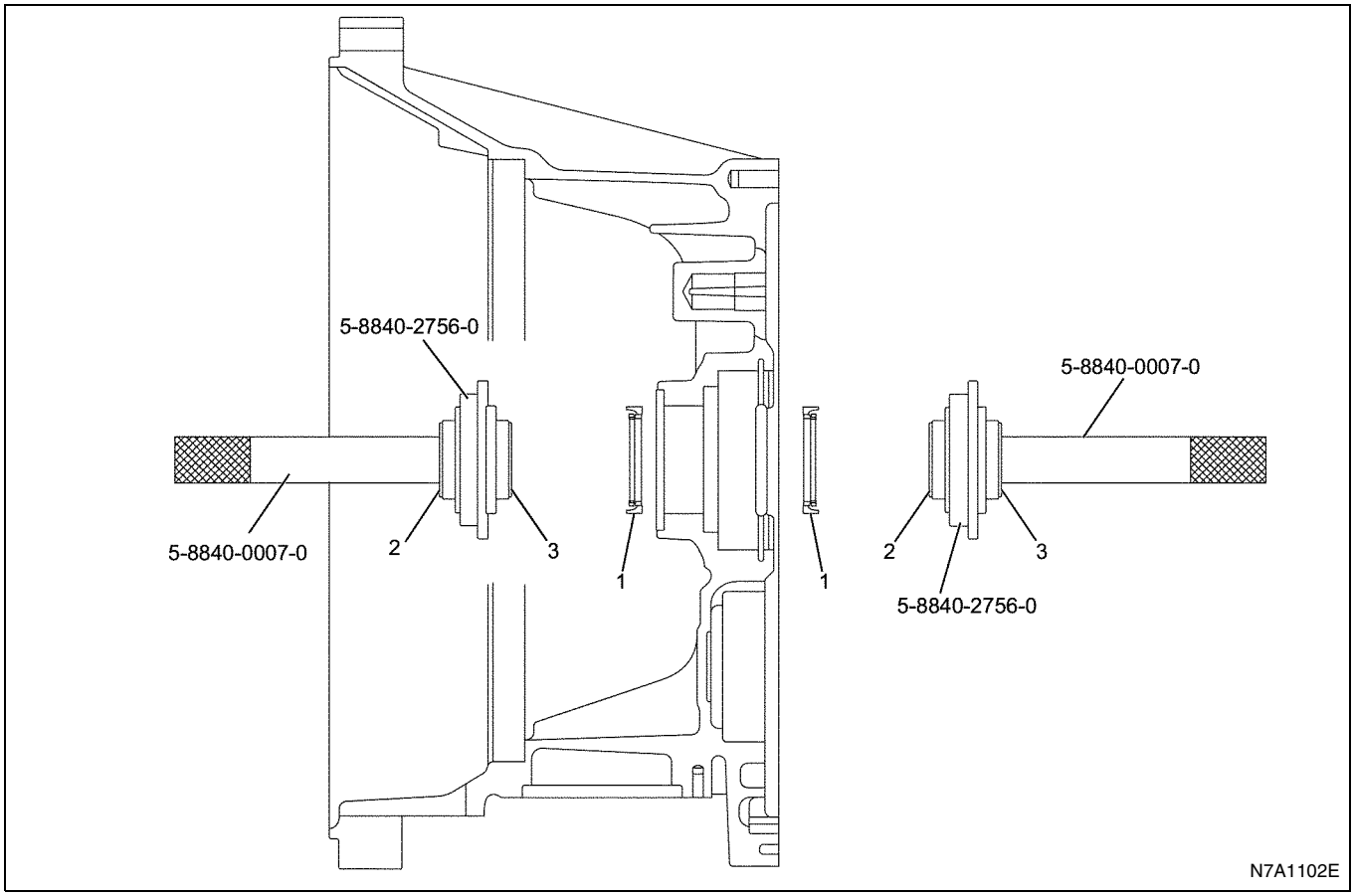
36. Inspect the speedometer driven gear and driven gear bushing for wear.
    - Replace if there is excessive wear.



Assembly

1. Inspect the oil seal. If it needs to be replaced with a new one due to wear or damage, apply engine oil or grease to the oil seal's outer circumference, and then use an installer (5-8840-2756-0) and grip (5-8840-0007-0) to press-fit it into the clutch housing as shown in the illustration, taking care that the front-back orientation of the front oil seal is correct.
    - Fill the lip of the oil seal with Besco L2 grease.

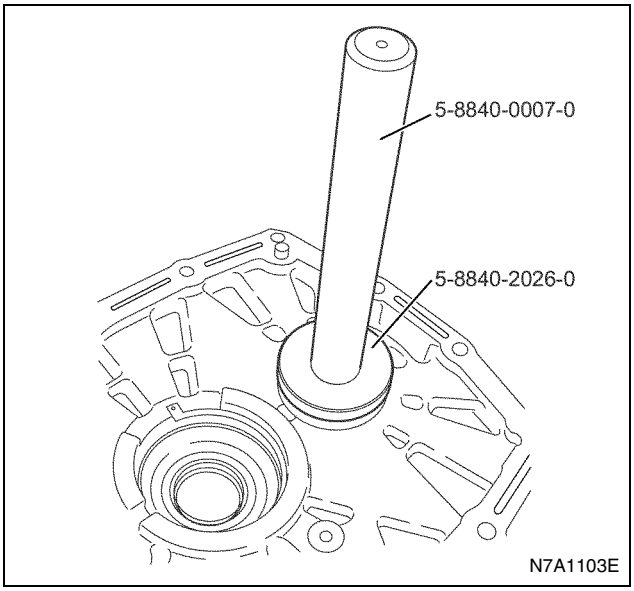
Caution:
Take care to avoid damaging the oil seal lip.



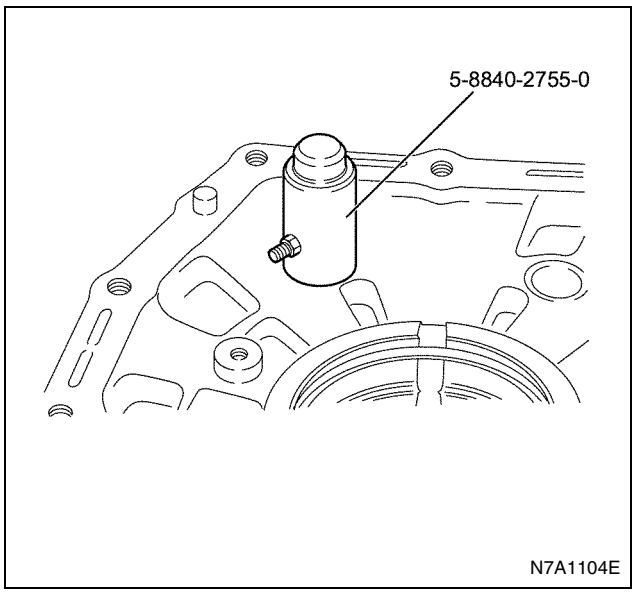
Legend

1. Front Oil Seal
2. T/M Mark
3. ENG Mark

2. Inspect the counter shaft front bearing. If it needs to be replaced with a new one due to wear or damage, use a grip (5-8840-0007-0) and installer (5-8840-2026-0) to press-fit the bearing outer race.

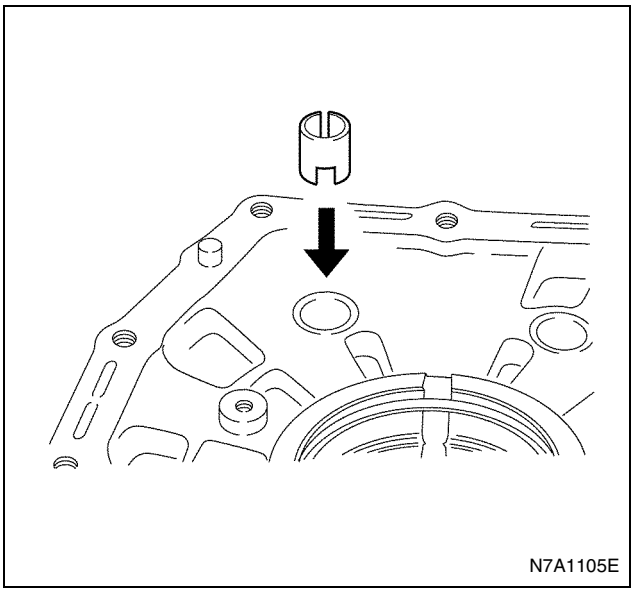


3. Inspect the clutch housing bushing. If it needs to be replaced with a new one due to wear or damage, use an installer (5-8840-2755-0) to press-fit.

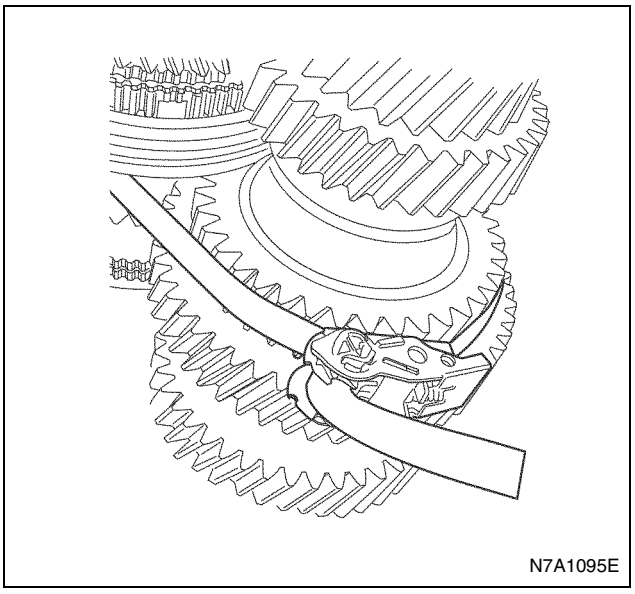


- Before installing, carefully remove all protrusions from the bore side of the old caulking.

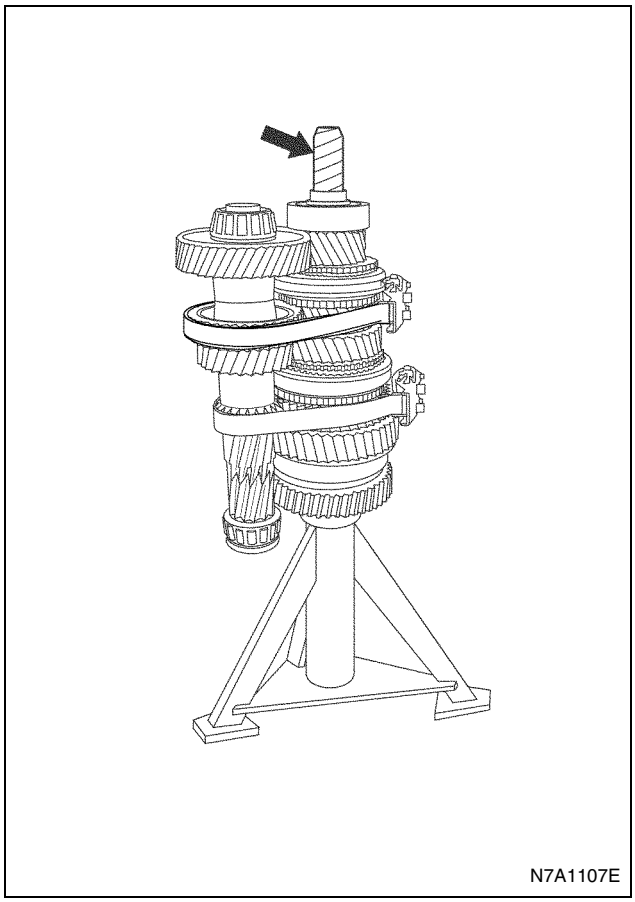
- Before installing, securely caulk at three points, avoiding the old caulking points and grooves.
- For the second and subsequent press-fitting, the notched part should face in the direction of the clutch housing.
- After press-fitting, check that the shift rod slides smoothly.


N7A1105E

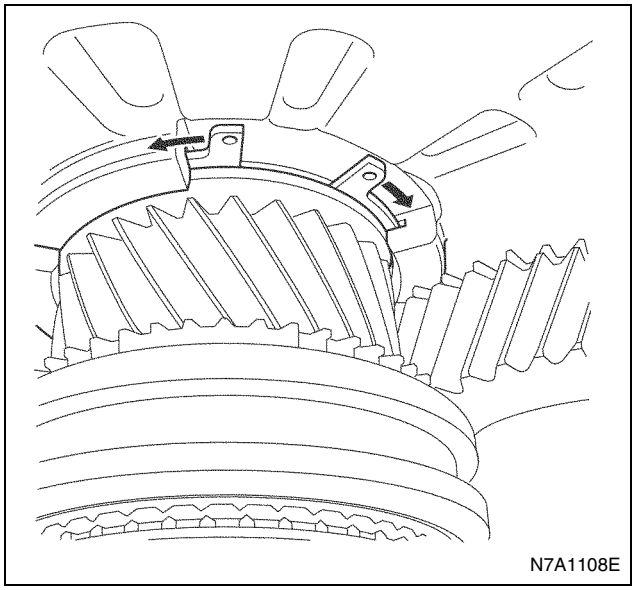
4. Install the main shaft assembly, top gear shaft assembly, and counter shaft assembly.
   a. Use a lashing belt or some other belt from a lashing device to bundle the main shaft assembly, counter shaft assembly, and top gear shaft assembly at two points so they cannot separate. Tighten the belt securely. When handing the top gear shaft, take care that it does not drop.


N7A1095E

   b. Stand the top gear shaft assembly, main shaft assembly, and counter shaft assembly on a support stand with the top gear shaft assembly on top.
   c. Wrap the main shaft with tape to avoid damage to the front oil seal.


N7A1107E

   d. While using snap ring pliers to open the top gear shaft bearing outer snap ring, which already has been set on the clutch housing, insert the top gear shaft, counter shaft, and shaft rod into their appropriate positions in the clutch housing.


N7A1108E

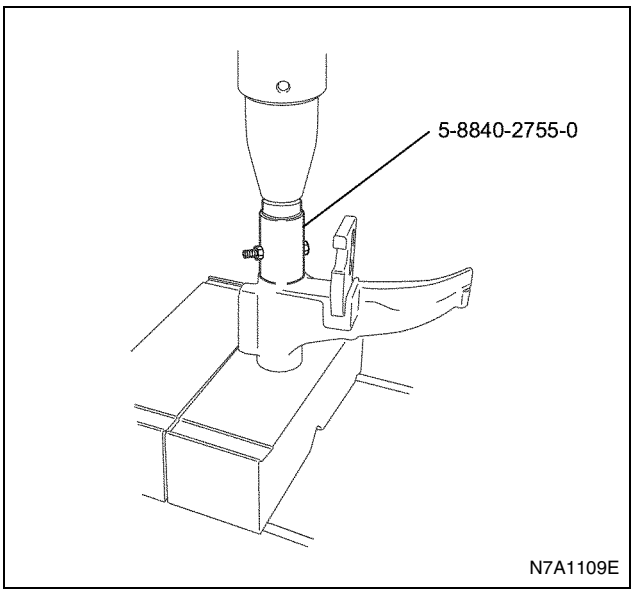
Caution:
- Confirm that the snap ring is installed properly.

- Work carefully in order to avoid damaging the front oil seal.

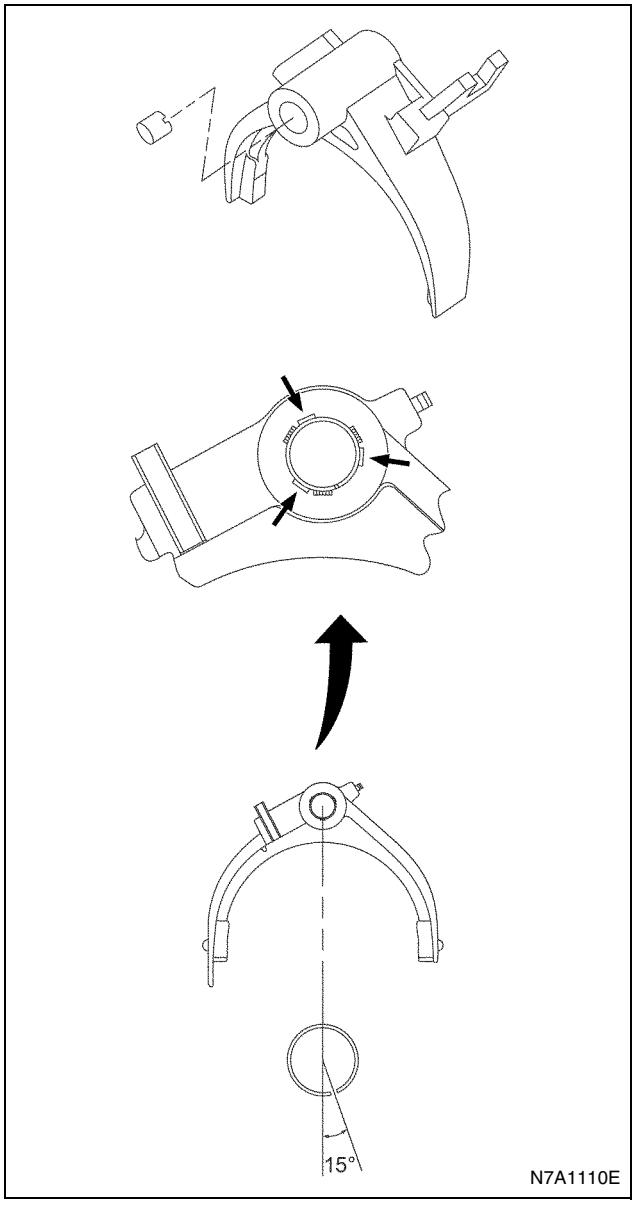
5. Install the magnet in the clutch housing.
6. Install the 5th relay lever in the clutch housing.

Tighten:
44 N·m (4.5 kg·m / 32.5 lb·ft)

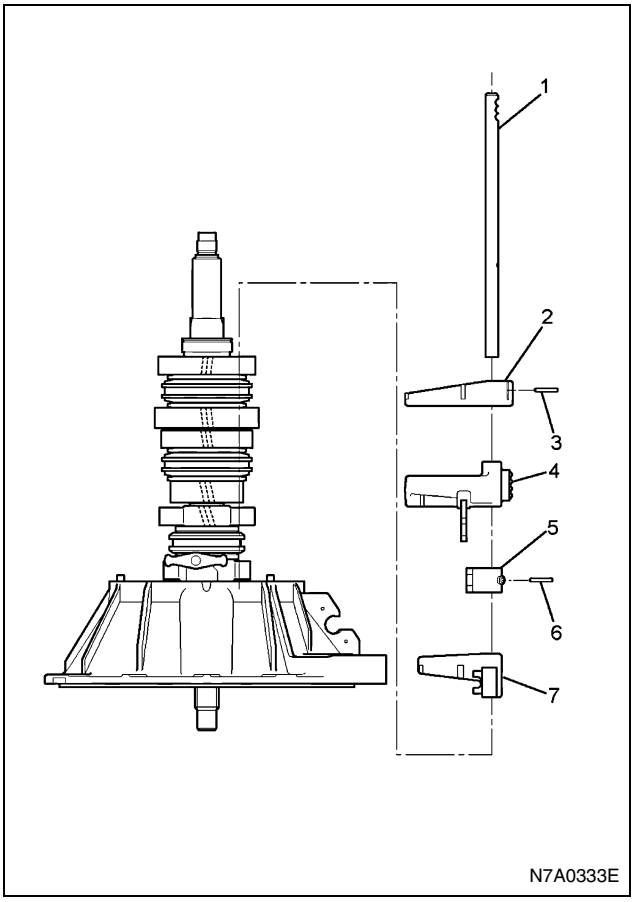
7. Inspect the 4th — 5th shift arm bushing. If it needs to be replaced with a new one due to wear or damage, use an installer (5-8840-2755-0) to press-fit with a press.
8. Inspect the 2nd — 3rd shift arm bushing. If it needs to be replaced with a new one due to wear or damage, use an installer (5-8840-2755-0) to press-fit with a press.



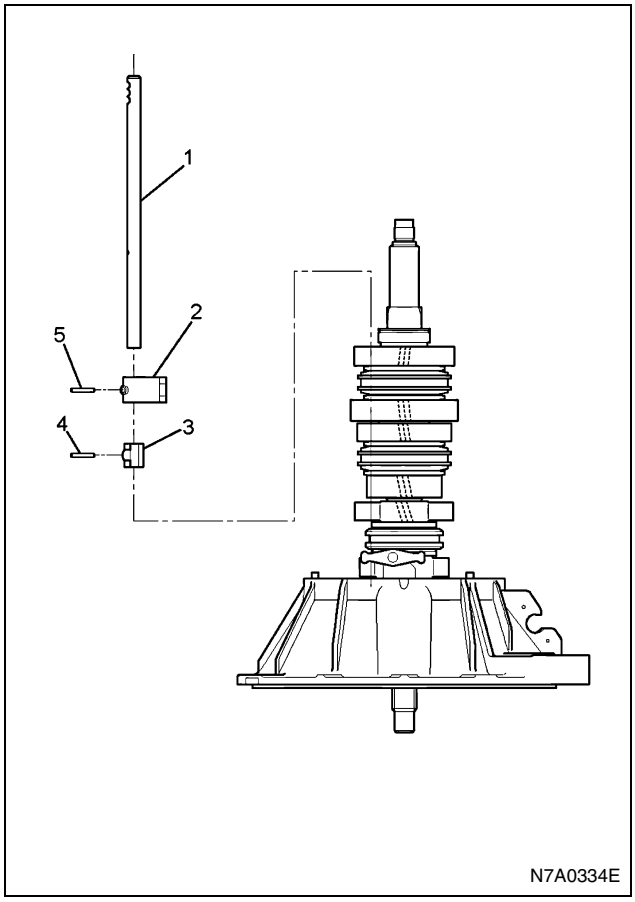
- Before installing, carefully remove all protrusions from the bore side of the old caulking.
- Press-fit the shift arm bushing taking care to use the correct orientation and angle. Caulk at three points, avoiding the bushing gap and old caulking.
- After press-fitting, check that the shift rod slides smoothly.



9. Install the 4th — 5th shift arm (7), 1st — Reverse shift block (5), 2nd — 3rd shift arm (4), 1st — Reverse shift arm (2), 1st — Reverse and 2nd — and 3rd shift rod (1).
   - Use a hammer to drive the spring pins (3), (6) into the spring pin holes.
   - When press-fitting spring pins, insert a round bar on the opposite side of the shift rod, and press-fit while taking care to avoid damage to other parts.

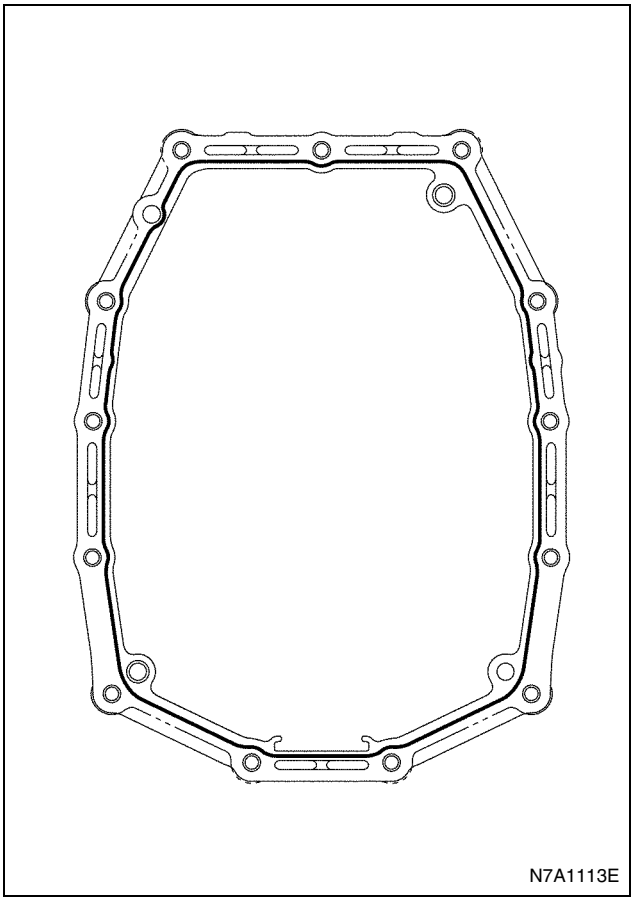


10. Install the 4th — 5th sub shift block (3), 4th — 5th main shift block (2), 3rd — 4th shift block (1).
    - Use a hammer to drive the spring pins (4), (5) into the spring pin holes.
    - When press-fitting spring pins, insert a round bar on the opposite side of the shift rod, and press-fit while taking care to avoid damage to other parts.

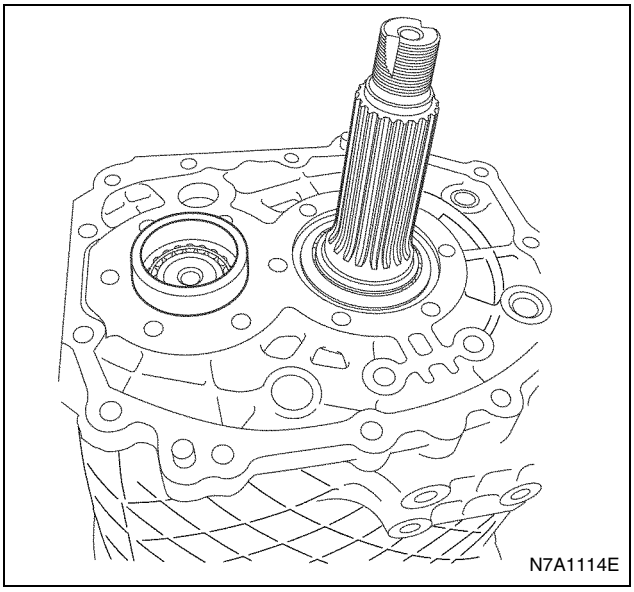


11. Apply Three Bond TB1215 to the mating surface of the transmission case and clutch housing, and install to the clutch housing.
    - Before applying the Three Bond, remove all moisture and oil from the contact surface. Use a bead diameter of at least 2mm across the entire surface, ensuring there are no gaps.

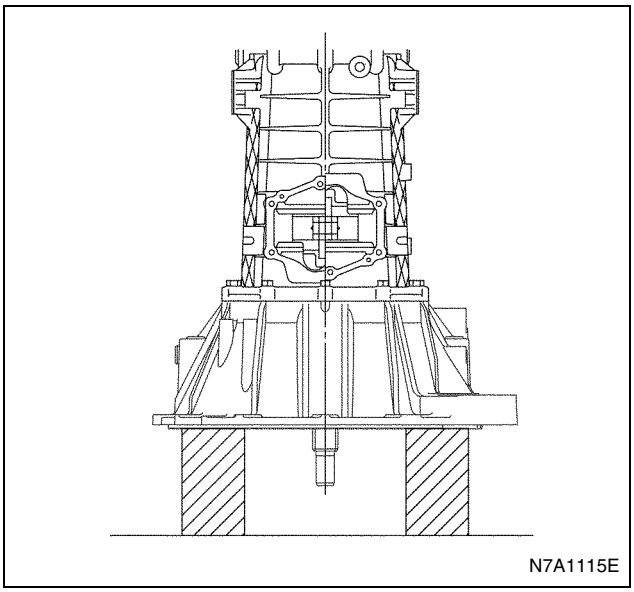
Tighten:
46 N·m (4.7 kg·m / 33.9 lb·ft)


N7A1113E

12. Install the bearing rear outer race in the transmission case.


N7A1114E

13. Install counter shims.
    a. Set the gear position to neutral.
    b. Position the transmission assembly so the clutch housing is downwards.

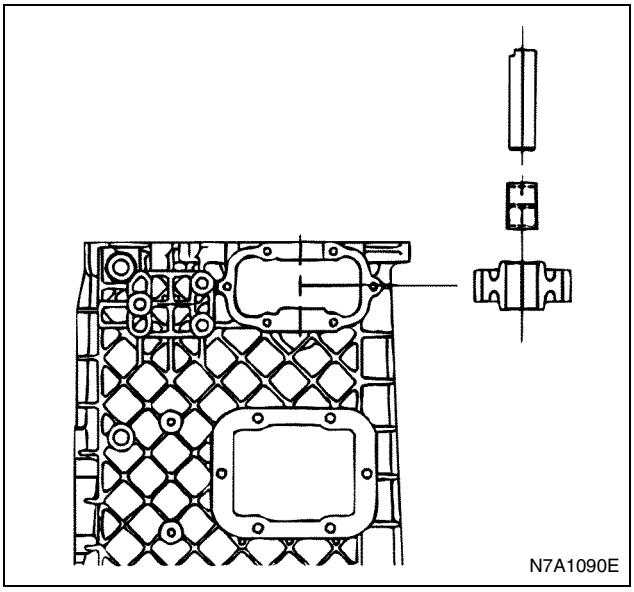

N7A1115E

    c. Rotate the counter shaft for more than 30 turns to fit the taper roller bearing in.
    d. Select the counter shim.
       - At 120-degree intervals, take measurements at three points for the depth from the transmission case back surface up to the counter shaft rear bearing outer ring surface, and then calculate the average of the measured values.
       - Use the table below to select the shim thickness to match the measured average value.

Measured Value (mm)	Shim Thickness (mm)
From — To	
3.34 — 3.40	3.19
3.28 — 3.34	3.13
3.22 — 3.28	3.07
3.16 — 3.22	3.01
3.10 — 3.16	2.95
3.04 — 3.10	2.89
2.98 — 3.04	2.83
2.92 — 2.98	2.77
2.86 — 2.92	2.71
2.80 — 2.86	2.65
2.74 — 2.80	2.59
2.68 — 2.74	2.53
2.62 — 2.68	2.47
2.56 — 2.62	2.41
2.50 — 2.56	2.35
2.44 — 2.50	2.29

Measured Value (mm)	Shim Thickness (mm)
From — To	
2.38 — 2.44	2.23
2.32 — 2.38	2.17
2.26 — 2.32	2.11

14. Install the rear outer snap ring in the main shaft rear bearing.
15. Apply engine oil to the needle bearing, install the reverse idle gear and needle bearing, and insert the reverse idle shaft.

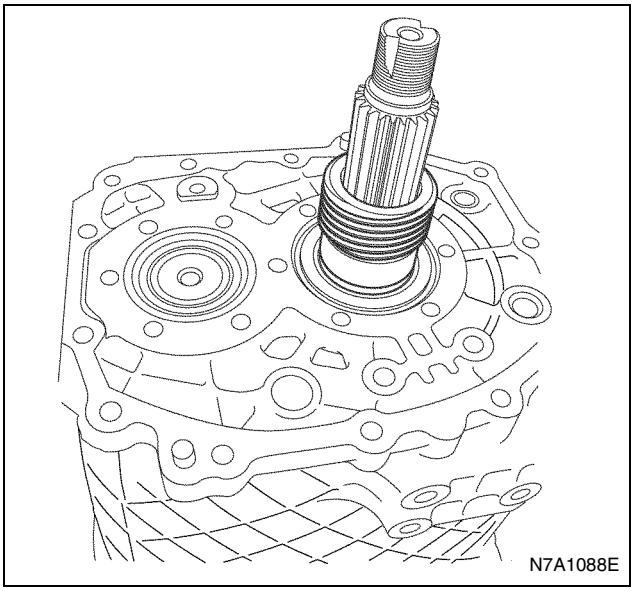


16. Install the retainer in the transmission case.

Tighten:
26N·m (2.7 kg·m / 19.2 lb·ft)

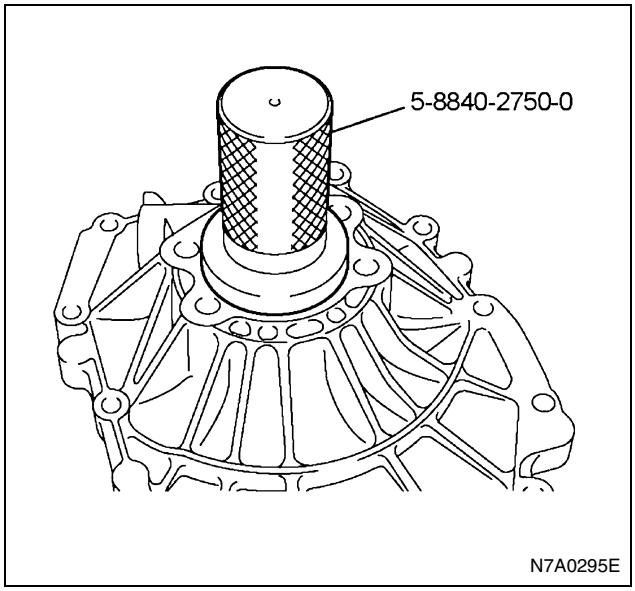
Caution:
Thoroughly remove the sealant from the threads of the transmission case, and use all new screws.

17. Install the collar and speedometer gear.



18. Inspect the rear cover oil seal. If it needs to be replaced with a new one due to wear or damage, apply engine oil to the outer circumference of the oil seal, and then use an installer (5-8840-2750-0) to press-fit it the oil seal to the rear cover.
    - Apply Besco L2 grease to the lip of the oil seal.

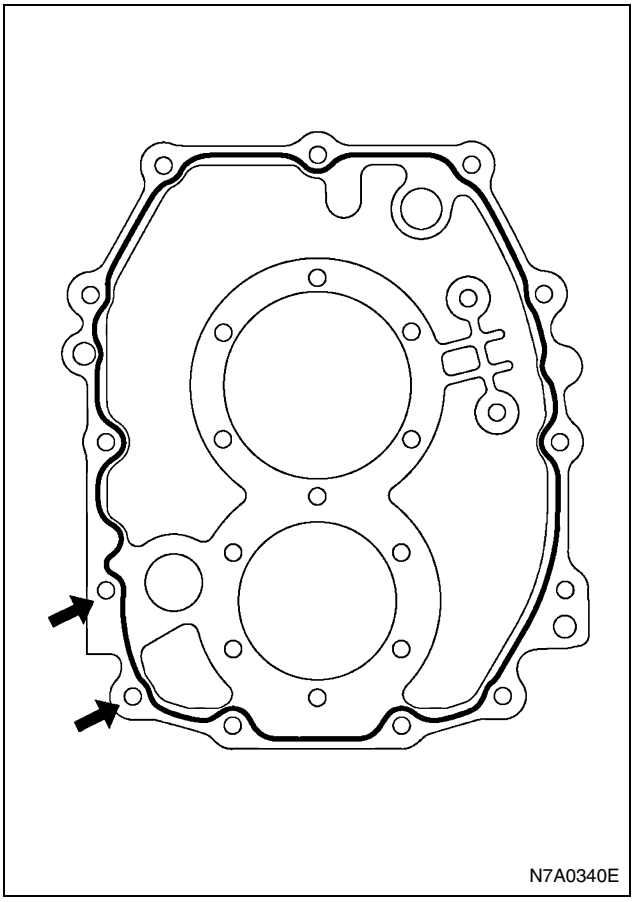
Caution:
Take care to avoid damaging the oil seal lip.



19. Apply Three Bond TB1215 to the mating surface of the transmission case rear cover, and install the rear cover.
    Before applying the Three Bond, remove all moisture and oil from the contact surface. Use a bead diameter of at least 2mm across the entire surface, ensuring there are no gaps.

Caution:
The bolts indicated by arrows (two points) have Loctite applied. Thoroughly remove the sealant from the transmission case threads, and use new Loctite coated bolts.

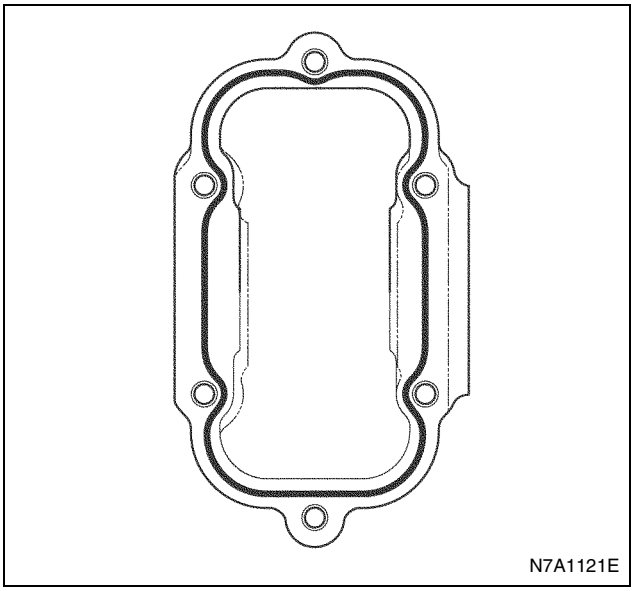
Tighten:
46 N·m (4.7 kg·m / 33.9 lb·ft)


N7A0340E

20. Apply Three Bond TB1215 to the mating surface of the transmission case reverse idle cover, and install the reverse idle cover (2).

Tighten:
19 N·m (1.9 kg·m / 14 lb·ft)

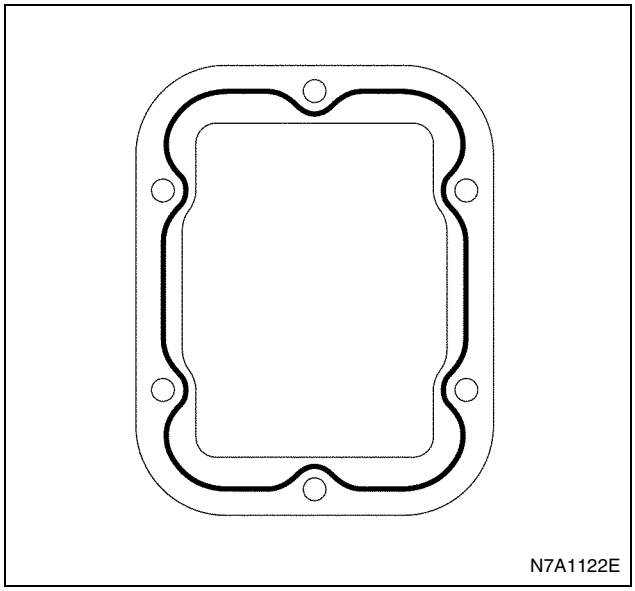
- Before applying the Three Bond, remove all moisture and oil from the contact surface. Use a bead diameter of at least 2mm across the entire surface, ensuring there are no gaps.


N7A1121E

21. Apply Three Bond TB1215 to the mating surface of the transmission case front side cover, and install the PTO cover (1).
    - Before applying the Three Bond, remove all moisture and oil from the contact surface. Use a bead diameter of at least 2mm across the entire surface, ensuring there are no gaps.

Tighten:
37 N·m (3.8 kg·m / 27.3 lb·ft)

Caution:
The bolts have Loctite applied. Thoroughly remove the sealant from the transmission case threads, and use new Loctite coated bolts.


N7A1122E

22. Apply engine oil to the input shaft speed sensor O-ring, and install the input shaft speed sensor.

Tighten:
9 N·m (0.9 kg·m / 6.6 lb·ft)

23. Thoroughly remove sealant from the threads of the detent assembly (13), (12), (11), apply Loctite 242, and install.

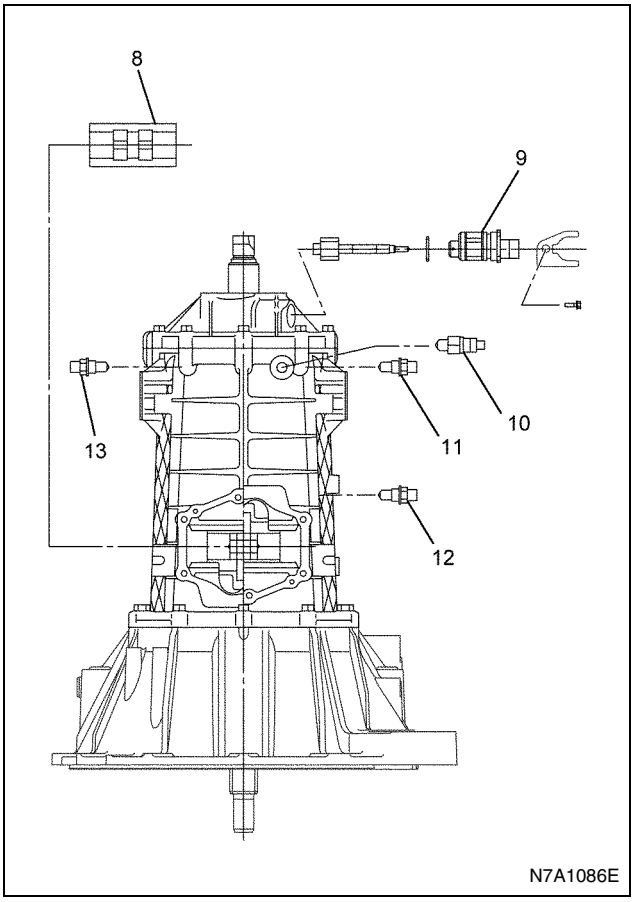
Tighten:
27 N·m (2.8 kg·m / 19.9 lb·ft)

24. Apply Loctite 242 to the reverse switch threads, and install the reverse switch (10).

Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

25. Apply engine oil to the speedometer driver gear and O-ring, and then install the speedometer driven gear (9).

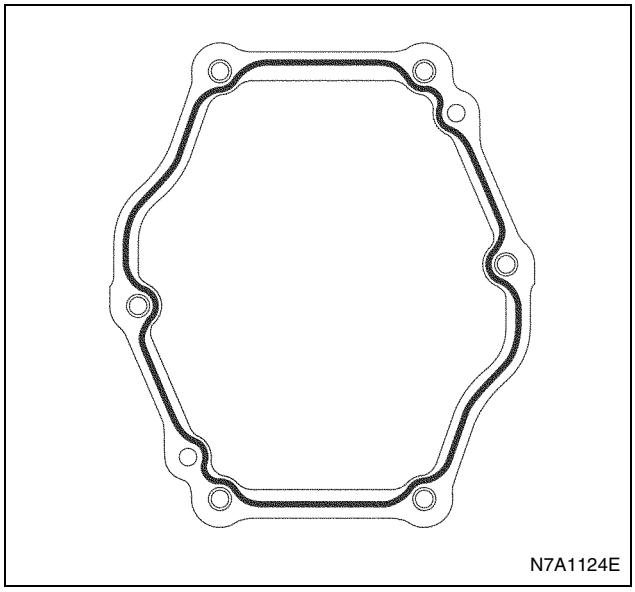
Tighten:
20 N·m (2.0 kg·m / 14.8 lb·ft)



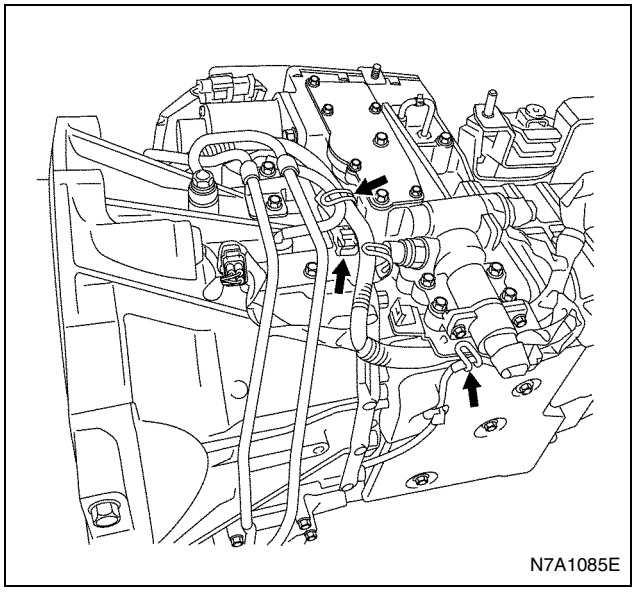
26. Install the gearshift control box.
    a. Set the gear position to neutral, apply Three Bond TB1215 to the surface, which mates with control box, of the transmission case, and install the interlock plate and gearshift control box.
        • Before applying the Three Bond, remove all moisture and oil from the contact surface. Use a bead diameter of at least 2mm across the entire surface, ensuring there are no gaps.

Caution:
The bolts have Loctite applied. Thoroughly remove the sealant from the transmission case threads, and use new Loctite coated bolts.

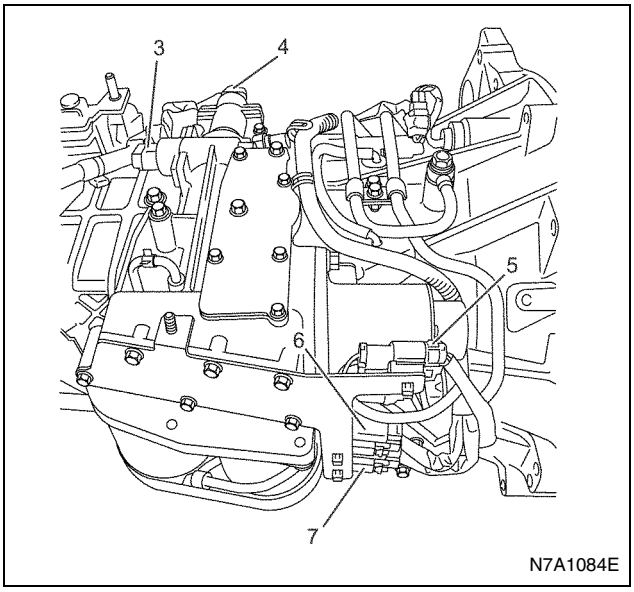
Tighten:
27 N·m (2.8 kg·m / 19.9 lb·ft)



    b. Attach the harness to the clip (two points) and install the neutral switch connector to the bracket.



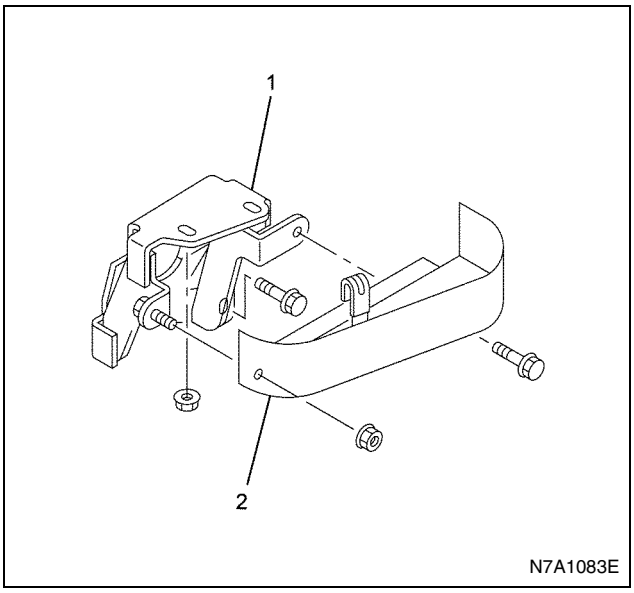
    c. Connect the five connectors to the gearshift control box.
        • Connect the connectors of the select sensor (3), shift sensor (4), select solenoid (5), 2-4-6-R shift solenoid (6), and 1-3-5 shift solenoid (7).



27. Install the heat protector bracket (1) and heat protector (2).

Tighten:

Bracket	45 N·m (4.6 kg·m / 33.2 lb·ft)
Protector	23 N·m (2.3 kg·m / 17 lb·ft)



28. Apply engine oil to the O-ring, and then install the drain plug and O-ring.

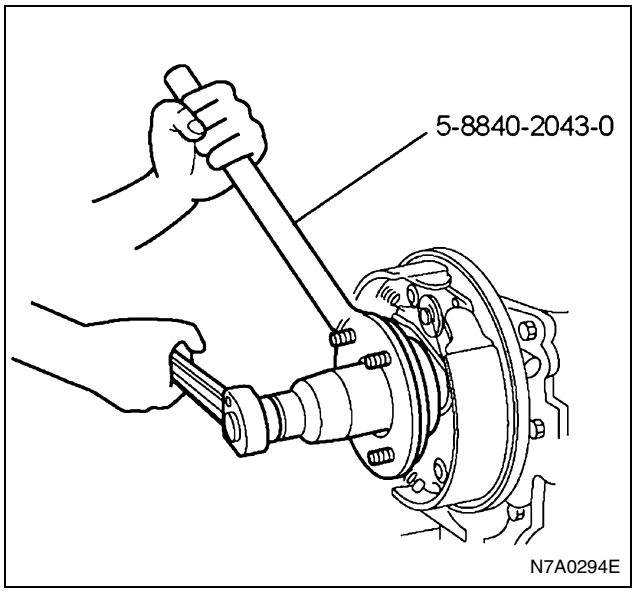
Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

29. Apply 5W-30 engine oil to the O-ring, and then install the filler plug and O-ring.

Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

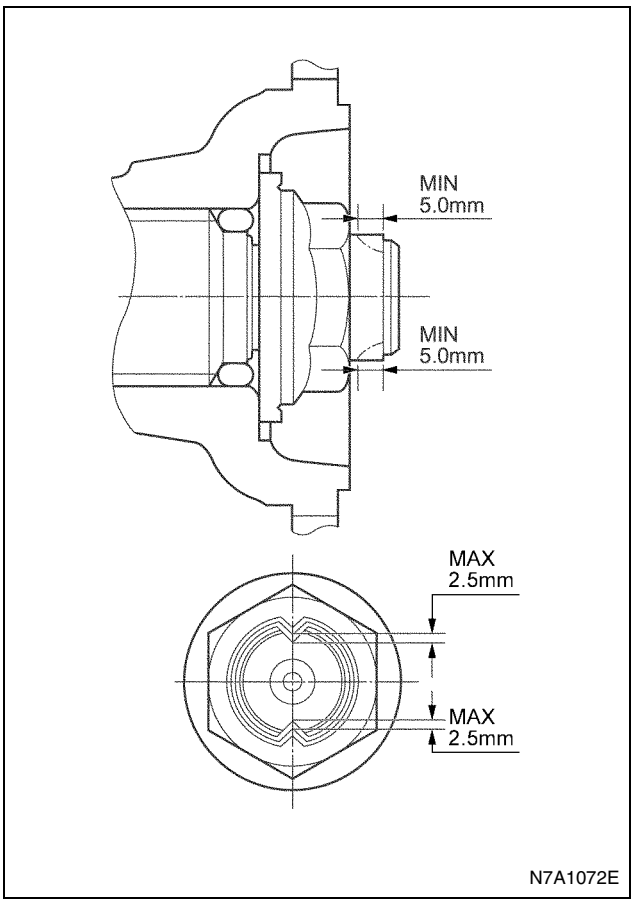
30. Install the parking brake assembly.
    - Refer to “Parking Brake”.
31. Apply engine oil to the O-ring, and then install the coupling driver and O-ring.
32. Using a new lock nut, use the flange holder (5-8840-2043-0) to tighten the lock nut.

Tighten:
289 N·m (29.5 kg·m / 213.2 lb·ft)



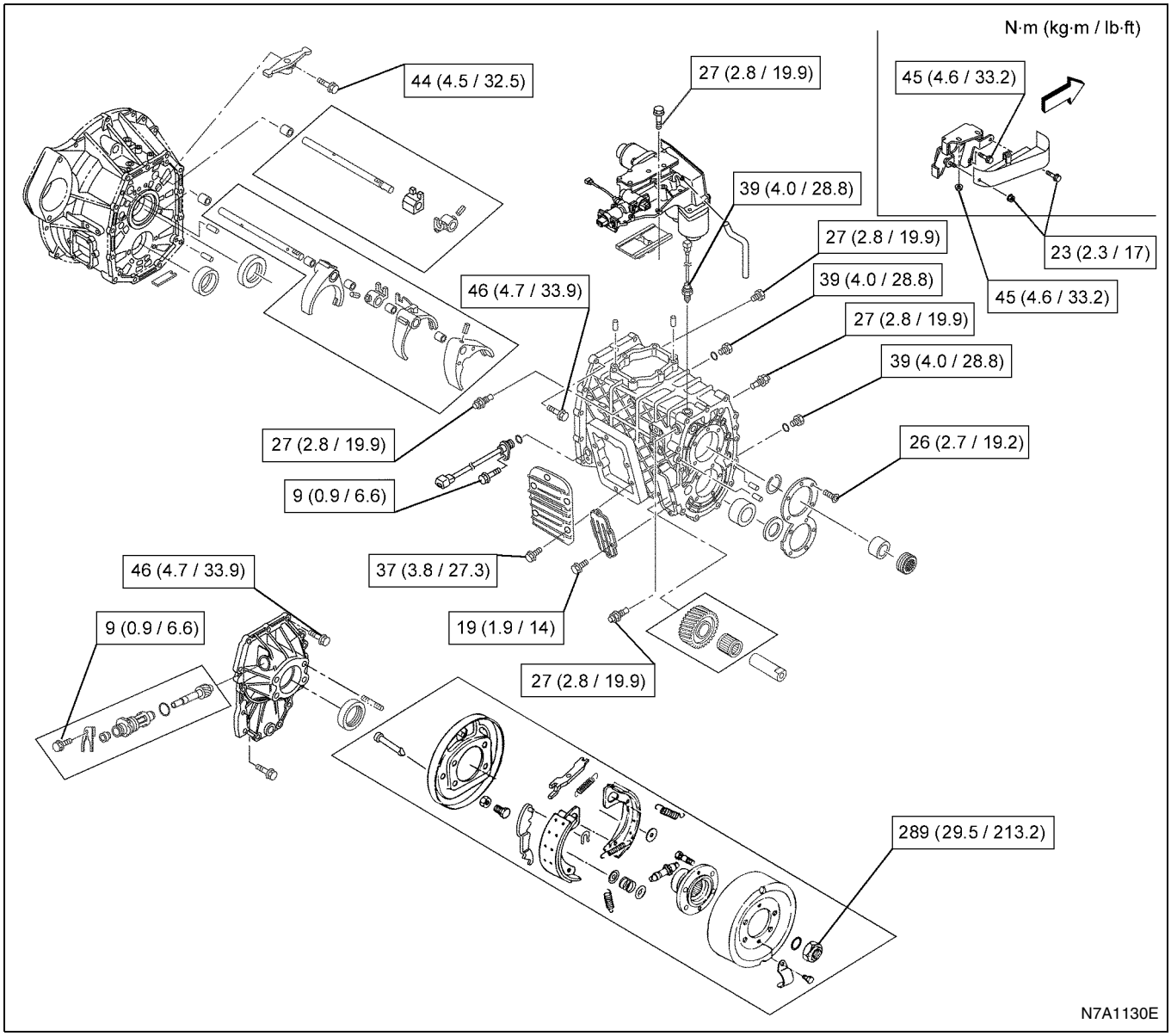
- After tightening the lock nut to the specified torque, stake it (2 points) securely using a chisel (chisel tip shape: approx. 1 mm in radius × 60 degrees) so the lock nut lip gap is aligned with the V-groove of the shaft and is at least 5 mm, and the clearance between the V-groove bottom and the nut lip is 2.5 mm or less.

Caution:
After caulking, check the caulking of the nut. If any cracks are discovered, replace the lock nut and re-caulk.



33. Install the parking brake drum and adjust hole cover fixing bolt.
    - Refer to “Parking Brake”.

Tightening Torques



Special Tools

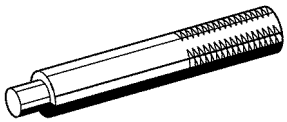
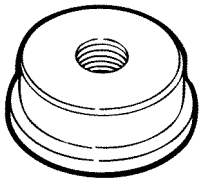
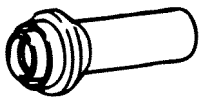
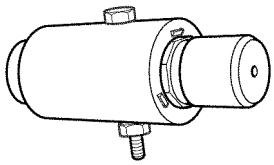
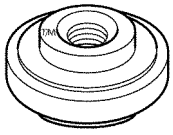
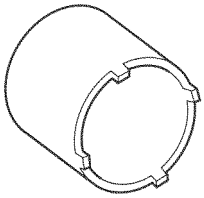
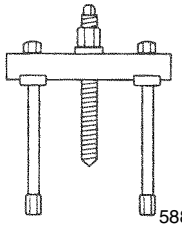
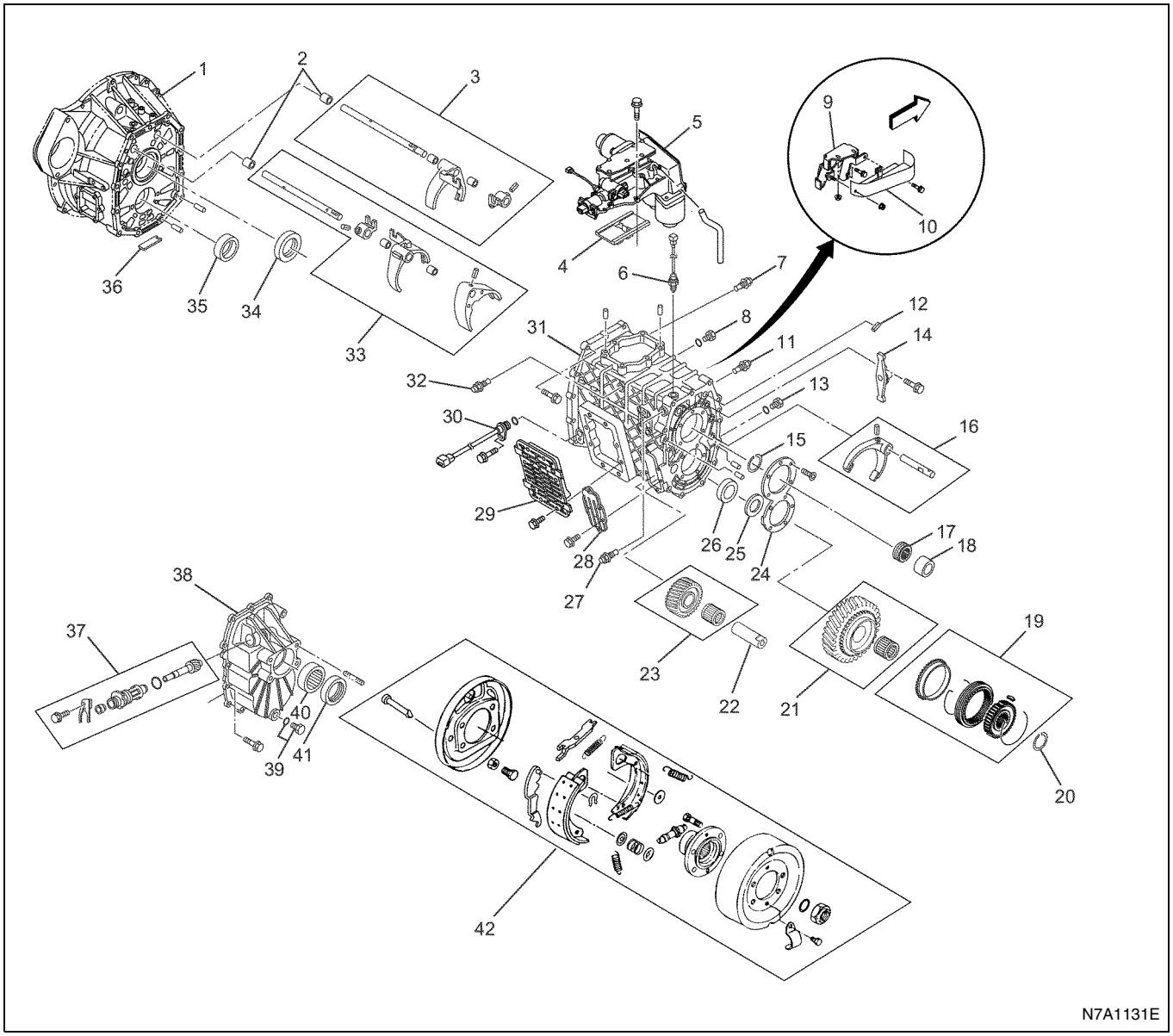
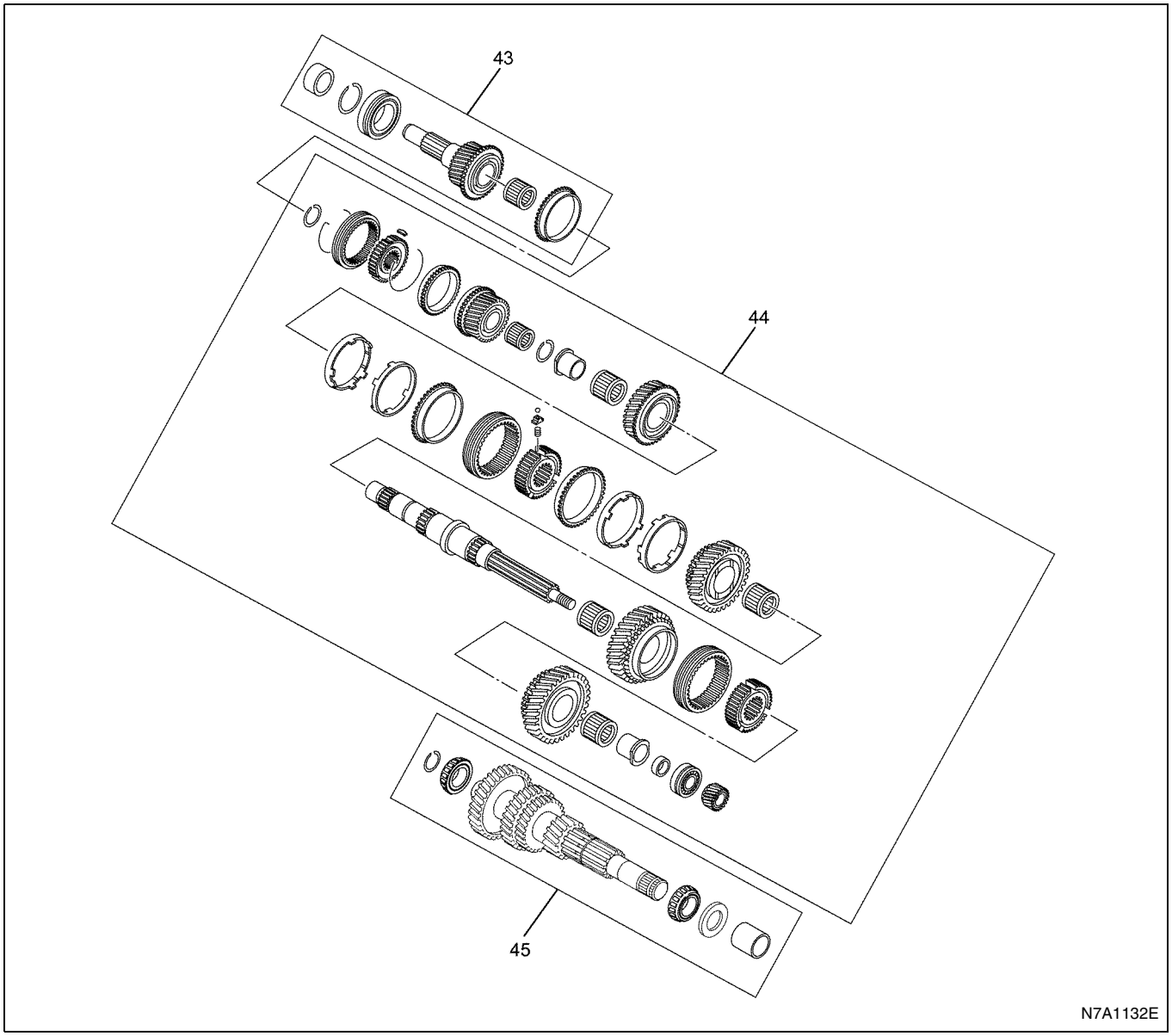
Illustration	Tool No. Tool Name
 5884000070	5-8840-0007-0 Grip
 5884020260	5-8840-2026-0 Bearing Installer
 5884020430	5-8840-2043-0 Flange Holder
 5884027500	5-8840-2750-0 Oil Seal Installer
 5884027550	5-8840-2755-0 Busing Remover and Installer
 5884027560	5-8840-2756-0 Oil Seal Installer

Illustration	Tool No. Tool Name
 5884027570	5-8840-2757-0 Bearing Remover
 5884027980	5-8840-2798-0 Wrench
 5884028020	5-8840-2802-0 Brushing Puller

MYY Transmission (6-Speed)

Components





Legend

1. Clutch Housing
2. Clutch Housing Bushing
3. 4th — 5th, 6th Shift Arm
4. Interlock Plate
5. Gearshift Control Box
6. Reverse Switch
7. Detent Assembly
8. Filler Plug
9. Control Box Bracket
10. Harness Protector
11. Detent Assembly
12. Spring Pin
13. Drain Plug
14. 6th Relay Lever
15. Snap Ring
16. 6th Shift Arm and Shift Rod
17. Speedometer Gear
18. Collar
19. 6th Clutch Hub Assembly and Sleeve
20. Snap Ring
21. 6th Gear and Needle Bearing
22. Reverse Idle Shaft
23. Reverse Idle Gear and Needle Bearing
24. Retainer
25. Counter Shim
26. Counter Rear Bearing
27. Detent Assembly
28. Reverse Idle Cover
29. PTO Cover
30. Input Shaft Speed Sensor
31. Transmission Case
32. Detent Assembly
33. 1st — Reverse and 2nd — 3rd Shift Arm
34. Front Oil Seal
35. Bearing Outer Race
36. Magnet

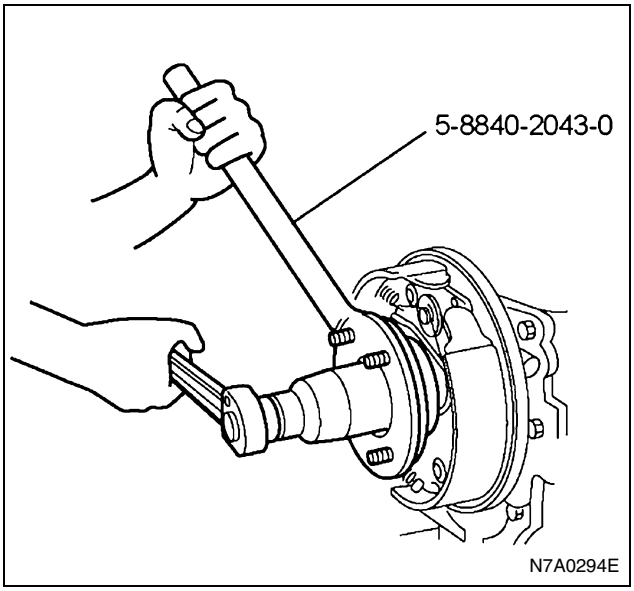
37. Speedometer Driven Gear
38. Rear Cover
39. Drain Plug
40. Main End Needle Bearing
41. Rear Oil Seal
42. Parking Brake Assembly
43. Top Gear Shaft Assembly
44. Main Shaft Assembly
45. Counter Shaft Assembly

Disassembly

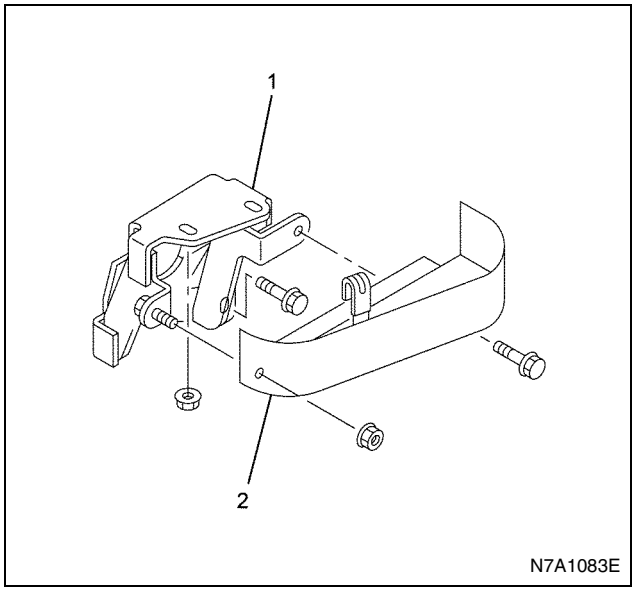
Caution:
The transmission case and clutch housing are made of aluminium, to be sure to exercise sufficient care to ensure they are not damaged. A particularly high level of care is required to protect against rib damage, which can affect the strength of the case.

Also take care to avoid personal injury when working with cases, gears, and other heavy items.

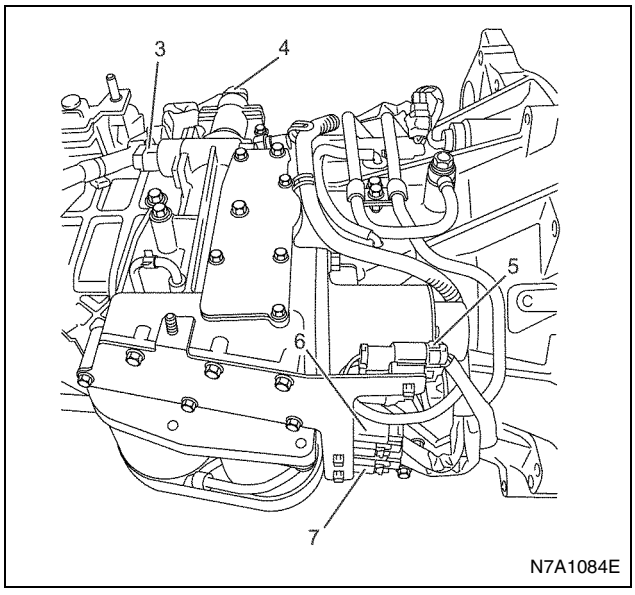
1. Remove the parking brake drum.
   - Refer to “Parking Brake”.
2. Carefully release the caulking (two points) of the coupling driver lock nut, and remove the lock nut by fixing it with the flange holder (5-8840-2043-0).



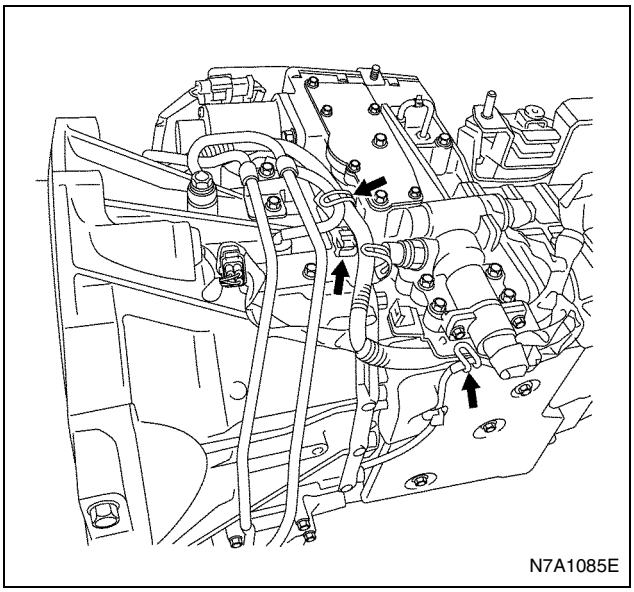
3. Remove the coupling driver and O-ring.
4. Remove the parking brake assembly.
   - Refer to “Parking Brake”.
5. Remove the parking brake cable bracket from the transmission case.
6. Remove the filler plug and O-ring.
7. Remove the drain plug and O-ring.
   - Drain the transmission oil. When draining the oil, check the oil amount, and check for metal bits and foreign matter.
8. Remove the heat protector (2) and heat protector bracket (1).



9. Remove the gearshift control box.
   a. Disconnect the five connectors from the control box.
      - Disconnect the connectors of the select sensor (3), shift sensor (4), select solenoid (5), 2-4-6-R shift solenoid (6), and 1-3-5 shift solenoid (7).

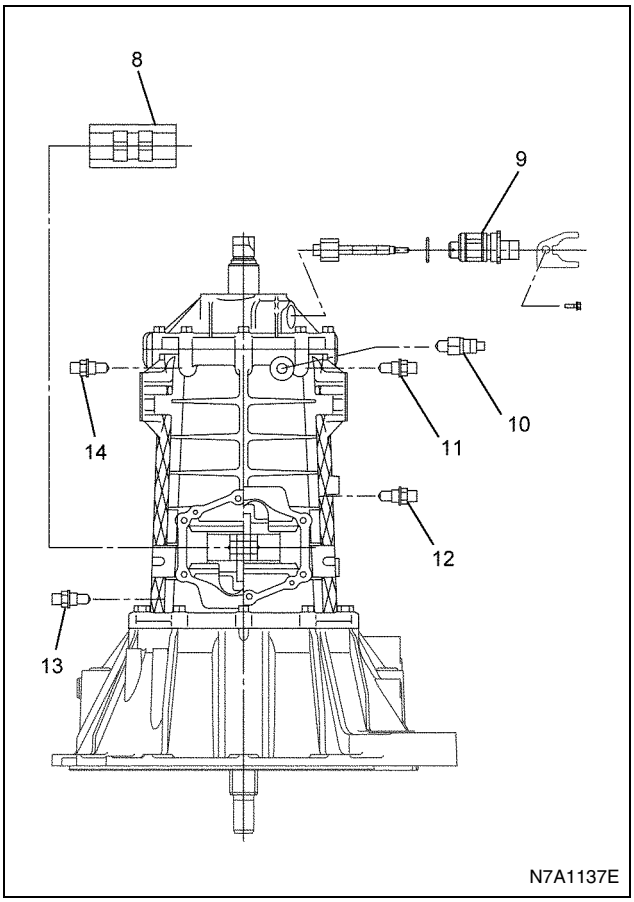


b. Remove the harness from the clip (two points), and remove the neutral switch connector from the bracket.


N7A1085E

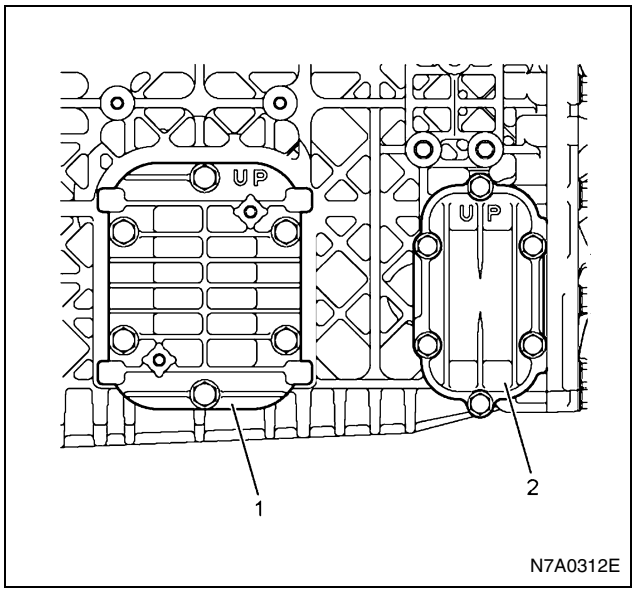
c. Remove the six bolts and the gearshift control box.

10. Remove the interlock plate (8).
11. Remove the speedometer driven gear (9).
12. Remove the reverse switch (10).
13. Remove the detent assembly (11), (12), (13), (14).



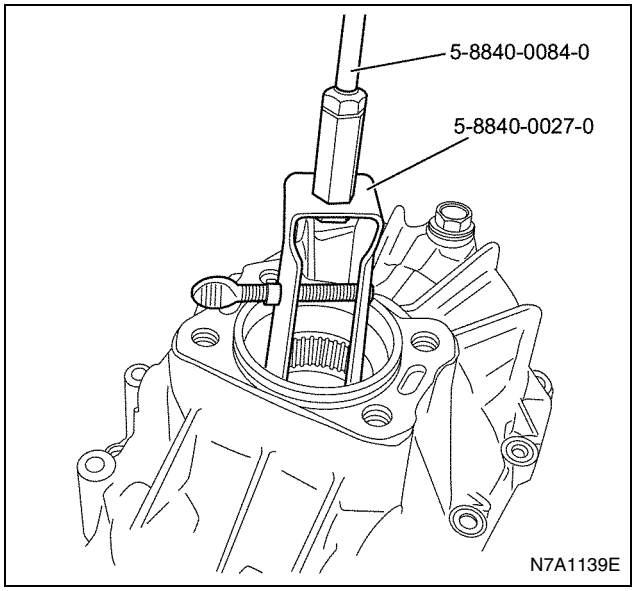
N7A1137E

14. Remove the input shaft speed sensor.
15. Remove the PTO cover (1).
16. Remove the reverse idle cover (2).



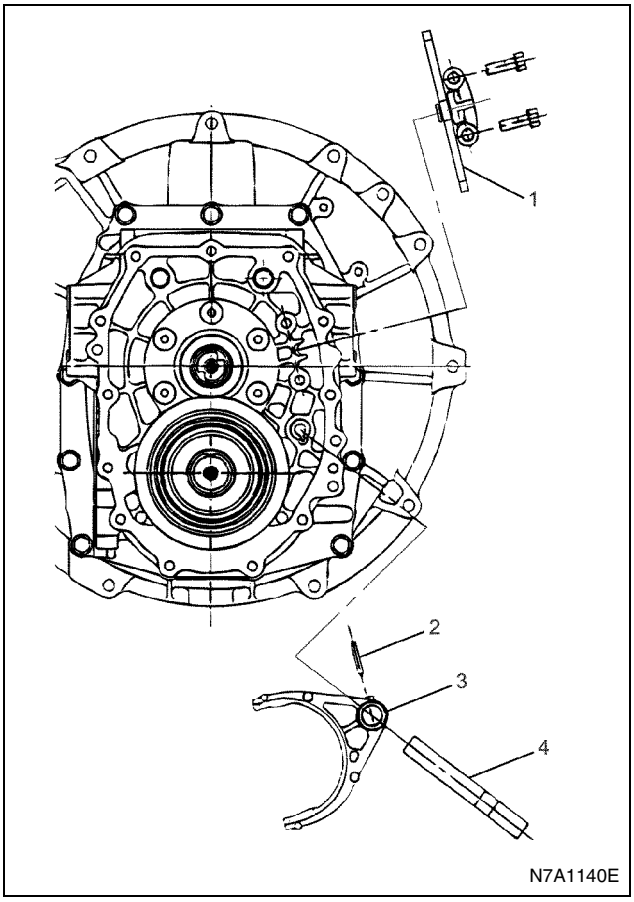
N7A0312E

17. Remove the rear cover assembly.
18. Inspect the rear cover oil seal. If it is worn or damaged, remove it from the rear cover.
19. Use a remover (5-8840-0027-0) and sliding hammer (5-8840-0084-0) to remove the main end needle bearing from the rear cover.

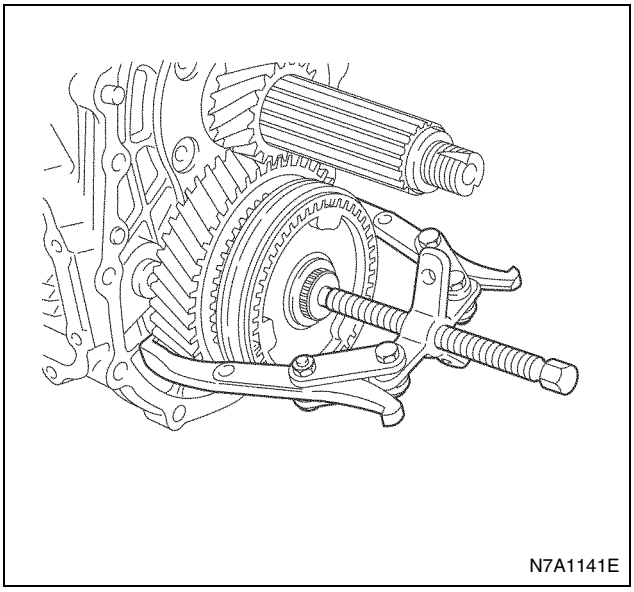


N7A1139E

20. Remove the 6th relay lever (1).
21. Remove the 6th shift arm (3) and 6th shift rod (4).
    - Use a spring remover to drive out the spring pin (2).

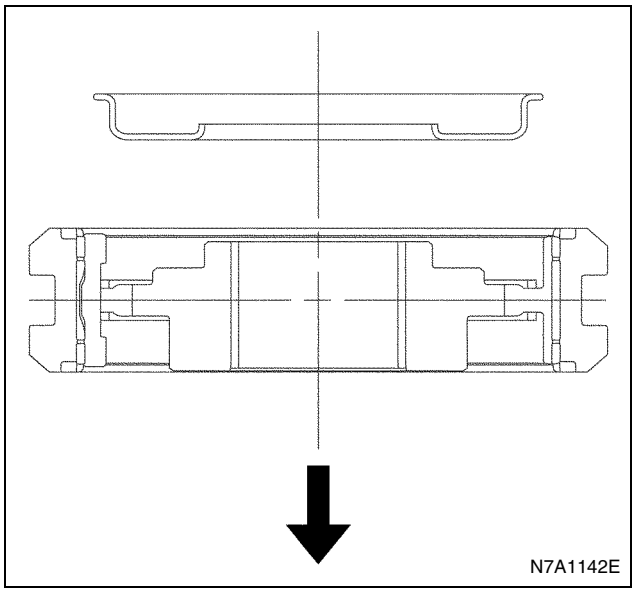


22. Use snap ring pliers to remove the 6th clutch hub snap ring.
23. Use a puller to remove the 6th clutch hub assembly and sleeve, 6th block ring, 6th gear, and needle bearing from the counter shaft.

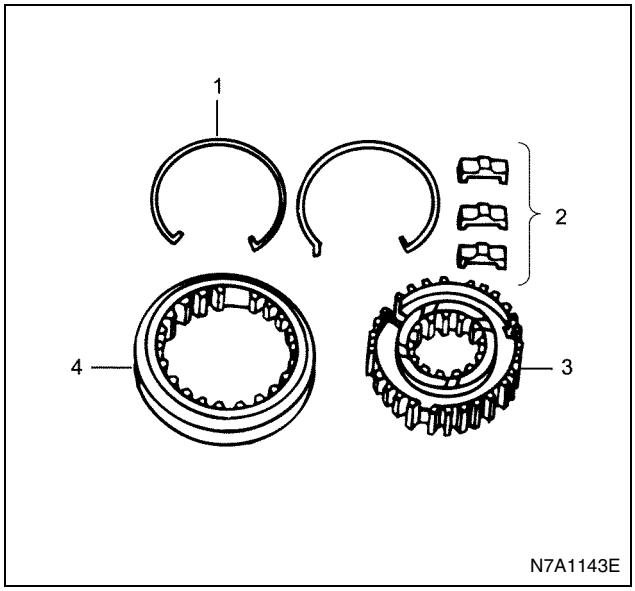


24. Disassemble the 6th clutch hub assembly and sleeve.
    a. Remove the stopper plate from the clutch hub.
    • The arrow indicates the front of the transmission.

Caution:
If you remove the stopper plate, replace it with a new plate when re-installing.

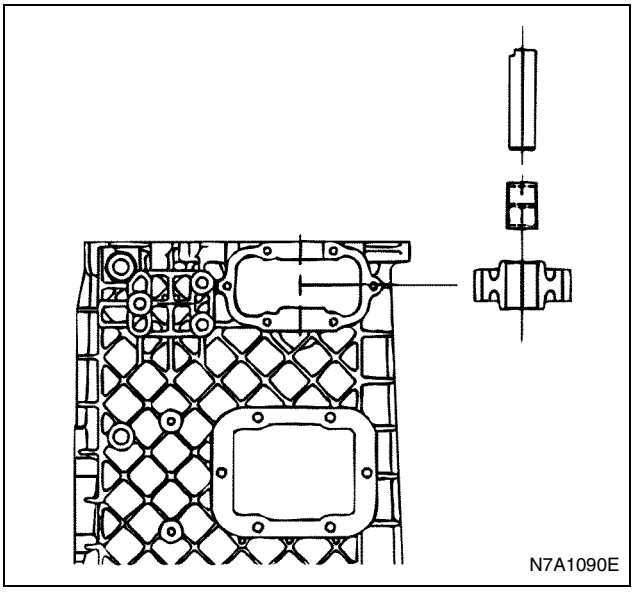


    b. Disassemble the clutch hub assembly and sleeve.

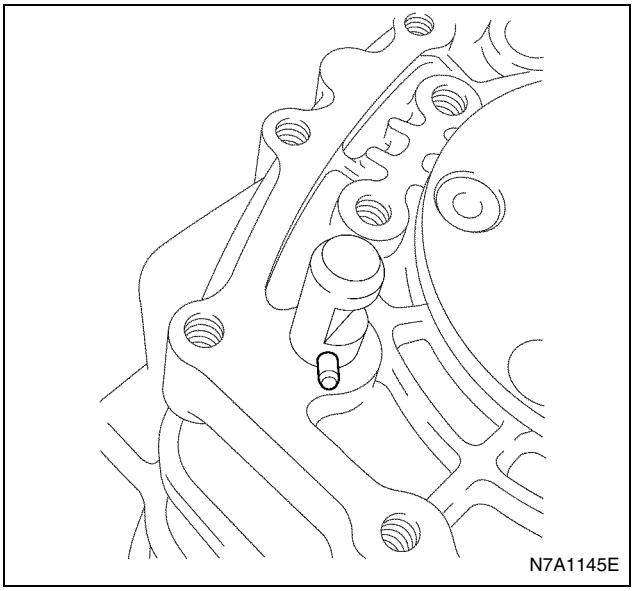


Legend
1. Spring
2. Insert Key
3. Clutch Hub
4. Sleeve

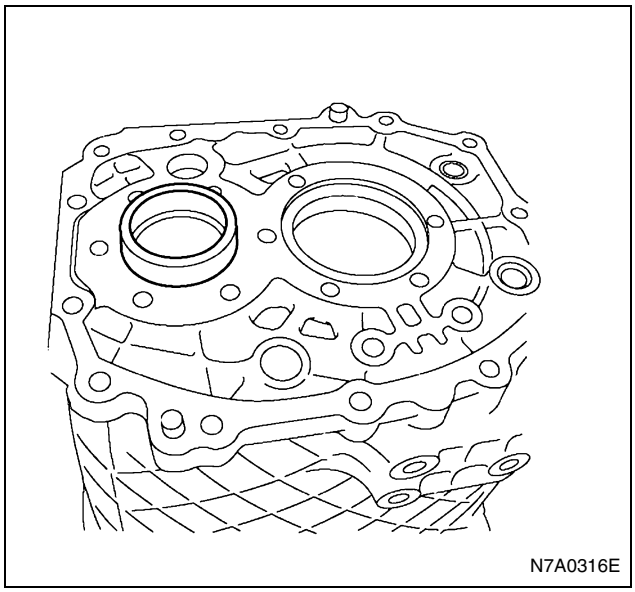
25. Remove the speedometer gear.
    • Remove the collar.
26. Remove the retainer from the transmission case.
27. Pull out the reverse idle shaft, and remove the reverse idle gear and needle bearing.


N7A1090E

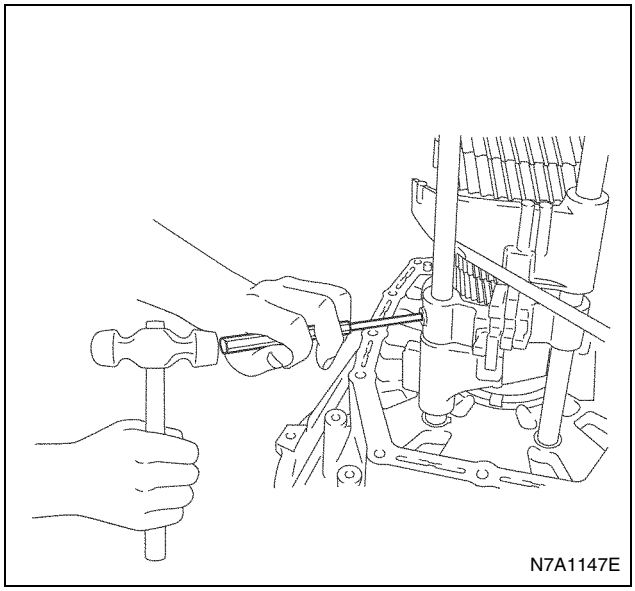
28. Remove the rear outer snap ring from the main shaft rear bearing.
29. Remover the counter shim.
30. Remove the 4th — 5th and 6th shift rod snap rings.


N7A1145E

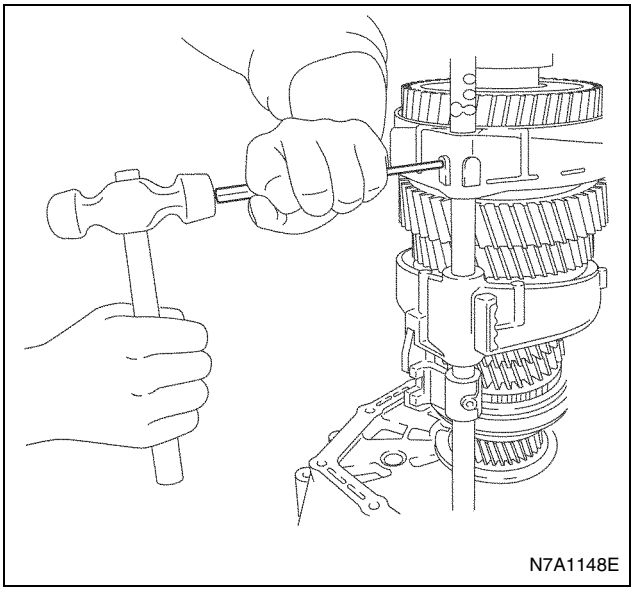
31. Remove the transmission case from the clutch housing.
32. Remove the bearing rear outer race from the transmission case.


N7A0316E

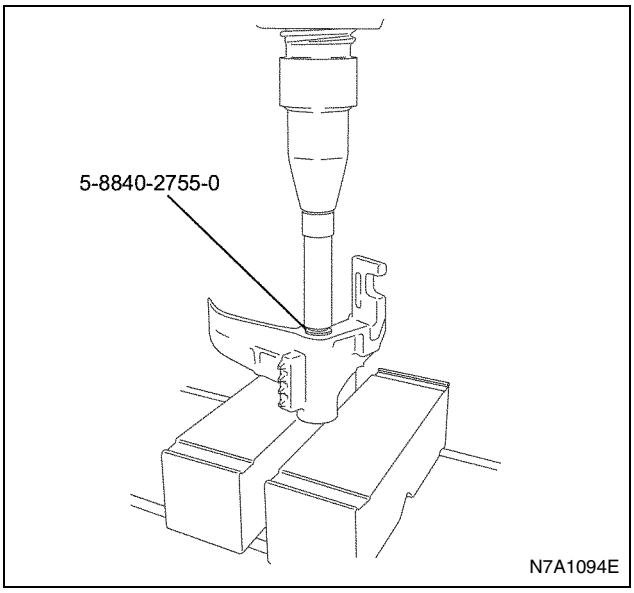
33. Remove the 4th — 5th and 6th shift rod, 1st — Reverse and 6th shift block, 4th — and 5th shift arm.
    - When driving out the spring pin, insert a round bar on the opposite side of the shift rod, and use a spring pin remover to remove the spring pin while taking care to avoid damage to other parts.


N7A1147E

34. Remove the 1st — Reverse and 2nd — 3rd shift rod, 1st — Reverse shift arm, 3rd — 2nd shift arm, 1st — and Reverse and 6th shift block.
    - When driving out the spring pin, insert a round bar on the opposite side of the shift rod, and use a spring pin remover to remove the spring pin while taking care to avoid damage to other parts.

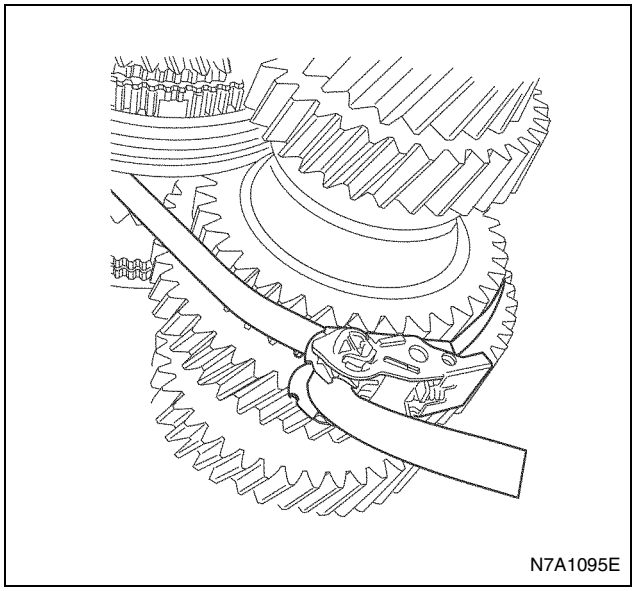

N7A1148E

35. Use a remover (5-8840-2755-0) to remove the bushing from the 4th — 5th shift arm.
36. Use a remover (5-8840-2755-0) to remove the busing from the 3rd — 2nd shift arm.
    - Use the remover in combination with a round bar of a length that makes it possible to push in as far as possible.

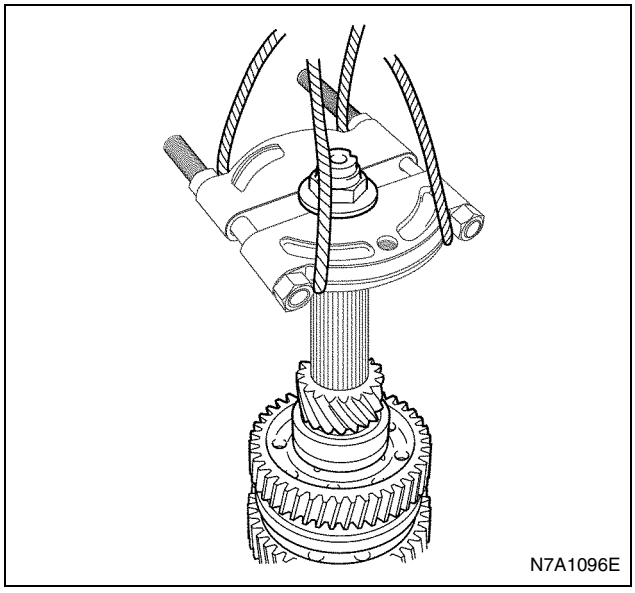


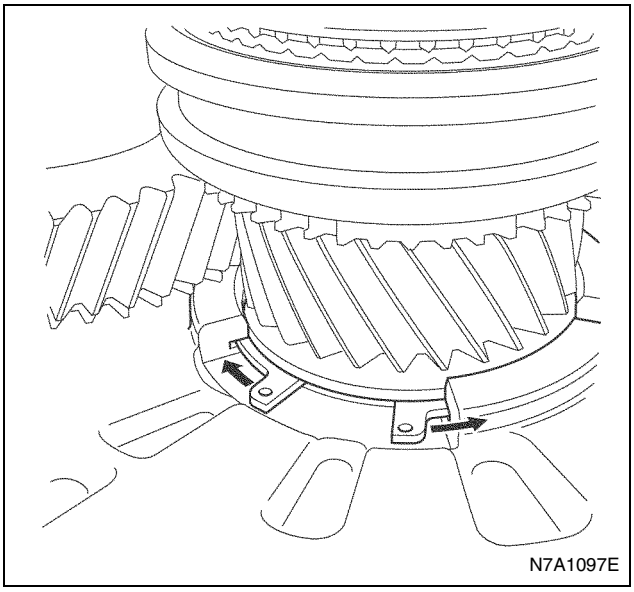
N7A1094E

37. Remove the magnet from the clutch housing.
38. Remove the main shaft assembly, top gear shaft assembly, and counter shaft assembly.
    a. Use a lashing belt or some other belt from a lashing device to bundle the main shaft assembly, counter shaft assembly, and top gear shaft assembly at two points so they cannot separate. Tighten the belt securely.

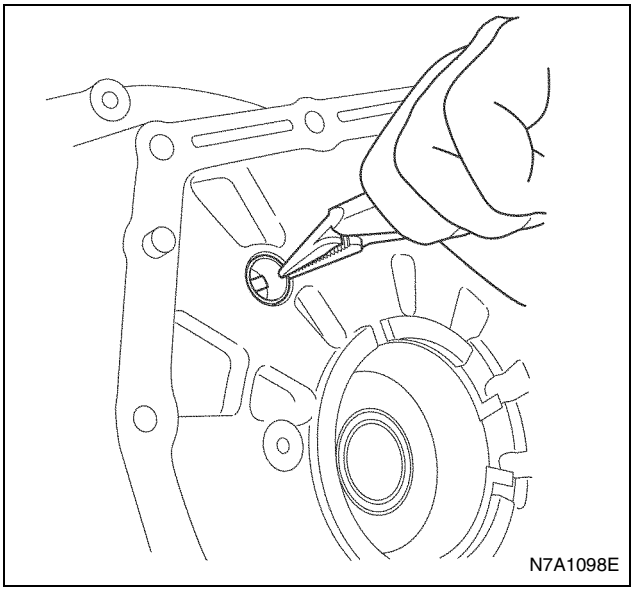

N7A1095E

    b. Attach a bearing remover to the main shaft and secure with a lock nut. Then attach a wire and raise it using a hoist. While opening the top gear shaft bearing outer snap ring attached to the clutching housing, simultaneously remove the top gear shaft assembly, main shaft assembly, and counter shaft assembly from the clutch housing.

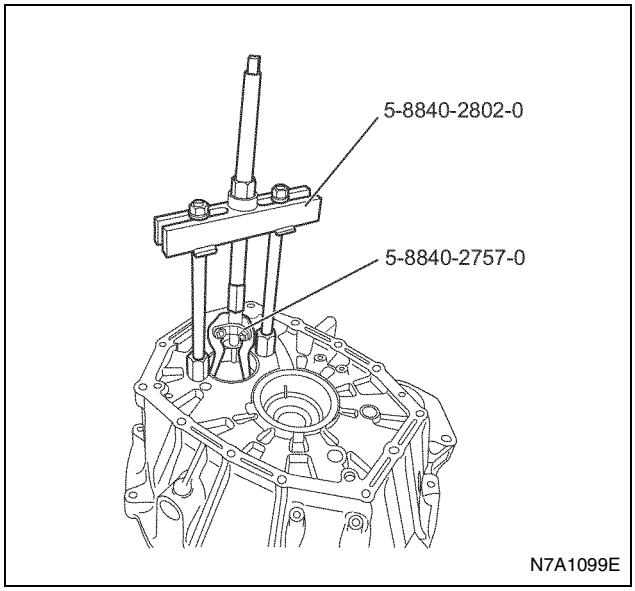

N7A1096E


N7A1097E

39. Inspect the clutch housing bushing. If it is worn or damaged, use pliers to remove it from the clutch housing.


N7A1098E

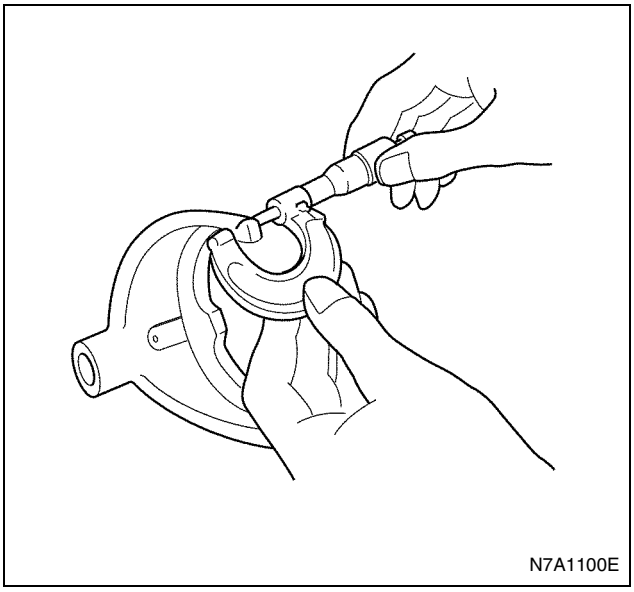
40. Inspect the counter shaft front bearing. If it is worn or damaged, use a bearing remover (5-8840-2757-0) and bushing puller (5-8840-2802-0) to remove the bearing outer race from the clutch housing.



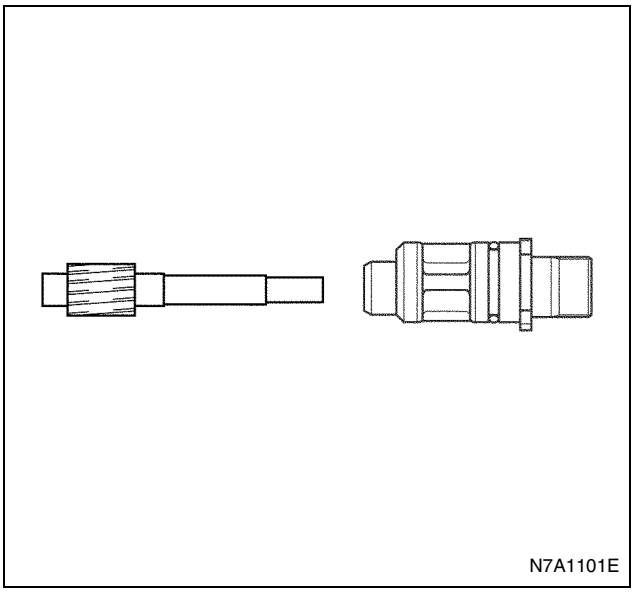
N7A1099E

41. Inspect the front oil seal. If it is worn or damaged, remove it from the clutch housing cover.
Inspect each part. Replace or repair as required if anything is worn or damaged or if any other defect is discovered.
42. Inspect each shift mechanism component. Repair any minor damage, bending, or stepped wear. Replace any component that is badly damaged or worn, and any component that exceeds the allowable limit.
    - Shift rod and shift arm bending, wear, damage
    - Shift arm thickness
        – Use a micrometer to measure the thickness of the shift arm tip.

Shift Arm Thickness (mm)		
	Specified Value	Limit
1st — Reverse 3rd — 2nd 5th — 4th	9.60 — 9.85	9.00
6th	9.60 — 9.85	9.30


N7A1100E

43. Inspect the speedometer driven gear and driven gear bushing for wear.
    - Replace if there is excessive wear.


N7A1101E

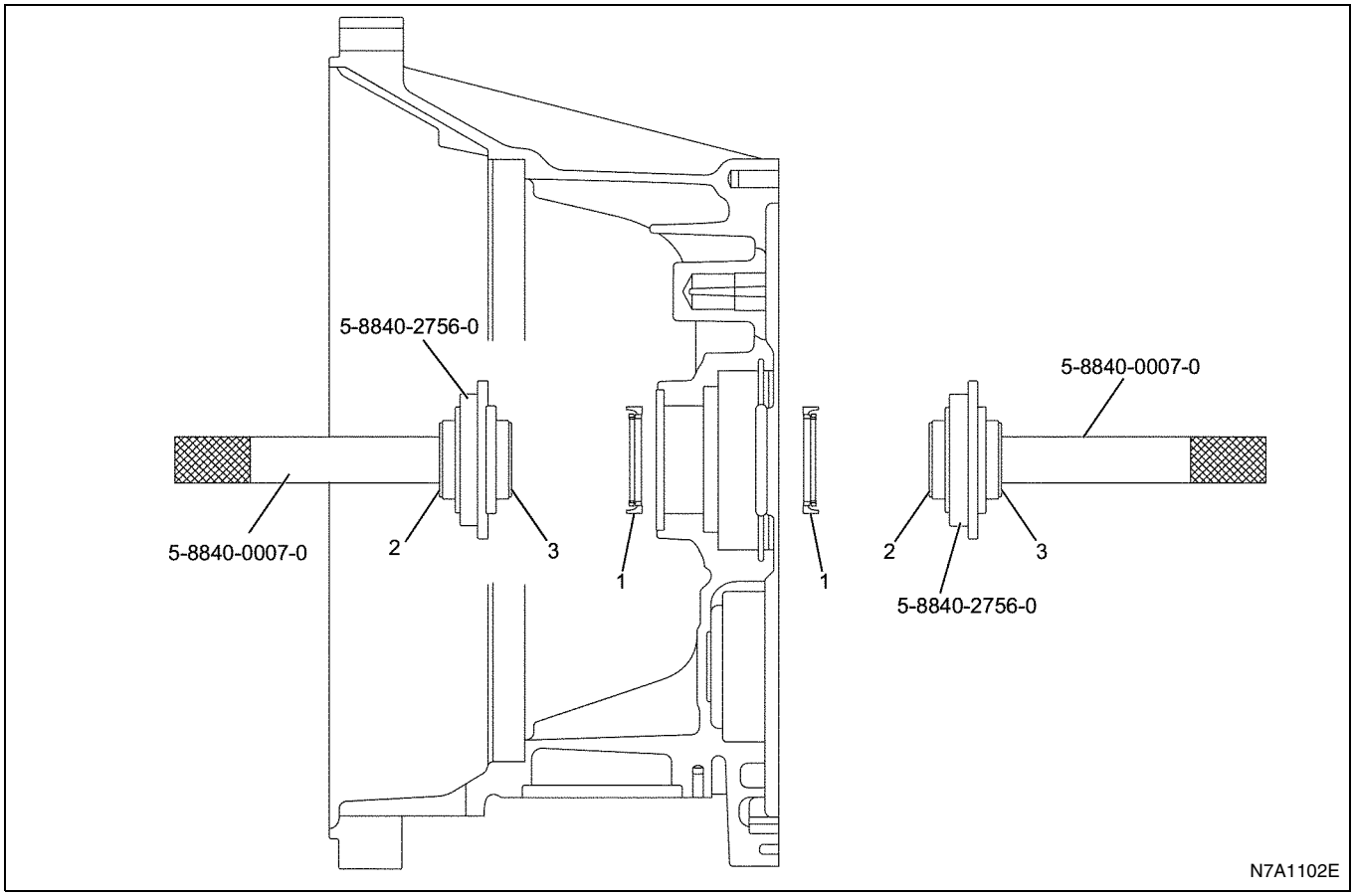
44. Measure the gap between the insert key and the block ring groove.
    - Use a caliper to measure the gap.
    - If the measured value exceeds the limit, replace the insert key and block ring.

Gap Between the Insert Key and Block Ring Groove (mm)	
	Specified Value
6th	3.46 — 3.76

Assembly

1. Inspect the oil seal. If it needs to be replaced due to wear or damage, apply engine oil or grease to the oil seal's outer circumference, and then use an installer (5-8840-2756-0) and grip (5-8840-0007-0) to press-fit it into the clutch housing as shown in the illustration, taking care that the front-back orientation of the front oil seal is correct.
    - Fill the lip of the oil seal with Besco L2 grease.

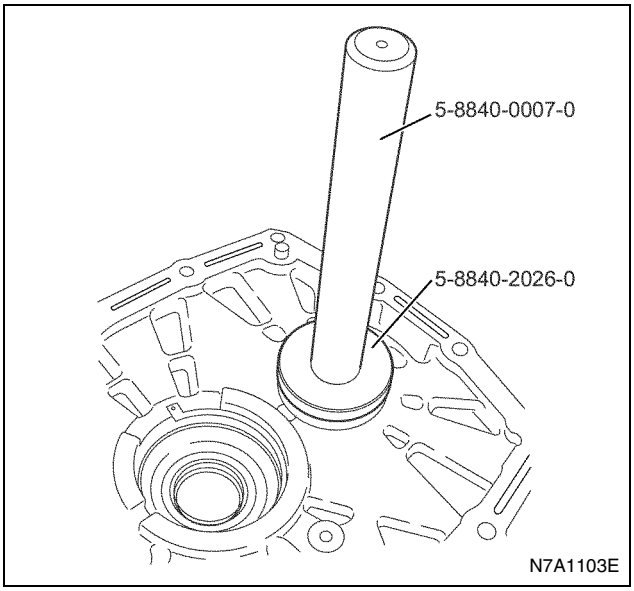
Caution:
Take care to avoid damaging the oil seal lip.



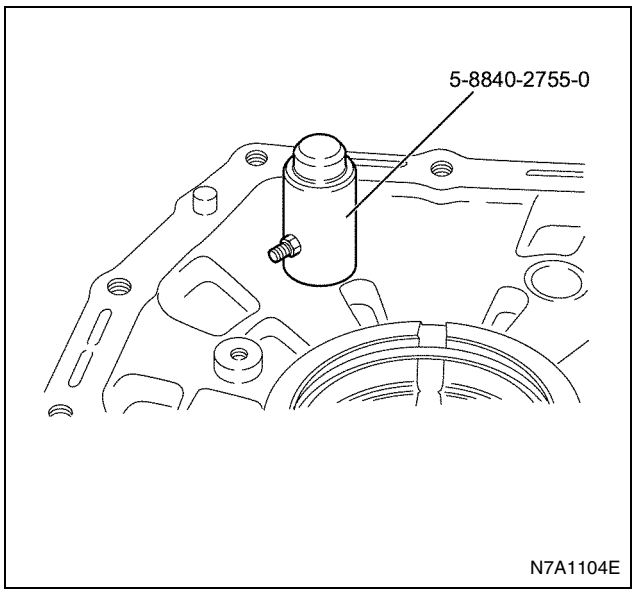
Legend

1. Front Oil Seal
2. T/M Mark
3. ENG Mark

2. Inspect the counter shaft front bearing. If it needs to be replaced with a new one due to wear or damage, use a grip (5-8840-0007-0) and installer (5-8840-2026-0) to press-fit the bearing outer race.

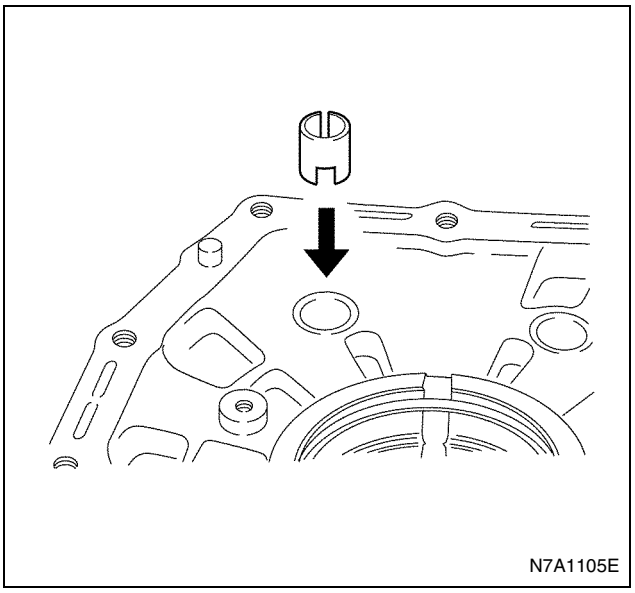


3. Inspect the clutch housing bushing. If it needs to be replaced with a new one due to wear or damage, use an installer (5-8840-2755-0) to press-fit.

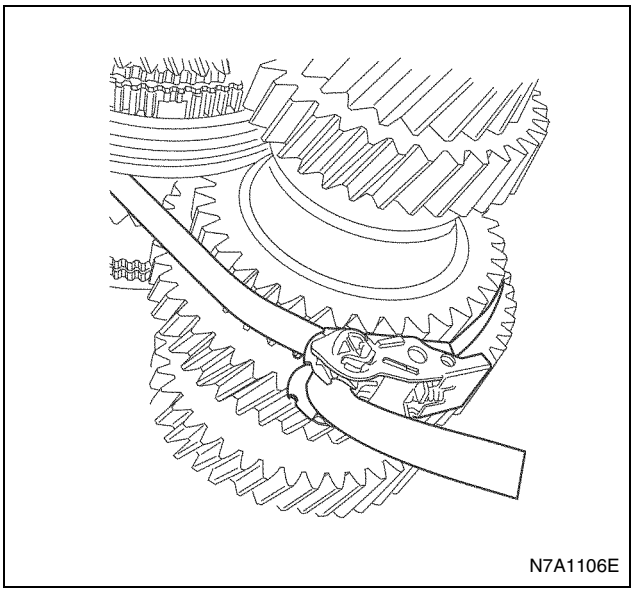


- Before installing, carefully remove all protrusions from the bore side of the old caulking.

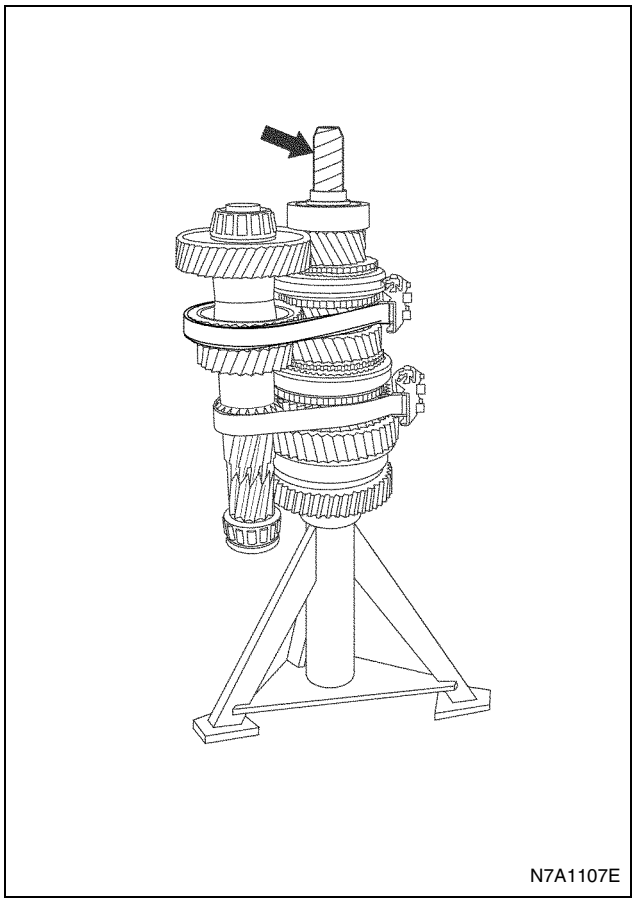
- Before installing, carefully caulk at three points, avoiding the old caulking points and grooves.
- For the second and subsequent press-fitting, the notched part should face in the direction of the clutch housing.
- After press-fitting, check that the shift rod slides smoothly.


N7A1105E

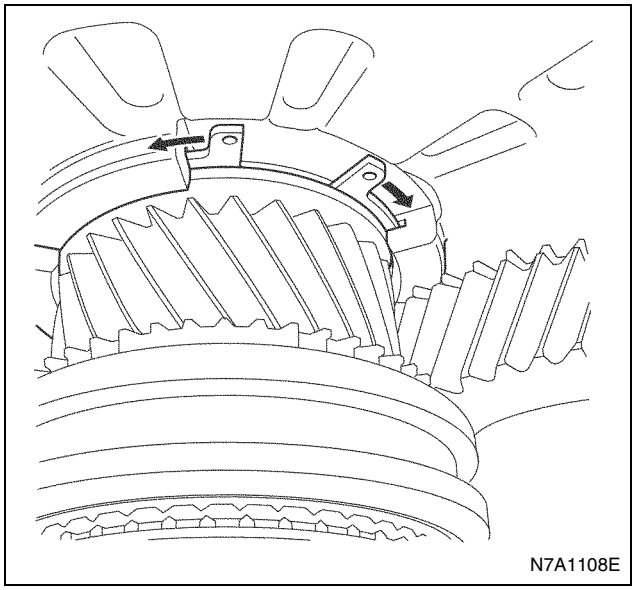
4. Install the main shaft assembly, top gear shaft assembly, and counter shaft assembly.
   a. Use a lashing belt or some other belt from a lashing device to bundle the main shaft assembly, counter shaft assembly, and top gear shaft assembly at two points so they cannot separate. Tighten the belt securely. When handing the top gear shaft, take care that it does not drop.


N7A1106E

   b. Stand the top gear shaft assembly, main shaft assembly, and counter shaft assembly on a support stand with the top gear shaft assembly on top.
   c. Wrap the main shaft with tape to avoid damage to the front oil seal.


N7A1107E

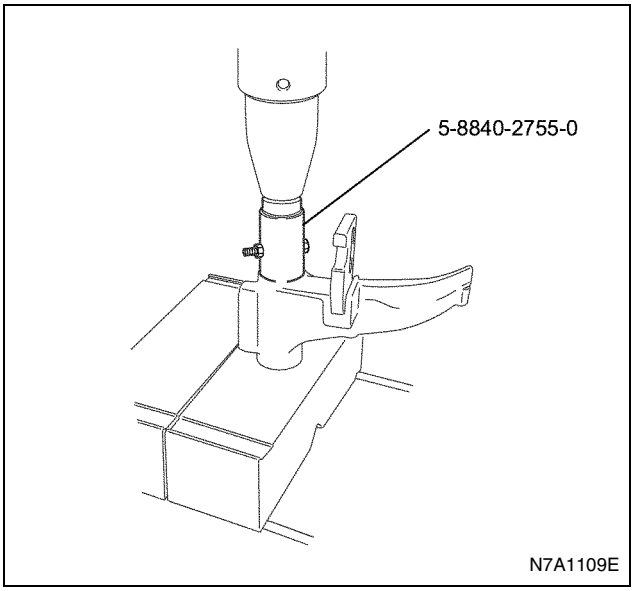
   d. While using snap ring pliers to open the top gear shaft bearing outer snap ring, which already has been set on the clutch housing, insert the top gear shaft, counter shaft, and shaft rod into their appropriate positions in the clutch housing.


N7A1108E

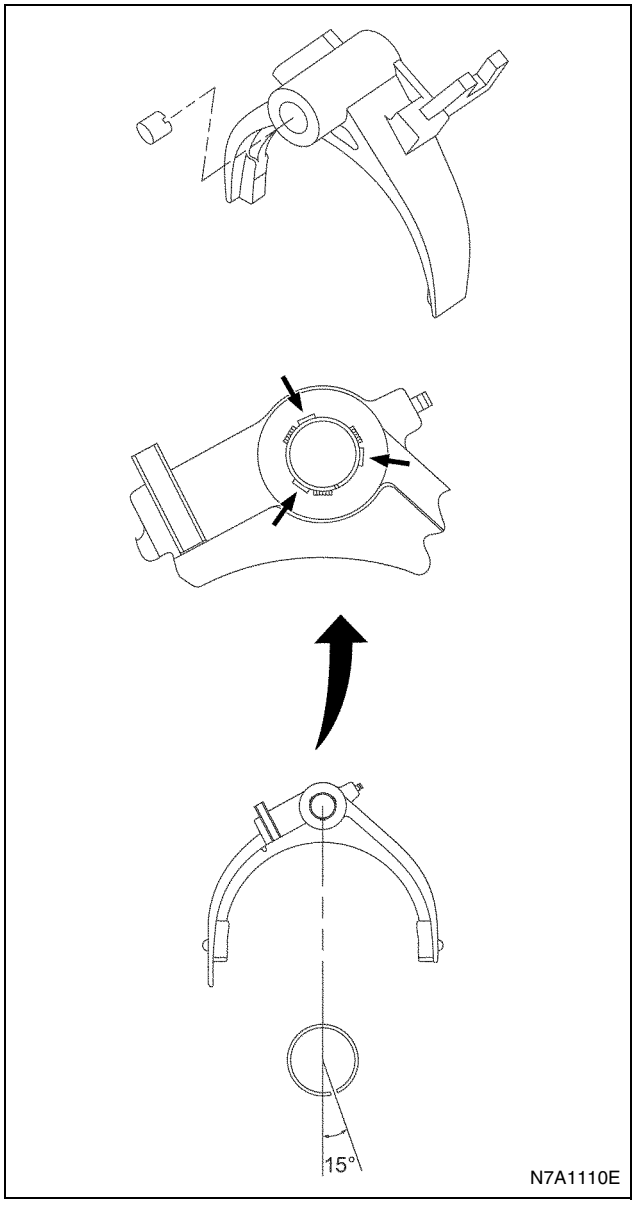
Caution:
- Confirm that the snap ring is installed properly.

- Work carefully in order to avoid damaging the front oil seal.

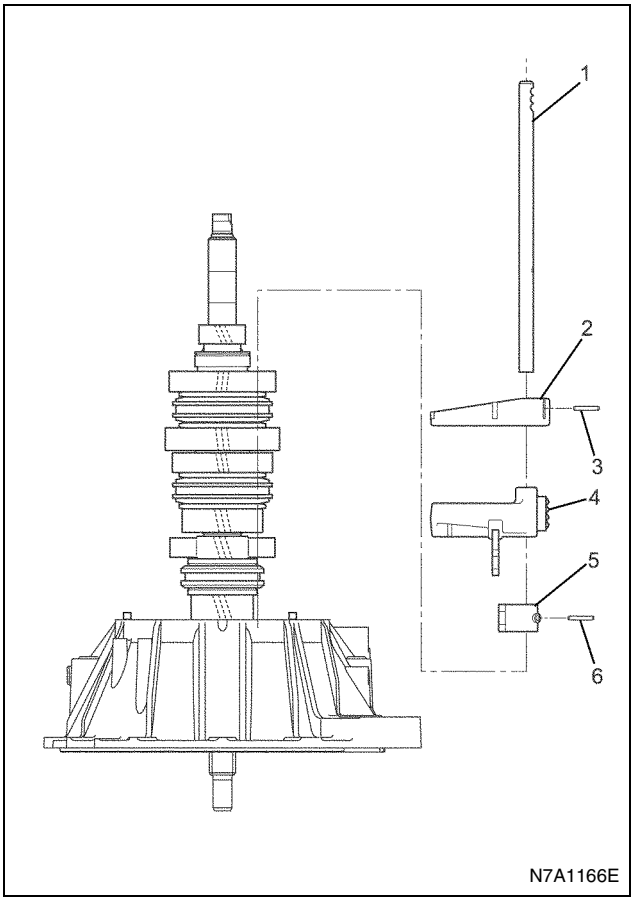
5. Install the magnet in the clutch housing.
6. Inspect the 3rd — 2nd shift arm bushing. If it needs to be replaced with a new one due to wear or damage, use an installer (3-8840-2755-0) to press-fit with a press.
7. Inspect the 4th — 5th shift arm bushing. If it needs to be replaced with a new one due to wear or damage, use an installer (5-8840-2755-0) to press-fit with a press.



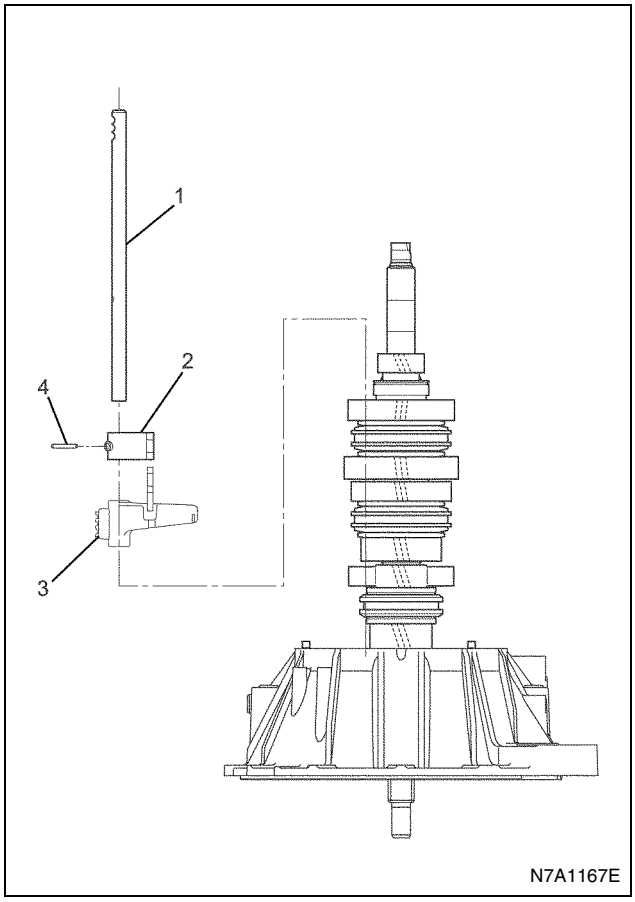
- Before installing, carefully remove all protrusions from the bore side of the old caulking.
- Press-fit the shift arm bushing taking care to use the correct orientation and angle. Caulk at three points, avoiding the bushing gap and old caulking.
- After press-fitting, check that the shift rod slides smoothly.



8. Install the 1st — Reverse and 2nd — 3rd shift rod (1) on the 1st — Reverse 6th shift block (5), 2nd — 3rd shift arm (4), 1st — Reverse shift arm (2).
   - Use a hammer to drive the spring pins (3), (6) into the spring pin holes.
   - When press-fitting spring pins, insert a round bar on the opposite side of the shift rod, and press-fit while taking care to avoid damage to other parts.

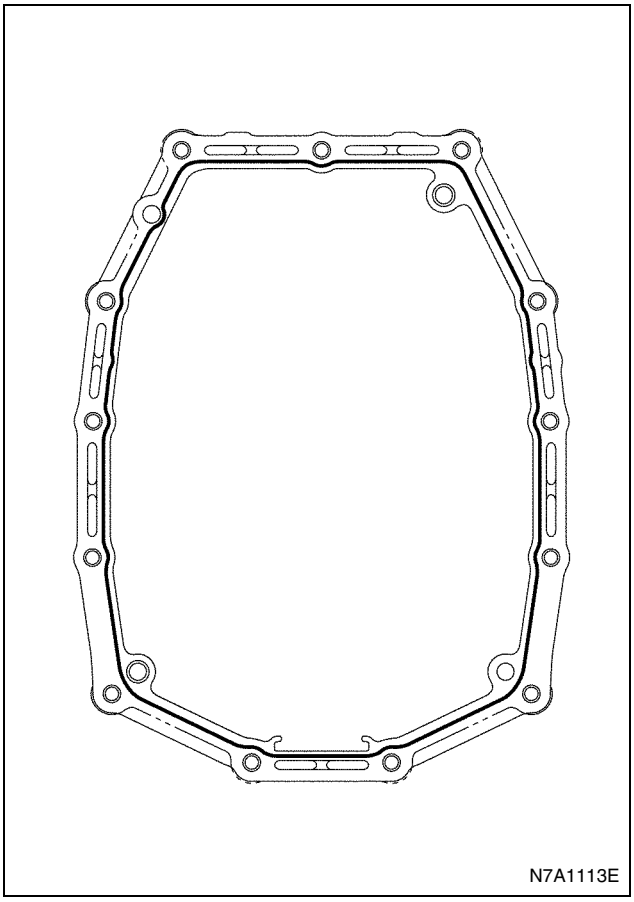


9. Install the 4th — 5th and 6th shift rod (1) on the 4th — 5th shift arm (3), 1st — Reverse and 6th shift block (2).
   - Use a hammer to drive the spring pin (4) into the spring pin hole.
   - When press-fitting spring pins, insert a round bar on the opposite side of the shift rod, and press-fit while taking care to avoid damage to other parts.



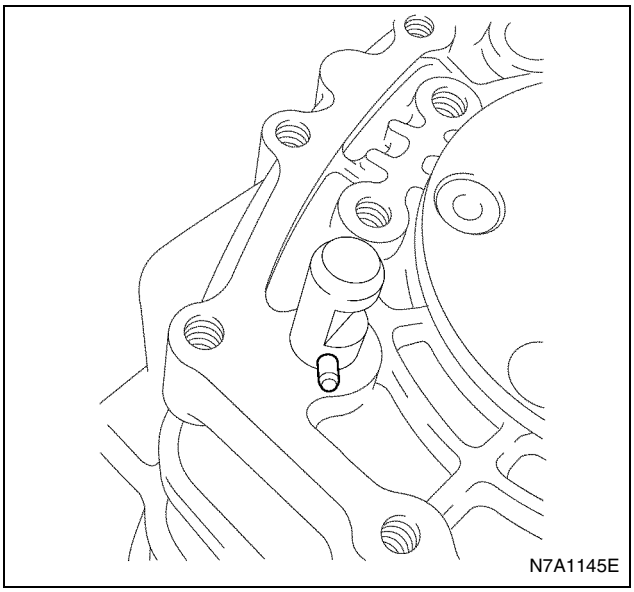
10. Apply Three Bond TB1215 to the mating surface of the transmission case and clutch housing, and install to the clutch housing.
    - Before applying the Three Bond, remove all moisture and oil from the contact surface. Use a bead diameter of at least 2mm across the entire surface, ensuring there are no gaps.

Tighten:
46 N·m (4.7 kg·m / 33.9 lb·ft)

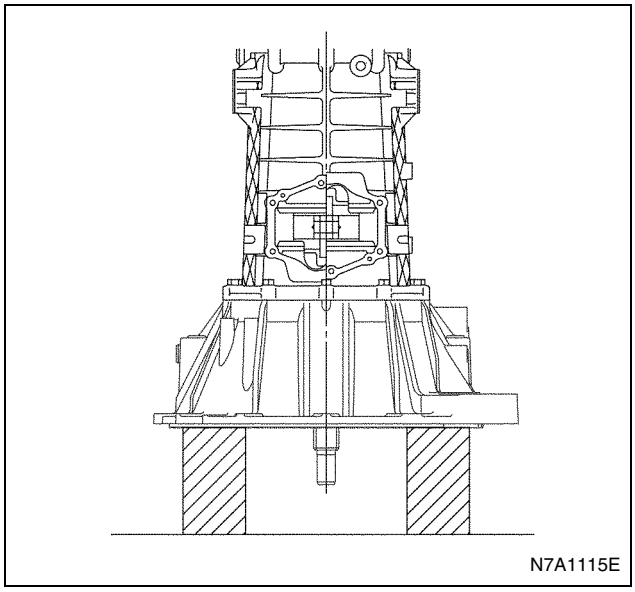

N7A1113E

11. Install the bearing rear outer race in the transmission case.
12. Remove the 4th — 5th and 6th shift rod snap ring.

Caution:
If the spring pin is deformed or damaged, replace it with a new one and check to make sure it is installed securely.


N7A1145E

13. Install counter shims.
    a. Set the gear position to neutral.
    b. Position the transmission assembly so the clutch housing is downwards.

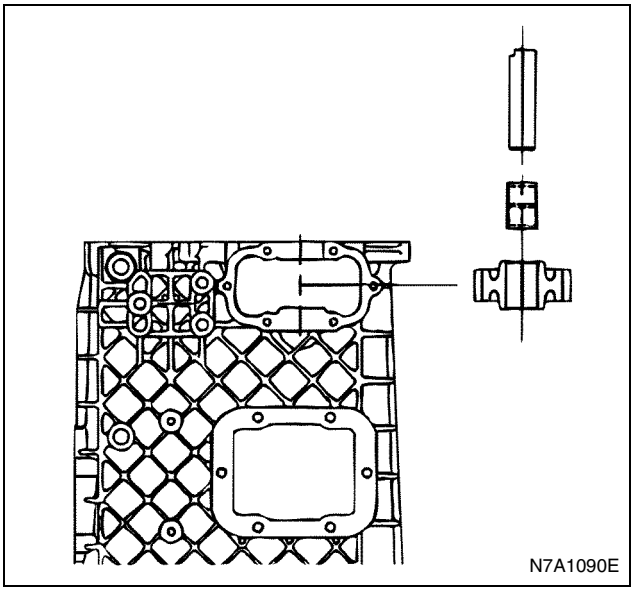

N7A1115E

    c. Rotate the counter shaft at least 30 turns to make the taper roller bearing seated.
    d. Select the counter shim.
       - At 120-degree intervals, take measurements at three points at a depth from the transmission case back surface up to the counter shaft rear bearing outer ring surface, and then calculate the average of the measured values.
       - Use the table below to select the shim thickness to match the measured average value.

Measured Value (mm)	Shim Thickness (mm)
From — To	
3.34 — 3.40	3.19
3.28 — 3.34	3.13
3.22 — 3.28	3.07
3.16 — 3.22	3.01
3.10 — 3.16	2.95
3.04 — 3.10	2.89
2.98 — 3.04	2.83
2.92 — 2.98	2.77
2.86 — 2.92	2.71
2.80 — 2.86	2.65
2.74 — 2.80	2.59
2.68 — 2.74	2.53
2.62 — 2.68	2.47
2.56 — 2.62	2.41
2.50 — 2.56	2.35
2.44 — 2.50	2.29
2.38 — 2.44	2.23

Measured Value (mm)	Shim Thickness (mm)
From — To	
2.32 — 2.38	2.17
2.26 — 2.32	2.11

14. Install the rear outer snap ring in the main shaft rear bearing.
15. Apply engine oil to the needle bearing, install the reverse idle gear and needle bearing, and insert the reverse idle shaft.



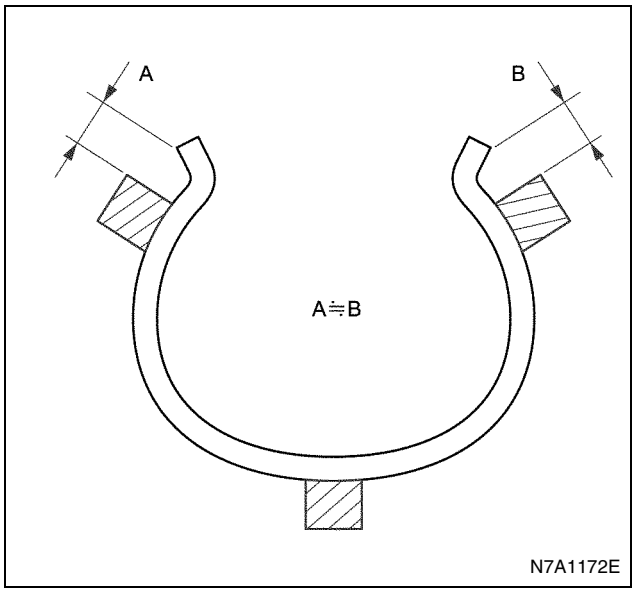
16. Install the retainer in the transmission case.

Tighten:
26 N·m (2.7 kg·m / 19.2 lb·ft)

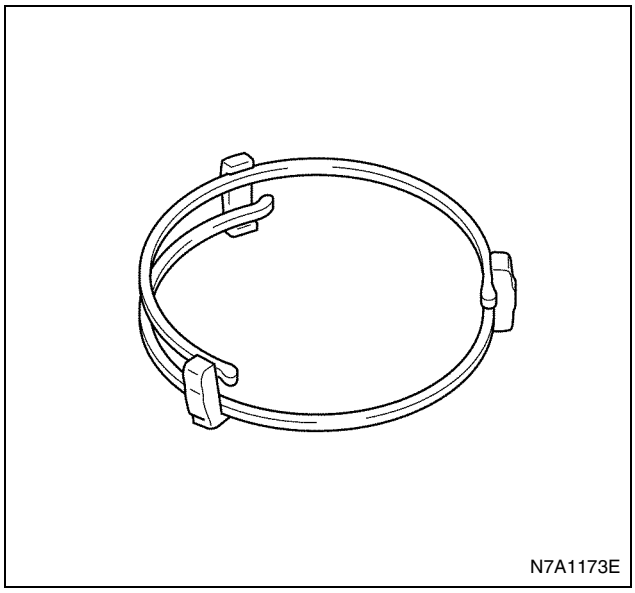
Caution:
Thoroughly remove the sealant from the threads of the transmission case, and use all new screws.

17. Install the speedometer gear.
    - Install the collar.
18. Perform the following steps to assemble the 6th clutch hub assembly (2) and sleeve (1).
    a. Securely assemble the insert key (3) into the block ring insert key groove.
    b. Install the insert spring (4) on the insert key.

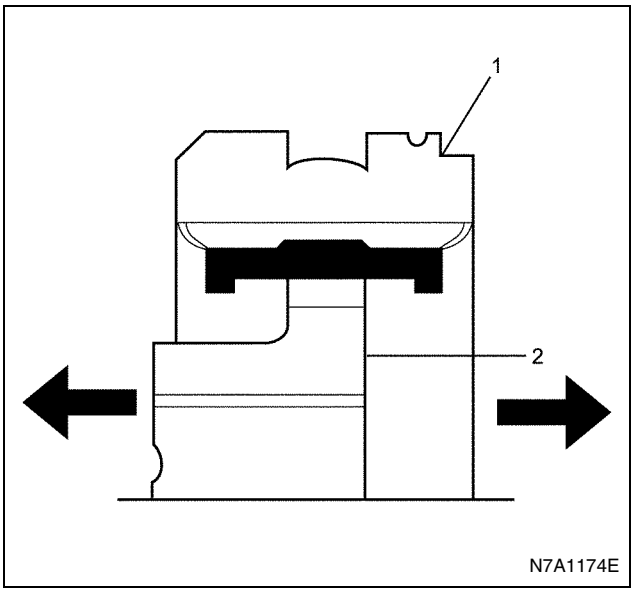
Caution:
- When assembling the insert spring, make sure that the surplus length on either end of the spring is about the same that it does not interfere with the interior diameter of the hub.

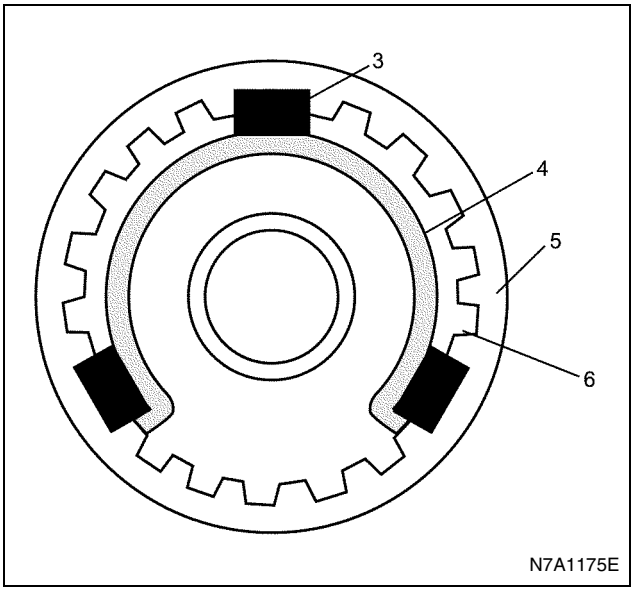


- The insert spring opening on the back should not be in the same position as the front opening.



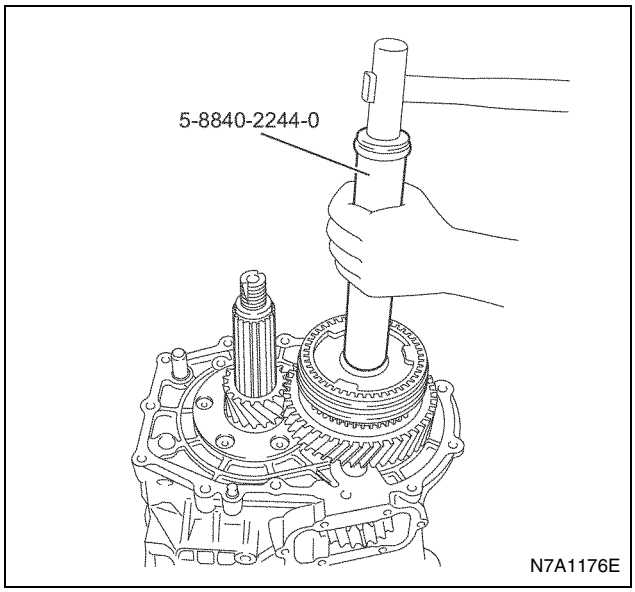
c. Confirm that the clutch hub (5) and sleeve (6) slide smoothly.





d. Install a new stopper plug to the clutch hub.

19. Apply engine oil to the needle bearing and block ring bore. Assemble the 6th gear and needle bearing, and the 6th block ring. In phase with the clutch hub block ring groove, assemble the 6th clutch hub assembly and sleeve and use an installer (5-8840-2244-0) to press fit with a hammer.



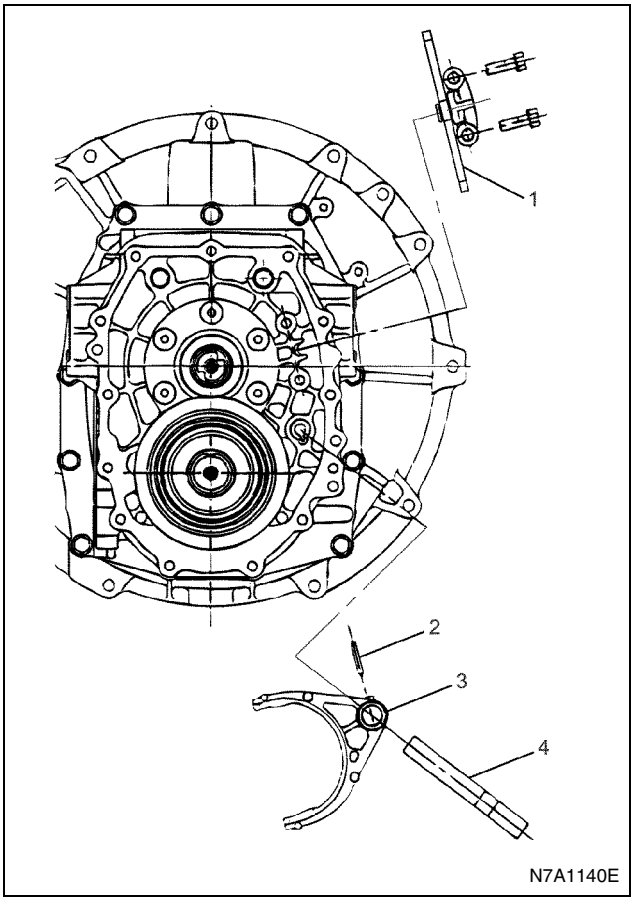
20. Use snap ring pliers to install the 6th clutch hub snap ring.
    - Select the thickest snap ring from among the three types that can be installed.

Thickness (mm)	Color Code
1.7	White
1.8	None
1.9	Blue

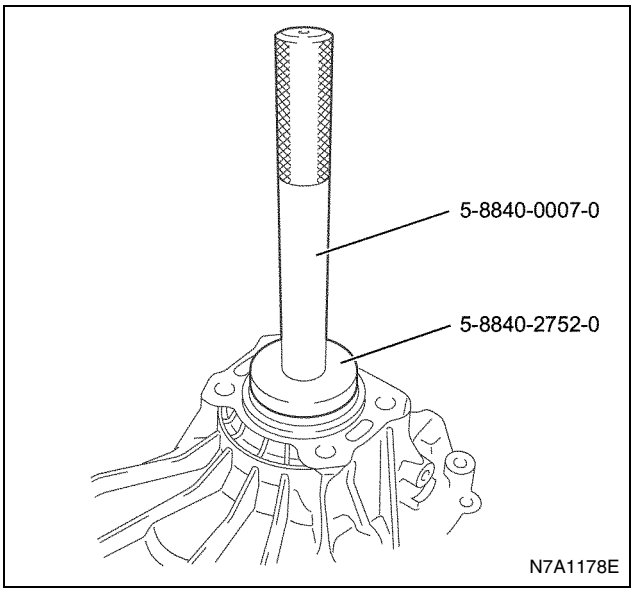
Caution:
If the snap ring is deformed or damaged during installation, replace it with a new one and check to make sure it is installed securely.

21. Apply engine oil to the transmission case shift rod hole. Install the 6th shift arm (3) and 6th shift rod (4) and press-fit the spring pin (2) by aligning with the spring pin hole.
22. Install the 6th relay lever (1).

Tighten:
44 N·m (4.5 kg·m / 32.5 lb·ft)

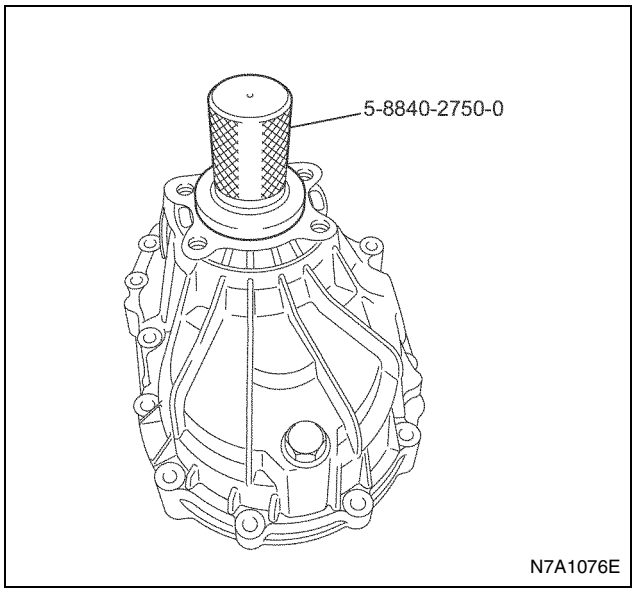


23. Install the main end needle bearing.
    - Apply Besco L2 grease to the inside of the needle bearing, and apply engine oil to the rear cover bearing contact surface bore.
    - With the stamped surface of the bearing facing outwards, use an installer (5-8840-2752) and grip (5-8840-0007-0) to press fit the needle bearing to the rear cover, from the outside.



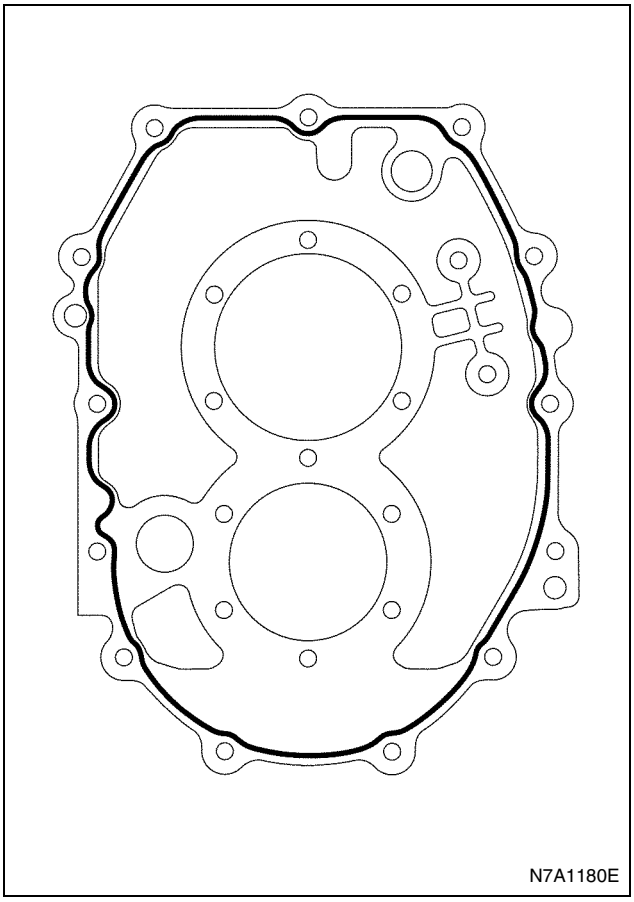
24. Inspect the rear cover oil seal. If it needs to be replaced with a new one due to wear, damage, or main end needle bearing replacement, apply engine oil to the outer circumference of the oil seal, and then use an installer (5-8840-2750-0) to press-fit it.
    - Apply Besco L2 grease to the lip of the oil seal.

Caution:
Take care to avoid damaging the oil seal lip.

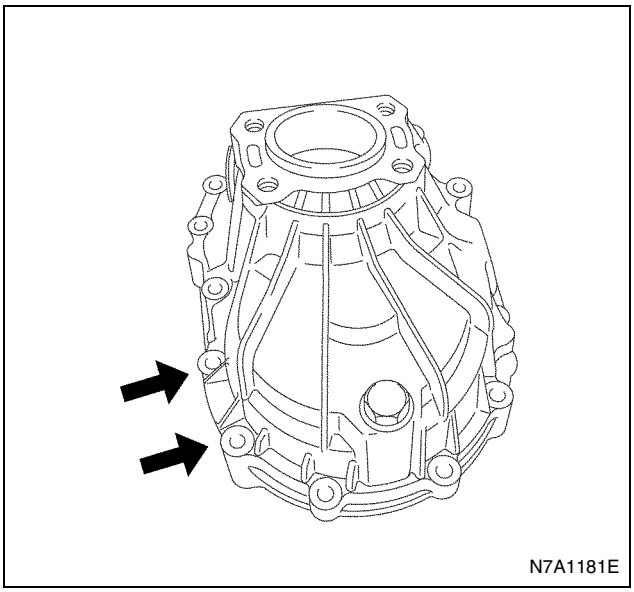


25. Apply Three Bond TB1215 to the mating surface of the transmission case rear cover, and install the rear cover.
    - Before applying the Three Bond, remove all moisture and oil from the contact surface. Use a bead diameter of at least 2mm across the entire surface, ensuring there are no gaps.

Tighten:
46 N·m (4.7 kg·m / 33.9 lb·ft)

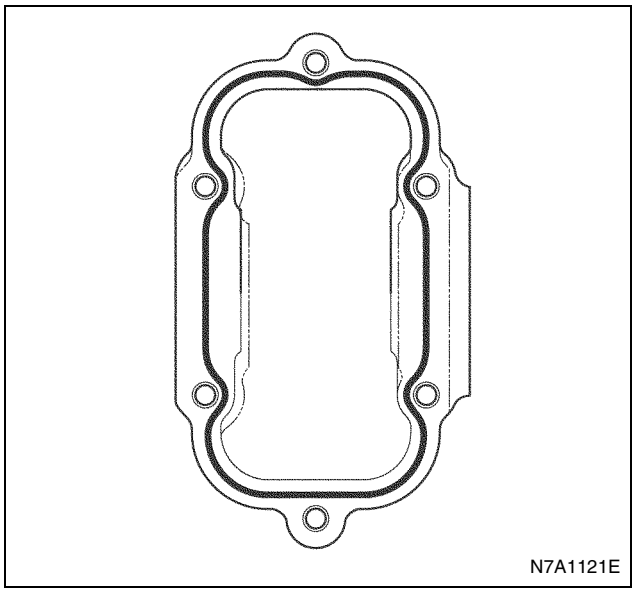

N7A1180E

Caution:
The bolts indicated by arrows (two points) have Loctite applied. Thoroughly remove the sealant from the transmission case threads, and use new Loctite coated bolts.


N7A1181E

26. Apply Three Bond TB1215 to the mating surface of the transmission case reverse idle cover, and install the reverse idle cover.
    - Before applying the Three Bond, remove all moisture and oil from the contact surface. Use a bead diameter of at least 2mm across the entire surface, ensuring there are no gaps.

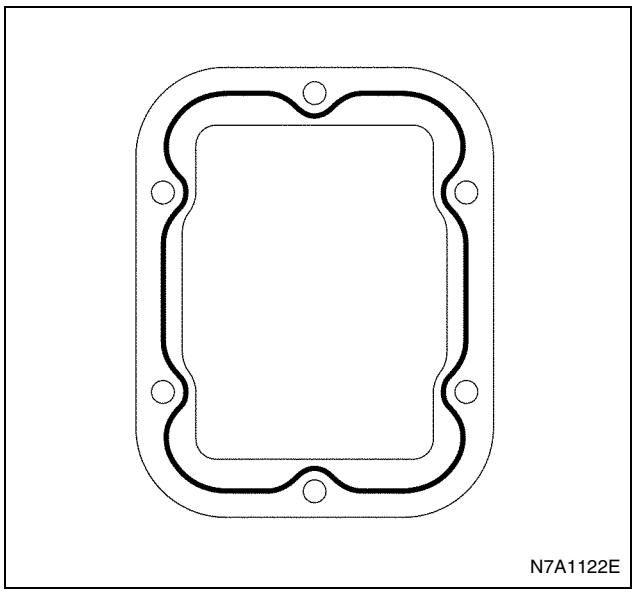
Tighten:
19 N·m (1.9 kg·m / 14 lb·ft)


N7A1121E

27. Apply Three Bond TB1215 to the mating surface of the transmission case PTO cover, and install the PTO cover.
    - Before applying the Three Bond, remove all moisture and oil from the contact surface. Use a bead diameter of at least 2mm across the entire surface, ensuring there are no gaps.

Tighten:
37 N·m (3.8 kg·m / 27.3 lb·ft)

Caution:
The bolts have Loctite applied. Thoroughly remove the sealant from the transmission case threads, and use new Loctite coated bolts.


N7A1122E

28. Apply engine oil to the input shaft speed sensor O-ring, and install the input shaft speed sensor.

Tighten:
9 N·m (0.9 kg·m / 6.6 lb·ft)

29. Thoroughly remove sealant from the threads of the detent assembly (14), (13), (12), (11), apply Loctite 242, and install.

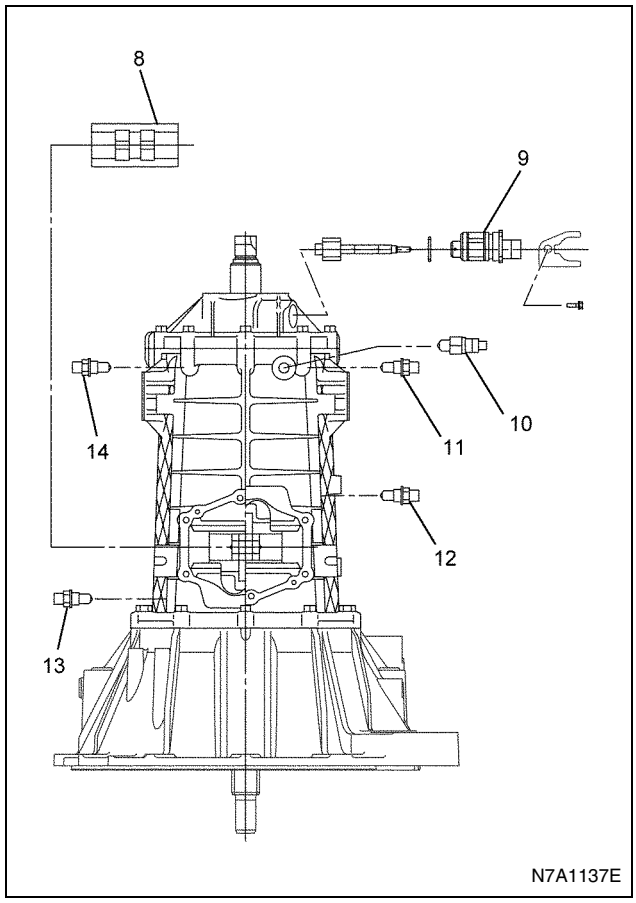
Tighten:
27 N·m (2.8 kg·m / 19.9 lb·ft)

30. Apply Loctite 242 to the reverse switch threads, and install the reverse switch (10).

Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

31. Apply engine oil to the speedometer driver gear and O-ring, and then install the speedometer driven gear (9).

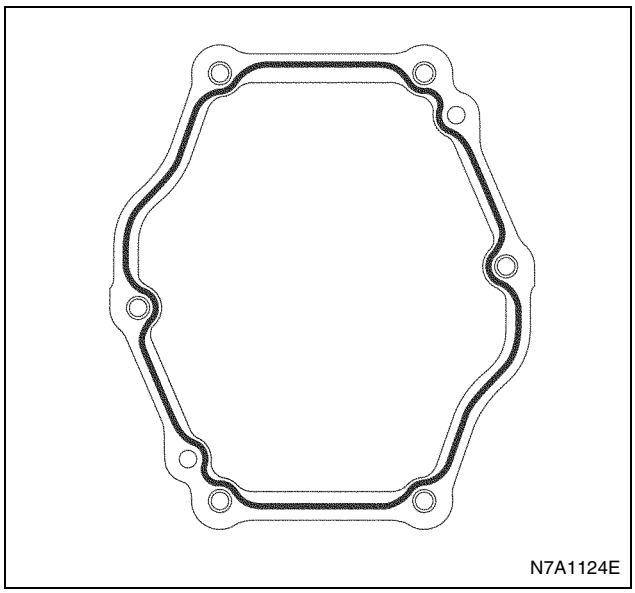
Tighten:
20 N·m (2.0 kg·m / 14.8 lb·ft)



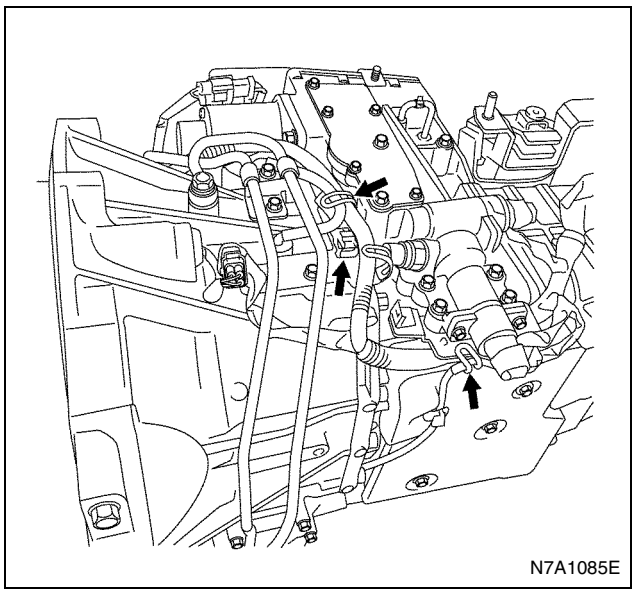
32. Install the control box.
    a. Set the gear position to neutral, apply Three Bond TB1215 to the surface, which mates with control box, of the transmission case, and install the interlock plate and control box.
       - Before applying the Three Bond, remove all moisture and oil from the contact surface. Use a bead diameter of at least 2mm across the entire surface, ensuring there are no gaps.

Caution:
The bolts have Loctite applied. Thoroughly remove the sealant from the transmission case threads, and use new Loctite coated bolts.

Tighten:
27 N·m (2.8 kg·m / 19.9 lb·ft)

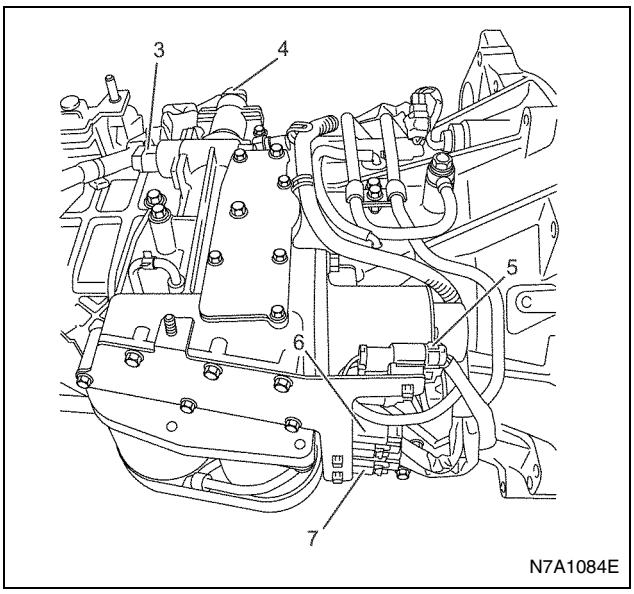


    b. Attach clips to the harness (two points) and install the neutral switch connector to the bracket.



    c. Connect the five connectors to the control box.

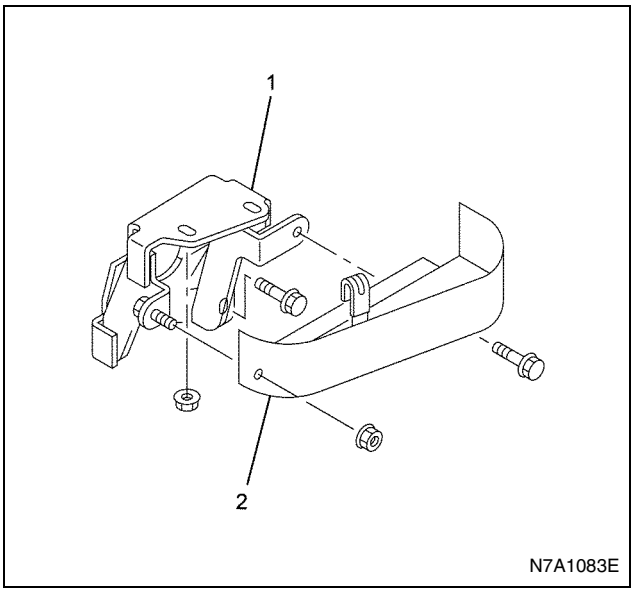
- Connect the connectors of the select sensor (3), shift sensor (4), select solenoid (5), 2-4-6-R shift solenoid (6), and 1-3-5 shift solenoid (7).



33. Install the heat protector bracket (1) and heat protector (2).

Tighten:

Bracket	45 N·m (4.6 kg·m / 33.2 lb·ft)
Protector	23 N·m (2.3 kg·m / 17 lb·ft)



34. Apply engine oil to the O-ring, and then install the drain plug and O-ring.

Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

35. Apply engine oil to the O-ring, and then install the filler plug and O-ring.

Tighten:
39 N·m (4.0 kg·m / 28.8 lb·ft)

36. Install the parking brake assembly.
    - Refer to “Parking Brake”.
37. Install the parking brake bracket in the transmission case.

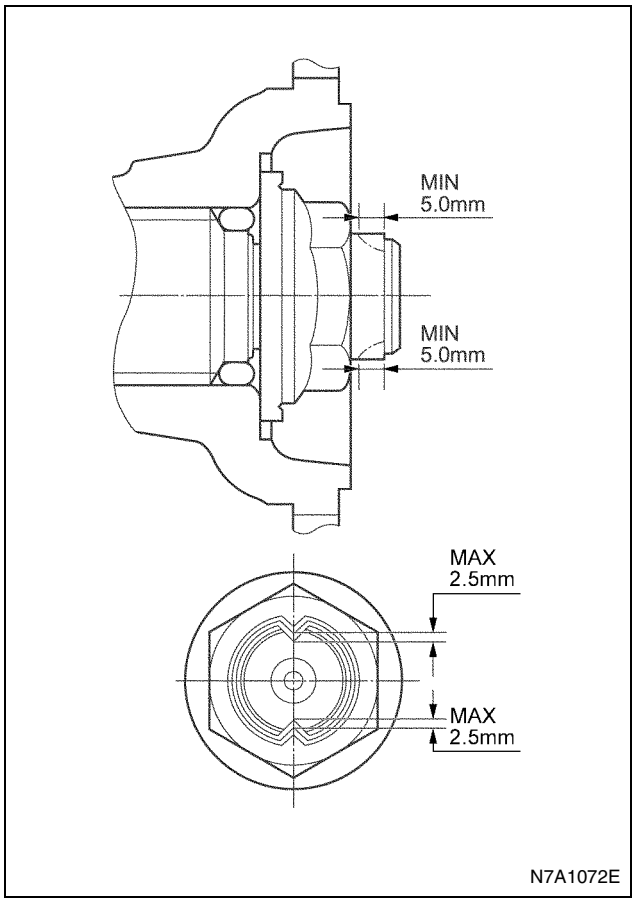
Tighten:
48 N·m (4.9 kg·m / 35.4 lb·ft)

38. Apply engine oil to the O-ring, and then install the coupling driver and O-ring.
39. Using a new lock nut, use the flange holder (5-8840-2043-0 for MYY, 9-8529-2101-1) to tighten the lock nut.

Tighten:
289 N·m (29.5 kg·m / 213.2 lb·ft)

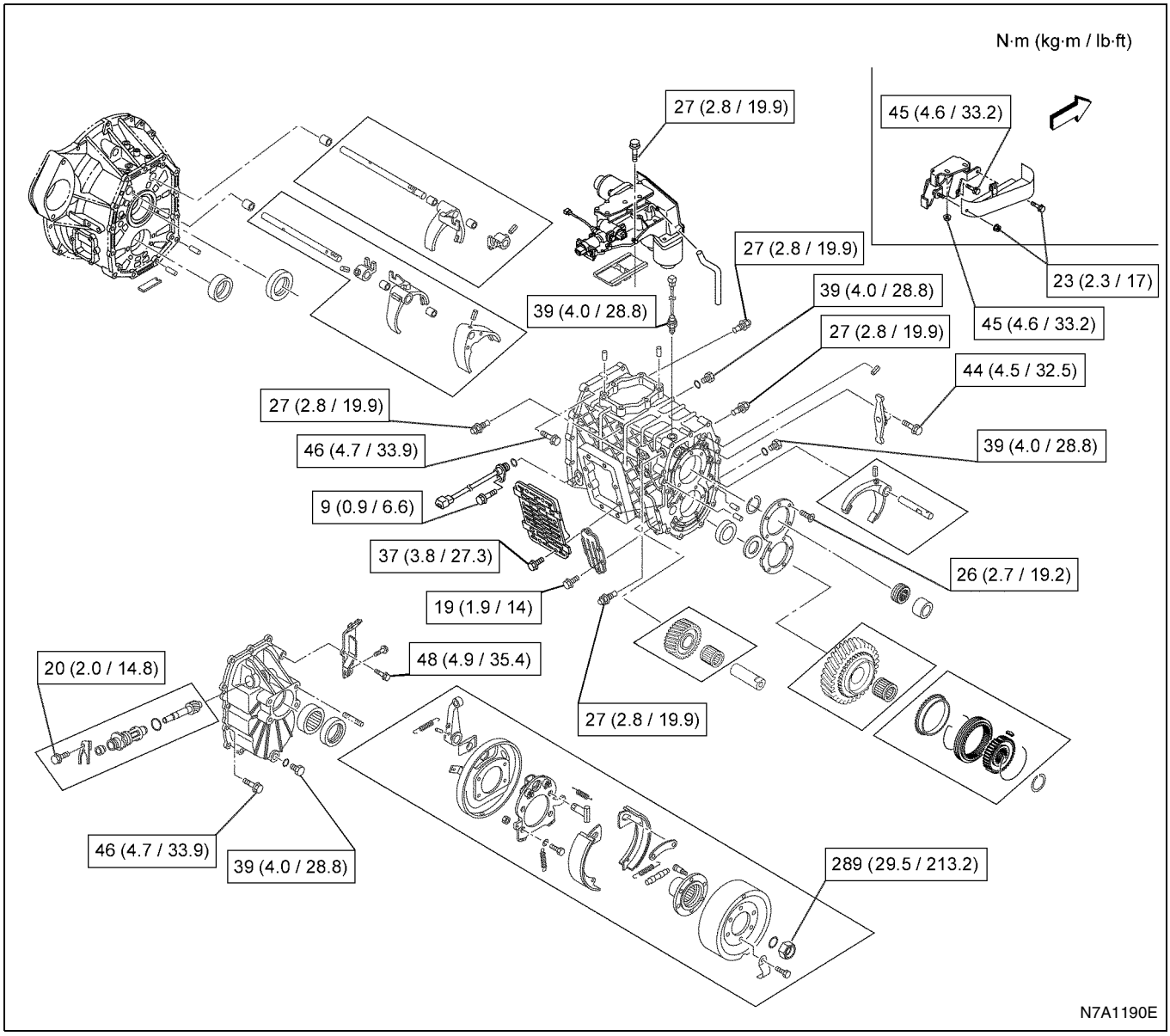
- After tightening the lock nut to the specified torque, stake it (2 points) securely using a chisel (chisel tip shape: approx. 1 mm in radius × 60 degrees) so the lock nut lip gap is aligned with the V-groove of the shaft and is at least 5 mm, and the clearance between the V-groove bottom and the nut lip is 2.5 mm or less.

Caution:
After caulking, check the caulking of the nut. If any cracks are discovered, replace the lock nut and re-caulk.



40. Install the parking brake drum.
    - Refer to “Parking Brake”.

Tightening Torques



Special Tools

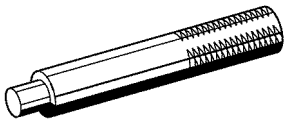
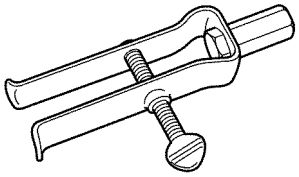
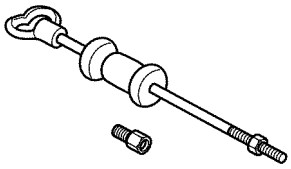
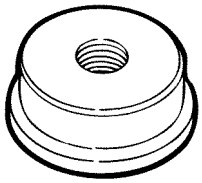
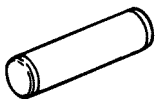
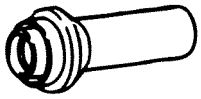
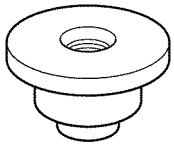
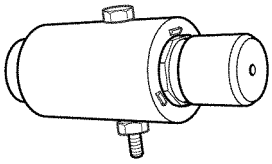
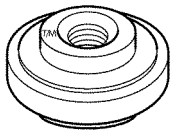
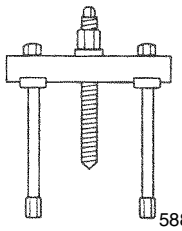
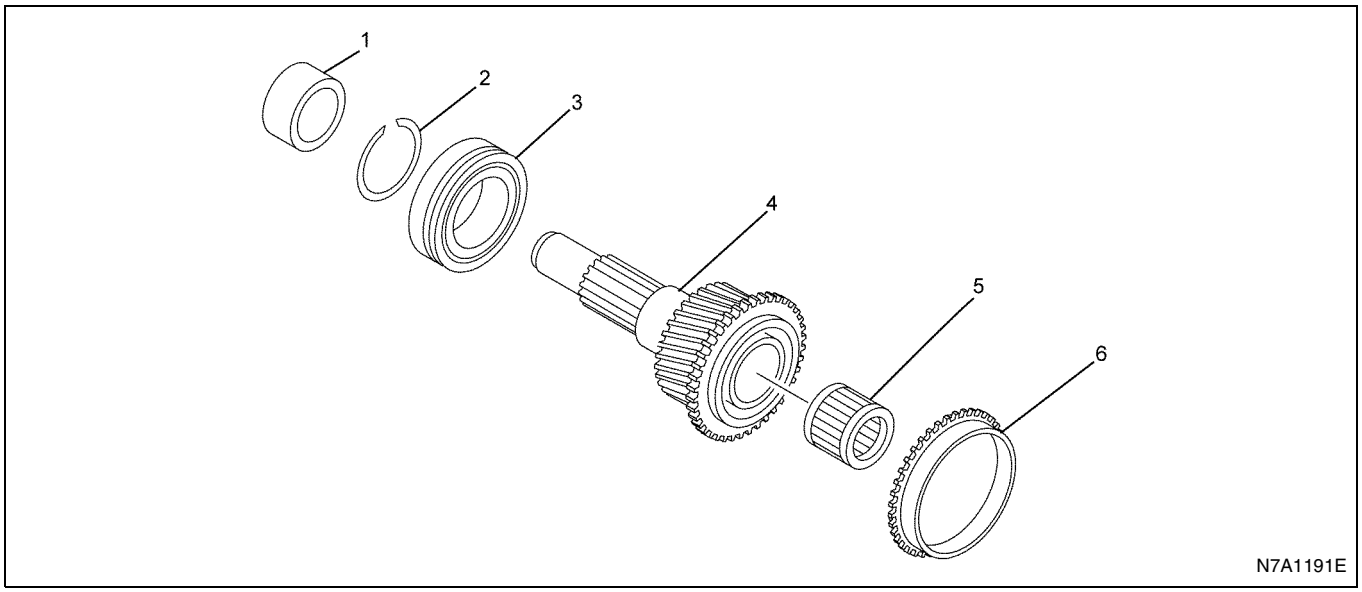
Illustration	Tool No. Tool Name
 5884000070	5-8840-0007-0 Grip
 5884000270	5-8840-0027-0 Remover
 5884000840	5-8840-0084-0 Sliding Hammer
 5884020260	5-8840-2026-0 Bearing Installer
 5884020430	5-8840-2043-0 Flange Holder
 5884022440	5-8840-2244-0 Bearing Installer

Illustration	Tool No. Tool Name
 5884027500	5-8840-2750-0 Oil Seal Installer
 5884027520	5-8840-2752-0 Oil Seal Installer
 5884027550	5-8840-2755-0 Bushing Remover and Installer
 5884027560	5-8840-2756-0 Oil Seal Installer
 5884027570	5-8840-2757-0 Bearing Remover
 5884028020	5-8840-2802-0 Bushing Puller

Top Gear Shaft

Components



Legend

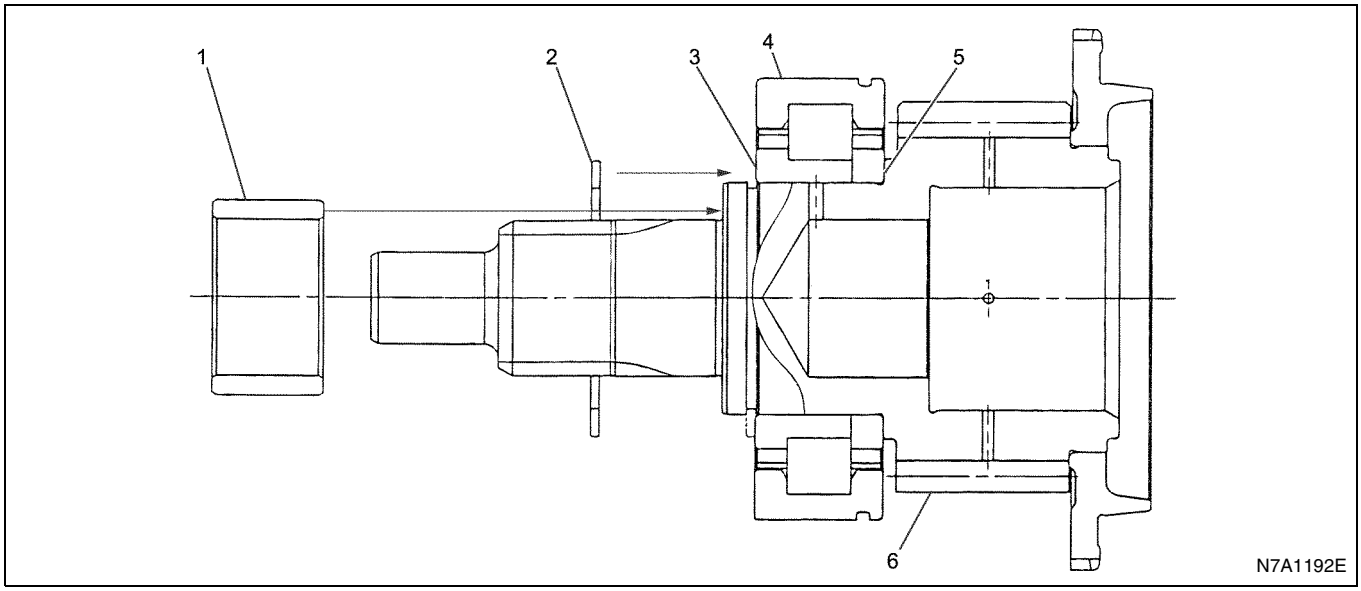
1. Collar
2. Snap Ring
3. Bearing
4. Top Gear Shaft
5. Needle Bearing
6. Block Ring

Disassembly

1. Remove the block ring from the top gear shaft.
2. Remove the needle bearing from the top gear shaft.
   - Since the needle bearing is a separator type, take care that you do not drop it or damage it during disassembly and assembly. During assembly, remove all foreign matter, apply Besco L2 grease, and then assemble it.
3. Use snap ring pliers to remove the snap ring.
4. Use a bearing remover to remove the bearing with a press.
5. Remove the collar.

Inspect each part. Replace or repair as required if anything is worn or damaged or if any other defect is discovered.

6. Inspect the gear tooth surface, spline, and tip sliding surface for damage and wear. If any abnormality is detected, replace the applicable part.
7. Inspect each of the bearings for the following characteristics. If any abnormality is detected, replace the applicable bearing.
   - Smoothness of rotation
   - Noise
   - Damage, rust, or other visible abnormality
   - Abnormal play in the thrust direction
   - Discoloration, extreme wear, or pitching of the needle bearing rolling element or rolling surface

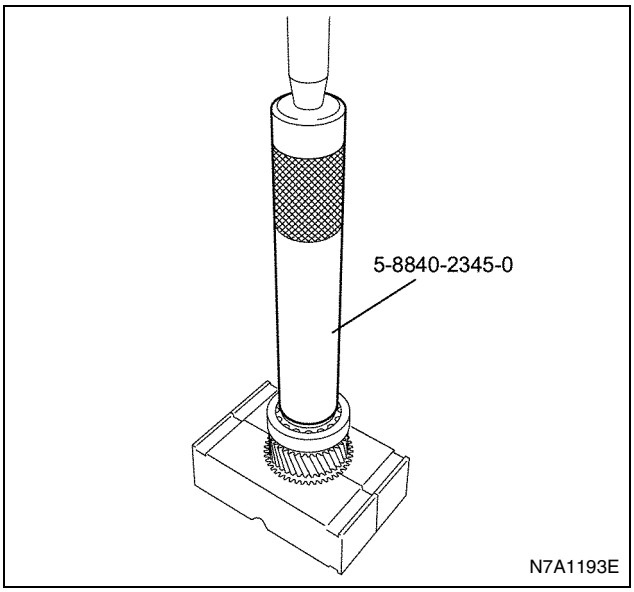


Legend

1. Collar
2. Snap Ring
3. Stamped Surface A
4. Bearing
5. Stamped Surface B
6. Top Gear Shaft

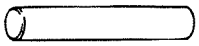
Assembly

1. Press-fit the collar.
2. Use an installer (5-8840-2345-0) to press fit the bearing with a press.
   Press stamped surface A.



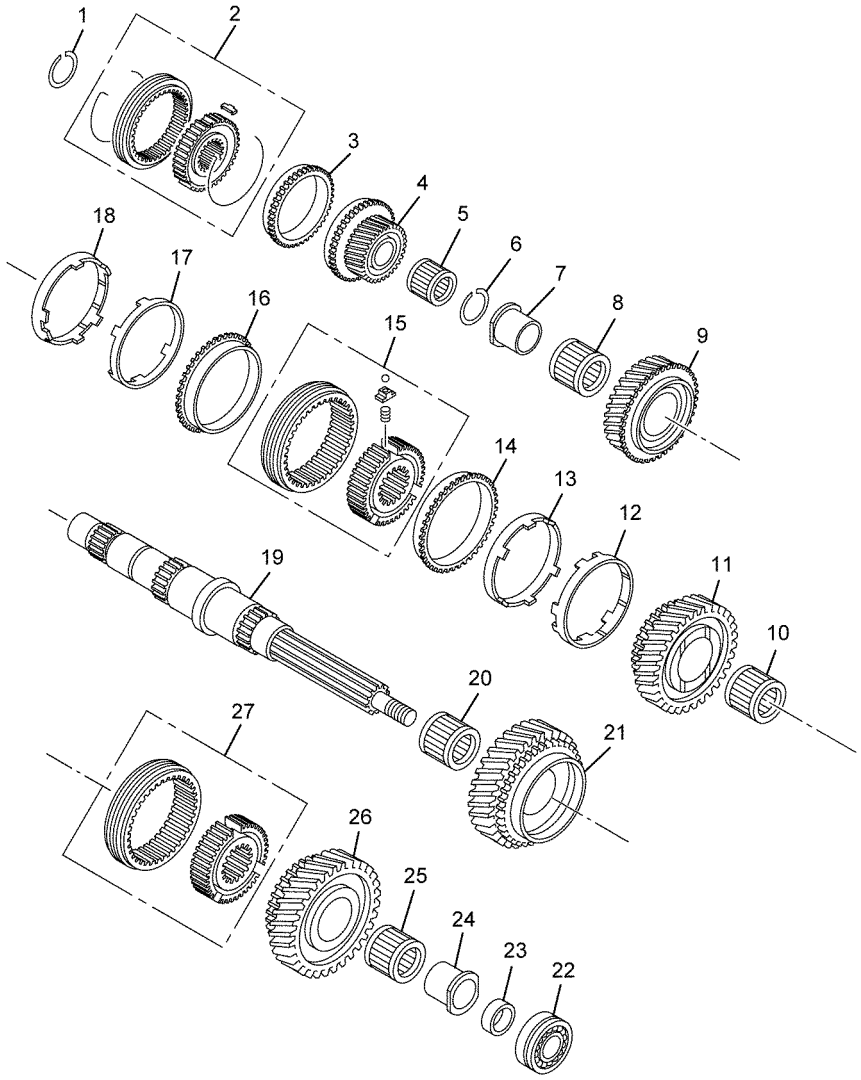
3. Use snap ring pliers to install the snap ring.
4. Install the needle bearing on the top gear shaft.
5. Install the block ring on the top gear shaft.

Special Tools

Illustration	Tool No. Tool Name
 5884023450	5-8840-2345-0 Installer

Main Shaft (5-Speed)

Components

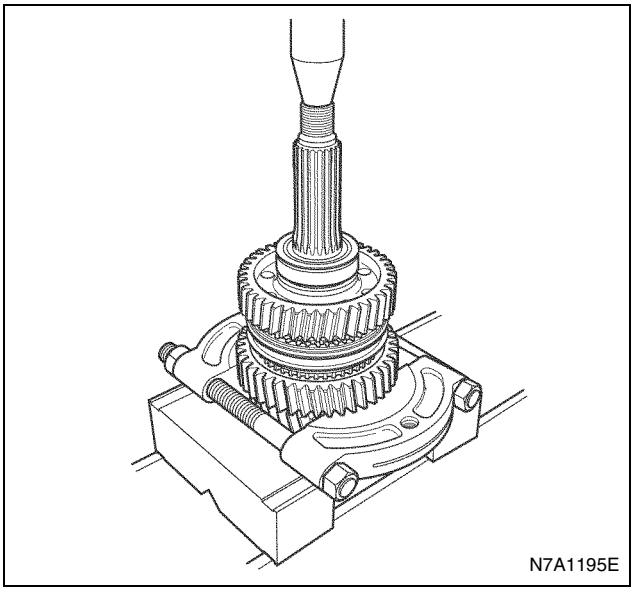


Legend

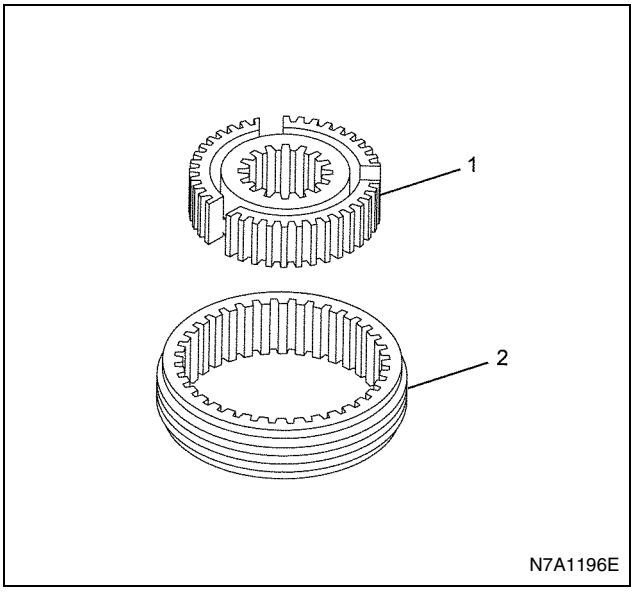
1. Snap Ring
2. 4th — 5th Clutch Hub Assembly Sleeve
3. 5th Block Ring
4. 5th Gear
5. Needle Bearing
6. Snap Ring
7. Collar
8. Needle Bearing
9. 3rd Gear
10. Needle Bearing
11. 2nd Gear
12. 2nd Inside Ring
13. 2nd Outside Ring
14. 2nd Block Ring
15. 2nd — 3rd Clutch Hub Assembly Sleeve
16. 3rd Block Ring
17. 3rd Outside Ring
18. 3rd Inside Ring
19. Main Shaft
20. Needle Bearing
21. 1st Gear
22. Bearing
23. Spacer
24. Collar
25. Needle Bearing
26. Reverse Gear
27. 1st — Reverse Clutch Hub Assembly and Sleeve

Disassembly

1. Use a bearing remover to remove the following items simultaneously with a press: bearing, spacer, collar, reverse gear, needle bearing, 1st — Reverse clutch hub assembly and sleeve, 1st gear, and needle bearing.

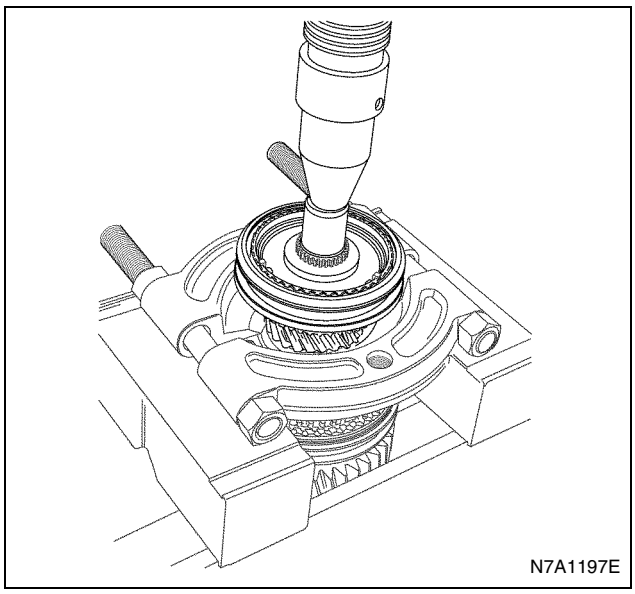


2. Disassemble the 1st — Reverse clutch hub assembly and sleeve.

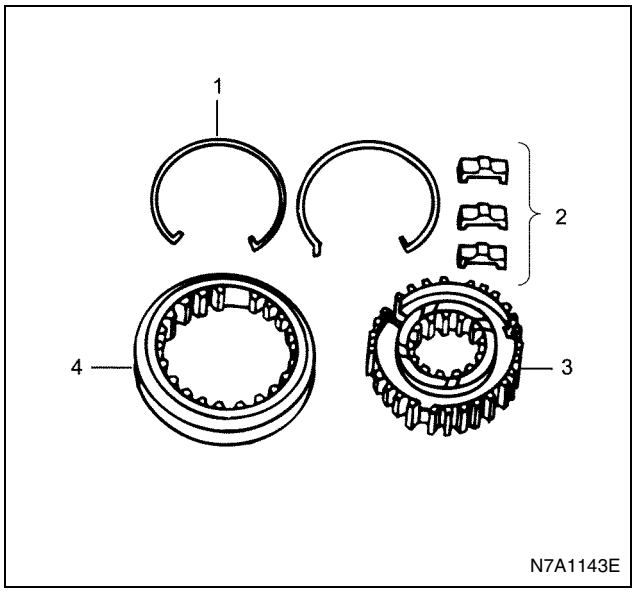


Legend
1. Clutch Hub
2. Sleeve

3. Use snap ring pliers to remove the snap ring that secures the 4th — 5th clutch hub assembly.
4. Use a bearing remover to remove the following items simultaneously with a press: 4th — 5th clutch hub assembly and sleeve, 5th block ring, 5th gear, and needle bearing.



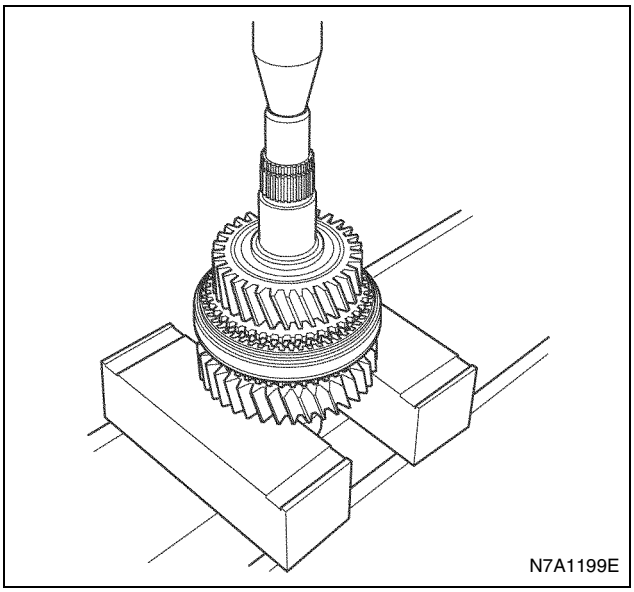
5. Disassemble the 4th — 5th clutch hub assembly and sleeve.



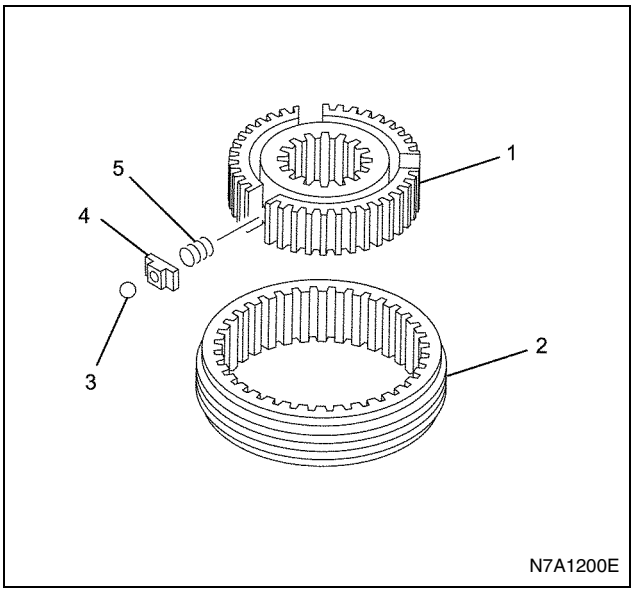
Legend
1. Spring
2. Insert Key
3. Clutch Hub
4. Sleeve

6. Use snap ring pliers to remove the snap ring that secures the 3rd gear collar.

7. Use a bearing remover to remove the following items from the main shaft simultaneously with a press: collar, 3rd gear, needle bearing, 3rd inside ring, 3rd outside ring, 3rd block ring, 2nd — 3rd clutch hub assembly and sleeve, 2nd block ring, 2nd outside ring, 2nd inside ring, 2nd gear, and needle bearing.


N7A1199E

8. Disassemble the 2nd — 3rd clutch hub assembly and sleeve.



N7A1200E

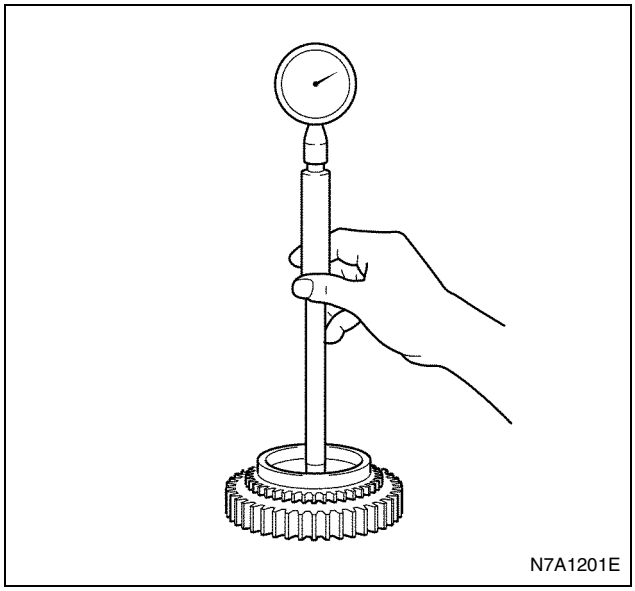
Legend

1. Clutch Hub
2. Sleeve
3. Ball
4. Index Block
5. Spring

Inspect each part. Replace or repair as required if anything is worn or damaged or if any other defect is discovered.

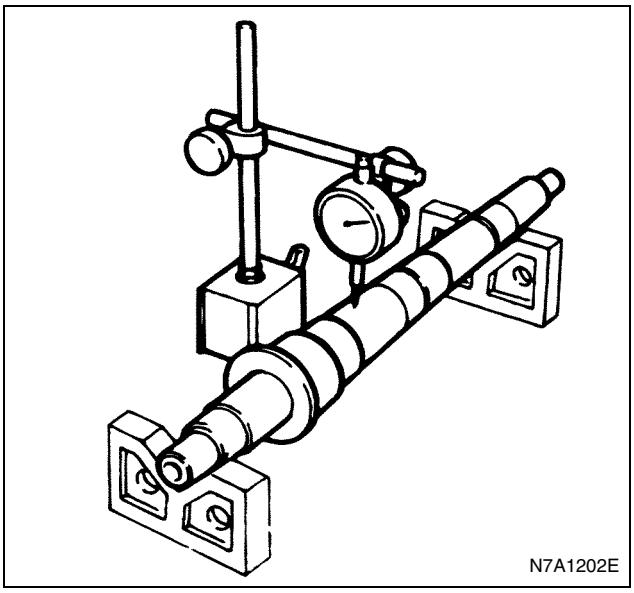
9. Inspect each of the bearings for the following characteristics. If any abnormality is detected, replace the applicable bearing.
   - Smoothness of rotation
   - Noise
   - Damage, rust, or other visible abnormality
   - Abnormal play in the thrust direction
10. Inspect the gear bore.
    - Use an inside dial gauge to measure the bore of each gear.
    - If the measured value exceeds the limit, replace the gear.

Gear Bore (mm)		
	Specified Value	Limit
5th Gear	44.009 — 44.025	44.065
3rd Gear	63.010 — 63.029	63.069
2nd Gear	63.010 — 63.029	63.069
1st Gear	63.010 — 63.029	63.069
Reverse Gear	63.010 — 63.029	63.069

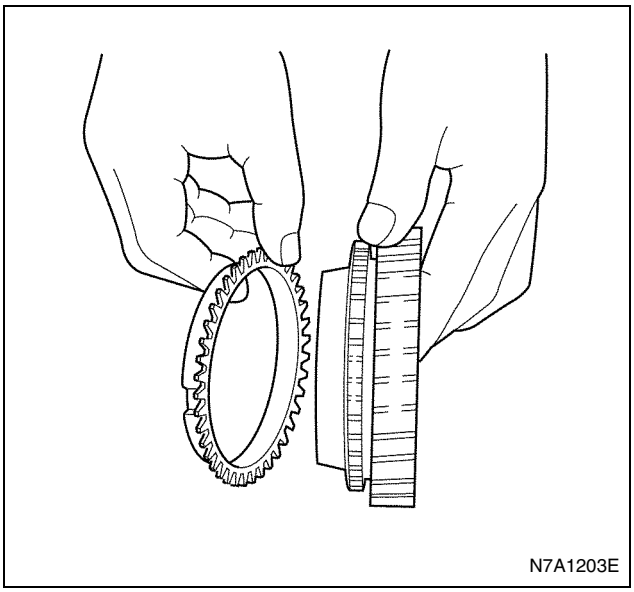

N7A1201E

11. Main shaft runout
    - Use a dial gauge to measure the bend of the main shaft.

- If the measured value exceeds the limit, replace the main shaft.
  Specified value: 0.015 mm Limit: 0.1 mm

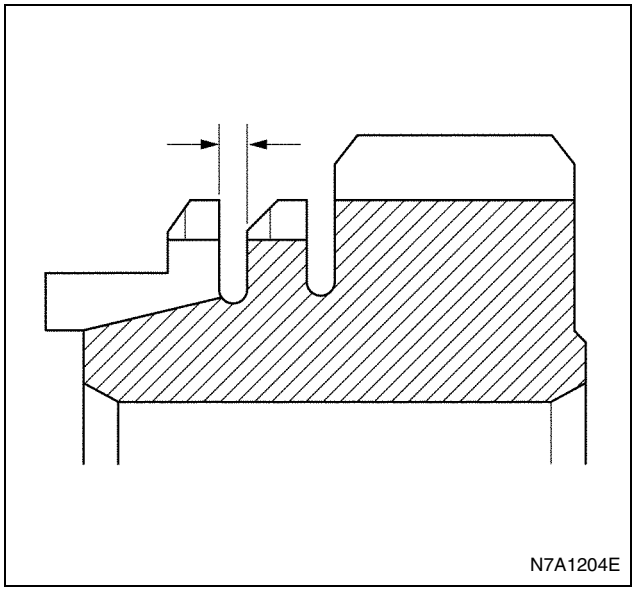

N7A1202E

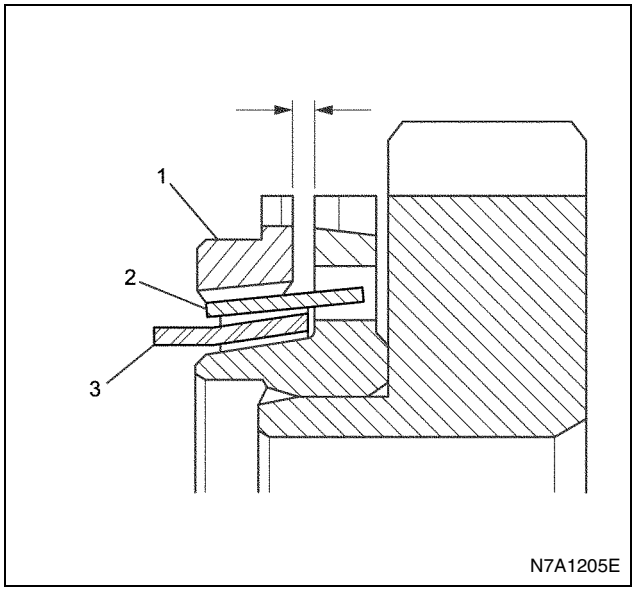
12. Inspect the synchromesh mechanism.
    - Inspect the component parts. Use an oil stone or pencil grinder to repair any minute stepped wear or damage.


N7A1203E

13. Gap between the block ring and dog gear
    - Use a thickness gauge to measure the gap.
    - If the measured value exceeds the limit, replace the block ring.

Gap Between the Block Ring and Dog Gear (mm)		
	Specified Value	Limit
4th/5th/Reverse	1.30 — 2.60	0.5
2nd/3rd	1.00 — 2.50	0.5
1st	1.00 — 2.50	0.5


N7A1204E

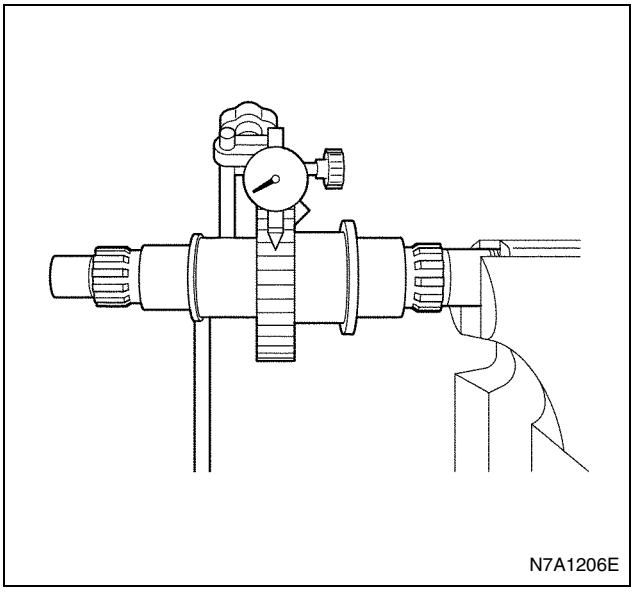


N7A1205E

Legend
1. Block Ring
2. Outside Ring
3. Inside Ring

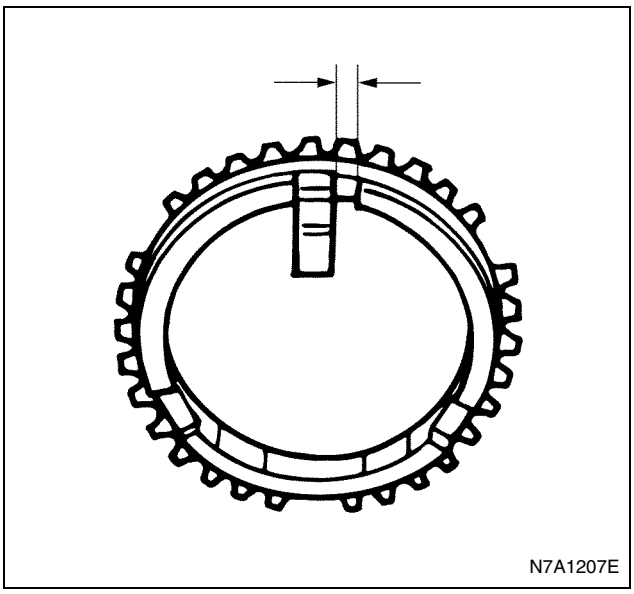
14. Inspect the sliding part of the clutch hub and sliding sleeve, the insert key of the spline, and the insert key groove for wear and damage.
15. Measure the play in the spline rotation direction (on the clutch hub outer circumference).
    - If the measured value exceeds the limit, replace.

Spline Play (mm)	
Specified Value	Limit
0 — 0.05	0.3


N7A1206E

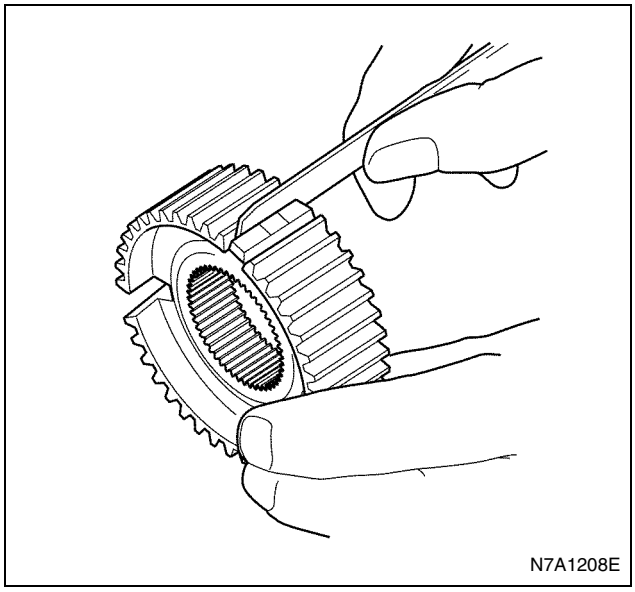
16. Use a caliper to measure the gap between the insert key and block ring groove.
    - If the measured value exceeds the limit, replace the insert key and block ring.

Gap Between the Insert Key and Block Ring Groove (mm)	
	Specified Value
4th/5th	3.46 — 3.76


N7A1207E

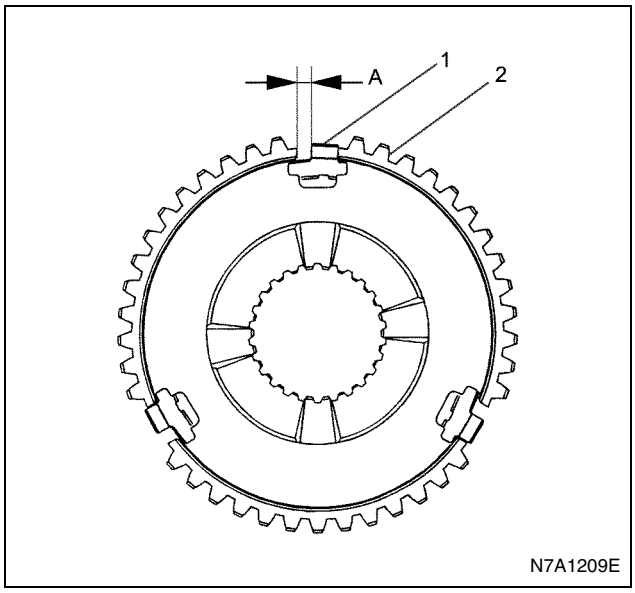
17. Use a thickness gauge to measure the gap between the insert key and clutch hub.
    - If the measured value exceeds the limit, replace the insert key and clutch hub.

Gap Between the Insert Key and Block Ring Groove (mm)	
	Specified Value
4th/5th	0.01 — 0.21


N7A1208E

18. Use a thickness gauge to measure gap A between the index block and clutch hub.
    - If the measured value exceeds the specified value, replace the index block and clutch hub.

Gap Between the Index Block and Clutch Hub (mm)	
	Specified Value
2nd/3rd	4.30 — 4.70



N7A1209E

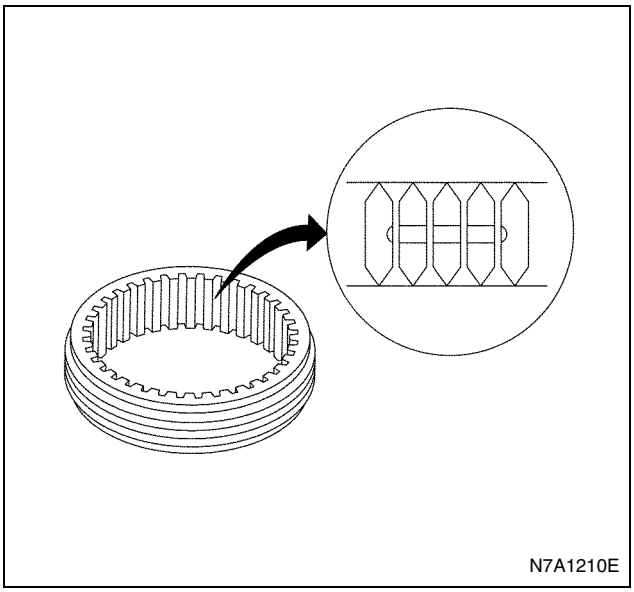
Legend
1. Index Block
2. Clutch Hub

Assembly

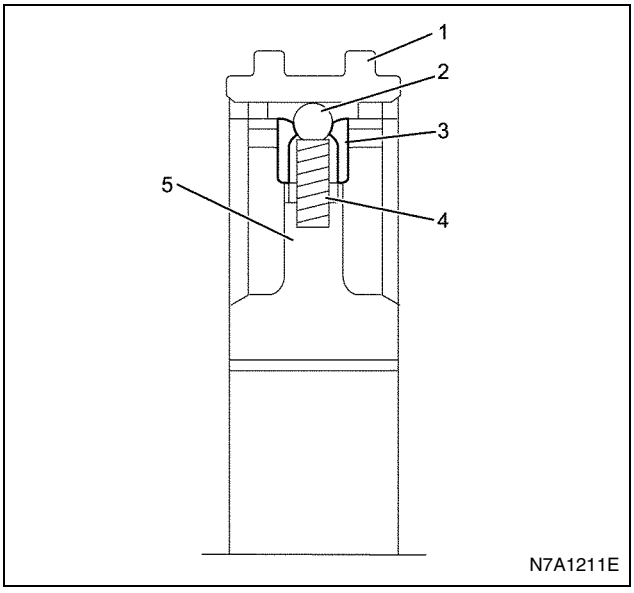
- Thoroughly clean each part.

- Set the main shaft into a vice, with the long spline length downwards. At this time, take care to avoid damage to the grinding surface.

1. Perform the following steps to assemble the 2nd — 3rd clutch hub assembly and sleeve.
   a. Install the index block and spring onto the clutch hub.
   b. There are three ball grooves on the inner surface of the sleeve. Align the phase so the balls are in the center of the ball grooves.

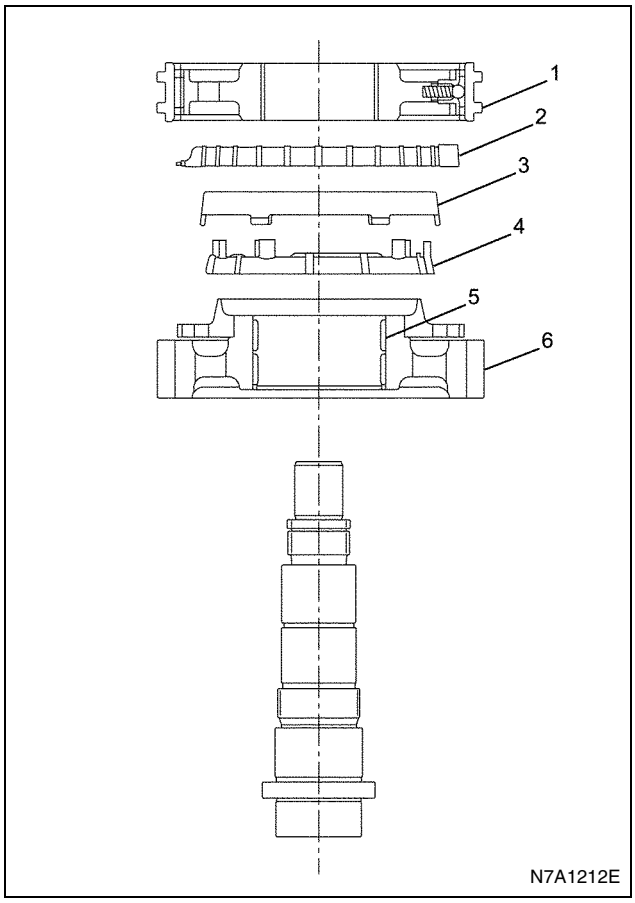

N7A1210E

   c. Insert the sleeve (1) on the clutch hub (5) until the index block is slightly covered.
   d. While pressing in the balls (2), index block (2), and spring (4), securely insert the sleeve until balls enter the sleeve ball grooves.



N7A1211E

2. Apply engine oil to the needle bearing, 2nd gear thrust surface and synchro cone taper. With the dog gear upwards, install the 2nd gear (6) and needle bearing (5) on the main shaft.
3. Install the 2nd inside ring (4), 2nd outside ring (3) and 2nd block ring (2) so the outside ring claw enters the hole in the 2nd gear dog gear. At this time, apply engine oil to both surfaces of the inside ring and outside ring, and the bore surface of the block ring.
4. Install the 2nd — 3rd clutch hub assembly and sleeve (1) so the six inside ring claws are aligned with the six holes of the hub, and use an installer (5-8840-2345-0) to press-fit.

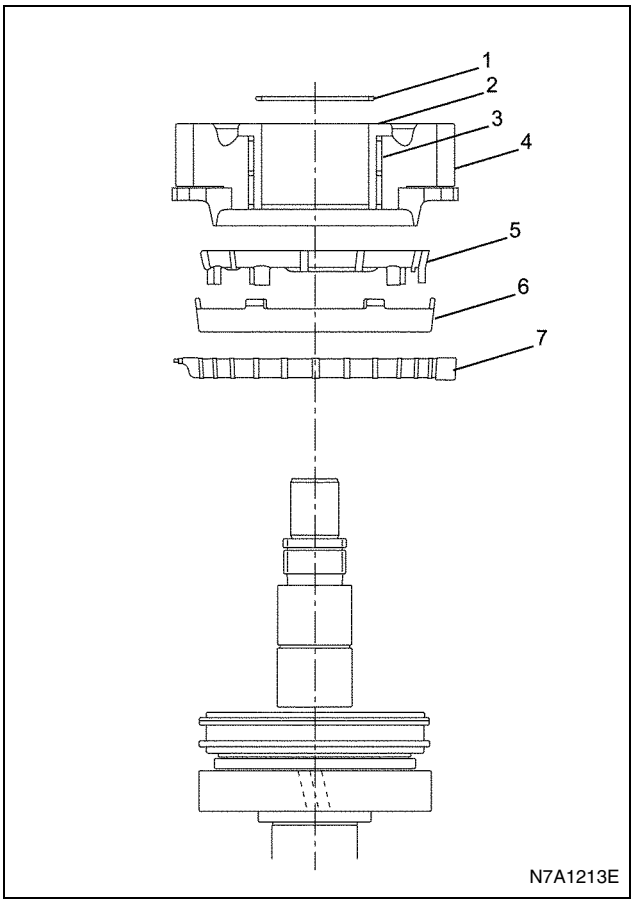


N7A1212E

5. Install the 3rd block ring (7), 3rd outside ring (6), and 3rd inside ring (5) so their six inside ring claws align with the six holes of the hub. At this time, apply engine oil to the bore surface of the inside ring and outside ring, and the bore surface of the block ring.

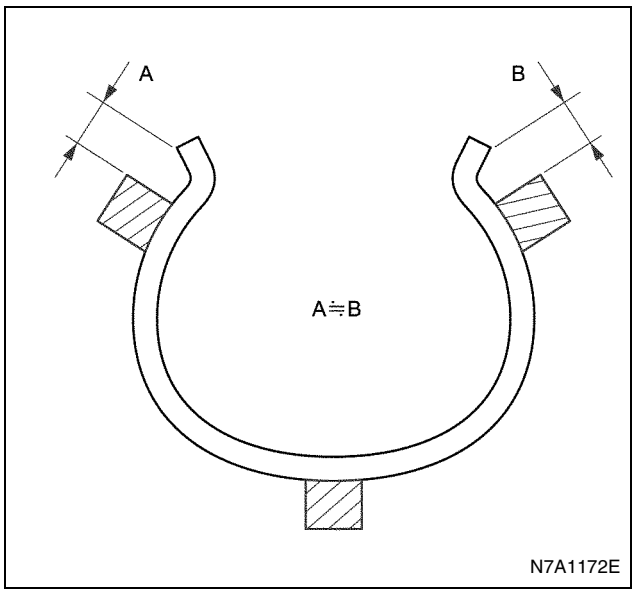
6. Apply engine oil to the needle bearing, 3rd gear thrust surface, and synchro cone taper. With the dog gear facing downwards, use an installer (5-8840-2345-0) to press-fit the 3rd gear (4), needle bearing (3), and collar (2) so the outer ring claw aligns with the 3rd gear dog gear hole.
7. Use snap ring pliers to install the snap ring (1).

Caution:
If the snap ring is deformed or damaged, replace it with a new one and check to make sure it is installed securely.

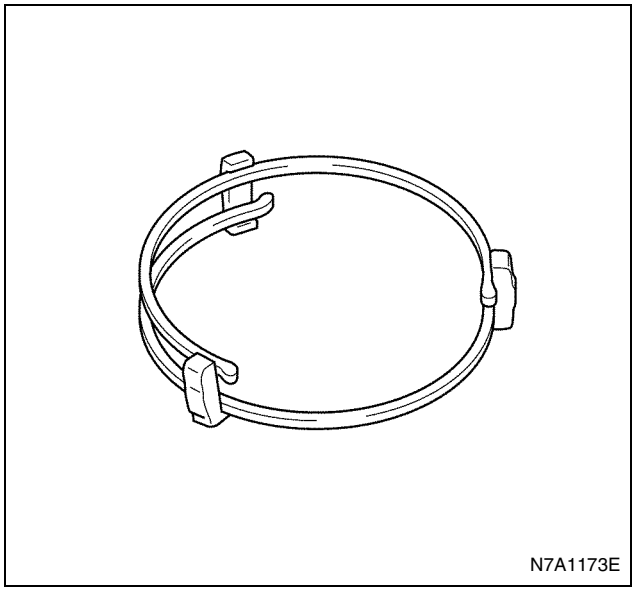


8. Perform the following steps to assemble the 4th — 5th clutch hub assembly and sleeve.
   a. Securely assemble the insert key (2) into the block ring insert key groove.
   b. Install the insert spring (3) on the insert key.

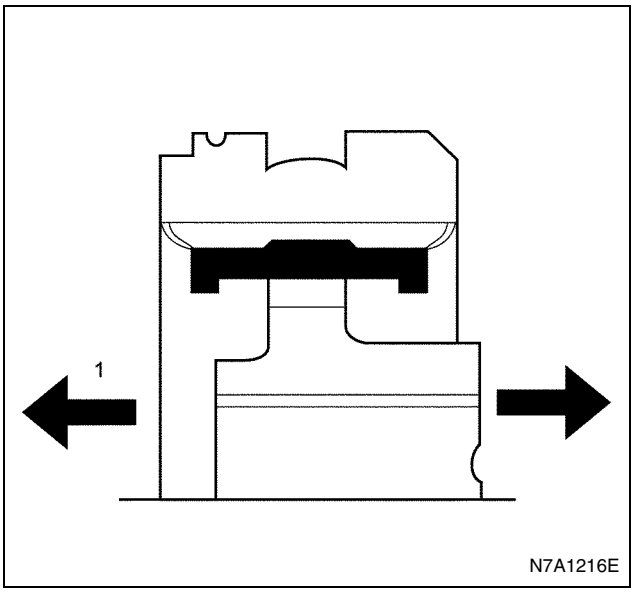
Caution:
- When assembling the insert spring, make sure that the surplus length on either end of the spring is about the same that it does not interfere with the interior diameter of the hub.

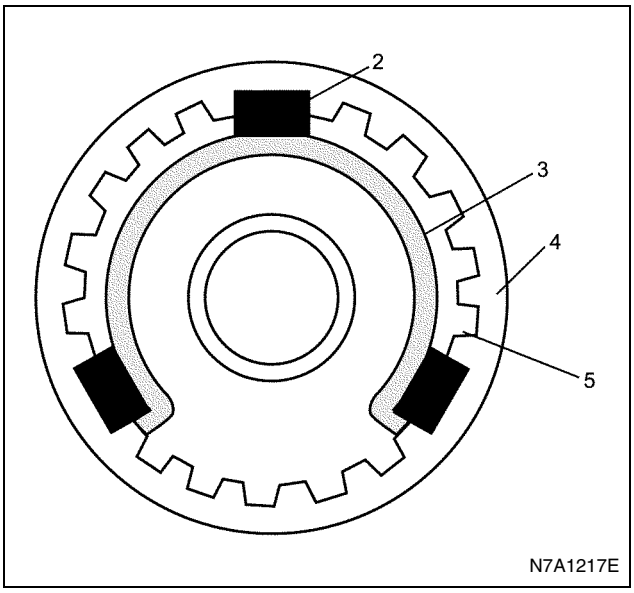


- The insert spring opening on the back should not be in the same position as the front opening.



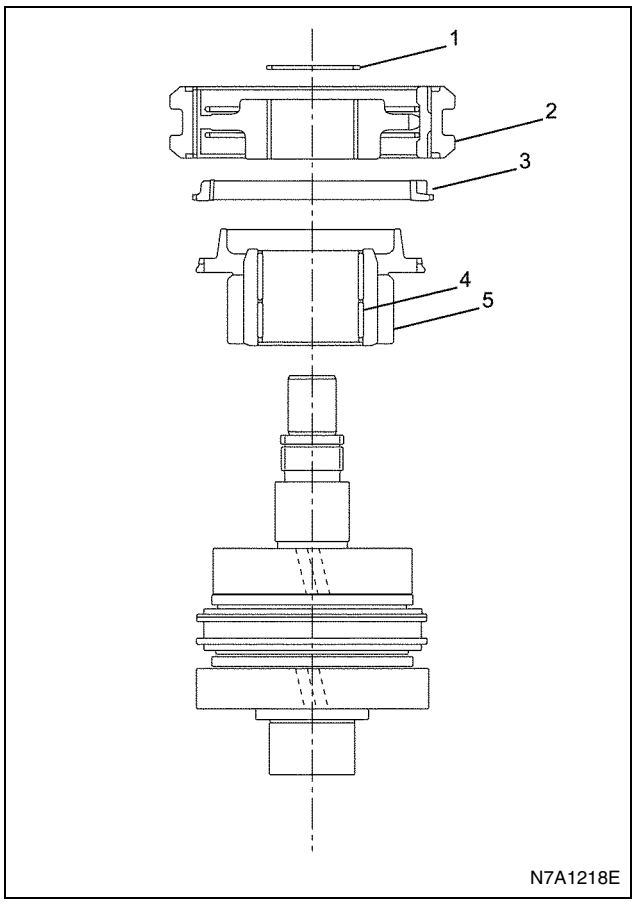
c. Confirm that the clutch hub (4) and sleeve (5) slide smoothly.
   - The arrow (1) indicates the front of the transmission.



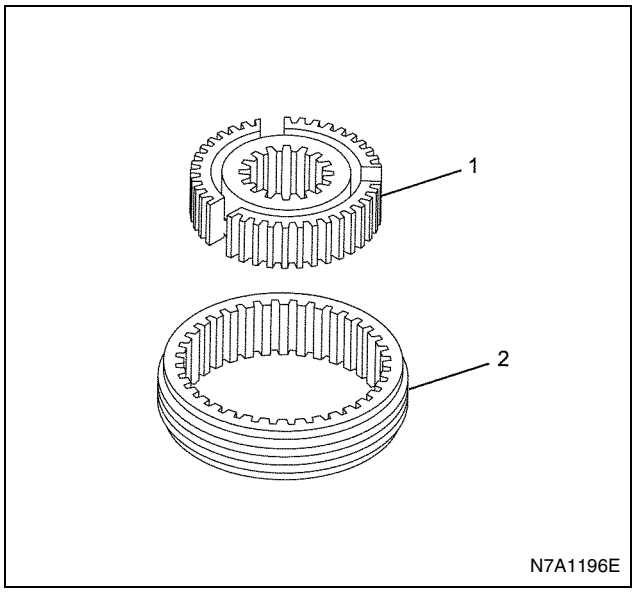


9. Apply engine oil to the needle bearing, 5th gear thrust surface and synchro cone taper. With the dog gear upwards, install the 5th gear (5) and needle bearing (4).
10. Apply engine oil to the 5th block ring (3), and install.
11. With the oil groove surface of the 4th — 5th clutch hub assembly and spring (2) facing downwards, align with the phase of the 4th — 5th block ring groove, and use an installer (5-8840-2345-0) to press-fit.
12. Use snap ring pliers to install the snap ring (1).

Caution:
If the snap ring is deformed or damaged, replace it with a new one and check to make sure it is installed securely.



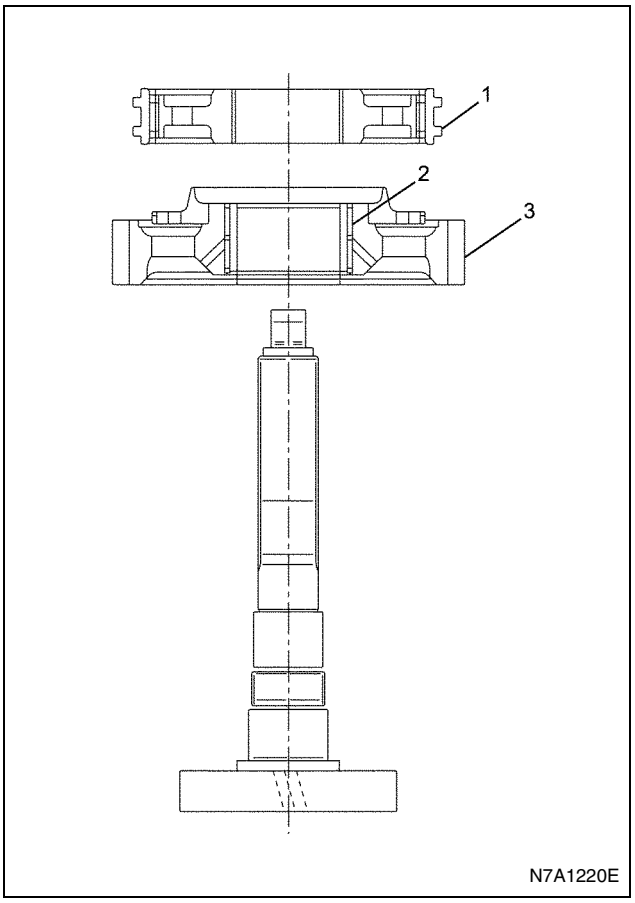
13. Assemble the 1st — Reverse clutch hub assembly and sleeve.



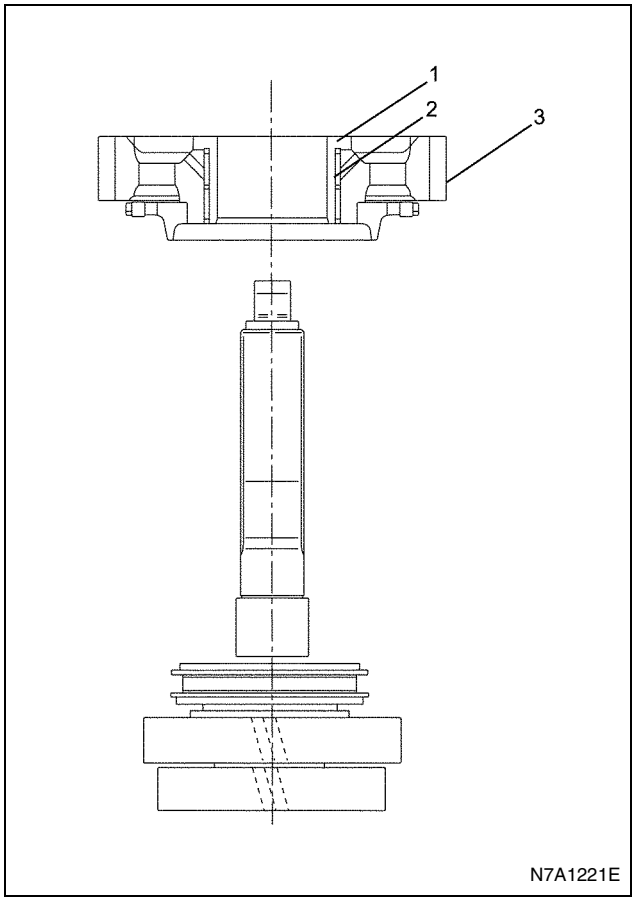
Legend
1. Clutch Hub
2. Sleeve

14. Apply engine oil to the needle bearing, 1st gear thrust surface and synchro cone taper. With the dog gear upwards, install the 1st gear (3) and needle bearing (2).

15. Install the 1st — Reverse clutch hub assembly and sleeve (1), and use an installer (5-8840-2345-0) to press-fit.

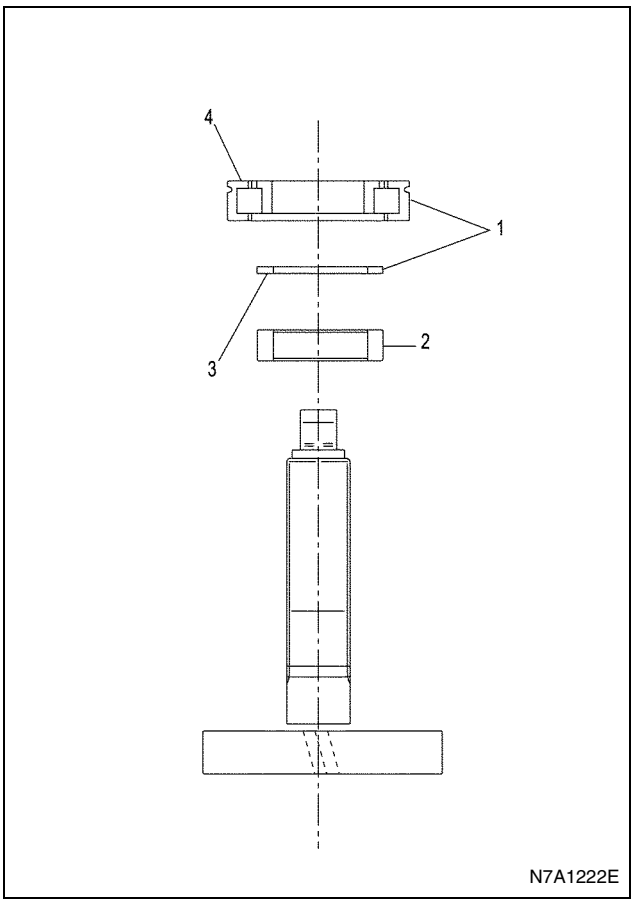


16. Apply engine oil to the needle bearing and reverse gear thrust surface. With the dog gear of the reverse gear (3) facing downwards, use an installer (5-8840-2345-0) to press-fit the needle bearing (2) and collar (1).

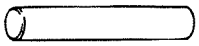


17. Install the spacer (2).

18. With the stamped surface (4) of the bearing (1) facing upwards and stamped surface (3) facing downwards, use an installer (5-8840-2345-0) to press-fit.

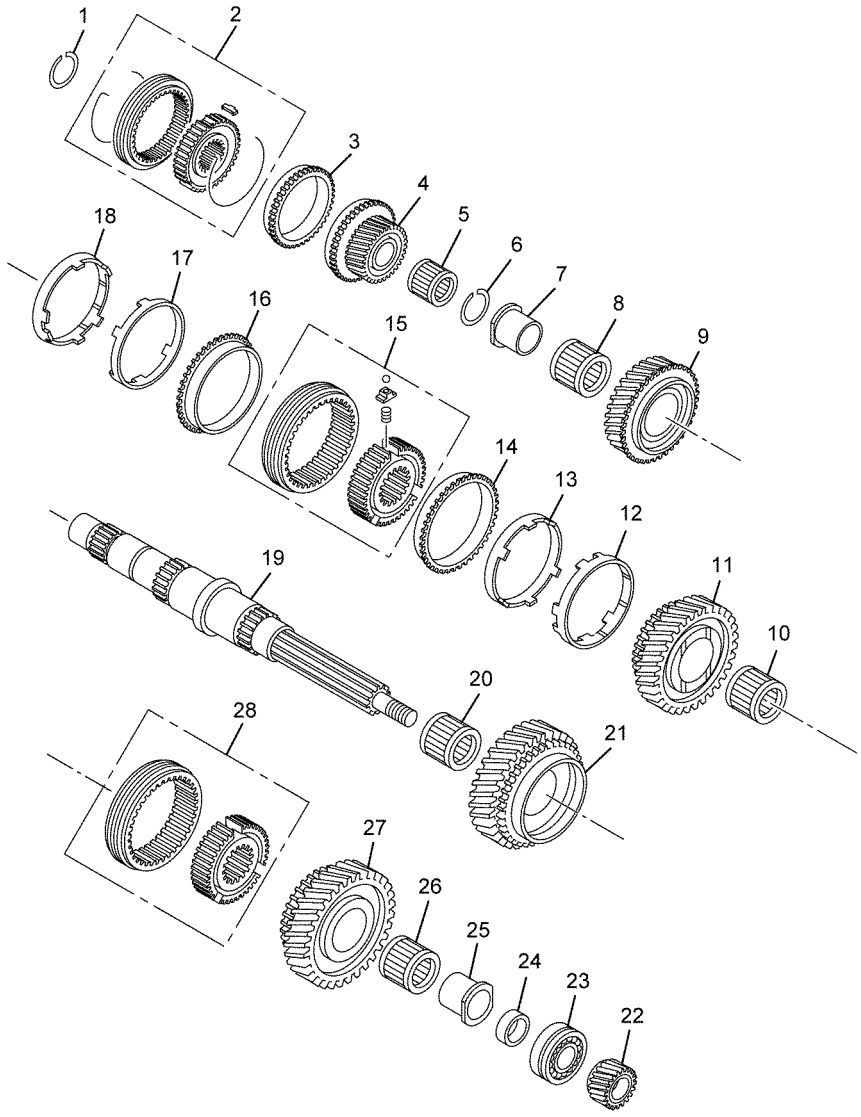


Special Tools

Illustration	Tool No. Tool Name
 5884023450	5-8840-2345-0 Clutch Hub & Collar Installer

Main Shaft (6-Speed)

Components

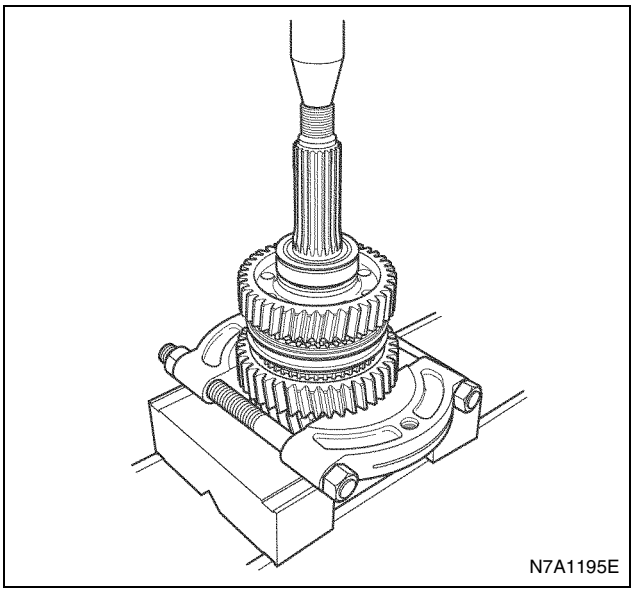


Legend

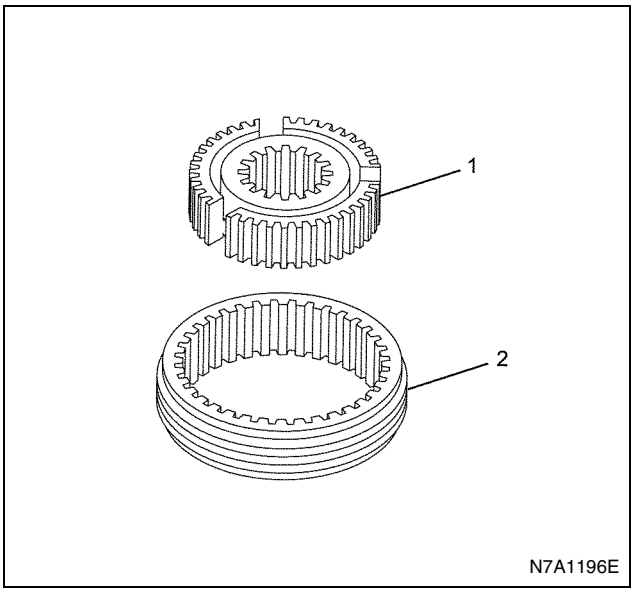
1. Snap Ring
2. 4 — 5th Clutch Hub Assembly and Sleeve
3. 4th Block Ring
4. 4th Gear
5. Needle Bearing
6. Snap Ring
7. Collar
8. Needle Bearing
9. 3rd Gear
10. Needle Bearing
11. 2nd Gear
12. 2nd Inside Ring
13. 2nd Outside Ring
14. 2nd Block Ring
15. 2nd — 3rd Clutch Hub Assembly and Sleeve
16. 3rd Block Ring
17. 3rd Outside Ring
18. 3rd Inside Ring
19. Main Shaft
20. Needle Bearing
21. 1st Gear
22. 6th Gear
23. Bearing
24. Spacer
25. Collar
26. Needle Bearing
27. Reverse Gear
28. 1st — Reverse Clutch Hub Assembly and Sleeve

Disassembly

1. Remove the 6th gear.
2. Use a bearing remover to remove the following items simultaneously with a press: bearing, spacer, collar, reverse gear, needle bearing, 1st — Reverse clutch hub assembly and sleeve, 1st gear, and needle bearing.


N7A1195E

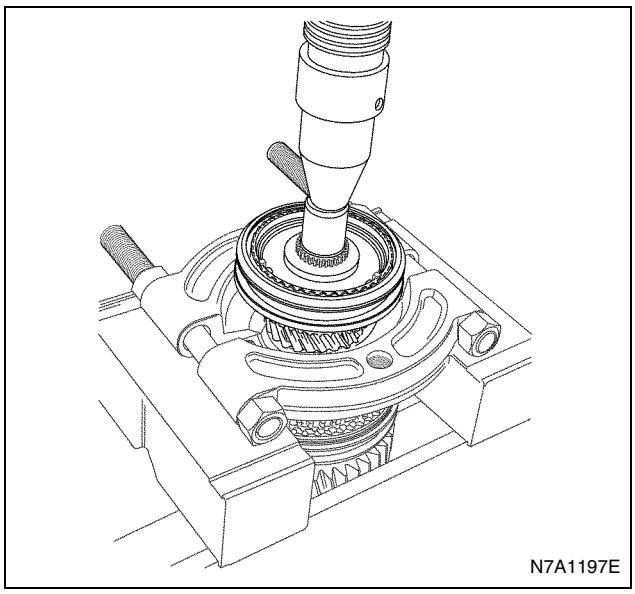
3. Disassemble the 1st — Reverse clutch hub assembly and sleeve.



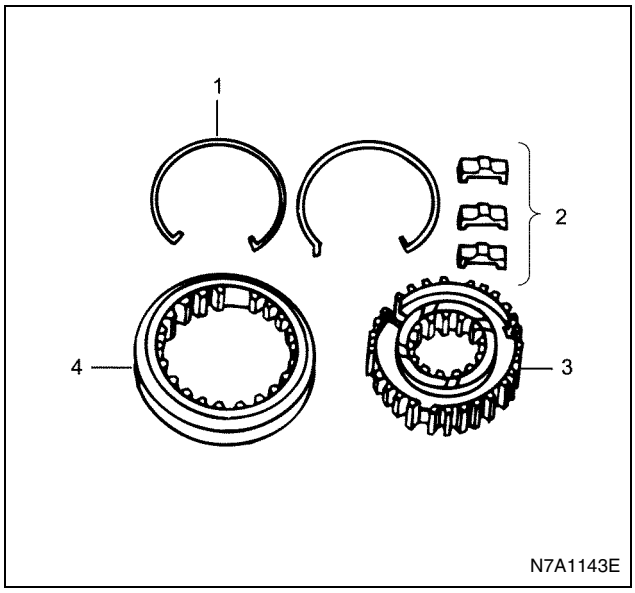
N7A1196E

Legend
1. Clutch Hub
2. Sleeve

4. Use snap ring pliers to remove the snap ring that secures the 4th — 5th clutch hub assembly.
5. Use a bearing remover to remove the following items simultaneously with a press: 4th — 5th clutch hub assembly and sleeve, 4th block ring, 4th gear, and needle bearing.


N7A1197E

6. Disassemble the 4th — 5th clutch hub assembly and sleeve.

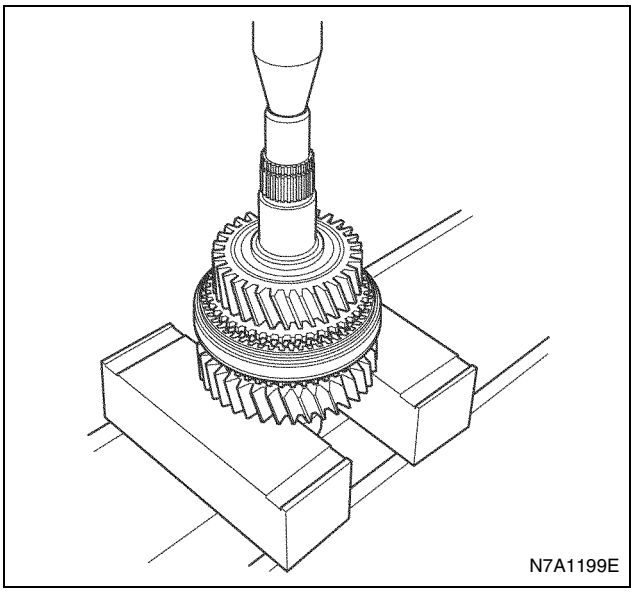


N7A1143E

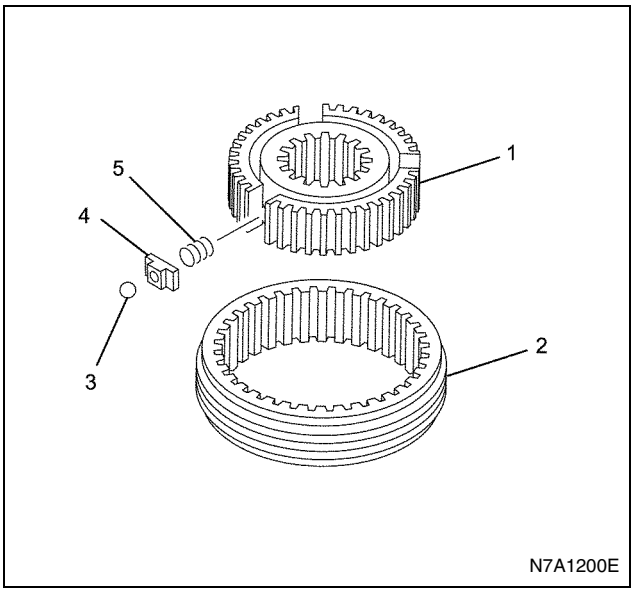
Legend
1. Spring
2. Insert Key
3. Clutch Hub
4. Sleeve

7. Use snap ring pliers to remove the snap ring that secures the 3rd gear collar.

8. Use a gearing remover to remove the following items from the main shaft simultaneously with a press: collar, 3rd gear, needle bearing, 3rd inside ring, 3rd outside ring, 3rd block ring, 2nd — 3rd clutch hub assembly and sleeve, 2nd block ring, 2nd outside ring, 2nd inside ring, 2nd gear, and needle bearing.



9. Disassemble the 2nd — 3rd clutch hub assembly and sleeve.



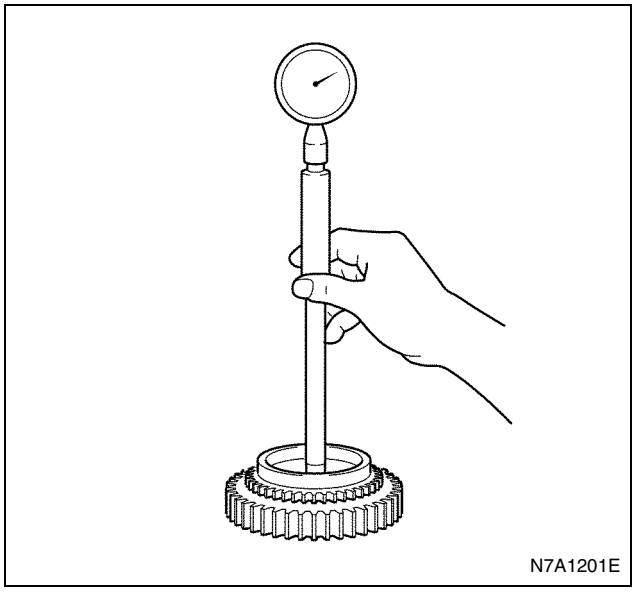
Legend

1. Clutch Hub
2. Sleeve
3. Ball
4. Index Block
5. Spring

Inspect each part. Replace or repair as required if anything is worn or damaged or if any other defect is discovered.

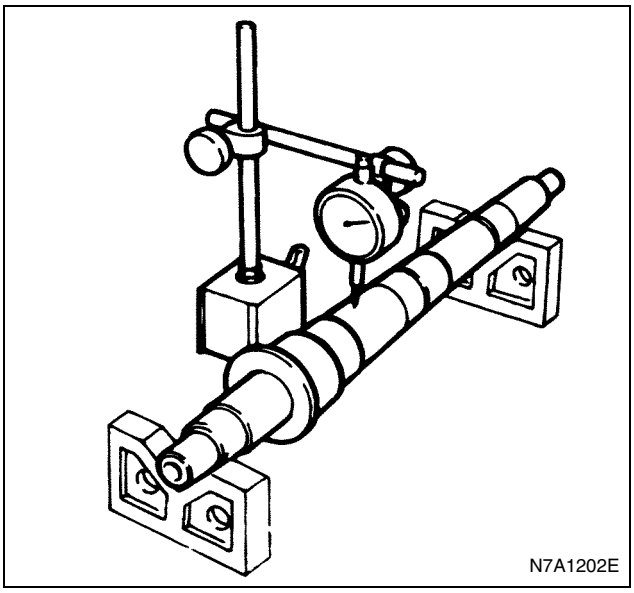
10. Inspect each of the bearings for the following characteristics. If any abnormality is detected, replace the applicable bearing.
    - Smoothness of rotation
    - Noise
    - Damage, rust, or other visible abnormality
    - Abnormal play in the thrust direction
11. Inspect the gear bore.
    - Use an inside dial gauge to measure the bore of each gear.
    - If the measured value exceeds the limit, replace the gear.

Gear Bore (mm)		
	Specified Value	Limit
6th Gear	50.009 — 50.025	50.065
5th Gear	44.009 — 44.025	44.065
4th Gear	44.009 — 44.025	44.065
3rd Gear	63.010 — 63.029	63.069
2nd Gear	63.010 — 63.029	63.069
1st Gear	63.010 — 63.029	63.069
Reverse Gear	63.010 — 63.029	63.069

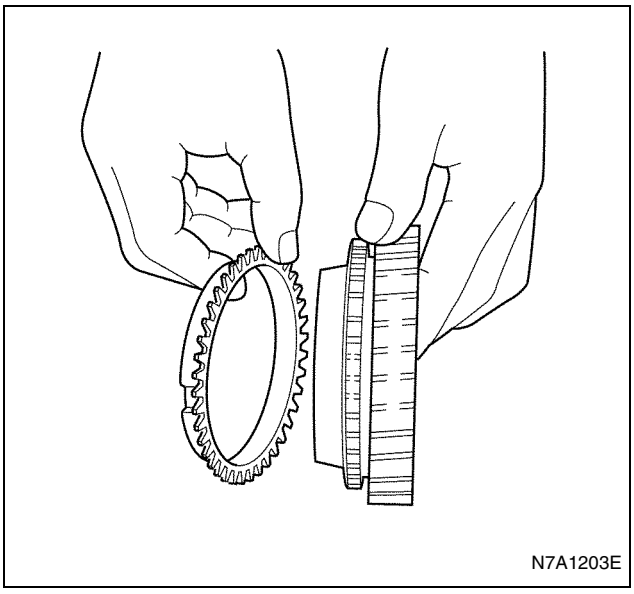


12. Inspect the main shaft runout.
    - Use a dial gauge to measure the bend of the main shaft.

- If the measured value exceeds the limit, replace the main shaft.
  Standard value: 0.015 mm Limit: 0.1 mm

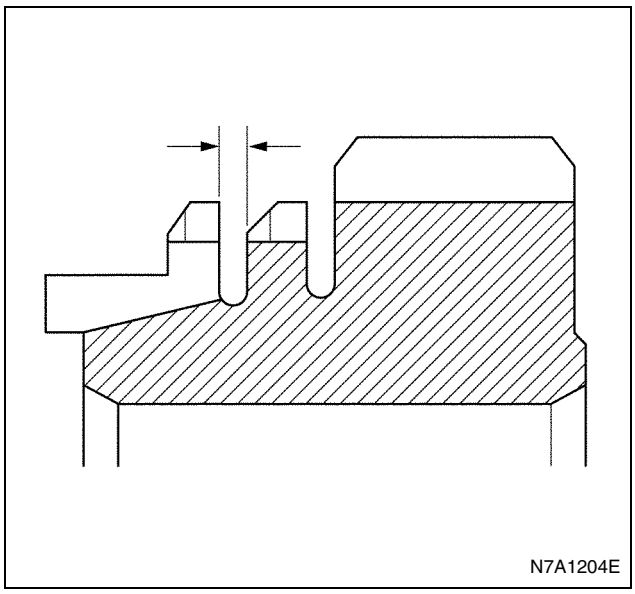

N7A1202E

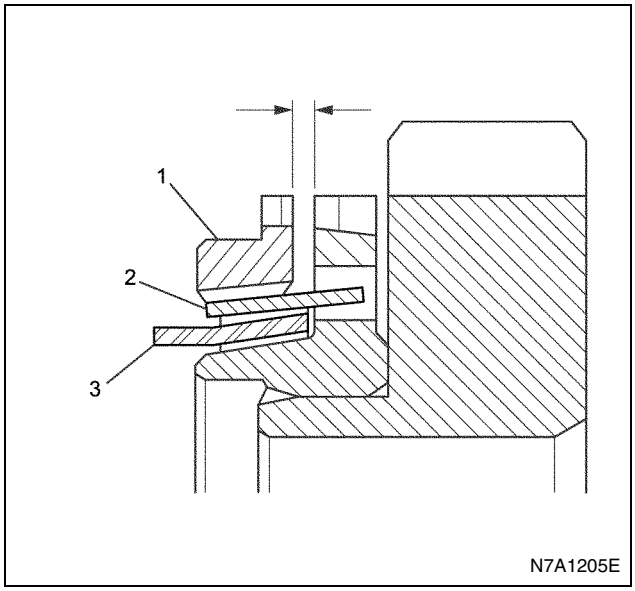
13. Inspect the synchromesh mechanism.
    - Inspect the component parts. Use an oil stone or pencil grinder to repair any minute stepped wear or damage.


N7A1203E

14. Use a thickness gauge to measure the gap between the block ring and dog gear.
    - If the measured value exceeds the limit, replace the block ring.

Gap Between the Block Ring and Dog Gear (mm)		
	Specified Value	Limit
4th/5th/6th	1.30 — 2.60	0.5
2nd/3rd	1.00 — 2.50	0.5


N7A1204E

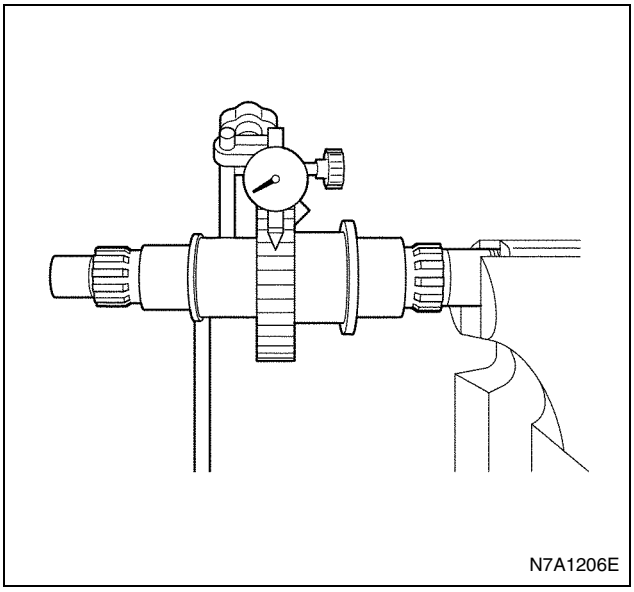


N7A1205E

Legend
1. Block Ring
2. Outside Ring
3. Inside Ring

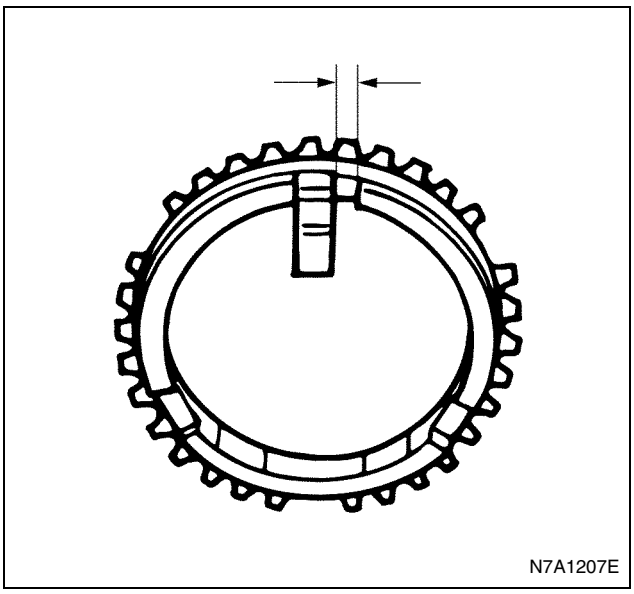
15. Inspect the sliding part of the clutch hub and sliding sleeve, the insert key of the spline, and the insert groove for wear and damage.
16. Measure the play in the spline rotation direction (on the clutch hub outer circumference).
    - If the measured value exceeds the limit, replace.

Spline Play (mm)	
Specified Value	Limit
0 — 0.05	0.3


N7A1206E

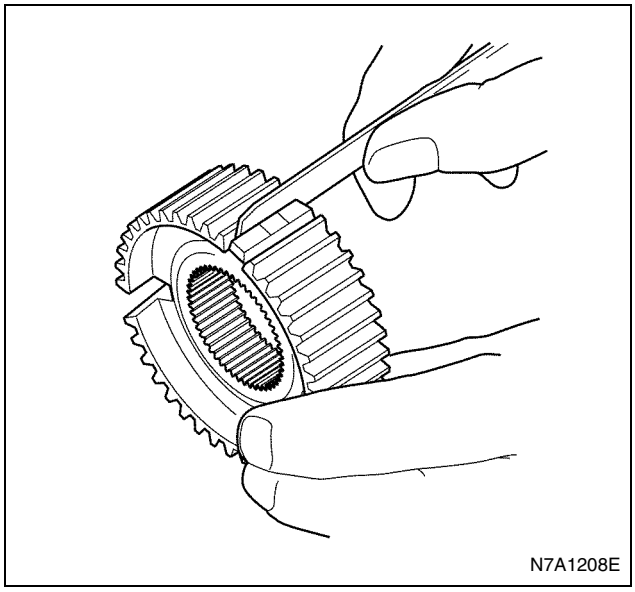
17. Use a caliper to measure the gap between the insert key and block ring groove.
    - If the measured value exceeds the specified value, replace the insert key and block ring.

Gap Between the Insert Key and Block Ring Groove (mm)	
	Specified Value
4th/5th/6th	3.46 — 3.76


N7A1207E

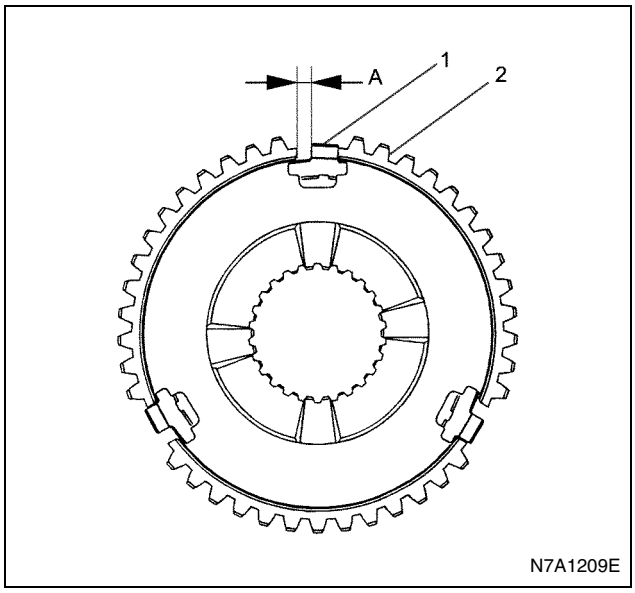
18. Use a thickness gauge to measure the gap between the insert key and clutch hub.
    - If the measured value exceeds the specified value, replace the insert key and clutch hub.

Gap Between the Insert Key and Clutch Hub (mm)	
	Specified Value
4th/5th/6th	0.01 — 0.21


N7A1208E

19. Use a thickness gauge to measure the gap between the index block and clutch hub.
    - If the measured value exceeds the limit, replace the index block and clutch hub.

Gap Between the Index Block and Clutch Hub (mm)	
	Specified Value
2nd/3rd	4.30 — 4.70



N7A1209E

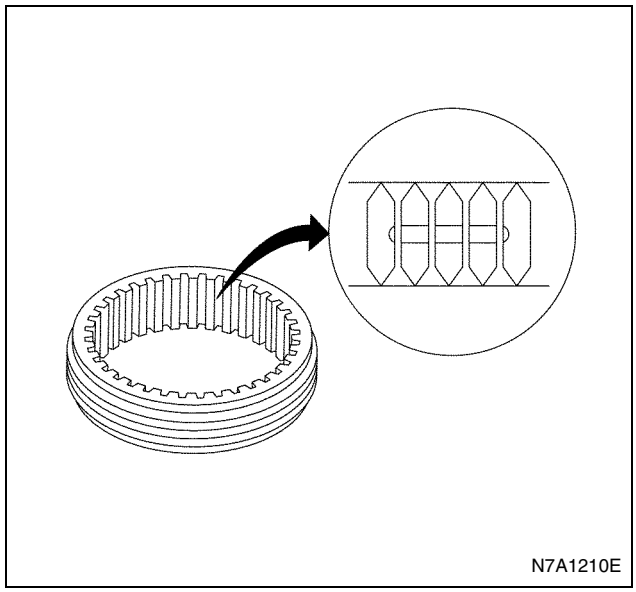
Legend
1. Index Block
2. Clutch Hub

Assembly

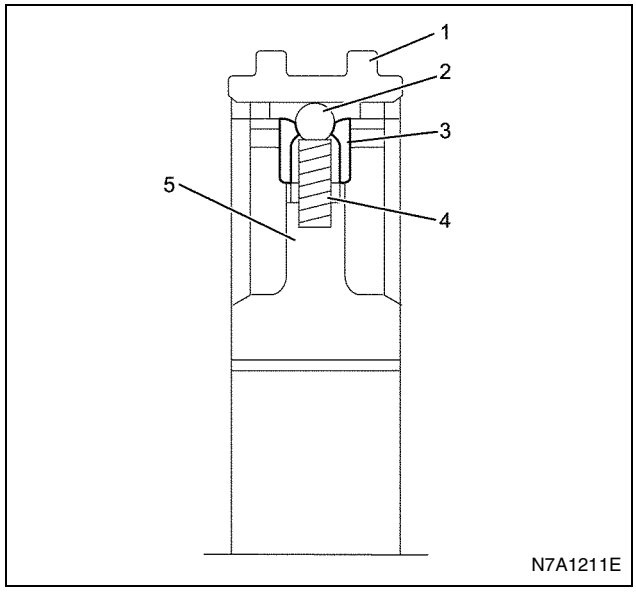
- Thoroughly clean each part.

- Set the main shaft into a vice, with the long spline length downwards. At this time, take care to avoid damage to the grinding surface.

1. Perform the following steps to assemble the 2nd — 3rd clutch hub assembly and sleeve.
   a. Install the index block and spring onto the clutch hub.
   b. There are three ball grooves on the inner surface of the sleeve. Align the phase so the balls are in the center of the ball grooves.

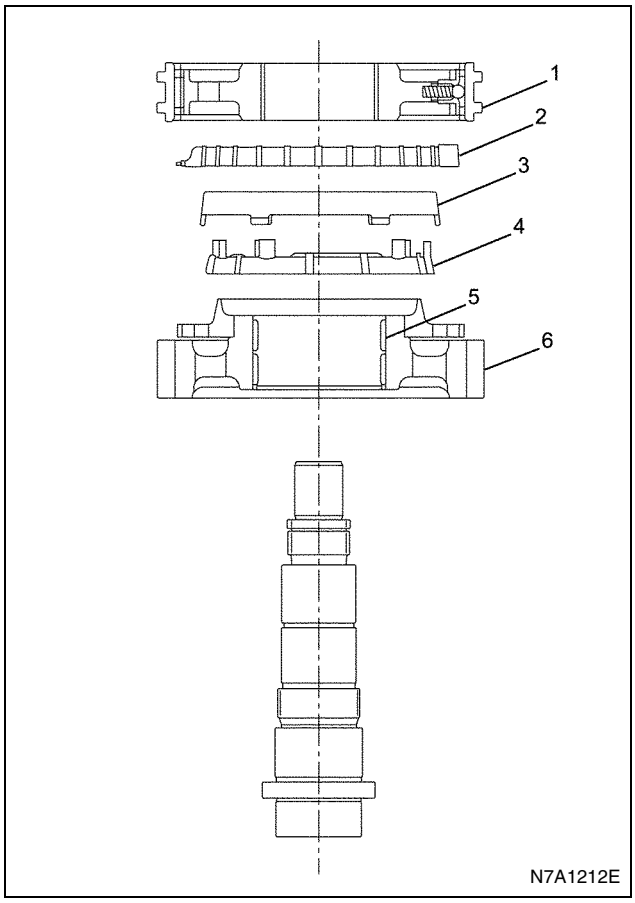

N7A1210E

   c. Insert the sleeve (1) on the clutch hub (5) until the index block is slightly covered.
   d. While pressing in the balls (2), index block (2), and spring (4), securely insert the sleeve until balls enter the sleeve ball grooves.



N7A1211E

2. Apply engine oil to the needle bearing, 2nd gear thrust surface and synchro cone taper. With the dog gear upwards, install the 2nd gear (6) and needle bearing (5) on the main shaft.
3. Install the 2nd inside ring (4), 2nd outside ring (3) and 2nd block ring (2) so the outside ring claw enters the hole in the 2nd gear dog gear. At this time, apply engine oil to the bore surface of the inside ring and outside ring, and the bore surface of the block ring.
4. Install the 2nd — 3rd clutch hub assembly and sleeve (1) so the six inside ring claws are aligned with the six holes of the hub, and use an installer (5-8840-2345-0) to press-fit.

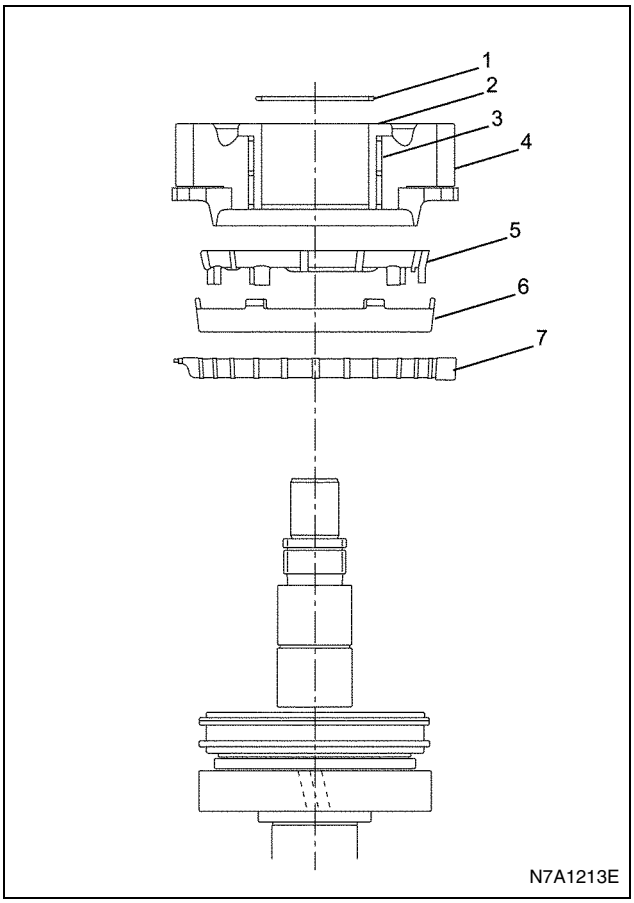


N7A1212E

5. Install the 3rd block ring (7), 3rd outside ring (6), and 3rd inside ring (5) so their six inside ring claws align with the six holes of the hub. At this time, apply engine oil to the bore surface of the inside ring and outside ring, and the bore surface of the block ring.

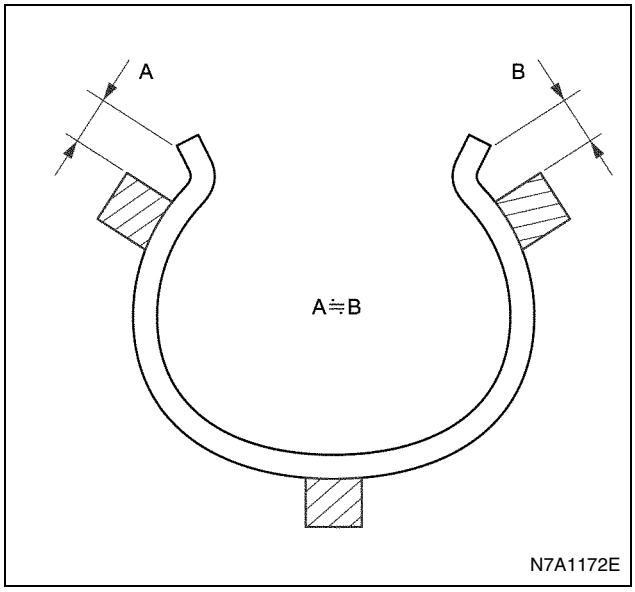
6. Apply engine oil to the needle bearing, 3rd gear thrust surface, and synchro cone taper. With the dog gear facing downwards, use an installer (5-8840-2345-0) to press-fit the 3rd gear (4), needle bearing (3), and collar (2) so the outer ring claw aligns with the 3rd gear dog gear hole.
7. Use snap ring pliers to install the snap ring (1).

Caution:
If the snap ring is deformed or damaged, replace it with a new one and check to make sure it is installed securely.

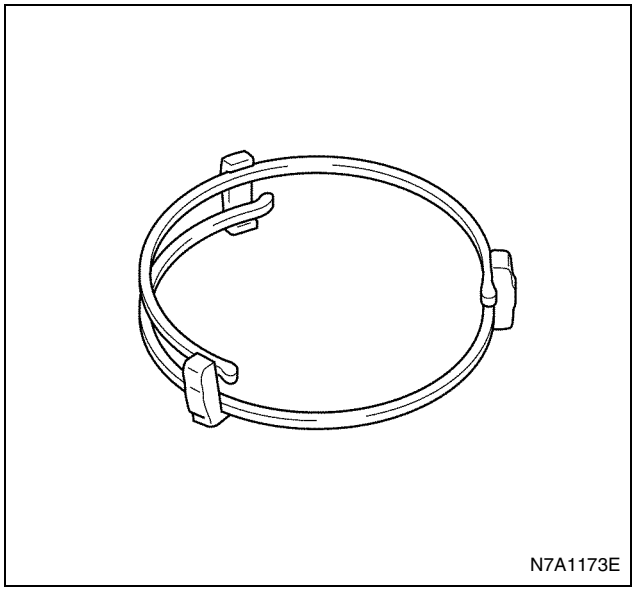


8. Perform the following steps to assemble the 4th — 5th clutch hub assembly and sleeve.
   a. Securely assemble the insert key (2) into the block ring insert key groove.
   b. Install the insert spring (3) on the insert key as shown in the illustration.

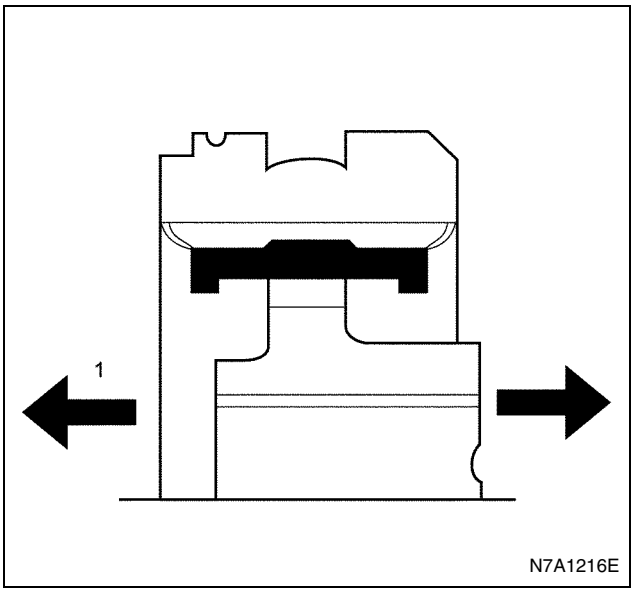
Caution:
- When assembling the insert spring, make sure that the surplus length on either end of the spring is about the same that it does not interfere with the interior diameter of the hub.

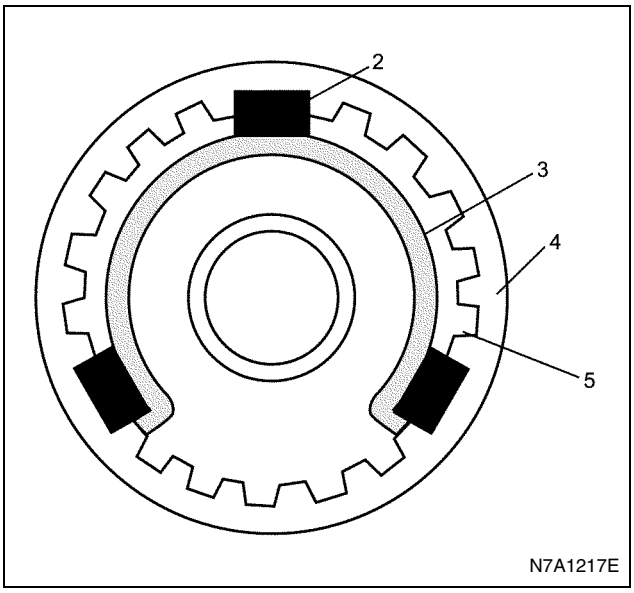


- The insert spring opening on the back should not be in the same position as the front opening.



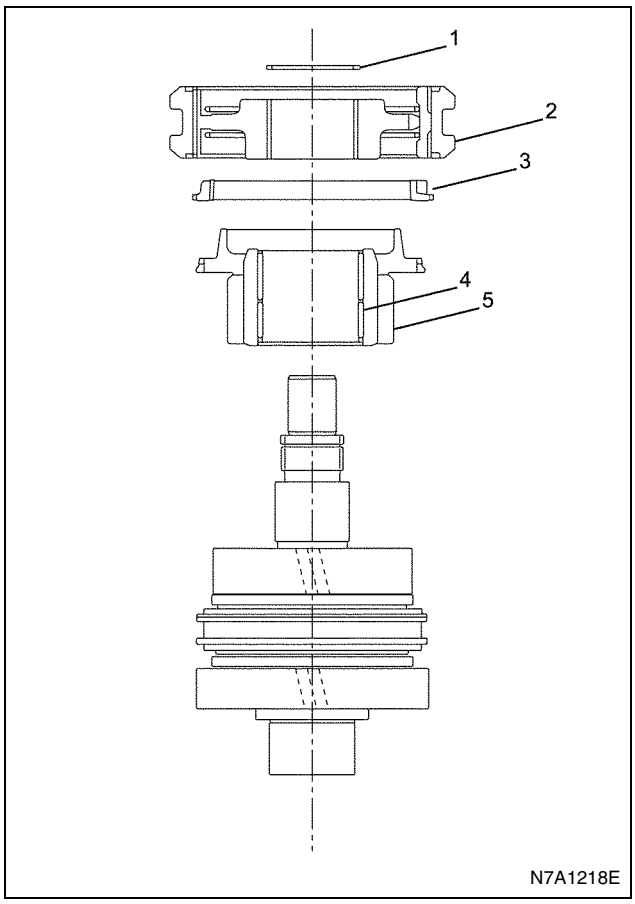
c. Confirm that the clutch hub (4) and sleeve (5) slide smoothly.
   - The arrow (1) indicates the front of the transmission.



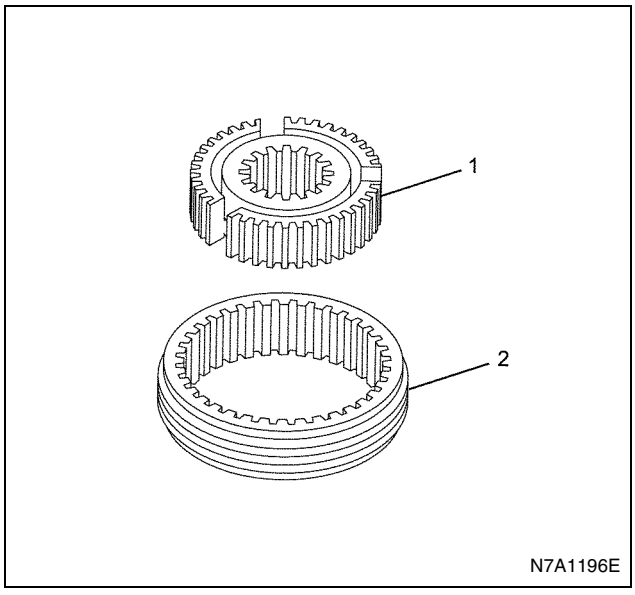


9. Apply engine oil to the needle bearing, 4th gear thrust surface and synchro cone taper. With the dog gear upwards, install the 4th gear (5) and needle bearing (4).
10. Apply engine oil to the 4th block ring (3), and install.
11. With the oil groove surface of the 4th — 5th clutch assembly and sleeve (2) facing downwards, align with the pass of the 4th — 5th block ring groove and use an installer (5-8840-23450-0) to press-fit.
12. Use snap ring pliers to install the snap ring (1).

Caution:
If the snap ring is deformed or damaged, replace it with a new one and check to make sure it is installed securely.



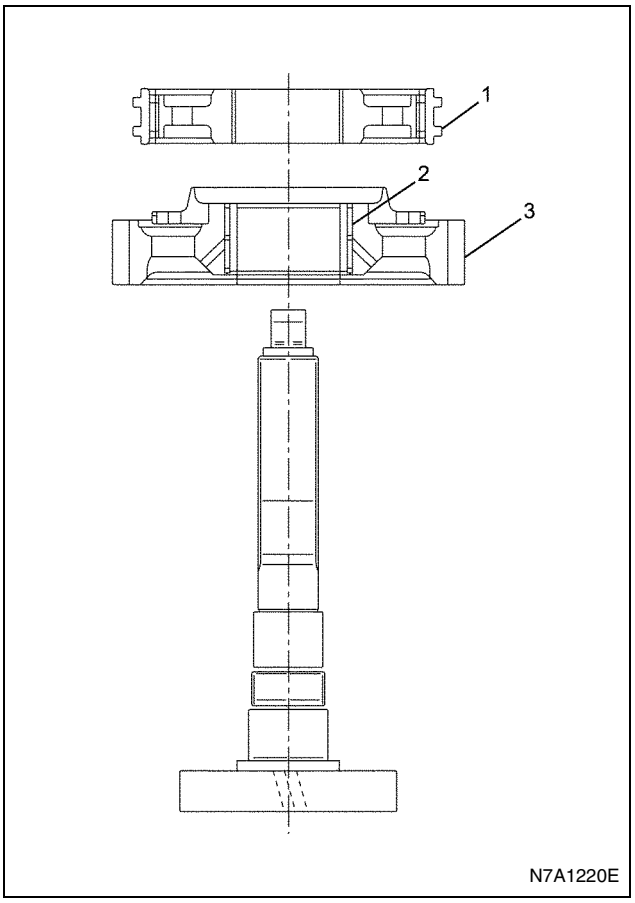
13. Assemble the 1st — Reverse clutch hub assembly and sleeve.



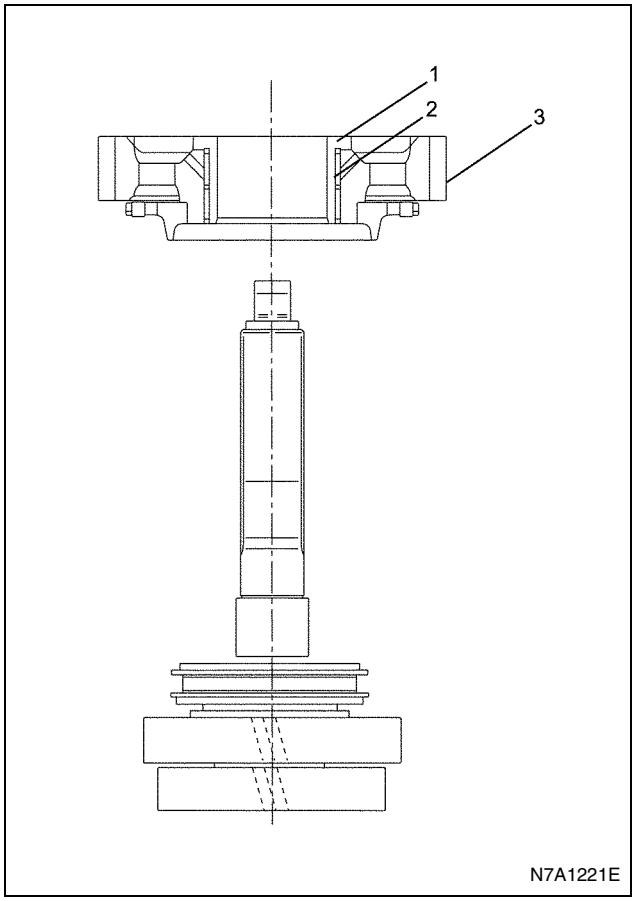
Legend
1. Clutch Hub
2. Sleeve

14. Apply engine oil to the needle bearing, 1st gear thrust surface and synchro cone taper. With the dog gear upwards, install the 1st gear (3) and needle bearing (2).

15. Install the 1st — Reverse clutch hub assembly and sleeve (1), and use an installer (5-8840-2345-0) to press-fit.

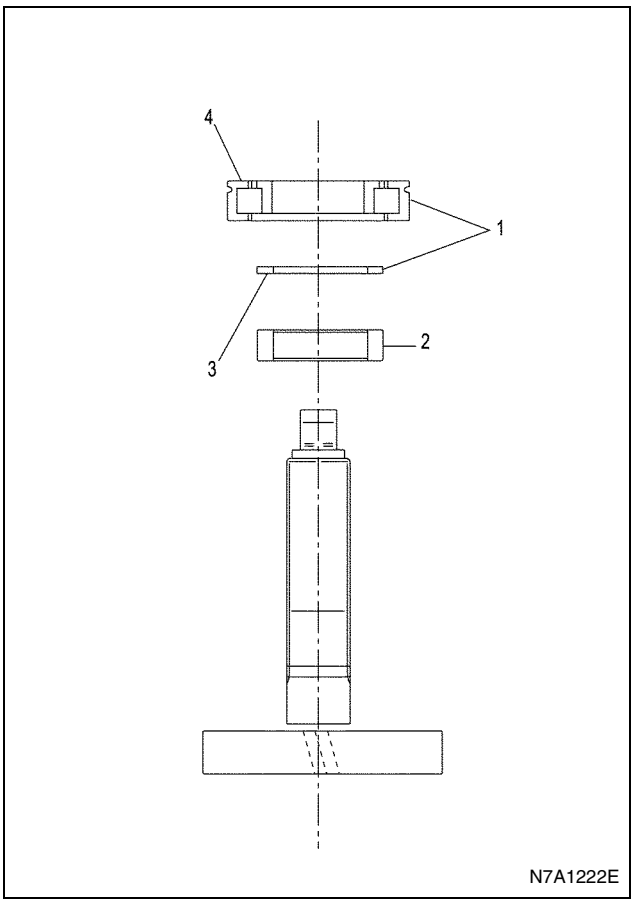


16. Apply engine oil to the needle bearing and reverse gear thrust surface. With the dog gear of the reverse gear (3) facing downwards, use an installer (5-8840-2345-0) to press-fit the needle bearing (2) and collar (1).



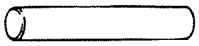
17. Install the spacer (2).

18. With the stamped surface (4) of the bearing (1) facing upwards and stamped surface (3) facing downwards, use an installer (5-8840-2345-0) to press-fit.



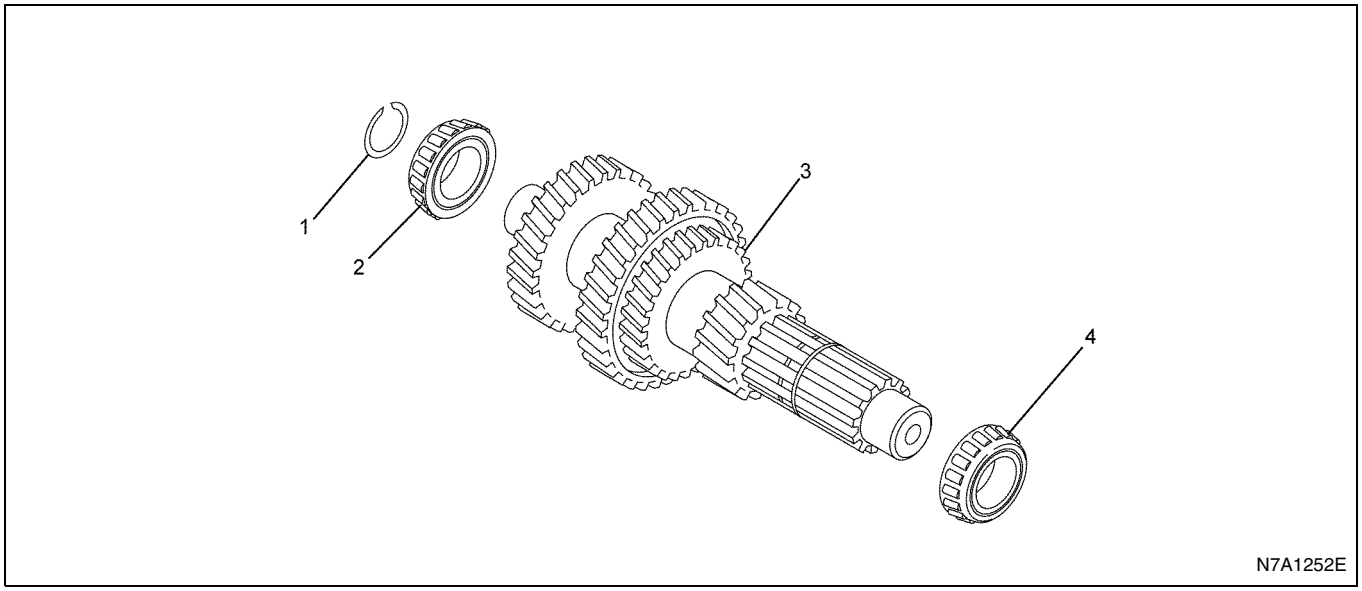
19. Install the 6th gear.
    - Install with the convex portion facing downwards.

Special Tools

Illustration	Tool No. Tool Name
 5884023450	5-8840-2345-0 Clutch Hub & Collar Installer

Counter Shaft (5-Speed)

Components

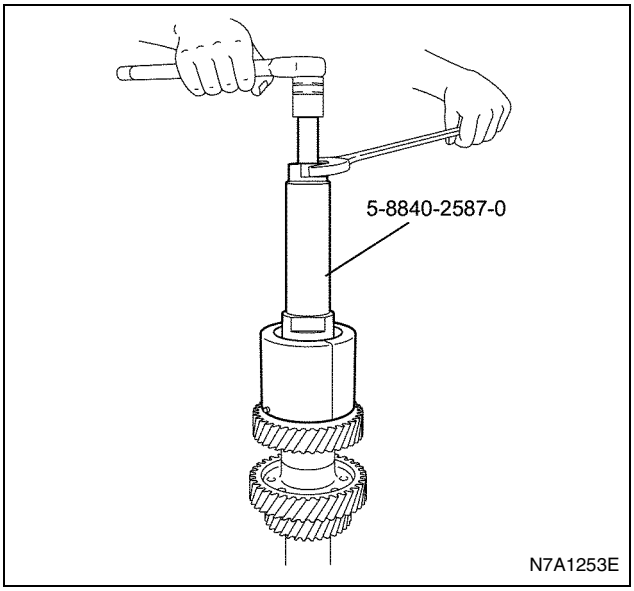


Legend

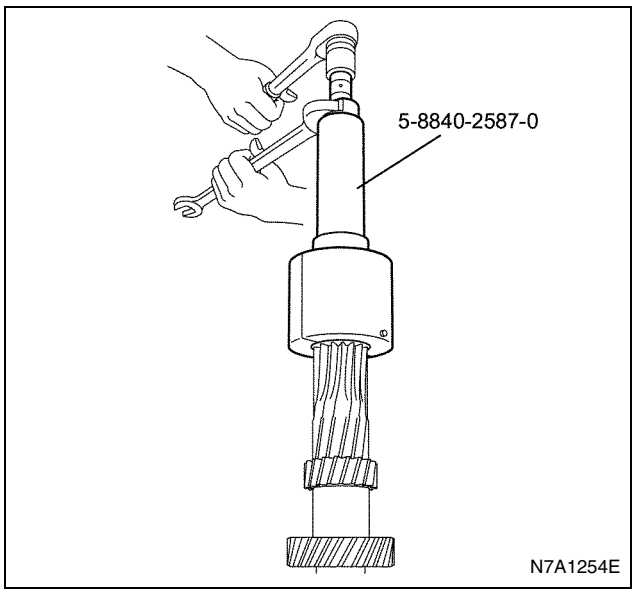
1. Snap Ring
2. Counter Front Bearing
3. Counter Shaft Assembly
4. Counter Rear Bearing

Disassembly

1. Use snap ring pliers to remove the snap ring that fixes the bearing.
2. Use a bearing remover (5-8840-2587-0) to remove the counter front bearing.
   - Use a 303173 bearing remover insert and 44802 collet.



3. Use a bearing remover (5-8840-2587-0) to remove the counter rear bearing.
   - Use a 303173 bearing remover insert and 44802 collet.



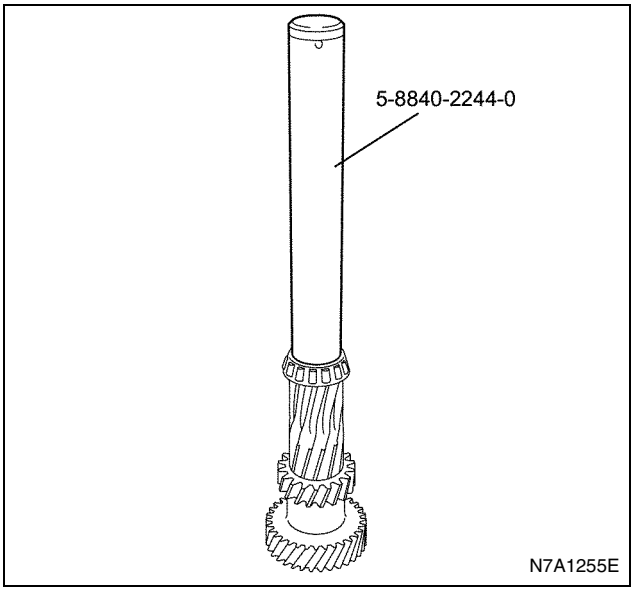
Inspect each disassembled part. Replace or repair as required if anything is worn or damaged or if any other defect is discovered.

4. Inspect each gear profile for damage and wear. If any abnormality is detected, replace the applicable gear.
5. Inspect each of the bearings for the following characteristics. If any abnormality is detected, replace the applicable bearing.
   - Smoothness of rotation
   - Noise
   - Damage, rust, or other visible abnormality

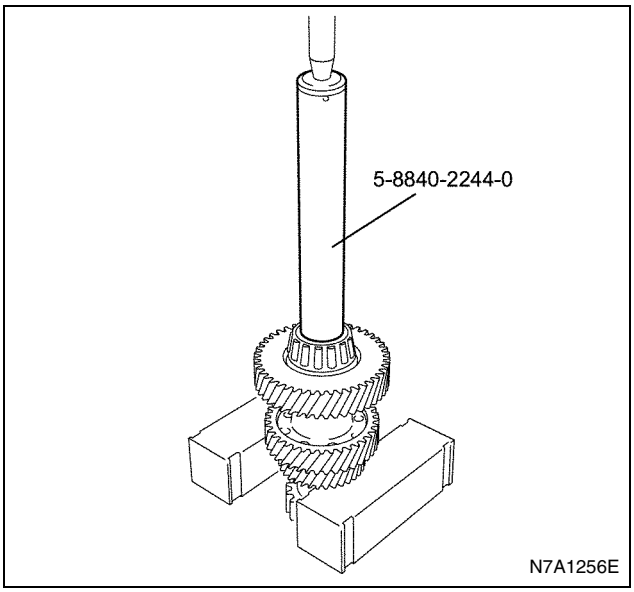
- Abnormal play in the thrust direction

Assembly

1. Use an installer (5-8840-2244-0) to press fit the counter rear bearing with a press.



2. Use an installer (5-8840-2244-0) to press fit the counter front bearing with a press.

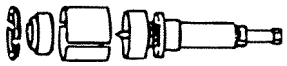
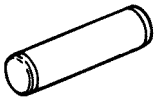


3. Use snap ring pliers to install the snap ring that fixes the bearing.
   - Select the thickest snap ring from among the three types that can be installed.

Thickness (mm)	Color Code
1.9	Blue
2.1	Yellow
2.3	Pink

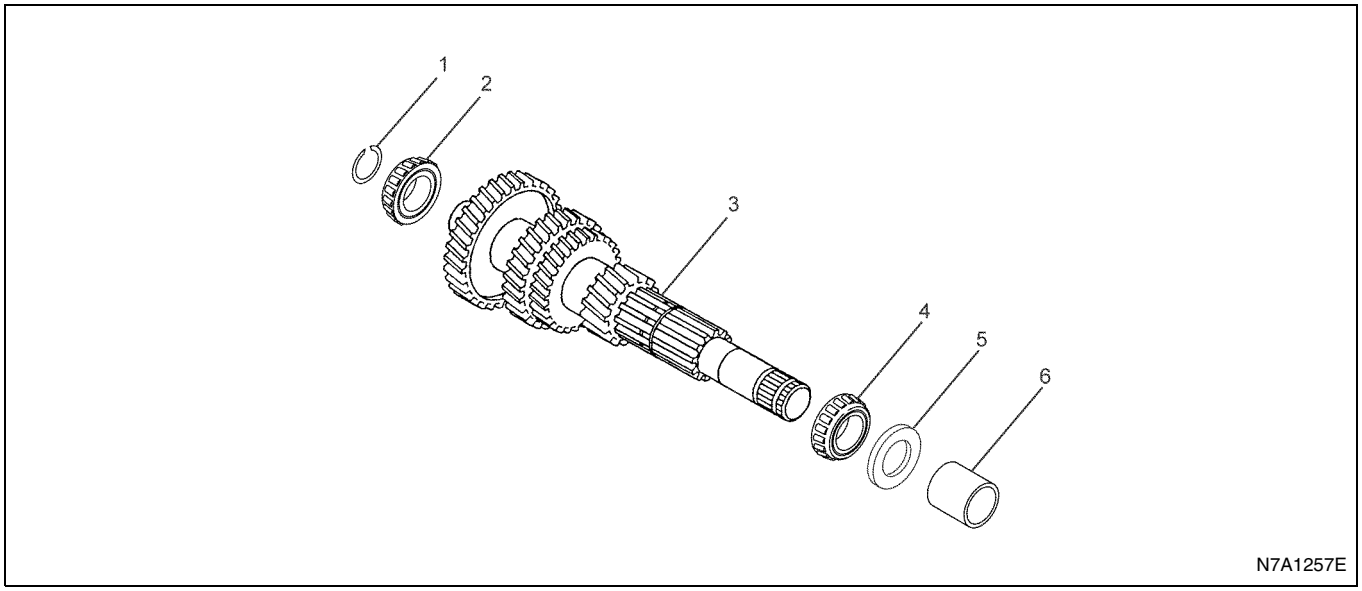
Caution:
If the snap ring is deformed or damaged, replace it with a new one and check to make sure it is installed securely.

Special Tools

Illustration	Tool No. Tool Name
 5884025870	5-8840-2587-0 Bearing Remover
 5884022440	5-8840-2244-0 Bearing Installer

Counter Shaft (6-Speed)

Components

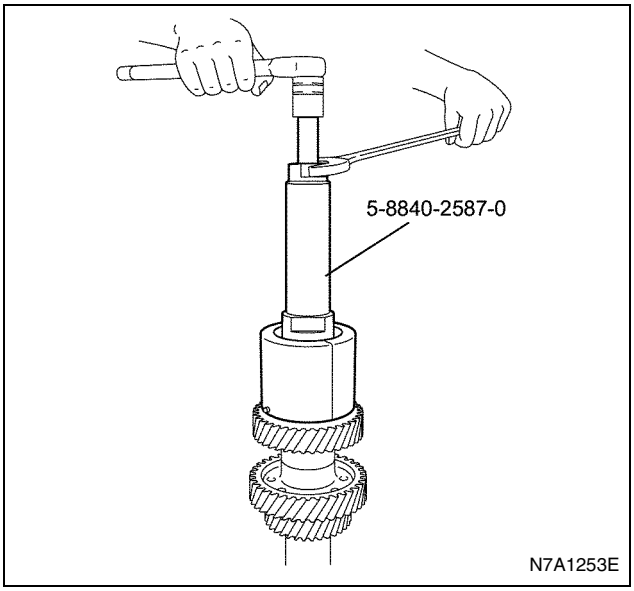


Legend

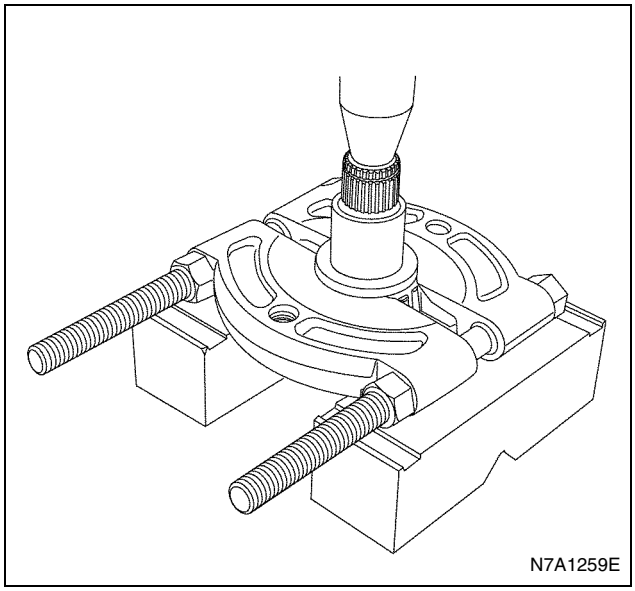
1. Snap Ring
2. Counter Front Bearing
3. Counter Shaft Assembly
4. Counter Rear Bearing
5. Thrust Washer
6. Collar

Disassembly

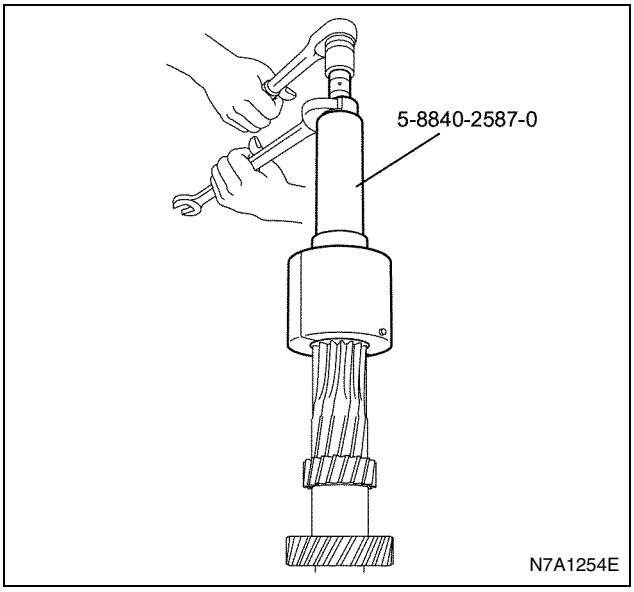
1. Use snap ring pliers to remove the snap ring that fixes the bearing.
2. Use a bearing remover (5-8840-2587-0) to remove the counter front bearing.
   - Use a 303173 bearing remover insert and 44802 collet.



3. Use a bearing remover to remove the collar and thrust washer with a press.



4. Use a bearing remover (5-8840-2587-0) to remove the counter rear bearing.
   - Use a 303173 bearing remover insert and 44802 collet.

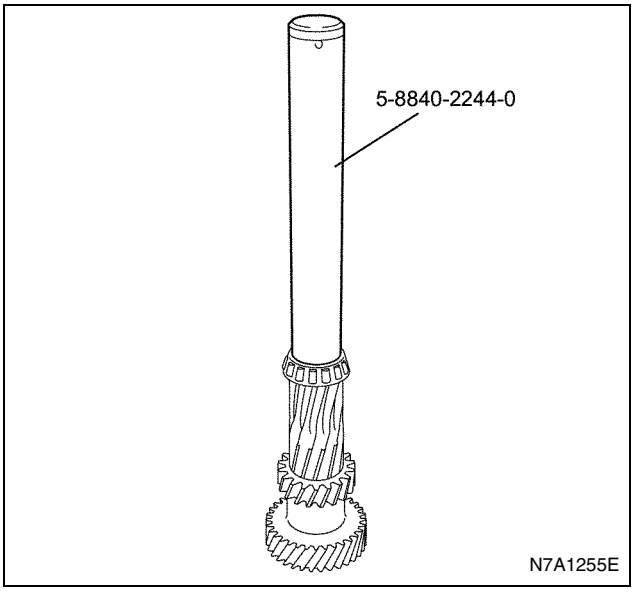


Inspect each disassembled part. Replace or repair as required if anything is worn or damaged or if any other defect is discovered.

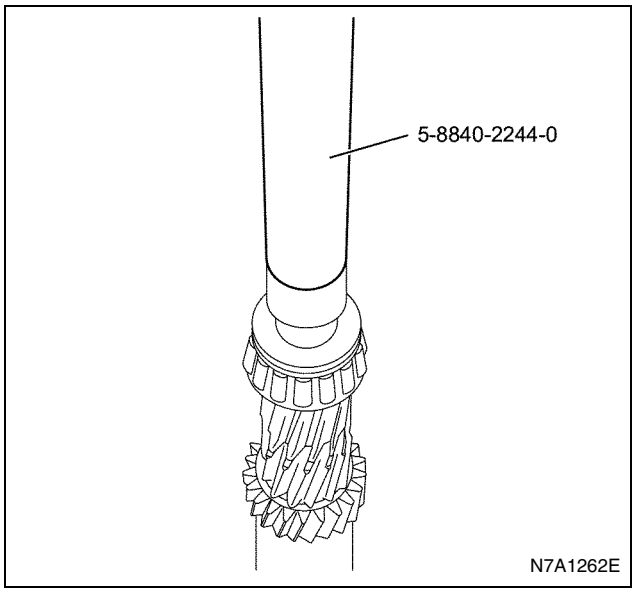
5. Inspect each gear profile for damage and wear. If any abnormality is detected, replace the applicable gear.
6. Inspect each of the bearings for the following characteristics. If any abnormality is detected, replace the applicable bearing.
   - Smoothness of rotation
   - Noise
   - Damage, rust, or other visible abnormality
   - Abnormal play in the thrust direction

Assembly

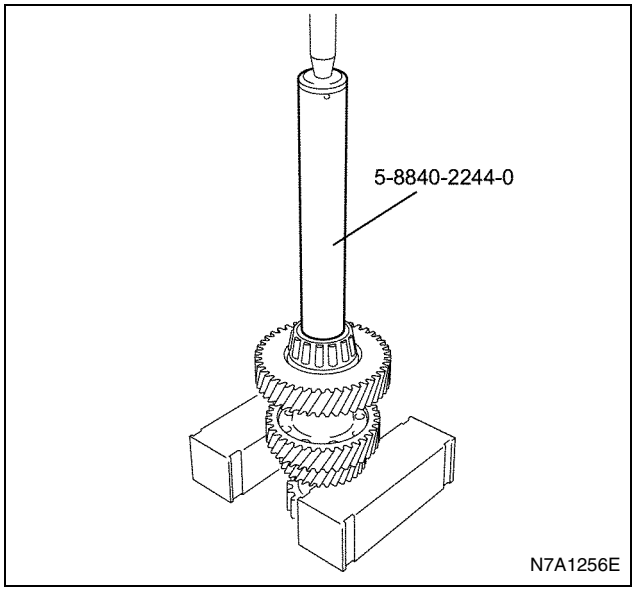
1. Use an installer (5-8840-2244-0) to press fit the counter rear bearing with a press.



2. Use an installer (5-8840-2244-0) to press fit the collar and thrust washer with a press.



3. Use an installer (5-8840-2244-0) to press fit the counter front bearing with a press.

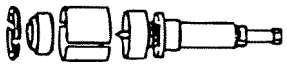
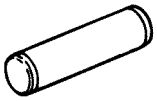


4. Use snap ring pliers to install the snap ring that fixes the bearing.
   - Select the thickest snap ring from among the three types that can be installed.

Thickness (mm)	Color Code
1.9	Blue
2.1	Yellow
2.3	Pink

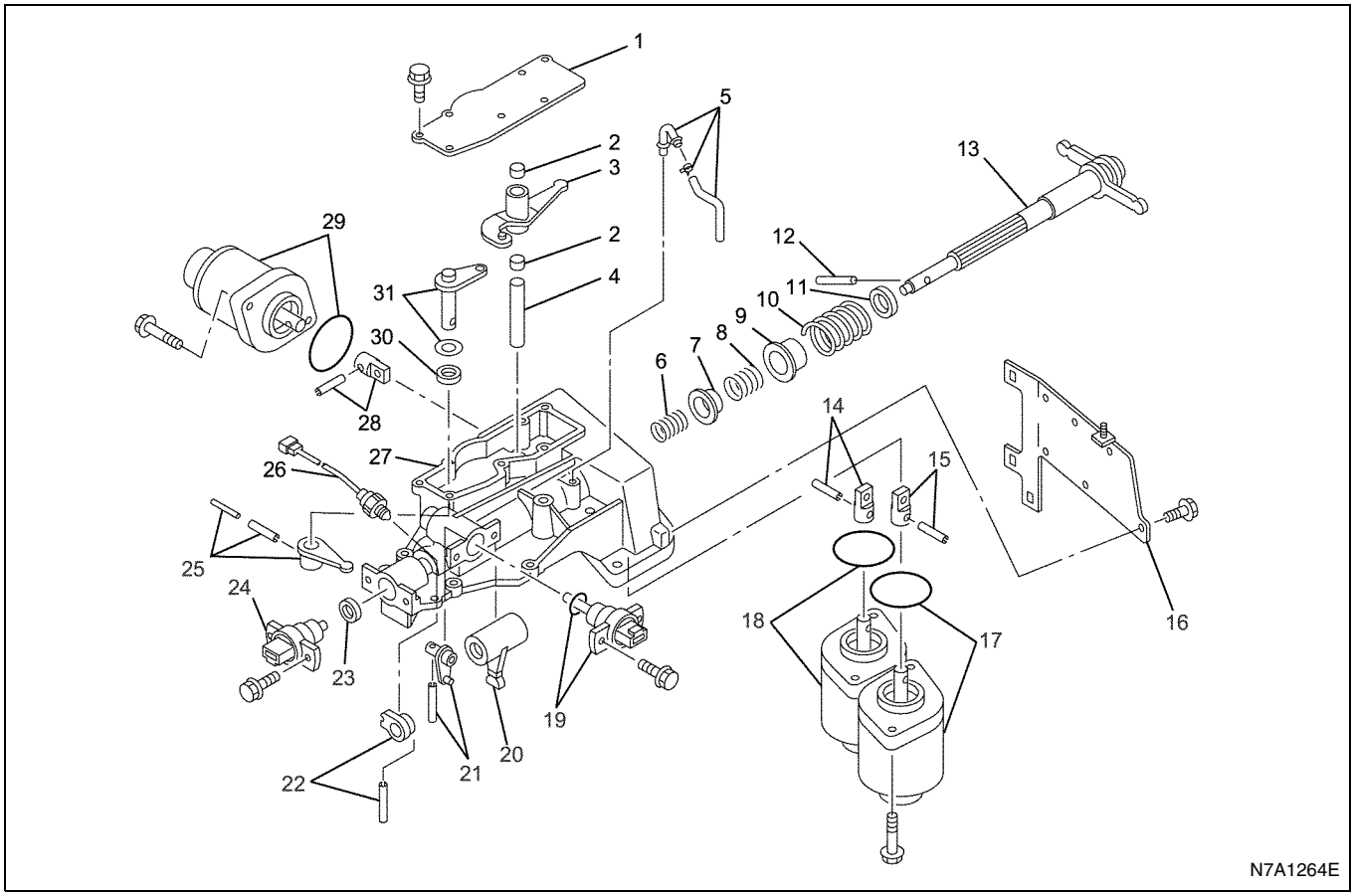
Caution:
If the snap ring is deformed or damaged, replace it with a new one and check to make sure it is installed securely.

Special Tools

Illustration	Tool No. Tool Name
 5884025870	5-8840-2587-0 Bearing Remover
 5884022440	5-8840-2244-0 Bearing Installer

Control Box

Components

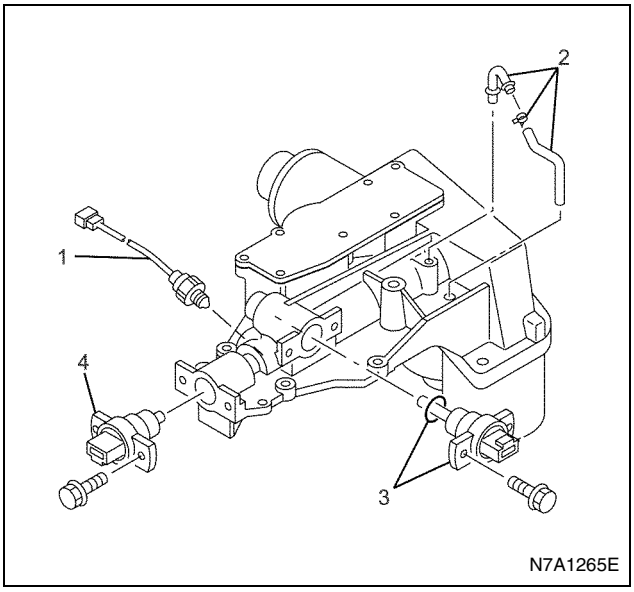


Legend

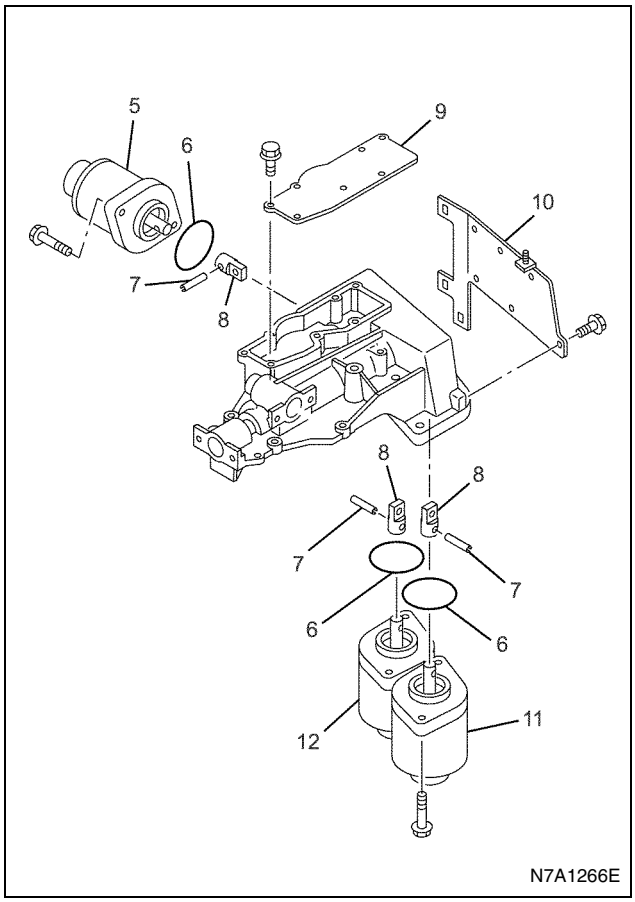
1. Cover
2. Lever Bushing
3. Relay Lever
4. Relay Lever Shaft
5. Breather Pipe, Breather Hose, and Clip
6. Spring
7. Spring Seat
8. Spring
9. Spring Seat
10. Spring
11. Shift Lever Shaft Oil Seal A
12. Spring Pin; Shift Lever Shaft
13. Shift Lever Shaft
14. Spring Pin and Joint; 1-3-5 Shift Solenoid
15. Spring Pin and Joint; 2-4-6-R Shift Solenoid
16. Plate
17. 2-4-6-r Shift Solenoid and O-ring
18. 1-3-5 Shift Solenoid and O-ring
19. Gear Select Position Sensor and O-ring
20. Internal Lever
21. Select Lever
22. Spring Pin and Stopper Ring
23. Shift Lever Shaft Oil Seal B
24. Gear Shift Position Sensor and O-ring
25. Spring Pin and Select Internal Lever
26. Neutral Switch
27. Gearshift Control Box
28. Spring Pin and Joint; Select Solenoid
29. Select Solenoid and O-ring
30. Select External Lever Oil Seal
31. Select External Lever

Disassembly

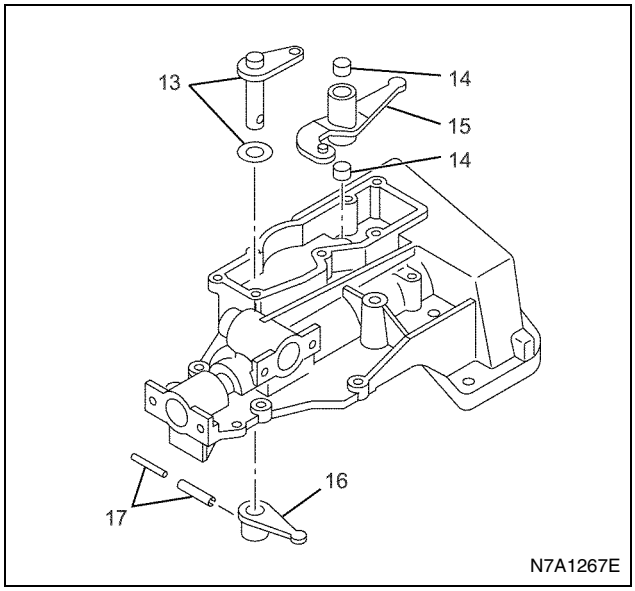
1. Remove the neutral switch (1), the breather pipe, breather hose and clip (2), the gear select position sensor and O-ring (3), and the gear shift position sensor (4).



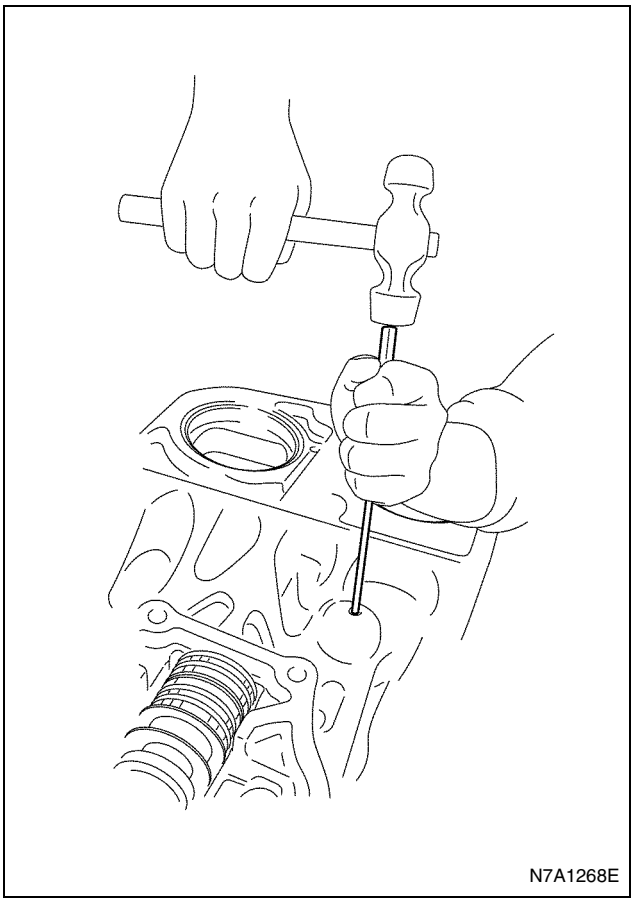
2. Remove the plate (10).
   a. Remove the select solenoid, 2-4-6-R shift solenoid, and 1-3-5 shift solenoid connectors from the plate.
   b. Remove the plate from the gearshift control box.
3. Remove 2-4-6-R shift solenoid (11) and 1-3-5 shift solenoid (12).
4. Remove the cover (9).
5. Remove the select solenoid (5).
6. Remove 2-4-6-R shift solenoid, 1-3-5 shift solenoid, and select solenoid O-rings (6) and joints (8).
   a. Remove the O-rings from the solenoids.
   b. Use a spring pin remover to remove the spring pins (7), and then remove the joints.



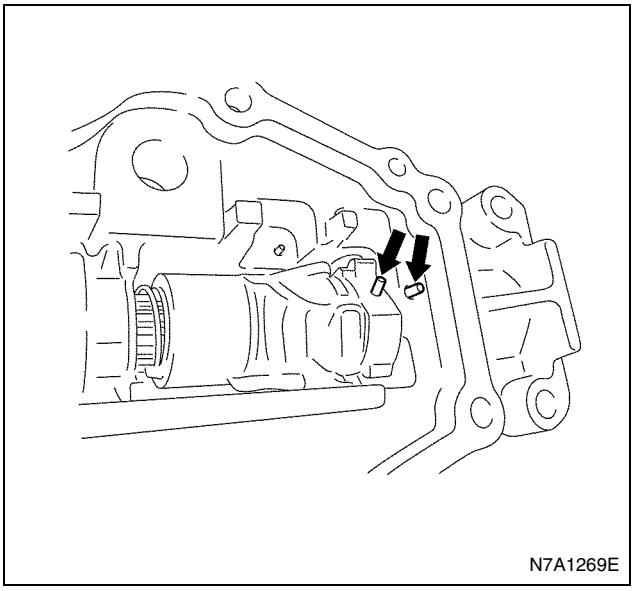
7. Use a spring pin remover to remove the spring pin (17), and then remove the select internal lever (16), and select external lever and washer (13).
8. Remove the relay lever (15).
   - Remove the lever bushing (14) from the relay lever.



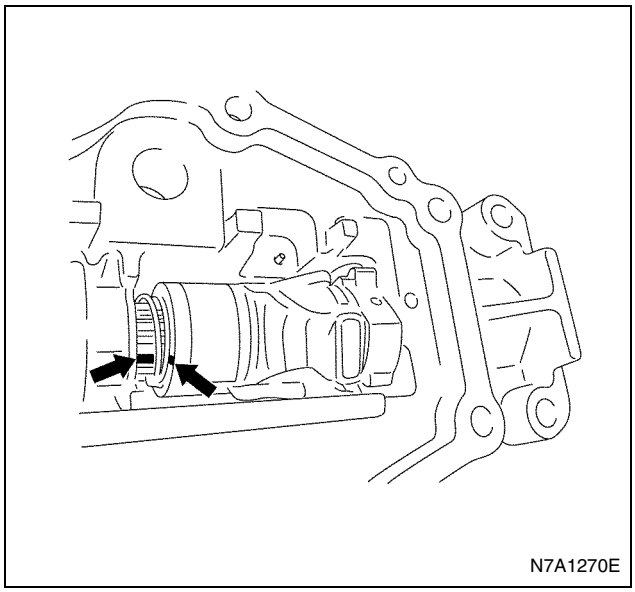
9. Use a spring pin remover to remove the relay lever shaft.


N7A1268E

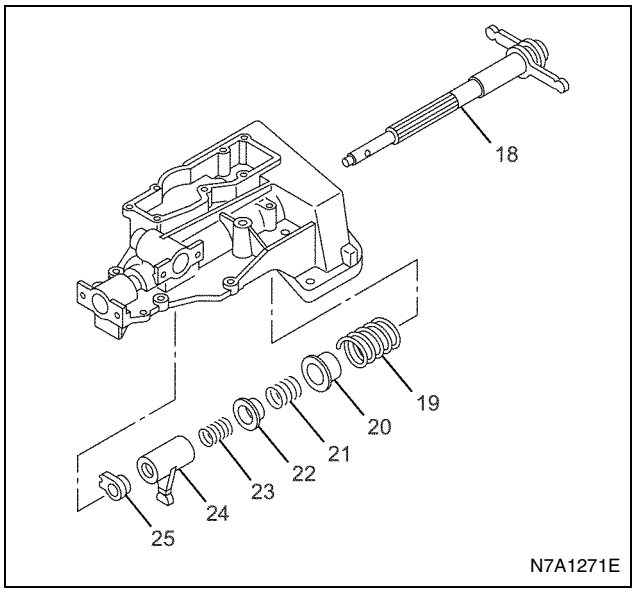
10. Use pliers to remove the spring pin; stopper ring and spring pin; shift lever shaft.


N7A1269E

11. Mark where the shift lever shaft and internal lever align.

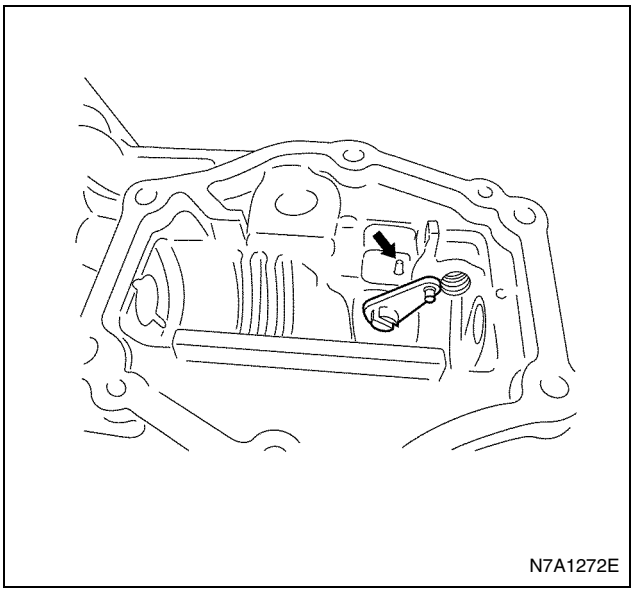

N7A1270E

12. Pull out the shift lever shaft (18), and remove the stopper ring (25), internal lever (24), spring (23), spring seat (22), spring (21), spring seat (20), and spring (19).

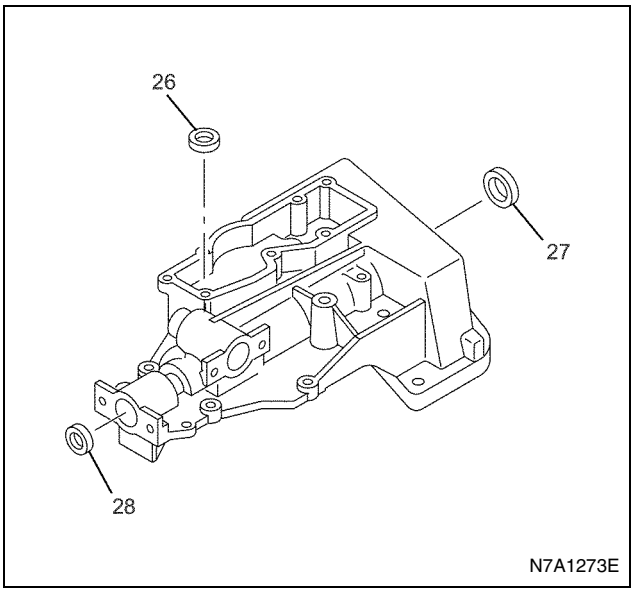


N7A1271E

13. Use pliers to remove the spring pin and select lever.


N7A1272E

14. Remove the select external lever oil seal (26), shift lever shaft oil seal A (27), and shift lever shaft oil seal B (28) from the gearshift control box.

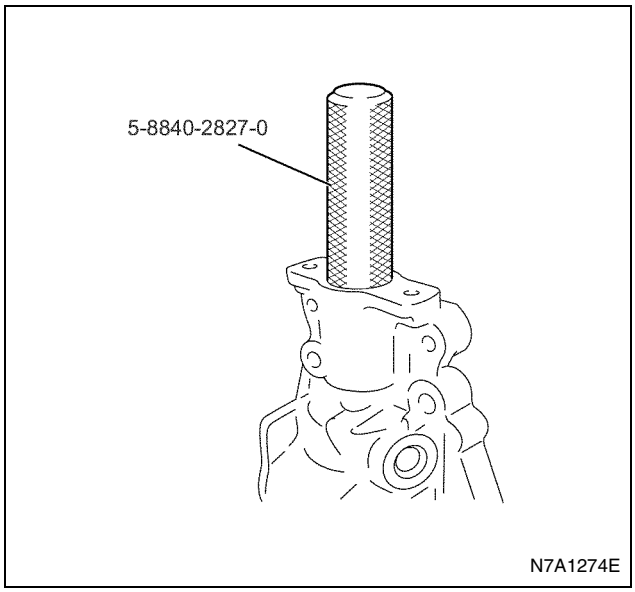


N7A1273E

15. Inspect each disassembled part for wear, damage, or other defects. Replace or repair as required if any abnormality is discovered.
16. Inspect the shift lever shaft for wear, looseness with the control box, and operation for lack of smooth operation. Replace if any abnormality is discovered.
17. Inspect the select solenoid, 2-4-6-R shift solenoid, and 1-3-5 shift solenoid rods to ensure they slide smoothly without sticking. Replace if any abnormality is discovered.

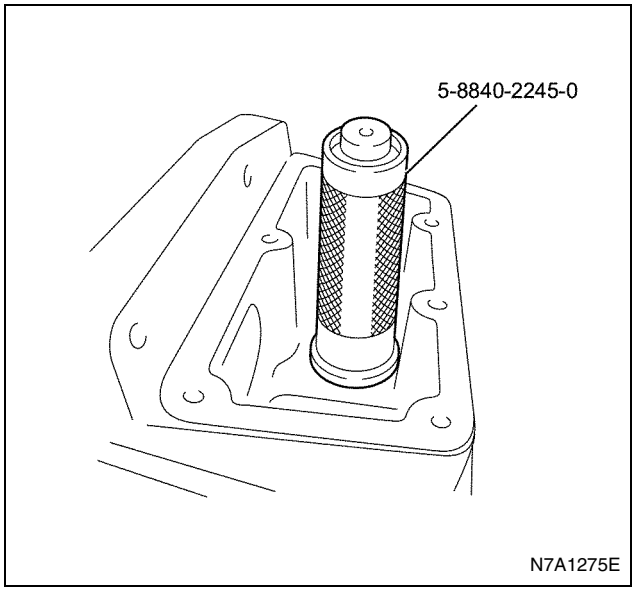
Assembly

1. Use an installer (5-8840-2827-0) to install the shift lever shaft oil seal B on the control box.
   - Coat the outer circumference of the oil seal with engine oil.



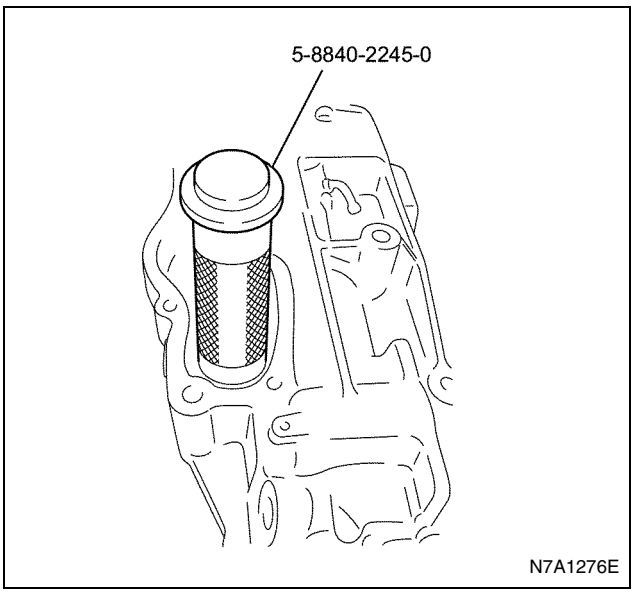
N7A1274E

2. Use an installer (5-8840-2245-0) to install the shift lever shaft oil seal A on the gearshift control box.
   - Coat the outer circumference of the oil seal with engine oil.

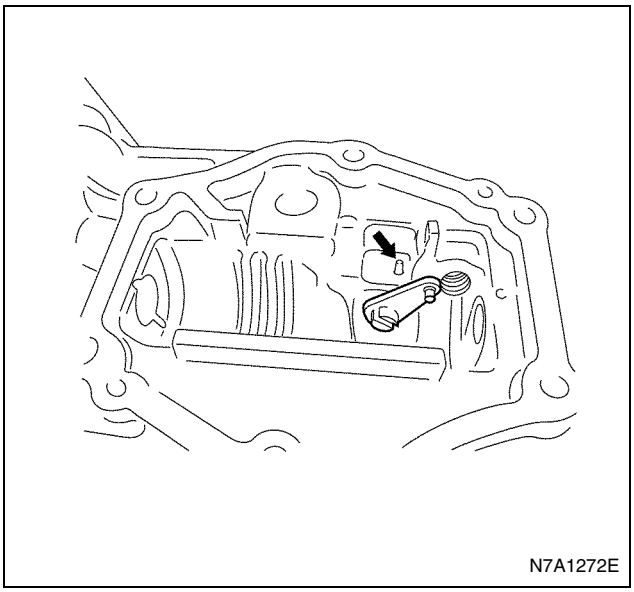


N7A1275E

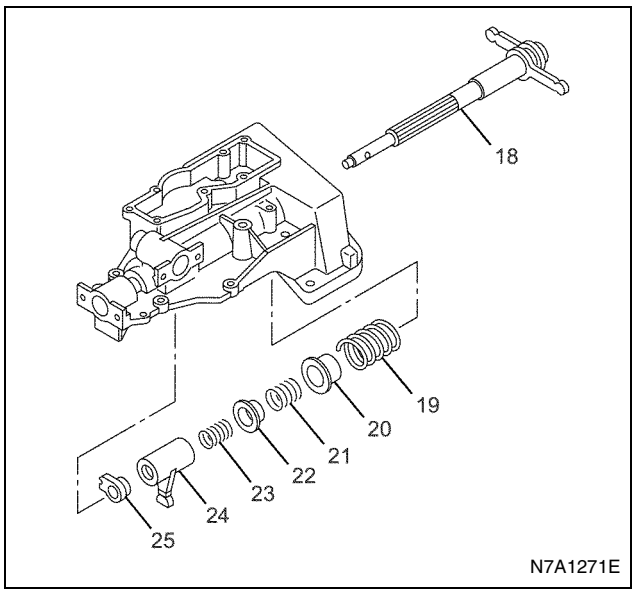
3. Use an installer (5-8840-2245-0) to install the select external lever oil seal on the gearshift control box.
   - Coat the outer circumference of the oil seal with engine oil.

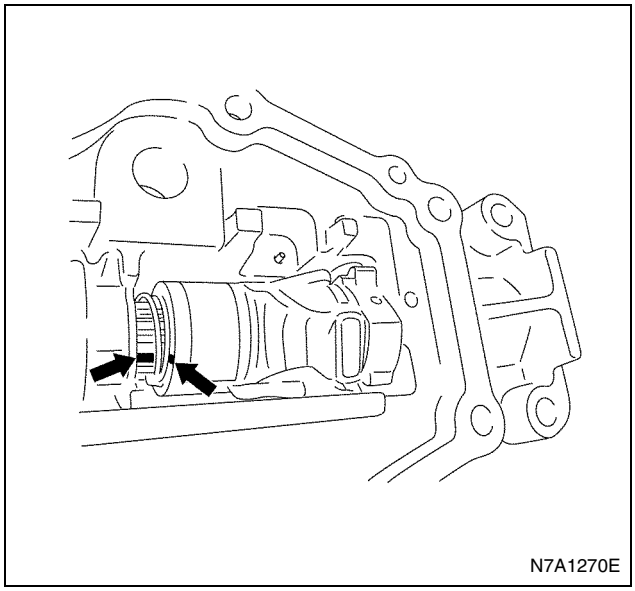


4. Install the select lever, using a hammer to drive a new spring pin.

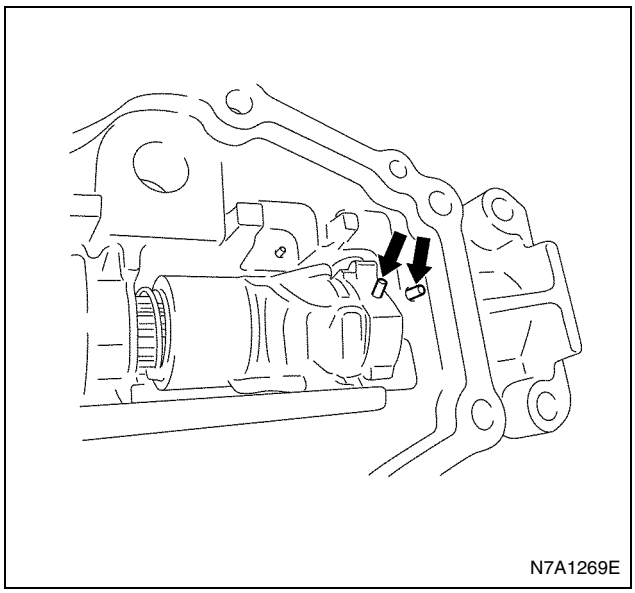


5. Assemble the spring (19), spring seat (20), spring (21), spring seat (22), spring (23), internal lever (24), and stopper ring (25) in the gearshift control box, and insert the shift lever shaft (18) so it is aligned with the internal lever alignment mark.
   - Apply GL-5 oil to the sliding part of the shift lever shaft.

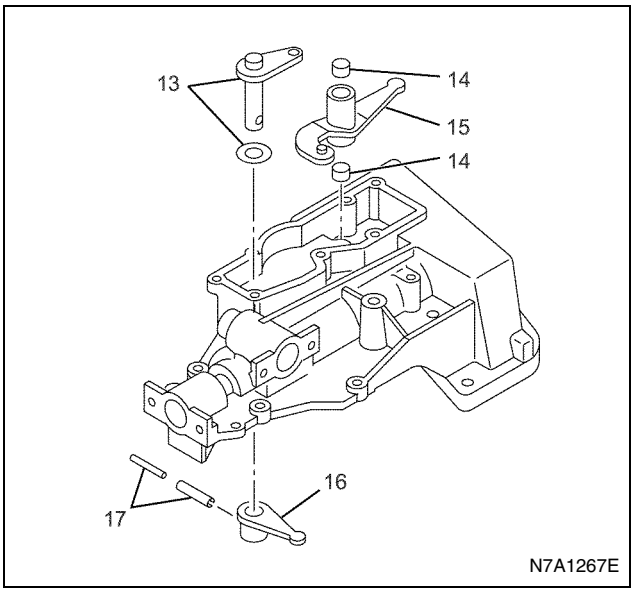




6. Use a hammer to drive a new spring pin; stopper ring and spring pin; shift lever shaft.



7. With the groove of the relay lever shaft facing upwards, use a hammer to drive it into the gearshift control box.
   - Apply Unimax R No. 2 grease or equivalent to the shaft.
8. Install the lever bushing (14) on the relay lever.
9. Insert the relay lever (15) in the shaft.
10. Install the select external lever and washer (13) and select internal lever (16). Use a hammer to drive a new spring pin (17).
    - Apply GL-5 oil to the shaft of the select external lever.
    - Apply Unimax R No. 2 grease or equivalent to the joint of the select external lever and the relay lever.



11. Install the 2-4-6-R shift solenoid, 1-3-5 shift solenoid, select solenoid O-rings (6), and joints (8).
    a. Install the joints, using a hammer to drive new spring pins (7).

Caution:
When driving spring pins, secure the solenoid in order to avoid distortion of the shafts.

    b. Install the O-rings in the solenoids.
12. Install the select solenoid (5).
    - Apply sufficient amount of Unimax R No. 2 grease or equivalent to the joint hole.

Tighten:
44 N·m (4.5 kg·m / 32.5 lb·ft)

13. Apply Three Bond TB1215 to the mating surface of the control box cover, and install the cover (9).

Tighten:
6 N·m (0.6 kg·m / 4.4 lb·ft)

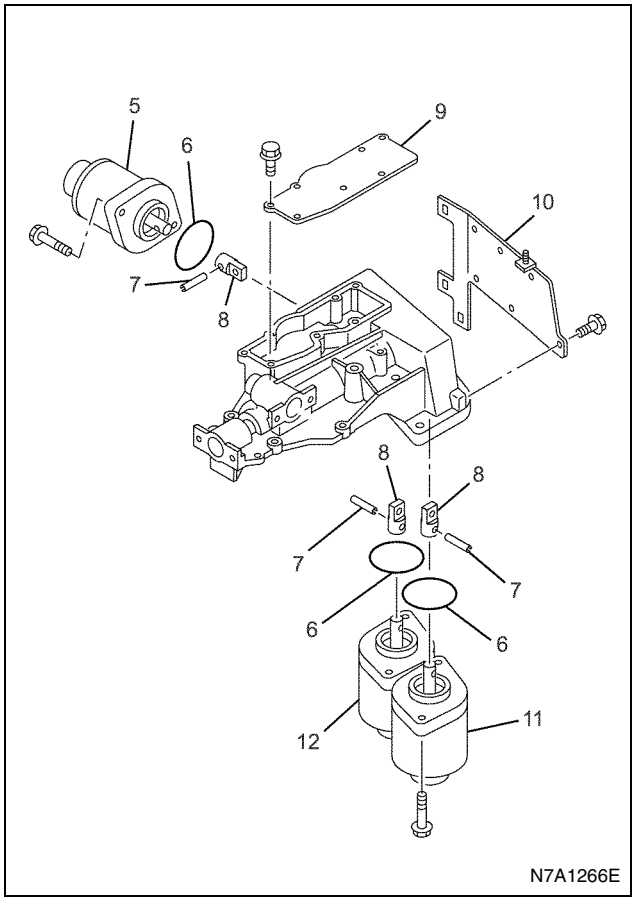
14. Install the 2-4-6-R shift solenoid (11) and 1-3-5 shift solenoid (12).
    - Apply sufficient amount of Unimax R No. 2 grease or equivalent to the joint hole.
    - During installation, check the stud hole position.

Tighten:
44 N·m (4.5 kg·m / 32.5 lb·ft)

15. Install the plate (10).
    a. Apply Three Bond TB1215 to the mating surface of the control box plate, and install the plate.

Tighten:
6 N·m (0.6 kg·m / 4.4 lb·ft)

    b. Install the select solenoid, 2-4-6-R shift solenoid, and 1-3-5 shift solenoid connectors on the plate.



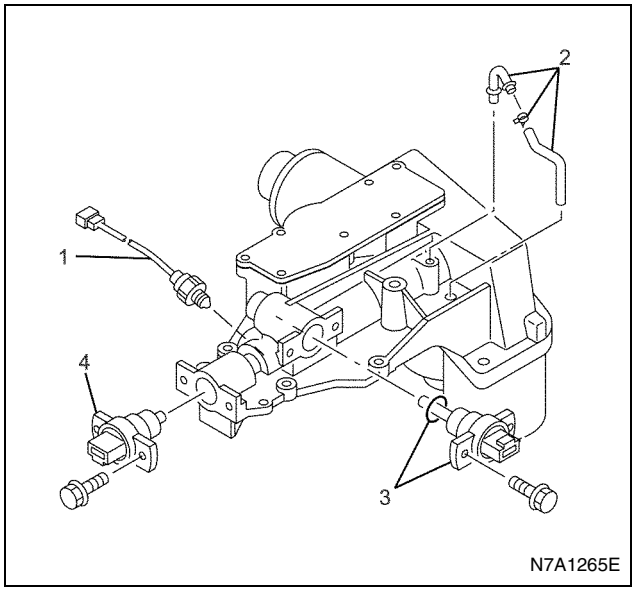
16. Install the gear shift position sensor (4), gear select position sensor, and O-rings (3).
    a. Insert the sensors while aligning the angle of sensor shaft tip with the groove in connection. Rotate the sensor to align with the installation bolt hole.
    b. Secure the sensors with bolts.

Tighten:
6 N·m (0.6 kg·m / 4.4 lb·ft)

Caution:
Take care to install the gear shift position sensor and gear select position sensor correctly.

17. Apply Loctite 262 or Three Bond TB1386, and then install the breather pipe, breather hose, and clip (2).
18. Install the neutral switch (1).
    - Carefully remove any sealant remaining on the threads, and then apply Loctite 242 to the threads.

Tighten:
34 N·m (3.5 kg·m / 25.1 lb·ft)



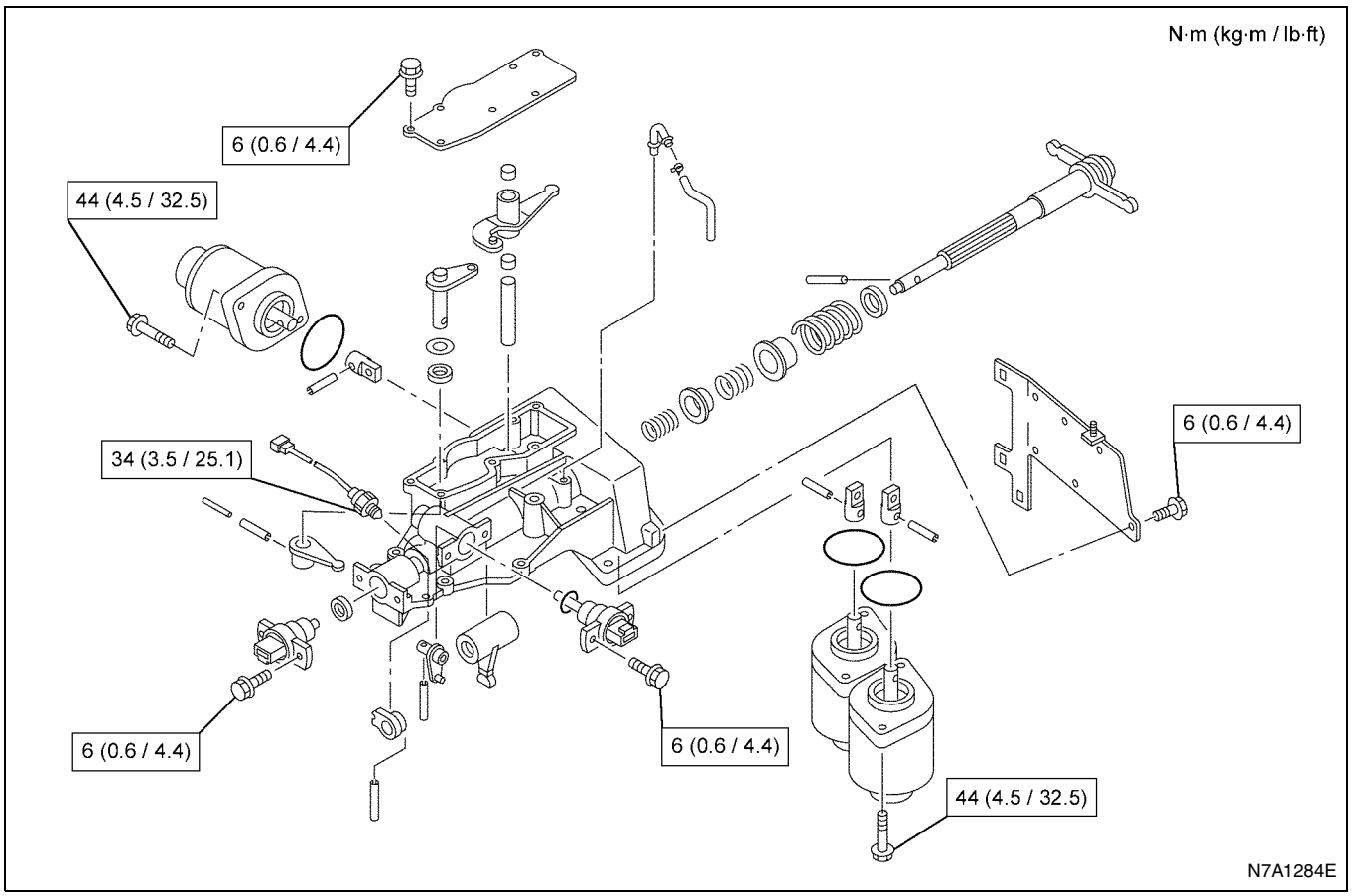
Specifications

Smoother

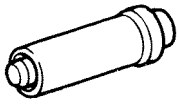
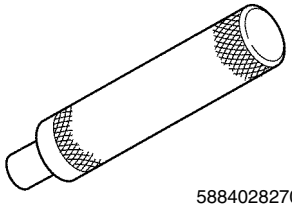
Power Transmission System	Fluid Coupling (With Lock up Clutch) and Gearshift Clutch	
Oil Pump	Trochoid-Type Oil Pump	
Oil	Besco ATF III	
Oil Capacity	Smoother	6.1L
	Oil Cooler	0.6L
	Total	6.7L
Cooling Method	Radiator-assisted Cooling (Coolant)	

Transmission Type		MYY5T	MYY6P
Transmission	1st	5.315	5.979
	2nd	3.053	3.434
	3rd	1.655	1.862
	4th	1.000	1.297
	5th	0.721	1.000
	6th	—	0.774
	Reverse	5.068	5.701
Oil Capacity	Standard	2.8L	3.5L
	With Side PTO	3.1L	3.8L
Oil		Besco 5W-30 Gear Oil Transaxle	

Tightening Torques



Special Tools

Illustration	Tool No. Tool Name
 5884022450	5-8840-2245-0 Control Box Oil Seal Installer
 5884028270	5-8840-2827-0 Shift Lever Shaft Oil Seal Installer

LGCEL-WE-0552LH

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LGCEL-WE-0552LH PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

CAB AND CHASSIS ELECTRICAL (LEFT HAND DRIVE MODEL)

SECTION 8

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

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8	CAB AND CHASSIS ELECTRICAL

CAB AND CHASSIS ELECTRICAL

SECTION 8

CAB AND CHASSIS ELECTRICAL

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GENERAL INFORMATION

General Information

The chassis electrical system is of 12-volt specifications with a negative ground polarity.
Wire sizes are appropriate to respective circuits, and classified by color. (The classification of harnesses by color is shown on the circuit diagram for ease of harness identification.)
The wire size is determined by load capacity and the length of wire required.
The vehicle harnesses are: body harness, floor harness, engine harness, frame front harness, frame rear harness, rear body harness, dome light harness, door harness and battery cable.
The harnesses are protected either by tape or corrugated tube, depending on harness location.
The circuit for each system consists of the power source, wire, fuse, relay switch, load parts and ground, all of which are shown on the circuit diagram.
In this manual, each electrical device is classified by system. For major parts shown on the circuit based on the circuit diagram for each system, a summary, diagnosis of troubles, inspection and removal and installation procedures are detailed.

Notes for Working on Electrical Items

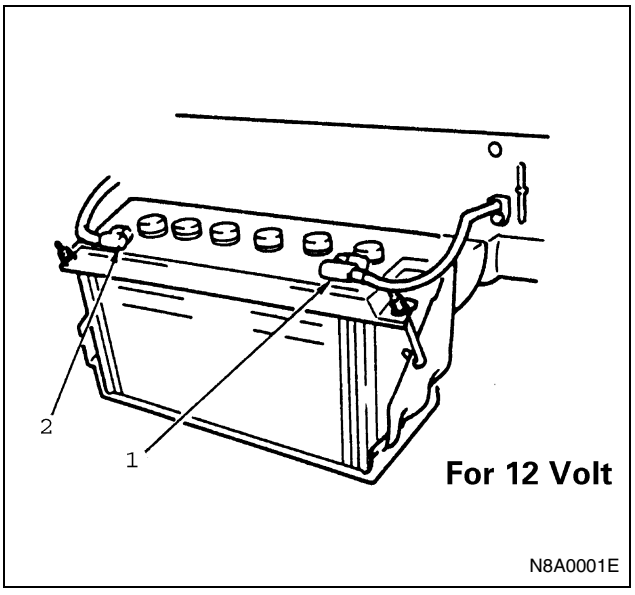
Battery Cable

Disconnecting The Battery Cable

1. All switches should be in the “OFF” position.
2. Disconnect the battery ground cable 1.
3. Disconnect the battery positive cable 2.
4. Disconnect the battery cable 3.

Caution:
It is important that the battery ground cable be disconnected first.

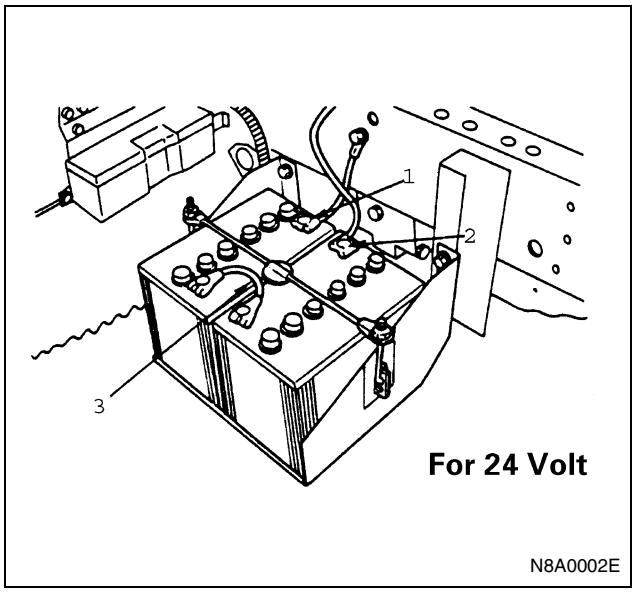
Disconnecting the battery positive cable first can result in a short circuit.



Connecting The Battery Cable

Follow the disconnecting procedure in the reverse order.

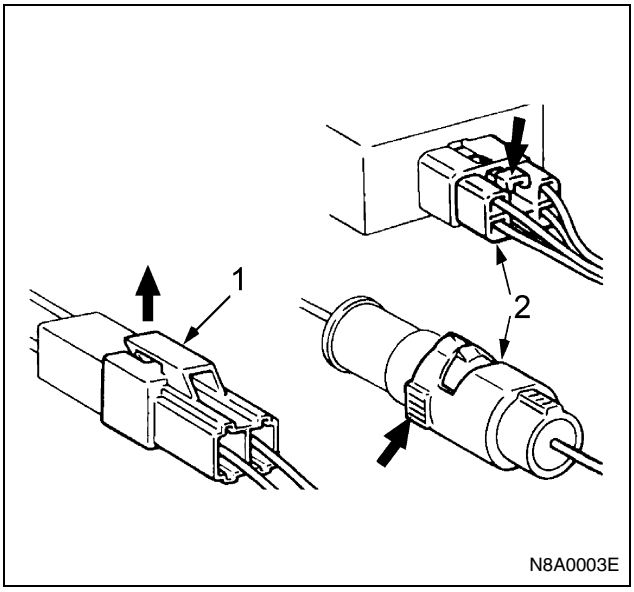
Caution:
Clean the battery terminal and apply a light coat of grease to prevent terminal corrosion.



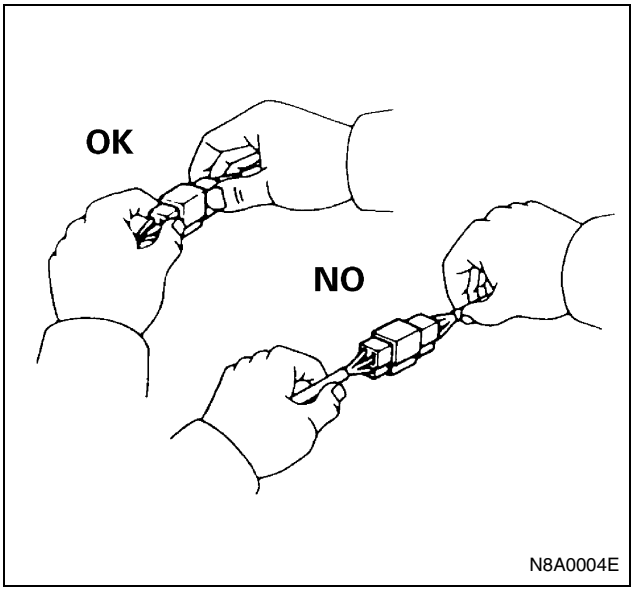
Connector Handling

Disconnecting The Connectors

Some connectors have a tang lock to hold the connectors together during vehicle operation.
Some tang locks are released by pulling them towards you 1.
Other tang locks are released by pressing them forward 2.
Determine which type of tang lock is on the connector being handled.
Firmly grasp both sides (male and female) of the connector.
Release the tang lock and carefully pull the two halves of the connector apart.

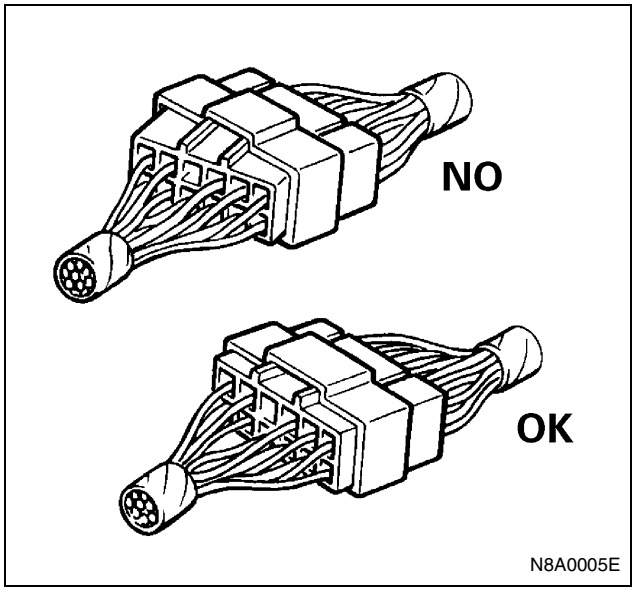


Never pull on the wires to separate the connectors. This will result in wire breakage.



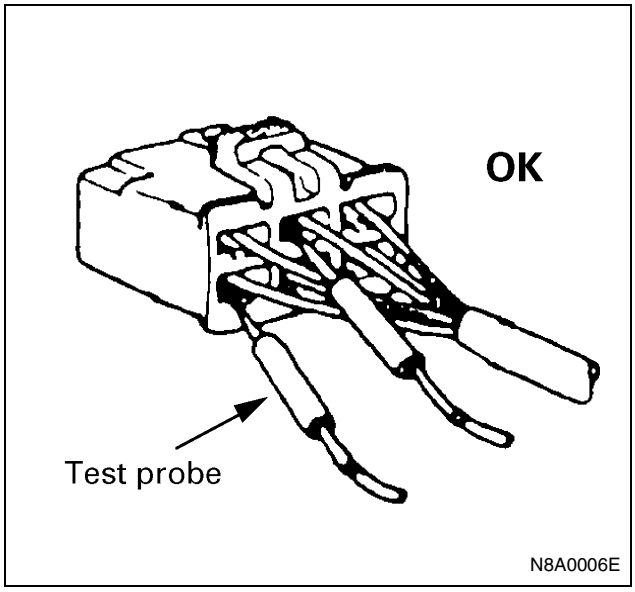
Connecting the Connector

Firmly grasp both sides (male and female) of the connector. Be sure that the connector pins and pin holes match. Be sure that both sides of the connector are aligned with each other. Firmly but carefully push the two sides of the connector together until a distinct click is heard.

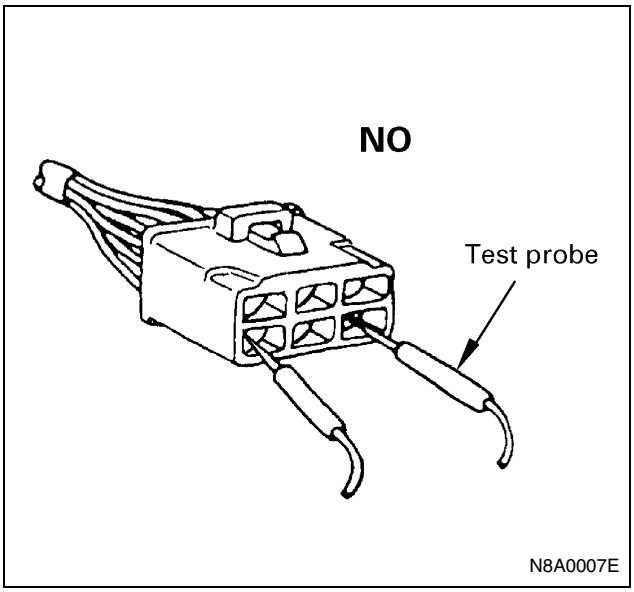


Connector Inspection

Use a circuit tester to check the connector for continuity. Insert the test probes from the connector wire side.

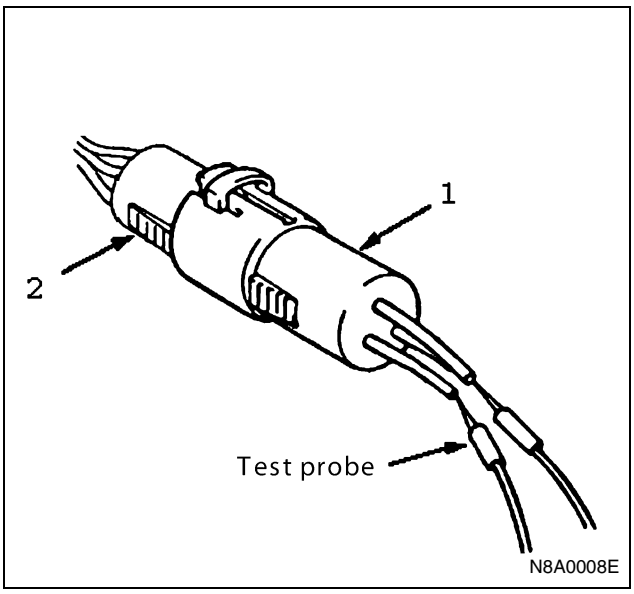


Never insert the circuit tester test probes into the connector open end to test the continuity. Broken or open connector terminals will result.



Waterproof Connector Inspection

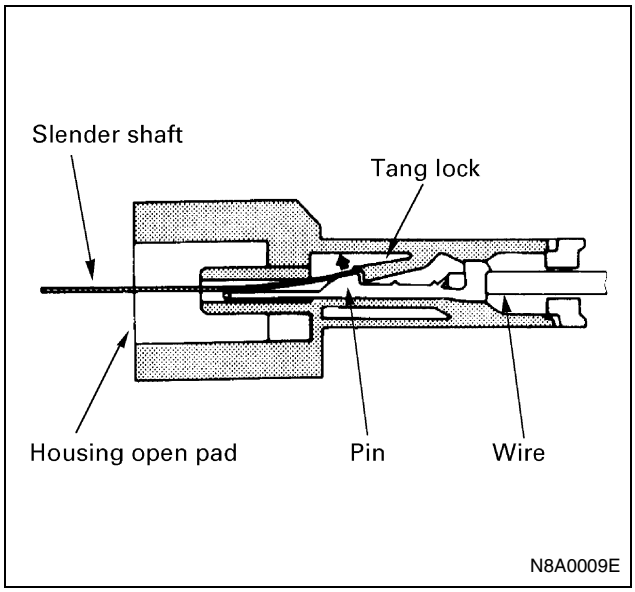
It is not possible to insert the test probes into the connector wire side of a waterproof connector.
Use one side of a connector 1 with its wires cut to make the test. Connect the test connector 2 to the connector to be tested. Connect the test probes to the cut wires to check the connector continuity.



Connector Pin Removal

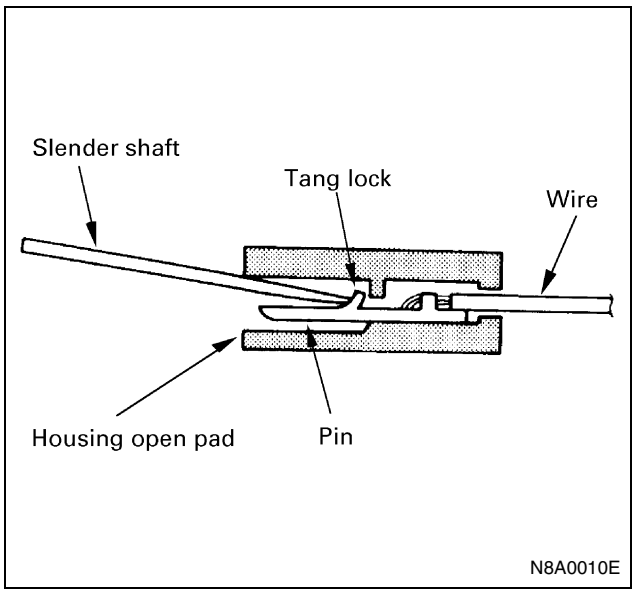
Connector Housing Tang Lock Type

1. Insert a slender shaft into the connector housing open end.
2. Push the tang lock up (in the direction of the arrow in the illustration). Pull the wire with pin free from the wire side of the connector.



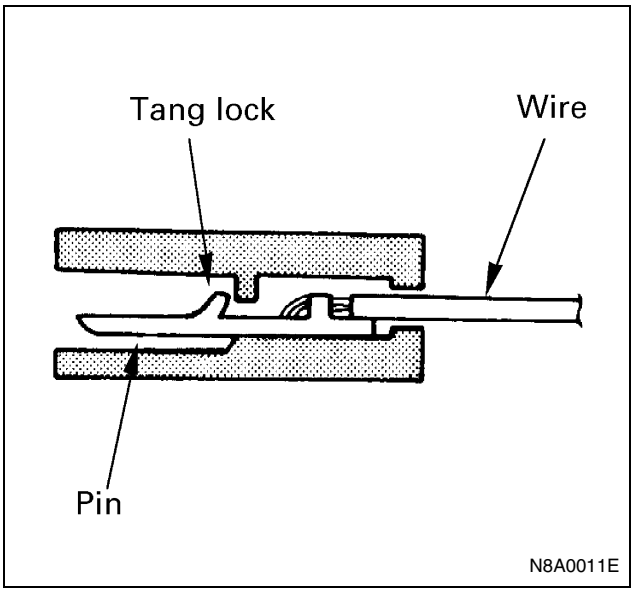
Pin Tang Lock Type

1. Insert a slender shaft into the connector housing open end.
2. Push the tang lock flat (toward the wire side of the connector). Pull the wire with pin free from the wire side of the connector.



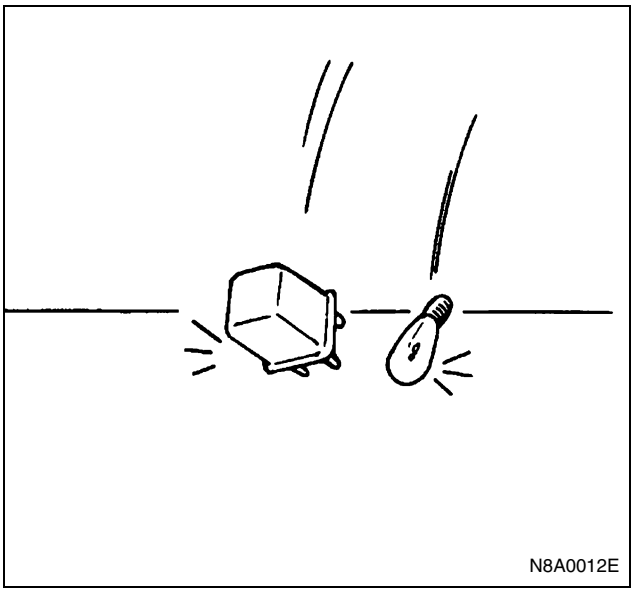
Connector Pin Insertion

1. Check that the tang lock is fully up.
2. Insert the pin from the connector wire side. Push the pin in until the tang lock closes firmly.
3. Gently pull on the wires to make sure that the connector pin is firmly set in place.



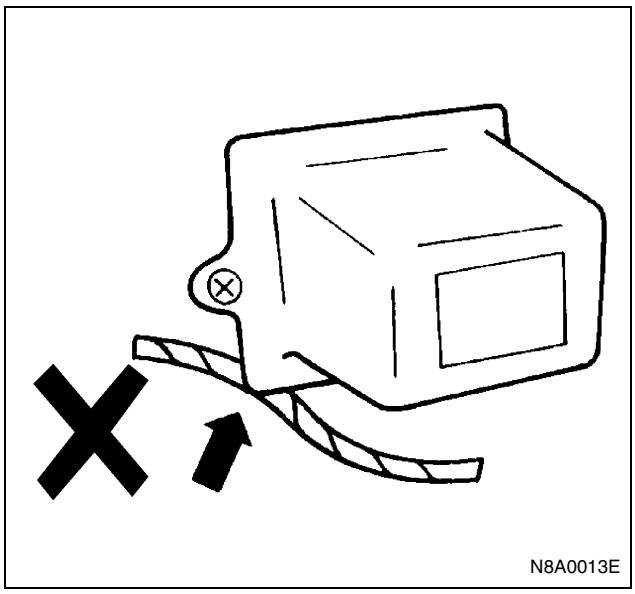
Parts Handling

Be careful when handling electrical parts. They should not be dropped or thrown, because short circuit or other damage may result.

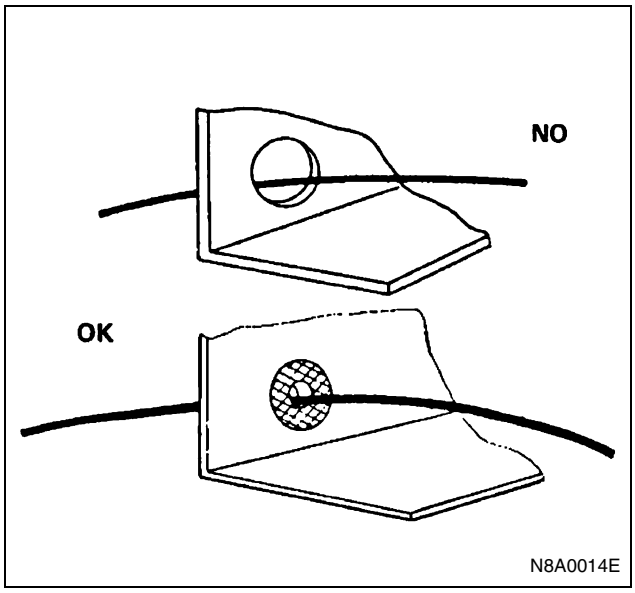


Cable Harness

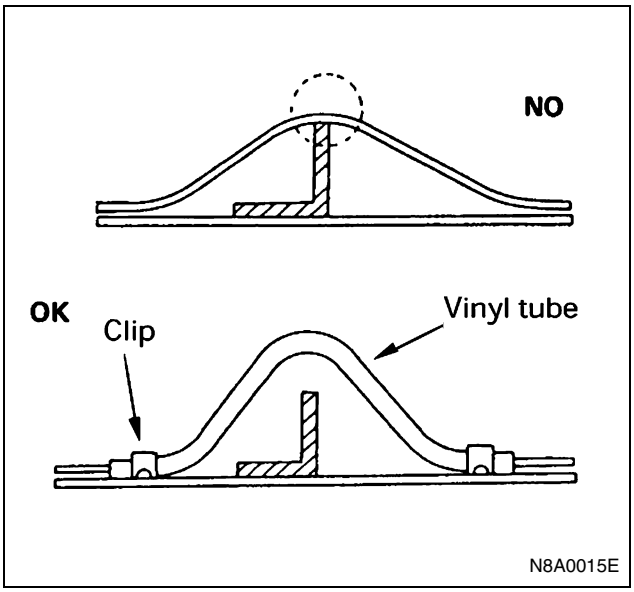
When installing the parts, be careful not to pinch or wedge the wiring harness.
All electrical connections must be kept clean and tight.



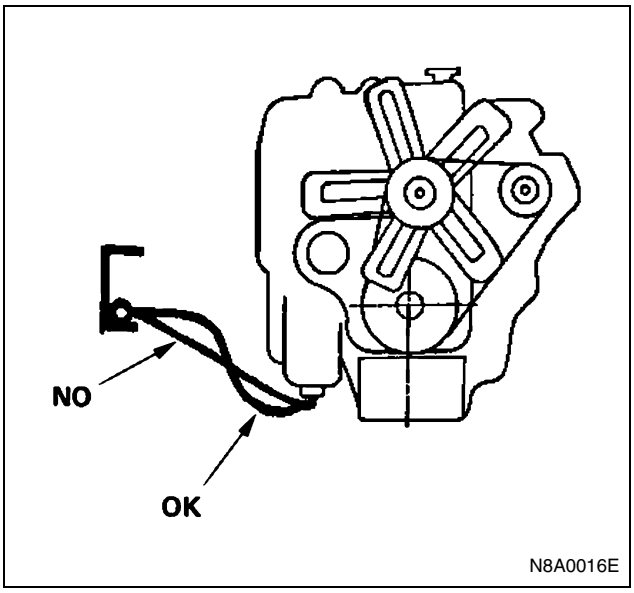
Use a grommet or guard tube to protect the wiring harness from contacting a sharp edge or surface.



Position the wiring harness with a enough clearance from the other parts and guard the wiring harness with a vinyl tube and clips to avoid direct contact.

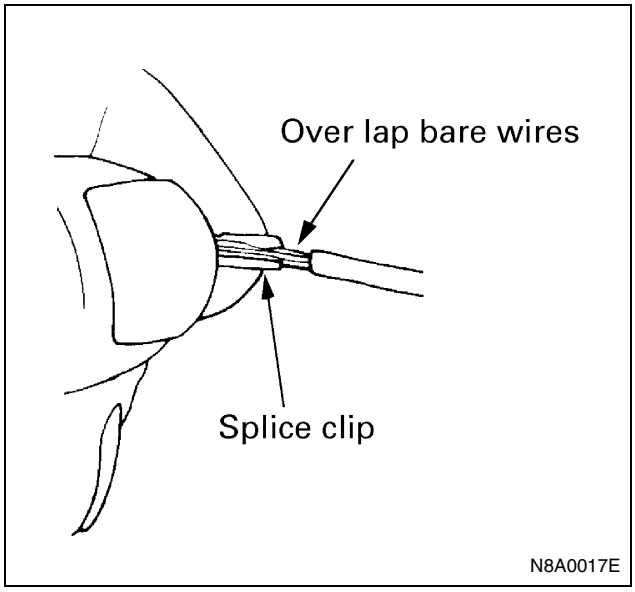


The wiring harness between engine and chassis should be long enough to prevent chafing or damage due to various vibrations.

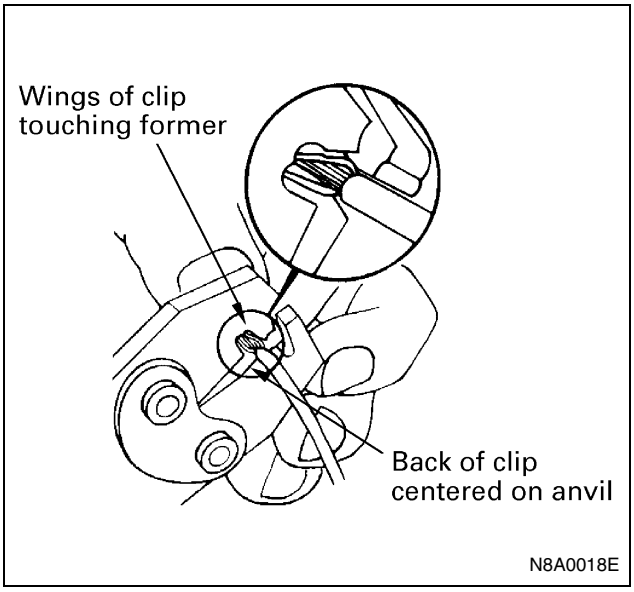


Splicing Wire

1. Open the Harness
   If the harness is taped, remove the tape. To avoid wire insulation damage, use a sewing “seam ripper” (available from sewing supply stores) to cut open the harness.
   If the harness has a block plastic conduit, simply pull out the desired wire.
2. Cut the wire
   Begin by cutting as little wire off the harness as possible. You may need the extra length of wire later if you decide to cut more wire off to change the location of a splice. You may have to adjust splice locations to make certain that each splice is at least 1-2/2″ (40 mm) away from other splices, harness branches, or connectors.
3. Strip the insulation
   When replacing a wire, use a wire of the same size as the original wire. Check the stripped wire for nicks or cut stands. If the wire is damaged, repeat the procedure on a new section of wire. The two stripped wire ends should be equal in length.
4. Crimp the Wires
   Select the proper clip to secure the splice. To determine the proper clip size for the wire being spliced, follow the directions included with your clips.
   Select the correct anvil on the crimper. (On most crimpers your choice is limited to either a small or large anvil.) Overlap the two stripped wire ends and hold them between your thumb and forefinger.
   Then, center the splice clip under the stripped wires and hold it in place.



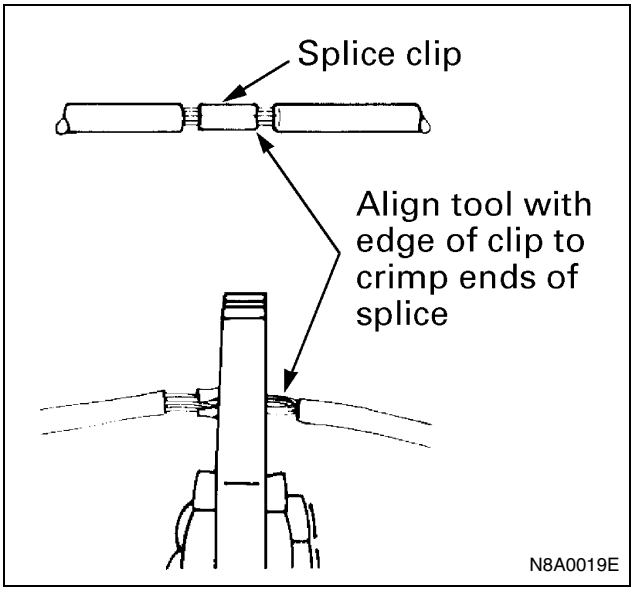
- Open the crimping tool to its full width and rest one handle on a firm flat surface.
- Center the back of the splice clip on the proper anvil and close the crimping tool to the point where the back of the splice clip touches the wings of the clip.
- Make sure that the clip and wires are still in the correct position. Then, apply steady pressure until the crimping tool closes.



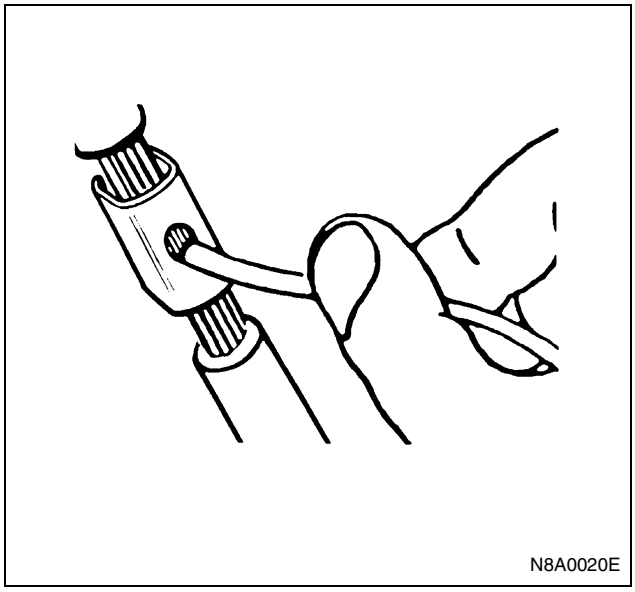
Before crimping the ends of the clip, be sure that:

- The wires extend beyond the clip in each direction.
- No strands of wire are cut loose, and
- No insulation is caught under the clip.

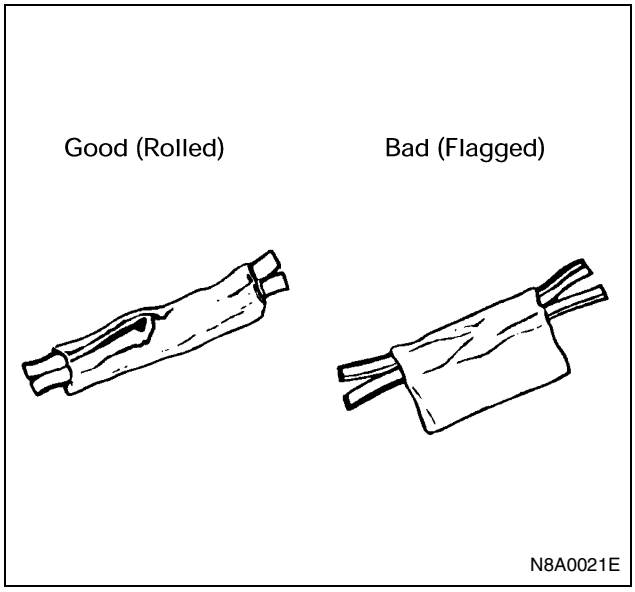
Crimp the splice again, once on each end. Do not let the crimping tool extend beyond the edge of the clip or you may damage or nick the wires.



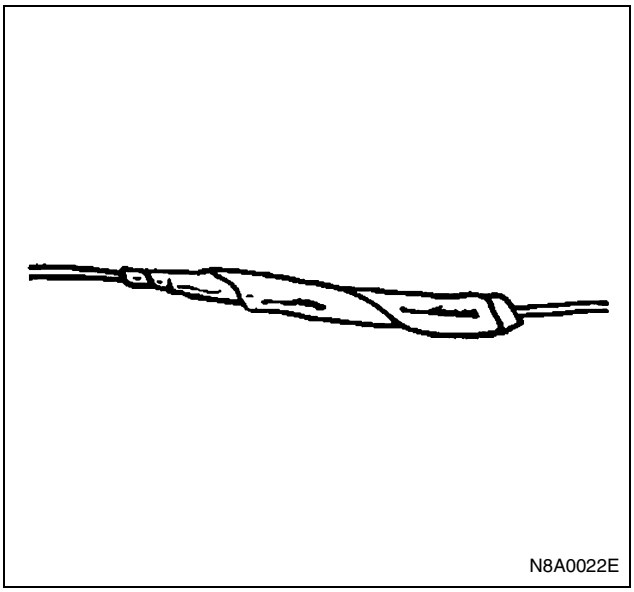
5. Solder
   Apply 60/40 rosin core solder to the opening in the back of the clip. Follow the manufacturer's instructions for the solder equipment you are using.



6. Tape the Splice
   Center and roll the splicing tape. The tape should cover the entire splice. Roll on enough tape to duplicate the thickness of the insulation on the existing wires. Do not flag the tape. Flagged tape may not provide enough insulation, and the flagged ends will tangle with the other wires in the harness.

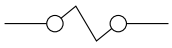
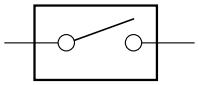
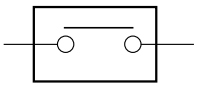
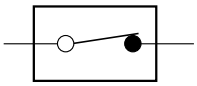
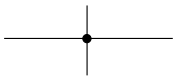
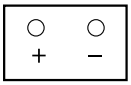
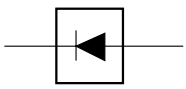
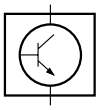


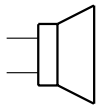
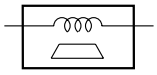
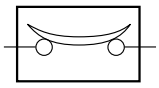
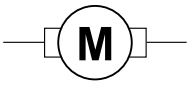
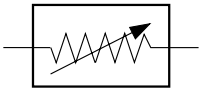
If the wire does not belong in a conduit or other harness covering, tape the wire again. Use a winding motion to cover the first piece of tape.

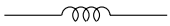
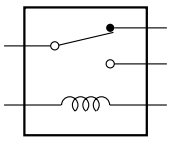
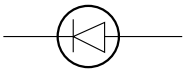
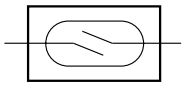
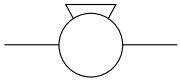

N8A0022E

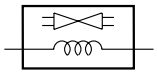
Symbols and Abbreviations

Symbols

Symbol	Meaning of Symbol
N8A5501E	Fuse
N8A5502E	Fusible link
 N8A5503E	Fusible link wire
 N8A5504E	Switch
 N8A5505E	Switch
 N8A5506E	Switch (Normal close type)
 N8A5507E	Contact wiring
 N8A5508E	Battery
 N8A5509E	Diode
 N8A5510E	Electronic Parts
N8A5511E	Resistor

Symbol	Meaning of Symbol
 N8A5512E	Speaker
 N8A5513E	Buzzer
 N8A5514E	Circuit breaker
N8A5515E	Bulb
N8A5516E	Double filament bulb
 N8A5517E	Motor
 N8A5518E	Variable register Rheostat

Symbol	Meaning of Symbol
 N8A5519E	Coil (inductor), solenoid, magnetic valve
 N8A5520E	Relay
N8A5521E	Connector
 N8A5522E	Light emitting diode
 N8A5523E	Reed switch
N8A5524E	Condenser
 N8A5525E	Horn

Symbol	Meaning of Symbol
 N8A5526E	Vacuum switching valve

Abbreviations

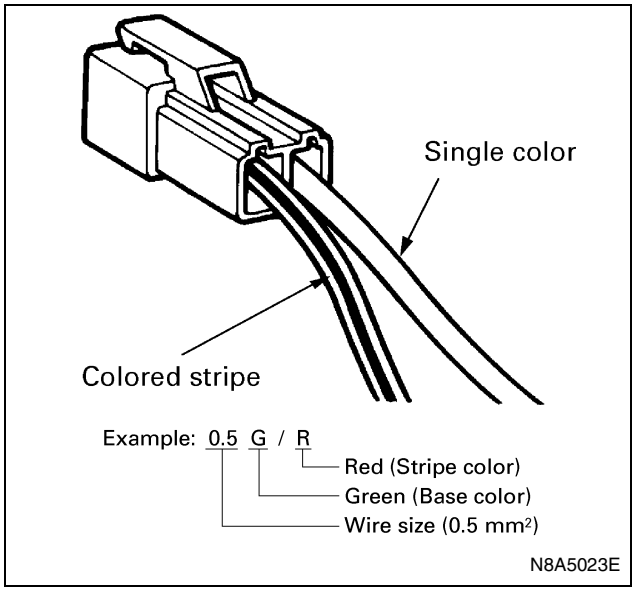
Abbreviation	Meaning of Abbreviation	Abbreviation	Meaning of Abbreviation
A	Ampere (S)	kW	kilowatt
ABS	Anti-lock brake system	LH	Left hand
ASM	Assembly	LWB	Long wheel base
AC	Alternating current	M/T	Manual transmission
A/C	Air conditioner	OD	Over drive
ACC	Accessories	OPT	Option
C/B	Circuit breaker	QOS	Quick on start
CSD	Cold start device	RH	Right hand
DIS	Direct ignition system	RR	Rear
EBCM	Electronic brake control module	RWAL	Rear wheel anti-lock brake system
ECGI	Electronic control gasoline injection	ST	Start
ECM	Electronic control module	STD	Standard
ECU	Electronic control unit	SW	Switch
EFE	Early fuel evaporation	SWB	Short wheel base
4X4	Four-wheel drive	V	Volt
FL	Fusible link	VSV	Vacuum switching valve
FRT	Front	W	Watt (S)
H/L	Headlight	WOT	Wide open throttle
IC	Integrated circuit	W/	With
IG	Ignition	W/O	Without

Parts for Electrical Circuit

Wiring

Wire Color

All wires have color-coded insulation.
Wires belonging to a system's main harness will have a single color. Wires belonging to a system's subcircuits will have a colored stripe. Striped wires use the following code to show wire size and colors.



Abbreviations are used to indicate wire color within a circuit diagram.
Refer to the following table.

Wire Color Coding

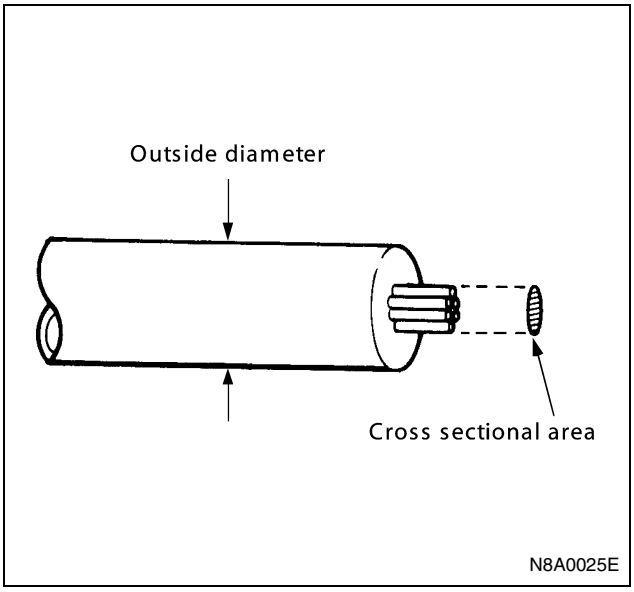
Color-Coding	Meaning	Color-Coding	Meaning
B	Black	BR	Brown
W	White	LG	Light green
R	Red	GR	Grey
G	Green	P	Pink
Y	Yellow	LB	Light blue
L	Blue	V	Violet
O	Orange		

Distinction of Circuit by Wire Base Color

Base color	Circuits	Base color	Circuits
B	Starter circuit	Y	Instrument circuit
W	Charging circuit	L, O, BR, LG, GR, P, LB, V	Other circuit
R	Lighting circuit		
G	Signal circuits		

Wire Size

The size of wire used in a circuit is determined by the amount of current (amperage), the length of the circuit, and the voltage drop allowed. The following wire size and load capacity, shown below, are specified by AWG (American Wire Gauge) (Nominal size means approximate cross sectional area).



Wire Size Table

Nominal size	Cross sectional area (mm^2)	Outside diameter (mm)	Allowable current (A)	AWG size (cross reference)
0.3	0.372	1.8	9	22
0.5	0.563	2.0	12	20
0.85	0.885	2.2	16	18
1.25	1.287	2.5	21	16
2	2.091	2.9	28	14
3	3.296	3.6	37.5	12
5	5.227	4.4	53	10
8	7.952	5.5	67	8
15	13.36	7.0	75	6
20	20.61	8.2	97	4

Fuse, Fusible Link and Circuit Breaker

Fuse

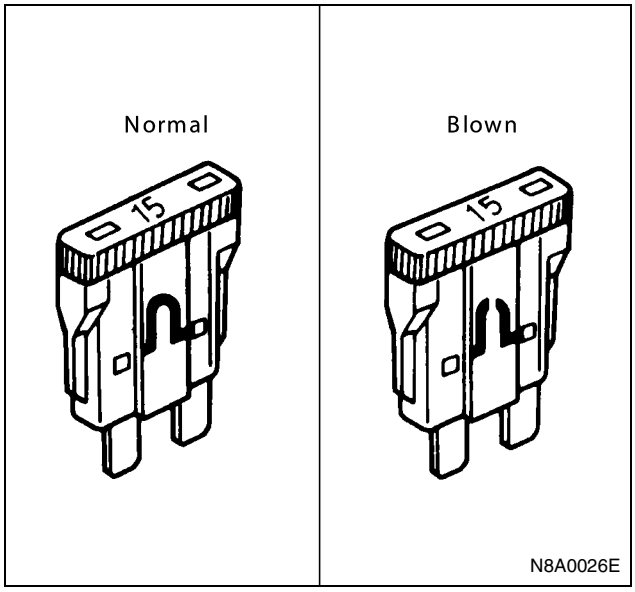
Fuses are the most common form of circuit protection used in vehicle wiring. A fuse is a thin piece of wire or strip of metal encases in a glass or plastic housing. It is wired in series with the circuit it protects. When there is an overload of current in a circuit, such as a short of a ground, the wire or metal strip is designed to burn out and interrupt the flow of current. This prevents a surge of high current from reaching and damaging other components in the circuit.

Determine the cause of the overloaded before replacing the fuse.

The replacement fuse must have the same amperage specifications as the original fuse.

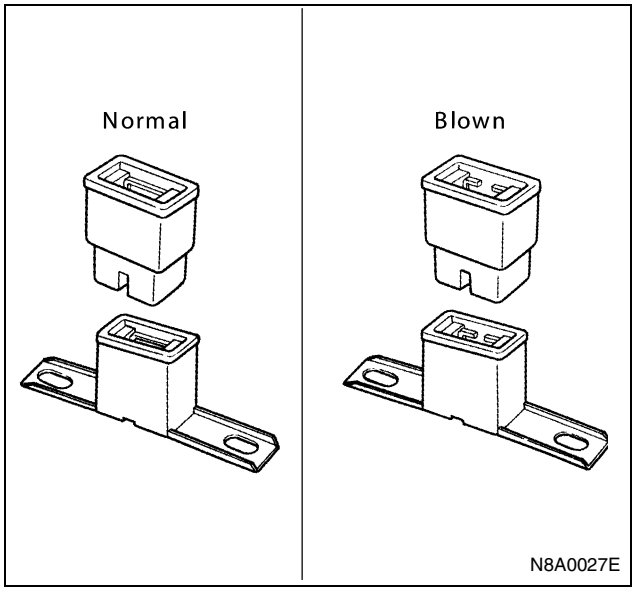
Never replace a blown fuse with a fuse of a different amperage specification.

Doing so can result in an electrical fire or other serious circuit damage. A blown fuse is easily identified.



Fusible Link

The fusible link is primarily used to protect circuits where high amounts of current flow and where is would not be practical to use a fuse. For example, the starter circuit. When a current overload occurs, the fusible link melts open and interrupts the flow of current so as to prevent the rest of the wiring harness from burning.
Determine the cause of the overload before replacing the fusible link. The replacement fusible link must have the same amperage specification as the original fusible link.
Never replace a blown fusible link with fusible link of a different amperage specification. Doing so can result in an electrical fire or other serious circuit damage.
A blown fusible link is easily identified.

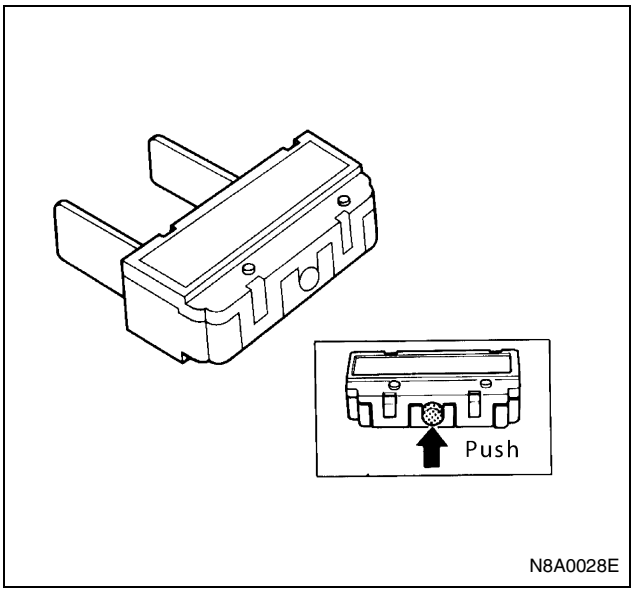


Fusible Link Specifications

Type	Rating	Case Color	Maximum Circuit Current (A)
Connector	30 A	Pink	15
Connector	40 A	Green	20
Bolted	50 A	Red	25
Bolted	60 A	Yellow	30
Bolted	80 A	Black	40

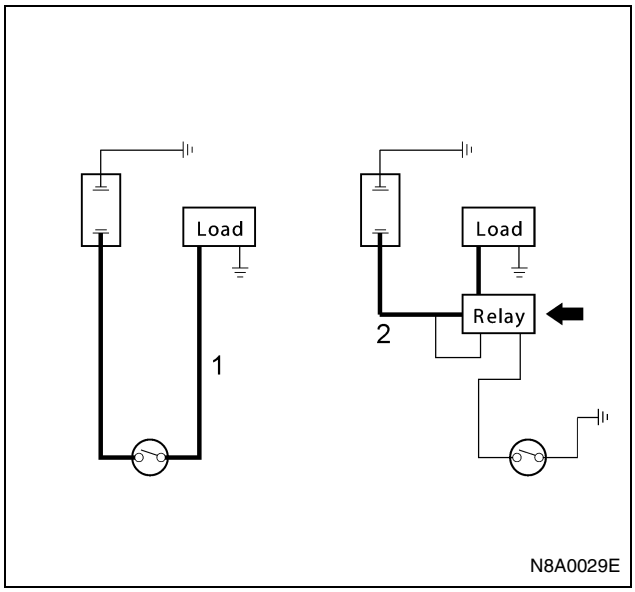
Circuit Breaker

The circuit breaker is a protective device designed to open the circuit when a current load is in excess of rated breaker capacity. If there is a short or other type of overload condition in the circuit, the excessive current will open the circuit between the circuit breaker terminals. The reset knob pops out when the circuit is open. Push the reset knob in place to restore the circuit after repairing it.

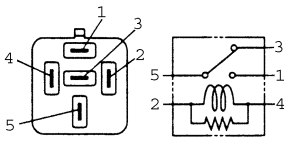


Relay

Battery and load location may require that a switch be placed some distance from either component. This means a longer wire and a higher voltage drop 1.
The installation of a relay between the battery and the load reduces the voltage drop 2.
Because the switch controls the relay, amperage through the switch can be reduced.



Relay Specification, Configuration and Inspection

<table>
<tr><td>Name/
Color</td><td>Rated voltage/
Coil resistance</td><td colspan="2">Internal circuit</td><td>Name/
Color</td><td>Rated voltage/
Coil resistance</td><td colspan="2">Internal circuit</td></tr>
<tr><td>MR5C
(1T)/
Black</td><td>12 V/
Approx. 90 Ω
Minimum
operating
voltage: 7 V
at 25°C (77°F)</td><td colspan="2" rowspan="4"> 
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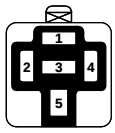
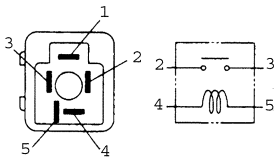
 
N8A0432E
(connector face)</td><td rowspan="2">MR82C/
White
label</td><td rowspan="2">12 V/
Approx. 23 Ω
Minimum
operating
voltage: 7 V
at 20°C (68°F)</td><td colspan="2" rowspan="4"> 
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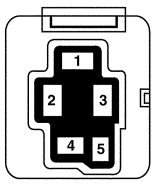
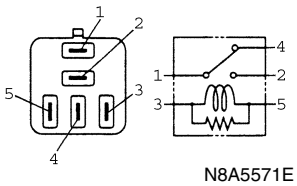
 
N8A0434E
(connector face)</td></tr>
<tr><td>MR5C
(1T)/
Brown</td><td>12 V/
Approx. 90 Ω
Minimum
operating
voltage: 10.5 V
at 25°C (77°F)</td></tr>
<tr><td>MR5C
(1T)/
Green</td><td>24 V/
Approx. 266 Ω
Minimum
operating
voltage: 16 V
at 25°C (77°F)</td><td rowspan="2">MR82C/
Green
label</td><td rowspan="2">24 V/
Approx. 100 Ω
Minimum
operating
voltage: 16 V
at 20°C (68°F)</td></tr>
<tr><td>MR5C
(1T)/
Grey</td><td>24 V/
Approx. 266 Ω
Minimum
operating
voltage: 20 V
at 25°C (77°F)</td></tr>
<tr><td rowspan="5">Inspec-
tion</td><td></td><td>The
way</td><td>Check to see if there is any continuity between the relay terminals.</td><td rowspan="5">Inspec-
tion</td><td></td><td>The
way</td><td>Check to see if there is any continuity between the relay terminals.</td></tr>
<tr><td>Result</td><td colspan="2" rowspan="2">(When no voltage is applied relay terminals 2 -4)
3 -5 → continuity
1 -5 → No continuity
Inspection</td><td>Result</td><td colspan="2" rowspan="2">(When no voltage is applied relay terminals 4 -5)
2 -3 → No continuity</td></tr>
<tr><td>Normal</td><td>Normal</td></tr>
<tr><td>Abnormal</td><td colspan="2">(When minimum operating voltage is applied relay terminals between 2 -4)
3 -5 → continuity
1 -5 → No continuity</td><td>Abnormal</td><td colspan="2">(When minimum operating voltage is applied relay terminals between 4 -5)
2 -3 → No continuity</td></tr>
<tr><td>Normal</td><td colspan="2">(When minimum operating voltage is applied relay terminals between 2 -4)
3 -5 → No continuity
1 -5 → continuity</td><td>Normal</td><td colspan="2">(When minimum operating voltage is applied relay terminals between 4 -5)
2 -3 → continuity</td></tr>
</table>

<table>
<tr><td>Name/
Color</td><td>Rated voltage/
Coil resistance</td><td colspan="2">Internal circuit</td></tr>
<tr><td>ACM
13221
M04/
Black</td><td>12 V/
Approx. 120 Ω
Minimum
operating
voltage: 8 V
at 25°C (77°F)</td><td colspan="2" rowspan="2"> 

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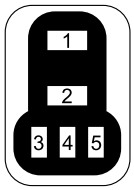
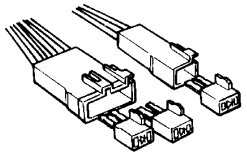
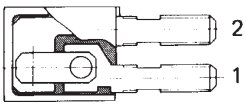
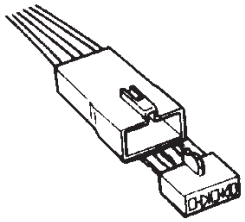
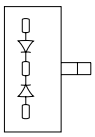
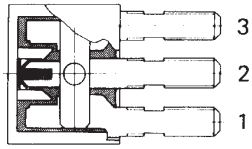
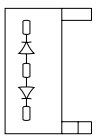
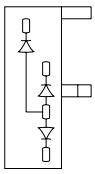
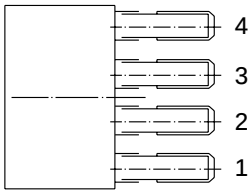
 

N8A5572E
(connector face)</td></tr>
<tr><td>ACM
13222
M01/
Green</td><td>24 V/
Approx. 320 Ω
Minimum
operating
voltage: 18 V
at 25°C (77°F)</td></tr>
<tr><td rowspan="4">Inspec-
tion</td><td></td><td>The way</td><td>Check to see if there is any continuity between the relay terminals.</td></tr>
<tr><td>Result</td><td colspan="2" rowspan="2">(When no voltage is applied relay terminals 3 - 5)
1 - 4 → continuity
1 - 2 → No continuity
Inspection</td></tr>
<tr><td>Normal</td></tr>
<tr><td>Abnormal</td><td colspan="2">(When minimum operating voltage is applied relay terminals between 3 - 5)
1 - 4 → continuity
1 - 2 → No continuity</td></tr>
<tr><td>Normal</td><td colspan="2">(When minimum operating voltage is applied relay terminals between 3 - 5)
1 - 4 → No continuity
1 - 2 → continuity</td></tr>
</table>

Diode

Diode Specifications and Configurations

SHAPE	MARK/ COLOR	CONSTRUCTION	CHECKING (THERE SHOULD BE CONTINUITY IN EITHER A OR B WHEN A CIRCUIT TESTER IS CONNECTED WITH DIODE TERMINAL)
	BLACK	 2 1	TERMINAL NO.: 2, 1 CONNECTION PATTERN A: ⊕ ⊖ CONNECTION PATTERN B: ⊖ ⊕
	 BLACK	 3 2 1	TERMINAL NO.: 3, 2, 1 CONNECTION PATTERN A: ⊖ ⊕ ; ⊕ ⊖ CONNECTION PATTERN B: ⊕ ⊖ ; ⊖ ⊕
	 BLACK		TERMINAL NO.: 3, 2, 1 CONNECTION PATTERN A: ⊖ ⊕ ; ⊕ ⊖ CONNECTION PATTERN B: ⊕ ⊖ ; ⊖ ⊕
	 BLACK	 4 3 2 1	TERMINAL NO.: 4, 3, 2, 1 CONNECTION PATTERN A: ⊕ ⊖ ; ⊕ ; ⊖ ⊕ CONNECTION PATTERN B: ⊖ ; ⊕ ⊖ ; ⊕ ⊖

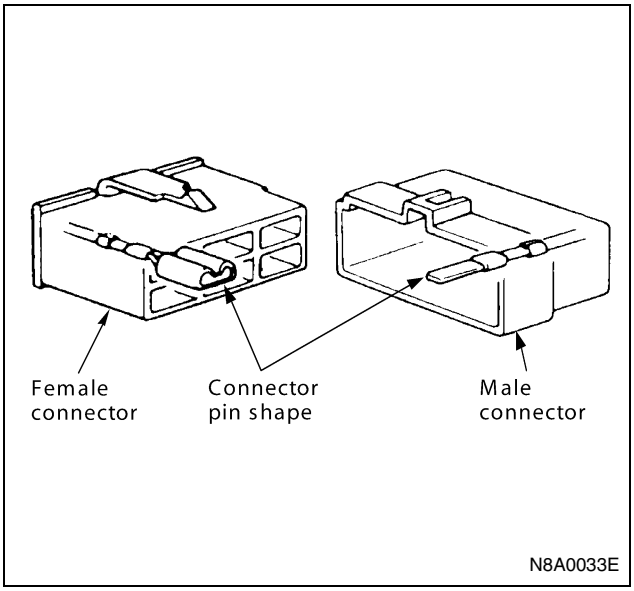
N8A0032E

Maximum Rating (Temp. = 25°C)

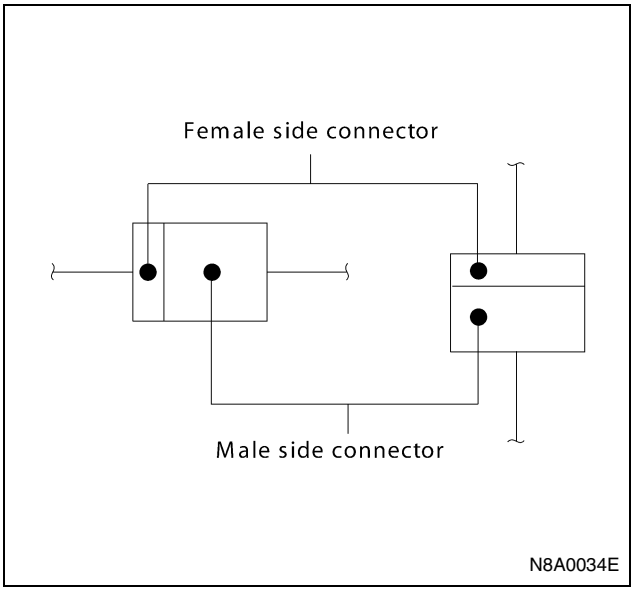
Items	Rating	Remarks
Peak reverse voltage	400 V	
Transient peak reverse voltage	500 V	
Average output current	1.5 A	Temp. = 40°C
Working ambient temperature	–30°C — 80°C	
Storage temperature	–40°C — 100°C	

Connector

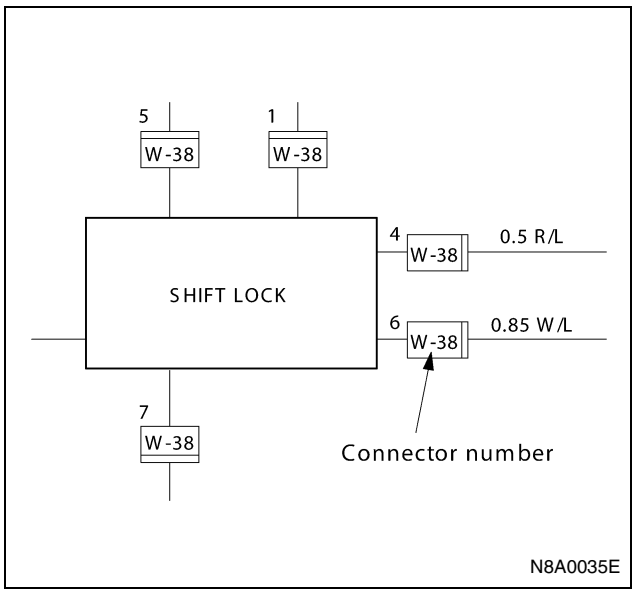
The connector pin shape determines whether the connector is male or female.
The connector housing configuration does not determine whether a connector is male or female.



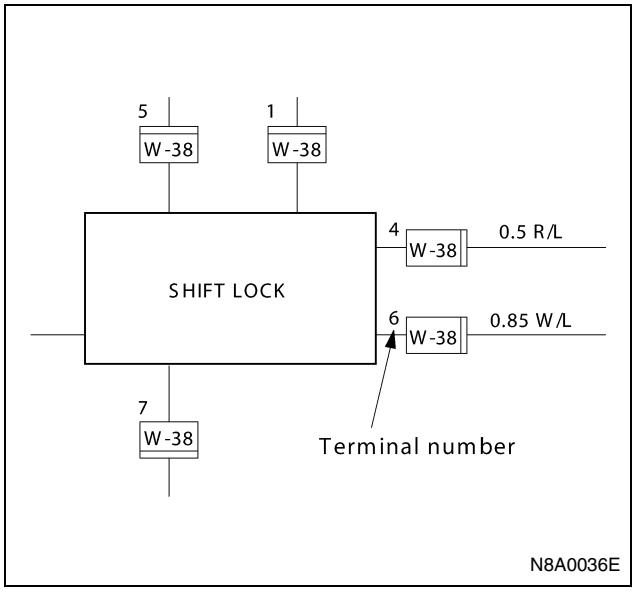
The symbol illustrated in the figure is used as connector, in the circuit of this section.



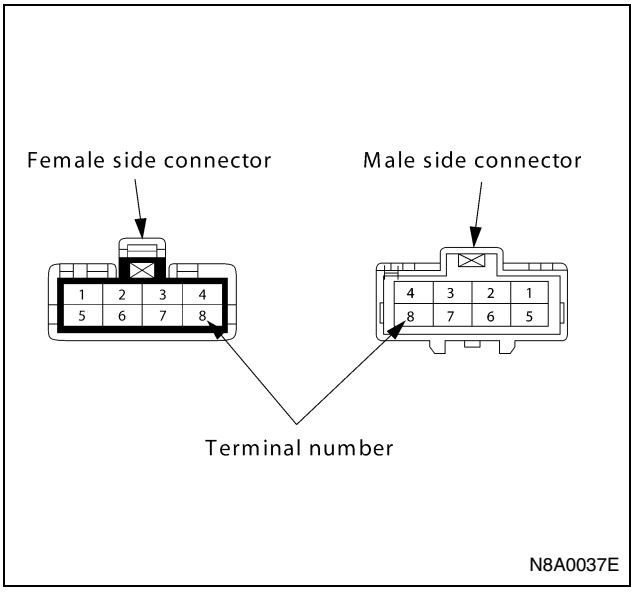
Connector is identified with a number.



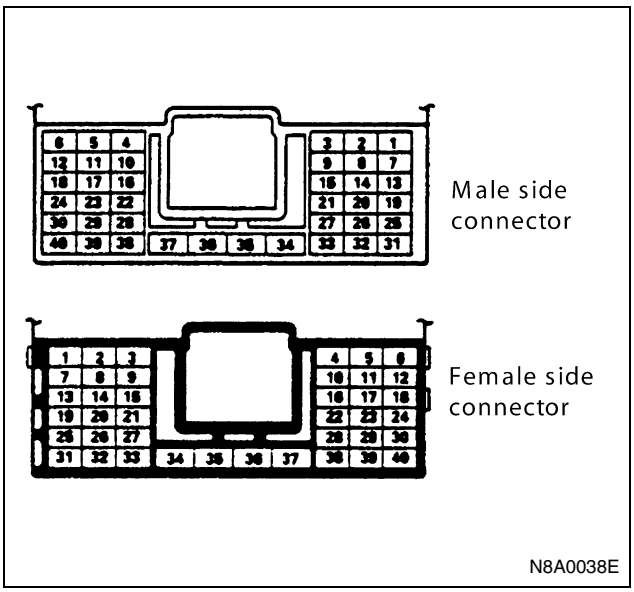
The applicable terminal number is shown for each connector.



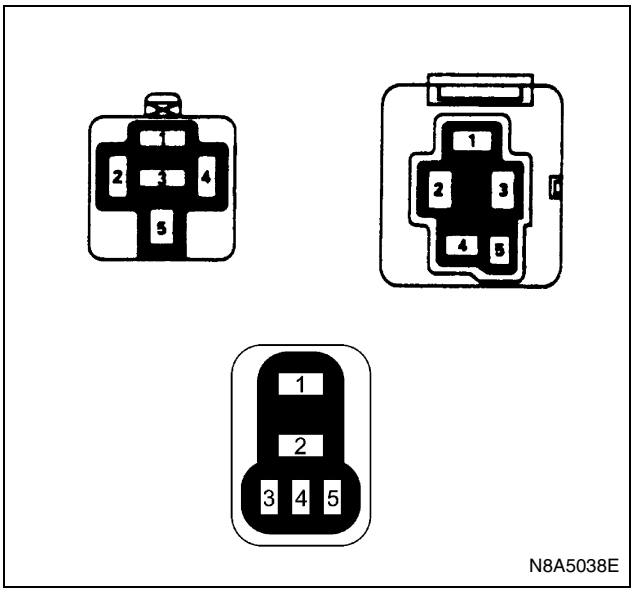
Connector terminal numbers are clearly shown.
Male side connector terminal numbers are in sequence from upper right to lower left.
Female side connector terminal numbers are in sequence from upper left to lower right.



Notice:
For those connectors on which specific terminal numbers or symbols are shown (such as ECM), the terminal numbers or symbols are used in the circuit diagram, irrespective of the above rule.



The connectors used for relays have their own terminal number assignment, irrespective of the above rule.

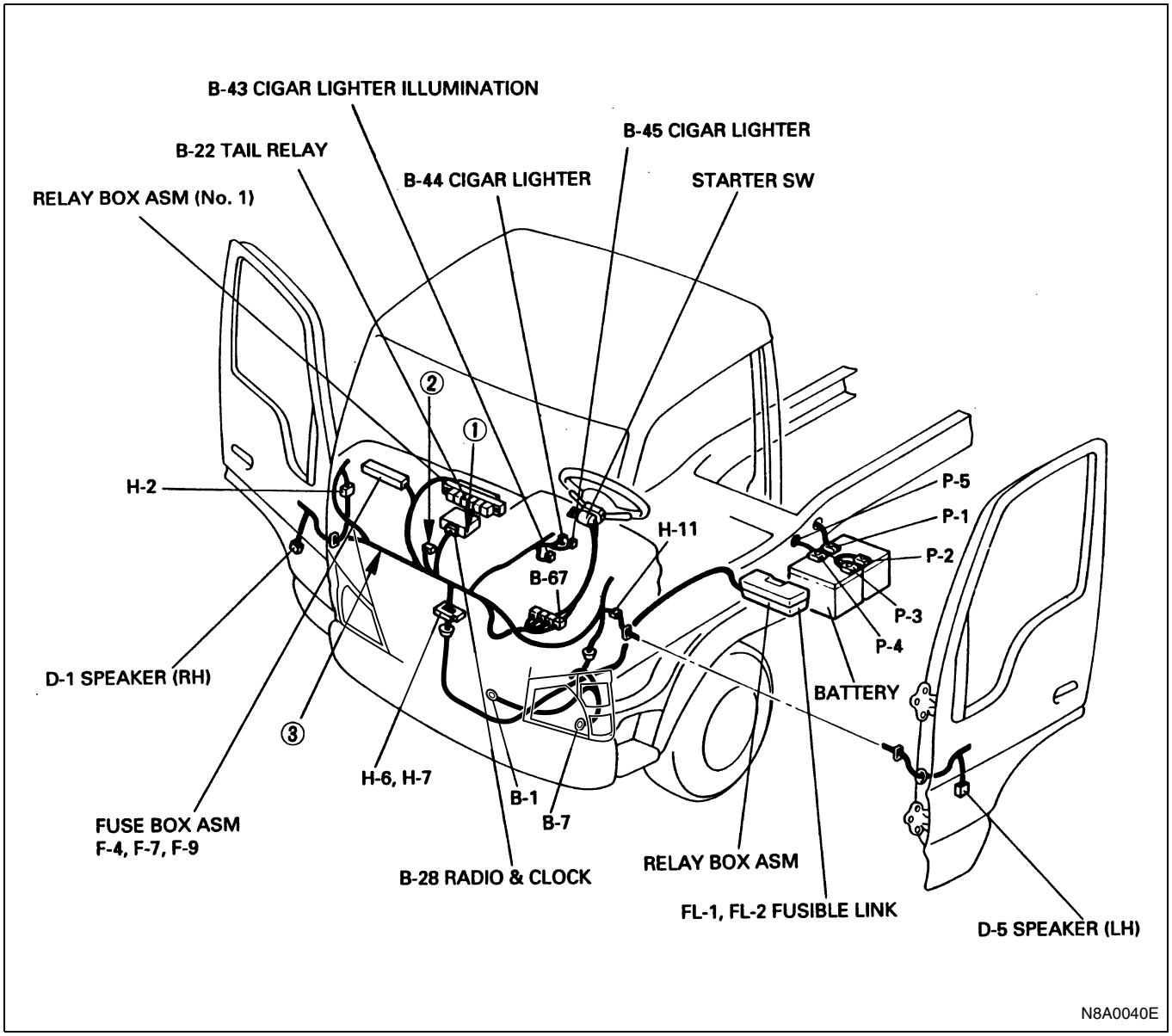


Reading The Circuit Diagram

In this manual, each system has its own parts location illustration, circuit diagram and connector configuration used in the circuit diagram.

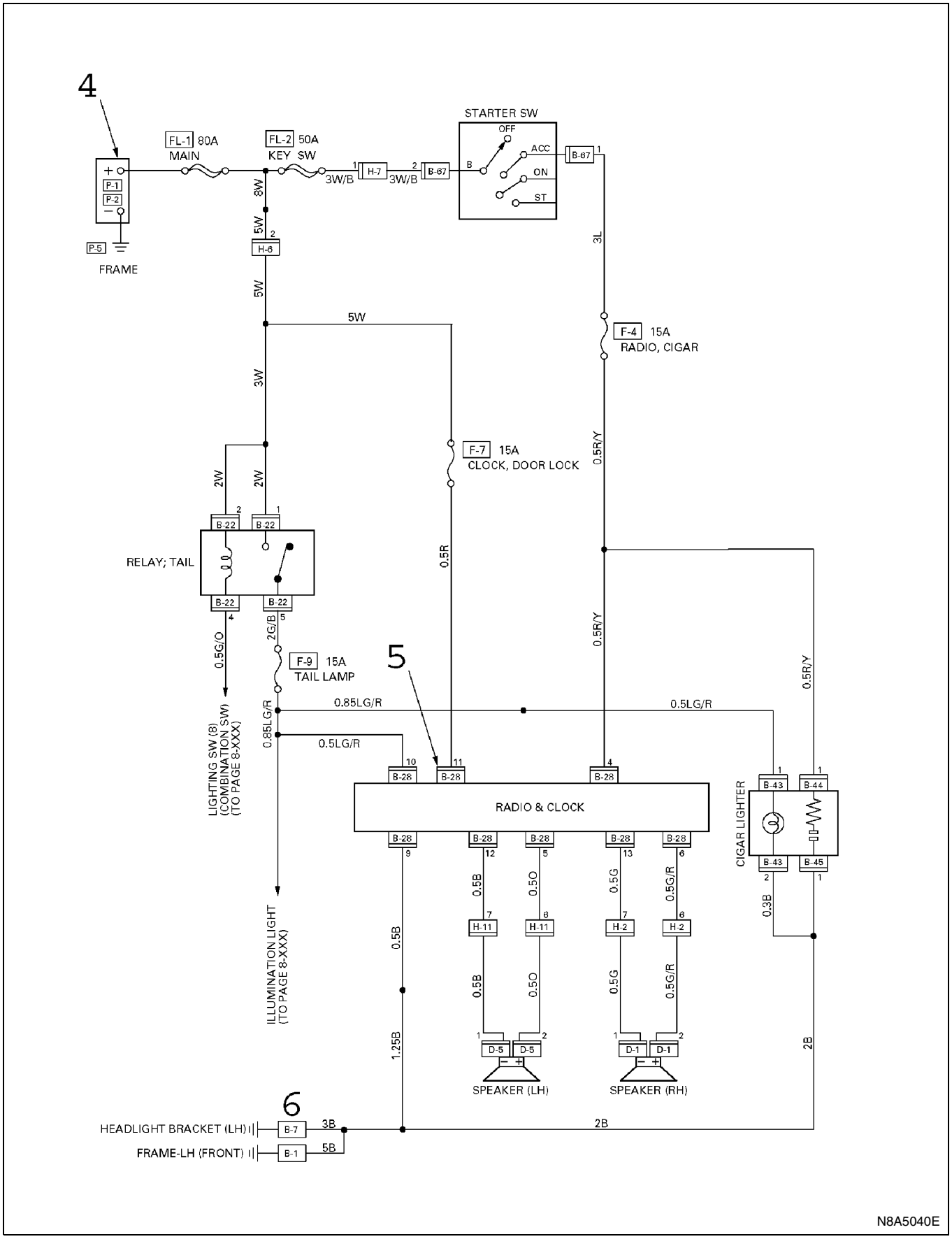
Parts Location

The parts location shows the location of the parts 1 and the connector 2 used in each harness routing 3.



Circuit Diagram

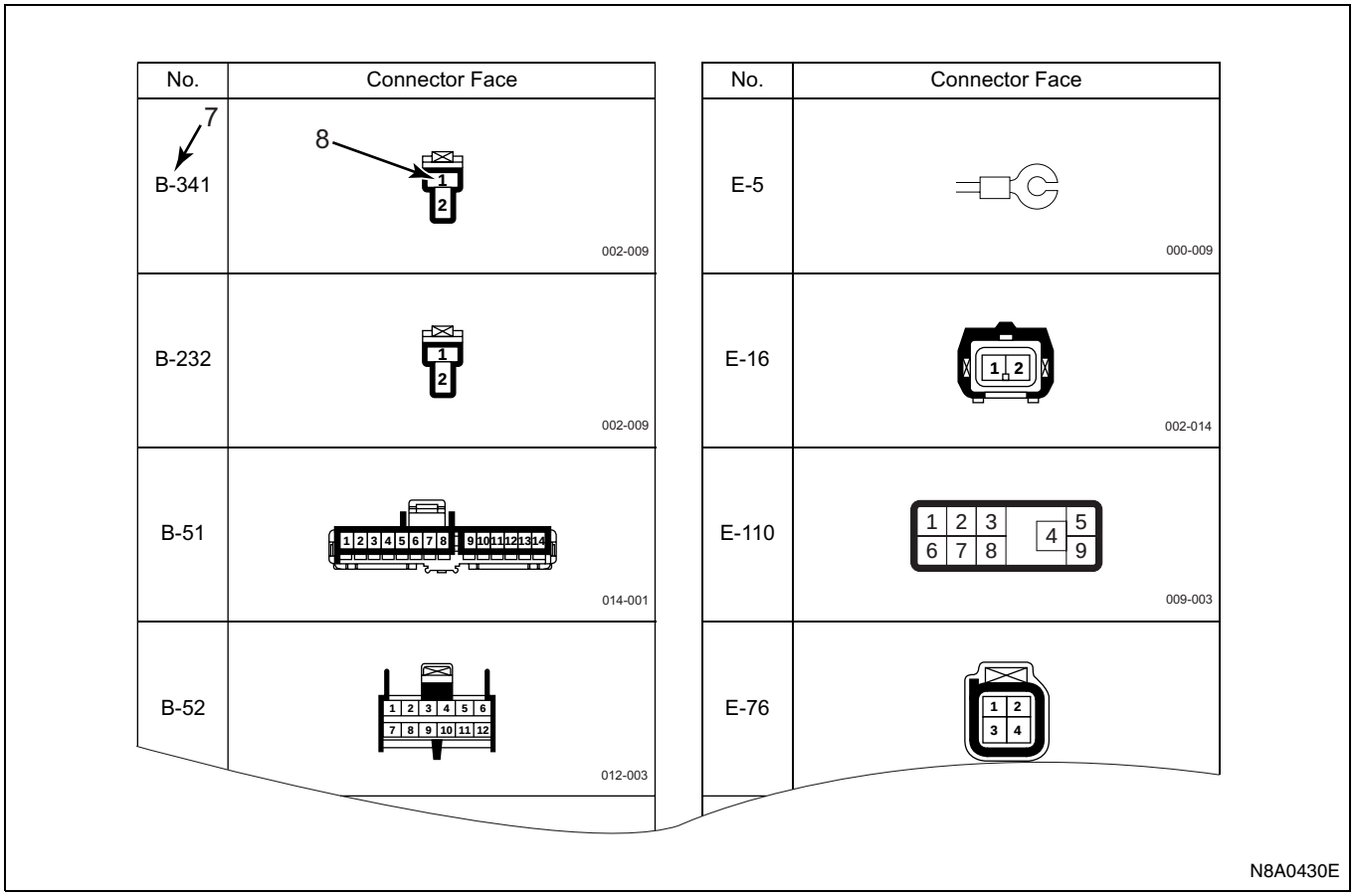
The circuit diagram shows the power supply 4 the load or loads 5 and the grounding point(s) 6.



N8A5040E

Connector List

The connector list shows each connectors' configuration 7 and the pin number 8.

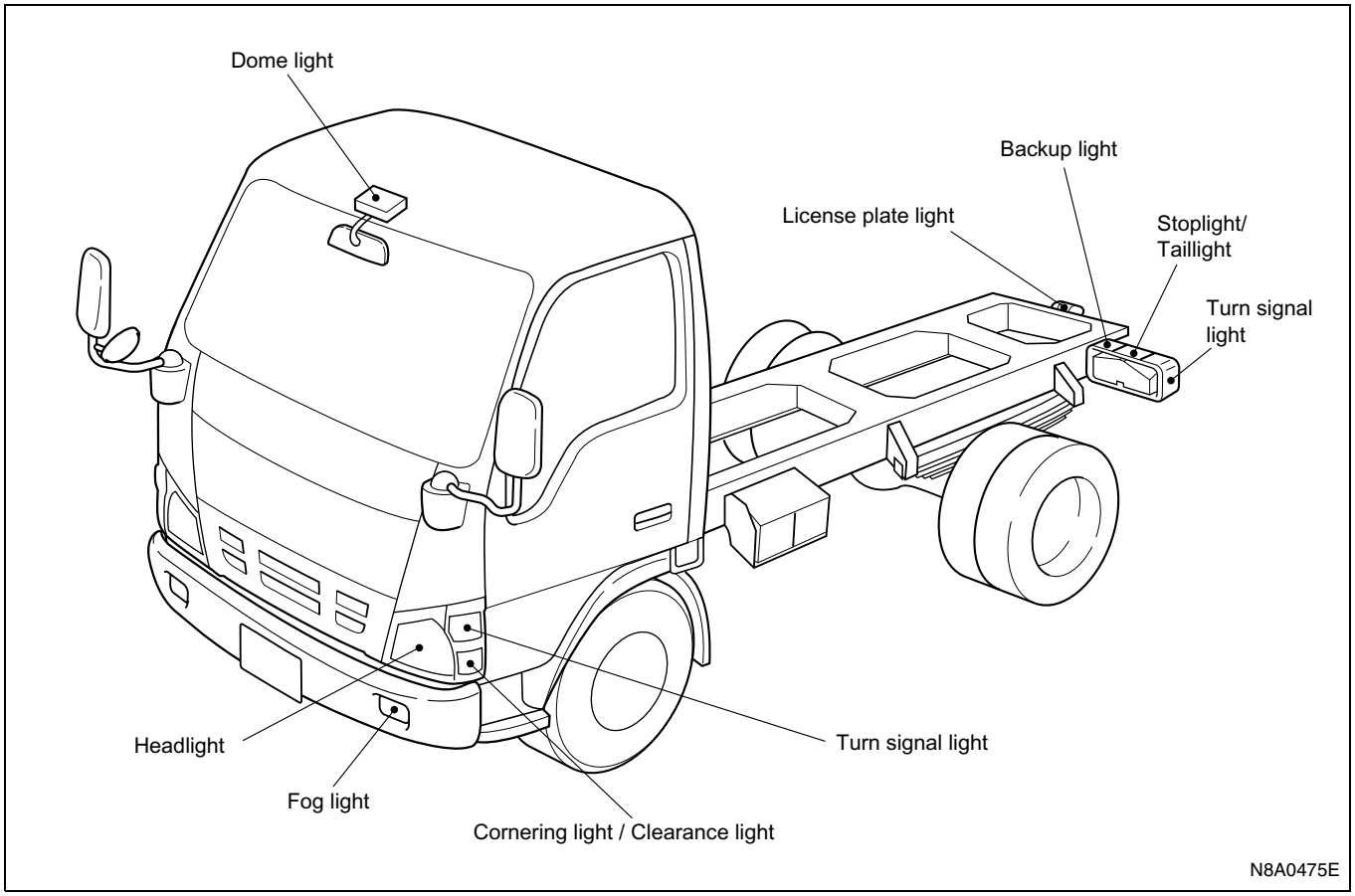


Connector Symbol

Connector Symbol	Harness name	Connector Symbol	Harness name
B	Body harness	L	Dome Light harness
D	Door harness	N	Floor harness (LH & RH)
E	Engine harness	P	Battery harness
H	For joint between harnesses	R	Rear body harness
J	Front frame & Rear frame harness		

MAIN DATA AND SPECIFICATIONS

Bulb Specifications



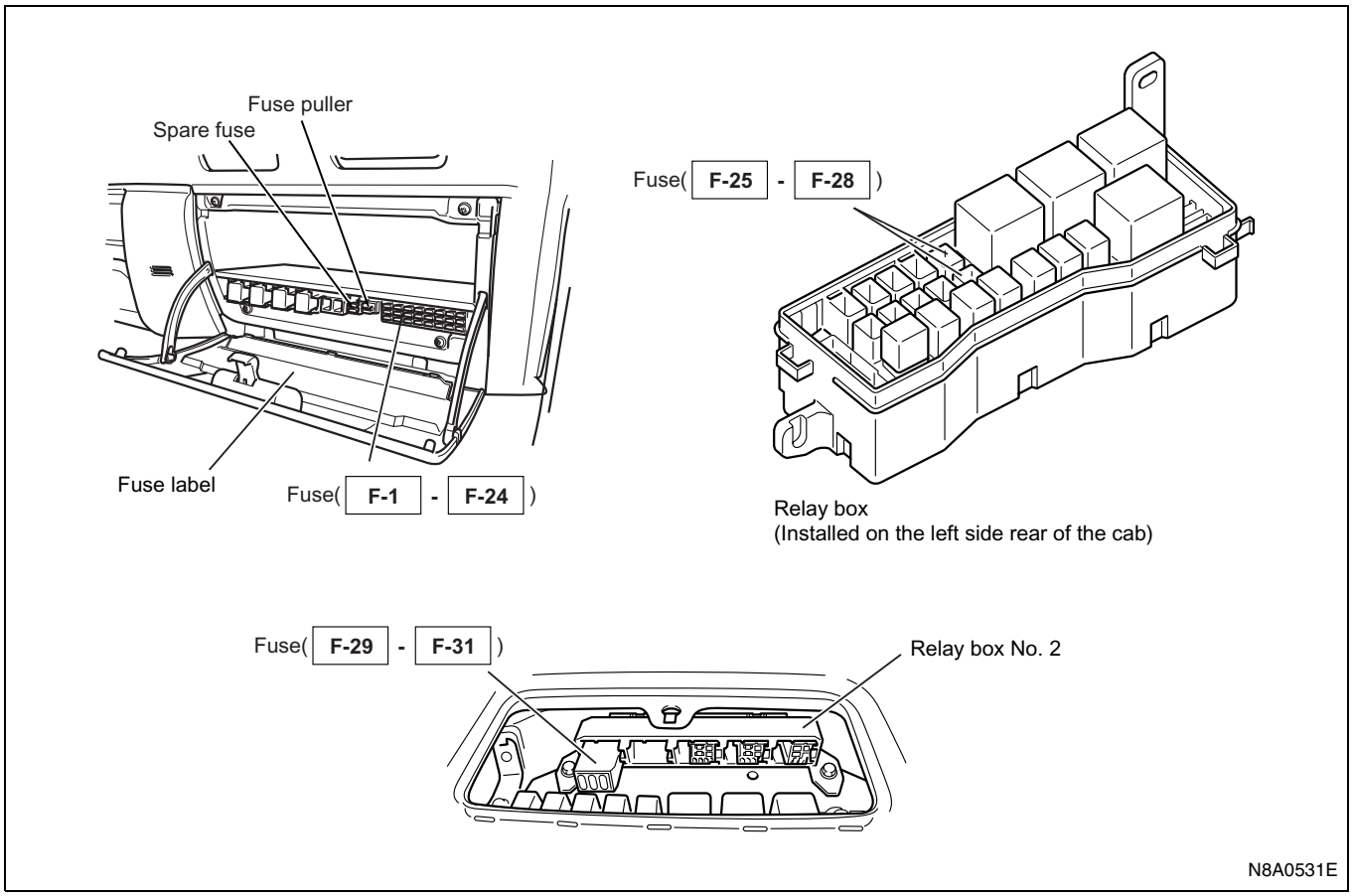
Light Name		Rated Power	No. of Bulb	Lens Color	Remarks
Halogen Headlight		60 W / 55 W	2	Clear	12 V
		75 W / 70 W	2		24 V
Front combination light	Turn signal light	21 W	2	Amber	12 V, 24 V
	Cornering light / Clearance light	21 W / 5 W	2	Clear	12 V, 24 V
Fog light	Front	55 W	2	Clear	12 V
		70 W			24 V
	Rear	21 W	1	Red	12 V, 24 V
Rear combination light	Stoplight / Taillight	21 W / 5 W	2	Red	12 V, 24 V
	Turn signal light	21 W	2	Amber	12 V, 24 V
	Backup light	21 W	2	Clear	12 V, 24 V
License plate light		5 W	1	Clear	12 V, 24 V
Dome light		10 W	1	White	12 V, 24 V
Roof marker light		5 W	2	White	24 V
Side turn signal light		21 W	2	Amber	24 V

Light Name		Rated Power		No. of Bulb	Remarks
		Except 4HK1-TC	4HK1-TC		
Indicator / Warning Light (In the meter assembly)	Glow	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Engine oil pressure	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Fuel sedimenter	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Brake fluid level / Parking brake	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Charge	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Exhaust brake	2 W	—	1	12 V
	High beam	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Turn signal	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Fuel level	2 W	—	1	12 V
		1.8 W	1.8 W		24 V
	Seat belt	2 W	—	1	12 V
		1.8 W	1.8 W		24 V
	4WD	1.8 W	1.8 W	1	24 V
	Rear fog	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Brake booster	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	ABS	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Check engine	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	P.T.O.	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Smoother	—	LED	1	24 V
	1st start	—	LED	1	24 V
	ECONO	—	LED	1	24 V
	ASR	—	1.8 W	1	24 V

Light Name			Rated Power		No. of Bulb	Remarks
			Except 4HK1-TC	4HK1-TC		
Illumination	Illumination light for meter assembly		3.4 W		1	12 V
			3 W			24 V
	Hazard warning Switch		2 W		1	12 V
			1.8 W			24 V
	Dome light switch		2 W		1	12 V
			1.8 W			24 V
	Front fog light switch		2 W		1	12 V
			1.8 W			24 V
	Rear fog light switch	For indicator	60 mA		1	12 V
		For illumination	60 mA		1	
	Cigar lighter		1.4 W		1	12 V
			1.8 W			24 V
	Heater bezel		1.4 W		1	
	Ashtray		1.4 W		1	

Fuse and Fusible Link Location

Fuse and Circuit Breaker



Fuse Label-for 12 Volt (4JB1)

10 A (1)	AIR CON
15 A (2)	EXH. BRAKE, FUEL HEATER
15 A (3)	REAR HEATER
15 A (4)	AUDIO (B), DOOR LOCK
10 A (5)	STOP LIGHT
10 A (6)	FRT FOG LIGHT, CORNERING LAMP
10 A (7)	TAIL LIGHT
10 A (8)	EGR
10 A (9)	FUEL CUT
15 A (10)	FRONT WIPER & WASHER
10 A (11)	TURN LIGHT
10 A (12)	H/LAMP LEVEL
(13)	—
(14)	—
15 A (15)	AUDIO (IG), CIGAR LIGHTER
10 A (16)	METER
(17)	—
(18)	—
15 A (19)	HORN, HAZARD
10 A (20)	ABS (IG)
15 A (21)	GENERATOR
10 A (22)	STARTER
10 A (23)	HEAD LIGHT RH

10 A (24)	HEAD LIGHT LH
15 A (25)	MARKER LAMP
15 A (26)	COND. FAN
10 A (27)	RR FOG
(28)	—

Fuse Label-for 12 Volt (4HG1 / 4HE1)

10 A (1)	AIR CON
15 A (2)	EXH. BRAKE
(3)	—
15 A (4)	AUDIO (B), DOOR LOCK
10 A (5)	STOP LIGHT
(6)	—
10 A (7)	TAIL LIGHT
10 A (8)	FRT FOG LIGHT, CORNERING LAMP
10 A (9)	ENG.(IG)
15 A (10)	FRONT WIPER & WASHER
10 A (11)	TURN LIGHT
(12)	—
10 A (13)	ENG. STOP
(14)	—
15 A (15)	AUDIO (IG), CIGAR LIGHTER
10 A (16)	METER
(17)	—
(18)	—
15 A (19)	ENG.(B)
15 A (20)	HORN, HAZARD
(21)	—
10 A (22)	STARTER

10 A (23)	HEAD LIGHT RH
10 A (24)	HEAD LIGHT LH
15 A (25)	MARKER LAMP
(26)	—
10 A (27)	RR FOG
(28)	—

Fuse Label-for 12 Volt (4JH1)

10 A (1)	AIR CON
15 A (2)	FUEL HEATER
15 A (3)	REAR HEATER
15 A (4)	AUDIO (B), DOOR LOCK
10 A (5)	STOP LIGHT
10 A (6)	FRT FOG LIGHT, CORNERING LAMP
10 A (7)	TAIL LIGHT
15 A (8)	ENG.(B1)
15 A (9)	ENG.(B2)
15 A (10)	FRONT WIPER & WASHER
10 A (11)	TURN LIGHT
10 A (12)	H/LAMP LEVEL
(13)	—
(14)	—
15 A (15)	AUDIO (IG), CIGAR LIGHTER
10 A (16)	METER
(17)	—
(18)	—
15 A (19)	HORN, HAZARD
10 A (20)	ABS (IG)

(21)	—
10 A (22)	STARTER
10 A (23)	HEAD LIGHT RH
10 A (24)	HEAD LIGHT LH
15 A (25)	MARKER LAMP
15 A (26)	COND. FAN
10 A (27)	RR FOG
(28)	—

Fuse Label-for 24 Volt (4HF1 / 4HG1 / 4HE1)

15 A (1)	HEATER, AIR CON
10 A (2)	EXH. BRAKE, FUEL HEATER
15 A (3)	REAR HEATER
15 A (4)	AUDIO (B), DOOR LOCK
10 A (5)	STOP LIGHT
20 A (6)	POWER WINDOW
10 A (7)	TAIL LIGHT
10 A (8)	FRT FOG LIGHT, CORNERING LAMP
10 A (9)	ENG. (IG)
	FUEL CUT
15 A (10)	FRONT WIPER & WASHER
10 A (11)	TURN LIGHT
10 A (12)	H/LAMP LEVEL
10 A (13)	ENG. STOP
(14)	—
15 A (15)	AUDIO (IG), CIGAR LIGHTER
10 A (16)	METER
(17)	—
15 A (18)	GENERATOR
15 A (19)	ENG. (B)
15 A (20)	HORN, HAZARD
10 A (21)	ABS (IG)
10 A (22)	STARTER
10 A (23)	HEAD LIGHT RH
10 A (24)	HEAD LIGHT LH
15 A (25)	MARKER LAMP
15 A (26)	COND. FAN
10 A (27)	RR FOG
(28)	—
20 A (29)	PTO
10 A (30)	PTO
10 A (31)	PTO

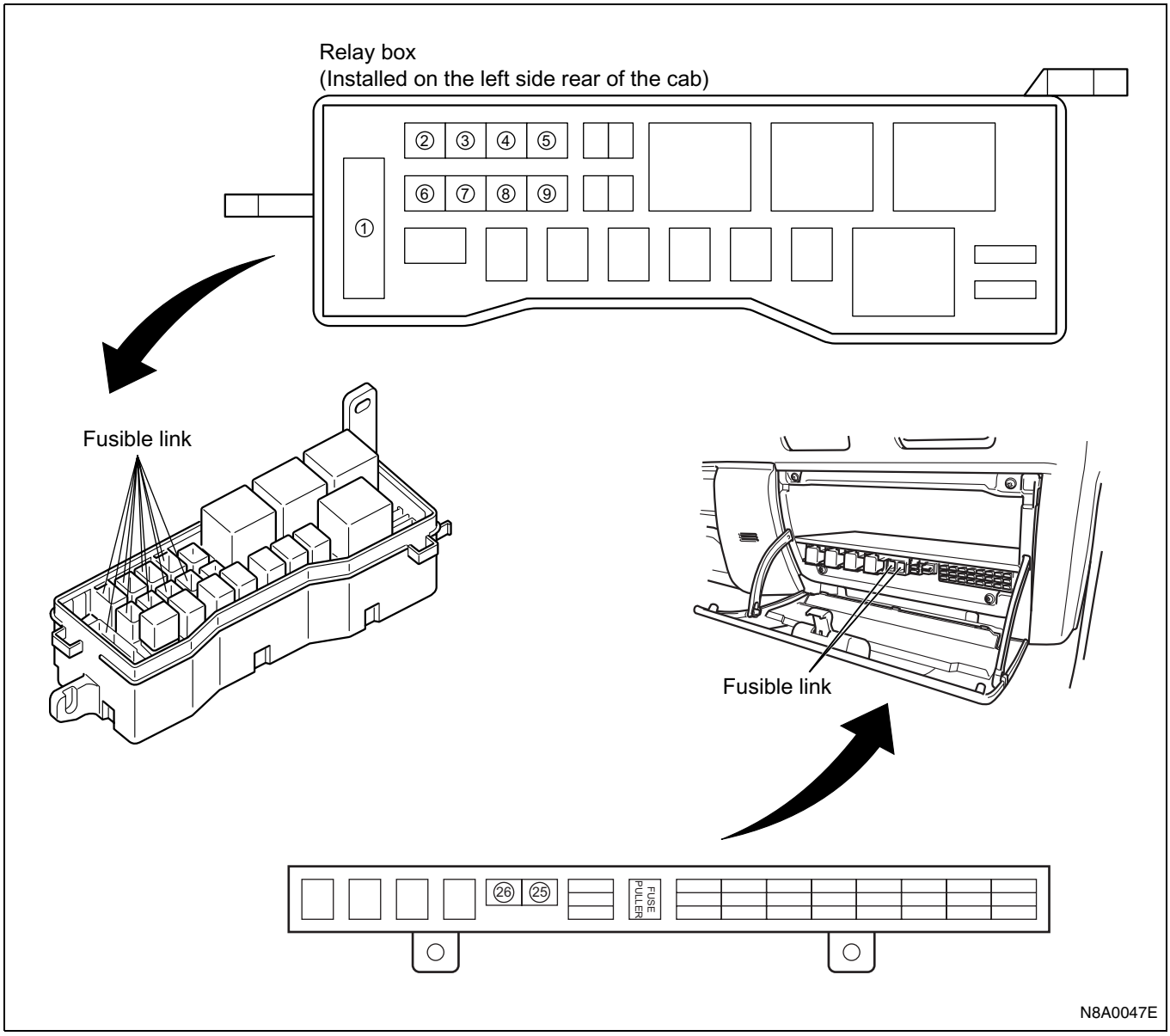
Fuse Label-for 24 Volt (4HK1)

15 A (1)	HEATER, AIR CON
10 A (2)	FUEL HEATER
15 A (3)	REAR HEATER
15 A (4)	AUDIO (B), DOOR LOCK
10 A (5)	STOP LIGHT
20 A (6)	POWER WINDOW
10 A (7)	TAIL LIGHT
10 A (8)	FRT FOG LIGHT
10 A (9)	ENG. (IG)
15 A (10)	FRONT WIPER & WASHER

10 A (11)	TURN LIGHT
10 A (12)	H/LAMP LEVEL
10 A (13)	NEES (B)
(14)	—
15 A (15)	AUDIO (IG), CIGAR LIGHTER
10 A (16)	METER
10 A (17)	NEES (IG)
	HSA
10 A (18)	SRS
10 A (19)	ENG. (BACK UP) HSA
15 A (20)	HORN, HAZARD
10 A (21)	ABS (IG)
10 A (22)	STARTER
10 A (23)	HEAD LIGHT RH
10 A (24)	HEAD LIGHT LH
15 A (25)	MARKER LAMP
15 A (26)	COND. FAN
10 A (27)	RR FOG
10 A (28)	ECM. ENG.

Notice:
The fuse numbers (1) — (31) indicated on the fuse labels are expressed as F-1 — F-31 in the circuit diagrams of this manual.

Fusible Link



For 12 Volt (4JB1)

100 A (1)	MAIN
50 A (2)	KEY
60 A (3)	GLOW
30 A (4)	HEAD LAMP
(5)	—
(6)	—
(7)	—
60 A (8)	STARTER
60 A (9)	ABS
30 A (25)	HEATER
30 A (26)	POWER WINDOW

For 12 Volt (4HG1 / 4HE1)

100 A (1)	MAIN
50 A (2)	KEY
60 A (3)	GLOW

30 A (4)	HEAD LAMP
(5)	—
(6)	—
(7)	—
60 A (8)	STARTER
(9)	—
30 A (25)	HEATER
30 A (26)	POWER WINDOW

For 12 Volt (4JH1)

100 A (1)	MAIN
50 A (2)	KEY
60 A (3)	GLOW
30 A (4)	HEAD LAMP
(5)	—
(6)	—
(7)	—
60 A (8)	STARTER
60 A (9)	ABS
30 A (25)	HEATER
30 A (26)	POWER WINDOW

For 24 Volt (4HF1 / 4HG1 / 4HE1)

100 A / 120 A (1)	MAIN
40 A (2)	KEY
60 A (3)	GLOW
30 A (4)	HEAD LAMP
(5)	—
(6)	—
(7)	—
60 A (8)	STARTER
40 A (9)	ABS

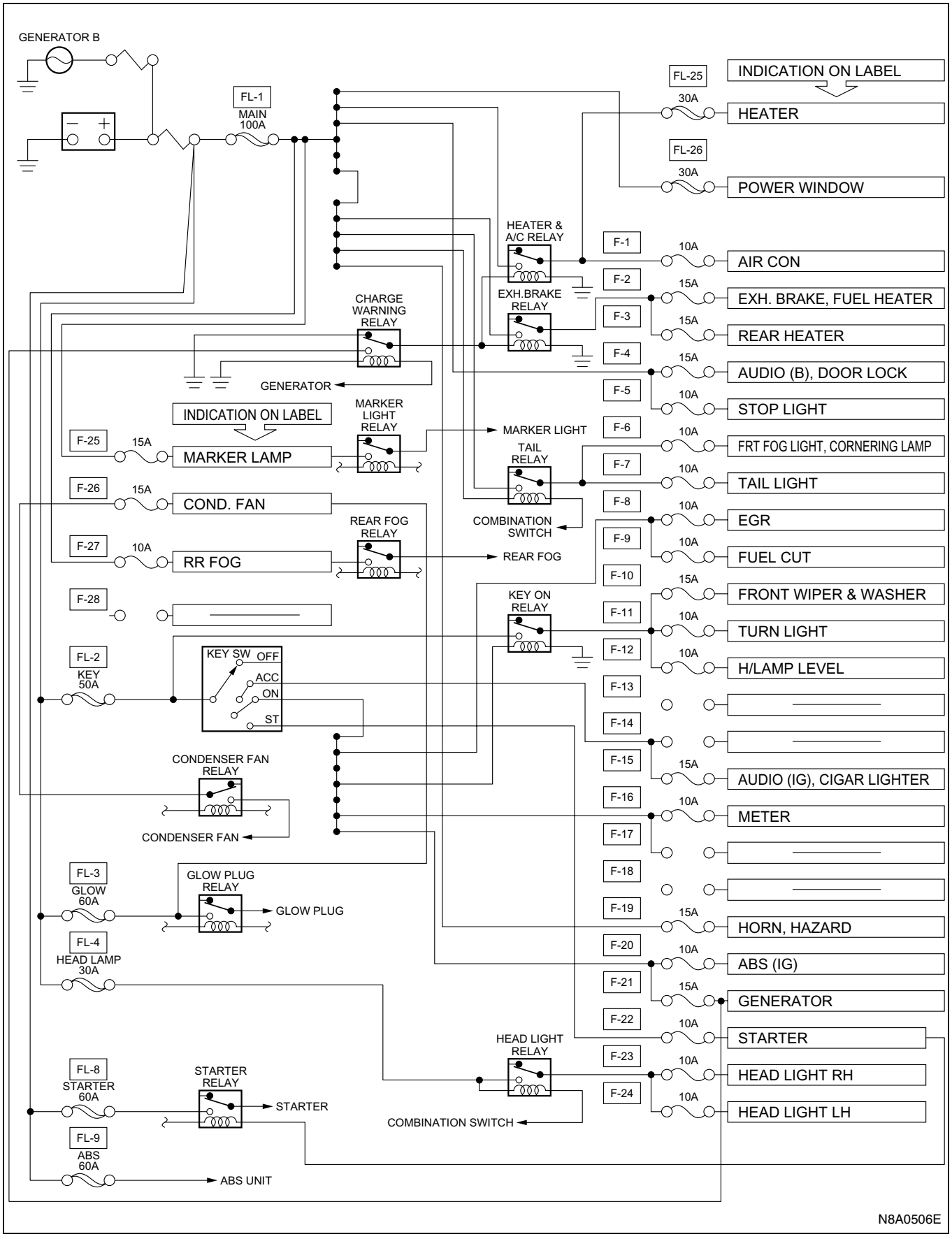
For 24 Volt (4HK1)

100 A / 120 A (1)	MAIN
40 A (2)	KEY
60 A (3)	GLOW
30 A (4)	HEAD LAMP
40 A (5)	ECM. ENG.
60 A (6)	CERAMIC HEATER
60 A (7)	NEES
60 A (8)	STARTER
40 A (9)	ABS

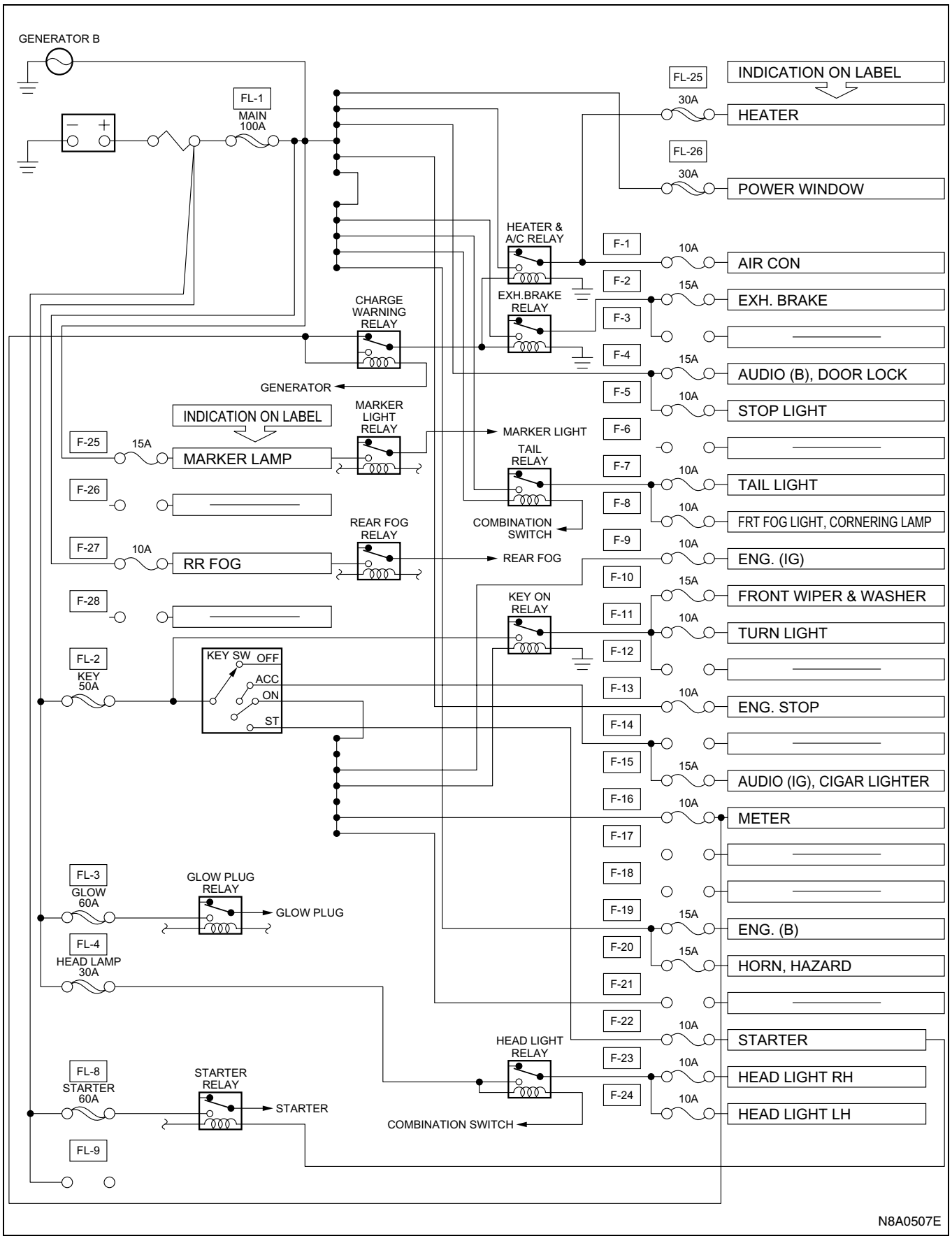
Notice:
The fusible link numbers (1) — (26) are expressed as FL-1 — FL-26 in the circuit diagrams of this manual.

Fuse Block Circuit

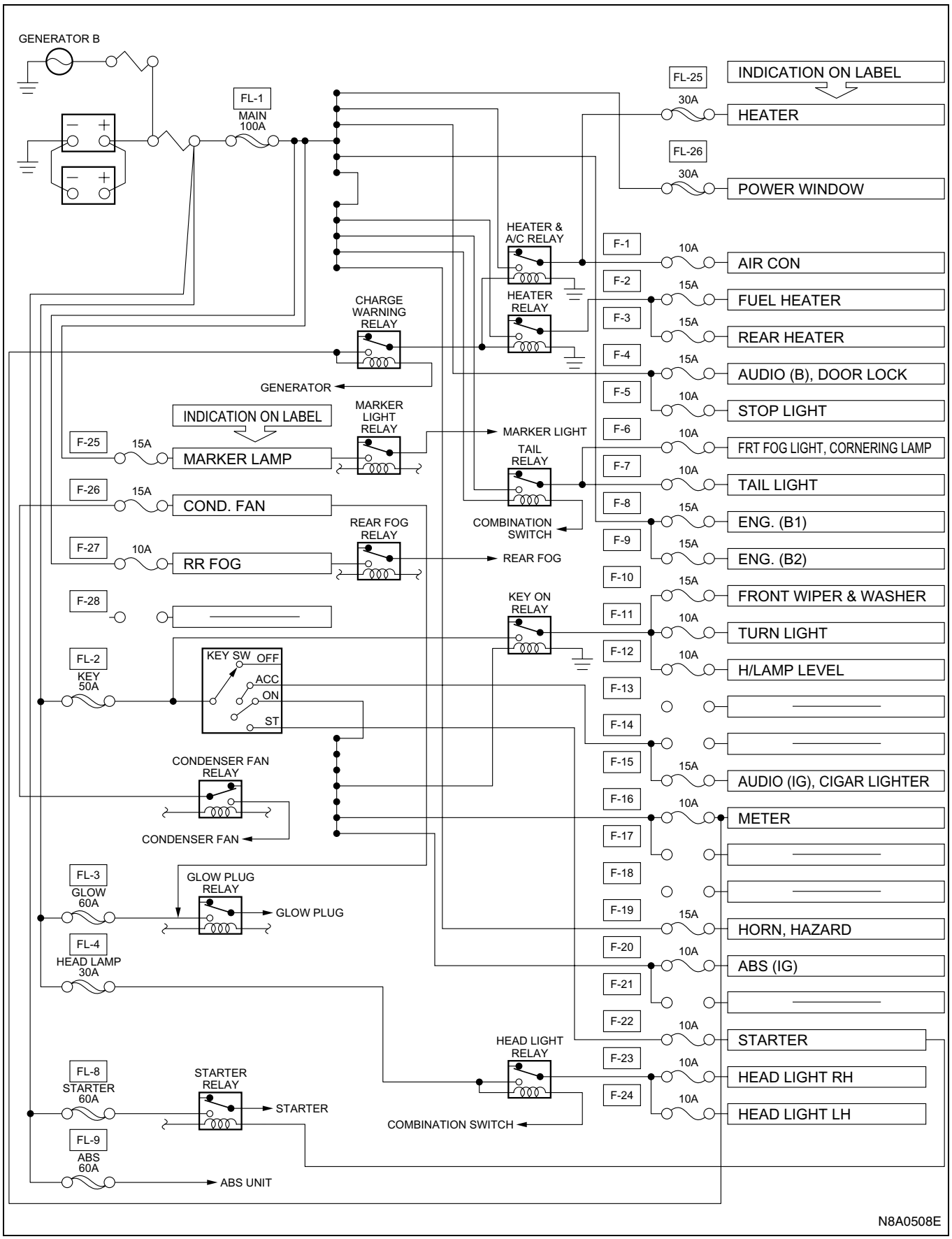
For 12 Volt-4JB1 Engine



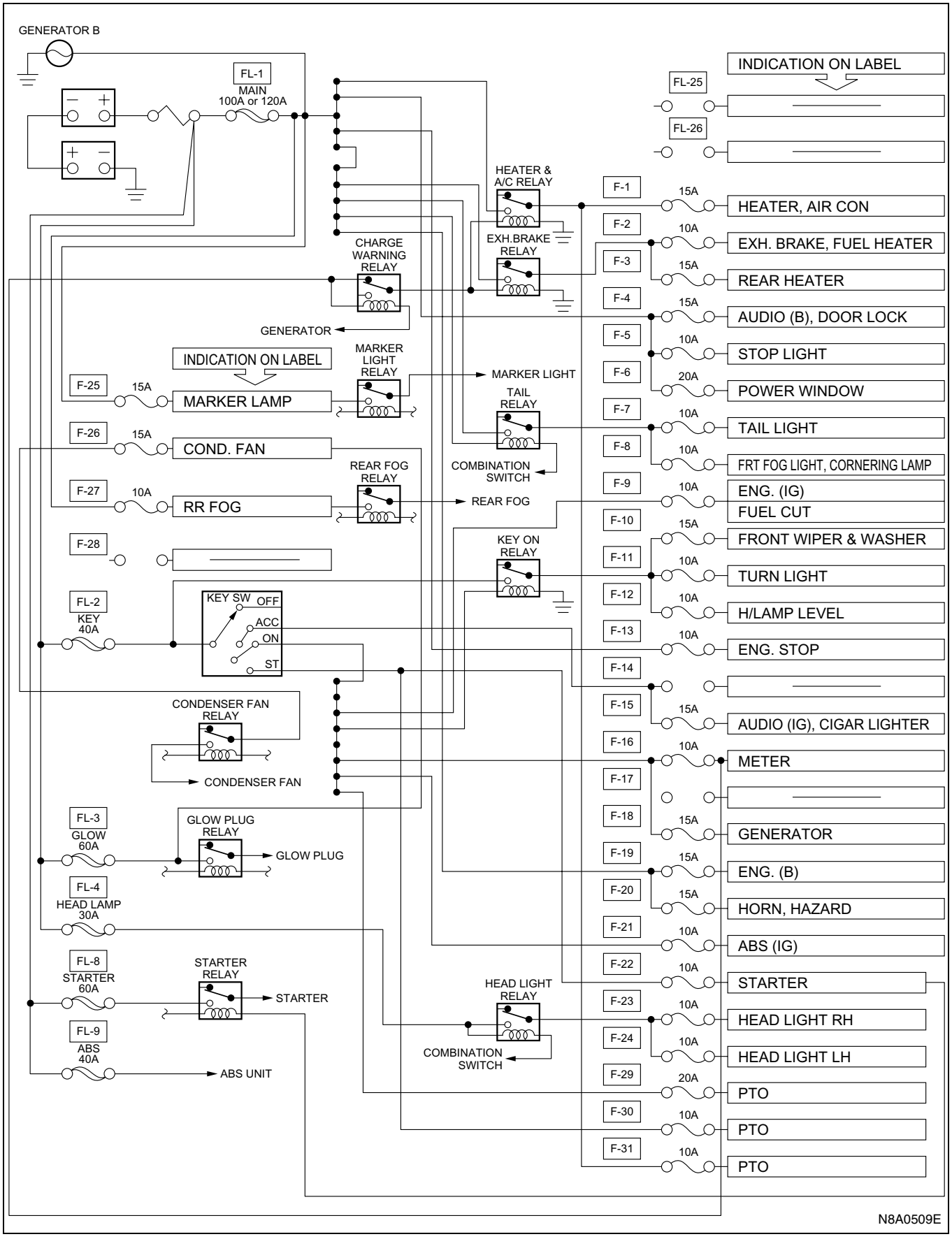
For 12 Volt-4HG1 / 4HE1 Engine



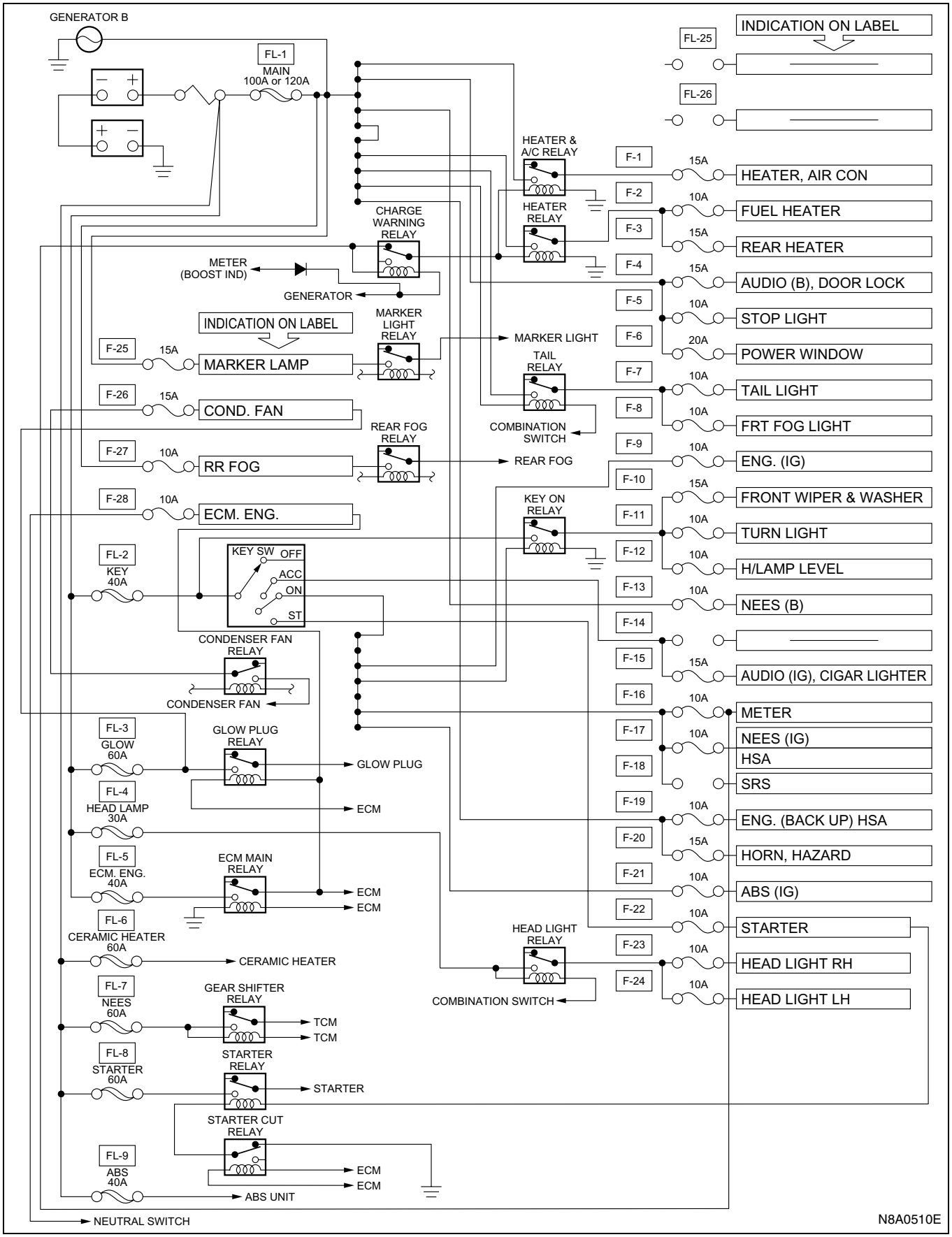
For 12 Volt-4JH1 Engine



For 24 Volt-4HF1 / 4HG1 / 4HE1 Engine



For 24 Volt-4HK1 Engine



Reference Table of Fuse and Circuit Breaker

Fuse

12 Volt 4JB1 Engine

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-1	10 A	AIR CON	A/C switch, A/C thermo relay, Pressure switch, Magnetic clutch, VSV: FICD, Electronic thermostat
F-2	15 A	EXH. BRAKE, FUEL HEATER	Exhaust brake switch, Exhaust brake control relay, Exhaust brake magnetic valve, Clutch switch, Accel switch, Fuel heater
F-3	15 A	REAR HEATER	Rear heater, Rear heater switch
F-4	15 A	AUDIO (B), DOOR LOCK	Radio & clock, Dome light switch, Dome light, Door switch (RH & LH), Door lock switch, Door lock actuator, Door lock controller, Speedometer, Key cylinder switch, Key remind buzzer
F-5	10 A	STOP LIGHT	Stoplight switch, Stoplight
F-6	10 A	FRT FOG LIGHT, CORNERING LAMP	Fog light switch, Fog light, Lighting switch, Cornering light relay, Cornering light, Cornering light switch
F-7	10 A	TAIL LIGHT	Tail relay, Illumination light(s), Clearance light(s), Tail light(s)
F-8	10 A	EGR	ECM ignition
F-9	10 A	FUEL CUT	Fuel cut solenoid
F-10	15 A	FRONT WIPER & WASHER	Wiper & Washer switch, Wiper motor, Washer motor, Intermittent relay
F-11	10 A	TURN LIGHT	Flasher unit, Front turn signal light, Rear turn signal light, Turn signal light switch, Hazard warning switch
F-12	10 A	H/LAMP LEVEL	Headlight leveling switch, Headlight leveling motor (actuator)
F-13	—	—	—
F-14	—	—	—
F-15	15 A	AUDIO (IG), CIGAR LIGHTER	Radio, Cigar lighter
F-16	10 A	METER	Exhaust brake control relay, CSD Relay, Key remind buzzer, Backup light switch, Backup light, Neutral switch, Starter relay, QOS-II controller, QOS-III controller, Glow relay, Glow-1 relay, Glow-2 relay, Glow indicator (Meter), Coolant temperature gauge, Thermo unit, Vehicle speed sensor (Installed on the meter assembly & Transmission), Meter assembly, Power window relay, Cornering light relay
F-17	—	—	—
F-18	—	—	—
F-19	15 A	HORN, HAZARD	Horn, Horn relay, Horn switch, Flasher unit, Hazard warning switch
F-20	10 A	ABS (IG)	ABS
F-21	15 A	GENERATOR	Generator
F-22	10 A	STARTER	Starter relay, QOS-II controller, QOS-III controller
F-23	10 A	HEAD LIGHT RH	Headlight (RH), Dimmer relay, High beam indicator light
F-24	10 A	HEAD LIGHT LH	Headlight (LH), Dimmer relay
F-25	15 A	MARKER LAMP	Marker light, Marker light relay
F-26	15 A	COND. FAN	Condenser fan
F-27	10 A	RR FOG	Rear fog light switch, Rear fog light relay

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-28	—	—	—

12 Volt 4HG1 / 4HE1 Engine

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-1	10 A	AIR CON	A/C switch, A/C thermo relay, Pressure switch, Magnetic clutch, VSV: FICD, Electronic thermostat
F-2	15 A	EXH. BRAKE	Exhaust brake switch, Exhaust brake control relay, Exhaust brake magnetic valve, Clutch switch, Accel switch
F-3	—	—	—
F-4	15 A	AUDIO (B), DOOR LOCK	Radio & clock, Dome light switch, Dome light, Door switch (RH & LH), Door lock switch, Door lock actuator, Door lock controller, Speedometer, Key cylinder switch, Key remind buzzer
F-5	10 A	STOP LIGHT	Stoplight switch, Stoplight
F-6	—	—	—
F-7	10 A	TAIL LIGHT	Tail relay, Illumination light(s), Clearance light(s), Tail light(s)
F-8	10 A	FRT FOG LIGHT, CORNERING LAMP	Fog light switch, Fog light, Lighting switch, Cornering light relay, Cornering light, Cornering light switch
F-9	10 A	ENG. (IG)	ECM ignition
F-10	15 A	FRONT WIPER & WASHER	Wiper & Washer switch, Wiper motor, Washer motor, Intermittent relay
F-11	10 A	TURN LIGHT	Flasher unit, Front turn signal light, Rear turn signal light, Turn signal light switch, Hazard warning switch
F-12	—	—	—
F-13	10 A	ENG. STOP	Engine stop motor
F-14	—	—	—
F-15	15 A	AUDIO (IG), CIGAR LIGHTER	Radio, Cigar lighter
F-16	10 A	METER	Exhaust brake control relay, CSD Relay, Key remind buzzer, Backup light switch, Backup light, Inhibitor switch, Neutral switch, Starter relay, QOS-II controller, QOS-III controller, Glow relay, Glow-1 relay, Glow-2 relay, Glow indicator (Meter), Coolant temperature gauge, Thermo unit, Vehicle speed sensor (Installed on the meter assembly & Transmission), Meter assembly, Power window relay, Cornering light relay
F-17	—	—	—
F-18	—	—	—
F-19	15 A	ENG. (B)	ECM battery
F-20	15 A	HORN, HAZARD	Horn, Horn relay, Horn switch, Flasher unit, Hazard warning switch
F-21	—	—	—
F-22	10 A	STARTER	Starter relay, Inhibitor switch, QOS-II controller, QOS-III controller
F-23	10 A	HEAD LIGHT RH	Headlight (RH), Dimmer relay, High beam indicator light
F-24	10 A	HEAD LIGHT LH	Headlight (LH), Dimmer relay
F-25	15 A	MARKER LAMP	Marker light, Marker light relay

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-26	—	—	—
F-27	10 A	RR FOG	Rear fog light switch, Rear fog light relay
F-28	—	—	—

12 Volt 4JH1 Engine

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-1	10 A	AIR CON	A/C switch, A/C thermo relay, Pressure switch, Magnetic clutch, VSV: FICD, Electronic thermostat
F-2	15 A	FUEL HEATER	Fuel heater
F-3	15 A	REAR HEATER	Rear heater, Rear heater switch
F-4	15 A	AUDIO (B), DOOR LOCK	Radio & clock, Dome light switch, Dome light, Door switch (RH & LH), Door lock switch, Door lock actuator, Door lock controller, Speedometer, Key cylinder switch, Key remind buzzer
F-5	10 A	STOP LIGHT	Stoplight switch, Stoplight
F-6	10 A	FRT FOG LIGHT, CORNERING LAMP	Fog light switch, Fog light, Lighting switch, Cornering light relay, Cornering light, Cornering light switch
F-7	10 A	TAIL LIGHT	Tail relay, Illumination light(s), Clearance light(s), Tail light(s)
F-8	15 A	ENG. (B1)	ECM battery
F-9	15 A	ENG. (B2)	ECM battery
F-10	15 A	FRONT WIPER & WASHER	Wiper & Washer switch, Wiper motor, Washer motor, Intermittent relay
F-11	10 A	TURN LIGHT	Flasher unit, Front turn signal light, Rear turn signal light, Turn signal light switch, Hazard warning switch
F-12	10 A	H/LAMP LEVEL	Headlight leveling switch, Headlight leveling motor (actuator)
F-13	—	—	—
F-14	—	—	—
F-15	15 A	AUDIO (IG), CIGAR LIGHTER	Radio, Cigar lighter
F-16	10 A	METER	Exhaust brake control relay, CSD Relay, Key remind buzzer, Backup light switch, Backup light, Neutral switch, Starter relay, QOS-II controller, QOS-III controller, Glow relay, Glow-1 relay, Glow-2 relay, Glow indicator (Meter), Coolant temperature gauge, Thermo unit, Vehicle speed sensor (Installed on the meter assembly & Transmission), Meter assembly, Power window relay, Cornering light relay
F-17	—	—	—
F-18	—	—	—
F-19	15 A	HORN, HAZARD	Horn, Horn relay, Horn switch, Flasher unit, Hazard warning switch
F-20	10 A	ABS (IG)	ABS
F-21	—	—	—
F-22	10 A	STARTER	Starter relay, QOS-II controller, QOS-III controller
F-23	10 A	HEAD LIGHT RH	Headlight (RH), Dimmer relay, High beam indicator light
F-24	10 A	HEAD LIGHT LH	Headlight (LH), Dimmer relay
F-25	15 A	MARKER LAMP	Marker light, Marker light relay

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-26	15 A	COND. FAN	Condenser fan
F-27	10 A	RR FOG	Rear fog light switch, Rear fog light relay
F-28	—	—	—

24 Volt 4HF1 / 4HG1 / 4HE1 Engine

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-1	15 A	HEATER, AIR CON	Blower motor, Blower resistor, Fan switch, A/C switch, A/C thermo relay, Pressure switch, A/C cut relay, Thermo switch (A/C cut), VSV: FICD, Electronic thermostat
F-2	10 A	EXH. BRAKE, FUEL HEATER	Exhaust brake switch, Exhaust brake control relay, Exhaust brake magnetic valve, Clutch switch, Accel switch, Fuel heater
F-3	15 A	REAR HEATER	Rear heater, Rear heater switch
F-4	15 A	AUDIO (B), DOOR LOCK	Radio & clock, Dome light switch, Dome light, Door switch (RH & LH), Door lock switch, Door lock actuator, Door lock controller, Speedometer, Key cylinder switch, Key remind buzzer
F-5	10 A	STOP LIGHT	Stoplight switch, Stoplight
F-6	20 A	POWER WINDOW	Power window
F-7	10 A	TAIL LIGHT	Tail relay, Illumination light(s), Clearance light(s), Tail light(s)
F-8	10 A	FRT FOG LIGHT, CORNERING LAMP	Fog light switch, Fog light, Lighting switch, Cornering light relay, Cornering light, Cornering light switch
F-9	10 A	ENG. (IG)	ECM ignition (EXCEPT 4HF1-2)
		FUEL CUT	Fuel cut solenoid (4HF1-2)
F-10	15 A	FRONT WIPER & WASHER	Wiper & Washer switch, Wiper motor, Washer motor, Intermittent relay
F-11	10 A	TURN LIGHT	Flasher unit, Front turn signal light, Rear turn signal light, Turn signal light switch, Hazard warning switch
F-12	10 A	H/LAMP LEVEL	Headlight leveling switch, Headlight leveling motor (actuator)
F-13	10 A	ENG. STOP	Engine stop motor
F-14	—	—	—
F-15	15 A	AUDIO (IG), CIGAR LIGHTER	Radio, Cigar lighter
F-16	10 A	METER	Exhaust brake control relay, CSD Relay, Key remind buzzer, Backup light switch, Backup light, Neutral switch, Starter relay, QOS-II controller, QOS-III controller, Glow relay, Glow-1 relay, Glow-2 relay, Glow indicator (Meter), Coolant temperature gauge, Thermo unit, Vehicle speed sensor (Installed on the meter assembly & Transmission), Meter assembly, Power window relay, Cornering light relay
F-17	—	—	—
F-18	15 A	GENERATOR	Generator
F-19	15 A	ENG. (B)	ECM battery (4HG1-T)
F-20	15 A	HORN, HAZARD	Horn, Horn relay, Horn switch, Flasher unit, Hazard warning switch
F-21	10 A	ABS (IG)	ABS
F-22	10 A	STARTER	Starter relay, QOS-II controller, QOS-III controller

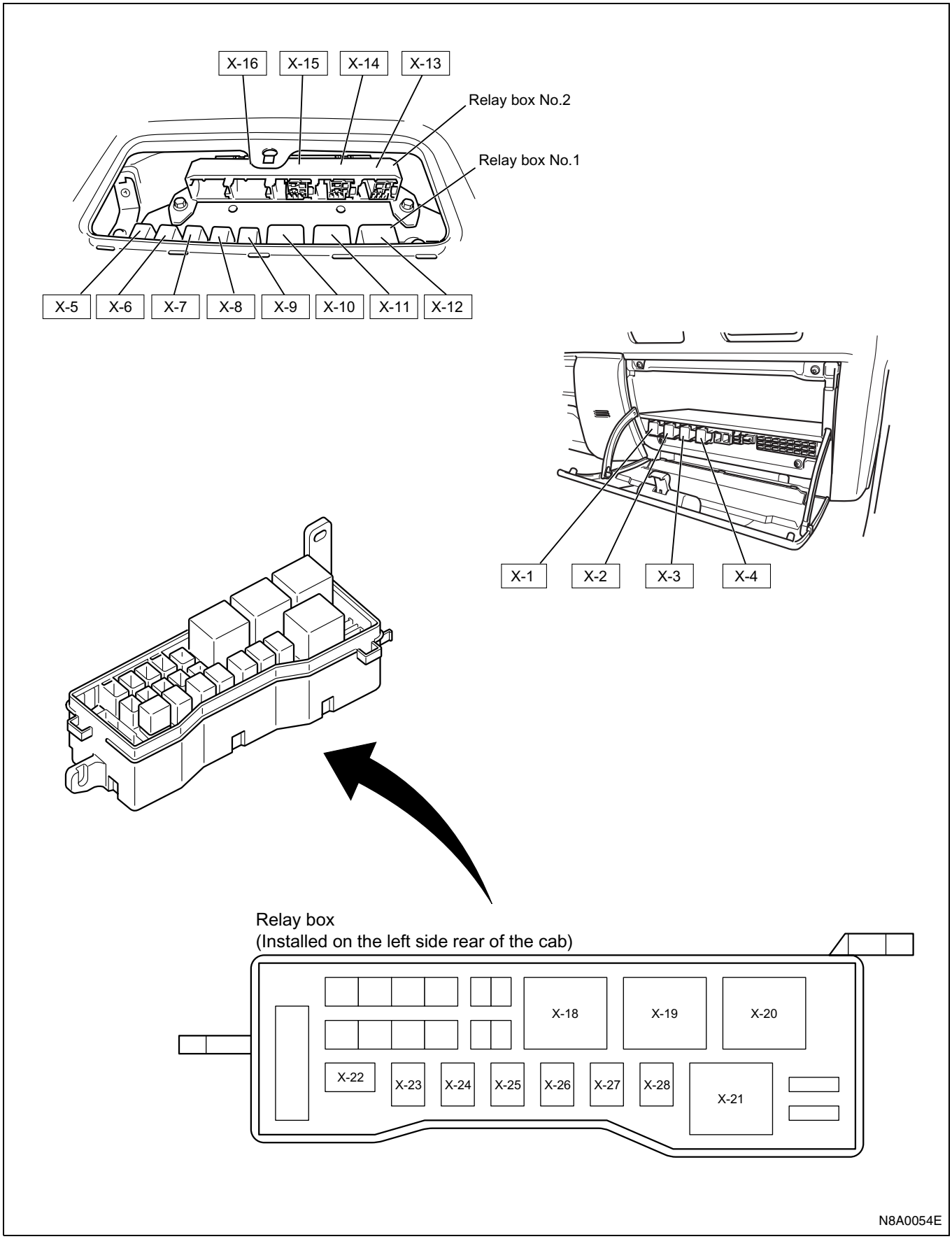
Fuse No.	Capacity	Indication on label	Main parts (Load)
F-23	10 A	HEAD LIGHT RH	Headlight (RH), Dimmer relay, High beam indicator light
F-24	10 A	HEAD LIGHT LH	Headlight (LH), Dimmer relay
F-25	15 A	MARKER LAMP	Marker light, Marker light relay
F-26	15 A	COND. FAN	Condenser fan
F-27	10 A	RR FOG	Rear fog light switch, Rear fog light relay
F-28	—	—	—
F-29	20 A	PTO	PTO main relay (Electronic control type PTO)
F-30	10 A	PTO	PTO cut relay (Electronic control type PTO)
F-31	10 A	PTO	PTO cut relay (Electronic control type PTO)

24 Volt 4HK1 Engine

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-1	15 A	HEATER, AIR CON	Blower motor, Blower resistor, Fan switch, A/C switch, A/C thermo relay, Pressure switch, VSV: FICD, Electronic thermostat, A/C compressor, A/C thermo relay, Condenser fan, ECM (A/C compressor SIG.)
F-2	10 A	FUEL HEATER	Exhaust brake magnetic valve, Clutch switch, Accel switch, Fuel heater, VSV: Intake throttle, ABS (Exhaust brake SIG.), Ceramic heater relay
F-3	15 A	REAR HEATER	Rear heater, Rear heater switch
F-4	15 A	AUDIO (B), DOOR LOCK	Radio & clock, Dome light switch, Dome light, Door switch (RH & LH), Door lock switch, Door lock actuator, Door lock controller, Speedometer, Key cylinder switch, Key remind buzzer, Side turn signal light(s)
F-5	10 A	STOP LIGHT	Stoplight switch, Stoplight, ABS (Stop on SIG.), ECM (brake on SIG.)
F-6	20 A	POWER WINDOW	Power window
F-7	10 A	TAIL LIGHT	Tail relay, Illumination light(s), Clearance light(s), Tail light(s), Roof marker light, License light(s), Marker light relay
F-8	10 A	FRT FOG LIGHT	Fog light switch, Fog light, Lighting switch, Cornering light relay, Cornering light, Cornering light switch
F-9	10 A	ENG. (IG)	ECM (IG SIG.), Starter cut relay, ECM (Exhaust brake SIG.), Exhaust brake indicator, ECM (brake off SIG.), ECM (clutch on SIG.), ALDL connector
F-10	15 A	FRONT WIPER & WASHER	Wiper & Washer switch, Wiper motor, Washer motor, Intermittent relay
F-11	10 A	TURN LIGHT	Flasher unit, Front turn signal light, Rear turn signal light, Turn signal light switch, Hazard warning switch, Side turn signal light relay
F-12	10 A	H/LAMP LEVEL	Headlight leveling switch, Headlight leveling motor (actuator)
F-13	10 A	NEES (B)	Smoother
F-14	—	—	—
F-15	15 A	AUDIO (IG), CIGAR LIGHTER	Radio, Cigar lighter, Digital clock

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-16	10 A	METER	CSD Relay, Key remind buzzer, Backup light switch, Backup light, Neutral switch, Starter relay, QOS-II controller, Glow relay, Glow indicator (Meter), Coolant temperature gauge, Thermo unit, Vehicle speed sensor (Installed on the meter assembly & Transmission), Meter assembly, Power window relay, Cornering light relay, Backup buzzer, ABS indicator relay, Charge relay, Heater A/C relay, VSV: 2WD (4WD), VSV: 4WD (4WD), 4WD relay
F-17	10 A	NEES (IG)	Smoother (IGN SIG.)
		HSA	—
F-18	—	SRS	—
F-19	10 A	ENG. (BACK UP) HSA	ECM (Back up)
F-20	15 A	HORN, HAZARD	Horn, Horn relay, Horn switch, Flasher unit, Hazard warning switch, Turn light(s), Side turn signal light relay
F-21	10 A	ABS (IG)	ABS (IGN SIG.)
F-22	10 A	STARTER	Starter relay, QOS-II controller
F-23	10 A	HEAD LIGHT RH	Headlight (RH), Dimmer relay, High beam indicator light
F-24	10 A	HEAD LIGHT LH	Headlight (LH), Dimmer relay
F-25	15 A	MARKER LAMP	Marker light, Marker light relay
F-26	15 A	COND. FAN	Condenser fan
F-27	10 A	RR FOG	Rear fog light switch, Rear fog light relay
F-28	10 A	ECM. ENG.	ECM

Relay Location



Relay List

❍: Standard, ❑: Option

		X-1		X-2	X-3	X-4	X-5		X-6
		Charge warning	Key ON	Horn	Lamp	Tail	ABS IND.	Smoother main	Dimmer
12 V	NHR55	—	❍	❍	❍	❍	—	—	❍
	NKR55	—	❍	❍	❍	❍	—	—	❍
	NKR69	—	❍	❍	❍	❍	—	—	❍
	NPR71	—	❍	❍	❍	❍	—	—	❍
	NKR77	—	❍	❍	❍	❍	❑	—	❍
	NPR77	—	❍	❍	❍	❍	❑	—	❍
	NKR77 for Taiwan	—	❍	❍	❍	❍	—	—	❍
24 V	NKR66	❍	—	❍	❍	❍	—	—	❍
	NPR66	❍	—	❍	❍	❍	❑	—	❍
	NQR66	❍	—	❍	❍	❍	❑	—	❍
	NPR70	❍	—	❍	❍	❍	—	—	❍
	NQR70	❍	—	❍	❍	❍	—	—	❍
	NKR71	❍	—	❍	❍	❍	—	—	❍
	NQR71 with turbocharger	❍	—	❍	❍	❍	❑	—	❍
	NPS71	❍	—	❍	❍	❍	—	—	❍
	NPR71	❍	—	❍	❍	❍	—	—	❍
	NQR71 w/o turbocharger	❍	—	❍	❍	❍	—	—	❍
	NPR75	❍	—	❍	❍	❍	—	❑	❍
	NQR75	❍	—	❍	❍	❍	—	❑	❍

		X-7	X-8		X-9	X-10	X-11		X-12
		Power window	Exh. brake	Heater	Corner-ing lamp	Thermo A/C	Charge warning	Key ON	Heater & A/C
12 V	NHR55	❑	❑	—	❍	❑	❍	—	❍
	NKR55	❑	❑	—	❍	❑	❍	—	❍
	NKR69	❑	❑	—	❍	❑	❍	—	❍
	NPR71	❑	❍	—	❍	❑	❍	—	❍
	NKR77	❑	—	—	❑	❑	❍	—	❍
	NPR77	❑	—	—	❑	❑	❍	—	❍
	NKR77 for Taiwan	❑	—	—	❍	❑	❍	—	❍
24 V	NKR66	❑	❑	—	❍	❑	—	❍	❍
	NPR66	❑	❍	—	❍	❑	—	❍	❍
	NQR66	❑	❍	—	❍	❑	—	❍	❍
	NPR70	❑	❍	—	❍	❑	—	❍	❍
	NQR70	❑	❍	—	❍	❑	—	❍	❍
	NKR71	❑	❑	—	❍	❑	—	❍	❍
	NQR71 with turbocharger	❑	❍	—	❍	❑	—	❍	❍
	NPS71	❑	❍	—	❍	❑	—	❍	❍
	NPR71	❑	❍	—	❍	❑	—	❍	❍
	NQR71 w/o turbocharger	❑	❍	—	❍	❑	—	❍	❍
	NPR75	❑	—	❍	❑*	❑	—	❍	❍
	NQR75	❑	—	❍	❑*	❑	—	❍	❍

* : Except EC / Turkey

		X-13		X-14				X-15	X-16
		Heater	Buzzer cancel	ECM	PTO main	Timing	Smoother emer-gency	PTO solenoid, M/T	PTO cut
12 V	NHR55	—	—	—	—	—	—	—	—
	NKR55	—	—	—	—	—	—	—	—
	NKR69	—	—	—	—	—	—	—	—
	NPR71	—	—	—	—	—	—	—	—
	NKR77	❍	—	❍	—	—	—	—	—
	NPR77	❍	—	❍	—	—	—	—	—
	NKR77 for Taiwan	❍	—	❍	—	—	—	—	—
24 V	NKR66	—	—	—	—	—	—	—	—
	NPR66	—	❑	—	—	—	—	—	—
	NQR66	—	❑	—	—	—	—	—	—
	NPR70	—	❑	—	—	❍	—	—	—
	NQR70	—	❑	—	—	❍	—	—	—
	NKR71	—	—	—	—	—	—	—	—
	NQR71 with turbocharger	—	❑	—	—	—	—	—	—
	NPS71	—	—	—	❑	—	—	❑	❑
	NPR71	—	❑	—	—	—	—	—	—
	NQR71 w/o turbocharger	—	❑	—	—	—	—	—	—
	NPR75	—	❑	❍	—	—	❑	—	—
	NQR75	—	❑	❍	—	—	❑	—	—

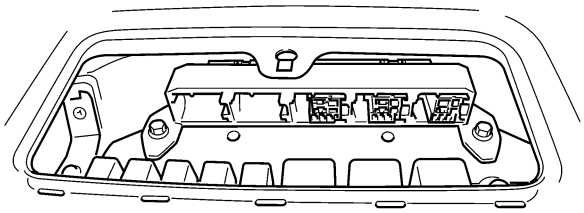
		X-18	X-19		X-20	X-21	X-22	X-23	X-24
		ECM main	Gear shifter	Glow 2	Glow plug	Starter	Marker lamp	Rear fog	A/C COMP
12 V	NHR55	—	—	—	❍	❍	—	—	—
	NKR55	—	—	—	❍	❍	—	❑	—
	NKR69	—	—	❍	❍	❍	—	—	—
	NPR71	—	—	—	❍	❍	—	—	—
	NKR77	—	—	—	❍	❍	❑ *1	❑ *1	❑
	NPR77	—	—	—	❍	❍	❑ *1	❑ *1	❑
	NKR77 for Taiwan	—	—	—	❍	❍	—	—	❑
24 V	NKR66	—	—	—	❍	❍	—	—	—
	NPR66	—	—	—	❍	❍	❑ *2	❑ *2	—
	NQR66	—	—	—	❍	❍	—	—	—
	NPR70	—	—	—	❍	❍	—	—	—
	NQR70	—	—	—	❍	❍	—	—	—
	NKR71	—	—	—	❍	❍	—	—	—
	NQR71 with turbocharger	—	—	—	❍	❍	❑ *2	❑ *2	—
	NPS71	—	—	—	❍	❍	—	—	—
	NPR71	—	—	—	❍	❍	—	—	—
	NQR71 w/o turbocharger	—	—	—	❍	❍	—	—	—
	NPR75	❍	❑	—	❍	❍	❑ *3	❑ *3	—
	NQR75	❍	❑	—	❍	❍	❑ *3	❑ *3	—

*1 : For EC
*2 : For Turkey
*3 : For EC / Turkey

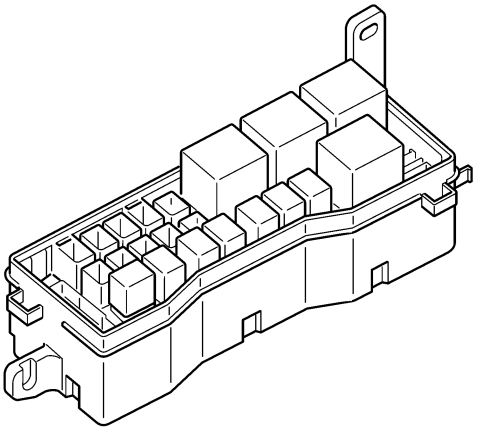
		X-24	X-25	X-26			X-27	X-28
		4WD ind. lamp	Exh. brake control	CSD	A/C ON SIGNAL	Starter cut	Con-denser fan	Exh. brake cut
12V	NHR55	—	❑	❍	—	—	—	—
	NKR55	—	❑	❍	—	—	—	—
	NKR69	—	❑	—	—	—	—	—
	NPR71	—	❍	—	—	—	—	—
	NKR77	—	—	—	❑	—	—	—
	NPR77	—	—	—	❑	—	—	—
	NKR77 for Taiwan	—	—	—	❑	—	❑	—
24V	NKR66	—	❑	—	—	—	—	—
	NPR66	—	❍	—	—	—	—	❑
	NQR66	—	❍	—	—	—	—	❑
	NPR70	—	❍	—	—	—	❑	—
	NQR70	—	❍	—	—	—	❑	—
	NKR71	—	❑	—	—	—	—	—
	NQR71 with turbocharger	—	❍	—	—	—	—	❑
	NPS71	❍	❍	—	—	—	—	—
	NPR71	—	❍	—	—	—	—	❑
	NQR71 w/o turbocharger	—	❍	—	—	—	—	—
	NPR75	—	—	—	—	❍	❍	—
	NQR75	—	—	—	—	❍	❍	—

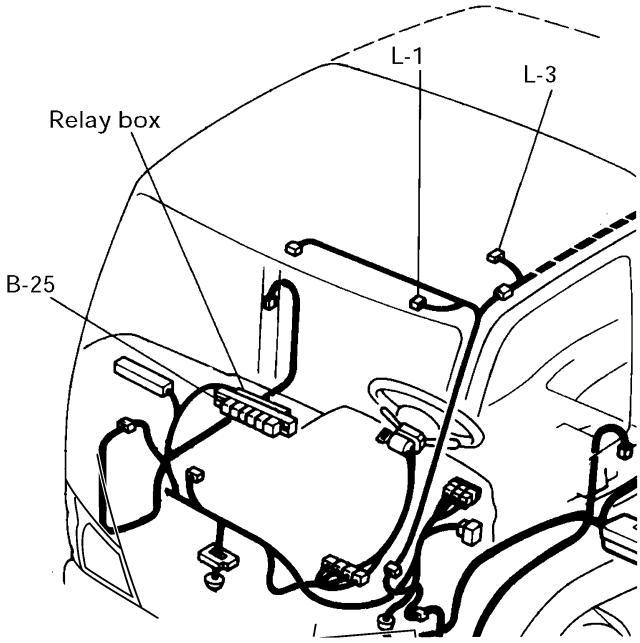
Diode Location

Relay box
(Installed on the instrument panel)



Relay box
(Installed on the cab left side rear)





N8A0055E

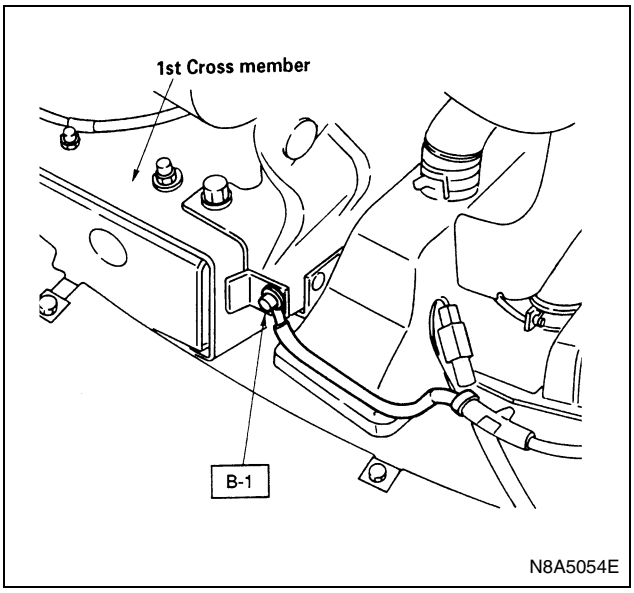
Connector No.	B-17	B-18	B-25	J-23	L-1	L-3
Usage	A/C Door switch	Lighting	QOS-III (Except GCC and Taiwan)	VSV: FICD (Except GCC and Taiwan)	Dome light	Dome light (Except Taiwan)

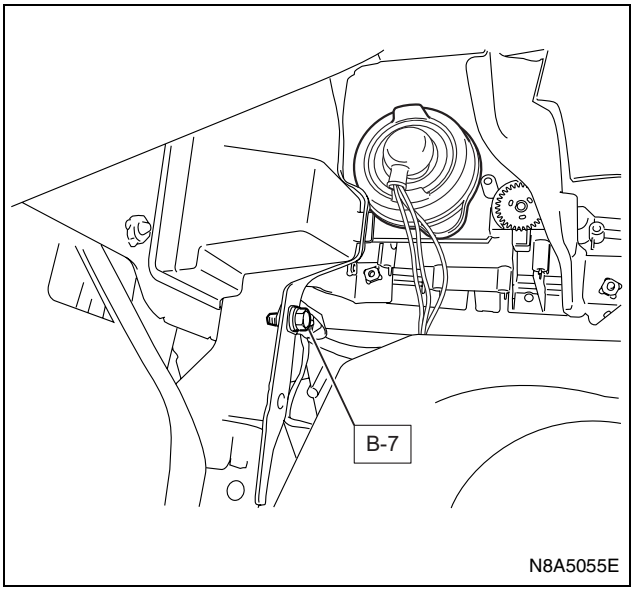
Reference Table of Grounding Point

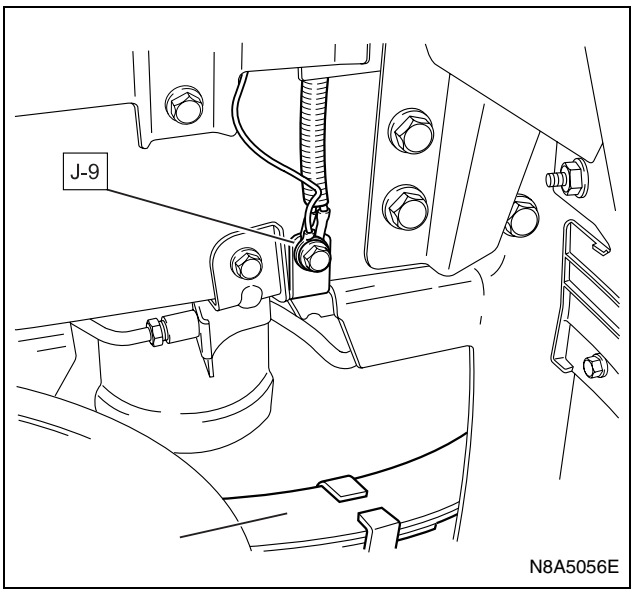
Notice:
Abnormal phenomena of electrical components are considered resulted from defective grounding.
In repair, be sure to inspect grounding points and to tighten all fastening parts surrounding the grounding points.

Connector No.	Cable harness name	Location	Main parts (Load)
B-1	Body harness	Frame-LH (FRT)	Vehicle speed sensor, QOS-III control unit, Turn signal indicator light, Meter, High beam indicator light, PTO lever, TCM
B-7		Headlight bracket-LH	Charge relay, Exhaust brake relay, QOS-II control unit, QOS-III control unit, Dome light switch, Key remind and back up buzzer, Meter, Brake fluid switch, Tail relay, Cornering light switch, Cornering light, Cornering light relay, Fog light switch, Fog light, Dimmer relay, Door lock switch, Door lock relay, Power window switch (RH), Power window relay, Stoplight switch, Mirror switch, Wiper motor, Washer motor intermittent relay, Radio, Cigar lighter, Heater & A/C relay, Fan switch, Horn relay, Rear heater switch, Rear heater, Radio & clock, Cigar lighter, Fan switch, Blower resistor, A/C switch, Blower motor, Electronic thermostat, Accel switch, Door lock switch, Door lock controller, Headlight leveling switch, Headlight leveling motor, Power window relay, Power window switch, QOS-III control unit, Ceramic heater relay, Emergency relay, Select switch, Emergency adjust switch, PTO-Smoother switch
J-9	Frame front harness	Frame-LH (CTR)	Marker light relay, Marker light, Water sedimenter switch, Fuel tank unit, Starter relay, Neutral switch, Fuel heater, Pressure switch, A/C thermo relay, VSV: FICD, Exhaust brake control relay, Exhaust brake magnetic valve, Accel switch, Clutch switch, VSV: intake throttle, Engine stop motor, ECM, ECM main relay, Starter cut relay, Shift 1,3,5 solenoid, Shift 2,4,R solenoid, Select solenoid License plate light, Taillight, Rear fog light, Rear turn signal light, Stoplight, Stoplight switch, Backup light

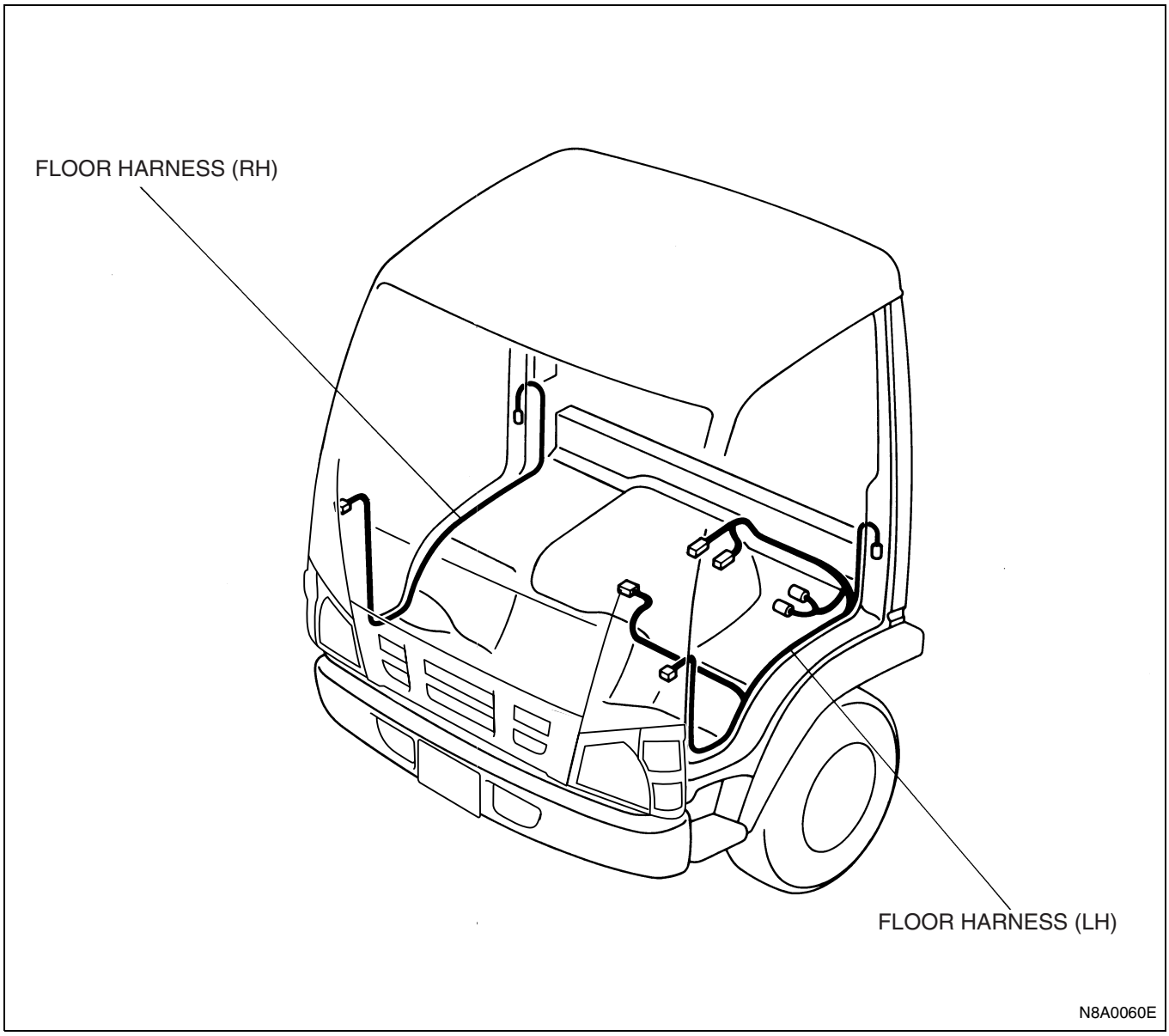
Grounding Point Location

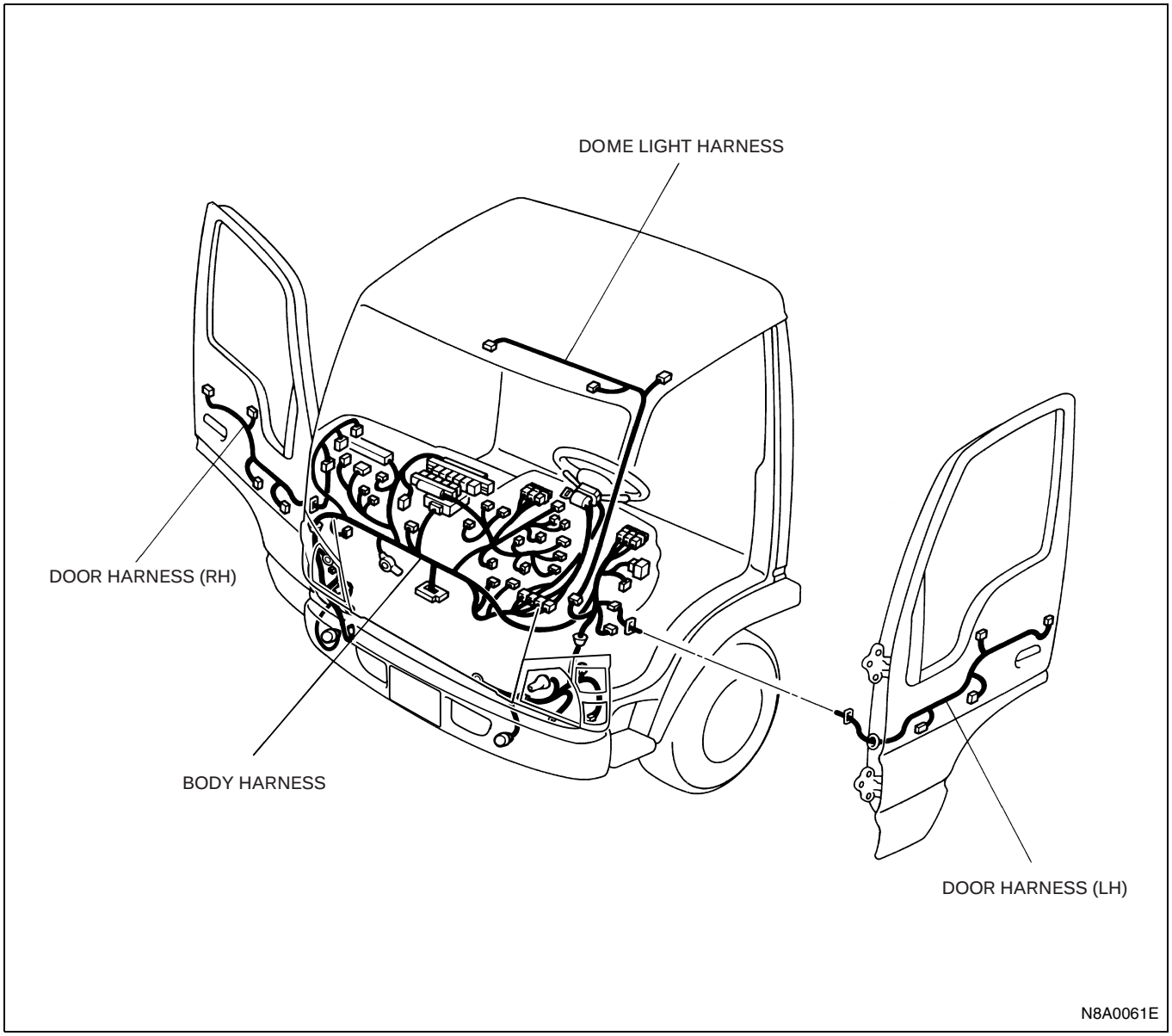




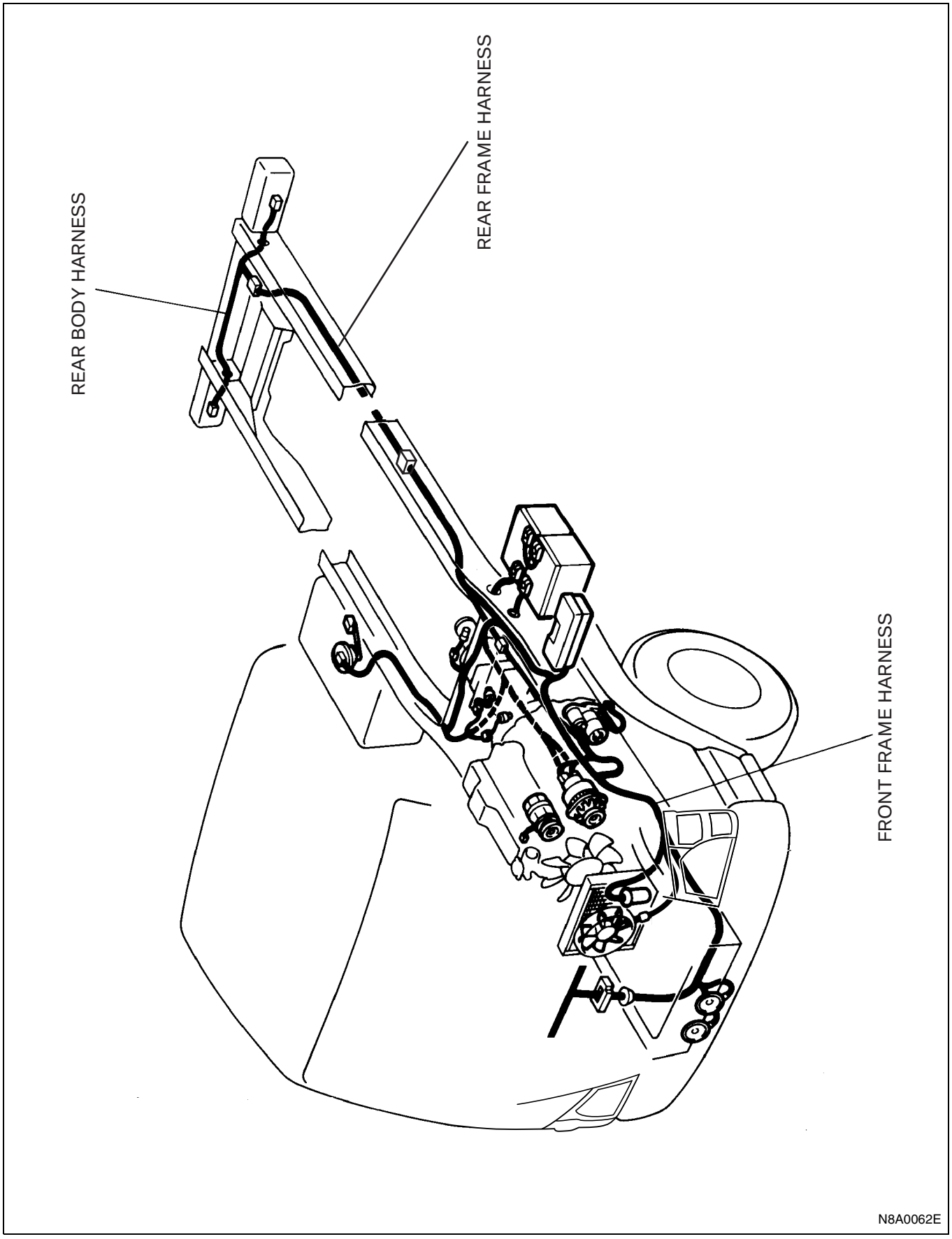


Cable Harness Routing

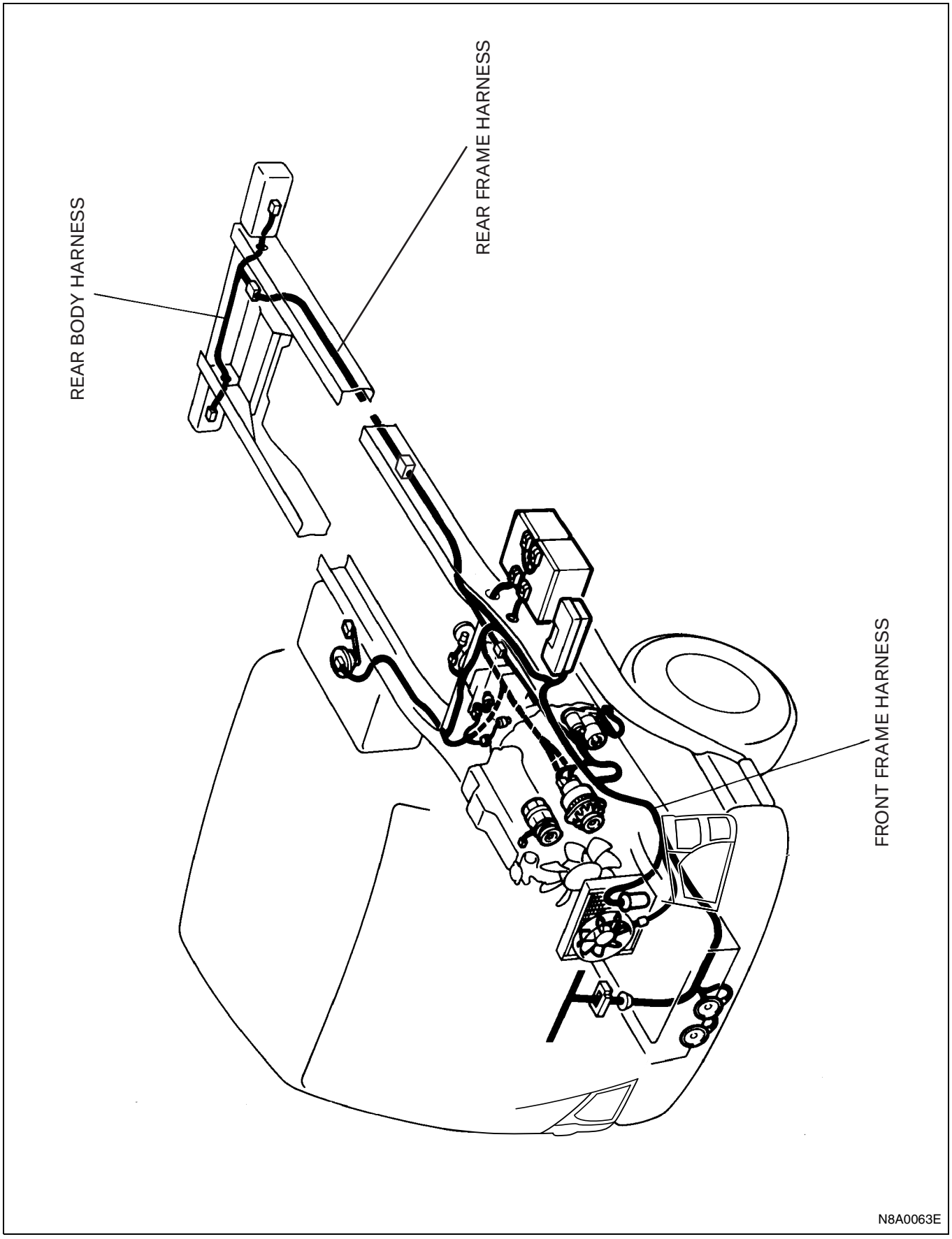



DOME LIGHT HARNESS
DOOR HARNESS (RH)
BODY HARNESS
DOOR HARNESS (LH)
N8A0061E

For Taiwan


REAR BODY HARNESS
REAR FRAME HARNESS
FRONT FRAME HARNESS
N8A0062E

For GCC


REAR BODY HARNESS
REAR FRAME HARNESS
FRONT FRAME HARNESS
N8A0063E

SYSTEM REPAIR

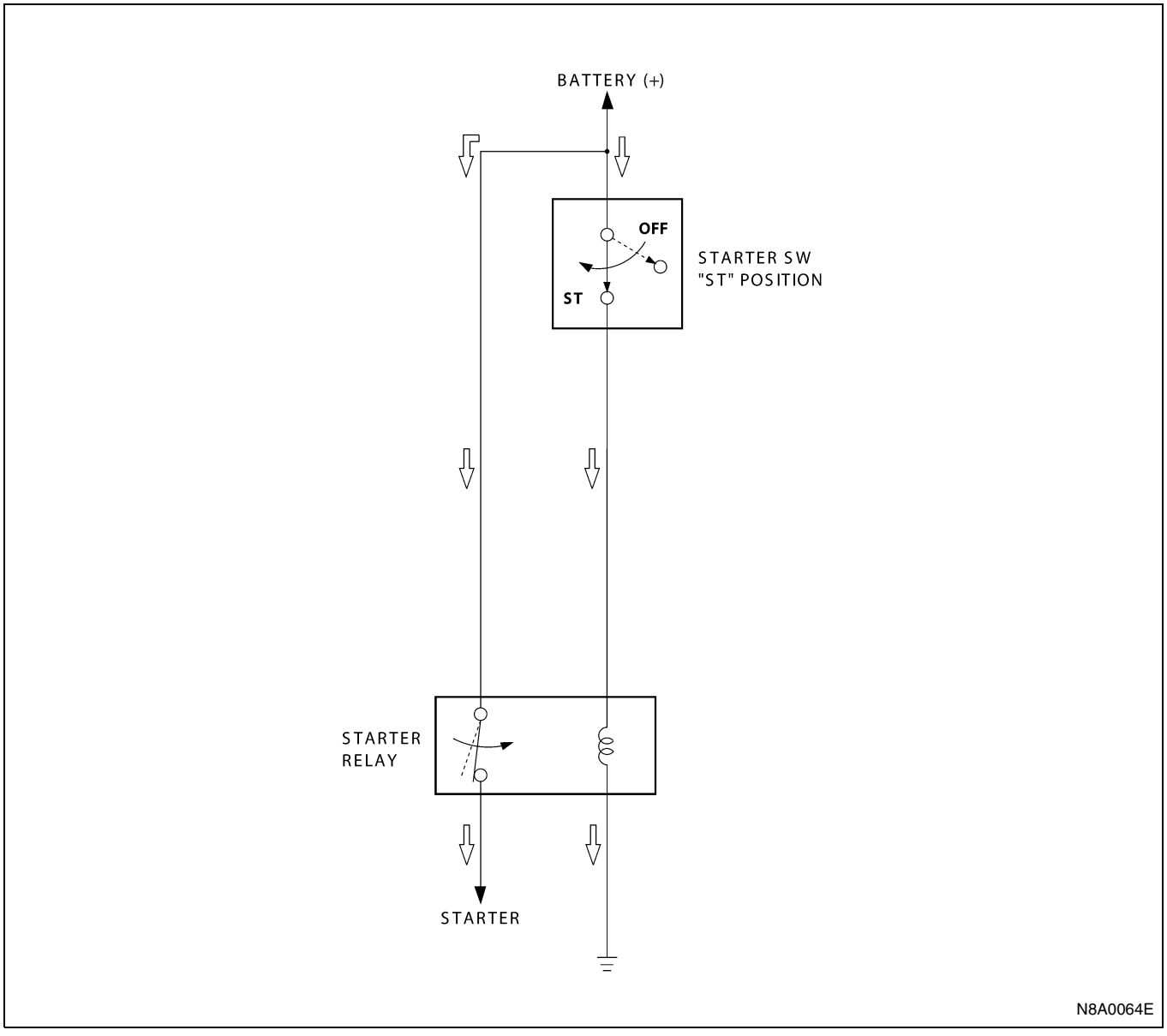
Start and Charging

General Description

The system consists of the starter switch, starter, AC generator, starter relay, charge relay and heater and A/C relay. When the starter SW is set to the “ST” position, the battery voltage is applied to the starter solenoid coil through the starter relay to start the starter.

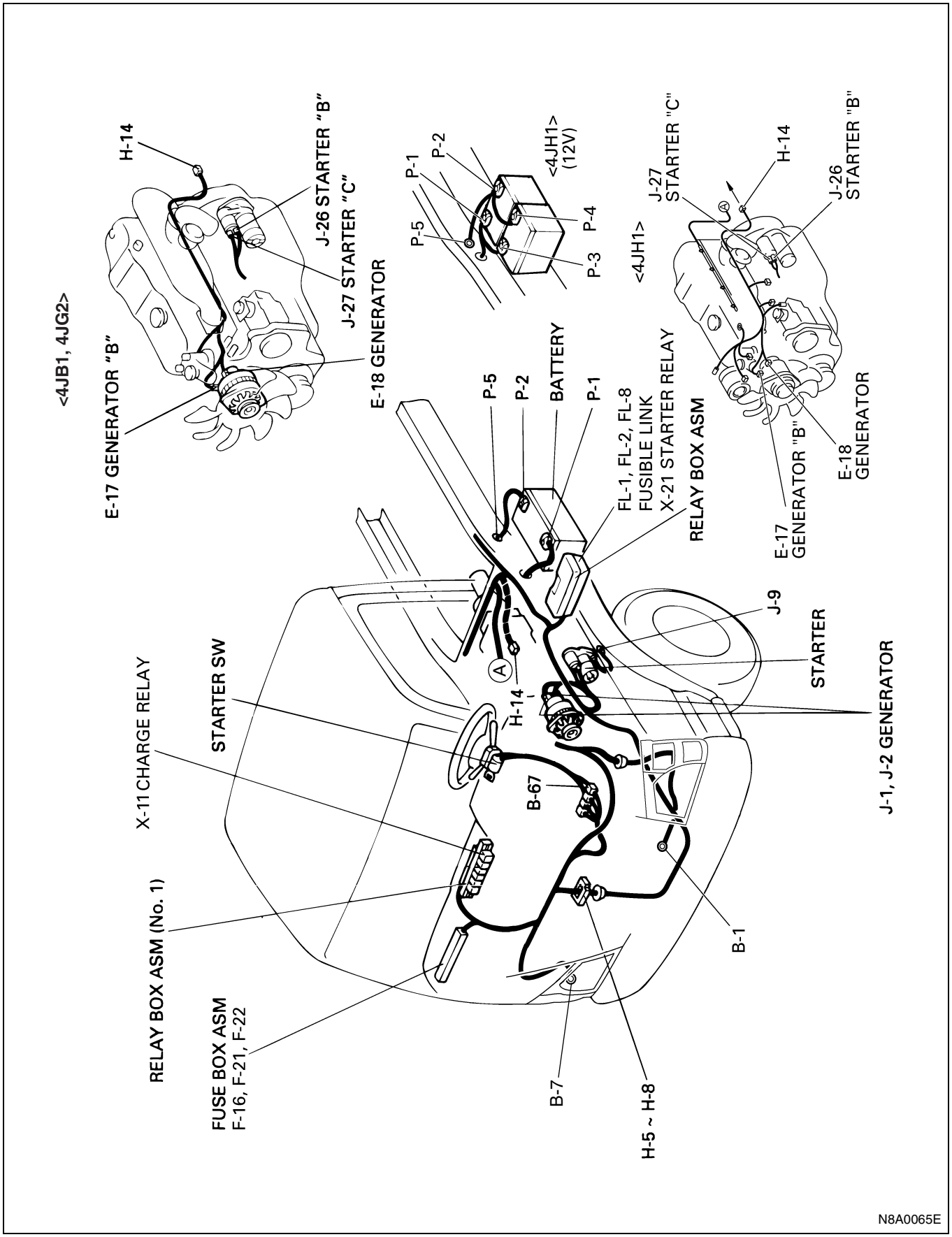
- On the 4HK1 engine, the function that ECM controls STARTER RELAY is added.

Starting Circuit

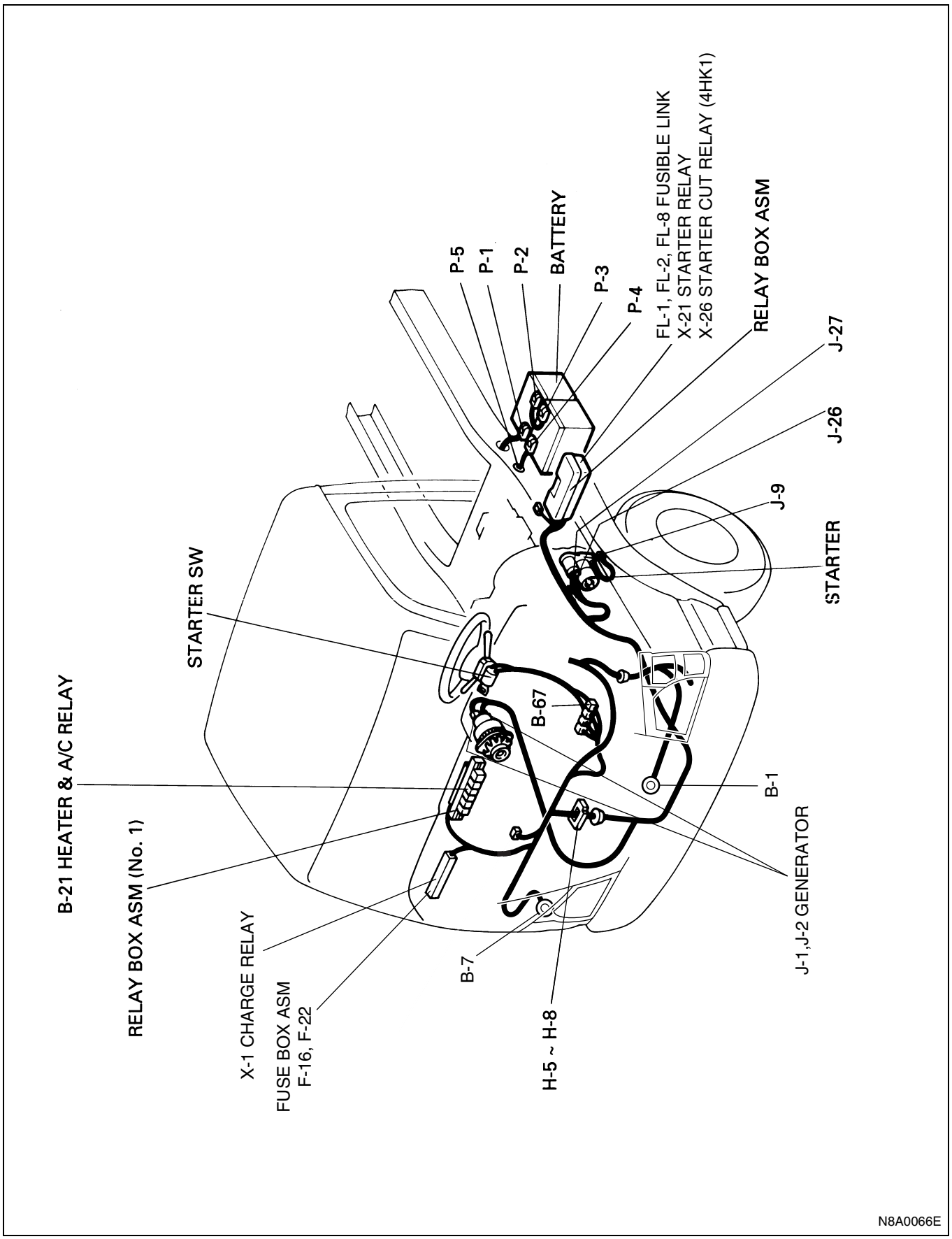


Parts Location

For 12 Volt

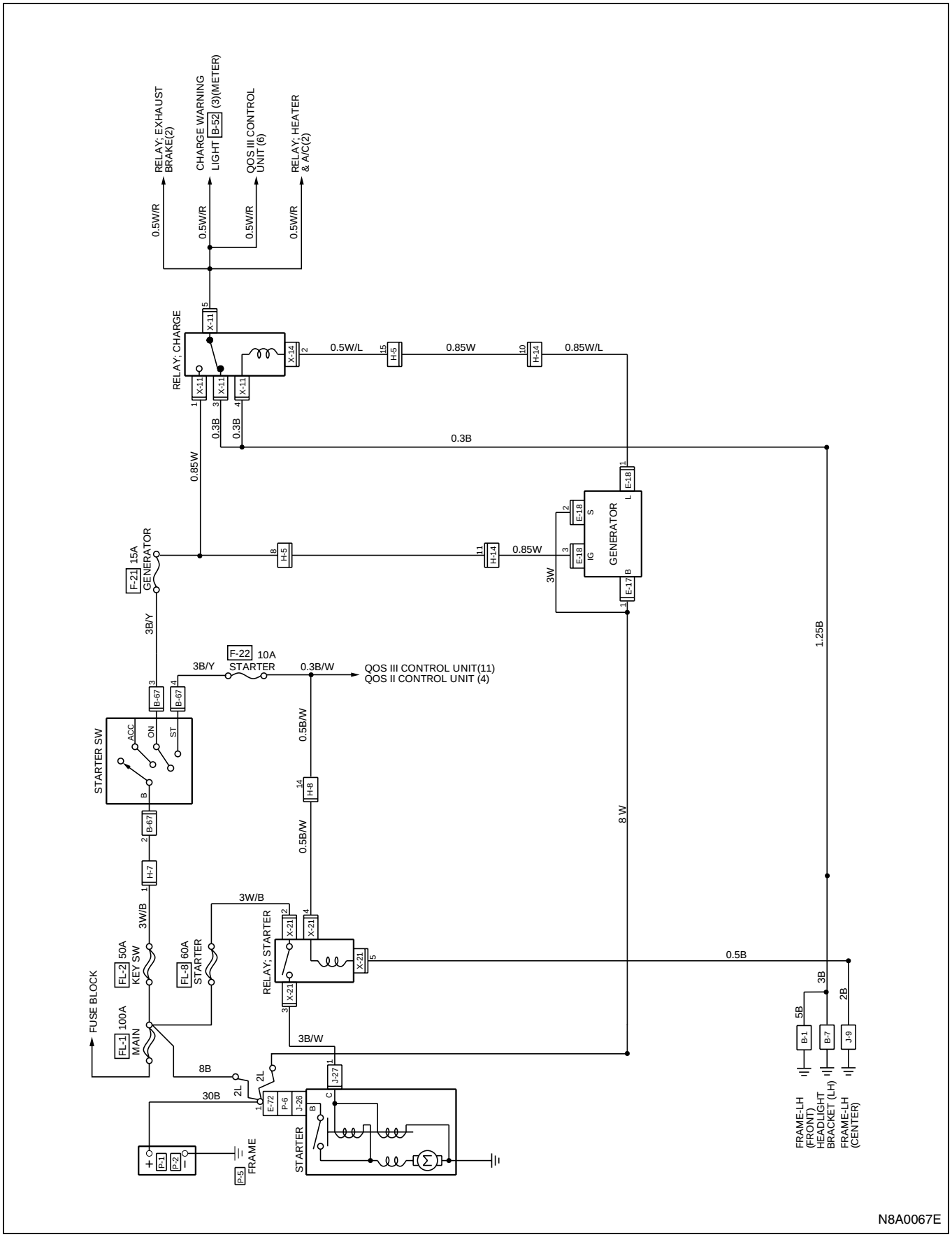


For 24 Volt

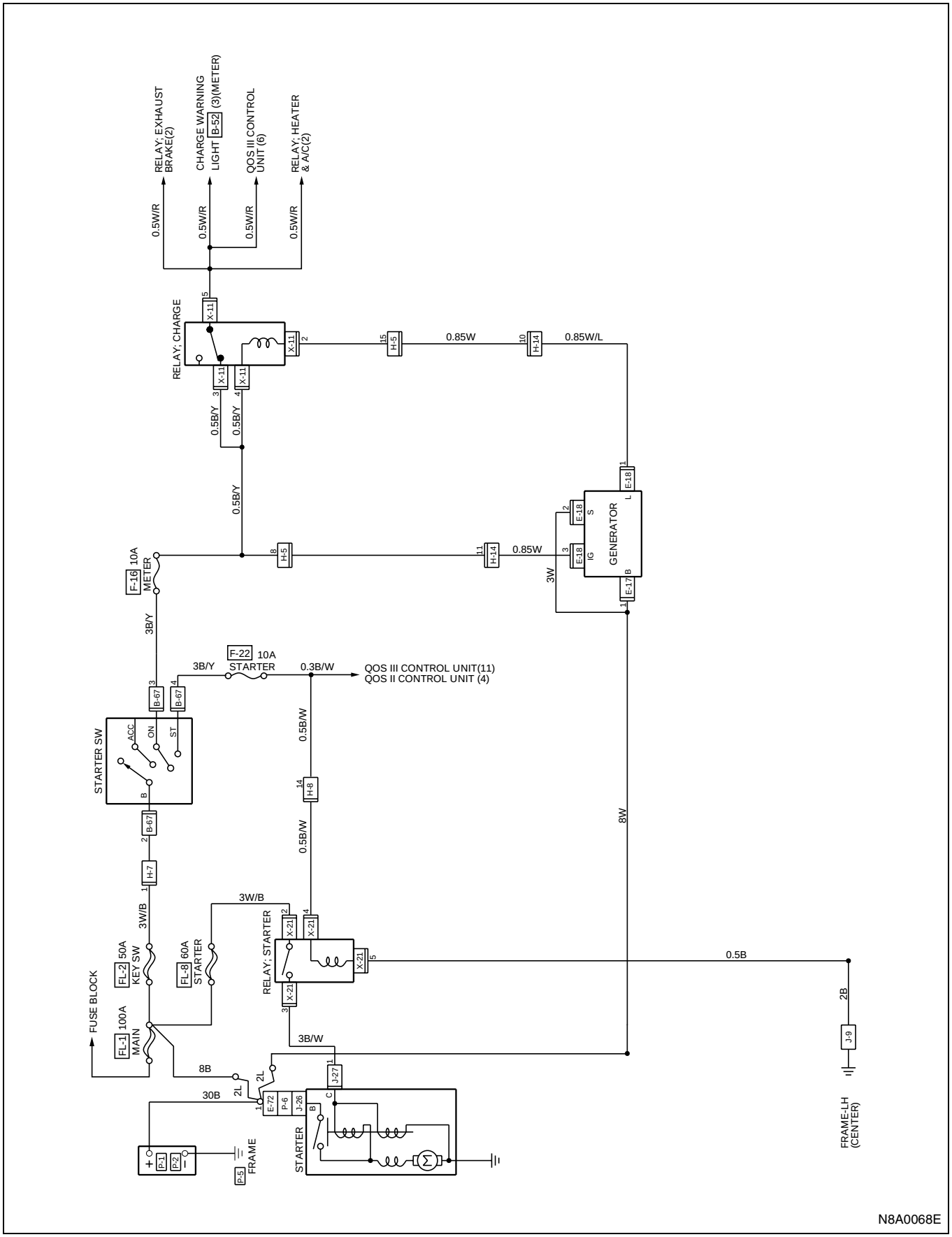

B-21 HEATER & A/C RELAY
RELAY BOX ASM (No. 1)
X-1 CHARGE RELAY
FUSE BOX ASM
F-16, F-22
STARTER SW
B-7
H-5 ~ H-8
B-67
P-5
P-1
P-2
BATTERY
P-3
P-4
FL-1, FL-2, FL-8 FUSIBLE LINK
X-21 STARTER RELAY
X-26 STARTER CUT RELAY (4HK1)
RELAY BOX ASM
J-9
STARTER
J-26
J-27
B-1
J-1,J-2 GENERATOR
N8A0066E

Circuit Diagram

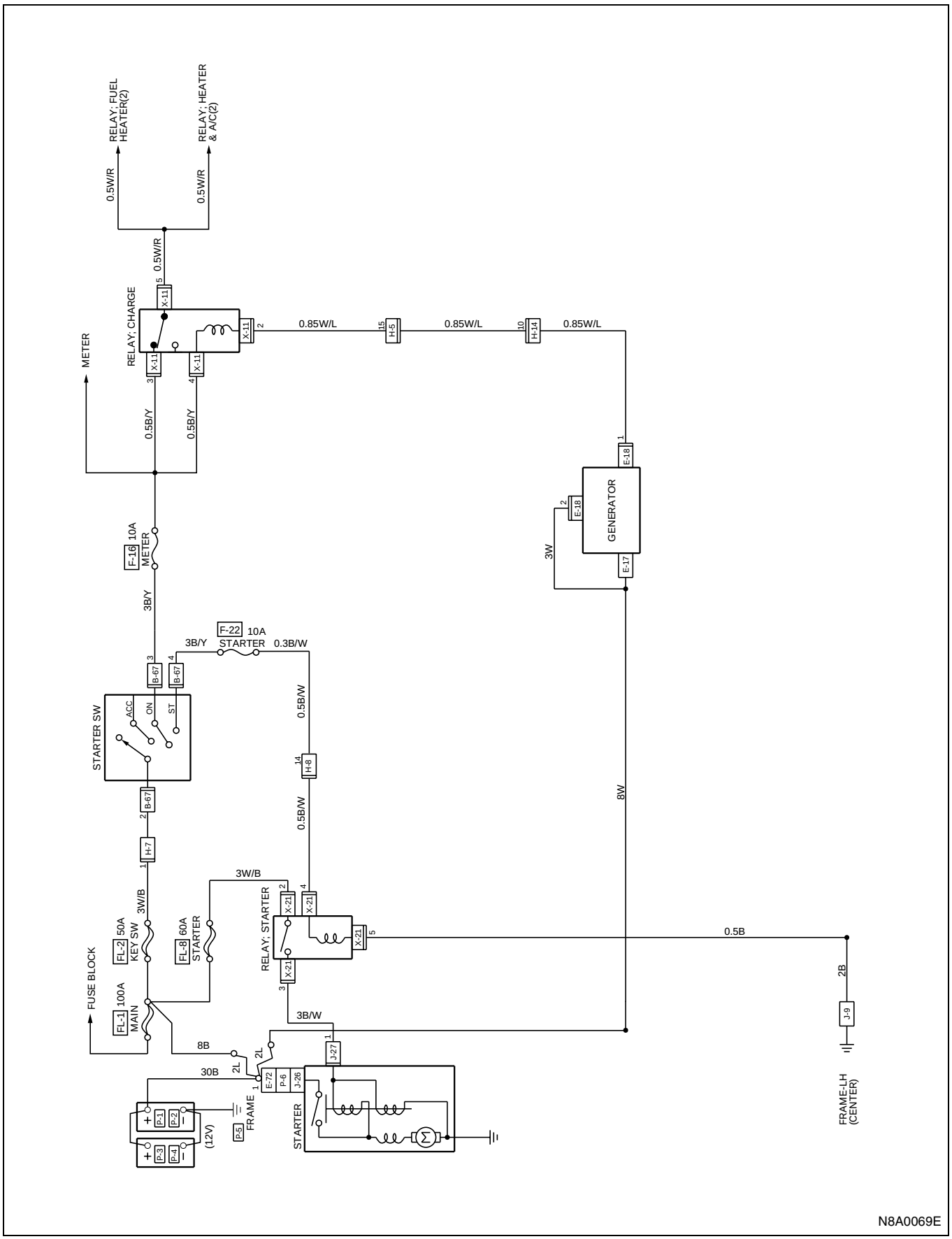
For 4JB1, 4JB1-TC, 4JG2 Engine & 12 Volt



For 4HG1-T Engine & 12 Volt

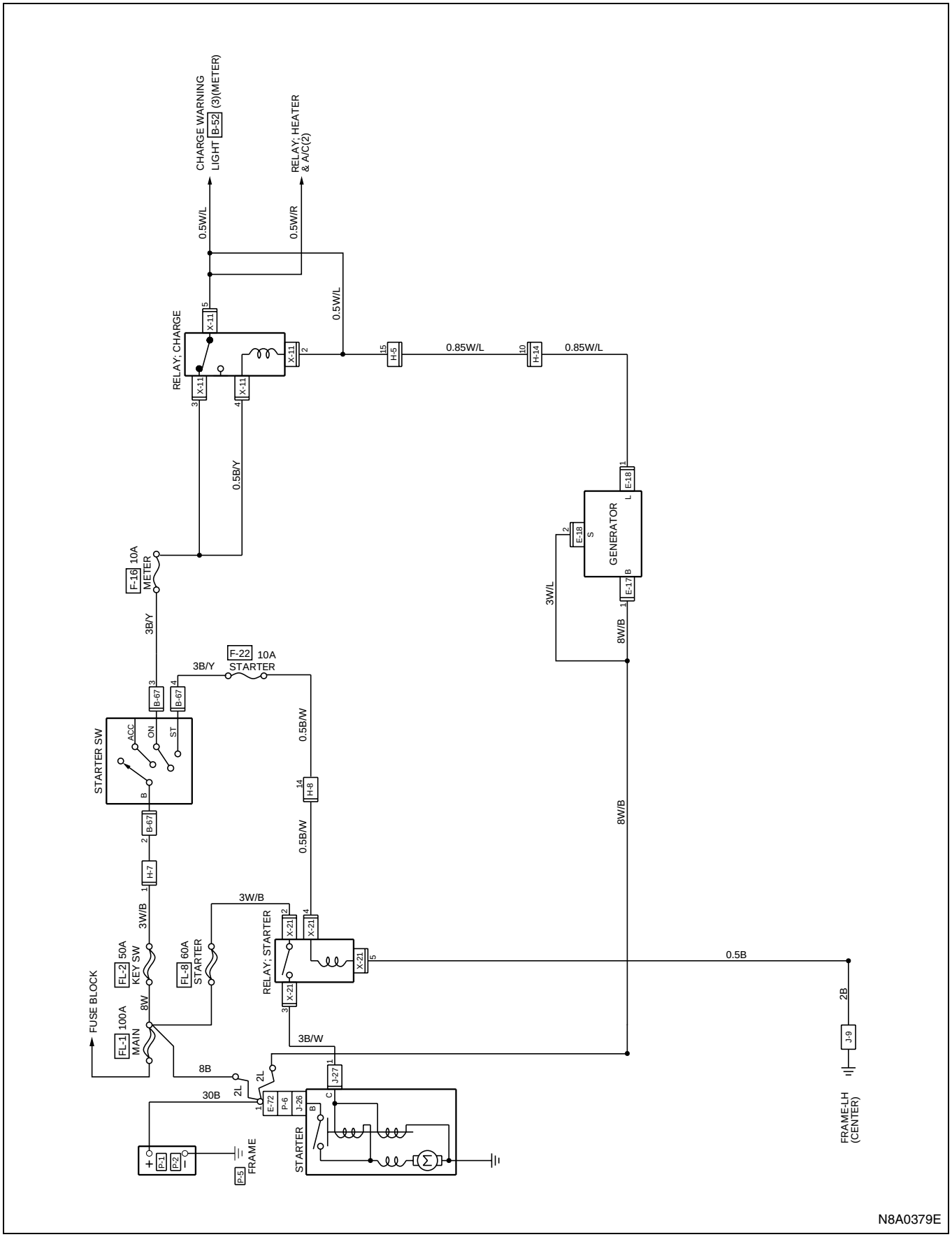


For 4JH1 Engine & 12 Volt



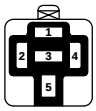
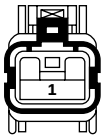
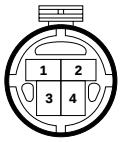
N8A0069E

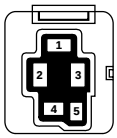
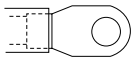
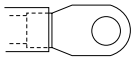
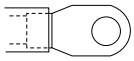
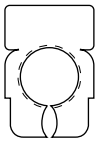
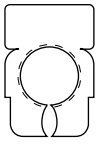
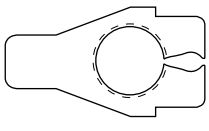
For 4JH1 Engine, NKR77 for Taiwan

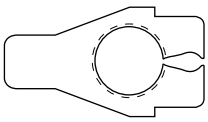


Connector List

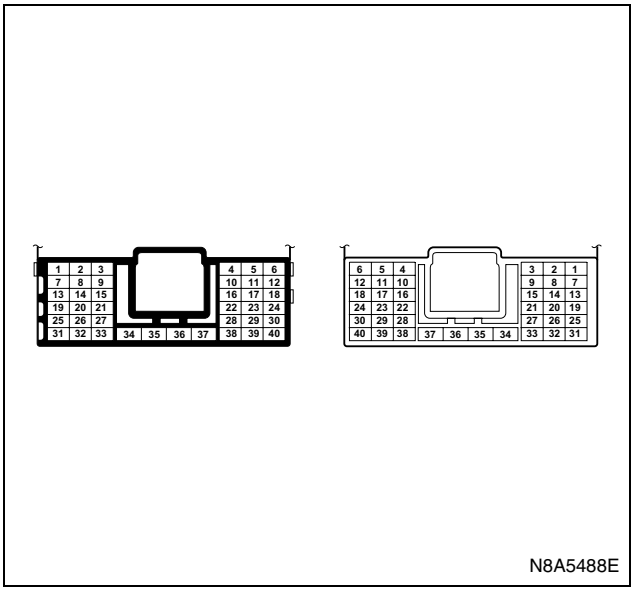
For 12 Volt

No.	Connector Face
X-11	 005-001
B-67	004-001
B-67	004-002
E-17	 001-001
E-18	 004-003
E-18 (4JH1)	002-003
H-14	016-001
H-14	016-002

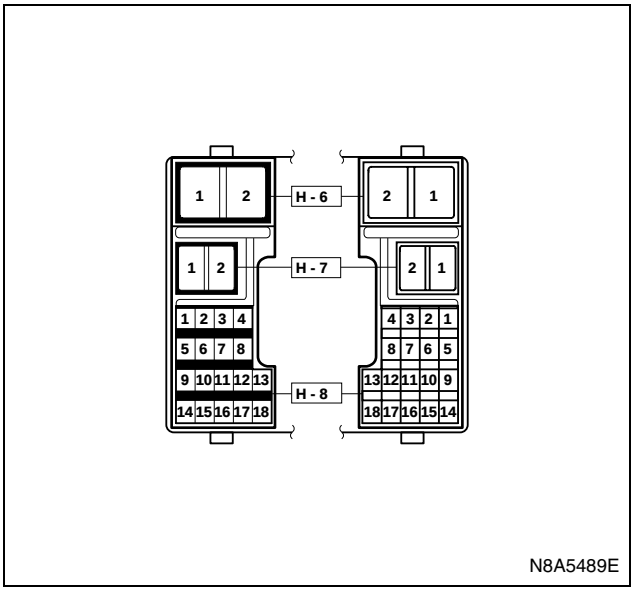
No.	Connector Face
X-21	 005-003
E-17 (4JH1)	 000-002
J-26	 000-002
P-6	 000-002
J-27	001-002
P-1	 000-004
P-4	 000-004
P-2	 000-006

No.	Connector Face
P-3 (4JH1)	 000-006
P-5	000-007

H-5

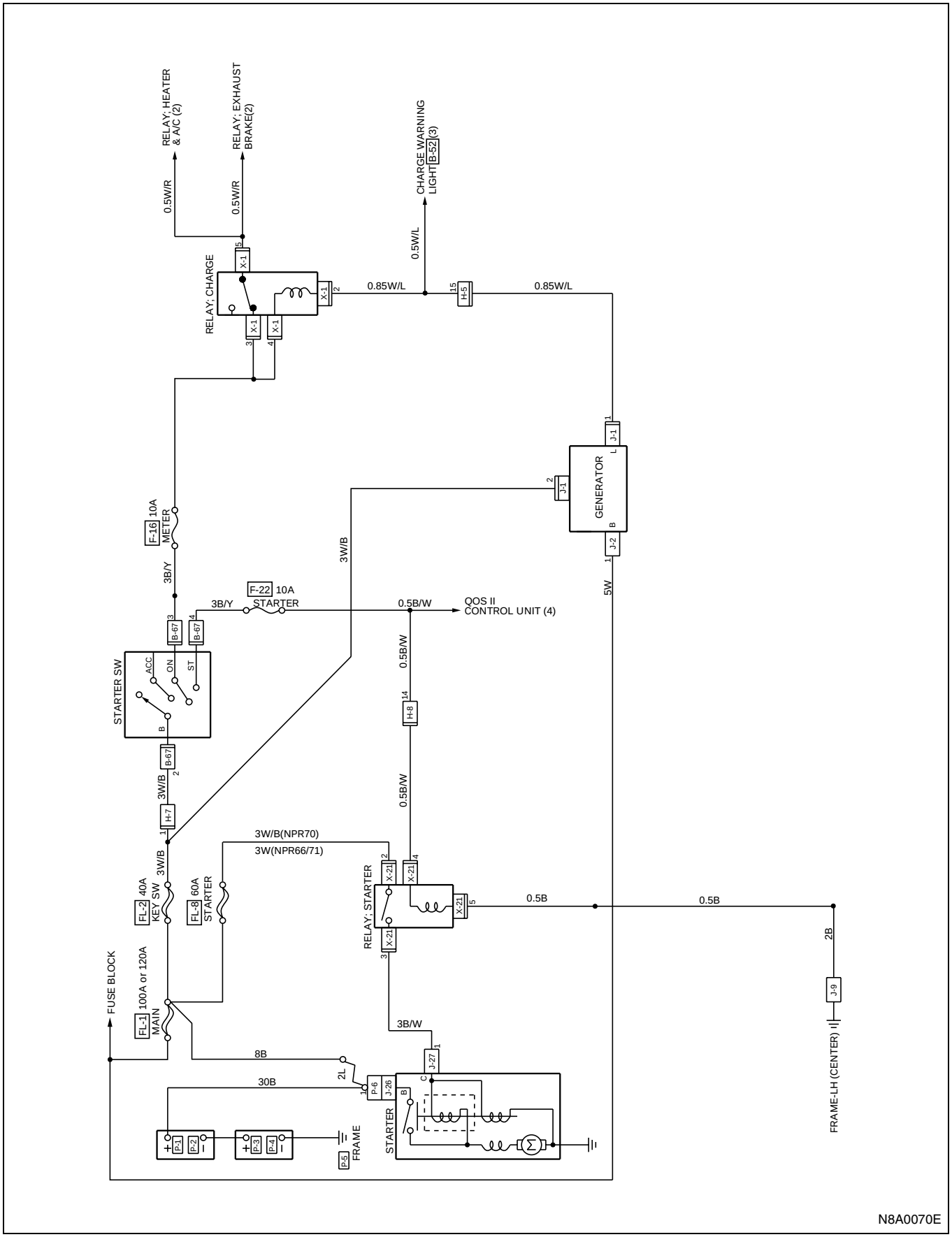


H-6, H-7, H-8

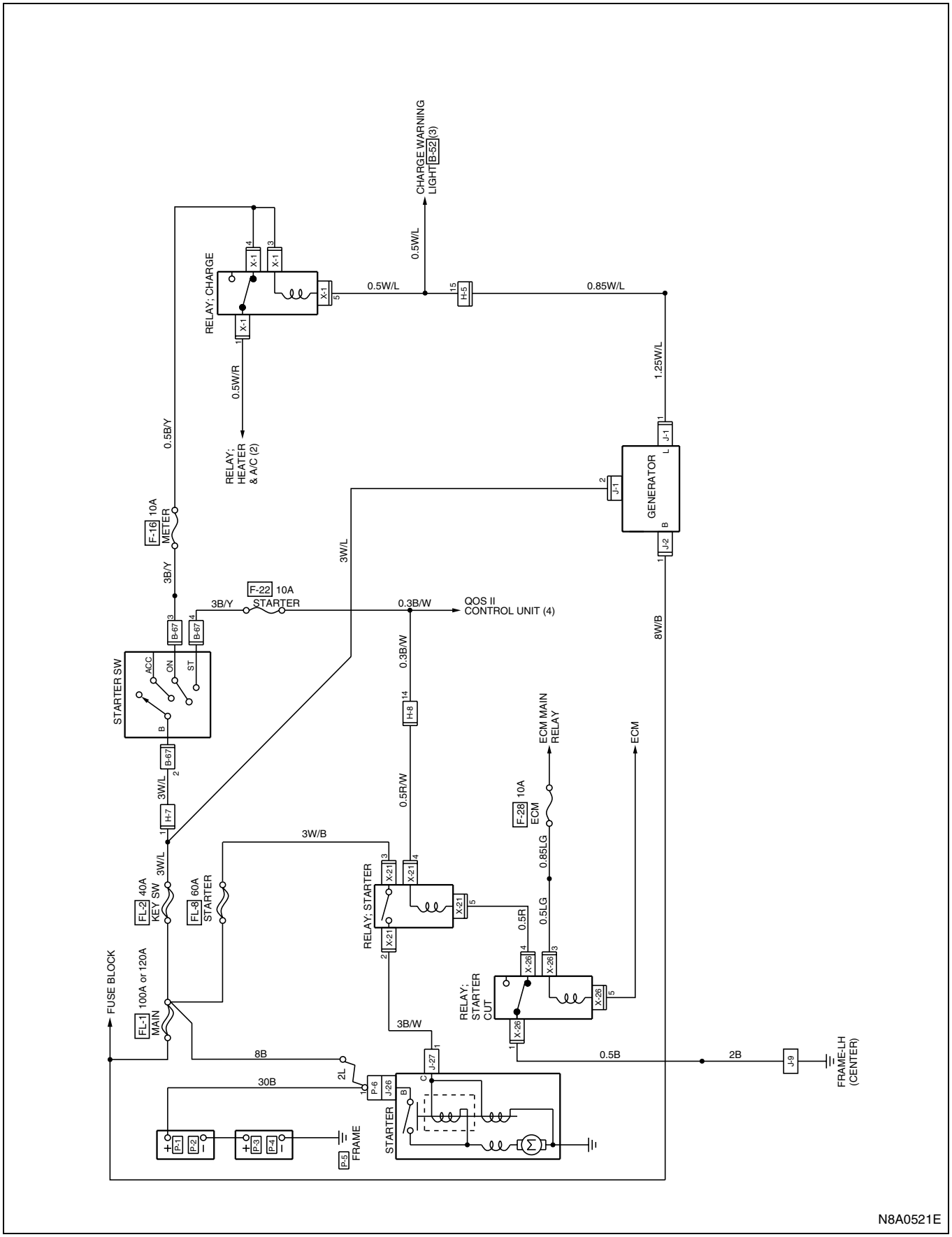


Circuit Diagram

4H Type Engine & 24 Volt (Except 4HK1 Engine)

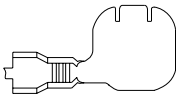
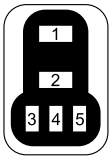
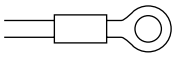
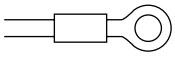
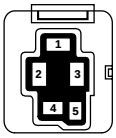


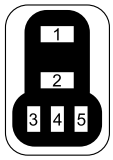
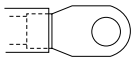
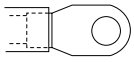
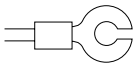
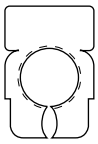
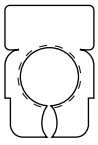
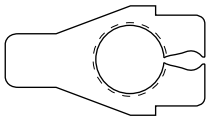
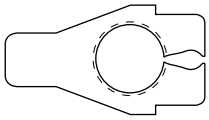
4HK1 Engine

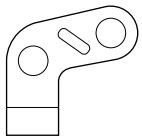

CHARGE WARNING LIGHT B-52 (3)
0.5W/L
RELAY; CHARGE
X-1 4
X-1 3
X-1 5
0.5W/L
I5
H-5
0.85W/L
X-1 1
0.5W/R
1.25W/L
RELAY; HEATER & A/C (2)
0.5B/Y
J-1 1
L
GENERATOR
B
J-1 2
J-2 1
F-16 10A METER
3W/L
3B/Y
F-22 10A STARTER
3B/Y
0.3B/W
QOS II CONTROL UNIT (4)
B-67 3
B-67 4
0.3B/W
8W/B
STARTER SW
ACC
ON
ST
B
B-67 2
H-8 14
ECM MAIN RELAY
ECM
3W/L
H-7 1
0.5R/W
F-28 10A ECM
3W/B
0.85LG
3W/L
FL-2 40A KEY SW
FL-8 60A STARTER
RELAY; STARTER
X-21 3
X-21 4
X-21 5
X-21 2
0.5R
0.5LG
X-26 4
X-26 3
X-26 5
RELAY; STARTER CUT
X-26 1
FUSE BLOCK
FL-1 100A or 120A MAIN
3B/W
8B
J-27 1
0.5B
2B
J-9
FRAME-LH (CENTER)
2L
30B
P-6
J-26
C
B
STARTER
P-1
P-2
P-3
P-4
P-5
FRAME
N8A0521E

Connector List

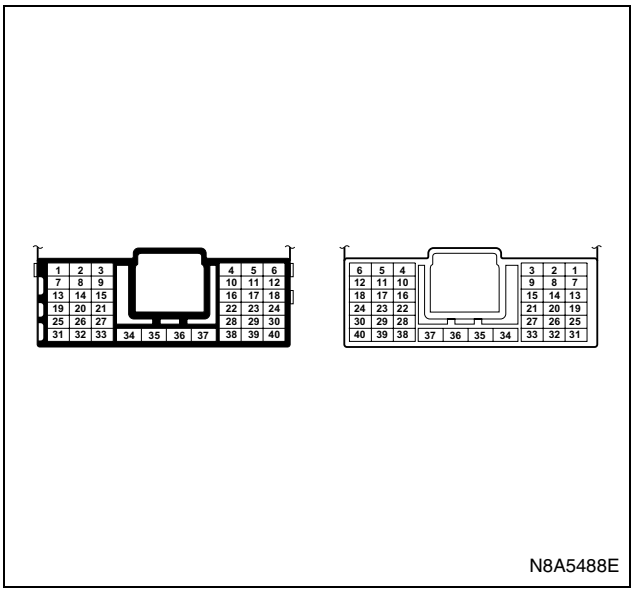
For 24 Volt

No.	Connector Face
B-7	 000-012
X-1	 005-006
B-67	004-001
B-67	004-002
J-1	002-003
J-2	 000-001
J-9	 000-001
X-21	 005-003

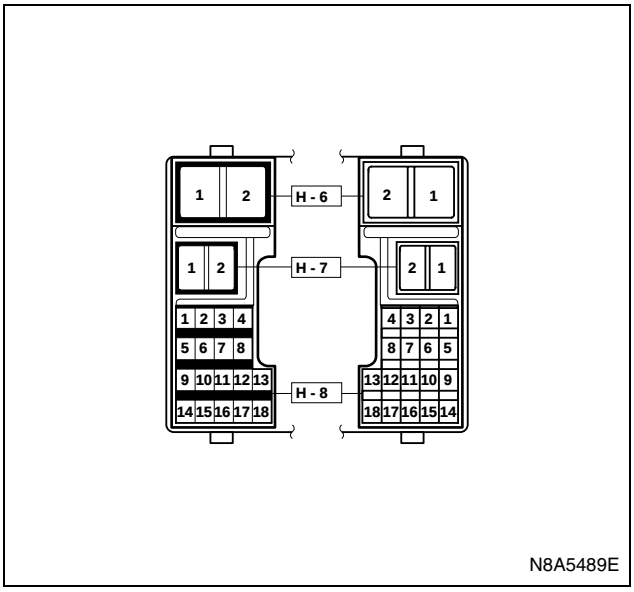
No.	Connector Face
X-26 (N*R 75)	 005-006
J-26	 000-002
P-5	 000-002
J-27	 000-009
P-1	 000-004
P-4	 000-004
P-2	 000-006
P-3	 000-006

No.	Connector Face
P-6 (N*R 66)	 000-008

H-5

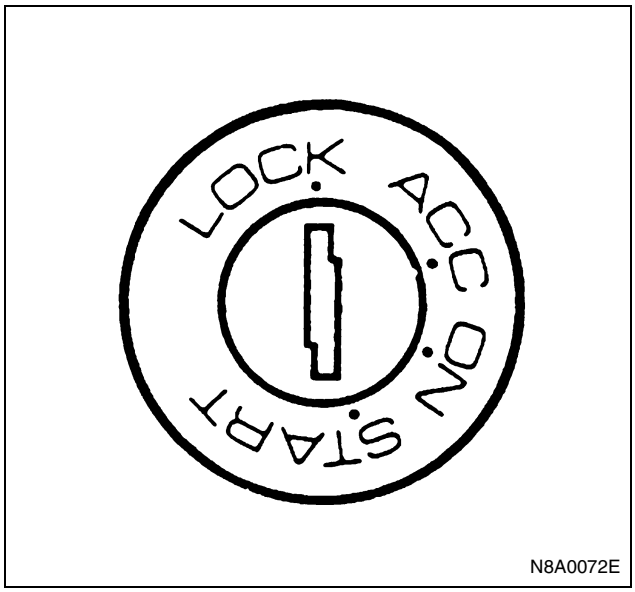


H-6, H-7, H-8



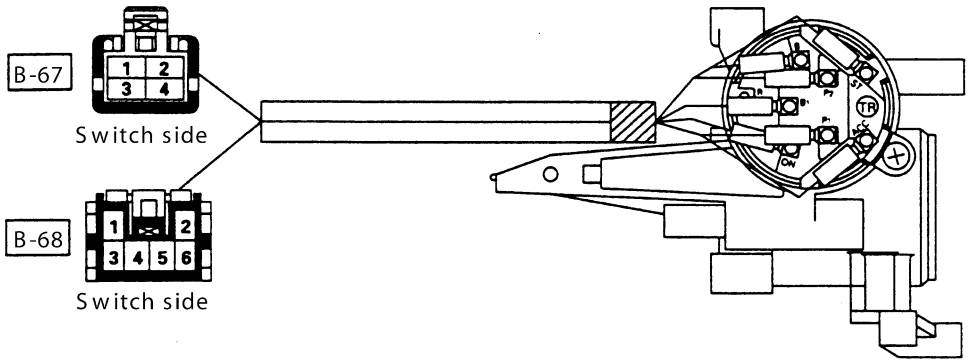
Starter Switch

The starter switch positions are LOCK, ACC, ON and START. Turning the starter key to these positions a circuit for starting the engine, the operation of accessories, or stop the engine.



Inspection

Check the continuity between the starter switch connector terminals.
Repair or replace the switch when the result of inspection is found abnormal.



Starter SW key position	Terminal No. / Connector No.	B-67 1	B-67 2	B-67 3	B-67 4	B-68 1	B-68 2	B-68 4	B-68 5	B-68 6
		ACC	B	ON	ST	B1	P1	P2	W	W
Removed	LOCK					○—○				
Inserted	ACC	○—○				○—○			○—○	
	ON	○—○—○				○———○				
	START		○—○—○			○———○				

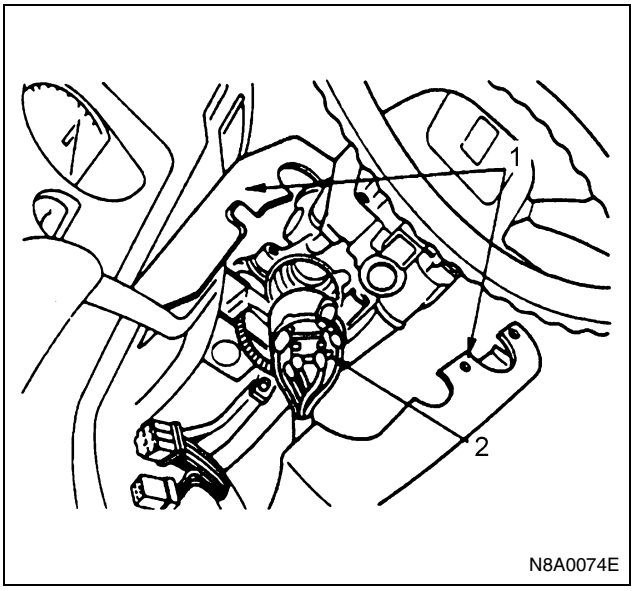
N8A0073E

Removal

Preparation:

Disconnect the battery ground cable.

1. Steering Cowl
   Remove four screws and take off the steering cowl.
2. Starter Switch
   1) Disconnect the connector.
   2) Remove the screw.



N8A0074E

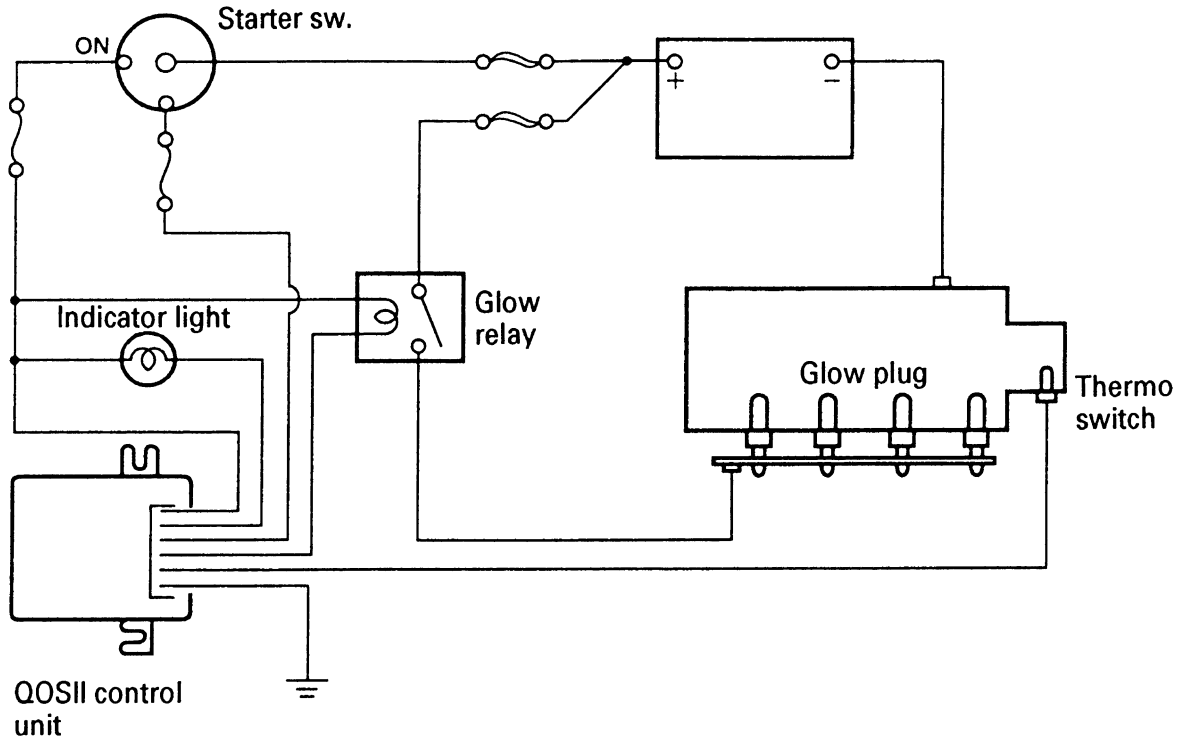
QOS (Quick On Start) II System (4HF1 and 4JB1 Engine Model)

General Description

The circuit consists of starter switch, QOSII control unit, glow relay, thermo switch, glow plug, fuel cut solenoid, CSD relay, CSD solenoid and glow indicator light.
The QOS-II controller controls glow plug relay by the ON or OFF signal of QOS thermo switch.
Immediately when the starter switch turns “ON”, the glow plug relay indicator light turns on to start preheating.
The engine should be started after the indicator light is off. However, the glow plug relay keeps preheating for a fixed period even after the indicator light turns off. When the fixed time is over, QOS-II controller performs to switch the glow plug relay off to stop preheating.
For details, refer to “PREHEATING SYSTEM”.

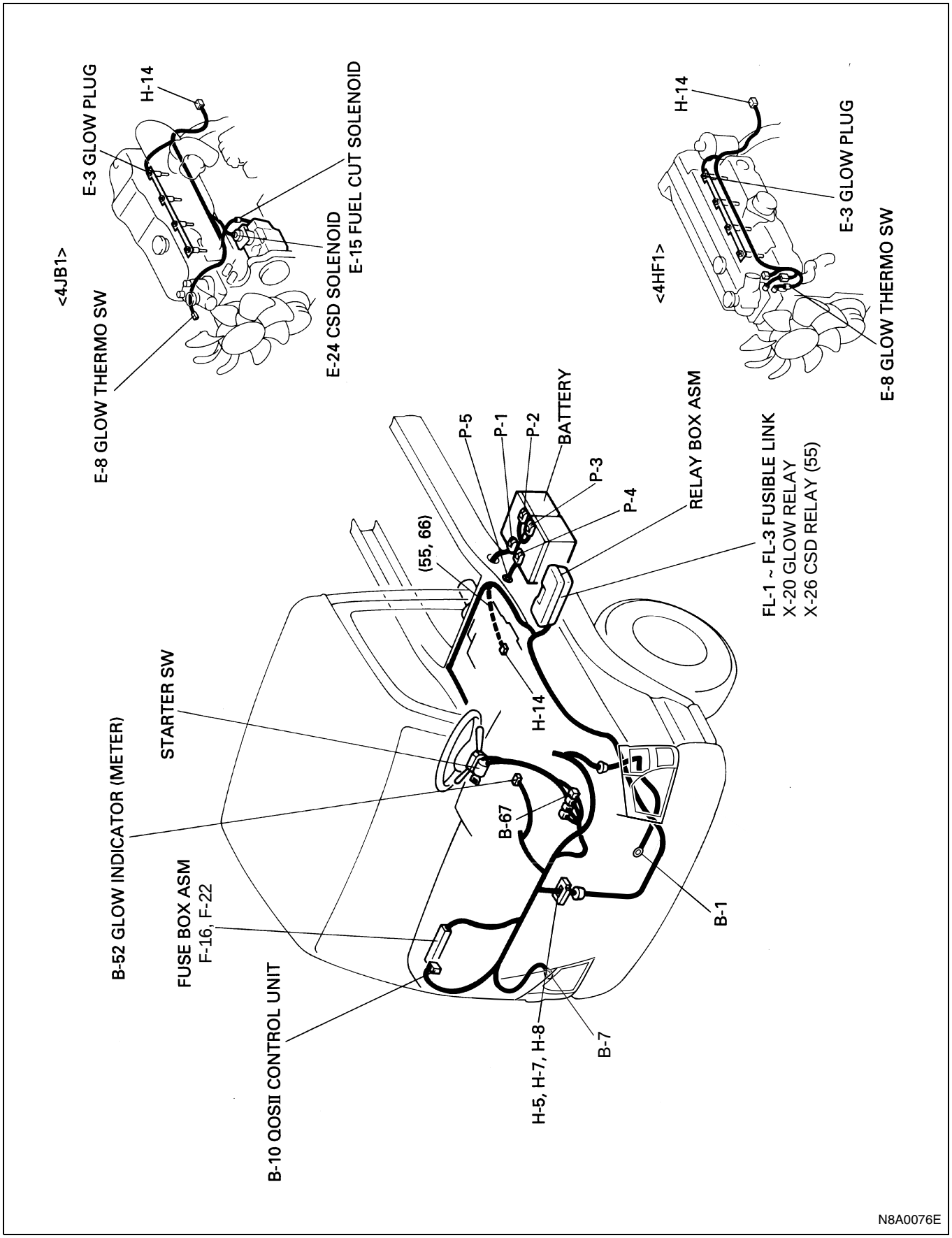
System Circuit

This illustration is based on N*R 66·55.



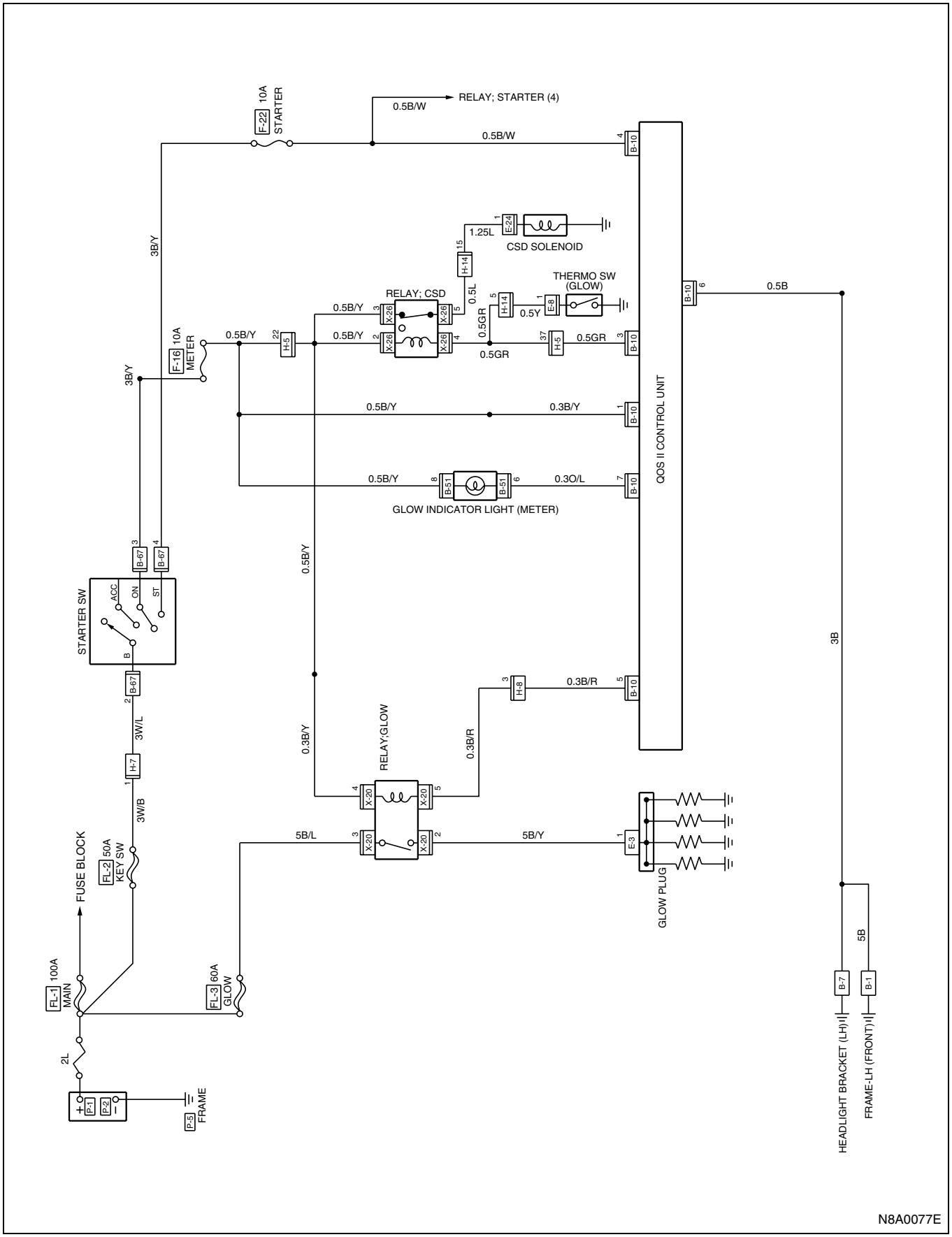
N8A0075E

Parts Location

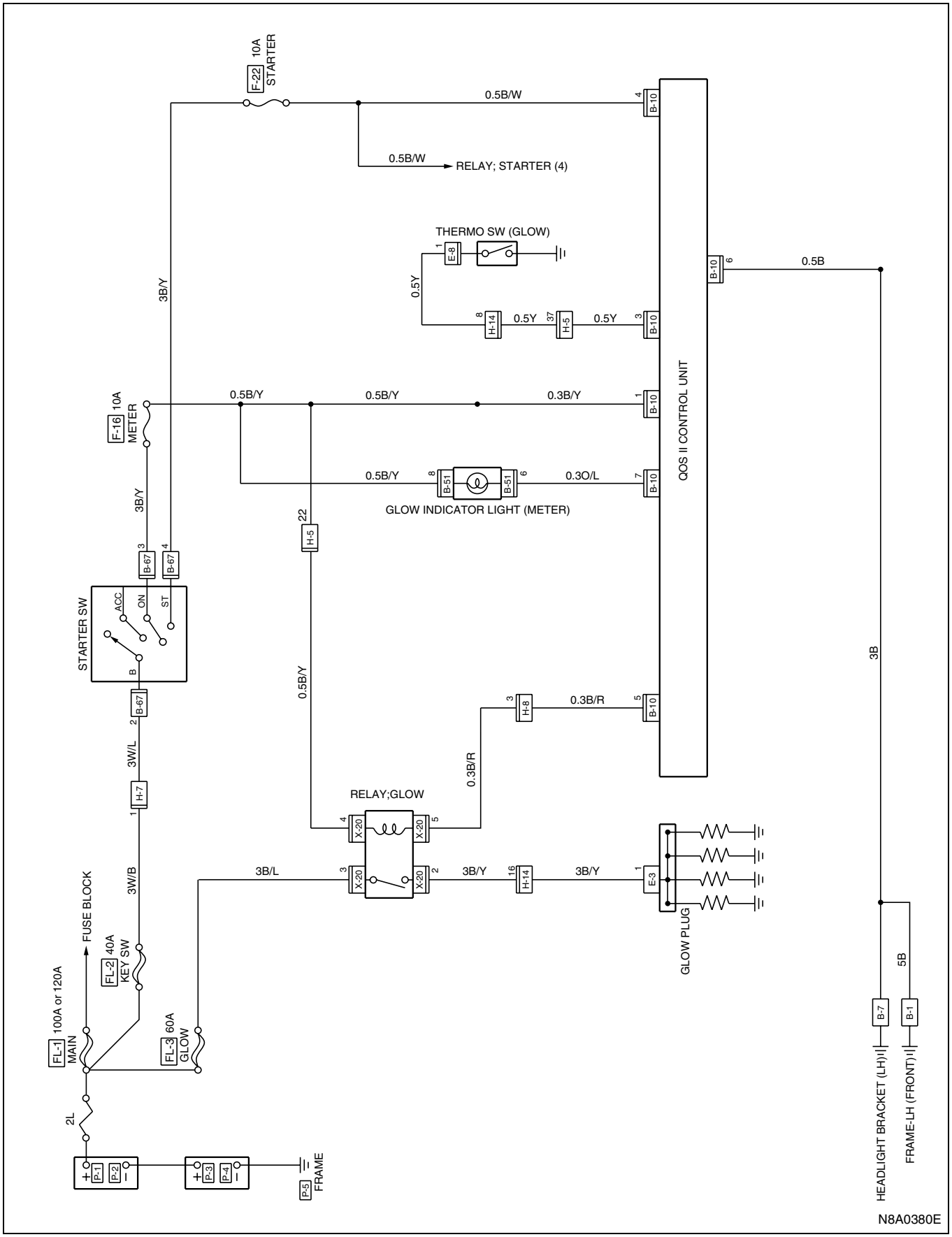


Circuit Diagram

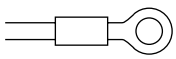
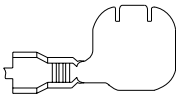
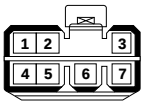
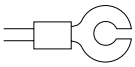
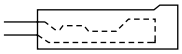
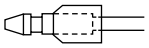
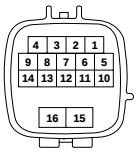
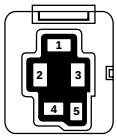
NHR55, NKR55

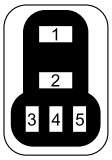
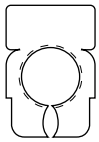
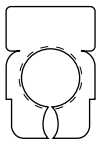
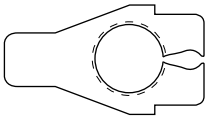
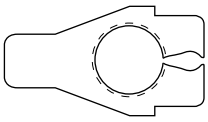
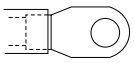
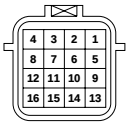


NKR66, NPR66, NQR66

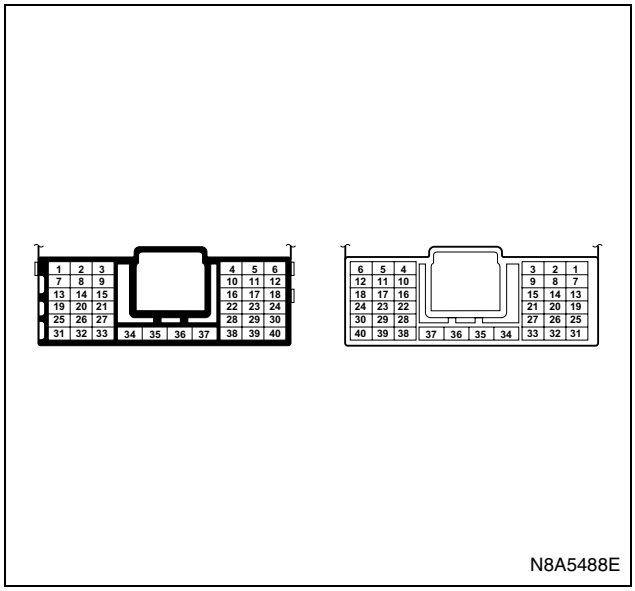


Connector List

No.	Connector Face
B-1	 000-001
B-7	 000-012
B-10	 007-001
B-51	014-001
B-67	004-001
B-67	004-002
E-3	 000-009
E-8	 000-010
E-8	 000-011
E-15	001-002
E-15	001-003
E-24	001-002
E-24	001-003
H-14 (4H/ 4JH1 type ENGIN E)	016-003
H-14 (4H/ 4JH1 type ENGIN E)	 016-004
X-20	 005-003

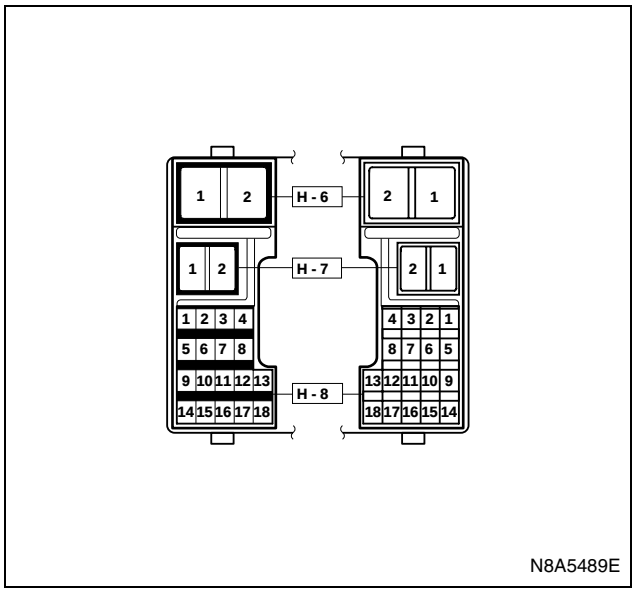
No.	Connector Face
X-26	 005-006
P-1	 000-004
P-4	 000-004
P-2	 000-006
P-3	 000-006
P-5	 000-002
H-14 (4J type ENGINE) (Except 4JH1)	016-001
H-14 (4J type ENGINE) (Except 4JH1)	 016-002

H-5



N8A5488E

H-7, H-8



N8A5489E

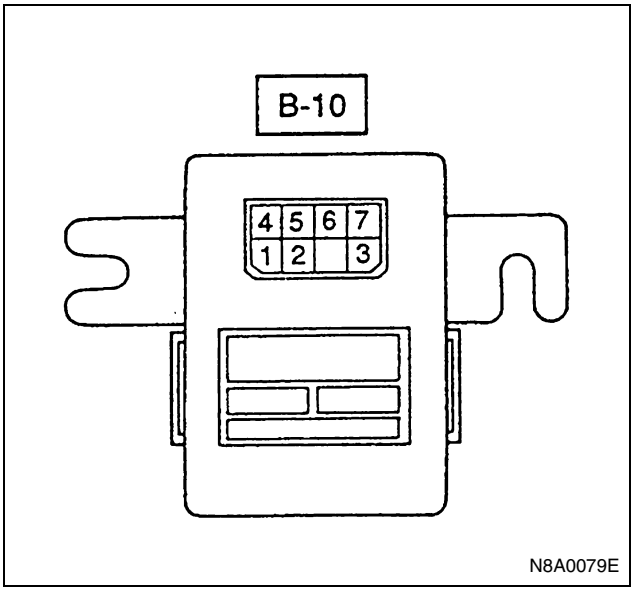
Starter Switch

Refer to “START AND CHARGING” in this section.

Glow Indicator Light Thermo Switch

Refer to “METER AND WARNING/INDICATOR LIGHT” in this section.

QOSII Control Unit



Terminal No.	Connected to
1	Starter switch (ON)
2	—
3	Thermo switch
4	Starter switch (ST)
5	Glow relay
6	Ground
7	Glow indicator (Meter)

Exhaust Brake System

General Description

This circuit consists of starter switch, exhaust brake switch (combination switch), accelerator switch, clutch switch, vacuum switching valve, neutral switch and relay.

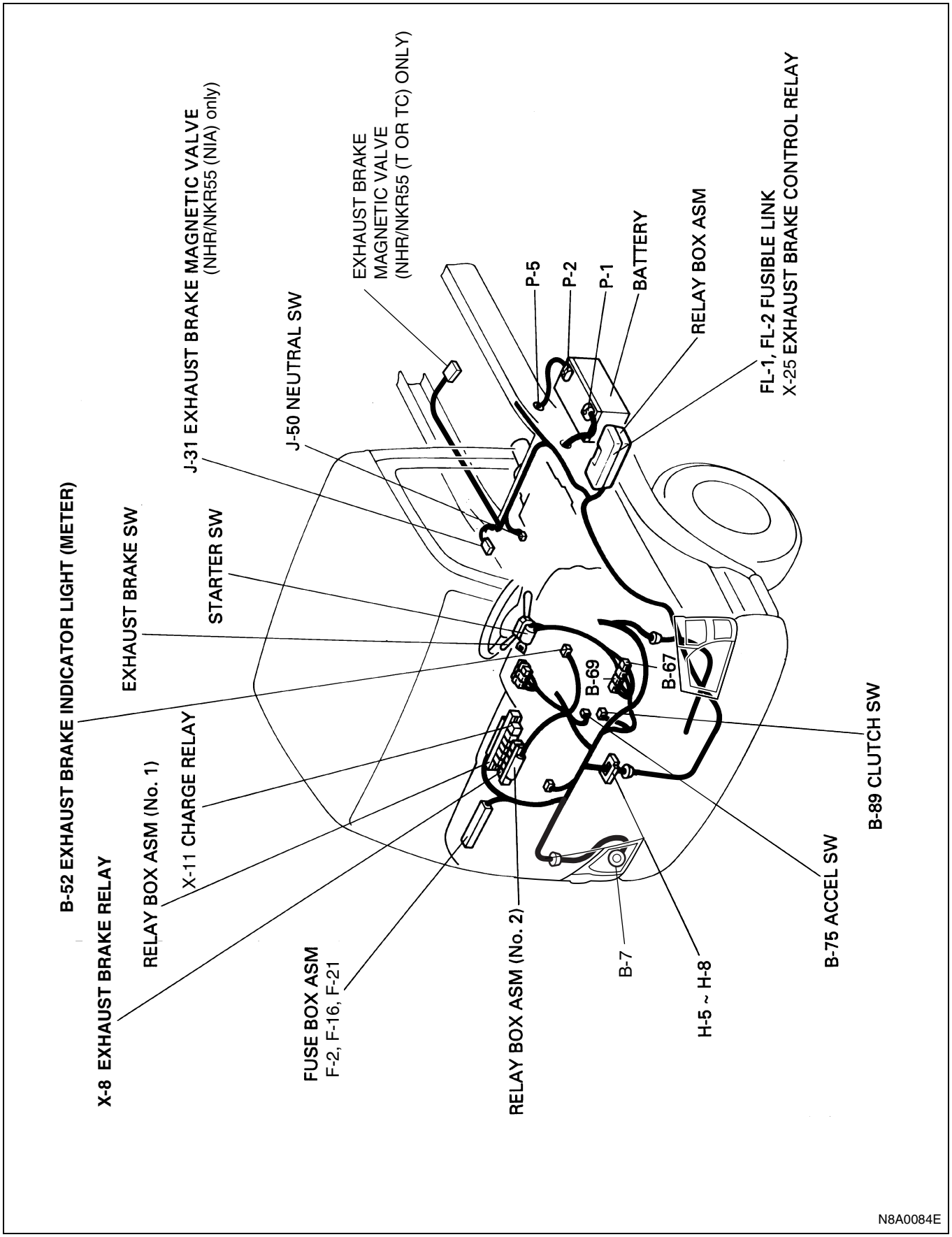
Exhaust brake is a system to increase exhaust pressure by means of squeezing exhaust gas from engine and exert engine brake.

Turn the exhaust brake SW on, and the exhaust brake valve starts to work by the function of the magnetic valve to enable the exhaust bake to operate, when the exhaust brake indicator light will be on.

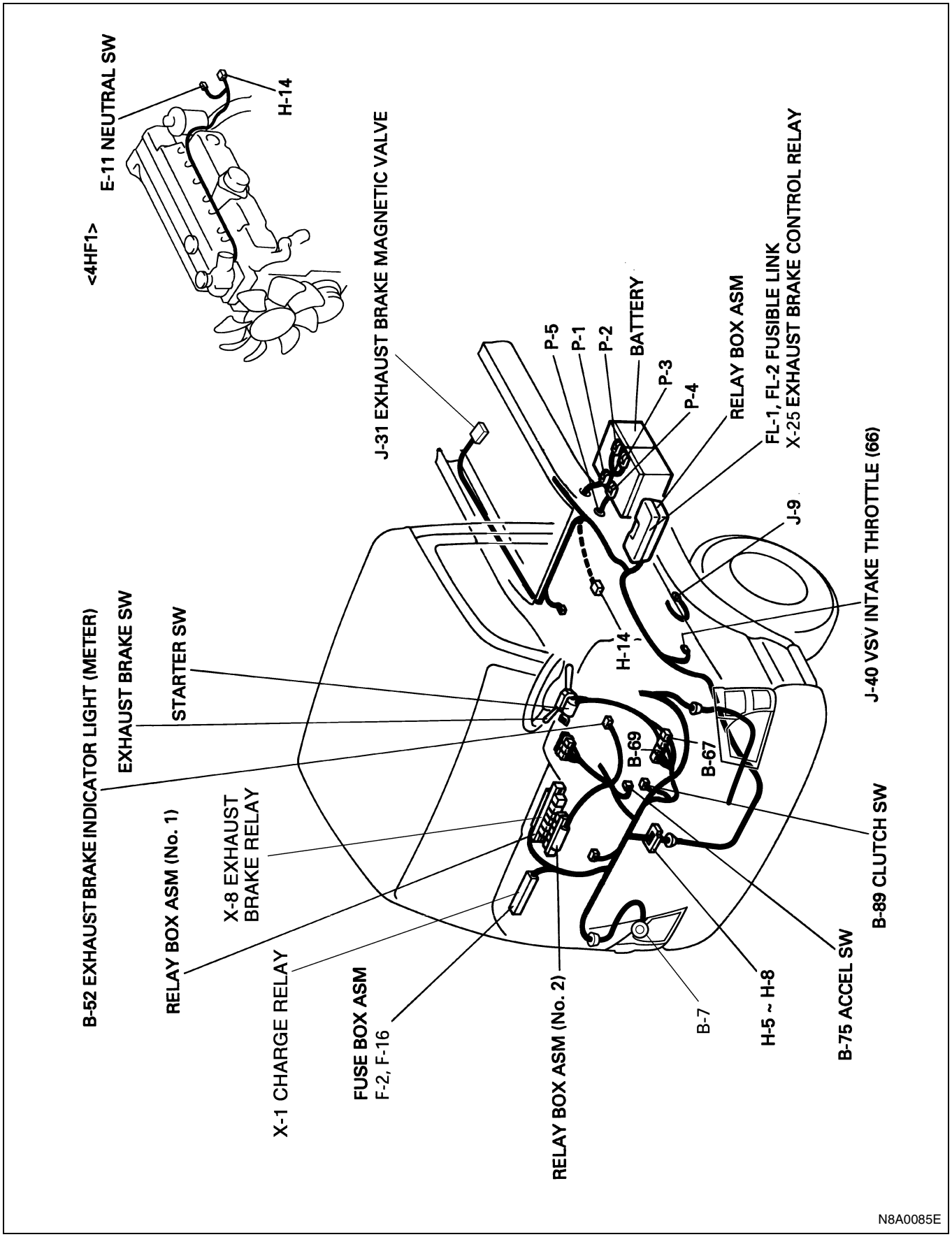
When either the accelerator pedal or the clutch pedal is depressed while driving, the switch of the depressed pedal will turn off, subsequently the exhaust braking will stop working.

Parts Location

NHR55, NKR55

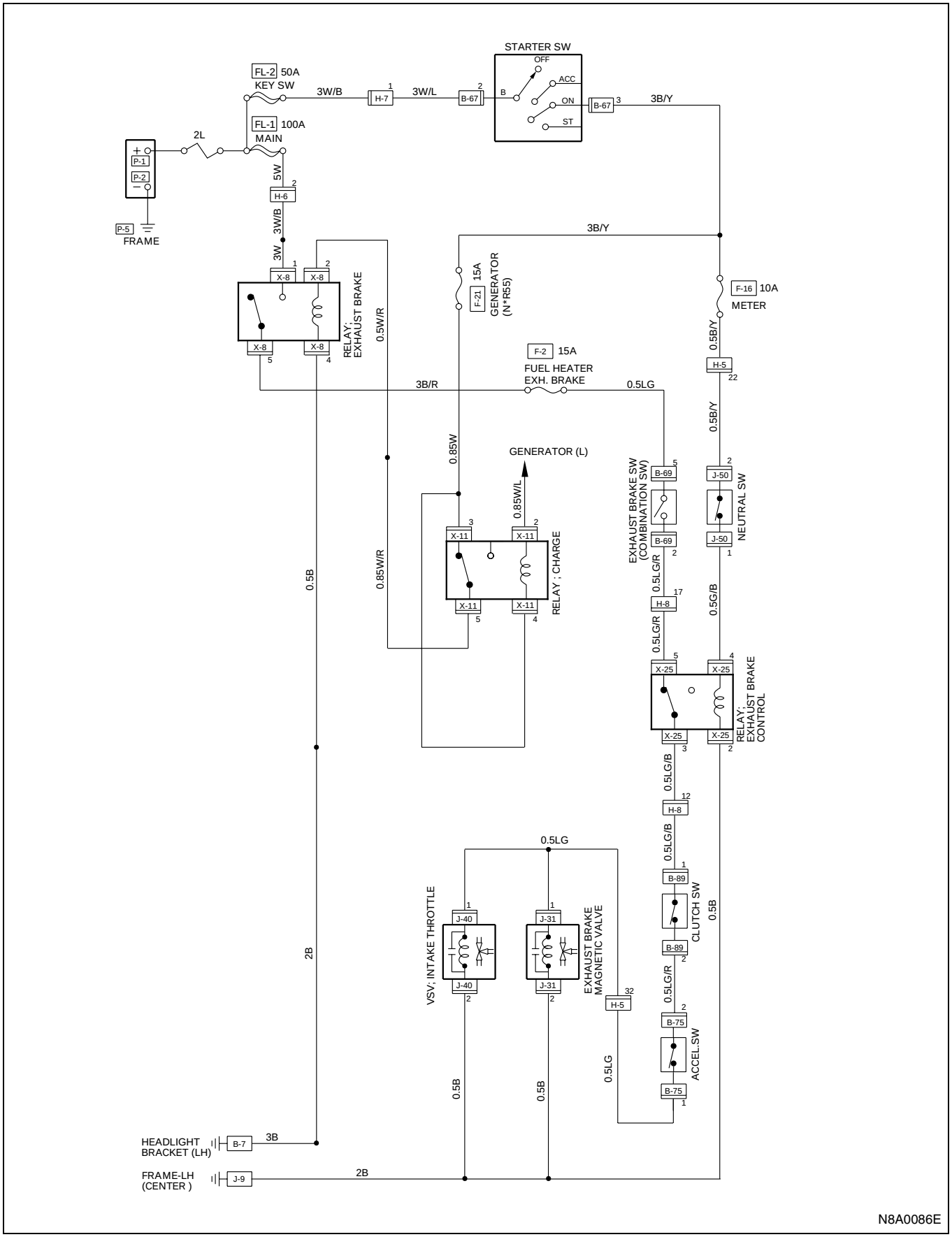


NKR66, NPR66, NQR66

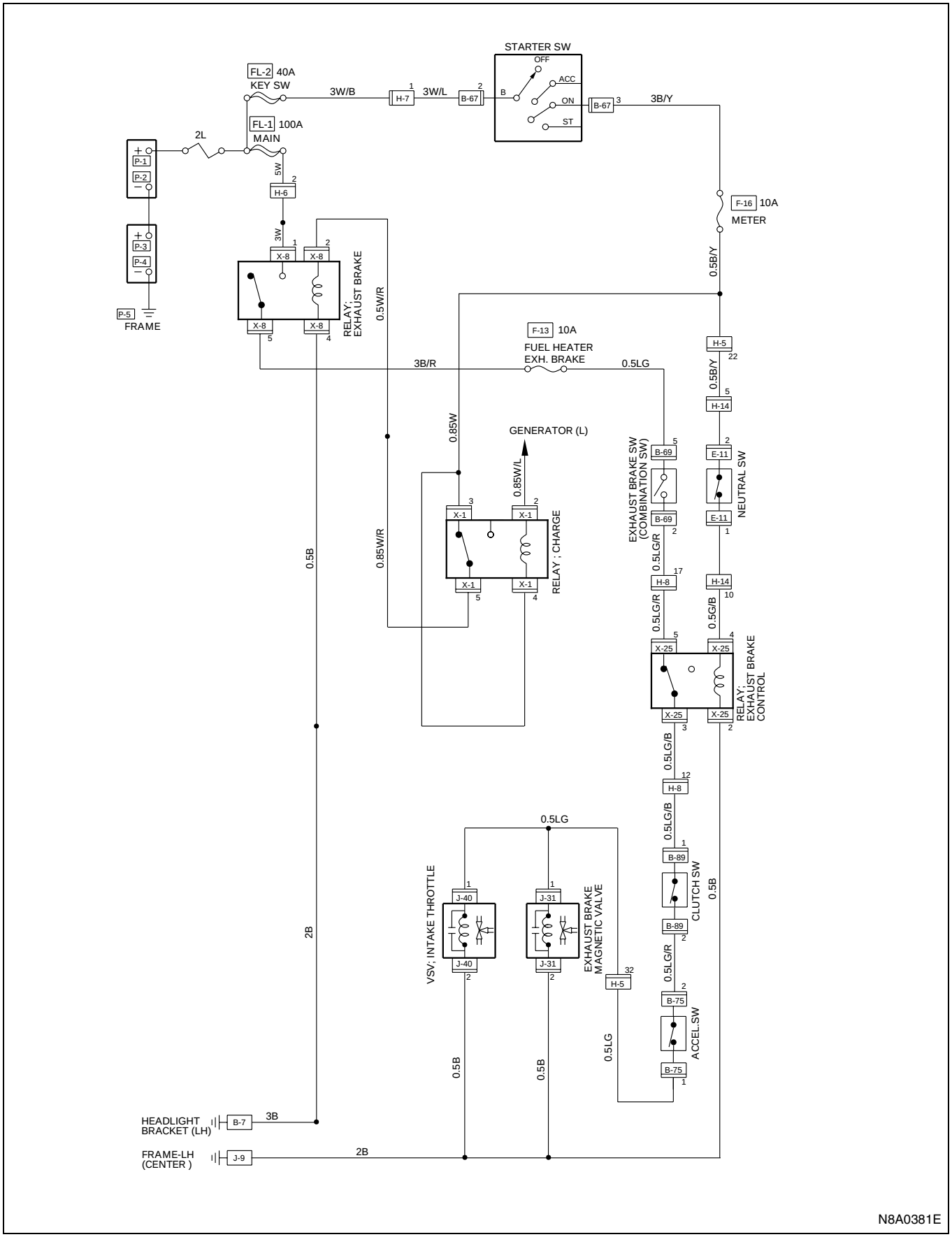


Circuit Diagram

NHR55, NKR55



NKR66, NPR66, NQR66



N8A0381E

Connector List

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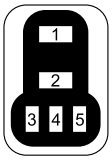
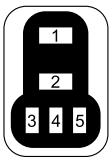
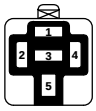
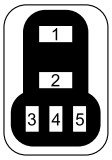
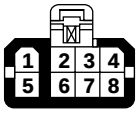
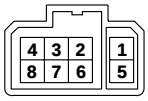
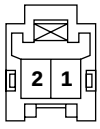
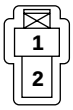
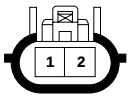
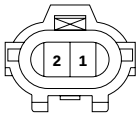
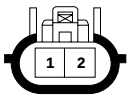
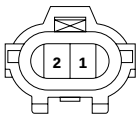
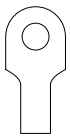
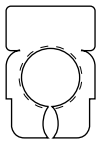
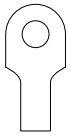
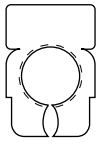
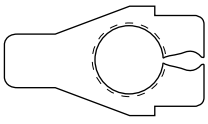
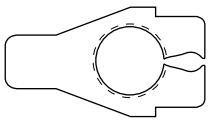
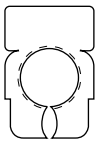
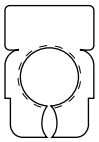
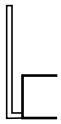
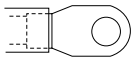
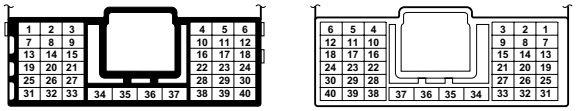
X-1	 005-006
X-8	 005-006
X-11	 005-001
X-25	 005-006
B-69	 008-001
B-69	 008-002
B-75	002-022
B-75	 002-023

No.	Connector Face
B-89	002-009
B-89	 002-010
E-11	 002-001
E-11	 002-002
J-50	 002-001
J-50	 002-002
H-14	016-003
H-14	016-004

No.	Connector Face
J-31	002-011
J-31	002-012
J-40	002-014
P-1 (12 V)	 000-003
P-1 (12 V)	 000-004
P-2	 000-003
P-2	 000-004
P-2 (24 V)	 000-006

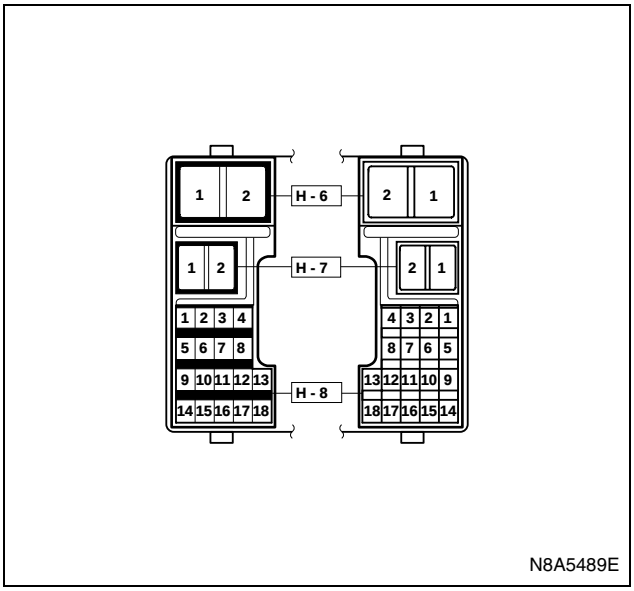
No.	Connector Face
P-3	 000-006
P-1 (24 V)	 000-004
P-4	 000-004
P-5 (12 V)	 000-007
P-5 (24 V)	 000-002

H-5



N8A5488E

H-6, H-7, H-8



Neutral Switch

Refer to “START AND CHARGING” in this section.

Starter Relay

Refer to “START AND CHARGING” in this section.

Charge Relay

Refer to “START AND CHARGING” in this section.

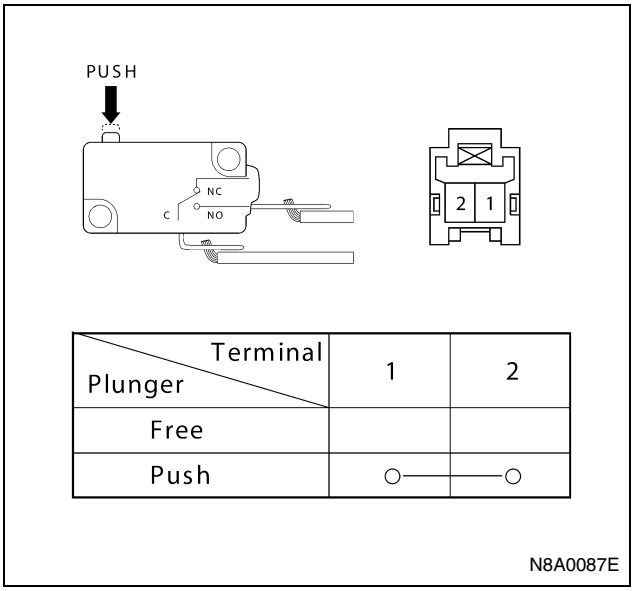
Starter Switch

Refer to “START AND CHARGING” in this section.

Accel Switch

Inspection

1. Check the continuity between the switch connector terminals.
2. Check to see if switch plunger operates smoothly. Repair or replace the accel switch when result of inspection is found abnormal.

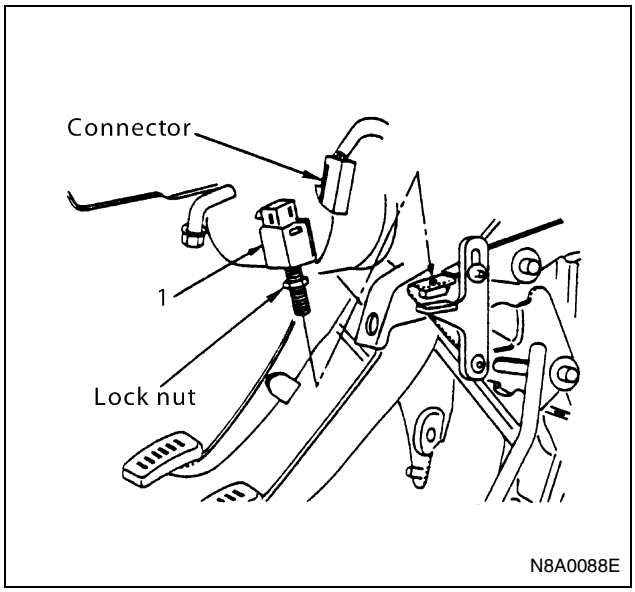


Removal

Preparation:

Disconnect the battery ground cable.

1. Accel Switch
   1) Disconnect the connector.
   2) Remove the two screws.



Installation

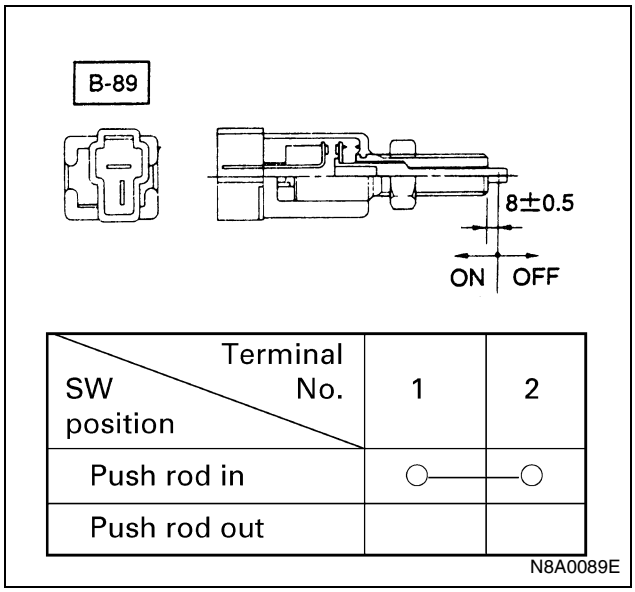
To install, follow the removal steps in the reverse order, noting the following points.

1. Check to see if the accel pedal has been returned by the return spring to the specified position.

Clutch Switch

Inspection

1. Check the continuity between the switch connector terminals.
2. Check to see if switch push rod operates smoothly. Repair or replace the switch when result of inspection is found abnormal.

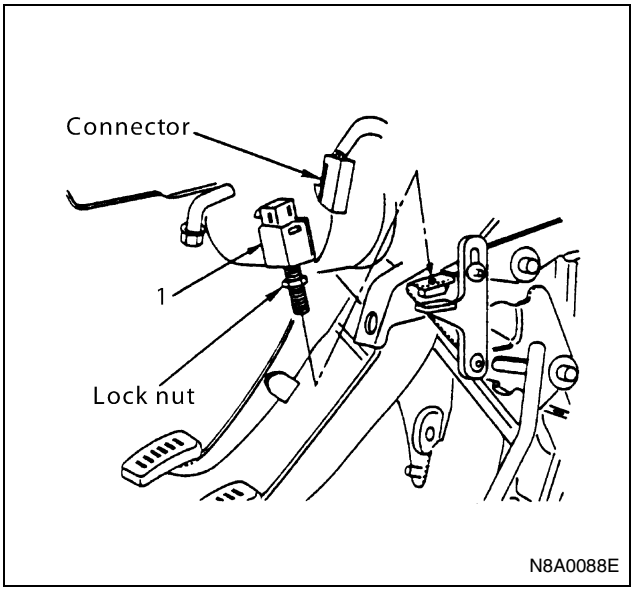


Removal

Preparation:

Disconnect the battery ground cable.

1. Clutch Switch
   1) Disconnect the connector.
   2) Loosen the lock nut of the switch.
   3) Remove the switch by turning it.



Installation

To install, follow the removal steps in the reverse order, noting the following points.

1. Check to see if the clutch pedal has been returned by the return spring to the specified position.
2. Turn the clutch switch clockwise until the tip of the threaded portion of the switch contacts the pedal arm.
3. Tighten the lock nut to the specified torque.

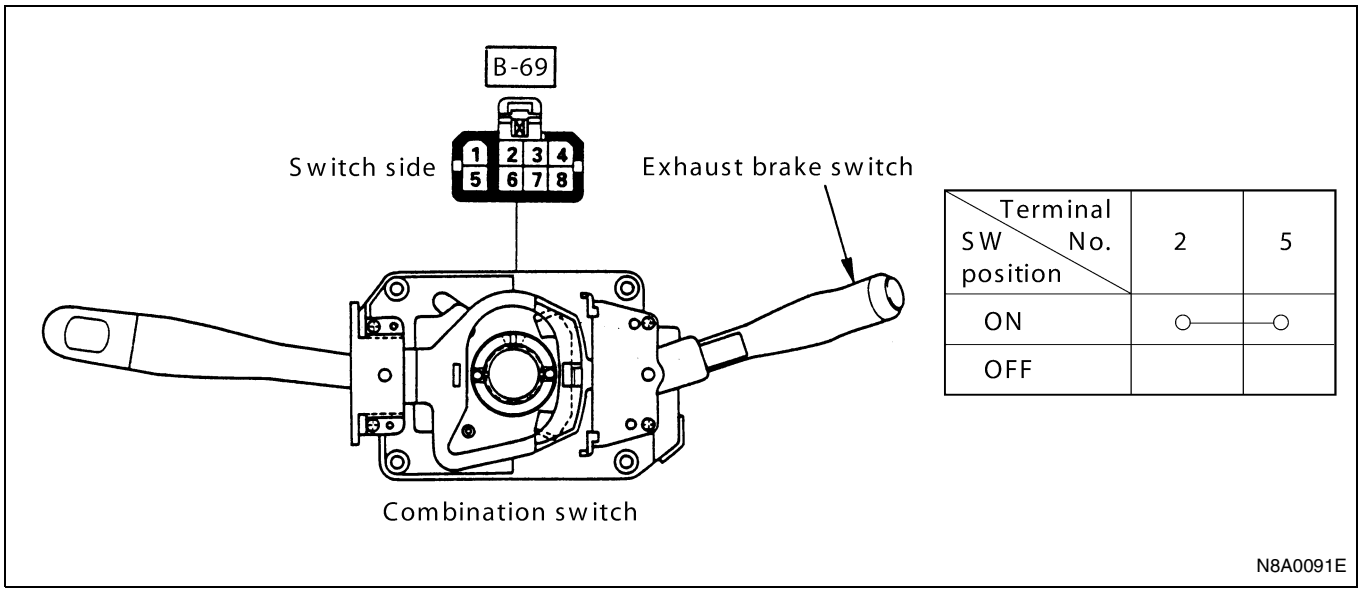
Tighten:

Lock nut to 13 N·m (130 kg·cm / 115 lb·in)

Exhaust Brake Switch

Inspection

Check the continuity between the terminals of the exhaust brake switch.
Repair or replace the switch when the result of inspection is found abnormal.



SW position \ Terminal No.	2	5
ON	○	○
OFF		

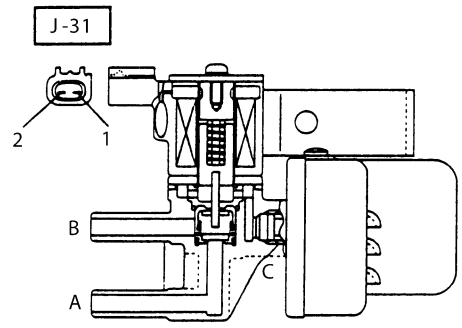
Removal and Installation

Refer to “HEADLIGHT, FOG LIGHT AND CORNERING LIGHT” in this section.

Exhaust Brake Magnetic Valve (4H Series Engine)

Inspection

Connect the magnetic valve connector terminal No. 1 to the battery (+) terminal and terminal No. 2 to the (–) terminal and then check the continuity among each port.



Operation \ Port	A	B	C
When battery voltage applied	○——	——○	
When battery voltage not applied		○——	——○

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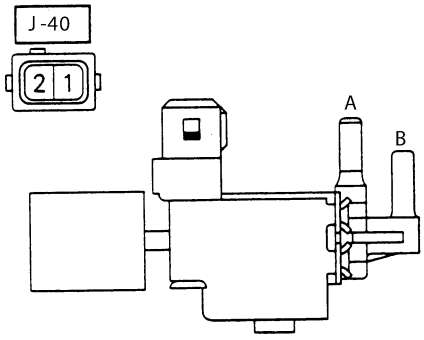
Vacuum Switching Valve: Intake Throttle (4H Series Engine)

Inspection

Connect the magnetic valve connector terminal No. 1 to the battery (+) terminal and terminal No. 2 to the (–) terminal and then check the continuity among each port. Repair or replace the vacuum switching valve when the result of inspection is found abnormal.



Operation \ Port	A	B
When battery voltage applied	○——	——○
When battery voltage not applied		

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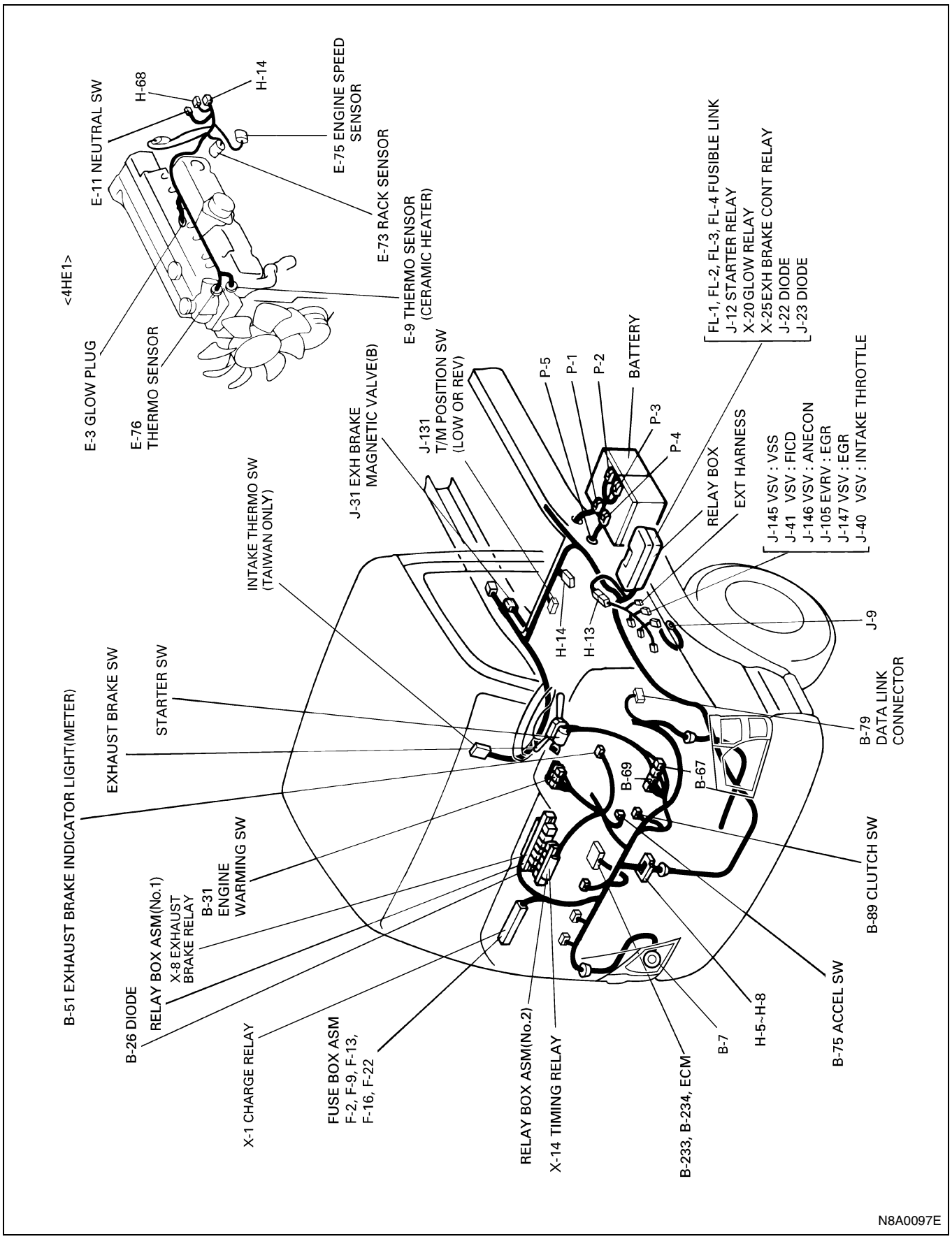
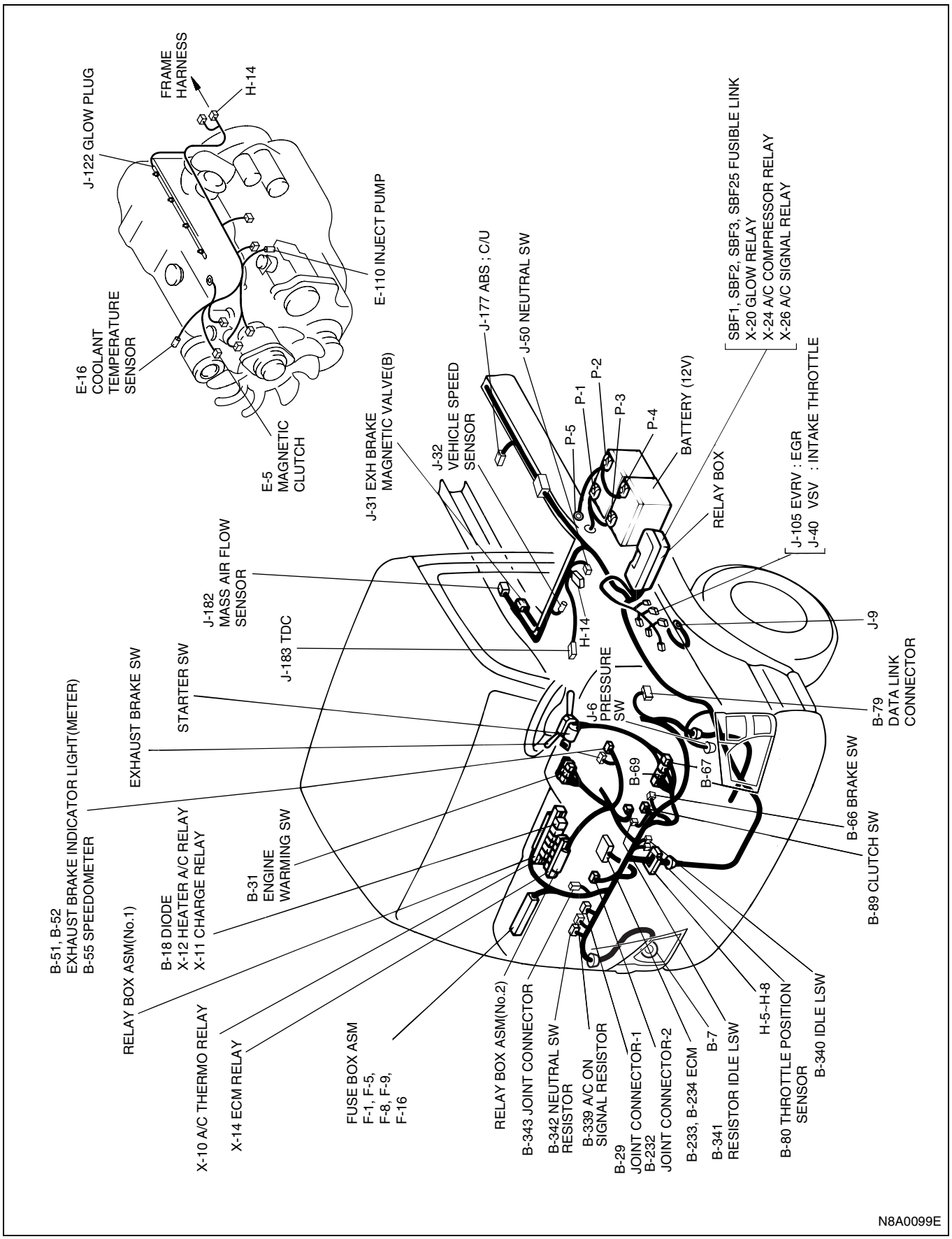
Exhaust Brake System and Engine Control

Parts Location

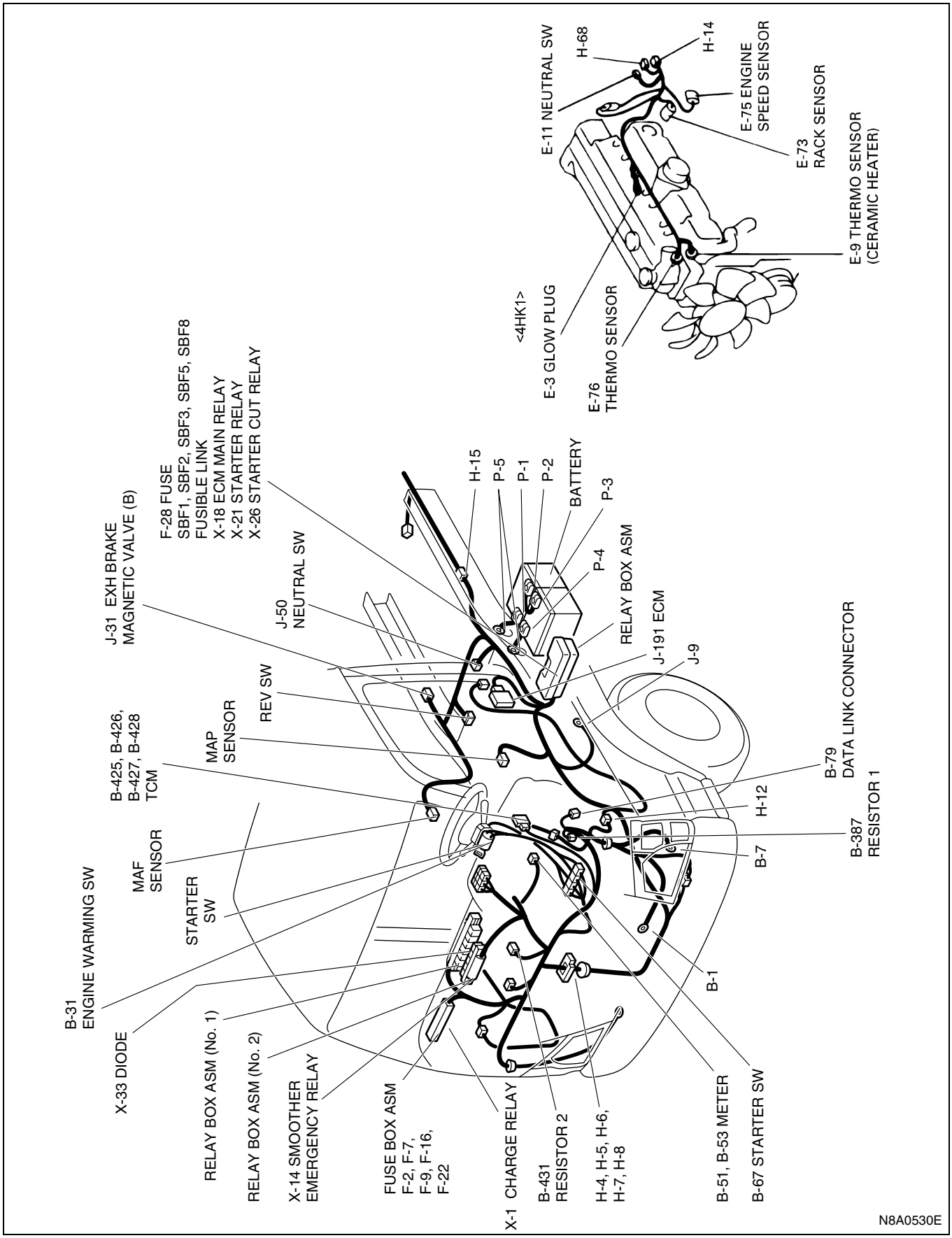
For 4HE1-TC Engine



For 4JH1 Engine

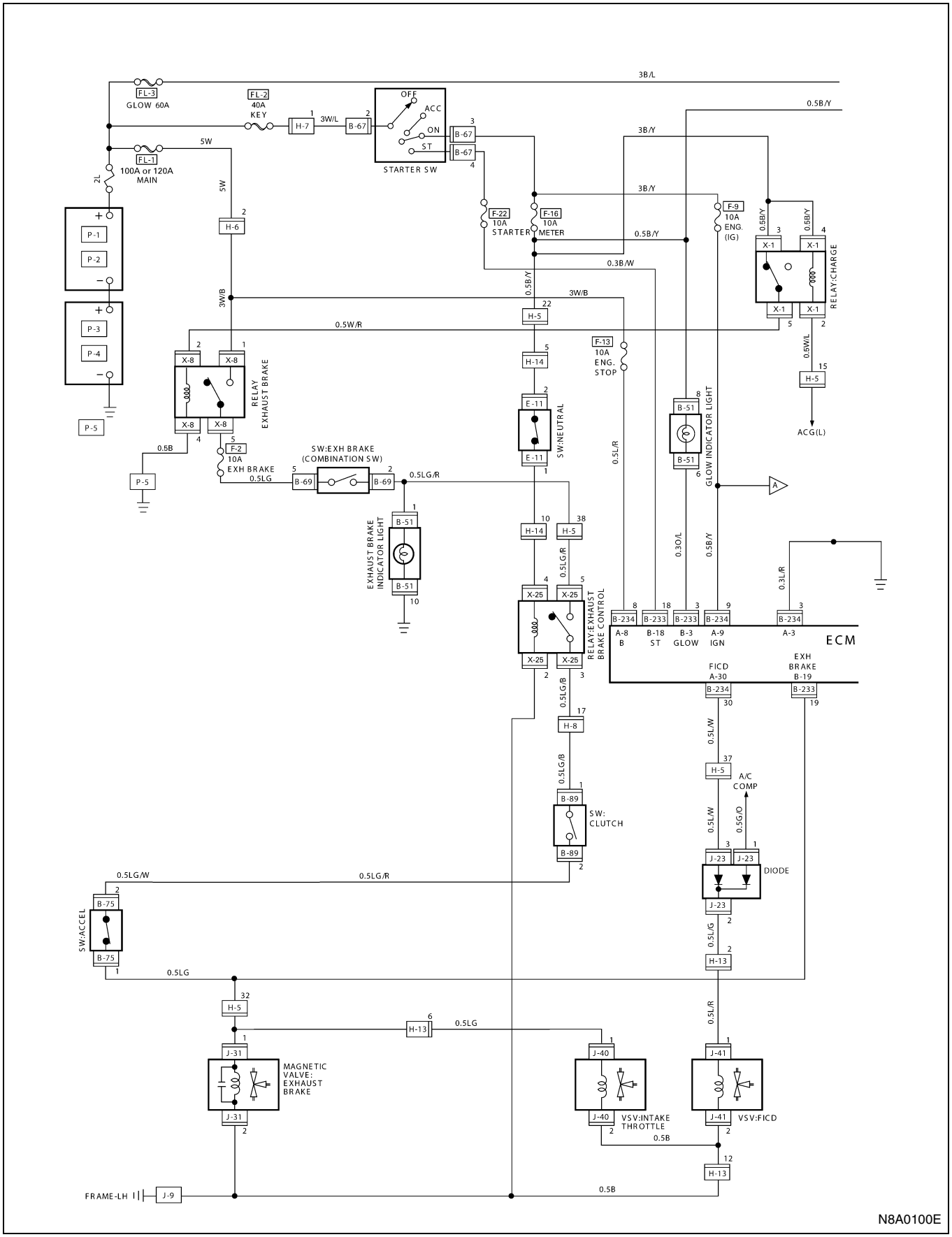


For 4HK1-TC Engine

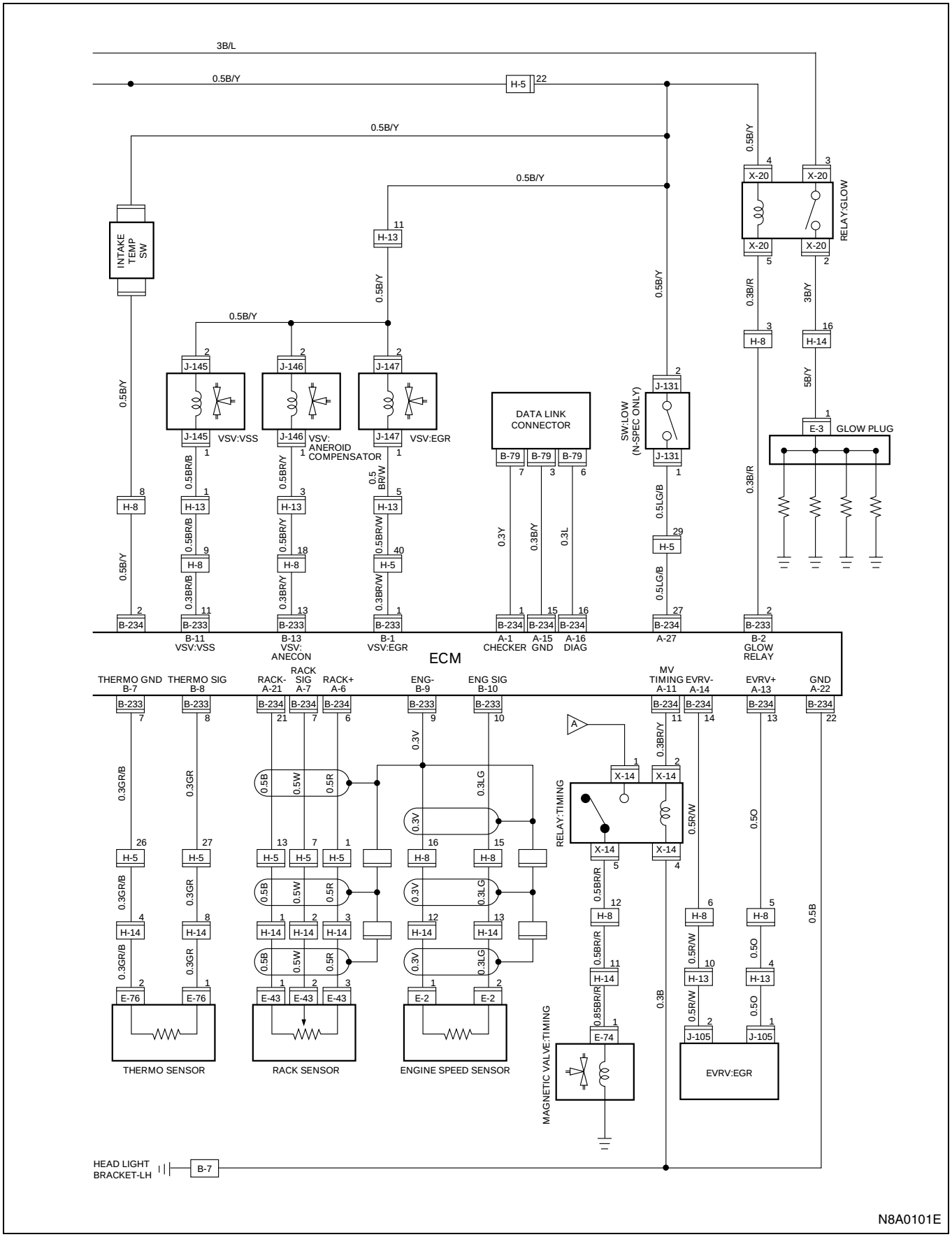


Circuit Diagram

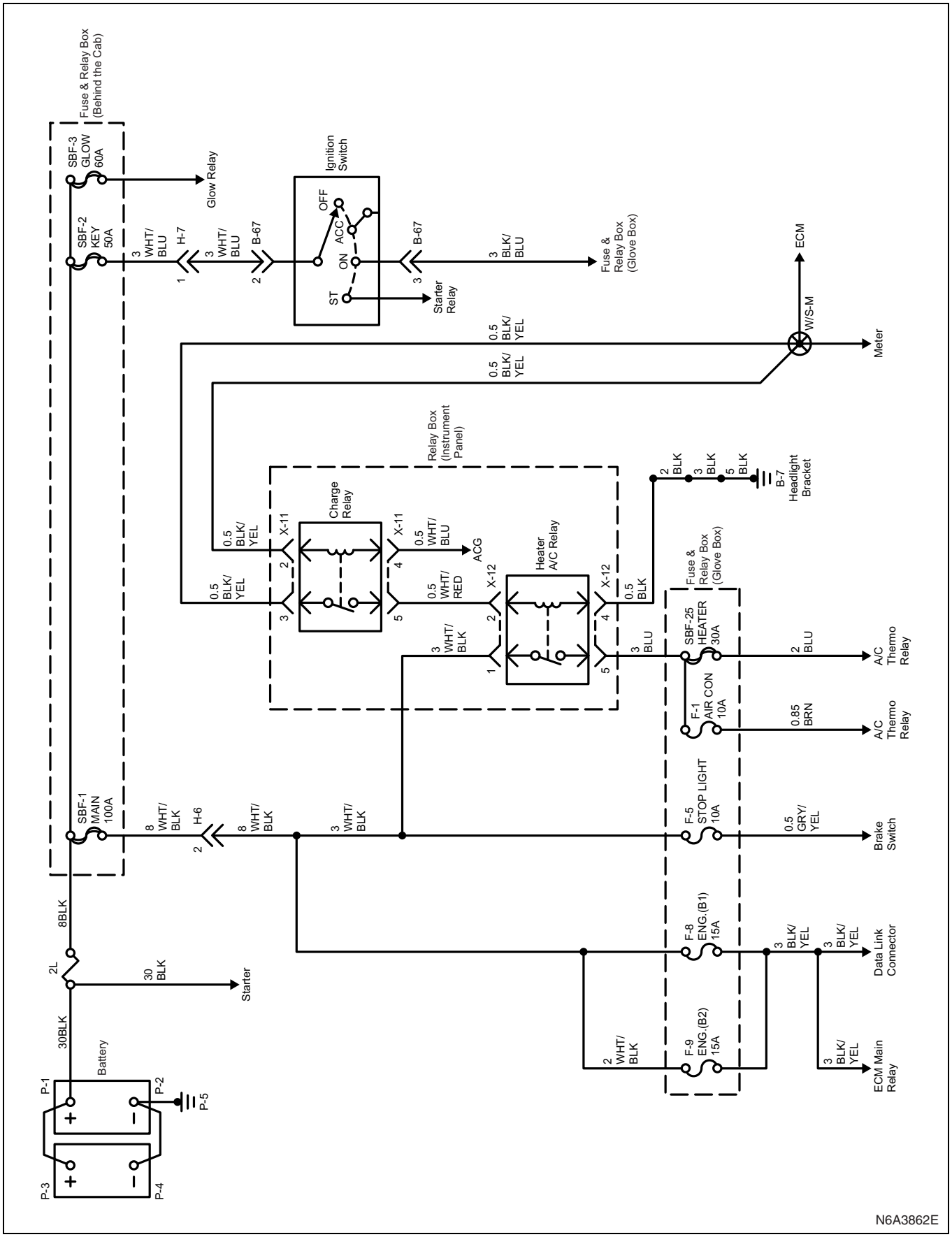
4HE1-TC Engine (1)



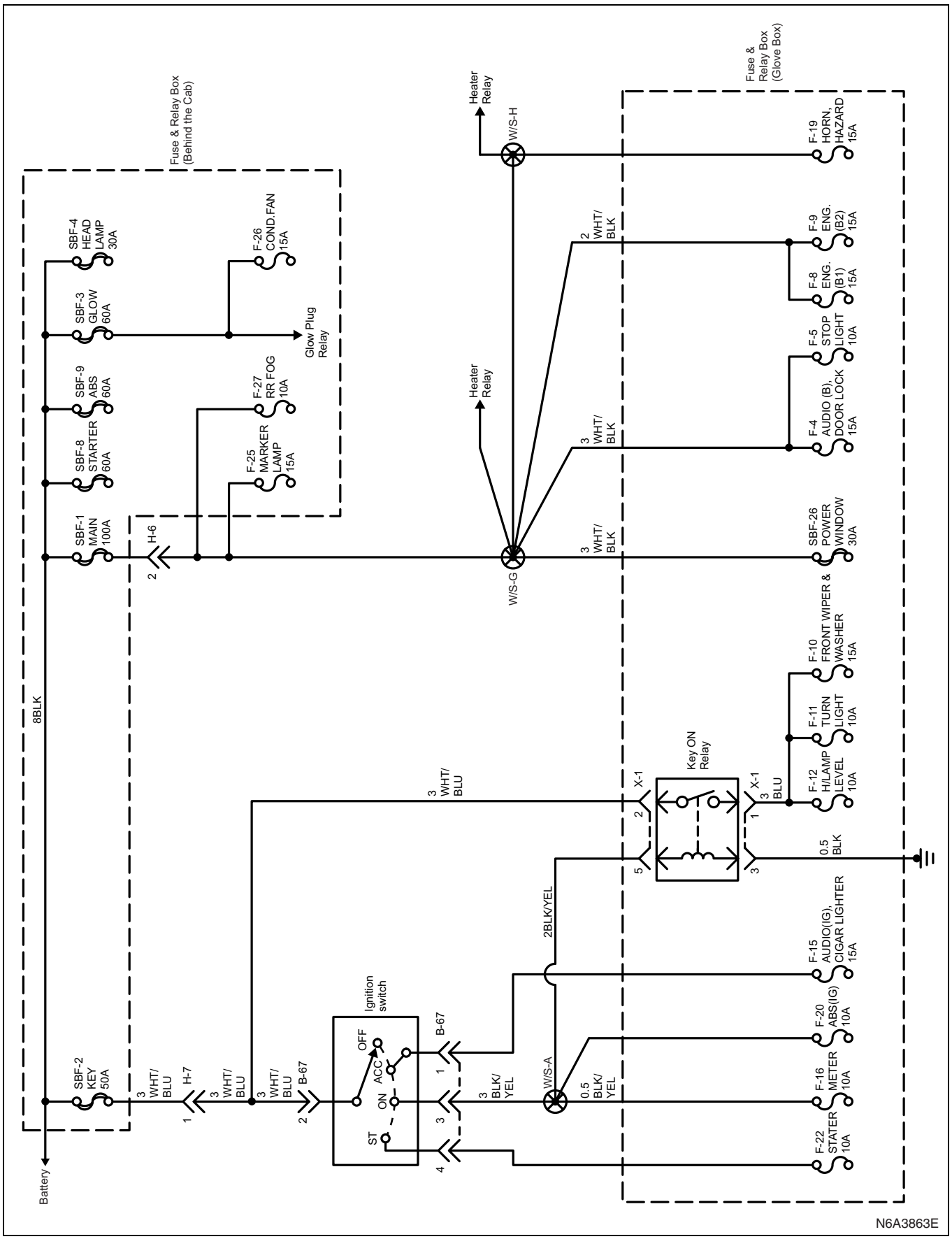
4HE1-TC Engine (2)



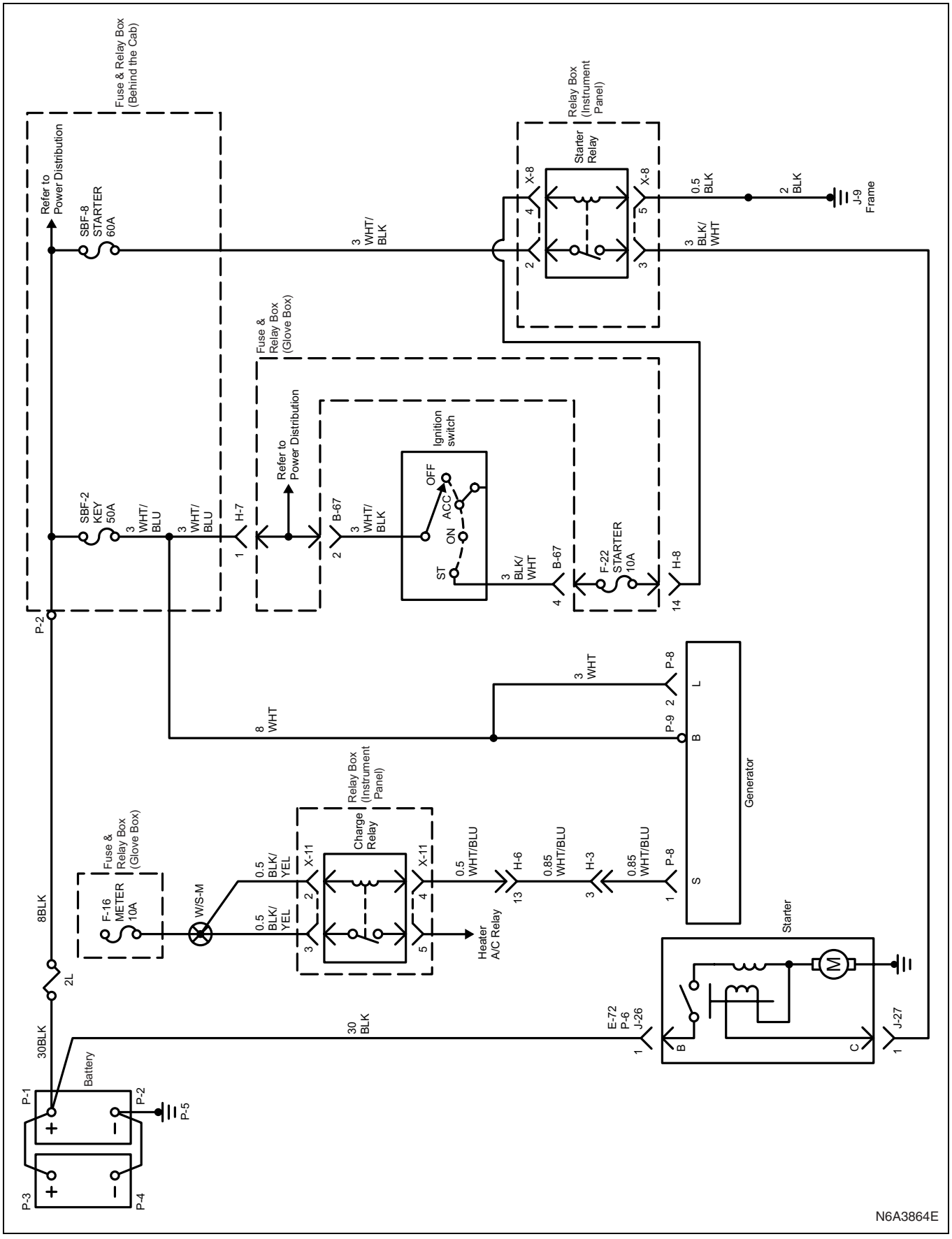
4JH1 Engine (1)



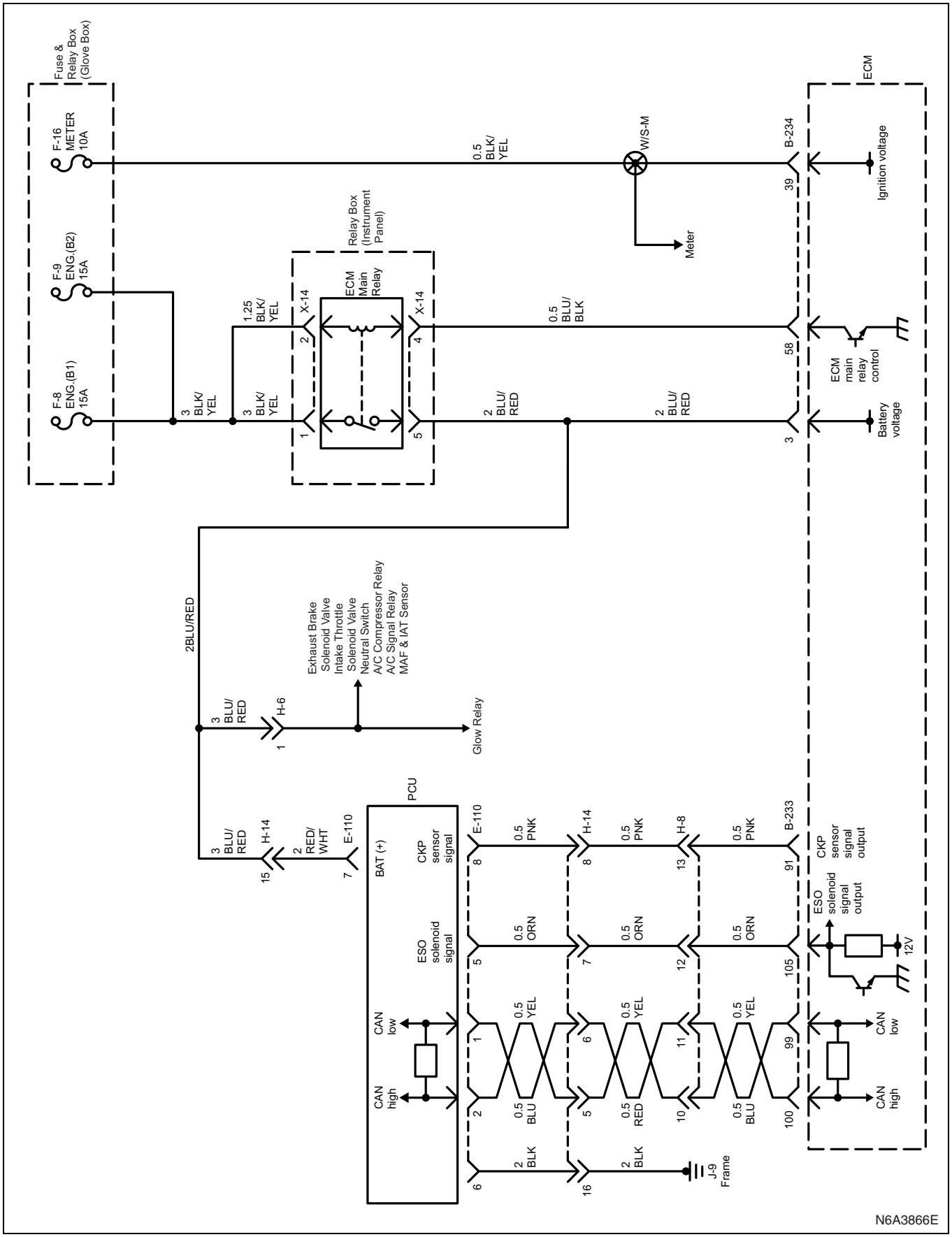
4JH1 Engine (2)



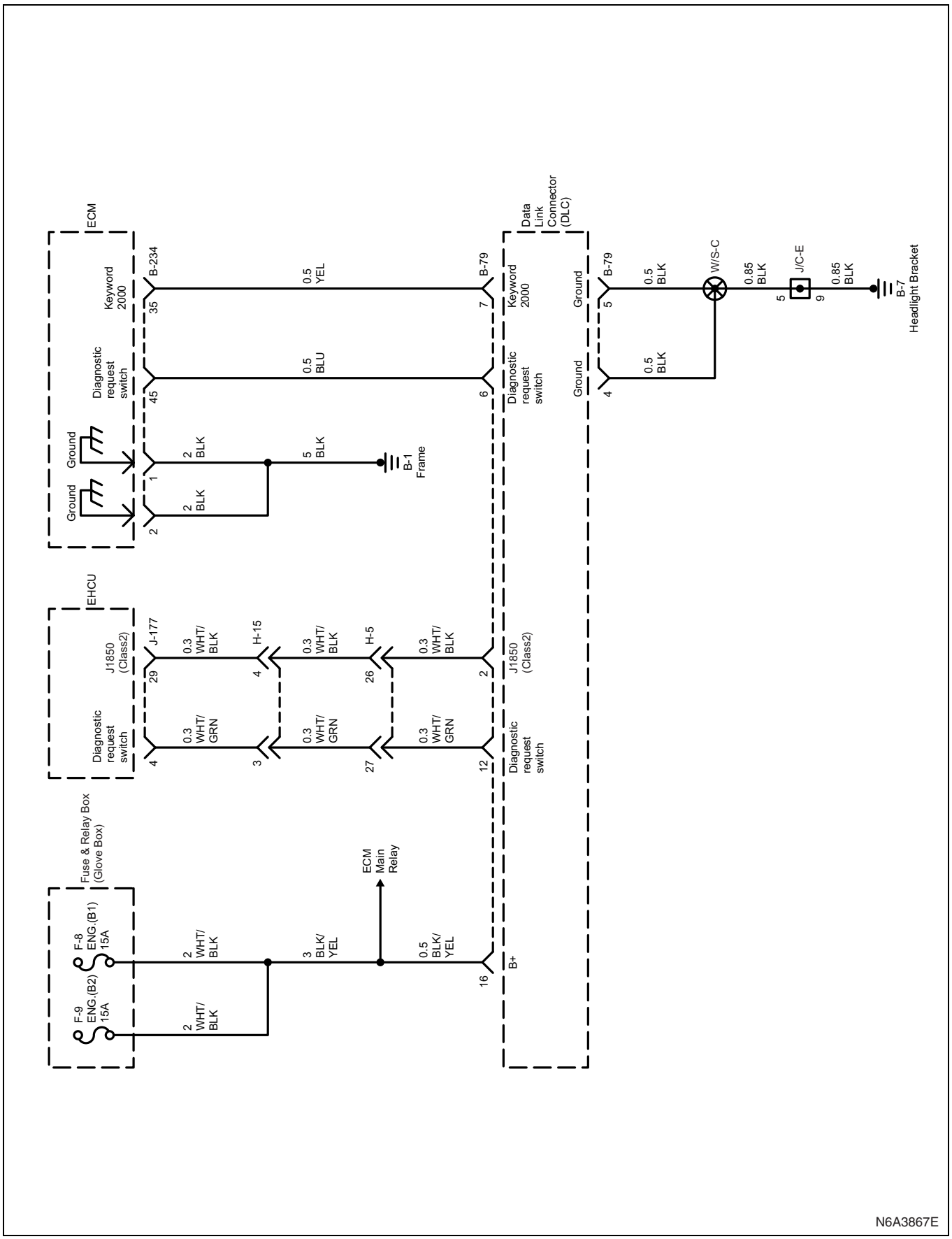
4JH1 Engine (3)



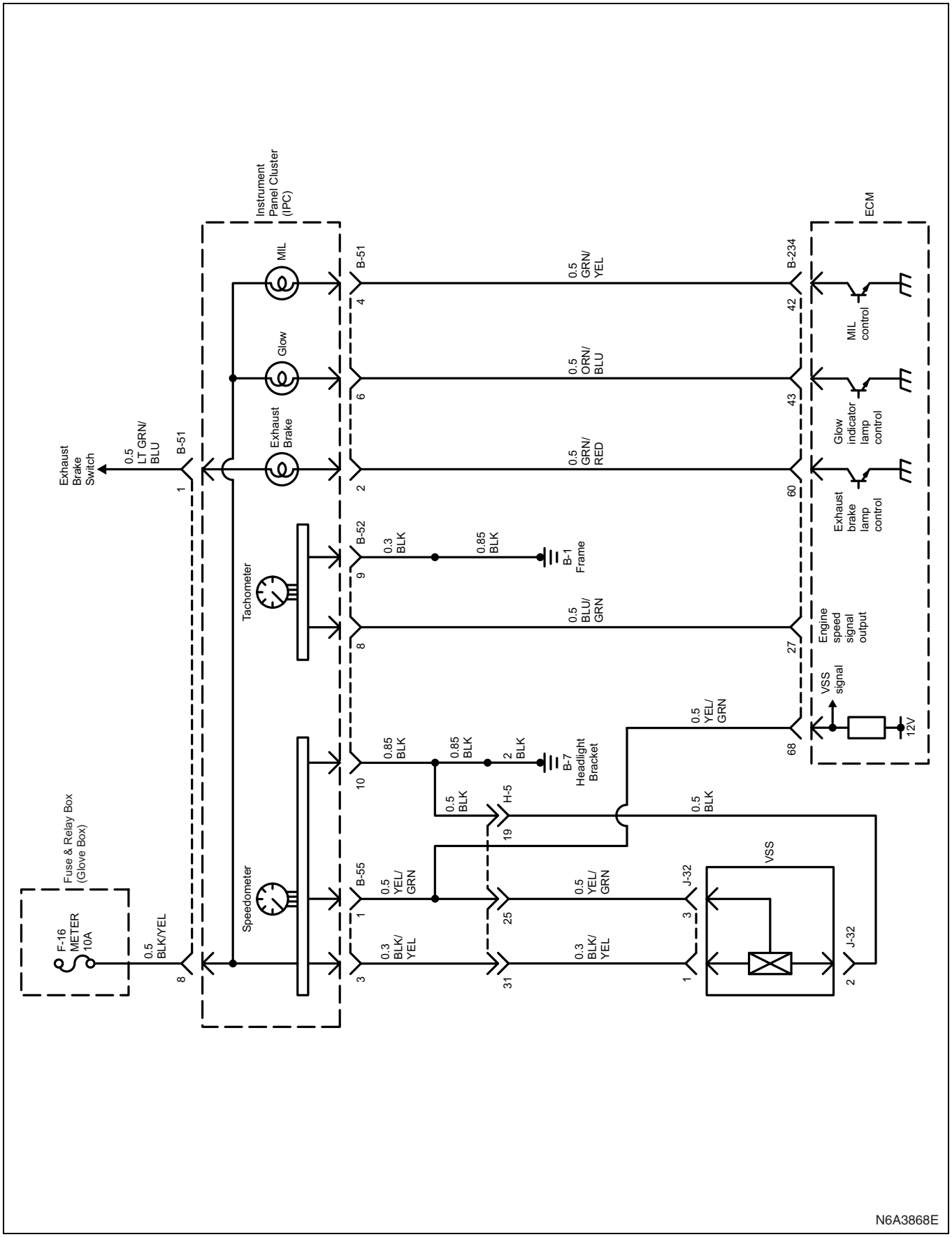
4JH1 Engine (4)



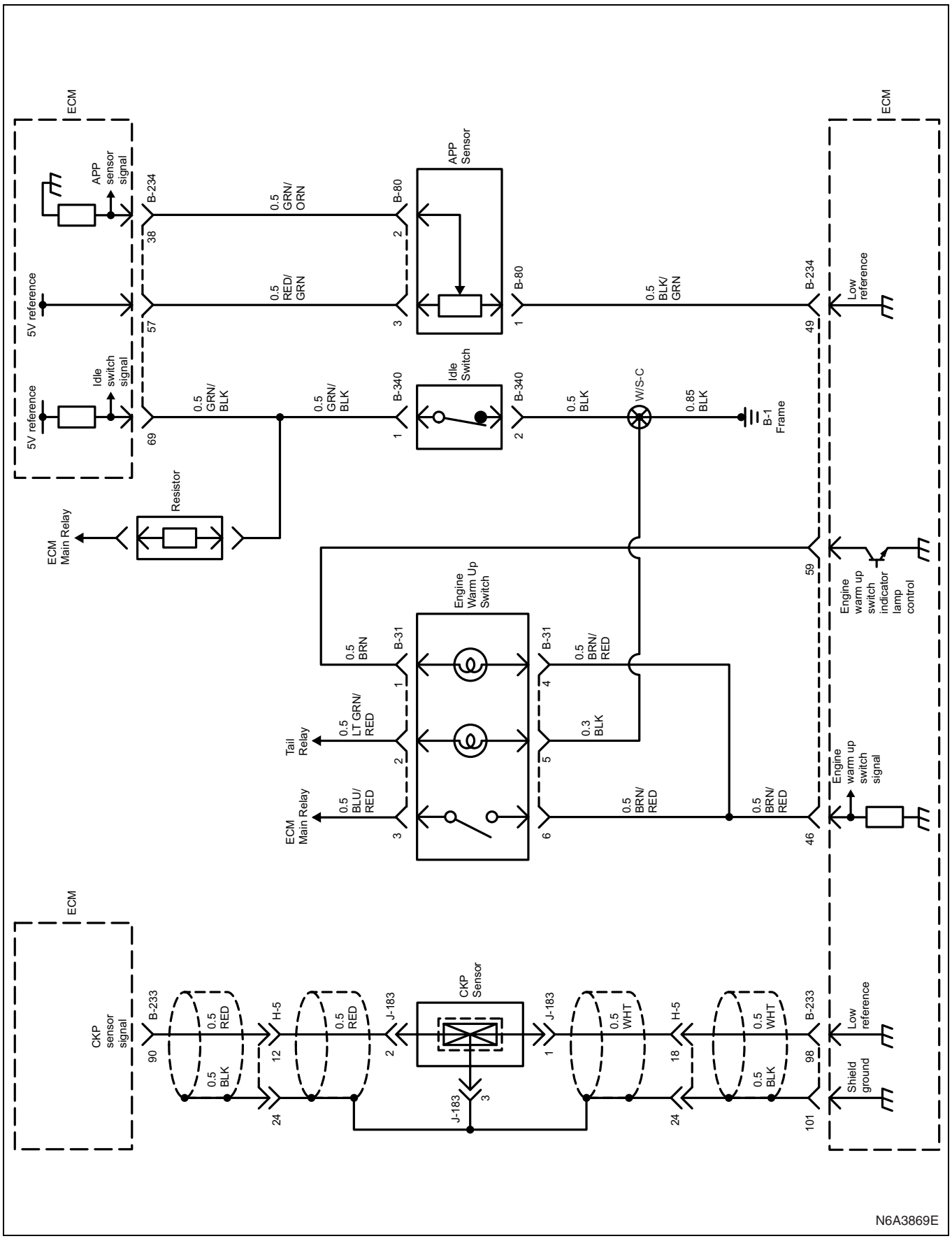
4JH1 Engine (5)



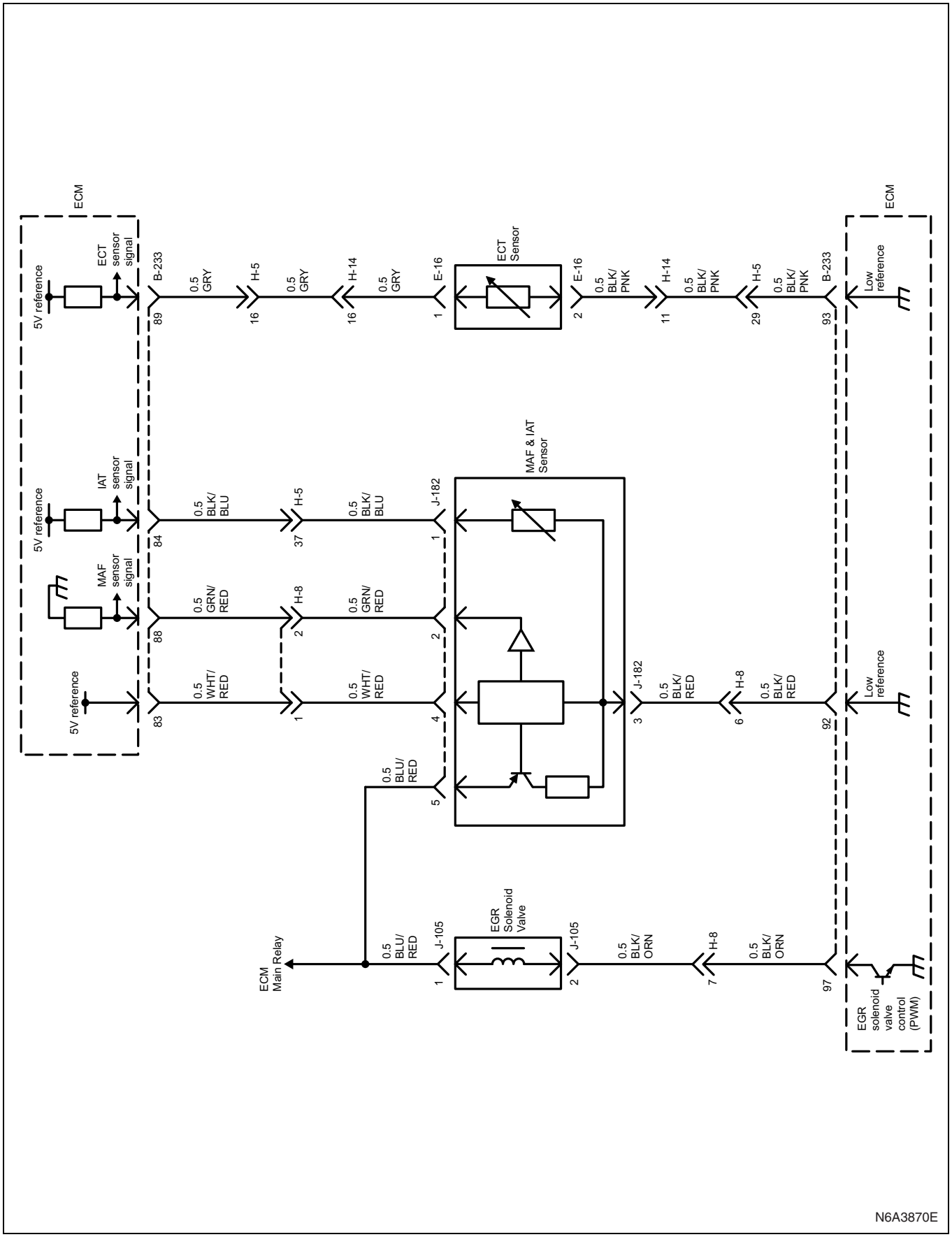
4JH1 Engine (6)



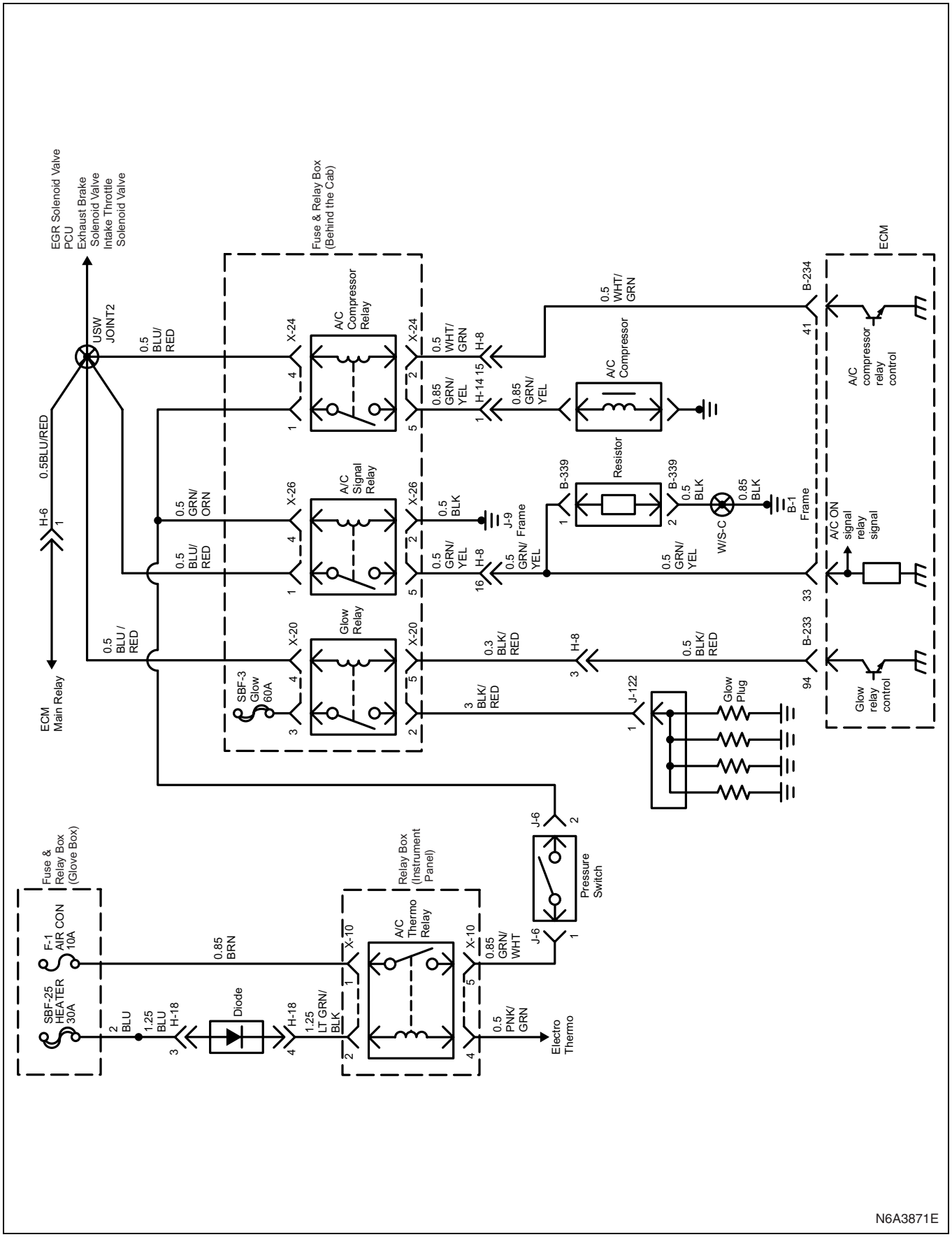
4JH1 Engine (7)



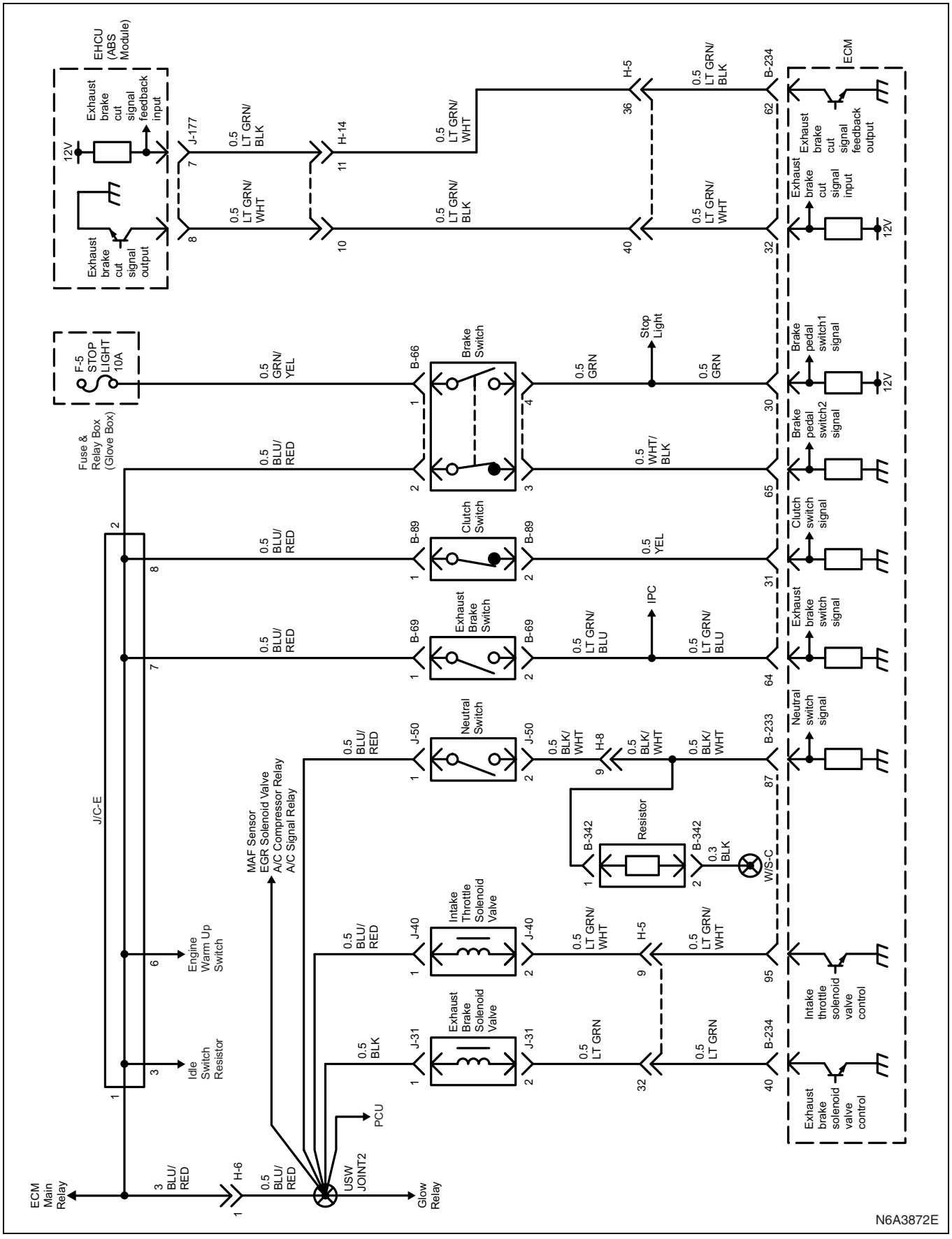
4JH1 Engine (8)



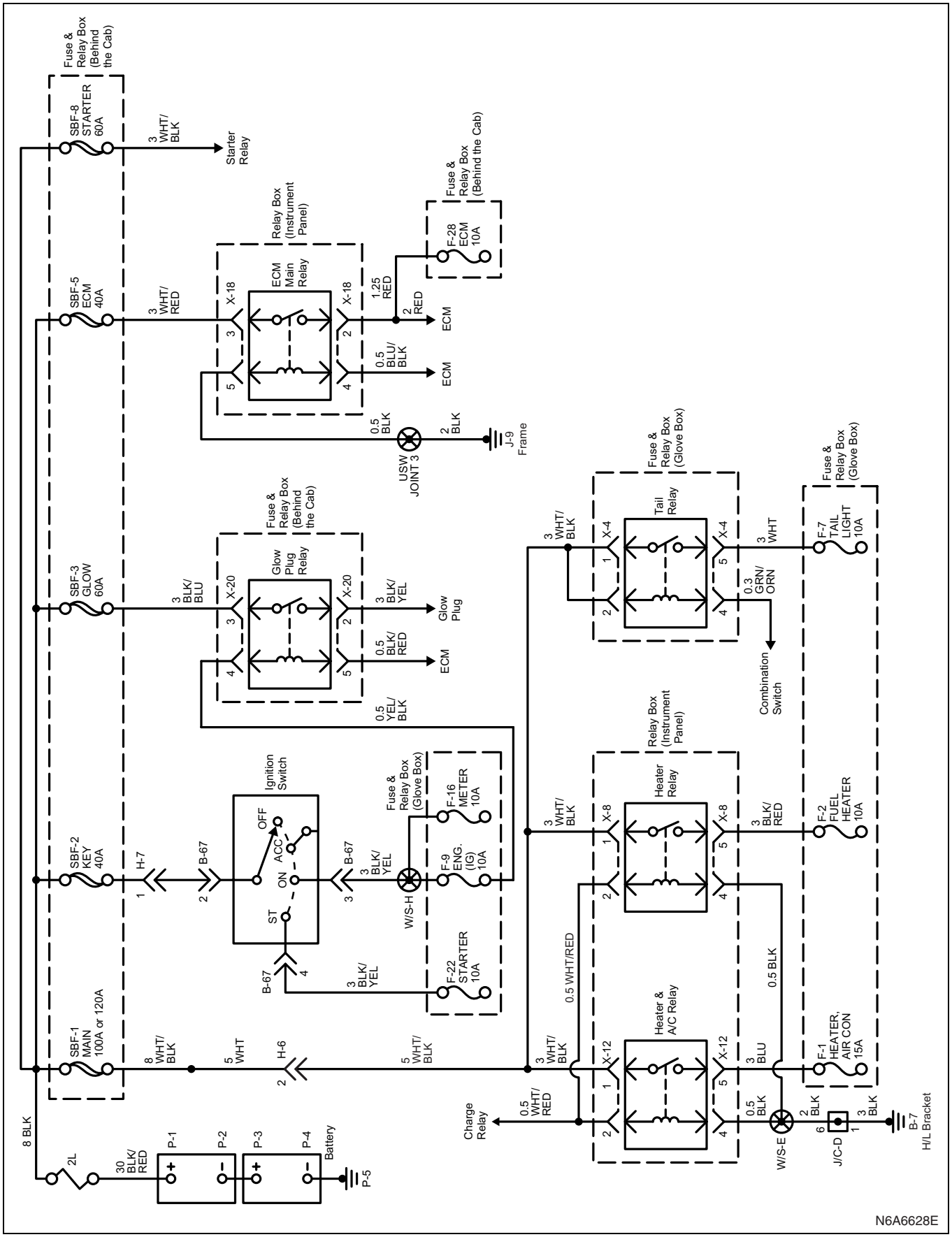
4JH1 Engine (9)



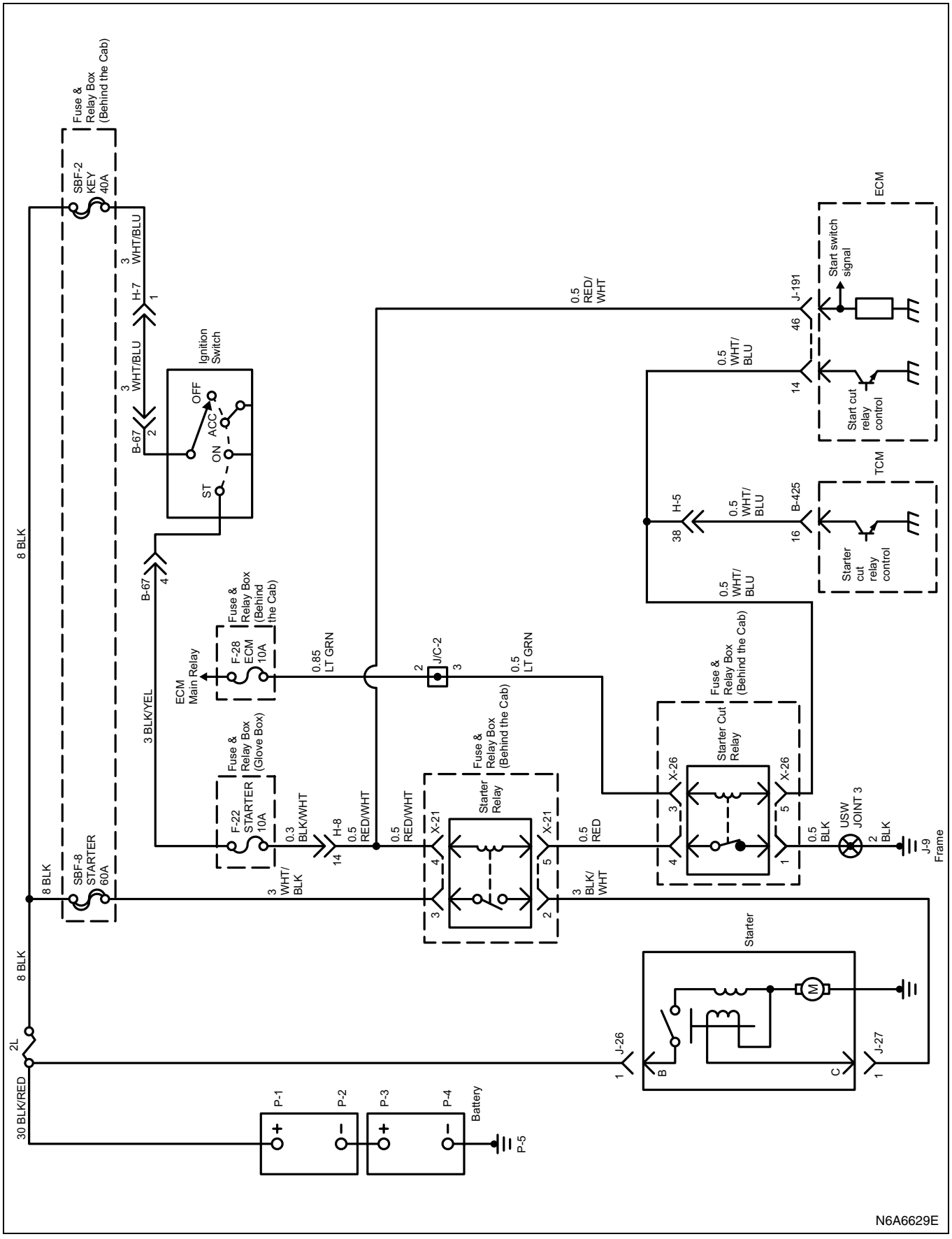
4JH1 Engine (10)



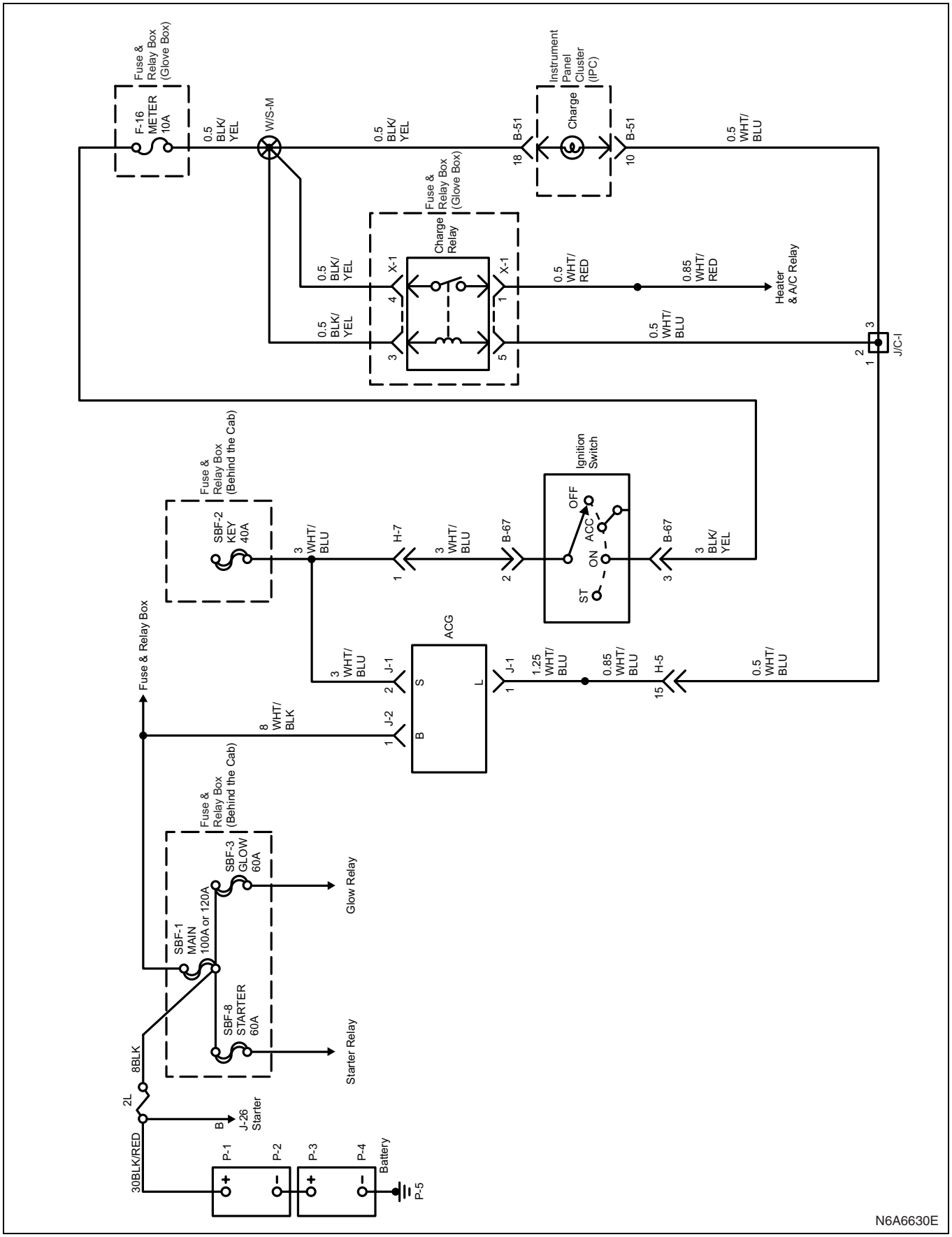
4HK1-TC Engine (1)



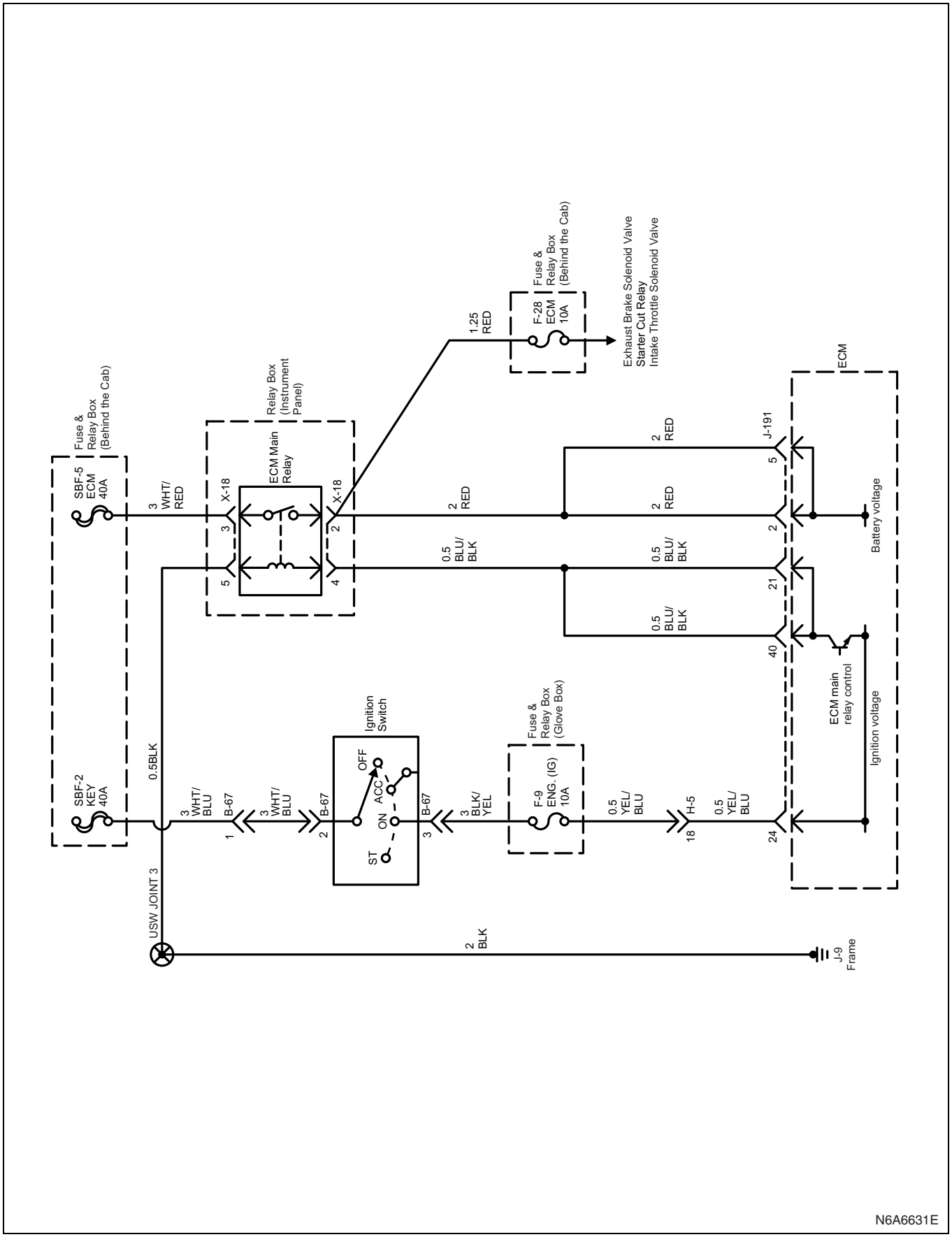
4HK1-TC Engine (2)



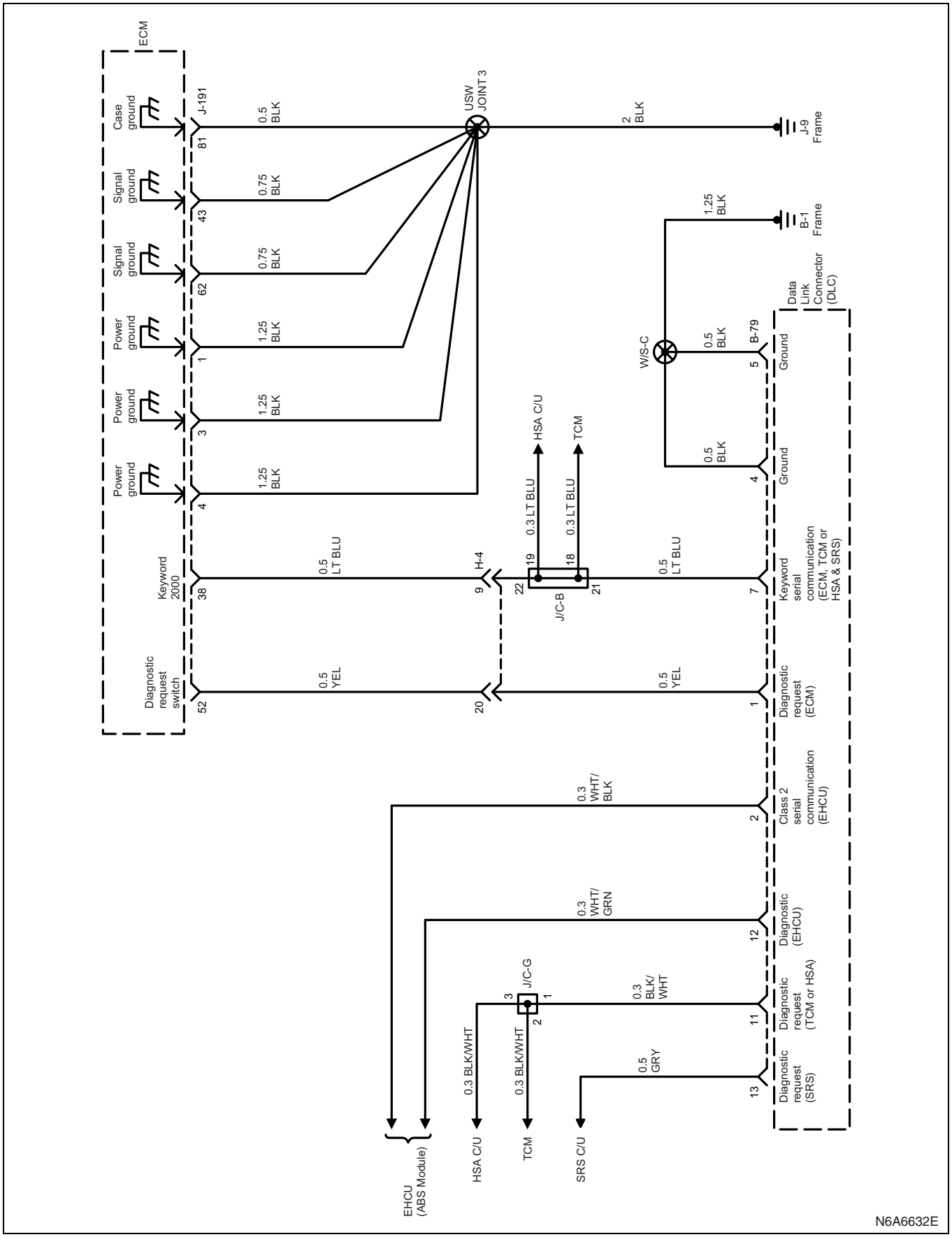
4HK1-TC Engine (3)



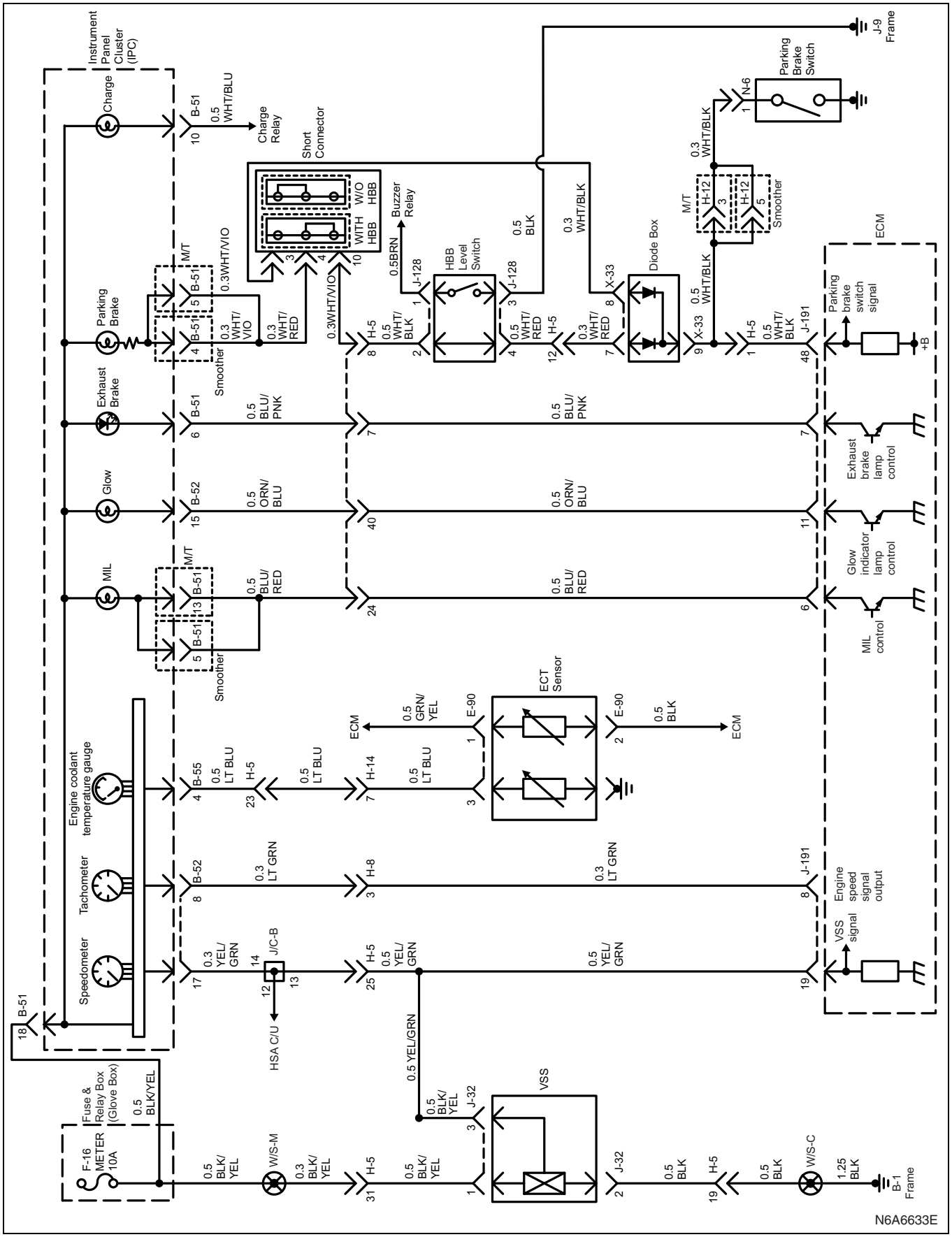
4HK1-TC Engine (4)



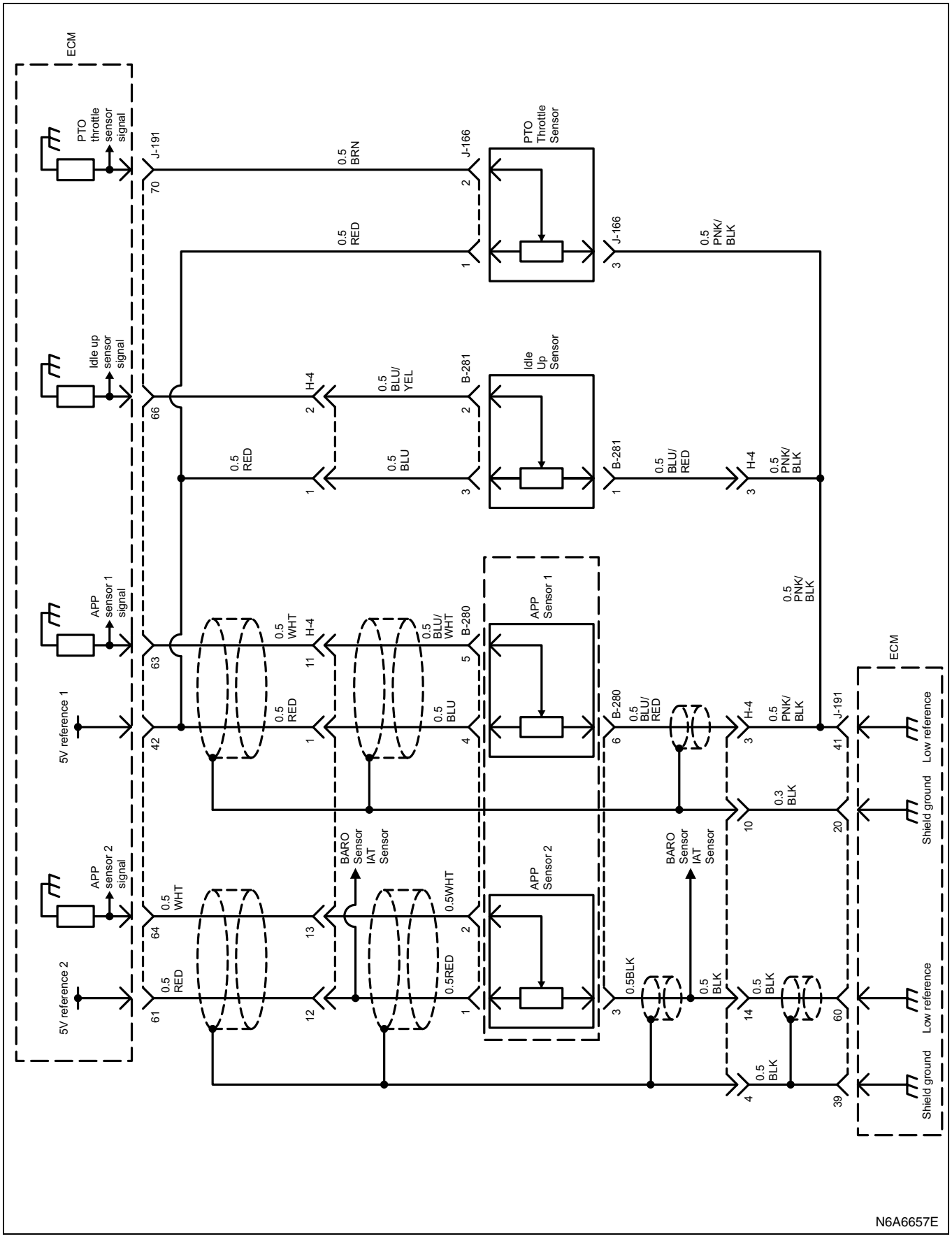
4HK1-TC Engine (5)



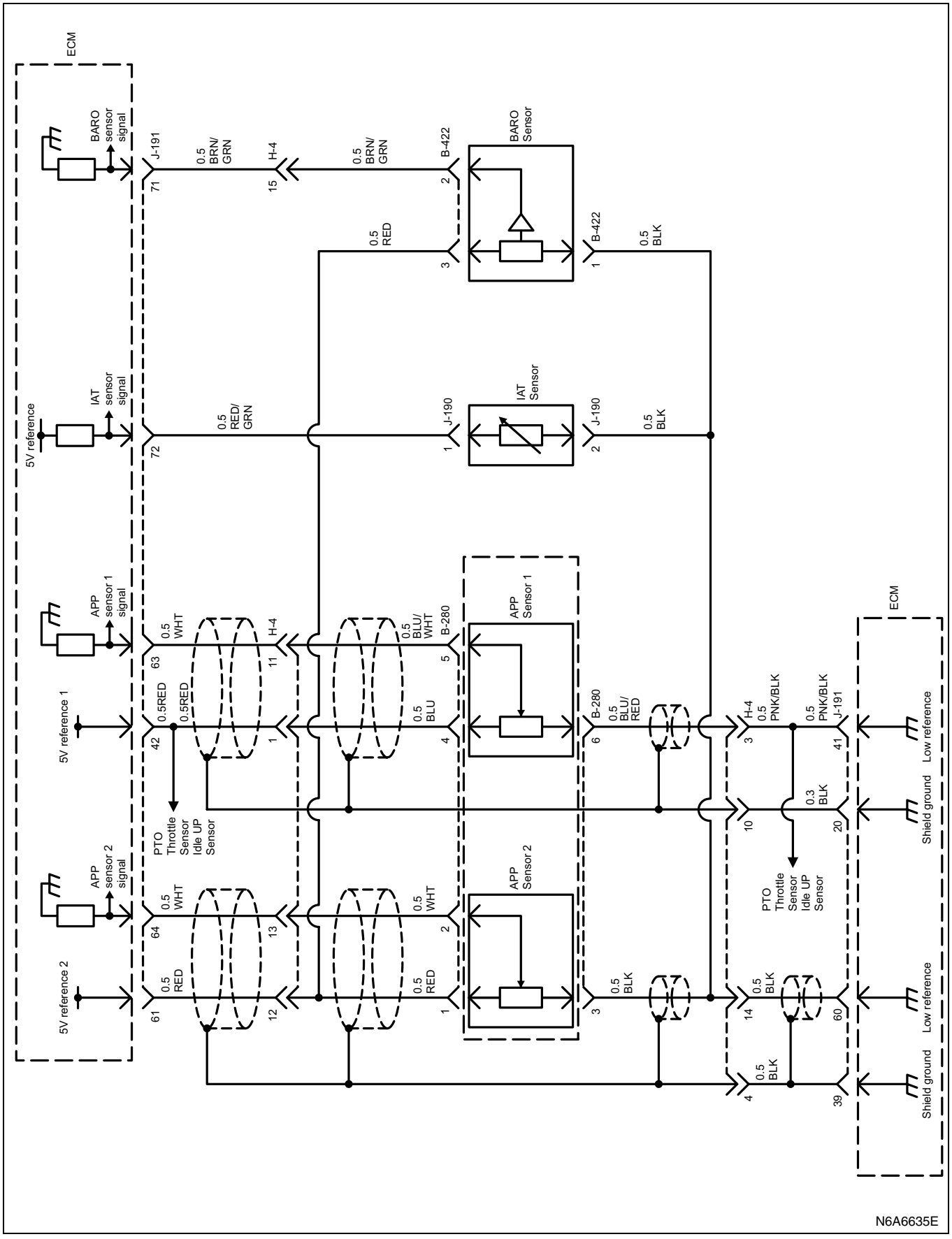
4HK1-TC Engine (6)



4HK1-TC Engine (7)



4HK1-TC Engine (8)



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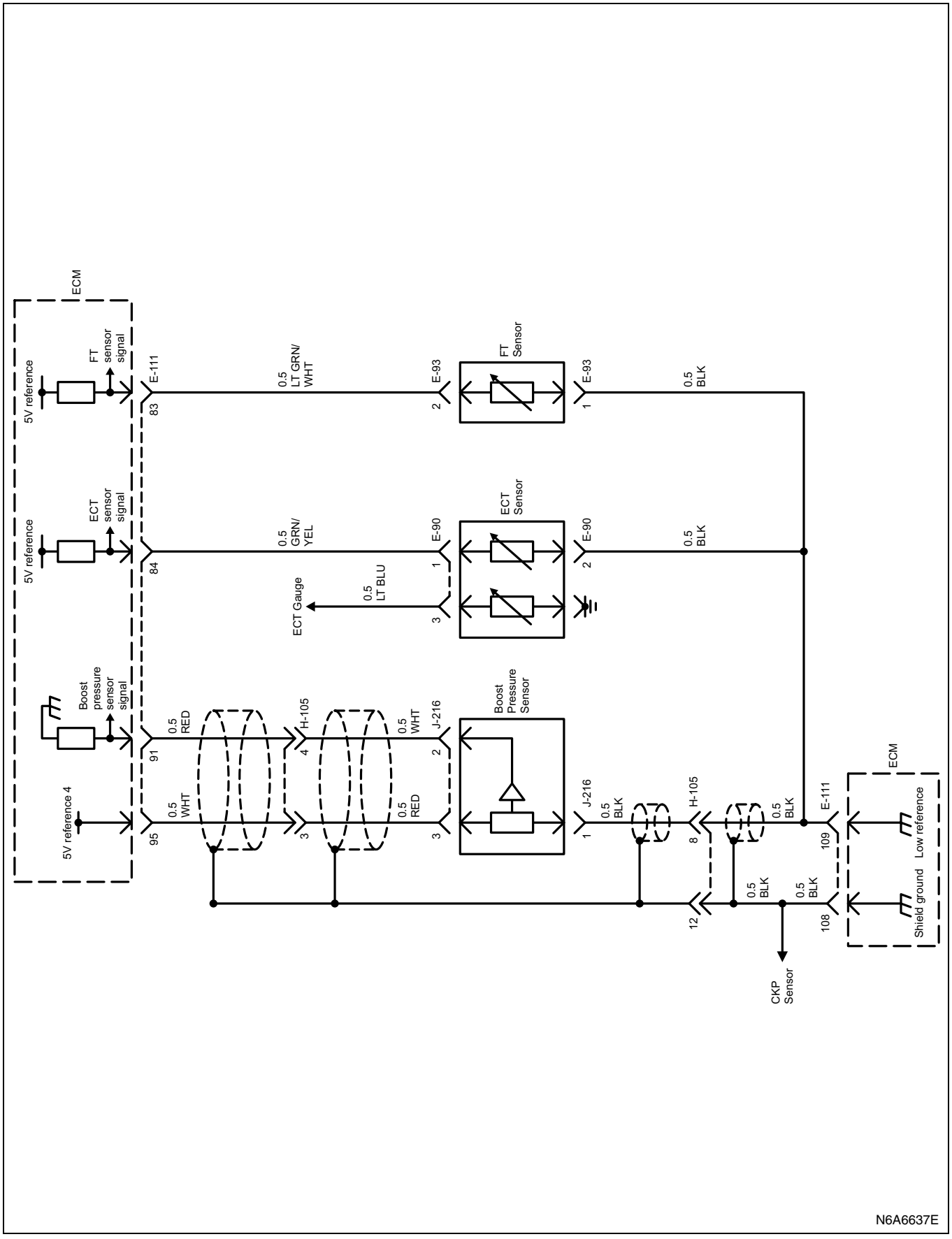

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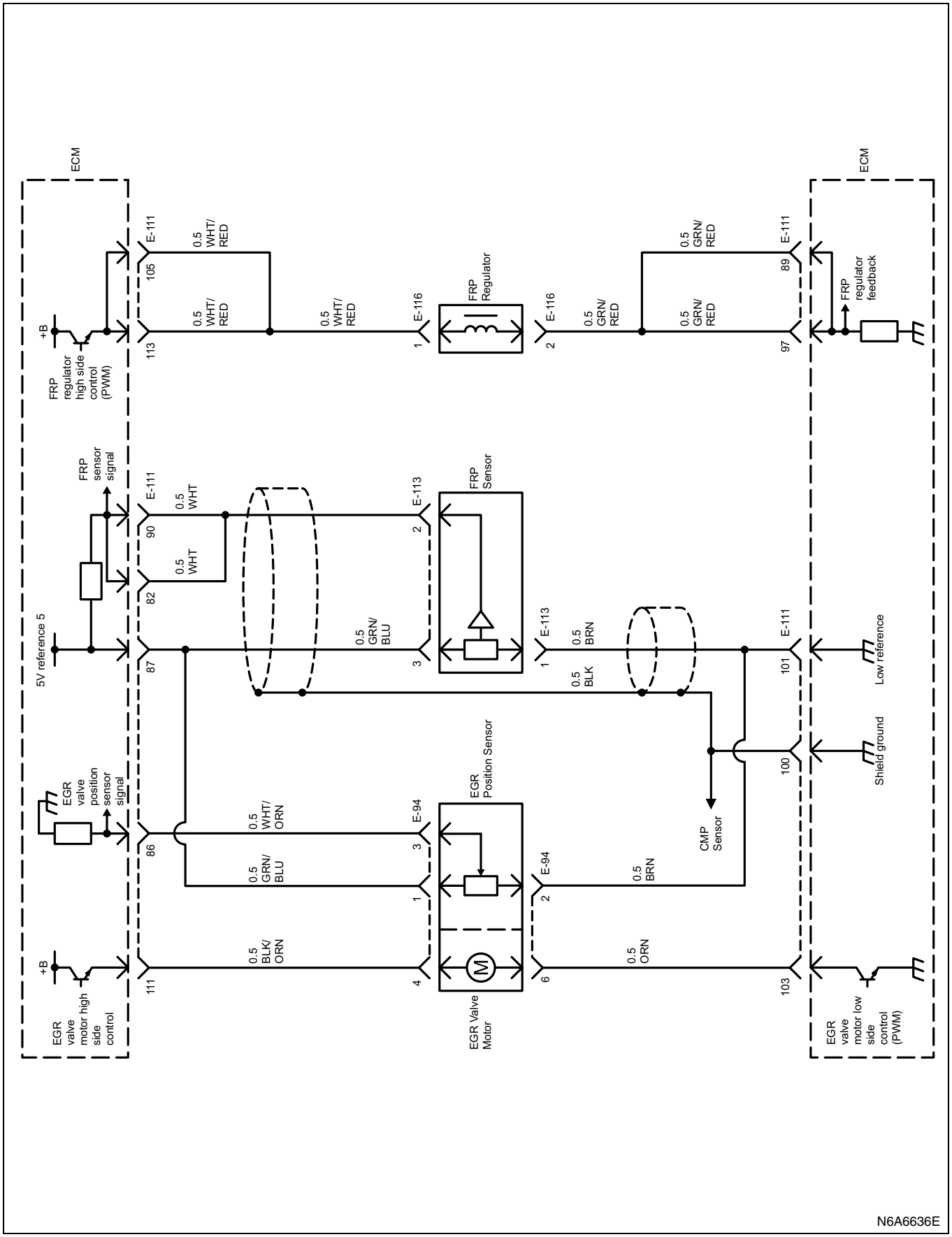
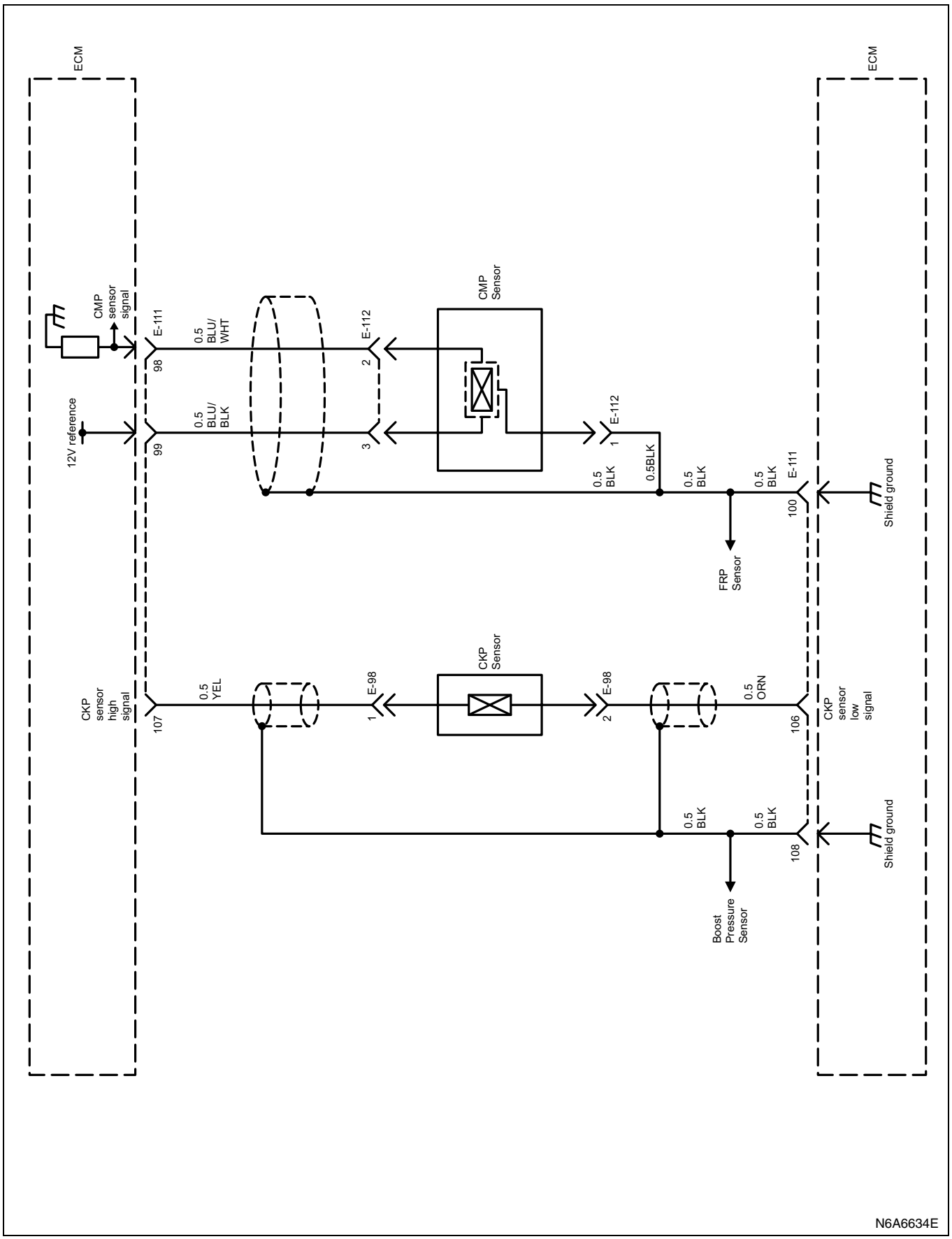
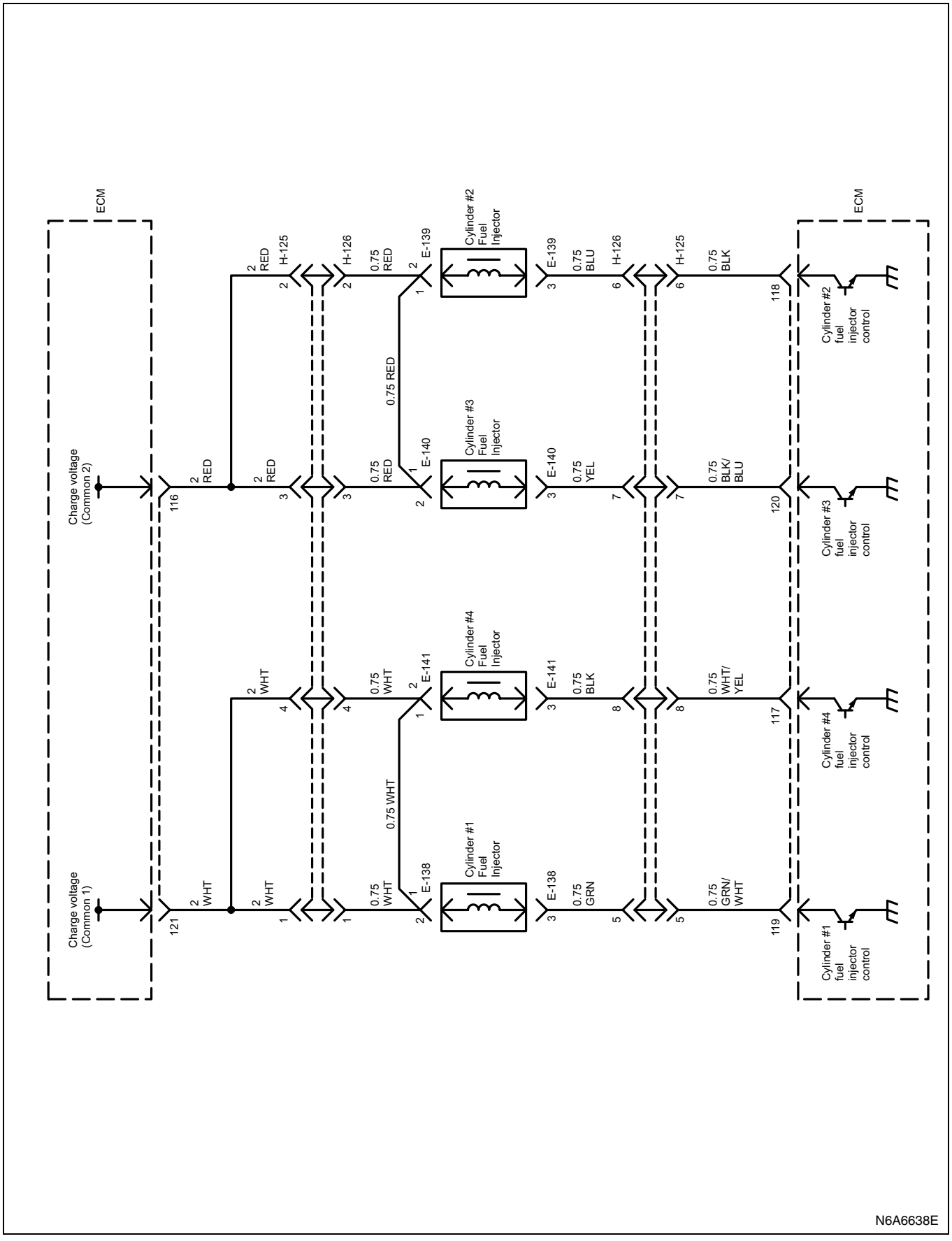


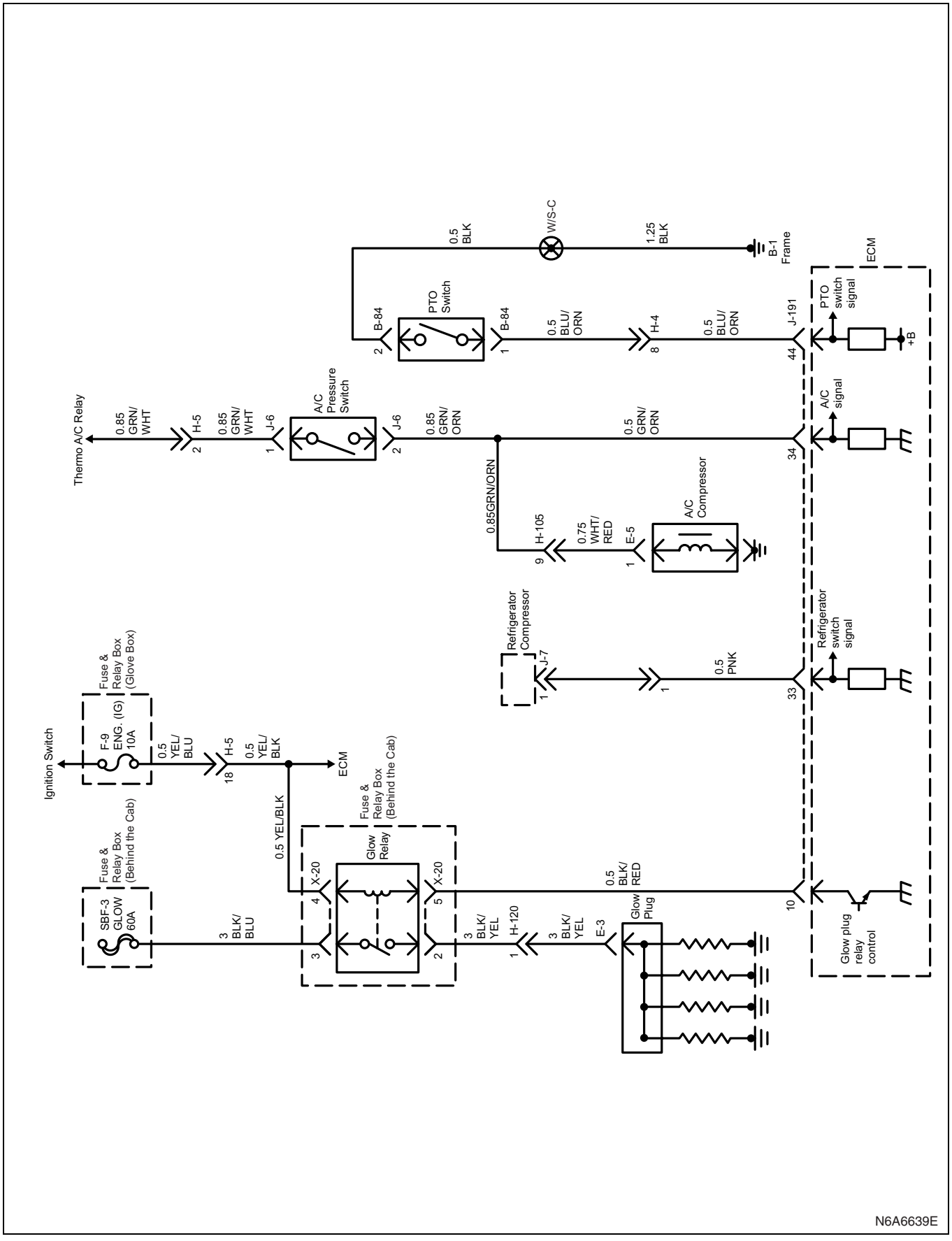
4HK1-TC Engine (11)



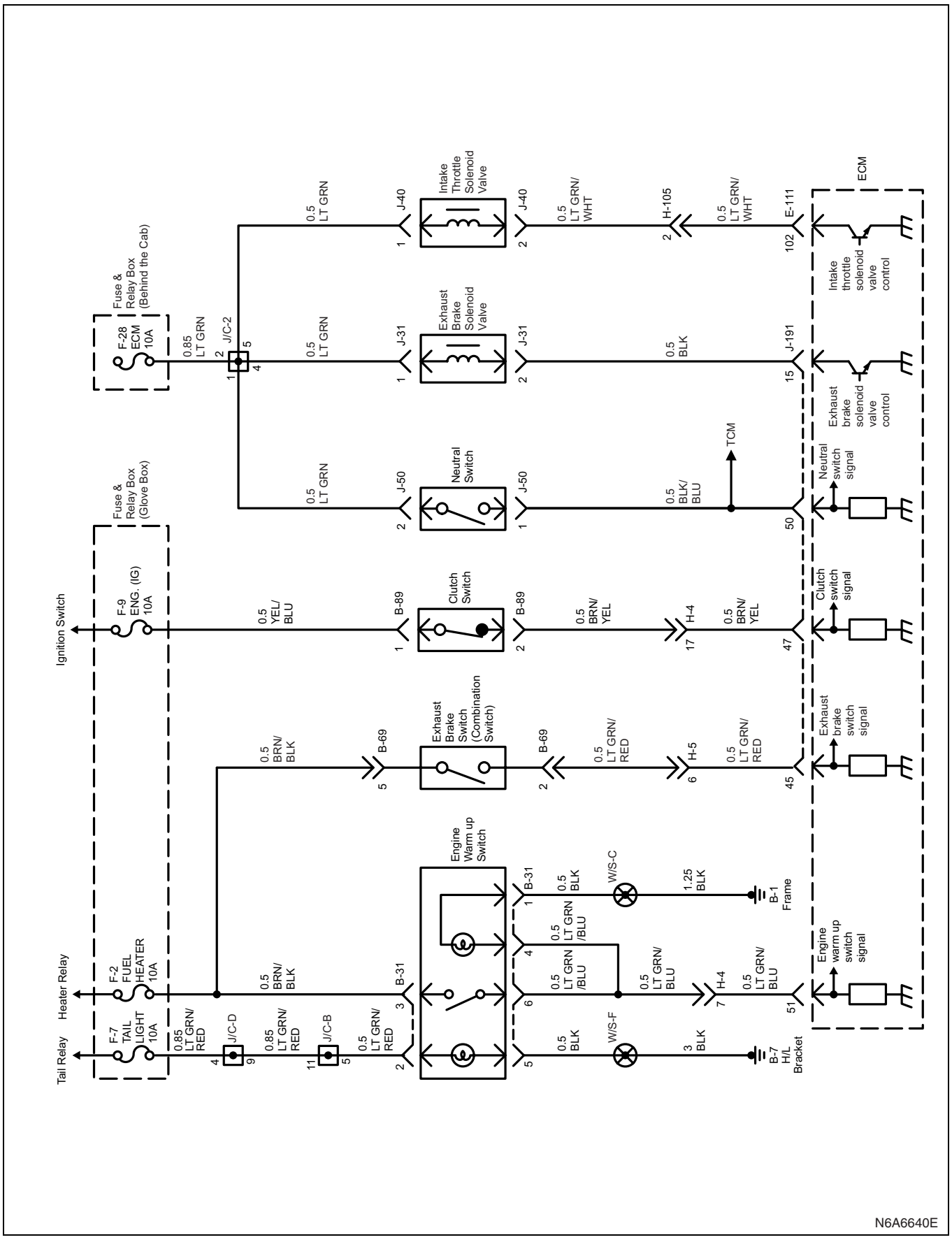
4HK1-TC Engine (12)



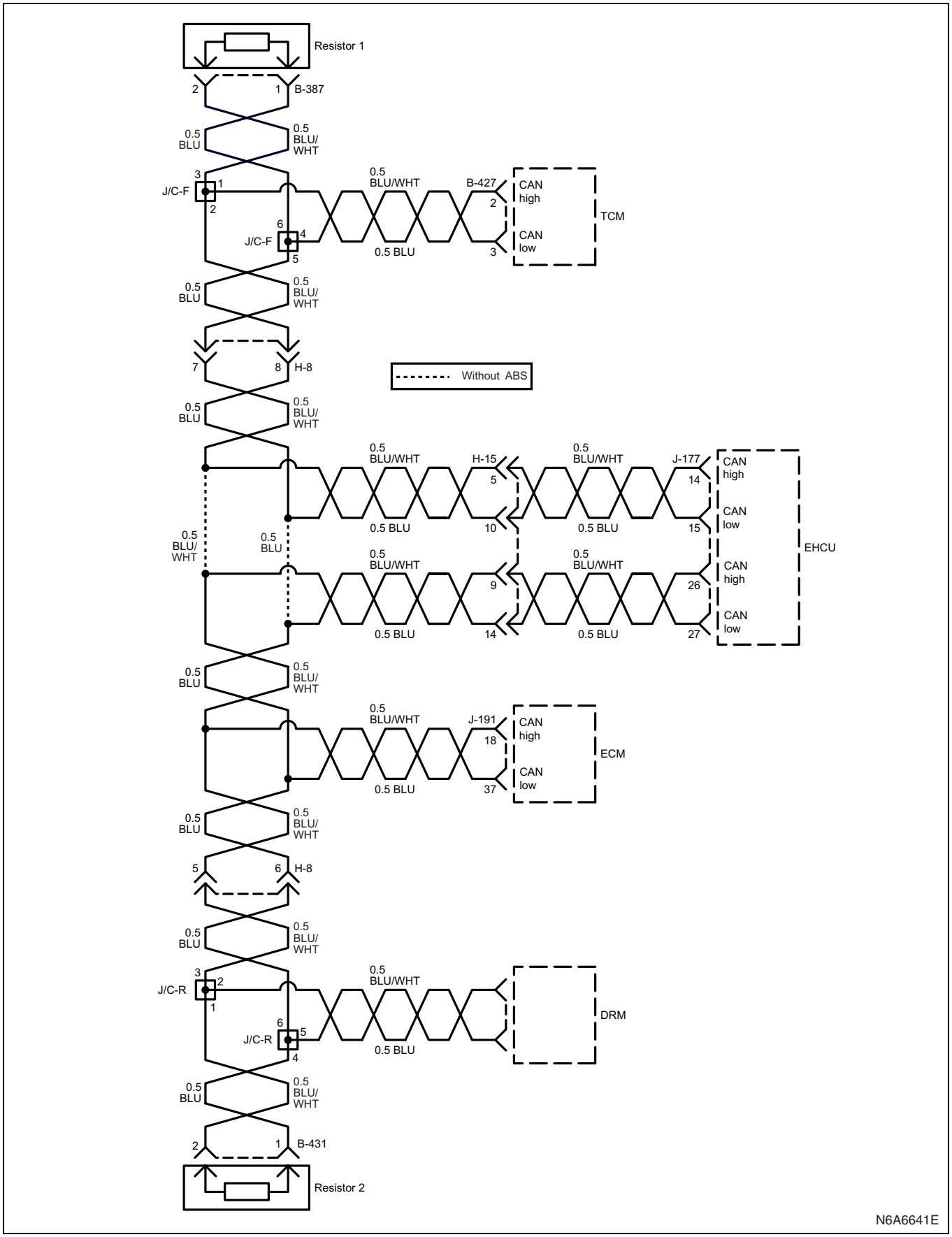
4HK1-TC Engine (13)



4HK1-TC Engine (14)

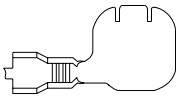
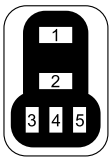
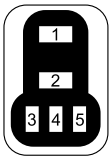
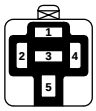
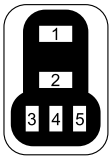
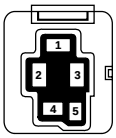


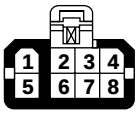
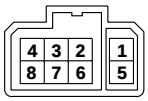
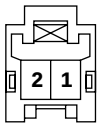
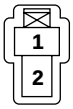
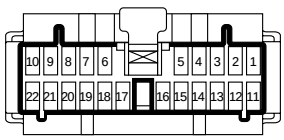
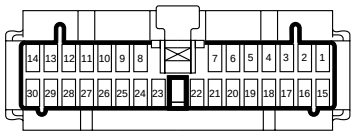
4HK1-TC Engine (15)

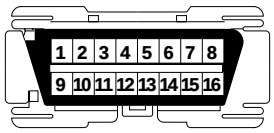
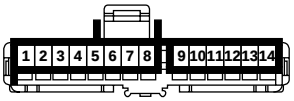
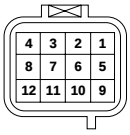
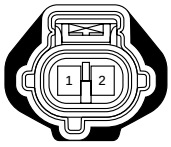
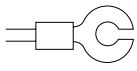


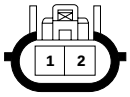
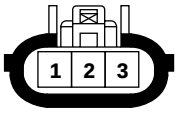
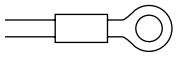
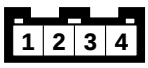
Connector List

For 4HE1-TC Engine

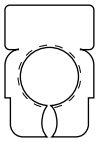
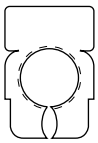
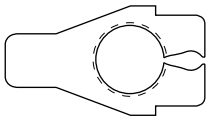
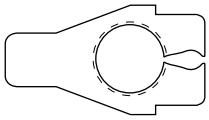
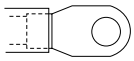
No.	Connector Face
B-7	 000-012
X-1	 005-006
X-8	 005-006
X-14	 005-001
X-25	 005-006
X-20	 005-003
B-67	004-001
B-67	004-002

No.	Connector Face
B-69	 008-001
B-69	 008-002
B-75	002-022
B-75	 002-023
B-89	002-009
B-89	 002-010
B-233	 022-002
B-234	 030-002

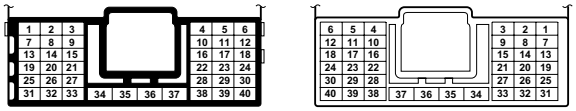
No.	Connector Face
B-79	 016-005
B-51	 014-001
H-14	016-003
H-14	016-004
H-13	012-001
H-13	 012-002
E-2	 002-013
E-3	 000-009

No.	Connector Face
E-11	 002-001
E-43	 003-003
E-74	001-013
E-76	003-004
J-9	 000-001
J-23	 004-009
J-31	002-011
J-31	002-012

No.	Connector Face
J-131	002-011
J-131	002-012
J-145	002-014
J-146	002-015
J-41	002-015
J-40	002-015
J-105	002-016
J-147	002-017

No.	Connector Face
P-1	 000-004
P-4	 000-004
P-2	 000-006
P-3	 000-006
P-5	 000-002

H-5



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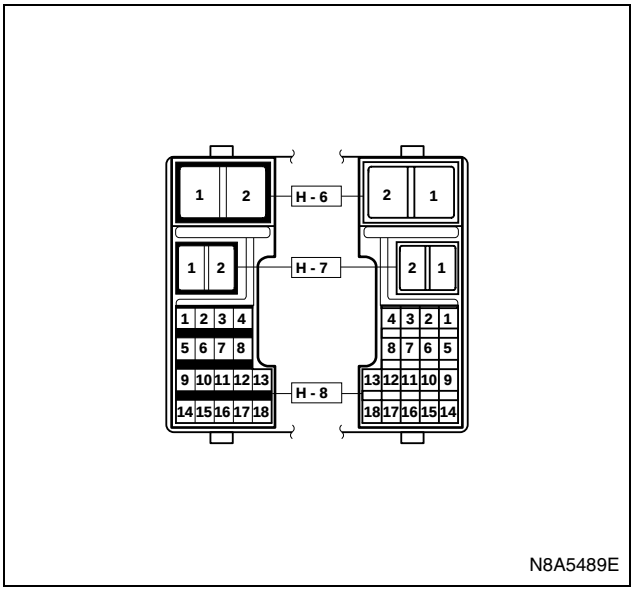
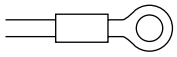
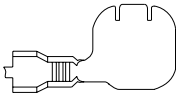
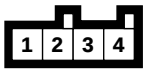
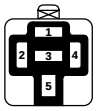
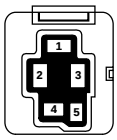
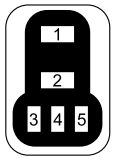
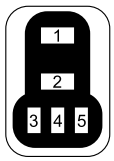
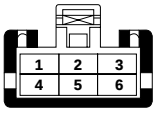
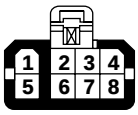
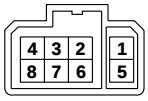
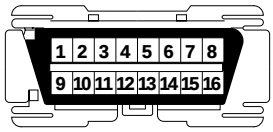
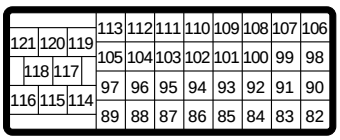
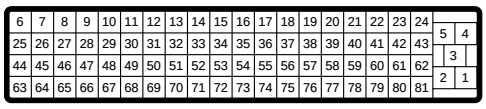
H-6, H-7, H-8

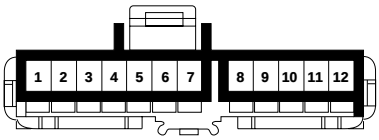
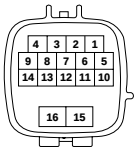


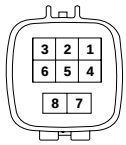
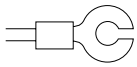
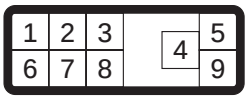
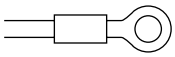
For 4JH1 Engine

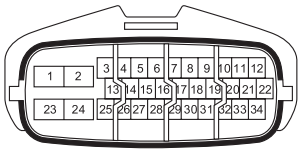
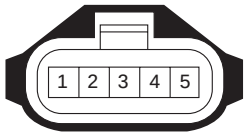
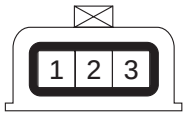
No.	Connector Face
B-1	 000-001
B-7	 000-012
B-18	 004-004
X-10	 005-001
X-11	005-001

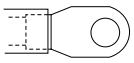
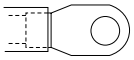
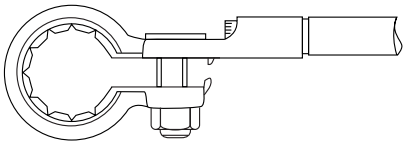
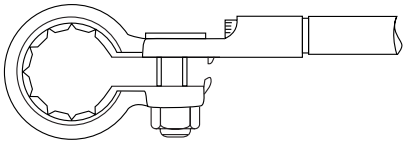
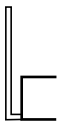
No.	Connector Face
X-12	005-001
X-14	005-001
X-20	 005-003
X-24	 005-006
X-26	 005-006
B-31	 006-001
B-66	004-010
B-339	004-010

No.	Connector Face
B-67	004-001
B-67	004-002
B-69	 008-001
B-69	 008-002
B-79	 016-005
B-89	002-019
B-233	 121-002
B-234	 121-001

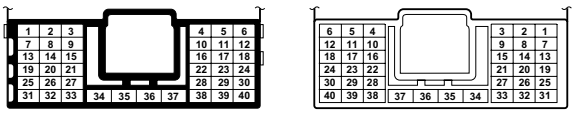
No.	Connector Face
B-340	002-022
B-341	002-009
B-342	002-009
B-51	014-001
B-52	 012-005
H-14	016-003
H-14	 016-004
H-15	008-023

No.	Connector Face
H-15	 008-024
B-80	003-005
E-5	 000-009
E-16	002-014
E-110	 009-003
J-6	004-011
J-9	 000-001
J-31	002-011

No.	Connector Face
J-31	002-012
J-32	003-018
J-40	002-017
J-50	002-035
J-122	001-007
J-177	 034-001
J-182	 005-004
J-183	 003-006

No.	Connector Face
P-1	 000-002
P-2	 000-002
P-4	 000-014
P-3	 000-014
P-5	 000-007

H-5



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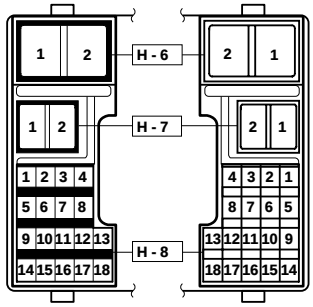
H-6, H-7, H-8



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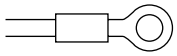
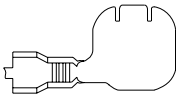
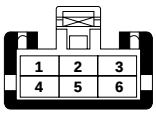
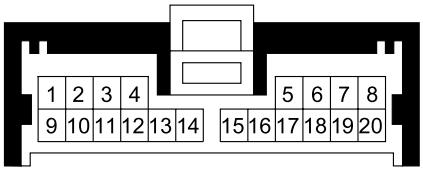
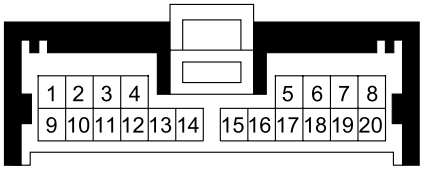
No.	Connector Face
B-1	 000-001
B-7	 000-012
B-31	 006-001
B-51	 020-005
B-52	 020-005
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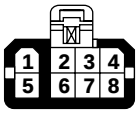
B-67	004-002
B-69	 008-001

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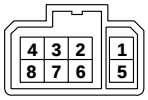
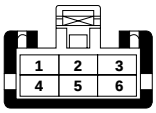
B-69	 008-002
B-84	 006-001
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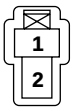
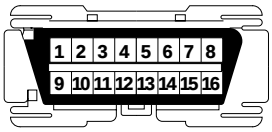
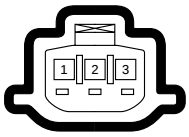
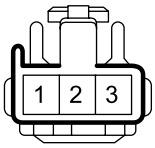
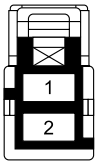
B-89	 002-010
B-79	 016-005
B-280	 003-005
B-281	 003-028
B-387	 002-038

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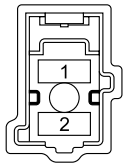
B-387	 002-039
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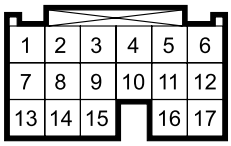
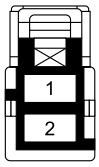
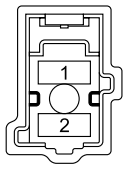
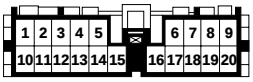
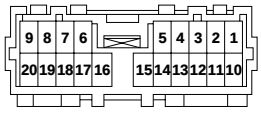
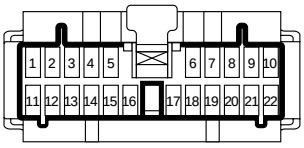
B-427	 017-001
B-431	 002-038
B-431	 002-039
H-4	 020-002
H-4	 020-003
H-12	 022-001

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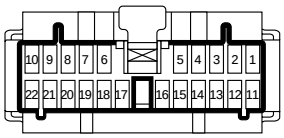
H-12	 022-002
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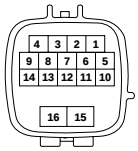
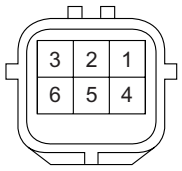
H-15	 016-004
H-105	 006-026
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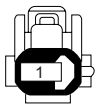
H-120	 001-023
H-120	001-022
H-125	008-019

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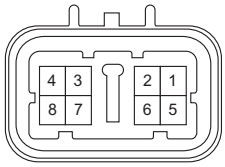
H-125	 008-020
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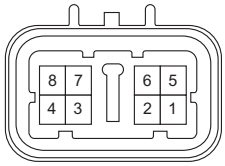
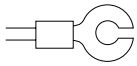
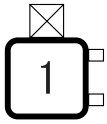
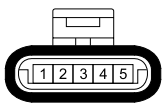
H-126	 008-021
E-3	 000-009
E-5	 001-021
E-90	003-004
E-93	002-035
E-94	 005-007

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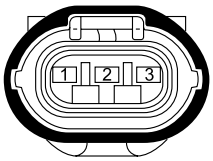
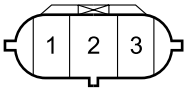
E-112	 003-026
E-113	 003-029
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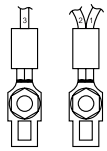
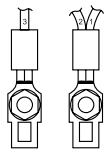
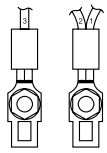
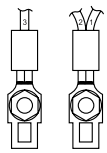
E-138	 003-031
E-139	 003-031
E-140	 003-031
E-141	 003-031

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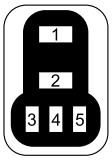
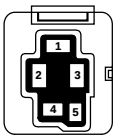
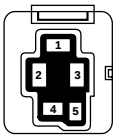
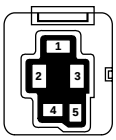
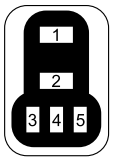
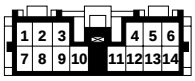
X-1	 005-006
X-11	005-001
X-18	 005-003
X-20	 005-003
X-21	 005-003
X-26	 005-006
X-33	 014-002
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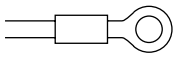
J-2	 000-001
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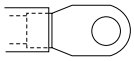
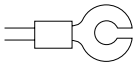
J-26	 000-002
J-27	 000-009
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J-32	003-018
J-40	002-017

No.	Connector Face
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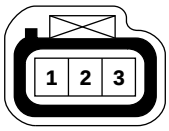
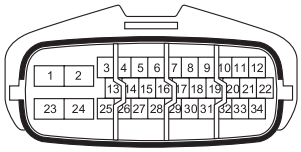
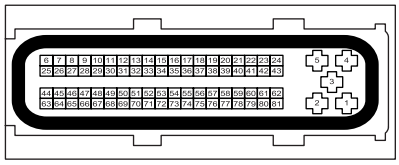
J-166	 003-001
J-177	 034-001
J-191	 081-001
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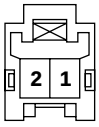
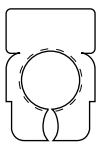
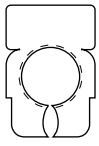
N-6	 002-023
P-1	 000-004
P-4	 000-004

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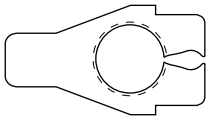
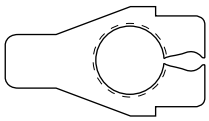
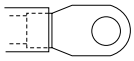
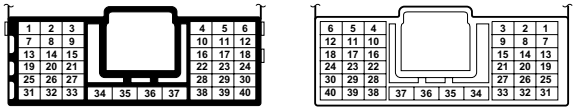
P-2	 000-006
P-3	 000-006
P-5	 000-002

H-5



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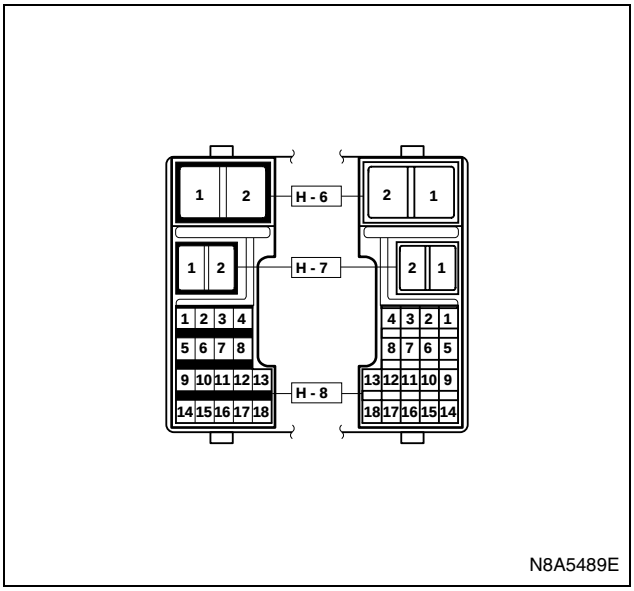
H-6, H-7, H-8



Engine Stop System

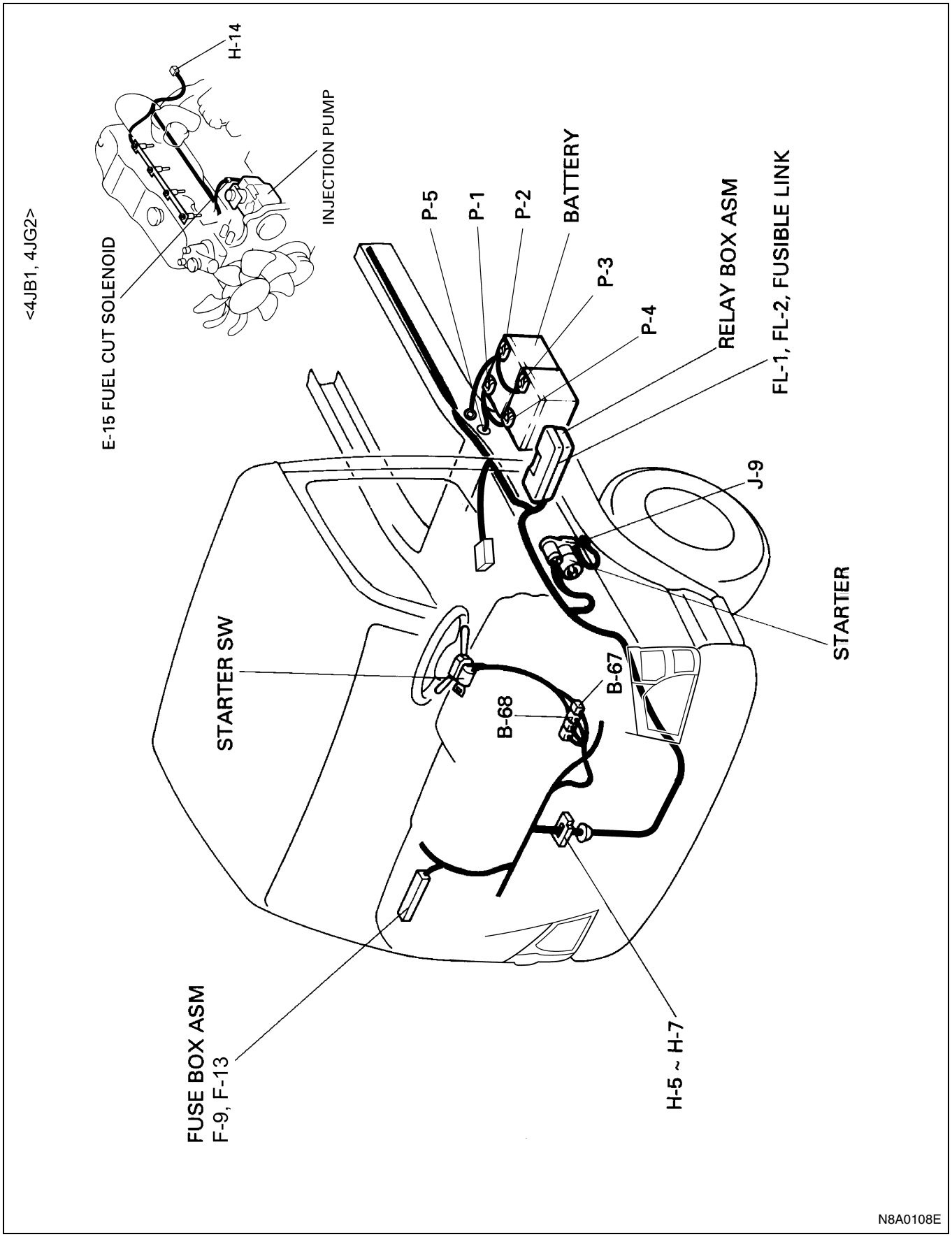
General Description

The circuit consists of starter switch and engine stop motor.
The engine stop mechanism aims at shut-off of fuel supply.
Available are motor type and solenoid type depending on the types of the engine mounted.
Motor type is forcible pull the injection pump control rack to the direction of fuel supply reduction by means of engine stop motor, thus shutting it off.
Solenoid type is to have the starter switch turn from “ON” position to “OFF”, so that the solenoid valve fitted to the injection pump closes to shut off the fuel circuit.

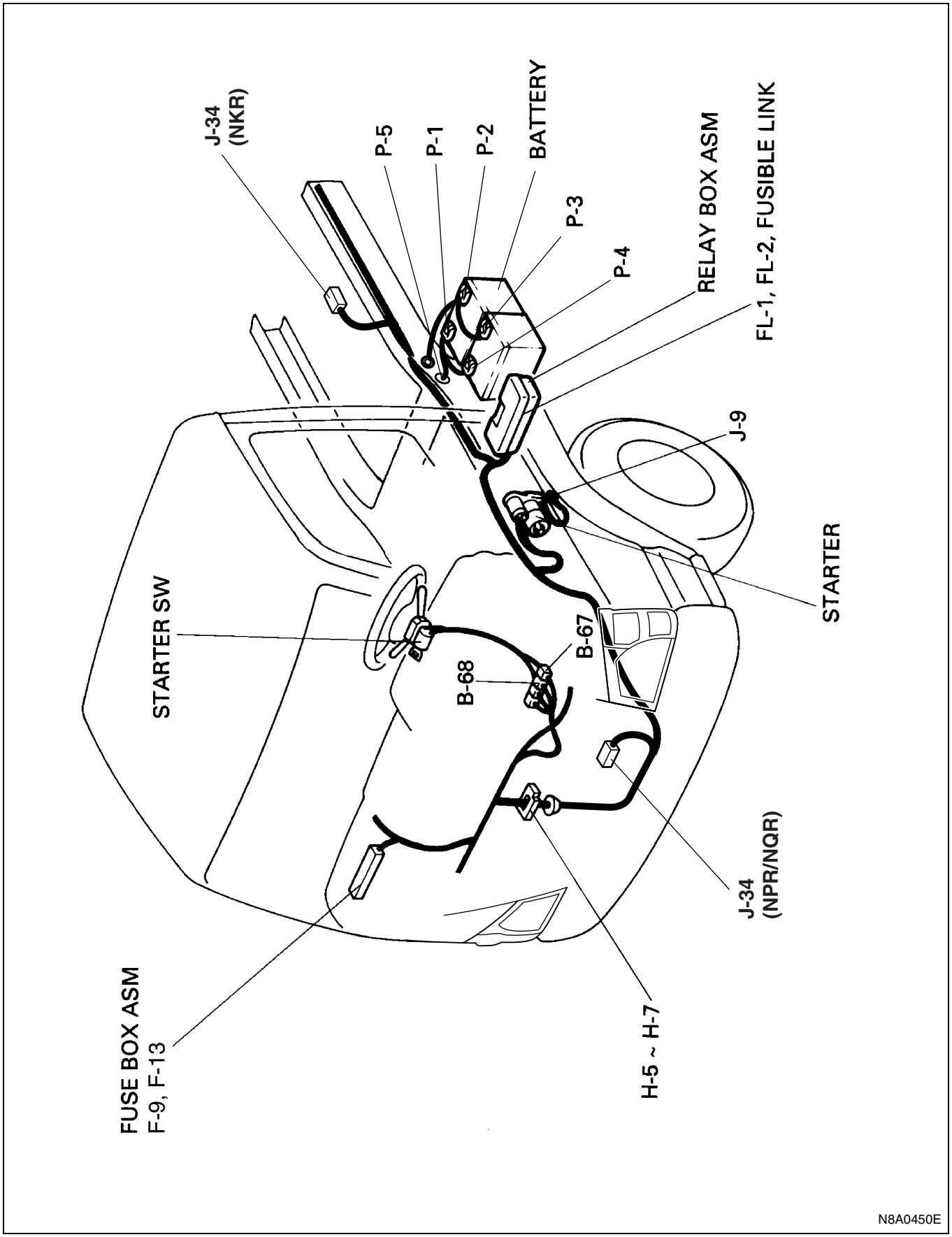
Engine stop system	Engine model
Motor type	4HF1, 4HG1,4HE1
Solenoid type	4JB1, 4JG2

Parts Location

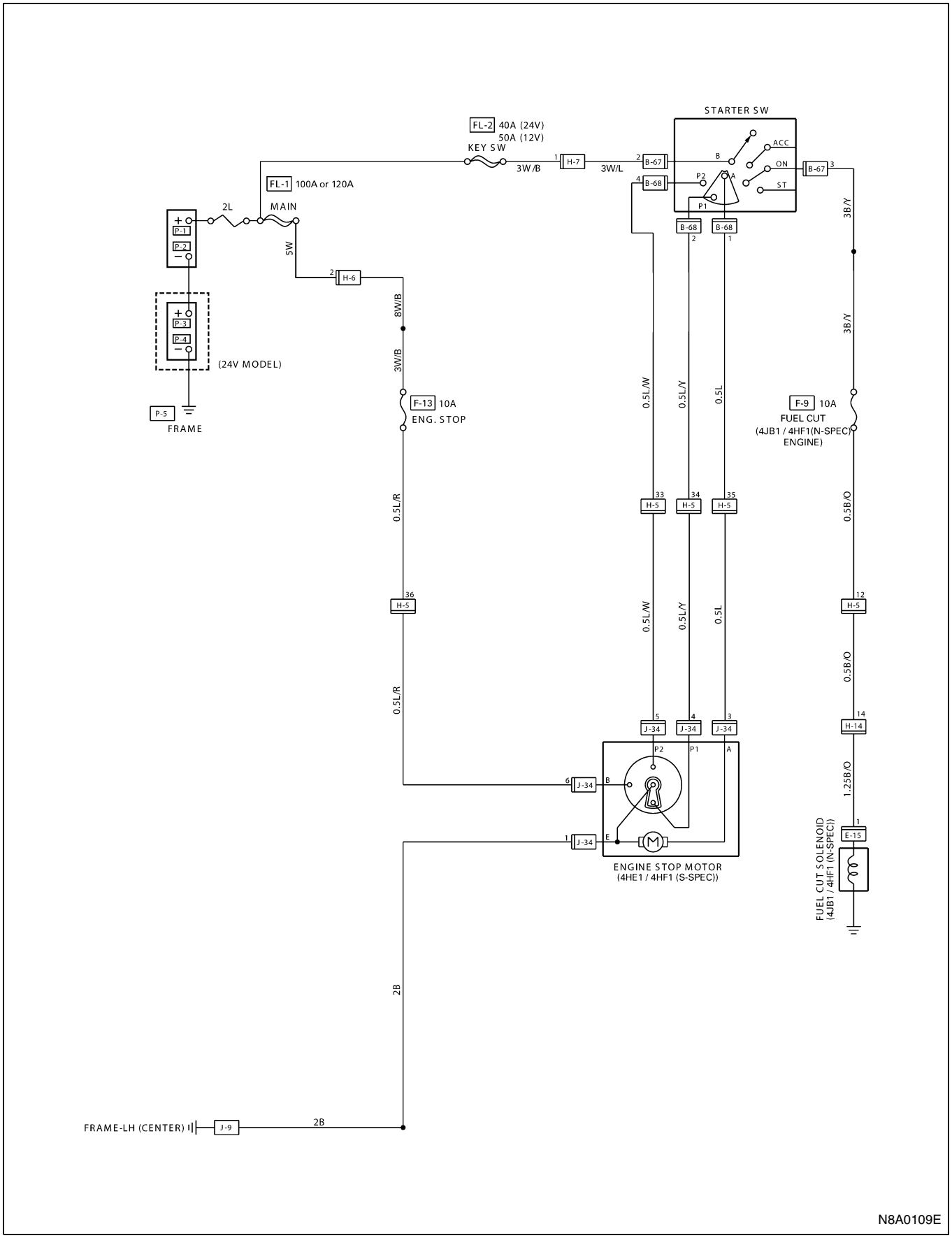
4JB1 / 4JG2 / 4HG1 (N-Spec) Engine



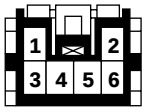
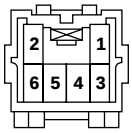
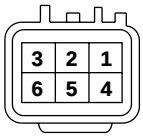
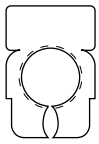
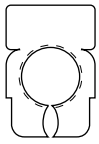
4HF1 (S-Spec) / 4HG1 / 4HE1 Engine

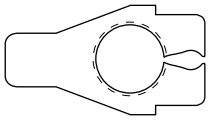
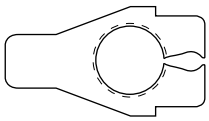
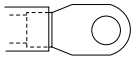
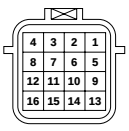


Circuit Diagram

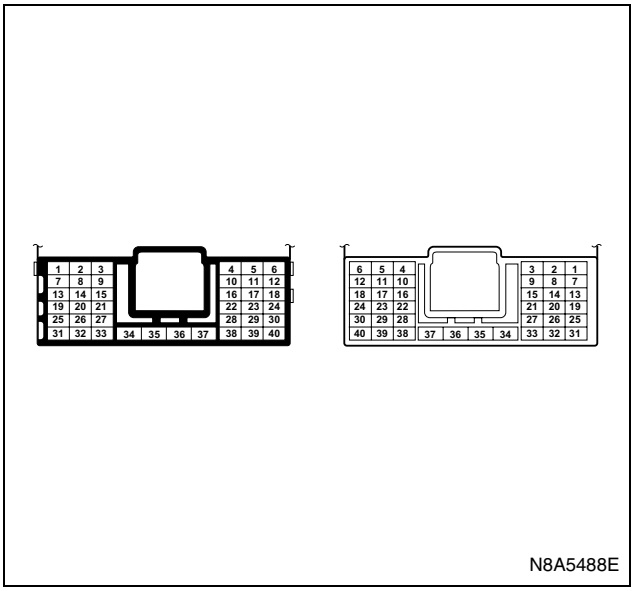


Connector List

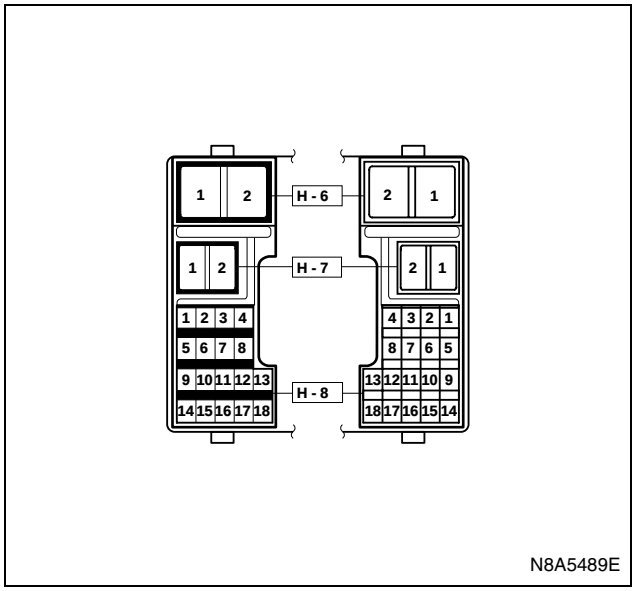
No.	Connector Face
B-67	004-001
B-67	004-002
B-68	 006-002
B-68	 006-003
J-34	006-004
J-34	 006-005
P-1	 000-004
P-4	 000-004

No.	Connector Face
P-2	 000-006
P-3	 000-006
P-5 (12 V)	000-007
P-5 (24 V)	 000-002
E-15	001-002
E-15	001-003
H-14	016-001
H-14	 016-002

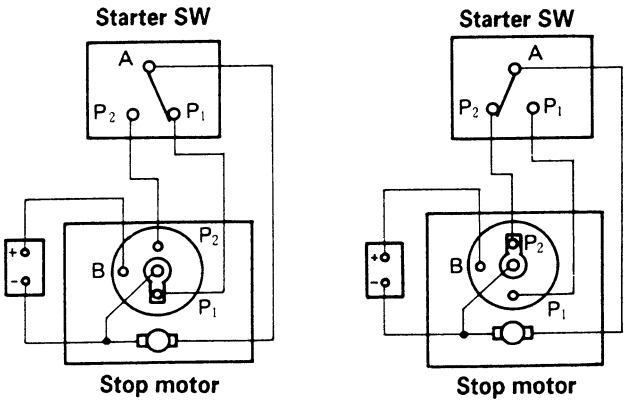
H-5



H-6, H-7



Function of Engine Stop Motor



Turn the starter switch from "ACC" position to "ON", and the engine stop motor will turn by 180 degrees (from 0° to 180°) so that the stop motor's electrode will be in potential equal to that of the starter switch for the stop.

Turn the starter switch from "ON" position to "ACC" or "LOCK", and then the stop motor will rotate by 180 degrees(from 180° to 360°) and crease operating.

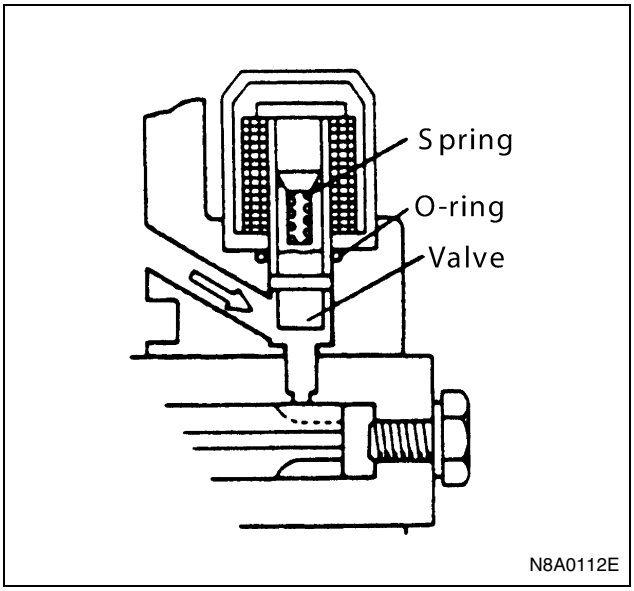
Starter SW key position \ Connector No. / Terminal No.	B-68 A (1)	B-68 P1 (2)	B-68 P2 (4)	Stop motor	Stop lever position
LOCK	○	○		0° (360°)	Stop
ACC	○	○			
ACC → ON				0° → 180°	Stop → Run
ON	○		○	180°	Stop
START	○		○		
ON → ACC LOCK				0° → 360°	Stop → Run

N8A5127E

Solenoid Type

Starter Switch and Solenoid Valve

Turn the starter switch from “ON” position to “OFF”, and then the solenoid valve fitted to the injection pump closes to cut off the fuel circuit.



Key position	Solenoid valve
LOCK	Close
ACC	
ON	Open
START	

Headlight, Fog Light, Rear Fog Light and Cornering Light

General Description

The circuit consists of headlight, fog light, cornering light, starter switch, combination switch (Lighting switch, dimmer / passing switch, cornering light switch), fog light switch, rear fog light switch, rear fog light, high beam indicator light and relay.

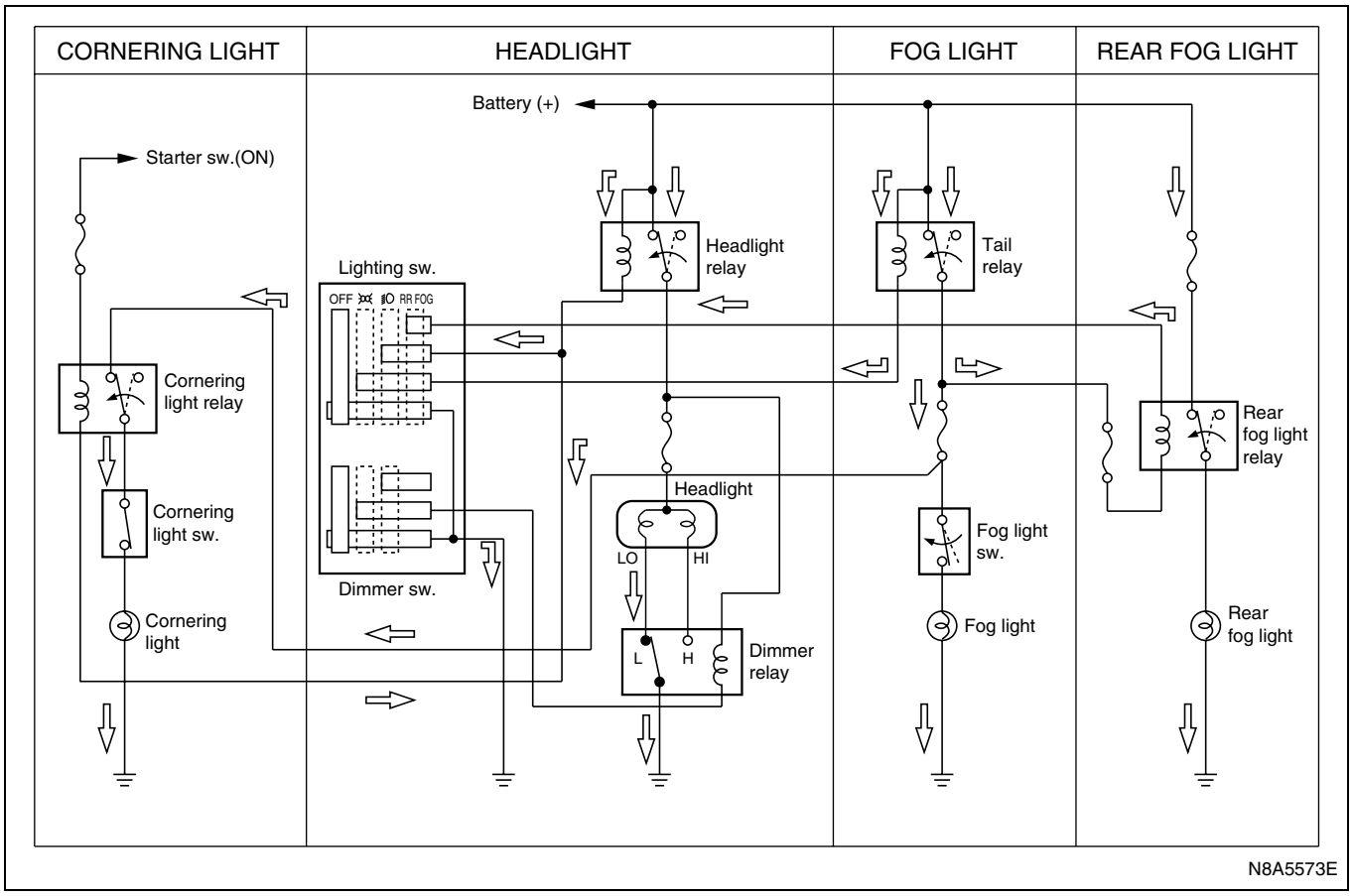
When the lighting SW is turned on by setting it at headlight position, the lighting relay is actuated to turn on the headlight. The optical axis of the headlight can be turned up or down by operating the dimmer SW while headlight is on.

The passing SW is independent of the lighting SW, and the optical axis of the passing light can be turned up only while the switch lever is pulled up and held in this state.

Fog light turns on by switching it to “ON” position to activate relay only while lighting SW is on. Rear fog light turns on by switching it to “ON” position to activate relay only while lighting SW is at headlight position.

When the headlight is on, turn the turn-signal switch left or right, and then the cornering switch built in the combination switch turns on, followed by the cornering light turning on.

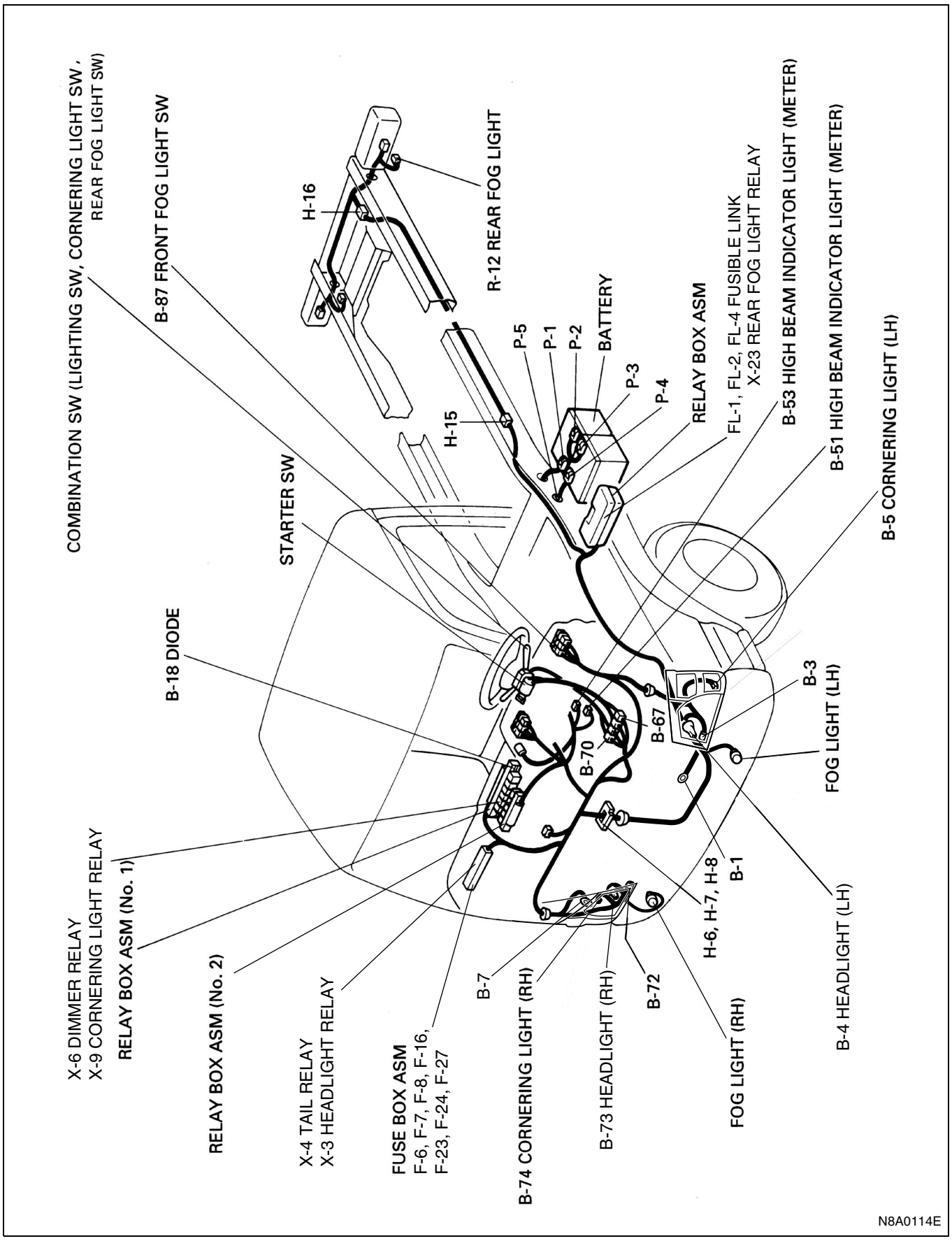
Lighting Circuit



Notice:

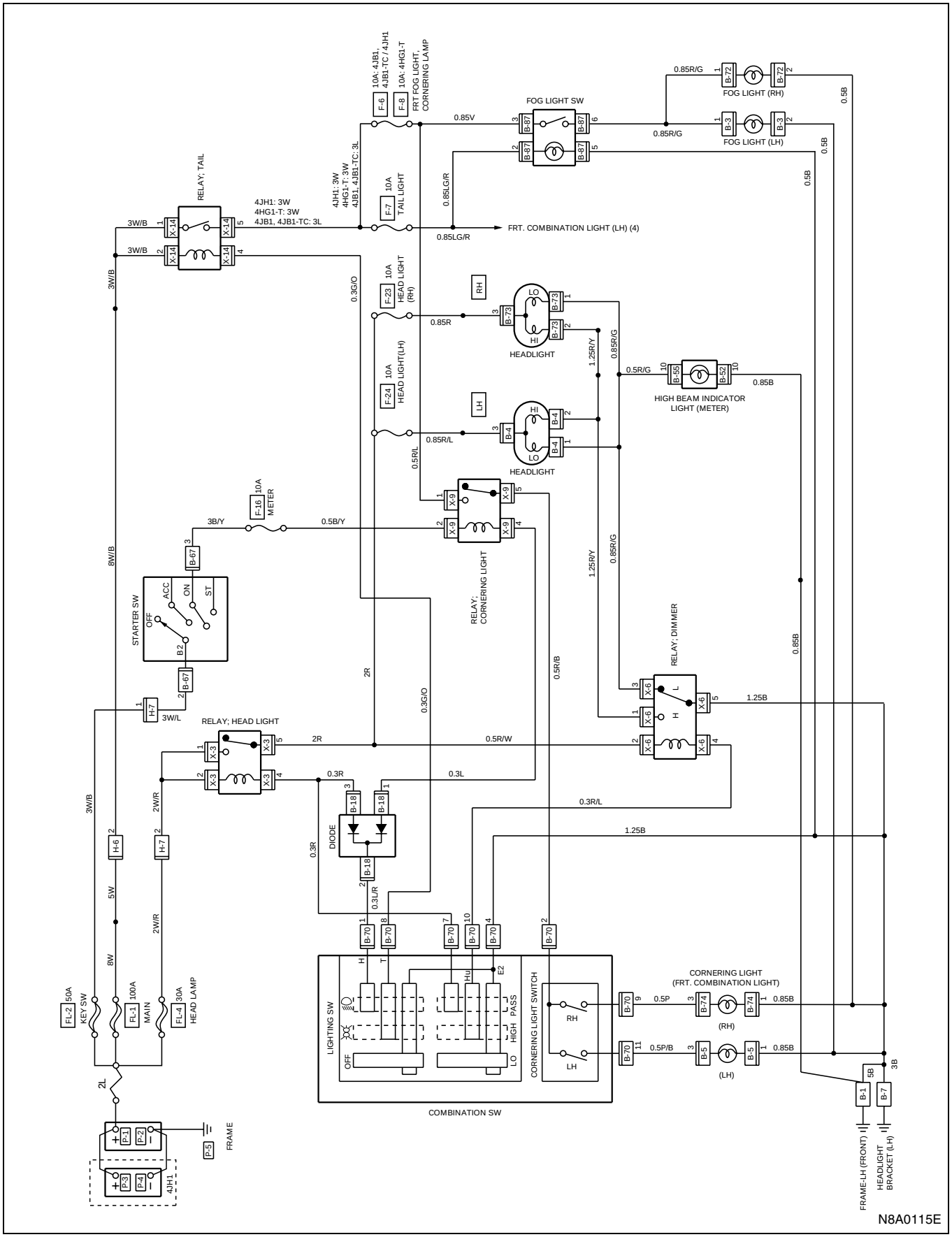
Arrow marks indicate the direction of current.

Parts Location

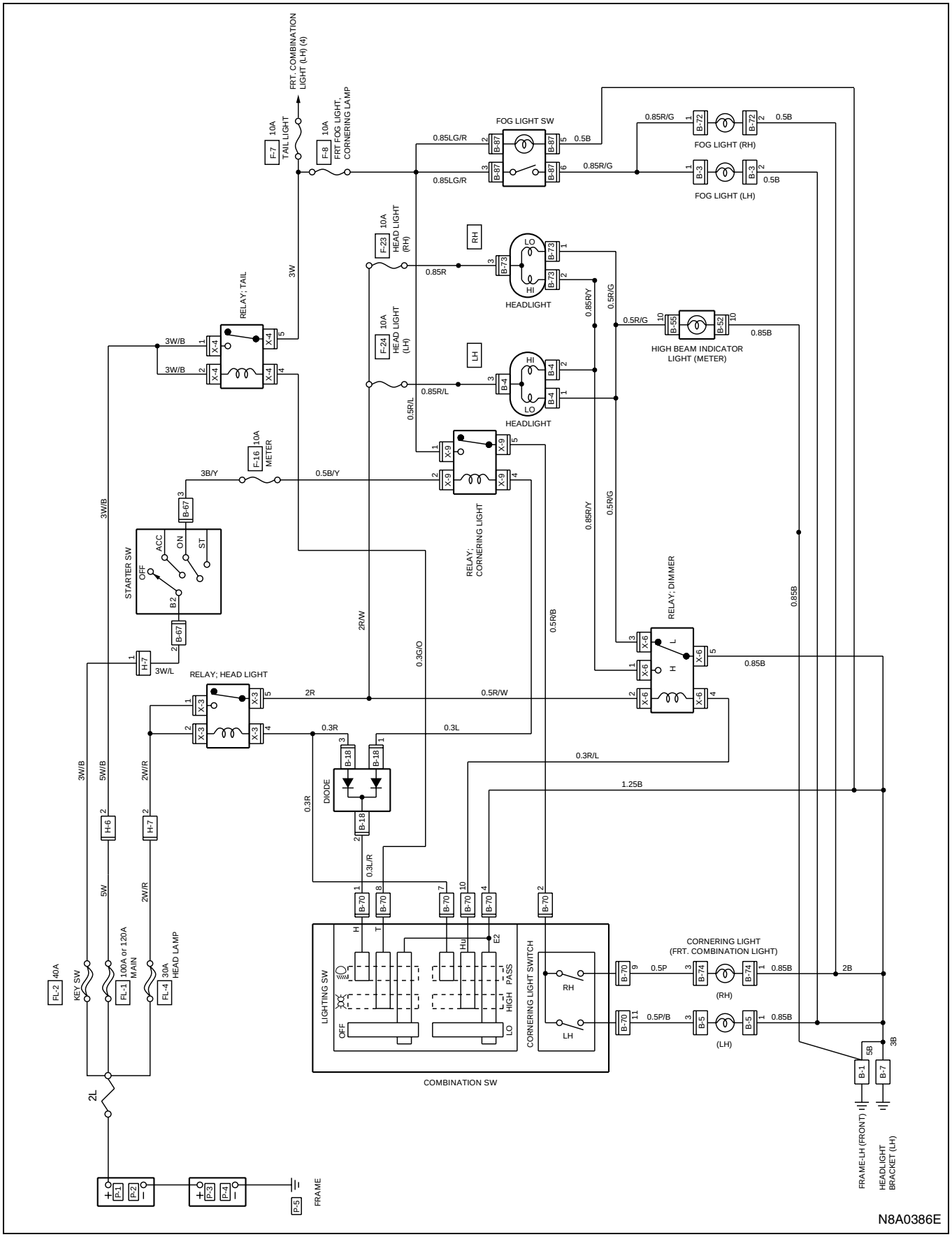


Circuit Diagram

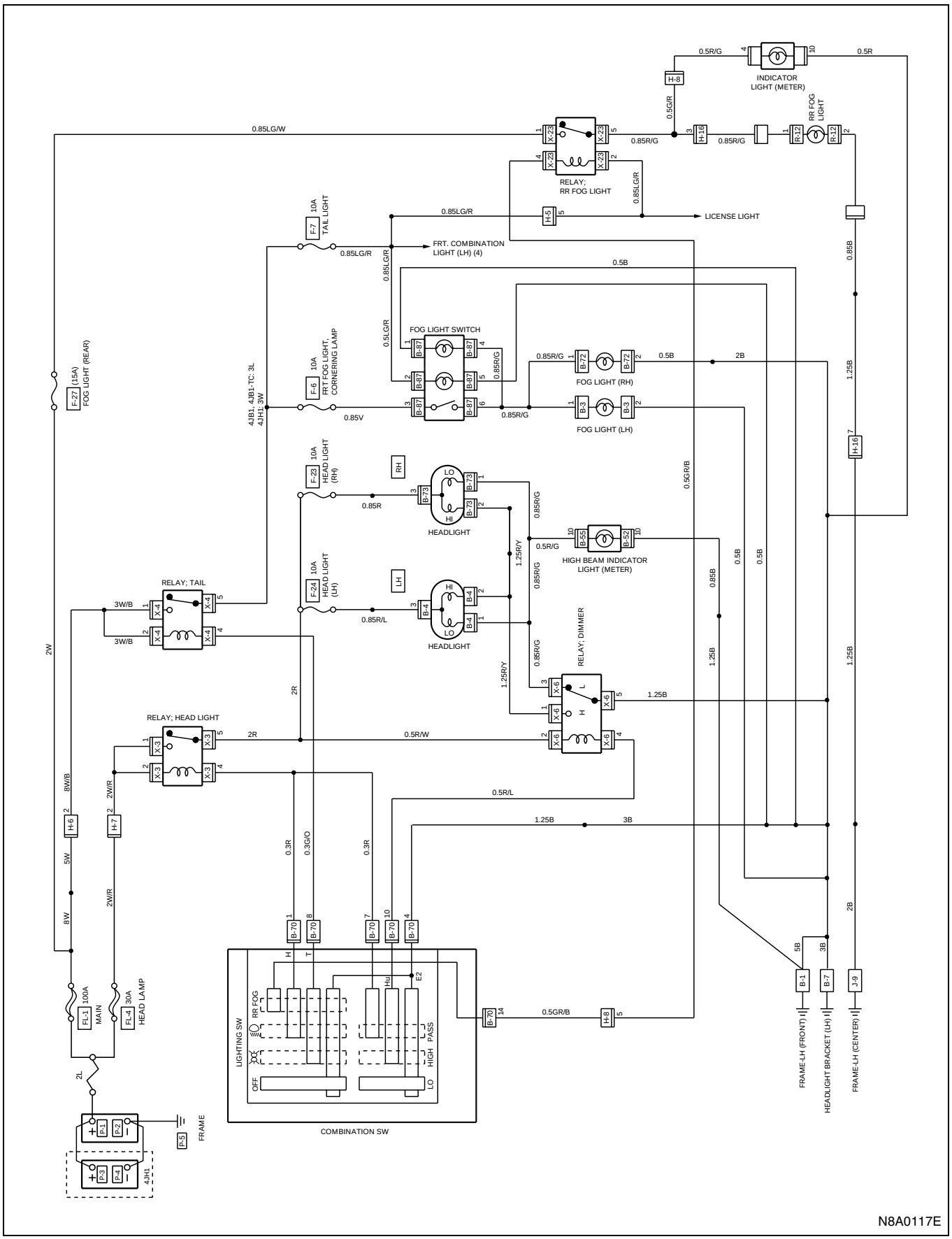
For 12 Volt (Except NKR77 for Taiwan)



For 24 Volt


FRT. COMBINATION LIGHT (LH) (4)
F-7 10A TAIL LIGHT
F-8 10A FRT FOG LIGHT, CORNERING LAMP
FOG LIGHT SW
FOG LIGHT (RH)
FOG LIGHT (LH)
F-23 10A HEAD LIGHT (RH)
F-24 10A HEAD LIGHT (LH)
HEADLIGHT
HIGH BEAM INDICATOR LIGHT (METER)
RELAY; TAIL
F-16 10A METER
RELAY; CORNERING LIGHT
RELAY; DIMMER
STARTER SW
RELAY; HEAD LIGHT
DIODE
LIGHTING SW
CORNERING LIGHT SWITCH
COMBINATION SW
CORNERING LIGHT (FRT. COMBINATION LIGHT)
FL-2 40A KEY SW
FL-1 100A or 120A MAIN
FL-4 30A HEAD LAMP
FRAME-LH (FRONT)
HEADLIGHT BRACKET (LH)
FRAME
N8A0386E

With Rear Fog Light



Connector List

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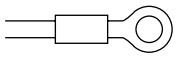
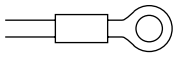
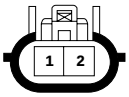
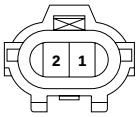
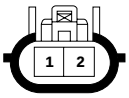
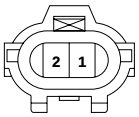
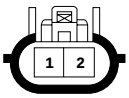
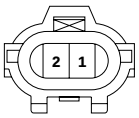
B-1	 000-001
J-61	 000-001
B-3	 002-001
B-3	 002-002
B-72	 002-001
B-72	 002-002
R-12	 002-001
R-12	 002-002

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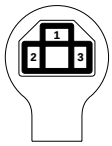
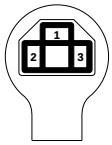
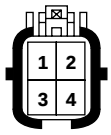
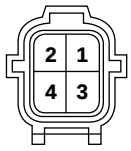
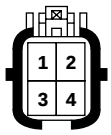
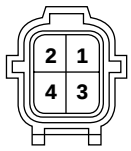
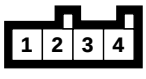
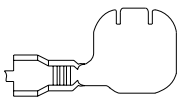
B-4	 003-007
B-73	 003-007
B-5	 004-012
B-5	 004-013
B-74	 004-012
B-74	 004-013
B-18	 004-004
B-7	 000-012

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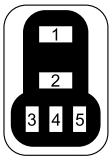
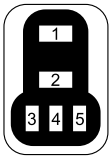
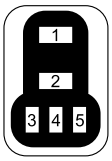
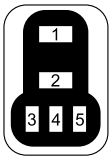
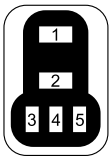
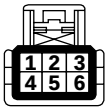
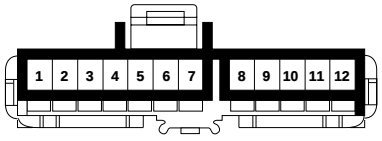
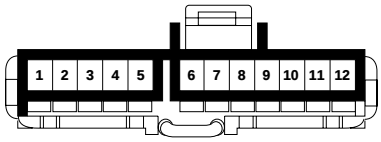
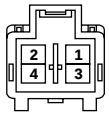
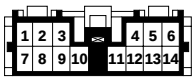
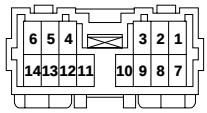
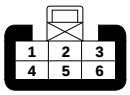
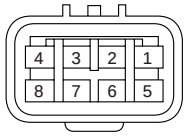
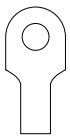
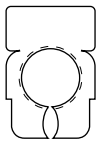
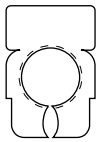
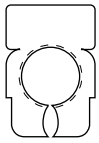
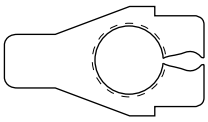
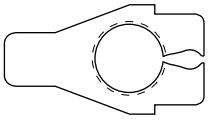
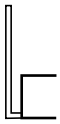
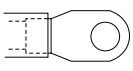
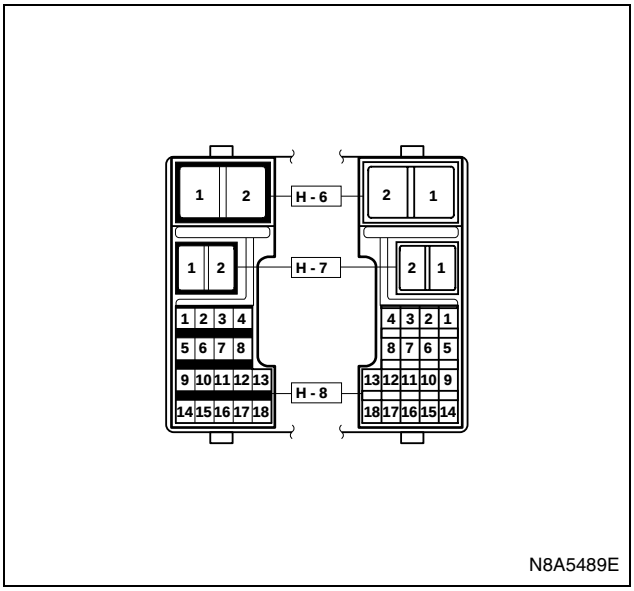
X-3	 005-006
X-4	 005-006
X-6	 005-006
X-9	 005-006
X-23	 005-006
B-153	 006-007
B-154	000-016
B-52	 012-005

No.	Connector Face
B-55	 012-004
B-67	004-001
B-67	 004-002
B-70	 014-002
B-70	 014-003
B-87	 006-006
H-16	008-003
H-16	 008-004

No.	Connector Face
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
P-5 (12 V)	 000-007
P-5 (24 V)	 000-002

H-6, H-7, H-8



N8A5489E

Diagnosis

Quick Chart for Check Point

1. Headlight

		Check point										
		Fuse			Fusible link	Headlight relay	Lighting SW	Dimmer / Passing SW	Dimmer relay	Headlight bulb		Cable harness
		F-6 F-8 (10 A)	F-23 (10 A)	F-24 (10 A)	FL-4 (30A)					LH	RH	
Trouble mode	1-1. Both Headlights inoperative				❍ (2)	❍ (1)	❍ (4)					❍ (3)
	1-2. Headlight on the left (or right) side inoperative		❍ (1)	❍ ((1))								❍ (2)
	1-3. Headlight in low-beam inoperative								❍ (1)			❍ (2)
	1-4. Headlight in high-beam inoperative								❍ (1)			❍ (2)
	1-5. Headlight on the left (or right) side in low (or high)-beam inoperative									❍ (1)	❍ ((1))	❍ (2)
	1-6. Headlight beam does not change	❍ (1)						❍ (2)	❍ (3)			❍ (4)
	1-7. Headlights remain on when the lighting switch turned off					❍ (1)	❍ (2)					❍ (3)
	1-8. Headlights come on with the lighting SW at the clearance light position						❍ (1)					

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

2. Fog Light

		Check point					
		Fuse F-6 (10 A): 4JH1,4JB1, 4JB1-TC F-8 (10 A): 24V, 4HG1-T (12 V)	Tail-light relay	Fog light SW	Fog light bulb		Cable harness
					LH	RH	
Trouble mode	2-1. Both fog lights inoperative (while lighting switch is on)	❍ (1)	❍ (2)	❍ (3)			❍ (4)
	2-2. Fog light on the left (or right) side inoperative (while lighting switch is on)				❍ (1)	❍ ((1))	❍ (2)
	2-3. Fog lights remain on		❍ (1)	❍ (2)			❍ (3)

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

3. Cornering Light

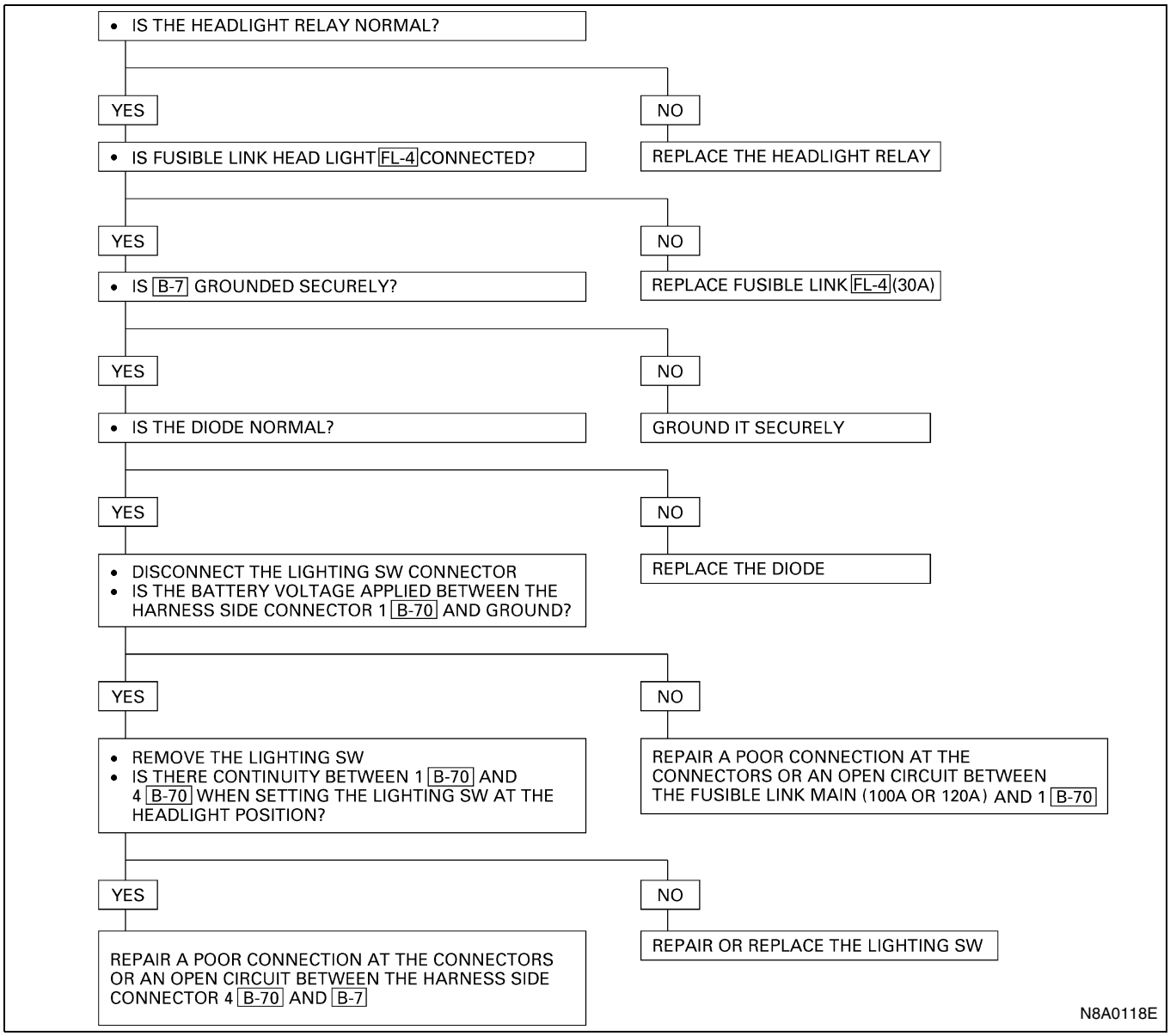
		Check point					
		Fuse		Cornering light SW	Cornering light bulb	Cornering light relay	Cable harness
		F-6 : 4JH1,4JB1,4JB1-TC F-8 : 24V,4HG1-T(12V)	F-16 (10 A)				
Trouble mode	3-1. Both cornering lights inoperative	❍ (2)	❍ (1)	❍ (5)		❍ (3)	❍ (4)
	3-2. Cornering light on the left (or right) side inoperative			❍ (2)	❍ (1)		❍ (3)
	3-3. Cornering light remains on even when steering wheel is in the straight ahead position			❍ (1)			

4. Rear Fog Light

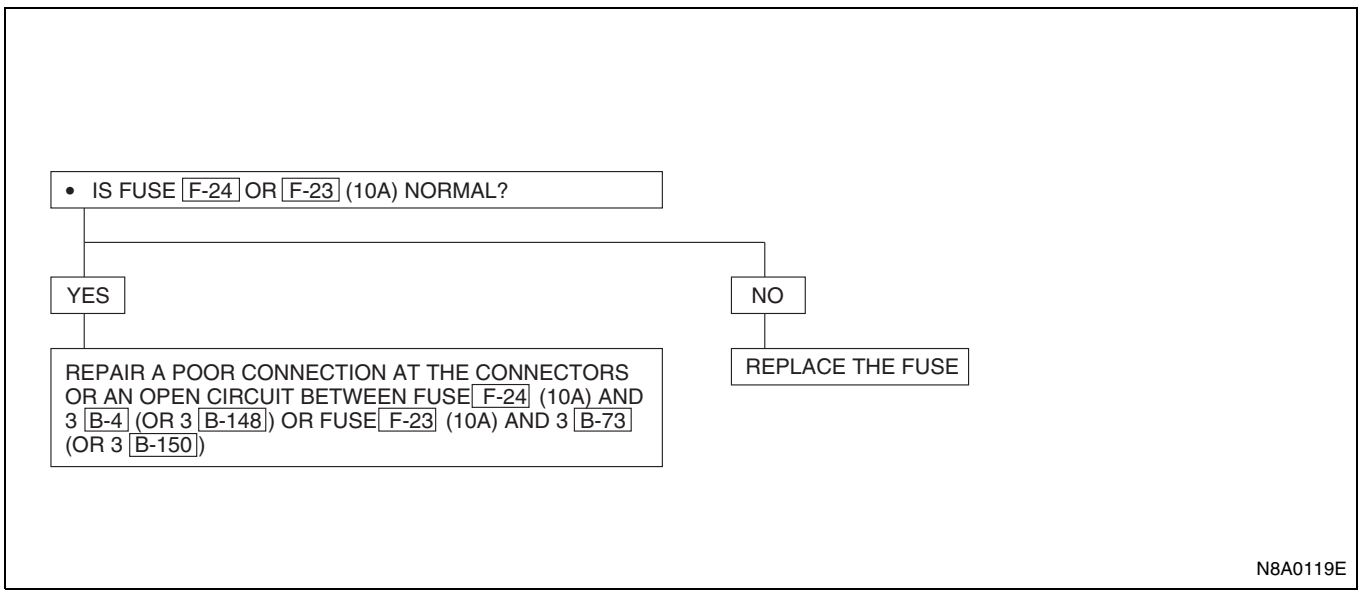
		Check point				
		Fuse F-27 (15 A)	Rear fog light SW	Rear fog light relay	Rear fog light bulb	Cable harness
Trouble mode	4-1. Rear fog light inoperative (while headlight is ON)	❍ (2)	❍ (4)	❍ (3)	❍ (1)	❍ (5)

1. Headlight

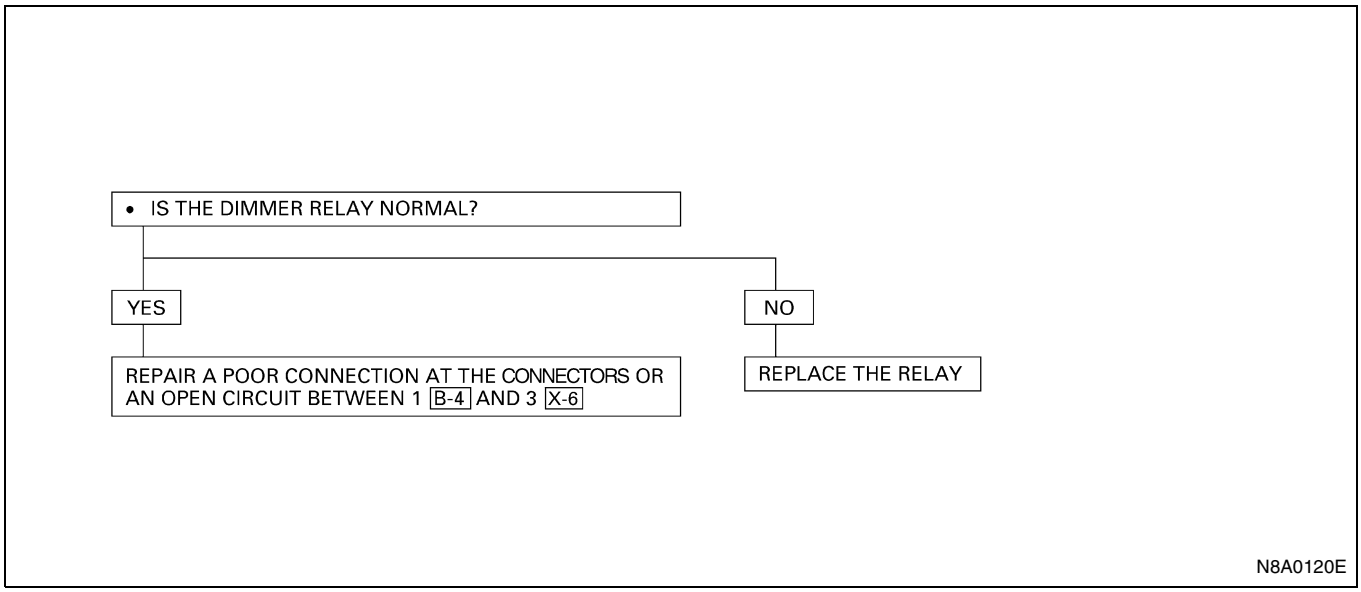
1-1. Both Headlights Inoperative



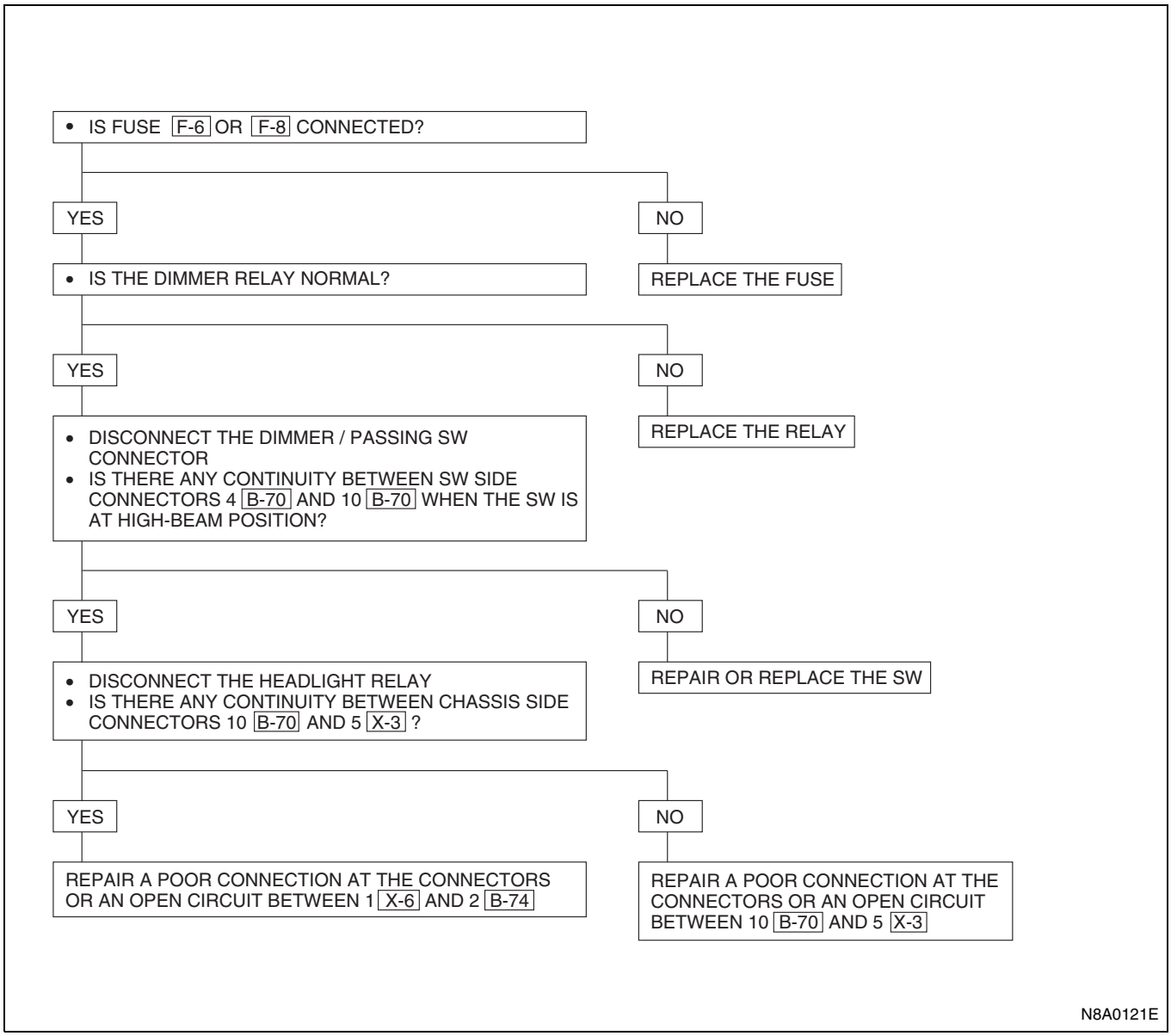
1-2. Headlight on The Left (or Right) Side Inoperative



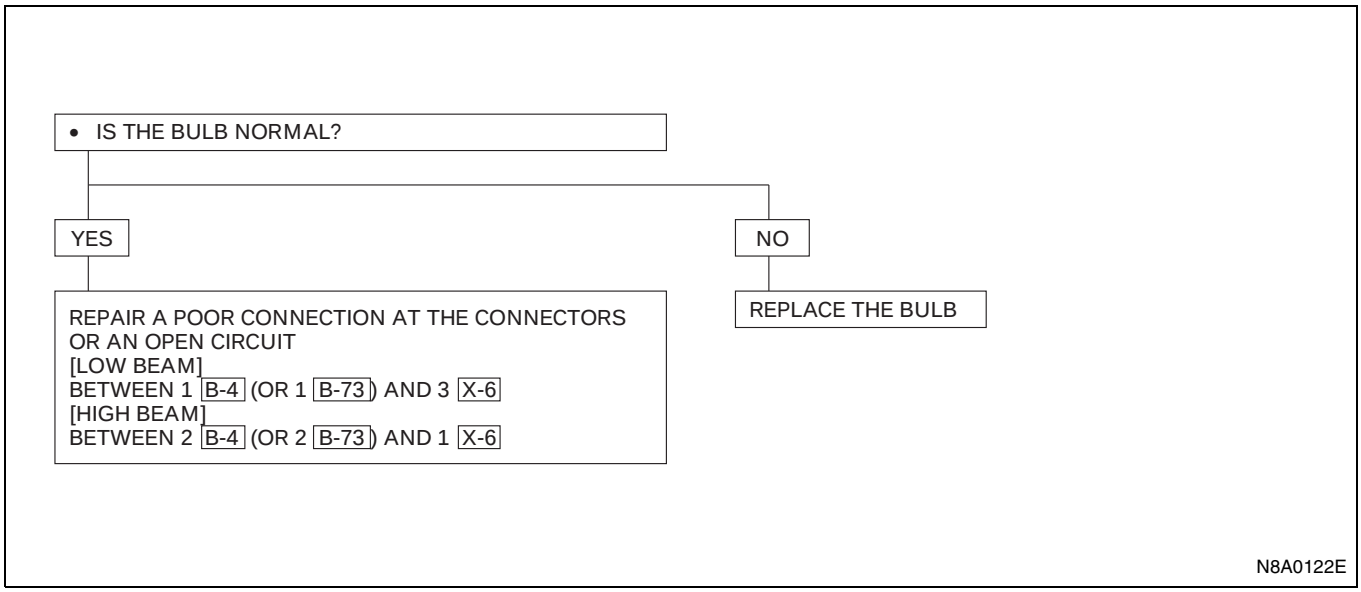
1-3. Headlight in Low-beam Inoperative



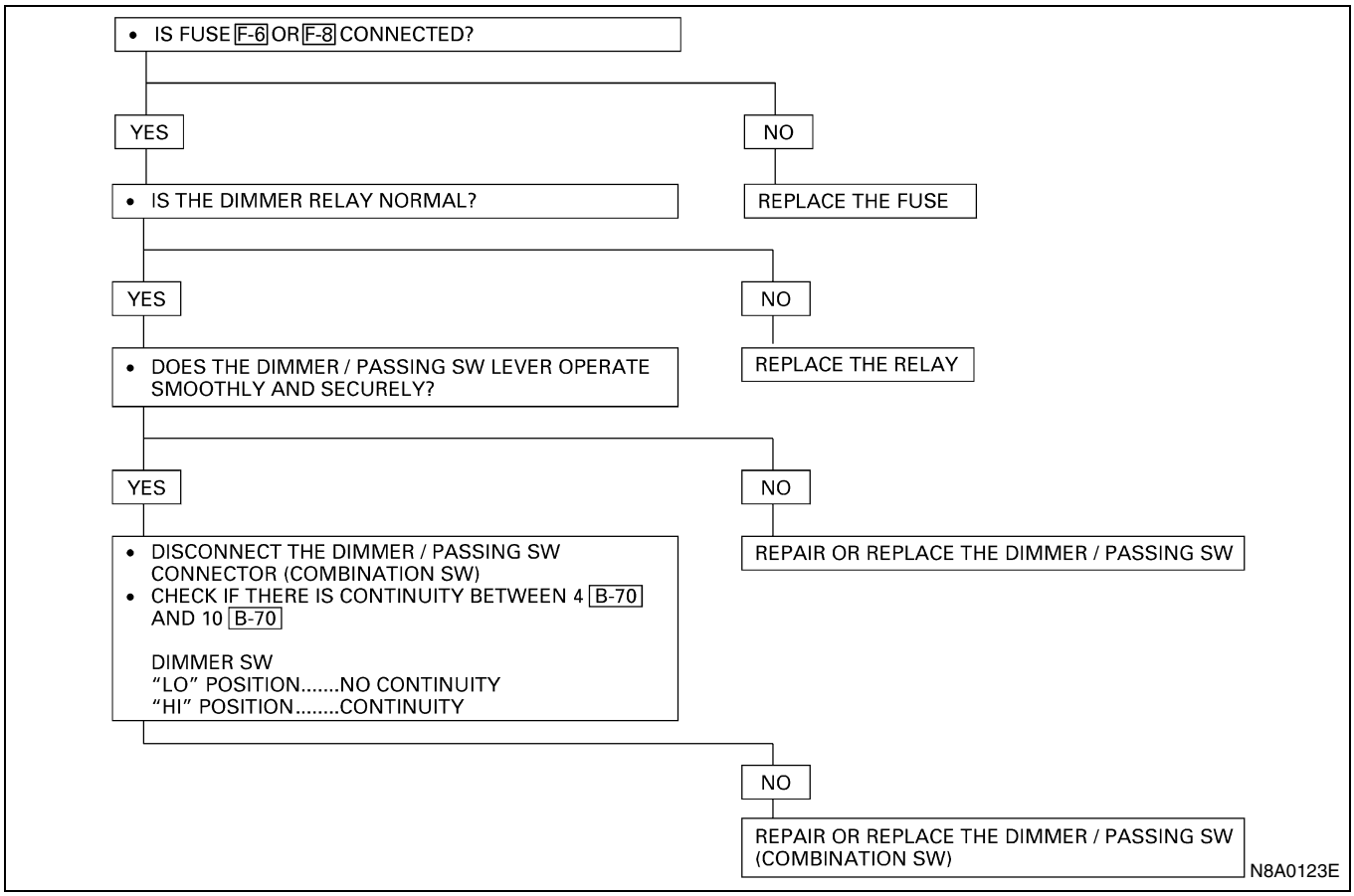
1-4. Headlight in High-beam Inoperative



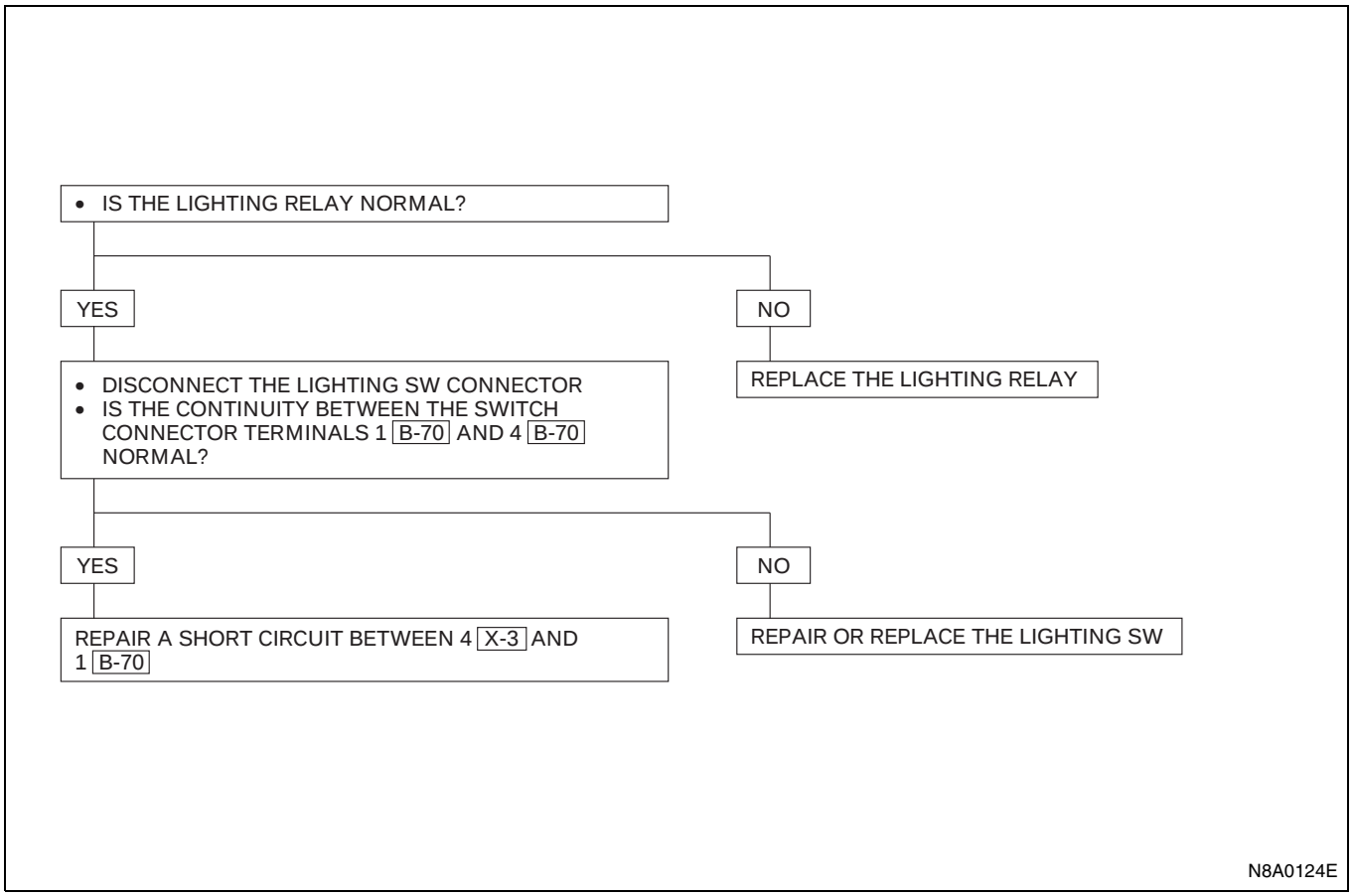
1-5. Headlight on The Left (or Right) Side in Low (or High)-beam Inoperative



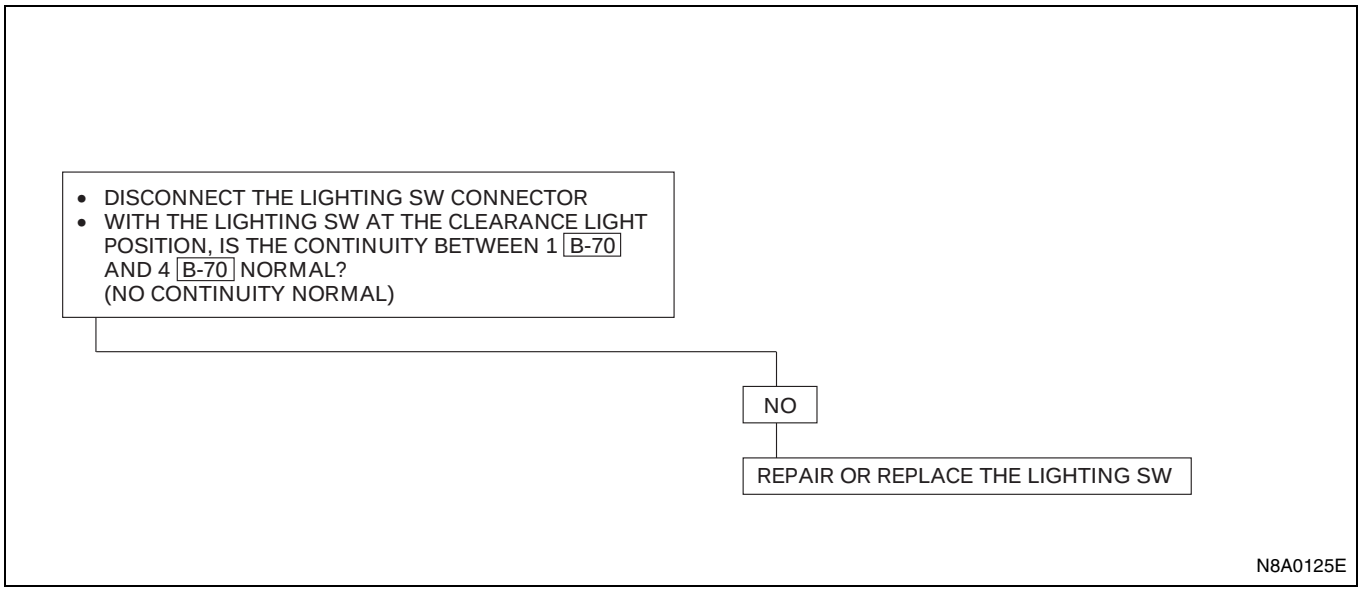
1-6. Headlight Beam Does Not Change



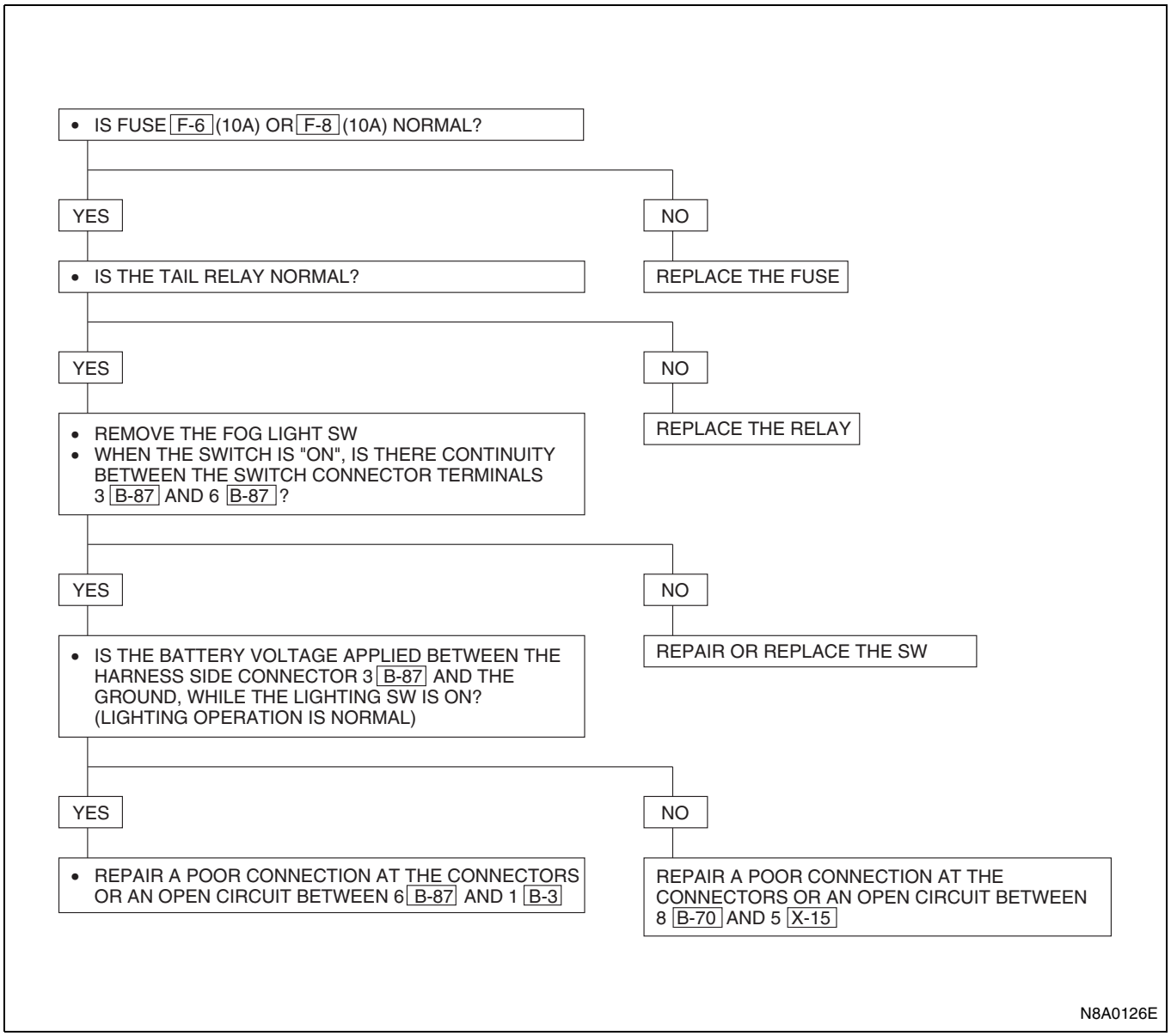
1-7. Headlight Remains On when the Lighting SW is Turned Off



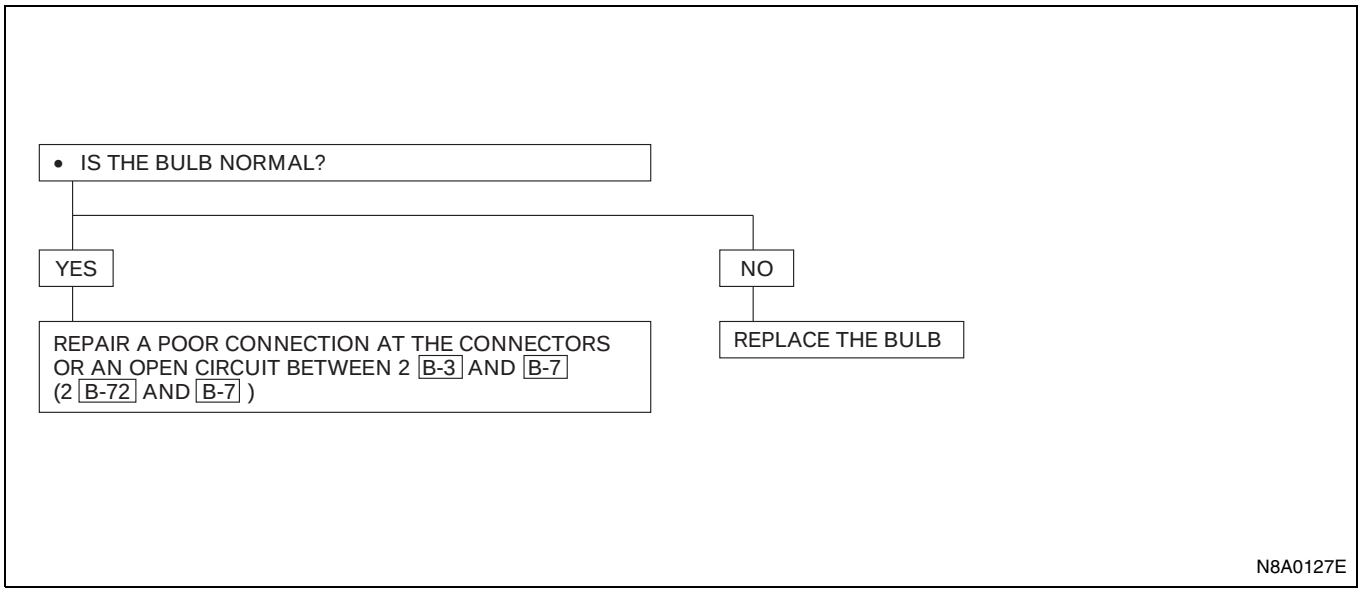
1-8. Headlight Comes On with The Lighting SW at The Clearance Light Position



2. Fog Light
2-1. Both Fog Lights Inoperative (While Lighting Switch is On)

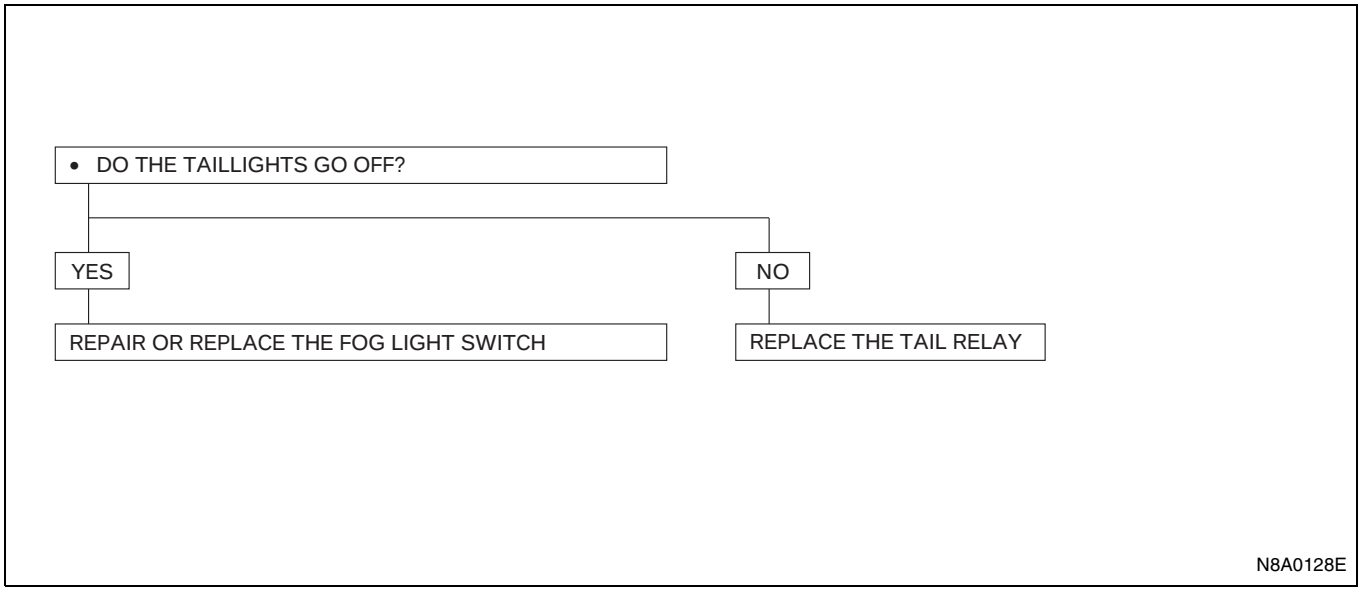


2-2. Fog Light on The Left (or Right) Side Inoperative (While Lighting Switch is On)

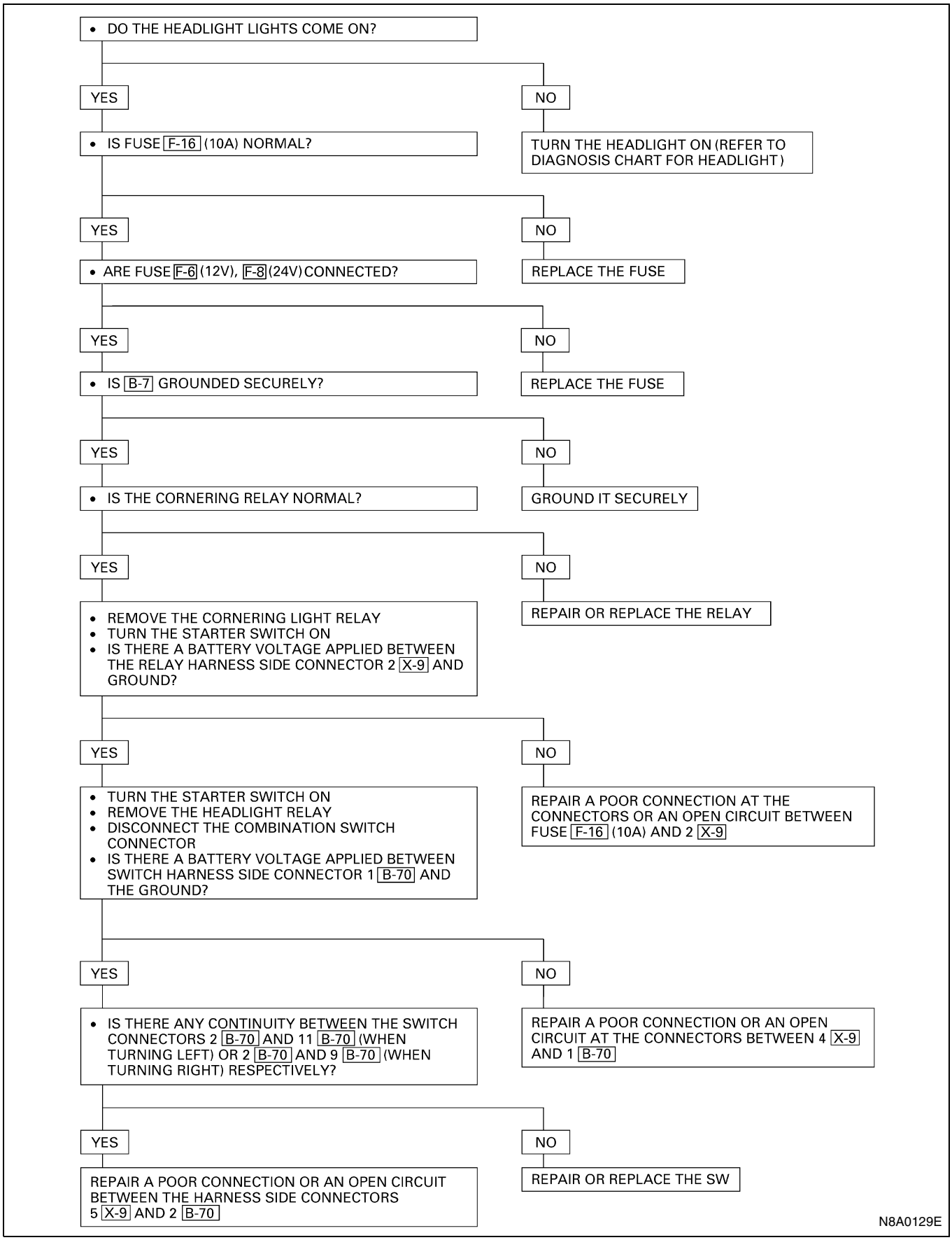


Notice:
Figures in parenthesis “( )” indicate place of inspection for the fog light on the right.

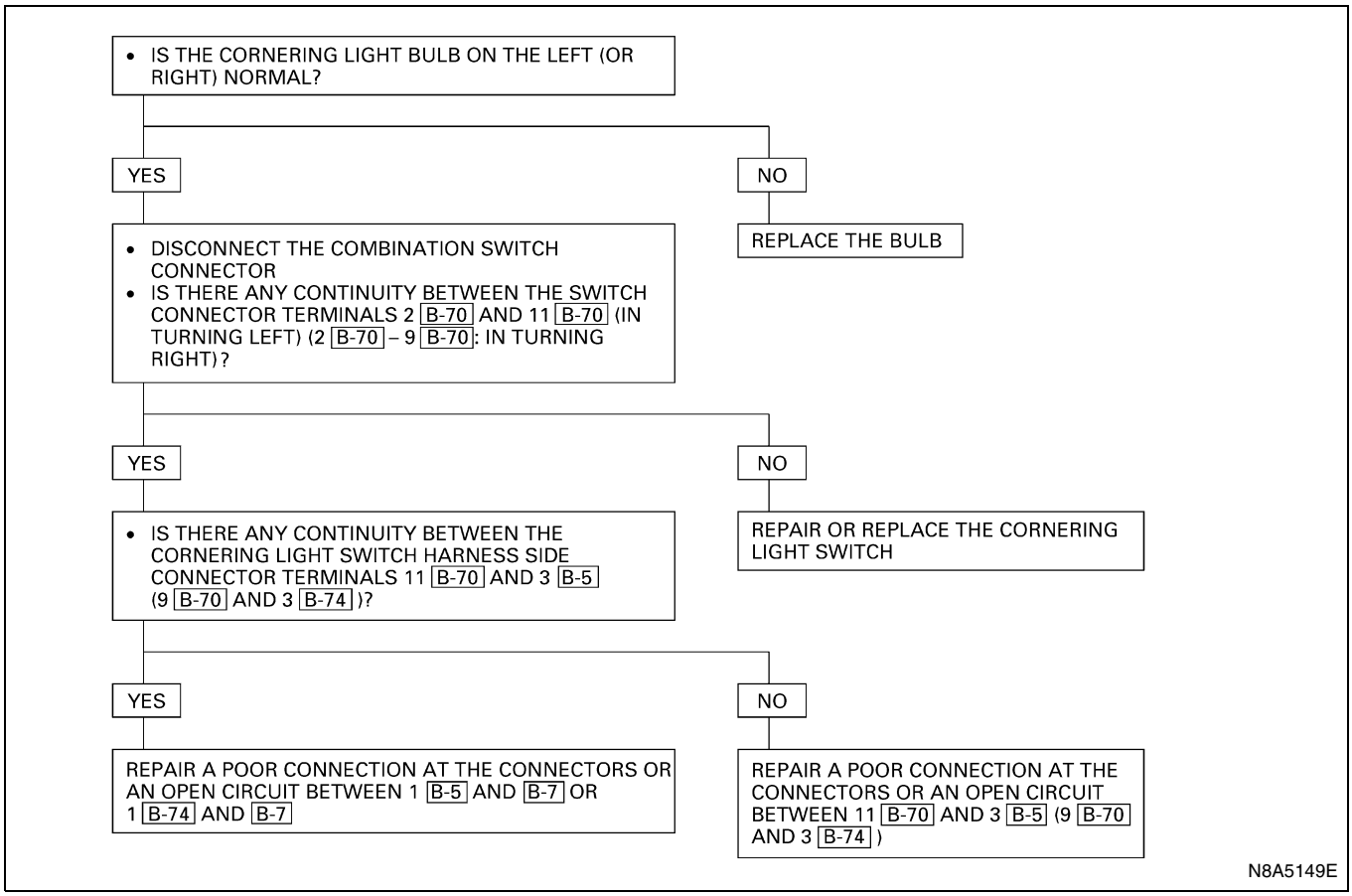
2-3. Fog Light Remains On



3. Cornering Light
3-1. Both Cornering Lights Inoperative

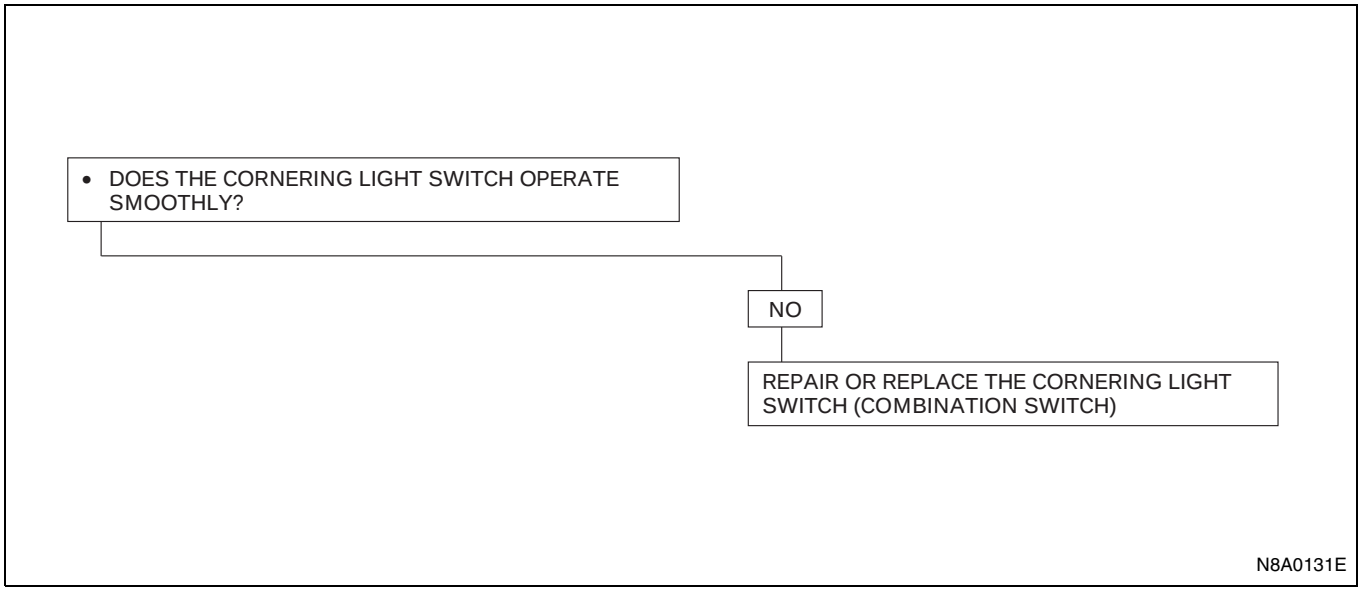


3-2. Cornering Light on The Left (or Right) Side Inoperative

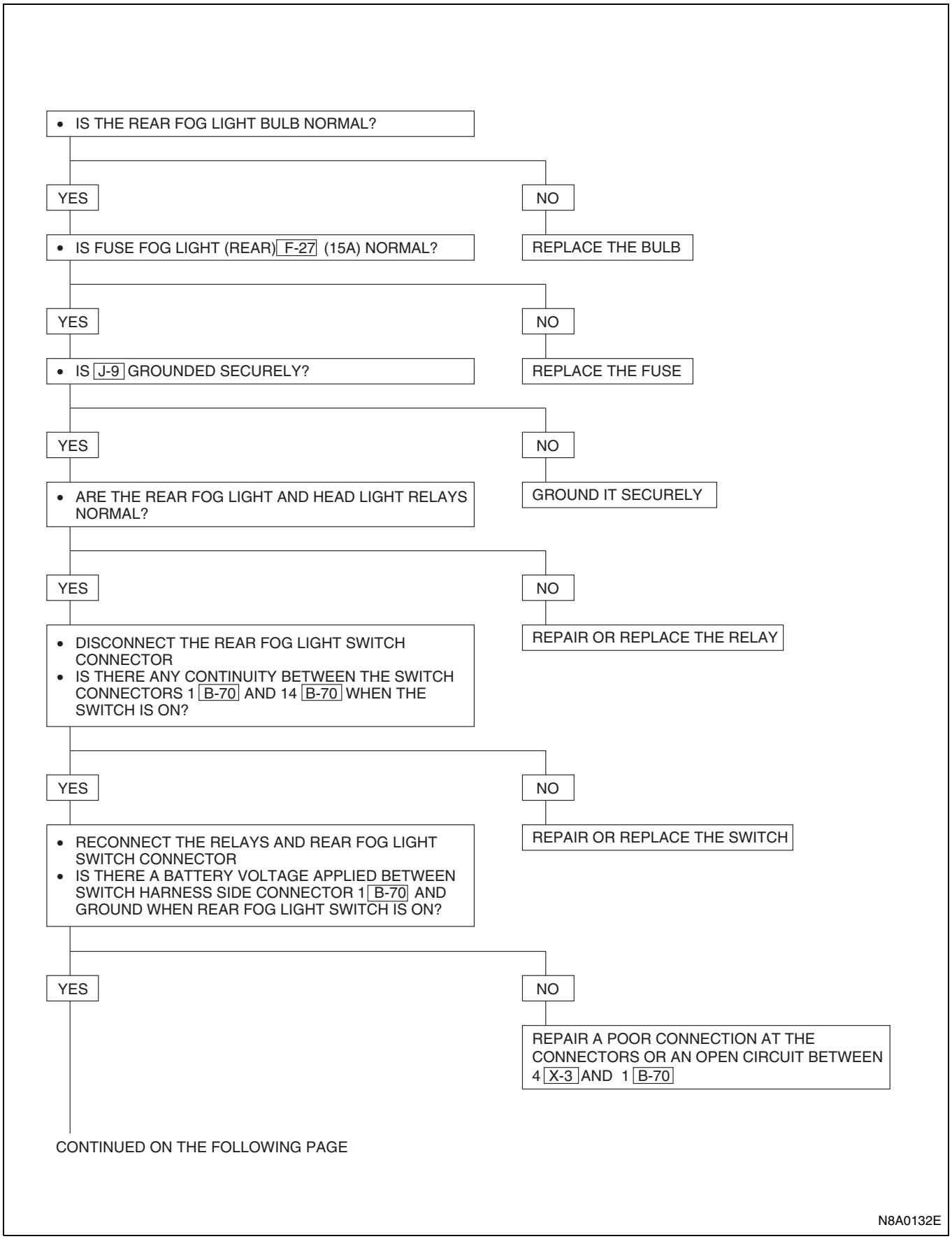


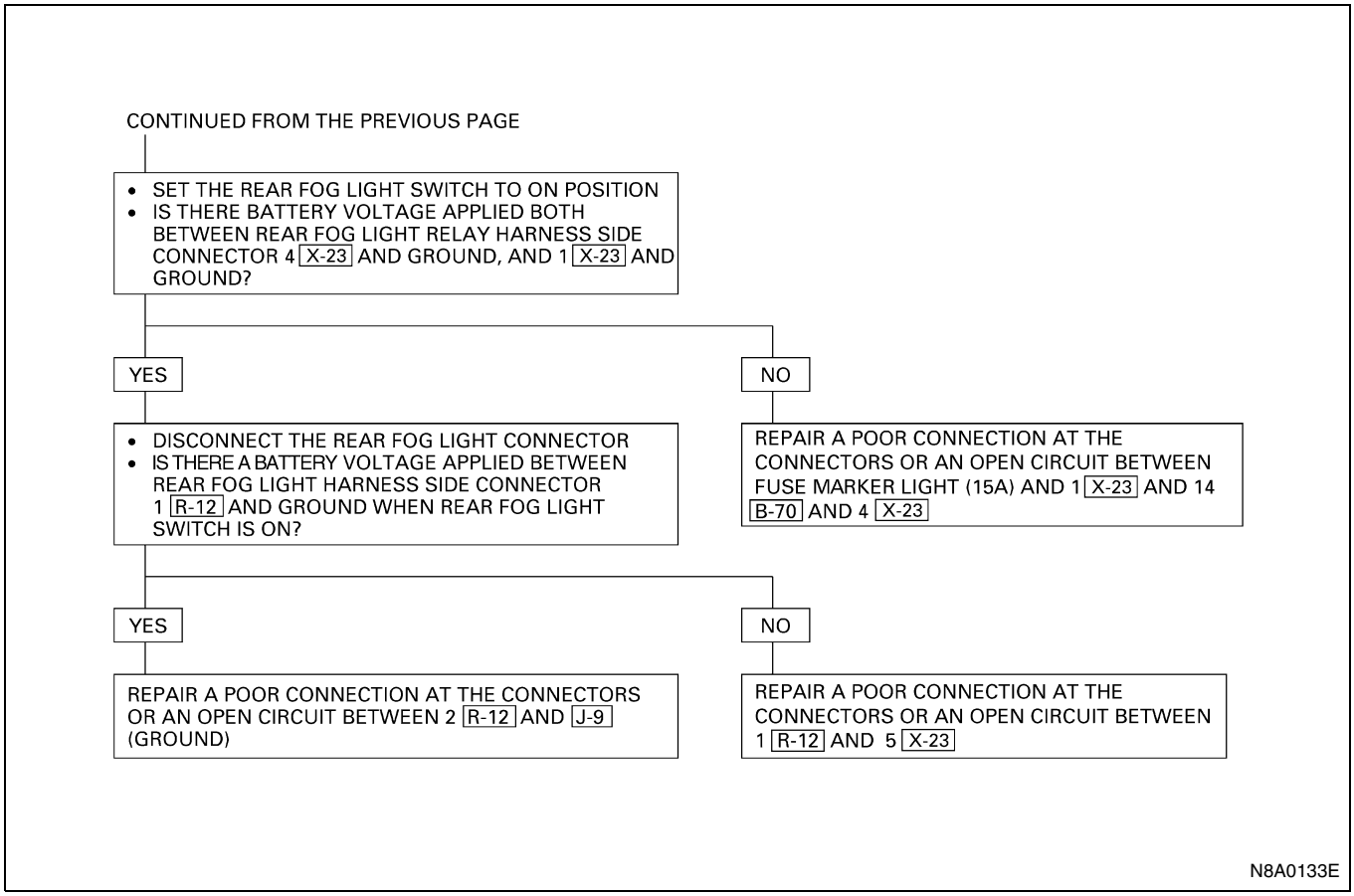
Notice:
Figures in parenthesis “( )” indicate place of inspection for the cornering light on the right.

3-3. Cornering Light Remains on Even when Steering Wheel is in Straight Ahead Position



4. Rear Fog Light
4-1. Rear Fog Light Inoperative (while Headlight is On)





Starter Switch

Refer to “START AND CHARGING” in this section.

High Beam Indicator Light

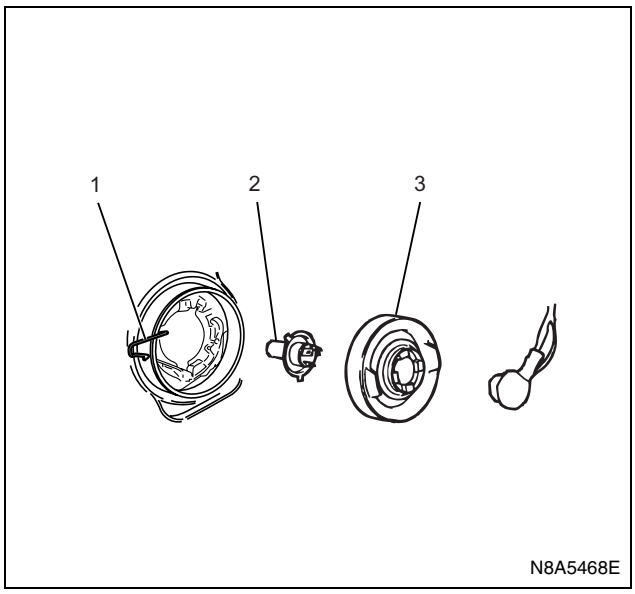
Refer to “METER AND WARNING/INDICATOR LIGHT” in this section.

Headlight Bulb Replacement

Removal

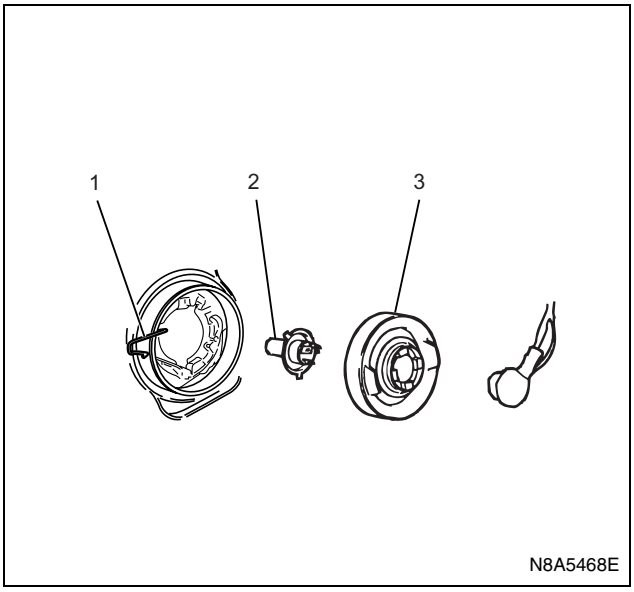
1. Remove the battery ground cable at the battery.
2. Remove the headlight assembly. (Refer to ‘Headlight Replacement’ below.)
3. Remove the headlight bulb.
   - Remove the dust cover (3).
   - Remove the clip (1).
   - Remove the headlight bulb (2).

Caution:
Do not touch the glass portion of the bulb with your fingers.



Installation

1. Install the headlight bulb.
   - Set the headlight bulb (2).
   - Fix the headlight bulb with clip (1).
   - Install the dust cover (3).
2. Install the headlight assembly.
   (Refer to ‘Headlight Replacement’ below.)
3. Connect the battery ground cable at the battery.
4. Check if the light lights.



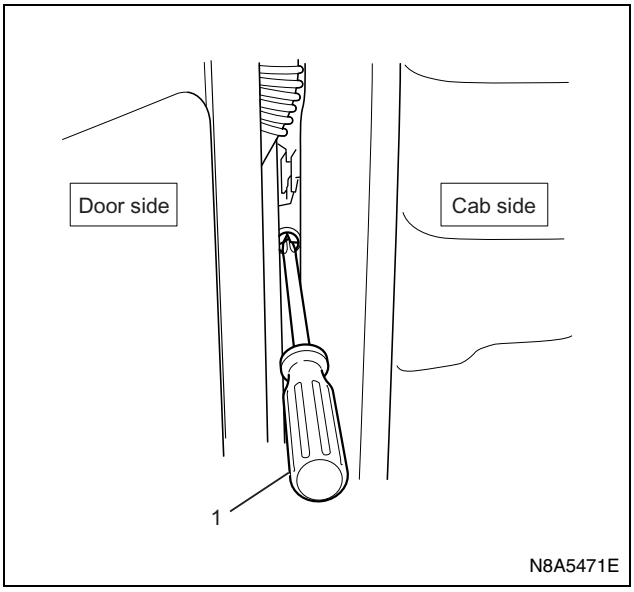
Caution:
Do not touch the glass portion of the new bulb with your fingers.

Headlight Replacement

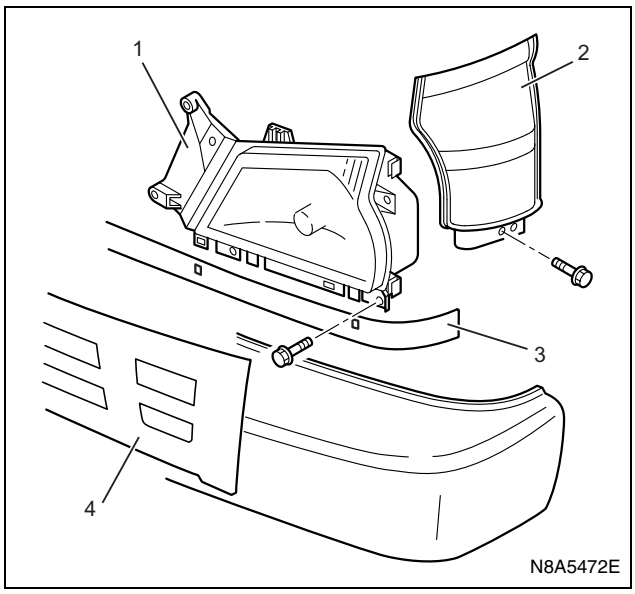
Removal

Preparation: Disconnect the battery ground cable.

1. Remove the battery ground cable at the battery.
2. Remove the seal rubber (3).
   - Remove the seal rubber from beneath the headlight.
3. Remove the front combination light (2).
   - Open the cab door. Insert a screwdriver (1) into the space between the cab and the cab door. Use the screwdriver to force out the stud pin at the center of the grommet (the pin securing the front combination light).



   - Remove the fixing screw.
   - Remove the two catches.
   - Remove the front combination light connector.
4. Remove the front grille (4).
   - Remove the bolt at the center of the front grille.
   - Remove the four clips securing the front grille.
   - The grille is secured by 4 clips (2 clips at the inside of each headlight). Pull the grille toward you to remove it.
5. Remove the front corner panel.
6. Remove the headlight (1).
   - Remove the four bolts securing the headlight (loosen the fixing bolts at the bottom of the front side panel to create working space).
   - Remove the headlight clips.
   - Remove the headlight connector.



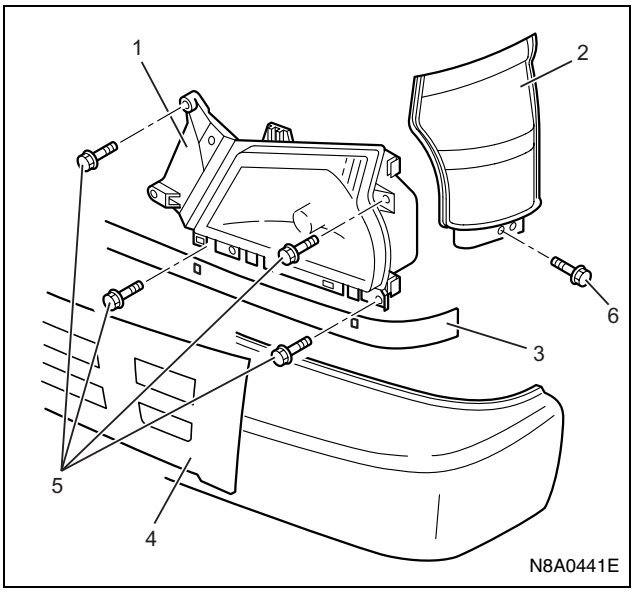
Installation

1. Assemble the headlight assembly (1).
   - Connect the connector.
   - Fix it to body panel with four bolts (5).
2. Assemble the front panel side.
   (Refer to “DOOR” in section 2.)
3. Install the front grille (4).
4. Install the front combination assembly (2).
   1) Position it by aligning two pawls with the groove of H/L.
   2) Fit the iron PIN in the upper portion by aligning it with the center of corresponding grommet.

Notice:
Push it into securely with a force of approx. 250 N (25 kgf) until click is heard.

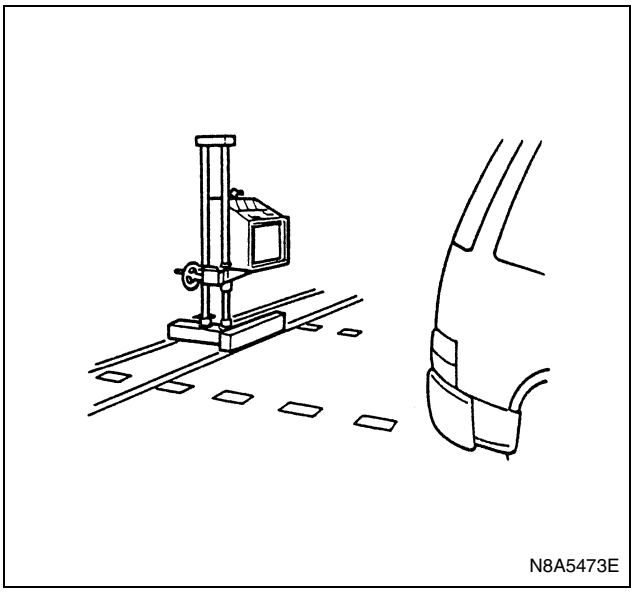
   3) Pull the front combination light assembly lightly toward the front of vehicle to make sure that the PIN and grommet are engaged securely.
   4) Tighten one bolt (6) in the lower portion of front combination light assembly.
   5) Hook the seal rubber (3) on two projections under H/L.

5. Connect the battery ground cable.
6. Check the operation and lighting of each lamp.



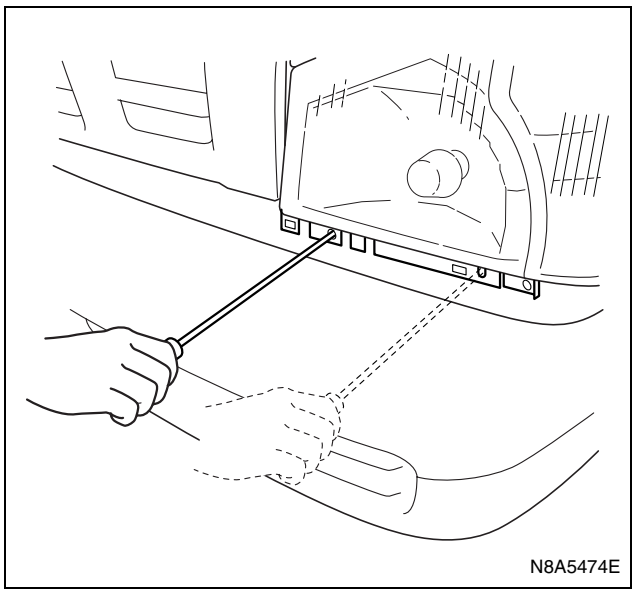
Aiming of Headlight

Preparation: Place the unloaded vehicle on a level surface and check to see if the inflation pressure of the tires is correct, the lenses are clean, and the battery is sufficiently charged. Adjust the aim with the headlight tester. When adjusting, follow the procedure of the tester manufacturer's.



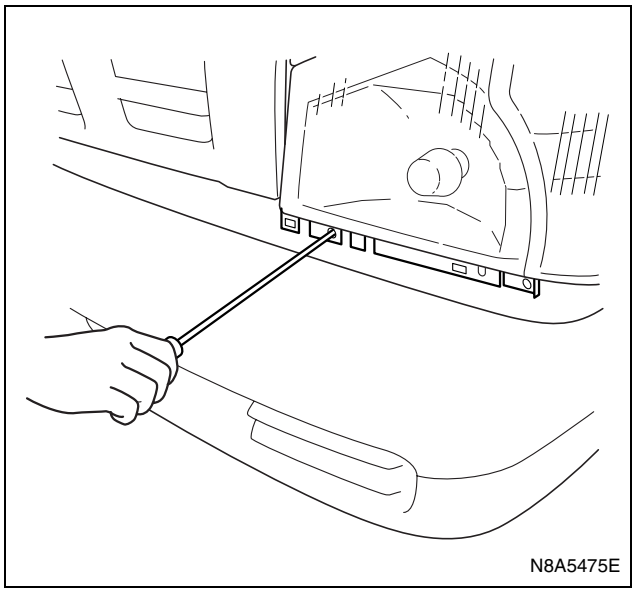
Vertical Adjustment

Insert the tip of a screwdriver into the hole beneath the headlight (the shaft of the screwdriver must be slanted up) until contact is made with the head of the adjusting screw. Turn the screw to adjust headlight focus up or down.
Two vertical aim screws should be turned in the same direction at the same time to adjust aiming.



Horizontal Adjustment

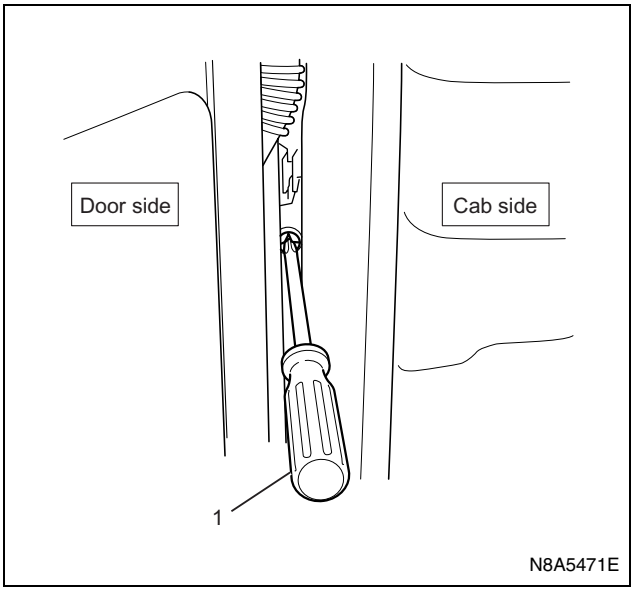
Insert the tip of a screwdriver into the hole beneath the headlight (the shaft of the screwdriver must be slanted up) until contact is made with the head of the adjusting screw. Turn the screw to adjust headlight focus to the left or right.



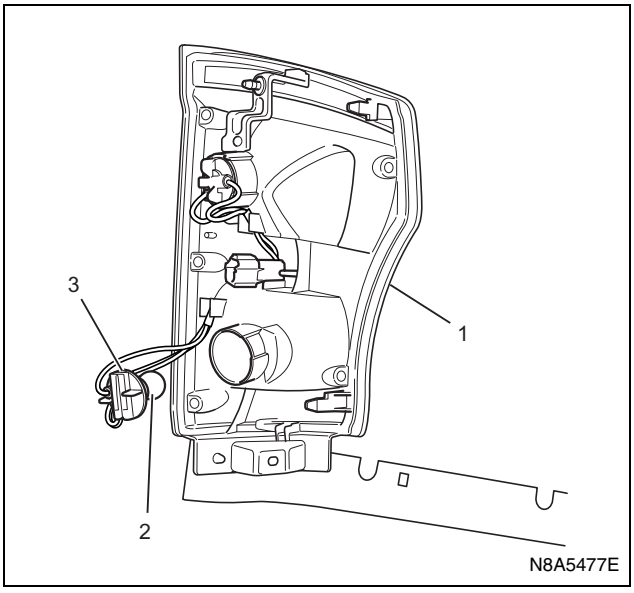
Cornering Light Bulb Replacement

Removal

1. Remove the battery ground cable at the battery.
2. Remove the front combination light.
   - Open the cab door. Insert a screwdriver (1) into the space between the cab and the cab door. Use the screwdriver to force out the stud pin at the center of the grommet (the pin securing the front combination light).



- Remove the fixing screw.
- Remove the two catches.
- Remove the front combination light (1) connector.



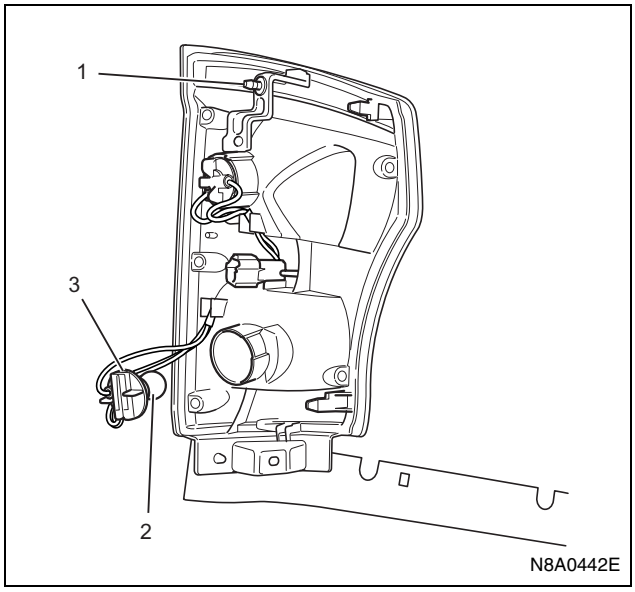
3. Remove the cornering light bulb.
   - Turn the cornering / clearance bulb socket (3) to the left to remove it.
   - Press the bulb (2) in and turn it to the left to remove it from the socket.

Installation

1. Install the cornering / clearance bulb.
   - While pressing the bulb (2), turn it clockwise to fit.

Notice:
Do not let the glass portion dirty with sebum etc.

- Turn the bulb socket (3) clockwise to fit.



2. Installation procedure of front combination light assembly
   - Connect the connector of the front combination light assembly.
   - Position it by aligning two pawls with the groove of H/L.
   - Fit the iron PIN (1) in the upper portion of the side by aligning it with the center of corresponding grommet.

Notice:
Push it into securely with a force of approx. 250 N (25 kgf) until click is heard.

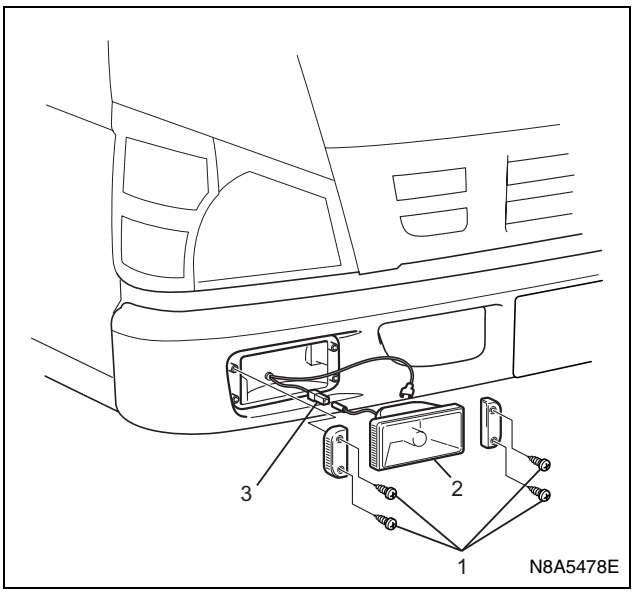
- Pull the front combination light assembly lightly toward the front of vehicle to make sure that the PIN and grommet are engaged securely.
- Tighten one bolt in the lower portion of front combination light assembly.

3. Hook the seal rubber on two projections under H/L.
4. Connect the battery ground cable.
5. Check lighting of each light.

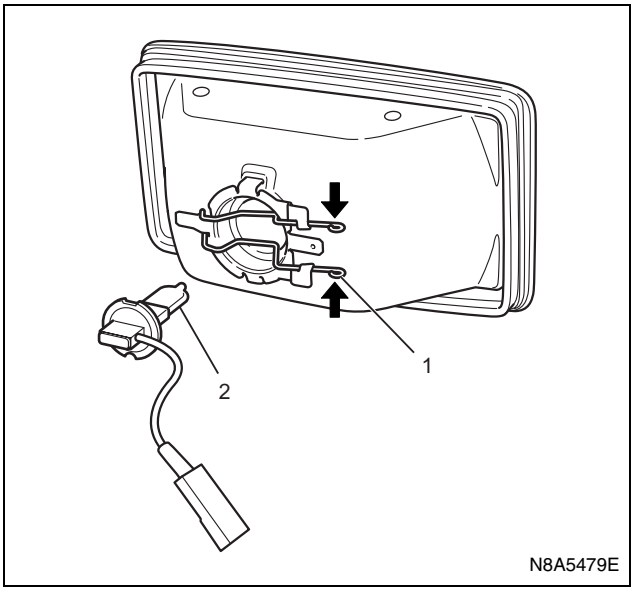
Fog Light Bulb

Removal

1. Remove the battery ground cable at the battery.
2. Remove the four screws (1) to remove the cover which holds fog light assembly (2).
3. Remove the connector (3).
4. Remove the fog light assembly (2).

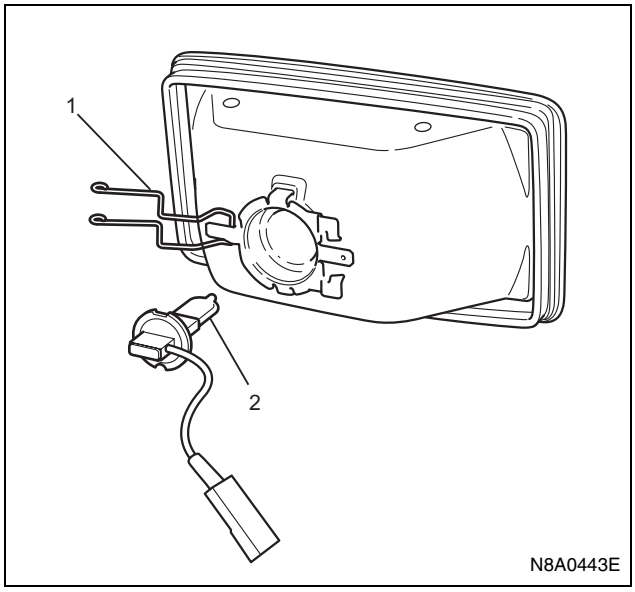


5. Bulb
   - Push the clip (1) inward as arrow to remove.
   - Remove the bulb (2).



Installation

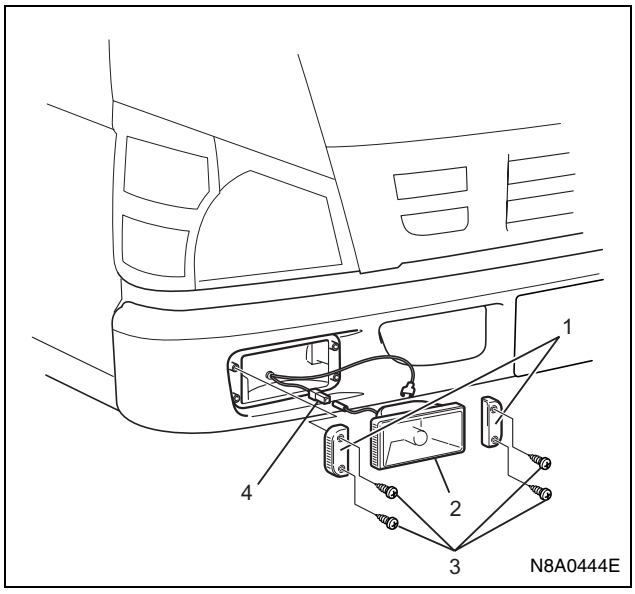
1. Install the fog light bulb.
   - Set the fog light bulb (2).
   - Hook the clip (1) to secure fog light bulb.



2. Connect the two locations of connector (4).
3. Install the fog light assembly.
   - Hold the fog light (2) with right and left covers (1) and secure it with four screws (3).

Notice:
Make sure that “TOP” mark on the lens comes upside.

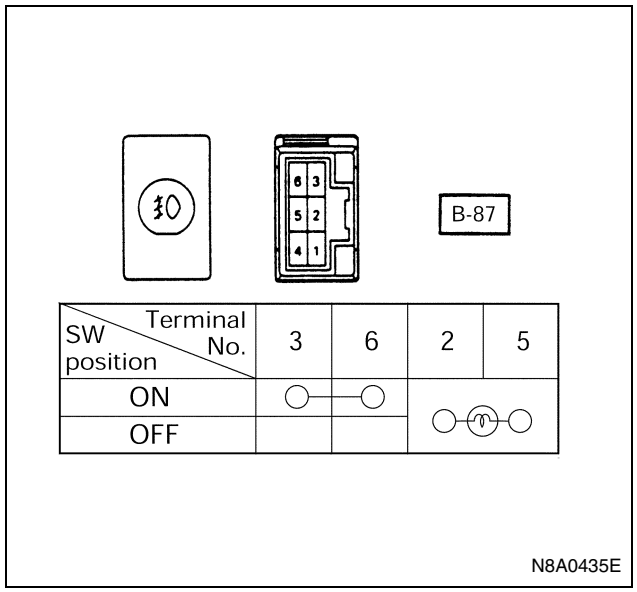
4. Connect the battery ground cable.
5. Check lighting.



Fog Light Switch

Inspection

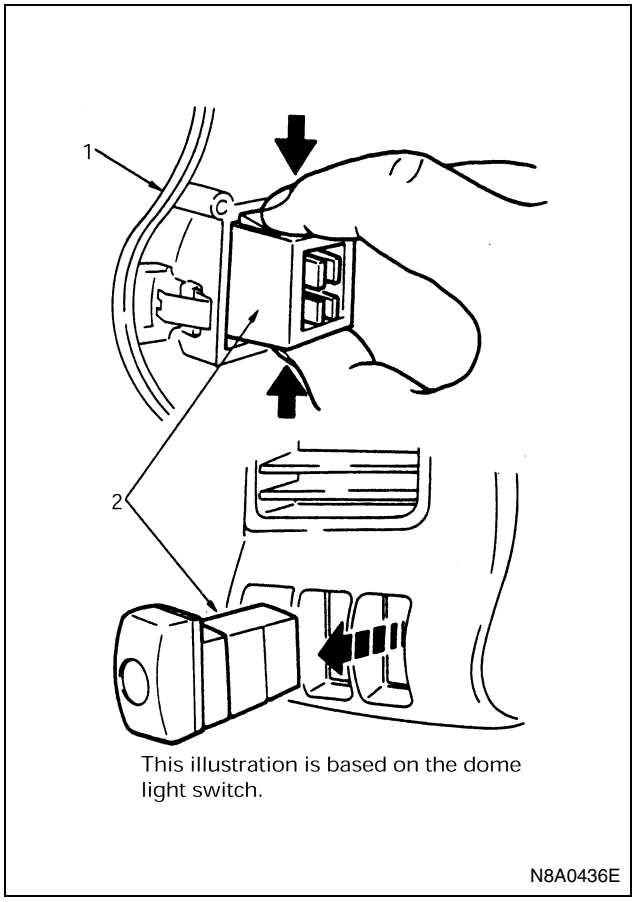
Check the continuity between the connector terminals while operating the switch.
Replace the switch when the result of inspection is found abnormal.



Removal

Preparation:
Disconnect the battery ground cable.

1. Meter Cluster
   Refer to “METER AND WARNING/INDICATOR LIGHT” in this section.
2. Fog Light Switch
   Release the lock pushing the switch from the back side of the meter cluster.



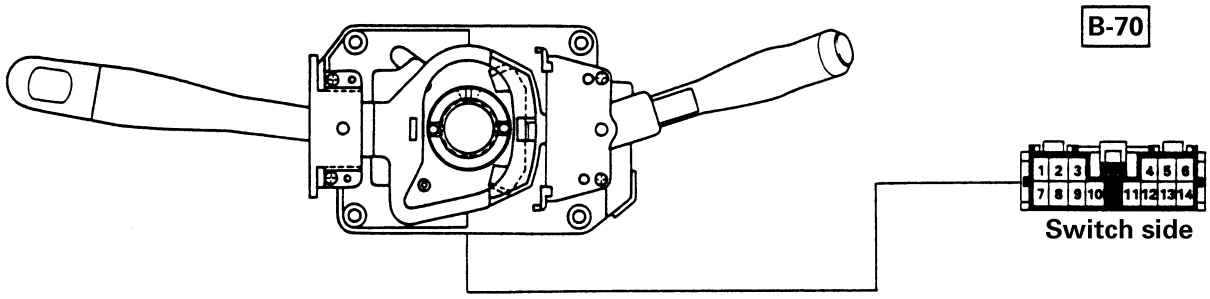
Installation

To install, follow the removal steps in the reverse order.

Combination Switch (Lighting Switch, Dimmer, Passing Switch, Cornering Light Switch and Rear Fog Light Switch)

Inspection

Check the continuity between the connector terminals while operating the switch.
Replace the switch when the result of inspection is found abnormal.



SW position \ Terminal No.		1	2	4	5	7	8	9	10	11	12	13	14
Lighting SW		○		○			○						
				○			○						
	REAR FOG SW	○		○			○						○
	OFF												
Dimmer· passing SW	High beam			○					○				
	Passing			○		○			○				
Cornering light SW	Turning left		○							○			
	Neutral												
	Turning right		○					○					

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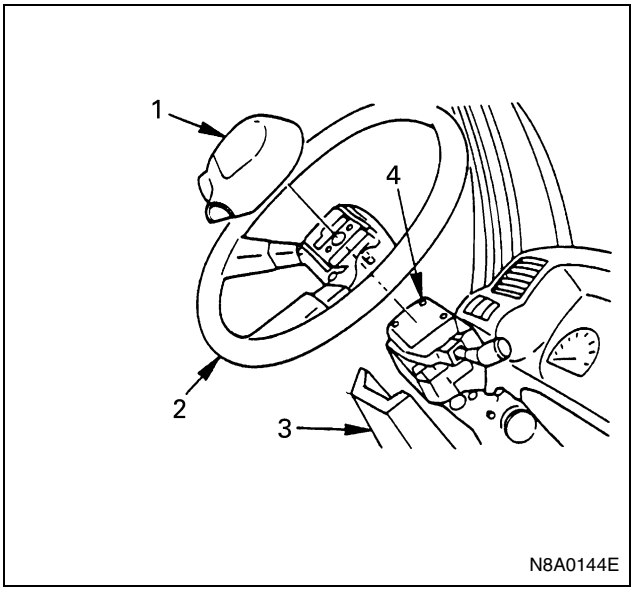
Removal

Preparation:
Disconnect the battery ground cable.

1. Horn Pad
   1) Hold the horn pad and pull it upward.
2. Steering Wheel
   1) Remove the steering shaft nut.
   2) Remove the steering wheel by using steering wheel remover.
      (Refer to Section 3B4 “STEERING COLUMN” for steering wheel removal steps.)
3. Steering Cowl
   Remove the four screws.
4. Combination Switch
   1) Remove the four screws.
   2) Disconnect the connector.



Installation

To install, follow the removal steps in the reverse order, noting the following point.

1. Tighten the steering shaft nut to the specified torque.

Tighten:

Shaft nut to 49 N·m (5 kg·m / 36 lb·ft)

Headlight Leveling

General Description

The circuit consists of starter SW, headlight leveling SW and headlight leveling actuator.

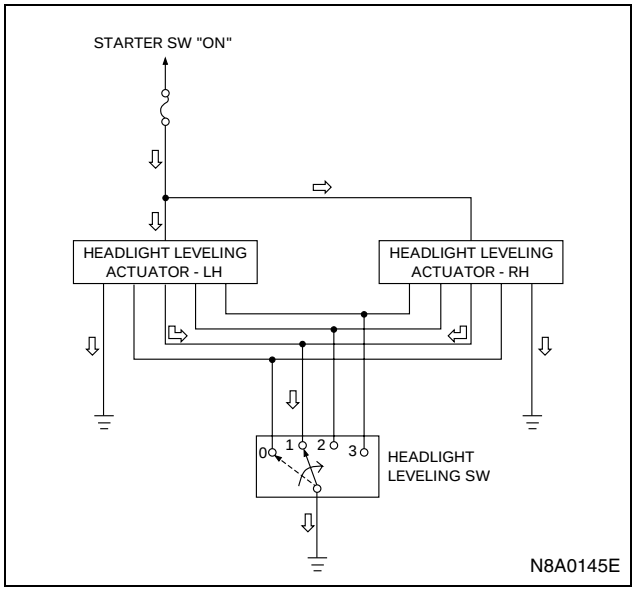
When the headlight leveling SW is operated with the starter SW at ON position, the actuator is operated to change the angle of the optical axis of the headlight.

Operation of The Circuit

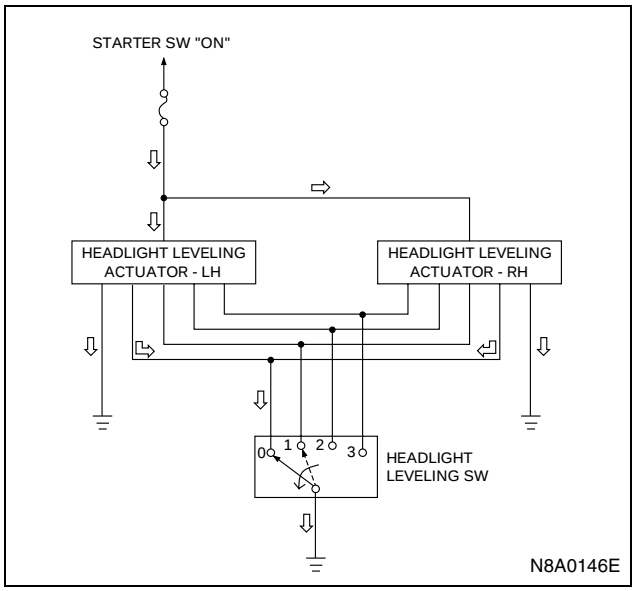
Notice:

Arrow marks indicate the direction of current.

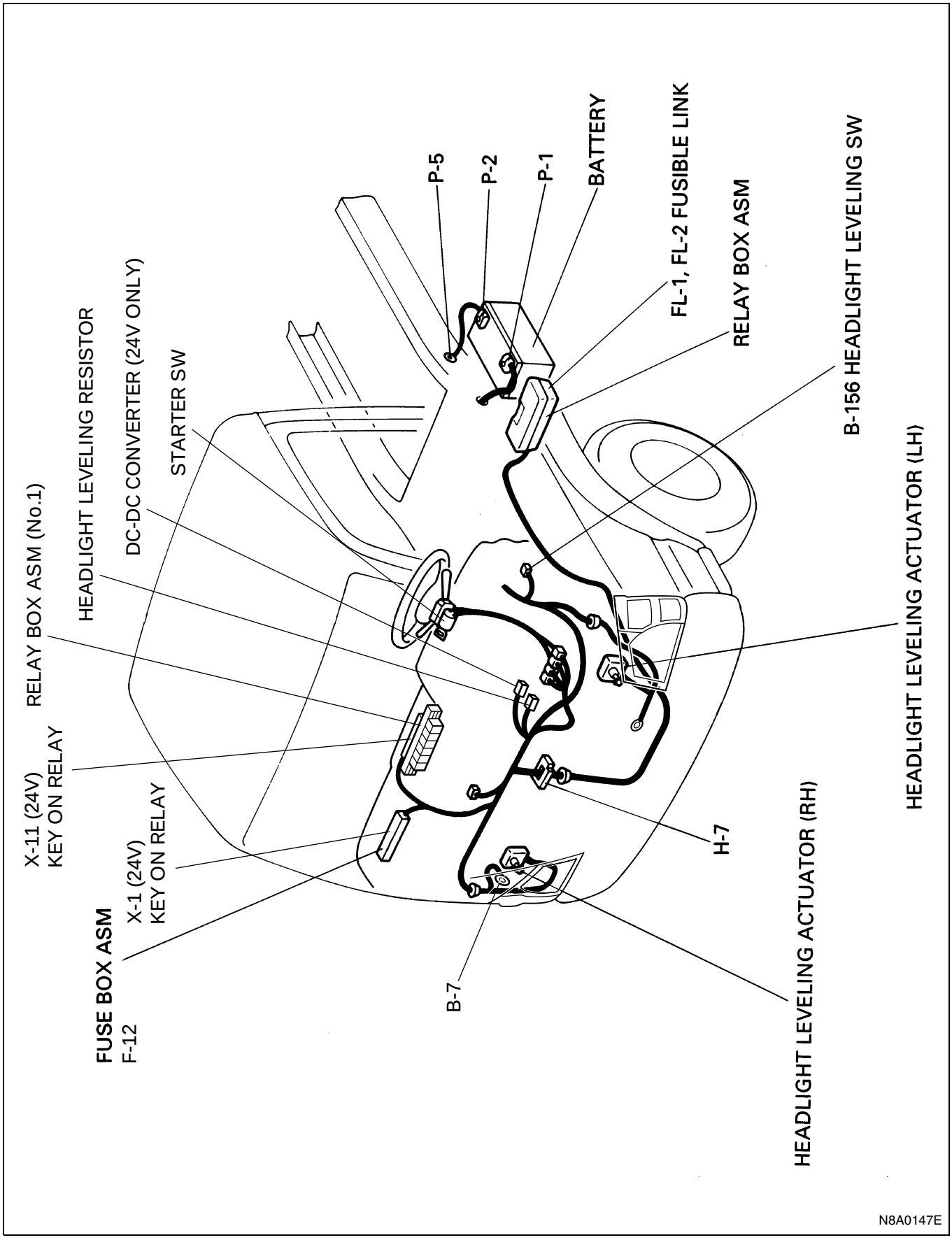
1. When headlight leveling SW is turned to “1” position



2. When headlight leveling SW is turned to “0” position

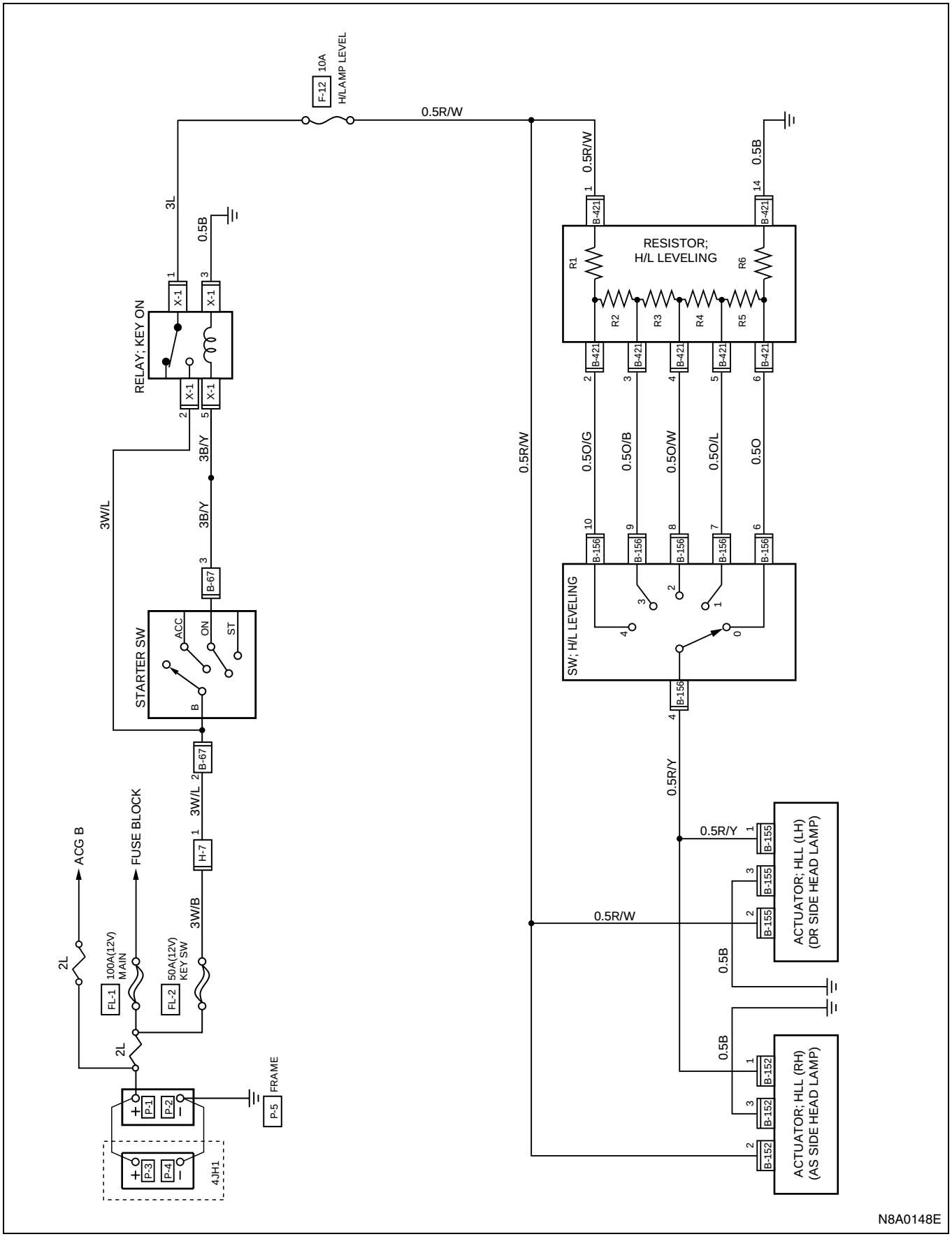


Parts Location

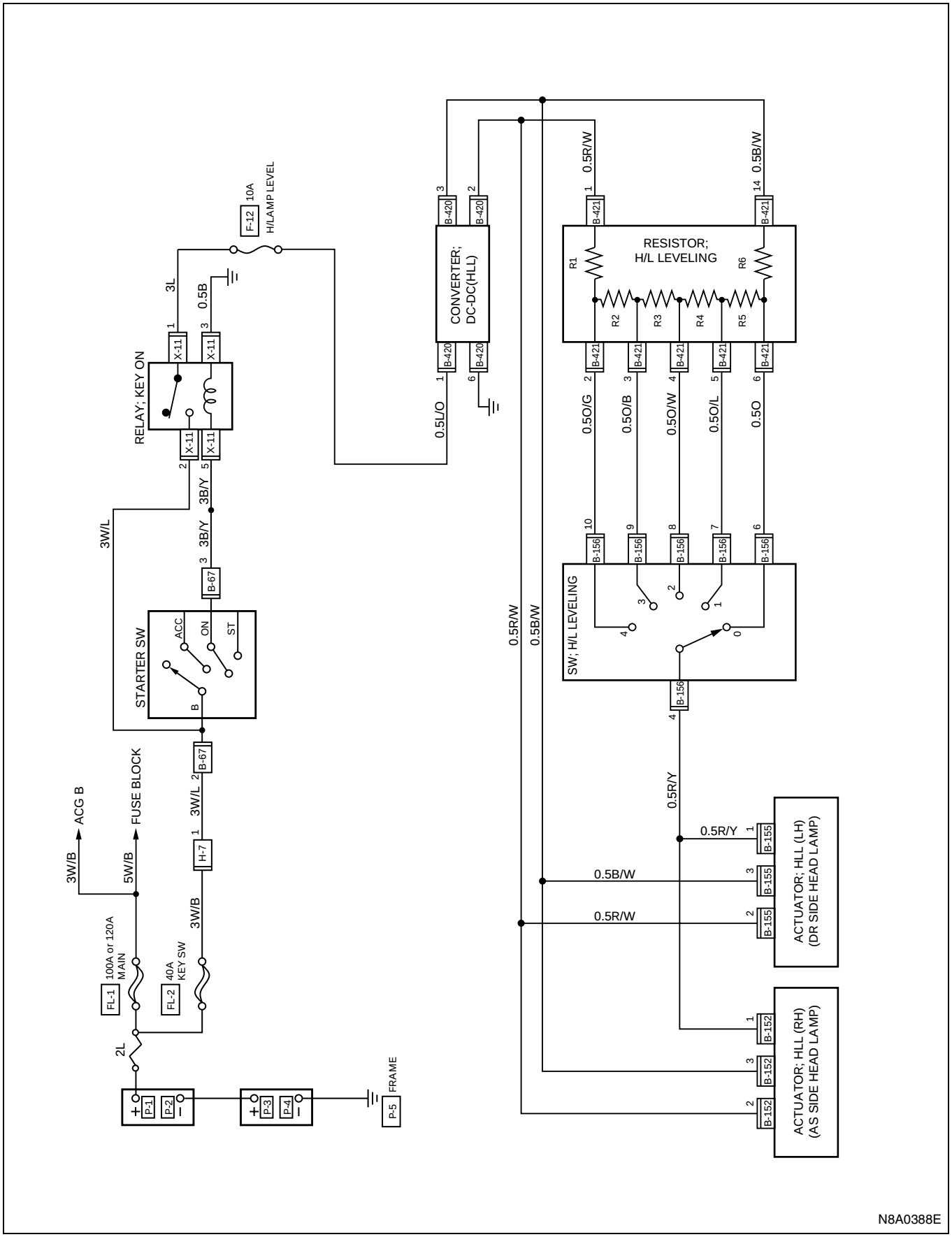


Circuit Diagram

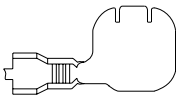
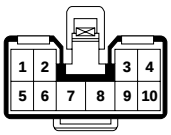
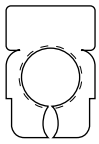
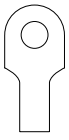
For 12 Volt

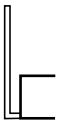
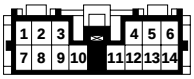
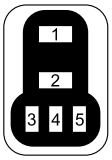


For 24 Volt

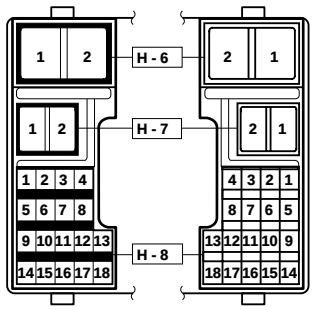

F-12 10A H/LAMP LEVEL
3L
0.5B
RELAY; KEY ON
X-11
3B/Y
3W/L
B-67
STARTER SW
ACC
ON
ST
B
3W/IB
ACG B
FUSE BLOCK
5W/IB
3W/L
H-7
100A or 120A MAIN
FL-1
40A KEY SW
FL-2
3W/IB
2L
P-1
P-2
P-3
P-4
P-5
FRAME
CONVERTER; DC-DC(HLL)
B-420
0.5L/O
0.5R/W
0.5B/W
RESISTOR; H/L LEVELING
R1
R2
R3
R4
R5
R6
B-421
0.5O/G
0.5O/B
0.5O/W
0.5O/L
0.5O
SW; H/L LEVELING
B-156
0.5R/Y
ACTUATOR; HLL (LH) (DR SIDE HEAD LAMP)
ACTUATOR; HLL (RH) (AS SIDE HEAD LAMP)
B-155
B-152
N8A0388E

Connector List

No.	Connector Face
B-7	 000-012
B-67	004-001
B-67	004-002
B-152	003-016
B-155	003-016
B-156	 010-002
P-1	 000-004
P-2	 000-003

No.	Connector Face
P-5	 000-007
B-420 (24 V)	006-019
B-421	 014-002
X-1 (12V)	 005-006
X-11 (24 V)	005-001

H-7



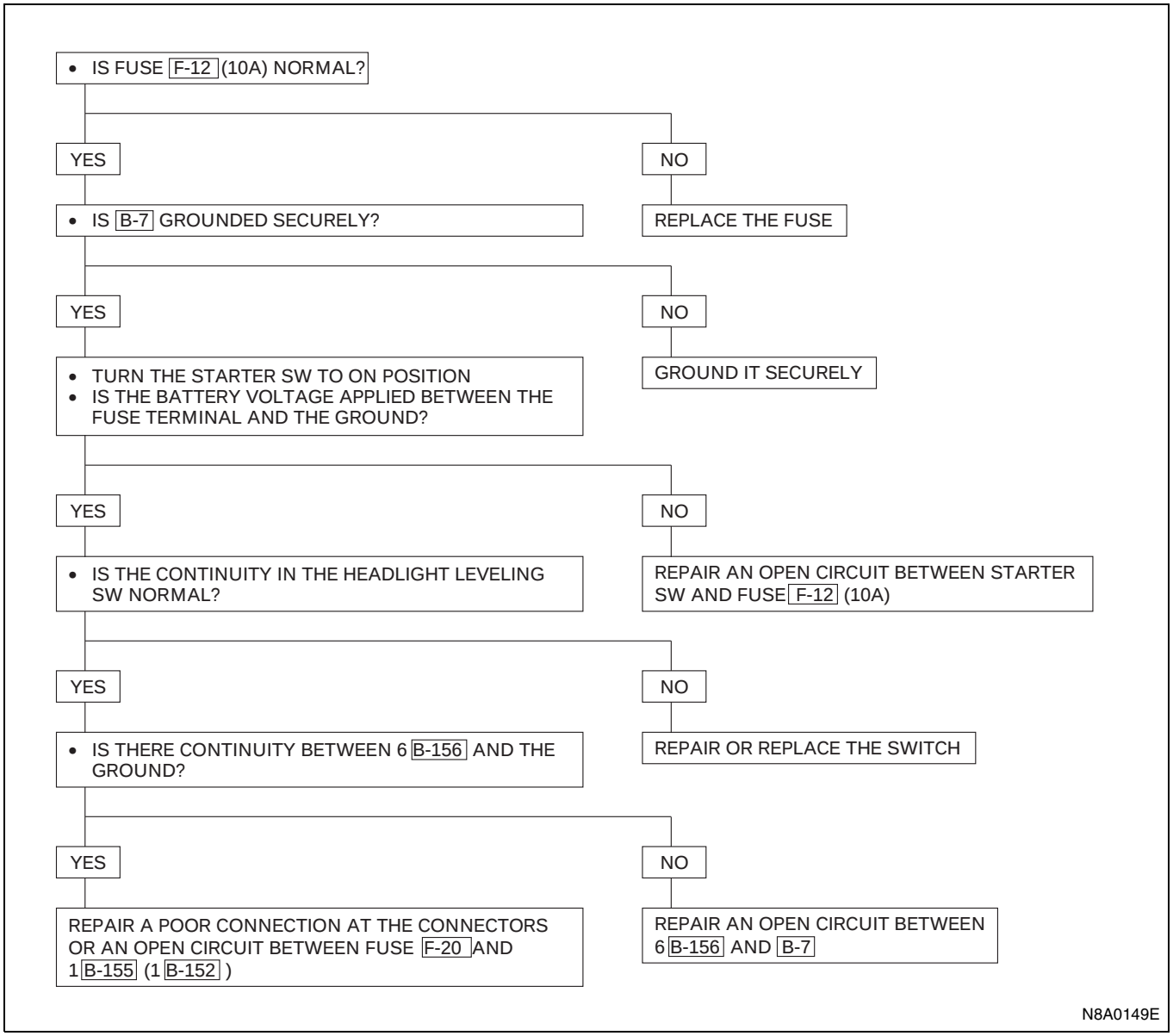
N8A5489E

Diagnosis

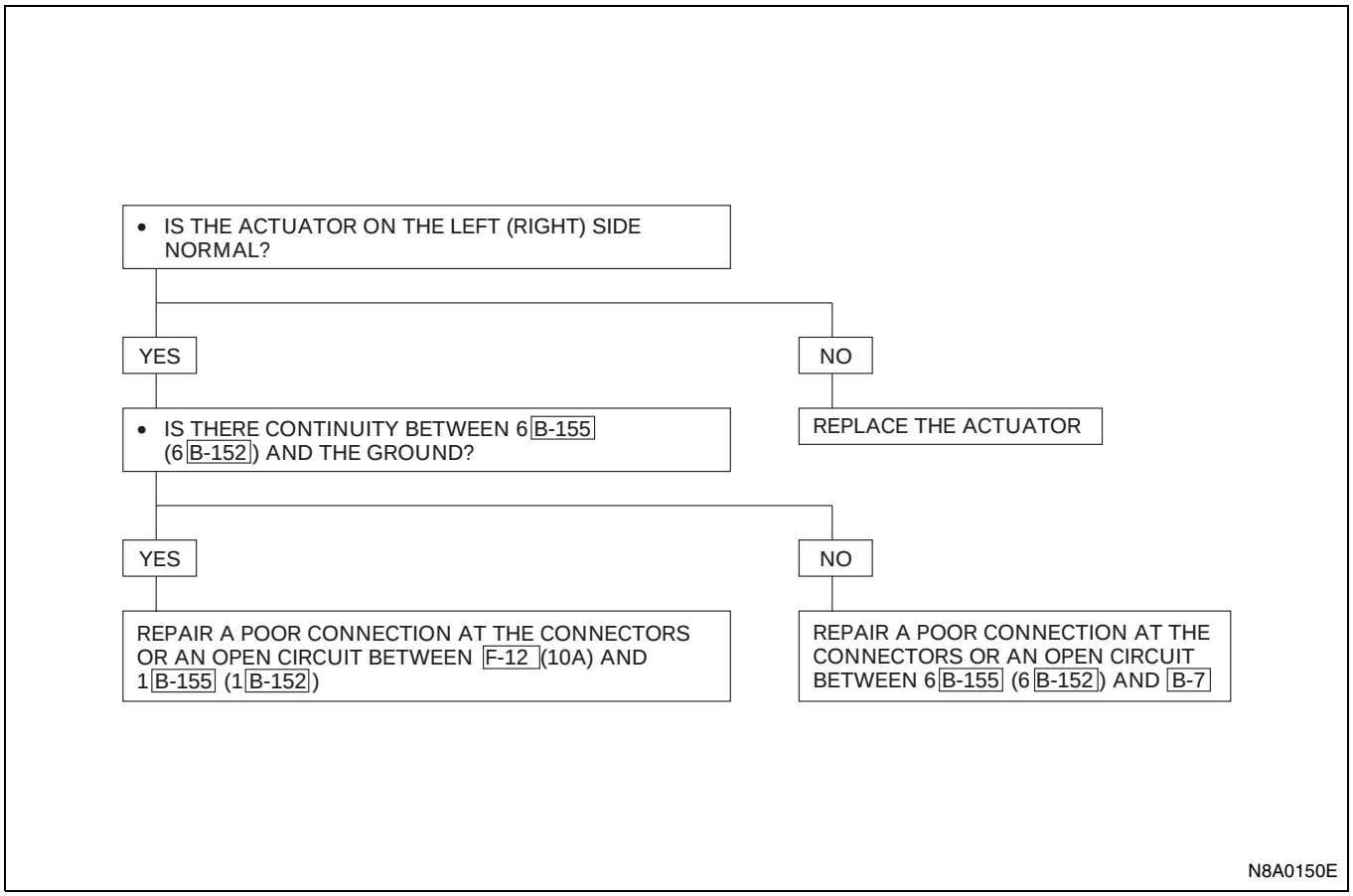
Quick Chart for Check Points

		Check point			
		Fuse F-12 (10 A)	Headlight leveling switch	Headlight leveling actuator	Cable harness
Trouble mode	1. Both actuators inoperative	❍	❍		❍
	2. Actuator on the left (right) side inoperative			❍	❍
	3. When leveling SW is turned to a certain position, actuator inoperative		❍	❍	❍

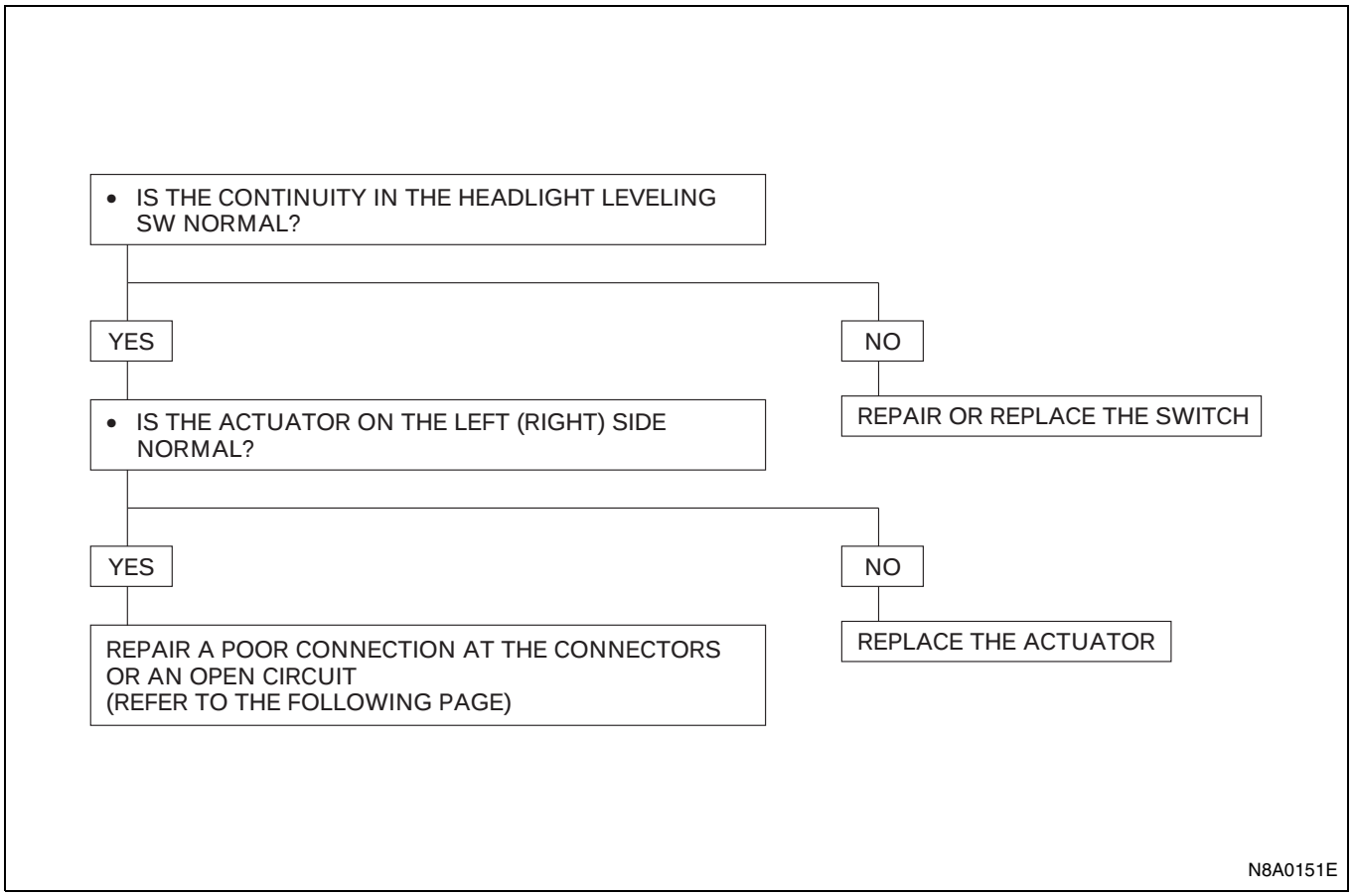
1. Both Actuators Inoperative



2. Actuator on the Left (Right) Side Inoperative



3. When Headlight Leveling SW is Turned to A Certain Position, Actuator Inoperative



Inspect and repair the circuit that is corresponding to the headlight leveling switch position where the actuator becomes inoperative.

Actuator - LH

Headlight leveling SW position	Circuit
1	Between 3 B-156 and 3 B-155
2	Between 2 B-156 and 4 B-155
3	Between 1 B-156 and 5 B-155
0	Between 4 B-156 and 2 B-155

Actuator - RH

Headlight leveling SW position	Circuit
1	Between 3 B-156 and 3 B-152
2	Between 2 B-156 and 4 B-152
3	Between 1 B-156 and 5 B-152
0	Between 4 B-156 and 2 B-152

Starter Switch

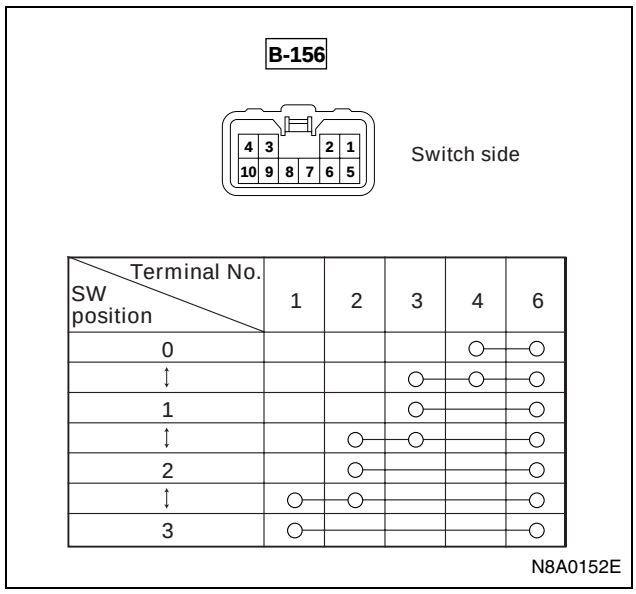
Refer to “START AND CHARGING” in this manual.

Headlight Leveling Switch

Inspection

Check the continuity between the switch connector terminals.

Repair or replace the switch when the result of inspection is found abnormal.

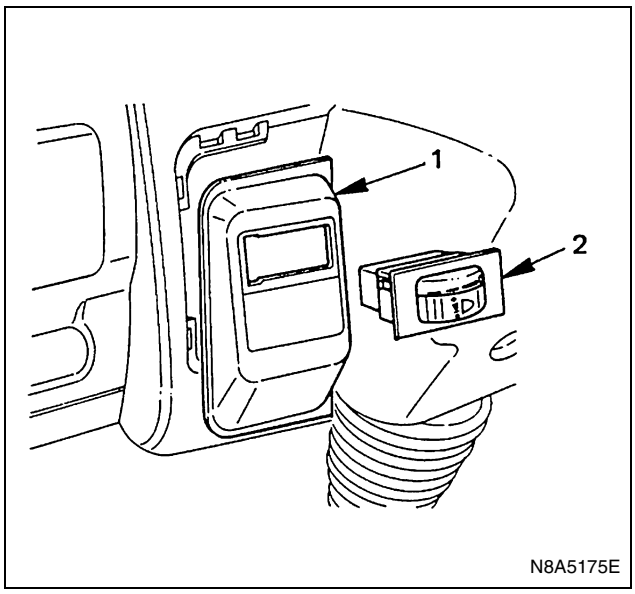


Removal

Preparation:

Disconnect the battery ground cable.

1. Switch Bezel
2. Headlight Leveling Switch
   Disconnect the connector.



Installation

To install, follow the removal steps in the reverse order.

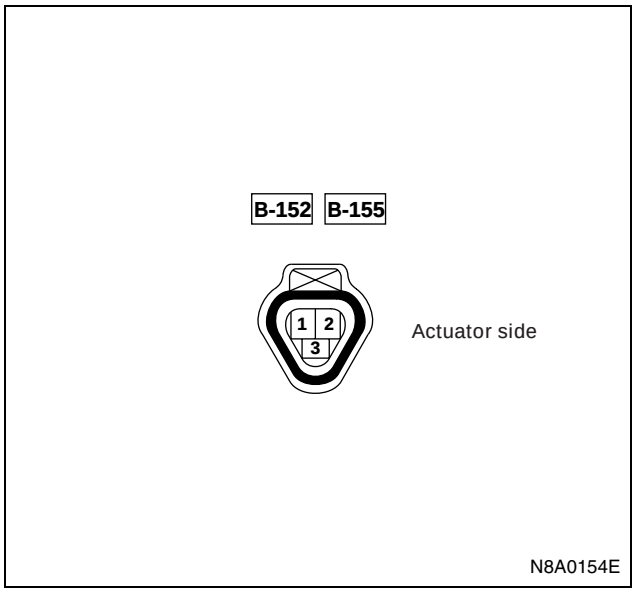
Headlight Leveling Actuator

Inspection

Apply the battery voltage to the connector terminals and check its function.

This actuator has a mechanism that the angle of headlight leveling varies according to input voltage of SIGNAL.

1. Make sure that the voltage specified in table is output to vehicle harness connector which will be connected to actuator.
   If the power supply is not 12 V, the SIGNAL output varies in proportion to its voltage.
2. Connect the connector of actuator and vehicle harness connector.
   Make sure that the reflector of headlight moves to the position indicated by HEAD LAMP LEVELING SW.



1	2	3
SIGNAL	–	+

		Input signal voltage ratio for SIGNAL when the voltage difference between positive and negative is specified as 100%	–	+
HEAD LAMP POSITION	Position 0	10.0% (1.2 V)	0 V	12 V
	Position 1	23.4% (2.8 V)	0 V	12 V
	Position 2	36.7% (4.4 V)	0 V	12 V
	Position 3	50.0% (6.0 V)	0 V	12 V
	Position 4	63.4% (7.6 V)	0 V	12 V

Caution:

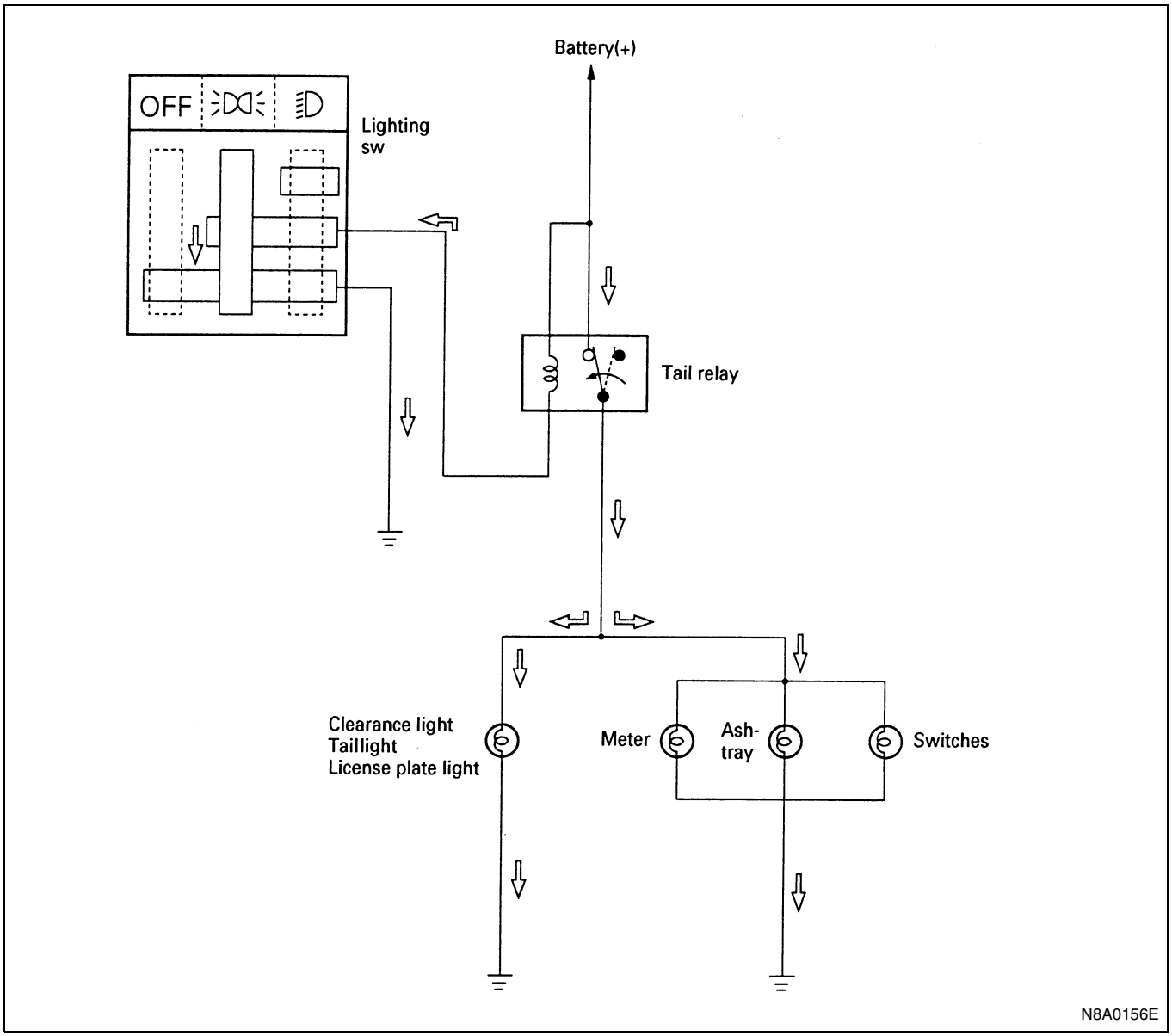
1. For vehicles with 12 V and 24 V, this leveling input voltage is 12 V.
2. Input to SIGNAL must be less than 65% of the input voltage to positive terminal.

Clearance Light, Taillight, License Plate Light and Illumination Light

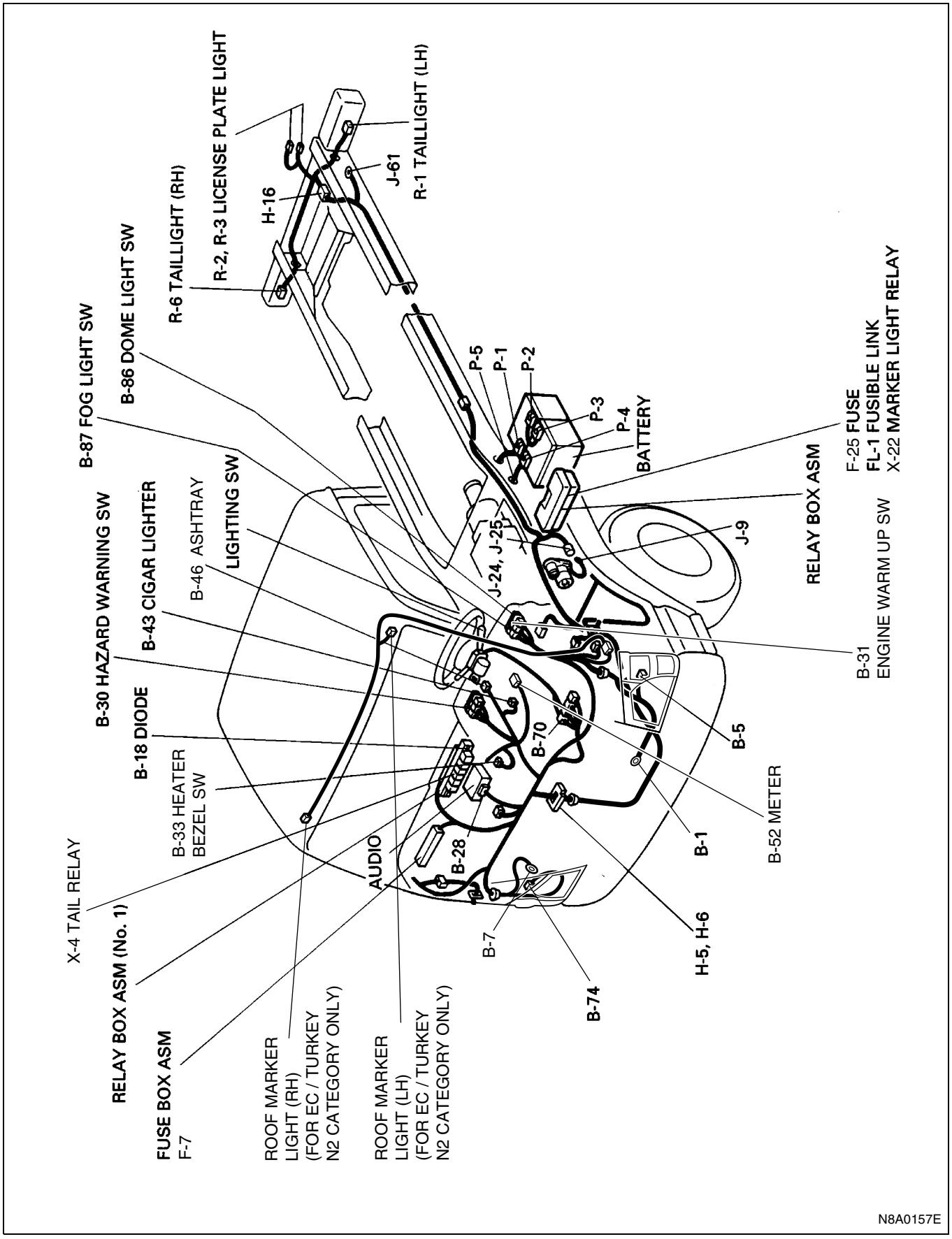
General Description

The circuit consists of the lighting switch, clearance light, taillight, license plate light and the illumination light for each of switch, meter and ashtray.
All these lights come on when the lighting switch is turned on with the switch to either clearance or headlight position.

Lighting Circuit

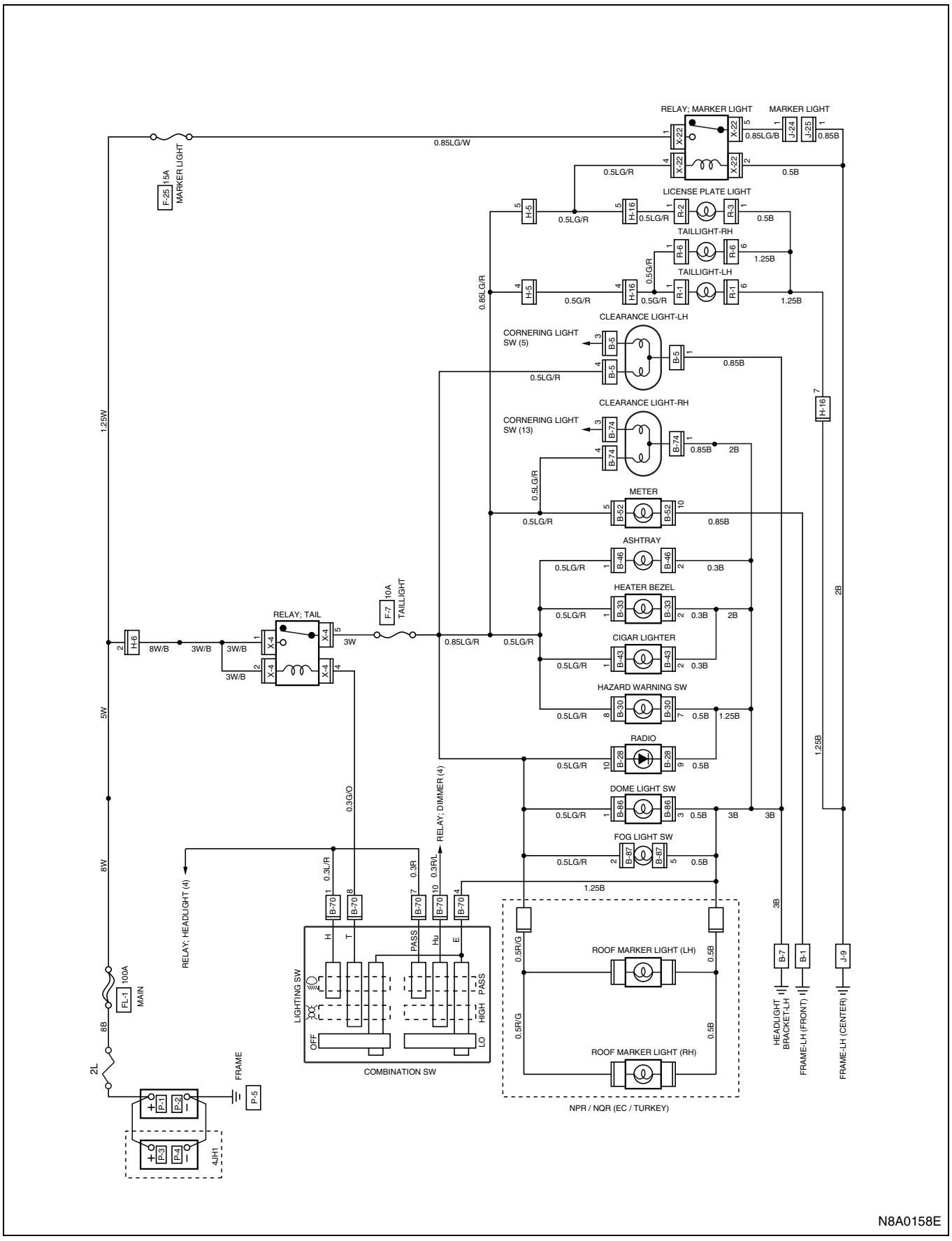


Parts Location

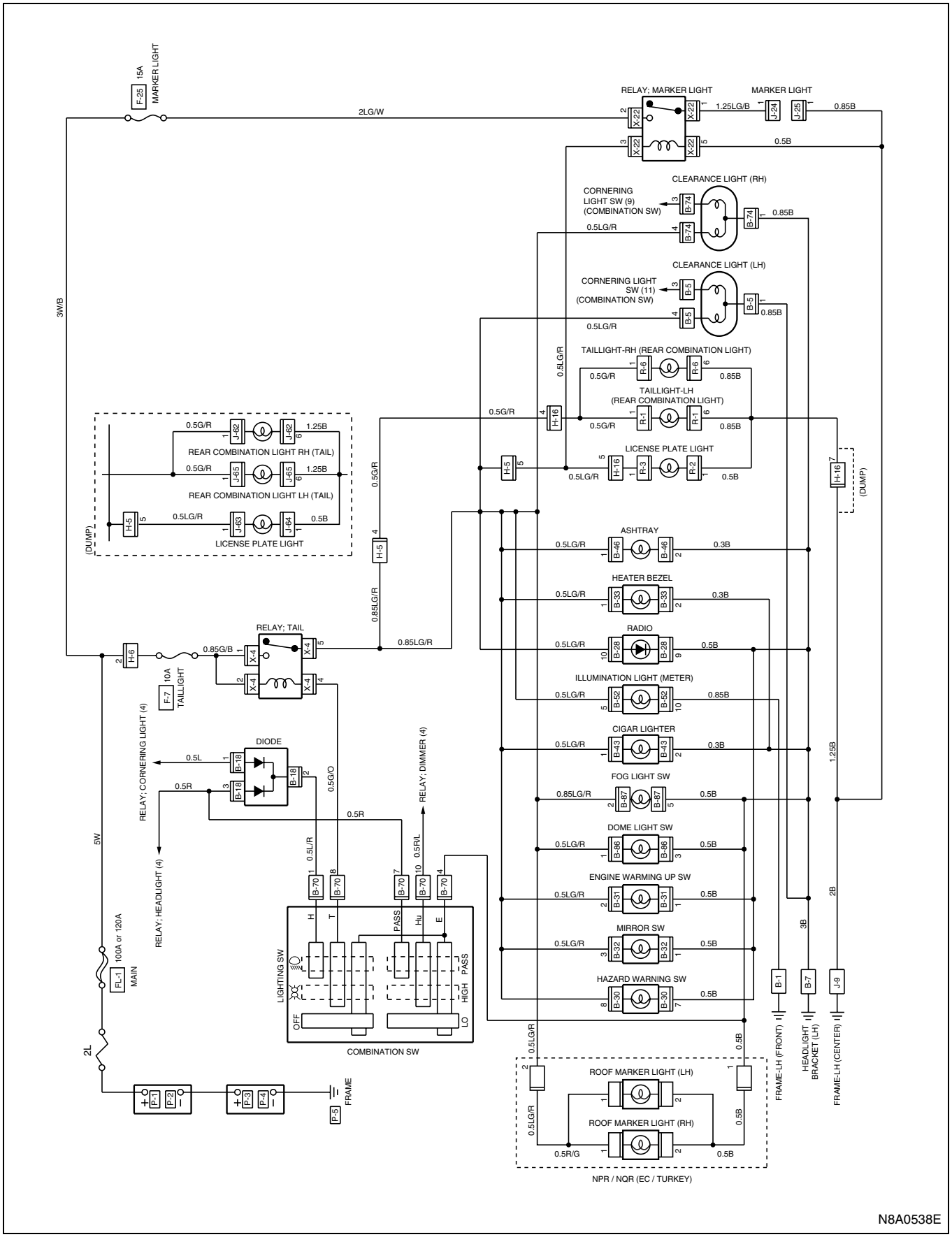


Circuit Diagram

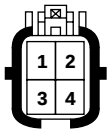
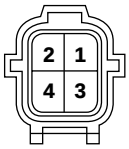
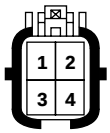
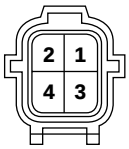
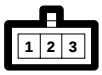
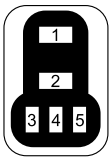
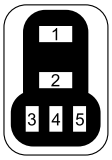
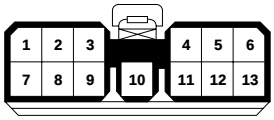
For 12 Volt

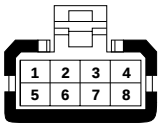
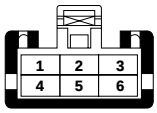
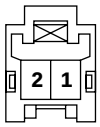


For 24 Volt


F-25 15A MARKER LIGHT
2LG/W
RELAY; MARKER LIGHT
MARKER LIGHT
1.25LG/B
0.85B
0.5B
CLEARANCE LIGHT (RH)
CORNERING LIGHT SW (9) (COMBINATION SW)
0.5LG/R
CLEARANCE LIGHT (LH)
CORNERING LIGHT SW (11) (COMBINATION SW)
3W/B
TAILLIGHT-RH (REAR COMBINATION LIGHT)
0.5G/R
0.5LG/R
TAILLIGHT-LH (REAR COMBINATION LIGHT)
LICENSE PLATE LIGHT
REAR COMBINATION LIGHT RH (TAIL)
REAR COMBINATION LIGHT LH (TAIL)
1.25B
(DUMP)
ASHTRAY
0.3B
HEATER BEZEL
RADIO
ILLUMINATION LIGHT (METER)
CIGAR LIGHTER
FOG LIGHT SW
DOME LIGHT SW
ENGINE WARMING UP SW
MIRROR SW
HAZARD WARNING SW
RELAY; TAIL
0.85G/B
0.85LG/R
F-7 10A TAILLIGHT
DIODE
0.5L
0.5R
0.5G/O
RELAY; CORNERING LIGHT (4)
RELAY; HEADLIGHT (4)
RELAY; DIMMER (4)
0.5L/R
0.5R/L
5W
2L
FL-1 100A or 120A MAIN
LIGHTING SW
OFF
HIGH
LO
PASS
COMBINATION SW
P-1
P-2
P-3
P-4
P-5
FRAME
ROOF MARKER LIGHT (LH)
ROOF MARKER LIGHT (RH)
0.5R/G
NPR / NQR (EC / TURKEY)
B-1
B-7
J-9
FRAME-LH (FRONT)
HEADLIGHT BRACKET (LH)
FRAME-LH (CENTER)
1.25B
3B
2B
N8A0538E

Connector List

No.	Connector Face
B-5	 004-012
B-5	 004-013
B-74	 004-012
B-74	 004-013
B-18	 003-024
X-4	 005-006
X-22	 005-006
B-28	 013-001

No.	Connector Face
B-30	 008-005
B-31	 006-001
B-33	002-022
B-33	 002-023
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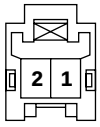
B-46	 002-023
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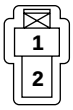
B-43	 002-010

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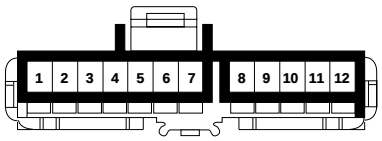
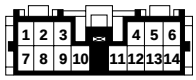
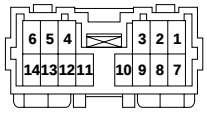
B-52	 012-005
B-70	 014-002
B-70	 014-003
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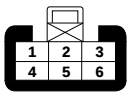
B-87	 006-006
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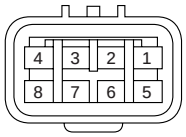
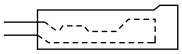
H-16	 008-004
J-24	 000-010

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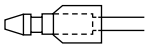
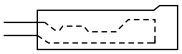
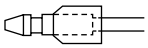
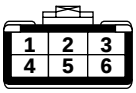
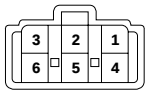
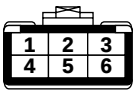
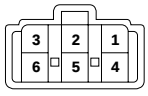
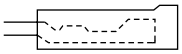
J-24	 000-011
J-25	 000-010
J-25	 000-011
J-62	 006-010
J-62	 006-015
J-65	 006-010
J-65	 006-015
J-63	 000-010

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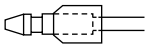
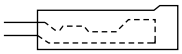
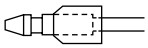
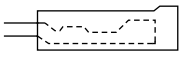
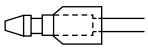
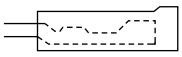
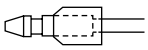
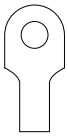
J-63	 000-011
J-64	 000-010
J-64	 000-011
R-2	 000-010
R-2	 000-011
R-3	 000-010
R-3	 000-011
P-1 (12 V)	 000-003

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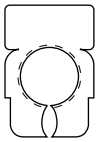
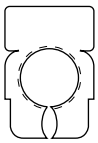
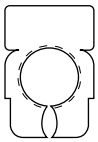
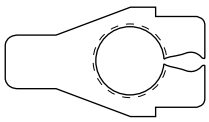
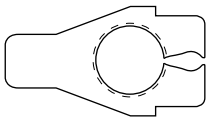
P-2	 000-004
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
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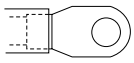
P-5 (24 V)	 000-002
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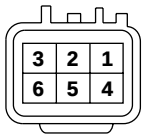
R-1	 006-005
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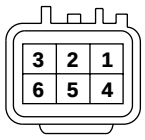
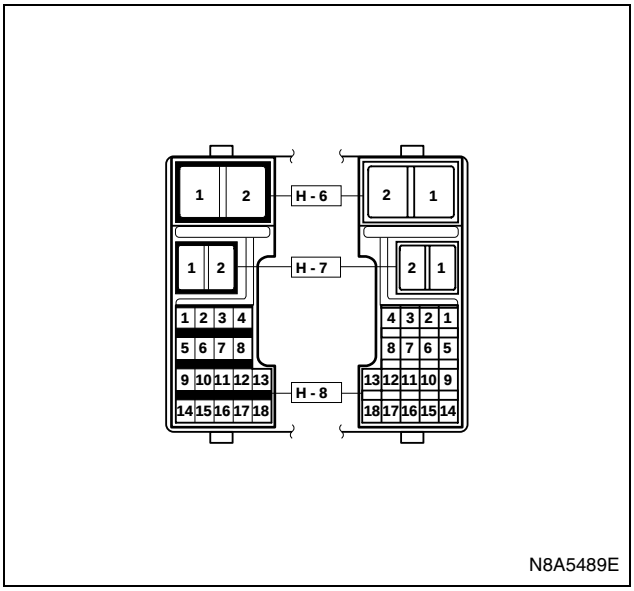
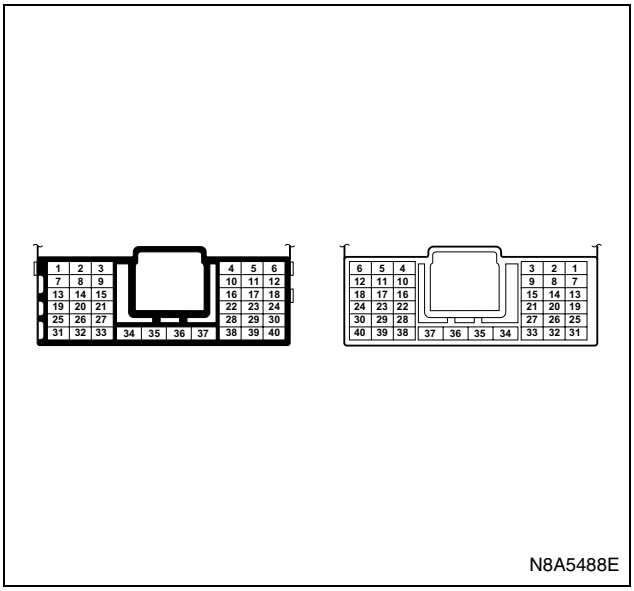
R-6	 006-005

H-6



N8A5489E

H-5



N8A5488E

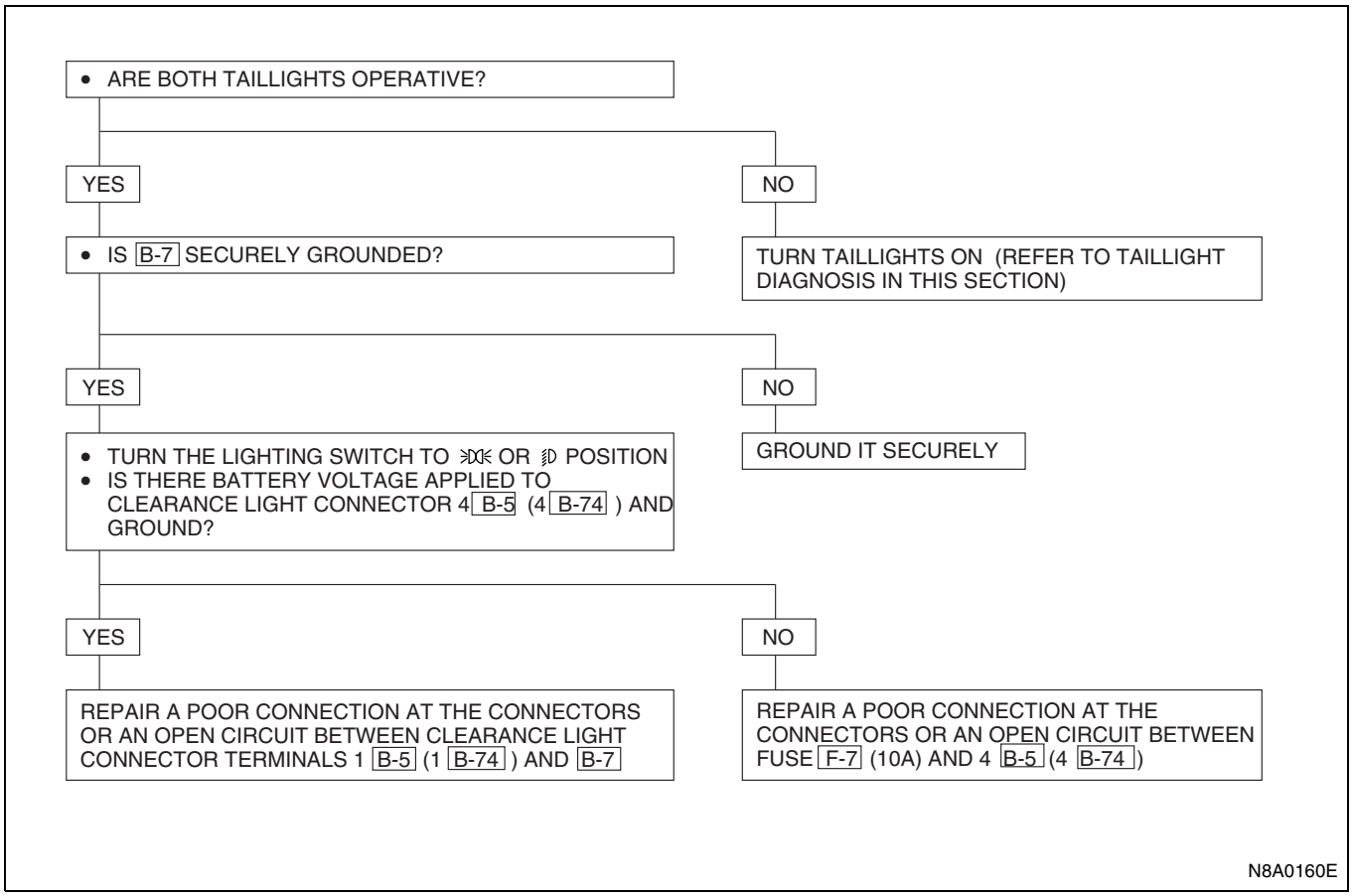
Diagnosis

Quick Chart for Check Point

		Check point								
		Fuse		Light-ing SW	Tail-light bulb	Clear-ance light bulb	License plate light bulb	Marker light relay	Cable har-ness	Marker light bulb
		F-7 (10 A)	F-25 (15 A)							
Trouble mode	1. Both clearance lights inoperative	❍ (1)		❍ (3)		❍ (2)			❍ (4)	
	2. Clearance light on the left (or right) side inoperative					❍ (1)			❍ (2)	
	3. Both taillights inoperative	❍ (1)		❍ (2)					❍ (3)	
	4. Taillight on the left (or right) side inoperative				❍ (1)				❍ (2)	
	5. License plate light inoperative						❍ (1)		❍ (2)	
	6. Marker light inoperative		❍ (2)					❍ (3)	❍ (4)	❍ (1)

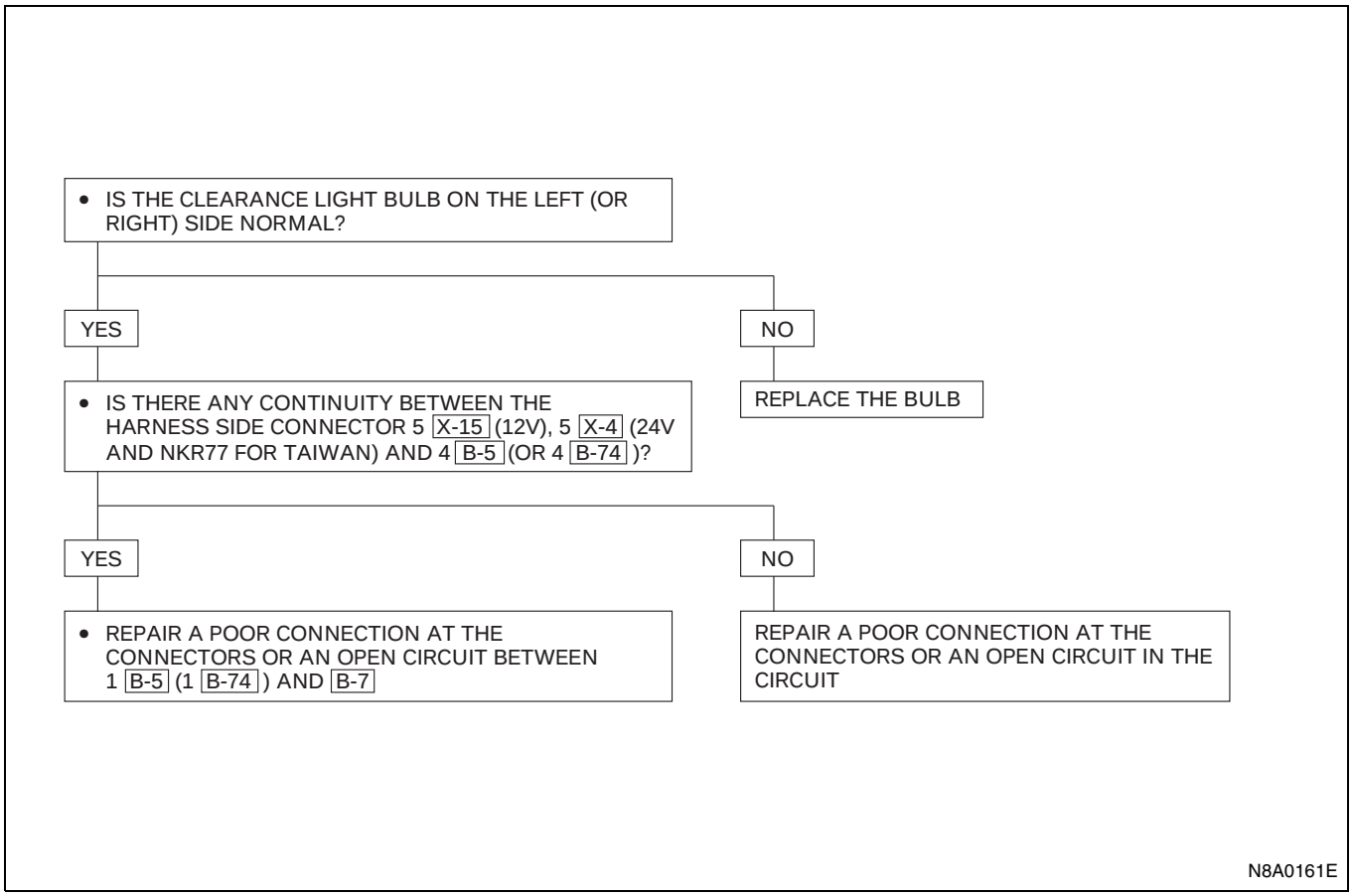
Notice:
Figure in parenthesis “( )” indicates the order of inspection.

1. Both Clearance Lights Inoperative



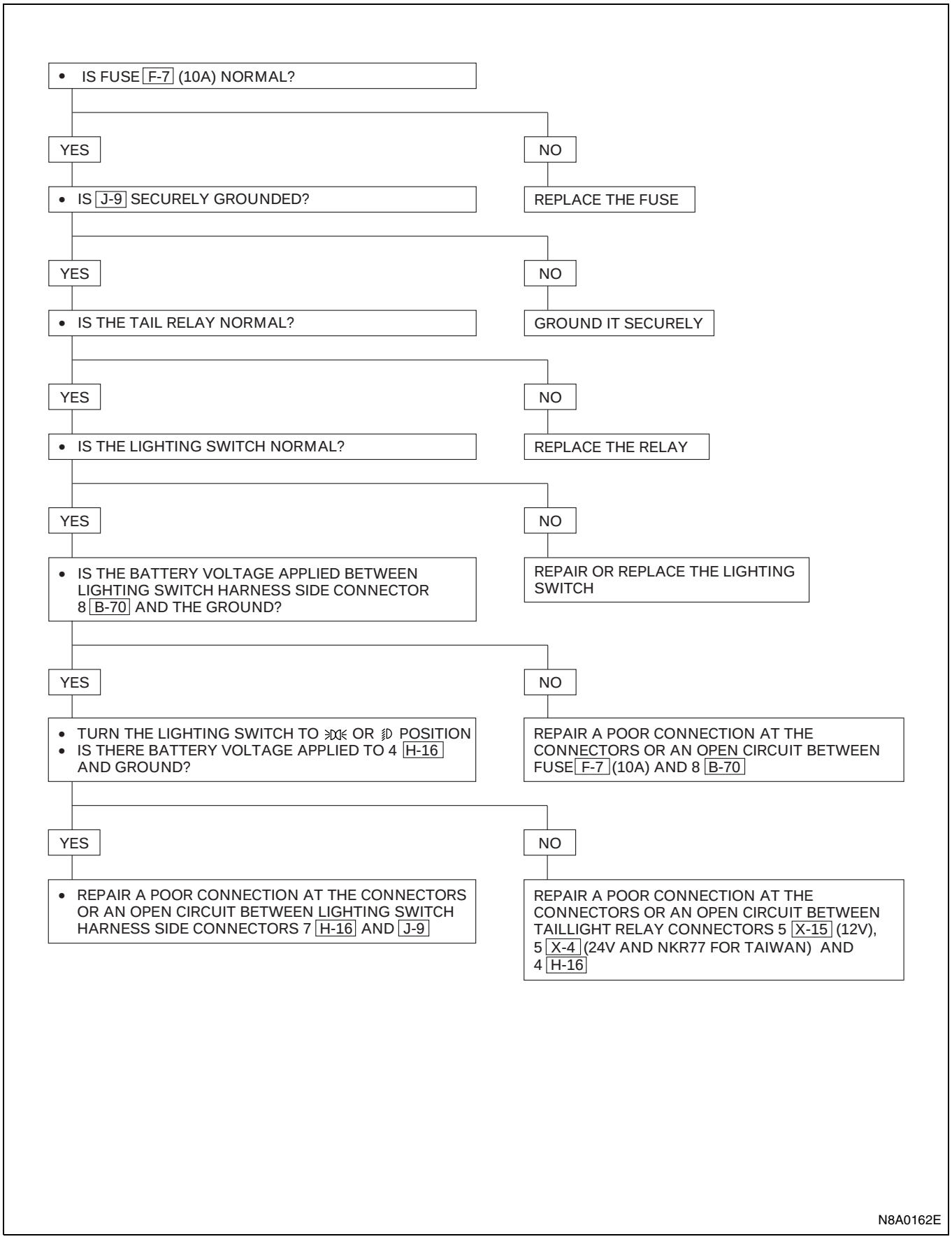
Notice:
Figure in parenthesis “( )” indicates place of inspection for clearance light on the right side.

2. Clearance Light on the Left (or Right) Side Inoperative

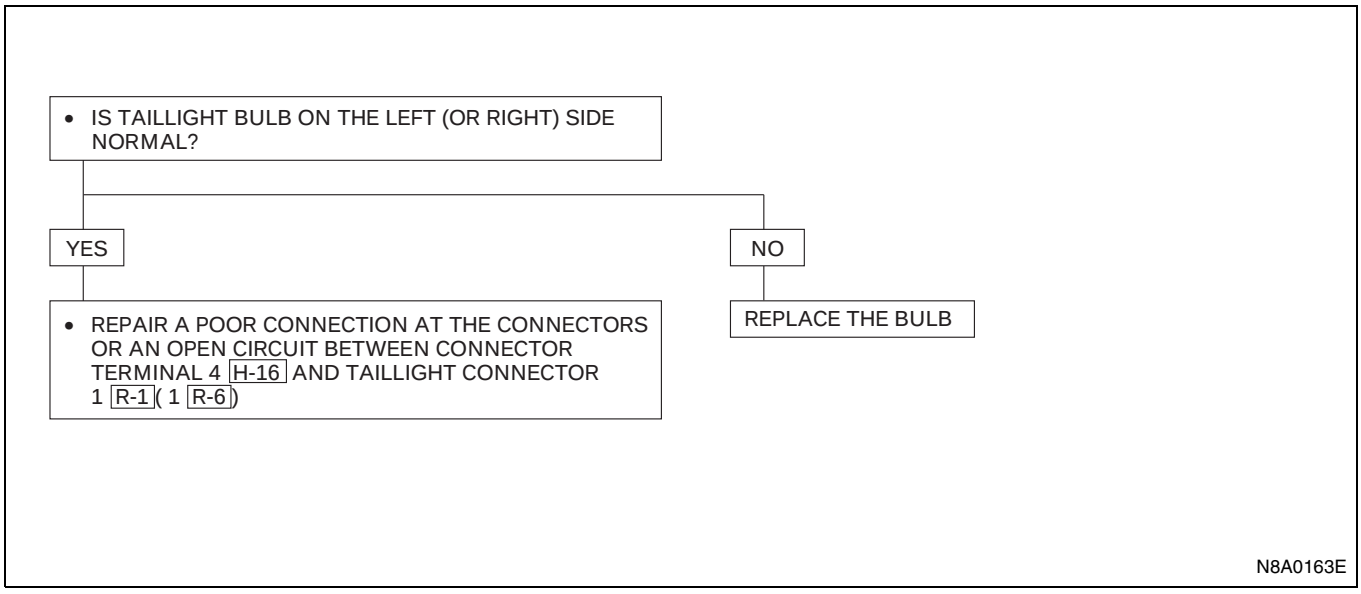


Notice:
Figure in parenthesis “( )” indicates place of inspection for clearance light on the right side.

3. Both Taillights Inoperative

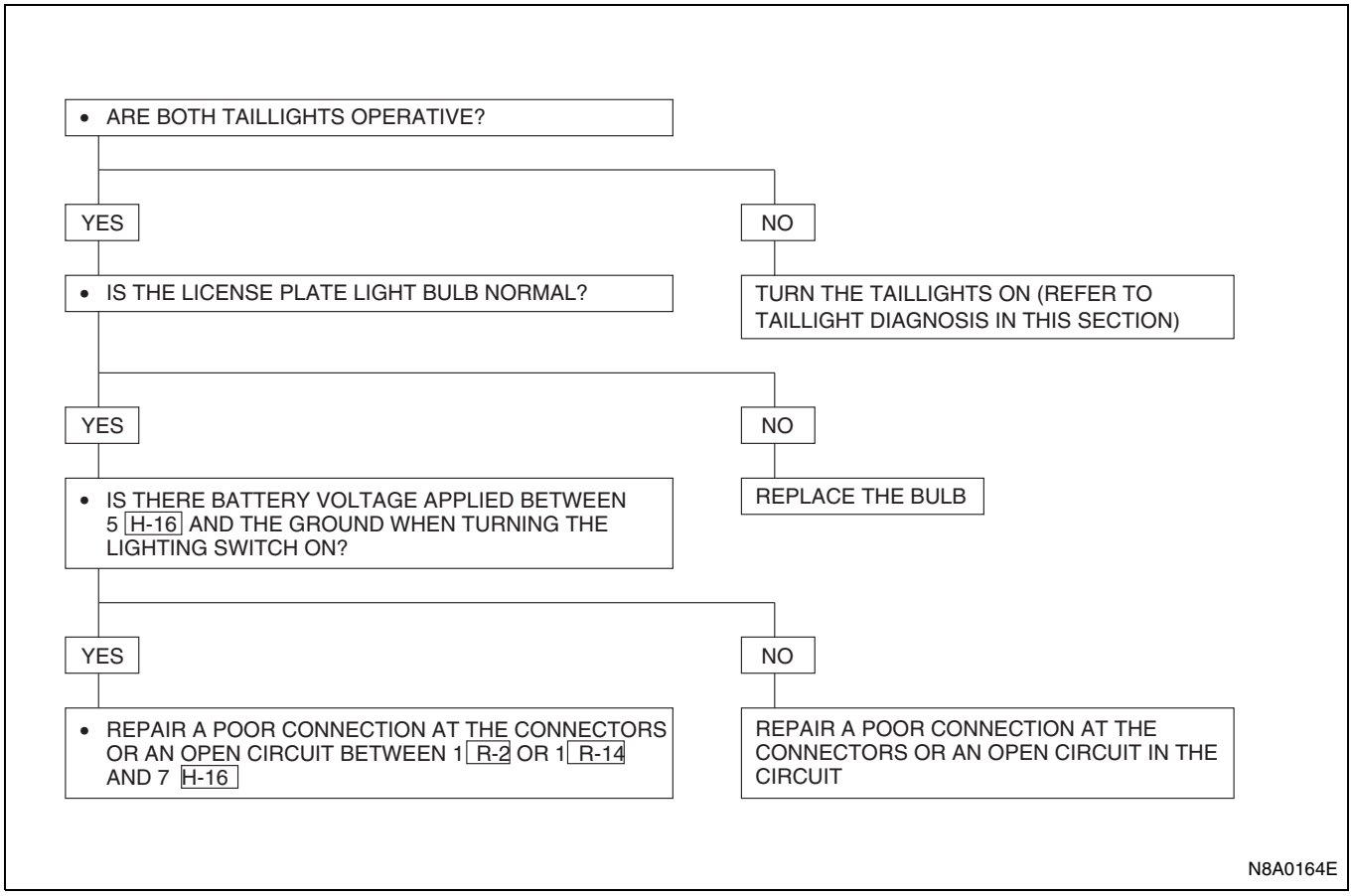


4. Taillight on the Left (or Right) Side Inoperative

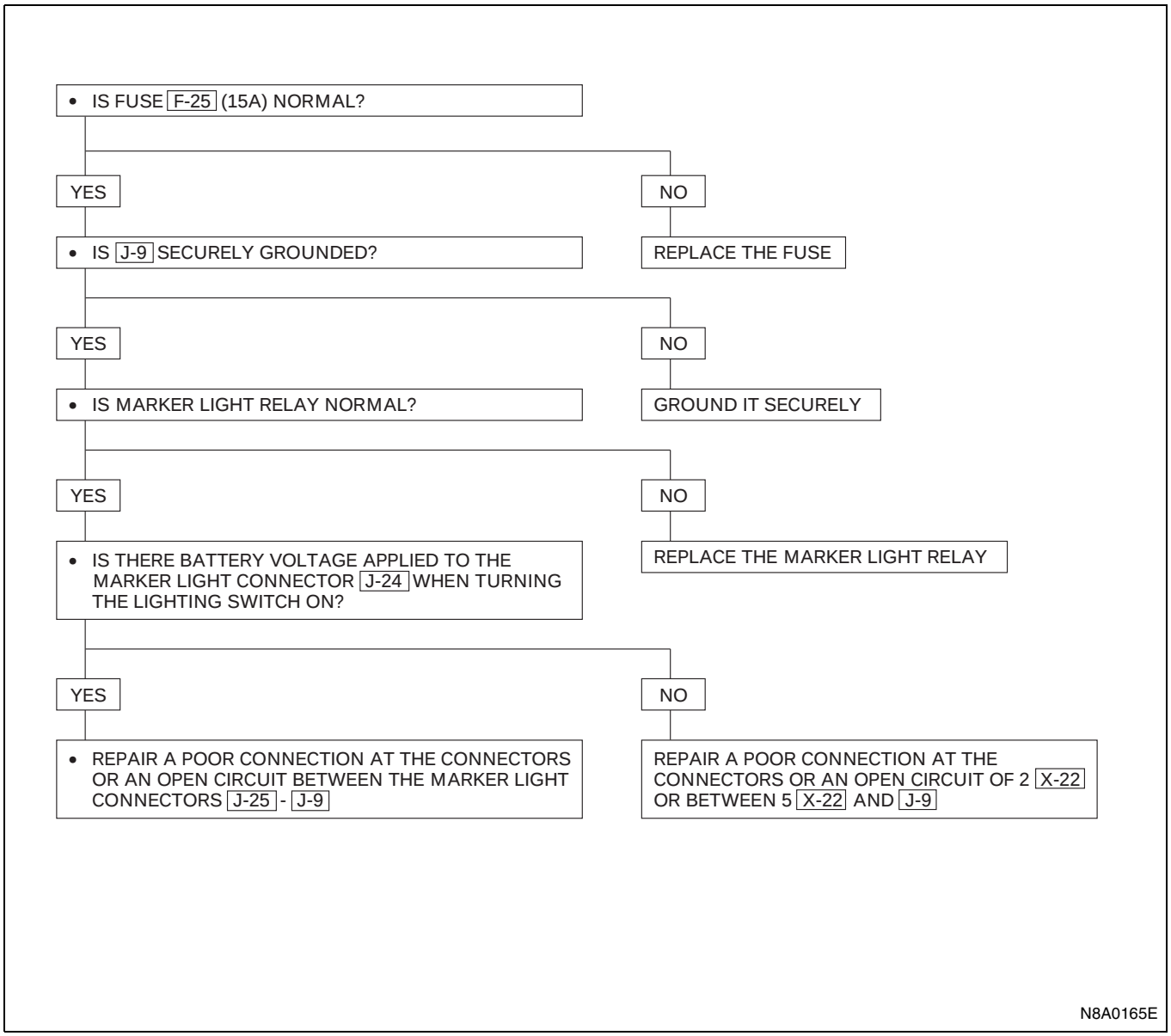


Notice:
Figure in parenthesis “( )” indicates place of inspection for taillight on the right side.

5. License Plate Light Inoperative



6. Marker Light Inoperative



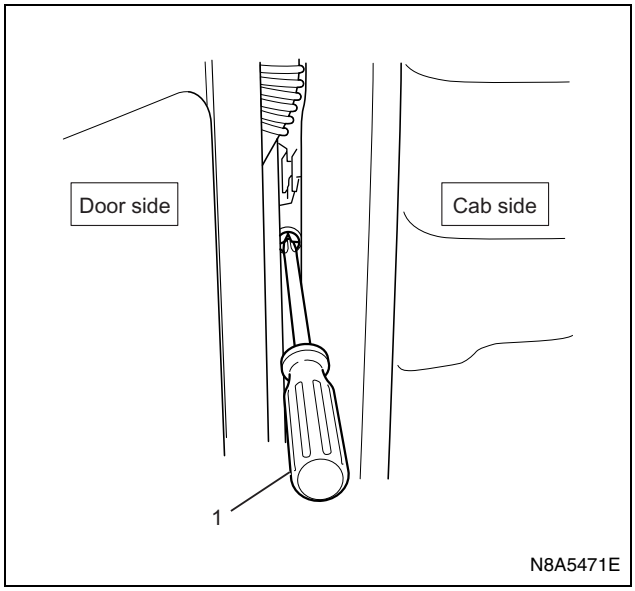
Lighting Switch

Refer to “HEADLIGHT, FOG LIGHT AND CORNERING LIGHT” in this section.

Clearance Light/Bulb

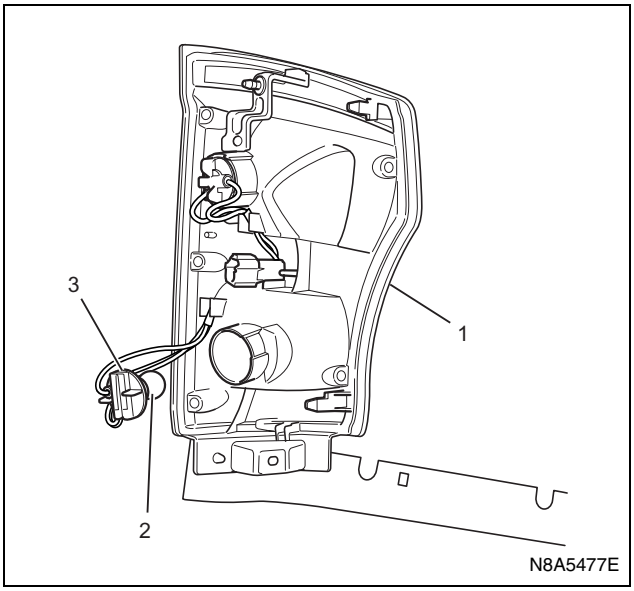
Removal

1. Remove the battery ground cable at the battery.
2. Remove the front combination light.
   - Open the cab door. Insert a screwdriver (1) into the space between the cab and the cab door. Use the screwdriver to force out the stud pin at the center of the grommet (the pin securing the front combination light).



   - Remove the fixing screw.

- Remove the two catches.
- Remove the front combination light (1) connector.



3. Remove the clearance light bulb.
   - Turn the bulb socket (3) to the left to remove it.
   - Press the bulb (2) in and turn it to the left to remove it from the socket.

Installation

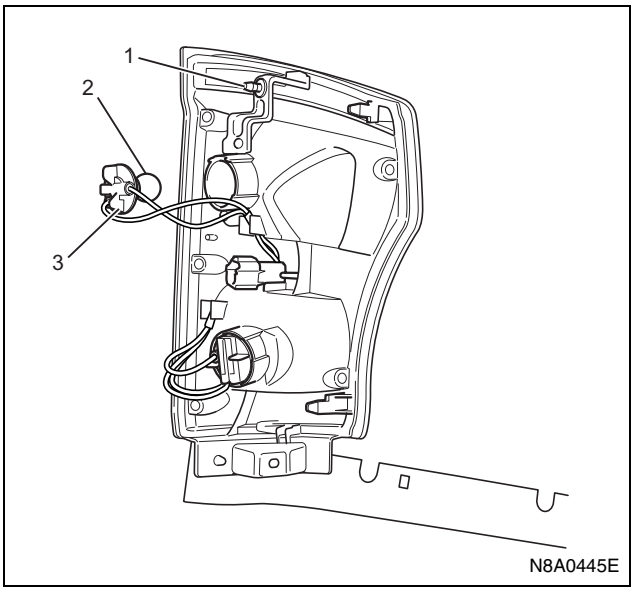
Installation procedure of cornering/clearance light bulb

1. Install the cornering/clearance light bulb.
   - While pressing the bulb (2), turn it clockwise to fit.

Notice:

Do not let the glass portion dirty with sebum etc.

- Turn the bulb socket (3) clockwise to fit.



2. Installation procedure of front combination light assembly
   - Connect the connector of the combination light assembly.
   - Position it by aligning two pawls with the groove of H/L.
   - Fit the iron PIN (1) in the upper portion of the side by aligning it with the center of corresponding grommet.

Notice:

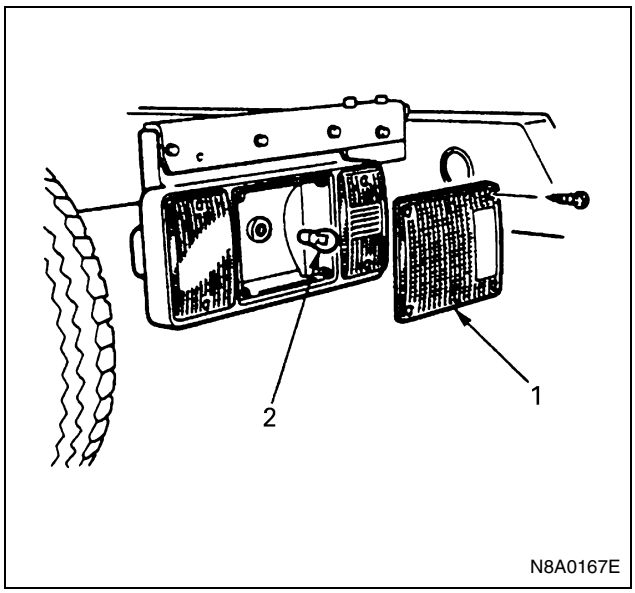
Push it into securely with a force of approx. 250 N (25 kgf) until click is heard.

   - Pull the front combination light assembly lightly toward the front of vehicle to make sure that the PIN and grommet are engaged securely.
   - Tighten one bolt in the lower portion of front combination light assembly.
3. Hook the seal rubber on two projections under H/L.
4. Connect the battery ground cable.
5. Check lighting of each light.

Taillight Bulb

Removal

1. Lens
2. Bulb



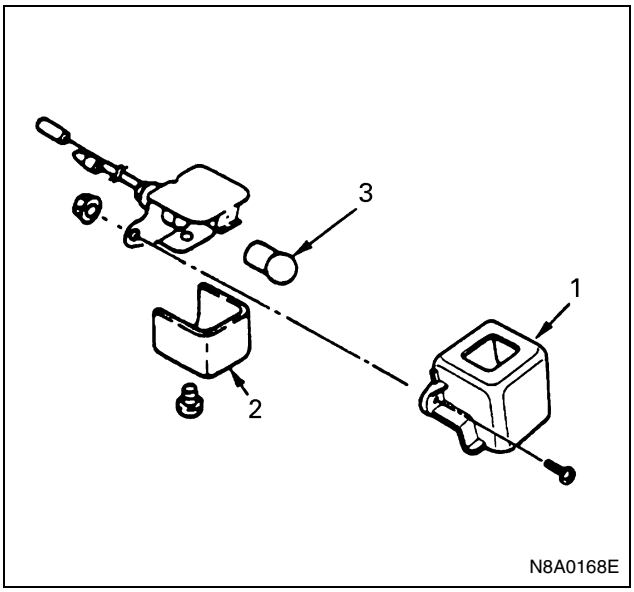
Installation

To install, follow the removal steps in the reverse order.

License Plate Light Bulb

Removal

1. Cover
2. Lens
3. Bulb



Installation

To install, follow the removal steps in the reverse order.

Turn Signal Light, Hazard Warning Light, and Stoplight

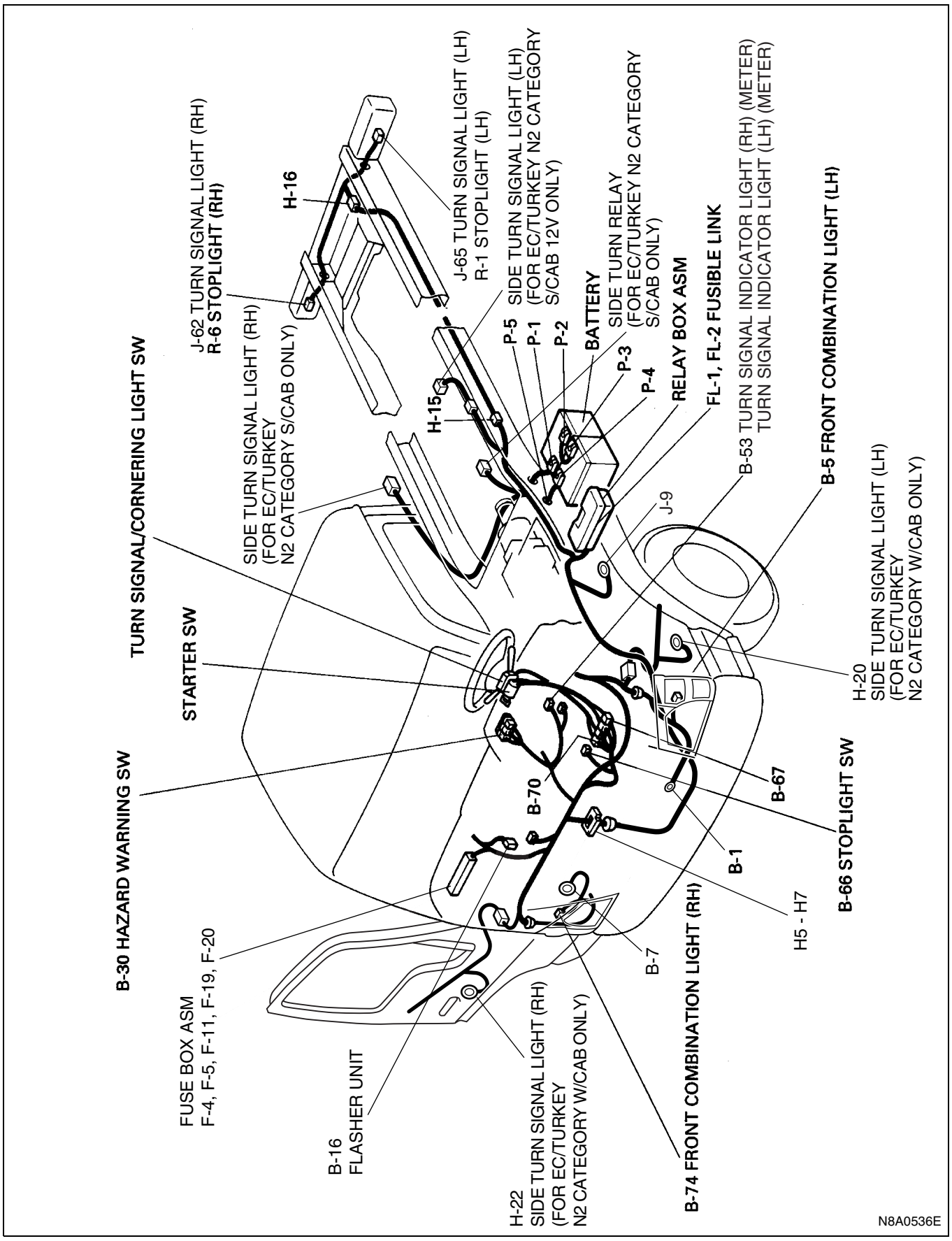
General Description

The circuit consists of the starter switch, turn signal light (front and rear), turn signal light switch, hazard warning light, flasher unit, stoplight and stoplight switch.

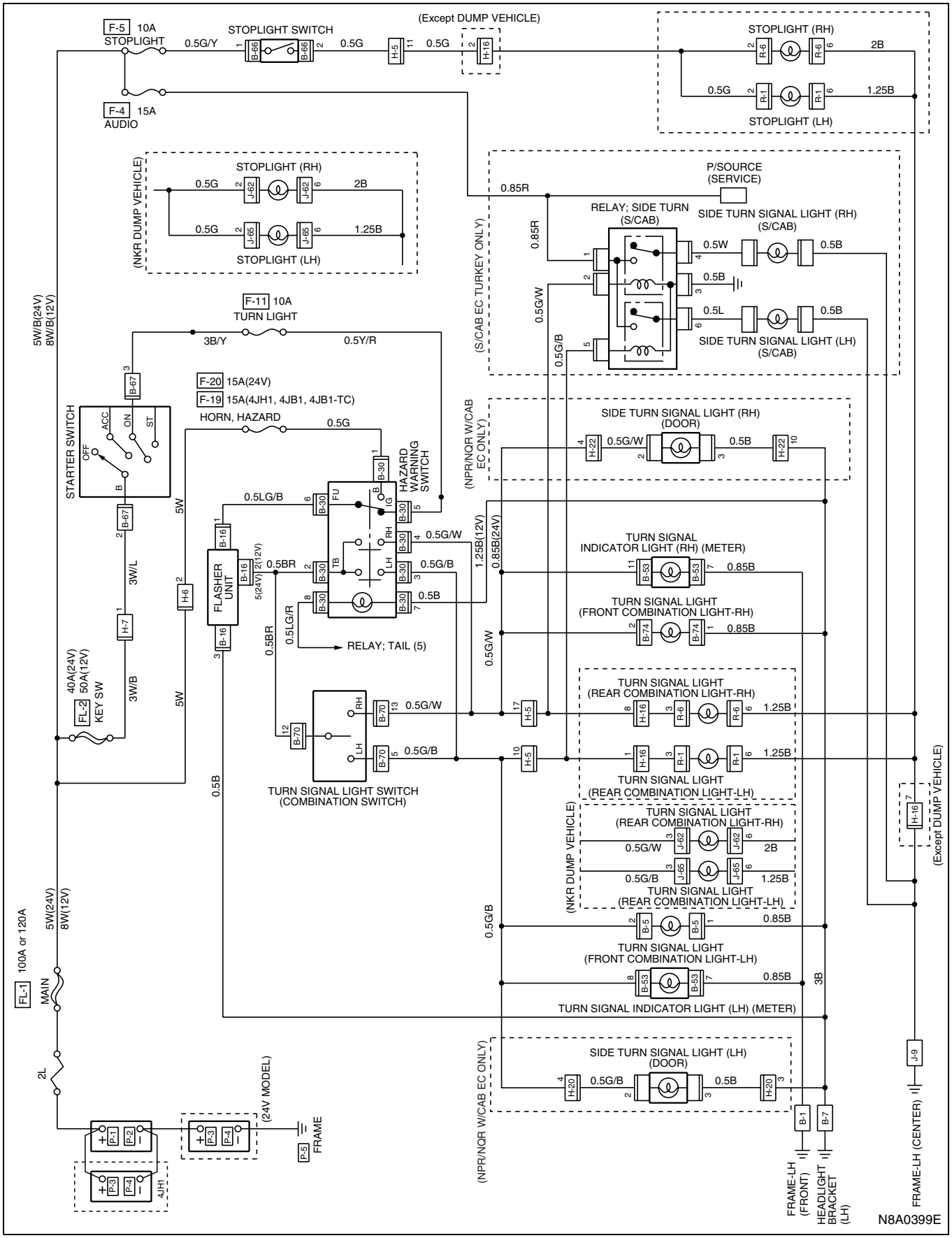
When turning on the respective switches with the starter switch on, the turn signal light will operate. When the turn signal light is flashing, the indicator light in the meter also starts flashing. When the hazard warning switch is turned on, the current flows to the flasher unit through the hazard warning switch to cause the hazard warning light to flash, independent of the position of the starter switch. At the same time, the indicator lights in the meter also start flashing.

The stoplight switch will turn on and the light comes on once the brake pedal is depressed, independent of the position of the starter switch.

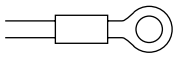
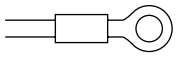
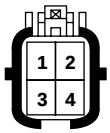
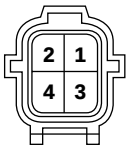
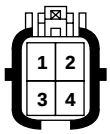
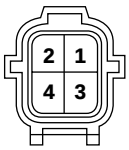
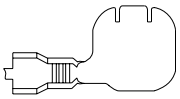
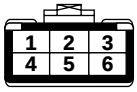
Parts Location

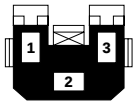
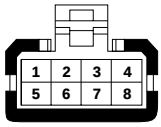
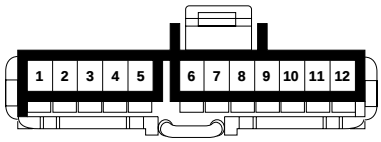


Circuit Diagram



Connector List

No.	Connector Face
B-1	 000-001
J-9	 000-001
B-5	 004-012
B-5	 004-013
B-74	 004-012
B-74	 004-013
B-7	 000-012
B-16 (24 V)	 006-010

No.	Connector Face
B-16 (12 V)	 003-008
B-30	 008-005
B-53	 012-004
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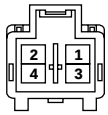
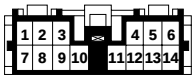
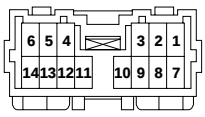
B-67	004-001
B-67	 004-002
B-70	 014-002
B-70	 014-003

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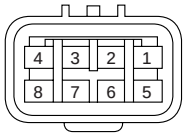
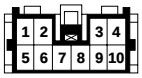
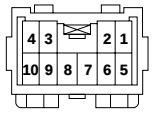
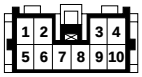
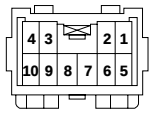
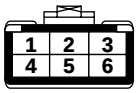
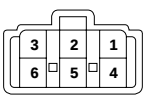
H-16	 008-004
H-20	 010-003
H-20	 010-004
H-22	 010-003
H-22	 010-004
J-62	 006-010
J-62	 006-015

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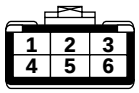
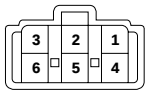
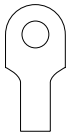
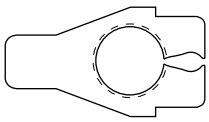
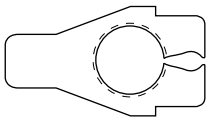
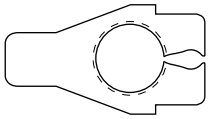
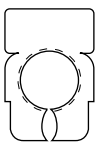
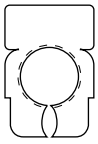
J-65	 006-010
J-65	 006-015
P-1 (12 V)	 000-003
P-2	 000-006
P-1 (24 V)	 000-006
P-4	 000-006
P-2 (24 V)	 000-004
P-3	 000-004

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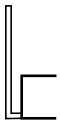
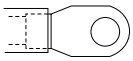
P-5 (12 V)	 000-007
P-5 (24 V)	 000-002
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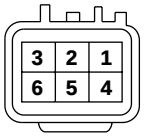
R-1	 006-005
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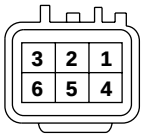
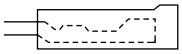
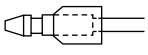
R-6	 006-005
	 000-010
	 000-011

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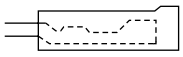
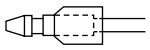
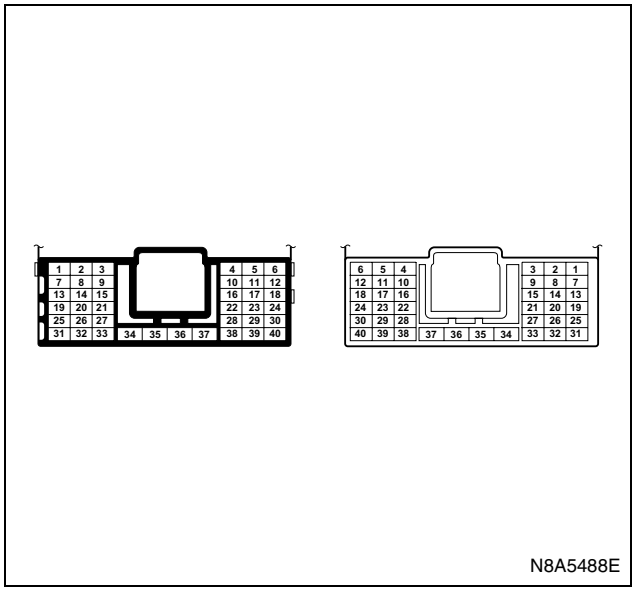
	 000-010
	 000-011

H-5



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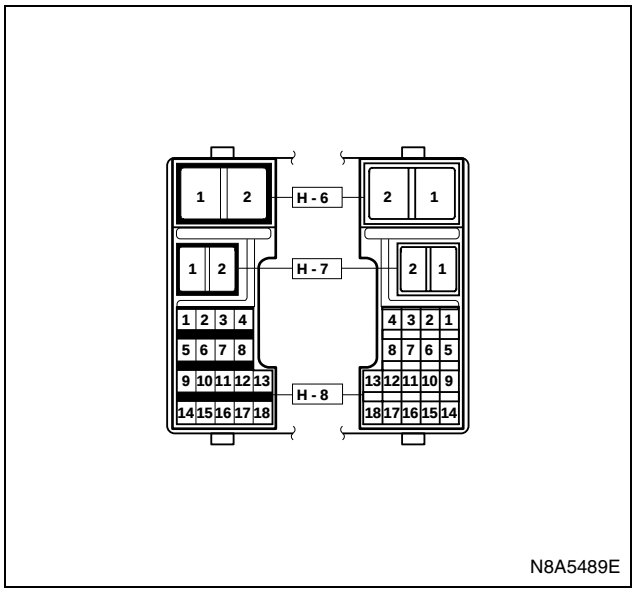
H-6, H-7



N8A5489E

Diagnosis

Quick Chart for Check Point

1. Turn Signal Light, Hazard Warning Light

		Check point						
		Fuse		Turn signal light SW	Hazard warning light SW	Flasher unit	Turn signal light bulb	Cable harness
		F-19, F-20 (15 A)	F-11 (10 A)					
Trouble mode	1-1. Turn signal lights inoperative		❍	❍		❍		❍
	1-2. Turn signal lights flash too quickly						❍	❍
	1-3. Hazard warning lights inoperative	❍			❍			

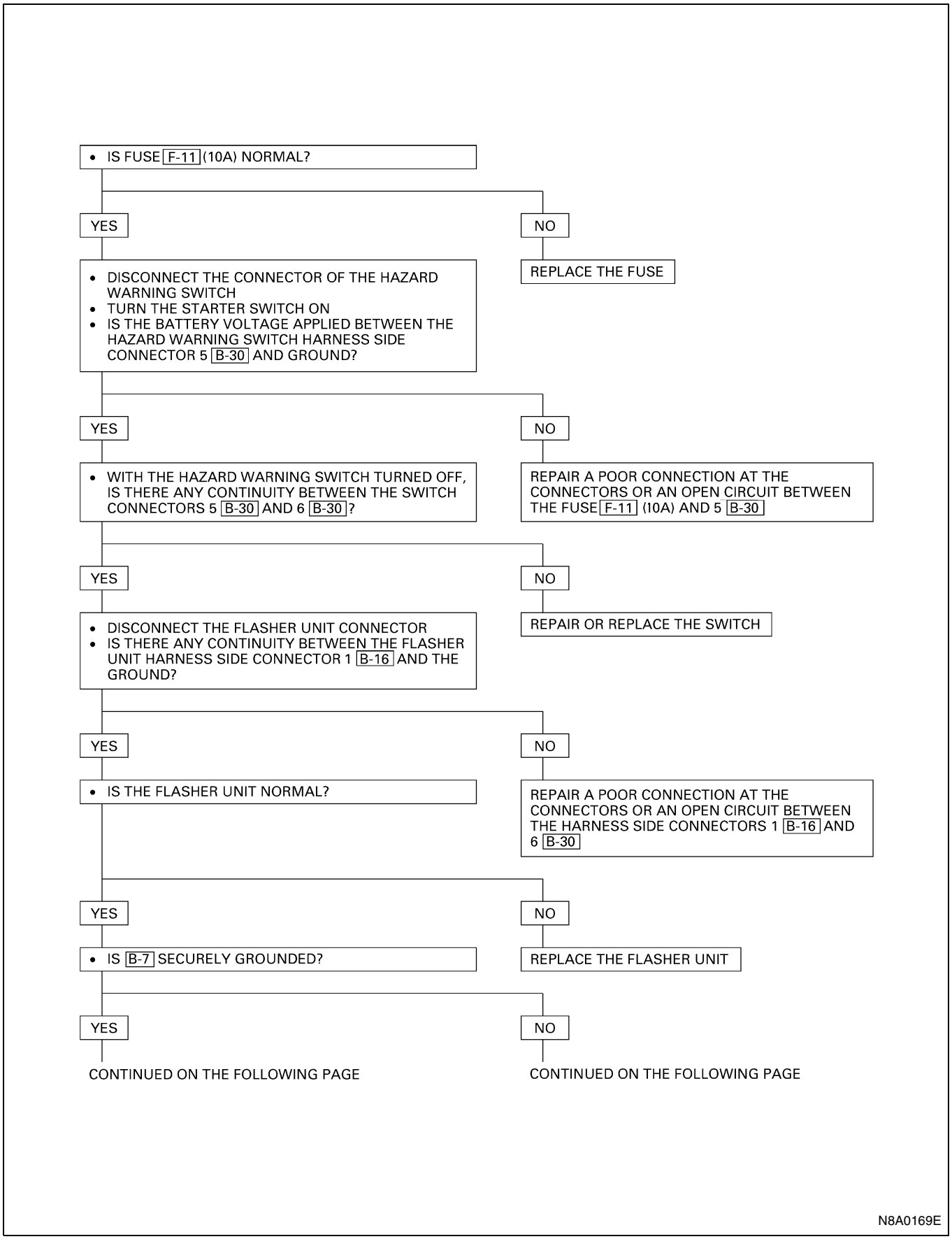
Notice:
Figure in parenthesis “( )” indicates the order of inspection.

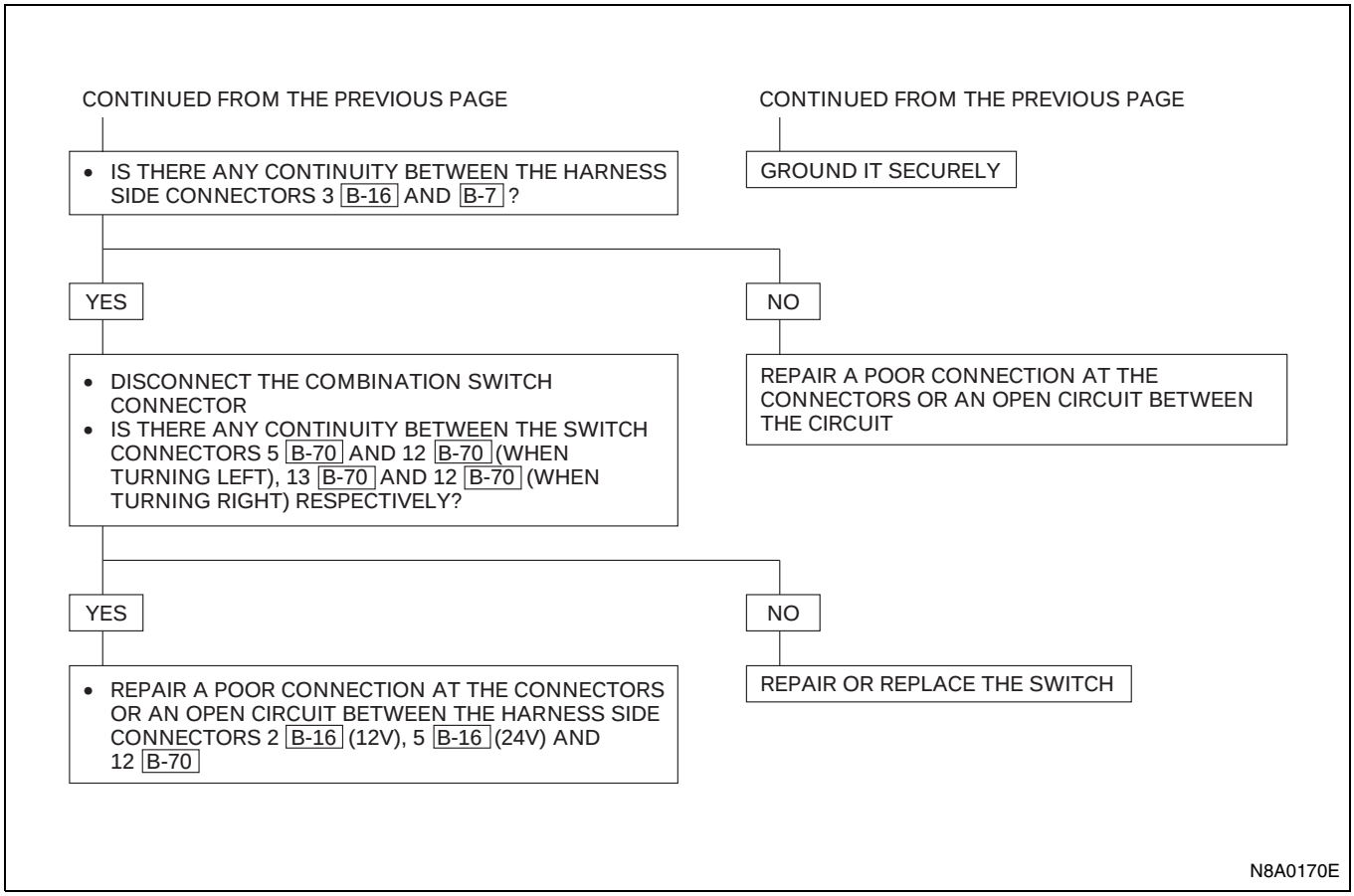
2. Stoplight

		Check point			
		Fuse F-5 (10 A)	Stoplight SW	Stoplight bulb	Cable harness
Trouble mode	2-1. Both stoplights inoperative	❍	❍		❍
	2-2. Stoplight on the left (or right) side inoperative			❍	❍

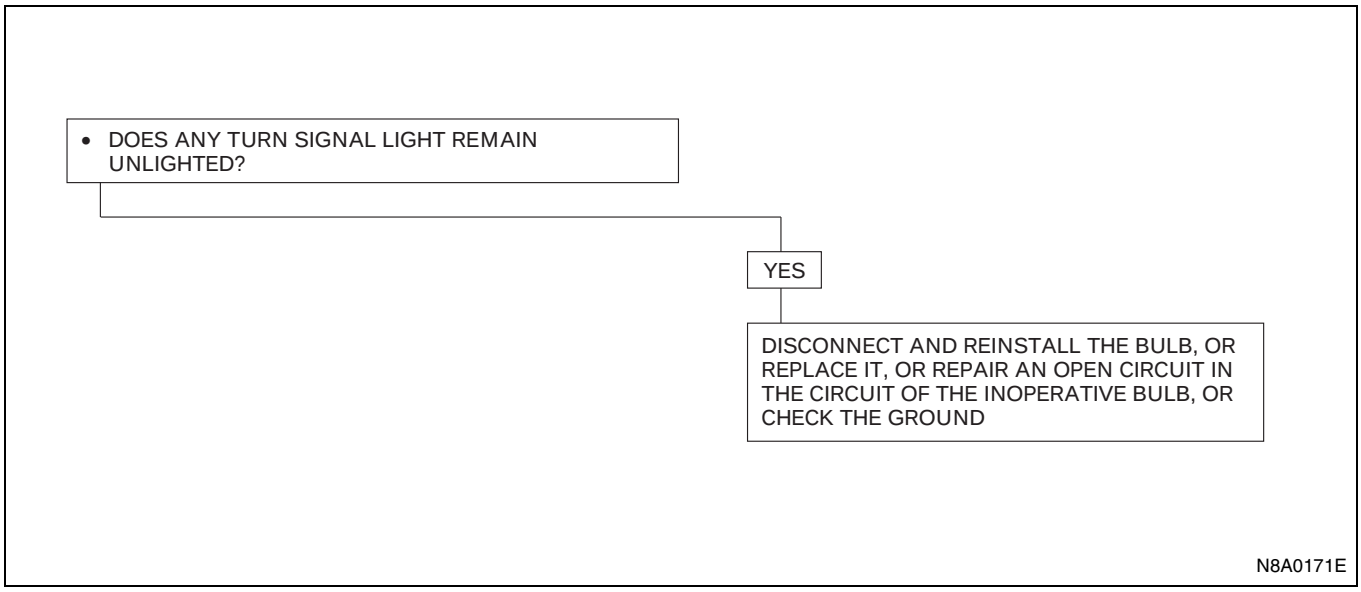
Notice:
Figure in parenthesis “( )” indicates the order of inspection.

1. Turn Signal Light, Hazard Warning Light
1-1. Turn Signal Lights Inoperative

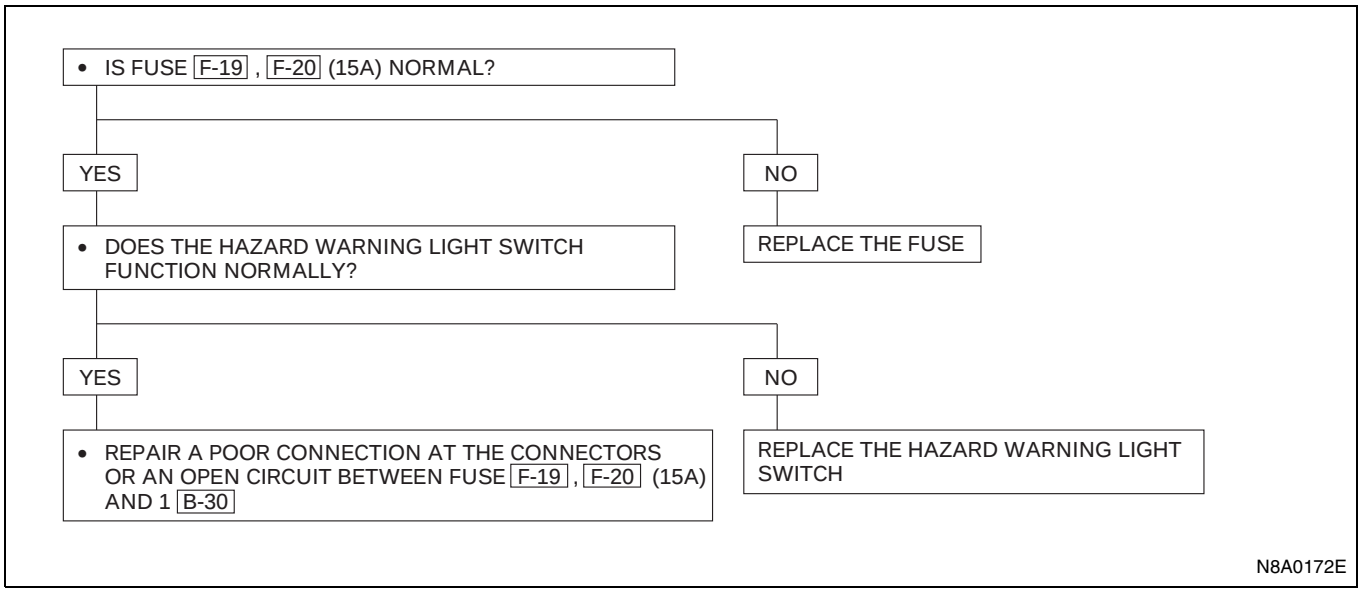




1-2. Turn Signal Lights Flash Too Quickly

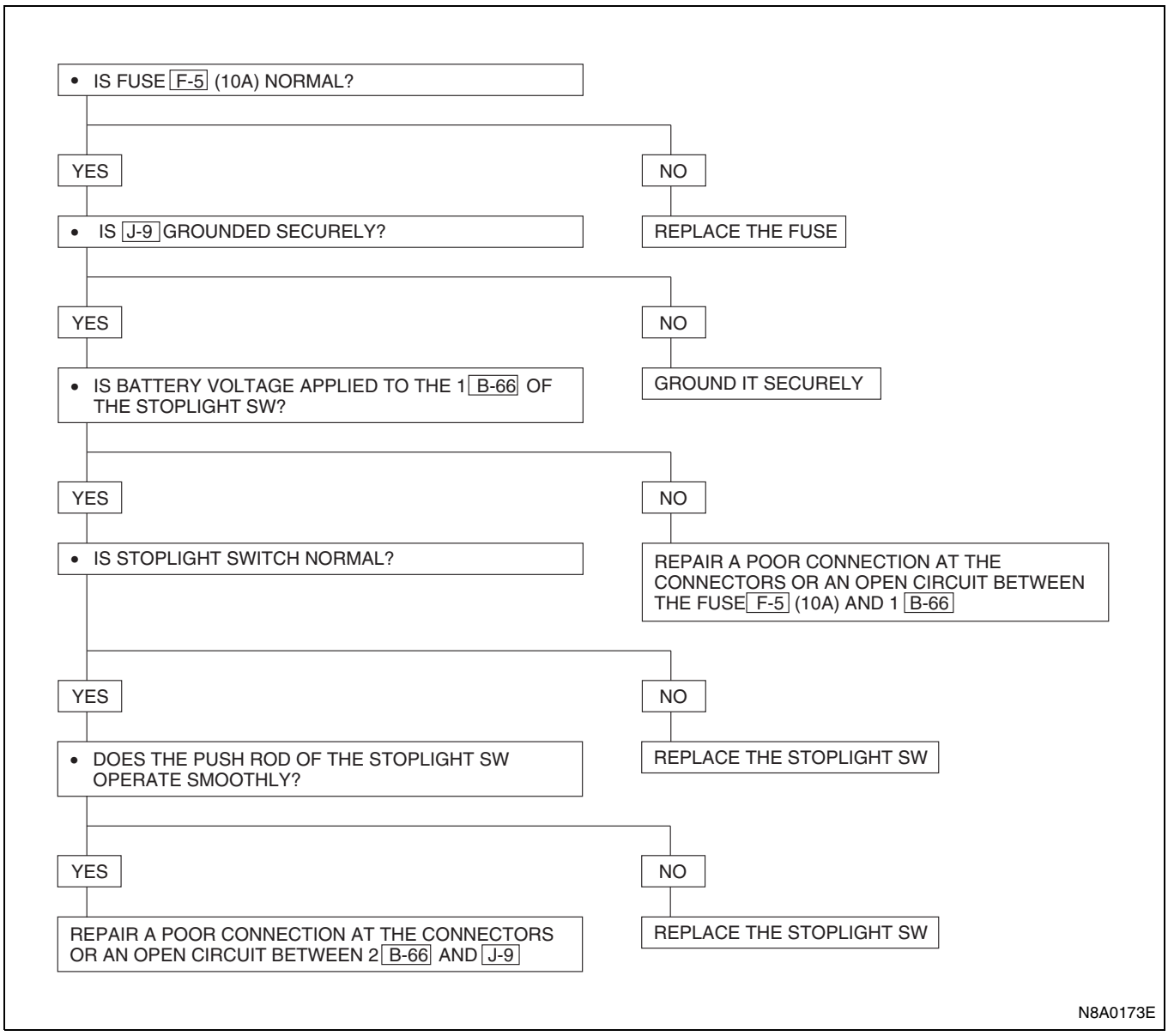


1-3. Hazard Warning Lights Inoperative

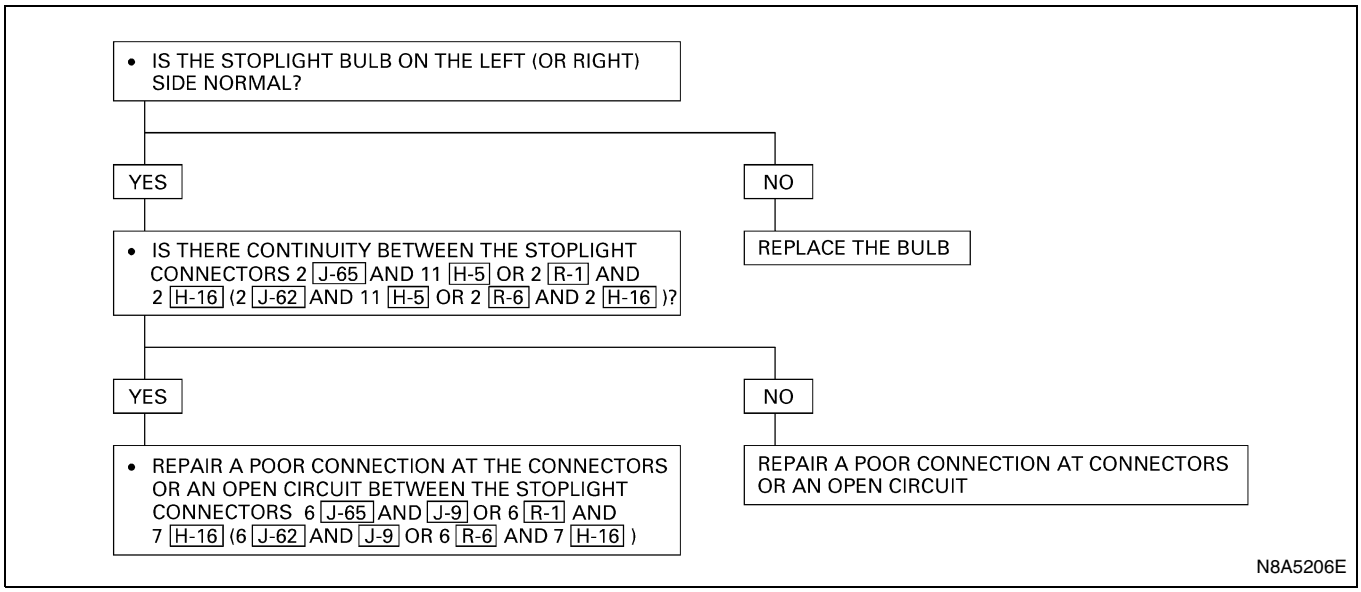


2. Stoplight

2-1. Both Stoplights Inoperative



2-2. Stoplight on the Left (or Right) Side Inoperative



Notice:
Figure in parenthesis “( )” indicates the place of inspection for the right side stoplight.

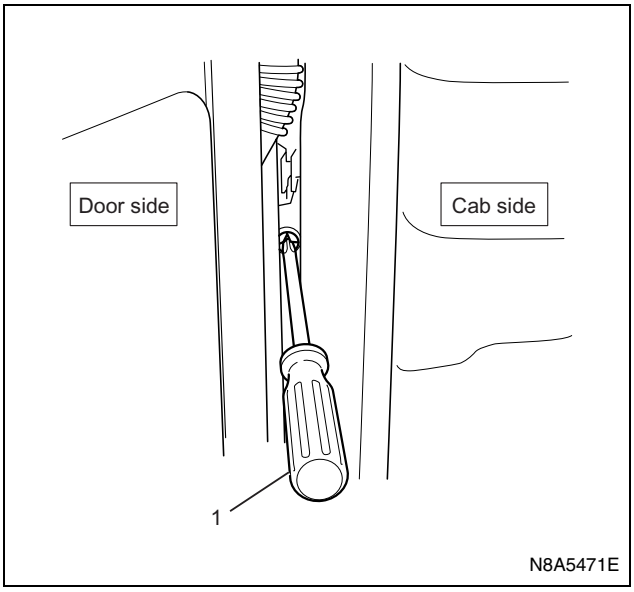
Starter Switch

Refer to “START AND CHARGING” in this section.

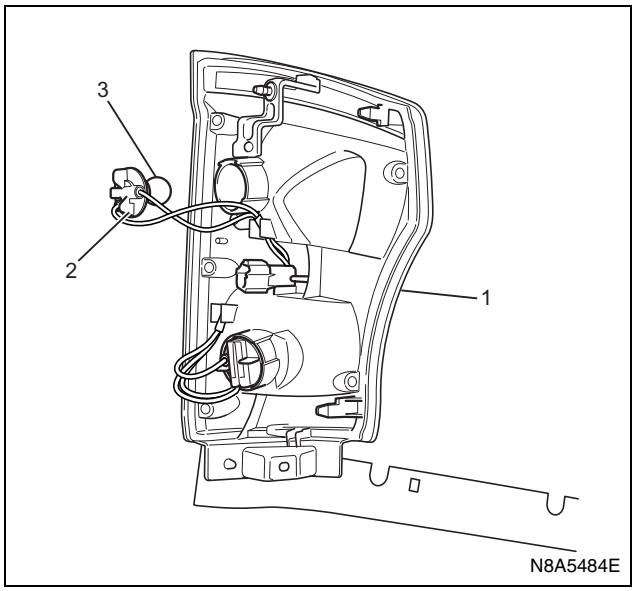
Front Turn Signal Light/Bulb

Removal

1. Remove the battery ground cable at the battery.
2. Remove the front combination light.
   - Open the cab door. Insert a screwdriver (1) into the space between the cab and the cab door. Use the screwdriver to force out the stud pin at the center of the grommet (the pin securing the front combination light).



   - Remove the fixing screw.
   - Remove the two catches.
   - Remove the front combination light (1) connector.



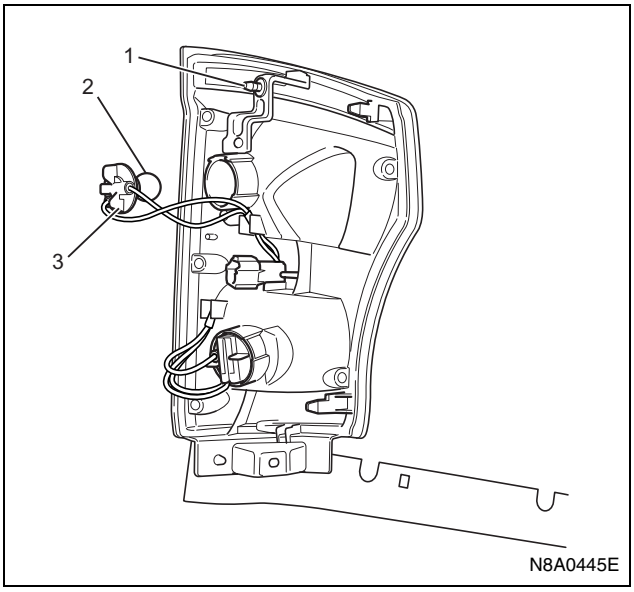
3. Remove the front turn signal light bulb.
   - Turn the bulb socket (2) to the left to remove it.
   - Press the bulb (3) in and turn it to the left to remove it from the socket.

Installation

1. Install the front turn signal light bulb.
   - While pressing the bulb (2), turn it clockwise to fit.

Notice:
Do not let the glass portion dirty with sebum etc.

   - Turn the bulb socket (3) clockwise to fit.



2. Installation procedure of front combination light assembly
   - Connect the connector of the front combination light assembly.
   - Position it by aligning two pawls with the groove of H/L.
   - Fit the iron PIN (1) in the upper portion of the side by aligning it with the center of corresponding grommet.

Notice:
Push it into securely with a force of approx. 250 N (25 kgf) until click is heard.

   - Pull the front combination light assembly lightly toward the front of vehicle to make sure that the PIN and grommet are engaged securely.
   - Tighten one bolt in the lower portion of front combination light assembly.

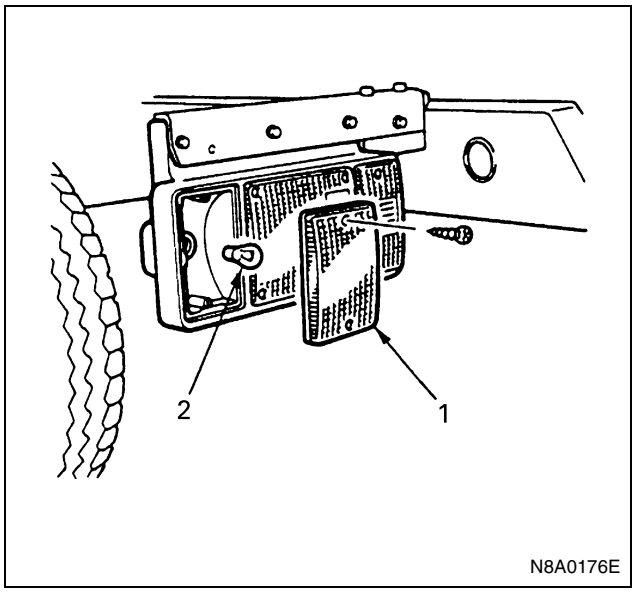
3. Hook the seal rubber on two projections under H/L.
4. Connect the battery ground cable.
5. Check lighting of each light.

Rear Turn Signal Light/Bulb

Removal

Preparation:
Disconnect the battery ground cable.

1. Lens
2. Bulb



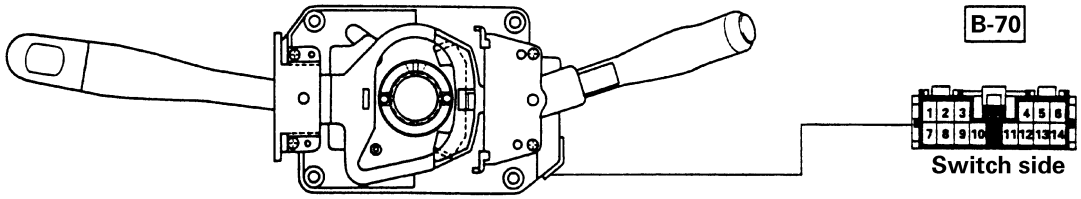
Installation

To install, follow the removal steps in the reverse order.

Turn Signal Light Switch (Combination Switch)

Inspection

Check the continuity between the terminals of the turn signal light switch.
Repair or replace the switch when the result of inspection is found abnormal.



SW position \ Terminal No.		2	5	9	11	12	13
Turn signal light SW	Turning left		○			○	
	Neutral						
	Turning right					○	○

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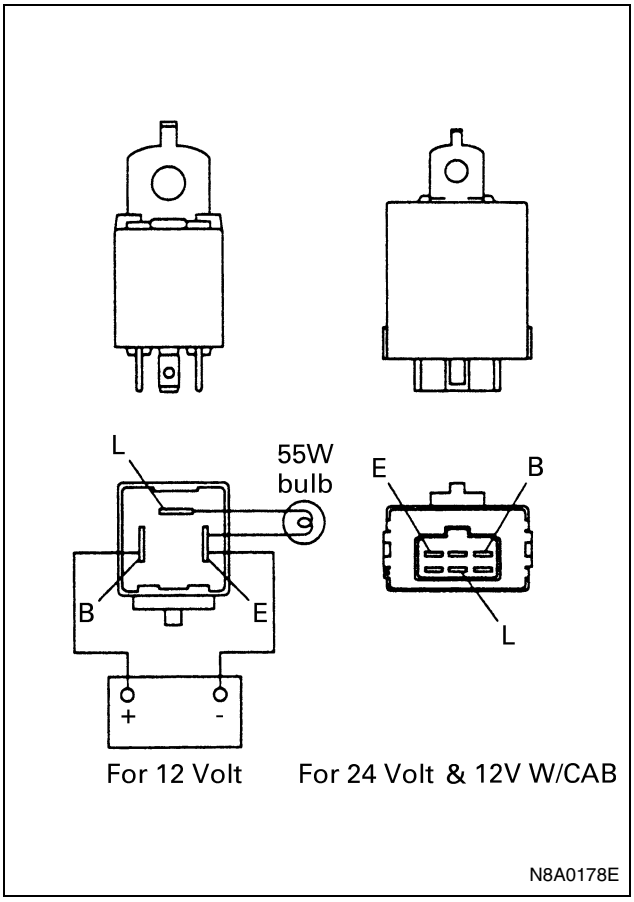
Removal and Installation

Refer to “HEADLIGHT, FOG LIGHT AND CORNERING LIGHT” in this section.

Flasher Unit

Inspection

When a 55W bulb is connected to the unit side terminals “L” and “E” while connecting the battery (+) terminal to terminal “B”, and the battery (−) terminal to terminal “E”, does the bulb light on and off?
Replace the unit when the result of inspection is found abnormal.



Stoplight Bulb

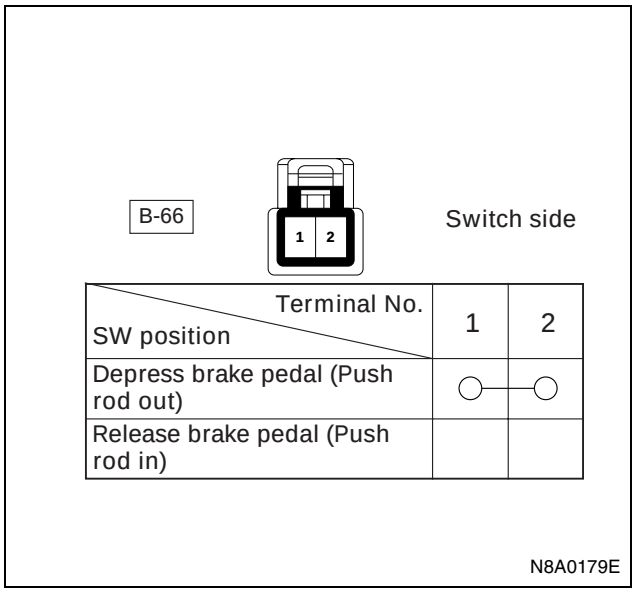
Removal and Installation

Refer to “CLEARANCE LIGHT, TAILLIGHT, LICENSE PLATE LIGHT AND ILLUMINATION LIGHT” for TAILLIGHT BULB removal and installation steps in this section.

Stoplight Switch

Inspection

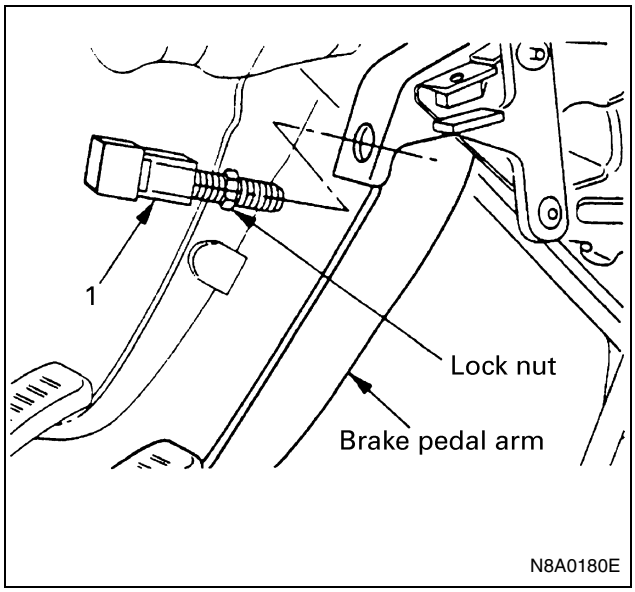
1. Check to see if the stoplight switch is installed correctly to the specified position. Adjust the position when the result of the inspection is found abnormal.
2. Check to see if there is any continuity between the terminals of the stoplight switch.
   Replace the switch when the result of inspection is found abnormal.



Removal

Preparation:
Disconnect the battery ground cable.

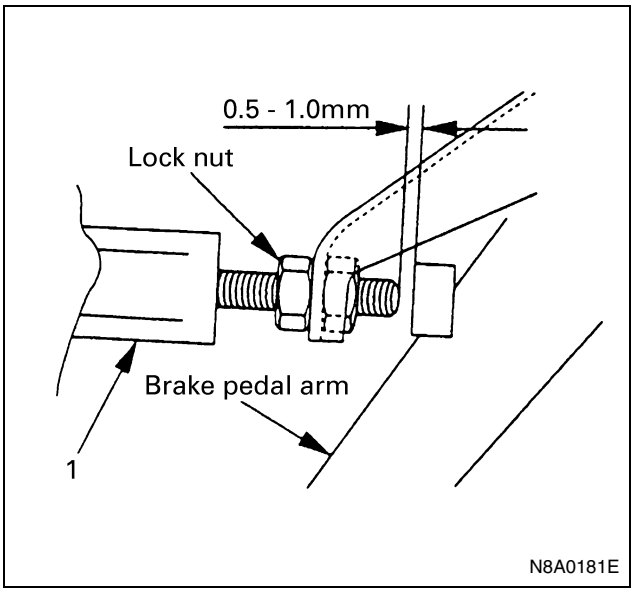
1. Stoplight Switch
   1) Disconnect the connector.
   2) Loosen the lock nut of the switch.
   3) Remove the switch by turning it.



Installation

To install, follow the removal steps in the reverse order, noting the following points.

1) Check to see if the brake pedal has been returned by the return spring to the specified position.
2) Turn the stoplight switch clockwise until the tip of the threaded portion of the switch contacts the pedal arm.
3) Turn the switch counterclockwise until the space between the tip of the threaded portion and the pedal arm is 0.5 to 1.0 mm (0.02 — 0.04 in.).

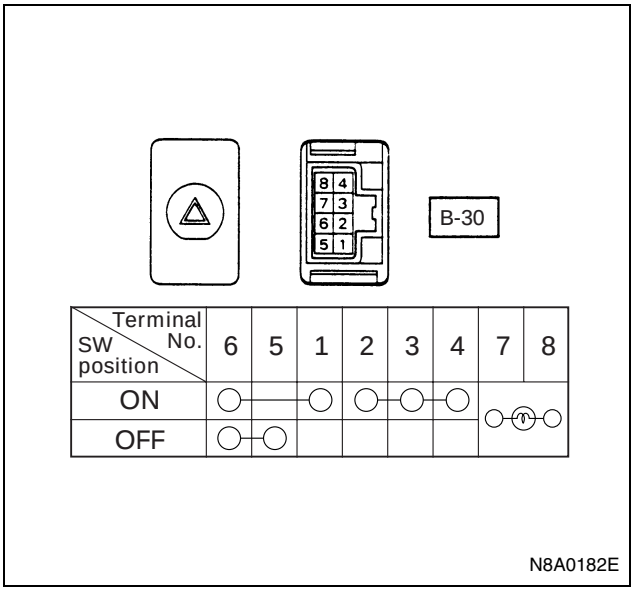


Hazard Warning Switch

Inspection

Check the continuity between the terminals of the hazard warning switch.

Repair or replace the switch when the result of inspection is found abnormal.

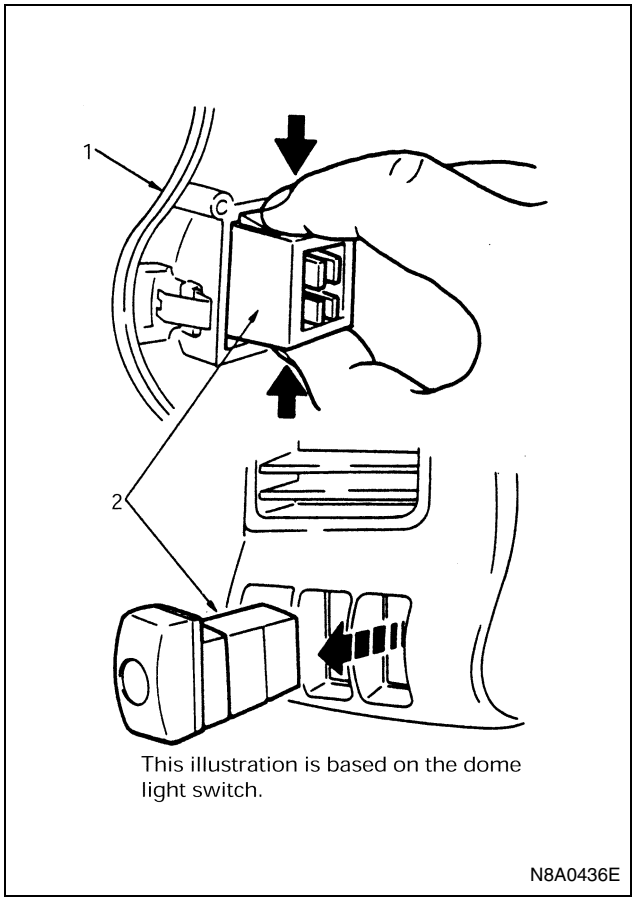


Removal

Preparation:

Disconnect the battery ground cable.

1. Meter Cluster
   Refer to the “METER AND WARNING/INDICATOR LIGHT” in this section.
2. Hazard Warning Switch
   Release the lock pushing the switch from the back side of the meter cluster.



Installation

To install, follow the removal steps in the reverse order noting the following point.

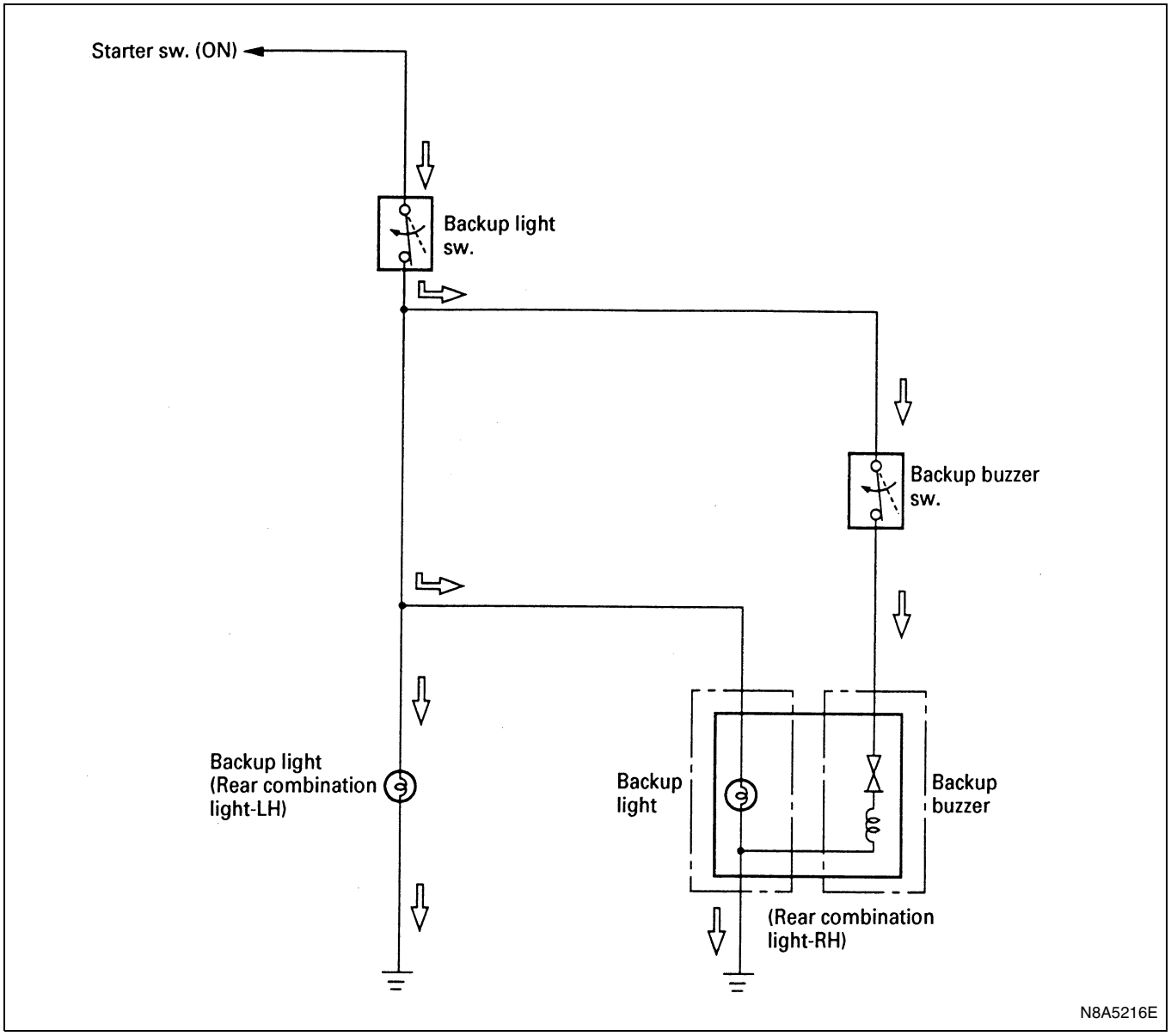
1. Push the switch with your fingers until locks securely.

Horn, Backup Light and Backup Buzzer

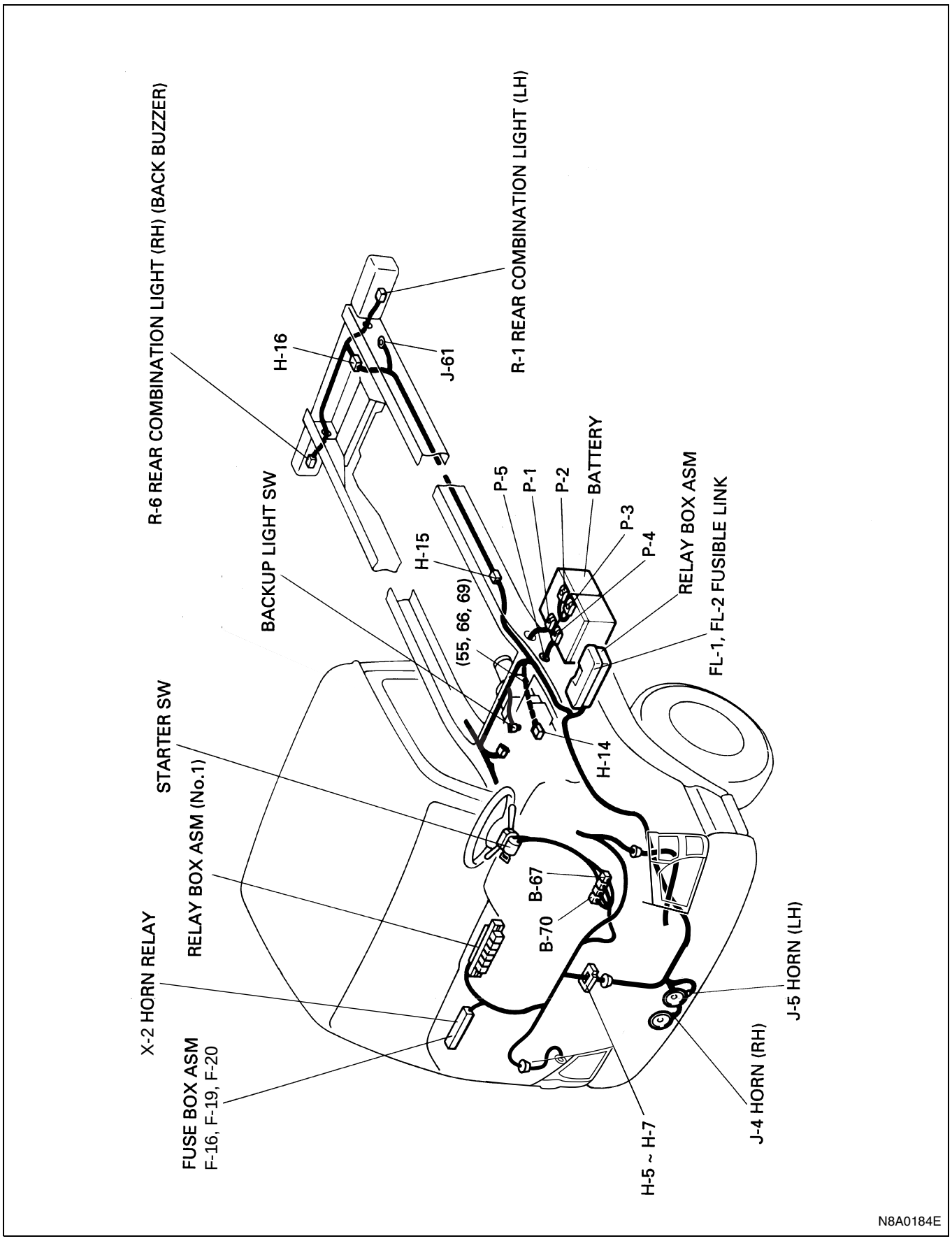
General Description

The circuit consists of the starter switch, horn, horn switch, backup light (Rear combination light), backup light switch, back buzzer and the relay.
When the horn switch is turned on independent of the position of the starter switch, the relay is activated to sound the horn. When the backup light switch turns on with the starter switch on, the backup light will operate.

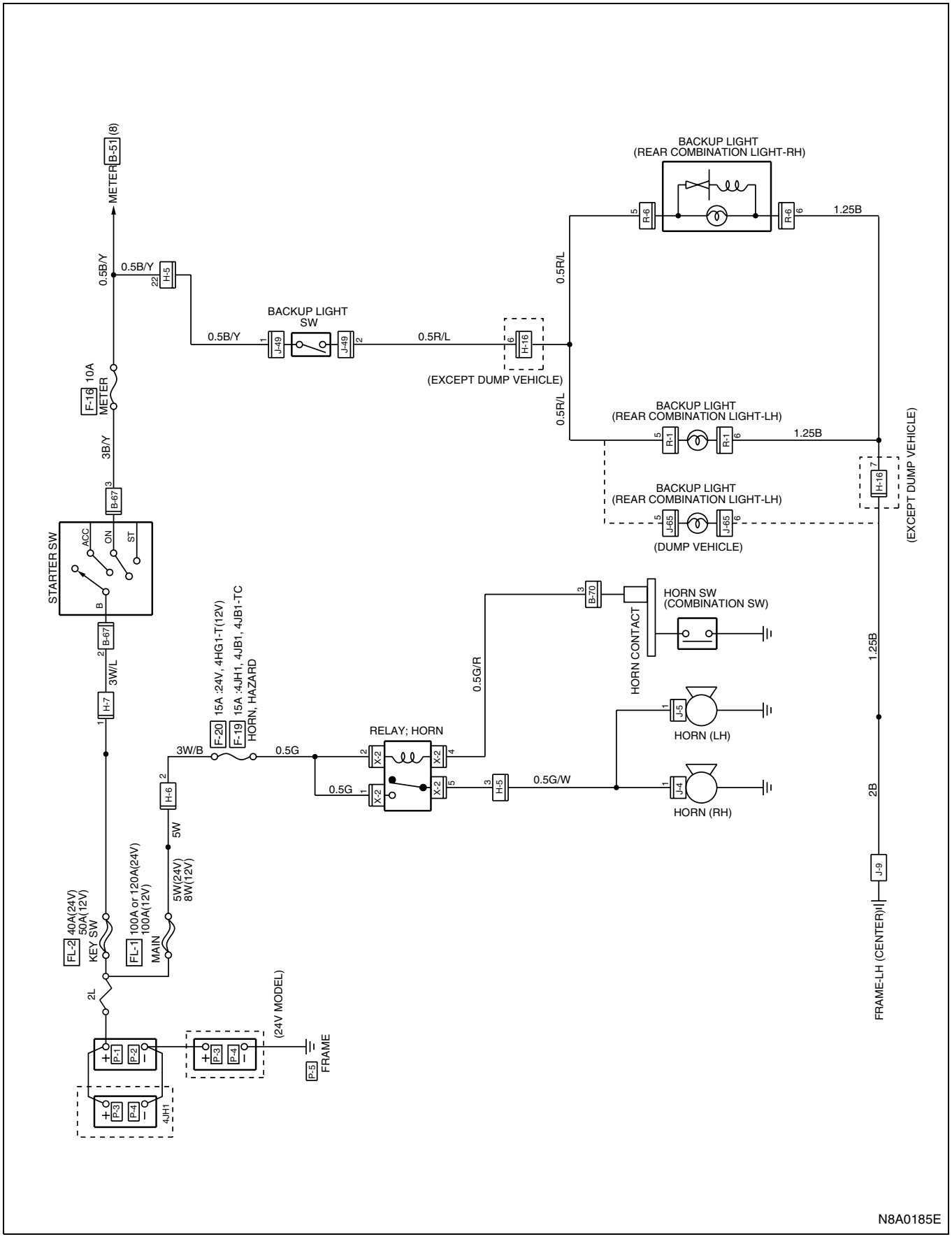
Backup Light and Backup Buzzer Circuit



Parts Location



Circuit Diagram



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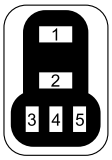
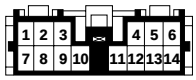
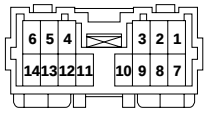
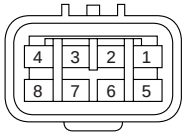
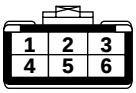
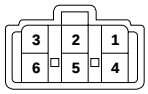
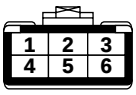
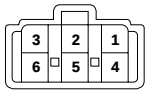
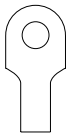
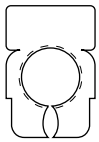
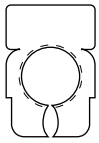
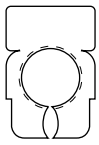
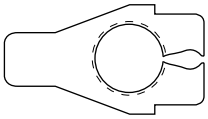
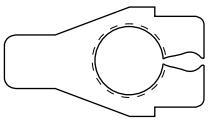
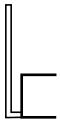
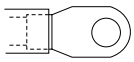
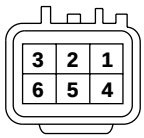
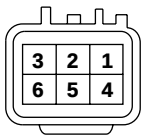
Connector List

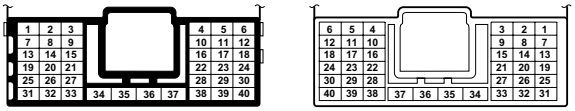
No.	Connector Face
X-2	 005-006
B-70	 014-002
B-70	 014-003
E-10	002-025
E-10	002-026
J-49	002-025
J-49	002-026
H-14	016-003

No.	Connector Face
H-14	016-004
H-16	008-003
H-16	 008-004
J-62	 006-010
J-62	 006-015
J-65	 006-010
J-65	 006-015
J-4	001-018

No.	Connector Face
J-5	001-018
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
P-5 (12 V)	 000-007

No.	Connector Face
P-5 (24 V)	 000-002
R-1	006-004
R-1	 006-005
R-6	006-004
R-6	 006-005

H-5



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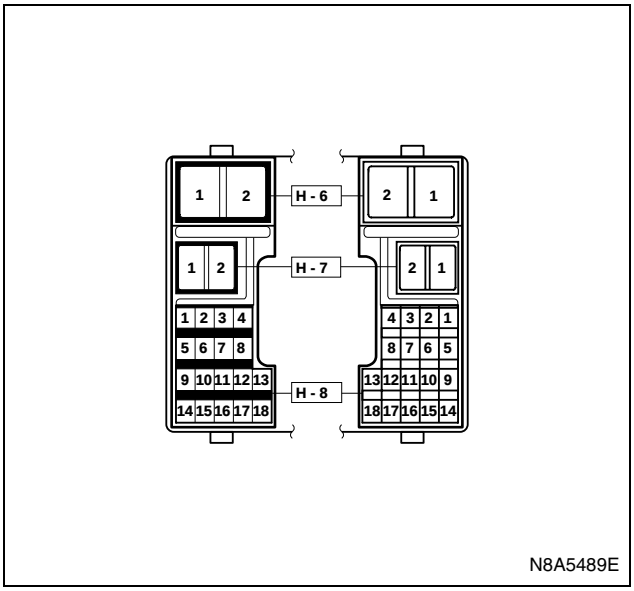
H-6



Diagnosis

Quick Chart for Check Point

1. Horn

		Check point					
		Fuse F-19, F-20 (15 A)	Horn	Horn SW	Horn relay	Horn contact	Cable harness
Trouble mode	1-1. Horn does not sound	❍ (1)	❍ (4)	❍ (6)	❍ (2)	❍ (5)	❍ (3)
	1-2. Horn does not shut off			❍ (2)	❍ (1)		❍ (3)

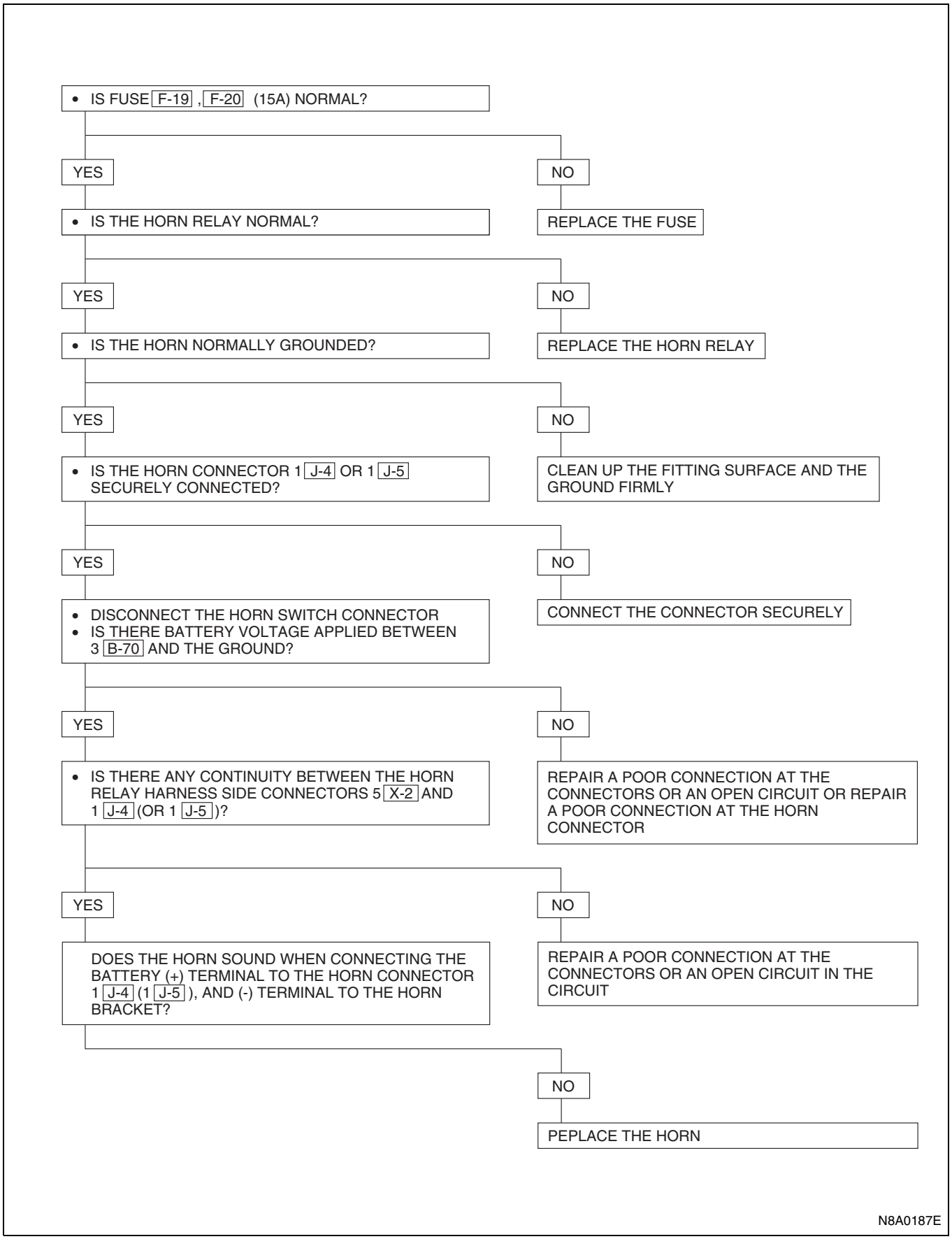
Notice:
Figure in parenthesis “( )” indicates the order of inspection.

2. Backup Light

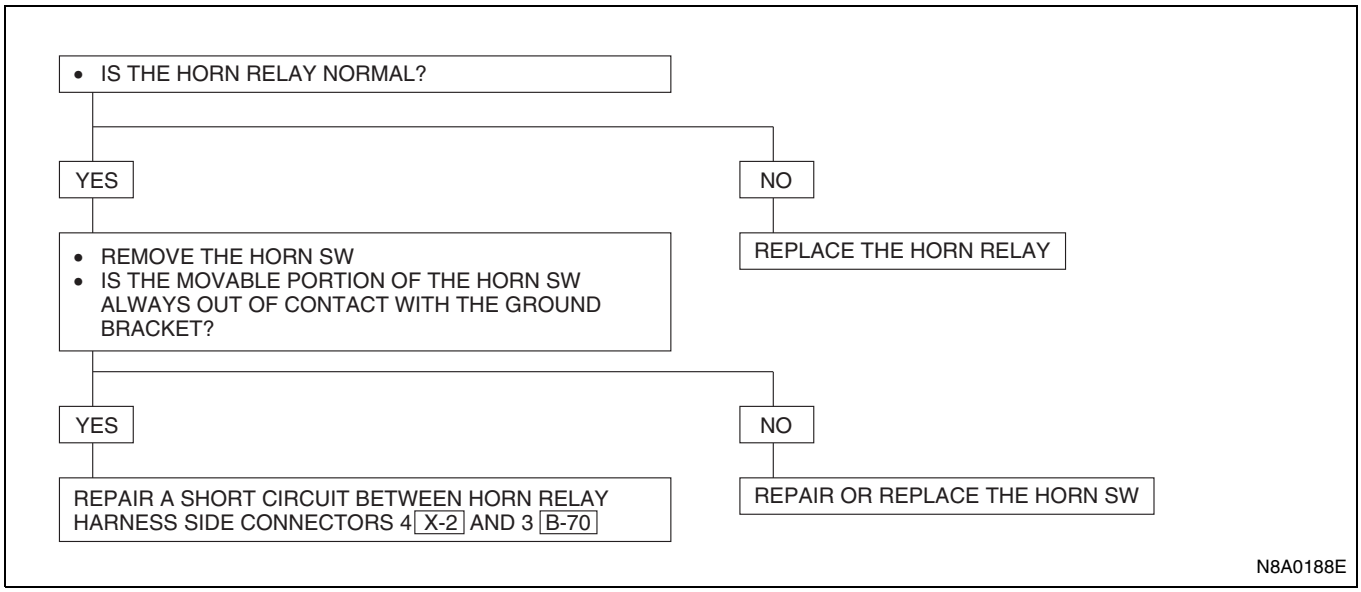
		Check point				
		Fuse F-16 (10 A)	Backup light SW (Inhibitor SW)	Backup light bulb	Backup buzzer	Cable harness
Trouble mode	2-1. Both backup lights inoperative	❍ (1)	❍ (3)			❍ (2)
	2-2. Backup light on the left (or right) side inoperative			❍ (1)		❍ (2)
	2-3. Backup light remains on		❍ (1)			

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

1. Horn
1-1. Horn Does Not Sound

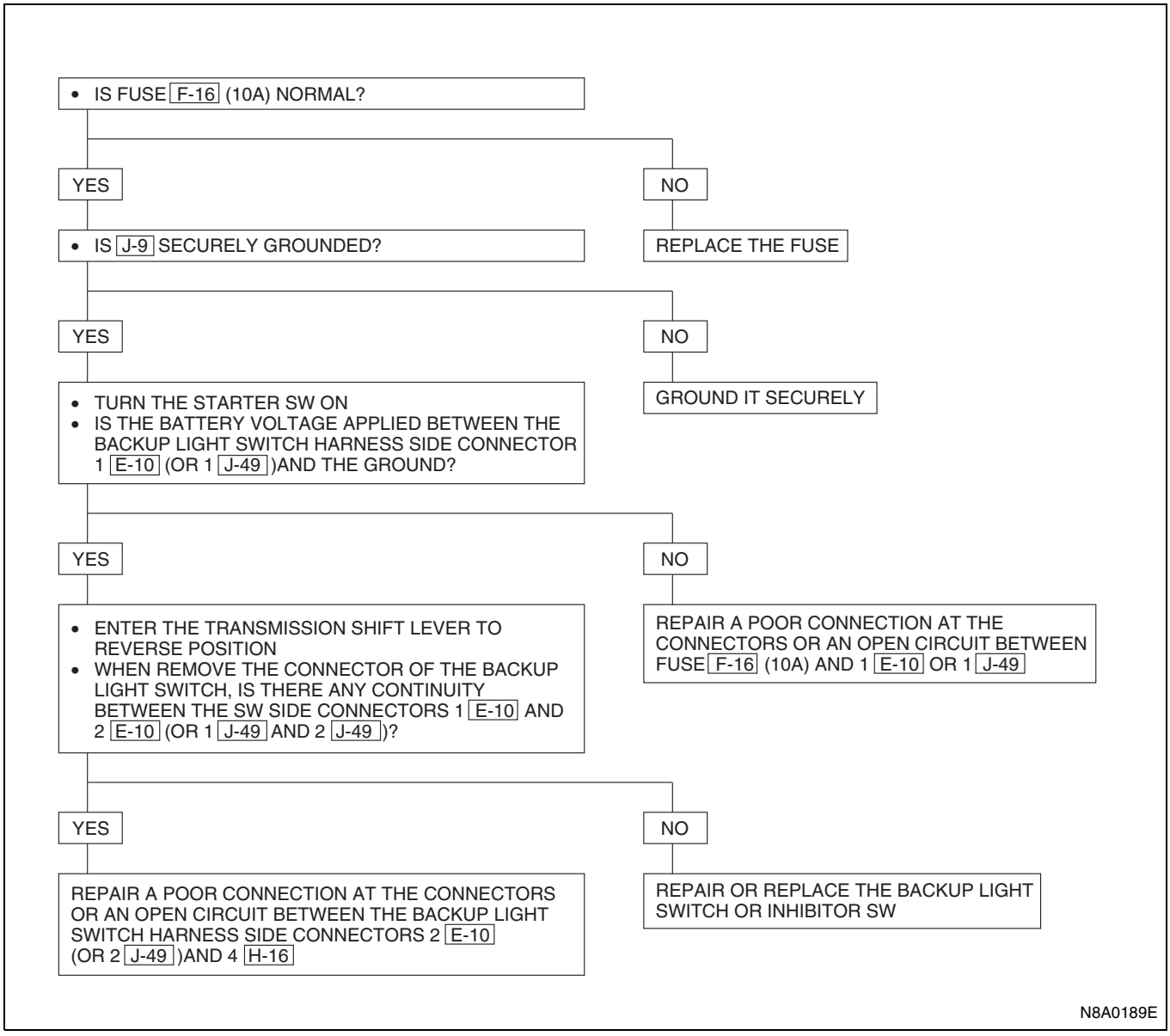


1-2. Horn Does Not Shut Off

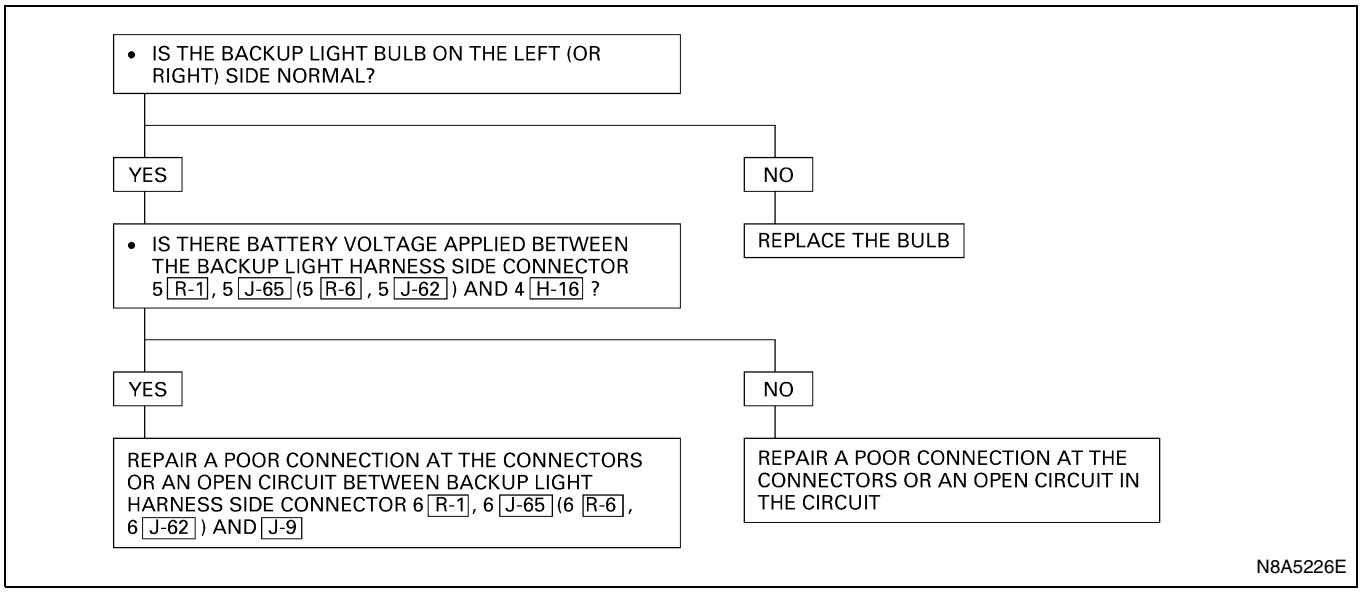


2. Backup Light

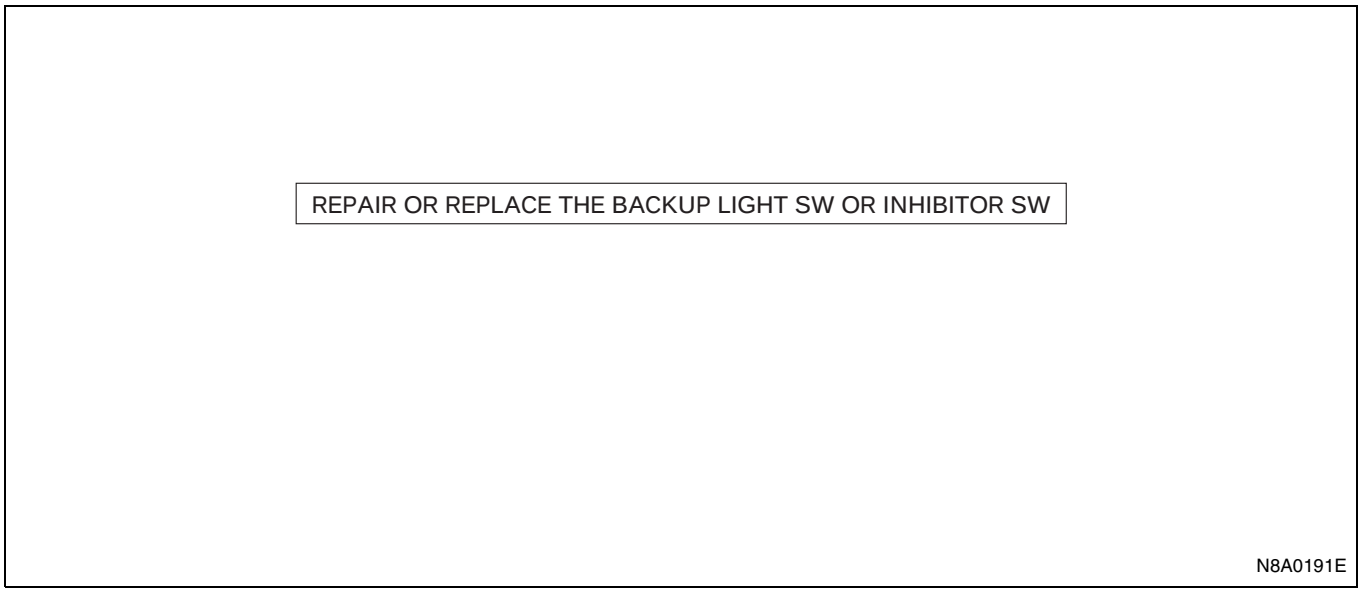
2-1. Backup Lights Inoperative



2-2. Backup Light on the Left (or Right) Side Inoperative



2-3. Backup Light Remains on



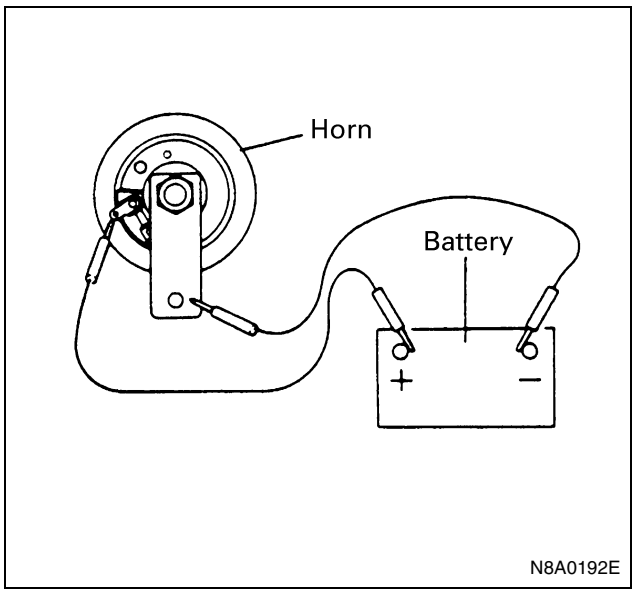
Starter Switch

Refer to “START AND CHARGING” in this section.

Horn

Inspection

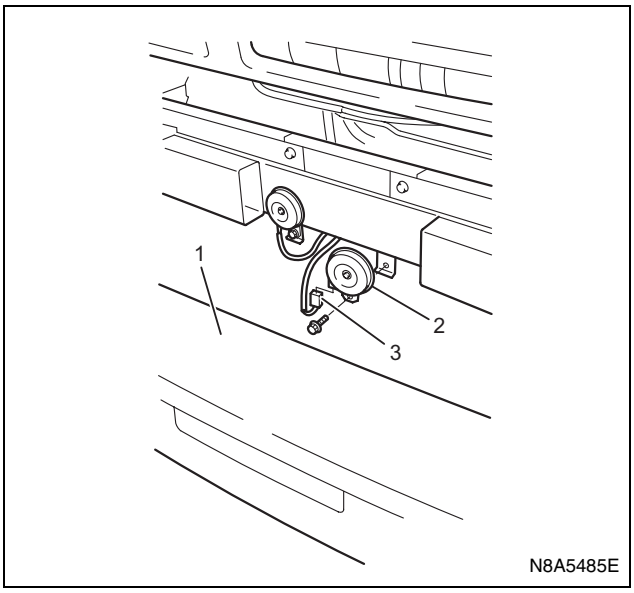
Check to see if horn sound when a battery voltage between horn terminal and the fixing bracket. Repair or replace the horn when the result of inspection is found abnormal.



Removal

Preparation:
Disconnect the battery ground cable.

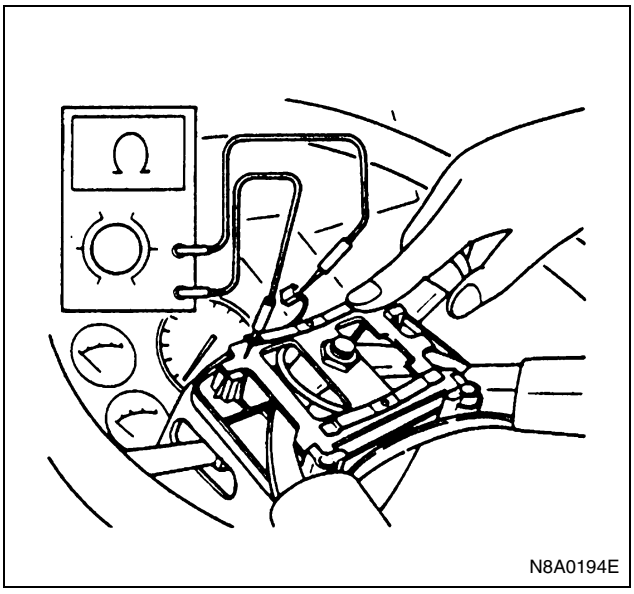
1. Bumper
   Refer to “BUMPER” in section 2.
2. Horn
   Disconnect the connector (3).



Installation
To install, follow the removal steps in the reverse order.

Horn Switch

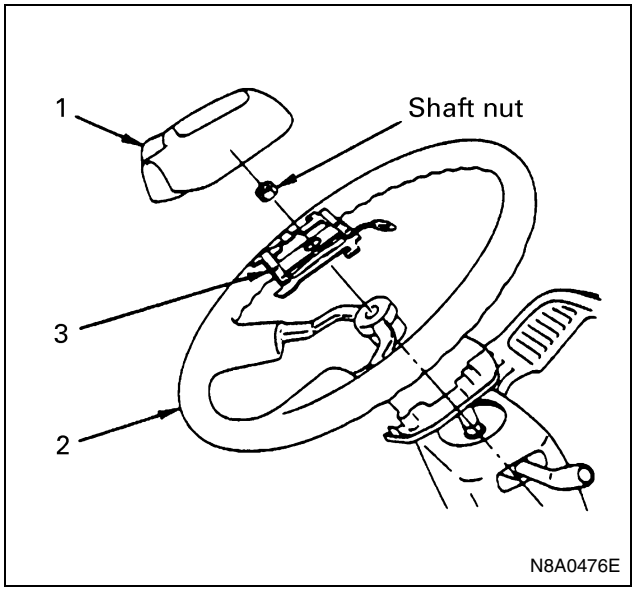
Inspection
With the contact point of the horn switch pressed to the switch bracket, check the continuity between the connector terminal and the bracket of the switch.
Check the contact condition between horn contact of the combination switch and contact plate of steering wheel.
Repair or replace the switch when the result of inspection is found abnormal.



Removal

Preparation:
Disconnect the battery ground cable.

1. Horn Pad
   1) Hold the horn pad and pull it upward.
2. Steering Wheel
   1) Remove the steering shaft nut.
   2) Remove the steering wheel by using steering wheel remover.
      (Refer to Section 3B4 “STEERING COLUMN” for steering wheel removal steps.)
3. Horn Switch



Installation
To install, follow the removal steps in the reverse order, noting the following point.

1. Tighten the steering shaft nut to the specified torque.

Tighten:
Shaft nut to 49 N·m (5 kg·m / 36 lb·ft)

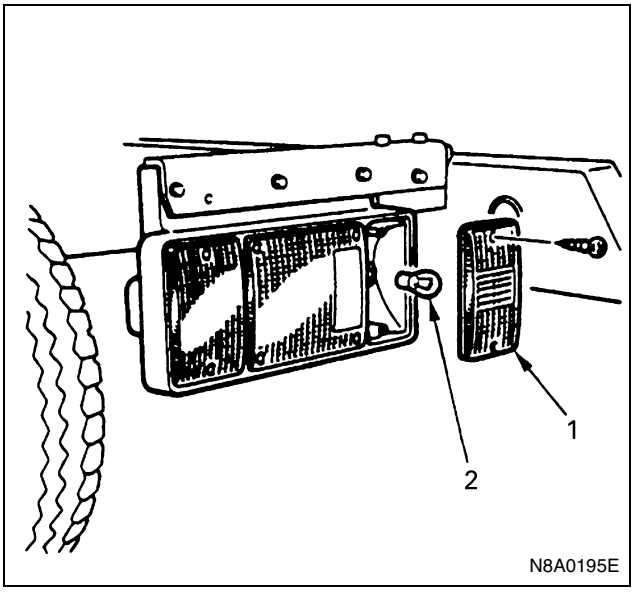
Backup Light Bulb

Removal

Preparation:

Disconnect the battery ground cable.

1. Lens
2. Bulb



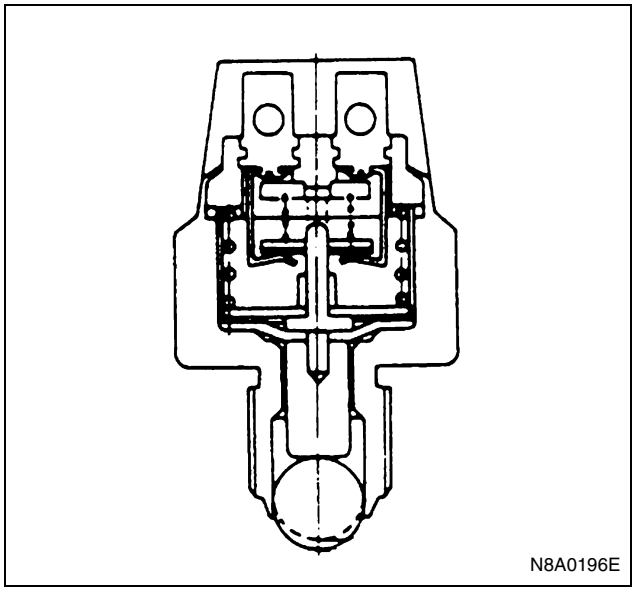
Installation

To install, follow the removal steps in the reverse order.

Backup Light Switch

Inspection

1. With the switch installed to the transmission, check the continuity between the terminals of the switch connectors.
   When the continuity is found between the terminals only with the switch shifted to the reverse position, the switch is normal.
2. When the result of the above inspection is found abnormal, remove the switch from the transmission and conduct a test on the switch alone.
   If the continuity appears between the connector terminals when the ball of the switch is released, the switch is normal. (When the ball is pushed, the continuity disappears.)
3. If there is no continuity with the switch installed to the transmission, even though the switch is found to be normal, then adjust the stroke of the switch by changing the thickness of the switch gasket.



Removal

Preparation:

Disconnect the battery ground cable.

1. Backup Light Switch
   1) Disconnect the connectors.
   2) Remove the switch by turning it counterclockwise.

Installation

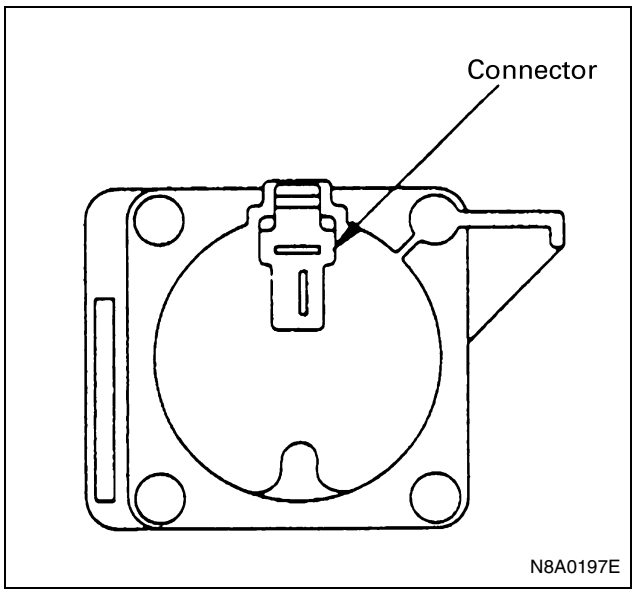
1. Backup Light Switch
   Apply liquid gasket to the screw portion of the switch to prevent oil leak.

Backup Buzzer

Inspection

Apply battery voltage to the backup buzzer connector to check the buzzer sound.

Repair or replace the buzzer when the result of inspection is found abnormal.

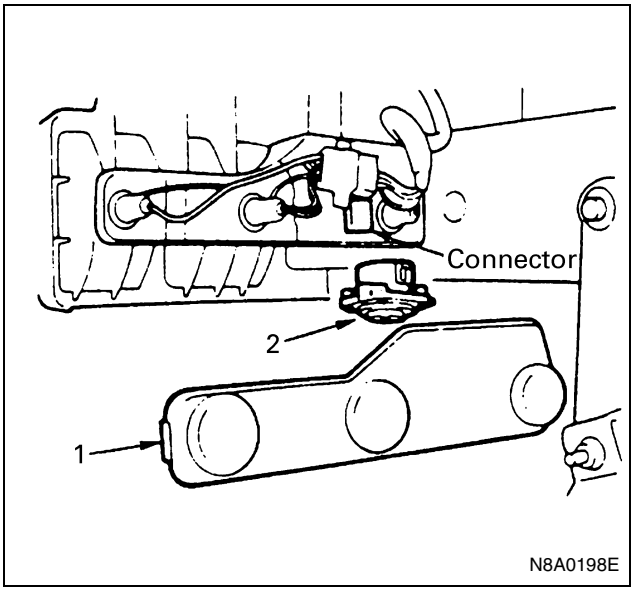


Removal

Preparation:

Disconnect the battery ground cable.

1. Rear Combination Light Cover
2. Backup Buzzer
   1) Remove the rear combination light connector fixing screw.
   2) Remove buzzer fixing screw.
   3) Disconnect the connector.



Installation

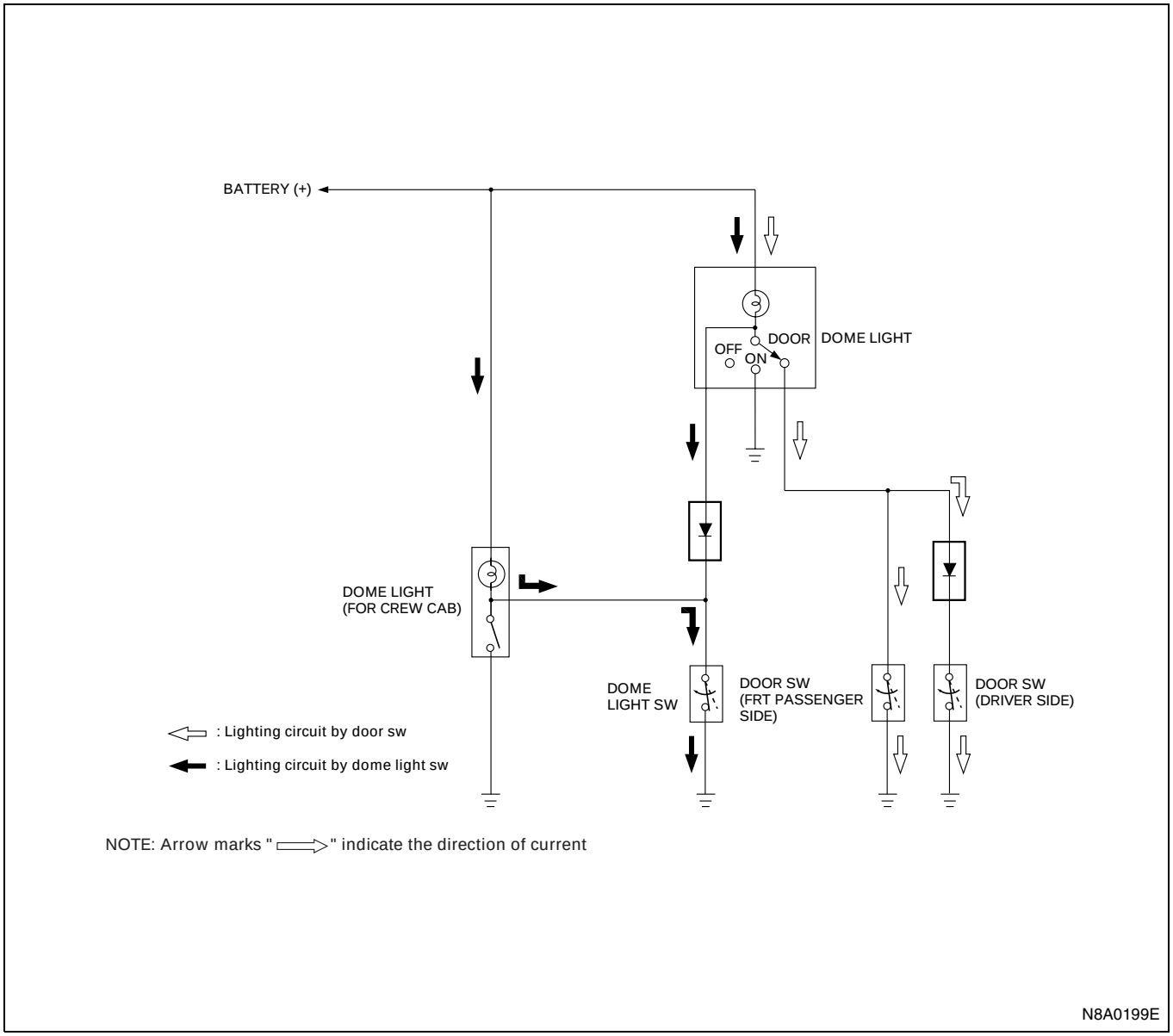
To install, follow the removal steps in the reverse order.

Dome Light and Key Remind Buzzer

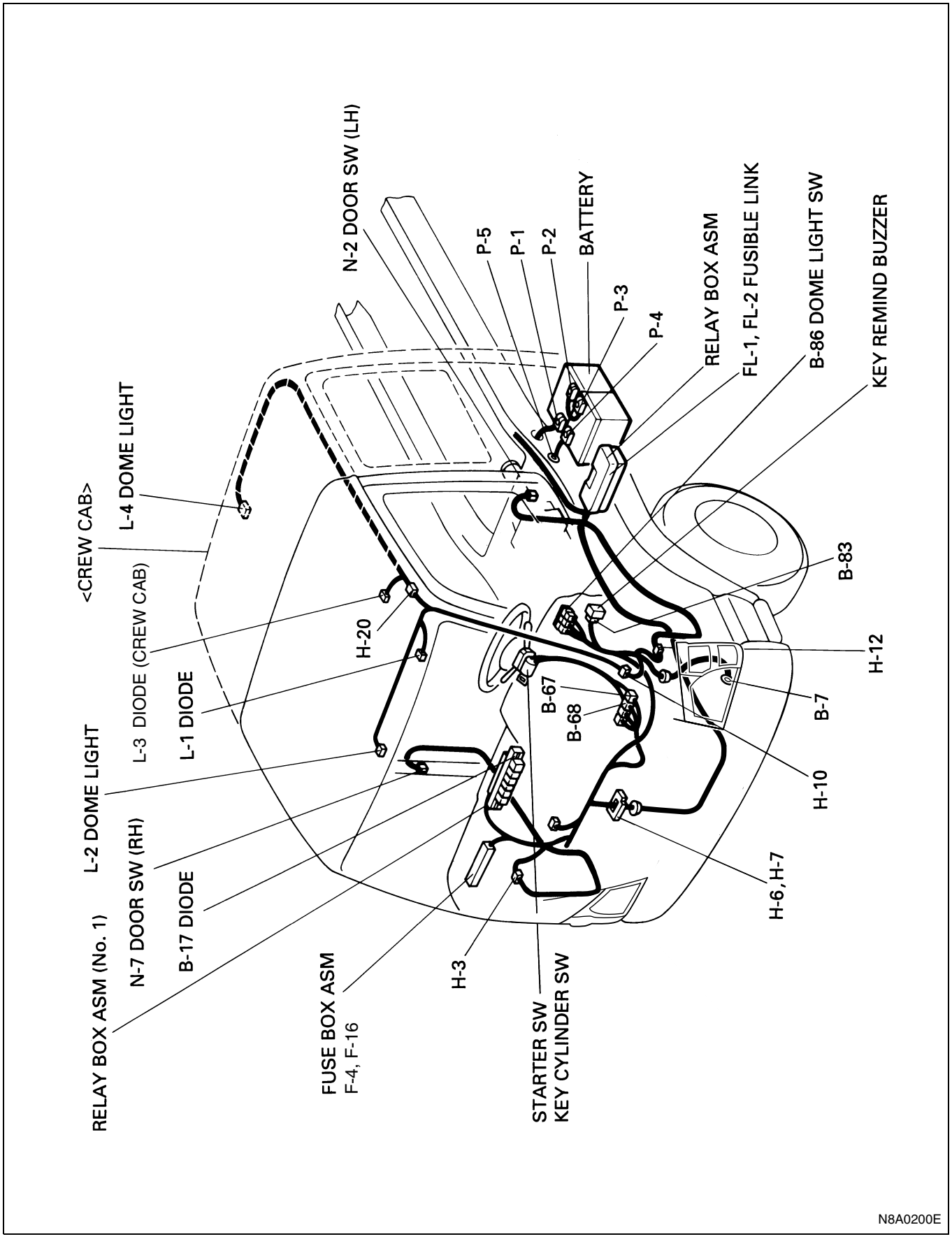
General Description

The circuit consists of the starter switch, dome light, dome light switch, door switch, backup light switch and the key remind buzzer.
The dome light lights up when the left or right side door is opened with the switch set at the door mode. It can be lit by operating ON or OFF of the dome light switch.
The dome light can be lit by respective switch independent of the position of the starter switch.
By operating the dome light switch fitted on the instrument panel, the dome light can be lit independent of the switch position of dome light.
Key remind buzzer sounds to remind the driver of leaving the key in the starter switch when opening the driver's side door.

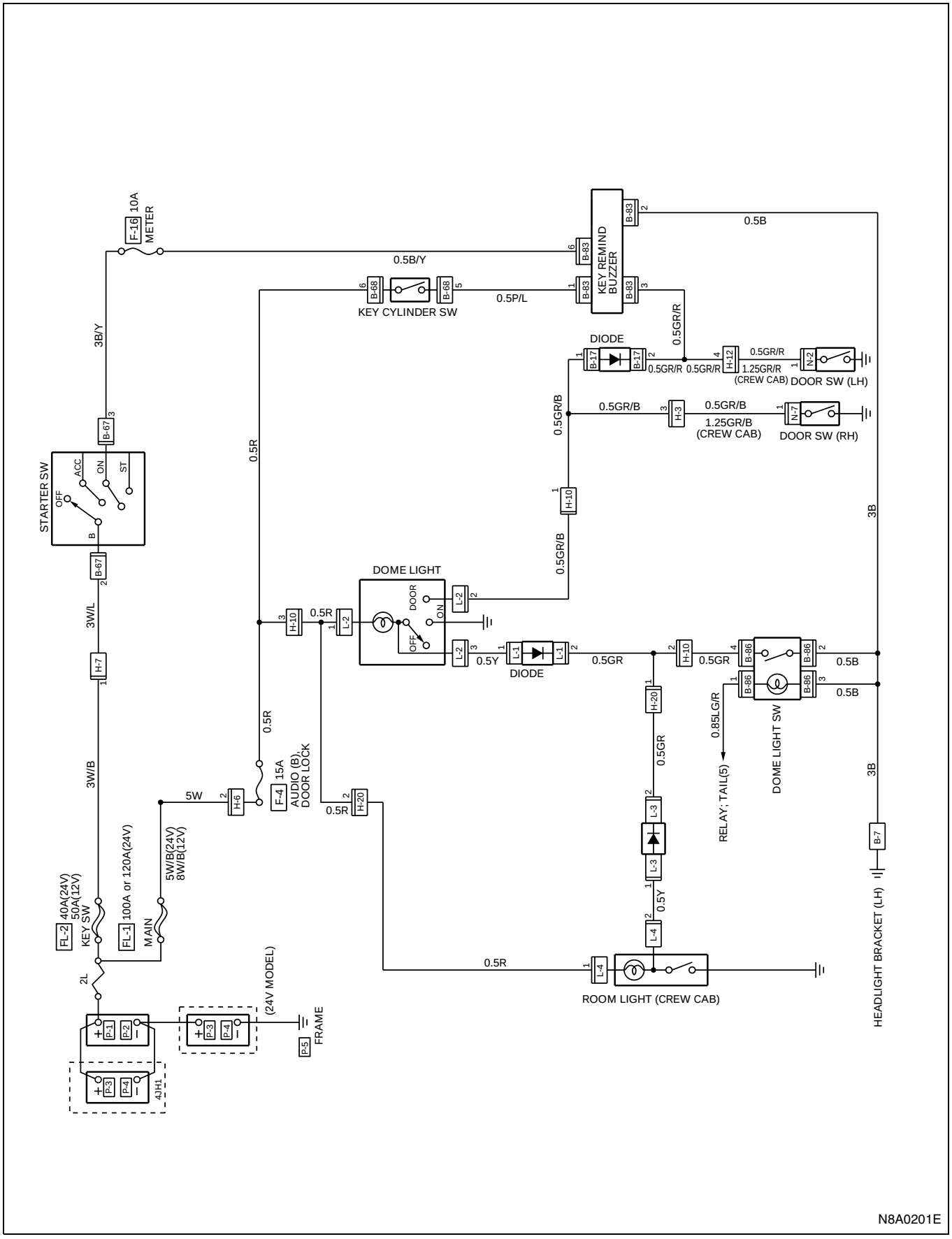
Lighting Circuit



Parts Location



Circuit Diagram



N8A0201E

Connector List

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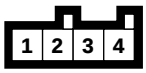
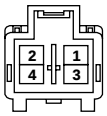
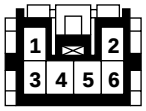
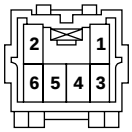
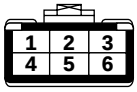
B-17	 004-004
B-67	004-001
B-67	004-002
B-86	004-001
B-86	 004-002
B-68	 006-002
B-68	 006-003
B-83	 006-010

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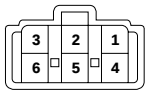
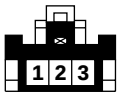
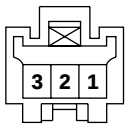
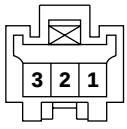
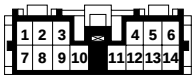
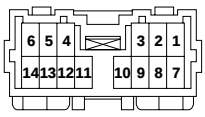
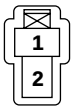
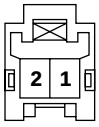
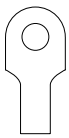
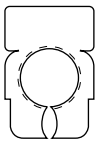
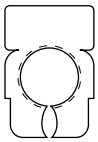
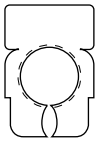
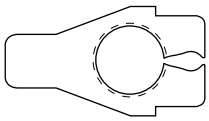
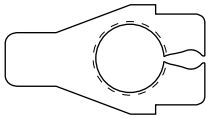
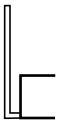
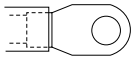
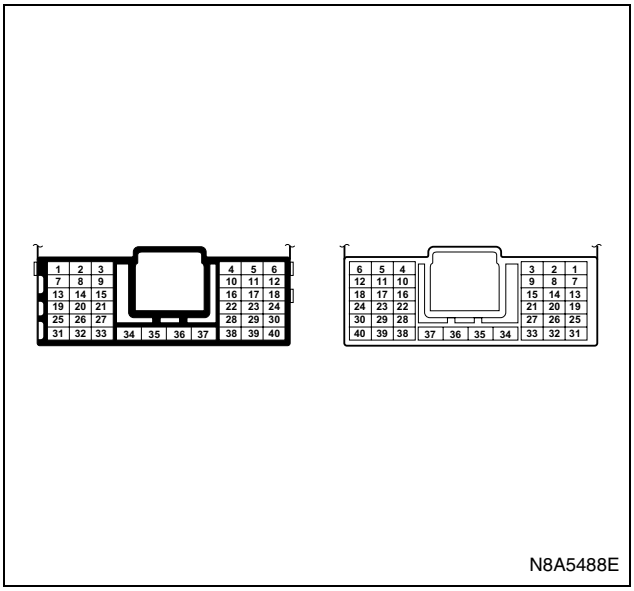
H-3	 006-015
H-10	 003-009
H-10	 003-010
L-2	003-009
L-2	 003-010
H-12	 014-002
H-12	 014-003

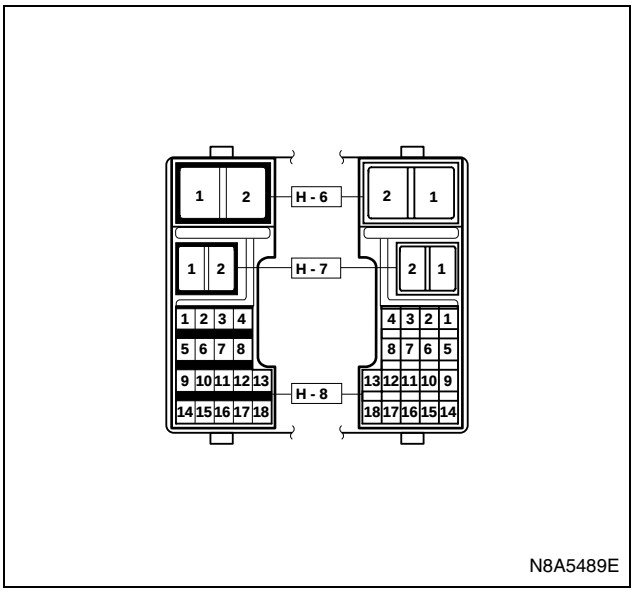
No.	Connector Face
H-20	002-009
H-20	 002-010
L-1	002-027
L-3	002-027
L-4	002-022
L-4	 002-023
N-2	001-009
N-7	001-009

No.	Connector Face
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
P-5 (12 V)	 000-007
P-5 (24 V)	 000-002

H-5



H-7



Starter Switch

Refer to “START AND CHARGING” in this section.

Key Cylinder Switch

Refer to “START AND CHARGING” in this section.

Backup Light Switch

Refer to “HORN, BACKUP LIGHT AND BACKUP BUZZER” in this section.

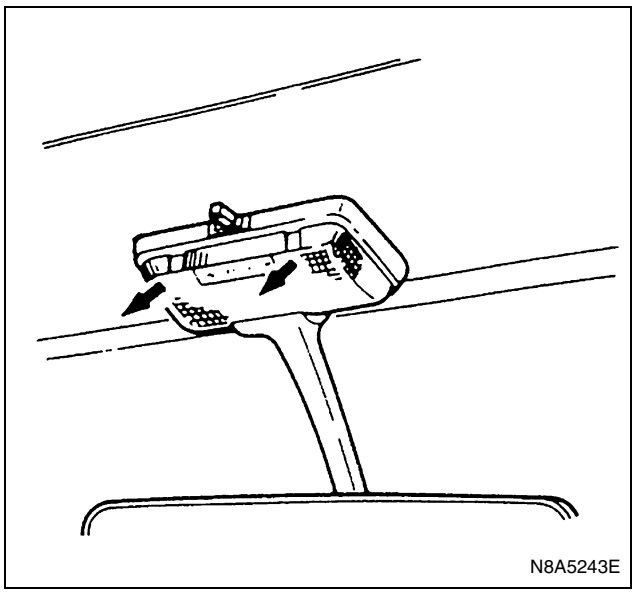
Dome Light Bulb

Removal

Preparation:

Disconnect the battery ground cable.

1. Lens
   Hold the lens and pull it downward.



2. Bulb

Installation

To install, follow the removal steps in the reverse order.

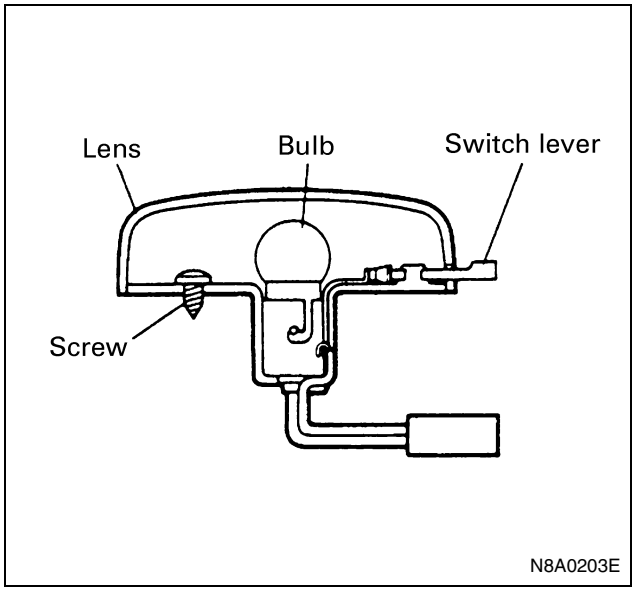
Dome Light Bulb (for Crew Cab)

Removal

Preparation:

Disconnect the battery ground cable.

1. Lens
   Hold the lens and pull it down.
2. Bulb



Installation

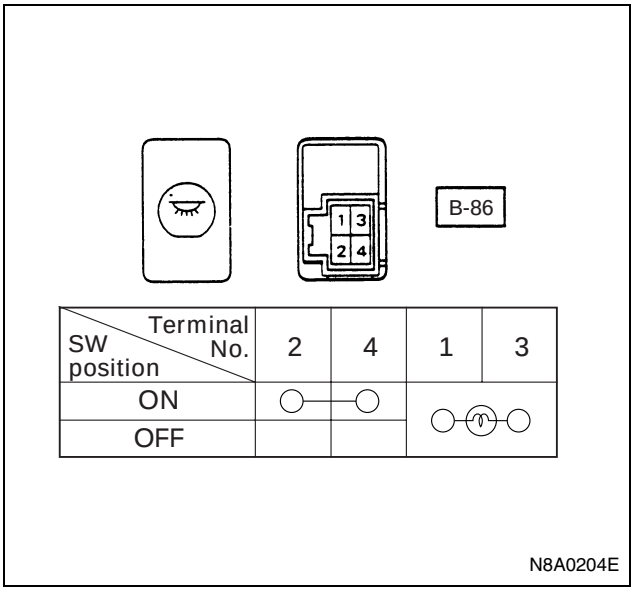
To install, follow the removal steps in the reverse order.

Dome Light Switch

Inspection

Check the continuity between the dome light switch connector terminals.

Repair or replace the switch when the result of inspection is found abnormal.



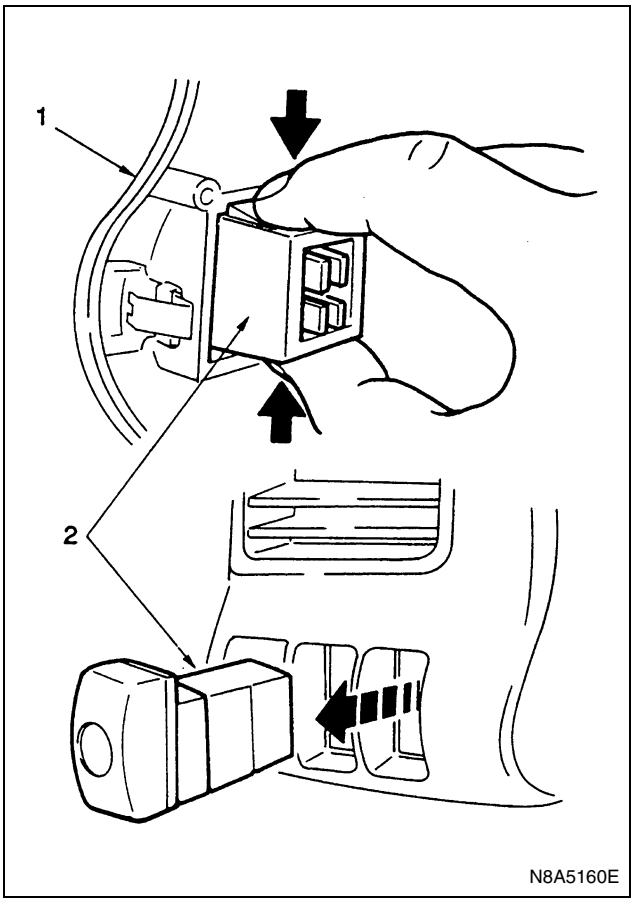
SW position \ Terminal No.	2	4	1	3
ON	○	○	○	○
OFF				

Removal

Preparation:

Disconnect the battery ground cable.

1. Meter cluster
   Refer to the “METER AND WARNING/INDICATOR LIGHT” in this section.
2. Dome Light Switch
   Release the lock pushing the switch from the back side of the meter cluster.



Installation

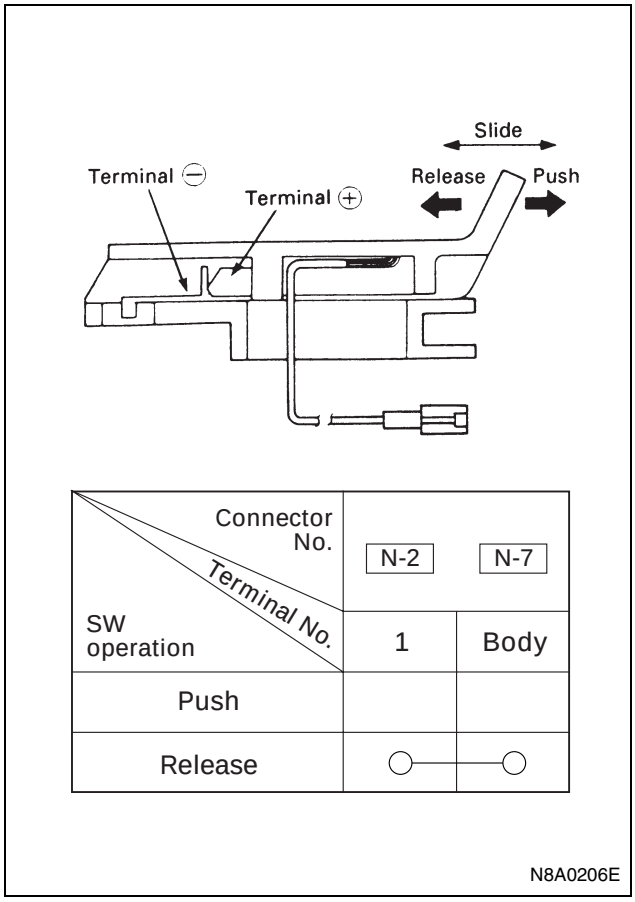
To install, follow the removal steps in the reverse order noting the following point.

1. Push the switch with your fingers until locks securely.

Door Switch

Inspection

Check to see if there is any continuity between the terminals and the body while operating the door switch. Repair or replace the switch, when the result of inspection is found abnormal.



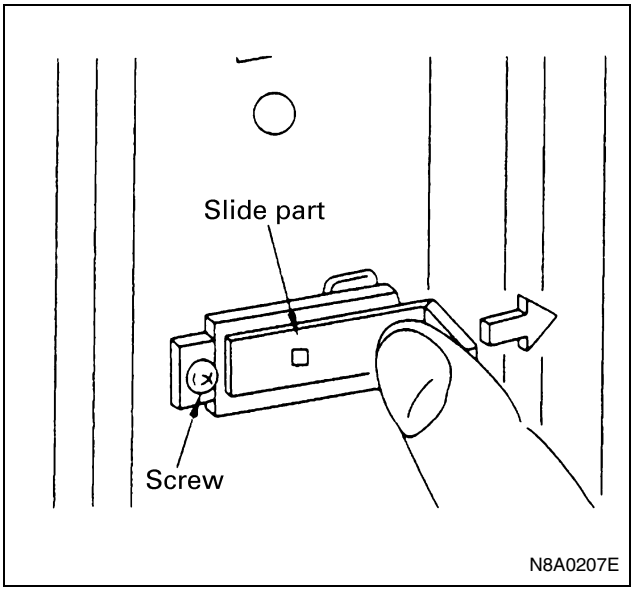
SW operation \ Connector No. / Terminal No.	N-2	N-7
	1	Body
Push		
Release	○	○

Removal

Preparation:

Disconnect the battery ground cable.

1. Door Switch
   1) Remove the screw.
   2) Disconnect the connector of the switch.

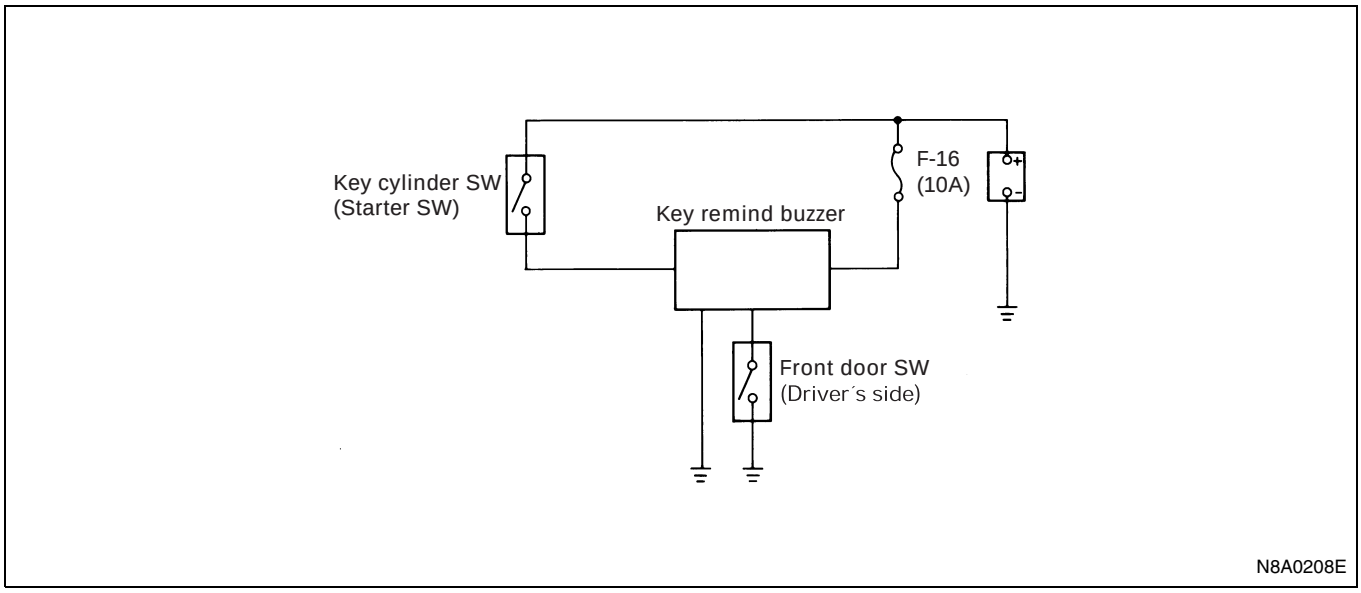


Installation

To install, follow the removal steps in the reverse order.

Key Remind Buzzer

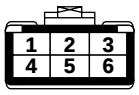
The key remind buzzer sounds to remind the driver to remove the starter key from the starter switch when front driver side door is opened (Front driver side door switch is on).



Inspection of The Buzzer Circuit

Disconnect the key remind buzzer connector, measure the continuity and voltage between the harness side connector terminals.

B-83



Harness side

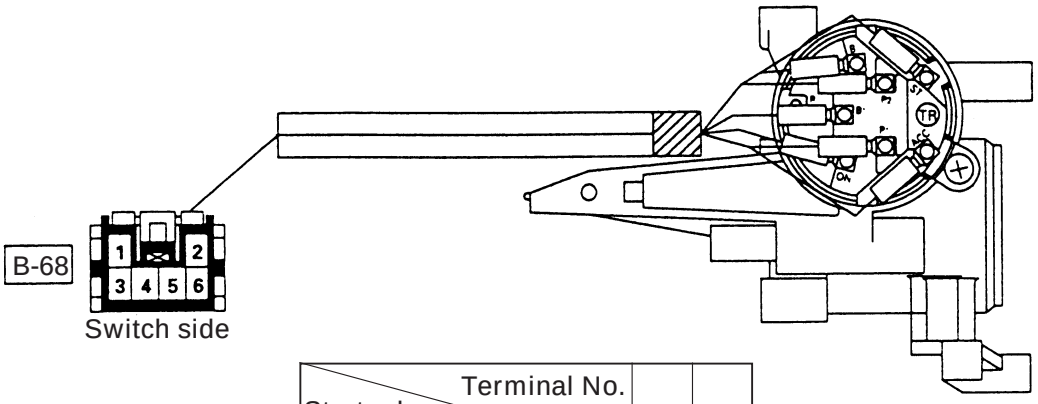
Terminal No.	Wire color	Connected to	Item to be checked	Connecting terminal	Checking conditions	Standard
2	B	Ground	Continuity	2-Ground	-	Continuity
1	P/L	Ground	Voltage	1-Ground	Starter key inserted	Approx. battery voltage
					Starter key removed	0V
3	GR/R	Ground	Continuity	3-Ground	Front driver·s side door "OPEN"	Continuity
					Front driver·s side door "CLOSE"	No Continuity
6	B/Y	Fuse F-12 (10A)	Voltage	6-Ground	• Starter SW ON	Approx. battery voltage

N8A0209E

Key Cylinder Switch (Starter Switch)

Inspection

Check to see if there is any continuity between the connector terminals of the key cylinder switch.
Repair or replace the switch when the result of inspection is found abnormal.



Starter key position \ Terminal No.		5	6
LOCK	Key removed		
OFF	Key inserted	○—○	
ACC			
ON			
START			

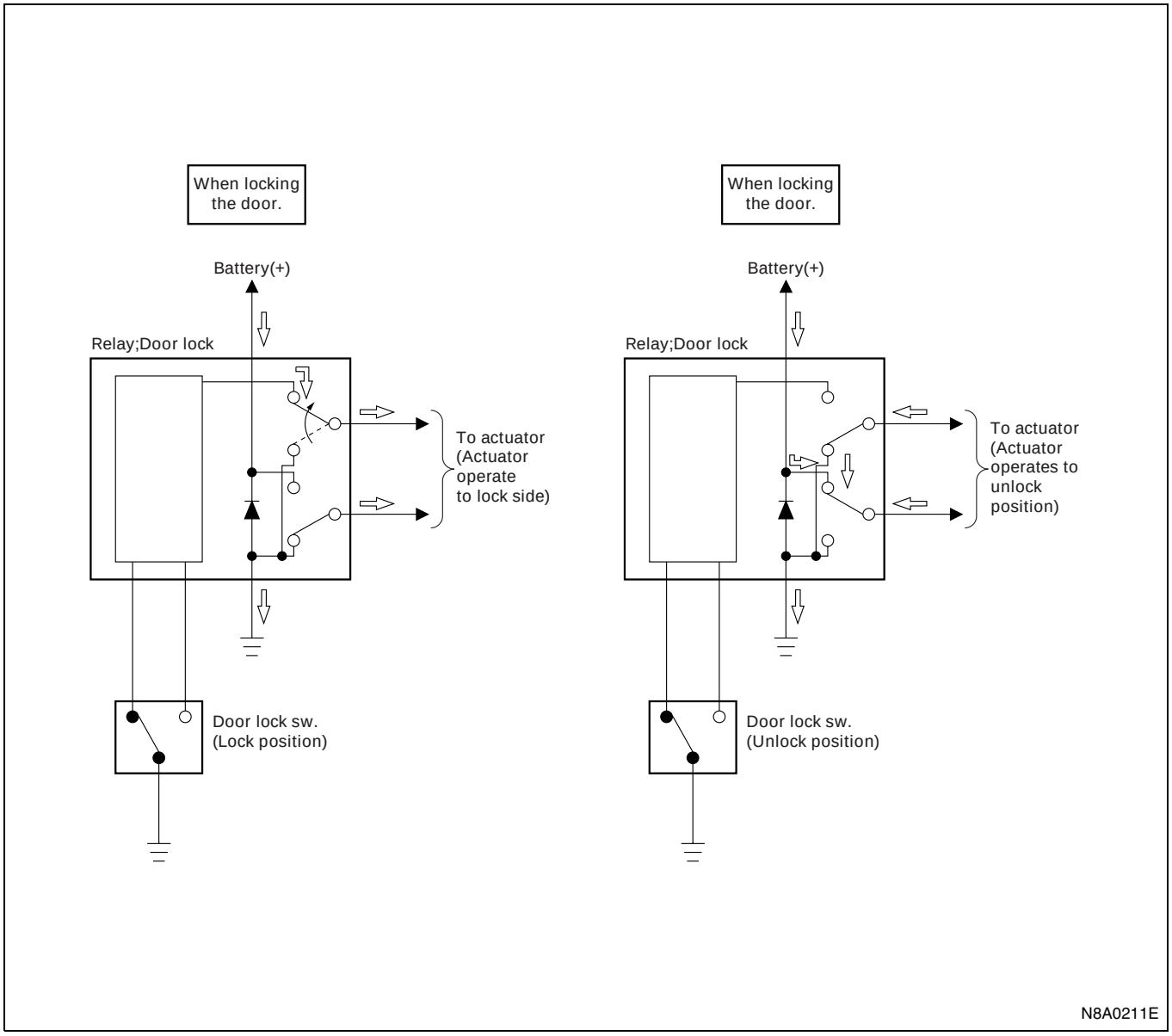
N8A0210E

Power Door Lock

General Description

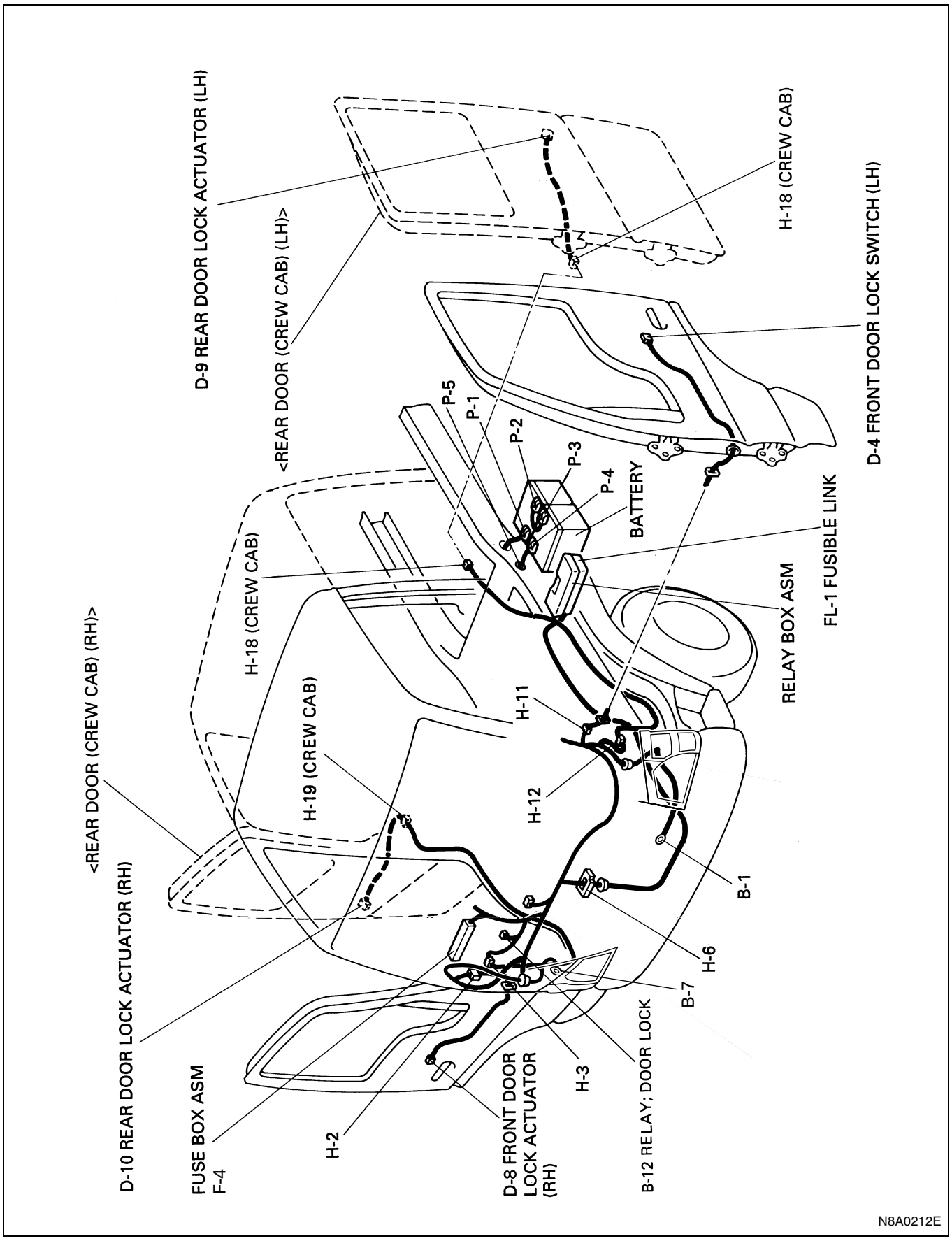
The circuit consists of the door lock switch, actuator for the front passenger door, rear doors and the door lock controller.
The door lock controller is always provided with battery voltage. The key or the inside lock knob on the driver's door can activate the lock mechanism of all the doors.
When the driver's door lock switch is turned on, current flows for about one second to the door lock actuator of each door connected in parallel with the controller to activate the actuator to lock and unlock the doors.

Operation of Door Lock Controller

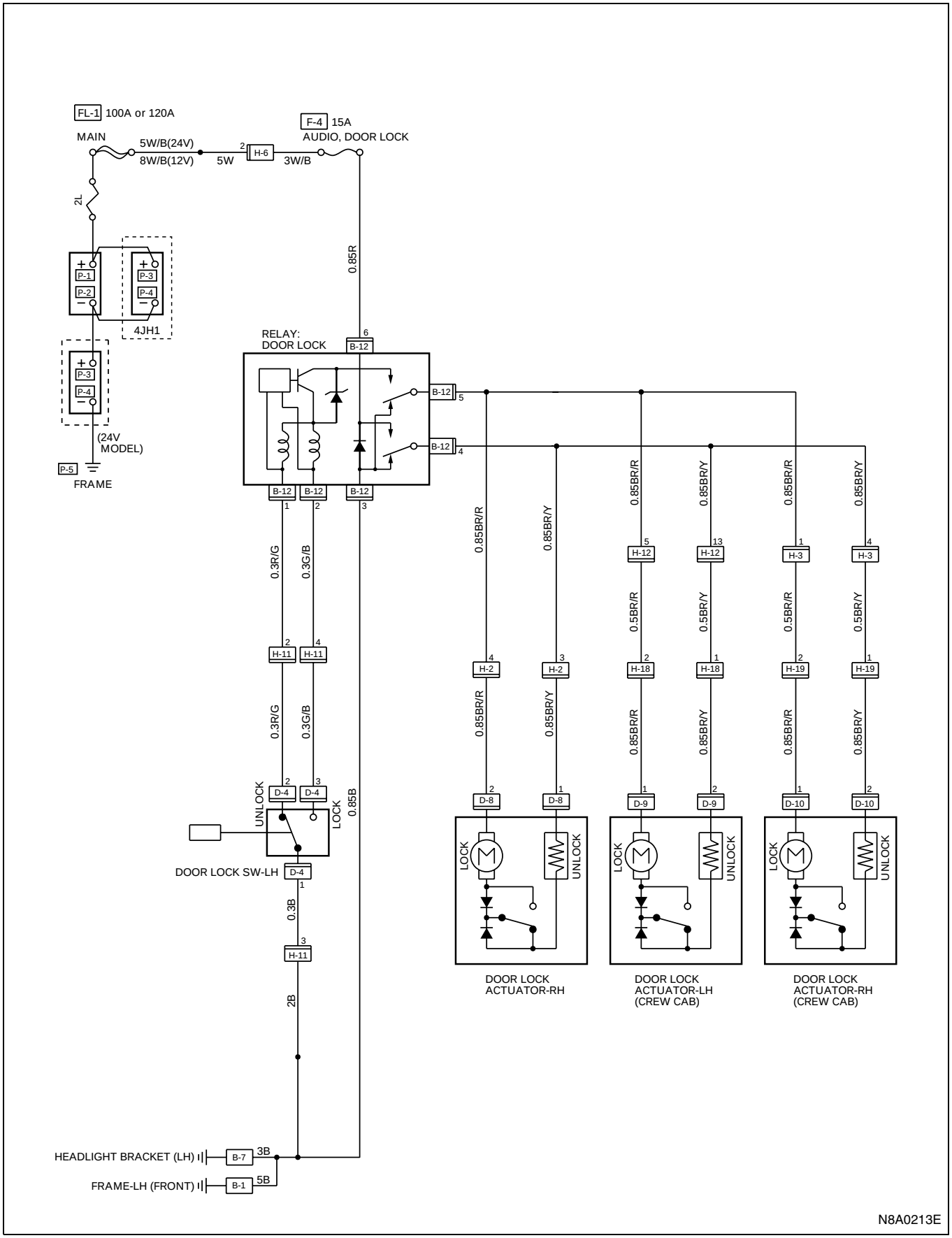


Notice:
Arrow marks indicate the direction of current.

Parts Location



Circuit Diagram



Connector List

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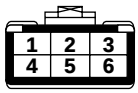
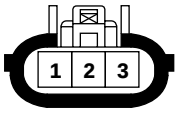
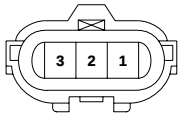
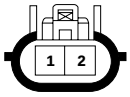
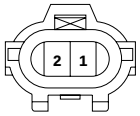
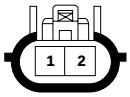
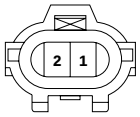
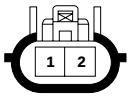
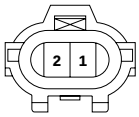
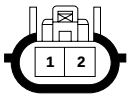
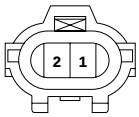
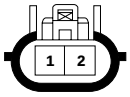
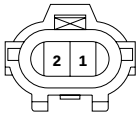
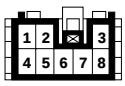
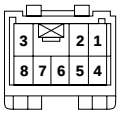
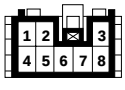
B-12	 006-010
D-4	 003-003
D-4	 003-011
D-8	 002-001
D-8	 002-002
D-9	 002-001
D-9	 002-002
D-10	 002-001

No.	Connector Face
D-10	 002-002
H-18	 002-001
H-18	 002-002
H-19	 002-001
H-19	 002-002
H-2	 008-009
H-2	 008-010
H-11	 008-009

No.	Connector Face
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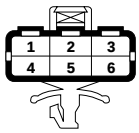
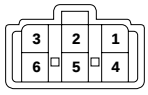
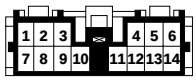
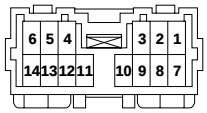
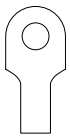
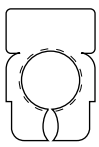
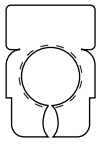
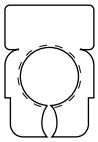
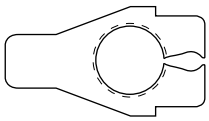
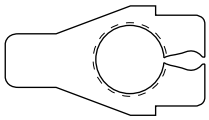
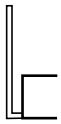
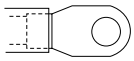
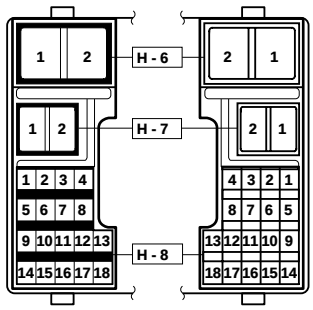
H-3	 006-014
H-3	 006-015
H-12	 014-002
H-12	 014-003
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004

No.	Connector Face
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
P-5 (12 V)	 000-007
P-5 (24 V)	 000-002

H-6



N8A5489E

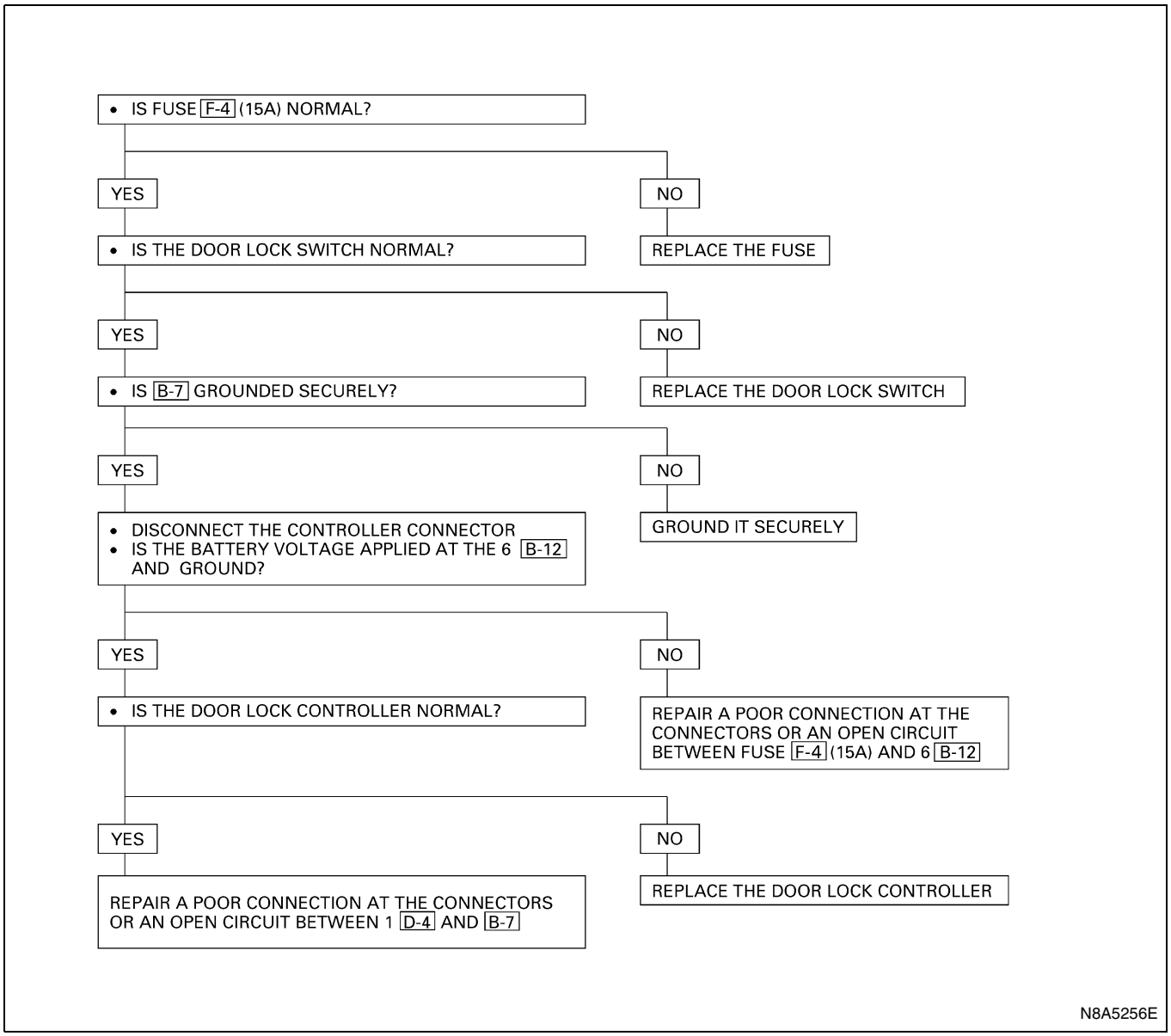
Diagnosis

Quick Chart for Check Point

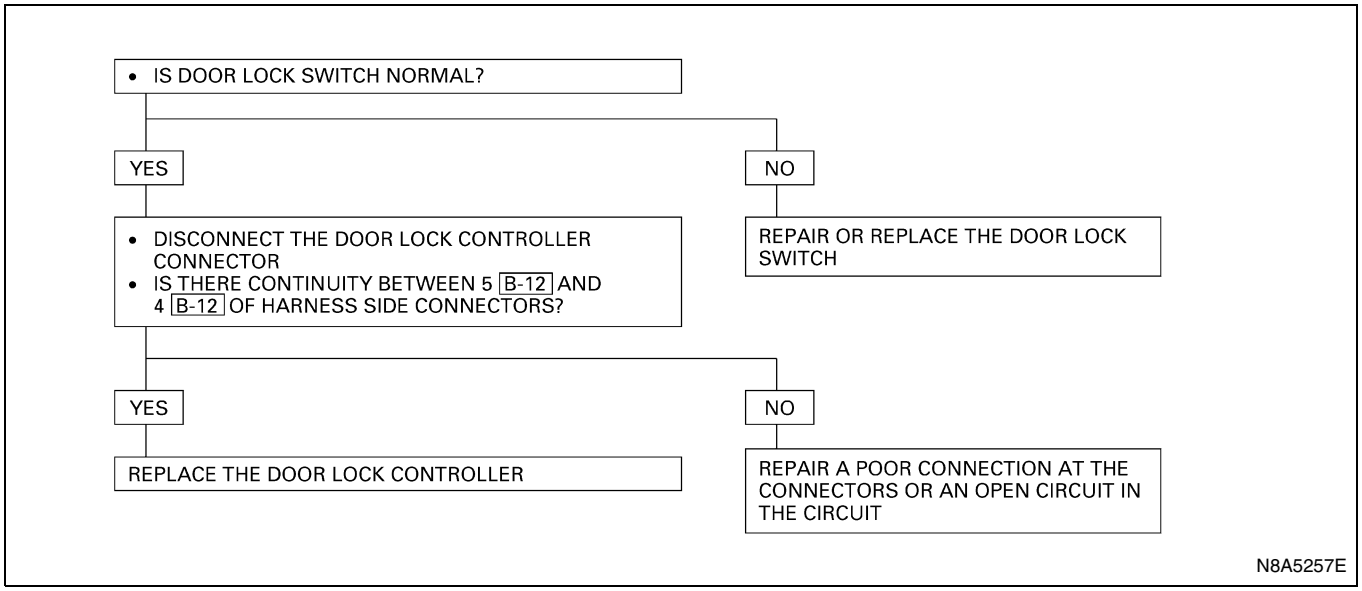
		Check point						
		Fuse F-4 (15 A)	Door lock controller	Door lock SW (Driver side)	Door lock actuator			
					Front (Passen-ger side)	Rear (RH)	Rear (LH)	Cable harness
Trouble mode	1. All the doors do not lock and unlock	❍	❍					❍
	2. All the doors do not get locked (or unlocked)		❍					❍
	3. Driver side door does not get locked (or unlocked)			❍				❍
	4. Front passenger side door does not get locked (or unlocked)				❍			❍
	5. Rear door-RH side does not get locked (or unlocked)					❍		❍
	6. Rear door-LH side does not get locked (or unlocked)						❍	❍

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

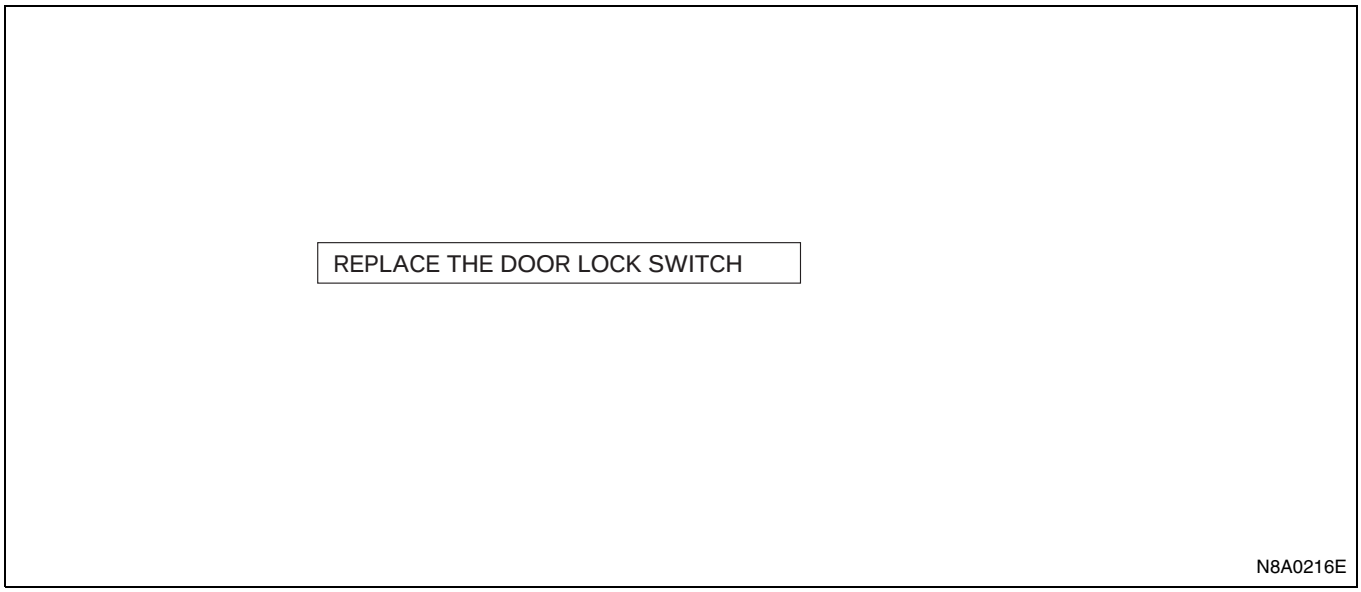
All the Doors Do Not Lock and Unlock



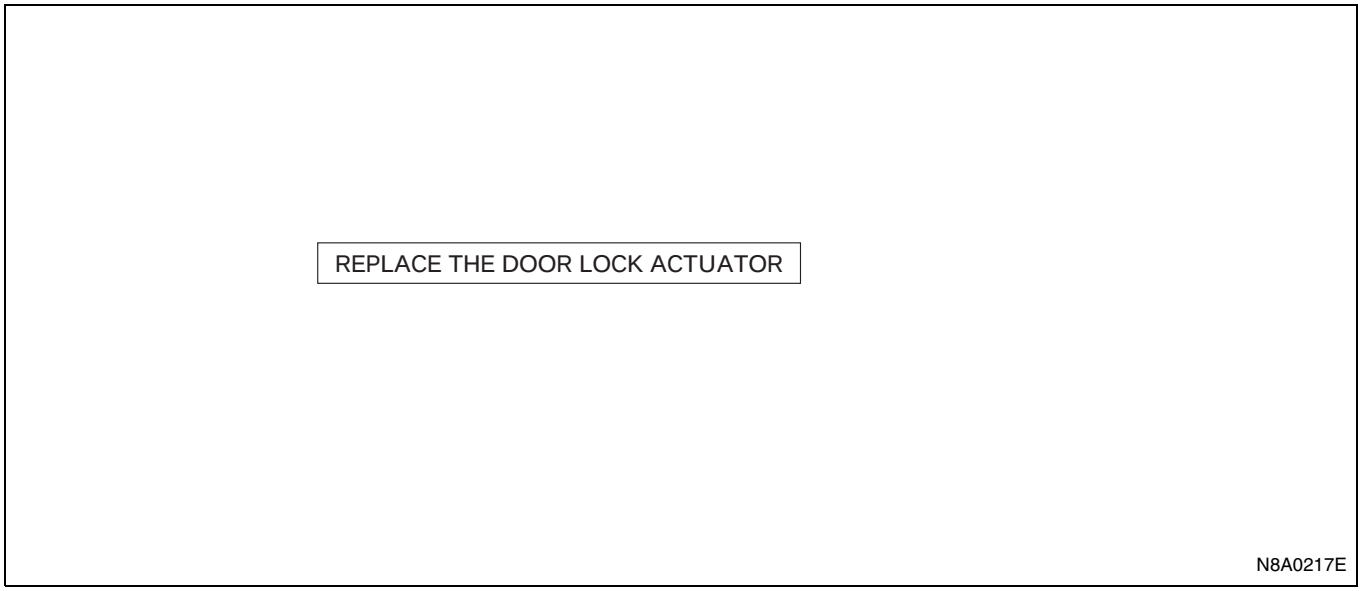
All the Doors Do Not Get Locked (or Unlocked)



Driver Side Door Does Not Get Locked (or Unlocked)



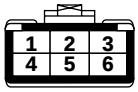
FRT Passenger Side Door Does Not Get Locked (or Unlocked)
RR Door-RH Side Does Not Get Locked (or Unlocked)
RR Door-LH Side Does Not Get Locked (or Unlocked)



Inspection of The Door Lock Circuit

Check the voltage and the continuity between the controller harness side connector terminals.

B-12



Harness side

Terminal No.	Wire color	Connected to	Item to be checked	Connecting terminal	Checking conditions		Standard
1	R/G	Door lock SW (Unlock)	Continuity (Resistance)	1-Ground	Driver seat side door	Unlock	Continuity
						Lock	No continuity
2	G/B	Door lock SW (Lock)		2-Ground	Driver seat side door	Unlock	No continuity
						Lock	Continuity
3	B	Ground		3-Ground	-		Continuity
4	BR/Y	Actuator (Unlock)		4-5	-		Continuity (There is some resistance)
5	BR/R	Actuator (Lock)		5-4	-		Continuity (There is some resistance)
6	R	Fuse F-7 (15A)	Voltage	6-Ground	-		Battery voltage

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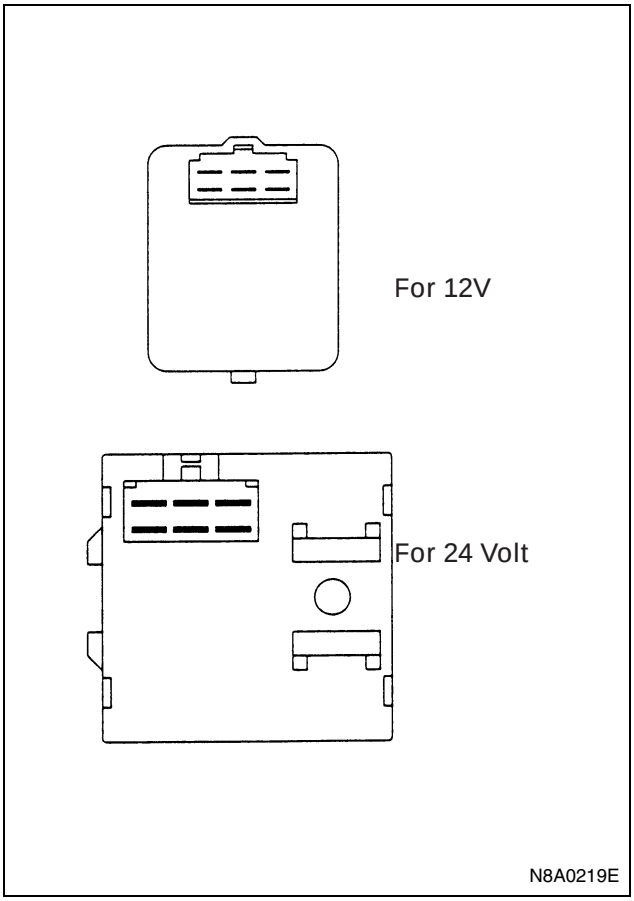
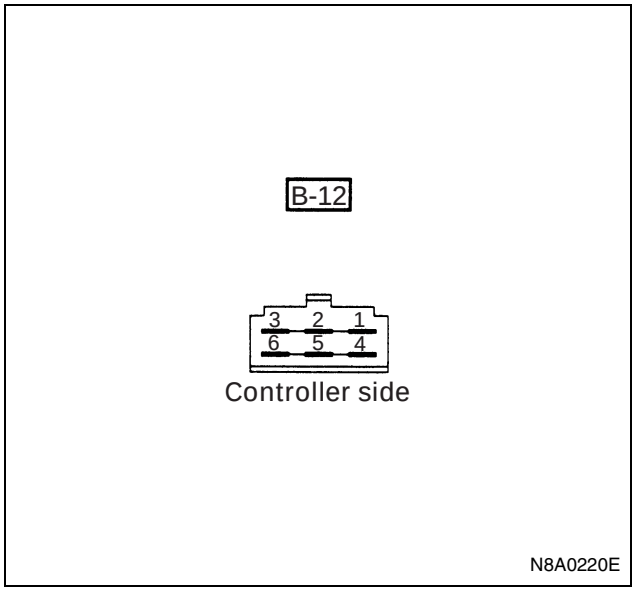
Door Lock Relay

The door lock controller sends out to each door lock actuator the lock/unlock signals received from door lock switch of driver seat side.



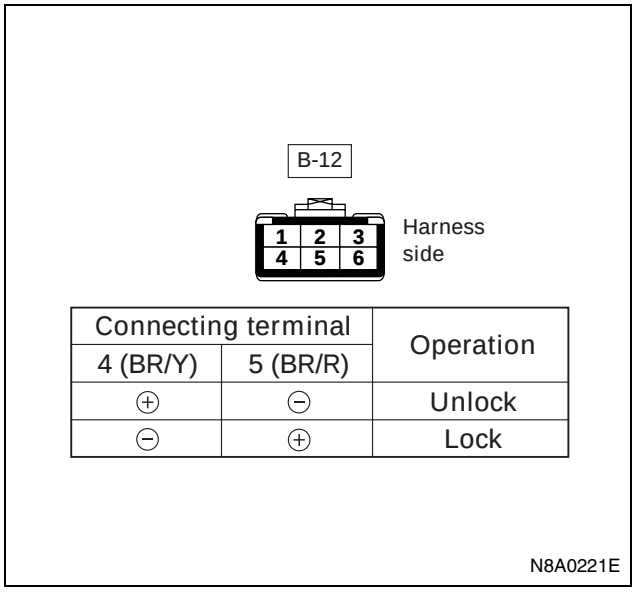
Inspection

Remove the connector of the door lock controller, and check the continuity and the voltage between the controller side connector terminals.
(Connect the (+) terminal of the battery to 6 B-12 and the (–) terminal to 3 B-12.)
3 B-12 — 5 B-12.....Continuity
3 B-12 — 4 B-12.....Continuity
(Then, ground 2 B-12.)
5 B-12.....Voltage for approx. 1 second
(Disconnect the ground of 2 B-12, and ground 1 B-12.)
4 B-12.....Voltage for approx. 1 second
Replace the controller when the result of inspection is found abnormal.



Door Lock Operation Test

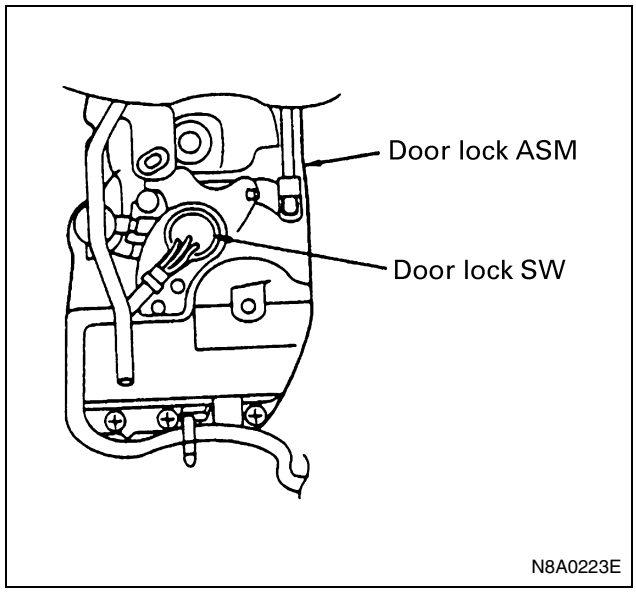
After confirming that there is continuity between the harness side connector terminals 4 B-12 and 5 B-12 of the door lock controller, apply battery voltage to each of the terminals to conduct the operation test.
When the door lock will not operate, check the door lock actuator for any trouble.



Connecting terminal		Operation
4 (BR/Y)	5 (BR/R)	
⊕	⊖	Unlock
⊖	⊕	Lock

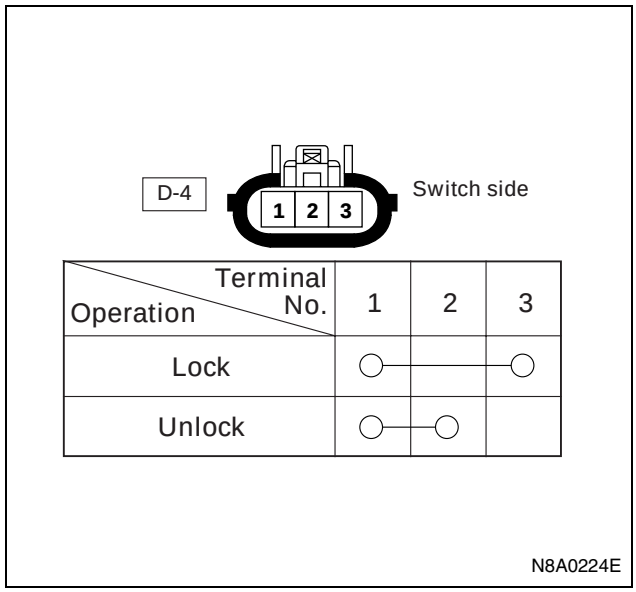
Door Lock Switch (Driver Seat Side)

The door lock switch on the driver's door is connected with the door lock cylinder and the inside lock knob with a rod. The switch sends lock/unlock signals to the door lock controller.



Inspection

Check to see if there is any continuity between the connector terminals of the door lock switch.
Replace the switch when the result of inspection is found abnormal.

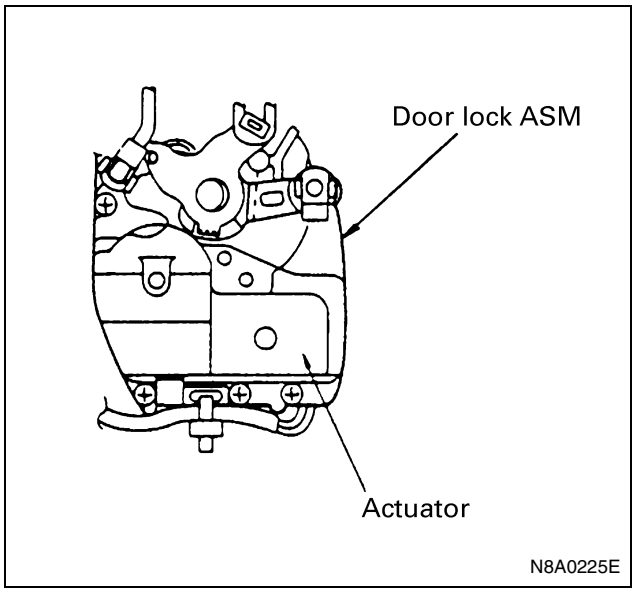


Removal and Installation

Refer to Section 2 for "DOOR LOCK ASSEMBLY".

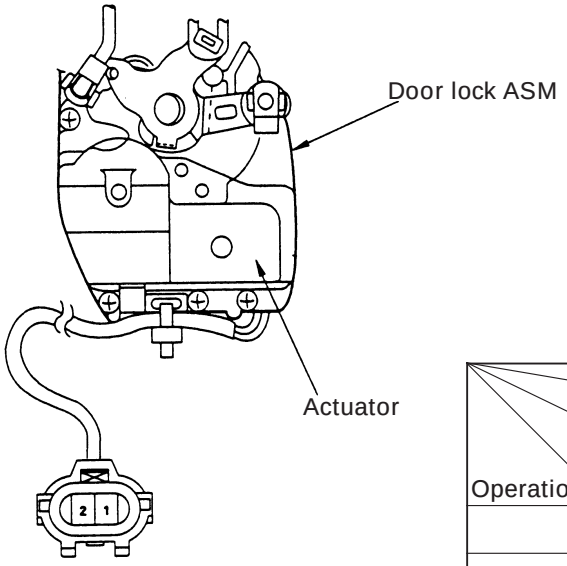
Door Lock Actuator

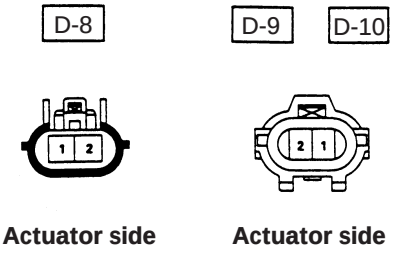
Receiving forward or reverse current from the door lock controller, the door lock actuator locks or unlocks the door with the rod connected to the door lock mechanism.



Inspection of The Door Lock Actuator

Apply the battery voltage to the connector terminals of the door lock actuator to check the operation.
When the door lock actuator is checked on the vehicle and there is no continuity, and when the door lock actuator itself is checked and no trouble is found, check the circuit between the door lock actuator and the door lock controller for any failure.





Operation \ Door	FRT Passenger		RR-LH		RR-RH	
Connector No.	D-8		D-9		D-10	
Terminal No.	1	2	1	2	1	2
Lock	⊖	⊕	⊕	⊖	⊕	⊖
Unlock	⊕	⊖	⊖	⊕	⊖	⊕

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Removal and Installation

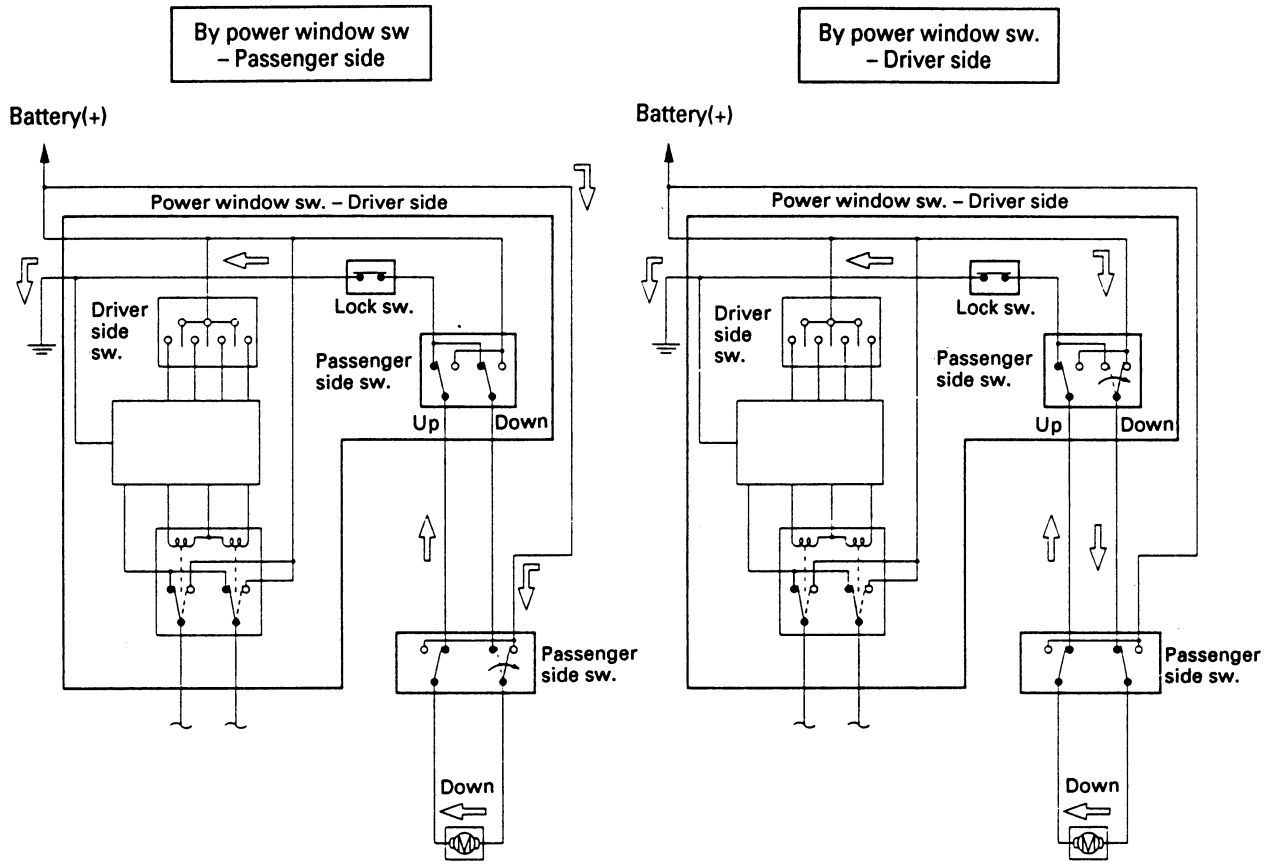
Refer to Section 2 for “DOOR LOCK ASSEMBLY”.

Power Window

General Description

The circuit consists of the starter switch, power window switch for each of the windows and power window motor.
When the starter switch is turned on, the battery voltage is applied to each of the power window switches through the circuit breaker and the power window relay on the circuit.
By operating the switches of each window to select “UP” or “DOWN”, the revolving direction of the power window motor changes to open or close the window.
The driver’s power window switch has a built-in one-touch operating circuit which allows to automatically open the window by operating the switch to the AUTO position.
When the driver’s power lock switch at the driver side is depressed, the power source to the passenger’s power window switches will be shut off and passenger’s side power window motor will not operate if the switch is operated.

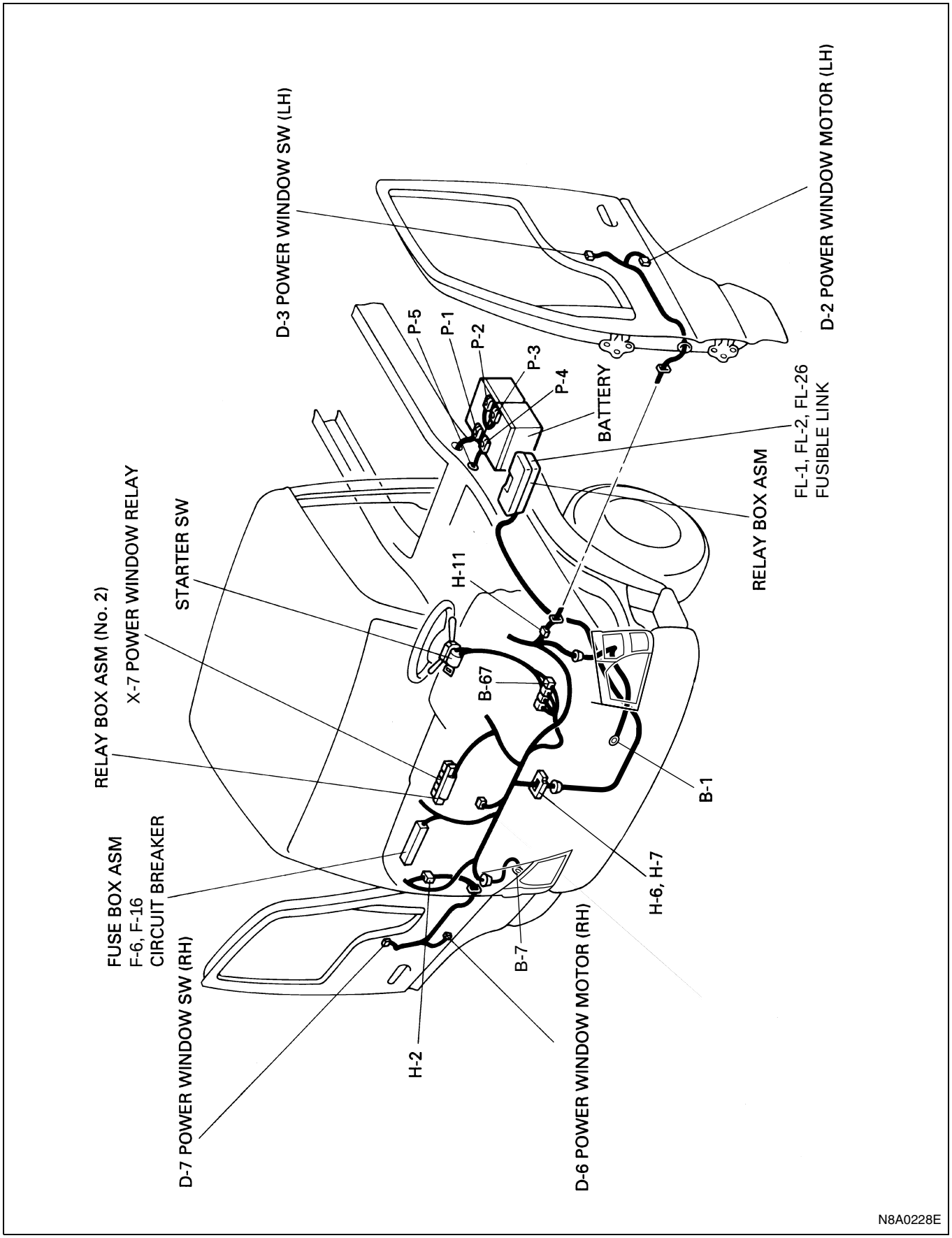
Operation of Passenger Side Window



NOTE: Arrow marks " ⟹ " indicate the direction of current

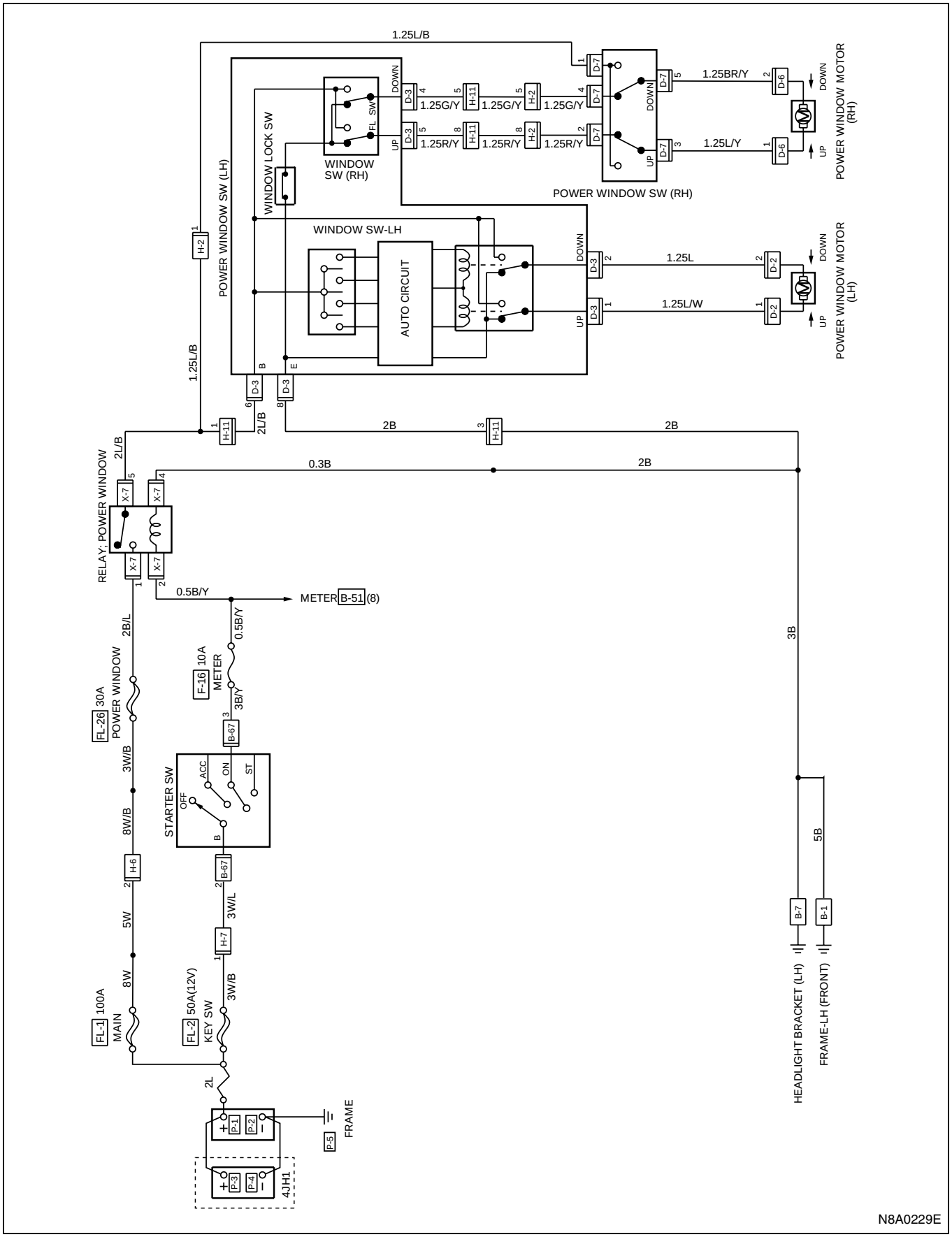
N8A0227E

Parts Location

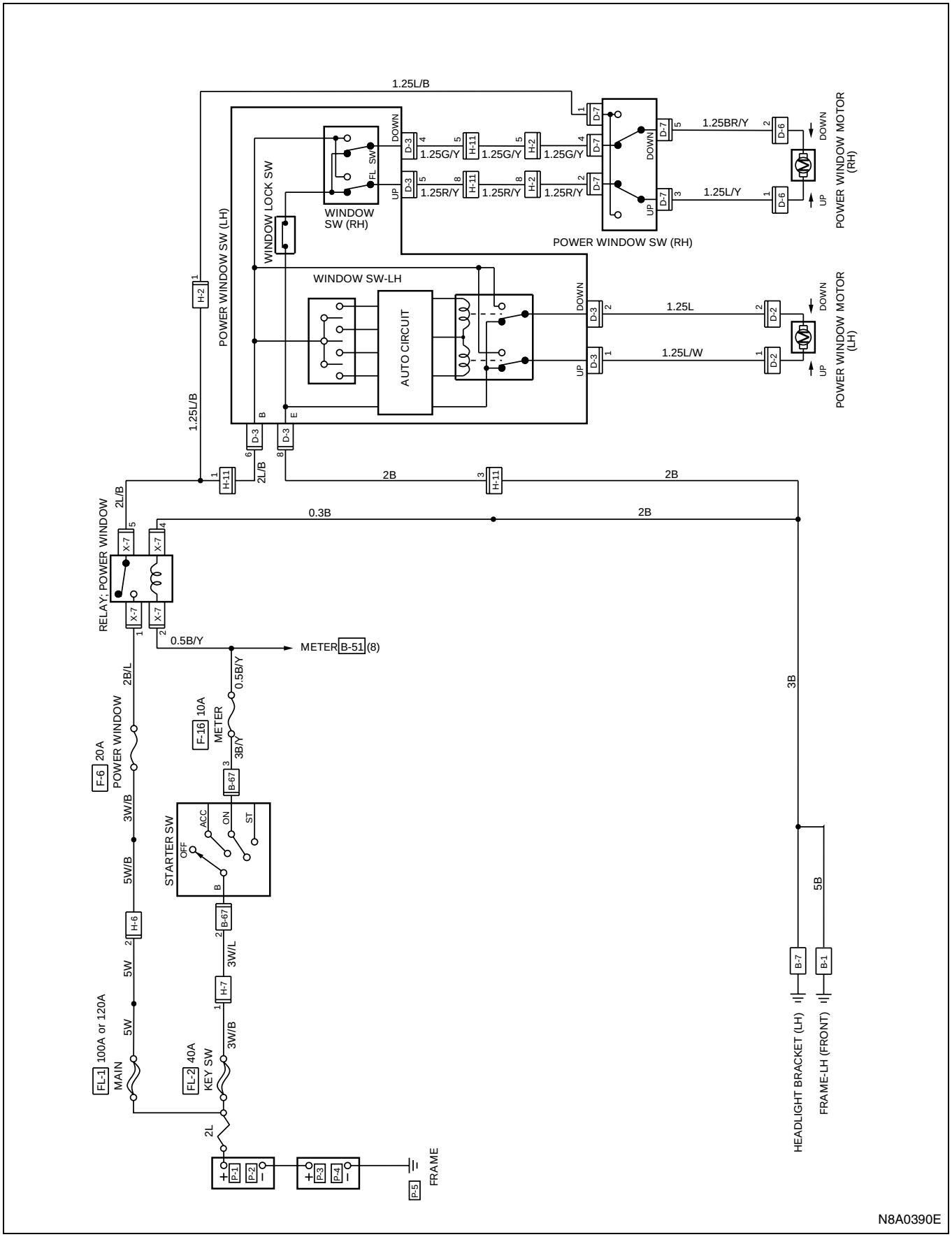


Circuit Diagram

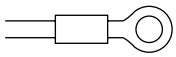
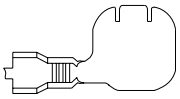
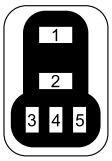
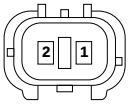
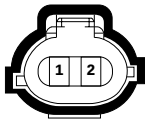
For 12 Volt

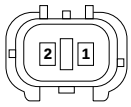
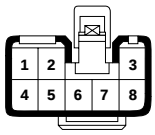
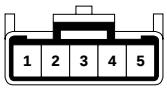
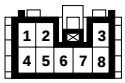
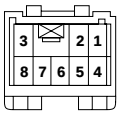
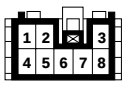
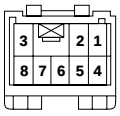
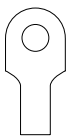


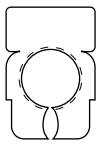
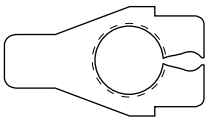
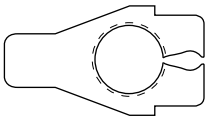
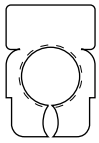
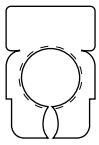
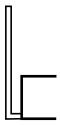
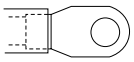
For 24 Volt


1.25L/B
POWER WINDOW SW (LH)
WINDOW LOCK SW
WINDOW SW (RH)
FL SW
DOWN
UP
1.25G/Y
1.25R/Y
1.25BR/Y
1.25L/Y
POWER WINDOW SW (RH)
POWER WINDOW MOTOR (RH)
WINDOW SW-LH
AUTO CIRCUIT
1.25L
1.25L/W
POWER WINDOW MOTOR (LH)
1.25L/B
2L/B
2B
0.3B
RELAY; POWER WINDOW
0.5B/Y
METER B-51 (8)
2B/L
F-16 10A METER
3B/Y
F-6 20A POWER WINDOW
3W/B
5W/B
STARTER SW
OFF
ACC
ON
ST
B
5W
3W/L
FL-1 100A or 120A MAIN
FL-2 40A KEY SW
2L
P-1
P-2
P-3
P-4
P-5
FRAME
3B
5B
HEADLIGHT BRACKET (LH)
FRAME-LH (FRONT)
N8A0390E

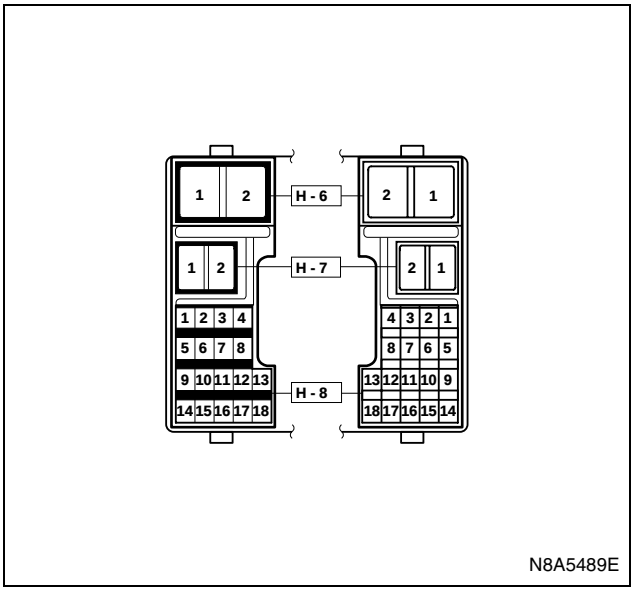
Connector List

No.	Connector Face
B-1	 000-001
B-7	 000-012
X-7	 005-006
B-67	004-001
B-67	004-002
D-2	002-028
D-2	 002-029
D-6	 002-028

No.	Connector Face
D-6	 002-029
D-3	 008-011
D-7	 005-005
H-2	 008-009
H-2	 008-010
H-11	 008-009
H-11	 008-010
P-1 (12V)	 000-003

No.	Connector Face
P-2	 000-004
P-1 (24V)	 000-006
P-4	 000-006
P-2 (24V)	 000-004
P-3	 000-004
P-5 (12V)	 000-007
P-5 (24V)	 000-002

H-6, H-7



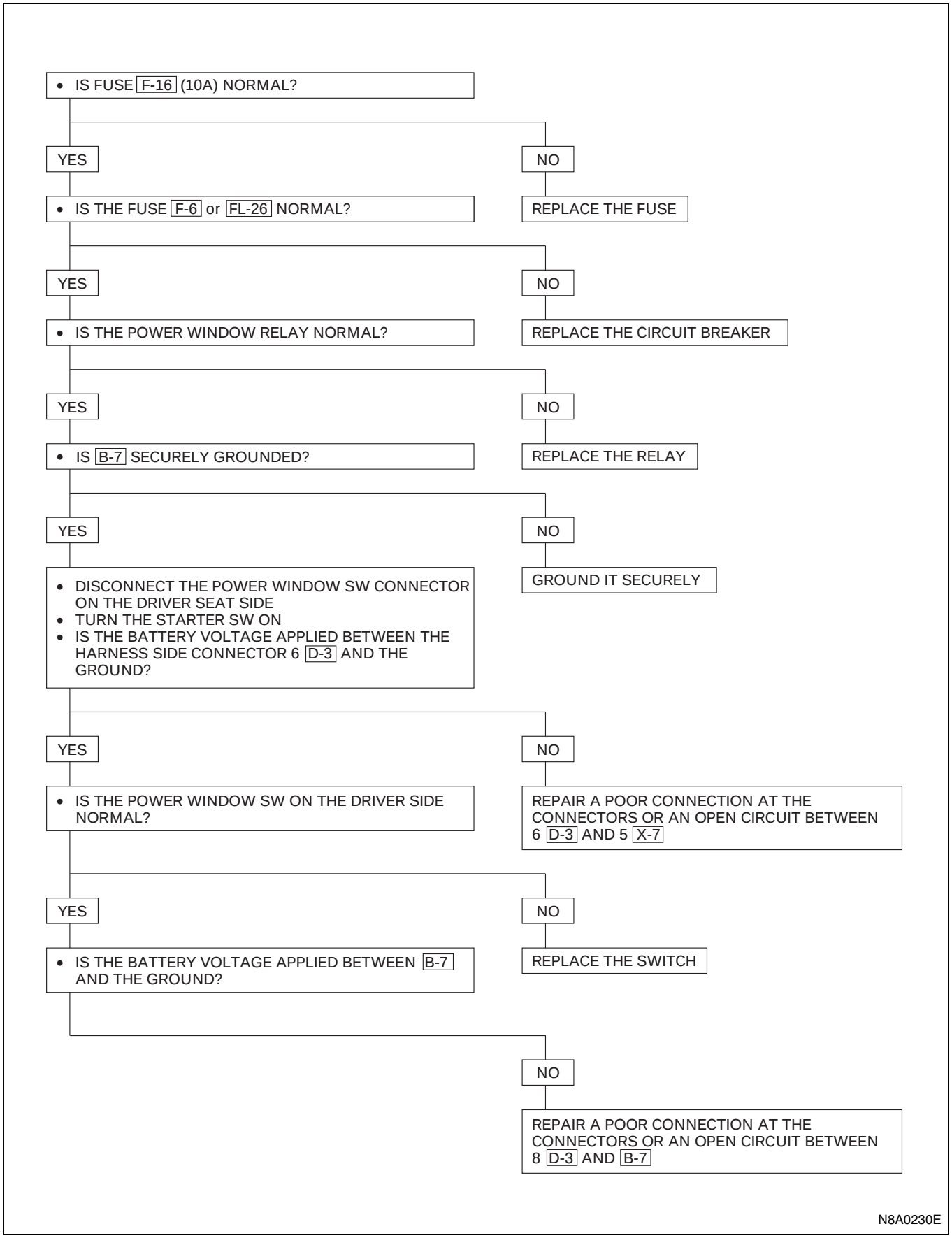
Diagnosis

Quick Chart for Check Point

		Check point							
		Fuse F-16 (10A)	F-6, FL-26 (20A, 30A)	Power window relay	Power window SW		Power window motor		Cable harness
					Driver side	Passenger side	Driver side	Passenger side	
Trouble mode	All windows do not operate	❍ (1)	❍ (2)	❍ (3)	❍ (5)				❍ (4)
	Lock SW does not function				❍ (1)				
	Driver side window								
	Window does not operate				❍ (1)		❍ (2)		❍ (3)
	One-touch operation does not operate				❍ (1)				
	Window operates in only one direction				❍ (1)				
	Front passenger side window								
	Window does not operate				❍ (2)	❍ (1)		❍ (3)	❍ (4)
	Window does not operate when operating the driver side SW				❍ (1)				❍ (2)
	Window does not operate when operating the passenger side SW					❍ (1)			❍ (2)
	Window operates in only one direction when operating the driver side SW				❍ (1)				❍ (2)
	Window operates in only one direction when operating the passenger side SW				❍ (2)	❍ (1)			

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

All Windows Do Not Operate



Lock Sw Does Not Function

REPAIR OR REPLACE THE POWER WINDOW SW ON THE DRIVER SEAT SIDE

N8A0231E

Window on the Driver Side Does Not Operate

- IS THE POWER WINDOW SWITCH ON THE DRIVER SEAT SIDE NORMAL?

YES

- DISCONNECT THE CONNECTOR OF THE POWER WINDOW MOTOR ON THE DRIVER SEAT SIDE
- WHEN CONNECTING THE MOTOR CONNECTOR 1 [D-2] TO THE BATTERY (+) TERMINAL AND 2 [D-2] TO THE (-) TERMINAL, DOES THE MOTOR ROTATE IN THE "UP" DIRECTION OF THE WINDOW (OR WHEN CONNECTING 2 [D-2] TO THE (+) TERMINAL AND 1 [D-2] TO THE (-) TERMINAL, DOES THE MOTOR ROTATE IN THE "DOWN" DIRECTION OF THE WINDOW)?

YES

REPAIR A POOR CONNECTION AT THE CONNECTORS OR AN OPEN CIRCUIT BETWEEN HARNESS SIDE CONNECTOR TERMINALS 1 [D-3] AND POWER WINDOW MOTOR 1 [D-2] OR 2 [D-3] AND 2 [D-2]

NO

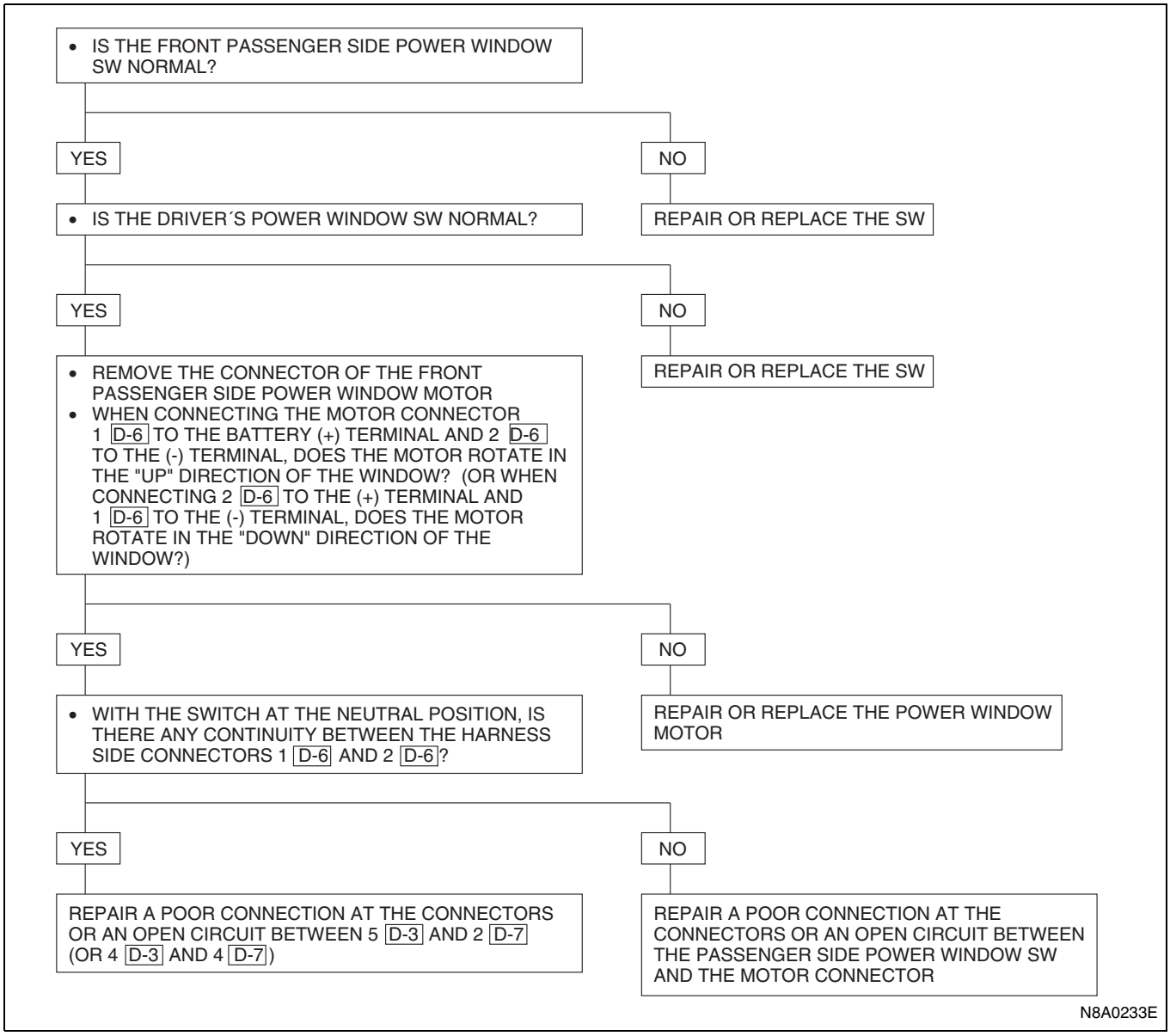
REPAIR OR REPLACE THE POWER WINDOW MOTOR

NO

REPLACE THE POWER WINDOW SWITCH ON THE DRIVER SEAT SIDE

N8A0232E

Window on the Front Passenger Side Does Not Operate



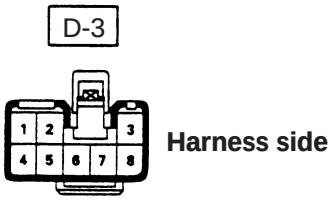
Starter Switch

Refer to “START AND CHARGING” in this section.

Power Window Switch-driver Side

Circuit Inspection

Disconnect the switch connectors to check the voltage and the continuity between the harness side connector terminals.

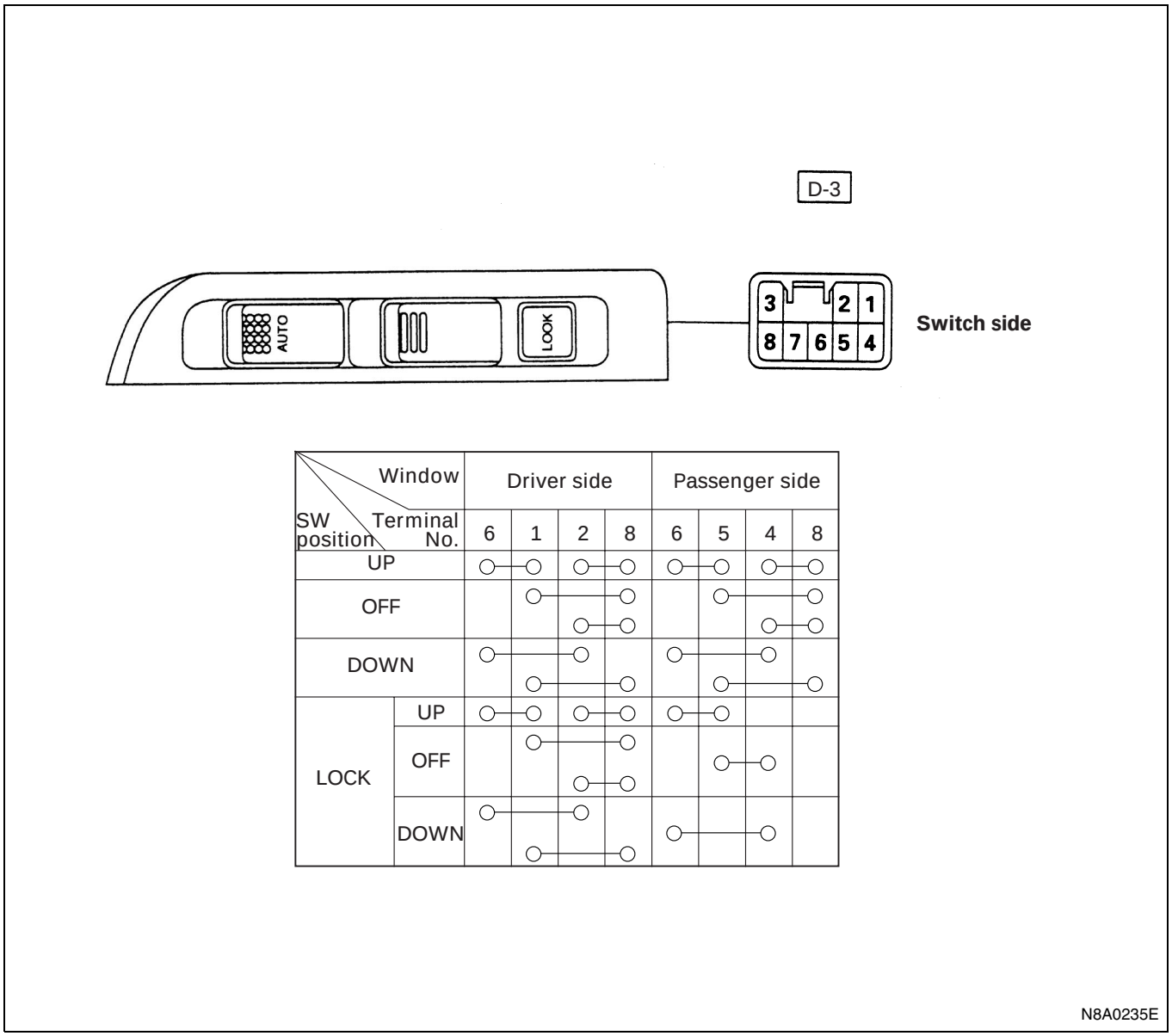


Terminal No.	Wire color	Connected to	Item to be checked	Connecting terminal	Checking conditions	Standard
1	L/W	Driver seat side motor	Continuity (resistance)	1-2	-	Continuity
2	L					
4	G/Y	Passenger side power window SW		4-5		
5	R/Y			5-4		
6	L/B	Power window relay	Voltage	6-Ground	Starter SW "ON"	Battery voltage
8	B	Ground	Continuity (resistance)	8-Ground	-	Continuity

N8A0234E

Inspection

Check the continuity between the connector terminals of the switch.
Repair or replace the switch when the result of inspection is found abnormal.



SW position \ Terminal No. / Window		Driver side				Passenger side			
		6	1	2	8	6	5	4	8
UP		○—○		○—○		○—○		○—○	
OFF			○		○		○		○
				○—○				○—○	
DOWN		○		○		○		○	
			○		○		○		○
LOCK	UP	○—○		○—○		○—○			
	OFF		○		○		○—○		
				○—○					
	DOWN	○		○					
			○		○	○		○	

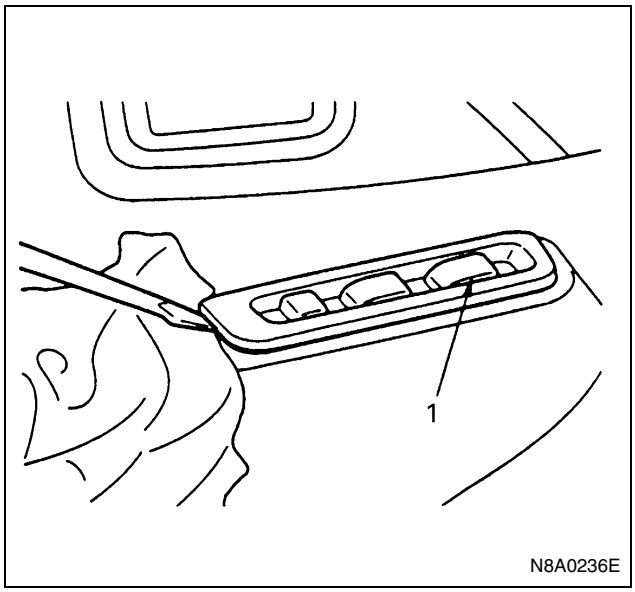
N8A0235E

Removal

Preparation:

Disconnect the battery ground cable.

1. Switch
   1) Insert the screw driver to the cut off portion to remove the switch.
   2) Disconnect the connector.



N8A0236E

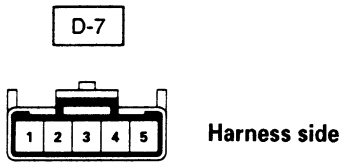
Installation

To install, follow the removal steps in the reverse order.

Power Window Switch-passenger Side

Circuit Inspection

Disconnect the switch connectors to check the voltage and the continuity between the harness side connector terminals.

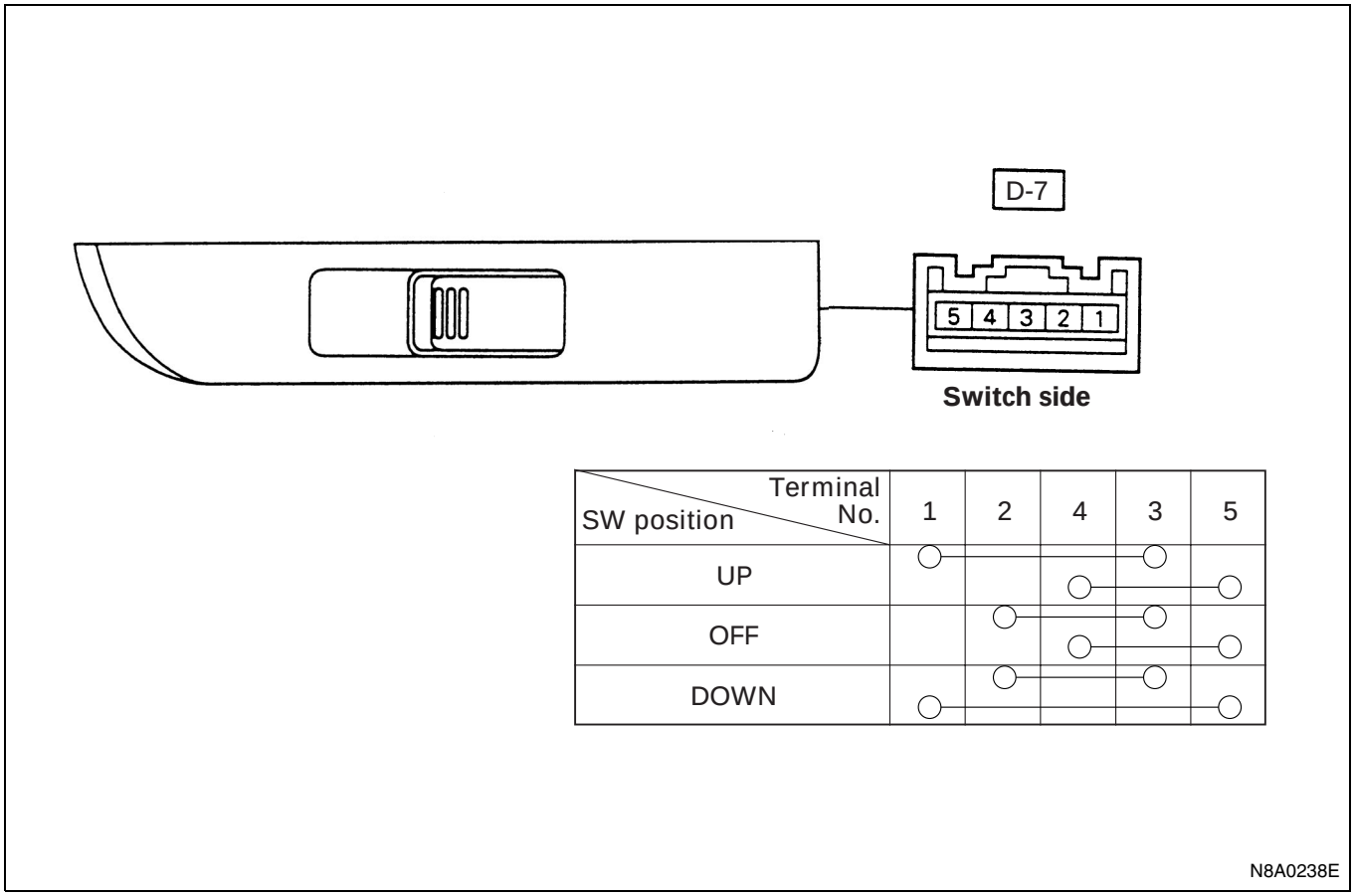


Terminal No.	Wire color	Connected to	Item to be checked	Connecting terminal	Checking conditions	Standard
1	L/B	Power window relay	Voltage	1-Ground	· Turn "ON" the starter SW	Battery voltage
2	R/Y	Driver side SW	Continuity (Resistance)	2-Ground	· Turn "OFF" the passenger side SW at the driver side SW	Continuity
			Voltage	2-Ground	· Turn "ON" the starter SW · Turn to "UP" the passenger side SW at the driver side SW	Battery voltage
3	L/Y	Passenger side motor	Continuity (Resistance)	3-5	–	Continuity
4	G/Y	Driver side SW	Continuity (Resistance)	4-Ground	· Turn "OFF" the passenger side SW at the driver side SW	Continuity
			Voltage	4-Ground	· Turn "ON" the starter SW · Turn to "DOWN" the passenger side SW at the driver side SW	Battery voltage
5	BR/Y	Passenger side motor	Continuity (Resistance)	5-3	–	Continuity

N8A5280E

Inspection

Check the continuity between the connector terminals of the switch.
Repair or replace the switch when the result of inspection is found abnormal.

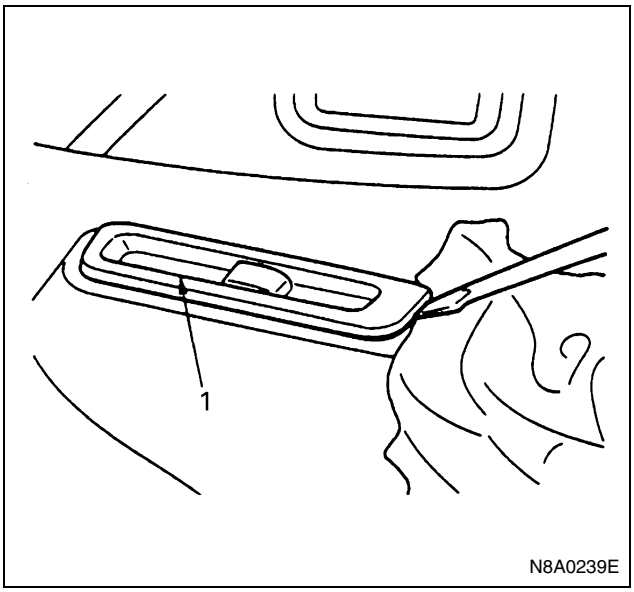


Removal

Preparation:

Disconnect the battery ground cable.

1. Switch
   1) Insert the screw driver to the cut off portion to remove the switch.
   2) Disconnect the connector.



Installation

To install, follow the removal steps in the reverse order.

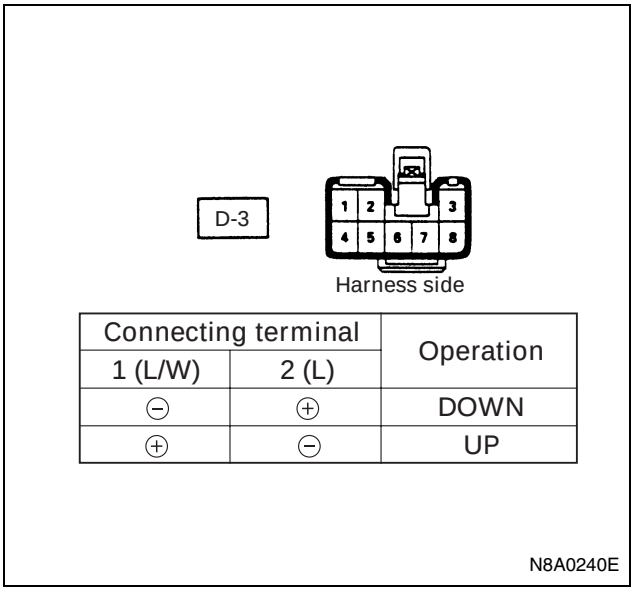
Driver Seat Side Power Window Motor

Inspection

Before checking to see if the motor functions correctly, be sure to check the circuit through the connector D-3 of the driver's power window switch.

If the motor does not operate smoothly, either the motor or the circuit between the switch and the motor is defective.

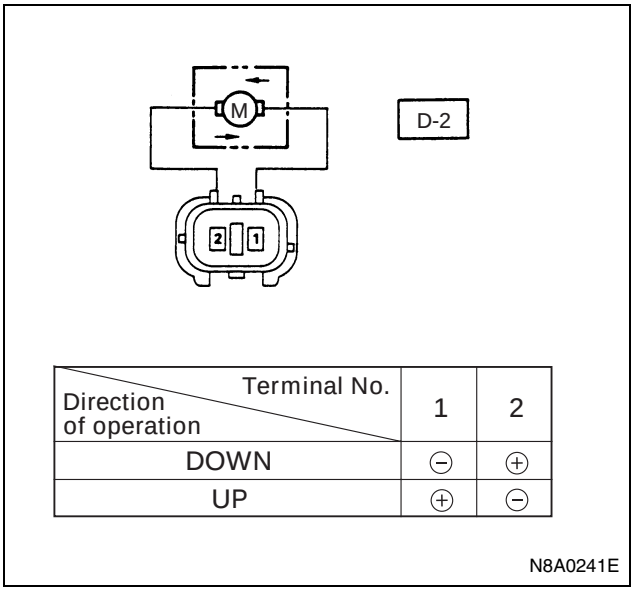
1. Circuit inspection of the driver side window switch
   Disconnect the switch connector and apply battery voltage to the harness side connector terminals to check its function.



Connecting terminal		Operation
1 (L/W)	2 (L)	
⊖	⊕	DOWN
⊕	⊖	UP

N8A0240E

2. Inspection of the driver seat side motor
   Remove the motor connector and apply battery voltage to the motor side connector terminals to check its function.
   Replace the motor when the result of inspection is found abnormal.



Direction of operation \ Terminal No.	1	2
DOWN	⊖	⊕
UP	⊕	⊖

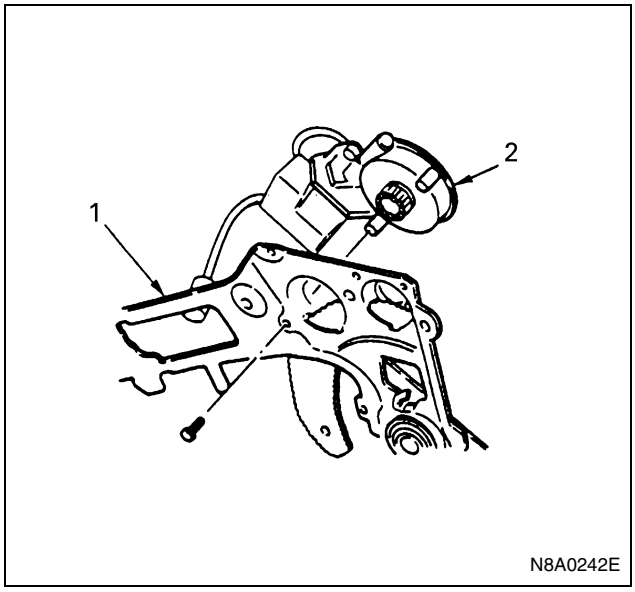
N8A0241E

Removal

Preparation:

Disconnect the battery ground cable.

1. Window Regulator Assembly
   Refer to Section 2 for Window Regulator and Glass.
2. Power Window Motor
   Remove three screws.



N8A0242E

Installation

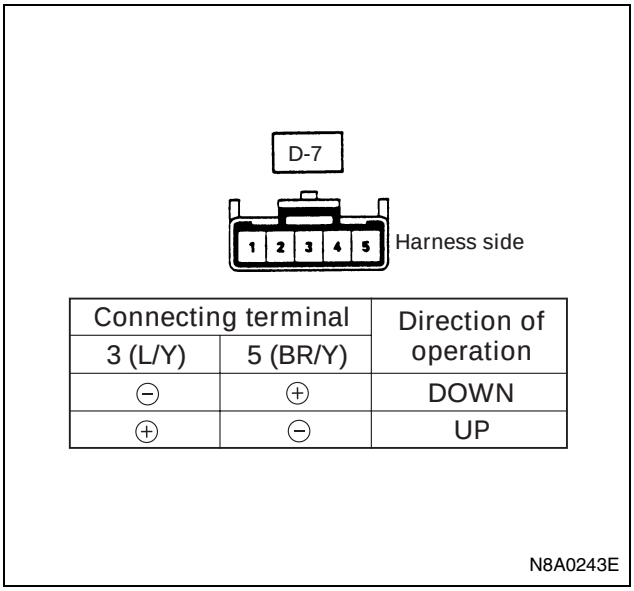
To install, follow the removal steps in the reverse order.

Front Passenger Seat Side Power Window Motor

Inspection

Before checking to see if the motor functions correctly, be sure to check the circuit through the front passenger's switch connector D-7 and the driver's power window switch connector D-3.
If the motor does not operate smoothly, either the motor or the circuit between the switch and the motor is defective.

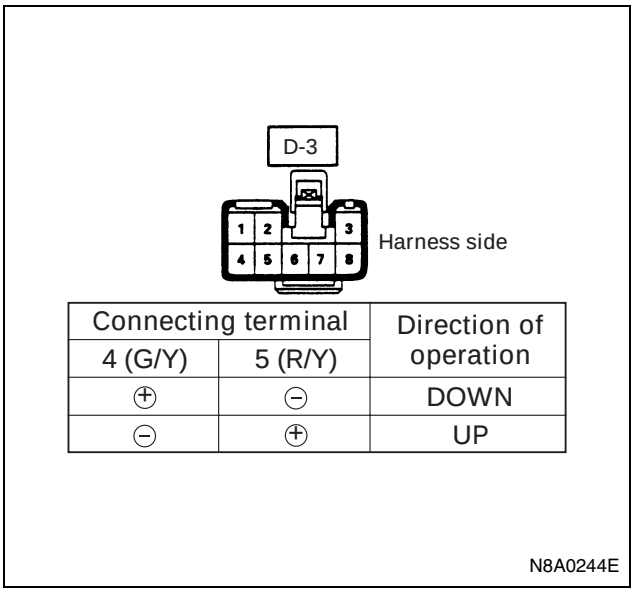
1. Circuit inspection of the front passenger seat side window
   Disconnect the switch connector and apply battery voltage to the harness side connector terminals to check its function.



Connecting terminal		Direction of operation
3 (L/Y)	5 (BR/Y)	
⊖	⊕	DOWN
⊕	⊖	UP

N8A0243E

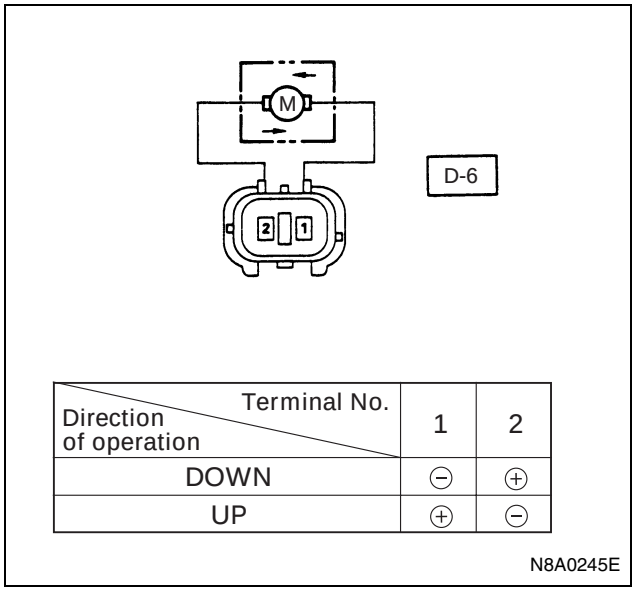
2. Circuit inspection of the driver seat side switch
   Disconnect the switch connector and apply battery voltage to the harness side connector terminals to check its function.



Connecting terminal		Direction of operation
4 (G/Y)	5 (R/Y)	
⊕	⊖	DOWN
⊖	⊕	UP

N8A0244E

3. Inspection of the front passenger window motor
   Disconnect the motor connector and apply battery voltage to the motor side connector terminals to check its function.
   Repair or replace the motor when the result of inspection is found abnormal.



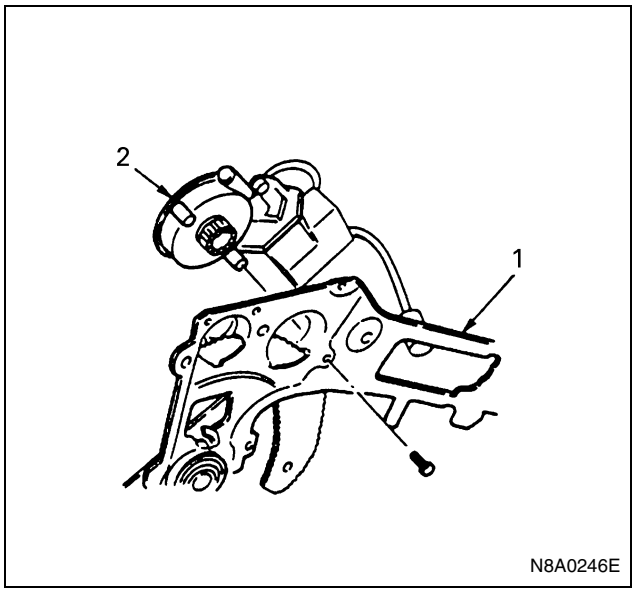
Direction of operation \ Terminal No.	1	2
DOWN	⊖	⊕
UP	⊕	⊖

N8A0245E

Removal

Preparation:
Disconnect the battery ground cable.

1. Window Regulator Assembly
   Refer to Section 2 for Window Regulator and Glass.
2. Power Window Motor
   Remove three screws.



N8A0246E

Installation

To install, follow the removal steps in the reverse order.

Windshield Wiper and Washer

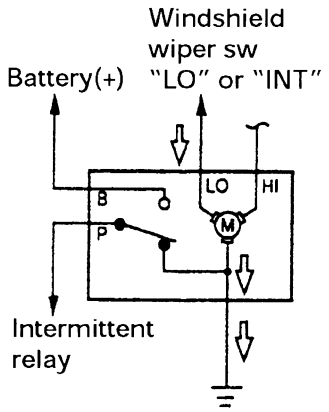
General Description

The circuit consists of the starter switch, windshield wiper & washer switch, wiper motor, washer motor and the intermittent relay.
When the wiper & washer switch is turned on with starter switch on, the battery voltage is applied to the wiper motor to activate the wiper.
The washer motor squirts glass cleaning fluid while the washer switch is being pushed. The intermittent relay is used to control motion of the wiper.

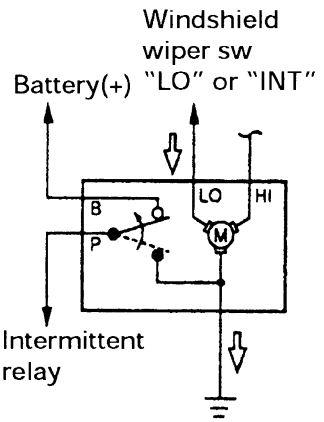
Operation of Windshield Wiper Motor

(When wiper “LO” or “INT” position)

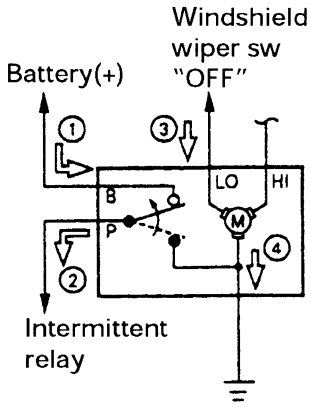
1. Condition of wiper switch is "LO"or "INT"position (Wiper motor is starting to operate)



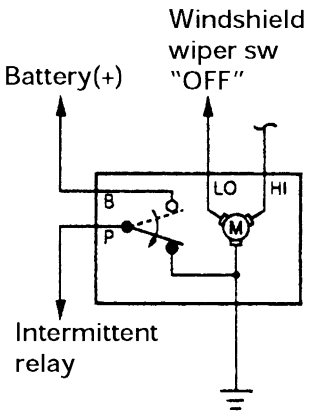
2. Condition of wiper motor is operating



3. Condition of wiper switch is just "OFF" (Wiper motor is still operating until auto-stop position)



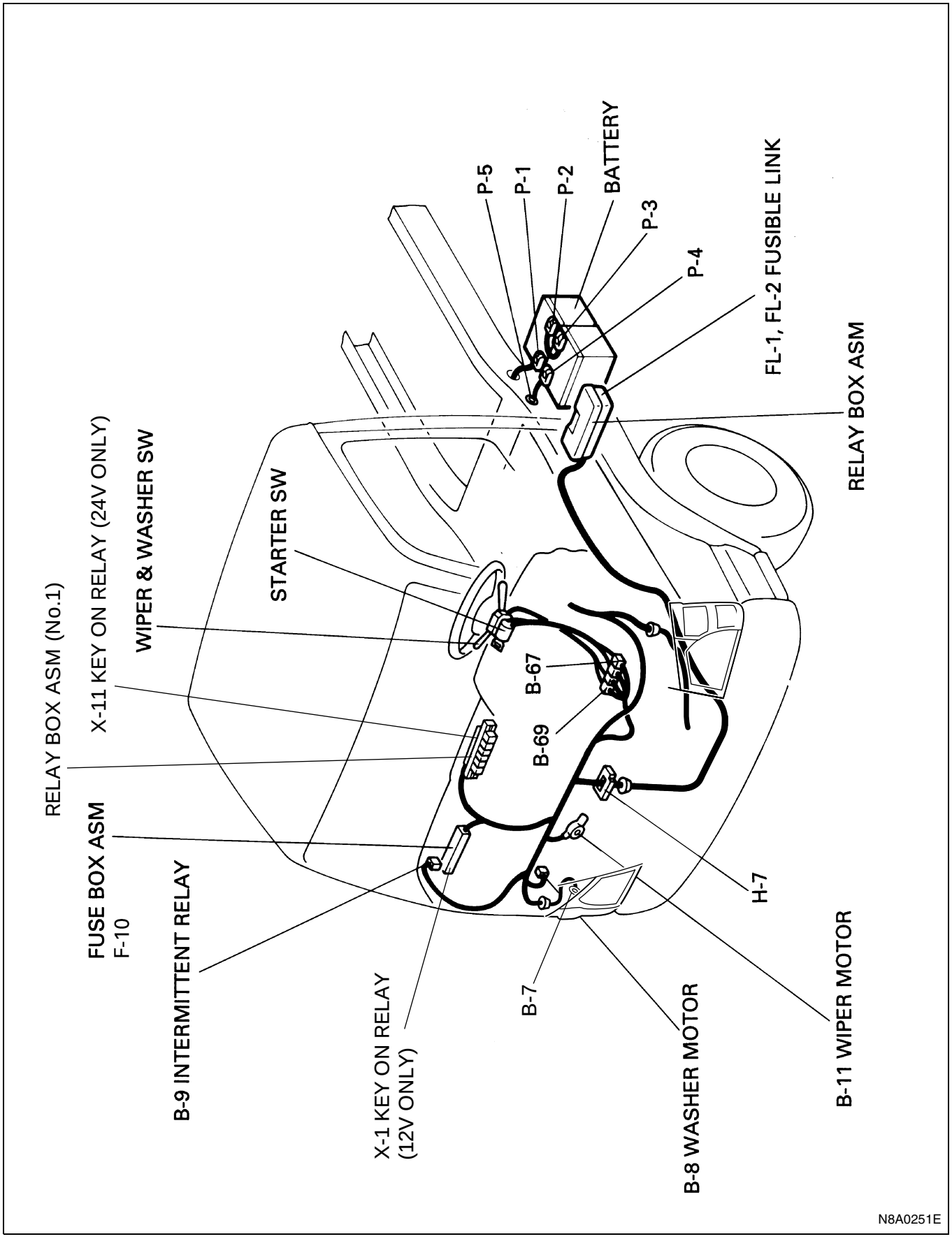
4. Wiper motor stops at auto-stop position



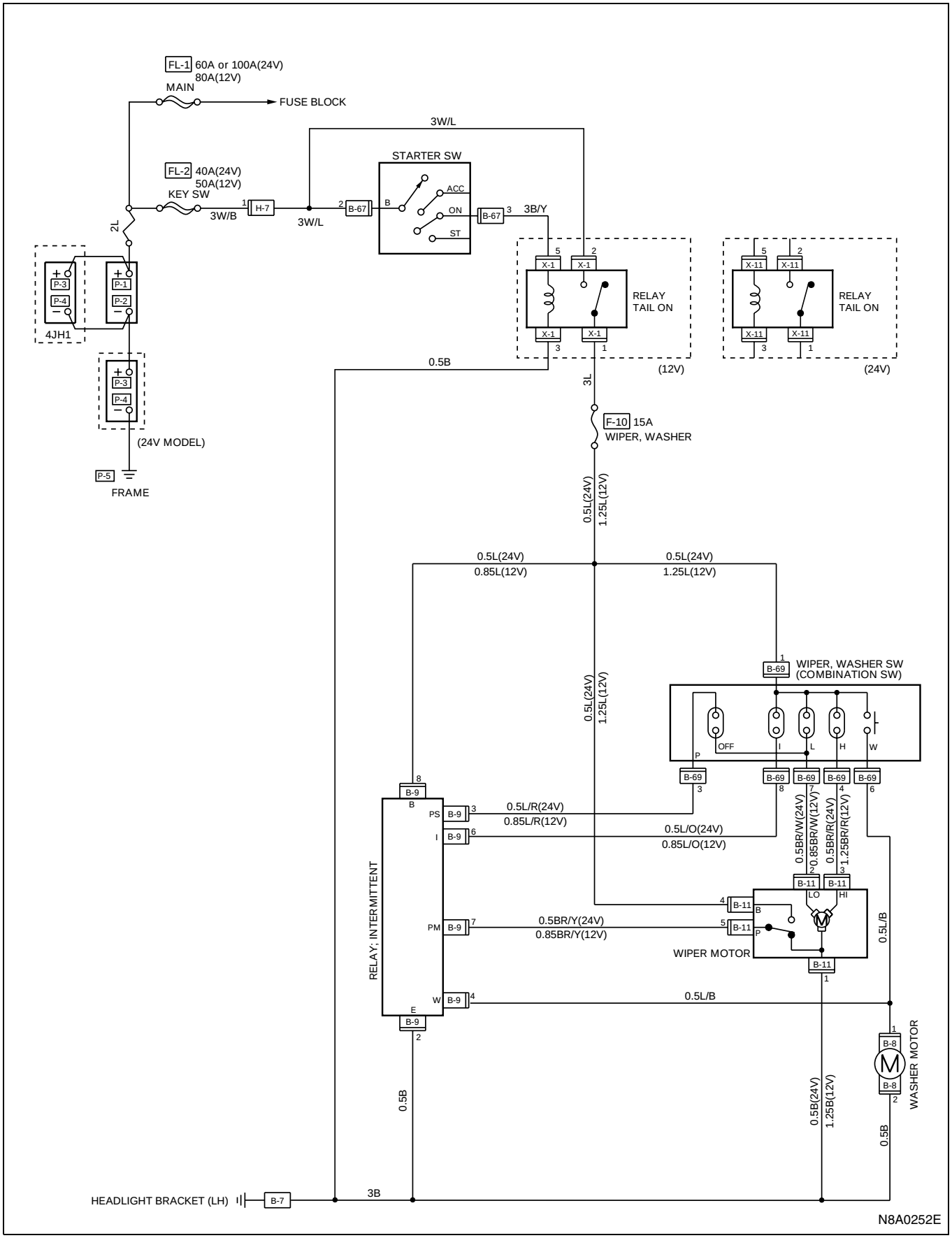
N8A0250E

Notice:
Arrow marks indicate the direction of current.

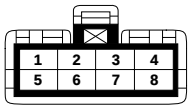
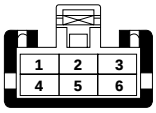
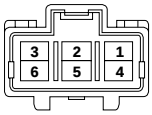
Parts Location



Circuit Diagram



Connector List

No.	Connector Face
B-8	002-009
B-9	 008-012
B-11	 006-001
B-11	 006-016
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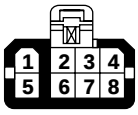
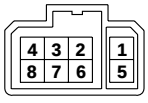
B-67	004-002
B-69	 008-001
B-69	 008-002

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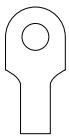
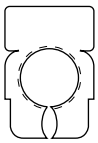
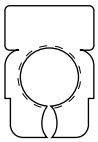
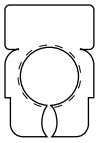
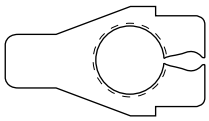
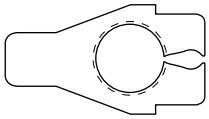
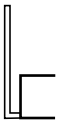
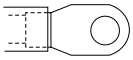
P-1 (12V)	 000-003
P-2	 000-004
P-1 (24V)	 000-004
P-4	 000-004
P-2 (24V)	 000-006
P-3	 000-006
P-5 (12V)	 000-007
P-5 (24V)	 000-002

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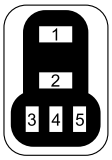
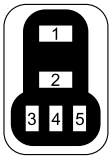
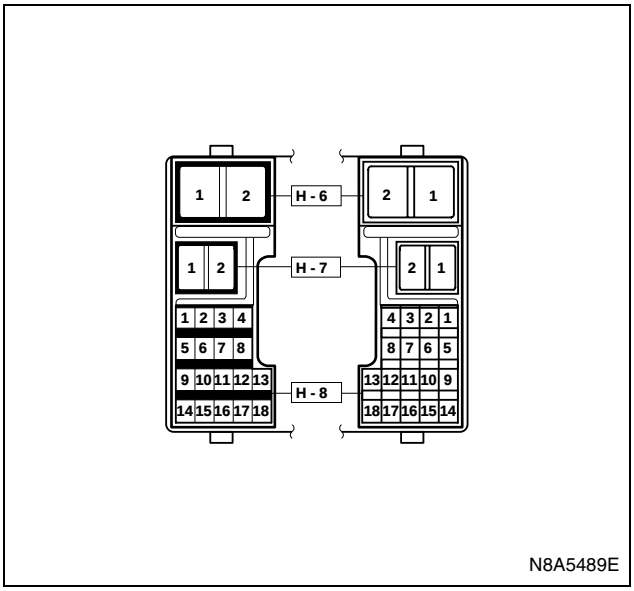
X-1	 005-006
X-11	 005-006

H-7



Diagnosis

Quick Chart for Check Point

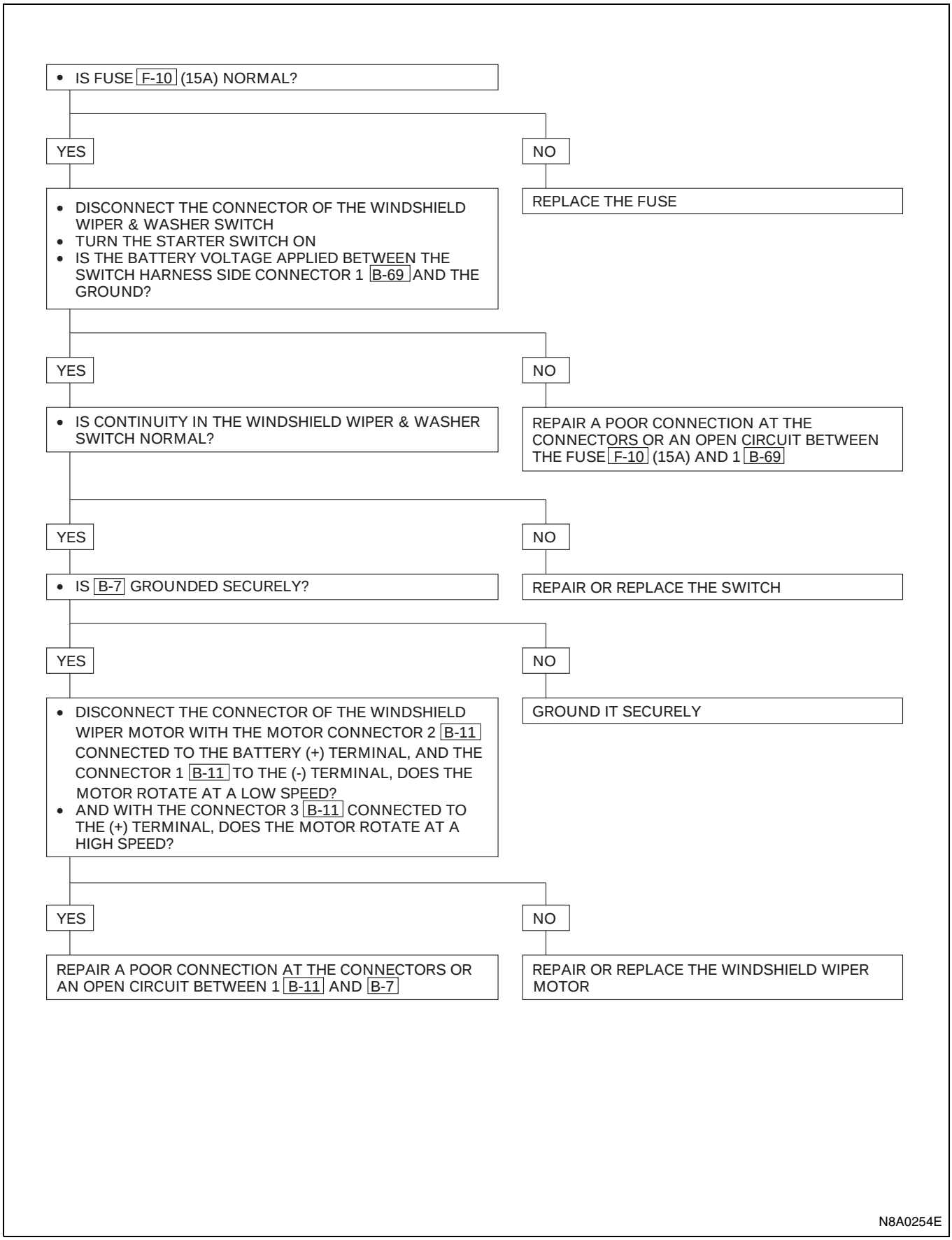
1. Windshield Wiper and Washer

		Check point					
		Fuse F-10 (15A)	Wiper& washer SW	Intermitt ent relay	Wiper motor	Washer motor	Cable harness
Trouble mode	1. Windshield wiper does not operate at any switch position	❍ (1)	❍ (3)		❍ (4)		❍ (2)
	2. Windshield wiper does not operate at “INT” position		❍ (1)	❍ (3)			❍ (2)
	3. Windshield wiper does not operate at “LO” position		❍ (1)		❍ (3)		❍ (2)
	4. Windshield wiper does not operate at “HI” position		❍ (1)		❍ (2)		❍ (3)
	5. Auto-stop function of the windshield wiper motor does not operate		❍ (1)	❍ (4)	❍ (2)		❍ (3)
	6. Rotation of the windshield wiper motor does not stop		❍ (1)		❍ (2)		
	7. Windshield washer motor does not operate		❍ (1)			❍ (3)	❍ (2)

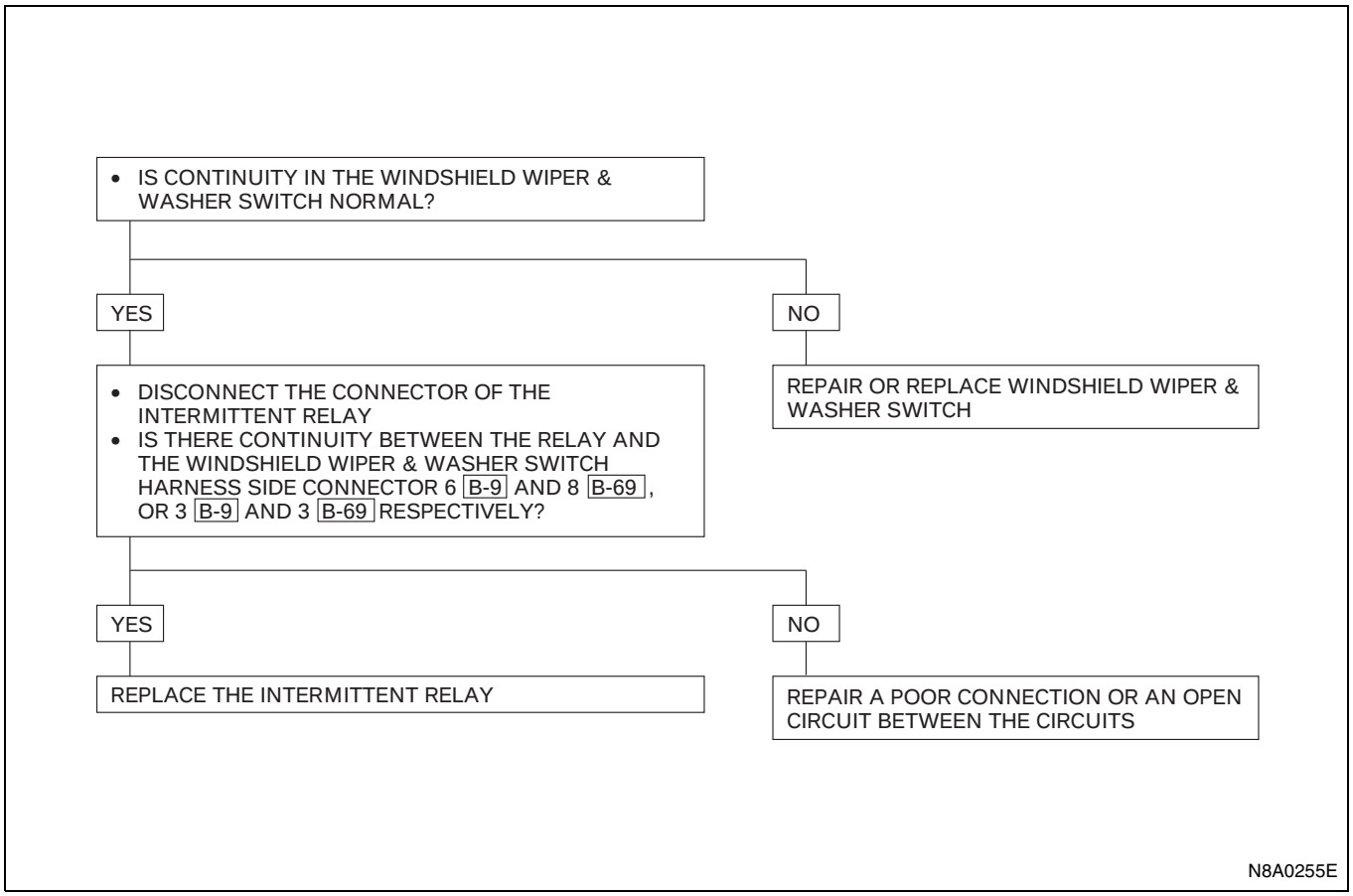
Notice:
Figure in parenthesis “( )” indicates the order of inspection.

1. Windshield Wiper and Washer

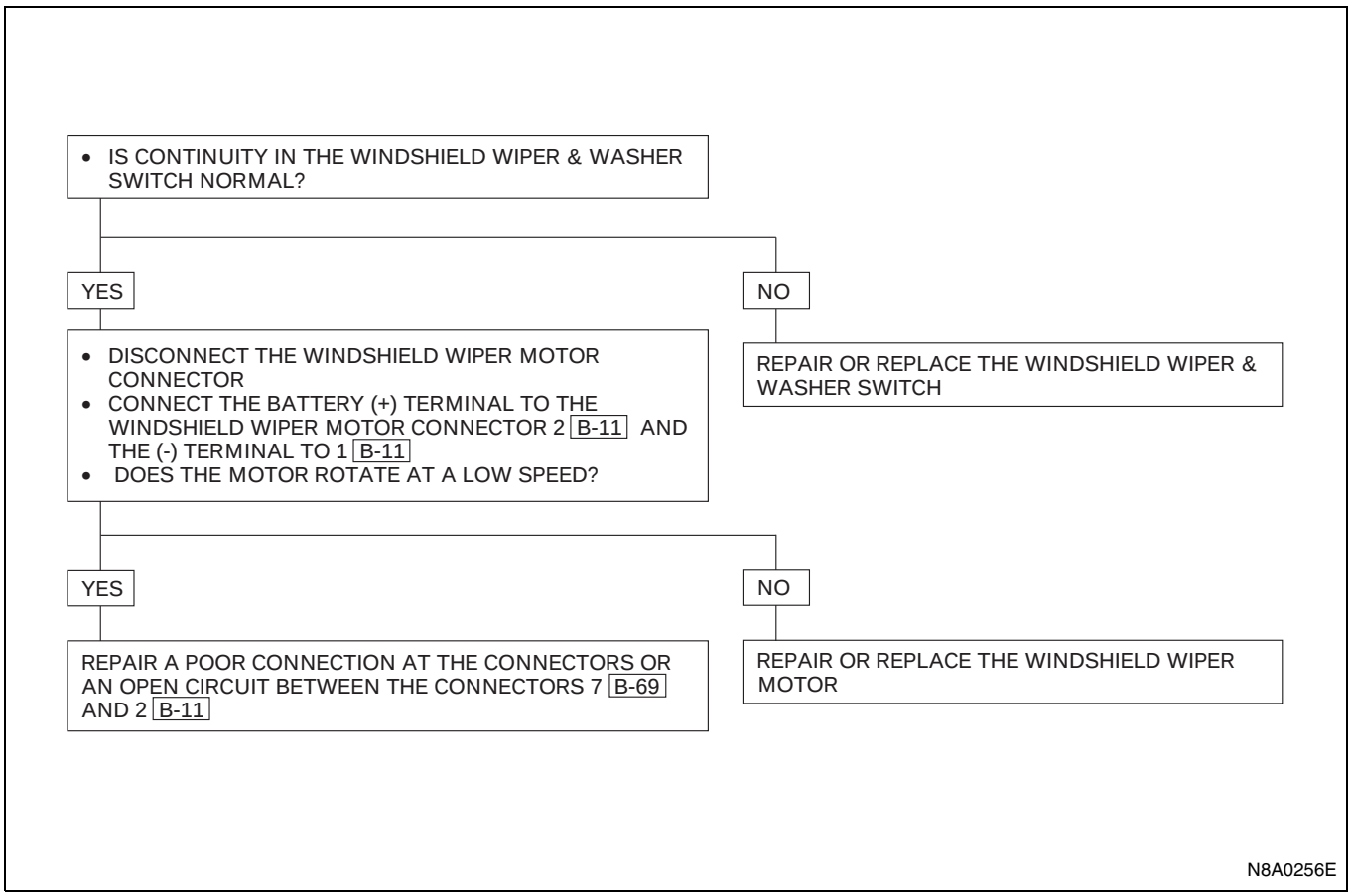
1-1. Windshield Wiper Does Not Operate at Any Switch Position



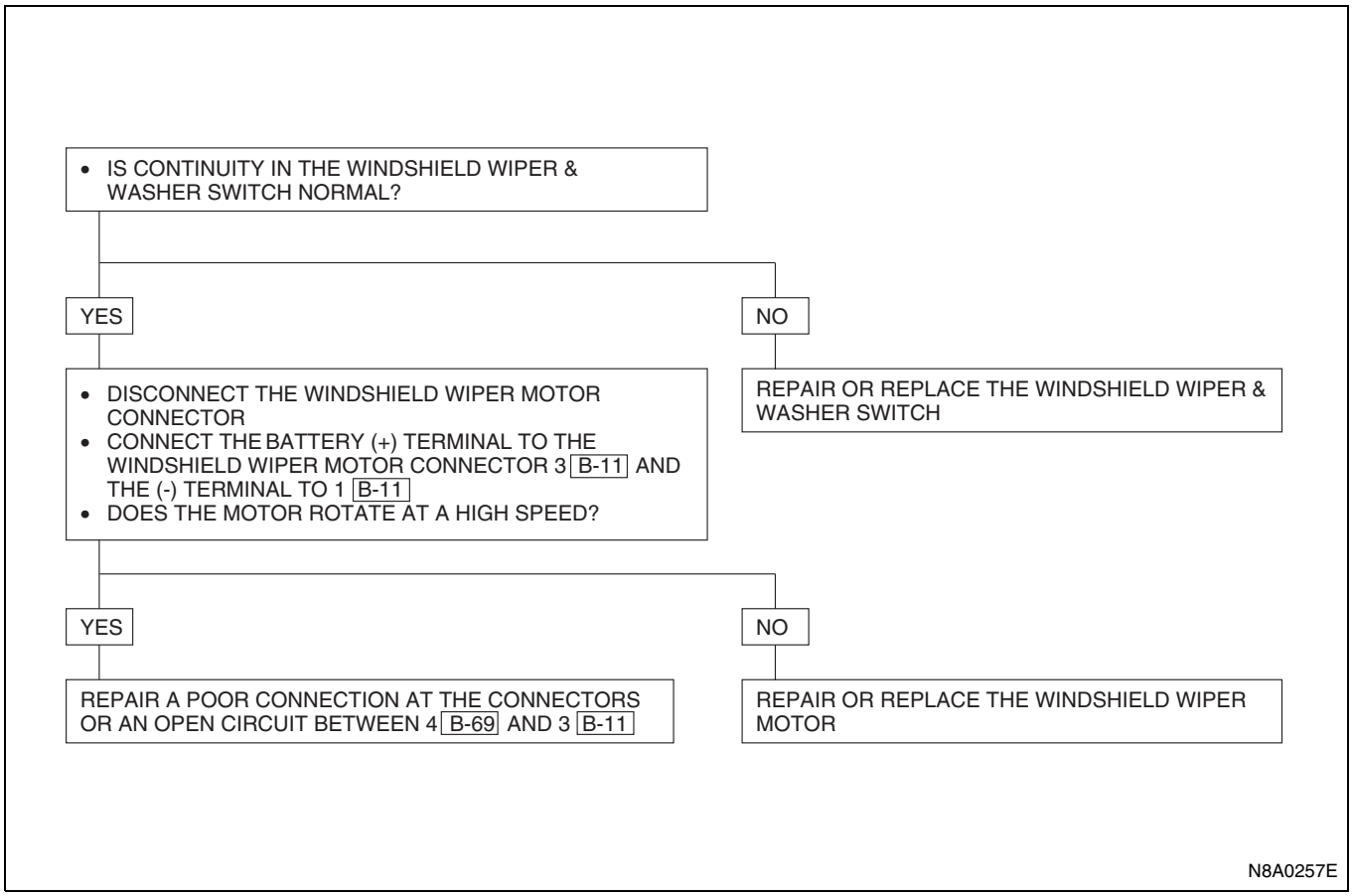
1-2. Windshield Wiper Does Not Operate at "INT" Position



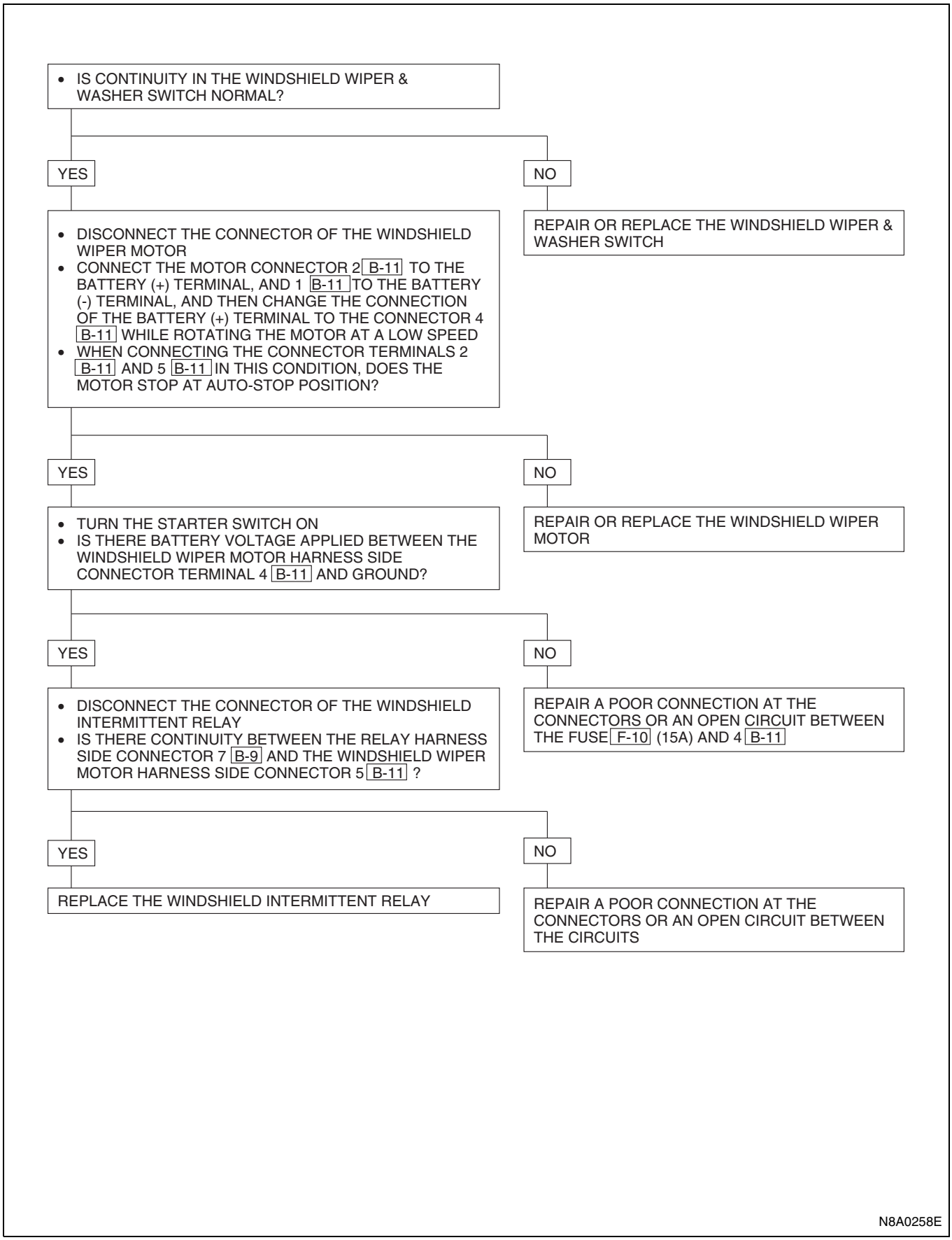
1-3. Windshield Wiper Does Not Operate at "LO" Position



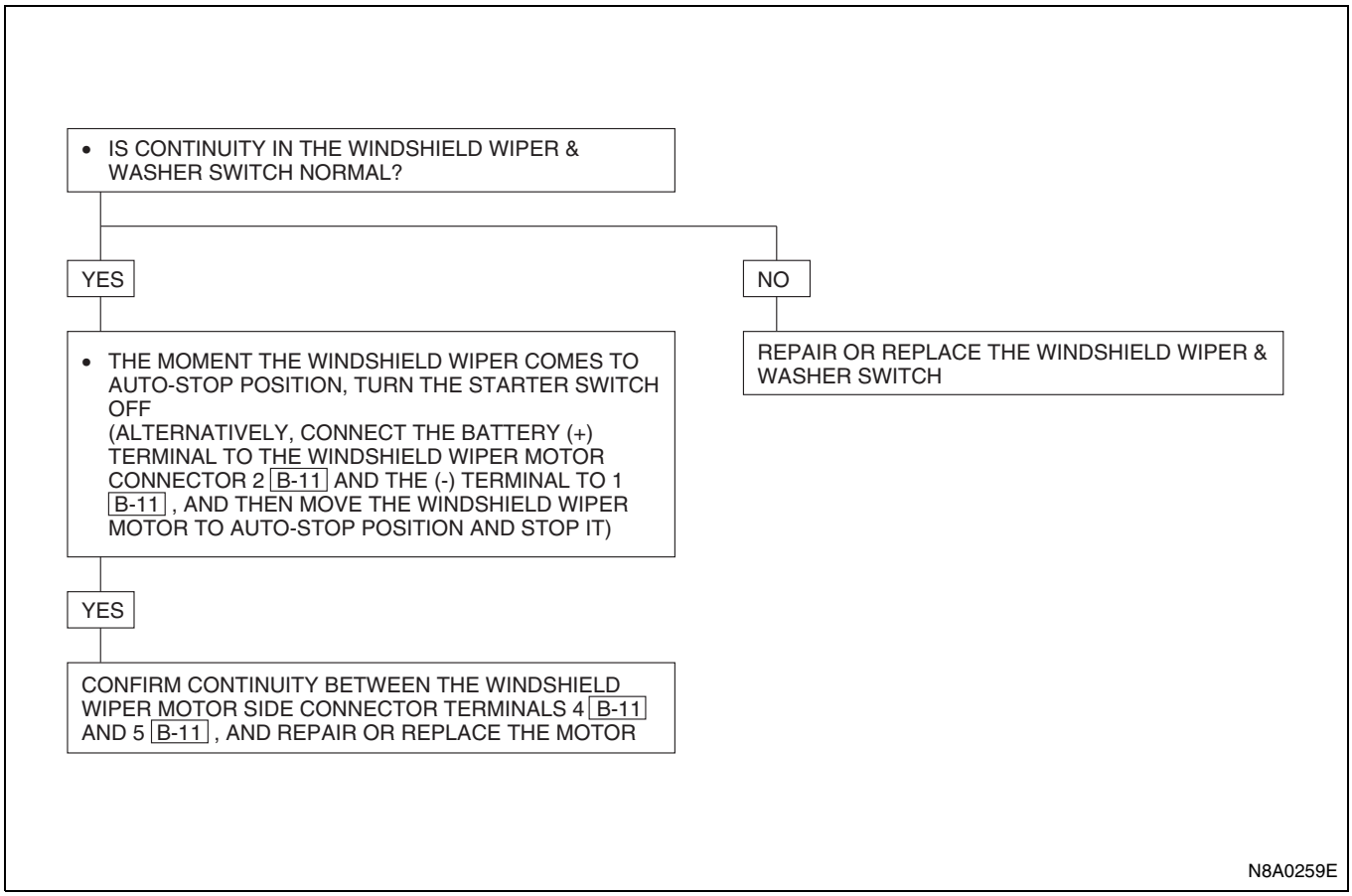
1-4. Windshield Wiper Does Not Operate at "HI" Position



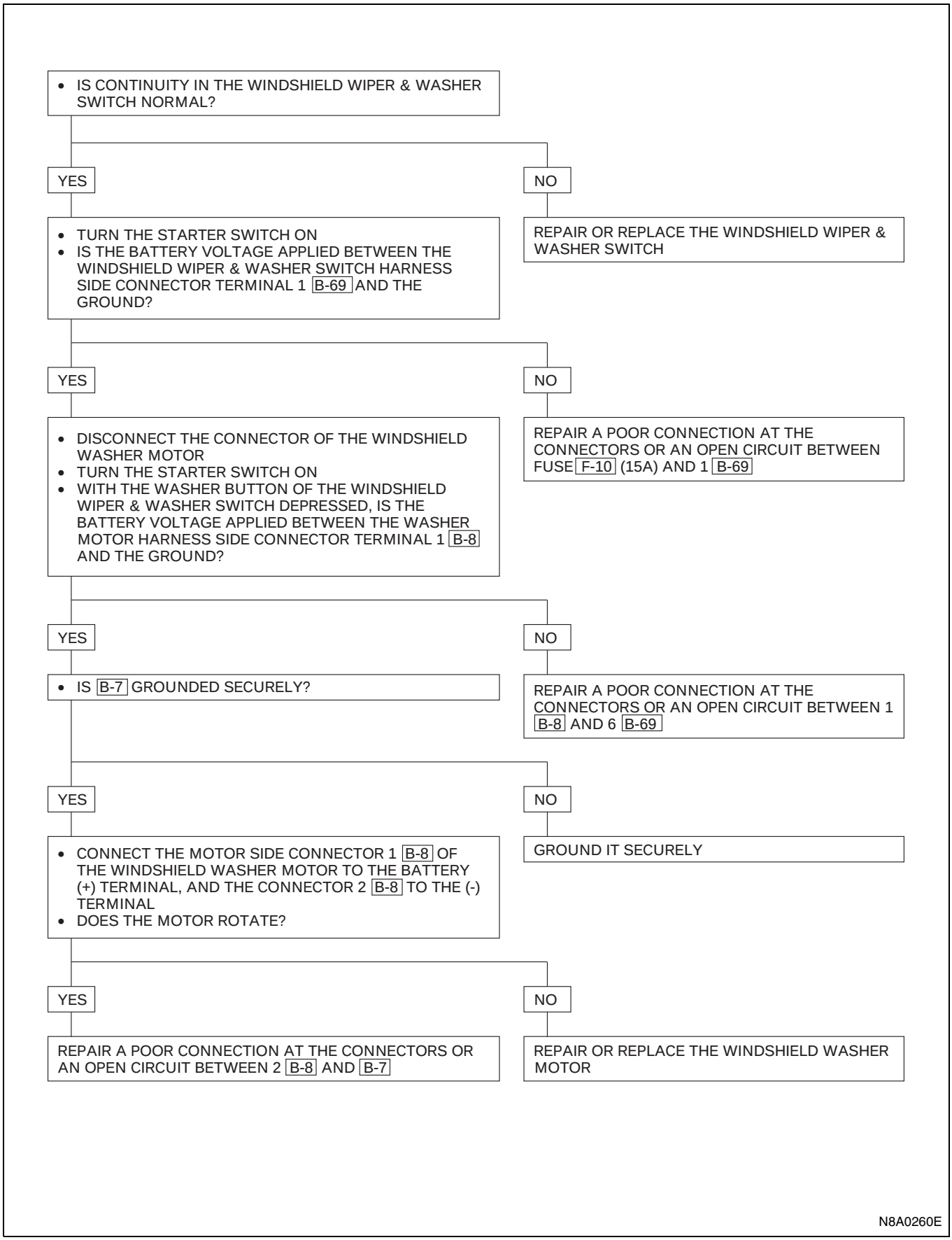
1-5. Auto-stop Function of the Windshield Wiper Motor Does Not Operate



1-6. Rotation of the Windshield Wiper Motor Does Not Stop



1-7. Windshield Washer Motor Does Not Operate

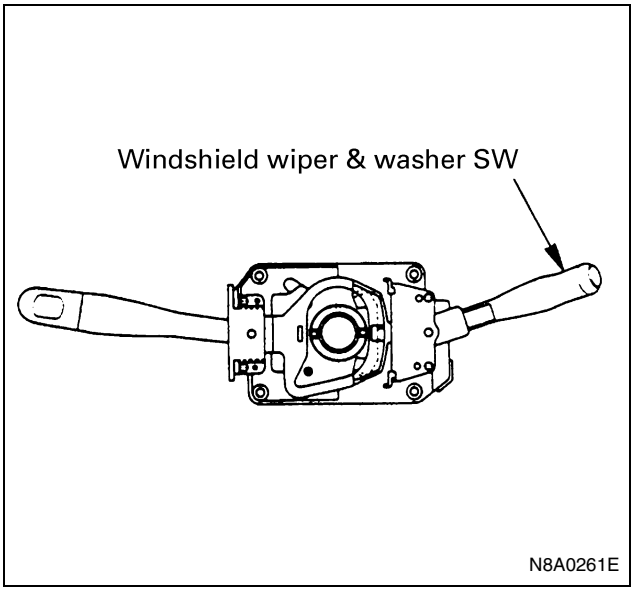


Starter Switch

Refer to “START AND CHARGING” in this section.

Windshield Wiper & Washer Switch

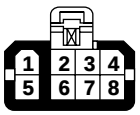
With the starter switch on, the windshield wiper and washer switch controls the start and stop operation as well as the change of operating speeds.
Both the windshield washer motor and the wiper motor jointly operate while the washer button is pushed.



Inspection

Check the continuity between the connector terminals of the switch.
Repair or replace the switch when the result of inspection is found abnormal.

B-69



Switch side

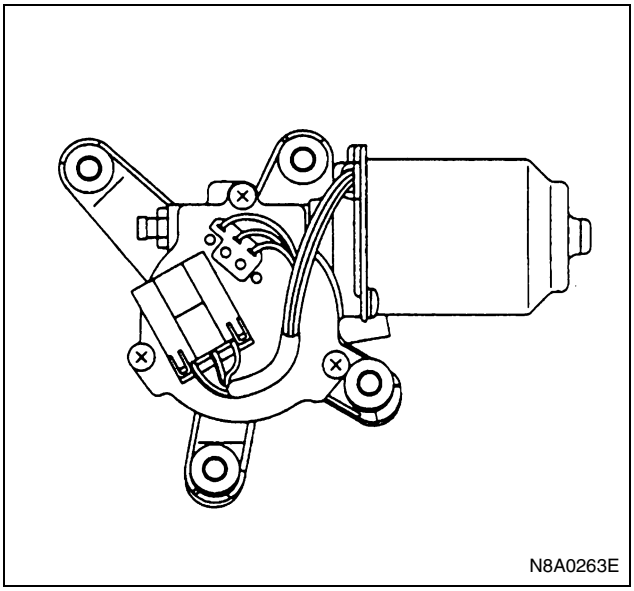
Washer SW	Wiper SW	Terminal No.					
		3	7	1	4	8	6
OFF	OFF	○	○				
	INT	○	○	○		○	
	LO		○	○			
	HI			○	○		
ON	MIST,OFF INT,LO,HI			○			○

N8A0262E

Removal and Inspection

Refer to “HEADLIGHT, FOG LIGHT AND CORNERING LIGHT” in this section.

Windshield Wiper Motor


N8A0263E

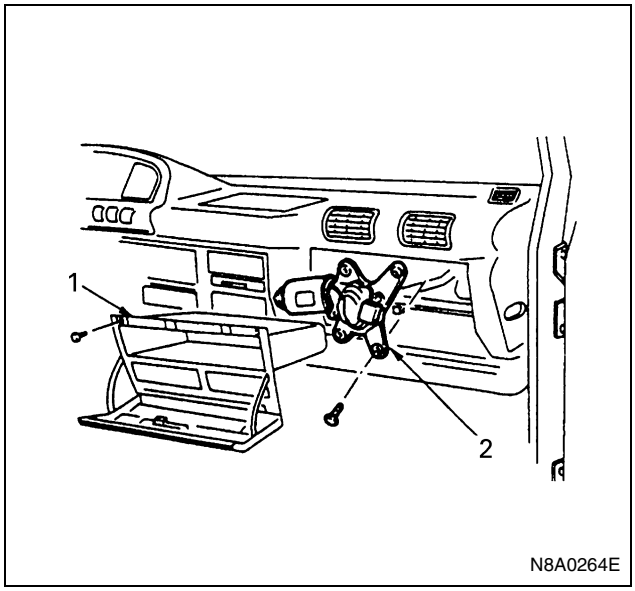
Inspection

1. Operation in low speed
   With the motor connector terminal 2 B-11 connected to the battery (+) terminal and the connector 1 B-11 to the (–) terminal, check to see if the motor rotates in low speed.
2. Operation in high speed
   With the motor connector terminal 3 B-11 connected to the battery (+) terminal and the connector 1 B-11 to the (–) terminal, check to see if the motor rotates in low speed.
3. Stop operation
   After stopping the windshield wiper in the position on the way by confirming the operation at the low speed in item No. 1.
   When the connectors 2 B-11 and 5 B-11 are connected, while connecting the motor connector terminal 4 B-11 to the battery (+) terminal, check to see, if the motor rotates at low speed and stops at the auto-stop position.
   Repair or replace the motor when the results of the above inspections are found abnormal.

Removal

Preparation:
Disconnect the battery ground cable.

1. Glove Box
   Refer to “INSTRUMENT PANEL” of section 2.
2. Windshield Wiper Motor
   1) Disconnect the connector.
   2) Remove four screws.
   3) Remove the ball joint between crank arm and wiper link.



N8A0264E

Installation

To install, follow the removal steps in the reverse order, noting the following points.

- Windshield Wiper Motor
  When the crank arm is removed from the windshield wiper motor, tighten the motor shaft nut with the specified torque.

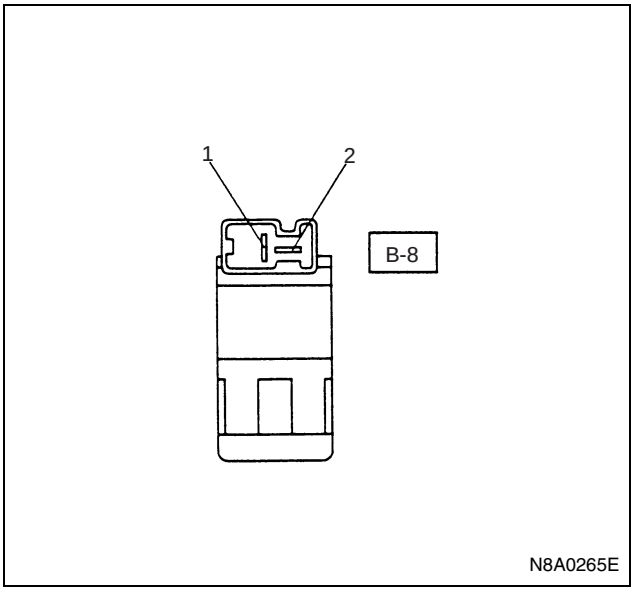
Tighten:
Shaft nut to 17 N·m (170 kg·cm/147 lb·in)

- Temporarily fit the motor by using one of the four wiper motor fixing screws.
- Put the crank arm ball joint in the wiper link hole and fix them together while pulling the wiper link.

Windshield Washer Motor

Inspection

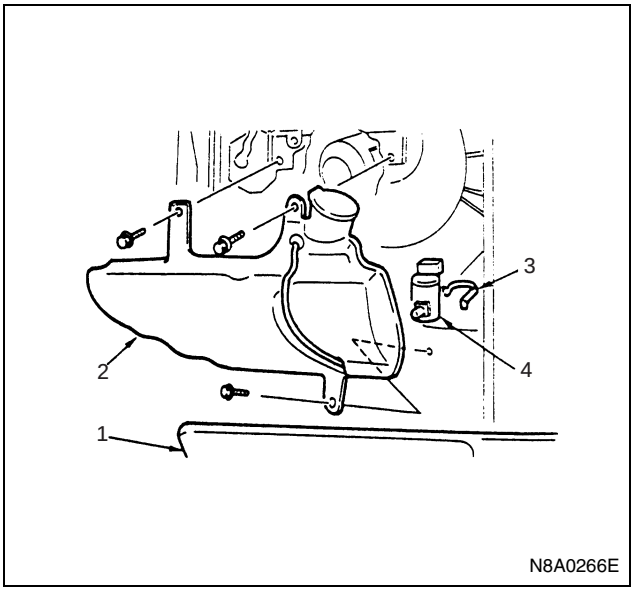
With the battery (+) terminal connected to the washer motor connector terminal 1 B-8 and the (−) terminal to the connector 2 B-8, check to see if the cleaning fluid pushes out.
Replace the tank/motor when the result of inspection is found abnormal.



Removal

Preparation:
Disconnect the battery ground cable.

1. Instrument Panel Under Cover
   Refer to “INSTRUMENT PANEL” of section 2.
2. Washer Tank
   1) Disconnect the washer motor connector.
   2) Disconnect the washer hose.
   3) Remove three fixing screws.
3. Clip Band
4. Windshield Washer Motor
   Hold the motor and pull it out from the washer tank.

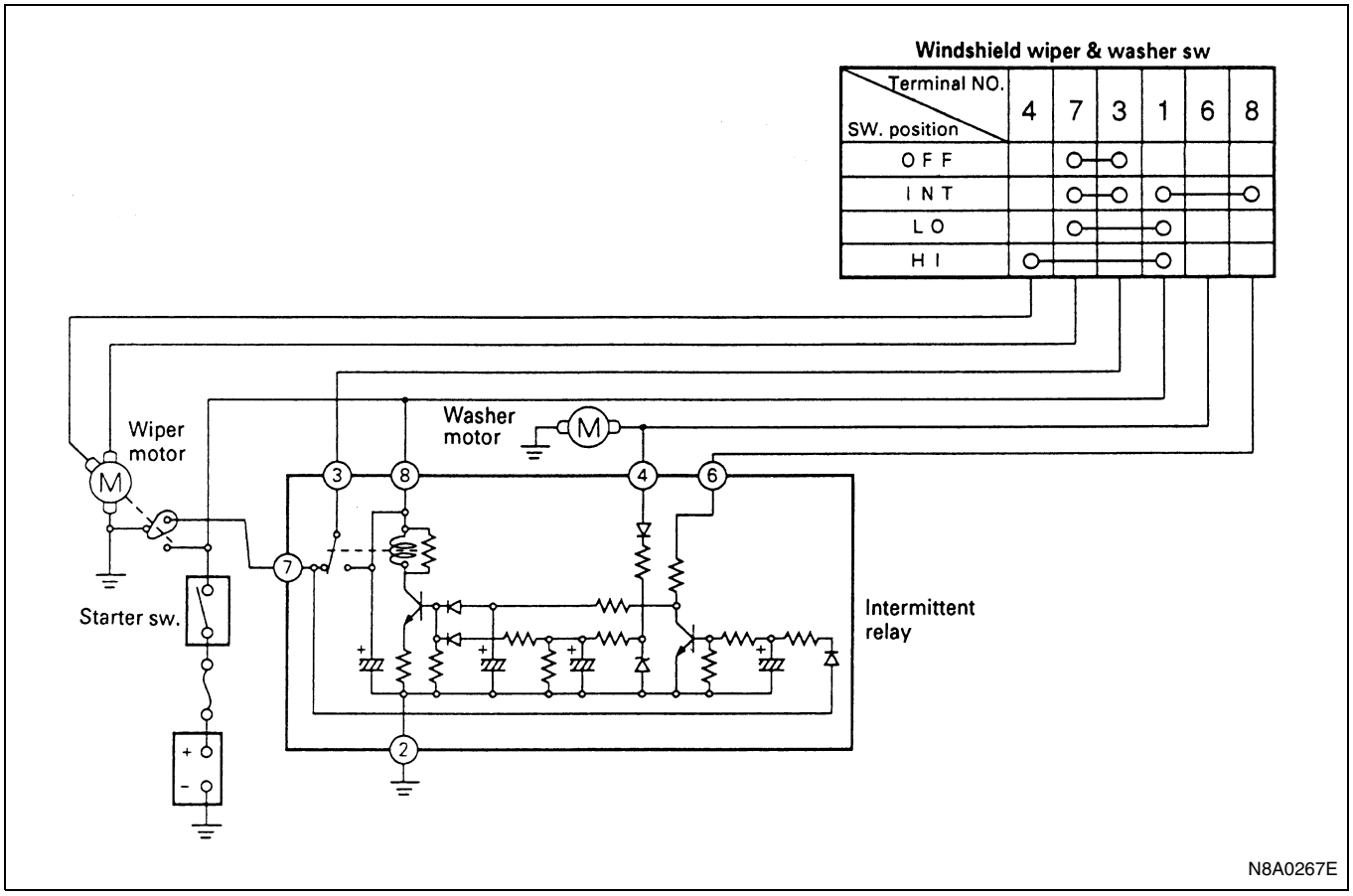


Installation

To install, follow the removal steps in the reverse order.

Intermittent Relay

Circuit Diagram

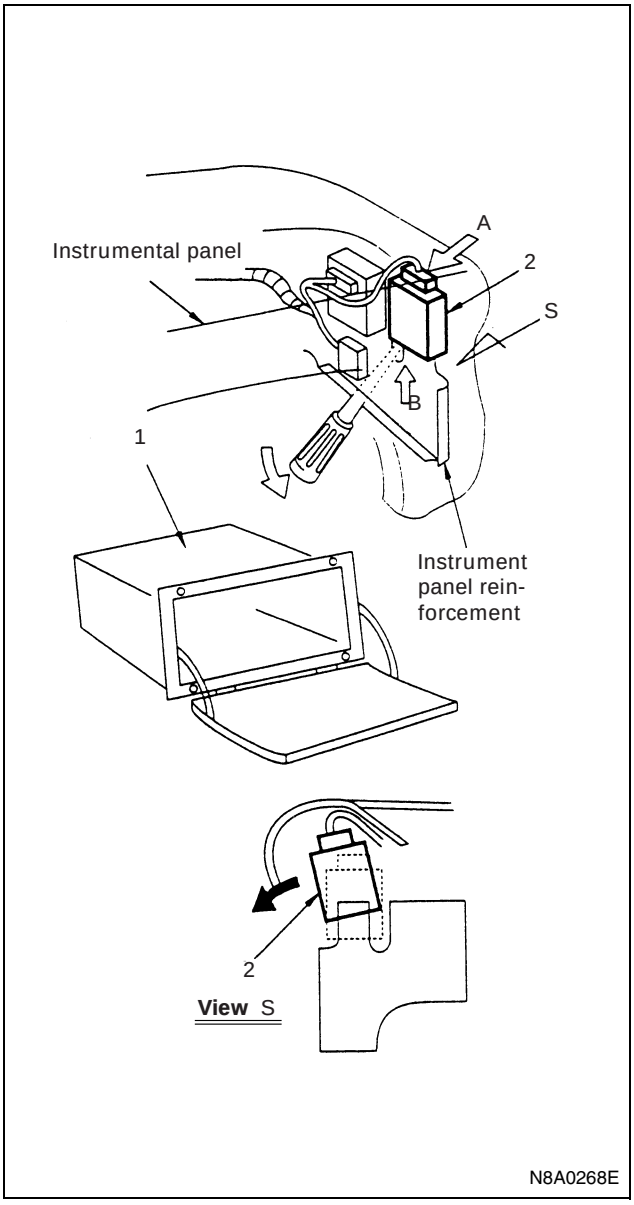


Removal

Preparation:

Disconnect the battery ground cable.

1. Glove Box
   Open the lid and remove the four screws.
2. Intermittent Relay
   1) Press A position with your finger and pry up B position with the tip of a screw-driver.
   2) When the relay moves up by about 2/3 of its size, tilt and take off the relay to avoid interference with the instrument panel.
   3) Disconnect the connector.



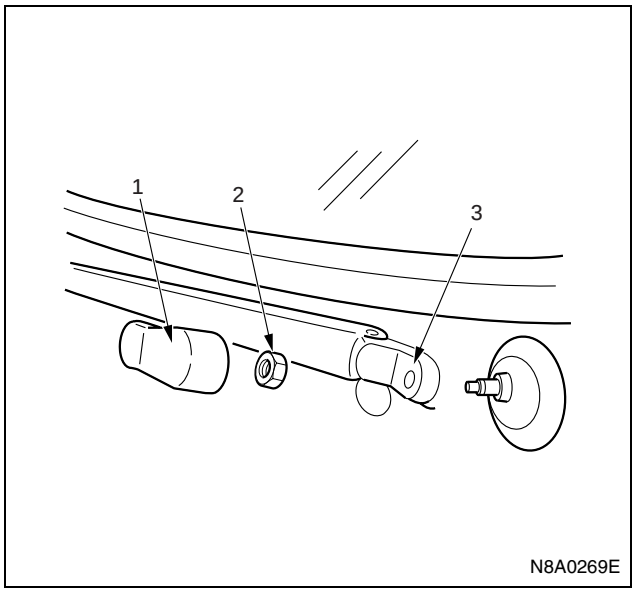
Installation

To install, follow the removal steps in the reverse order.

Windshield Wiper Arm & Blade

Removal

1. Cover
2. Wiper Arm Nut
3. Wiper Arm & Blade



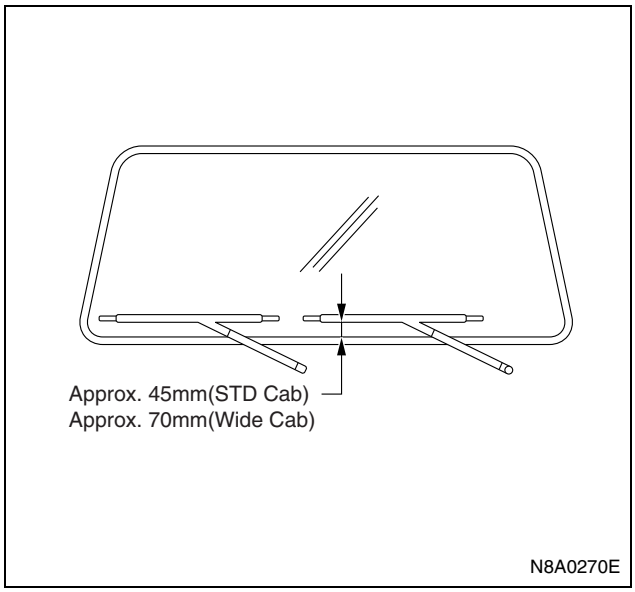
Installation

To install, follow the removal steps in the reverse order, noting the following points.

1. Before installing the wiper arm & blade to the shaft, confirm that the motor stops at the auto-stop position.
2. Set the wiper arm & blade so that the tips of both blades are positioned as shown in the illustration.
3. Tighten the wiper arm nut to the specified torque.

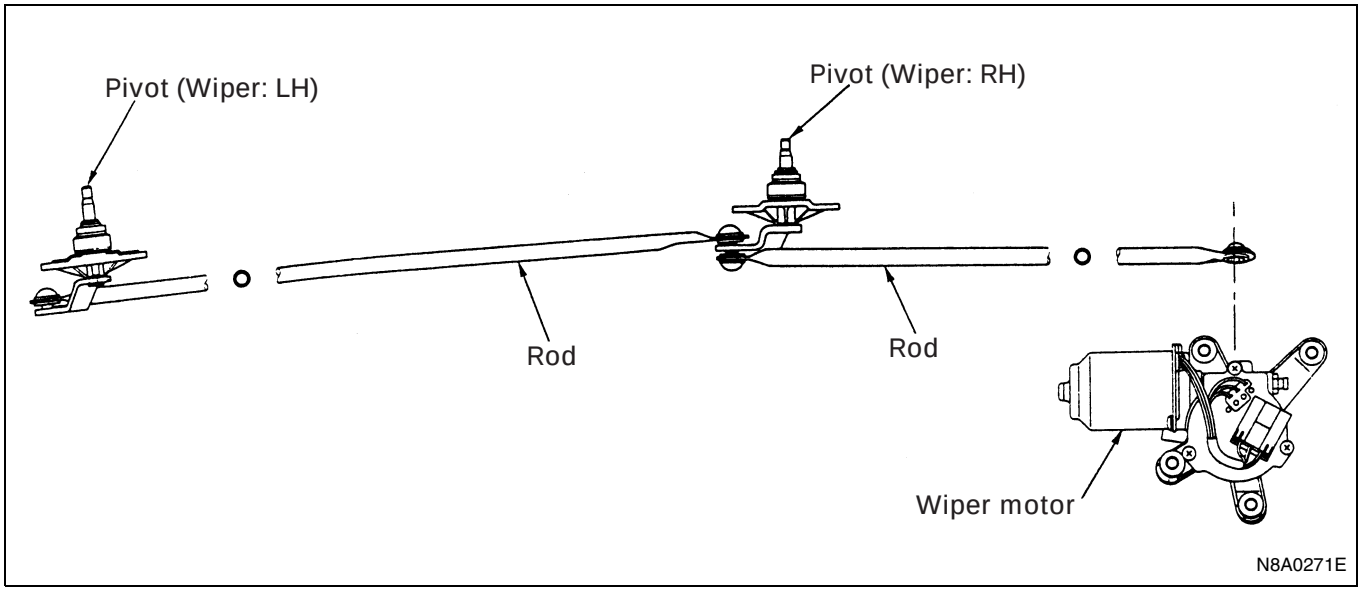
Tighten:

Wiper arm nut to 17 N·m (170 kg·cm/147 lb·in)



Windshield Wiper Linkage

Location of Rod and Pivot

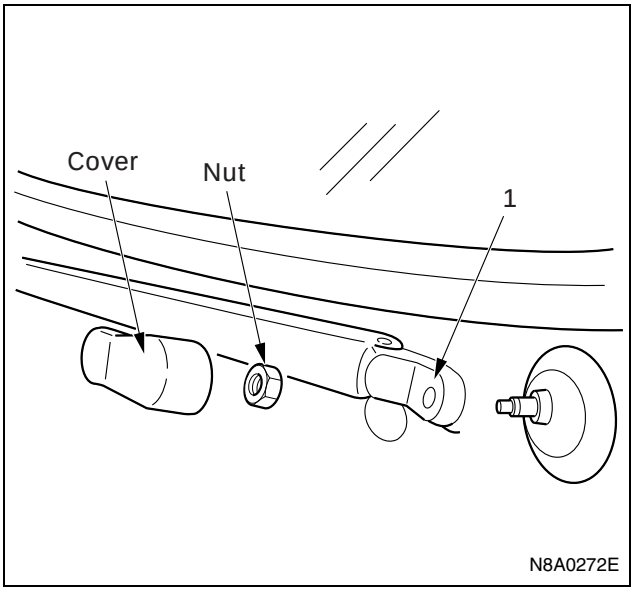


Removal

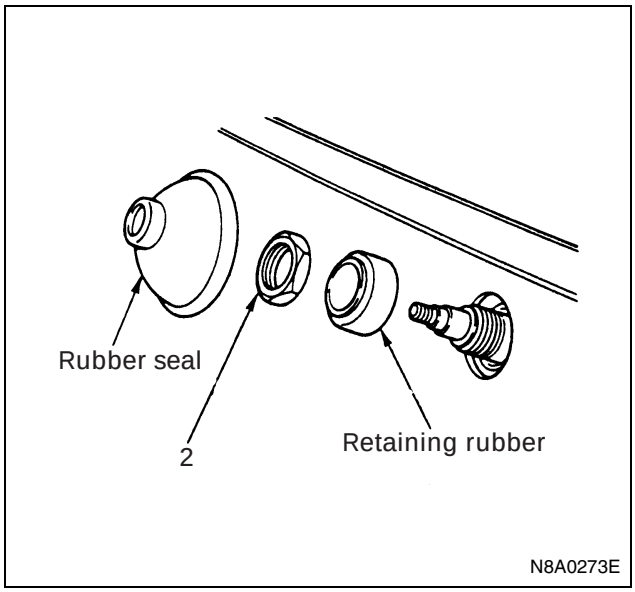
Preparation:

Disconnect the battery ground cable.

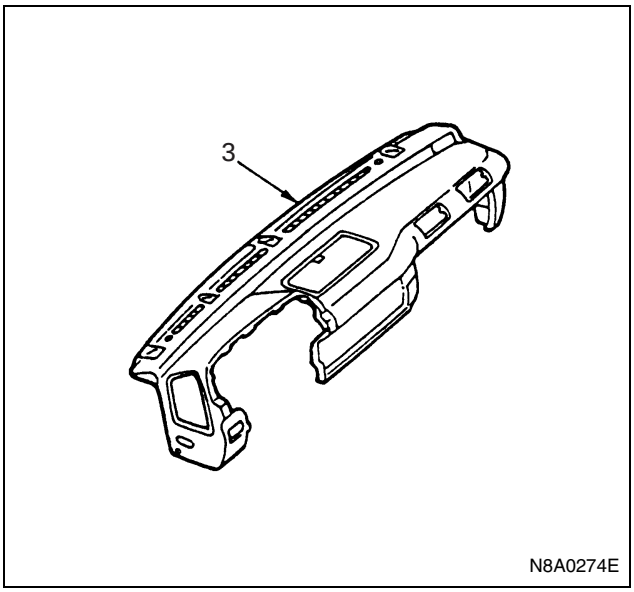
1. Wiper Arm & Blade
   Remove the cover, nut and wiper arm & blade.



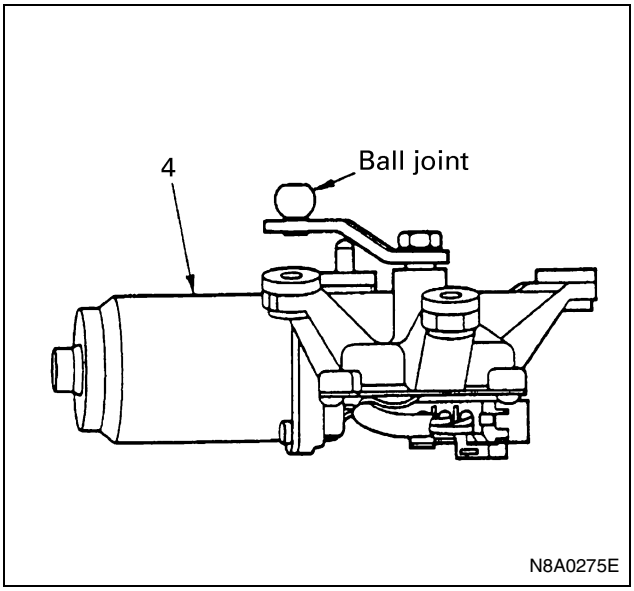
2. Pivot Nut
   Remove the rubber seal, nut and retaining rubber.



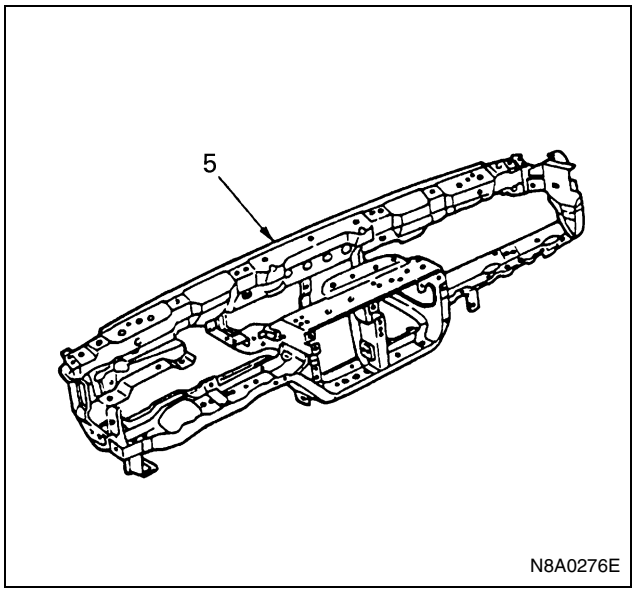
3. Instrument Panel Assembly
   Refer to “INSTRUMENT PANEL” of section 2.



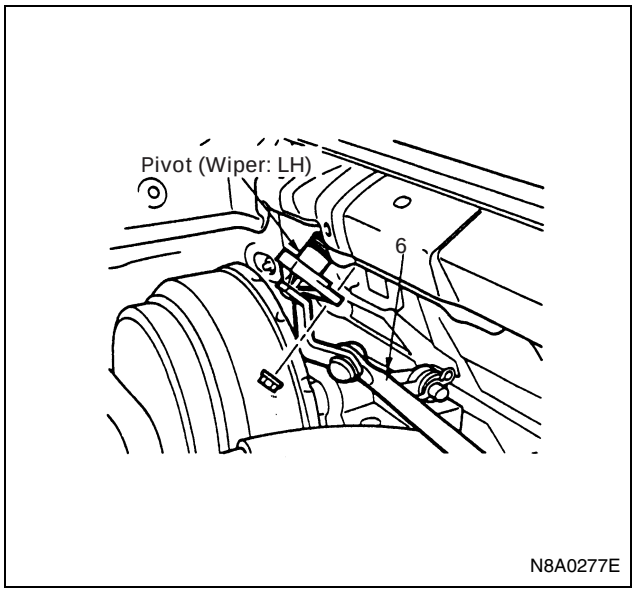
4. Wiper Motor
   1) Remove the four screws.
   2) Disconnect the ball joint between the crank arm and the wiper link.



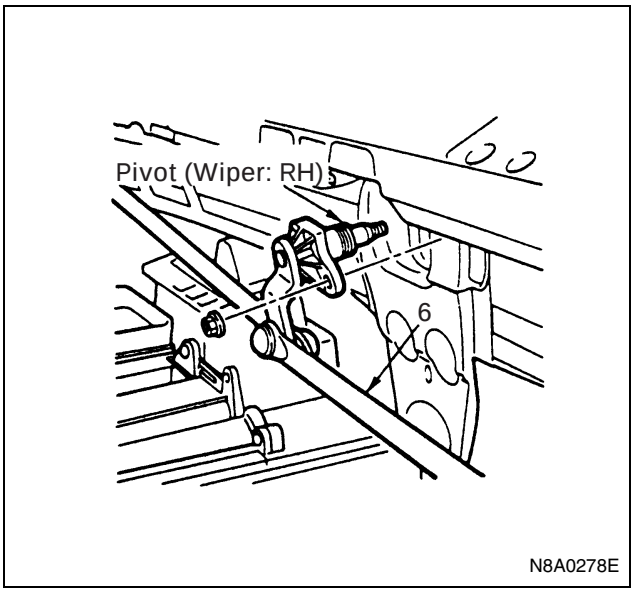
5. Instrument Panel Reinforcement
   Refer to “INSTRUMENT PANEL” of section 2.



6. Wiper Link Assembly
   Remove two retaining nuts from left hand side of pivot.



Remove two retaining nuts from right hand side of pivot.



Installation

To install, follow the removal steps in the reverse order, noting the following points.

- Temporarily fit the wiper motor by using one of the four wiper motor fixing screws.
- Put the crank arm ball joint in the wiper link hole and fix them together while pulling the wiper link.
- Fit the motor with four screws.
- Tighten the pivot nut with the specified torque.

Tighten:

Pivot nut to 8 N·m (80 kg·cm/70 lb·in)

- Tighten the wiper arm nut with the specified torque.

Tighten:

Wiper arm nut to 17 N·m (170 kg·cm/147 lb·in)

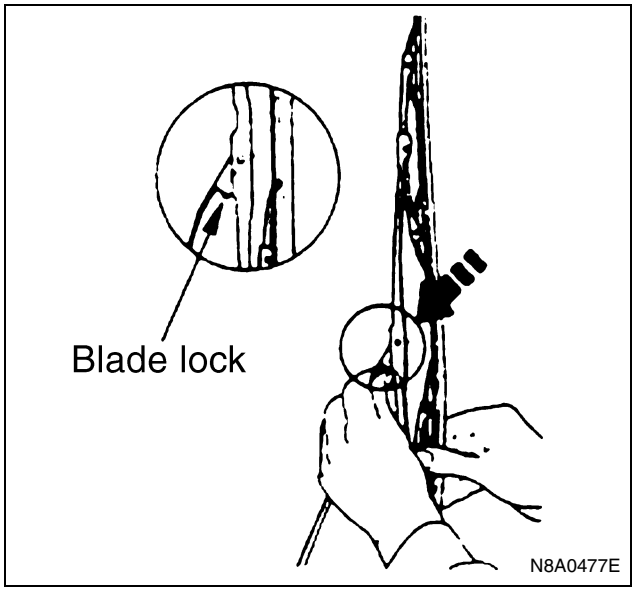
Wiper Blade Rubber

Removal

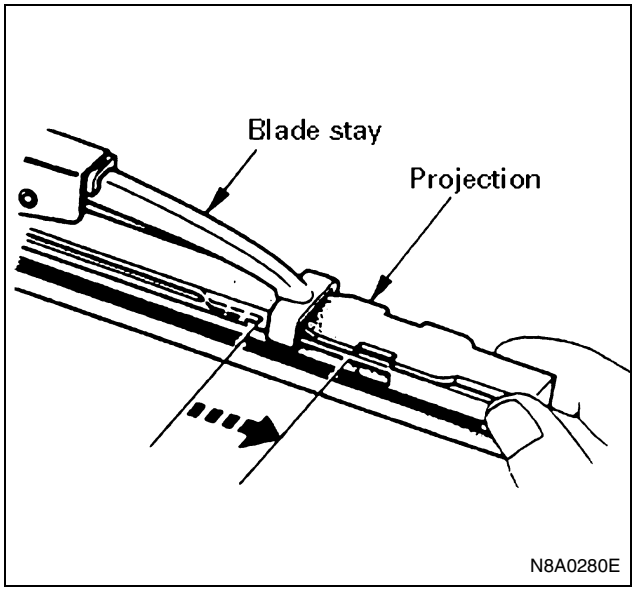
1. Wiper Blade
   Push the wiper blade lock while pulling the wiper blade in the arrow direction.

Notice:

When the wiper blade has been removed, wrap the tip of the wiper arm with cloth, to avoid damaging the glass.

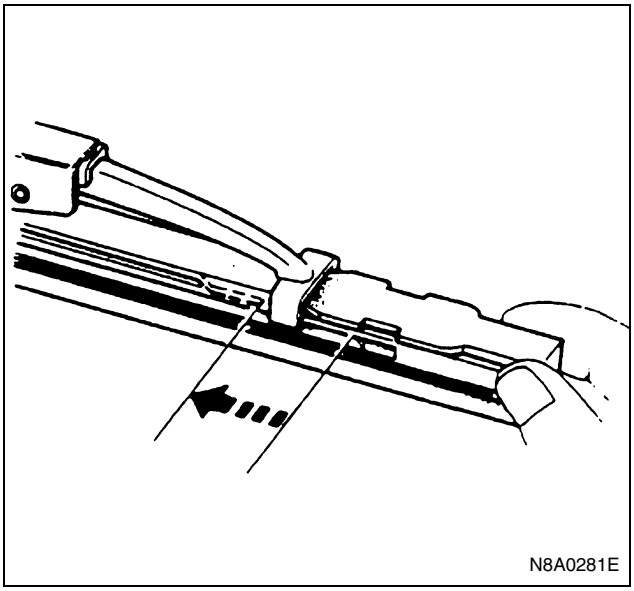


2. Wiper Blade Rubber
   1) Pull the end of rubber and remove the projection from the click of the blade stay.
   2) Pull the rubber out in the same direction.

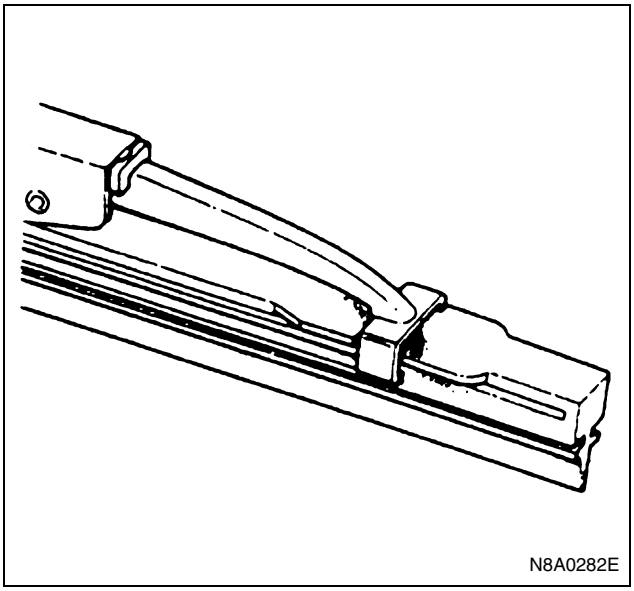


Installation

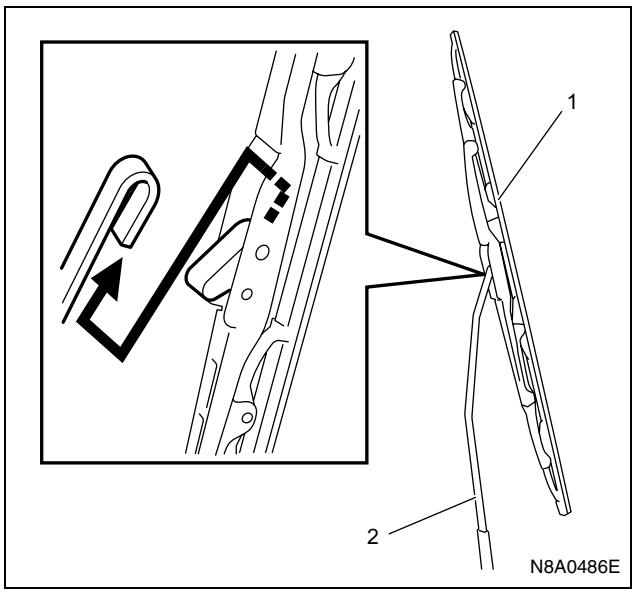
1. Wiper Blade Rubber
   Install the click of the blade stay in the groove of the new rubber and slide it in. Complete installation by pushing the click.


N8A0281E

   Finally, check that the click of the stay has caught in the hole of the rubber.


N8A0282E

2. Wiper Blade
   Push the lock of wiper blade (1) into the retentive portion on the tip of wiper arm (2).

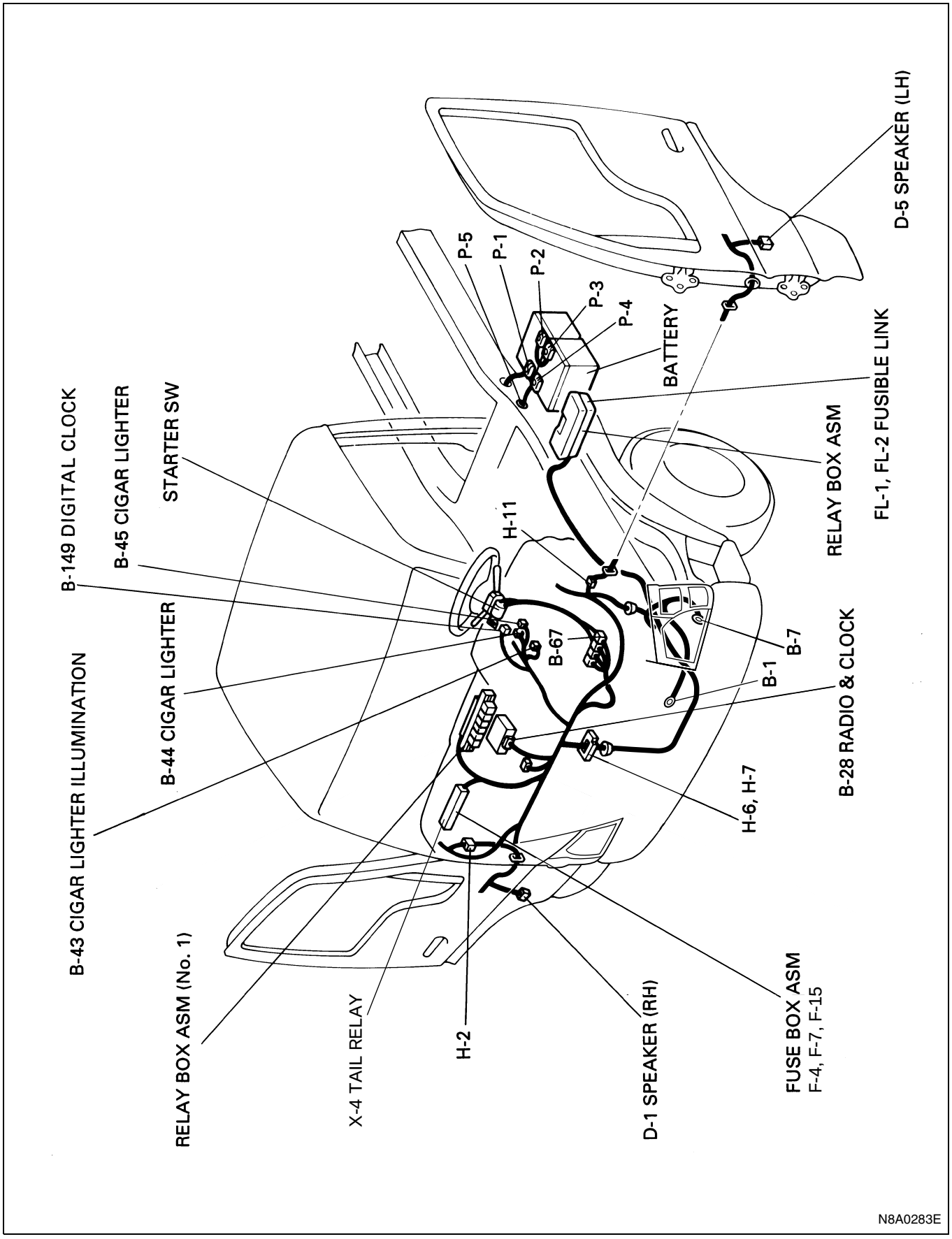


Audio and Cigar Lighter

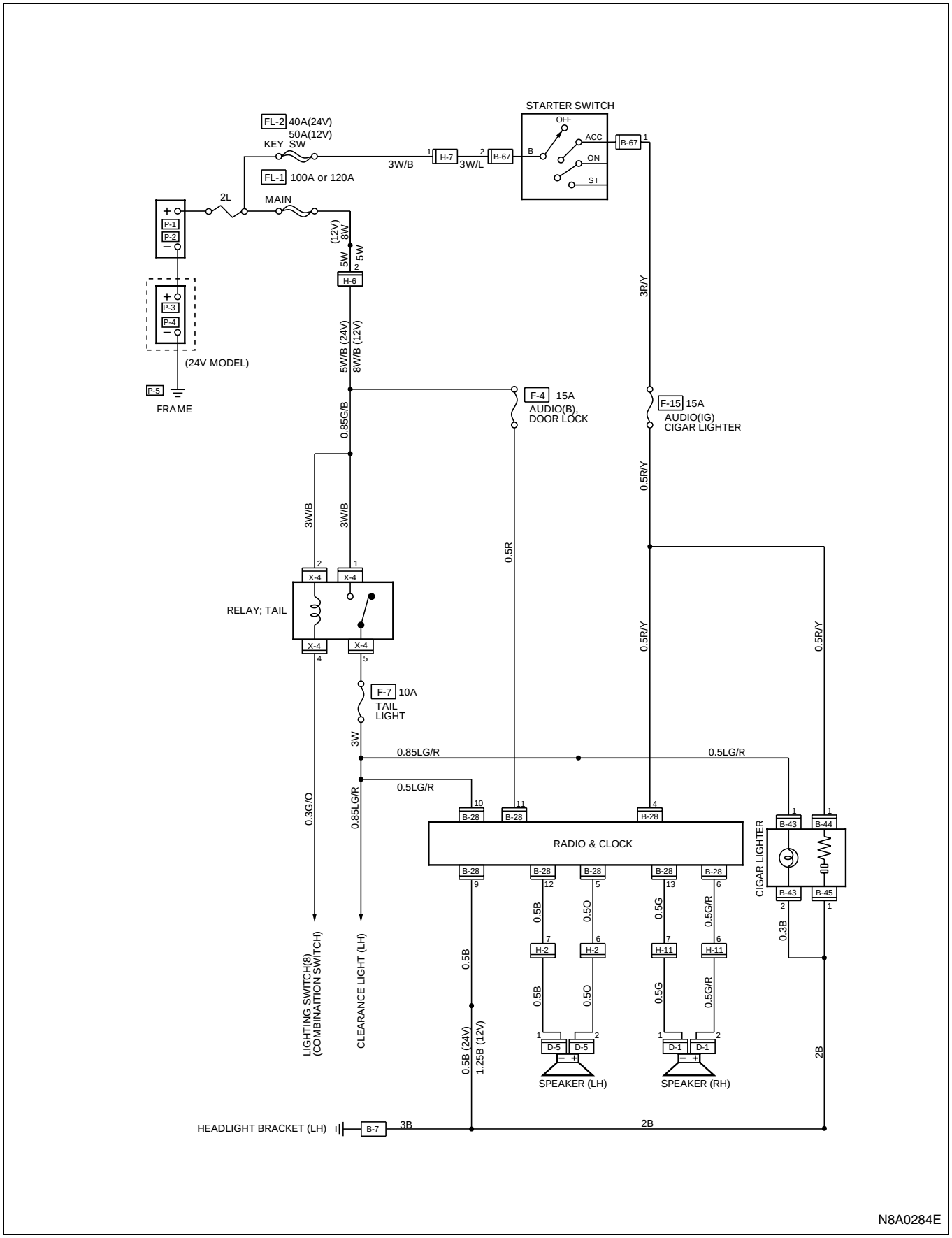
General Description

The circuit consists of the starter switch, radio, cigar lighter and the relay.
The audio circuit is designed for the current to flow through the receiver circuit when the radio switch is turned on with the starter switch in “ACC” or “ON”. Current runs through the memory circuit of the audio regardless of the position of the starter switch.
When the cigar lighter is pushed in with the starter switch at either “ACC” or “ON” position, a circuit is formed in the cigar lighter case to heat the lighter coil. The cigar lighter is spring back to its original position after the lighter coil is heated.

Parts Location



Circuit Diagram



N8A0284E

Connector List

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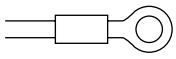
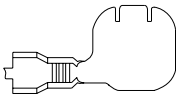
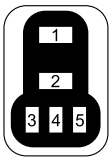
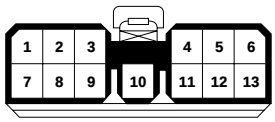
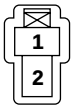
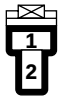
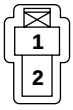
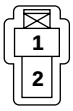
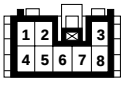
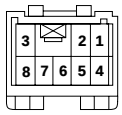
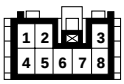
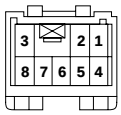
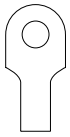
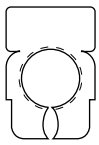
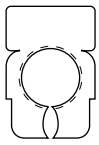
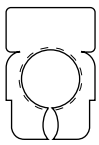
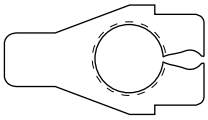
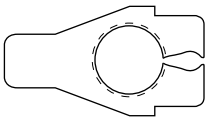
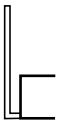
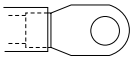
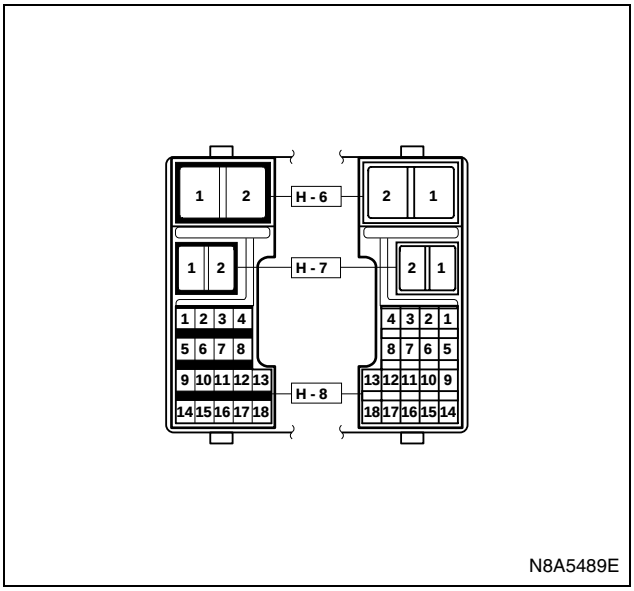
B-1	 000-001
B-7	 000-012
X-4	 005-006
B-28	 013-001
B-43	002-009
B-43	 002-010
D-5	 002-009
D-5	 002-010

No.	Connector Face
D-1	002-009
D-1	 002-010
B-44	001-011
B-45	001-009
B-67	004-001
B-67	004-002
H-2	 008-009
H-2	 008-010

No.	Connector Face
H-11	 008-009
H-11	 008-010
P-1 (12V)	 000-003
P-2	 000-004
P-1 (24V)	 000-004
P-4	 000-004
P-2 (24V)	 000-006
P-3	 000-006

No.	Connector Face
P-5 (12V)	 000-007
P-5 (24V)	 000-002

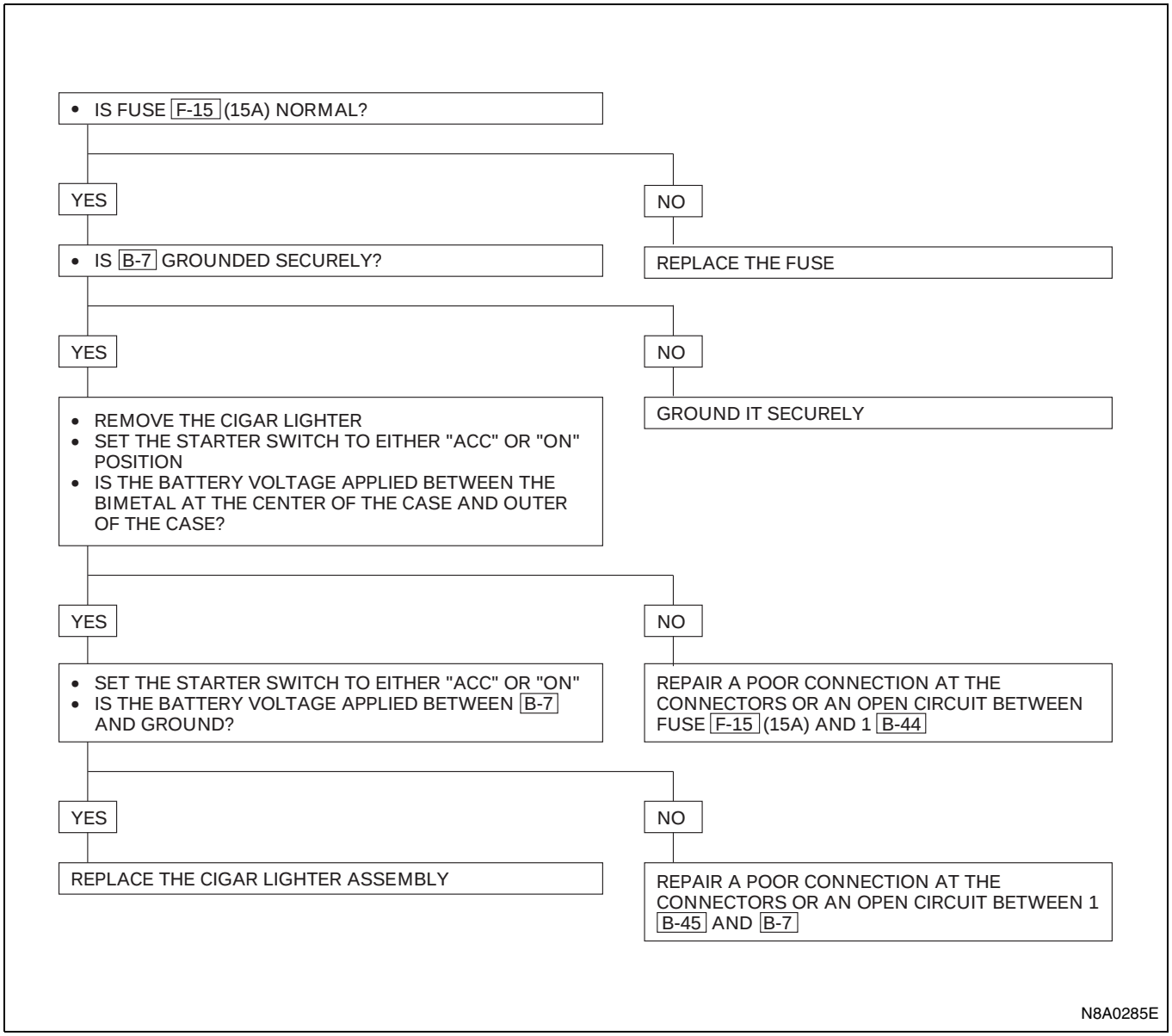
H-6, H-7



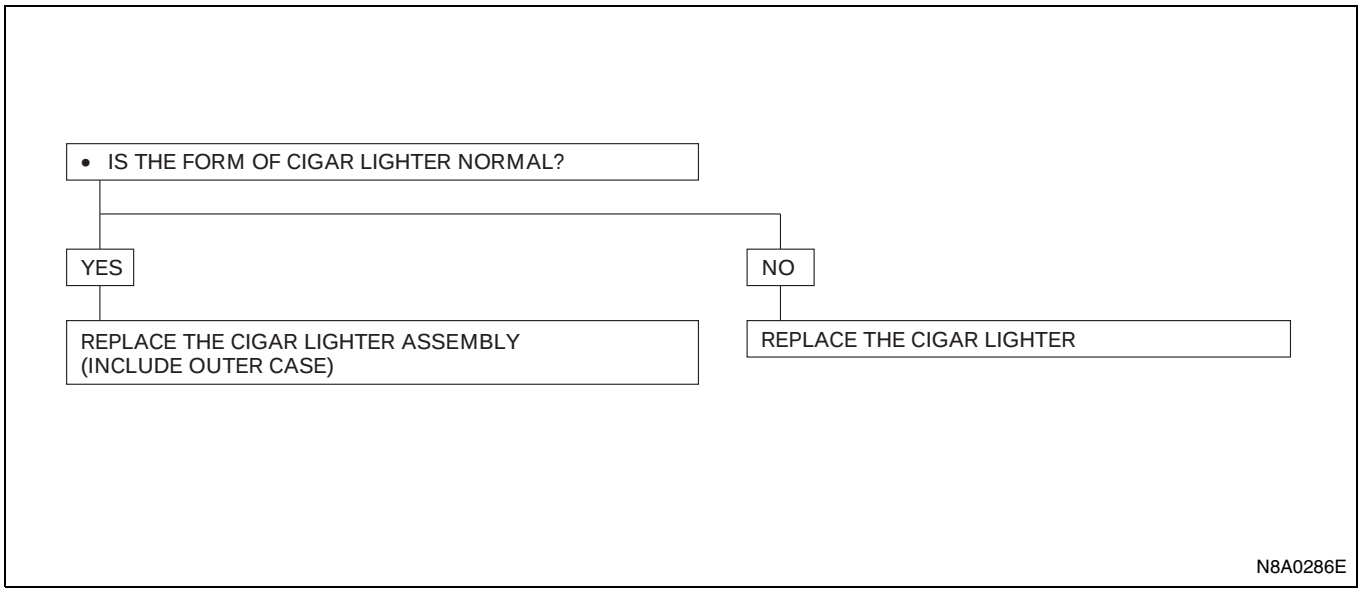
N8A5489E

Diagnosis

1. Cigar Lighter Does Not Heat Sufficiently



2. The Cigar Lighter Does Not Spring Out After Being Heated



Starter Switch

Refer to “START AND CHARGING” in this section.

Radio

Removal

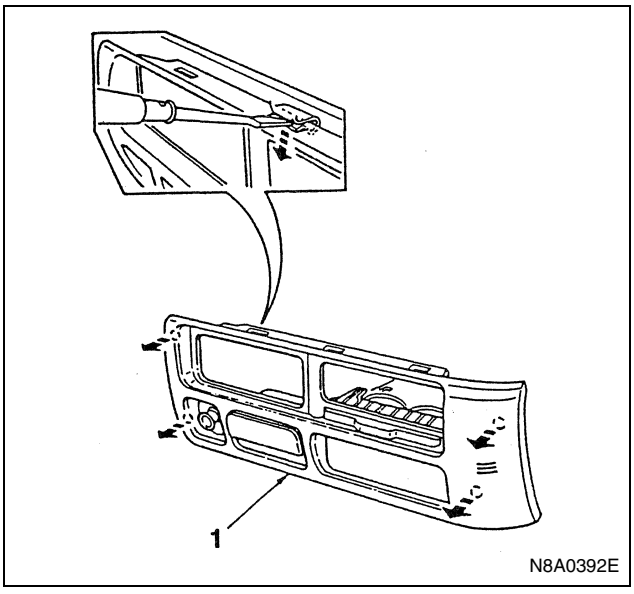
Preparation:

Disconnect the battery ground cable.

1. Center Cluster
   1) Pull it to remove. Pry off three clips by the tip of screwdriver.
   2) Remove the cigar lighter power source and its illumination connector.

Notice:

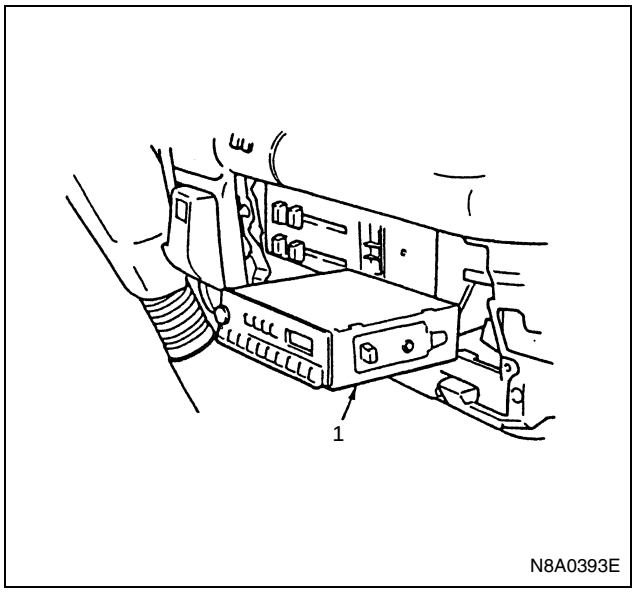
To remove the center cluster, do not force to pry off three clips at upper portion of the center cluster.



Legend

1. Center Cluster

2. Radio
   1) Remove the two radio fixing screws.
   2) Disconnect the connector and feeder plug.



Legend

1. Radio

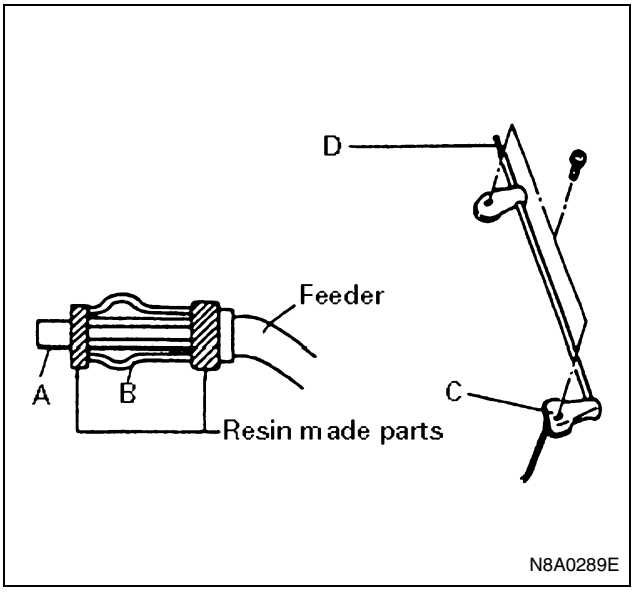
Installation

To install, follow the removal steps in the reverse order.

Antenna

Inspection

The metal A is connected to the pole D at the top of the antenna through the core of the feeder.
The metal B is fitted in the feeder shielding the core, and grounded at the screw C to avoid the core hampered by noise.
Defective grounding would cause noise.



In checking, measure the following three points with the circuit tester in the range of "resistance x 1 (Ω)."

Between A and B

No continuity (No reading at the indicator) → Normal

Continuity (A bite in the feeder. The core grounded) → Lower reception

Between B and C

Continuity (Indicator reading: 0Ω) → Normal

No continuity (Shielded core disconnected or defective grounding at the screw → Hampered by noise)

Between A and D

Continuity or no continuity

There are some antenna feeders and relay feeders with a condenser built in their connections.

Measuring resistance between the two points does not result in correct judgment. Connect temporarily another normal antenna to the radio and check to see if its reception is audible. Most antenna now available are slide type. Rust at the screw C and the cab panel where grounded would lead no continuity, followed by lower reception.

Keep this portion clean to avoid rust.

Removal

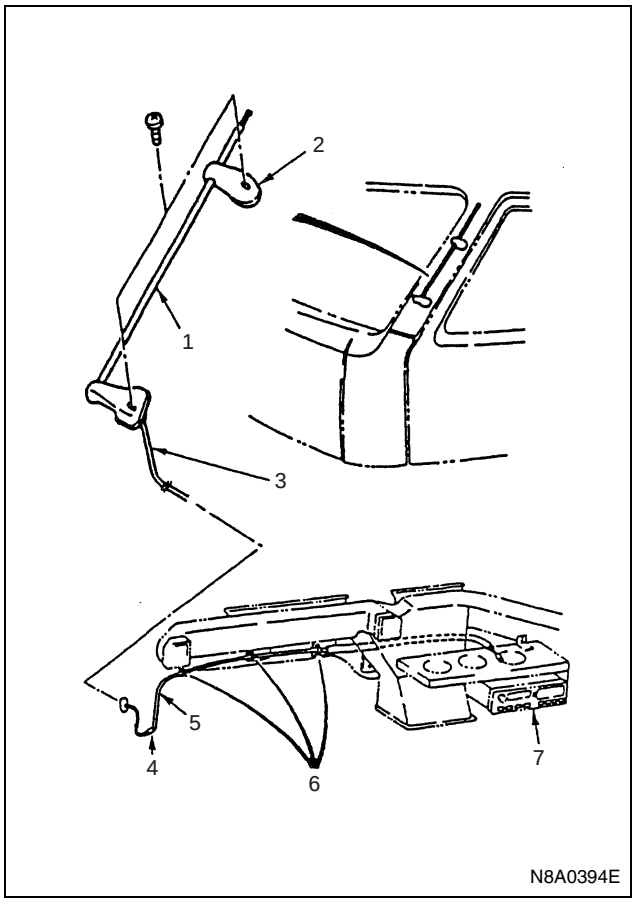
Preparation:

Disconnect the battery ground cable.

1. Antenna
   1) Disconnect the joint connector.
   2) Remove the upper and lower side antenna bracket.
   3) Pull out the antenna feeder.

Notice:

For easier fitting, tie the lead wire to the end of the antenna feeder in advance.



Legend

1. Antenna
2. Antenna Bracket
3. Feeder
4. Joint Connection
5. Feeder
6. Clip
7. Radio

Installation

To install, follow the removal steps in the reverse order.

Speaker

Inspection

1. With the circuit tester set to the range of × 1 (Ω), connect the circuit tester probes (red and black) to the (+) and (−) terminals of the speaker.
2. When the speaker is normal, a low buzzing sound is heard.
3. When the speaker is defective, no sound is heard. However, the distortion or chattering of the sound cannot be identified.
   When the speaker is installed to the vehicle, disconnect the connectors before checking.

When no sound is heard, the following are considered as the cause.

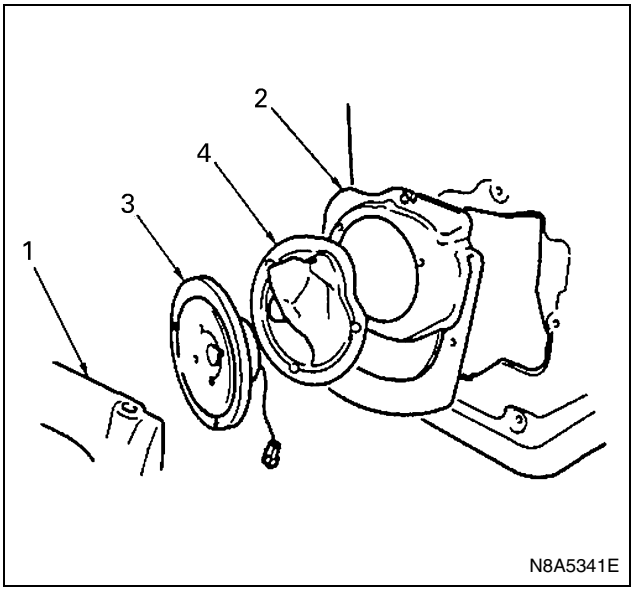
- The speaker wiring is disconnected at the speaker terminals.
- The speaker body is defective.
- There is an open circuit somewhere in the speaker harness on the vehicle side.
- The speaker harness on the vehicle side is grounded or caught up.

Removal

Preparation:

Disconnect the battery ground cable.

1. Door Pad
   Refer to “FRONT DOOR TRIM PAD” of section 2.
2. Speaker Panel
   Disconnect the speaker connector.
3. Speaker
4. Waterproof Sheet



Legend

1. Trim Panel
2. Speaker Panel
3. Speaker
4. Waterproof Sheet

Installation

To install, follow the removal steps in the reverse order.

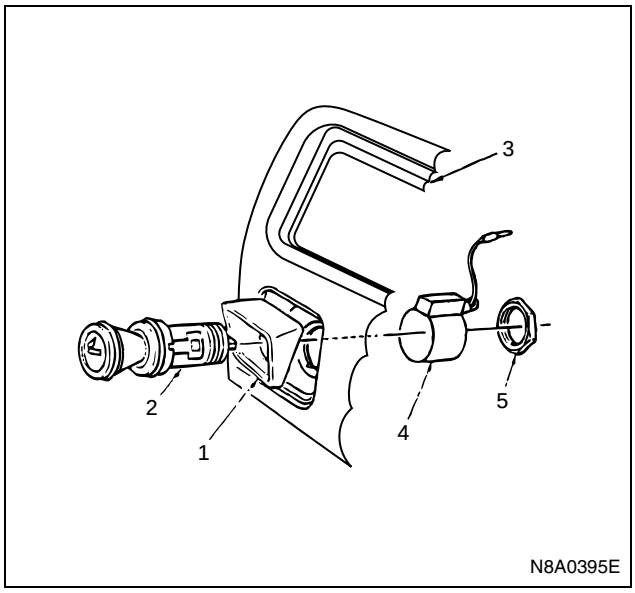
Cigar Lighter

Removal

Preparation:

Disconnect the battery ground cable.

1. Center Cluster
   Refer to “RADIO” in this section.
2. Cigar Lighter Assembly
   Remove the nut, then remove cigar lighter assembly, bezel and outer case.



Legend

1. Bezel
2. Cigar Lighter Assembly
3. Center Cluster
4. Outer Case
5. Nut

Installation

To install, follow the removal steps in the reverse order.

Meter and Warning/indicator Light

General Description

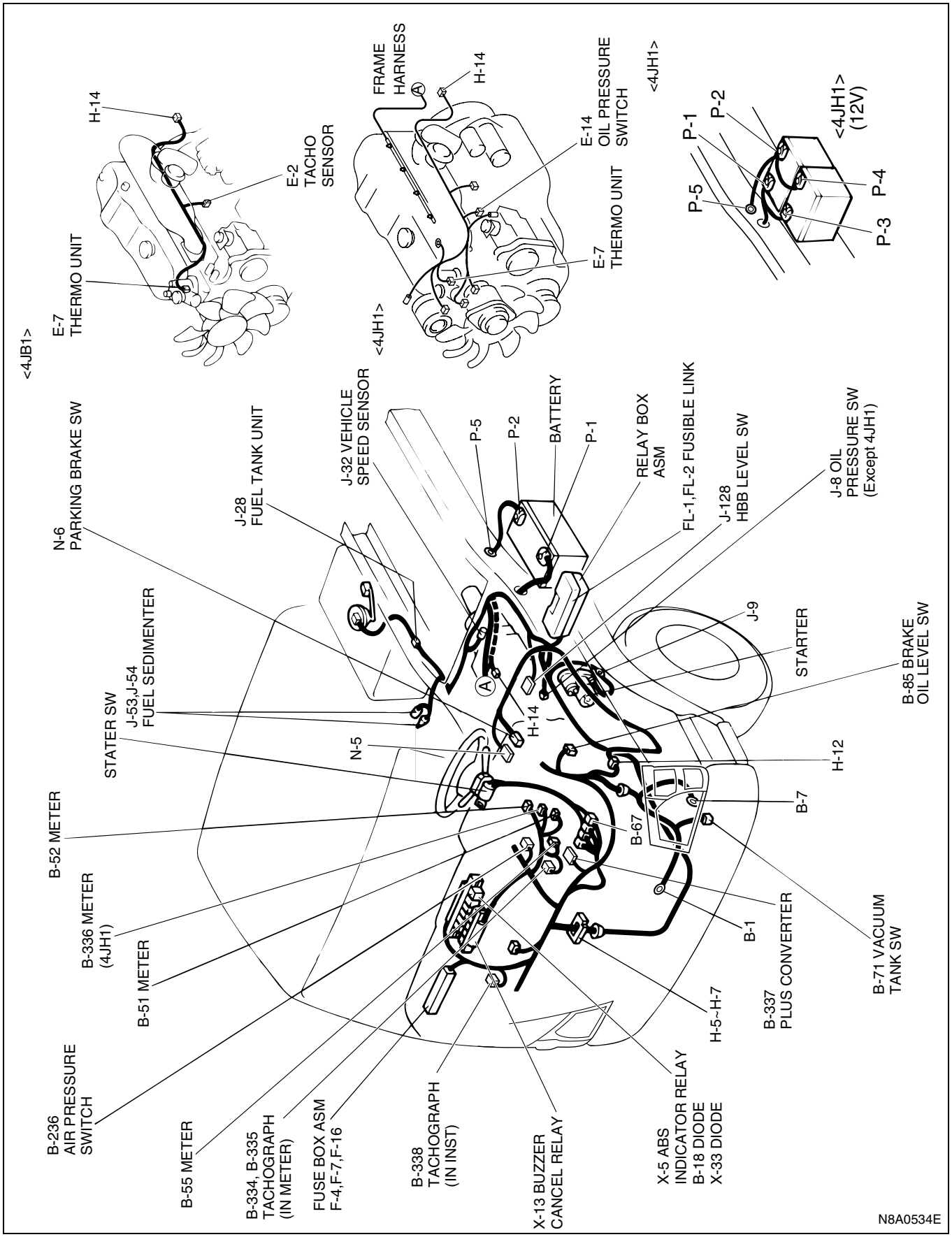
The circuit consists of the starter switch, meter assembly, vacuum tank switch, seat belt switch, oil pressure switch, fuel sedimenter switch, brake fluid switch, parking brake switch, vehicle speed sensor, fuel tank unit, thermo unit and engine speed sensor.

The meter assembly contains the speedometer, tachometer, fuel meter, thermometer and the warning/indicator light.

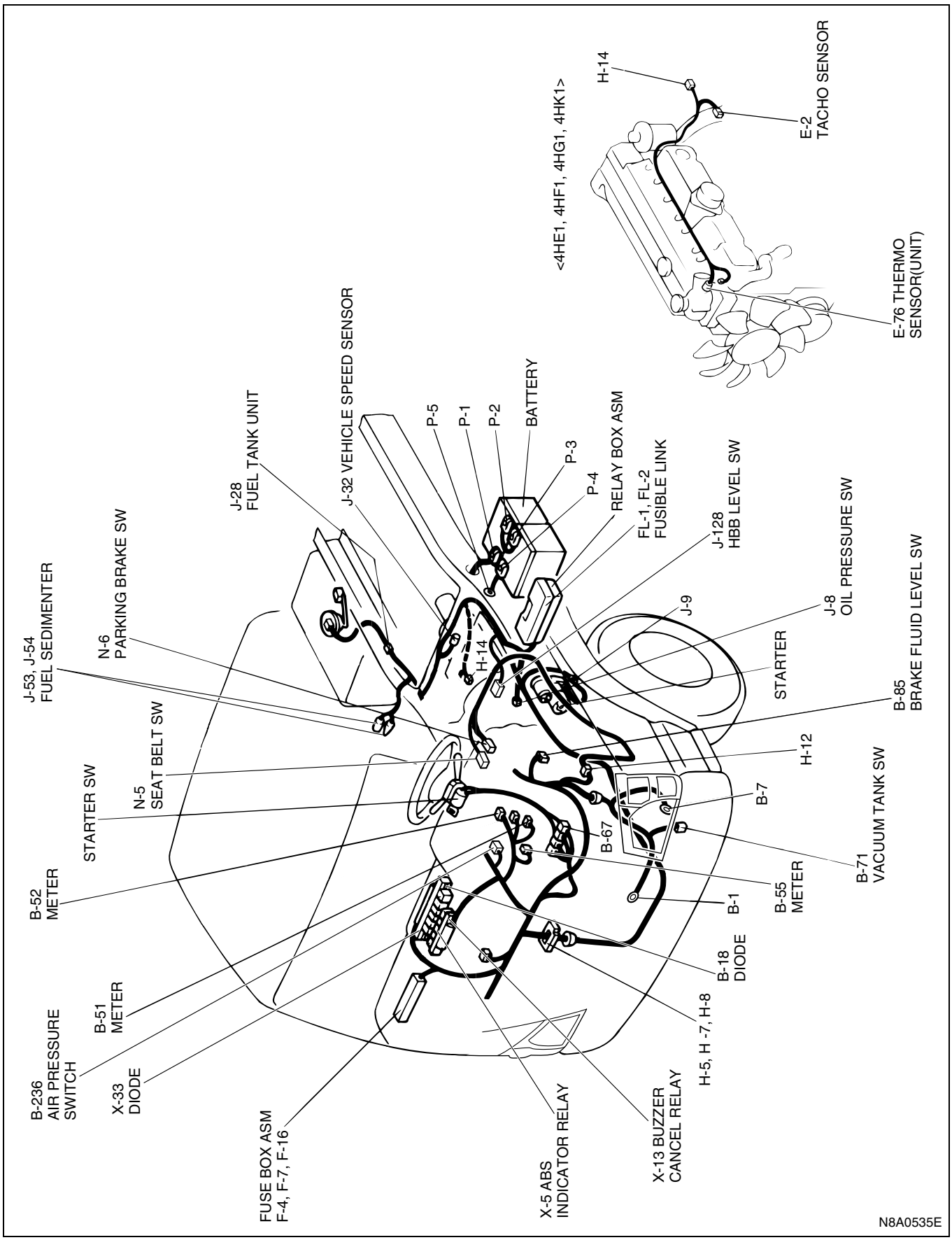
The meter warning/indicator lights and their bulb sockets are a unit, they are installed from the back of the speedometer assembly.

Parts Location

For 12 Volt

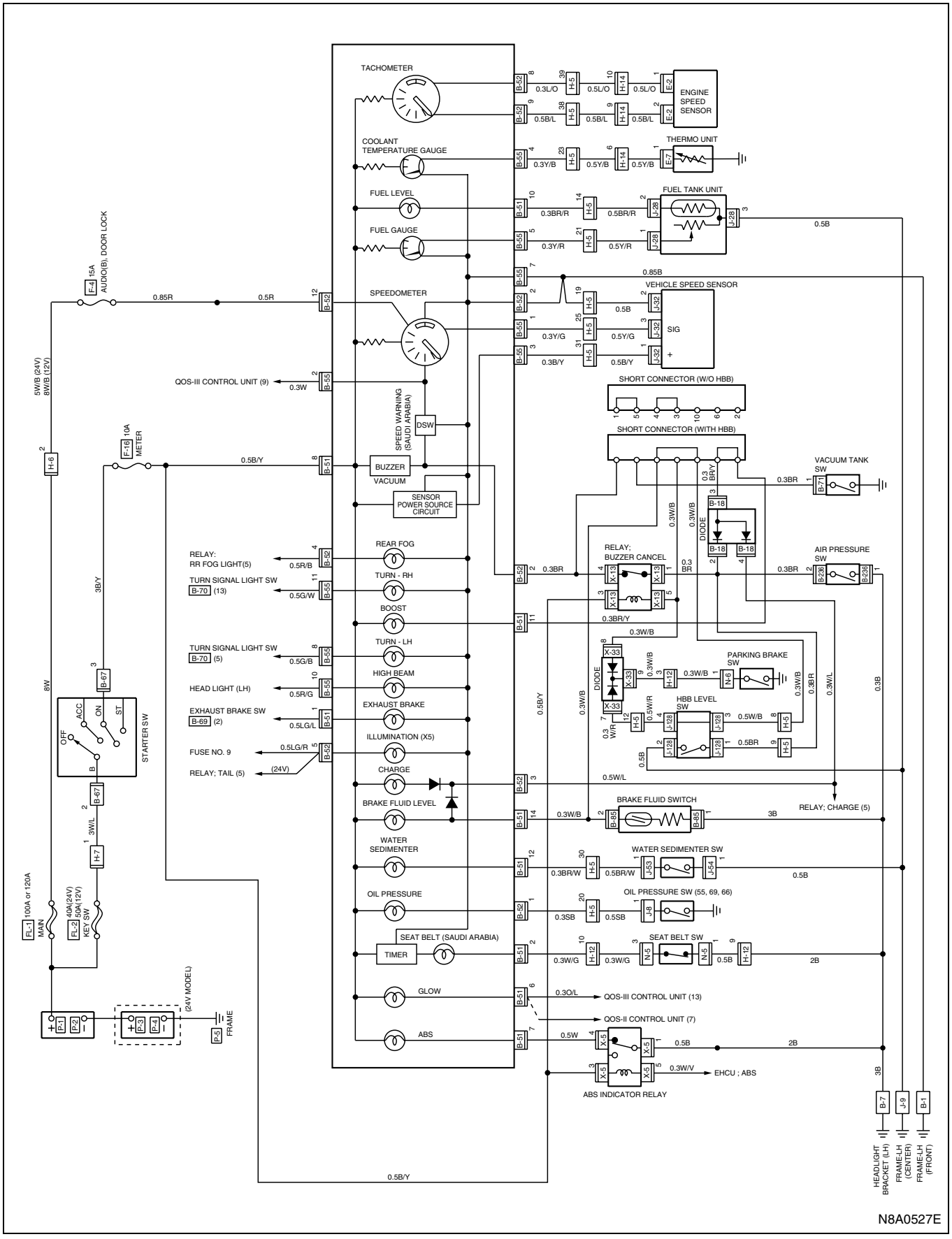


For 24 Volt

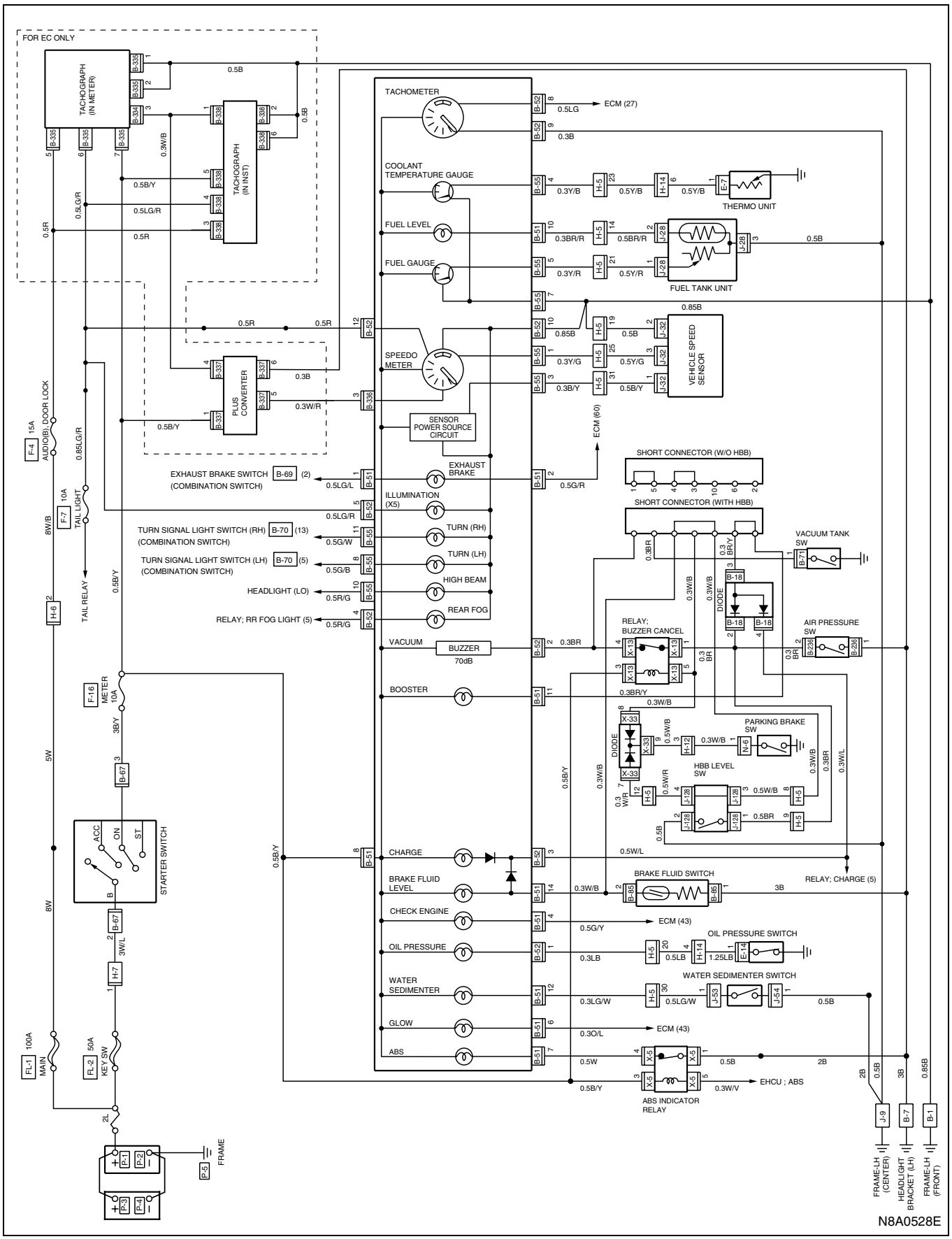

B-236
AIR PRESSURE
SWITCH
B-52
METER
B-51
METER
X-33
DIODE
STARTER SW
N-5
SEAT BELT SW
N-6
PARKING BRAKE SW
J-53, J-54
FUEL SEDIMENTER
J-28
FUEL TANK UNIT
J-32 VEHICLE SPEED SENSOR
P-5
P-1
P-2
BATTERY
P-3
P-4
RELAY BOX ASM
FL-1, FL-2
FUSIBLE LINK
J-128
HBB LEVEL SW
J-9
J-8
OIL PRESSURE SW
STARTER
B-85
BRAKE FLUID LEVEL SW
H-12
B-7
B-71
VACUUM TANK SW
B-55
METER
B-1
B-67
H-14
B-18
DIODE
H-5, H -7, H-8
X-13 BUZZER
CANCEL RELAY
X-5 ABS
INDICATOR RELAY
FUSE BOX ASM
F-4, F-7, F-16
<4HE1, 4HF1, 4HG1, 4HK1>
H-14
E-2
TACHO SENSOR
E-76 THERMO
SENSOR(UNIT)
N8A0535E

Circuit Diagram

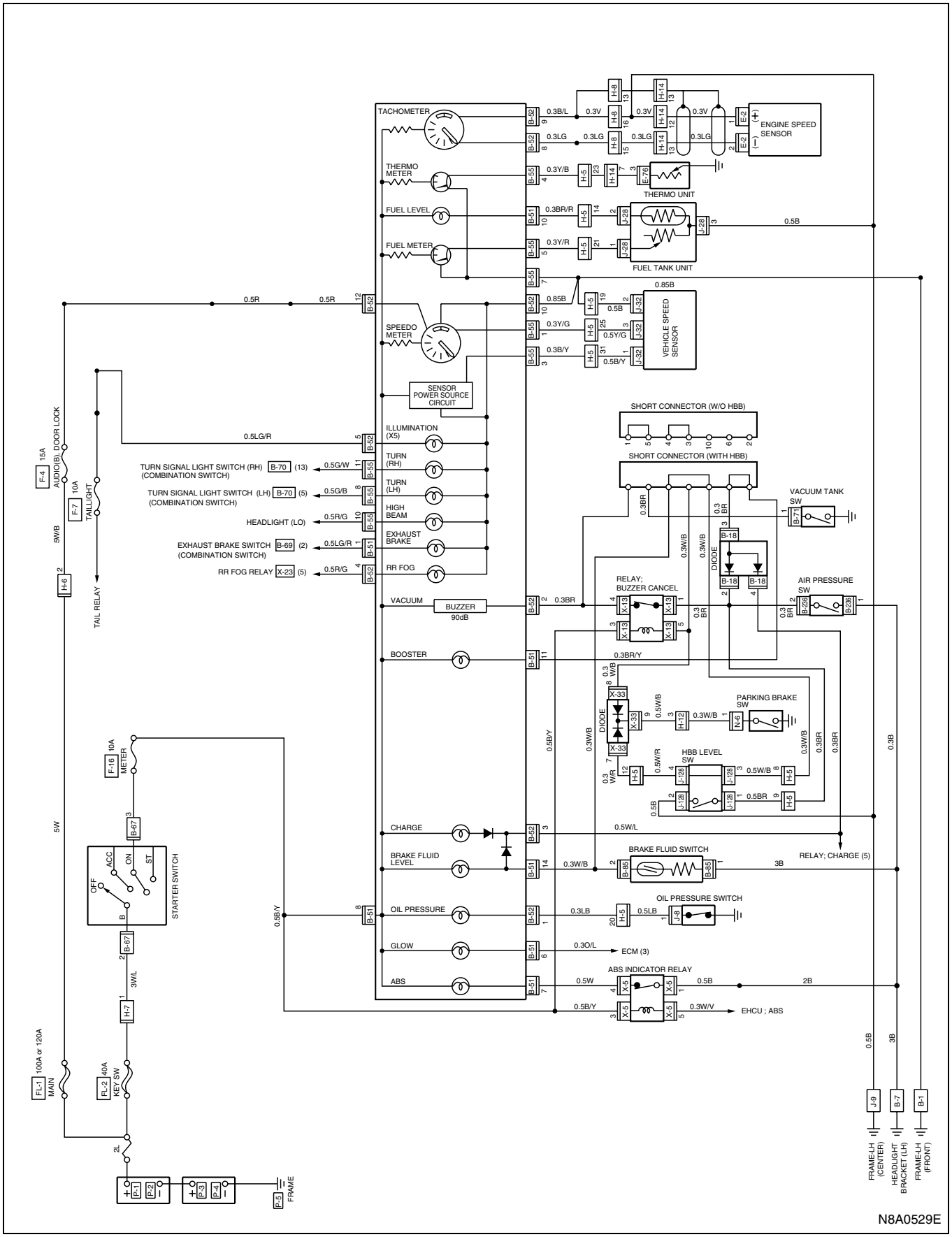
Except 4JH1 / 4HK1 Engine



For 4JH1 Engine

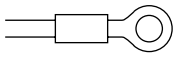
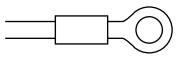
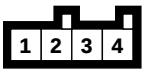
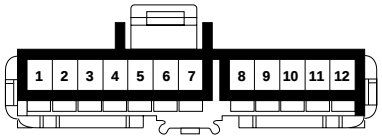
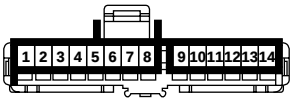
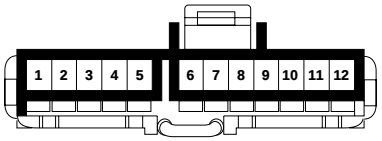


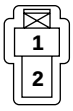
For 4HK1 Engine

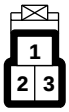
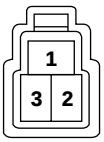
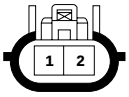
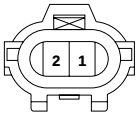


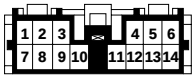
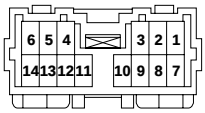
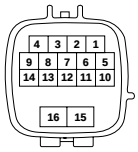
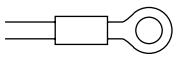
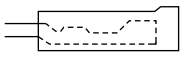
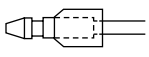
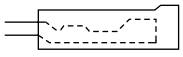
Connector List

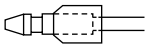
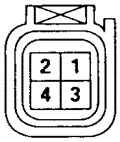
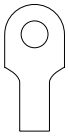
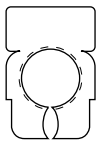
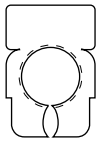
Except 4JH1 / 4HK1 Engine

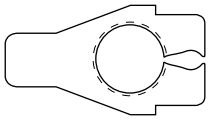
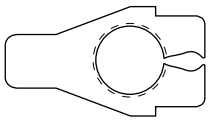
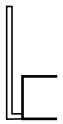
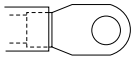
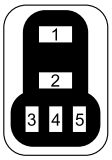
No.	Connector Face
B-1	 000-001
B-7	 000-001
B-18	 004-004
B-52	 012-005
B-51	 014-001
B-55	 012-004
N-6	001-002
N-6	001-011

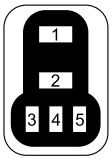
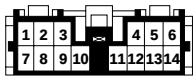
No.	Connector Face
B-67	004-001
B-67	004-002
B-71	001-013
B-71	001-014
J-8	001-013
J-8	001-014
B-85	002-009
B-85	 002-010

No.	Connector Face
B-236	002-022
N-5	 003-020
N-5	 003-021
E-2 (66)	 002-001
E-2 (66)	 002-002
E-2 (55,69)	002-011
E-2 (55,69)	002-012
E-7	001-018

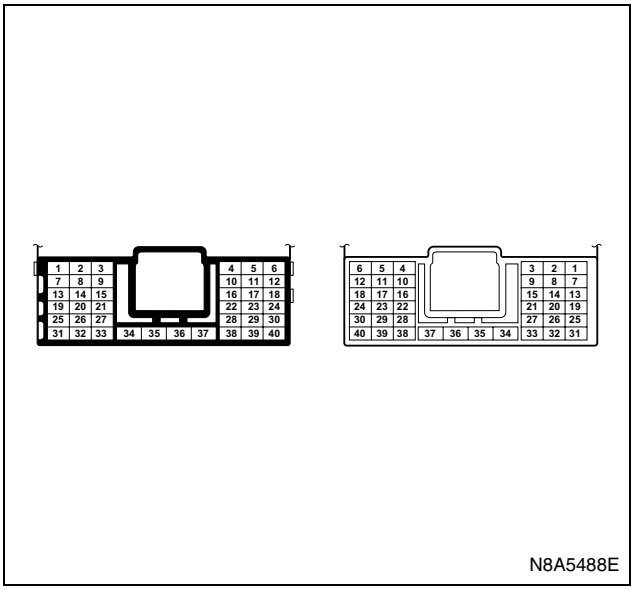
No.	Connector Face
H-12	 014-002
H-12	 014-003
H-14	016-003
H-14	 016-004
J-9	 000-001
J-53	 000-010
J-53	 000-011
J-54	 000-010

No.	Connector Face
J-54	 000-011
J-128	 004-018
J-28	003-016
J-28	003-017
J-32	003-018
P-1 (12V)	 000-003
P-1	 000-004
P-4	 000-004

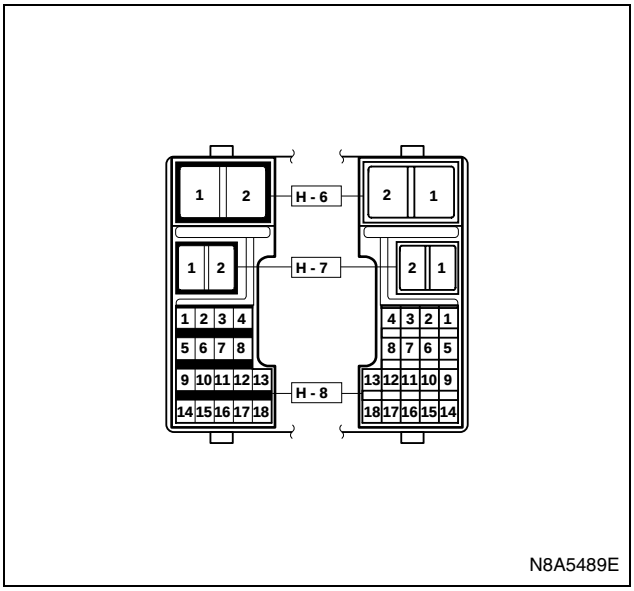
No.	Connector Face
P-2	 000-006
P-3	 000-006
P-5 (12V)	 000-007
P-5	 000-002
H-14	016-001
H-14	016-002
J-8 (FOR 4J type ENGINE)	001-019
X-5	 005-006

No.	Connector Face
X-13	 005-006
X-33	 014-002

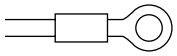
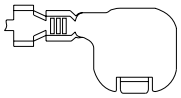
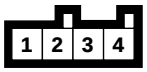
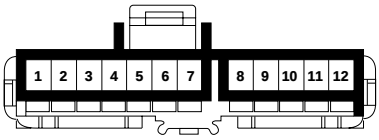
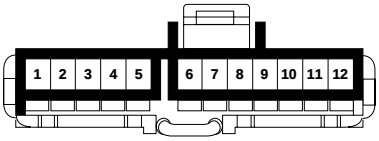
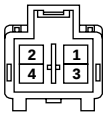
H-5

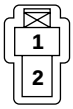
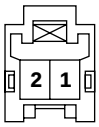

N8A5488E

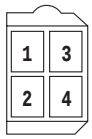
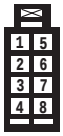
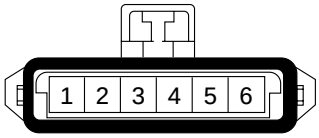
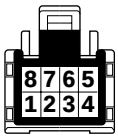
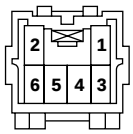
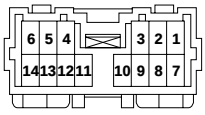
H-6, H-7

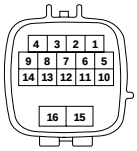
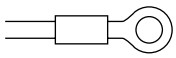
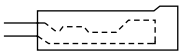
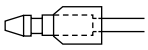
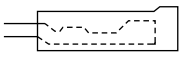
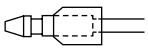

N8A5489E

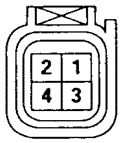
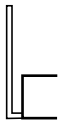
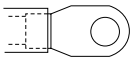
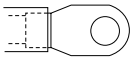
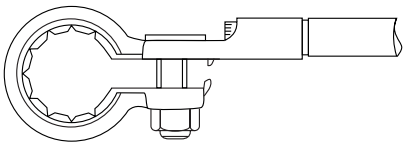
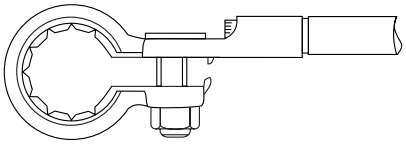
For 4JH1 Engine

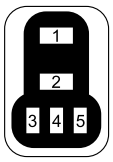
No.	Connector Face
B-1	 000-001
B-7	 000-017
B-18	 004-004
B-52	 012-005
B-51	014-001
B-55	 012-004
B-67	004-001
B-67	 004-002

No.	Connector Face
B-71	001-013
B-71	001-014
E-14	001-013
E-14	001-014
B-85	002-009
B-85	 002-010
N-6	 002-023
B236	002-022

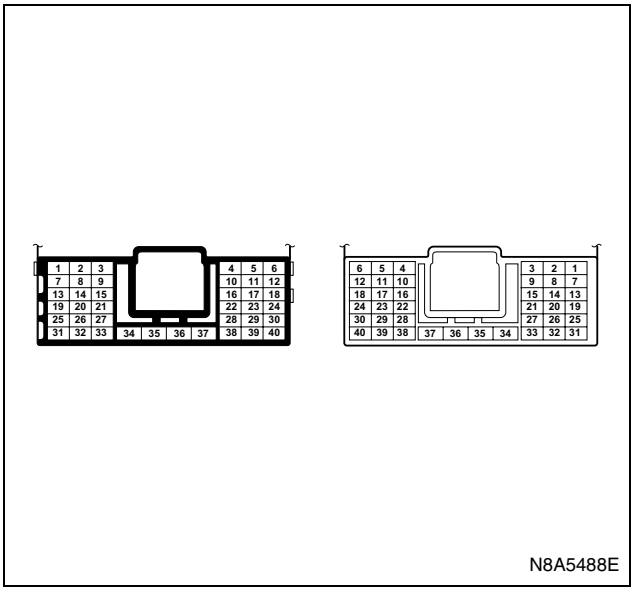
No.	Connector Face
B-334	 004-014
B-335	 008-014
B-336	 006-018
B-337	 008-013
B-338	 006-003
E-7	001-009
H-12	014-002
H-12	 014-003

No.	Connector Face
H-14	016-003
H-14	 016-004
J-9	 000-001
J-53	 000-010
J-53	 000-011
J-54	 000-010
J-54	 000-011
J-28	003-016

No.	Connector Face
J-28	003-017
J-32	003-018
J-128	 004-018
P-5	 000-007
P-1	 000-002
P-2	 000-002
P-3	 000-014
P-4	 000-014

No.	Connector Face
X-5	005-001
X-13	 005-006
X-33	014-002

H-5



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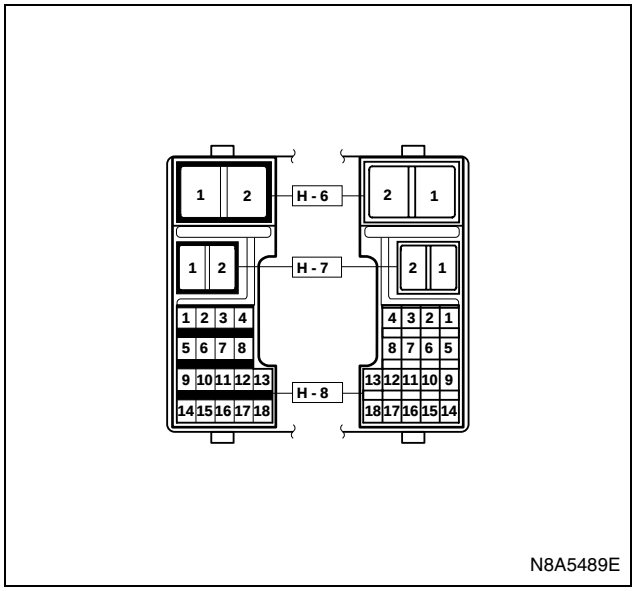
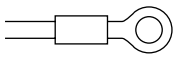
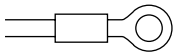
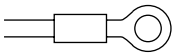
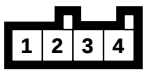
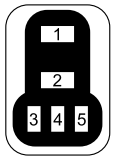
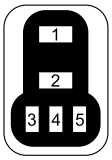
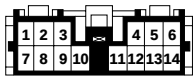
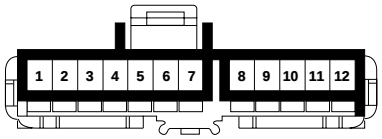
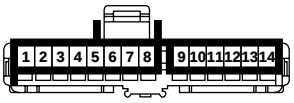
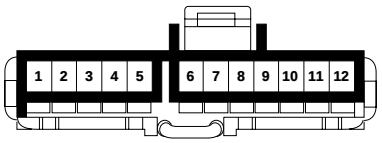
H-6, H-7

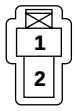
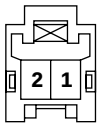
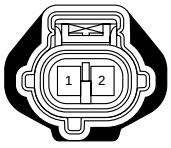


N8A5489E

For 4HK1 Engine

No.	Connector Face
B-1	 000-001
B-7	 000-001
J-9	 000-001
B-18	 004-004
X-5	 005-006

No.	Connector Face
X-13	 005-006
X-33	 014-002
B-52	 012-005
B-51	 014-001
B-55	 012-004
B-67	004-001
B-67	004-002
B-71	001-013

No.	Connector Face
B-71	001-014
J-8	001-013
J-8	001-014
B-85	002-009
B-85	 002-010
B-236	002-022
N-6	 002-023
E-2	 002-013

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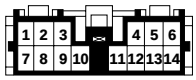
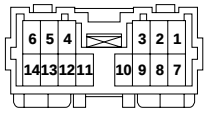
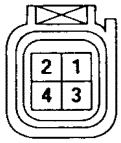
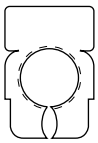
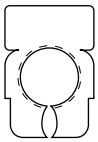
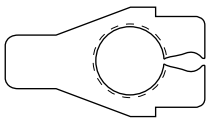
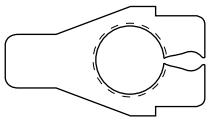
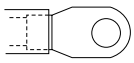
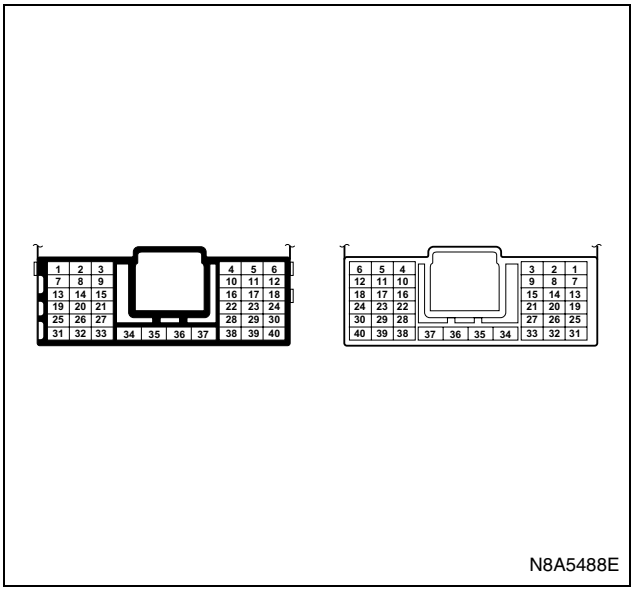
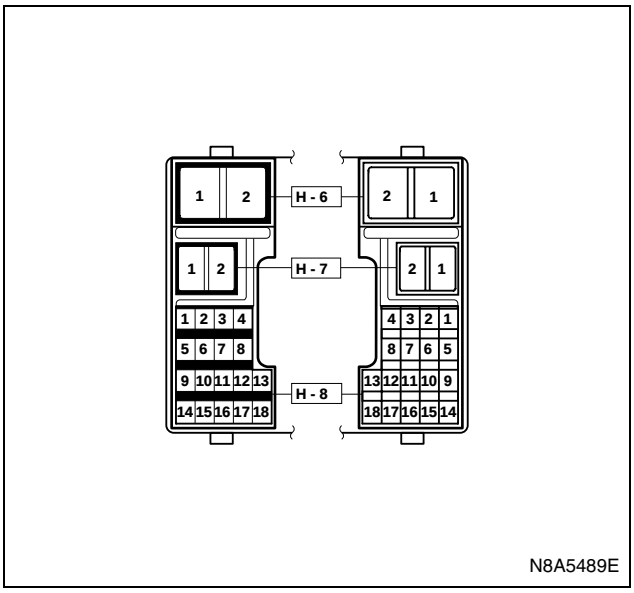
E-76	003-004
H-12	 014-002
H-12	 014-003
H-14	016-003
H-14	016-004
J-28	003-016
J-28	003-017
J-32	003-018

No.	Connector Face
J-128	 004-018
P-1	 000-004
P-4	 000-004
P-2	 000-006
P-3	 000-006
P-5	 000-002

H-5


1 2 3 4 5 6
7 8 9 10 11 12
13 14 15 16 17 18
19 20 21 22 23 24
25 26 27 28 29 30
31 32 33 34 35 36 37 38 39 40
6 5 4 3 2 1
12 11 10 9 8 7
18 17 16 15 14 13
24 23 22 21 20 19
30 29 28 27 26 25
40 39 38 37 36 35 34 33 32 31
N8A5488E

H-6, H-7, H-8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H - 6
2 1
1 2
H - 7
2 1
1 2 3 4
5 6 7 8
4 3 2 1
8 7 6 5
9 10 11 12 13
14 15 16 17 18
H - 8
13 12 11 10 9
18 17 16 15 14
N8A5489E

Diagnosis

Quick Chart for Check Point

1. Speedometer

		Check point		
		Speedometer	Vehicle speed sensor	Cable harness
Trouble mode	1-1. Speedometer and odometer do not function	❍ (3)	❍ (1)	❍ (2)
	1-2. Speedometer does not function (odometer is normal)	❍ (1)		
	1-3. Odometer does not function (Speedometer is normal)	❍ (1)		
	1-4. Speedometer needle fluctuates (May be wide fluctuation)	❍ (3)	❍ (1)	❍ (2)
	1-5. Speedometer needle jumps erratically	❍ (3)	❍ (1)	❍ (2)

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

2. Tachometer

		Check point		
		Tachometer	Engine speed sensor	Cable harness
Trouble mode	2-1. Tachometer does not function	❍ (3)	❍ (1)	❍ (2)
	2-2. Tachometer needle fluctuates (May be wide fluctuation)	❍ (3)	❍ (1)	❍ (2)
	2-3. Tachometer needle jumps erratically	❍ (3)	❍ (1)	❍ (2)

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

3. Coolant Temperature Gauge

		Check point				
		Meter ASM	Thermo meter	Thermo unit	Thermo seat	Cable harness
Trouble mode	3-1. Coolant temperature gauge needle does not move	❍ (3)	❍ (4)	❍ (2)		❍ (1)
	3-2. Coolant temperature gauge reading is too low (or high)	❍ (4)	❍ (5)	❍ (3)	❍ (1)	❍ (2)
	3-3. Needle overshoots (or goes up to the “H” range)	❍ (3)	❍ (4)	❍ (1)		❍ (2)

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

4. Fuel Gauge

		Check point			
		Meter ASM	Fuel gauge	Fuel tank unit	Cable harness
Trouble mode	4-1. Fuel gauge needle does not move	❍ (3)	❍ (4)	❍ (2)	❍ (1)
	4-2. Even when the tank is filled up with fuel, the needle does not reach “F”	❍ (3)	❍ (4)	❍ (2)	❍ (1)
	4-3. When the tank is not full of fuel, the needle overshoots (or goes to “F”)	❍ (3)	❍ (4)	❍ (2)	❍ (1)

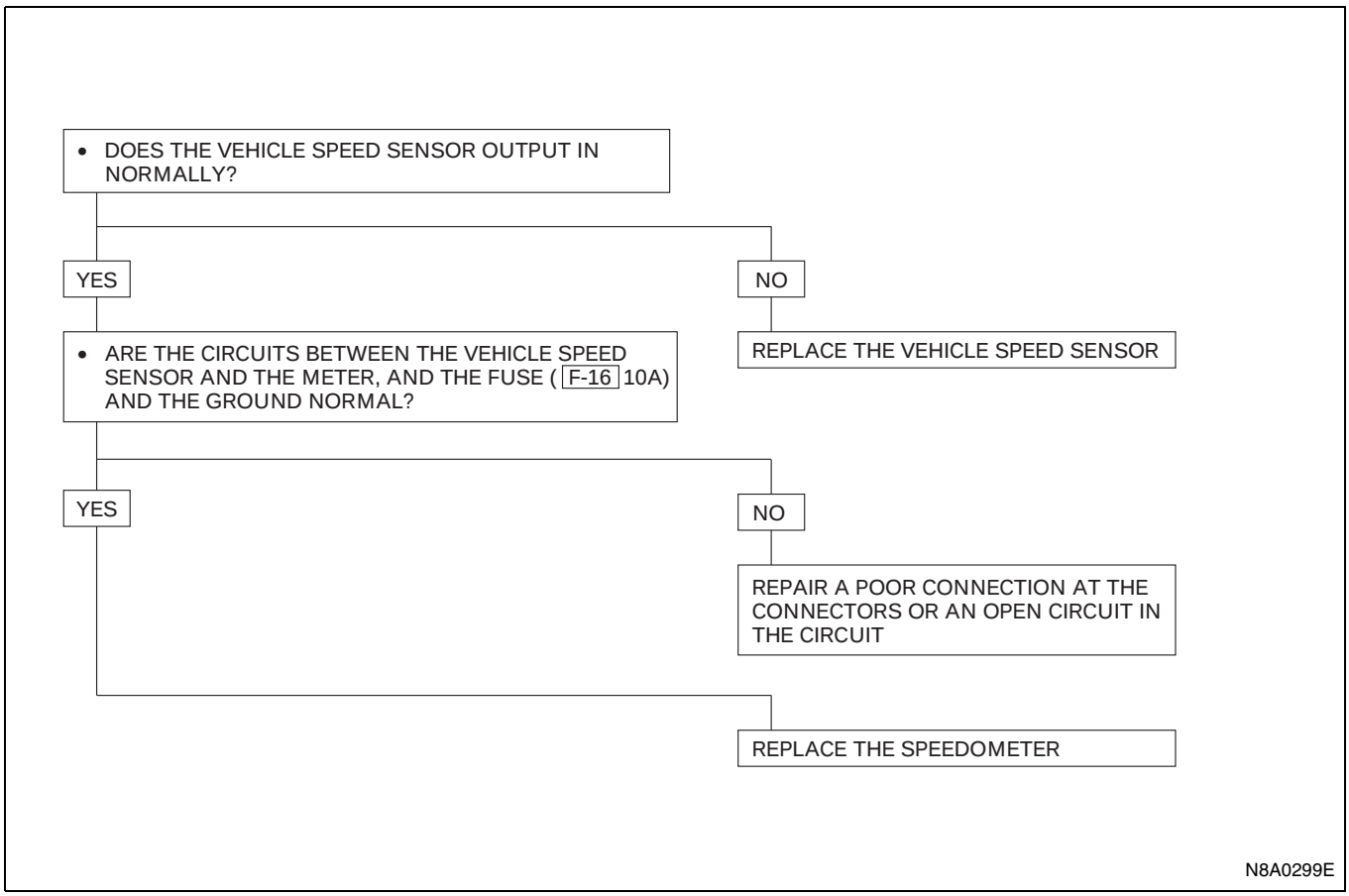
Notice:
Figure in parenthesis “( )” indicates the order of inspection.

5. Warning/indicator Light

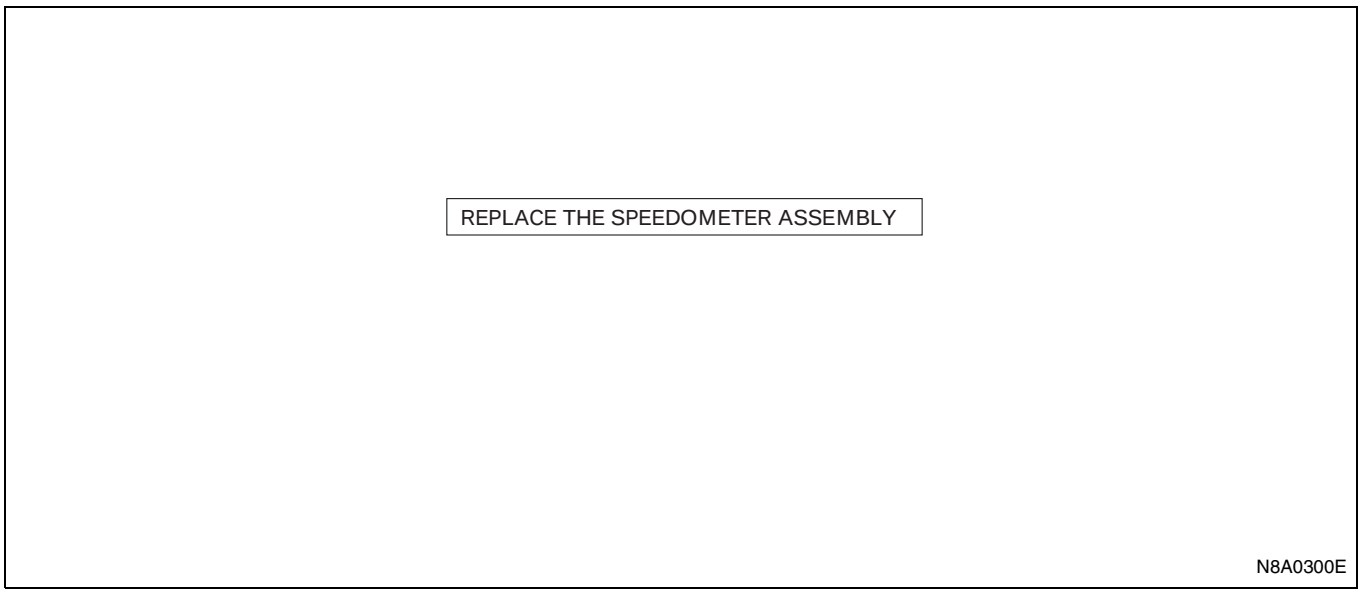
		Check point									
		Light bulb	Parking brake SW	Brake fluid SW	Oil pressure SW	Fuel tank unit	Vacuum SW	4WD SW	Sedim enter SW	Seat belt SW	Cable harness
Trouble mode	5-1. When the parking brake lever is pulled, the indicator light does not light up	❍ (2)	❍ (1)								❍ (3)
	5-2. Even when the parking brake lever is released, the indicator light does not go off		❍ (1)								❍ (2)
	5-3. While the engine operating, the oil pressure warning light does not go off				❍ (2)						❍ (1)
	5-4. Even when the tank is full with fuel, the fuel warning light lights up					❍ (1)					❍ (2)
	5-5. Even when the tank is empty, the low fuel warning light does not light up	❍ (1)				❍ (2)					❍ (3)
	5-6. Even when the float in the water sedimenter goes up above the drain warning level, the indicator light does not light up	❍ (2)							❍ (1)		❍ (3)
	5-7. Even when the brake fluid is lower than specified level, the level warning light does not light up	❍ (1)		❍ (2)							❍ (3)
	5-8. Even when the vacuum tank is empty vacuum warning buzzer does not sound						❍ (1)				❍ (2)

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

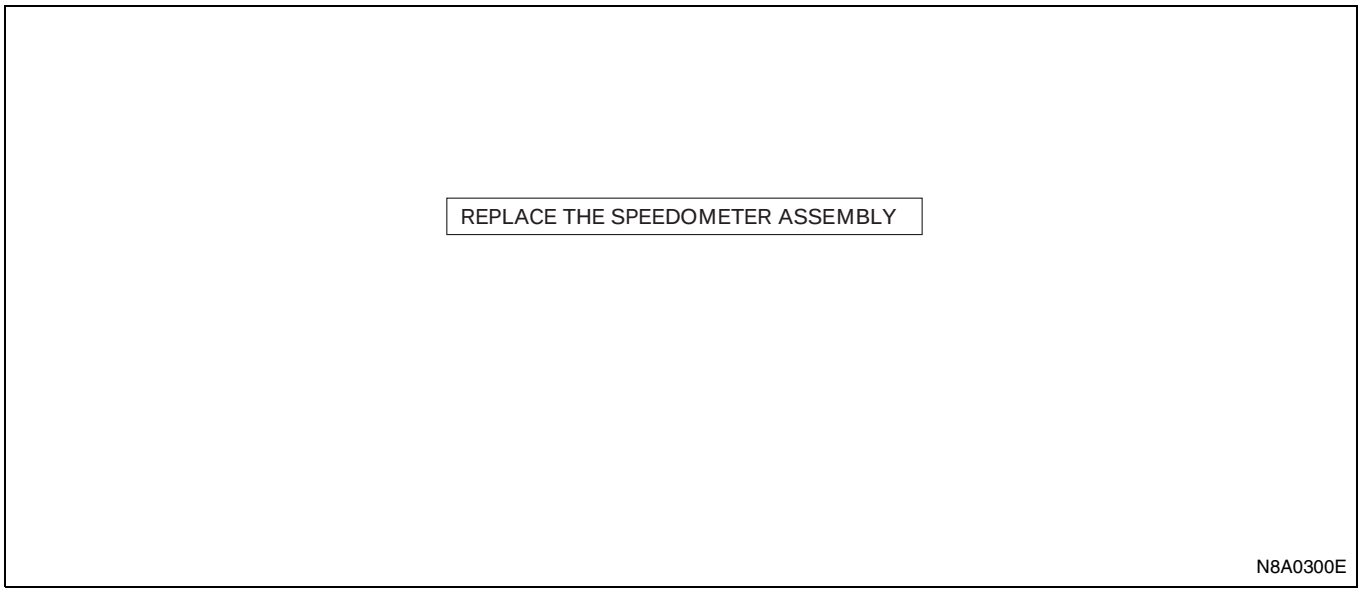
1. Speedometer
1-1. Speedometer and Odometer Do Not Function



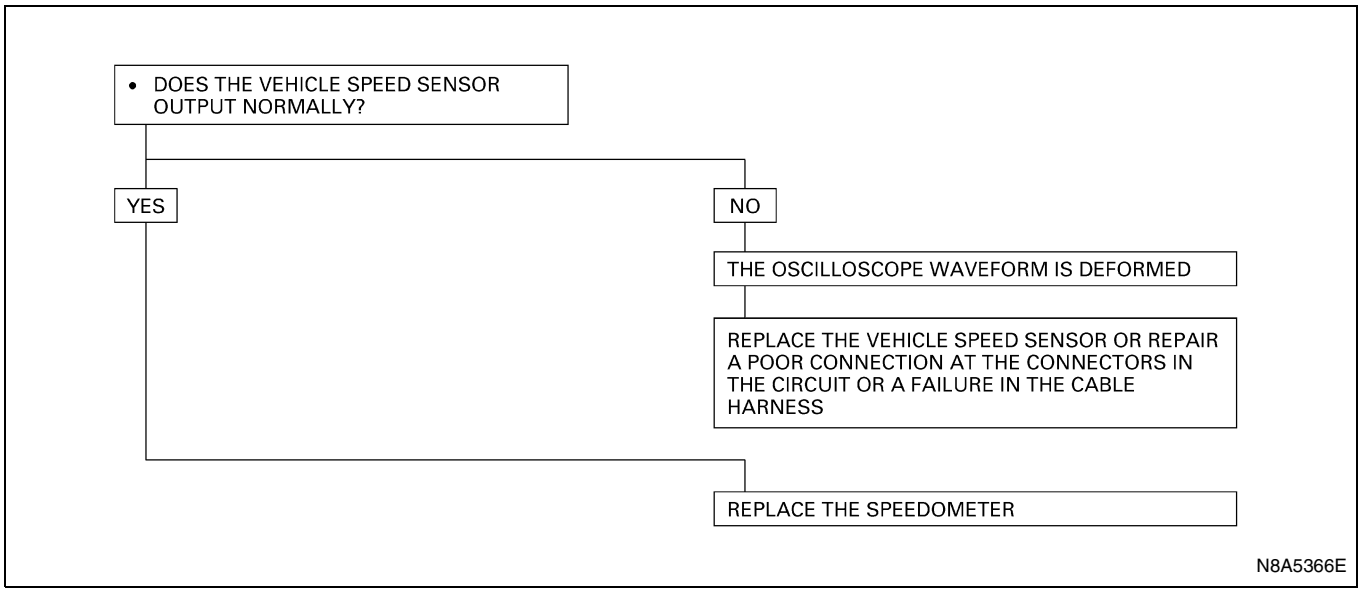
1-2. Speedometer Does Not Function (Odometer Is Normal)



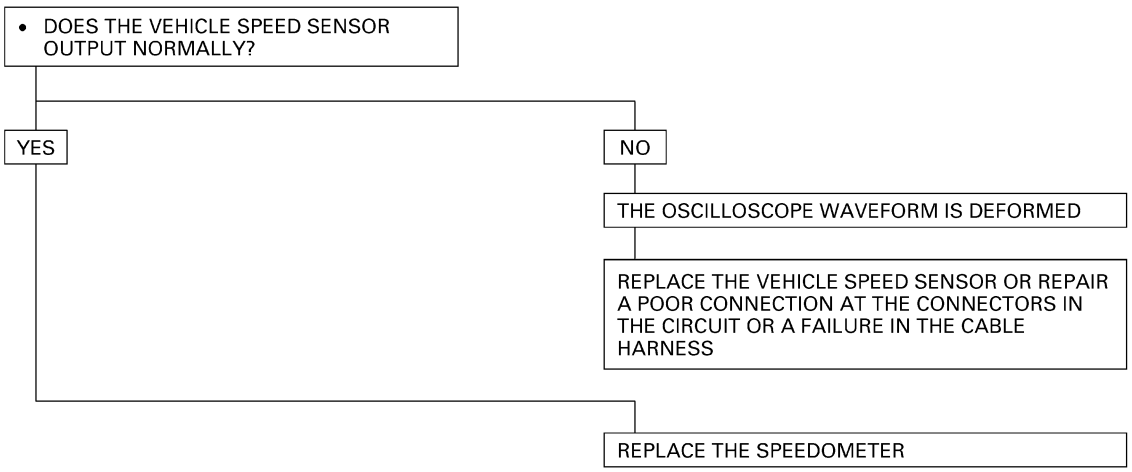
1-3. Odometer Does Not Function (Speedometer Is Normal)



1-4. Speedometer Needle Fluctuates (May Be Wide Fluctuation)



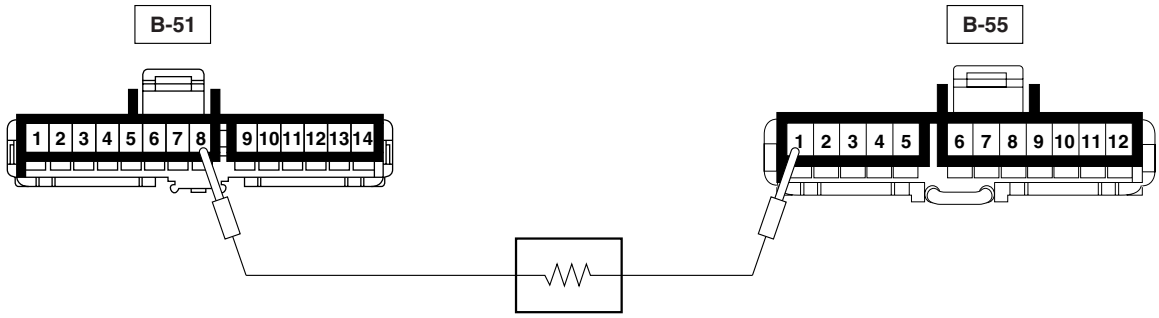
1-5. Speedometer Needle Jumps Erratically



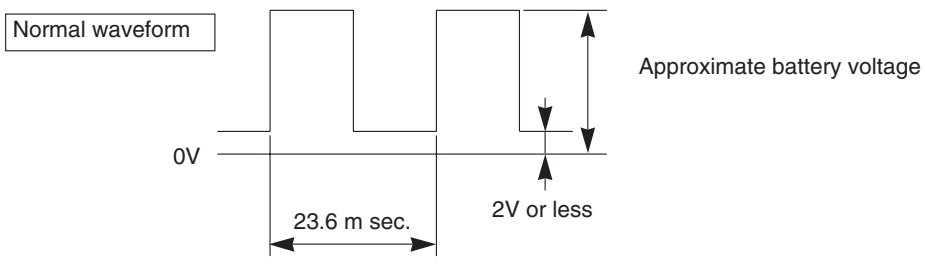
N8A5366E

Inspection of waveform by oscilloscope

1. Connect a resistance of 1.3 to 5k ohm (1.4W or more) between the harness side connectors 8 B-51 and 1 B-55 of the meter.



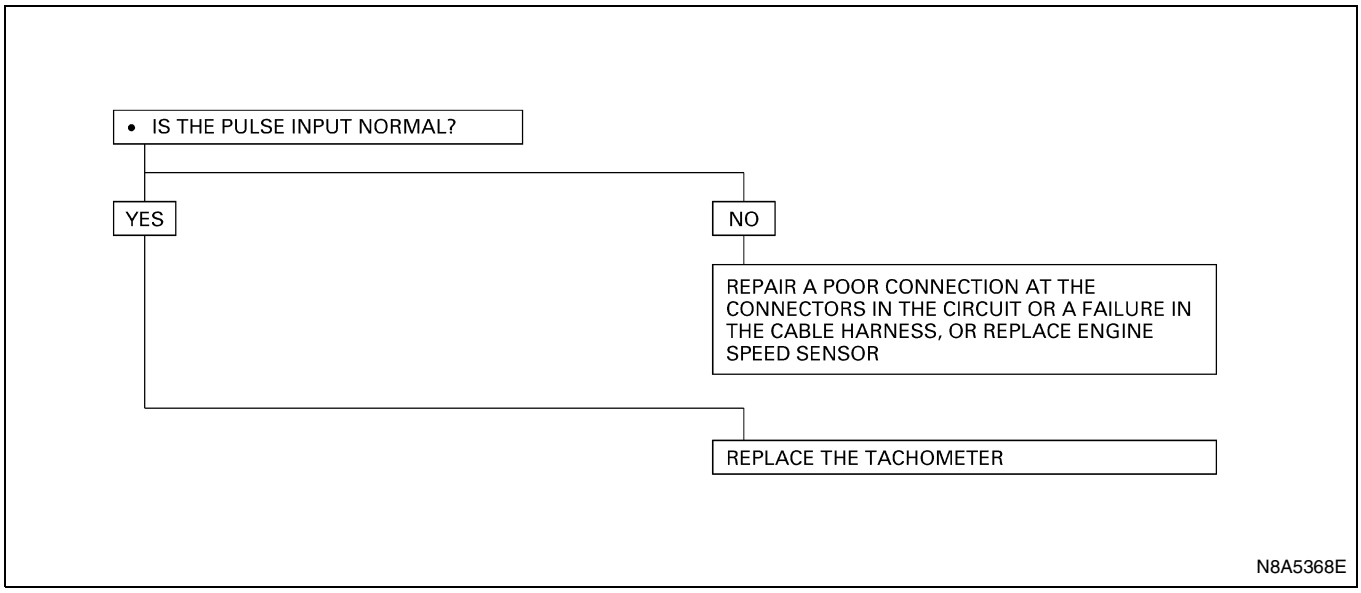
2. Install a speedometer tester.
3. Turn on the starter SW.
4. Check the waveform at the time when the vehicle speed is at 60 Km (37 mph).



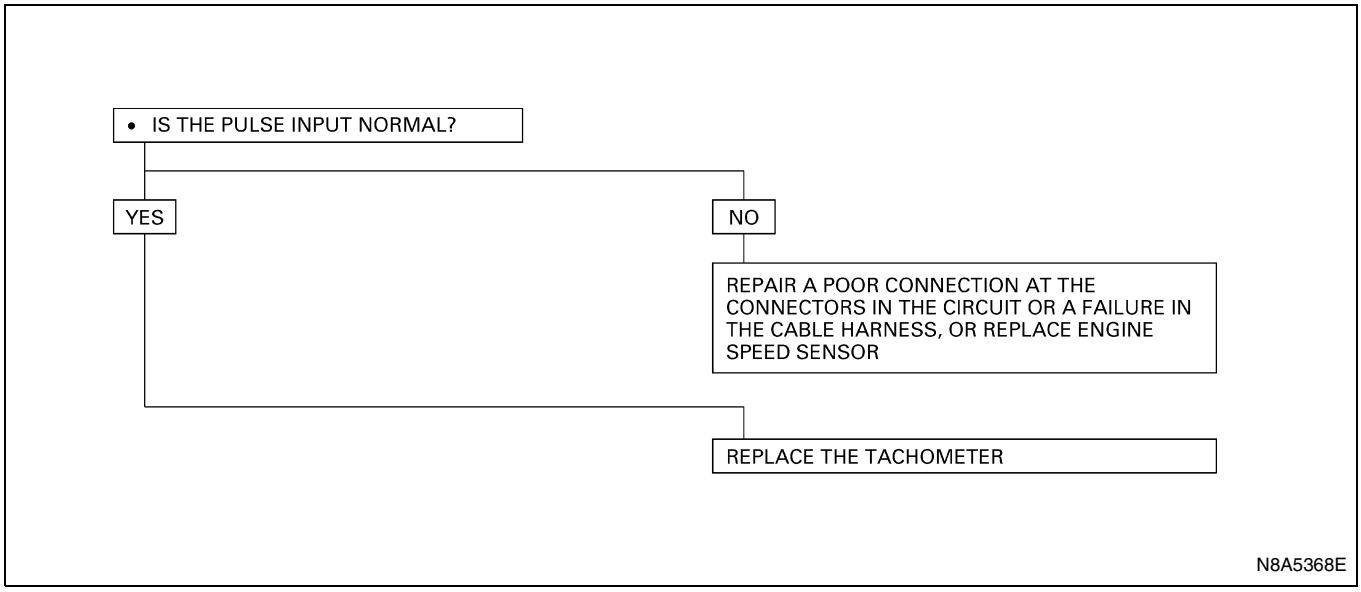
N8A0304E

2. Tachometer

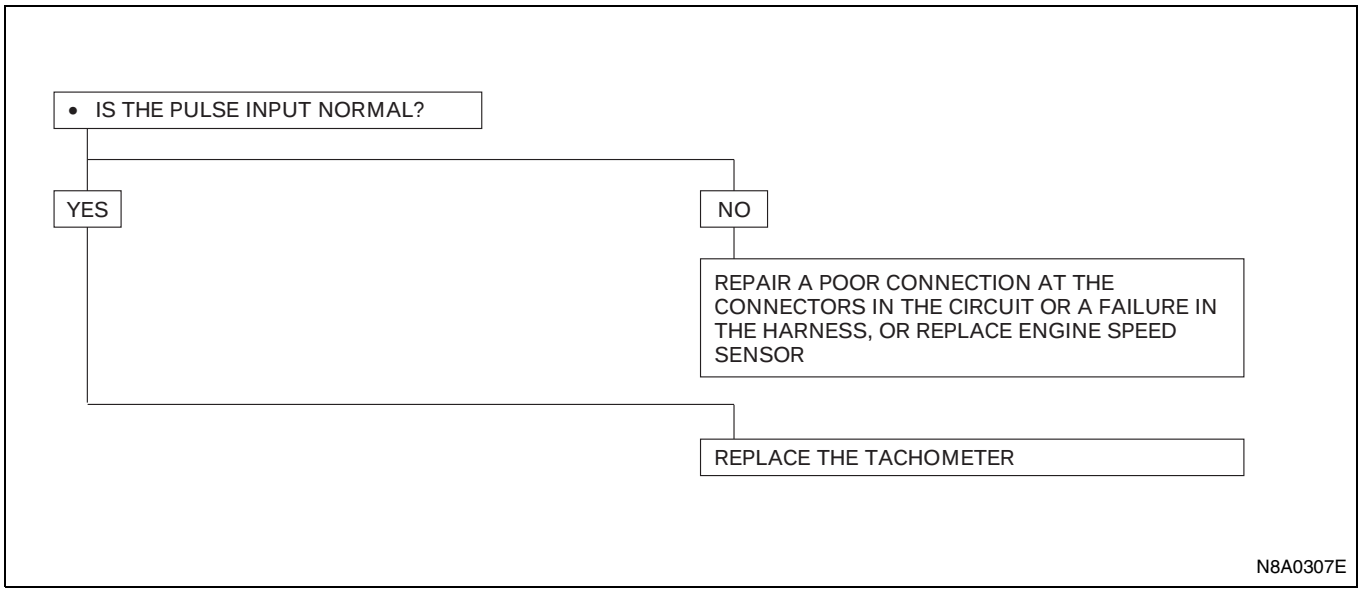
2-1. Tachometer Does Not Function



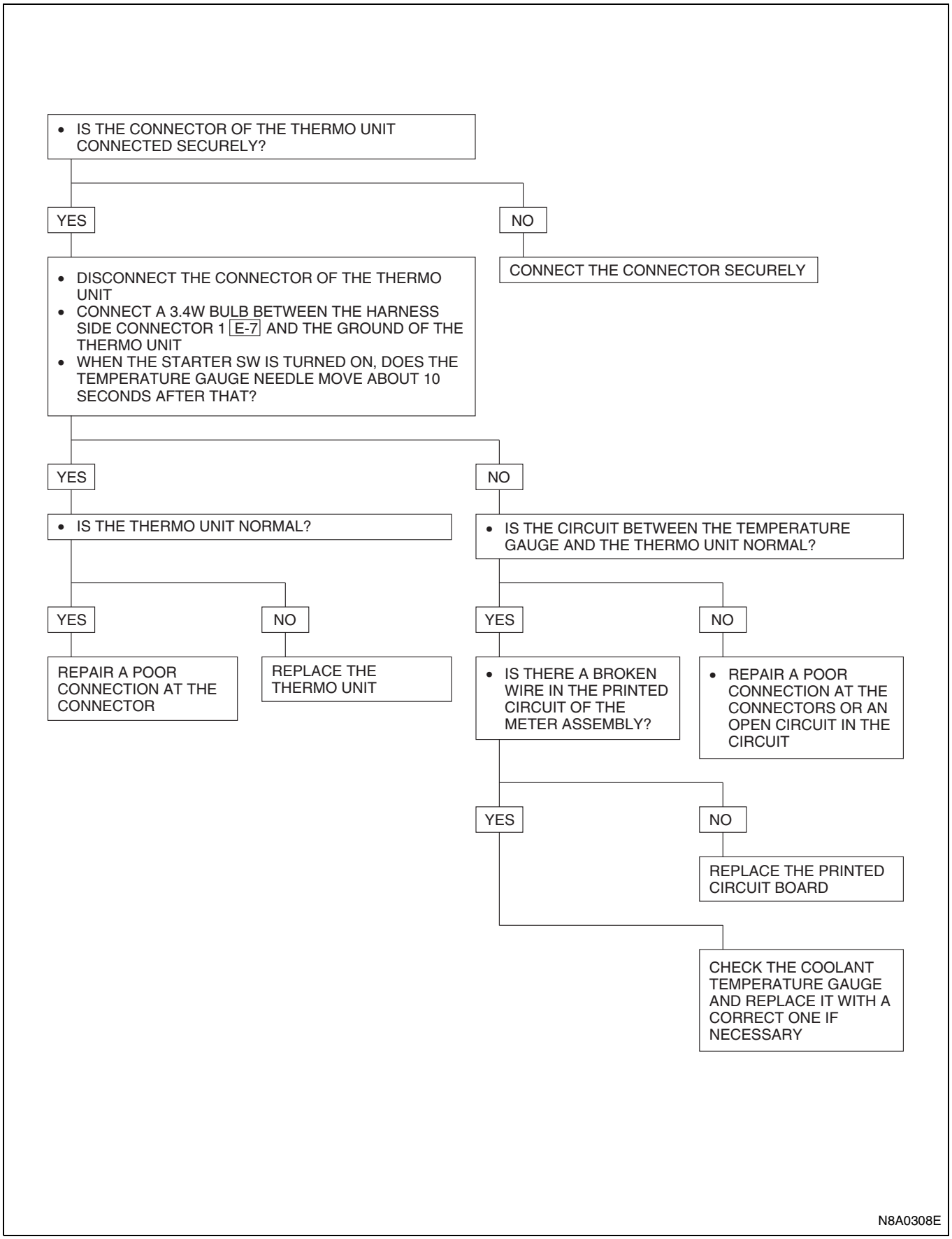
2-2. Tachometer Needle Fluctuates (May Be Wide Fluctuation)



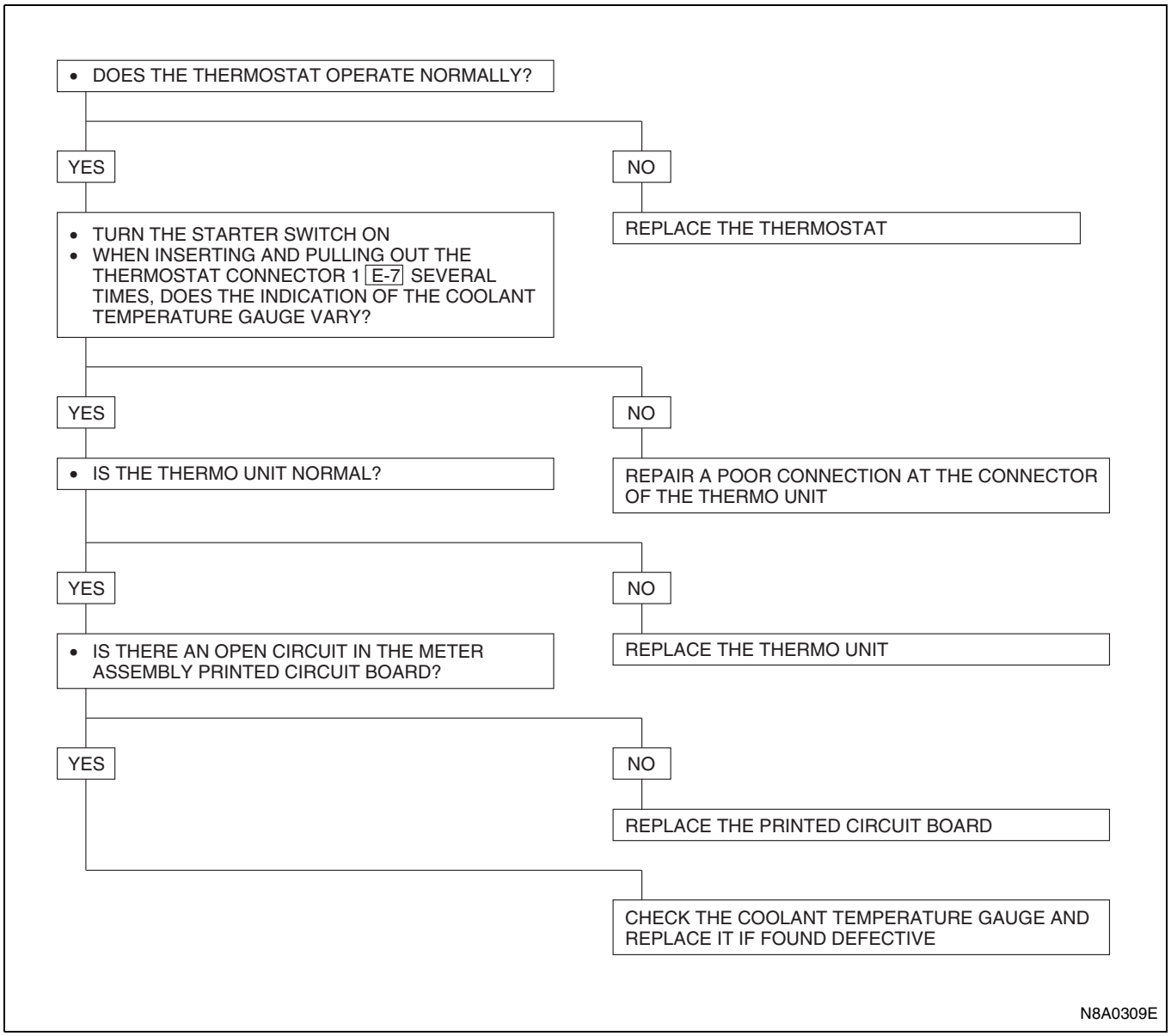
2-3 Tachometer Needle Jumps Erratically



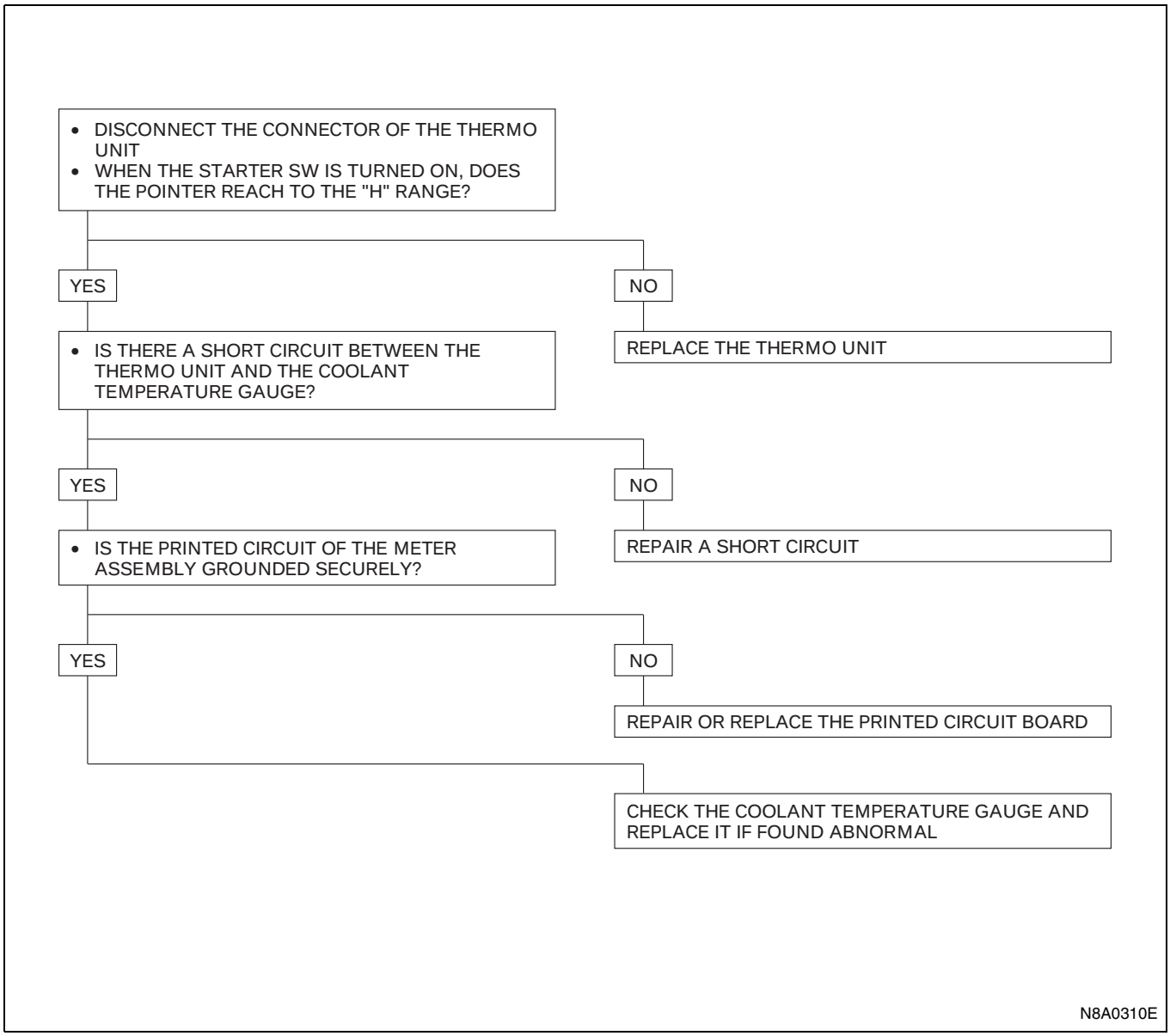
3. Coolant Temperature Gauge
3-1. Coolant Temperature Gauge Needle Does Not Move



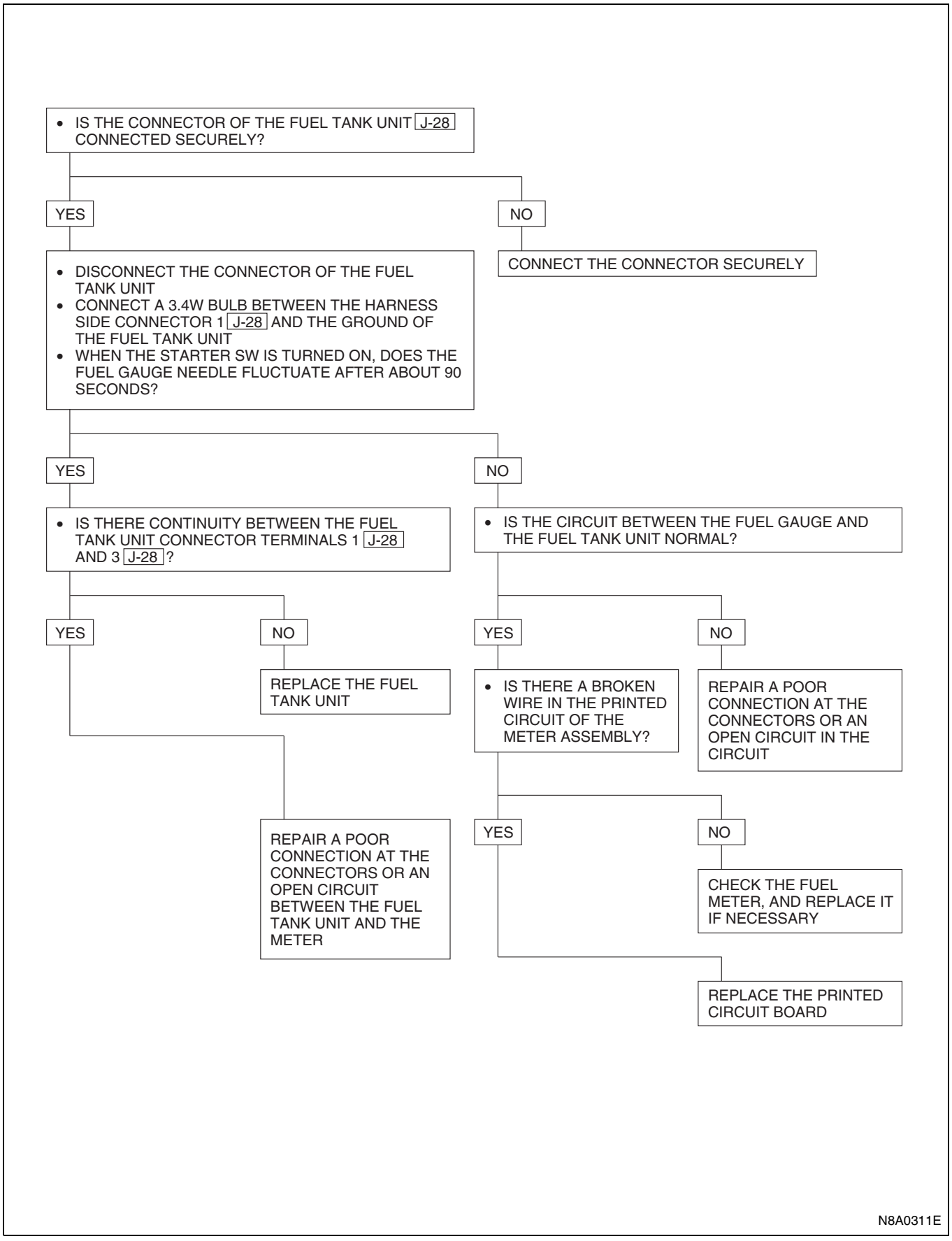
3-2. Coolant Temperature Gauge Reading Is Too Low (or High)



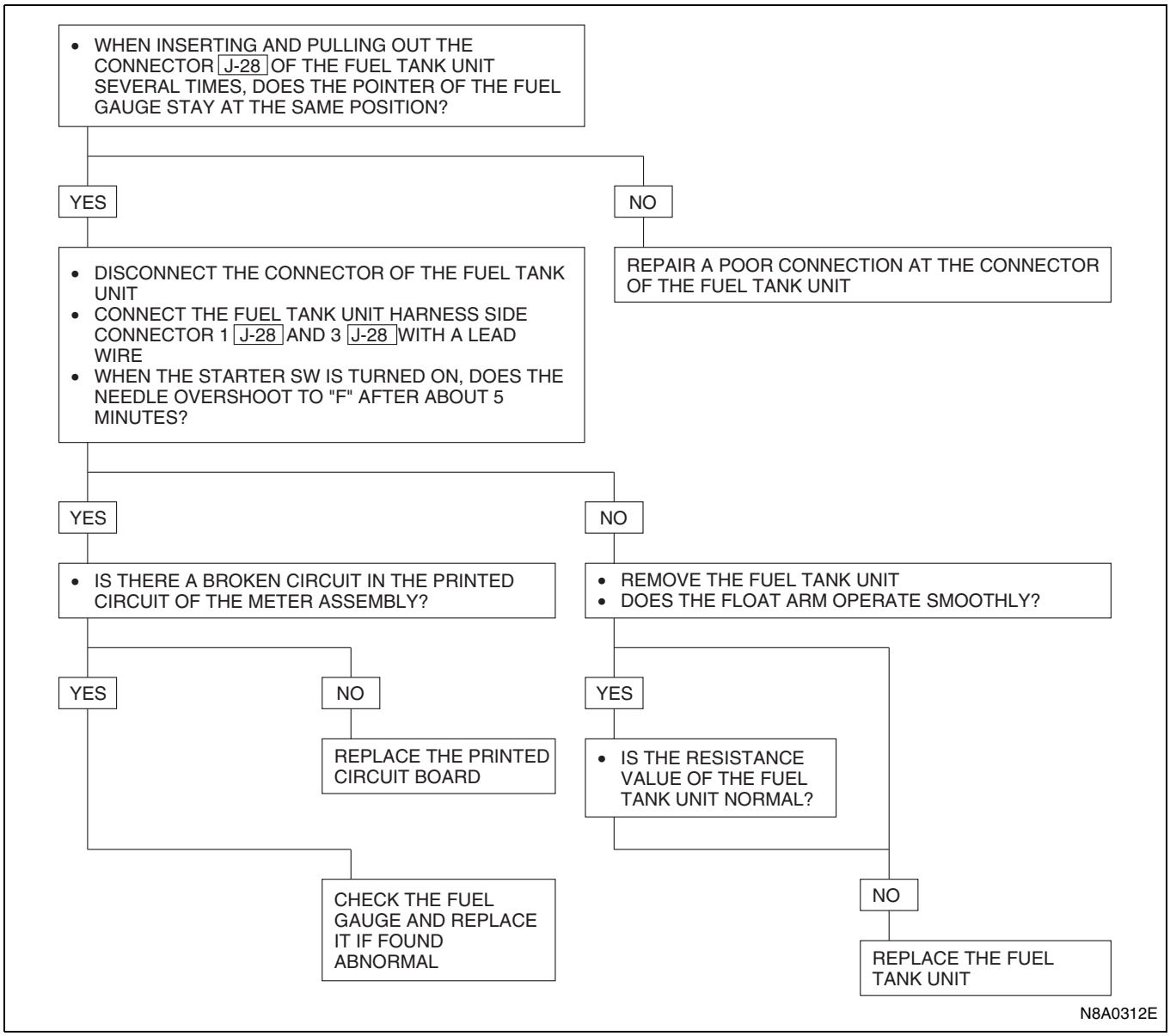
3-3. Needle Overshoots (or Goes Up to the “H” Range)



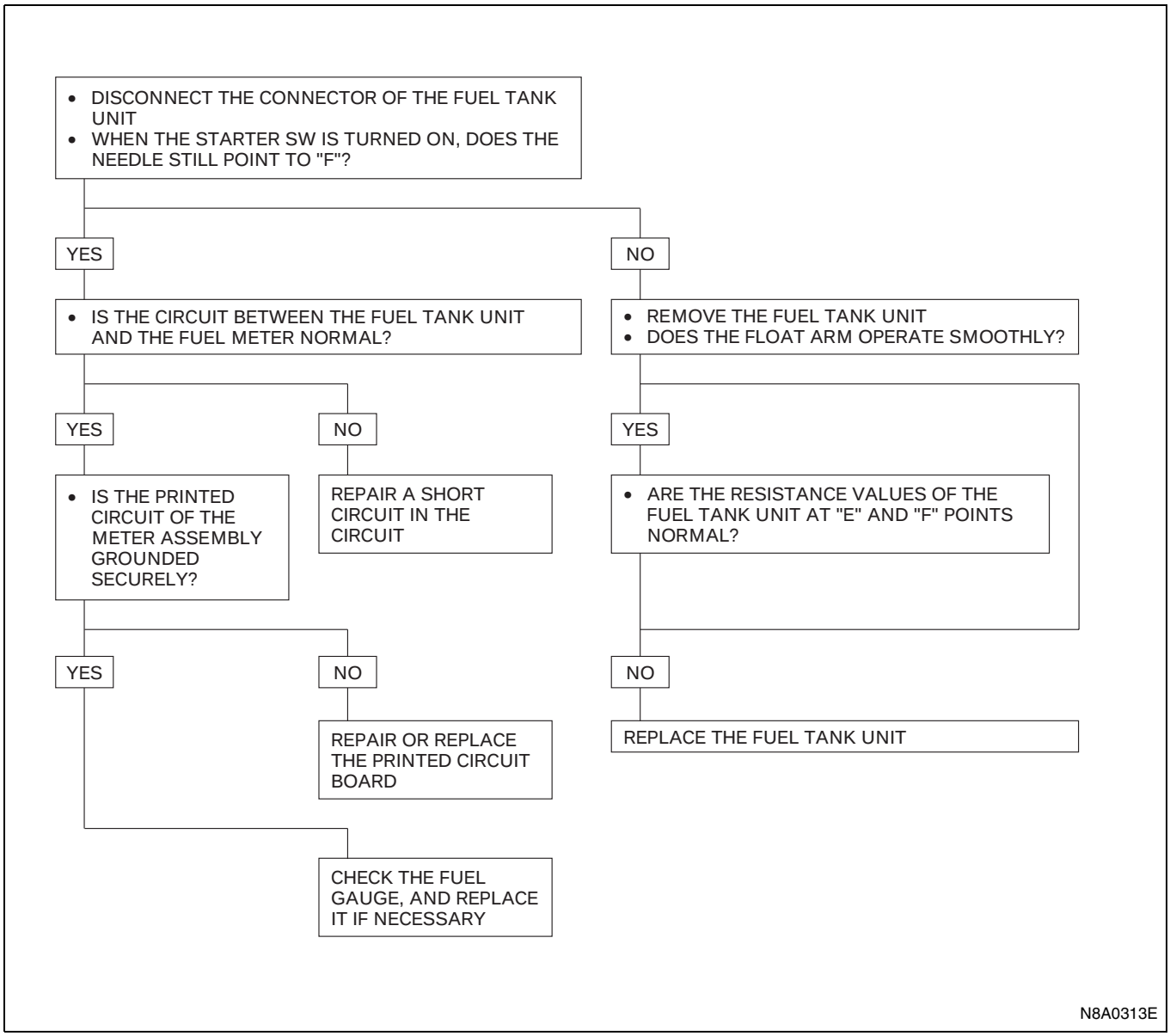
4. Fuel Gauge
4-1. Fuel Gauge Needle Does Not Move



4-2. Even when the Tank Is Filled Up with Fuel, the Needle Does Not Reach “F”

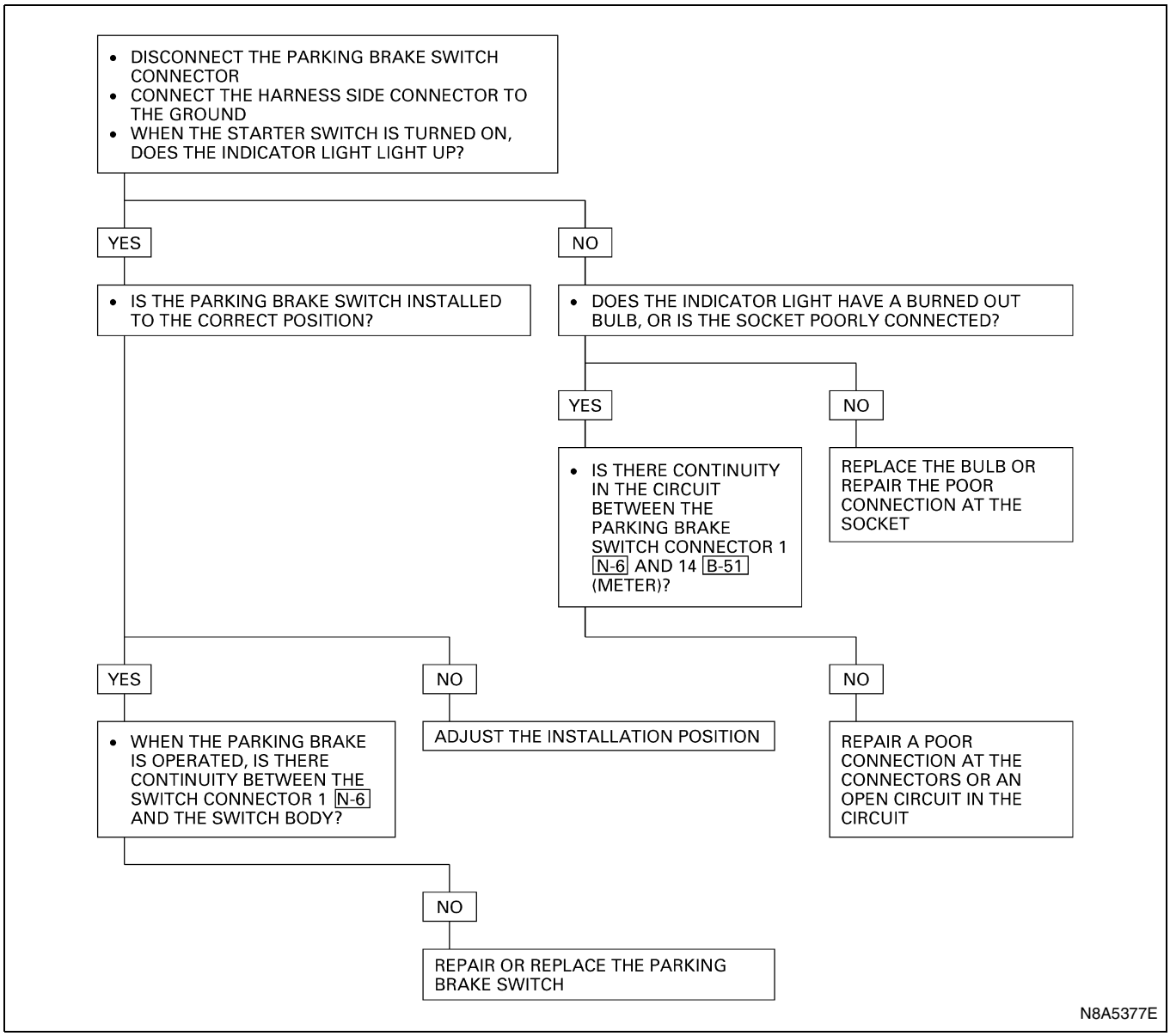


4-3. When the Tank Is Not Full of Fuel, the Needle Overshoots (or Goes Up To “F”)

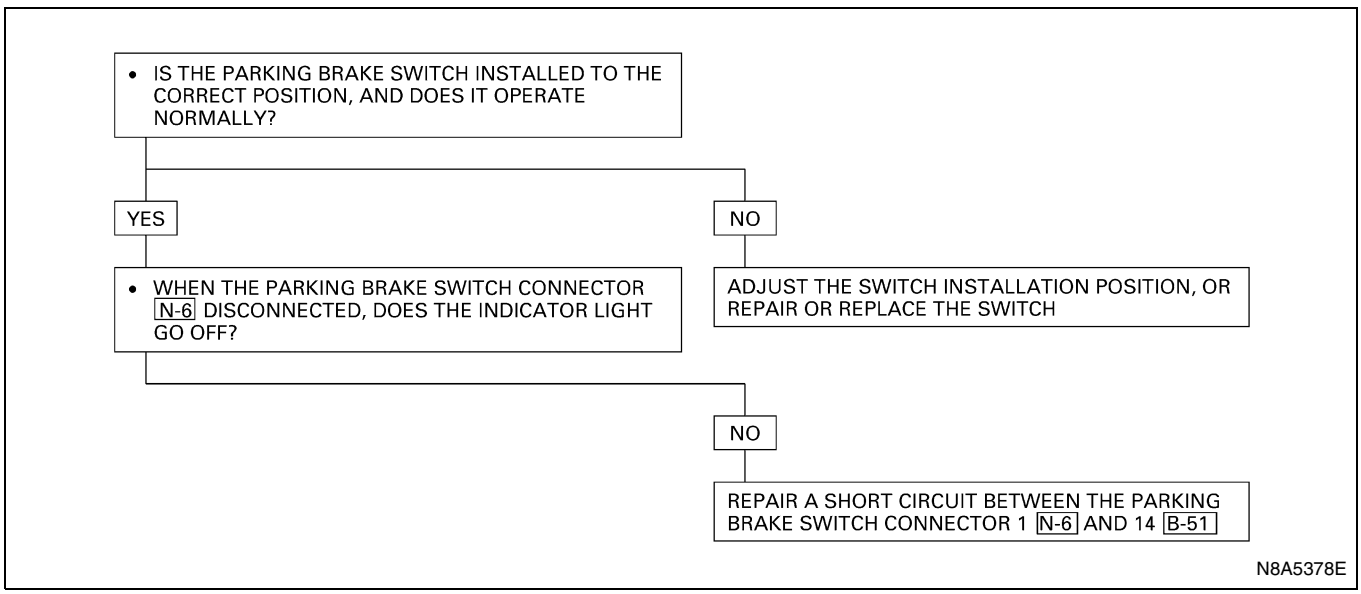


5. Warning/indicator Light

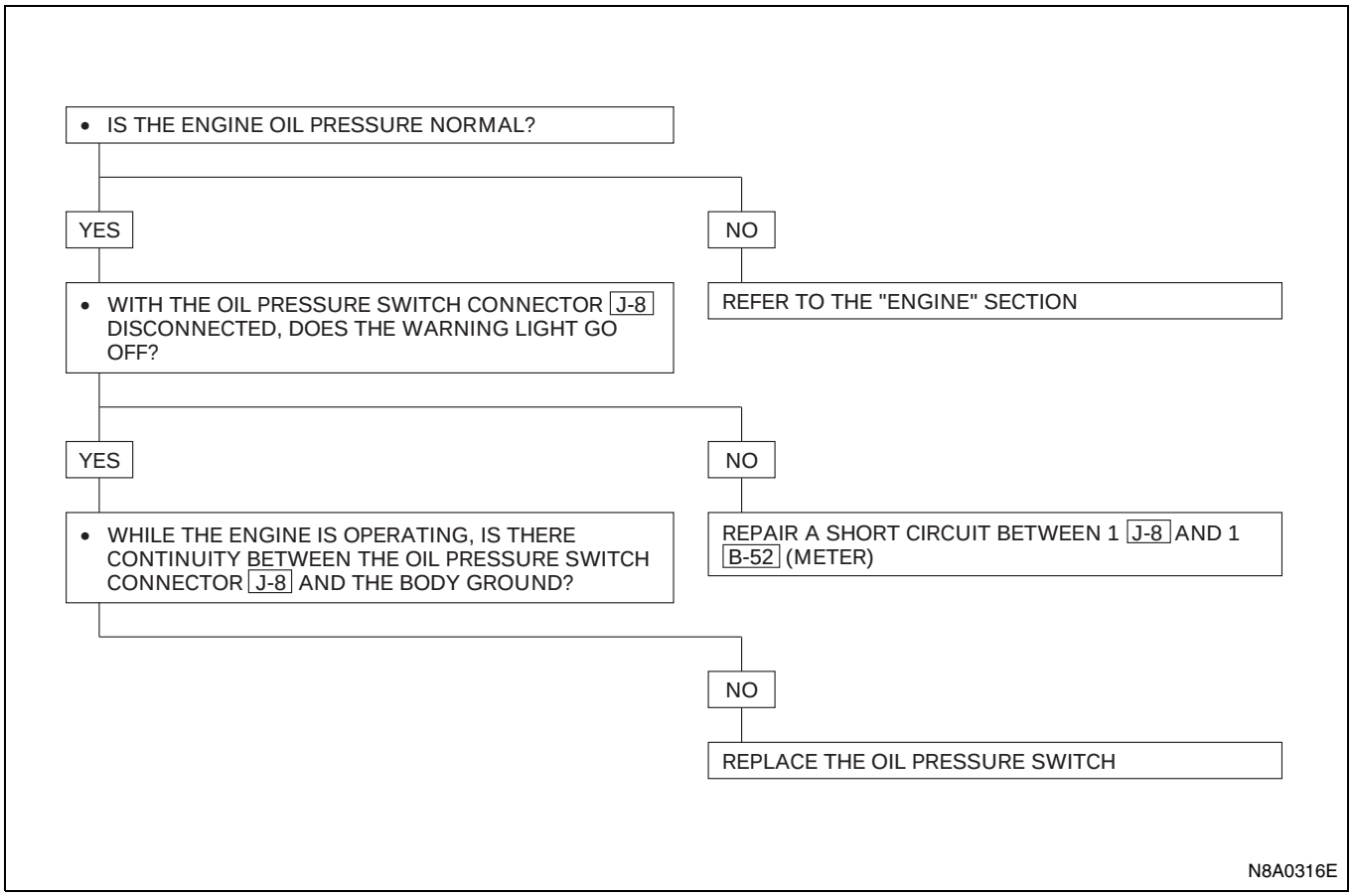
5-1. When the Parking Brake Lever Is Pulled, the Indicator Light Does Not Light Up



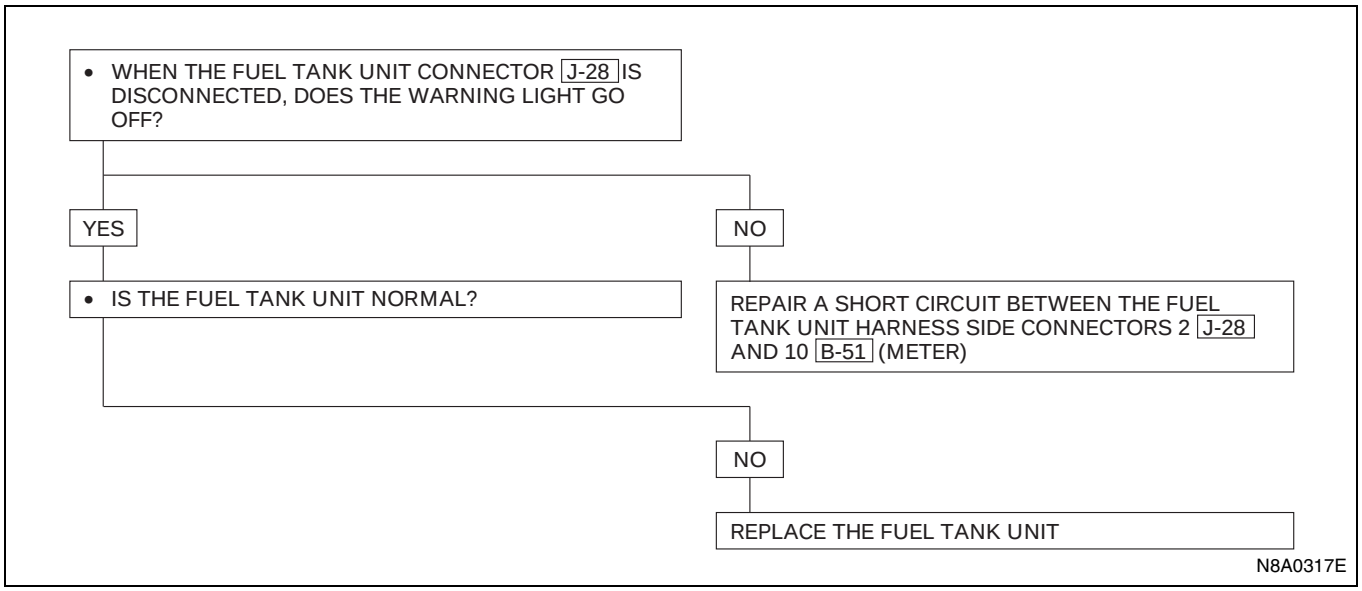
5-2. Even when the Parking Brake Lever Is Released, the Indicator Light Does Not Go Off



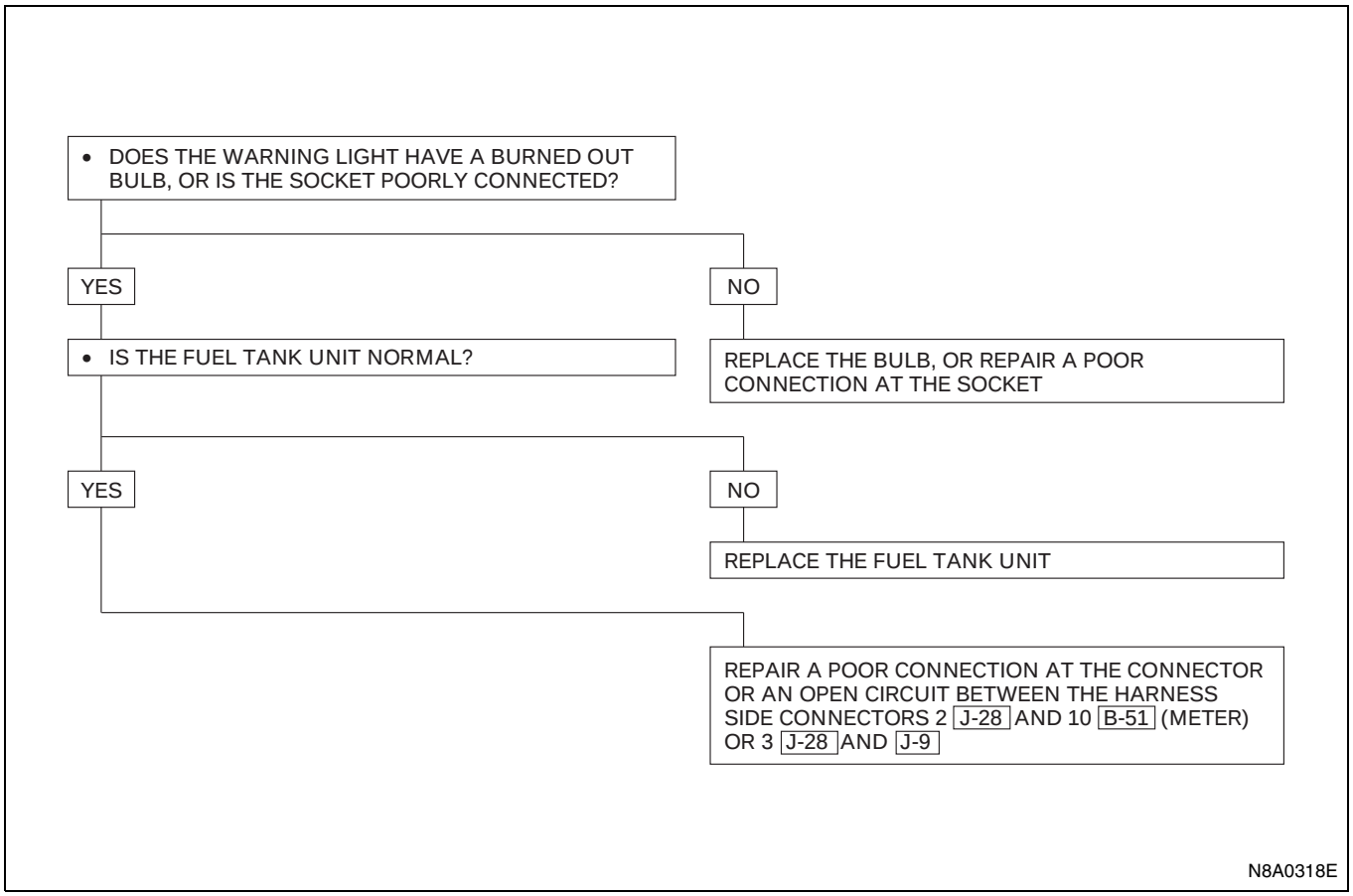
5-3. While the Engine Is Operating, the Oil Pressure Warning Light Does Not Go Off



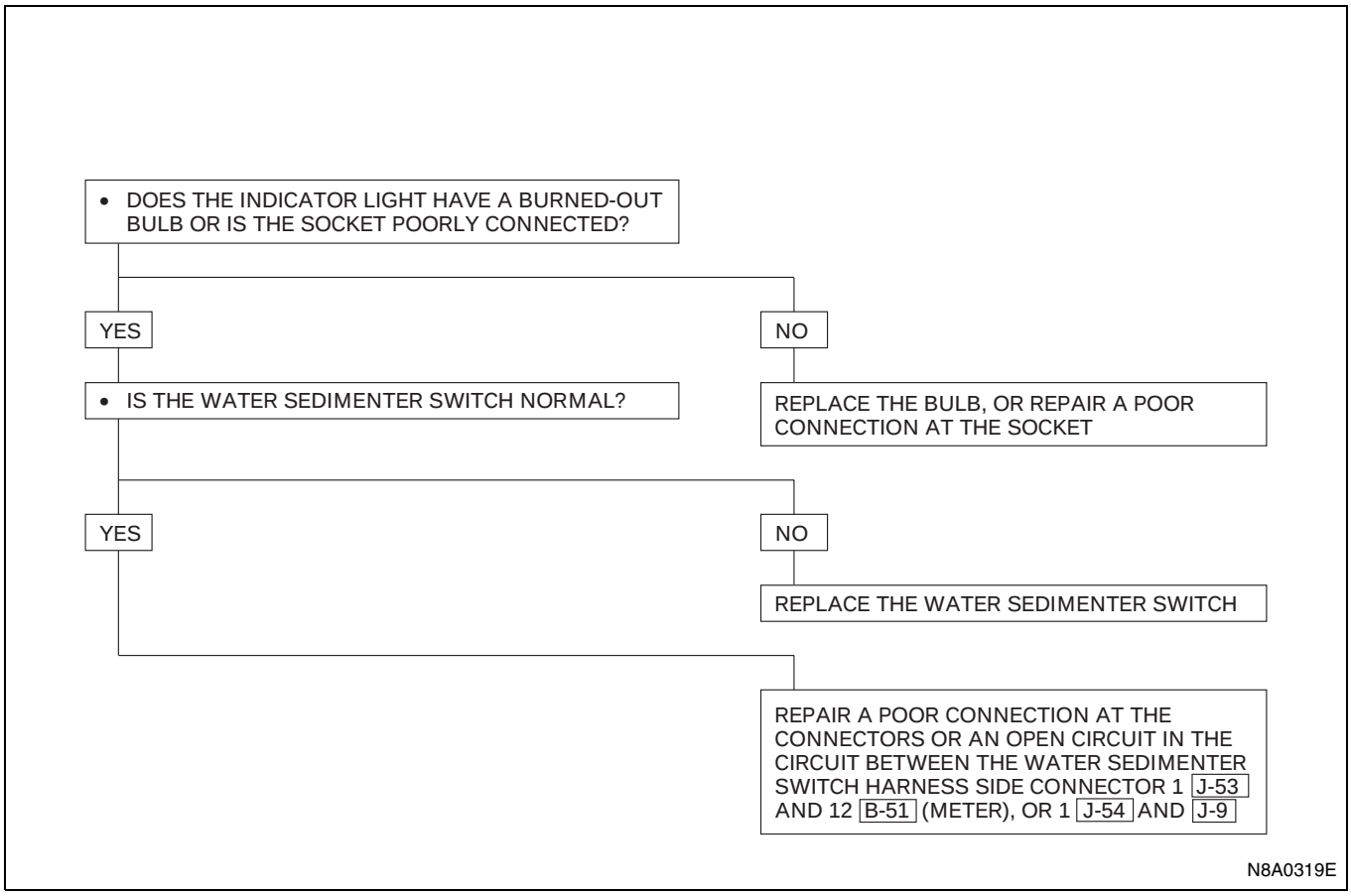
5-4. Even when the Fuel Tank Is Full with Fuel, the Fuel Warning Light Lights Up



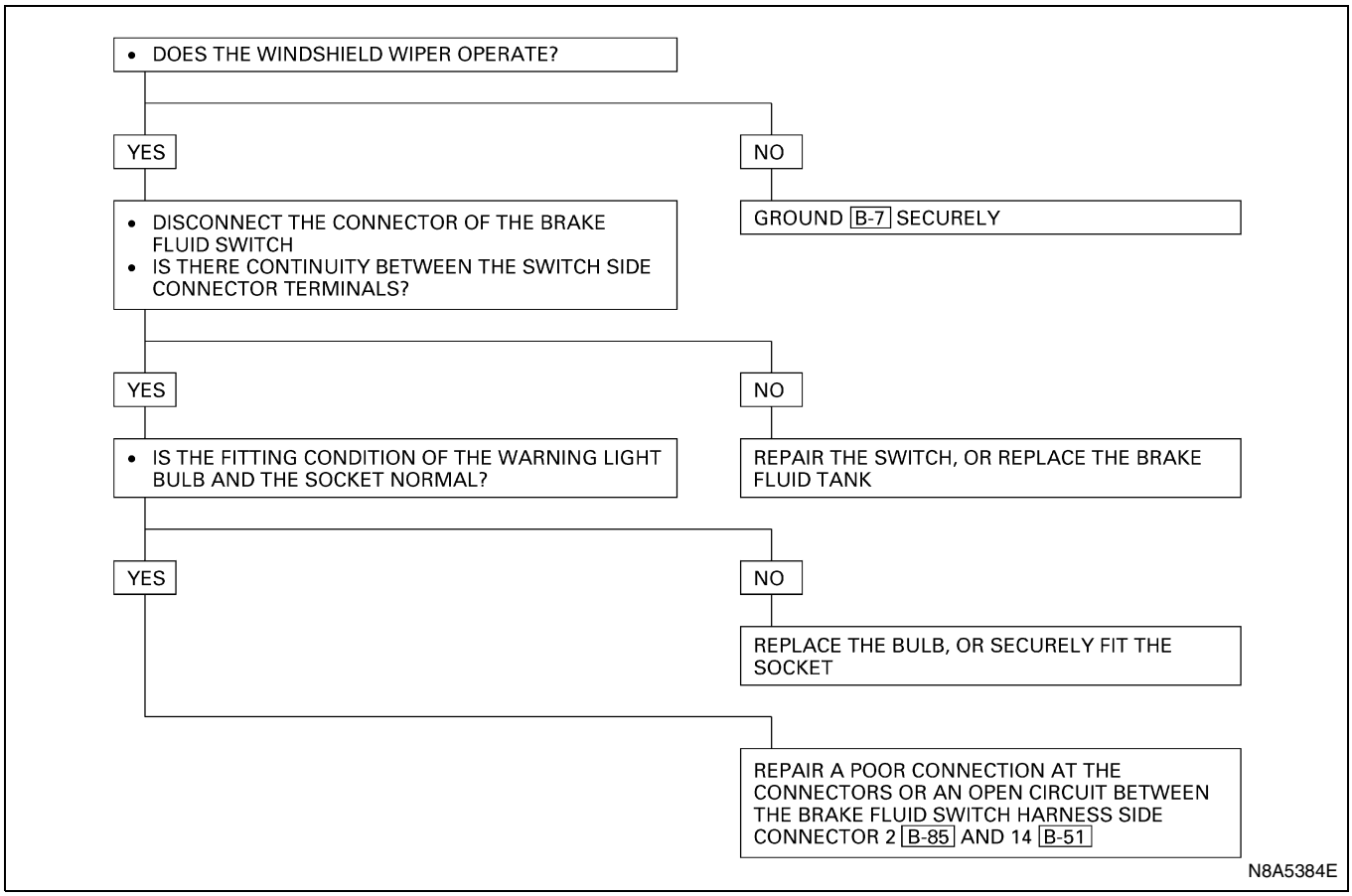
5-5. Even when the Fuel Tank Is Empty, the Low Fuel Warning Light Does Not Light Up



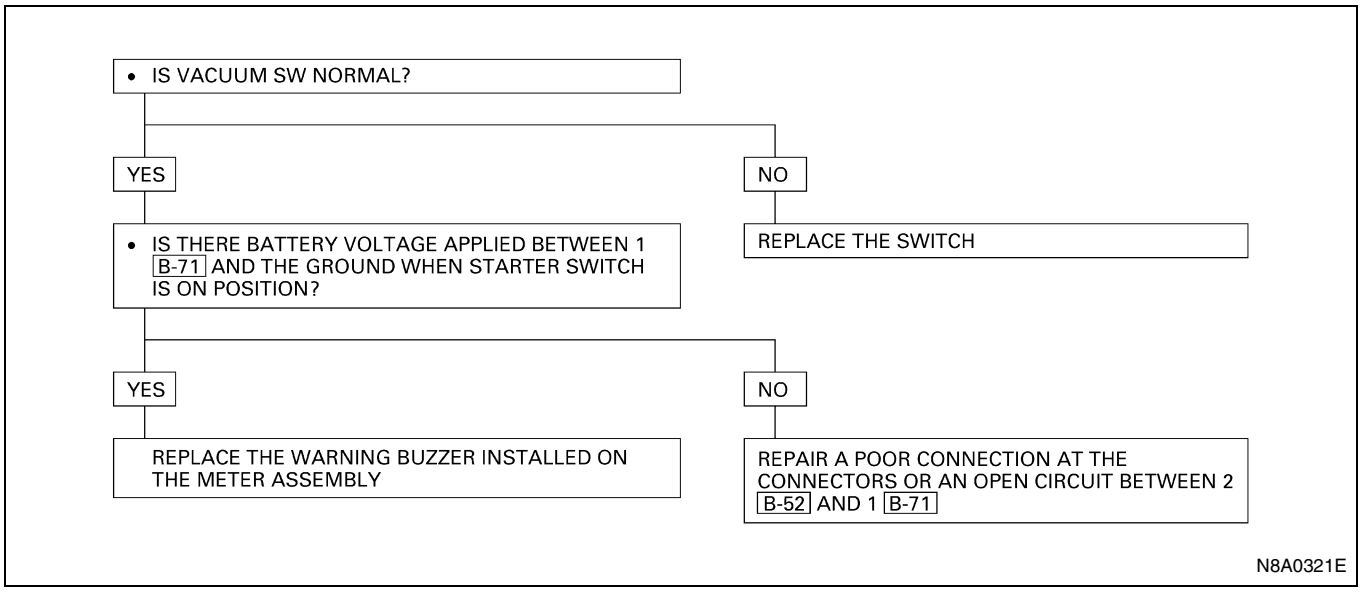
5-6. Even when the Float in the Water Sedimenter Goes Up above the Drain Warning Level, the Indicator Light Does Not Light Up



5-7. Even when the Brake Fluid Is Lower than Specified Level, the Level Warning Light Does Not Light Up



5-8. Vacuum Warning Buzzer Does Not Sound



Starter Switch

Refer to “START AND CHARGING” in this section.

Turn Signal Light Switch

Refer to “TURN SIGNAL LIGHT, HAZARD WARNING LIGHT AND STOPLIGHT” in this section.

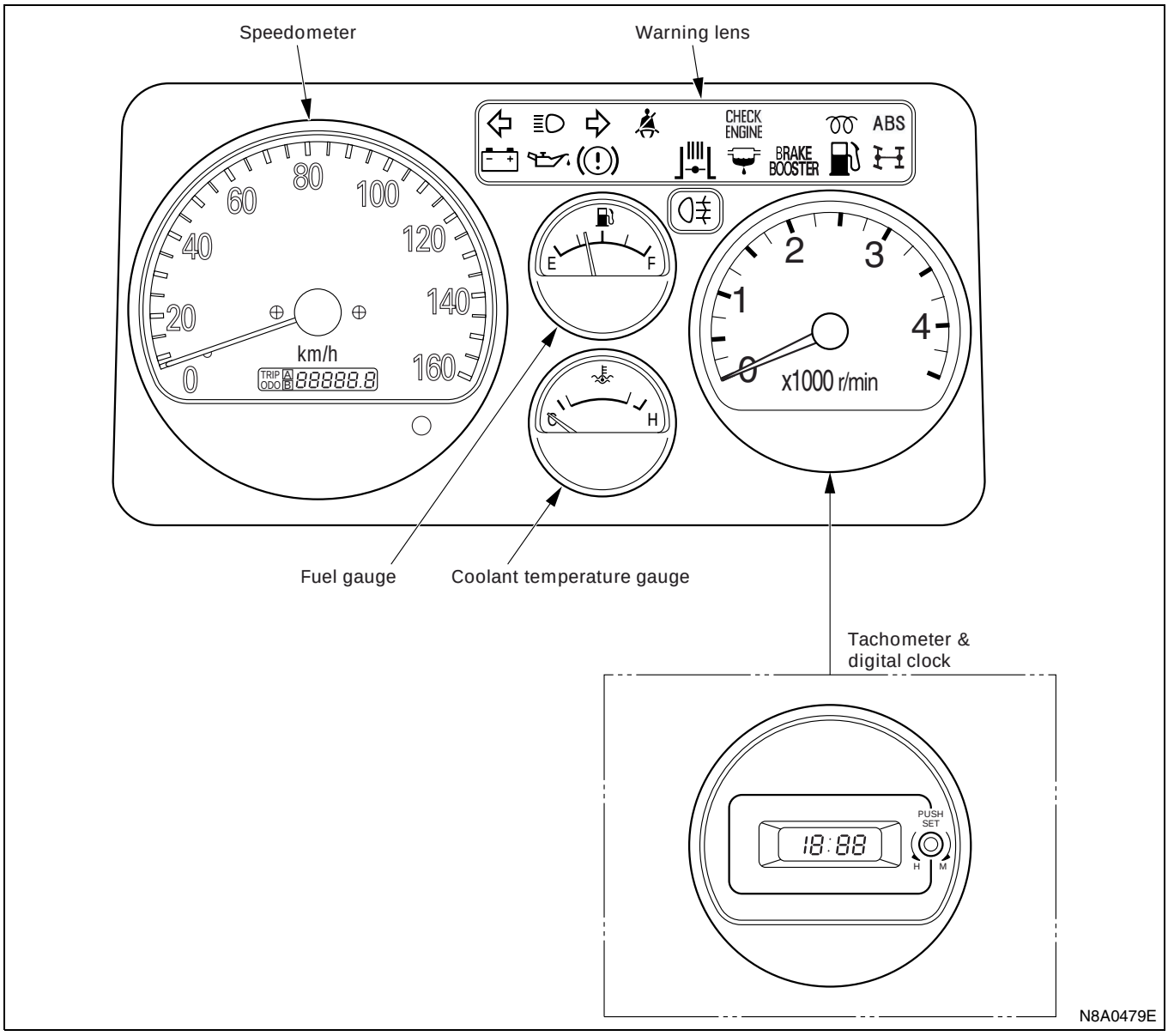
Exhaust Brake Switch

Refer to “EXHAUST BRAKE” in this section.

Meter Assembly

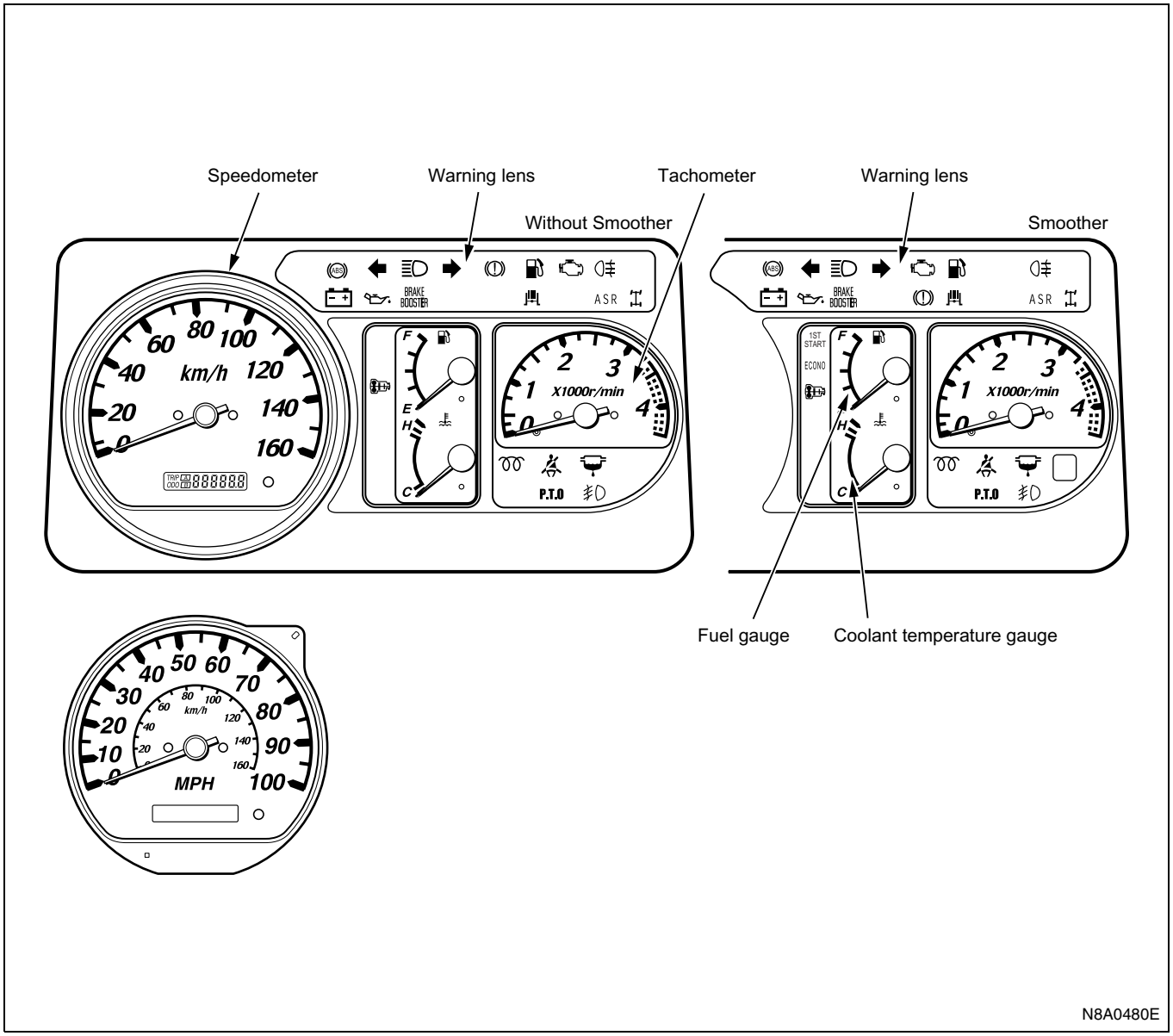
Layout for Gauges, Warning, Indicator and Illumination Lights

Except 4HK1-TC



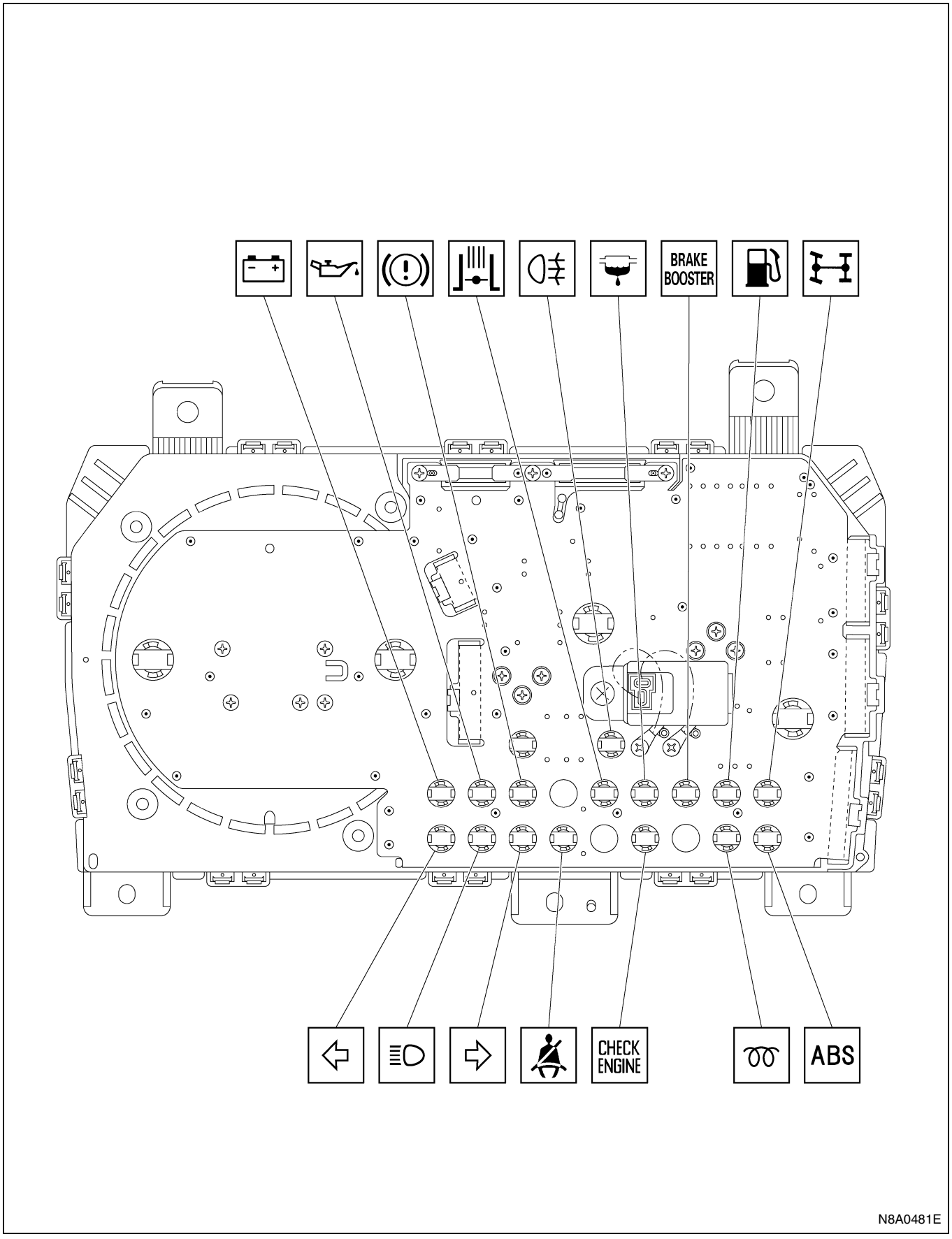
Notice:
The calibration and the red zone of tachometer are various depending on the models fitted.

For 4HK1-TC


Speedometer
Warning lens
Tachometer
Warning lens
Without Smoother
Smoother
km/h
X1000r/min
P.T.O
MPH
Fuel gauge
Coolant temperature gauge
N8A0480E

Bulb Location for Warning Lens

Except 4HK1-TC



For 4HK1-TC

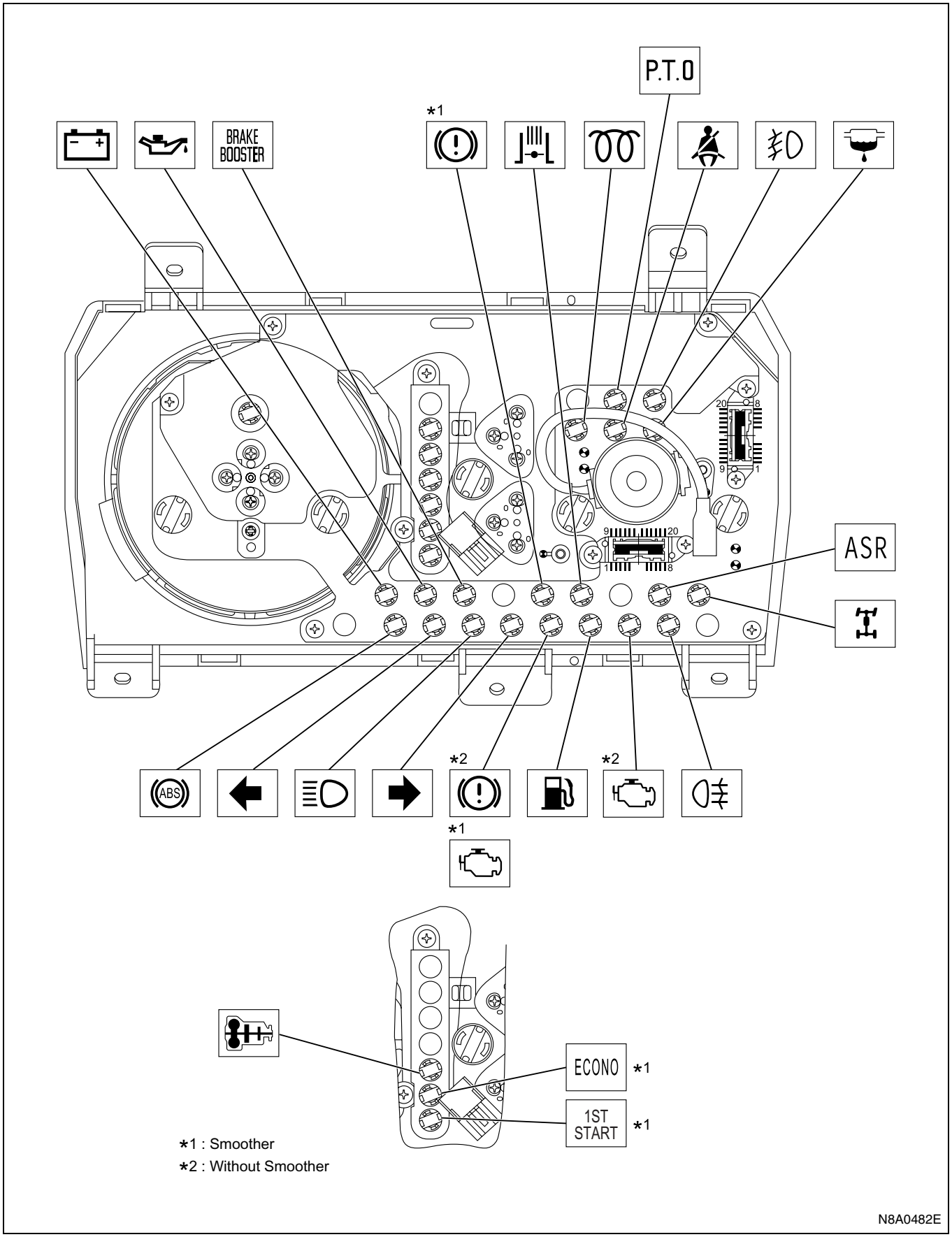
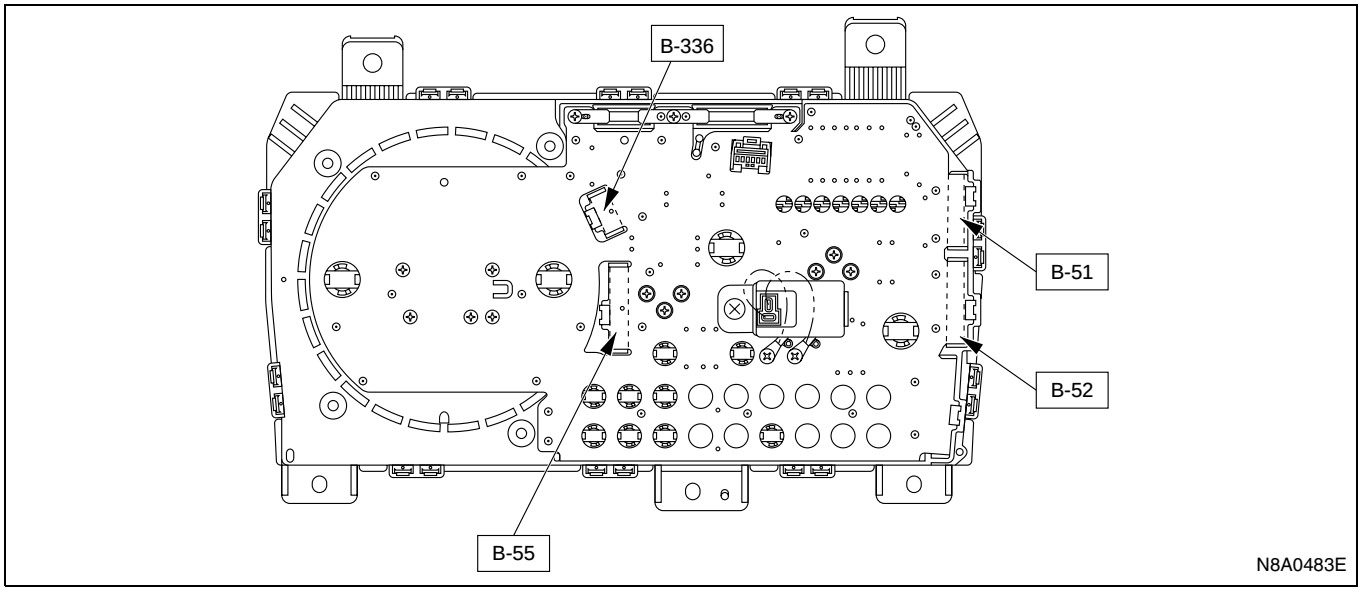

P.T.O
*1
BRAKE BOOSTER
ASR
ABS
*2
*2
*1
ECONO
*1
1ST START
*1
*1 : Smoother
*2 : Without Smoother
N8A0482E

Table for Meter Connector Terminal Connections

Except 4HK1-TC



B-336

Terminal No.	Connected to
1	IGN (+)
2	—
3	Speed pulse input
4	—
5	Ground
6	Illumination (+)

B-51

Terminal No.	Connected to
1	Exh. Brake
2	Exh. Brake / Seat belt (GCC)
3	—
4	Check engine
5	PTO
6	Glow
7	ABS
8	IGN (+)
9	4WD
10	Fuel low
11	Vacuum / Booster
12	Sedimenter
13	Low coolant
14	Brake

B-55

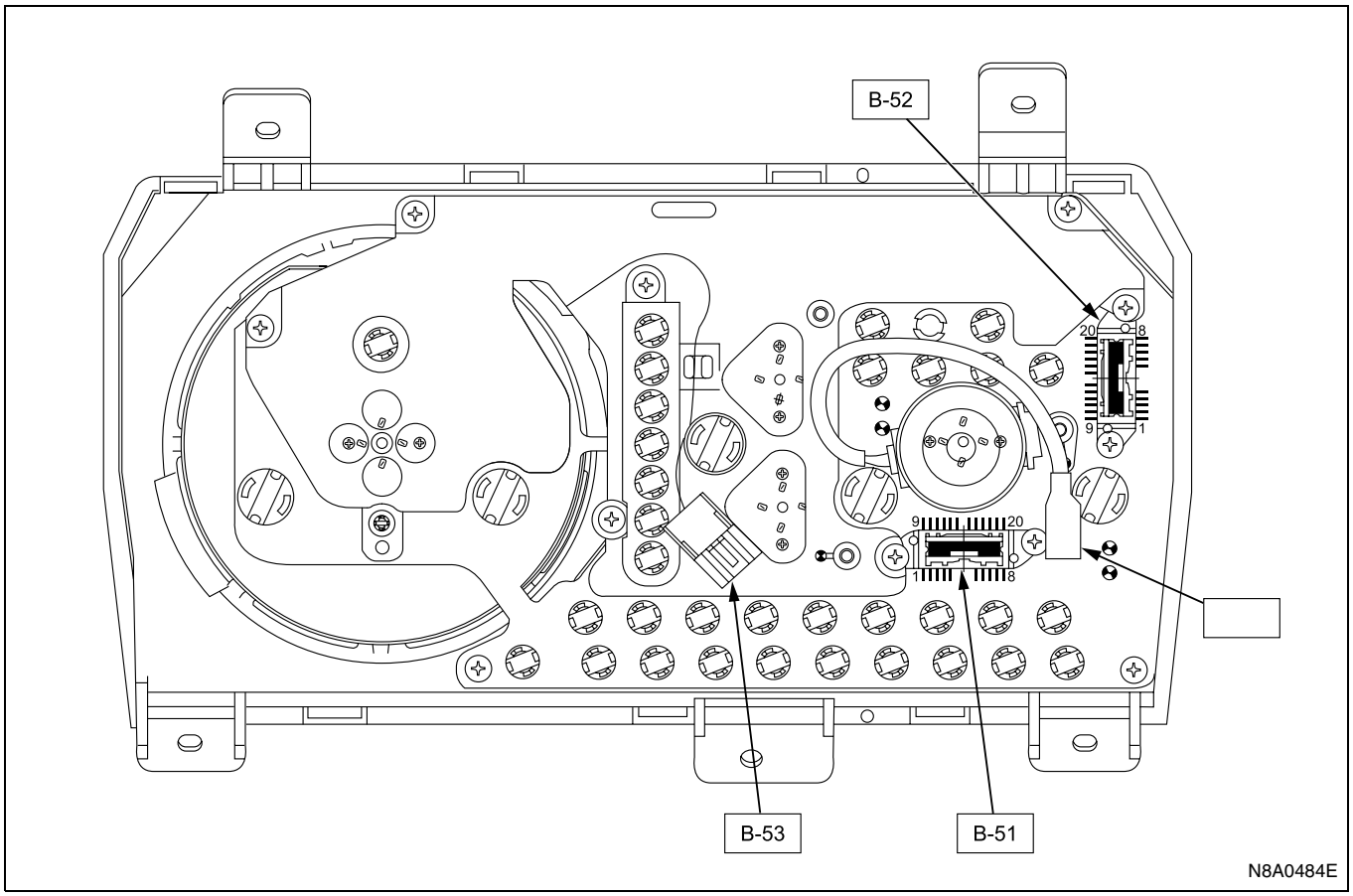
Terminal No.	Connected to
1	Speed pulse input
2	—
3	Power output (sensor)
4	ECT unit (GAUGE)
5	Fuel tank unit (GAUGE)
6	—
7	Ground
8	Turn signal (LH)
9	—
10	Beam (+)
11	Turn signal (RH)
12	—

ECT - Engine Coolant Temperature

B-52

Terminal No.	Connected to
1	Oil pressure
2	Vacuum SW
3	Charge
4	Parking / Rear fog
5	Illumination (+)
6	—
7	Illumination (–)
8	Signal (tacho)
9	Ground (tacho)
10	Ground
11	—
12	+B

For 4HK1-TC



B-53 (With Smoother)

Terminal No.	Connected to
1	TCM
2	—
3	—
4	—
5	—
6	1st Start
7	ECONO
8	Smoother
9	—
10	—
11	—
12	—

B-51

Terminal No.	Connected to
1	Turn LH
2	Beam
3	—
4	Brake (*1) / — (*2)
5	Check Engine (*1) / Brake (*2)
6	Exhaust Brake
7	—
8	—
9	Brake Booster
10	Charge
11	Oil Pressure
12	ABS
13	— (*1) / Check Engine (*2)
14	—
15	Ground
16	Vehicle Speed Signal Output
17	Illumination +
18	Ignition
19	Rear Fog
20	ASR

*1: With Smoother
*2: Without Smoother

B-52

Terminal No.	Connected to
1	4WD
2	—
3	Turn RH
4	—
5	Thermal
6	Fuel
7	TAM Pulse (–)
8	TAM Pulse (+)
9	—
10	Sedimenter
11	Front Fog
12	—
13	—
14	—
15	Glow
16	Battery
17	Vehicle Speed Sensor
18	—
19	—
20	Ground

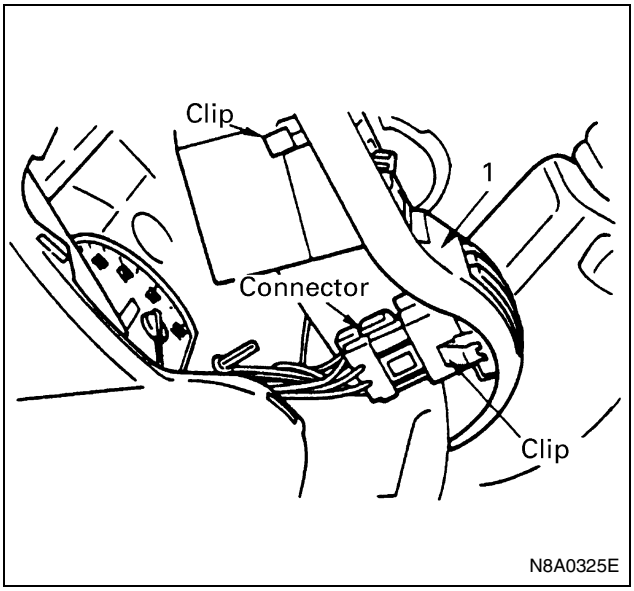
Terminal No.	Connected to
1	Battery
2	—
3	Ground

Removal

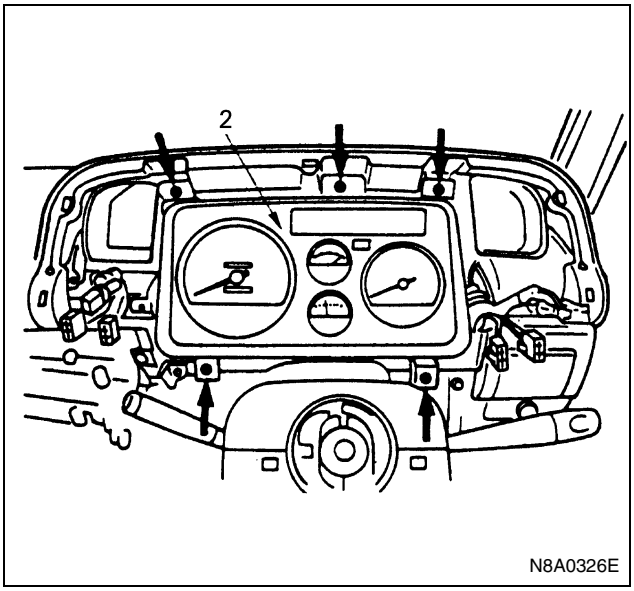
Preparation:

Disconnect the battery ground cable.

1. Meter Cluster



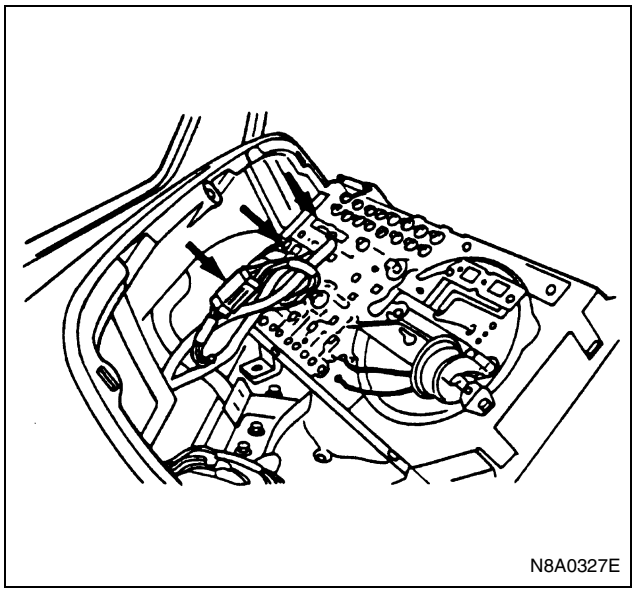
2. Meter Assembly
   Remove the five screws.



Disconnect the meter connectors.

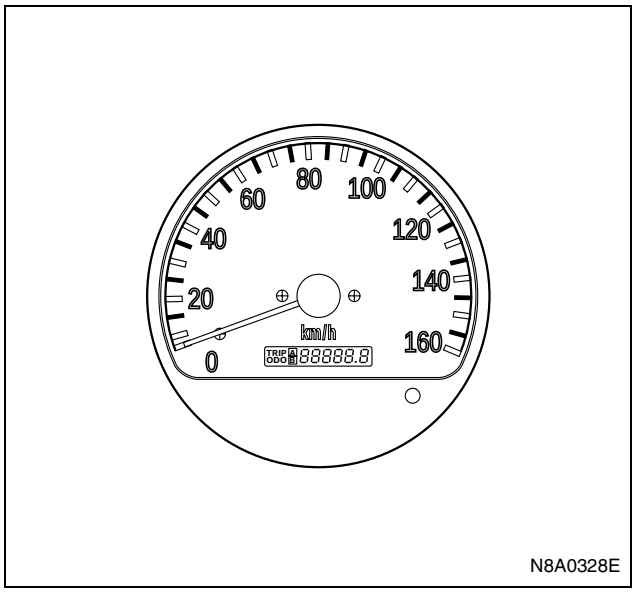
Installation

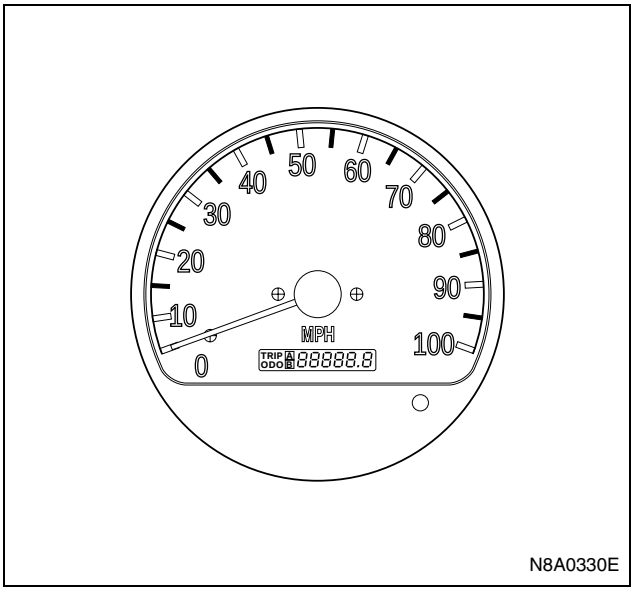
To install, follow the removal steps in the reverse order.



Speedometer

The speedometer is made up of the cross coil type ammeter (movement) that displays indications, the stepper motor that drives and adds up the odometer and trip meter, and the driving circuit (printed circuit board) that makes exchanges between the pulse signals and the current.





On-vehicle Service

Check the meter display accuracy and the operation of the odometer with the speedometer tester.

Notice:

Inappropriate tire inflation may affect the accuracy of the odometer.

(To conduct this test, refer to the tester manufacturer's instruction manual.)

Since the meter display permissible levels above are specifications solely for the meter, they are to be used as reference values when conducting on-vehicle service.

Except 4HK1-TC

Tester display speed	Meter display permissible level
20 km/h	17.5 — 22.5 km/h
40	37.5 — 42.5
60	57.5 — 62.5
80	77.5 — 82.5
100	97.6 — 103.4
120	117.6 — 123.4
140	137.6 — 143.4

Tester display speed	Meter display permissible level
20 MPH	18.3 — 21.7 MPH
40	38.3 — 41.7
60	58.3 — 61.7
80	77.8 — 82.8

For 4HK1-TC (General Export)

Tester display speed	Meter display permissible level
40 km/h	37 — 41 km/h
60	58 — 62
80	77.5 — 82.5
100	97.5 — 103
120	117 — 122.5
140	137.5 — 143

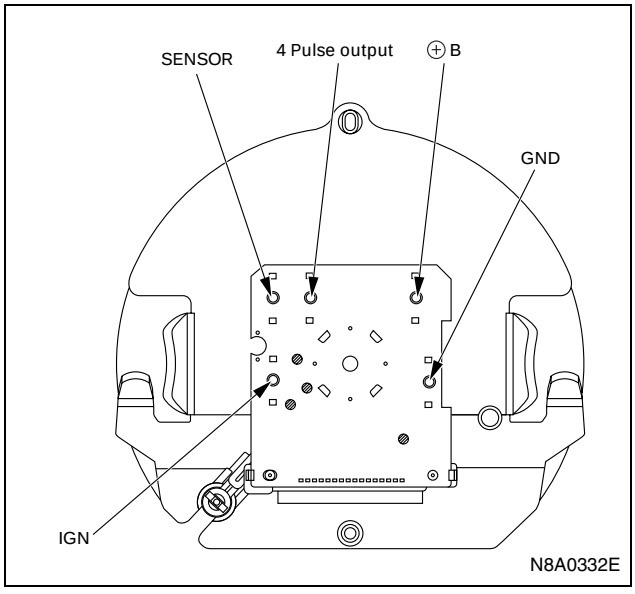
For 4HK1-TC (Europe)

Tester display speed	Meter display permissible level
20 km/h	20 — 22.5 km/h
40	40 — 42.5
60	60 — 63.2
80	79.7 — 83.4

Individual Inspection

Remove the speedometer from the meter assembly and measure the resistance and the current consumption between each terminals.

Replace the speedometer when the result of inspection is found abnormal.



Terminal symbol	Resistance value
IGN — GND	58±20 kΩ
SEN — GND	70±20 kΩ
4P — GND	∞

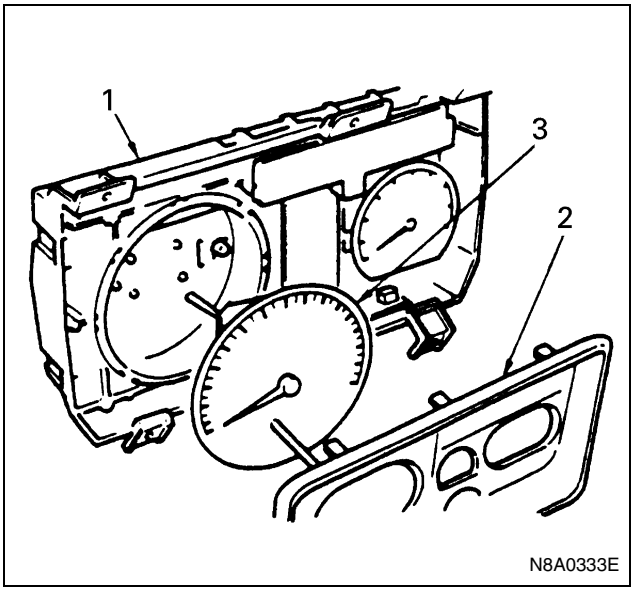
Removal

Preparation:

Disconnect the battery ground cable.

- Except 4HK1-TC

1. Meter Assembly
   Refer to “METER ASSEMBLY” in this section.
2. Meter Glass
   Remove it by pushing the catches with your finger.
3. Speedometer
   Remove four screws securing the meter at the back side.



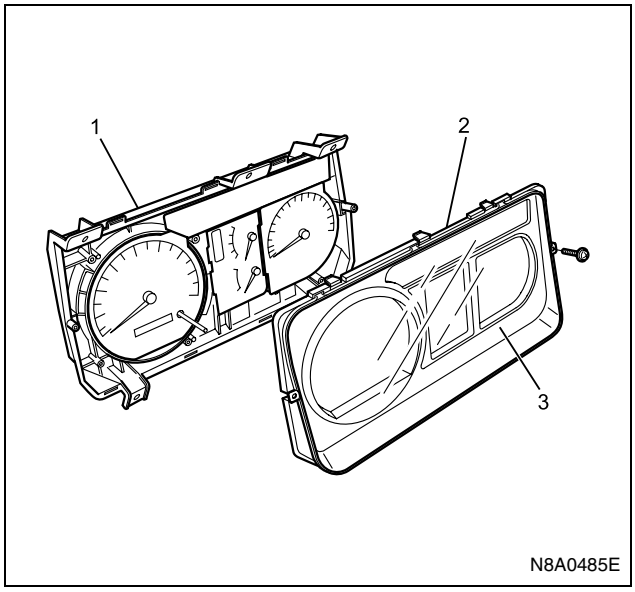
- For 4HK1-TC

1. Remove the meter assembly/speedometer (1).

Notice:
Speedometer cannot be removed as a single unit since it is integrated into the meter assembly.

   - Refer to “Meter Assembly” in this section.

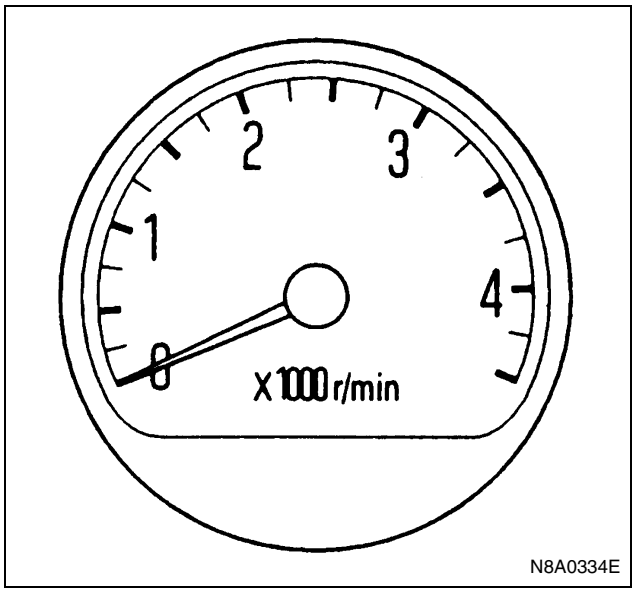
2. Remove the meter plate (2) and meter glass (3).
   - Remove the two installing screws on the meter surface.
   - Remove the meter plate by pushing the catches with your finger.



Installation
To install, follow the removal steps in the reverse order.

Tachometer

The tachometer is made up of the cross coil type ammeter (movement) that displays indications, and the drive circuit (printed board) that makes exchange between the pulse signals and the current.



On-vehicle Service Inspection

1. Set up the tune-up tester to the engine.
2. Start the engine and compare the readings displayed by the tachometer and the tester.
   When the difference between these two readings differs largely from the specified value, replace it with a correct one.

Notice:
Since the meter display permissible levels above are specifications solely for the meter, they are to be used as reference values when conducting on-vehicle inspection.

Except 4HK1-TC

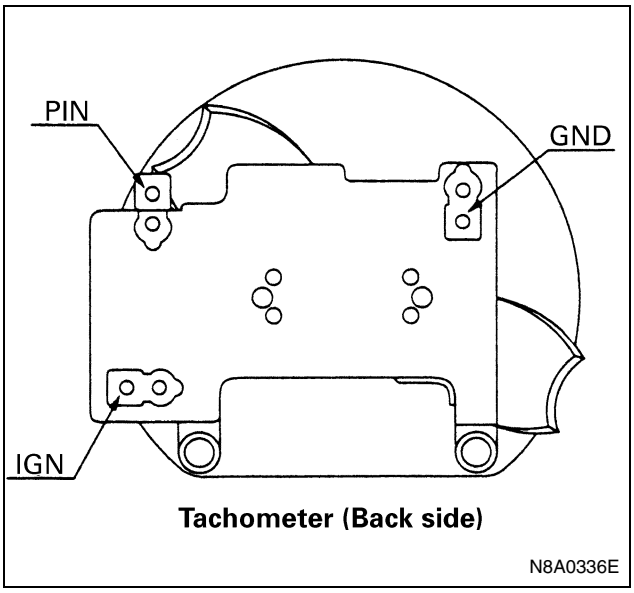
Tester display speed	Meter display permissible level
500	400 — 500
1000	800 — 1050
2000	1800 — 2050
3000	2800 — 3050
4000	3800 — 4050

For 4HK1-TC

Tester display speed	Meter display permissible level
750	700 — 800
2000	1900 — 2150
3000	2950 — 3200
4000	3950 — 4200

Individual Inspection

Remove the tachometer from the meter assembly and measure the resistance value and the current consumption between each terminals.
Replace the tachometer when the result of inspection is found abnormal.



Tachometer (Back side)

N8A0336E

1. Resistance value

Use the analog type circuit tester. (Range: 1K)
For 12 Volt tachometer

Terminal symbol	Tester terminal			
	Red (+)	Black (–)	Black (–)	Red (+)
IGN — GND	IGN	GND	IGN	GND
	∞		30±5 kΩ	
PIN — GND	PIN	GND	PIN	GND
	33±5 kΩ		500 — 1000 kΩ	

For 24 Volt tachometer

Terminal symbol	Tester terminal			
	Red (+)	Black (–)	Black (–)	Red (+)
IGN — GND	IGN	GND	IGN	GND
	∞		30±5 kΩ	
PIN — GND	PIN	GND	PIN	GND
	33±5 kΩ		500 — 1000 kΩ	

2. Current value

Use the analog type circuit tester.
Since the current consumption fluctuates as the power voltage varies, check to be sure that the voltage applied is 12±1 V or 24±1 V.

Voltage	Connecting terminal	Current consumption	Remarks
12Volt	IGN — GND	12±1 V (when 12±1 V applied)	No signal input
24Volt		24±1 V (when 24±1 V applied)	No signal input

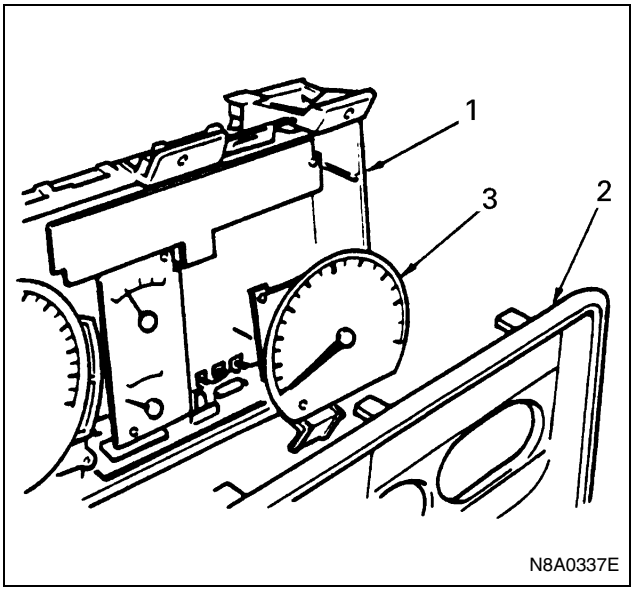
Removal

Preparation:

Disconnect the battery ground cable.

- Except 4HK1-TC

1. Meter Assembly
   Refer to “METER ASSEMBLY” in this section.
2. Meter Glass
   Remove it by pushing the catches with your finger.
3. Tachometer
   Remove three screws securing the meter at the back side.



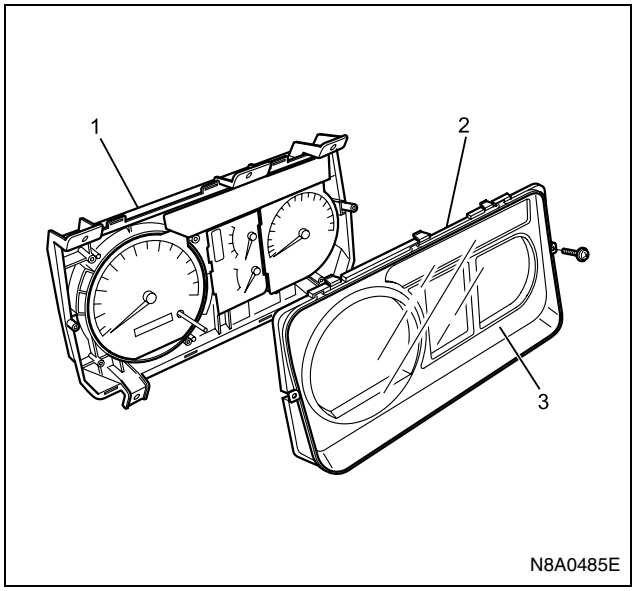
- For 4HK1-TC

1. Remove the meter assembly/tachometer (1).

Notice:
Tachometer cannot be removed as a single unit since it is integrated into the meter assembly.

- Refer to “Meter Assembly” in this section.

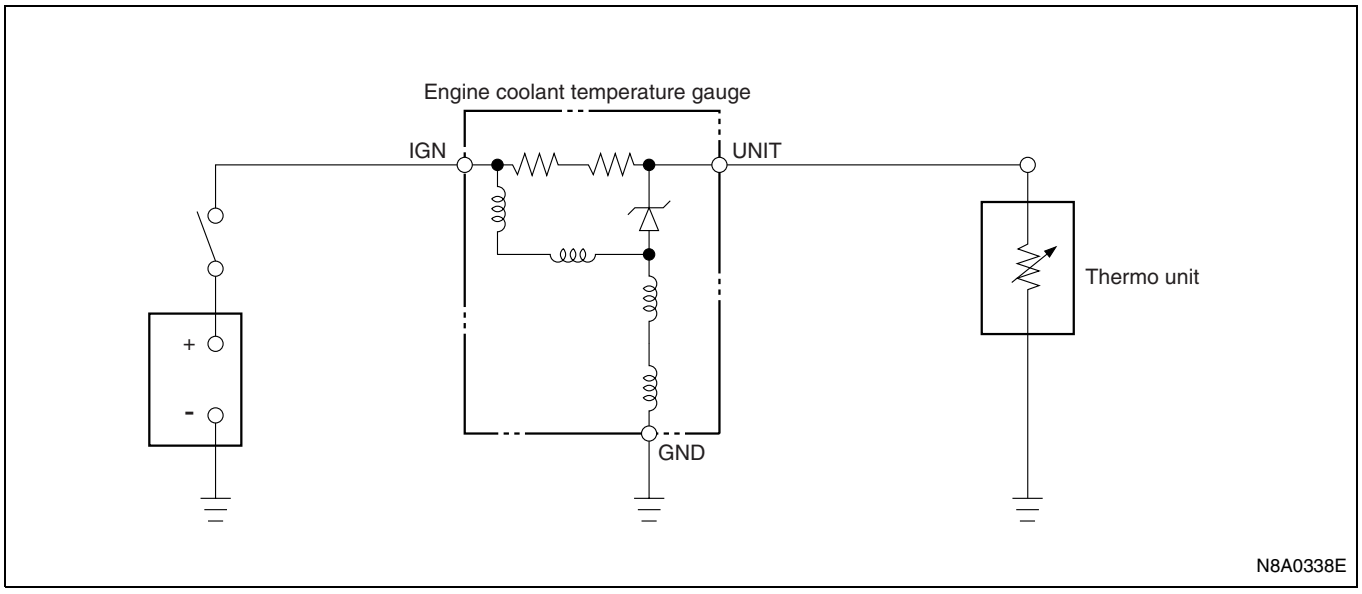
2. Remove the meter plate (2) and meter glass (3).
   - Remove the two installing screws on the meter surface.
   - Remove the meter plate by pushing the catches with your finger.



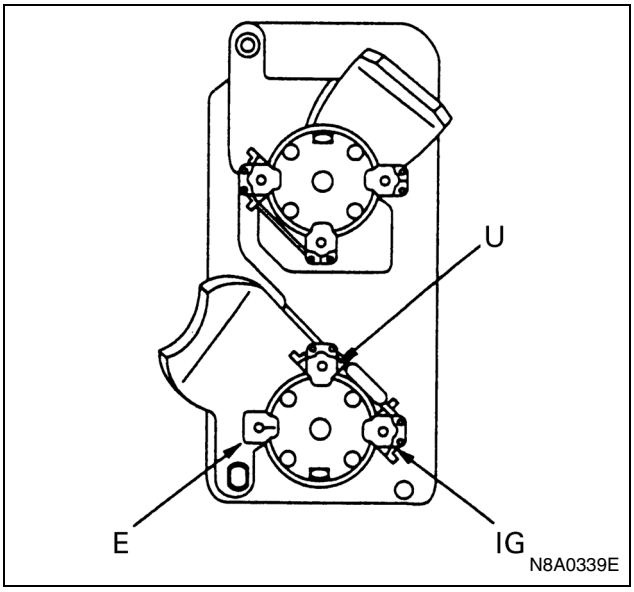
Installation
To install, follow the removal steps in the reverse order.

Coolant Temperature Gauge

Circuit Diagram



Inspection
Remove the coolant temperature gauge from the meter assembly, and measure the resistance value between each terminal.
Replace the coolant temperature gauge when the result of inspection is found abnormal.



Terminal symbol	Resistance value
IG — U	169 Ω±10%
U — E	333 Ω±10%
IG — E	242 Ω±10%

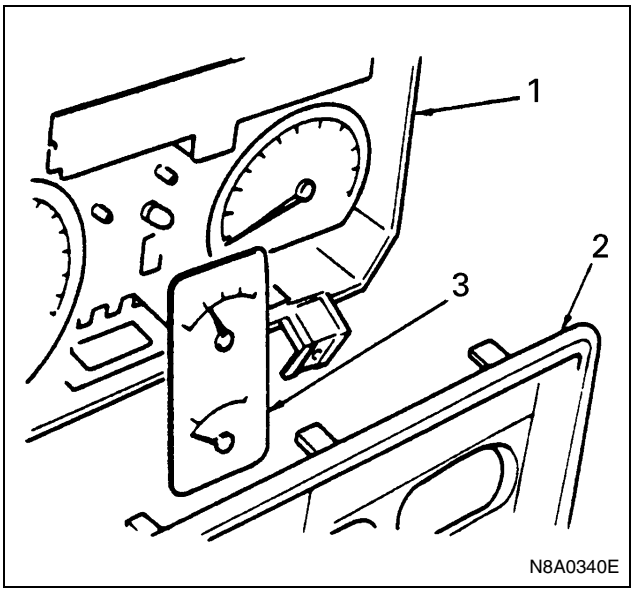
Removal

Preparation:

Disconnect the battery ground cable.

- Except 4HK1-TC

1. Meter Assembly
   Refer to “METER ASSEMBLY” in this section.
2. Meter Glass
   Remove it by pushing the catches with your finger.
3. Coolant Temperature Gauge
   Remove six screws securing the meter at the back side.



- For 4HK1-TC

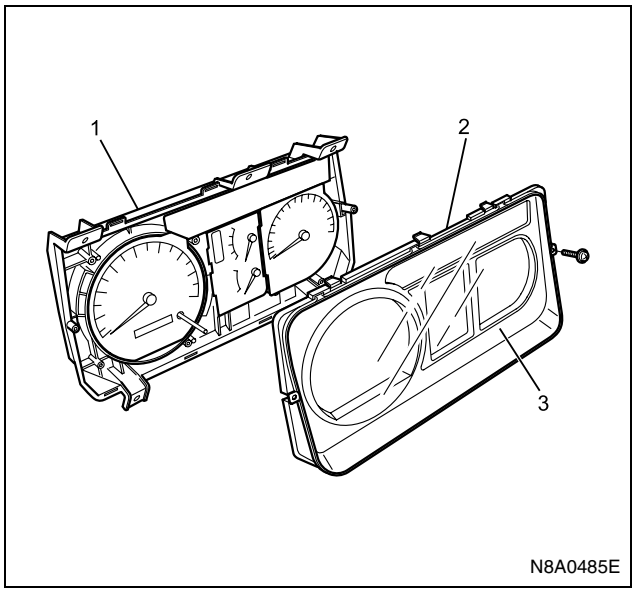
1. Remove the meter assembly (1).

Notice:

Coolant temperature gauge and fuel gauge cannot be removed as a single unit since they are integrated into the meter assembly.

- Refer to “Meter Assembly” in this section.

2. Remove the meter plate (2) and meter glass (3).
   - Remove the two installing screws on the meter surface.
   - Remove the meter plate by pushing the catches with your finger.

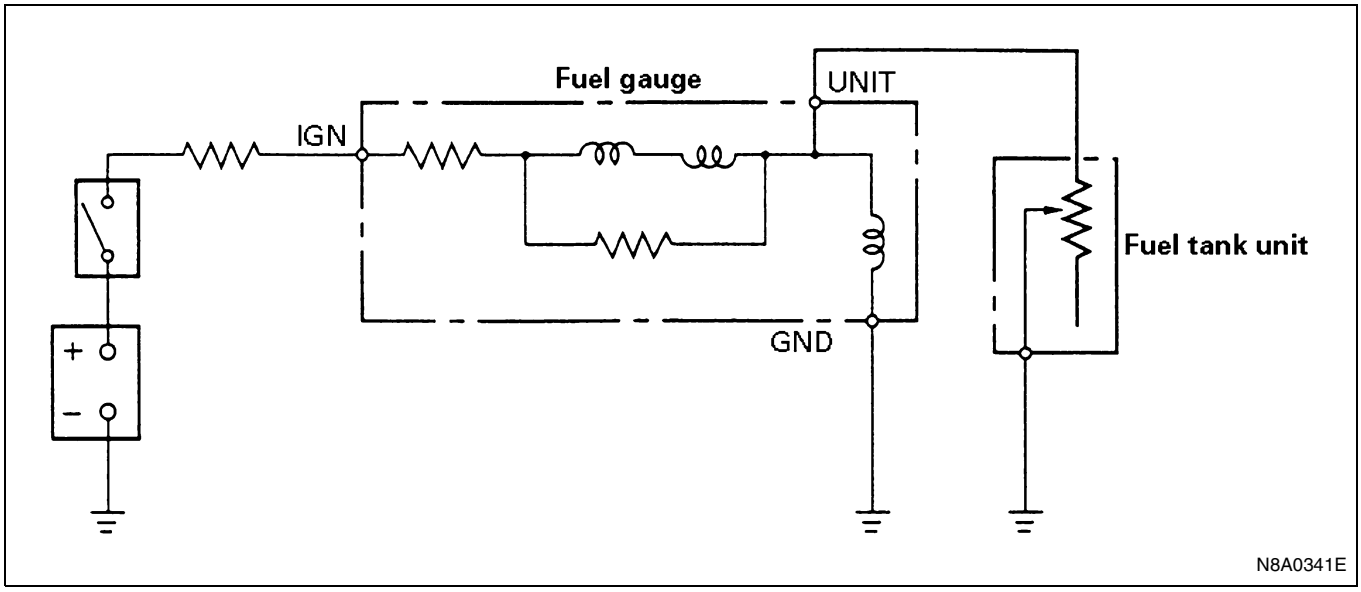


Installation

To install, follow the removal steps in the reverse order.

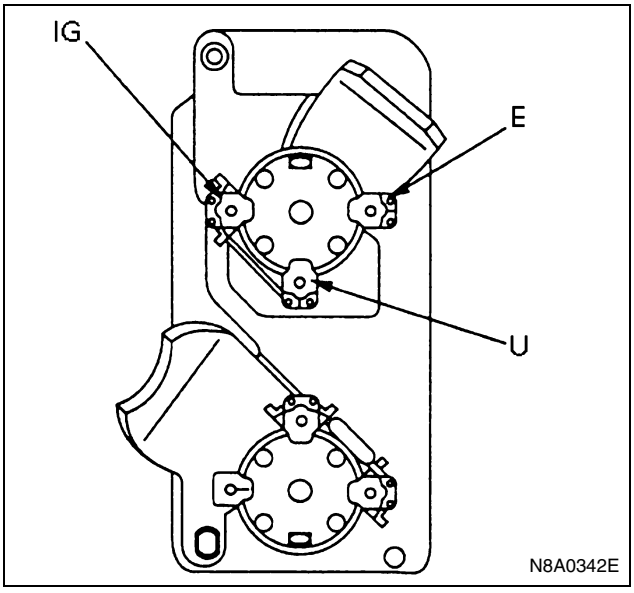
Fuel Gauge

Circuit Diagram



Inspection

Remove the fuel gauge from the meter assembly, and measure the resistance value between each terminal. Replace the meter when the result of inspection is found abnormal.



Terminal symbol	Resistance value
IG — U	108.1 Ω±10%
U — E	103 Ω±10%
IG — E	211.1 Ω±10%

Removal and Installation

Refer to the “COOLANT TEMPERATURE GAUGE” in this section.

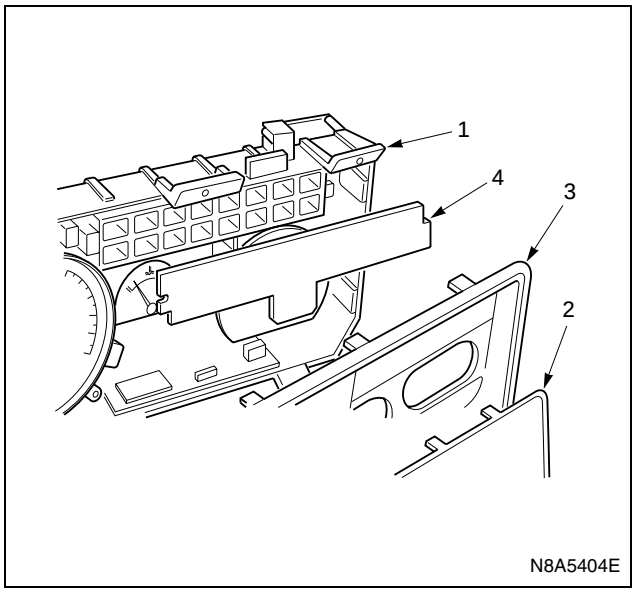
Warning Lens

Removal

Preparation:

Disconnect the battery ground cable.

1. Meter Assembly
   Refer to “METER ASSEMBLY” in this section.
2. Meter Glass
   Remove it by pushing the catches with your finger.
3. Meter Plate
   Remove it by pushing the catches with your finger.
4. Warning Lens



Legend

1. Meter Assembly
2. Meter Glass
3. Meter Plate
4. Warning Lens

Installation

To install, follow the removal steps in the reverse order.

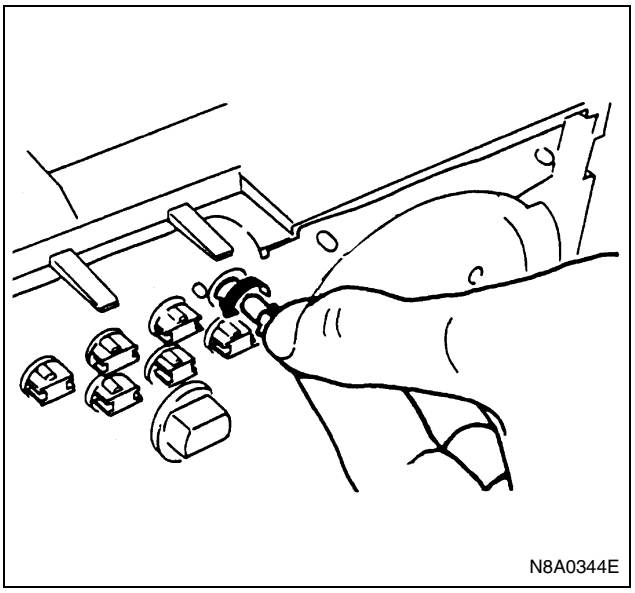
Warning Light Bulb, Indicator Light Bulb and Illumination Light Bulb

Removal

Preparation:

Disconnect the battery ground cable.

1. Meter Assembly
   Refer to “METER ASSEMBLY” in this section.
2. Socket and Bulb
   Hold the bulb socket by hand and rotate it counterclockwise to remove them from the meter body.
3. Bulb
   Pull out the bulb from the socket.



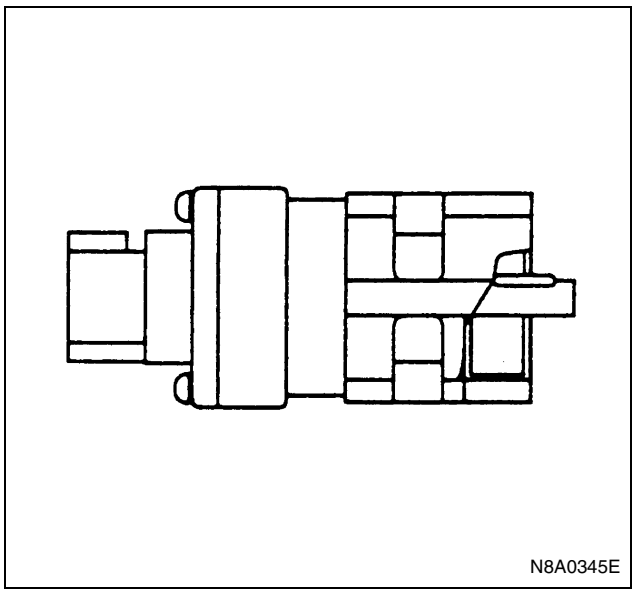
N8A0344E

Installation

To install, follow the removal steps in the reverse order.

Vehicle Speed Sensor

The vehicle speed sensor is installed on the rear portion of the transmission or transfer case.
The number of pulses generated is four pulses per one rotation of the pinion shaft.



N8A0345E

Inspection

1. Connect a resistance of 390 Ω±5%, 2W between connector terminal 1 J-32 and battery (+) terminal and connect the connector terminal 2 J-32 to the battery (−) terminal.

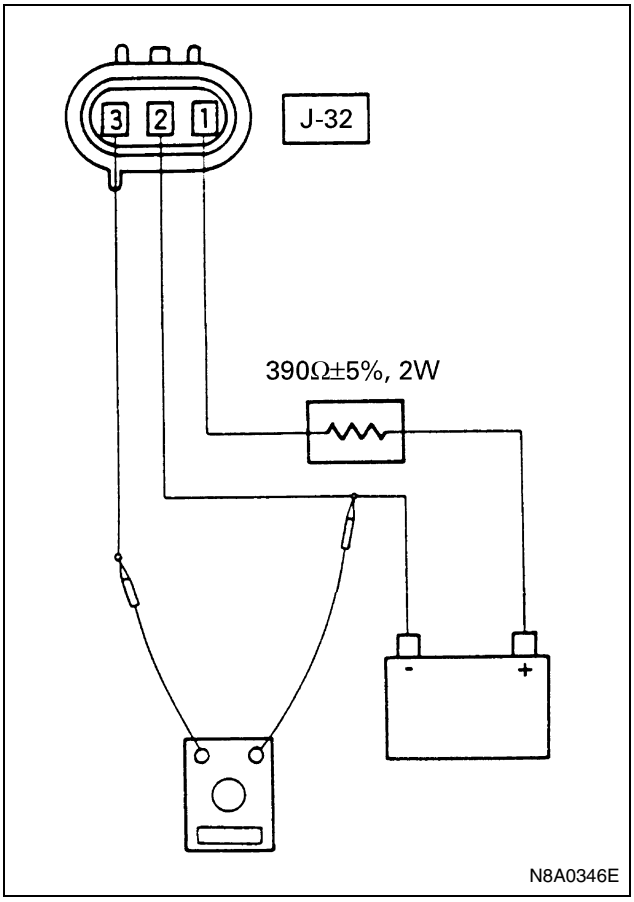
Caution:

Be extremely careful not to connect the battery (+) terminal to the connector 3 J-32.

This may damage the vehicle speed sensor.

2. Rotate the shaft of the vehicle speed sensor slowly and measure the voltage between 3 J-32 and 2 J-32 with a digital tester.

The voltage, with one rotation of shaft, fluctuates four times in the following range: 10 to 14V ↔ 24 or less.
Replace the sensor when the result of inspection is found abnormal.

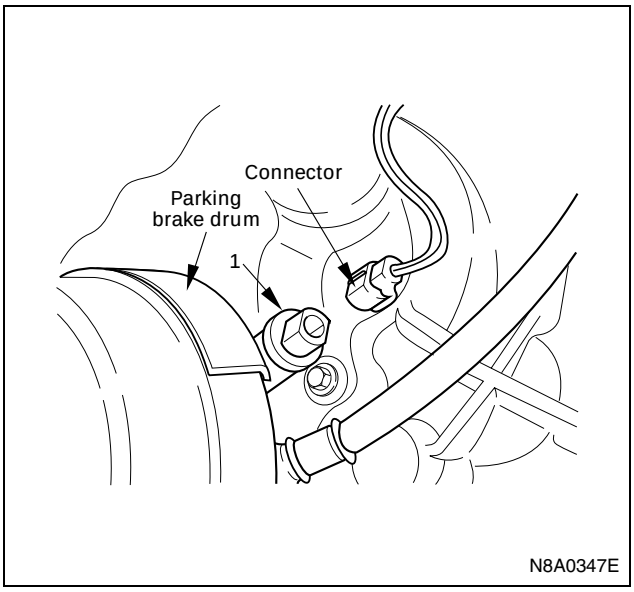


Removal

Preparation:

Disconnect the battery ground cable.

1. Vehicle Speed Sensor
   Disconnect the connector.



Installation

1. Tighten the vehicle speed sensor to the specified torque.

Tighten:

Vehicle speed sensor to 25 N·m (2.5 kg·m/18 lb·ft)

Caution:

Tightening must be made at the hexagonal part of the sensor.

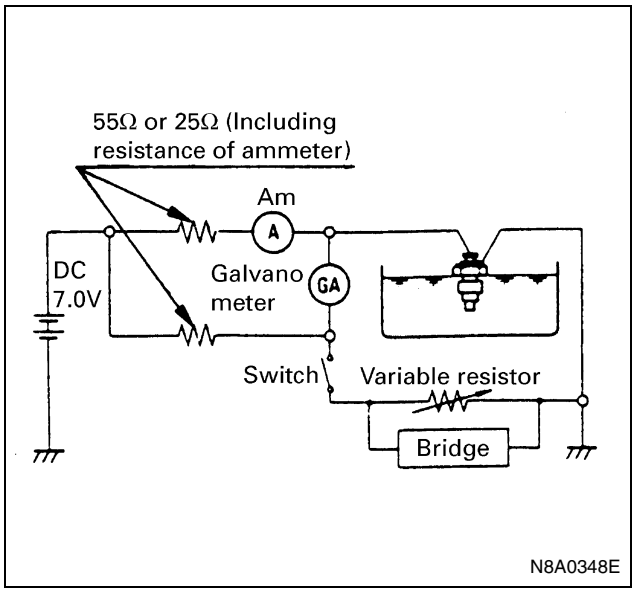
To tighten the connector itself would cause damage.

Thermo Unit

Inspection

The thermo unit is thermistor type and must be inspected under the conditions as shown below.

1. Put the deviation of the galvanometer to 0 by using the variable resistor, switch the thermo unit off and then measure the resistance of the resistor through the bridge.
   Confirm that the resistance is continuously variable in any other points than those shown below.
2. Dip the thermo unit into 80 — 90°C (176 — 194°F) water and confirm that there is no bubble continuously coming out of inside of the unit.
   Replace the unit when the result of inspection is found abnormal.

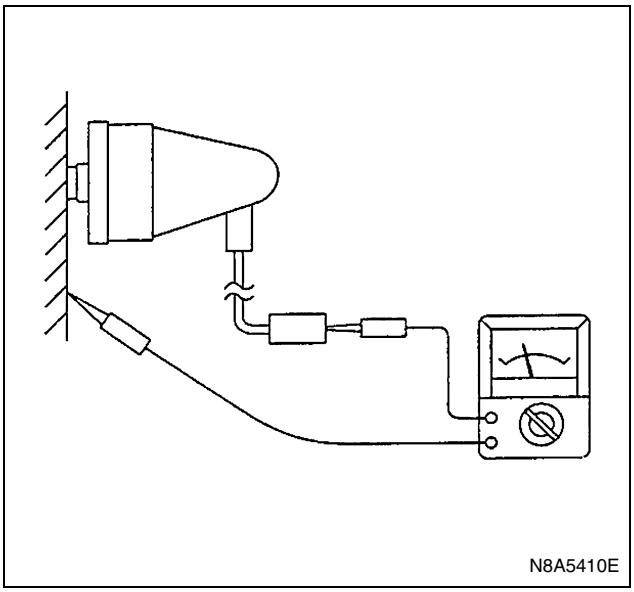


Check condition		Temperature	
		50°C (112°F)	115°C (239°F)
7 V 55 Ω Gauge	Resistance value (Ω)	+33.6 −33.6 226.0	+1.71 −2.21 26.4
7 V 25 Ω Gauge		—	+2.68 −3.68 24.3

Oil Pressure Switch

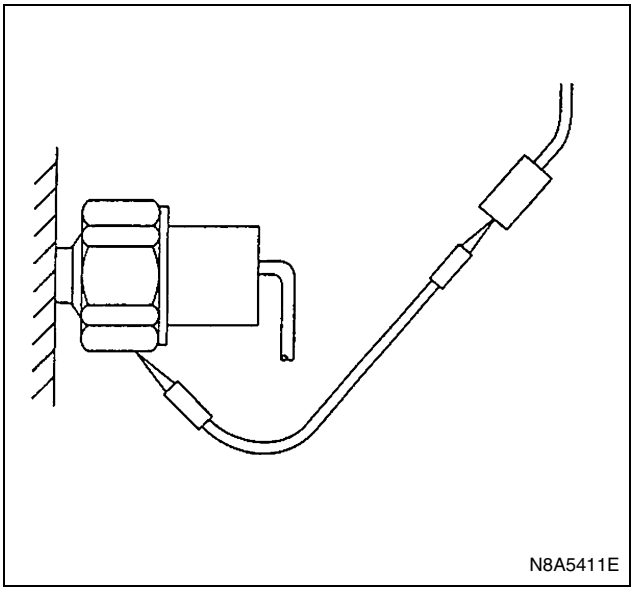
Inspection

Check the continuity between the switch terminal and the body ground with the starter switch is OFF position. Replace the switch when the result of inspection is found abnormal.



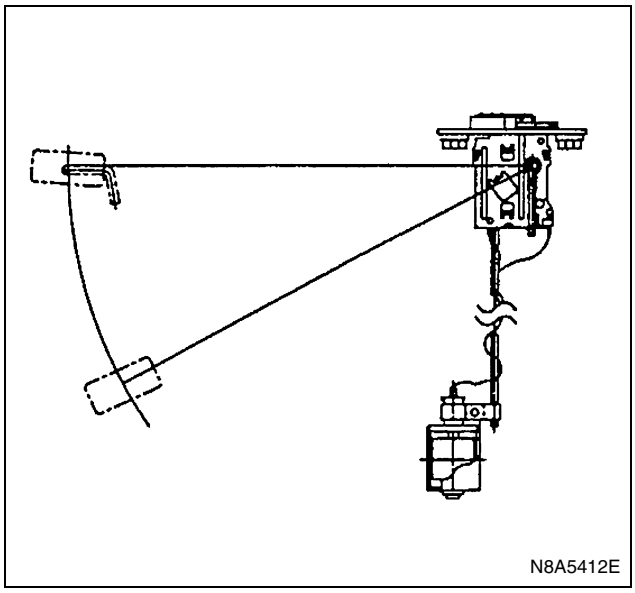
Circuit Inspection

1. Start the engine.
2. When disconnecting the oil pressure switch connector then connecting the harness side connector to the ground, check to see if the oil pressure warning light lights up. When the light will not light up, check the circuit between the meter and the oil pressure switch, and repair an open circuit if necessary.



Fuel Tank Unit

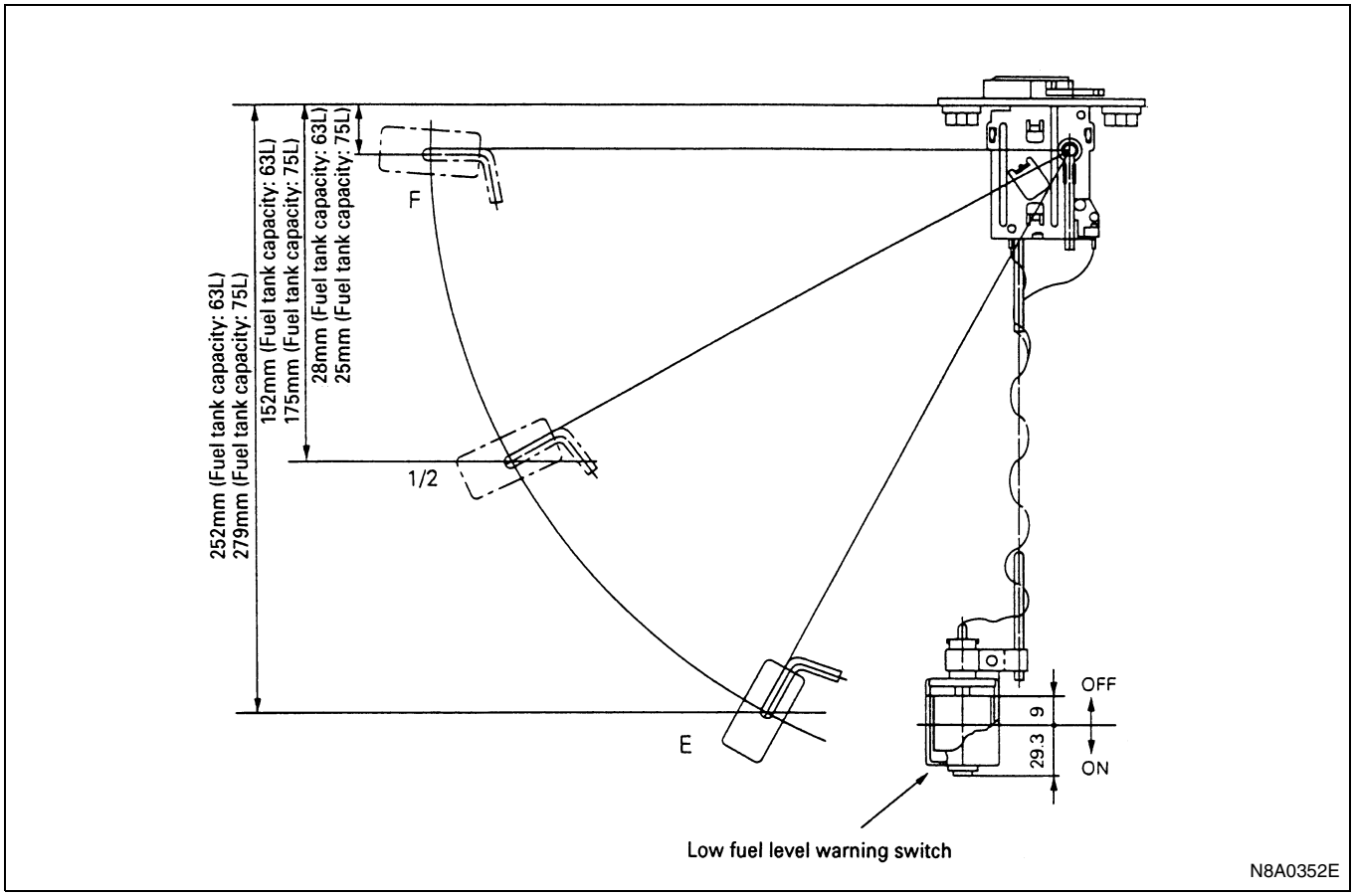
The tank unit varies the internal resistance according to the float position (fluid level) to operate the fuel meter needle. Also available is the build-in switch type to warn the driver of low fuel level (about 5 liters left in the tank) by illuminating the fuel warning light.



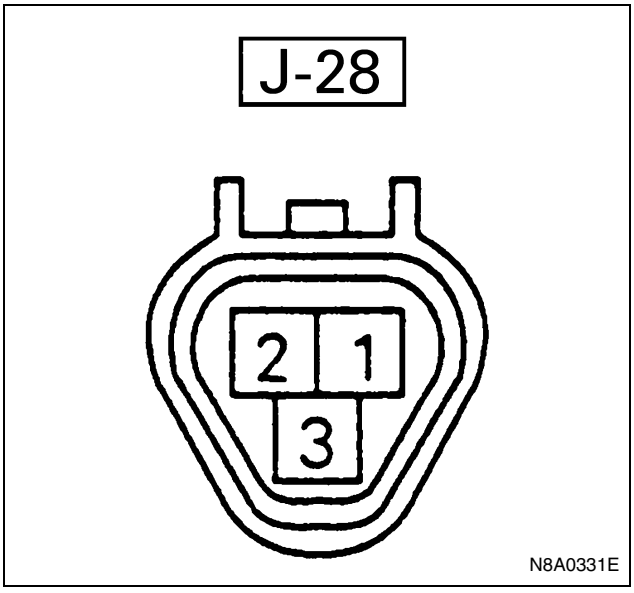
Inspection

(Level Switch type of warn low fuel level)

1. Check the resistance between the connector terminals 1 J-28 and 3 J-28 while shifting the float from “E” to “F” point.
2. Check if the low fuel warning switch turns on and off at the specified positions. If found defective, replace the fuel tank unit.



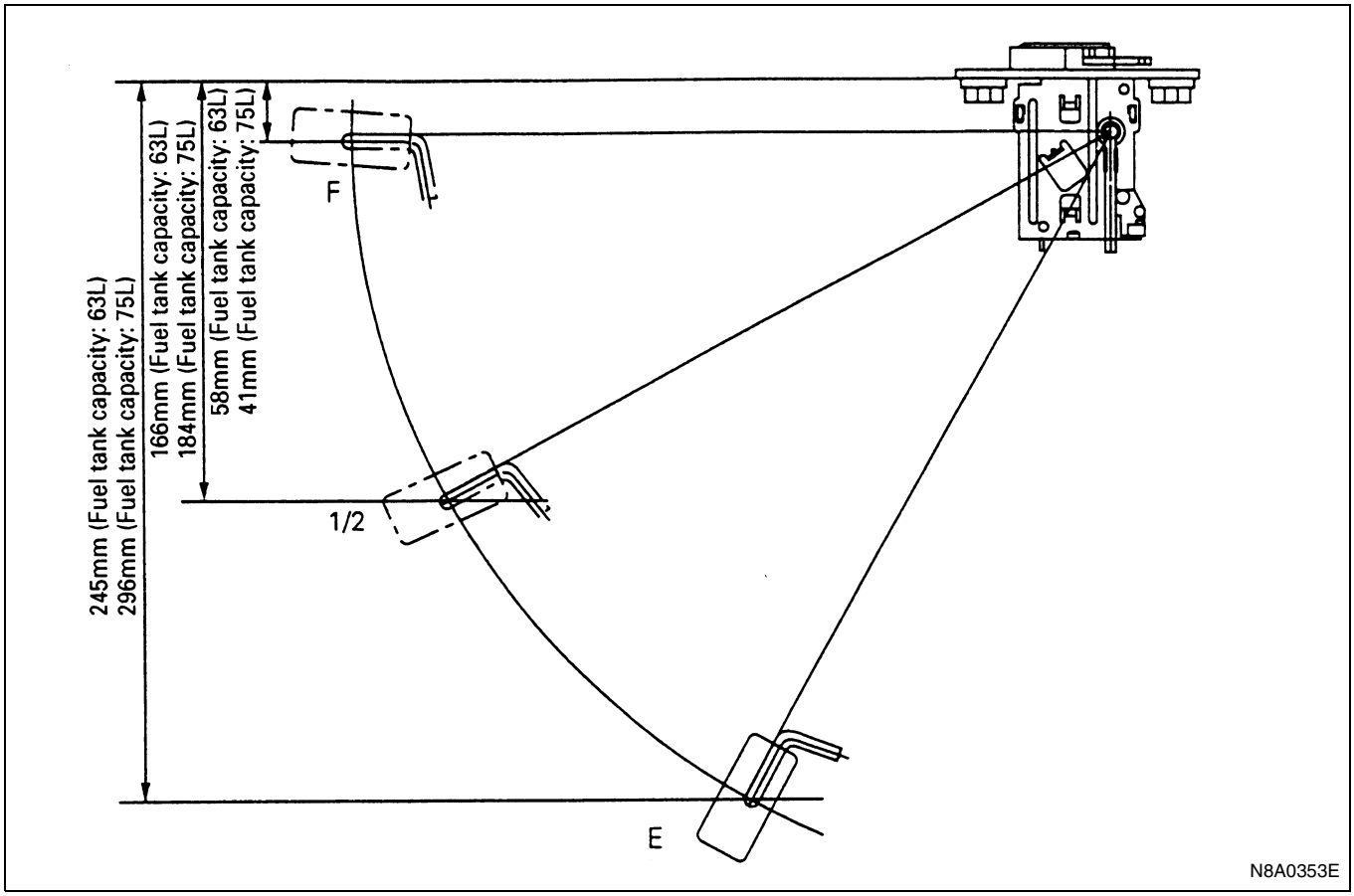
2. Check if the low fuel warning light turns on when the float is at “E” position. If found defective replace the fuel tank unit.

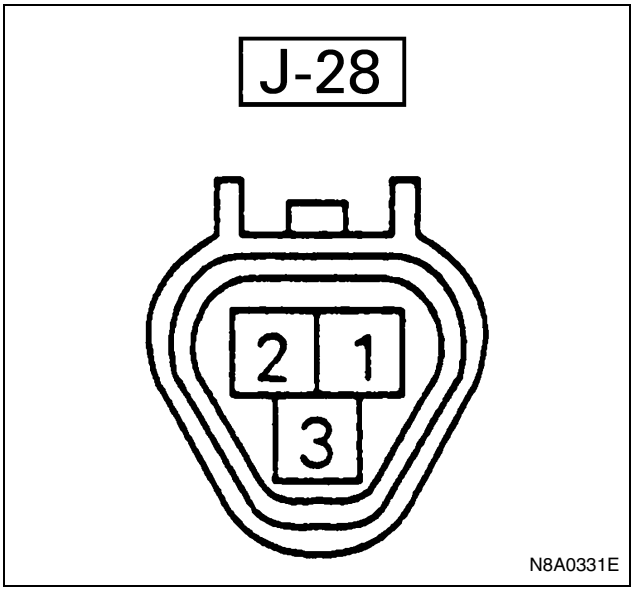


Float position	Resistance value (Ω)
F	3±2.1
1/2	32.5±4.8
E	110±7.7

(Float type of warn low fuel level)

1. Check the resistance between the connector terminals 1 J-28 and 3 J-28 while shifting the float from “E” to “F” point.





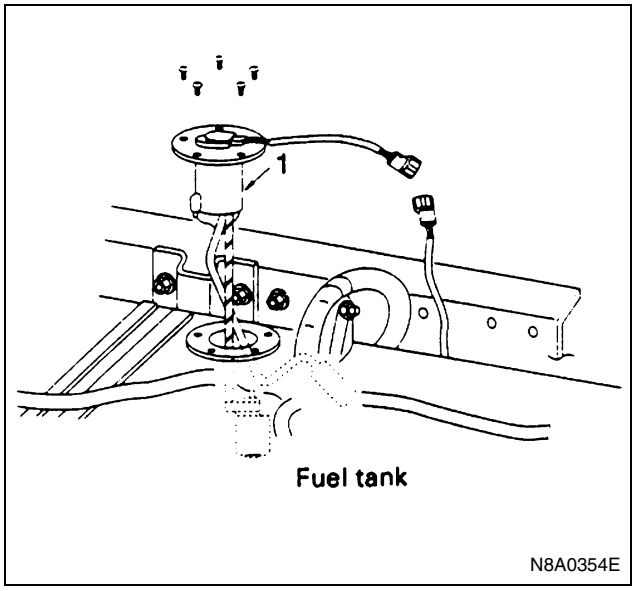
Float position	Resistance value (Ω)
F	3±2.1
1/2	32.5±4.8
E	110±7.7

Removal

Preparation:

Disconnect the battery ground cable.

1. Fuel Tank Unit
   1) Disconnect the connector.
   2) Remove five screws.



Installation

To install, follow the removal steps in the reverse order.

Engine Speed Sensor

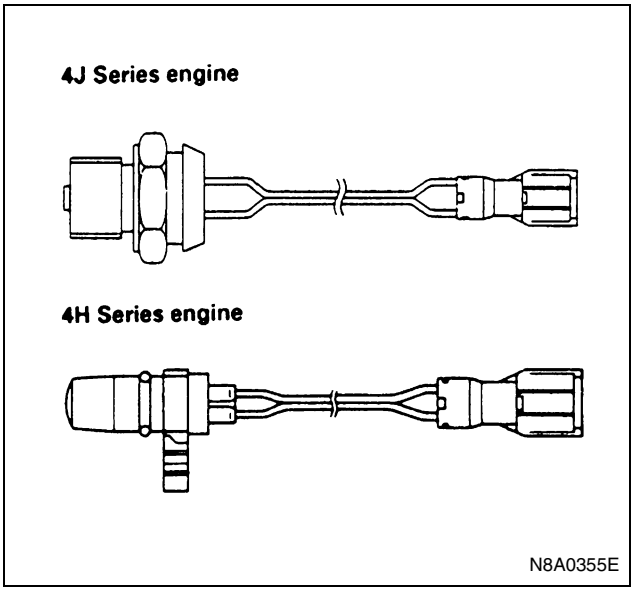
Inspection

Measure the resistance value between the engine speed sensor connector terminals.

Replace the engine speed sensor when the result of inspection is found abnormal.

4J Series engine = 1.36 — 1.86 KΩ

4H Series engine = 0.57 — 0.86 KΩ

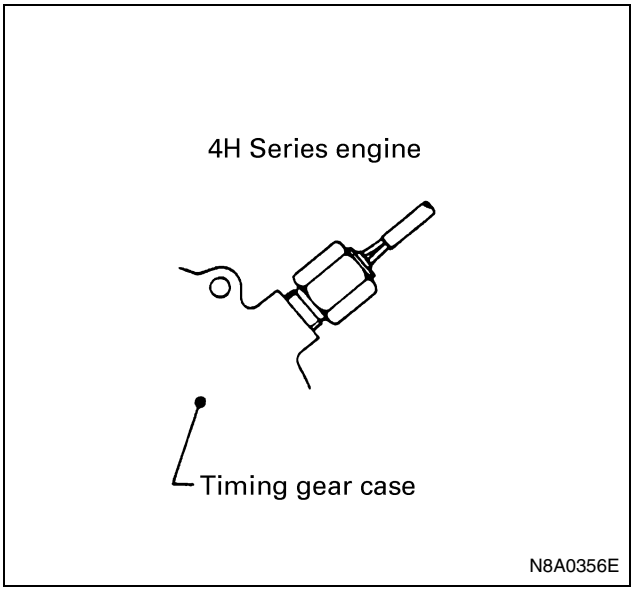


Removal

Preparation:

Disconnect the battery ground cable.

1. Engine Speed Sensor
   1) Disconnect the connector.
   2) Remove the engine speed sensor.



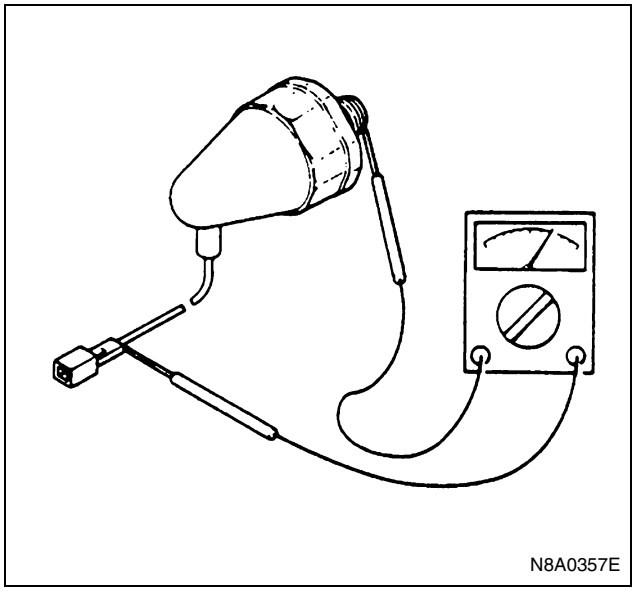
Installation

To install, follow the removal steps in the reverse order.

Vacuum Switch

Inspection

When the pressure value is below 250±30 mm Hg (33.3±4.0 kPa), check to see if there is continuity between the terminal and the ground. If no continuity, replace the switch with a normal one.



Removal

Preparation:

Disconnect the battery ground cable.

1. Vacuum Switch
   1) Disconnect the connector.
   2) Remove the vacuum switch.

Installation

Apply liquid gasket to the screw portion of the switch to prevent vacuum leak.

Vacuum Warning Buzzer

Inspection

Apply battery voltage to the buzzer connector terminals to check the buzzer sound.

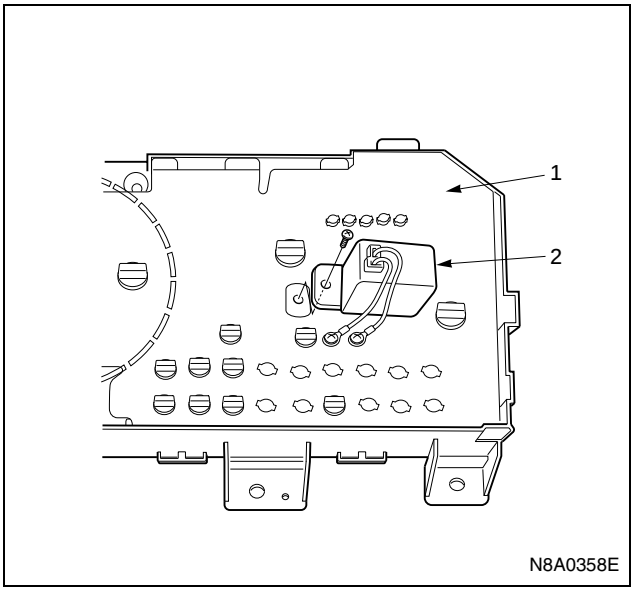
Replace the buzzer when the result of inspection is found abnormal.

Removal

Preparation:

Disconnect the battery ground cable.

1. Meter Assembly
   Refer to “METER ASSEMBLY” in this section.
2. Vacuum Warning Buzzer
   1) Disconnect the connector.
   2) Remove the buzzer fixing screw.



Legend

1. Meter Assembly
2. Vacuum Warning Buzzer

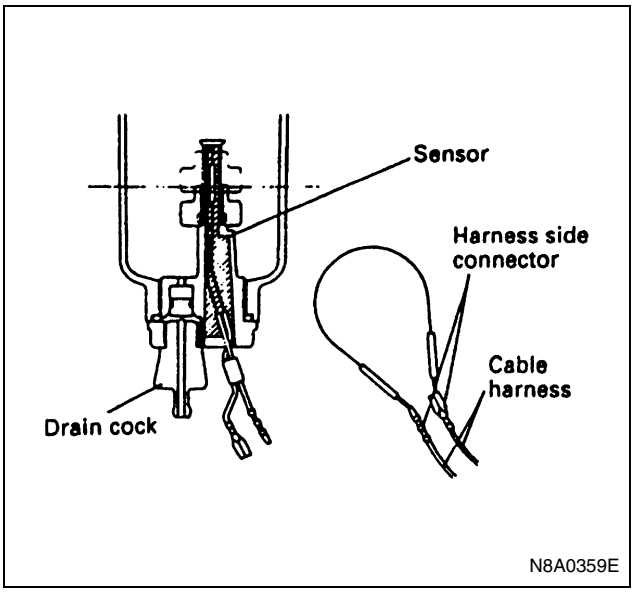
Installation

To install, follow the removal steps in the reverse order.

Water Sedimenter Switch

Inspection

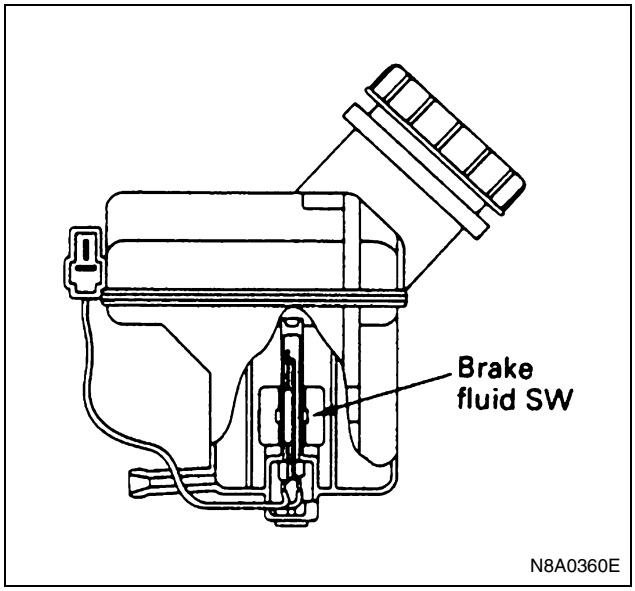
1. When the float in the water sedimenter is above the drain warning level, confirm if there is continuity between the switch connector terminals.
2. Turn the starter switch on, disconnect the water sedimenter connector and connect the harness side connector terminals. Then confirm that the sedimenter warning light turns on.
   If found defective, replace the switch or repair a poor connection or an open circuit between the connector terminals.



Brake Fluid Switch

Inspection

1. Confirm there is continuity between the switch connector terminals when the brake fluid in the tank is between 60 — 75 cc level.
2. Turn the switch on, disconnect the brake fluid switch connector and connect the harness side connector terminals. Then confirm that brake warning light turns on.
   If found defective, replace the tank, or repair a poor connection or an open circuit between the connector terminals.



Removal

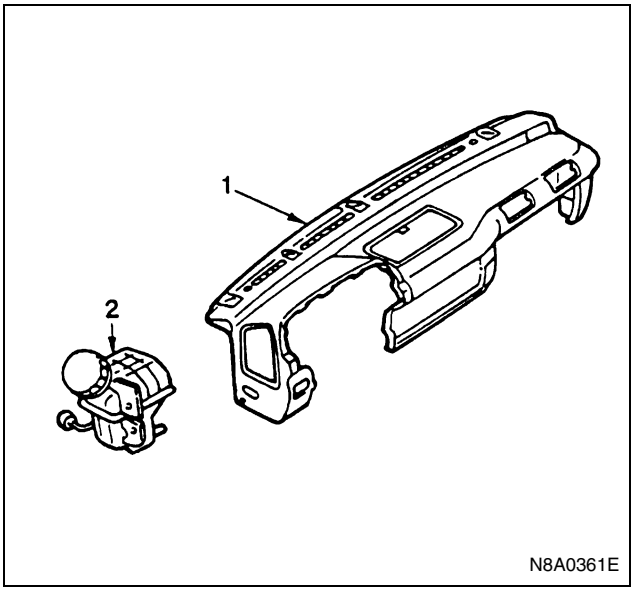
Preparation:

Disconnect the battery ground cable.

1. Instrument Panel Assembly
   Refer to “INSTRUMENT PANEL” of section 2.
2. Brake Fluid Tank (Brake Fluid Switch)
   1) Disconnect the switch connector.
   2) Remove four fixing nuts.
   3) Drain brake fluid in the tank.
   4) Disconnect the tubes.

Caution:

Be very careful not to allow the brake fluid to come in contact with painted surfaces or resin parts surfaces.



Installation

To install, follow the removal steps in the reverse order, noting the following points.

1. Bleed the air from brake and clutch fluid pipe line.
2. Check to see if the brake fluid level in the tank within specified level.
3. Check to see if brake warning light comes on when starter switch is turned on and then warning light goes off after the engine running.

Parking Brake Indicator Light

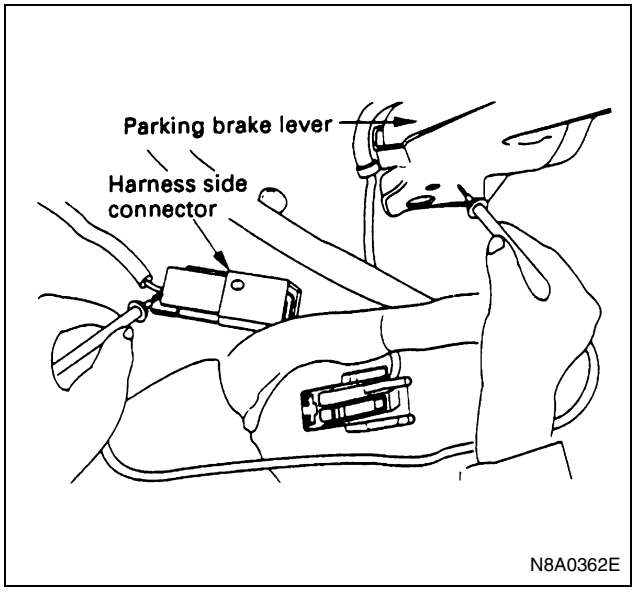
The parking brake indicator light is connected in series with the parking brake switch installed to the parking brake lever bracket.
The light comes on when the parking brake lever is pulled, and goes out when the parking brake lever is fully released.

Notice:

The parking brake indicator light illuminates to warn the driver that the parking brake is on. This light does not indicate the condition of the operability of the parking brake.

Circuit Inspection

1. Disconnect the parking brake switch connector.
2. Connect the harness side connector terminal to the ground.
3. Check to see if the indicator light comes on with the starter switch “ON”.
   Check the bulb or the harness when the result of inspection is found abnormal.



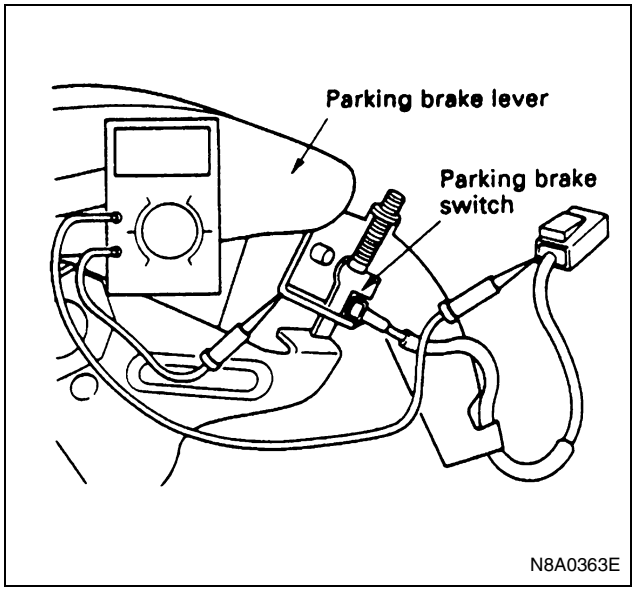
Parking Brake Switch

Inspection

1. Disconnect the parking brake switch connector.
2. Check to see if there is any continuity between the switch terminal and the body ground with the circuit tester connected between them.

When parking brake applied	Continuity
When parking brake released	No continuity

Repair the parking brake switch or replace it when the result of inspection is found abnormal.

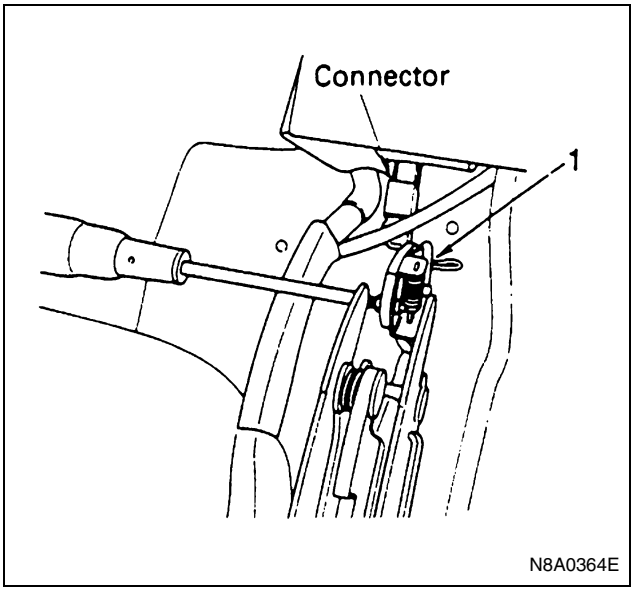


Removal

Preparation:

Disconnect the battery ground cable.

1. Parking Brake Switch
   1) Disconnect the connector.
   2) Remove the fixing screw.



Installation
To install, follow the removal steps in the reverse order.

Heater and Air Conditioning

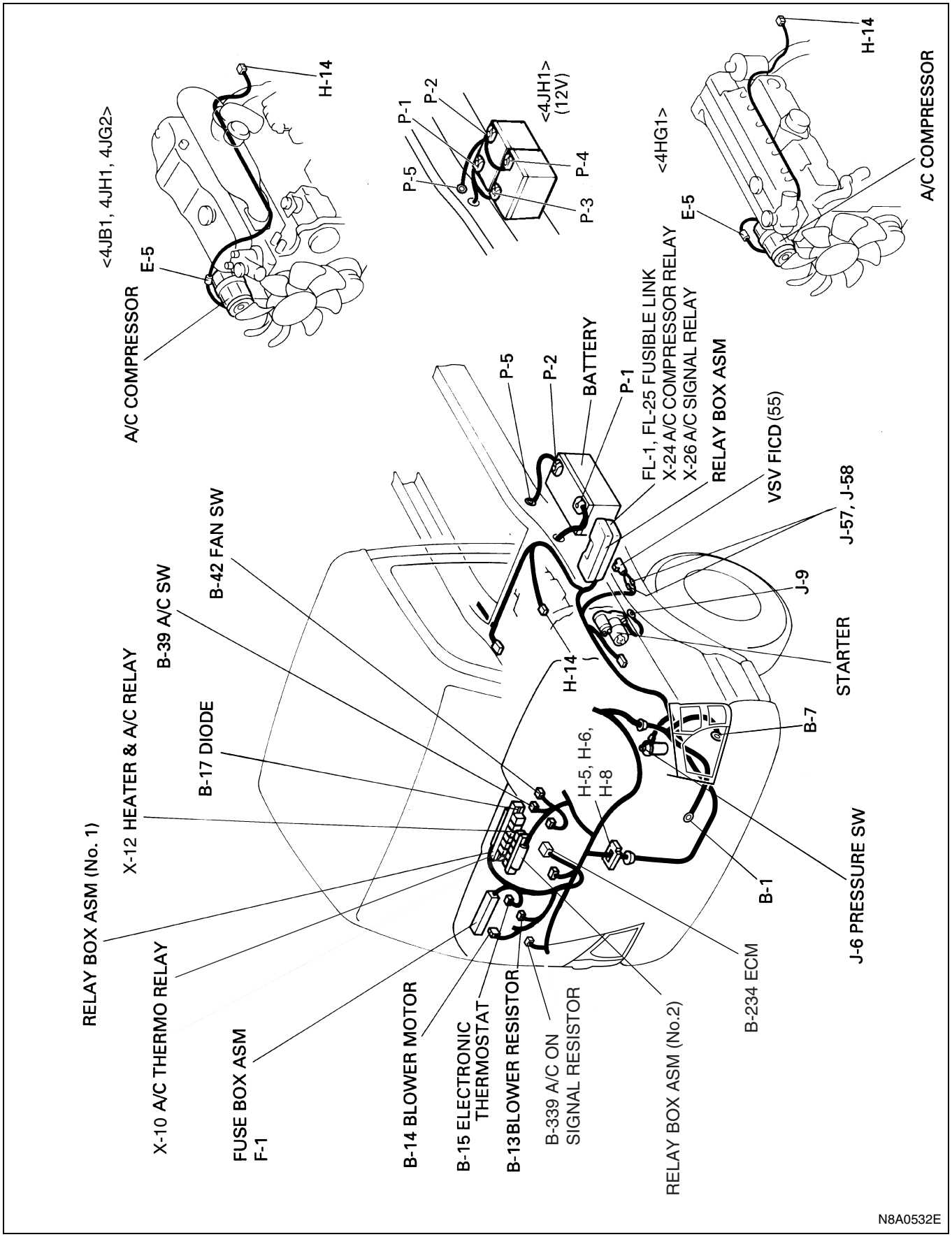
General Description

The air conditioning consists of compressor, evaporator, condenser, A/C switch, fan switch, etc. When the engine is rotating, the A/C starts to work with both the A/C and fan switches “ON”, followed by the engagement of the magnetic clutch. It stops to work when either the fan switch or the A/C switch turns “OFF”. In addition to the switches, the A/C has the function of temporary stop of its operation by the sensing system in the A/C cycle, such as:

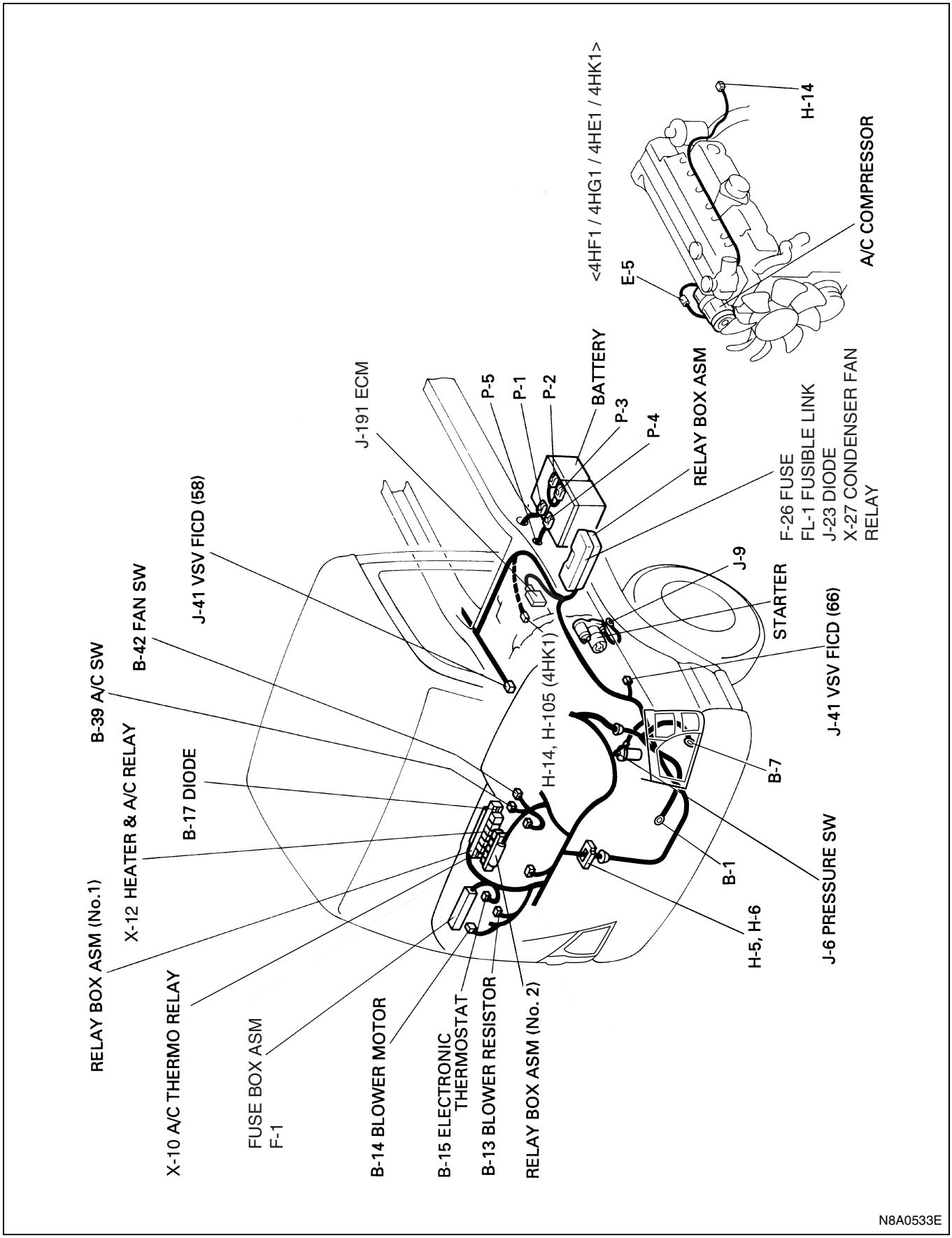
- sensing abnormal rise of the refrigerant pressure by means of the pressure switch.
- sensing temperature of the blowing-off air by means of the thermo switch preventing the evaporator from freezing.
- sensing the coolant temperature by the thermo switch (available for limited models only).

Parts Location

For 12 Volt

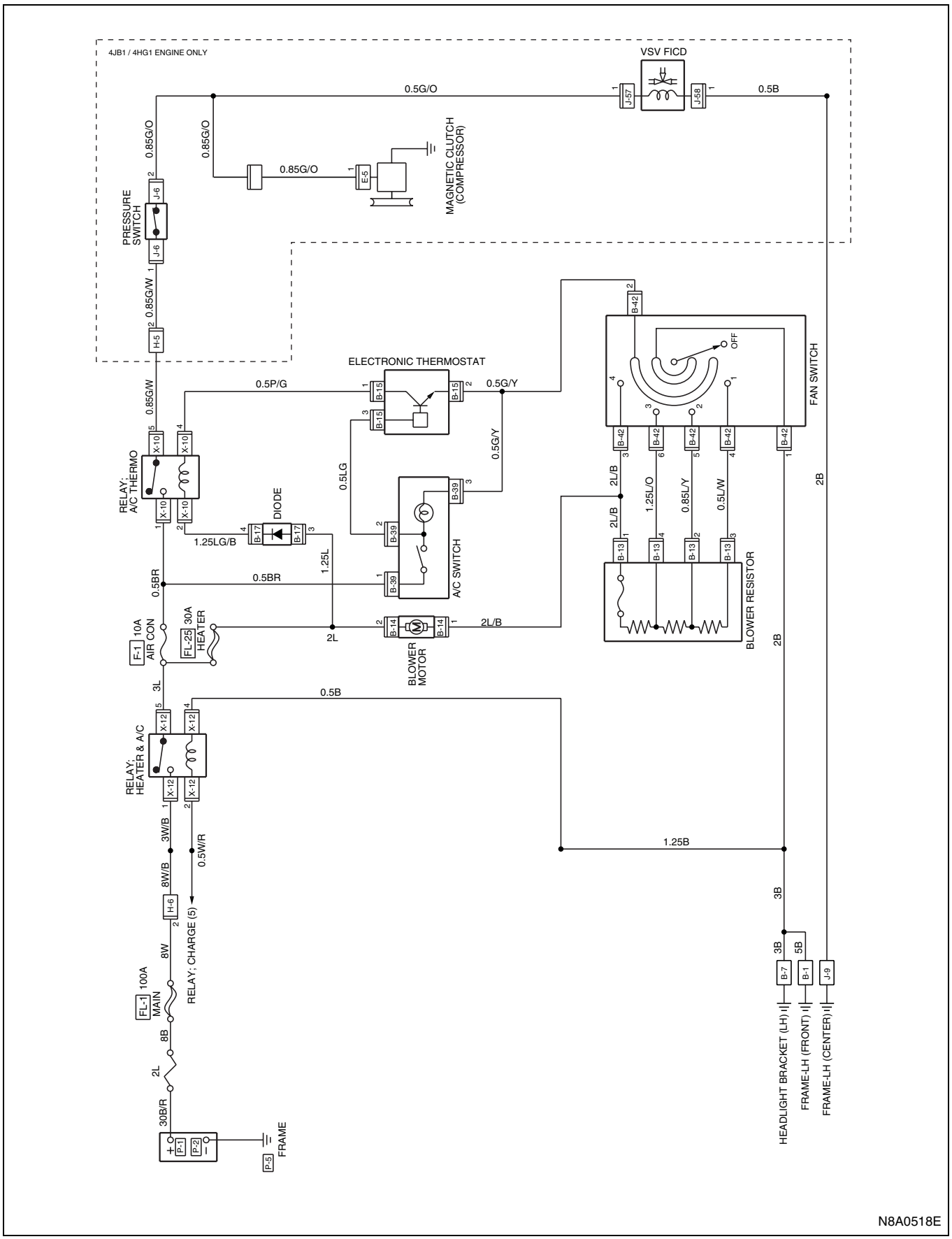


For 24 Volt

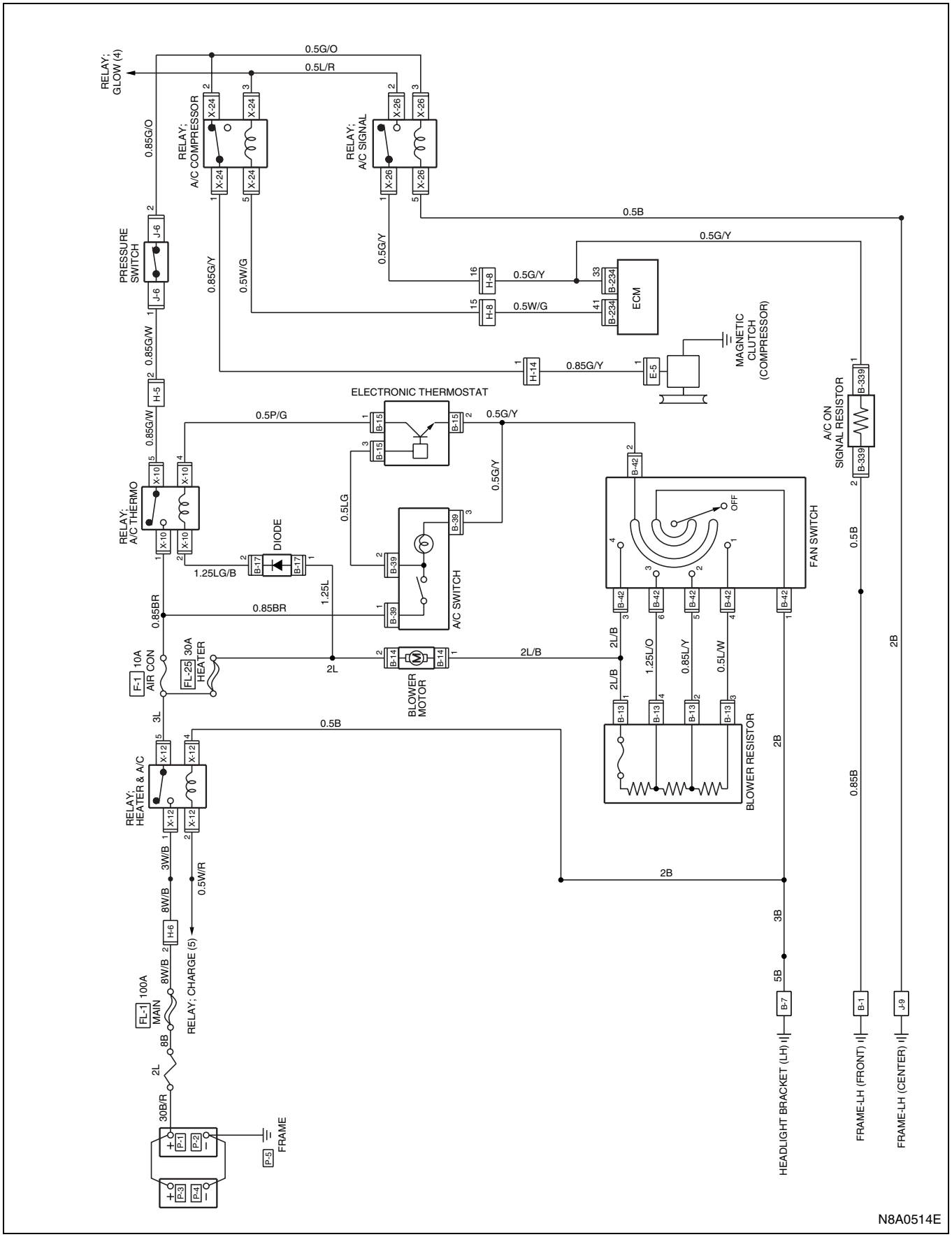

RELAY BOX ASM (No.1)
X-12 HEATER & A/C RELAY
X-10 A/C THERMO RELAY
FUSE BOX ASM
F-1
B-14 BLOWER MOTOR
B-15 ELECTRONIC THERMOSTAT
B-13 BLOWER RESISTOR
RELAY BOX ASM (No. 2)
B-39 A/C SW
B-42 FAN SW
B-17 DIODE
J-41 VSV FICD (58)
J-191 ECM
H-14, H-105 (4HK1)
P-5
P-1
P-2
P-3
P-4
BATTERY
RELAY BOX ASM
<4HF1 / 4HG1 / 4HE1 / 4HK1>
E-5
H-14
A/C COMPRESSOR
F-26 FUSE
FL-1 FUSIBLE LINK
J-23 DIODE
X-27 CONDENSER FAN RELAY
J-9
STARTER
J-41 VSV FICD (66)
B-7
B-1
H-5, H-6
J-6 PRESSURE SW
N8A0533E

Circuit Diagram

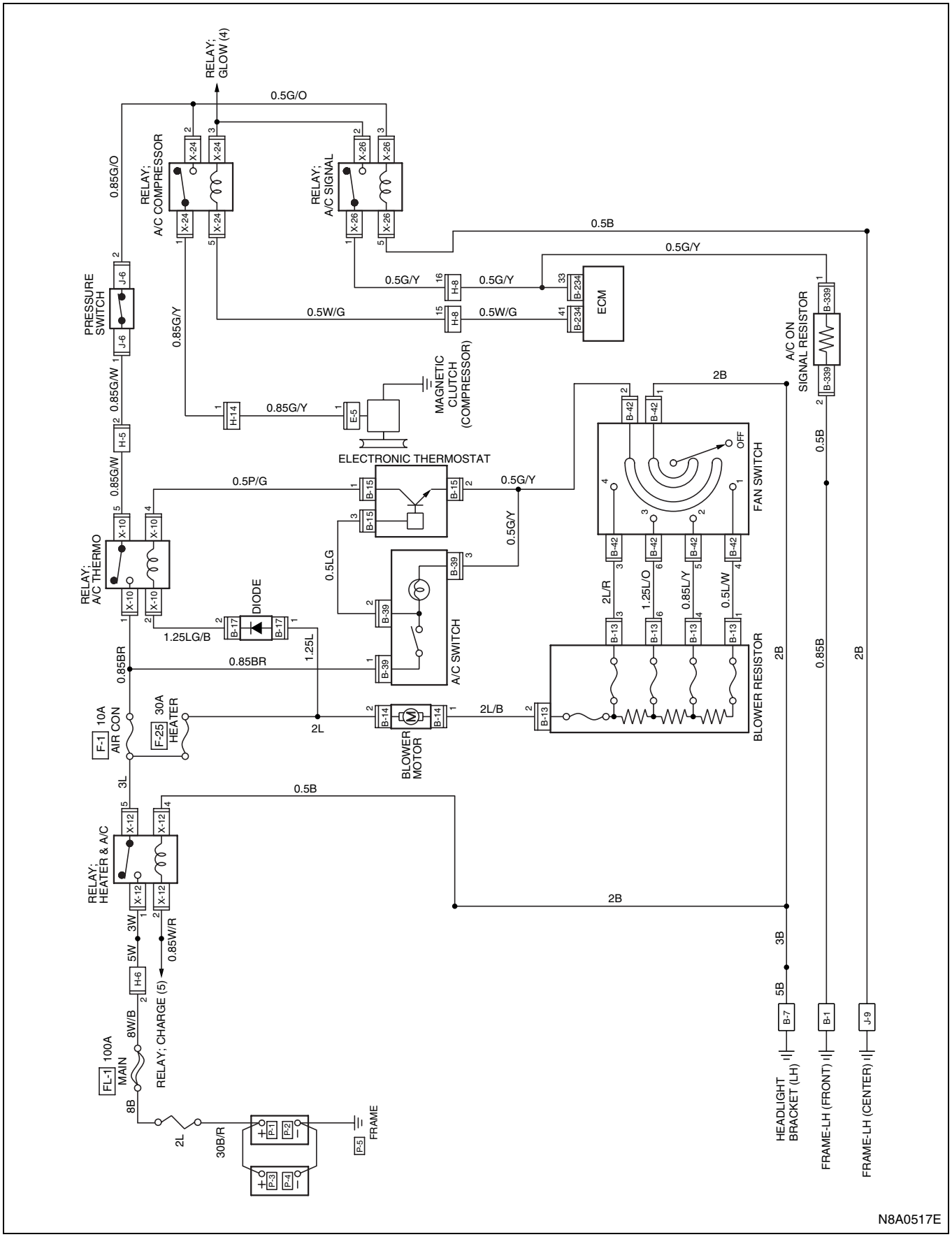
For 12 Volt - Except 4JH1



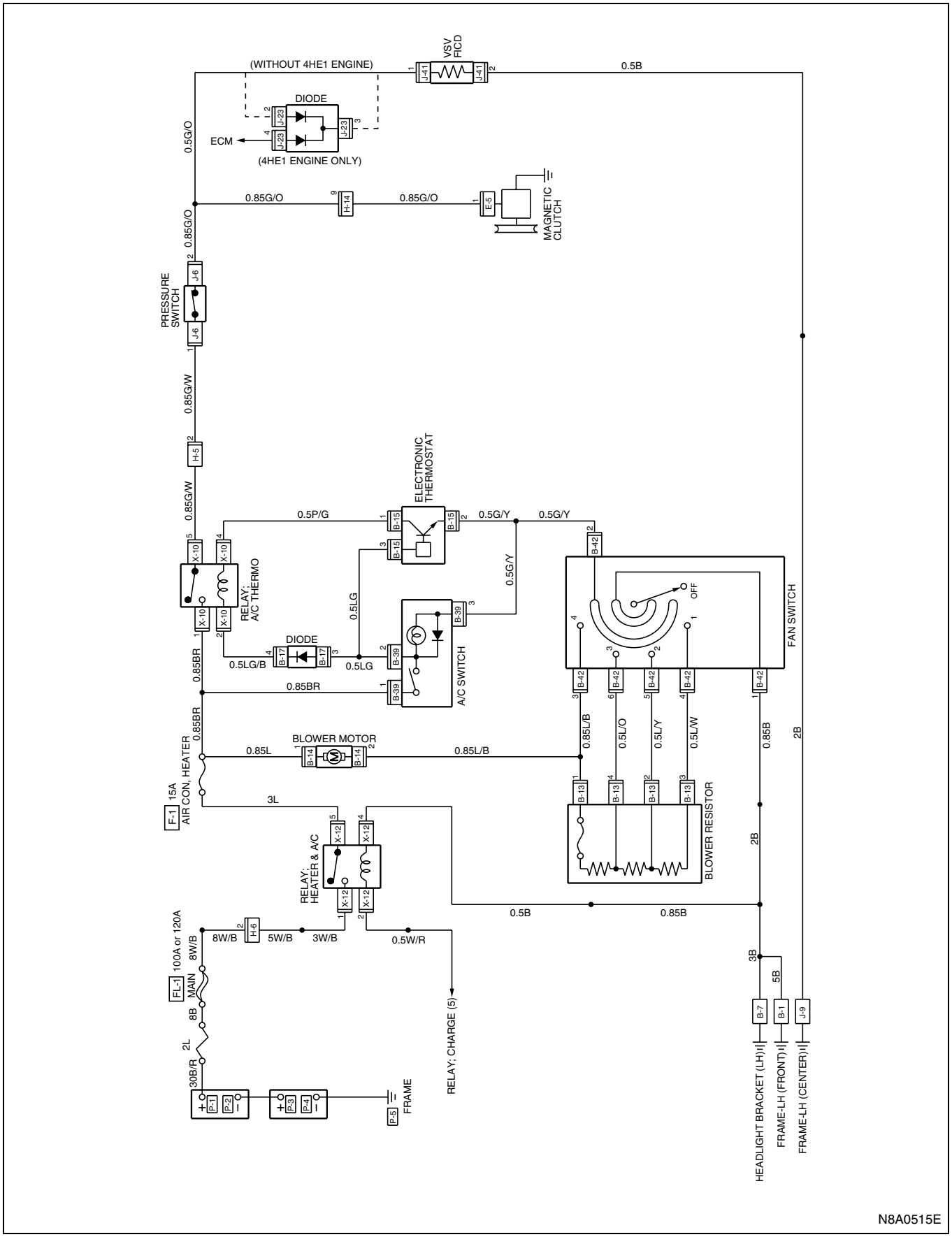
For 12 Volt - 4JH1 Engine



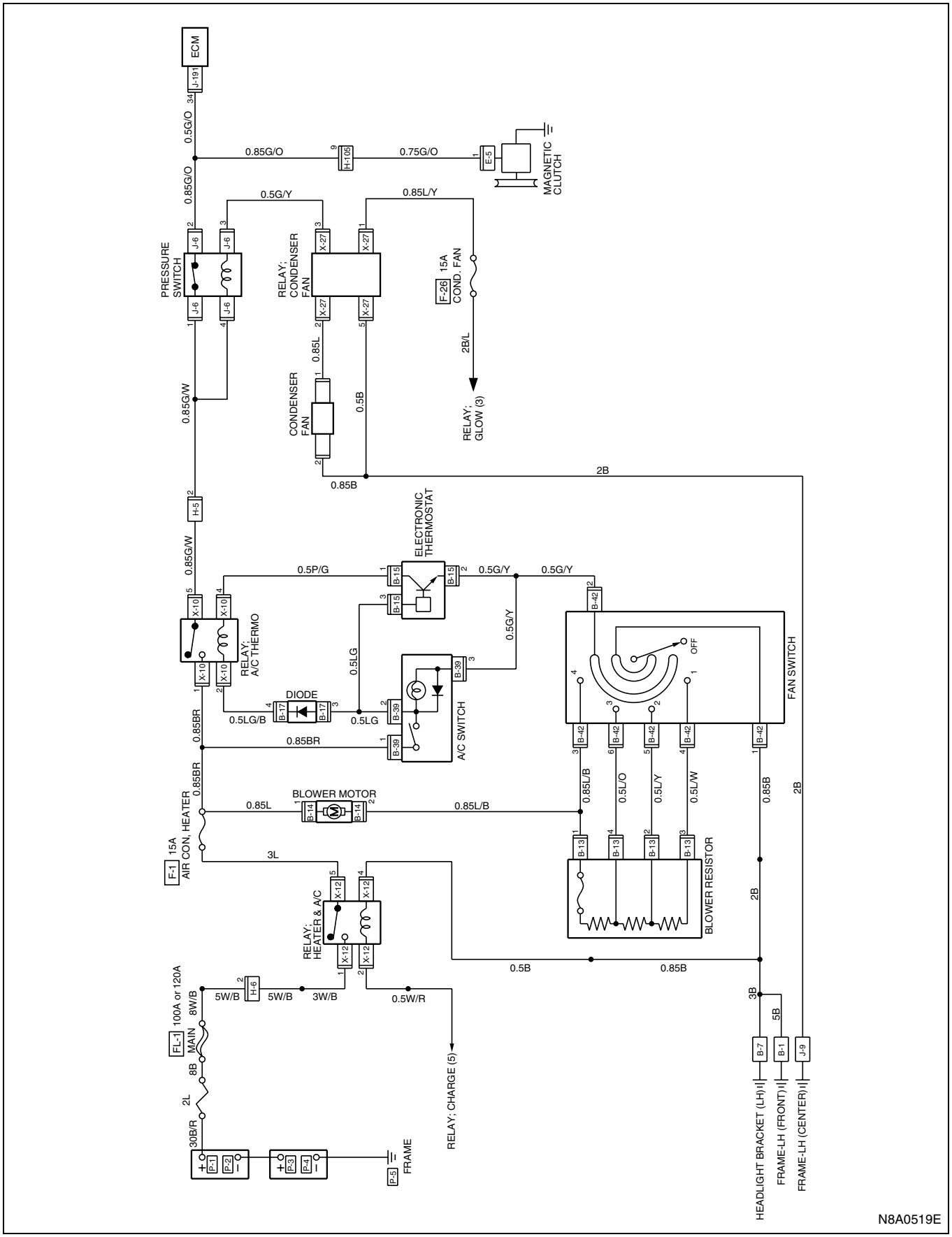
For 12 Volt - 4JH1 Engine For Taiwan



For 24 Volt - Except 4HK1 Engine

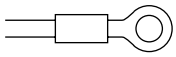
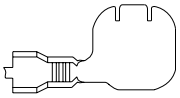
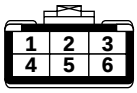
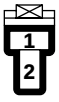
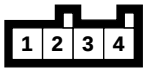
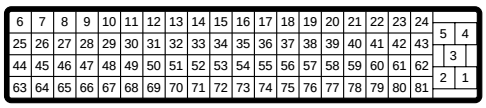


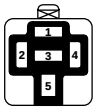
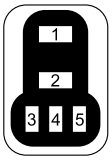
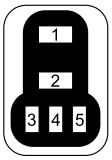
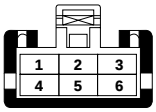
For 24 Volt - 4HK1 Engine

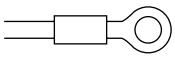
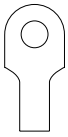
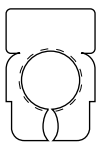
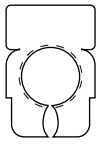


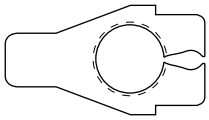
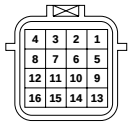
Connector List

For 12 Volt

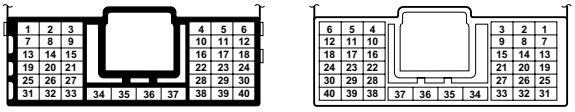
No.	Connector Face
B-1	 000-001
B-7	 000-012
B-13	004-010
B-13 (For Tai-wan)	 006-010
B-14	 002-009
B-17	 004-004
B-234	 121-001
B-339	004-010

No.	Connector Face
B-15	003-009
X-12	005-001
X-10	 005-001
X-24	 005-006
X-26	 005-006
B-39	003-019
B-42	 006-001
E-5	001-013

No.	Connector Face
E-5	001-014
J-6	004-011
J-9	 000-001
J-57	001-009
J-58	001-009
P-1	 000-003
P-2	 000-004
P-4	 000-004

No.	Connector Face
P-3	 000-006
P-5	000-007
H-14	016-001
H-14	 016-002

H-5



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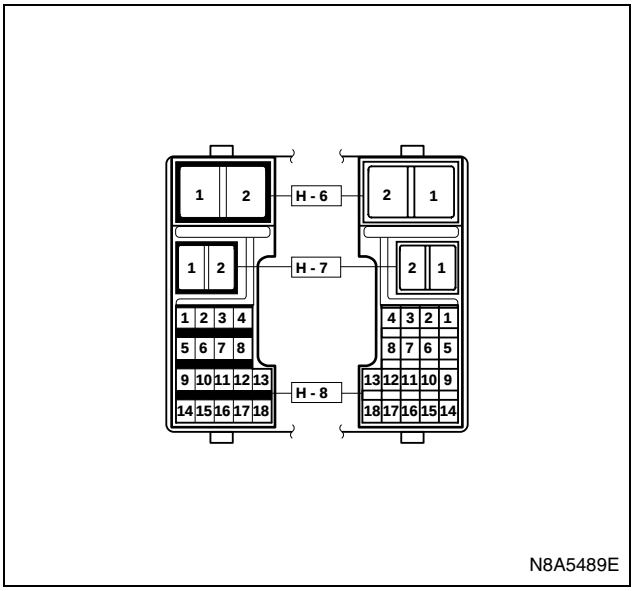
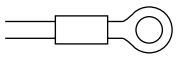
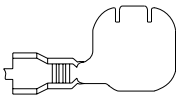
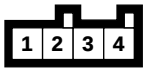
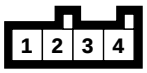
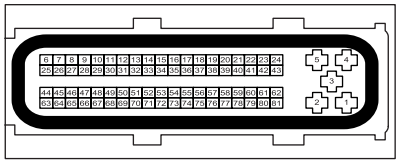
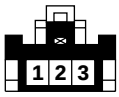
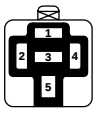
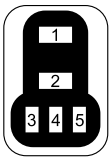
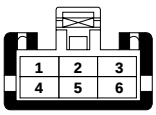
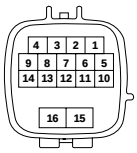
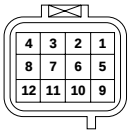
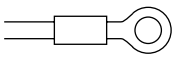
H-6

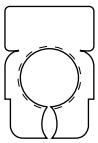
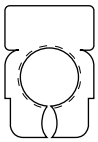
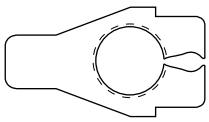
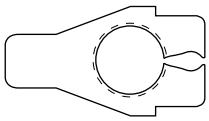
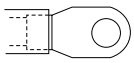


For 24 Volt

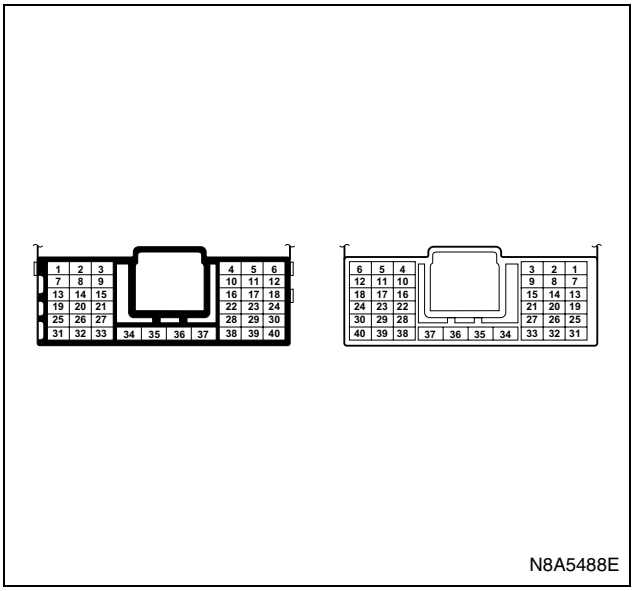
No.	Connector Face
B-1	 000-001
B-7	 000-012
B-13	004-010
B-14	002-009
B-17	 004-004

No.	Connector Face
J-23	 004-004
J-191	 081-001
B-15	 003-009
X-12	 005-001
X-10	005-001
X-27	 005-006
B-39	003-019
B-42	 006-001

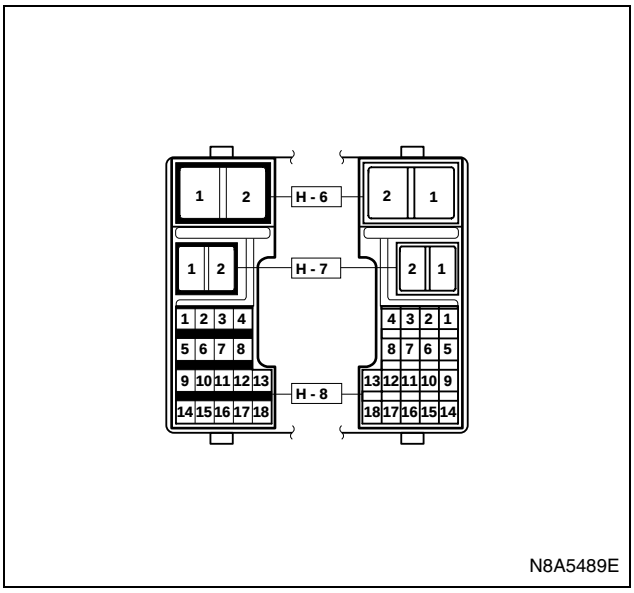
No.	Connector Face
E-5	001-013
E-5	001-014
H-14	016-003
H-14	 016-004
H-105	012-001
H-105	 012-002
J-6	004-011
J-9	 000-001

No.	Connector Face
J-41	002-015
P-1	 000-004
P-4	 000-004
P-2	 000-006
P-3	 000-006
P-5	 000-002
J-23	001-009

H-5



H-6

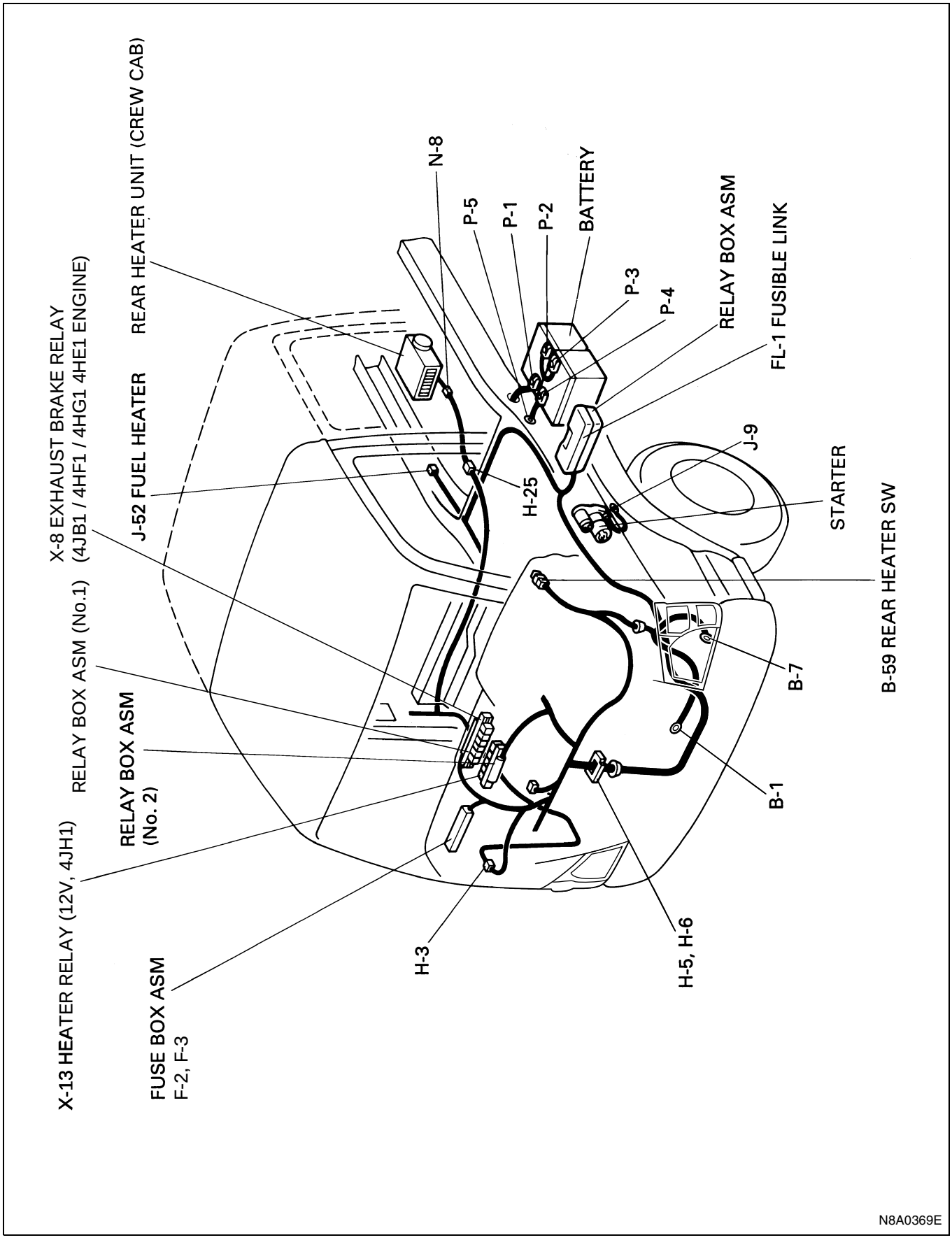


Fuel Heater and Rear Heater

General Description

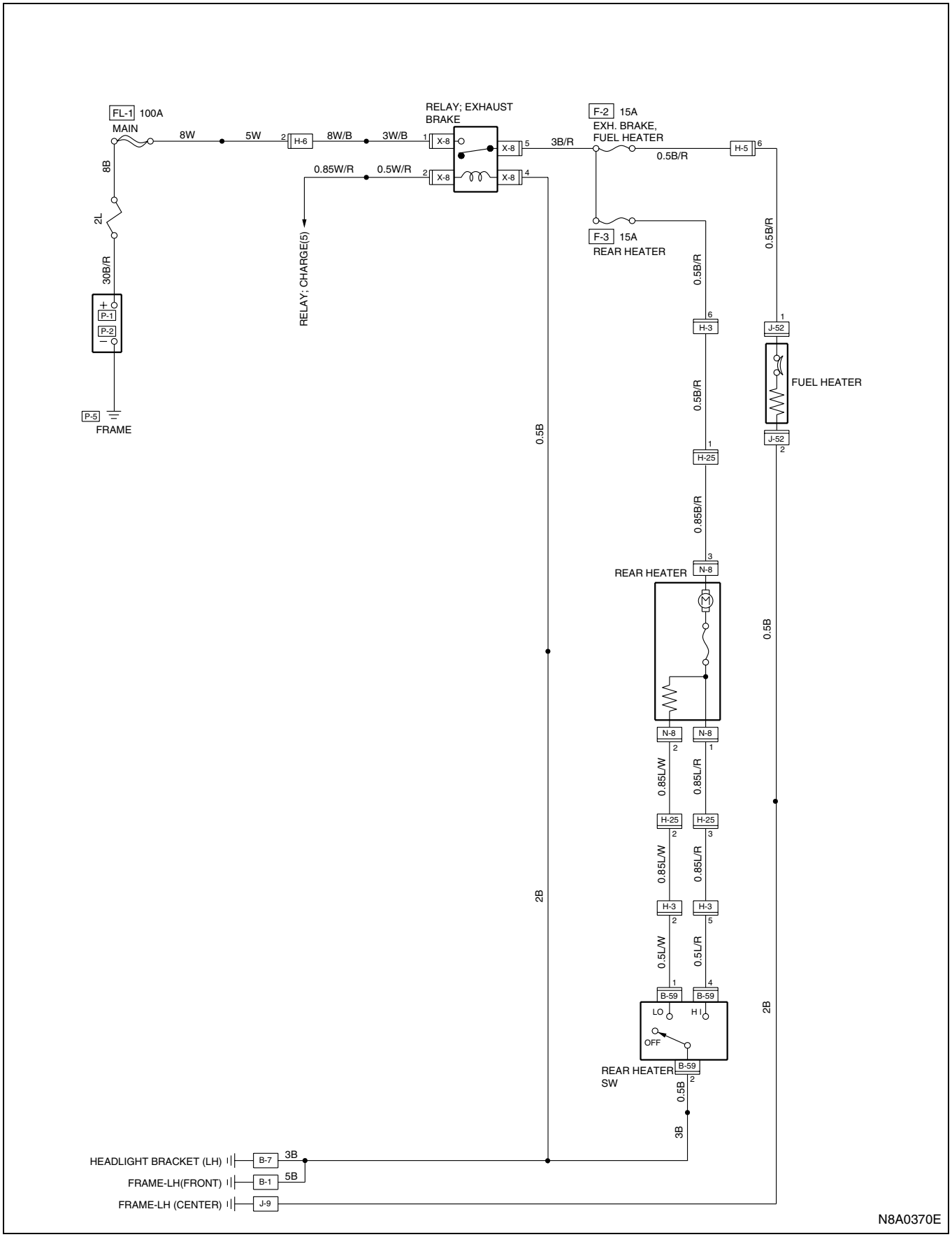
The circuit consists of fuel heater, rear heater, rear heater switch and the exhaust brake relay.
The fuel heater circuit is always in “ON” position when the generator is charging and its temperature is automatically controlled by the circuit breaker built in the fuel heater.

Parts Location

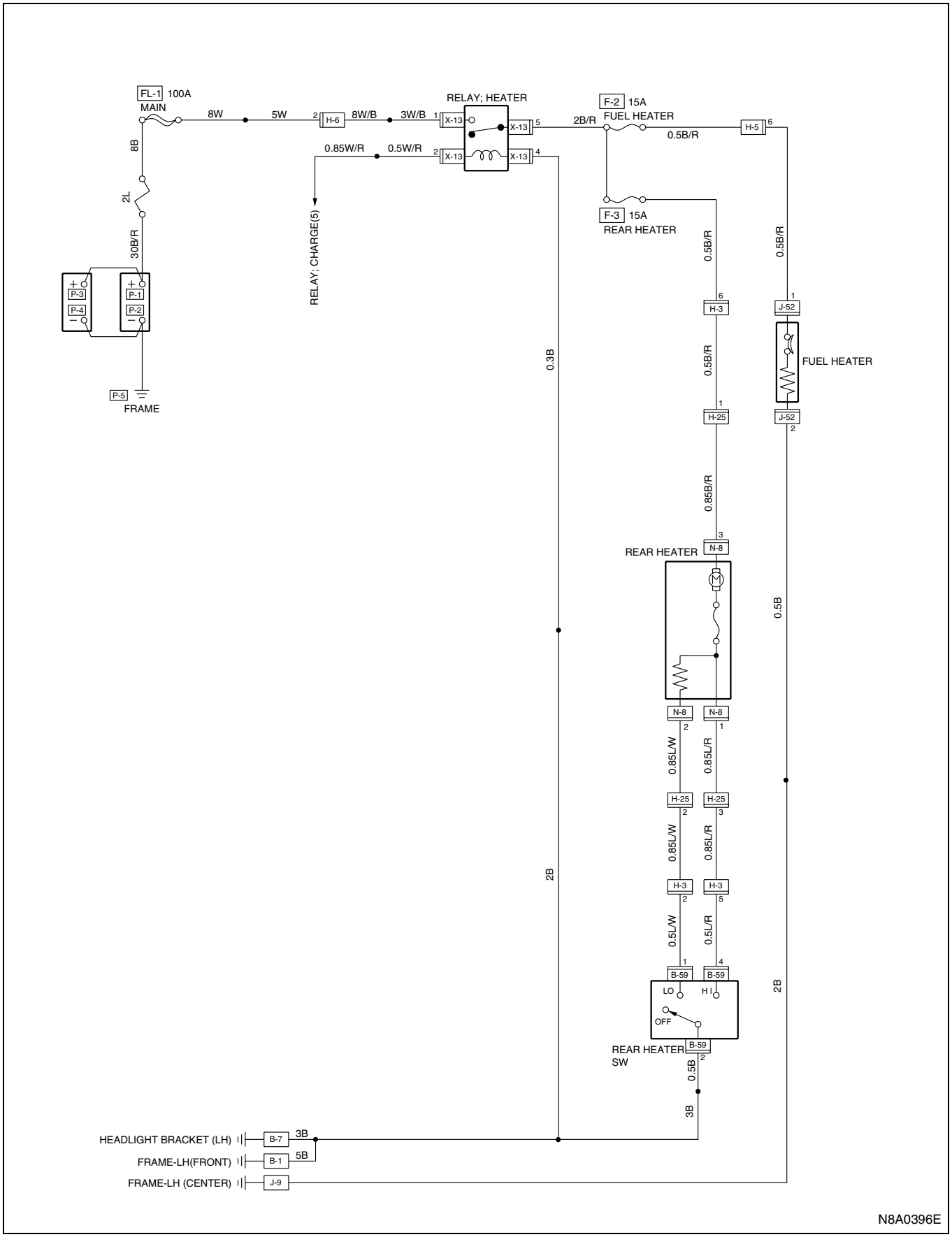


Circuit Diagram

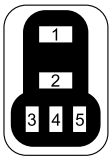
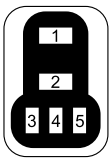
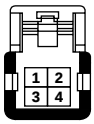
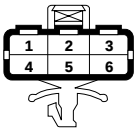
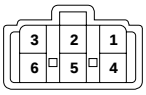
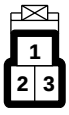
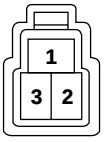
Except 4JH1 Engine

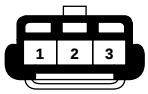
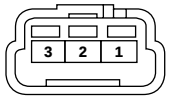
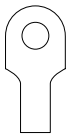
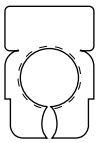
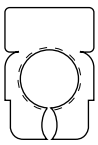
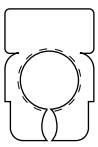
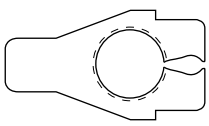


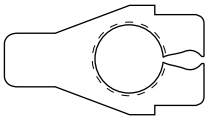
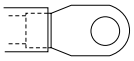
4JH1 Engine


FL-1 100A
MAIN
8W
5W
2
H-6
8W/B
3W/B
1
X-13
RELAY; HEATER
X-13
5
2B/R
F-2 15A
FUEL HEATER
0.5B/R
H-5
6
0.85W/R
0.5W/R
2
X-13
X-13
4
8B
2L
30B/R
RELAY; CHARGE(5)
F-3 15A
REAR HEATER
0.5B/R
0.5B/R
P-3
P-4
P-1
P-2
P-5
FRAME
0.3B
6
H-3
1
J-52
FUEL HEATER
0.5B/R
1
H-25
J-52
2
0.85B/R
3
N-8
REAR HEATER
0.5B
N-8
2
N-8
1
0.85L/W
0.85L/R
H-25
2
H-25
3
0.85L/W
0.85L/R
2B
H-3
2
H-3
5
0.5L/W
0.5L/R
1
4
B-59
B-59
LO
HI
OFF
B-59
2
REAR HEATER
SW
2B
0.5B
3B
HEADLIGHT BRACKET (LH)
B-7
3B
FRAME-LH(FRONT)
B-1
5B
FRAME-LH (CENTER)
J-9
N8A0396E

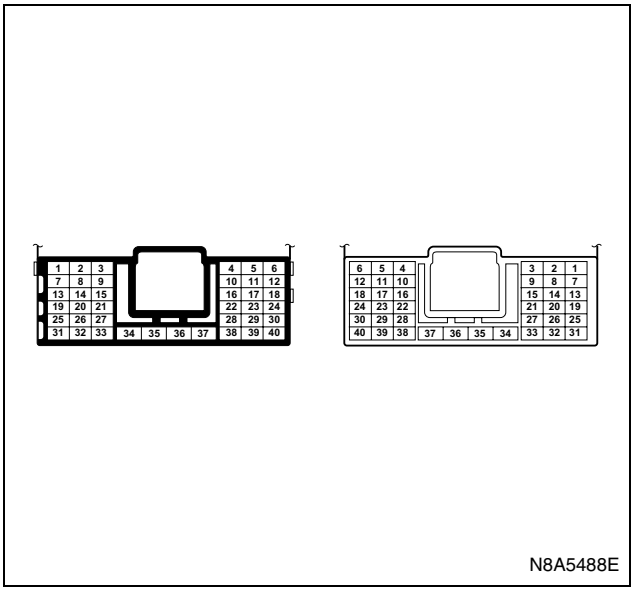
Connector List

No.	Connector Face
X-8	 005-006
X-13	 005-006
B-59	 004-015
H-3	 006-014
H-3	 006-015
H-25	 003-020
H-25	 003-021
J-52	002-033

No.	Connector Face
J-52	002-034
N-8	 003-022
N-8	 003-023
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006

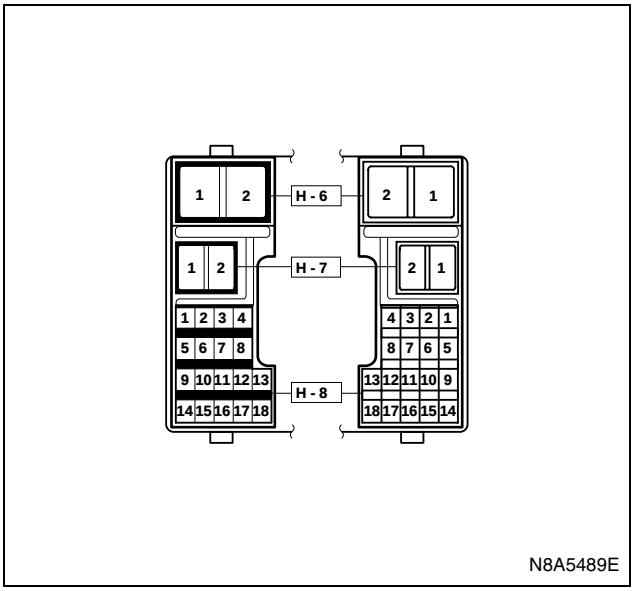
No.	Connector Face
P-3	 000-006
P-5 (12 V)	000-007
P-5 (24 V)	 000-002

H-5



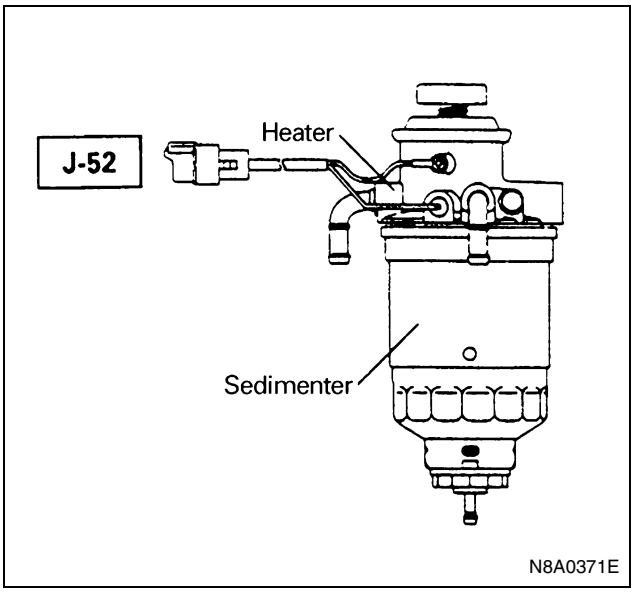
N8A5488E

H-6



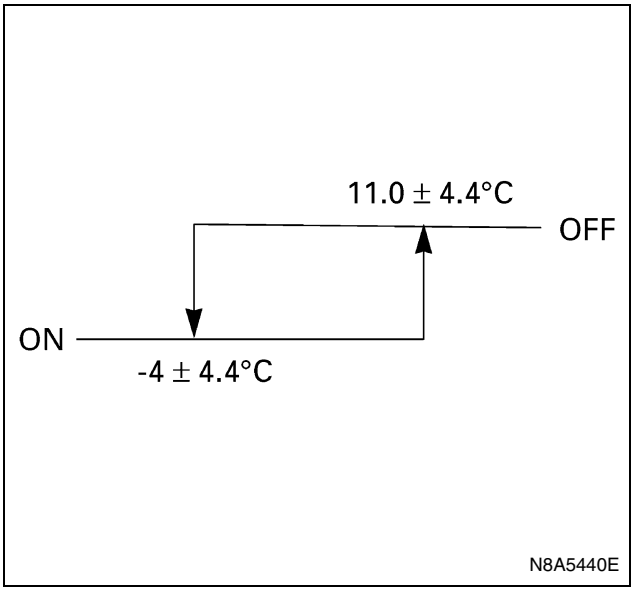
N8A5489E

Fuel Heater



N8A0371E

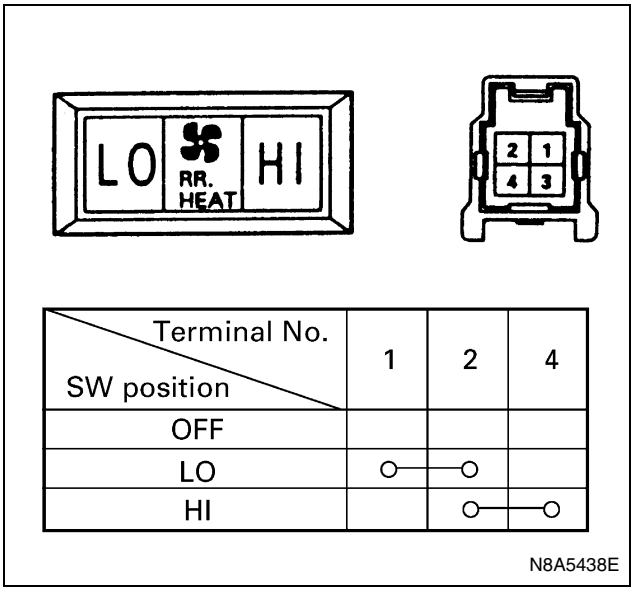
Characteristic of fuel heater



Rear Heater Switch

Inspection

Check the continuity between the connector terminals while operating the switch.
Replace the switch when the result of inspection is found abnormal.

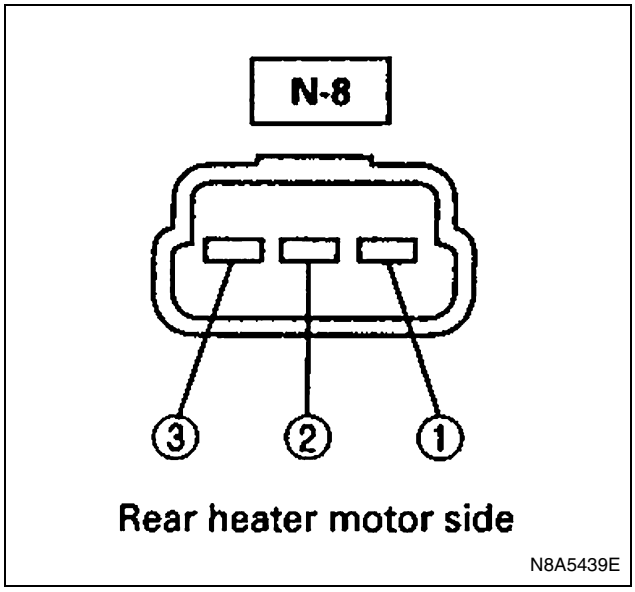


Terminal No. / SW position	1	2	4
OFF			
LO	○	○	
HI		○	○

Rear Heater Motor

Inspection

Disconnect the rear heater connector.
Connect the battery positive terminal to the NO.3 terminal of the rear heater motor side connector and negative to the NO.2. Check to see if rear heater motor operates low-speed correctly.
Connect the battery positive terminal to the NO.3 terminal of the rear heater motor side connector and negative to the NO.1. Check to see if rear heater motor operates high-speed correctly.
Replace the rear heater motor when the result of inspection is found abnormal.

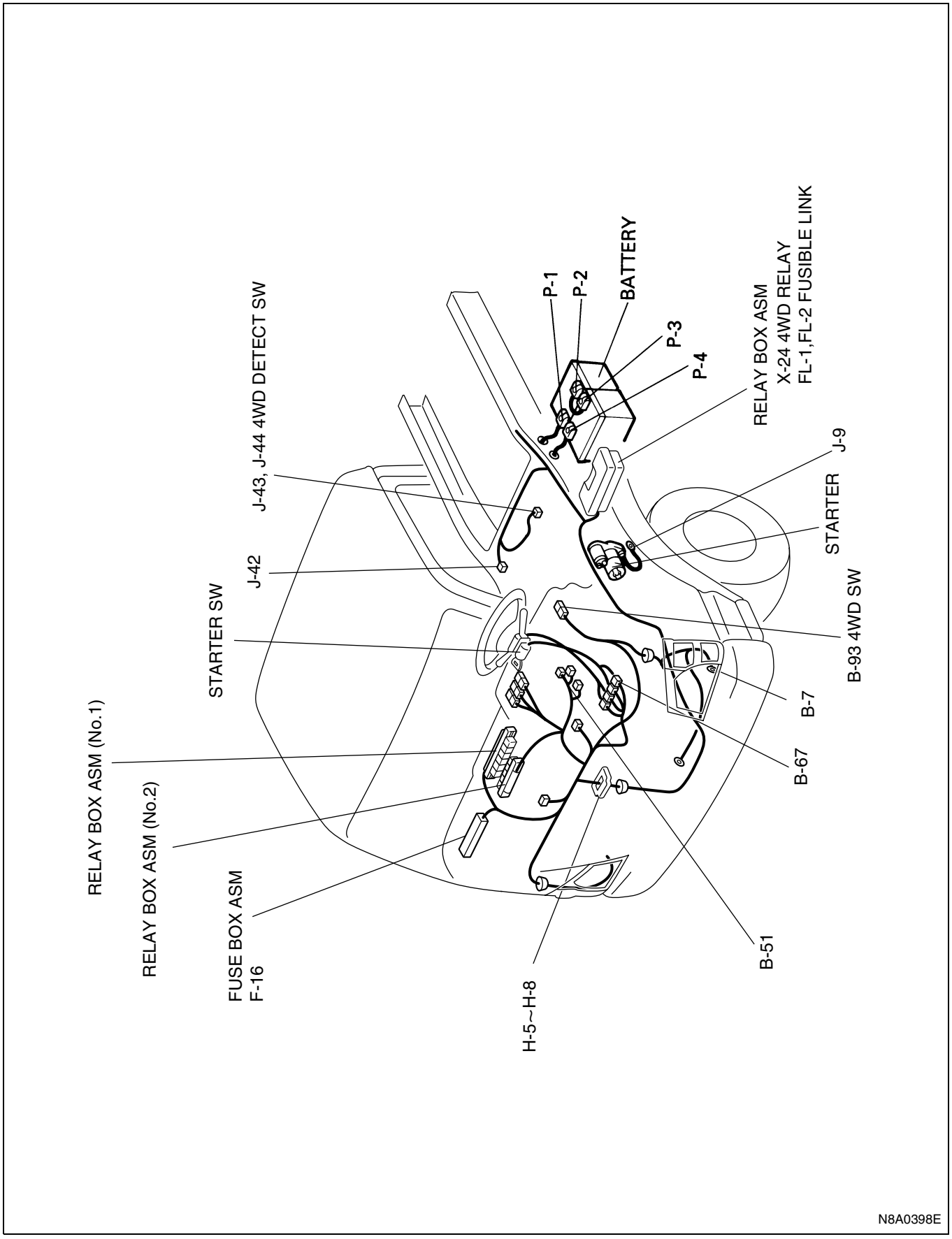


4WD Transfer (Vacuum Control)

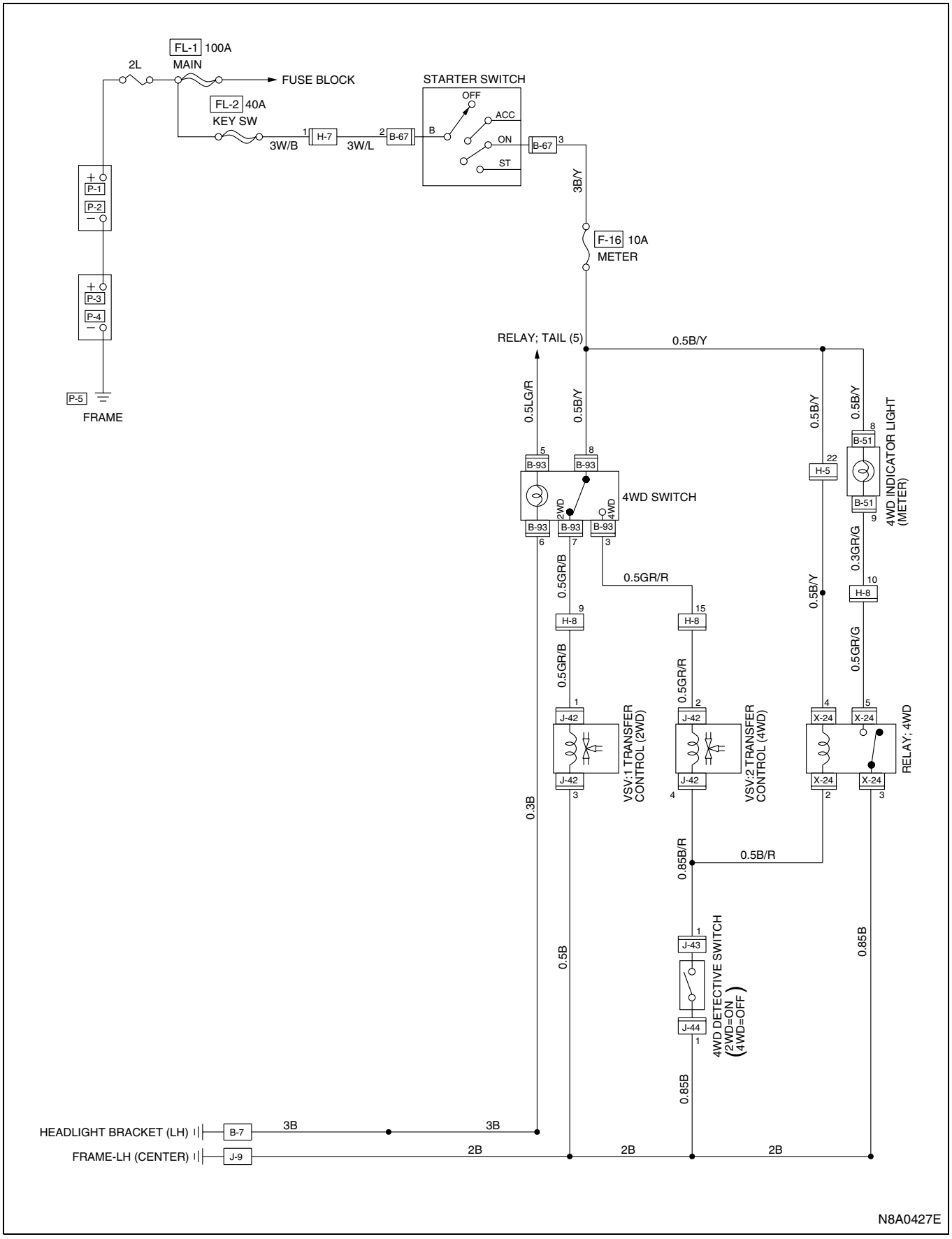
General Description

The circuit consists of the starter switch, 4WD switch, 4WD detect switch, 4L switch, vacuum switching valve, 4WD indicator light, neutral switch and the relay.
When the 4WD switch is turned on to drive in the 4WD mode, the vacuum switching valve for the transfer control is activated through the 4WD relay, and the transfer shift rod connected to the vacuum actuator is shifted to the 4WD side to turn on the 4WD detect switch. At the same time, the indicator light in the meter lights on to tell that the mode is transferred to 4WD mode.
However, when running in the normal mode (2WD), the 4WD switch is not operated. Accordingly, no current flows through the 4WD vacuum switching valve for the transfer control, with the 4WD detect switch left in the “OFF” condition (2WD mode).

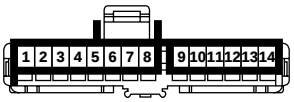
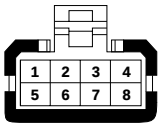
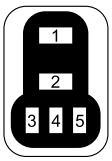
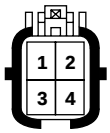
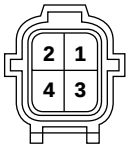
Parts Location

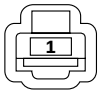
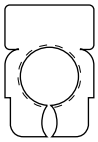
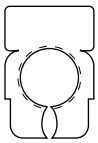
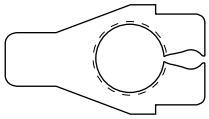
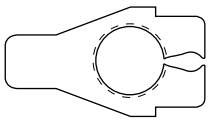
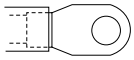


Circuit Diagram

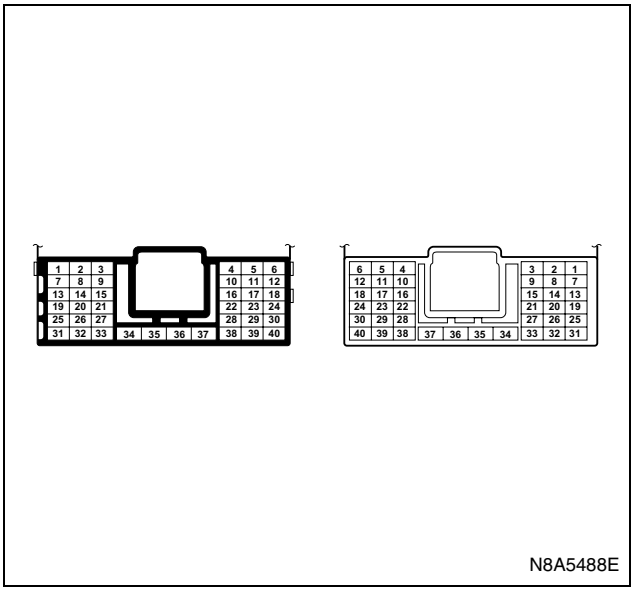


Connector List

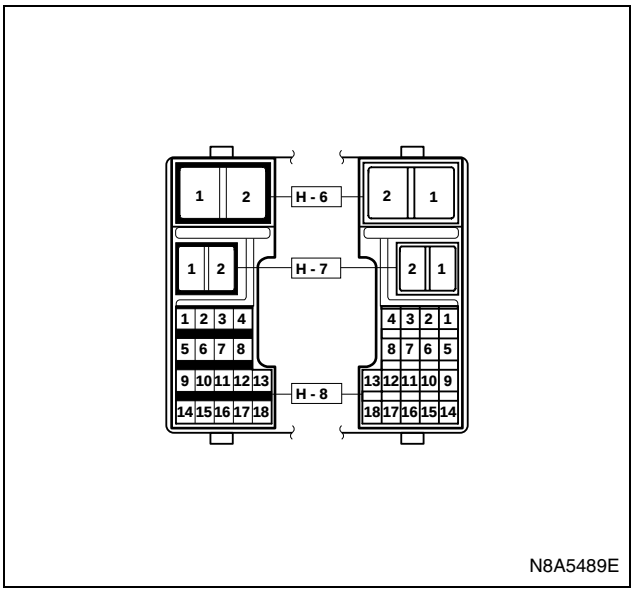
No.	Connector Face
B-51	 014-001
B-67	004-001
B-67	004-002
B-93	 008-005
X-24	 005-006
J-42	 004-012
J-42	 004-013
J-43	001-002

No.	Connector Face
J-43	001-003
J-44	001-002
J-44	 001-003
P-1	 000-004
P-4	 000-004
P-2	 000-006
P-3	 000-006
P-5	 000-002

H-5



H-7



Starter Switch

Refer to “START AND CHARGING” in this section.

Neutral Switch

Refer to “START AND CHARGING” in this section.

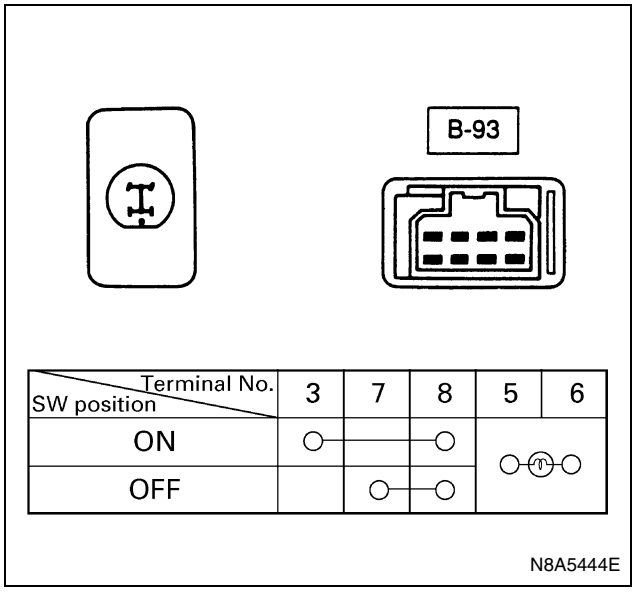
4WD Indicator Light

Refer to “METER AND WARNING/INDICATOR LIGHT” in this section.

4WD Switch

Inspection

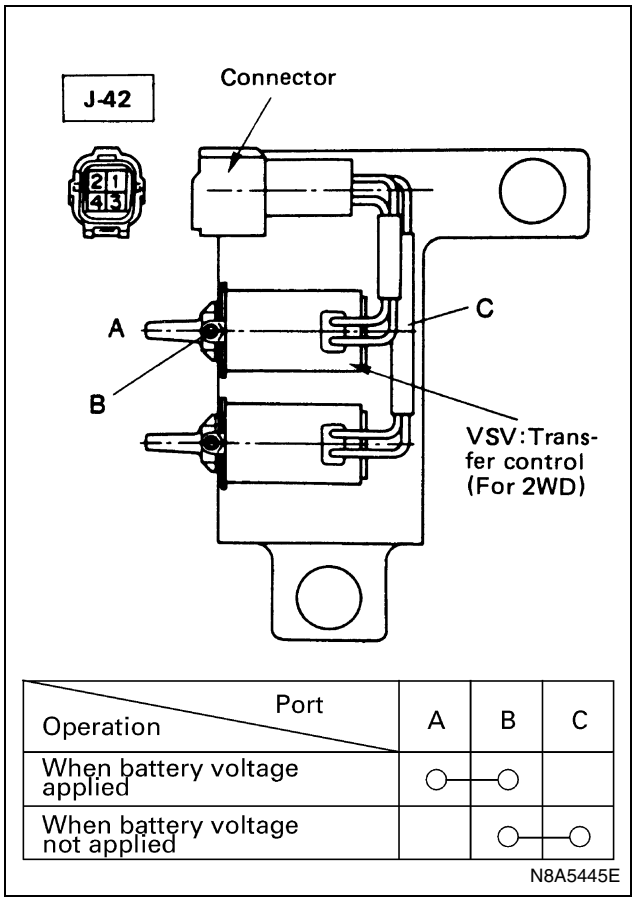
Check the continuity between the connector terminals while operating the switch.
Replace the switch when the result of inspection is found abnormal.



Vacuum Switching Valve: Transfer Control (for 2WD)

Inspection

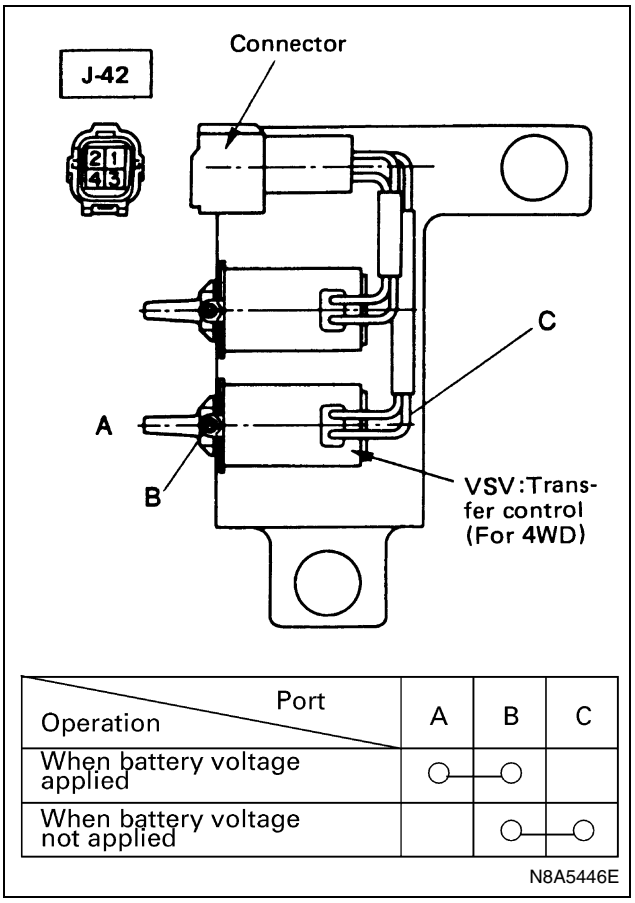
Connect the vacuum switching valve connector terminal No. 1 to the battery (+) terminal and terminal No. 3 to the (−) terminal and then check the continuity among each port.



Vacuum Switching Valve: Transfer Control (for 4WD)

Inspection

Connect the vacuum switching valve connector terminal No. 2 to the battery (+) terminal and terminal No. 4 to the (−) terminal and then check the continuity among each port.



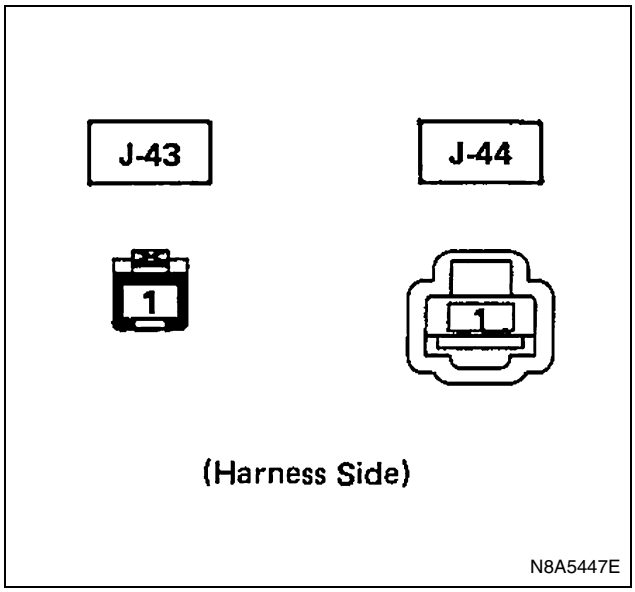
Operation \ Port	A	B	C
When battery voltage applied	○	○	
When battery voltage not applied		○	○

N8A5446E

4WD Detective Switch

Inspection of the 4WD Warning Light Circuit

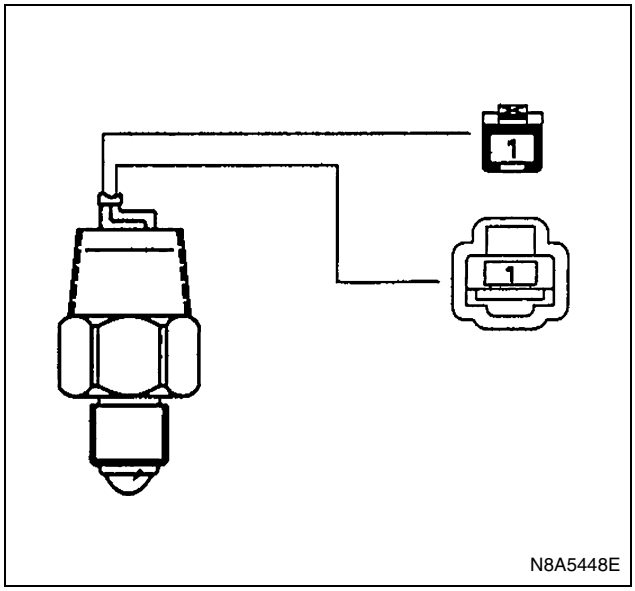
1. Disconnect the 4WD switch connectors.
2. Connect the harness side connector terminals.
3. Check to see if the indicator light comes on with the starter switch “ON”.
   Check the bulb or harness when the result of inspection is found abnormal.



N8A5447E

Inspection

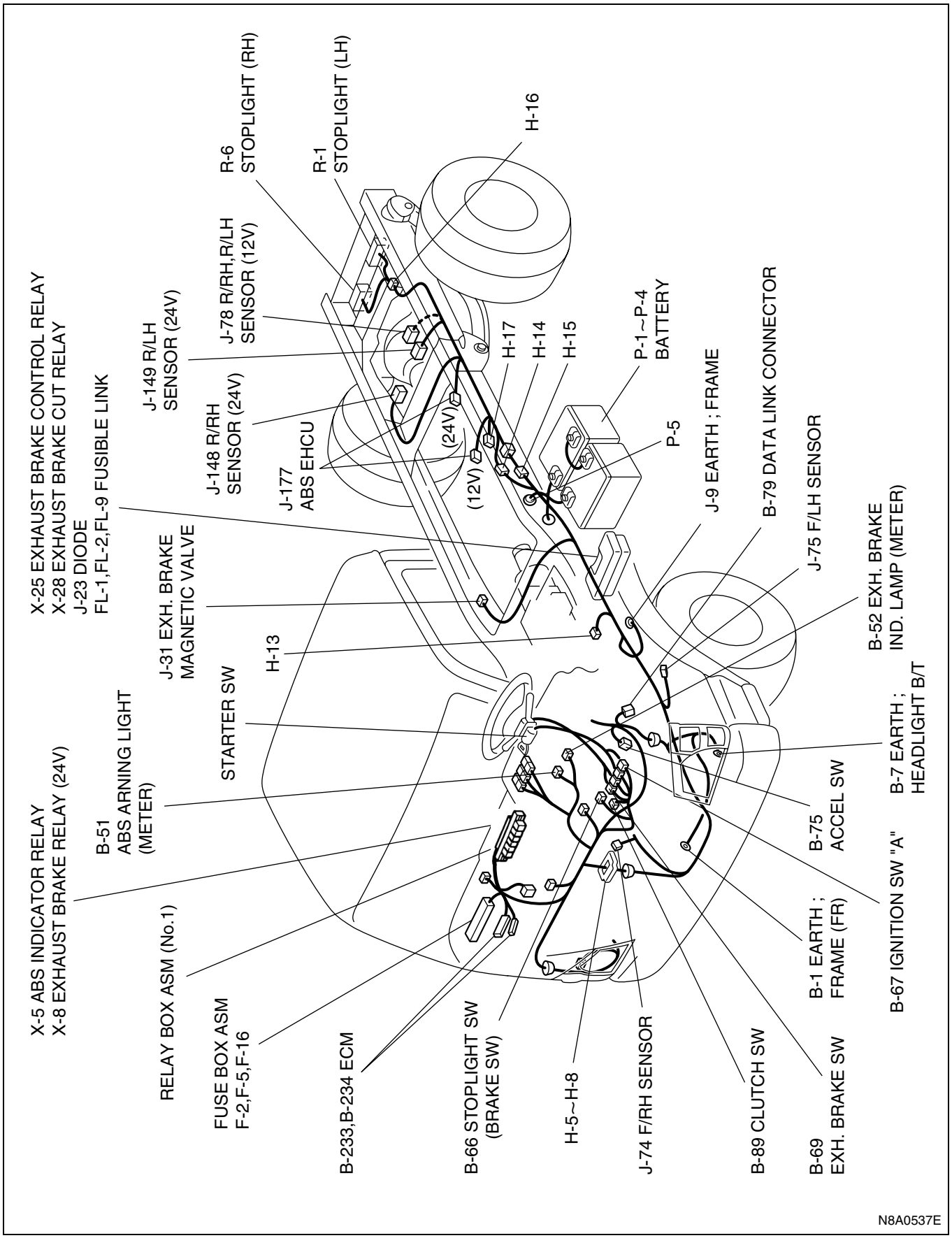
1. Shift the transfer lever to the 4H (4L) position.
2. Check to see if there is continuity between the 4WD switch connectors.
   Replace the switch when the result of the inspection is found abnormal.



N8A5448E

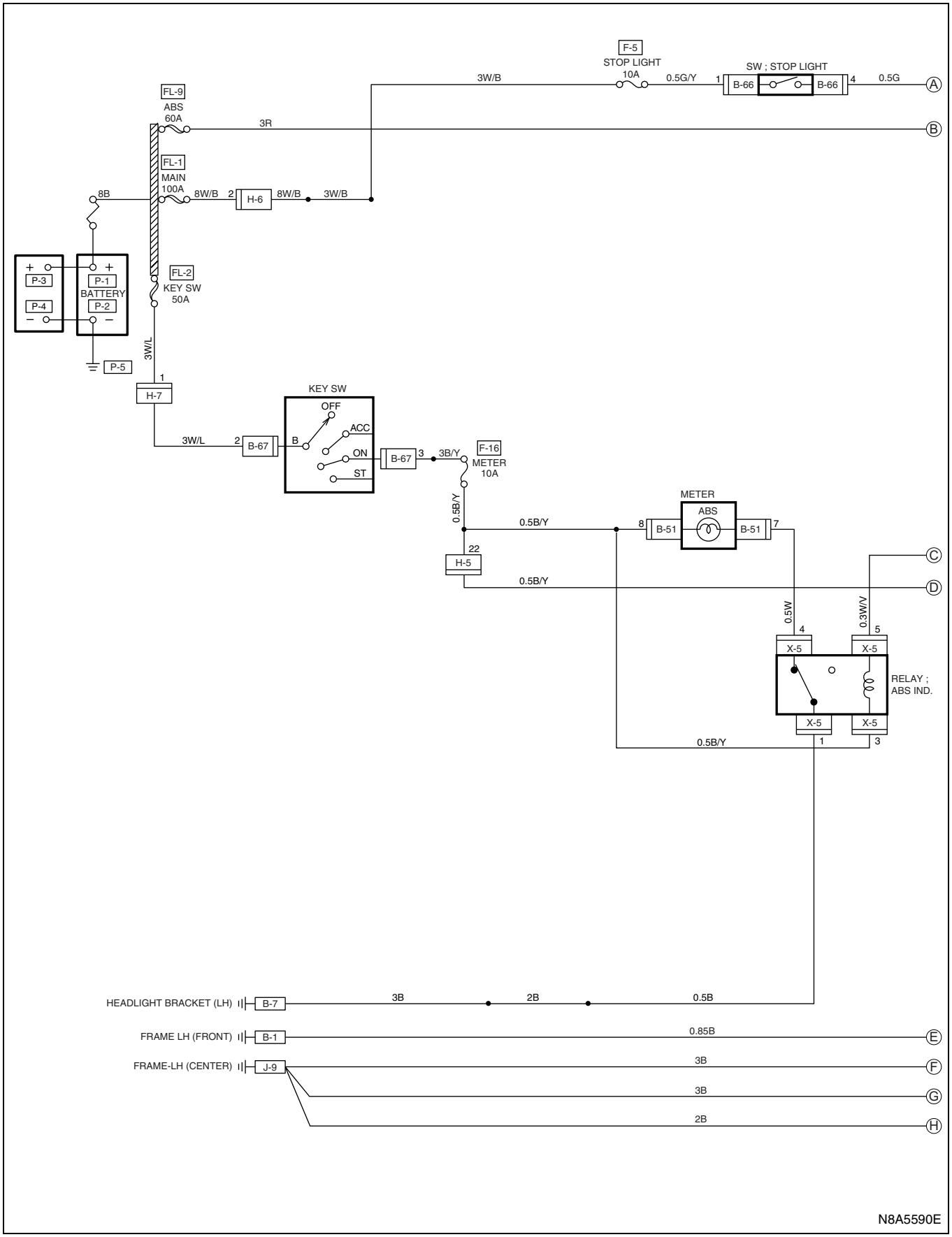
ABS (Anti-lock Brake System, Without ASR)

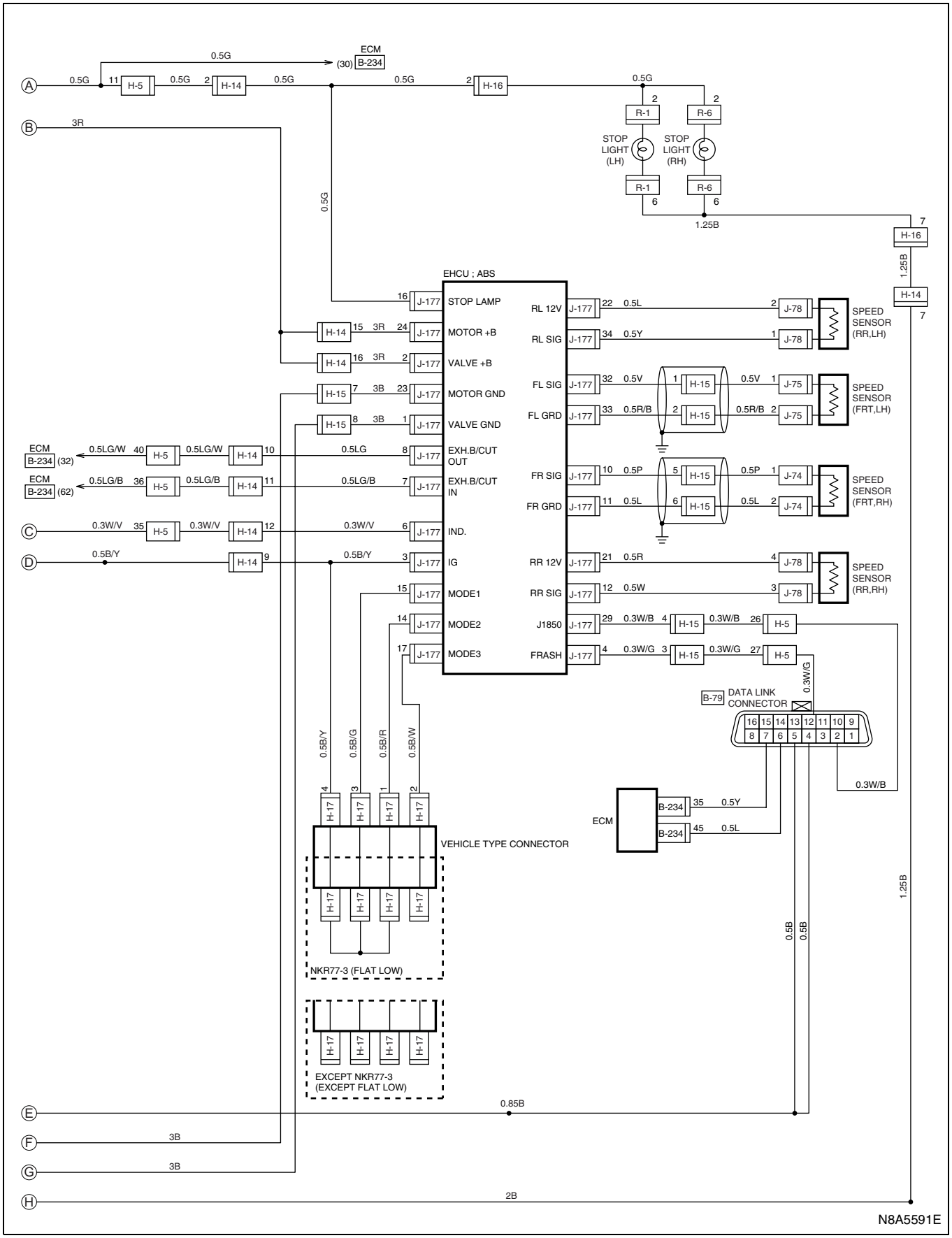
Parts Location



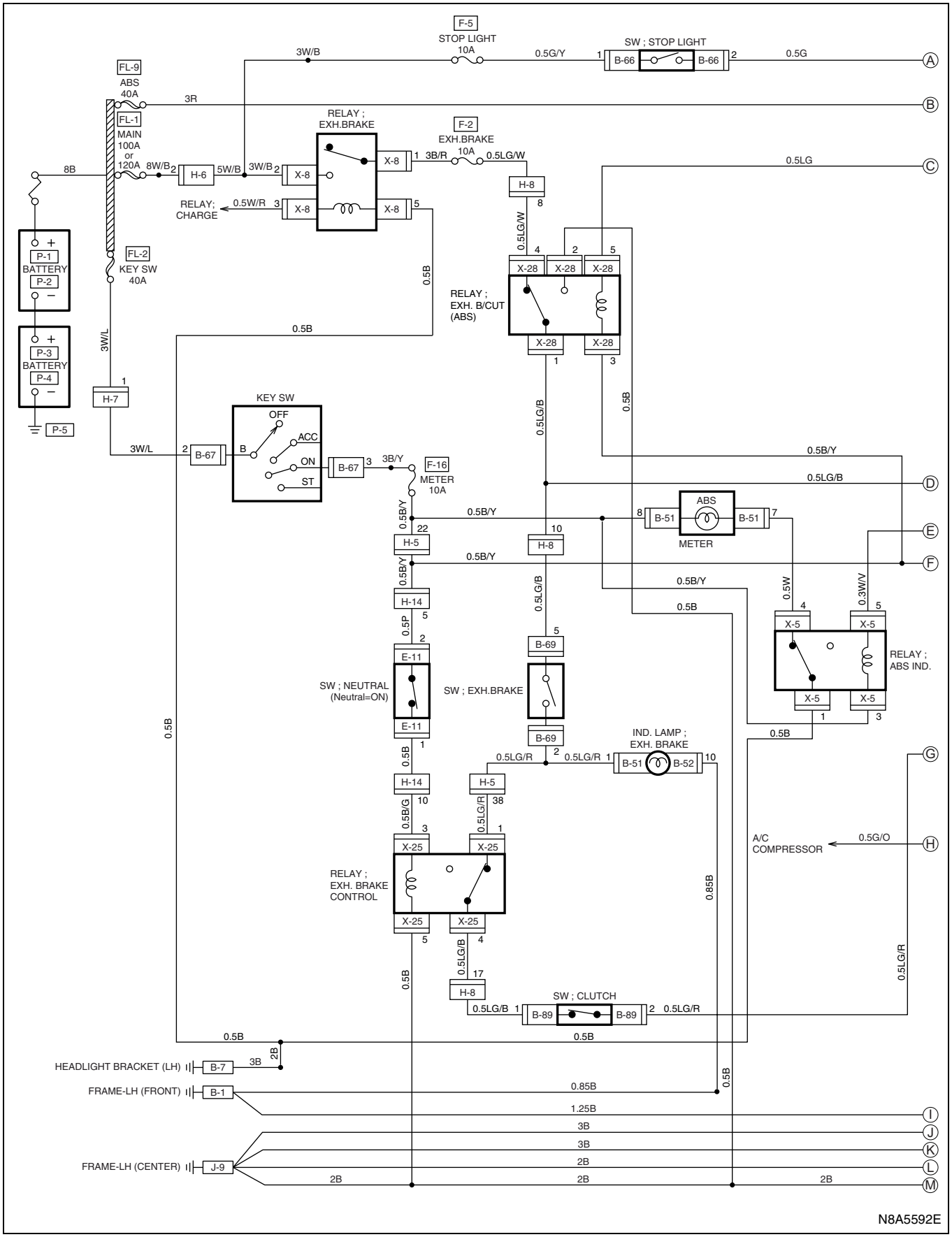
Circuit Diagram

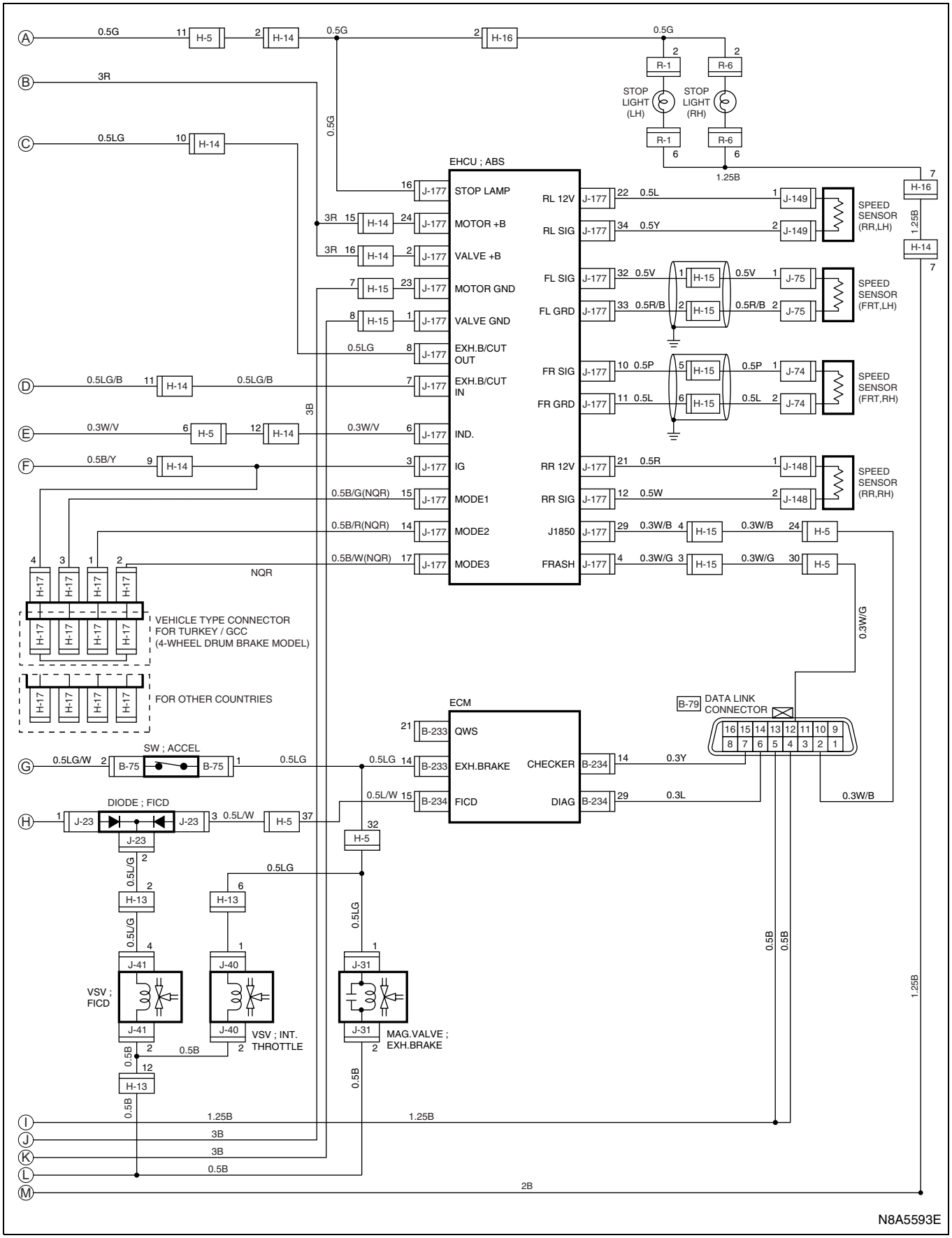
For 12 Volt (4JH1 Engine)



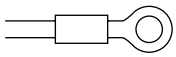
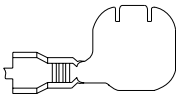
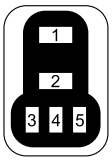
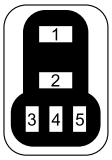
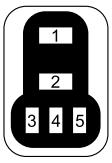
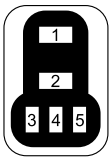
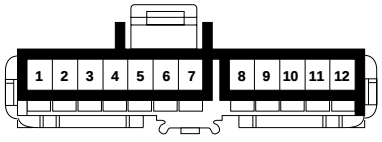

ECM
B-234
(30)
0.5G
A
11
H-5
2
H-14
H-16
R-1
R-6
STOP LIGHT (LH)
STOP LIGHT (RH)
6
1.25B
7
B
3R
EHCU ; ABS
J-177
STOP LAMP
MOTOR +B
VALVE +B
MOTOR GND
VALVE GND
EXH.B/CUT OUT
EXH.B/CUT IN
IND.
IG
MODE1
MODE2
MODE3
RL 12V
RL SIG
FL SIG
FL GRD
FR SIG
FR GRD
RR 12V
RR SIG
J1850
FRASH
J-78
J-75
J-74
H-15
SPEED SENSOR (RR,LH)
SPEED SENSOR (FRT,LH)
SPEED SENSOR (FRT,RH)
SPEED SENSOR (RR,RH)
0.5LG/W
0.5LG/B
0.3W/V
0.5B/Y
0.5LG
0.3W/B
0.3W/G
B-79
DATA LINK CONNECTOR
16 15 14 13 12 11 10 9
8 7 6 5 4 3 2 1
0.5B/Y
0.5B/G
0.5B/R
0.5B/W
H-17
VEHICLE TYPE CONNECTOR
NKR77-3 (FLAT LOW)
EXCEPT NKR77-3 (EXCEPT FLAT LOW)
0.5Y
0.5L
0.5B
0.85B
3B
2B
C
D
E
F
G
H
N8A5591E

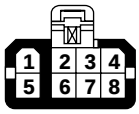
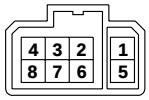
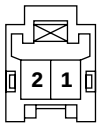
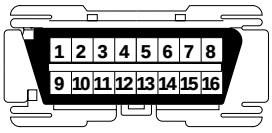
For 24 Volt

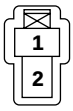
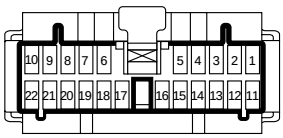
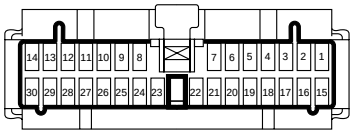
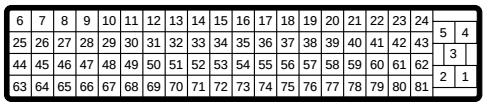
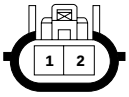
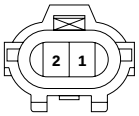
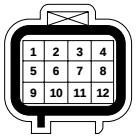

F-5
STOP LIGHT
10A
3W/B
0.5G/Y
SW ; STOP LIGHT
B-66
0.5G
FL-9
ABS
40A
3R
FL-1
MAIN
100A
or
120A
8W/B
RELAY ;
EXH.BRAKE
F-2
EXH.BRAKE
10A
3B/R
0.5LG/W
8B
H-6
5W/B
3W/B
X-8
RELAY;
CHARGE
0.5W/R
0.5LG
P-1
BATTERY
P-2
P-3
BATTERY
P-4
P-5
FL-2
KEY SW
40A
3W/L
0.5B
H-7
KEY SW
OFF
ACC
ON
ST
B-67
3B/Y
F-16
METER
10A
H-8
X-28
RELAY ;
EXH. B/CUT
(ABS)
0.5LG/B
0.5B/Y
0.5LG/B
ABS
B-51
METER
H-5
H-14
0.5P
E-11
SW ; NEUTRAL
(Neutral=ON)
SW ; EXH.BRAKE
B-69
IND. LAMP ;
EXH. BRAKE
B-52
0.5LG/R
0.5W
0.3W/Y
X-5
RELAY ;
ABS IND.
0.5B/G
X-25
RELAY ;
EXH. BRAKE
CONTROL
0.85B
A/C
COMPRESSOR
0.5G/O
SW ; CLUTCH
B-89
HEADLIGHT BRACKET (LH)
B-7
2B
3B
FRAME-LH (FRONT)
B-1
1.25B
FRAME-LH (CENTER)
J-9
N8A5592E

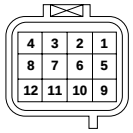
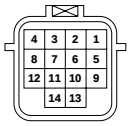
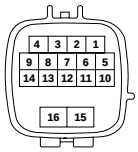
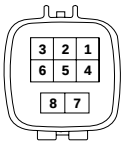

EHCU ; ABS
STOP LAMP
MOTOR +B
VALVE +B
MOTOR GND
VALVE GND
EXH.B/CUT OUT
EXH.B/CUT IN
IND.
IG
MODE1
MODE2
MODE3
RL 12V
RL SIG
FL SIG
FL GRD
FR SIG
FR GRD
RR 12V
RR SIG
J1850
FRASH
SPEED SENSOR (RR,LH)
SPEED SENSOR (FRT,LH)
SPEED SENSOR (FRT,RH)
SPEED SENSOR (RR,RH)
STOP LIGHT (LH)
STOP LIGHT (RH)
VEHICLE TYPE CONNECTOR FOR TURKEY / GCC (4-WHEEL DRUM BRAKE MODEL)
FOR OTHER COUNTRIES
NQR
ECM
QWS
EXH.BRAKE
FICD
CHECKER
DIAG
DATA LINK CONNECTOR
SW ; ACCEL
DIODE ; FICD
VSV ; FICD
VSV ; INT. THROTTLE
MAG.VALVE ; EXH.BRAKE
N8A5593E

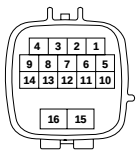
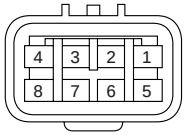
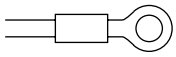
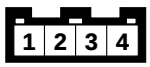
Connector List

No.	Connector Face
B-1	 000-001
B-7	 000-012
X-5	 005-006
X-8	 005-006
X-25	 005-006
X-28	 005-006
B-51	014-001
B-52	 012-005

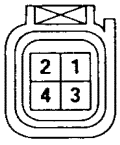
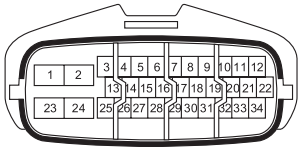
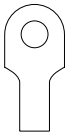
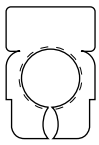
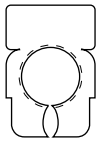
No.	Connector Face
B-66	004-010
B-67	004-001
B-67	004-002
B-69	 008-001
B-69	 008-002
B-75	002-022
B-75	 002-023
B-79	 016-005

No.	Connector Face
B-89	002-009
B-89	 002-010
B-233 (24 V)	 022-002
B-234 (24 V)	 030-002
B-234 (12 V)	 121-001
E-11	 002-001
E-11	 002-002
H-13	 012-001

No.	Connector Face
H-13	 012-002
H-14 (12 V)	014-004
H-14 (12 V)	 014-005
H-14 (24 V)	016-003
H-14 (24 V)	 016-004
H-15 (12 V)	008-023
H-15 (12 V)	 008-024
H-15 (24 V)	016-003

No.	Connector Face
H-15 (24 V)	 016-004
H-16	008-003
H-16	 008-004
H-17	004-011
J-9	 000-001
J-23	 004-009
J-31	002-011
J-31	002-012

No.	Connector Face
J-40	002-015
J-41	002-015
J-74	002-011
J-74	002-012
J-75	002-011
J-75	002-012
J-148	002-011
J-148	002-012

No.	Connector Face
J-149 (24 V)	002-011
J-149 (24 V)	002-012
J-78 (12 V)	004-011
J-78 (12 V)	 004-018
J-177	 034-001
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004

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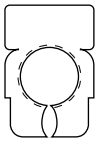
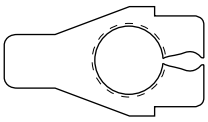
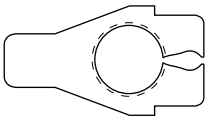
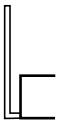
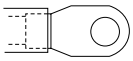
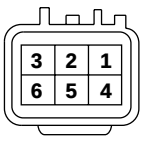
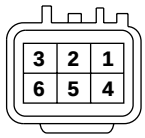
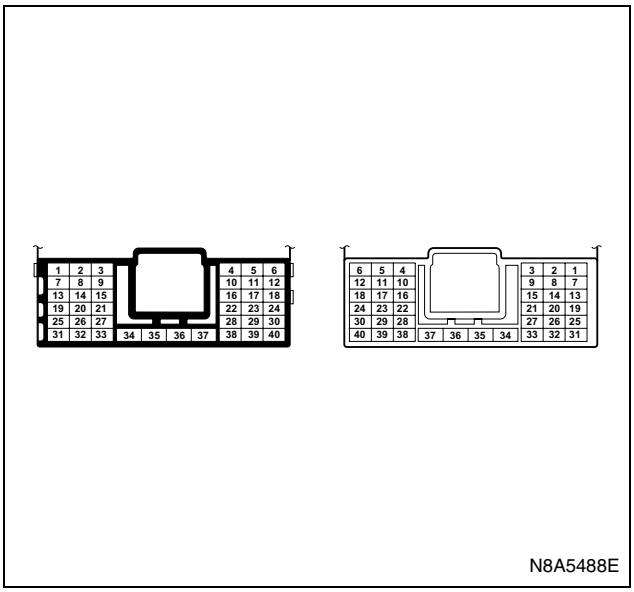
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
P-5 (12 V)	 000-007
P-5 (24 V)	 000-002
R-1	006-004
R-1	 006-005
R-6	006-004

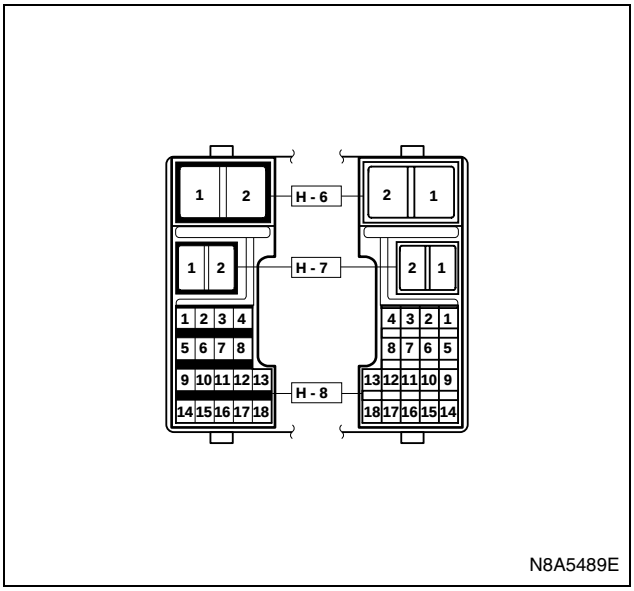
No.	Connector Face
R-6	 006-005

H-5



N8A5488E

H-6, H-7, H-8



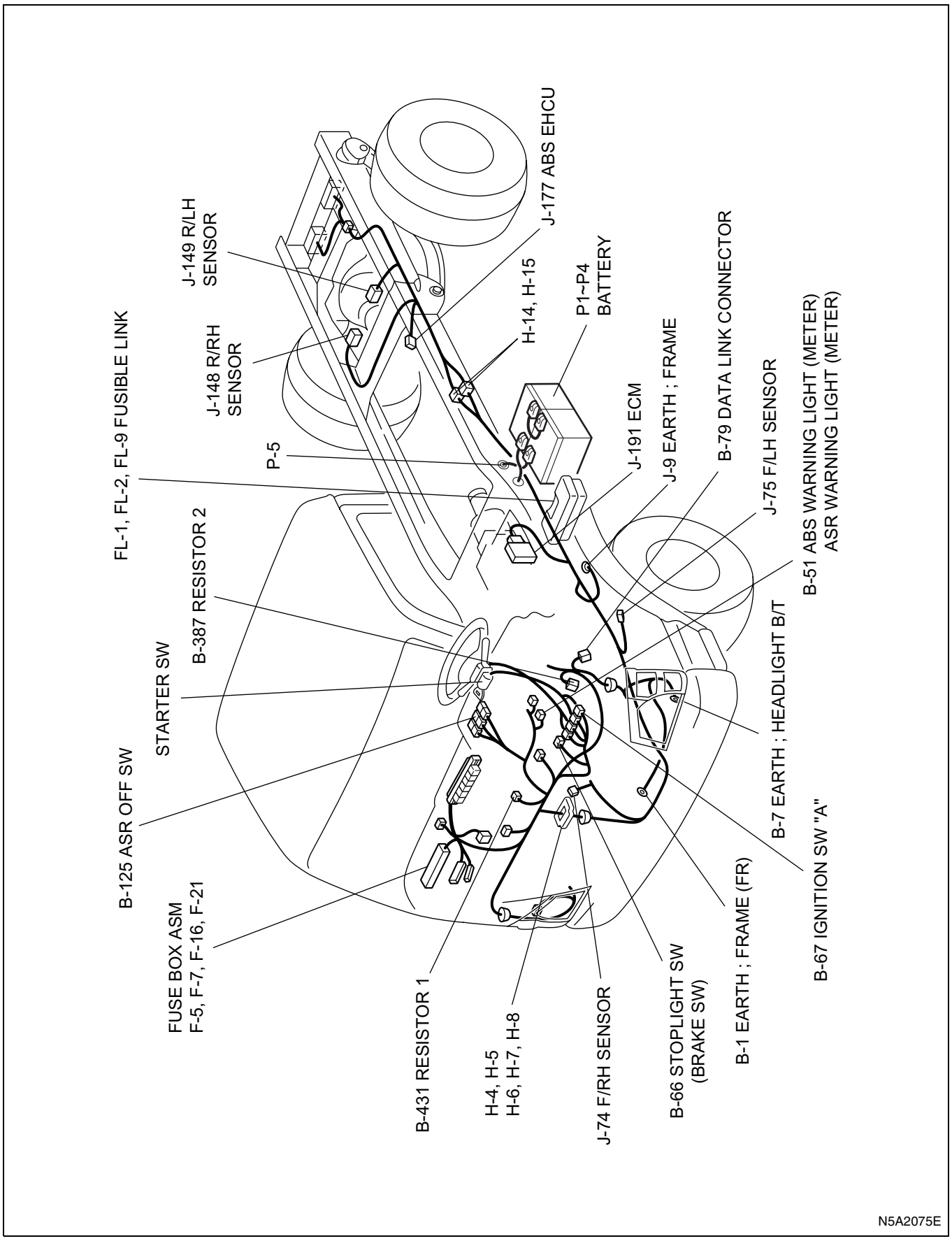
N8A5489E

ABS/ASR System

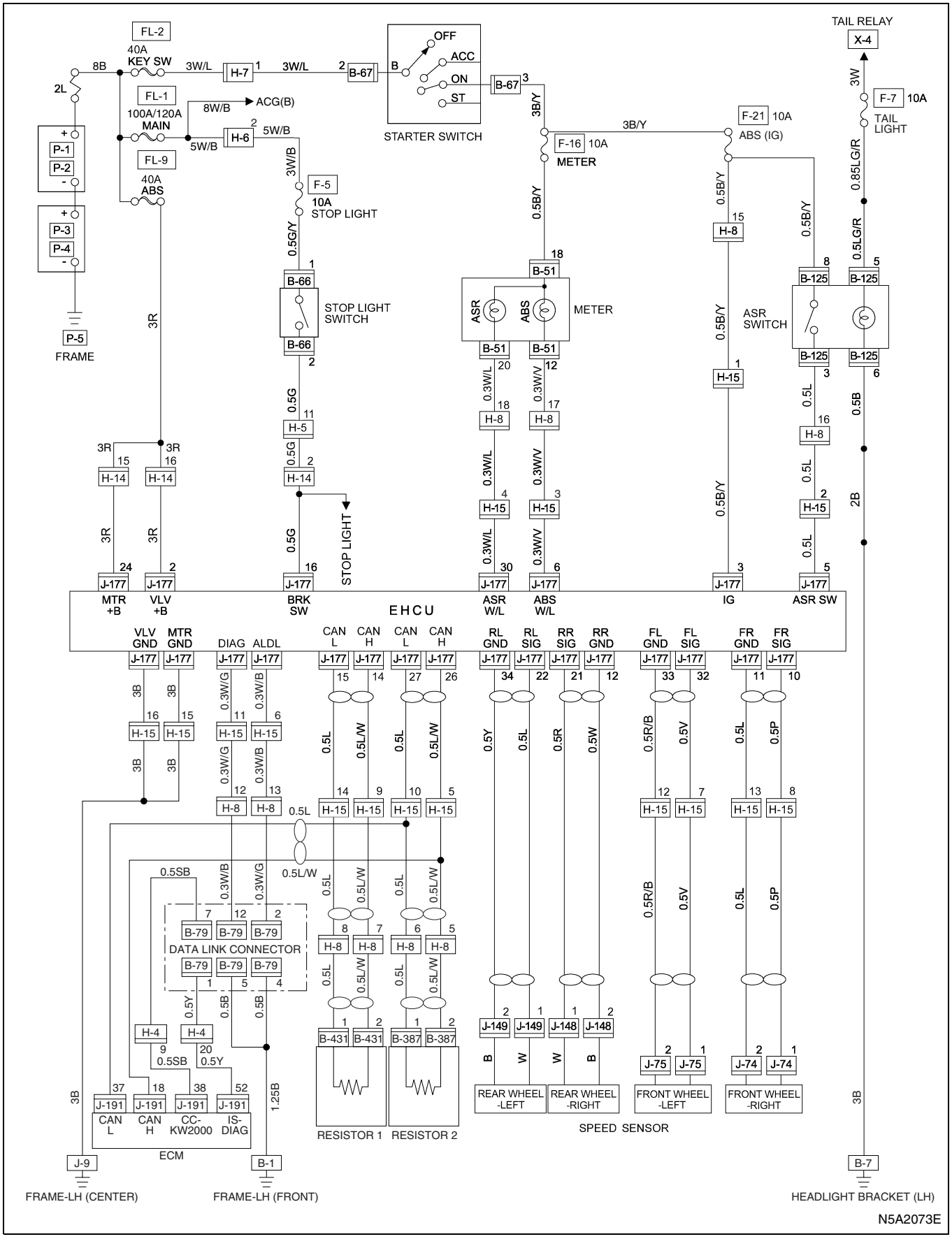
General Description

ABS (Anti-lock Brake System) and ASR (Anti-Slip Regulator) are the system to prevent the wheels from locking and wheel spin, and to assure stability and steering ability of the vehicle.
When a malfunction occurs in the system, fail-safe deactivate the ABS and ASR, and the warning lamp comes on. Also, the self-diagnosis function is equipped to improve serviceability.

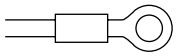
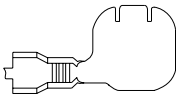
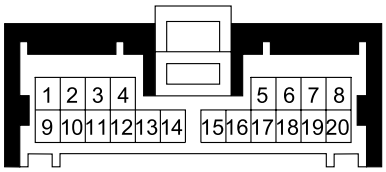
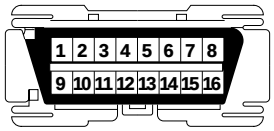
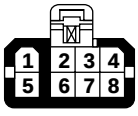
Parts Location

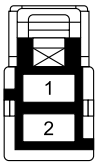
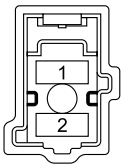
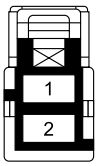
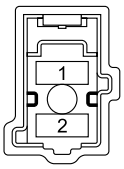
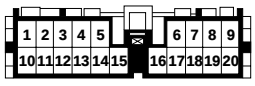
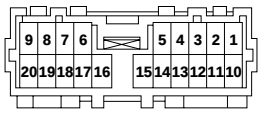
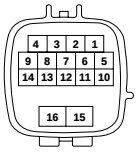


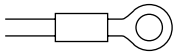
Circuit Diagram

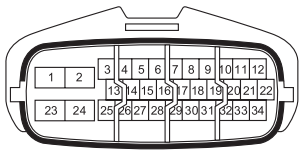
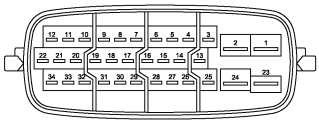
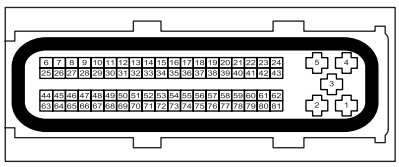
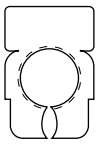
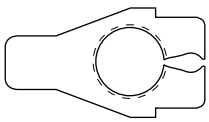


Connector List

No.	Connector Face
B-1	 000-001
B-7	 000-012
B-51	 020-004
B-66	002-031
B-67	004-002
B-67	004-001
B-79	 016-005
B-125	 008-001

No.	Connector Face
B-387	 002-038
B-387	 002-039
B-431	 002-038
B-431	 002-039
H-4	 020-002
H-4	 020-003
H-14	 016-004
H-14	016-003

No.	Connector Face
H-15	016-003
H-15	016-004
J-9	 000-001
J-74	002-012
J-74	002-011
J-75	002-012
J-75	002-011
J-148	002-012

No.	Connector Face
J-148	002-011
J-149	002-012
J-149	002-011
J-177	 034-001
J-177	 034-002
J-191	 081-001
P-1	 000-004
P-2	 000-006

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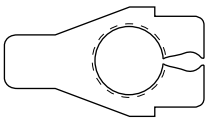
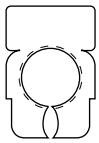
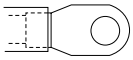
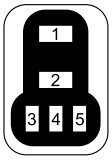
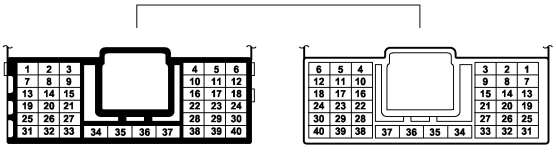
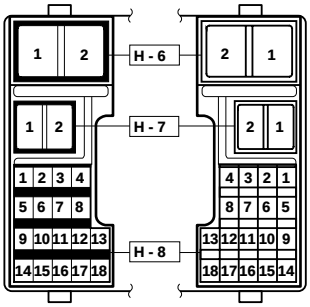
P-3	 000-006
P-4	 000-004
P-5	 000-002
X-4	 005-006

H-5



N5A2011E

H-6, H-7, H-8



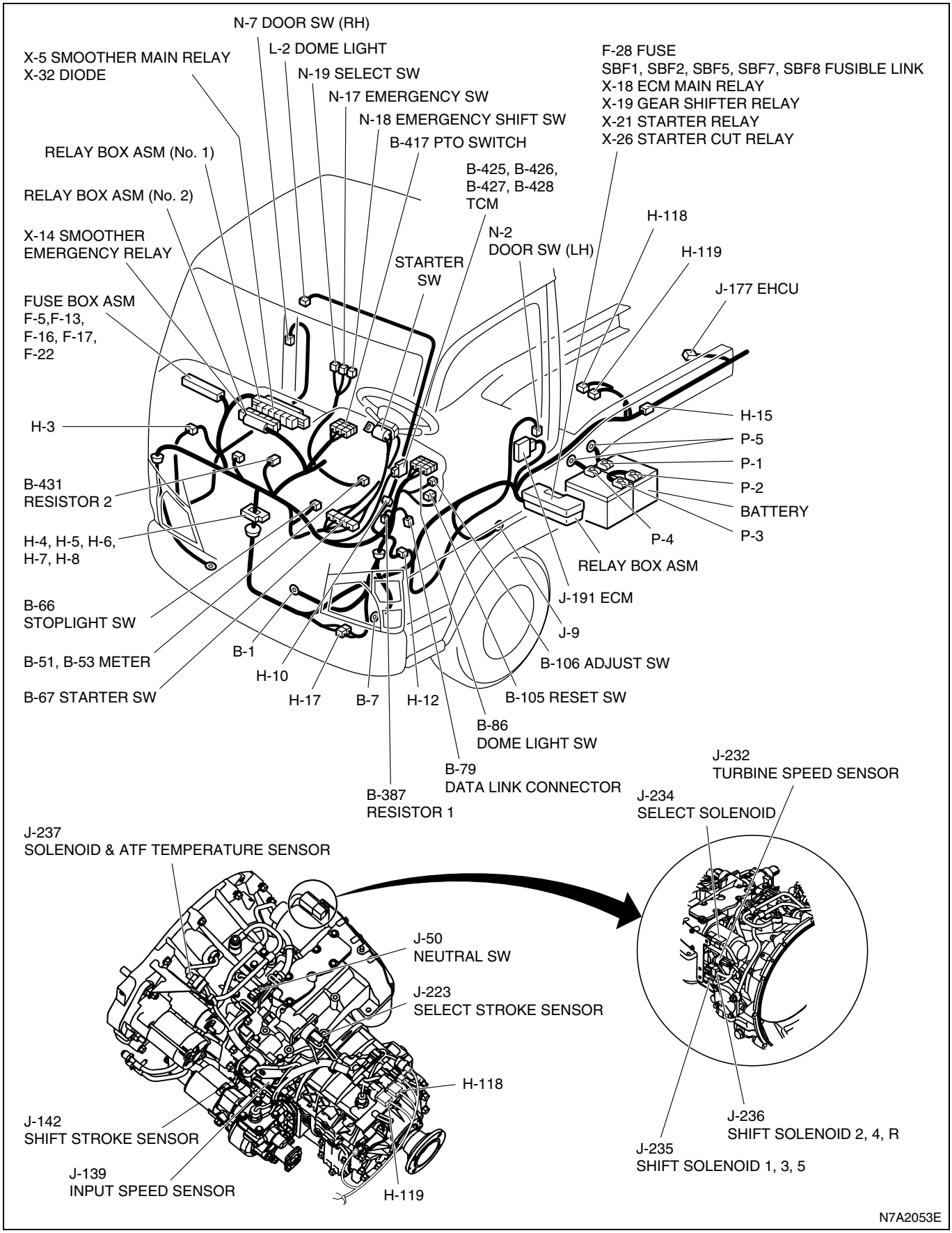
N8A5489E

Transmission Control System (Smoother)

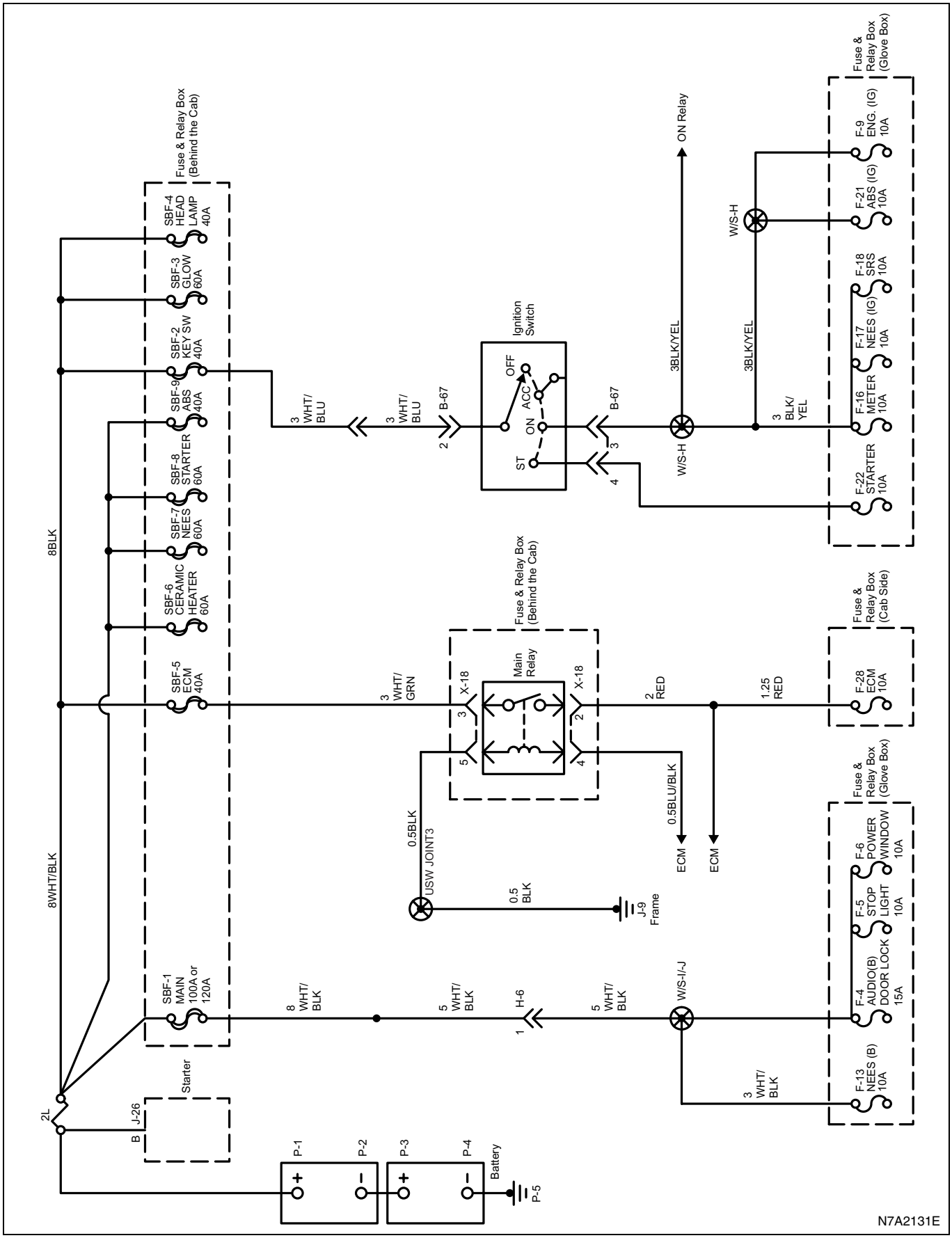
General Description

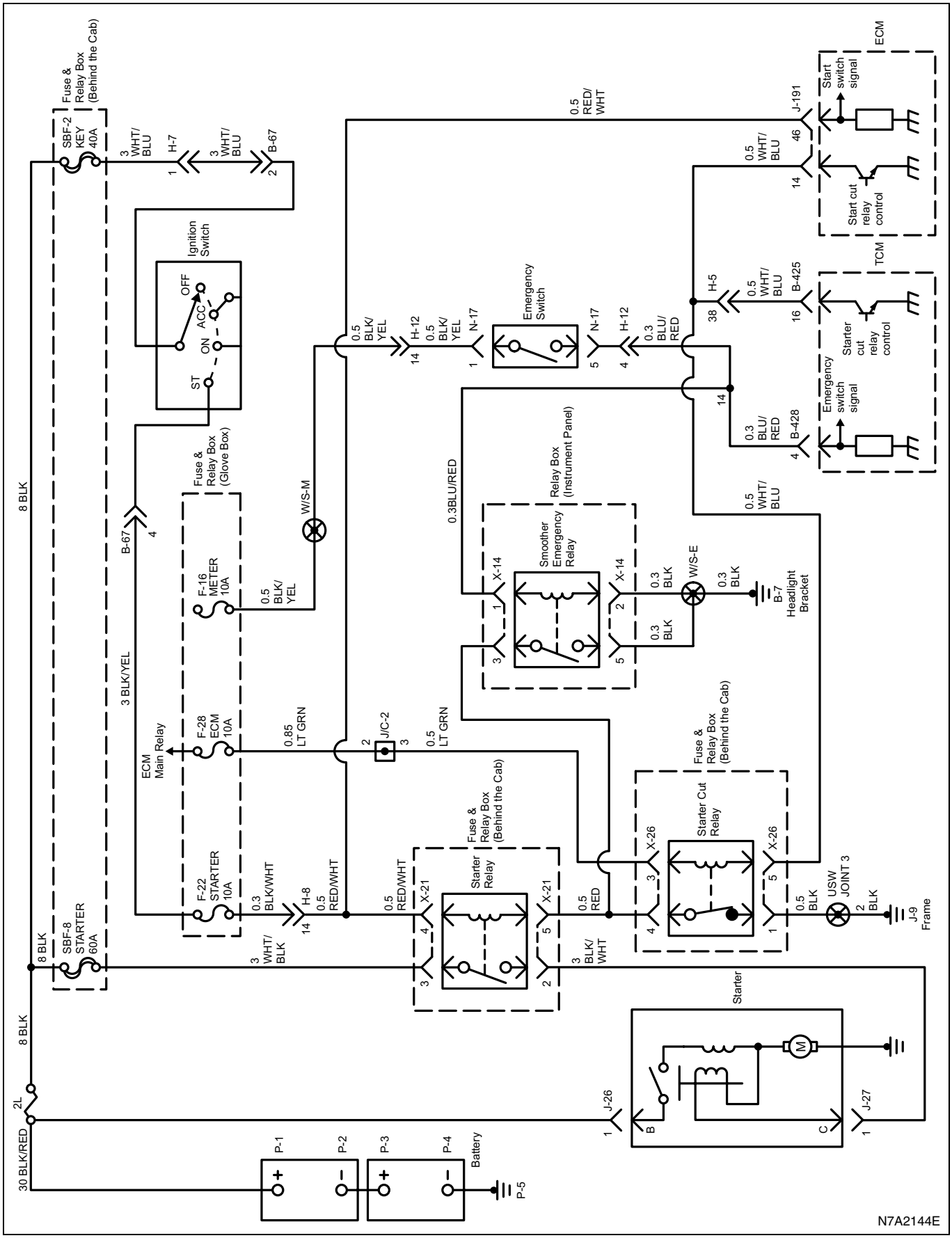
"Smoother" is the name of a new-generation drive train that provides benefits in terms of both life cycle costs (low initial cost and maintenance cost, lower fuel consumption, etc.) and easy driving. Smoother is a system that adds an automatic transmission to the existing Smoother, for even better fuel consumption and easier driving. This is accomplished by installing a solenoid system shift control box on the Smoother, which combines a manual transmission with fluid coupling, so all shifting is performed automatically in accordance with signals from the transmission control module (TCM). When starting moving the vehicle, depressing the brake pedal and operating the change lever as on an automatic vehicle causes a change lever position signal to be detected by the TCM. This actuates the shift control box solenoid and shifts the gear into the starting position or the reverse position, and then engages the shift change clutch (wet multi-disc clutch). (After the shift clutch engages, creep force is generated the same as on an AT vehicle.) Releasing the foot from the brake pedal and pressing the accelerator pedal starts the vehicle moving forward. If there is an up-shift or down-shift while running, the control unit determines the vehicle status based on vehicle speed, accelerator opening angle, and other factors, and shifts to the optimal gear automatically. If the driver moves the change lever in the "+" or "-" direction, a gear change is indicated, so sequential manual shifting is also possible. (Even during sequential manual shifting, the transmission shifts to the starting position when the vehicle is stopped.)

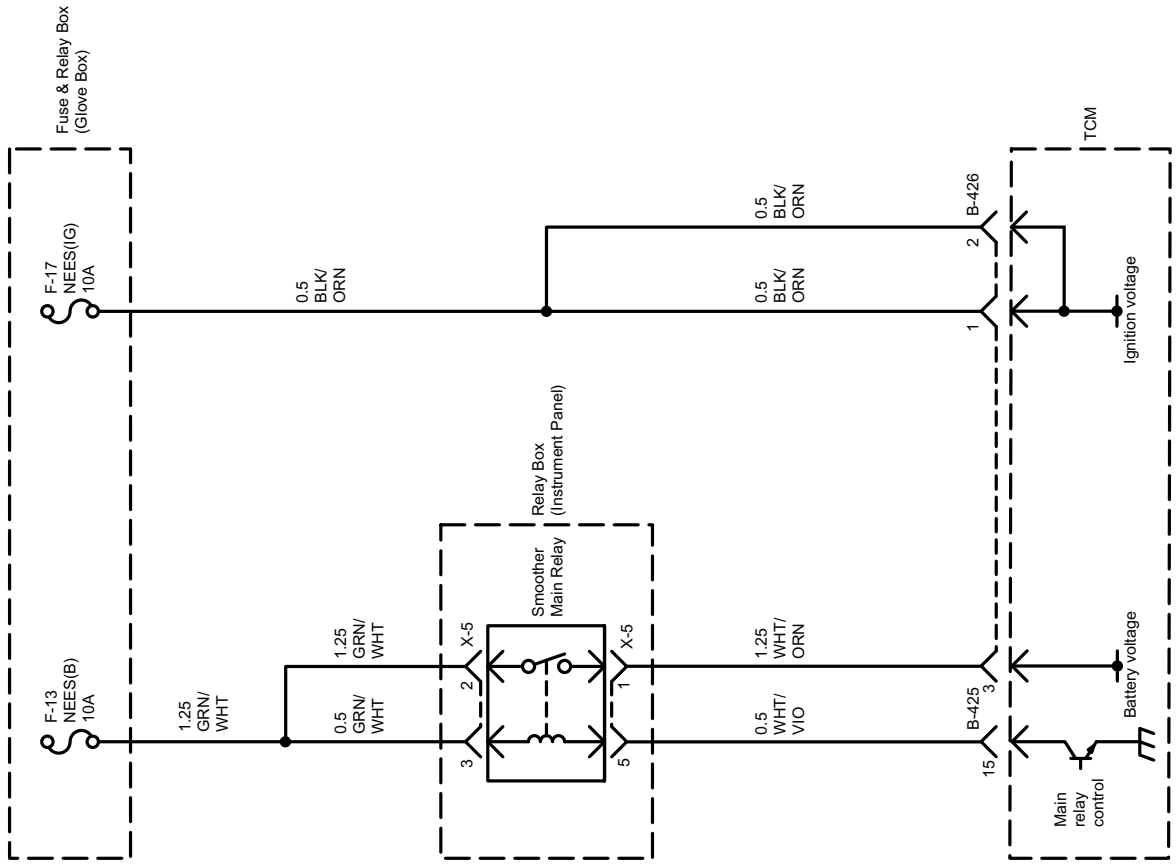
Parts Location



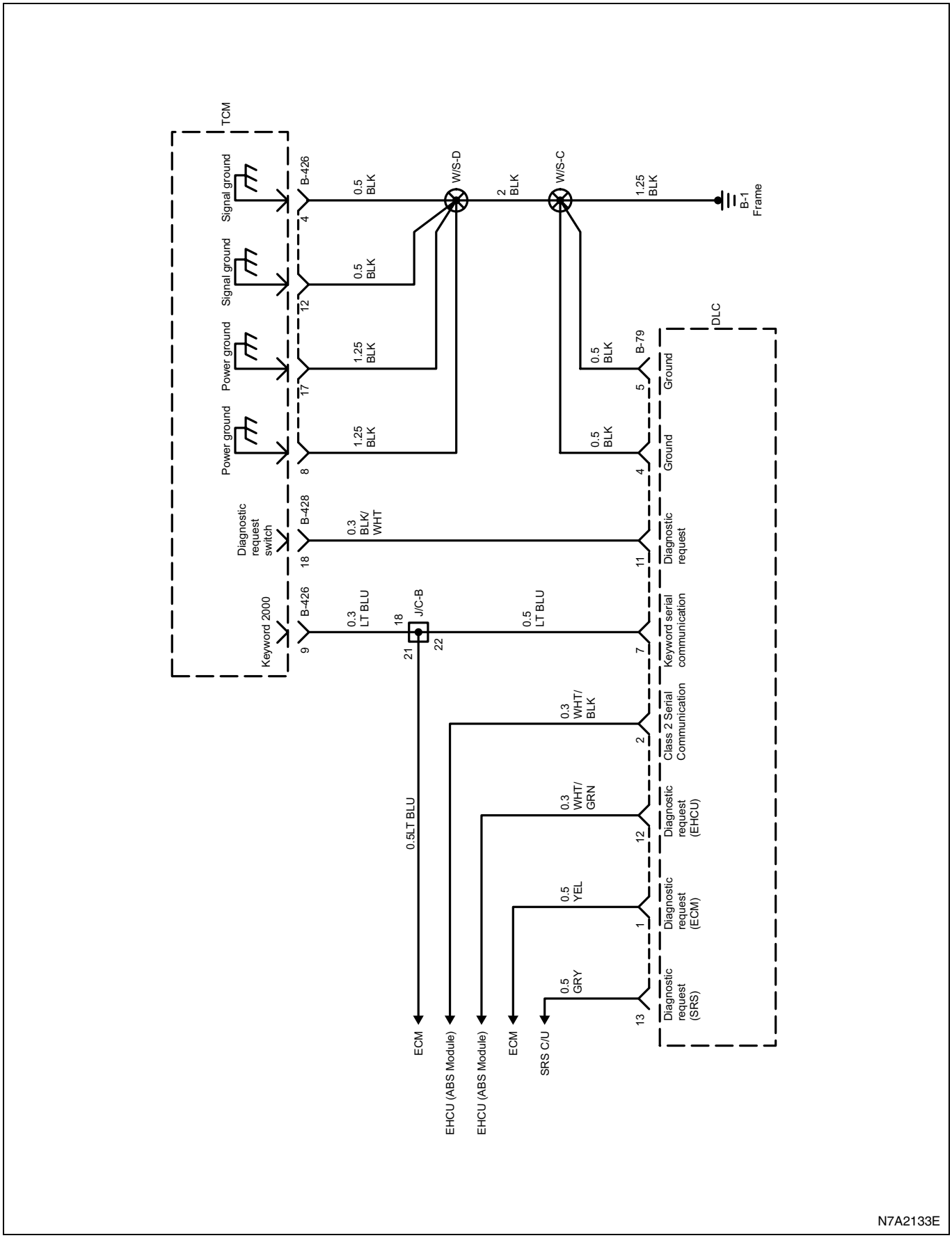
Circuit Diagram

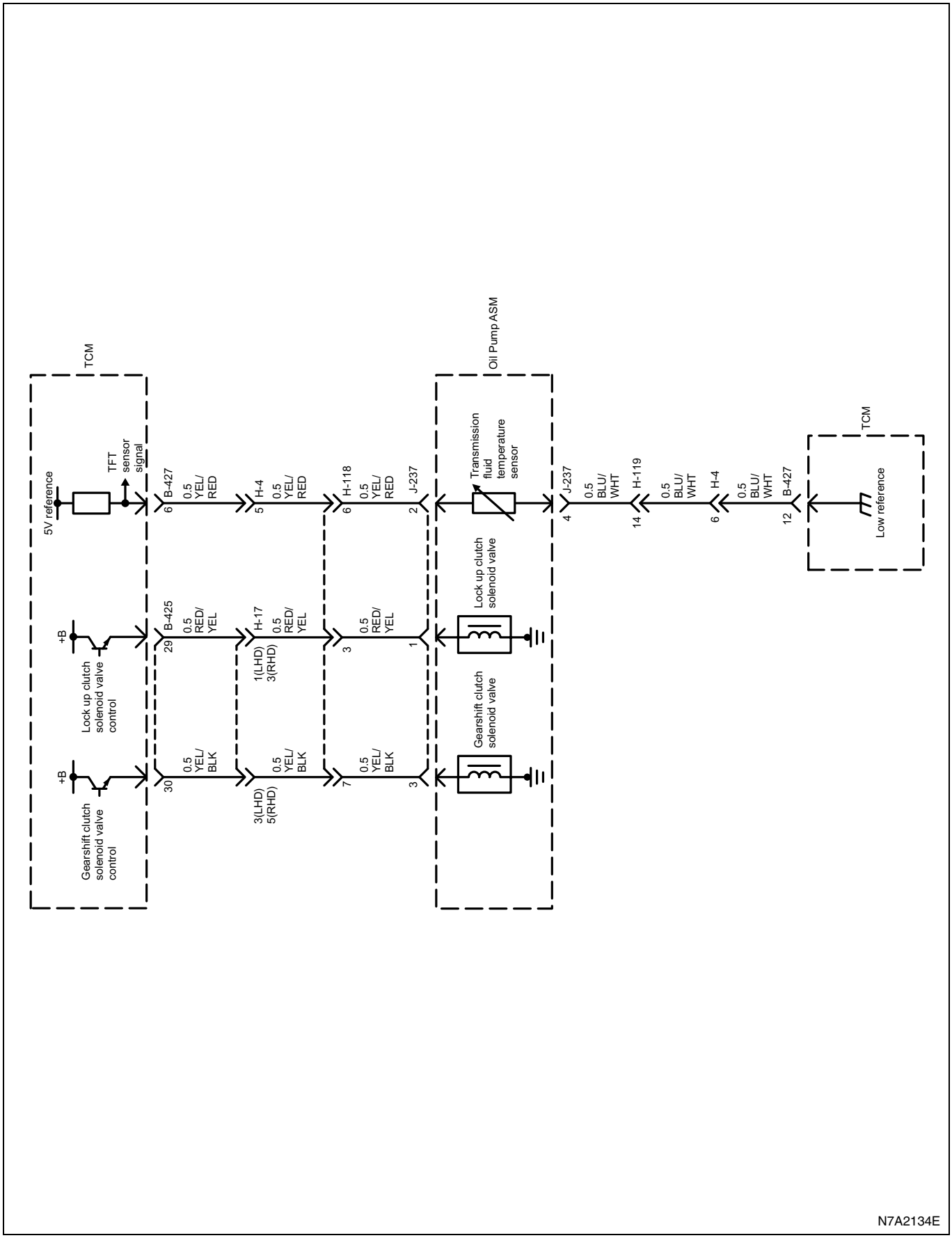


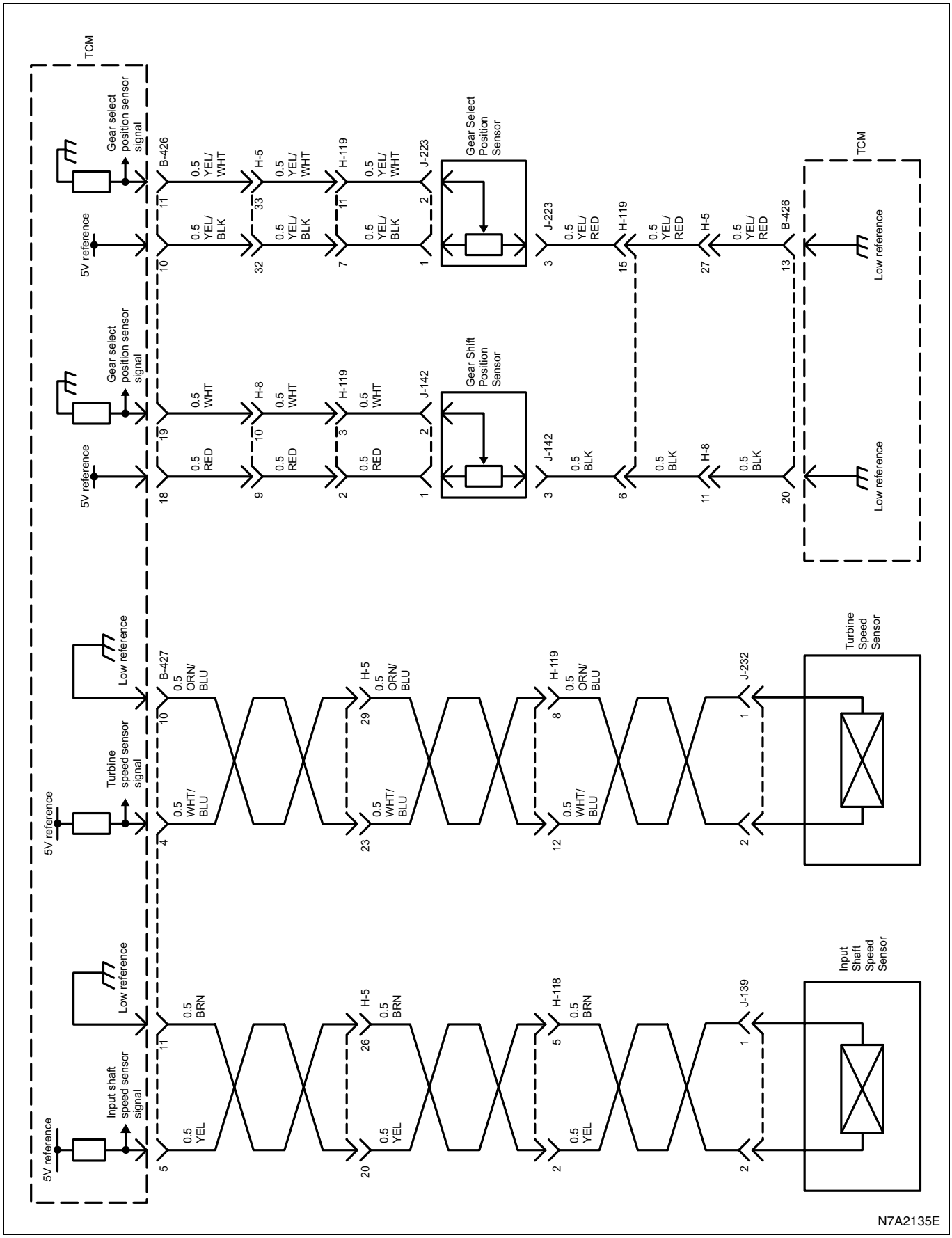

Fuse & Relay Box (Behind the Cab)
SBF-2 KEY 40A
3 WHT/BLU
H-7
B-67
Ignition Switch
OFF
ACC
ON
ST
Fuse & Relay Box (Glove Box)
W/S-M
0.5 BLK/YEL
H-12
N-17
Emergency Switch
0.5 RED/WHT
J-191
ECM
Start switch signal
Start cut relay control
0.5 WHT/BLU
H-5
B-425
TCM
Starter cut relay control
Emergency switch signal
0.3 BLU/RED
B-428
0.3BLU/RED
Relay Box (Instrument Panel)
Smoother Emergency Relay
X-14
W/S-E
0.3 BLK
B-7 Headlight Bracket
8 BLK
SBF-8 STARTER 60A
F-16 METER 10A
F-28 ECM 10A
F-22 STARTER 10A
3 BLK/YEL
ECM Main Relay
0.85 LT GRN
J/C-2
0.5 LT GRN
0.3 BLK/WHT
H-8
0.5 RED/WHT
3 WHT/BLK
Fuse & Relay Box (Behind the Cab)
Starter Relay
X-21
0.5 RED
Starter Cut Relay
X-26
USW JOINT 3
J-9 Frame
3 BLK/WHT
Starter
J-26
J-27
2L
30 BLK/RED
P-1
P-2
P-3
P-4
Battery
P-5
N7A2144E

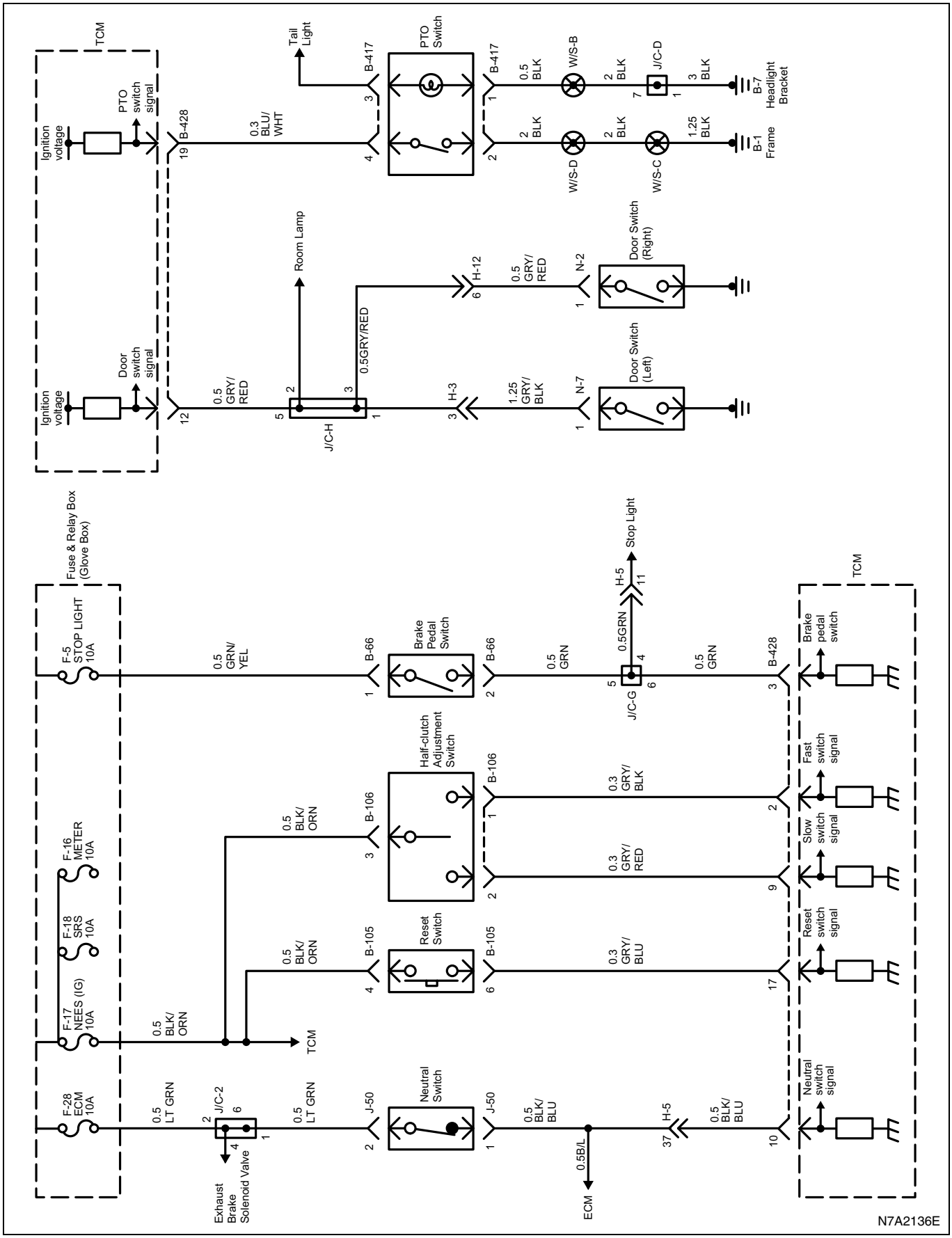

Fuse & Relay Box
(Glove Box)
F-17
NEES(IG)
10A
F-13
NEES(B)
10A
0.5
BLK/
ORN
1.25
GRN/
WHT
0.5
GRN/
WHT
Relay Box
(Instrument Panel)
Smoother
Main Relay
X-5
2
3
1
5
0.5
BLK/
ORN
0.5
BLK/
ORN
1.25
WHT/
ORN
0.5
WHT/
VIO
TCM
B-426
2
1
B-425
3
15
Ignition voltage
Battery voltage
Main
relay
control

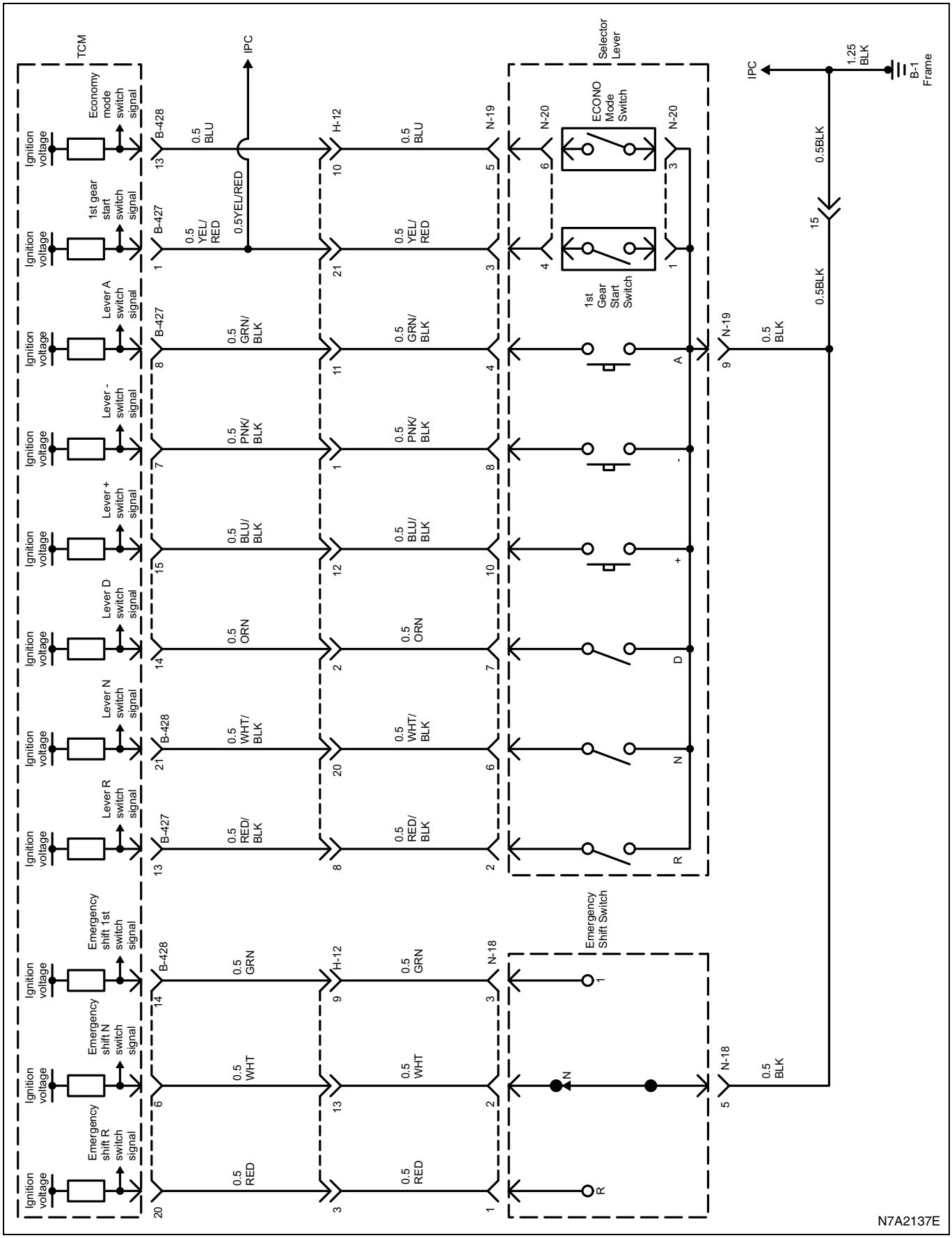
N7A2132E

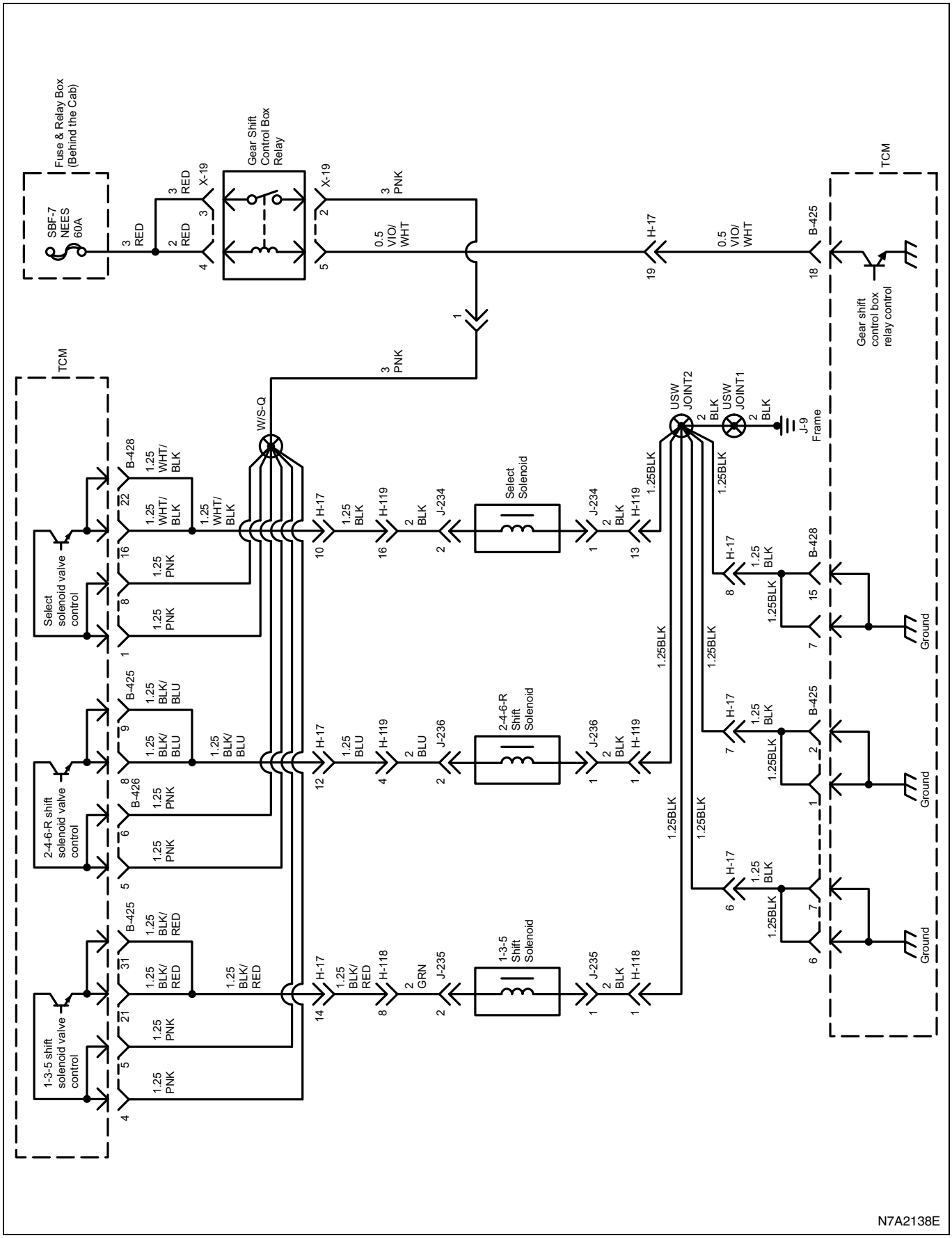

TCM
Signal ground
Signal ground
Power ground
Power ground
Diagnostic request switch
Keyword 2000
B-426
B-428
B-426
4
12
17
8
18
9
0.5 BLK
0.5 BLK
1.25 BLK
1.25 BLK
0.3 BLK/ WHT
0.3 LT BLU
18
21
22
J/C-B
0.5 LT BLU
W/S-D
2 BLK
W/S-C
1.25 BLK
B-1 Frame
DLC
0.5 BLK
0.5 BLK
B-79
5
4
Ground
Ground
11
Diagnostic request
7
Keyword serial commnication
0.3 WHT/ BLK
2
Class 2 Serial Communication
0.3 WHT/ GRN
12
Diagnostic request (EHCU)
0.5 YEL
1
Diagnostic request (ECM)
0.5 GRY
13
Diagnostic request (SRS)
0.5LT BLU
ECM
EHCU (ABS Module)
EHCU (ABS Module)
ECM
SRS C/U
N7A2133E

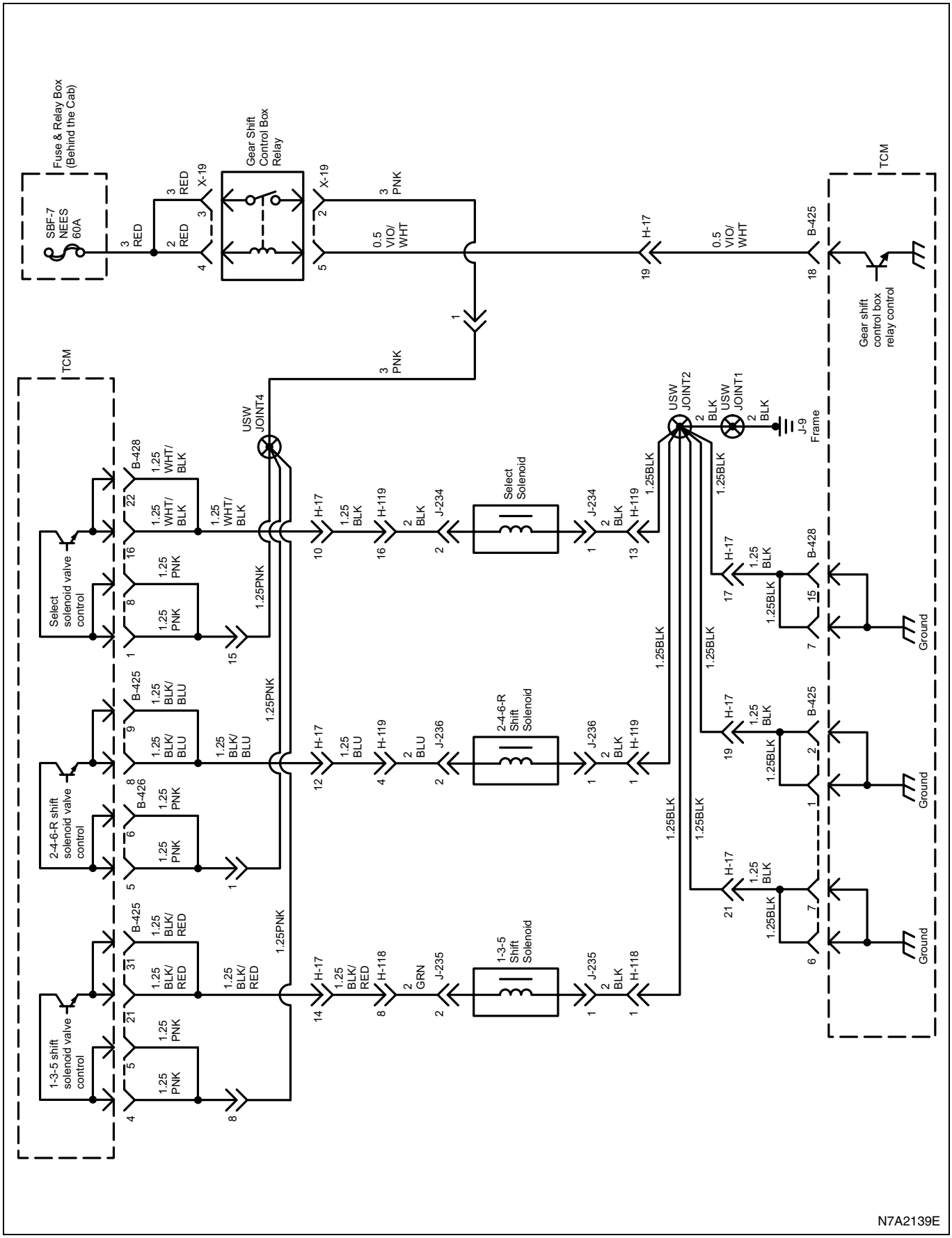

TCM
5V reference
TFT sensor signal
+B
Lock up clutch solenoid valve control
+B
Gearshift clutch solenoid valve control
B-427
6
0.5 YEL/ RED
H-4
5
0.5 YEL/ RED
H-118
6
0.5 YEL/ RED
J-237
2
B-425
29
0.5 RED/ YEL
H-17
1(LHD) 3(RHD)
0.5 RED/ YEL
3
0.5 RED/ YEL
1
30
0.5 YEL/ BLK
3(LHD) 5(RHD)
0.5 YEL/ BLK
7
0.5 YEL/ BLK
3
Oil Pump ASM
Transmission fluid temperature sensor
Lock up clutch solenoid valve
Gearshift clutch solenoid valve
J-237
4
0.5 BLU/ WHT
H-119
14
0.5 BLU/ WHT
H-4
6
0.5 BLU/ WHT
B-427
12
TCM
Low reference
N7A2134E

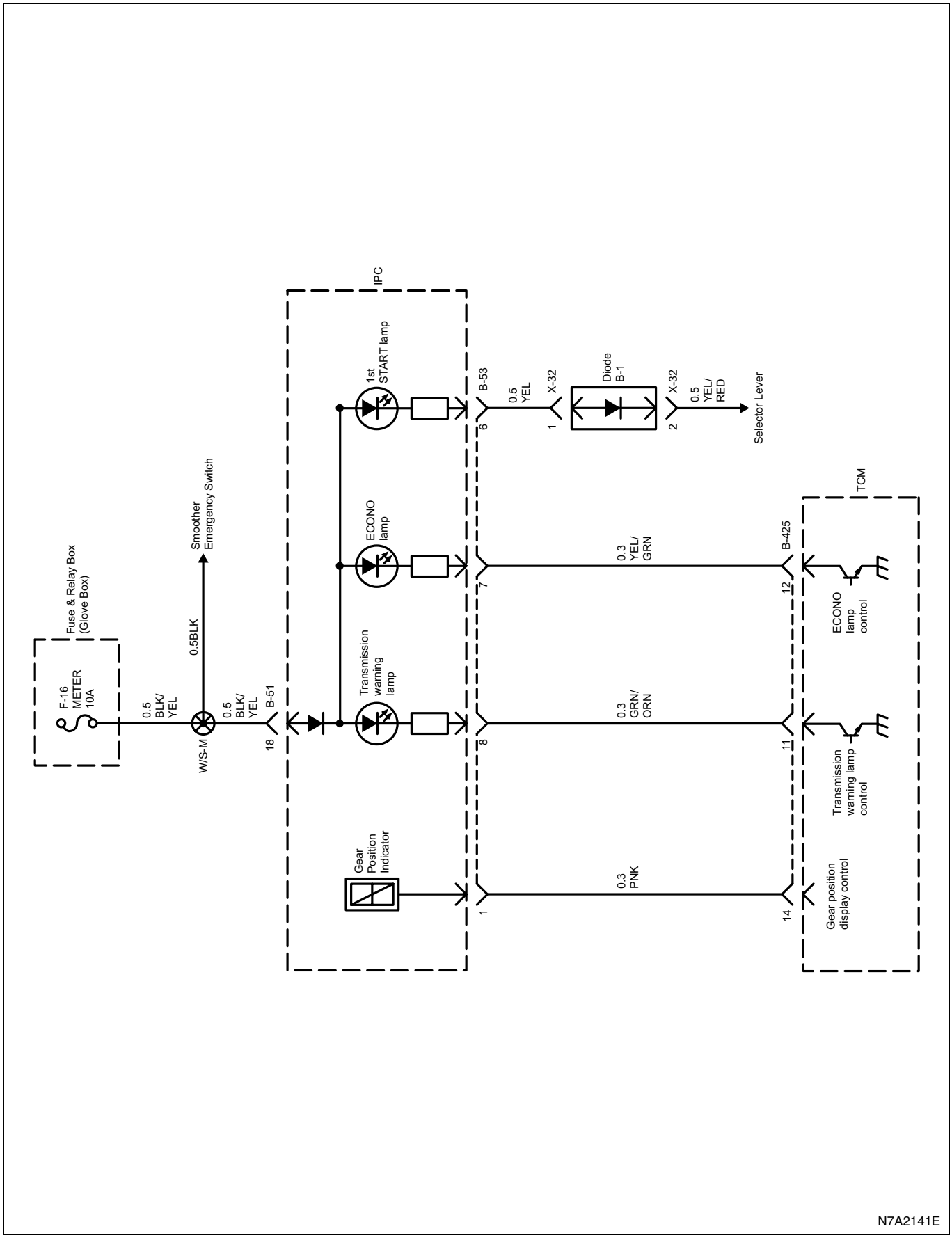

TCM
Gear select position sensor signal
5V reference
B-426
0.5 YEL/WHT
0.5 YEL/BLK
H-5
H-119
J-223
Gear Select Position Sensor
J-142
0.5 BLK
H-8
0.5 RED
0.5 WHT
Gear Shift Position Sensor
J-232
Turbine Speed Sensor
Turbine speed sensor signal
Low reference
B-427
0.5 ORN/BLU
0.5 WHT/BLU
H-118
J-139
Input Shaft Speed Sensor
Input shaft speed sensor signal
0.5 BRN
0.5 YEL
N7A2135E

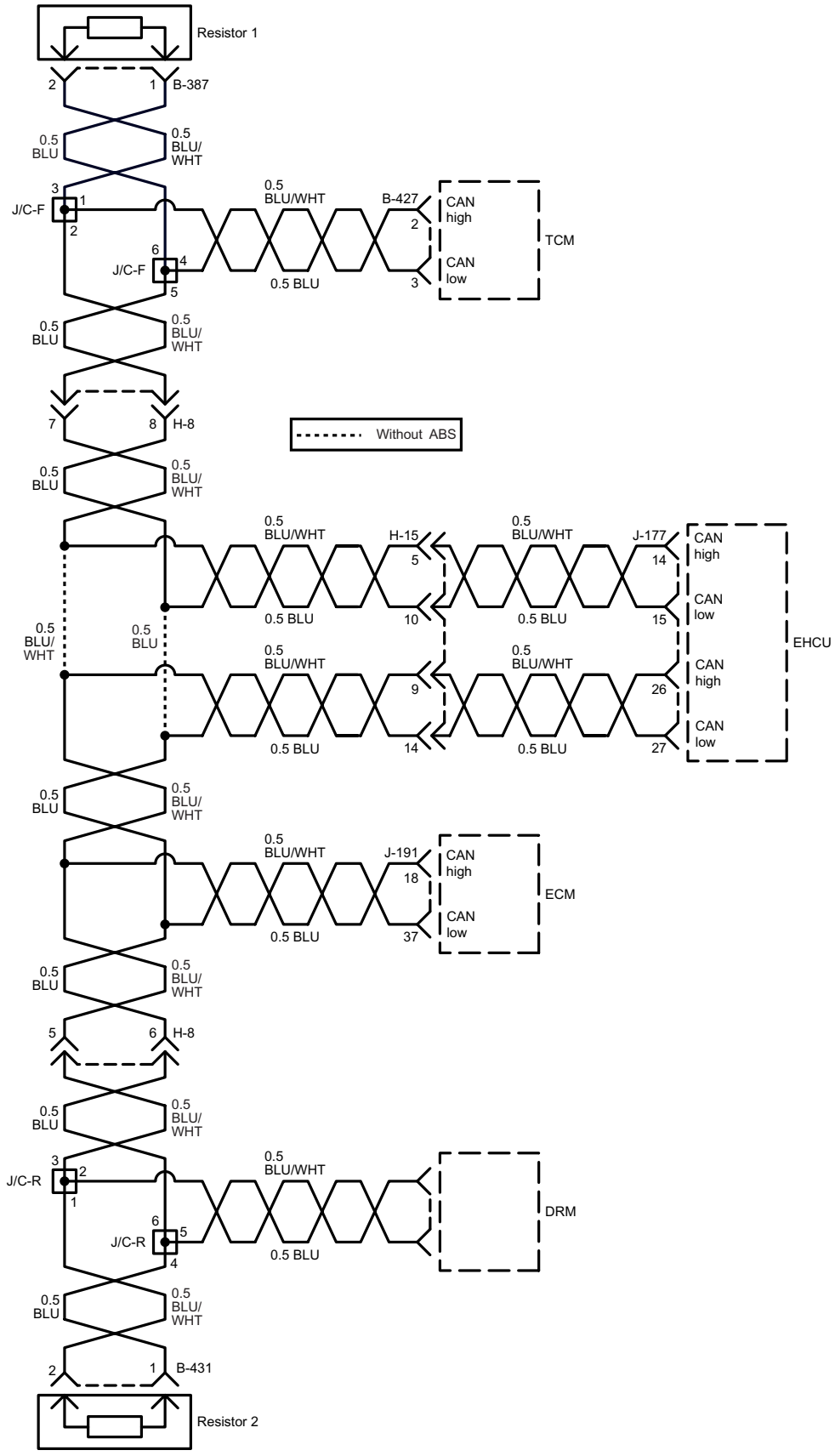

TCM
Ignition voltage
PTO switch signal
Door switch signal
B-428
19
12
0.3 BLU/ WHT
0.5 GRY/ RED
Tail Light
B-417
PTO Switch
0.5 BLK
2 BLK
W/S-B
W/S-D
W/S-C
J/C-D
7
3 BLK
B-7 Headlight Bracket
1.25 BLK
B-1 Frame
Room Lamp
J/C-H
0.5GRY/RED
H-12
0.5 GRY/ RED
N-2
Door Switch (Right)
H-3
1.25 GRY/ BLK
N-7
Door Switch (Left)
Fuse & Relay Box (Glove Box)
F-5 STOP LIGHT 10A
F-16 METER 10A
F-18 SRS 10A
F-17 NEES (IG) 10A
F-28 ECM 10A
0.5 GRN/ YEL
B-66
Brake Pedal Switch
0.5 GRN
H-5
Stop Light
0.5GRN
J/C-G
B-428
Brake pedal switch
Half-clutch Adjustment Switch
B-106
0.5 BLK/ ORN
0.3 GRY/ BLK
0.3 GRY/ RED
Fast switch signal
Slow switch signal
Reset Switch
B-105
0.3 GRY/ BLU
Reset switch signal
0.5 BLK/ ORN
TCM
0.5 LT GRN
J/C-2
Exhaust Brake Solenoid Valve
Neutral Switch
J-50
0.5 BLK/ BLU
0.5B/L
ECM
Neutral switch signal
N7A2136E


TCM
IPC
Selector Lever
Emergency Shift Switch
ECONO Mode Switch
1st Gear Start Switch
Ignition voltage
Economy mode switch signal
1st gear start switch signal
Lever A switch signal
Lever - switch signal
Lever + switch signal
Lever D switch signal
Lever N switch signal
Lever R switch signal
Emergency shift 1st switch signal
Emergency shift N switch signal
Emergency shift R switch signal
B-428
B-427
H-12
N-19
N-20
N-18
0.5 BLU
0.5YEL/RED
0.5 YEL/ RED
0.5 GRN/ BLK
0.5 PNK/ BLK
0.5 BLU/ BLK
0.5 ORN
0.5 WHT/ BLK
0.5 RED/ BLK
0.5 GRN
0.5 WHT
0.5 RED
0.5BLK
0.5 BLK
1.25 BLK
B-1 Frame
N7A2137E


Fuse & Relay Box (Behind the Cab)
SBF-7 NEES 60A
Gear Shift Control Box Relay
X-19
H-17
B-425
B-428
TCM
Gear shift control box relay control
W/S-Q
USW JOINT2
USW JOINT1
J-9 Frame
Select Solenoid
2-4-6-R Shift Solenoid
1-3-5 Shift Solenoid
Select solenoid valve control
2-4-6-R shift solenoid valve control
1-3-5 shift solenoid valve control
Ground
N7A2138E

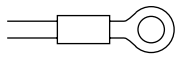
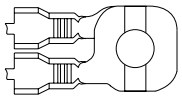
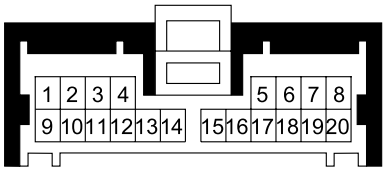
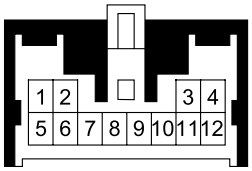
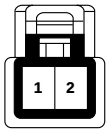
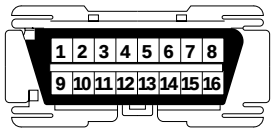

Fuse & Relay Box (Behind the Cab)
SBF-7 NEES 60A
Gear Shift Control Box Relay
X-19
H-17
B-425
B-428
B-426
J-9 Frame
USW JOINT1
USW JOINT2
USW JOINT4
TCM
Gear shift control box relay control
Select solenoid valve control
2-4-6-R shift solenoid valve control
1-3-5 shift solenoid valve control
Select Solenoid
2-4-6-R Shift Solenoid
1-3-5 Shift Solenoid
Ground
N7A2139E

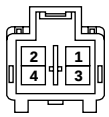
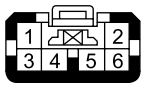
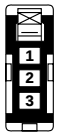
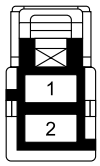
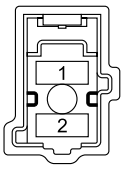
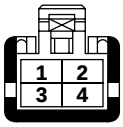
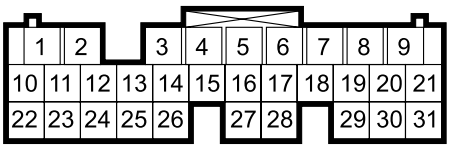

IPC
1st START lamp
ECONO lamp
Transmission warning lamp
Gear Position Indicator
B-53
6
7
8
1
0.5 YEL
X-32
1
Diode B-1
X-32
2
0.5 YEL/ RED
Selector Lever
0.3 YEL/ GRN
0.3 GRN/ ORN
0.3 PNK
B-425
12
11
14
TCM
ECONO lamp control
Transmission warning lamp control
Gear position display control
Fuse & Relay Box (Glove Box)
F-16 METER 10A
0.5 BLK/ YEL
0.5BLK
Smoother Emergency Switch
W/S-M
0.5 BLK/ YEL
B-51
18
N7A2141E

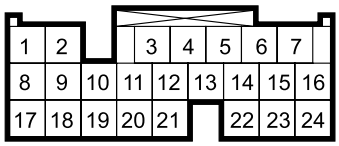
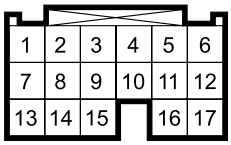
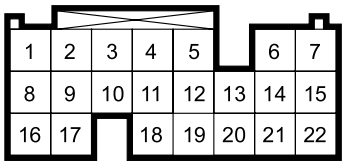
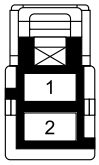
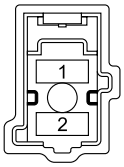
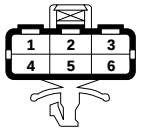
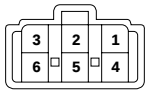
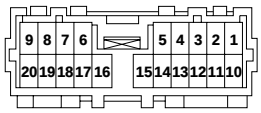

Resistor 1
2
1
B-387
0.5 BLU
0.5 BLU/ WHT
3
J/C-F
1
2
0.5 BLU/WHT
B-427
2
CAN high
CAN low
3
TCM
6
J/C-F
4
5
0.5 BLU
0.5 BLU
0.5 BLU/ WHT
7
8
H-8
Without ABS
0.5 BLU
0.5 BLU/ WHT
0.5 BLU/WHT
H-15
5
10
0.5 BLU
0.5 BLU/WHT
J-177
14
15
0.5 BLU
CAN high
CAN low
0.5 BLU/ WHT
0.5 BLU
0.5 BLU/WHT
9
14
0.5 BLU
0.5 BLU/WHT
26
27
0.5 BLU
CAN high
CAN low
EHCU
0.5 BLU
0.5 BLU/ WHT
0.5 BLU/WHT
J-191
18
37
0.5 BLU
CAN high
CAN low
ECM
0.5 BLU
0.5 BLU/ WHT
5
6
H-8
0.5 BLU
0.5 BLU/ WHT
3
J/C-R
2
1
0.5 BLU/WHT
6
J/C-R
5
4
0.5 BLU
DRM
0.5 BLU
0.5 BLU/ WHT
2
1
B-431
Resistor 2

N6A6641E

Connector list

No.	Connector Face
B-1	 000-001
B-7	 000-018
B-51	 020-004
B-53	 012-009
B-66	 002-031
B-67	004-002
B-67	004-001
B-79	 016-005

No.	Connector Face
B-86	004-001
B-86	 004-002
B-105	 006-021
B-106	 003-014
B-387	 002-038
B-387	 002-039
B-417	 004-001
B-425	 031-001

No.	Connector Face
B-426	 024-001
B-427	 017-001
B-428	 022-006
B-431	 002-038
B-431	 002-039
H-3	 006-014
H-3	 006-015
H-4	 020-003

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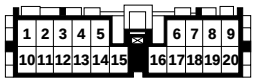
H-4	 020-002
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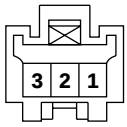
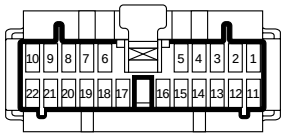
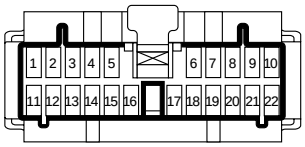
H-10	 003-010
H-12	 022-002
H-12	 022-001
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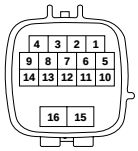
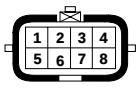
H-15	 016-004
H-17	 008-007

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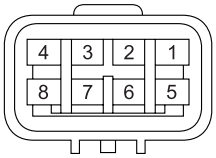
H-118	 008-018
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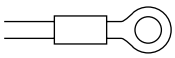
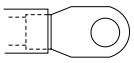
J-9	 000-001
J-26	 000-002

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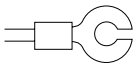
J-27	 000-009
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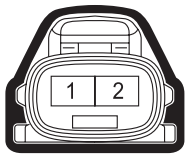
J-139	 002-040
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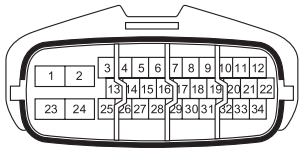
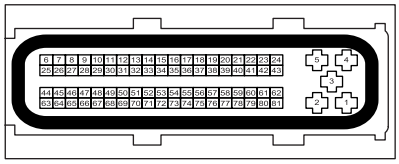
J-177	 034-001
J-191	 081-001
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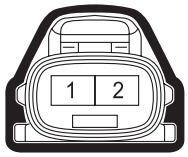
J-232	 002-040

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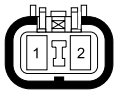
J-236	 002-042
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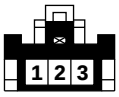
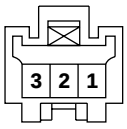
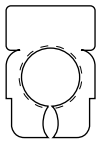
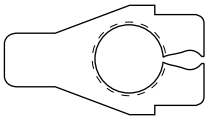
L-2	 003-009
L-2	 003-010
P-1	 000-004
P-2	 000-006

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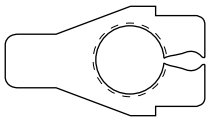
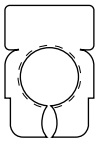
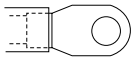
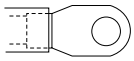
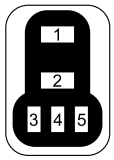
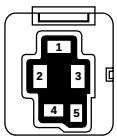
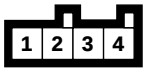
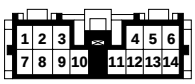
P-3	 000-006
P-4	 000-004
P-5	 000-002
P-6	 000-002
X-5, 14, 18, 26	 005-006
X-19, 21	 005-003
X-32	 004-004
X-33	 014-002

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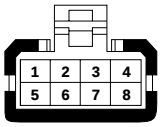
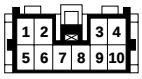
N-17	 008-005
N-18	006-007
N-19	 010-003

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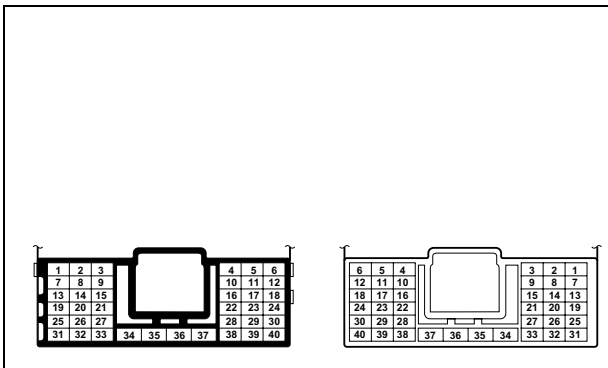

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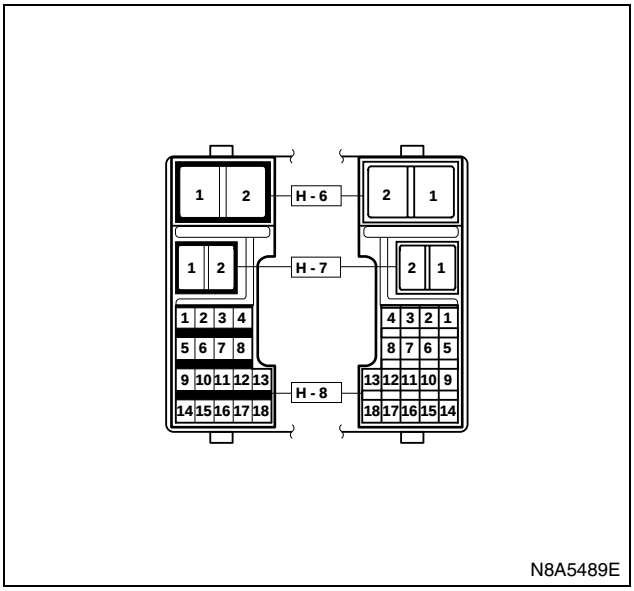
H-6, H-7, H-8



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Electronic Control Type PTO

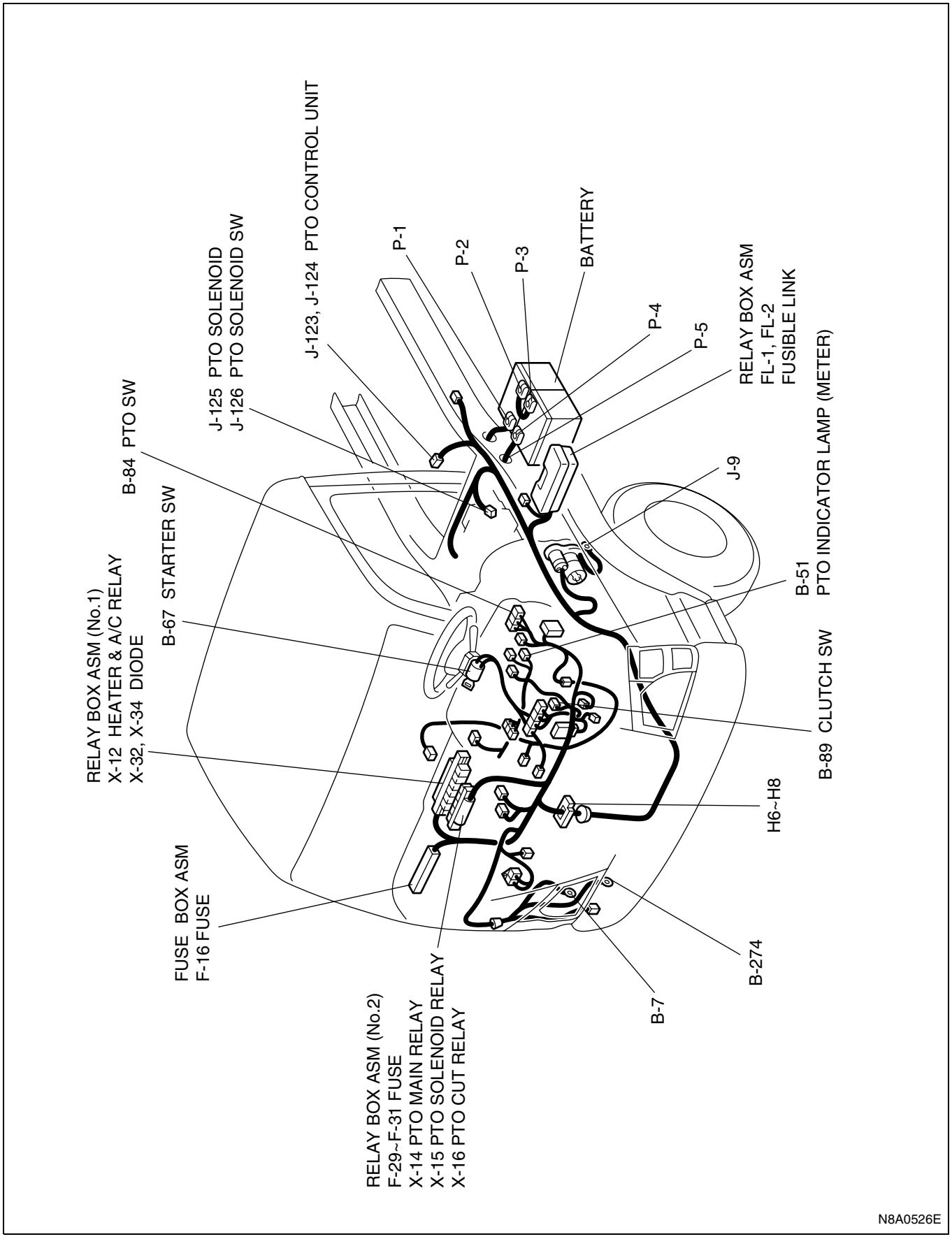
General Description

This circuit consists of starter switch, PTO switch (for dump vehicle, it shares with dump control switch), relay, diodes, solenoid and control unit.

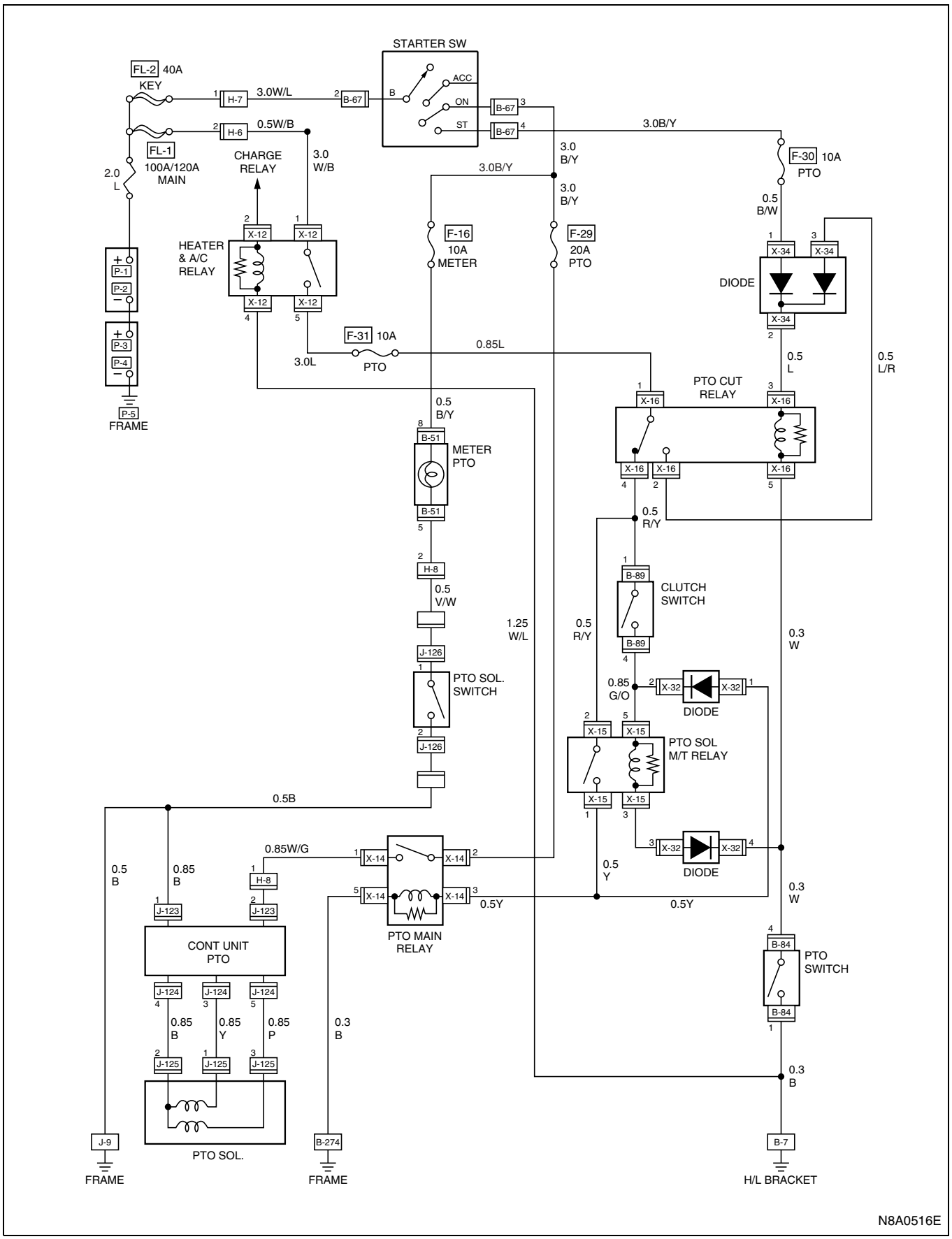
Electronic control type PTO is installed on the left side of transmission.

PTO's gears are engaged at any time. There is a sleeve installed on the output shift, and the sleeve is shifted by the solenoid through the shift rods(s) and shift arm(s). This causes turning the power on or off.

Parts Location



Circuit Diagram



Connector List

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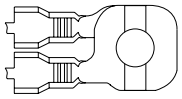
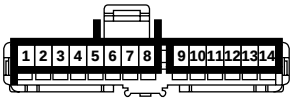
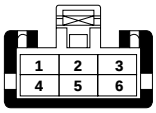
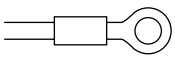
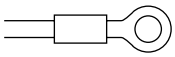
B-7	 000-018
B-51	 014-001
B-67	004-002
B-67	004-001
B-84	 006-001
B-89	004-001
B-274	 000-001
J-9	 000-001

No.	Connector Face
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J-123	002-011
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J-126	002-011
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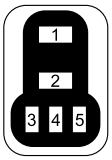
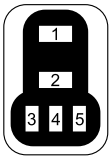
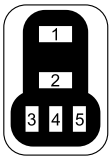
X-14	 005-006
X-15	 005-006
X-16	 005-006

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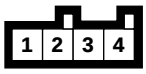
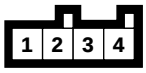
X-32	 004-004
X-34	 004-004

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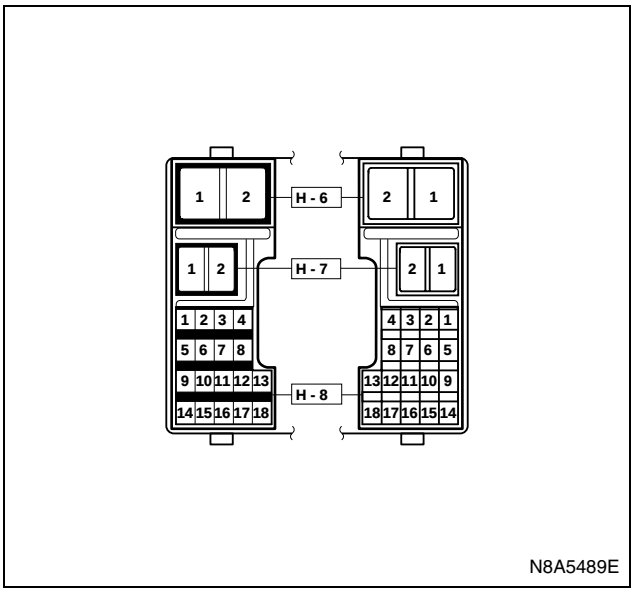

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LGCEL-WE-0552RH

You are requested to order this manual using the manual number that is shown above.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LGCEL-WE-0552RH PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

CAB AND CHASSIS ELECTRICAL (RIGHT HAND DRIVE MODEL)

SECTION 8

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
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Applicable Model:

N-Series

This manual is applicable to 2005 year model.

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CAB AND CHASSIS ELECTRICAL

SECTION 8

CAB AND CHASSIS ELECTRICAL

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GENERAL INFORMATION

General Information

The chassis electrical system is of 12-volt specifications with a negative ground polarity.
Wire sizes are appropriate to respective circuits, and classified by color. (The classification of harnesses by color is shown on the circuit diagram for ease of harness identification.)
The wire size is determined by load capacity and the length of wire required.
The vehicle harnesses are: body harness, floor harness, engine harness, frame front harness, frame rear harness, rear body harness, dome light harness, door harness and battery cable.
The harnesses are protected either by tape or corrugated tube, depending on harness location.
The circuit for each system consists of the power source, wire, fuse, relay switch, load parts and ground, all of which are shown on the circuit diagram.
In this manual, each electrical device is classified by system. For major parts shown on the circuit based on the circuit diagram for each system, a summary, diagnosis of troubles, inspection and removal and installation procedures are detailed.

Notes for Working on Electrical Items

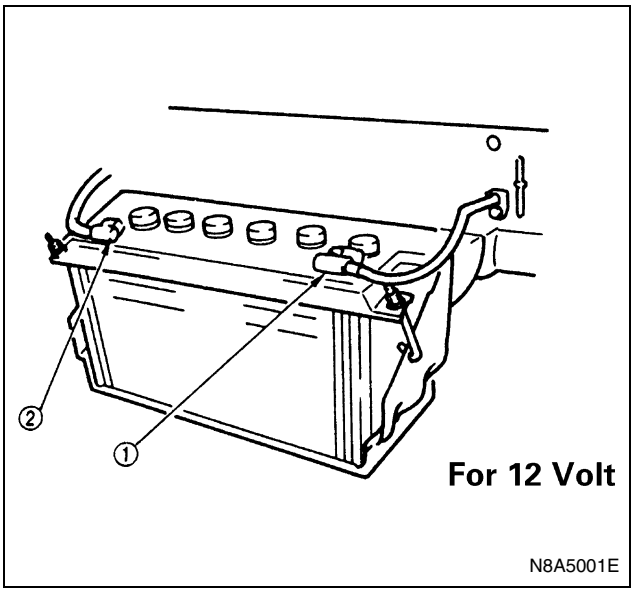
Battery Cable

Disconnecting The Battery Cable

1. All switches should be in the “OFF” position.
2. Disconnect the battery ground cable.
3. Disconnect the battery positive cable.
4. Disconnect the battery cable 3.

Caution:
It is important that the battery ground cable be disconnected first.

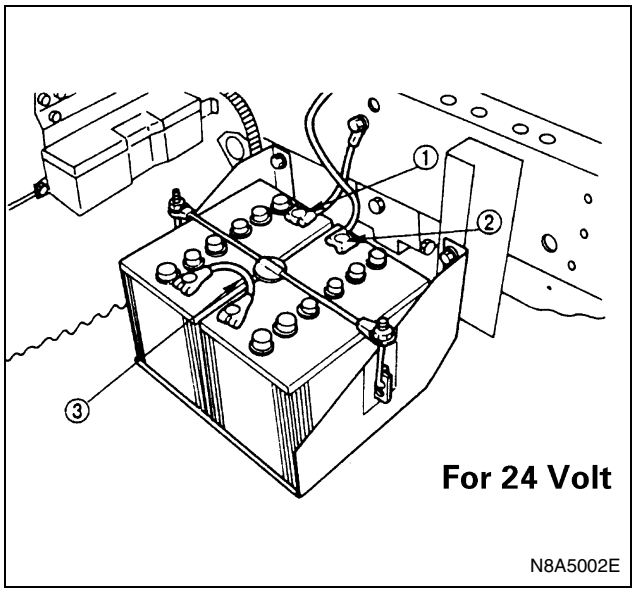
Disconnecting the battery positive cable first can result in a short circuit.



Connecting The Battery Cable

Follow the disconnecting procedure in the reverse order.

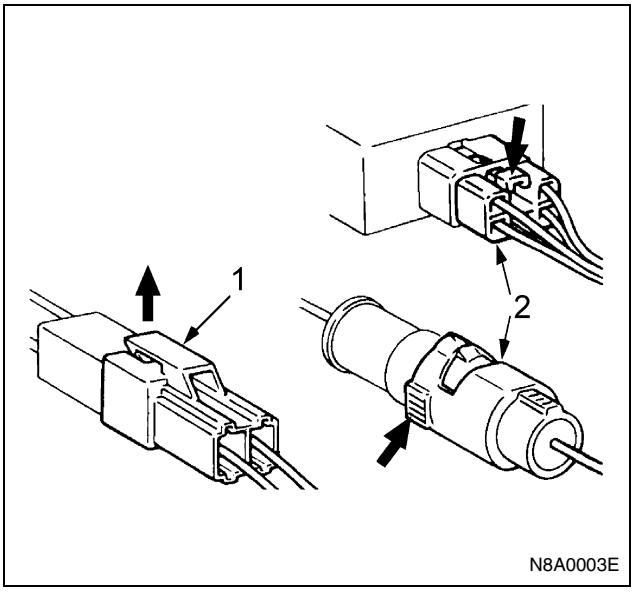
Caution:
Clean the battery terminal and apply a light coat of grease to prevent terminal corrosion.



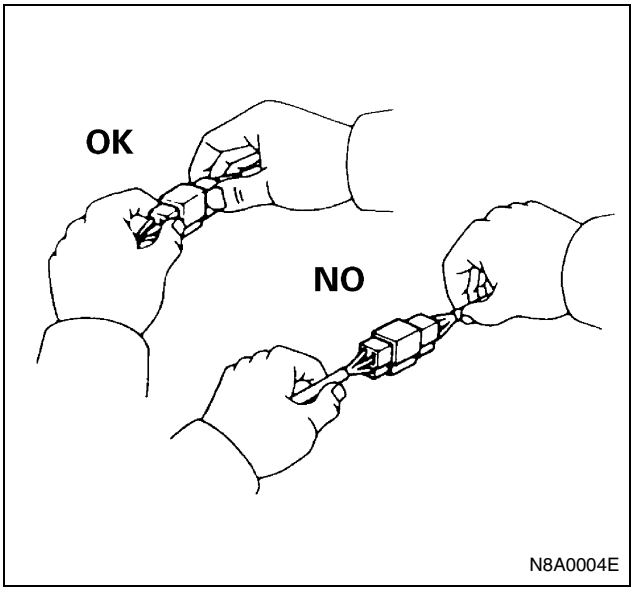
Connector Handling

Disconnecting The Connectors

Some connectors have a tang lock to hold the connectors together during vehicle operation.
Some tang locks are released by pulling them towards you 1.
Other tang locks are released by pressing them forward 2.
Determine which type of tang lock is on the connector being handled.
Firmly grasp both sides (male and female) of the connector.
Release the tang lock and carefully pull the two halves of the connector apart.

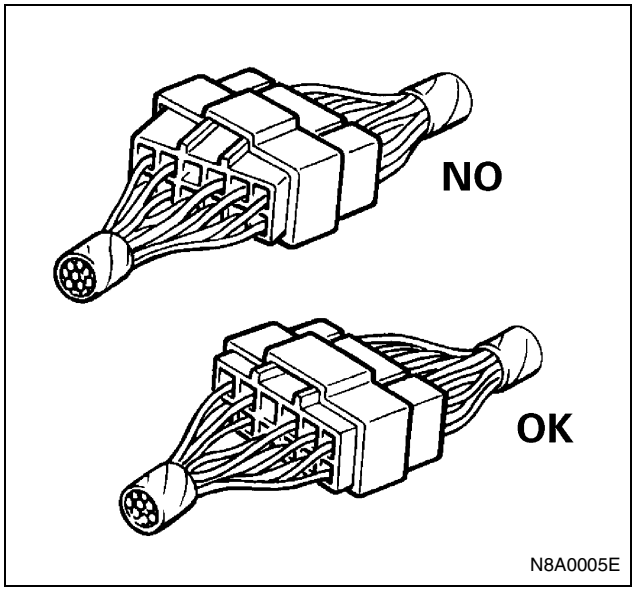


Never pull on the wires to separate the connectors. This will result in wire breakage.



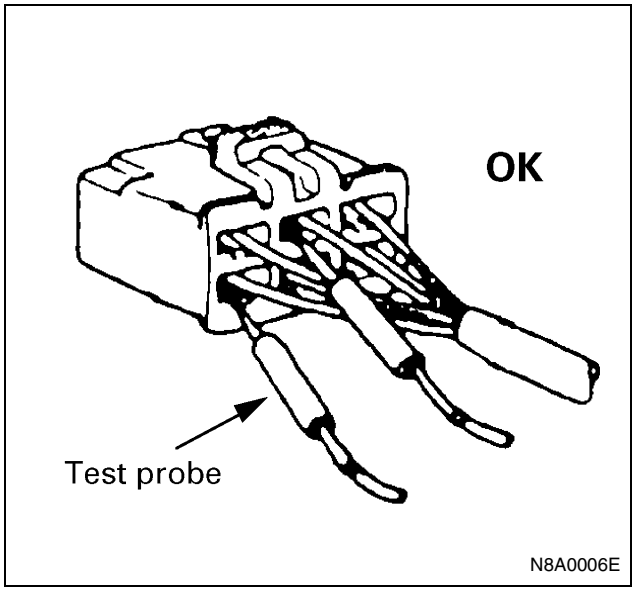
Connecting the Connector

Firmly grasp both sides (male and female) of the connector. Be sure that the connector pins and pin holes match. Be sure that both sides of the connector are aligned with each other. Firmly but carefully push the two sides of the connector together until a distinct click is heard.

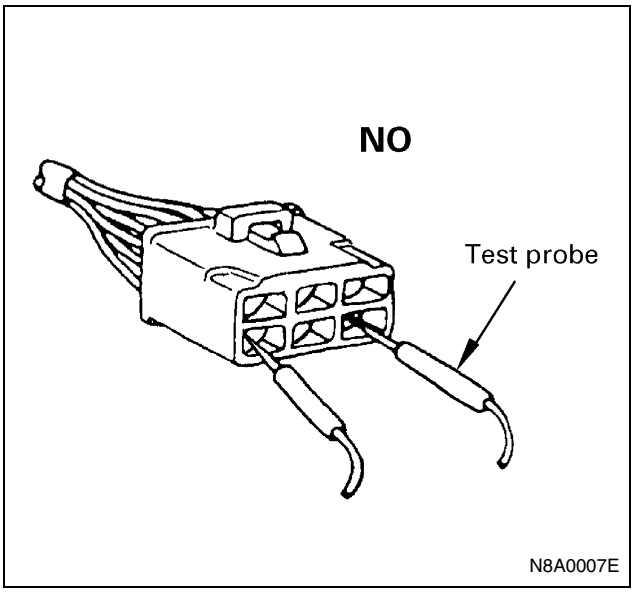


Connector Inspection

Use a circuit tester to check the connector for continuity. Insert the test probes from the connector wire side.

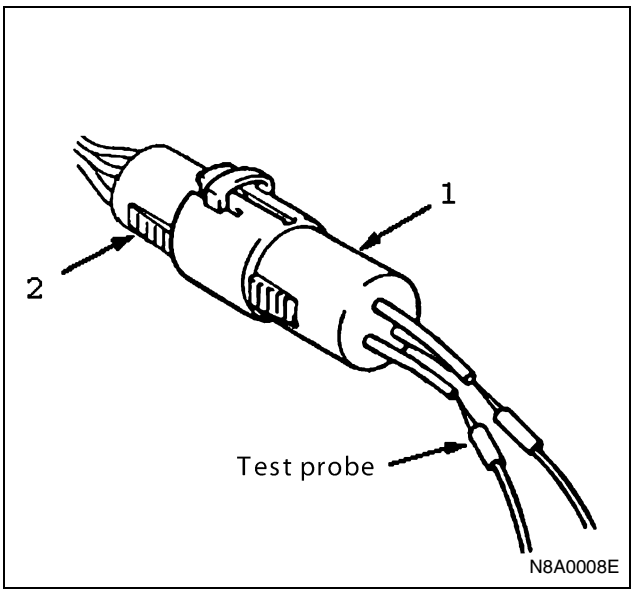


Never insert the circuit tester test probes into the connector open end to test the continuity. Broken or open connector terminals will result.



Waterproof Connector Inspection

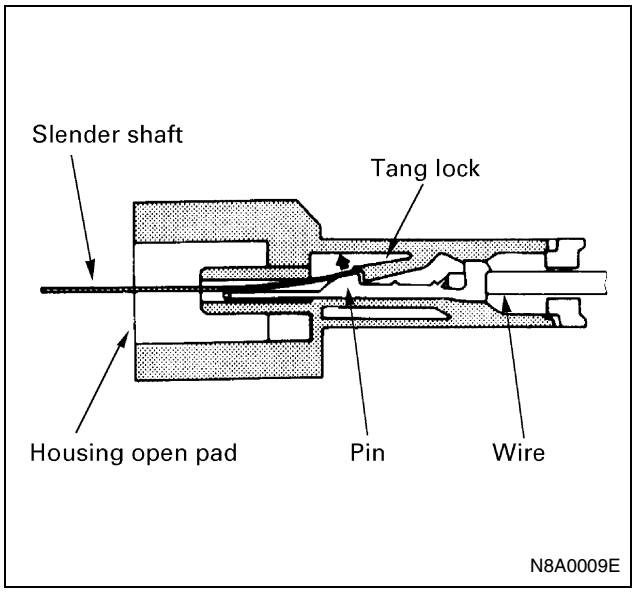
It is not possible to insert the test probes into the connector wire side of a waterproof connector.
Use one side of a connector 1 with its wires cut to make the test. Connect the test connector 2 to the connector to be tested. Connect the test probes to the cut wires to check the connector continuity.



Connector Pin Removal

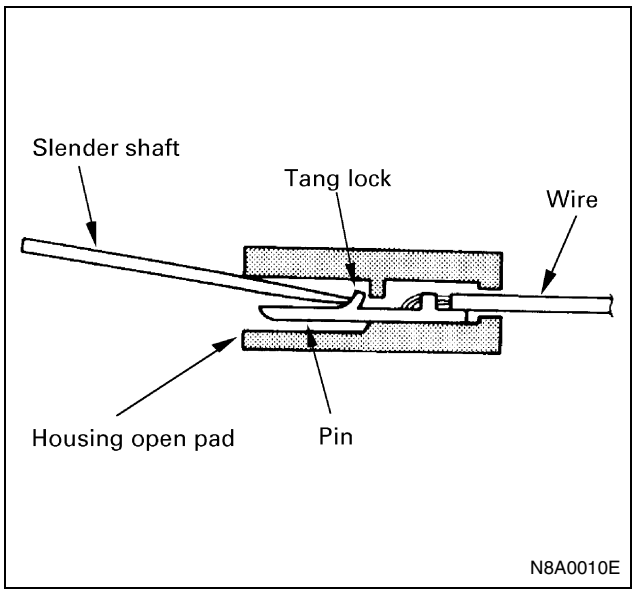
Connector Housing Tang Lock Type

1. Insert a slender shaft into the connector housing open end.
2. Push the tang lock up (in the direction of the arrow in the illustration). Pull the wire with pin free from the wire side of the connector.



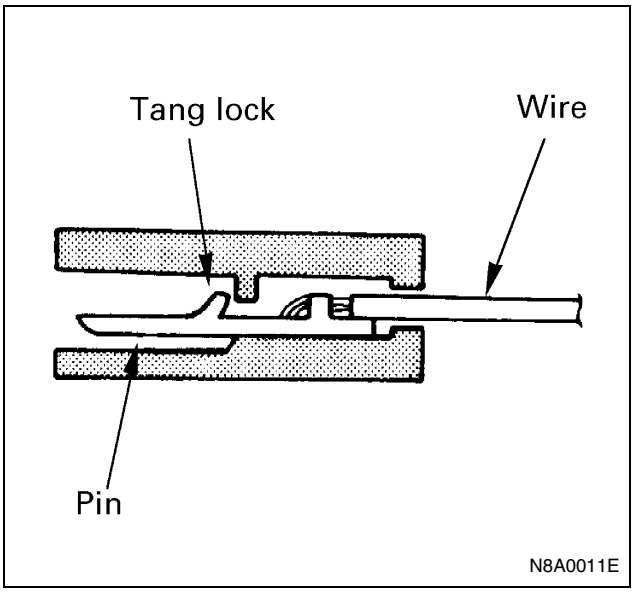
Pin Tang Lock Type

1. Insert a slender shaft into the connector housing open end.
2. Push the tang lock flat (toward the wire side of the connector). Pull the wire with pin free from the wire side of the connector.



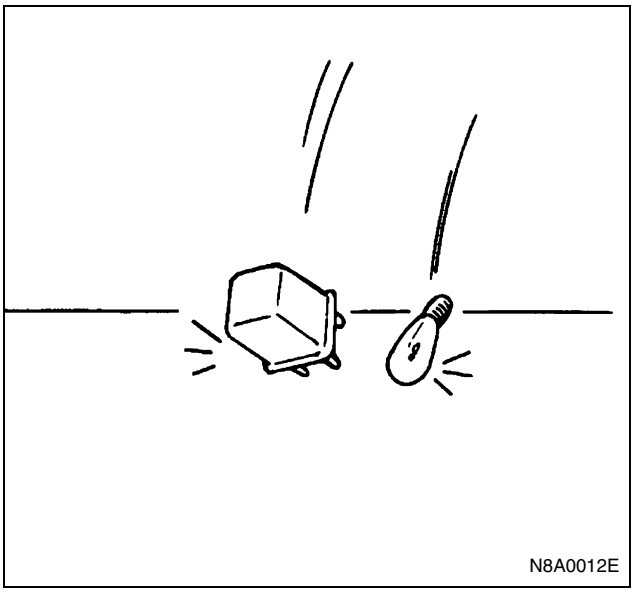
Connector Pin Insertion

3. Check that the tang lock is fully up.
4. Insert the pin from the connector wire side. Push the pin in until the tang lock closes firmly.
5. Gently pull on the wires to make sure that the connector pin is firmly set in place.



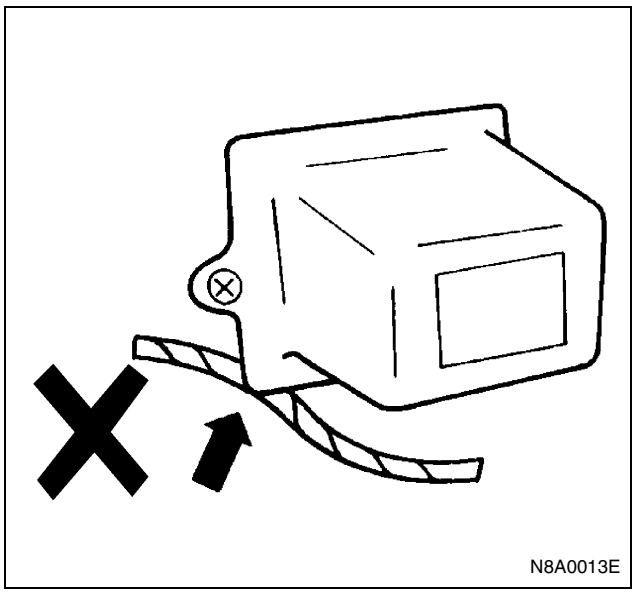
Parts Handling

Be careful when handling electrical parts. They should not be dropped or thrown, because short circuit or other damage may result.

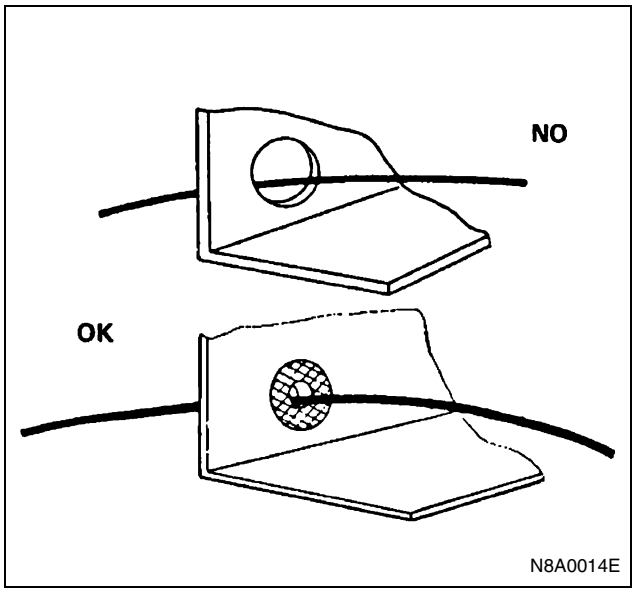


Cable Harness

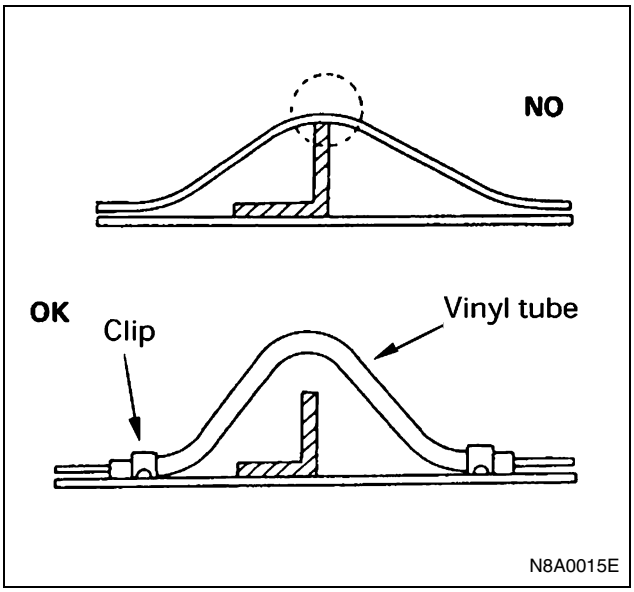
When installing the parts, be careful not to pinch or wedge the wiring harness.
All electrical connections must be kept clean and tight.



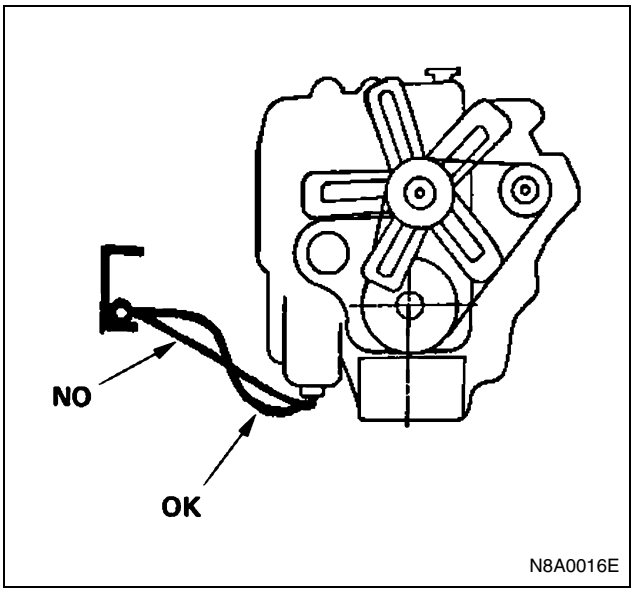
Use a grommet or guard tube to protect the wiring harness from contacting a sharp edge or surface.



Position the wiring harness with a enough clearance from the other parts and guard the wiring harness with a vinyl tube and clips to avoid direct contact.

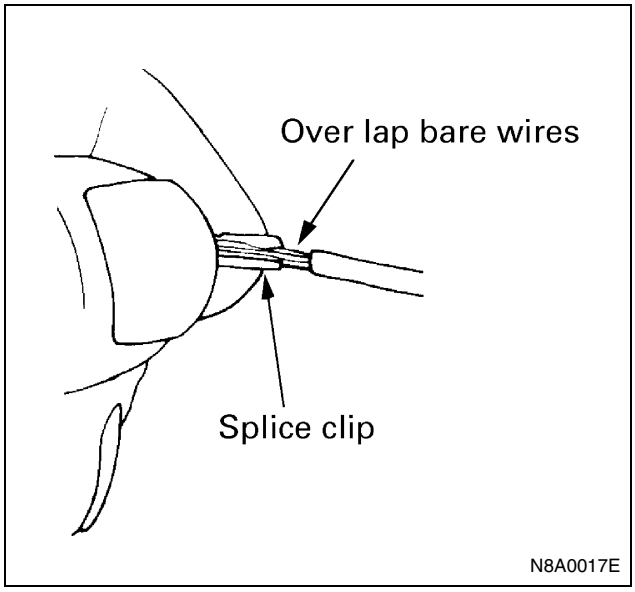


The wiring harness between engine and chassis should be long enough to prevent chafing or damage due to various vibrations.

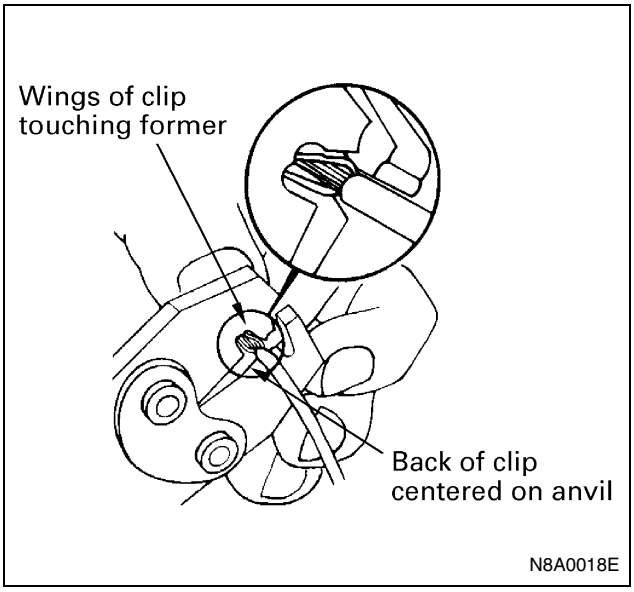


Splicing Wire

1. Open the Harness
   If the harness is taped, remove the tape. To avoid wire insulation damage, use a sewing “seam ripper” (available from sewing supply stores) to cut open the harness.
   If the harness has a block plastic conduit, simply pull out the desired wire.
2. Cut the wire
   Begin by cutting as little wire off the harness as possible. You may need the extra length of wire later if you decide to cut more wire off to change the location of a splice. You may have to adjust splice locations to make certain that each splice is at least 1-2/2″ (40 mm) away from other splices, harness branches, or connectors.
3. Strip the insulation
   When replacing a wire, use a wire of the same size as the original wire. Check the stripped wire for nicks or cut stands. If the wire is damaged, repeat the procedure on a new section of wire. The two stripped wire ends should be equal in length.
4. Crimp the Wires
   Select the proper clip to secure the splice. To determine the proper clip size for the wire being spliced, follow the directions included with your clips.
   Select the correct anvil on the crimper. (On most crimpers your choice is limited to either a small or large anvil.) Overlap the two stripped wire ends and hold them between your thumb and forefinger.
   Then, center the splice clip under the stripped wires and hold it in place.



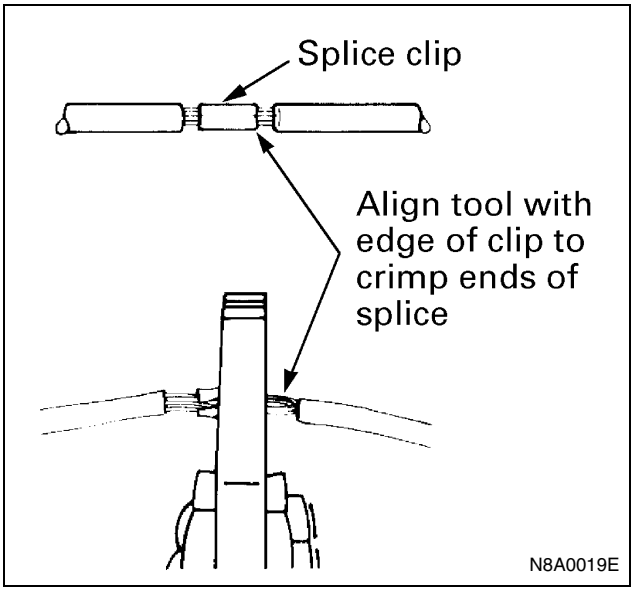
- Open the crimping tool to its full width and rest one handle on a firm flat surface.
- Center the back of the splice clip on the proper anvil and close the crimping tool to the point where the back of the splice clip touches the wings of the clip.
- Make sure that the clip and wires are still in the correct position. Then, apply steady pressure until the crimping tool closes.



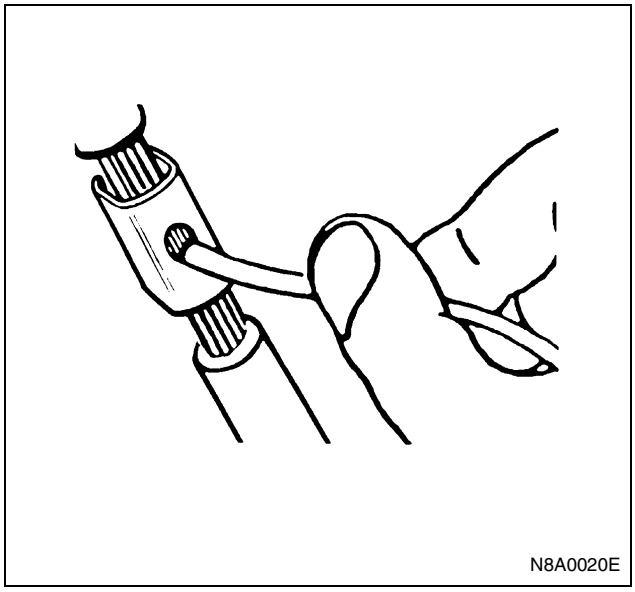
Before crimping the ends of the clip, be sure that:

- The wires extend beyond the clip in each direction.
- No strands of wire are cut loose, and
- No insulation is caught under the clip.

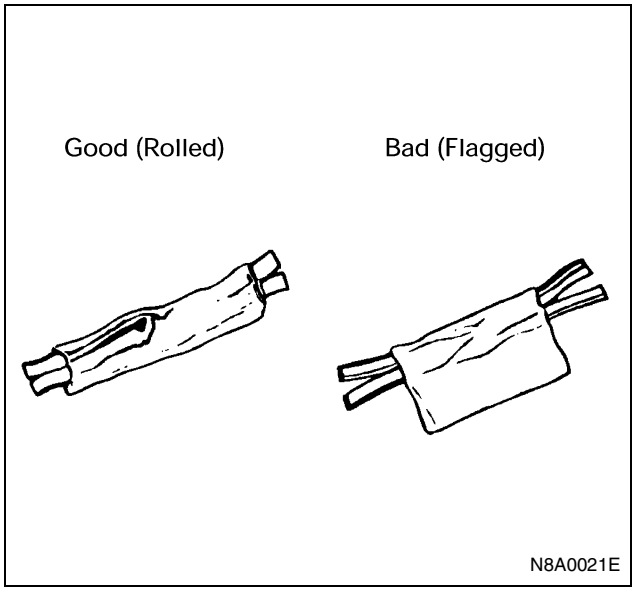
Crimp the splice again, once on each end. Do not let the crimping tool extend beyond the edge of the clip or you may damage or nick the wires.



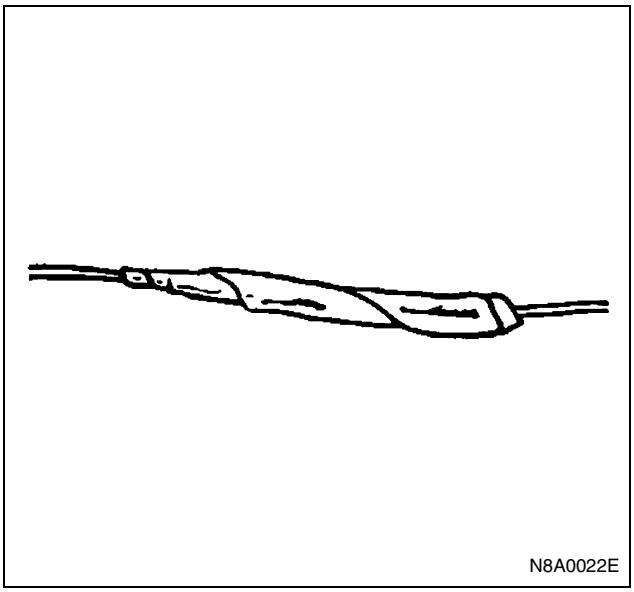
5. Solder
   Apply 60/40 rosin core solder to the opening in the back of the clip. Follow the manufacturer's instructions for the solder equipment you are using.



6. Tape the Splice
   Center and roll the splicing tape. The tape should cover the entire splice. Roll on enough tape to duplicate the thickness of the insulation on the existing wires. Do not flag the tape. Flagged tape may not provide enough insulation, and the flagged ends will tangle with the other wires in the harness.

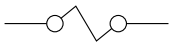
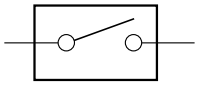
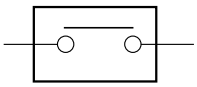
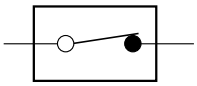
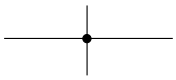
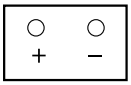
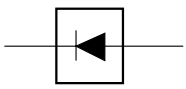
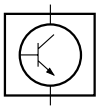


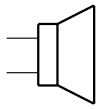
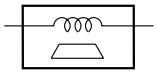
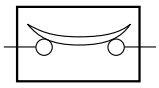
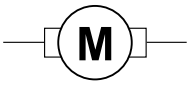
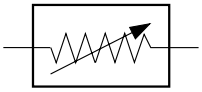
If the wire does not belong in a conduit or other harness covering, tape the wire again. Use a winding motion to cover the first piece of tape.

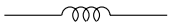
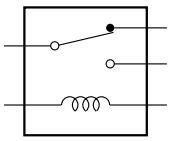
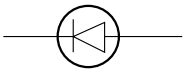
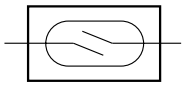
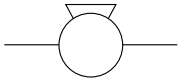

N8A0022E

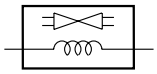
Symbols and Abbreviations

Symbols

Symbol	Meaning of Symbol
N8A5501E	Fuse
N8A5502E	Fusible link
 N8A5503E	Fusible link wire
 N8A5504E	Switch
 N8A5505E	Switch
 N8A5506E	Switch (Normal close type)
 N8A5507E	Contact wiring
 N8A5508E	Battery
 N8A5509E	Diode
 N8A5510E	Electronic Parts
N8A5511E	Resistor

Symbol	Meaning of Symbol
 N8A5512E	Speaker
 N8A5513E	Buzzer
 N8A5514E	Circuit breaker
N8A5515E	Bulb
N8A5516E	Double filament bulb
 N8A5517E	Motor
 N8A5518E	Variable register Rheostat

Symbol	Meaning of Symbol
 N8A5519E	Coil (inductor), solenoid, magnetic valve
 N8A5520E	Relay
N8A5521E	Connector
 N8A5522E	Light emitting diode
 N8A5523E	Reed switch
N8A5524E	Condenser
 N8A5525E	Horn

Symbol	Meaning of Symbol
 N8A5526E	Vacuum switching valve

Abbreviations

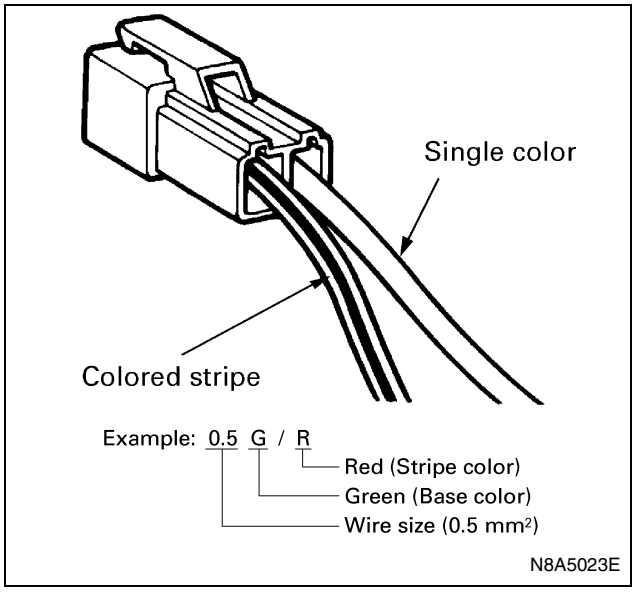
Abbreviation	Meaning of Abbreviation	Abbreviation	Meaning of Abbreviation
A	Ampere (S)	kW	kilowatt
ABS	Anti-lock brake system	LH	Left hand
ASM	Assembly	LWB	Long wheel base
AC	Alternating current	M/T	Manual transmission
A/C	Air conditioner	OD	Over drive
ACC	Accessories	OPT	Option
C/B	Circuit breaker	QOS	Quick on start
CSD	Cold start device	RH	Right hand
DIS	Direct ignition system	RR	Rear
EBCM	Electronic brake control module	RWAL	Rear wheel anti-lock brake system
ECGI	Electronic control gasoline injection	ST	Start
ECM	Electronic control module	STD	Standard
ECU	Electronic control unit	SW	Switch
EFE	Early fuel evaporation	SWB	Short wheel base
4X4	Four-wheel drive	V	Volt
FL	Fusible link	VSV	Vacuum switching valve
FRT	Front	W	Watt (S)
H/L	Headlight	WOT	Wide open throttle
IC	Integrated circuit	W/	With
IG	Ignition	W/O	Without

Parts for Electrical Circuit

Wiring

Wire Color

All wires have color-coded insulation.
Wires belonging to a system's main harness will have a single color. Wires belonging to a system's subcircuits will have a colored stripe. Striped wires use the following code to show wire size and colors.



Abbreviations are used to indicate wire color within a circuit diagram.
Refer to the following table.

Wire Color Coding

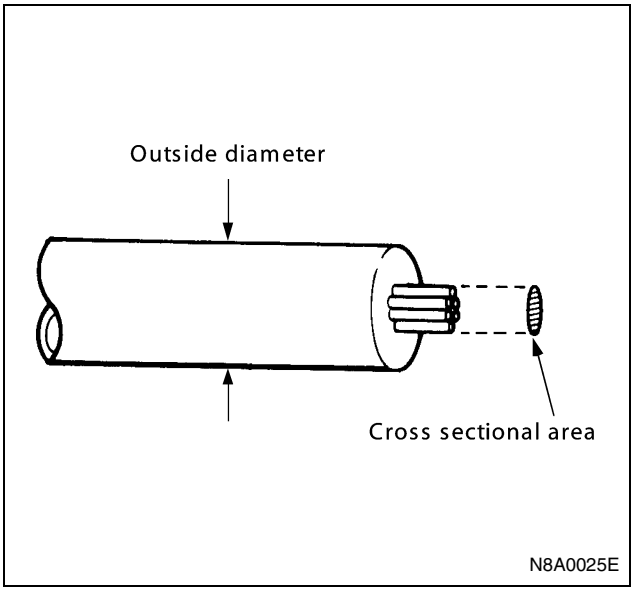
Color-Coding	Meaning	Color-Coding	Meaning
B	Black	BR	Brown
W	White	LG	Light green
R	Red	GR	Grey
G	Green	P	Pink
Y	Yellow	LB	Light blue
L	Blue	V	Violet
O	Orange		

Distinction of Circuit by Wire Base Color

Base color	Circuits	Base color	Circuits
B	Starter circuit	Y	Instrument circuit
W	Charging circuit	L, O, BR, LG, GR, P, LB, V	Other circuit
R	Lighting circuit		
G	Signal circuits		

Wire Size

The size of wire used in a circuit is determined by the amount of current (amperage), the length of the circuit, and the voltage drop allowed. The following wire size and load capacity, shown below, are specified by AWG (American Wire Gauge) (Nominal size means approximate cross sectional area).



Wire Size Table

Nominal size	Cross sectional area (mm^2)	Outside diameter (mm)	Allowable current (A)	AWG size (cross reference)
0.3	0.372	1.8	9	22
0.5	0.563	2.0	12	20
0.85	0.885	2.2	16	18
1.25	1.287	2.5	21	16
2	2.091	2.9	28	14
3	3.296	3.6	37.5	12
5	5.227	4.4	53	10
8	7.952	5.5	67	8
15	13.36	7.0	75	6
20	20.61	8.2	97	4

Fuse, Fusible Link and Circuit Breaker

Fuse

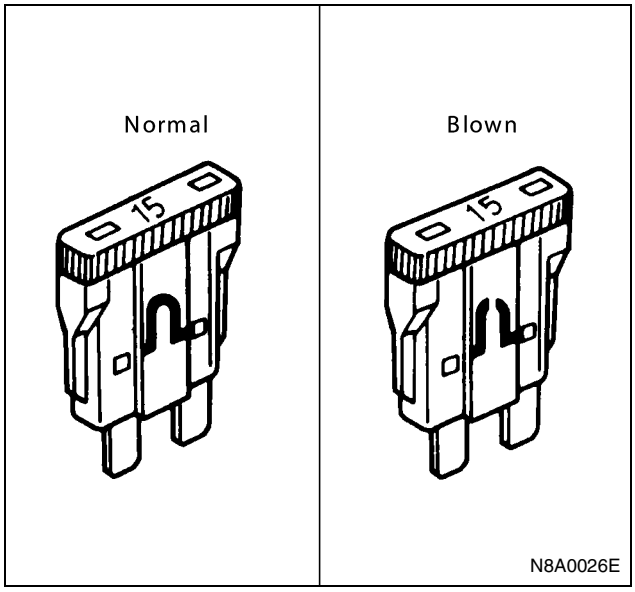
Fuses are the most common form of circuit protection used in vehicle wiring. A fuse is a thin piece of wire or strip of metal encases in a glass or plastic housing. It is wired in series with the circuit it protects. When there is an overload of current in a circuit, such as a short of a ground, the wire or metal strip is designed to burn out and interrupt the flow of current. This prevents a surge of high current from reaching and damaging other components in the circuit.

Determine the cause of the overloaded before replacing the fuse.

The replacement fuse must have the same amperage specifications as the original fuse.

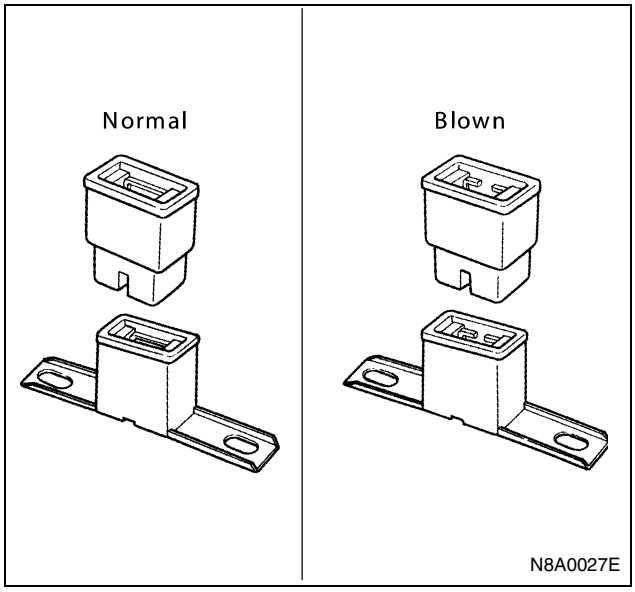
Never replace a blown fuse with a fuse of a different amperage specification.

Doing so can result in an electrical fire or other serious circuit damage. A blown fuse is easily identified.



Fusible Link

The fusible link is primarily used to protect circuits where high amounts of current flow and where is would not be practical to use a fuse. For example, the starter circuit. When a current overload occurs, the fusible link melts open and interrupts the flow of current so as to prevent the rest of the wiring harness from burning.
Determine the cause of the overload before replacing the fusible link. The replacement fusible link must have the same amperage specification as the original fusible link.
Never replace a blown fusible link with fusible link of a different amperage specification. Doing so can result in an electrical fire or other serious circuit damage.
A blown fusible link is easily identified.

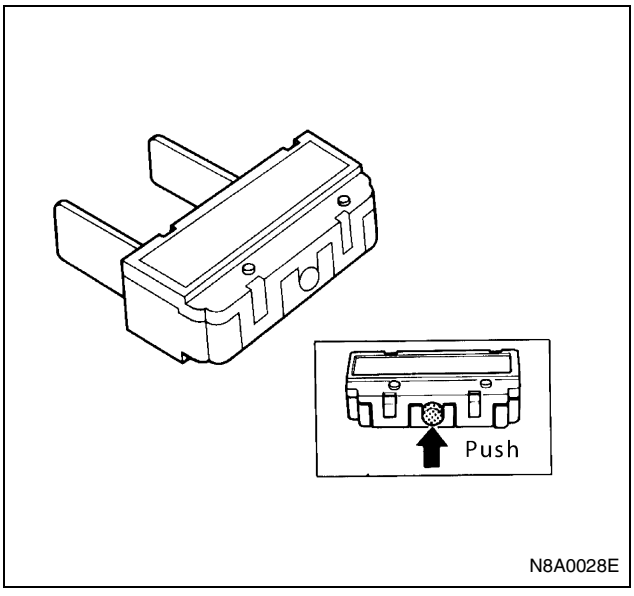


Fusible Link Specifications

Type	Rating	Case Color	Maximum Circuit Current (A)
Connector	30 A	Pink	15
Connector	40 A	Green	20
Bolted	50 A	Red	25
Bolted	60 A	Yellow	30
Bolted	80 A	Black	40

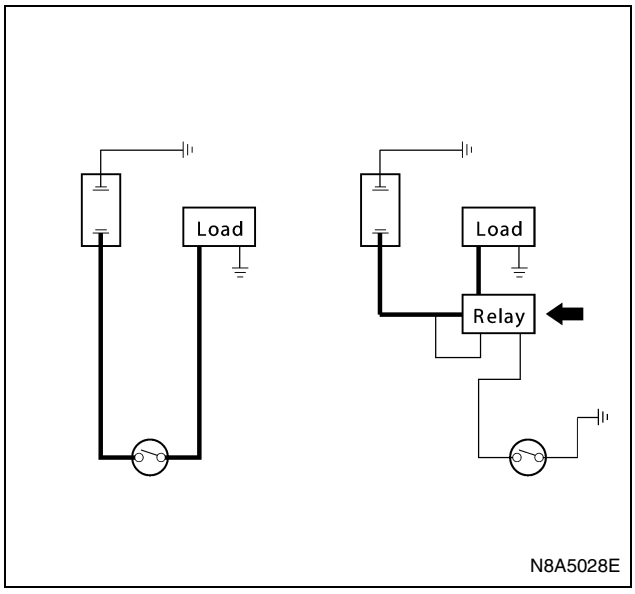
Circuit Breaker

The circuit breaker is a protective device designed to open the circuit when a current load is in excess of rated breaker capacity. If there is a short or other type of overload condition in the circuit, the excessive current will open the circuit between the circuit breaker terminals. The reset knob pops out when the circuit is open. Push the reset knob in place to restore the circuit after repairing it.

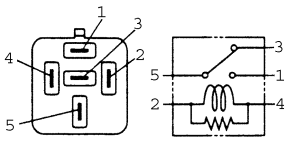


Relay

Battery and load location may require that a switch be placed some distance from either component. This means a longer wire and a higher voltage drop 1.
The installation of a relay between the battery and the load reduces the voltage drop 2.
Because the switch controls the relay, amperage through the switch can be reduced.



Relay Specification, Configuration and Inspection

<table>
<tr><td>Name/
Color</td><td>Rated voltage/
Coil resistance</td><td colspan="2">Internal circuit</td><td>Name/
Color</td><td>Rated voltage/
Coil resistance</td><td colspan="2">Internal circuit</td></tr>
<tr><td>MR5C
(1T)/
Black</td><td>12 V/
Approx. 90 Ω
Minimum
operating
voltage: 7 V
at 25°C (77°F)</td><td colspan="2" rowspan="4"> 
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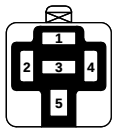
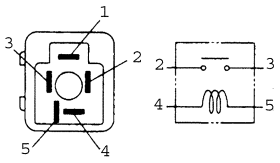
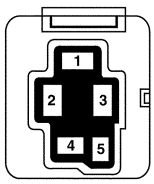
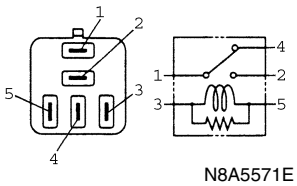
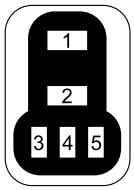
 
N8A0432E
(connector face)</td><td rowspan="2">MR82C/
White
label</td><td rowspan="2">12 V/
Approx. 23 Ω
Minimum
operating
voltage: 7 V
at 20°C (68°F)</td><td colspan="2" rowspan="4"> 
N8A0433E
 
N8A0434E
(connector face)</td></tr>
<tr><td>MR5C
(1T)/
Brown</td><td>12 V/
Approx. 90 Ω
Minimum
operating
voltage: 10.5 V
at 25°C (77°F)</td></tr>
<tr><td>MR5C
(1T)/
Green</td><td>24 V/
Approx. 266 Ω
Minimum
operating
voltage: 16 V
at 25°C (77°F)</td><td rowspan="2">MR82C/
Green
label</td><td rowspan="2">24 V/
Approx. 100 Ω
Minimum
operating
voltage: 16 V
at 20°C (68°F)</td></tr>
<tr><td>MR5C
(1T)/
Grey</td><td>24 V/
Approx. 266 Ω
Minimum
operating
voltage: 20 V
at 25°C (77°F)</td></tr>
<tr><td rowspan="5">Inspec-
tion</td><td></td><td>The
way</td><td>Check to see if there is any continuity between the relay terminals.</td><td rowspan="5">Inspec-
tion</td><td></td><td>The
way</td><td>Check to see if there is any continuity between the relay terminals.</td></tr>
<tr><td>Result</td><td colspan="2" rowspan="2">(When no voltage is applied relay terminals 2 -4)
3 -5 → continuity
1 -5 → No continuity
Inspection</td><td>Result</td><td colspan="2" rowspan="2">(When no voltage is applied relay terminals 4 -5)
2 -3 → No continuity</td></tr>
<tr><td>Normal</td><td>Normal</td></tr>
<tr><td>Abnormal</td><td colspan="2">(When minimum operating voltage is applied relay terminals between 2 -4)
3 -5 → continuity
1 -5 → No continuity</td><td>Abnormal</td><td colspan="2">(When minimum operating voltage is applied relay terminals between 4 -5)
2 -3 → No continuity</td></tr>
<tr><td>Normal</td><td colspan="2">(When minimum operating voltage is applied relay terminals between 2 -4)
3 -5 → No continuity
1 -5 → continuity</td><td>Normal</td><td colspan="2">(When minimum operating voltage is applied relay terminals between 4 -5)
2 -3 → continuity</td></tr>
</table>

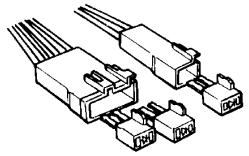
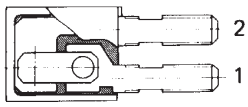
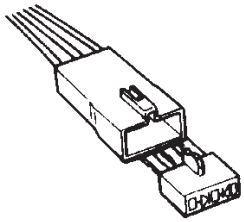
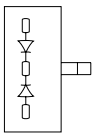
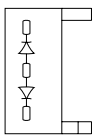
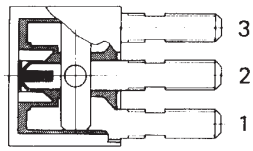
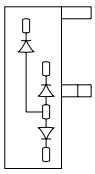
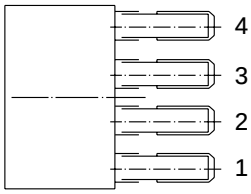
<table>
<tr><td>Name/
Color</td><td>Rated voltage/
Coil resistance</td><td colspan="2">Internal circuit</td></tr>
<tr><td>ACM
13221
M04/
Black</td><td>12 V/
Approx. 120 Ω
Minimum
operating
voltage: 8 V
at 25°C (77°F)</td><td colspan="2" rowspan="2"> 

N8A5571E
 

N8A5572E
(connector face)</td></tr>
<tr><td>ACM
13222
M01/
Green</td><td>24 V/
Approx. 320 Ω
Minimum
operating
voltage: 18 V
at 25°C (77°F)</td></tr>
<tr><td rowspan="4">Inspec-
tion</td><td></td><td>The way</td><td>Check to see if there is any continuity between the relay terminals.</td></tr>
<tr><td>Result</td><td colspan="2" rowspan="2">(When no voltage is applied relay terminals 3 - 5)
1 - 4 → continuity
1 - 2 → No continuity
Inspection</td></tr>
<tr><td>Normal</td></tr>
<tr><td>Abnormal</td><td colspan="2">(When minimum operating voltage is applied relay terminals between 3 - 5)
1 - 4 → continuity
1 - 2 → No continuity</td></tr>
<tr><td>Normal</td><td colspan="2">(When minimum operating voltage is applied relay terminals between 3 - 5)
1 - 4 → No continuity
1 - 2 → continuity</td></tr>
</table>

Diode

Diode Specifications and Configurations

SHAPE	MARK/ COLOR	CONSTRUCTION	CHECKING (THERE SHOULD BE CONTINUITY IN EITHER A OR B WHEN A CIRCUIT TESTER IS CONNECTED WITH DIODE TERMINAL)
	BLACK		TERMINAL NO. 2 1 CONNECTION PATTERN A: ⊕ ⊖ CONNECTION PATTERN B: ⊖ ⊕
	 BLACK		TERMINAL NO. 3 2 1 CONNECTION PATTERN A: ⊖ ⊕ ; ⊕ ⊖ CONNECTION PATTERN B: ⊕ ⊖ ; ⊖ ⊕
	 BLACK		TERMINAL NO. 3 2 1 CONNECTION PATTERN A: ⊖ ⊕ ; ⊕ ⊖ CONNECTION PATTERN B: ⊕ ⊖ ; ⊖ ⊕
	 BLACK		TERMINAL NO. 4 3 2 1 CONNECTION PATTERN A: ⊕ ⊖ ; ⊖ ⊕ ; ⊖ ⊕ CONNECTION PATTERN B: ⊖ ⊕ ; ⊕ ⊖ ; ⊕ ⊖

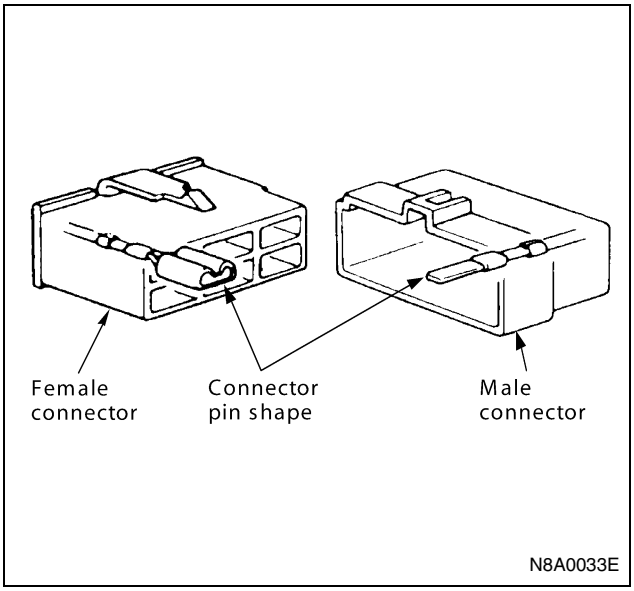
N8A0032E

Maximum Rating (Temp. = 25°C)

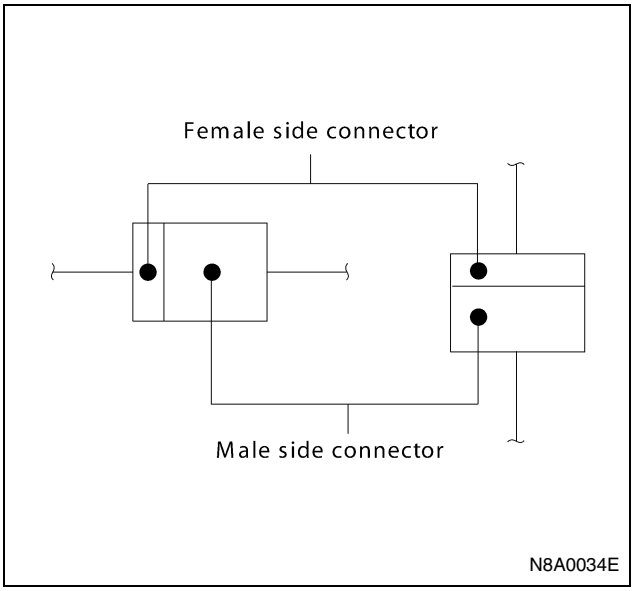
Items	Rating	Remarks
Peak reverse voltage	400 V	
Transient peak reverse voltage	500 V	
Average output current	1.5 A	Temp. = 40°C
Working ambient temperature	–30°C — 80°C	
Storage temperature	–40°C — 100°C	

Connector

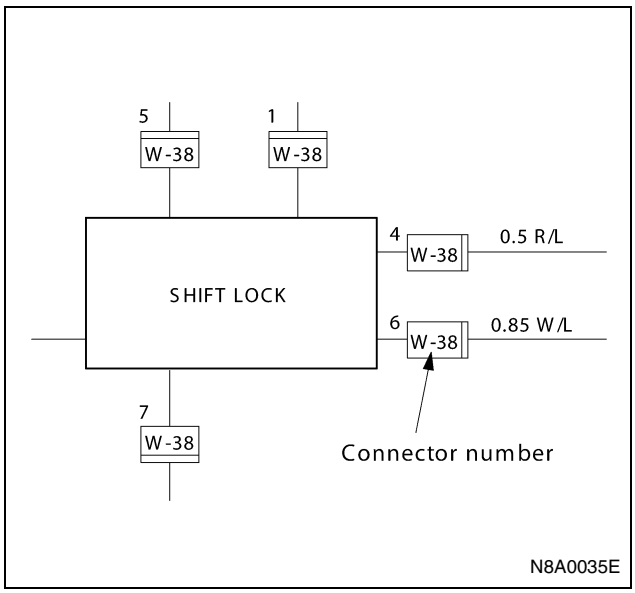
The connector pin shape determines whether the connector is male or female.
The connector housing configuration does not determine whether a connector is male or female.



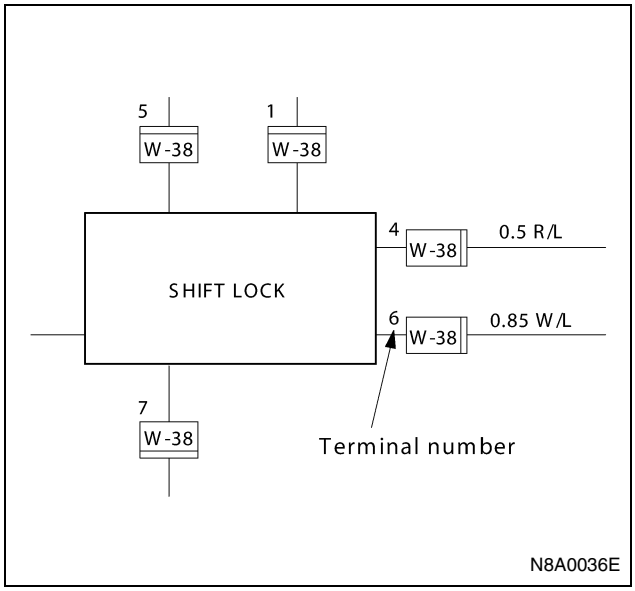
The symbol illustrated in the figure is used as connector, in the circuit of this section.



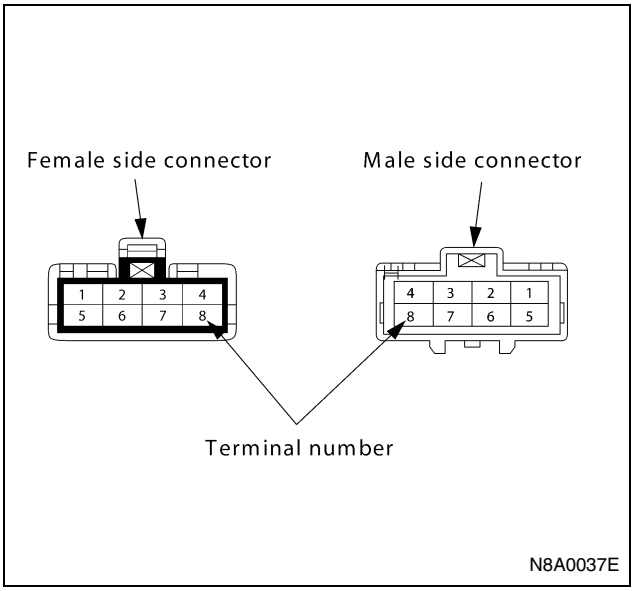
Connector is identified with a number.



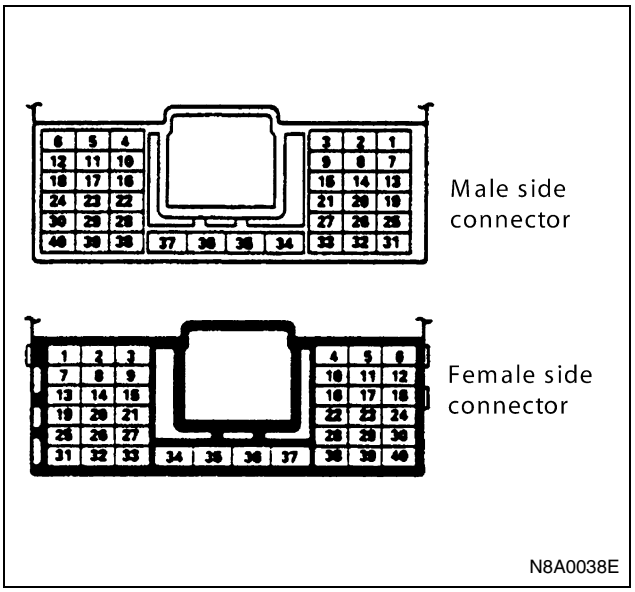
The applicable terminal number is shown for each connector.



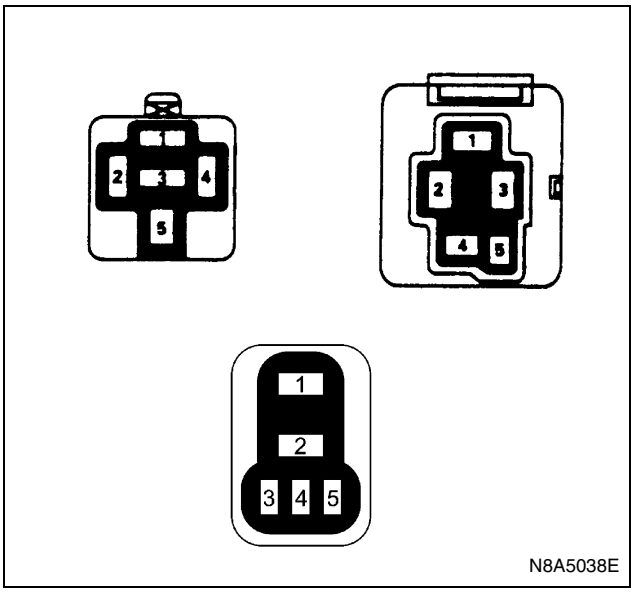
Connector terminal numbers are clearly shown.
Male side connector terminal numbers are in sequence from upper right to lower left.
Female side connector terminal numbers are in sequence from upper left to lower right.



Notice:
For those connectors on which specific terminal numbers or symbols are shown (such as ECM), the terminal numbers or symbols are used in the circuit diagram, irrespective of the above rule.



The connectors used for relays have their own terminal number assignment, irrespective of the above rule.

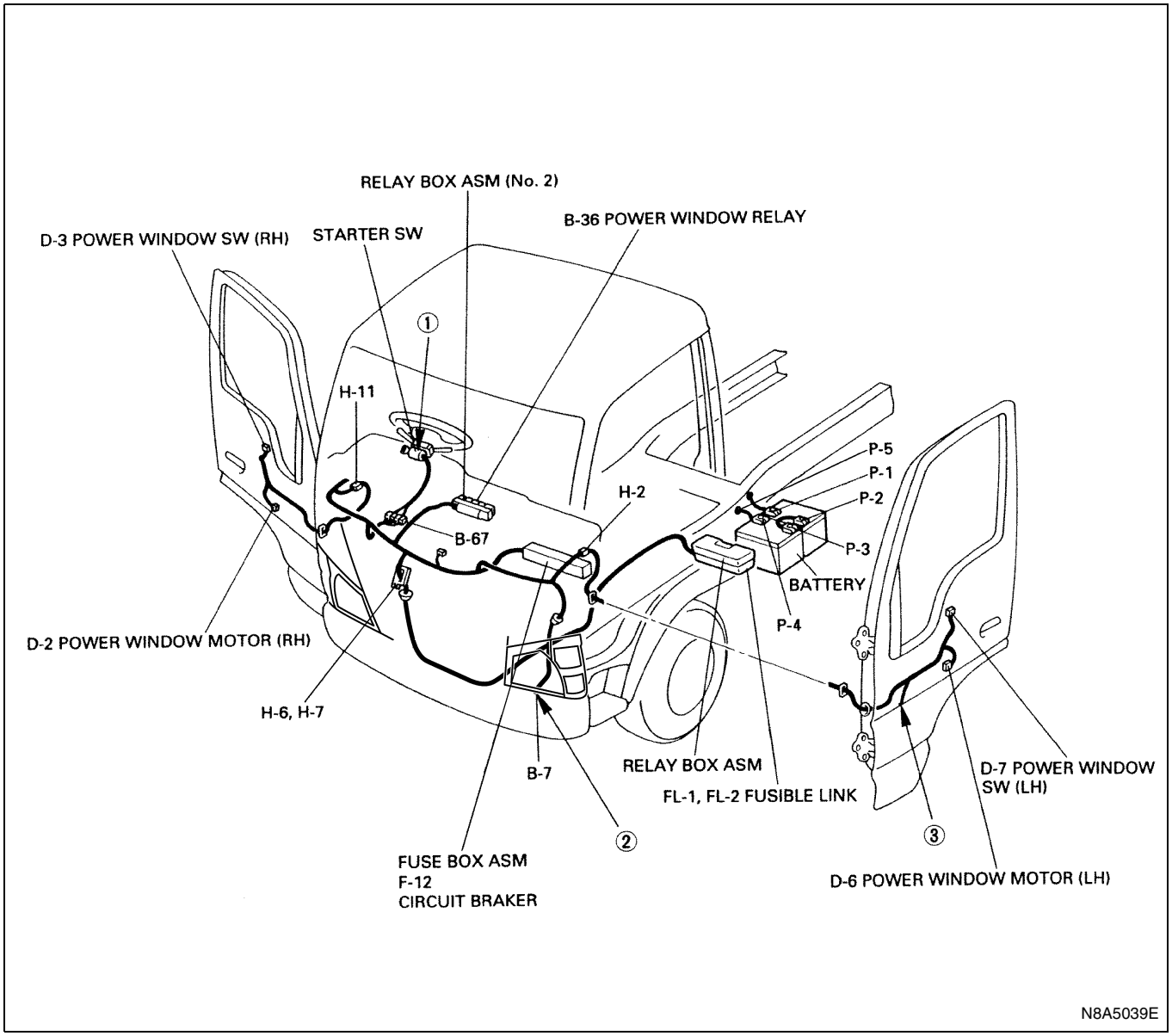


Reading The Circuit Diagram

In this manual, each system has its own parts location illustration, circuit diagram and connector configuration used in the circuit diagram.

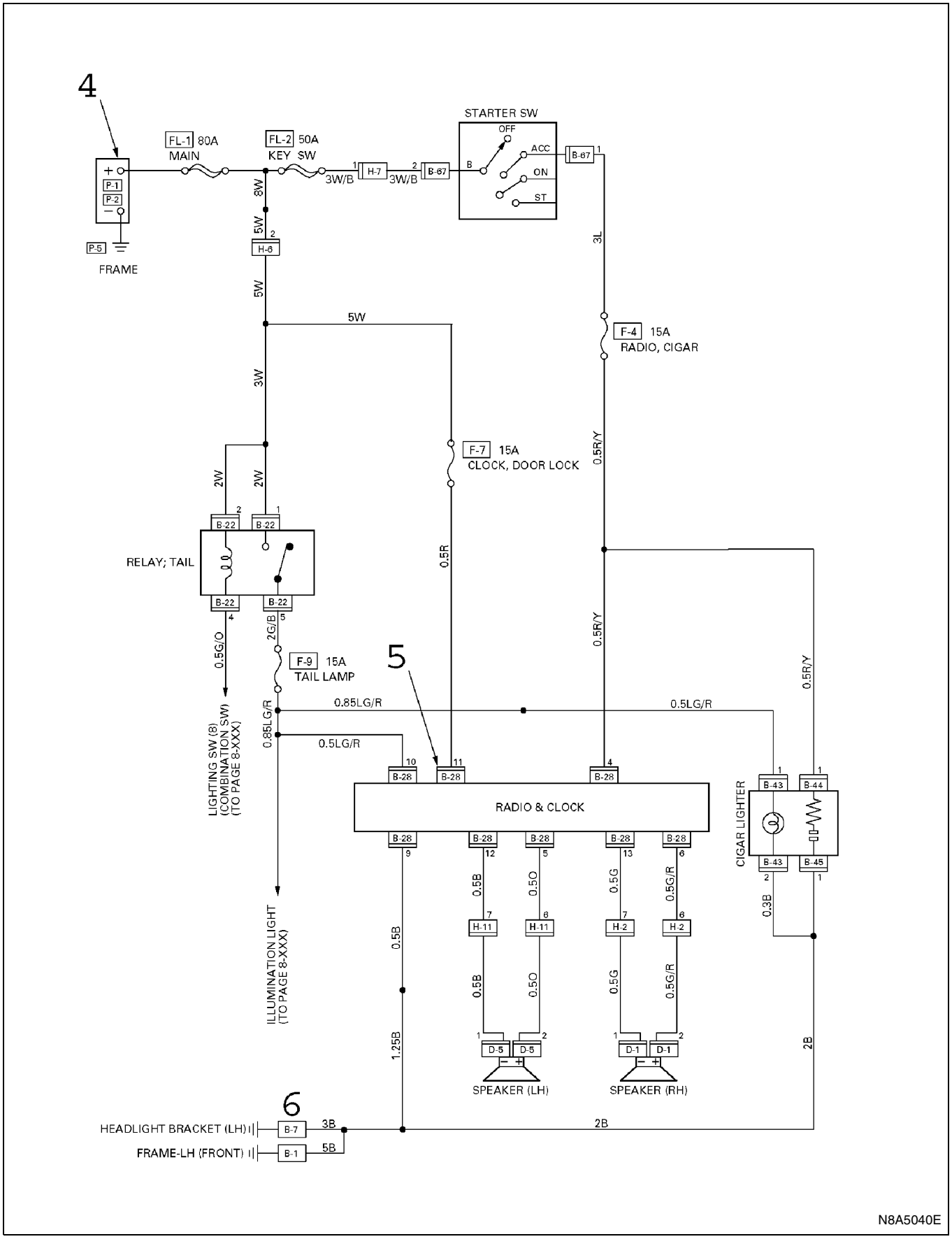
Parts Location

The parts location shows the location of the parts 1 and the connector 2 used in each harness routing 3.



Circuit Diagram

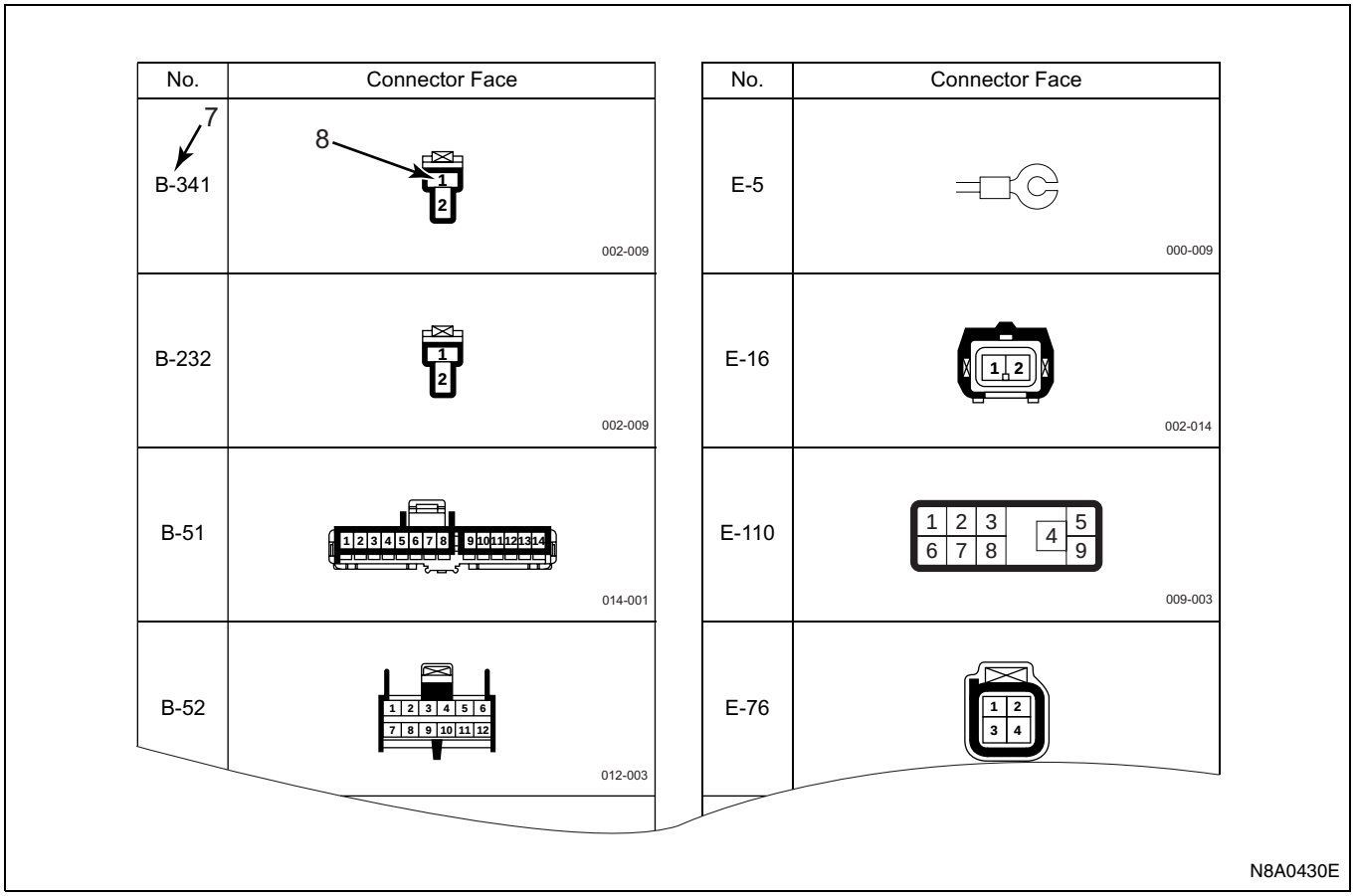
The circuit diagram shows the power supply 4 the load or loads 5 and the grounding point(s) 6.



N8A5040E

Connector List

The connector list shows each connectors' configuration 7 and the pin number 8.

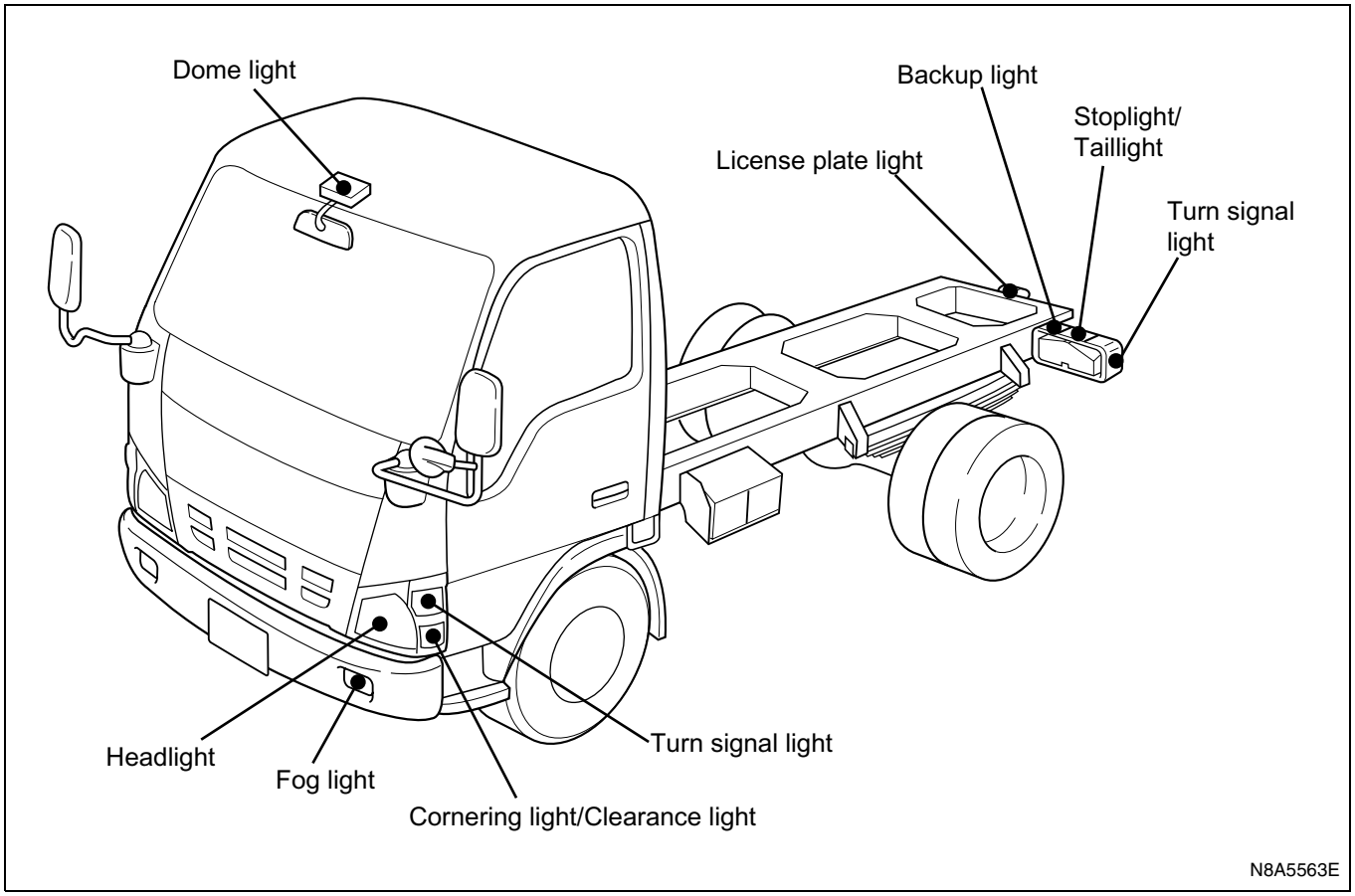


Connector Symbol

Connector Symbol	Harness name	Connector Symbol	Harness name
B	Body harness	L	Dome Light harness
D	Door harness	N	Floor harness (LH & RH)
E	Engine harness	P	Battery harness
H	For joint between harnesses	R	Rear body harness
J	Front frame & Rear frame harness		

MAIN DATA AND SPECIFICATIONS

Bulb Specifications



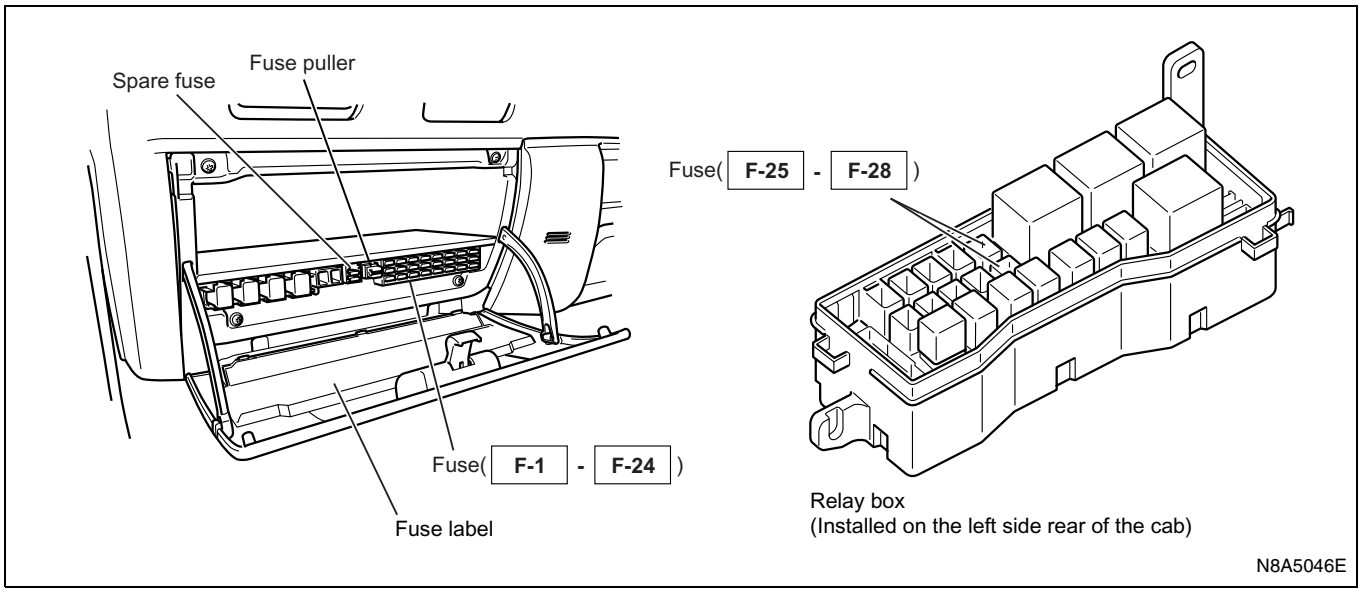
Light Name		Rated Power	No. of Bulb	Lens Color	Remarks
Headlight		60 W / 55 W	2	Clear	12 V
		75 W / 70 W			24 V
Front combination light	Turn signal light	21 W	2	Amber	12 V, 24 V
	Cornering light / Clearance light	21 W / 5 W	2	Clear	12 V, 24 V
Fog light	Front	55 W	2	Clear	12 V
		70 W			24 V
	Rear	21 W	1	Red	12 V, 24 V
Rear combination light	Stoplight / Taillight	21 W / 5 W	2	Red	12 V, 24 V
	Turn signal light	21 W	2	Amber	12 V, 24 V
	Backup light	21 W	2	Clear	12 V, 24 V
License plate light		5 W	1	Clear	12 V, 24 V
Dome light		10 W	1	White	12 V
		12 W			24 V
Roof marker light		5 W	2	White	

Light Name		Rated Power		No. of Bulb	Remarks
		Except 4HK1-TC	4HK1-TC		
Indicator / Warning Light (In the meter assembly)	Glow	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	4WD	1.8 W	1.8 W	1	24 V
	Engine oil pressure	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Fuel sedimenter	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Brake fluid level / Parking brake	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Charge	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Exhaust brake	2 W	—	1	12 V
	High beam	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Turn signal	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Fuel level	2 W	—	1	12 V
		1.8 W	1.8 W		24 V
	Rear fog	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Brake booster	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	ABS	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Check engine	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	P.T.O.	1.4 W	—	1	12 V
		1.4 W	1.8 W		24 V
	Seat belt	2 W	—	1	12 V
		1.8 W	1.8 W		24 V
	SRS airbag	1.4 W	1.8 W	1	24 V
	Smoother	—	LED	1	24 V
	1st start	—	LED	1	24 V
	ECONO	—	LED	1	24 V
	H.S.A	—	1.8 W	1	24 V
	ASR	—	1.8 W	1	24 V

Light Name			Rated Power		No. of Bulb	Remarks
			Except 4HK1-TC	4HK1-TC		
Illumination	Illumination light for meter assembly		3.4 W		1	12 V
			3 W			24 V
	Hazard warning Switch		2 W		1	12 V
			1.8 W			24 V
	Dome light switch		2 W		1	12 V
			1.8 W			24 V
	Front fog light switch		2 W		1	12 V
			1.8 W			24 V
	Rear fog light switch	For indicator	60 mA		1	12 V
		For illumination	60 mA		1	
	Cigar lighter		1.4 W		1	12 V
			1.8 W			24 V
	Heater bezel		1.4 W		1	
	Ashtray		1.4 W		1	
	4WD Switch		40 mA		1	24 V

Fuse and Fusible Link Location

Fuse and Circuit Breaker



Fuse Label-for 12 Volt (4JB1 / 4JG2)

10 A (1)	AIR CON
15 A (2)	EXH. BRAKE, FUEL HEATER
15 A (3)	REAR HEATER
15 A (4)	AUDIO (B), DOOR LOCK
10 A (5)	STOP LIGHT
10 A (6)	FRT FOG LIGHT, CORNERING LAMP
10 A (7)	TAIL LIGHT
10 A (8)	EGR
10 A (9)	FUEL CUT
15 A (10)	FRONT WIPER & WASHER
10 A (11)	TURN LIGHT
10 A (12)	H/LAMP LEVEL
(13)	—
(14)	—
15 A (15)	AUDIO (IG), CIGAR LIGHTER
10 A (16)	METER
(17)	—
(18)	—
15 A (19)	HORN, HAZARD
10 A (20)	ABS (IG)
15 A (21)	GENERATOR
10 A (22)	STARTER
10 A (23)	HEAD LIGHT RH
10 A (24)	HEAD LIGHT LH
15 A (25)	MARKER LAMP
15 A (26)	COND. FAN
10 A (27)	RR FOG
(28)	—

Fuse Label-for 12 Volt (4JH1)

10 A (1)	AIR CON
15 A (2)	FUEL HEATER

15 A (3)	REAR HEATER
15 A (4)	AUDIO (B), DOOR LOCK
10 A (5)	STOP LIGHT
10 A (6)	FRT FOG LIGHT, CORNERING LAMP
10 A (7)	TAIL LIGHT
15 A (8)	ENG. (B1)
15 A (9)	ENG. (B2)
15 A (10)	FRONT WIPER & WASHER
10 A (11)	TURN LIGHT
10 A (12)	H/LAMP LEVEL
(13)	—
(14)	—
15 A (15)	AUDIO (IG), CIGAR LIGHTER
10 A (16)	METER
(17)	—
(18)	—
15 A (19)	HORN, HAZARD
10 A (20)	ABS(IG)
(21)	—
10 A (22)	STARTER
10 A (23)	HEAD LIGHT RH
10 A (24)	HEAD LIGHT LH
15 A (25)	MARKER LAMP
15 A (26)	COND. FAN
10 A (27)	RR FOG
(28)	—

Fuse Label-for 24 Volt (4HF1 / 4HG1 / 4HE1 except Hong Kong)

15 A (1)	HEATER, AIR CON
10 A (2)	EXH. BRAKE, FUEL HEATER
15 A (3)	REAR HEATER
15 A (4)	AUDIO (B), DOOR LOCK
10 A (5)	STOP LIGHT
20 A (6)	POWER WINDOW
10 A (7)	TAIL LIGHT
10 A (8)	FRT FOG LIGHT, CORNERING LAMP
10 A (9)	ENG. (IG)
	FUEL CUT
15 A (10)	FRONT WIPER & WASHER
10 A (11)	TURN LIGHT
10 A (12)	H/LAMP LEVEL
10 A (13)	ENG. STOP
(14)	—
15 A (15)	AUDIO (IG), CIGAR LIGHTER
10 A (16)	METER
(17)	—
15 A (18)	GENERATOR
15 A (19)	ENG. (B)
15 A (20)	HORN, HAZARD
10 A (21)	ABS (IG)
10 A (22)	STARTER
10 A (23)	HEAD LIGHT RH
10 A (24)	HEAD LIGHT LH

15 A (25)	MARKER LAMP
15 A (26)	COND. FAN
10 A (27)	RR FOG
(28)	—

Fuse Label-for 24 Volt (4HE1 for Hong Kong)

15 A (1)	HEATER, AIR CON
10 A (2)	EXH. BRAKE, FUEL HEATER
15 A (3)	REAR HEATER
15 A (4)	AUDIO (B), DOOR LOCK
10 A (5)	STOP LIGHT
20 A (6)	POWER WINDOW
10 A (7)	TAIL LIGHT
10 A (8)	FRT FOG LIGHT, CORNERING LAMP
10 A (9)	ENG. (IG)
	FUEL CUT
15 A (10)	FRONT WIPER & WASHER
10 A (11)	TURN LIGHT
10 A (12)	H/LAMP LEVEL
10 A (13)	ENG. STOP
(14)	—
15 A (15)	AUDIO (IG), CIGAR LIGHTER
10 A (16)	METER
(17)	—
10 A (18)	SRS
15 A (19)	ENG. (B)
15 A (20)	HORN, HAZARD
10 A (21)	ABS (IG)
10 A (22)	STARTER
10 A (23)	HEAD LIGHT RH
10 A (24)	HEAD LIGHT LH
15 A (25)	MARKER LAMP
15 A (26)	COND. FAN
10 A (27)	RR FOG
(28)	—

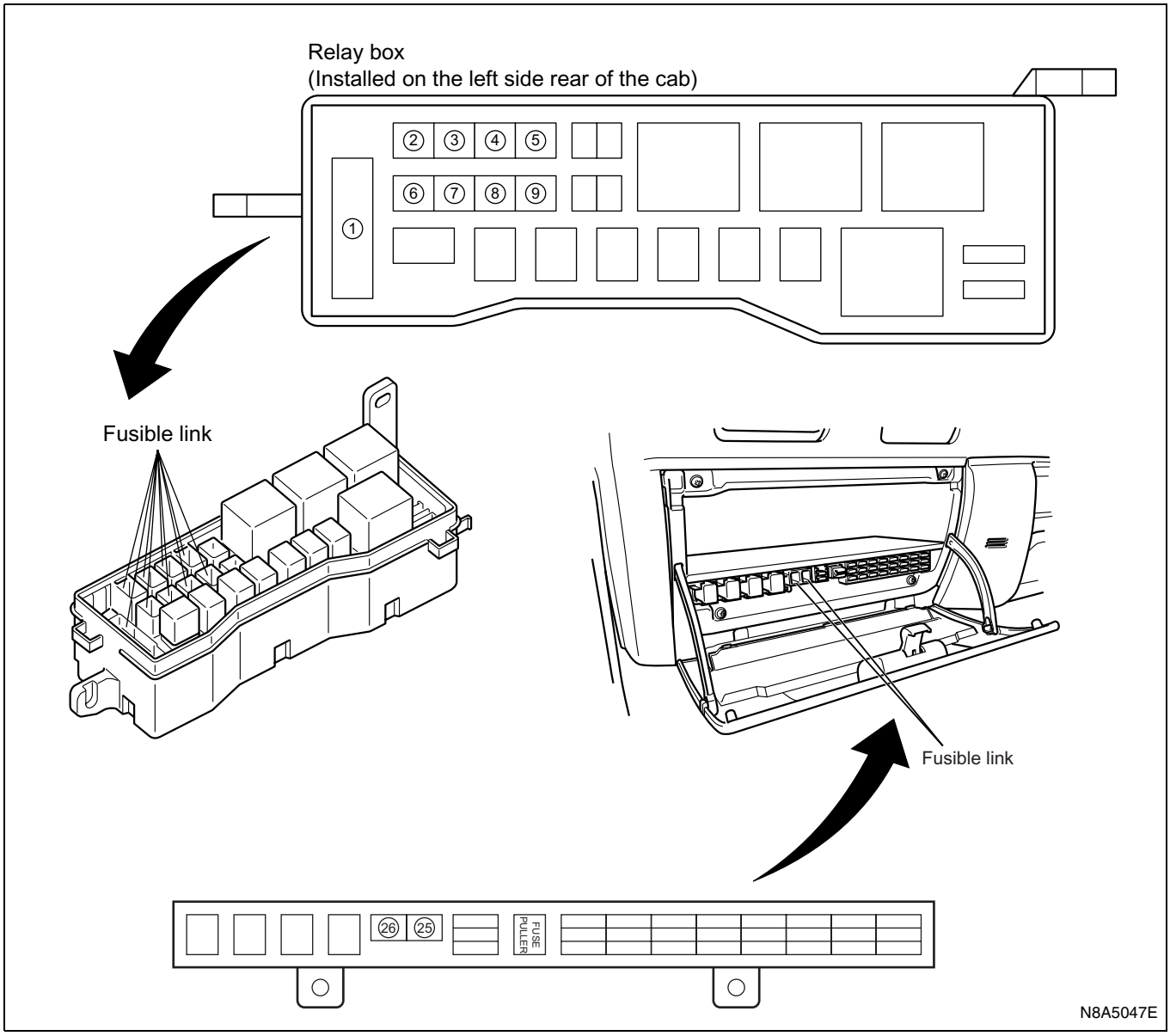
Fuse Label-for 24 Volt (4HK1)

15 A (1)	HEATER, AIR CON
10 A (2)	FUEL HEATER
15 A (3)	REAR HEATER
15 A (4)	AUDIO (B), DOOR LOCK
10 A (5)	STOP LIGHT
20 A (6)	POWER WINDOW
10 A (7)	TAIL LIGHT
10 A (8)	FRT FOG LIGHT
10 A (9)	ENG. (IG)
15 A (10)	FRONT WIPER & WASHER
10 A (11)	TURN LIGHT
10 A (12)	H/LAMP LEVEL
10 A (13)	NEES (B)
(14)	—
15 A (15)	AUDIO (IG), CIGAR LIGHTER
10 A (16)	METER
10 A (17)	NEES (IG)
	HSA

10 A (18)	SRS
10 A (19)	ENG. (BACK UP) HSA
15 A (20)	HORN, HAZARD
10 A (21)	ABS (IG)
10 A (22)	STARTER
10 A (23)	HEAD LIGHT RH
10 A (24)	HEAD LIGHT LH
15 A (25)	MARKER LAMP
15 A (26)	COND. FAN
10 A (27)	RR FOG
10 A (28)	ECM. ENG.

Notice:
The fuse numbers (1) — (28) indicated on the fuse labels are expressed as F-1 — F-28 in the circuit diagrams of this manual.

Fusible Link



For 12 Volt (4JB1 / 4JG2)

100 A (1)	MAIN
50 A (2)	KEY
60 A (3)	GLOW
30 A (4)	HEAD LAMP
(5)	—
(6)	—
(7)	—
60 A (8)	STARTER
60 A (9)	ABS
30 A (25)	HEATER
30 A (26)	POWER WINDOW

For 12 Volt (4JH1)

100 A (1)	MAIN
50 A (2)	KEY
60 A (3)	GLOW

30 A (4)	HEAD LAMP
(5)	—
(6)	—
(7)	—
60 A (8)	STARTER
60 A (9)	ABS
30 A (25)	HEATER
30 A (26)	POWER WINDOW

For 24 Volt (4HF1 / 4HG1 / 4HE1 except Hong Kong)

100 A / 120 A (1)	MAIN
40 A (2)	KEY
60 A (3)	GLOW
30 A (4)	HEAD LAMP
(5)	—
(6)	—
(7)	—
60 A (8)	STARTER
40 A (9)	ABS

For 24 Volt (4HE1 for Hong Kong)

100 A / 120 A (1)	MAIN
40 A (2)	KEY
60 A (3)	GLOW
30 A (4)	HEAD LAMP
(5)	—
(6)	—
(7)	—
60 A (8)	STARTER
40 A (9)	ABS

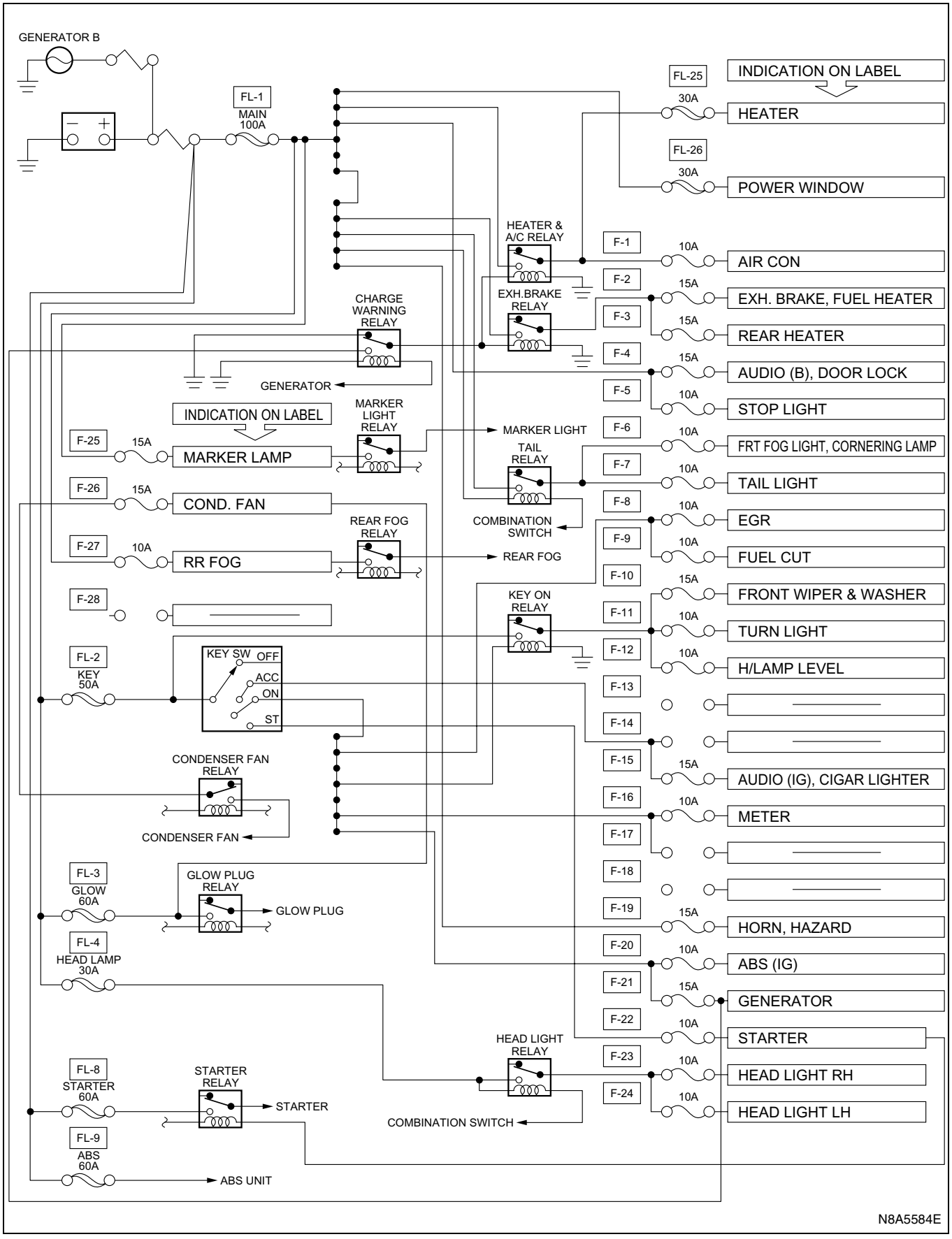
For 24 Volt (4HK1)

100 A / 120 A (1)	MAIN
40 A (2)	KEY
60 A (3)	GLOW
30 A (4)	HEAD LAMP
40 A (5)	ECM. ENG.
60 A (6)	CERAMIC HEATER
60 A (7)	NEES
60 A (8)	STARTER
40 A (9)	ABS

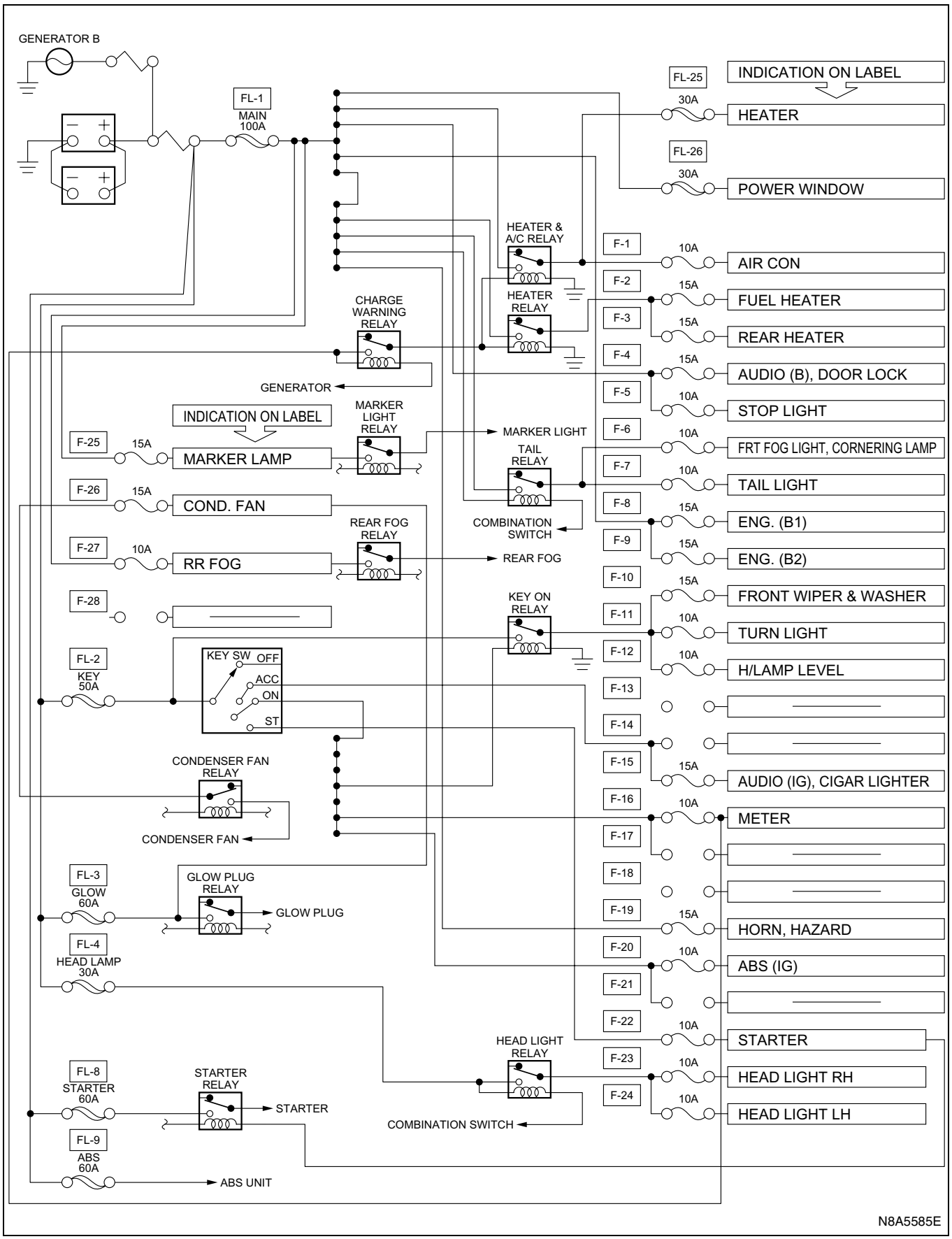
Notice:
The fusible link numbers (1) — (26) are expressed as FL-1 — FL-26 in the circuit diagrams of this manual.

Fuse Block Circuit

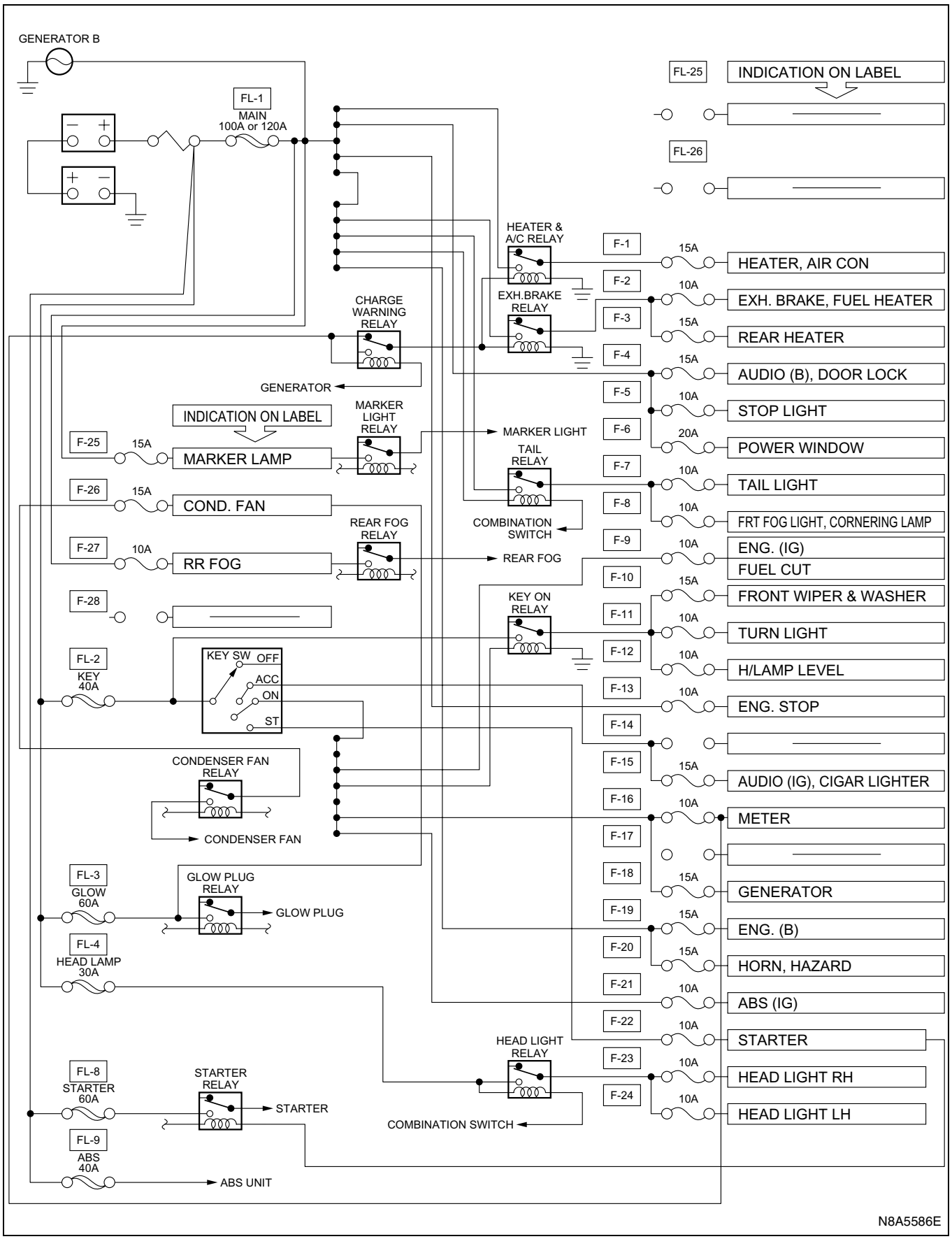
For 12 Volt-4JB1 / 4JG2 Engine



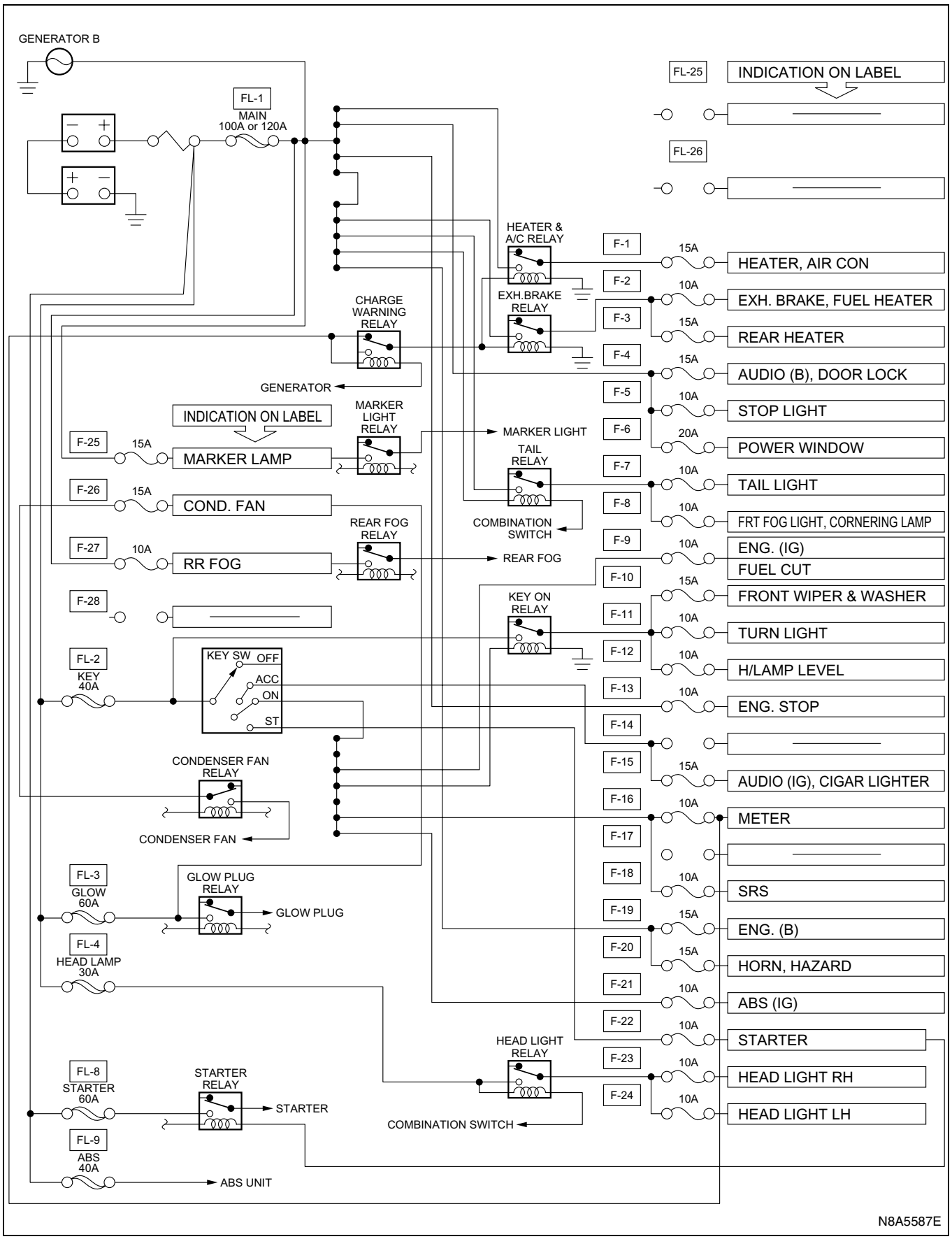
For 12 Volt-4JH1 Engine



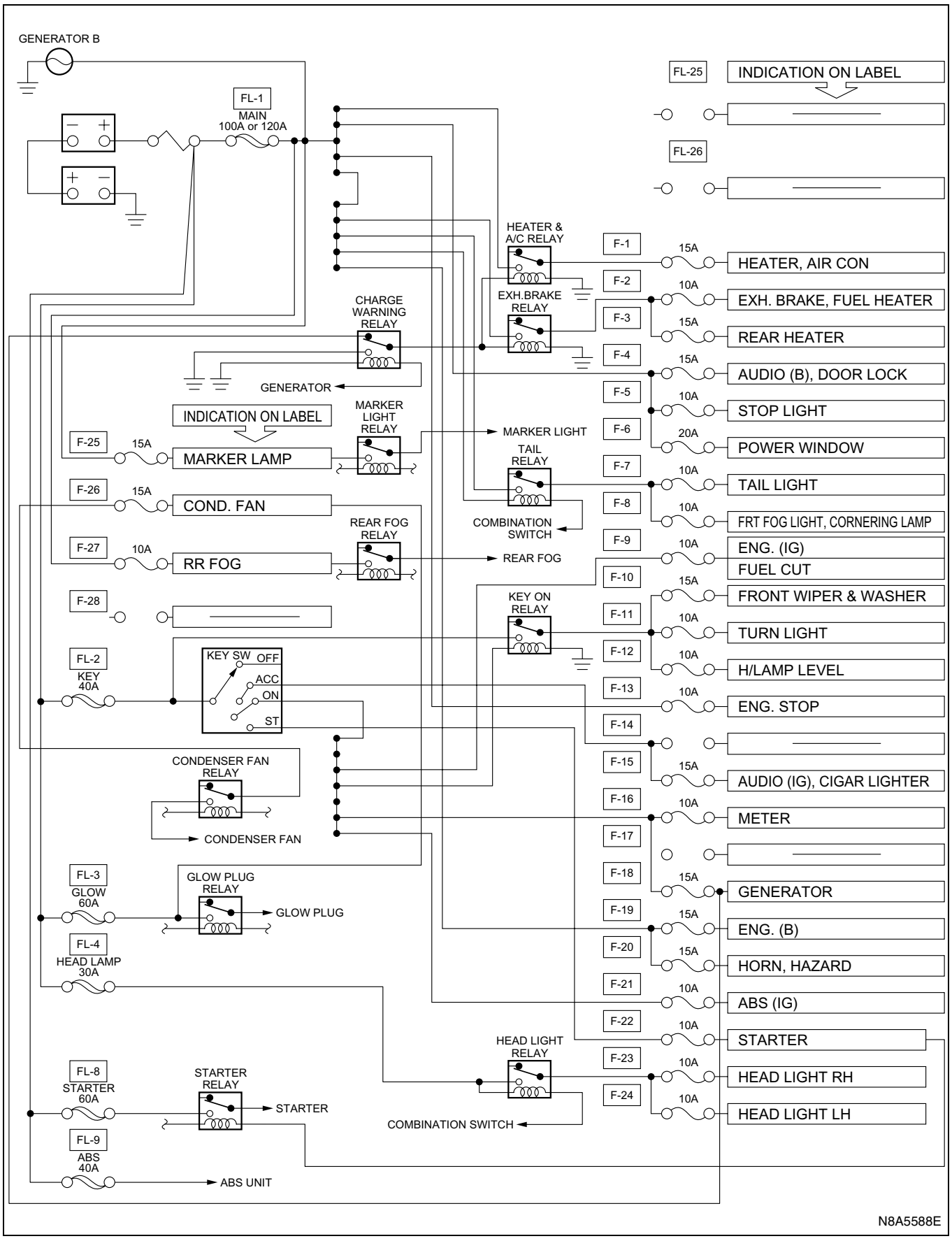
For 24 Volt-4HF1 / 4HG1 / 4HE1 (Except Hong Kong) Engine



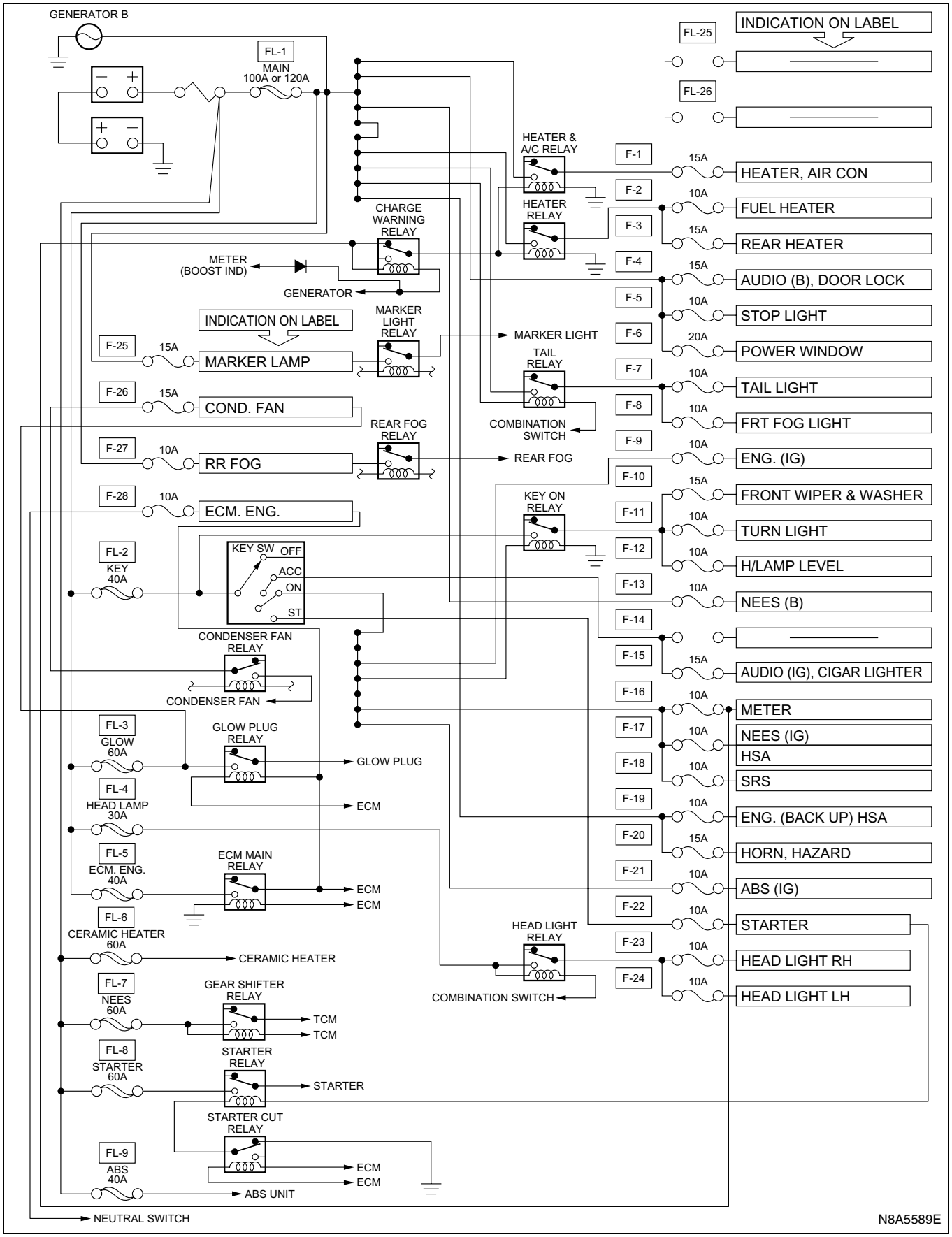
For 24 Volt-4HE1 (For Hong Kong) Engine



For 24 Volt-4HF1 / 4HG1 (For Indonesia) Engine



For 24 Volt-4HK1 Engine



Reference Table of Fuse and Circuit Breaker

Fuse

12 Volt 4JB1 / 4JG2 Engine

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-1	10 A	AIR CON	A/C switch, A/C thermo relay, Pressure switch, Magnetic clutch, VSV: FICD, Electronic thermostat
F-2	15 A	EXH. BRAKE, FUEL HEATER	Exhaust brake switch, Exhaust brake control relay, Exhaust brake magnetic valve, Clutch switch, Accel switch, Fuel heater
F-3	15 A	REAR HEATER	Rear heater, Rear heater switch
F-4	15 A	AUDIO (B), DOOR LOCK	Radio & clock, Dome light switch, Dome light, Door switch (RH & LH), Door lock switch, Door lock actuator, Door lock controller, Speedometer, Key cylinder switch, Key remind buzzer
F-5	10 A	STOP LIGHT	Stoplight switch, Stoplight
F-6	10 A	FRT FOG LIGHT, CORNERING LAMP	Fog light switch, Fog light, Lighting switch, Cornering light relay, Cornering light, Cornering light switch
F-7	10 A	TAIL LIGHT	Tail relay, Illumination light(s), Clearance light(s), Tail light(s)
F-8	10 A	EGR	ECM ignition
F-9	10 A	FUEL CUT	Fuel cut solenoid
F-10	15 A	FRONT WIPER & WASHER	Wiper & Washer switch, Wiper motor, Washer motor, Intermittent relay
F-11	10 A	TURN LIGHT	Flasher unit, Front turn signal light, Rear turn signal light, Turn signal light switch, Hazard warning switch
F-12	10 A	H/LAMP LEVEL	Headlight leveling switch, Headlight leveling motor (actuator)
F-13	—	—	—
F-14	—	—	—
F-15	15 A	AUDIO (IG), CIGAR LIGHTER	Radio, Cigar lighter
F-16	10 A	METER	Exhaust brake control relay, CSD Relay, Key remind buzzer, Backup light switch, Backup light, Neutral switch, Starter relay, QOS-II controller, QOS-III controller, Glow relay, Glow-1 relay, Glow-2 relay, Glow indicator (Meter), Coolant temperature gauge, Thermo unit, Vehicle speed sensor (Installed on the meter assembly & Transmission), Meter assembly, Power window relay, Cornering light relay
F-17	—	—	—
F-18	—	—	—
F-19	15 A	HORN, HAZARD	Horn, Horn relay, Horn switch, Flasher unit, Hazard warning switch
F-20	10 A	ABS (IG)	ABS
F-21	15 A	GENERATOR	Generator
F-22	10 A	STARTER	Starter relay, QOS-II controller, QOS-III controller
F-23	10 A	HEAD LIGHT RH	Headlight (RH), Dimmer relay, High beam indicator light
F-24	10 A	HEAD LIGHT LH	Headlight (LH), Dimmer relay
F-25	15 A	MARKER LAMP	Marker light, Marker light relay
F-26	15 A	COND. FAN	Condenser fan
F-27	10 A	RR FOG	Rear fog light switch, Rear fog light relay

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-28	—	—	—

12 Volt 4JH1 Engine

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-1	10 A	AIR CON	A/C switch, A/C thermo relay, Pressure switch, Magnetic clutch, VSV: FICD, Electronic thermostat
F-2	15 A	FUEL HEATER	Fuel heater
F-3	15 A	REAR HEATER	Rear heater, Rear heater switch
F-4	15 A	AUDIO (B), DOOR LOCK	Radio & clock, Dome light switch, Dome light, Door switch (RH & LH), Door lock switch, Door lock actuator, Door lock controller, Speedometer, Key cylinder switch, Key remind buzzer
F-5	10 A	STOP LIGHT	Stoplight switch, Stoplight
F-6	10 A	FRT FOG LIGHT, CORNERING LAMP	Fog light switch, Fog light, Lighting switch, Cornering light relay, Cornering light, Cornering light switch
F-7	10 A	TAIL LIGHT	Tail relay, Illumination light(s), Clearance light(s), Tail light(s)
F-8	15 A	ENG. (B1)	ECM battery
F-9	15 A	ENG. (B2)	ECM battery
F-10	15 A	FRONT WIPER & WASHER	Wiper & Washer switch, Wiper motor, Washer motor, Intermittent relay
F-11	10 A	TURN LIGHT	Flasher unit, Front turn signal light, Rear turn signal light, Turn signal light switch, Hazard warning switch
F-12	10 A	H/LAMP LEVEL	Headlight leveling switch, Headlight leveling motor (actuator)
F-13	—	—	—
F-14	—	—	—
F-15	15 A	AUDIO (IG), CIGAR LIGHTER	Radio, Cigar lighter
F-16	10 A	METER	Key remind buzzer, Backup light switch, Backup light, Starter relay, Glow indicator (Meter), Coolant temperature gauge, Thermo unit, Vehicle speed sensor (Installed on the meter assembly & Transmission), Meter assembly, Power window relay, Cornering light relay
F-17	—	—	—
F-18	—	—	—
F-19	15 A	HORN, HAZARD	Horn, Horn relay, Horn switch, Flasher unit, Hazard warning switch
F-20	10 A	ABS (IG)	ABS
F-21	—	—	—
F-22	10 A	STARTER	Starter relay, QOS-II controller, QOS-III controller
F-23	10 A	HEAD LIGHT RH	Headlight (RH), Dimmer relay, High beam indicator light
F-24	10 A	HEAD LIGHT LH	Headlight (LH), Dimmer relay
F-25	15 A	MARKER LAMP	Marker light, Marker light relay
F-26	15 A	COND. FAN	Condenser fan
F-27	10 A	RR FOG	Rear fog light switch, Rear fog light relay
F-28	—	—	—

24 Volt 4HF1 / 4HG1 / 4HE1 Engine

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-1	15 A	HEATER, AIR CON	Blower motor, Blower resistor, Fan switch, A/C switch, A/C thermo relay, Pressure switch, A/C cut relay, Thermo switch (A/C cut), VSV: FICD, Electronic thermostat
F-2	10 A	EXH. BRAKE, FUEL HEATER	Exhaust brake switch, Exhaust brake control relay, Exhaust brake magnetic valve, Clutch switch, Accel switch, Fuel heater
F-3	15 A	REAR HEATER	Rear heater, Rear heater switch
F-4	15 A	AUDIO (B), DOOR LOCK	Radio & clock, Dome light switch, Dome light, Door switch (RH & LH), Door lock switch, Door lock actuator, Door lock controller, Speedometer, Key cylinder switch, Key remind buzzer
F-5	10 A	STOP LIGHT	Stoplight switch, Stoplight
F-6	20 A	POWER WINDOW	Power window
F-7	10 A	TAIL LIGHT	Tail relay, Illumination light(s), Clearance light(s), Tail light(s)
F-8	10 A	FRT FOG LIGHT, CORNERING LAMP	Fog light switch, Fog light, Lighting switch, Cornering light relay, Cornering light, Cornering light switch
F-9	10 A	ENG. (IG)	ECM ignition (EXCEPT 4HF1-2)
		FUEL CUT	Fuel cut solenoid (4HF1-2)
F-10	15 A	FRONT WIPER & WASHER	Wiper & Washer switch, Wiper motor, Washer motor, Intermittent relay
F-11	10 A	TURN LIGHT	Flasher unit, Front turn signal light, Rear turn signal light, Turn signal light switch, Hazard warning switch
F-12	10 A	H/LAMP LEVEL	Headlight leveling switch, Headlight leveling motor (actuator)
F-13	10 A	ENG. STOP	Engine stop motor
F-14	—	—	—
F-15	15 A	AUDIO (IG), CIGAR LIGHTER	Radio, Cigar lighter
F-16	10 A	METER	Exhaust brake control relay, CSD Relay, Key remind buzzer, Backup light switch, Backup light, Inhibitor Switch, Neutral switch, Starter relay, QOS-II controller, QOS-III controller, Glow relay, Glow-1 relay, Glow-2 relay, Glow indicator (Meter), Coolant temperature gauge, Thermo unit, Vehicle speed sensor (Installed on the meter assembly & Transmission), Meter assembly, Power window relay, Cornering light relay
F-17	—	—	—
F-18	15 A	GENERATOR	Generator (Except Hong Kong)
	10 A	SRS	SRS (For Hong Kong)
F-19	15 A	ENG. (B)	ECM battery (4HG1-T)
F-20	15 A	HORN, HAZARD	Horn, Horn relay, Horn switch, Flasher unit, Hazard warning switch
F-21	10 A	ABS (IG)	ABS
F-22	10 A	STARTER	Starter relay, QOS-II controller, QOS-III controller
F-23	10 A	HEAD LIGHT RH	Headlight (RH), Dimmer relay, High beam indicator light
F-24	10 A	HEAD LIGHT LH	Headlight (LH), Dimmer relay
F-25	15 A	MARKER LAMP	Marker light, Marker light relay
F-26	15 A	COND. FAN	Condenser fan

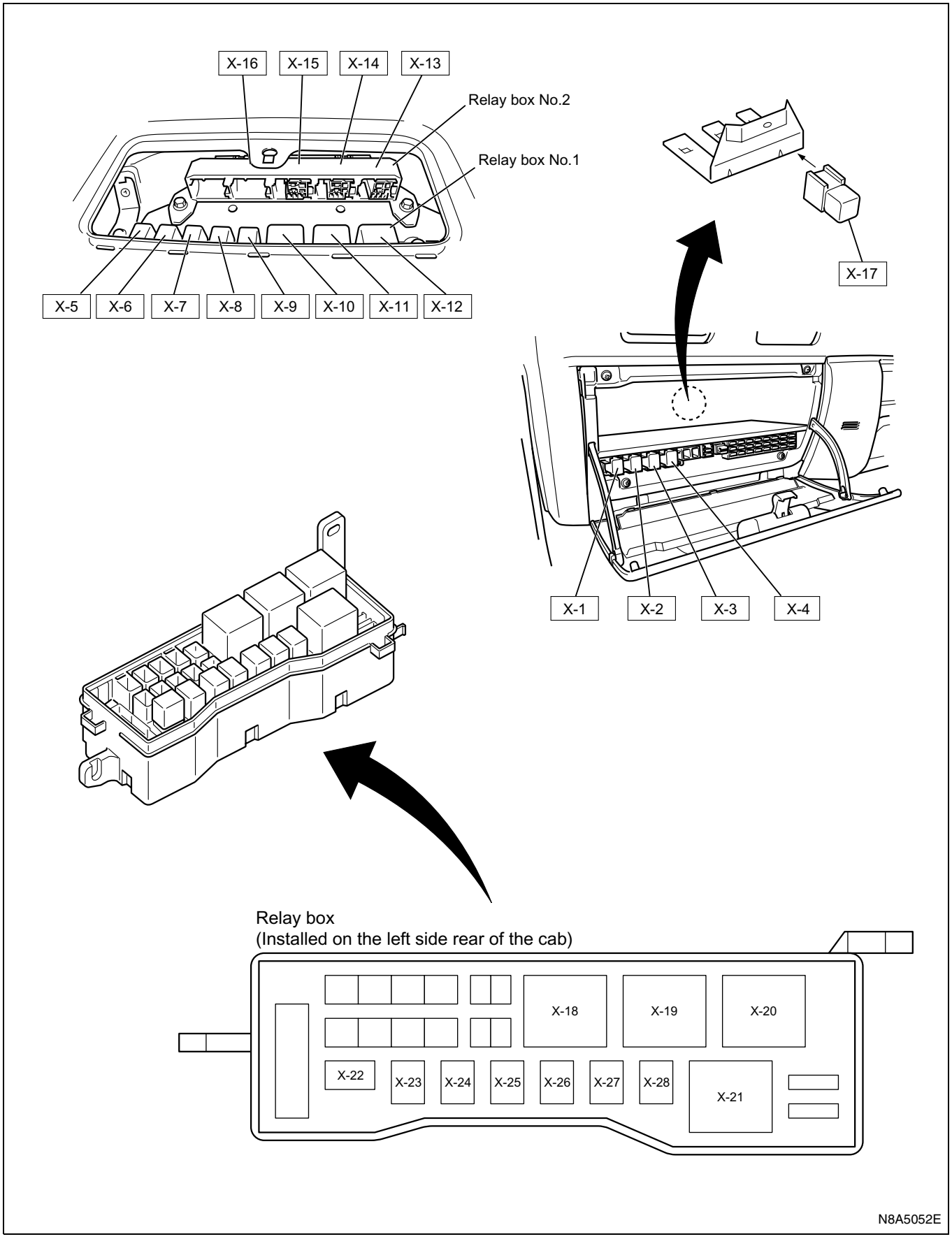
Fuse No.	Capacity	Indication on label	Main parts (Load)
F-27	10 A	RR FOG	Rear fog light switch, Rear fog light relay
F-28	—	—	—

24 Volt 4HK1 Engine

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-1	15 A	HEATER, AIR CON	Blower motor, Blower resistor, Fan switch, A/C switch, A/C thermo relay, Pressure switch, VSV: FICD, Electronic thermostat, A/C compressor, A/C thermo relay, Condenser fan, ECM (A/C compressor SIG.)
F-2	10 A	FUEL HEATER	Exhaust brake magnetic valve, Clutch switch, Accel switch, Fuel heater, VSV: Intake throttle, ABS (Exhaust brake SIG.), Ceramic heater relay
F-3	15 A	REAR HEATER	Rear heater, Rear heater switch
F-4	15 A	AUDIO (B), DOOR LOCK	Radio & clock, Dome light switch, Dome light, Door switch (RH & LH), Door lock switch, Door lock actuator, Door lock controller, Speedometer, Key cylinder switch, Key remind buzzer, Side turn signal light(s)
F-5	10 A	STOP LIGHT	Stoplight switch, Stoplight, ABS (Stop on SIG.), ECM (brake on SIG.)
F-6	20 A	POWER WINDOW	Power window
F-7	10 A	TAIL LIGHT	Tail relay, Illumination light(s), Clearance light(s), Tail light(s), Roof marker light, License light(s), Marker light relay
F-8	10 A	FRT FOG LIGHT	Fog light switch, Fog light, Lighting switch, Cornering light relay, Cornering light, Cornering light switch
F-9	10 A	ENG. (IG)	ECM (IG SIG.), Starter cut relay, ECM (Exhaust brake SIG.), Exhaust brake indicator, ECM (brake off SIG.), ECM (clutch on SIG.), ALDL connector
F-10	15 A	FRONT WIPER & WASHER	Wiper & Washer switch, Wiper motor, Washer motor, Intermittent relay
F-11	10 A	TURN LIGHT	Flasher unit, Front turn signal light, Rear turn signal light, Turn signal light switch, Hazard warning switch, Side turn signal light relay
F-12	10 A	H/LAMP LEVEL	Headlight leveling switch, Headlight leveling motor (actuator)
F-13	10 A	NEES (B)	Smoother
F-14	—	—	—
F-15	15 A	AUDIO (IG), CIGAR LIGHTER	Radio, Cigar lighter, Digital clock
F-16	10 A	METER	CSD Relay, Key remind buzzer, Backup light switch, Backup light, Neutral switch, Starter relay, QOS-II controller, Glow relay, Glow indicator (Meter), Coolant temperature gauge, Thermo unit, Vehicle speed sensor (Installed on the meter assembly & Transmission), Meter assembly, Power window relay, Cornering light relay, Backup buzzer, ABS indicator relay, Charge relay, Heater A/C relay, VSV: 2WD (4WD), VSV: 4WD (4WD), 4WD relay
F-17	10 A	NEES (IG)	Smoother (IGN SIG.)
		HSA	HSA
F-18	10 A	SRS	SRS

Fuse No.	Capacity	Indication on label	Main parts (Load)
F-19	10 A	ENG. (BACK UP) HSA	ECM (Back up), HSA control unit
F-20	15 A	HORN, HAZARD	Horn, Horn relay, Horn switch, Flasher unit, Hazard warning switch, Turn light(s), Side turn signal light relay
F-21	10 A	ABS (IG)	ABS (IGN SIG.)
F-22	10 A	STARTER	Starter relay, QOS-II controller
F-23	10 A	HEAD LIGHT RH	Headlight (RH), Dimmer relay, High beam indicator light
F-24	10 A	HEAD LIGHT LH	Headlight (LH), Dimmer relay
F-25	15 A	MARKER LAMP	Marker light, Marker light relay
F-26	15 A	COND. FAN	Condenser fan
F-27	10 A	RR FOG	Rear fog light switch, Rear fog light relay
F-28	10 A	ECM. ENG.	ECM

Relay Location



Relay List

❍: Standard, ❑: Option

		X-1		X-2	X-3	X-4	X-5		X-6
		Charge warning	Key ON	Horn	Lamp	Tail	ABS IND.	Smoother main	Dimmer
12V	NHR55	—	❍	❍	❍	❍	—	—	❍
	NKR55	—	❍	❍	❍	❍	—	—	❍
	NHR69	—	❍	❍	❍	❍	—	—	❍
	NKR77	—	❍	❍	❍	❍	❑	—	❍
	NPR77	—	❍	❍	❍	❍	❑	—	❍
24V	NKR66	❍	—	❍	❍	❍	—	—	❍
	NPR66	❍	—	❍	❍	❍	—	—	❍
	NQR66	❍	—	❍	❍	❍	—	—	❍
	NPR70	❍	—	❍	❍	❍	❑	—	❍
	NQR70	❍	—	❍	❍	❍	❑	—	❍
	NKR71	❍	—	❍	❍	❍	—	—	❍
	NQR71 with turbocharger	❍	—	❍	❍	❍	—	—	❍
	NPS71	❍	—	❍	❍	❍	—	—	❍
	NPR71	❍	—	❍	❍	❍	—	—	❍
	NQR71 w/o turbocharger	❍	—	❍	❍	❍	—	—	❍
	NPR75	❍	—	❍	❍	❍	—	❑	❍
	NQR75	❍	—	❍	❍	❍	—	❑	❍
	NPS75	❍	—	❍	❍	❍	—	—	❍

		X-7	X-8		X-9	X-10	X-11		X-12
		Power window	Exh. brake	Heater	Corner-ing lamp	Thermo A/C	Charge warning	Key ON	Heater & A/C
12V	NHR55	❑	❑	—	❍	❑	❍	—	❍
	NKR55	❑	❑	—	❍	❑	❍	—	❍
	NHR69	❑	❑	—	❍	❑	❍	—	❍
	NKR77	❑	—	—	❍	❑	❍	—	❍
	NPR77	❑	—	—	❍	❑	❍	—	❍
24V	NKR66	❑	❑	—	❍	❑	—	❍	❍
	NPR66	❑	❍	—	❍	❑	—	❍	❍
	NQR66	❑	❍	—	❍	❑	—	❍	❍
	NPR70	❑	❍	—	❍	❑	—	❍	❍
	NQR70	❑	❍	—	❍	❑	—	❍	❍
	NKR71	❑	❑	—	❍	❑	—	❍	❍
	NQR71 with turbocharger	❑	❍	—	❍	❑	—	❍	❍
	NPS71	❑	❍	—	❍	❑	—	❍	❍
	NPR71	❑	❍	—	❍	❑	—	❍	❍
	NQR71 w/o turbocharger	❑	❍	—	❍	❑	—	❍	❍
	NPR75	❍	—	❍	❍	❍	—	❍	❍
	NQR75	❍	—	❍	❍	❍	—	❍	❍
	NPS75	❍	—	❍	❍	❍	—	❍	❍

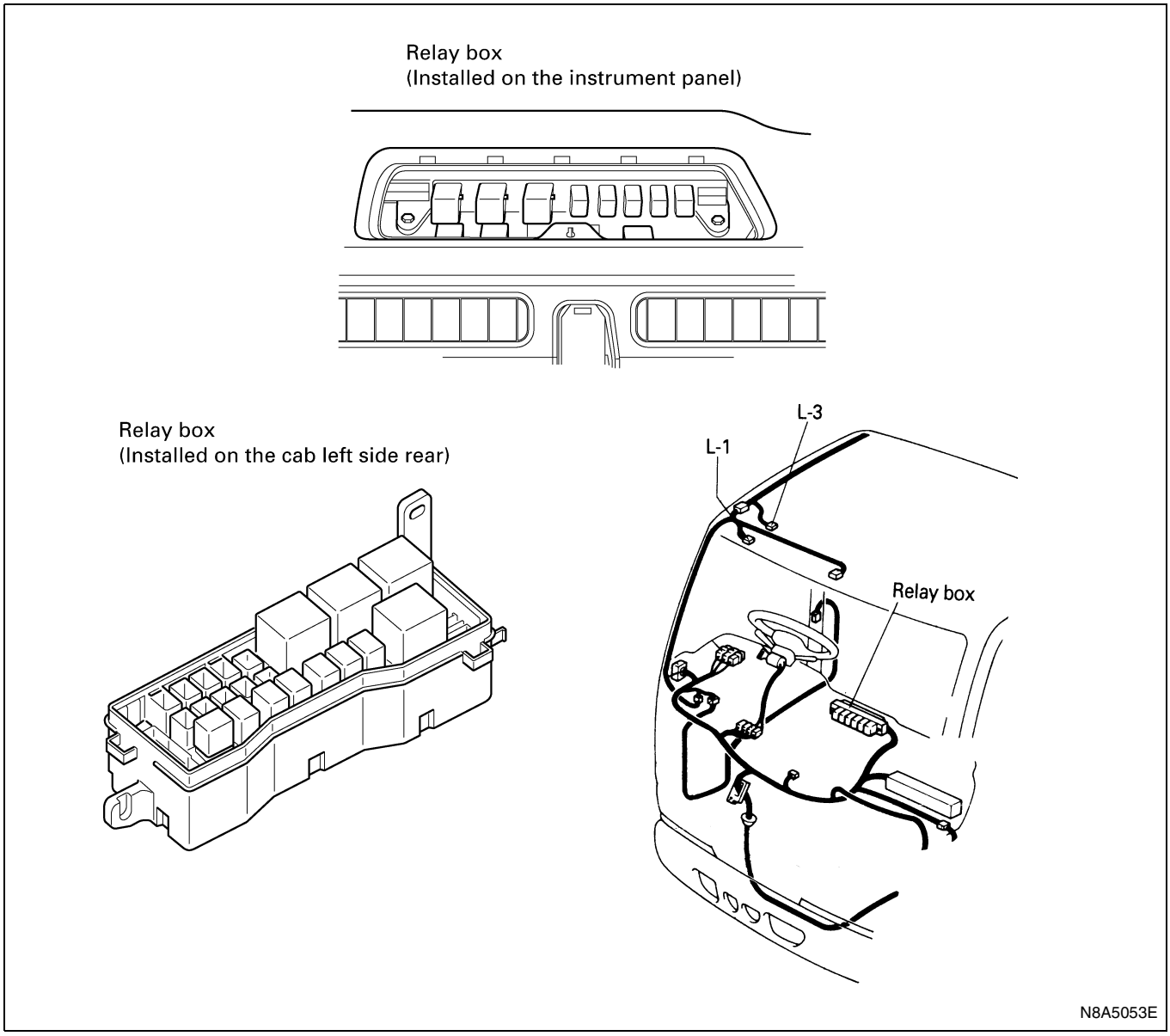
		X-13		X-14			X-17	X-18
		Buzzer cancel	Heater	ECM	Timing	Smoother emergency	Ceramic Heater	ECM main
12V	NHR55	—	—	—	—	—	—	—
	NKR55	—	—	—	—	—	—	—
	NHR69	—	—	—	—	—	—	—
	NKR77	—	❍	❍	—	—	—	—
	NPR77	—	❍	❍	—	—	—	—
24V	NKR66	—	—	—	—	—	—	—
	NPR66	❑	—	—	—	—	—	—
	NQR66	❑	—	—	—	—	—	—
	NPR70	❑	—	—	❍	—	—	—
	NQR70	❑	—	—	❍	—	—	—
	NKR71	—	—	—	—	—	—	—
	NQR71 with turbocharger	❑	—	—	—	—	—	—
	NPS71	—	—	—	—	—	—	—
	NPR71	❑	—	—	—	—	—	—
	NQR71 w/o turbocharger	❑	—	—	—	—	—	—
	NPR75	❑	—	❍	—	❑	❑	❍
	NQR75	❑	—	❍	—	❑	❑	❍
	NPS75	—	—	❍	—	❑	—	❍

		X-19		X-20	X-21	X-22	X-23	X-24	
		Glow No.2	Gear shifter	Glow plug	Starter	Marker lamp	Rear fog	A/C COMP	4WD ind. lamp
12V	NHR55	—	—	❍	❍	—	—	—	—
	NKR55	—	—	❍	❍	—	—	—	—
	NHR69	❍	—	❍	❍	—	—	—	—
	NKR77	—	—	❍	❍	❑	❑	❑	—
	NPR77	—	—	❍	❍	❑	❑	❑	—
24V	NKR66	—	—	❍	❍	—	—	—	—
	NPR66	—	—	❍	❍	—	—	—	—
	NQR66	—	—	❍	❍	—	—	—	—
	NPR70	—	—	❍	❍	—	—	—	—
	NQR70	—	—	❍	❍	—	—	—	—
	NKR71	—	—	❍	❍	—	—	—	—
	NQR71 with turbocharger	—	—	❍	❍	—	—	—	—
	NPS71	—	—	❍	❍	—	—	—	❍
	NPR71	—	—	❍	❍	—	—	—	—
	NQR71 w/o turbocharger	—	—	❍	❍	—	—	—	—
	NPR75	—	❍	❍	❍	❑ *	❑ *	—	—
	NQR75	—	❍	❍	❍	❑ *	❑ *	—	—
	NPS75	—	❍	❍	❍	—	—	—	❍

* : For EC

		X-25	X-26			X-27	X-28
		Exh. brake control	CSD	A/C ON SIGNAL	Starter cut	Con-denser fan	Exh. brake cut
12V	NHR55	❑	❍	—	—	—	—
	NKR55	❑	❍	—	—	—	—
	NHR69	❑	—	—	—	—	—
	NKR77	—	—	❑	—	—	—
	NPR77	—	—	❑	—	—	—
24V	NKR66	❑	—	—	—	—	—
	NPR66	❍	—	—	—	—	—
	NQR66	❍	—	—	—	—	—
	NPR70	❍	—	—	—	❑	❑
	NQR70	❍	—	—	—	❑	❑
	NKR71	❑	—	—	—	—	—
	NQR71 with turbocharger	❍	—	—	—	—	—
	NPS71	❍	—	—	—	—	—
	NPR71	❍	—	—	—	—	—
	NQR71 w/o turbocharger	❍	—	—	—	—	—
	NPR75	—	—	—	❍	❑	—
	NQR75	—	—	—	❍	❑	—
	NPS75	—	—	—	❍	❑	—

Diode Location



Connector No.	B-17	B-18	J-23	L-1	L-3
Usage	QOS III, Lighting	Dome light, A/C	VSV: FICD	Dome light	Dome light

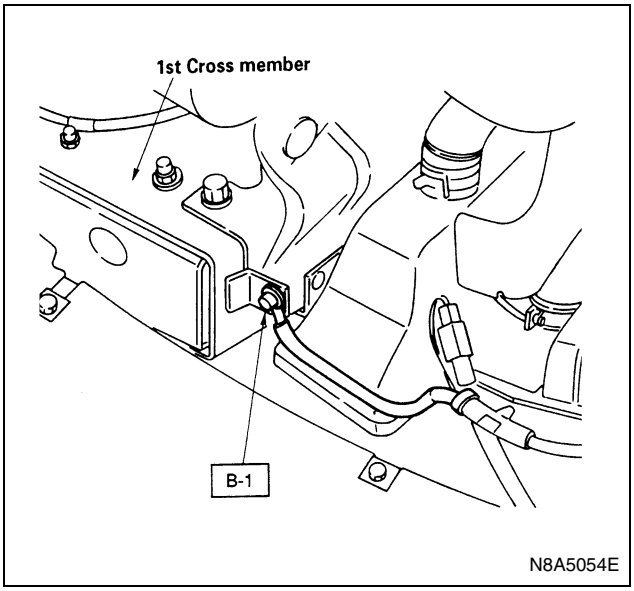
Connector No.	X-33	X-32
Usage	A/C, ECM	Smoother, Dome light

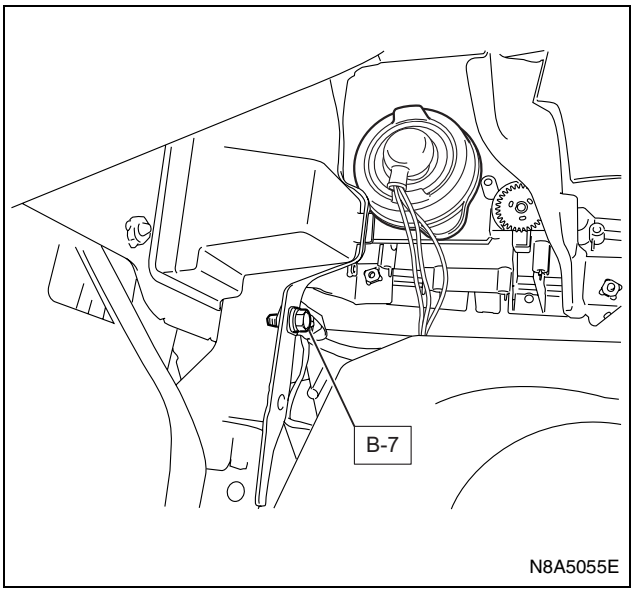
Reference Table of Grounding Point

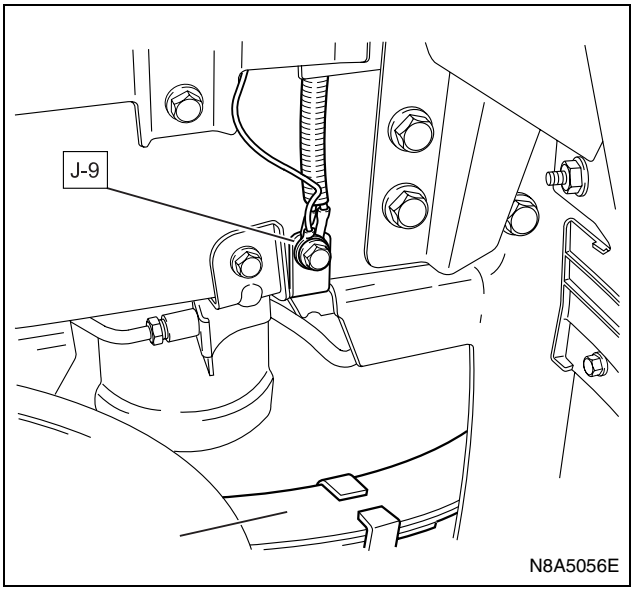
Notice:
Abnormal phenomena of electrical components are considered resulted from defective grounding.
In repair, be sure to inspect grounding points and to tighten all fastening parts surrounding the grounding points.

Connector No.	Cable harness name	Location	Main parts (Load)
B-1	Body harness	Frame-LH (FRT)	Vehicle speed sensor, Heater & A/C relay, Fan switch, Ceramic heater relay, Ceramic heater thermo relay, Meter, High beam indicator light, PTO lever, TCM, SRS C/U
B-275		Frame-RH (FRT)	SRS C/U
B-7		Headlight bracket-LH	Charge relay, Exhaust brake relay, QOS II control unit, QOS III control unit, Dome light switch, Key remind and back up buzzer, Meter, Brake fluid switch, Tail relay, Cornering light switch, Cornering light, Cornering light relay, Fog light switch, Fog light, Dimmer relay, Door lock switch, Door lock relay, Power window switch (RH), Power window relay, Stoplight switch, Mirror switch, Wiper motor, Washer motor intermittent relay, ECM, Pattern select switch, Kickdown switch, Shift indicator, Shift lock controller, Radio, Cigar lighter, Heater & A/C relay, Fan switch, Ceramic heater relay, Ceramic heater thermo relay, ALDL connector (ECM), Vehicle speed sensor, Horn relay, Rear heater switch, Rear heater, Radio & clock, Cigar lighter, Fan switch, Blower resistor, A/C switch, Blower motor, Electronic thermostat, Accel switch, QOS II control unit, Door lock switch, Door lock controller, Headlight levering switch, Headlight levering motor, 4WD switch, Shift lock controller, Power window relay, Power window switch, QOS III control unit, Pattern select switch, Ceramic heater relay, Emergency relay, Select switch, Emergency adjust switch, PTO-Smoother switch
J-9	Frame front harness	Frame-LH (CTR)	Marker light relay, Marker light, Water sedimenter switch, Fuel tank unit, Starter relay, Inhibitor switch, 4WD switch, VSV; Transfer control (2WD & 4WD), 4WD detective switch, 4WD relay, Neutral switch, Fuel heater, Pressure switch, A/C thermo relay, VSV: FICD, Exhaust brake control relay, Exhaust brake magnetic valve, Accel switch, Clutch switch, VSV: intake throttle, Engine stop motor, ECM, ECM main relay, Starter cut relay, Shift 1,3,5 solenoid, Shift 2,4,R solenoid, Select solenoid, License plate light, Taillight, Rear fog light, Rear turn signal light, Stoplight, Stoplight switch, License plate light, Backup light

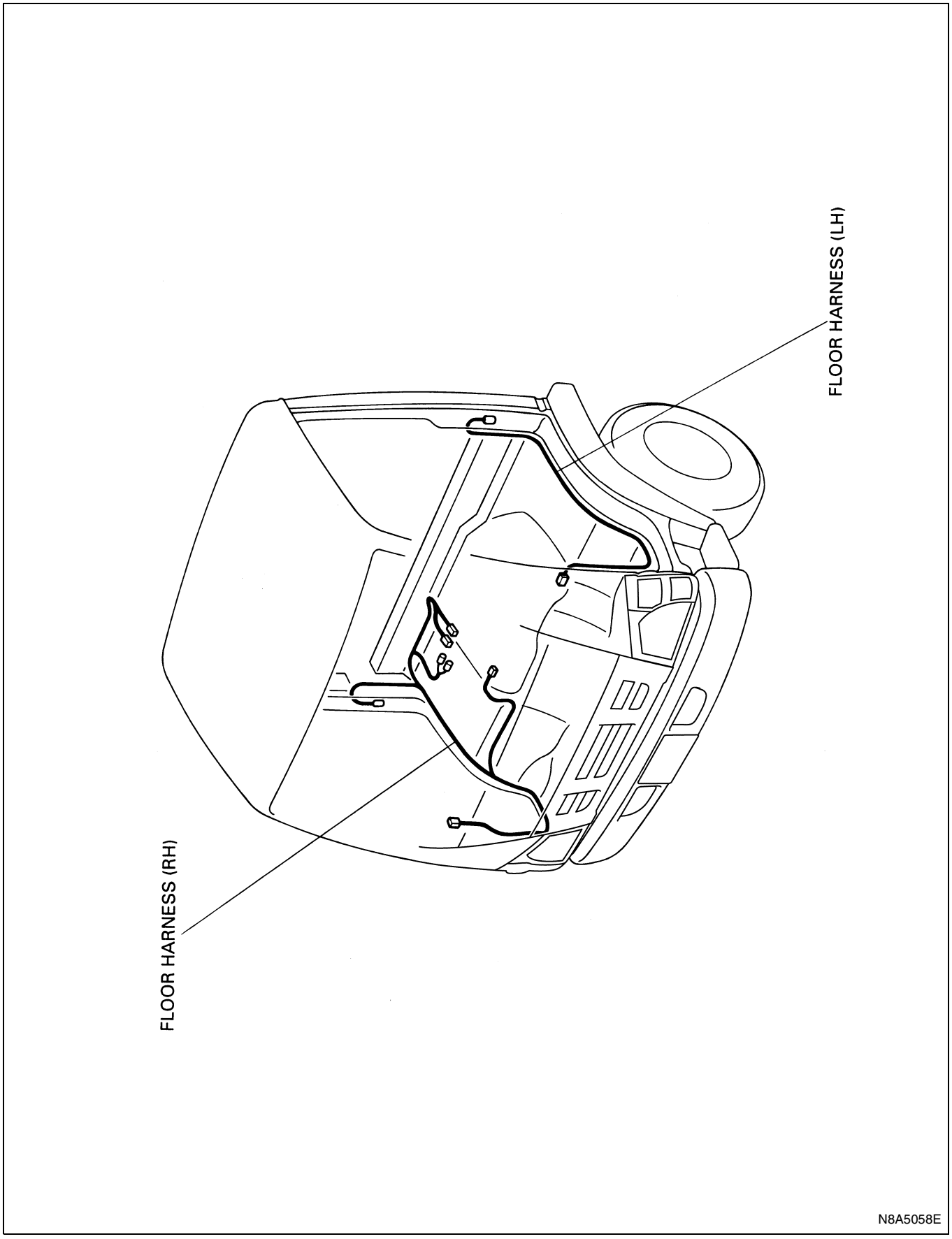
Grounding Point Location

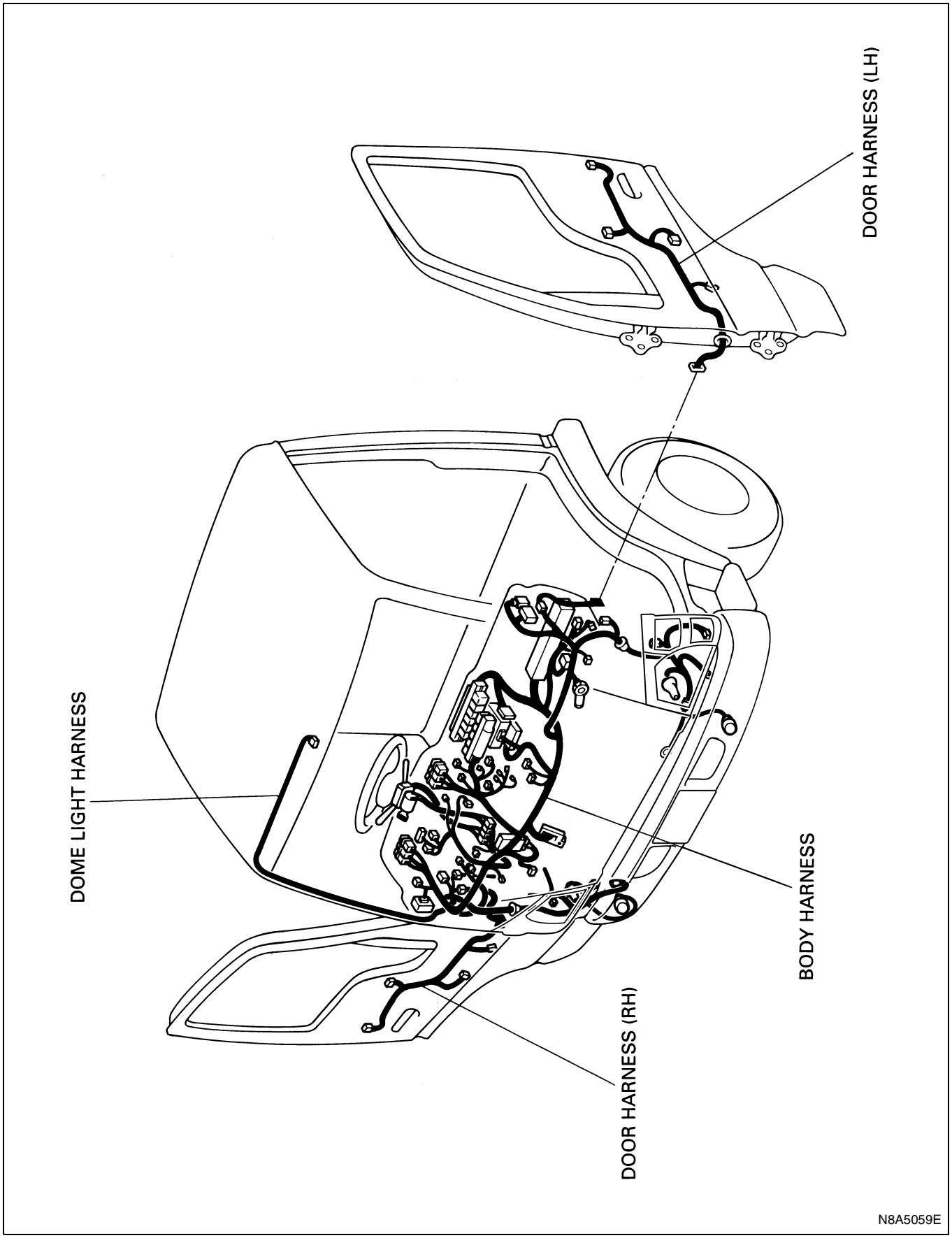


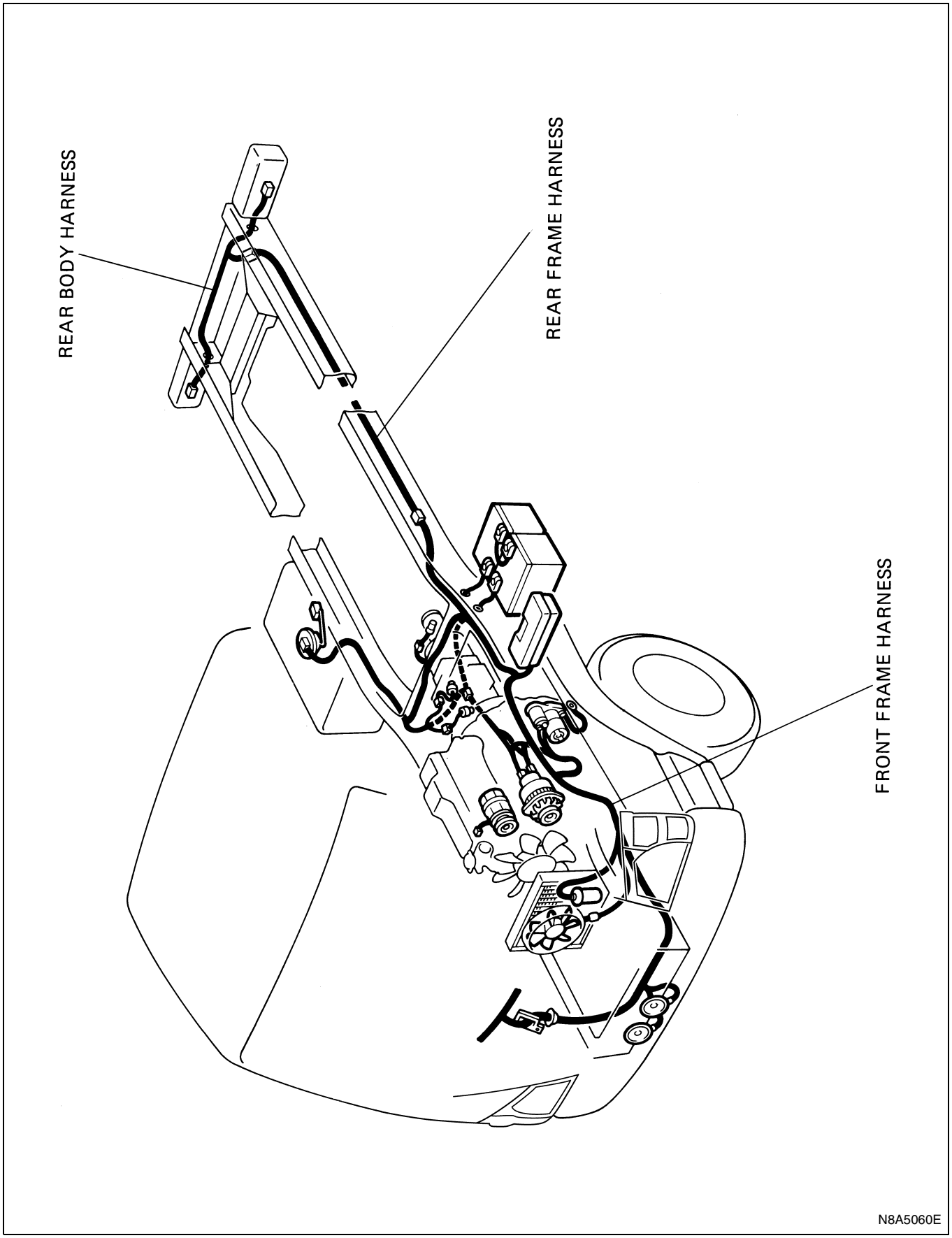




Cable Harness Routing




DOOR HARNESS (LH)
DOME LIGHT HARNESS
BODY HARNESS
DOOR HARNESS (RH)
N8A5059E


REAR BODY HARNESS
REAR FRAME HARNESS
FRONT FRAME HARNESS
N8A5060E

SYSTEM REPAIR

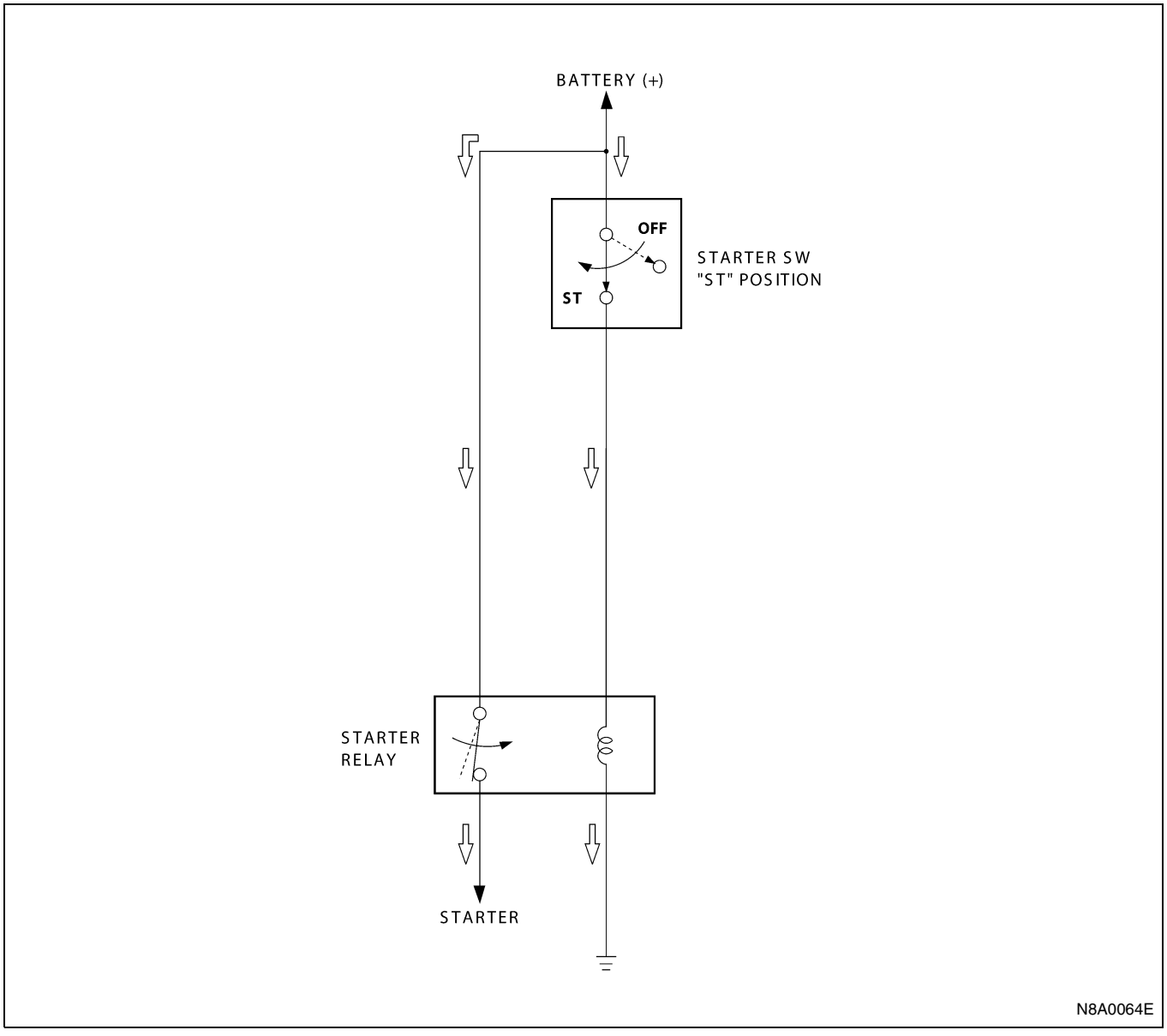
Start and Charging

General Description

The system consists of the starter switch, starter, AC generator, starter relay, charge relay, heater and A/C relay, inhibitor switch and neutral switch. When the starter SW is set to the “ST” position, the battery voltage is applied to the starter solenoid coil through the starter relay to start the starter.

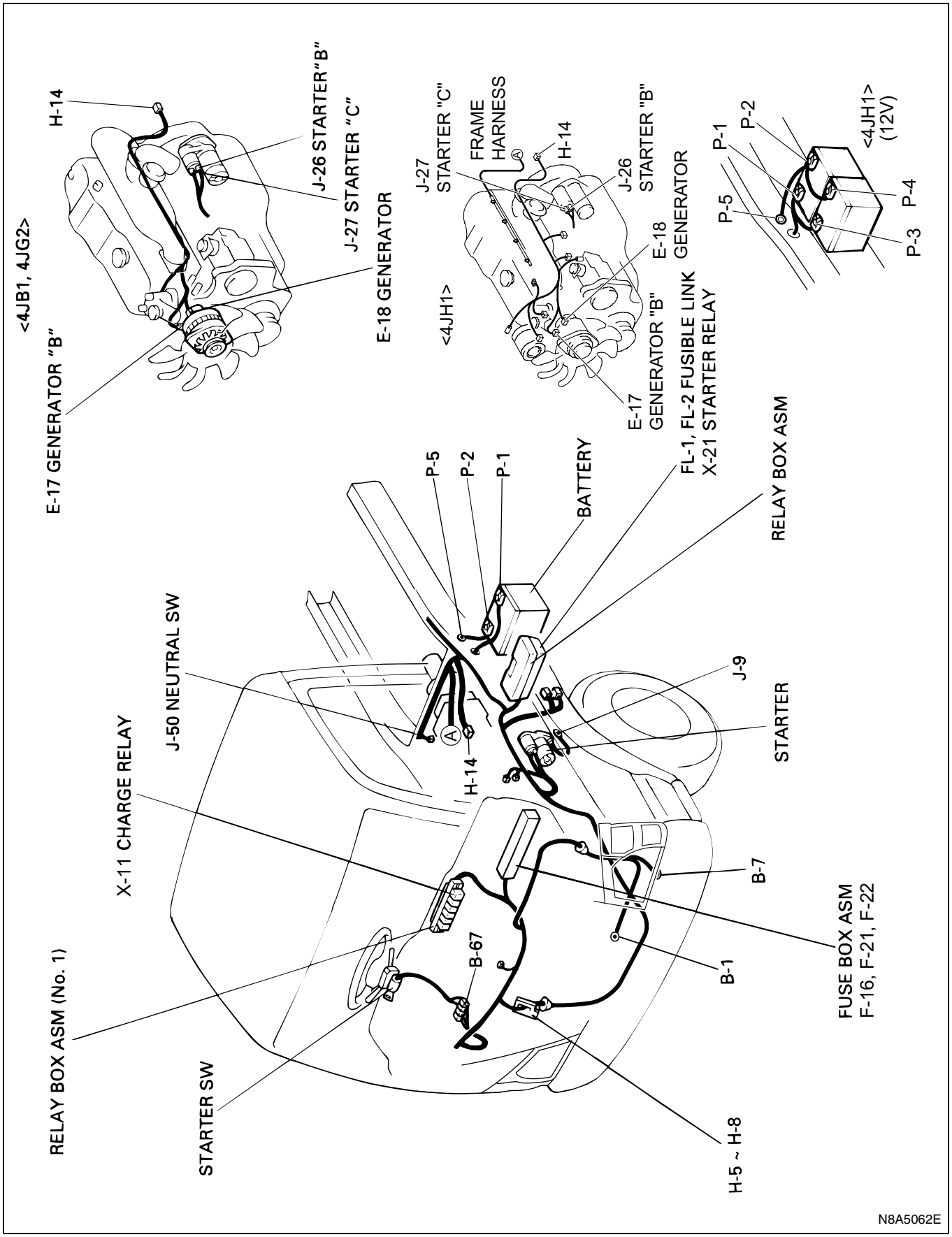
- On the 4HK1 engine, the function that ECM controls STARTER RELAY is added.

Starting Circuit

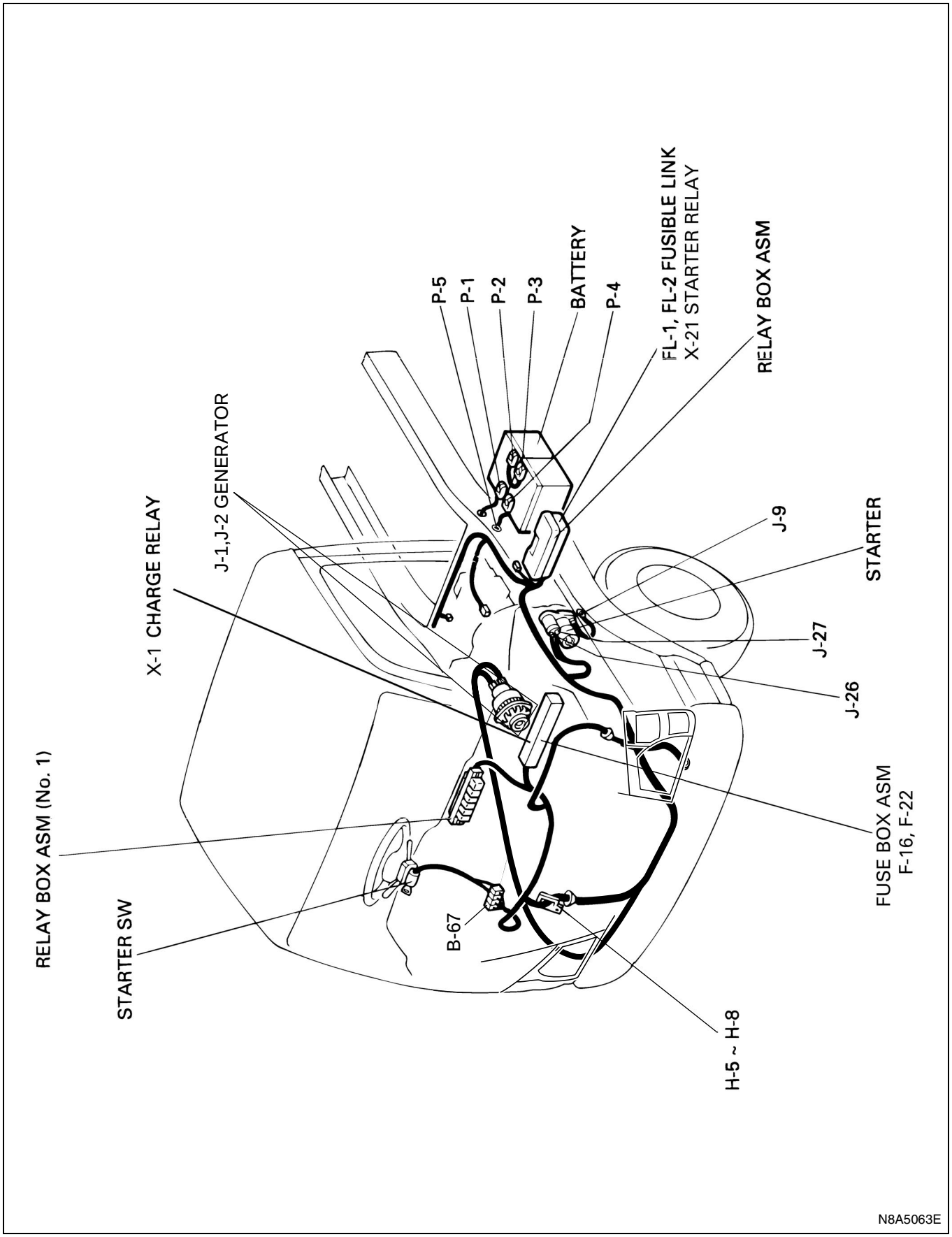


Parts Location

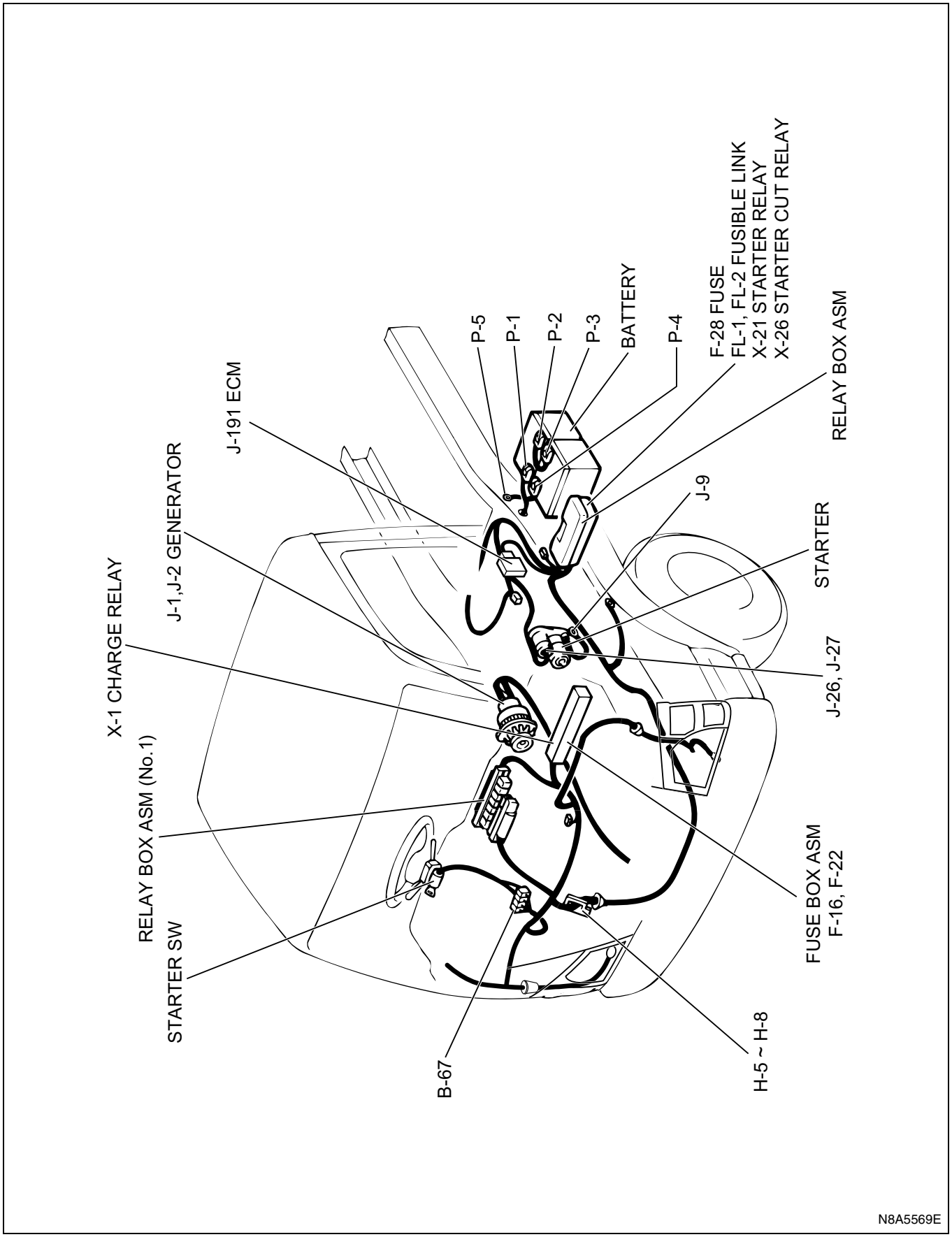
For 12 Volt



For 24 Volt (Except 4HK1)

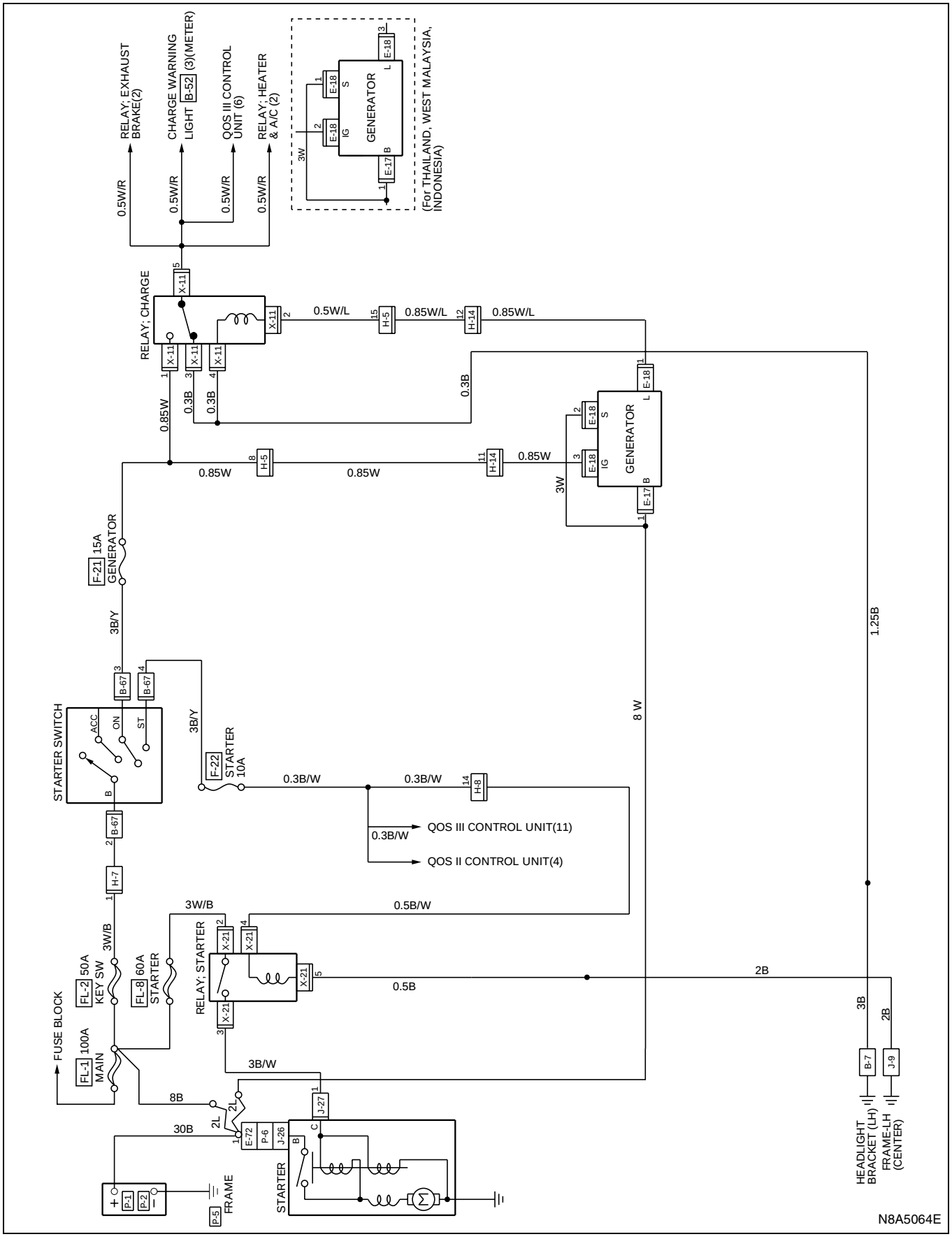


For 24 Volt (4HK1)

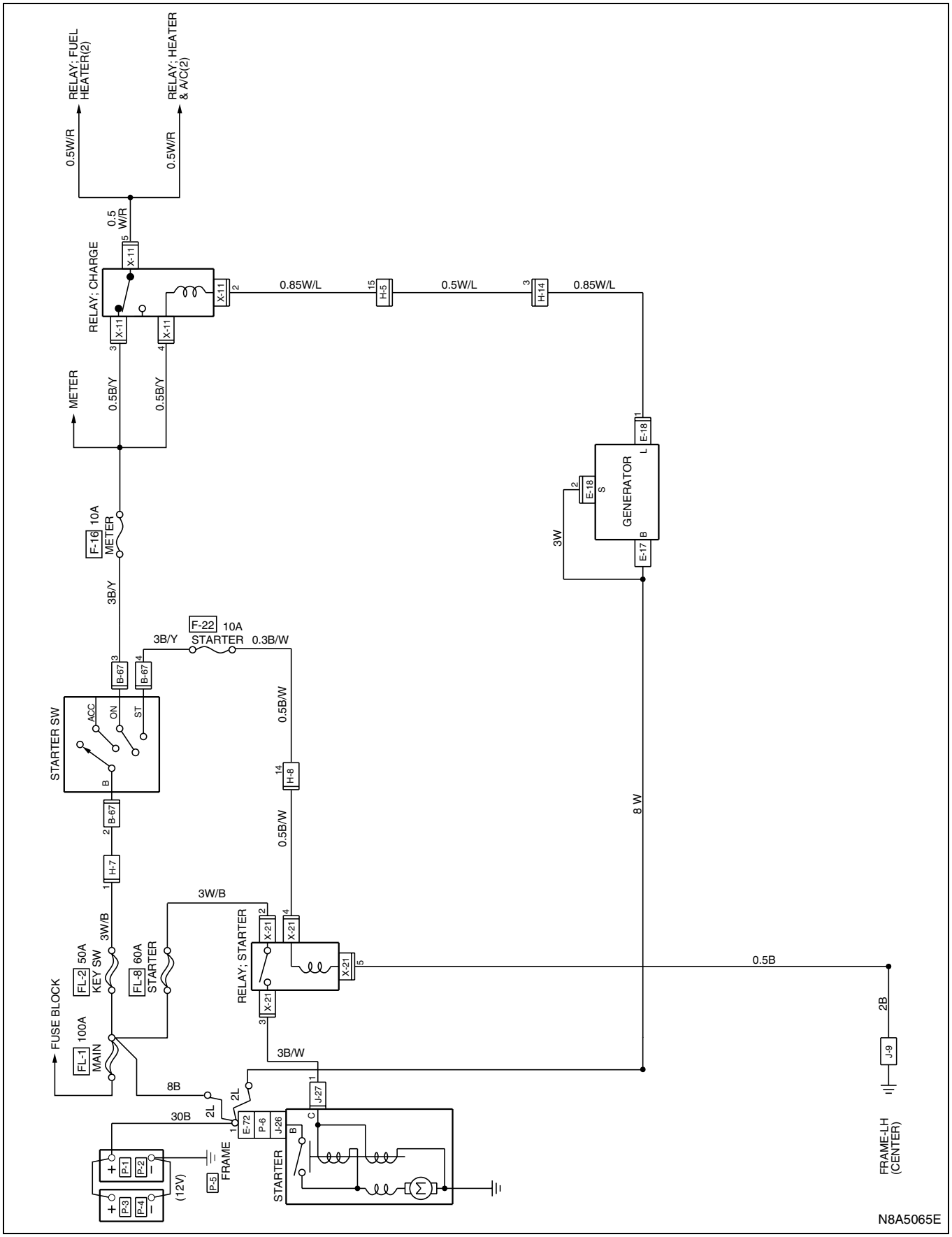


Circuit Diagram

For 12 Volt (Except 4JH1)



For 12 Volt (4JH1)



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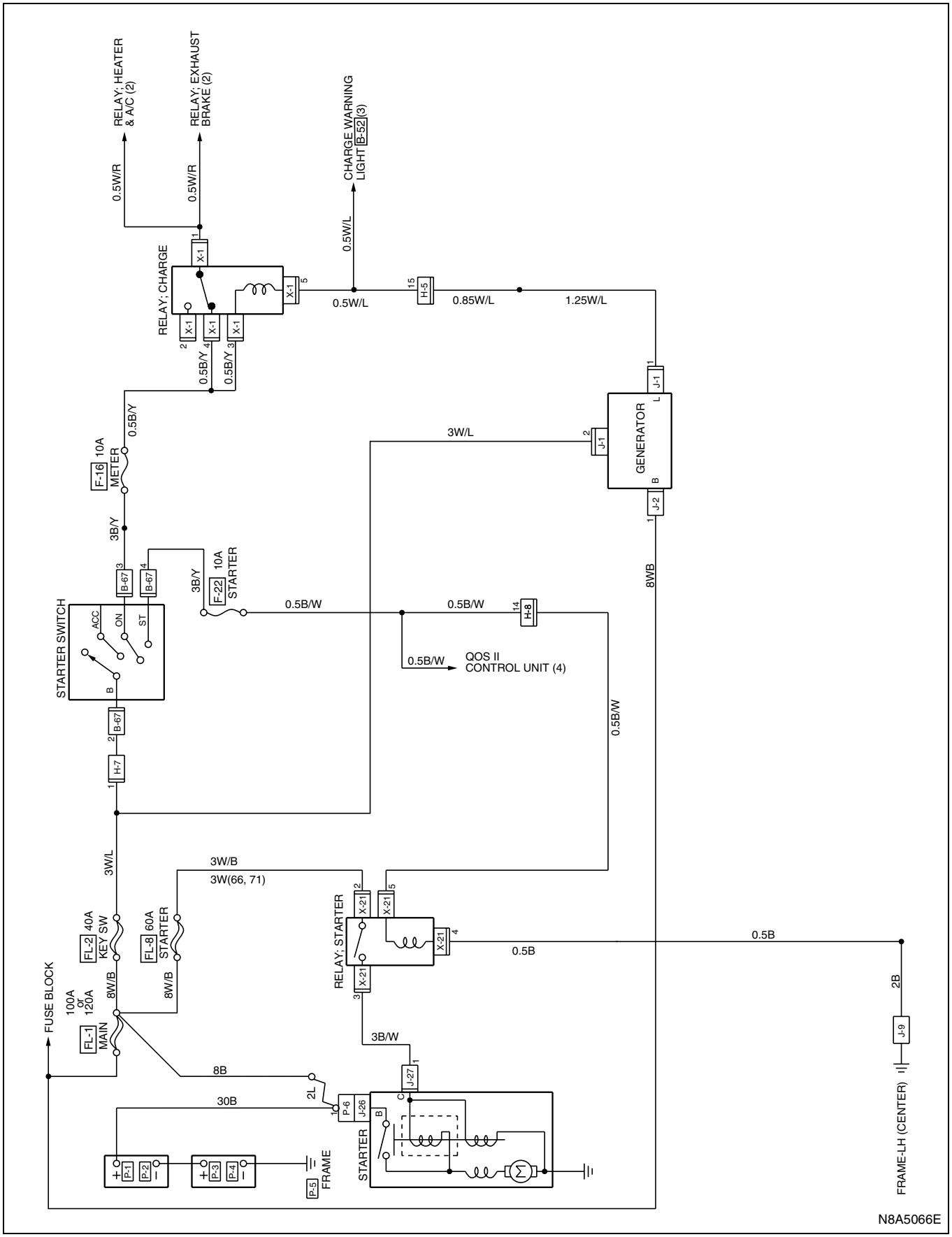
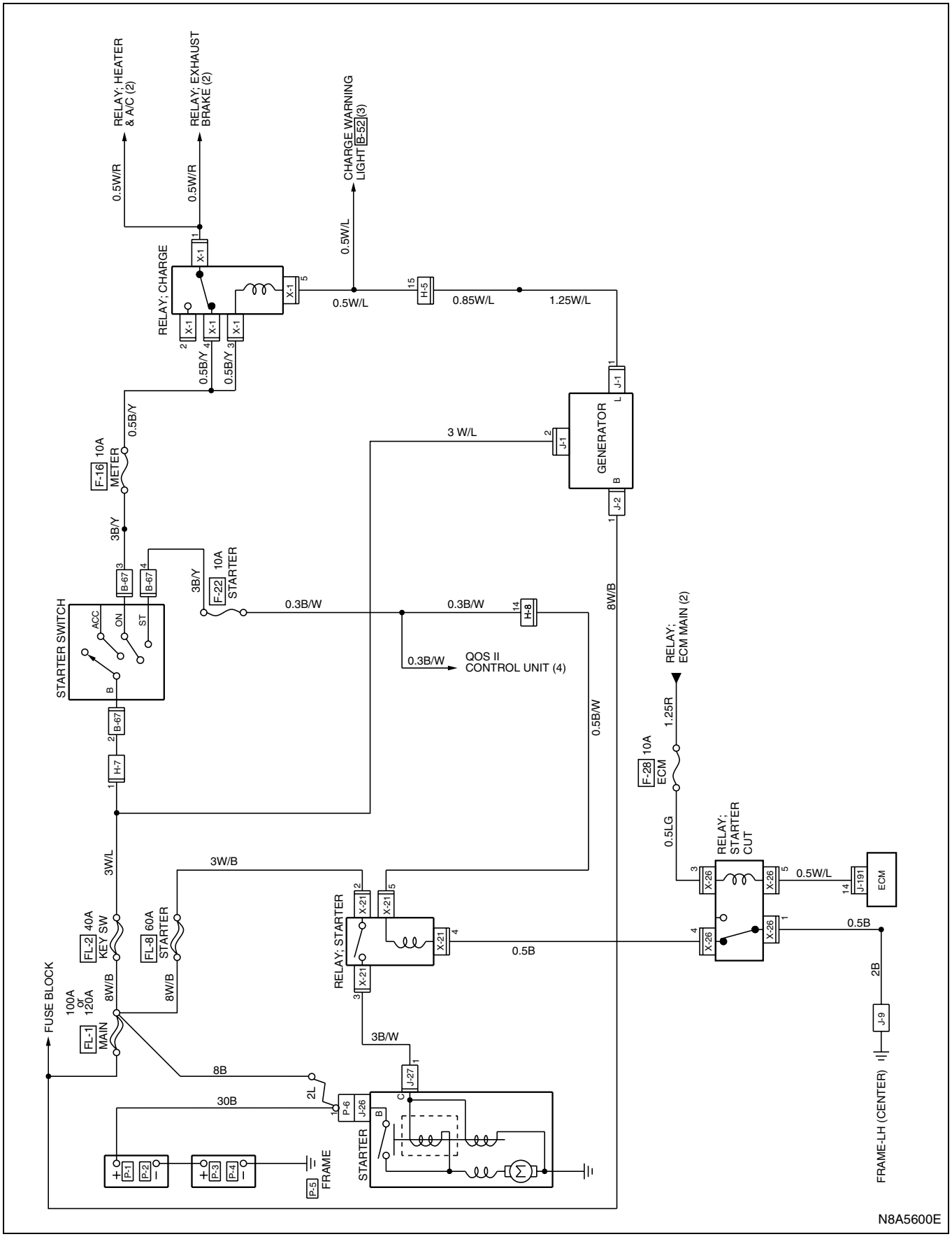


For 24 Volt (4HK1)



Connector List

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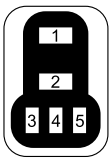
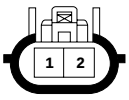
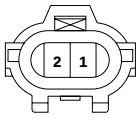
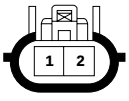
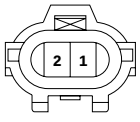
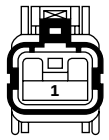
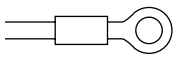
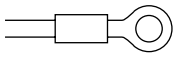
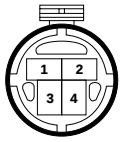
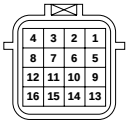
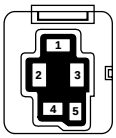
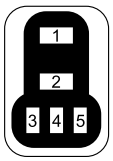
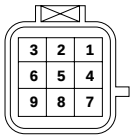
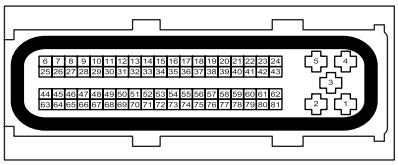
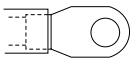
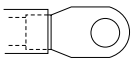
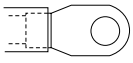
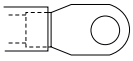
X-1	 005-006
B-67	004-001
B-67	004-002
E-11	 002-001
E-11	 002-002
J-70	 002-001
J-70	 002-002
E-17	 001-001
E-17	 000-001
J-2	 000-001
E-18	 004-003
J-1	002-003
E-18 (4JH1)	002-003
H-14	016-001
H-14	 016-002

No.	Connector Face
X-21	 005-003
X-26	 005-006
J-69	 009-001
J-191	 081-001
E-17 (4JH1)	 000-002
J-26	 000-002
P-6 (Except 66)	 000-002
P-5 (24 V)	 000-002

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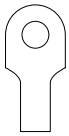
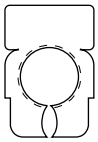
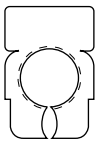
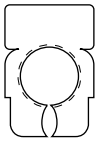
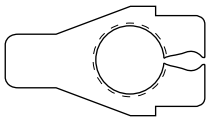
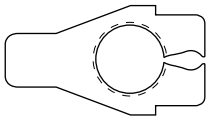
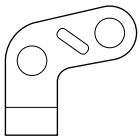
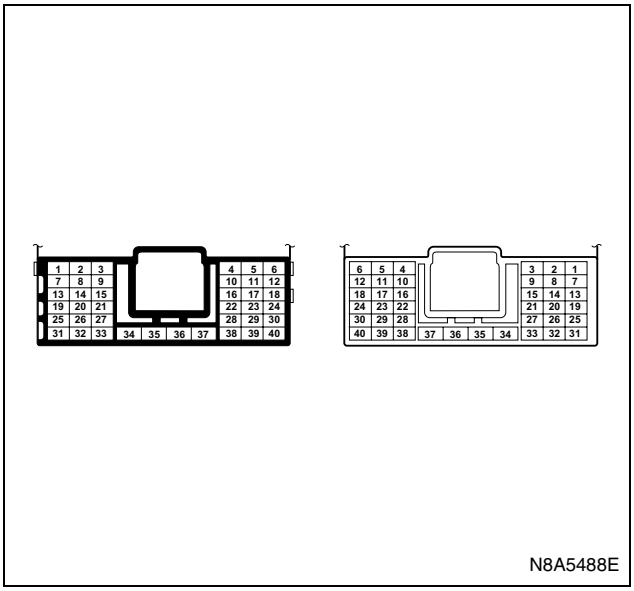
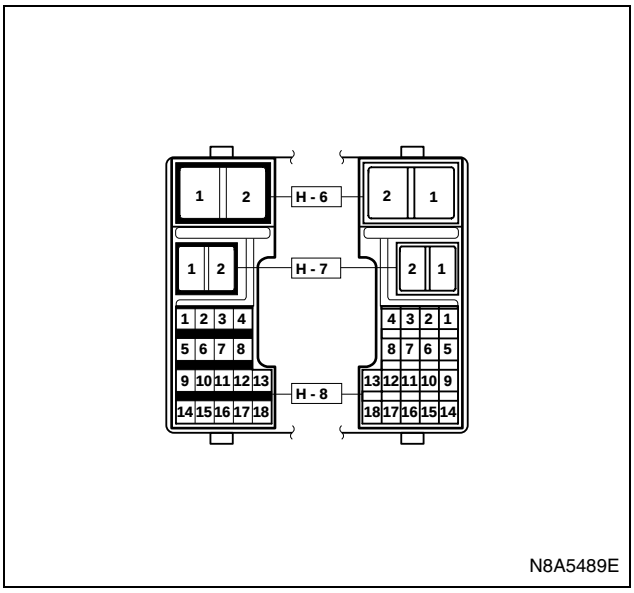
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006
P-3 (4JH1 12 V)	 000-006
P-5 (12 V)	000-007
P-6 (Except 66)	 000-008

H-5

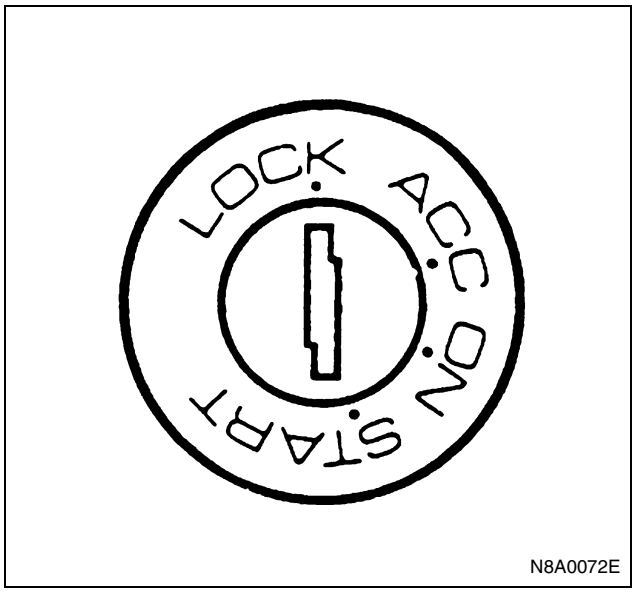


H-7, H-8



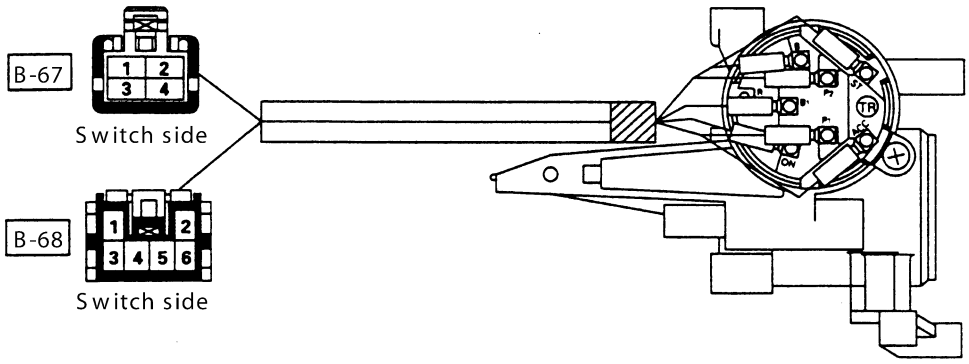
Starter Switch

The starter switch positions are LOCK, ACC, ON and START. Turning the starter key to these positions a circuit for starting the engine, the operation of accessories, or stop the engine.



Inspection

Check the continuity between the starter switch connector terminals.
Repair or replace the switch when the result of inspection is found abnormal.



Starter SW key position	Terminal No. / Connector No.	B-67 1	B-67 2	B-67 3	B-67 4	B-68 1	B-68 2	B-68 4	B-68 5	B-68 6
		ACC	B	ON	ST	B1	P1	P2	W	W
Removed	LOCK					○—○				
Inserted	ACC	○—○				○—○			○—○	
	ON	○—○—○				○———○				
	START		○—○—○			○———○				

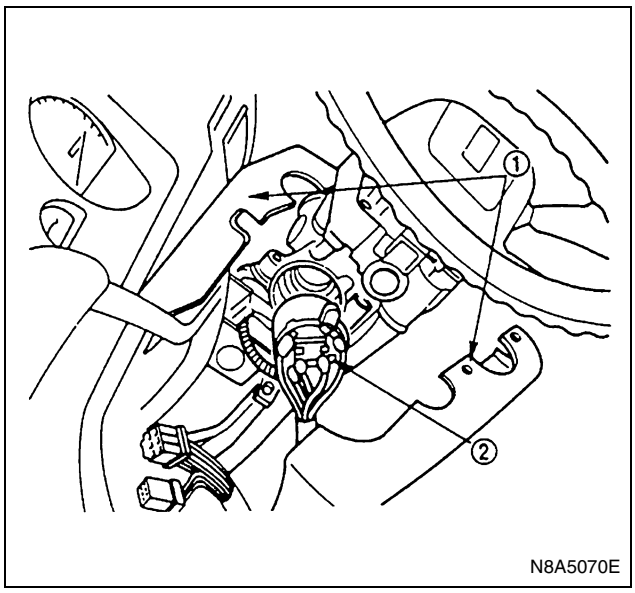
N8A0073E

Removal

Preparation:

Disconnect the battery ground cable.

1. Steering Cowl
   Remove four screws and take off the steering cowl.
2. Starter Switch
   1) Disconnect the connector.
   2) Remove the screw.



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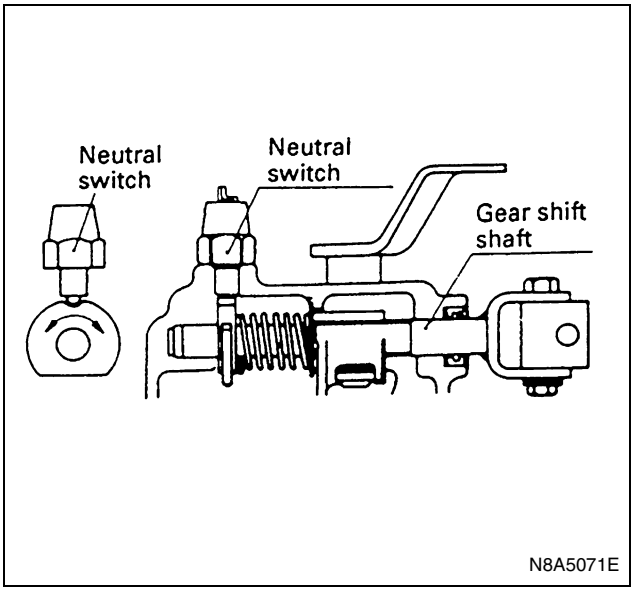
Installation

To install, follow the removal steps in the reverse order.

Neutral switch

Inspection

Check to see if there is any continuity between the switch terminals.
Replace the switch when the result of inspection is found abnormal.

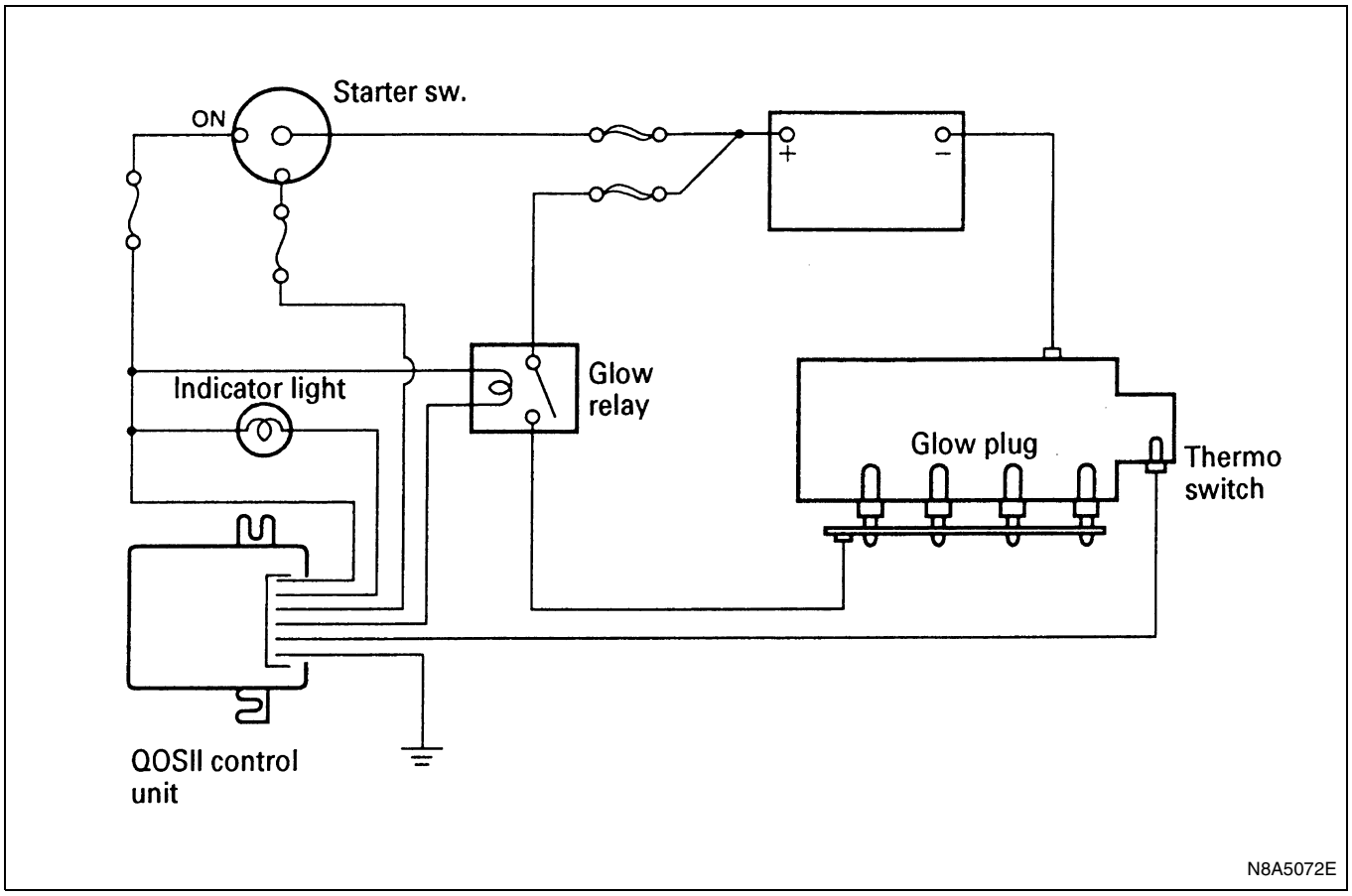


QOS (Quick On Start) II System (4HF1 and 4JB1 Engine Model)

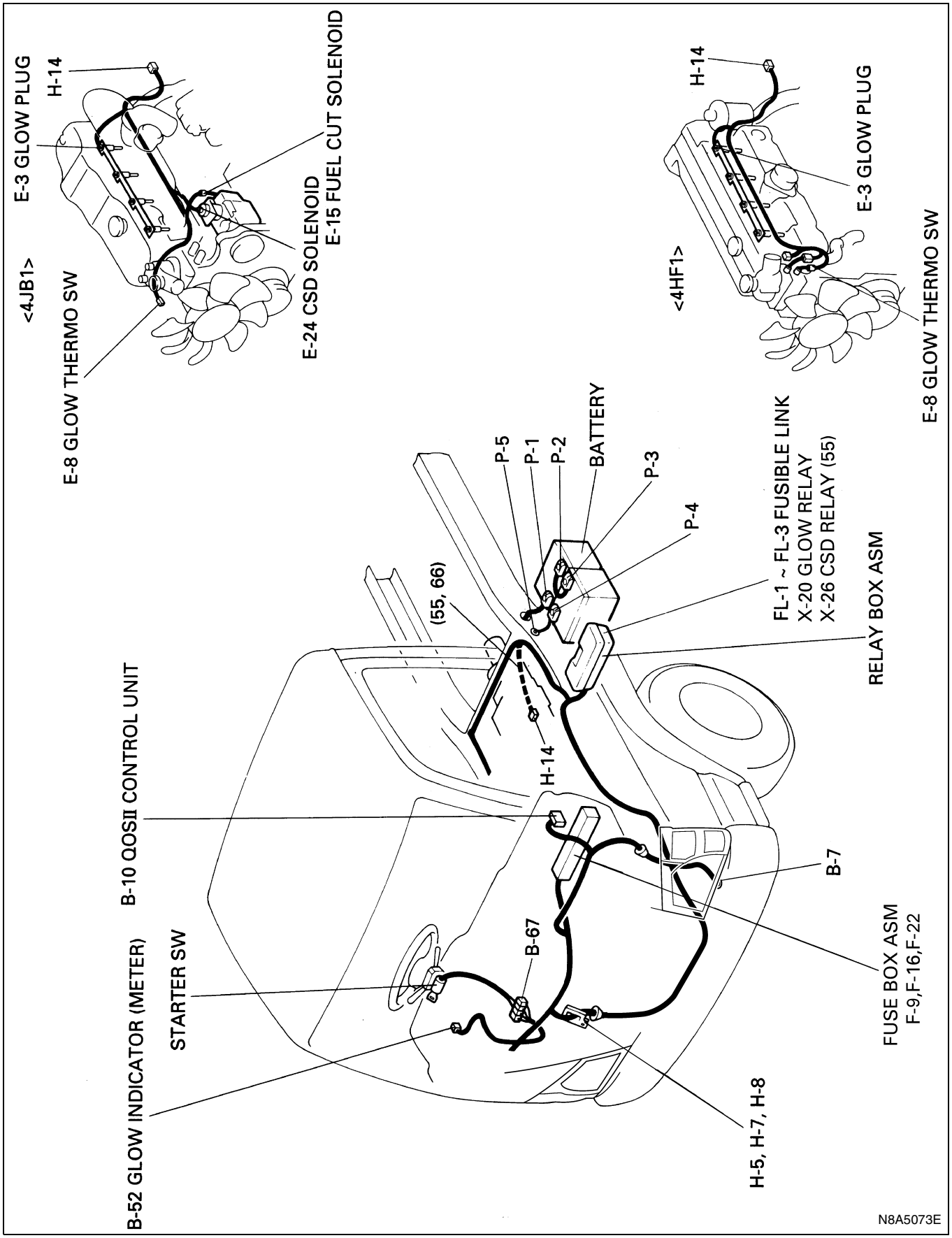
General Description

The circuit consists of starter switch, QOSII control unit, glow relay, thermo switch, glow plug, fuel cut solenoid, CSD relay, CSD solenoid and glow indicator light.
The QOS-II controller controls glow plug relay by the ON or OFF signal of QOS thermo switch.
Immediately when the starter switch turns “ON”, the glow plug relay indicator light turns on to start preheating.
The engine should be started after the indicator light is off. However, the glow plug relay keeps preheating for a fixed period even after the indicator light turns off. When the fixed time is over, QOS-II controller performs to switch the glow plug relay off to stop preheating.
For details, refer to “PREHEATING SYSTEM”.

System Circuit

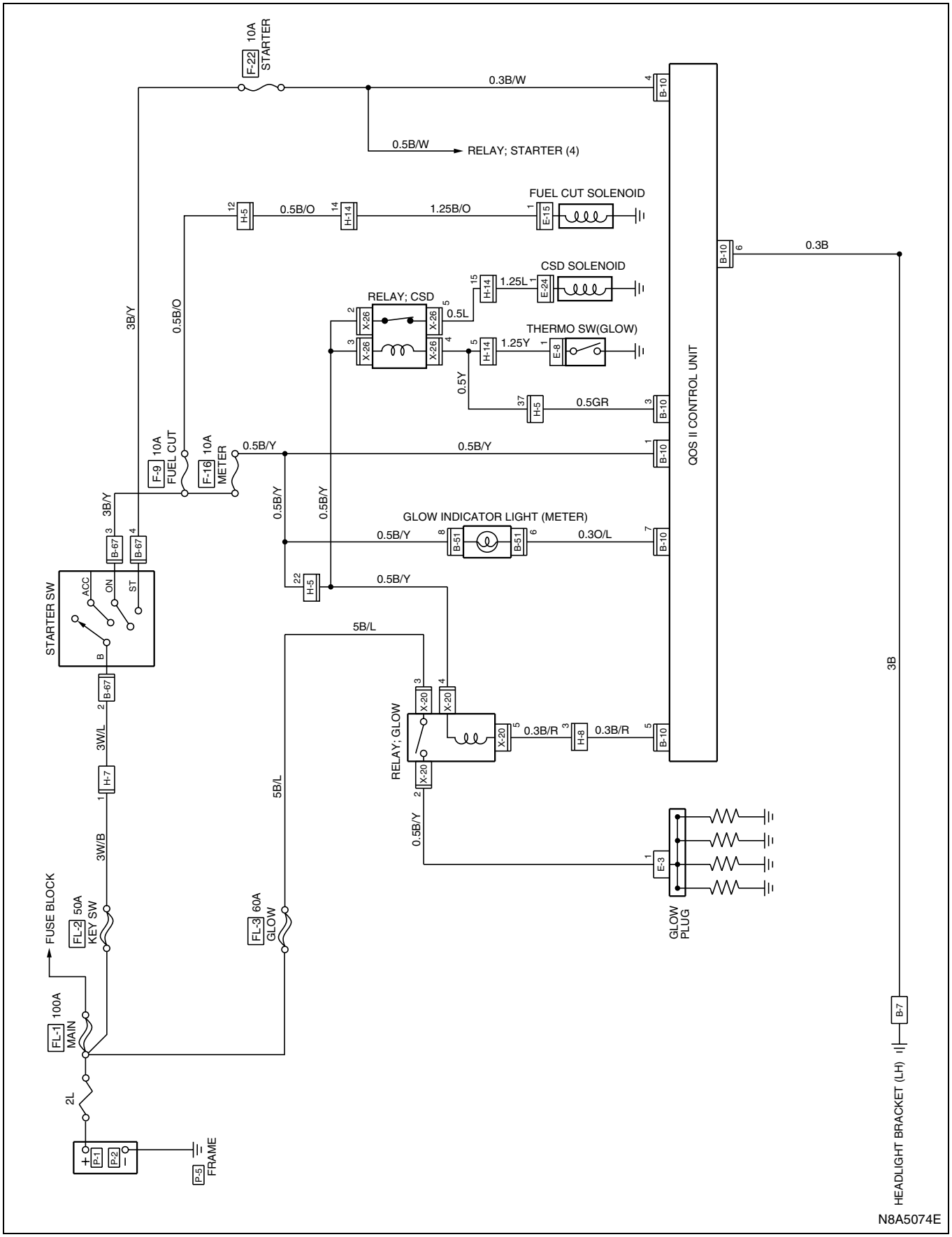


Parts Location

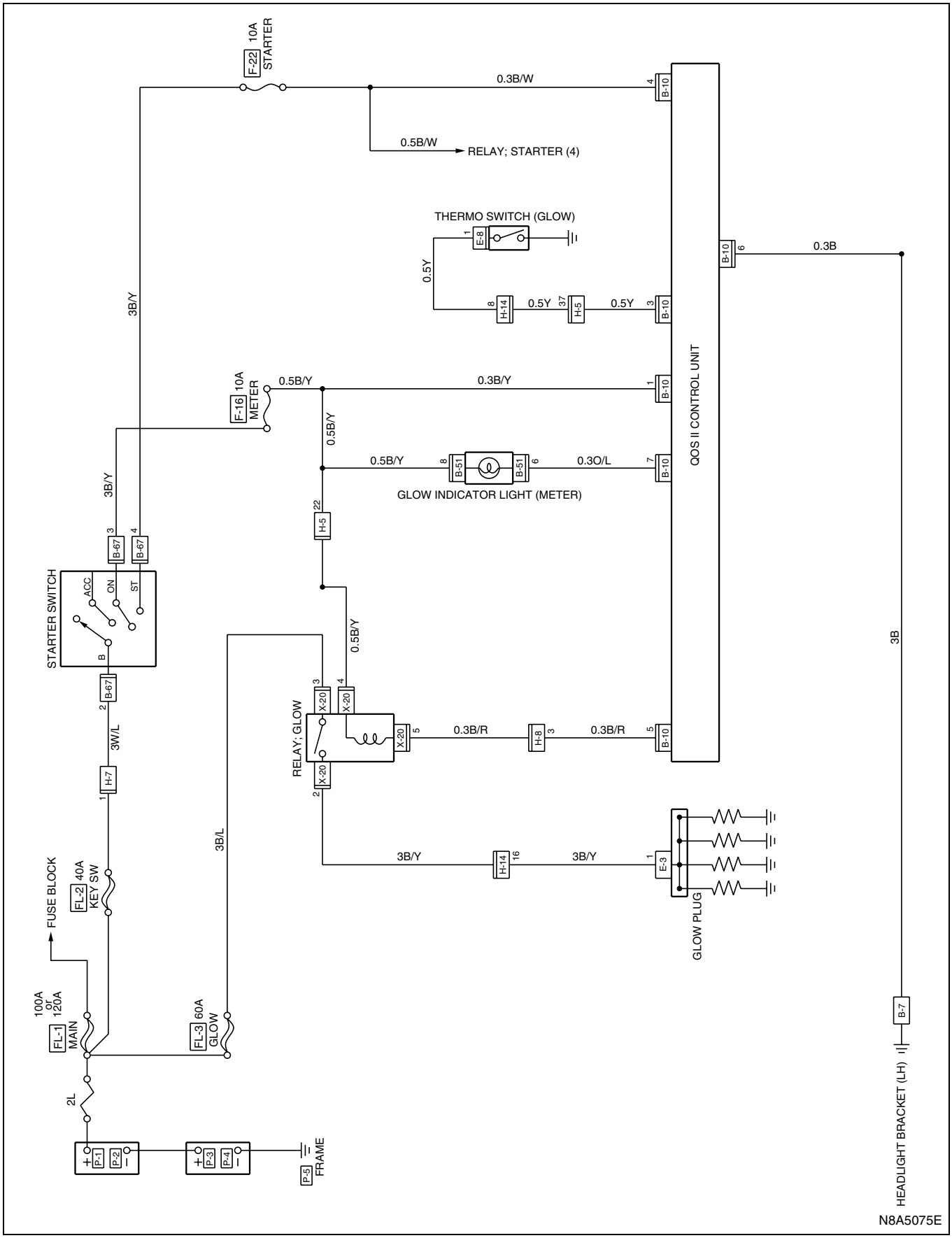


Circuit Diagram

NHR55, NKR55



NKR66, NPR66, NQR66



Connector List

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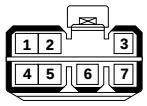
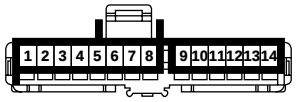
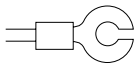
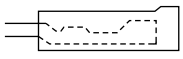
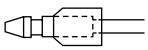
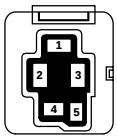
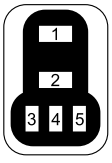
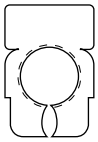
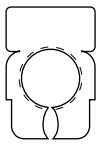
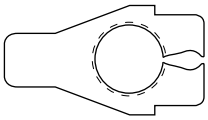
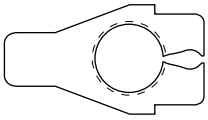
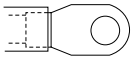
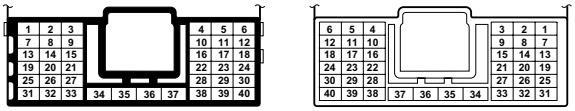
B-10	 007-001
B-51	 014-001
B-67	004-001
B-67	004-002
E-3	 000-009
E-8	 000-010
E-8	 000-011
E-24	001-002

No.	Connector Face
E-24	001-003
H-14	016-001
H-14	016-002
H-14 (4HF1)	016-003
H-14 (4HF1)	016-004
X-20	 005-003
X-26	 005-006
P-1	 000-004

No.	Connector Face
P-4	 000-004
P-2	 000-006
P-3	 000-006
P-5 (12 V)	000-007
P-5 (24 V)	 000-002

H-5



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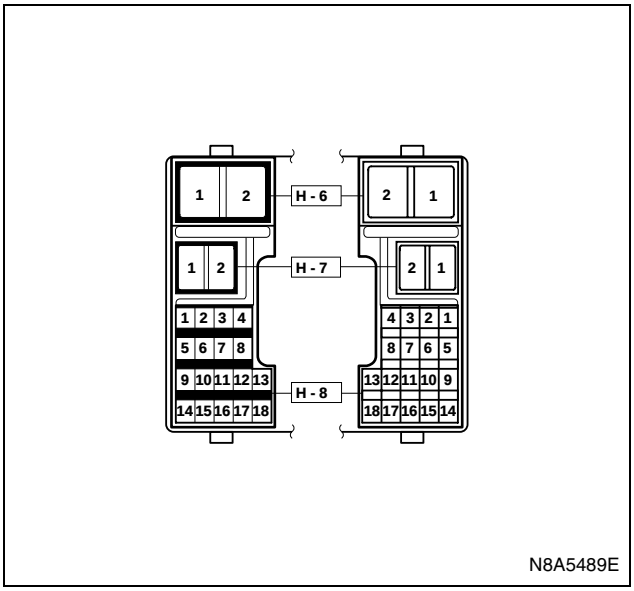
H-7, H-8



N8A5489E

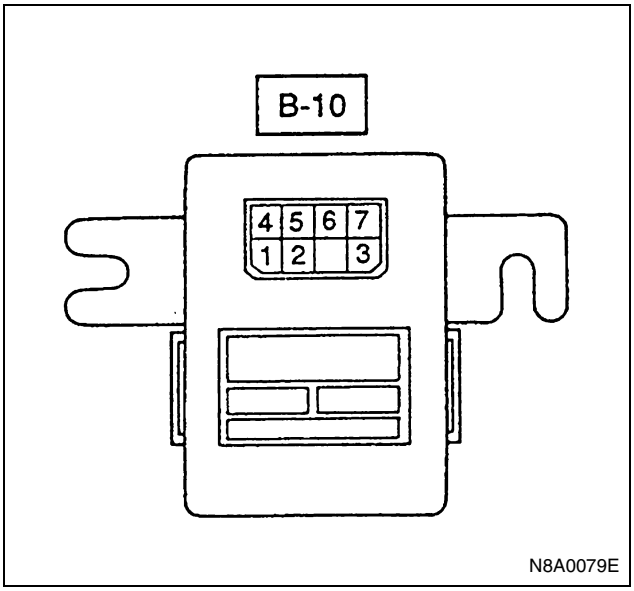
Starter Switch

Refer to “START AND CHARGING” in this section.

Glow Indicator Light Thermo Switch

Refer to “METER AND WARNING/INDICATOR LIGHT” in this section.

QOSII Control Unit



N8A0079E

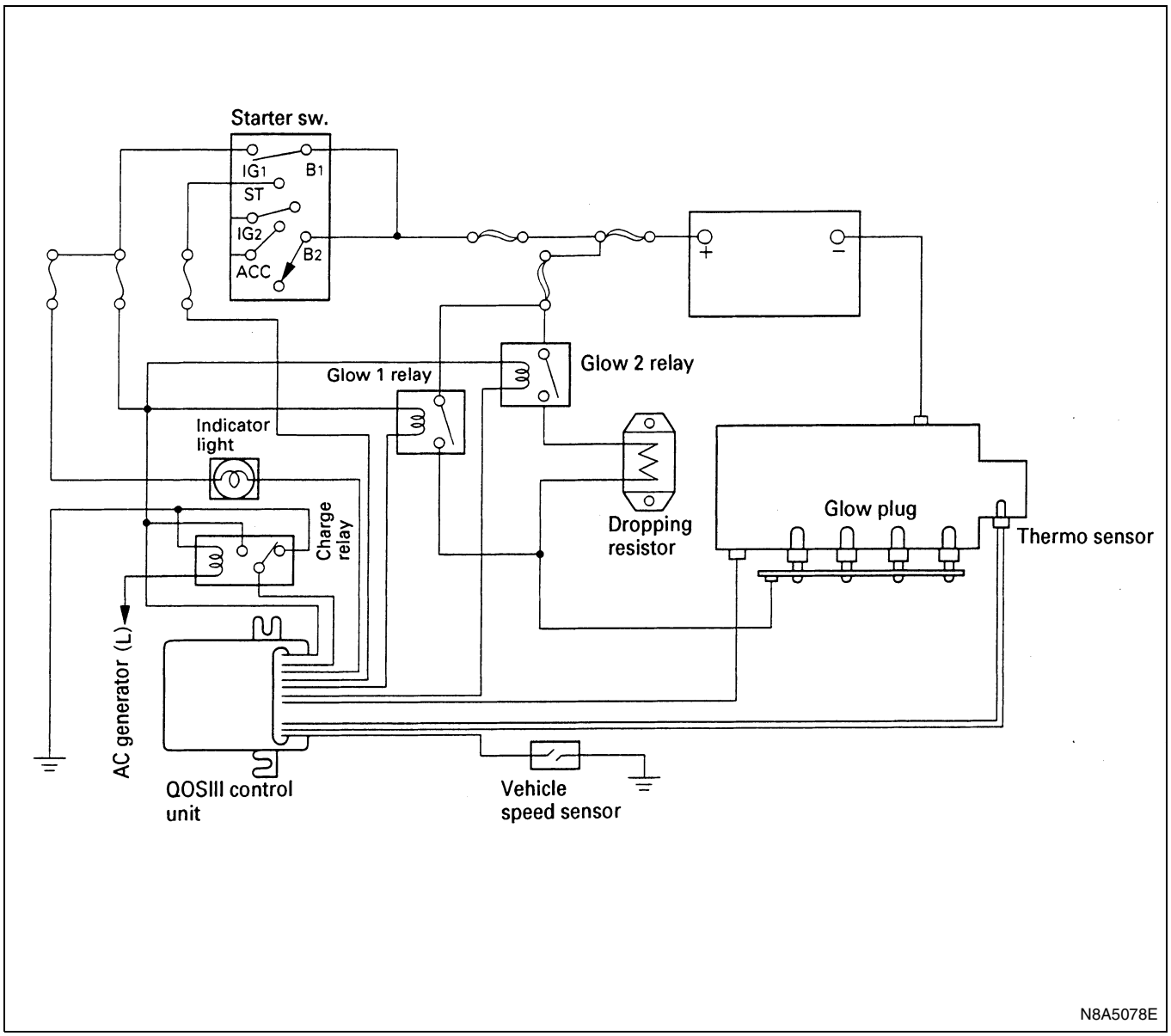
Terminal No.	Connected to
1	Starter switch (ON)
2	—
3	Thermo switch
4	Starter switch (ST)
5	Glow relay
6	Ground
7	Glow indicator (Meter)

QOS (Quick On Start) III System (4JG2 Engine Model)

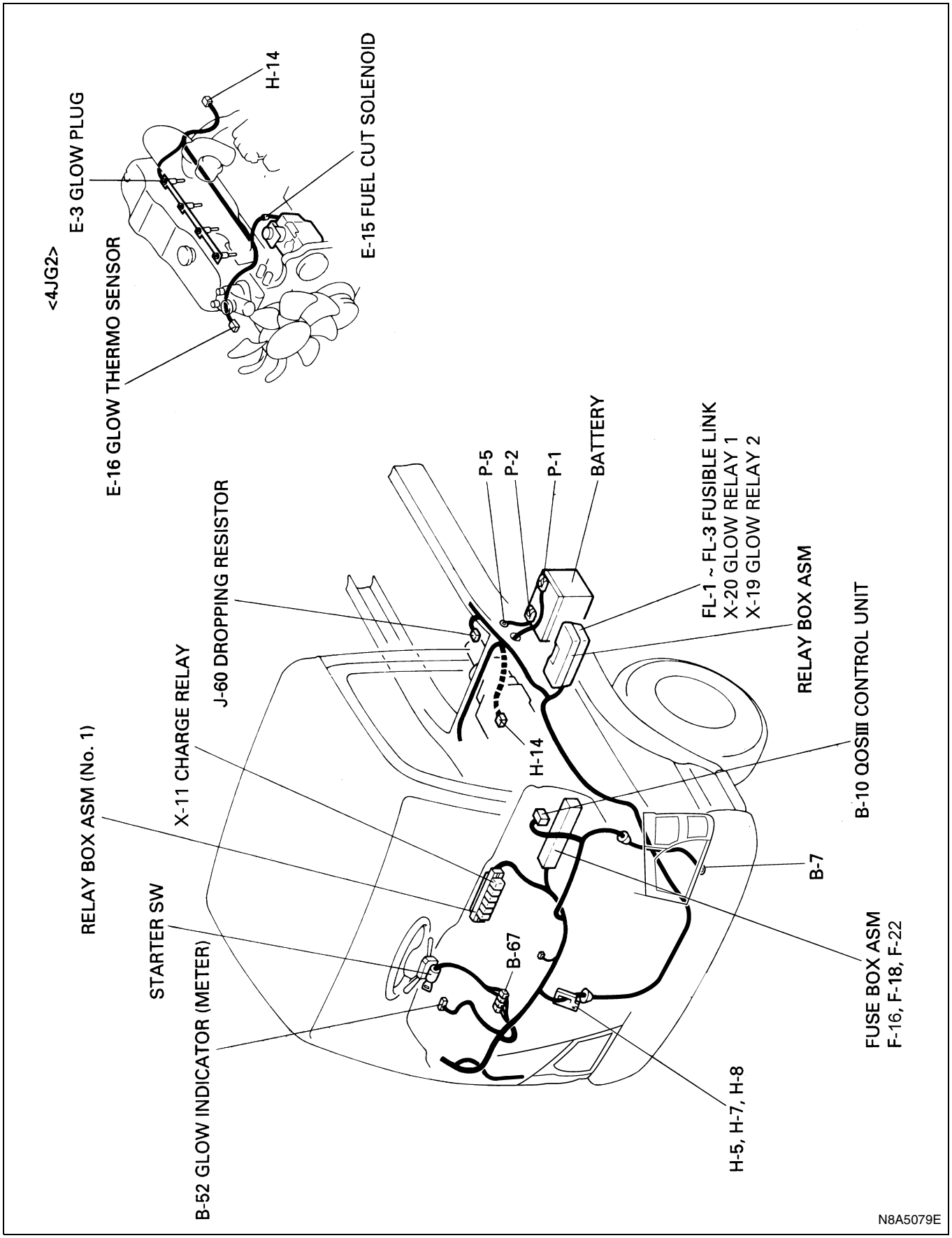
General Description

The system consists of starter switch, QOS III control unit, glow relay, charge relay, fuel cut solenoid, dropping resistor, thermo sensor, glow plug, engine speed sensor, accel switch and glow indicator light.
Perceiving the engine coolant temperature when the engine started, the thermo sensor varies the glowing time to always get the most suitable condition for engine starting.
The indicator timer starts to operate as soon as the starter switch turns to “ON” position, and the indicator light turns on and keeps lit until the glow plugs have been heated to the level ready for the engine starting, when the indicator light is off.
For details, refer to “PREHEATING SYSTEM”.

System Circuit

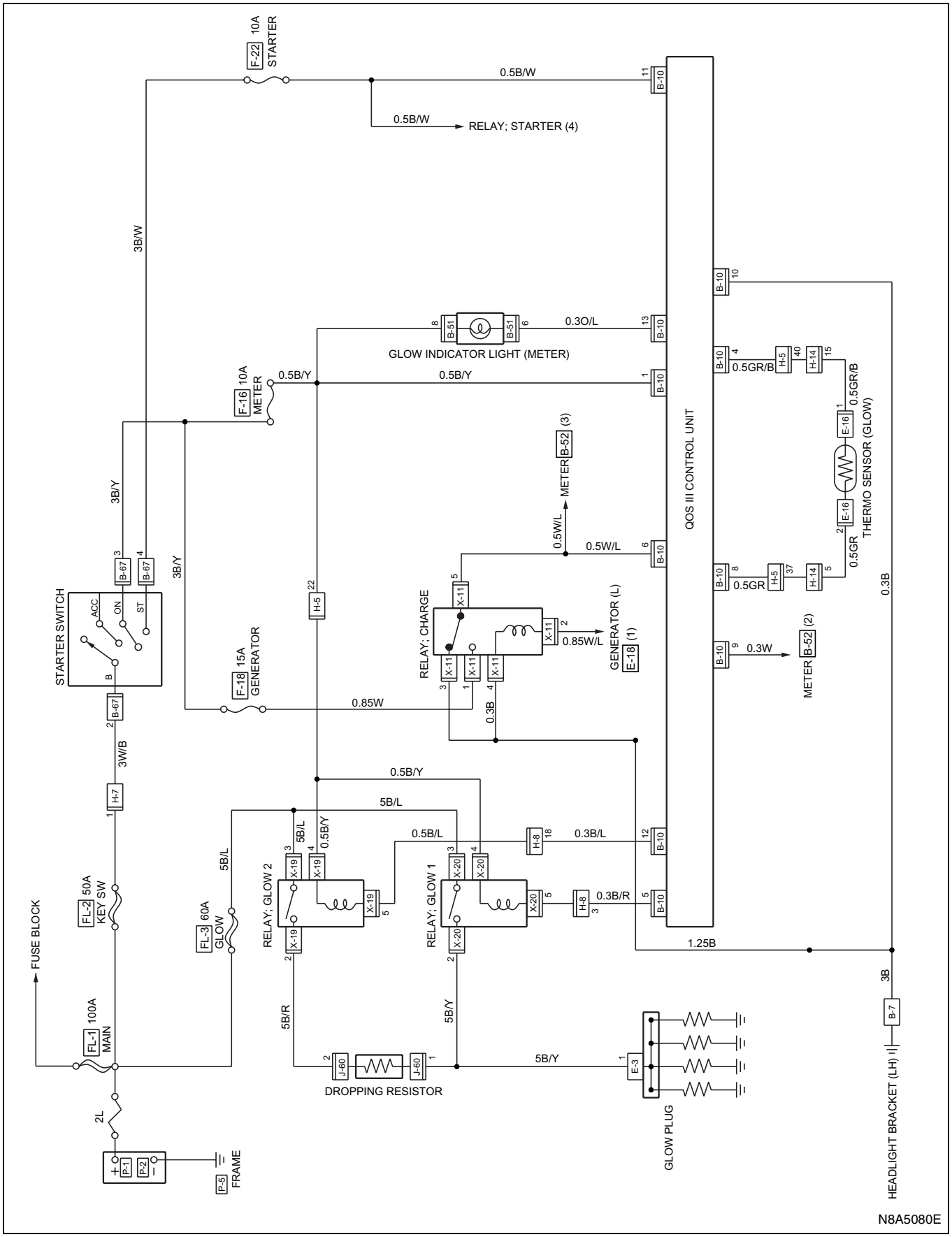


Parts Location



Circuit Diagram

NHR69



Connector List

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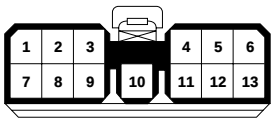
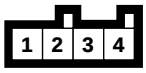
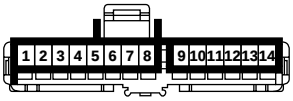
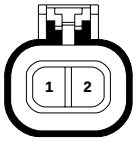
B-10	 013-001
B-17	 004-004
X-11	005-001
B-51	 014-001
B-67	004-001
B-67	004-002
B-75	005-002
E-2	 002-005

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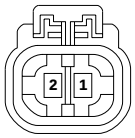
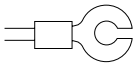
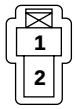
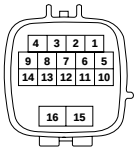
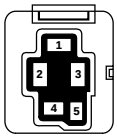
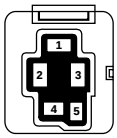
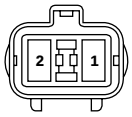
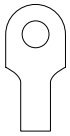
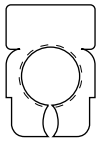
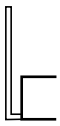
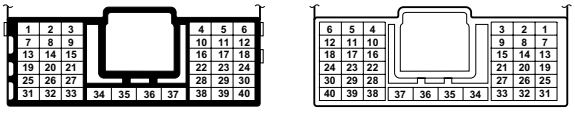
E-2	 002-006
E-3	 000-009
E-16	002-009
E-16	 002-010
H-14	016-003
H-14	 016-004
X-19	 005-003
X-20	 005-003

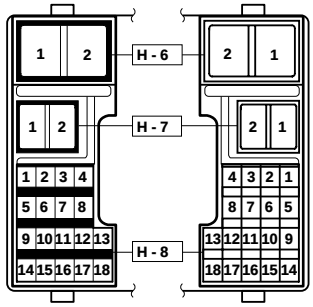
No.	Connector Face
J-60	002-007
J-60	 002-008
P-1	 000-003
P-2	 000-004
P-5	 000-007

H-5



N8A5488E

H-7, H-8



N8A5489E

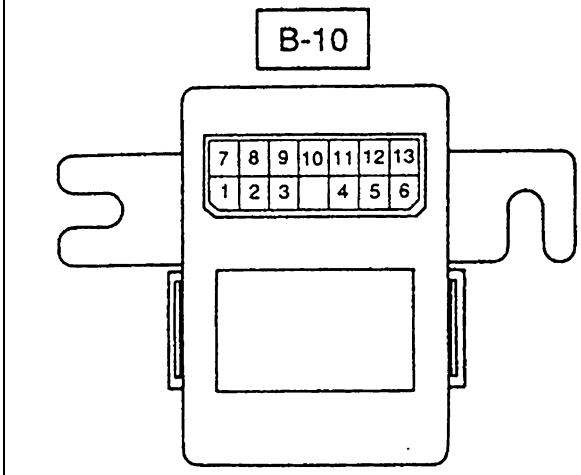
Starter Switch

Refer to “START AND CHARGING” in this section.

Glow Indicator Light

Refer to “METER AND WARNING/INDICATOR LIGHT” in this section.

QOSIII Control Unit



N8A5082E

Terminal No.	Connected to
1	Starter switch (ON)
2	—
3	—
4	Thermo sensor (-)
5	Glow 1 relay
6	Charge relay
7	—

Terminal No.	Connected to
8	Thermo sensor (+)
9	Meter
10	Ground
11	Starter switch (ST)
12	Glow 2 relay
13	Glow indicator (Meter)

Exhaust Brake System

General Description

This circuit consists of starter switch, exhaust brake switch (combination switch), accelerator switch, clutch switch, vacuum switching valve, neutral switch and relay.

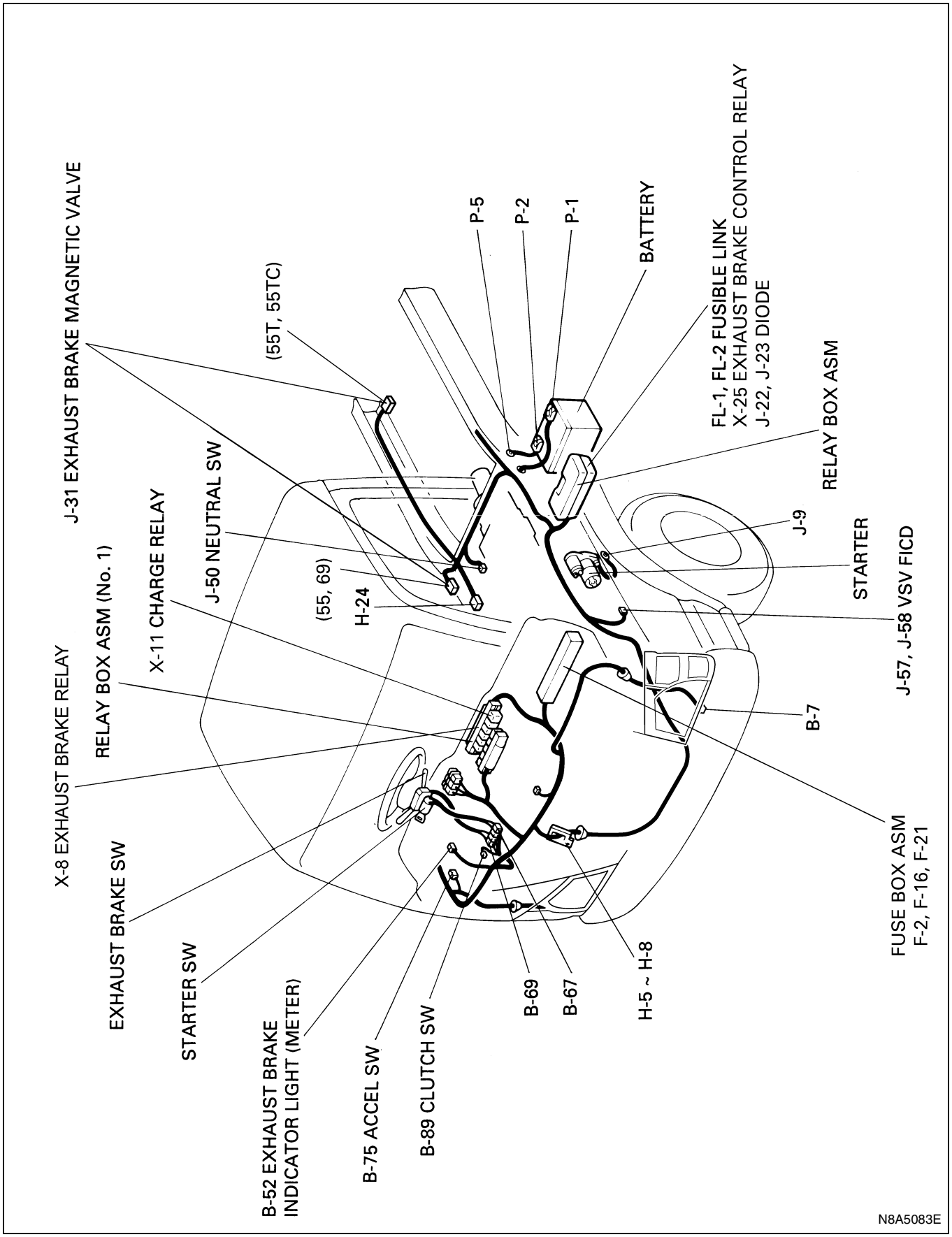
Exhaust brake is a system to increase exhaust pressure by means of squeezing exhaust gas from engine and exert engine brake.

Turn the exhaust brake SW on, and the exhaust brake valve starts to work by the function of the magnetic valve to enable the exhaust bake to operate, when the exhaust brake indicator light will be on.

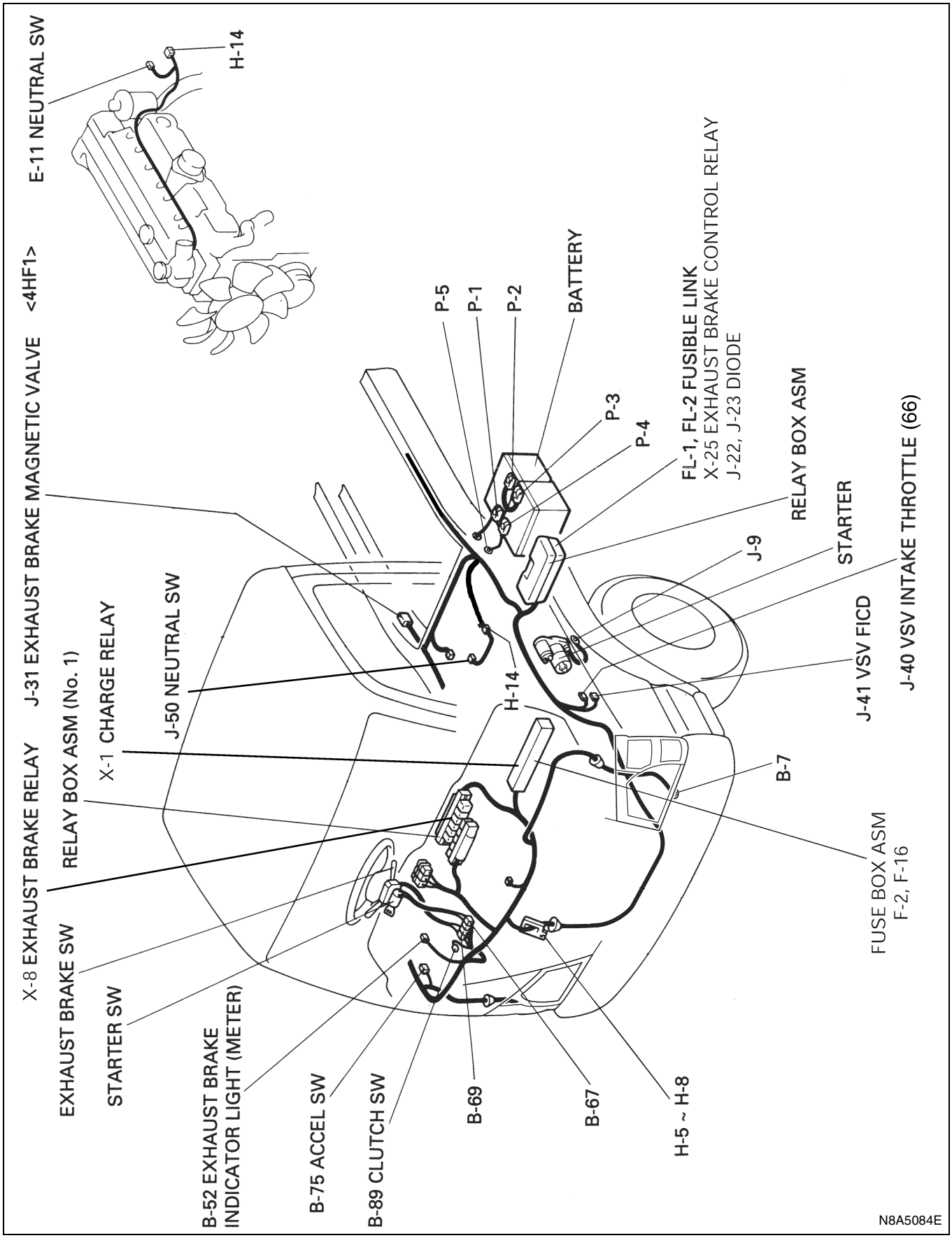
When either the accelerator pedal or the clutch pedal is depressed while driving, the switch of the depressed pedal will turn off, subsequently the exhaust braking will stop working.

Parts Location

NHR55, NKR55, NHR69

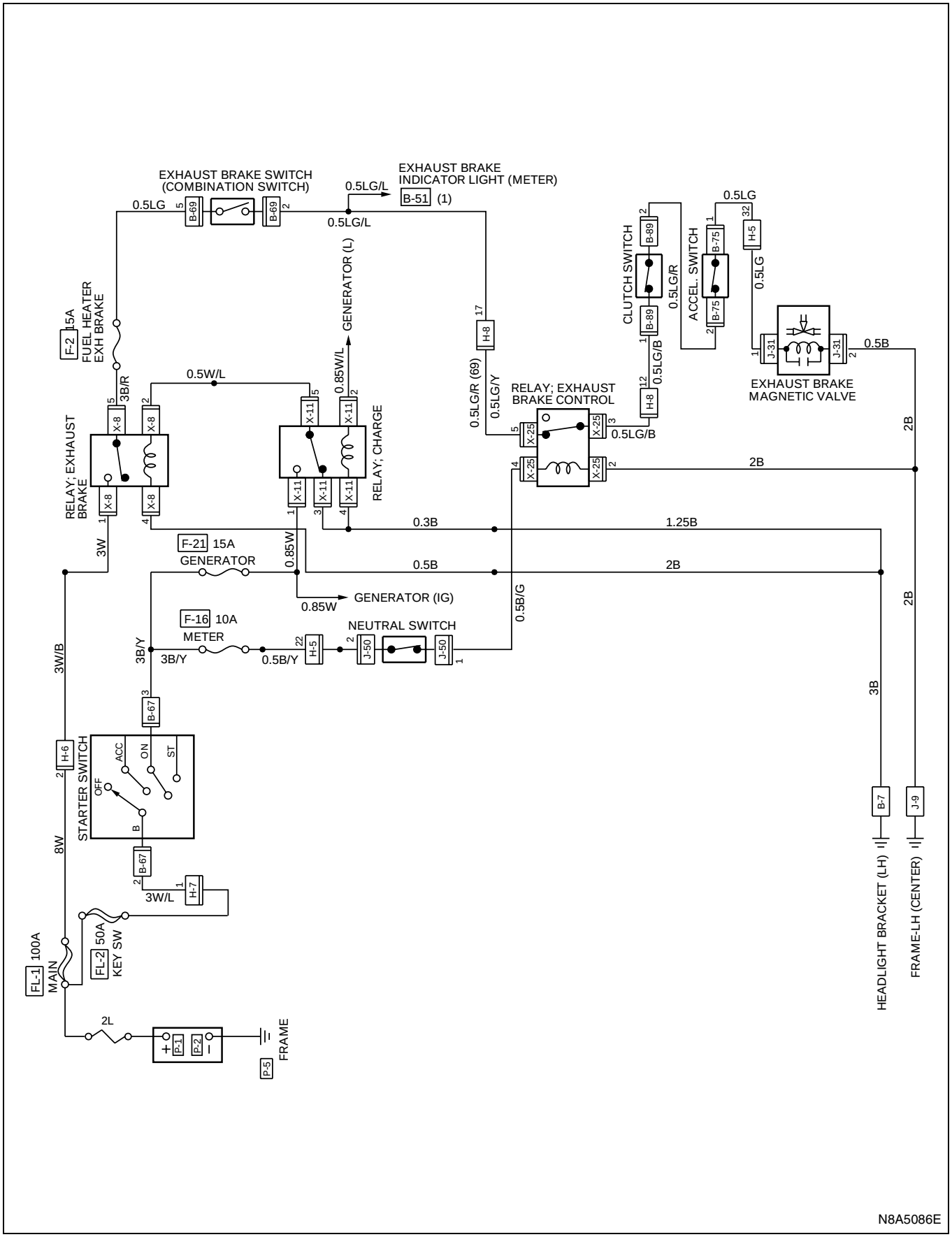


NKR66, NPR66, NQR66, NPR71

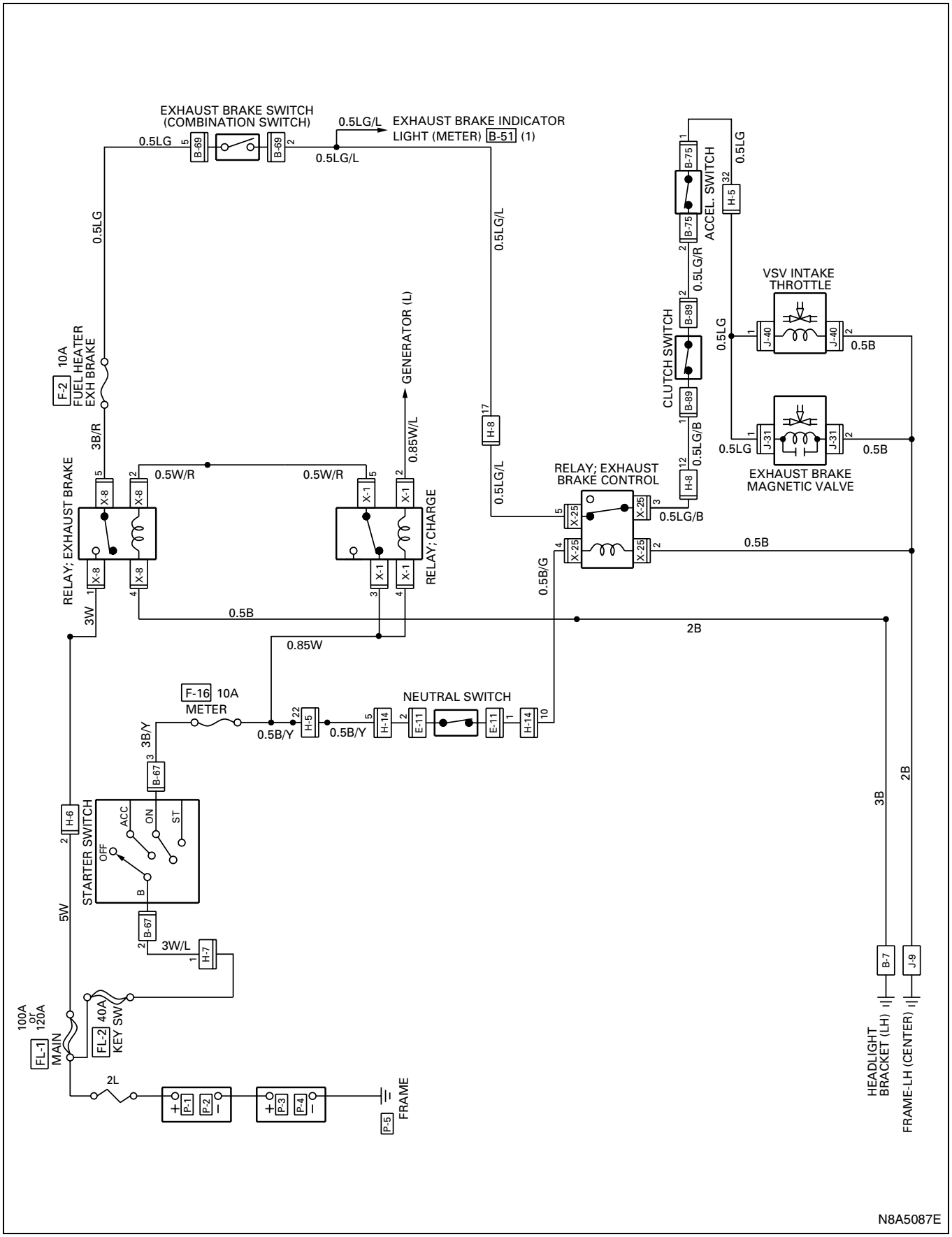


Circuit Diagram

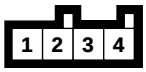
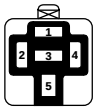
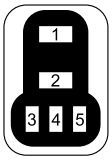
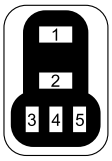
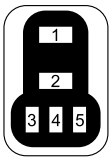
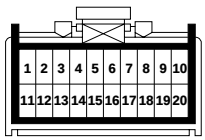
NHR55, NKR55, NHR69

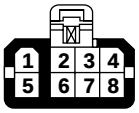
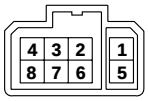
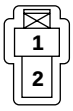
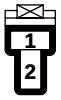
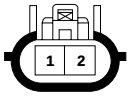
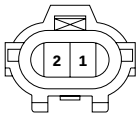
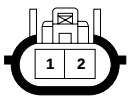


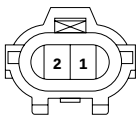
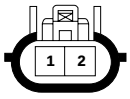
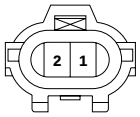
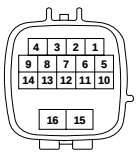
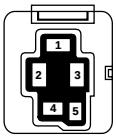
NKR66, NPR66, NQR66, NPR71

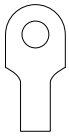
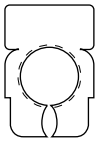
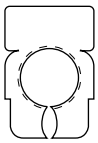
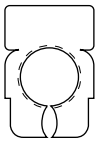
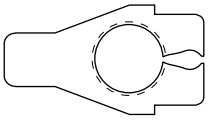
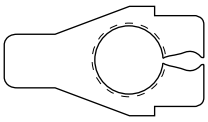
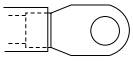


Connector List

No.	Connector Face
B-17	 004-004
X-11	 005-001
X-1	 005-006
X-8	 005-006
X-25	 005-006
B-47	 020-001
B-67	004-001
B-67	004-002

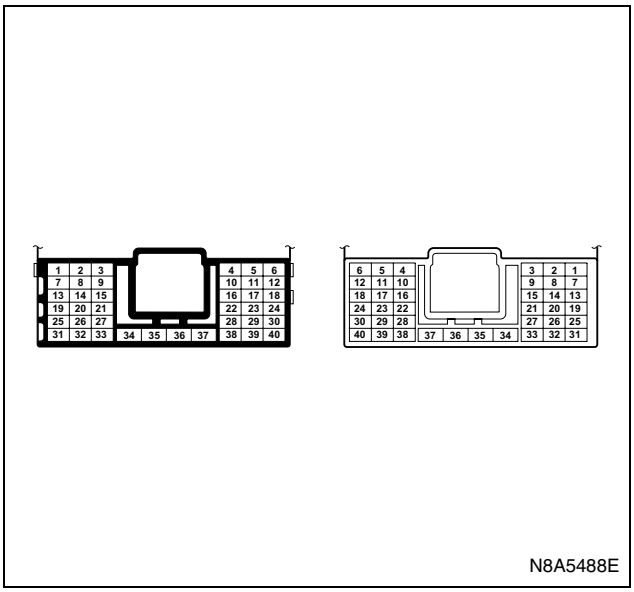
No.	Connector Face
B-69	 008-001
B-69	 008-002
B-75	002-009
B-75	 002-010
B-89	 002-009
E-11	 002-001
E-11	 002-002
J-50	 002-001

No.	Connector Face
J-50	 002-002
J-70	 002-001
J-70	 002-002
H-14	016-003
H-14	 016-004
X-21	 005-003
J-31	002-011
J-31	002-012

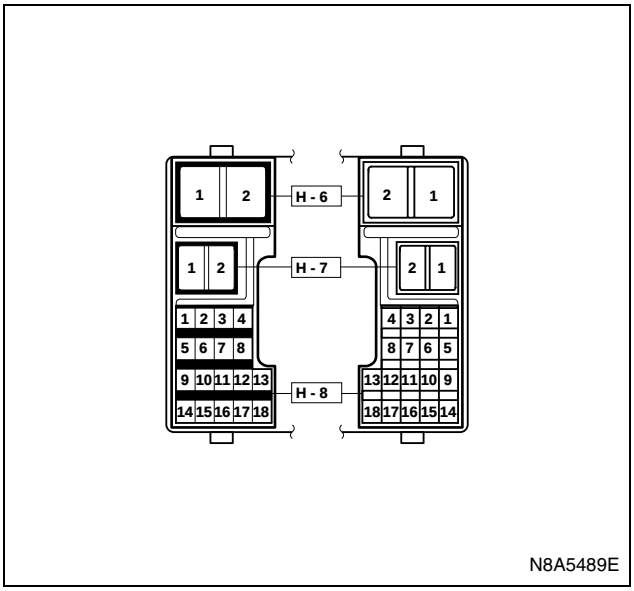
No.	Connector Face
J-40	002-014
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
P-5 (24 V)	 000-002

No.	Connector Face
P-5 (12 V)	000-007

H-5



H-6, H-7, H-8



Neutral Switch

Refer to “START AND CHARGING” in this section.

Starter Relay

Refer to “START AND CHARGING” in this section.

Charge Relay

Refer to “START AND CHARGING” in this section.

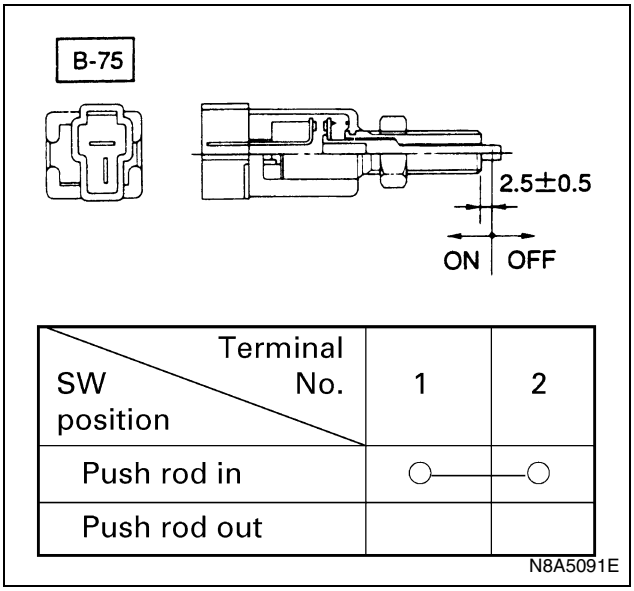
Starter Switch

Refer to “START AND CHARGING” in this section.

Accel Switch

Inspection

1. Check the continuity between the switch connector terminals.
2. Check to see if switch push rod operates smoothly. Repair or replace the accel switch when result of inspection is found abnormal.



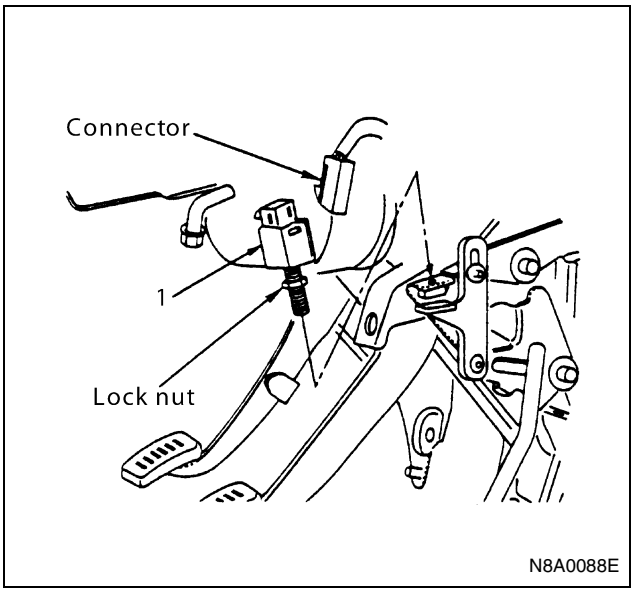
SW position \ Terminal No.	1	2
Push rod in	○	○
Push rod out		

Removal

Preparation:

Disconnect the battery ground cable.

1. Accel Switch
   1) Disconnect the connector.
   2) Loosen the lock nut of the switch.
   3) Remove the switch by turning it.



Installation

To install, follow the removal steps in the reverse order, noting the following points.

1. Check to see if the accel pedal has been returned by the return spring to the specified position.
2. Turn the accel switch clockwise until the tip of the threaded portion of the switch contacts the pedal arm.
3. Tighten the lock nut to the specified torque.

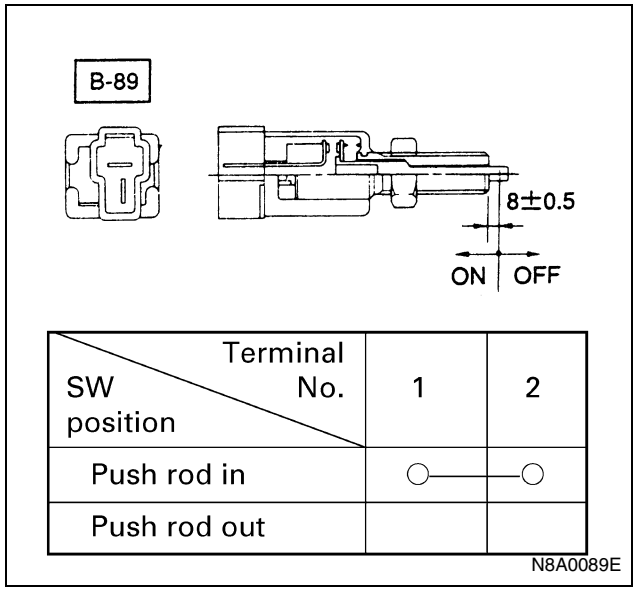
Tighten:

Lock nut to 13 N·m (130 kg·cm / 115lb·in)

Clutch Switch

Inspection

1. Check the continuity between the switch connector terminals.
2. Check to see if switch push rod operates smoothly. Repair or replace the switch when result of inspection is found abnormal.



SW position \ Terminal No.	1	2
Push rod in	○	○
Push rod out		

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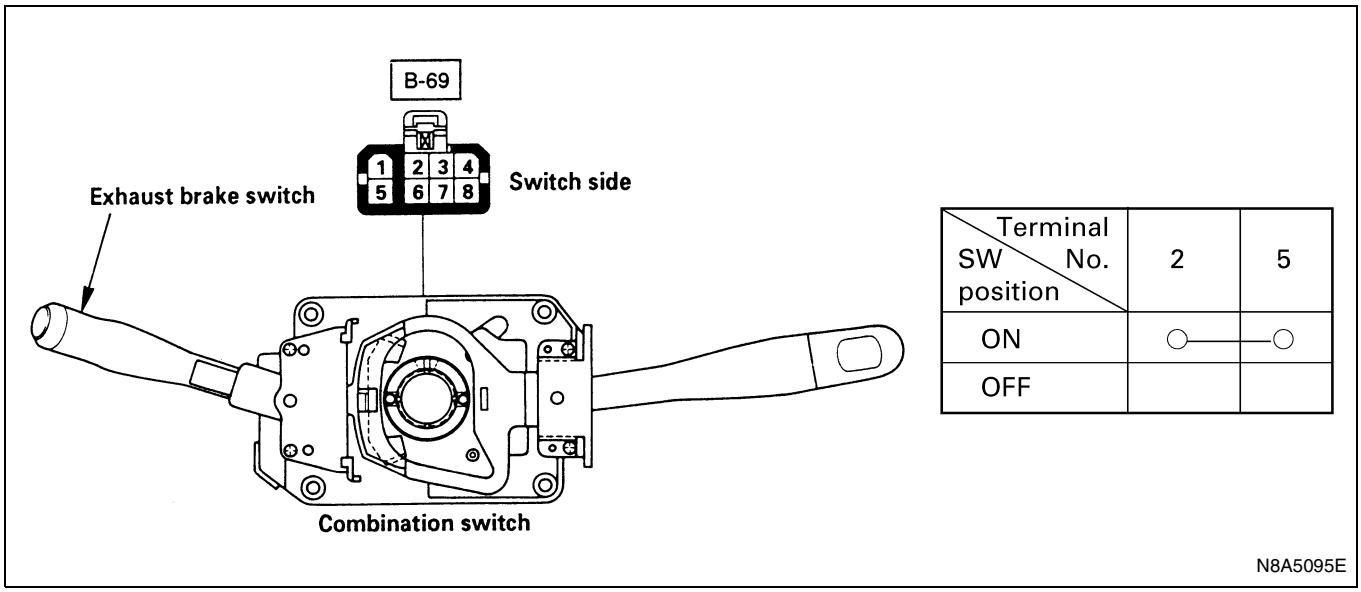
Removal and Installation

Refer to “Accel Switch” in this section.

Exhaust Brake Switch

Inspection

Check the continuity between the terminals of the exhaust brake switch.
Repair or replace the switch when the result of inspection is found abnormal.



SW position \ Terminal No.	2	5
ON	○——	——○
OFF		

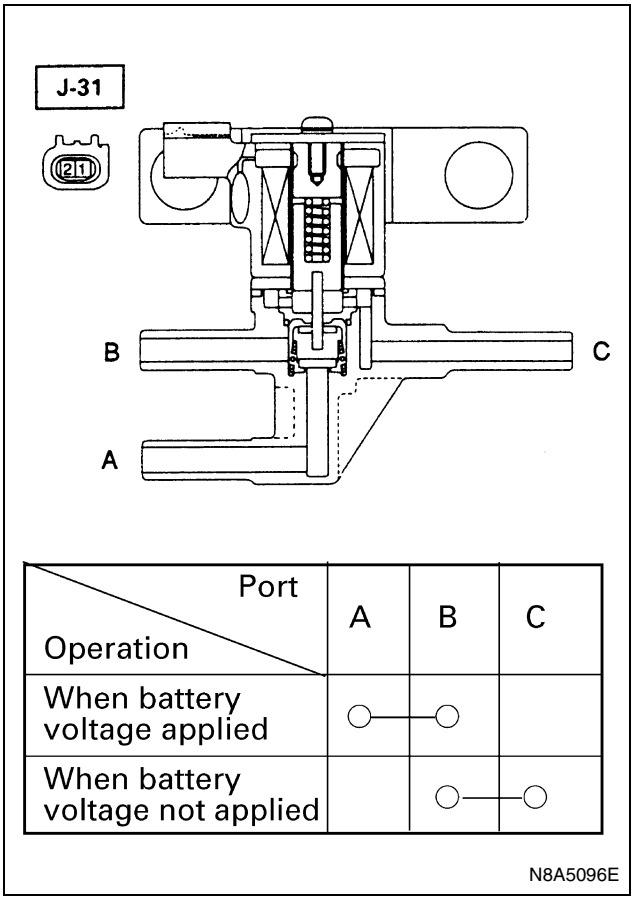
Removal and Installation

Refer to “HEADLIGHT, FOG LIGHT AND CORNERING LIGHT” in this section.

Exhaust Brake Magnetic Valve (4JG2 Engine)

Inspection

Connect the magnetic valve connector terminal No.1 to the battery (+) terminal and terminal No. 2 to the (−) terminal and then check the continuity among each port.
Repair or replace the magnetic valve when the result of inspection is found abnormal.

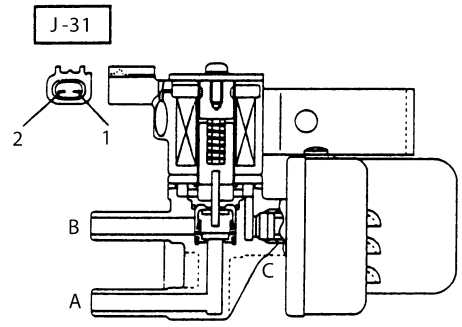


Operation \ Port	A	B	C
When battery voltage applied	○——	——○	
When battery voltage not applied		○——	——○

Exhaust Brake Magnetic Valve (4JG2, 4H Series Engine)

Inspection

Connect the magnetic valve connector terminal No. 1 to the battery (+) terminal and terminal No. 2 to the (–) terminal and then check the continuity among each port.



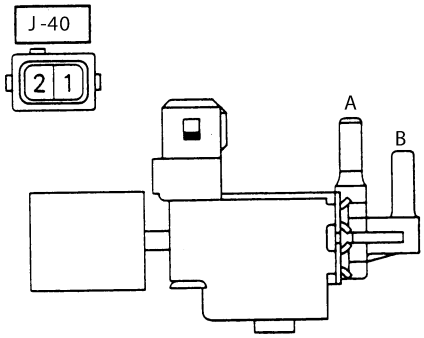
Operation \ Port	A	B	C
When battery voltage applied	○——	——○	
When battery voltage not applied		○——	——○

N8A0094E

Vacuum Switching Valve: Intake Throttle (4H Series Engine)

Inspection

Connect the magnetic valve connector terminal No. 1 to the battery (+) terminal and terminal No. 2 to the (–) terminal and then check the continuity among each port. Repair or replace the vacuum switching valve when the result of inspection is found abnormal.



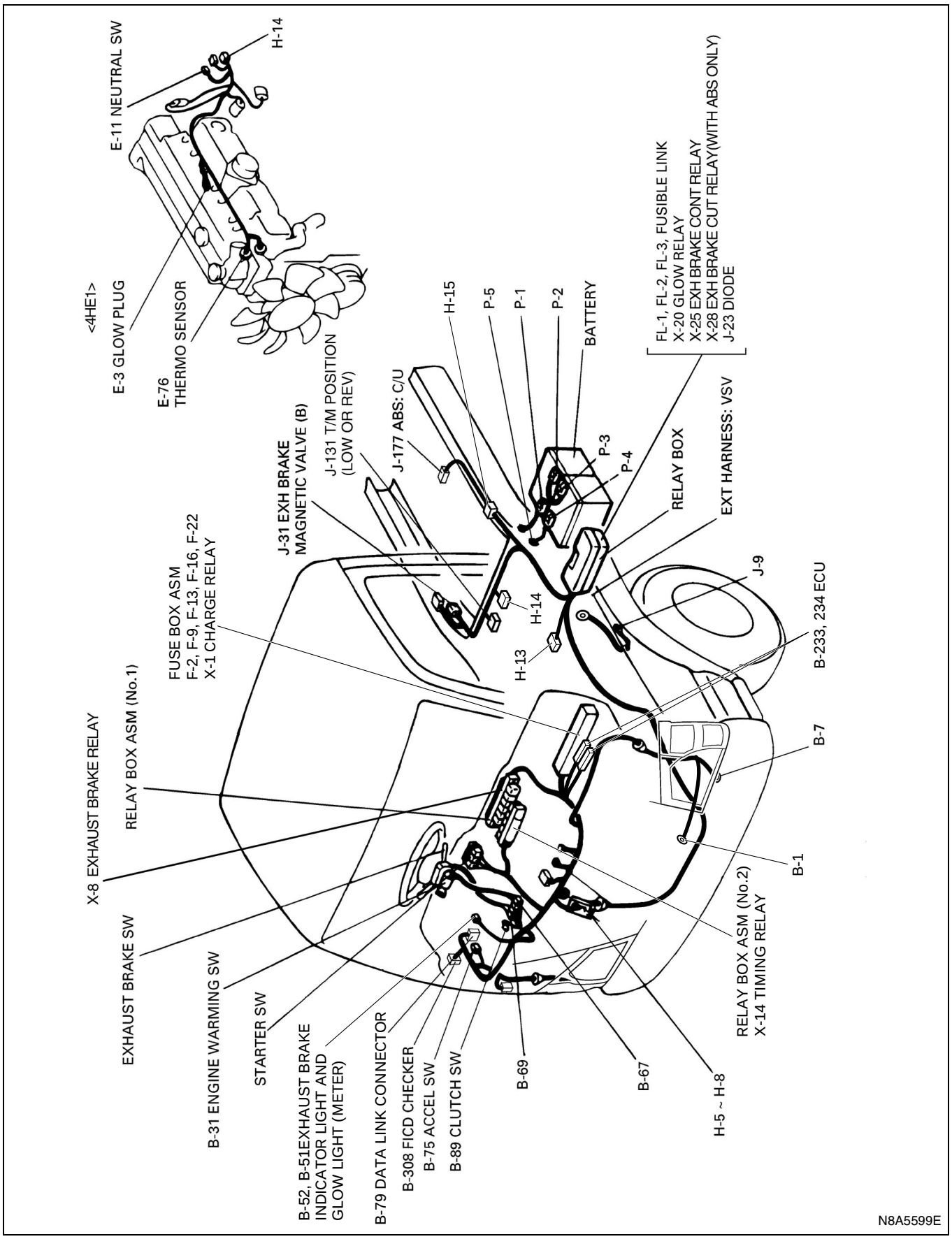
Operation \ Port	A	B
When battery voltage applied	○——	——○
When battery voltage not applied		

N8A0096E

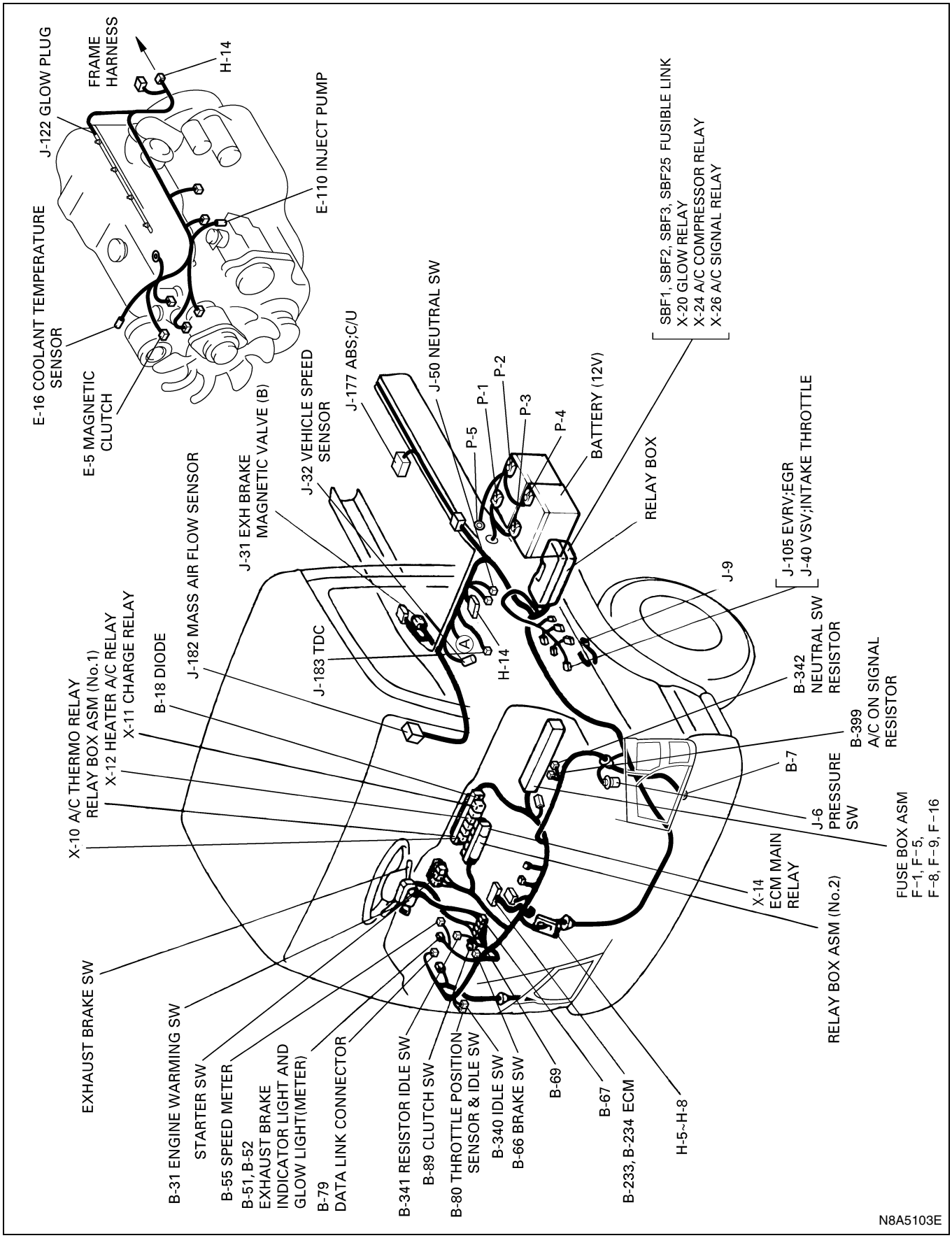
Exhaust Brake System and Engine Control

Parts Location

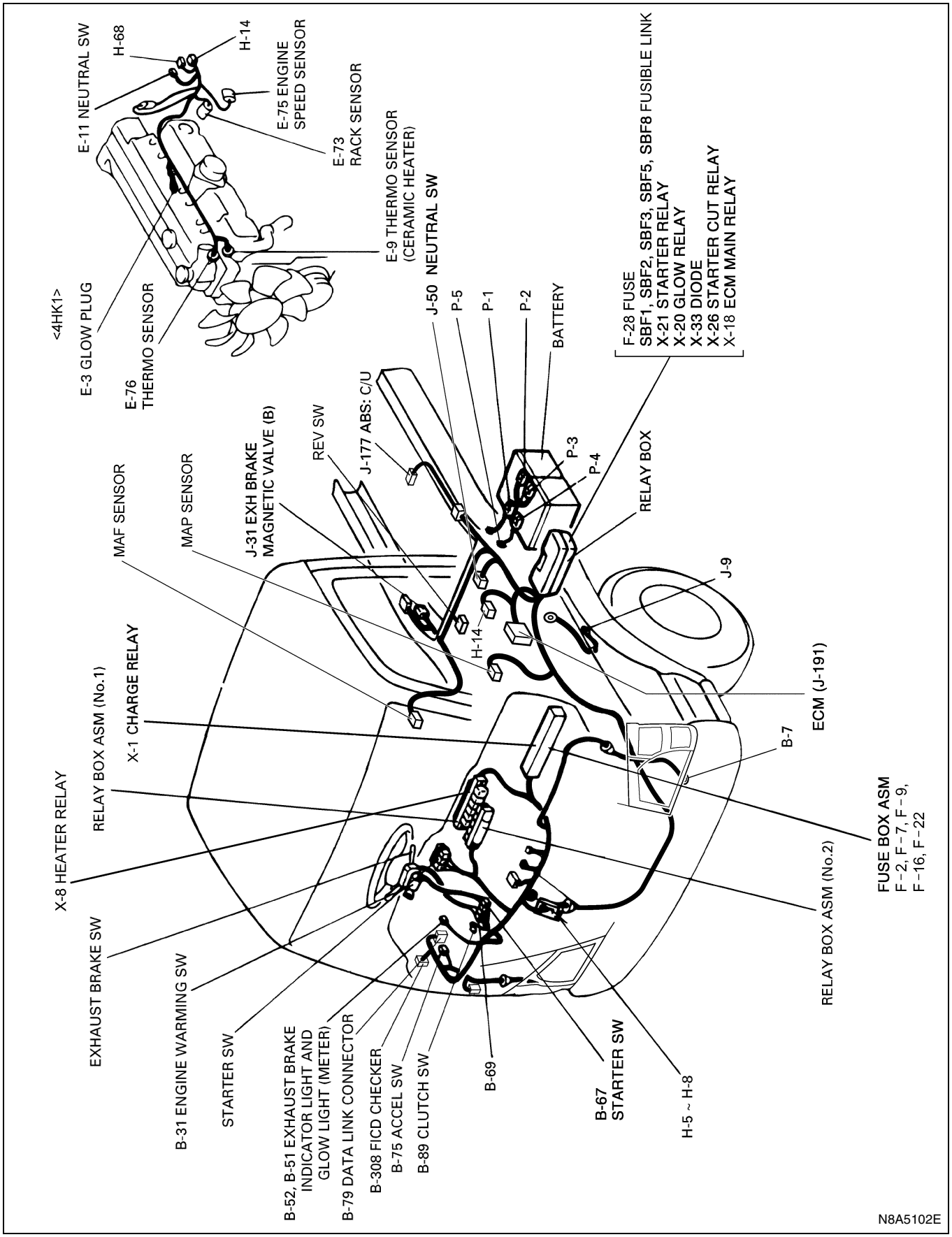
For 4HE1-TC Engine



For 4JH1 Engine

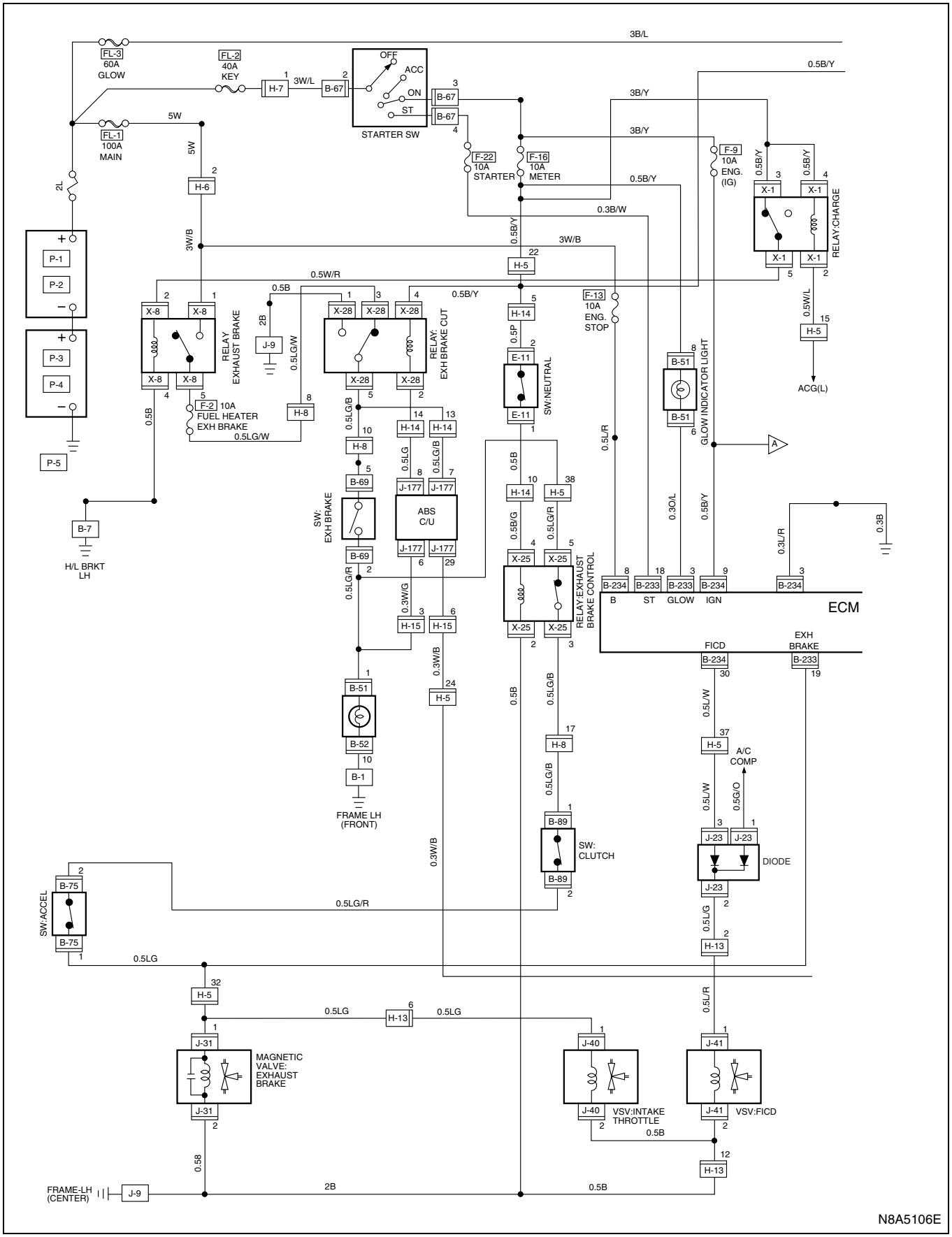


For 4HK1-TC Engine

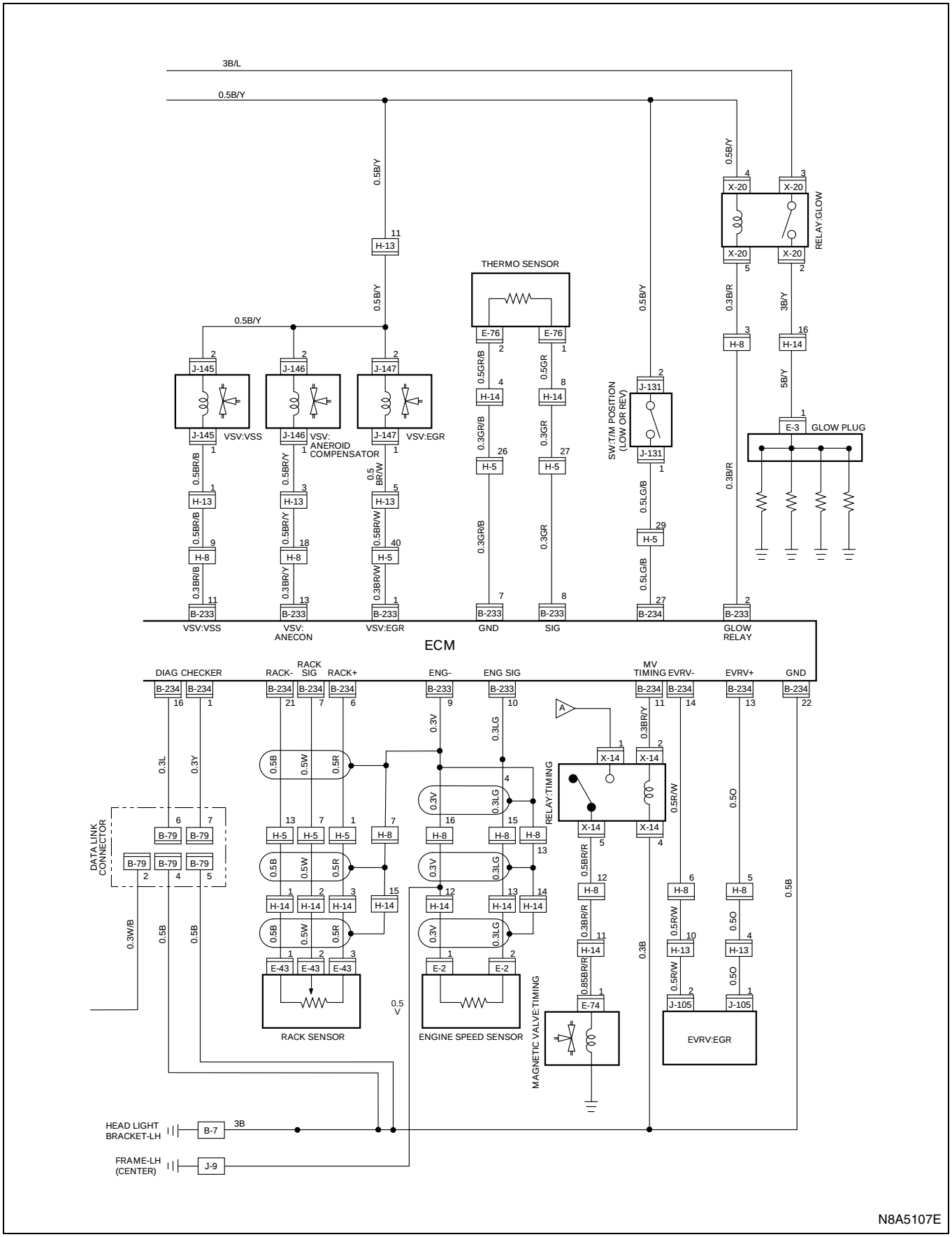


Circuit Diagram

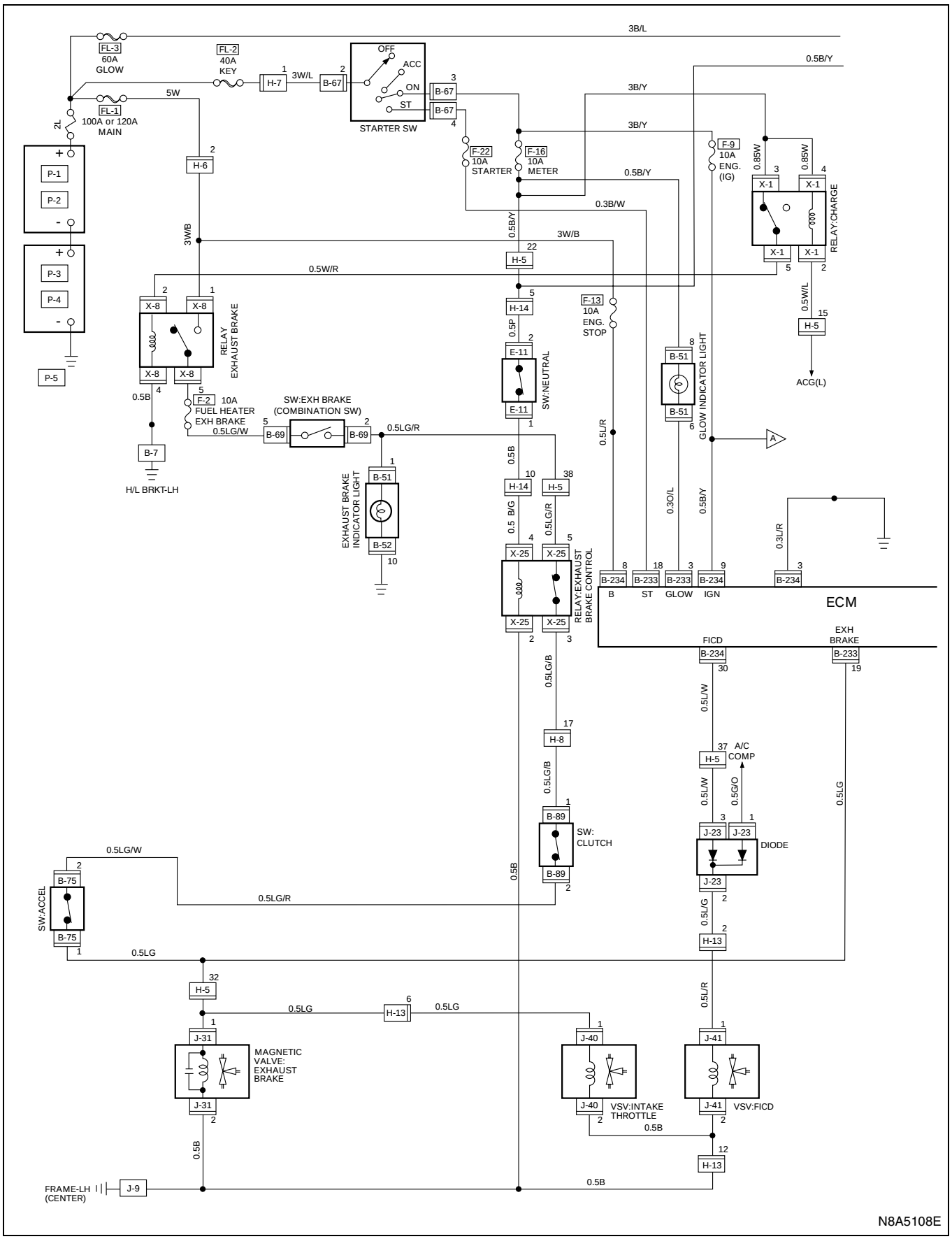
4HE1-TC Engine for Hong Kong (With ABS) (1)



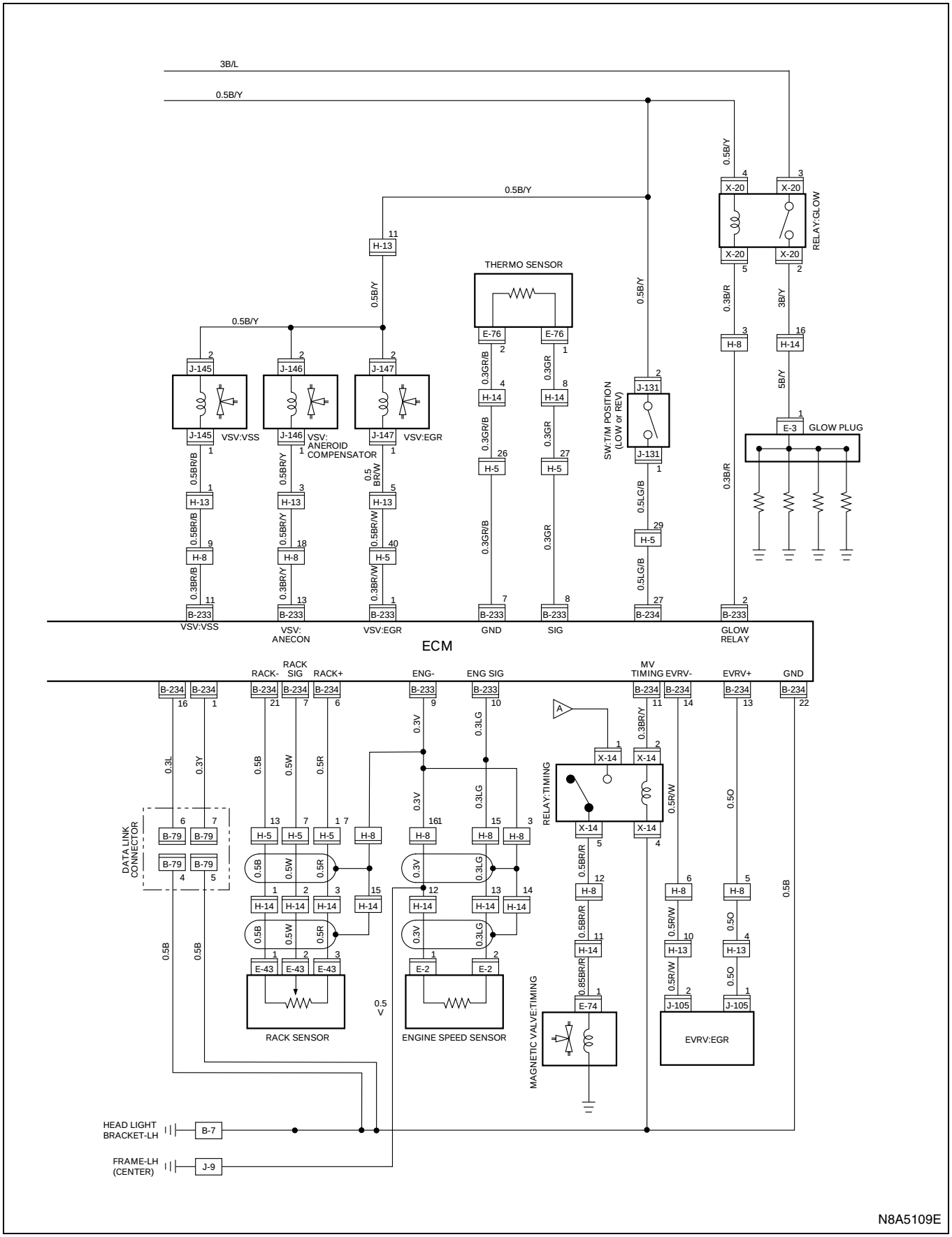
4HE1-TC Engine for Hong Kong (With ABS) (2)



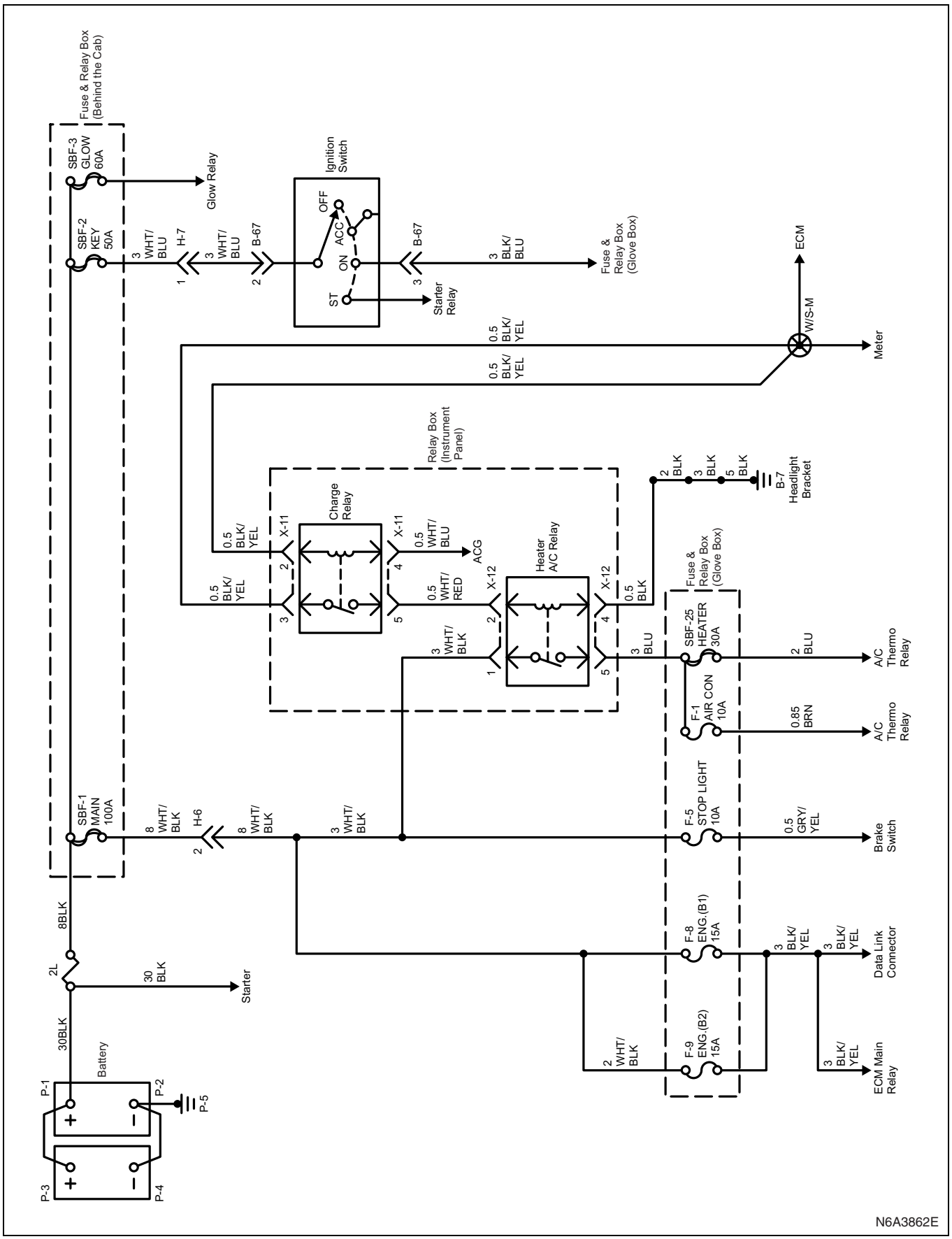
4HE1-TC Engine for Hong Kong (Without ABS) (1)



4HE1-TC Engine for Hong Kong (Without ABS) (2)



4JH1 Engine (1)



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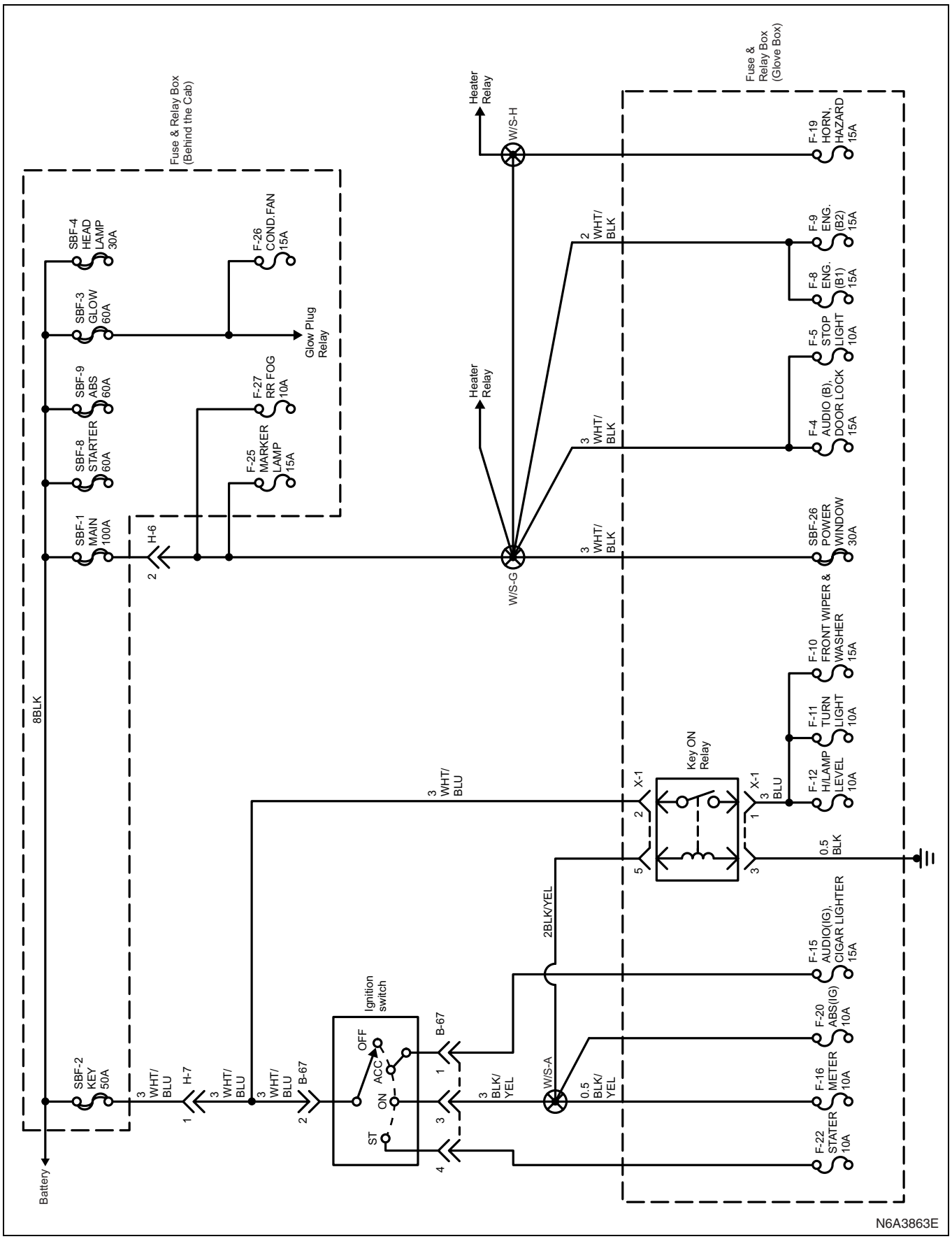
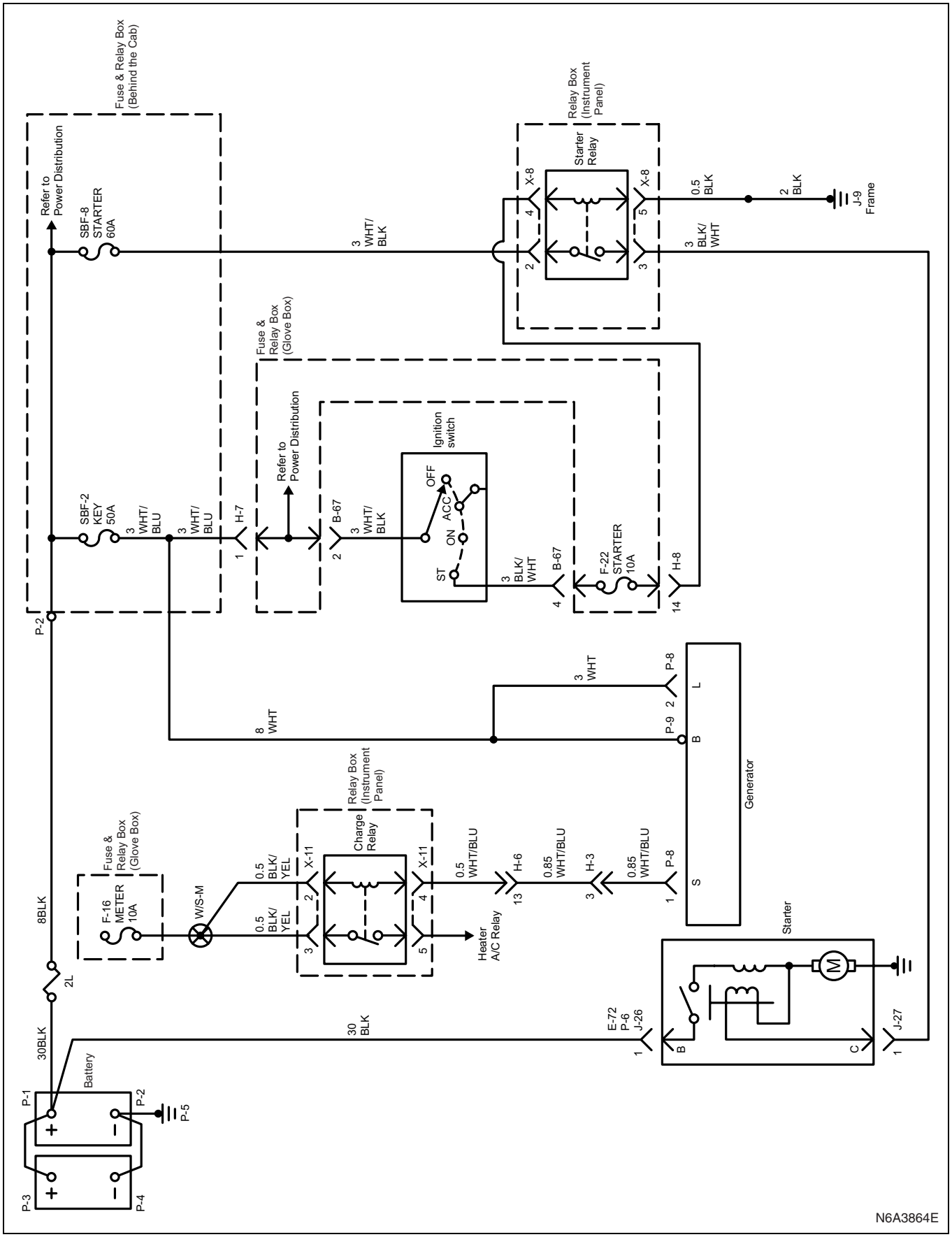
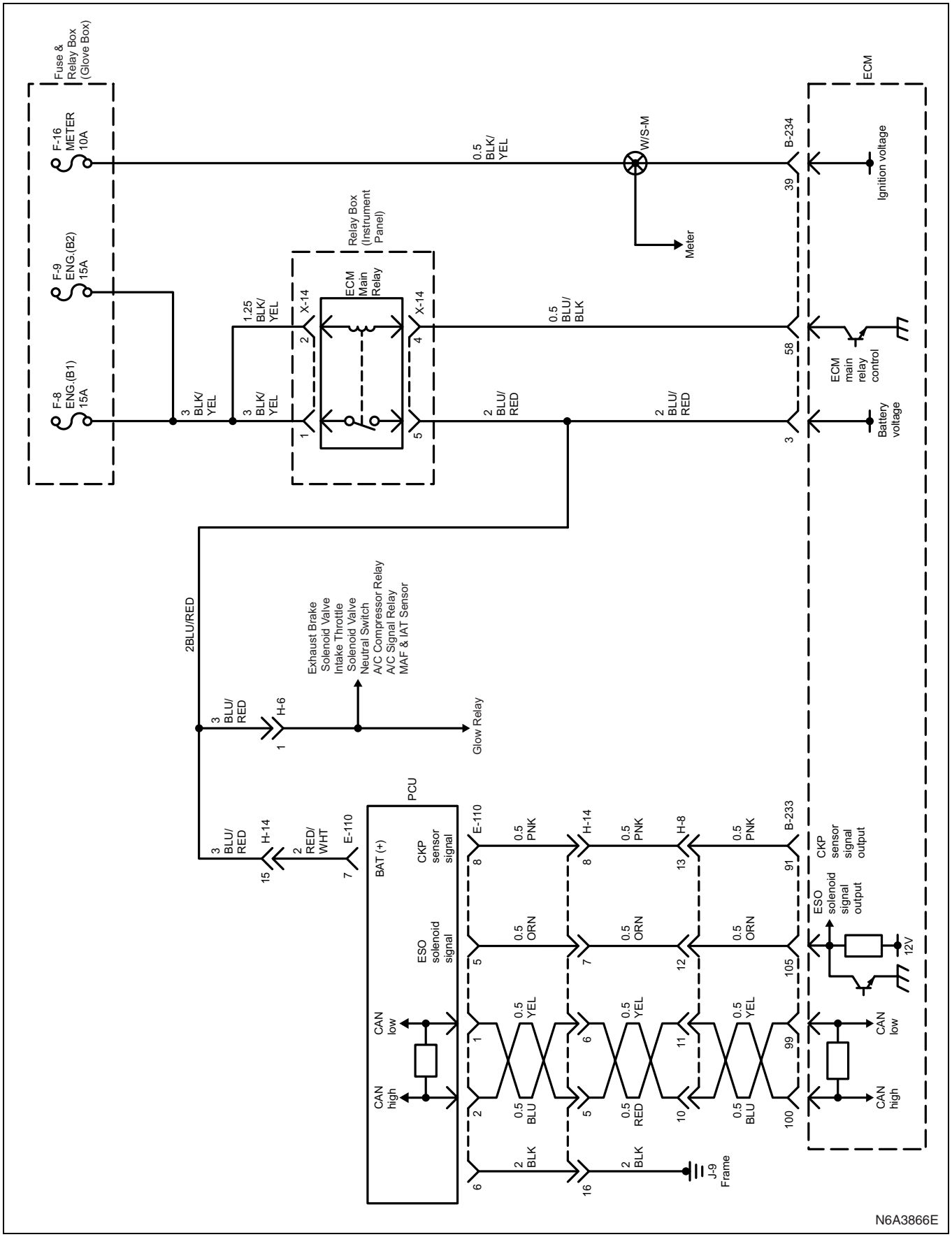


4JH1 Engine (3)



4JH1 Engine (4)



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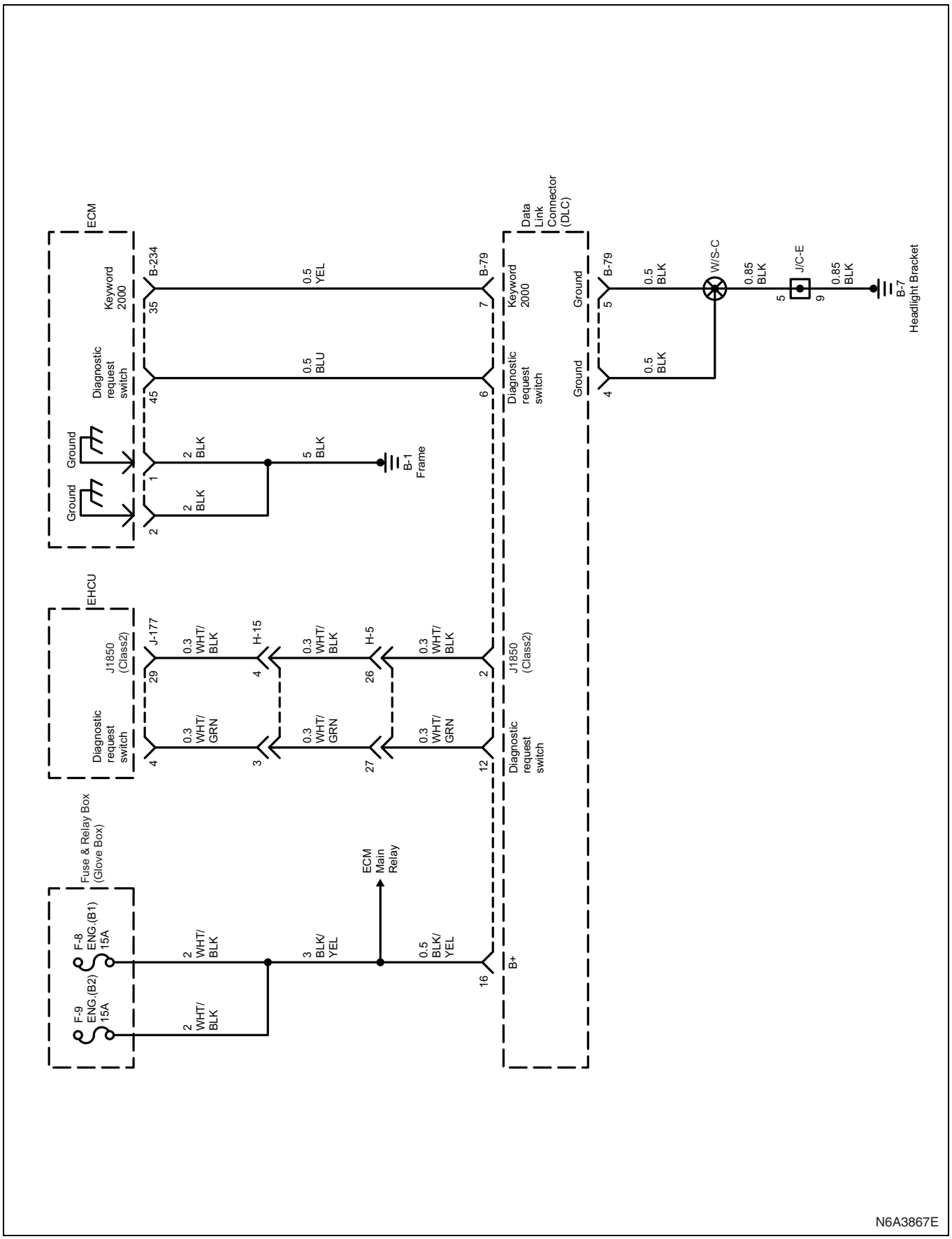
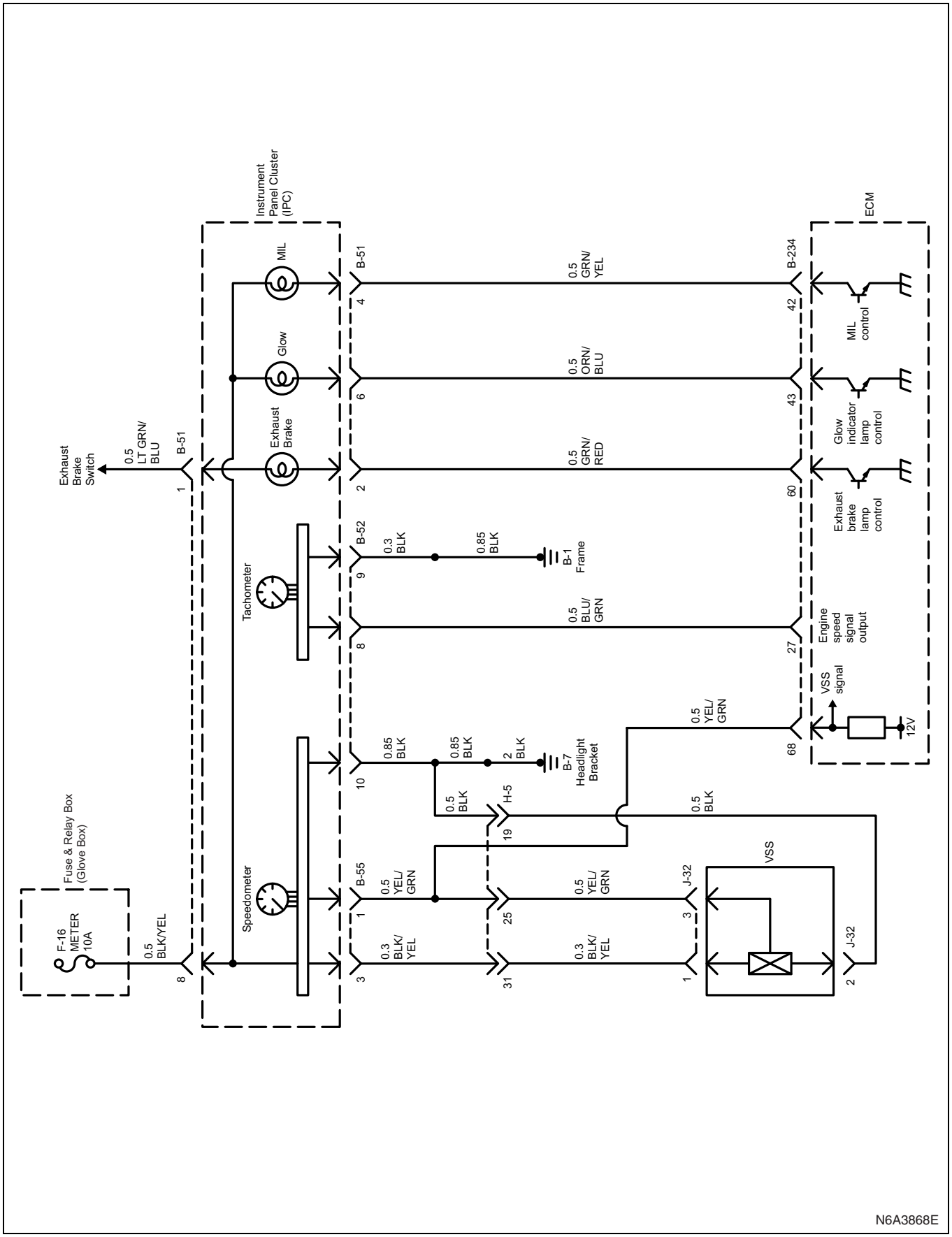
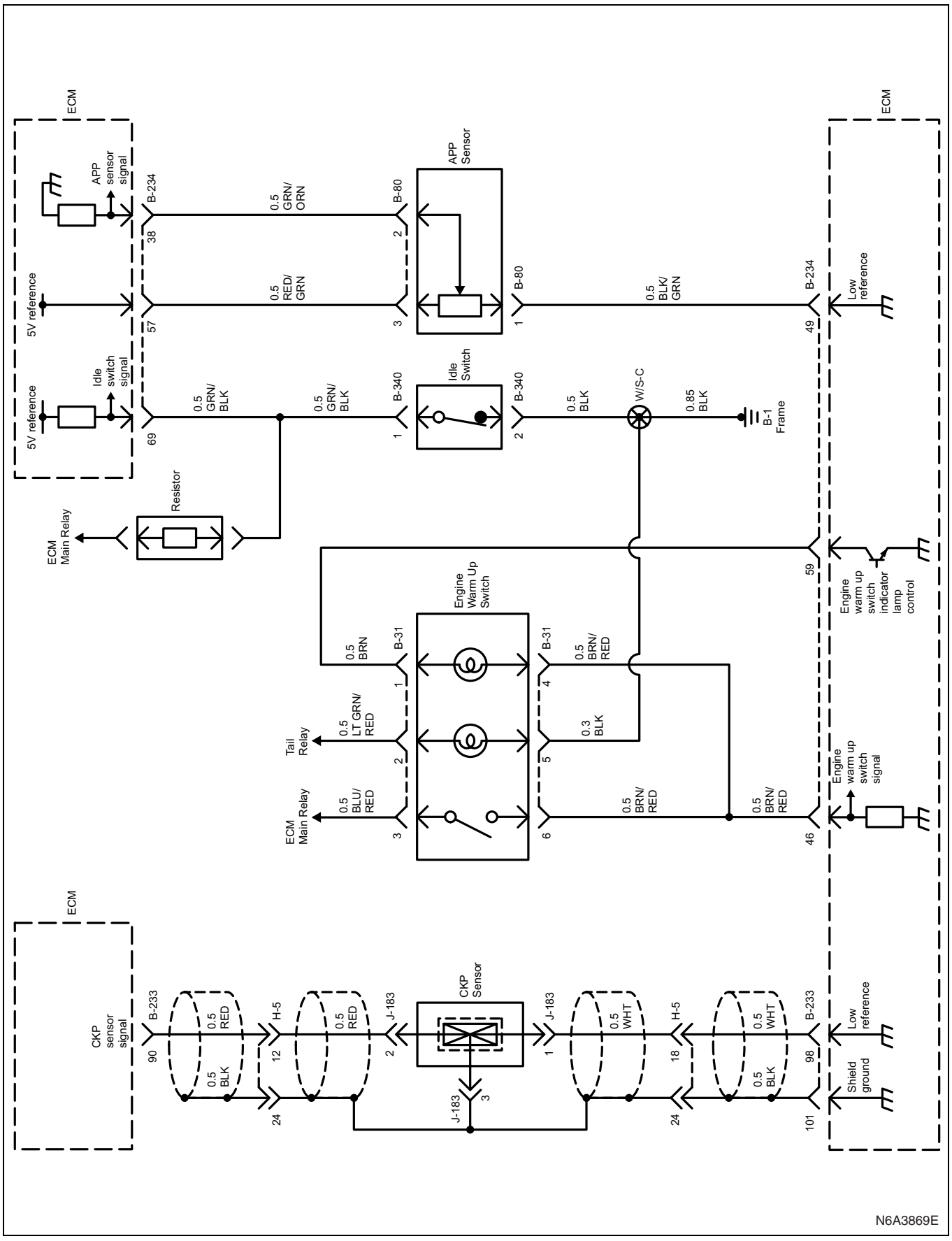


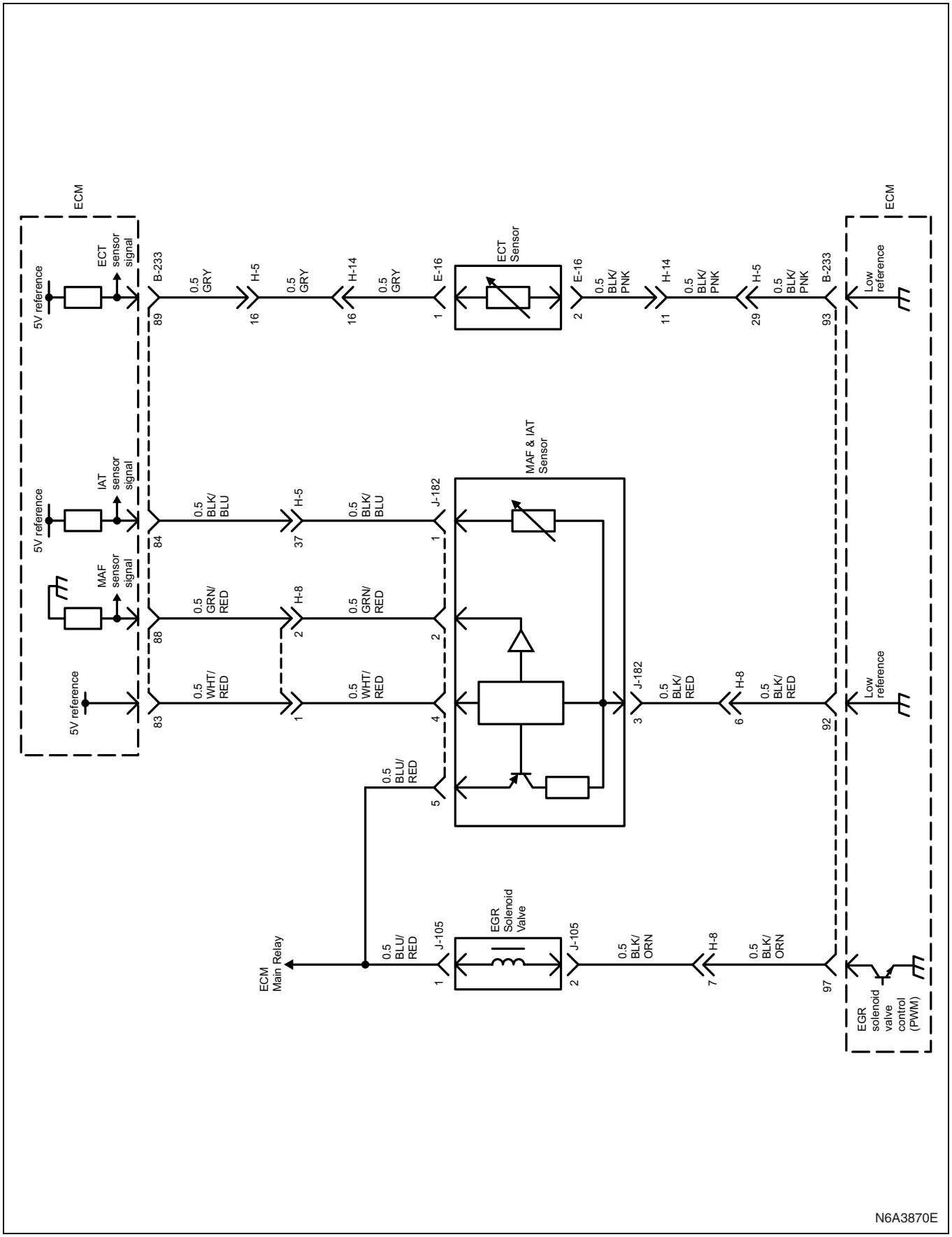
4JH1 Engine (6)



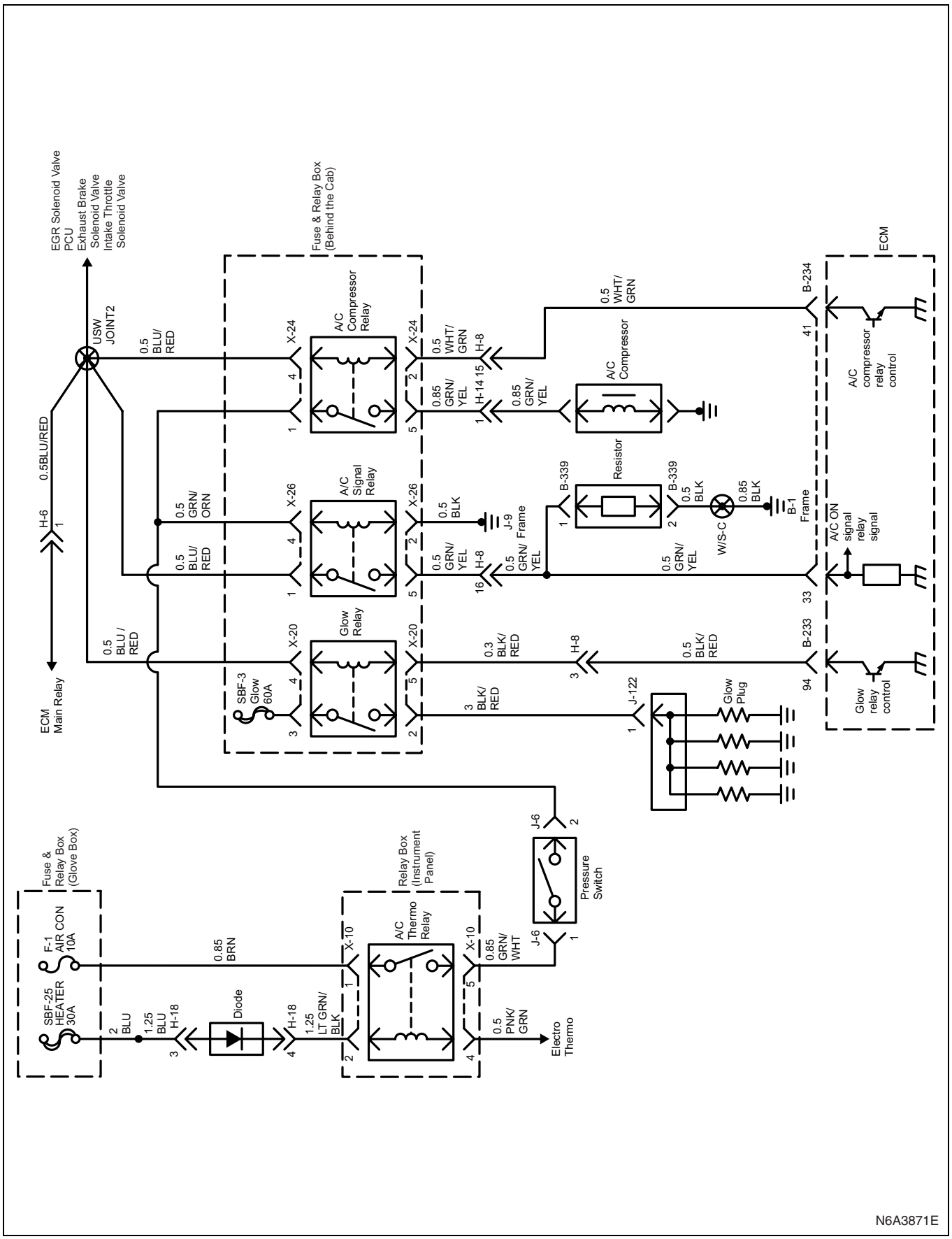
4JH1 Engine (7)



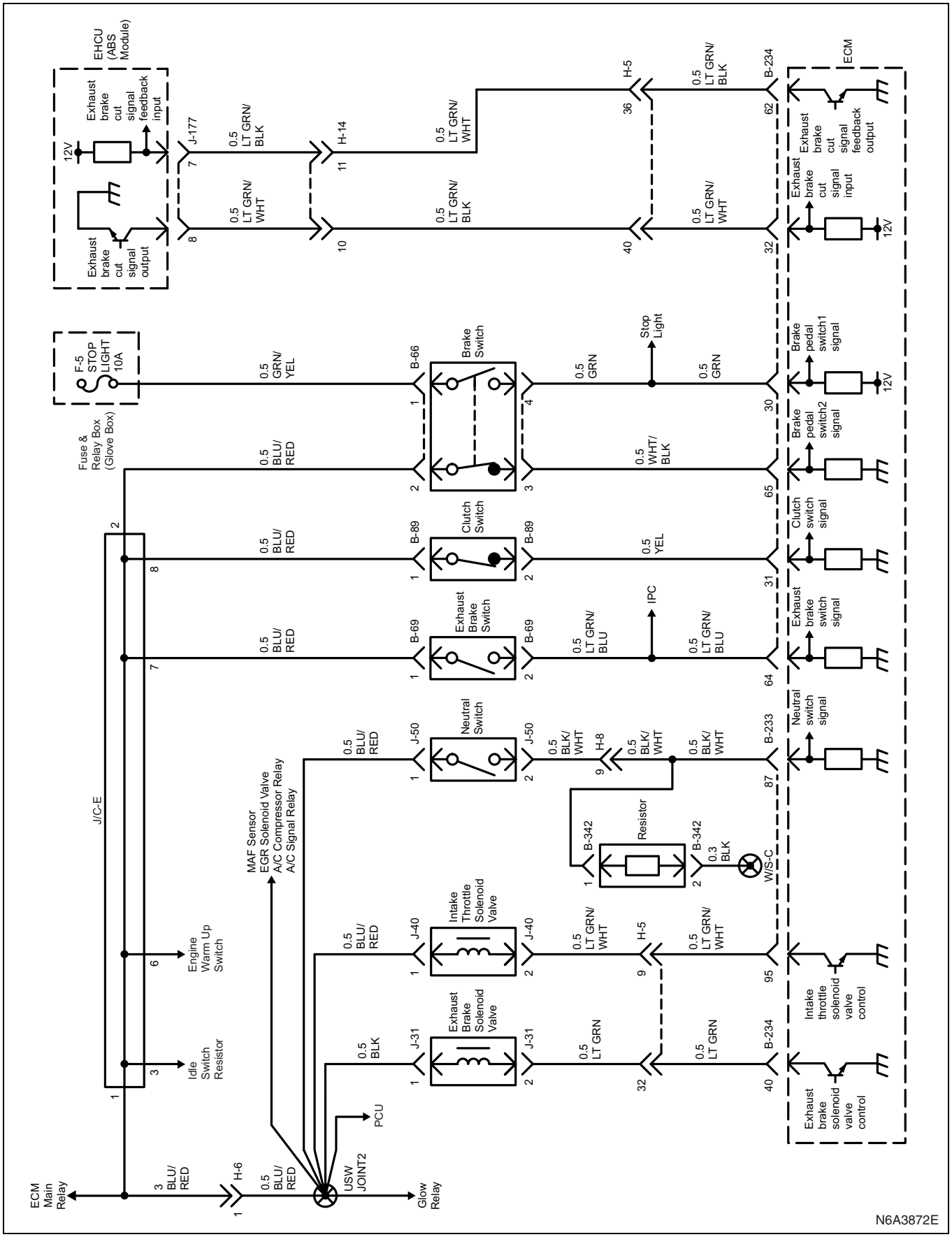
4JH1 Engine (8)



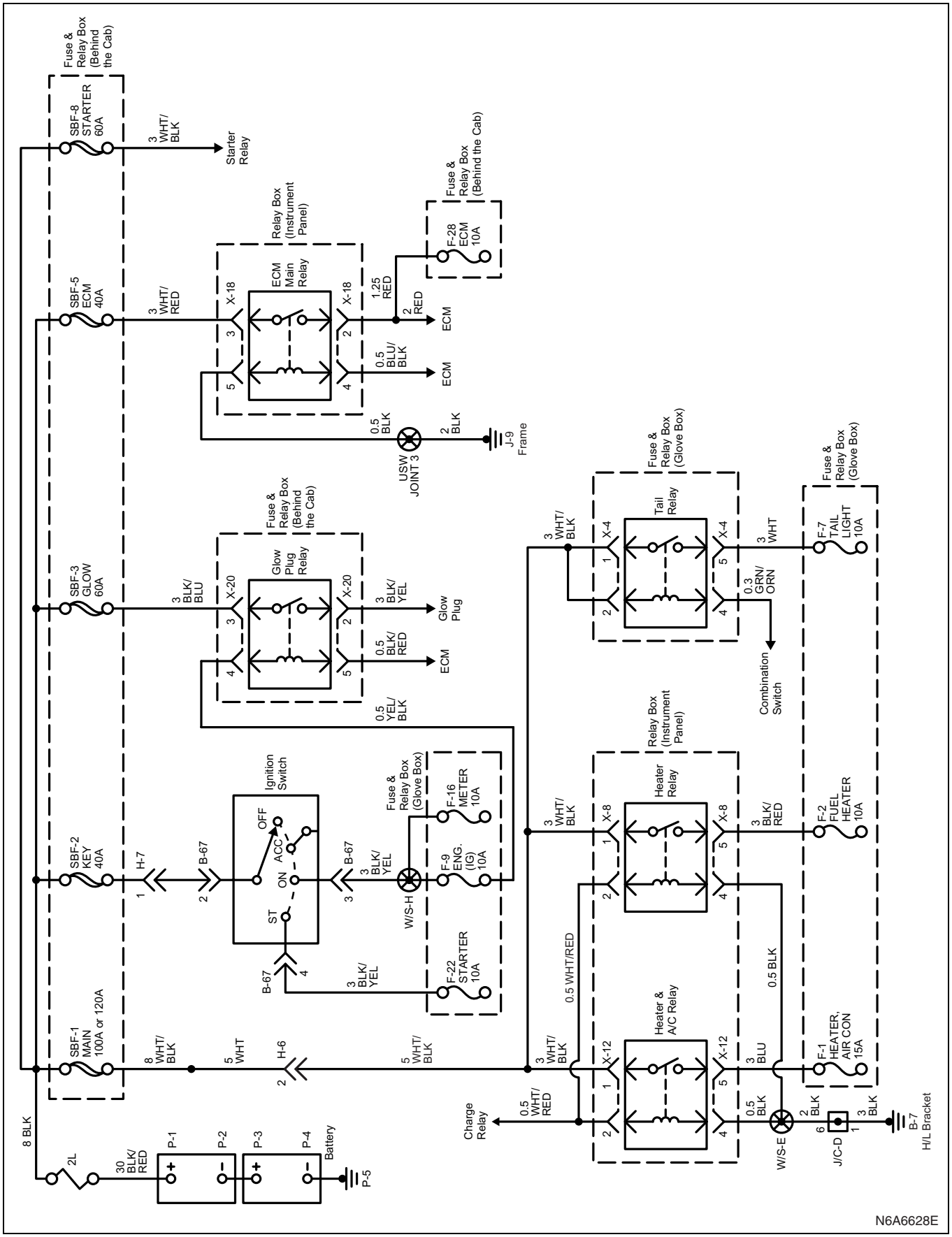
4JH1 Engine (9)



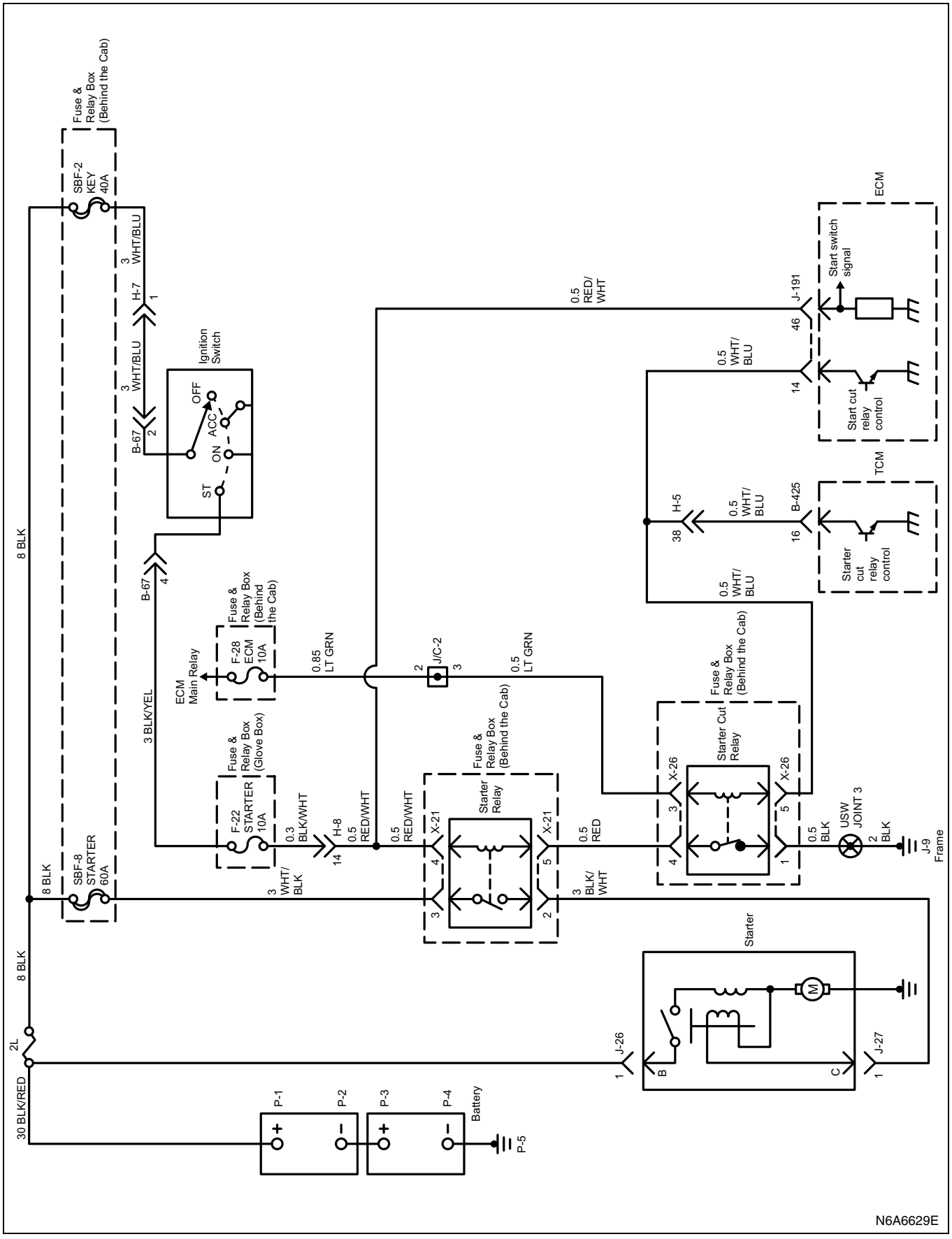
4JH1 Engine (10)



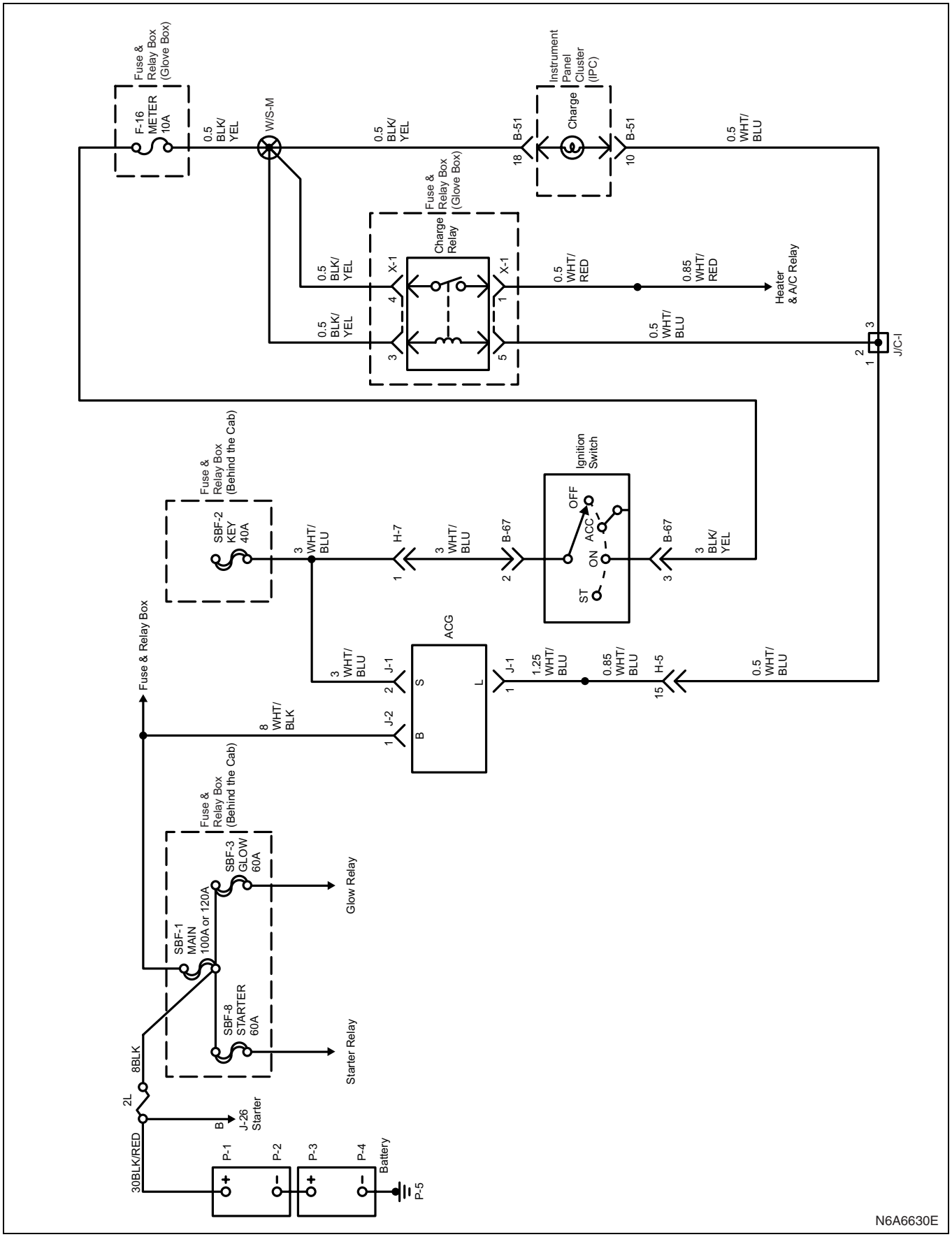
4HK1-TC Engine (1)



4HK1-TC Engine (2)



4HK1-TC Engine (3)



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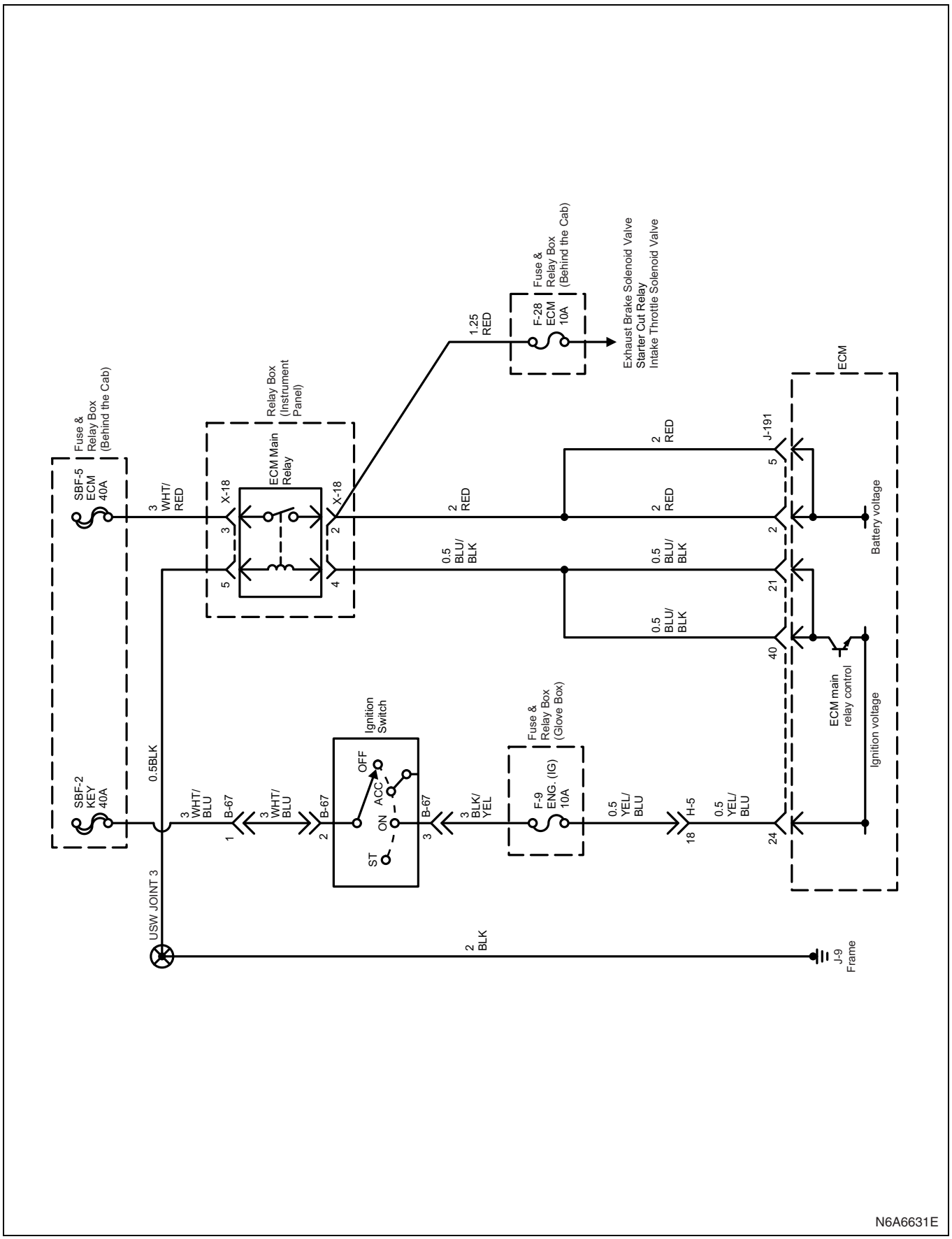
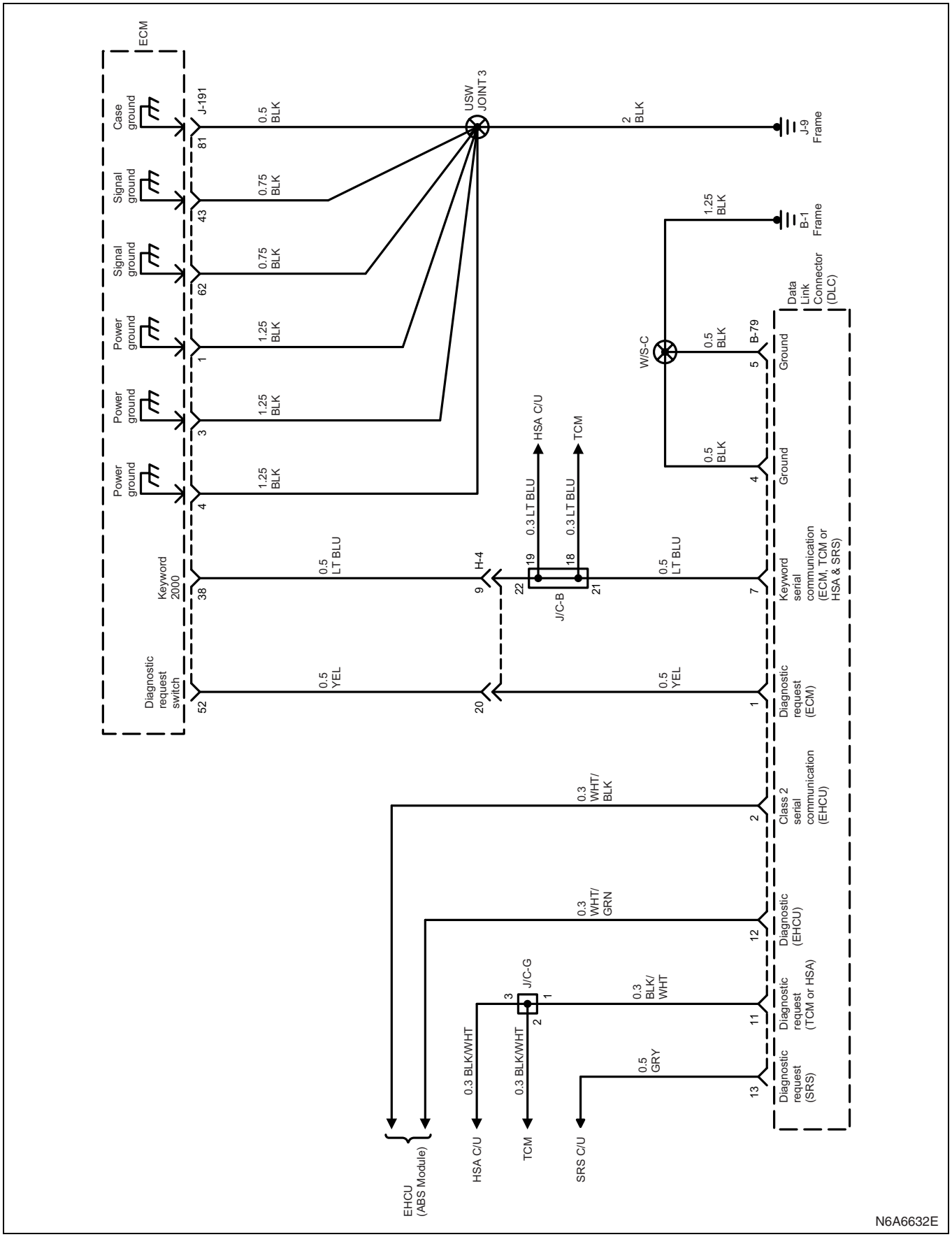
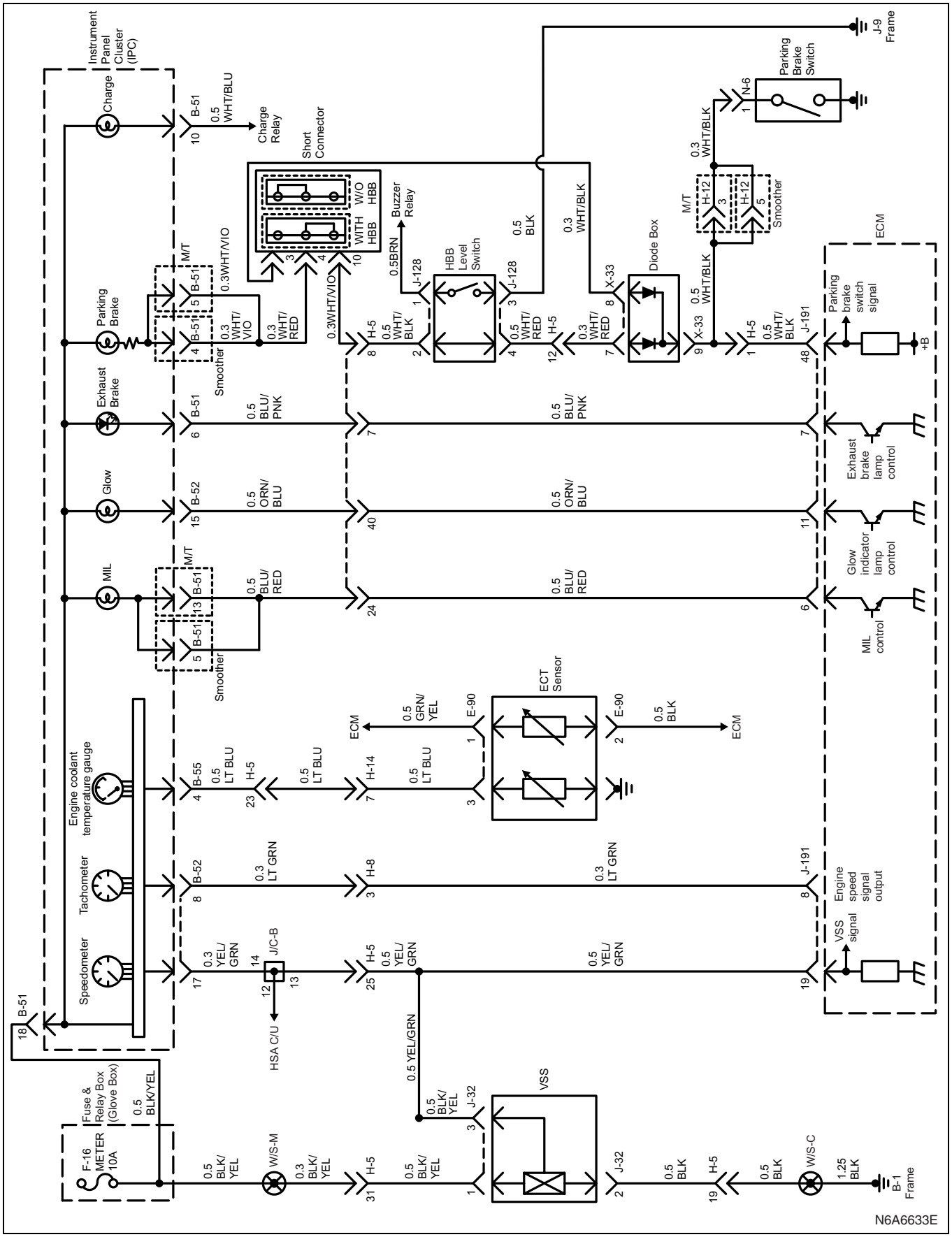


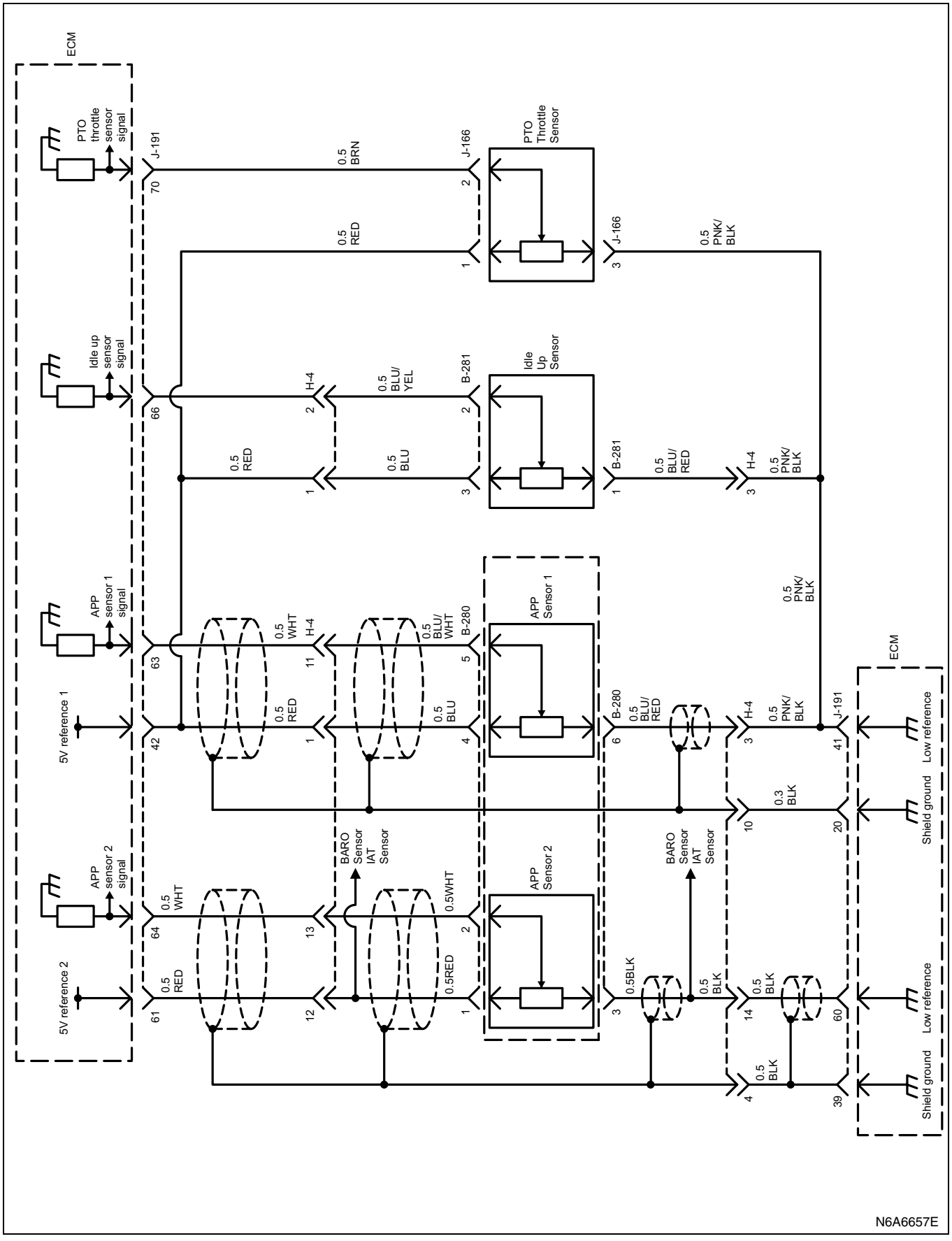
4HK1-TC Engine (5)



4HK1-TC Engine (6)



4HK1-TC Engine (7)



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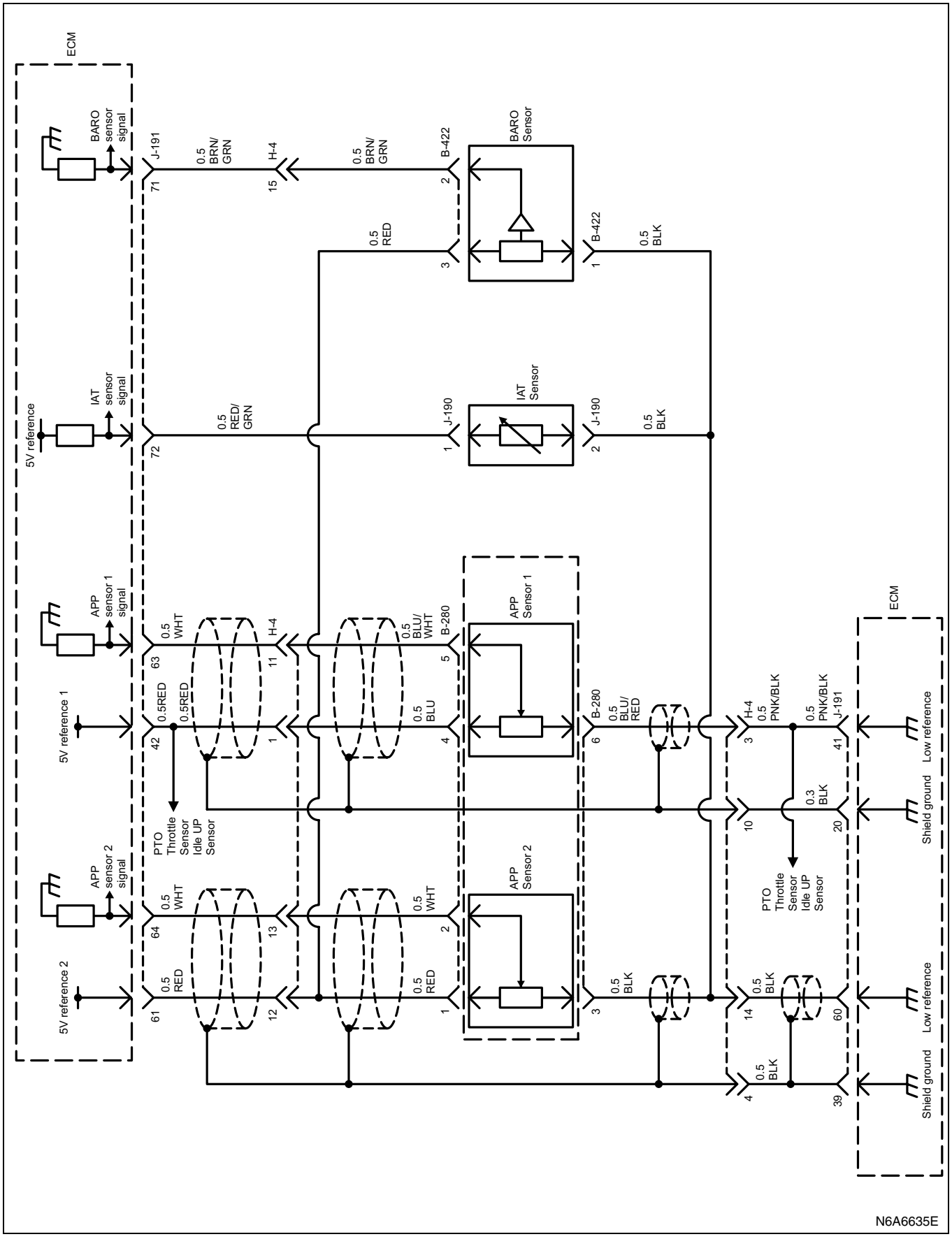

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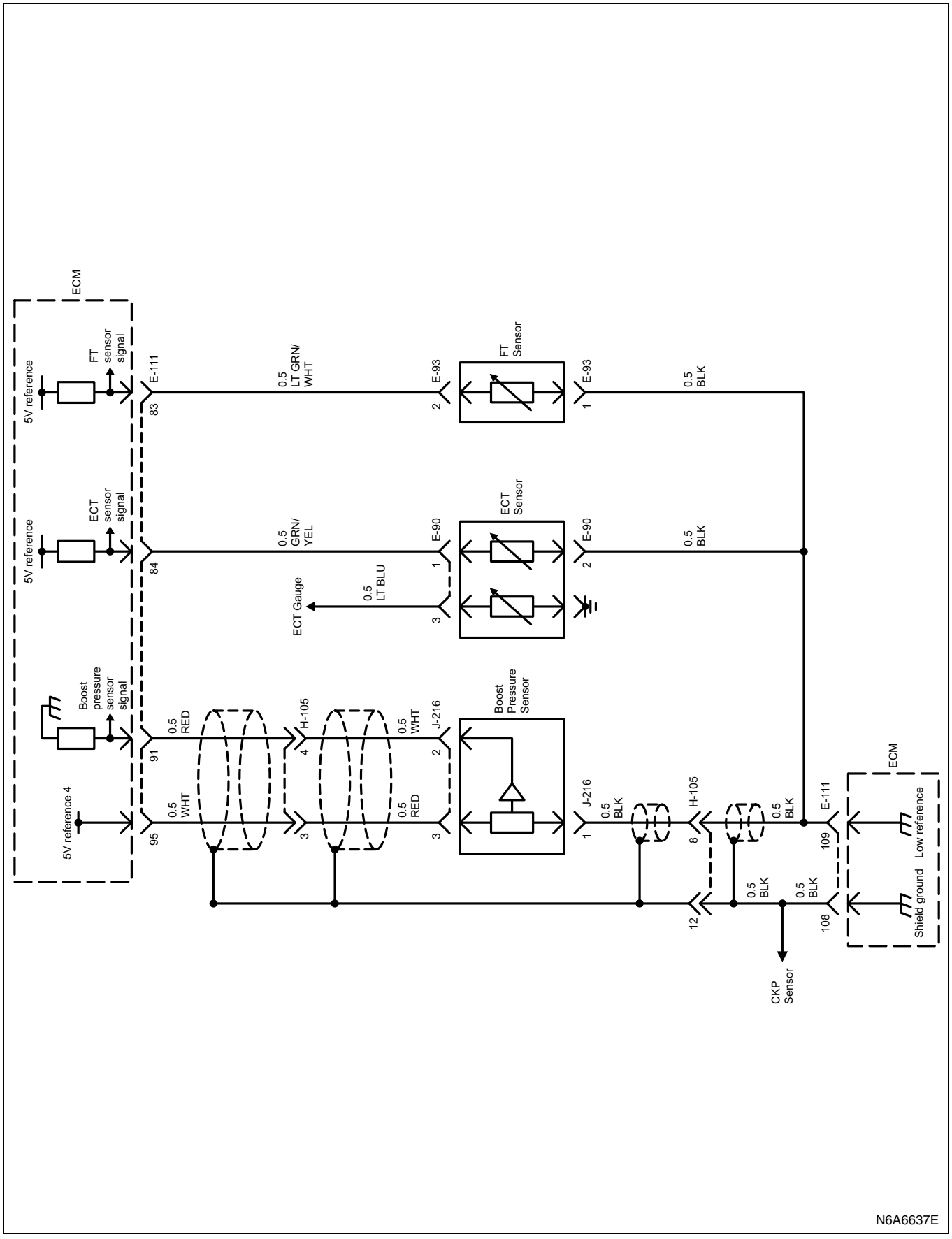

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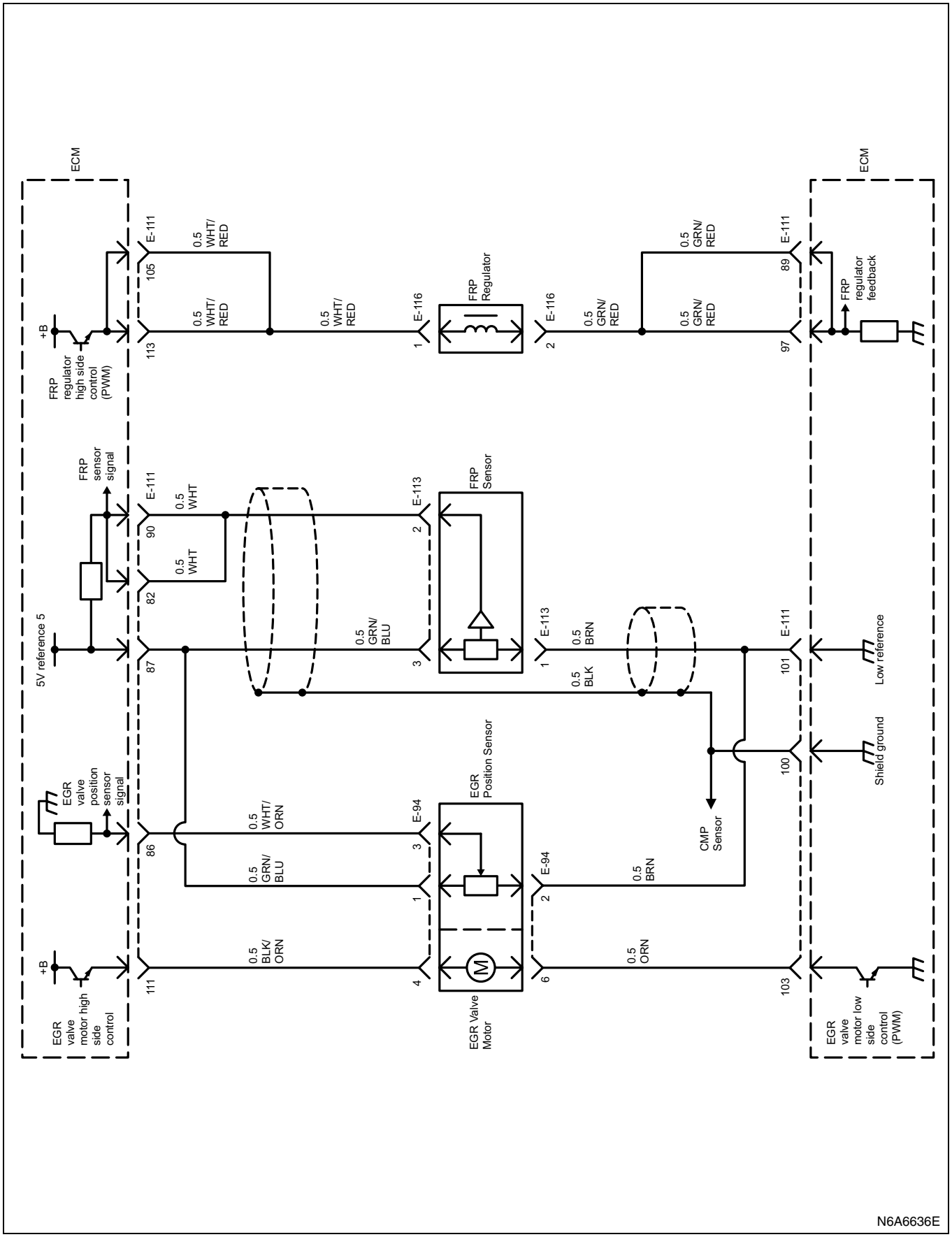
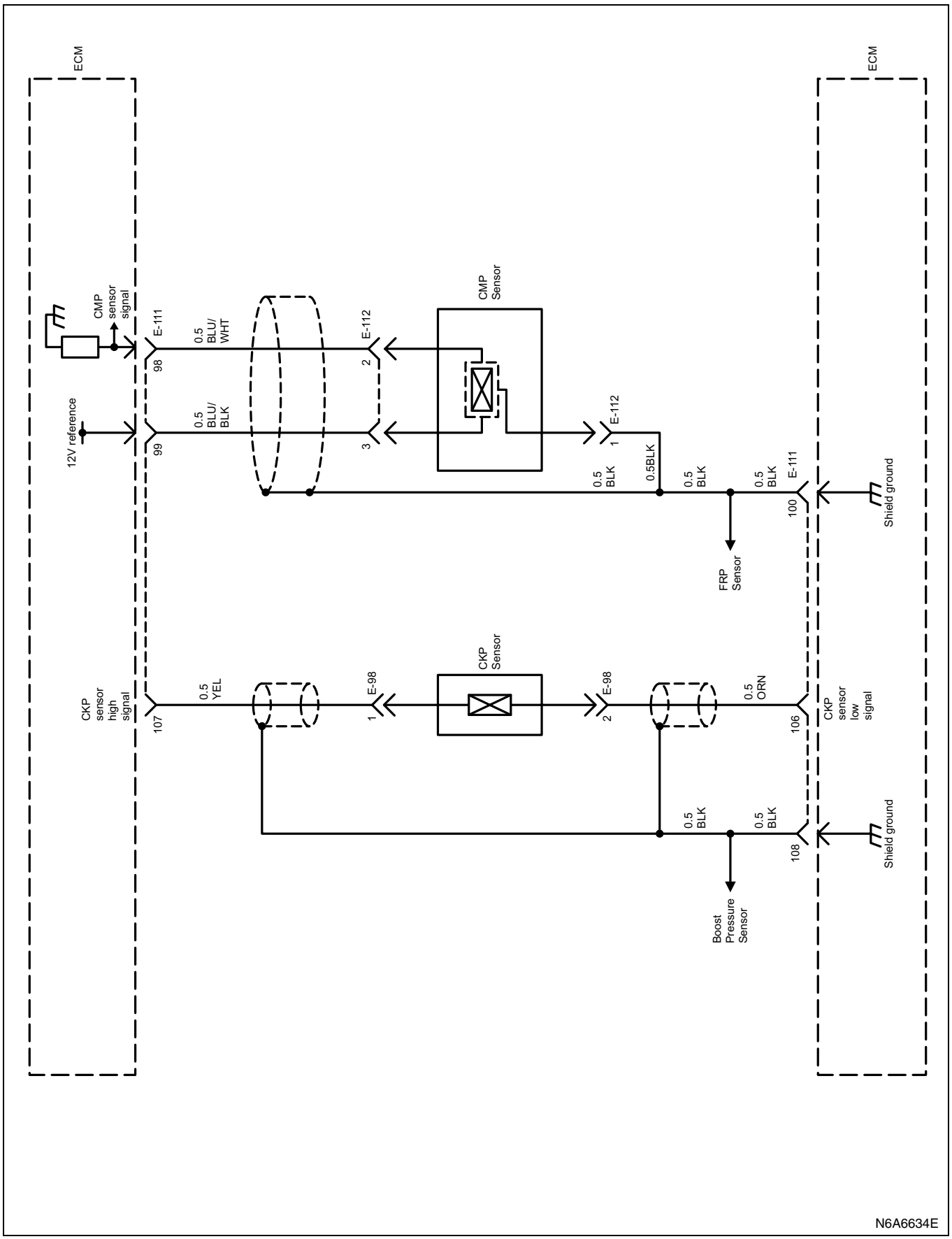
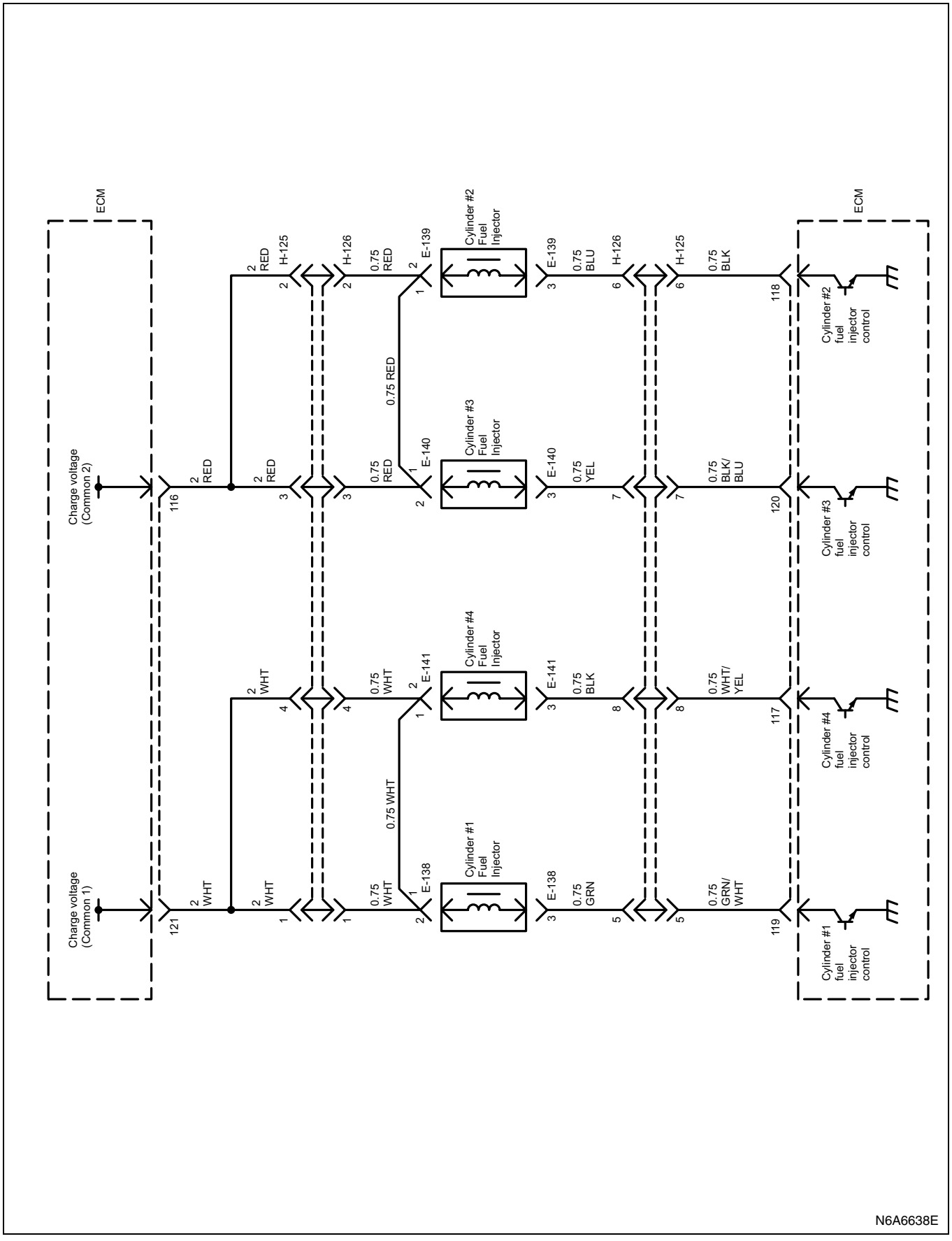


4HK1-TC Engine (11)



4HK1-TC Engine (12)



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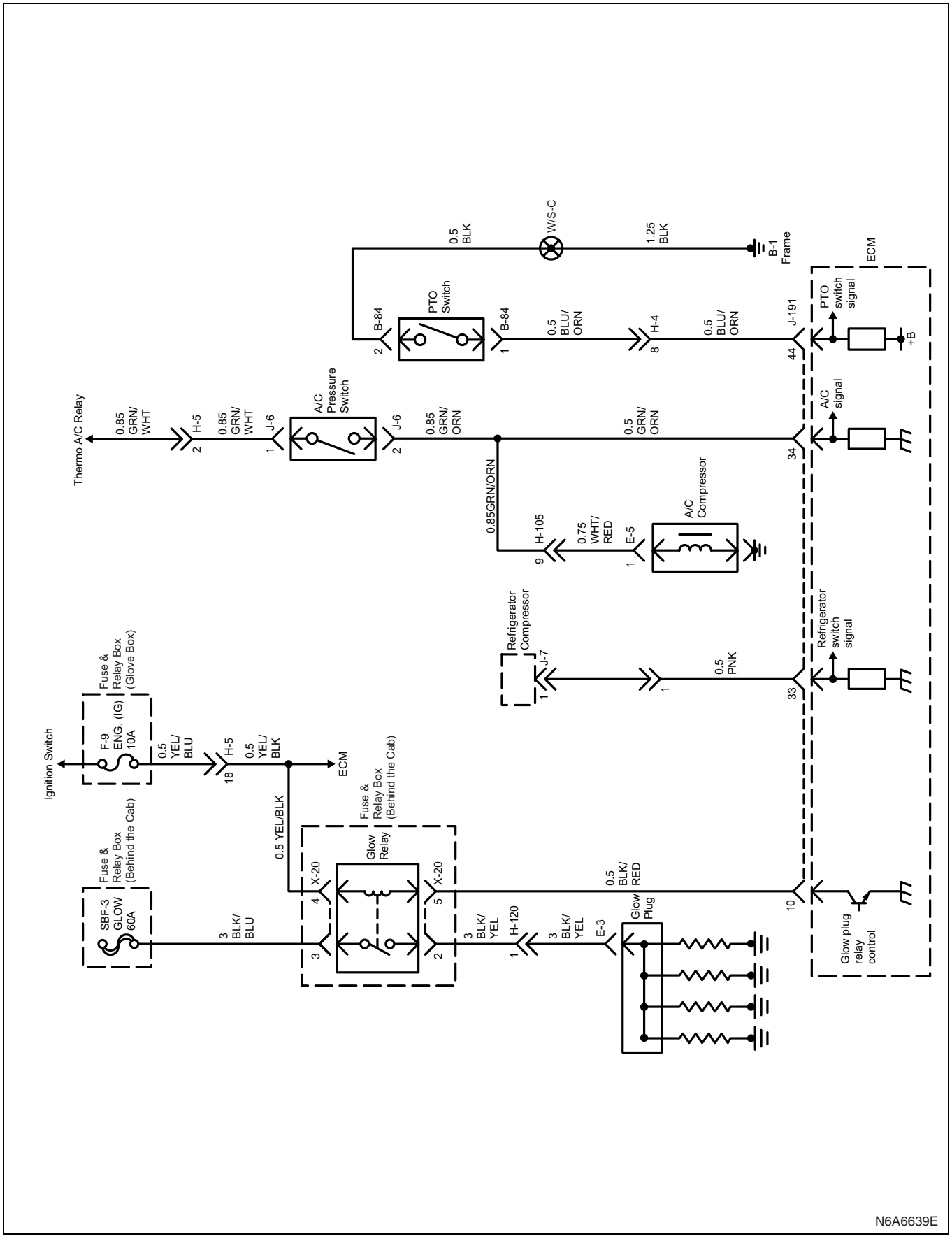

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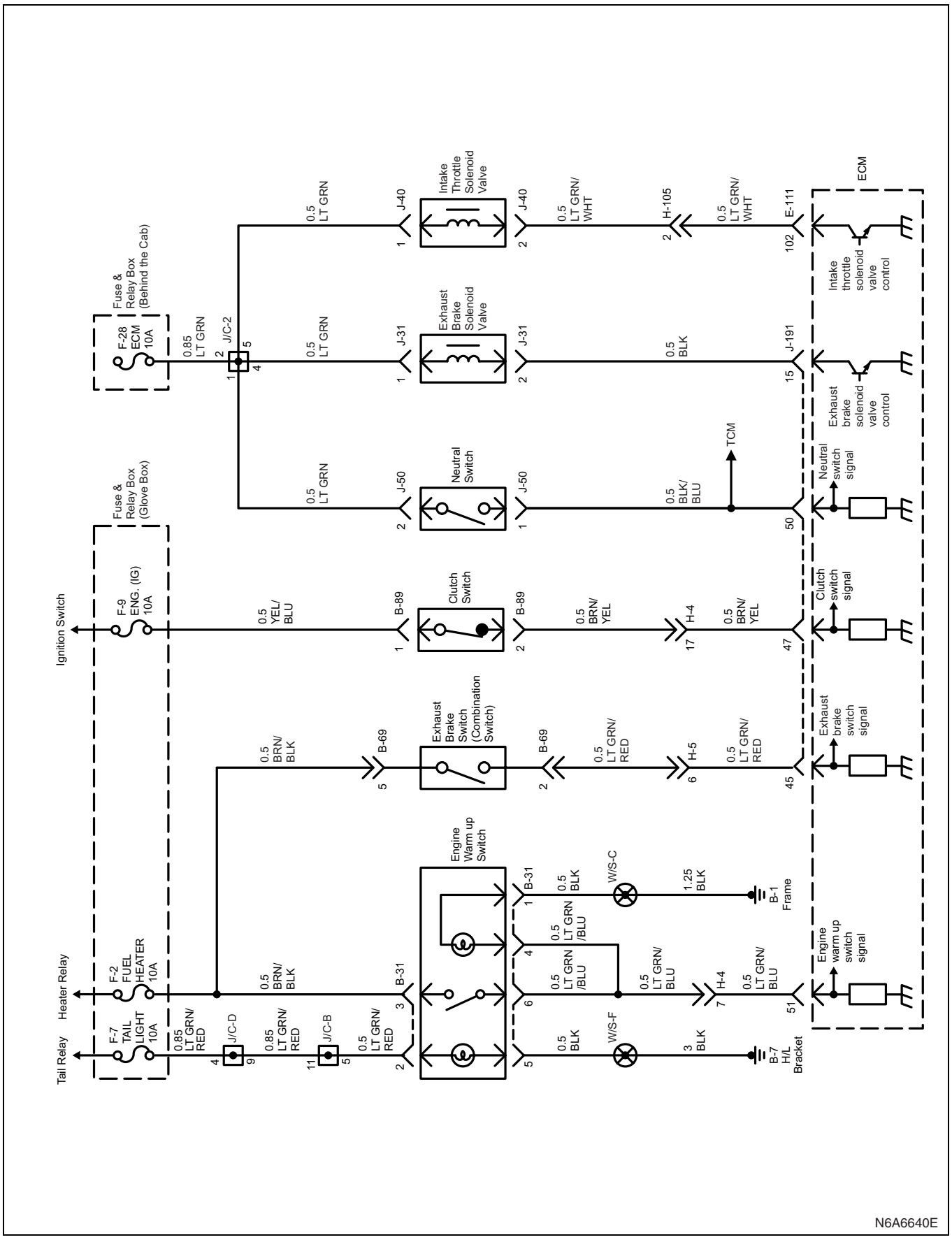

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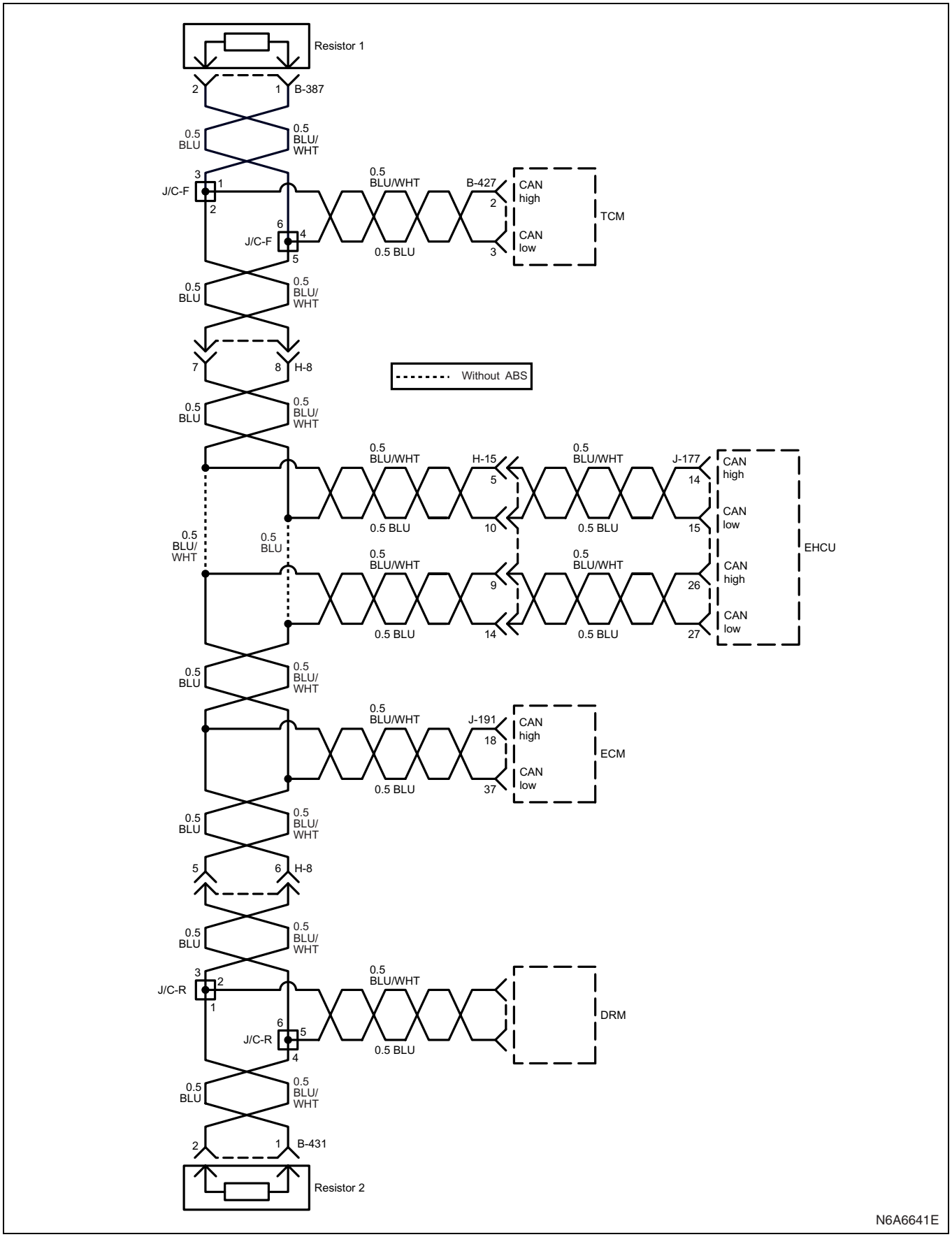

Connector List

For 4HE1-TC Engine

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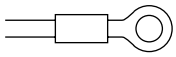
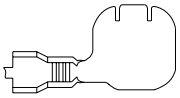
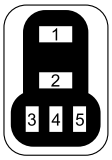
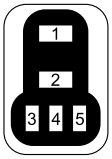
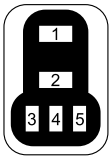
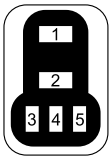
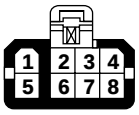
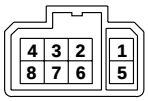
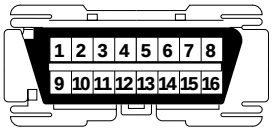
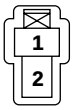
B-1	 000-001
B-7	 000-012
X-1	 005-006
X-8	 005-006
X-25	 005-006
X-28	 005-006
B-67	004-001
B-67	004-002

No.	Connector Face
B-69	 008-001
B-69	 008-002
B-79	 016-005
B-75	002-009
B-75	 002-010
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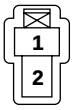
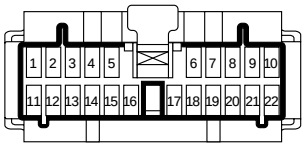
B-89	 002-010
B-233	 022-001

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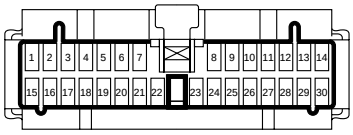
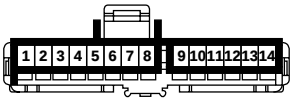
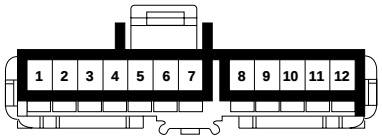
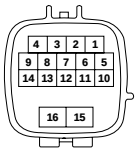
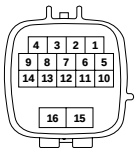
B-234	 030-001
B-51	 014-001
B-52	 012-005
H-14	016-003
H-14	 016-004
H-15	016-003
H-15	 016-004
H-13	012-001

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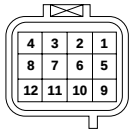
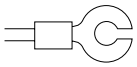
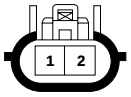
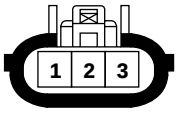
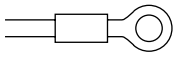
H-13	 012-002
E-2	002-013
E-3	 000-009
E-11	 002-001
E-43	 003-003
E-74	001-013
E-76	003-004
J-9	 000-001

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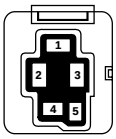
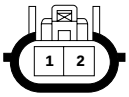
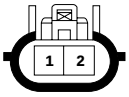
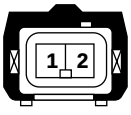
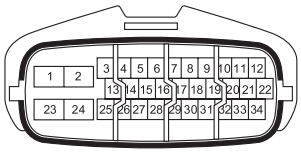
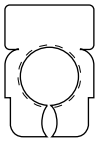
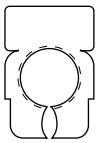
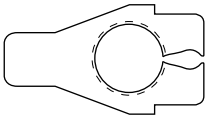
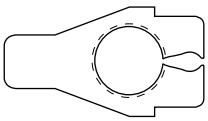
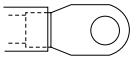
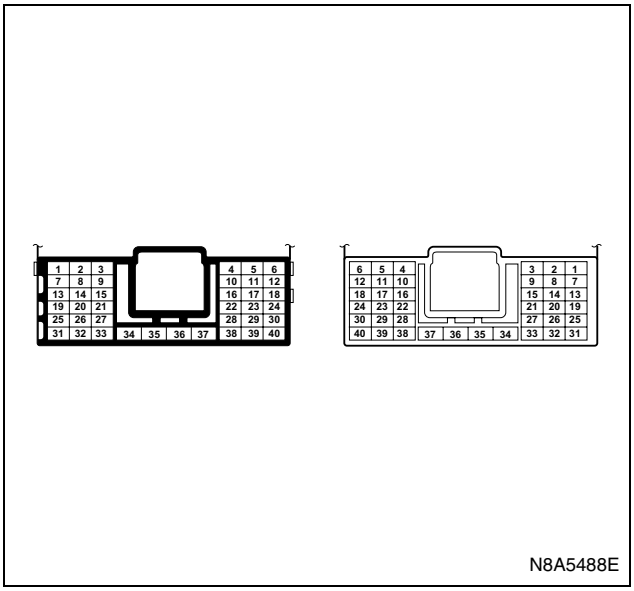
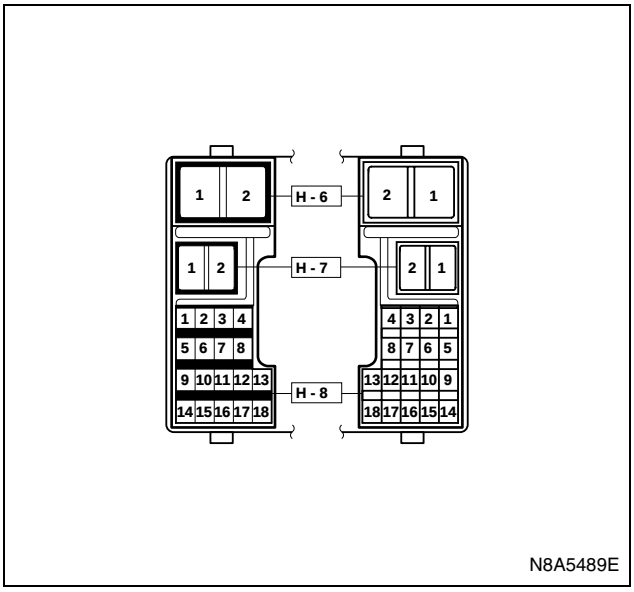
X-20	 005-003
J-23	004-009
J-31	 002-001
J-131	 002-001
J-145	002-014
J-146	002-014
J-40	002-015
J-41	 002-015

No.	Connector Face
J-105	002-016
J-147	002-017
J-177	 034-001
P-1	 000-004
P-4	 000-004
P-2	 000-006
P-3	 000-006
P-5	 000-002

H-5



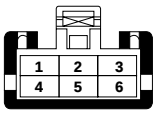
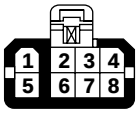
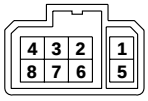
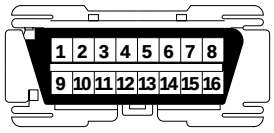
H-6, H-7, H-8

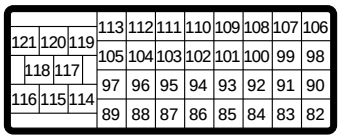
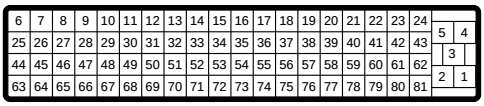
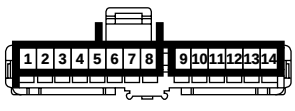


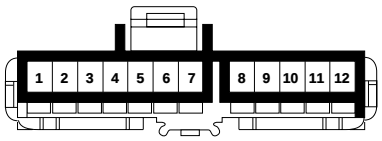
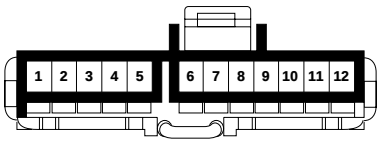
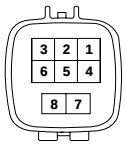
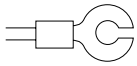
For 4JH1 Engine

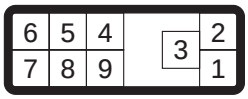
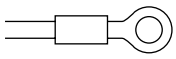
No.	Connector Face
B-1	000-001
B-7	000-012

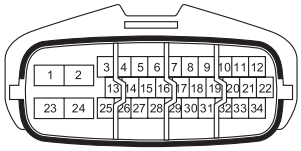
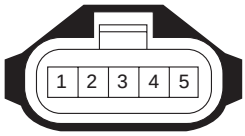
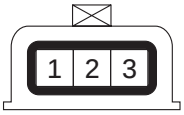
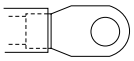
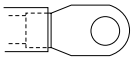
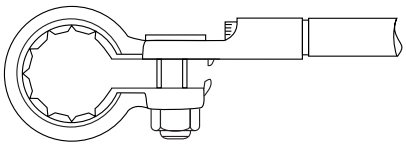
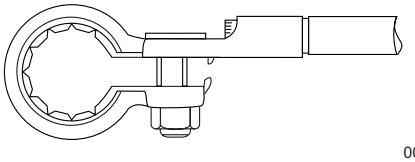
No.	Connector Face
B-18	004-004
X-10	005-001
X-11	005-001
X-14	005-001
X-12	005-001
X-20	005-003
X-24	005-006
X-26	005-006

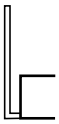
No.	Connector Face
B-31	 006-001
B-66	004-010
B-339	004-010
B-67	004-001
B-67	004-002
B-69	 008-001
B-69	 008-002
B-79	 016-005

No.	Connector Face
B-80	003-005
B-89	002-019
B-233	 121-002
B-234	 121-001
B-340	002-022
B-341	002-009
B-342	002-009
B-51	 014-001

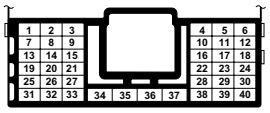
No.	Connector Face
B-52	 012-005
B-55	 012-004
H-14	016-003
H-14	016-004
H-15	008-023
H-15	 008-024
E-5	 000-009
E-16	002-014

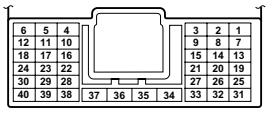
No.	Connector Face
E-110	 009-002
J-6	004-011
J-9	 000-001
J-31	002-011
J-31	002-012
J-32	003-018
J-40	002-017
J-50	002-035

No.	Connector Face
J-122	001-007
J-177	 034-001
J-182	 005-004
J-183	 003-006
P-1	 000-002
P-2	 000-002
P-4	 000-014
P-3	 000-014

No.	Connector Face
P-5	 000-007

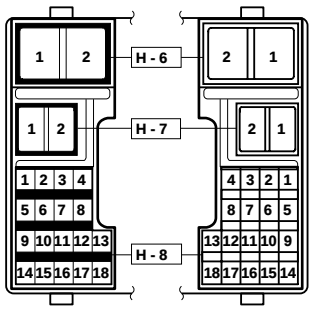
H-5





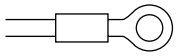
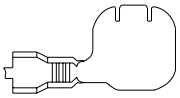
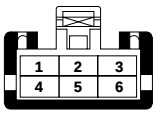
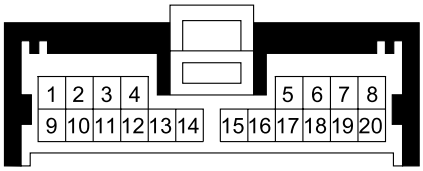
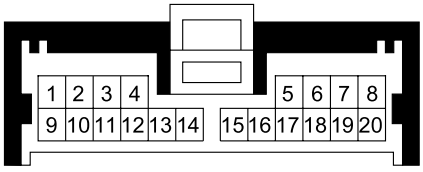
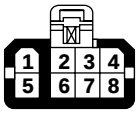
N8A5488E

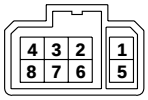
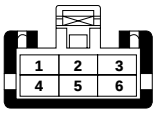
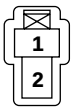
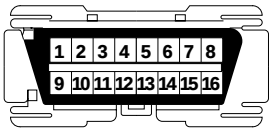
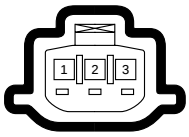
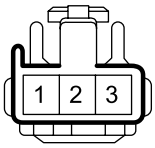
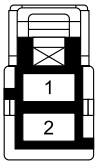
H-6, H-7, H-8

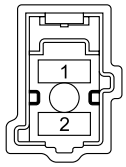
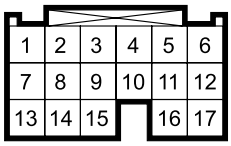
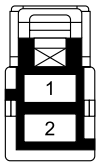
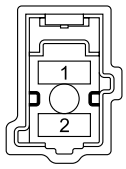
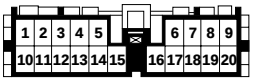
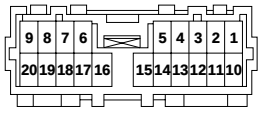
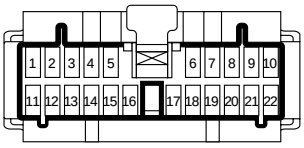


N8A5489E

For 4HK1-TC Engine

No.	Connector Face
B-1	 000-001
B-7	 000-012
B-31	 006-001
B-51	 020-005
B-52	 020-005
B-67	004-001
B-67	004-002
B-69	 008-001

No.	Connector Face
B-69	 008-002
B-84	 006-001
B-89	002-009
B-89	 002-010
B-79	 016-005
B-280	 003-005
B-281	 003-028
B-387	 002-038

No.	Connector Face
B-387	 002-039
B-422	002-027
B-427	 017-001
B-431	 002-038
B-431	 002-039
H-4	 020-002
H-4	 020-003
H-12	 022-001

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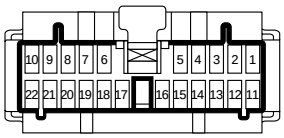
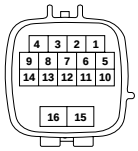
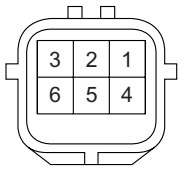
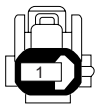
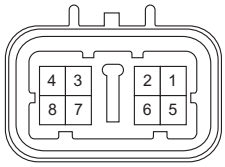
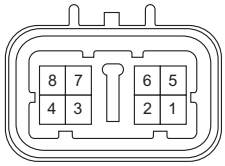
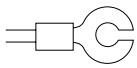
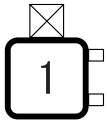
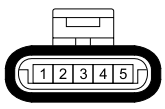
H-12	 022-002
H-15	016-003
H-15	 016-004
H-105	 006-026
H-105	006-027
H-120	 001-023
H-120	001-022
H-125	008-019

No.	Connector Face
H-125	 008-020
H-126	008-022
H-126	 008-021
E-3	 000-009
E-5	 001-021
E-90	003-004
E-93	002-035
E-94	 005-007

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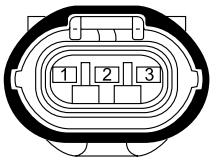
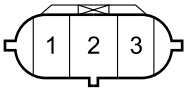
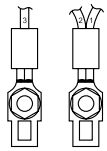
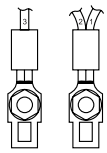
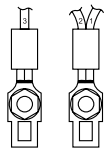
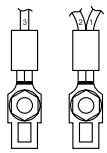
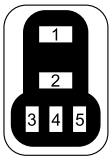
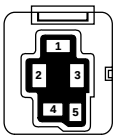
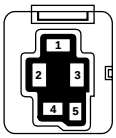
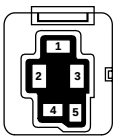
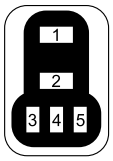
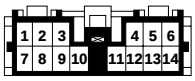
E-112	 003-026
E-113	 003-029
E-116	002-036
E-138	 003-031
E-139	 003-031
E-140	 003-031
E-141	 003-031

No.	Connector Face
X-1	 005-006
X-11	005-001
X-18	 005-003
X-20	 005-003
X-21	 005-003
X26	 005-006
X-33	 014-002
J-1	002-003

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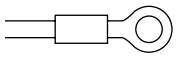
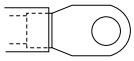
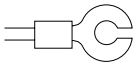
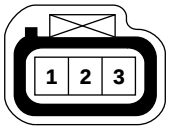
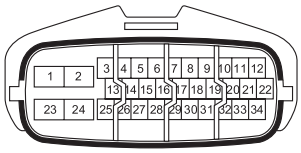
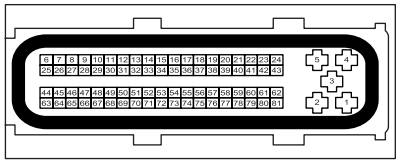
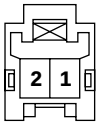
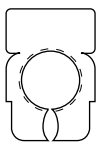
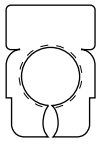
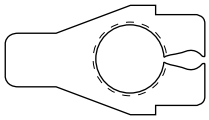
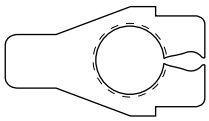
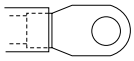
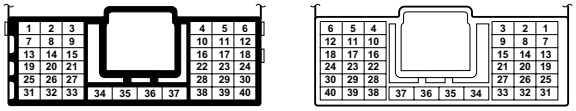
J-2	 000-001
J-6	002-032
J-26	 000-002
J-27	 000-009
J-31	002-011
J-31	002-012
J-32	003-018
J-40	002-017

No.	Connector Face
J-50	002-035
J-166	 003-001
J-177	 034-001
J-191	 081-001
N-6	002-022
N-6	 002-023
P-1	 000-004
P-4	 000-004

No.	Connector Face
P-2	 000-006
P-3	 000-006
P-5	 000-002

H-5



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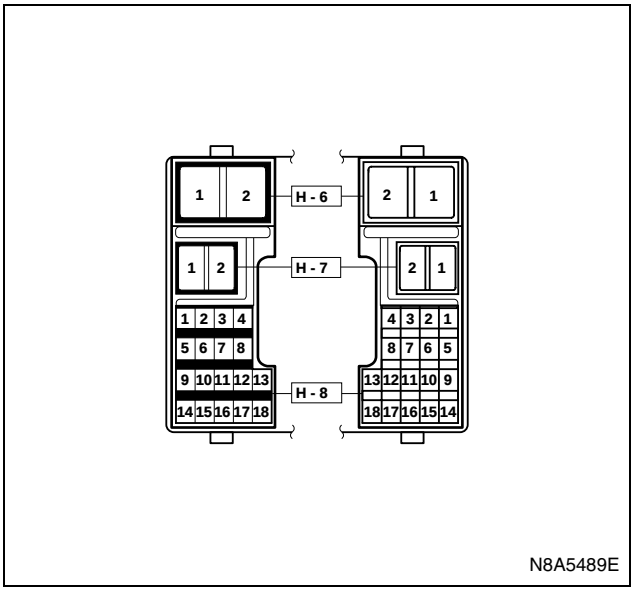
H-6, H-7, H-8



Engine Stop System

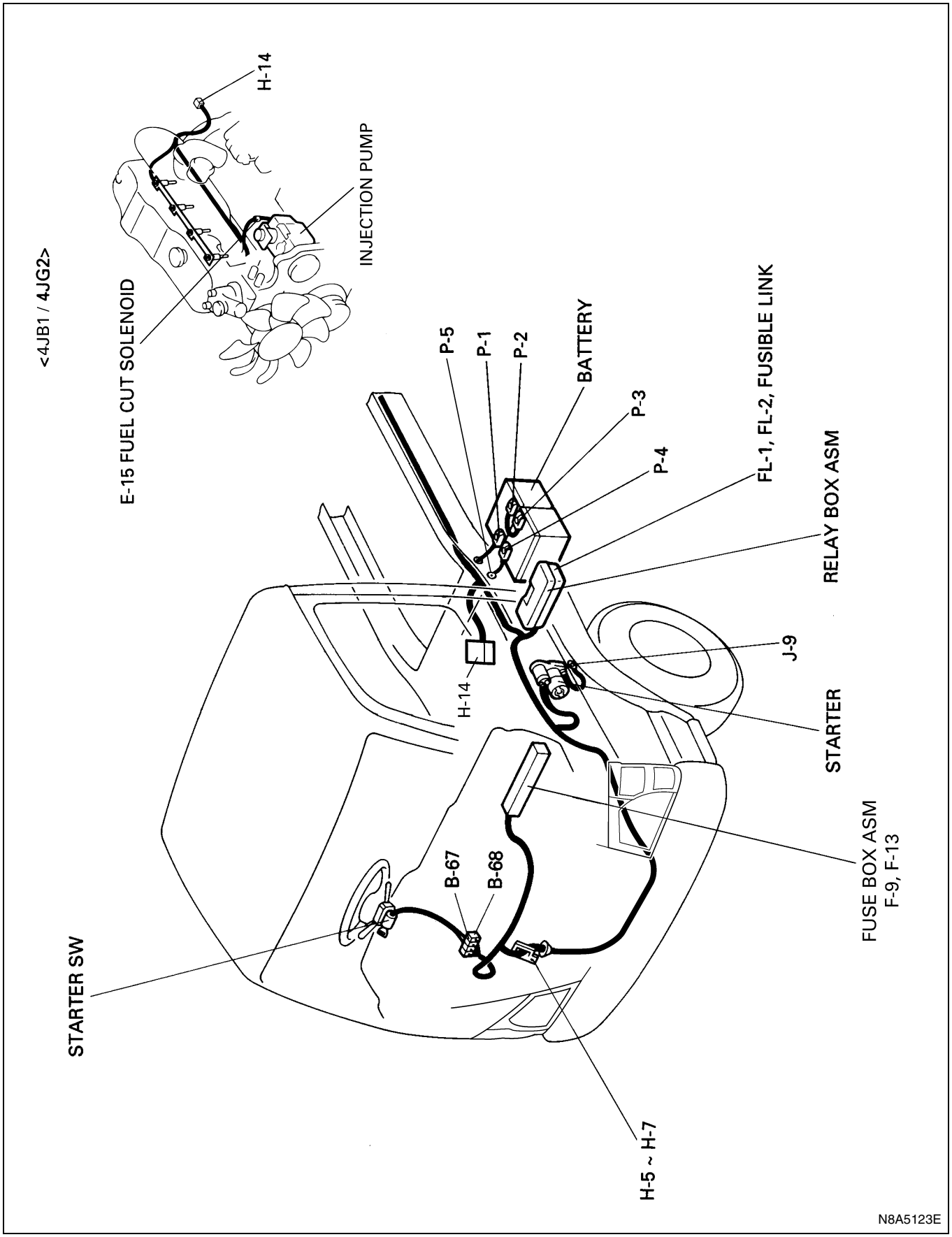
General Description

The circuit consists of starter switch and engine stop motor.
The engine stop mechanism aims at shut-off of fuel supply.
Available are motor type and solenoid type depending on the types of the engine mounted.
Motor type is forcible pull the injection pump control rack to the direction of fuel supply reduction by means of engine stop motor, thus shutting it off.
Solenoid type is to have the starter switch turn from “ON” position to “OFF”, so that the solenoid valve fitted to the injection pump closes to shut off the fuel circuit.

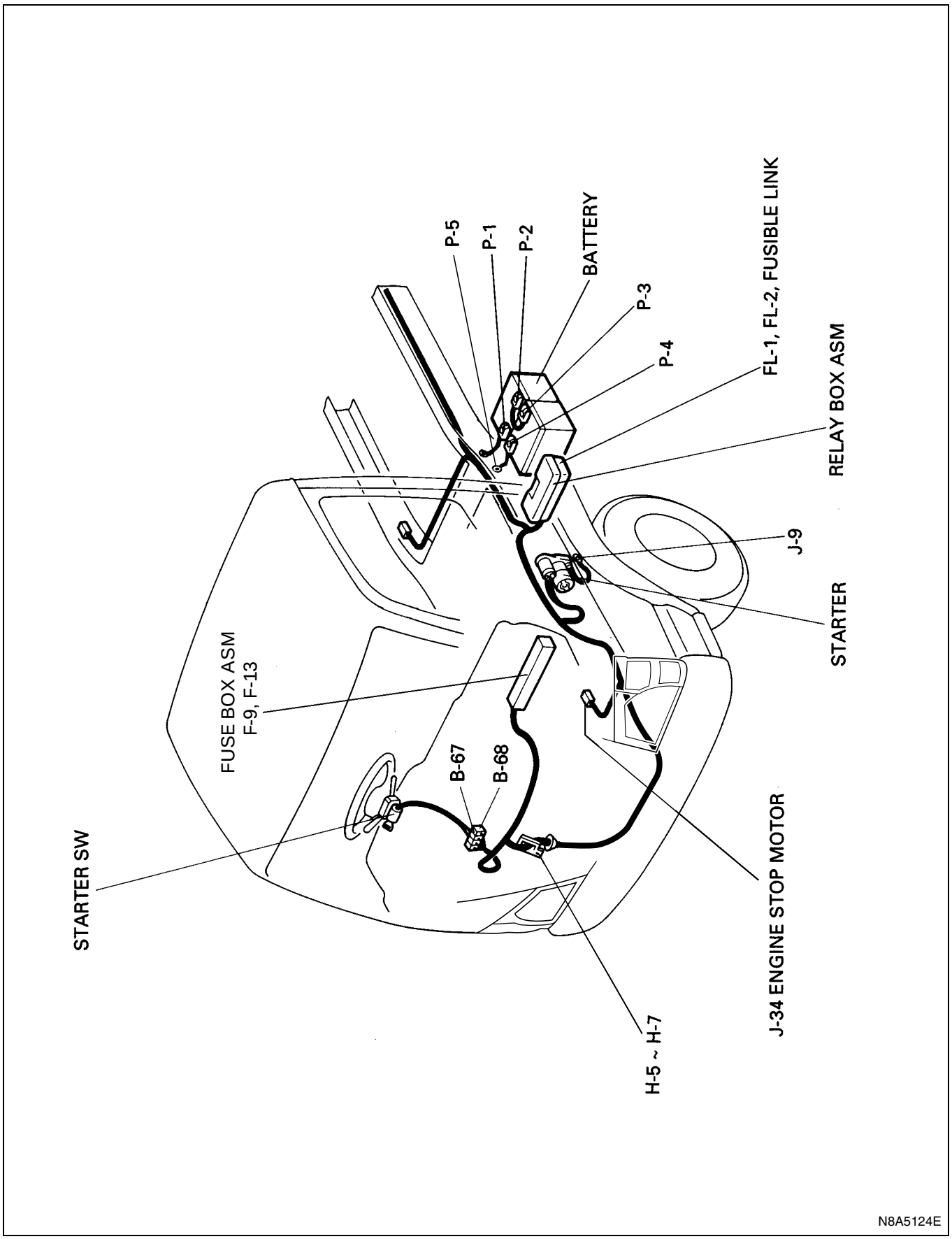
Engine stop system	Engine model
Motor type	4HF1, 4HG1, 4HE1
Solenoid type	4JB1, 4JG2

Parts Location

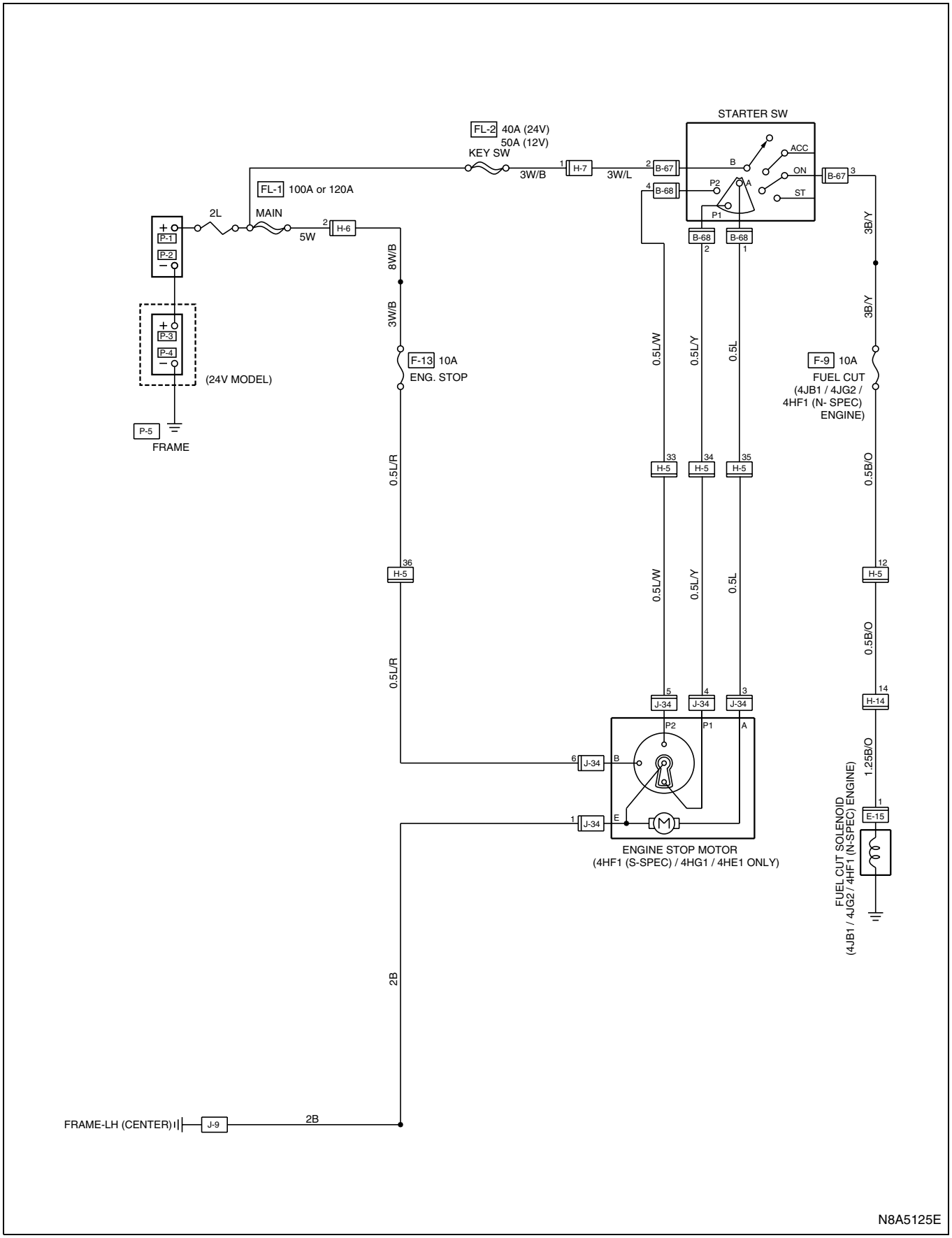
4JB1 / 4JG2 / 4HF1 (N-Spec) Engine



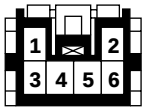
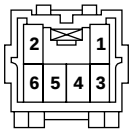
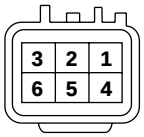
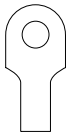
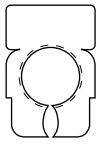
4HF1 (S-Spec) / 4HG1 / 4HE1 Engine

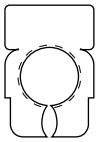
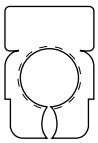
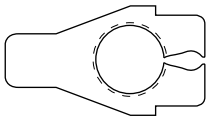
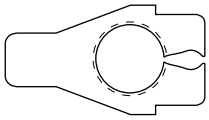
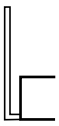
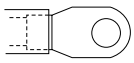
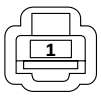


Circuit Diagram



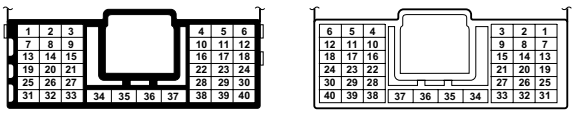
Connector List

No.	Connector Face
B-67	004-001
B-67	004-002
B-68	 006-002
B-68	 006-003
J-34	006-004
J-34	 006-005
P-1 (12 V)	 000-003
P-2	 000-004

No.	Connector Face
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
P-5 (12 V)	 000-007
P-5 (24 V)	 000-002
E-15	001-002
E-15	 001-003

No.	Connector Face
H-14	016-001
H-14	016-002

H-5



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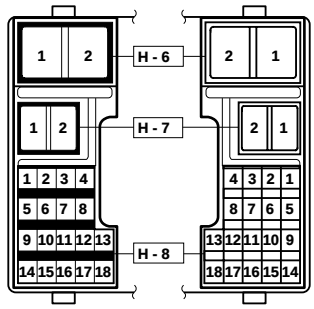
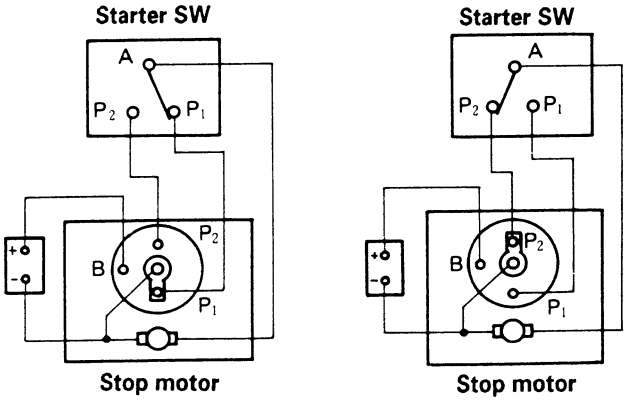
H-6, H-7



N8A5489E

Function of Engine Stop Motor



Turn the starter switch from "ACC" position to "ON", and the engine stop motor will turn by 180 degrees (from 0° to 180°) so that the stop motor's electrode will be in potential equal to that of the starter switch for the stop.

Turn the starter switch from "ON" position to "ACC" or "LOCK", and then the stop motor will rotate by 180 degrees(from 180° to 360°) and crease operating.

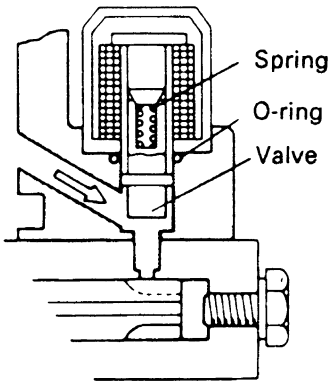
Connector No. / Terminal No. / Starter SW key position	B-68			Stop motor	Stop lever position
	A	P1	P2		
	1	2	4		
LOCK	○——○			0° (360°)	Stop
ACC	○——○				
ACC → ON				0° → 180°	Stop → Run
ON	○————○			180°	Stop
START	○————○				
ON → ACC → LOCK				0° → 360°	Stop → Run

N8A5127E

Solenoid Type

Starter Switch and Solenoid Valve

Turn the starter switch from “ON” position to “OFF”, and then the solenoid valve fitted to the injection pump closes to cut off the fuel circuit.
For the circuit of solenoid type fuel cut, refer to QOSIII circuit diagrams in this section.



Key position	Solenoid valve
LOCK	Close
ACC	
ON	Open
START	

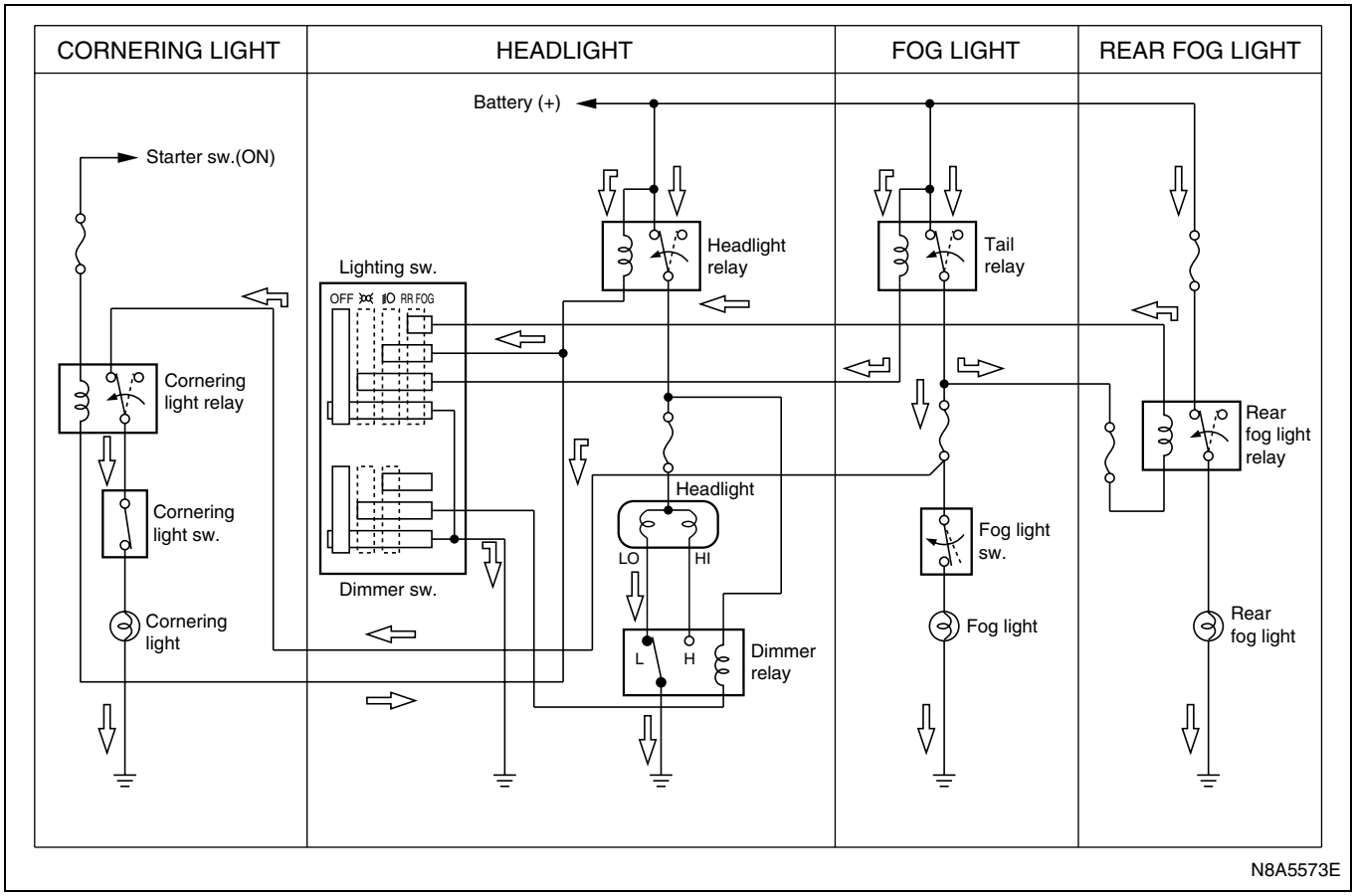
N8A5128E

Headlight, Fog Light, Rear Fog Light and Cornering Light

General Description

The circuit consists of headlight, fog light, cornering light, starter switch, combination switch (Lighting switch, dimmer / passing switch, cornering light switch), fog light switch, high beam indicator light and relay.
When the lighting SW is turned on by setting it at headlight position, the lighting relay is actuated to turn on the headlight. The optical axis of the headlight can be turned up or down by operating the dimmer SW while headlight is on.
The passing SW is independent of the lighting SW, and the optical axis of the passing light can be turned up only while the switch lever is pulled up and held in this state.
Fog light turns on by switching it to “ON” position to activate relay only while lighting SW is on.
When the headlight is on, turn the turn-signal switch left or right, and then the cornering switch built in the combination switch turns on, followed by the cornering light turning on.

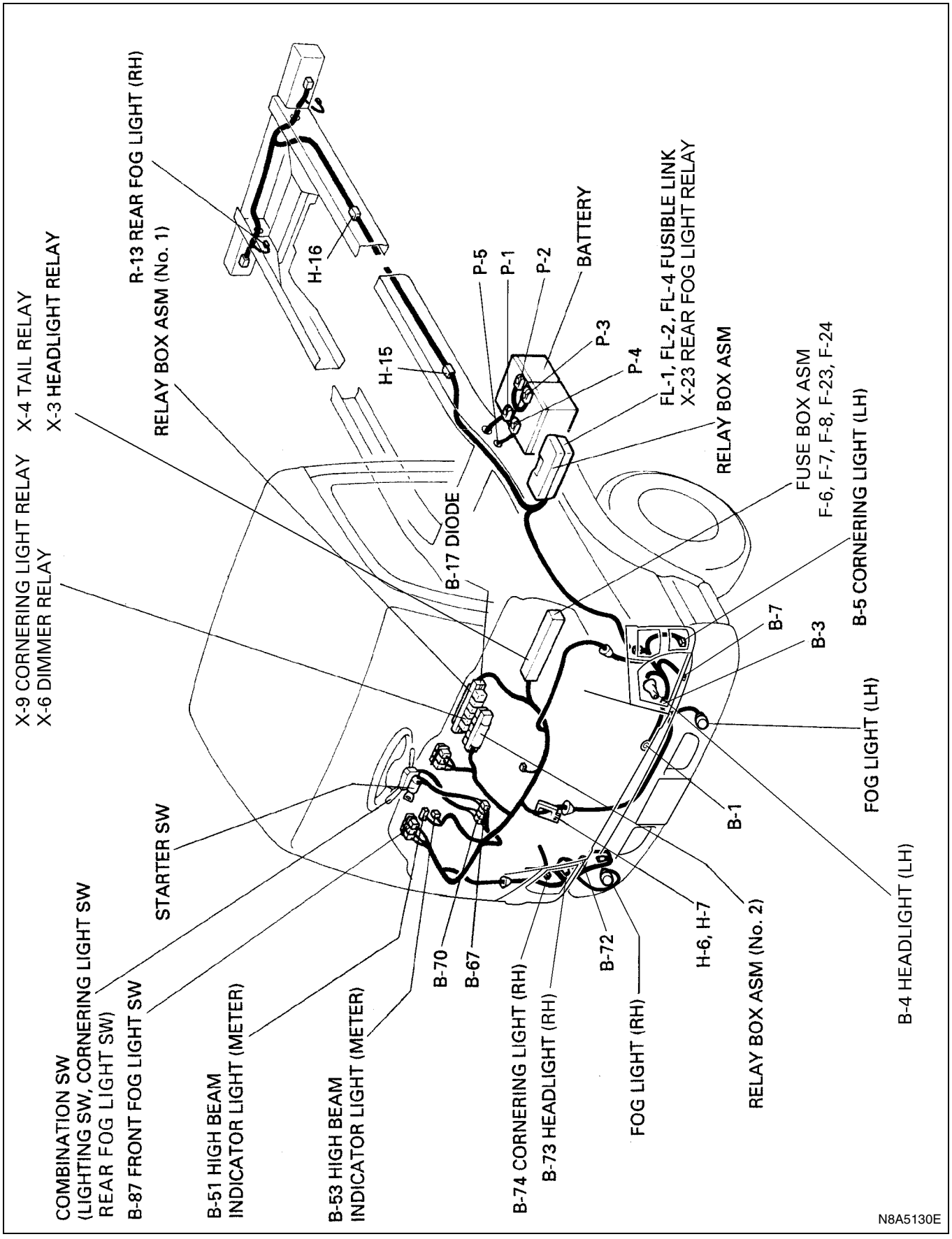
Lighting Circuit



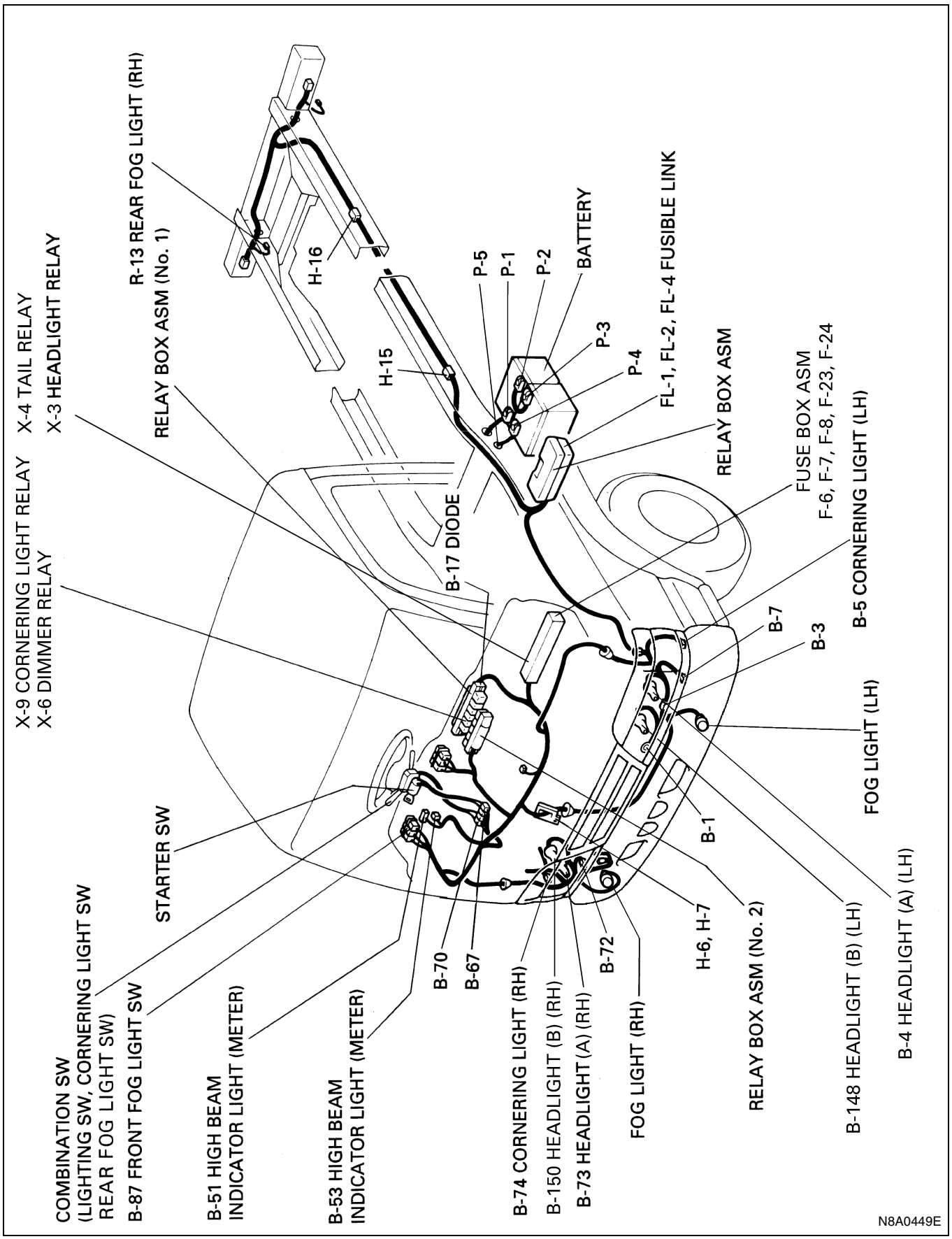
Notice:
Arrow marks indicate the direction of current.

Parts Location

Except NKR For Indonesia

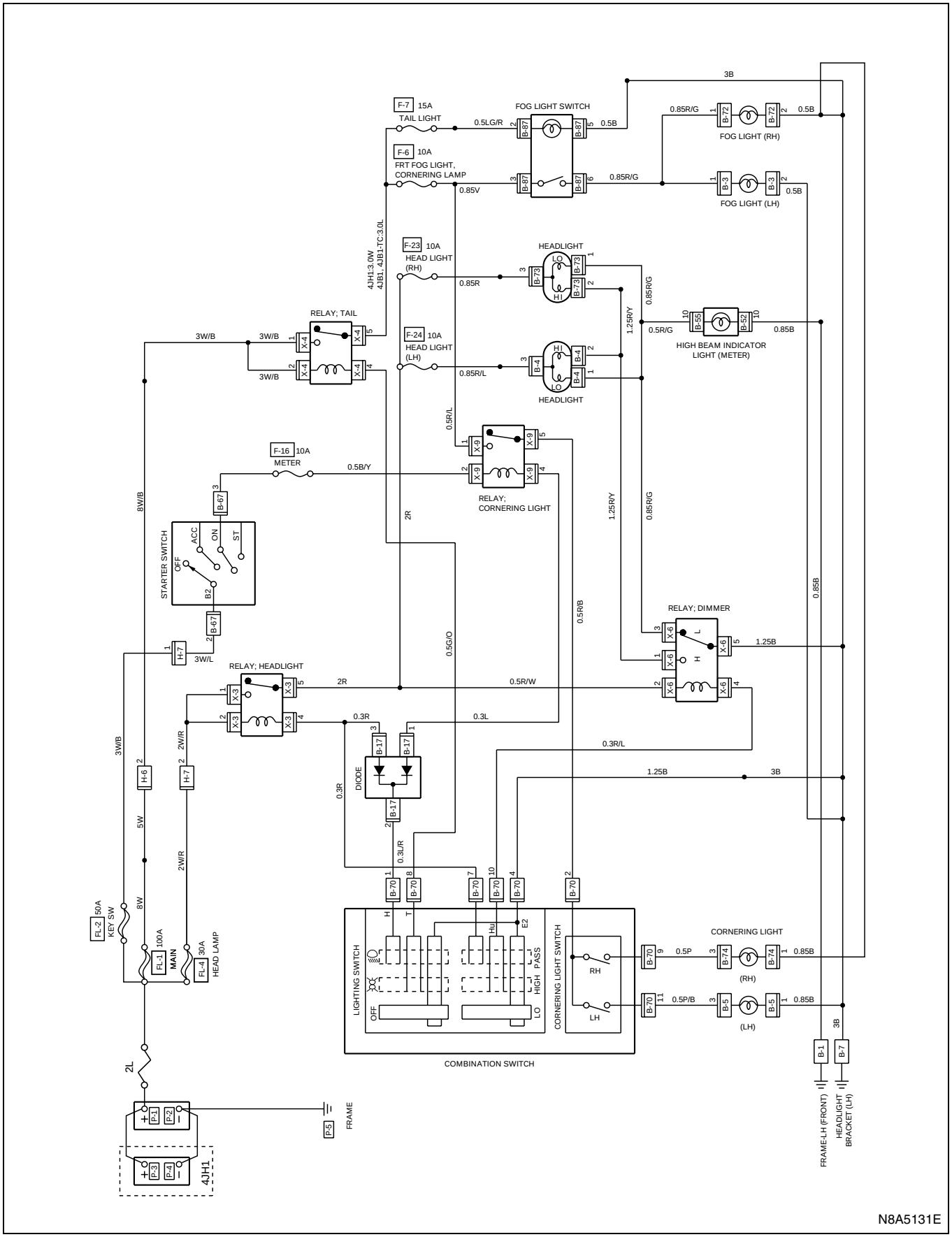


NKR For Indonesia

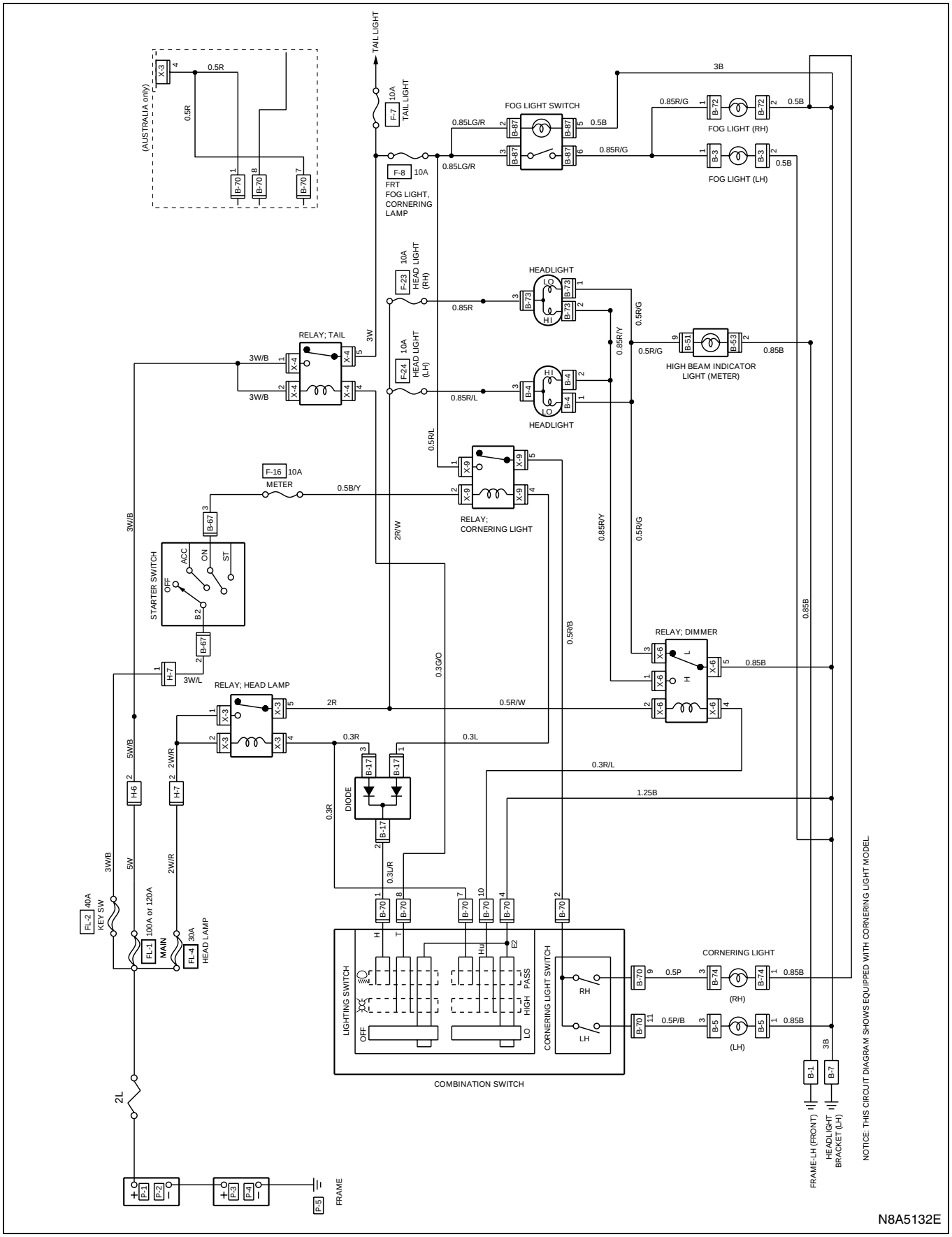


Circuit Diagram

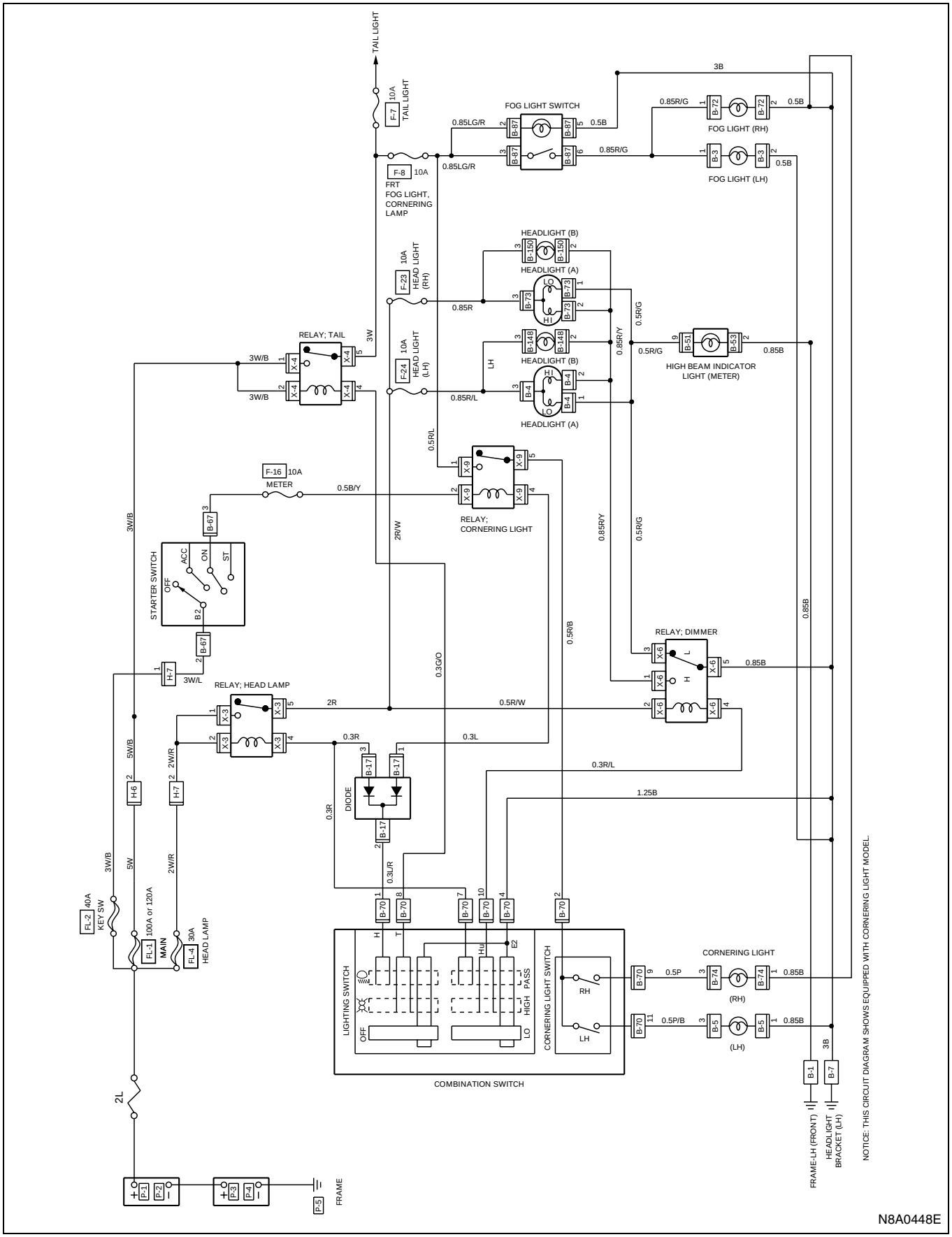
For 12 Volt



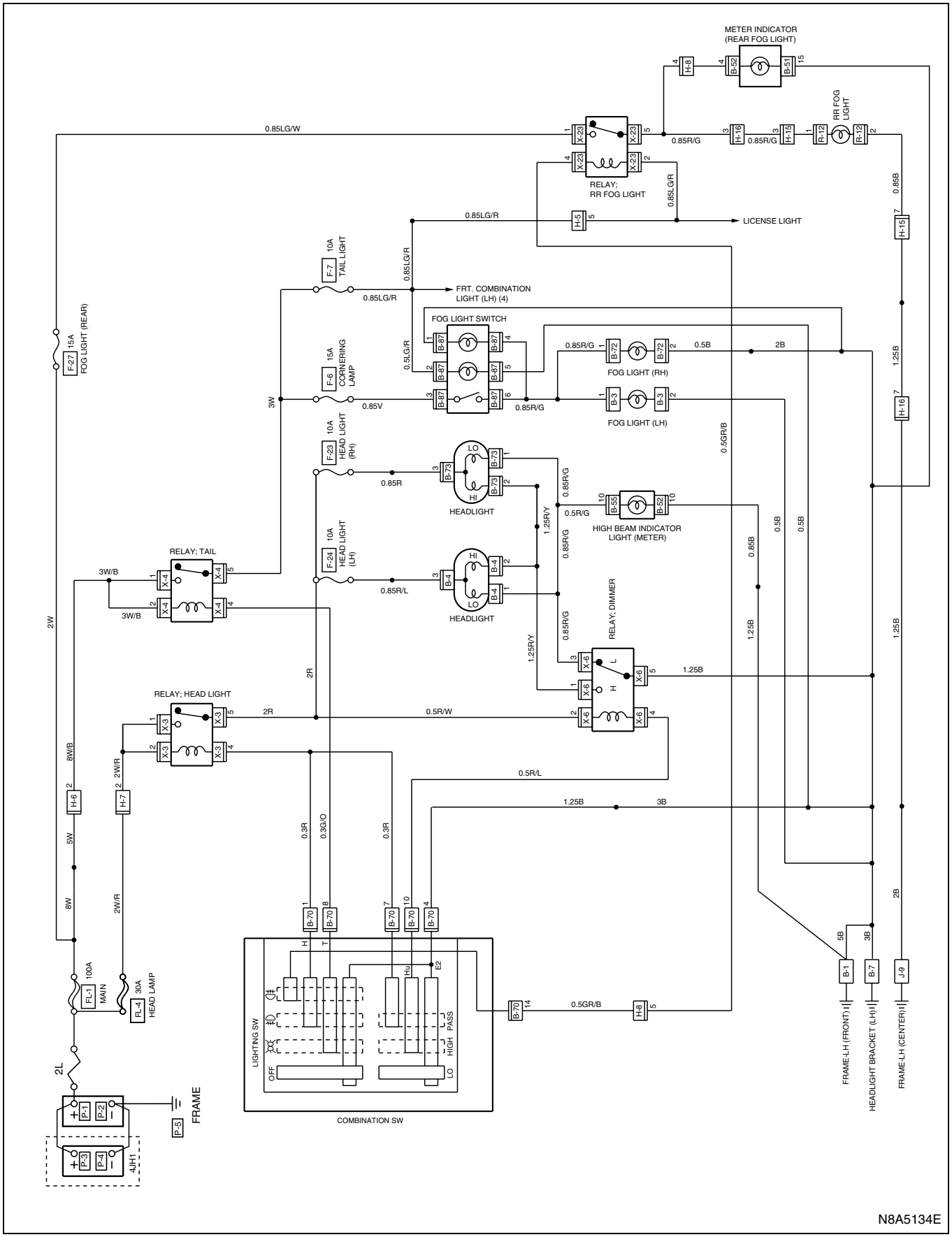
For 24 Volt (Except Europe / NKR For Indonesia)



For 24 Volt (NKR For Indonesia)



For Europe


METER INDICATOR
(REAR FOG LIGHT)
RR FOG
LIGHT
RELAY;
RR FOG LIGHT
LICENSE LIGHT
FRT. COMBINATION
LIGHT (LH) (4)
FOG LIGHT SWITCH
FOG LIGHT (RH)
FOG LIGHT (LH)
HEADLIGHT
HEADLIGHT
HIGH BEAM INDICATOR
LIGHT (METER)
RELAY; TAIL
RELAY; HEAD LIGHT
RELAY; DIMMER
LIGHTING SW
COMBINATION SW
FRAME
FRAME-LH (FRONT) II
HEADLIGHT BRACKET (LH) II
FRAME-LH (CENTER) II
F-27 15A FOG LIGHT (REAR)
F-7 10A TAIL LIGHT
F-6 15A CORNERING LAMP
F-23 10A HEAD LIGHT (RH)
F-24 10A HEAD LIGHT (LH)
FL-1 100A MAIN
RL-4 30A HEAD LAMP
0.85LG/W
0.85R/G
0.85LG/R
0.5LG/R
0.85V
0.85R
0.85R/L
0.5R/G
0.5R/W
0.5R/L
0.5GR/B
0.5GR/W
1.25R/Y
1.25B
0.5B
0.85B
2B
3B
5B
2W
3W
3W/B
8W/B
2W/R
5W
8W
2R
0.3R
0.3G/O
2L
4JH1
N8A5134E

Connector List

No.	Connector Face
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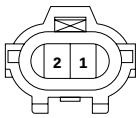
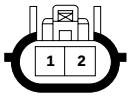
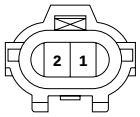
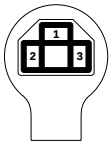
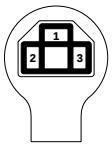
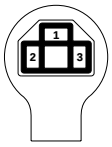
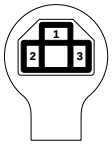
B-3	 002-002
B-72	 002-001
B-72	 002-002
B-4	 003-007
B-73	 003-007
B-148	 003-007
B-150	 003-007

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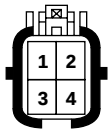
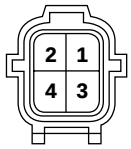
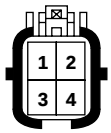
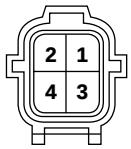
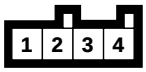
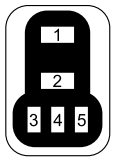
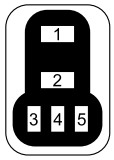
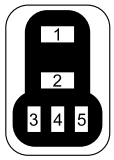
B-5	 004-012
B-5	 004-013
B-74	 004-012
B-74	 004-013
B-17	 004-004
X-3	 005-006
X-4	 005-006
X-6	 005-006

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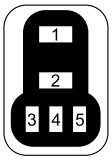
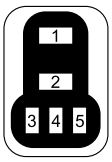
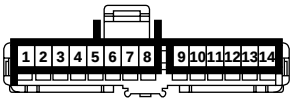
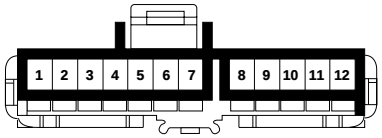
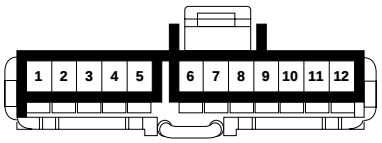
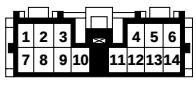
X-23	 005-006
X-9	 005-006
B-51	 014-001
B-52	 012-005
B-55	 012-004
B-67	004-001
B-67	004-002
B-70	 014-002

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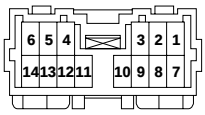
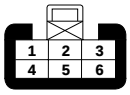
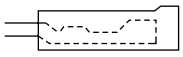
B-70	 014-003
B-87	 006-006
B-153	006-007
B-154	 000-010
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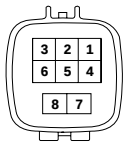
H-15	 008-024
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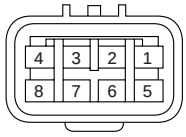
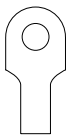
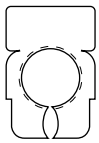
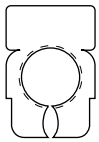
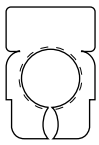
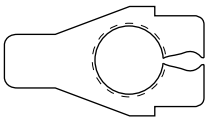
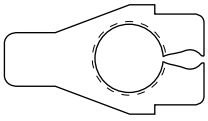
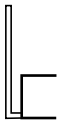
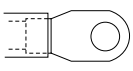
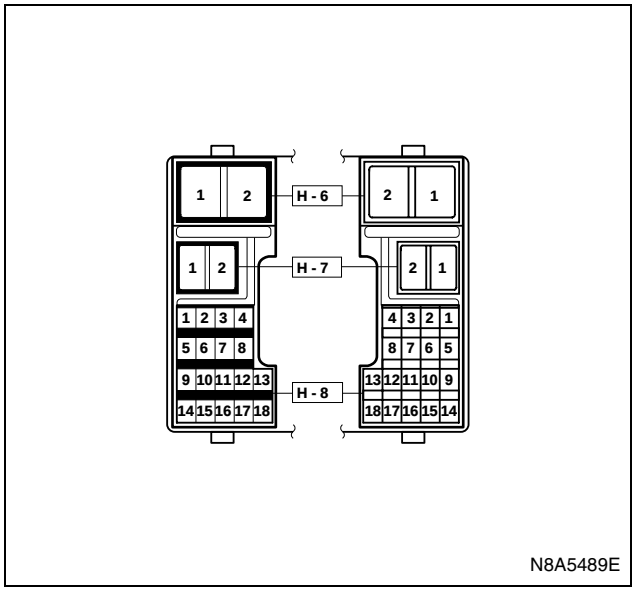
H-16	 008-004

No.	Connector Face
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
P-5 (12 V)	 000-007
P-5 (24 V)	 000-002

H-6, H-7, H-8



N8A5489E

Diagnosis

Quick Chart for Check Point

1. Headlight

		Check point										
		Fuse			Fusible link	Headlight relay	Lighting SW	Dimmer / Passing SW	Dimmer relay	Headlight bulb		Cable harness
		F-6 F-8 (10 A)	F-23 (10 A)	F-24 (10 A)	FL-4 (30A)					LH	RH	
Trouble mode	1-1. Both Headlights inoperative				❍ (2)	❍ (1)	❍ (4)					❍ (3)
	1-2. Headlight on the left (or right) side inoperative		❍ (1)	❍ ((1))								❍ (2)
	1-3. Headlight in low-beam inoperative								❍ (1)			❍ (2)
	1-4. Headlight in high-beam inoperative								❍ (1)			❍ (2)
	1-5. Headlight on the left (or right) side in low (or high)-beam inoperative									❍ (1)	❍ ((1))	❍ (2)
	1-6. Headlight beam does not change	❍ (1)						❍ (2)	❍ (3)			❍ (4)
	1-7. Headlights remain on when the lighting switch turned off					❍ (1)	❍ (2)					❍ (3)
	1-8. Headlights come on with the lighting SW at the clearance light position						❍ (1)					

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

2. Fog Light

		Check point					
		Fuse F-8 (10 A): 24 V F-6 (10 A): 12 V	Taillight relay	Fog light SW	Fog light bulb		Cable harness
					LH	RH	
Trouble mode	2-1. Both fog lights inoperative (while lighting switch is on)	❍ (1)	❍ (2)	❍ (3)			❍ (4)
	2-2. Fog light on the left (or right) side inoperative (while lighting switch is on)				❍ (1)	❍ ((1))	❍ (2)
	2-3. Fog lights remain on		❍ (1)	❍ (2)			❍ (3)

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

3. Cornering Light

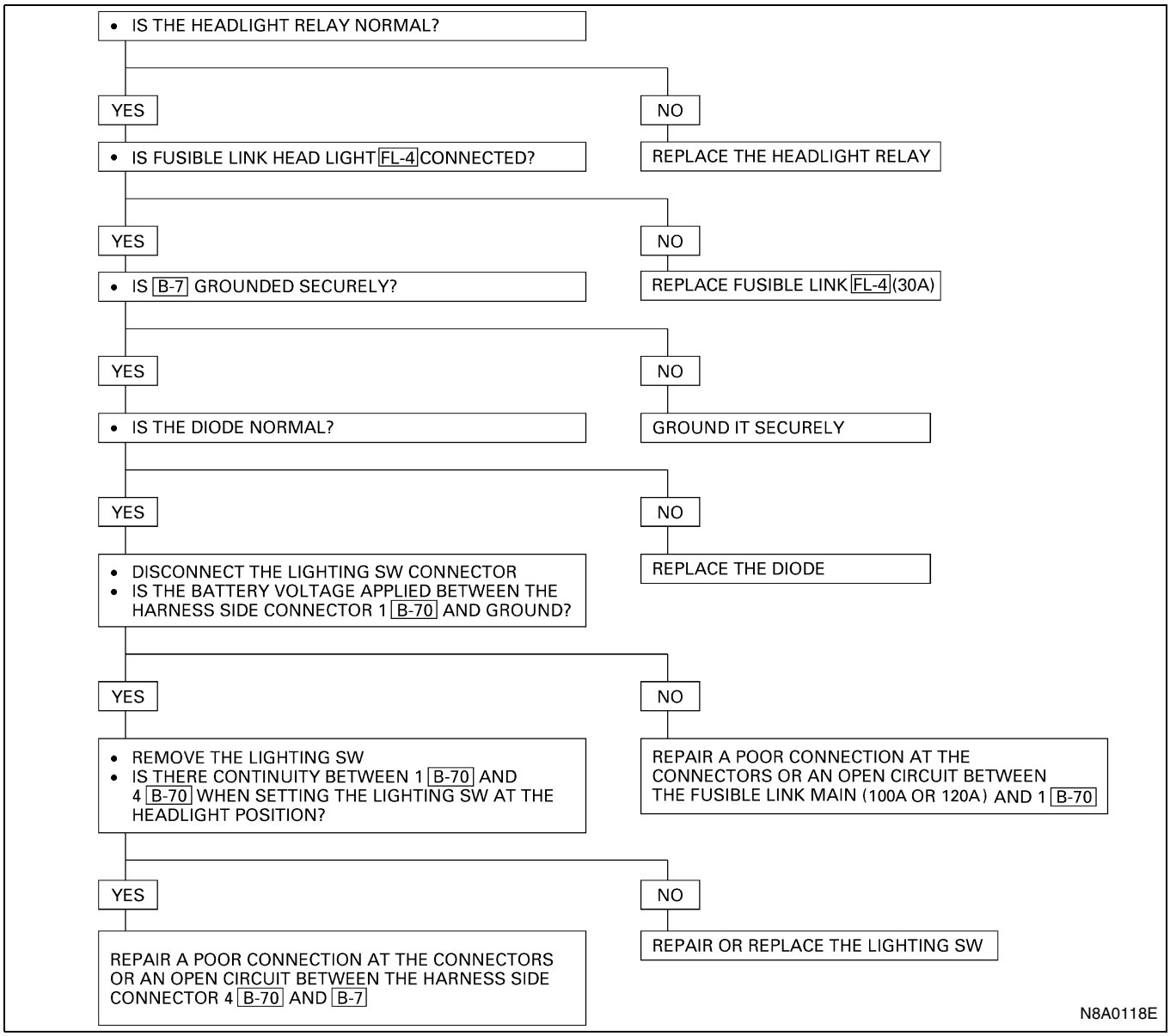
		Check point					
		Fuse		Cornering light SW	Cornering light bulb	Cornering light relay	Cable harness
		F-8 (24 V), F-6 (12 V) (10 A)	F-16 (10 A)				
Trouble mode	3-1. Both cornering lights inoperative	❍ (2)	❍ (1)	❍ (5)		❍ (3)	❍ (4)
	3-2. Cornering light on the left (or right) side inoperative			❍ (2)	❍ (1)		❍ (3)
	3-3. Cornering light remains on even when steering wheel is in the straight ahead position			❍ (1)			

4. Rear Fog Light

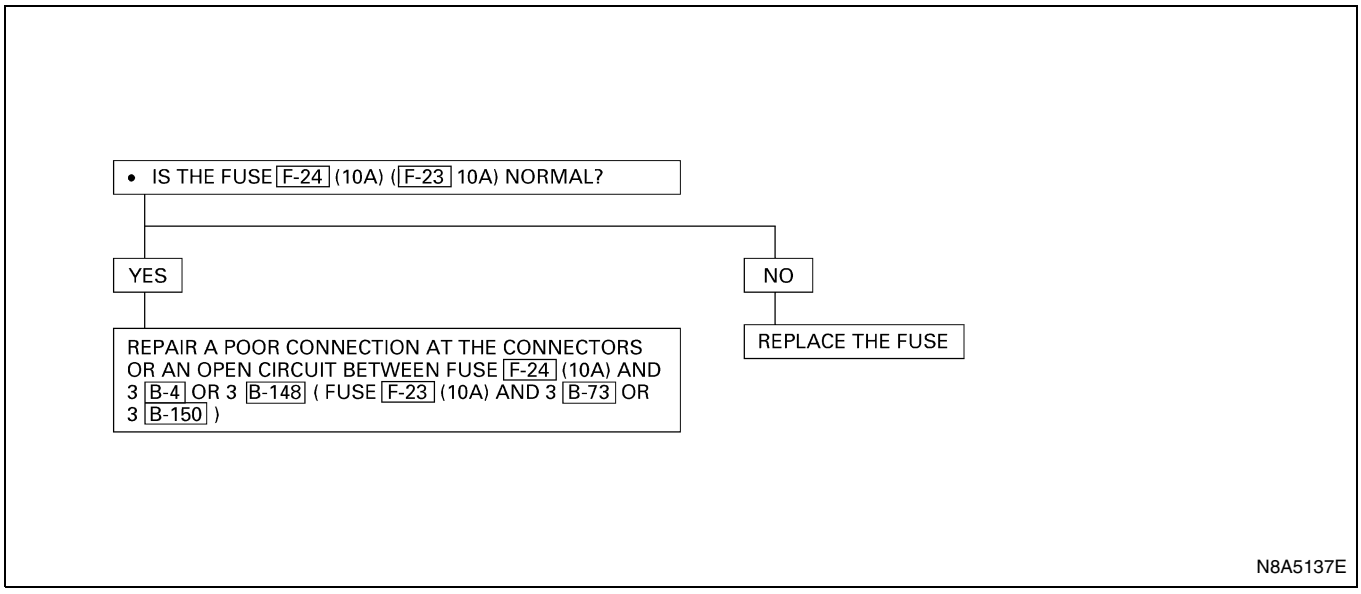
		Check point				
		Fuse F-27 (15 A)	Rear fog light SW	Rear fog light relay	Rear fog light bulb	Cable harness
Trouble mode	4-1. Rear fog light inoperative (while headlight is ON)	❍ (2)	❍ (4)	❍ (3)	❍ (1)	❍ (5)

1. Headlight

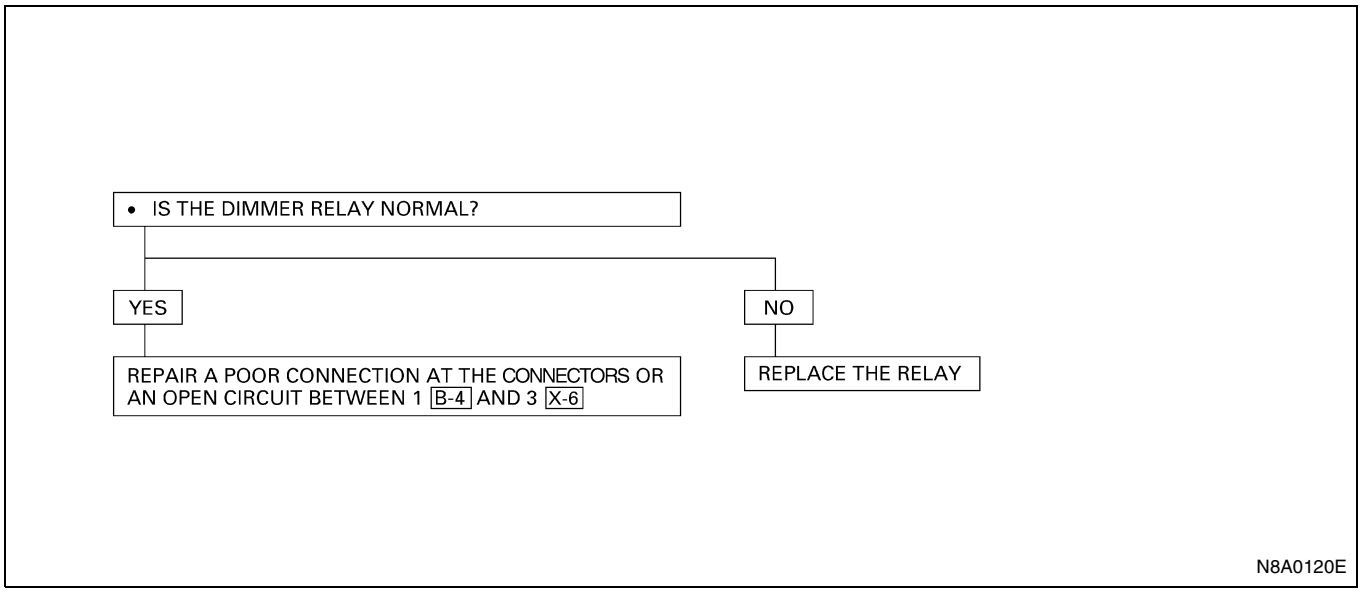
1-1. Both Headlights Inoperative



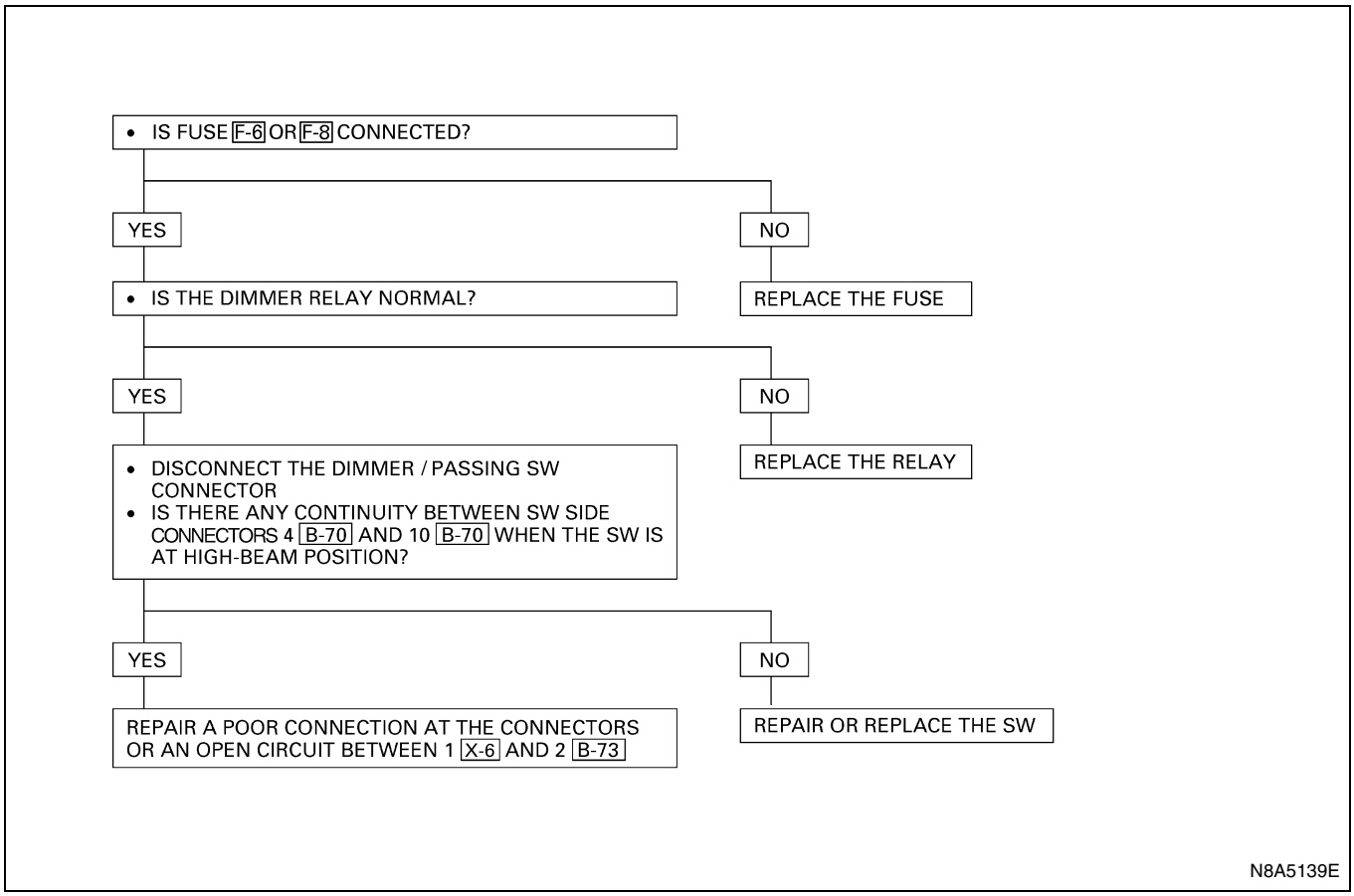
1-2. Headlight on The Left (or Right) Side Inoperative



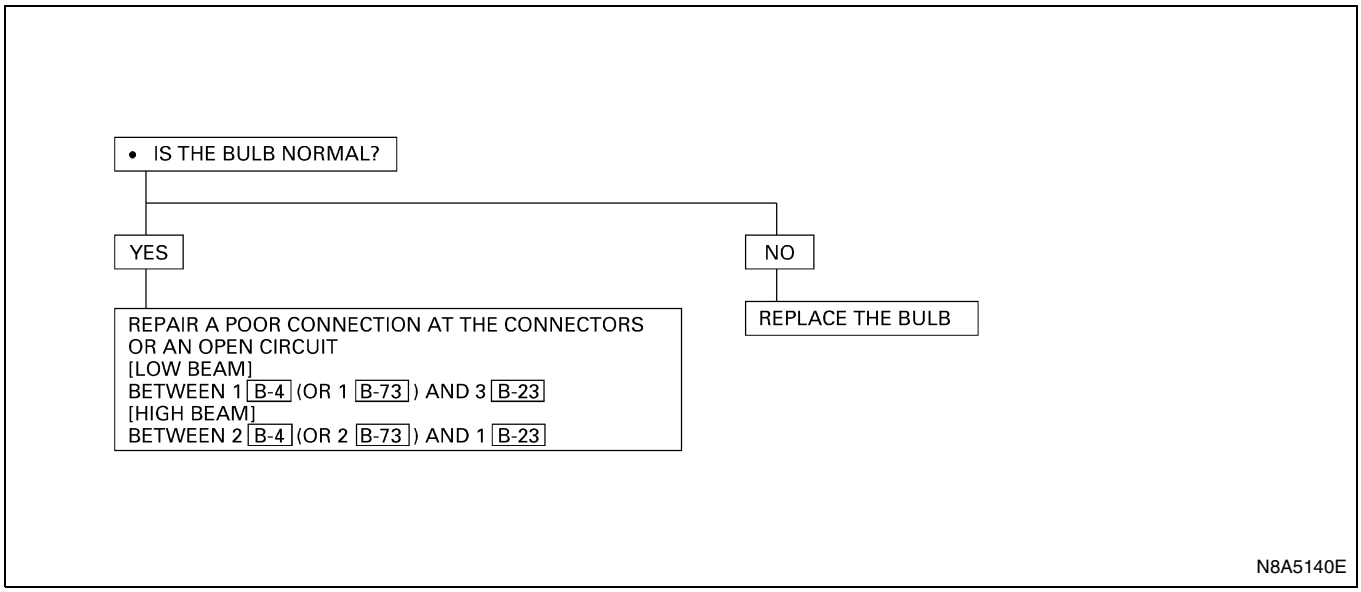
1-3. Headlight in Low-beam Inoperative



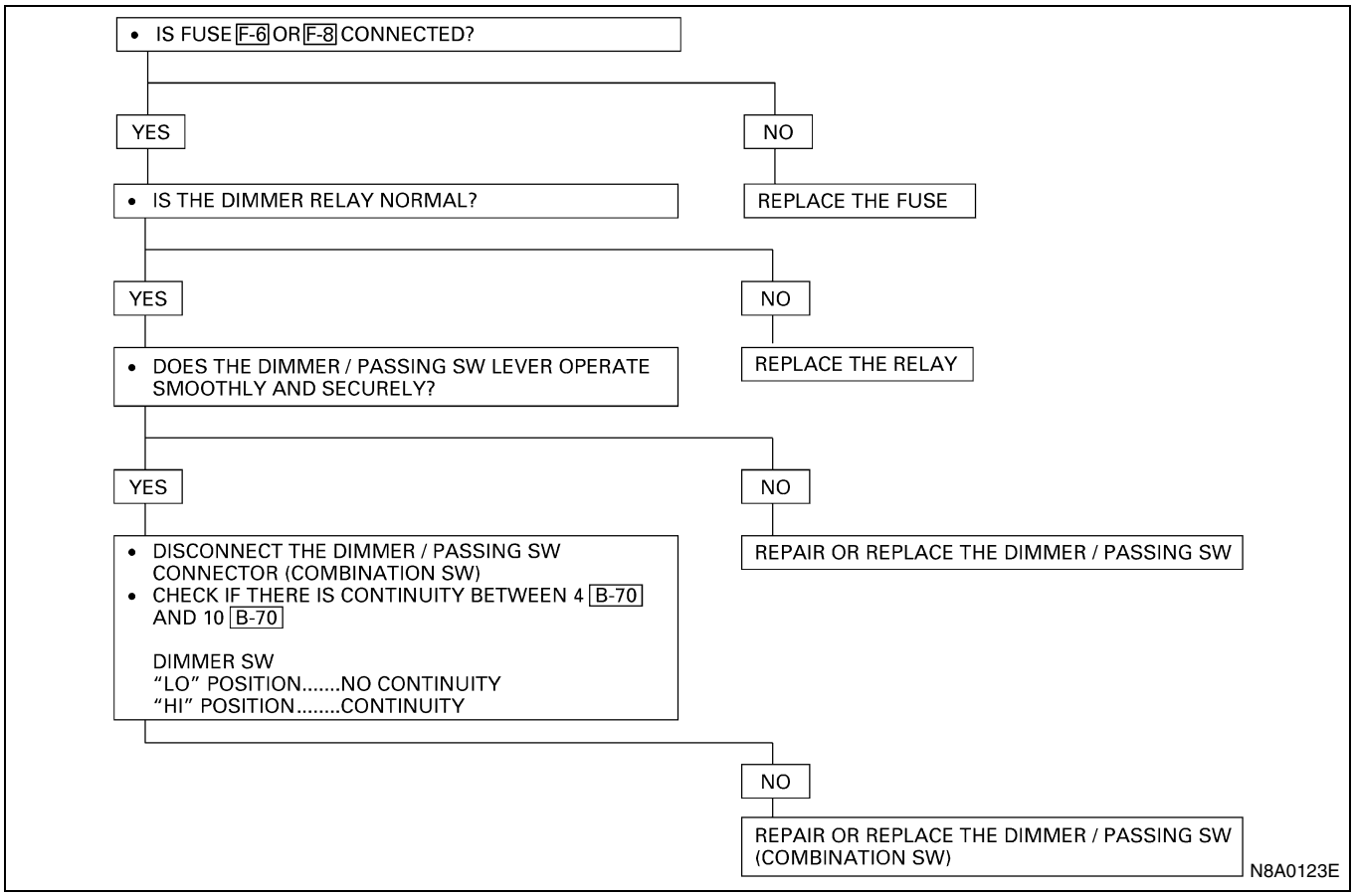
1-4. Headlight in High-beam Inoperative



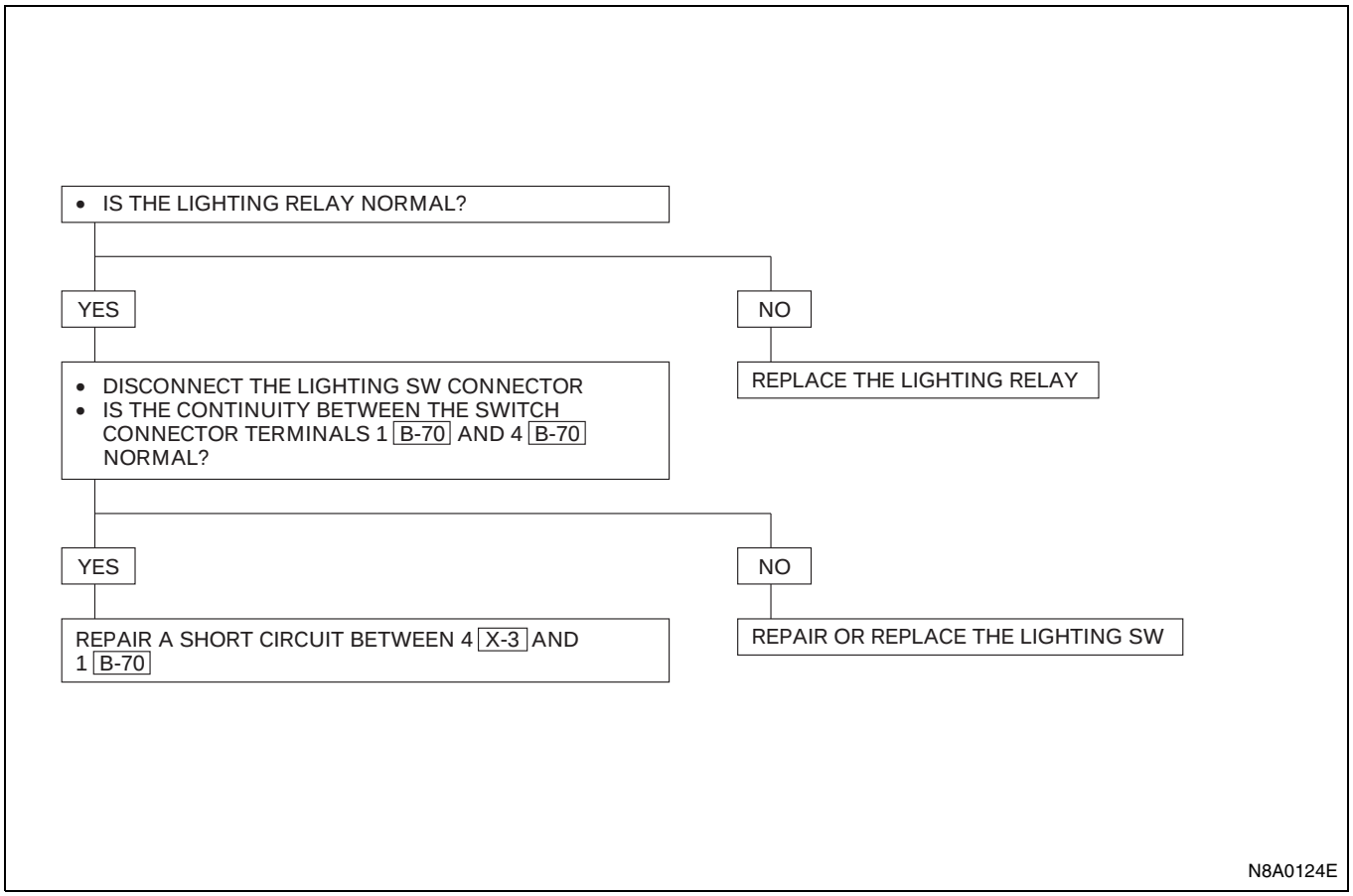
1-5. Headlight on The Left (or Right) Side in Low (or High)-beam Inoperative



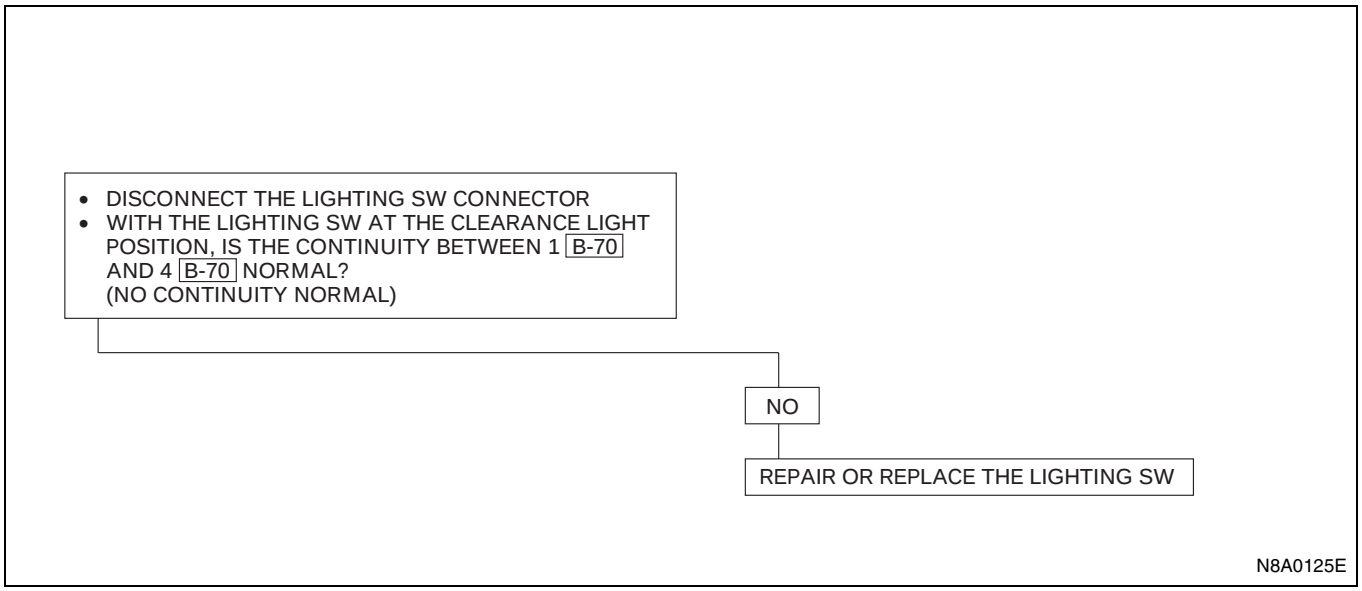
1-6. Headlight Beam Does Not Change



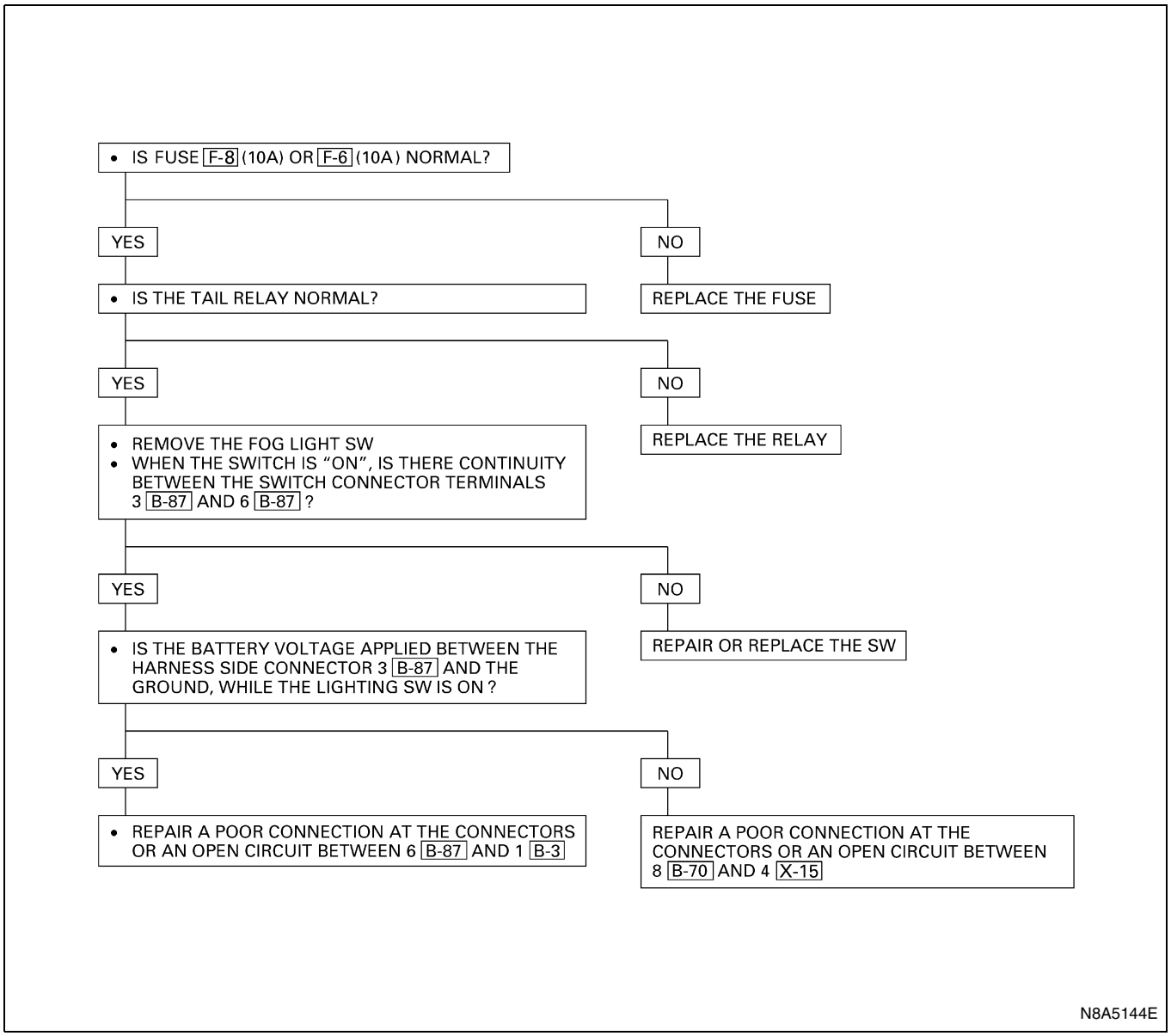
1-7. Headlight Remains On When The Lighting SW is Turned Off



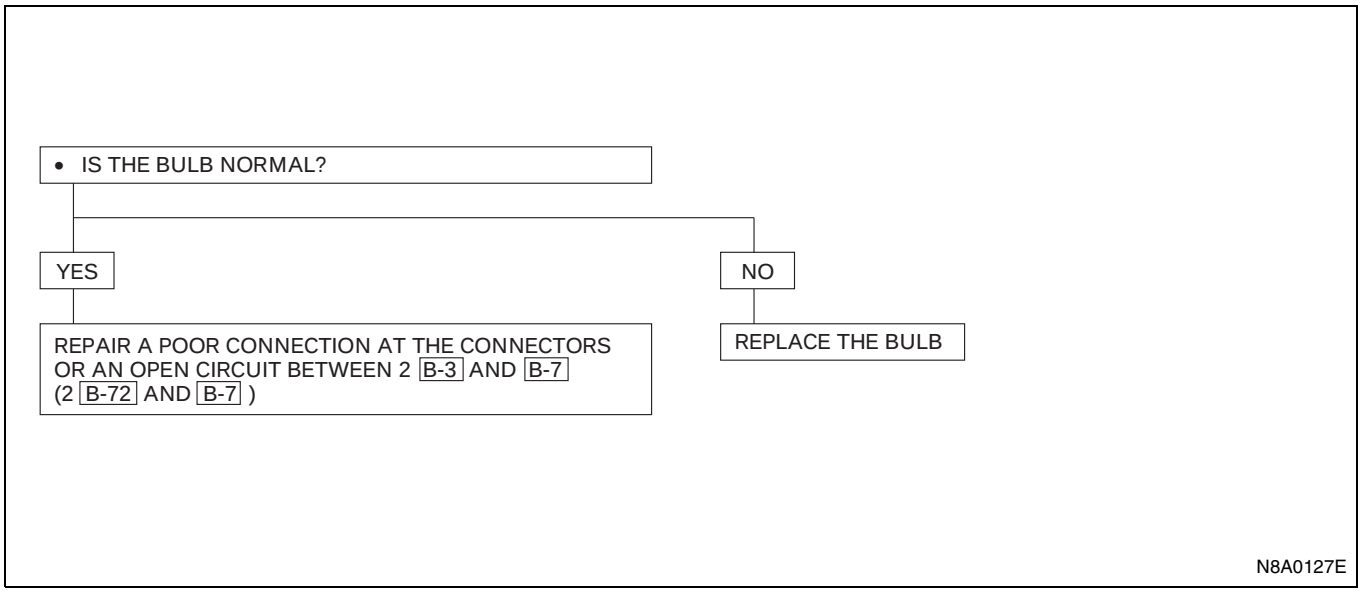
1-8. Headlight Comes On With The Lighting SW at The Clearance Light Position



2. Fog Light
2-1. Both Fog Lights Inoperative (while Lighting Switch is On)

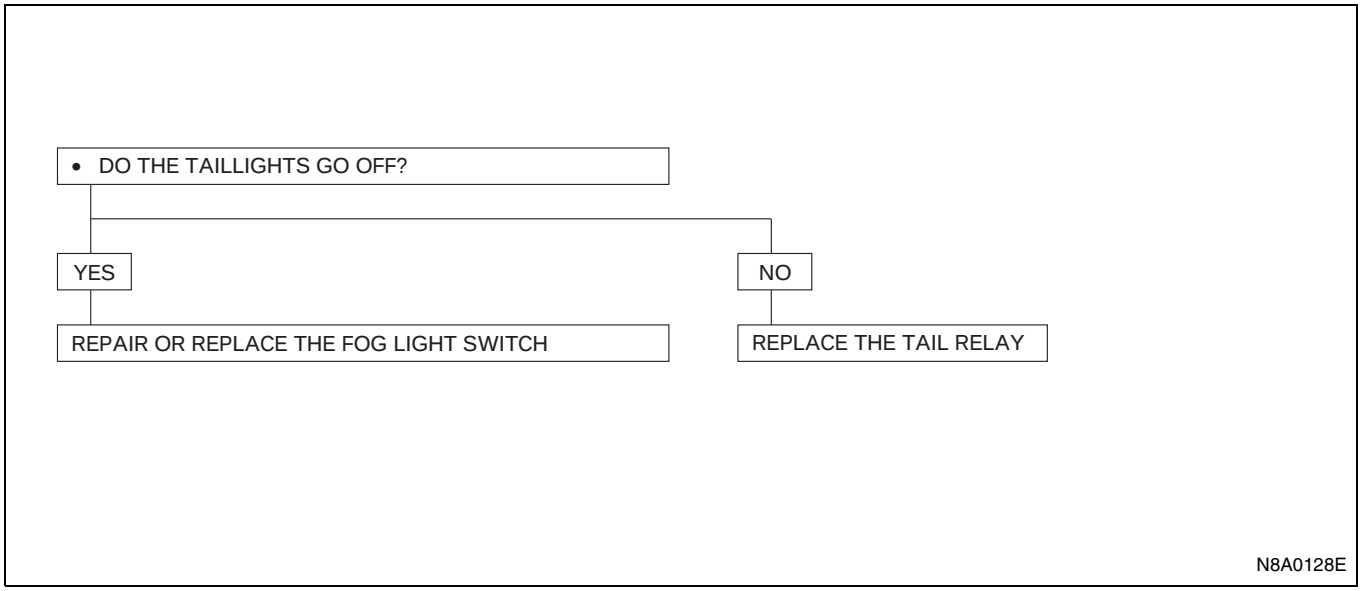


2-2. Fog Light on The Left (or Right) Side Inoperative (while Lighting Switch is On)

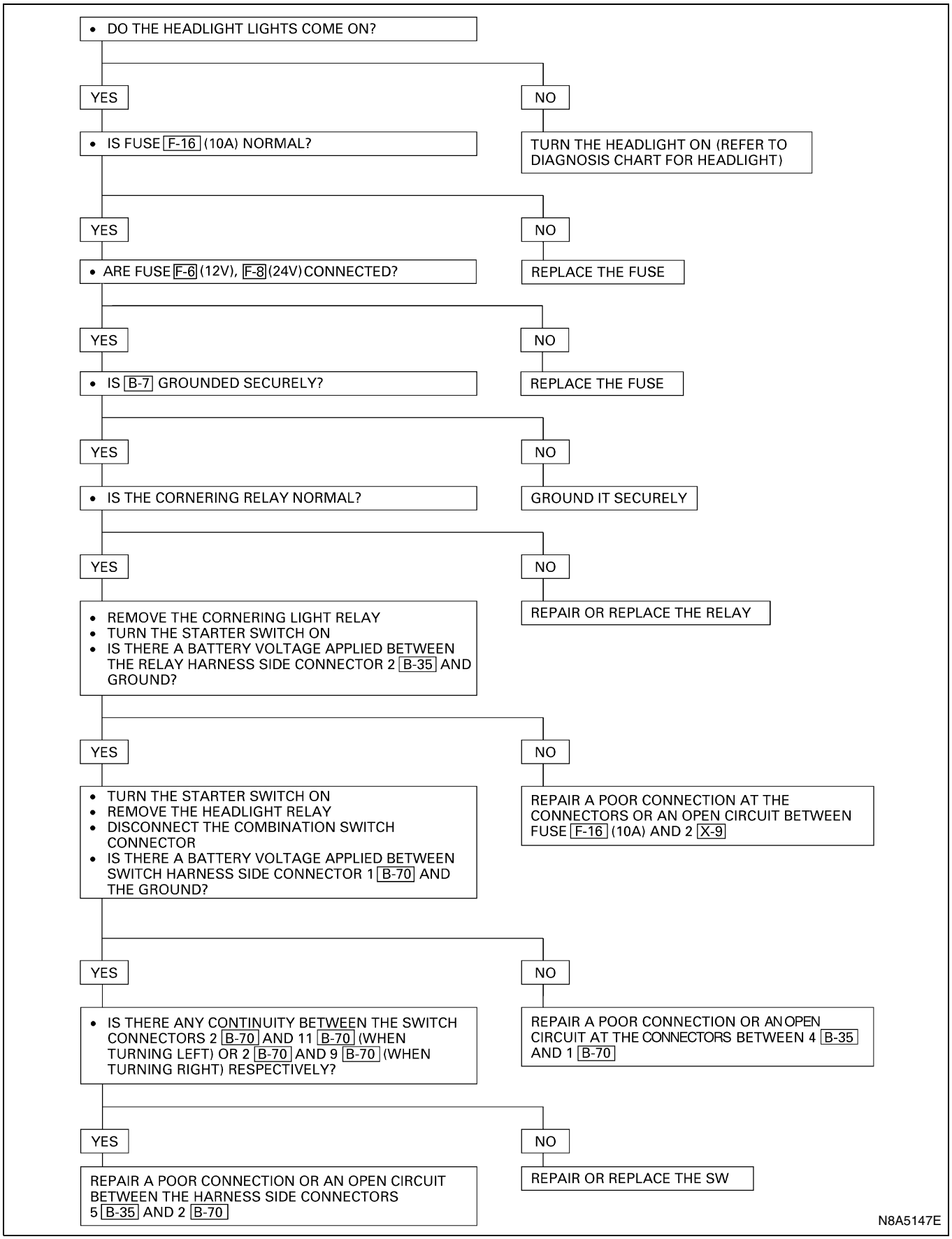


Notice:
Figures in parenthesis “( )” indicate place of inspection for the fog light on the right.

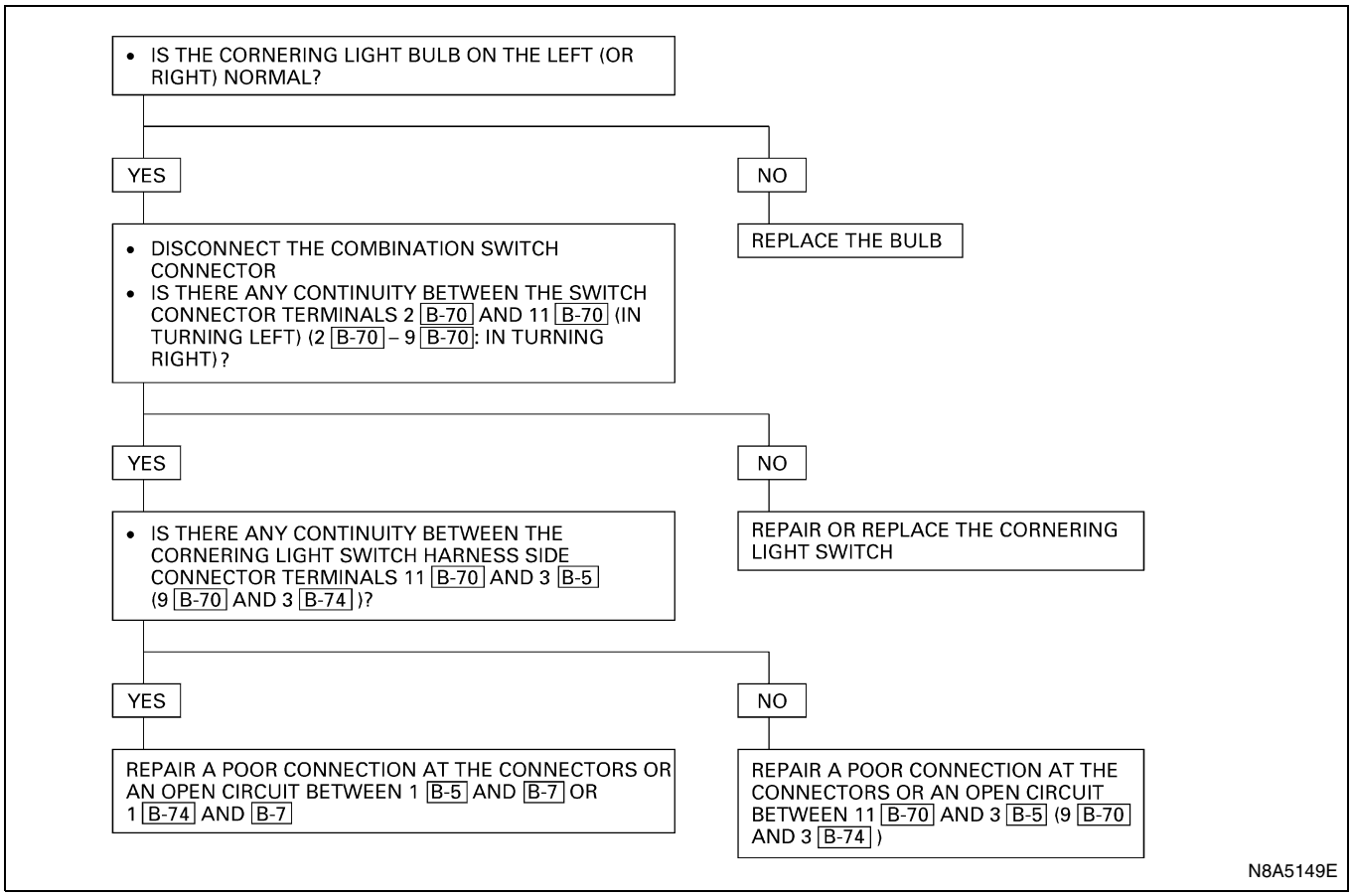
2-3. Fog Light Remains On



3. Cornering Light
3-1. Both Cornering Lights Inoperative

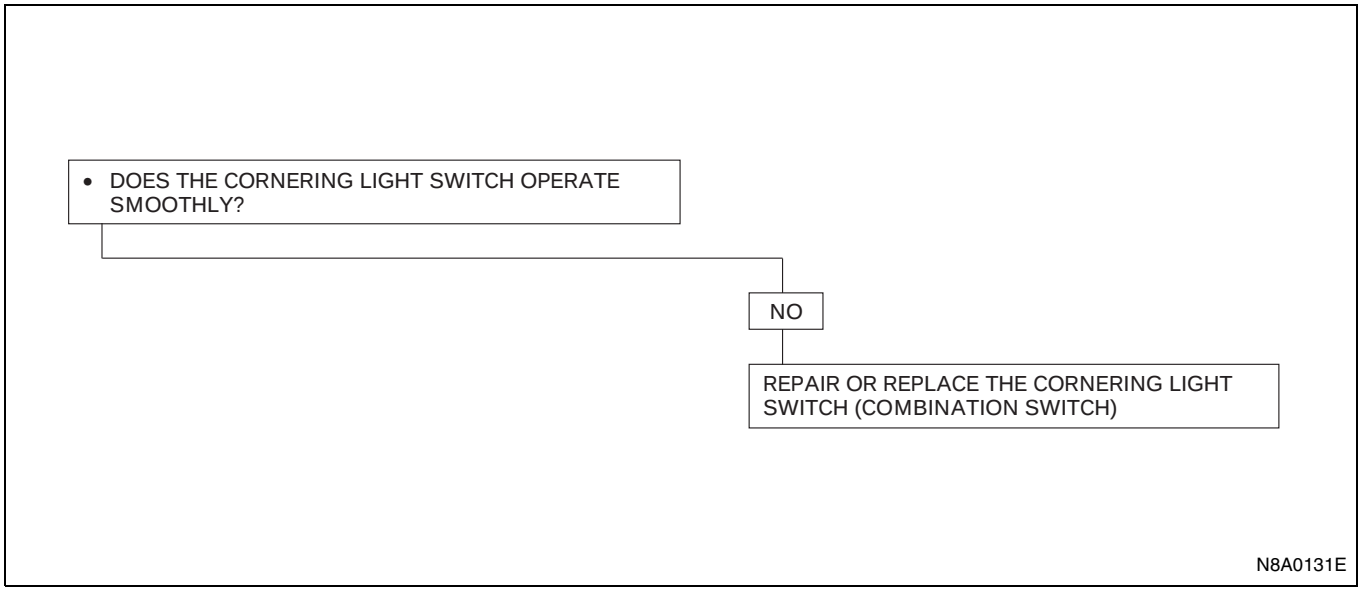


3-2. Cornering Light on The Left (or Right) Side Inoperative

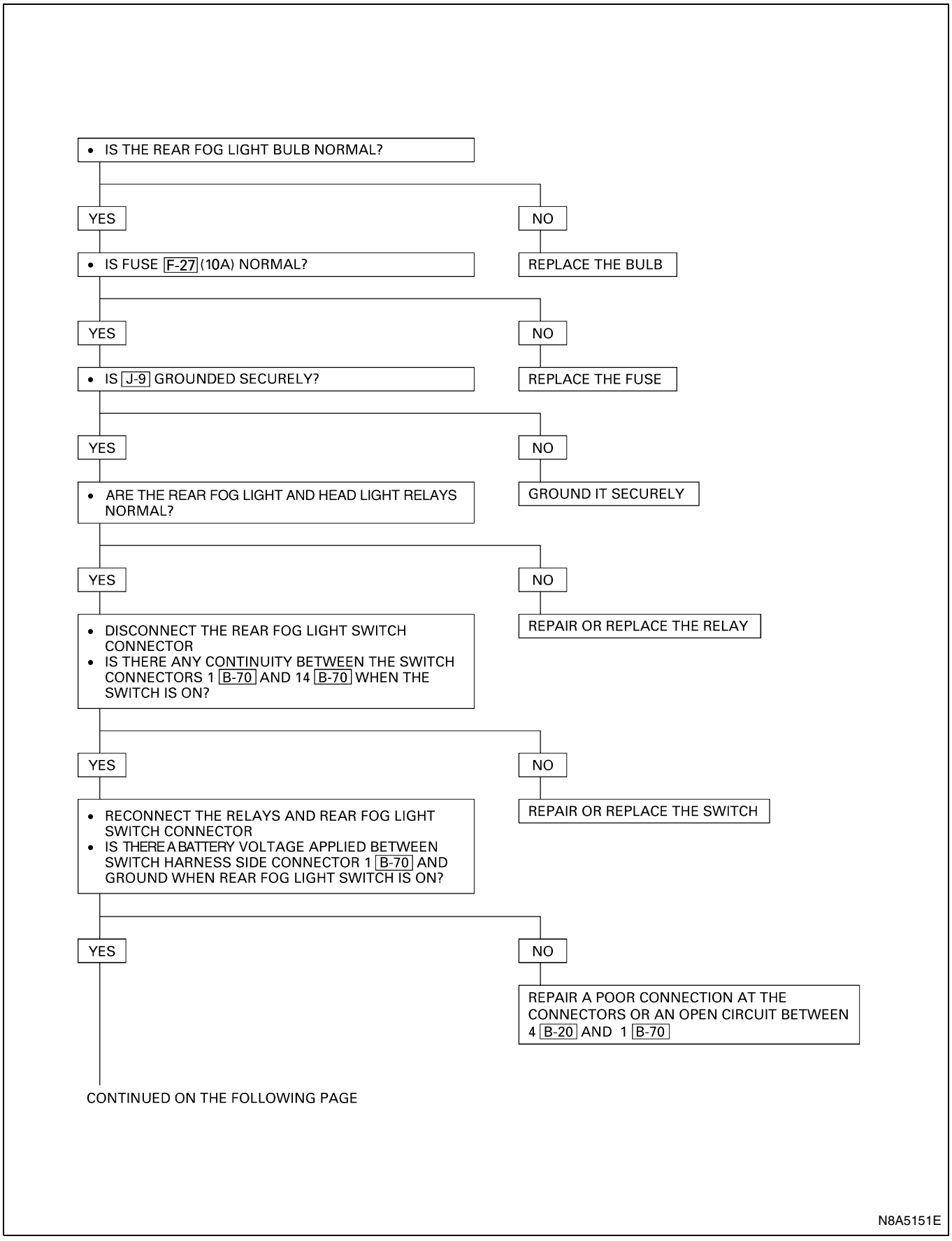


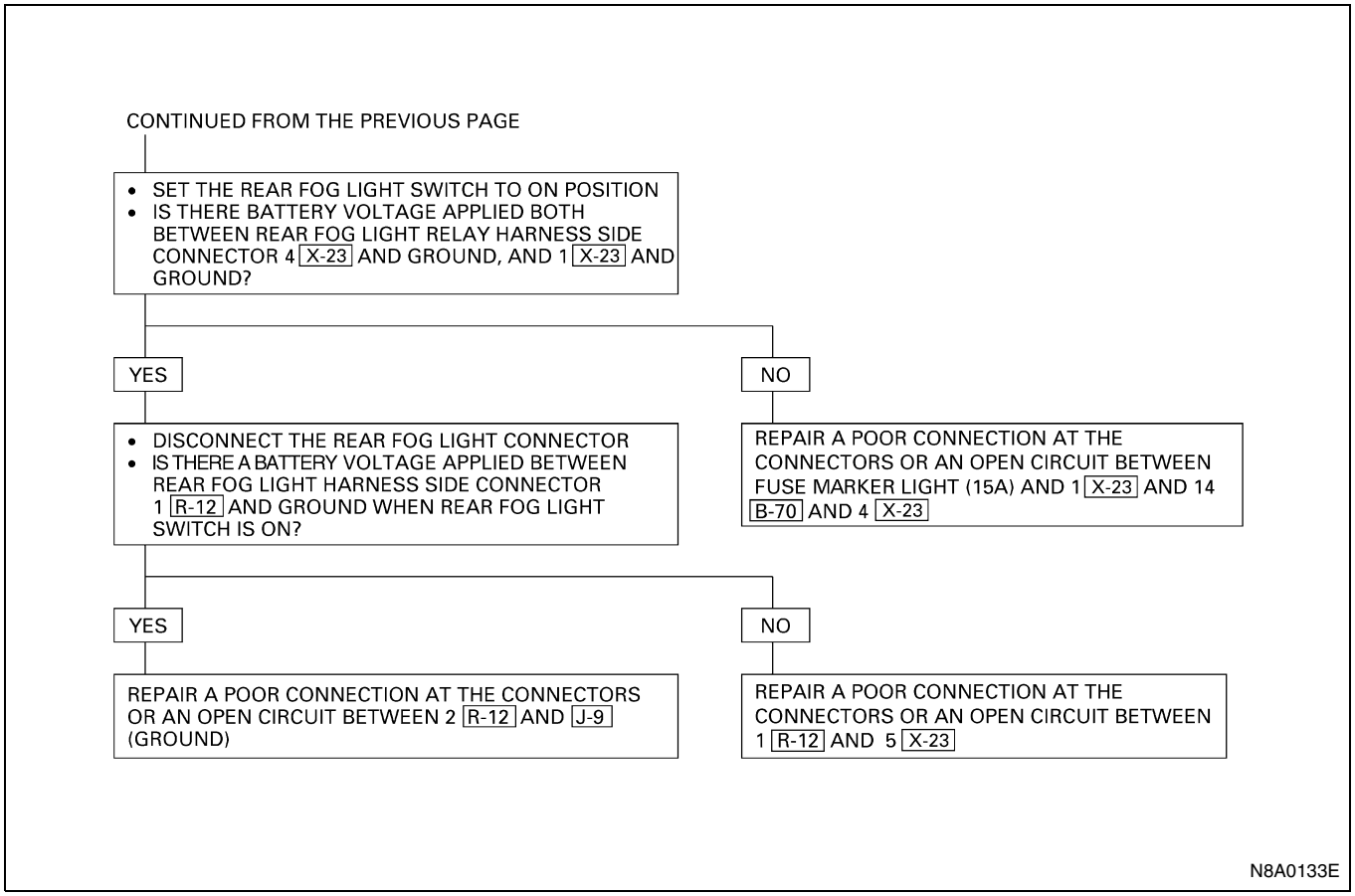
Notice:
Figures in parenthesis “( )” indicate place of inspection for the cornering light on the right.

3-3. Cornering Light Remains On Even When Steering Wheel is in Straight Ahead Position



4. Rear Fog Light
4-1. Rear Fog Light Inoperative (while Headlight is ON)





Starter Switch

Refer to “START AND CHARGING” in this section.

High Beam Indicator Light

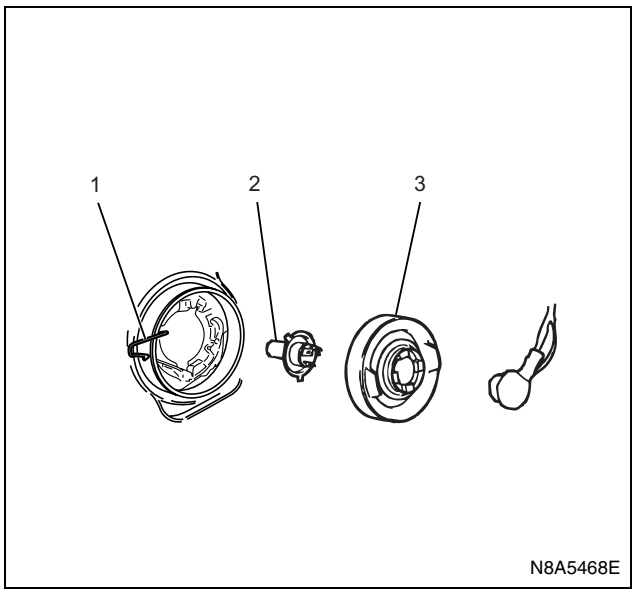
Refer to “METER AND WARNING/INDICATOR LIGHT” in this section.

Headlight Bulb Replacement

Removal

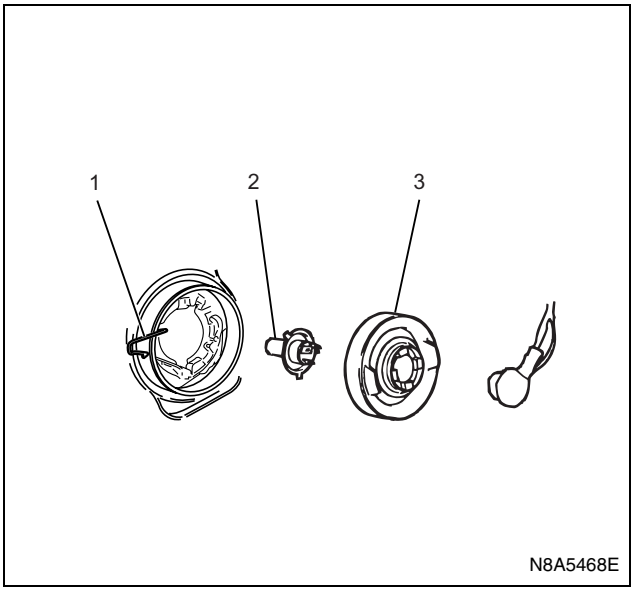
1. Remove the battery ground cable at the battery.
2. Remove the headlight assembly. (Refer to ‘Headlight Replacement’ below.)
3. Remove the headlight bulb.
   - Remove the dust cover (3).
   - Remove the clip (1).
   - Remove the headlight bulb (2).

Caution:
Do not touch the glass portion of the bulb with your fingers.



Installation

1. Install the headlight bulb.
   - Set the headlight bulb (2).
   - Fix the headlight bulb with clip (1).
   - Install the dust cover (3).
2. Install the headlight assembly.
   (Refer to ‘Headlight replacement’ below.)
3. Connect the battery ground cable at the battery.
4. Check if the light lights.



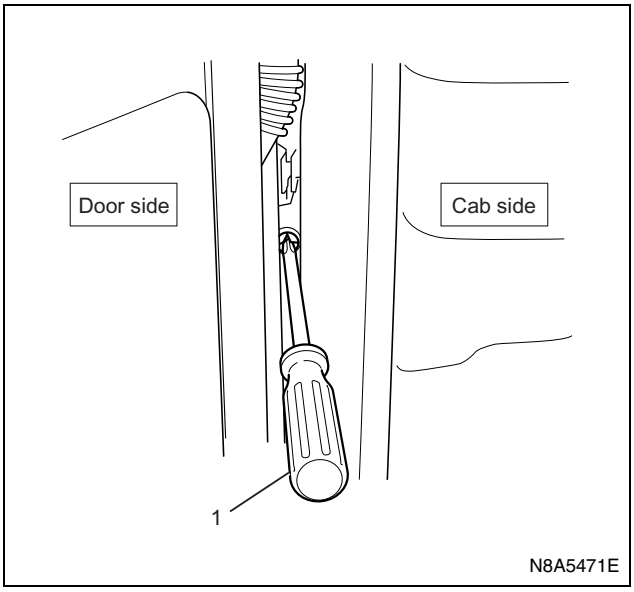
Caution:
Do not touch the glass portion of the new bulb with your fingers.

Headlight Replacement

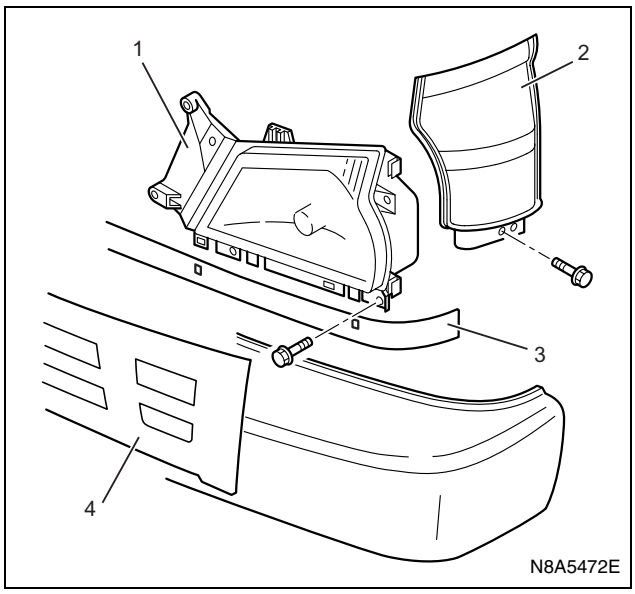
Removal

Preparation: Disconnect the battery ground cable.

1. Remove the battery ground cable at the battery.
2. Remove the seal rubber (3).
   - Remove the seal rubber from beneath the headlight.
3. Remove the front combination light (2).
   - Open the cab door. Insert a screwdriver (1) into the space between the cab and the cab door. Use the screwdriver to force out the stud pin at the center of the grommet (the pin securing the front combination light).



   - Remove the fixing screw.
   - Remove the two catches.
   - Remove the front combination light connector.
4. Remove the front grille (4).
   - Remove the bolt at the center of the front grille.
   - Remove the four clips securing the front grille.
   - The grille is secured by 4 clips (2 clips at the inside of each headlight). Pull the grille toward you to remove it.
5. Remove the front corner panel.
6. Remove the headlight (1).
   - Remove the four bolts securing the headlight (loosen the fixing bolts at the bottom of the front side panel to create working space).
   - Remove the headlight clips.
   - Remove the headlight connector.



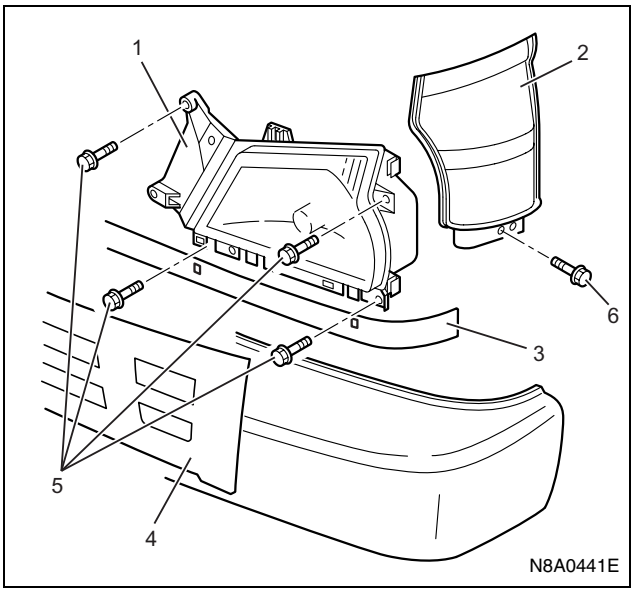
Installation

1. Assemble the headlight assembly (1).
   - Connect the connector.
   - Fix it to body panel with four bolts (5).
2. Assemble the front panel side.
   (Refer to “DOOR” in section 2.)
3. Install the front grille (4).
4. Install the front combination assembly (2).
   1) Position it by aligning two pawls with the groove of H/L.
   2) Fit the iron PIN in the upper portion by aligning it with the center of corresponding grommet.

Notice:
Push it into securely with a force of approx. 250 N (25 kgf) until click is heard.

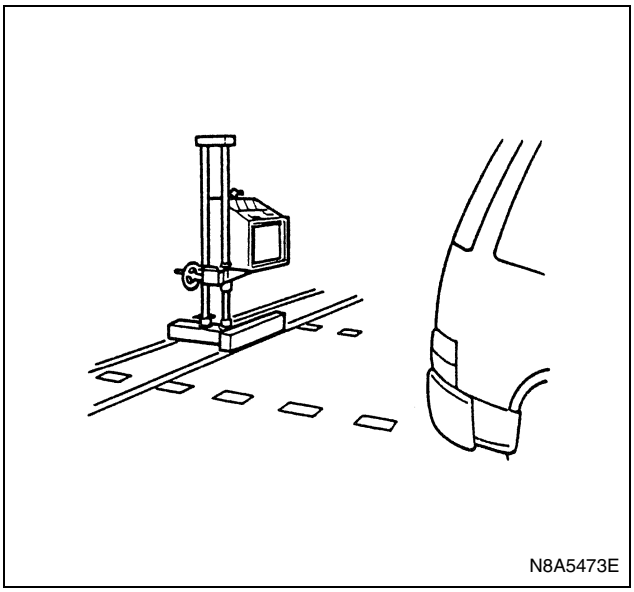
   3) Pull the front combination light assembly lightly toward the front of vehicle to make sure that the PIN and grommet are engaged securely.
   4) Tighten one bolt (6) in the lower portion of front combination light assembly.
   5) Hook the seal rubber (3) on two projections under H/L.

5. Connect the battery ground cable.
6. Check the operation and lighting of each lamp.



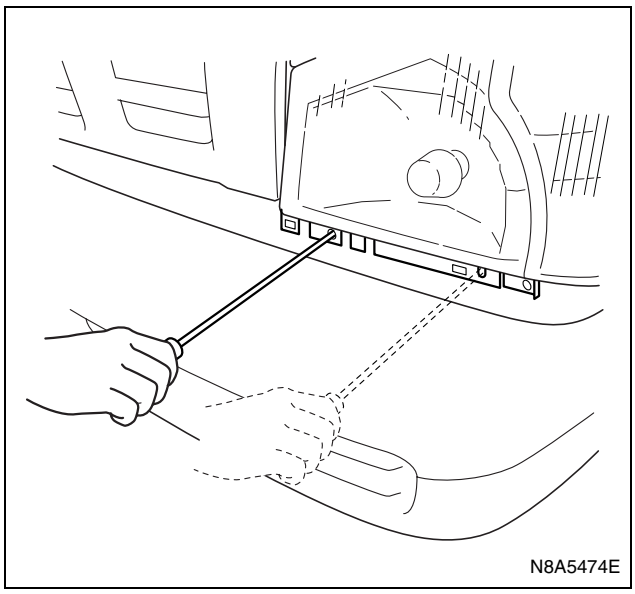
Aiming of Headlight

Preparation: Place the unloaded vehicle on a level surface and check to see if the inflation pressure of the tires is correct, the lenses are clean, and the battery is sufficiently charged. Adjust the aim with the headlight tester. When adjusting, follow the procedure of the tester manufacturer's.



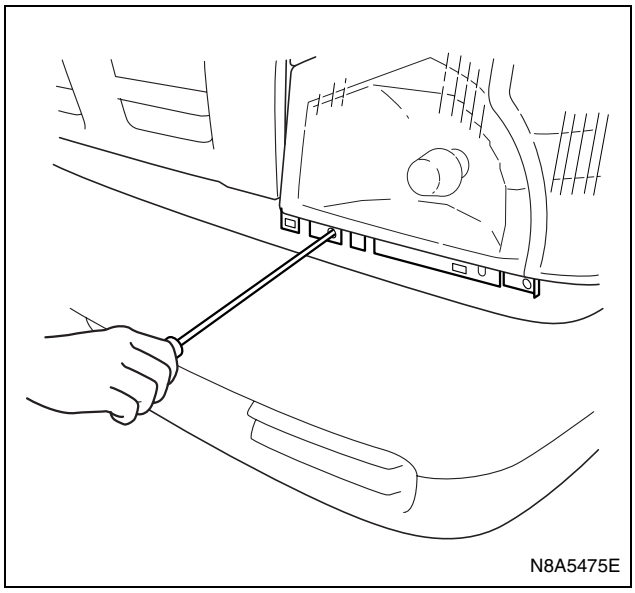
Vertical Adjustment

Insert the tip of a screwdriver into the hole beneath the headlight (the shaft of the screwdriver must be slanted up) until contact is made with the head of the adjusting screw. Turn the screw to adjust headlight focus up or down.
Two vertical aim screws should be turned in the same direction at the same time to adjust aiming.



Horizontal Adjustment

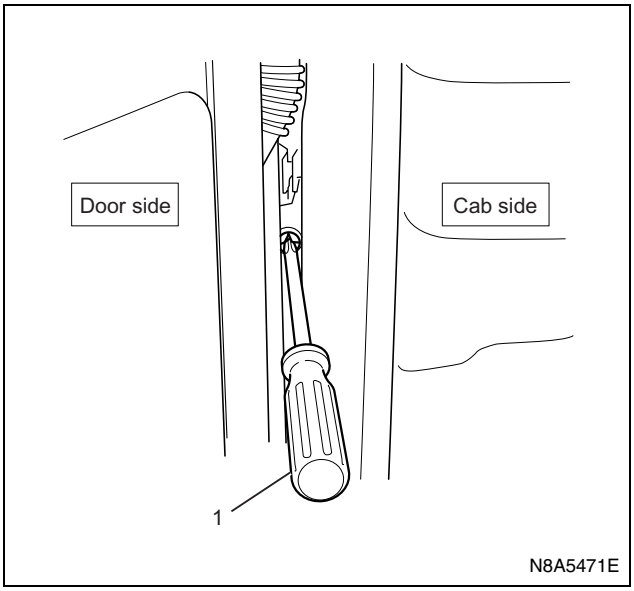
Insert the tip of a screwdriver into the hole beneath the headlight (the shaft of the screwdriver must be slanted up) until contact is made with the head of the adjusting screw. Turn the screw to adjust headlight focus to the left or right.



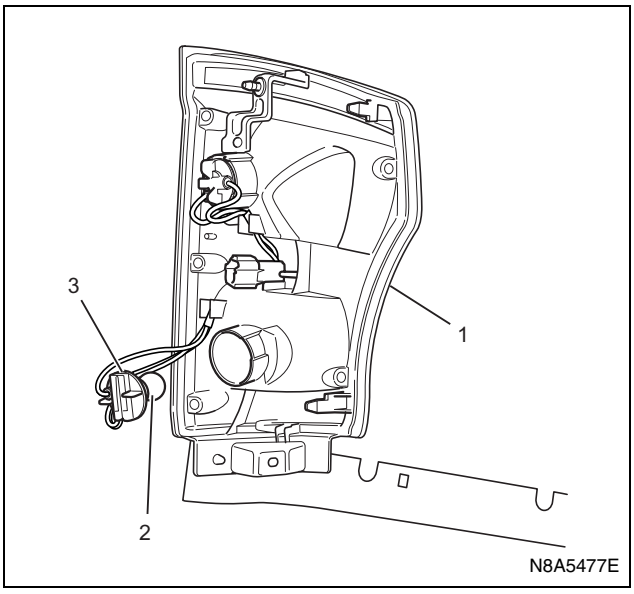
Cornering Light Bulb Replacement

Removal

1. Remove the battery ground cable at the battery.
2. Remove the front combination light.
   - Open the cab door. Insert a screwdriver (1) into the space between the cab and the cab door. Use the screwdriver to force out the stud pin at the center of the grommet (the pin securing the front combination light).



   - Remove the fixing screw.
   - Remove the two catches.
   - Remove the front combination light (1) connector.



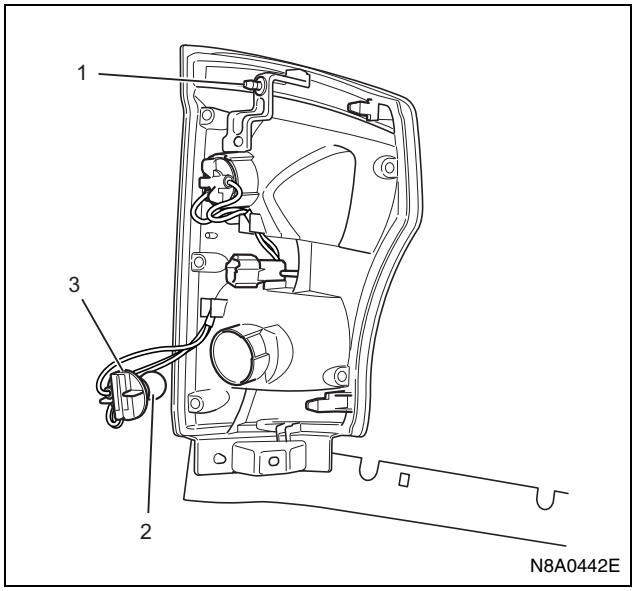
3. Remove the cornering light bulb.
   - Turn the cornering / clearance bulb socket (3) to the left to remove it.
   - Press the bulb (2) in and turn it to the left to remove it from the socket.

Installation

1. Install the cornering / clearance bulb.
   - While pressing the bulb (2), turn it clockwise to fit.

Notice:
Do not let the glass portion dirty with sebum etc.

   - Turn the bulb socket (3) clockwise to fit.



2. Installation procedure of front combination light assembly
   - Connect the connector of the front combination light assembly.
   - Position it by aligning two pawls with the groove of H/L.
   - Fit the iron PIN (1) in the upper portion of the side by aligning it with the center of corresponding grommet.

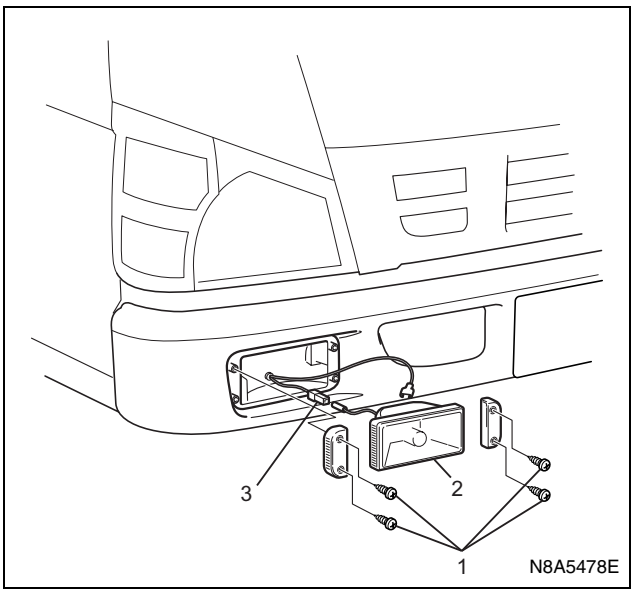
Notice:
Push it into securely with a force of approx. 250 N (25 kgf) until click is heard.

   - Pull the front combination light assembly lightly toward the front of vehicle to make sure that the PIN and grommet are engaged securely.
   - Tighten one bolt in the lower portion of front combination light assembly.
3. Hook the seal rubber on two projections under H/L.
4. Connect the battery ground cable.
5. Check lighting of each light.

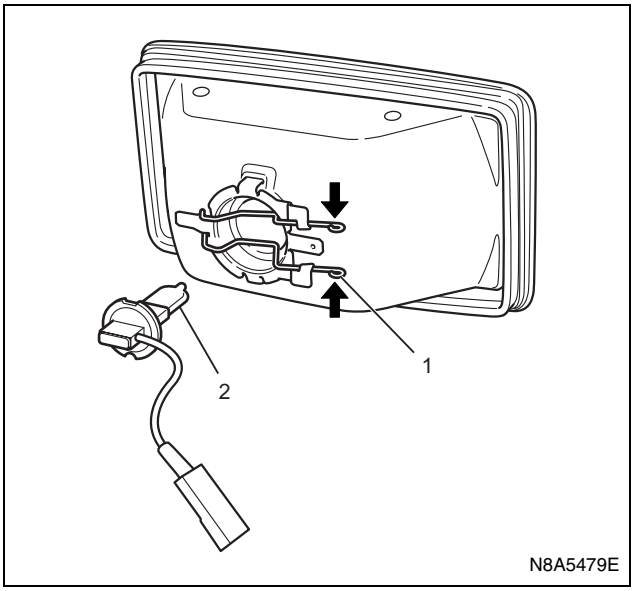
Fog Light Bulb

Removal

1. Remove the battery ground cable at the battery.
2. Remove the four screws (1) to remove the cover which holds fog light assembly (2).
3. Remove the connector (3).
4. Remove the fog light assembly (2).

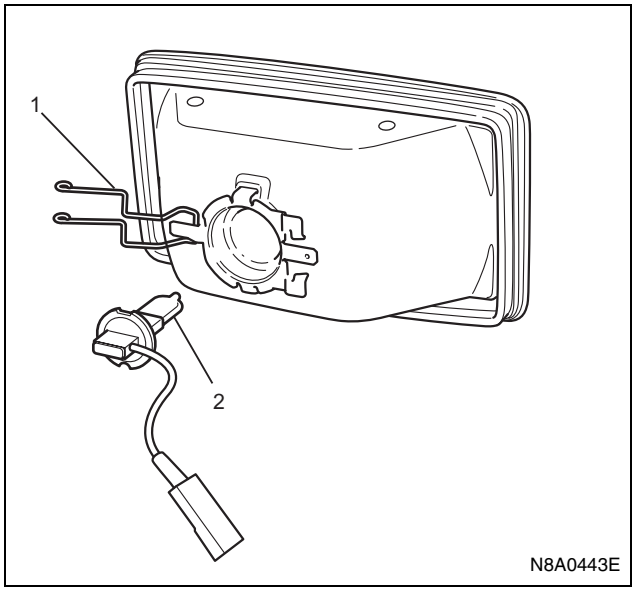


5. Bulb
   - Push the clip (1) inward as arrow to remove.
   - Remove the bulb (2).



Installation

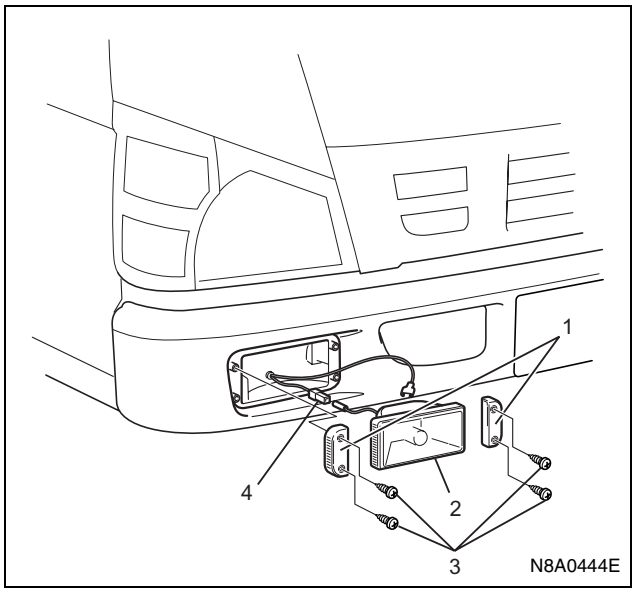
1. Install the fog light bulb.
   - Set the fog light bulb (2).
   - Hook the clip (1) to secure fog light bulb.



2. Connect the two locations of connector (4).
3. Install the fog light assembly.
   - Hold the fog light (2) with right and left covers (1) and secure it with four screws (3).

Notice:
Make sure that “TOP” mark on the lens comes upside.

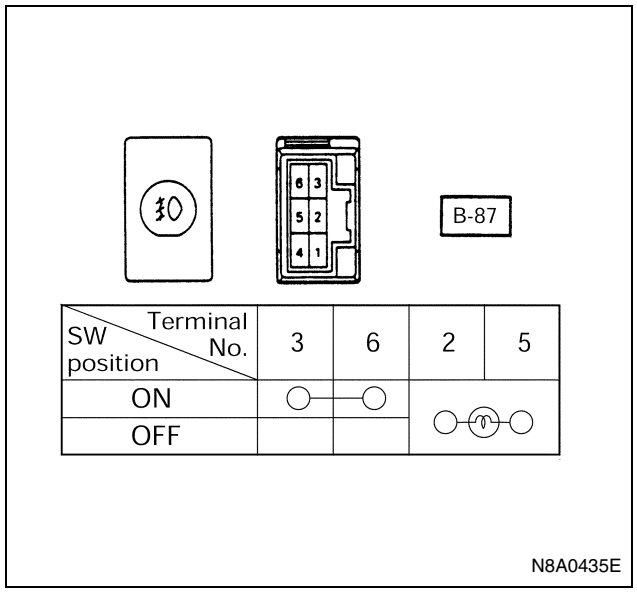
4. Connect the battery ground cable.
5. Check lighting.



Fog Light Switch

Inspection

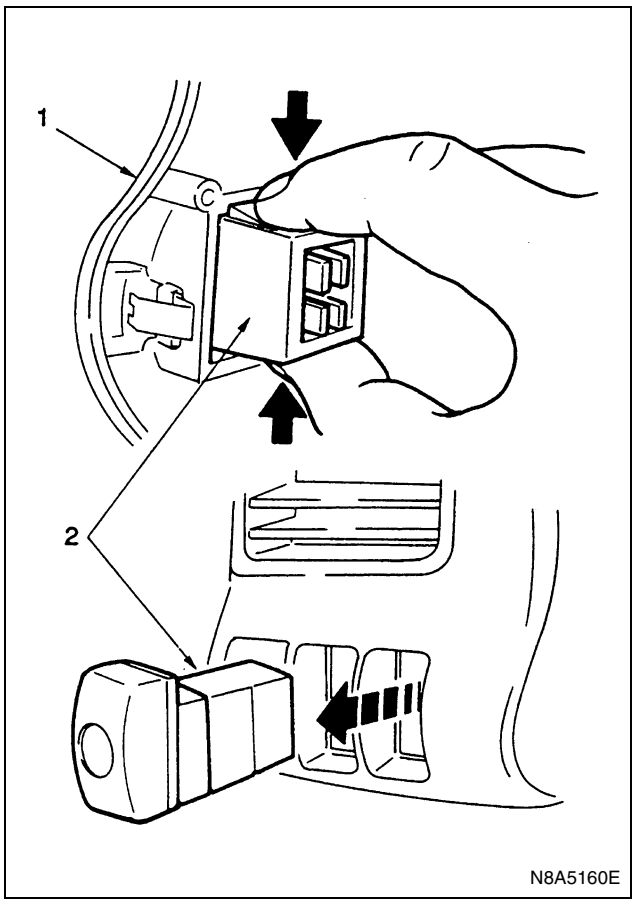
Check the continuity between the connector terminals while operating the switch.
Replace the switch when the result of inspection is found abnormal.



Removal

Preparation:
Disconnect the battery ground cable.

1. Meter Cluster
   Refer to “METER AND WARNING/INDICATOR LIGHT” in this section.
2. Fog Light Switch
   Release the lock pushing the switch from the back side of the meter cluster.



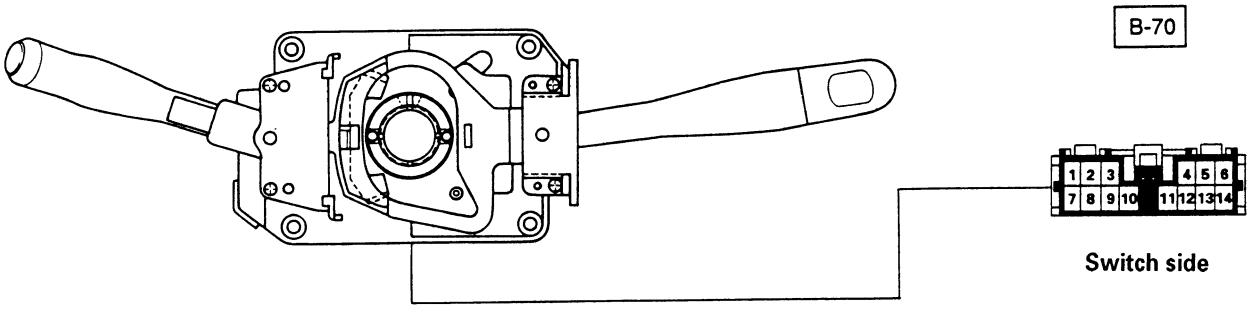
Installation

To install, follow the removal steps in the reverse order.

Combination Switch (Lighting Switch, Dimmer, Passing Switch, Cornering Light Switch and Rear Fog Light Switch)

Inspection

Check the continuity between the connector terminals while operating the switch.
Replace the switch when the result of inspection is found abnormal.



SW position \ Terminal No.		1	2	4	5	7	8	9	10	11	12	13	14
Lighting SW		○		○			○						
				○			○						
	REAR FOG SW	○		○			○						○
	OFF												
Dimmer· passing SW	High beam			○					○				
	Passing			○		○			○				
Cornering light SW	Turning left		○							○			
	Neutral												
	Turning right		○					○					

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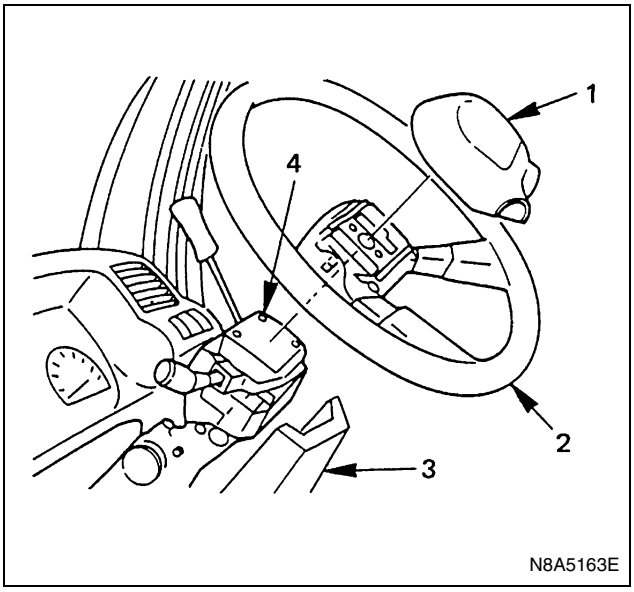
Removal

Preparation:
Disconnect the battery ground cable.

1. Horn Pad
   1) Hold the horn pad and pull it upward.
2. Steering Wheel
   1) Remove the steering shaft nut.
   2) Remove the steering wheel by using steering wheel remover.
      (Refer to Section 3B4 “STEERING COLUMN” for steering wheel removal steps.)
3. Steering Cowl
   Remove the four screws.
4. Combination Switch
   1) Remove the four screws.
   2) Disconnect the connector.



Installation

To install, follow the removal steps in the reverse order, noting the following point.

1. Tighten the steering shaft nut to the specified torque.

Tighten:

Shaft nut to 49 N·m (5 kg·m / 36 lb·ft)

Headlight Leveling

General Description

The circuit consists of starter SW, headlight leveling SW and headlight leveling actuator.

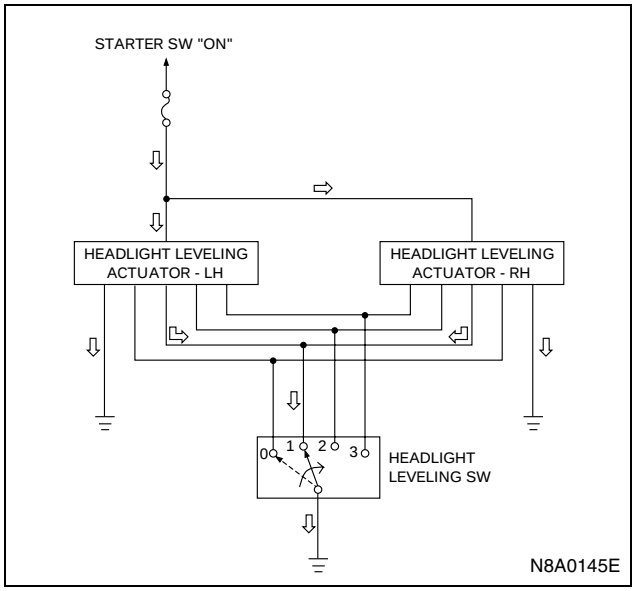
When the headlight leveling SW is operated with the starter SW at ON position, the actuator is operated to change the angle of the optical axis of the headlight.

Operation of The Circuit

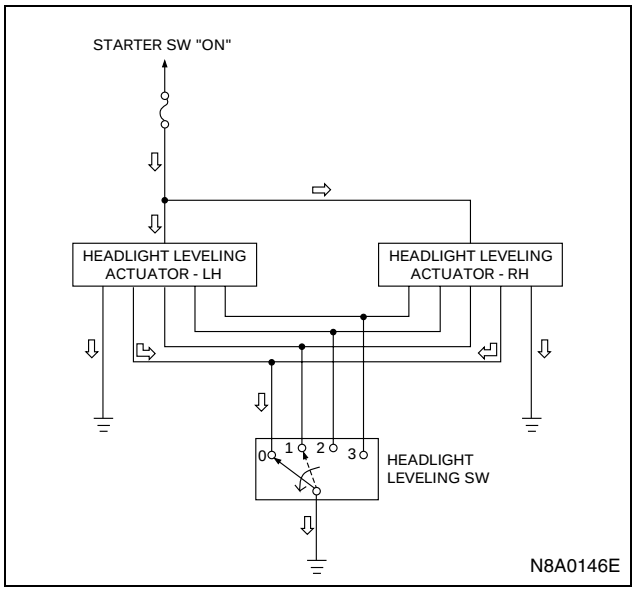
Notice:

Arrow marks indicate the direction of current.

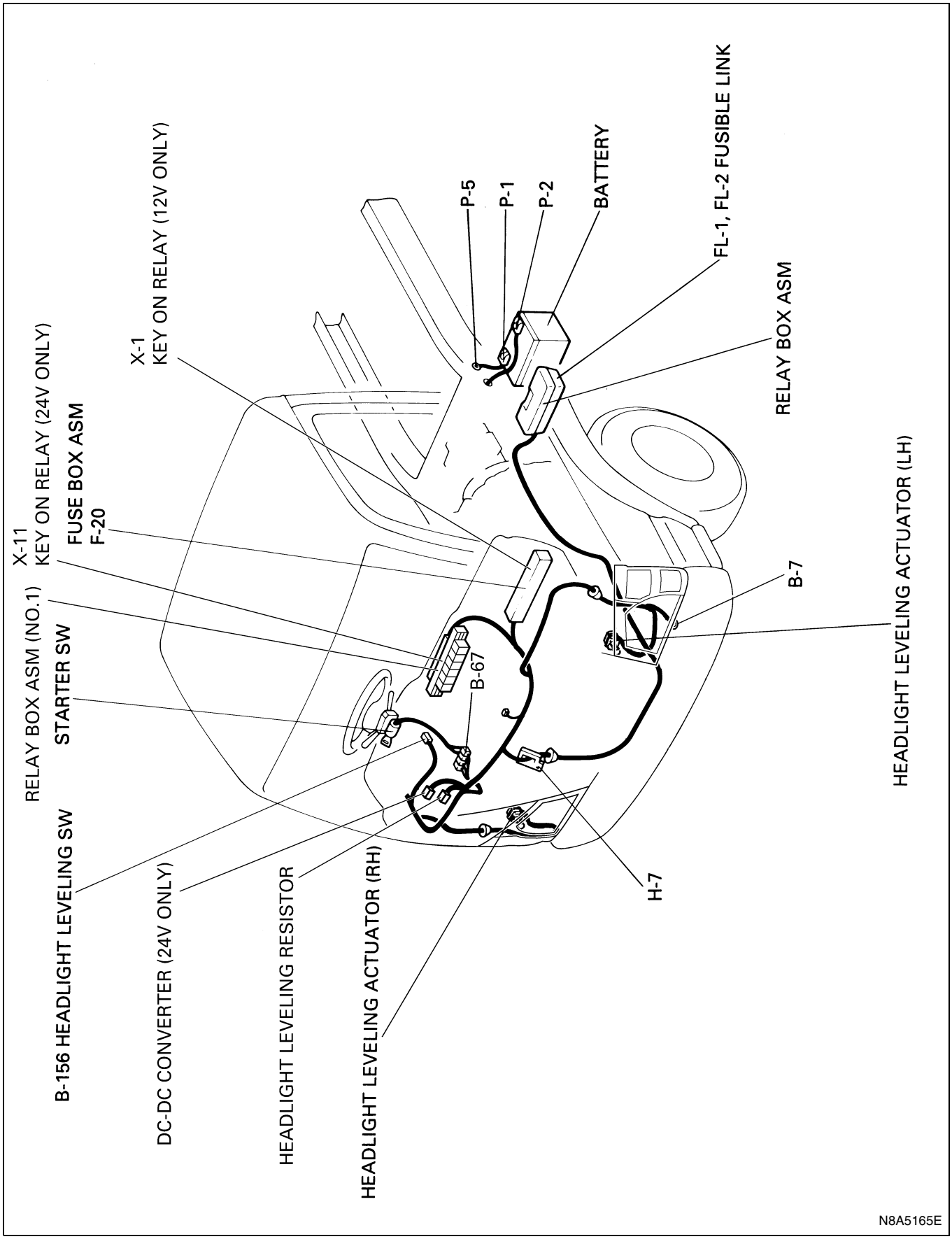
1. When headlight leveling SW is turned to “1” position



2. When headlight leveling SW is turned to “0” position

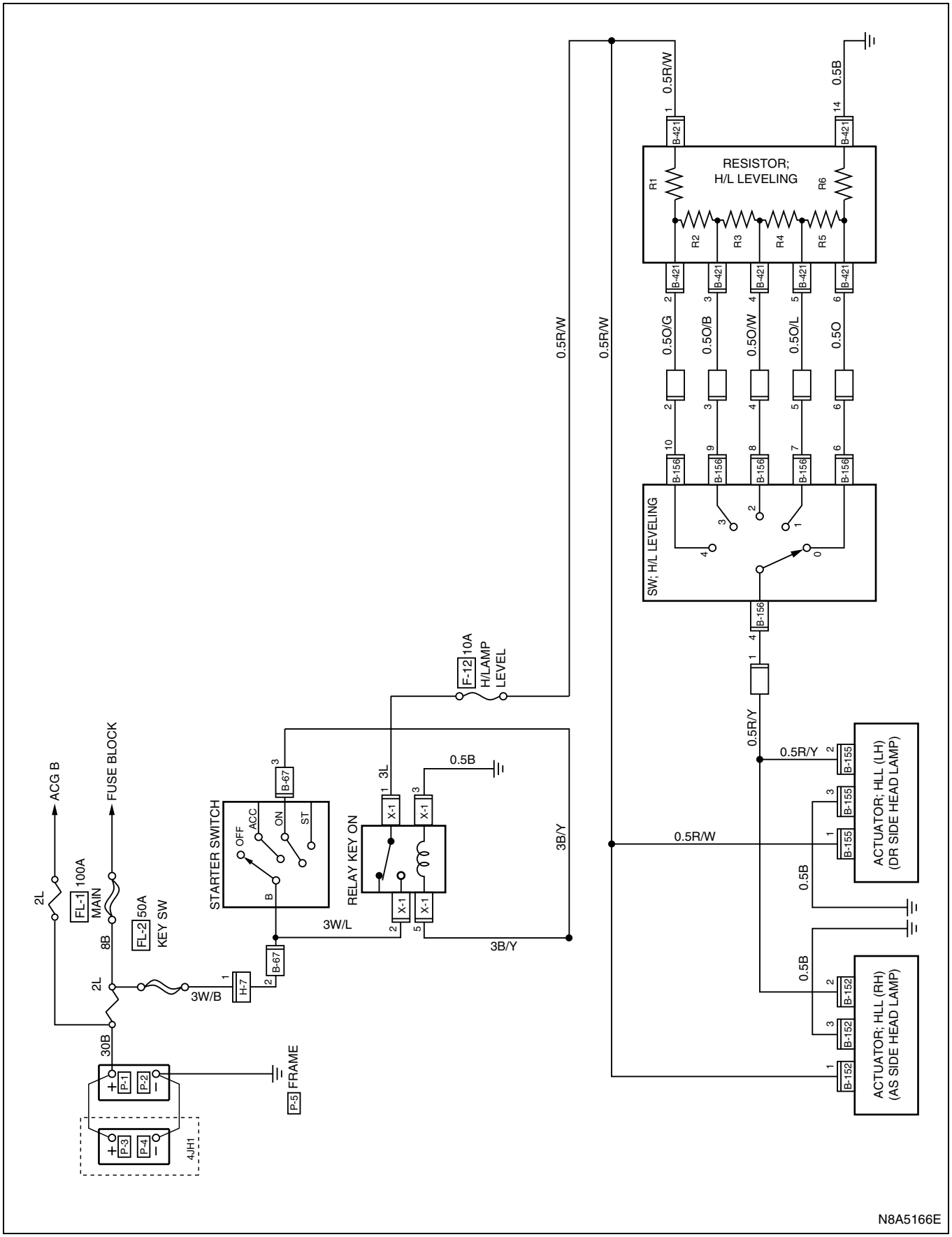


Parts Location

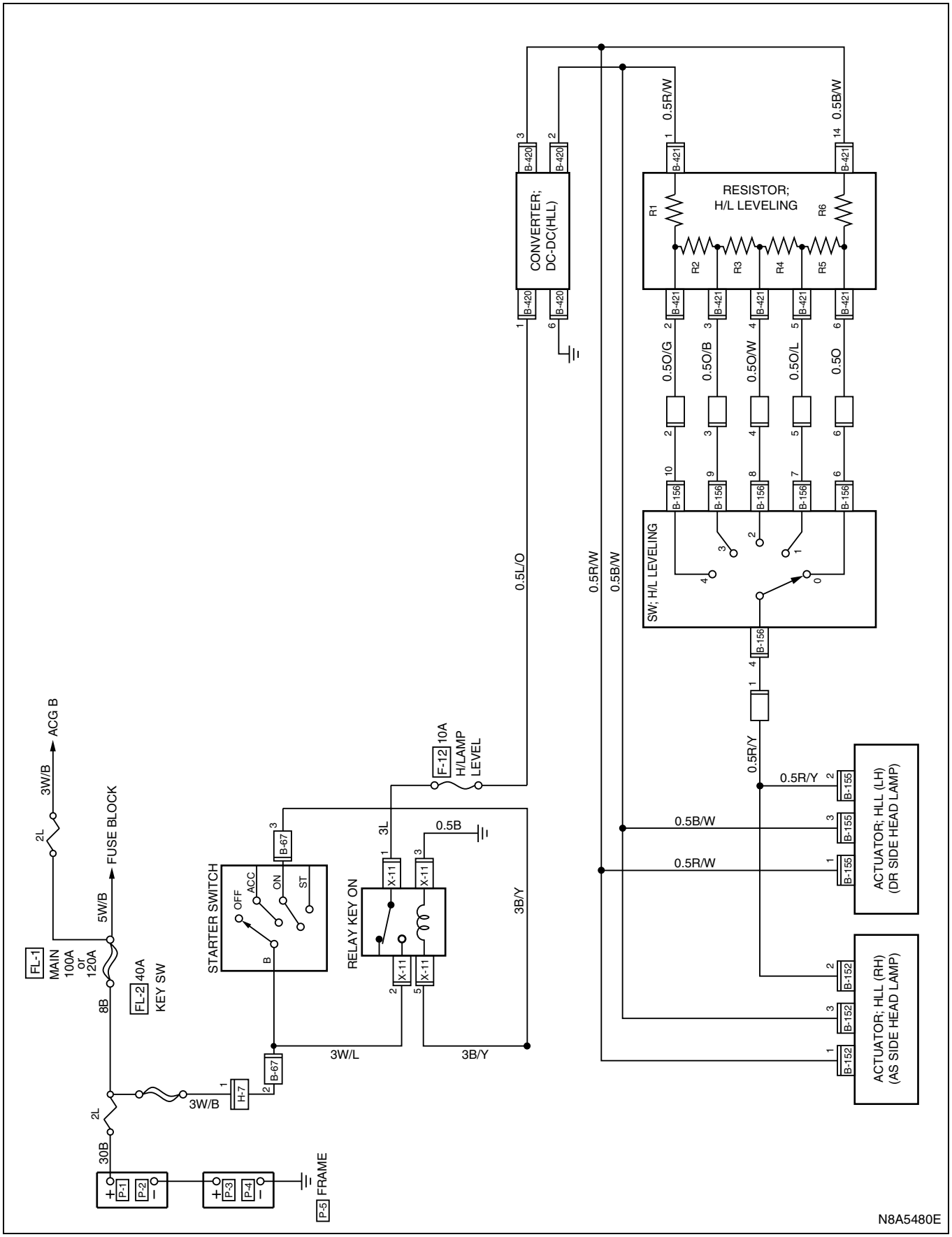


Circuit Diagram

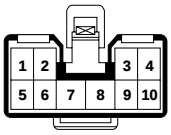
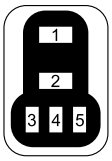
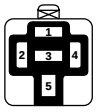
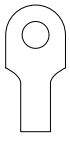
For 12 Volt

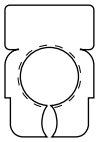
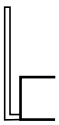
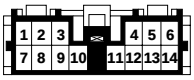
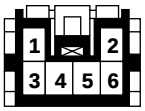
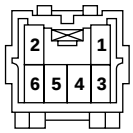


For 24 Volt

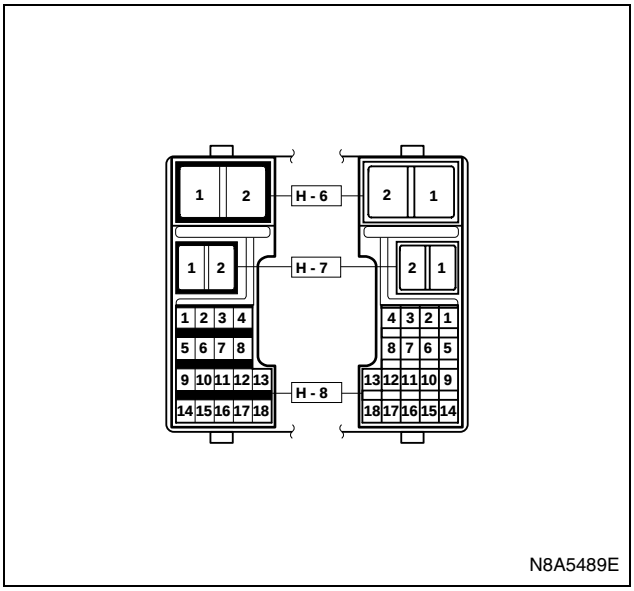

ACG B
3W/B
2L
FUSE BLOCK
5W/B
FL-1
MAIN
100A
or
120A
8B
FL-2
40A
KEY SW
2L
30B
P-1
P-2
P-3
P-4
P-5
FRAME
3W/B
H-7
B-67
STARTER SWITCH
OFF
ACC
ON
ST
B
3W/L
3B/Y
RELAY KEY ON
X-11
3L
0.5B
F-12
10A
H/LAMP
LEVEL
0.5L/O
CONVERTER;
DC-DC(HLL)
B-420
0.5R/W
0.5B/W
RESISTOR;
H/L LEVELING
R1
R2
R3
R4
R5
R6
B-421
0.5O/G
0.5O/B
0.5O/W
0.5O/L
0.5O
B-156
SW; H/L LEVELING
0.5R/Y
B-155
ACTUATOR; HLL (LH)
(DR SIDE HEAD LAMP)
B-152
ACTUATOR; HLL (RH)
(AS SIDE HEAD LAMP)
N8A5480E

Connector List

No.	Connector Face
B-67	004-001
B-67	004-002
B-152	003-016
B-155	003-016
B-156	 010-002
X-1	 005-006
X-11	 005-001
P-1	 000-003

No.	Connector Face
P-2	 000-004
P-5	 000-007
B-420 (24 V)	006-019
B-421	 014-002
B-xxx	 006-002
B-xxx	 006-003

H-7

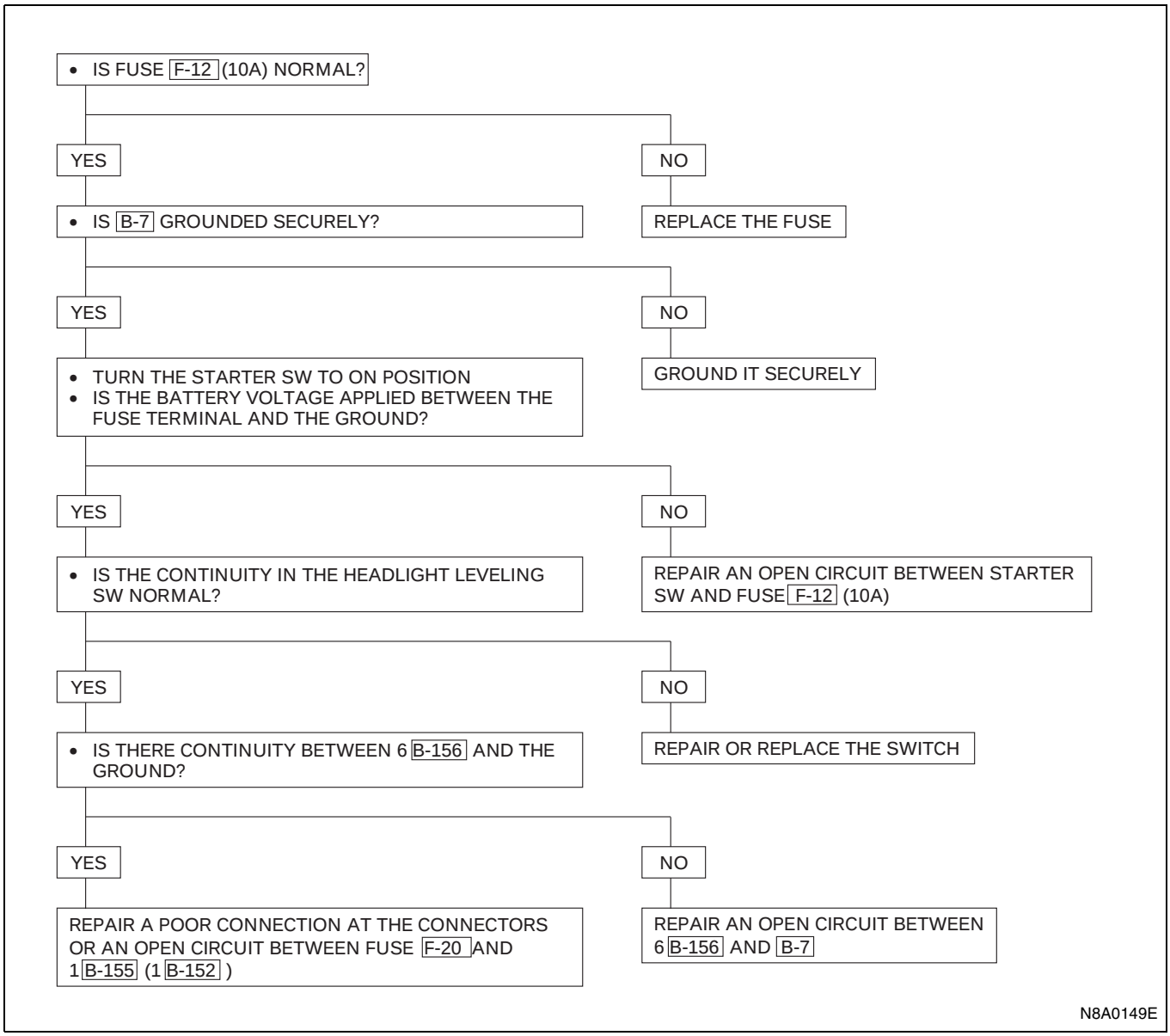


Diagnosis

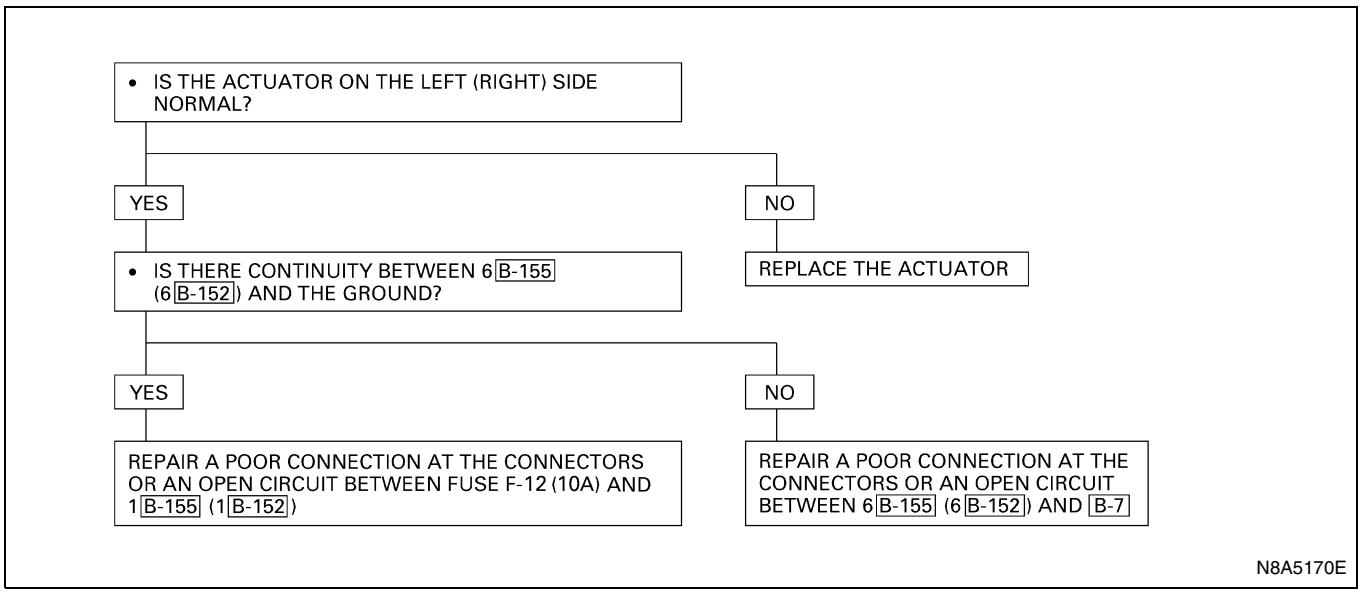
Quick Chart for Check Points

		Check point			
		Fuse F-12 (10 A)	Headlight leveling switch	Headlight leveling actuator	Cable harness
Trouble mode	1. Both actuators inoperative	❍	❍		❍
	2. Actuator on the left (right) side inoperative			❍	❍
	3. When leveling SW is turned to a certain position, actuator inoperative		❍	❍	❍

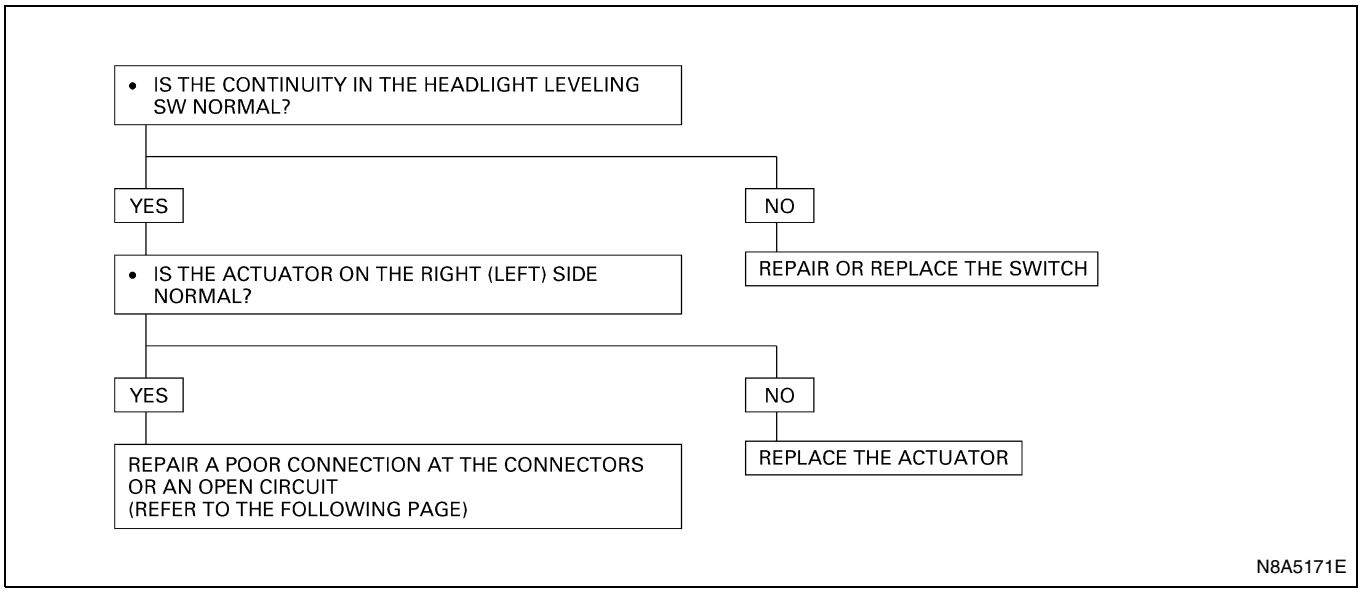
1. Both Actuators Inoperative



2. Actuator on the Right (Left) Side Inoperative



3. When Headlight Leveling SW is Turned to A Certain Position, Actuator Inoperative



Inspect and repair the circuit that is corresponding to the headlight leveling switch position where the actuator becomes inoperative.

Actuator - RH

Headlight leveling SW position	Circuit
1	Between 3 B-156 and 3 B-155
2	Between 2 B-156 and 4 B-155
3	Between 1 B-156 and 5 B-155
0	Between 4 B-156 and 2 B-155

Actuator - LH

Headlight leveling SW position	Circuit
1	Between 3 B-156 and 3 B-152
2	Between 2 B-156 and 4 B-152
3	Between 1 B-156 and 5 B-152
0	Between 4 B-156 and 2 B-152

Starter Switch

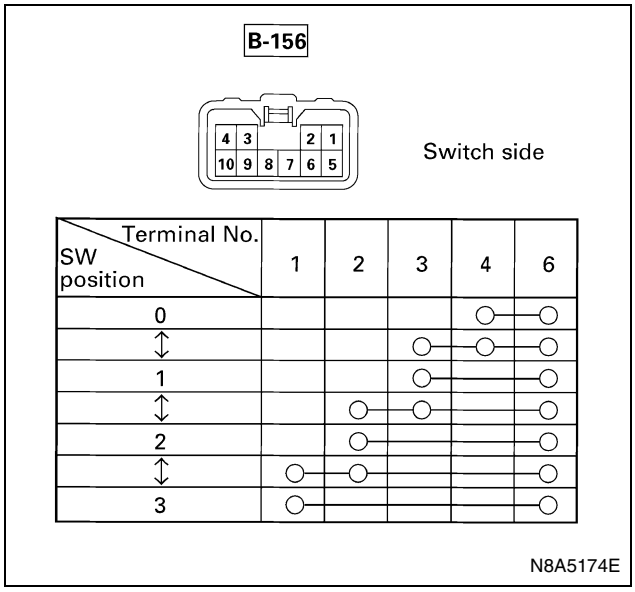
Refer to “START AND CHARGING” in this manual.

Headlight Leveling Switch

Inspection

Check the continuity between the switch connector terminals.

Repair or replace the switch when the result of inspection is found abnormal.

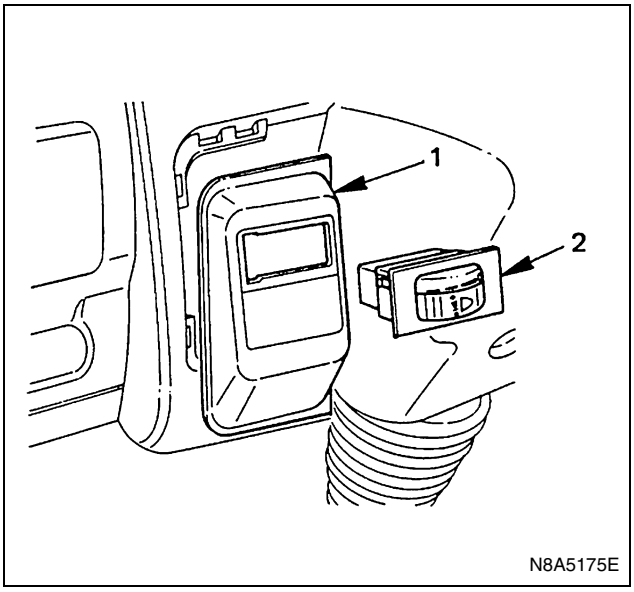


Removal

Preparation:

Disconnect the battery ground cable.

1. Switch Bezel
2. Headlight Leveling Switch
   Disconnect the connector.



Installation

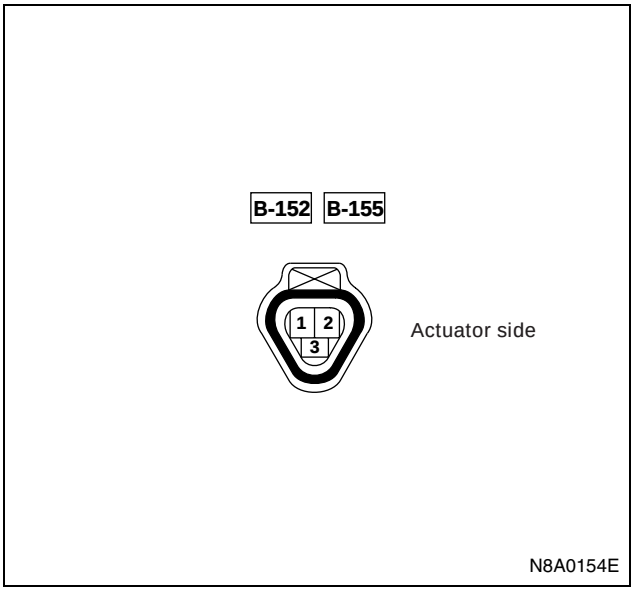
To install, follow the removal steps in the reverse order.

Headlight Leveling Actuator

Inspection

This actuator has a mechanism that the angle of head light leveling varies according to input voltage of SIGNAL.

1. Make sure that the voltage specified in table is output to vehicle harness connector which will be connected to actuator.
   If the power supply is not 12 V, the SIGNAL output varies in proportion to its voltage.
2. Connect the connector of actuator and vehicle harness connector.
   Make sure that the reflector of headlight moves to the position indicated by HEAD LAMP LEVELING SW.



1	2	3
SIGNAL	–	+

		Input signal voltage ratio for SIGNAL when the voltage difference between positive and negative is specified as 100%	–	+
HEAD LAMP POSITION	Position 0	10.0% (1.2 V)	0 V	12 V
	Position 1	23.4% (2.8 V)	0 V	12 V
	Position 2	36.7% (4.4 V)	0 V	12 V
	Position 3	50.0% (6.0 V)	0 V	12 V
	Position 4	63.4% (7.6 V)	0 V	12 V

Caution:

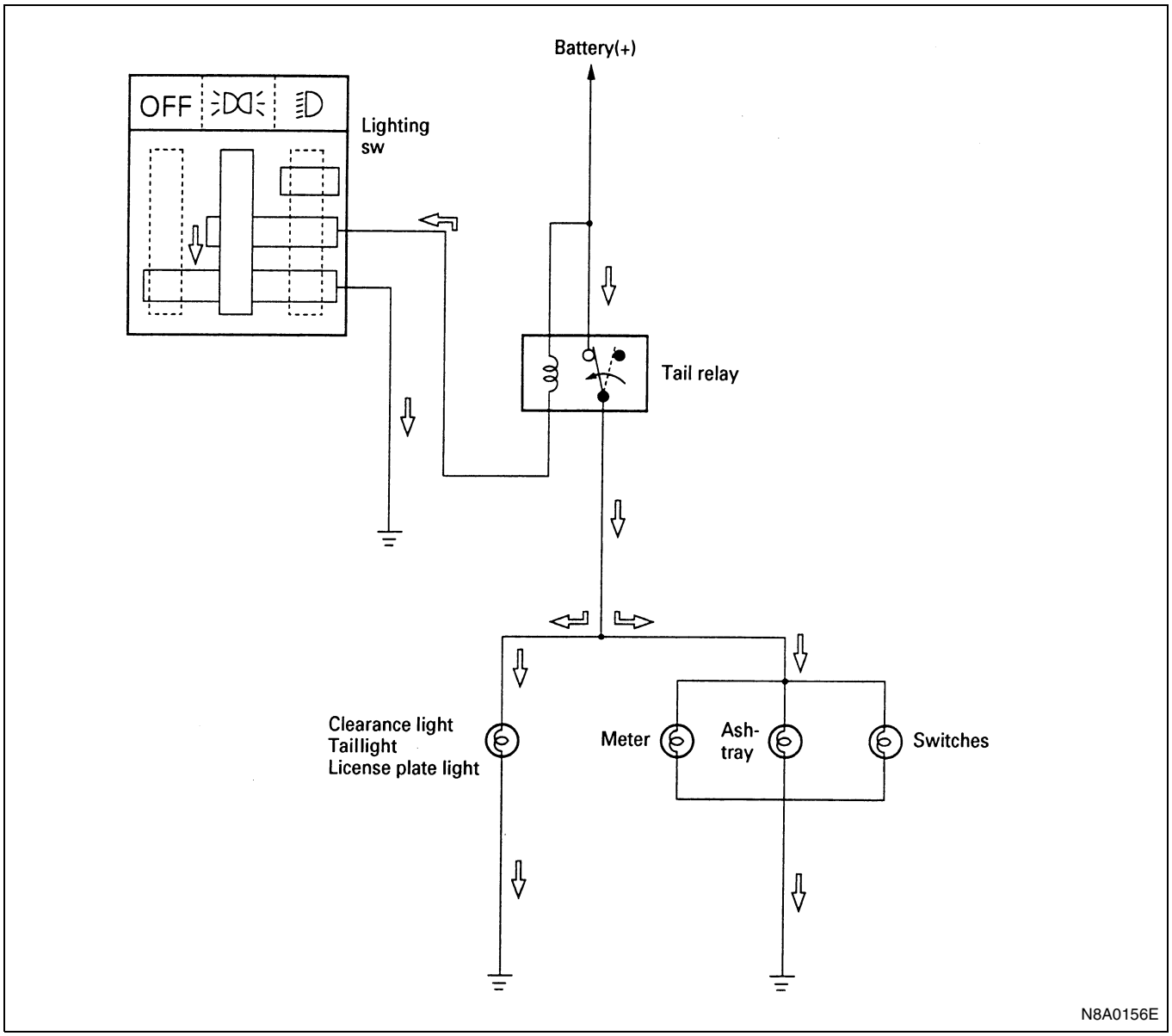
1. For vehicles with 12 V and 24 V, this leveling input voltage is 12 V.
2. Input to SIGNAL must be less than 65% of the input voltage to positive terminal.

Clearance Light, Taillight, License Plate Light and Illumination Light

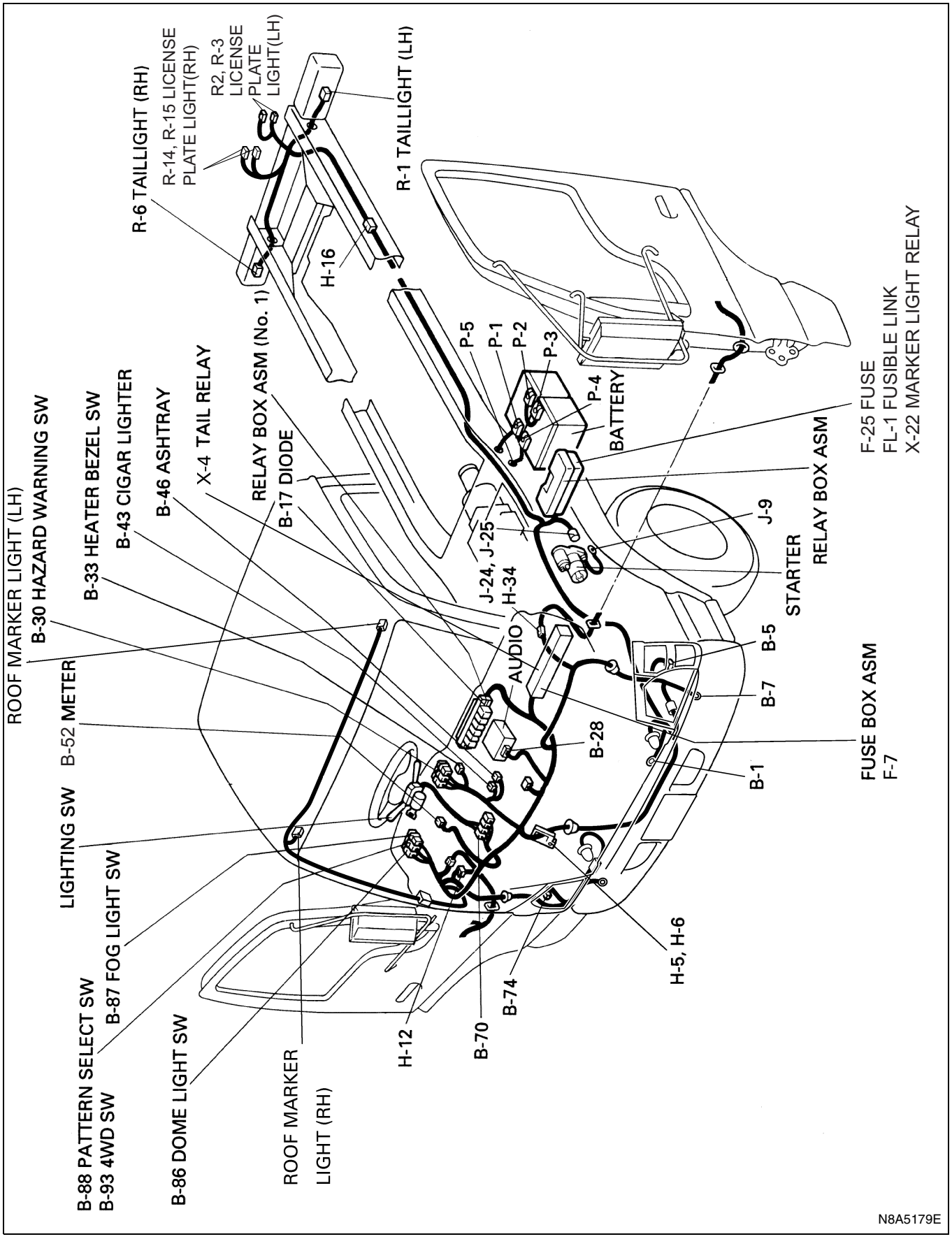
General Description

The circuit consists of the lighting switch, clearance light, taillight, license plate light and the illumination light for each of switch, meter and ashtray.
All these lights come on when the lighting switch is turned on with the switch to either clearance or headlight position.

Lighting Circuit

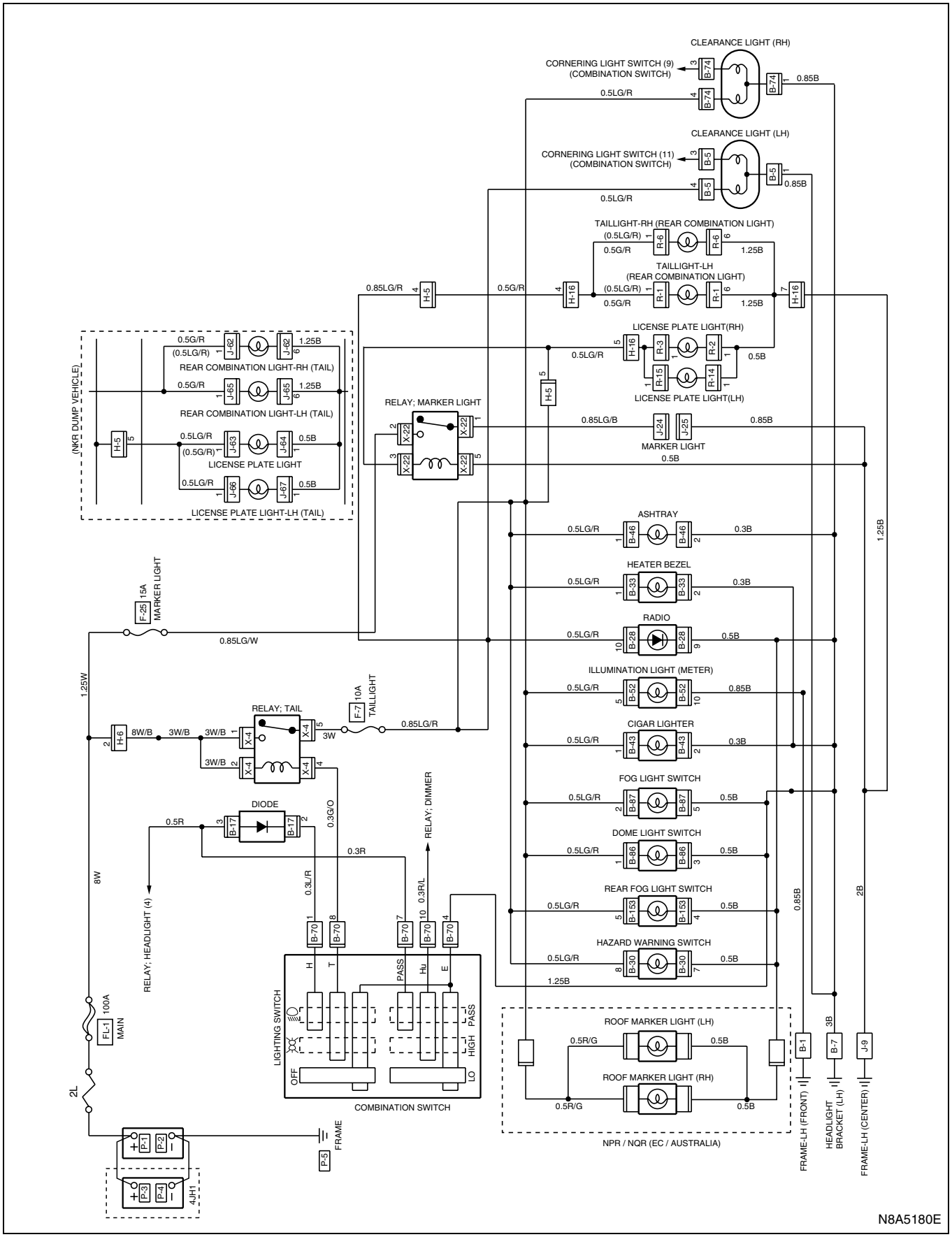


Parts Location

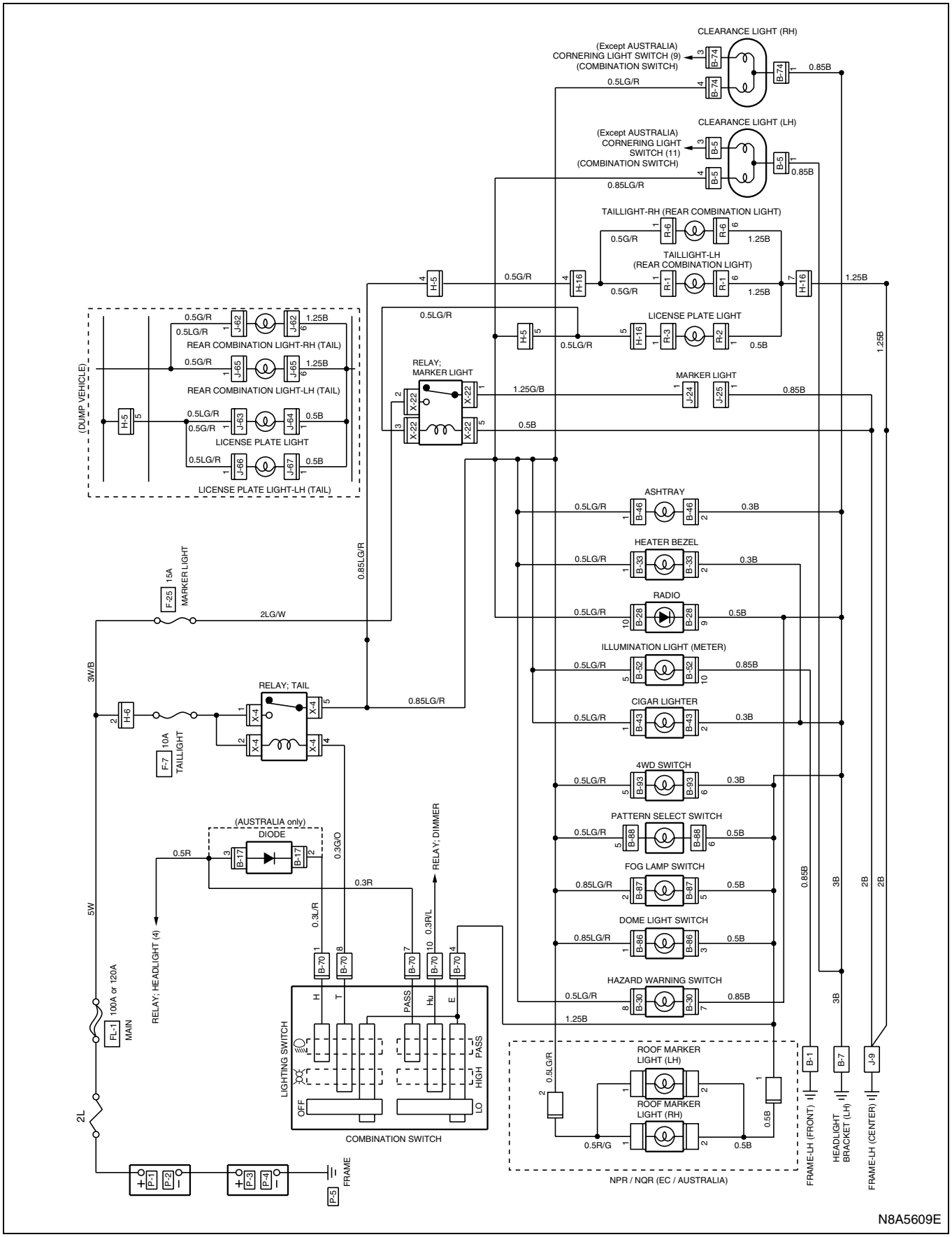


Circuit Diagram

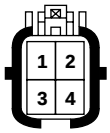
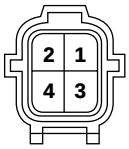
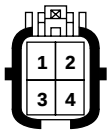
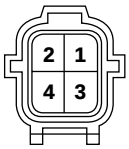
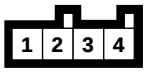
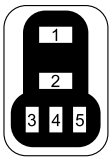
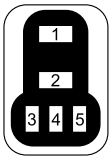
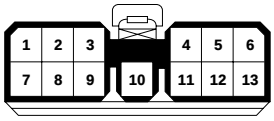
For 12 Volt

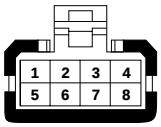
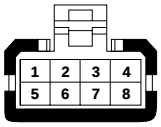
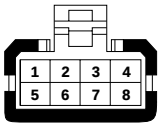
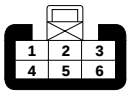
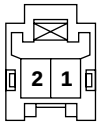
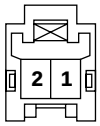


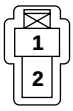
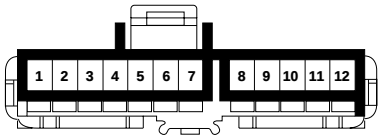
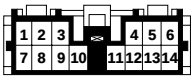
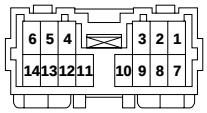
For 24 Volt

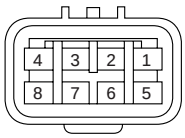
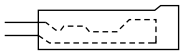
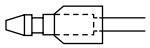
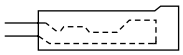
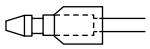
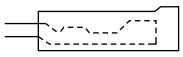
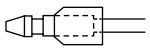
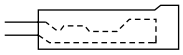

CLEARANCE LIGHT (RH)
(Except AUSTRALIA)
CORNERING LIGHT SWITCH (9)
(COMBINATION SWITCH)
CLEARANCE LIGHT (LH)
(Except AUSTRALIA)
CORNERING LIGHT
SWITCH (11)
(COMBINATION SWITCH)
TAILLIGHT-RH (REAR COMBINATION LIGHT)
TAILLIGHT-LH
(REAR COMBINATION LIGHT)
LICENSE PLATE LIGHT
MARKER LIGHT
RELAY;
MARKER LIGHT
(DUMP VEHICLE)
REAR COMBINATION LIGHT-RH (TAIL)
REAR COMBINATION LIGHT-LH (TAIL)
LICENSE PLATE LIGHT
LICENSE PLATE LIGHT-LH (TAIL)
ASHTRAY
HEATER BEZEL
RADIO
ILLUMINATION LIGHT (METER)
CIGAR LIGHTER
4WD SWITCH
PATTERN SELECT SWITCH
FOG LAMP SWITCH
DOME LIGHT SWITCH
HAZARD WARNING SWITCH
ROOF MARKER
LIGHT (LH)
ROOF MARKER
LIGHT (RH)
NPR / NQR (EC / AUSTRALIA)
F-25 15A MARKER LIGHT
F-7 10A TAILLIGHT
RELAY; TAIL
(AUSTRALIA only)
DIODE
RELAY; DIMMER
RELAY; HEADLIGHT (4)
FL-1 100A or 120A MAIN
LIGHTING SWITCH
COMBINATION SWITCH
OFF
LO
HIGH
PASS
FRAME
FRAME-LH (FRONT)
HEADLIGHT BRACKET (LH)
FRAME-LH (CENTER)
N8A5609E

Connector List

No.	Connector Face
B-5	 004-012
B-5	 004-013
B-74	 004-012
B-74	 004-013
B-17	 004-004
X-4	 005-006
X-22	 005-006
B-28	 013-001

No.	Connector Face
B-30	 008-005
B-88	 008-005
B-93	 008-005
B-87	 006-006
B-33	002-022
B-33	 002-023
B-46	002-022
B-46	 002-023

No.	Connector Face
B-43	002-009
B-43	 002-010
B-52	 012-005
B-70	 014-002
B-70	 014-003
B-86	004-001
B-153	006-007
H-16	008-003

No.	Connector Face
H-16	 008-004
J-24	 000-010
J-24	 000-011
J-25	 000-010
J-25	 000-011
J-63	 000-010
J-63	 000-011
J-64	 000-010

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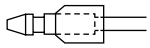
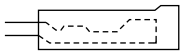
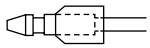
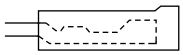
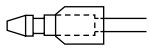
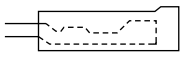
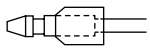
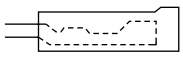
J-64	 000-011
J-66	 000-010
J-66	 000-011
J-67	 000-010
J-67	 000-011
R-2	 000-010
R-2	 000-011
R-3	 000-010

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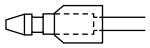
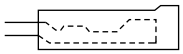
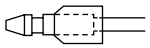
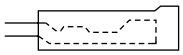
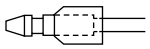
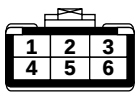
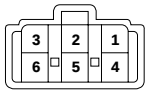
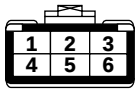
R-3	 000-011
R-14	 000-010
R-14	 000-011
R-15	 000-010
R-15	 000-011
J-62	 006-010
J-62	 006-015
J-65	 006-010

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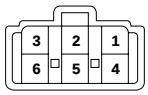
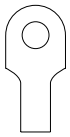
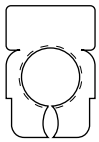
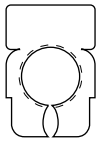
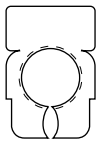
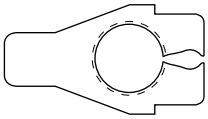
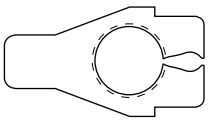
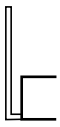
J-65	 006-015
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
P-5 (12 V)	 000-007

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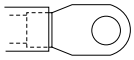
P-5 (24 V)	 000-002
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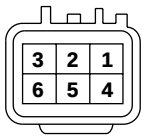
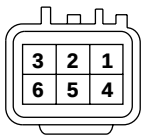
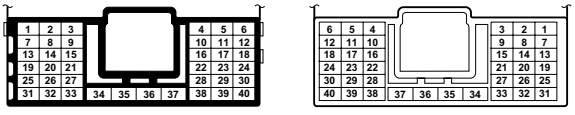
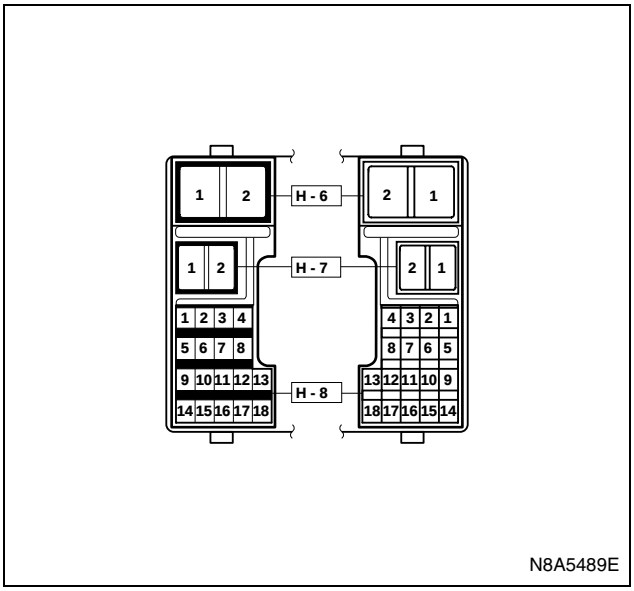
R-1	 006-005
R-6	006-004
R-6	 006-005

H-5



N8A5488E

H-6



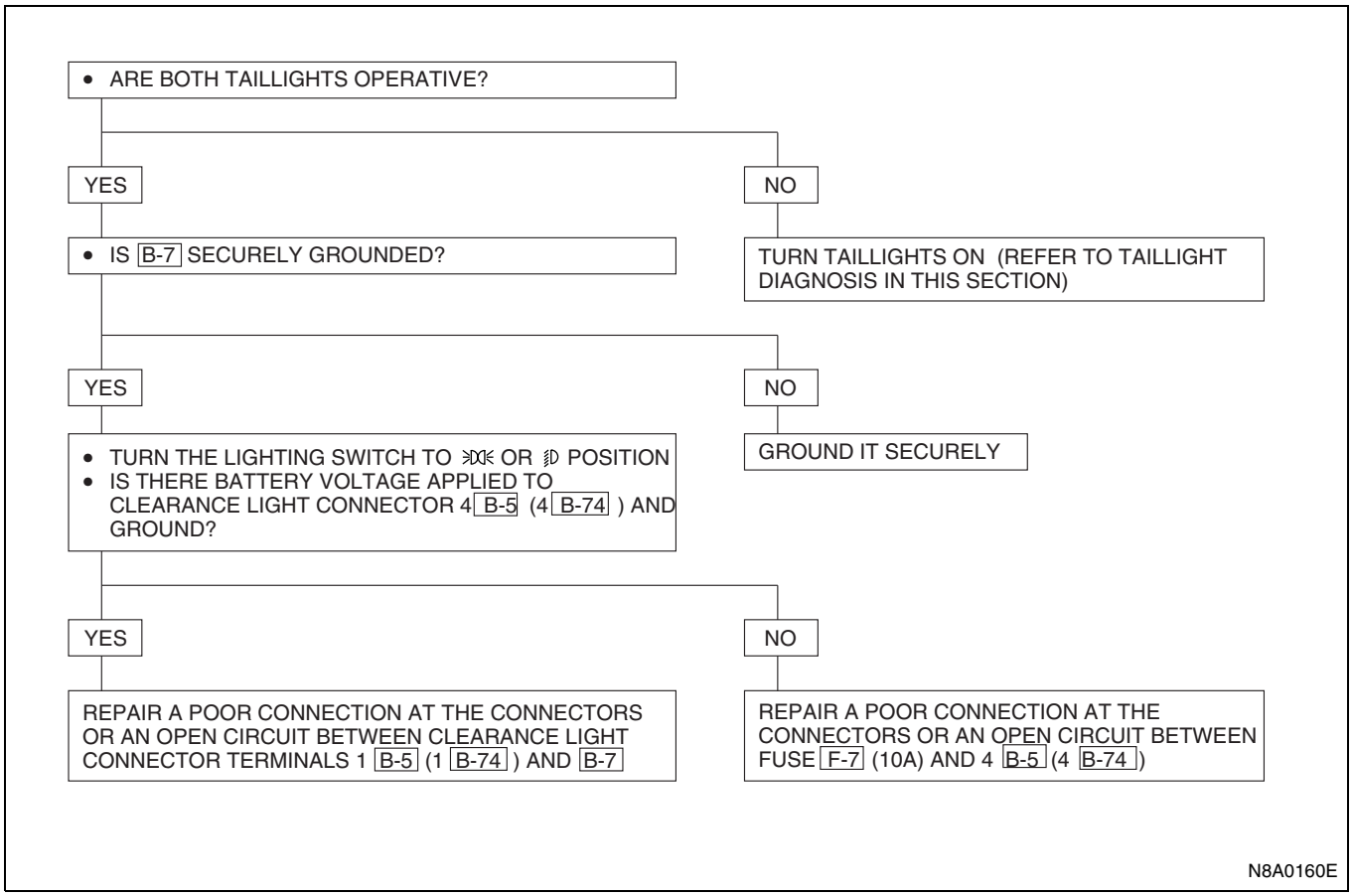
Diagnosis

Quick Chart for Check Point

		Check point								
		Fuse		Light-ing SW	Tail-light bulb	Clear-ance light bulb	License plate light bulb	Marker light relay	Cable har-ness	Marker light bulb
		F-7 (10 A)	F-25 (15 A)							
Trouble mode	1. Both clearance lights inoperative	❍ (1)		❍ (3)		❍ (2)			❍ (4)	
	2. Clearance light on the left (or right) side inoperative					❍ (1)			❍ (2)	
	3. Both taillights inoperative	❍ (1)		❍ (2)					❍ (3)	
	4. Taillight on the left (or right) side inoperative				❍ (1)				❍ (2)	
	5. License plate light inoperative						❍ (1)		❍ (2)	
	6. Marker light inoperative		❍ (2)					❍ (3)	❍ (4)	❍ (1)

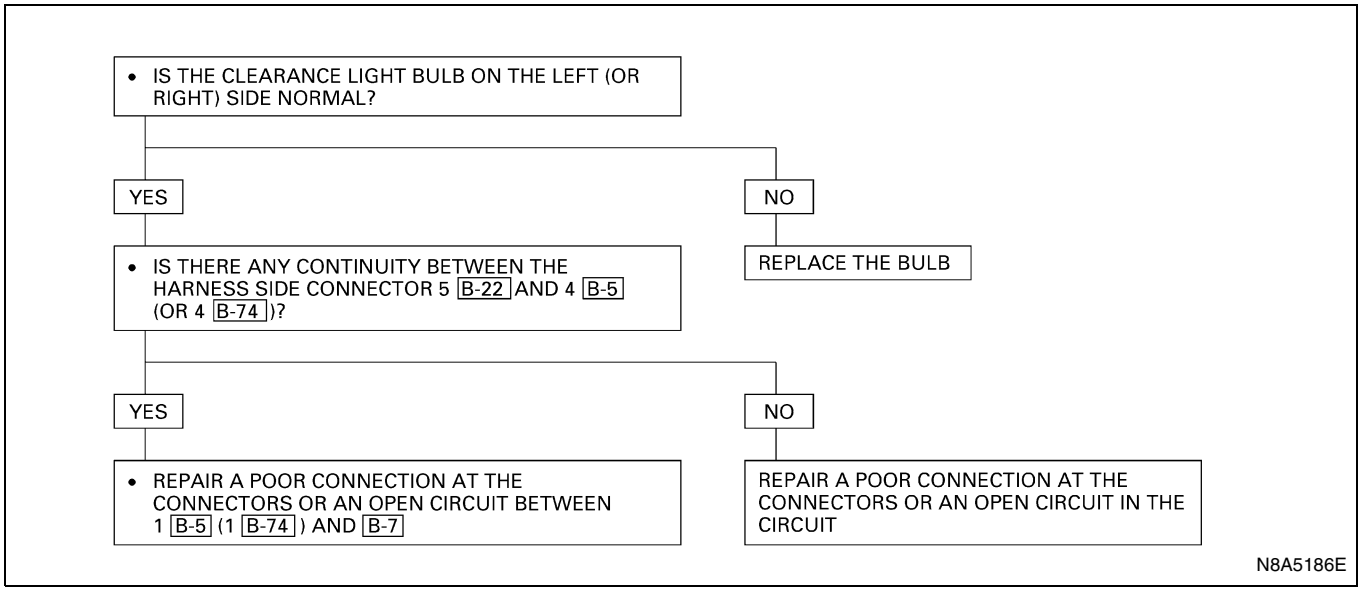
Notice:
Figure in parenthesis “( )” indicates the order of inspection.

1. Both Clearance Lights Inoperative



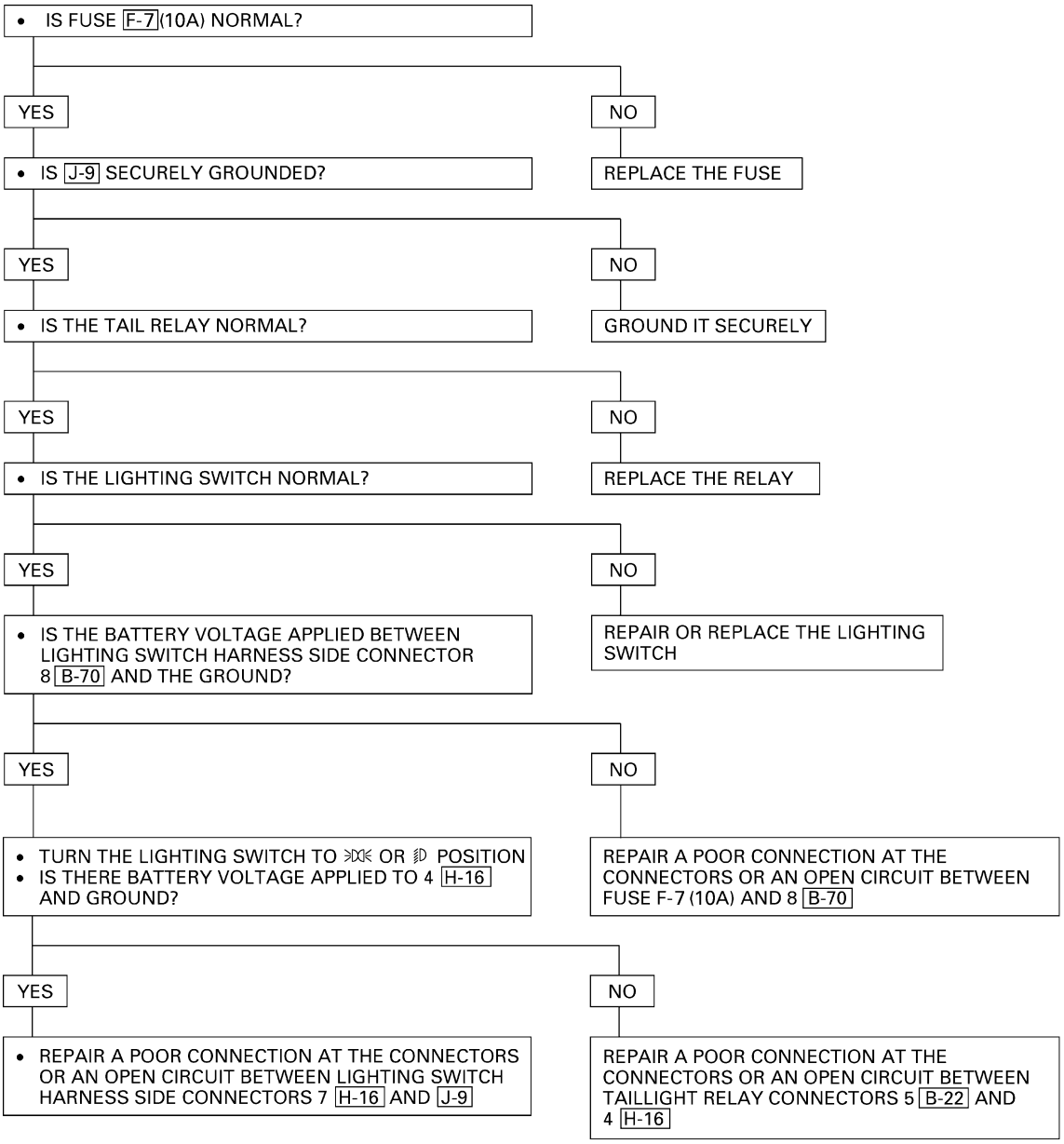
Notice:
Figure in parenthesis “( )” indicates place of inspection for clearance light on the right side.

2. Clearance Light on the Left (or Right) Side Inoperative

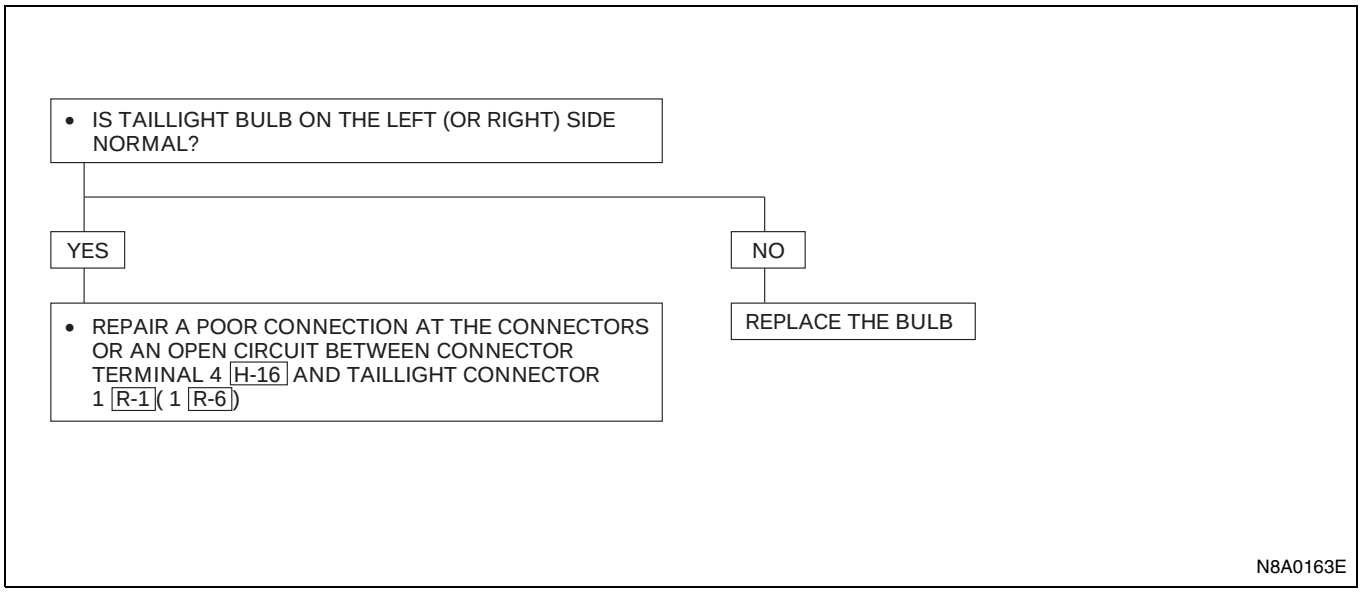


Notice:
Figure in parenthesis “( )” indicates place of inspection for clearance light on the right side.

3. Both Taillights Inoperative

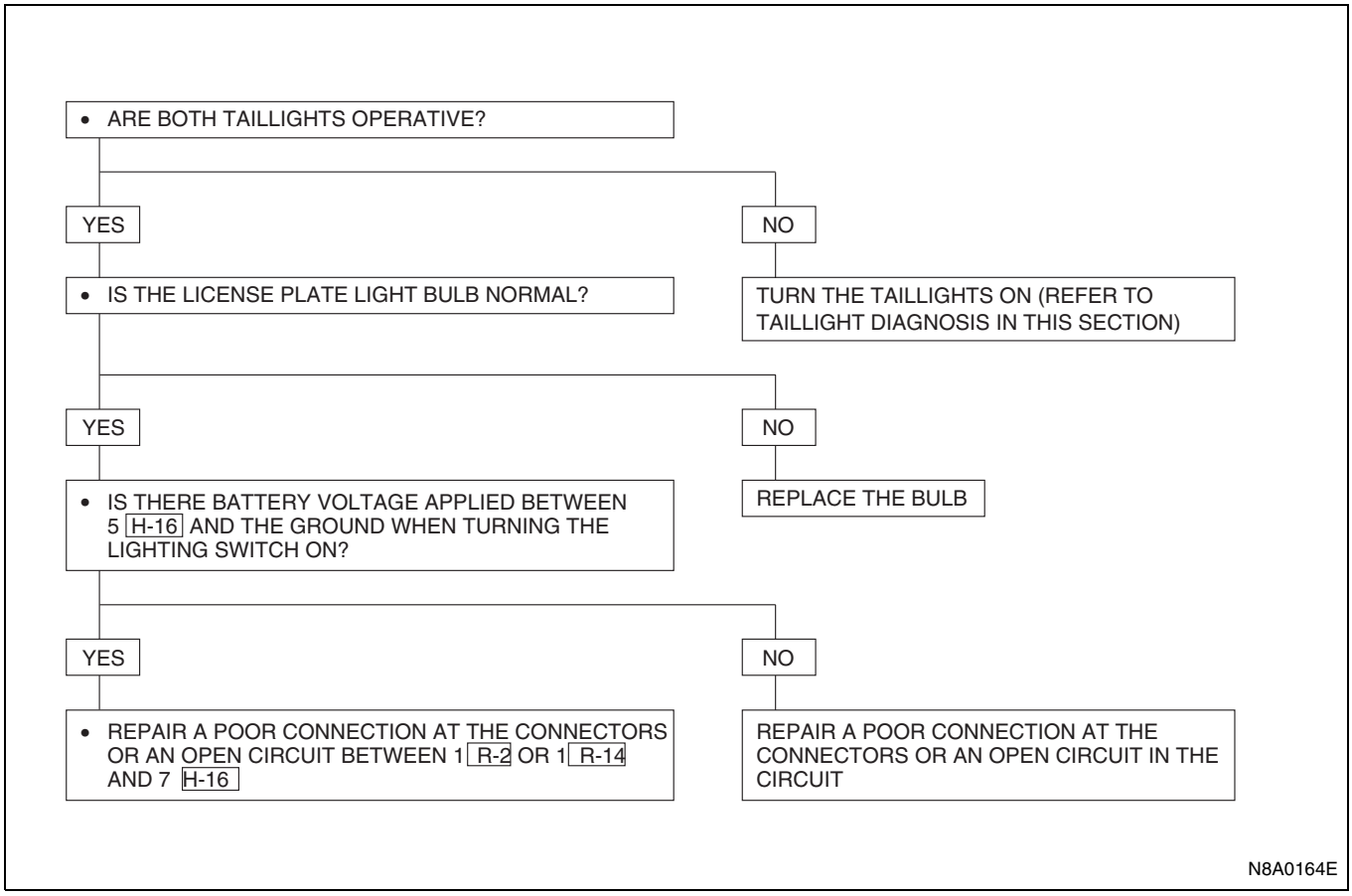


4. Taillight on the Left (or Right) Side Inoperative

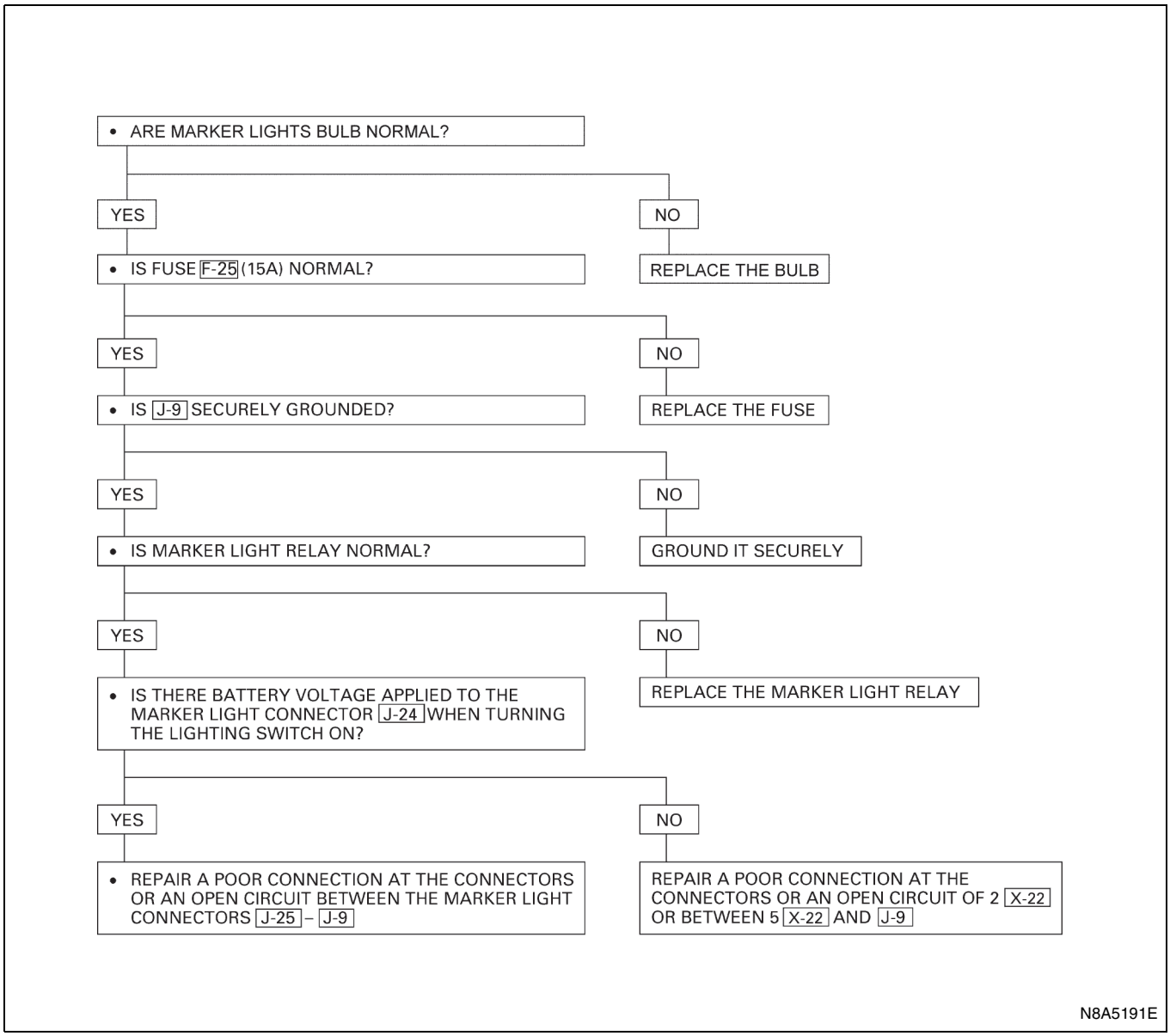


Notice:
Figure in parenthesis “( )” indicates place of inspection for taillight on the right side.

5. License Plate Light Inoperative



6. Marker Light Inoperative



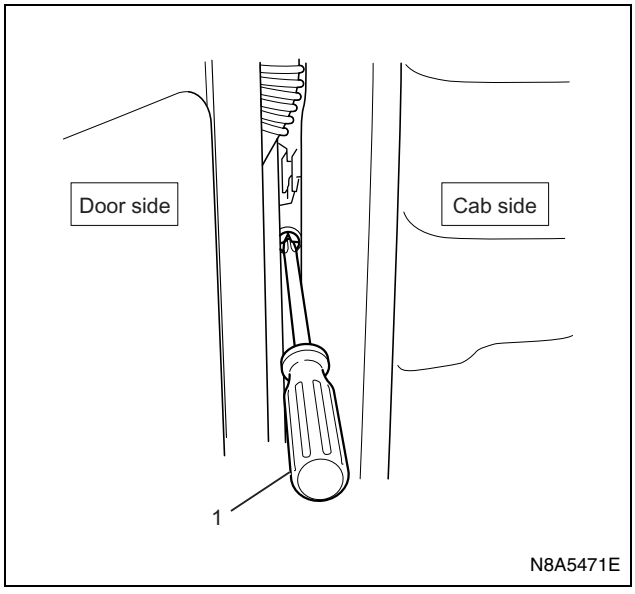
Lighting Switch

Refer to “HEADLIGHT, FOG LIGHT AND CORNERING LIGHT” in this section.

Clearance Light/Bulb

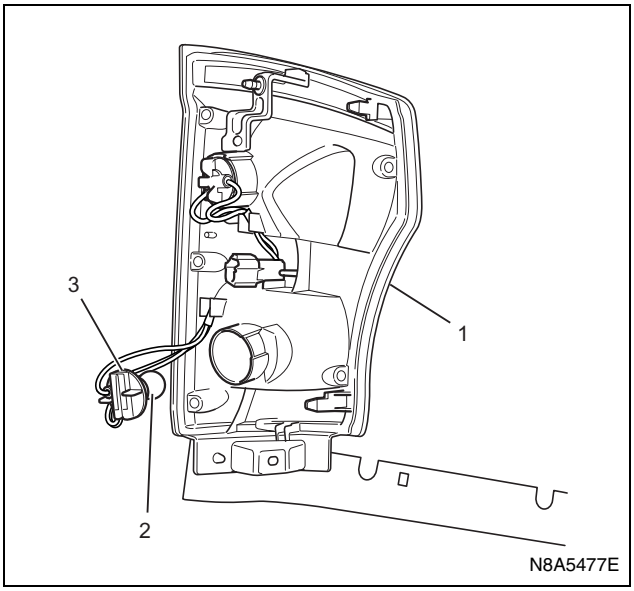
Removal

1. Remove the battery ground cable at the battery.
2. Remove the front combination light.
   - Open the cab door. Insert a screwdriver (1) into the space between the cab and the cab door. Use the screwdriver to force out the stud pin at the center of the grommet (the pin securing the front combination light).



   - Remove the fixing screw.

- Remove the two catches.
- Remove the front combination light (1) connector.



3. Remove the clearance light bulb.
   - Turn the bulb socket (3) to the left to remove it.
   - Press the bulb (2) in and turn it to the left to remove it from the socket.

Installation

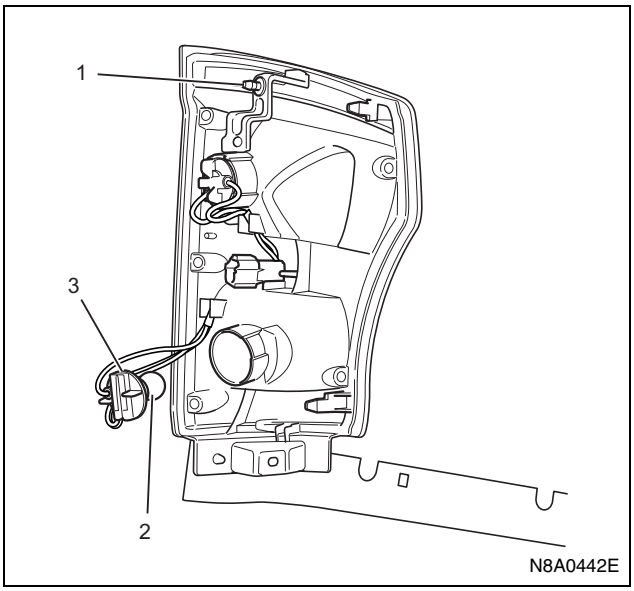
Installation procedure of cornering/clearance light bulb

1. Install the cornering/clearance light bulb.
   - While pressing the bulb (2), turn it clockwise to fit.

Notice:

Do not let the glass portion dirty with sebum etc.

- Turn the bulb socket (3) clockwise to fit.



2. Installation procedure of front combination light assembly
   - Connect the connector of the combination light assembly.
   - Position it by aligning two pawls with the groove of H/L.
   - Fit the iron PIN (1) in the upper portion of the side by aligning it with the center of corresponding grommet.

Notice:

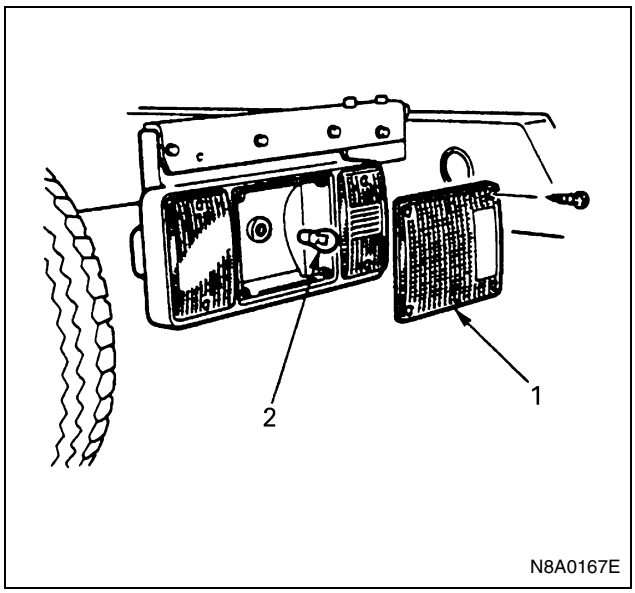
Push it into securely with a force of approx. 250 N (25 kgf) until click is heard.

   - Pull the front combination light assembly lightly toward the front of vehicle to make sure that the PIN and grommet are engaged securely.
   - Tighten one bolt in the lower portion of front combination light assembly.
3. Hook the seal rubber on two projections under H/L.
4. Connect the battery ground cable.
5. Check lighting of each light.

Taillight Bulb

Removal

1. Lens
2. Bulb



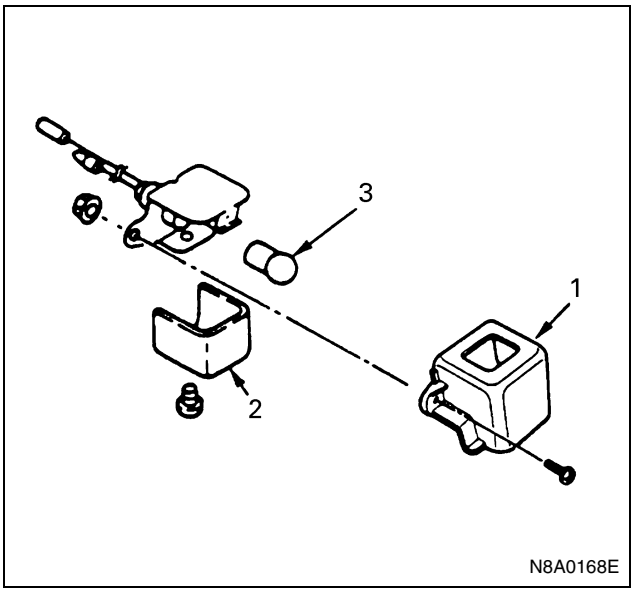
Installation

To install, follow the removal steps in the reverse order.

License Plate Light Bulb

Removal

1. Cover
2. Lens
3. Bulb



Installation

To install, follow the removal steps in the reverse order.

Turn Signal Light, Hazard Warning Light, and Stoplight

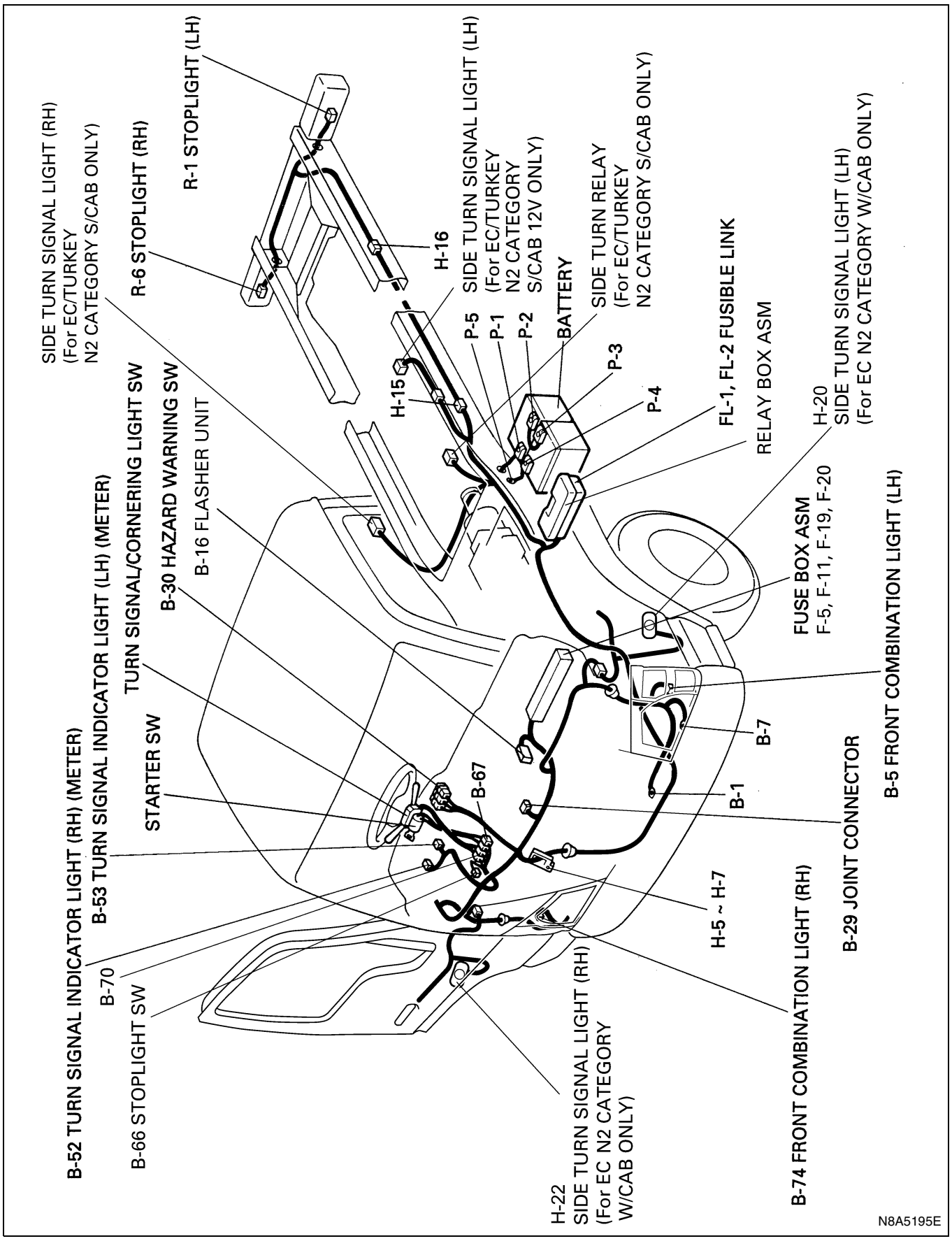
General Description

The circuit consists of the starter switch, turn signal light (front and rear), turn signal light switch, hazard warning light, flasher unit, stoplight and stoplight switch.

When turning on the respective switches with the starter switch on, the turn signal light will operate. When the turn signal light is flashing, the indicator light in the meter also starts flashing. When the hazard warning switch is turned on, the current flows to the flasher unit through the hazard warning switch to cause the hazard warning light to flash, independent of the position of the starter switch. At the same time, the indicator lights in the meter also start flashing.

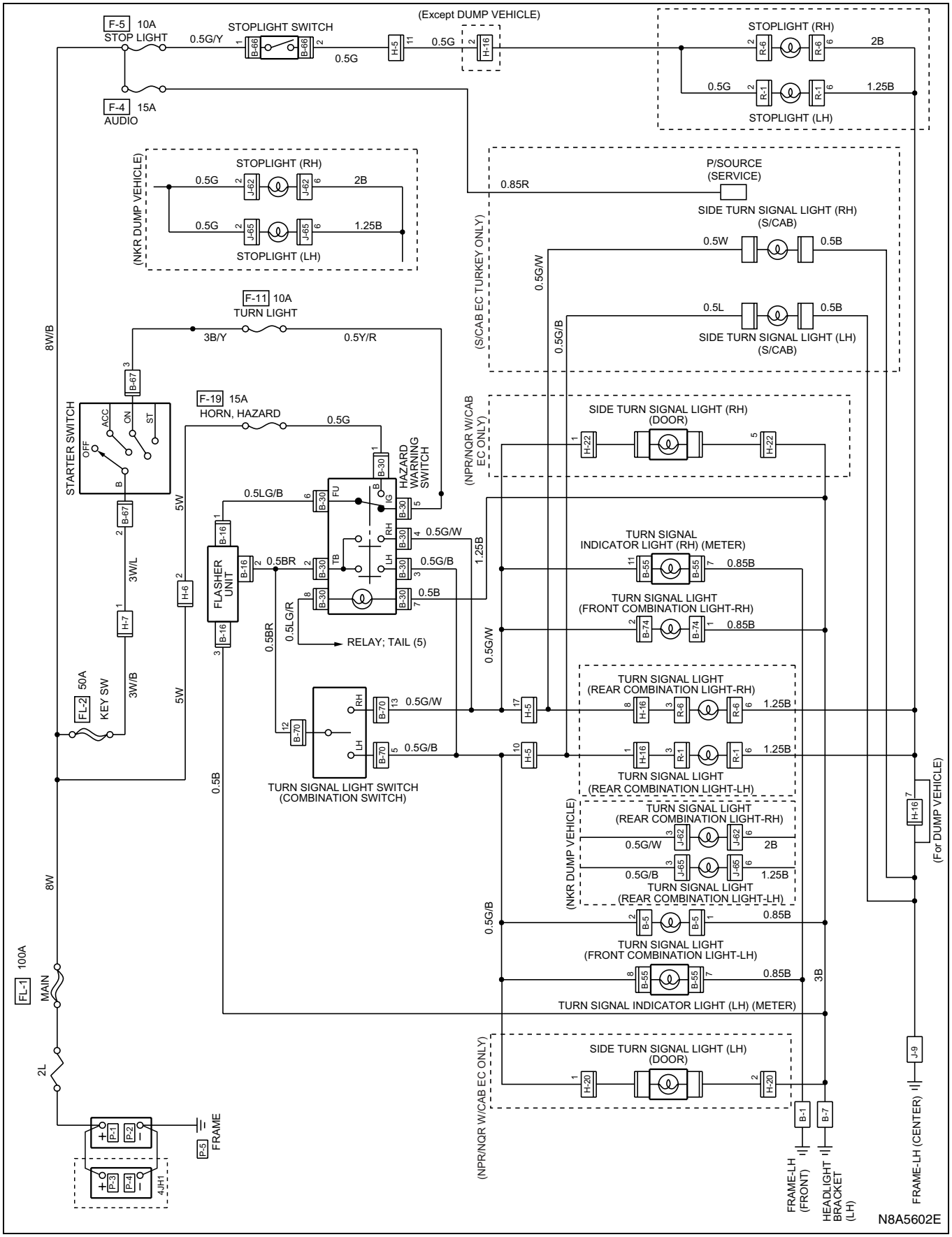
The stoplight switch will turn on and the light comes on once the brake pedal is depressed, independent of the position of the starter switch.

Parts Location

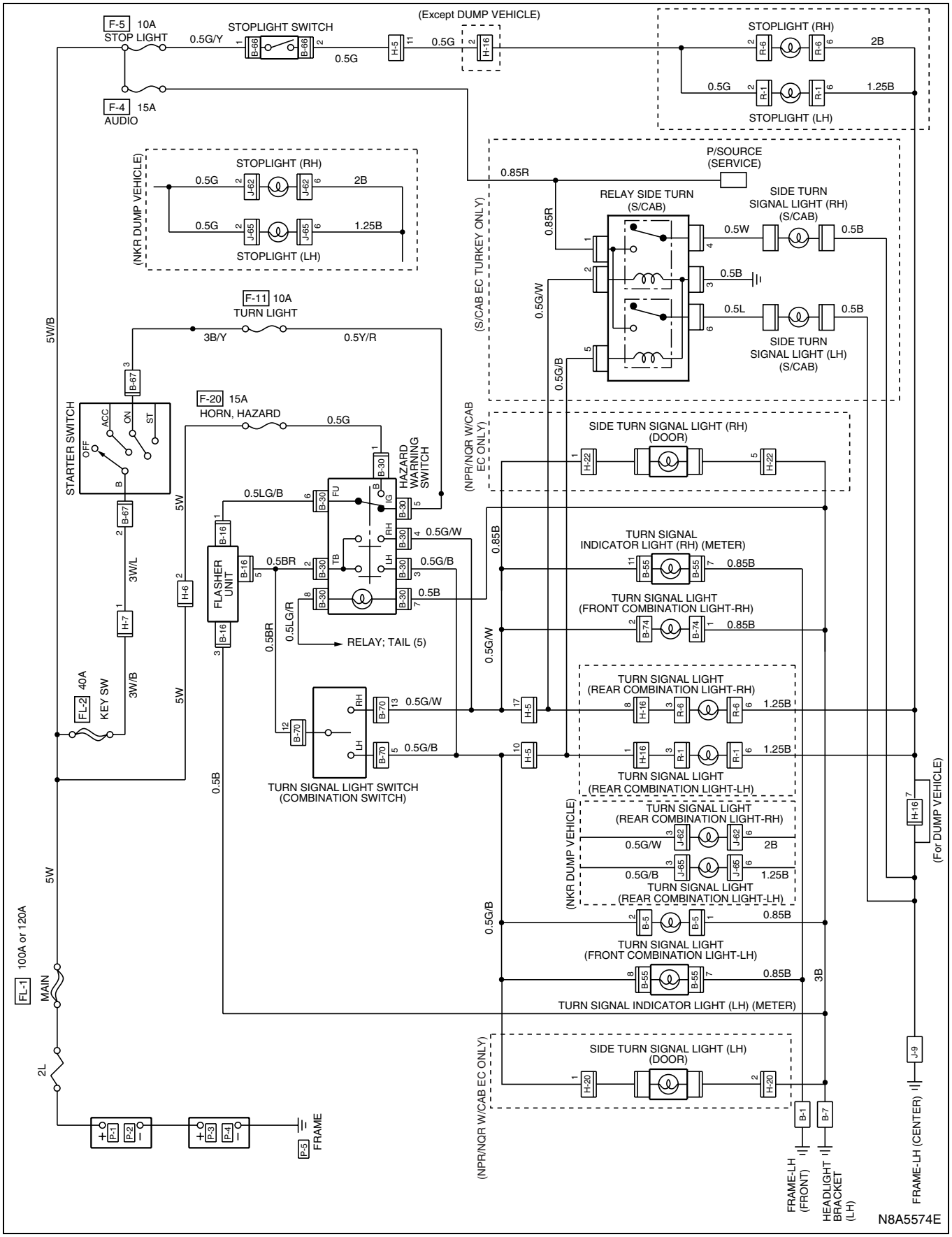


Circuit Diagram

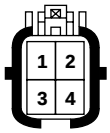
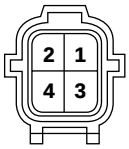
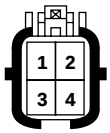
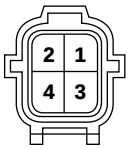
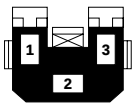
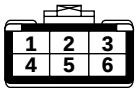
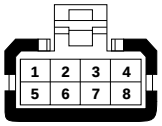
For 12 Volt

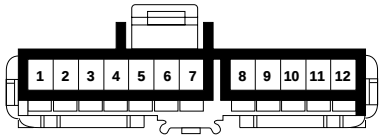
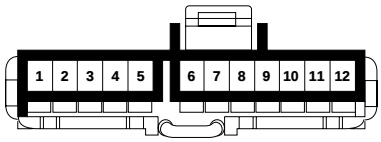
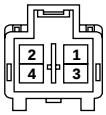
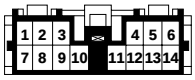
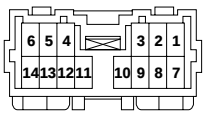


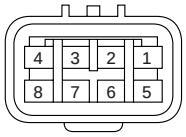
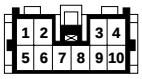
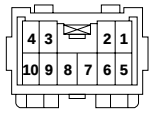
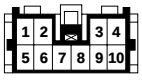
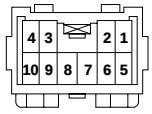
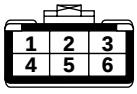
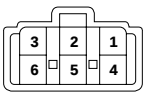
For 24 Volt

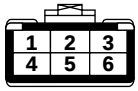
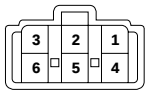
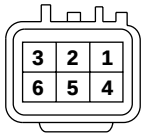
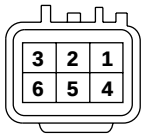
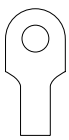
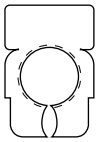

F-5 10A
STOP LIGHT
STOPLIGHT SWITCH
0.5G/Y
B-66
0.5G
H-5
11
(Except DUMP VEHICLE)
H-16
STOPLIGHT (RH)
R-6
2B
0.5G
R-1
1.25B
STOPLIGHT (LH)
F-4 15A
AUDIO
(NKR DUMP VEHICLE)
J-62
J-65
P/SOURCE
(SERVICE)
0.85R
RELAY SIDE TURN
(S/CAB)
SIDE TURN
SIGNAL LIGHT (RH)
(S/CAB)
0.5W
0.5B
0.5L
SIDE TURN
SIGNAL LIGHT (LH)
(S/CAB)
(S/CAB EC TURKEY ONLY)
0.5G/W
0.5G/B
F-11 10A
TURN LIGHT
3B/Y
0.5Y/R
5W/B
B-67
F-20 15A
HORN, HAZARD
STARTER SWITCH
OFF
ACC
ON
ST
B
HAZARD
WARNING
SWITCH
FU
IG
RH
LH
TB
FLASHER
UNIT
B-16
B-30
0.5LG/B
0.5BR
0.5LG/R
RELAY; TAIL (5)
3W/L
3W/B
5W
H-6
H-7
FL-2 40A
KEY SW
SIDE TURN SIGNAL LIGHT (RH)
(DOOR)
H-22
(NPR/NOR W/CAB
EC ONLY)
TURN SIGNAL
INDICATOR LIGHT (RH) (METER)
B-55
0.85B
TURN SIGNAL LIGHT
(FRONT COMBINATION LIGHT-RH)
B-74
TURN SIGNAL LIGHT
(REAR COMBINATION LIGHT-RH)
H-16
R-6
1.25B
TURN SIGNAL LIGHT
(REAR COMBINATION LIGHT-LH)
R-1
TURN SIGNAL LIGHT SWITCH
(COMBINATION SWITCH)
B-70
H-5
(NKR DUMP VEHICLE)
TURN SIGNAL LIGHT
(REAR COMBINATION LIGHT-RH)
J-62
0.5G/W
2B
TURN SIGNAL LIGHT
(REAR COMBINATION LIGHT-LH)
J-65
0.5G/B
1.25B
TURN SIGNAL LIGHT
(FRONT COMBINATION LIGHT-LH)
0.85B
TURN SIGNAL INDICATOR LIGHT (LH) (METER)
3B
SIDE TURN SIGNAL LIGHT (LH)
(DOOR)
H-20
(NPR/NQR W/CAB EC ONLY)
FL-1 100A or 120A
MAIN
2L
5W
P-1
P-2
P-3
P-4
P-5
FRAME
B-1
B-7
FRAME-LH
(FRONT)
HEADLIGHT
BRACKET
(LH)
J-9
FRAME-LH (CENTER)
(For DUMP VEHICLE)
N8A5574E

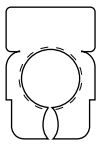
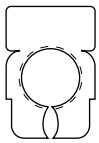
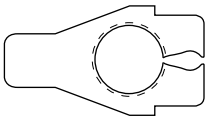
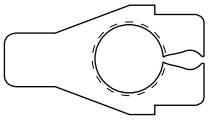
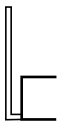
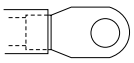
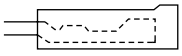
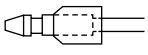
Connector List

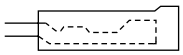
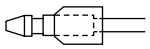
No.	Connector Face
B-5	 004-012
B-5	 004-013
B-74	 004-012
B-74	 004-013
B-16 (12 V s/cab and with-out side turn light c/ cab)	 003-008
B-16 (24 V and 12V with side turn light c/ cab)	 006-010
B-30	 008-005

No.	Connector Face
B-52	 012-005
B-51	014-001
B-53	 012-004
B-66	002-024
B-67	004-001
B-67	 004-002
B-70	 014-002
B-70	 014-003

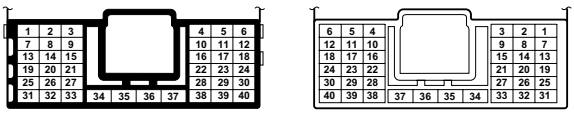
No.	Connector Face
H-16	008-003
H-16	 008-004
H-20	 010-003
H-20	 010-004
H-22	 010-003
H-22	 010-004
J-62	 006-010
J-62	 006-015

No.	Connector Face
J-65	 006-010
J-65	 006-015
R-1	006-004
R-1	 006-005
R-6	006-004
R-6	 006-005
P-1 (12 V)	 000-003
P-2	 000-004

No.	Connector Face
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
P-5 (12 V)	 000-007
P-5 (24 V)	 000-002
	 000-010
	 000-011

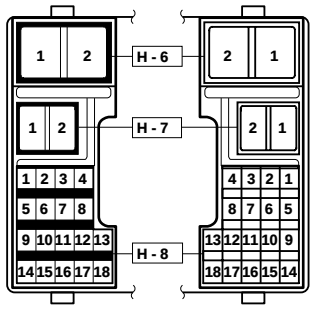
No.	Connector Face
	 000-010
	 000-011

H-5



N8A5488E

H-7, H-8



N8A5489E

Diagnosis

Quick Chart for Check Point

1. Turn Signal Light, Hazard Warning Light

		Check point						
		Fuse		Turn signal light SW	Hazard warning light SW	Flasher unit	Turn signal light bulb	Cable harness
		F-19, F-20 (15 A)	F-11 (10 A)					
Trouble mode	1-1. Turn signal lights inoperative		❍	❍		❍		❍
	1-2. Turn signal lights flash too quickly						❍	❍
	1-3. Hazard warning lights inoperative	❍			❍			

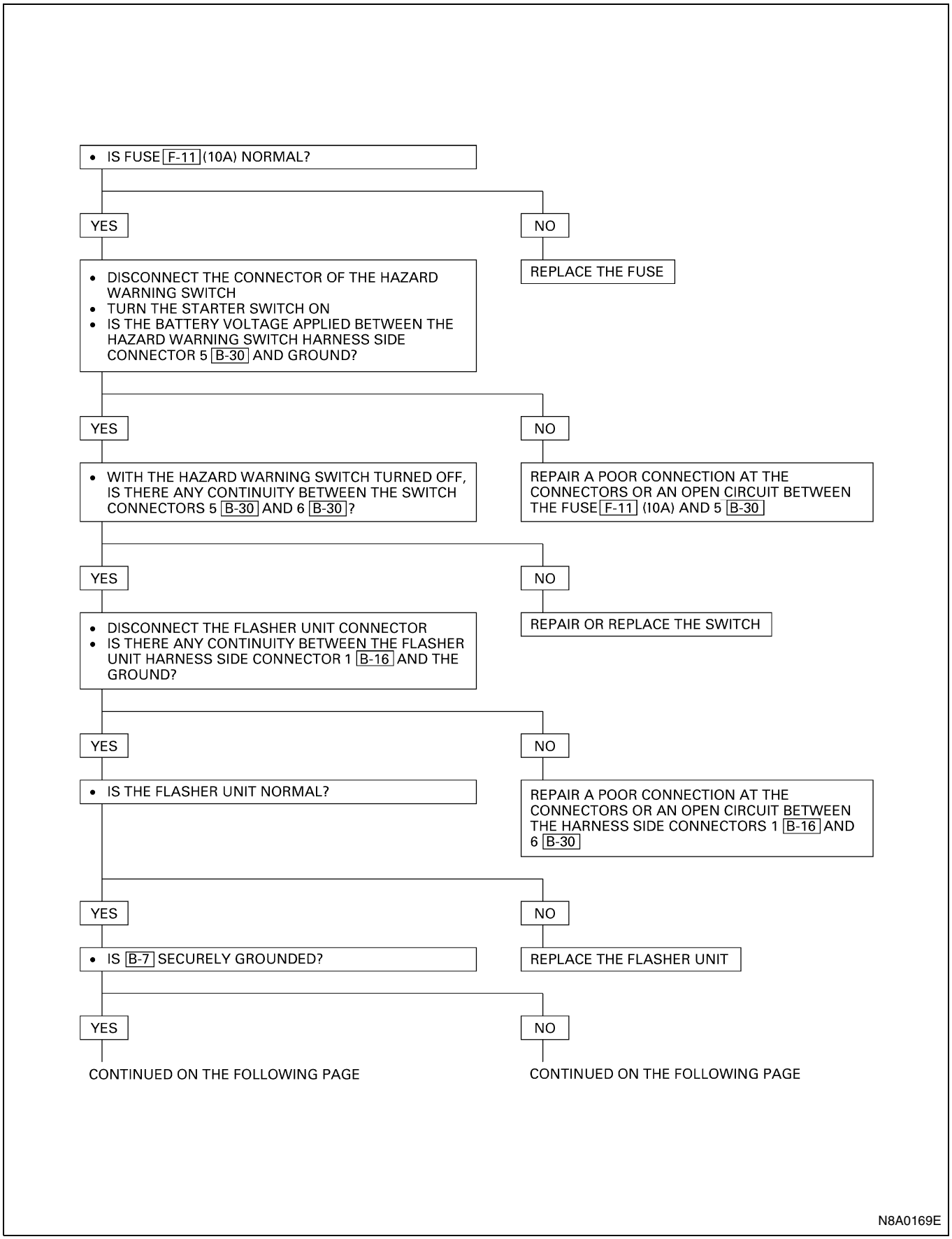
Notice:
Figure in parenthesis “( )” indicates the order of inspection.

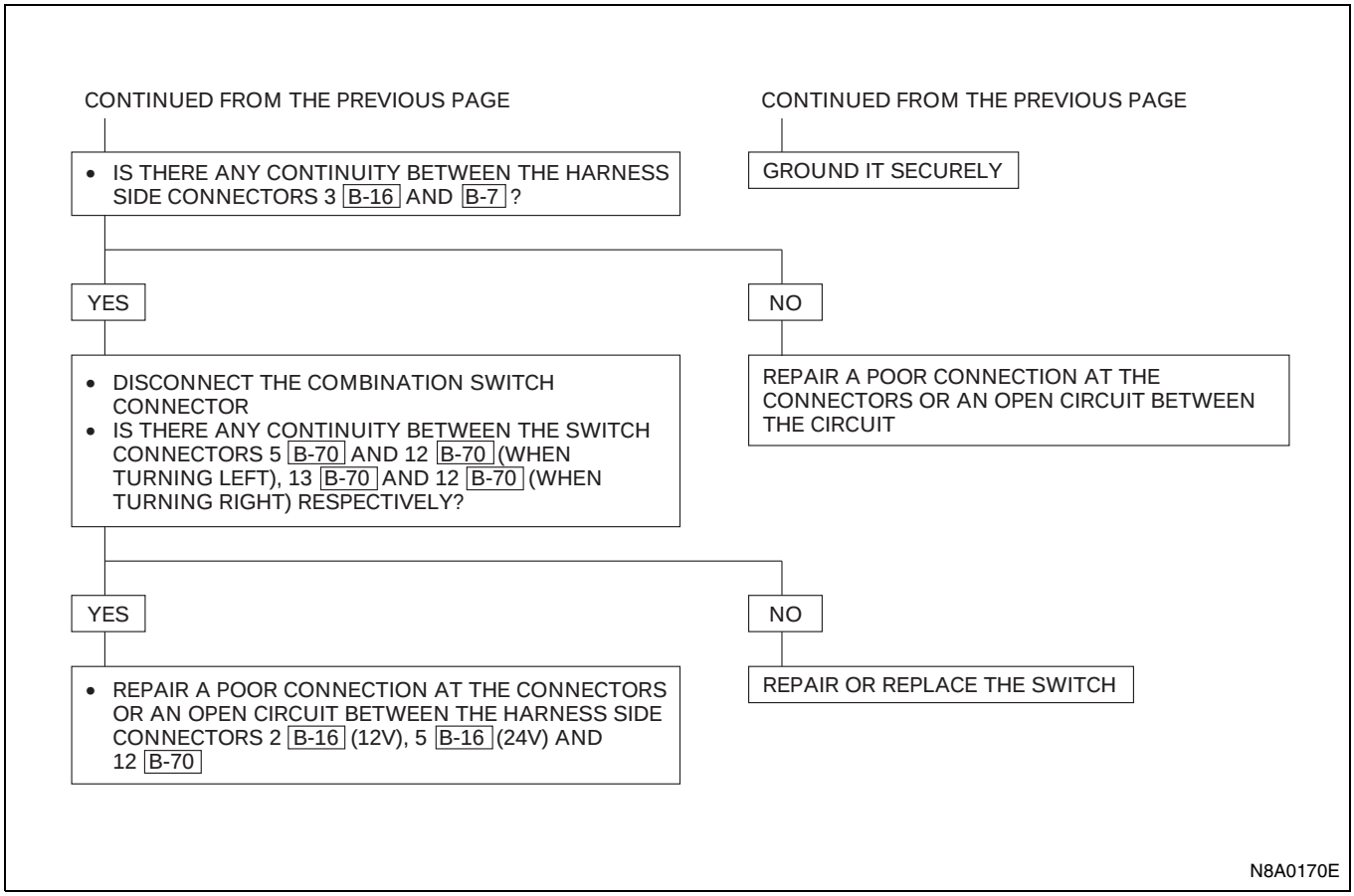
2. Stoplight

		Check point			
		Fuse F-5 (10 A)	Stoplight SW	Stoplight bulb	Cable harness
Trouble mode	2-1. Both stoplights inoperative	❍	❍		❍
	2-2. Stoplight on the left (or right) side inoperative			❍	❍

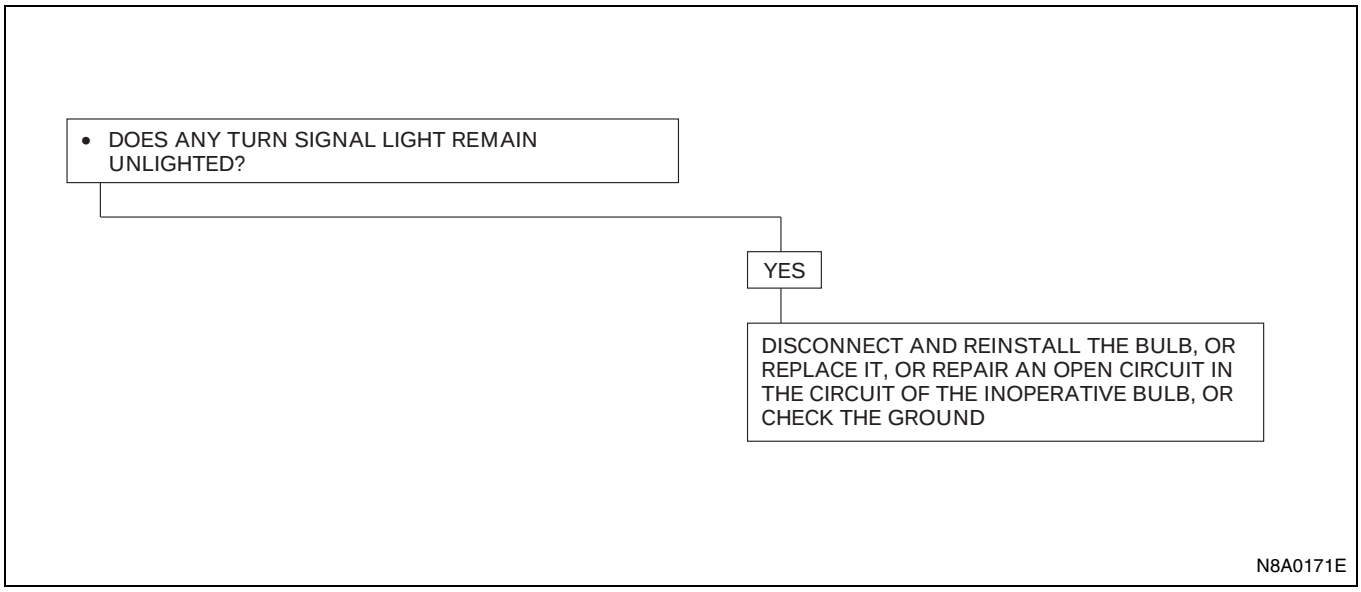
Notice:
Figure in parenthesis “( )” indicates the order of inspection.

1. Turn Signal Light, Hazard Warning Light
1-1. Turn Signal Lights Inoperative

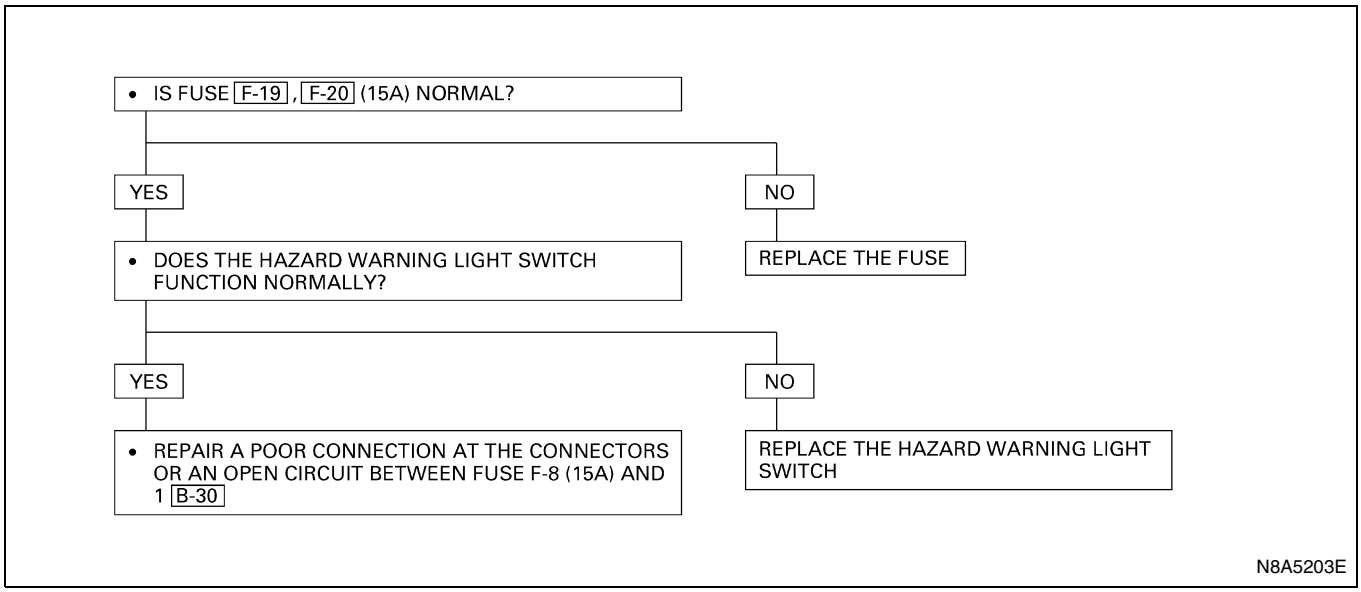




1-2. Turn Signal Lights Flash Too Quickly

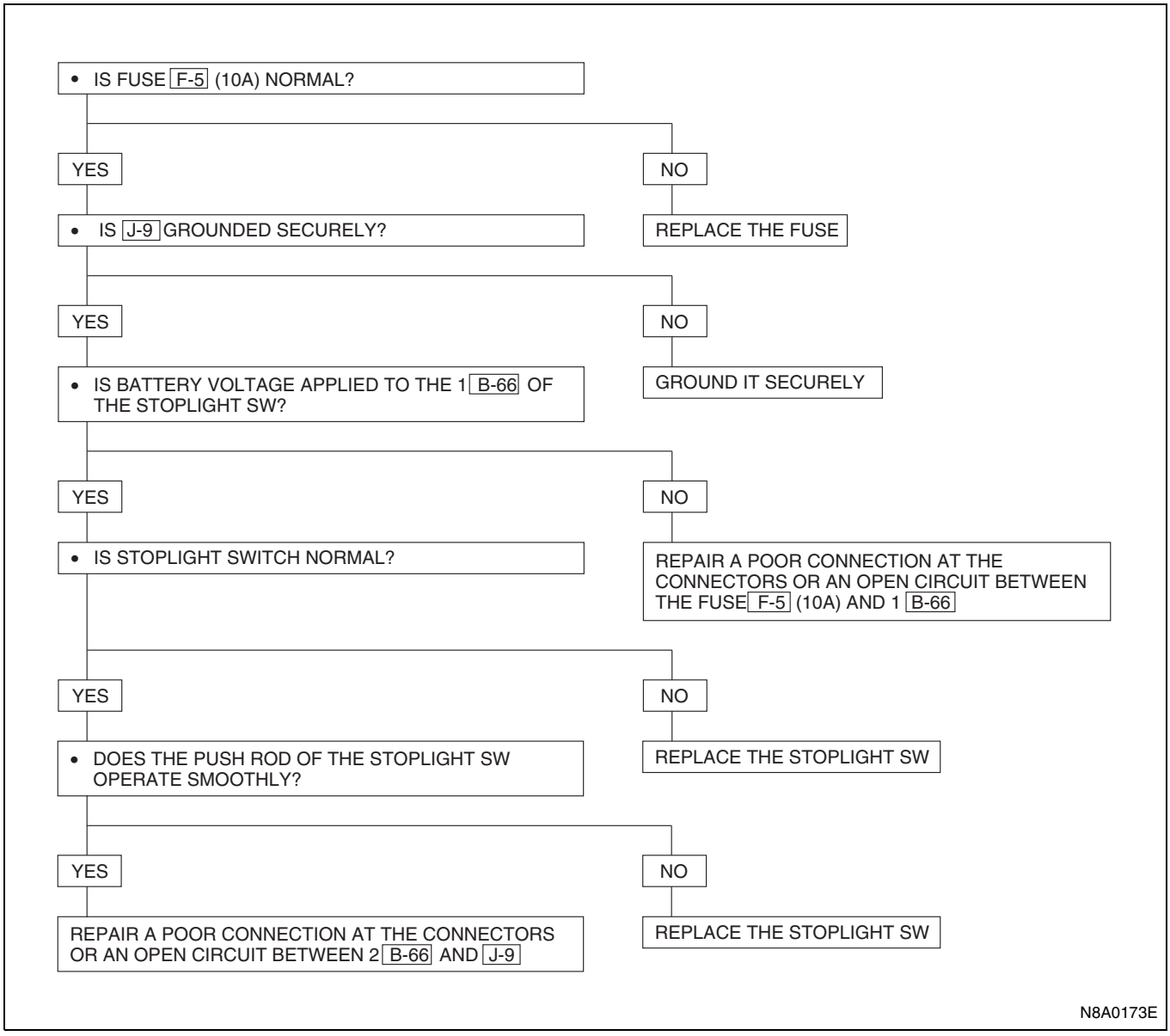


1-3. Hazard Warning Lights Inoperative

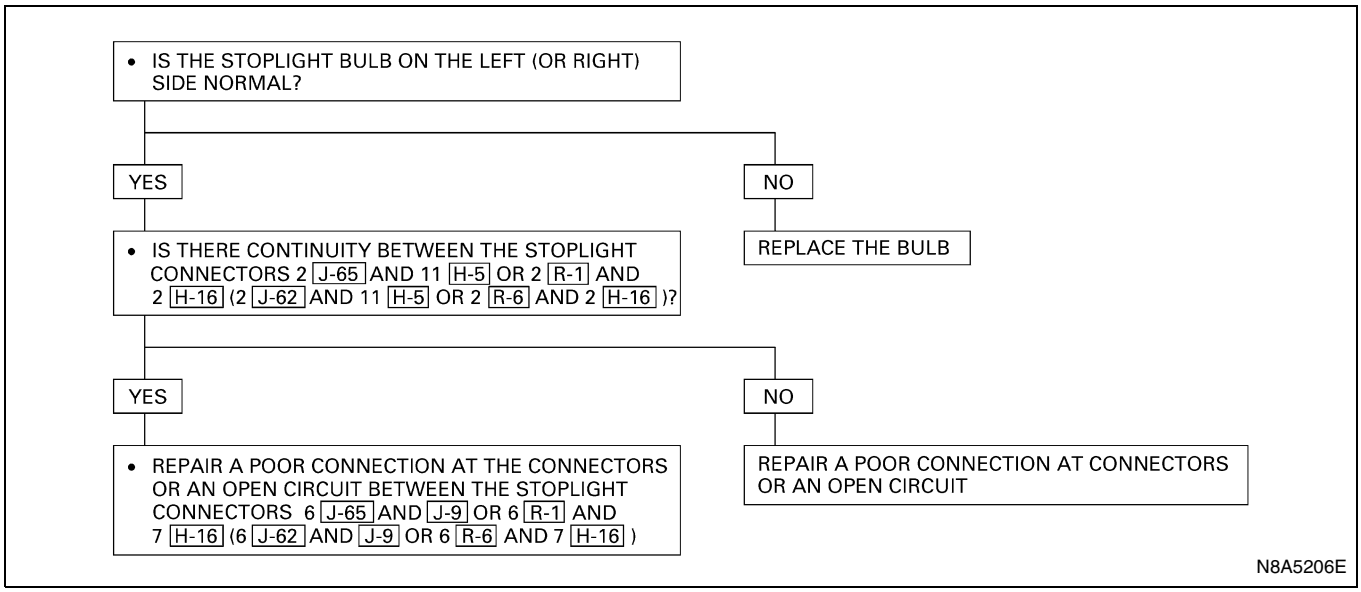


2. Stoplight

2-1. Both Stoplights Inoperative



2-2. Stoplight on The Left (or Right) Side Inoperative



Notice:
Figure in parenthesis “( )” indicates the place of inspection for the right side stoplight.

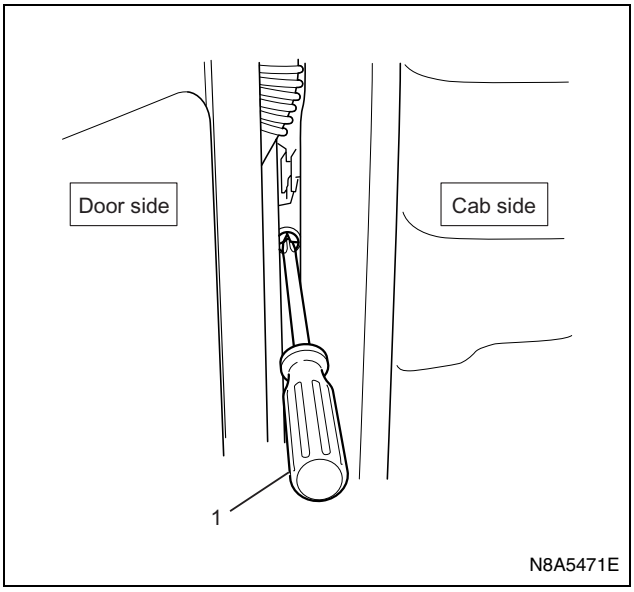
Starter Switch

Refer to “START AND CHARGING” in this section.

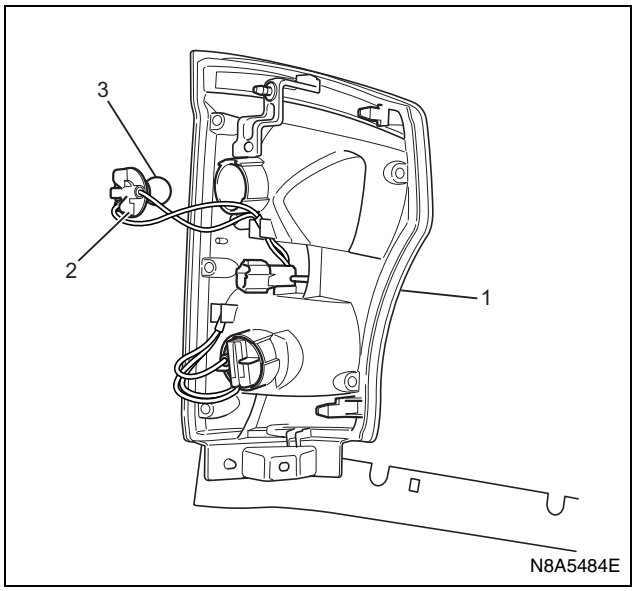
Front Turn Signal Light/Bulb

Removal

1. Remove the battery ground cable at the battery.
2. Remove the front combination light.
   - Open the cab door. Insert a screwdriver (1) into the space between the cab and the cab door. Use the screwdriver to force out the stud pin at the center of the grommet (the pin securing the front combination light).



   - Remove the fixing screw.
   - Remove the two catches.
   - Remove the front combination light (1) connector.



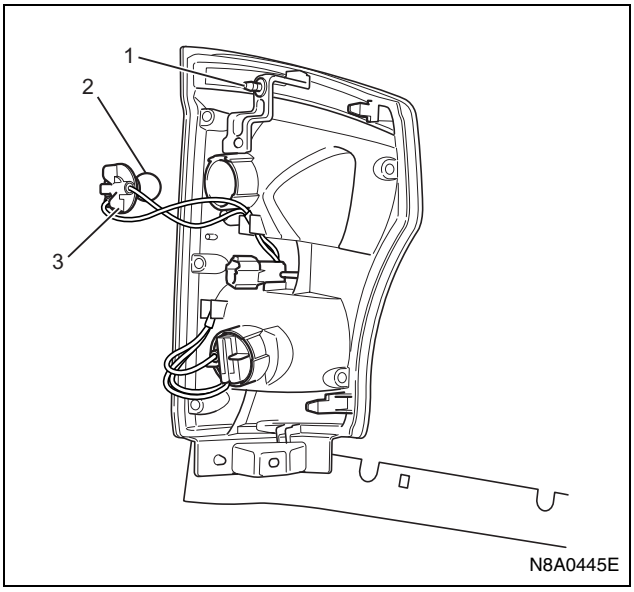
3. Remove the front turn signal light bulb.
   - Turn the bulb socket (2) to the left to remove it.
   - Press the bulb (3) in and turn it to the left to remove it from the socket.

Installation

1. Install the front turn signal light bulb.
   - While pressing the bulb (2), turn it clockwise to fit.

Notice:
Do not let the glass portion dirty with sebum etc.

   - Turn the bulb socket (3) clockwise to fit.



2. Installation procedure of front combination light assembly
   - Connect the connector of the front combination light assembly.
   - Position it by aligning two pawls with the groove of H/L.
   - Fit the iron PIN (1) in the upper portion of the side by aligning it with the center of corresponding grommet.

Notice:
Push it into securely with a force of approx. 250 N (25 kgf) until click is heard.

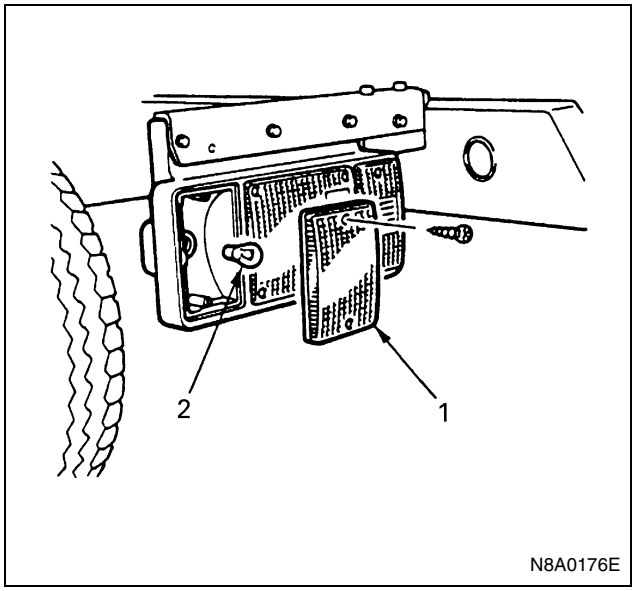
   - Pull the front combination light assembly lightly toward the front of vehicle to make sure that the PIN and grommet are engaged securely.
   - Tighten one bolt in the lower portion of front combination light assembly.
3. Hook the seal rubber on two projections under H/L.
4. Connect the battery ground cable.
5. Check lighting of each light.

Rear Turn Signal Light/Bulb

Removal

Preparation:
Disconnect the battery ground cable.

1. Lens
2. Bulb



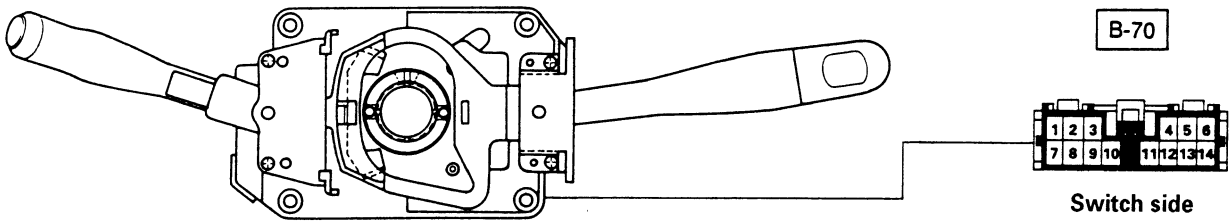
Installation

To install, follow the removal steps in the reverse order.

Turn Signal Light Switch (Combination Switch)

Inspection

Check the continuity between the terminals of the turn signal light switch.
Repair or replace the switch when the result of inspection is found abnormal.



SW position \ Terminal No.		2	5	9	11	12	13
Turn signal light SW	Turning left		○			○	
	Neutral						
	Turning right					○	○

N8A5209E

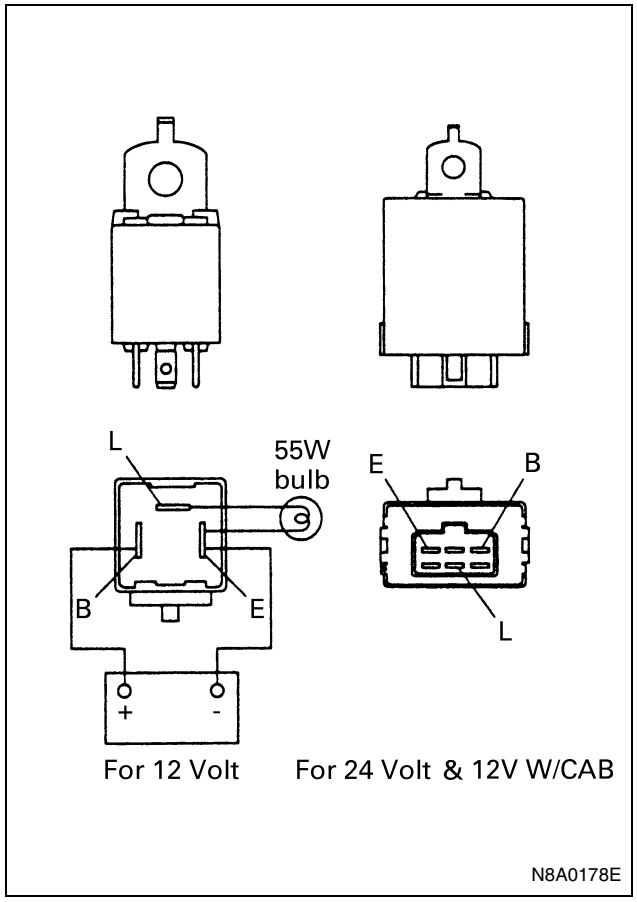
Removal and Installation

Refer to “HEADLIGHT, FOG LIGHT AND CORNERING LIGHT” in this section.

Flasher Unit

Inspection

When a 55W bulb is connected to the unit side terminals “L” and “E” while connecting the battery (+) terminal to terminal “B”, and the battery (−) terminal to terminal “E”, does the bulb light on and off?
Replace the unit when the result of inspection is found abnormal.



Stoplight Bulb

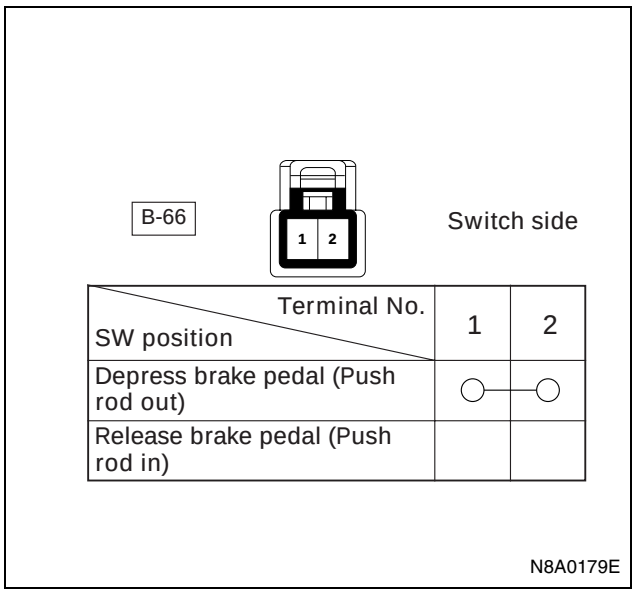
Removal and Installation

Refer to “CLEARANCE LIGHT, TAILLIGHT, LICENSE PLATE LIGHT AND ILLUMINATION LIGHT” for TAILLIGHT BULB removal and installation steps in this section.

Stoplight Switch

Inspection

1. Check to see if the stoplight switch is installed correctly to the specified position. Adjust the position when the result of the inspection is found abnormal.
2. Check to see if there is any continuity between the terminals of the stoplight switch.
   Replace the switch when the result of inspection is found abnormal.

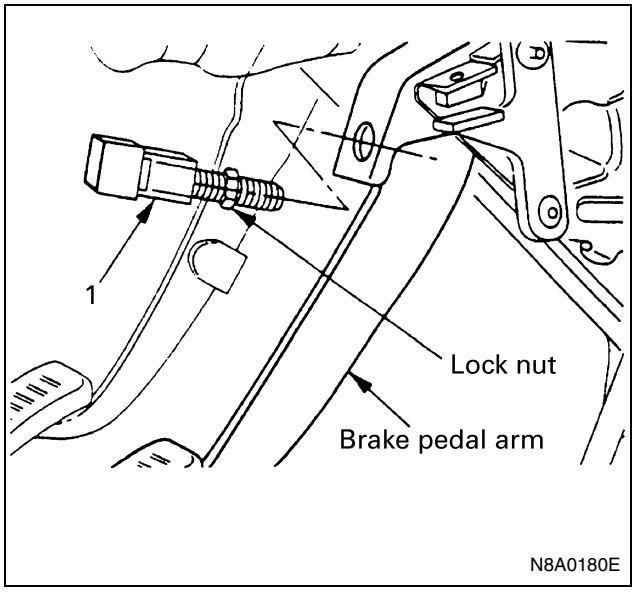


SW position \ Terminal No.	1	2
Depress brake pedal (Push rod out)	○	○
Release brake pedal (Push rod in)		

Removal

Preparation:
Disconnect the battery ground cable.

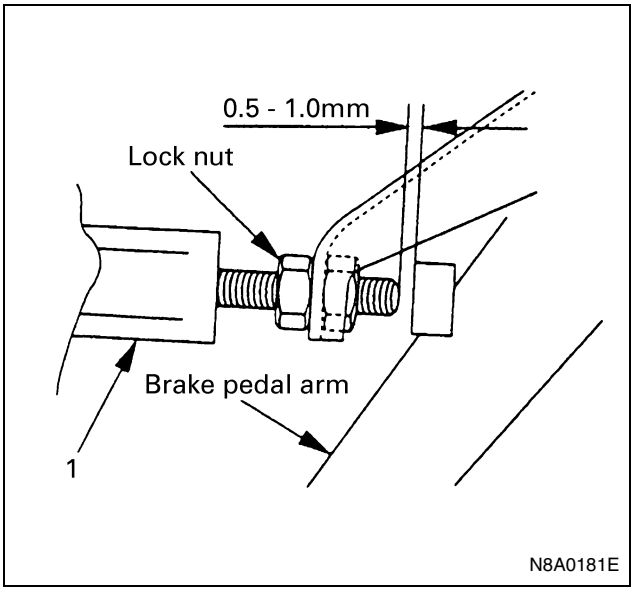
1. Stoplight Switch
   1) Disconnect the connector.
   2) Loosen the lock nut of the switch.
   3) Remove the switch by turning it.



Installation

To install, follow the removal steps in the reverse order, noting the following points.

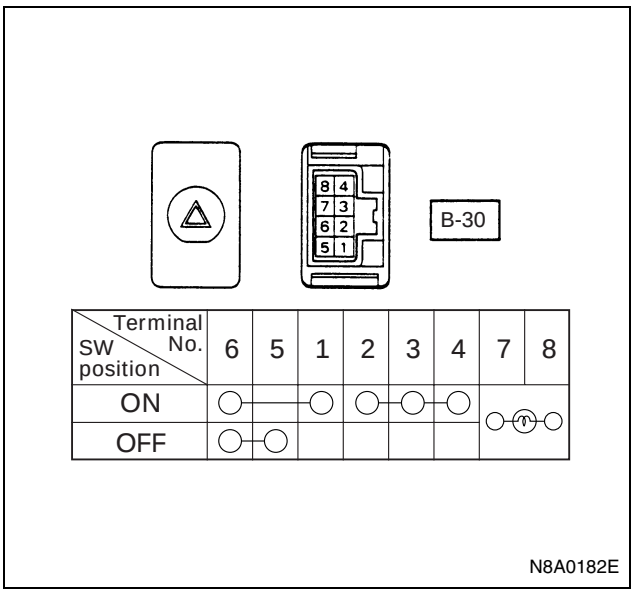
1) Check to see if the brake pedal has been returned by the return spring to the specified position.
2) Turn the stoplight switch clockwise until the tip of the threaded portion of the switch contacts the pedal arm.
3) Turn the switch counterclockwise until the space between the tip of the threaded portion and the pedal arm is 0.5 to 1.0 mm (0.02 — 0.04 in.).



Hazard Warning Switch

Inspection

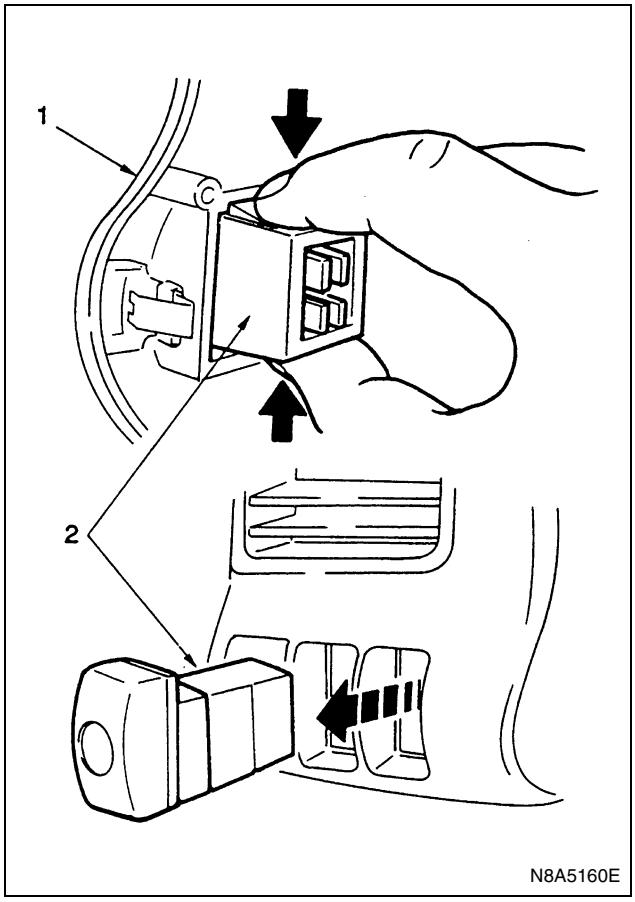
Check the continuity between the terminals of the hazard warning switch.
Repair or replace the switch when the result of inspection is found abnormal.



Removal

Preparation:
Disconnect the battery ground cable.

1. Meter Cluster
   Refer to the “METER AND WARNING/INDICATOR LIGHT” in this section.
2. Hazard Warning Switch
   Release the lock pushing the switch from the back side of the meter cluster.



Installation

To install, follow the removal steps in the reverse order noting the following point.

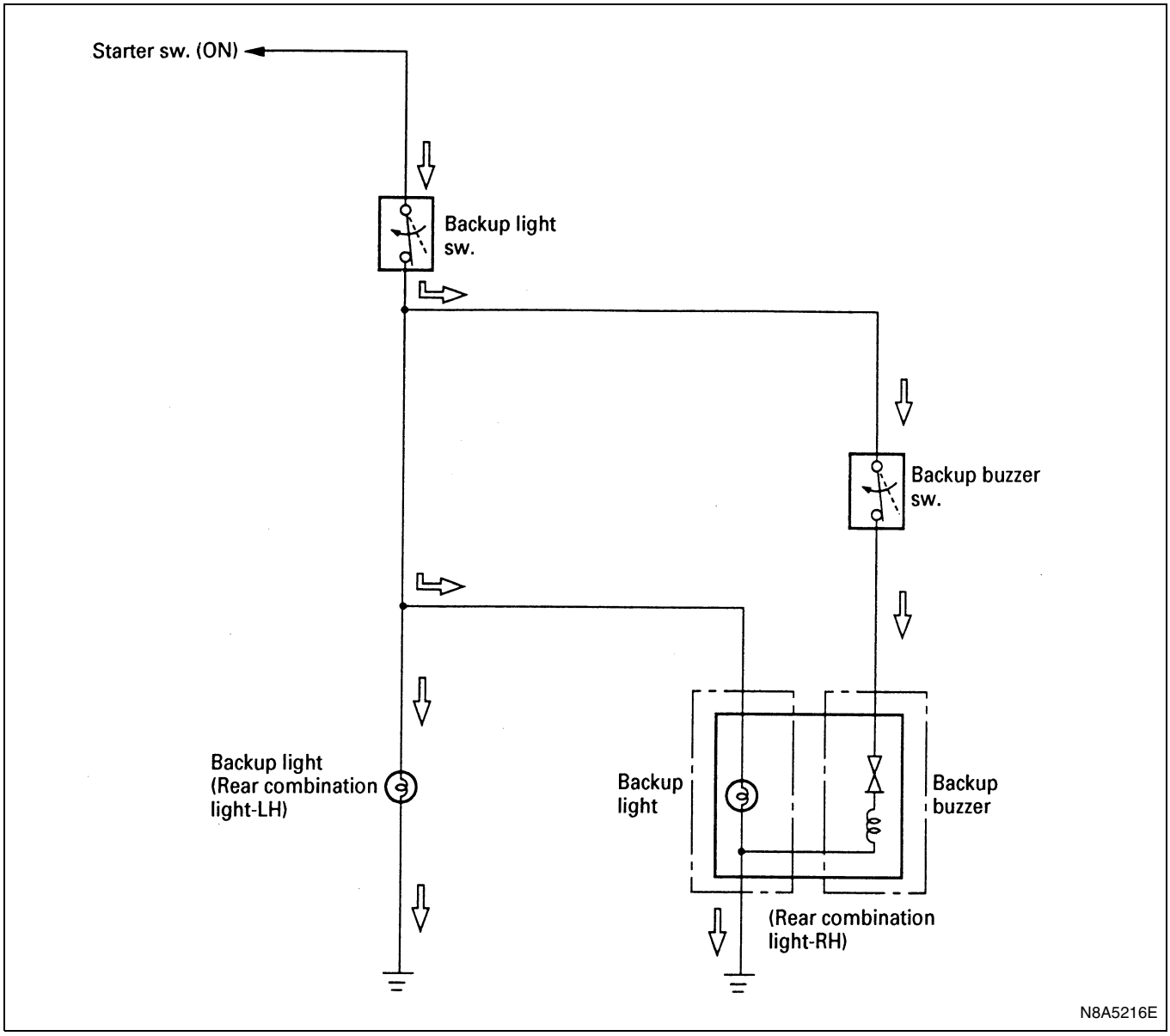
1. Push the switch with your fingers until locks securely.

Horn, Backup Light and Backup Buzzer

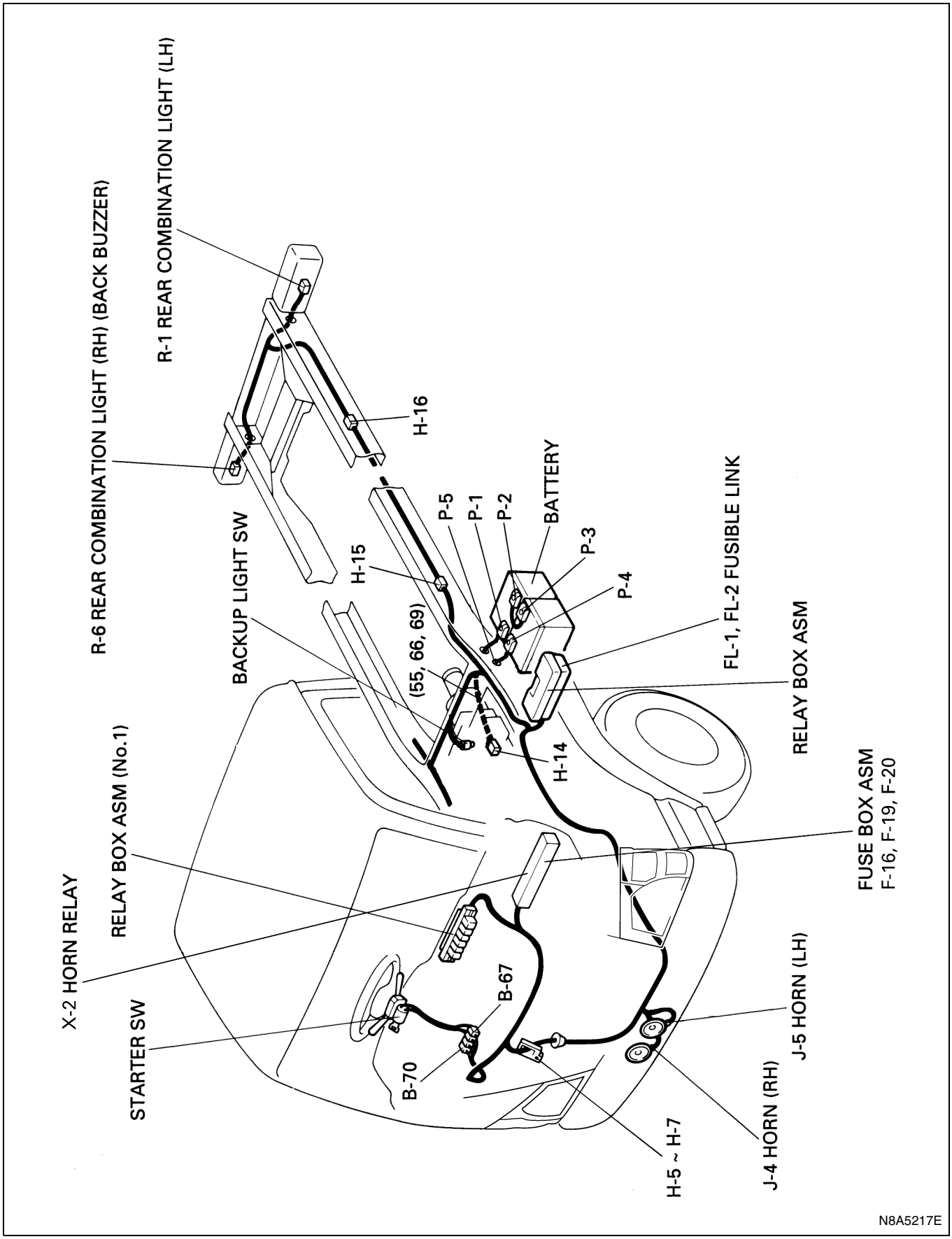
General Description

The circuit consists of the starter switch, horn, horn switch, backup light (Rear combination light), backup light switch, back buzzer and the relay.
When the horn switch is turned on independent of the position of the starter switch, the relay is activated to sound the horn. When the backup light switch turns on with the starter switch on, the backup light will operate.

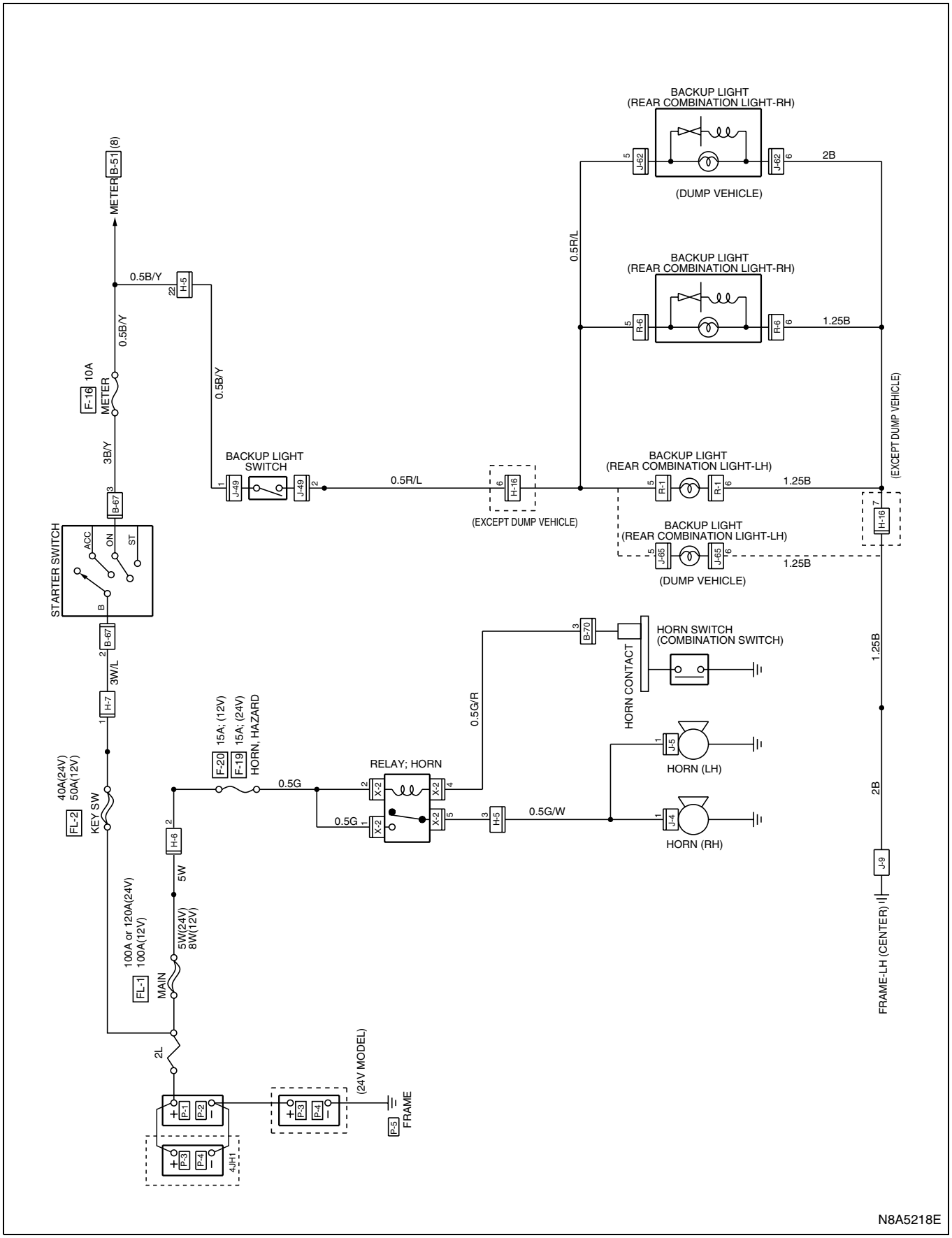
Backup Light and Backup Buzzer Circuit



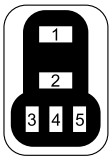
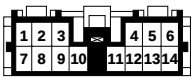
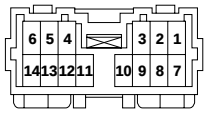
Parts Location

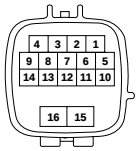
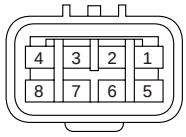
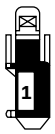
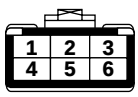


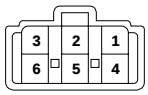
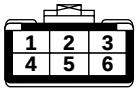
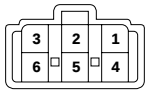
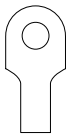
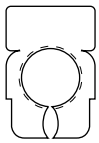
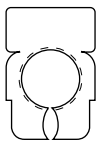
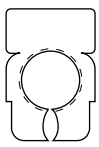
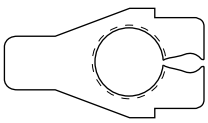
Circuit Diagram

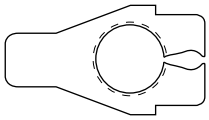
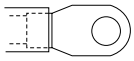
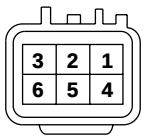
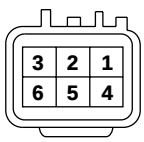


Connector List

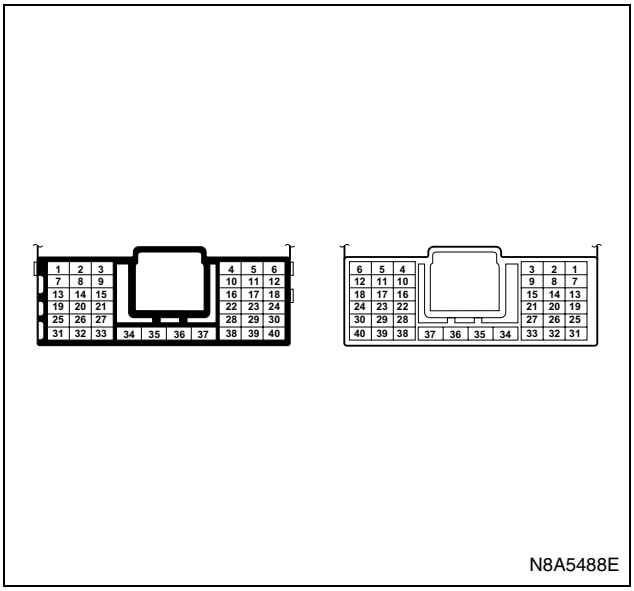
No.	Connector Face
X-2	 005-006
B-67	004-001
B-67	004-002
B-70	 014-002
B-70	 014-003
E-10	002-025
E-10	002-026
J-49	002-025

No.	Connector Face
J-49	002-026
H-14	016-003
H-14	 016-004
H-16	008-003
H-16	 008-004
J-4	001-008
J-5	 001-008
J-62	 006-010

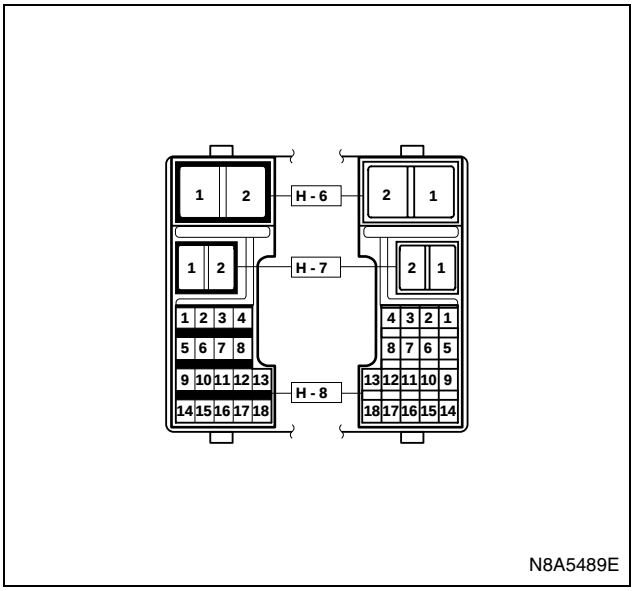
No.	Connector Face
J-62	 006-015
J-65	 006-010
J-65	 006-015
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006

No.	Connector Face
P-3	 000-006
P-5 (12 V)	000-007
P-5 (24 V)	 000-002
R-1	006-004
R-1	 006-005
R-6	006-004
R-6	 006-005

H-5



H-6, H-7



Diagnosis

Quick Chart for Check Point

1. Horn

		Check point					
		Fuse F-19, F-20 (15 A)	Horn	Horn SW	Horn relay	Horn contact	Cable harness
Trouble mode	1-1. Horn does not sound	❍ (1)	❍ (4)	❍ (6)	❍ (2)	❍ (5)	❍ (3)
	1-2. Horn does not shut off			❍ (2)	❍ (1)		❍ (3)

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

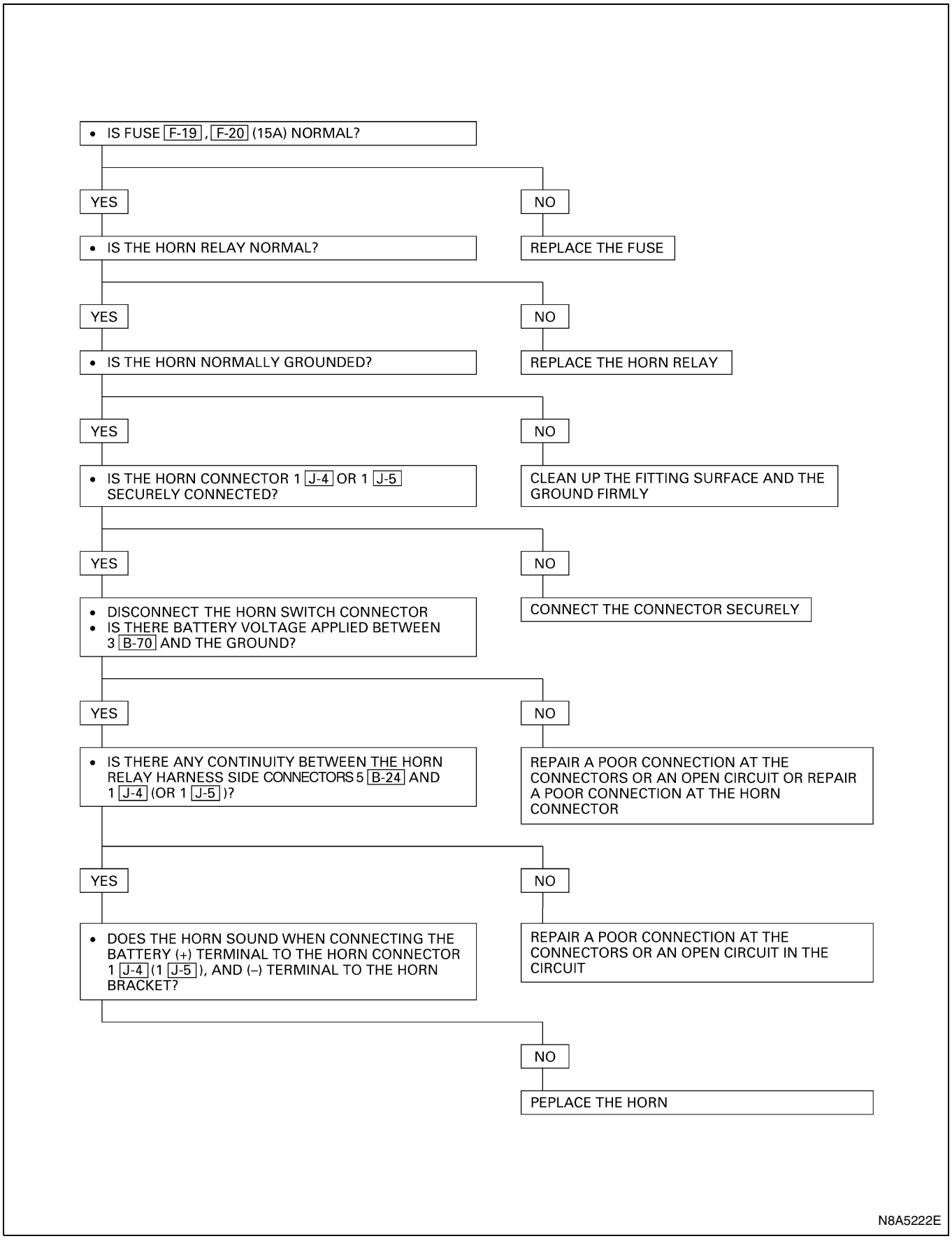
2. Backup Light

		Check point				
		Fuse F-16 (10 A)	Backup light SW (Inhibitor SW)	Backup light bulb	Backup buzzer	Cable harness
Trouble mode	2-1. Both backup lights inoperative	❍ (1)	❍ (3)			❍ (2)
	2-2. Backup light on the left (or right) side inoperative			❍ (1)		❍ (2)
	2-3. Backup light remains on		❍ (1)			

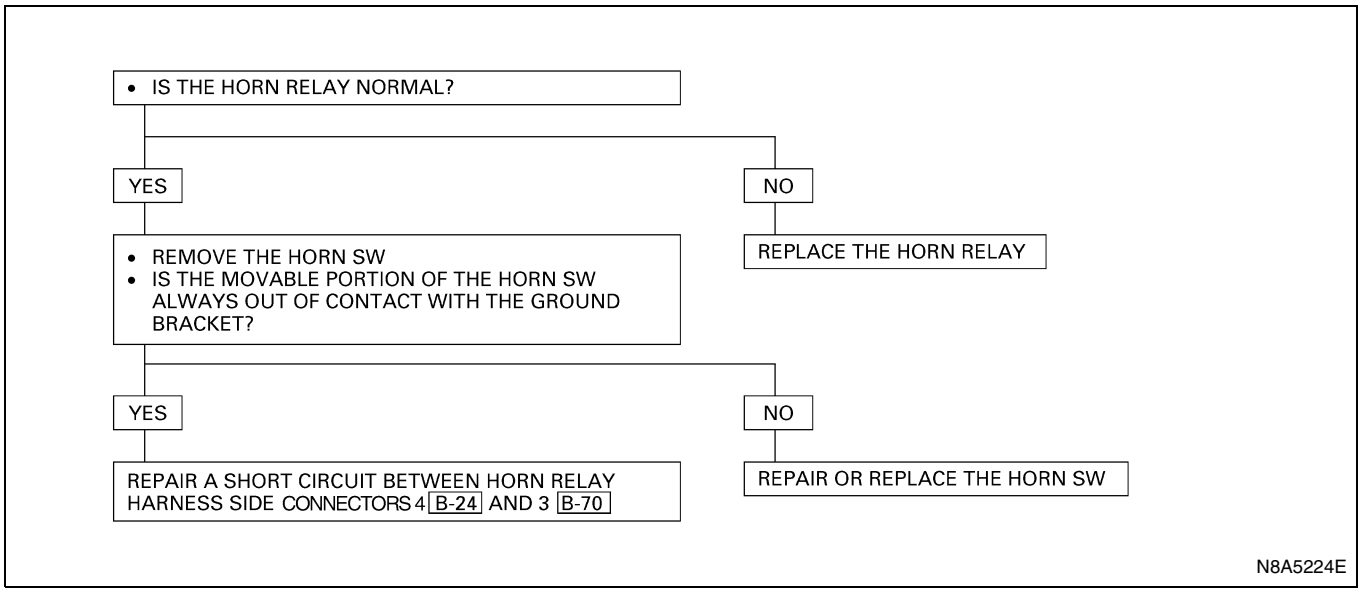
Notice:
Figure in parenthesis “( )” indicates the order of inspection.

1. Horn

1-1. Horn Does Not Sound

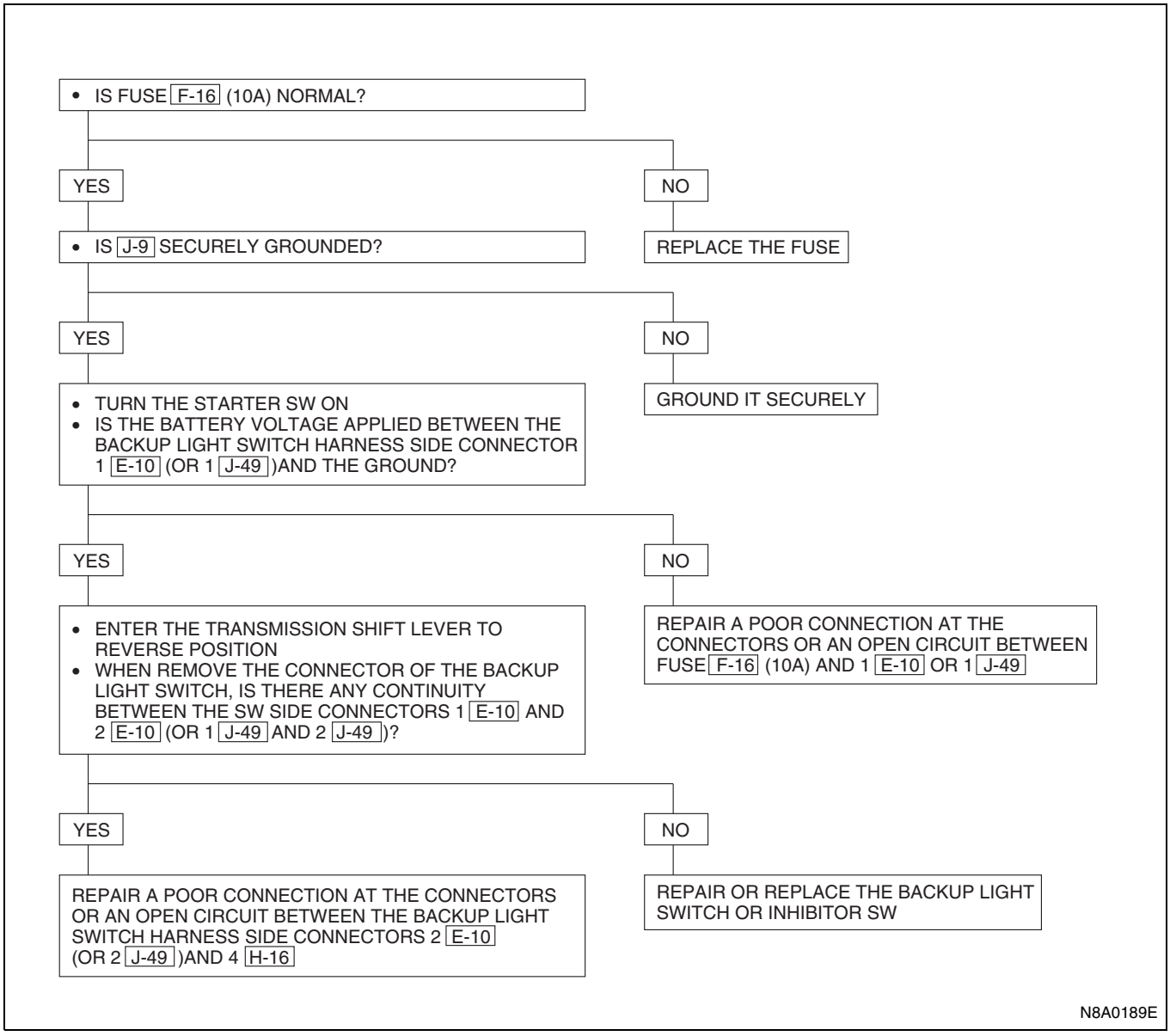


1-2. Horn Does Not Shut Off

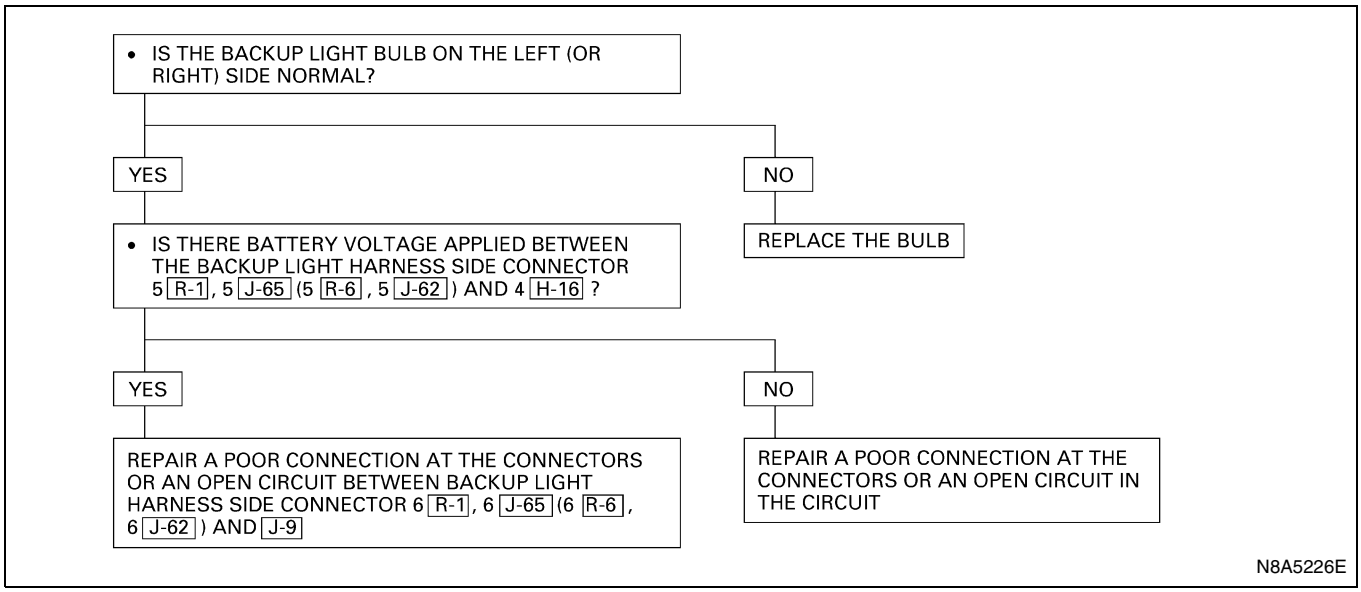


2. Backup Light

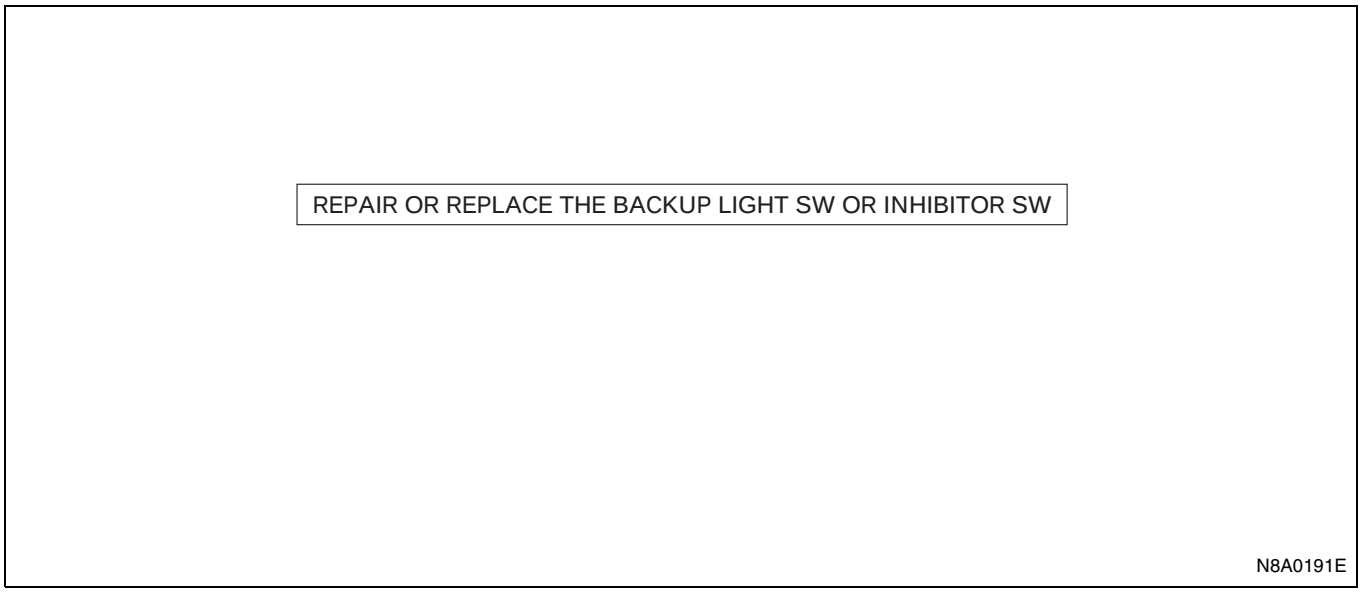
2-1. Backup Lights Inoperative



2-2. Backup Light on the Left (or Right) Side Inoperative



2-3. Backup Light Remains on



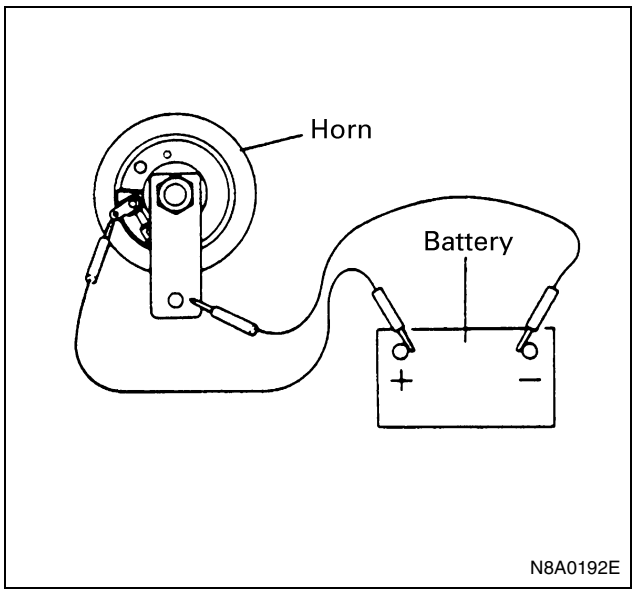
Starter Switch

Refer to “START AND CHARGING” in this section.

Horn

Inspection

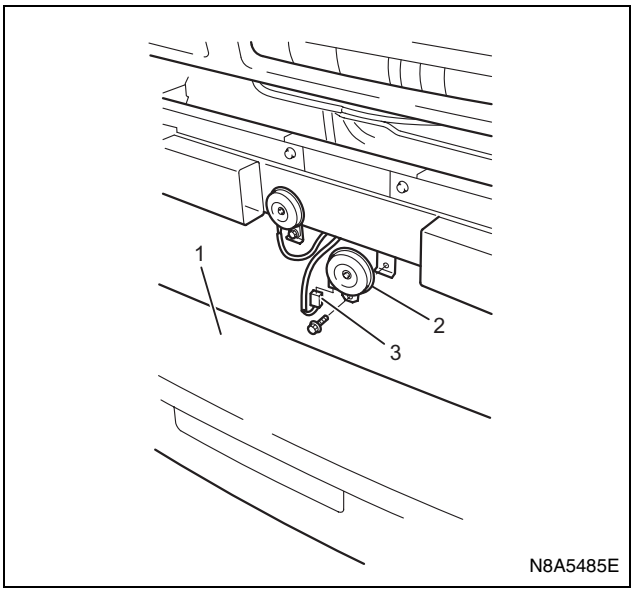
Check to see if horn sound when a battery voltage between horn terminal and the fixing bracket. Repair or replace the horn when the result of inspection is found abnormal.



Removal

Preparation:
Disconnect the battery ground cable.

1. Bumper
   Refer to “BUMPER” in section 2.
2. Horn
   Disconnect the connector (3).



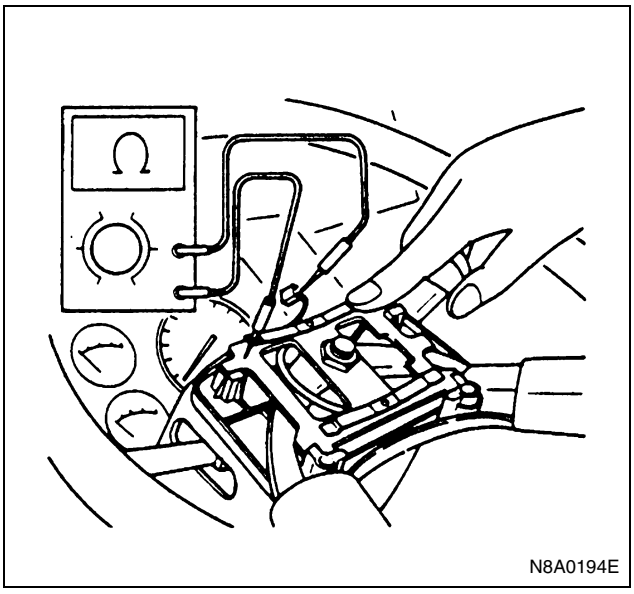
Installation

To install, follow the removal steps in the reverse order.

Horn Switch

Inspection

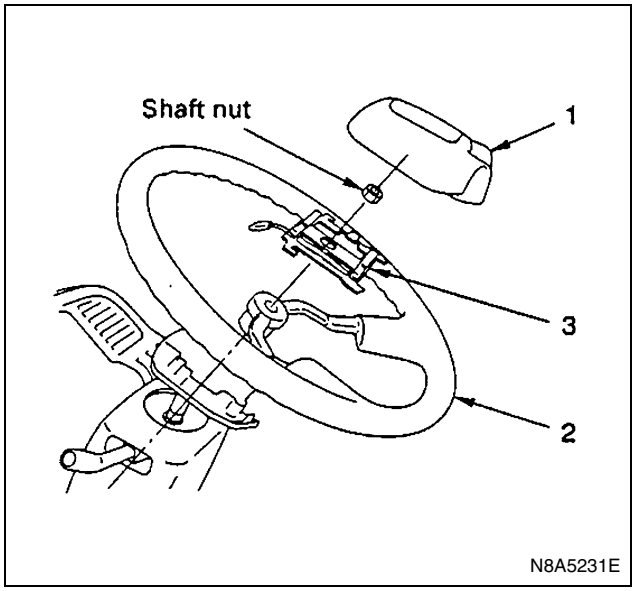
With the contact point of the horn switch pressed to the switch bracket, check the continuity between the connector terminal and the bracket of the switch.
Check the contact condition between horn contact of the combination switch and contact plate of steering wheel.
Repair or replace the switch when the result of inspection is found abnormal.



Removal

Preparation:
Disconnect the battery ground cable.

1. Horn Pad
   1) Hold the horn pad and pull it upward.
2. Steering Wheel
   1) Remove the steering shaft nut.
   2) Remove the steering wheel by using steering wheel remover.
      (Refer to Section 3B4 “STEERING COLUMN” for steering wheel removal steps.)
3. Horn Switch



Installation

To install, follow the removal steps in the reverse order, noting the following point.

1. Tighten the steering shaft nut to the specified torque.

Tighten:
Shaft nut to 49 N·m (5 kg·m / 36 lb·ft)

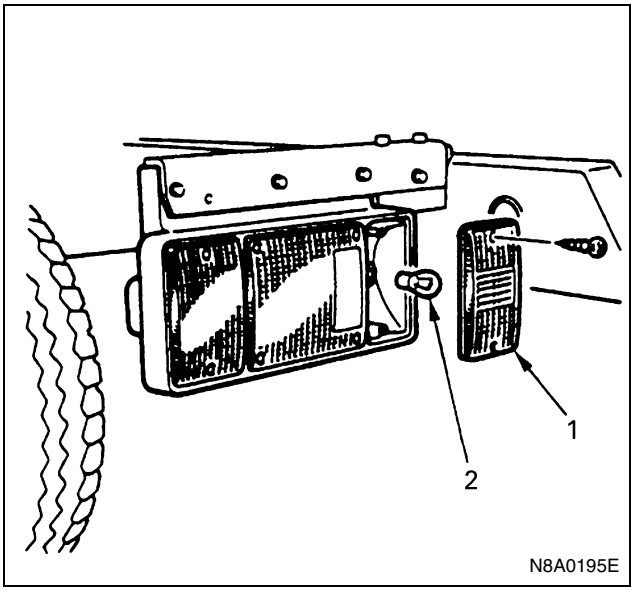
Backup Light Bulb

Removal

Preparation:

Disconnect the battery ground cable.

1. Lens
2. Bulb



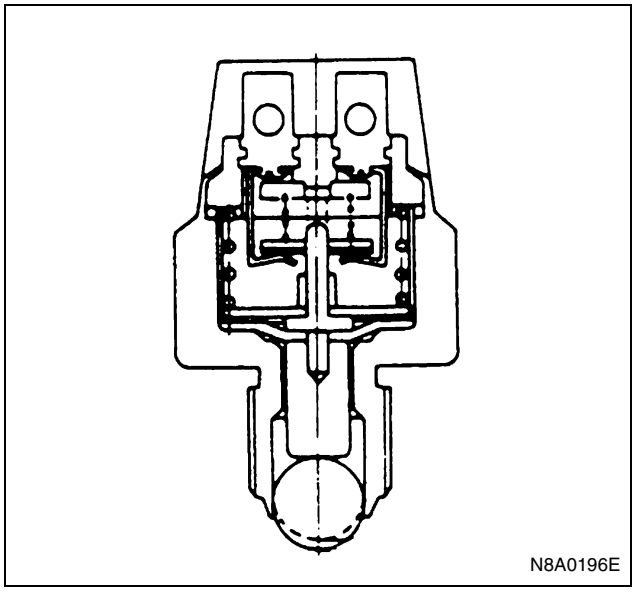
Installation

To install, follow the removal steps in the reverse order.

Backup Light Switch

Inspection

1. With the switch installed to the transmission, check the continuity between the terminals of the switch connectors.
   When the continuity is found between the terminals only with the switch shifted to the reverse position, the switch is normal.
2. When the result of the above inspection is found abnormal, remove the switch from the transmission and conduct a test on the switch alone.
   If the continuity appears between the connector terminals when the ball of the switch is pushed, the switch is normal. (When the ball is released, the continuity disappears.)
3. If there is no continuity with the switch installed to the transmission, even though the switch is found to be normal, then adjust the stroke of the switch by changing the thickness of the switch gasket.



Removal

Preparation:

Disconnect the battery ground cable.

1. Backup Light Switch
   1) Disconnect the connectors.
   2) Remove the switch by turning it counterclockwise.

Installation

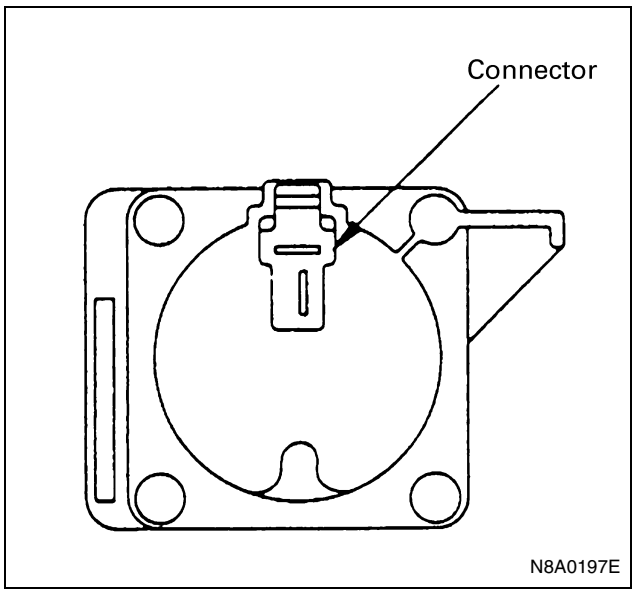
1. Backup Light Switch
   Apply liquid gasket to the screw portion of the switch to prevent oil leak.

Backup Buzzer

Inspection

Apply battery voltage to the backup buzzer connector to check the buzzer sound.

Repair or replace the buzzer when the result of inspection is found abnormal.

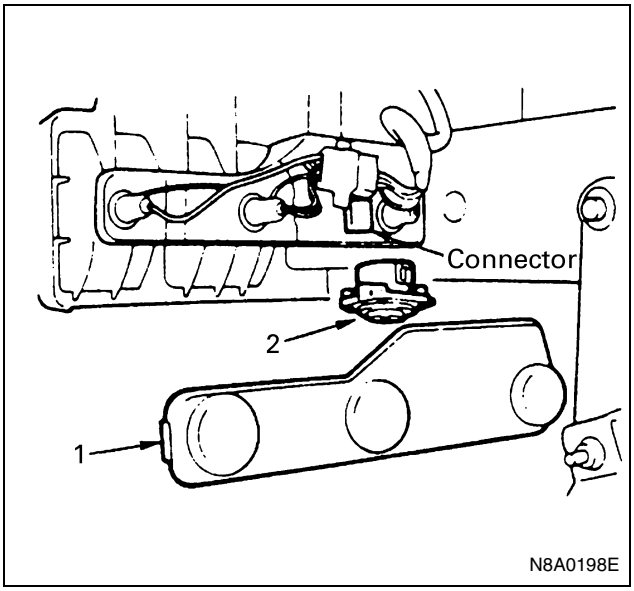


Removal

Preparation:

Disconnect the battery ground cable.

1. Rear Combination Light Cover
2. Backup Buzzer
   1) Remove the rear combination light connector fixing screw.
   2) Remove buzzer fixing screw.
   3) Disconnect the connector.



Installation

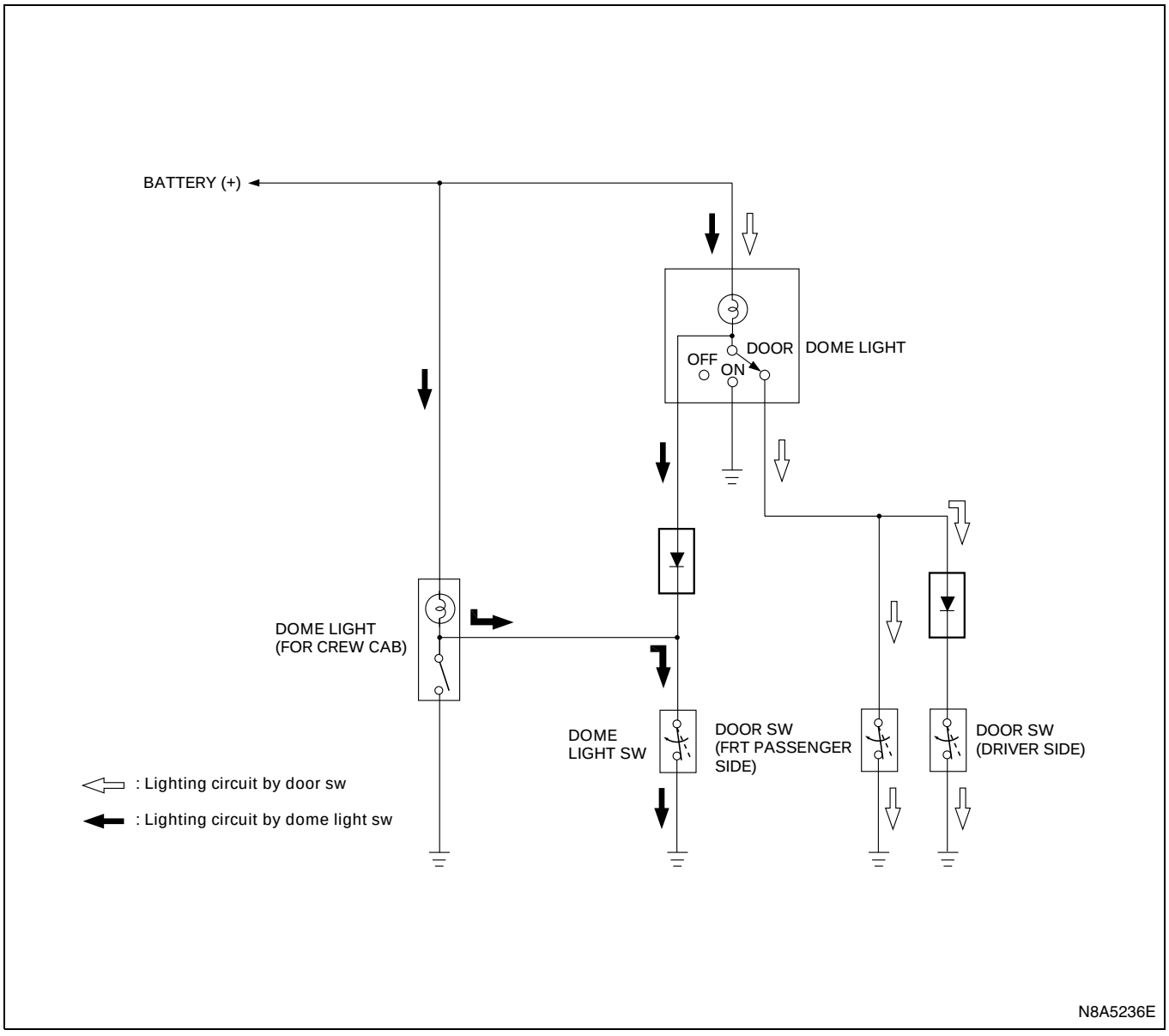
To install, follow the removal steps in the reverse order.

Dome Light and Backup Buzzer

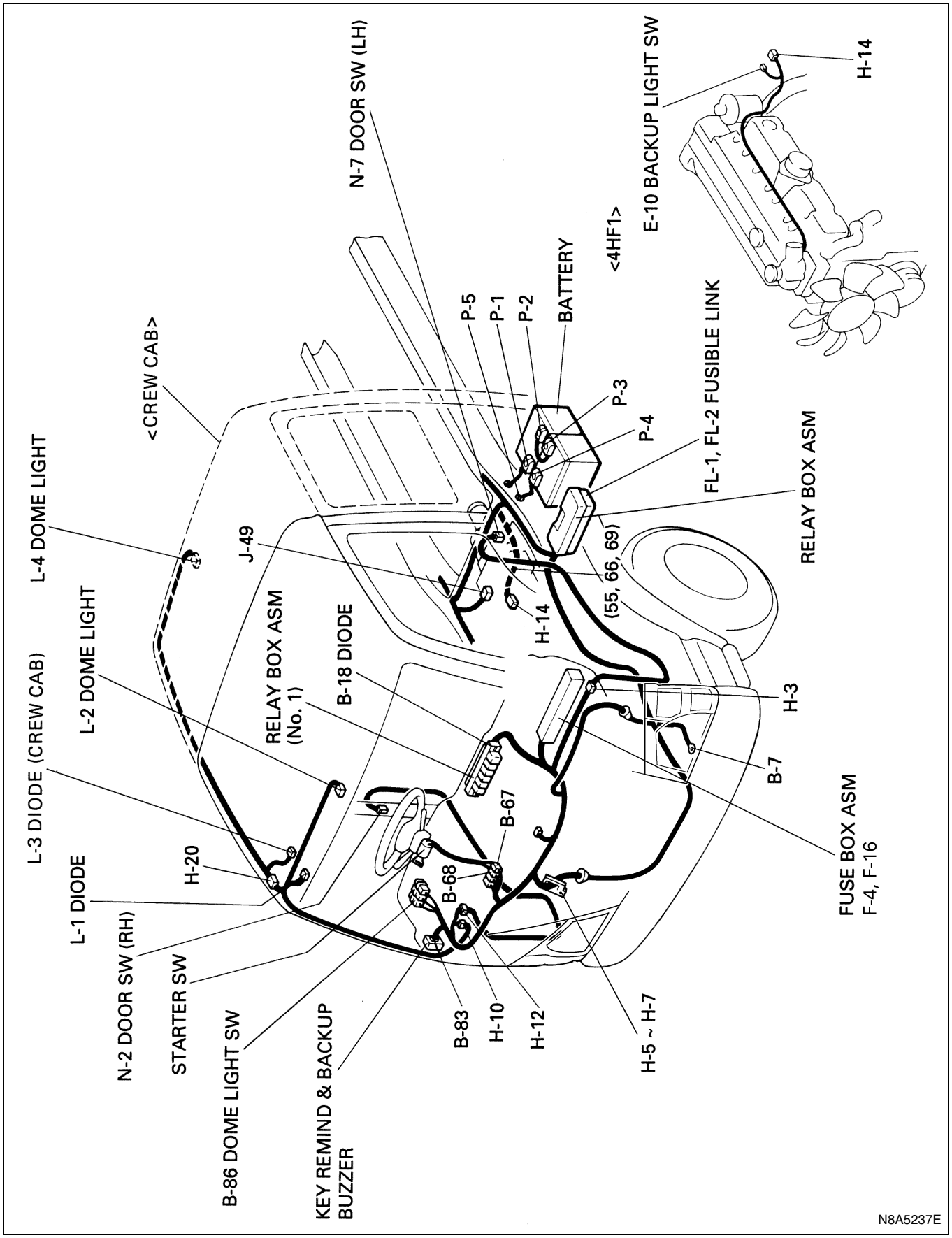
General Description

The circuit consists of the starter switch, dome light, dome light switch, door switch, backup light switch and the back-up buzzer.
The dome light lights up when the left or right side door is opened with the switch set at the door mode. It can be lit by operating ON or OFF of the dome light switch.
The dome light can be lit by respective switch independent of the position of the starter switch.
By operating the dome light switch fitted on the instrument panel, the dome light can be lit independent of the switch position of dome light.

Lighting Circuit

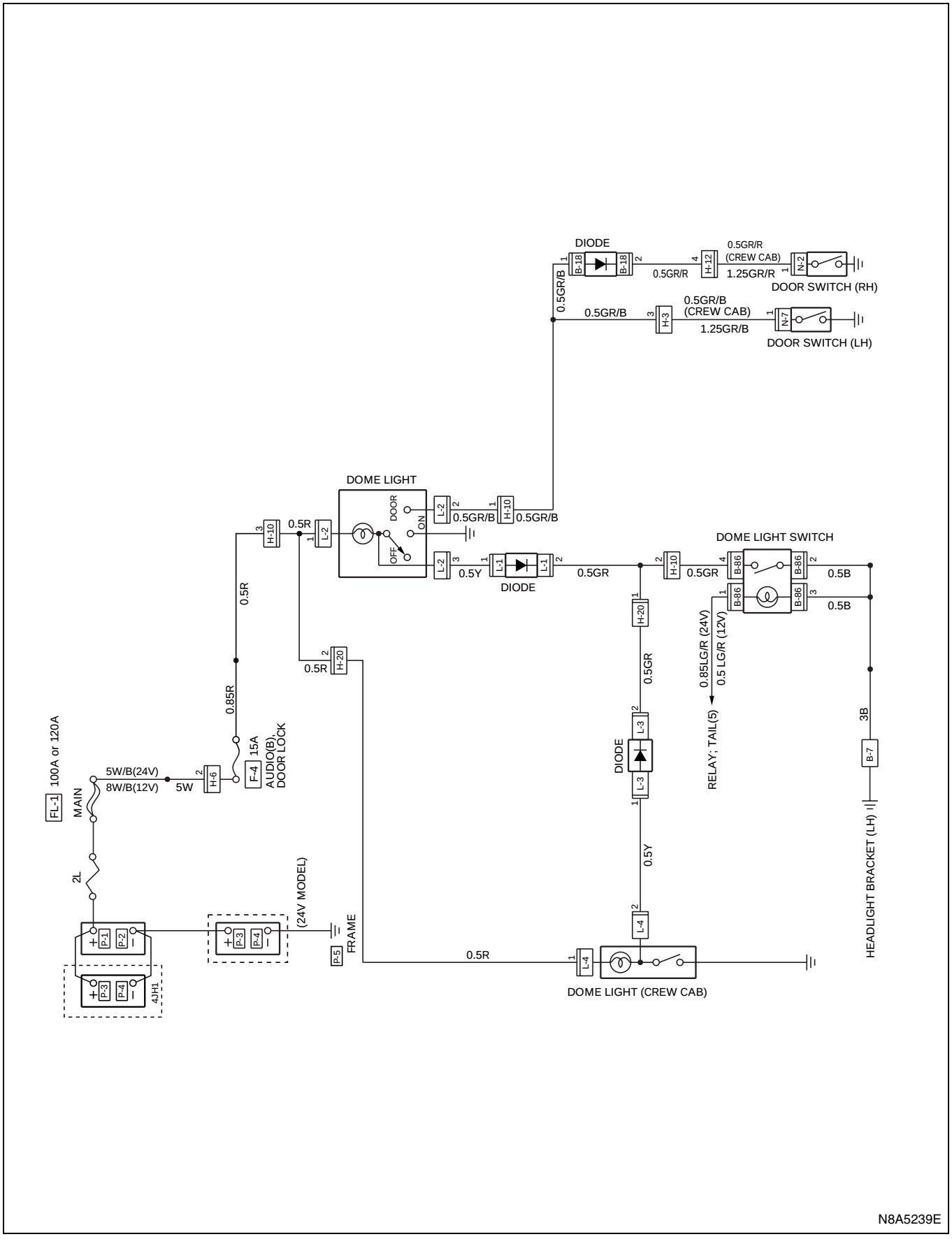


Parts Location

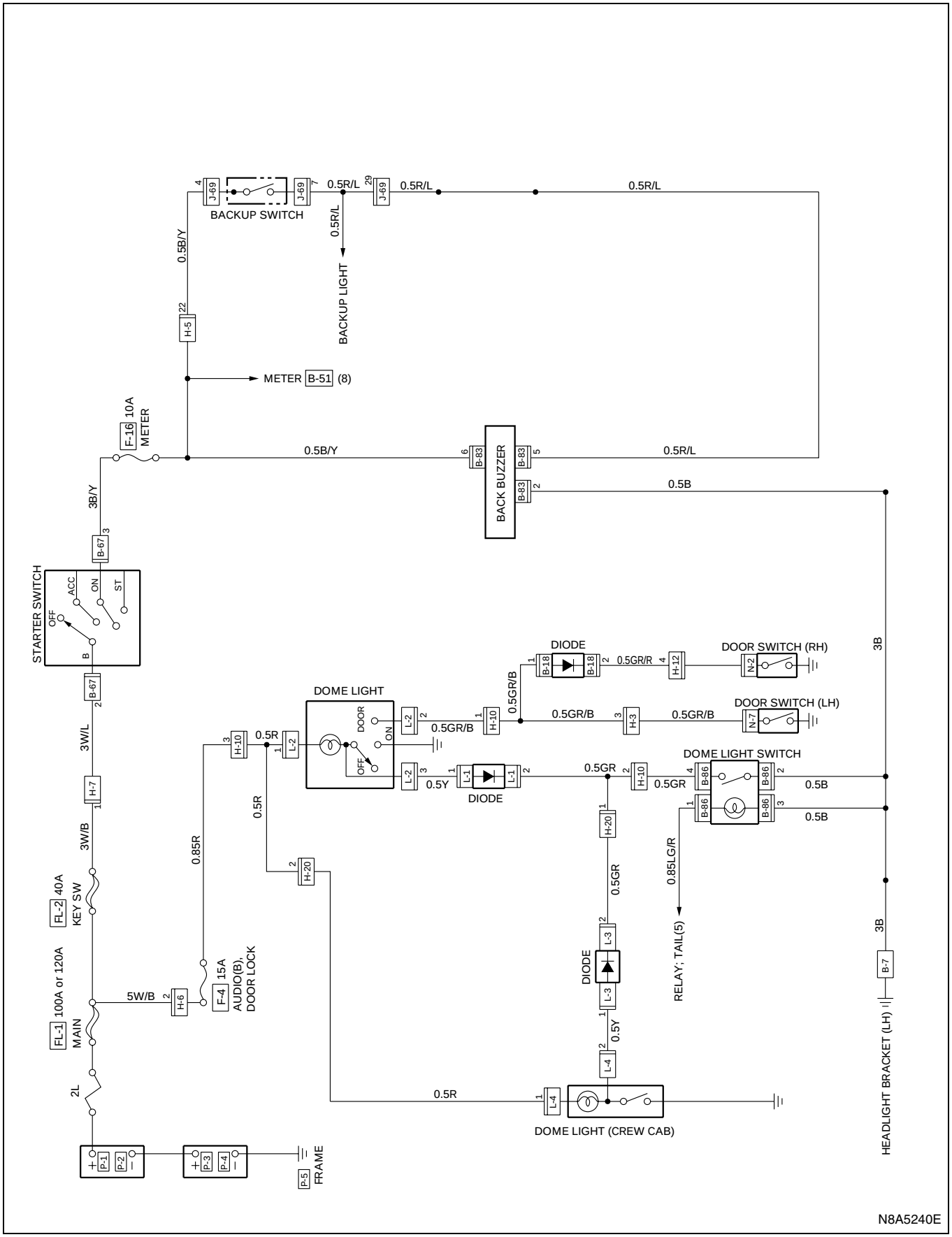


Circuit Diagram

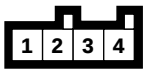
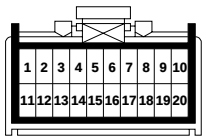
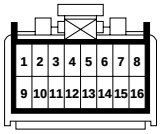
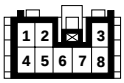
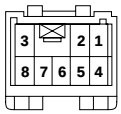
Except Europe

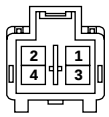
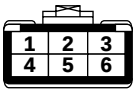
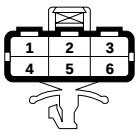
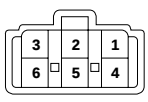


For Europe


BACKUP SWITCH
BACKUP LIGHT
METER B-51 (8)
F-16 10A METER
BACK BUZZER
STARTER SWITCH
OFF
ACC
ON
ST
B
DOME LIGHT
DOOR
ON
OFF
DIODE
DOOR SWITCH (RH)
DOOR SWITCH (LH)
DOME LIGHT SWITCH
FL-2 40A KEY SW
FL-1 100A or 120A MAIN
F-4 15A AUDIO(B), DOOR LOCK
RELAY; TAIL(5)
DOME LIGHT (CREW CAB)
HEADLIGHT BRACKET (LH)
FRAME
0.5B/Y
0.5R/L
3B/Y
3W/L
3W/B
5W/B
2L
0.85R
0.5R
0.5GR/B
0.5GR/R
0.5GR
0.5Y
0.85LG/R
0.5B
3B
N8A5240E

Connector List

No.	Connector Face
B-18	 004-004
B-47	 020-001
B-48	 016-007
B-54	 008-009
B-54	 008-010
B-67	004-001
B-67	004-002
B-86	004-001

No.	Connector Face
B-86	 004-002
B-83	 006-010
E-10	002-025
E-10	002-026
J-49	002-025
J-49	002-026
H-3	 006-014
H-3	 006-015

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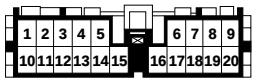
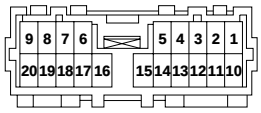
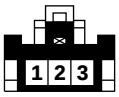
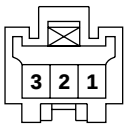
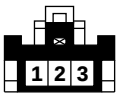
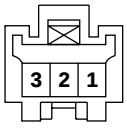
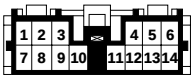
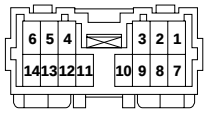
H-4	 020-002
H-4	 020-003
H-10	 003-009
H-10	 003-010
L-2	 003-009
L-2	 003-010
H-12	 014-002
H-12	 014-003

No.	Connector Face
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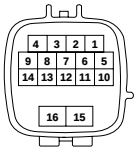
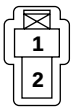
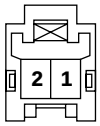
H-14	 016-004
H-20	002-009
H-20	 002-010
L-1	002-027
L-3	002-027
L-4	002-022
L-4	 002-023

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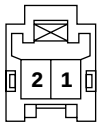
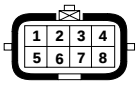
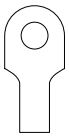
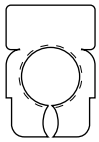
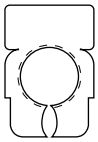
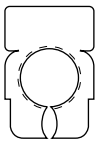
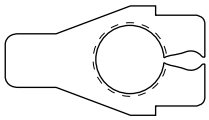
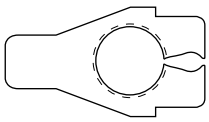
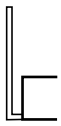
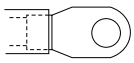
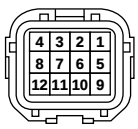
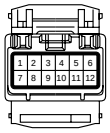
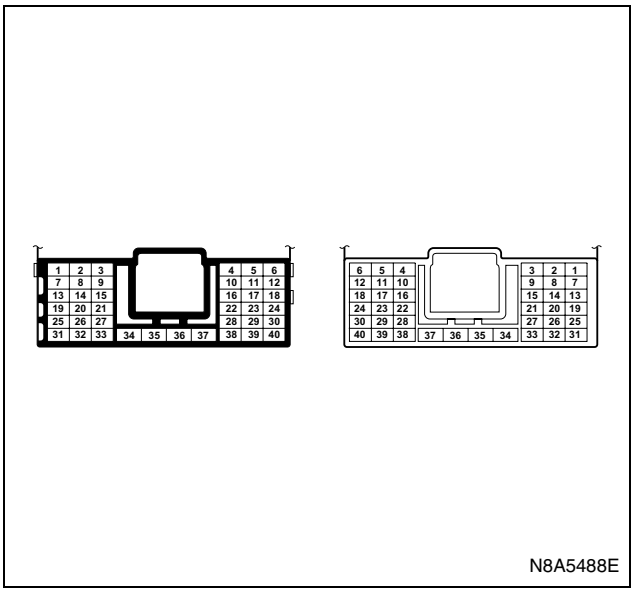
L-6	 002-023
J-69	 008-007
J-69	008-008
N-2	001-009
N-7	001-009
P-1 (12 V)	 000-003
P-2	 000-004

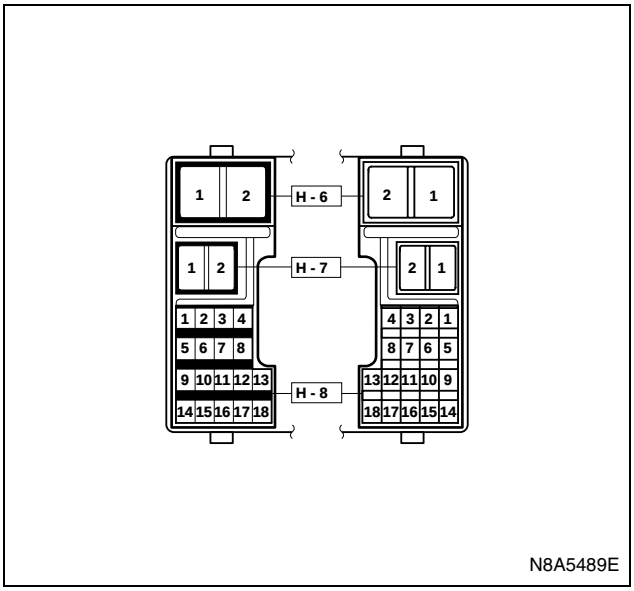
No.	Connector Face
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
P-5 (12 V)	 000-007
P-5 (24 V)	 000-002
J-69	012-006
J-69	 012-007

No.	Connector Face
B-231	 012-008

H-5



H-6, H-7



Starter Switch

Refer to “START AND CHARGING” in this section.

Key Cylinder Switch

Refer to “START AND CHARGING” in this section.

Backup Light Switch

Refer to “HORN, BACKUP LIGHT AND BACKUP BUZZER” in this section.

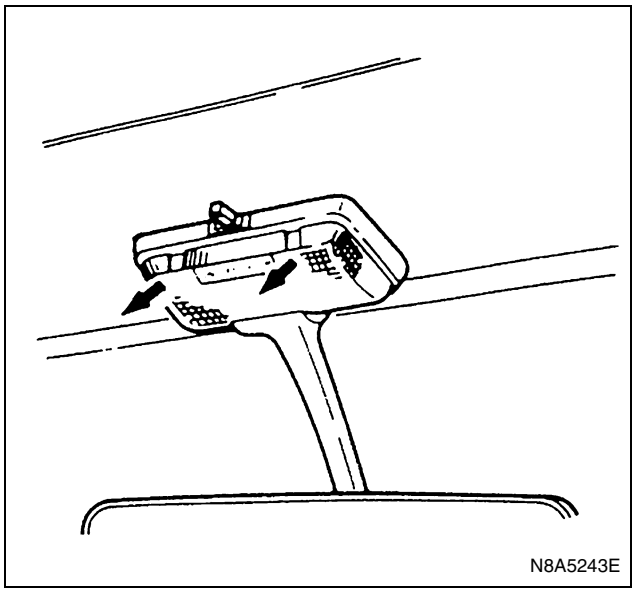
Dome Light Bulb

Removal

Preparation:

Disconnect the battery ground cable.

1. Lens
   Hold the lens and pull it downward.



2. Bulb

Installation

To install, follow the removal steps in the reverse order.

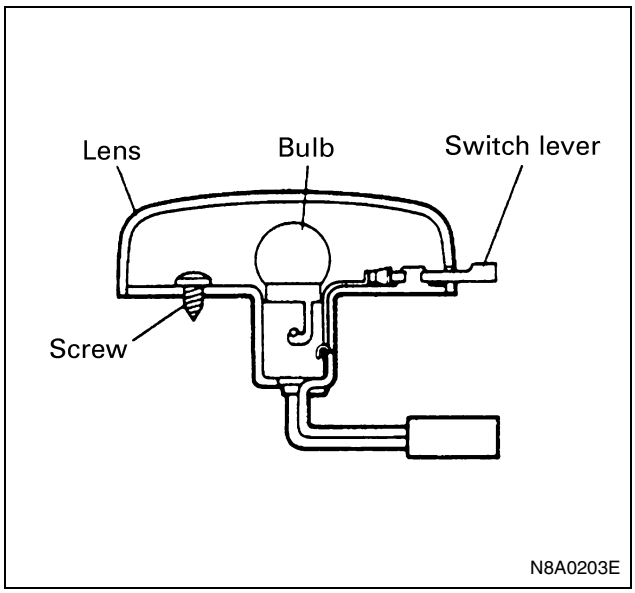
Dome Light Bulb (for Crew Cab)

Removal

Preparation:

Disconnect the battery ground cable.

1. Lens
   Hold the lens and pull it down.
2. Bulb



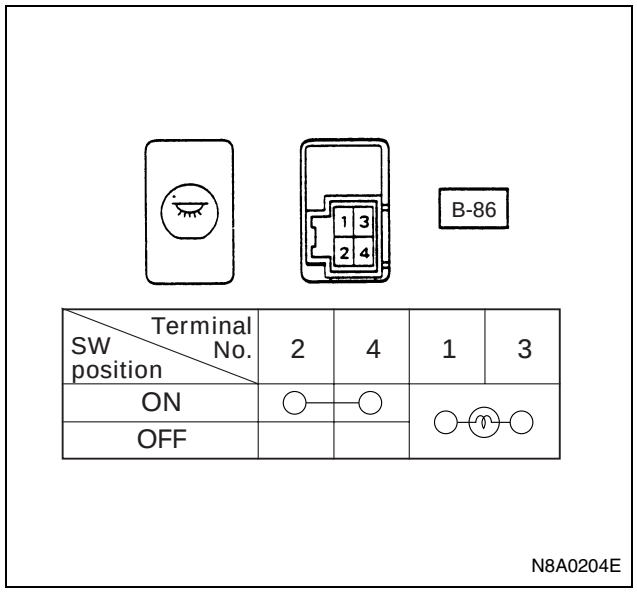
Installation

To install, follow the removal steps in the reverse order.

Dome Light Switch

Inspection

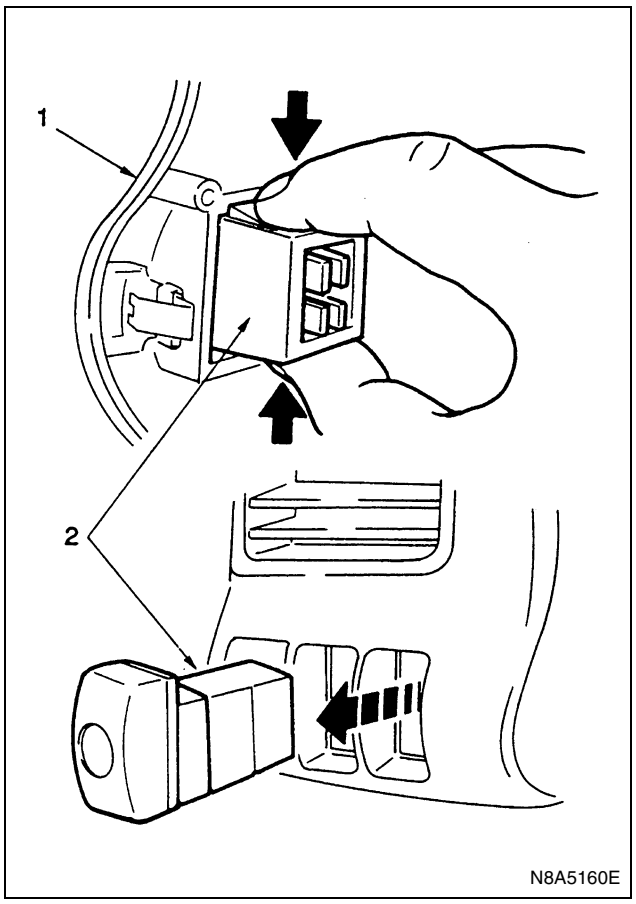
Check the continuity between the dome light switch connector terminals.
Repair or replace the switch when the result of inspection is found abnormal.



Removal

Preparation:
Disconnect the battery ground cable.

1. Meter cluster
   Refer to the “METER AND WARNING/INDICATOR LIGHT” in this section.
2. Dome Light Switch
   Release the lock pushing the switch from the back side of the meter cluster.



Installation

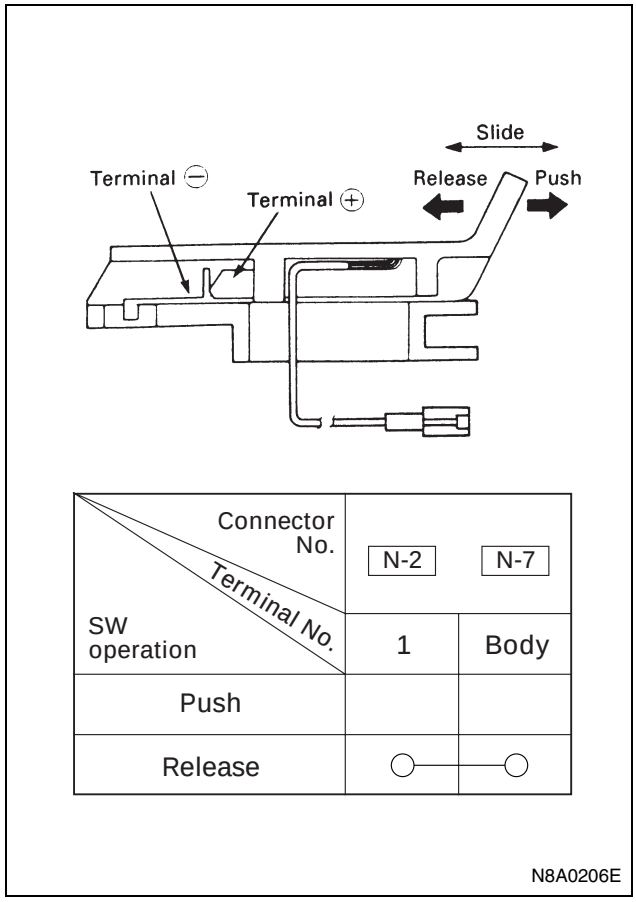
To install, follow the removal steps in the reverse order noting the following point.

1. Push the switch with your fingers until locks securely.

Door Switch

Inspection

Check to see if there is any continuity between the terminals and the body while operating the door switch.
Repair or replace the switch, when the result of inspection is found abnormal.

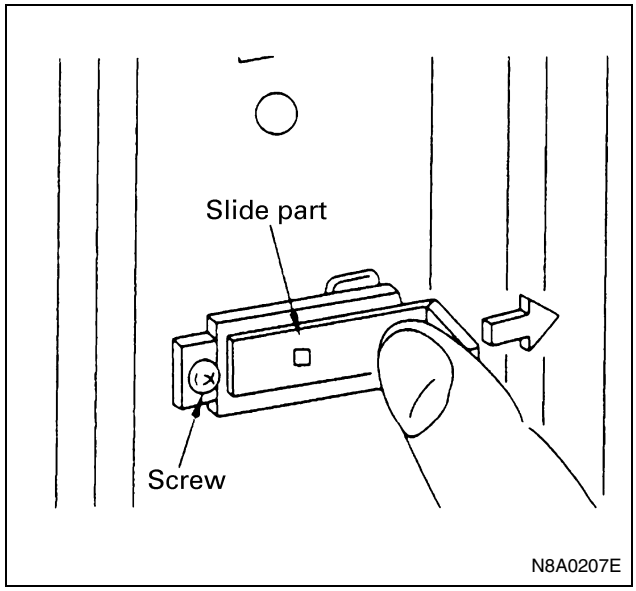


Removal

Preparation:

Disconnect the battery ground cable.

1. Door Switch
   1) Remove the screw.
   2) Disconnect the connector of the switch.

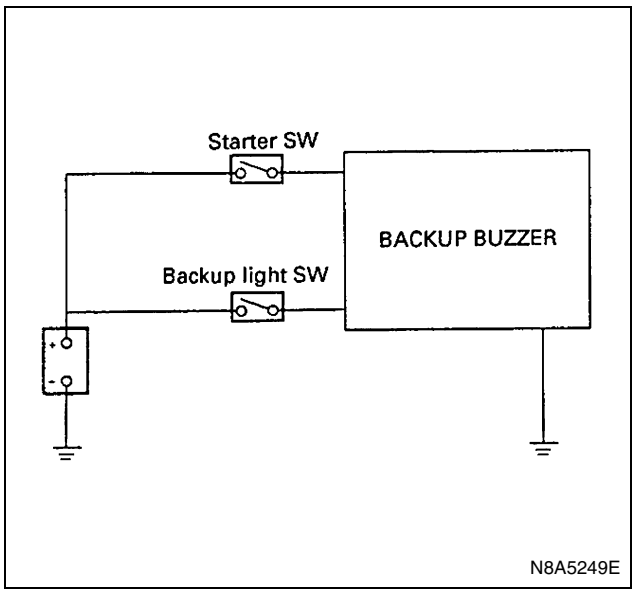


Installation

To install, follow the removal steps in the reverse order.

Backup Buzzer

Warning function	Operative conditions
Warning to reverse driving	When the transmission shift lever is engaged to the reverse position.



Inspection of the Buzzer Circuit

Disconnect the backup buzzer connector, measure the continuity and voltage between the harness side connector terminals.

Harness side

Terminal No.	Wire color	Connected to	Item to be checked	Connecting terminal	Checking conditions	Standard
2	B	Ground	Continuity	2-Ground	–	Continuity
5	R/L	Backup light SW (Inhibitor SW)	Voltage	5-Ground	· Starter SW ON · Backup light SW (Inhibitor SW) ON	Approx. battery voltage
6	B/Y	Fuse F-12 (10A)		6-Ground	· Starter SW ON	Approx. battery voltage

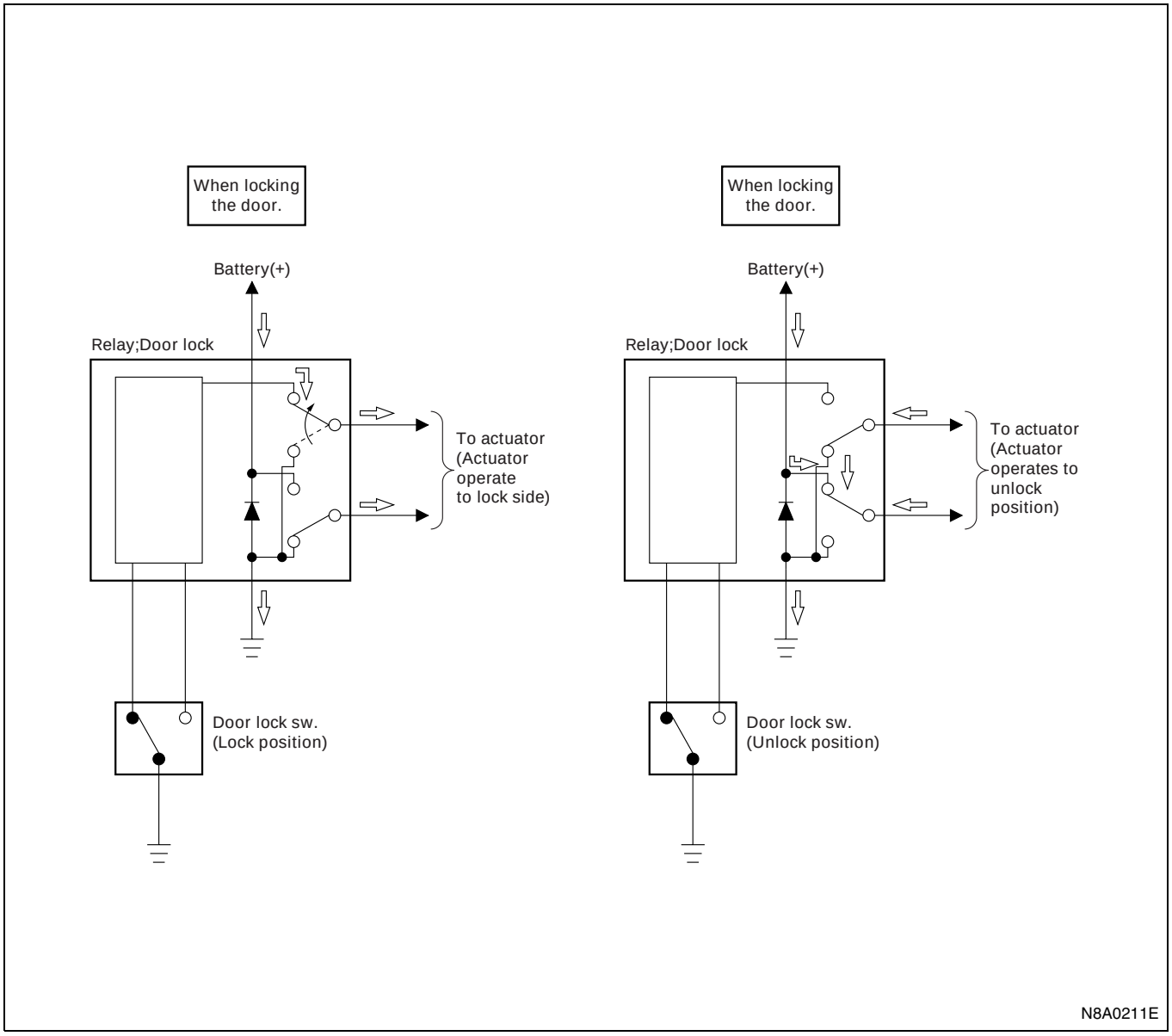
N8A5250E

Power Door Lock

General Description

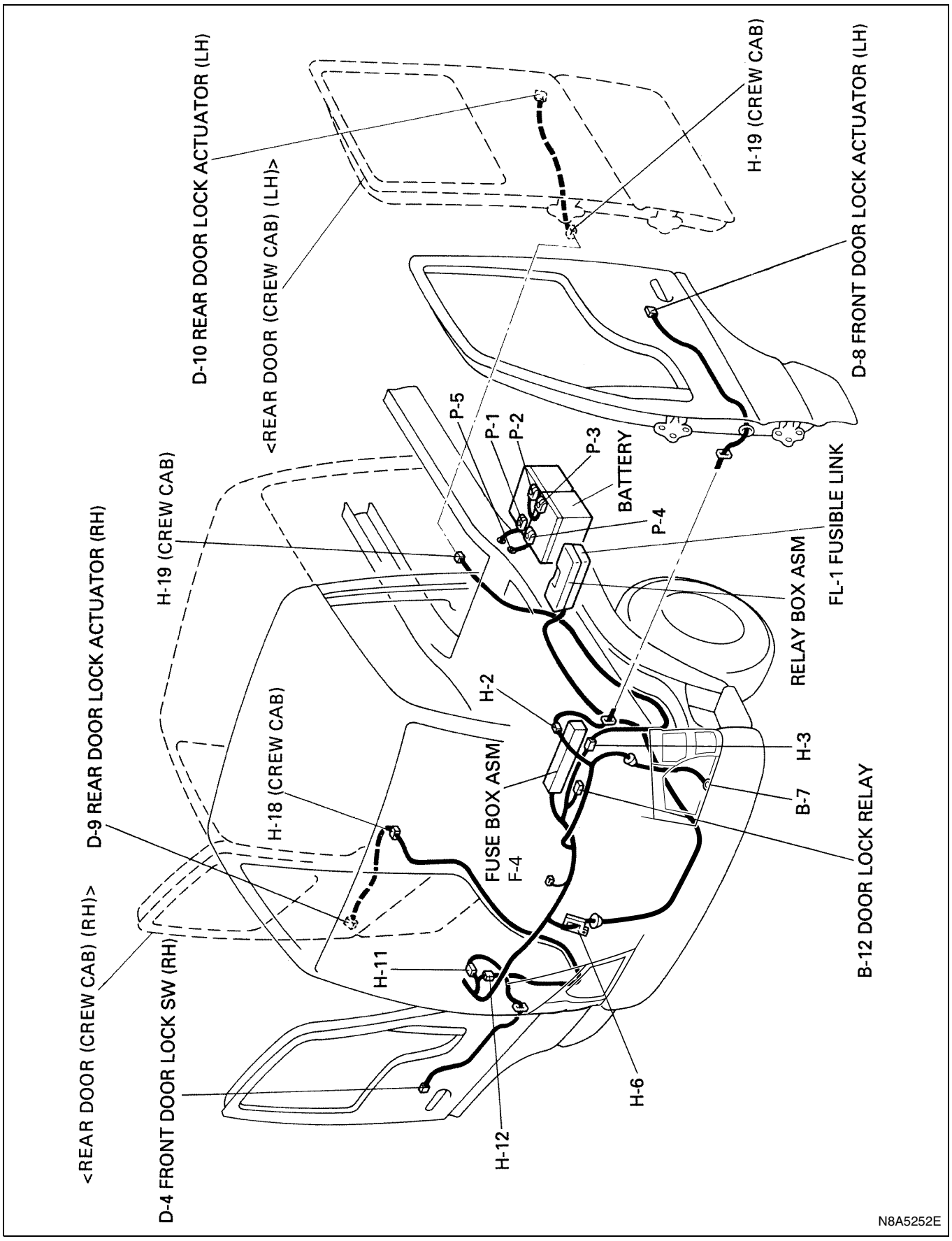
The circuit consists of the door lock switch, actuator for the front passenger door, rear doors and the door lock controller.
The door lock controller is always provided with battery voltage. The key or the inside lock knob on the driver's door can activate the lock mechanism of all the doors.
When the driver's door lock switch is turned on, current flows for about one second to the door lock actuator of each door connected in parallel with the controller to activate the actuator to lock and unlock the doors.

Operation of Door Lock Controller

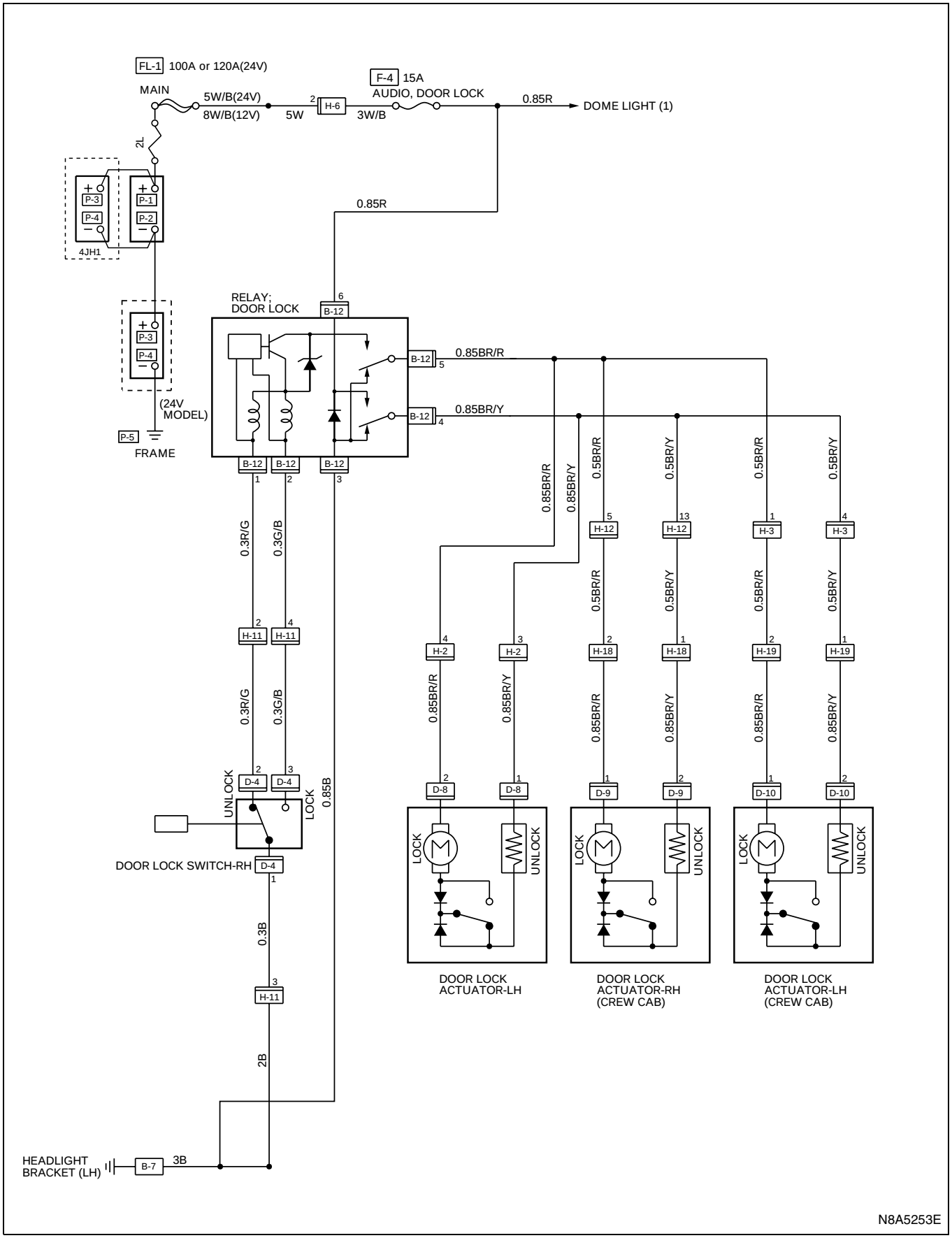


Notice:
Arrow marks indicate the direction of current.

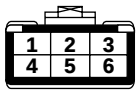
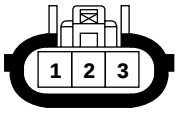
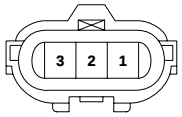
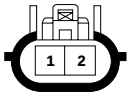
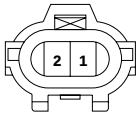
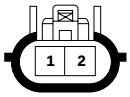
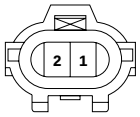
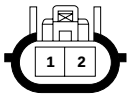
Parts Location



Circuit Diagram



Connector List

No.	Connector Face
B-12	 006-010
D-4	 003-003
D-4	 003-011
D-8	 002-001
D-8	 002-002
D-9	 002-001
D-9	 002-002
D-10	 002-001

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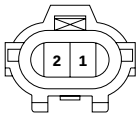
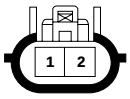
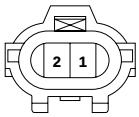
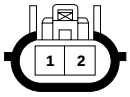
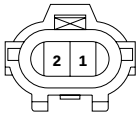
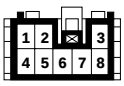
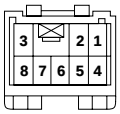
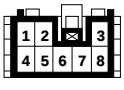
D-10	 002-002
H-18	 002-001
H-18	 002-002
H-19	 002-001
H-19	 002-002
H-2	 008-009
H-2	 008-010
H-11	 008-009

No.	Connector Face
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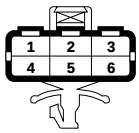
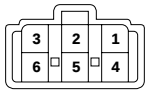
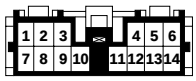
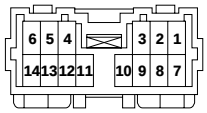
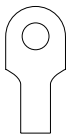
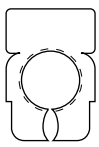
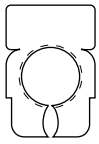
H-3	 006-014
H-3	 006-015
H-12	 014-002
H-12	 014-003
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004

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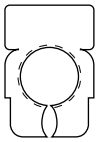
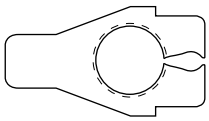
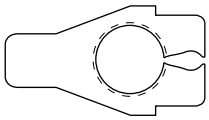
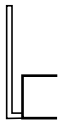
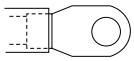
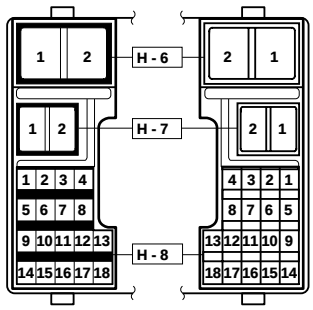
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
P-5 (12 V)	 000-007
P-5 (24 V)	 000-002

H-6



N8A5489E

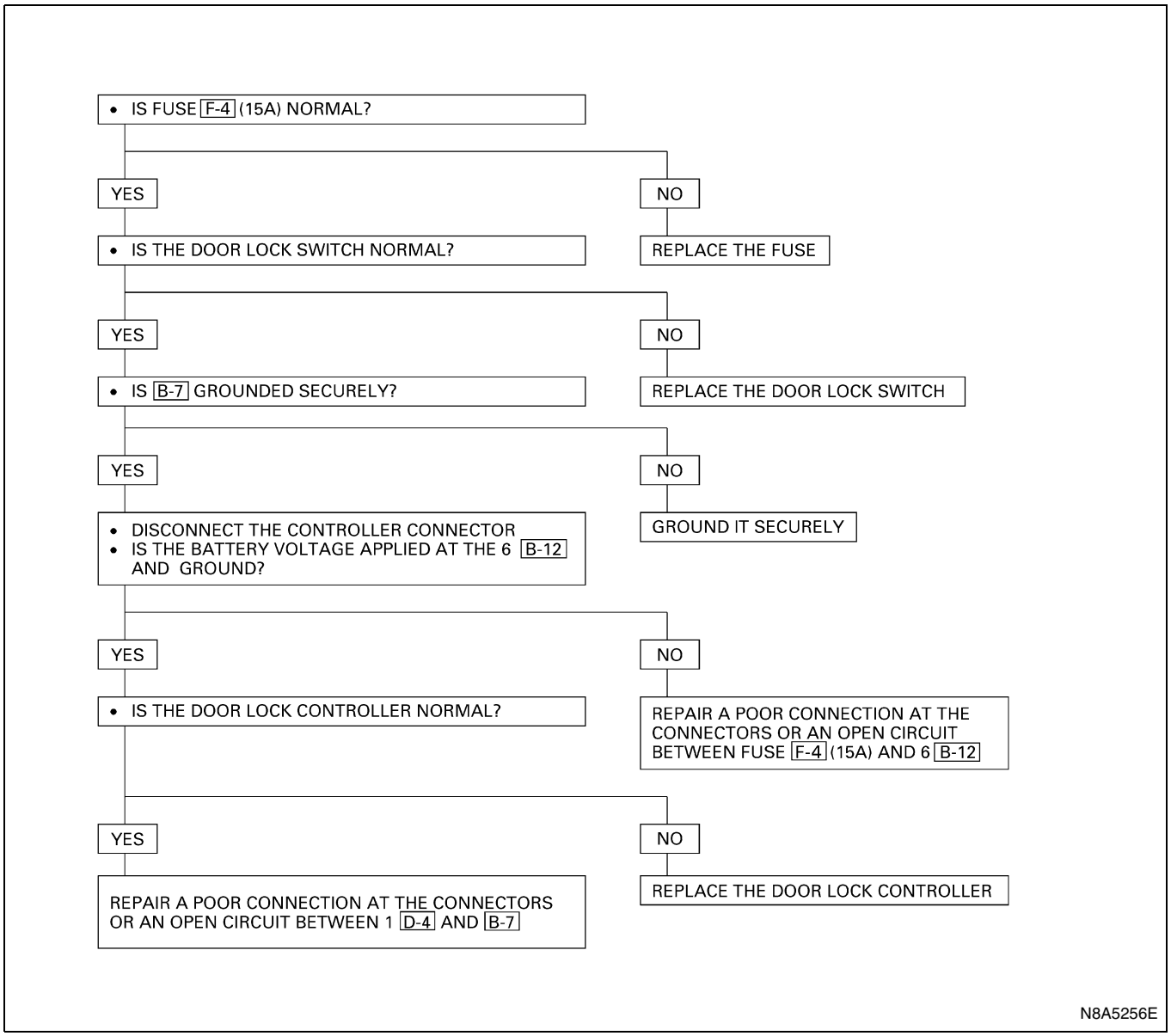
Diagnosis

Quick Chart for Check Point

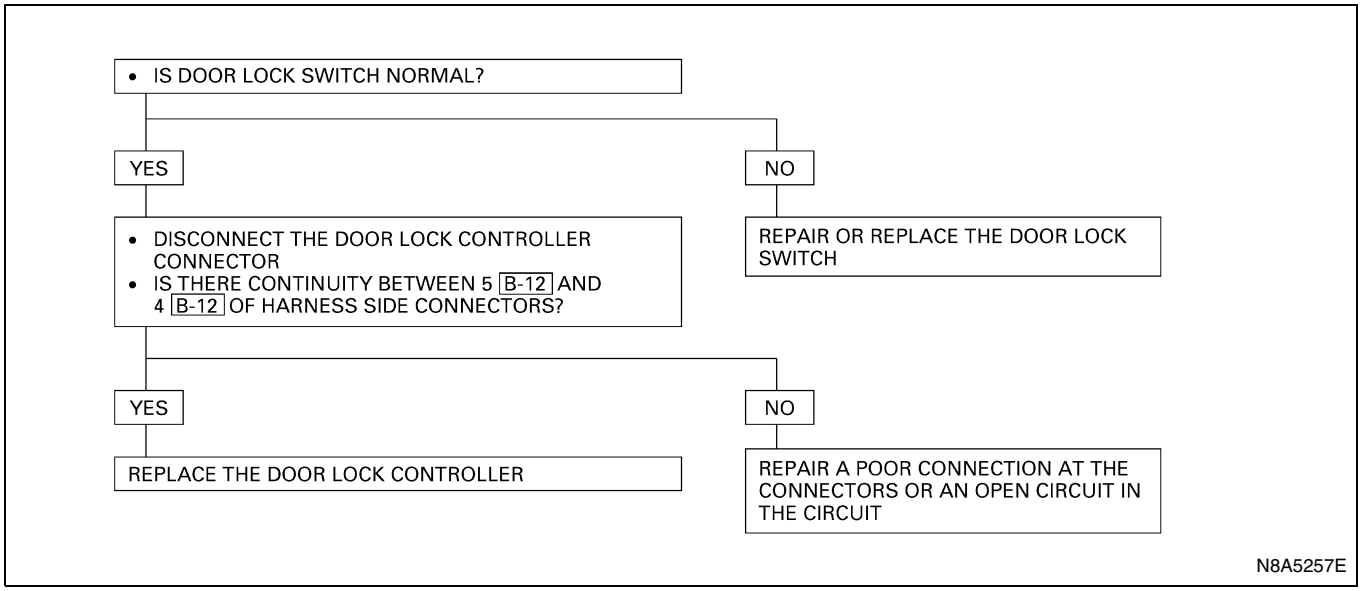
		Check point						
		Fuse F-4 (15 A)	Door lock controller	Door lock SW (Driver side)	Door lock actuator			
					Front (Passen-ger side)	Rear (RH)	Rear (LH)	Cable harness
Trouble mode	1. All the doors do not lock and unlock	❍	❍					❍
	2. All the doors do not get locked (or unlocked)		❍					❍
	3. Driver side door does not get locked (or unlocked)			❍				❍
	4. Front passenger side door does not get locked (or unlocked)				❍			❍
	5. Rear door-RH side does not get locked (or unlocked)					❍		❍
	6. Rear door-LH side does not get locked (or unlocked)						❍	❍

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

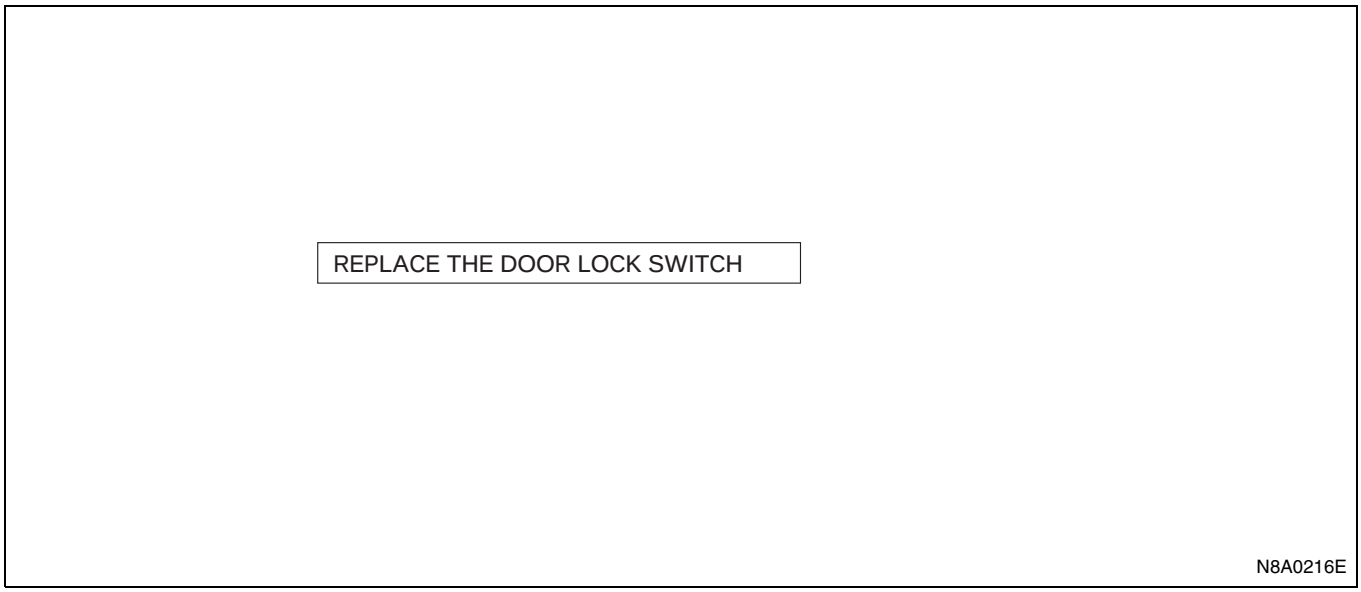
All the Doors Do Not Lock and Unlock



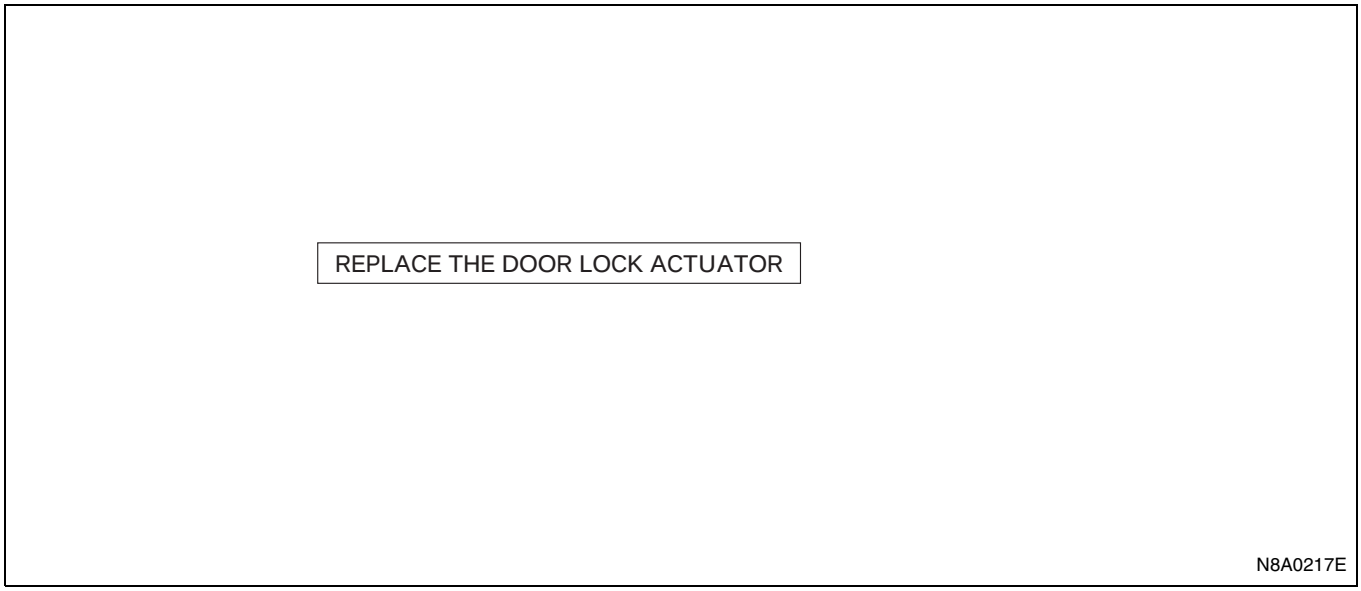
All the Doors Do Not Get Locked (or Unlocked)



Driver Side Door Does Not Get Locked (or Unlocked)



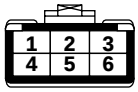
FRT Passenger Side Door Does Not Get Locked (or Unlocked)
RR Door-RH Side Does Not Get Locked (or Unlocked)
RR Door-LH Side Does Not Get Locked (or Unlocked)



Inspection of the Door Lock Circuit

Check the voltage and the continuity between the controller harness side connector terminals.

B-12



Harness side

Terminal No.	Wire color	Connected to	Item to be checked	Connecting terminal	Checking conditions		Standard
1	R/G	Door lock SW (Unlock)	Continuity (Resistance)	1-Ground	Driver seat side door	Unlock	Continuity
						Lock	No continuity
2	G/B	Door lock SW (Lock)		2-Ground	Driver seat side door	Unlock	No continuity
						Lock	Continuity
3	B	Ground		3-Ground	-		Continuity
4	BR/Y	Actuator (Unlock)		4-5	-		Continuity (There is some resistance)
5	BR/R	Actuator (Lock)		5-4	-		Continuity (There is some resistance)
6	R	Fuse F-7 (15A)	Voltage	6-Ground	-		Battery voltage

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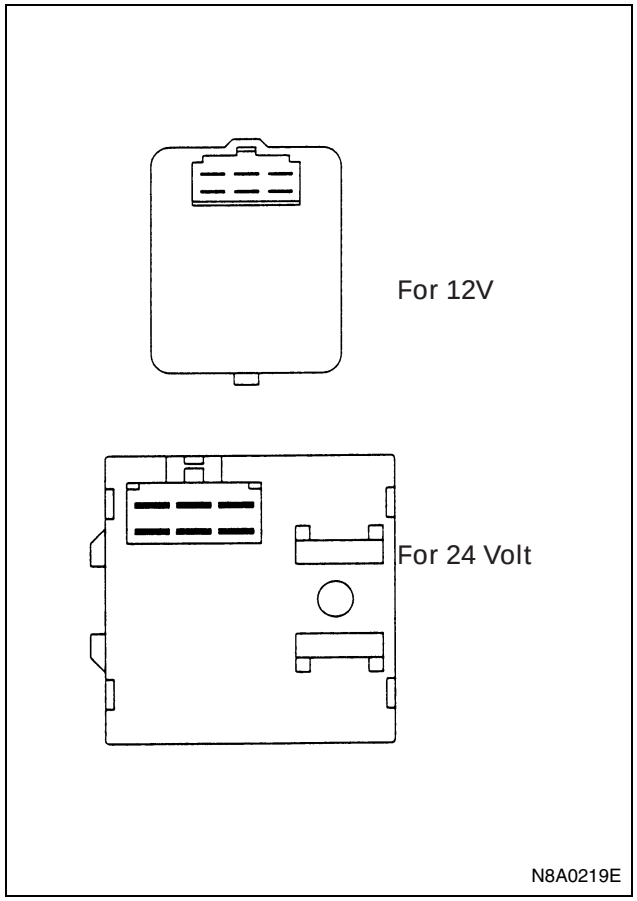
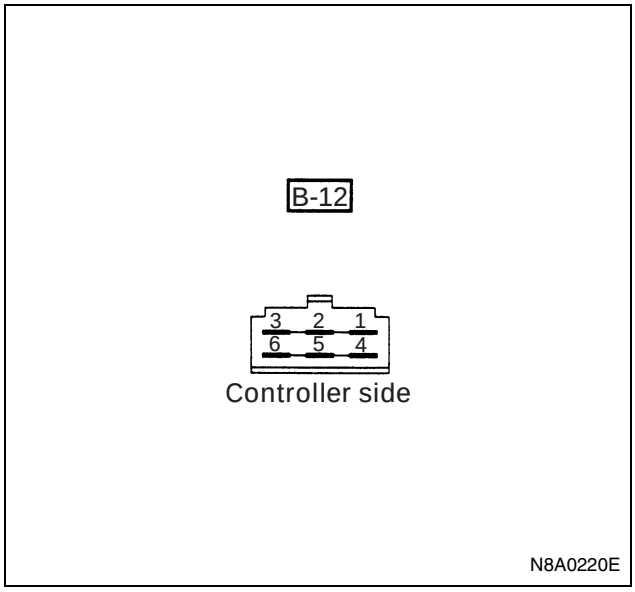
Door Lock Controller

The door lock controller sends out to each door lock actuator the lock/unlock signals received from door lock switch of driver seat side.



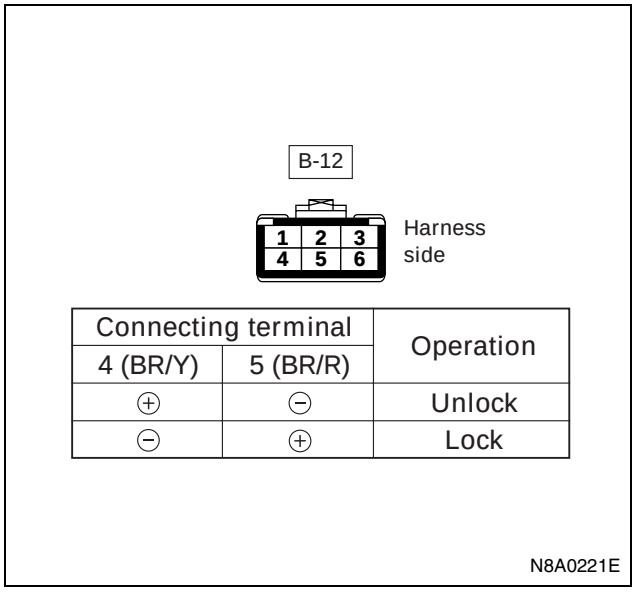
Inspection

Remove the connector of the door lock controller, and check the continuity and the voltage between the controller side connector terminals.
(Connect the (+) terminal of the battery to 6 B-12 and the (–) terminal to 3 B-12.)
3 B-12 — 5 B-12.....Continuity
3 B-12 — 4 B-12.....Continuity
(Then, ground 2 B-12.)
5 B-12.....Voltage for approx. 1 second
(Disconnect the ground of 2 B-12, and ground 1 B-12.)
4 B-12.....Voltage for approx. 1 second
Replace the controller when the result of inspection is found abnormal.



Door Lock Operation Test

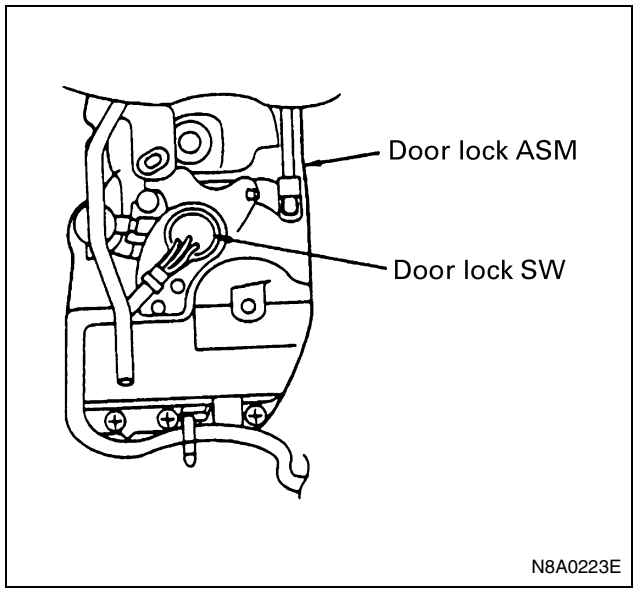
After confirming that there is continuity between the harness side connector terminals 4 B-12 and 5 B-12 of the door lock controller, apply battery voltage to each of the terminals to conduct the operation test.
When the door lock will not operate, check the door lock actuator for any trouble.



Connecting terminal		Operation
4 (BR/Y)	5 (BR/R)	
⊕	⊖	Unlock
⊖	⊕	Lock

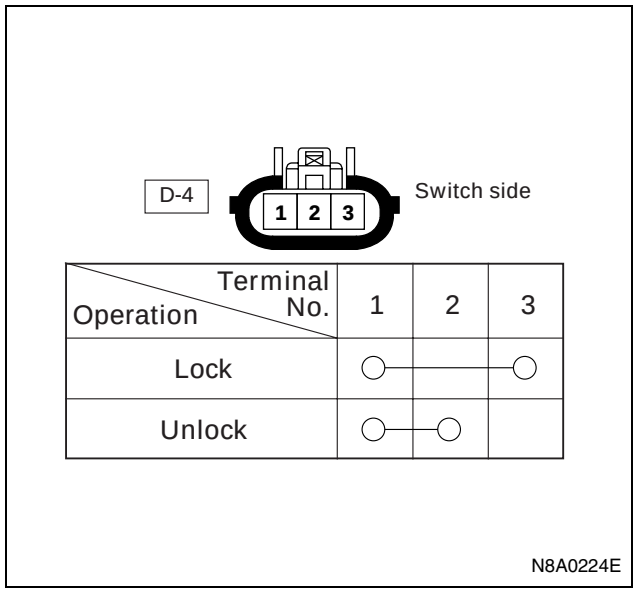
Door Lock Switch (Driver Seat Side)

The door lock switch on the driver's door is connected with the door lock cylinder and the inside lock knob with a rod. The switch sends lock/unlock signals to the door lock controller.



Inspection

Check to see if there is any continuity between the connector terminals of the door lock switch.
Replace the switch when the result of inspection is found abnormal.

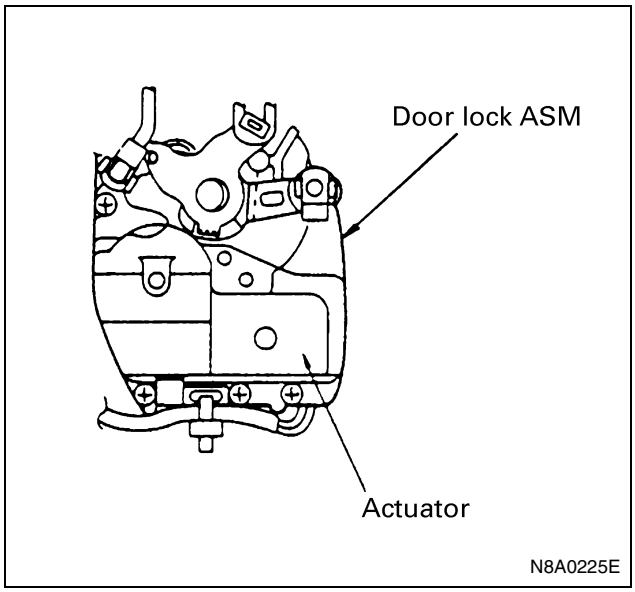


Removal and Installation

Refer to Section 2 "CAB AND FRAME" for "DOOR LOCK ASSEMBLY".

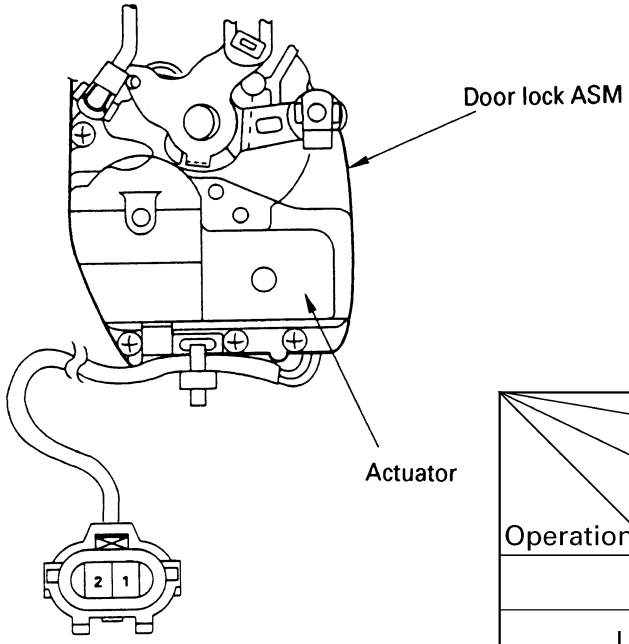
Door Lock Actuator

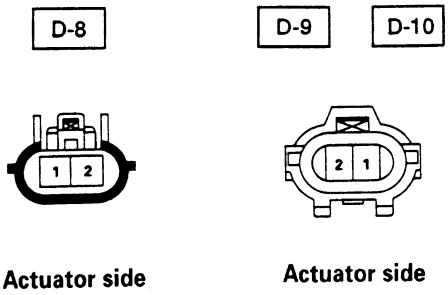
Receiving forward or reverse current from the door lock controller, the door lock actuator locks or unlocks the door with the rod connected to the door lock mechanism.



Inspection of the Door Lock Actuator

Apply the battery voltage to the connector terminals of the door lock actuator to check the operation.
When the door lock actuator is checked on the vehicle and there is no continuity, and when the door lock actuator itself is checked and no trouble is found, check the circuit between the door lock actuator and the door lock controller for any failure.





Operation \ Door	FRT Passenger		RR-RH		RR-LH	
Connector No.	D-8		D-9		D-10	
Terminal No.	1	2	1	2	1	2
Lock	⊖	⊕	⊕	⊖	⊕	⊖
Unlock	⊕	⊖	⊖	⊕	⊖	⊕

N8A5267E

Removal and Installation

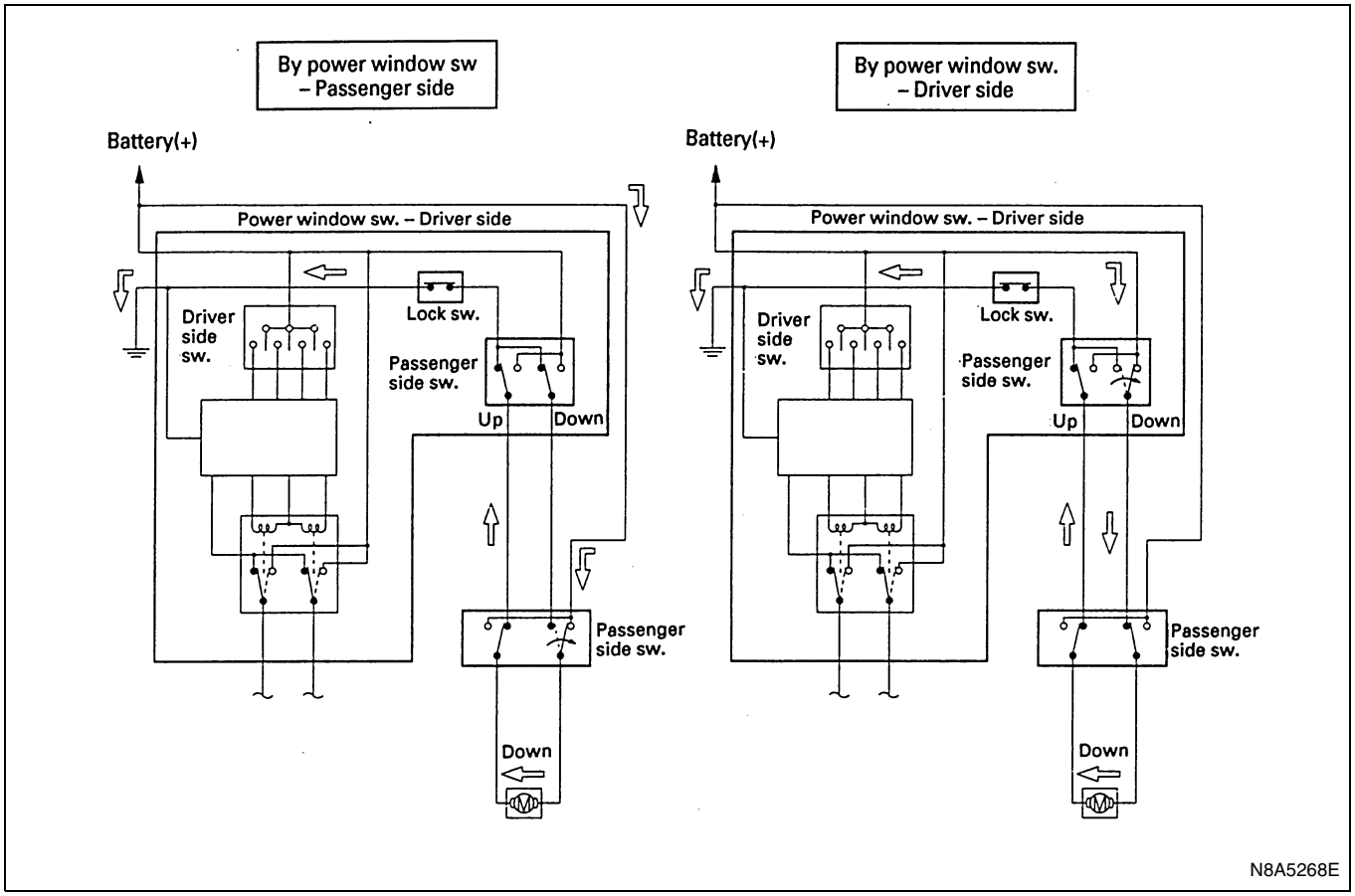
Refer to Section 2 “CAB AND FRAME” for “DOOR LOCK ASSEMBLY”.

Power Window

General Description

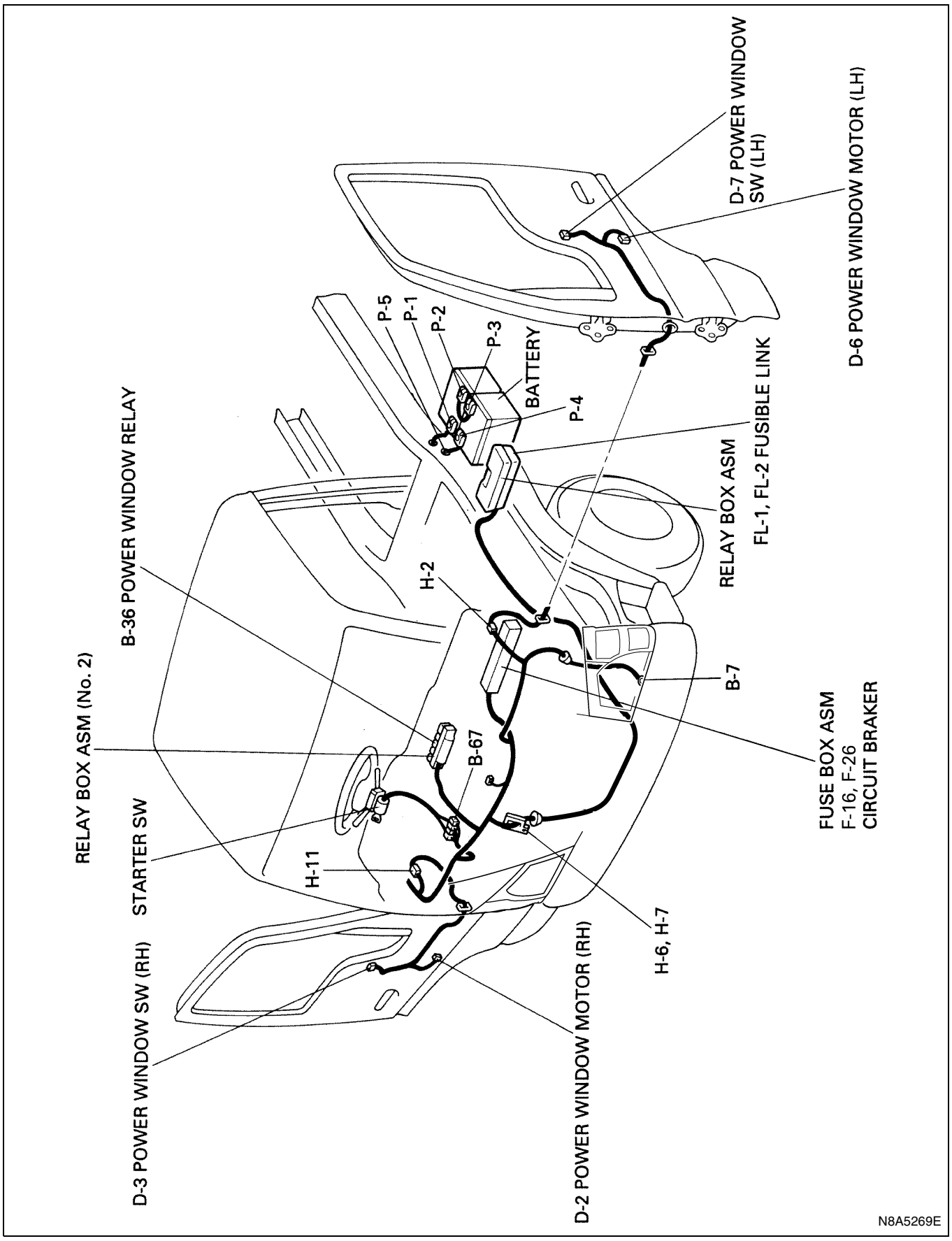
The circuit consists of the starter switch, power window switch for each of the windows and power window motor.
When the starter switch is turned on, the battery voltage is applied to each of the power window switches through the circuit breaker and the power window relay on the circuit.
By operating the switches of each window to select “UP” or “DOWN”, the revolving direction of the power window motor changes to open or close the window.
The driver’s power window switch has a built-in one-touch operating circuit which allows to automatically open the window by operating the switch to the AUTO position.
When the driver’s power lock switch at the driver side is depressed, the power source to the passenger’s power window switches will be shut off and passenger’s side power window motor will not operate if the switch is operated.

Operation of Passenger Side Window



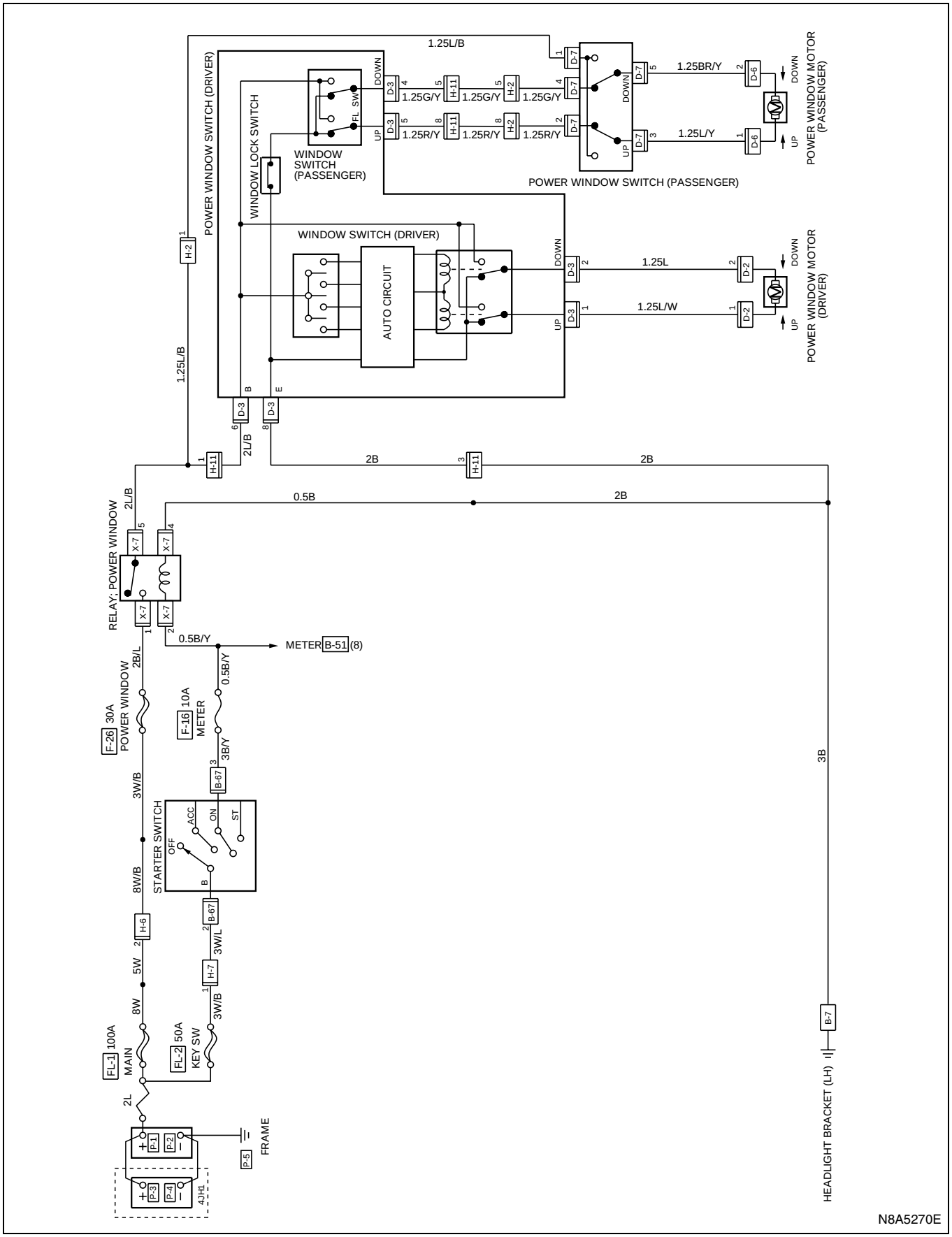
Notice:
Arrow marks indicate the direction of current.

Parts Location

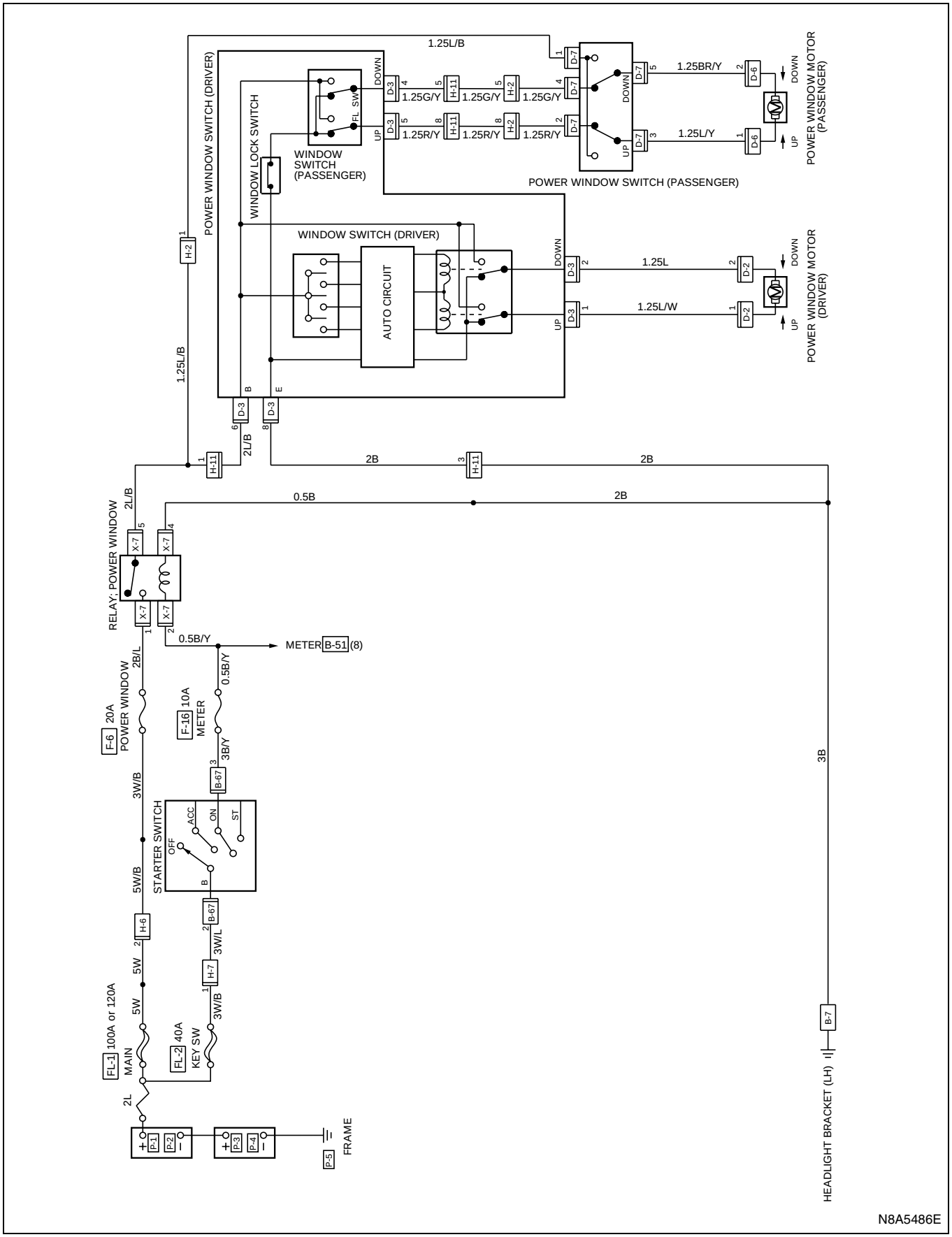


Circuit Diagram

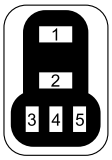
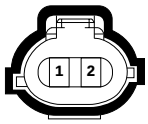
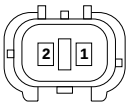
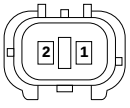
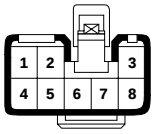
For 12 Volt

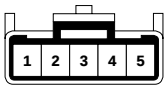
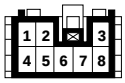
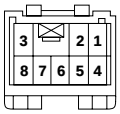
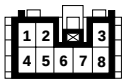
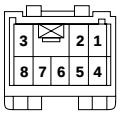
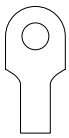
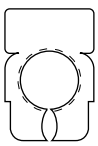
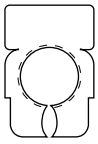


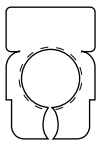
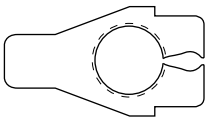
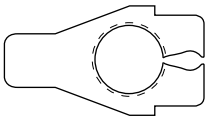
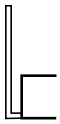
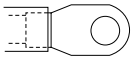
For 24 Volt


POWER WINDOW SWITCH (DRIVER)
WINDOW LOCK SWITCH
WINDOW SWITCH (PASSENGER)
WINDOW SWITCH (DRIVER)
AUTO CIRCUIT
POWER WINDOW SWITCH (PASSENGER)
POWER WINDOW MOTOR (PASSENGER)
POWER WINDOW MOTOR (DRIVER)
1.25L/B
1.25L/B
2L/B
2B
0.5B
0.5B/Y
METER B-51 (8)
RELAY: POWER WINDOW
F-6 20A POWER WINDOW
F-16 10A METER
STARTER SWITCH
OFF
ACC
ON
ST
FL-1 100A or 120A MAIN
FL-2 40A KEY SW
3B
HEADLIGHT BRACKET (LH)
FRAME
N8A5486E

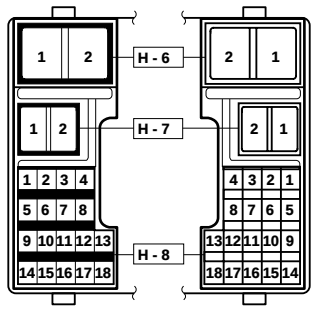
Connector List

No.	Connector Face
X-7	 005-006
B-67	004-001
B-67	004-002
D-2	 002-028
D-2	 002-029
D-6	002-028
D-6	 002-029
D-3	 008-011

No.	Connector Face
D-7	 005-005
H-2	 008-009
H-2	 008-010
H-11	 008-009
H-11	 008-010
P-1 (12V)	 000-003
P-2	 000-004
P-1 (24V)	 000-004

No.	Connector Face
P-4	 000-004
P-2 (24V)	 000-006
P-3	 000-006
P-5 (12V)	 000-007
P-5 (24V)	 000-002

H-6, H-7



N8A5489E

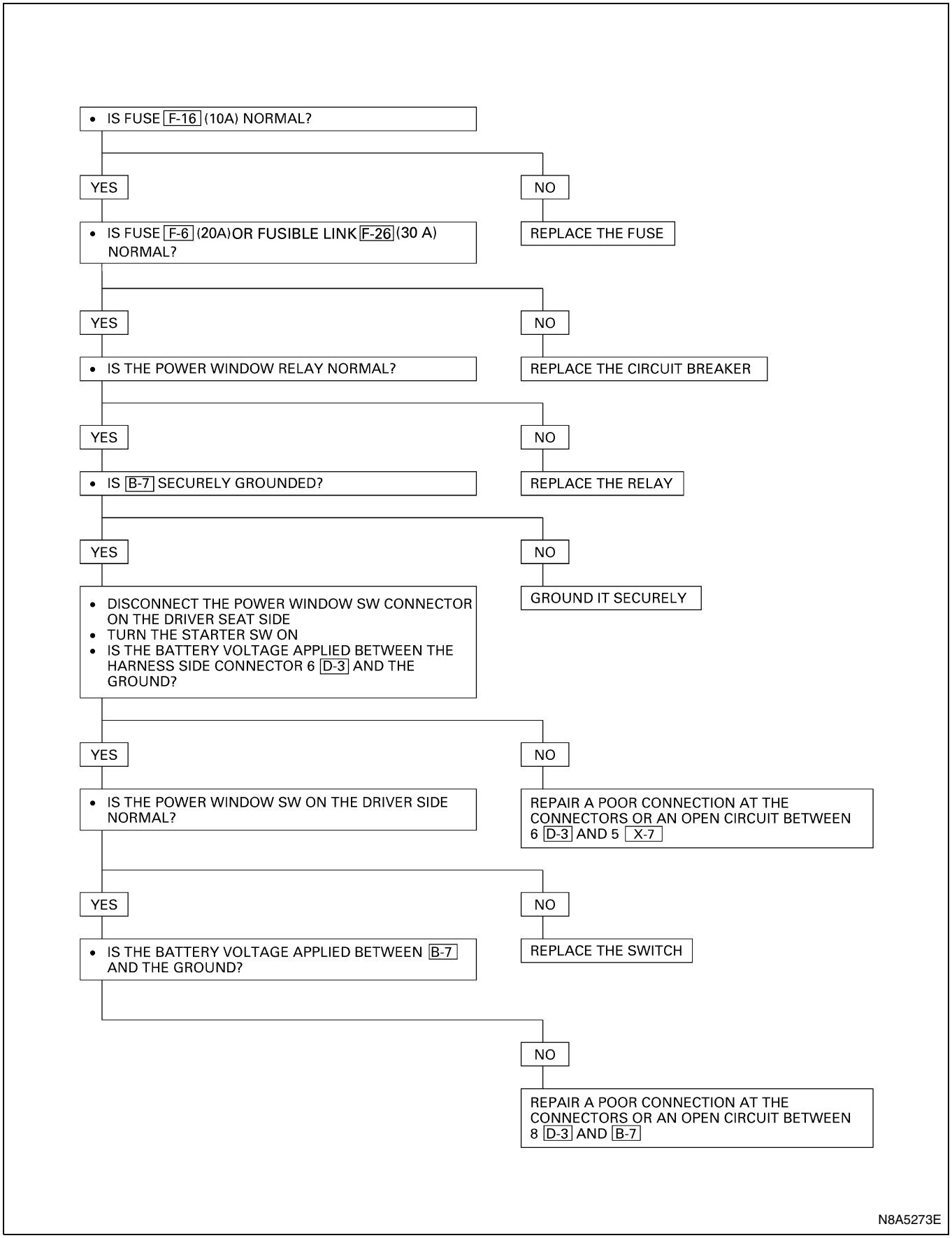
Diagnosis

Quick Chart for Check Point

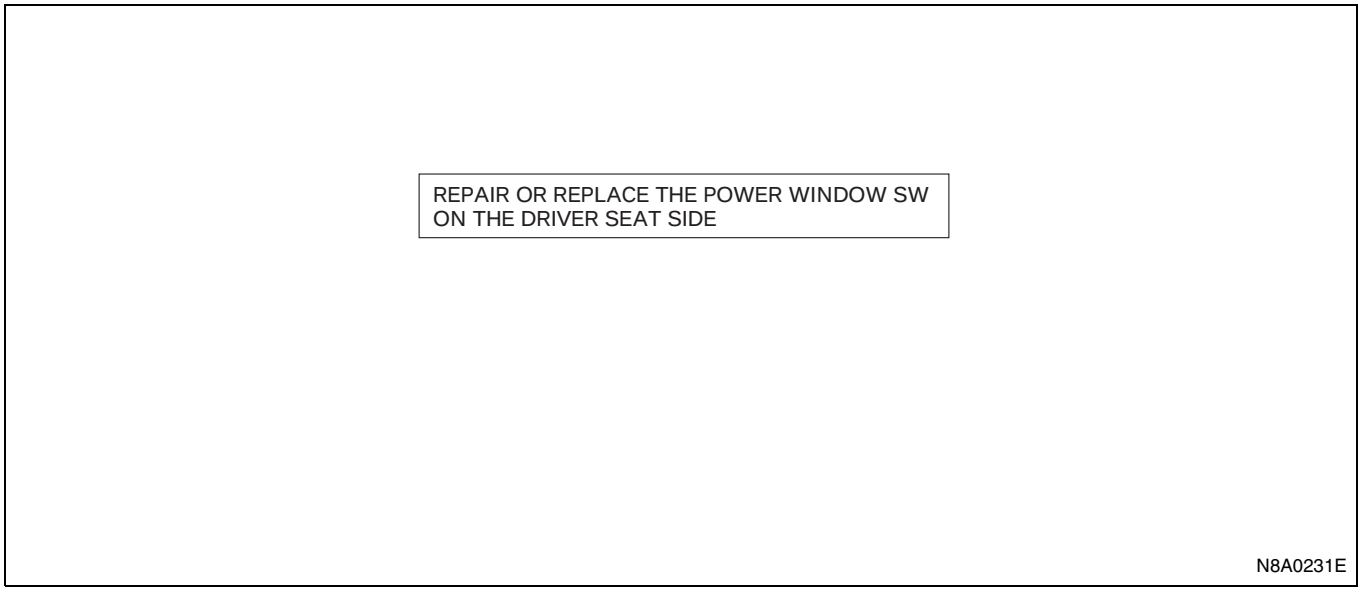
		Check point								
		Fuse F-16 (10A)	24 V Fuse F-6 (20A)	12 V Fusible link F-26 (30A)	Power window relay	Power window SW		Power window motor		Cable harness
						Driver side	Passenger side	Driver side	Passenger side	
Trouble mode	All windows do not operate	❍ (1)	❍	❍	❍	❍				❍
	Lock SW does not function					❍ (1)				
	Driver side window									
	Window does not operate					❍ (1)		❍ (2)		❍ (3)
	One-touch operation does not operate					❍ (1)				
	Window operates in only one direction					❍ (1)				
	Front passenger side window									
	Window does not operate					❍ (2)	❍ (1)		❍ (3)	❍ (4)
	Window does not operate when operating the driver side SW					❍ (1)				❍ (2)
	Window does not operate when operating the passenger side SW						❍ (1)			❍ (2)
	Window operates in only one direction when operating the driver side SW					❍ (1)				❍ (2)
	Window operates in only one direction when operating the passenger side SW					❍ (2)	❍ (1)			❍ (3)

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

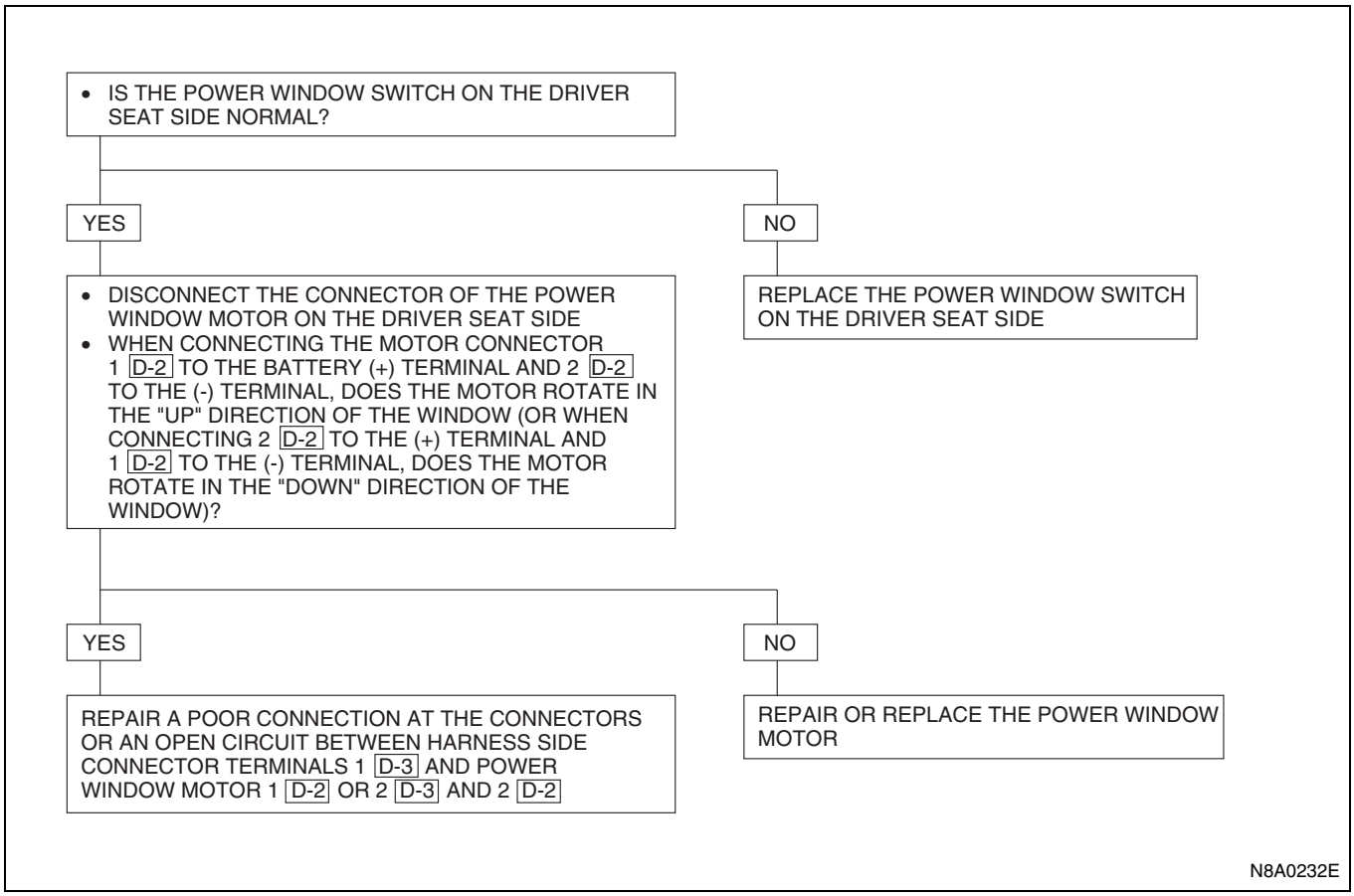
All Windows Do Not Operate



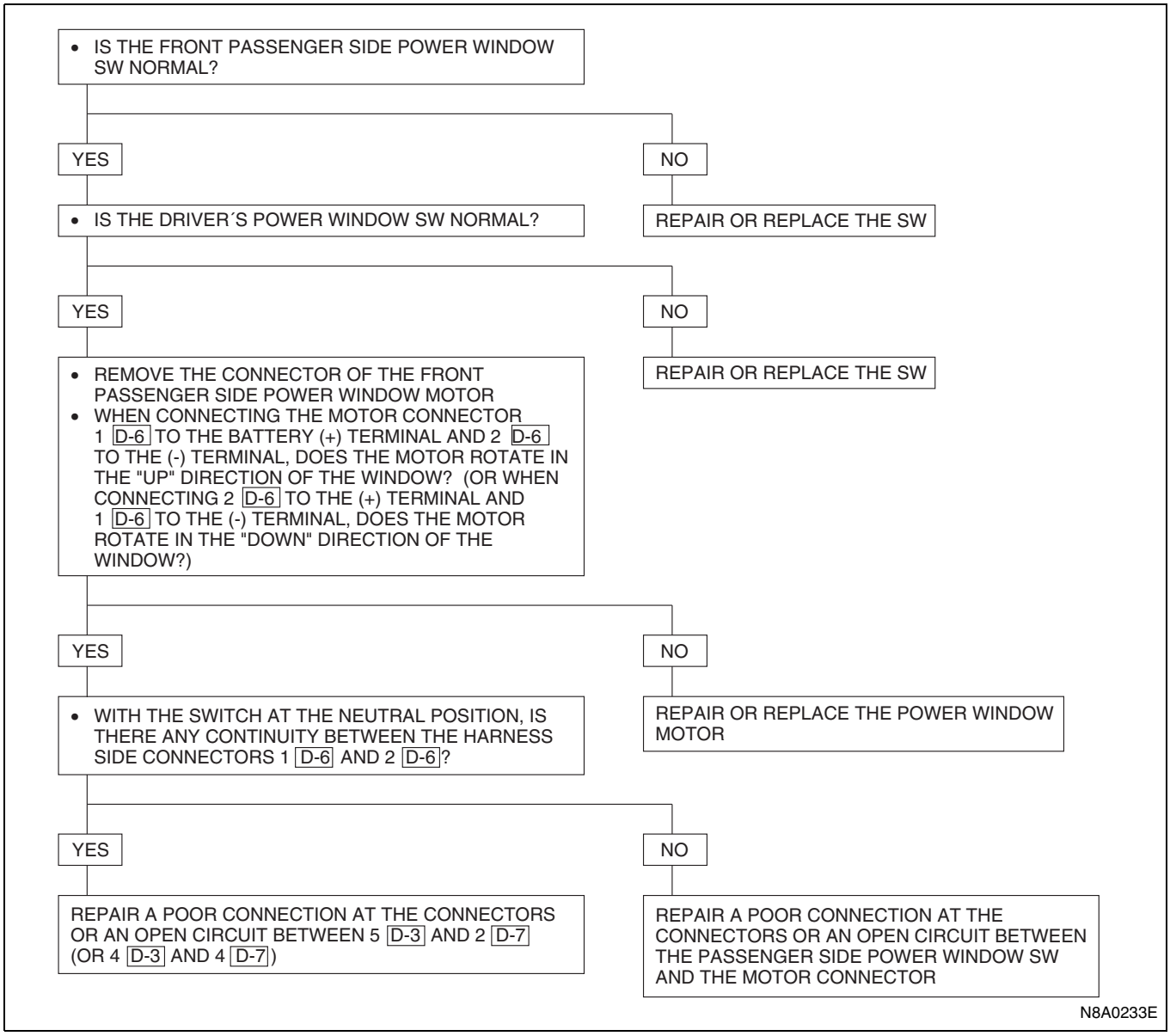
Lock Sw Does Not Function



Window on the Driver Side Does Not Operate



Window on the Front Passenger Side Does Not Operate



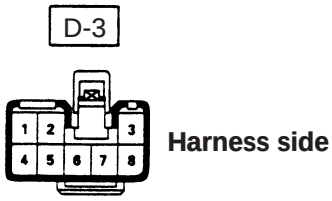
Starter Switch

Refer to “START AND CHARGING” in this section.

Power Window Switch-driver Side

Circuit Inspection

Disconnect the switch connectors to check the voltage and the continuity between the harness side connector terminals.

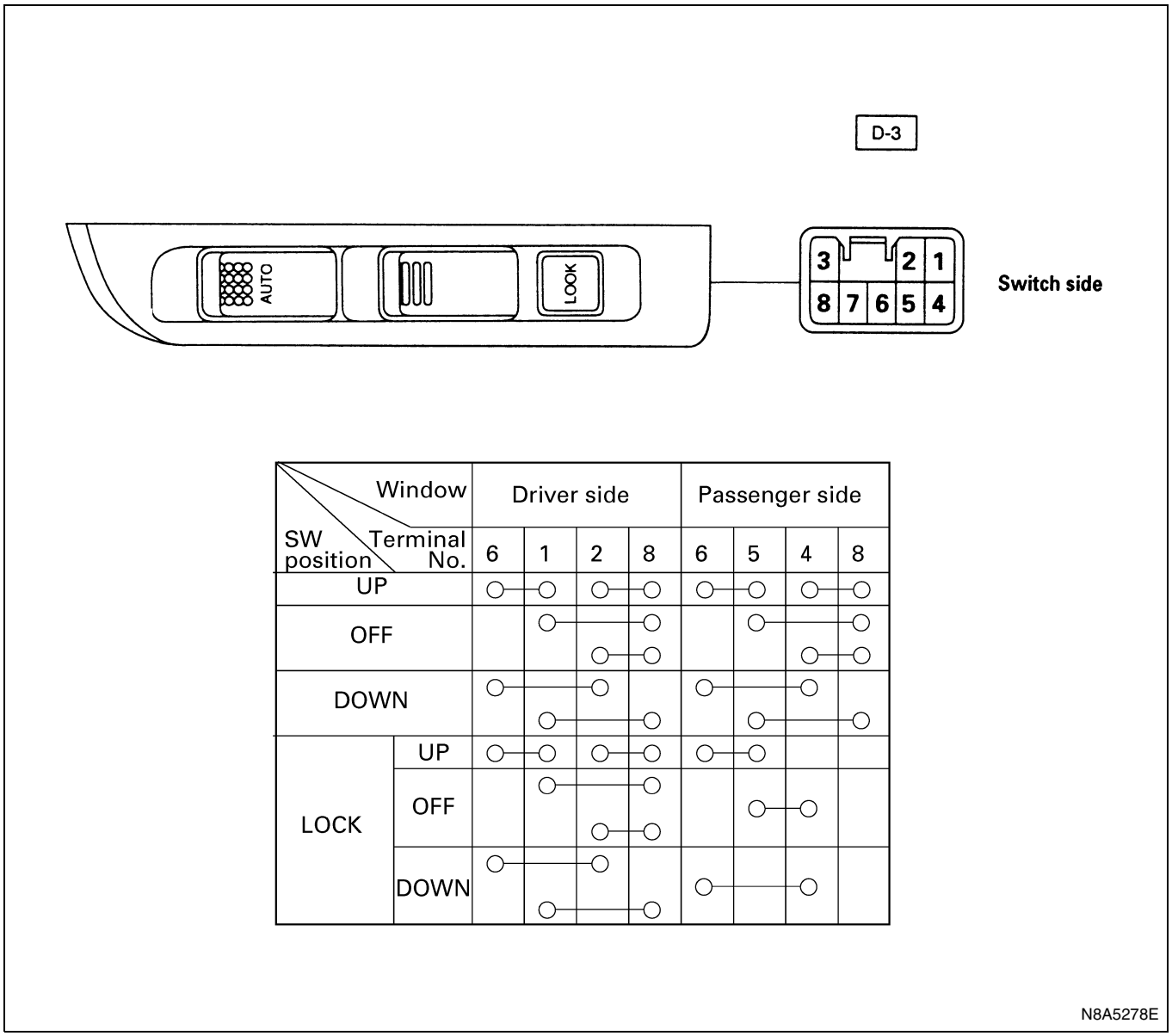


Terminal No.	Wire color	Connected to	Item to be checked	Connecting terminal	Checking conditions	Standard
1	L/W	Driver seat side motor	Continuity (resistance)	1-2	-	Continuity
2	L					
4	G/Y	Passenger side power window SW		4-5		
5	R/Y			5-4		
6	L/B	Power window relay	Voltage	6-Ground	Starter SW "ON"	Battery voltage
8	B	Ground	Continuity (resistance)	8-Ground	-	Continuity

N8A0234E

Inspection

Check the continuity between the connector terminals of the switch.
Repair or replace the switch when the result of inspection is found abnormal.



SW position \ Terminal No. / Window		Driver side				Passenger side			
		6	1	2	8	6	5	4	8
UP		○—○		○—○		○—○		○—○	
OFF			○—○		○—○		○—○		○—○
DOWN		○—○		○—○		○—○		○—○	
LOCK	UP	○—○		○—○		○—○			
	OFF		○—○		○—○		○—○		
	DOWN	○—○		○—○		○—○		○—○	

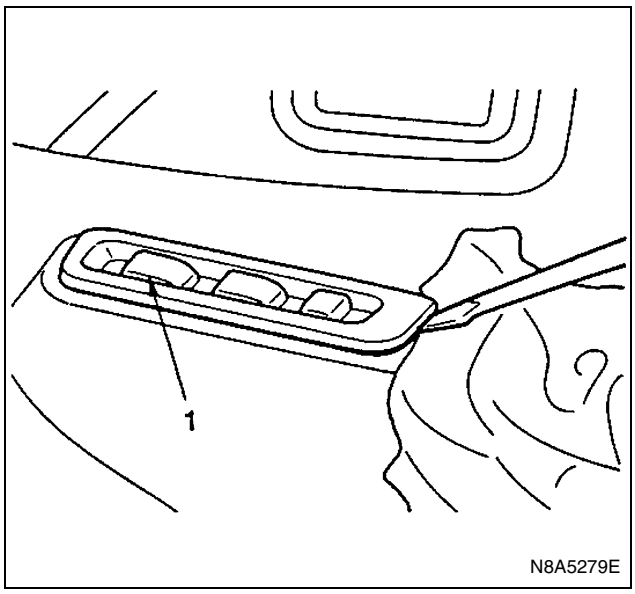
N8A5278E

Removal

Preparation:

Disconnect the battery ground cable.

1. Switch
   1) Insert the screw driver to the cut off portion to remove the switch.
   2) Disconnect the connector.



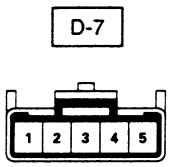
Installation

To install, follow the removal steps in the reverse order.

Power Window Switch-passenger Side

Circuit Inspection

Disconnect the switch connectors to check the voltage and the continuity between the harness side connector terminals.



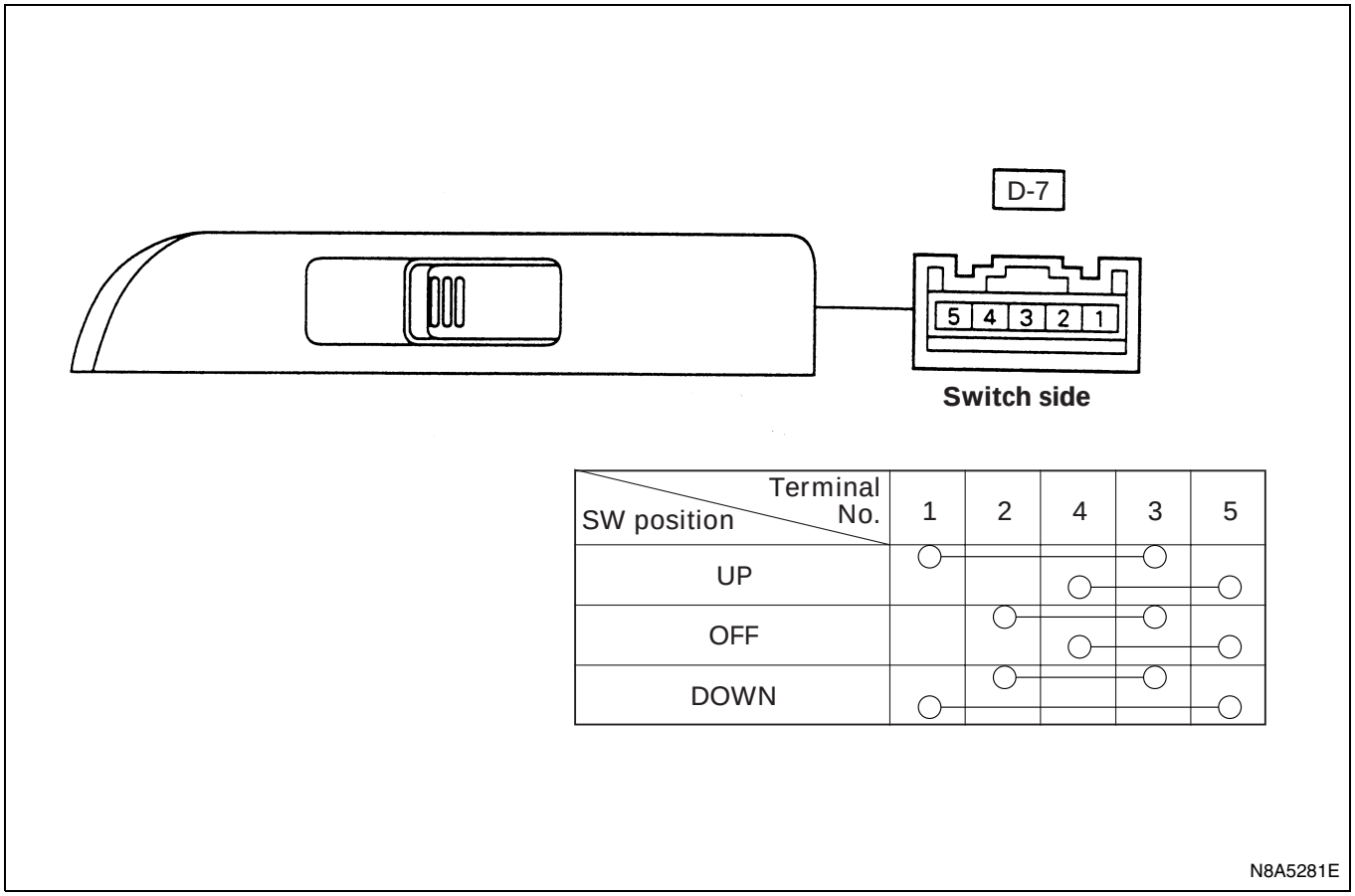
Terminal No.	Wire color	Connected to	Item to be checked	Connecting terminal	Checking conditions	Standard
1	L/B	Power window relay	Voltage	1-Ground	· Turn "ON" the starter SW	Battery voltage
2	R/Y	Driver side SW	Continuity (Resistance)	2-Ground	· Turn "OFF" the passenger side SW at the driver side SW	Continuity
			Voltage	2-Ground	· Turn "ON" the starter SW · Turn to "UP" the passenger side SW at the driver side SW	Battery voltage
3	L/Y	Passenger side motor	Continuity (Resistance)	3-5	–	Continuity
4	G/Y	Driver side SW	Continuity (Resistance)	4-Ground	· Turn "OFF" the passenger side SW at the driver side SW	Continuity
			Voltage	4-Ground	· Turn "ON" the starter SW · Turn to "DOWN" the passenger side SW at the driver side SW	Battery voltage
5	BR/Y	Passenger side motor	Continuity (Resistance)	5-3	–	Continuity

N8A5280E

Inspection

Check the continuity between the connector terminals of the switch.

Repair or replace the switch when the result of inspection is found abnormal.

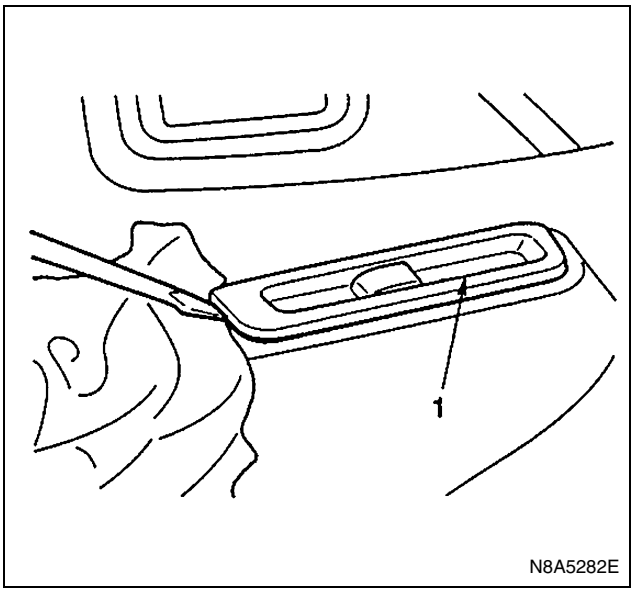


Removal

Preparation:

Disconnect the battery ground cable.

1. Switch
   1) Insert the screw driver to the cut off portion to remove the switch.
   2) Disconnect the connector.



Installation

To install, follow the removal steps in the reverse order.

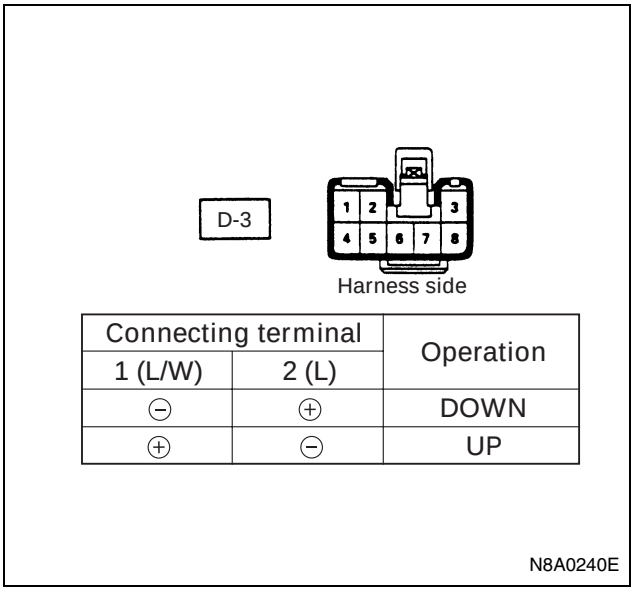
Driver Seat Side Power Window Motor

Inspection

Before checking to see if the motor functions correctly, be sure to check the circuit through the connector D-3 of the driver's power window switch.

If the motor does not operate smoothly, either the motor or the circuit between the switch and the motor is defective.

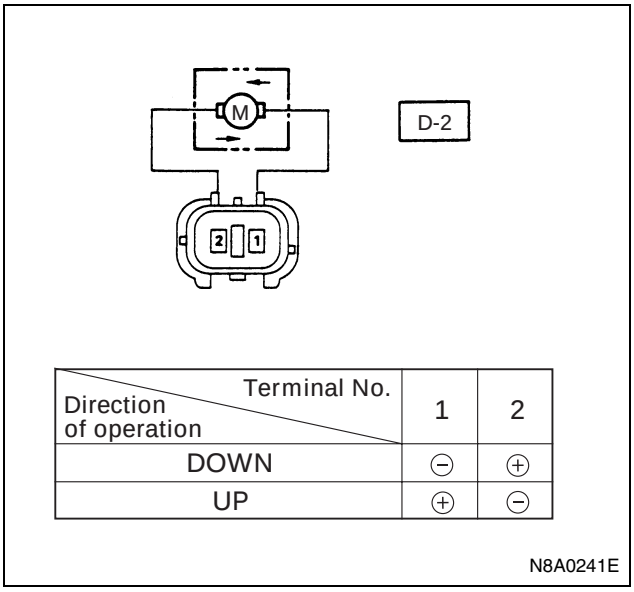
1. Circuit inspection of the driver side window switch
   Disconnect the switch connector and apply battery voltage to the harness side connector terminals to check its function.



Connecting terminal		Operation
1 (L/W)	2 (L)	
⊖	⊕	DOWN
⊕	⊖	UP

N8A0240E

2. Inspection of the driver seat side motor
   Remove the motor connector and apply battery voltage to the motor side connector terminals to check its function.
   Replace the motor when the result of inspection is found abnormal.



Direction of operation \ Terminal No.	1	2
DOWN	⊖	⊕
UP	⊕	⊖

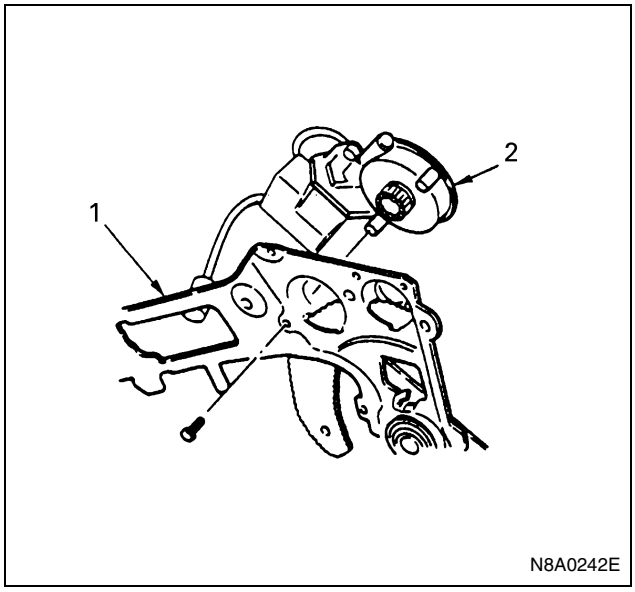
N8A0241E

Removal

Preparation:

Disconnect the battery ground cable.

1. Window Regulator Assembly
   Refer to Section 2 for Window Regulator and Glass.
2. Power Window Motor
   Remove three screws.



N8A0242E

Installation

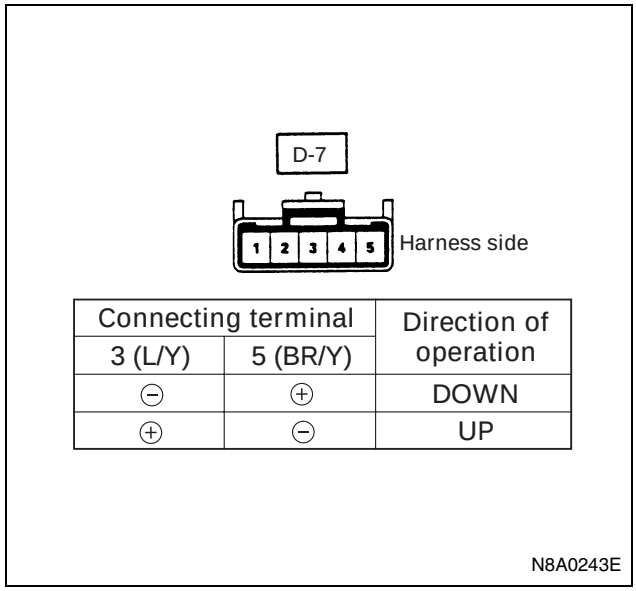
To install, follow the removal steps in the reverse order.

Front Passenger Seat Side Power Window Motor

Inspection

Before checking to see if the motor functions correctly, be sure to check the circuit through the front passenger's switch connector D-7 and the driver's power window switch connector D-3.
If the motor does not operate smoothly, either the motor or the circuit between the switch and the motor is defective.

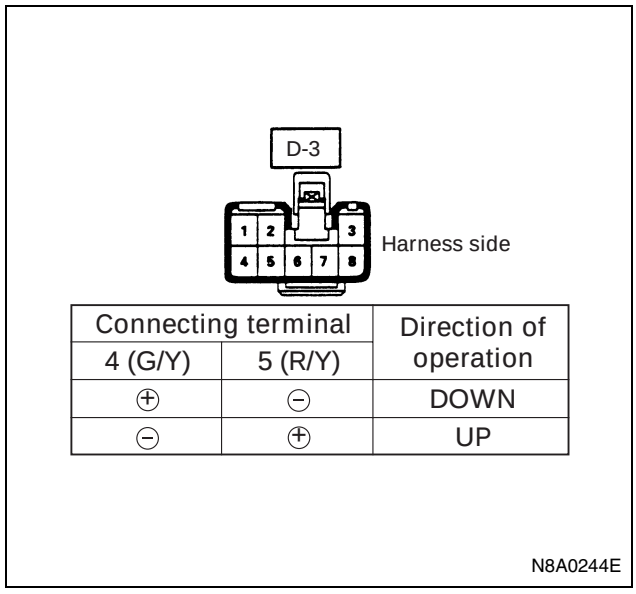
1. Circuit inspection of the front passenger seat side window
   Disconnect the switch connector and apply battery voltage to the harness side connector terminals to check its function.



Connecting terminal		Direction of operation
3 (L/Y)	5 (BR/Y)	
⊖	⊕	DOWN
⊕	⊖	UP

N8A0243E

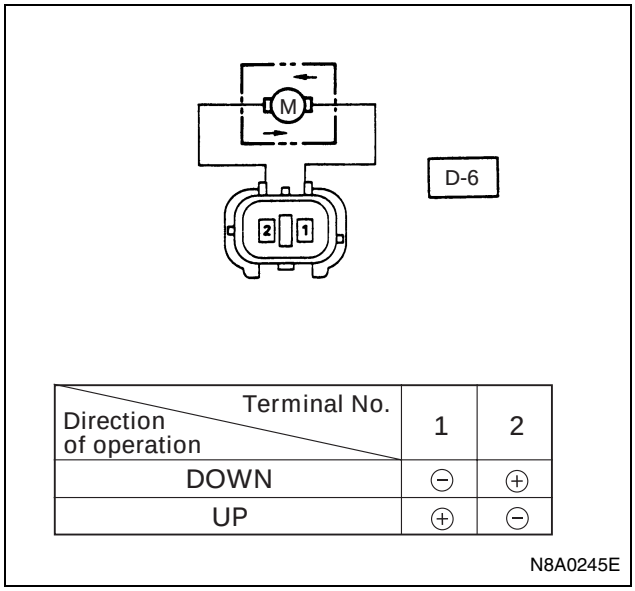
2. Circuit inspection of the driver seat side switch
   Disconnect the switch connector and apply battery voltage to the harness side connector terminals to check its function.



Connecting terminal		Direction of operation
4 (G/Y)	5 (R/Y)	
⊕	⊖	DOWN
⊖	⊕	UP

N8A0244E

3. Inspection of the front passenger window motor
   Disconnect the motor connector and apply battery voltage to the motor side connector terminals to check its function.
   Repair or replace the motor when the result of inspection is found abnormal.



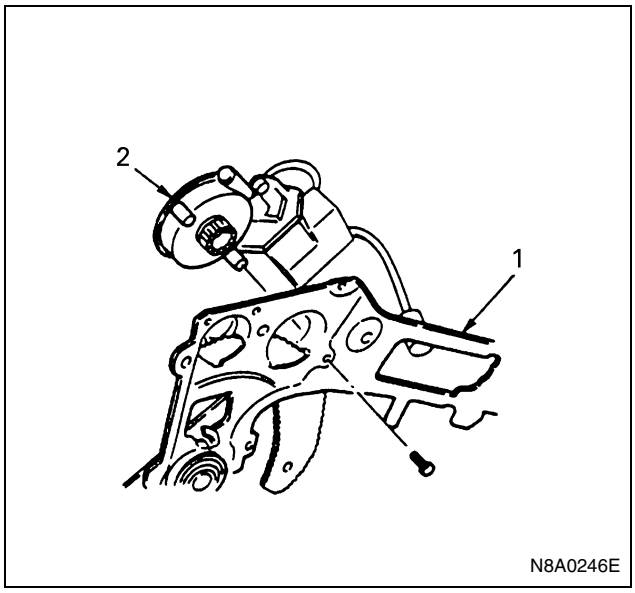
Direction of operation \ Terminal No.	1	2
DOWN	⊖	⊕
UP	⊕	⊖

N8A0245E

Removal

Preparation:
Disconnect the battery ground cable.

1. Window Regulator Assembly
   Refer to Section 2 for Window Regulator and Glass.
2. Power Window Motor
   Remove three screws.



N8A0246E

Installation

To install, follow the removal steps in the reverse order.

Windshield Wiper and Washer

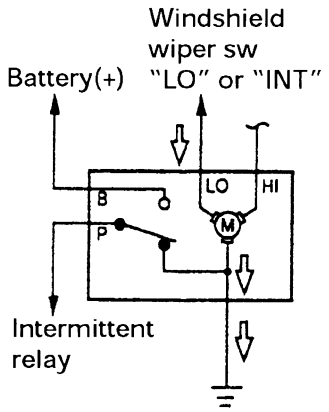
General Description

The circuit consists of the starter switch, windshield wiper & washer switch, wiper motor, washer motor and the intermittent relay.
When the wiper & washer switch is turned on with starter switch on, the battery voltage is applied to the wiper motor to activate the wiper.
The washer motor squirts glass cleaning fluid while the washer switch is being pushed. The intermittent relay is used to control motion of the wiper.

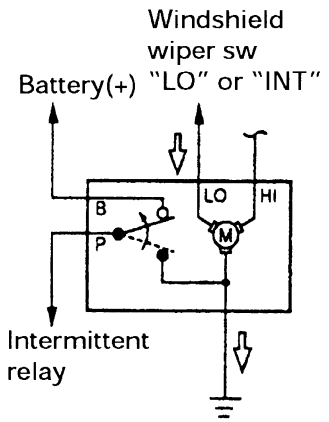
Operation of Windshield Wiper Motor

(When wiper "LO" or "INT" position)

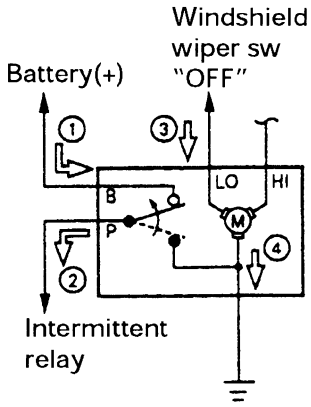
1. Condition of wiper switch is "LO"or "INT"position (Wiper motor is starting to operate)



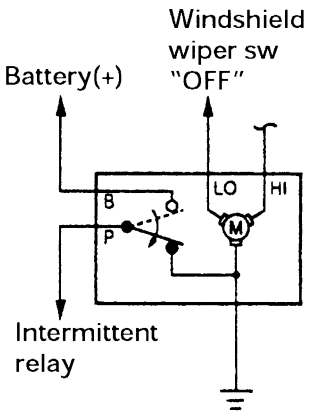
2. Condition of wiper motor is operating



3. Condition of wiper switch is just "OFF" (Wiper motor is still operating until auto-stop position)



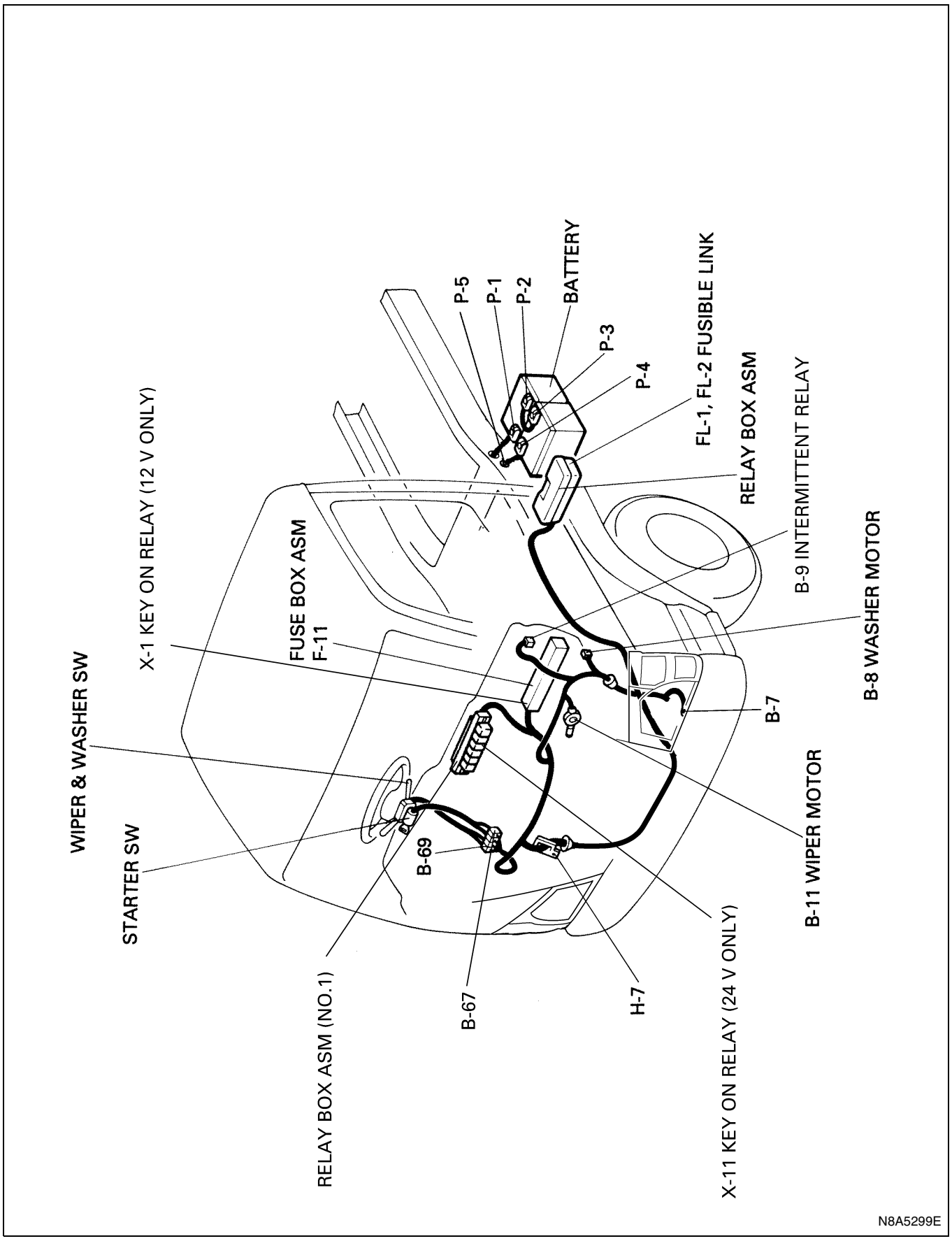
4. Wiper motor stops at auto-stop position



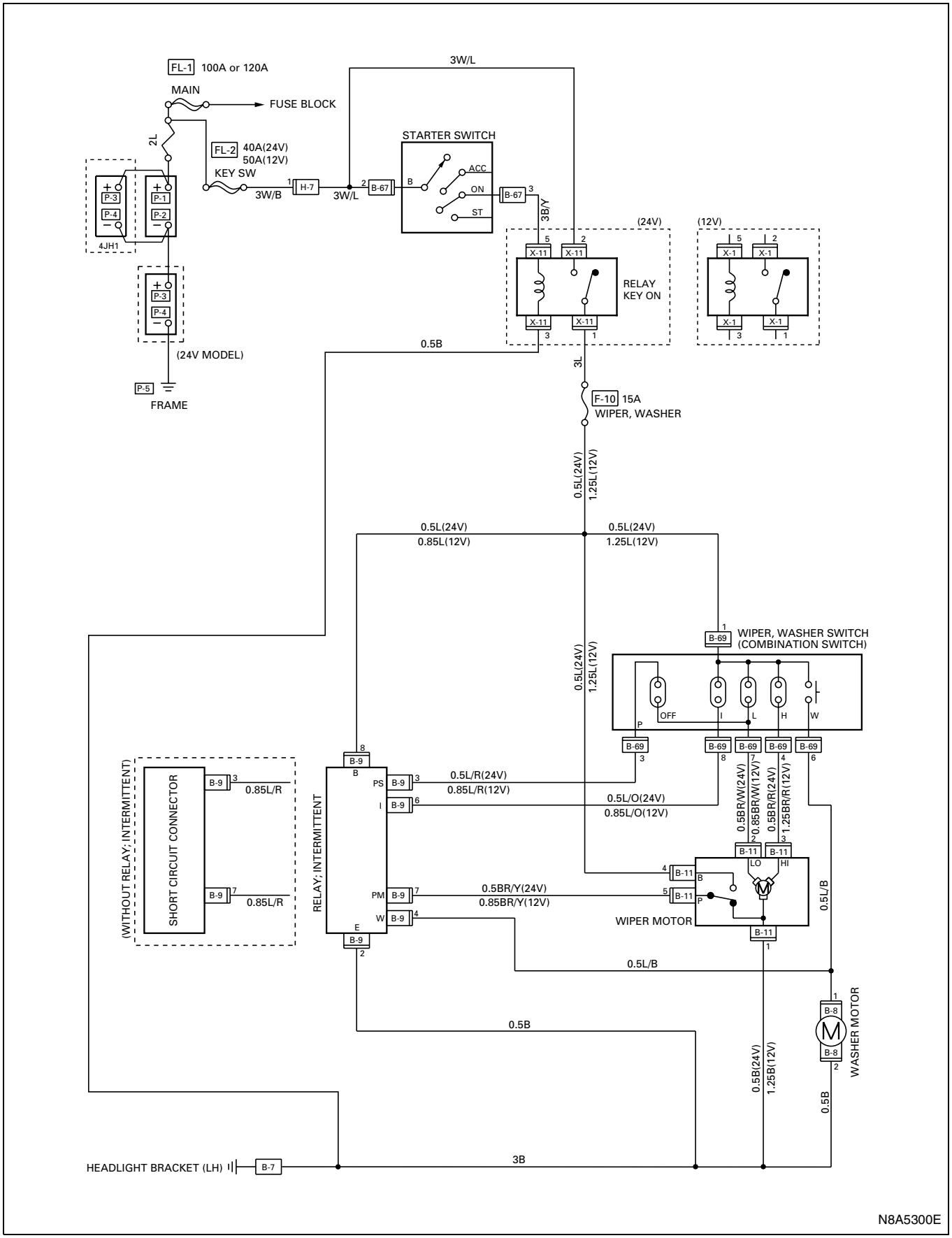
N8A0250E

Notice:
Arrow marks indicate the direction of current.

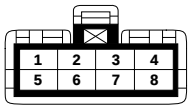
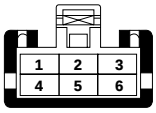
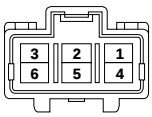
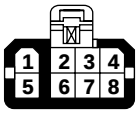
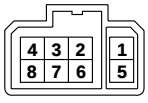
Parts Location

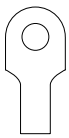
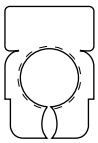
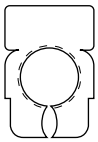
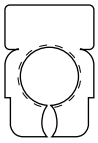
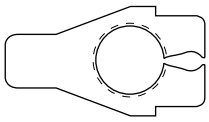
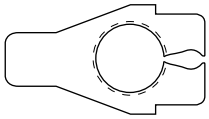
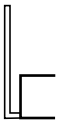
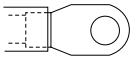


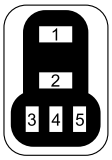
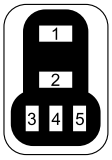
Circuit Diagram



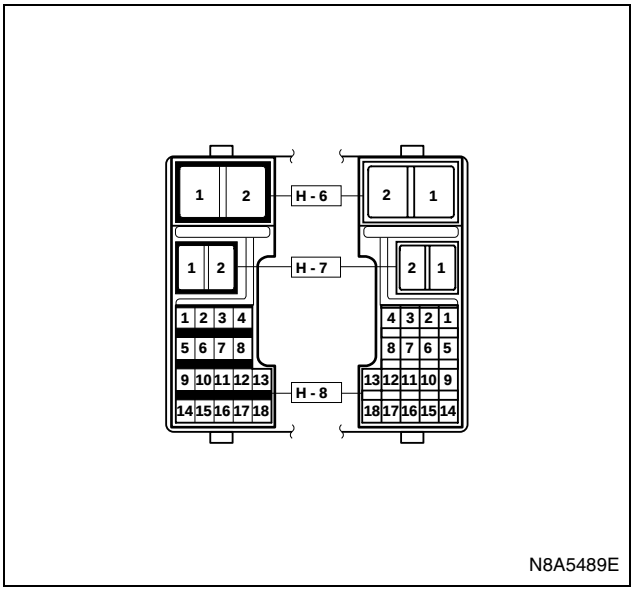
Connector List

No.	Connector Face
B-8	002-009
B-9	 008-012
B-11	 006-001
B-11	 006-016
B-67	004-001
B-67	004-002
B-69	 008-001
B-69	 008-002

No.	Connector Face
P-1 (12V)	 000-003
P-2	 000-004
P-1 (24V)	 000-004
P-4	 000-004
P-2 (24V)	 000-006
P-3	 000-006
P-5 (12V)	 000-007
P-5 (24V)	 000-002

No.	Connector Face
X-11	 005-006
X-1	 005-006

H-7



Diagnosis

Quick Chart for Check Point

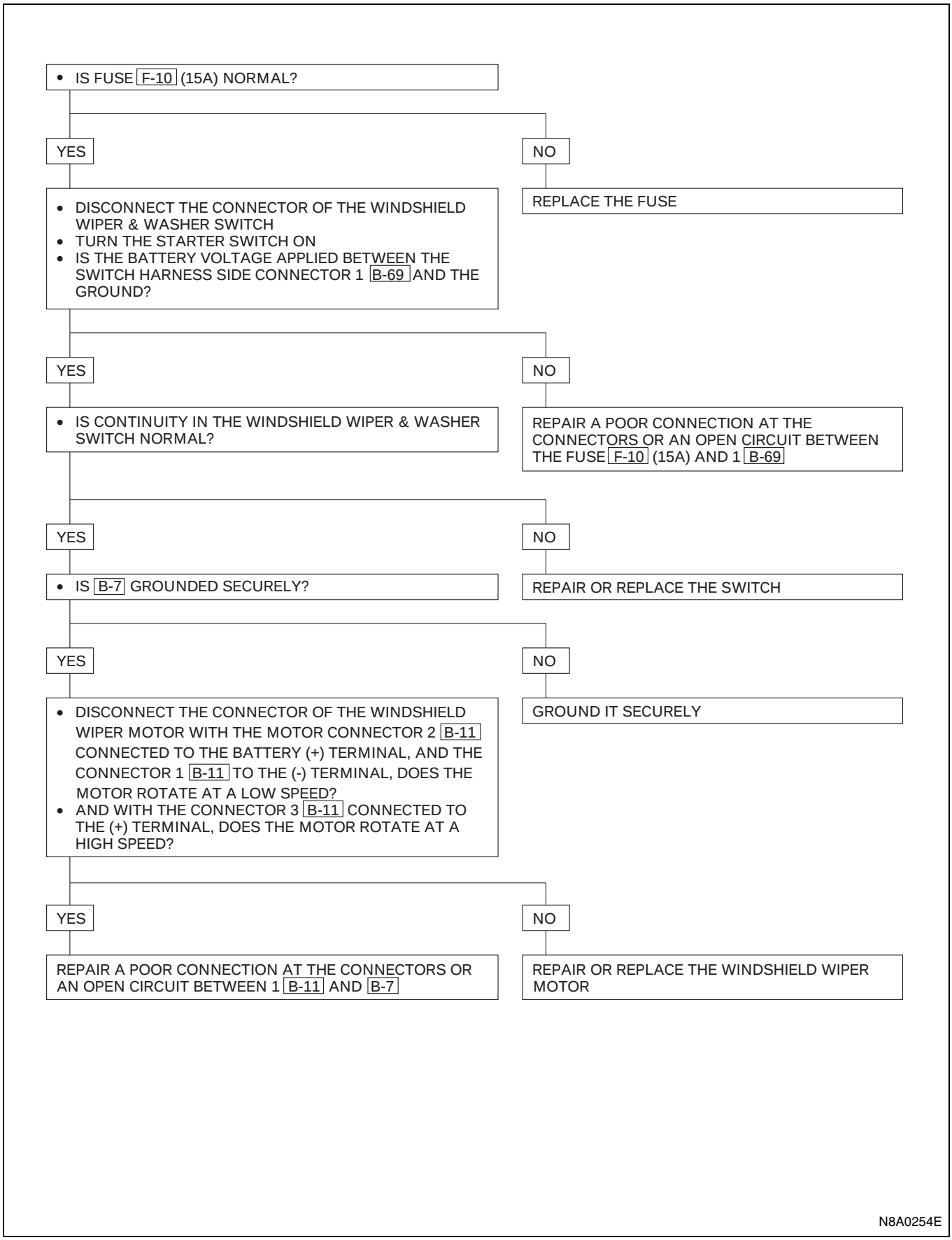
1. Windshield Wiper and Washer

		Check point					
		Fuse F-10 (15A)	Wiper& washer SW	Intermit-tent relay	Wiper motor	Washer motor	Cable harness
Trouble mode	1. Windshield wiper does not operate at any switch position	❍ (1)	❍ (3)		❍ (4)		❍ (2)
	2. Windshield wiper does not operate at “INT” position		❍ (1)	❍ (3)			❍ (2)
	3. Windshield wiper does not operate at “LO” position		❍ (1)		❍ (3)		❍ (2)
	4. Windshield wiper does not operate at “HI” position		❍ (1)		❍ (2)		❍ (3)
	5. Auto-stop function of the windshield wiper motor does not operate		❍ (1)	❍ (4)	❍ (2)		❍ (3)
	6. Rotation of the windshield wiper motor does not stop		❍ (1)		❍ (2)		
	7. Windshield washer motor does not operate		❍ (1)			❍ (3)	❍ (2)

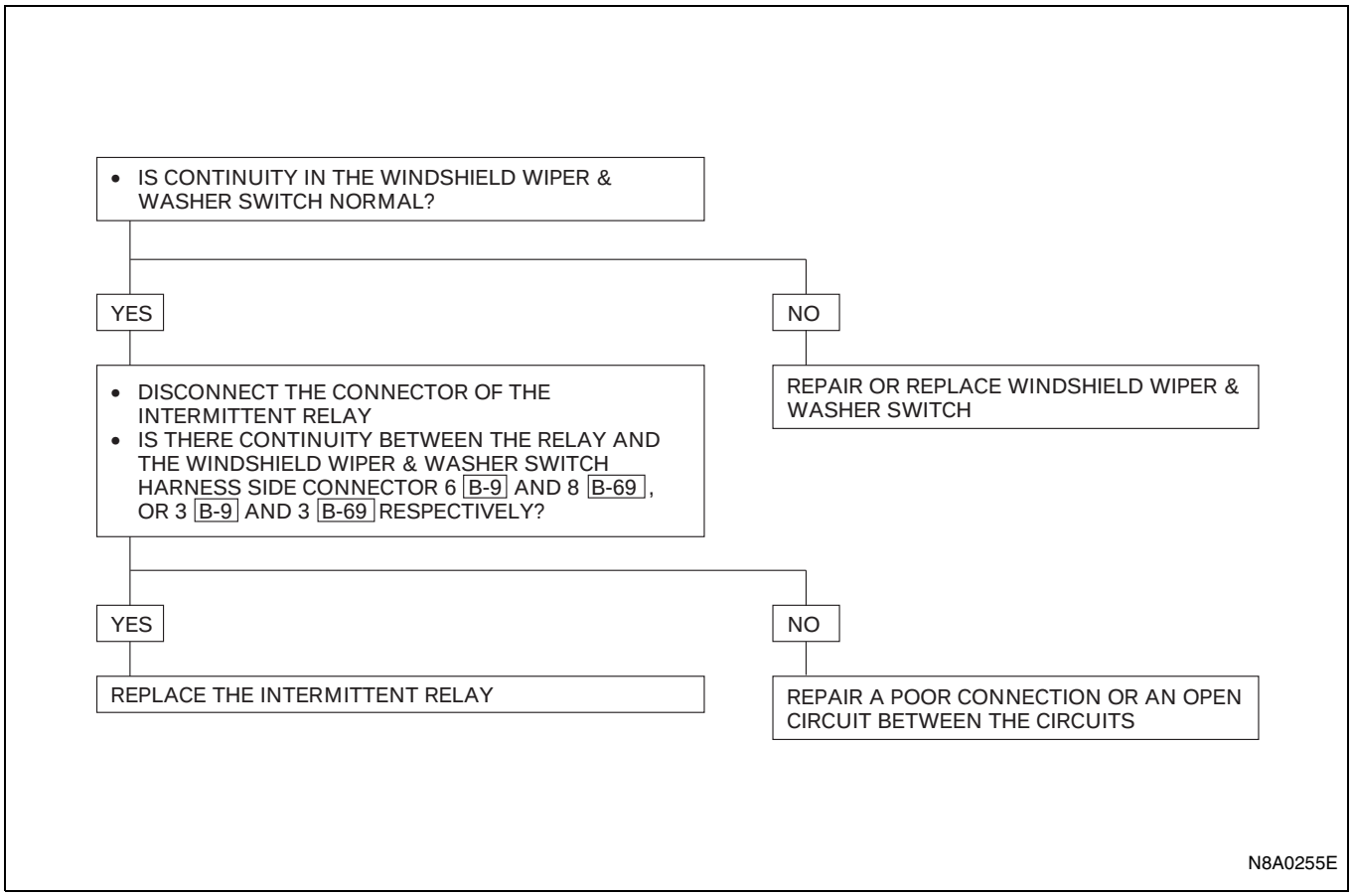
Notice:
Figure in parenthesis “( )” indicates the order of inspection.

1. Windshield Wiper and Washer

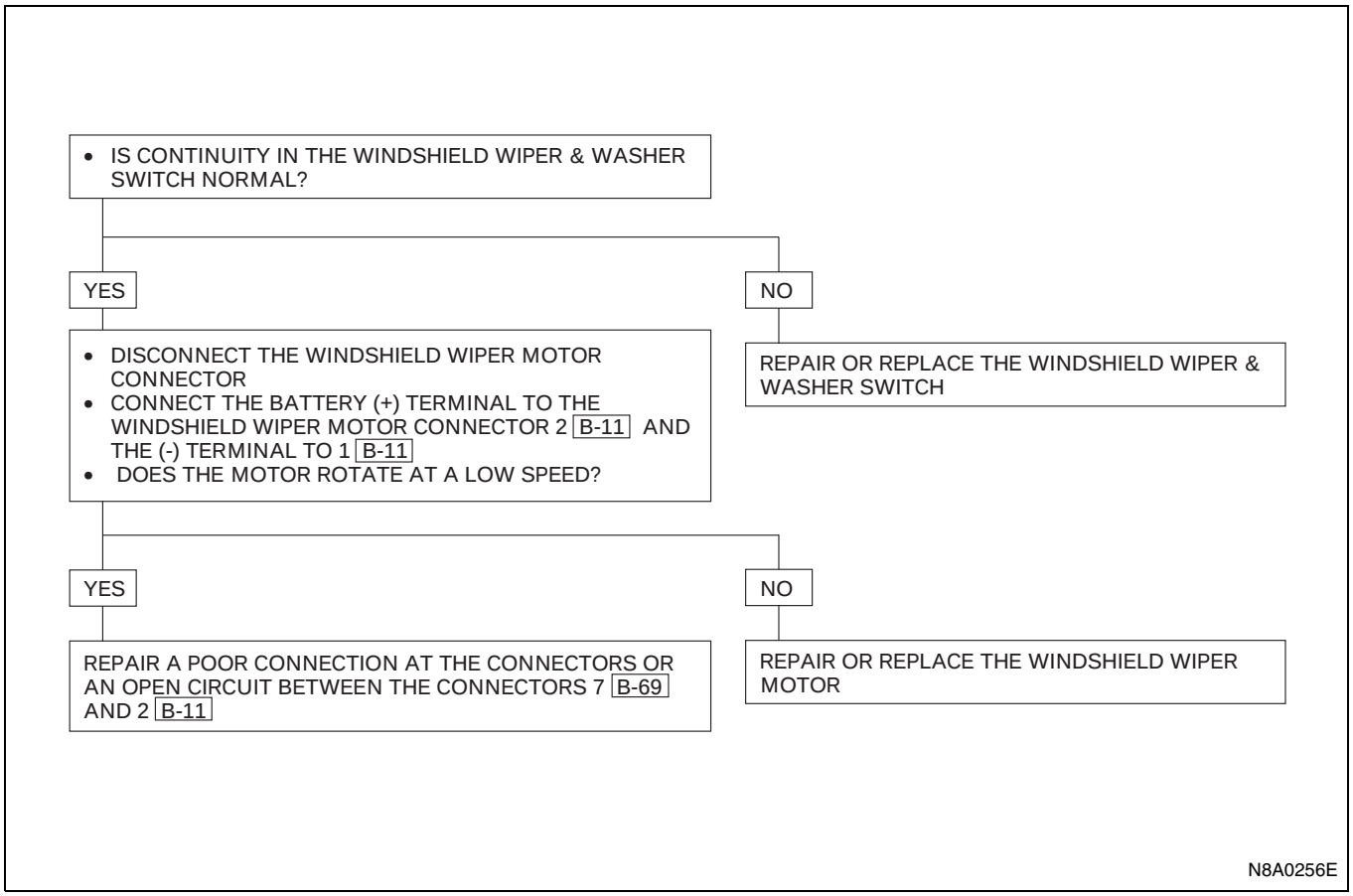
1-1. Windshield Wiper Does Not Operate at Any Switch Position



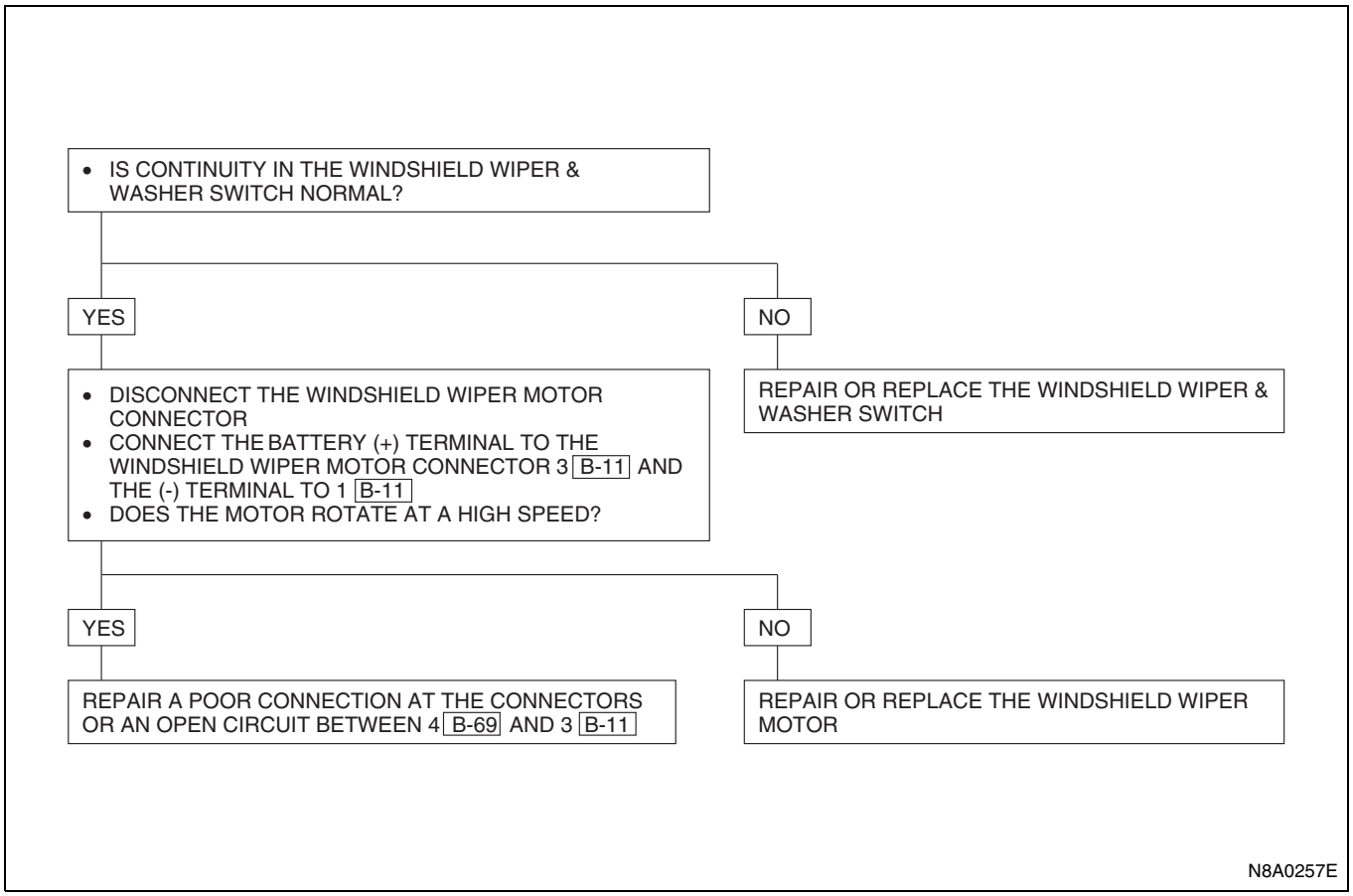
1-2. Windshield Wiper Does Not Operate at "INT" Position



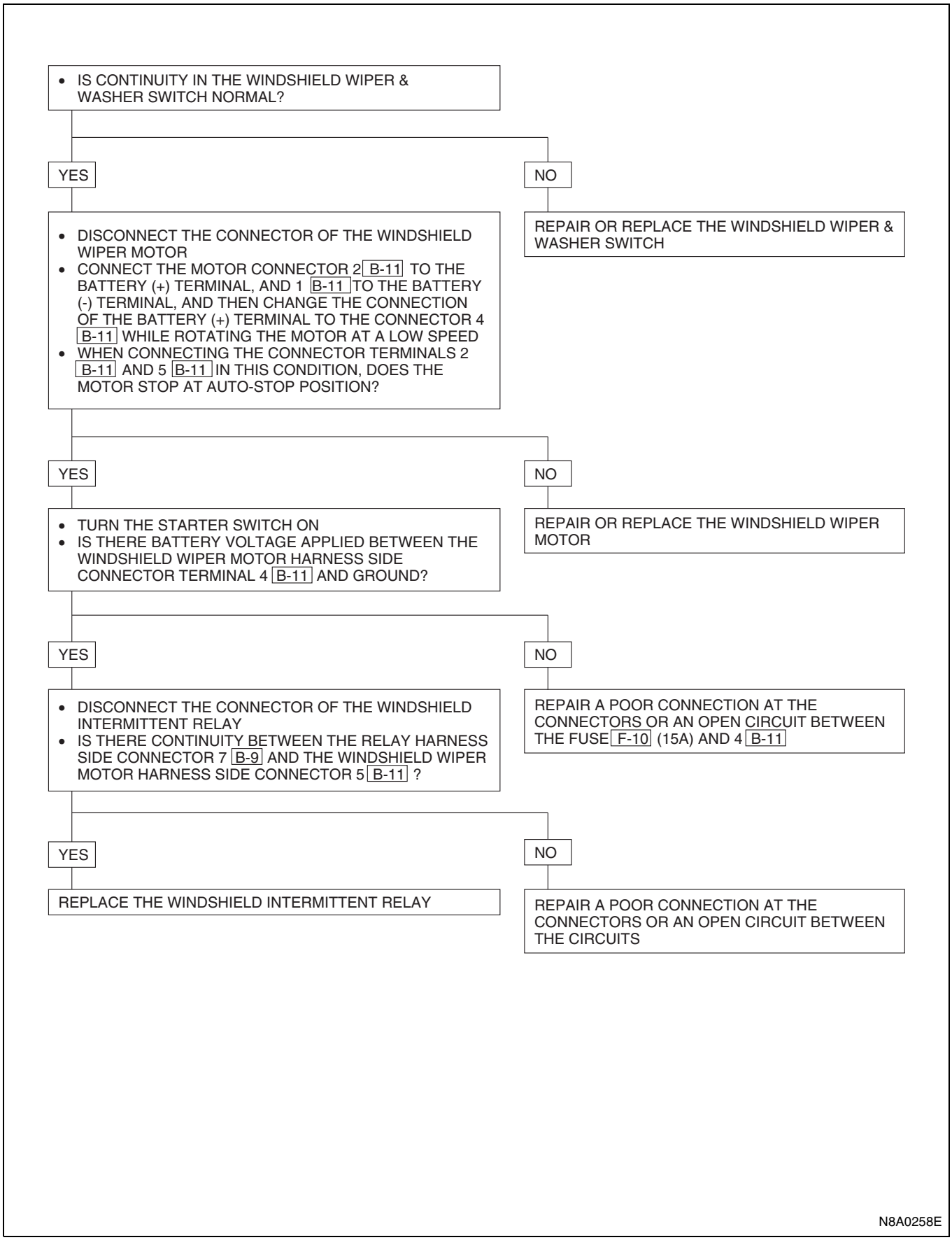
1-3. Windshield Wiper Does Not Operate at "LO" Position



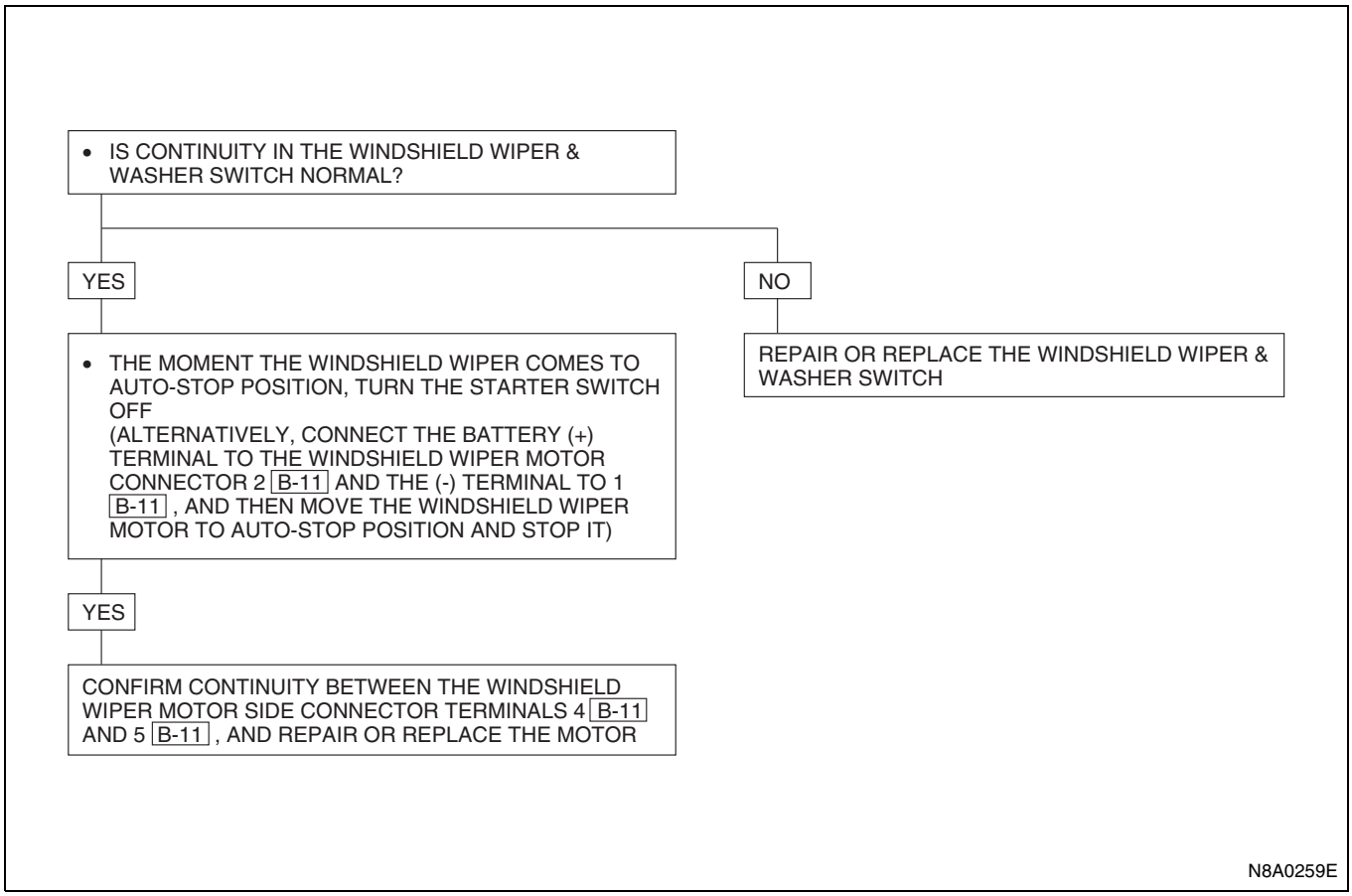
1-4. Windshield Wiper Does Not Operate at "HI" Position



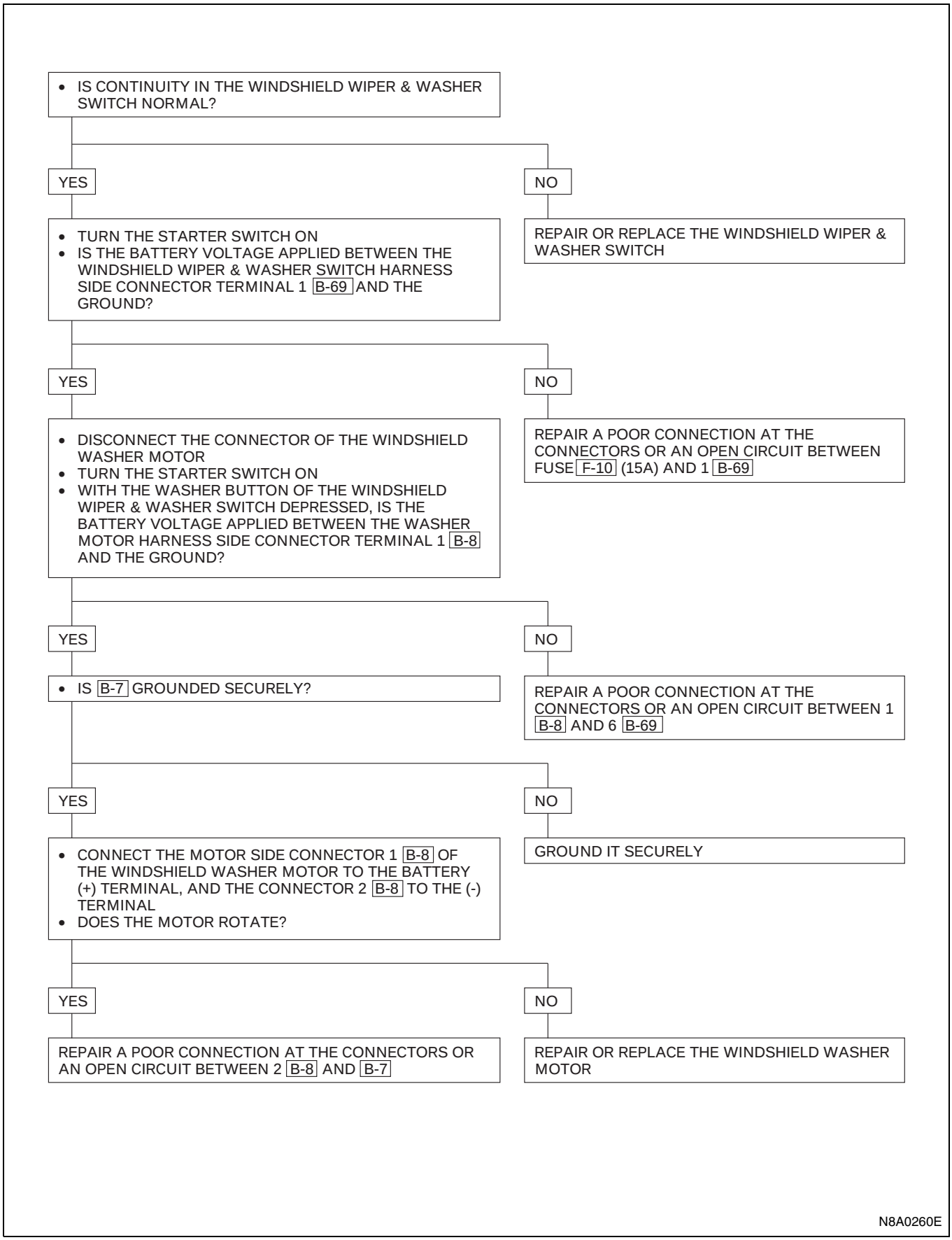
1-5. Auto-stop Function of The Windshield Wiper Motor Does Not Operate



1-6. Rotation of The Windshield Wiper Motor Does Not Stop



1-7. Windshield Washer Motor Does Not Operate

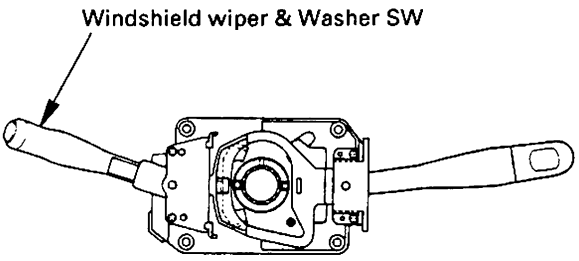


Starter Switch

Refer to “START AND CHARGING” in this section.

Windshield Wiper & Washer Switch

With the starter switch on, the windshield wiper and washer switch controls the start and stop operation as well as the change of operating speeds.
Both the windshield washer motor and the wiper motor jointly operate while the washer button is pushed.

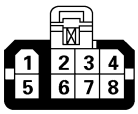


N8A5310E

Inspection

Check the continuity between the connector terminals of the switch.
Repair or replace the switch when the result of inspection is found abnormal.

B-69



Switch side

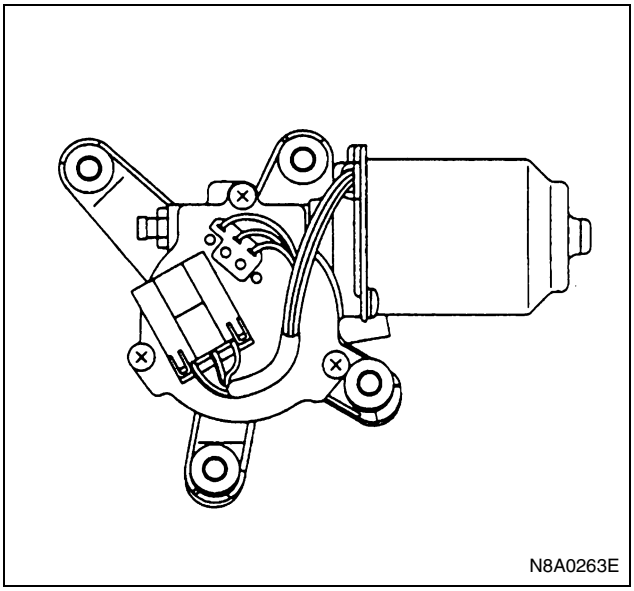
Washer SW	Wiper SW	Terminal No.					
		3	7	1	4	8	6
OFF	OFF	○	○				
	INT	○	○	○		○	
	LO		○	○			
	HI			○	○		
ON	OFF, INT LO, HI			○			○

N8A5311E

Removal and Inspection

Refer to “HEADLIGHT, FOG LIGHT AND CORNERING LIGHT” in this section.

Windshield Wiper Motor


N8A0263E

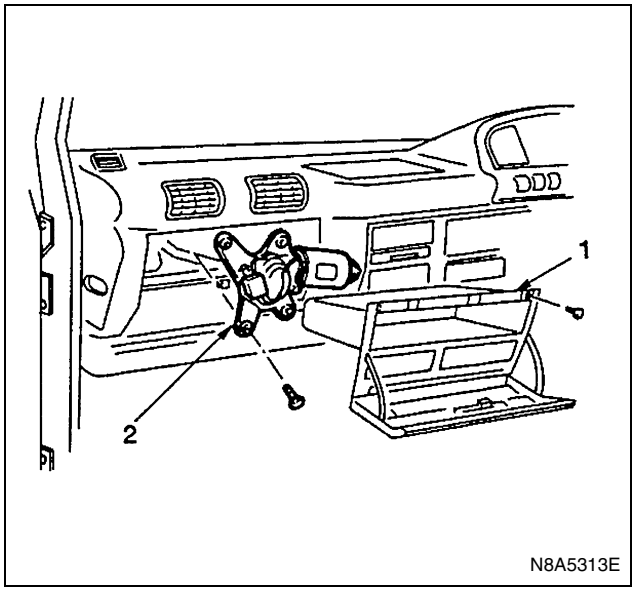
Inspection

1. Operation in low speed
   With the motor connector terminal 2 B-11 connected to the battery (+) terminal and the connector 1 B-11 to the (–) terminal, check to see if the motor rotates in low speed.
2. Operation in high speed
   With the motor connector terminal 3 B-11 connected to the battery (+) terminal and the connector 1 B-11 to the (–) terminal, check to see if the motor rotates in low speed.
3. Stop operation
   After stopping the windshield wiper in the position on the way by confirming the operation at the low speed in item No. 1.
   When the connectors 2 B-11 and 5 B-11 are connected, while connecting the motor connector terminal 4 B-11 to the battery (+) terminal, check to see, if the motor rotates at low speed and stops at the auto-stop position.
   Repair or replace the motor when the results of the above inspections are found abnormal.

Removal

Preparation:
Disconnect the battery ground cable.

1. Glove Box
   Refer to “INSTRUMENT PANEL” of section 2.
2. Windshield Wiper Motor
   1) Disconnect the connector.
   2) Remove four screws.
   3) Remove the ball joint between crank arm and wiper link.



N8A5313E

Installation

To install, follow the removal steps in the reverse order, noting the following points.

- Windshield Wiper Motor
  When the crank arm is removed from the windshield wiper motor, tighten the motor shaft nut with the specified torque.

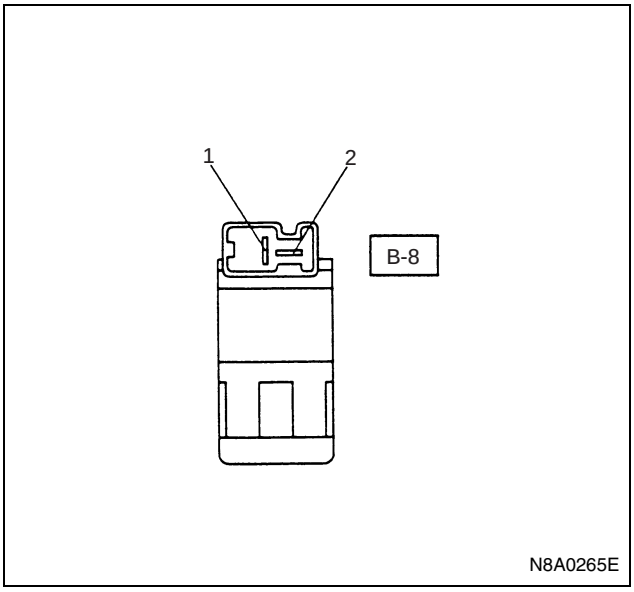
Tighten:
Shaft nut to 17 N·m (170 kg·cm/147 lb·in)

- Temporarily fit the motor by using one of the four wiper motor fixing screws.
- Put the crank arm ball joint in the wiper link hole and fix them together while pulling the wiper link.

Windshield Washer Motor

Inspection

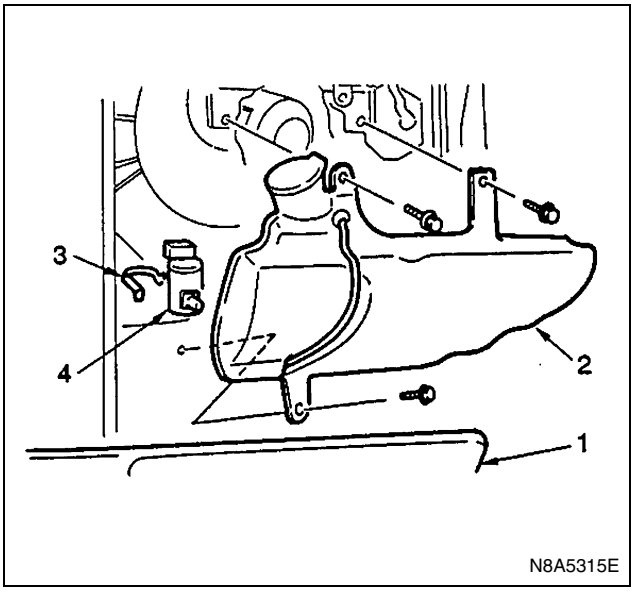
With the battery (+) terminal connected to the washer motor connector terminal 1 B-8 and the (−) terminal to the connector 2 B-8, check to see if the cleaning fluid pushes out.
Replace the tank/motor when the result of inspection is found abnormal.



Removal

Preparation:
Disconnect the battery ground cable.

1. Instrument Panel Under Cover
   Refer to “INSTRUMENT PANEL” of section 2.
2. Washer Tank
   1) Disconnect the washer motor connector.
   2) Disconnect the washer hose.
   3) Remove three fixing screws.
3. Clip Band
4. Windshield Washer Motor
   Hold the motor and pull it out from the washer tank.

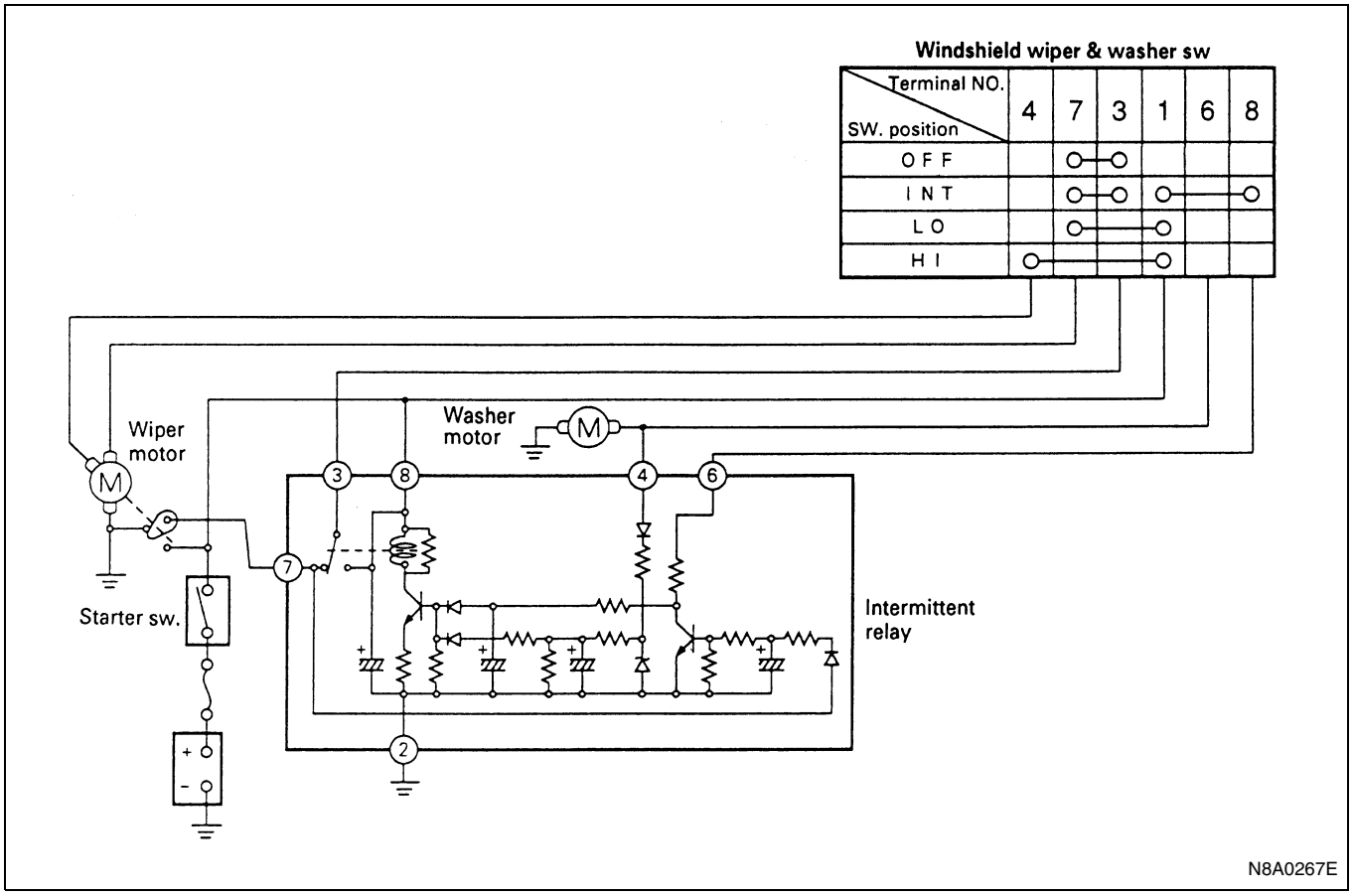


Installation

To install, follow the removal steps in the reverse order.

Intermittent Relay

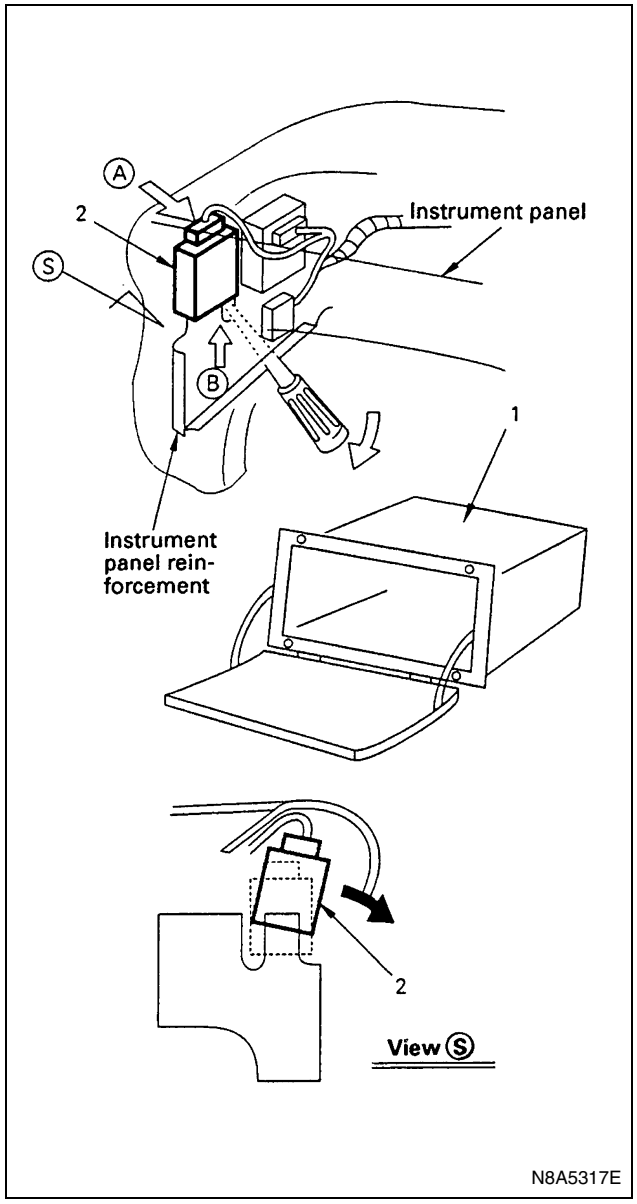
Circuit Diagram



Removal

Preparation:
Disconnect the battery ground cable.

1. Glove Box
   Open the lid and remove the four screws.
2. Intermittent Relay
   1) Press A position with your finger and pry up B position with the tip of a screw-driver.
   2) When the relay moves up by about 2/3 of its size, tilt and take off the relay to avoid interference with the instrument panel.
   3) Disconnect the connector.

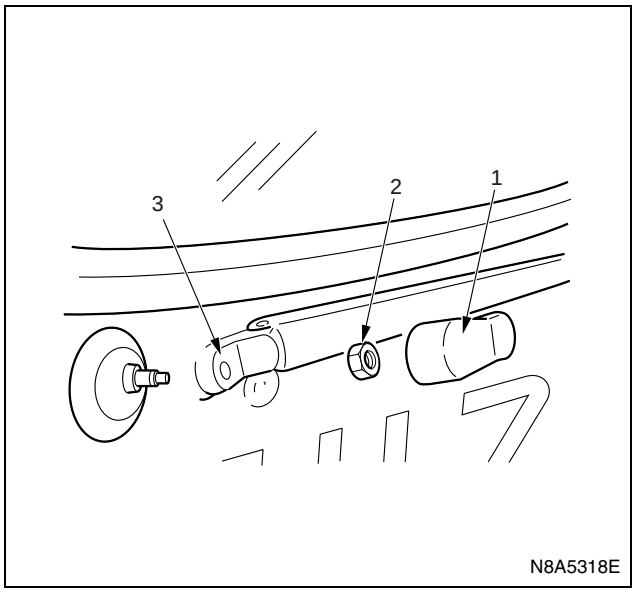


Installation
To install, follow the removal steps in the reverse order.

Windshield Wiper Arm & Blade

Removal

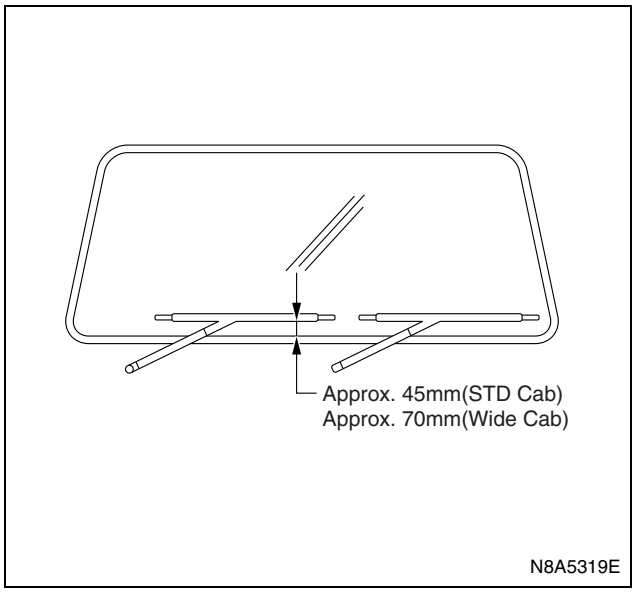
1. Cover
2. Wiper Arm Nut
3. Wiper Arm & Blade



Installation
To install, follow the removal steps in the reverse order, noting the following points.

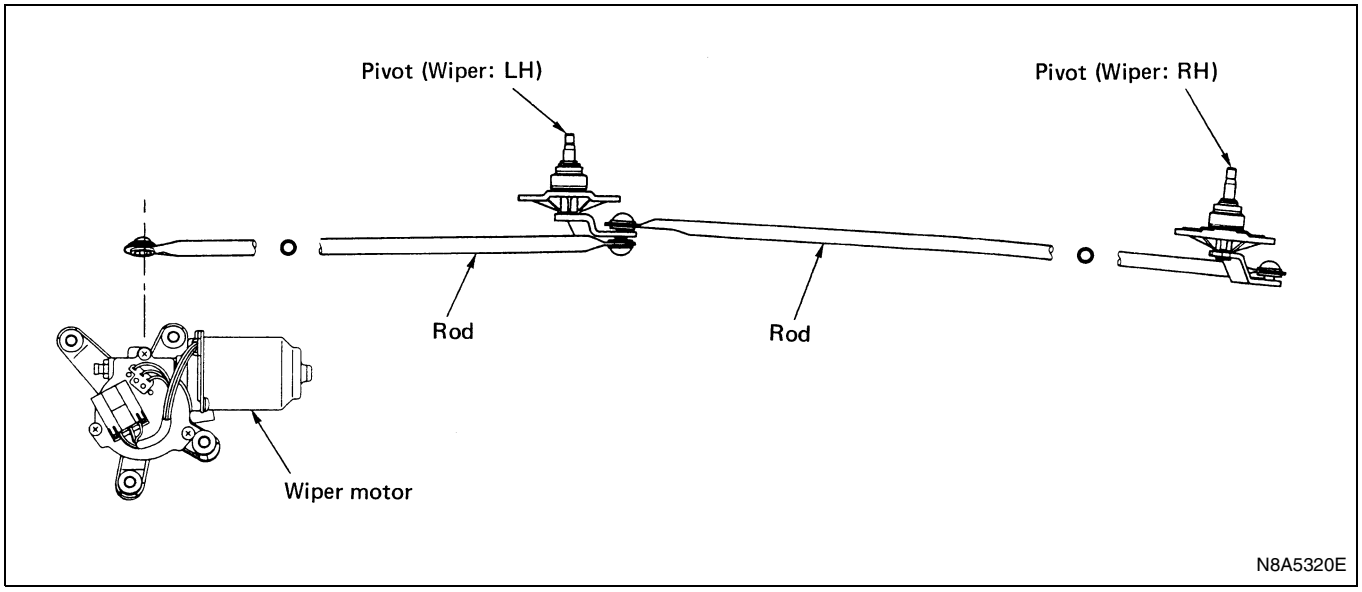
1. Before installing the wiper arm & blade to the shaft, confirm that the motor stops at the auto-stop position.
2. Set the wiper arm & blade so that the tips of both blades are positioned as shown in the illustration.
3. Tighten the wiper arm nut to the specified torque.

Tighten:
Wiper arm nut to 17 N·m (170 kg·cm/147 lb·in)



Windshield Wiper Linkage

Location of Rod and Pivot

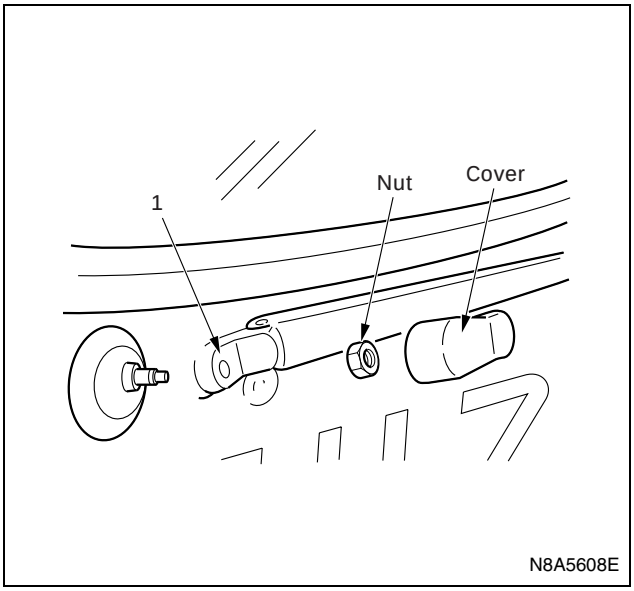


Removal

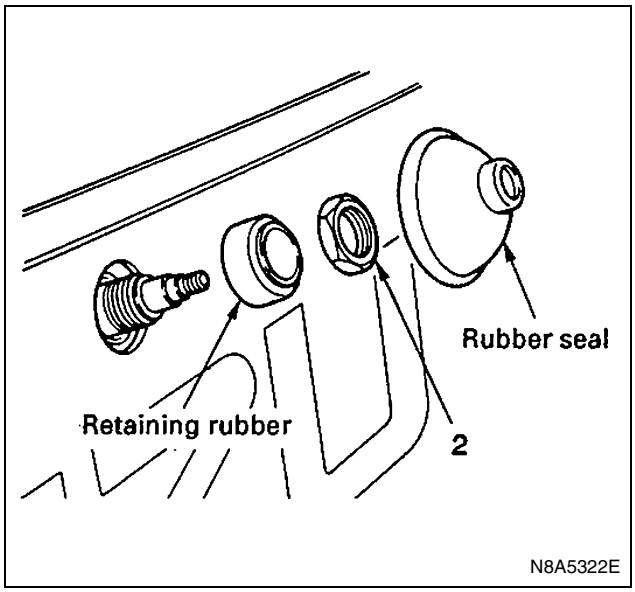
Preparation:

Disconnect the battery ground cable.

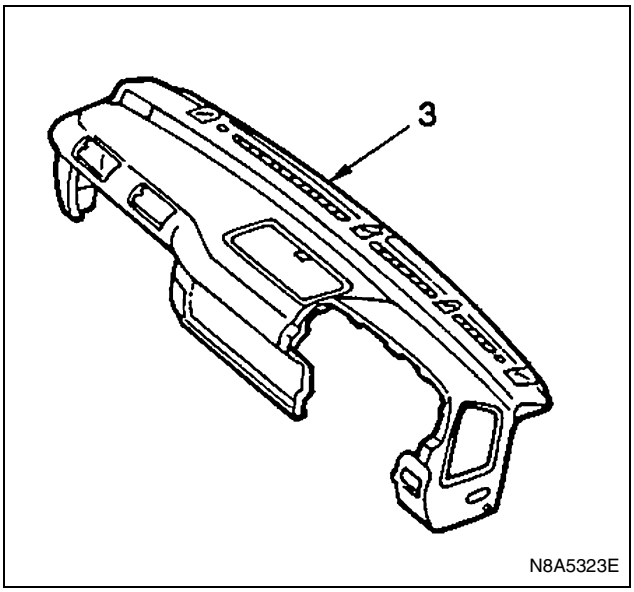
1. Wiper Arm & Blade
   Remove the cover, nut and wiper arm & blade.



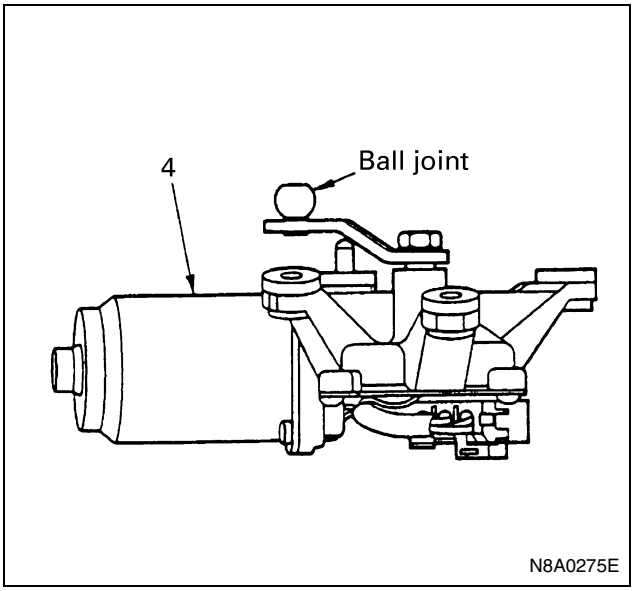
2. Pivot Nut
   Remove the rubber seal, nut and retaining rubber.



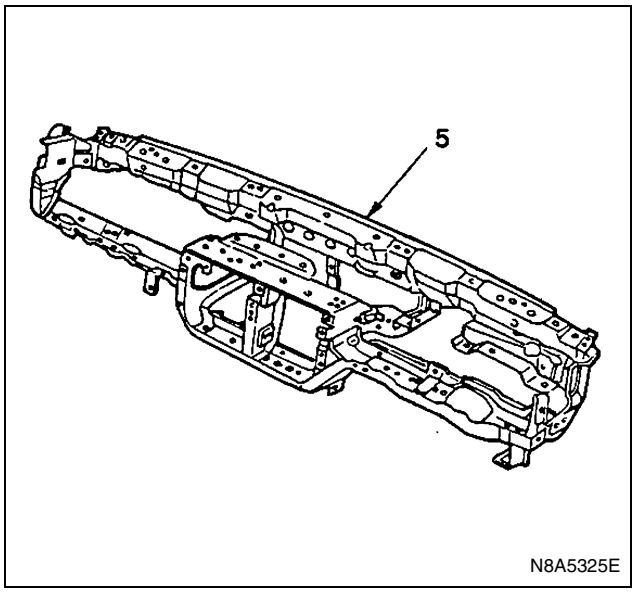
3. Instrument Panel Assembly
   Refer to “INSTRUMENT PANEL” of section 2.



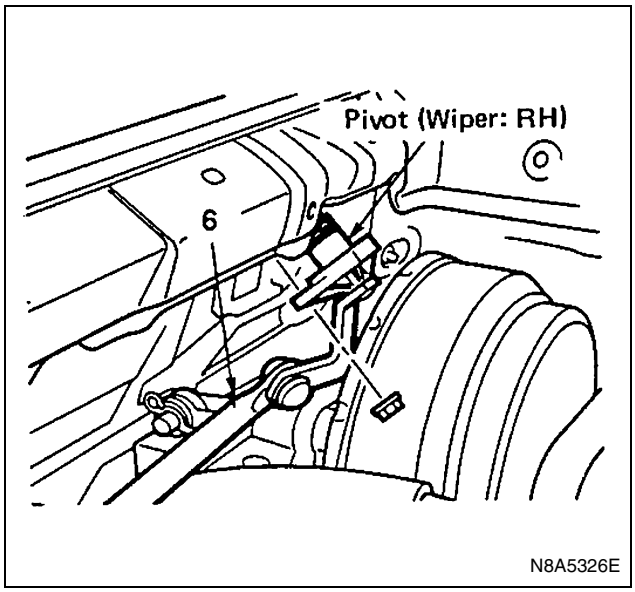
4. Wiper Motor
   1) Remove the four screws.
   2) Disconnect the ball joint between the crank arm and the wiper link.



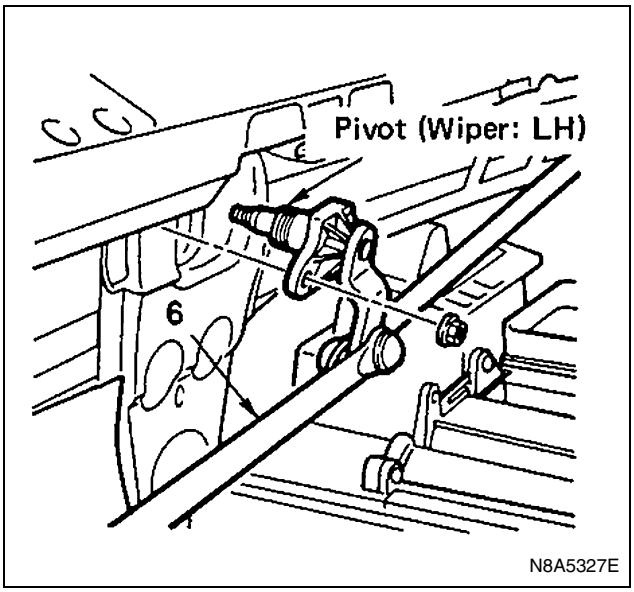
5. Instrument Panel Reinforcement
   Refer to “INSTRUMENT PANEL” of section 2.



6. Wiper Link Assembly
   Remove two retaining nuts from right hand side of pivot.



Remove two retaining nuts from left hand side of pivot.



Installation

To install, follow the removal steps in the reverse order, noting the following points.

- Temporarily fit the wiper motor by using one of the four wiper motor fixing screws.
- Put the crank arm ball joint in the wiper link hole and fix them together while pulling the wiper link.
- Fit the motor with four screws.
- Tighten the pivot nut with the specified torque.

Tighten:

Pivot nut to 8 N·m (80 kg·cm/70 lb·in)

- Tighten the wiper arm nut with the specified torque.

Tighten:

Wiper arm nut to 17 N·m (170 kg·cm/147 lb·in)

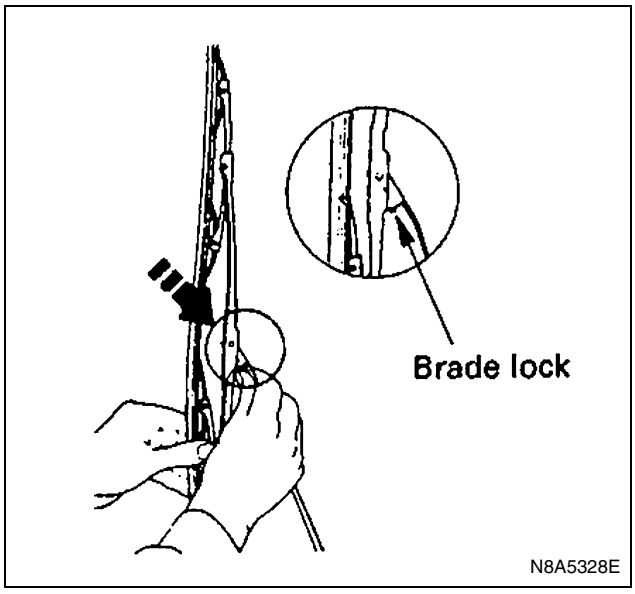
Wiper Blade Rubber

Removal

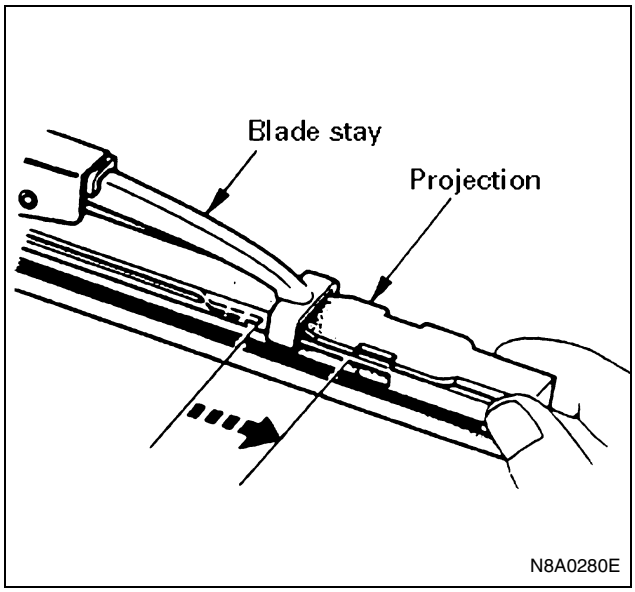
1. Wiper Blade
   Push the wiper blade lock while pulling the wiper blade in the arrow direction.

Notice:

When the wiper blade has been removed, wrap the tip of the wiper arm with cloth, to avoid damaging the glass.

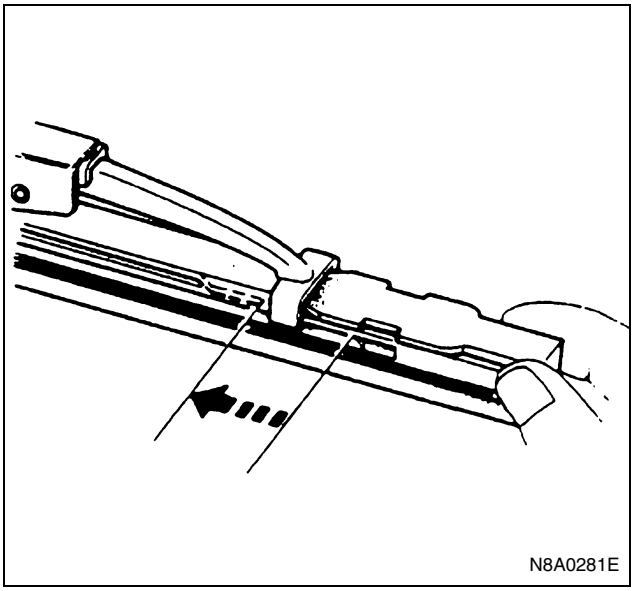


2. Wiper Blade Rubber
   1) Pull the end of rubber and remove the projection from the click of the blade stay.
   2) Pull the rubber out in the same direction.

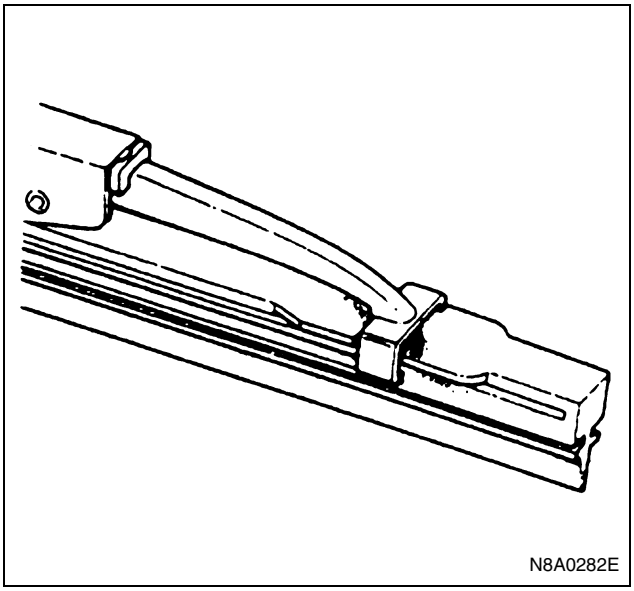


Installation

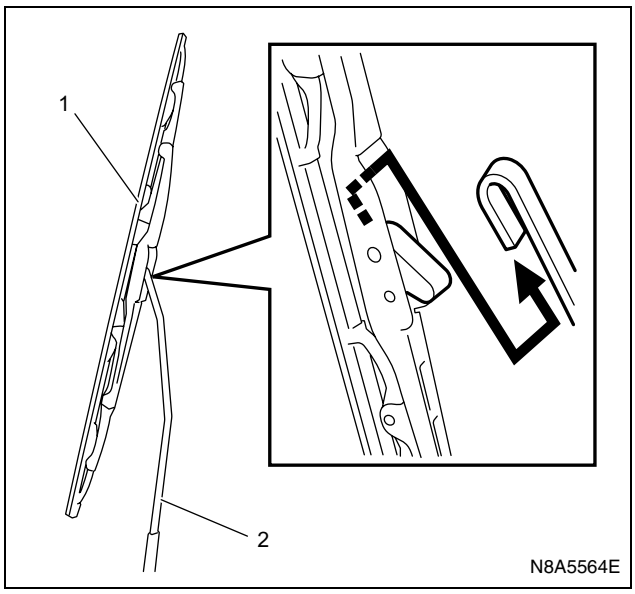
1. Wiper Blade Rubber
   Install the click of the blade stay in the groove of the new rubber and slide it in. Complete installation by pushing the click.


N8A0281E

   Finally, check that the click of the stay has caught in the hole of the rubber.


N8A0282E

2. Wiper Blade
   Push the lock of wiper blade (1) into the retentive portion on the tip of wiper arm (2).



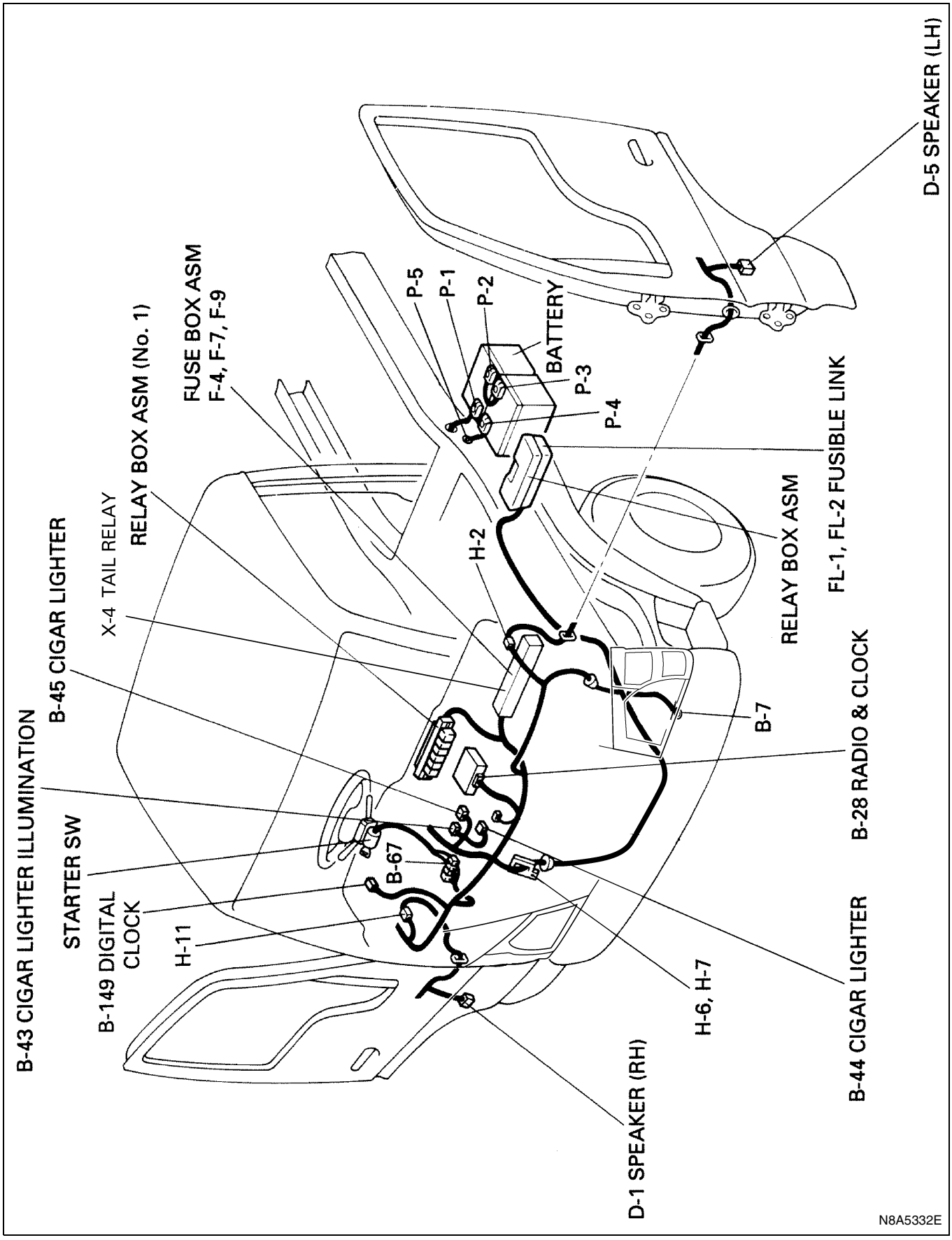
N8A5564E

Audio and Cigar Lighter

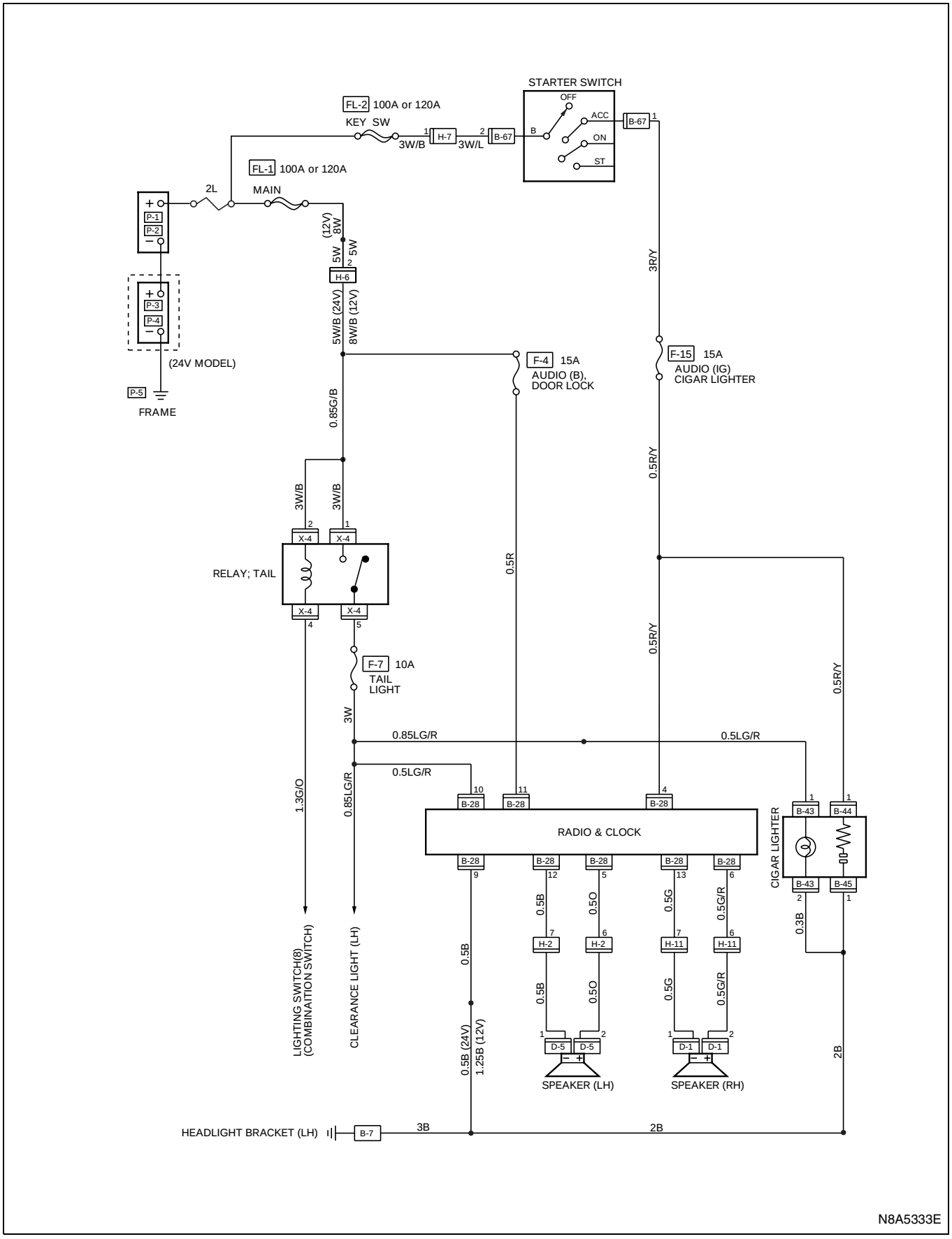
General Description

The circuit consists of the starter switch, radio, cigar lighter and the relay.
The audio circuit is designed for the current to flow through the receiver circuit when the radio switch is turned on with the starter switch in “ACC” or “ON”. Current runs through the memory circuit of the audio regardless of the position of the starter switch.
When the cigar lighter is pushed in with the starter switch at either “ACC” or “ON” position, a circuit is formed in the cigar lighter case to heat the lighter coil. The cigar lighter is spring back to its original position after the lighter coil is heated.

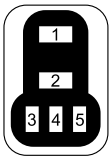
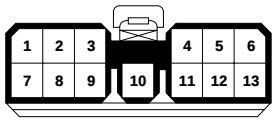
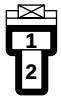
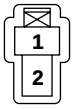
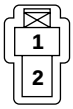
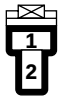
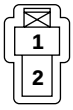
Parts Location

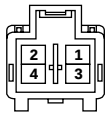
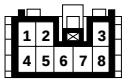
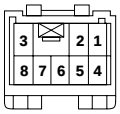
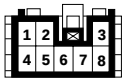
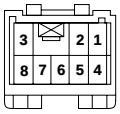


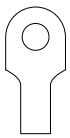
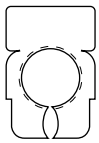
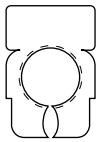
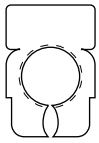
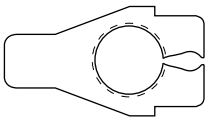
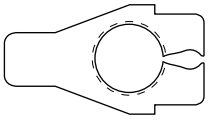
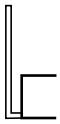
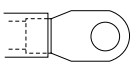
Circuit Diagram



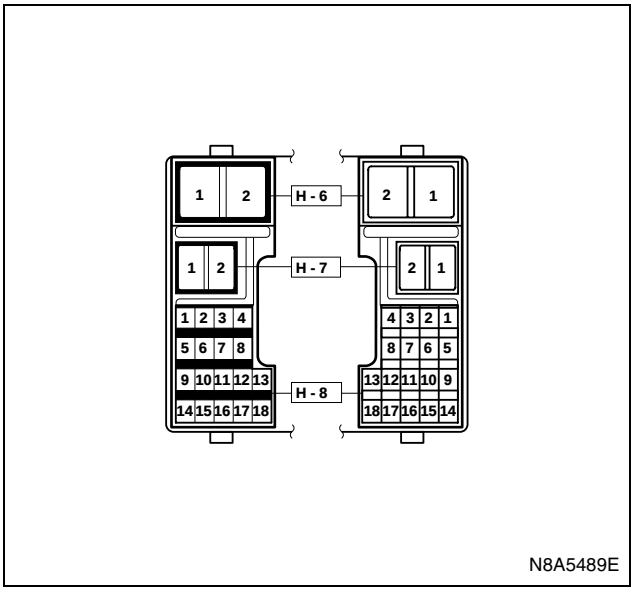
Connector List

No.	Connector Face
X-4	 005-006
B-28	 013-001
B-43	 002-009
B-43	 002-010
D-1	002-009
D-1	 002-010
D-5	 002-009
D-5	 002-010

No.	Connector Face
B-44	001-011
B-45	001-009
B-67	004-001
B-67	 004-002
H-2	 008-009
H-2	 008-010
H-11	 008-009
H-11	 008-010

No.	Connector Face
P-1 (12V)	 000-003
P-2	 000-004
P-1 (24V)	 000-004
P-4	 000-004
P-2 (24V)	 000-006
P-3	 000-006
P-5 (12V)	 000-007
P-5 (24V)	 000-002

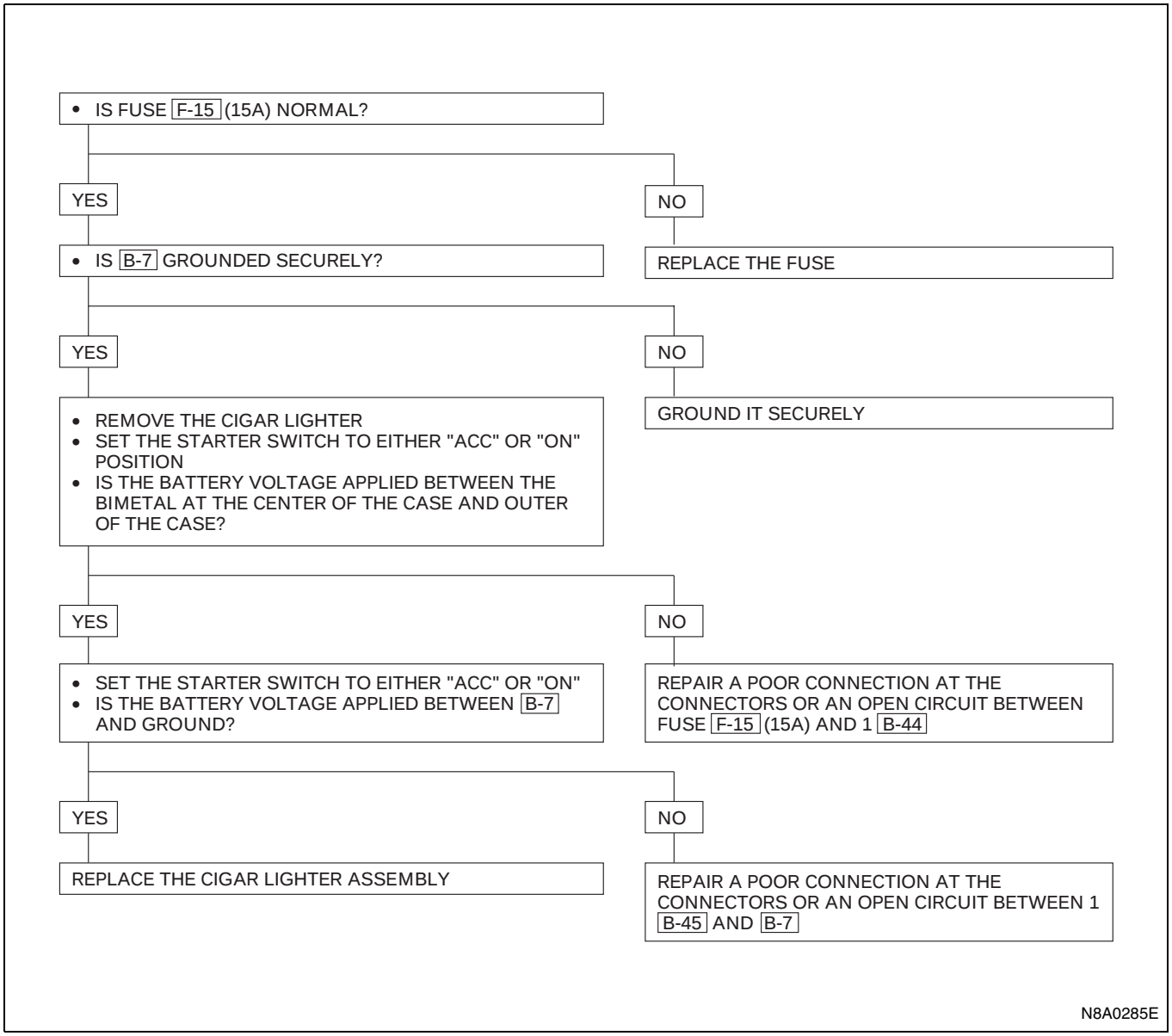
H-6, H-7



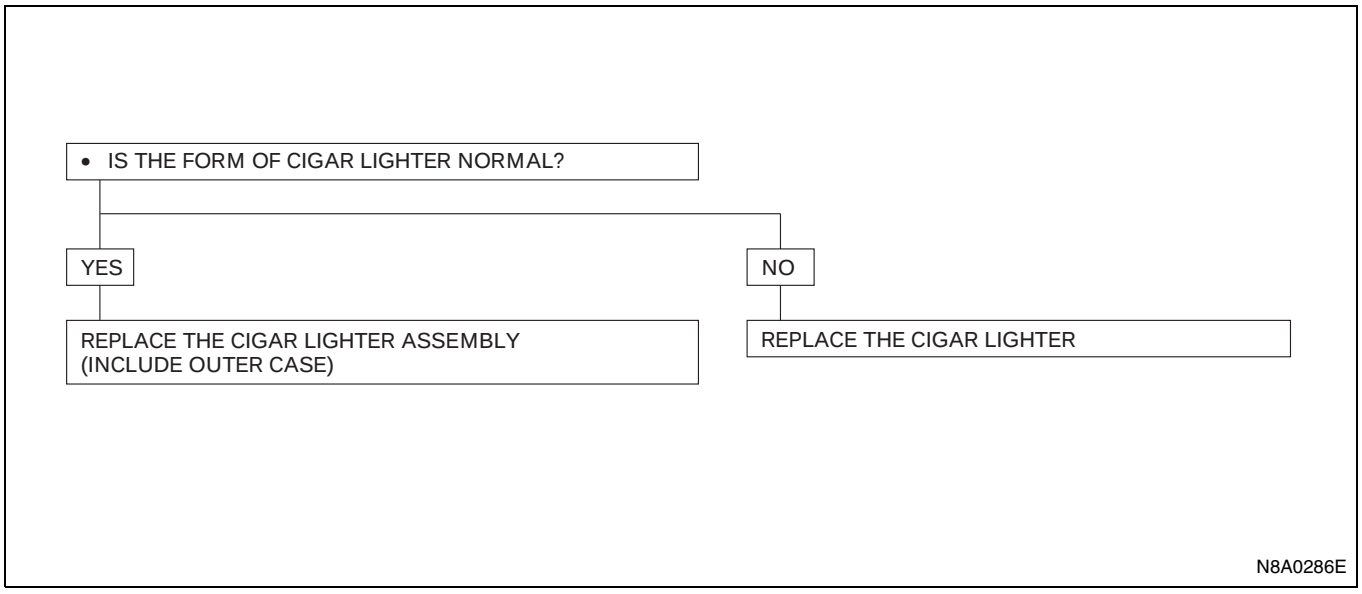
N8A5489E

Diagnosis

Cigar Lighter Does Not Heat Sufficiently



The Cigar Lighter Does Not Spring Out After Being Heated



Starter Switch

Refer to “START AND CHARGING” in this section.

Radio

Removal

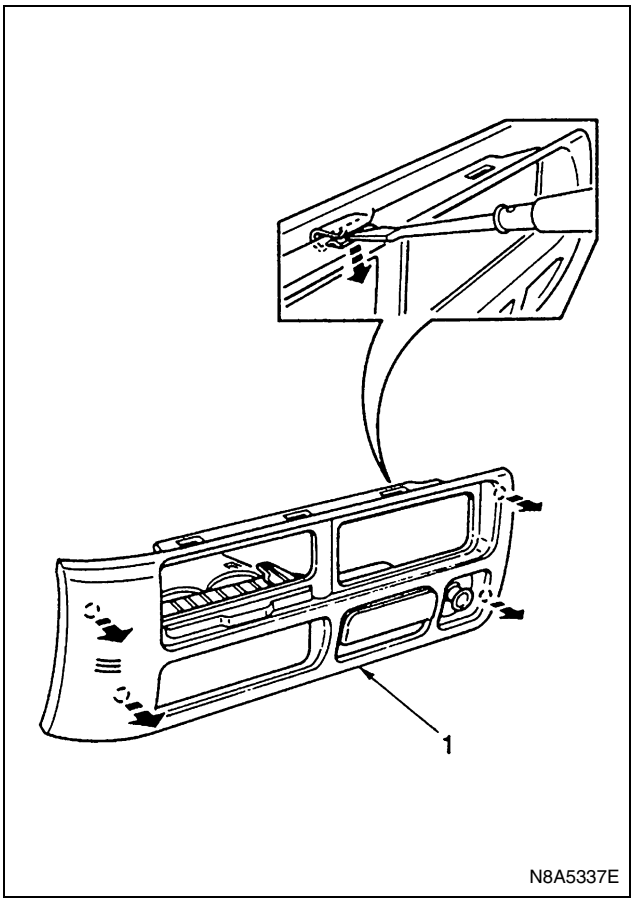
Preparation:

Disconnect the battery ground cable.

1. Center Cluster
   1) Pull it to remove. Pry off three clips by the tip of screwdriver.
   2) Remove the cigar lighter power source and its illumination connector.

Notice:

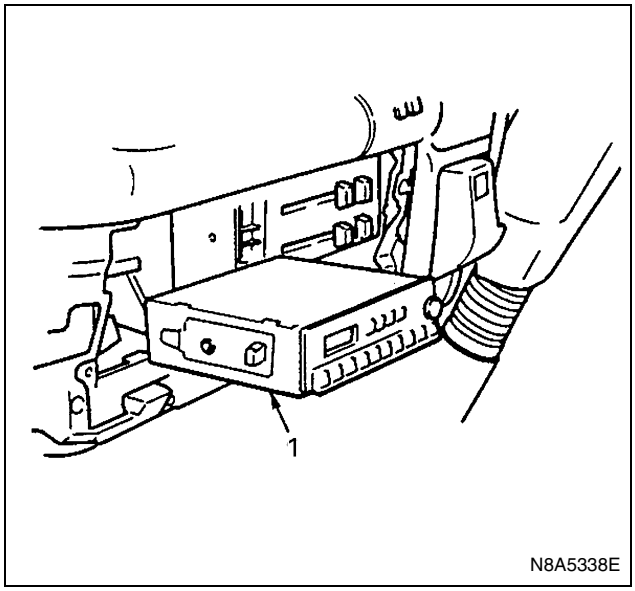
To remove the center cluster, do not force to pry off three clips at upper portion of the center cluster.



Legend

1. Center Cluster

2. Radio
   1) Remove the two radio fixing screws.
   2) Disconnect the connector and feeder plug.



Legend

1. Radio

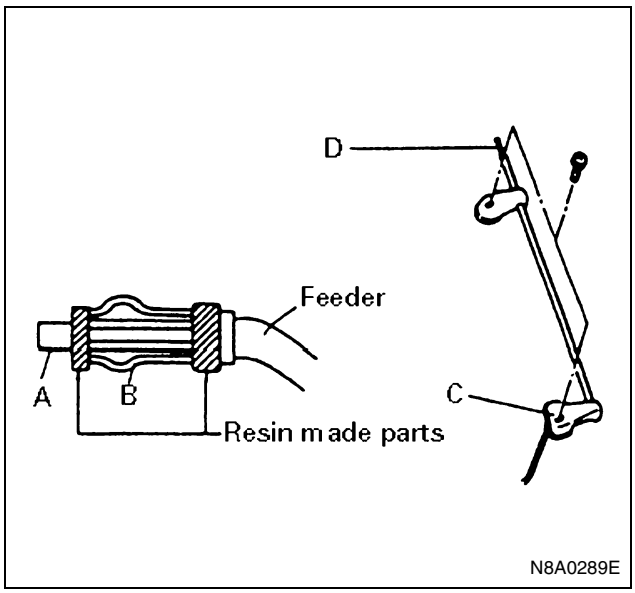
Installation

To install, follow the removal steps in the reverse order.

Antenna

Inspection

The metal A is connected to the pole D at the top of the antenna through the core of the feeder.
The metal B is fitted in the feeder shielding the core, and grounded at the screw C to avoid the core hampered by noise.
Defective grounding would cause noise.



In checking, measure the following three points with the circuit tester in the range of "resistance x 1 (Ω)."

Between A and B

No continuity (No reading at the indicator) → Normal

Continuity (A bite in the feeder. The core grounded) → Lower reception

Between B and C

Continuity (Indicator reading: 0Ω) → Normal

No continuity (Shielded core disconnected or defective grounding at the screw → Hampered by noise)

Between A and D

Continuity or no continuity

There are some antenna feeders and relay feeders with a condenser built in their connections.

Measuring resistance between the two points does not result in correct judgment. Connect temporarily another normal antenna to the radio and check to see if its reception is audible. Most antenna now available are slide type. Rust at the screw C and the cab panel where grounded would lead no continuity, followed by lower reception.

Keep this portion clean to avoid rust.

Removal

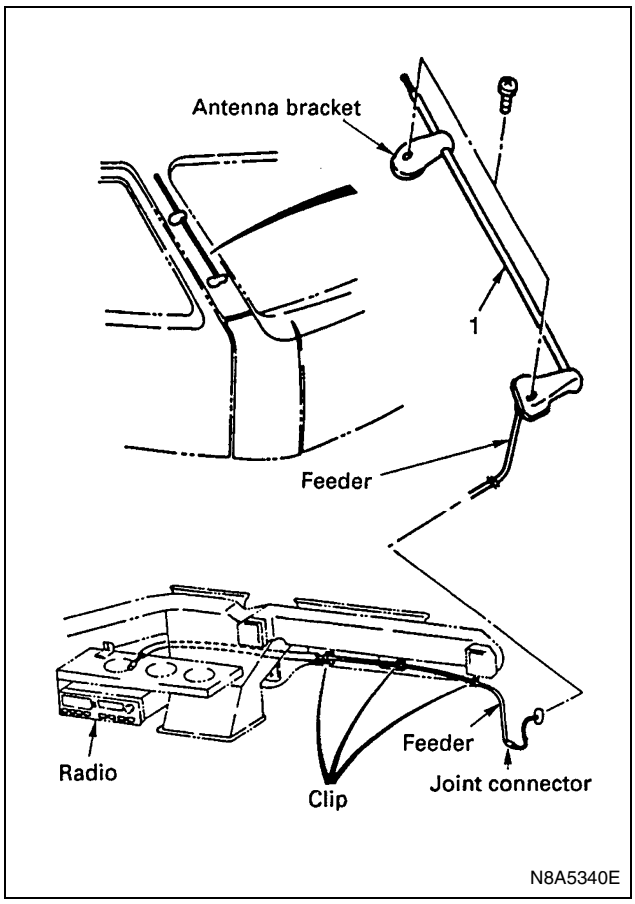
Preparation:

Disconnect the battery ground cable.

1. Antenna
   1) Disconnect the joint connector.
   2) Remove the upper and lower side antenna bracket.
   3) Pull out the antenna feeder.

Notice:

For easier fitting, tie the lead wire to the end of the antenna feeder in advance.



Legend

1. Antenna

Installation

To install, follow the removal steps in the reverse order.

Speaker

Inspection

1. With the circuit tester set to the range of × 1 (Ω), connect the circuit tester probes (red and black) to the (+) and (−) terminals of the speaker.
2. When the speaker is normal, a low buzzing sound is heard.
3. When the speaker is defective, no sound is heard. However, the distortion or chattering of the sound cannot be identified.
   When the speaker is installed to the vehicle, disconnect the connectors before checking.
   When no sound is heard, the following are considered as the cause.

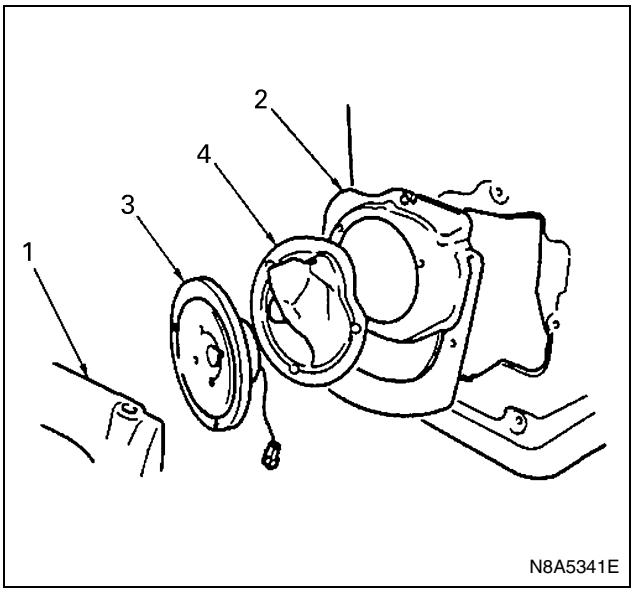
- The speaker wiring is disconnected at the speaker terminals.
- The speaker body is defective.
- There is an open circuit somewhere in the speaker harness on the vehicle side.
- The speaker harness on the vehicle side is grounded or caught up.

Removal

Preparation:

Disconnect the battery ground cable.

1. Door Pad
   Refer to “FRONT DOOR TRIM PAD” of section 2.
2. Speaker Panel
   Disconnect the speaker connector.
3. Speaker
4. Waterproof Sheet



Legend

1. Trim Panel
2. Speaker Panel
3. Speaker
4. Waterproof Sheet

Installation

To install, follow the removal steps in the reverse order.

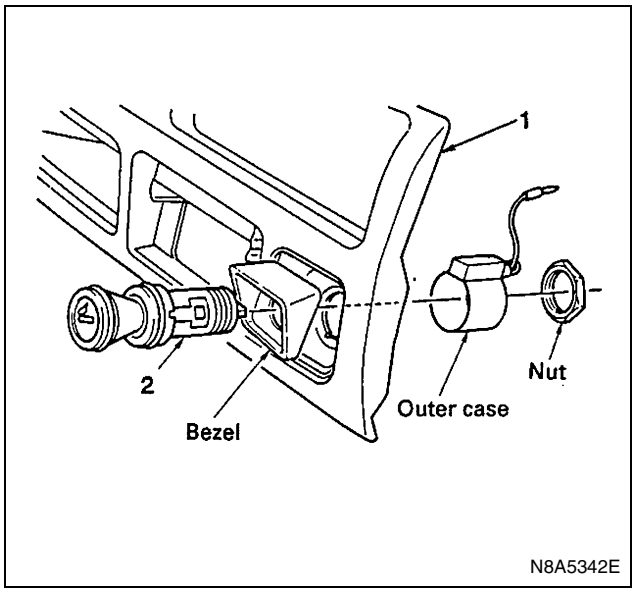
Cigar Lighter

Removal

Preparation:

Disconnect the battery ground cable.

1. Center Cluster
   Refer to “RADIO” in this section.
2. Cigar Lighter Assembly
   Remove the nut, then remove cigar lighter assembly, bezel and outer case.



Legend

1. Center Cluster
2. Cigar Lighter Assembly

Installation

To install, follow the removal steps in the reverse order.

Meter and Warning/indicator Light

General Description

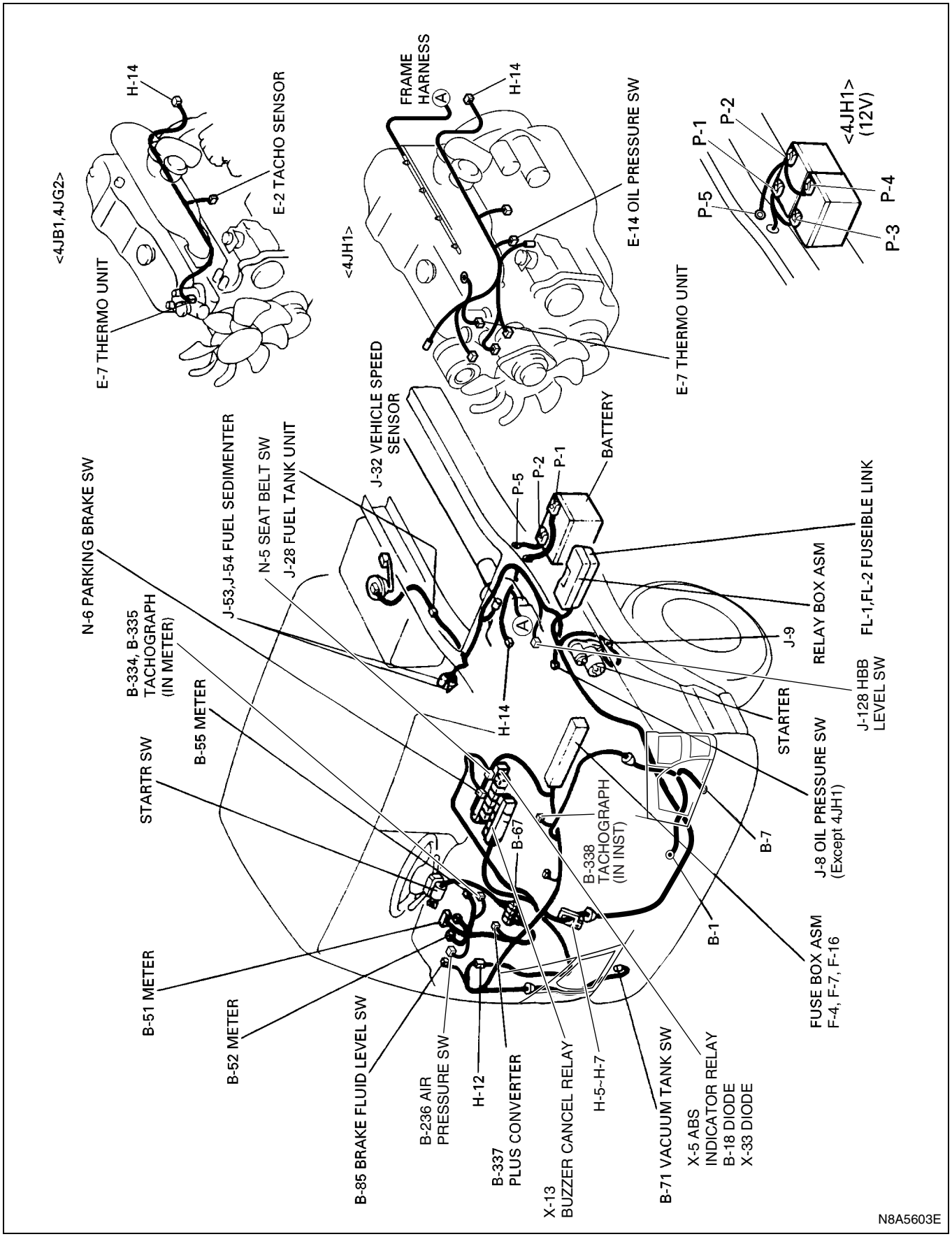
The circuit consists of the starter switch, meter assembly, vacuum tank switch, seat belt switch, oil pressure switch, fuel sedimenter switch, brake fluid switch, parking brake switch, vehicle speed sensor, fuel tank unit, thermo unit and engine speed sensor.

The meter assembly contains the speedometer, tachometer, fuel meter, thermometer and the warning/indicator light.

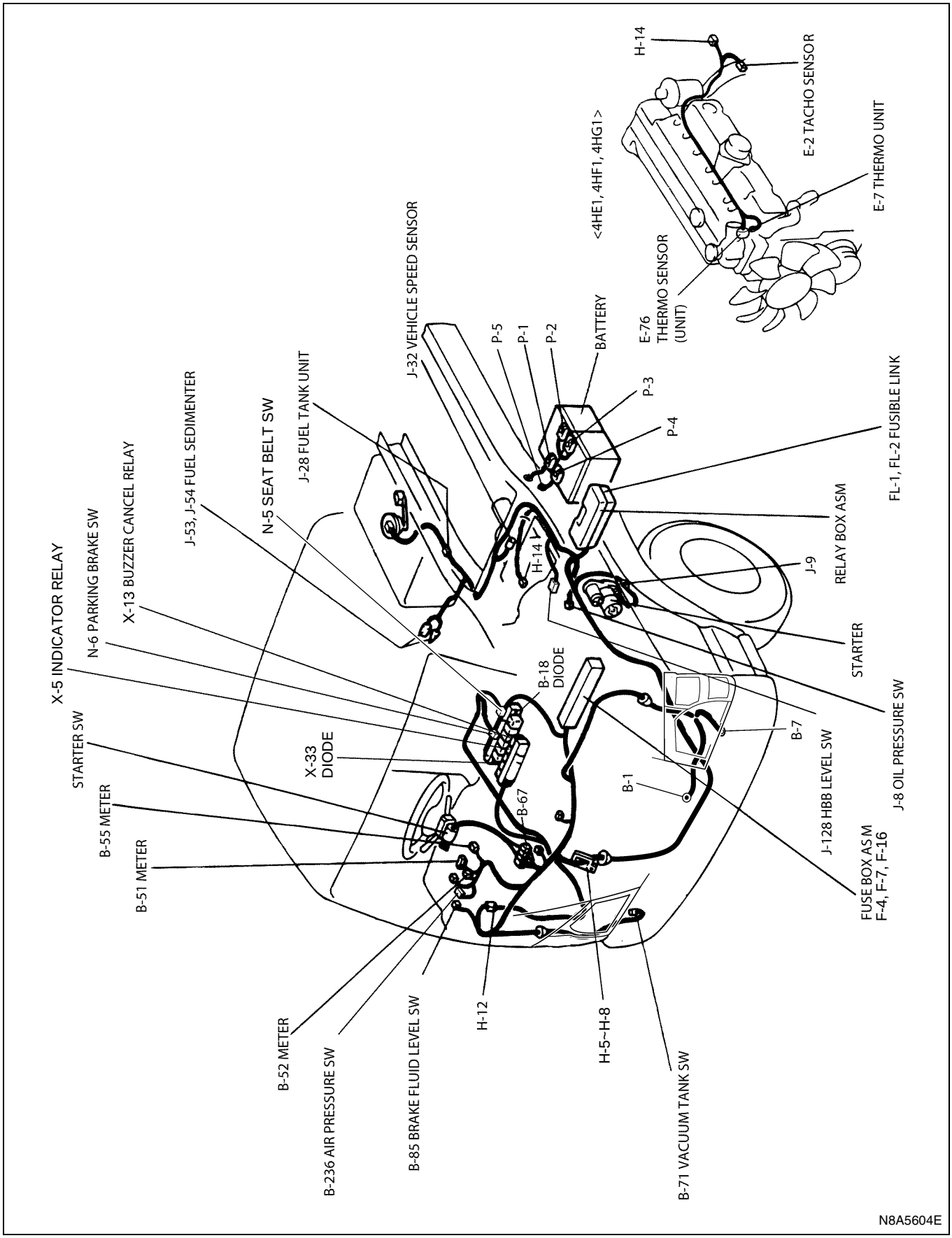
The meter warning/indicator lights and their bulb sockets are a unit, they are installed from the back of the speedometer assembly.

Parts Location

For 12 Volt

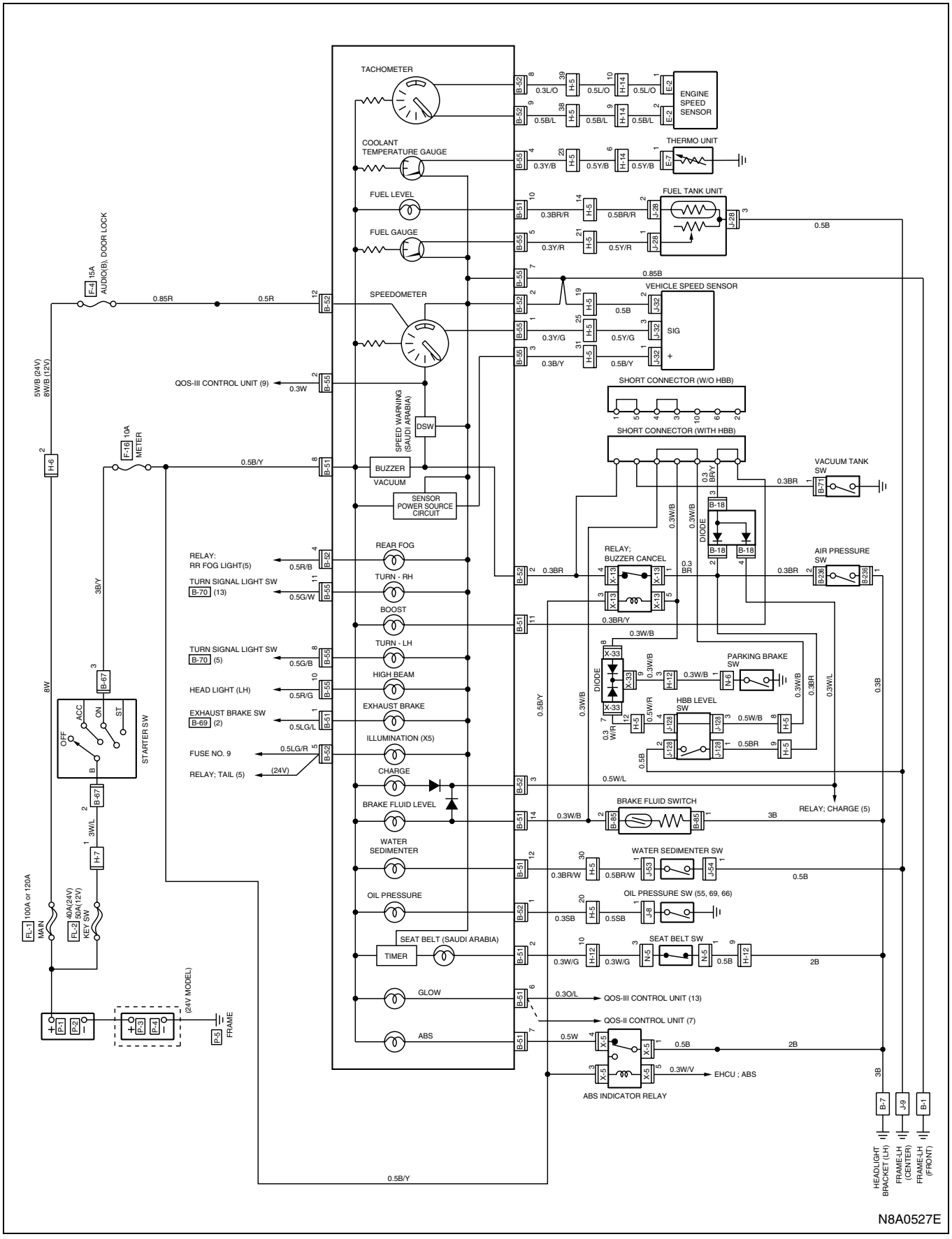


For 24 Volt

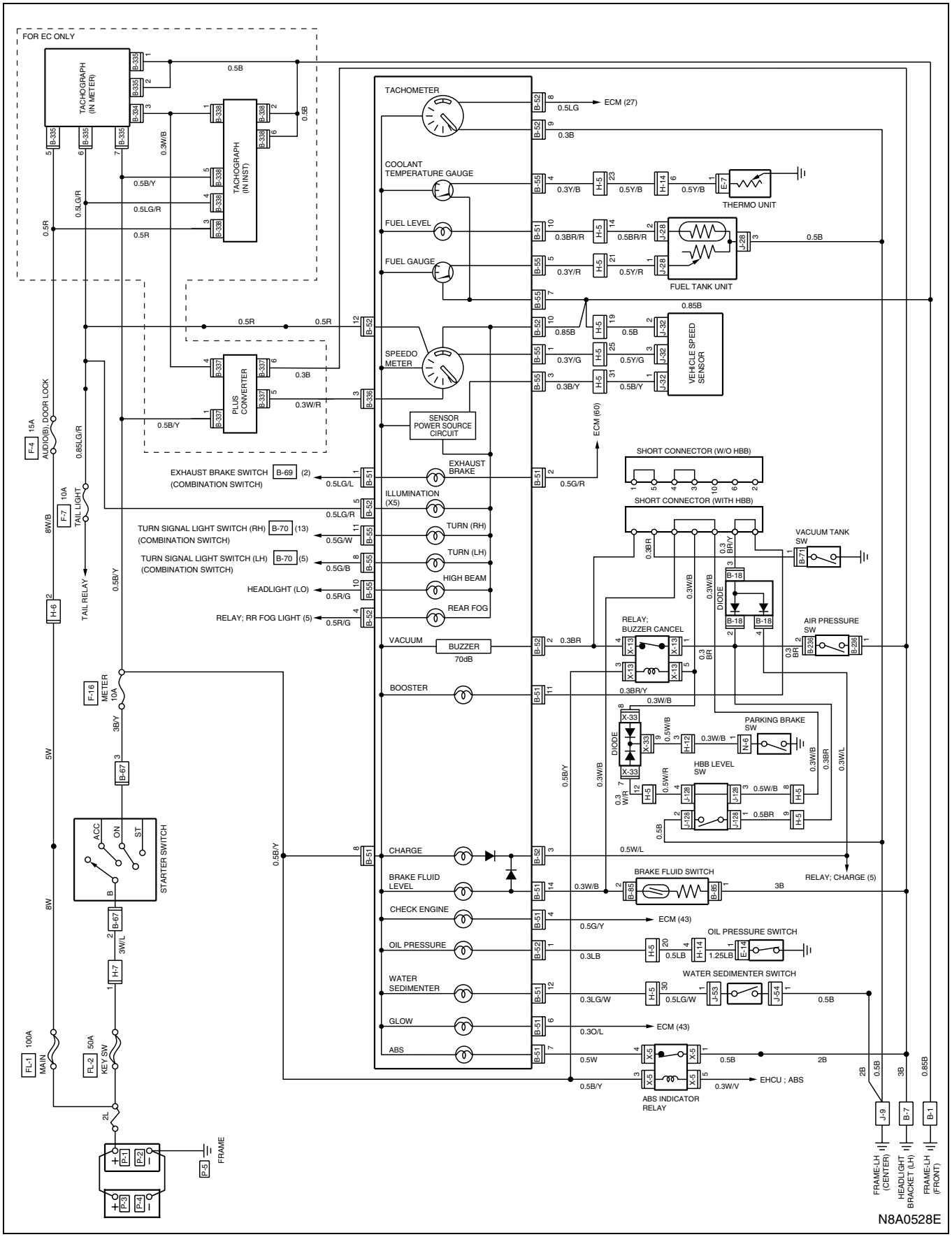

X-5 INDICATOR RELAY
N-6 PARKING BRAKE SW
X-13 BUZZER CANCEL RELAY
J-53, J-54 FUEL SEDIMENTER
N-5 SEAT BELT SW
J-28 FUEL TANK UNIT
J-32 VEHICLE SPEED SENSOR
P-5
P-1
P-2
P-3
P-4
BATTERY
<4HE1, 4HF1, 4HG1>
H-14
E-2 TACHO SENSOR
E-7 THERMO UNIT
E-76
THERMO SENSOR
(UNIT)
FL-1, FL-2 FUSIBLE LINK
RELAY BOX ASM
J-9
H-14
STARTER
STARTER SW
B-55 METER
B-51 METER
X-33
DIODE
B-18
DIODE
B-67
B-1
B-7
J-128 HBB LEVEL SW
J-8 OIL PRESSURE SW
FUSE BOX ASM
F-4, F-7, F-16
B-52 METER
B-236 AIR PRESSURE SW
B-85 BRAKE FLUID LEVEL SW
H-12
H-5~H-8
B-71 VACUUM TANK SW
N8A5604E

Circuit Diagram

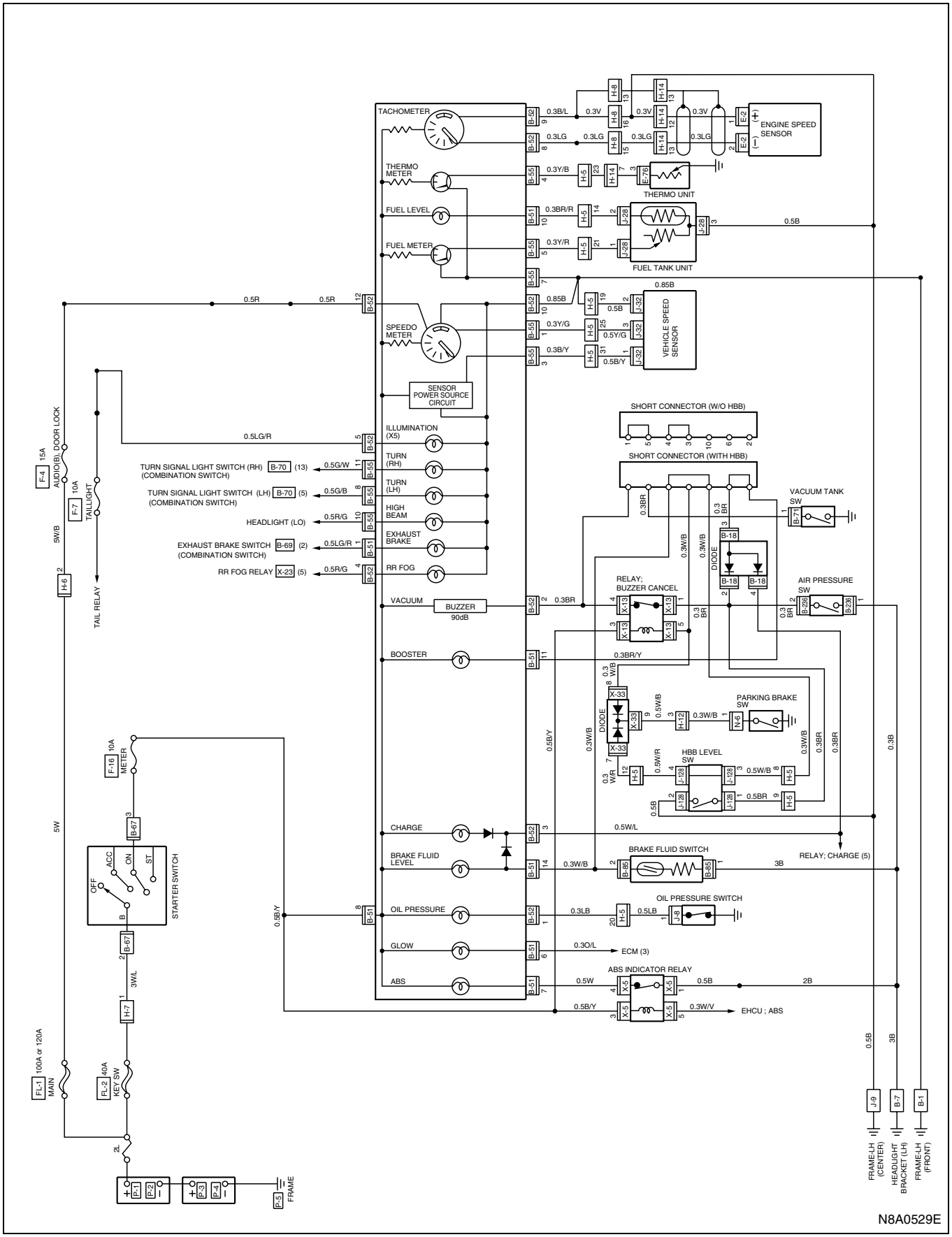
Except 4JH1 / 4HK1 Engine



For 4JH1 Engine

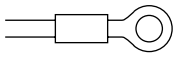
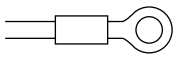
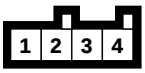
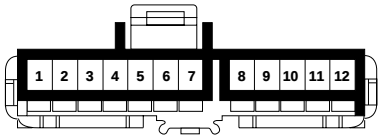
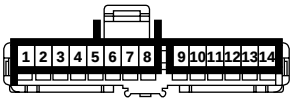
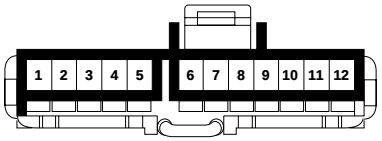


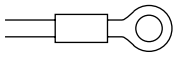
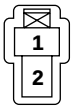
For 4HK1 Engine

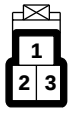
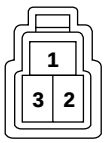
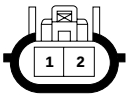
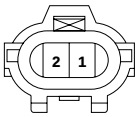


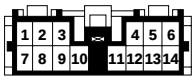
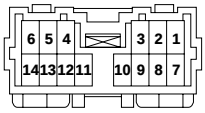
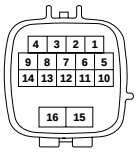
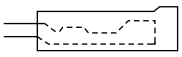
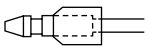
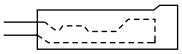
Connector List

Except 4JH1 / 4HK1 Engine

No.	Connector Face
B-1	 000-001
B-7	 000-001
B-18	 004-004
B-52	 012-005
B-51	 014-001
B-55	 012-004
B-67	004-001
B-67	004-002

No.	Connector Face
B-71	001-013
B-71	001-014
J-8	001-013
J-8	001-014
J-9	 000-001
B-85	002-009
B-85	 002-010
B-236	002-022

No.	Connector Face
N-5	 003-020
N-5	 003-021
N-6	001-002
N-6	001-011
E-2 (66)	 002-001
E-2 (66)	 002-002
E-2 (55,69)	002-011
E-2 (55,69)	002-012

No.	Connector Face
E-7	001-018
H-12	 014-002
H-12	 014-003
H-14	016-003
H-14	 016-004
J-53	 000-010
J-53	 000-011
J-54	 000-010

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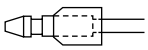
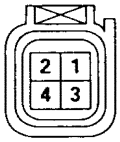
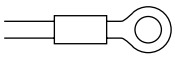
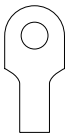
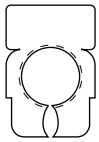
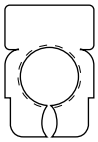
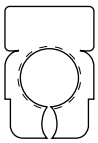
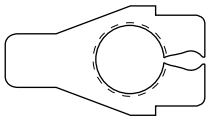
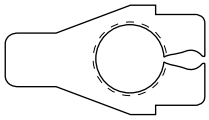
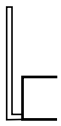
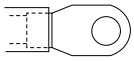
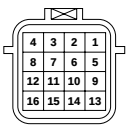
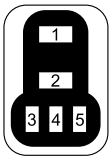
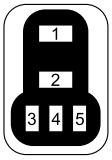
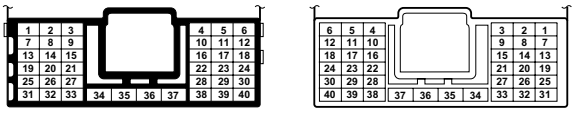
J-54	 000-011
J-28	003-016
J-28	003-017
J-32	003-018
J-128	 004-018
J-9	 000-001
P-1 (12V)	 000-003
P-2	 000-004

No.	Connector Face
P-1 (24V)	 000-004
P-4	 000-004
P-2 (24V)	 000-006
P-3	 000-006
P-5 (12V)	 000-007
P-5 (24V)	 000-002
H-14	016-001
H-14	 016-002

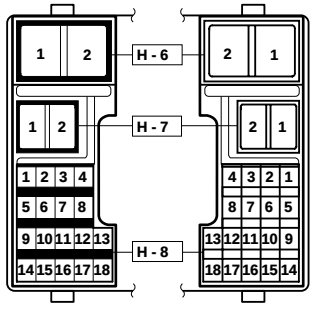
No.	Connector Face
X-5	 005-006
X-13	 005-006
X-33	014-002
J-8 (For 4J TYPE ENGINE)	001-019

H-5



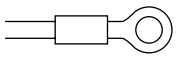
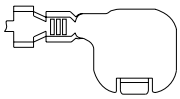
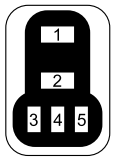
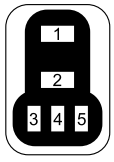
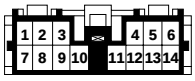
N8A5488E

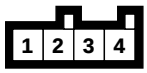
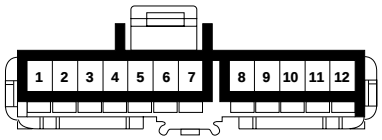
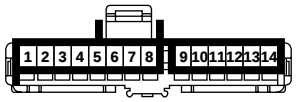
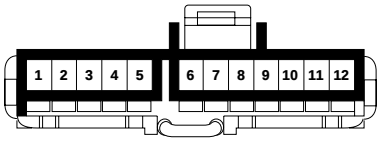
H-6, H-7

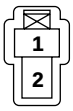
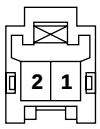
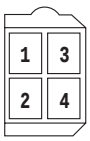


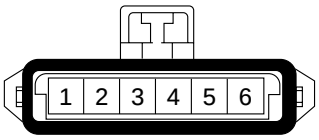
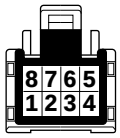
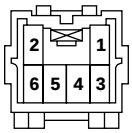
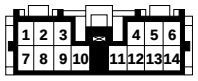
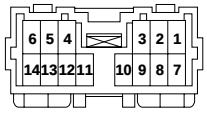
N8A5489E

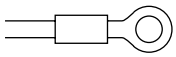
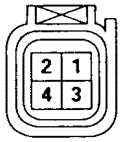
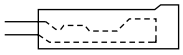
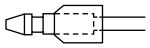
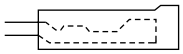
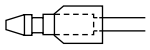
For 4JH1 Engine

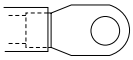
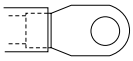
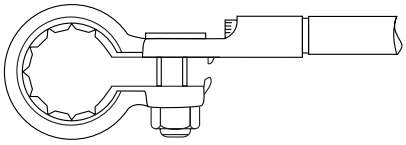
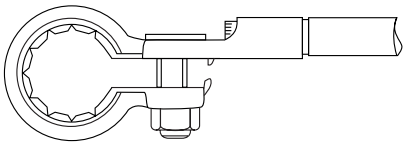
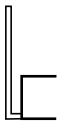
No.	Connector Face
B-1	 000-001
B-7	 000-017
X-5	 005-006
X-13	 005-006
X-33	 014-002

No.	Connector Face
B-18	 004-004
B-52	 012-005
B-51	 014-001
B-55	 012-004
B-67	004-001
B-67	004-002
B-71	001-013
B-71	001-014

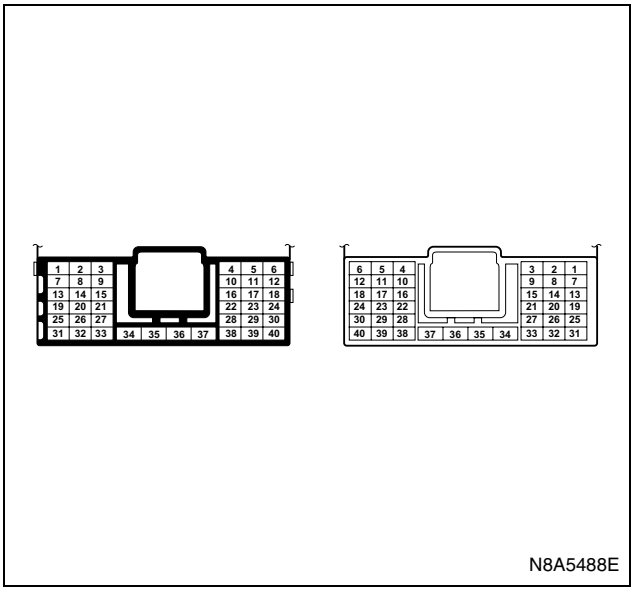
No.	Connector Face
E-14	001-013
E-14	001-014
B-85	002-009
B-85	 002-010
N-6	 002-023
B-236	002-022
B-334	 004-014
B-335	008-014

No.	Connector Face
B-336	 006-018
B-337	 008-013
B-338	 006-003
E-7	001-009
H-12	 014-002
H-12	 014-003
H-14	016-003
H-14	016-004

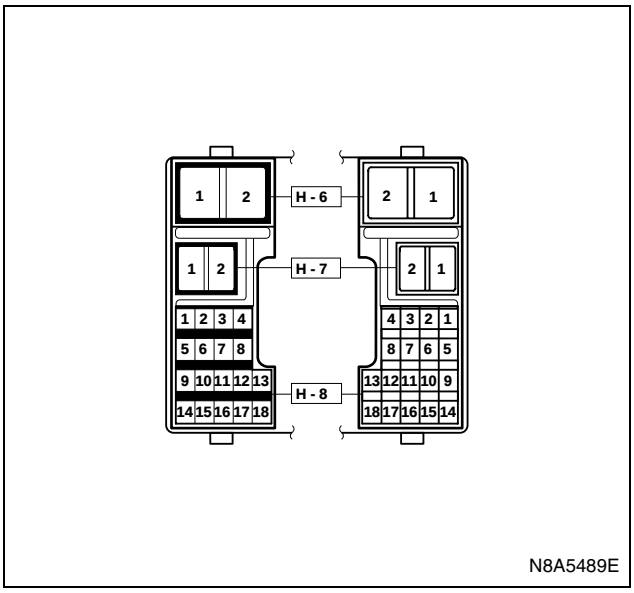
No.	Connector Face
J-9	 000-001
J-128	 004-018
J-53	 000-010
J-53	 000-011
J-54	 000-010
J-54	 000-011
J-28	003-016
J-28	003-017

No.	Connector Face
J-32	003-018
P-1	 000-002
P-2	 000-002
P-3	 000-014
P-4	 000-014
P-5	 000-007

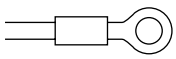
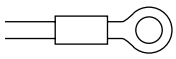
H-5

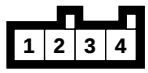
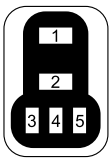
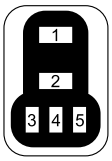
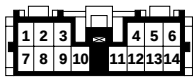
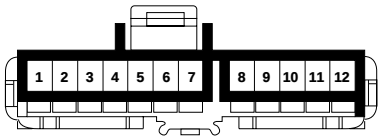
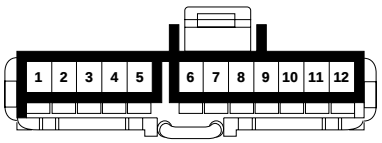


H-6, H-7



For 4HK1 Engine

No.	Connector Face
B-1	 000-001
B-7	 000-001

No.	Connector Face
B-18	 004-004
X-5	 005-006
X-13	 005-006
X-33	 014-002
B-52	 012-005
B-51	014-001
B-55	 012-004
B-67	004-001

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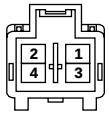
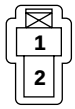
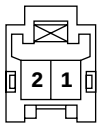
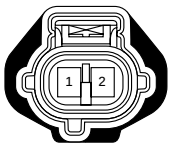
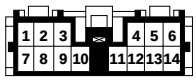
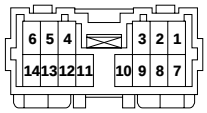
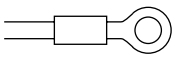
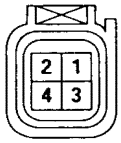
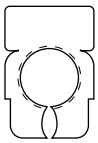
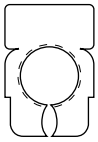
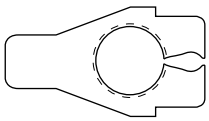
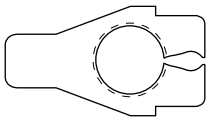
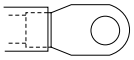
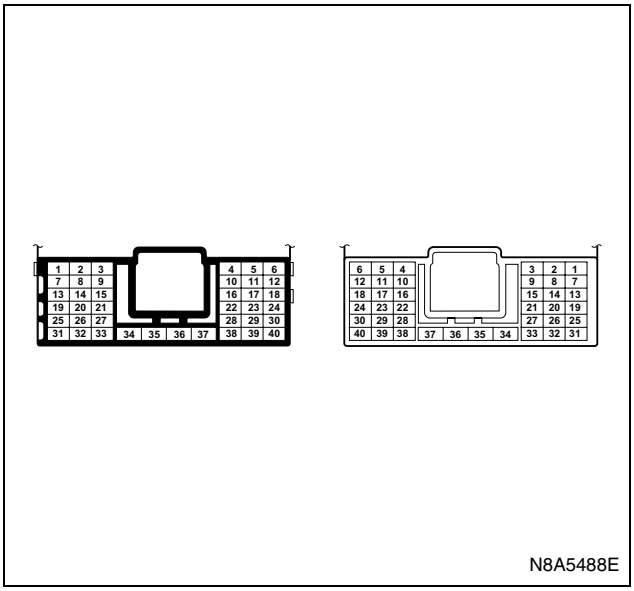
B-67	 004-002
B-71	001-013
B-71	001-014
J-8	001-013
J-8	001-014
B-85	002-009
B-85	 002-010
B-236	002-022

No.	Connector Face
N-6	 002-023
E-2	 002-013
E-76	003-004
H-12	 014-002
H-12	 014-003
H-14	016-003
H-14	016-004
J-9	 000-001

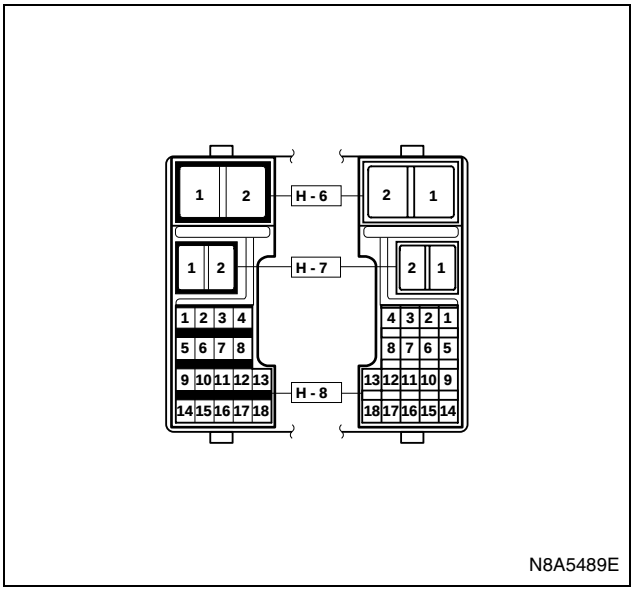
No.	Connector Face
J-28	003-016
J-28	003-017
J-32	003-018
J-128	 004-018
P-1	 000-004
P-4	 000-004
P-2	 000-006
P-3	 000-006

No.	Connector Face
P-5	 000-002

H-5



H-6, H-7, H-8



Diagnosis

Quick Chart for Check Point

1. Speedometer

		Check point		
		Speedometer	Vehicle speed sensor	Cable harness
Trouble mode	1-1. Speedometer and odometer do not function	❍ (3)	❍ (1)	❍ (2)
	1-2. Speedometer does not function (odometer is normal)	❍ (1)		
	1-3. Odometer does not function (Speedometer is normal)	❍ (1)		
	1-4. Speedometer needle fluctuates (May be wide fluctuation)	❍ (3)	❍ (1)	❍ (2)
	1-5. Speedometer needle jumps erratically	❍ (3)	❍ (1)	❍ (2)

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

2. Tachometer

		Check point		
		Tachometer	Engine speed sensor	Cable harness
Trouble mode	2-1. Tachometer does not function	❍ (3)	❍ (1)	❍ (2)
	2-2. Tachometer needle fluctuates (May be wide fluctuation)	❍ (3)	❍ (1)	❍ (2)
	2-3. Tachometer needle jumps erratically	❍ (3)	❍ (1)	❍ (2)

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

3. Coolant Temperature Gauge

		Check point				
		Meter ASM	Thermo meter	Thermo unit	Thermo seat	Cable harness
Trouble mode	3-1. Coolant temperature gauge needle does not move	❍ (3)	❍ (4)	❍ (2)		❍ (1)
	3-2. Coolant temperature gauge reading is too low (or high)	❍ (4)	❍ (5)	❍ (3)	❍ (1)	❍ (2)
	3-3. Needle overshoots (or goes up to the “H” range)	❍ (3)	❍ (4)	❍ (1)		❍ (2)

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

4. Fuel Gauge

		Check point			
		Meter ASM	Fuel gauge	Fuel tank unit	Cable harness
Trouble mode	4-1. Fuel gauge needle does not move	❍ (3)	❍ (4)	❍ (2)	❍ (1)
	4-2. Even when the tank is filled up with fuel, the needle does not reach “F”	❍ (3)	❍ (4)	❍ (2)	❍ (1)
	4-3. When the tank is not full of fuel, the needle overshoots (or goes to “F”)	❍ (3)	❍ (4)	❍ (2)	❍ (1)

Notice:
Figure in parenthesis “( )” indicates the order of inspection.

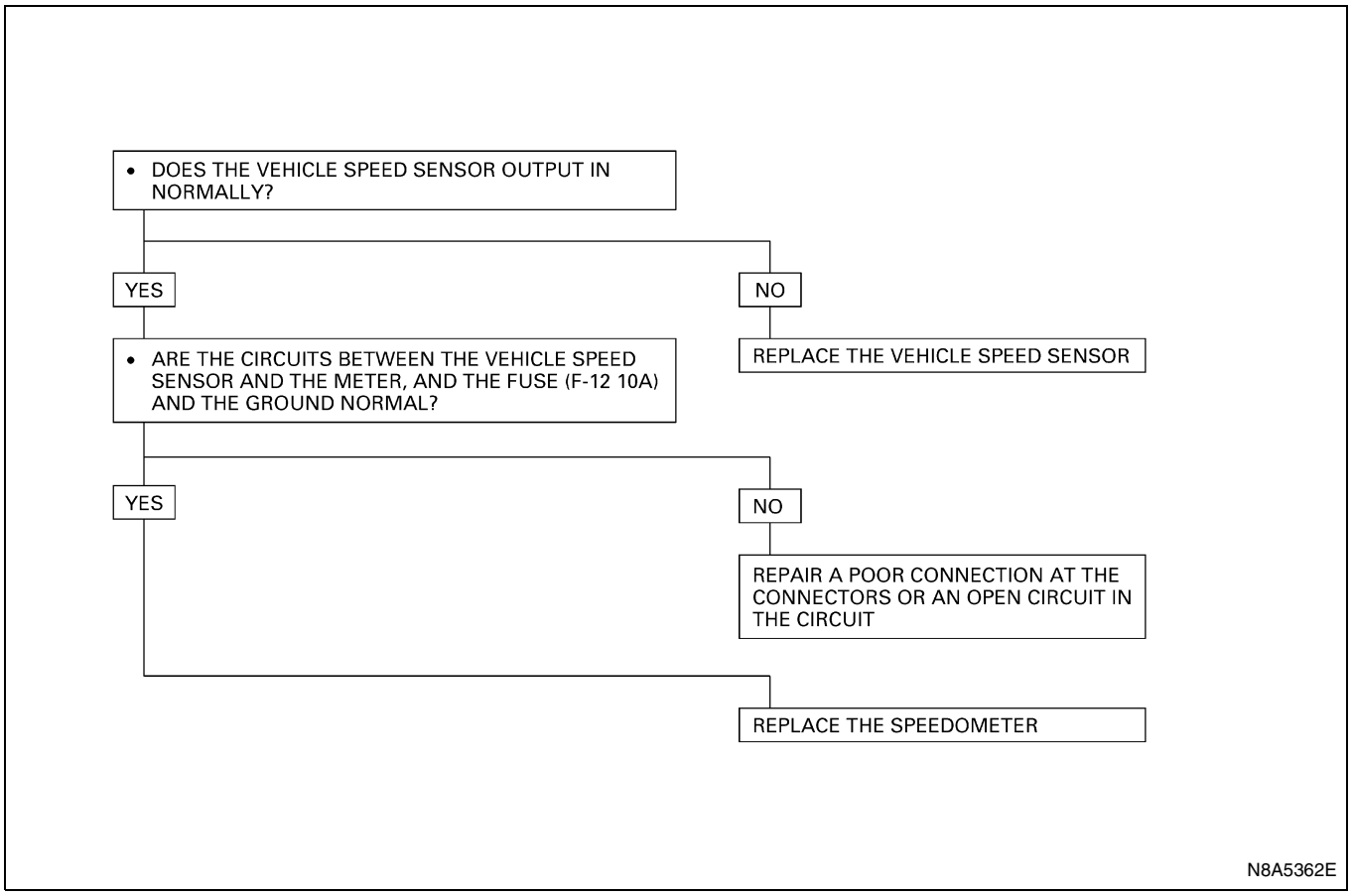
5. Warning/indicator Light

		Check point									
		Light bulb	Parking brake SW	Brake fluid SW	Oil pressure SW	Fuel tank unit	Vacuum SW	4WD SW	Sedimenter SW	Seat belt SW	Cable harness
Trouble mode	5-1. When the parking brake lever is pulled, the indicator light does not light up	❍ (2)	❍ (1)								❍ (3)
	5-2. Even when the parking brake lever is released, the indicator light does not go off		❍ (1)								❍ (2)
	5-3. While the engine operating, the oil pressure warning light does not go off				❍ (2)						❍ (1)
	5-4. Even when the tank is full with fuel, the fuel warning light lights up					❍ (1)					❍ (2)
	5-5. Even when the tank is empty, the low fuel warning light does not light up	❍ (1)				❍ (2)					❍ (3)
	5-6. Even when the transfer level is shifted to 4WD position, the indicator light does not light up	❍ (2)						❍ (1)			❍ (3)
	5-7. Even when the float in the water sedimenter goes up above the drain warning level, the indicator light does not light up	❍ (2)							❍ (1)		❍ (3)
	5-8. Even when the brake fluid is lower than specified level, the level warning light does not light up	❍ (1)		❍ (2)							❍ (3)
	5-9. Even when the vacuum tank is empty vacuum warning buzzer does not sound						❍ (1)				❍ (2)

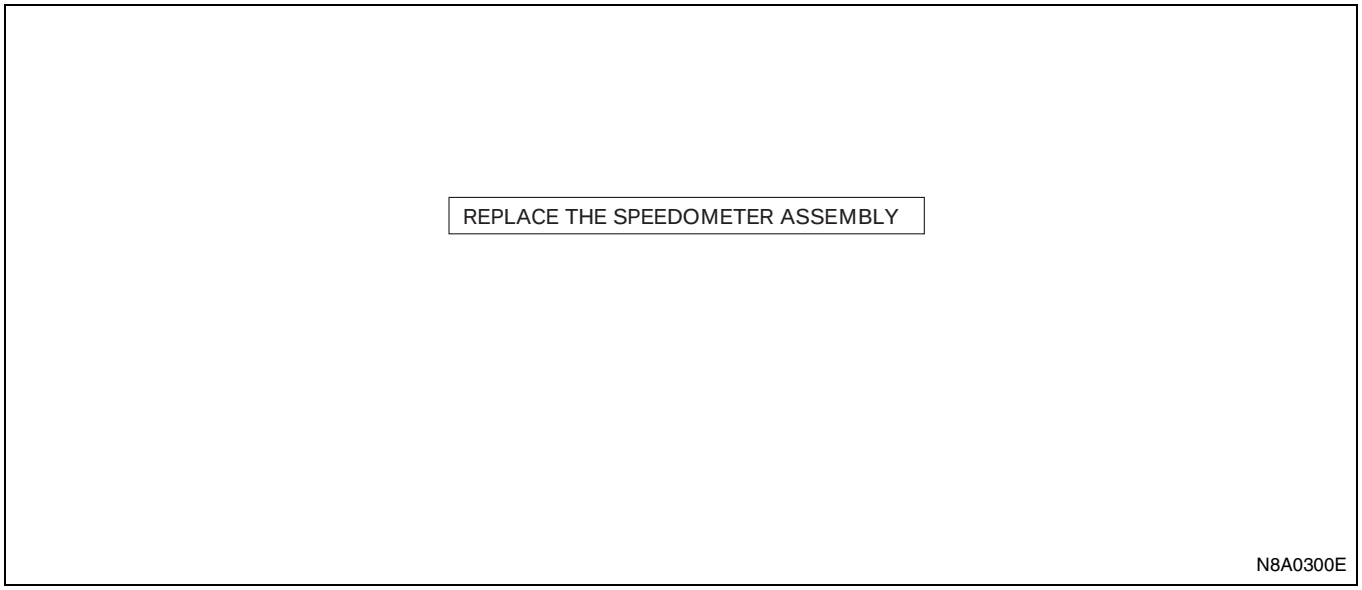
Notice:
Figure in parenthesis “( )” indicates the order of inspection.

1. Speedometer

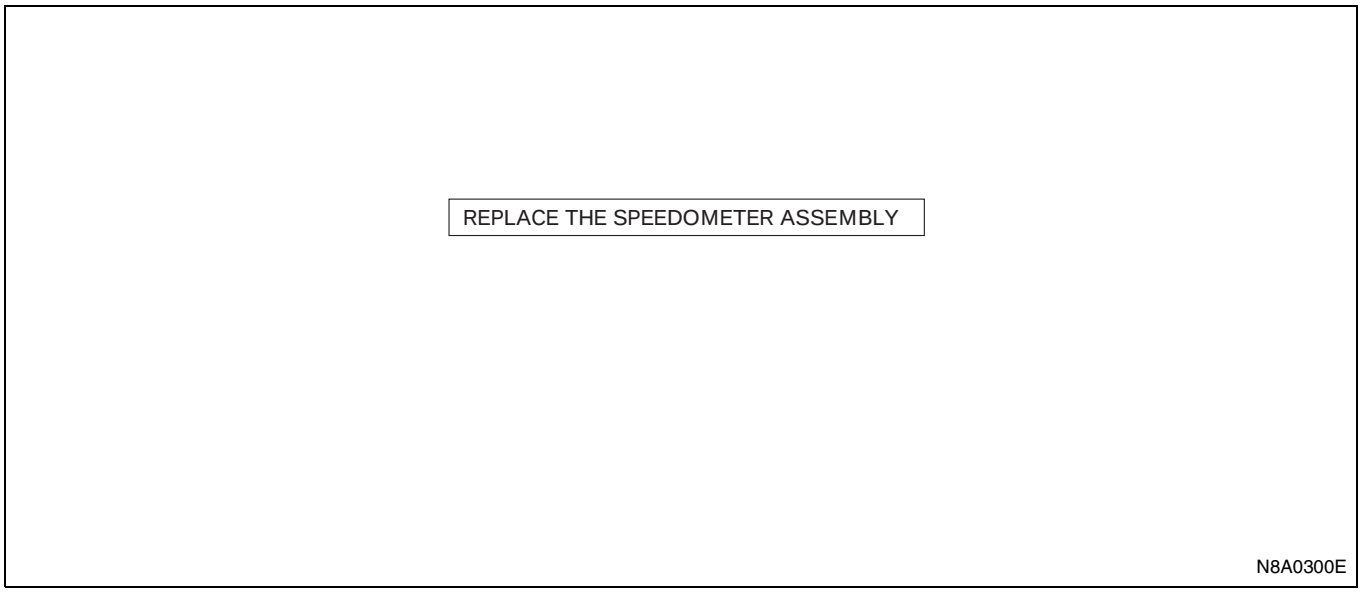
1-1. Speedometer and Odometer Do Not Function



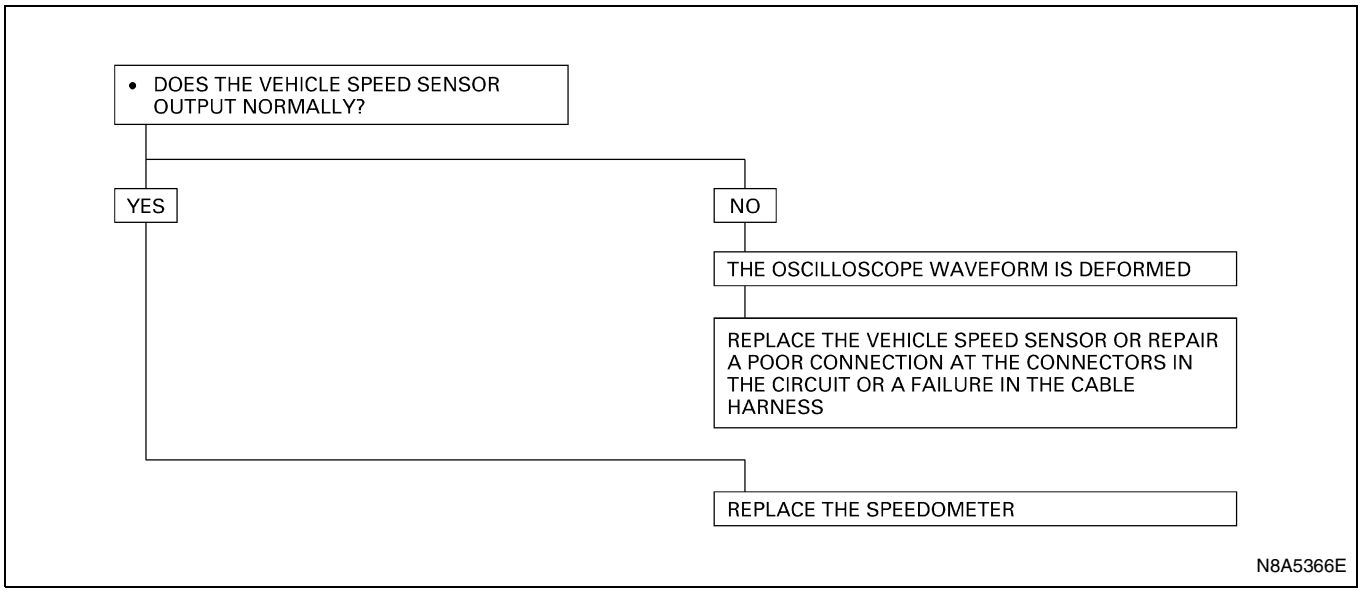
1-2. Speedometer Does Not Function (Odometer Is Normal)



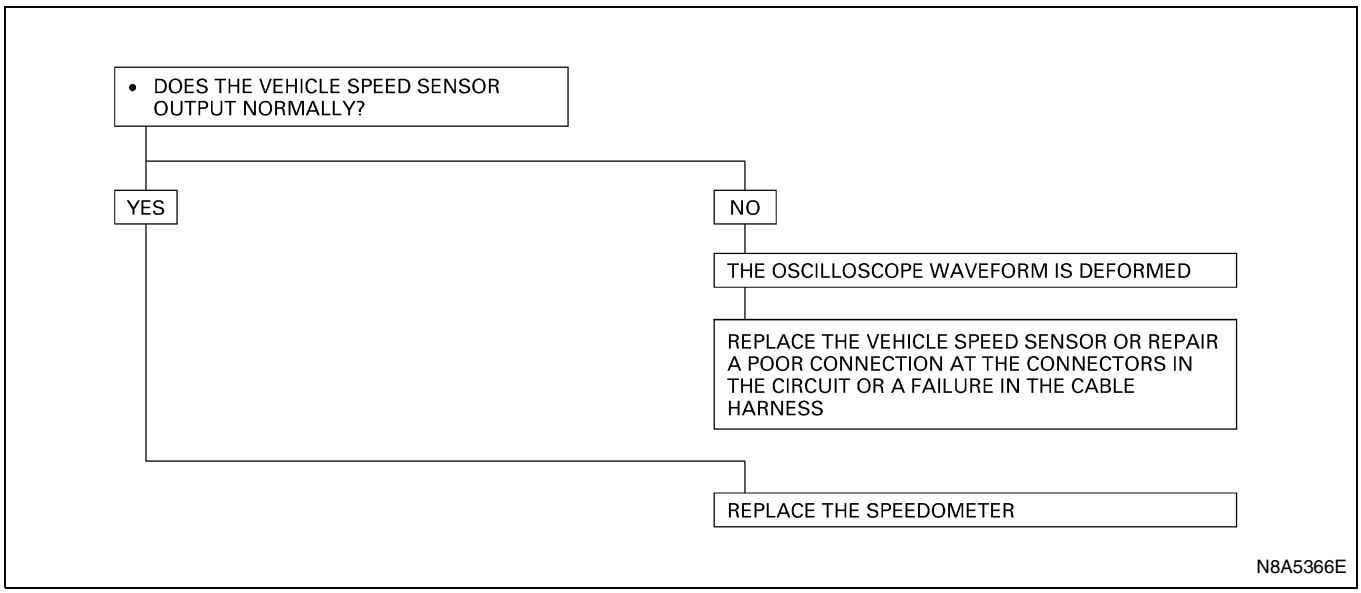
1-3. Odometer Does Not Function (Speedometer Is Normal)



1-4. Speedometer Needle Fluctuates (May Be Wide Fluctuation)

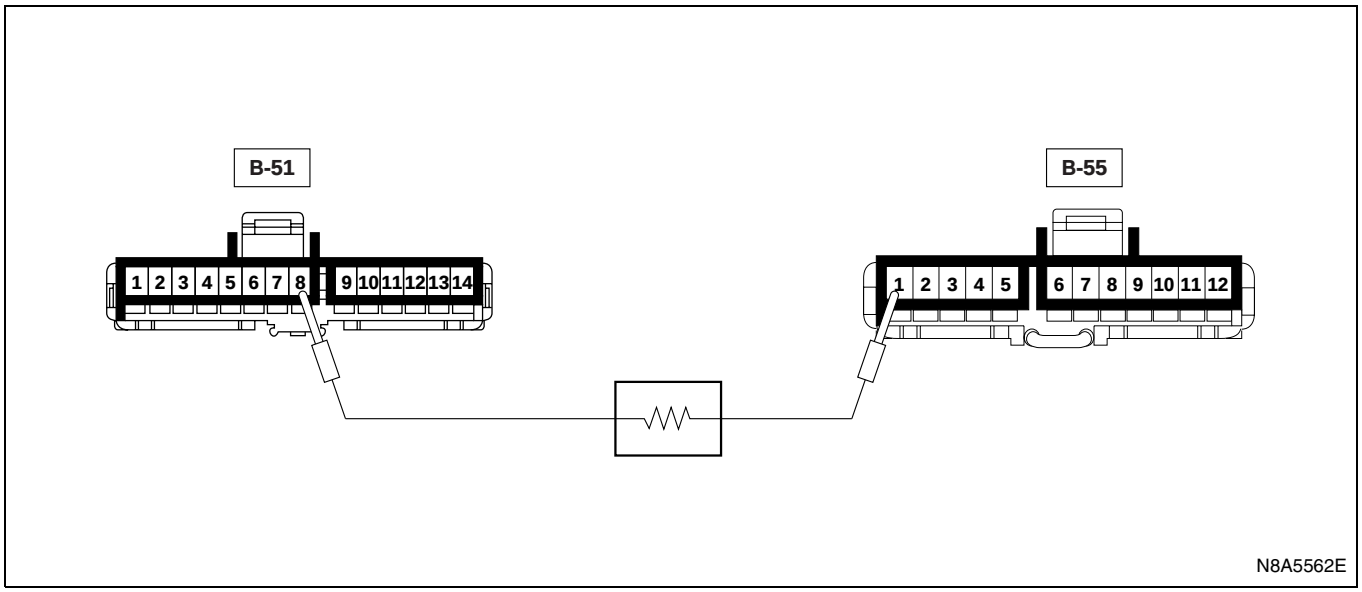


1-5. Speedometer Needle Jumps Erratically

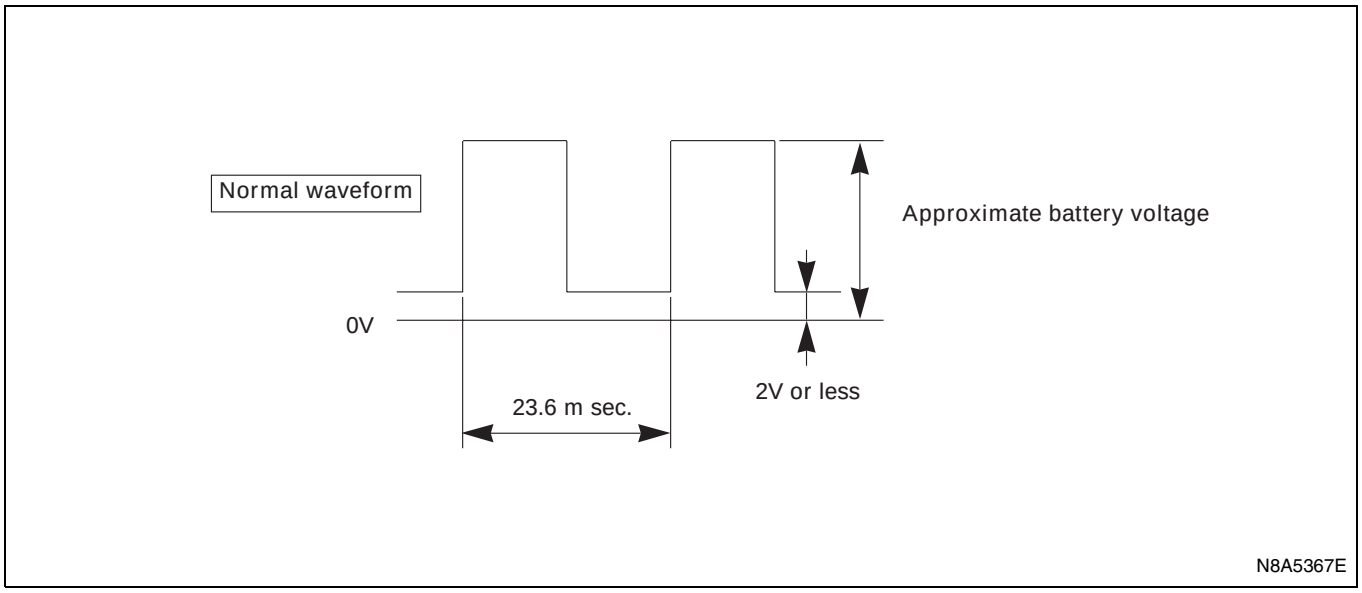


Inspection of waveform by oscilloscope

1. Connect a resistance of 1.3 to 5k ohm (1.4W or more) between the harness side connectors 8 B-51 and 1 B-55 of the meter.

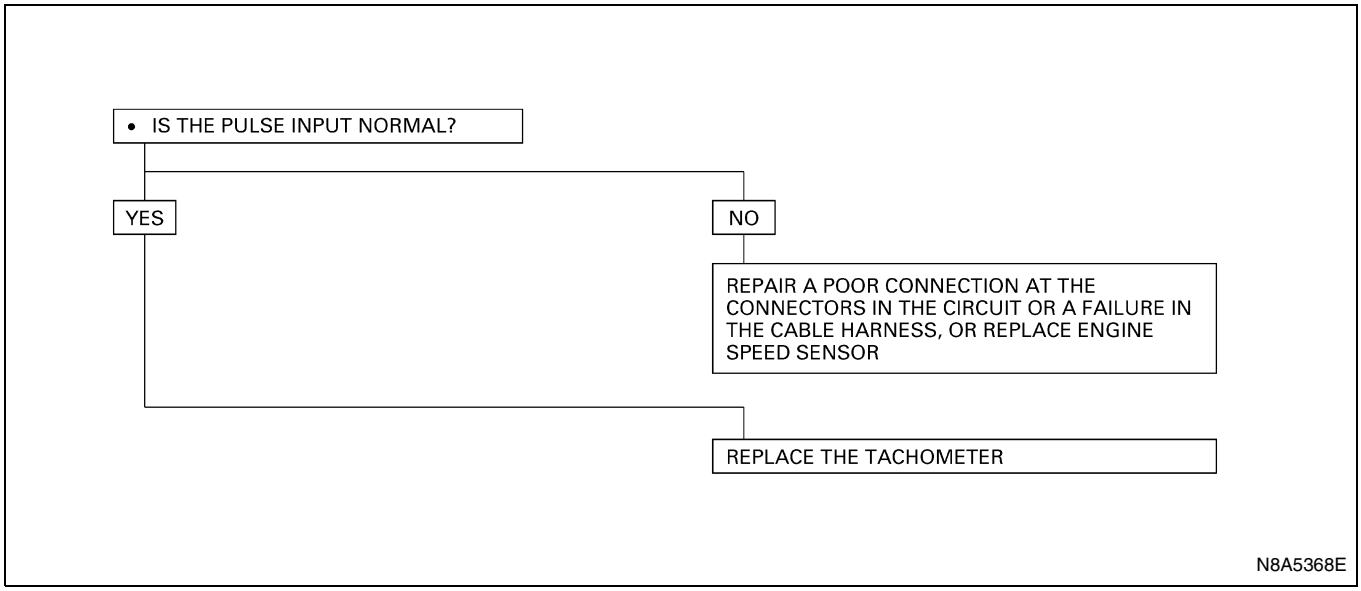


2. Install a speedometer tester.
3. Turn on the starter SW.
4. Check the waveform at the time when the vehicle speed is at 60 Km (37 mph).

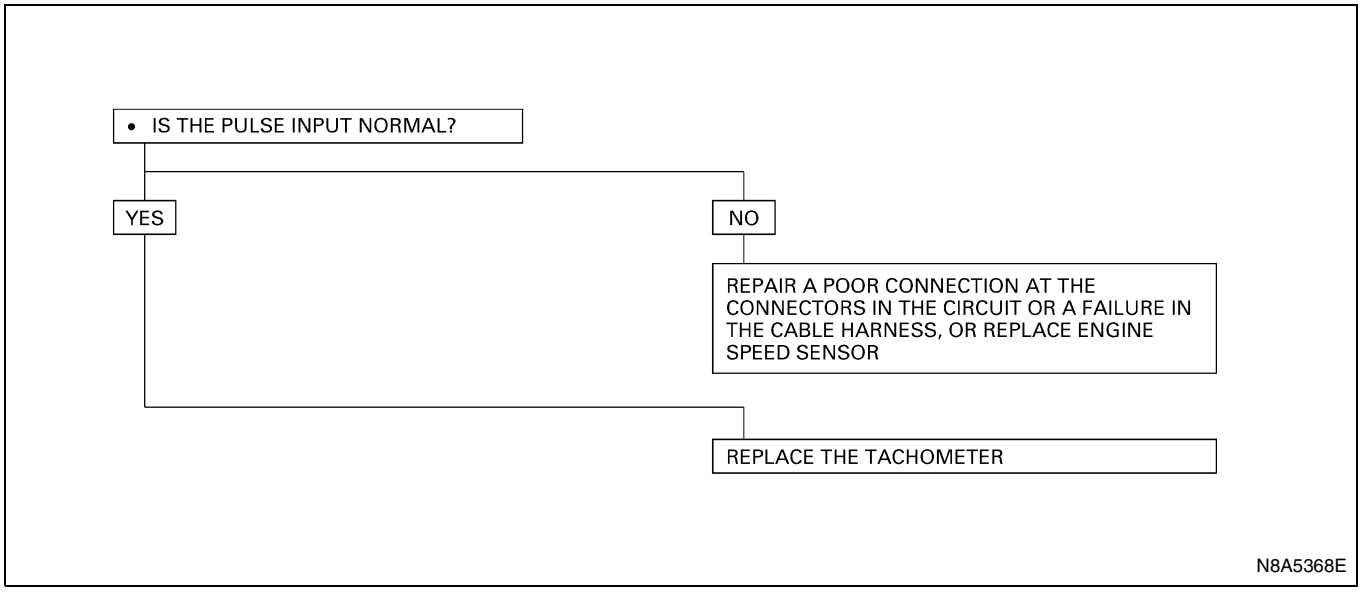


2. Tachometer

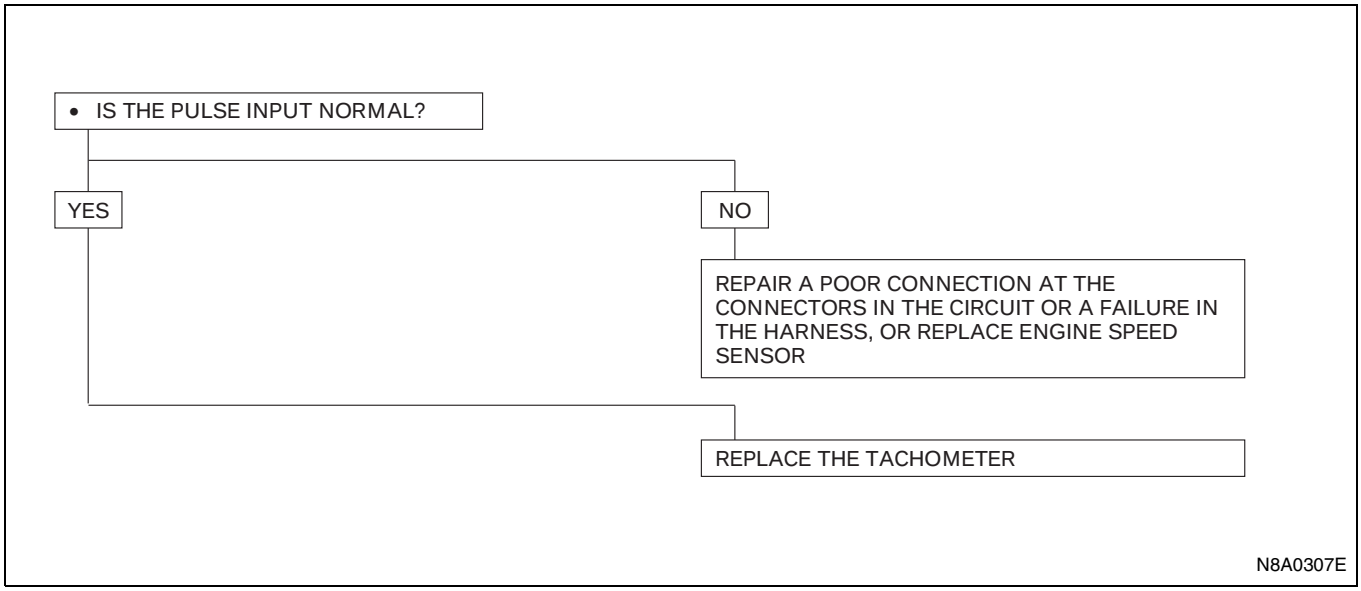
2-1. Tachometer Does Not Function



2-2. Tachometer Needle Fluctuates (May Be Wide Fluctuation)

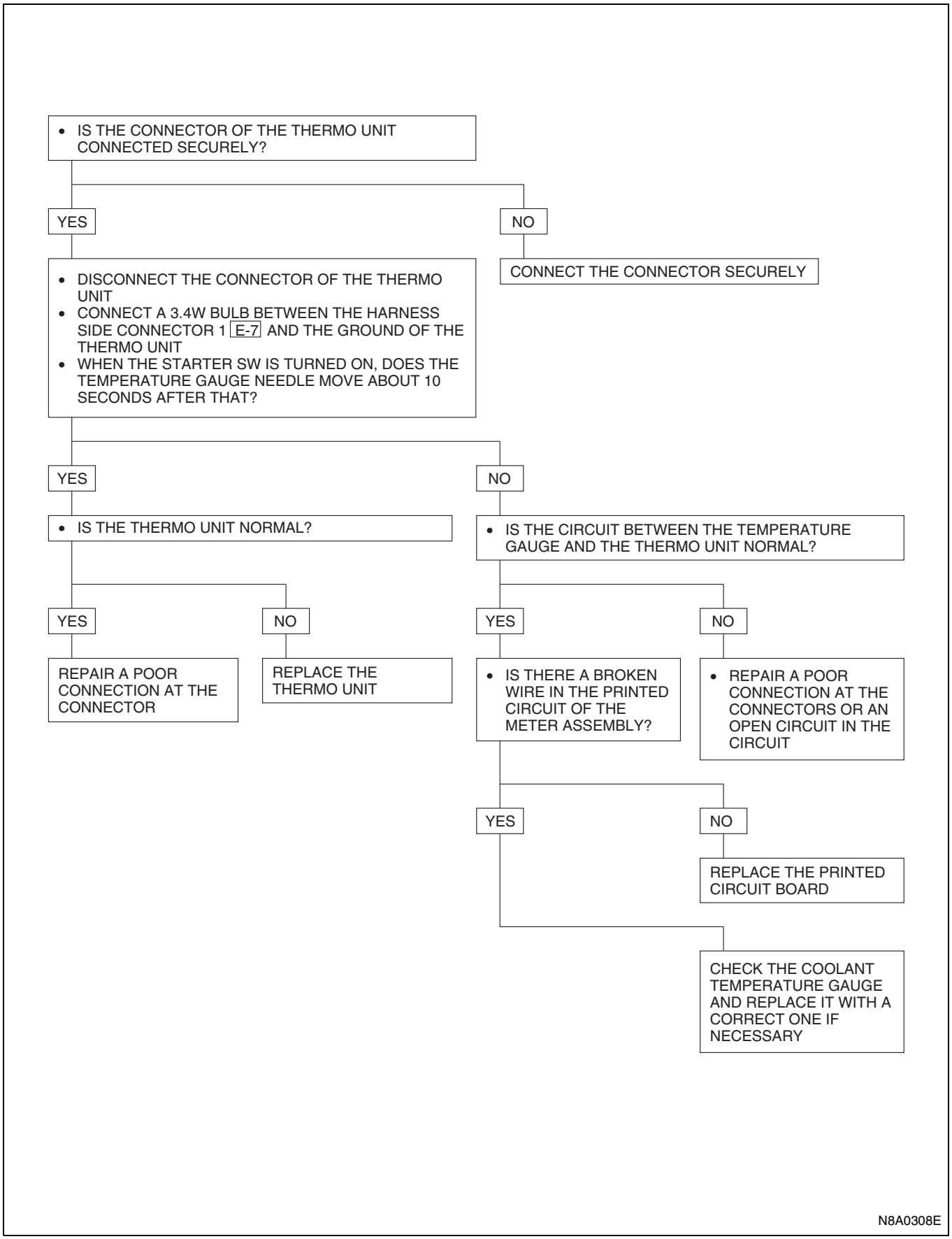


2-3. Tachometer Needle Jumps Erratically

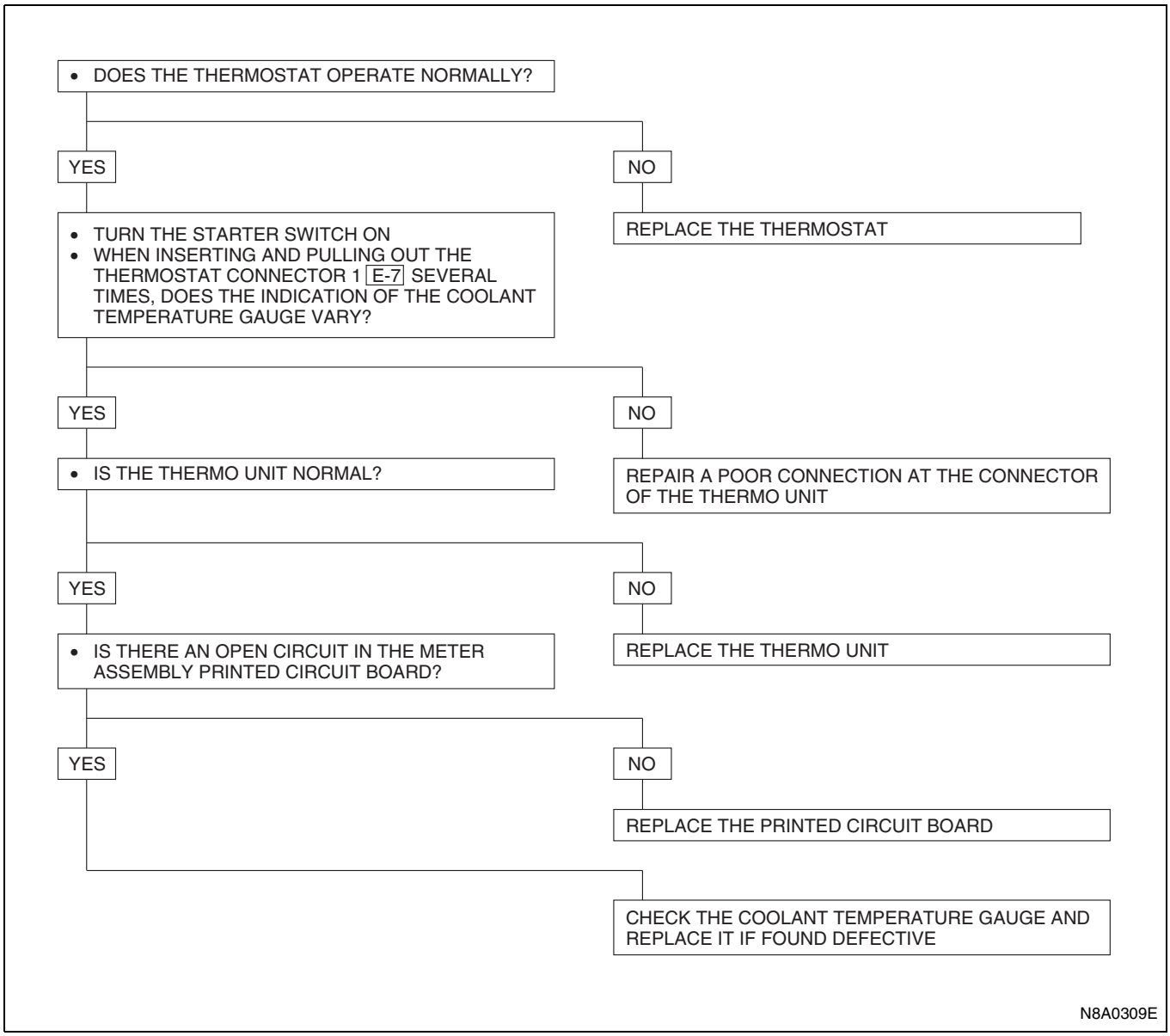


3. Coolant Temperature Gauge

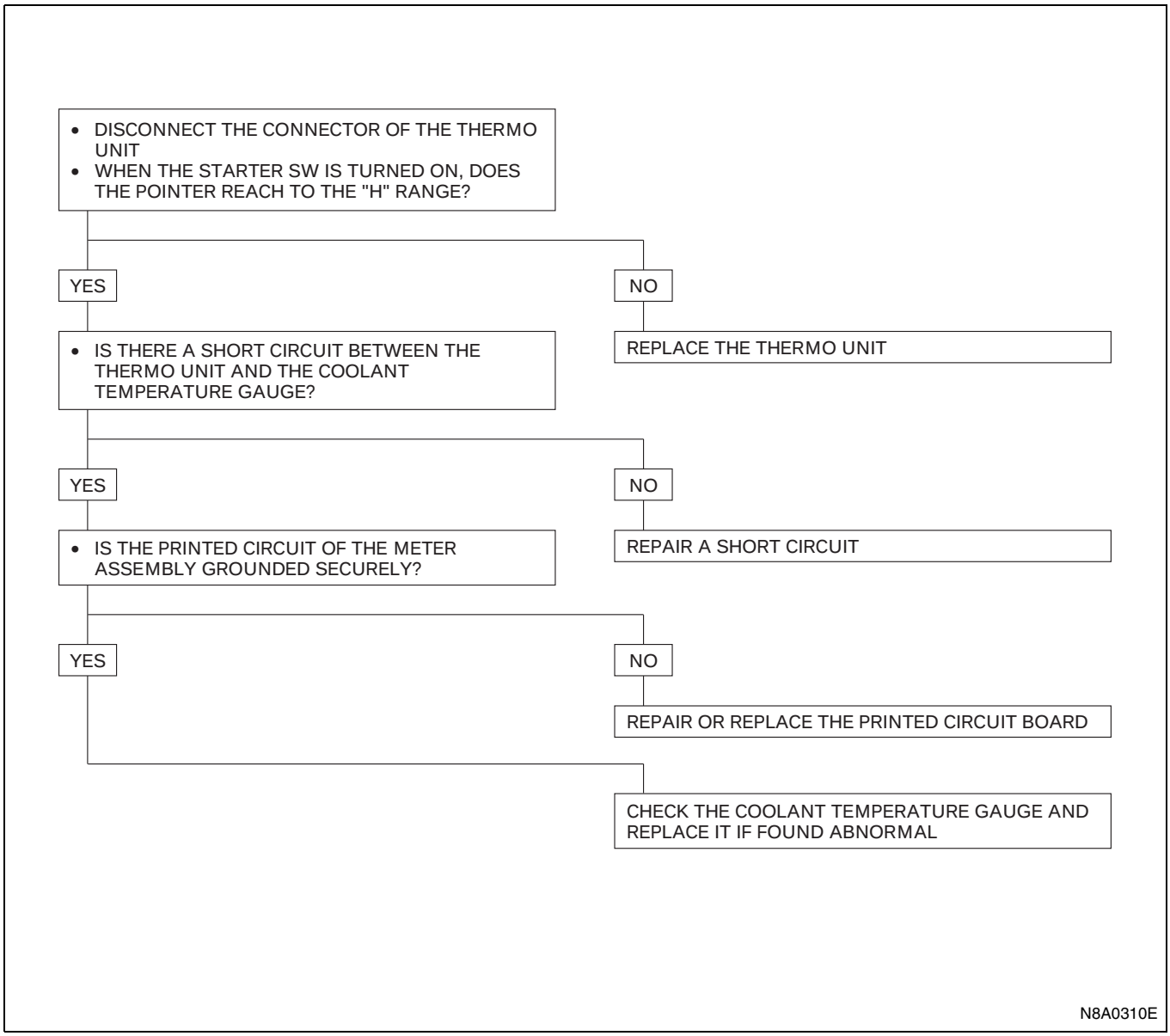
3-1. Coolant Temperature Gauge Needle Does Not Move



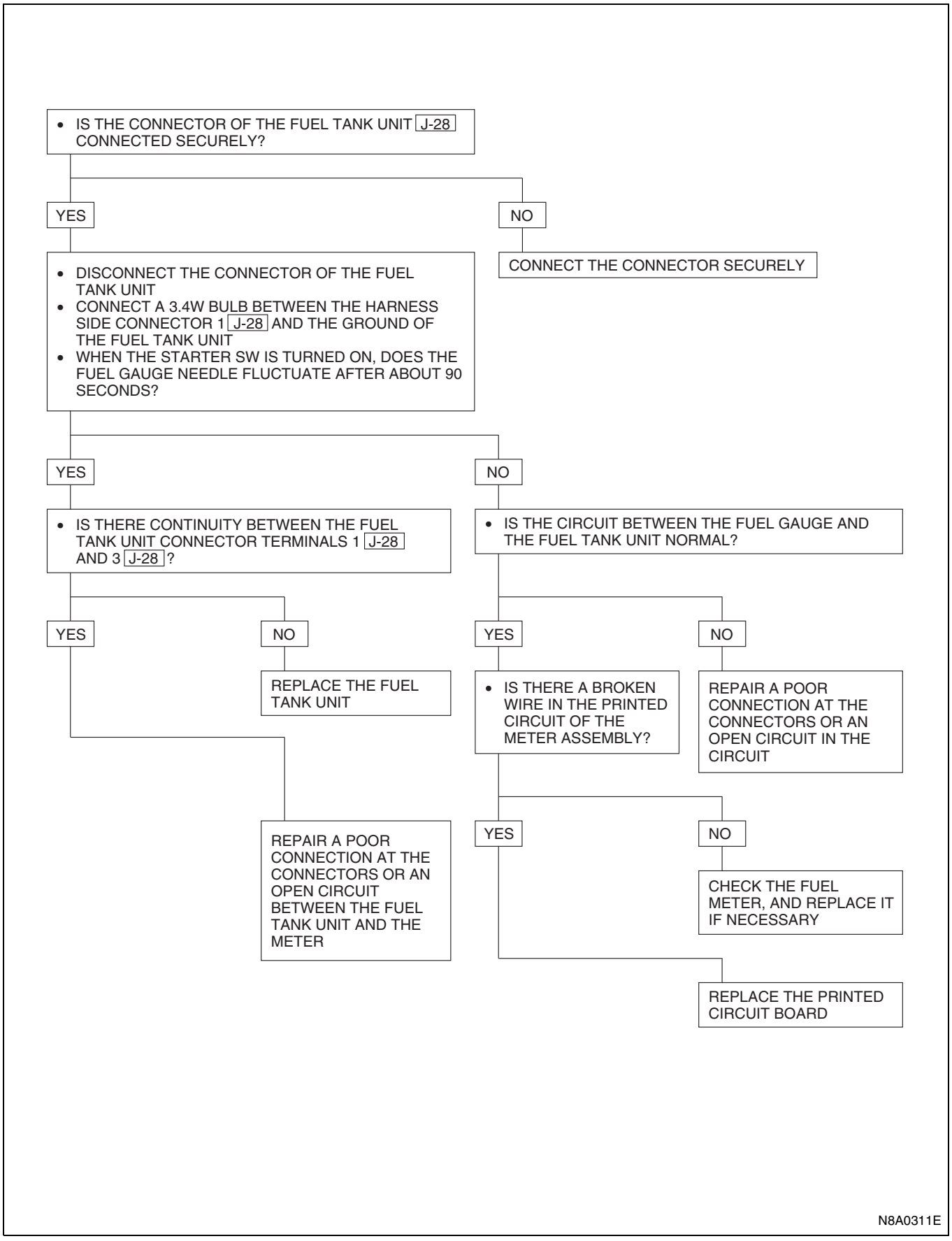
3-2. Coolant Temperature Gauge Reading Is Too Low (or High)



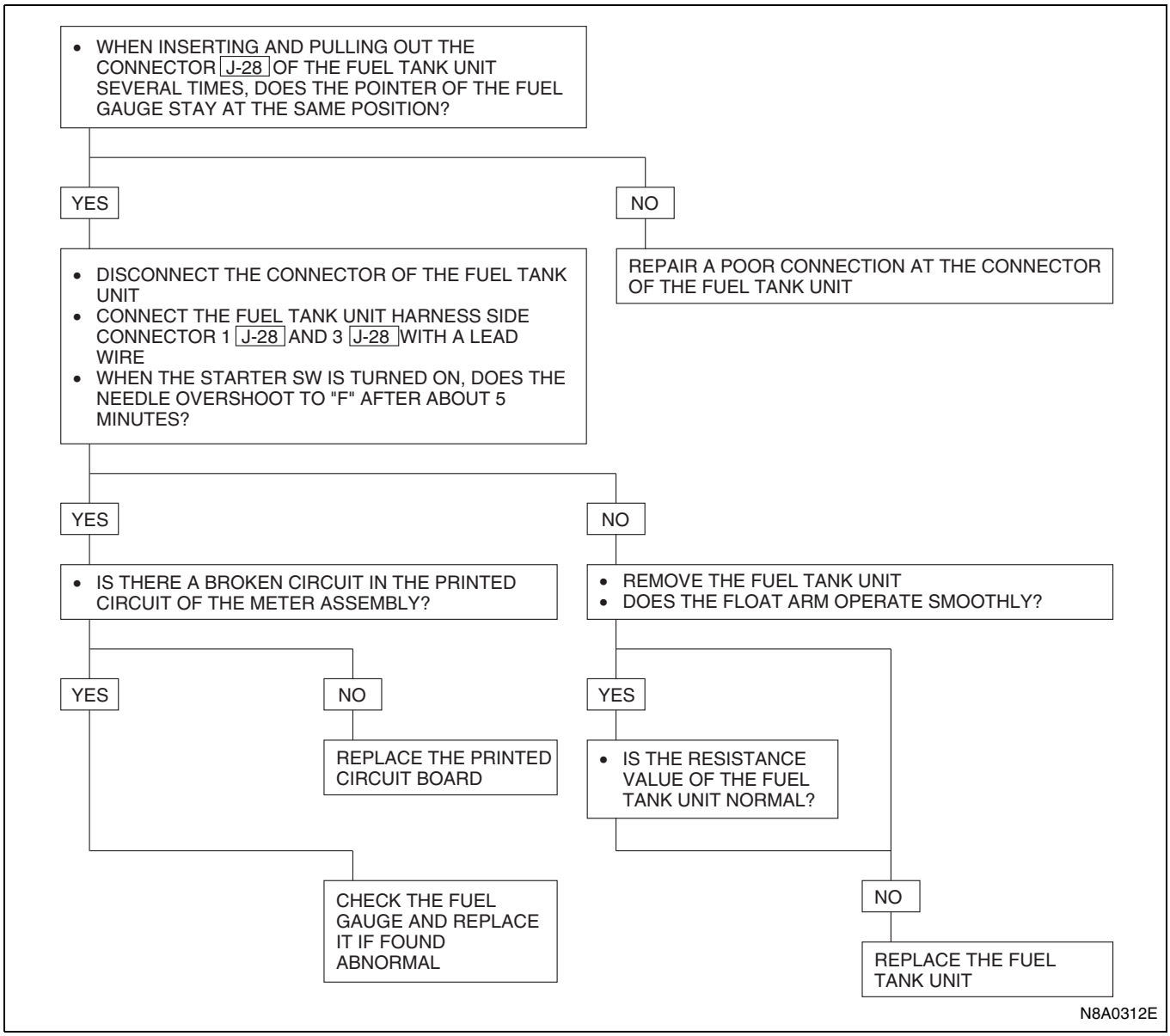
3-3. Needle Overshoots (or Goes Up to the “H” Range)



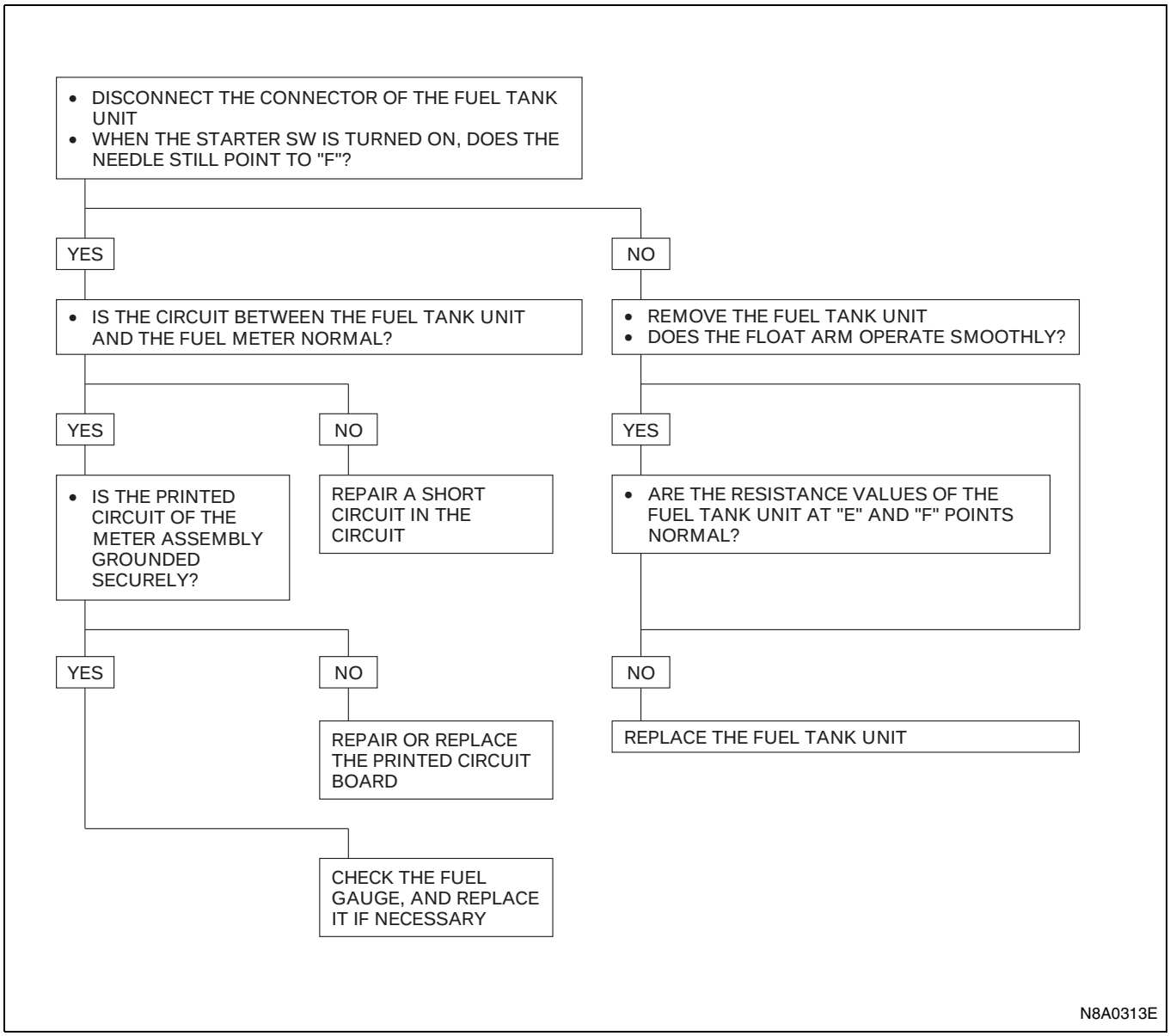
4. Fuel Gauge
4-1. Fuel Gauge Needle Does Not Move



4-2. Even when The Tank Is Filled Up with Fuel, The Needle Does Not Reach “F”

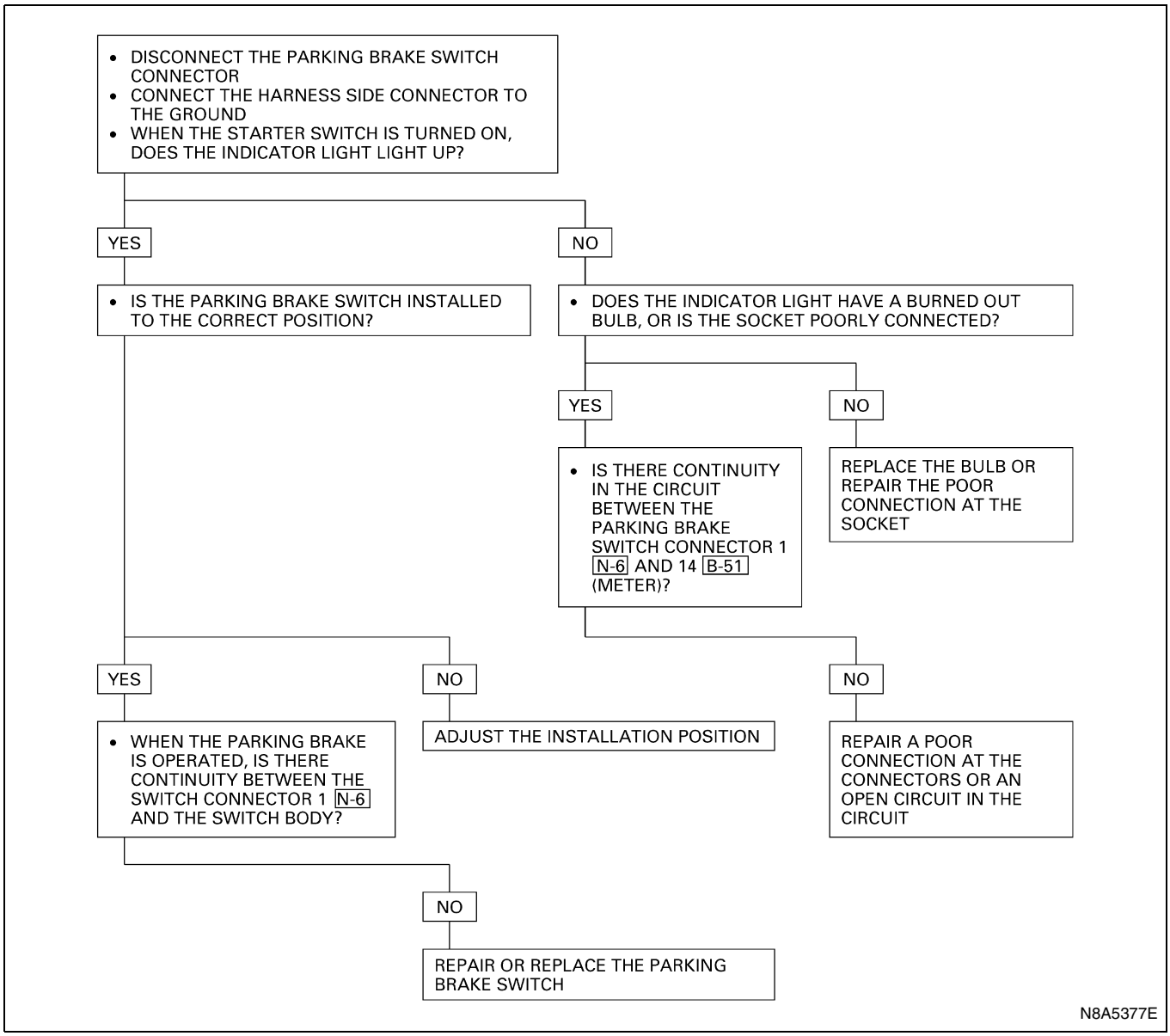


4-3. When The Tank Is Not Full of Fuel, The Needle Overshoots (or Goes Up to “F”)

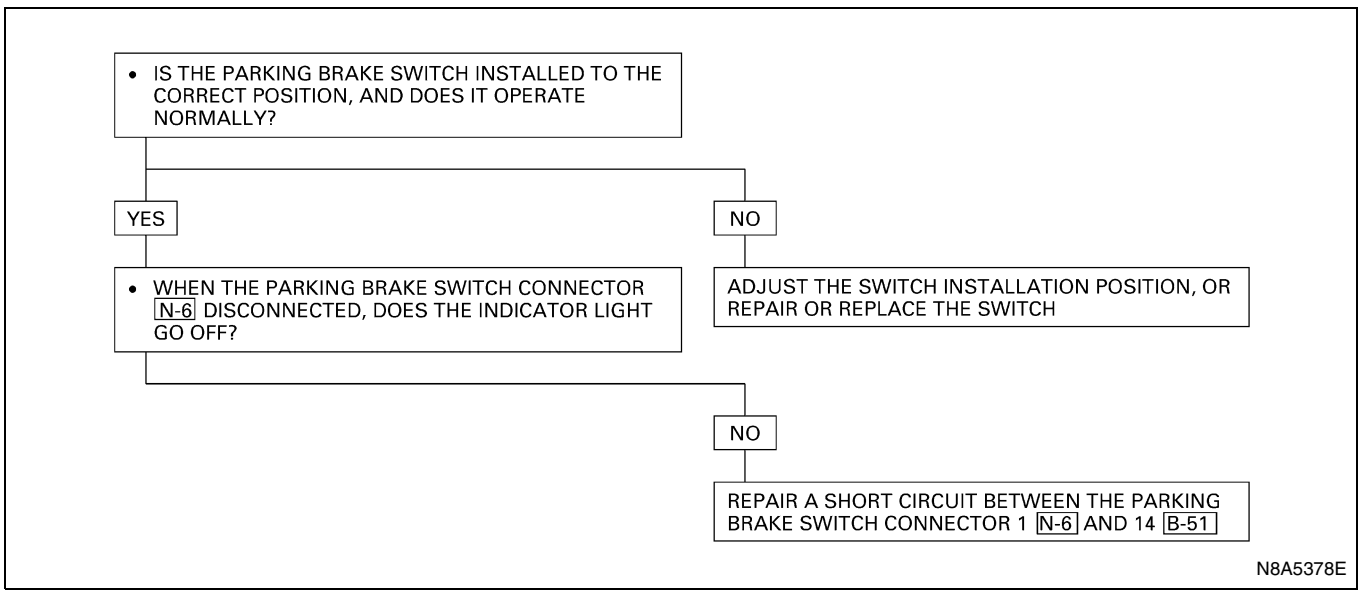


5. Warning/indicator Light

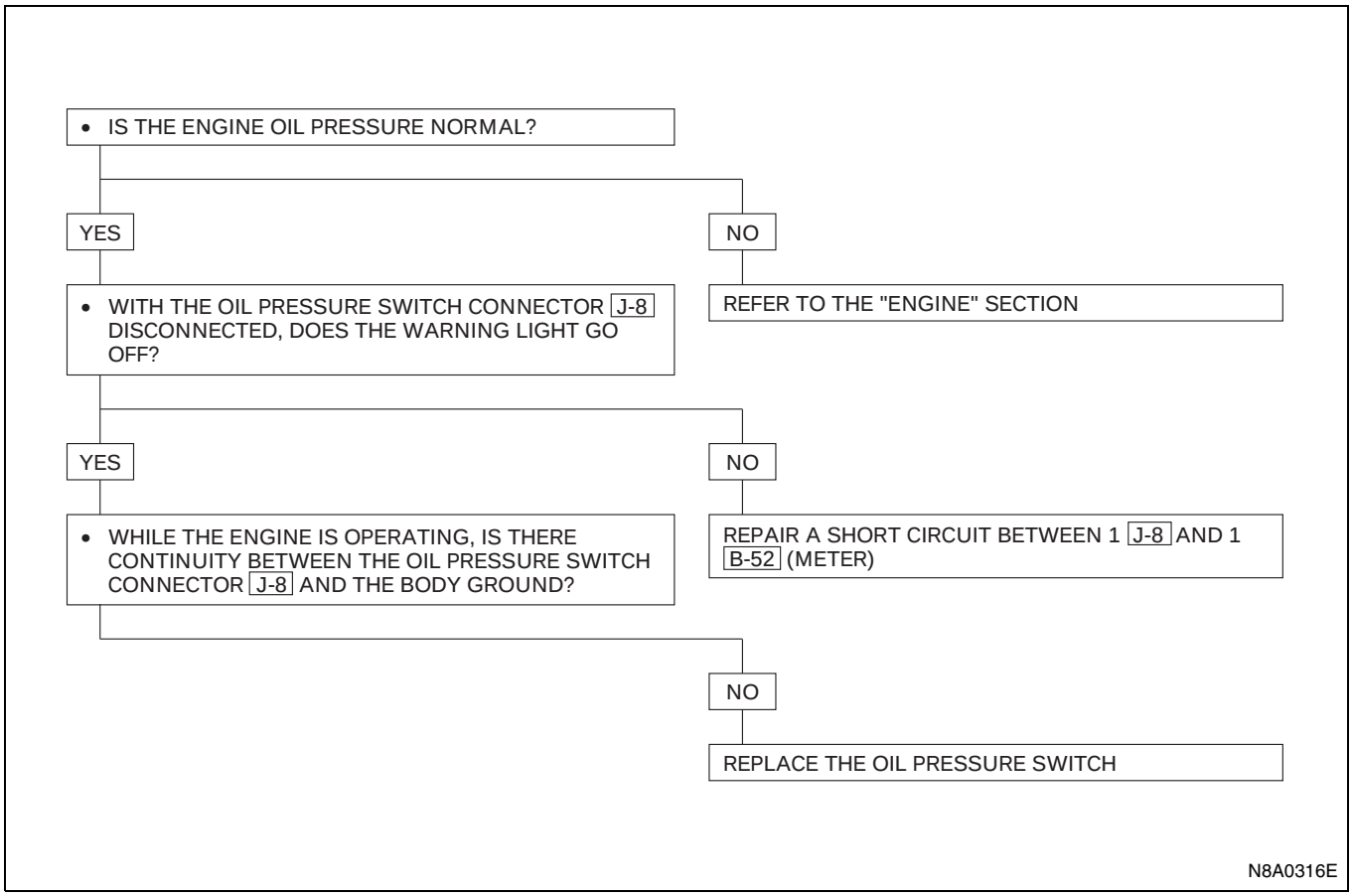
5-1. When The Parking Brake Lever Is Pulled, The Indicator Light Does Not Light Up



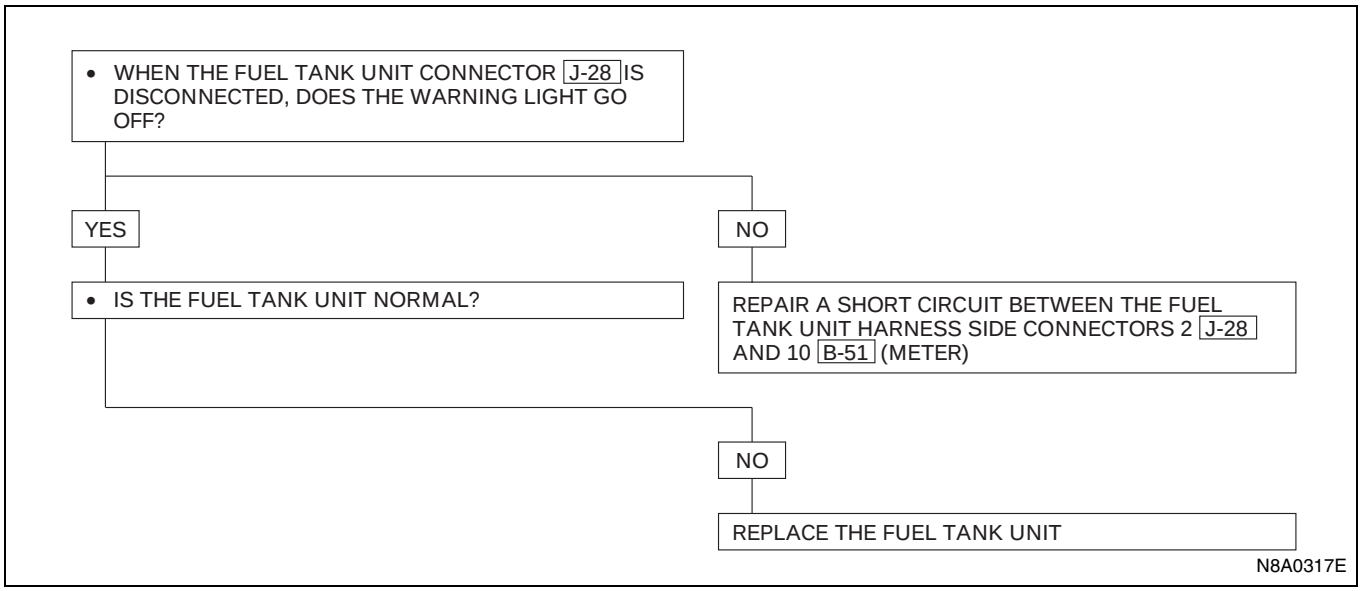
5-2. Even When The Parking Brake Lever Is Released, The Indicator Light Does Not Go Off



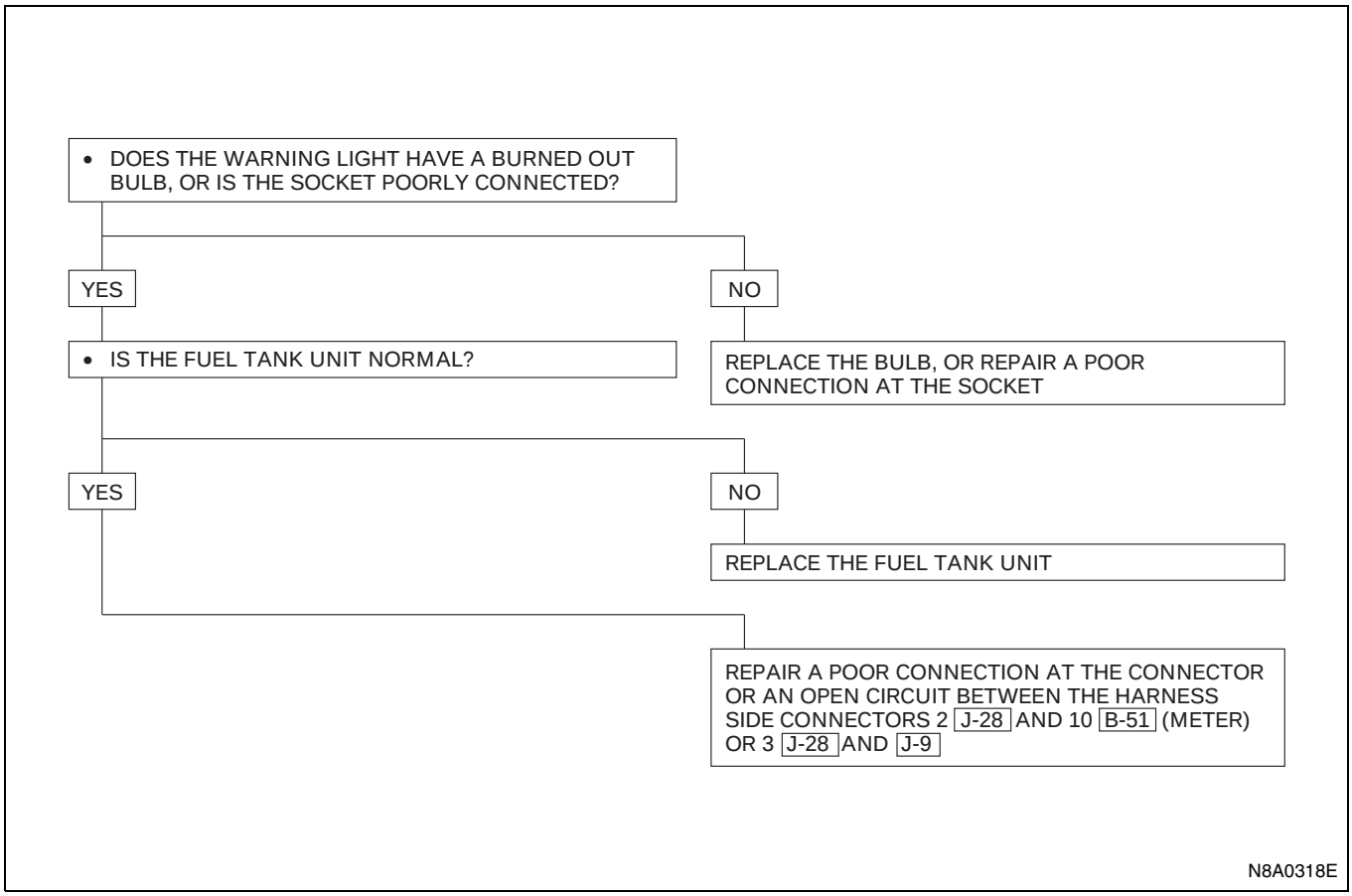
5-3. While The Engine Is Operating, The Oil Pressure Warning Light Does Not Go Off



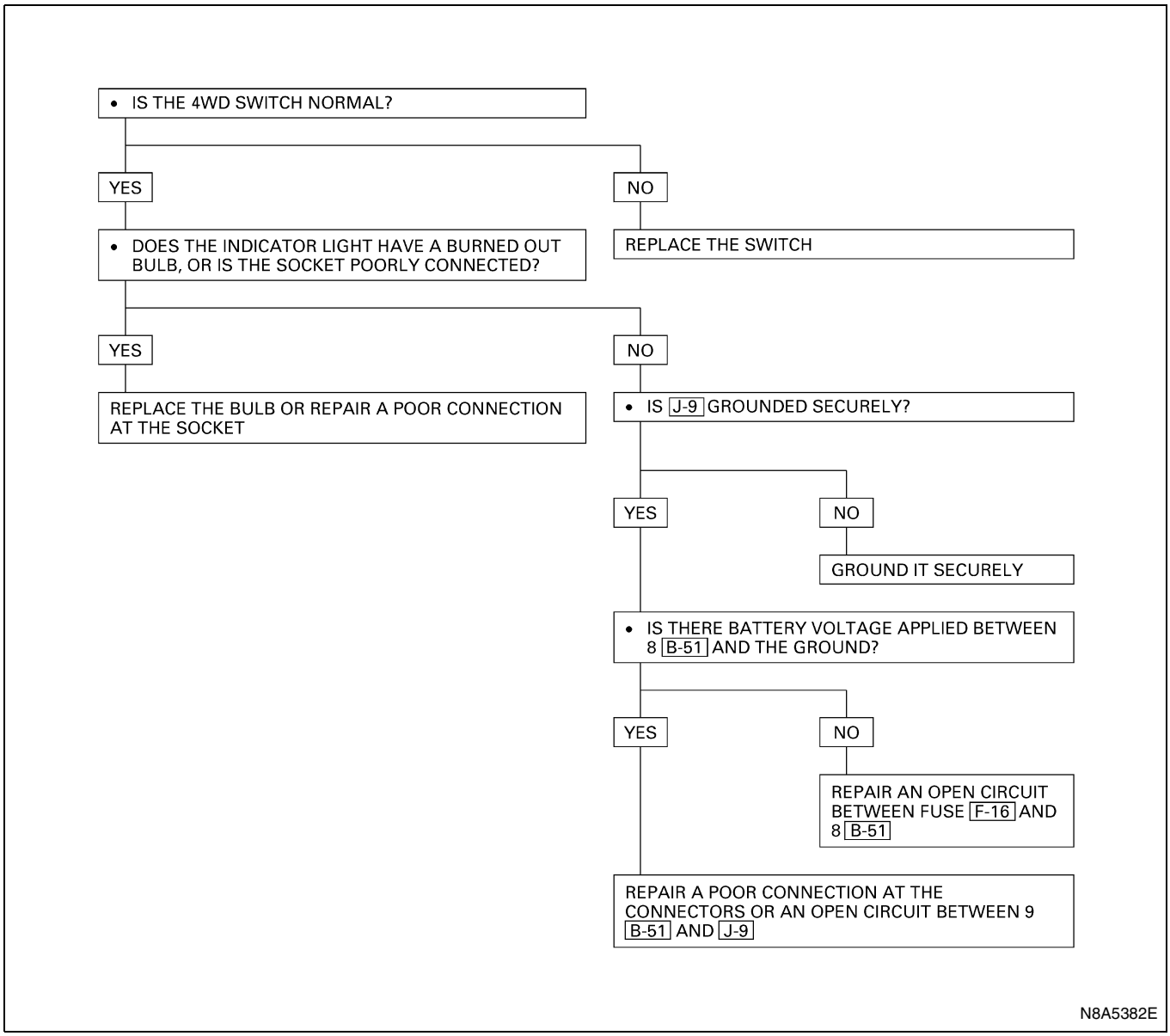
5-4. Even When The Fuel Tank Is Full with Fuel, The Fuel Warning Light Lights Up



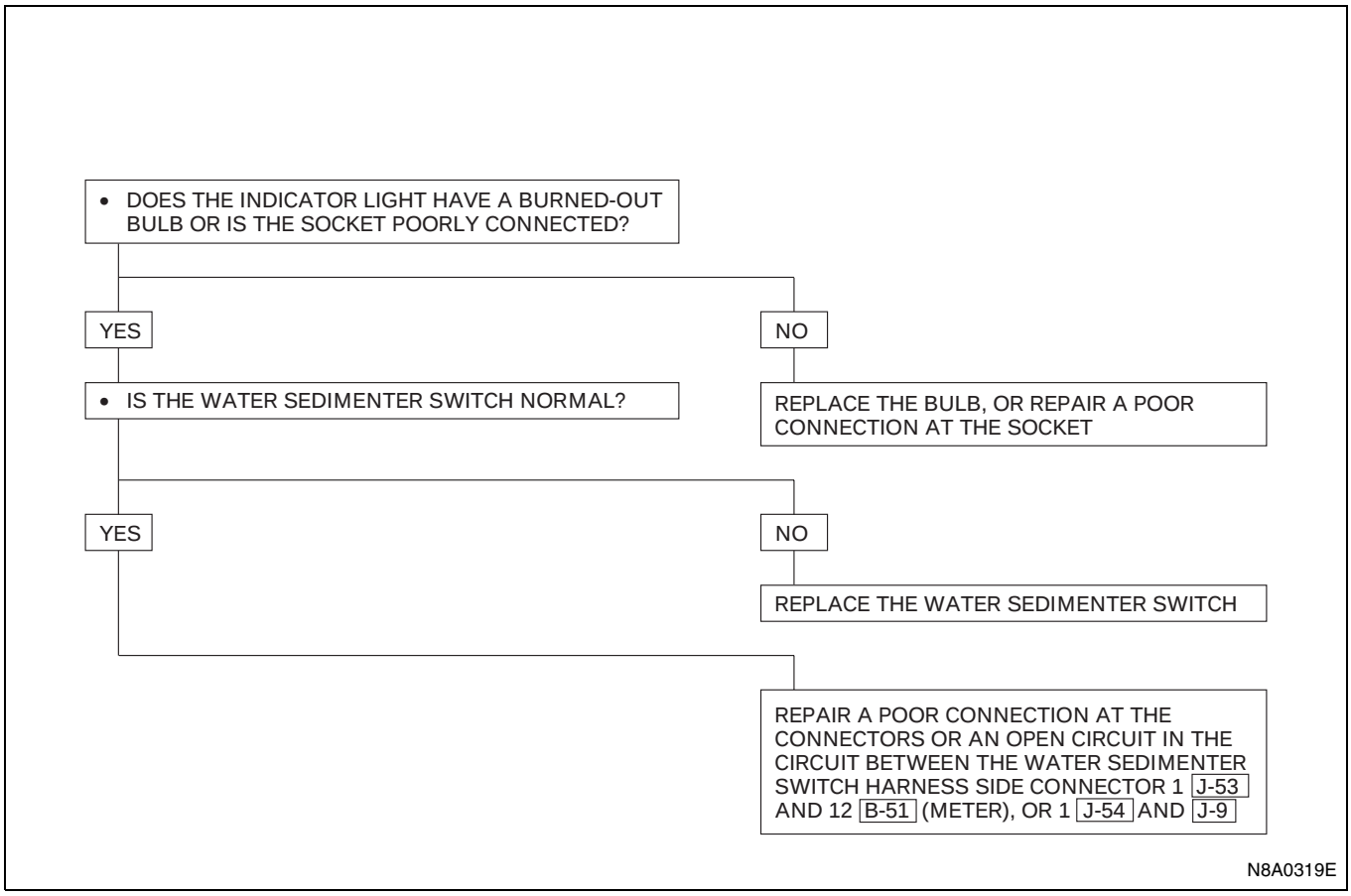
5-5. Even When The Fuel Tank Is Empty, The Low Fuel Warning Light Does Not Light Up



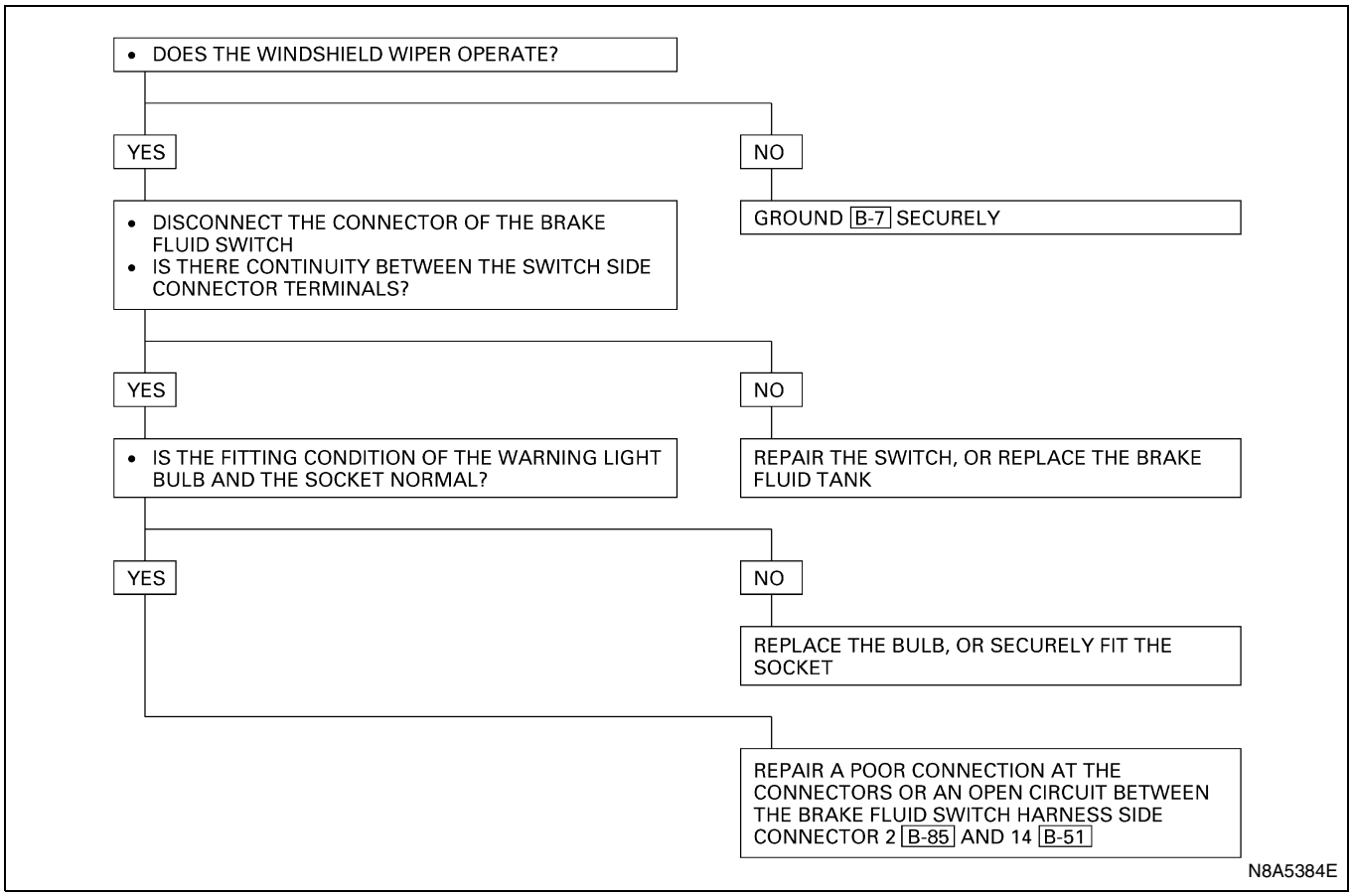
5-6. Even When The Transfer Level Is Shifted to 4wd Position, The Indicator Light Does Not Light Up



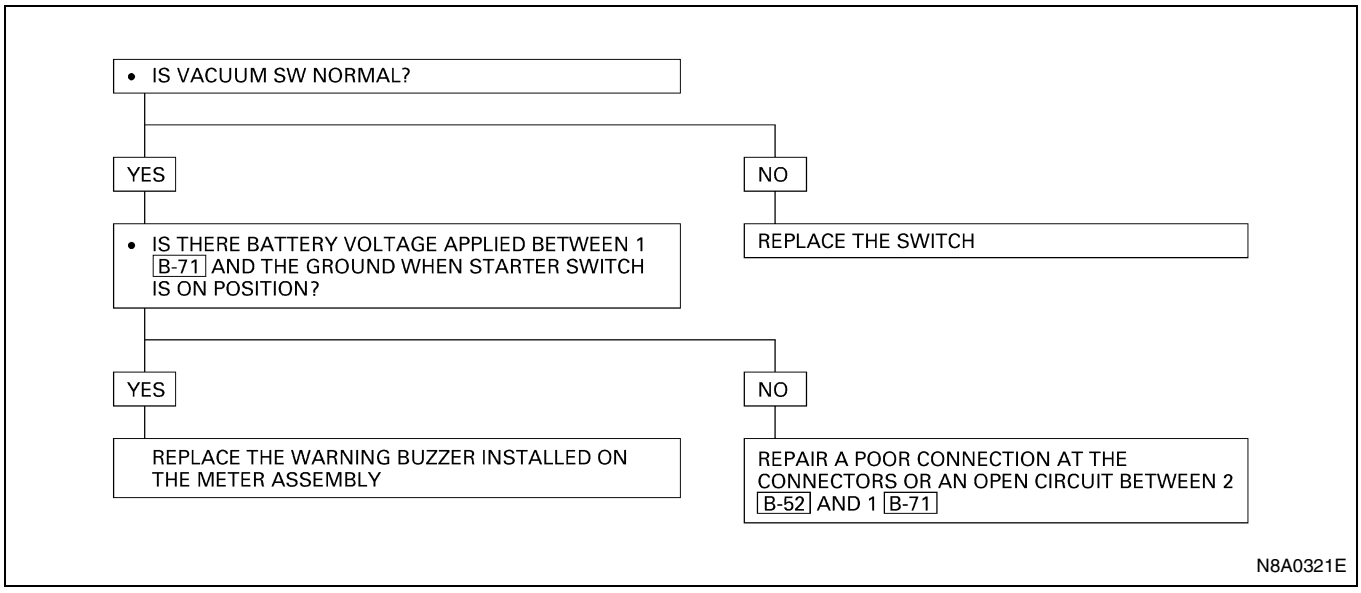
5-7. Even When The Float in The Water Sedimenter Goes Up above The Drain Warning Level, The Indicator Light Does Not Light Up



5-8. Even When The Brake Fluid Is Lower than Specified Level, The Level Warning Light Does Not Light Up



5-9. Vacuum Warning Buzzer Does Not Sound



Starter Switch

Refer to “START AND CHARGING” in this section.

Turn Signal Light Switch

Refer to “TURN SIGNAL LIGHT, HAZARD WARNING LIGHT AND STOPLIGHT” in this section.

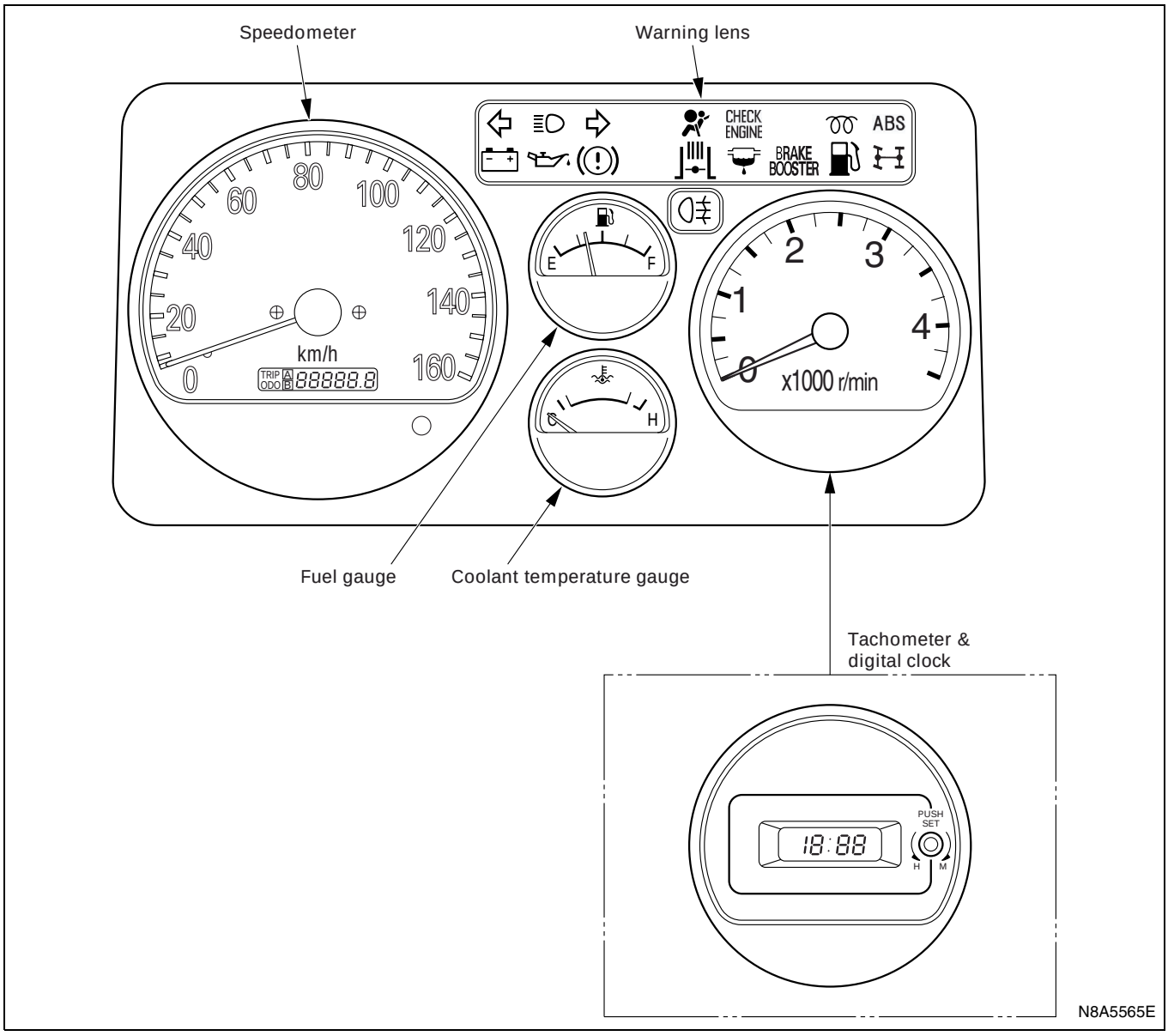
Exhaust Brake Switch

Refer to “EXHAUST BRAKE” in this section.

Meter Assembly

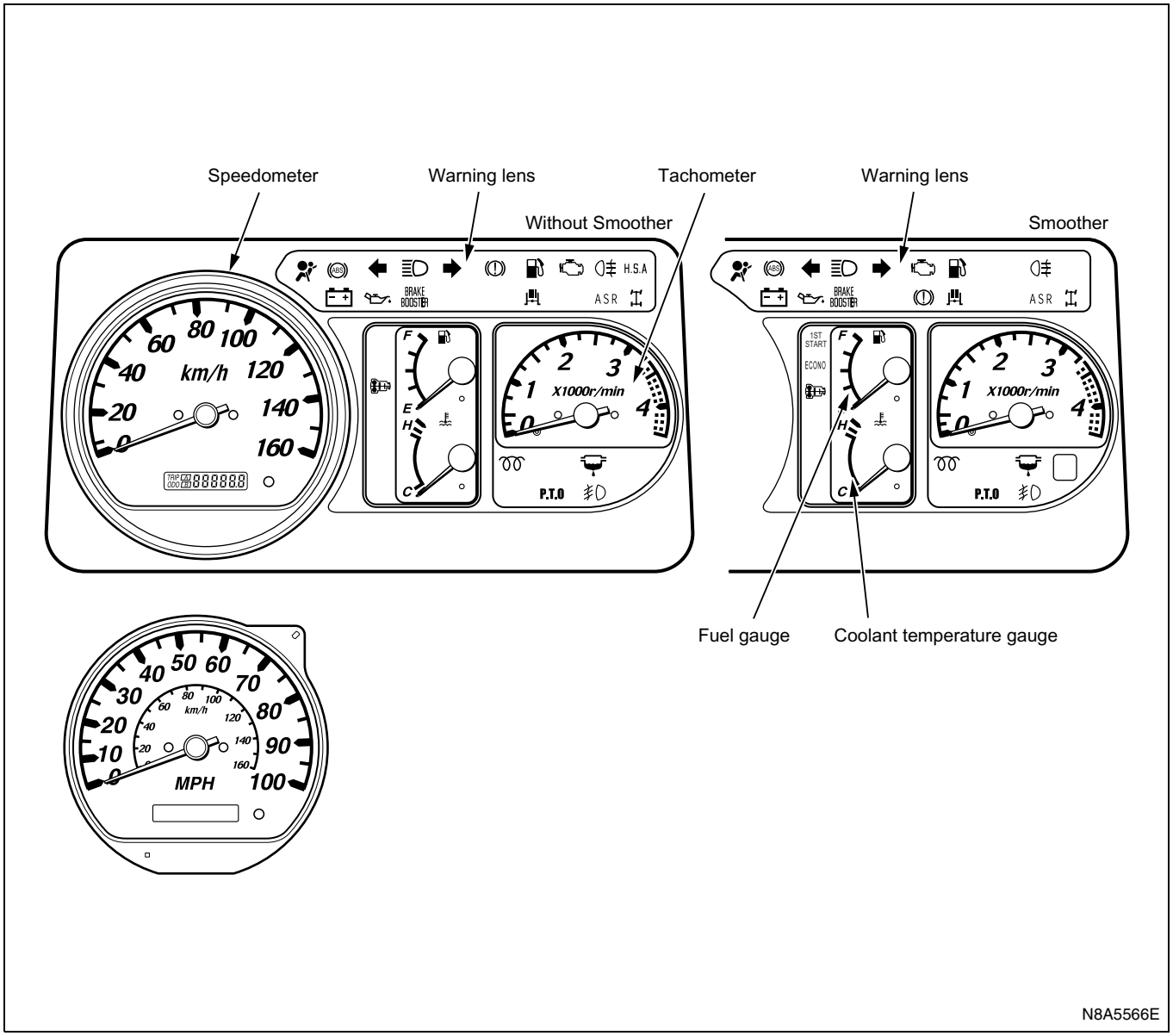
Layout for Gauges, Warning, Indicator and Illumination Lights

Except 4HK1-TC



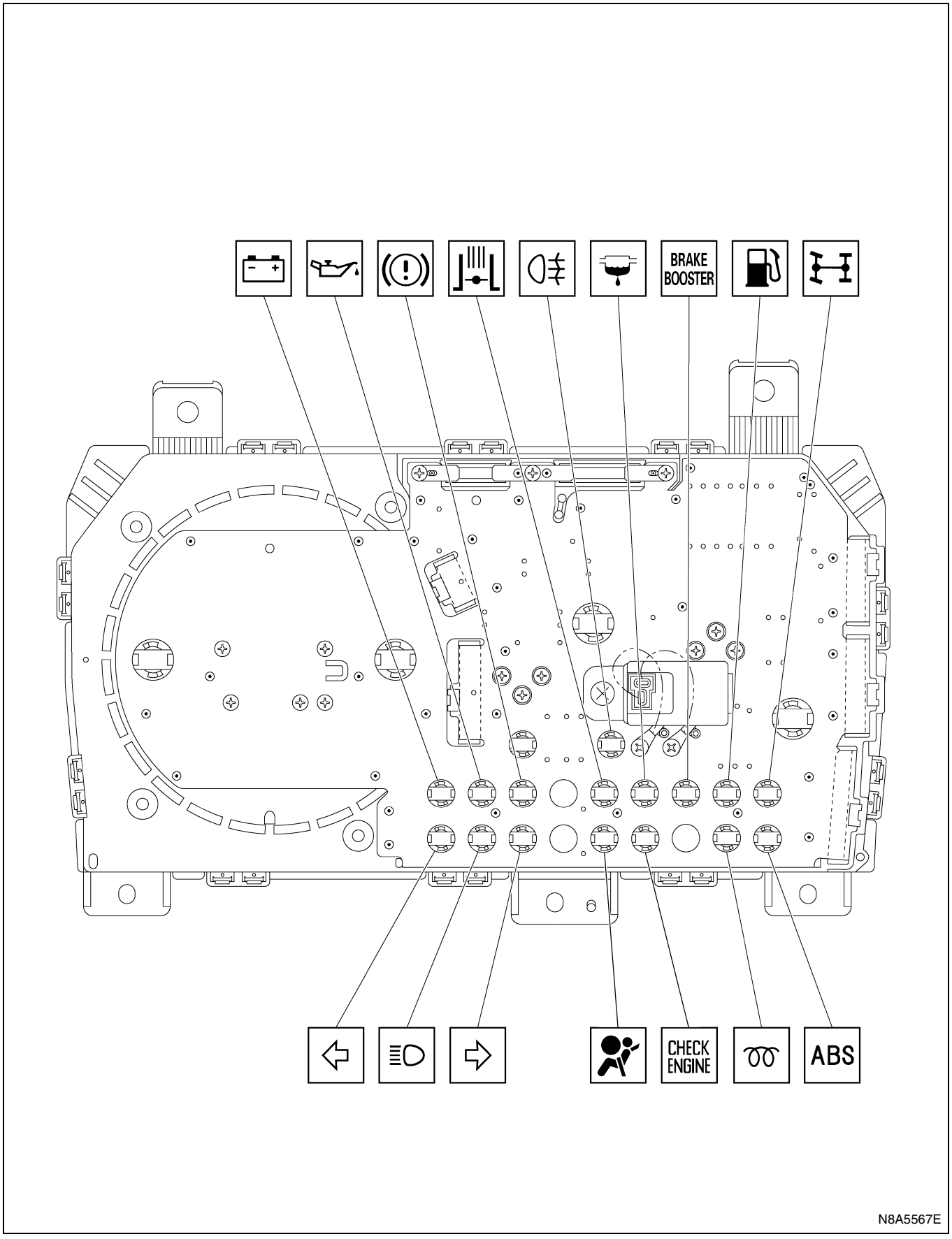
Notice:
The calibration and the red zone of tachometer are various depending on the models fitted.

For 4HK1-TC


Speedometer
Warning lens
Tachometer
Warning lens
Without Smoother
Smoother
km/h
X1000r/min
P.T.O
MPH
Fuel gauge
Coolant temperature gauge
N8A5566E

Bulb Location for Warning Lens

Except 4HK1-TC



For 4HK1-TC

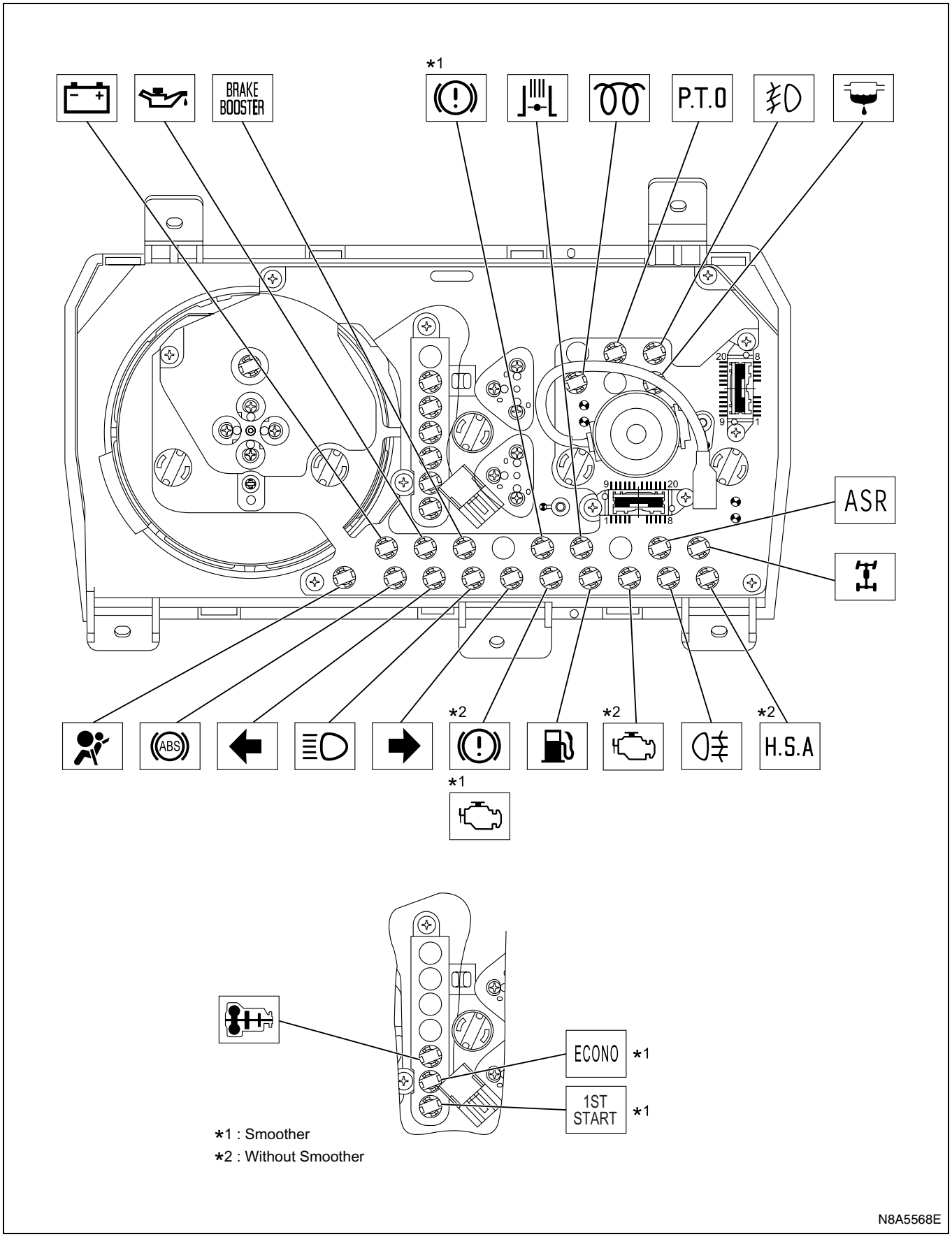
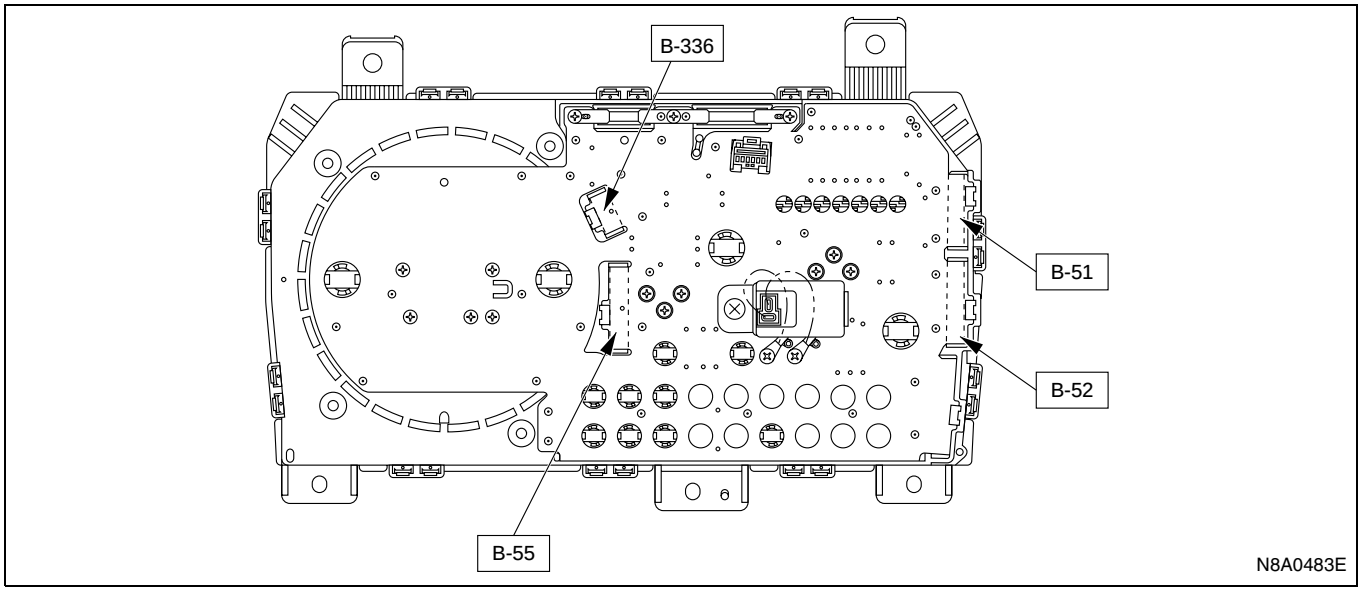

*1
BRAKE BOOSTER
P.T.O
ASR
ABS
*2
*2
*2
H.S.A
*1
ECONO
*1
1ST START
*1
*1 : Smoother
*2 : Without Smoother
N8A5568E

Table for Meter Connector Terminal Connections

Except 4HK1-TC



B-336

Terminal No.	Connected to
1	IGN (+)
2	—
3	Speed pulse input
4	—
5	Ground
6	Illumination (+)

B-51

Terminal No.	Connected to
1	Exh. Brake
2	Exh. Brake
3	Airbag
4	Check engine
5	PTO
6	Glow
7	ABS
8	IGN (+)
9	4WD
10	Fuel low
11	Vacuum / Booster
12	Sedimenter
13	Low coolant
14	Brake

B-55

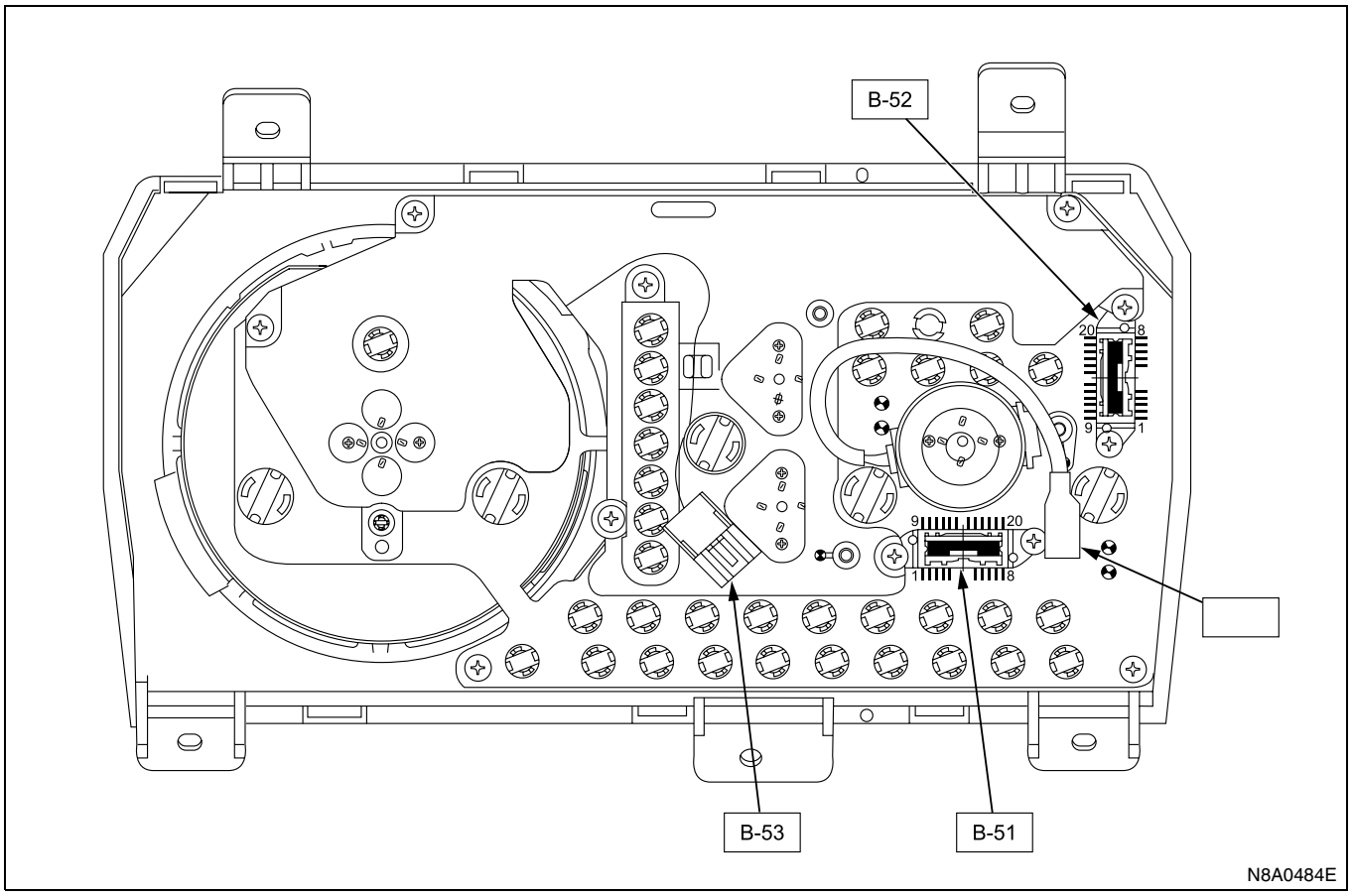
Terminal No.	Connected to
1	Speed pulse input
2	—
3	Power output (sensor)
4	ECT unit (GAUGE)
5	Fuel tank unit (GAUGE)
6	—
7	Ground
8	Turn signal (LH)
9	—
10	Beam (+)
11	Turn signal (RH)
12	—

ECT - Engine Coolant Temperature

B-52

Terminal No.	Connected to
1	Oil pressure
2	Vacuum SW
3	Charge
4	Parking / Rear fog
5	Illumination (+)
6	—
7	Illumination (–)
8	Signal (tacho)
9	Ground (tacho)
10	Ground
11	—
12	+B

For 4HK1-TC



B-53 (With Smoother)

Terminal No.	Connected to
1	TCM
2	—
3	—
4	—
5	—
6	1st Start
7	ECONO
8	Smoother
9	—
10	—
11	—
12	—

B-51

Terminal No.	Connected to
1	Turn LH
2	Beam
3	—
4	Brake (*1) / — (*2)
5	Check Engine (*1) / Brake (*2)
6	Exhaust Brake
7	—
8	—
9	Brake Booster
10	Charge
11	Oil Pressure
12	ABS
13	— (*1) / Check Engine (*2)
14	—
15	Ground
16	Vehicle Speed Signal Output
17	Illumination +
18	Ignition
19	Rear Fog
20	ASR

*1: With Smoother
*2: Without Smoother

B-52

Terminal No.	Connected to
1	4WD
2	—
3	Turn RH
4	—
5	Thermal
6	Fuel
7	TAM Pulse (–)
8	TAM Pulse (+)
9	—
10	Sedimenter
11	Front Fog
12	—
13	—
14	—
15	Glow
16	Battery
17	Vehicle Speed Sensor
18	—
19	—
20	Ground

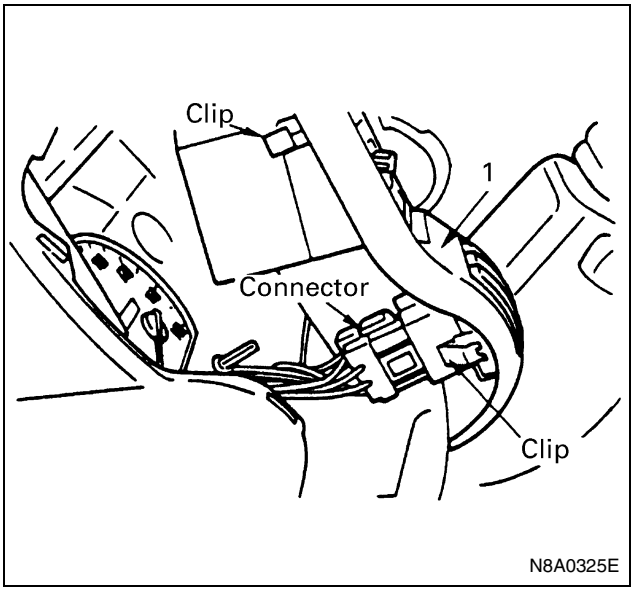
Terminal No.	Connected to
1	Battery
2	—
3	Ground

Removal

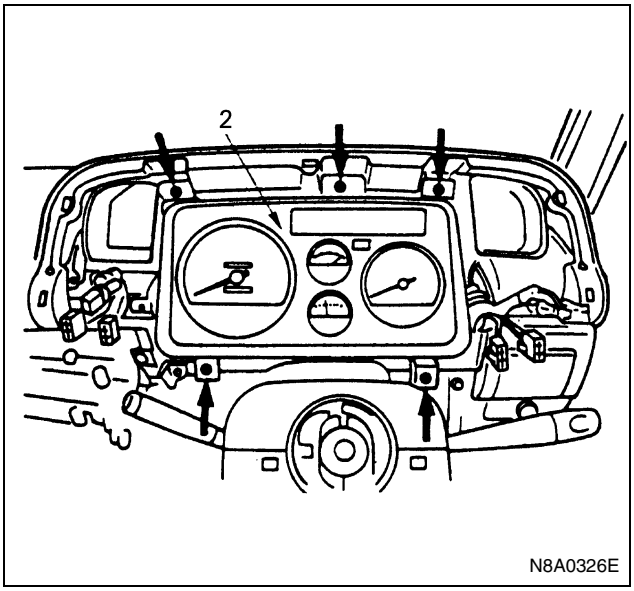
Preparation:

Disconnect the battery ground cable.

1. Meter Cluster



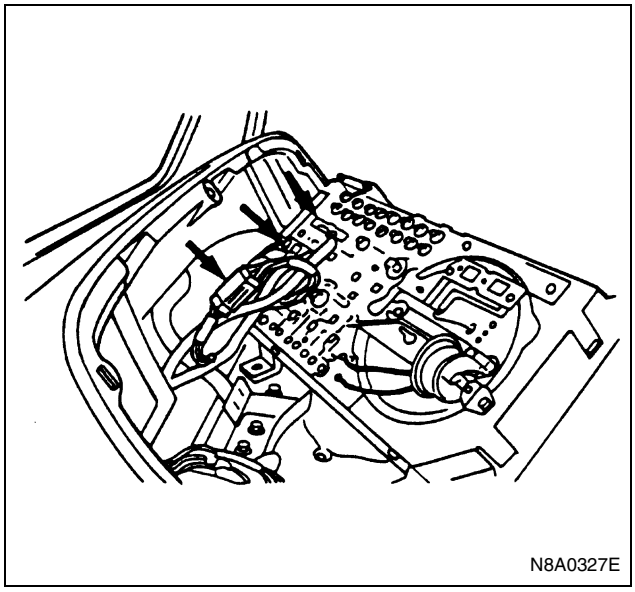
2. Meter Assembly
   Remove the five screws.



   Disconnect the meter connectors.

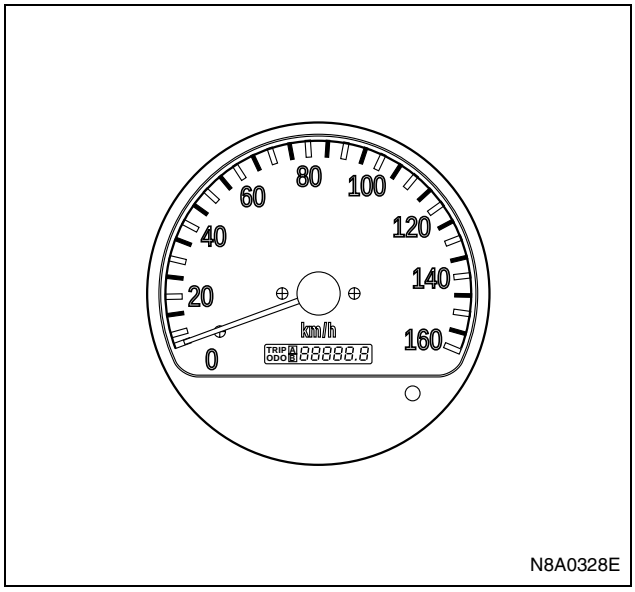
Installation

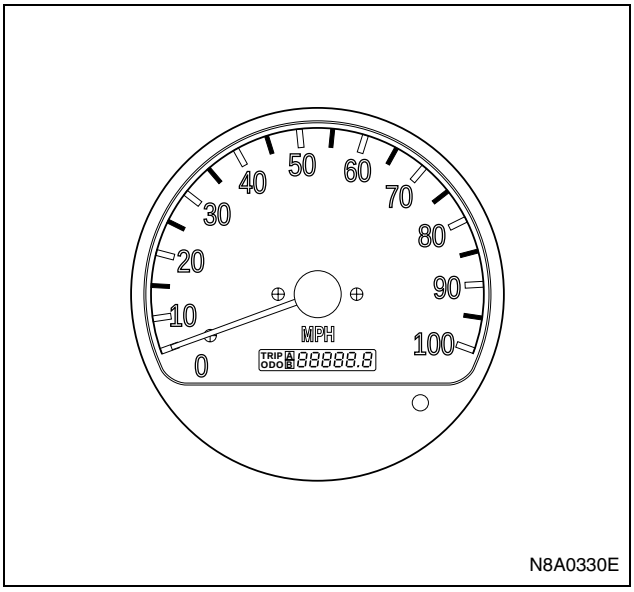
To install, follow the removal steps in the reverse order.



Speedometer

The speedometer is made up of the cross coil type ammeter (movement) that displays indications, the stepper motor that drives and adds up the odometer and trip meter, and the driving circuit (printed circuit board) that makes exchanges between the pulse signals and the current.





On-vehicle Service

Check the meter display accuracy and the operation of the odometer with the speedometer tester.

Notice:

Inappropriate tire inflation may affect the accuracy of the odometer.

(To conduct this test, refer to the tester manufacturer's instruction manual.)

Since the meter display permissible levels above are specifications solely for the meter, they are to be used as reference values when conducting on-vehicle service.

Except 4HK1-TC

Tester display speed	Meter display permissible level
20 km/h	17.5 — 22.5 km/h
40	37.5 — 42.5
60	57.5 — 62.5
80	77.5 — 82.5
100	97.6 — 103.4
120	117.6 — 123.4
140	137.6 — 143.4

Tester display speed	Meter display permissible level
20 MPH	18.3 — 21.7 MPH
40	38.3 — 41.7
60	58.3 — 61.7
80	77.8 — 82.8

For 4HK1-TC (General Export)

Tester display speed	Meter display permissible level
40 km/h	37 — 41 km/h
60	58 — 62
80	77.5 — 82.5
100	97.5 — 103
120	117 — 122.5
140	137.5 — 143

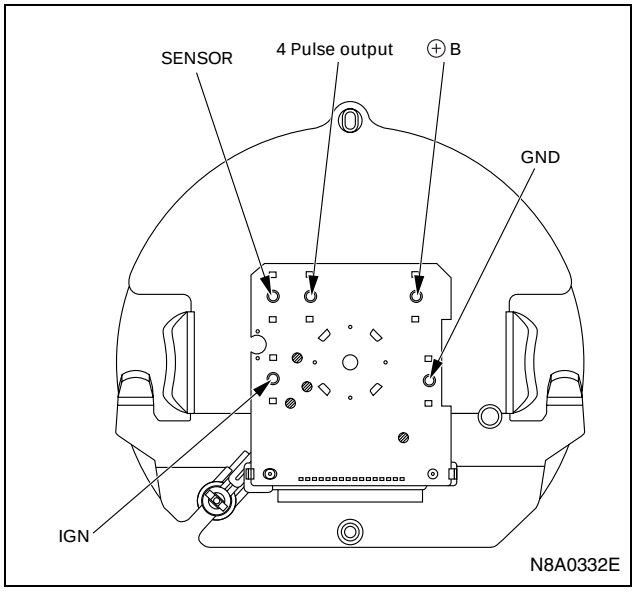
For 4HK1-TC (Europe)

Tester display speed	Meter display permissible level
20 km/h	20 — 22.5 km/h
40	40 — 42.5
60	60 — 63.2
80	79.7 — 83.4

Individual Inspection

Remove the speedometer from the meter assembly and measure the resistance and the current consumption between each terminals.

Replace the speedometer when the result of inspection is found abnormal.



Terminal symbol	Resistance value
IGN — GND	58±20 kΩ
SEN — GND	70±20 kΩ
4P — GND	∞

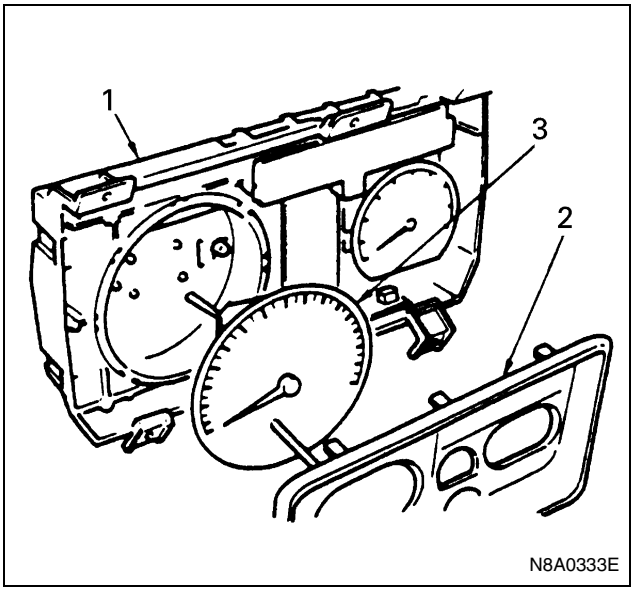
Removal

Preparation:

Disconnect the battery ground cable.

- Except 4HK1-TC

1. Meter Assembly
   Refer to “METER ASSEMBLY” in this section.
2. Meter Glass
   Remove it by pushing the catches with your finger.
3. Speedometer
   Remove four screws securing the meter at the back side.



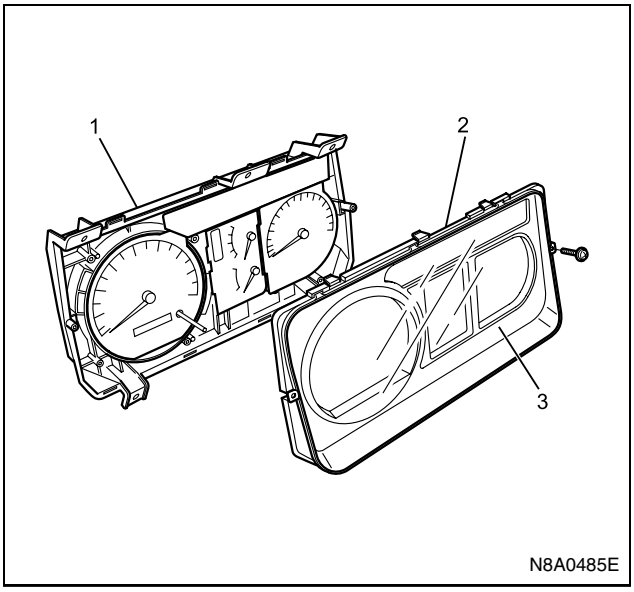
- For 4HK1-TC

1. Remove the meter assembly/speedometer (1).

Notice:
Speedometer cannot be removed as a single unit since it is integrated into the meter assembly.

- Refer to “Meter Assembly” in this section.

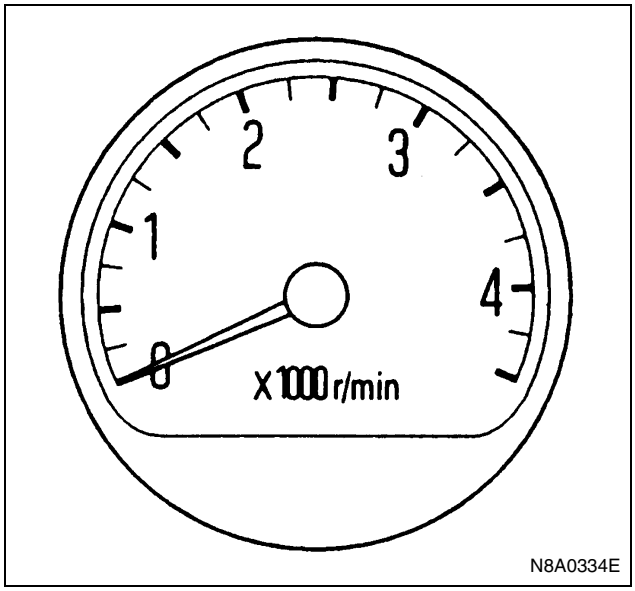
2. Remove the meter plate (2) and meter glass (3).
   - Remove the two installing screws on the meter surface.
   - Remove the meter plate by pushing the catches with your finger.



Installation
To install, follow the removal steps in the reverse order.

Tachometer

The tachometer is made up of the cross coil type ammeter (movement) that displays indications, and the drive circuit (printed board) that makes exchange between the pulse signals and the current.



On-vehicle Service Inspection

1. Set up the tune-up tester to the engine.
2. Start the engine and compare the readings displayed by the tachometer and the tester.
   When the difference between these two readings differs largely from the specified value, replace it with a correct one.

Notice:
Since the meter display permissible levels above are specifications solely for the meter, they are to be used as reference values when conducting on-vehicle inspection.

Except 4HK1-TC

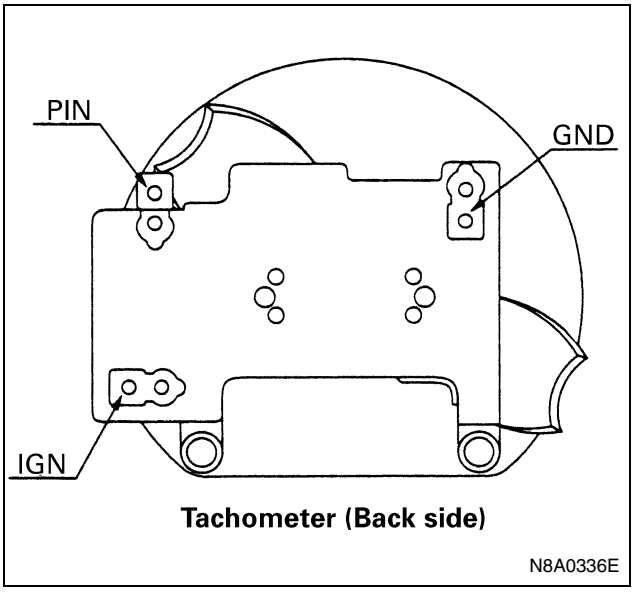
Tester display speed	Meter display permissible level
500	400 — 500
1000	800 — 1050
2000	1800 — 2050
3000	2800 — 3050
4000	3800 — 4050

For 4HK1-TC

Tester display speed	Meter display permissible level
750	700 — 800
2000	1900 — 2150
3000	2950 — 3200
4000	3950 — 4200

Individual Inspection

Remove the tachometer from the meter assembly and measure the resistance value and the current consumption between each terminals.
Replace the tachometer when the result of inspection is found abnormal.



Tachometer (Back side)

N8A0336E

1. Resistance value

Use the analog type circuit tester. (Range: 1K)
For 12 Volt tachometer

Terminal symbol	Tester terminal			
	Red (+)	Black (–)	Black (–)	Red (+)
IGN–GND	IGN	GND	IGN	GND
	∞		30±5 kΩ	
PIN–GND	PIN	GND	PIN	GND
	33±5 kΩ		500 — 1000 kΩ	

For 24 Volt tachometer

Terminal symbol	Tester terminal			
	Red (+)	Black (–)	Black (–)	Red (+)
IGN — GND	IGN	GND	IGN	GND
	∞		30±5 kΩ	
PIN — GND	PIN	GND	PIN	GND
	33±5 kΩ		500 — 1000 kΩ	

2. Current value

Use the analog type circuit tester.
Since the current consumption fluctuates as the power voltage varies, check to be sure that the voltage applied is 12±1 V or 24±1 V.

Voltage	Connecting terminal	Current consumption	Remarks
12Volt	IGN — GND	12±1 V (when 12±1 V applied)	No signal input
24Volt		24±1 V (when 24±1 V applied)	No signal input

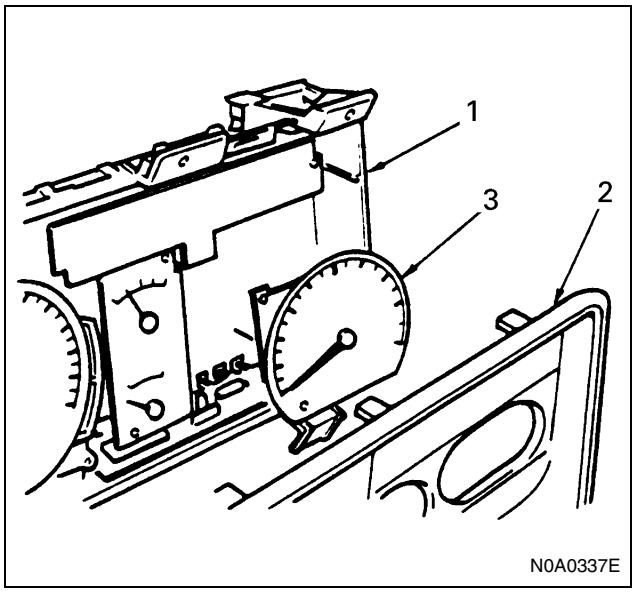
Removal

Preparation:

Disconnect the battery ground cable.

- Except 4HK1-TC

1. Meter Assembly
   Refer to “METER ASSEMBLY” in this section.
2. Meter Glass
   Remove it by pushing the catches with your finger.
3. Tachometer
   Remove three screws securing the meter at the back side.



N0A0337E

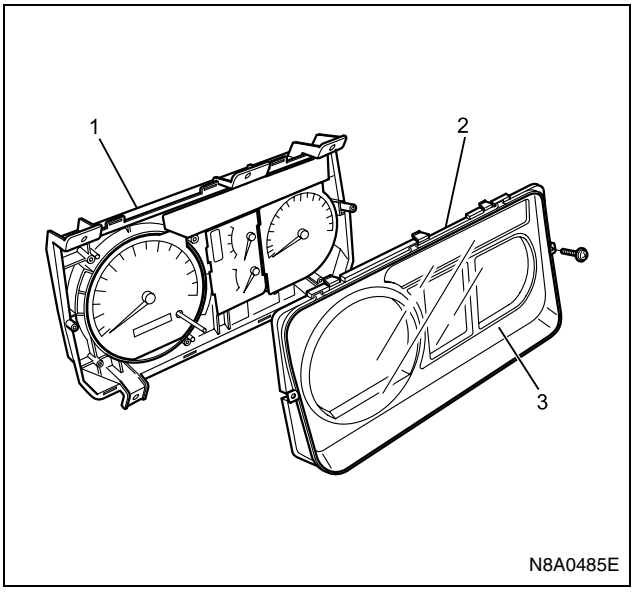
- For 4HK1-TC

1. Remove the meter assembly/tachometer (1).

Notice:
Tachometer cannot be removed as a single unit since it is integrated into the meter assembly.

- Refer to “Meter Assembly” in this section.

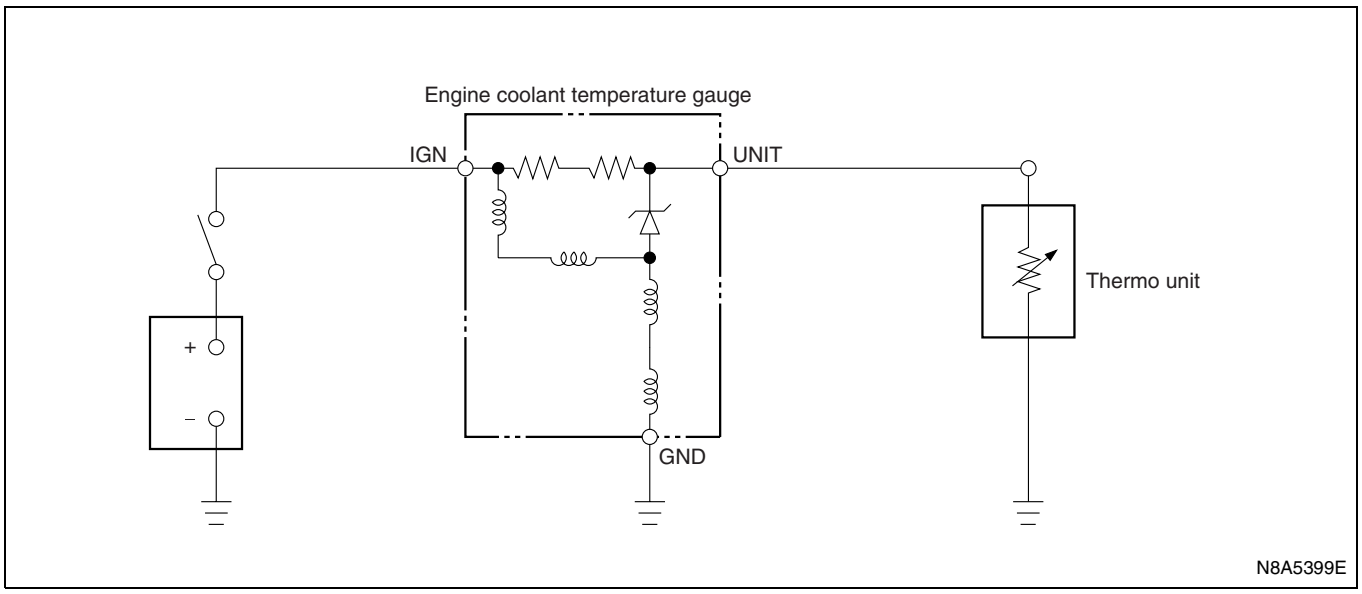
2. Remove the meter plate (2) and meter glass (3).
   - Remove the two installing screws on the meter surface.
   - Remove the meter plate by pushing the catches with your finger.



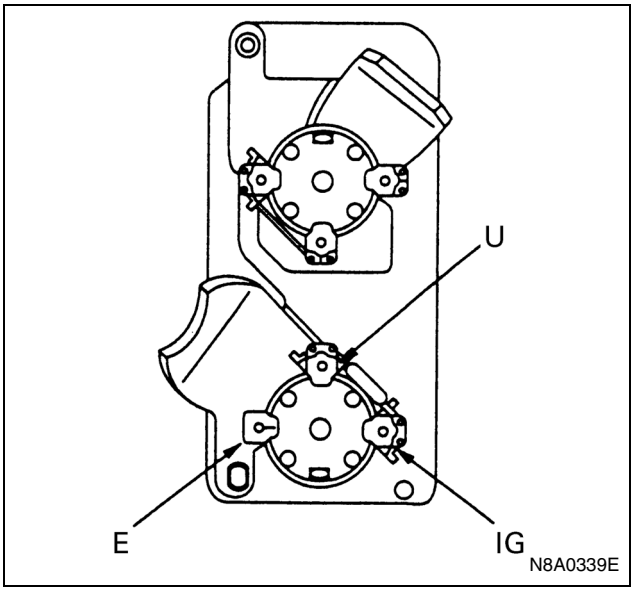
Installation
To install, follow the removal steps in the reverse order.

Coolant Temperature Gauge

Circuit Diagram



Inspection
Remove the coolant temperature gauge from the meter assembly, and measure the resistance value between each terminal.
Replace the coolant temperature gauge when the result of inspection is found abnormal.



Terminal symbol	Resistance value
IG — U	169 Ω±10%
U — E	333 Ω±10%
IG — E	242 Ω±10%

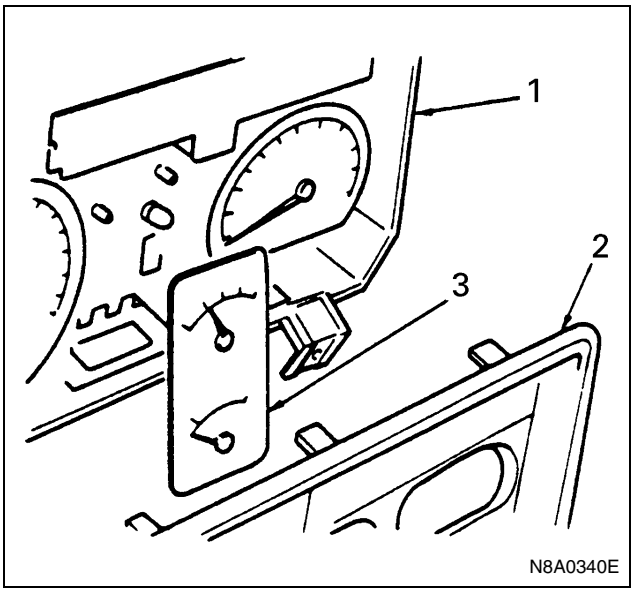
Removal

Preparation:

Disconnect the battery ground cable.

- Except 4HK1-TC

1. Meter Assembly
   Refer to “METER ASSEMBLY” in this section.
2. Meter Glass
   Remove it by pushing the catches with your finger.
3. Coolant Temperature Gauge
   Remove six screws securing the meter at the back side.



- For 4HK1-TC

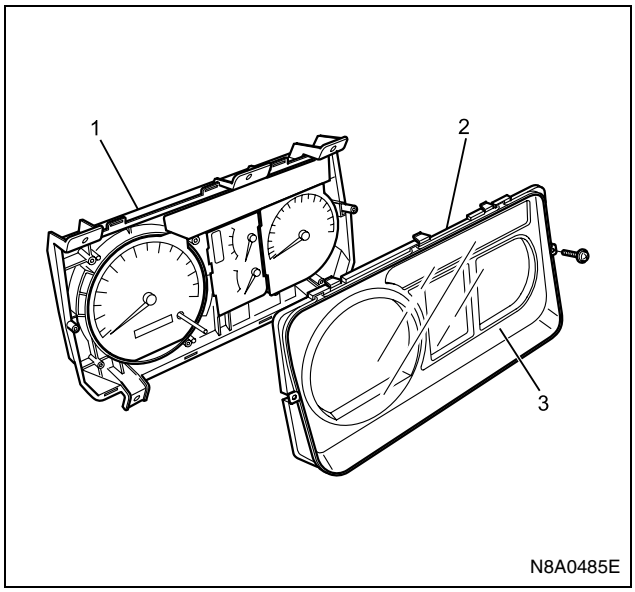
1. Remove the meter assembly (1).

Notice:

Coolant temperature gauge and fuel gauge cannot be removed as a single unit since they are integrated into the meter assembly.

- Refer to “Meter Assembly” in this section.

2. Remove the meter plate (2) and meter glass (3).
   - Remove the two installing screws on the meter surface.
   - Remove the meter plate by pushing the catches with your finger.

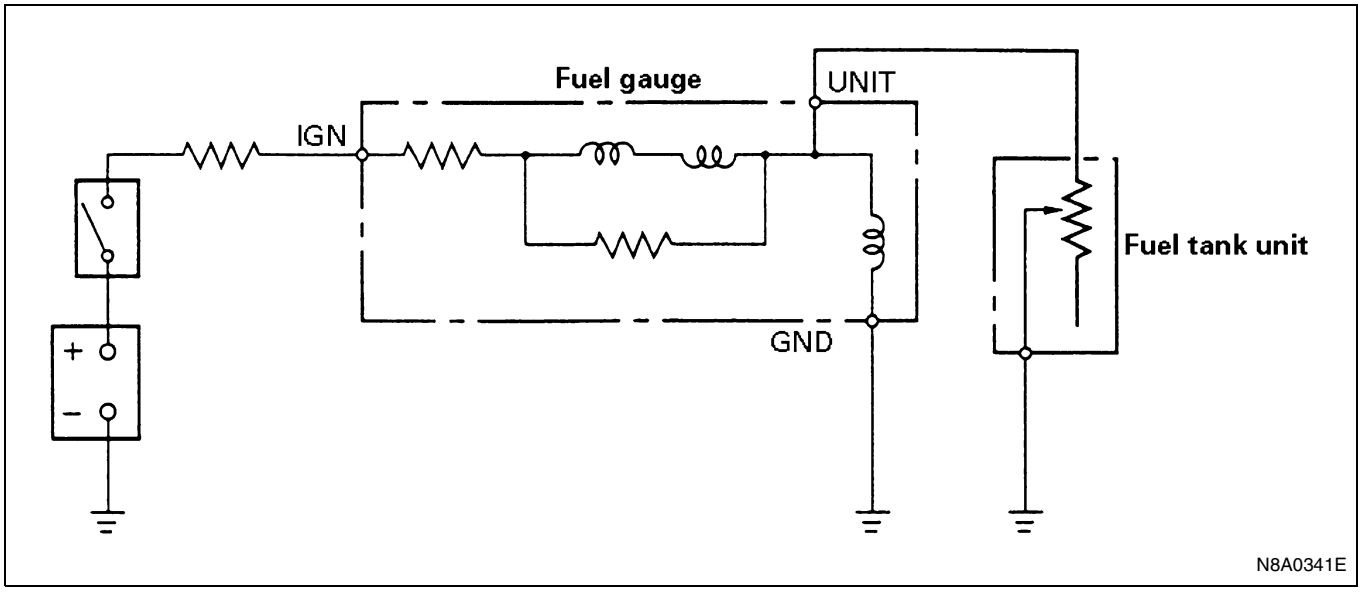


Installation

To install, follow the removal steps in the reverse order.

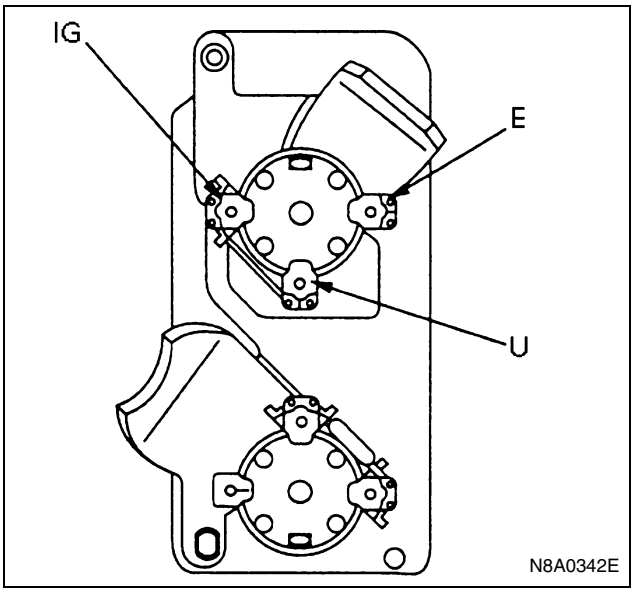
Fuel Gauge

Circuit Diagram



Inspection

Remove the fuel gauge from the meter assembly, and measure the resistance value between each terminal. Replace the meter when the result of inspection is found abnormal.



Terminal symbol	Resistance value
IG — U	108.1 Ω±10%
U — E	103 Ω±10%
IG — E	211.1 Ω±10%

Removal and Installation

Refer to the “COOLANT TEMPERATURE GAUGE” in this section.

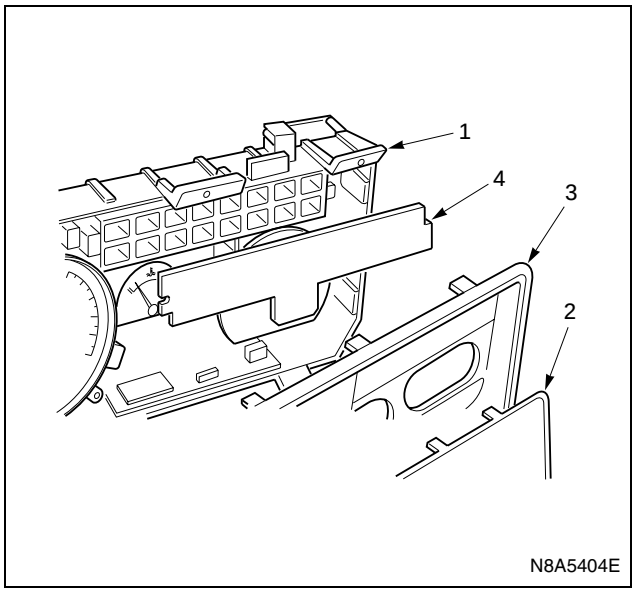
Warning Lens

Removal

Preparation:

Disconnect the battery ground cable.

1. Meter Assembly
   Refer to “METER ASSEMBLY” in this section.
2. Meter Glass
   Remove it by pushing the catches with your finger.
3. Meter Plate
   Remove it by pushing the catches with your finger.
4. Warning Lens



Legend

1. Meter Assembly
2. Meter Glass
3. Meter Plate
4. Warning Lens

Installation

To install, follow the removal steps in the reverse order.

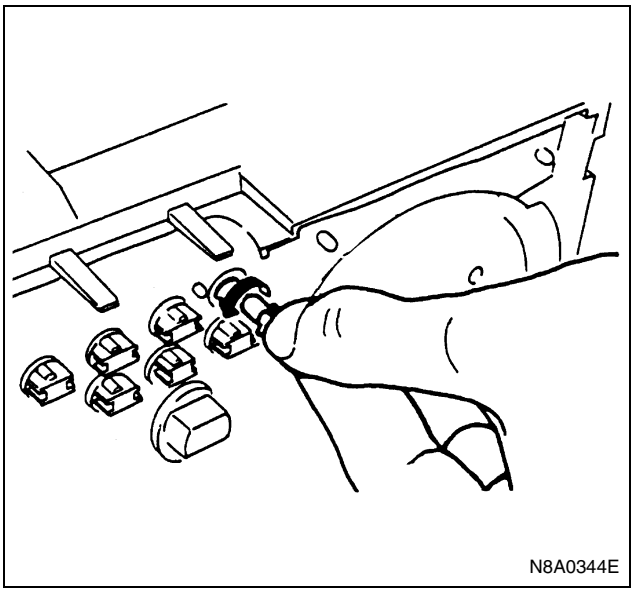
Warning Light Bulb, Indicator Light Bulb and Illumination Light Bulb

Removal

Preparation:

Disconnect the battery ground cable.

1. Meter Assembly
   Refer to “METER ASSEMBLY” in this section.
2. Socket and Bulb
   Hold the bulb socket by hand and rotate it counterclockwise to remove them from the meter body.
3. Bulb
   Pull out the bulb from the socket.



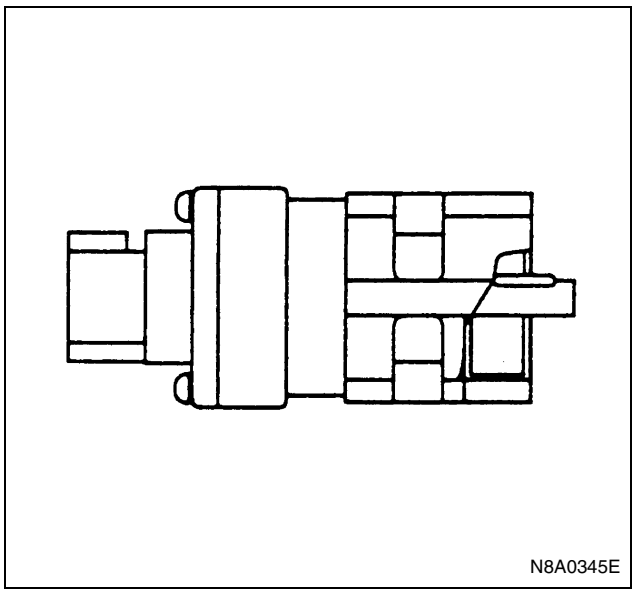
N8A0344E

Installation

To install, follow the removal steps in the reverse order.

Vehicle Speed Sensor

The vehicle speed sensor is installed on the rear portion of the transmission or transfer case.
The number of pulses generated is four pulses per one rotation of the pinion shaft.



N8A0345E

Inspection

1. Connect a resistance of 390 Ω±5%, 2W between connector terminal 1 J-32 and battery (+) terminal and connect the connector terminal 2 J-32 to the battery (−) terminal.

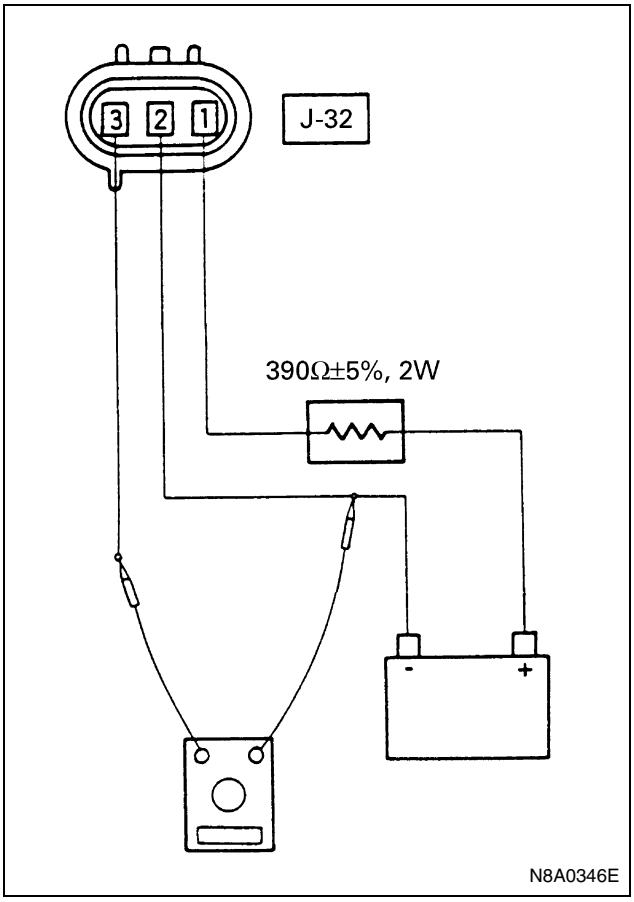
Caution:

Be extremely careful not to connect the battery (+) terminal to the connector 3 J-32.

This may damage the vehicle speed sensor.

2. Rotate the shaft of the vehicle speed sensor slowly and measure the voltage between 3 J-32 and 2 J-32 with a digital tester.

The voltage, with one rotation of shaft, fluctuates four times in the following range: 10 to 14V ↔ 24 or less.
Replace the sensor when the result of inspection is found abnormal.

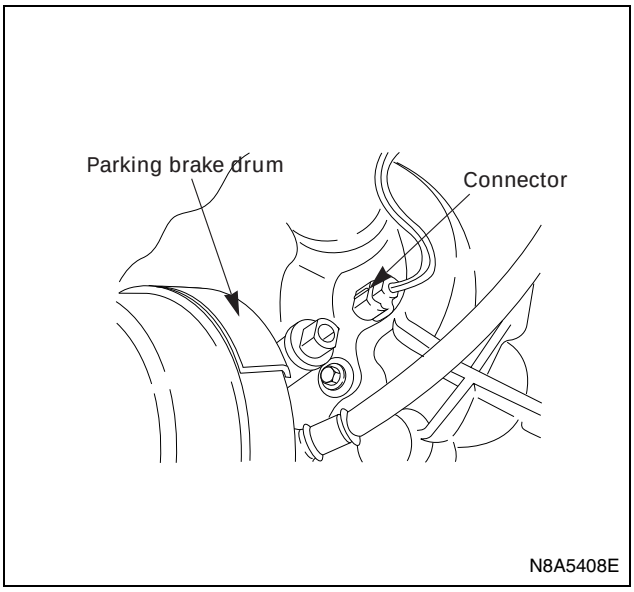


Removal

Preparation:

Disconnect the battery ground cable.

1. Vehicle Speed Sensor
   Disconnect the connector.



Installation

1. Tighten the vehicle speed sensor to the specified torque.

Tighten:

Vehicle speed sensor to 25 N·m (2.5 kg·m/18 lb·ft)

Caution:

Tightening must be made at the hexagonal part of the sensor.

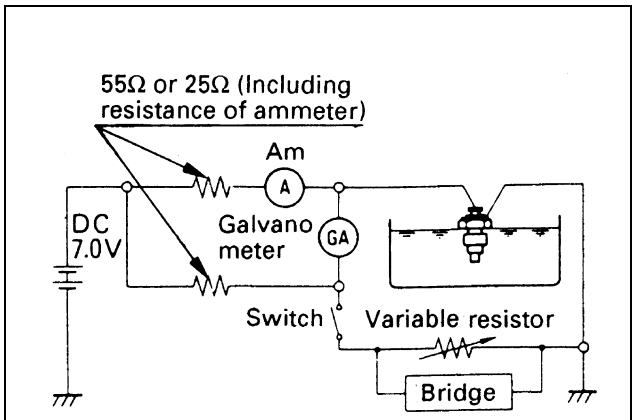
To tighten the connector itself would cause damage.

Thermo Unit

Inspection

The thermo unit is thermistor type and must be inspected under the conditions as shown below.

1. Put the deviation of the galvanometer to 0 by using the variable resistor, switch the thermo unit off and then measure the resistance of the resistor through the bridge.
   Confirm that the resistance is continuously variable in any other points than those shown below.
2. Dip the thermo unit into 80 — 90°C (176 — 194°F) water and confirm that there is no bubble continuously coming out of inside of the unit.
   Replace the unit when the result of inspection is found abnormal.



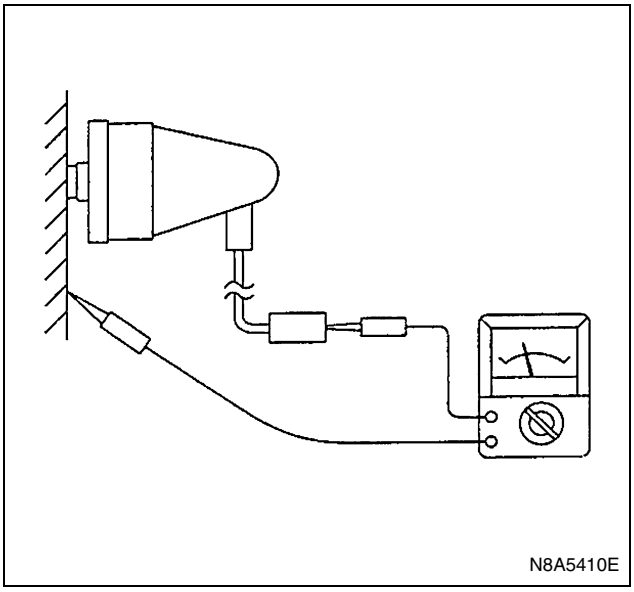
Check condition \ Temperature		50°c (112°F)	115°c (239°F)
7V 55Ω Gauge	Resistance value (Ω)	+33.6 −36.6 226.0	+1.71 −2.21 26.4
7V 25Ω Gauge		–	+2.68 −3.68 24.3

N8A5409E

Oil Pressure Switch

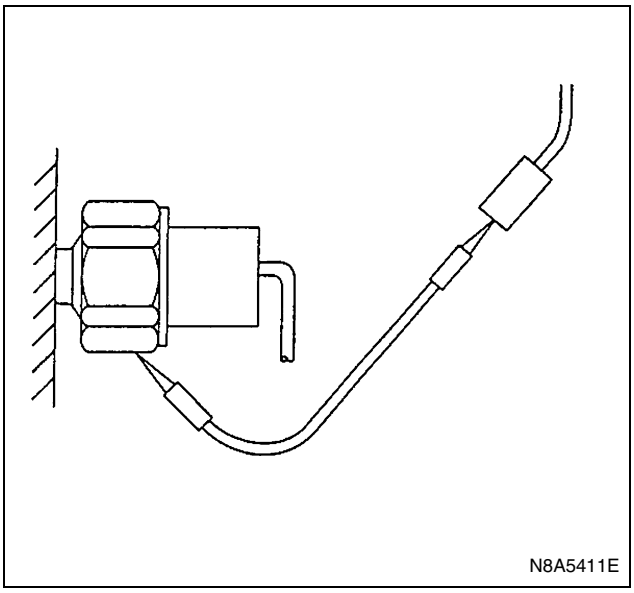
Inspection

Check the continuity between the switch terminal and the body ground with the starter switch is OFF position. Replace the switch when the result of inspection is found abnormal.


N8A5410E

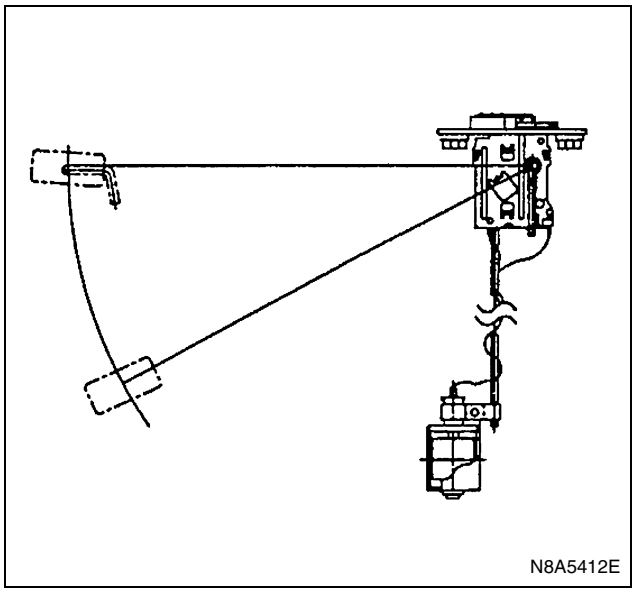
Circuit Inspection

1. Start the engine.
2. When disconnecting the oil pressure switch connector then connecting the harness side connector to the ground, check to see if the oil pressure warning light lights up. When the light will not light up, check the circuit between the meter and the oil pressure switch, and repair an open circuit if necessary.


N8A5411E

Fuel Tank Unit

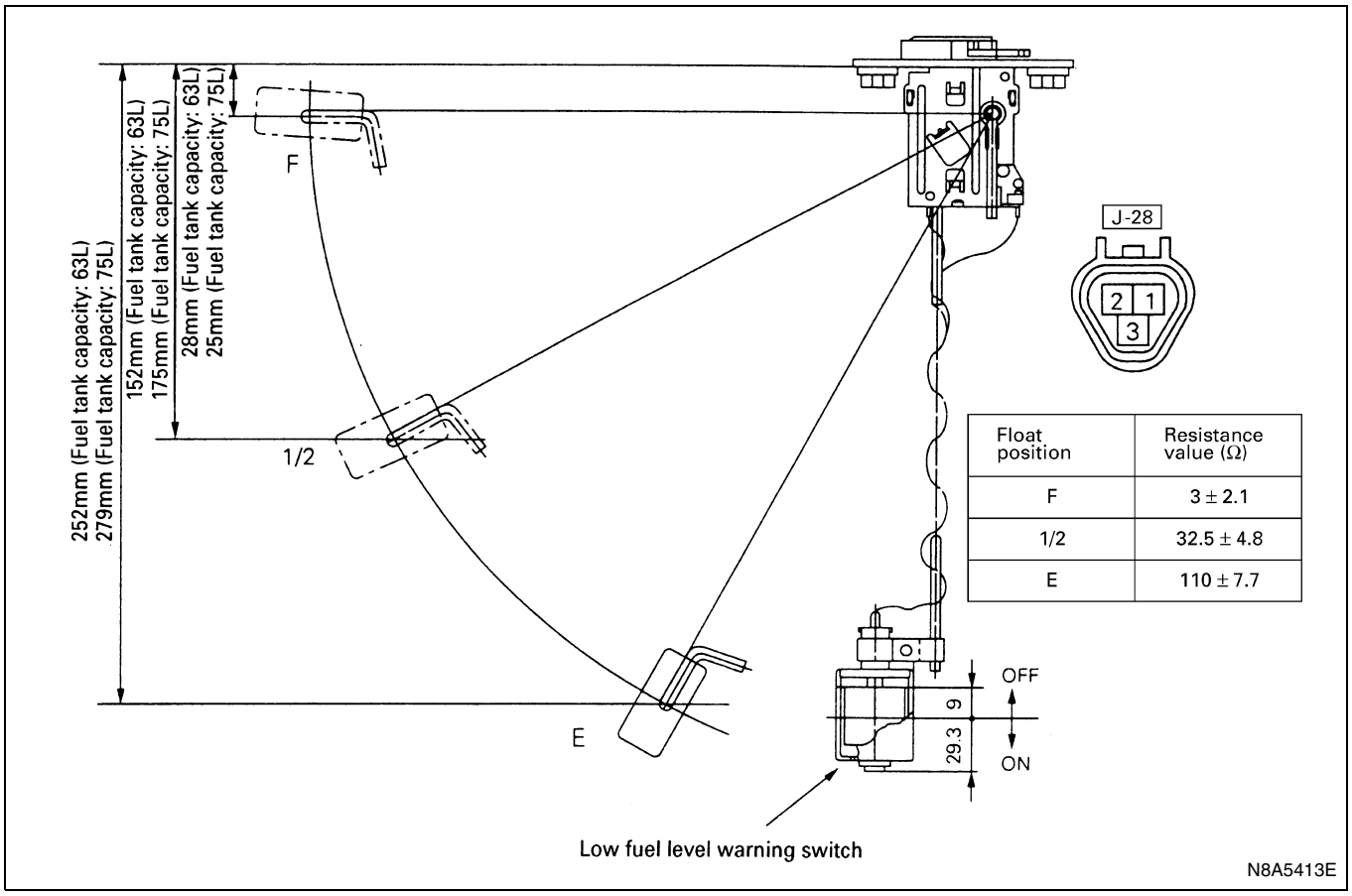
The tank unit varies the internal resistance according to the float position (fluid level) to operate the fuel meter needle. Also available is the build-in switch type to warn the driver of low fuel level (about 5 liters left in the tank) by illuminating the fuel warning light.


N8A5412E

Inspection

(Level Switch type of warn low fuel level)

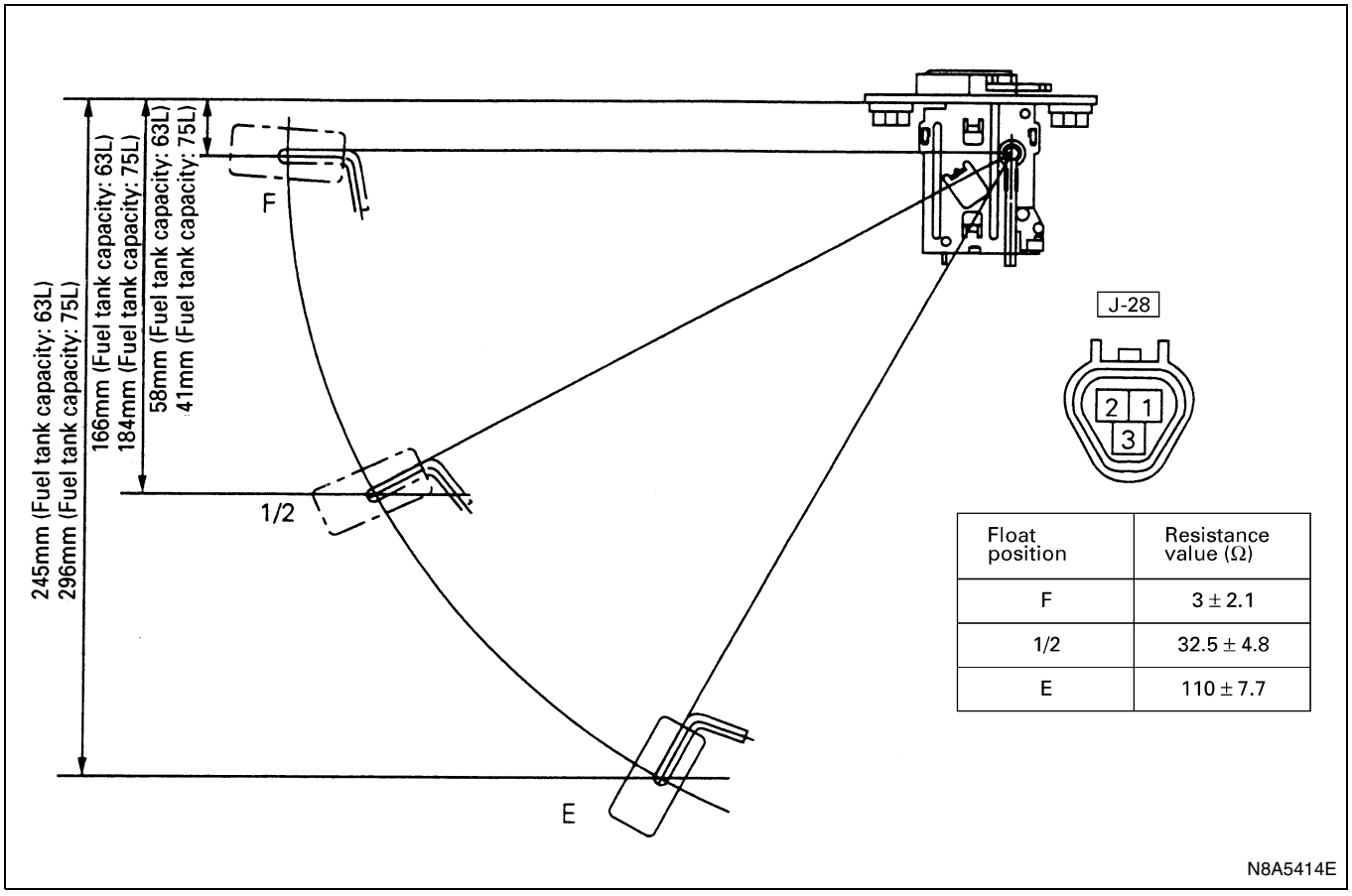
1. Check the resistance between the connector terminals 1 J-28 and 3 J-28 while shifting the float from “E” to “F” point.
2. Check if the low fuel warning switch turns on and off at the specified positions. If found defective, replace the fuel tank unit.



Float position	Resistance value (Ω)
F	3 ± 2.1
1/2	32.5 ± 4.8
E	110 ± 7.7

(Float type of warn low fuel level)

1. Check the resistance between the connector terminals 1 J-28 and 3 J-28 while shifting the float from “E” to “F” point.
2. Check if the low fuel warning light turns on when the float is at “E” position. If found defective replace the fuel tank unit.



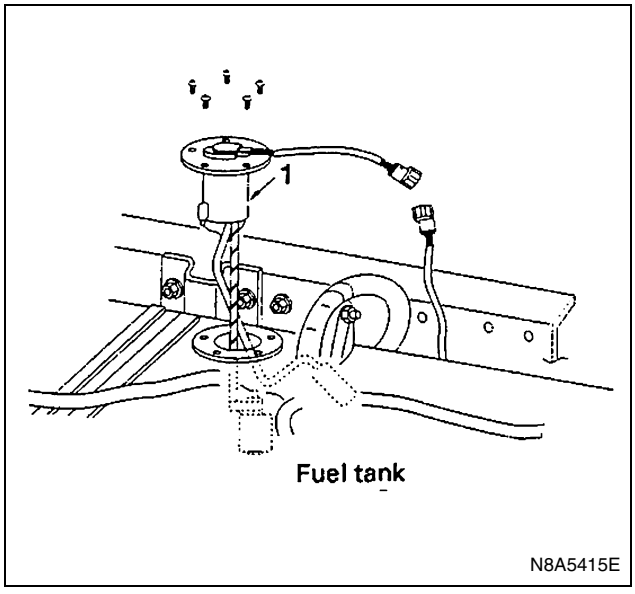
Float position	Resistance value (Ω)
F	3 ± 2.1
1/2	32.5 ± 4.8
E	110 ± 7.7

Removal

Preparation:

Disconnect the battery ground cable.

1. Fuel Tank Unit
   1) Disconnect the connector.
   2) Remove five screws.



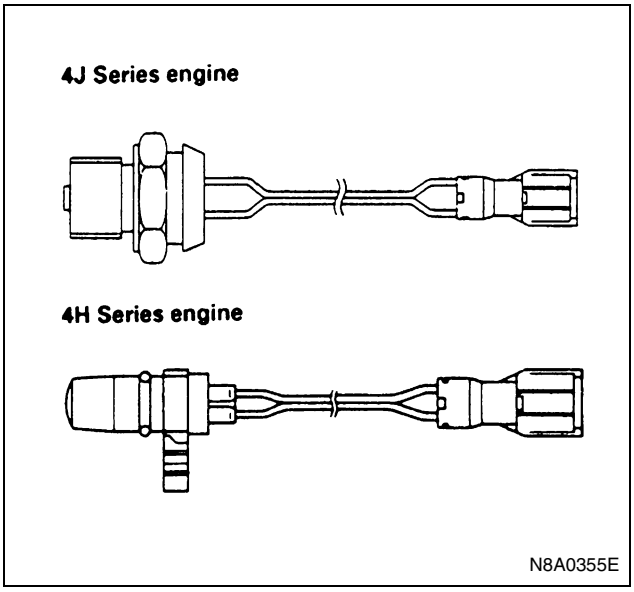
Installation

To install, follow the removal steps in the reverse order.

Engine Speed Sensor

Inspection

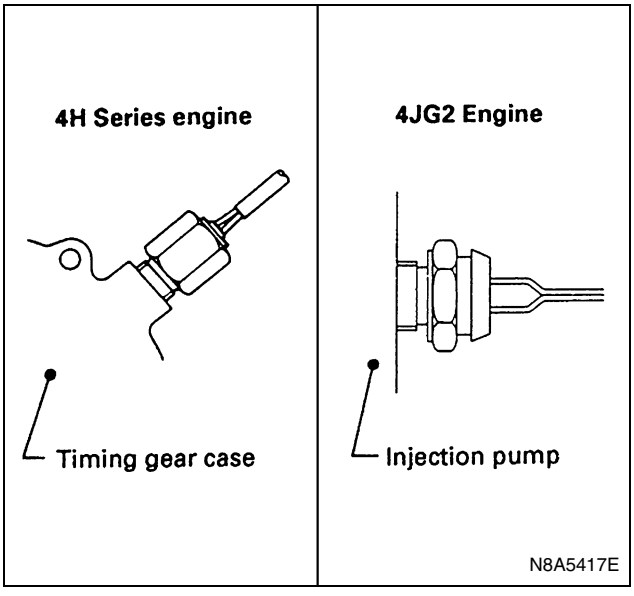
Measure the resistance value between the engine speed sensor connector terminals.
Replace the engine speed sensor when the result of inspection is found abnormal.
4J Series engine = 1.36 — 1.86 KΩ
4H Series engine = 0.57 — 0.86 KΩ



Removal

Preparation:
Disconnect the battery ground cable.

1. Engine Speed Sensor
   1) Disconnect the connector.
   2) Remove the engine speed sensor.



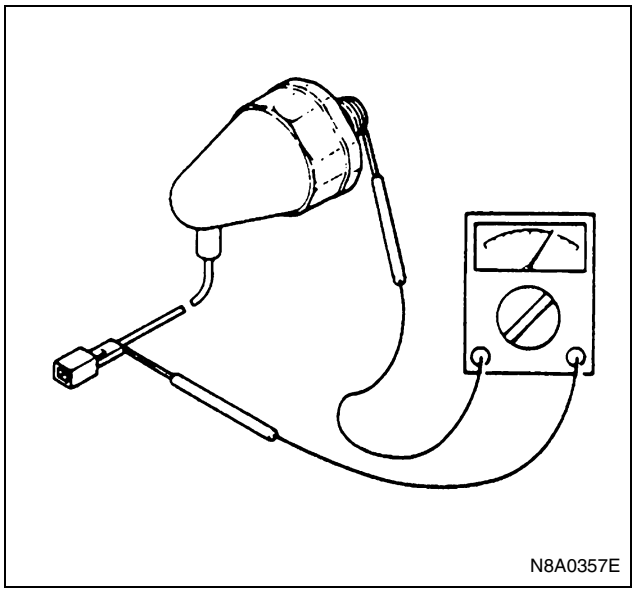
Installation

To install, follow the removal steps in the reverse order.

Vacuum Switch

Inspection

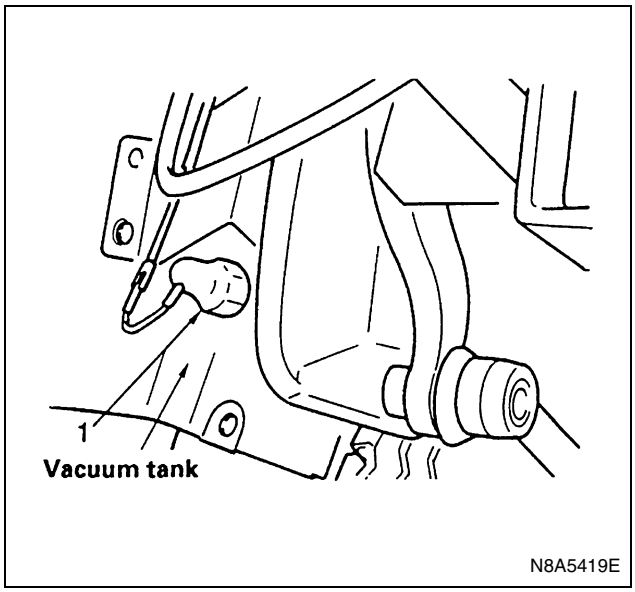
When the pressure value is below 250±30 mm Hg (33.3±4.0 kPa), check to see if there is continuity between the terminal and the ground. If no continuity, replace the switch with a normal one.



Removal

Preparation:
Disconnect the battery ground cable.

1. Vacuum Switch
   1) Disconnect the connector.
   2) Remove the vacuum switch.



Installation

Apply liquid gasket to the screw portion of the switch to prevent vacuum leak.

Vacuum Warning Buzzer

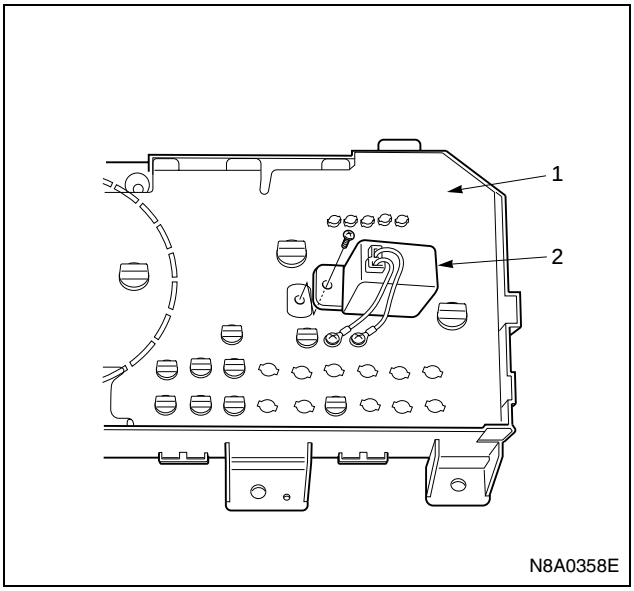
Inspection

Apply battery voltage to the buzzer connector terminals to check the buzzer sound.
Replace the buzzer when the result of inspection is found abnormal.

Removal

Preparation:
Disconnect the battery ground cable.

1. Meter Assembly
   Refer to “METER ASSEMBLY” in this section.
2. Vacuum Warning Buzzer
   1) Disconnect the connector.
   2) Remove the buzzer fixing screw.



Legend

1. Meter Assembly
2. Vacuum Warning Buzzer

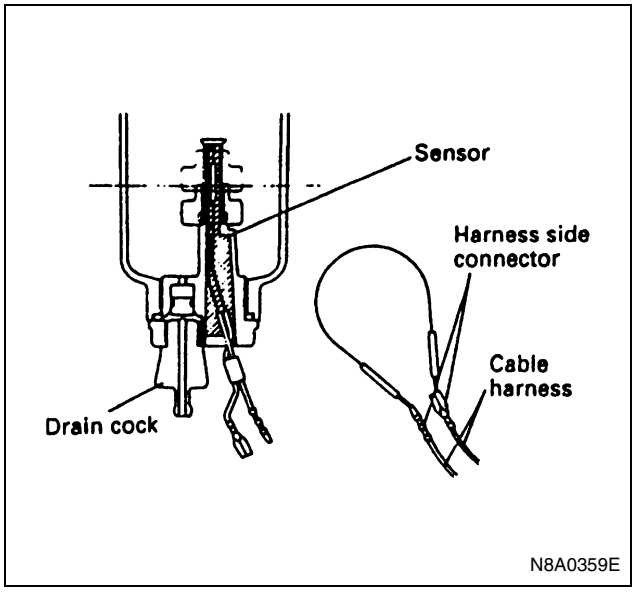
Installation

To install, follow the removal steps in the reverse order.

Water Sedimenter Switch

Inspection

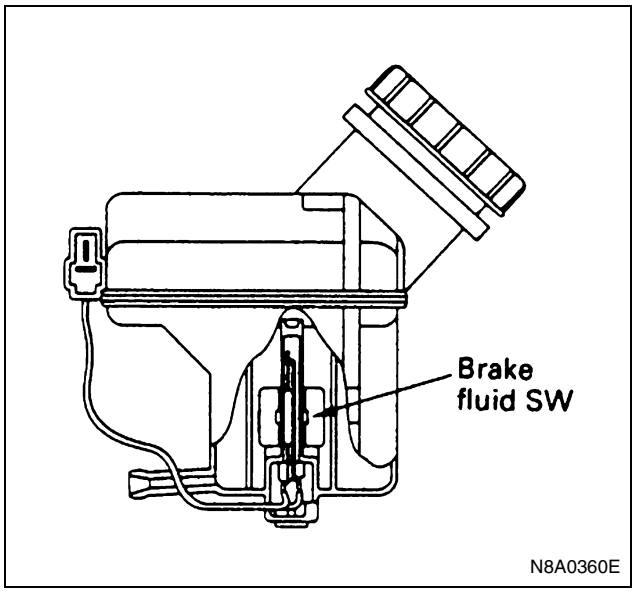
1. When the float in the water sedimenter is above the drain warning level, confirm if there is continuity between the switch connector terminals.
2. Turn the starter switch on, disconnect the water sedimenter connector and connect the harness side connector terminals. Then confirm that the sedimenter warning light turns on.
   If found defective, replace the switch or repair a poor connection or an open circuit between the connector terminals.



Brake Fluid Switch

Inspection

1. Confirm there is continuity between the switch connector terminals when the brake fluid in the tank is between 60 — 75 cc level.
2. Turn the switch on, disconnect the brake fluid switch connector and connect the harness side connector terminals. Then confirm that brake warning light turns on.
   If found defective, replace the tank, or repair a poor connection or an open circuit between the connector terminals.



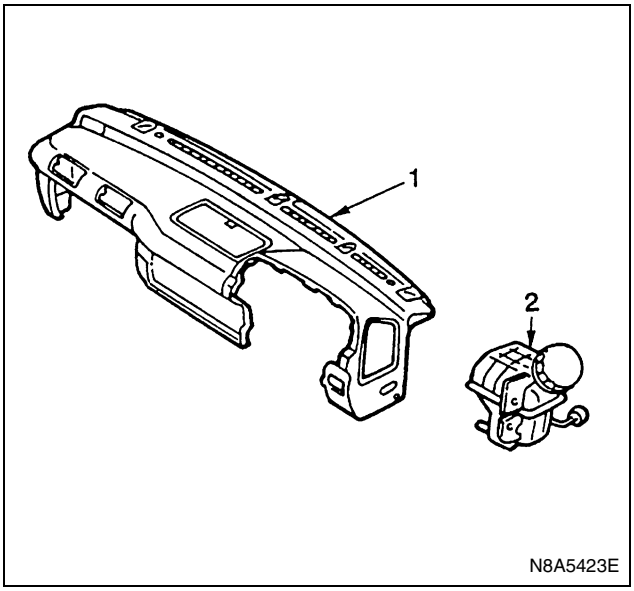
Removal

Preparation:
Disconnect the battery ground cable.

1. Instrument Panel Assembly
   Refer to “INSTRUMENT PANEL” of section 2.
2. Brake Fluid Tank (Brake Fluid Switch)
   1) Disconnect the switch connector.
   2) Remove four fixing nuts.

3) Drain brake fluid in the tank.
4) Disconnect the tubes.

Caution:
Be very careful not to allow the brake fluid to come in contact with painted surfaces or resin parts surfaces.



Installation

To install, follow the removal steps in the reverse order, noting the following points.

1. Bleed the air from brake and clutch fluid pipe line.
2. Check to see if the brake fluid level in the tank within specified level.
3. Check to see if brake warning light comes on when starter switch is turned on and then warning light goes off after the engine running.

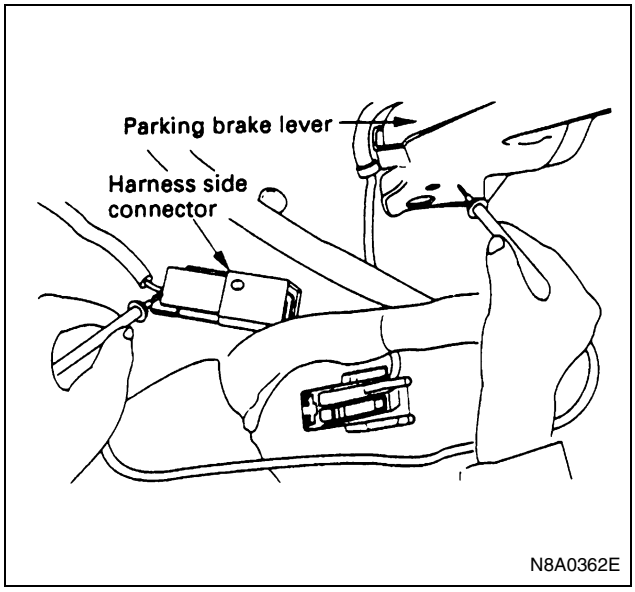
Parking Brake Indicator Light

The parking brake indicator light is connected in series with the parking brake switch installed to the parking brake lever bracket.
The light comes on when the parking brake lever is pulled, and goes out when the parking brake lever is fully released.

Notice:
The parking brake indicator light illuminates to warn the driver that the parking brake is on. This light does not indicate the condition of the operability of the parking brake.

Circuit Inspection

1. Disconnect the parking brake switch connector.
2. Connect the harness side connector terminal to the ground.
3. Check to see if the indicator light comes on with the starter switch “ON”.
   Check the bulb or the harness when the result of inspection is found abnormal.



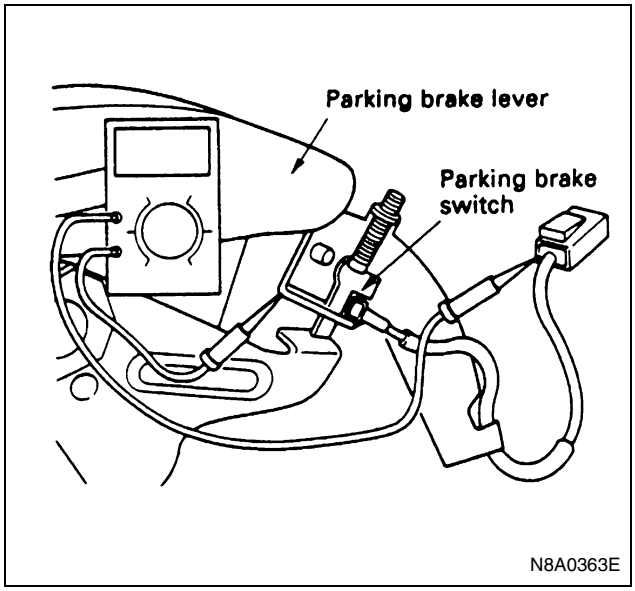
Parking Brake Switch

Inspection

1. Disconnect the parking brake switch connector.
2. Check to see if there is any continuity between the switch terminal and the body ground with the circuit tester connected between them.

When parking brake applied	Continuity
When parking brake released	No continuity

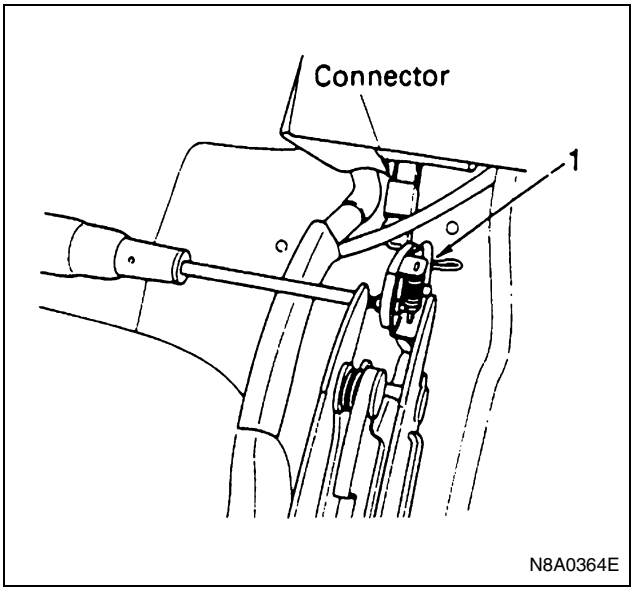
Repair the parking brake switch or replace it when the result of inspection is found abnormal.



Removal

Preparation:
Disconnect the battery ground cable.

1. Parking Brake Switch
   1) Disconnect the connector.
   2) Remove the fixing screw.



Installation

To install, follow the removal steps in the reverse order.

Parts Location

SRS Control System

General Description

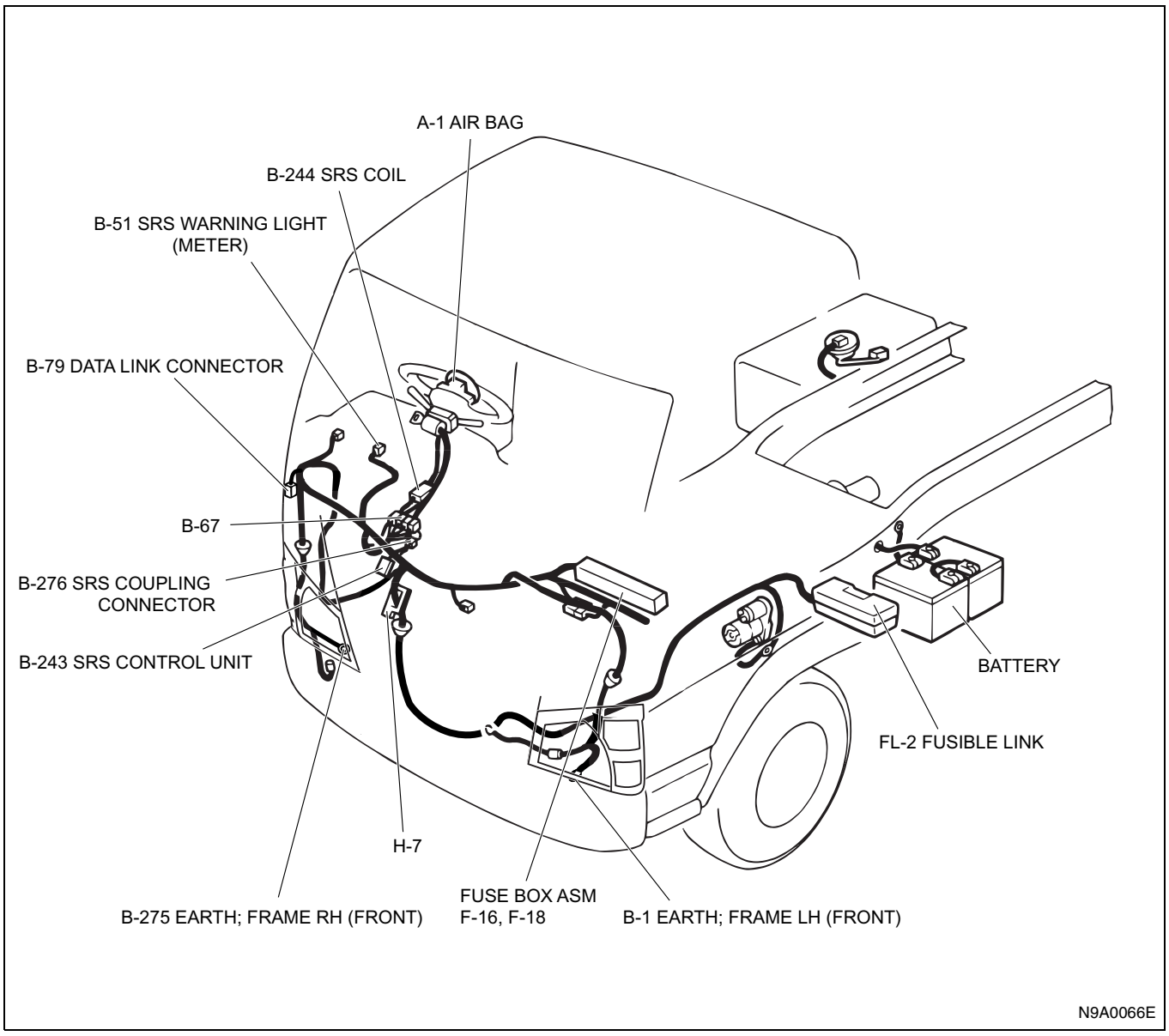
SRS airbag supplements the driver's seat belt protection by deploying airbag at the top center of the steering column.

SRS airbag deploys in case of front collision over certain degree of impact.

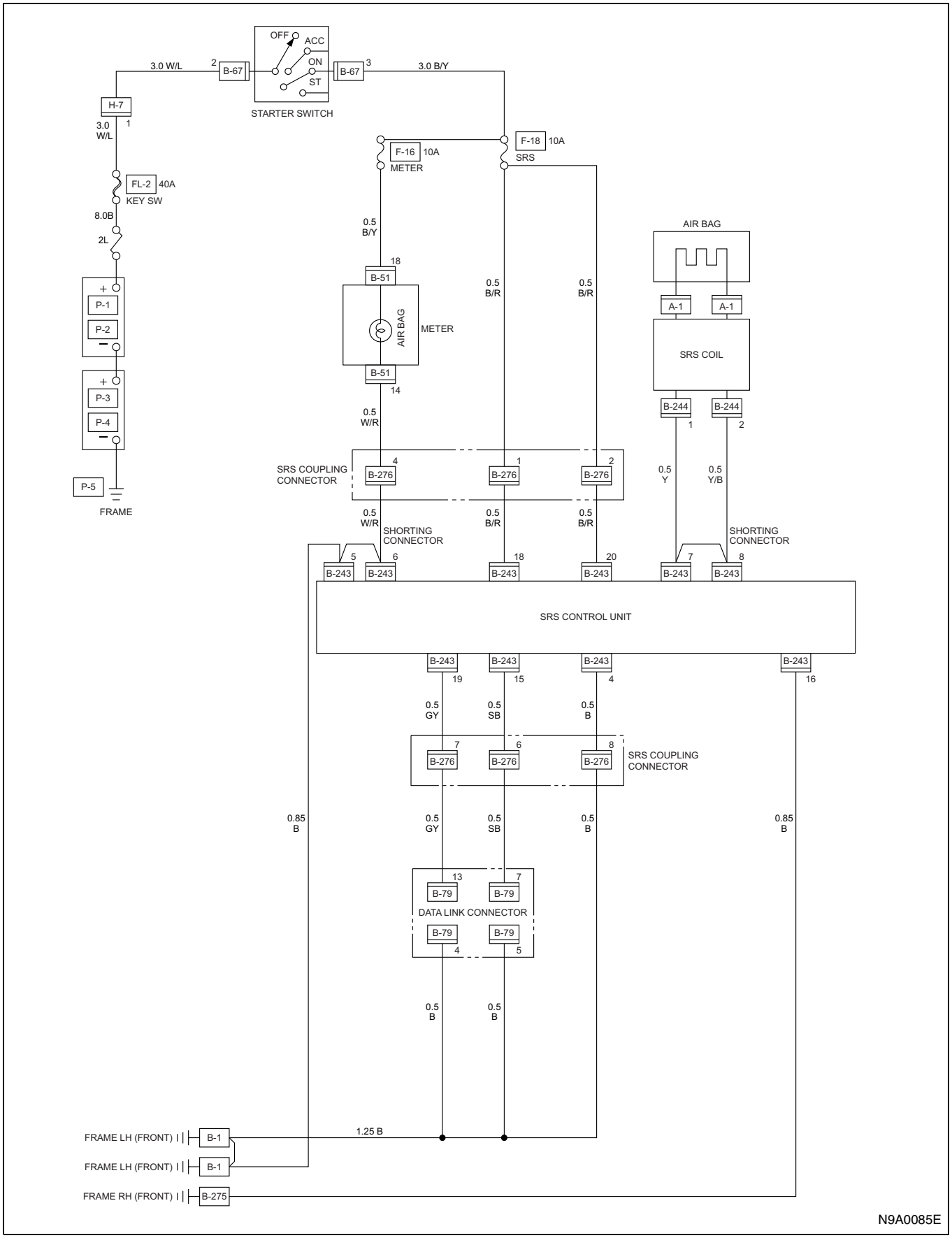
This system consists of SRS control unit, driver's SRS airbag, SRS coil assembly, exclusive wire harness, and "SRS" warning lamp in the meter and forms a deployment circuit.

A sensor is equipped to this circuit to convert the impact into an electrical signal in case of front collision over certain degree of impact. The electrical signal generated at this time will be processed in the SRS control unit to compare with the value stored in the memory.

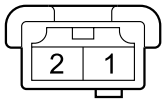
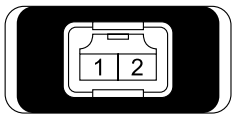
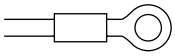
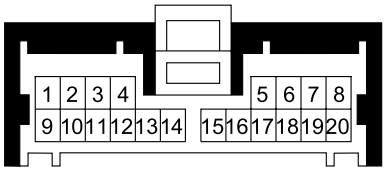
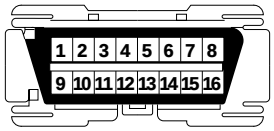
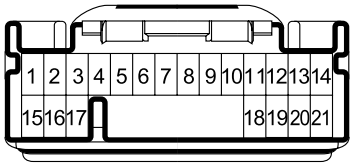
When the generated signal exceeds the setting value, SRS control unit sends sufficient current to SRS airbag for deployment.

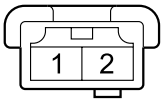
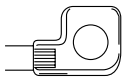
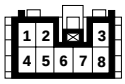
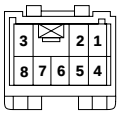
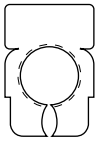
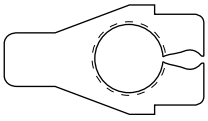
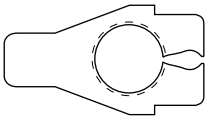


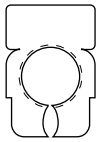
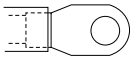
Circuit Diagram



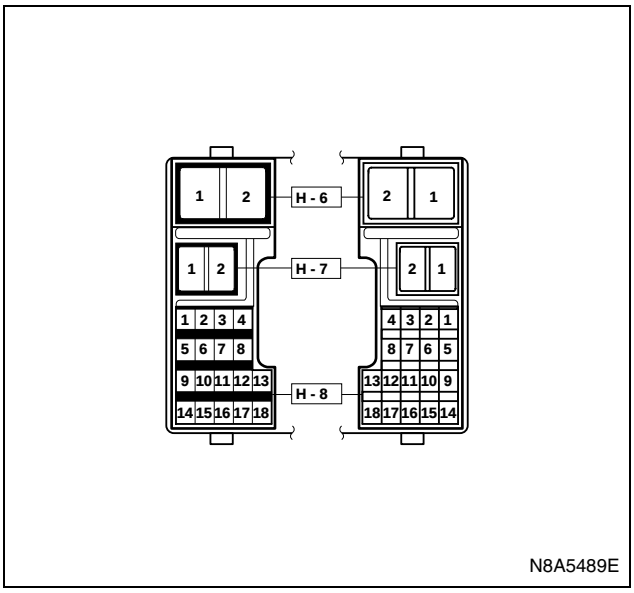
Connector List

No.	Connector Face
A-1	 002-045
A-1	 002-046
B-1	 000-001
B-51	 020-004
B-67	004-002
B-67	004-001
B-79	 016-005
B-243	 021-001

No.	Connector Face
B-244	 002-043
B-244	002-044
B-275	 000-020
B-276	 008-009
B-276	 008-010
P-1	 000-004
P-2	 000-006
P-3	 000-006

No.	Connector Face
P-4	 000-004
P-5	 000-002

H-7



Heater and Air Conditioning

General Description

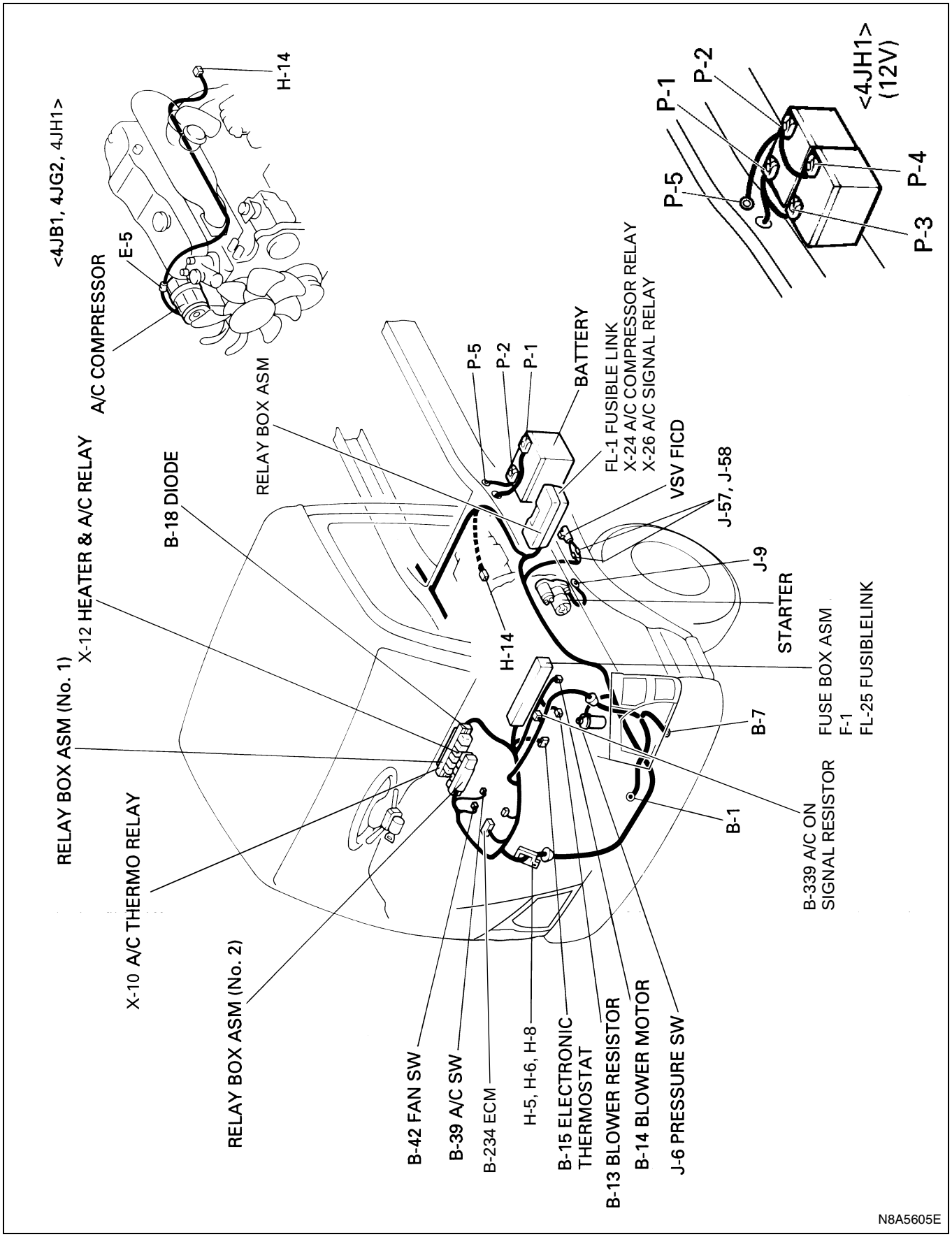
The air conditioning consists of compressor, evaporator, condenser, A/C switch, fan switch, etc. When the engine is rotating, the A/C starts to work with both the A/C and fan switches “ON”, followed by the engagement of the magnetic clutch. It stops to work when either the fan switch or the A/C switch turns “OFF”. In addition to the switches, the A/C has the function of temporary stop of its operation by the sensing system in the A/C cycle, such as:

- sensing abnormal rise of the refrigerant pressure by means of the pressure switch.
- sensing temperature of the blowing-off air by means of the thermo switch preventing the evaporator from freezing.
- sensing the coolant temperature by the thermo switch (available for limited models only).

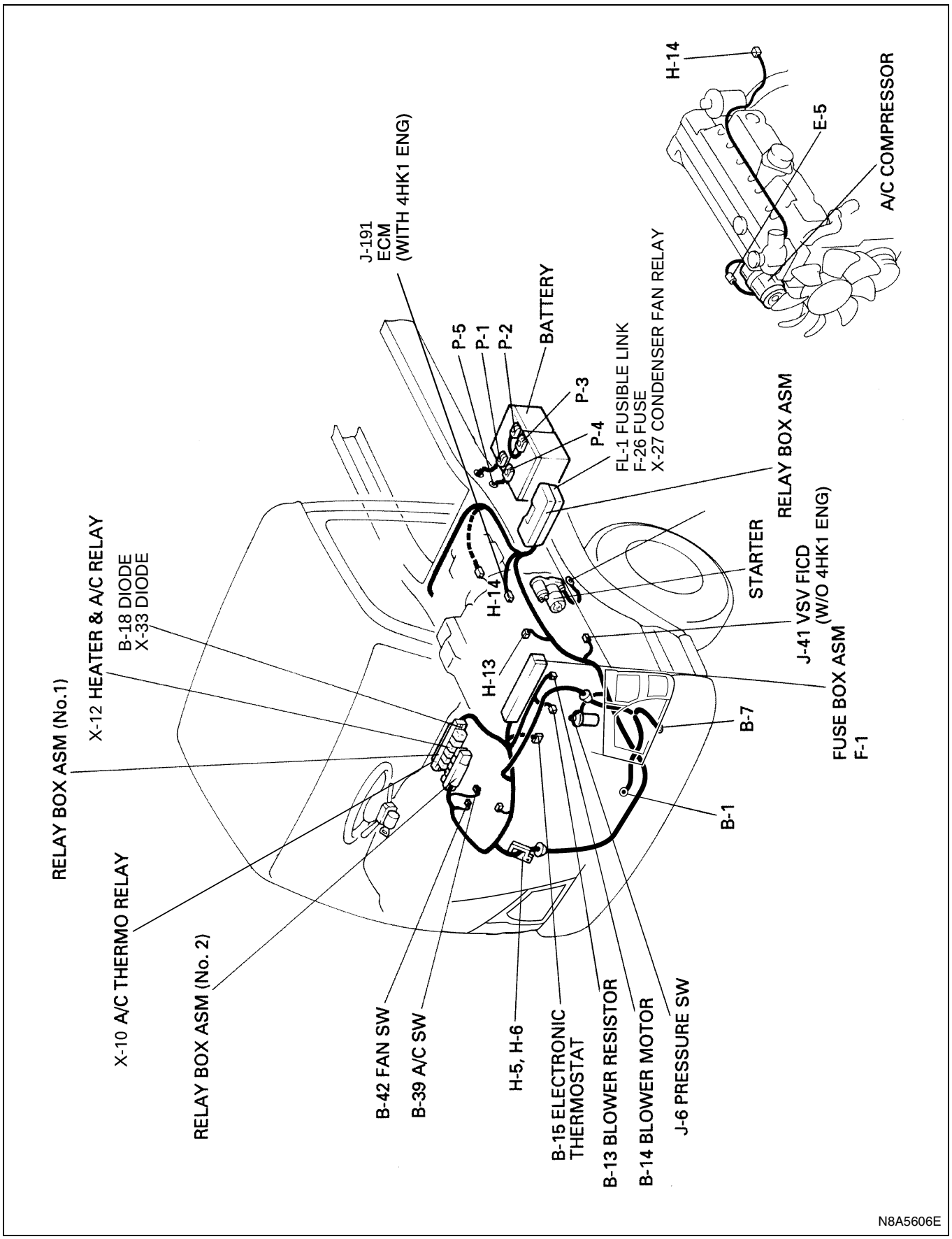
When fan control knob (fan switch) is put on with temp. Control lever being in the “FULL HOT” position (FULL HOT switch on) ceramic heater within heater unit generates heat, raising a heater blow-off temperature to enhance heating performance.

Parts Location

For 12 Volt

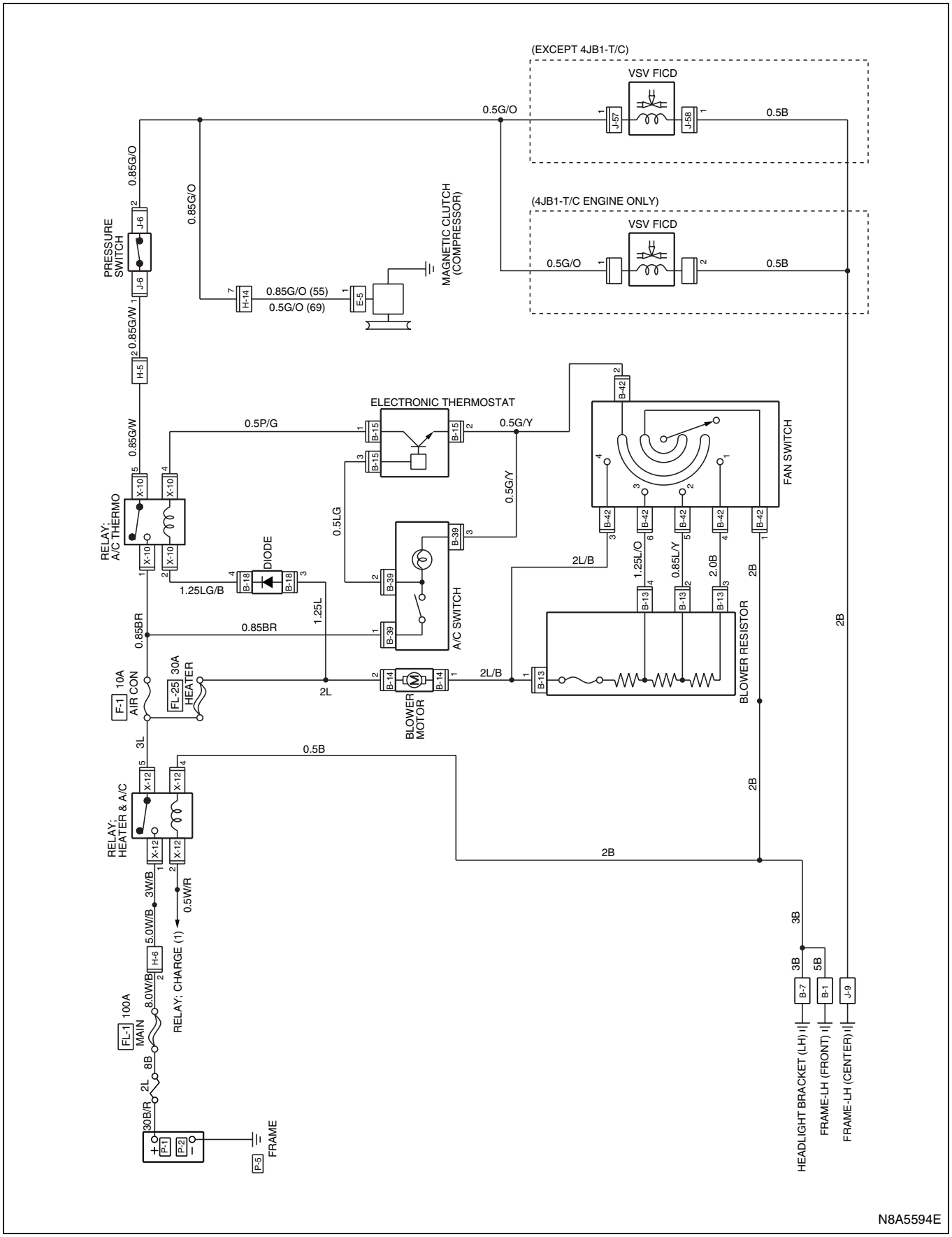


For 24 Volt

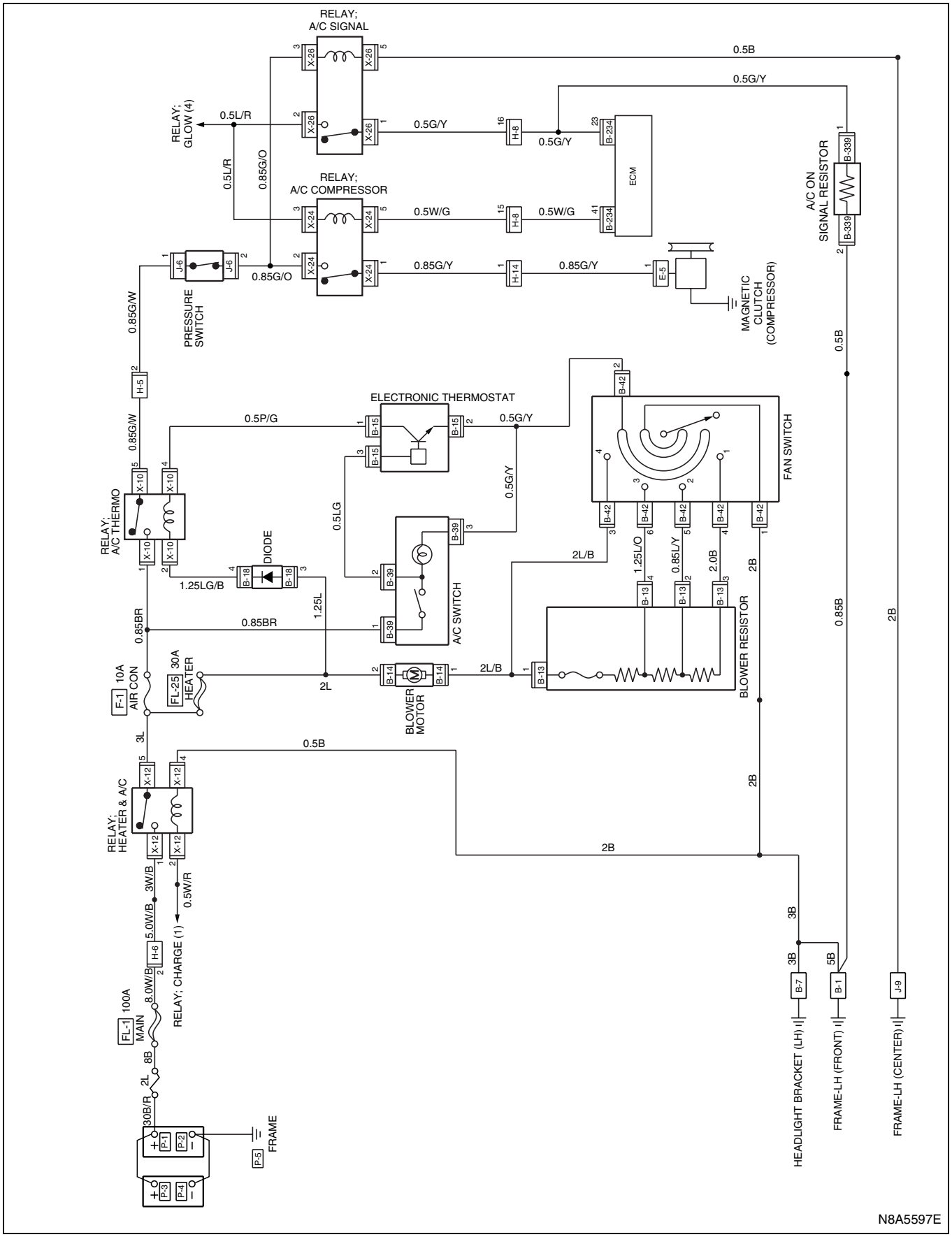

RELAY BOX ASM (No.1)
X-12 HEATER & A/C RELAY
B-18 DIODE
X-33 DIODE
X-10 A/C THERMO RELAY
RELAY BOX ASM (No. 2)
B-42 FAN SW
B-39 A/C SW
H-5, H-6
B-15 ELECTRONIC THERMOSTAT
B-13 BLOWER RESISTOR
B-14 BLOWER MOTOR
J-6 PRESSURE SW
B-1
B-7
H-13
H-14
J-191
ECM
(WITH 4HK1 ENG)
P-5
P-1
P-2
P-3
P-4
BATTERY
FL-1 FUSIBLE LINK
F-26 FUSE
X-27 CONDENSER FAN RELAY
RELAY BOX ASM
STARTER
J-41 VSV FICD
(W/O 4HK1 ENG)
FUSE BOX ASM
F-1
H-14
E-5
A/C COMPRESSOR
N8A5606E

Circuit Diagram

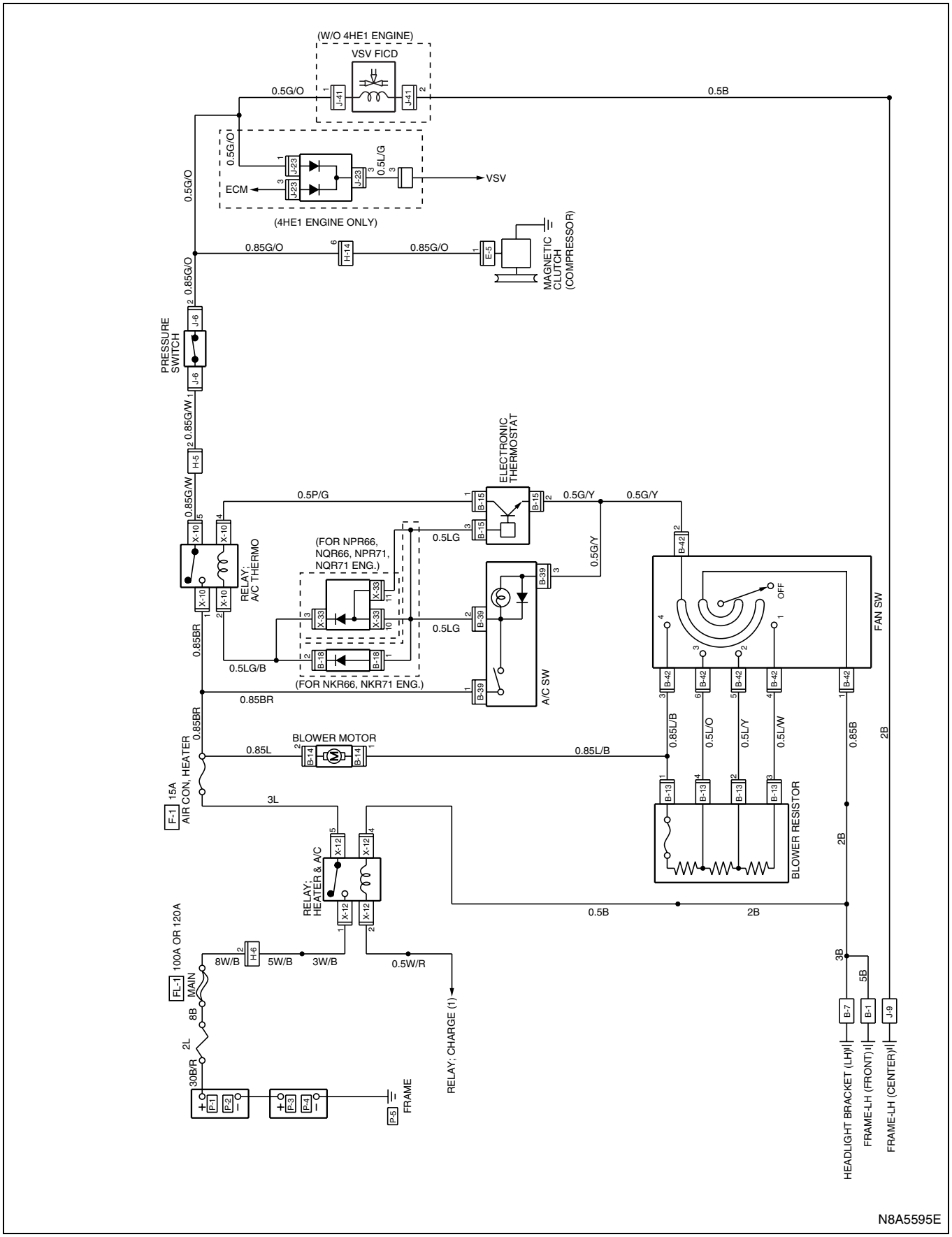
For 12 Volt - Except 4JH1



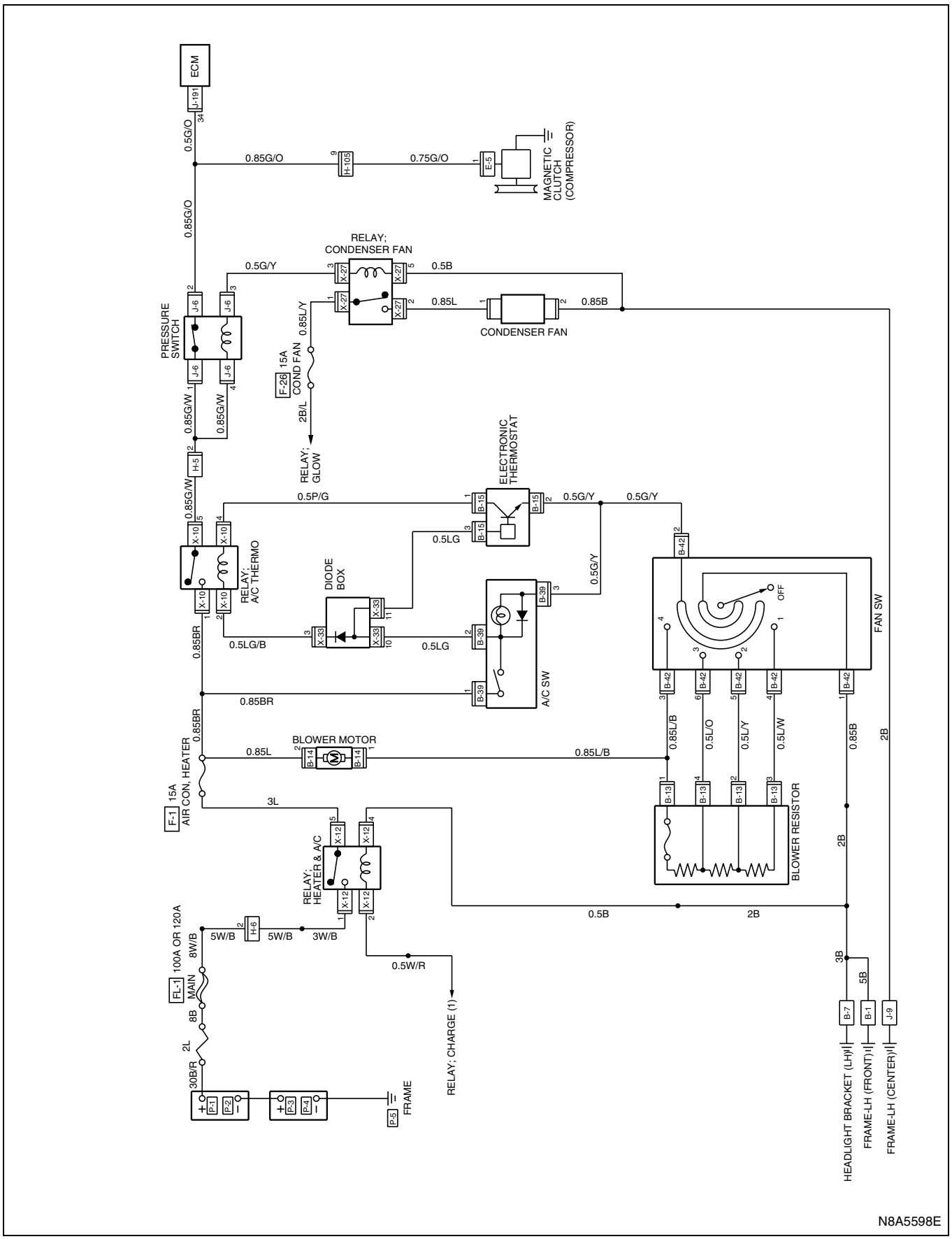
For 12 Volt - 4JH1 Engine



For 24 Volt - Except 4HK1 Engine

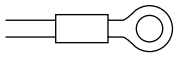
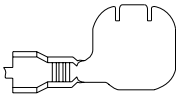
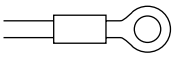
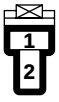
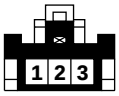
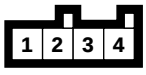
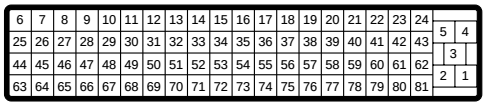


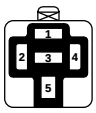
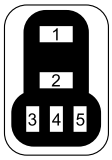
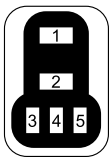
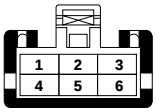
For 24 Volt - 4HK1 Engine

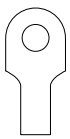


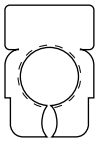
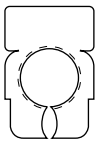
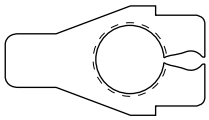
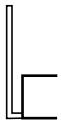
Connector List

For 12 Volt

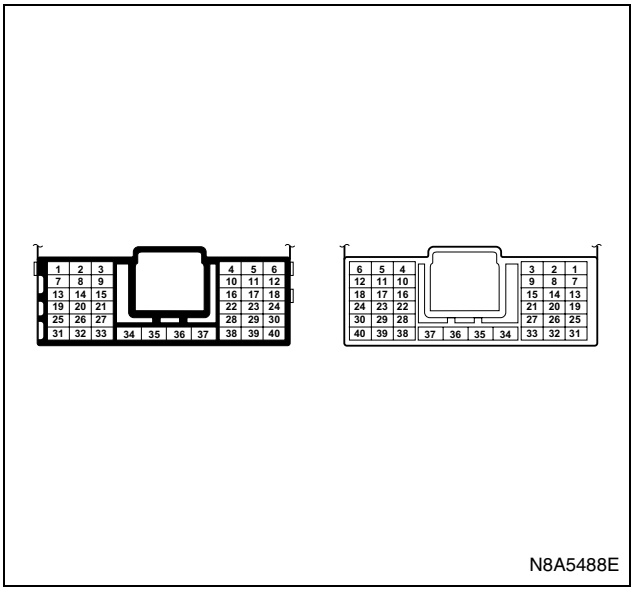
No.	Connector Face
B-1	 000-001
B-7	 000-012
J-9	 000-001
B-13	004-010
B-14	 002-009
B-15	 003-009
B-18	 004-004
B-234	 121-001

No.	Connector Face
B-339	004-010
X-10	005-001
X-12	 005-001
X-24	 005-006
X-26	 005-006
B-39	003-019
B-42	 006-001
E-5	001-013

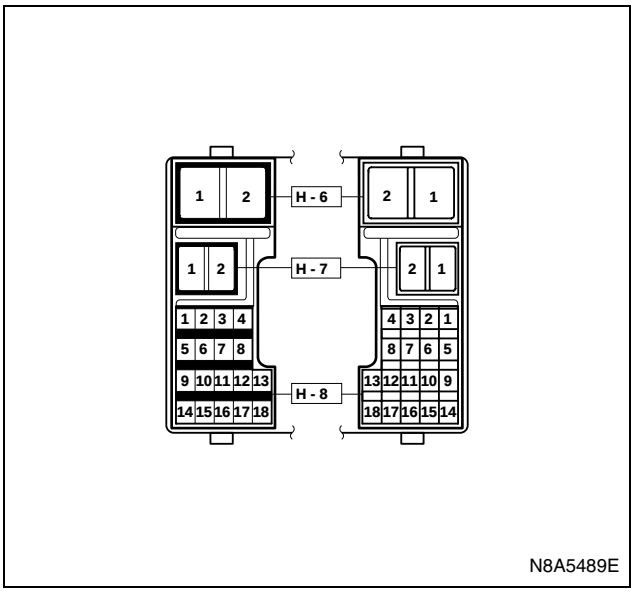
No.	Connector Face
E-5	001-014
J-57	001-009
J-58	001-009
H-14 (4JH1)	016-003
H-14 (4JH1)	016-004
J-6	004-011
J-41	002-015
P-1	 000-003

No.	Connector Face
P-2	 000-004
P-4	 000-004
P-3	 000-006
P-5	 000-007
H-14 (4JB1/ 4JG2)	016-001
H-14 (4JB1/ 4JG2)	016-002

H-5



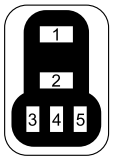
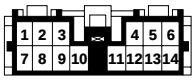
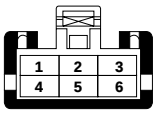
H-6, H-8

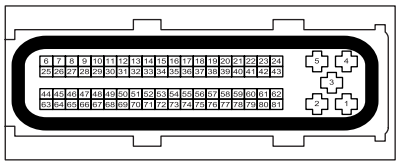
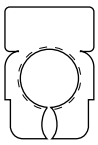
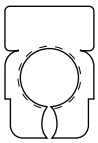
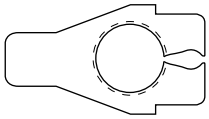
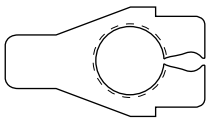
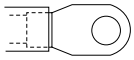


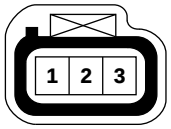
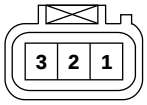
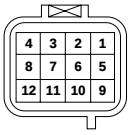
For 24 Volt

No.	Connector Face
B-1	000-001
B-7	000-012

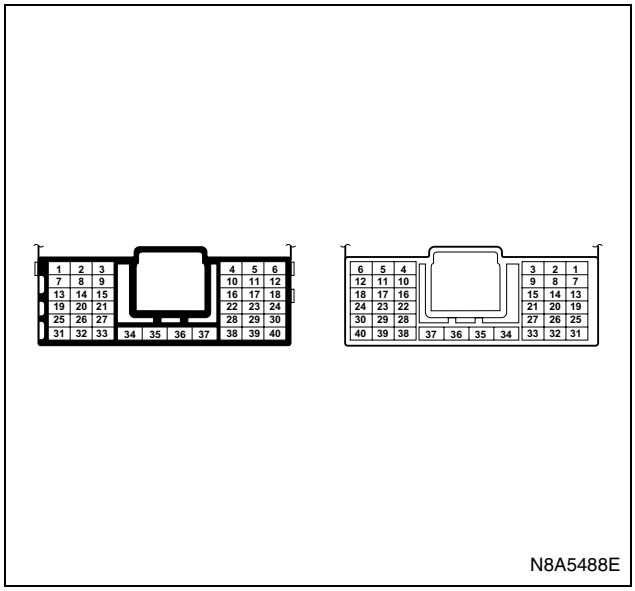
No.	Connector Face
J-9	000-001
B-13	004-010
B-14	002-009
B-15	003-009
B-18	004-004
J-23	004-004
X-10	005-001
X-12	005-001

No.	Connector Face
X-27	 005-006
X-33	 014-002
B-39	003-019
B-42	 006-001
E-5	001-013
E-5	001-014
H-14 (Except 4HK1)	016-003
H-14 (Except 4HK1)	016-004

No.	Connector Face
J-6	004-011
J-41	002-015
P-191	 081-001
P-1	 000-004
P-4	 000-004
P-2	 000-006
P-3	 000-006
P-5	 000-002

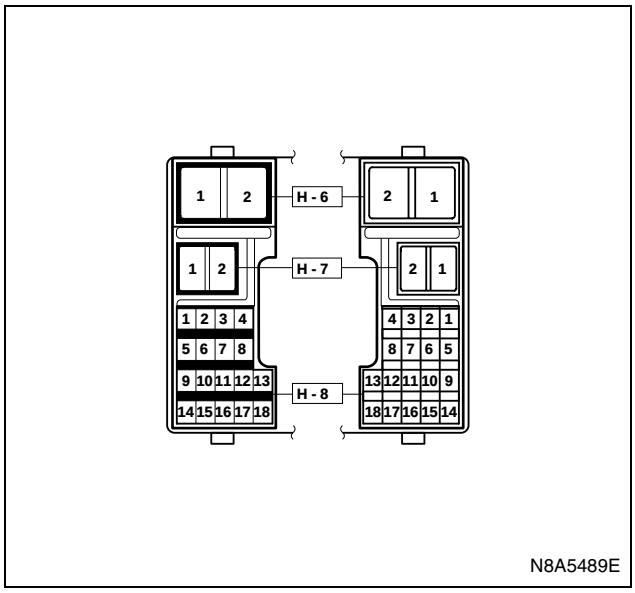
No.	Connector Face
H-13	 003-001
H-13	 003-002
H-14 (4HK1)	016-001
H-14 (4HK1)	016-002
H-105	012-001
H-105	 012-002

H-5



N8A5488E

H-6



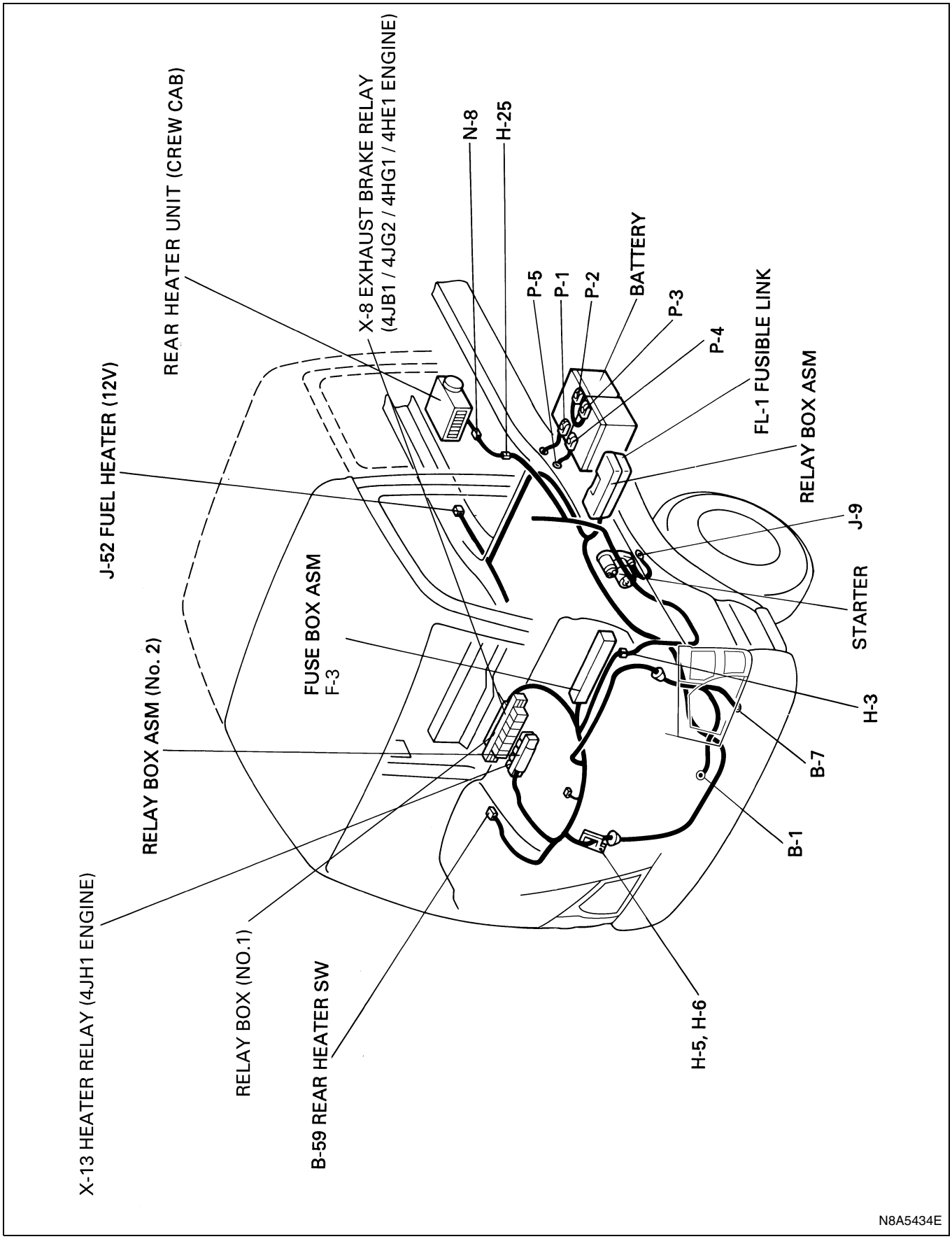
N8A5489E

Fuel Heater and Rear Heater

General Description

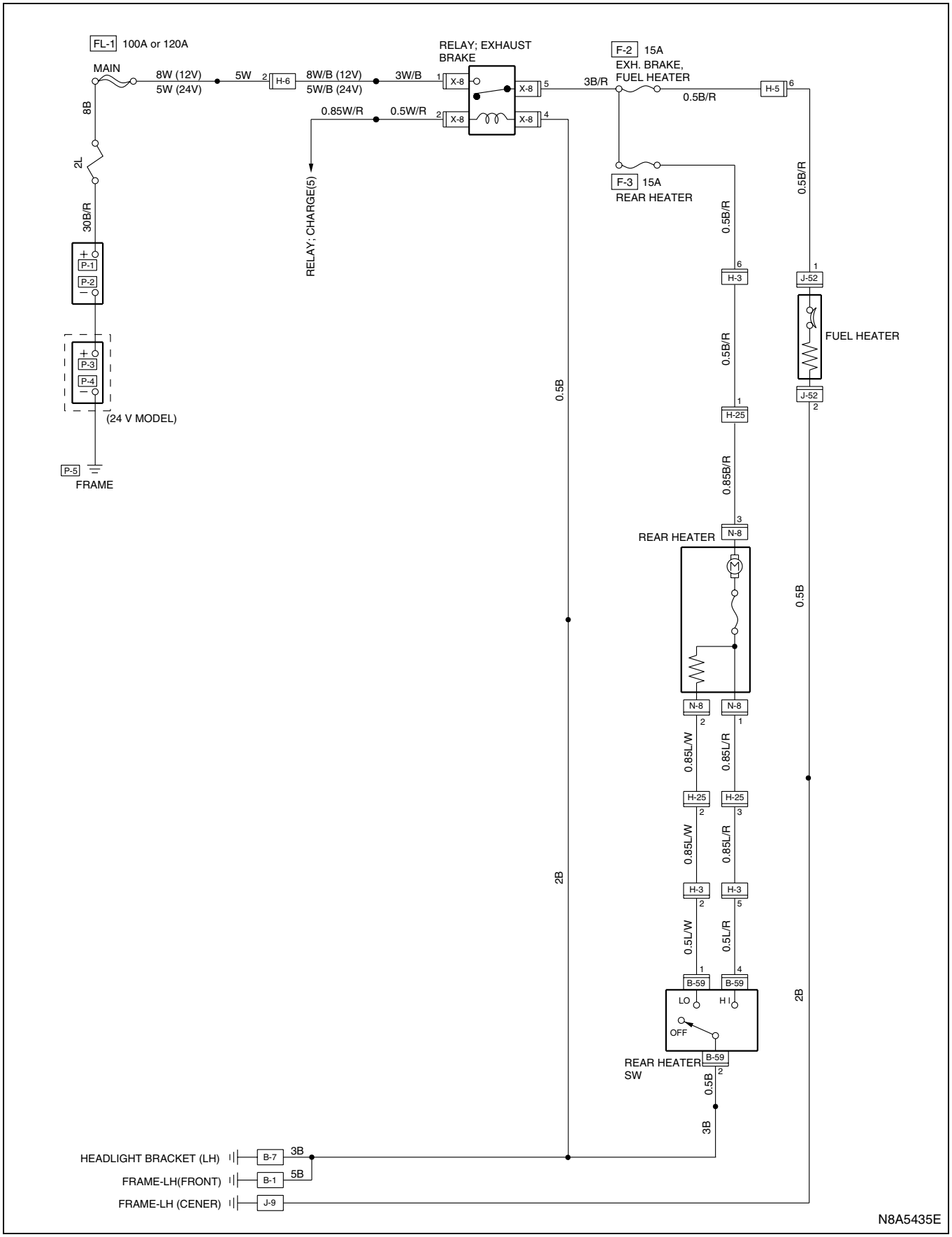
The circuit consists of fuel heater, rear heater, rear heater switch and the exhaust brake relay.
The fuel heater circuit is always in “ON” position when the generator is charging and its temperature is automatically controlled by the circuit breaker built in the fuel heater.

Parts Location

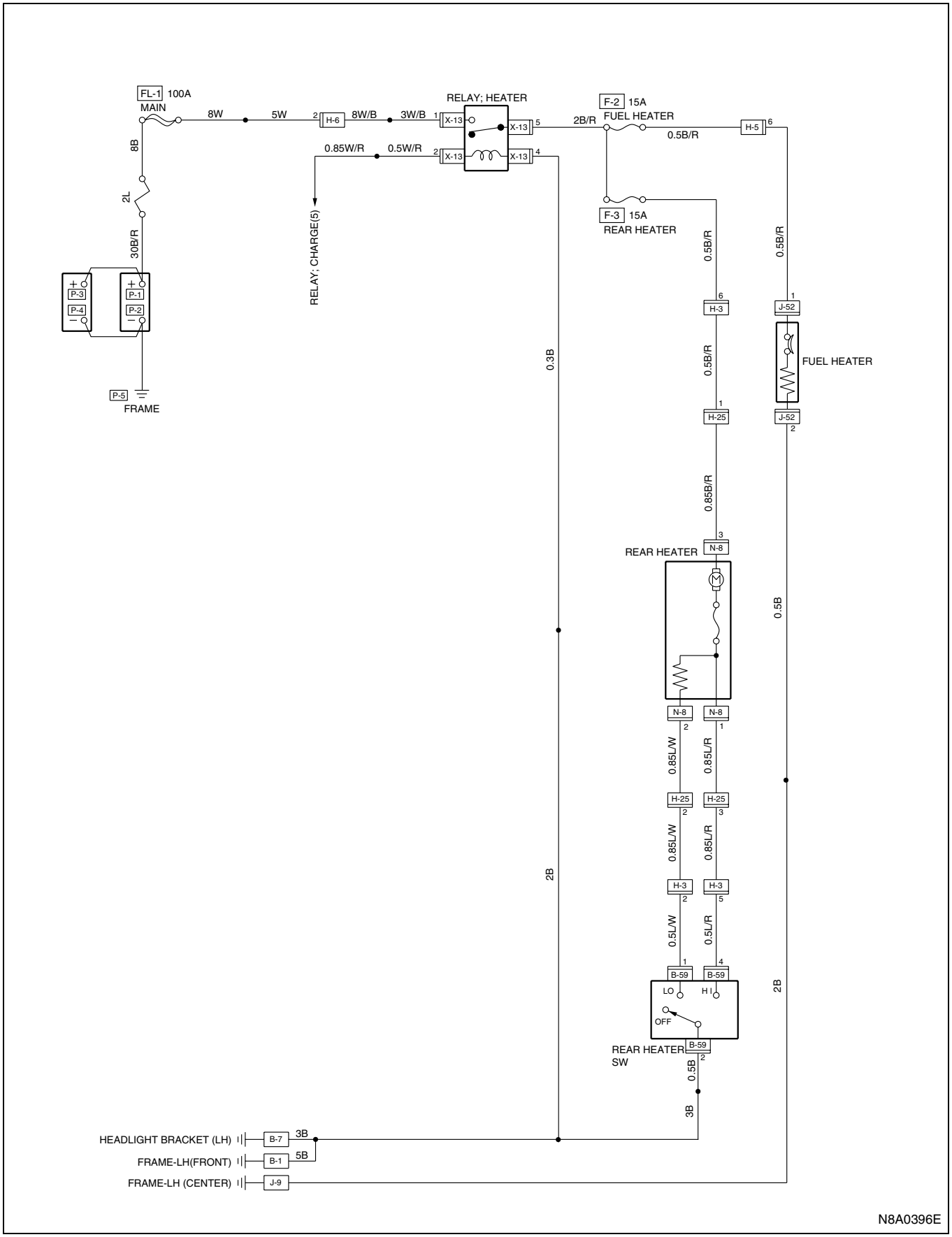


Circuit Diagram

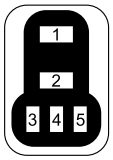
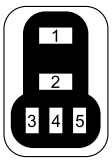
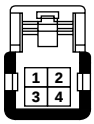
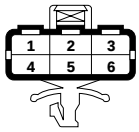
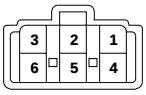
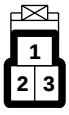
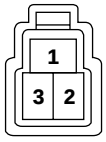
Except 4JH1 Engine

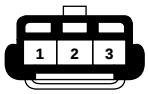
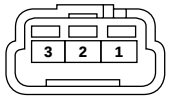
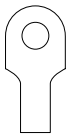
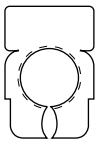
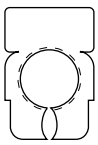
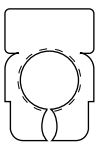
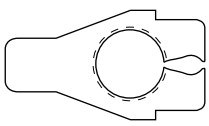


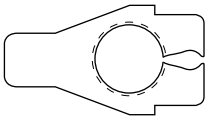
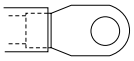
4JH1 Engine


FL-1 100A
MAIN
8W
5W
2
H-6
8W/B
3W/B
1
X-13
RELAY; HEATER
X-13
5
X-13
2
X-13
4
0.85W/R
0.5W/R
2B/R
F-2 15A
FUEL HEATER
0.5B/R
H-5
6
8B
2L
30B/R
P-3
P-4
P-1
P-2
P-5
FRAME
RELAY; CHARGE(5)
F-3 15A
REAR HEATER
0.5B/R
0.5B/R
6
H-3
1
J-52
FUEL HEATER
0.3B
0.5B/R
1
H-25
J-52
2
0.85B/R
3
N-8
REAR HEATER
0.5B
N-8
2
N-8
1
0.85L/W
0.85L/R
H-25
2
H-25
3
0.85L/W
0.85L/R
2B
H-3
2
H-3
5
0.5L/W
0.5L/R
1
4
B-59
B-59
LO
HI
OFF
B-59
2
REAR HEATER
SW
2B
0.5B
3B
HEADLIGHT BRACKET (LH)
B-7
3B
FRAME-LH(FRONT)
B-1
5B
FRAME-LH (CENTER)
J-9
N8A0396E

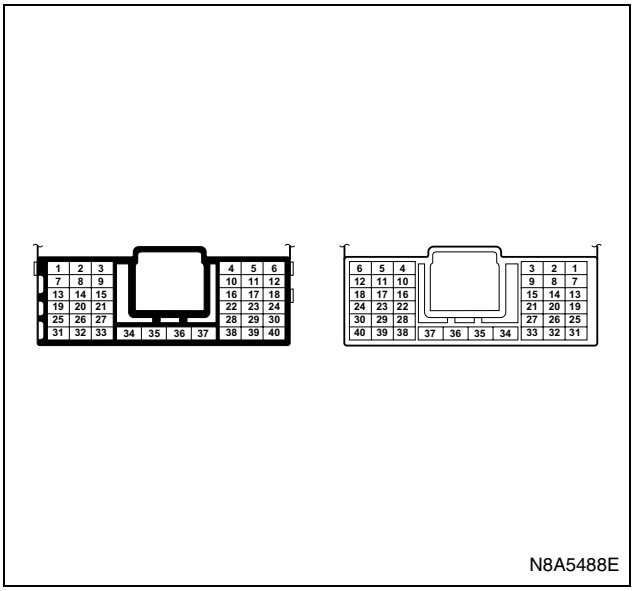
Connector List

No.	Connector Face
X-13	 005-006
X-8	 005-006
B-59	 004-015
H-3	 006-014
H-3	 006-015
H-25	 003-020
H-25	 003-021
J-52	002-033

No.	Connector Face
J-52	002-034
N-8	 003-022
N-8	 003-023
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004
P-4	 000-004
P-2 (24 V)	 000-006

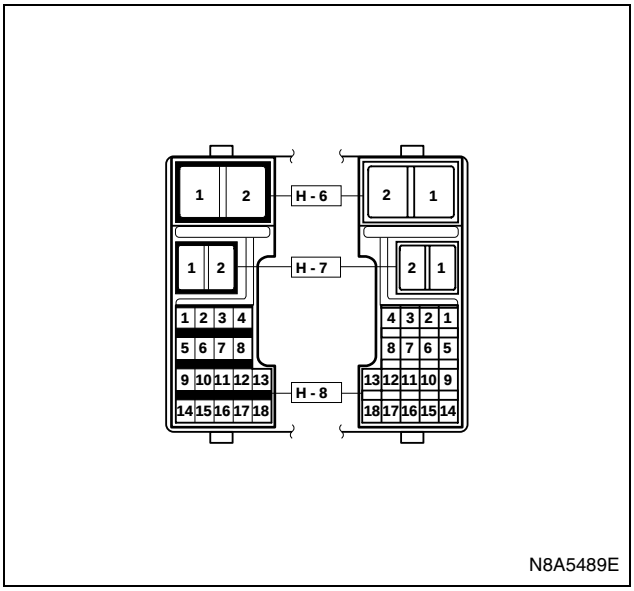
No.	Connector Face
P-3	 000-006
P-5 (12 V)	000-007
P-5 (24 V)	 000-002

H-5



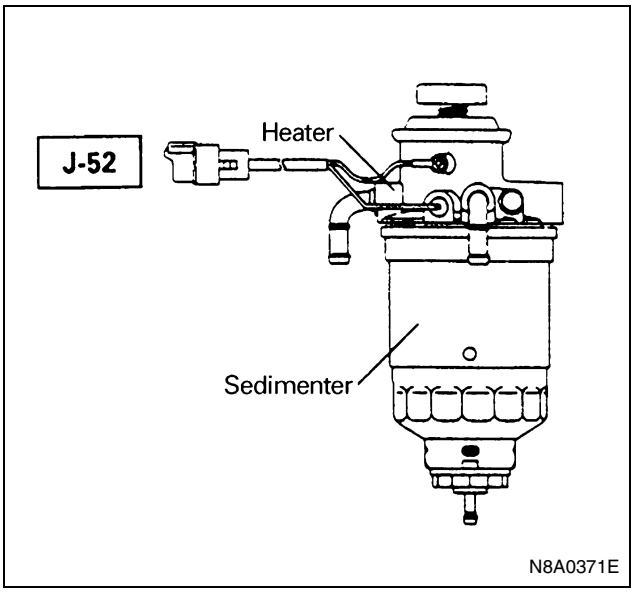
N8A5488E

H-6



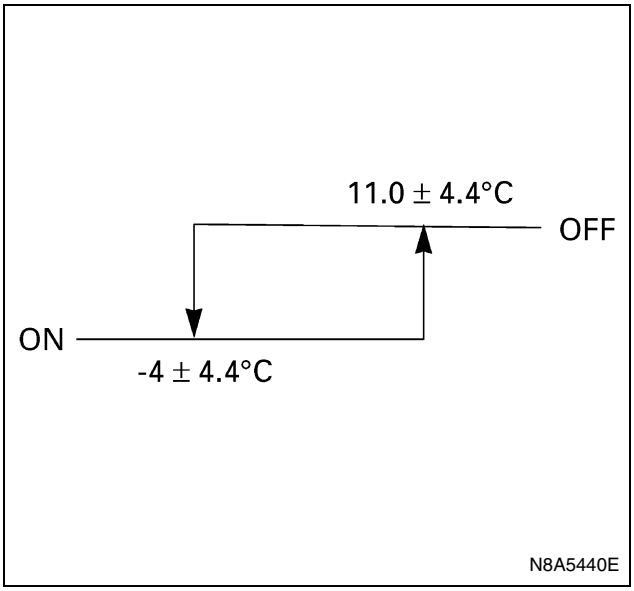
N8A5489E

Fuel Heater



N8A0371E

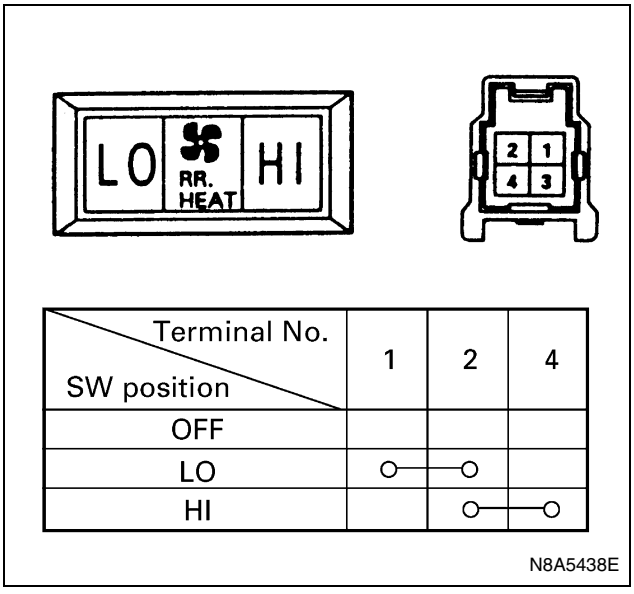
Characteristic of fuel heater



Rear Heater Switch

Inspection

Check the continuity between the connector terminals while operating the switch.
Replace the switch when the result of inspection is found abnormal.

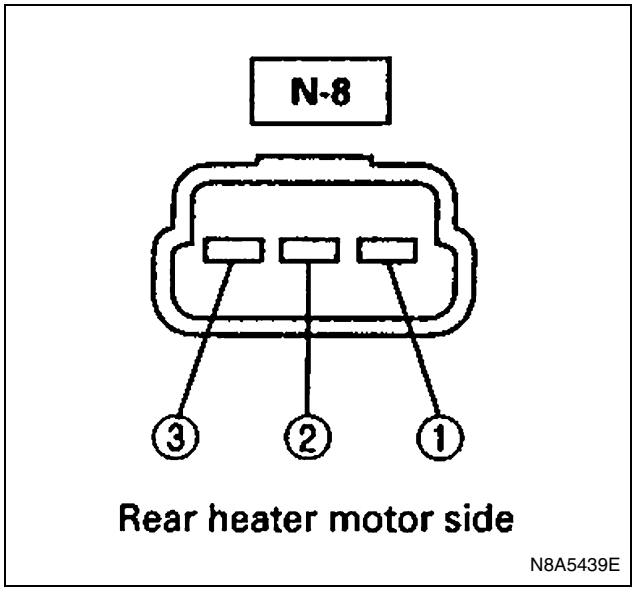


Terminal No. / SW position	1	2	4
OFF			
LO	○	○	
HI		○	○

Rear Heater Motor

Inspection

Disconnect the rear heater connector.
Connect the battery positive terminal to the NO.3 terminal of the rear heater motor side connector and negative to the NO.2. Check to see if rear heater motor operates low-speed correctly.
Connect the battery positive terminal to the NO.3 terminal of the rear heater motor side connector and negative to the NO.1. Check to see if rear heater motor operates high-speed correctly.
Replace the rear heater motor when the result of inspection is found abnormal.

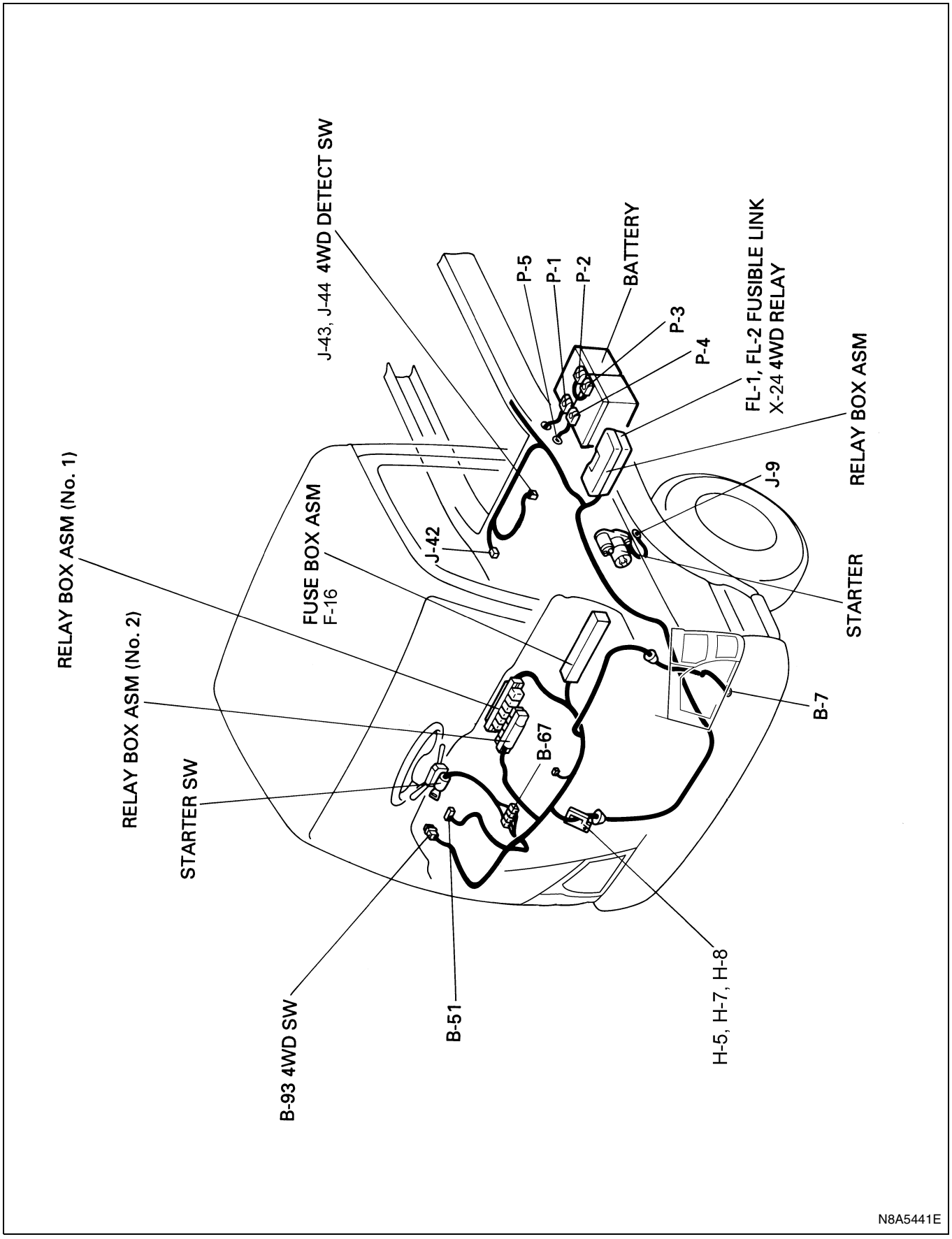


4WD Transfer (Vacuum Control)

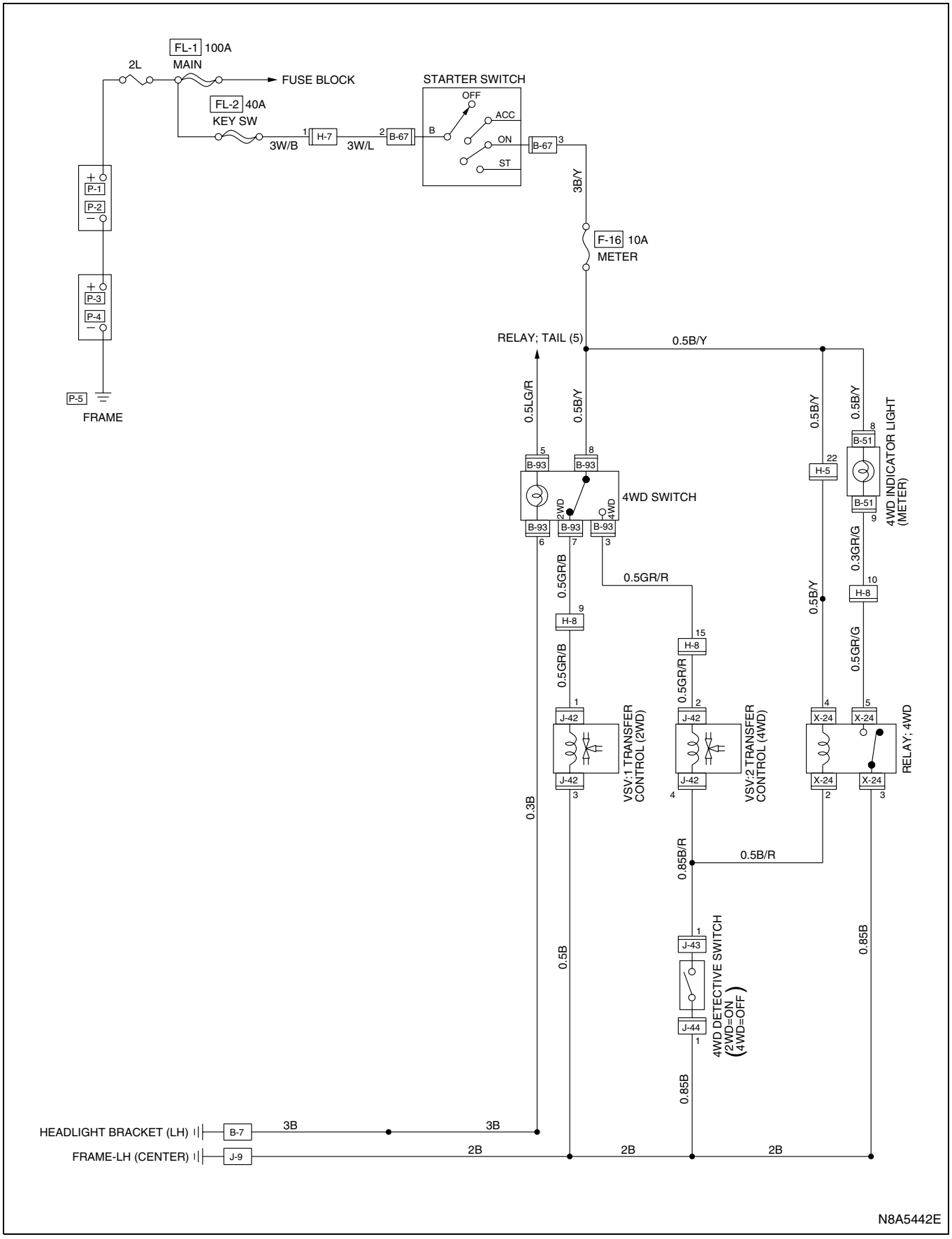
General Description

The circuit consists of the starter switch, 4WD switch, 4WD detect switch, 4L switch, vacuum switching valve, 4WD indicator light, neutral switch and the relay.
When the 4WD switch is turned on to drive in the 4WD mode, the vacuum switching valve for the transfer control is activated through the 4WD relay, and the transfer shift rod connected to the vacuum actuator is shifted to the 4WD side to turn on the 4WD detect switch. At the same time, the indicator light in the meter lights on to tell that the mode is transferred to 4WD mode.
However, when running in the normal mode (2WD), the 4WD switch is not operated. Accordingly, no current flows through the 4WD vacuum switching valve for the transfer control, with the 4WD detect switch left in the “OFF” condition (2WD mode).

Parts Location



Circuit Diagram



N8A5442E

Connector List

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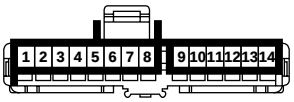
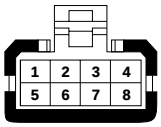
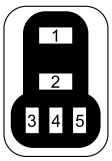
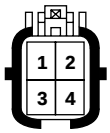
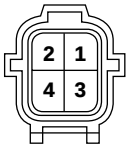
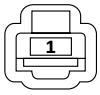
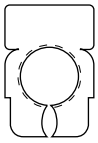
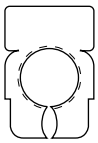
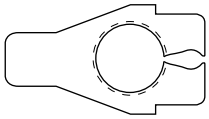
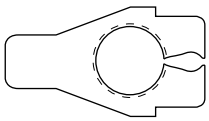
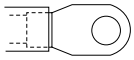
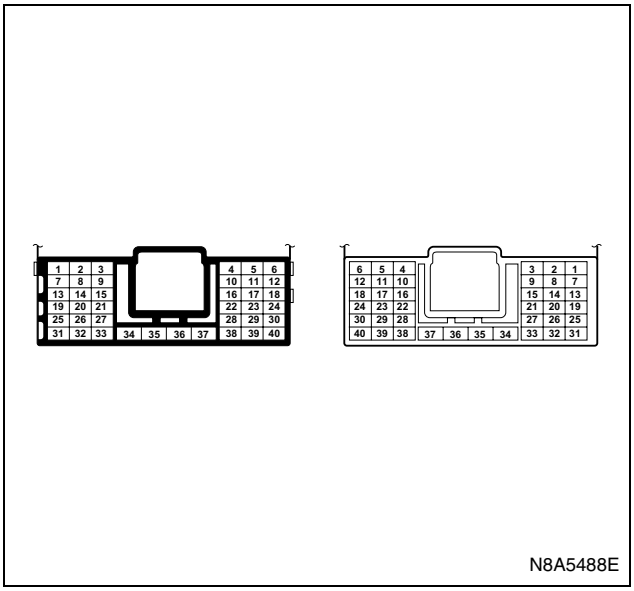
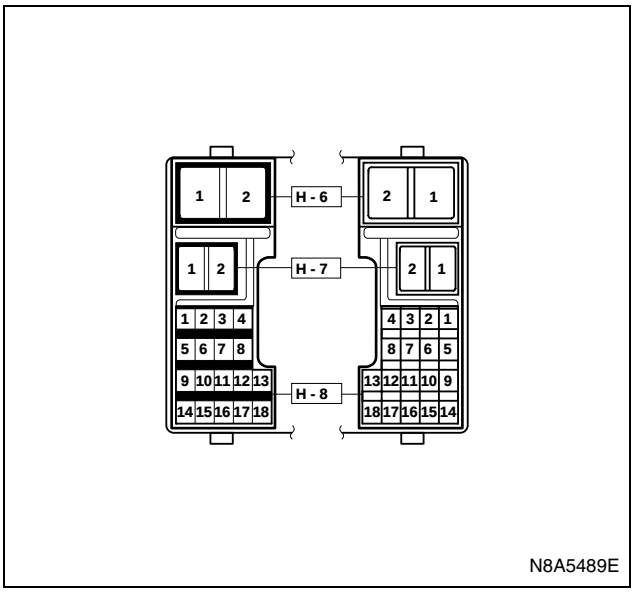
B-51	 014-001
B-67	004-001
B-67	004-002
B-93	 008-005
X-24	 005-006
J-42	 004-012
J-42	 004-013
J-43	001-002

No.	Connector Face
J-43	001-003
J-44	001-002
J-44	 001-003
P-1	 000-004
P-4	 000-004
P-2	 000-006
P-3	 000-006
P-5	 000-002

H-5



H-7



Starter Switch

Refer to “START AND CHARGING” in this section.

Neutral Switch

Refer to “START AND CHARGING” in this section.

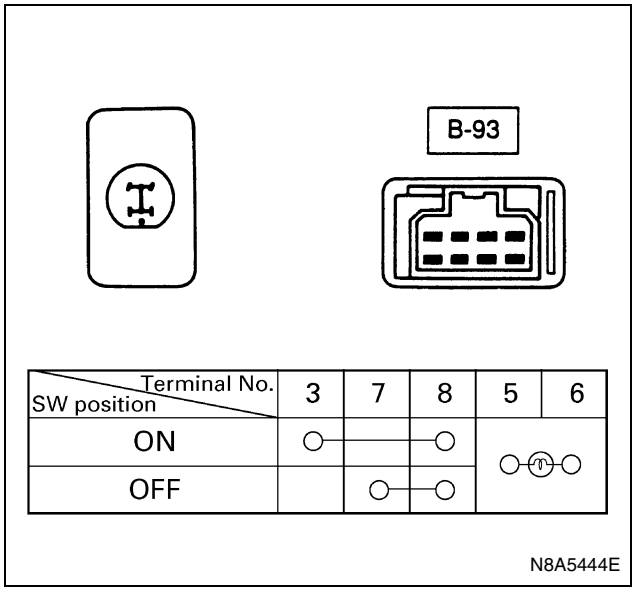
4WD Indicator Light

Refer to “METER AND WARNING/INDICATOR LIGHT” in this section.

4WD Switch

Inspection

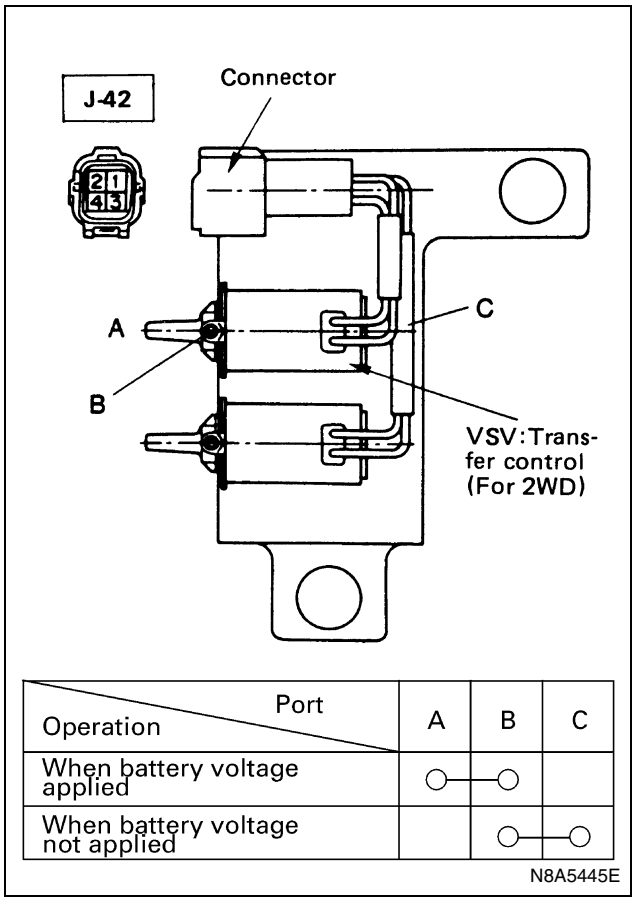
Check the continuity between the connector terminals while operating the switch.
Replace the switch when the result of inspection is found abnormal.



Vacuum Switching Valve: Transfer Control (for 2WD)

Inspection

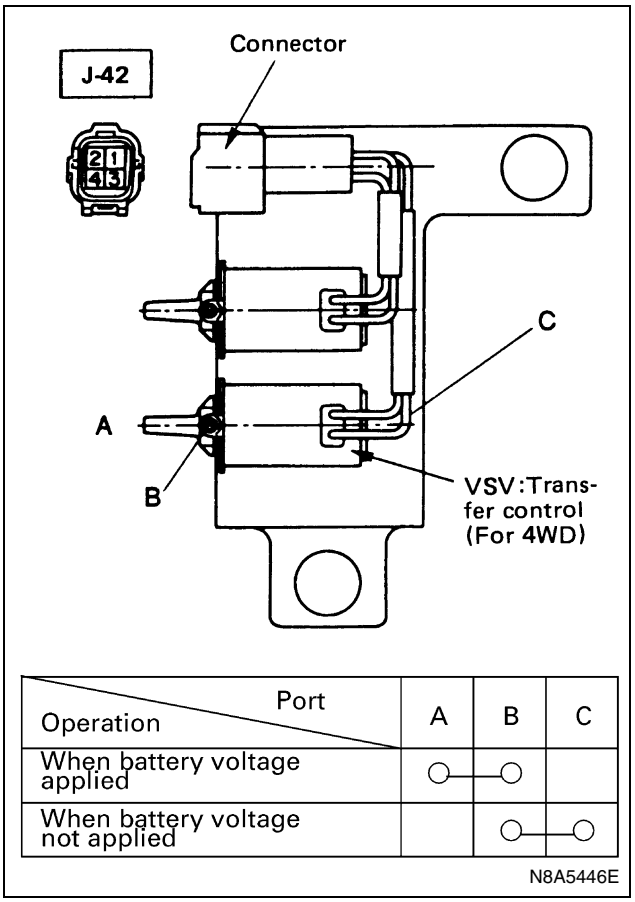
Connect the vacuum switching valve connector terminal No. 1 to the battery (+) terminal and terminal No. 3 to the (−) terminal and then check the continuity among each port.



Vacuum Switching Valve: Transfer Control (for 4WD)

Inspection

Connect the vacuum switching valve connector terminal No. 2 to the battery (+) terminal and terminal No. 4 to the (−) terminal and then check the continuity among each port.



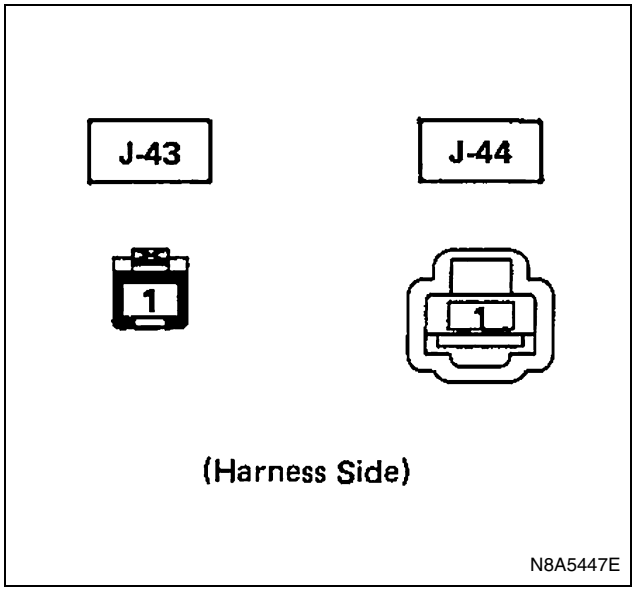
Operation \ Port	A	B	C
When battery voltage applied	○	○	
When battery voltage not applied		○	○

N8A5446E

4WD Detective Switch

Inspection of The 4WD Warning Light Circuit

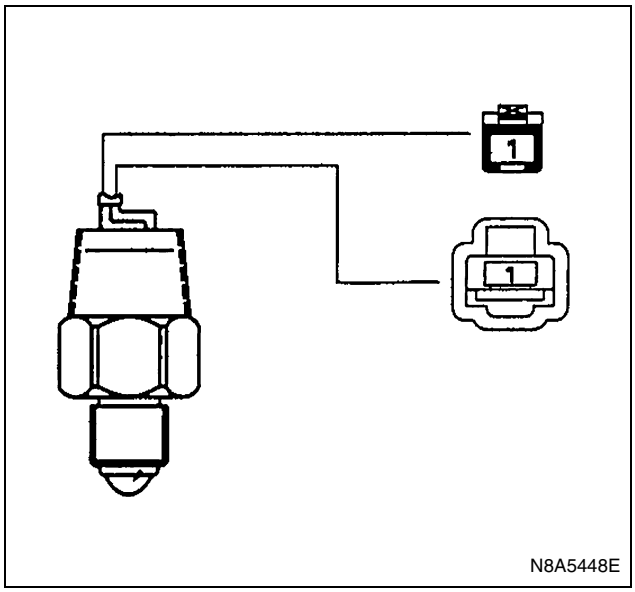
1. Disconnect the 4WD switch connectors.
2. Connect the harness side connector terminals.
3. Check to see if the indicator light comes on with the starter switch “ON”.
   Check the bulb or harness when the result of inspection is found abnormal.



N8A5447E

Inspection

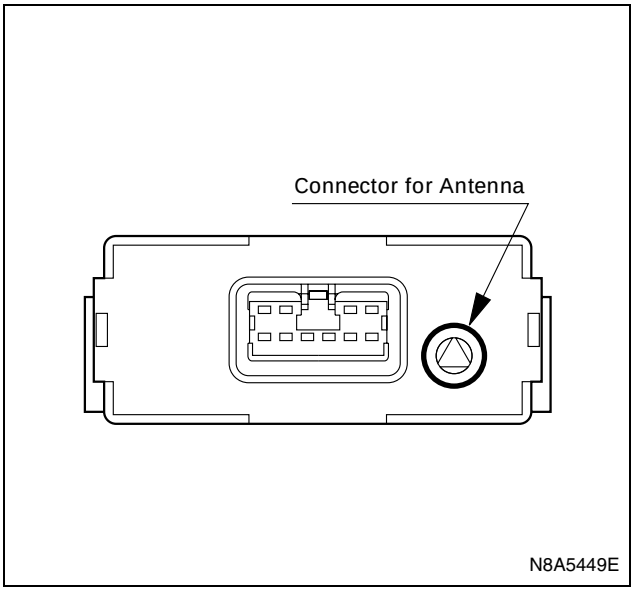
1. Shift the transfer lever to the 4H (4L) position.
2. Check to see if there is continuity between the 4WD switch connectors.
   Replace the switch when the result of the inspection is found abnormal.



N8A5448E

Keyless Entry System

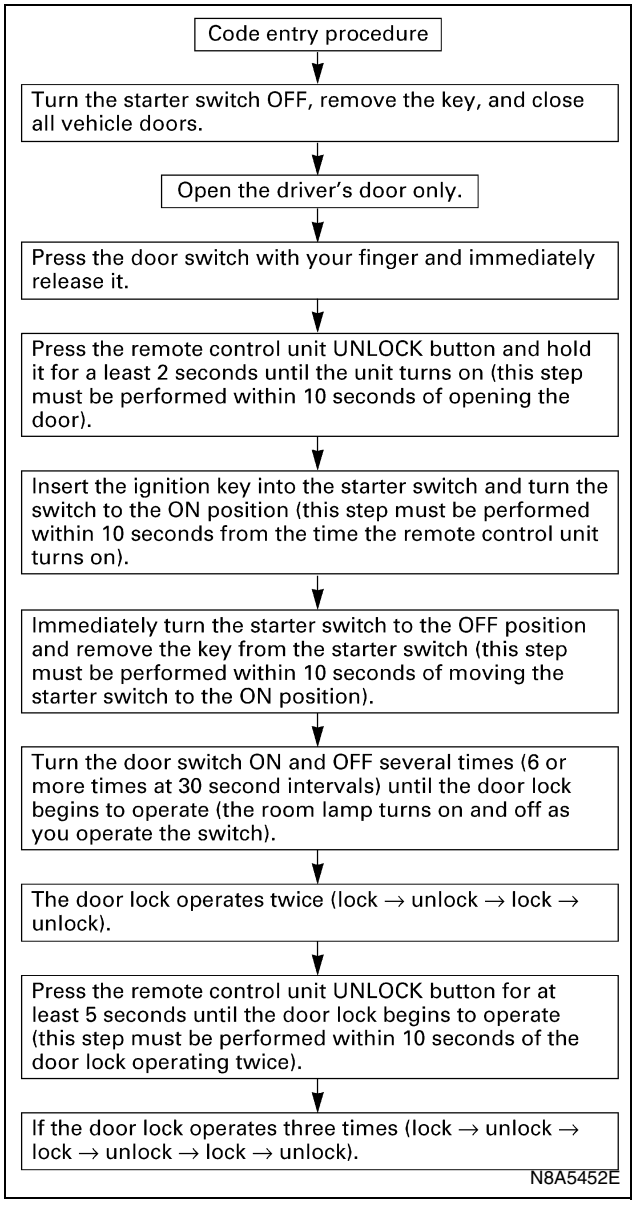
Keyless Entry Control Unit

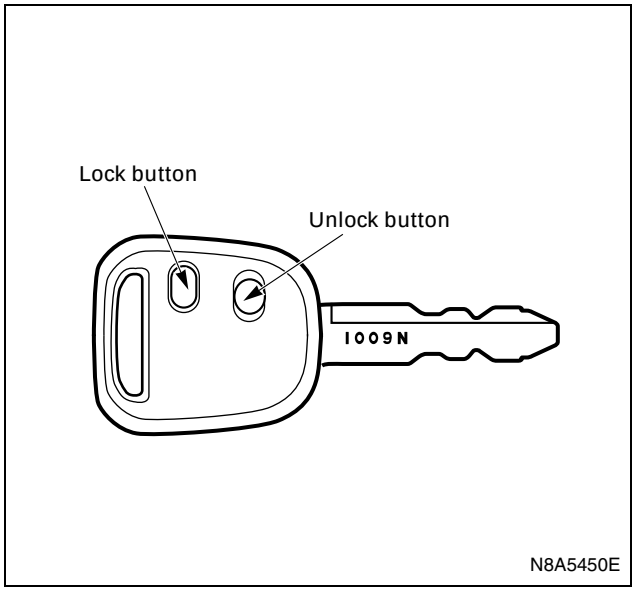


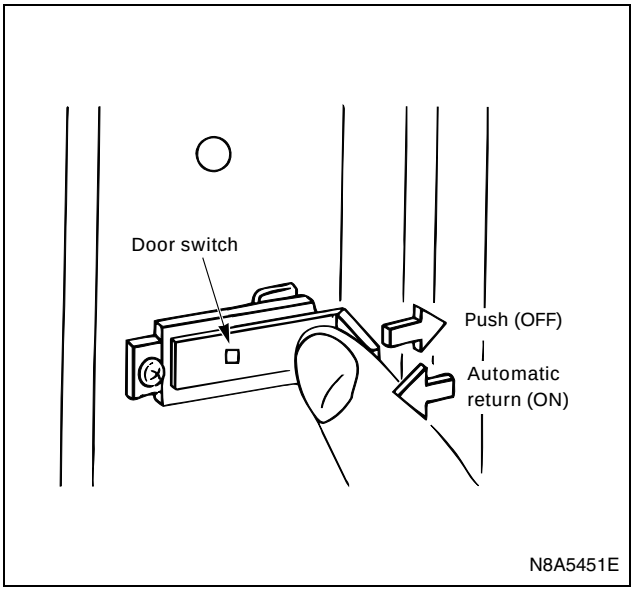
The unit receives a LOCK or UNLOCK signal from the remote control unit. This signal is conveyed to the driver's door lock switch and the door lock actuator(s) on the other door(s).

1. Remote control code registration
   - A single code is registered at a time.
   - Up to 3 codes can be registered and stored.
   - If a 4th code is registered, the oldest existing code is automatically erased (overwritten).

The remote control unit is built-in to the ignition key.



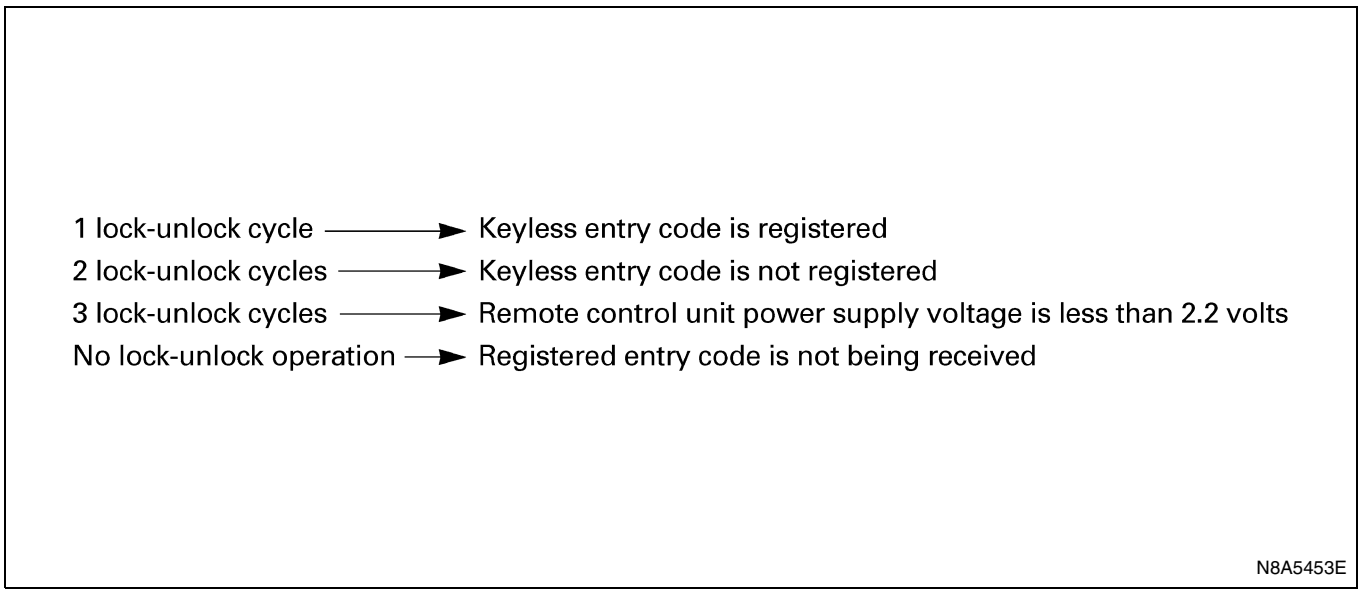




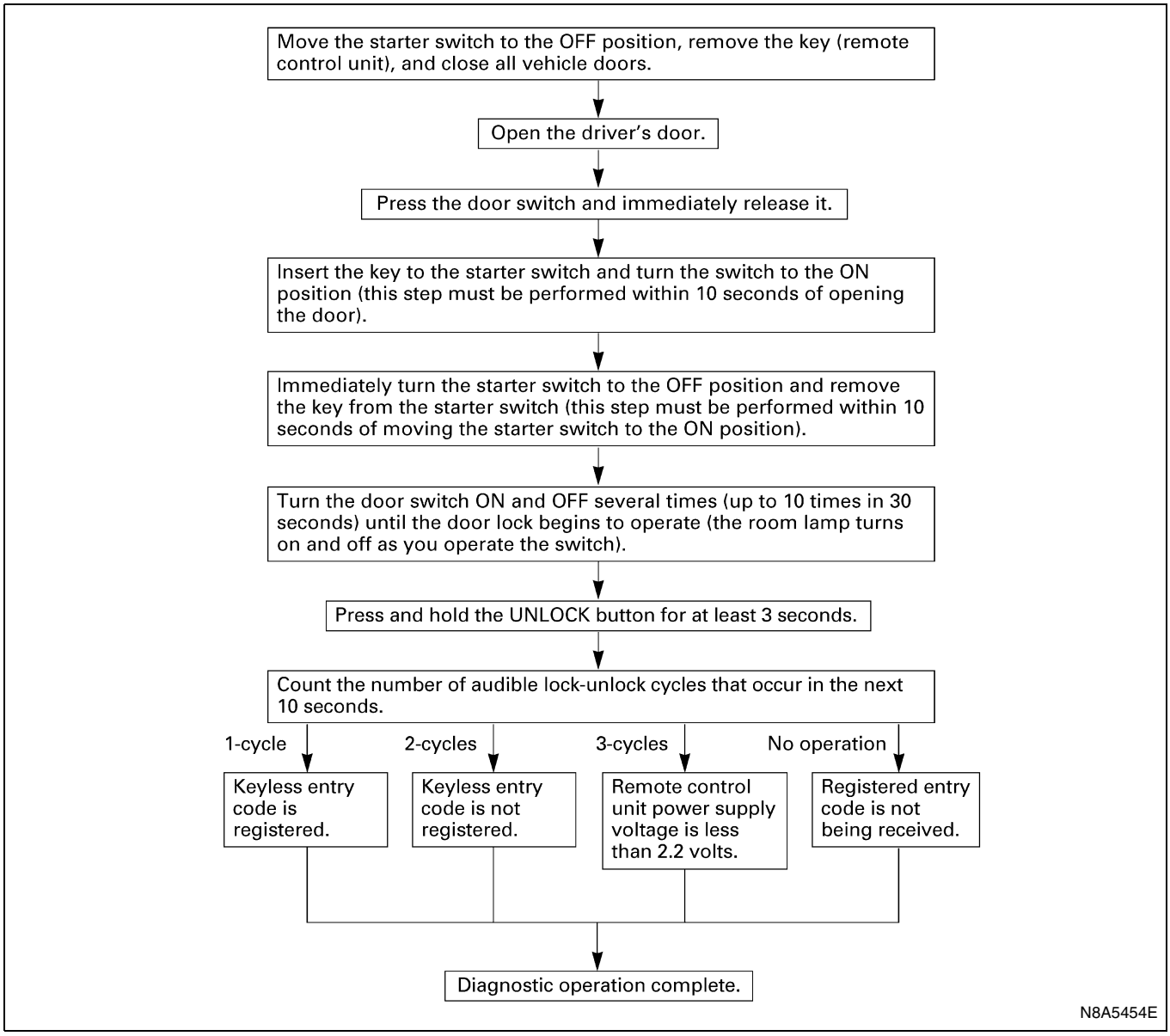
2. Timer lock
   The doors will automatically relock 30 seconds after being unlocked with the remote control unit.
   A second or more may elapse between lock and unlock operation when the LOCK and UNLOCK buttons are pressed in quick succession.

Diagnostic Functions

When the unit is in diagnostic mode, the door locks operate as specified below to indicate normal operation or a specific problem.

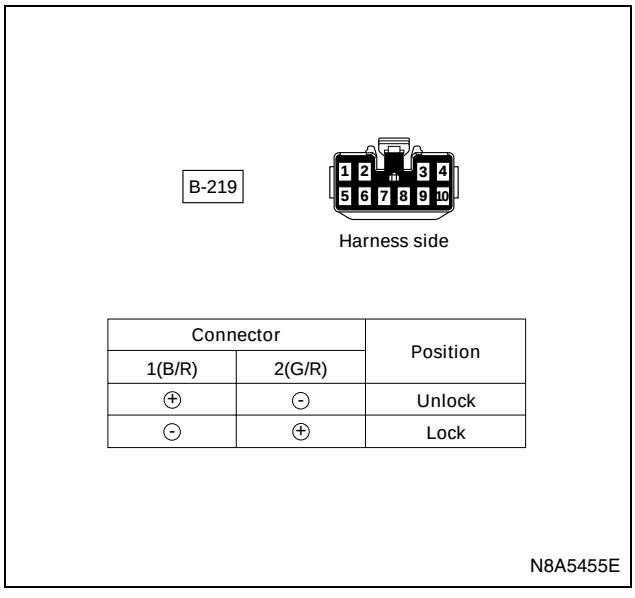


Diagnostic Mode



Door Lock Operational Test

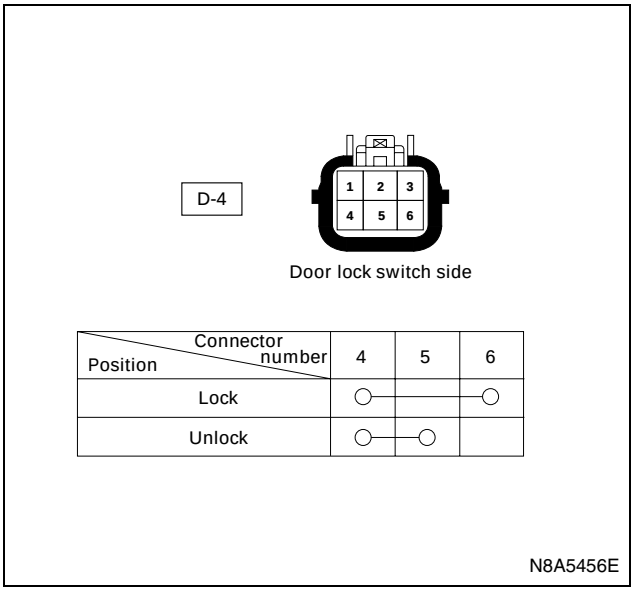
1. Check for continuity between the 1-B-219 connector and the 2-B-219 connector (harness side).
2. Check the remaining connectors to see that they have battery voltage.
3. If the above conditions are normal but the lock does not operate, check the door lock switch (driver's door).
   Refer to the item below.



Connector		Position
1(B/R)	2(G/R)	
⊕	⊖	Unlock
⊖	⊕	Lock

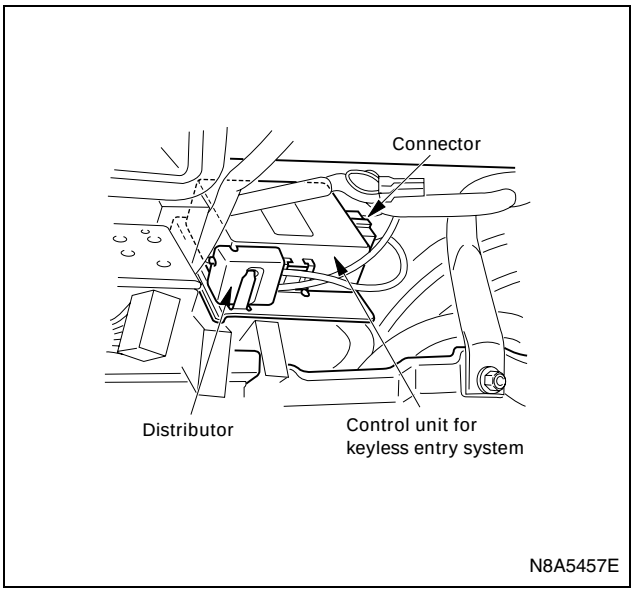
Door Lock Switch Inspection

Check for continuity between the connectors. If there is no continuity, the switch must be replaced.



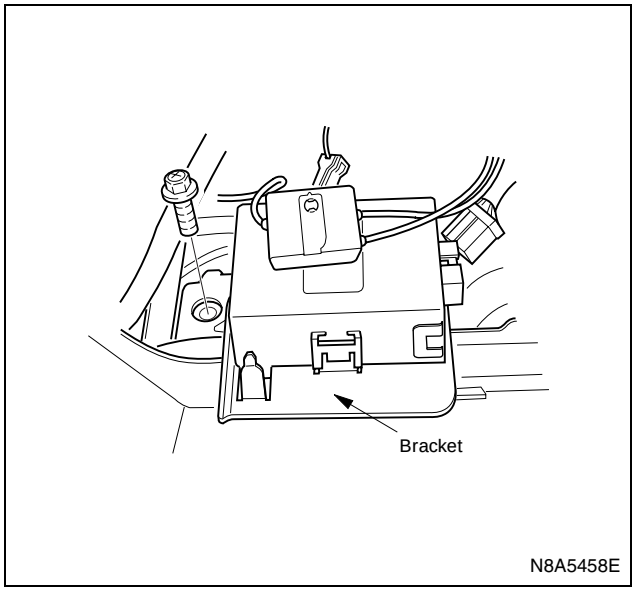
Control Unit Removal

1. Remove the meter cluster. Refer to the item “Meter assembly” in this Manual.
2. Release the pawl to remove the brackets holding the tail lamp and stop lamp warning light relays.
3. Remove the connectors.
4. Remove the distributor from its bracket.
5. Loosen the fixing screws.
6. Remove the control unit from the bracket.

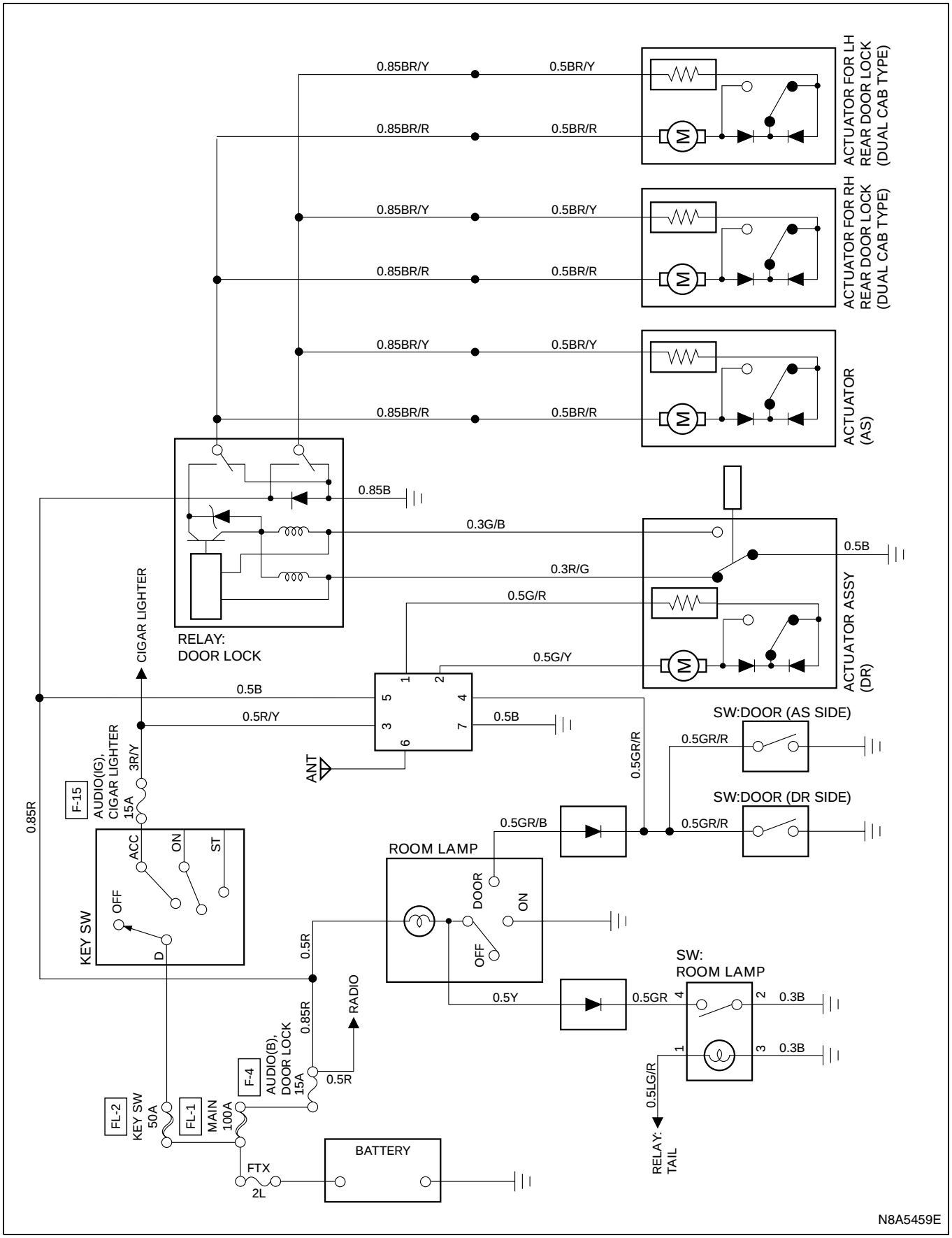


Control Unit Installation

Follow the removal steps in reverse order to install the control unit.

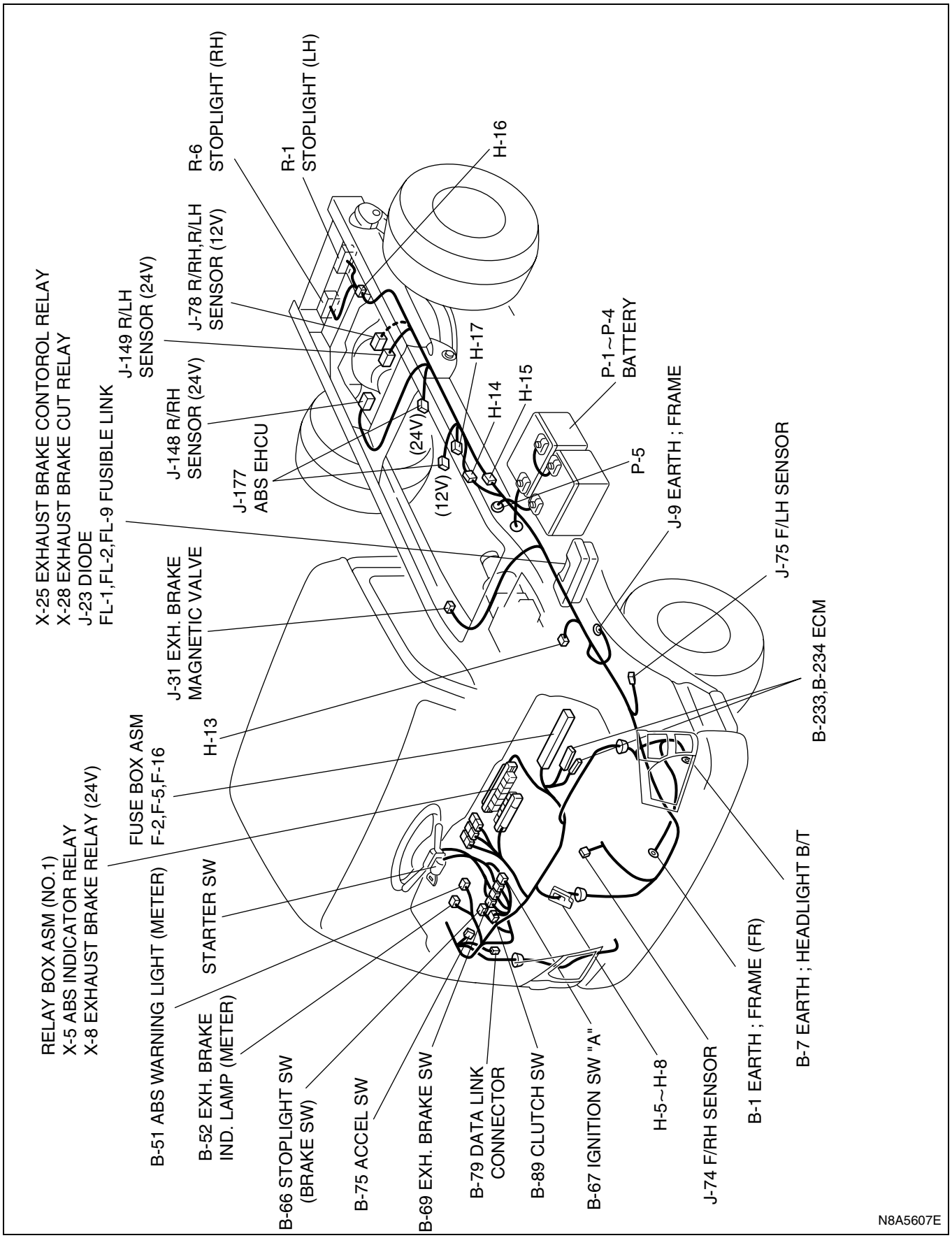


Circuit Diagram



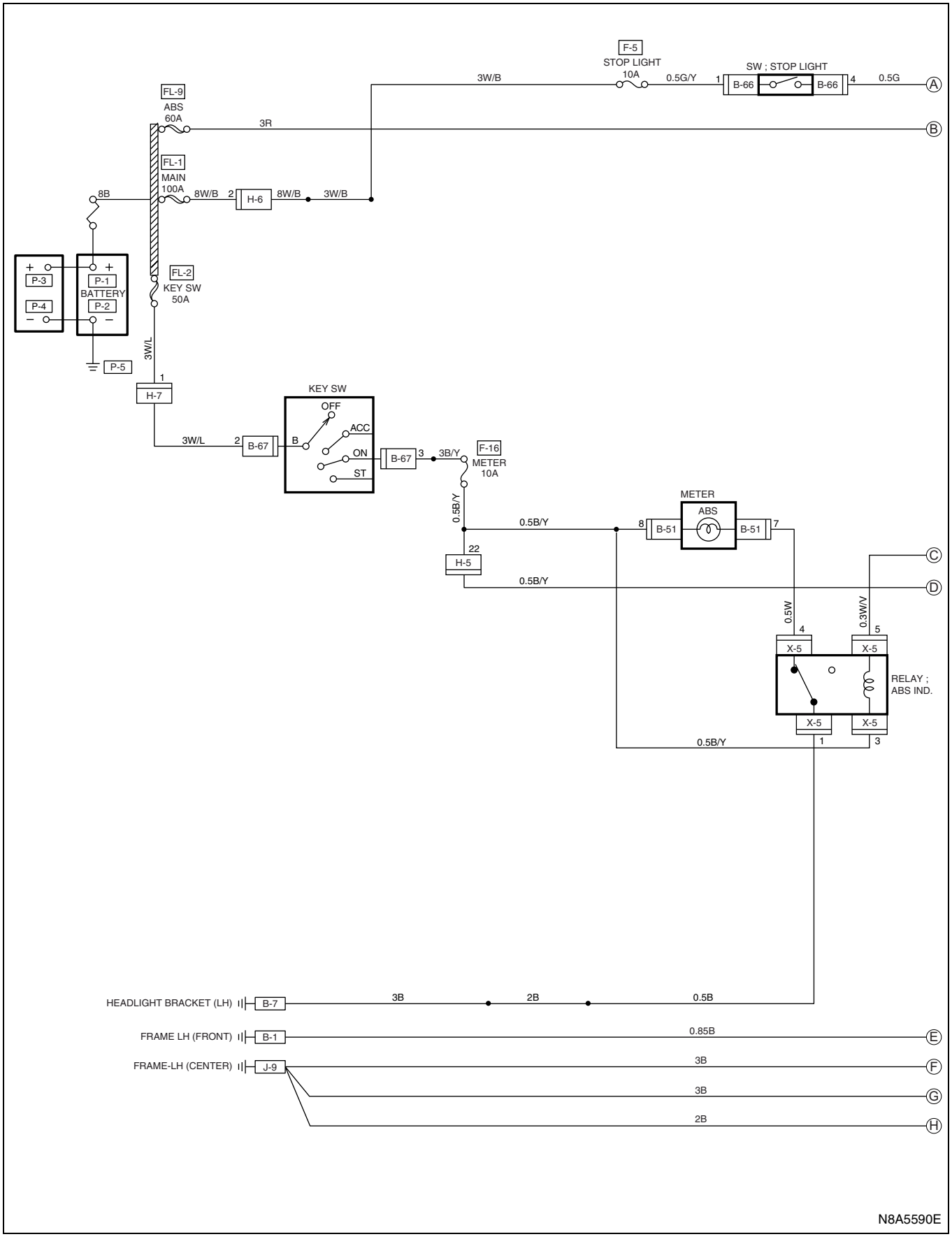
ABS (Anti-lock Brake System, Without ASR)

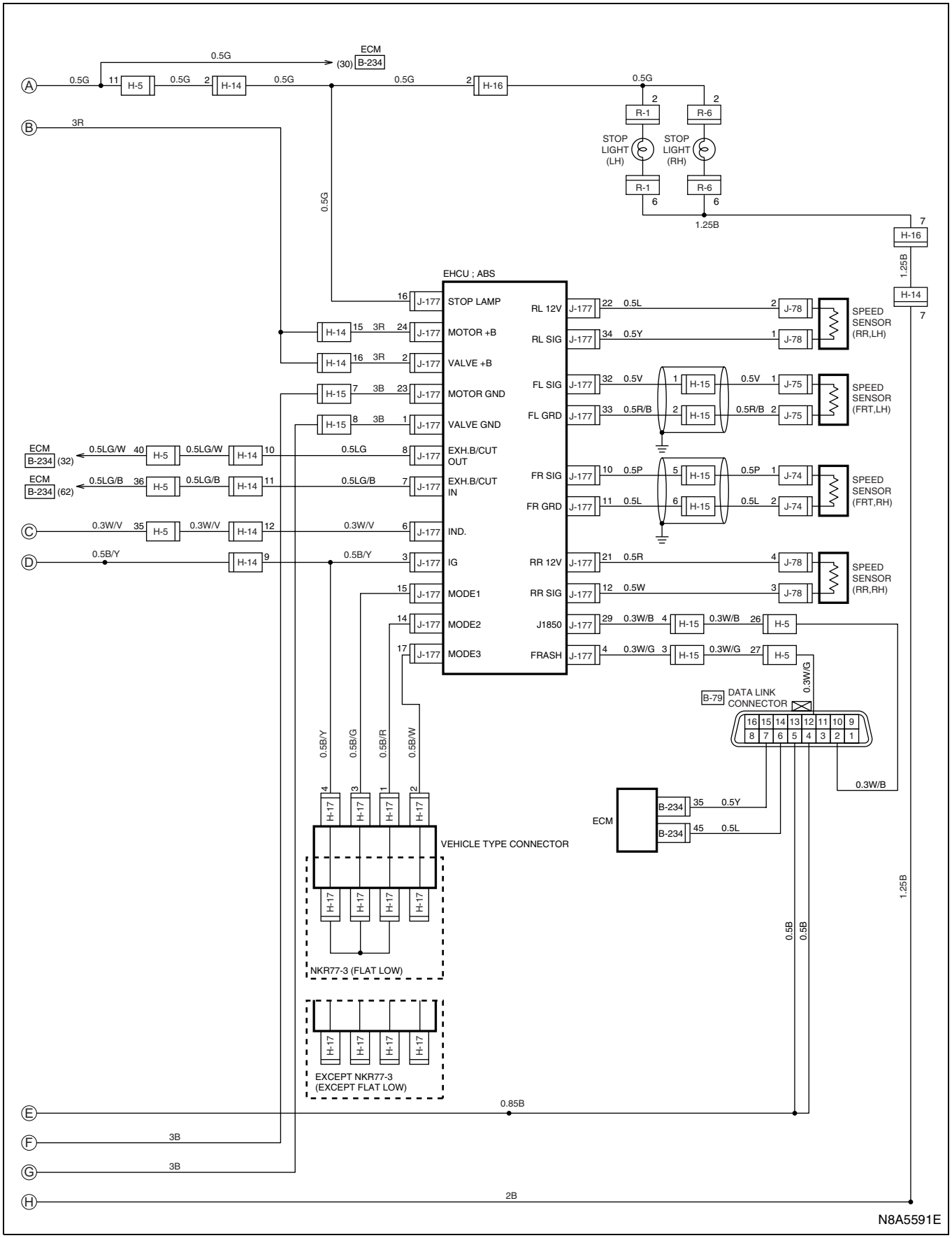
Parts Location



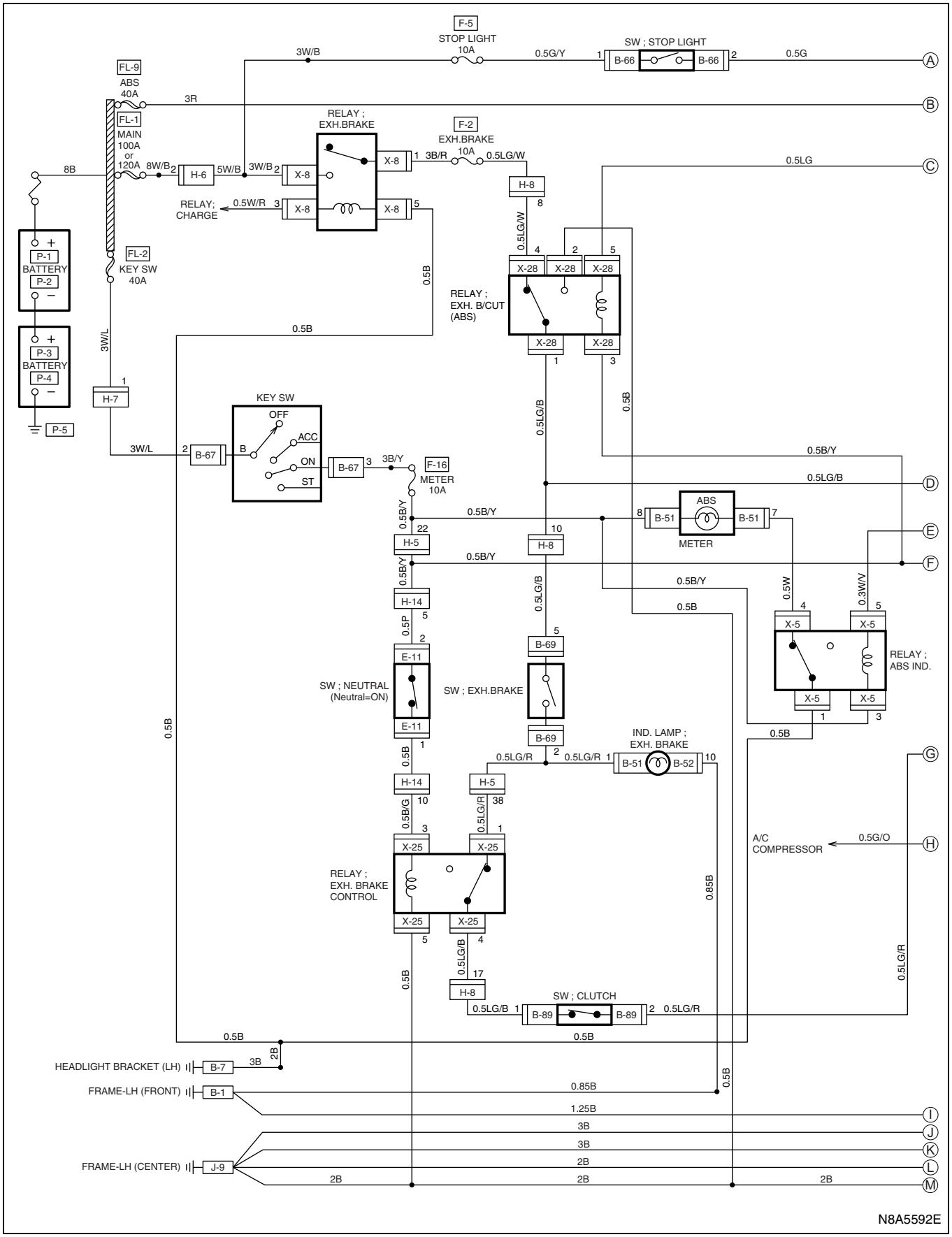
Circuit Diagram

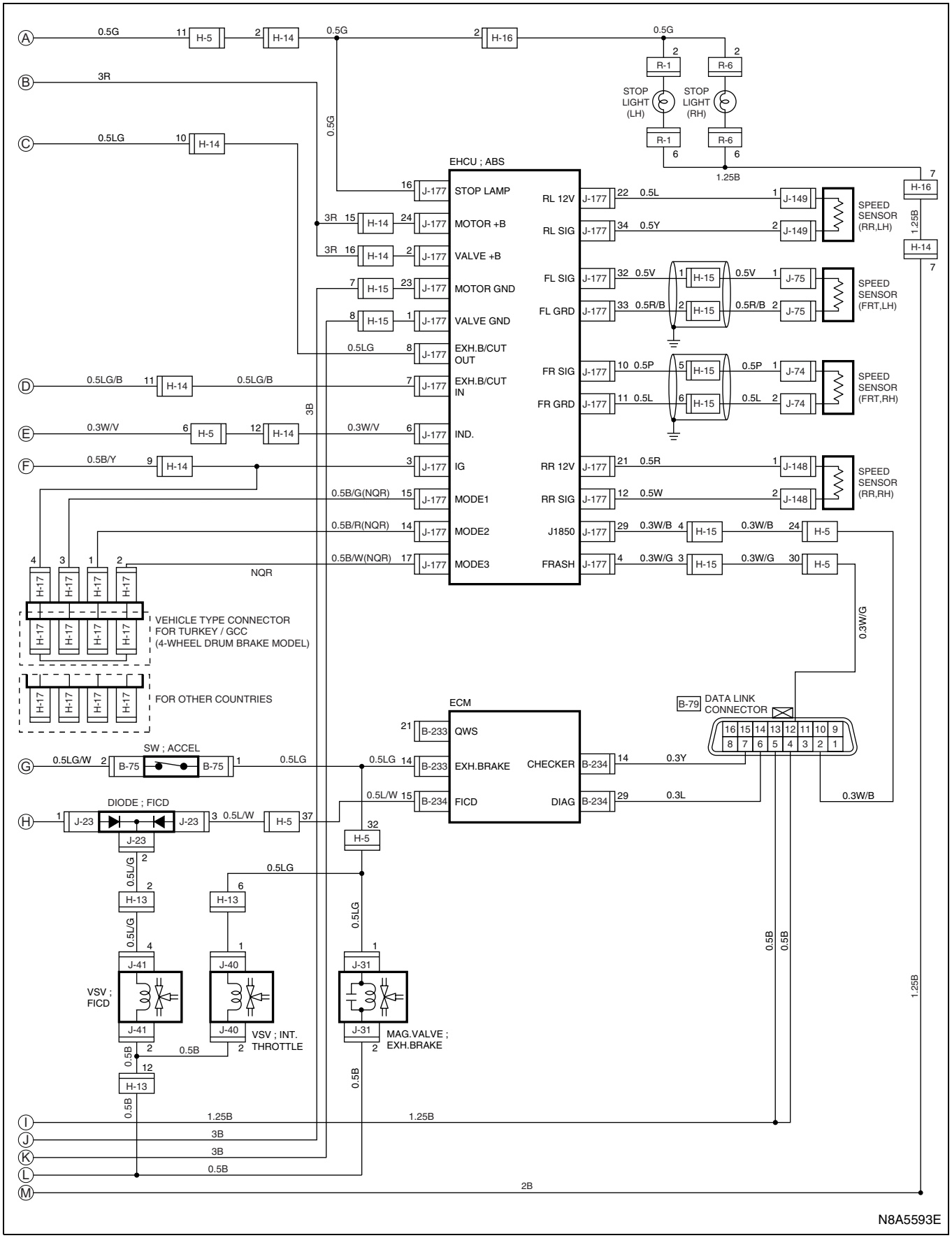
For 12 Volt (4JH1 Engine)



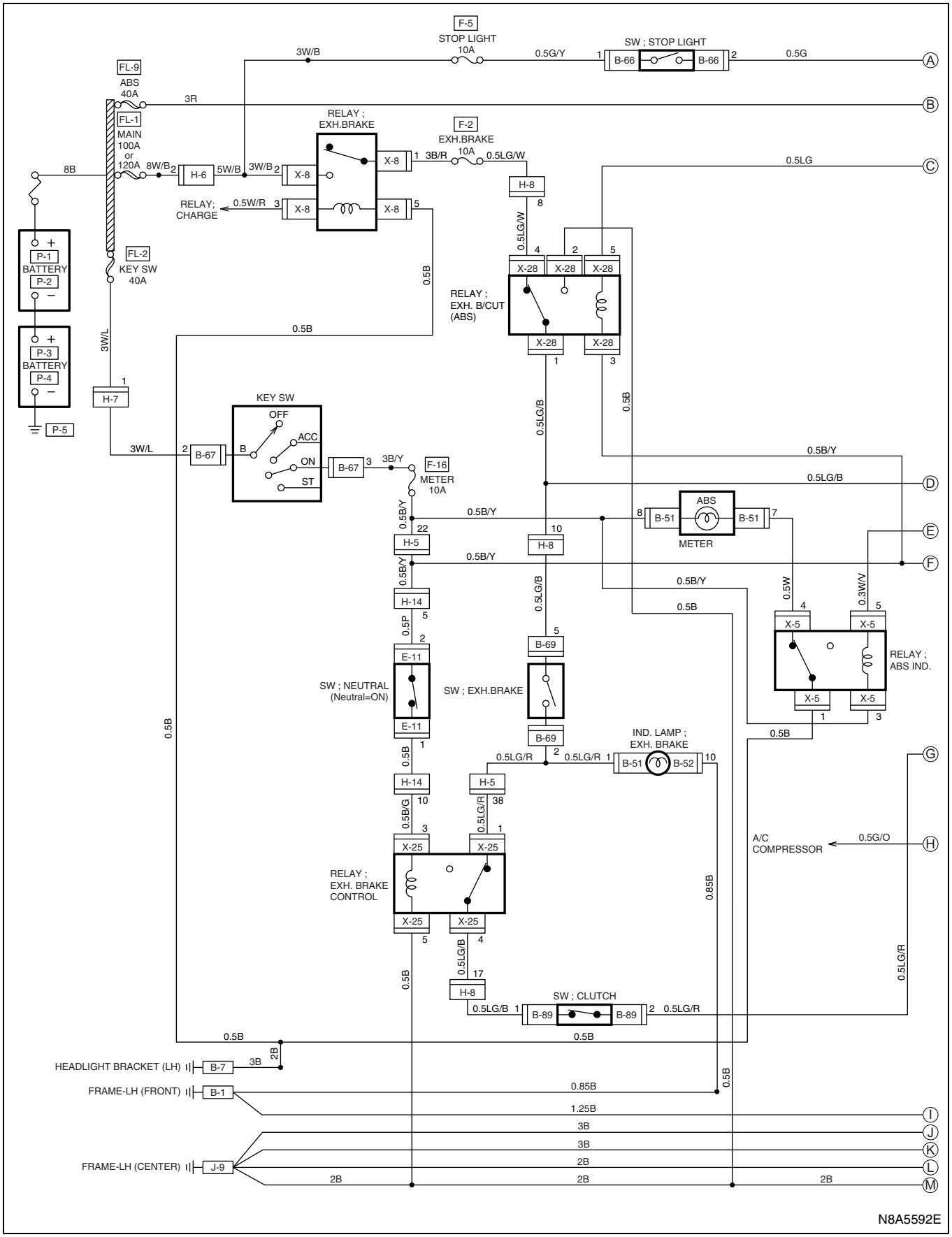

ECM
(30) B-234
0.5G
A
0.5G
11 H-5
0.5G
2 H-14
0.5G
0.5G
2 H-16
0.5G
2
R-1
2
R-6
STOP LIGHT (LH)
STOP LIGHT (RH)
R-1
6
R-6
6
1.25B
7
H-16
1.25B
H-14
7
B
3R
0.5G
EHCU ; ABS
16 J-177 STOP LAMP
H-14 15 3R 24 J-177 MOTOR +B
H-14 16 3R 2 J-177 VALVE +B
H-15 7 3B 23 J-177 MOTOR GND
H-15 8 3B 1 J-177 VALVE GND
ECM B-234 (32) 0.5LG/W 40 H-5 0.5LG/W H-14 10 0.5LG 8 J-177 EXH.B/CUT OUT
ECM B-234 (62) 0.5LG/B 36 H-5 0.5LG/B H-14 11 0.5LG/B 7 J-177 EXH.B/CUT IN
C 0.3W/V 35 H-5 0.3W/V H-14 12 0.3W/V 6 J-177 IND.
D 0.5B/Y H-14 9 0.5B/Y 3 J-177 IG
15 J-177 MODE1
14 J-177 MODE2
17 J-177 MODE3
RL 12V J-177 22 0.5L 2 J-78
RL SIG J-177 34 0.5Y 1 J-78
SPEED SENSOR (RR,LH)
FL SIG J-177 32 0.5V 1 H-15 0.5V 1 J-75
FL GRD J-177 33 0.5R/B 2 H-15 0.5R/B 2 J-75
SPEED SENSOR (FRT,LH)
FR SIG J-177 10 0.5P 5 H-15 0.5P 1 J-74
FR GRD J-177 11 0.5L 6 H-15 0.5L 2 J-74
SPEED SENSOR (FRT,RH)
RR 12V J-177 21 0.5R 4 J-78
RR SIG J-177 12 0.5W 3 J-78
SPEED SENSOR (RR,RH)
J1850 J-177 29 0.3W/B 4 H-15 0.3W/B 26 H-5
FRASH J-177 4 0.3W/G 3 H-15 0.3W/G 27 H-5
0.3W/G
B-79 DATA LINK CONNECTOR
16 15 14 13 12 11 10 9
8 7 6 5 4 3 2 1
0.3W/B
ECM
B-234 35 0.5Y
B-234 45 0.5L
0.5B/Y
0.5B/G
0.5B/R
0.5B/W
4 H-17
3 H-17
1 H-17
2 H-17
VEHICLE TYPE CONNECTOR
H-17 H-17 H-17 H-17
NKR77-3 (FLAT LOW)
H-17 H-17 H-17 H-17
EXCEPT NKR77-3 (EXCEPT FLAT LOW)
0.5B
0.5B
1.25B
E 0.85B
F 3B
G 3B
H 2B
N8A5591E

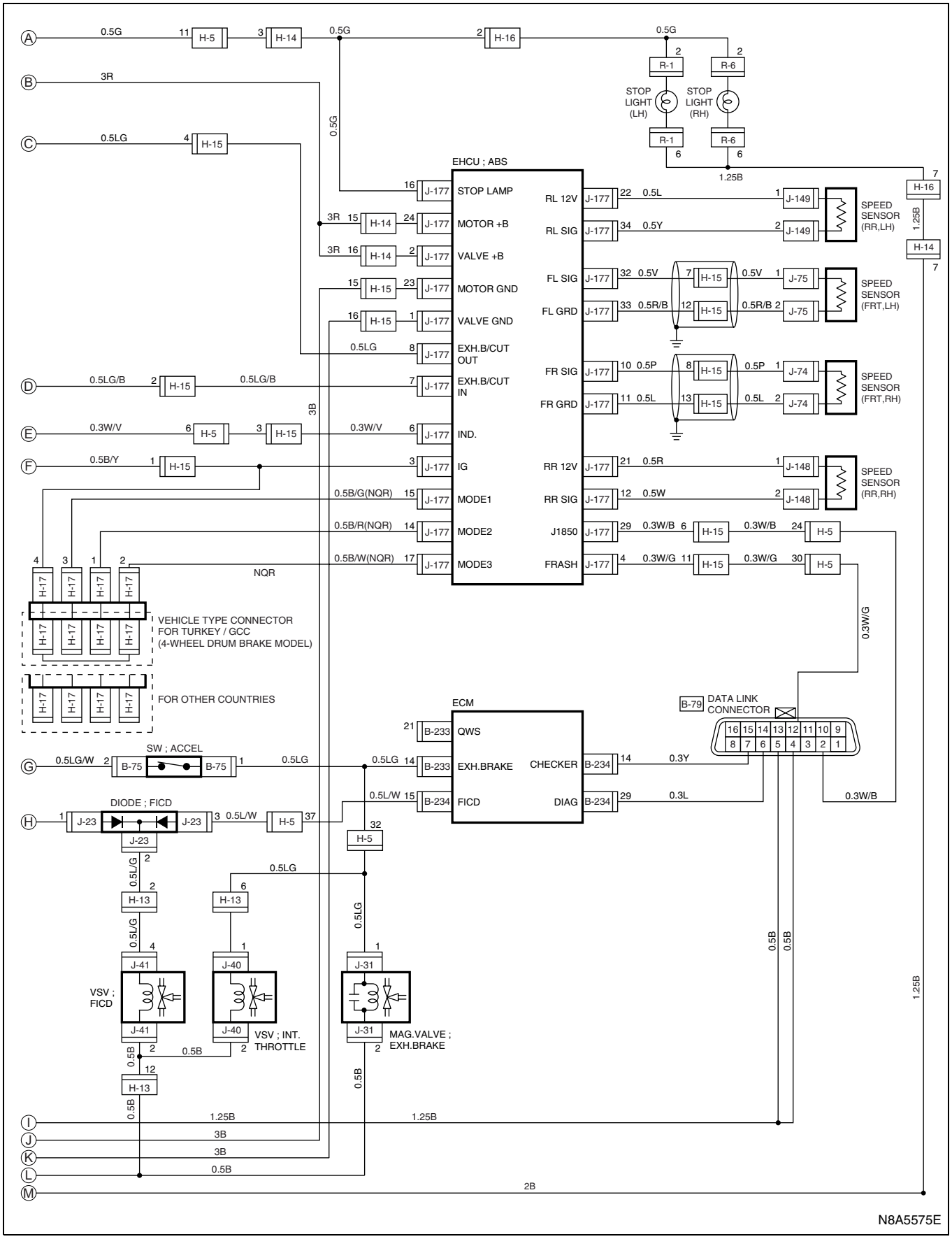
For 24 Volt - 4HE1 Engine (Single Cab Model)



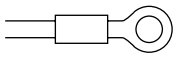
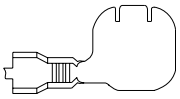
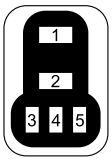
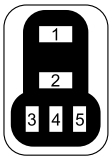
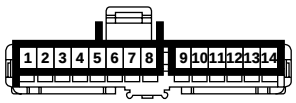
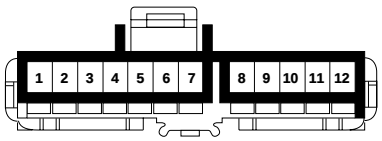

EHCU ; ABS
STOP LAMP
MOTOR +B
VALVE +B
MOTOR GND
VALVE GND
EXH.B/CUT OUT
EXH.B/CUT IN
IND.
IG
MODE1
MODE2
MODE3
RL 12V
RL SIG
FL SIG
FL GRD
FR SIG
FR GRD
RR 12V
RR SIG
J1850
FRASH
SPEED SENSOR (RR,LH)
SPEED SENSOR (FRT,LH)
SPEED SENSOR (FRT,RH)
SPEED SENSOR (RR,RH)
STOP LIGHT (LH)
STOP LIGHT (RH)
VEHICLE TYPE CONNECTOR FOR TURKEY / GCC (4-WHEEL DRUM BRAKE MODEL)
FOR OTHER COUNTRIES
NQR
ECM
QWS
EXH.BRAKE
FICD
CHECKER
DIAG
B-79 DATA LINK CONNECTOR
SW ; ACCEL
DIODE ; FICD
VSV ; FICD
VSV ; INT. THROTTLE
MAG.VALVE ; EXH.BRAKE
N8A5593E

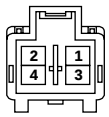
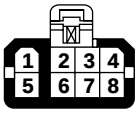
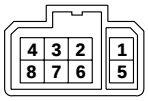
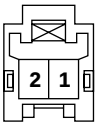
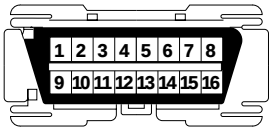
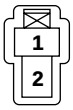
For 24 Volt - 4HE1 Engine (Crew Cab Model)

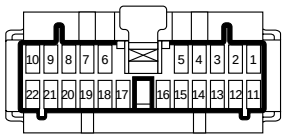
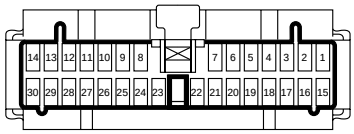
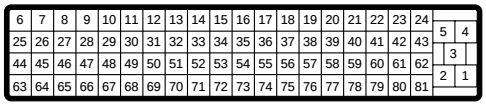
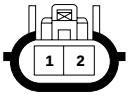
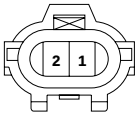
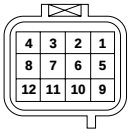



EHCU ; ABS
STOP LAMP
MOTOR +B
VALVE +B
MOTOR GND
VALVE GND
EXH.B/CUT OUT
EXH.B/CUT IN
IND.
IG
MODE1
MODE2
MODE3
RL 12V
RL SIG
FL SIG
FL GRD
FR SIG
FR GRD
RR 12V
RR SIG
J1850
FRASH
SPEED SENSOR (RR,LH)
SPEED SENSOR (FRT,LH)
SPEED SENSOR (FRT,RH)
SPEED SENSOR (RR,RH)
STOP LIGHT (LH)
STOP LIGHT (RH)
VEHICLE TYPE CONNECTOR FOR TURKEY / GCC (4-WHEEL DRUM BRAKE MODEL)
FOR OTHER COUNTRIES
NQR
ECM
QWS
EXH.BRAKE
FICD
CHECKER
DIAG
DATA LINK CONNECTOR
SW ; ACCEL
DIODE ; FICD
VSV ; FICD
VSV ; INT. THROTTLE
MAG.VALVE ; EXH.BRAKE
N8A5575E

Connector List

No.	Connector Face
B-1	 000-001
B-7	 000-012
X-5	 005-006
X-8	 005-006
B-51	 014-001
B-52	 012-005
B-66	004-010
B-67	004-001

No.	Connector Face
B-67	 004-002
B-69	 008-001
B-69	 008-002
B-75	002-022
B-75	 002-023
B-79	 016-005
B-89	002-009
B-89	 002-010

No.	Connector Face
B-233 (24 V)	 022-002
B-234 (24 V)	 030-002
B-234 (12 V)	 121-001
E-11	 002-001
E-11	 002-002
H-13	012-001
H-13	 012-002
H-14 (12 V)	014-004

No.	Connector Face
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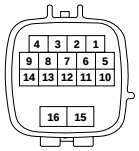
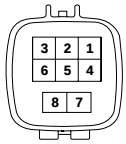
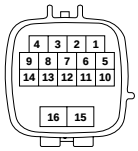
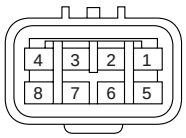
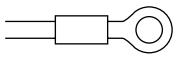
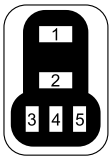
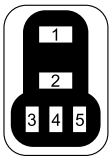
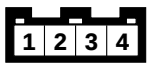
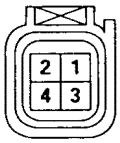
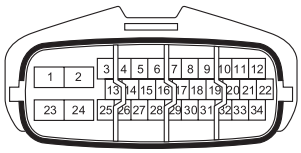
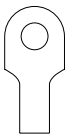
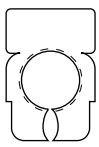
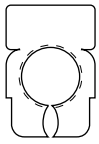
H-14 (24 V)	016-003
H-14 (24 V)	 016-004
H-15 (12 V)	008-023
H-15 (12 V)	 008-024
H-15 (24 V)	016-003
H-15 (24 V)	 016-004
H-16	008-003

No.	Connector Face
H-16	 008-004
H-17	004-011
J-9	 000-001
X-25	 005-006
X-28	 005-006
J-23	 004-009
J-31	002-011
J-31	002-012

No.	Connector Face
J-40	002-015
J-41	002-015
J-74	002-011
J-74	002-012
J-75	002-011
J-75	002-012
J-148	002-011
J-148	002-012

No.	Connector Face
J-149 (24 V)	002-011
J-149 (24 V)	002-012
J-78 (12 V)	 004-018
J-78 (12 V)	004-011
J-177	 034-001
P-1 (12 V)	 000-003
P-2	 000-004
P-1 (24 V)	 000-004

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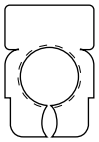
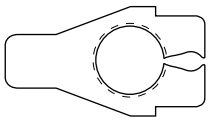
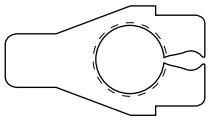
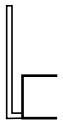
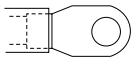
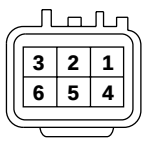
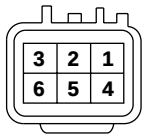
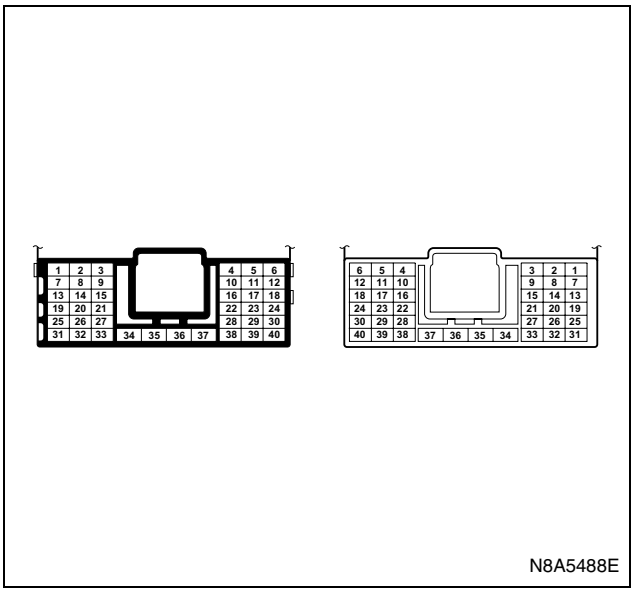
P-4	 000-004
P-2 (24 V)	 000-006
P-3	 000-006
P-5 (12 V)	 000-007
P-5 (24 V)	 000-002
R-1	006-004
R-1	 006-005
R-6	006-004

No.	Connector Face
R-6	 006-005

H-5



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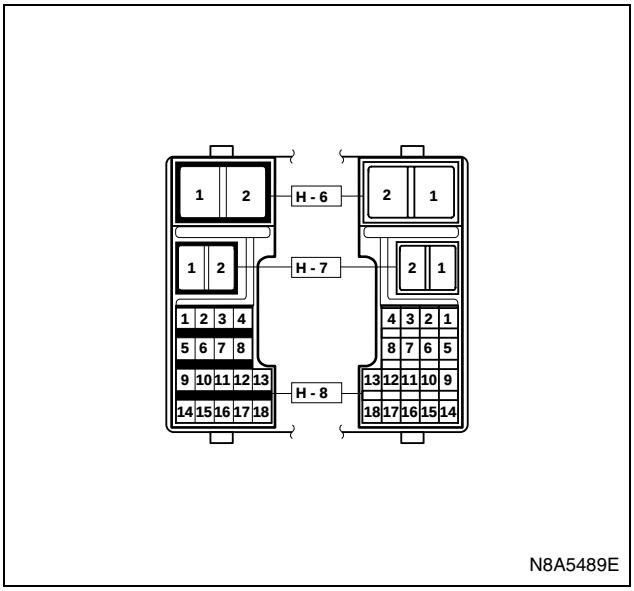
H-6, H-7, H-8



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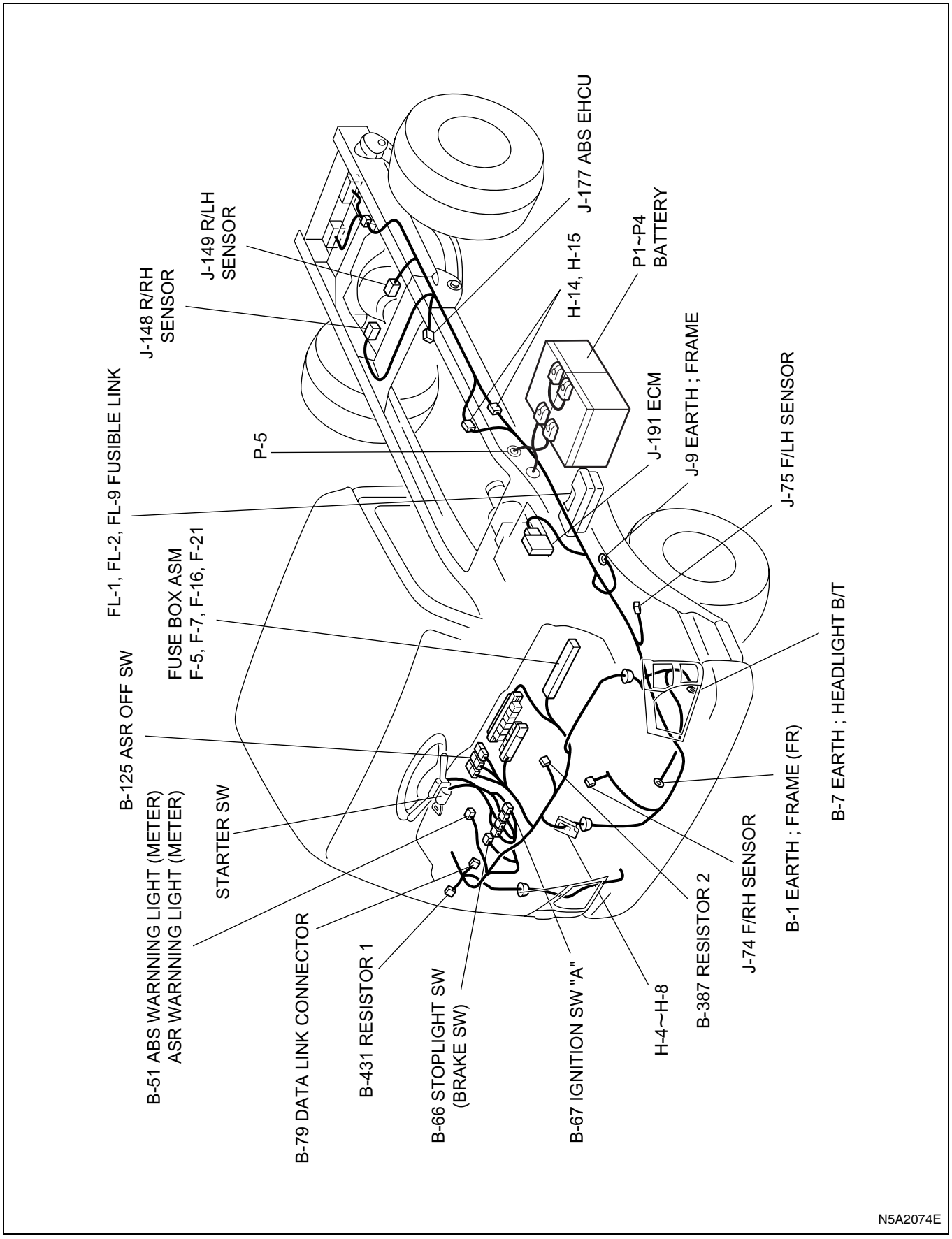
ABS/ASR System

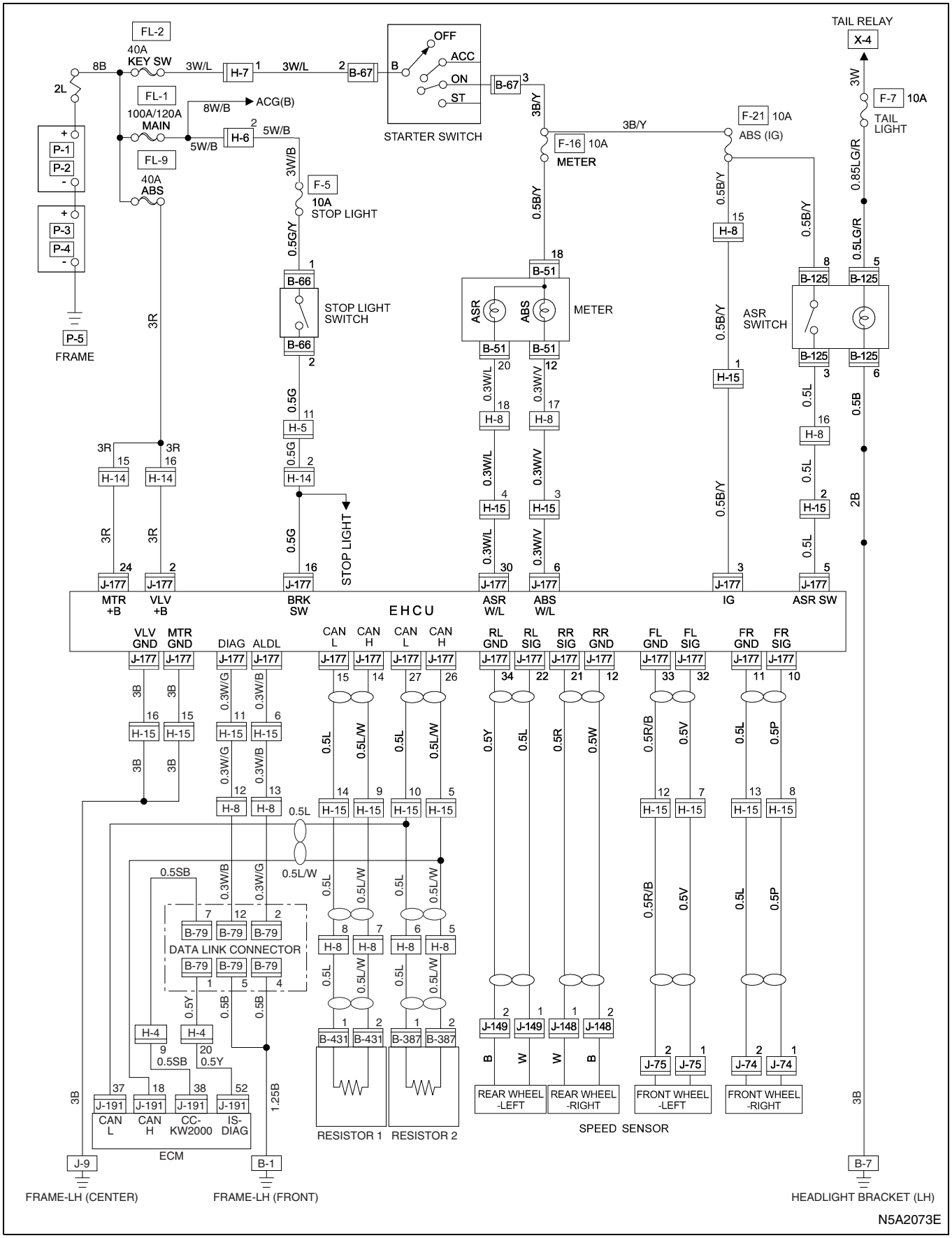
General Description

ABS (Anti-lock Brake System) and ASR (Anti-Slip Regulator) are the system to prevent the wheels from locking and wheel spin, and to assure stability and steering ability of the vehicle.
When a malfunction occurs in the system, fail-safe deactivate the ABS and ASR, and the warning lamp comes on. Also, the self-diagnosis function is equipped to improve serviceability.

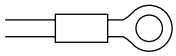
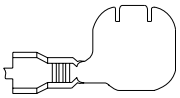
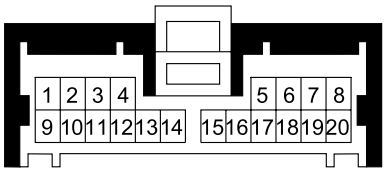
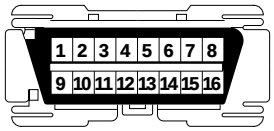
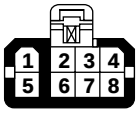
Parts Location

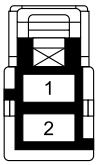
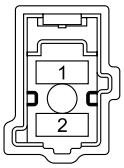
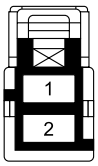
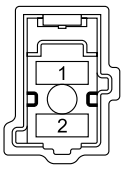
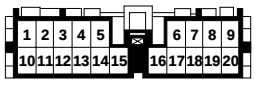
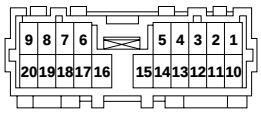
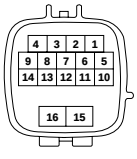


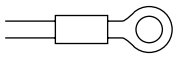
Circuit Diagram

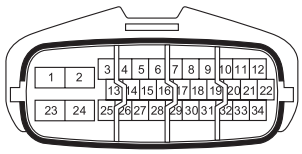
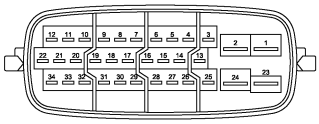
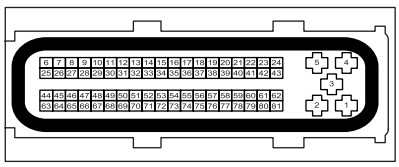
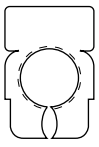
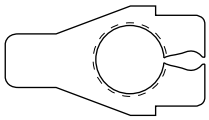


Connector List

No.	Connector Face
B-1	 000-001
B-7	 000-012
B-51	 020-004
B-66	002-031
B-67	004-002
B-67	004-001
B-79	 016-005
B-125	 008-001

No.	Connector Face
B-387	 002-038
B-387	 002-039
B-431	 002-038
B-431	 002-039
H-4	 020-002
H-4	 020-003
H-14	 016-004
H-14	016-003

No.	Connector Face
H-15	016-003
H-15	016-004
J-9	 000-001
J-74	002-012
J-74	002-011
J-75	002-012
J-75	002-011
J-148	002-012

No.	Connector Face
J-148	002-011
J-149	002-012
J-149	002-011
J-177	 034-001
J-177	 034-002
J-191	 081-001
P-1	 000-004
P-2	 000-006

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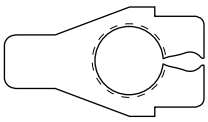
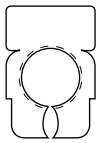
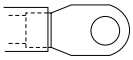
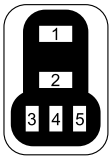
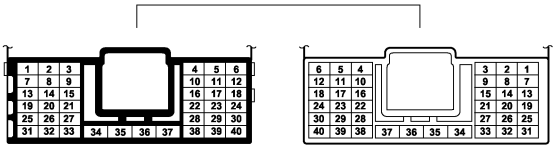
P-3	 000-006
P-4	 000-004
P-5	 000-002
X-4	 005-006

H-5



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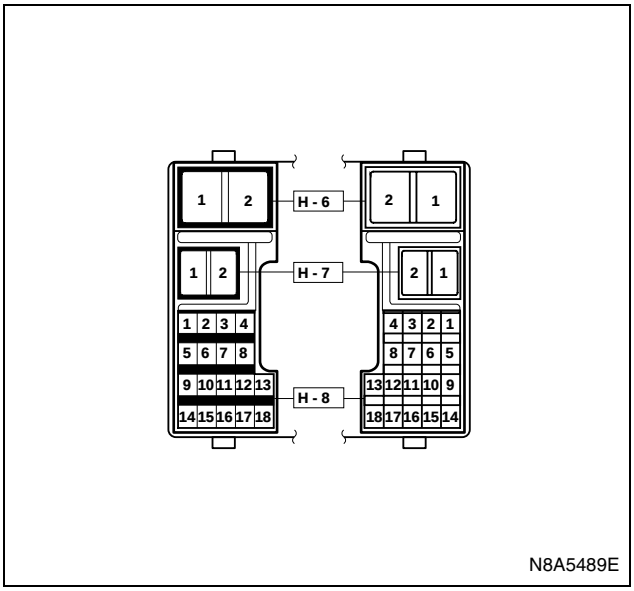
H-6, H-7, H-8



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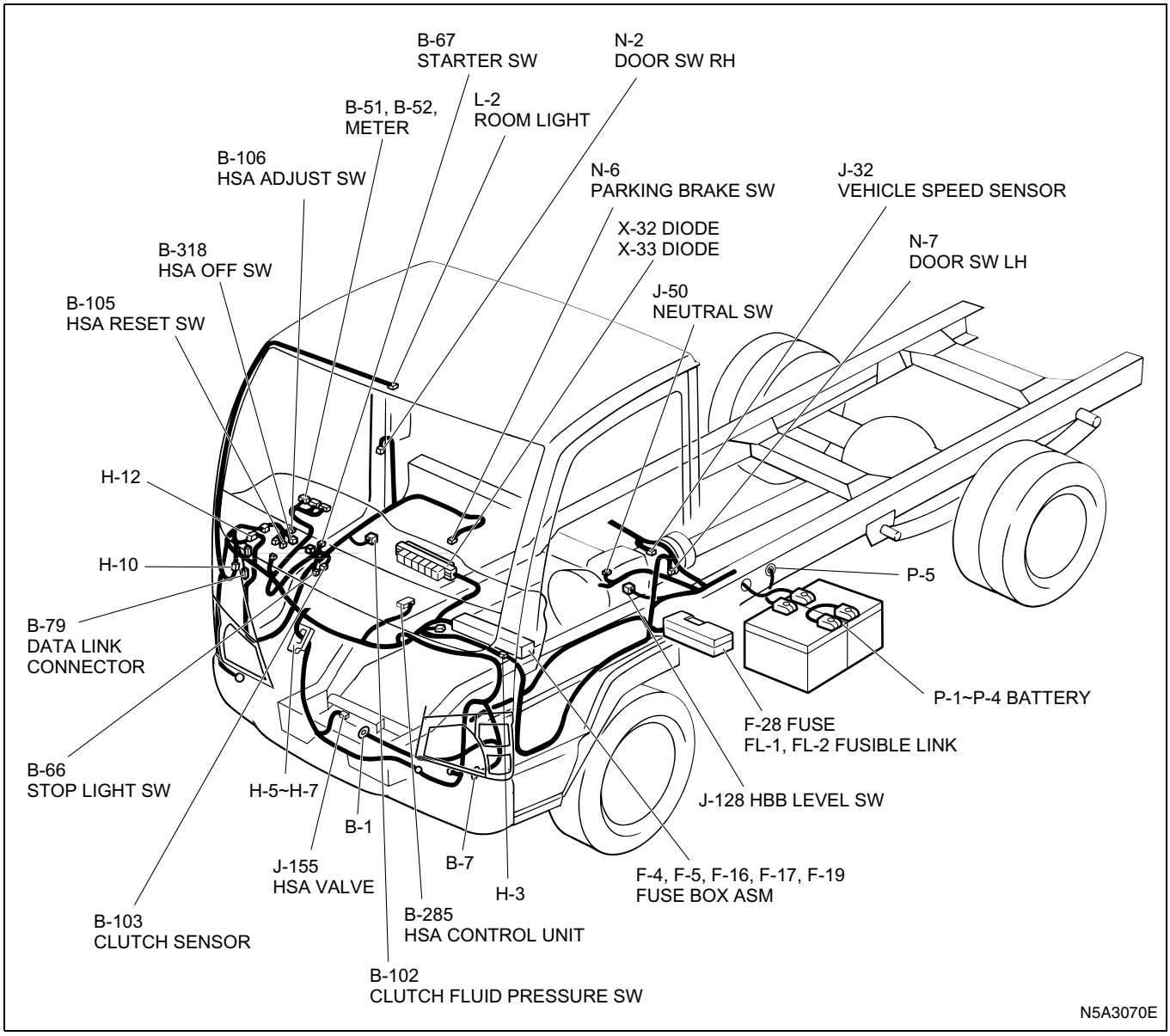
HSA (Hill Start Aid) System

General Description

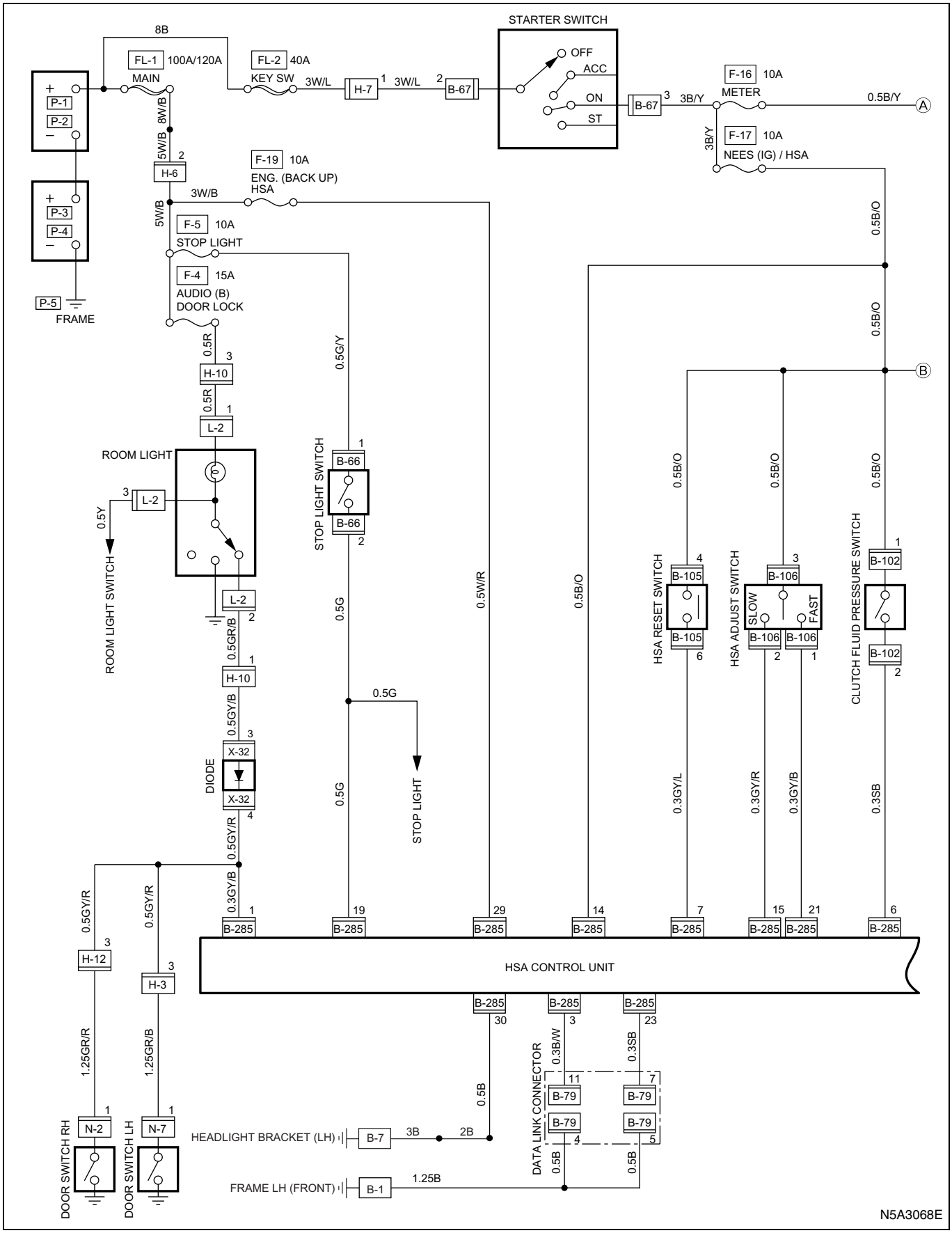
The HSA (hill start aid) is the system to retain the brake force with brake pedal not depressed when the vehicle is parked, and to automatically release the brake force when starting the vehicle.

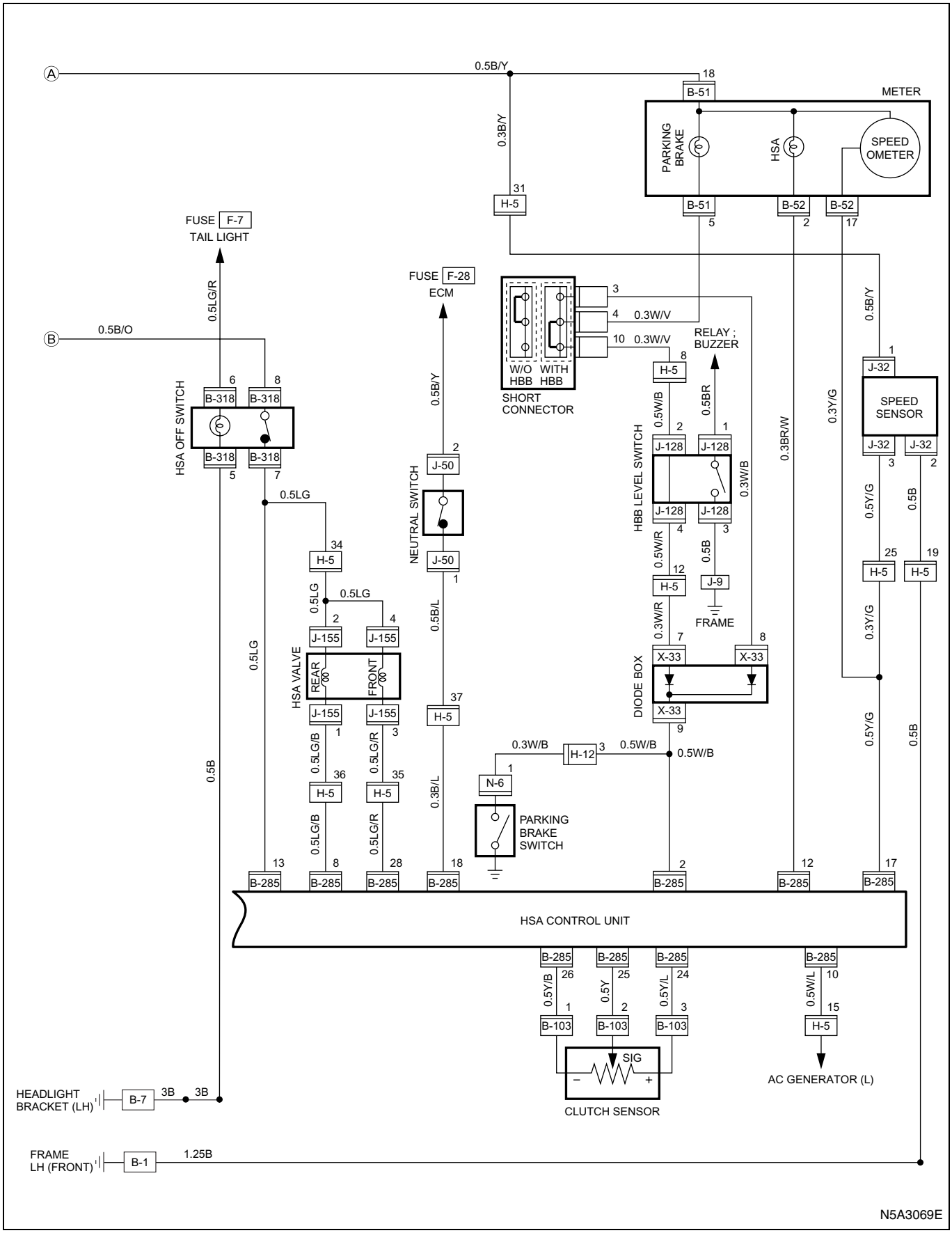
The HSA control unit drives the HSA valve located in the pipe route between the master cylinder and the wheel cylinder, to hold/release the brake fluid pressure. Also, alarm function (activates when the door opened with HSA operating, when the HSA system has running long time, when the HSA pressure goes down) and self-diagnosis function are equipped with the HSA control unit.

Parts Location

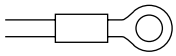
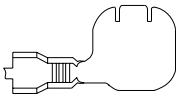
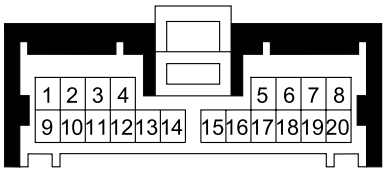
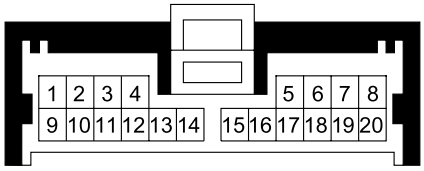
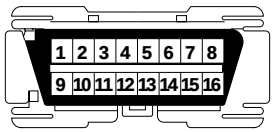


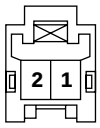
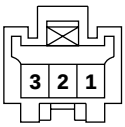
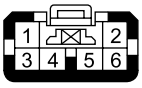
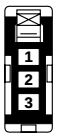
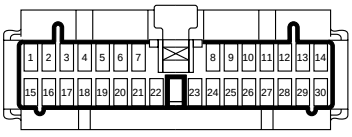
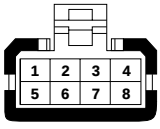
Circuit Diagram

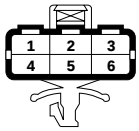
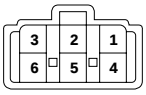
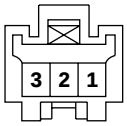
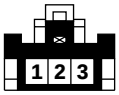
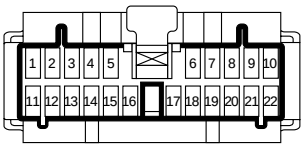
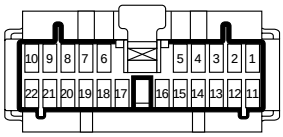
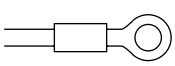


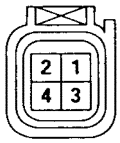
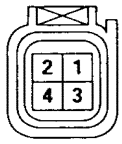
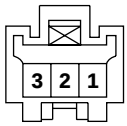
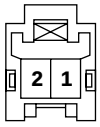

A
0.5B/Y
18
B-51
METER
PARKING BRAKE
HSA
SPEED OMETER
0.3B/Y
31
H-5
B-51
5
B-52
2
B-52
17
FUSE F-7
TAIL LIGHT
0.5LG/R
FUSE F-28
ECM
B
0.5B/O
W/O HBB
WITH HBB
SHORT CONNECTOR
3
4
0.3W/V
10
0.3W/V
RELAY ; BUZZER
8
H-5
0.5B/Y
1
J-32
SPEED SENSOR
J-32
J-32
3
2
0.3Y/G
0.5B/Y
2
J-50
NEUTRAL SWITCH
J-50
1
0.5B/L
0.5W/B
2
J-128
J-128
1
0.5BR
HBB LEVEL SWITCH
J-128
J-128
4
3
0.3W/B
0.5W/R
12
H-5
0.5B
J-9
FRAME
0.3W/R
7
X-33
X-33
8
DIODE BOX
X-33
9
0.3BR/W
0.5Y/G
0.5B
25
H-5
19
H-5
0.3Y/G
HSA OFF SWITCH
6
8
B-318
B-318
B-318
B-318
5
7
0.5LG
34
H-5
0.5LG
0.5LG
2
4
J-155
J-155
HSA VALVE
REAR
FRONT
J-155
J-155
1
3
0.5LG/B
0.5LG/R
36
35
H-5
H-5
0.5LG/B
0.5LG/R
0.5LG
0.5B
37
H-5
0.3B/L
0.3W/B
H-12
3
0.5W/B
0.5W/B
1
N-6
PARKING BRAKE SWITCH
13
8
28
18
2
12
17
B-285
B-285
B-285
B-285
B-285
B-285
B-285
0.5Y/G
0.5B
HSA CONTROL UNIT
B-285
B-285
B-285
B-285
0.5Y/B
26
0.5Y
25
0.5Y/L
24
0.5W/L
10
1
2
3
15
B-103
B-103
B-103
H-5
SIG
AC GENERATOR (L)
CLUTCH SENSOR
HEADLIGHT BRACKET (LH)
B-7
3B
3B
FRAME LH (FRONT)
B-1
1.25B
N5A3069E

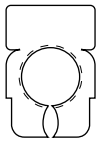
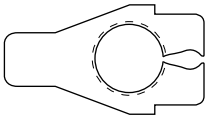
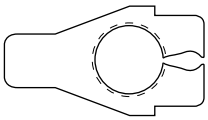
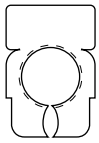
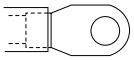
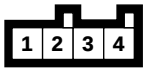
Connector List

No.	Connector Face
B-1	 000-001
B-7	 000-012
B-51	 020-004
B-52	 020-005
B-66	002-031
B-67	004-002
B-67	004-001
B-79	 016-005

No.	Connector Face
B-102	002-022
B-102	 002-023
B-103	003-009
B-103	 003-010
B-105	 006-021
B-106	 003-014
B-285	 030-001
B-318	 008-005

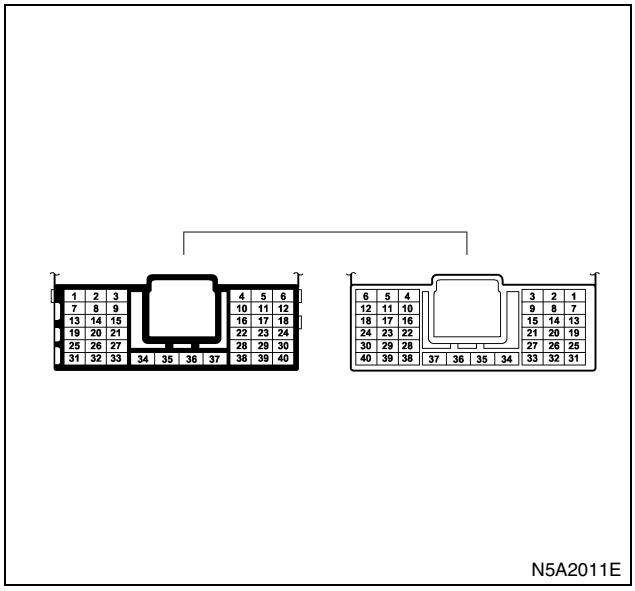
No.	Connector Face
H-3	 006-014
H-3	 006-015
H-10	 003-010
H-10	 003-009
H-12	 022-001
H-12	 022-002
J-9	 000-001
J-32	003-018

No.	Connector Face
J-50	002-035
J-128	 004-018
J-155	 004-018
J-155	004-011
L-2	 003-010
L-2	003-009
N-2	001-020
N-6	 002-023

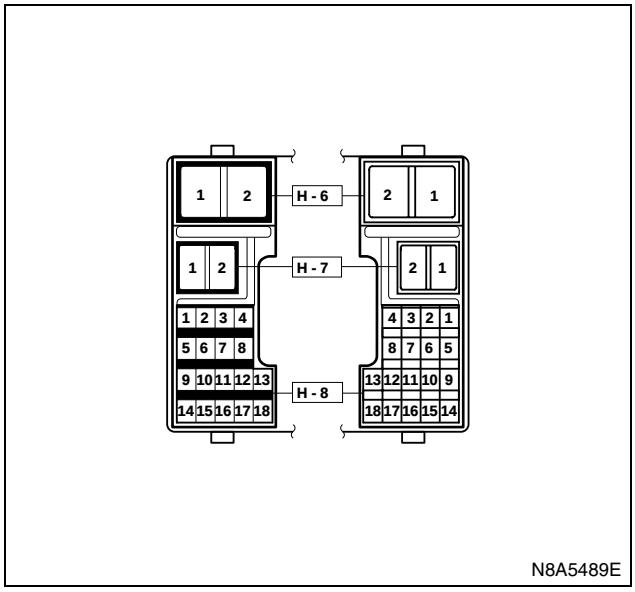
No.	Connector Face
N-6	002-022
N-7	001-020
P-1	 000-004
P-2	 000-006
P-3	 000-006
P-4	 000-004
P-5	 000-002
X-32	 004-004

No.	Connector Face
X-33	014-002

H-5



H-6, H-7

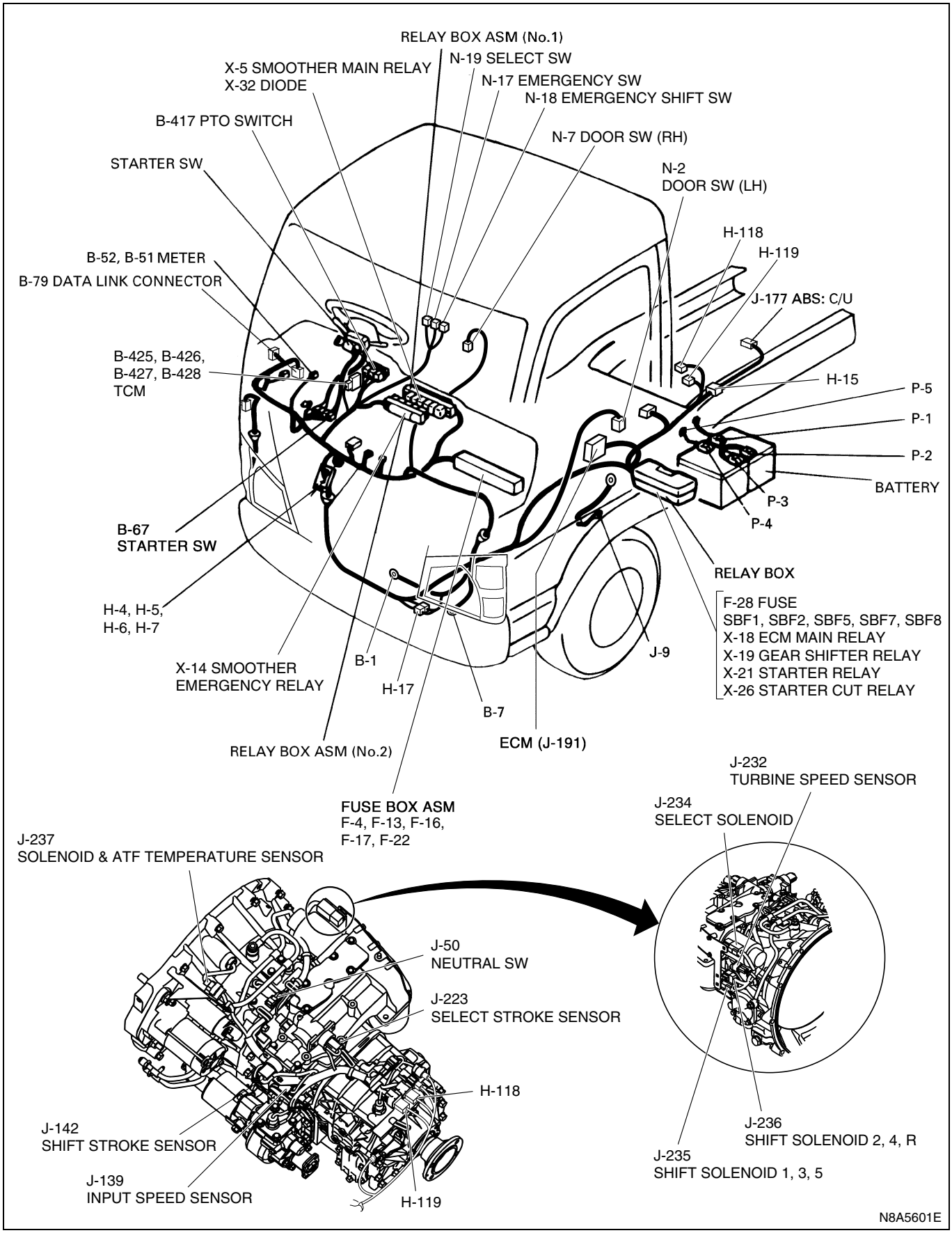


Transmission Control System (Smoother)

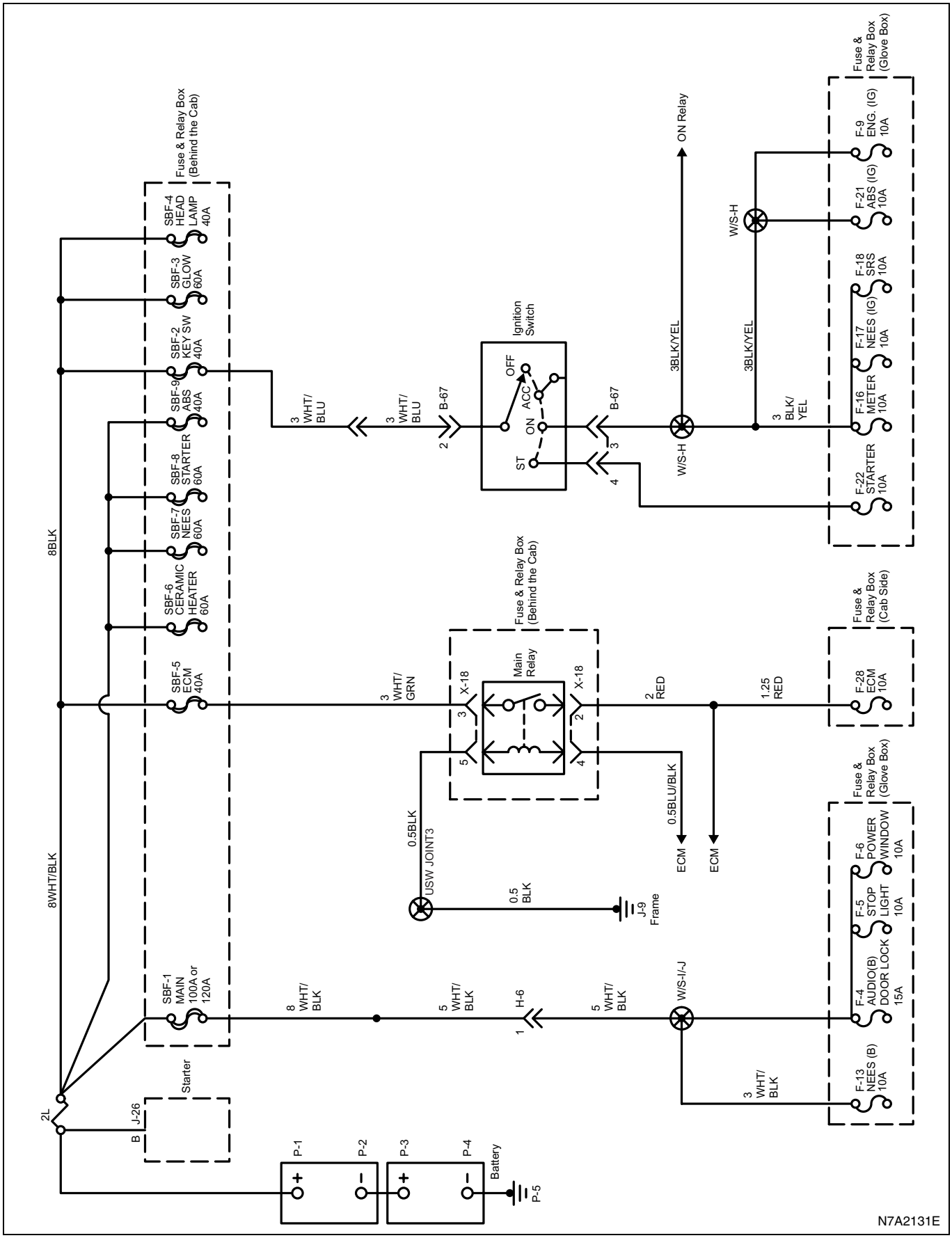
General Description

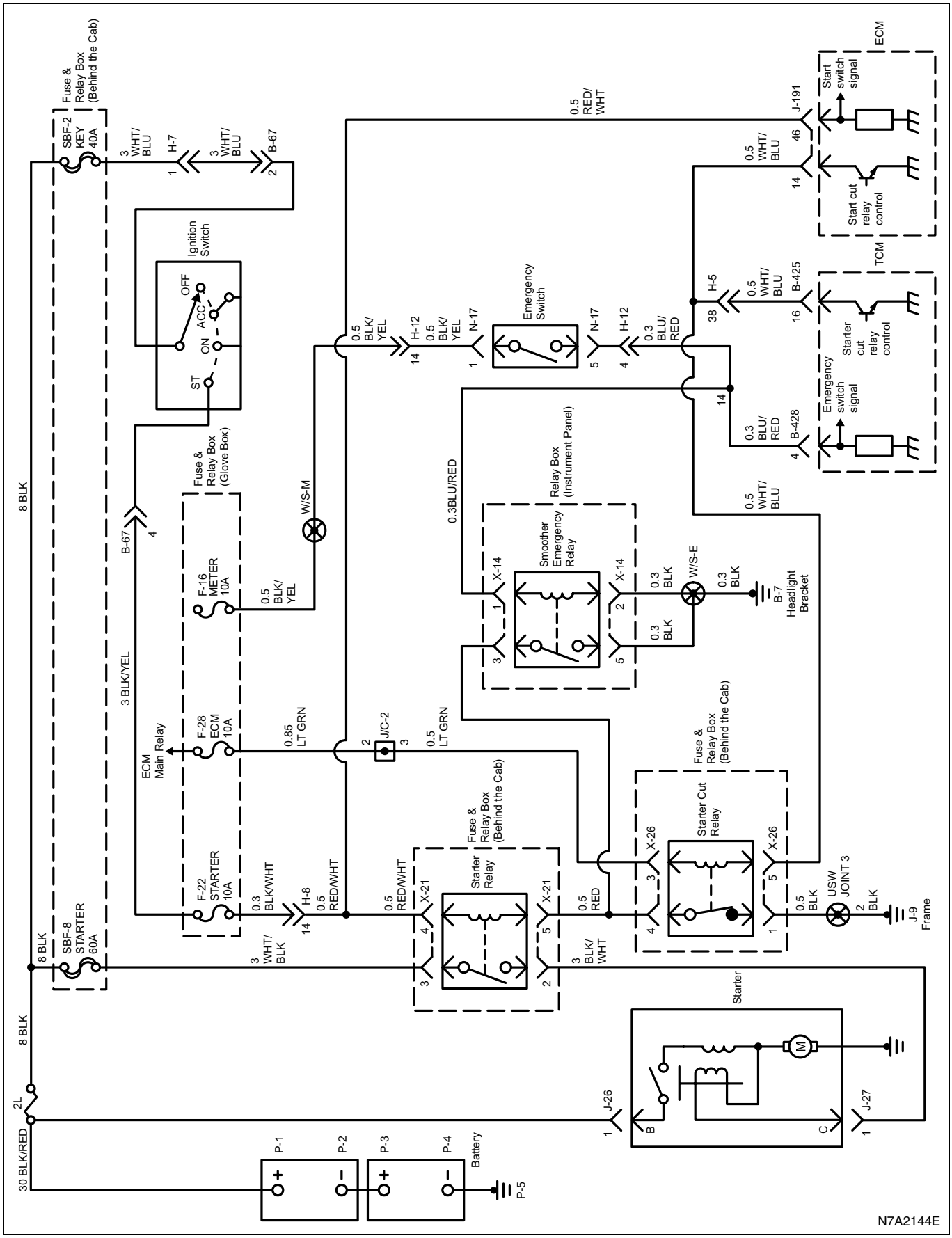
“Smoother” is the name of a new-generation drive train that provides benefits in terms of both life cycle costs (low initial cost and maintenance cost, lower fuel consumption, etc.) and easy driving. Smoother is a system that adds an automatic transmission to the existing Smoother, for even better fuel consumption and easier driving. This is accomplished by installing a solenoid system shift control box on the Smoother, which combines a manual transmission with fluid coupling, so all shifting is performed automatically in accordance with signals from the transmission control module (TCM). When starting moving the vehicle, depressing the brake pedal and operating the change lever as on an automatic vehicle causes a change lever position signal to be detected by the TCM. This actuates the shift control box solenoid and shifts the gear into the starting position or the reverse position, and then engages the shift change clutch (wet multi-disc clutch). (After the shift clutch engages, creep force is generated the same as on an AT vehicle.) Releasing the foot from the brake pedal and pressing the accelerator pedal starts the vehicle moving forward. If there is an up-shift or down-shift while running, the control unit determines the vehicle status based on vehicle speed, accelerator opening angle, and other factors, and shifts to the optimal gear automatically. If the driver moves the change lever in the “+” or “-” direction, a gear change is indicated, so sequential manual shifting is also possible. (Even during sequential manual shifting, the transmission shifts to the starting position when the vehicle is stopped.)

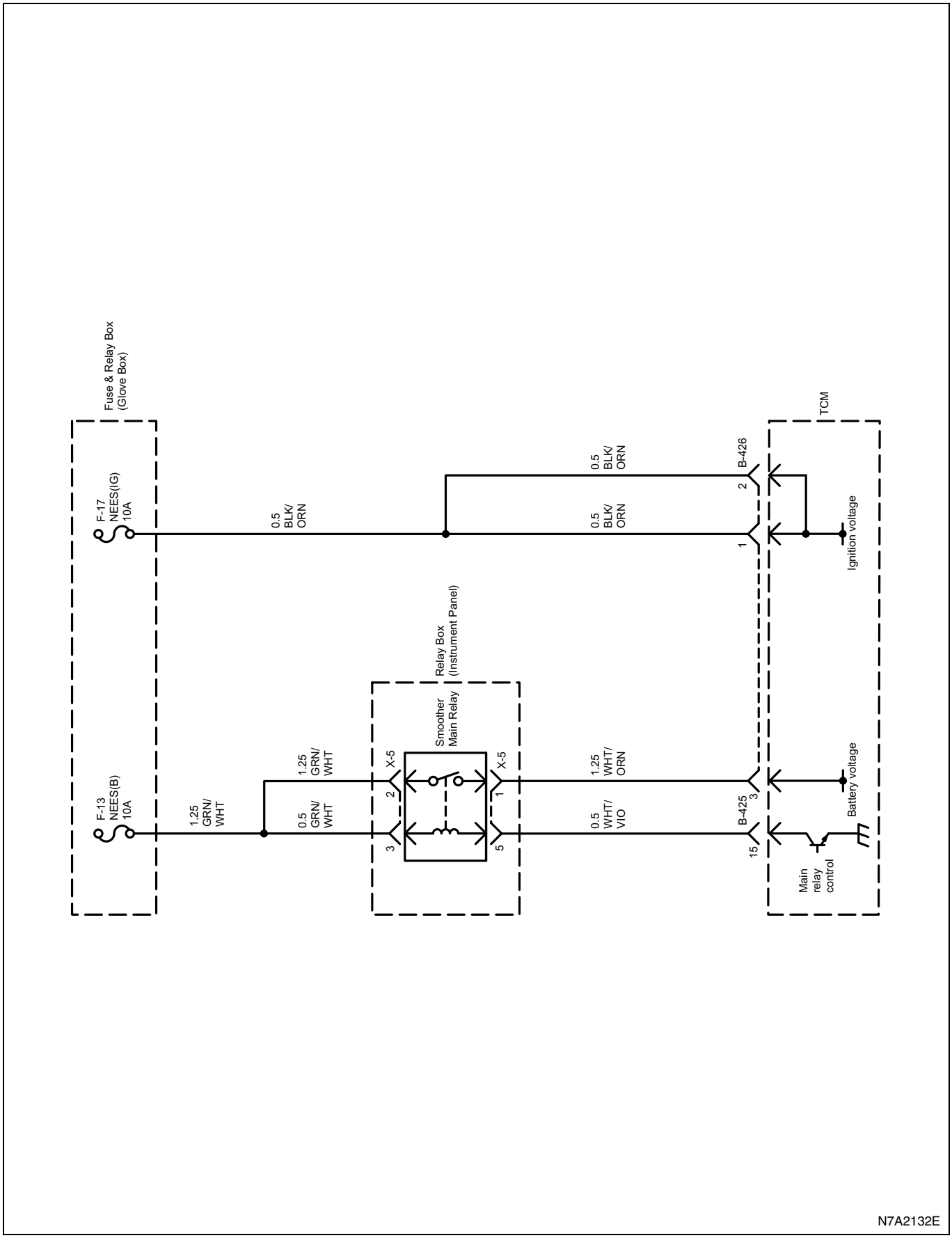
Parts Location

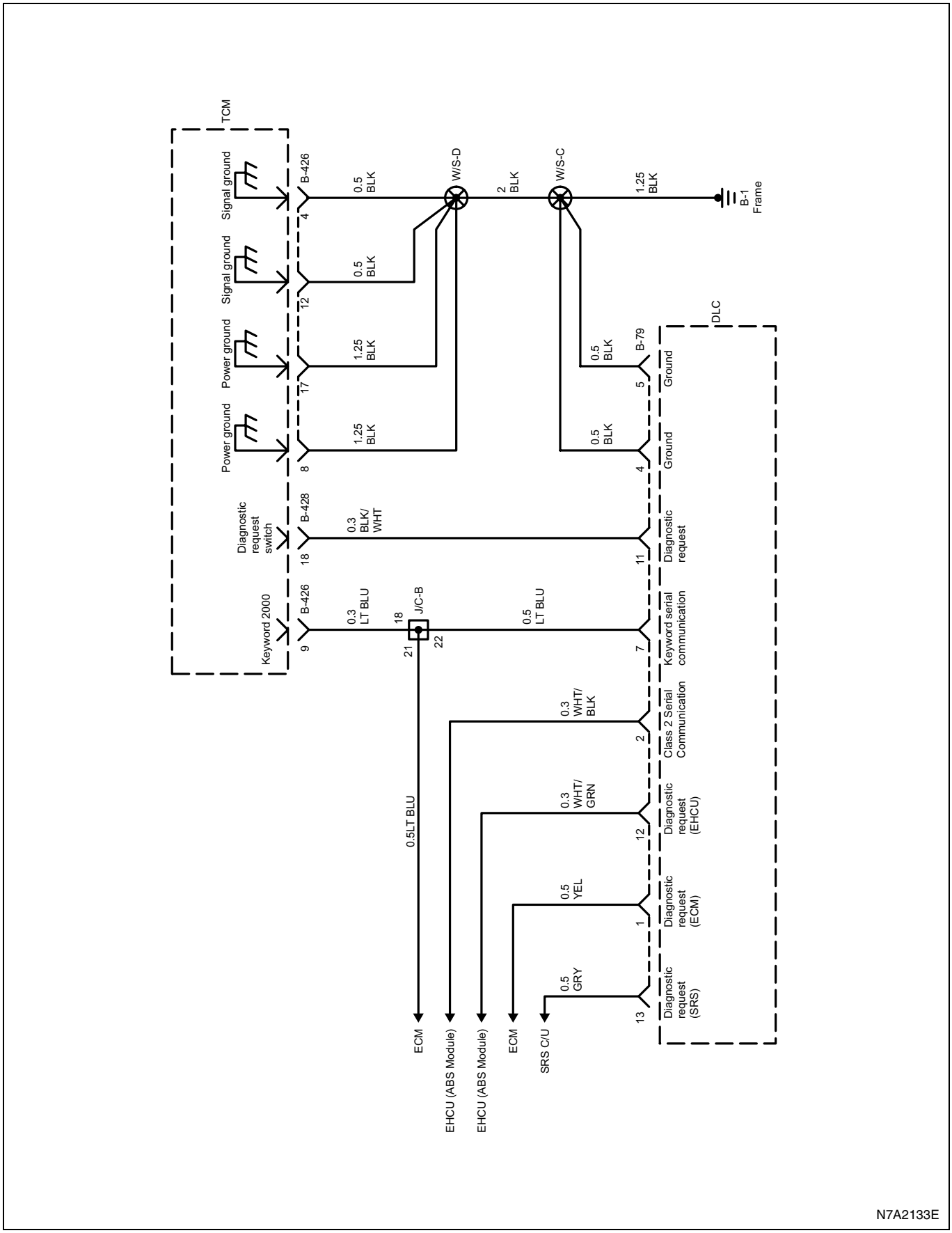


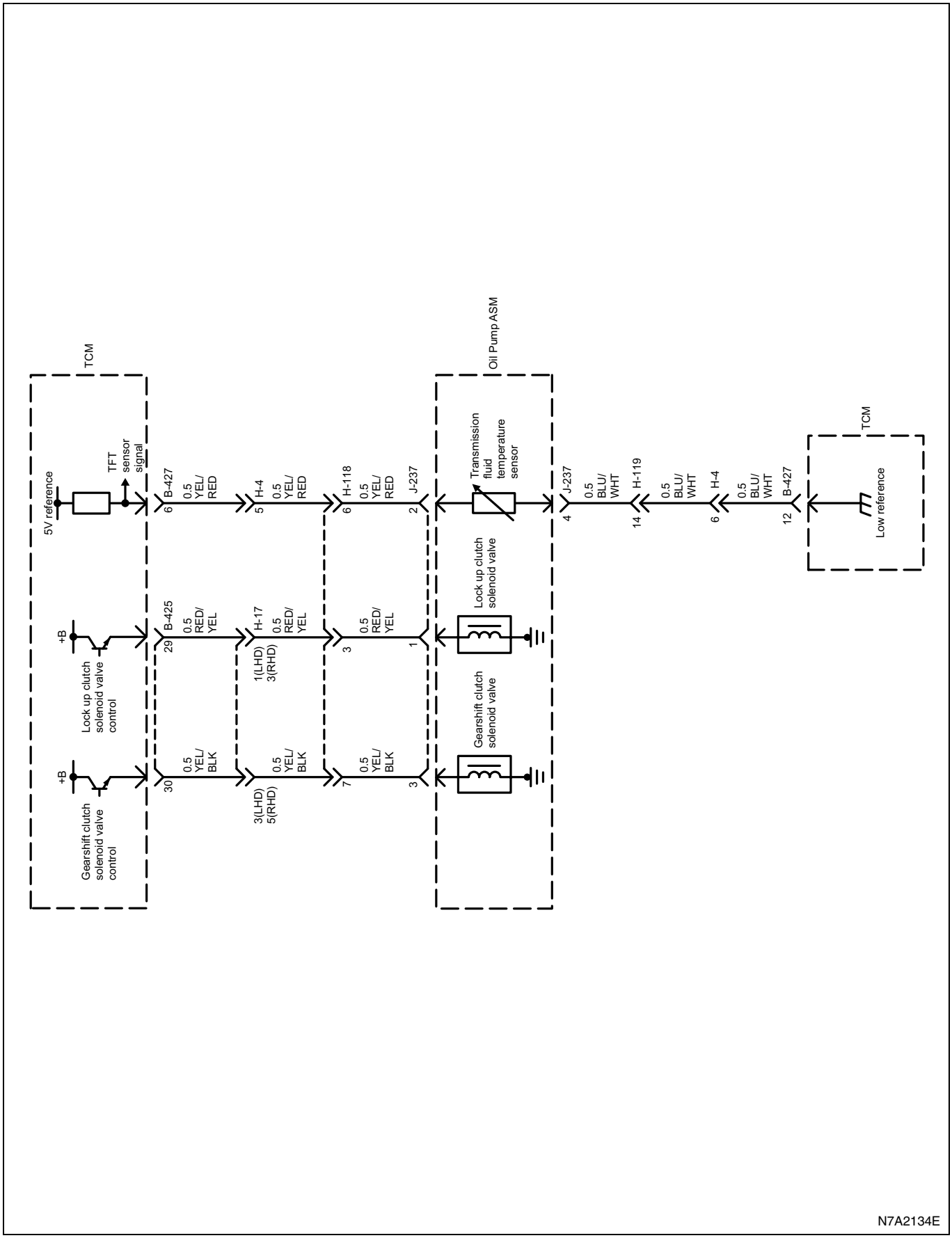
Circuit Diagram

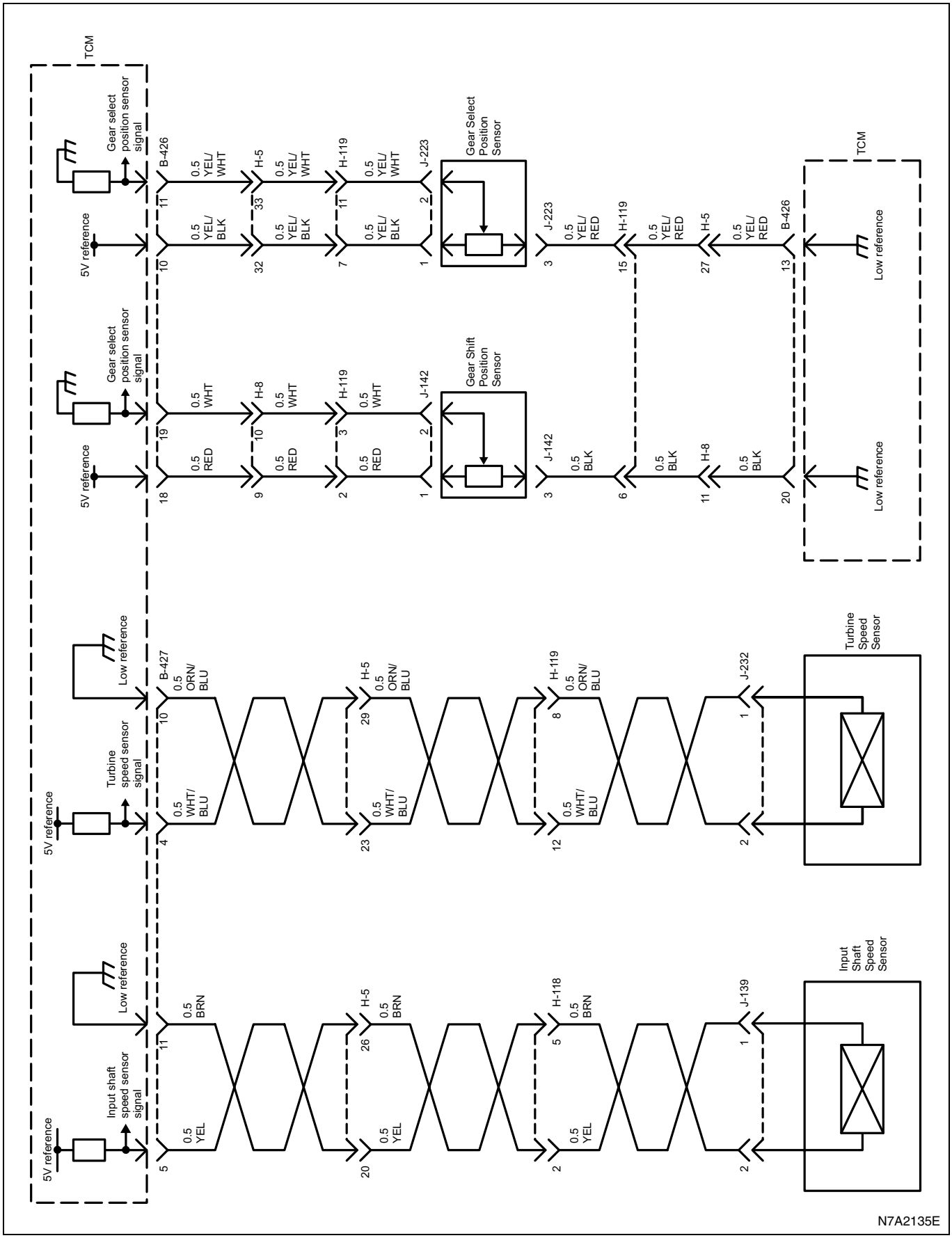


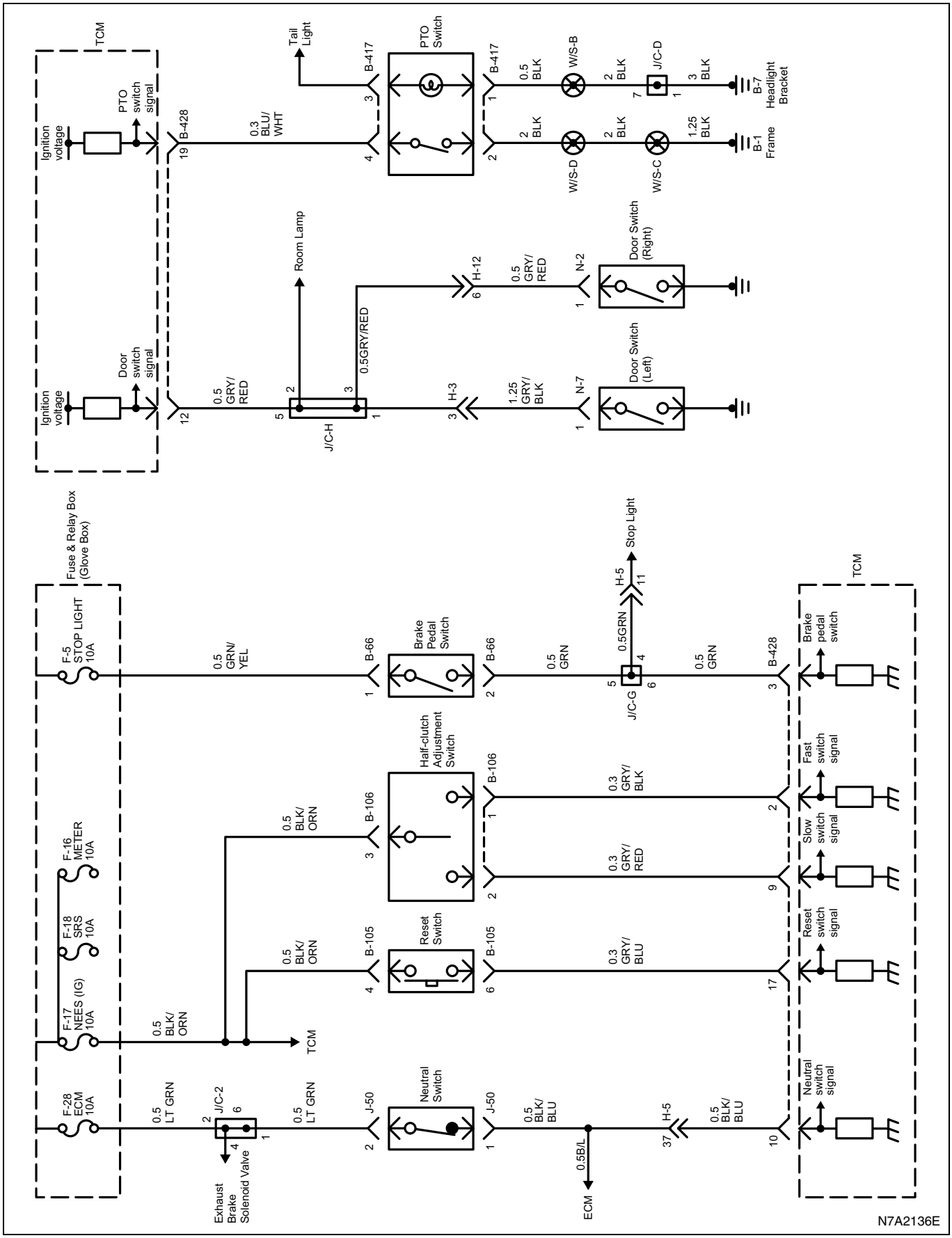

Fuse & Relay Box (Behind the Cab)
SBF-2 KEY 40A
3 WHT/BLU
H-7
B-67
Ignition Switch
OFF
ACC
ON
ST
Fuse & Relay Box (Glove Box)
W/S-M
0.5 BLK/YEL
H-12
N-17
Emergency Switch
0.5 RED/WHT
J-191
ECM
Start switch signal
Start cut relay control
0.5 WHT/BLU
46
14
TCM
H-5
B-425
16
38
Starter cut relay control
Emergency switch signal
0.3 BLU/RED
B-428
4
5
0.3BLU/RED
Relay Box (Instrument Panel)
Smoother Emergency Relay
X-14
W/S-E
0.3 BLK
B-7 Headlight Bracket
8 BLK
SBF-8 STARTER 60A
F-16 METER 10A
F-28 ECM 10A
F-22 STARTER 10A
3 BLK/YEL
ECM Main Relay
0.85 LT GRN
J/C-2
0.5 LT GRN
0.3 BLK/WHT
H-8
0.5 RED/WHT
3 WHT/BLK
Fuse & Relay Box (Behind the Cab)
Starter Relay
X-21
Starter Cut Relay
X-26
USW JOINT 3
J-9 Frame
Starter
J-26
J-27
2L
30 BLK/RED
P-1
P-2
P-3
P-4
Battery
P-5
N7A2144E

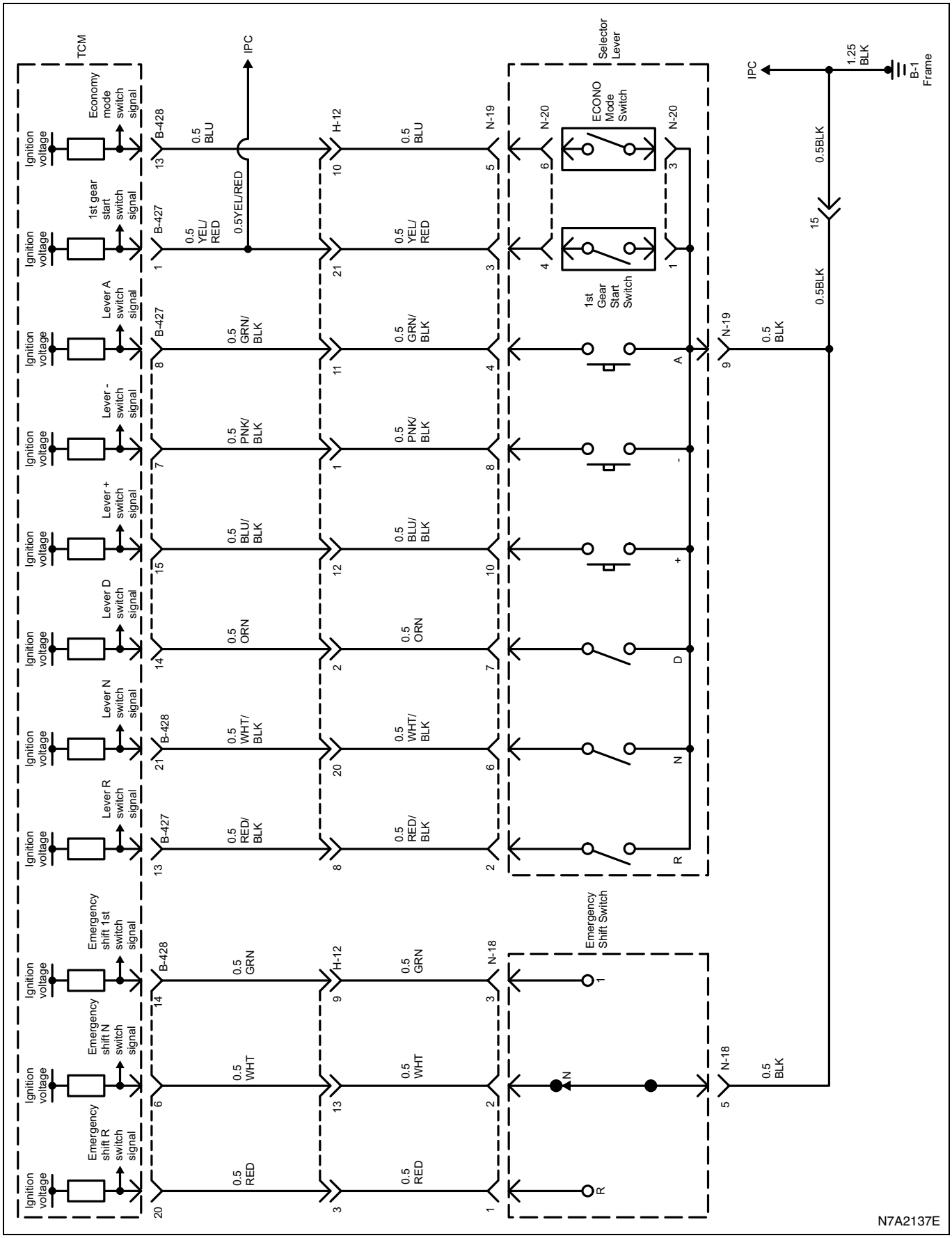

Fuse & Relay Box
(Glove Box)
F-17
NEES(IG)
10A
F-13
NEES(B)
10A
0.5
BLK/
ORN
1.25
GRN/
WHT
0.5
GRN/
WHT
Relay Box
(Instrument Panel)
Smoother
Main Relay
X-5
2
3
1
5
0.5
BLK/
ORN
0.5
BLK/
ORN
1.25
WHT/
ORN
0.5
WHT/
VIO
TCM
B-426
2
1
B-425
3
15
Ignition voltage
Battery voltage
Main
relay
control
N7A2132E

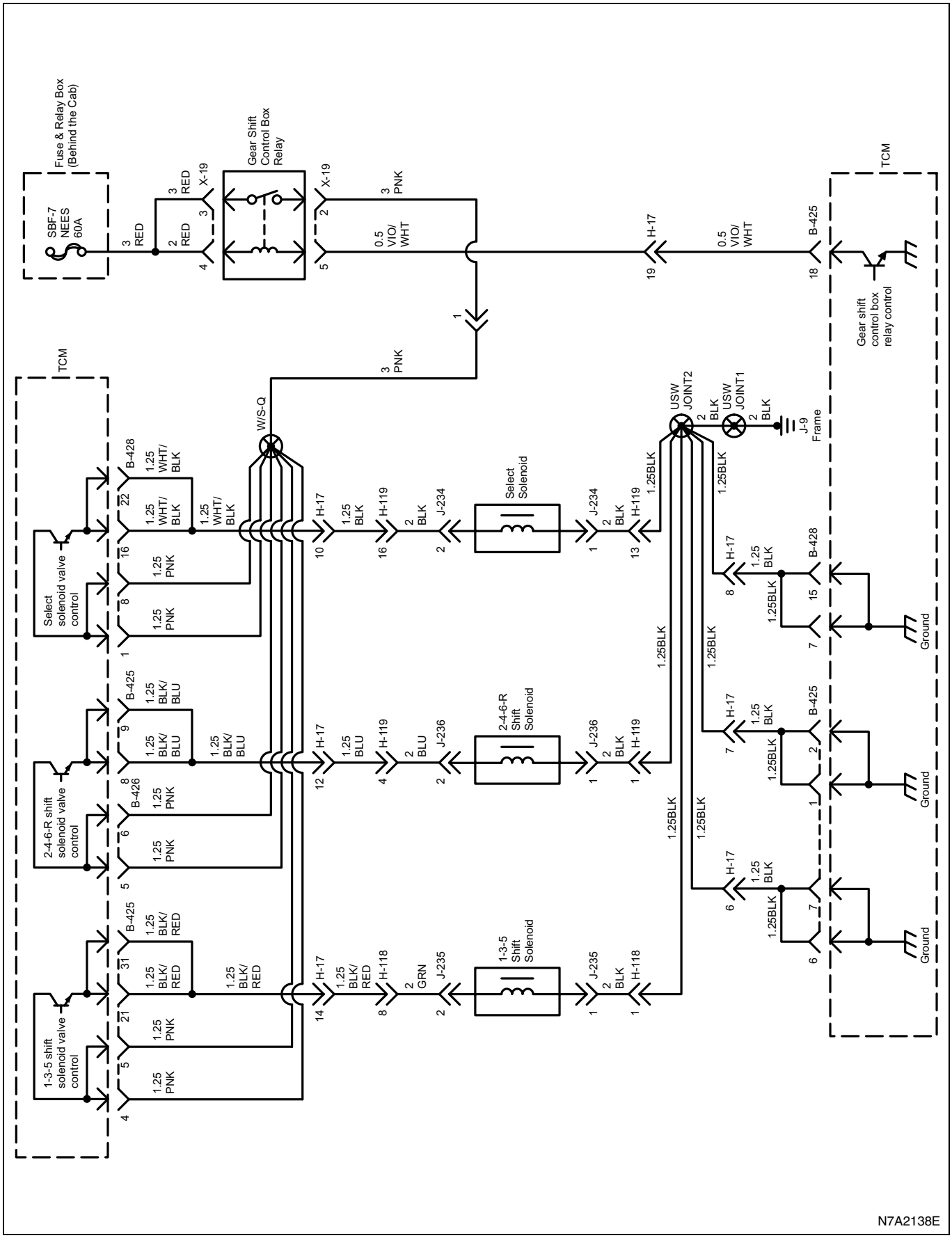

TCM
Signal ground
Signal ground
Power ground
Power ground
Keyword 2000
Diagnostic request switch
B-426
B-428
B-426
4
12
17
8
18
9
0.5 BLK
0.5 BLK
1.25 BLK
1.25 BLK
0.3 BLK/ WHT
0.3 LT BLU
18
21
J/C-B
22
0.5LT BLU
W/S-D
2 BLK
W/S-C
1.25 BLK
B-1 Frame
DLC
0.5 BLK
0.5 BLK
B-79
5
4
11
7
Ground
Ground
Diagnostic request
Keyword serial communication
0.5 LT BLU
0.3 WHT/ BLK
0.3 WHT/ GRN
0.5 YEL
0.5 GRY
2
12
1
13
Class 2 Serial Communication
Diagnostic request (EHCU)
Diagnostic request (ECM)
Diagnostic request (SRS)
ECM
EHCU (ABS Module)
EHCU (ABS Module)
ECM
SRS C/U
N7A2133E

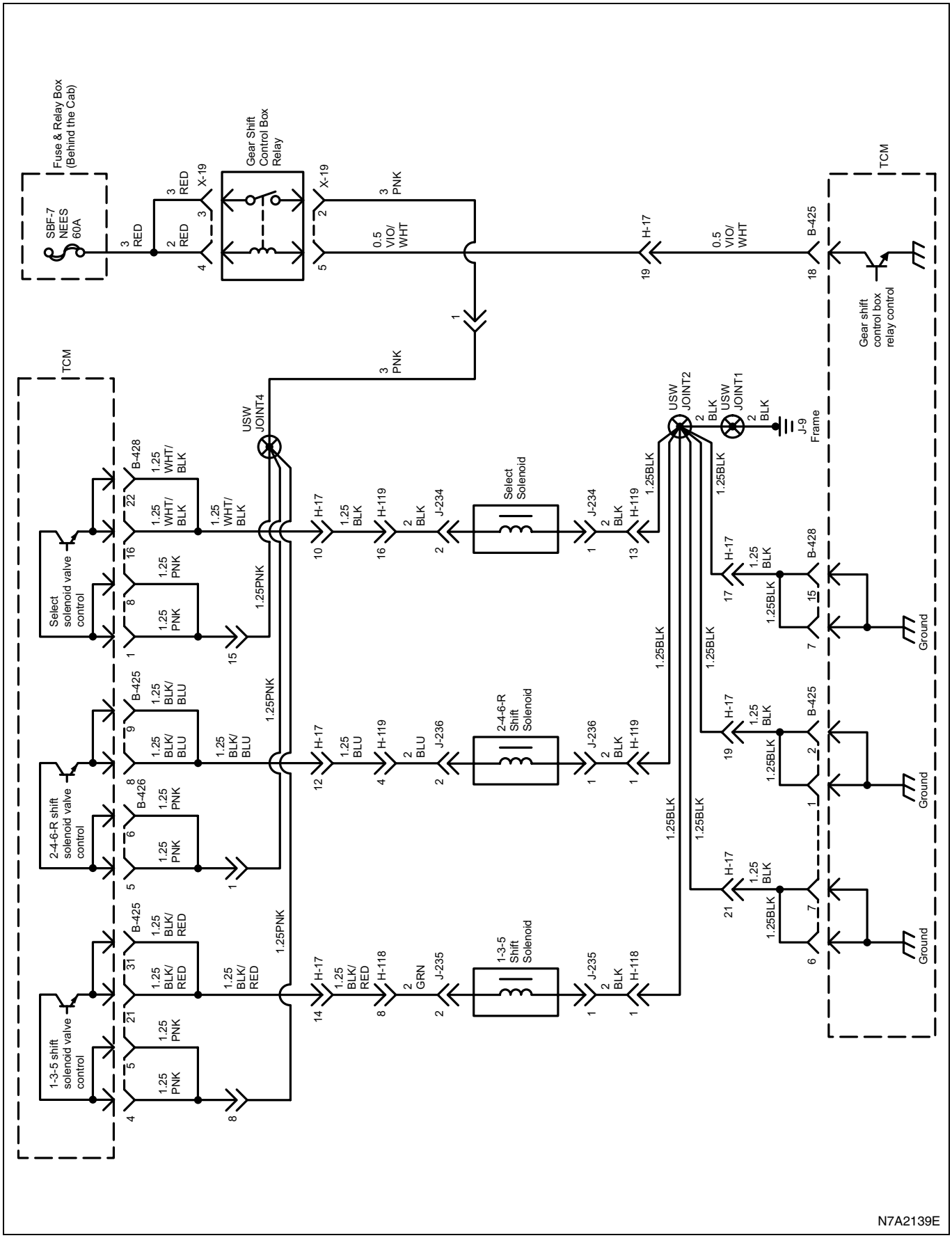

TCM
5V reference
TFT sensor signal
+B
Lock up clutch solenoid valve control
+B
Gearshift clutch solenoid valve control
B-427
6
0.5 YEL/ RED
H-4
5
0.5 YEL/ RED
H-118
6
0.5 YEL/ RED
J-237
2
B-425
29
0.5 RED/ YEL
H-17
1(LHD) 3(RHD)
0.5 RED/ YEL
3
0.5 RED/ YEL
1
30
0.5 YEL/ BLK
3(LHD) 5(RHD)
0.5 YEL/ BLK
7
0.5 YEL/ BLK
3
Oil Pump ASM
Transmission fluid temperature sensor
Lock up clutch solenoid valve
Gearshift clutch solenoid valve
J-237
4
0.5 BLU/ WHT
H-119
14
0.5 BLU/ WHT
H-4
6
0.5 BLU/ WHT
B-427
12
TCM
Low reference
N7A2134E

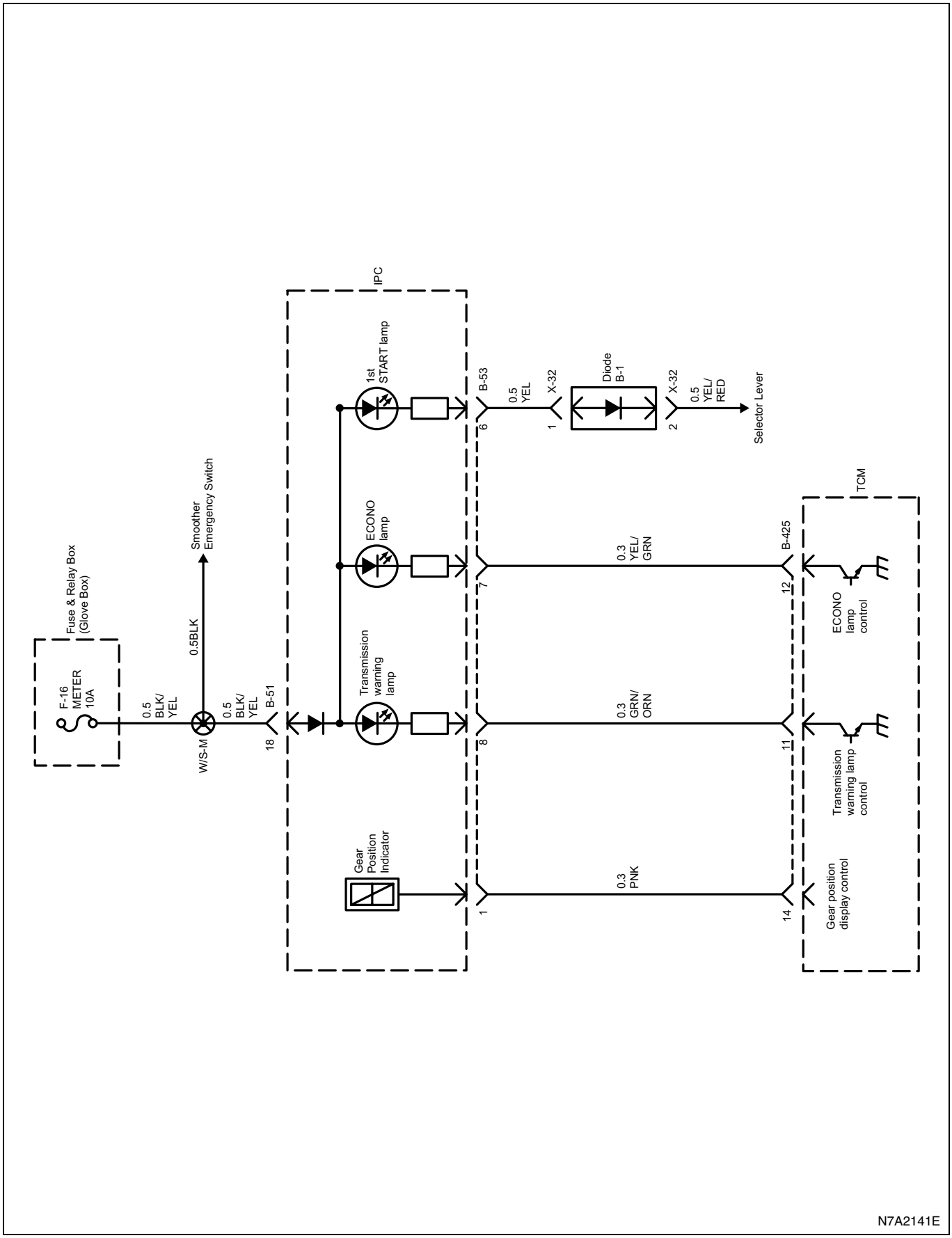

TCM
Gear select position sensor signal
5V reference
B-426
0.5 YEL/WHT
0.5 YEL/BLK
H-5
H-119
J-223
Gear Select Position Sensor
J-223
H-119
H-5
B-426
TCM
Low reference
Gear select position sensor signal
5V reference
0.5 WHT
0.5 RED
H-8
H-119
J-142
Gear Shift Position Sensor
J-142
H-8
Low reference
Low reference
Turbine speed sensor signal
5V reference
B-427
0.5 ORN/BLU
0.5 WHT/BLU
H-5
H-119
J-232
Turbine Speed Sensor
Input shaft speed sensor signal
5V reference
0.5 BRN
0.5 YEL
H-5
H-118
J-139
Input Shaft Speed Sensor
N7A2135E

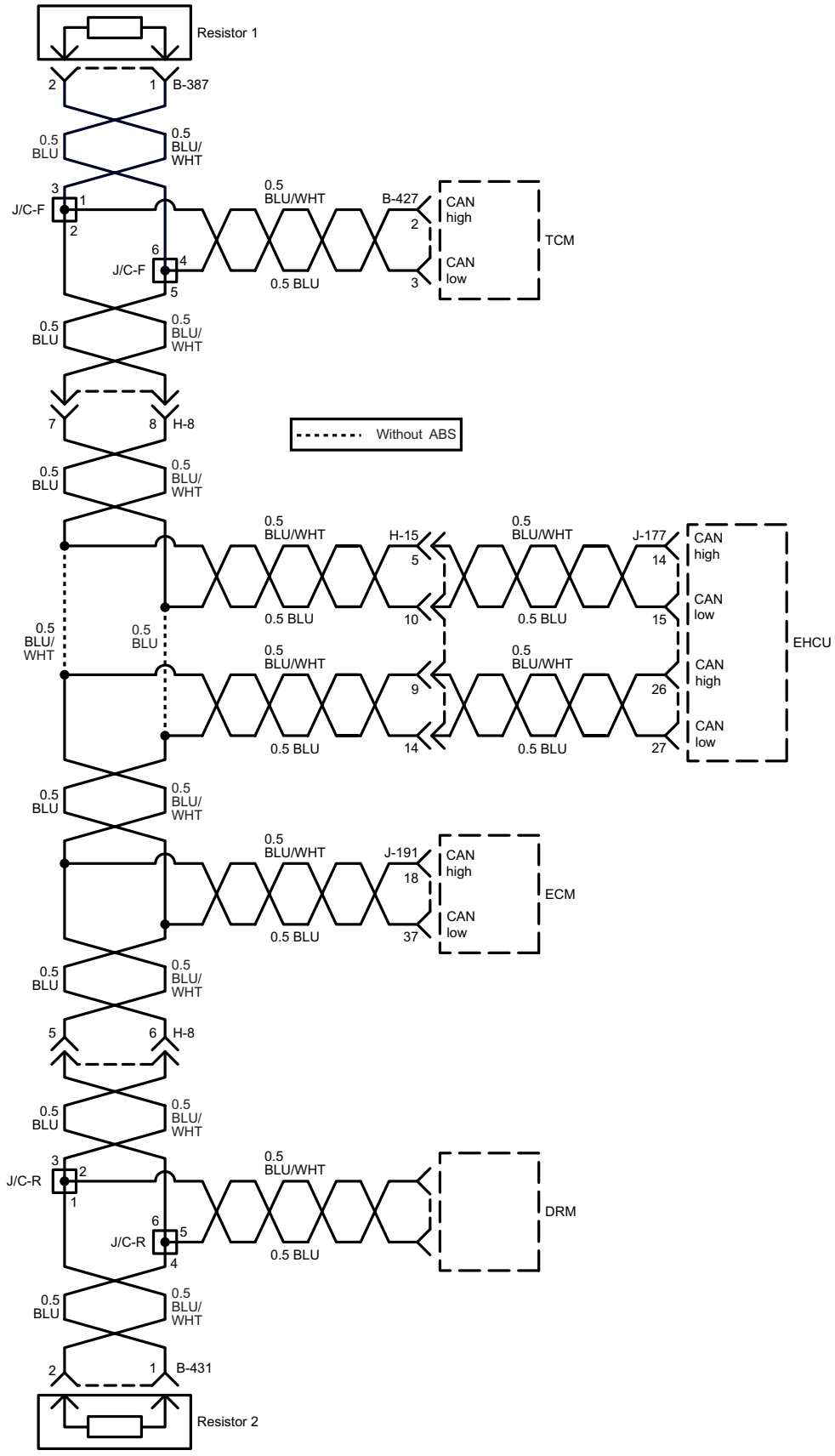

TCM
Ignition voltage
PTO switch signal
B-428
19
0.3 BLU/ WHT
Tail Light
B-417
3
PTO Switch
4
2
1
B-417
0.5 BLK
W/S-B
2 BLK
J/C-D
7
3 BLK
B-7 Headlight Bracket
W/S-D
2 BLK
W/S-C
1.25 BLK
B-1 Frame
Door switch signal
12
0.5 GRY/ RED
Room Lamp
2
3
0.5GRY/RED
J/C-H
5
1
H-12
6
0.5 GRY/ RED
N-2
1
Door Switch (Right)
H-3
3
1.25 GRY/ BLK
N-7
1
Door Switch (Left)
Fuse & Relay Box (Glove Box)
F-5 STOP LIGHT 10A
0.5 GRN/ YEL
B-66
1
Brake Pedal Switch
2
B-66
0.5 GRN
H-5
11
Stop Light
0.5GRN
5
4
J/C-G
6
0.5 GRN
B-428
3
TCM
Brake pedal switch
F-16 METER 10A
F-18 SRS 10A
F-17 NEES (IG) 10A
0.5 BLK/ ORN
B-106
3
Half-clutch Adjustment Switch
1
B-106
0.3 GRY/ BLK
2
Fast switch signal
0.3 GRY/ RED
2
9
Slow switch signal
0.5 BLK/ ORN
B-105
4
Reset Switch
6
B-105
0.3 GRY/ BLU
17
Reset switch signal
0.5 BLK/ ORN
TCM
F-28 ECM 10A
0.5 LT GRN
2
J/C-2
6
4
1
0.5 LT GRN
J-50
2
Neutral Switch
1
J-50
0.5 BLK/ BLU
0.5B/L
ECM
H-5
37
0.5 BLK/ BLU
10
Neutral switch signal
Exhaust Brake Solenoid Valve
N7A2136E


TCM
Ignition voltage
Economy mode switch signal
1st gear start switch signal
Lever A switch signal
Lever - switch signal
Lever + switch signal
Lever D switch signal
Lever N switch signal
Lever R switch signal
Emergency shift 1st switch signal
Emergency shift N switch signal
Emergency shift R switch signal
B-428
B-427
H-12
N-19
N-20
N-18
IPC
Selector Lever
ECONO Mode Switch
1st Gear Start Switch
Emergency Shift Switch
0.5 BLU
0.5YEL/RED
0.5 YEL/ RED
0.5 GRN/ BLK
0.5 PNK/ BLK
0.5 BLU/ BLK
0.5 ORN
0.5 WHT/ BLK
0.5 RED/ BLK
0.5 GRN
0.5 WHT
0.5 RED
0.5 BLK
0.5BLK
1.25 BLK
B-1 Frame
N7A2137E


Fuse & Relay Box (Behind the Cab)
SBF-7 NEES 60A
Gear Shift Control Box Relay
X-19
H-17
B-425
B-428
TCM
Gear shift control box relay control
W/S-Q
USW JOINT2
USW JOINT1
J-9 Frame
Select solenoid valve control
2-4-6-R shift solenoid valve control
1-3-5 shift solenoid valve control
Select Solenoid
2-4-6-R Shift Solenoid
1-3-5 Shift Solenoid
J-234
J-236
J-235
H-119
H-118
Ground
N7A2138E

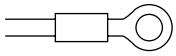
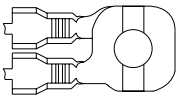
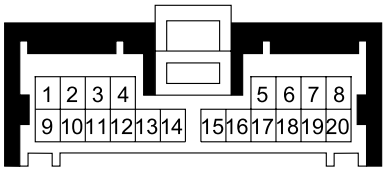
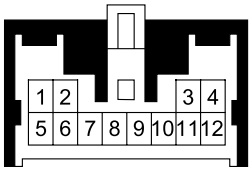
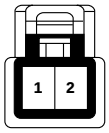
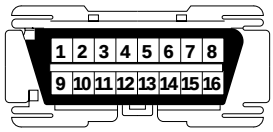

Fuse & Relay Box (Behind the Cab)
SBF-7 NEES 60A
Gear Shift Control Box Relay
TCM
Select solenoid valve control
2-4-6-R shift solenoid valve control
1-3-5 shift solenoid valve control
USW JOINT4
USW JOINT2
USW JOINT1
Select Solenoid
2-4-6-R Shift Solenoid
1-3-5 Shift Solenoid
J-9 Frame
Gear shift control box relay control
Ground
N7A2139E

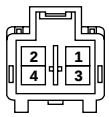
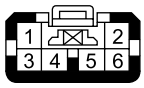
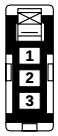
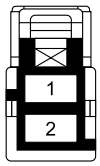
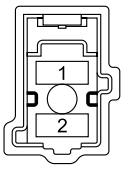
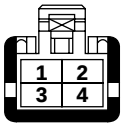
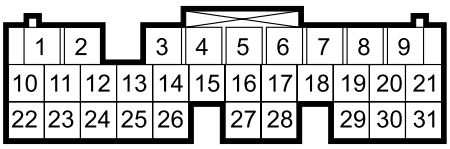

IPC
1st START lamp
ECONO lamp
Transmission warning lamp
Gear Position Indicator
B-53
6
7
8
1
0.5 YEL
X-32
1
Diode B-1
X-32
2
0.5 YEL/ RED
Selector Lever
0.3 YEL/ GRN
0.3 GRN/ ORN
0.3 PNK
B-425
12
11
14
TCM
ECONO lamp control
Transmission warning lamp control
Gear position display control
Fuse & Relay Box (Glove Box)
F-16 METER 10A
0.5 BLK/ YEL
0.5BLK
Smoother Emergency Switch
W/S-M
0.5 BLK/ YEL
B-51
18
N7A2141E

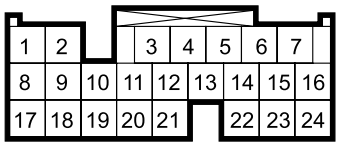
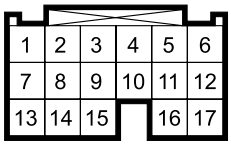
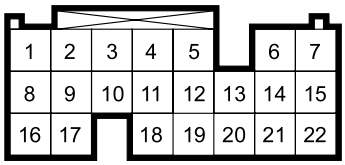
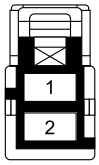
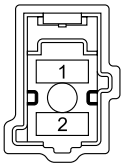
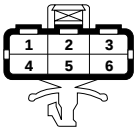
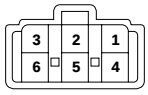
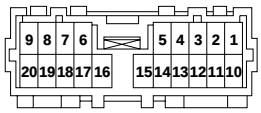

Resistor 1
2
1
B-387
0.5 BLU
0.5 BLU/ WHT
3
J/C-F
1
2
0.5 BLU/WHT
B-427
2
CAN high
CAN low
3
TCM
6
J/C-F
4
5
0.5 BLU
0.5 BLU
0.5 BLU/ WHT
7
8
H-8
Without ABS
0.5 BLU
0.5 BLU/ WHT
0.5 BLU/WHT
H-15
5
10
0.5 BLU
0.5 BLU/WHT
J-177
14
15
0.5 BLU
CAN high
CAN low
0.5 BLU/ WHT
0.5 BLU
0.5 BLU/WHT
9
14
0.5 BLU
0.5 BLU/WHT
26
27
0.5 BLU
CAN high
CAN low
EHCU
0.5 BLU
0.5 BLU/ WHT
0.5 BLU/WHT
J-191
18
37
0.5 BLU
CAN high
CAN low
ECM
0.5 BLU
0.5 BLU/ WHT
5
6
H-8
0.5 BLU
0.5 BLU/ WHT
3
J/C-R
2
1
0.5 BLU/WHT
6
J/C-R
5
4
0.5 BLU
DRM
0.5 BLU
0.5 BLU/ WHT
2
1
B-431
Resistor 2

N6A6641E

Connector list

No.	Connector Face
B-1	 000-001
B-7	 000-018
B-51	 020-004
B-53	 012-009
B-66	 002-031
B-67	004-002
B-67	004-001
B-79	 016-005

No.	Connector Face
B-86	004-001
B-86	 004-002
B-105	 006-021
B-106	 003-014
B-387	 002-038
B-387	 002-039
B-417	 004-001
B-425	 031-001

No.	Connector Face
B-426	 024-001
B-427	 017-001
B-428	 022-006
B-431	 002-038
B-431	 002-039
H-3	 006-014
H-3	 006-015
H-4	 020-003

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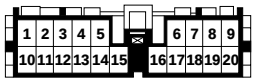
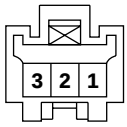
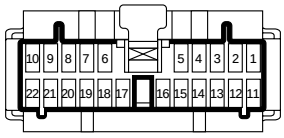
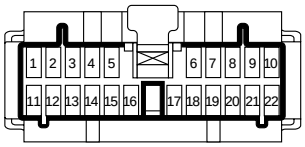
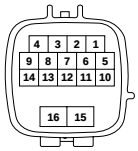
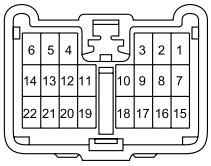
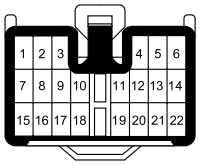
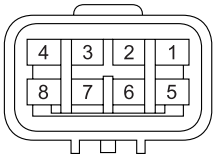
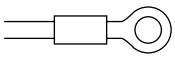
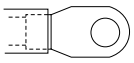
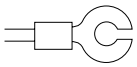
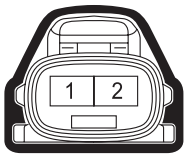
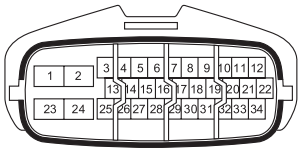
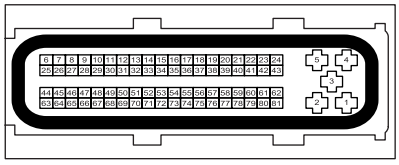
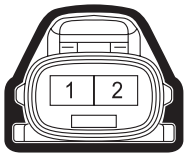
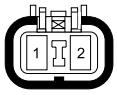
H-4	 020-002
H-10	003-009
H-10	 003-010
H-12	 022-002
H-12	 022-001
H-15	016-003
H-15	 016-004
H-17	 022-007

No.	Connector Face
H-17	 022-008
H-118	008-003
H-118	 008-018
H-119	016-001
H-119	016-002
H-xx	001-002
J-9	 000-001
J-26	 000-002

No.	Connector Face
J-27	 000-009
J-50	002-035
J-139	 002-040
J-142	003-005
J-177	 034-001
J-191	 081-001
J-223	003-005
J-232	 002-040

No.	Connector Face
J-234	002-003
J-235	002-003
J-236	 002-042
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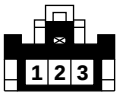
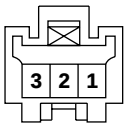
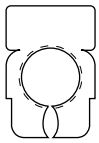
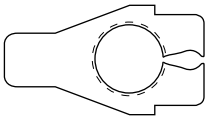
L-2	 003-009
L-2	 003-010
P-1	 000-004
P-2	 000-006

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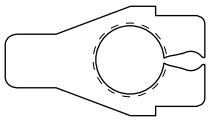
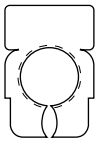
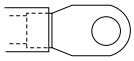
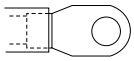
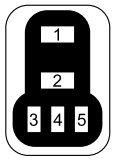
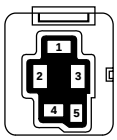
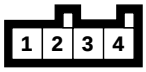
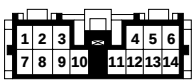
P-3	 000-006
P-4	 000-004
P-5	 000-002
P-6	 000-002
X-5, 14, 18, 26	 005-006
X-19, 21	 005-003
X-32	 004-004
X-33	 014-002

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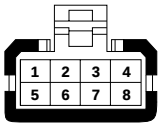
N-17	 008-005
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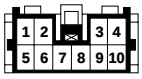
N-19	 010-003

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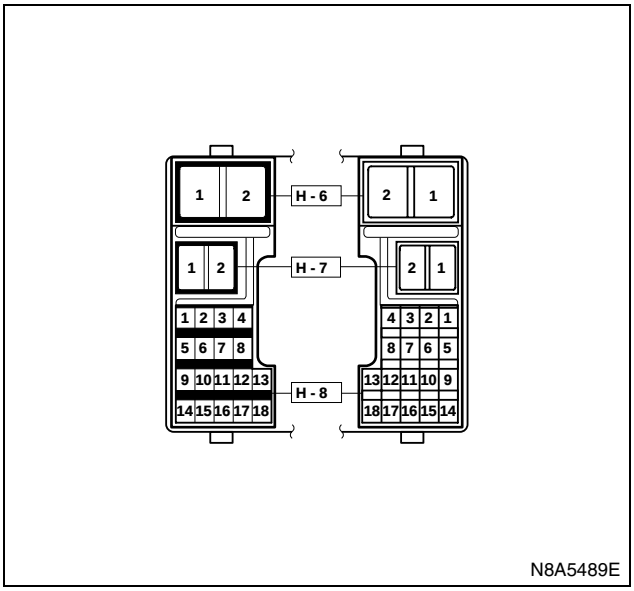

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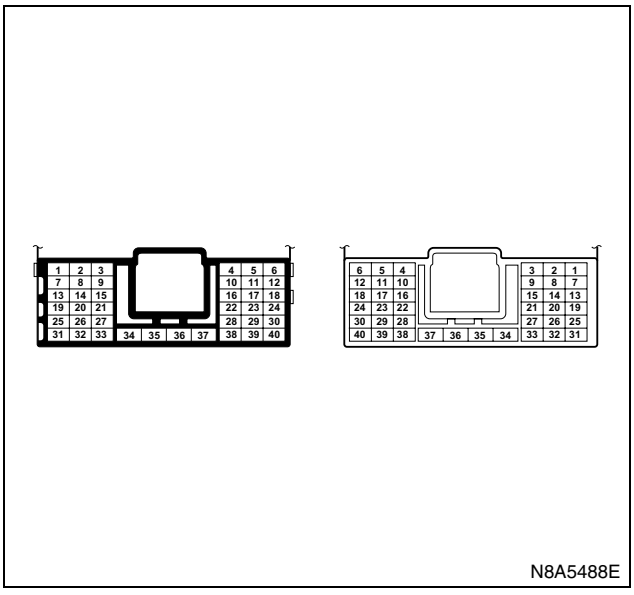
H-5



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SEAT BELT, SRS AIRBAG

SECTION 9A
SEAT BELT

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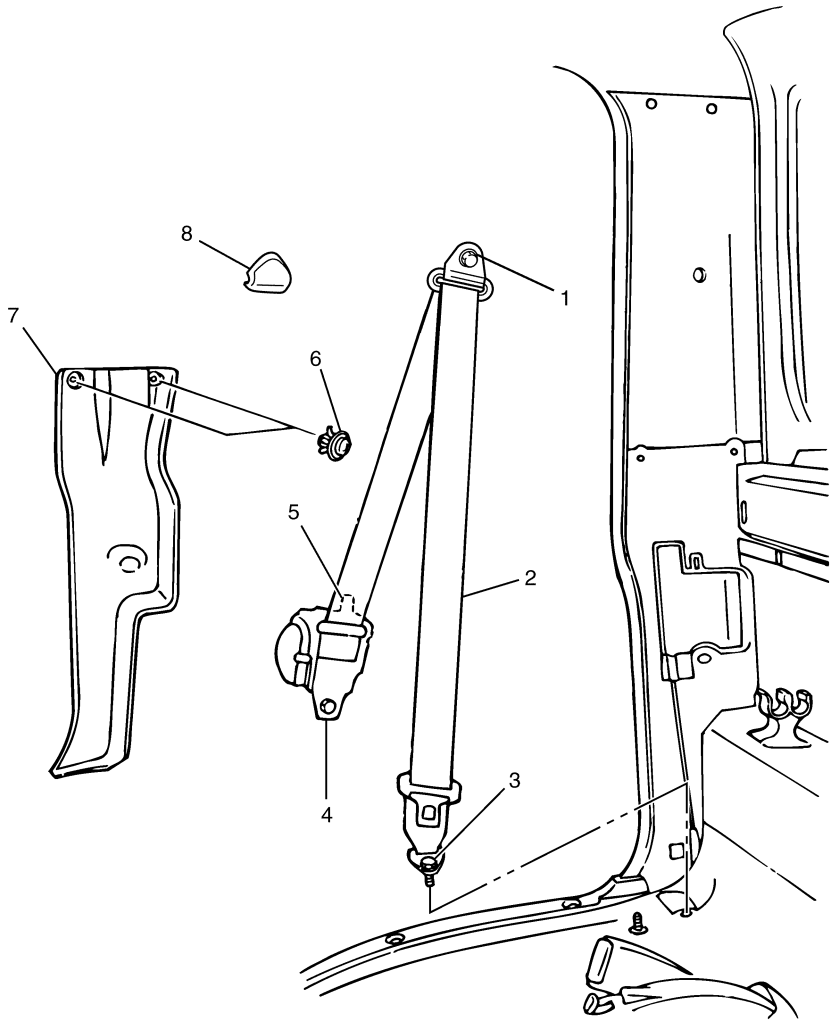
Tongue Side Seat Belt (Single Cab Model)

Components



Legend

1. Seat belt upper anchor bolt
2. Tongue side seat belt assembly
3. Seat belt lower anchor bolt
4. Retractor fixing bolt
5. Bracket
6. Clip
7. Rear pillar lower trim cover
8. Through anchor cover

Removal

1. Remove the seat belt lower anchor bolt.
2. Remove the rear pillar lower trim cover.
   - Refer to “Rear Side Trim Cover” in Interior & Exterior Trim Section of Cab Repair Manual.
3. Remove the through anchor cover.
4. Remove the seat belt upper anchor bolt.
5. Remove the retractor fixing bolt.
   - Remove the bolt and pull the retractor upper bracket from panel to remove.

Installation

For installation, reverse the removal procedure taking the following points into consideration.

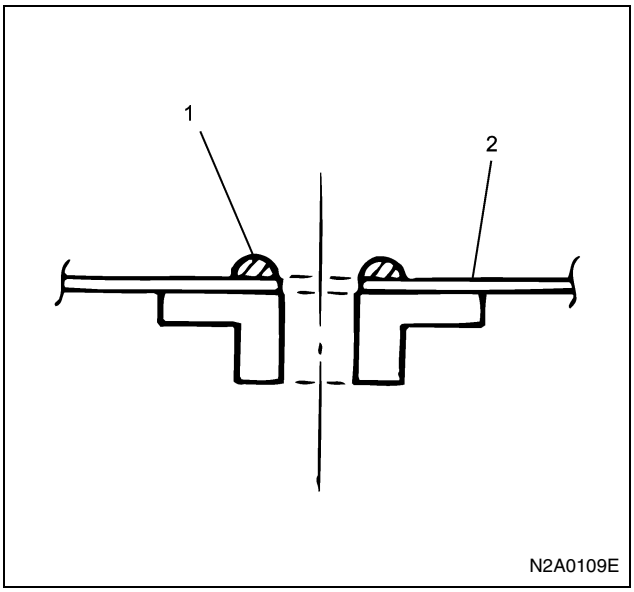
1. Tighten the seat belt upper anchor bolt to the specified torque.

Tighten:

Anchor bolt to 44 N·m (4.5 kg·m / 32.5 lb·ft)

2. Apply the sealant (1) around the seat belt lower anchor bolt mounting hole on the floor part (2).

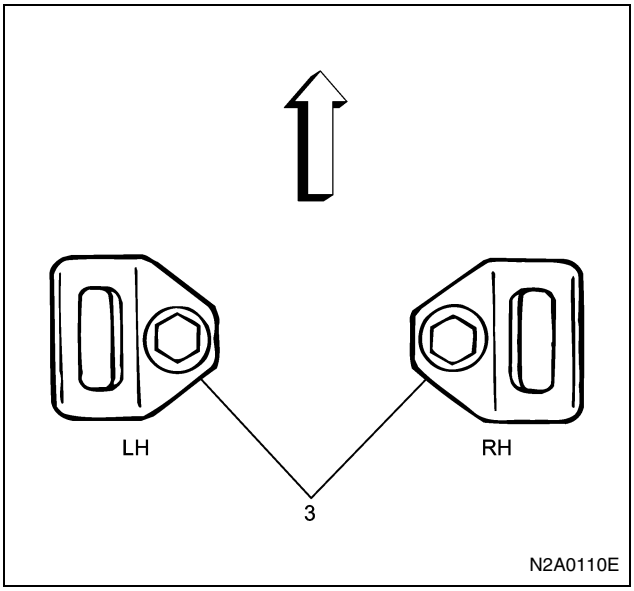
Sealant TOKIWA CHEMICAL INDUSTRY 770GA or equivalent



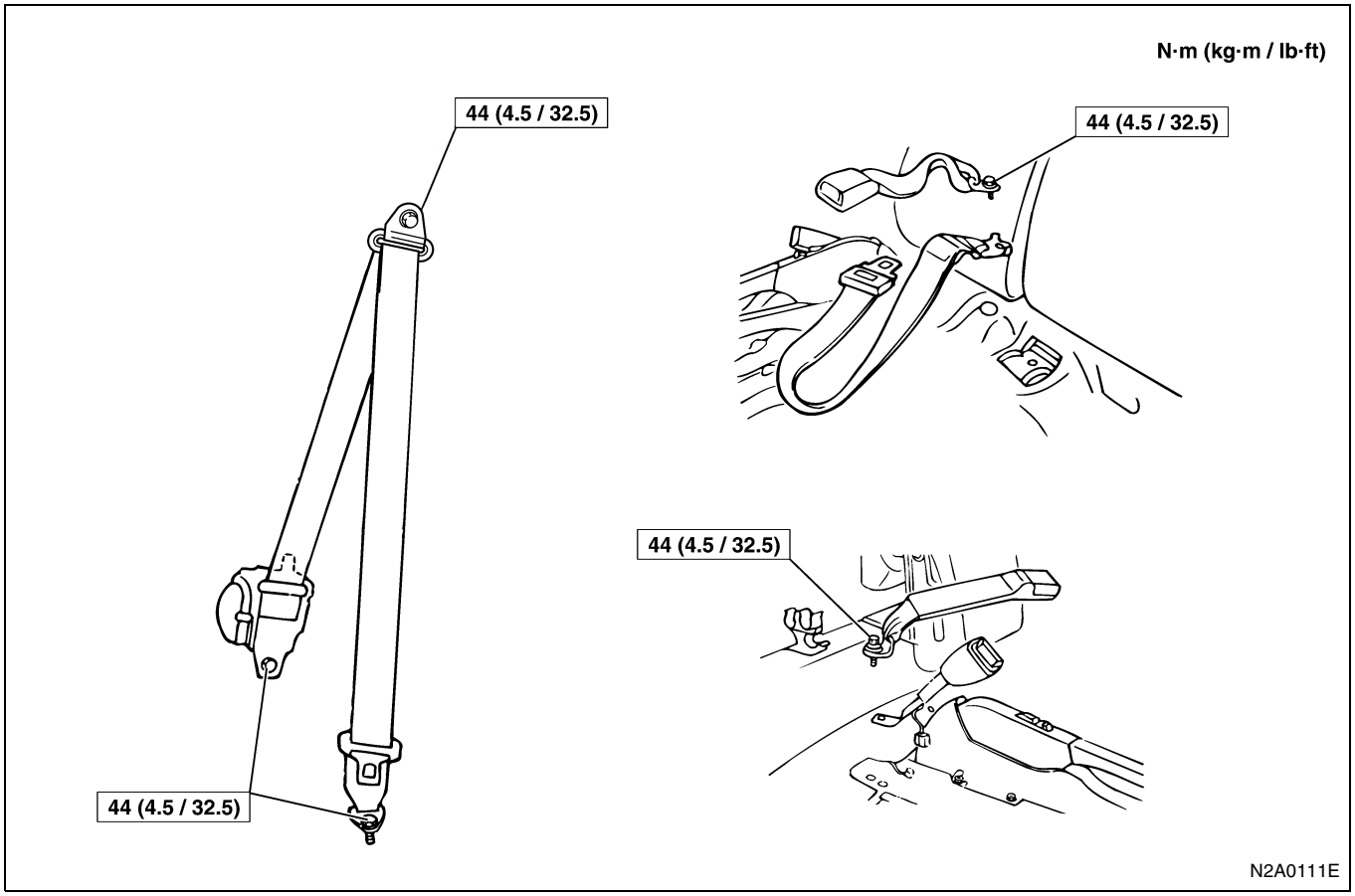
3. Install the seat belt lower anchor (3) in the specified direction, and tighten it to the specified torque.

Tighten:
Anchor bolt to 44 N·m (4.5 kg·m / 32.5 lb·ft)

Caution:
Install the seat belt lower anchor so that it may not run on the anchor detent bead.

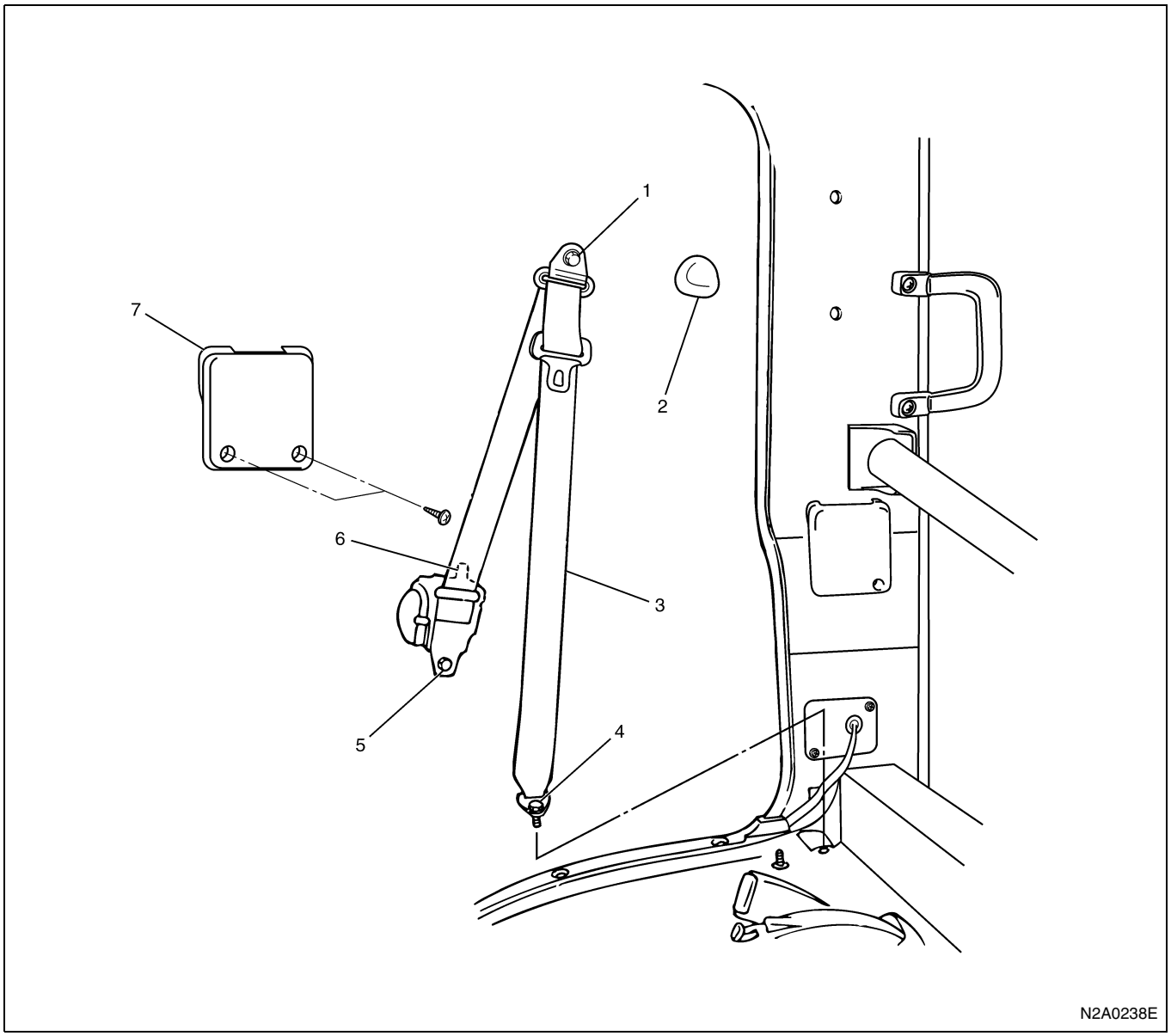


Fixing Torque



Tongue Side Seat Belt (Crew Cab Model)

Components



Legend

1. Seat belt upper anchor bolt
2. Through anchor cover
3. Tongue side seat belt assembly
4. Seat belt lower anchor bolt
5. Retractor fixing bolt
6. Bracket
7. Retractor cover

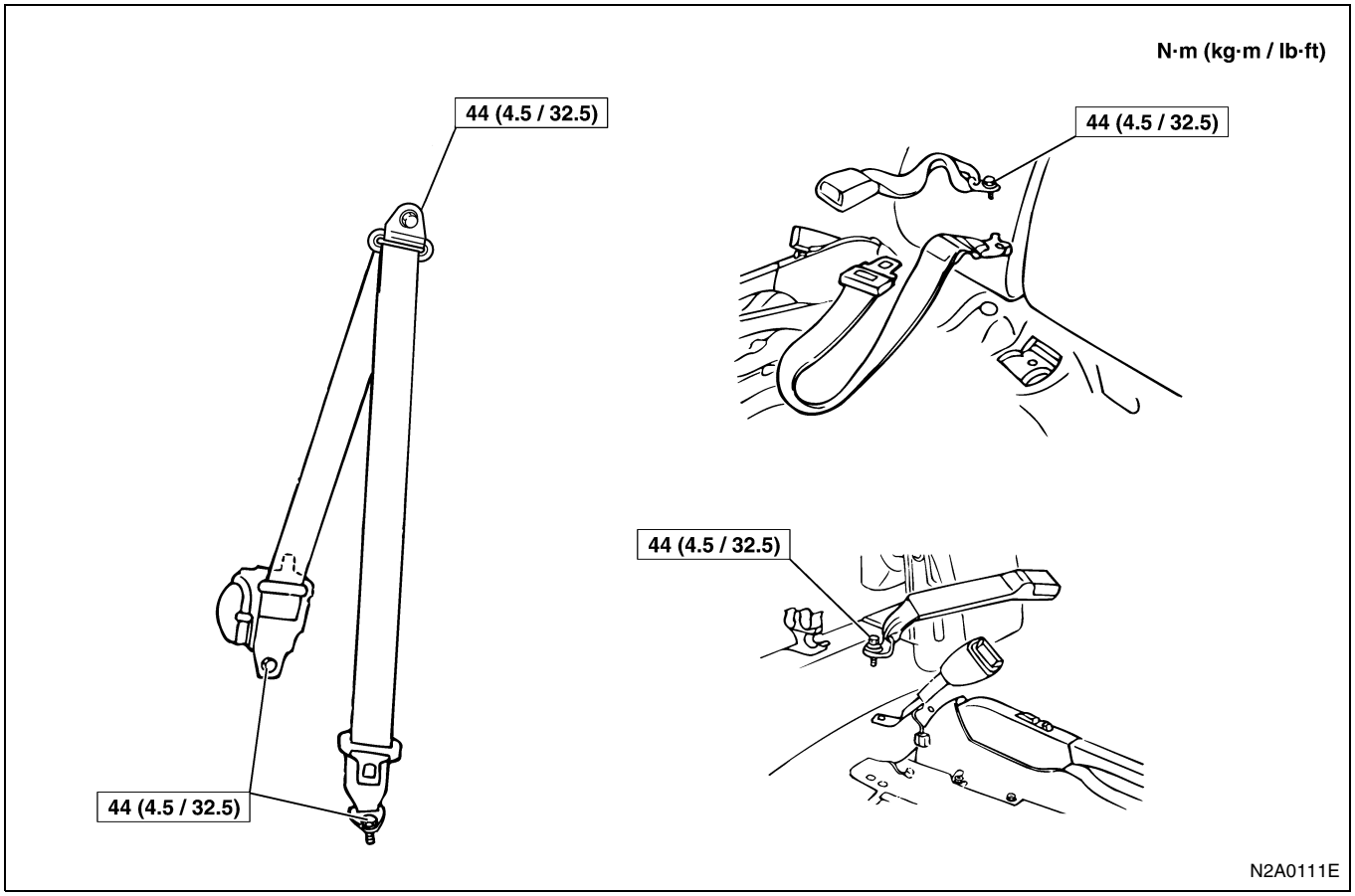
Removal

1. Remove the seat belt lower anchor bolt.
2. Remove the retractor cover.
   - Remove the 2 fixing screws.
3. Remove the through anchor cover.
4. Remove the seat belt upper anchor bolt.
5. Remove the retractor fixing bolt.
   - Remove the bolt and pull the retractor upper bracket from panel to remove.
6. Remove the adjuster cover.

Installation

For installation, refer to “Tongue Side Seat Belt (Single Cab Model)” in this section, and reverse the removal procedure.

Fixing Torque

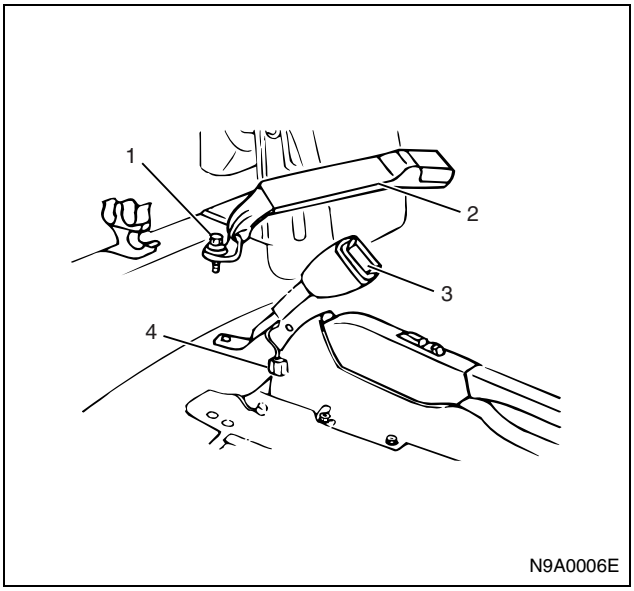


Front Center and Driver's Side Seat Belt Buckle

Removal

1. Disconnect the battery ground cable.
2. Remove the fixing bolt (1).
3. Remove the center seat belt buckle (2).
4. Disconnect the seat belt warning connector (4).
5. Remove the driver's seat belt belt buckle (3).

Caution:
For wide cab model, perform the steps 1 and 2 (Center), or the steps 1, 3 and 4 (Driver's side).

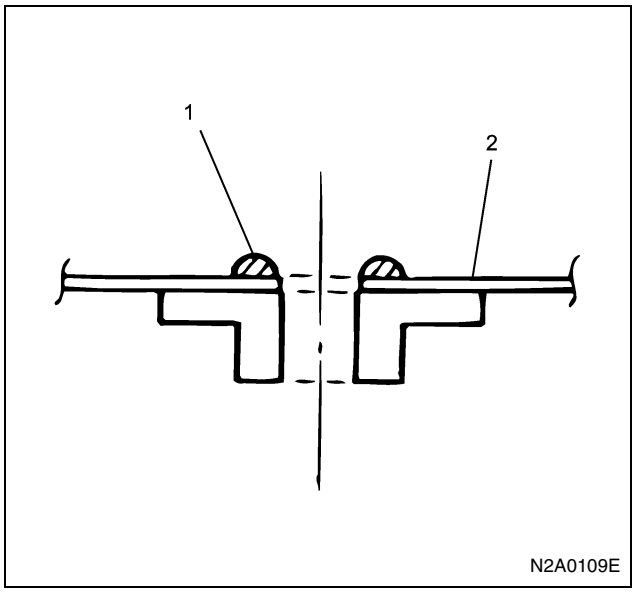


Installation

For installation, reverse the removal procedure taking the following points into consideration.

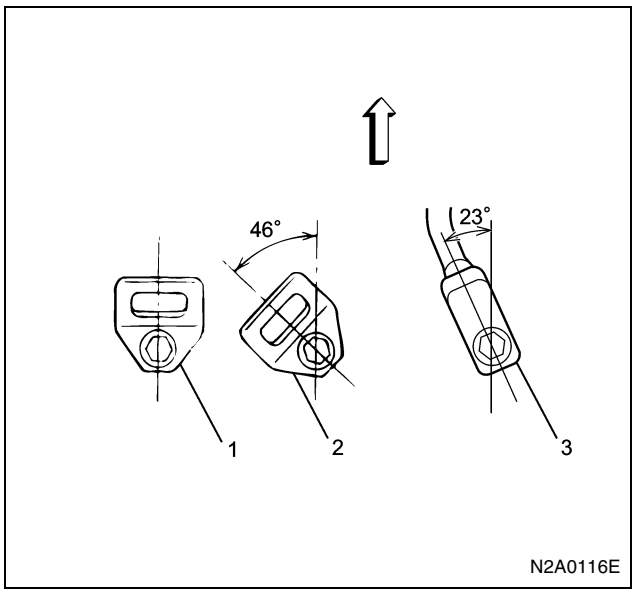
1. Apply the sealant (1) around the fixing bolt mounting hole on the floor part (2).

Sealant TOKIWA CHEMICAL INDUSTRY 770GA or equivalent



2. Install the anchor in the specified direction, and tighten it to the specified torque.

Tighten:
Fixing bolt to 44 N·m (4.5 kg·m / 32.5 lb·ft)

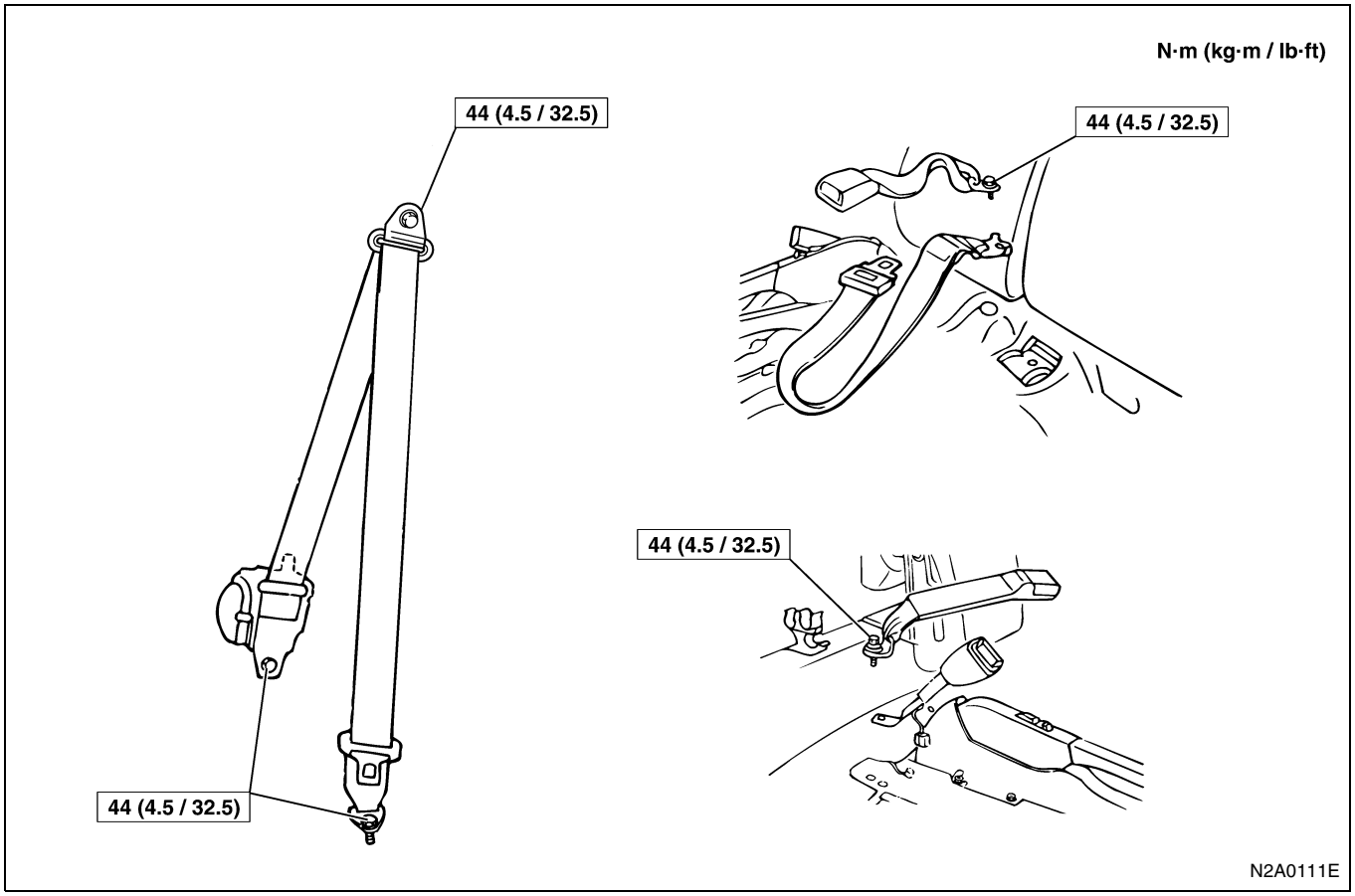


Legend
1. Center seat belt buckle (Wide cab model)
2. Center seat belt buckle (Except wide cab model)
3. Driver's side seat belt buckle

3. Pass the center seat belt buckle through the band on the end of seat cushion.

Caution:
Install it so that it may not run on the anchor detent bead.

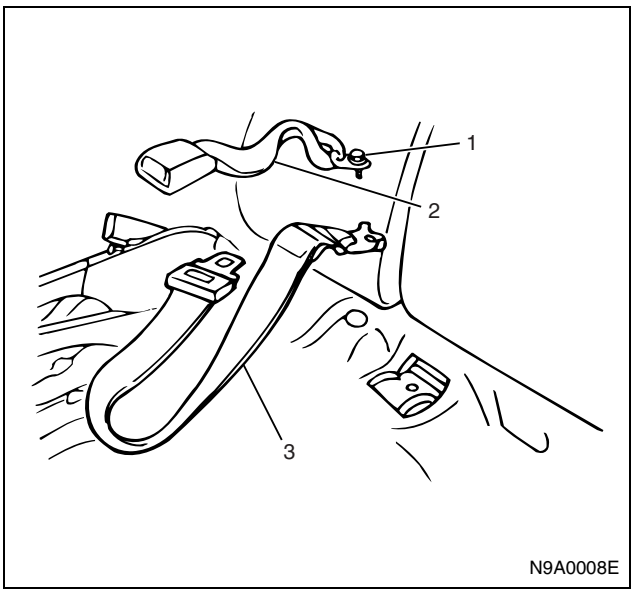
Fixing Torque



Front Center Seat Belt and Assistant's Side Seat Belt Buckle

Removal

1. Remove the assistant's seat cushion (three-passenger vehicle).
   - Refer to "Center and Assistant's Side Seat" in Seat Section of Cab Repair Manual.
2. Remove the fixing bolt (1).
3. Remove the assistant's seat belt buckle (2).
4. Remove the center seat belt (3).



Installation

For installation, reverse the removal procedure taking the following points into consideration.

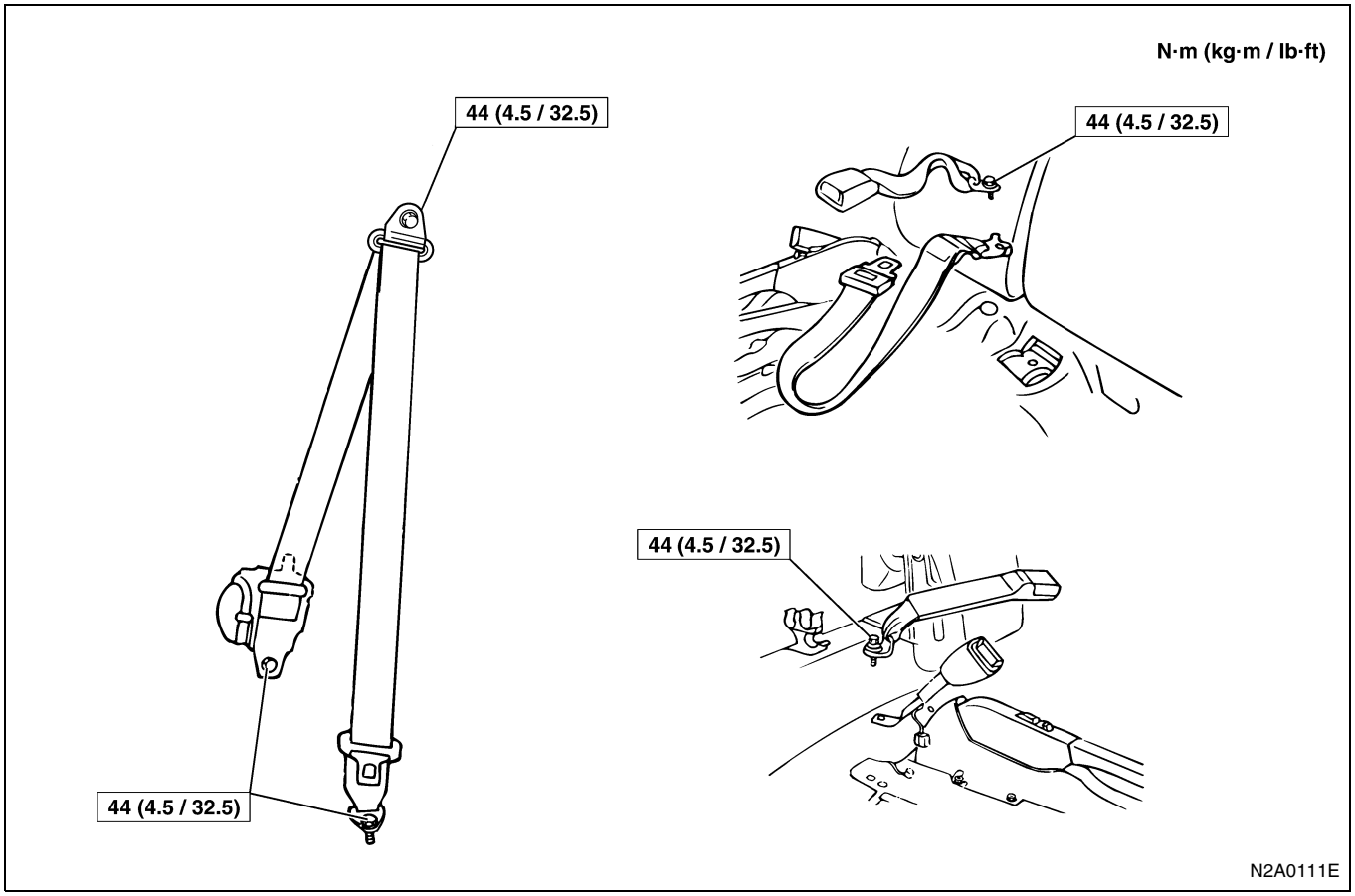
1. Apply the sealant around the fixing bolt mounting hole.

Sealant TOKIWA CHEMICAL INDUSTRY 770GA or equivalent

2. Install the anchor parallel to the traveling direction of vehicle.
3. Tighten the fixing bolts to the specified torque.

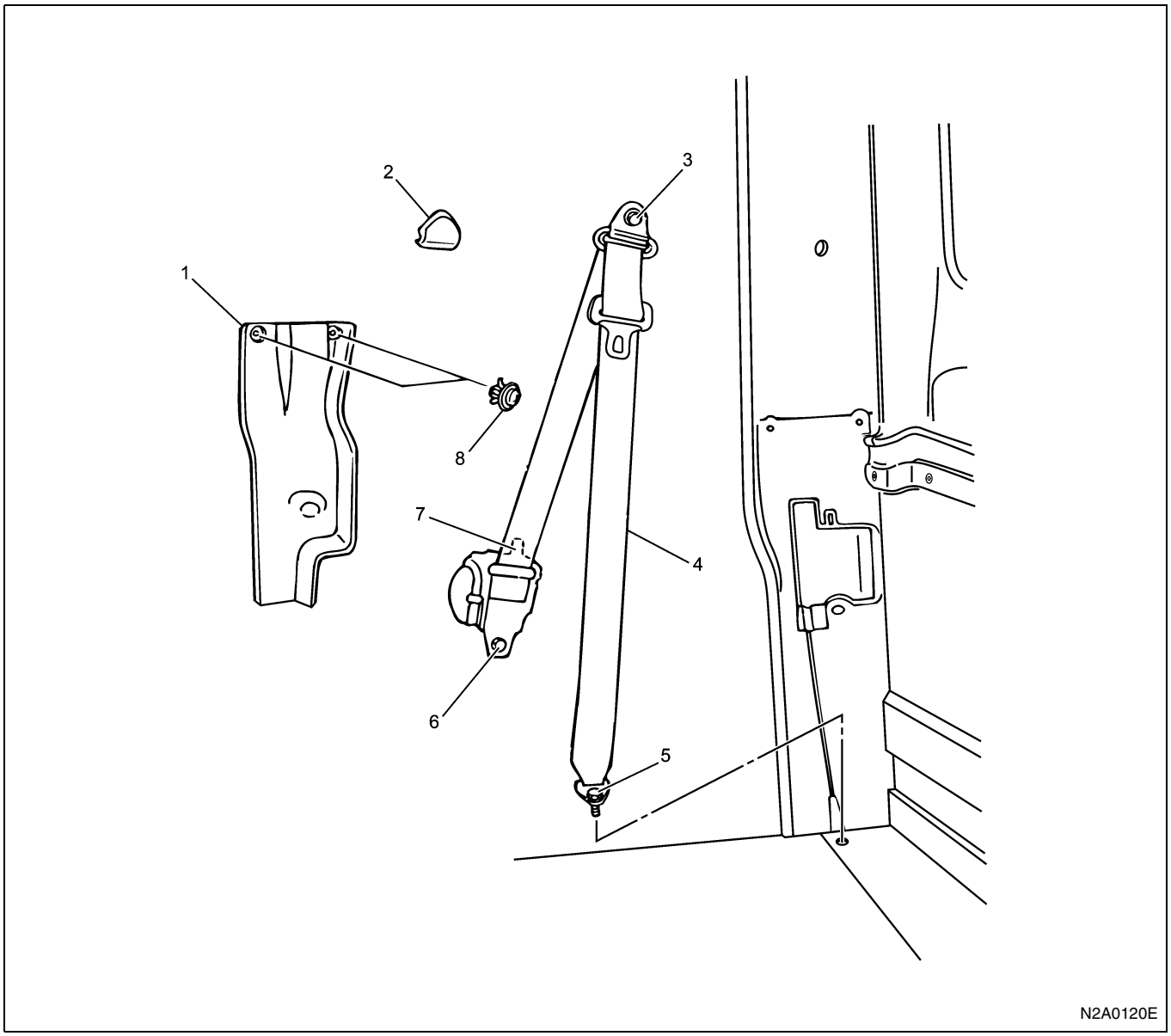
Tighten:
Fixing bolt to 44 N·m (4.5 kg·m / 32.5 lb·ft)

Fixing Torque



Rear Seat Belt (Crew Cab Model)

Components



Legend

1. Rear pillar lower trim cover
2. Through anchor cover
3. Seat belt upper anchor bolt
4. Rear seat belt assembly
5. Seat belt lower anchor bolt
6. Retractor fixing bolt
7. Bracket
8. Clip

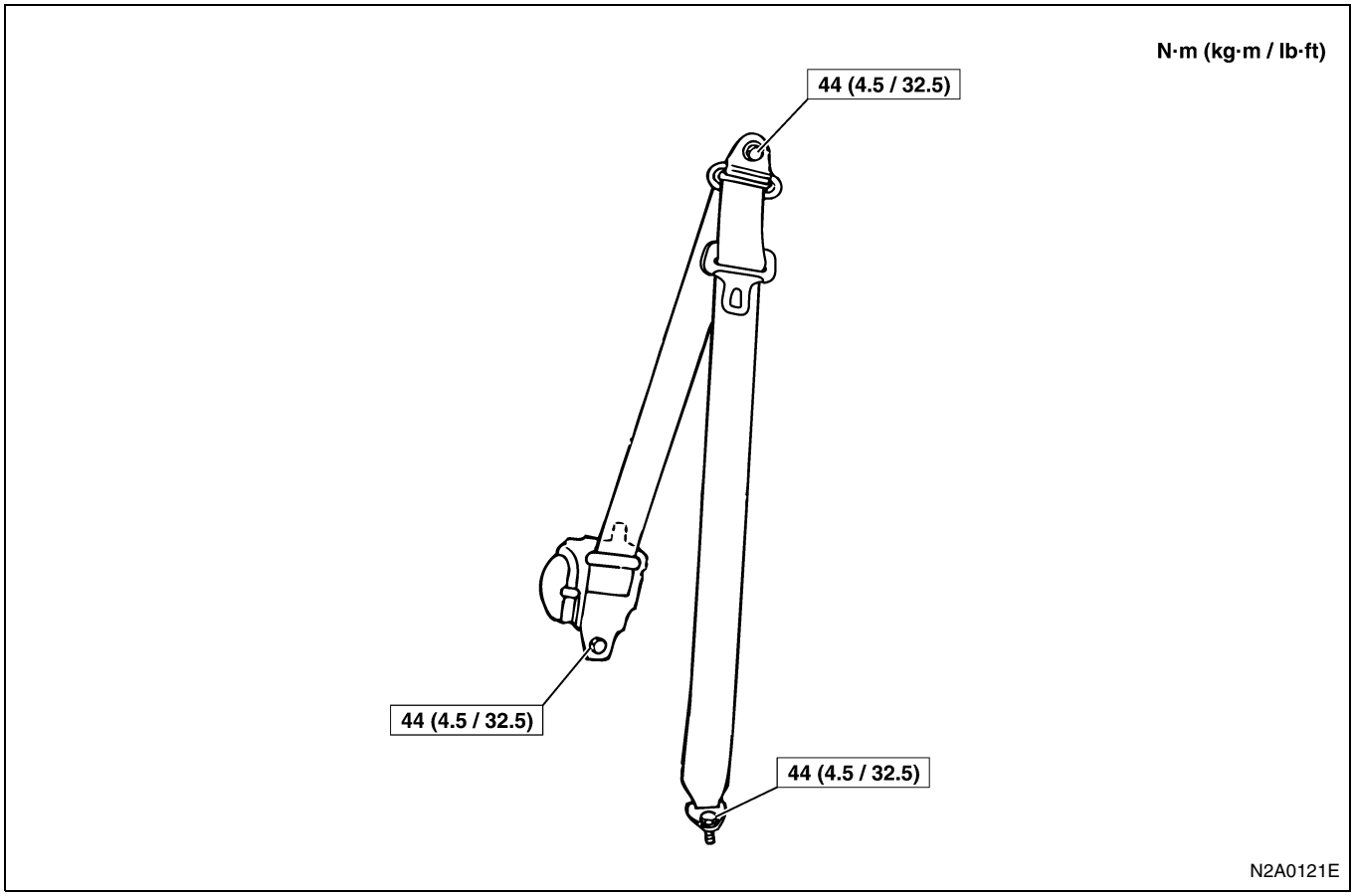
Removal

1. Remove the seat belt lower anchor bolt.
2. Remove the rear pillar lower trim cover.
   - Remove the 2 clips and pull it upward.
3. Remove the through anchor cover.
4. Remove the seat belt upper anchor bolt.
5. Remove the retractor fixing bolt.
   - Remove the bolt and pull the retractor upper bracket from panel to remove.

Installation

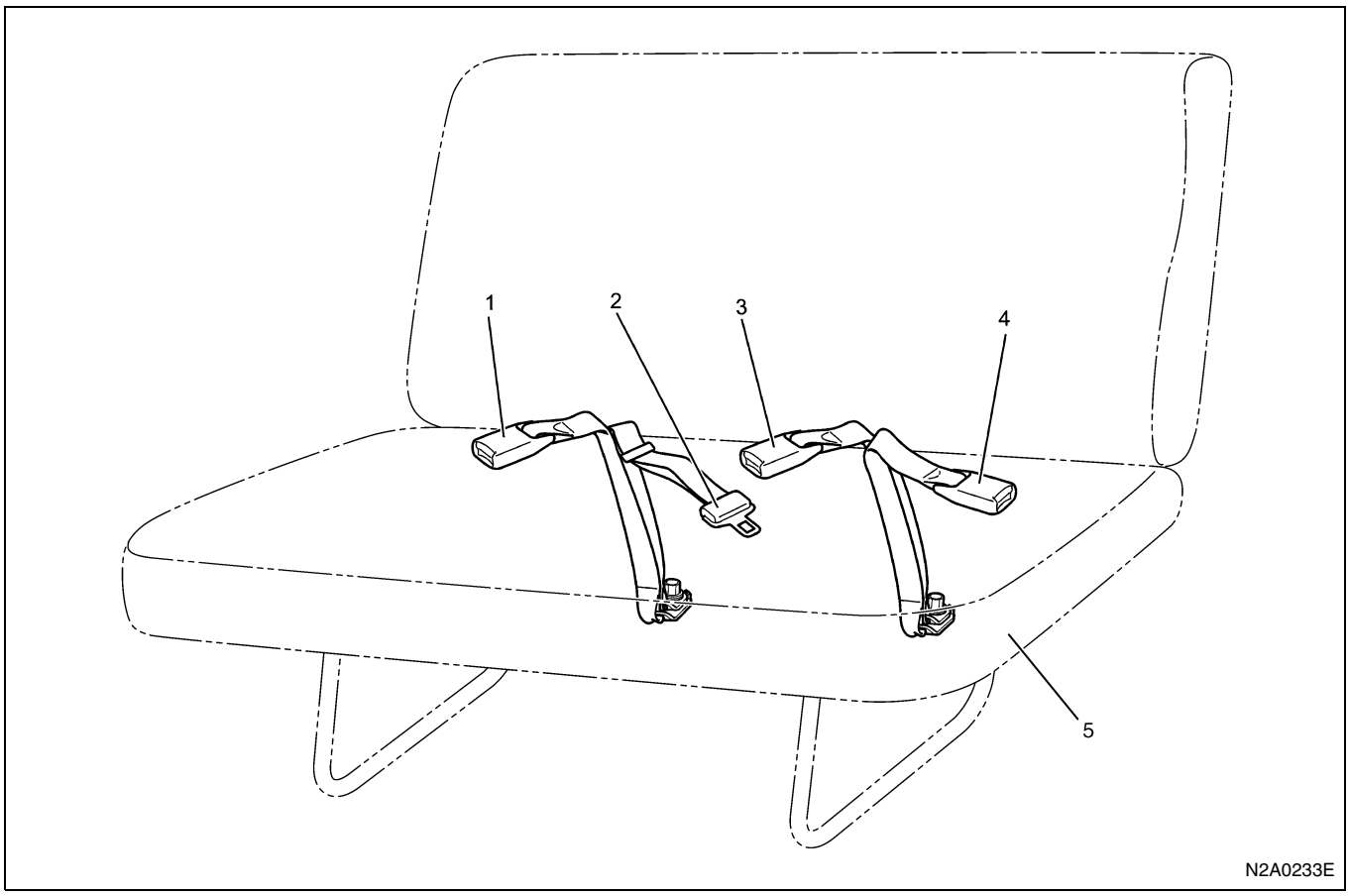
For installation, refer to “Tongue Side Seat Belt (Single Cab Model)” in this section, and reverse the removal procedure.

Fixing Torque



Rear Seat Belt Buckle and Rear Center Seat Belt/Buckle (Narrow Cab Model)

Components



Legend

1. Rear seat belt buckle (RH)
2. Rear center seat belt
3. Rear center belt buckle
4. Rear seat belt buckle (LH)
5. Rear seat cushion

Removal

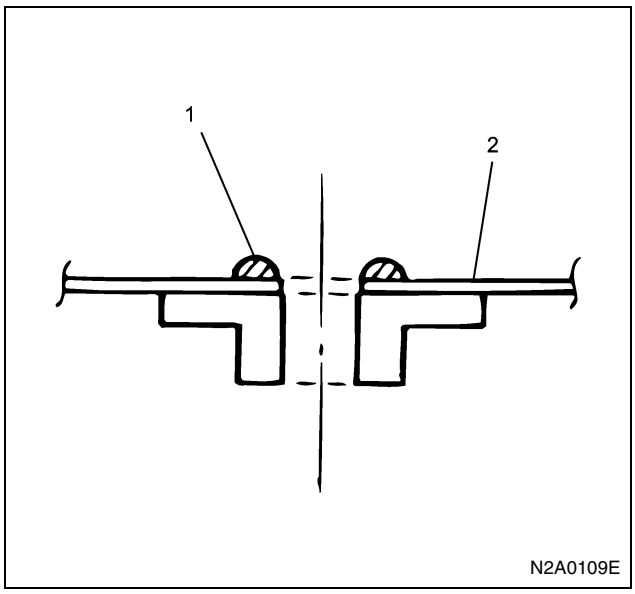
1. Fold the rear seat cushion.
   - Pull out each seat belt buckle and seat belt from the interval of the seat cushion and release the lock lever of rear seat cushion stay to fold it.
2. Remove the fixing bolt of each seat belt.

Installation

For installation, reverse the removal procedure taking the following points into consideration.

1. Apply the sealant (1) around the fixing bolt mounting hole on the floor part (2).

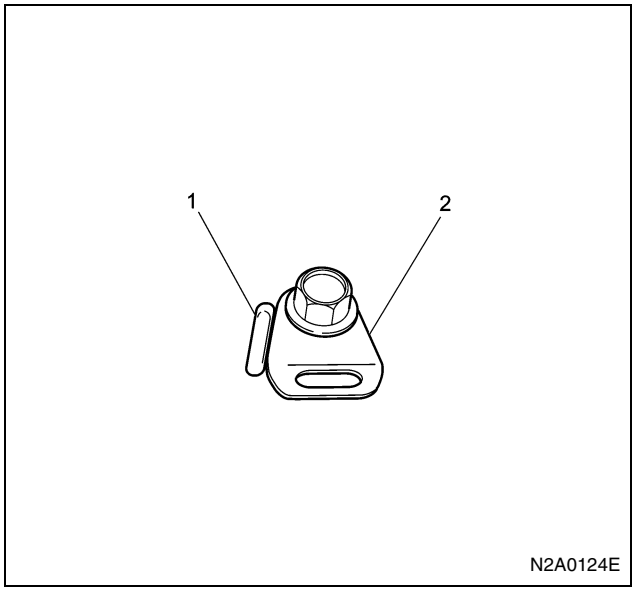
Sealant TOKIWA CHEMICAL INDUSTRY 770GA or equivalent



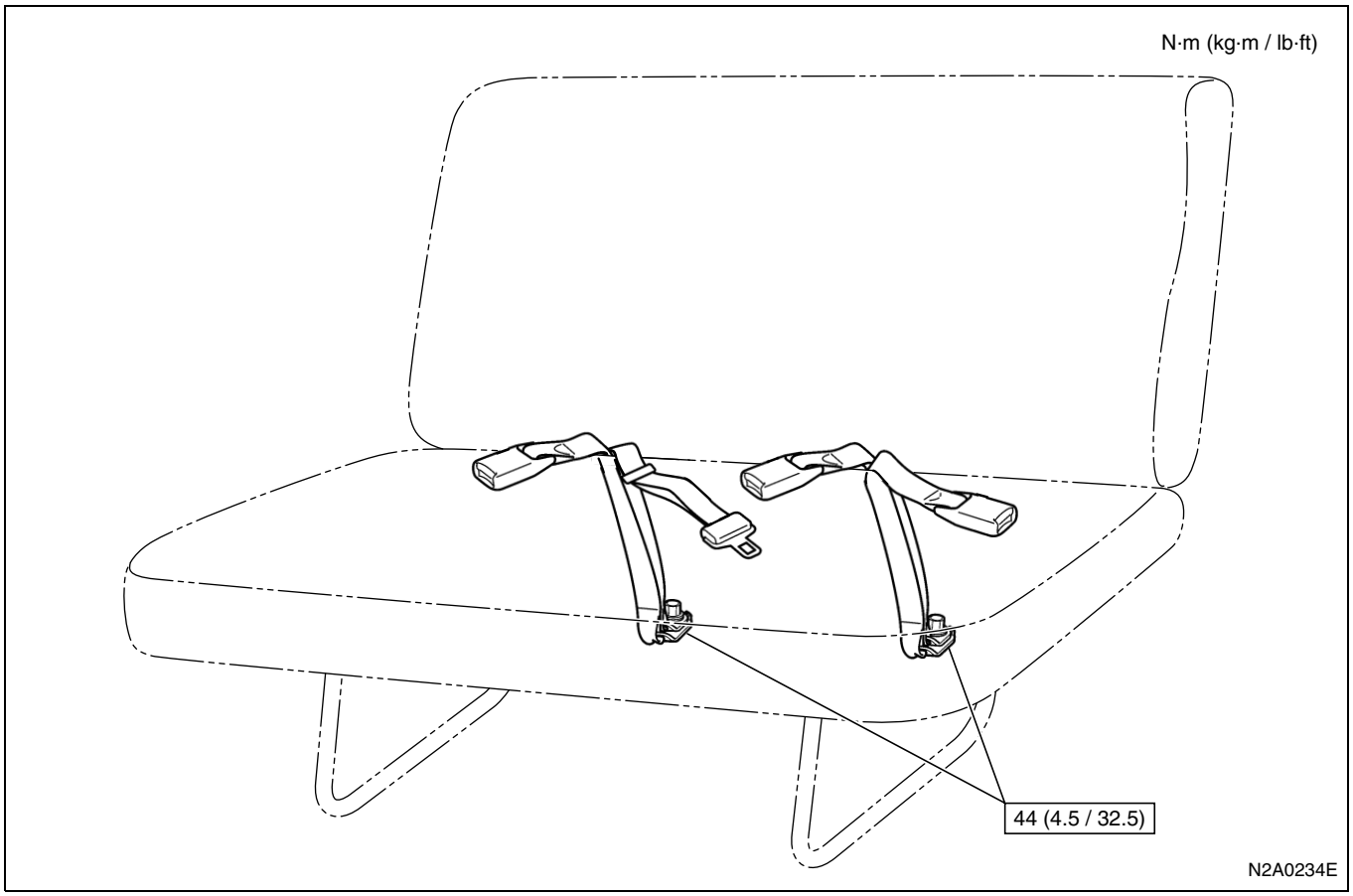
2. Install the anchor parallel to the traveling direction of vehicle.
3. Tighten the fixing bolts to the specified torque.

Tighten:
Fixing bolts to 44 N·m (4.5 kg·m / 32.5 lb·ft)

Caution:
Install the anchor bracket (2) so that it may not run on the anchor detent bead (1).

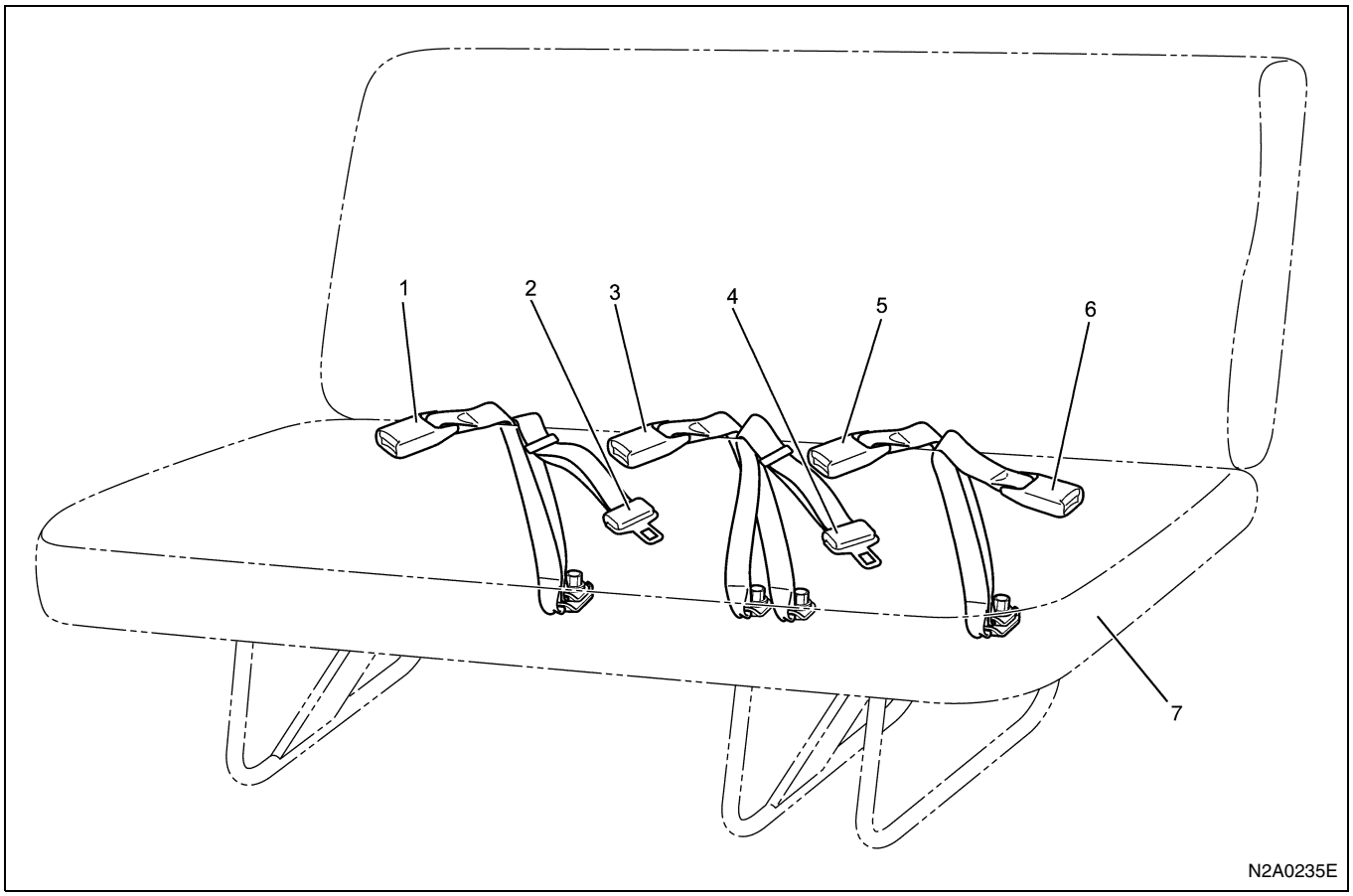


Fixing Torque



Rear Seat Belt Buckle and Rear Center Seat Belt/Buckle (Wide Cab Model)

Components



Legend

1. Rear seat belt buckle (RH)
2. Rear center seat belt (RH)
3. Rear center seat belt buckle (RH)
4. Rear center seat belt (LH)
5. Rear center seat belt buckle (LH)
6. Rear seat belt buckle (LH)
7. Rear seat cushion

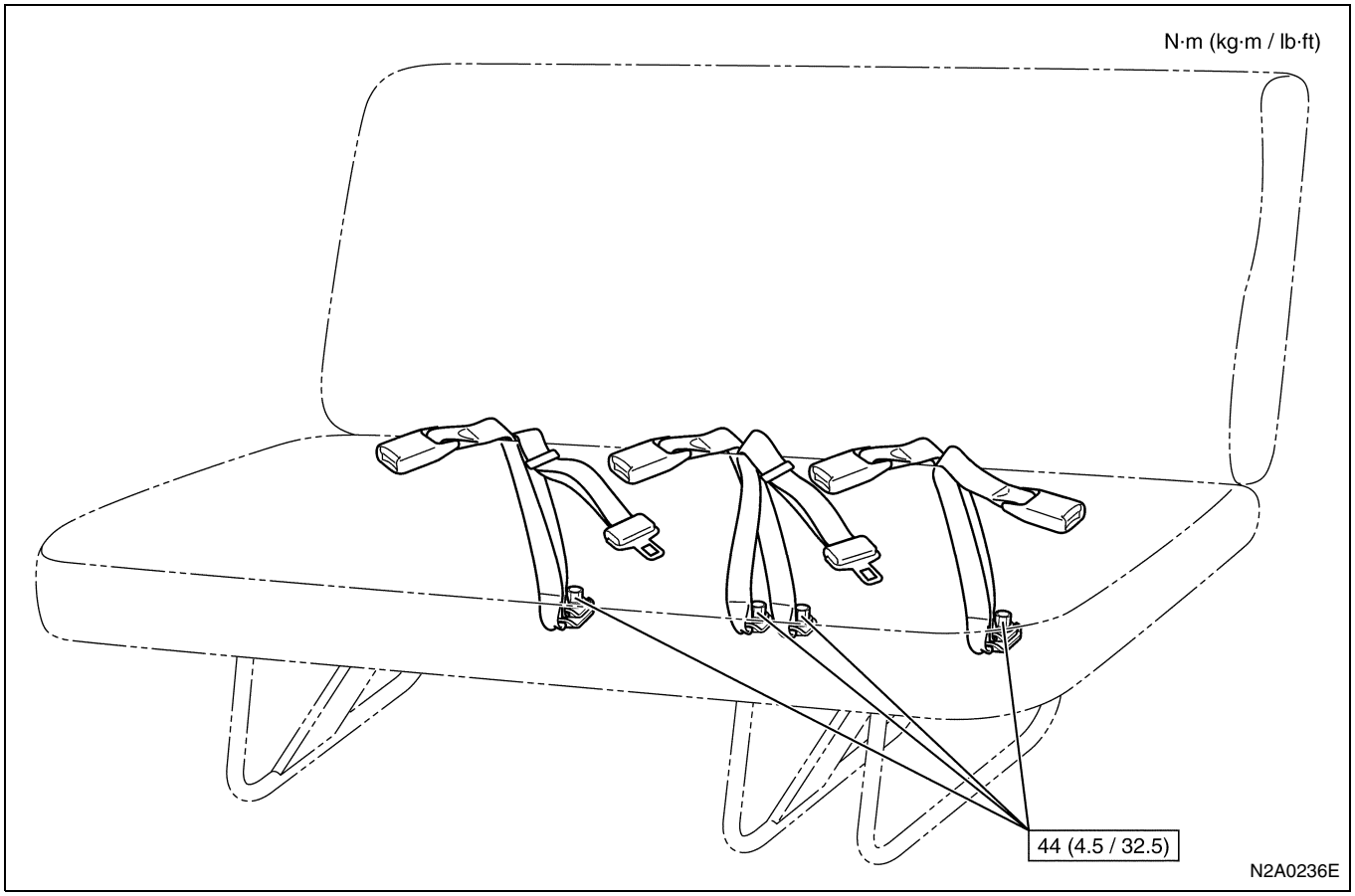
Removal

Refer to “Rear Seat Belt Buckle and Rear Center Seat Belt/Buckle (Narrow Cab Model)” in this section for removal.

Installation

Refer to “Rear Seat Belt Buckle and Rear Center Seat Belt/Buckle (Narrow Cab Model)” in this section for installation.

Fixing Torque



SEAT BELT, SRS AIRBAG

SECTION 9B
SRS

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SRS System Assembly

Precautions on Service Work

WARNING:
WHEN SERVICING SRS SYSTEM PARTS (SRS CONTROL UNIT, AIRBAG, HARNESS, ETC.) OR ITS CIRCUMFERENCE, STOP TEMPORARILY THE FUNCTION OF SRS ACCORDING TO THE PROCEDURE. FAILURE TO FOLLOW THE PROCEDURE MAY CAUSE INJURY DUE TO SRS AIRBAG DEPLOYMENT OR UNNECESSARY REPAIR.

Turn the starter switch to “LOCK” at first. Then, disconnect the battery or remove the fuse which sends power to SRS control unit. After that, do not perform the work at least 15 seconds since airbag may be deployed. In the service procedure, remove “SRS fuse” and detach SRS airbag from deployment circuit to prevent unnecessary SRS parts from deploying.
If removing SRS airbag from deployment circuit according to “Procedure to stop the function of SRS” in this topic, service work can be performed immediately without waiting for 15 seconds.

About Tools

WARNING:
WHEN SERVICING SRS, DO NOT USE ELECTRICAL TEST EQUIPMENTS EXCEPT ONES DESCRIBED IN THIS MANUAL TO AVOID DEPLOYMENT OF SRS AIRBAG. FAILURE TO FOLLOW THIS MANUAL MAY CAUSE INJURY DUE TO UNNECESSARY DEPLOYMENT OF SRS AIRBAG.

It is necessary to measure voltage and resistance. Familiarize yourself with use of Tech 2, SRS substitute load (5-8840-2421-0), connector test adapter kit (5-8840-0385-0), DVM (digital multi-meter, 5-8840-0366-0).

Necessary Repair and Inspection After Collision

- If the parts of this system are damaged, replacement is needed. If mounting portion of SRS parts are damaged, replacement is needed.
- Never use system parts of other vehicle.
- Do not disassemble or repair SRS control unit, SRS coil assembly or SRS airbag. These parts must be replaced with new ones.
- Confirm the part number to make sure that replacement SRS parts are legitimate.

Caution:
Do not use SRS airbag of other vehicle or model. Be sure to confirm the part number to use appropriate SRS airbag.

Caution:
After repair and replacement, set back the SRS airbag to the correct specification so that it is operated properly.

It is necessary to replace SRS control unit and SRS airbag, and inspect the dimension of steering column. If the mounting bracket of SRS control unit are damaged clearly, replacement is needed. Besides, the dimension of steering column should be inspected regardless of SRS airbag deployment.

Replacement and Inspection of Parts After Collision with Deployment

If frontal collision with airbag deployment occurs, following system parts must be replaced. It is necessary to check whether SRS coil assembly is damaged.

- SRS airbag assembly
- SRS control unit
- Combination switch assembly (including SRS coil)

Caution:
Refer to “Replacement guideline for SRS control unit” described later for important information about replacement of SRS control unit after collisions with deployment and without.

- Inspect SRS coil assembly harness and connector for burn due to excessive heat, dissolution or damage. If damaged, refer to “SRS Coil Assembly”.

Inspection of Parts After Collision with or Without Deployment

The certain parts of this system and supplemental restraint system should be inspected regardless of airbag deployment. The parts to be inspected are shown as follows.

- Steering column: inspect the dimension according to “Examination of damage for steering column” described in “Steering column”.
- Steering support bracket: inspect for distortion, bent, crack or other damage.
- Instrument panel bracket: inspect for distortion, bent, crack or other damage.
- Seat belt and its mounting portion: refer to “Seat Belt” section.

Replacement Guideline for SRS Control Unit

If collision with airbag deployment occurs, replacement of SRS control unit is needed. If “SRS” warning lamp illuminates, perform SRS diagnosis according to “Function check: SRS system check” in “SRS control system” in SRS Control System section.

Damaged Harness

If the SRS harness is damaged, it must be replaced.

Damaged SRS Connector (Case and Terminal)

If the connector or terminal of SRS harness (except lead wire) is damaged, replace it.

Damaged Lead Wire of SRS Part

If the lead wire of parts for SRS airbag, combination switch assembly (including SRS coil assembly), etc. is damaged, replace all the parts (including lead wire).

Procedure to Stop the Function of SRS

Removal

Turn the starter switch to “LOCK”, and remove the key.

1. Disconnect the SRS fuse from the fuse box on the upper right portion of dashboard or disconnect terminal of battery.
2. Disconnect the 2-pole connector (yellow) located in the lower portion of steering column. (for SRS airbag)

Caution:
When removing SRS fuse and turn starter switch to ON, SRS warning lamp remains on. This is normal condition.

Procedure to Resume the Function of SRS

Installation

WARNING:
DO NOT USE SRS AIRBAG OF OTHER VEHICLE OR MODEL. BE SURE TO CONFIRM THE PART NUMBER TO USE APPROPRIATE SRS AIRBAG.

Turn the starter switch to “LOCK”, and remove the key.

1. Connect the 2-pole connector (yellow) located in the lower portion of steering column and confirm that it is connected securely.
2. Install the SRS fuse to fuse box on the upper right portion of dashboard.

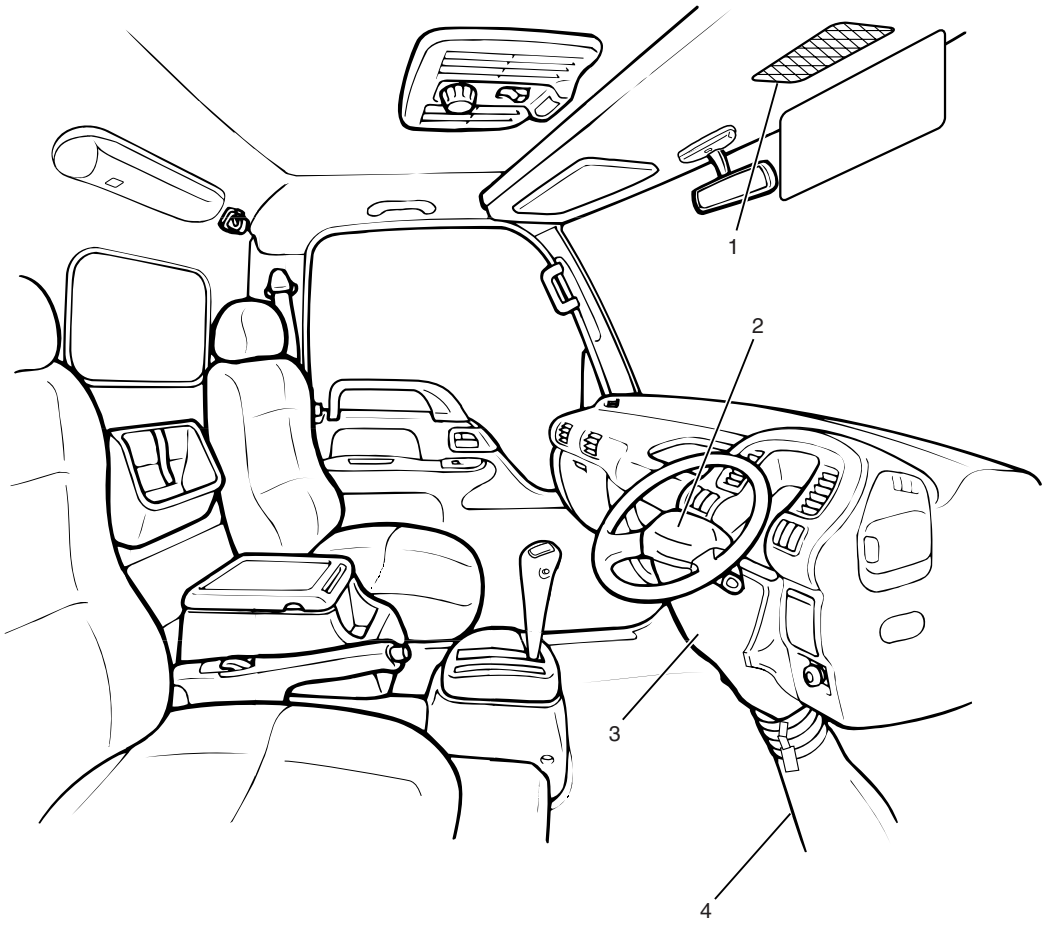
Turn the starter switch to “ON”, and confirm that the “SRS” warning lamp goes off after it blinks seven times. If the “SRS” warning lamp does not operate in that way, perform “Function check: SRS system check” in “SRS control system” in SRS Control System section.

Precautions on Handling/Installation/Diagnosis

- Do not expose SRS airbag to temperature of 93°C (199°F) or more.
- If SRS airbag and SRS control unit are dropped down with some sort of reason, do not use them.
- If disconnecting connectors related to SRS airbag and SRS control unit during repair, be sure to make sure that they are connected completely during reassembly.
- When replacing SRS control unit, install it to mounting surface correctly. Be sure to make sure there is no dust or other foreign matter on mounting surface of SRS control unit.
- When installing airbag parts, be sure to install them with specified tightening torque.
- Do not energize the system unless all SRS system parts are connected or diagnosis chart requires. If energizing the system, unnecessary diagnostic trouble code will be set in SRS control unit.
- Never diagnose the circuit using other than specified tester.
- At first, perform “SRS system check”. “SRS system check” checks whether “SRS” warning lamp operates properly and proceeds to appropriate chart to judge the function fault of system. Failure to perform this procedure leads to longer diagnosis period, wrong diagnosis or replacement of wrong part.

About Caution Labels

Caution labels, which describe exclusive precautions for driver's SRS airbag, are attached on vehicle at five locations.



N9A0016E

1. Backside of sun visor

⚠ 警告 SRSエアバッグ

SRSエアバッグ装着車（ステアリングホイール・センターパッド部に"SRS AIRBAG"の表示がある車）については、エアバッグの衝撃により、命にかかわる重大なけがをしないよう次の点を必ずお守りください。
(1)エアバッグはシートベルトの補助装置ですので、シートベルトは必ず着用してください。
(2)エアバッグに必要以上に近づいたり、寄りかかったりしないで正しい運転姿勢をとってください。
(3)エアバッグの上に物を置かないでください。
(4)エアバッグ警告灯が、走行中に点灯した場合又はスタータースイッチを"ON"位置にした時に点滅しない場合は、必ず販売店で点検を受けてください。

※SRSエアバッグの取扱い、交換、廃棄等については、販売店にご相談ください。

ーくわしくは、取扱説明書をごらんくださいー

⚠ 注意 坂路発進補助装置(HSA)

坂路発進補助装置（HSA）装着車については、次の点をお守りください。
(1)運転席を離れる時は、必ずパーキングブレーキを使用してください。
(2)HSA作動中にスタータースイッチやHSAÐOFFスイッチを操作するとブレーキ力が解除され、坂路では下がります。
(3)車両に異常があった場合には、HSAÐOFFスイッチでHSAを解除してください。

操作要領
(1)車両停止時にギヤーをニュートラルにした状態でブレーキを踏むと作動します。（HSAランプ 点灯）
(2)ギヤーをニュートラル以外のポジションにしてクラッチを継ぐとブレーキが解除します。（HSAランプ消灯）
※パーキングブレーキを引いているとHSAは、作動しません。
※HSAÐOFFスイッチを押すとHSAが解除されHSAÐOFFランプが点灯します。

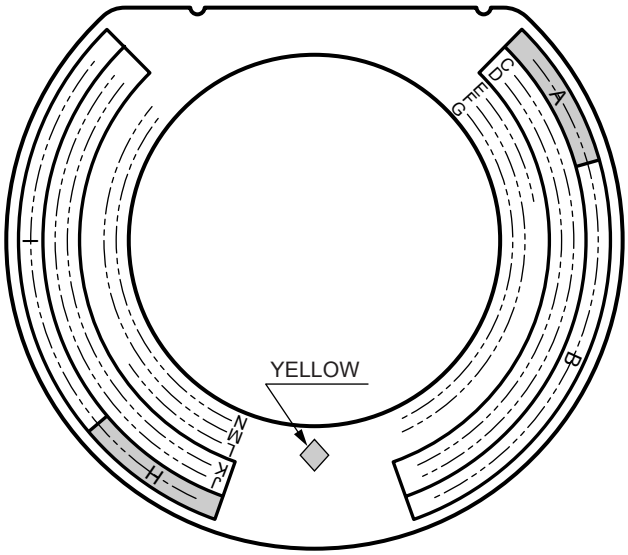
TS

N9A0018E

2. Backside of SRS airbag

N9A0019E

3. SRS coil assembly



A: Notice
B: SRS coil
C: 1. Do not rotate the SRS coil for more than 3 turns in either direction
from the neutral point. Doing so may
D: cause damage to the SRS coil.
2. Do not overhaul.
3. Do not let any oil or grease.
E: Mounting Instructions
F: 1. Straighten the front tires.
2. Rotate the SRS coil, fully clockwise, and then turn it back 4 turns.
G: 3. Align the neutral mark (◇ ▲).
4. See the service manual for details.
H - N: Written in Chinese.

N9A0084E

4. SRS control unit

N9A0021E

About Terms

SRS airbag

This is expansion-type cloth cushion designed to be deployed on frontal collision above a certain impact. Airbag reduces an impact on occupant's head and trunk and supplements the protection by seat belts.

B+

Battery voltage (B+)

Warning lamp bulb check

When no function fault is detected after starter switch is turned to "ON" position, "SRS" warning lamp blinks seven times and goes off.

"Constant diagnosis"

Fault diagnosis is constantly performed by SRS control unit as long as "Ignition A" voltage is within the range of specified operating voltage of the unit.

Diagnostic connector (16-pin)

This is a connector to communicate with Tech 2.

Deployment

This means expansion of airbag.

Deployment circuit

This is a circuit which sends current to airbag assembly to deploy airbag.

Diagnostic trouble code (DTC)

This is number used by SRS control unit to identify the trouble in SRS function. (Self-diagnosis code)

Current supply for driver's seat

This is output of SRS control unit to send current to driver's airbag assembly circuit during "Ignition device resistance test".

EEPROM

This is an electrically erasable programmable read only memory. This is a memory which can store contents without power on SRS control unit.

Ignition device

This is electric ignition device to combust gas generating agent of inflator.

Specified operating voltage range

This is voltage range from 18 to 32 V measured between "Ignition A" terminal and "Ground" terminal of SRS control unit.

Tech 2

This is diagnostic equipment to read diagnostic information from SRS control unit via diagnostic connector.

SRS control unit

This supplies backup current to deployment circuit and deploy airbag if necessary. Also it diagnoses all the SRS parts.

Serial data

This is Tech 2 information which indicates SRS operating condition.

SRS

This means supplemental restraint system.

SRS coil assembly

This is device to maintain successive continuity on deployment circuit for SRS airbag and allow steering wheel to rotate.

SRS harness

These are harnesses and connectors to connect SRS parts electrically.

Initial diagnosis

These are tests for SRS, performed by SRS control unit on the following conditions: after starter switch is "ON", immediately after "Ignition A" voltage is energized by SRS control unit, or before "Constant diagnosis". (performed within 6 seconds after starter switch is "ON")

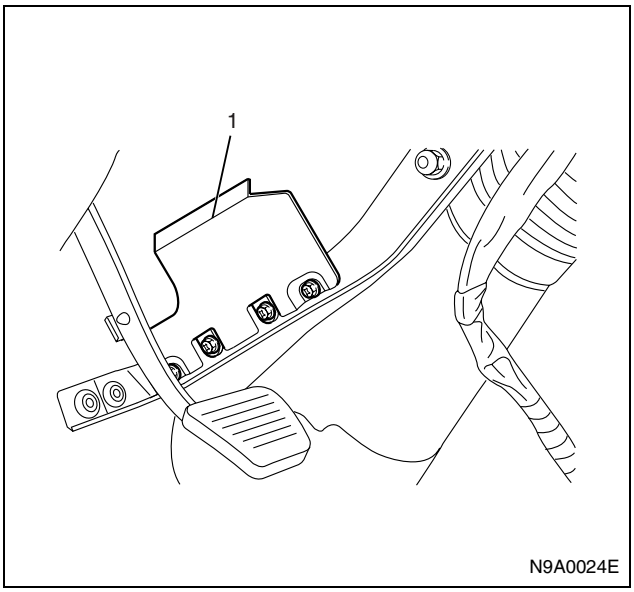
SRS Control Unit

Precautions on Service Work

WARNING:
DURING SERVICE WORK, BE CAREFUL NOT TO TAP OR SHAKE THE SRS CONTROL UNIT. ALSO, FAILURE TO INSTALL THE SRS CONTROL UNIT TO VEHICLE PROPERLY MAY LEAD TO MALFUNCTION OF THE UNIT WHEN THE STARTER SWITCH IS TURNED TO ON. THIS MAY RESULT IN INJURY DUE TO SUDDEN DEPLOYMENT OF SRS AIRBAG.

Removal

1. Stop the function of SRS. (Refer to “Procedure to stop the function of SRS” in “SRS System Assembly”.)
2. Remove the two bolts and protector.
3. Disconnect the SRS control unit harness connector.
4. Remove the four mounting bolts of SRS control unit and remove SRS control unit.



Legend
1. Protector

Installation

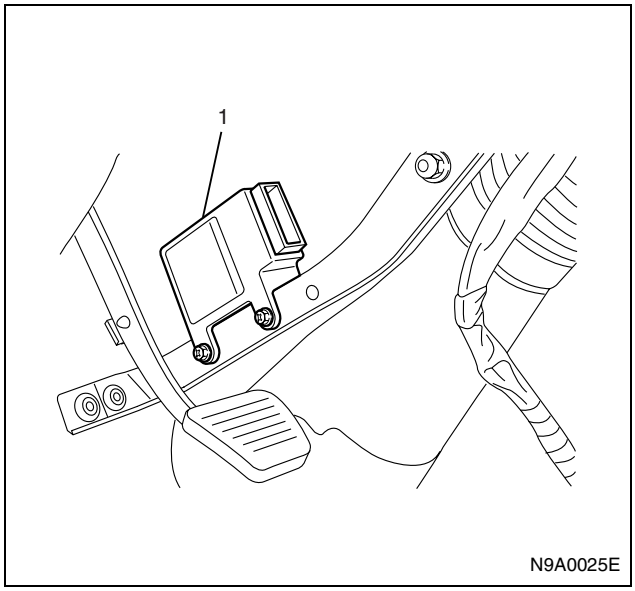
1. Install the SRS control unit to steering support bracket and tighten the mounting bolt to the specified torque.

Tighten:
Bolt to 9.8 ± 2.9 N·m (1.0 ± 0.3 kg·m / 7.2 ± 2.1 lb·ft)

2. Connect the SRS control unit harness connector.
3. Install the protector to steering support bracket and tighten the mounting bolt to the specified torque.

Tighten:
Bolt to 8.0 ± 2.0 N·m (0.8 ± 0.2 kg·m / 5.9 ± 1.5 lb·ft)

4. Resume the function of SRS. (Refer to “Procedure to resume the function of SRS” in “SRS System Assembly”.)



Legend
1. SRS control unit

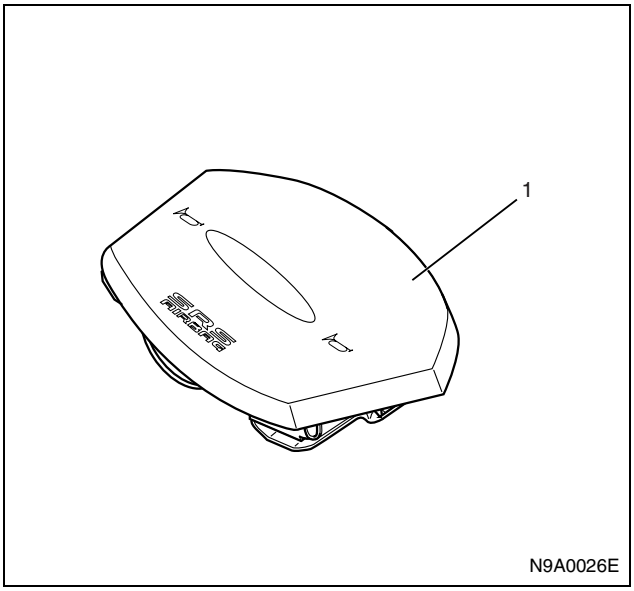
SRS Airbag Assembly

Precautions on Service Work

Procedure to Carry Undeployed SRS Airbag Assembly

Take extreme care when handling and storing undeployed airbag. In case of deployment of SRS airbag, object on the surface of SRS airbag may be blown away due to sudden generation of gas.

WARNING:
WHEN CARRYING UNDEPLOYED SRS AIRBAG ASSEMBLY, BE SURE TO TURN THE TRIM COVER TOWARD OUTSIDE TO REDUCE THE POSSIBILITY OF INJURY IN CASE OF AIRBAG DEPLOYMENT. ALSO, NEVER GRASP THE HARNESS OR CONNECTOR OF SRS AIRBAG TO CARRY IT.



Legend

1. Trim cover

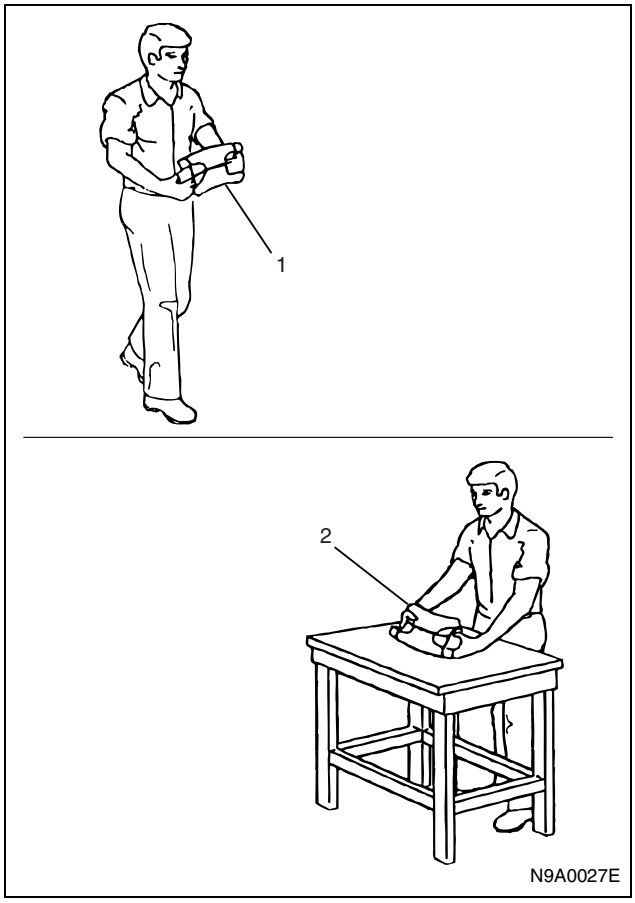
Handling of Deployed Airbag Assembly

After SRS airbag is deployed, do not touch within 30 minutes because a burn may occur due to its heat.
When handling deployed SRS airbag, wear gloves and safety goggles to protect from generated irritant and heat.

Disposal Procedure of SRS Airbag

In some cases, it may be necessary to dispose undeployed SRS airbag during usable life of the vehicle.
Perform the proper disposal procedure of undeployed airbag.
To dispose undeployed SRS airbag, the airbag must be deployed compulsorily beforehand. Undeployed airbag cannot be disposed as it is.

WARNING:
FAILURE TO FOLLOW THE PROPER DISPOSAL PROCEDURE MAY CAUSE INJURY DUE TO DEPLOYMENT OF SRS AIRBAG. UNDEPLOYED AIRBAG MUST BE DEPLOYED BEFORE DISPOSAL.



Legend

1. When carrying undeployed airbag, turn the trim cover toward outside.
2. When placing undeployed airbag, be sure to turn the trim cover upward.

Precautions on Airbag Deployment Procedure for Disposal

Failure to perform the correct procedure leads to serious accident due to airbag malfunction during work. Be sure to perform the correct procedure.

1. Turn the starter switch to OFF (LOCK), disconnect the (−) terminal of battery and wait for 15 seconds before starting work.
   (Because airbag can be activated by backup power even if battery power is cut off at collision.)
2. Never disassemble airbag.
3. Do not make an impact on airbag or put it close to magnet.
   (Because it may cause airbag malfunction. It is very dangerous.)

4. Place airbag with trim cover facing upward. Never put any object on it.
5. Do not put airbag on the floor directly to perform deployment.
   (Because it may be blown away for 2 to 3 meters (7 to 10 feet) due to impact.)
6. If installing airbag to vise or tire, fix it securely.
7. Place battery more than 10 m (33 ft) away from airbag.
8. Before disconnecting the harness of airbag, touch the metal parts of vehicle for body grounding of worker.
   (To prevent malfunction due to static electricity)
9. Do not stand in front of airbag when handling harness.
10. Let nearby personnel know about deployment because loud sound occurs. Also, put blanket on steering wheel or tire, or close the windows to reduce deployment sound as possible if deploying in vehicle.
11. Perform the work in well-ventilated area since deployment emits smoke.
    (For indoor deployment, do not perform near fire-alarm, smoke-alarm, or under fluorescent.)
12. Take care not to inhale smoke emitted on deployment.
13. Put cover on vehicle since glasses of vehicle may be broken on deployment if they are damaged.
14. Directly after airbag is deployed, leave it for 30 minutes since it is very hot.
15. Do not pour water etc. to the deployed airbag.
16. Wear protective tools such as safety goggles, gloves, etc. during work and wash them thoroughly after work.
17. Do not reuse removed airbag to equip other vehicle with.
    (Because operating characteristics depend on vehicle models.)

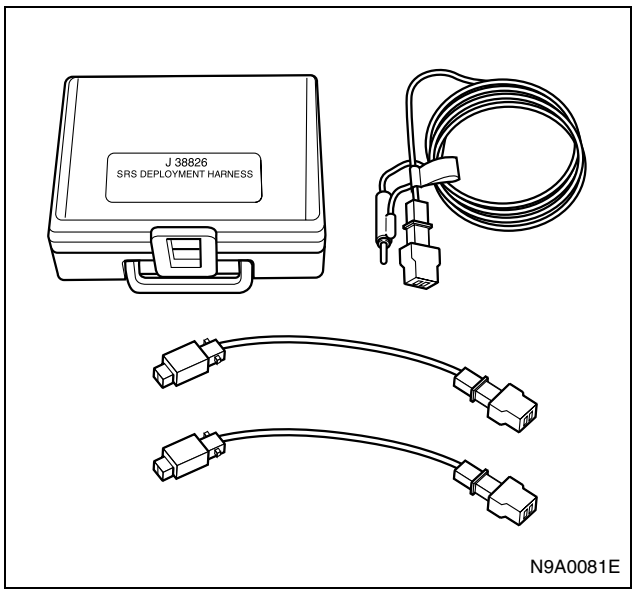
There are two methods to deploy undeployed airbag assembly: out-vehicle deployment and in-vehicle deployment.

Out-vehicle Deployment (Using Deployment Mounting tool)

WARNING:
FAILURE TO FOLLOW THE PROPER DISPOSAL PROCEDURE MAY CAUSE INJURY DUE TO DEPLOYMENT OF SRS AIRBAG. UNDEPLOYED AIRBAG MUST BE DEPLOYED BEFORE DISPOSAL.

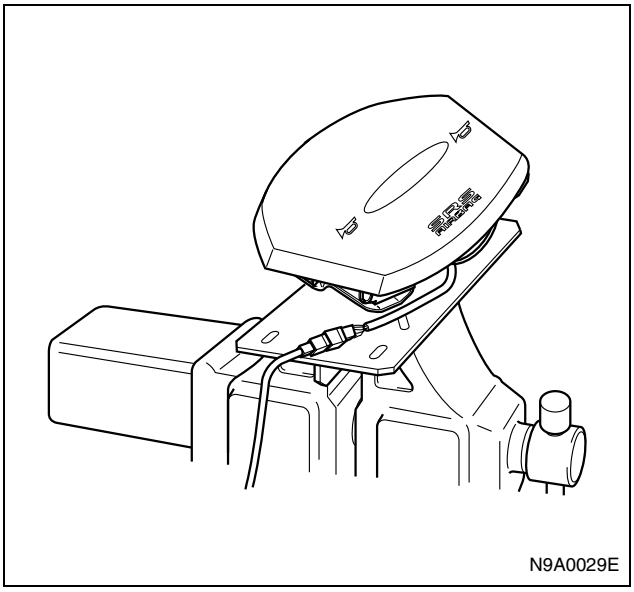
Deployment procedure must be observed to deploy the undeployed airbag assembly out of vehicle.
During deployment procedure, always wear safety goggles until disposing deployed airbag assembly. Before performing deployment procedure, read carefully description to understand the service work of SRS and the proper handling of airbag assembly.

Prepare SRS airbag deployment tool (5-8840-2468-0), 2-pole extension cord, SRS deployment mounting tool (5-8840-2420-0), vise and tire for the procedure. Do not perform the procedure without these tools.

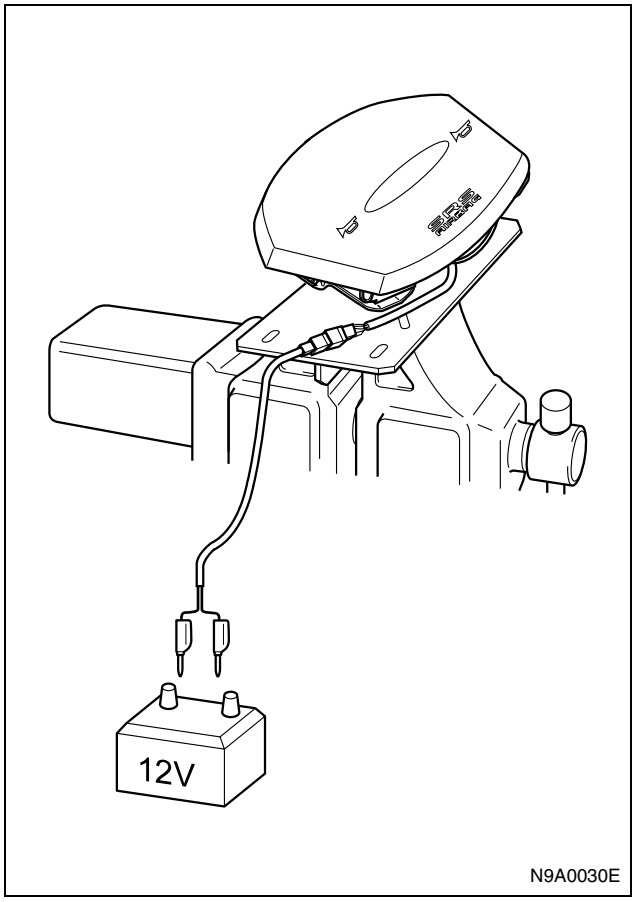


WARNING:
SRS AIRBAG ASSEMBLY DEPLOYS IMMEDIATELY AFTER CONNECTING POWER SUPPLY TO SRS DEPLOYMENT HARNESS. THEREFORE, BE SURE TO CONNECT POWER SUPPLY WITH THE HARNESS IN THE END OF THE DEPLOYMENT PROCEDURE OF SRS AIRBAG ASSEMBLY. FAILURE TO FOLLOW THIS MAY CAUSE INJURY. ALSO, ALWAYS WEAR SAFETY GOGGLES DURING DEPLOYMENT AND DISPOSAL PROCEDURES.

1. Turn the starter switch to “LOCK”, remove the key and wear safety goggles.
2. Inspect SRS airbag deployment tool (5-8840-2468-0) and 2-pole extension cord for damage. If the harness or extension cord is damaged, use new one.
3. Remove the SRS airbag assembly from the vehicle. Refer to “Removal” in “SRS Airbag Assembly”.
4. Make open space (diameter of more than 2 meters) for deployment of SRS airbag assembly mounted to deployment mounting tool. Outdoor paved place in which safety is secured is recommended, however well-ventilated service work place is also available. Besides, make sure that there are no objects or flammable materials in deployment area. (For indoor deployment, do not perform near fire-alarm, smoke-alarm, or under fluorescent.)
5. Install SRS airbag mounting tool (5-8840-2420-0) to vise to stabilize the tool during deployment.


N9A0029E

6. Firmly install SRS airbag assembly with trim cover facing upward to deployment mounting tool (5-8840-2420-0) using bolt or wire.
7. Extend SRS airbag deployment harness and the 2-pole extension cord more than 10 m (33 ft) away from airbag assembly.
8. Insert a banana plug to other banana plug firmly to short two SRS airbag deployment harnesses. Do not connect SRS airbag deployment harness to power supply until the stage of deploying airbag.
9. Place the power supply near the end of extended SRS airbag deployment harness. (Battery with 12 V and 2 A or more is recommended to use.)



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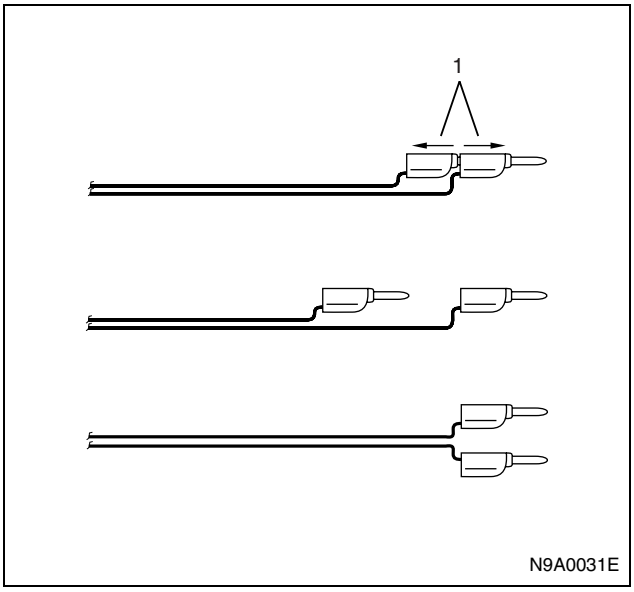
10. Connect the SRS airbag assembly to 2-pole extension cord of SRS airbag deployment harness. Do not connect deployment harness to power supply until the stage of deploying airbag because airbag deploys immediately after connecting the harness to power supply.

Caution:
Insert the extension cord to the connector of SRS airbag assembly firmly. Failure to insert connector firmly may cause the shorting bar in SRS airbag assembly connector to remain functional (remains short in deployment circuit). Therefore, SRS airbag assembly is not deployed.

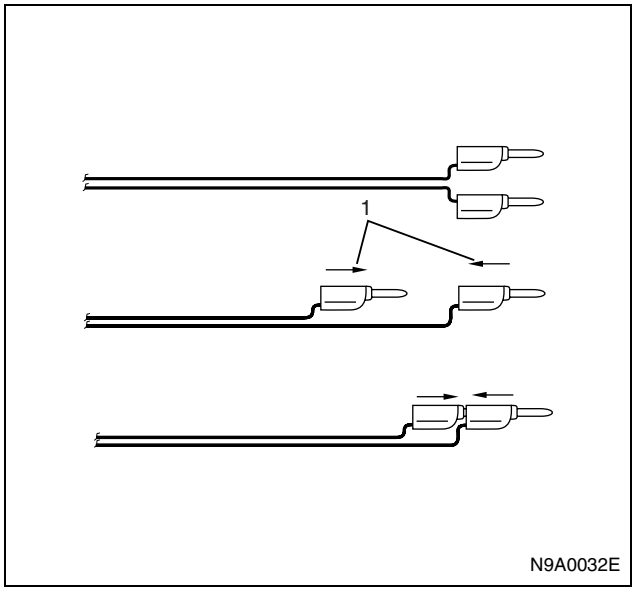
11. Make sure that there are no personnel, objects or flammable materials around SRS airbag assembly.
12. Make sure that SRS airbag assembly is installed correctly and firmly to SRS deployment mounting tool (5-8840-2420-0).
13. Let nearby personnel know about deployment because loud bursting sound occurs due to sudden gas expansion when airbag is deployed.
14. Remove the two banana plugs of SRS airbag deployment harness.



Legend
1. Disconnect the banana plugs.

WARNING:
SRS AIRBAG ASSEMBLY DEPLOYS IMMEDIATELY AFTER CONNECTING POWER SUPPLY TO SRS DEPLOYMENT HARNESS. THEREFORE, BE SURE TO CONNECT POWER SUPPLY WITH THE HARNESS IN THE END OF THE DEPLOYMENT PROCEDURE OF SRS AIRBAG ASSEMBLY. FAILURE TO FOLLOW THIS MAY CAUSE INJURY. ALSO, ALWAYS WEAR SAFETY GOGGLES DURING DEPLOYMENT AND DISPOSAL PROCEDURES.

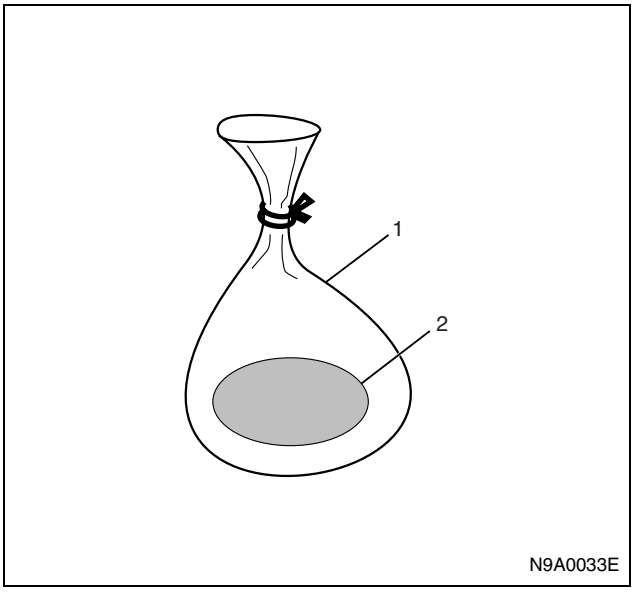
15. When connecting SRS airbag deployment harness to power supply, immediately SRS airbag assembly will be deployed. Battery with 12 V and 2 A or more is recommended to use for deployment.
16. If SRS airbag assembly has not been deployed in these steps, immediately perform the steps from 22 to 24. If SRS airbag assembly has been deployed, perform steps from 17 to 21.
17. Remove the SRS airbag deployment harness from power supply.
18. Insert a banana plug to other banana plug firmly to short two SRS airbag deployment harnesses.



Legend
1. Short the banana plug.

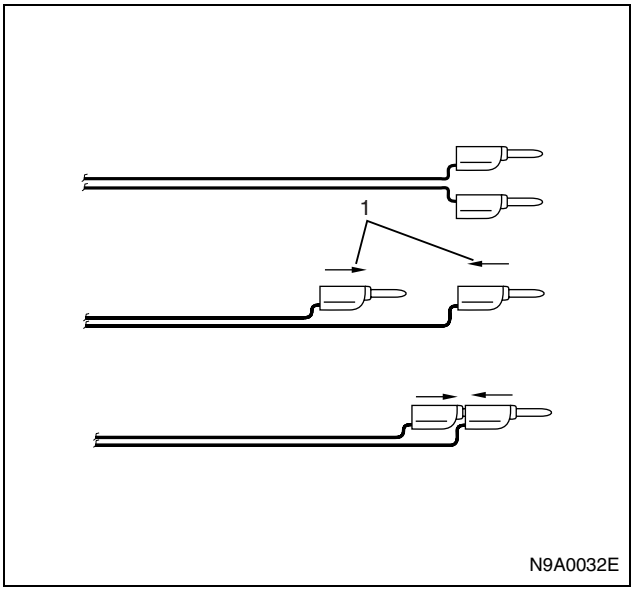
WARNING:
FOLLOW PRECAUTIONS ABOUT SAFETY WHEN HANDLING DEPLOYED SRS AIRBAG ASSEMBLY. METAL SURFACE OF SRS AIRBAG ASSEMBLY WILL BE VERY HOT DIRECTLY AFTER DEPLOYMENT. DO NOT TOUCH IT FOR 30 MINUTES AFTERWARD. DO NOT PUT THE DEPLOYED SRS AIRBAG ASSEMBLY NEAR FLAMMABLE MATERIALS. FAILURE TO FOLLOW THIS MAY CAUSE FIRE OR INJURY. IF THE DEPLOYED SRS AIRBAG ASSEMBLY NEEDS TO BE MOVED BEFORE IT COOLS DOWN, WEAR GLOVES AND GRASP THE SRS AIRBAG OR TRIM COVER TO MOVE.

19. Remove the 2-pole extension cord from SRS airbag assembly soon after deployment to prevent the extension cord and SRS airbag deployment harness from touching the hot metal parts. 2-pole extension cord and deployment harness are reusable. However, inspect them for damage every time after deployment, and replace them if necessary.
20. Leave the deployed SRS airbag assembly for more than 30 minutes to cool down, and put it in sturdy vinyl bag and seal it. Dispose it in the normal disposal procedure.



Legend
1. Sturdy vinyl bag
2. Deployed airbag

21. Wash out your hands with soap thoroughly.
22. Remove the SRS airbag deployment harness from power supply and insert the banana plug to the other banana plug firmly to short two banana plugs.



Legend
1. Short the banana plug.

23. Disconnect the 2-pole extension cord from SRS airbag assembly.

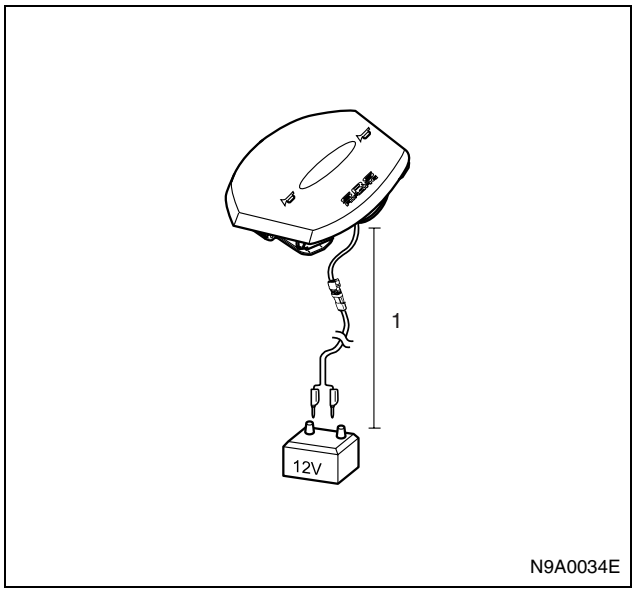
WARNING:
WHEN STORING UNDEPLOYED SRS AIRBAG ASSEMBLY, OR LEAVE IT UNATTENDED ON WORKBENCH OR SOMEWHERE ELSE, BE SURE TO TURN THE TRIM COVER UPWARD TO REDUCE THE POSSIBILITY OF INJURY IN CASE OF AIRBAG DEPLOYMENT.

24. Store temporarily the SRS airbag assembly with the trim cover facing upward. Do not pile it up.

Out-vehicle Deployment (Method of Securing to Tire)

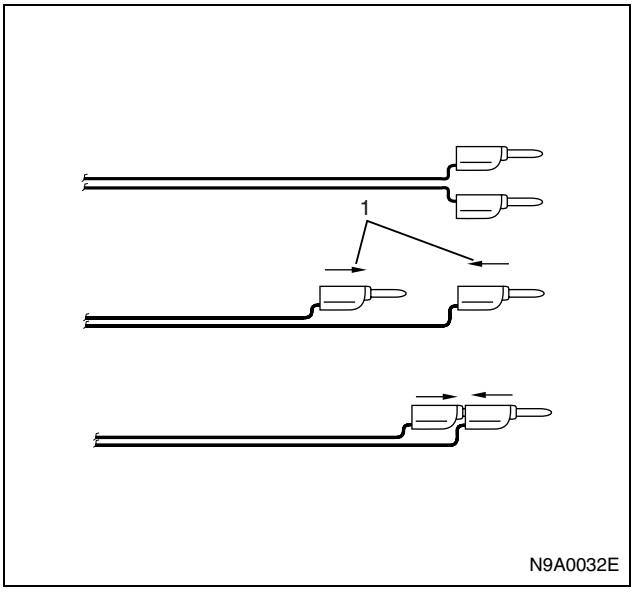
Thoroughly understand description in “Precautions on airbag deployment procedure for disposal” and precautions in “How to secure to deployment mounting tool” to perform safely.

1. Refer to “Removal” in “SRS Airbag Assembly” to remove SRS airbag assembly from the vehicle.
2. Inspect the 2-pole extension cord of SRS deployment for damage. If the harness or extension cord is damaged, use new one.
3. Extend the 2-pole extension cord more than 10 m (33 ft) away from airbag assembly.
4. Place the power supply near the end of extended SRS airbag deployment harness. (Battery with 12 V and 2 A or more is recommended to use.)



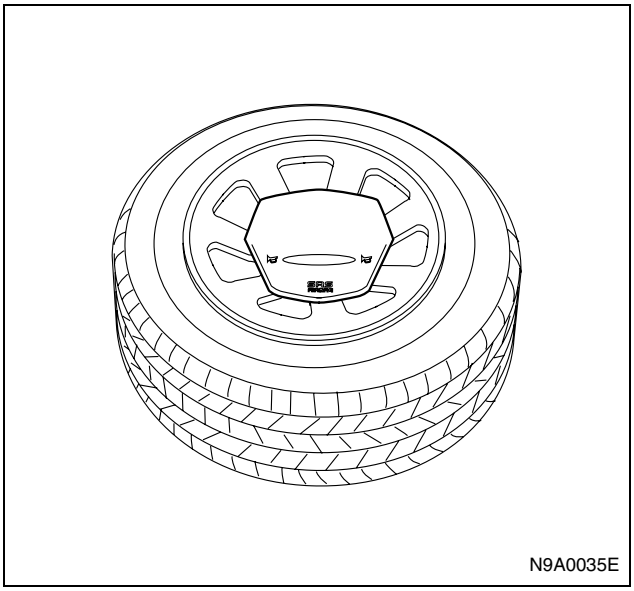
Legend
1. Keep more than 10 m (33 ft) away.

5. Insert the banana plug on the end of harness to the other banana plug firmly to short two SRS airbag deployment harnesses. Do not connect SRS airbag deployment harness to power supply until the stage of deploying airbag.



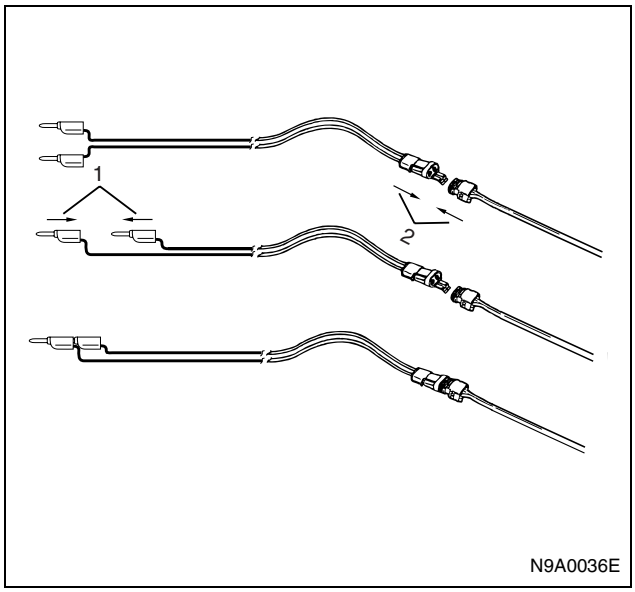
Legend
1. Short the banana plug.

6. Prepare three tires (15-inch or more) without wheel and two tires (same size) with wheel.
7. How to secure driver's airbag
   a. Secure the airbag with the trim cover facing upward to the tire with wheel. Wind automotive wire harness (cross-section of 1.25 mm^2 or more) or wire in triple-round at two locations to secure firmly.



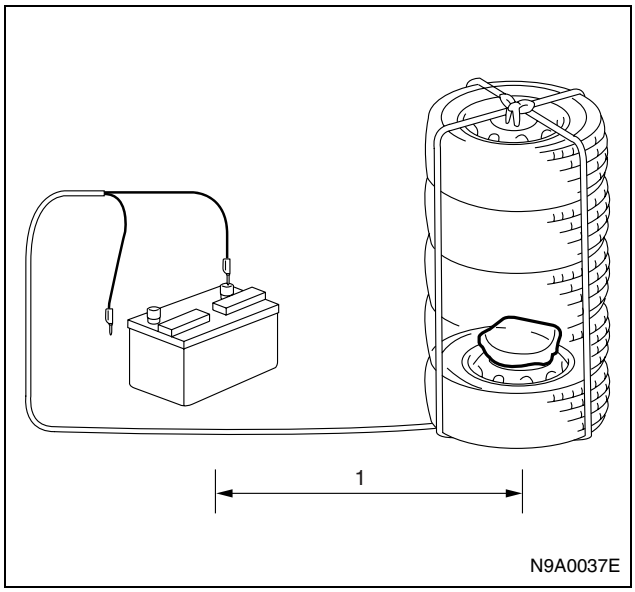
   b. Connect the SRS airbag assembly to 2-pole extension cord of airbag deployment harness. Do not connect deployment harness to power supply until the stage of deploying airbag because airbag deploys immediately after connecting the harness to power supply.

Caution:
Insert the extension cord to the connector of SRS airbag assembly firmly. Failure to insert connector firmly may cause the shorting bar in SRS airbag assembly connector to remain functional (remains short in deployment circuit). Therefore, SRS airbag assembly is not deployed.



Legend
1. Short the banana plug.
2. Connect the connector.

   c. Pile up three tires without wheel onto the tire, which secures airbag, and pile up a tire with wheel onto the top of them. Secure them firmly to prevent tires from tumbling down using ropes at four locations.

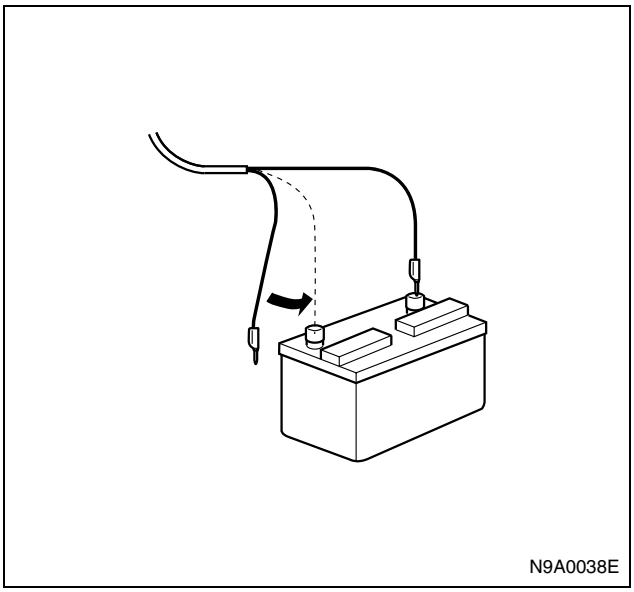


Legend
1. Keep more than 10 m (33 ft) away.

8. Let nearby personnel know about deployment because loud bursting sound occurs due to sudden gas expansion when airbag is deployed.

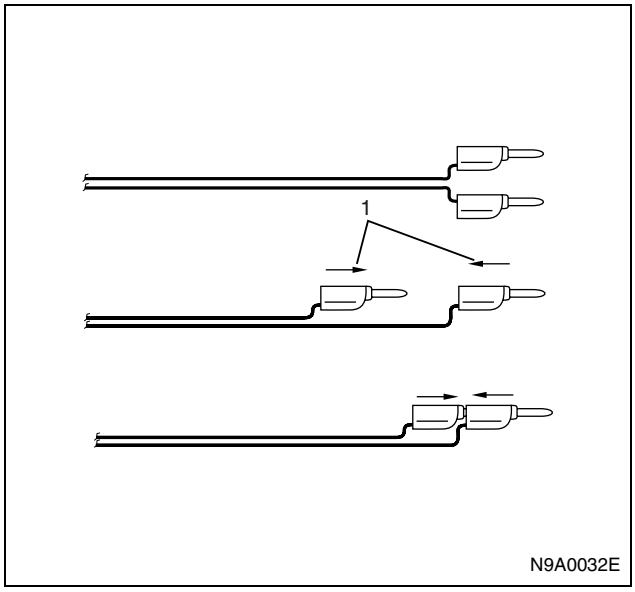
WARNING:
SRS AIRBAG ASSEMBLY DEPLOYS IMMEDIATELY AFTER CONNECTING POWER SUPPLY TO SRS DEPLOYMENT HARNESS. THEREFORE, BE SURE TO CONNECT POWER SUPPLY WITH THE HARNESS IN THE END OF THE DEPLOYMENT PROCEDURE OF SRS AIRBAG ASSEMBLY. FAILURE TO FOLLOW THIS MAY CAUSE INJURY. ALSO, ALWAYS WEAR SAFETY GOGGLES DURING DEPLOYMENT AND DISPOSAL PROCEDURES.

9. Connect the SRS airbag deployment harness to power supply. Immediately SRS airbag assembly will be deployed.


N9A0038E

WARNING:
FOLLOW PRECAUTIONS ABOUT SAFETY WHEN HANDLING DEPLOYED SRS AIRBAG ASSEMBLY. METAL SURFACE OF SRS AIRBAG ASSEMBLY WILL BE VERY HOT DIRECTLY AFTER DEPLOYMENT. DO NOT TOUCH IT FOR 30 MINUTES AFTERWARD. DO NOT PUT THE DEPLOYED SRS AIRBAG ASSEMBLY NEAR FLAMMABLE MATERIALS. FAILURE TO FOLLOW THIS MAY CAUSE FIRE OR INJURY. IF THE DEPLOYED SRS AIRBAG ASSEMBLY NEEDS TO BE MOVED BEFORE IT COOLS DOWN, WEAR GLOVES AND GRASP THE SRS AIRBAG OR TRIM COVER TO MOVE.

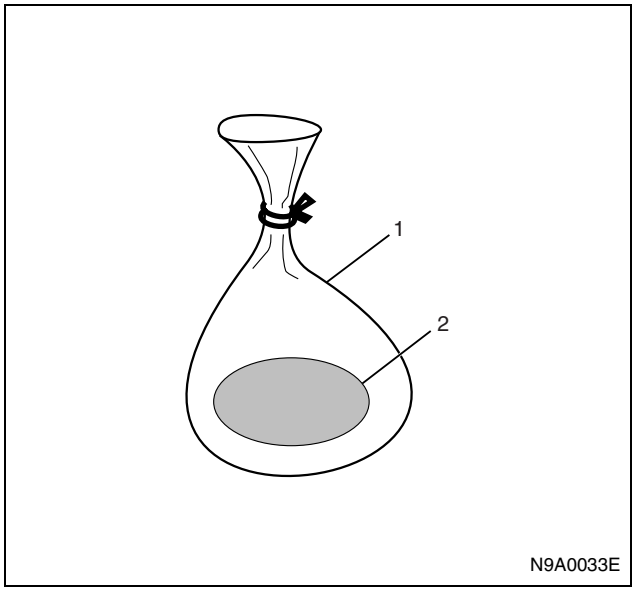
10. If SRS airbag assembly has not been deployed in these steps, immediately perform the steps from 15 to 17. If SRS airbag assembly has been deployed, perform steps from 11 to 14.
11. Remove the SRS airbag deployment harness from power supply and insert the banana plug to the other banana plug firmly to short two banana plugs.



N9A0032E

Legend
1. Short the banana plug.

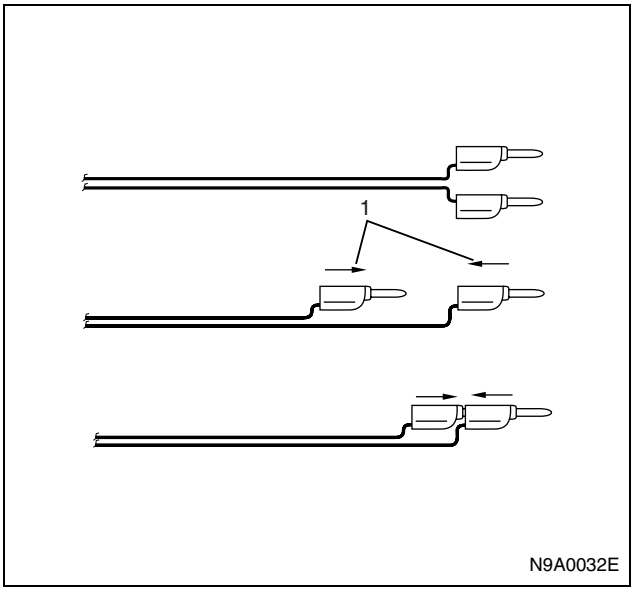
12. Disconnect the 2-pole extension cord from SRS airbag assembly.
13. Leave the deployed SRS airbag assembly for more than 30 minutes to cool down, and put it in sturdy vinyl bag and seal it. Dispose it in the normal disposal procedure.



N9A0033E

Legend
1. Sturdy vinyl bag
2. Deployed airbag

14. Wash out your hands with soap thoroughly.
15. Remove the SRS airbag deployment harness from power supply and insert the banana plug to the other banana plug firmly to short two banana plugs.

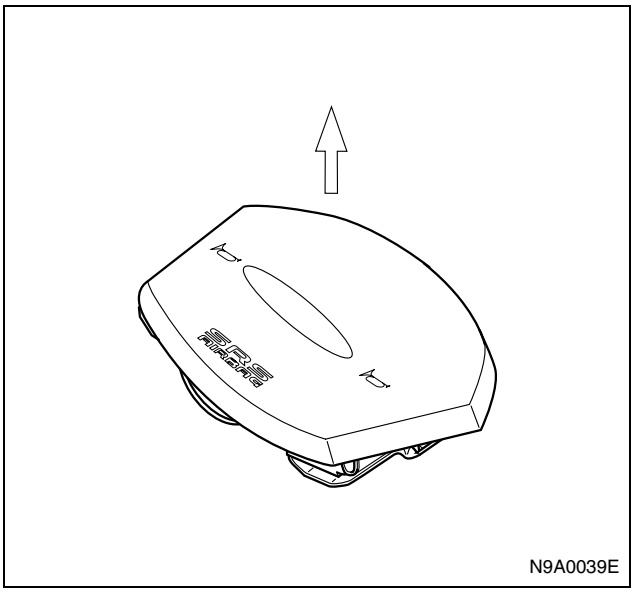


Legend
1. Short the banana plug.

16. Disconnect the 2-pole extension cord from SRS airbag assembly.

WARNING:
WHEN STORING UNDEPLOYED SRS AIRBAG ASSEMBLY, OR LEAVE IT UNATTENDED ON WORKBENCH OR SOMEWHERE ELSE, BE SURE TO TURN THE TRIM COVER UPWARD TO REDUCE THE POSSIBILITY OF INJURY IN CASE OF AIRBAG DEPLOYMENT.

17. Store temporarily the SRS airbag with the trim cover facing upward. Do not pile it up.



In-vehicle Deployment (Using SRS Deployment Harness)

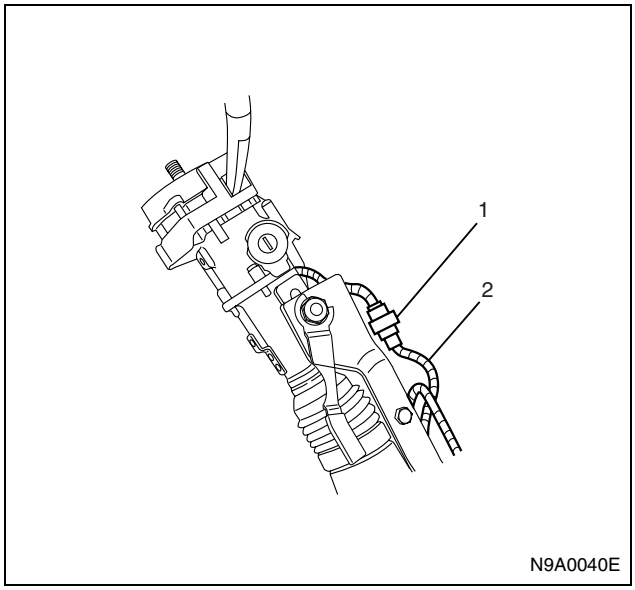
For discarding vehicle or collecting vehicle parts, in-vehicle deployment is proper. This may be one of the following situations.

- Usable life of vehicle ended.
- Vehicle has got damaged without deployment and it is impossible to be repaired.
- Vehicle was stolen and it is ripped off or damaged.

Caution:
If collecting the parts from vehicle to reuse for other one, never reuse SRS parts.

WARNING:
FAILURE TO FOLLOW THE PROPER DISPOSAL PROCEDURE MAY CAUSE INJURY DUE TO DEPLOYMENT OF SRS AIRBAG. UNDEPLOYED AIRBAG MUST BE DEPLOYED BEFORE DISPOSAL.

1. Turn the starter switch to “LOCK”, remove the key and wear safety goggles.
2. Remove all unnecessary objects inside vehicle.
3. Disconnect the 2-pole connector (yellow) of SRS coil. It is located in the lower portion of steering column.

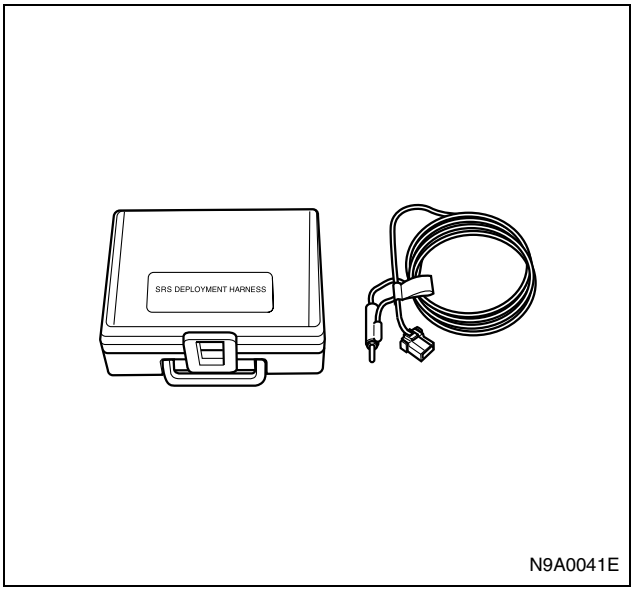


Legend
1. Connector (yellow)
2. SRS coil harness (yellow)

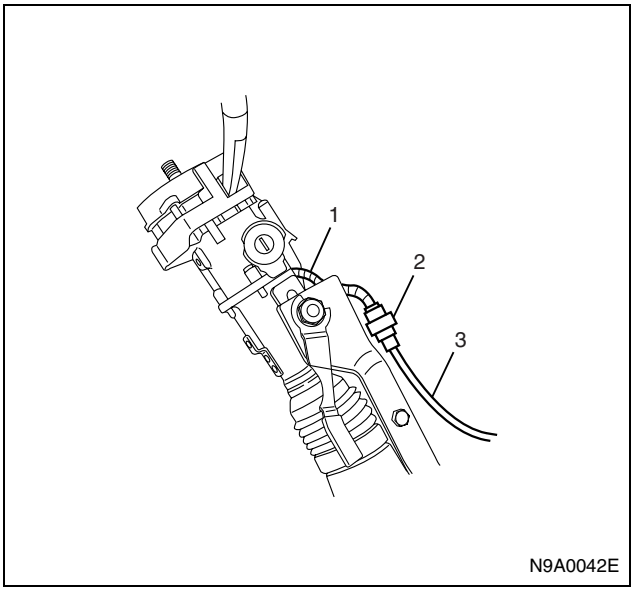
4. Insert a banana plug to other banana plug firmly to short two SRS airbag deployment harnesses.
   Do not connect SRS airbag deployment harness to power supply until the stage of deploying airbag.

WARNING:
SRS AIRBAG ASSEMBLY DEPLOYS IMMEDIATELY AFTER CONNECTING POWER SUPPLY TO SRS DEPLOYMENT HARNESS. THEREFORE, BE SURE TO CONNECT POWER SUPPLY WITH THE HARNESS IN THE END OF THE DEPLOYMENT PROCEDURE OF

SRS AIRBAG ASSEMBLY. FAILURE TO FOLLOW THIS MAY CAUSE INJURY. ALSO, ALWAYS WEAR SAFETY GOGGLES DURING DEPLOYMENT AND DISPOSAL PROCEDURES.



5. Take the SRS deployment harness out of vehicle from driver's side.
6. Make sure that there are no personnel, objects or flammable materials in or around the vehicle.
7. Extend the SRS deployment harness to keep a enough distance from it.
8. Cover windshield glass and front door glass with cloth or blanket completely. (Because personal injury may occur due to vehicle glasses or broken pieces of internal parts.)
9. Let nearby personnel know about deployment because loud bursting sound occurs due to sudden gas expansion when airbag is deployed.
10. Connect the SRS deployment harness to the disconnected harness of SRS coil harness side.



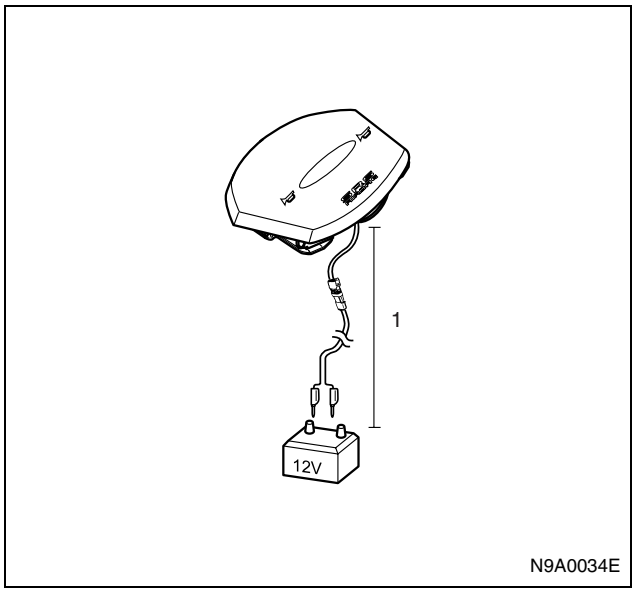
Legend
1. SRS coil harness (yellow)
2. Connector (yellow)
3. SRS deployment harness

11. Remove the insertion of banana plug on the end of SRS deployment harness.

WARNING:
SRS AIRBAG ASSEMBLY DEPLOYS IMMEDIATELY AFTER CONNECTING POWER SUPPLY TO SRS DEPLOYMENT HARNESS. THEREFORE, BE SURE TO CONNECT POWER SUPPLY WITH THE HARNESS IN THE END OF THE DEPLOYMENT PROCEDURE OF SRS AIRBAG ASSEMBLY. FAILURE TO FOLLOW THIS MAY CAUSE INJURY. ALSO, ALWAYS WEAR SAFETY GOGGLES DURING DEPLOYMENT AND DISPOSAL PROCEDURES.

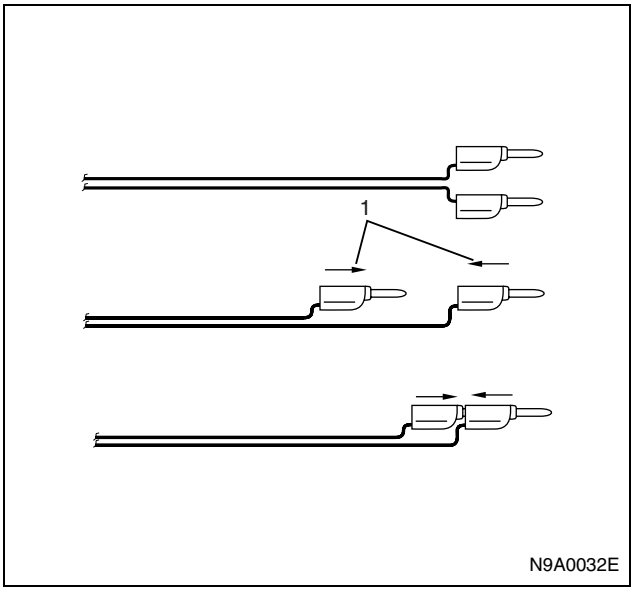
Caution:
Let nearby personnel know about SRS deployment because loud bursting sound occurs due to sudden gas expansion when SRS airbag is deployed.

12. When connecting the banana plug of SRS deployment harness to power supply, immediately SRS airbag will be deployed. Battery with 12 V and 2 A or more is recommended to use.



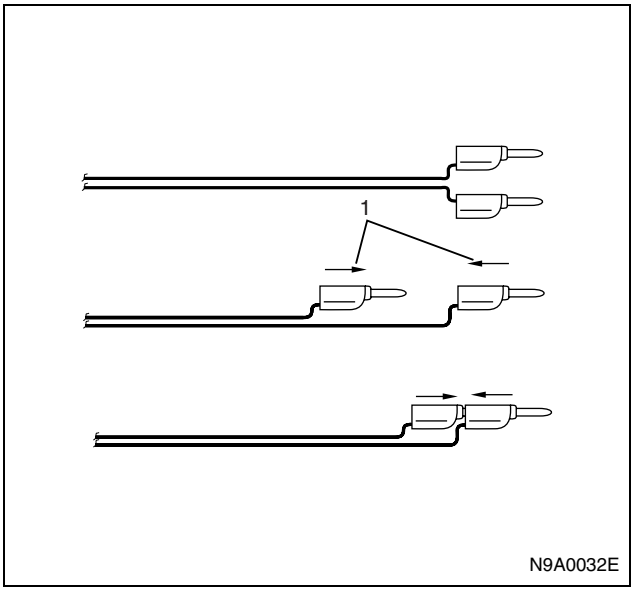
Legend
1. Keep more than 10 m (33 ft) (safe distance) away.

13. If SRS airbag has not been deployed in these steps, perform the steps from 18 to 22. If SRS airbag has been deployed, perform steps from 14 to 17.
14. Take out the SRS airbag deployment harness from power supply and insert the banana plug to the other banana plug firmly to short two banana plugs.



Legend
1. Short the banana plug.

15. Carefully remove the cloth from the vehicle, and remove broken pieces from it or dispose itself.
16. Remove the SRS deployment harness from the vehicle.
17. After deploying SRS airbag, the vehicle can be disposed in the same method as vehicles non-equipped with SRS airbag.
18. Take out the SRS airbag deployment harness from power supply and insert the banana plug to the other banana plug firmly to short two banana plugs.

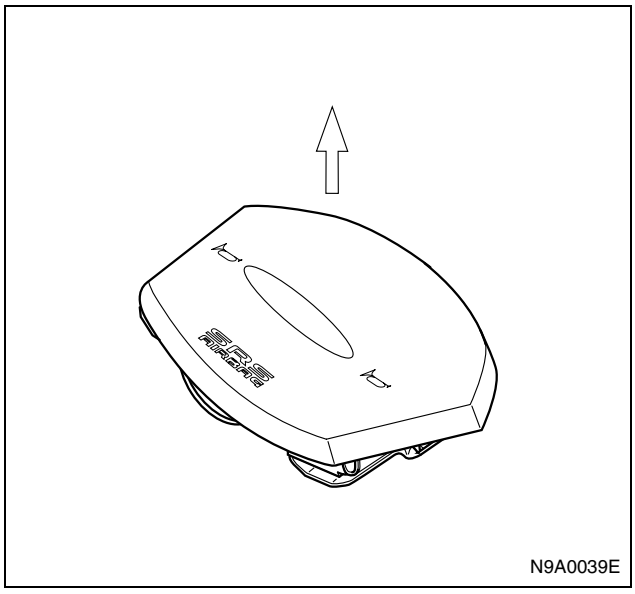


Legend
1. Short the banana plug.

19. Remove the cloth from the vehicle.
20. Remove the SRS deployment harness from the vehicle.
21. Remove the undeployed SRS airbag from the vehicle. Refer to “Removal” in “SRS Airbag Assembly” for SRS airbag.

WARNING:
WHEN STORING UNDEPLOYED SRS AIRBAG ASSEMBLY, OR LEAVE IT UNATTENDED ON WORKBENCH OR SOMEWHERE ELSE, BE SURE TO TURN THE TRIM COVER UPWARD TO REDUCE THE POSSIBILITY OF INJURY IN CASE OF AIRBAG DEPLOYMENT.

22. Store temporarily the SRS airbag with the trim cover facing upward. Do not pile it up.



In-vehicle Deployment (Using SRS Airbag Onboard Deployment tool)

For discarding vehicle or collecting vehicle parts, in-vehicle deployment is proper. This may be one of the following situations.

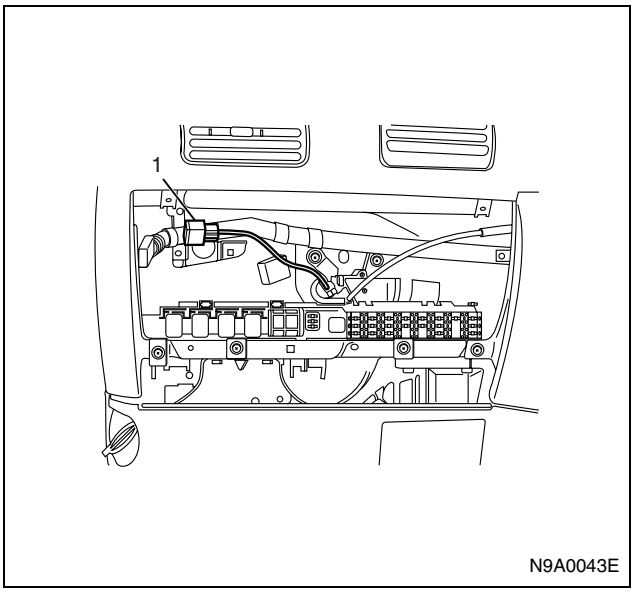
- Usable life of vehicle ended.
- Vehicle has got damaged without deployment and it is impossible to be repaired.
- Vehicle was stolen and it is ripped off or damaged.

Caution:
If collecting the parts from vehicle to reuse for other one, never reuse SRS parts.

WARNING:
FAILURE TO FOLLOW THE PROPER DISPOSAL PROCEDURE MAY CAUSE INJURY DUE TO DEPLOYMENT OF SRS AIRBAG. UNDEPLOYED AIRBAG MUST BE DEPLOYED BEFORE DISPOSAL.

1. Disconnect the battery of disposal vehicle to cut off power supply to SRS control unit.
2. Remove all objects on the front seats.

3. Remove the glove box, and connect the SRS airbag onboard deployment tool to disposal connector on vehicle side.



Legend
1. Disposal connector

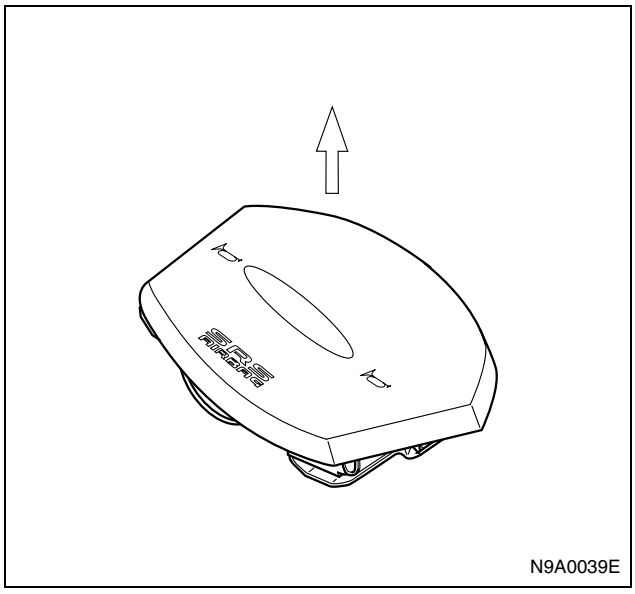
4. Place SRS airbag onboard deployment tool away from it.
5. Make sure that there are no personnel, objects or flammable materials in or around the vehicle.
6. Cover windshield glass and front door glass with cloth or blanket completely. This reduces possibility of injury due to glasses or broken pieces of internal parts.
7. Turn on the SRS airbag onboard deployment tool. This activates SRS control unit to be ready for deployment.

Caution:
Let nearby personnel know about SRS deployment because loud bursting sound occurs due to sudden gas expansion when SRS airbag is deployed.

8. Press the two ignition switches on SRS airbag onboard deployment tool at the same time to deploy the airbag. When handling deployed SRS airbag, wear gloves and safety goggles to protect from generated irritant and heat.
9. If SRS airbag has not been deployed in these steps, perform the steps from 10 to 11, then from 13 to 14. If SRS airbag has been deployed, perform steps from 10 to 12.
10. Carefully remove the cloth from the vehicle, and remove broken pieces from it or dispose itself.
11. Remove the SRS airbag onboard deployment tool from the vehicle.
12. After deploying SRS airbag, the vehicle can be disposed in the same method as vehicles non-equipped with SRS airbag.
13. Remove the undeployed SRS airbag from the vehicle. Refer to “Removal” in “SRS Airbag Assembly” for SRS airbag.

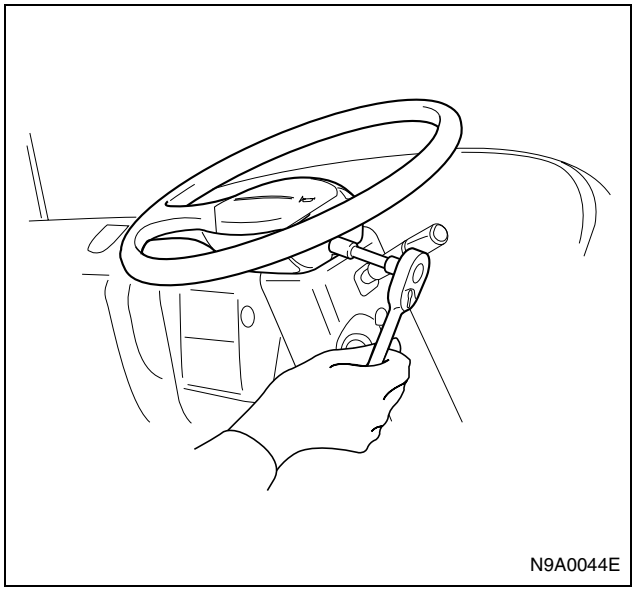
WARNING:
WHEN STORING UNDEPLOYED SRS AIRBAG ASSEMBLY, OR LEAVE IT UNATTENDED ON WORKBENCH OR SOMEWHERE ELSE, BE SURE TO TURN THE TRIM COVER UPWARD TO REDUCE THE POSSIBILITY OF INJURY IN CASE OF AIRBAG DEPLOYMENT.

14. Store temporarily the SRS airbag with the trim cover facing upward. Do not pile it up.

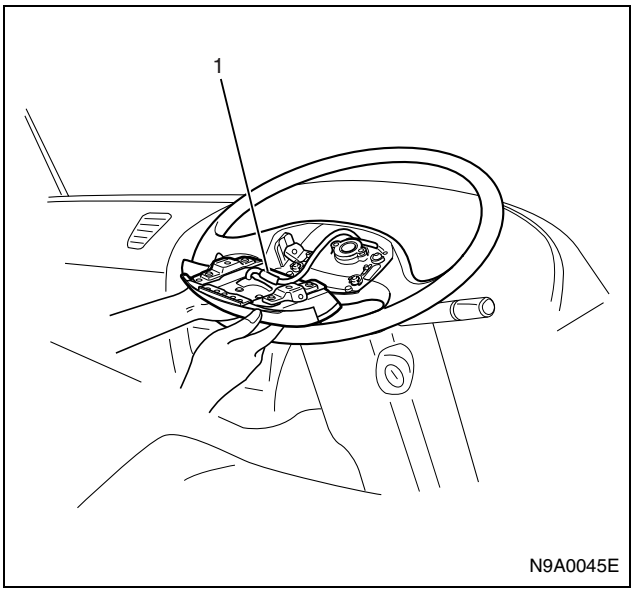


Removal

1. Stop the function of SRS. (Refer to “Procedure to stop the function of SRS” in “SRS System Assembly”.)
2. Loosen the mounting bolt from the back of steering wheel using TORX® driver or equivalent to remove SRS airbag.



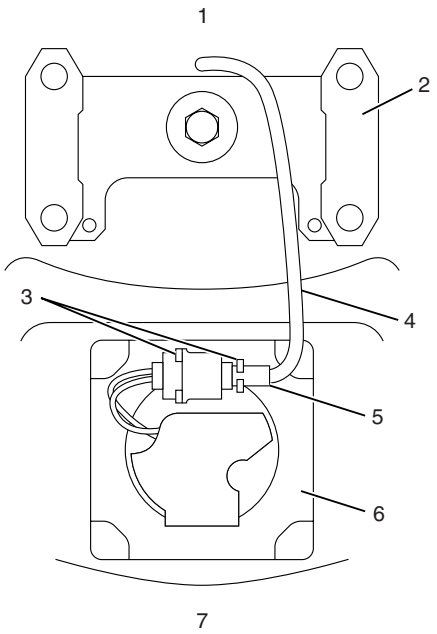
3. Disconnect the 2-pole airbag harness connector (yellow) and horn harness located in the back of SRS airbag and remove the airbag.



Legend
1. Airbag harness connector

Installation

1. Connect the 2-pole airbag harness connector (yellow) and horn connector located in the back of SRS airbag.
2. Secure the connector and harness.



N9A0046E

Legend

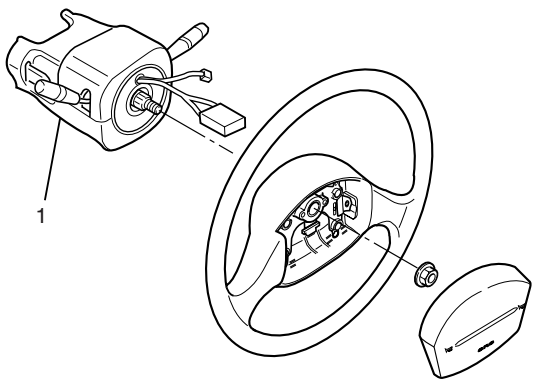
1. Front of steering wheel
2. Steering wheel
3. Connector holder portion
4. Airbag harness
5. Connector
6. Back side of SRS airbag
7. Forward direction of SRS airbag

3. Install the SRS airbag to steering wheel and tighten the bolt.

Tighten:
Bolt to 8.0 ± 2.0 N·m (0.8 ± 0.2 kg·m / 5.9 ± 1.5 lb·ft)

WARNING:
DO NOT USE SRS AIRBAG OF OTHER VEHICLE OR MODEL. BE SURE TO CONFIRM THE PART NUMBER TO USE APPROPRIATE SRS AIRBAG.

4. Resume the function of SRS. (Refer to “Procedure to resume the function of SRS” in “SRS System Assembly”.)



N9A0047E

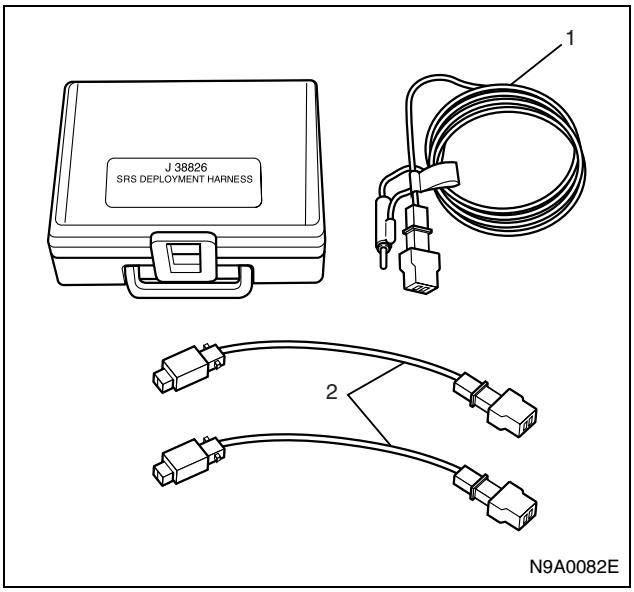
Legend

1. SRS coil and combination switch

Special Tool

5-8840-2468-0 SRS airbag deployment tool

When deploying undeployed SRS airbag, the following SRS airbag deployment tool (5-8840-2468-0) must be used.

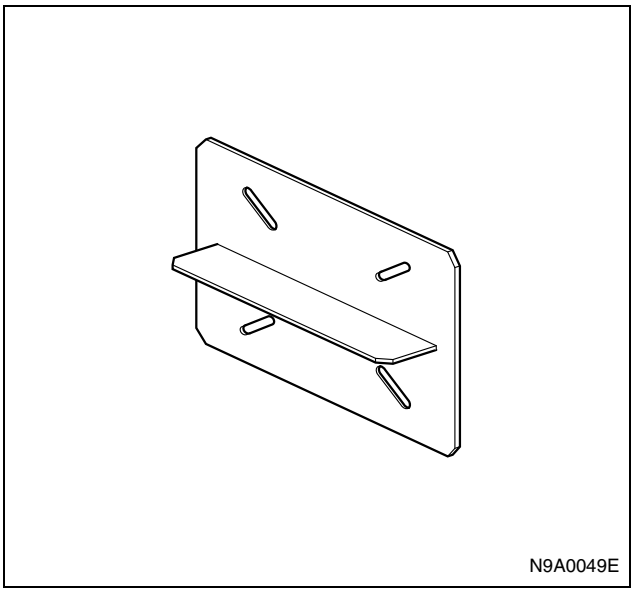


Legend

1. SRS airbag deployment harness
2. 2-pole extension cord

5-8840-2420-0 SRS deployment mounting tool

When deploying undeployed SRS airbag, SRS deployment mounting tool (5-8840-2420-0) must be used.



Steering Wheel

Precautions on Service Work

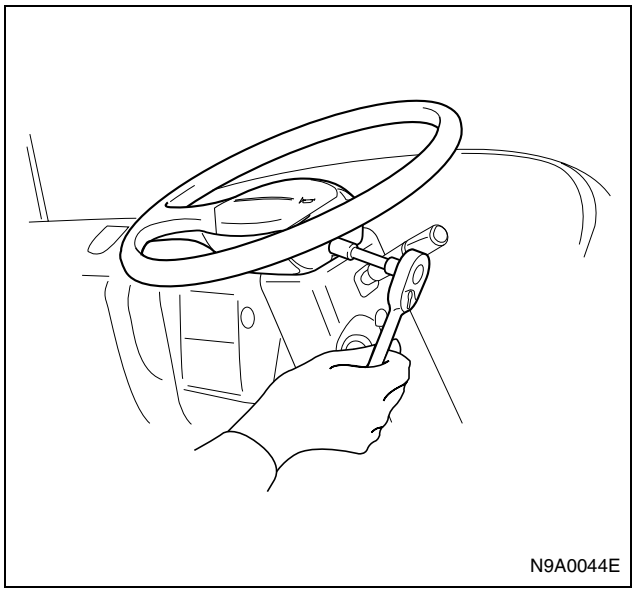
WARNING:
FOLLOW PRECAUTIONS ABOUT SAFETY WHEN HANDLING DEPLOYED SRS AIRBAG ASSEMBLY. METAL SURFACE OF SRS AIRBAG ASSEMBLY WILL BE VERY HOT DIRECTLY AFTER DEPLOYMENT. DO NOT TOUCH IT FOR 30 MINUTES AFTERWARD. DO NOT PUT THE DEPLOYED SRS AIRBAG ASSEMBLY NEAR FLAMMABLE MATERIALS. FAILURE TO FOLLOW THIS MAY CAUSE FIRE OR INJURY. IF THE DEPLOYED SRS AIRBAG ASSEMBLY NEEDS TO BE MOVED BEFORE IT COOLS DOWN, WEAR GLOVES AND GRASP THE SRS AIRBAG OR TRIM COVER TO MOVE.

WARNING:
WHEN CARRYING UNDEPLOYED SRS AIRBAG ASSEMBLY, BE SURE TO TURN THE TRIM COVER TOWARD OUTSIDE TO REDUCE THE POSSIBILITY OF INJURY IN CASE OF AIRBAG DEPLOYMENT. ALSO, NEVER GRASP THE HARNESS OR CONNECTOR OF SRS AIRBAG TO CARRY IT.
WHEN STORING UNDEPLOYED SRS AIRBAG ASSEMBLY, OR LEAVE IT UNATTENDED ON WORKBENCH OR SOMEWHERE ELSE, BE SURE TO TURN THE TRIM COVER UPWARD TO REDUCE THE POSSIBILITY OF INJURY IN CASE OF AIRBAG DEPLOYMENT.

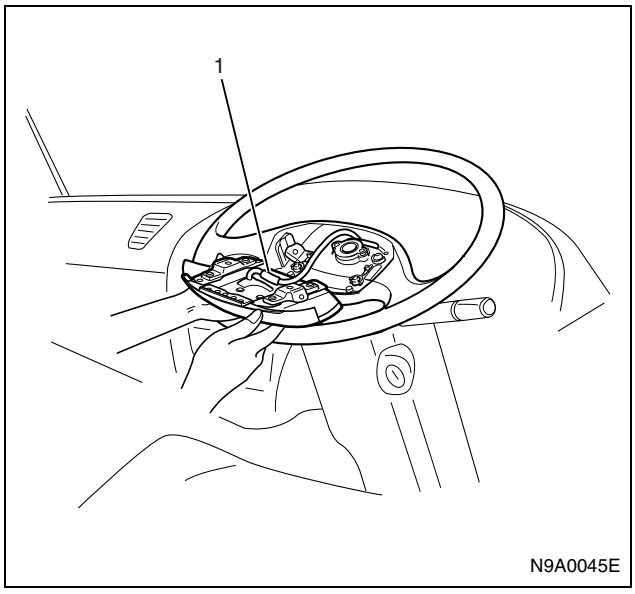
Caution:
If deployment occurs, replace the coil assembly.

Removal

1. Stop the function of SRS. (Refer to “Procedure to stop the function of SRS”.)
2. Loosen the mounting bolt from the back of steering wheel assembly using TORX® driver or equivalent to remove SRS airbag assembly.


N9A0044E

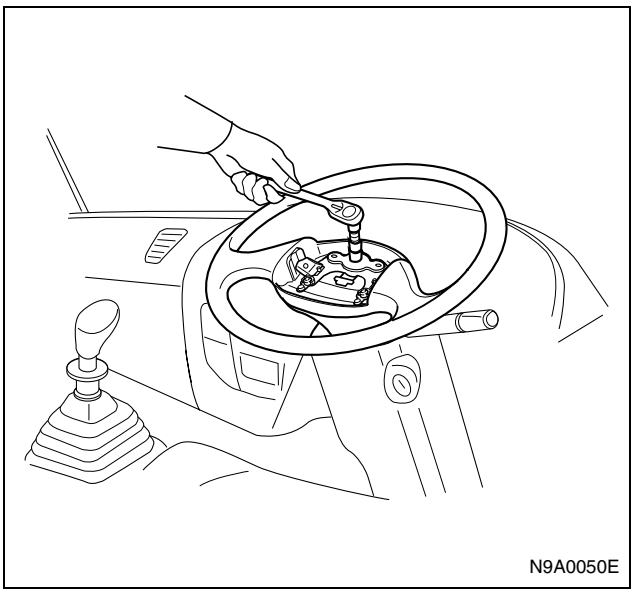
3. Disconnect the 2-pole connector (yellow) and horn harness located in the back of airbag assembly and remove the airbag.



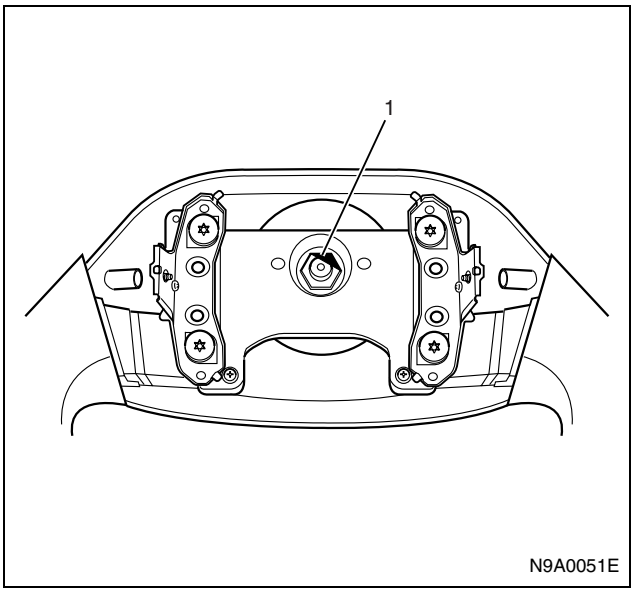
N9A0045E

Legend
1. Airbag harness connector

4. Remove the nut which installs steering wheel.



5. Put the setting marks on steering wheel and shaft in order to reassemble parts to the original position.



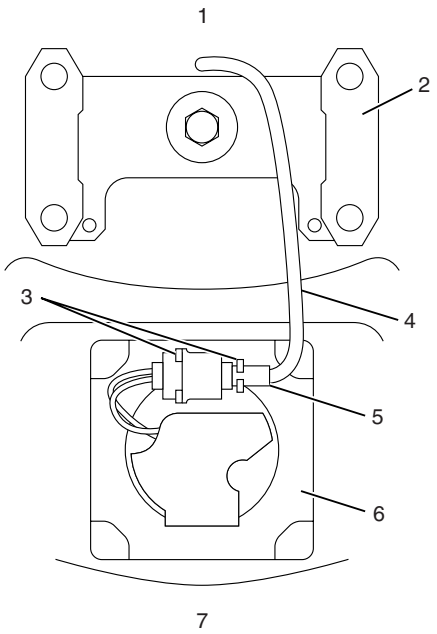
Legend
1. Setting mark

6. Set tires in straight position before removing steering wheel. Install the steering wheel puller (5-8840-2035-0) to steering wheel and remove it.
7. After removing the cover of harness through hole, put wire into wheel to remove steering wheel.

Caution:
Steering shaft has function as shock absorber. Do not apply a force in the direction of steering wheel shaft. When removing the steering wheel, use special tool.

Installation

1. Make sure that tires are in the straight position.
2. While checking the engagement in canceller of flasher, install steering wheel straight and align the setting marks.



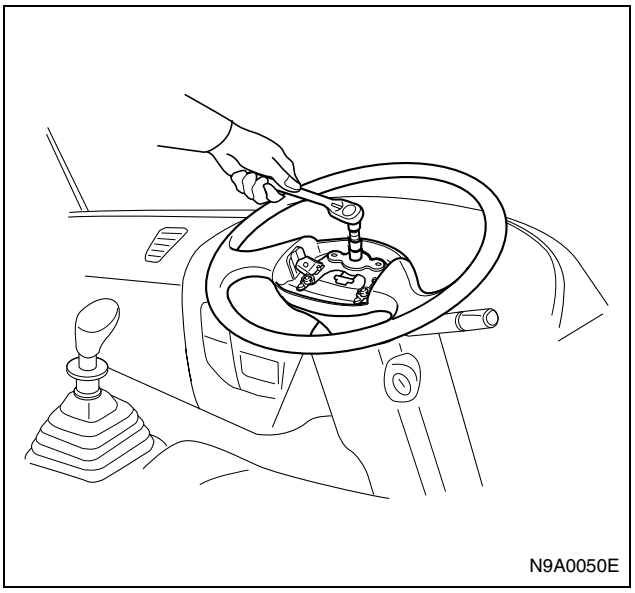
N9A0046E

Legend

1. Front of steering wheel
2. Steering wheel
3. Connector holder portion
4. Airbag harness
5. Connector
6. Back side of SRS airbag
7. Forward direction of SRS airbag

3. Tighten the mounting nut which installs steering wheel to the specified torque.

Tighten:
Nut to 42.0 ± 6.8 N·m (4.3 ± 0.7 kg·m / 31.0 ± 5.0 lb·ft)



N9A0050E

4. Put the harness through the harness through hole and assembly the cover.
5. Connect the 2-pole connector (yellow) and horn harness located in the back of SRS airbag.
6. Secure the connector and harness.
7. Install the SRS airbag to steering wheel and tighten the bolt to the specified torque.

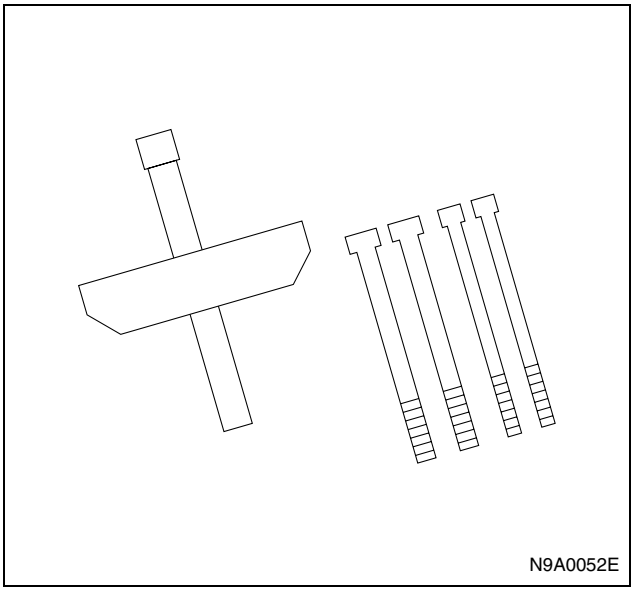
Tighten:
Bolt to 8.0 ± 2.0 N·m (0.8 ± 0.2 kg·m / 5.9 ± 1.5 lb·ft)

WARNING:
NEVER USE SRS AIRBAG OF OTHER VEHICLE. BE SURE TO CONFIRM THE PART NUMBER TO USE APPROPRIATE SRS AIRBAG.

8. Resume the function of SRS. (Refer to “Procedure to resume the function of SRS”.)

Special tool

5-8840-2035-0 Steering wheel puller


N9A0052E

SRS Coil Assembly

Precautions on Service Work

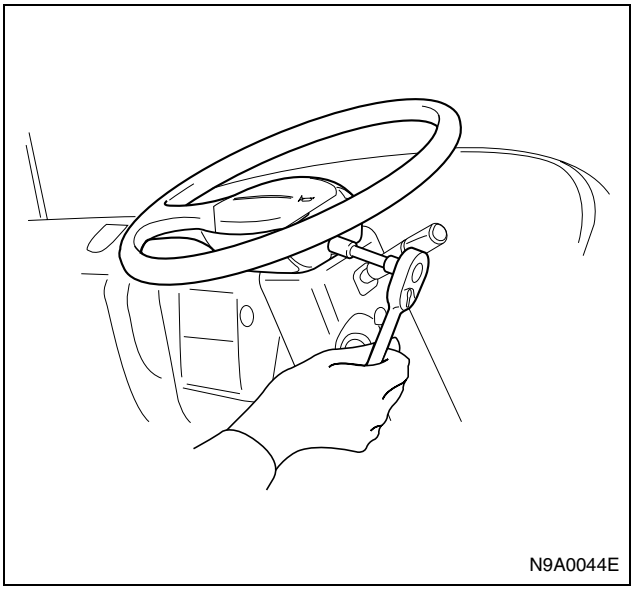
WARNING:
FOLLOW PRECAUTIONS ABOUT SAFETY WHEN HANDLING DEPLOYED SRS AIRBAG ASSEMBLY. METAL SURFACE OF SRS AIRBAG ASSEMBLY WILL BE VERY HOT DIRECTLY AFTER DEPLOYMENT. DO NOT TOUCH IT FOR 30 MINUTES AFTERWARD. DO NOT PUT THE DEPLOYED SRS AIRBAG ASSEMBLY NEAR FLAMMABLE MATERIALS. FAILURE TO FOLLOW THIS MAY CAUSE FIRE OR INJURY. IF THE DEPLOYED SRS AIRBAG ASSEMBLY NEEDS TO BE MOVED BEFORE IT COOLS DOWN, WEAR GLOVES AND GRASP THE SRS AIRBAG OR TRIM COVER TO MOVE.

WARNING:
WHEN CARRYING UNDEPLOYED SRS AIRBAG ASSEMBLY, BE SURE TO TURN THE TRIM COVER TOWARD OUTSIDE TO REDUCE THE POSSIBILITY OF INJURY IN CASE OF AIRBAG DEPLOYMENT. ALSO, NEVER GRASP THE HARNESS OR CONNECTOR OF SRS AIRBAG TO CARRY IT.

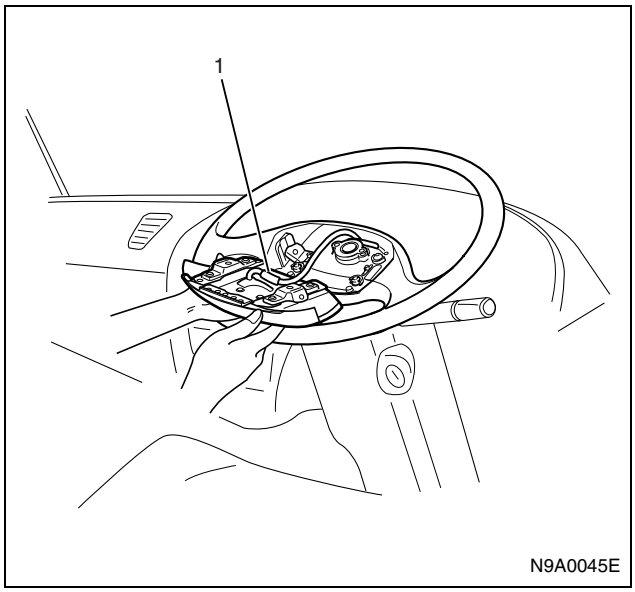
Caution:
If deployment occurs, replace the SRS coil assembly.

Removal

1. Stop the function of SRS. (Refer to “Procedure to stop the function of SRS” in “SRS System Assembly”.)
2. Loosen the mounting bolt from the back of steering wheel using TORX® driver or equivalent to remove SRS airbag.

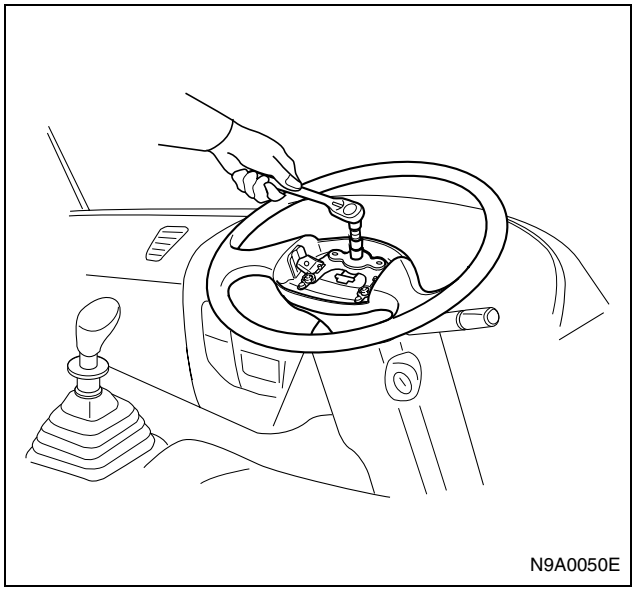


3. Disconnect the 2-pole airbag harness connector (yellow) and horn harness located in the back of SRS airbag assembly and remove the SRS airbag.

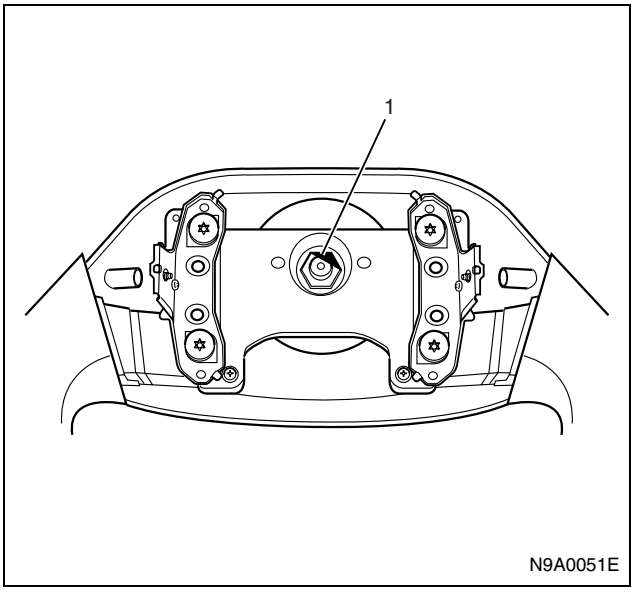


Legend
1. Airbag harness connector

4. Remove the nut which installs steering wheel.



5. Put the setting marks on steering wheel and shaft in order to reassemble parts to the original position.

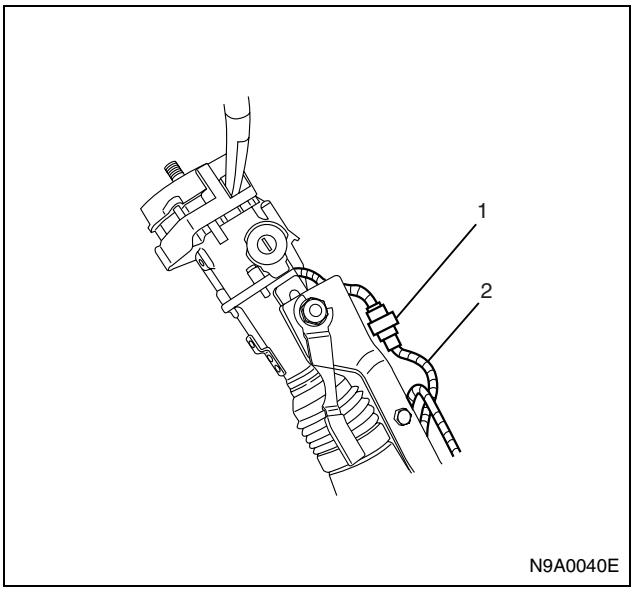


Legend
1. Setting mark

6. Set tires in straight position before removing steering wheel. Install the steering wheel puller (5-8840-2035-0) to steering wheel and remove it.
7. After removing the cover of harness through hole, put wire into wheel to remove it.

Caution:
Steering shaft has function as shock absorber. Do not apply a force in the direction of steering wheel shaft. When removing the steering wheel, use special tool.

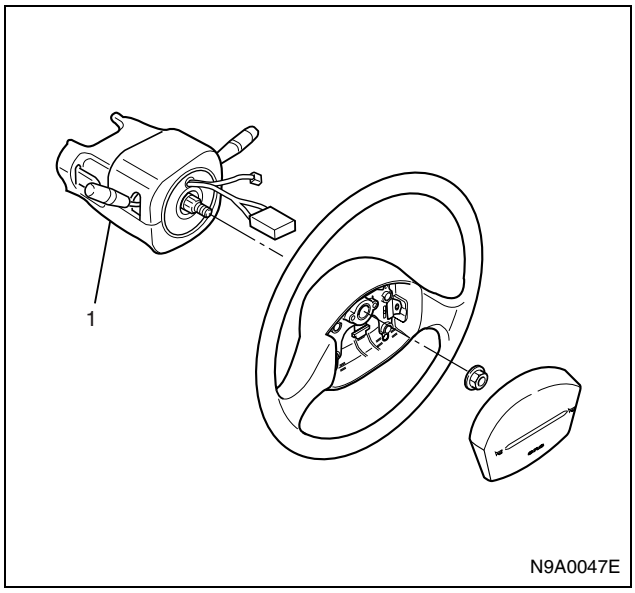
8. Remove the steering cowl.
9. Disconnect SRS harness connector and combination switch harness connector located in the lower portion of steering column.



Legend
1. Connector (yellow)
2. SRS coil harness (yellow)

10. Remove the combination switch.

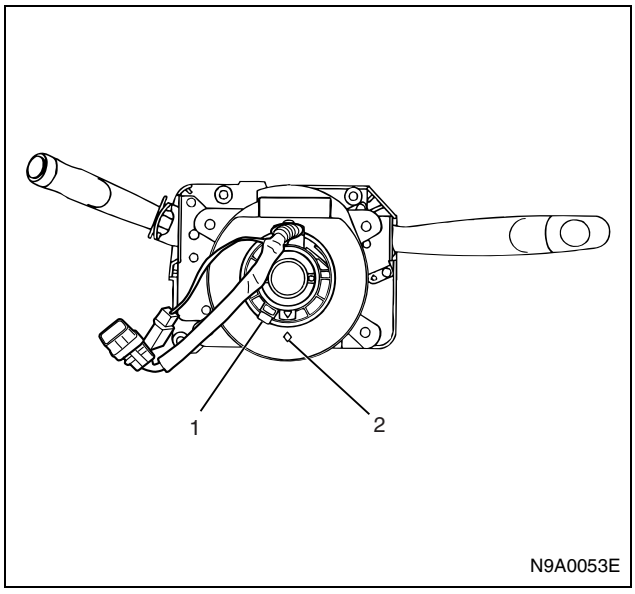
Caution:
Combination switch contains SRS coil assembly. When replacing SRS coil assembly, always replace the combination switch assembly as a unit.



Legend
1. SRS coil and combination switch

Installation

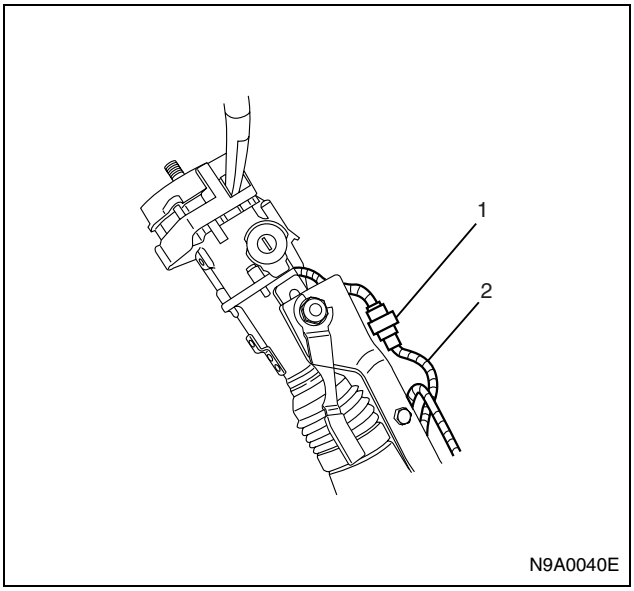
1. Set the steering wheel in the straight position.
2. Install the combination switch assembly.
3. Rotate the SRS coil clockwise fully and back off it about 4 rotations to align neutral mark. (Rotating is not necessary when assembling new SRS coil with lock pin.)



Legend
1. Lock pin
2. Neutral mark

Caution:
- While rotating the SRS coil clockwise fully, stop rotating if resistance is felt. Additional rotation by force may lead to damage or disconnection on SRS coil cable.
- More than 3 rotations from neutral point in each direction lead to damage on SRS coil.

4. Install the combination switch.
5. Connect SRS harness connector (yellow) and combination switch harness connector located in the lower portion of steering column.



Legend
1. Connector (yellow)
2. SRS coil harness (yellow)

6. Install the steering cowl.

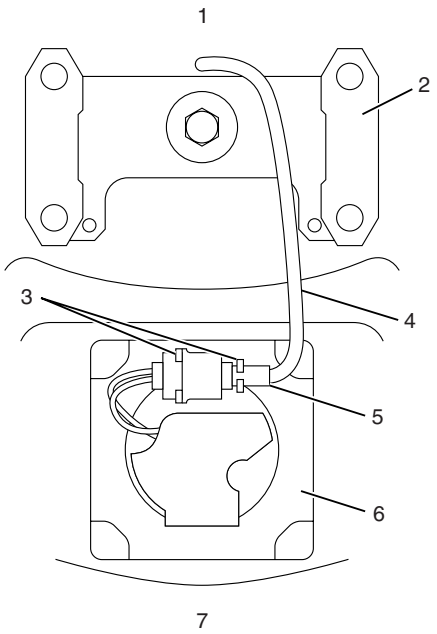
Caution:
When installing steering cowl, assemble carefully not to let wire hang up on starter switch, combination switch or SRS coil.

7. Make sure that tires are in the straight position.
8. While checking the engagement in canceller of flasher, install steering wheel straight and align the setting marks.
9. Tighten the mounting nut which installs steering wheel to the specified torque.

Tighten:
Nut to 42.0 ± 6.8 N·m (4.3 ± 0.7 kg·m / 31.0 ± 5.0 lb·ft)

10. For new combination switch (including SRS coil) with lock pin, pull the lock pin in front to bend.
11. Put the harness through the harness through hole and assembly the cover.
12. Connect the 2-pole connector (yellow) and horn harness located in the back of SRS airbag assembly.
13. Secure the connector and harness.
14. Install the SRS airbag to steering wheel and tighten the bolt to the specified torque.

Tighten:
Bolt to 8.0 ± 2.0 N·m (0.8 ± 0.2 kg·m / 5.9 ± 1.5 lb·ft)



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Legend

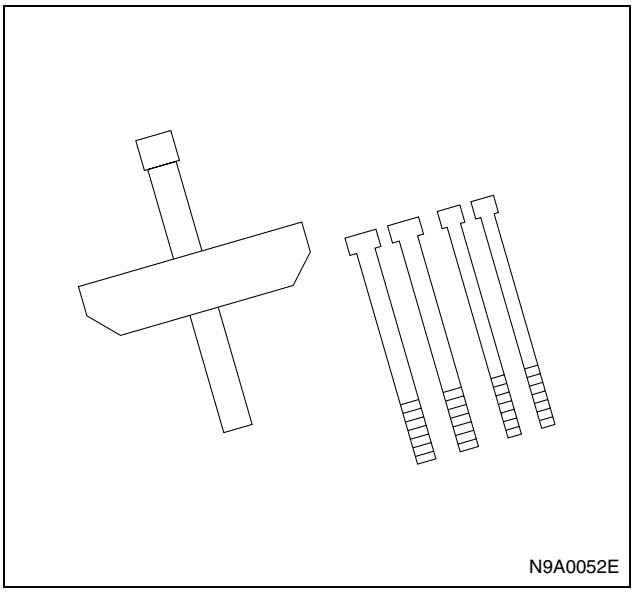
1. Front of steering wheel
2. Steering wheel
3. Connector holder portion
4. Airbag harness
5. Connector
6. Back side of SRS airbag
7. Forward direction of SRS airbag

WARNING:
DO NOT USE SRS AIRBAG OF OTHER VEHICLE OR MODEL. BE SURE TO CONFIRM THE PART NUMBER TO USE APPROPRIATE SRS AIRBAG.

15. Resume the function of SRS. (Refer to “Procedure to resume the function of SRS” in “SRS System Assembly”.)

Special Tool

5-8840-2035-0 Steering wheel puller



N9A0052E

Steering Column

Precautions on Service Work

WARNING:
FOLLOW PRECAUTIONS ABOUT SAFETY WHEN HANDLING DEPLOYED SRS AIRBAG ASSEMBLY. METAL SURFACE OF SRS AIRBAG ASSEMBLY WILL BE VERY HOT DIRECTLY AFTER DEPLOYMENT. DO NOT TOUCH IT FOR 30 MINUTES AFTERWARD. DO NOT PUT THE DEPLOYED SRS AIRBAG ASSEMBLY NEAR FLAMMABLE MATERIALS. FAILURE TO FOLLOW THIS MAY CAUSE FIRE OR INJURY. IF THE DEPLOYED SRS AIRBAG ASSEMBLY NEEDS TO BE MOVED BEFORE IT COOLS DOWN, WEAR GLOVES AND GRASP THE SRS AIRBAG OR TRIM COVER TO MOVE.

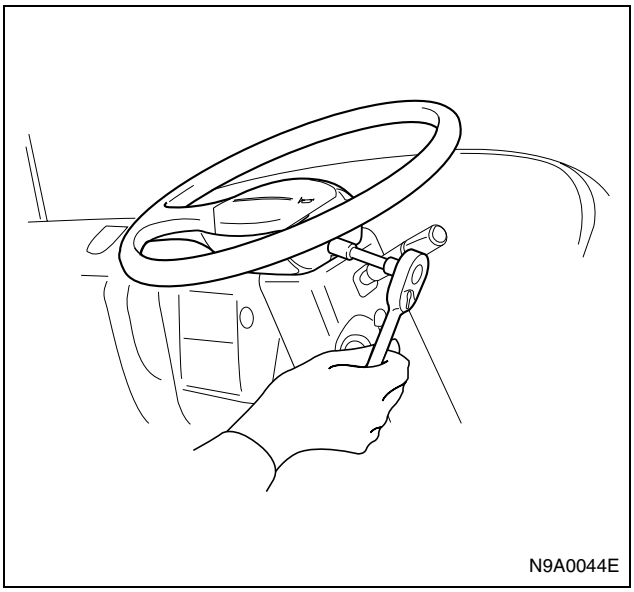
WARNING:
WHEN CARRYING UNDEPLOYED SRS AIRBAG ASSEMBLY, BE SURE TO TURN THE TRIM COVER TOWARD OUTSIDE TO REDUCE THE POSSIBILITY OF INJURY IN CASE OF AIRBAG DEPLOYMENT. ALSO, NEVER GRASP THE HARNESS OR CONNECTOR OF SRS AIRBAG TO CARRY IT.

WHEN STORING UNDEPLOYED SRS AIRBAG ASSEMBLY, OR LEAVE IT UNATTENDED ON WORKBENCH OR SOMEWHERE ELSE, BE SURE TO TURN THE TRIM COVER UPWARD TO REDUCE THE POSSIBILITY OF INJURY IN CASE OF AIRBAG DEPLOYMENT.

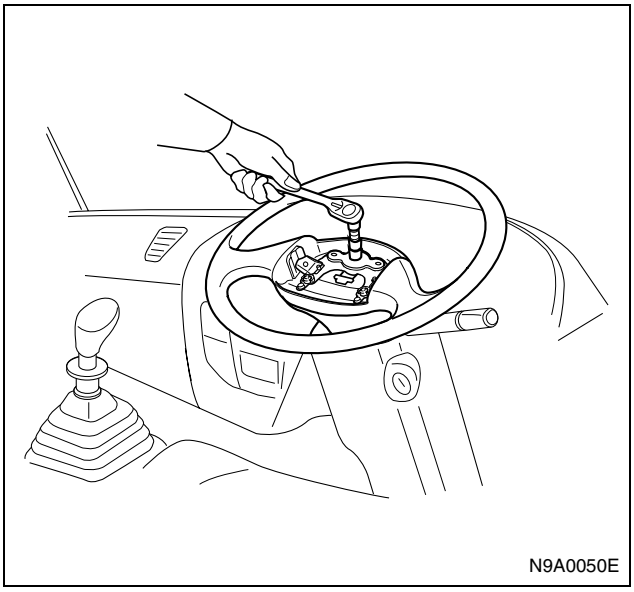
Caution:
If deployment occurs, replace the coil assembly.

Removal

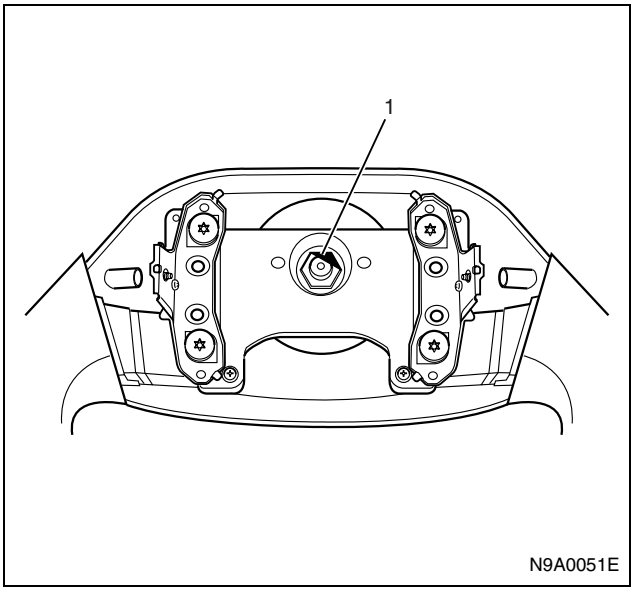
1. Stop the function of SRS. (Refer to “Procedure to stop the function of SRS”.)
2. Loosen the mounting bolt from the back of steering wheel using TORX® driver or equivalent to remove SRS airbag.


N9A0044E

3. Disconnect the 2-pole connector (yellow) and horn harness located in the back of SRS airbag and remove the SRS airbag.
4. Remove the nut which installs steering wheel.


N9A0050E

5. Put the setting marks on steering wheel and shaft in order to reassemble parts to the original position.

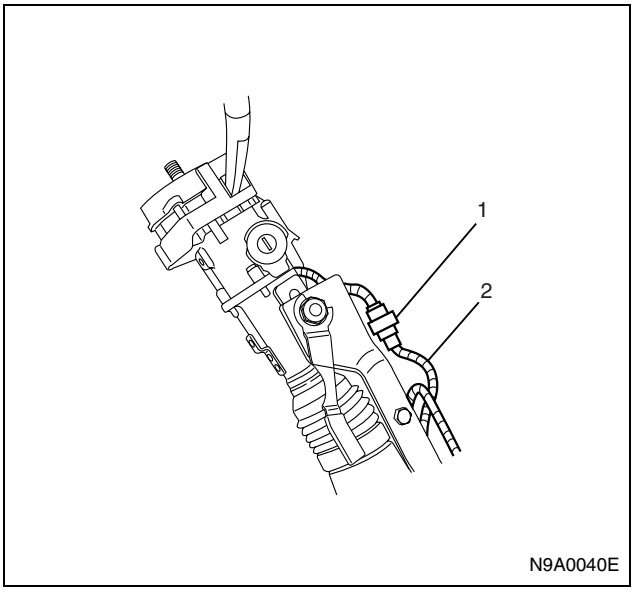


Legend
1. Setting mark

6. Set tires in straight position before removing steering wheel. Install the steering wheel puller (5-8840-2035-0) to steering wheel and remove it.
7. After removing the cover of harness through hole, put wire into wheel to remove it.

Caution:
Steering shaft has function as shock absorber. Do not apply a force in the direction of steering wheel shaft. When removing the steering wheel, use special tool.

8. Remove the steering cowl.
9. Disconnect SRS harness connector (yellow) and combination switch harness connector located in the lower portion of steering column.

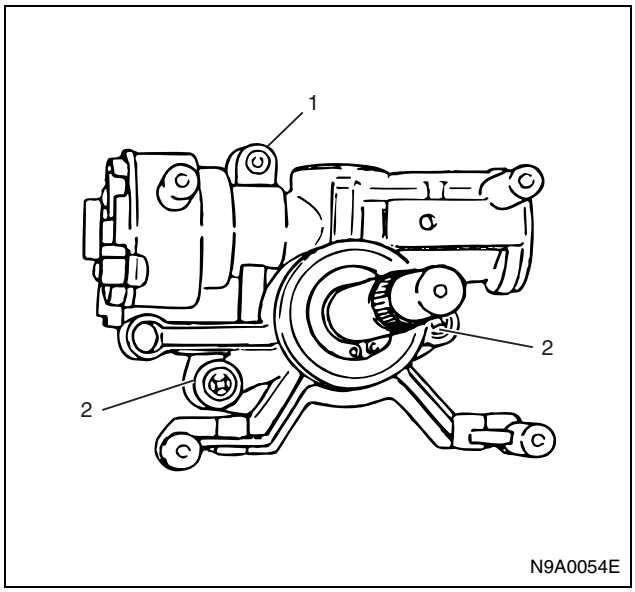


Legend
1. Connector (yellow)
2. SRS coil harness (yellow)

10. Remove the combination switch assembly together with SRS coil.

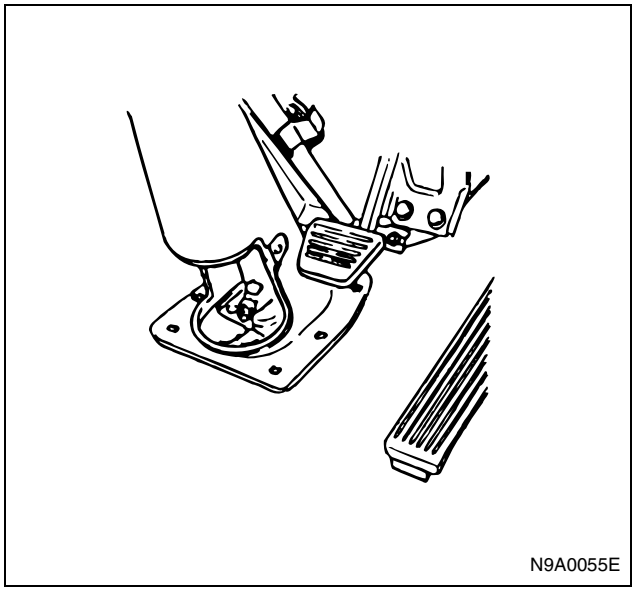
Caution:
Combination switch contains SRS coil assembly. When replacing SRS coil assembly, always replace the combination switch assembly as a unit.

11. Make a small cut on screw of steering lock assembly using a saw, loosen the screw, remove the snap ring, and then remove the steering lock assembly.

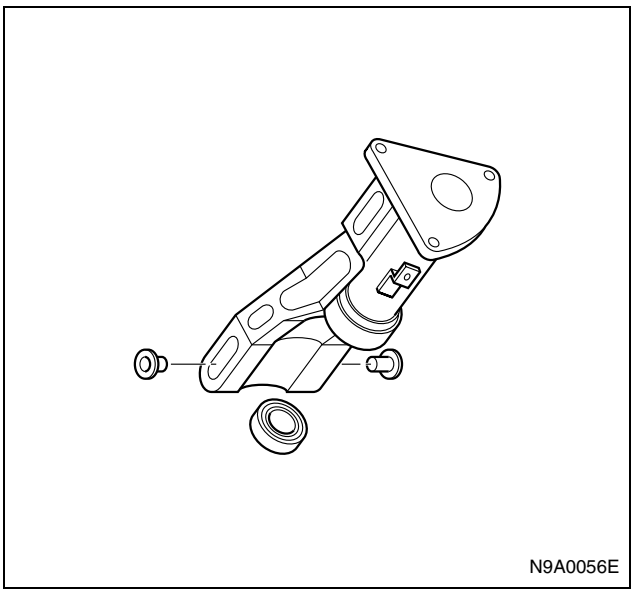


Legend
1. Snap ring
2. Screw

12. Remove the sight glass, put alignment marks on steering shaft and universal joint yoke, and then remove tilt control.

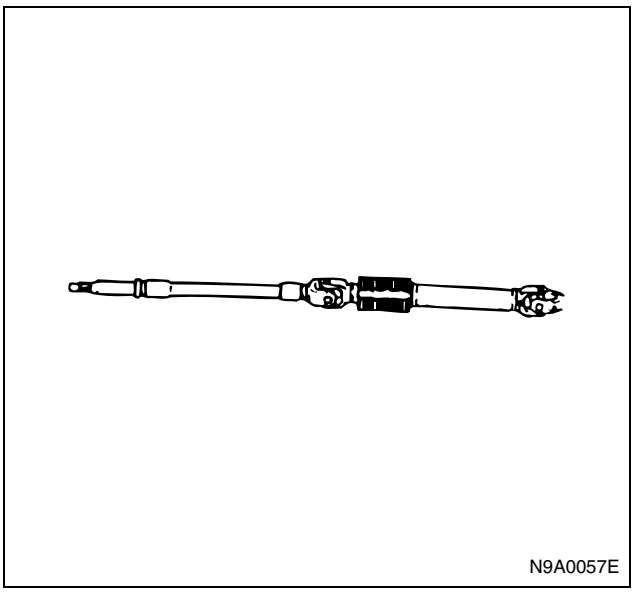


13. Pull out the steering shaft from column and remove the steering column.
    Put alignment marks on the spline shaft and steering shaft and then disassemble them.

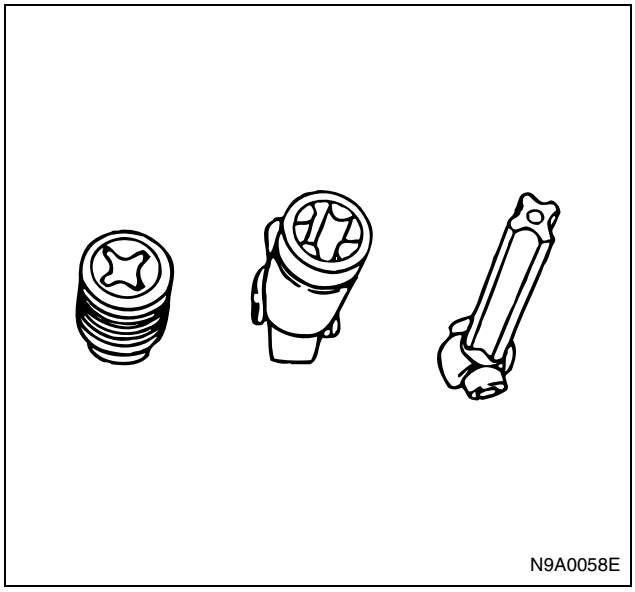

N9A0056E

14. Clean disassembled parts and check them.
    Steering shaft
    - Check for bent.
    - Check the universal joint yoke for crack or deformation.
    - Check the joint bearing for play.

Caution:
Universal joint is non-disassembled part.


N9A0057E

Spline shaft
- Check for play in rotational direction against steering shaft.
- Check the joint for play.
- Check the boot for breakage or deterioration.

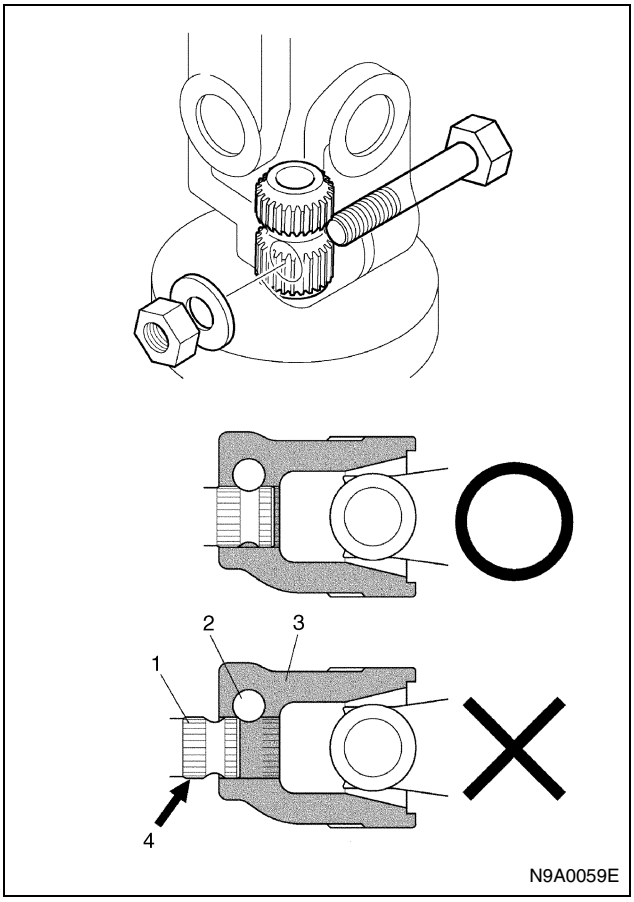

N9A0058E

Installation

1. Install the steering column.
2. By aligning the alignment marks put at disassembly, assemble the steering shaft to install.
   By aligning the alignment marks put at disassembly, install the steering shaft to steering unit and tighten the key bolt to the specified torque.

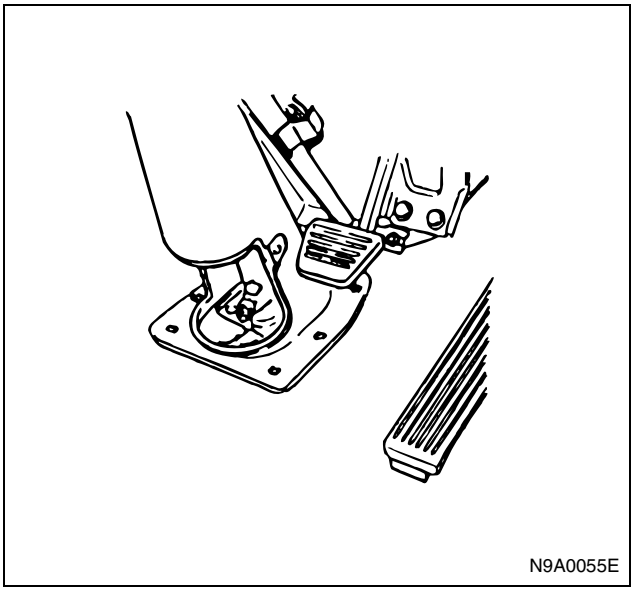
Tighten:
Bolt to 25 ± 5 N·m (2.5 ± 0.5 kg·m / 18.4 ± 3.7 lb·ft)

Caution:
Align the yoke so that the universal mounting bolt comes through the groove of the shaft of steering unit, angle gear box or transfer gear. The mounting bolt must be inserted and tightened after yoke is positioned. (Do not install the yoke after the bolt is temporarily tightened.) After yoke is secured, check that the serration portion is not seen.



Legend

1. Serration shaft
2. Bolt hole
3. Yoke
4. Yoke is not inserted sufficiently if serration can be seen.



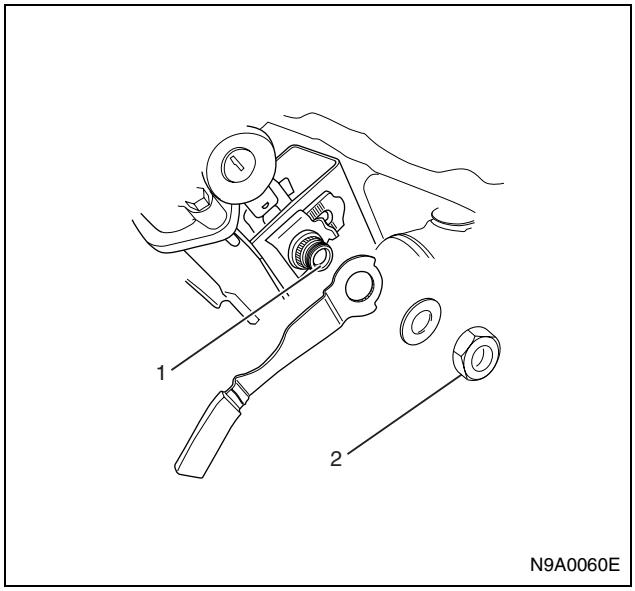
3. Tighten the nut on bottom of tilt control, which installs steering column support bracket, and nut on outside of tilt control to the specified torque.

Tighten:
Nut (bottom) to 13.5 ± 1.5 N·m (1.4 ± 0.2 kg·m / 10.0 ± 1.1 lb·ft)

Tighten:
Nut (outside) to 32.5 ± 2.5 N·m (3.3 ± 0.3 kg·m / 24.0 ± 1.8 lb·ft)

Install the lever to lock position and tighten the nut to the specified torque.

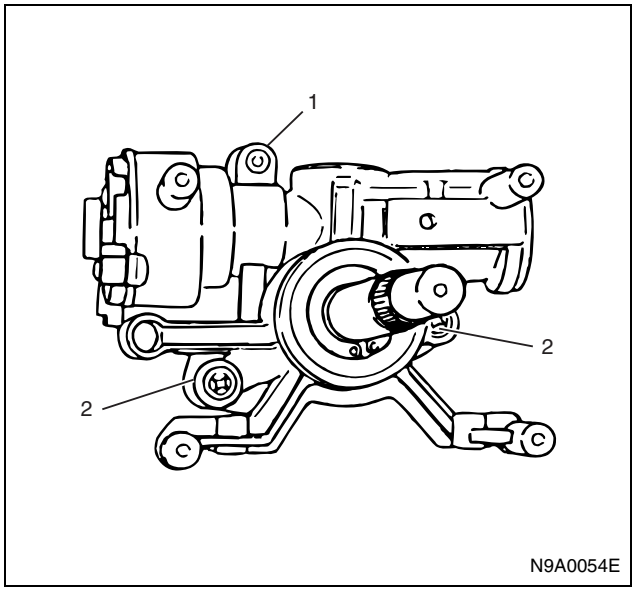
Tighten:
Nut to 22 N·m (2.2 kg·m / 16.2 lb·ft)



Legend

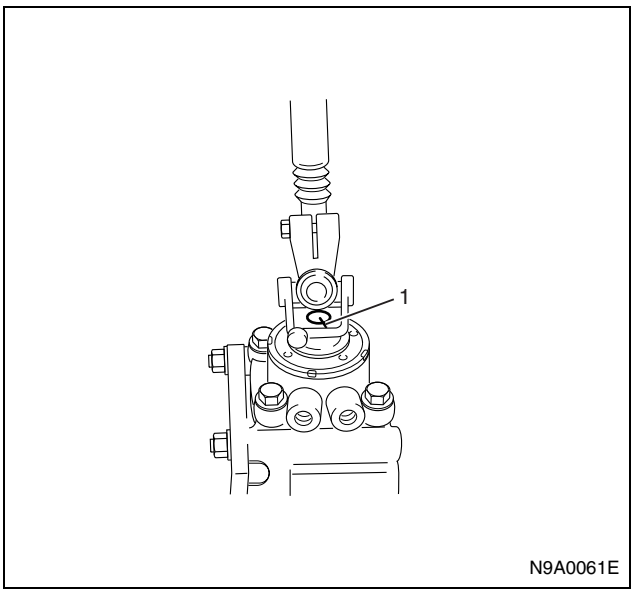
1. Steering column support bracket mounting nut
2. Nut

4. Install the steering lock assembly and insert the snap ring securely.
   Use new screw at this time.



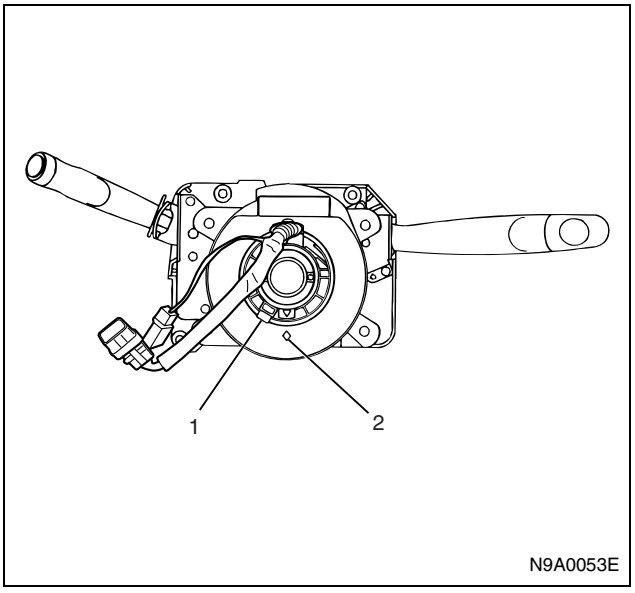
Legend
1. Snap ring
2. Screw

5. Set the steering wheel in the straight position.
6. Install the combination switch assembly (including SRS coil).



Legend
1. Alignment mark

7. Rotate the SRS coil clockwise fully and back off it about 4 rotations to align neutral mark.
   (Rotating is not necessary when assembling new SRS coil with lock pin.)

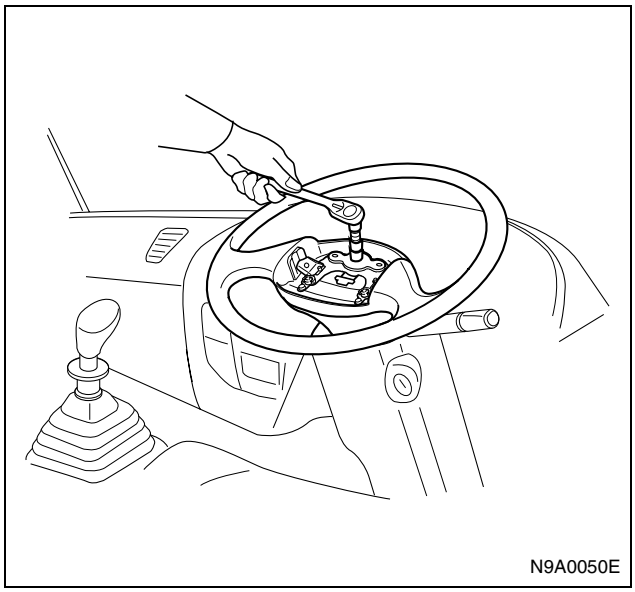


Legend
1. Lock pin
2. Neutral mark

Caution:
- While rotating the SRS coil clockwise fully, stop rotating if resistance is felt. Additional rotation by force may lead to damage or disconnection on SRS coil cable.
- More than 3 rotations from neutral point in each direction lead to damage on SRS coil.

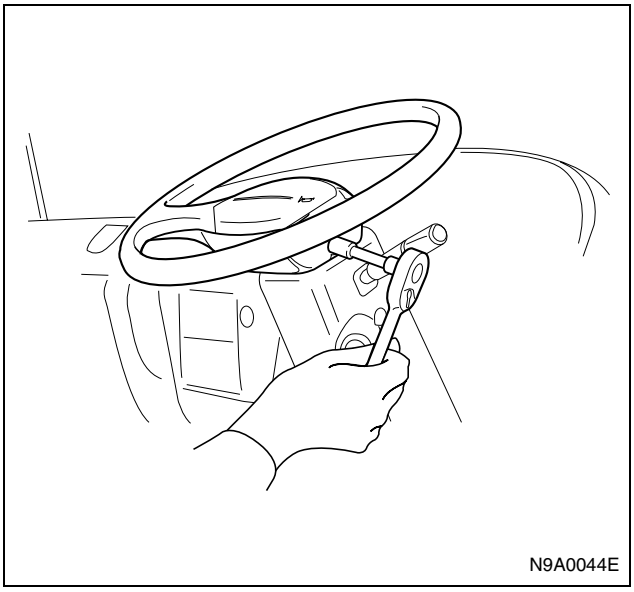
8. Connect SRS harness connector (yellow) and combination switch harness connector located in the lower portion of steering column.
9. Make sure that tires are in the straight position.
10. While checking the engagement in canceller of flasher, install steering wheel straight and align the setting marks.
11. Tighten the mounting nut which installs steering wheel to the specified torque.

Tighten:
Nut to 42 ± 6.8 N·m (4.3 ± 0.7 kg·m / 31.0 ± 5.0 lb·ft)



12. For new combination switch (including SRS coil) with lock pin, pull the lock pin in front to bend.
13. Put the harness through the harness through hole and assembly the cover.
14. Connect the 2-pole connector (yellow) and horn harness located in the back of airbag assembly.
15. Secure the connector and harness.
16. Install the airbag to steering wheel and tighten the bolt to the specified torque.

Tighten:
Bolt to 8.0 ± 2.0 N·m (0.8 ± 0.2 kg·m / 5.9 ± 1.5 lb·ft)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WARNING:
DO NOT USE SRS AIRBAG OF OTHER VEHICLE OR MODEL. BE SURE TO CONFIRM THE PART NUMBER TO USE APPROPRIATE SRS AIRBAG.

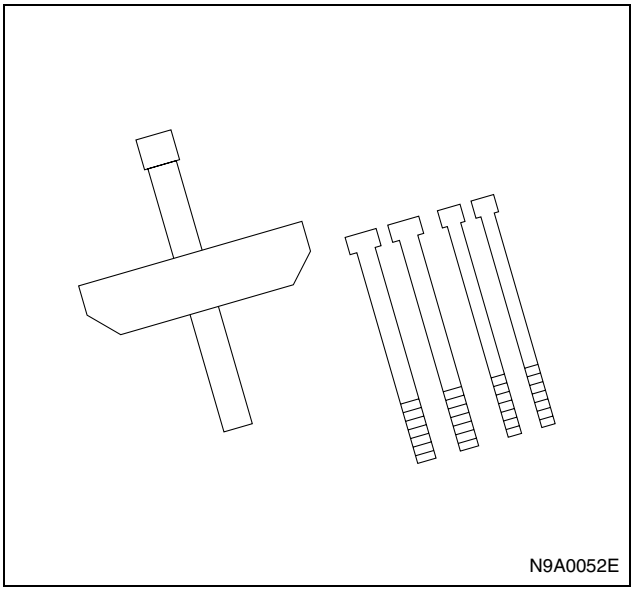
17. Install the steering cowl.

WARNING:
WHEN INSTALLING STEERING COWL, ASSEMBLE CAREFULLY NOT TO LET WIRE HANG UP ON STARTER SWITCH, COMBINATION SWITCH OR SRS COIL.

18. Resume the function of SRS. (Refer to “Procedure to resume the function of SRS”.)

Special tool

5-8840-2035-0 Steering wheel puller


N9A0052E

SEAT BELT, SRS AIRBAG

SECTION 9C

SRS CONTROL SYSTEM

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SRS Control System

Precautions on Service Work

WARNING:
WHEN SERVICING SRS SYSTEM PARTS (SRS CONTROL UNIT, AIRBAG, HARNESS, ETC.) OR ITS CIRCUMFERENCE, STOP TEMPORARILY THE FUNCTION OF SRS ACCORDING TO THE PROCEDURE. FAILURE TO FOLLOW THE PROCEDURE MAY CAUSE INJURY DUE TO SRS AIRBAG DEPLOYMENT OR UNNECESSARY REPAIR.

Turn the starter switch to “LOCK” at first. Then, disconnect the battery or remove the fuse which sends power to SRS control unit. After that, do not perform the work at least 15 seconds since airbag may be deployed. In the service procedure, remove “SRS fuse” and detach SRS airbag from deployment circuit to prevent SRS airbag from unnecessary deploying. If removing SRS airbag from deployment circuit according to “Procedure to stop the function of SRS” in this topic, service work can be performed immediately without waiting for 15 seconds.

About tools

WARNING:
WHEN SERVICING SRS, DO NOT USE ELECTRICAL TEST EQUIPMENT EXCEPT ONES DESCRIBED IN THIS MANUAL TO AVOID DEPLOYMENT OF SRS AIRBAG. FAILURE TO FOLLOW THIS MANUAL MAY CAUSE INJURY DUE TO UNNECESSARY DEPLOYMENT OF SRS AIRBAG.

Familiarize yourself with use of Tech 2, SRS substitute load (5-8840-2421-0), Connector test adapter kit (5-8840-0385-0), DMM (digital multi-meter, 5-8840-0366-0), to be able to measure voltage and resistance.

Necessary repair and inspection after collision

- If the parts of this system are damaged, replacement is needed. If mounting portion of SRS parts are damaged, replacement is needed.
- Never use system parts of other vehicle.
- Do not disassemble or repair SRS control unit, SRS coil assembly or SRS airbag. These parts must be replaced with new ones.
- Confirm the part number to make sure that replacement SRS parts are legitimate.

WARNING:
DO NOT USE SRS AIRBAG OF OTHER VEHICLE OR MODEL. BE SURE TO CONFIRM THE PART NUMBER TO USE APPROPRIATE SRS AIRBAG.

Caution:
Always replace the SRS coil with combination switch assembly, since the SRS coil assembly is supplied as an item in the combination switch.

Caution:
After repair and replacement, set back the SRS airbag to the correct specification so that it is operated properly. It is necessary to replace SRS control unit and SRS airbag, and inspect the dimension of steering column. If the mounting bracket of SRS control unit are damaged clearly, replacement is needed. Besides, the dimension of steering column should be inspected regardless of SRS airbag deployment.

Replacement and Inspection of Parts After Collision with Deployment

If front collision with airbag deployment occurs, following system parts must be replaced. It is necessary to check whether SRS coil assembly is damaged.

- SRS airbag assembly
- SRS control unit
- Combination switch assembly (including SRS coil)

Caution:
Refer to “Replacement guideline for SRS control unit” described later for important information about replacement of SRS control unit after collisions with deployment and without.

- Inspect SRS coil assembly harness and connector for burn due to excessive heat, dissolution or damage. If damaged, replace it. Refer to “SRS System Assembly” in SRS section.

Inspection of Parts After Collision with or Without Deployment

The certain parts of this system and supplemental restraint system should be inspected regardless of SRS airbag deployment. The parts to be inspected are shown as follows.

- Steering column: inspect the dimension according to “Examination of damage for steering column” described in “SRS System Assembly” in SRS section.
- Steering support bracket: inspect for distortion, bent, crack or other damage.
- Instrument panel bracket: inspect for distortion, bent, crack or other damage.
- Seat belt and its mounting portion: refer to “Seat Belt” section.

Replacement Guideline for SRS Control unit

If collision with SRS airbag deployment occurs, replacement of SRS control unit is needed. If “SRS” warning lamp illuminates, perform SRS diagnosis according to “Function check: SRS system check”.

Damaged Harness

If the SRS harness is damaged, it must be replaced.

Damaged SRS Connector (Case and Terminal)

If the connector or terminal of SRS harness (except lead wire) is damaged, replace it.

Damaged Lead wire of SRS Part

If the lead wire of parts for SRS airbag, combination switch assembly (including SRS coil assembly), etc. is damaged, replace all the parts (including lead wire).

Procedure to stop the function of SRS

Removal

Turn the starter switch to "LOCK", and remove the key.

1. Disconnect the SRS fuse from the fuse box on the upper right portion of dashboard or disconnect terminal of battery.
2. Remove the 2-pole connector (yellow) located in the lower portion of steering column. (for SRS airbag)

Caution:
When removing SRS fuse and turn starter switch to ON, SRS warning lamp remains on. This is normal condition.

Procedure to Resume the Function of SRS

Installation

WARNING:
DO NOT USE SRS AIRBAG OF OTHER VEHICLE OR MODEL. BE SURE TO CONFIRM THE PART NUMBER TO USE APPROPRIATE SRS AIRBAG.

Turn the starter switch to "LOCK", and remove the key.

1. Connect the 2-pole connector (yellow) located in the lower portion of steering column and confirm that it is connected securely.
2. Install the "SRS fuse" to fuse box on the upper right portion of dashboard.

Turn the starter switch to "ON", and confirm that the "SRS" warning lamp goes off after it blinks seven times. If the "SRS" warning lamp does not operate in that way, perform "Function check: SRS system check".

Precautions on Handling/Installation/Diagnosis

1. Do not expose SRS airbag to temperature of 93°C (199°F) or more.
2. If SRS airbag and SRS control unit are dropped down with some sort of reason, do not use them.
3. If disconnecting connectors related to SRS airbag and SRS control unit during repair, be sure to make sure that they are connected completely during reassembly.
4. When replacing SRS control unit, install it to mounting surface correctly. Be sure to make sure there is no dust or other foreign matter on mounting surface of SRS control unit.
5. When installing SRS airbag parts, be sure to tighten with specified tightening torque.
6. Do not energize the system unless all SRS system parts are connected, or diagnosis chart requires doing so. If energizing the system, unnecessary diagnostic trouble code will be set in SRS control unit.
7. Never diagnose the circuit using other than specified tester.
8. At first, perform "SRS system check".
   "SRS system check" checks whether "SRS" warning lamp operates properly and proceeds to appropriate chart to judge the function fault of system. Failure to perform this procedure leads to longer diagnosis period, wrong diagnosis or replacement of wrong part.

About Terms

SRS airbag

This is expansion-type cloth cushion designed to be deployed on frontal collision above a certain impact. SRS airbag reduces an impact on occupant's head and trunk and supplements the protection by seat belts.

B+

Battery voltage (B+)

Warning lamp bulb check

When no function fault is detected after starter switch is turned to "ON" position, "SRS" warning lamp blinks seven times and goes off.

"Constant diagnosis"

Fault diagnosis is constantly performed by SRS control unit as long as "Ignition A" voltage is within the range of specified operating voltage of the unit.

Diagnostic connector (16-pin)

This is a connector to communicate with Tech 2.

Deployment

This means expansion of airbag.

Deployment circuit

This is a circuit which sends current to SRS airbag assembly to deploy SRS airbag.

Diagnostic trouble code (DTC)

This is number used by SRS control unit to identify the trouble in SRS function. (Self-diagnosis code)

Current supply for driver's seat

This is output of SRS control unit to send current to driver's airbag assembly circuit during "Ignition device resistance test".

EEPROM

This is an electrically erasable programmable read only memory. This is a memory which can store contents without power on SRS control unit.

Ignition device

This is electric ignition device to combust gas generating agent of inflator.

Specified operating voltage range

This is voltage range from 18 to 32 V measured between “Ignition A” terminal and “Ground” terminal of SRS control unit.

Tech 2

This is diagnostic equipment to read diagnostic information from SRS control unit via diagnostic connector.

SRS control unit

This supplies backup current to deployment circuit and deploy airbag if necessary. Also it diagnoses all the SRS parts.

Serial data

This is Tech 2 information which indicates SRS operating condition.

SRS

This means supplemental restraint system.

SRS coil assembly

This is device to maintain successive continuity on deployment circuit for SRS airbag and allow steering wheel to rotate.

SRS harness

These are harnesses and connectors to connect SRS parts electrically.

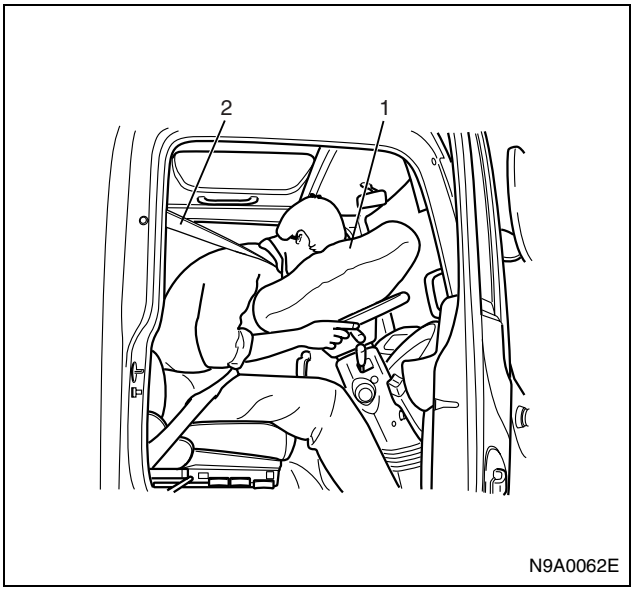
Initial diagnosis

These are tests for SRS, performed by SRS control unit on the following conditions: after starter switch is “ON”, immediately after “Ignition A” voltage is energized by SRS control unit, or before “Constant diagnosis”. (performed within 6 seconds after starter switch is “ON”)

Description of Function and Operation

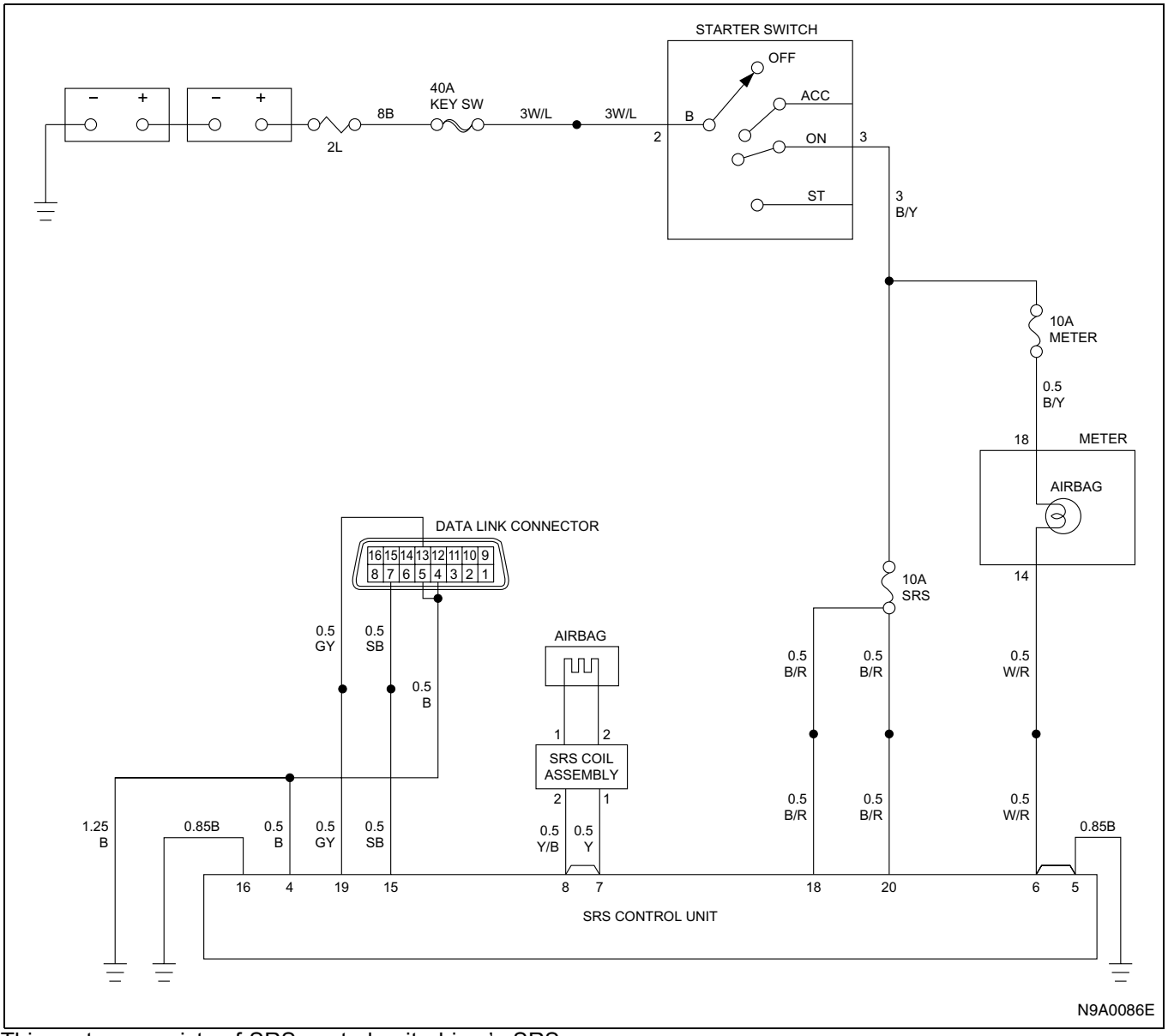
SRS Airbag System

SRS airbag supplements the driver’s seat belt protection by deploying airbag at the top center of the steering column.
SRS airbag deploys in case of front collision over certain degree of impact.



Legend

1. Deployed airbag
2. Seat belt



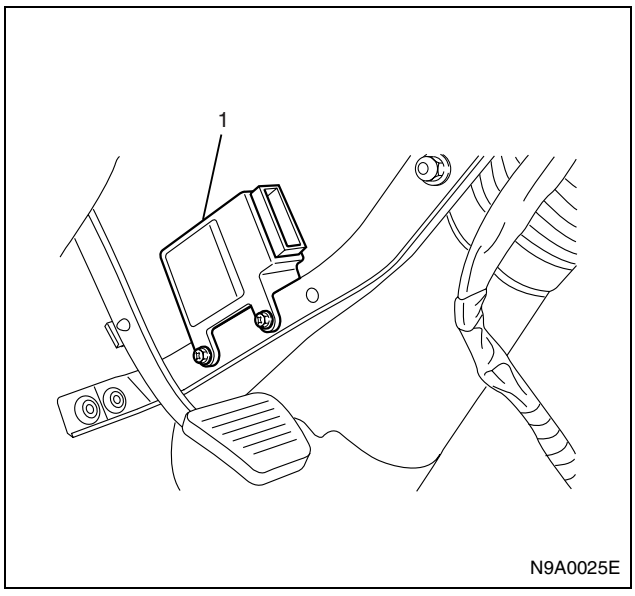
This system consists of SRS control unit, driver's SRS airbag, SRS coil assembly, exclusive wire harness, and "SRS" warning lamp in the meter and forms a deployment circuit.

A sensor is equipped to this circuit to convert the impact into an electrical signal in case of front collision over certain degree of impact. The electrical signal generated at this time will be processed in the SRS control unit to compare with the value stored in the memory.

When the generated signal exceeds the setting value, SRS control unit sends sufficient current to SRS airbag for deployment.

SRS Control Unit

WARNING:
DURING SERVICE WORK, BE CAREFUL NOT TO TAP OR SHAKE THE SRS CONTROL UNIT. ALSO, FAILURE TO INSTALL THE SRS CONTROL UNIT TO VEHICLE PROPERLY MAY LEAD TO MALFUNCTION OF THE UNIT WHEN THE STARTER SWITCH IS TURNED TO ON. THIS MAY RESULT IN INJURY DUE TO SUDDEN DEPLOYMENT OF SRS AIRBAG.



Legend

1. SRS control unit

Following functions are included in the SRS control unit.

1. Energy back-up — SRS control unit builds up the energy necessary to deploy airbag when it lose the ignition voltage during front collision.
2. Front collision detection — SRS control unit monitors the impact and detects the front collision for which airbag must be deployed.
3. SRS airbag deployment — SRS control unit sends sufficient current to the SRS airbag assembly for airbag deployment, when it detects the front collision over certain degree of impact.
4. Function fault detection — SRS control unit diagnoses electrical parts of this system. It set the diagnostic trouble code once it detects function fault.
5. Front collision detection — SRS control unit records information regarding operating conditions of this system during the event of front collision.
6. Function fault diagnostics — SRS control unit displays diagnostic trouble codes (DTC) and operating conditions of the system using Tech 2.
7. Warning to the driver — SRS control unit warns driver of function fault of this system by turning "SRS" warning lamp on.

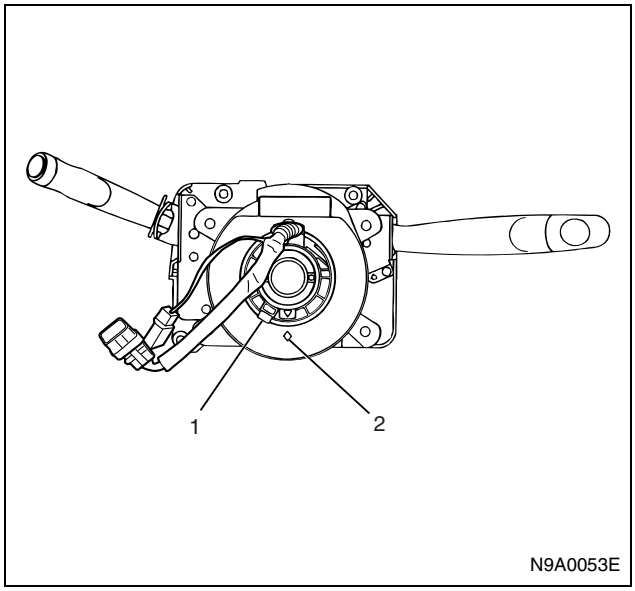
SRS control unit is connected to SRS harness with a 21-pole connector. This harness connector has shorting clip in the contact surface of particular terminal.

"SRS" Warning Lamp

When the starter switch is turned "ON" or "START", SRS control unit controls "SRS" warning lamp as follows.

1. When the starter switch is turned to "ON", it checks "SRS" warning lamp and SRS control unit operations while blinking the "SRS" warning lamp seven times.
2. It warns the driver of function fault in the electrical system of this system. Those function faults may cause undeployment of SRS airbag in the event of front collision, or unnecessary deployment. "SRS" warning lamp tells the driver of function fault of this system. Refer to "SRS system check" for proper operation of warning lamp.

SRS Coil Assembly



Legend

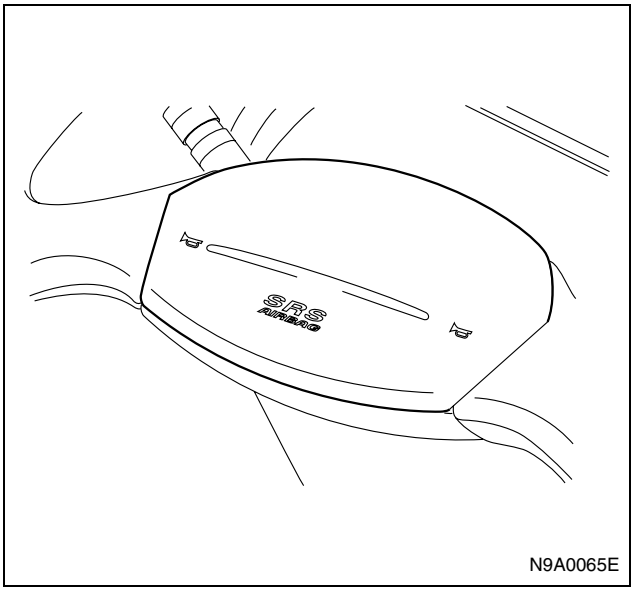
1. Lock pin
2. Neutral mark

SRS coil assembly is installed to the steering column. It maintains successive continuity on deployment circuit for SRS airbag while allowing steering wheel to rotate.

It has shorting clip in the 2-pole connector (yellow) to be connected to the SRS body harness located in the lower portion of steering column.

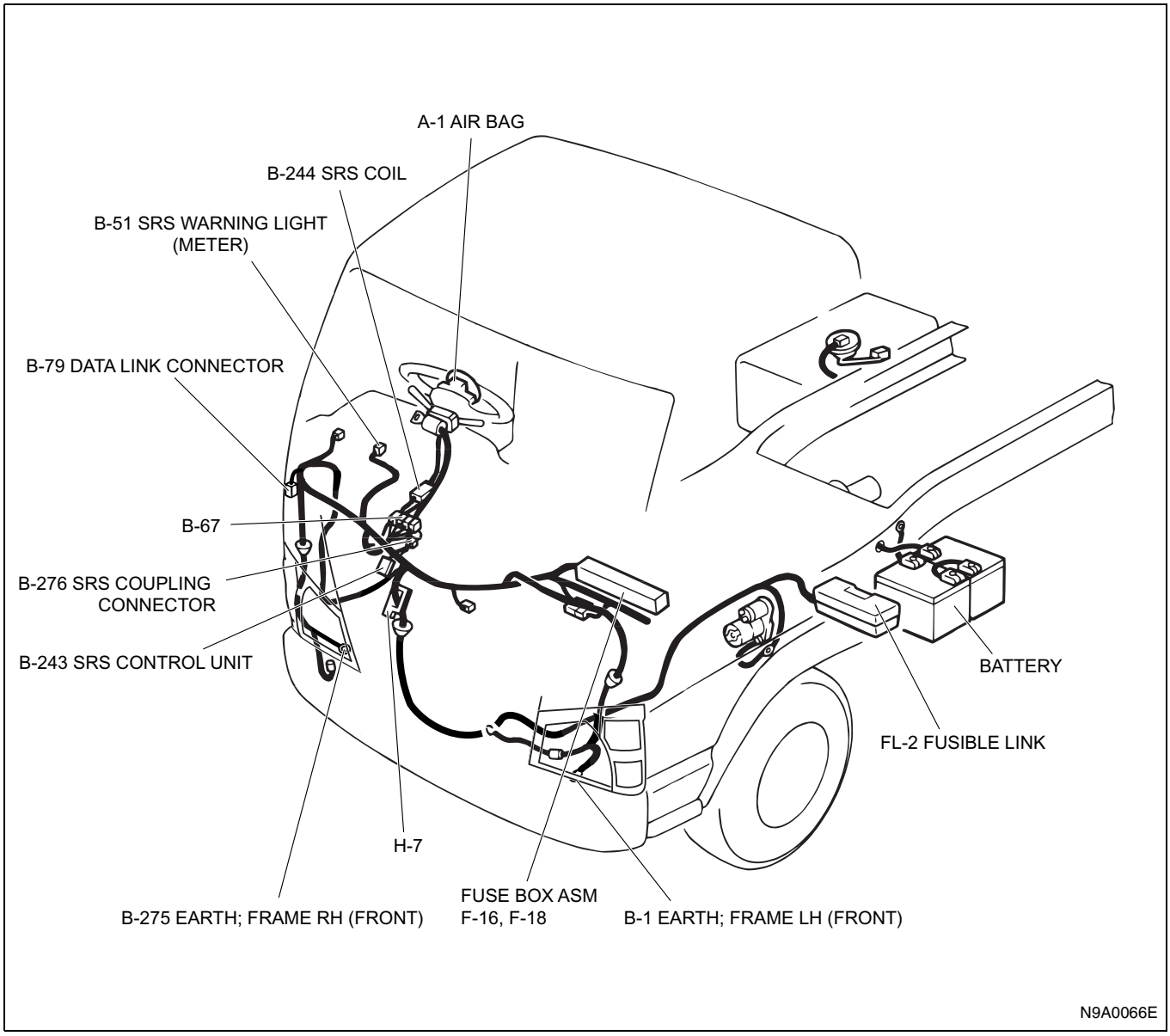
Upon removal of 2-pole connector (yellow), the shorting clip will short the SRS airbag. This prevents unnecessary deployment of SRS airbag when servicing the steering column or other SRS system parts.

SRS airbag assembly

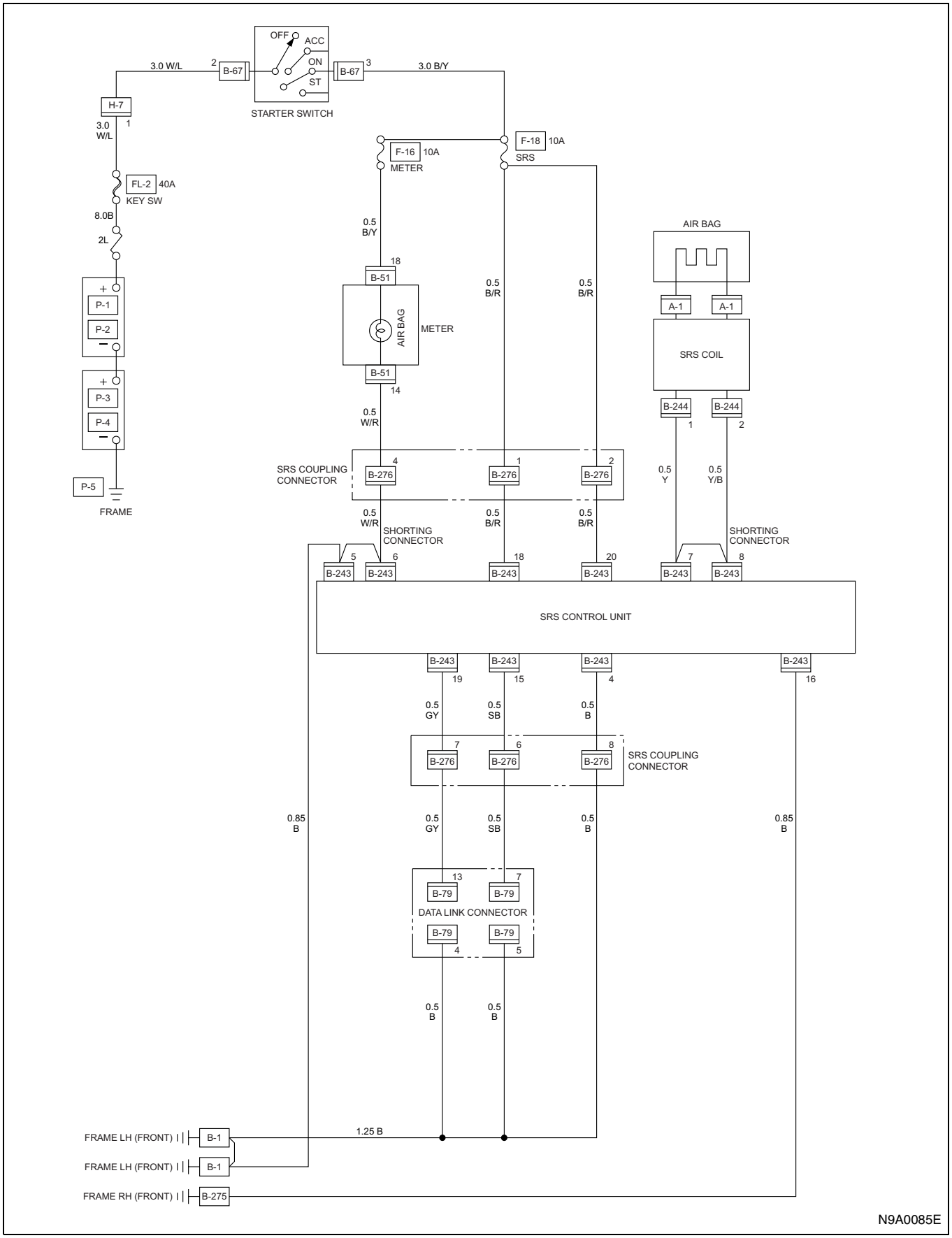


SRS airbag consists of the airbag and the inflator (a can with gas generator agent and a ignition device). SRS control unit sends current to the deployment circuit in the event of front collision over certain degree of impact. Passage of electric current in the inflator will light the gas generator agent in the SRS airbag.
Gas generated in the reaction rapidly inflate the airbag.
A shorting clip is equipped to the SRS airbag. Upon removal of SRS airbag connector, the shorting clip shorts the SRS airbag circuit.
The circuit to SRS airbag is shorted in this manner. This prevents unnecessary deployment of SRS airbag when servicing SRS airbag assembly, steering column or other SRS system parts.

Part Location Diagram



Circuit Diagram



Connector List

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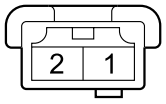
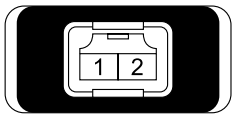
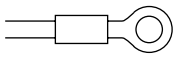
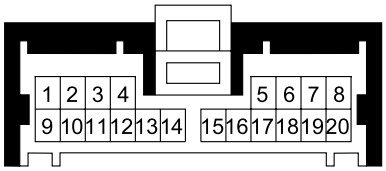
A-1	 002-045
A-1	 002-046
B-1	 000-001
B-51	 020-004
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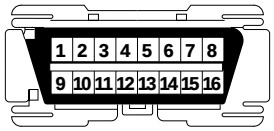
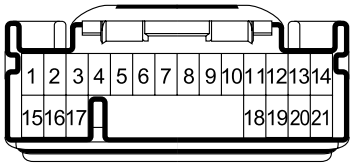
B-67	004-001
B-79	 016-005
B-243	 021-001

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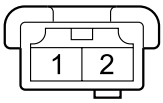
B-244	 002-043
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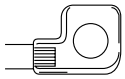
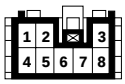
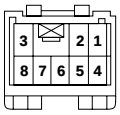
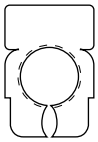
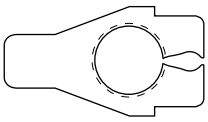
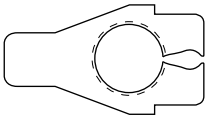
B-275	 000-020
B-276	 008-009
B-276	 008-010
P-1	 000-004
P-2	 000-006
P-3	 000-006

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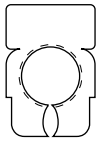
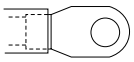
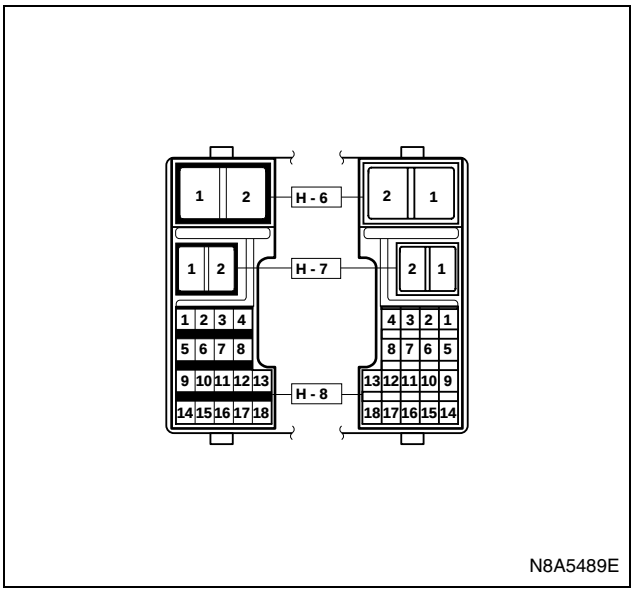
P-4	 000-004
P-5	 000-002

H-7



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Procedure of Trouble Diagnosis

Diagnostic Trouble Code (Self-diagnosis Code)

At first, perform “SRS system check”. “SRS system check” is to check whether “SRS” warning lamp operates properly and confirms SRS diagnostic trouble code (DTC) using warning lamp blinking or Tech 2.

1. Active diagnostic trouble code: Function fault currently detected. Active diagnostic trouble codes are stored in the RAM (Random Access Memory). (Code of current trouble)
2. History diagnostic trouble code: Function fault detected after history memory had been cleared last time. History diagnostic trouble codes are stored in the EEPROM. (Trouble code occurred in the past)

System Diagnostic Method

System diagnostic method is a standardized method to repair all the electric/electronic (E/E) systems. Diagnostic procedure is always used to solve the problem of E/E system and is a starting point when service is required. Procedure of diagnosis is described in the following steps:

1. Confirm a customer’s complaint.
   - It is necessary for technicians to understand the normal operations of the systems to confirm a customer’s complaint.
2. Perform pre-inspection.
   - Perform overall visual check.
   - Review service record.
   - Detect noise or abnormal odor.
   - Collect the diagnostic trouble code information for effective repair.
3. Check service information.
   - This includes video, news letter, etc.

If DTC is Stored

Perform service correctly according to the specified DTC chart.

If there is No DTC

Select symptom from the diagnostic chart according to symptom. Complete the service following diagnostic procedure. You may also perform inspection by referring function diagnosis.

If there is No Applicable Symptom

1. Confirm the complaint in detail.
2. Create diagnostic plan.
3. Use wiring diagram and principle of operation.

Ask for technical support when repair history is available for similar case. Connect technician’s knowledge with the effective usage of available service information.

If there is Intermittent (Intermittent Trouble)

The trouble situation not occurring constantly is called intermittent (intermittent trouble). Perform the following steps to solve the intermittent trouble.

1. Check the DTC information and SRS data.
2. Evaluate symptom and situation explained by the customer.
3. Check the circuits or the electric system components using check sheet or other methods.

If the Trouble is not Detected

In this case, the vehicle is judged as it operates properly. The condition explained by the customer may be the normal condition. Confirm the customer’s complaint comparing with the condition of the vehicle to that of another vehicle. That condition may mean an intermittent trouble. Confirm the complaint in the situation the customer explains before returning the vehicle to the customer.

1. Confirm the complaint again.
   If the complaint can not be fully detected or identified, the vehicle must be diagnosed again. Confirm the complaint one more time. The complaint may be an intermittent trouble as defined in “If there is intermittent”, but it may also be possible that the vehicle is normal.

2. Repair and confirm.
   If the problem is confirmed, repair it. Confirm that the vehicle operates properly and the symptoms are corrected.

   This includes road test or other procedures to confirm that the trouble is solved under following conditions:

   - Confirm by testing in the situation that the customer described.
   - If DTC is diagnosed, while monitoring Tech 2 data, reproduce the situation found when the DTC is set, and confirm the repair.

About Diagnostic Procedure

WARNING:
WHEN SERVICING SRS, DO NOT USE ELECTRICAL TEST EQUIPMENT EXCEPT ONES DESCRIBED IN THIS MANUAL TO AVOID DEPLOYMENT OF SRS AIRBAG. FAILURE TO FOLLOW THIS MANUAL MAY CAUSE INJURY DUE TO UNNECESSARY DEPLOYMENT OF SRS AIRBAG.

The purpose of the diagnostic procedure in this topic is to find SRS problems and repair them. The procedures to find SRS problems quickly and repair effectively is described as follows. Failure to perform this procedure leads to longer diagnosis period, wrong diagnosis or replacement of wrong part.

1. Perform pre-inspection.

Always begin the diagnosis with the followings.

- Perform overall visual check. (Such as improper connection of terminal, wire, etc., trace of water (coffee, juice, etc.) contact with SRS control unit)
- Review service record.
- Detect noise or abnormal odor.

2. Perform “SRS system check”.

“SRS system check” includes whether “SRS” warning lamp operates properly and SRS diagnostic trouble code check using “warning lamp blinking” or “Tech 2”.

3. Refer to appropriate diagnostic chart according to the instruction of “SRS system check”.

Go on to the appropriate chart to diagnose SRS problems with “SRS system check”. Failure to perform this procedure leads to longer diagnosis period, wrong diagnosis or replacement of wrong part.

4. Repeat the “SRS system check” after performing repair and diagnostic procedure.

“SRS system check” after every repair or diagnostic procedure can confirm correct repair work and if other problem exists.

About Diagnostic Code

SRS control unit records troubles occurred in the past after the trouble code had been cleared last time.

1. Active code (trouble code occurring currently)

Troubles currently detected during this ignition cycle. Active codes are stored in the RAM (Random Access Memory).

2. History code (trouble code occurred in the past)

All troubles detected after history trouble memory had been cleared last time.
History codes are stored in EEPROM (Electrically Erasable Programmable Read Only Memory).

Necessary Basic Knowledge

Certain basic knowledge is required before using this topic of the service manual. Absence of this knowledge cause difficulty when using diagnostic procedure in this topic. Be cautious to protect from harmful or unnecessary deployment. Be sure to read and understand every caution on the caution label attached to SRS parts as well as the service manual.

Basic Electrical Circuit

Understand the basic electrical theory including serial and pararel circuits, and understand voltage drop in the series resistance. Understand the meaning of voltage, current (ampere), resistance (ohm), and what happens on the circuit by bare wire or short circuit. You must be able to read and understand wiring diagram.

How to Read Trouble Code

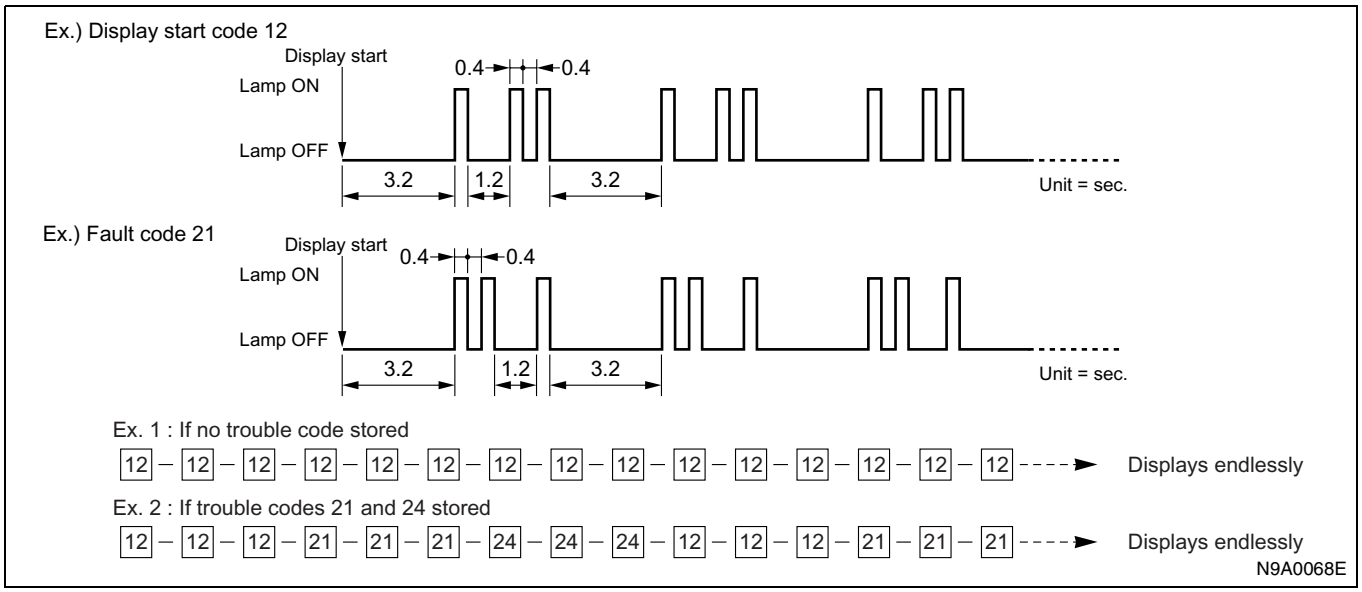
By connecting diagnosis connector, trouble records are displayed by blinking of warning lamp.
Also Tech 2 can read (and clear excluding some code) all codes (current and history codes).

Flash Code Diagnosis

Using SRS warning lamp flash code diagnosis, you can read current code and check if history code exists, but cannot clear the code or read history code. To enable SRS warning lamp flash code diagnosis, short the diagnosis connector terminals No. 4 with No. 13, and turn the starter switch to “ON”.
SRS control unit displays trouble code by blinking “SRS” warning lamp. Before starting blinking mode, it makes the initial lamp off for 1.2 seconds and blinks code “12”. The period of lamp ON and OFF is 0.4 second each, and there is a 1.2-second interval between tens digit and ones digit, and 3.2-second interval between codes. If more than one trouble code are stored, each code is displayed one by one. After all the codes are displayed, they are repeatedly displayed until short circuit is disconnected between diagnosis connector terminals 4 and 13. There are two special codes (code 12 and code 13) in the warning lamp flash code mode. “Code 12” indicates it is in flash display mode. If neither current code nor history code is stored, SRS control unit displays code 12 repeatedly until the connection is removed in the diagnosis connector terminal.
“Code 13” is displayed when history code is detected or when history code is detected but no longer appears as current code. Tech 2 is necessary to read history codes. Normally, keep the diagnosis connector terminals No. 4 and No. 13 disconnected.

If trouble code stored

After displaying the code 12 for three times, the stored trouble code will be displayed for three times.
If more than one trouble code are stored, they are displayed in the ascending order for three times each.
After taking a round, codes are repeatedly displayed starting with code 12. This will last as long as the self-diagnosis connector terminal is kept shorted.



How to clear trouble code

Trouble codes can be cleared only with Tech 2. However, in case DTC 25, 51, 52, 53 or 71 occurs, memory clear cannot be performed. In this occasion, SRS control unit must be replaced.

"Lamp OFF function when replacing SRS control unit"
A function is installed to the system that the lamp will not turn off unless manually turned off using Tech 2 upon completion of all inspection when replacing SRS control unit. By communicating by following the instruction on the display panel in Tech 2, the lamp goes off.
This function allows to confirm if checks are completed.
SRS control unit without this function is also available.

Inspection Standards for SRS airbag system repair

Description		Standard		Standard for parts replacement
		In case of collision	In case of trouble/ periodical inspection	
SRS parts	SRS airbag	❍	❍	• SRS airbag had been deployed by collision. • Pad surface is scratched or cracked. • Connector is chapped or chipped. • Harness is disconnected or wire is exposed.
	SRS control unit	❍	❍	• SRS airbag had been deployed by collision. • SRS control unit body is chapped, cracked, or deformed. • Connector is chapped or chipped. • Result of trouble diagnosis in the service manual indicates to replace SRS control unit. • Water attached to connector adjacent area.
	SRS coil	❍	❍	• SRS airbag had been deployed. • Case body or bracket is chapped, cracked, or deformed. • Result of trouble diagnosis in the service manual indicates to replace parts.
	SRS harness	❍	❍	• Wiring harness in the SRS airbag circuit is open or wire is exposed. • Connector is chapped or chipped. • Result of trouble diagnosis in the service manual indicates to replace parts. • Wheel is out of round.
	Steering wheel	❍		• Bracket is deformed. • New SRS airbag cannot be installed without strain. • When new SRS airbag is installed, pad interferes with steering wheel, or clearance is not uniform.

Description		Standard		Standard for parts replacement
		In case of collision	In case of trouble/ periodical inspection	
Relevant parts	Steering column	❍		• Shaft and shaft support bracket are deformed. • Tilt operation cannot be performed smoothly.
	Instrument panel, crossbeam, cover, etc. Glove box Seat Seat belt Windshield glass	❍		• Dent, bent, chapped, cracked, or deformed. • Replace the seat belt which were used in collusion.
	Counterpart	❍		• If it is dent, bent, chapped, cracked, or deformed, repair or replace with new one. • If installation is loose, tighten the to the specified torque.

Standard

In case of collision: In any case of collision regardless of SRS airbag deployment
In case of trouble: In case trouble code is detected with Tech 2 diagnosis when “SRS” warning lamp does not come on or remains on.

List of Function Checks

Item to be checked	Contents of inspection
SRS system check	Inspection to identify defective point of SRS control system (inspection procedure)
SRS control unit function check (Chart A)	Inspection to identify function fault of SRS control unit (inspection procedure)
“SRS” warning lamp turns on continuously (Chart B)	Check when “SRS” warning lamp turns on continuously when starter switch is turned ON.
“SRS” warning lamp does not come on (Chart C)	Check when “SRS” warning lamp does not come on when starter switch is turned ON.

SRS System Check

Outline

The purpose of the diagnostic procedure in this topic is to find SRS function faults and repair them. For best results, it is important to use diagnostic chart and follow the order indicated as follows.

A. Perform “SRS system check”.

Always begin with “SRS system check” for SRS diagnosis.
“SRS system check” includes whether “SRS” warning lamp operates properly, and whether SRS control unit can communicate via “serial data” line, and if SRS diagnostic trouble code exists.

B. Refer to appropriate diagnostic chart according to the instruction of “SRS system check”.

Go on to the appropriate chart to diagnose SRS function fault with “SRS system check”. Failure to perform this procedure leads to longer diagnosis period, wrong diagnosis or replacement of wrong part.

C. Repeat “SRS system check” after performing repair and diagnostic procedure.

“SRS system check” after every repair or diagnostic procedure can confirm correct repair work and if other function fault exists.

Description of Circuit

Once the starter switch is turned to “ON”, ignition voltage is applied from “SRS fuse” to “Ignition A” input terminal “20” and “Ignition B” input terminal “18” of SRS control unit. SRS control unit executes tests related to SRS, and “SRS” warning lamp responds by blinking seven times.

Cautions at Each Step of “SRS System Check”

(Numbers below indicate step numbers in the system check.)

1. Turn the starter switch to “ON”, and check that the “SRS” warning lamp blinks seven times.
2. Check that the “SRS” warning lamp goes off after it blinks seven times.
3. This test is to check whether “serial data” line operates properly. Also, it detects whether history trouble codes are stored, and confirms the code if stored.
4. This test is to check whether “serial data” line operates properly. Also, it confirms the stored history trouble codes, and confirms whether those are current code or history code.

Point of Diagnosis

Order is very important to diagnose diagnostic trouble code. Be sure to diagnose in the specified order. Failure to do so leads to longer diagnosis period, wrong diagnosis or replacement of wrong part.

Diagnostic Aid

The intermittent “SRS” warning lamp illumination may be caused by poor contact, worn wire insulation or disconnection in insulation. Check for following conditions:

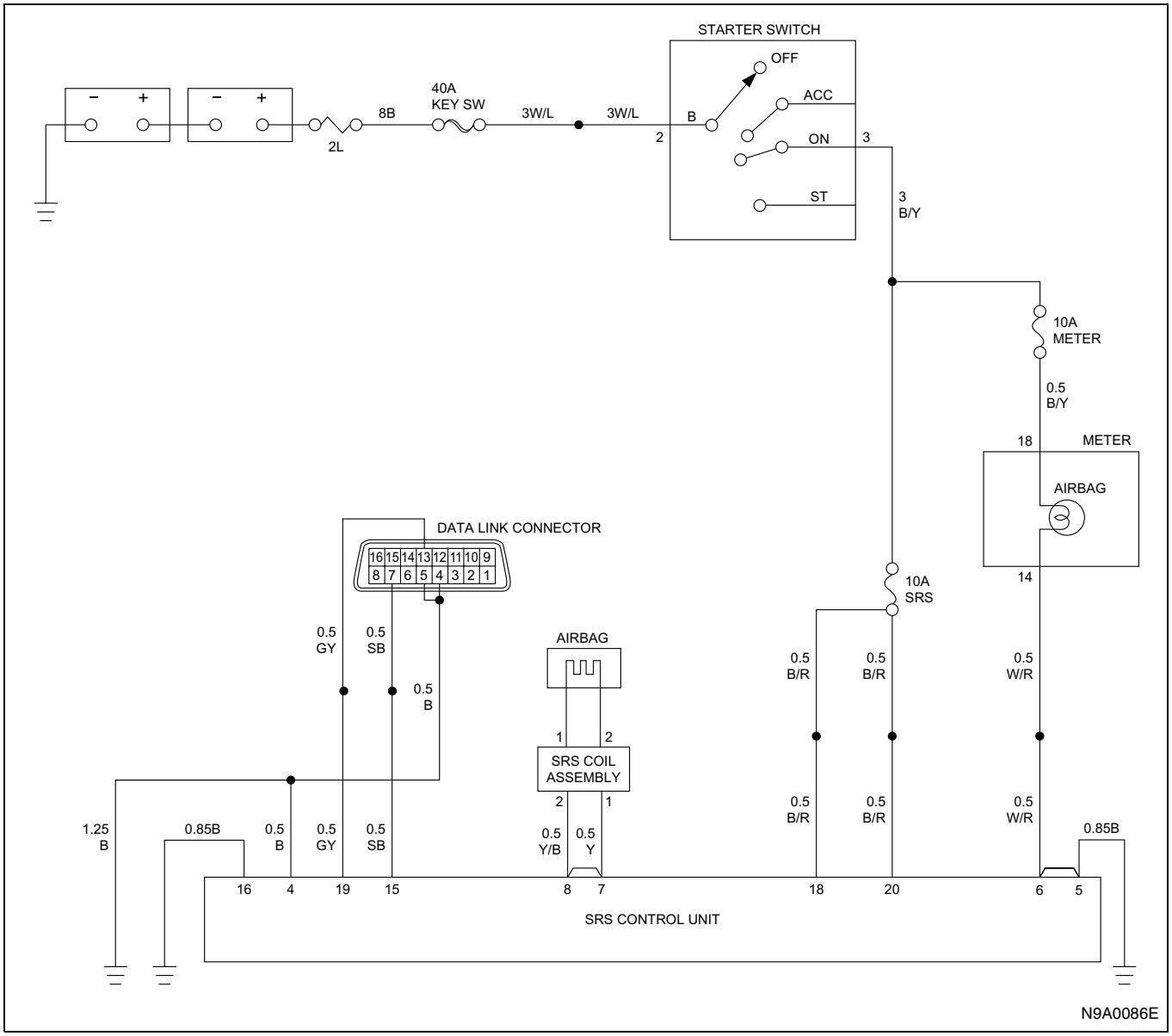
- Check for improper connection of the SRS control unit harness and the connector, lock breakage, deformation or damage of the terminal, poor contact between the terminal and the wire, and damaged harness.

Step	Action	Value	YES	NO
1	Turn the starter switch to “ON”, and check the “SRS” warning lamp operation. Does the “SRS” warning lamp blink seven times?	—	Go to Step2	Go to Chart C “SRS” warning lamp does not come on.
2	Check the “SRS” warning lamp operation after it blinks seven times. Does the “SRS” warning lamp go off?	—	Go to Step3	Go to Step4
3	1. Turn the starter switch to OFF. 2. Connect the Tech 2 with diagnosis connector, and follow the instruction on Tech 2 manual. 3. Turn the starter switch to ON. 4. Request SRS diagnostic trouble code display, and record all the history trouble code in the repair order with taking notes that it is recorded in this manner. Is the diagnostic trouble code displayed?	—	Turn the starter switch to OFF. Refer to “Point of diagnosis” of other specific DTC for all the history code. History DTC indicates that the function fault has been corrected or it is intermittent.	SRS is in function, and there is no function fault. Further diagnosis is not necessary.

Step	Action	Value	YES	NO
4	1. Turn the starter switch to OFF. 2. Connect the Tech 2 to the diagnosis connector. 3. Turn the starter switch to ON. 4. Confirm the diagnostic trouble code (DTC) using Tech 2, and record all the DTC in the repair order with taking notes that it is current code or history code if it appears. Is the diagnostic trouble code (DTC) displayed?	—	If DTC 51 is displayed, go to DTC 51 chart. If DTC 53 is displayed, go to DTC 53 chart. If DTC 25 is displayed, go to DTC 25 chart. If DTC 71 is displayed, go to DTC 71 chart. Diagnose rest of the current DTC in the order from lower level. Refer to “Point of diagnosis” of the specific DTC, if only history codes exist.	Go to Chart B “SRS” warning lamp turns on continuously.

Chart A SRS Control Unit Function Check

Outline



Description of Circuit

If either of the “Ignition A” voltage applied to terminal “20” or “Ignition B” voltage applied to terminal “18” exceeds 10V, the airbag SRS control unit recognizes it and “SRS” warning lamp blinks seven times to confirm operation. At this point, SRS control unit performs “Initial diagnosis” and “Constant diagnosis” subsequently. Once function fault is detected, SRS control unit set the current diagnostic trouble code and turn “SRS” warning lamp to ON.

When SRS control unit does not detect any more function fault except DTC 25, 51, 53, 71, it clears the current diagnostic trouble code moving them to the EEPROM.

Trouble codes cannot be cleared but with “Clear code” command of Tech 2, except following DTCs. In addition, “Clear code” command cannot clear DTCs 25, 51, 53, and 71.

Description of Chart Test

Numbers below indicate step numbers in the diagnostic chart.

1. This test is to confirm current function fault. Refer to “Point of diagnosis” of appropriate DTC, if there is no current function fault (history DTC is set). Do not replace the SRS control unit because of history diagnostic trouble code.
2. Confirm diagnostic trouble code using Tech 2.
3. This test is to check function fault occurred in the SRS control unit during diagnosis. Function fault of SRS control unit hardly cause new function fault during diagnosis.

4. Replace the SRS control unit only when all circuits except SRS control unit are confirmed to be functioning properly. Failure to do so may cause inerasable code stored in the SRS control unit and it may requires replacement again.

Point of Diagnosis

Order is very important to diagnose diagnostic trouble code. Be sure to diagnose in the specified order. Failure to do so leads to longer diagnosis period, wrong diagnosis or replacement of wrong part.

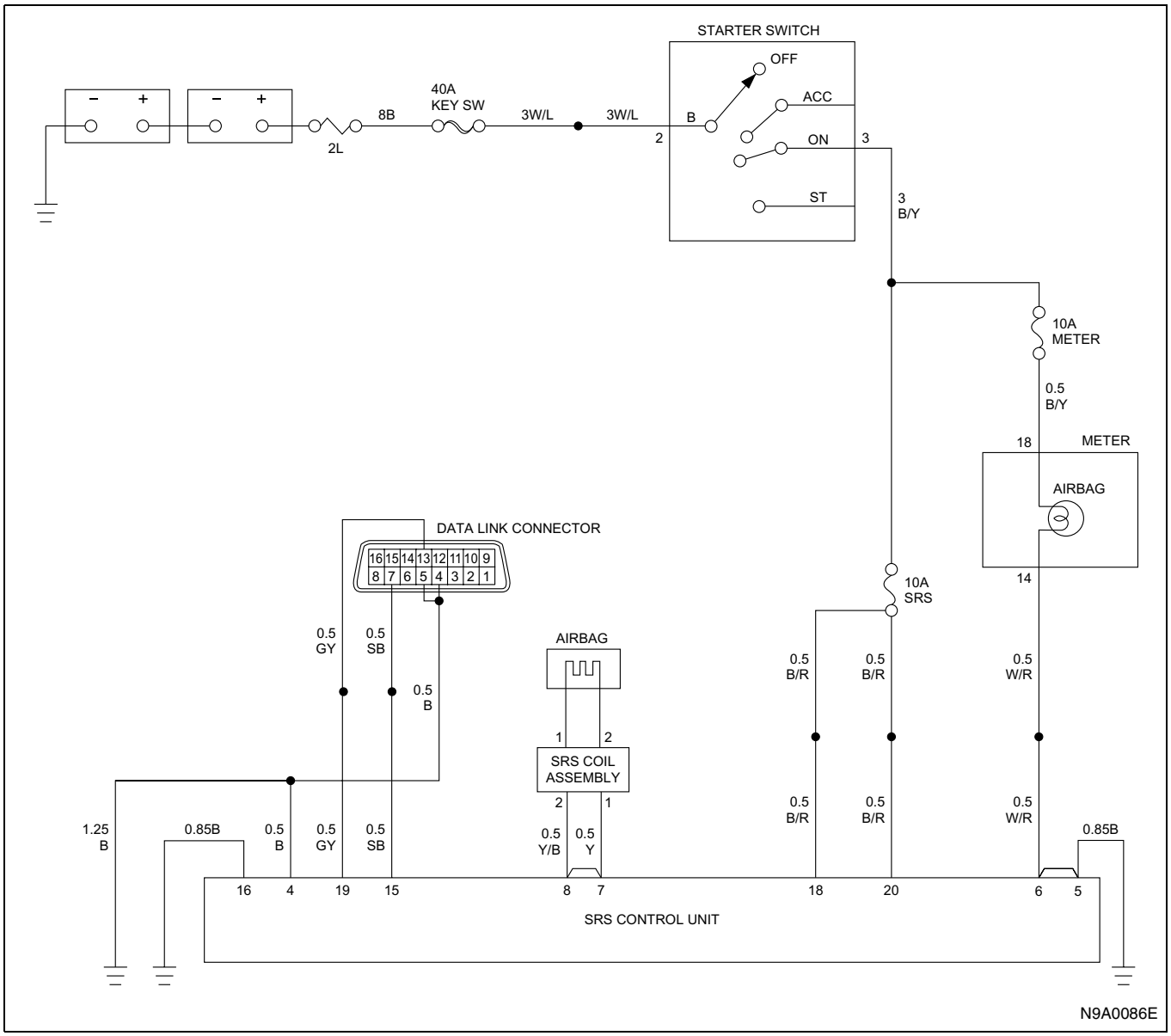
WARNING:
DURING SERVICE WORK, BE CAREFUL NOT TO TAP OR SHAKE THE SRS CONTROL UNIT. ALSO, FAILURE TO INSTALL THE SRS CONTROL UNIT TO VEHICLE PROPERLY MAY LEAD TO MALFUNCTION OF THE UNIT WHEN THE STARTER SWITCH IS TURNED TO ON. THIS MAY RESULT IN INJURY DUE TO SUDDEN DEPLOYMENT OF SRS AIRBAG.

Step	Action	Value	YES	NO
1	1. This chart is based on the assumption that “SRS system check” diagnosis has been performed. Perform the following procedure when the chart shows and proves that all circuits except SRS control unit are confirmed to be functioning properly, and DTC remains stored as current code. 2. Perform the diagnostic procedure to check if the SRS control unit has to be replaced. 3. Turn the starter switch to OFF. 4. Connect all the system components, and make sure those are installed properly. 5. Make sure that the starter switch is “OFF” at least for 15 seconds. 6. Turn the starter switch to “ON”, and check the “SRS” warning lamp operation. Does the “SRS” warning lamp go off after it blinks seven times?	—	Go to Step3	Go to Step2
2	Request diagnostic trouble code display using Tech 2. Is there any other DTC than that appeared at the “SRS system check” in the beginning?	—	Turn the starter switch to OFF. Go to appropriate chart according to the function fault indicated.	Go to Step3
3	1. Clear the SRS DTC. 2. Turn the starter switch to OFF at least for 15 seconds. Turn the starter switch to “ON”, and check the “SRS” warning lamp blinking operation. Does the “SRS” warning lamp go off after it blinks seven times?	—	System is in function, and there is no function fault. Further diagnosis is not necessary.	Turn the starter switch to OFF. Go to Step4

Step	Action	Value	YES	NO
4	1. Replace the SRS control unit. 2. Connect all the SRS components, and check that those are installed properly. 3. Connect the Tech 2, and check if “Event data clear prohibition” flag is displayed. 4. If not, put the flag up. Is this step completed?	—	Check the repair.	Go to Step4

Chart B “SRS” Warning Lamp Turns on Continuously

Outline



Description of Circuit

Turn the starter switch to “ON”. Battery voltage is applied to “SRS” warning lamp and the “SRS” warning lamp comes ON.

“SRS fuse” can apply system voltage to the “Ignition” input terminal “20” and “18”. After “SRS” warning lamp blinks seven times, SRS control unit calls warning lamp drive circuit in the SRS control unit to turn the “SRS” warning lamp off, if there is no current DTC.

If the “Ignition” voltage is less than 10V, “SRS” warning lamp turns on continuously, and no DTC is set.

Description of Chart test

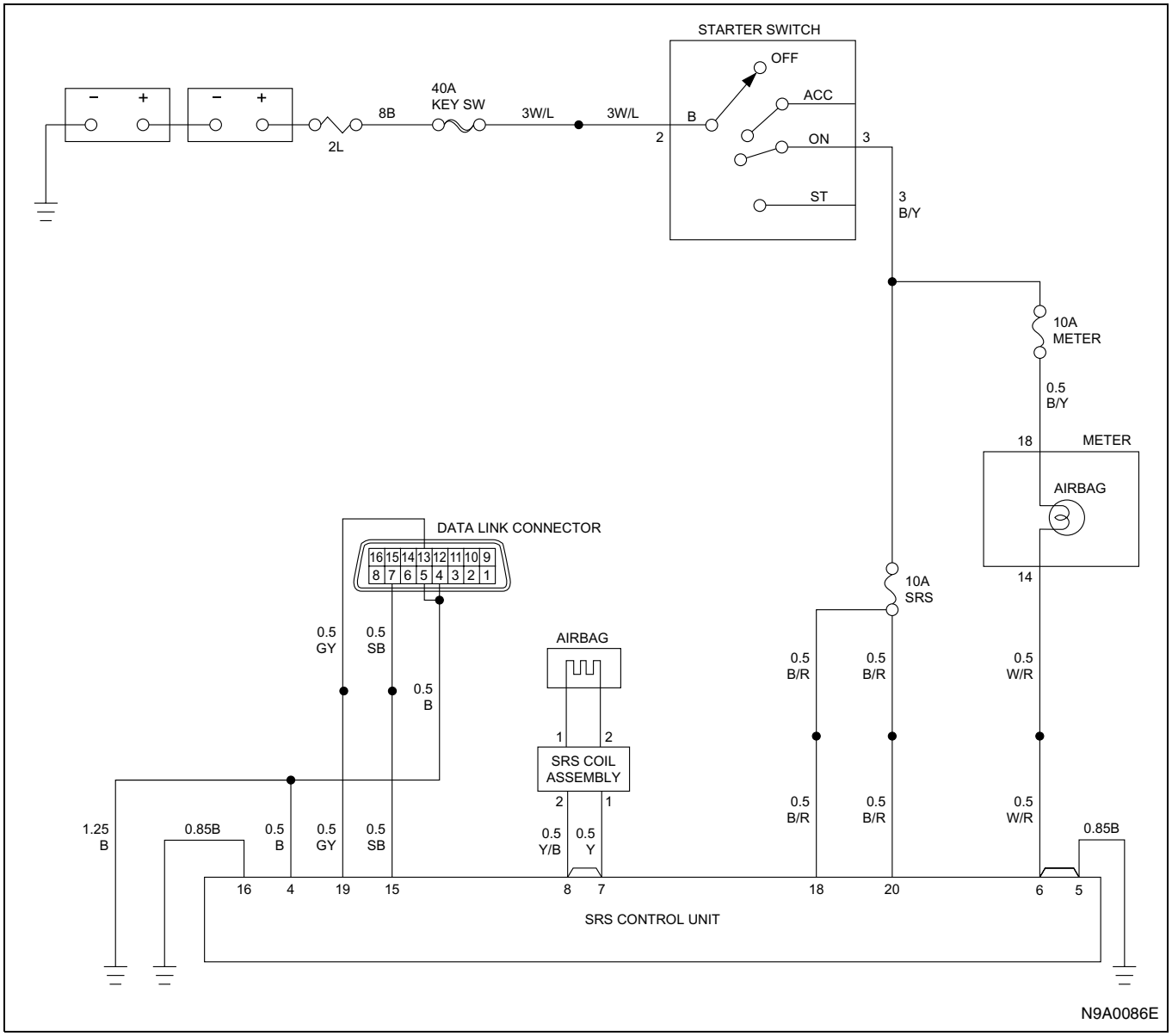
Numbers below indicate step numbers in the diagnostic chart.

1. This test is to check if power is provided to the SRS control unit feeder circuit.
2. This test is to check if the “Ignition” and ground circuit is normal against the SRS control unit.
3. This test is to check if the location of function fault is in the SRS control unit.
4. This test is to check ground short circuit from the SRS control unit feeder circuit.

Step	Action	Value	YES	NO
1	1. Turn the starter switch to OFF. 2. Remove the “SRS fuse” of SRS airbag to inspect. Is the fuse normal?	—	Go to Step2	Go to Step4
2	1. Turn the starter switch to OFF. 2. Disconnect the SRS control unit harness connector. 3. Remove the 2-pole connector (yellow) located in the lower portion of steering column. 4. Turn the starter switch to ON. 5. Measure the voltage between the SRS control unit harness connector terminals “20” and “16”. Is the voltage 18V?	—	Go to Step3	Go to Step5
3	1. Turn the starter switch to OFF. 2. Connect all the parts. 3. Connect the Tech 2, and turn the starter switch to ON. 4. Check if “Event data clear prohibition” flag is displayed. Is the flag displayed?	—	Put the “Event data clear prohibition” flag up.Go to Step7	Go to Chart A SRS control unit function check.
4	1. Replace the “SRS fuse”. 2. Turn the starter switch to ON, and wait for 10 seconds. Then, turn the starter switch to OFF. 3. Remove the “SRS fuse” to inspect. Is the fuse normal?	—	Install the fuse and Go to Step7.	Go to Step6
5	1. The power supply circuit of SRS control unit or ground circuit is open. 2. Find the cause. 3. Replace the SRS harness, if it has problem. Is this step completed?	—	Go to Step7	Go to Step5
6	1. The power supply circuit of SRS control unit is shorted. 2. Find the cause. 3. Replace the SRS harness, if it has problem. Is this step completed?	—	Go to Step4	Go to Step6
7	Reconnect all the parts, and check that those are installed properly. Is this step completed?	—	Check the repair.	Go to Step7

Chart C "SRS" warning lamp does not come on

Outline



Description of Circuit

Turn the starter switch to "ON". Battery voltage is applied to "SRS" warning lamp and the "SRS" warning lamp comes ON.
"SRS fuse" can apply system voltage to the "Ignition" input terminal "20" and "18".
After "SRS" warning lamp blinks seven times, SRS control unit calls warning lamp drive circuit in the SRS control unit to turn the "SRS" warning lamp off, if there is no current DTC.
If the "Ignition" voltage is less than 10V, "SRS" warning lamp turns on continuously, and no DTC is set.

Description of Chart test

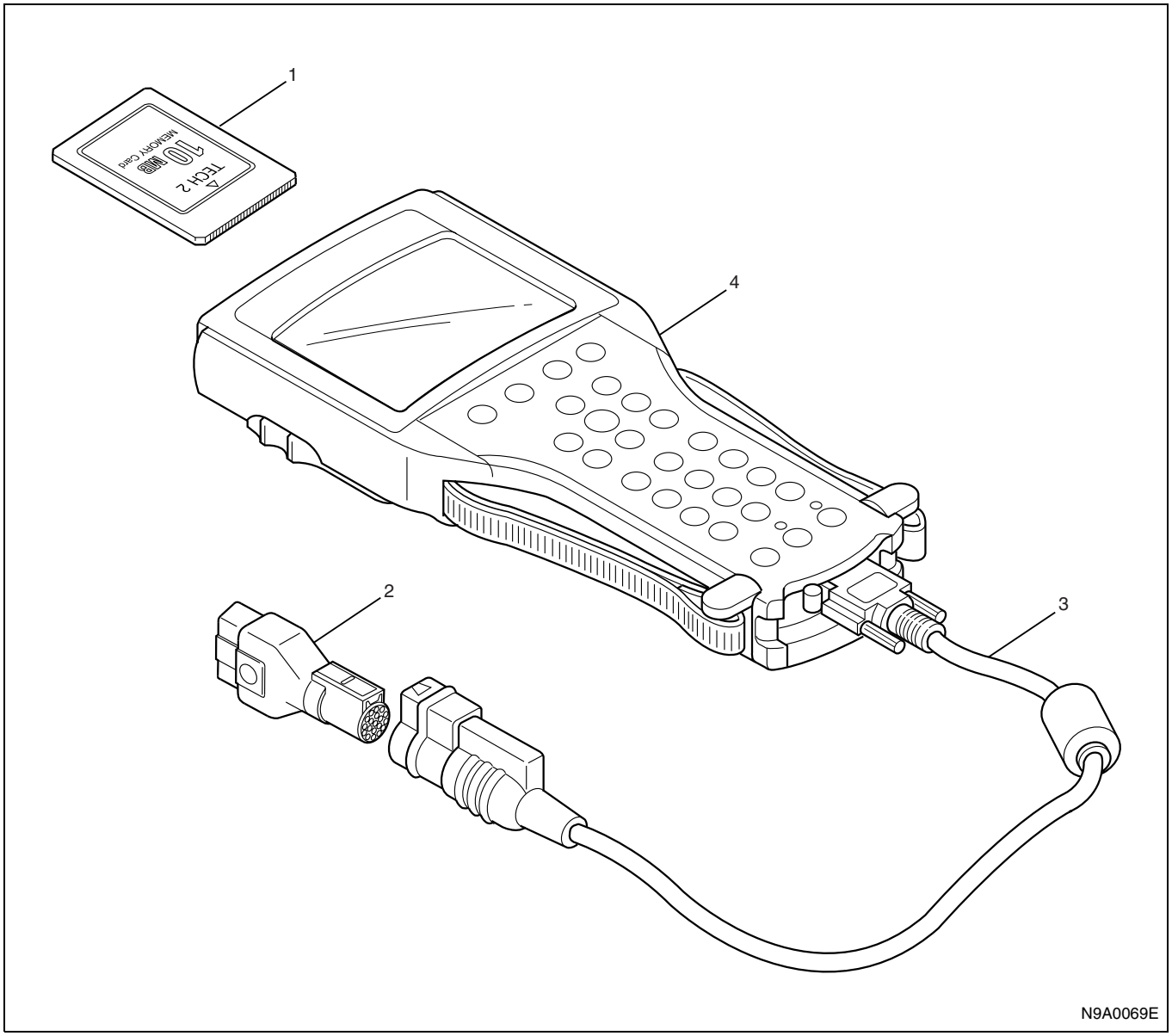
Numbers below indicate step numbers in the diagnostic chart.
1. This test is to check if power is provided to the SRS warning lamp feeder circuit.
2. This test is to check if SRS control unit operates improperly to prevent the "SRS" warning lamp from coming on.
3. This test is to check if the circuit between warning lamp and SRS control unit is shorted to ground.
4. This test is to check if "SRS" warning lamp circuit is normal.
5. This test is to check ground short circuit from the SRS warning lamp feeder circuit.

Step	Action	Value	YES	NO
1	Turn the starter switch to ON. Do warning lamps other than “SRS” operate properly?	—	Go to Step2	Go to Step3
2	1. Turn the starter switch to OFF. 2. Remove the SRS control unit connector. 3. Turn the starter switch to ON. Does the “SRS” warning lamp come on?	—	Replace the SRS control unit.Go to Step5	Go to Step4
3	Replace the meter assembly. Is this step completed?	—	Go to Step5	Go to Step3
4	1. Either of the “SRS” warning lamp power supply circuit or “SRS” warning lamp is open. 2. Find the cause. Is this step completed?	—	Go to Step5	Go to Step4
5	Connect all the SRS parts, and check that those are installed properly. Is this step completed?	—	Check the repair.	Go to Step5

Trouble Diagnosis with Scan Tool

Tech 2

Tech 2 is a useful tool to diagnose electric fault and system check of the airbag system.
Though it is possible to diagnose the fault without Tech 2, using the Tech 2 allows you to diagnose quickly.
Tech 2 is small and light tester. It can communicate with the SRS control unit to perform various types of diagnosis and tests by connecting the self-diagnosis connector equipped to the vehicle.



Legend

1. PCMCIA card
2. SAE 16/19 adapter
3. DLC cable
4. Tech 2

Feature of Tech 2

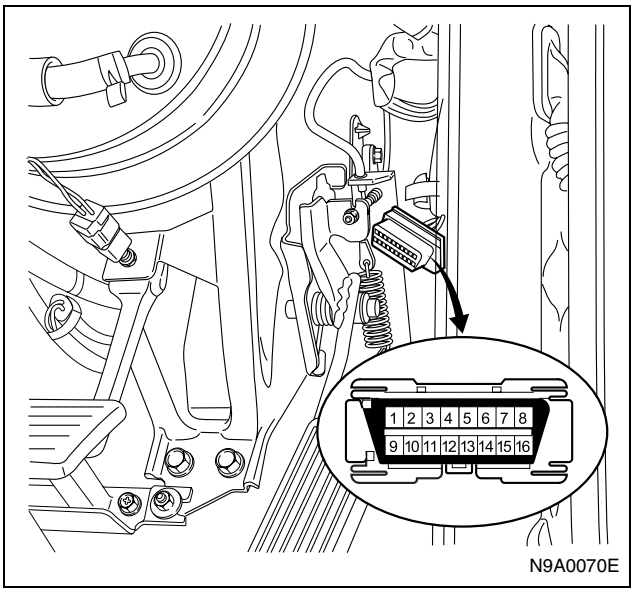
Caution:

- Tech 2 (4) is a 12-V power supply system. Do not use 24-V power supply. If the vehicle system is equipped with a 24-V power supply, use a 12-V battery with an adapter for power distribution.
- Never use cigarette lighter socket.

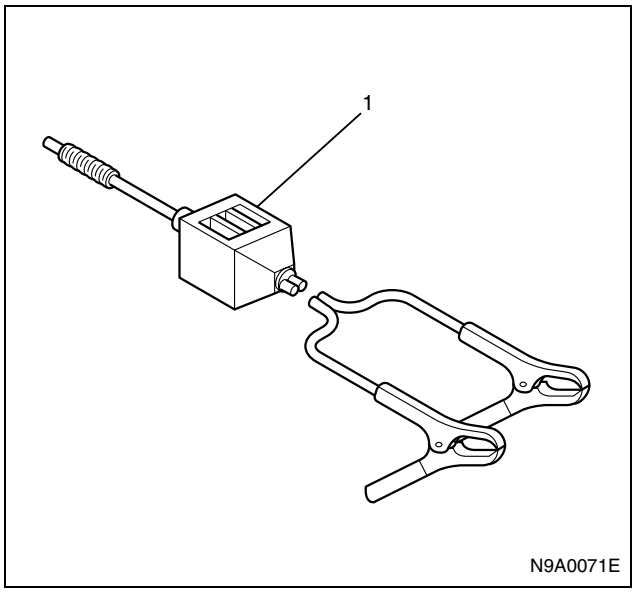
- Set the PCMCIA card (1) to Tech 2, and attach the VCI (Vehicle Communication Interface) (2)(3) to connect to the DLC in the vehicle.
- Turn the power switch off before installing/removing the PCMCIA card.
- Tech 2 has a capacity of equivalent to two snapshots.
- PCMCIA card is sensitive to magnetic and electrostatic. Handle it with care.
- Tech 2 can plot a graph of snapshots.
- Pressing the EXIT key can bring back to the main menu anytime.
- Open the application menu and press the “F1:Clear DTC Info” or the DTC clear to clear diagnosis trouble codes (DTCs).

How to Connect Tech 2

1. Insert the PCMCIA card to the Tech 2 body.
2. Install the SAE 16/19 adapter to the DLC cable.
3. Install the DLC cable to the Tech 2 body.
4. Make sure that the ignition key is OFF.
5. Connect the SAE-16/19 adapter of the Tech 2 to the self-diagnosis connector (black) in the body side.



Connect an adapter cable between the Tech 2 and 12-V battery.



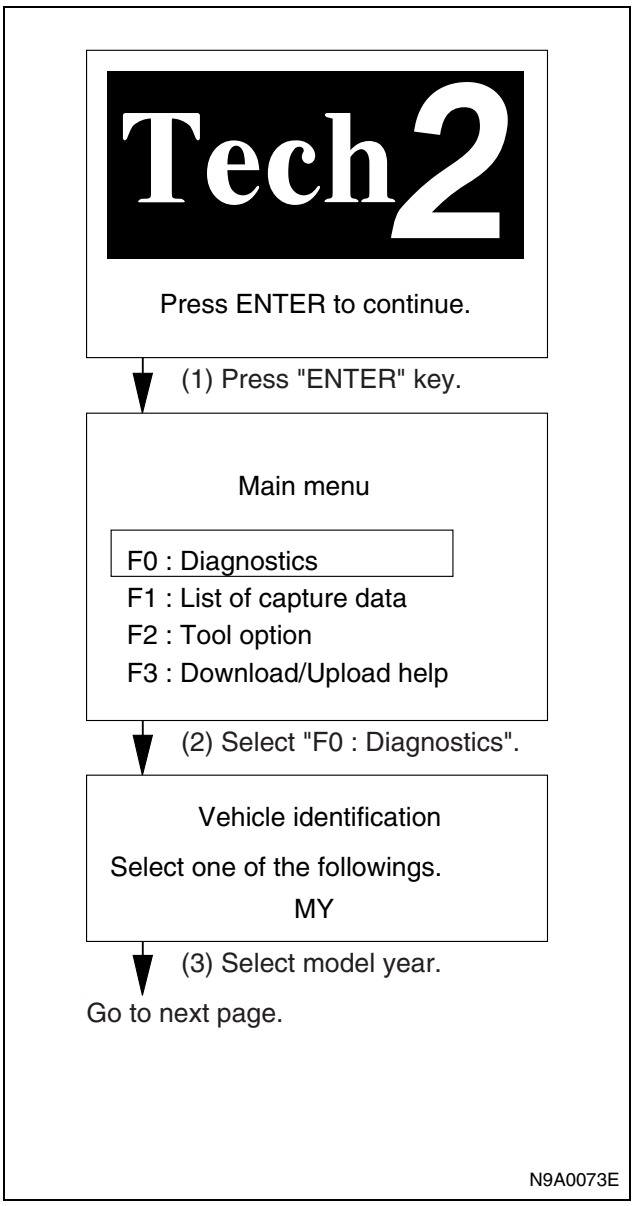
Legend

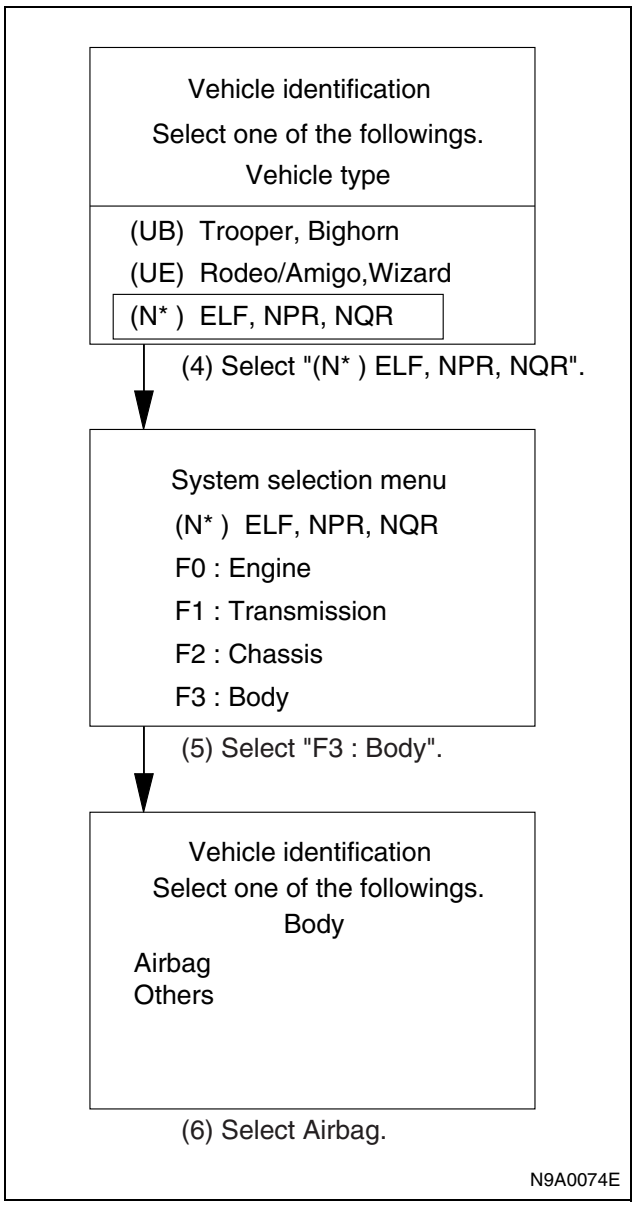
1. 3A-fuse

6. Turn the ignition switch to “ON” and press the “PWR” key of the Tech 2.
7. Check the display of the Tech 2.

Caution:
Make sure that no power is supplied to the Tech 2 when installing/removing the PCMCIA card.

Operation Procedure





Menu

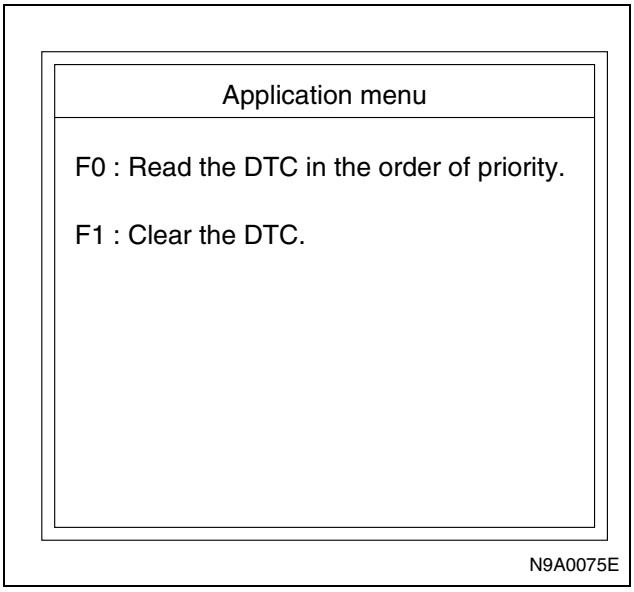
- The following chart shows the functions used by the current Tech 2 software.

F0: Diagnostic trouble code F0: Read the DTC in the order of priority. F1: Clear the DTC.
F1: Data display
F2: Snapshot
F3: Programming F0: Event data clear prohibition

DTC (Diagnostic Trouble Code) Mode

Two options are available for Tech 2 DTC mode. After selecting the DTC, the following menu is displayed.

- DTC Info (DTC information)
- Clear Info (DTC clear)



Data Display

Move the connector or harness by hand. If the display changes from fix to release, connection of connector is faulty, pin tip length is uneven, or open or short circuit in the harness exists where you have moved. Therefore, repair is necessary. When asterisk mark (*) is displayed in place of numeric display; Problem of Tech 2.
If asterisk mark (*) is found any of the data, PCMCIA card must be version upgraded.

Snapshot (Graph Plotting)

- The snapshot can record the data list menu and plot a graph.
- Utilizing this mode, reproduce and record the conditions claimed by the customer to identify the engine data fault.
- The stored data can be replayed with a domestic power supply.

Programming

- Before replacing SRS control unit, be sure to check/save the vehicle information. After replacement, input it.

List of Diagnostic Trouble Code

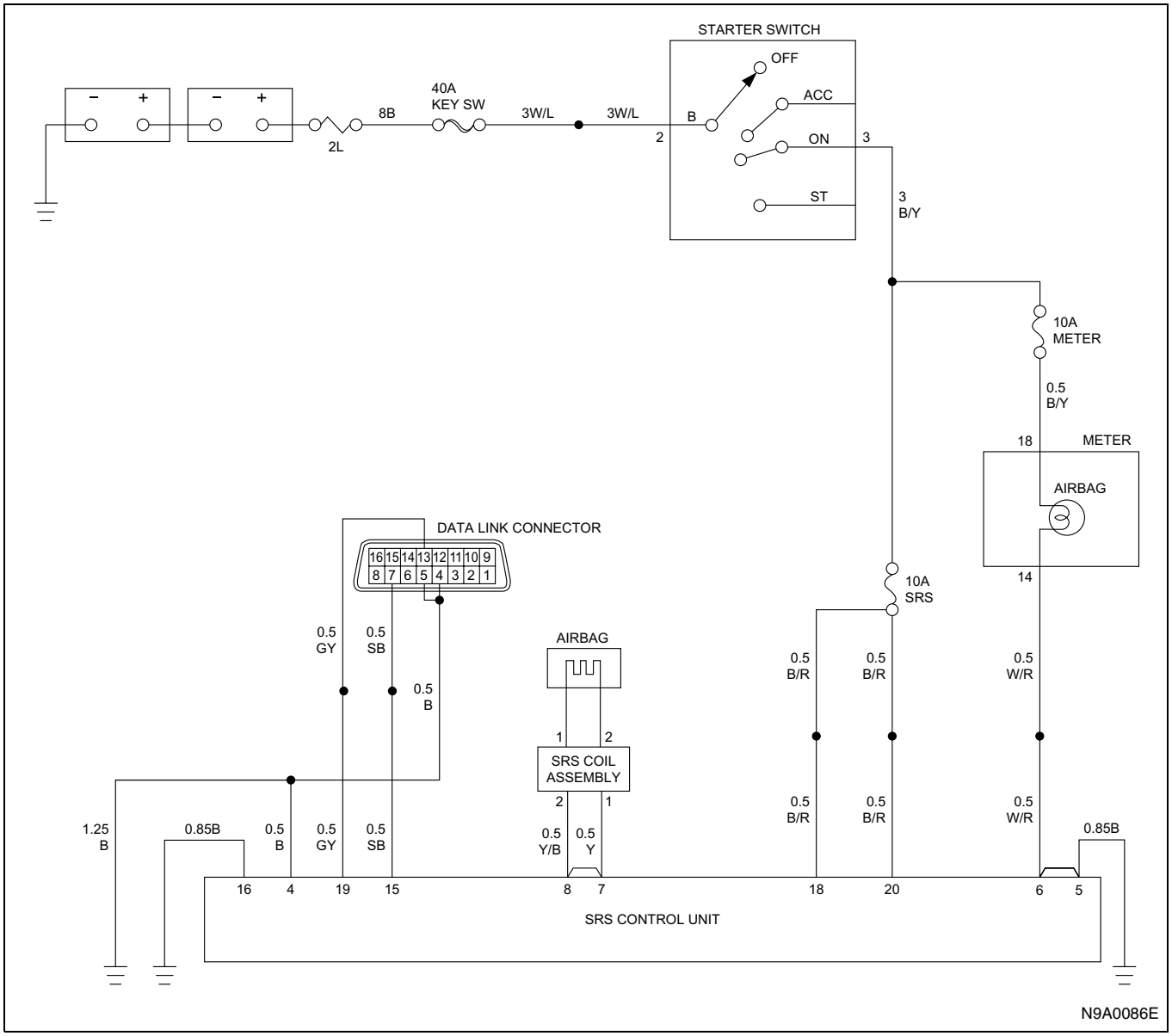
Trouble code No.	Item to be detected	"SRS" warning lamp ON
14	Connector is half-connected	ON
21	Resistance of SRS airbag deployment circuit is large	ON
22	Resistance of SRS airbag deployment circuit is small	ON
24	SRS airbag deployment circuit is shorted to ground	ON
25	SRS airbag deployment circuit is shorted to ignition voltage	ON
26	SRS airbag deployment circuit is open	ON
51	SRS airbag deployment current had output	ON
53	Specific trouble when SRS airbag deployment current had output	ON
54	Deployment output by onboard deployment system communication	
55	Vehicle type error	ON
61	Warning lamp circuit trouble	ON
63	Power supply voltage failure	ON
71	SRS control unit internal trouble	ON

Caution:

- Trouble codes No. 21, 25, 71 cannot be cleared.
- Code No. 12 indicates that the system is normal.

DTC: 14 Connector is Half-connected

Outline



Description of Circuit

Turn the starter switch to “ON”. SRS control unit checks the condition of half-connection detection terminal.

Condition when DTC is set

The half-connection detection terminals “a” and “b” are not connected via connector.

Action to be taken

SRS control unit turns the warning lamp ON and set the code 14.

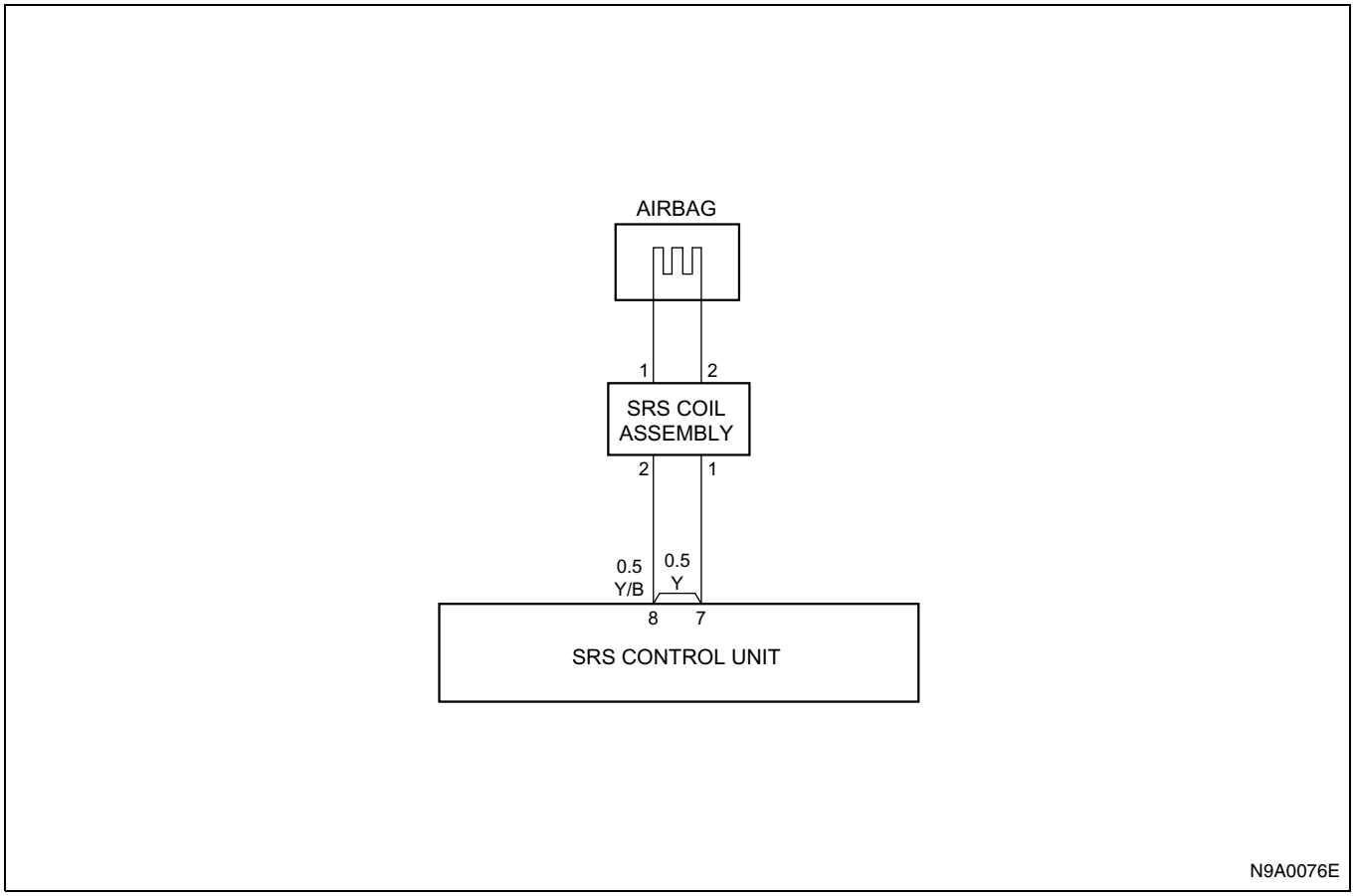
Condition when DTC is cleared

Connector is connected completely, and the half-connected terminal has continuity.

Step	Action	Value	YES	NO
1	Has the “SRS system check” been performed?	—	Go to Step2	Go to “SRS system check”.
2	1. Turn the starter switch to OFF. 2. Check if the connector of the SRS control unit is connected securely. Is the connector of the SRS control unit connected securely?	—	Go to Step3	Insert the SRS control unit connector securely.Go to Step4
3	Temporarily disconnect the SRS control unit connector, and check the half-connection detection terminal for faulty such as bent and dirt. Is there any fault?	—	Replace either of the SRS control unit or SRS harness whichever is faulty.Go to Step4	Go to Chart A SRS control unit function check.
4	1. Reconnect all the parts, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Check the repair.	Go to Step4

DTC: 21 Resistance of SRS Airbag Deployment Circuit is Large

Outline



Description of Circuit

Turn the starter switch to “ON”. SRS control unit performs the tests to diagnose critical function fault inside the SRS control unit. Upon completion of the tests, when the results are pass, “Ignition” voltage and deployment circuit voltage will be measured to check they are within the normal range. Then, the SRS control unit performs “Resistance measurement test”. SRS control unit flows a minimal known amount of current between the terminals “7” and “8”, and measures the voltage difference between the two, and then calculates the combined resistance in the SRS airbag, SRS coil assembly, SRS airbag deployment circuit, and connector terminal contact point.

Condition when DTC is Set

When combined resistance of SRS airbag, SRS coil assembly, SRS airbag deployment circuit, and connector terminal contact point exceeds the specified value. This test is performed constantly after elapse of six seconds from the “Ignition” voltage exceeds 10V.

Action to be Taken

SRS control unit turns the “SRS” warning lamp ON and set the DTC 21.

Condition when DTC is Cleared

When the resistance goes back to less than specified value.

Description of DTC Chart Test

Numbers below indicate step numbers in the diagnostic chart.
2. This test is to check if the location of function fault is in the SRS control unit.
3. This test is to check if the 2-pole connector (yellow) located in the lower portion of steering column is properly connected.
4. This test is to check the 2-pole connector (yellow) terminal located in the lower portion of steering column for secure contact and/or corrosion.
5. This test is to check if the location of function fault is up to the 2-pole connector (yellow) located in the lower portion of steering column.
6. This test is to check the function fault is caused by high resistance value in the wiring.
7. This test is to check if the location of function fault is in the SRS coil assembly or SRS airbag.

Point of Diagnosis

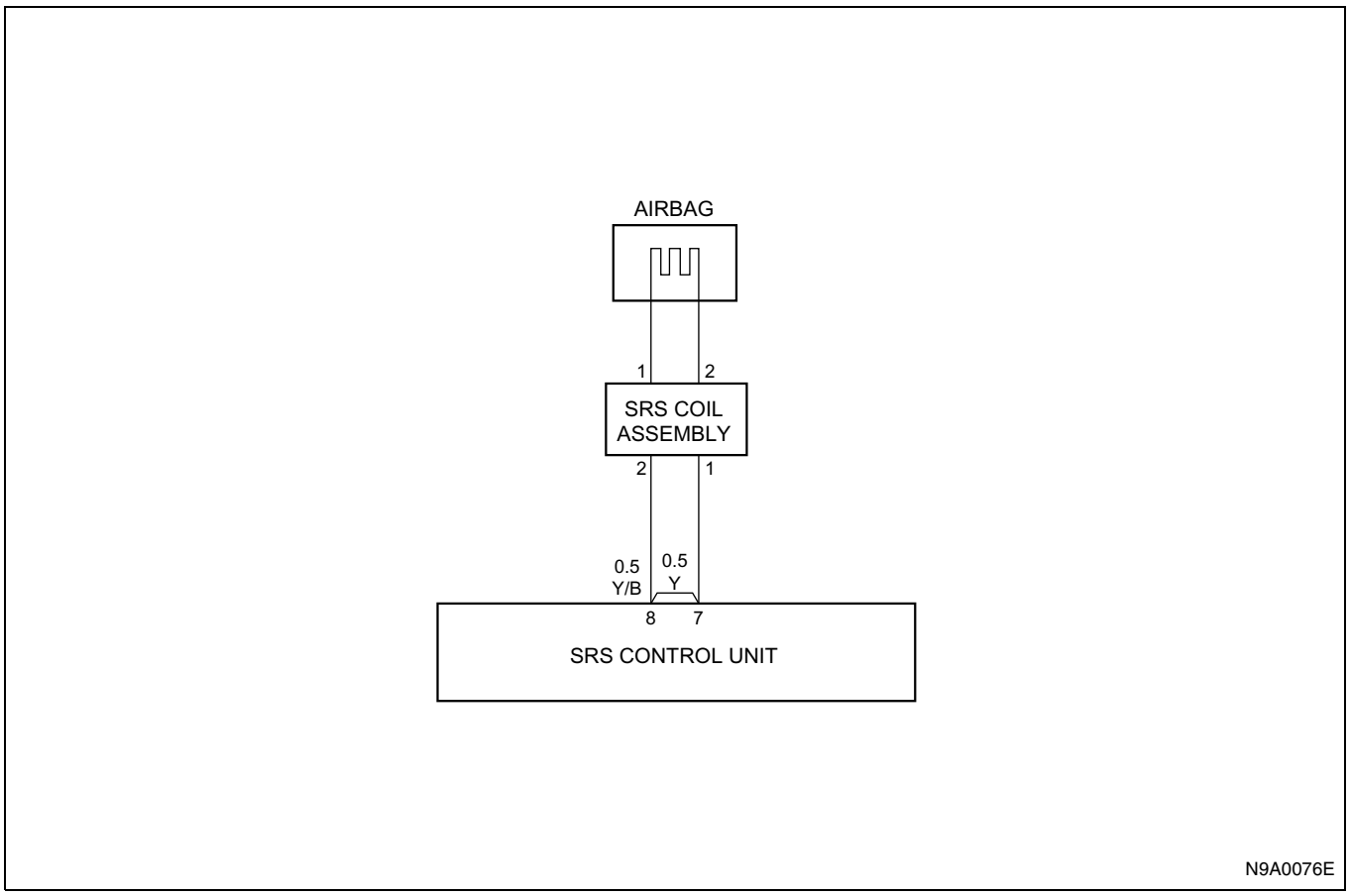
In the situations that the trouble display appears intermittently, it may be caused by improper connection between 2-pole connector terminals “1” and “2” of SRS coil located in the lower portion of steering column, between 2-pole connector terminals “1” and “2” of SRS airbag located in the upper portion of steering column, between SRS control unit terminals “7” and “8”, or between the wire and terminal in SRS airbag deployment circuit.

Step	Action	Value	YES	NO
1	Has the “SRS system check” been performed?	—	Go to Step2	Go to “SRS system check”.
2	1. When measurement is required in this chart, use 5-8840-0366-0 DMM and appropriate terminal adapter in 5-8840-0385-0 Connector test adapter kit. 2. Using the data list function of Tech 2, read the resistance in airbag deployment circuit and record it. Does the resistance in airbag deployment circuit exceed specified value?	7.2Ω	Go to Step3	Go to Chart A SRS control unit function check.
3	1. Turn the starter switch to OFF. 2. Check the 2-pole connector (yellow) of SRS coil located in the lower portion of steering column for proper connection. Is the 2-pole connector connected properly?	—	Go to Step4	Connect the 2-pole connector of SRS coil assembly properly.Go to Step8
4	1. Remove the 2-pole connector (yellow) of SRS coil located in the lower portion of steering column for inspection. 2. If it is normal, reconnect the 2-pole connector of SRS coil assembly properly. 3. Turn the starter switch to ON. Is DTC 21 detected as current trouble?	—	Go to Step5	Go to Step8
5	1. Turn the starter switch to OFF. 2. Remove the 2-pole connector (yellow) of SRS coil assembly located in the lower portion of steering column. 3. Connect the 5-8840-2421-0 SRS substitute load and an appropriate terminal adapter in the 5-8840-0385-0 Connector test adapter kit to the SRS harness side connector which connects to SRS coil assembly. 4. Turn the starter switch to ON. Is DTC 21 detected as current trouble?	—	Go to Step6	Go to Step7

Step	Action	Value	YES	NO
6	1. Turn the starter switch to OFF. 2. Resistance of all circuit in the driver's airbag deployment circuit is increasing. 3. Inspect the SRS airbag deployment circuit and SRS control unit connector terminals "7" and "8", and use high-resolution resistance meter mode of DMM to detect the cause. Is the trouble detected?	—	Replace the SRS harness.Go to Step8	Go to Chart A SRS control unit function check.
7	1. Turn the starter switch to OFF. 2. Remove the 5-8840-2421-0 SRS substitute load from SRS coil assembly harness connector. 3. Connect the 5-8840-2421-0 SRS substitute load to the upper portion of steering column. 4. Reconnect the SRS coil assembly harness connector to the lower portion of steering column. 5. Turn the starter switch to ON. Is DTC 21 detected as current trouble?	—	Turn the starter switch to OFF. Replace the SRS coil assembly by referring to "SRS Coil Assembly" in SRS section. Go to Step8	Turn the starter switch to OFF. Replace the SRS airbag. Go to Step8
8	1. Reconnect all the parts, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Check the repair.	Go to Step8

DTC: 22 Resistance of SRS Airbag Deployment Circuit is Small

Outline



Description of Circuit

Turn the starter switch to “ON”. SRS control unit performs the tests to diagnose critical function fault in the SRS control unit. Upon completion of the tests, when the results are pass, “Ignition” voltage and deployment circuit voltage will be measured to check they are within the normal range. Then, the SRS control unit performs “Resistance measurement test”. SRS control unit flows a minimal known amount of current between the terminals “7” and “8”, and monitors the voltage difference between the two, and then calculates the combined resistance in the SRS airbag, SRS coil assembly, SRS airbag deployment circuit, and connector terminal contact point.

Condition when DTC is Set

When combined resistance of SRS airbag, SRS coil assembly, SRS airbag deployment circuit, and connector terminal contact point is less than the specified value. This test is performed constantly after elapse of six seconds from the “Ignition” voltage exceeds 10V.

Action to be Taken

Airbag SRS control unit turns the “SRS” warning lamp ON and set the DTC 22.

Condition when DTC is Cleared

When the resistance goes back to more than the specified value.

Description of DTC Chart Test

Numbers below indicate step numbers in the diagnostic chart.
2. This test is to check if the location of function fault is in the SRS control unit.
3. This test is to check if the 2-pole connector (yellow) located in the lower portion of steering column is properly connected.
4. This test is to check if the shorting clip of 2-pole connector (yellow) operates properly.
5. This test is to check if the location of function fault is up to the 2-pole connector (yellow) located in the lower portion of steering column.
6. This test is to check the function fault is caused by low resistance value in the wiring.
7. This test is to check if the location of function fault is in the SRS coil assembly or SRS airbag.

Point of Diagnosis

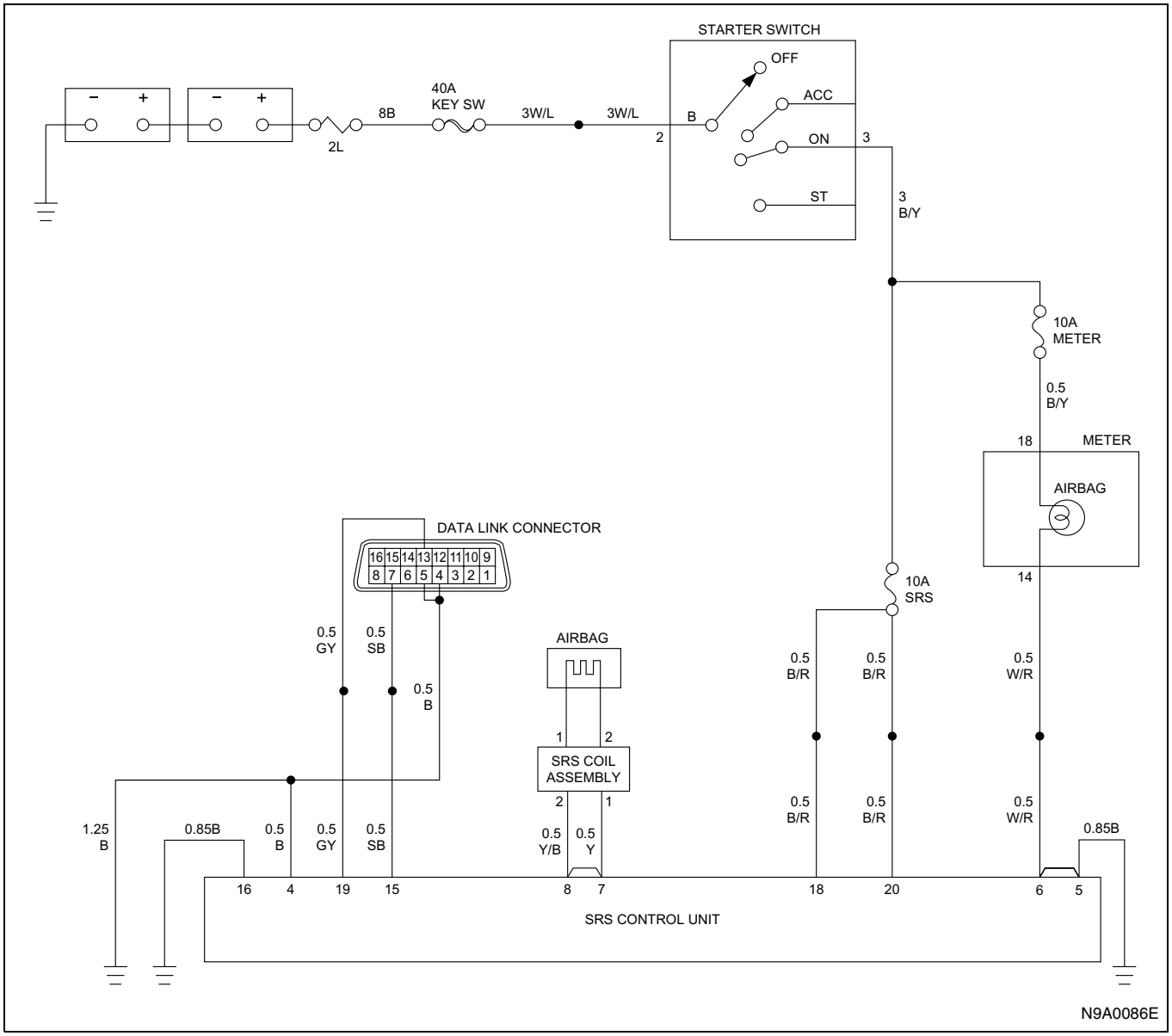
In the situations that the trouble appears intermittently, it may be caused by short circuit in the SRS airbag deployment circuit, or function fault in the SRS airbag or in the shorting clip of SRS coil assembly which requires parts replacement.

Step	Action	Value	YES	NO
1	Has the “SRS system check” been performed?	—	Go to Step2	Go to “SRS system check”.
2	1. When measurement is required in this chart, use 5-8840-0366-0 DMM and appropriate terminal adapter in 5-8840-0385-0 Connector test adapter kit. 2. Using the data list function of Tech 2, read the resistance in SRS airbag deployment circuit and record it. Is the resistance in airbag deployment circuit less than the specified value?	2.1Ω	Go to Step3	Go to Chart A SRS control unit function check.
3	1. Turn the starter switch to OFF. 2. Check the 2-pole connector (yellow) of SRS coil assembly located in the lower portion of steering column for proper connection. Is the 2-pole connector connected properly?	—	Go to Step4	Connect the 2-pole connector of SRS coil assembly properly.Go to Step8
4	1. Remove the 2-pole connector (yellow) of SRS coil assembly located in the lower portion of steering column for inspection. 2. If it is normal, reconnect the 2-pole connector of SRS coil assembly properly. 3. Turn the starter switch to ON. Is DTC 22 detected as current trouble?	—	Go to Step5	Go to Step8
5	1. Turn the starter switch to OFF. 2. Remove the 2-pole connector (yellow) of SRS coil assembly located in the lower portion of steering column. 3. Connect the 5-8840-2421-0 SRS substitute load and an appropriate terminal adapter in 5-8840-0385-0 Connector test adapter kit to the SRS harness side connector which connects to SRS coil assembly. 4. Turn the starter switch to ON. Is DTC 22 detected as current trouble?	—	Go to Step6	Go to Step7
6	1. Turn the starter switch to OFF. 2. Resistance of all circuit in the SRS airbag deployment circuit is decreasing. 3. Inspect the SRS airbag deployment circuit and SRS control unit connector terminals “7” and “8”, and use high-resolution resistance meter mode of 5-8840-0366-0 DMM to detect the cause. Is the trouble detected?	—	Replace the SRS harness.Go to Step8	Go to Chart A SRS control unit function check.

Step	Action	Value	YES	NO
7	1. Turn the starter switch to OFF. 2. Remove the 5-8840-2421-0 SRS substitute load from SRS coil assembly harness connector. 3. Connect the 5-8840-2421-0 SRS substitute load to the upper portion of steering column. 4. Reconnect the SRS coil assembly harness connector to the lower portion of steering column. 5. Turn the starter switch to ON. Is DTC 22 detected as current trouble?	—	Turn the starter switch to OFF. Replace the SRS coil assembly by referring to “SRS Coil Assembly” in SRS section. Go to Step8	Turn the starter switch to OFF. Replace the SRS airbag. Go to Step8
8	1. Reconnect all the parts, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Check the repair.	Go to Step8

DTC: 24 SRS Airbag Deployment Circuit is Shorted to Ground

Outline



Description of Circuit

Turn the starter switch to “ON”. SRS control unit performs the tests to diagnose critical function fault in the SRS control unit. Upon completion of the tests, when the results are pass, “Ignition” voltage and deployment circuit voltage will be measured to check they are within the normal range. SRS control unit detects ground short circuit in the SRS airbag circuit by monitoring the voltage of “Airbag low” terminal “8”.

Condition when DTC is Set

When “Ignition” is within the normal operational voltage. If the voltage of “Airbag low” is less than the specified value, the DTC 24 is set.

Action to be Taken

SRS control unit turns the “SRS” warning lamp ON and set the DTC 24.

Condition when DTC is Cleared

When the voltage of “Airbag low” terminal goes back to more than the specified value.

Description of DTC Chart Test

Numbers below indicate step numbers in the diagnostic chart.
2. This test is to check if the location of function fault is up to the 2-pole connector (yellow) located in the lower portion of steering column.
3. This test is to check if the location of function fault is in the SRS airbag deployment circuit.
4. This test is to check if the location of function fault is in the SRS airbag deployment circuit.
5. This test is to check if the location of function fault is in the SRS coil assembly or SRS airbag.

Point of Diagnosis

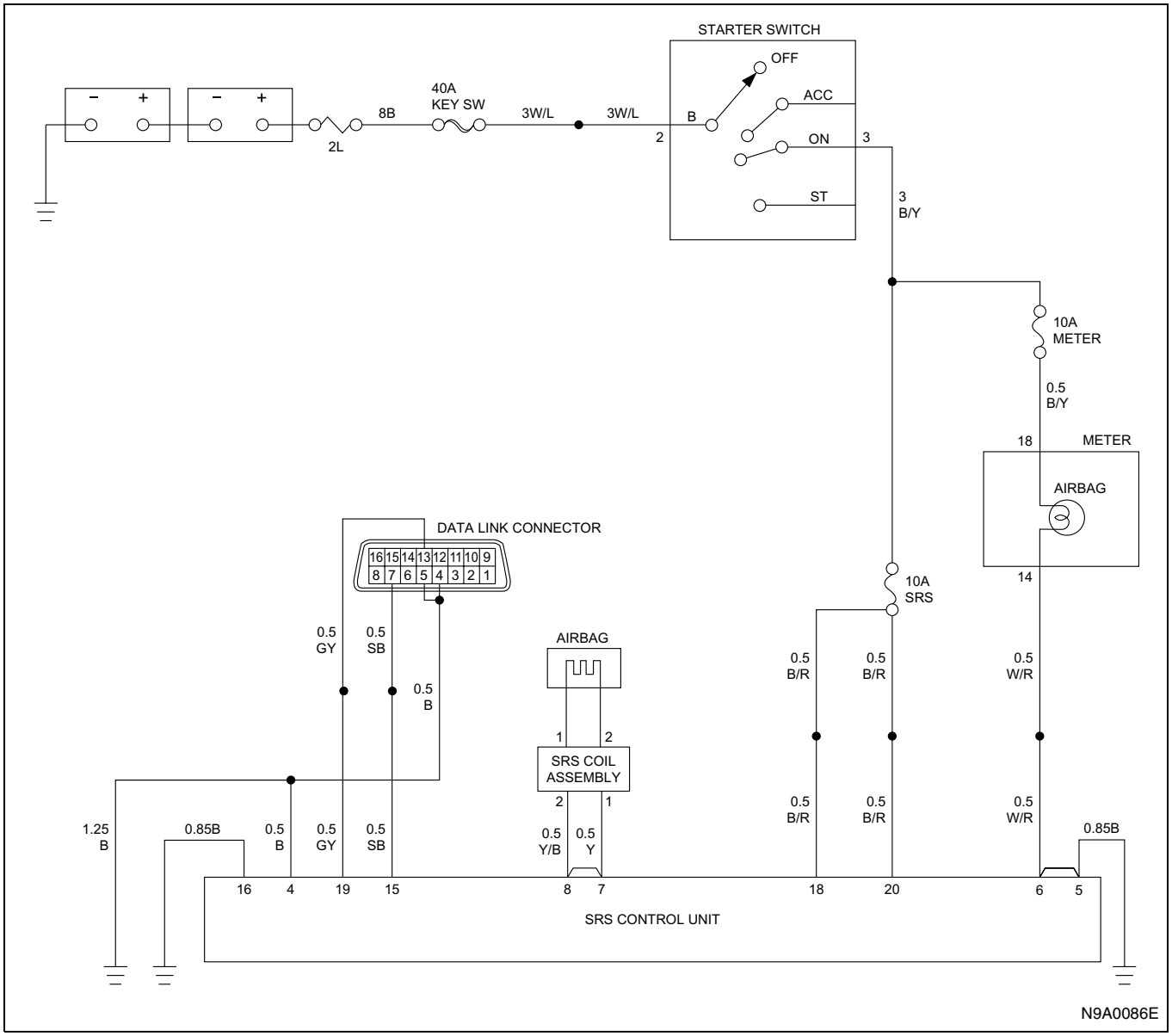
In the situations that the trouble appears intermittently, it may be caused by ground short circuit in the SRS airbag circuit.
Carefully check the SRS airbag deployment circuit for wire breakage or exposed wire.

Step	Action	Value	YES	NO
1	Has the “SRS system check” been performed?	—	Go to Step2	Go to “SRS system check”.
2	1. When measurement is required in this chart, use 5-8840-0366-0 DMM and appropriate terminal adapter in 5-8840-0385-0 Connector test adapter kit. 2. Turn the starter switch to OFF. 3. Remove the 2-pole connector (yellow) of SRS coil assembly located in the lower portion of steering column. 4. Connect the 5-8840-2421-0 SRS substitute load to SRS harness side connector which connects to SRS coil assembly. 5. Turn the starter switch to ON. Is DTC 24 detected as current trouble?	—	Go to Step3	Go to Step5
3	1. Turn the starter switch to OFF. 2. Remove the SRS control unit. 3. Remove the 5-8840-2421-0 SRS substitute load. 4. Measure the resistance between the SRS control unit harness connector terminals “7” and “5” (ground). Does the 5-8840-0366-0 DMM indicate “OL” (infinity)?	—	Go to Step4	Replace the SRS harness.Go to Step6
4	Measure the resistance between the SRS control unit harness connector terminals “8” and “5” (ground). Does the 5-8840-0366-0 DMM indicate “OL” (infinity)?	—	Go to Chart A SRS control unit function check.	Replace the SRS harness.Go to Step6

Step	Action	Value	YES	NO
5	1. Turn the starter switch to OFF. 2. Remove the 5-8840-2421-0 SRS substitute load from SRS coil assembly harness connector. 3. Connect the 5-8840-2421-0 SRS substitute load and an appropriate terminal adapter in the 5-8840-0385-0 Connector test adapter kit to the SRS airbag harness connector located in the upper portion of steering column. 4. Reconnect the SRS coil assembly harness connector to the lower portion of steering column. 5. Turn the starter switch to ON. Is DTC 24 detected as current trouble?	—	Turn the starter switch to OFF. Replace the SRS coil assembly by referring to “SRS Coil Assembly” in SRS section. Go to Step6	Turn the starter switch to OFF. Replace the SRS airbag. Go to Step6
6	1. Reconnect all the parts, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Check the repair.	Go to Step6

DTC: 25 SRS Airbag Deployment Circuit is Shorted to Ignition Voltage

Outline



Description of Circuit

Turn the starter switch to “ON”. SRS control unit performs the tests to diagnose critical function fault in the SRS control unit. Upon completion of the tests, when the results are pass, “Ignition” voltage and deployment circuit voltage will be measured to check they are within the normal range. SRS control unit detects battery voltage short circuit in the SRS airbag circuit by monitoring the voltage of “Airbag low” terminal “8”.

Condition when DTC is Set

When “Ignition” is within the normal operational voltage but the voltage of “Airbag low” exceeds the specified value, the DTC 25 is set.

Action to be Taken

SRS control unit turns the “SRS” warning lamp ON and set the DTC 25.

Condition when DTC is Cleared

When this function fault disappears after SRS control unit replacement.

Description of DTC Chart Test

Numbers below indicate step numbers in the diagnostic chart.
2. This test is to check if the location of function fault is in the SRS airbag deployment circuit.
3. This test is to check if the location of function fault is in the SRS airbag deployment circuit.
4. This test is to check if the location of function fault is in the SRS coil.
5. This test is to check if the location of function fault is in the SRS coil assembly or SRS airbag.

Point of Diagnosis

In the situations that the trouble appears intermittently, it may be caused by battery voltage short circuit in the SRS airbag circuit.
Carefully check the SRS airbag deployment circuit for wire breakage or exposed wire. If the lead wire and SRS coil assembly of SRS airbag are damaged, the part must be replaced. To prevent the replaced SRS control unit from damage, carefully check the SRS airbag deployment circuit including SRS coil assembly and SRS airbag.

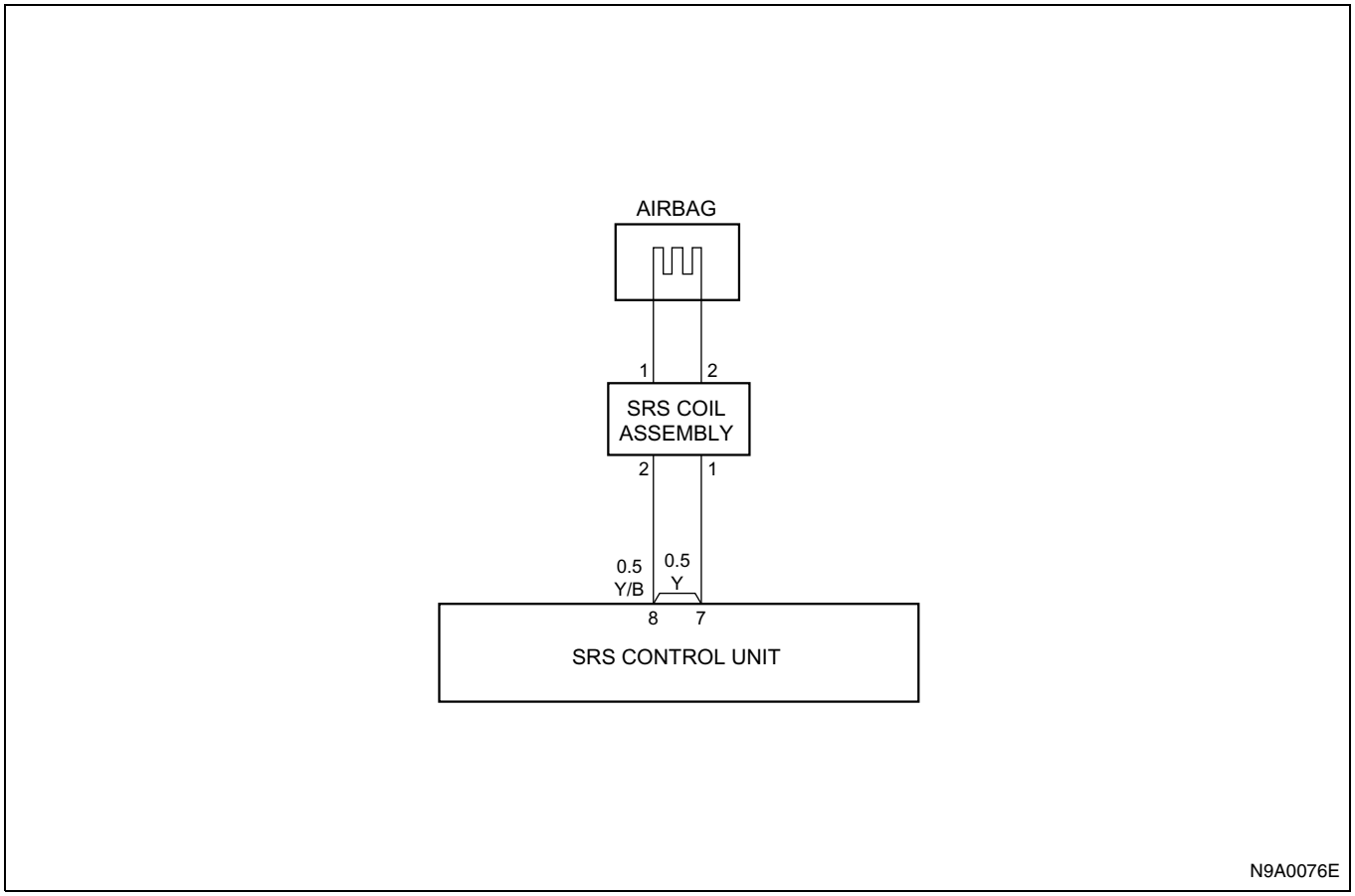
Caution:
When this DTC is set, all the SRS system parts (SRS control unit, airbag, etc.) must be replaced. In addition, This DTC cannot be cleared. Be sure to disconnect the battery cable before replacement, otherwise it will result malfunction of replaced SRS system parts or cause battery short circuit.

Step	Action	Value	YES	NO
1	Has the “SRS system check” been performed?	—	Go to Step2	Go to “SRS system check”.
2	1. When measurement is required in this chart, use 5-8840-0366-0 DMM. 2. Turn the starter switch to OFF. 3. Remove the 2-pole connector (yellow) of SRS coil assembly located in the lower portion of steering column. 4. Remove the SRS control unit. 5. Measure the resistance between the SRS control unit harness connector terminals “8” and “20” (ignition). Does the 5-8840-0366-0 DMM indicate “OL” (infinity)?	—	Go to Step3	Replace the SRS harness. Go to Step6
3	Measure the resistance between the SRS control unit harness connector terminals “7” and “20” (ignition). Does the 5-8840-0366-0 DMM indicate “OL” (infinity)?	—	Go to Step4	Replace the SRS harness. Go to Step6
4	1. Turn the starter switch to OFF. 2. Remove the 2-pole connector (yellow) of SRS airbag harness located in the upper portion of steering column. 3. Reconnect the SRS coil assembly harness connector to the lower portion of steering column. 4. Measure the resistance between the SRS control unit harness connector terminals “8” and “20” (ignition). Does the 5-8840-0366-0 DMM indicate “OL” (infinity)?	—	Go to Step5	Replace the coil assembly.Go to Step7

Step	Action	Value	YES	NO
5	Measure the resistance between the SRS control unit harness connector terminals “7” and “20” (ignition). Does the 5-8840-0366-0 DMM indicate “OL” (infinity)?	—	Replace the driver’s airbag assembly. Go to Step6	Replace the coil assembly.Go to Step6
6	Reconnect all the parts, and check that those are installed properly. Are all the parts installed properly?	—	Turn the starter switch to OFF. Replace the SRS control unit. Go to Step7	Go to Step6
7	1. Reconnect all the parts, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Check the repair.	Go to Step7

DTC: 26 SRS Airbag Deployment Circuit is Open

Outline



Description of Circuit

Turn the starter switch to “ON”. SRS control unit performs the tests to diagnose critical function fault in the SRS control unit. Upon completion of the tests, when the results are pass, “Ignition” voltage and deployment circuit voltage will be measured to check they are within the normal range. SRS control unit detects open circuit in the SRS airbag circuit by monitoring the voltage of “Airbag low” terminal.

Condition when DTC is Set

When the voltage of “Airbag low” terminal is within a certain range.

Action to be Taken

SRS control unit turns the “SRS” warning lamp ON and set the DTC 26.

Condition when DTC is Cleared

When the voltage of “Airbag low” terminal is out of a certain range.

Description of DTC Chart Test

Numbers below indicate step numbers in the diagnostic chart.
2. This test is to check if the 2-pole connector (yellow) located in the lower portion of steering column is properly connected.
3. This test is to check the 2-pole connector (yellow) located in the lower portion of steering column for secure contact and/or corrosion.
4. This test is to check if the location of function fault is up to the 2-pole connector (yellow) located in the lower portion of steering column.
5. This test is to check if the wire is open.
6. This test is to check if the location of function fault is in the SRS coil assembly or SRS airbag.

Point of Diagnosis

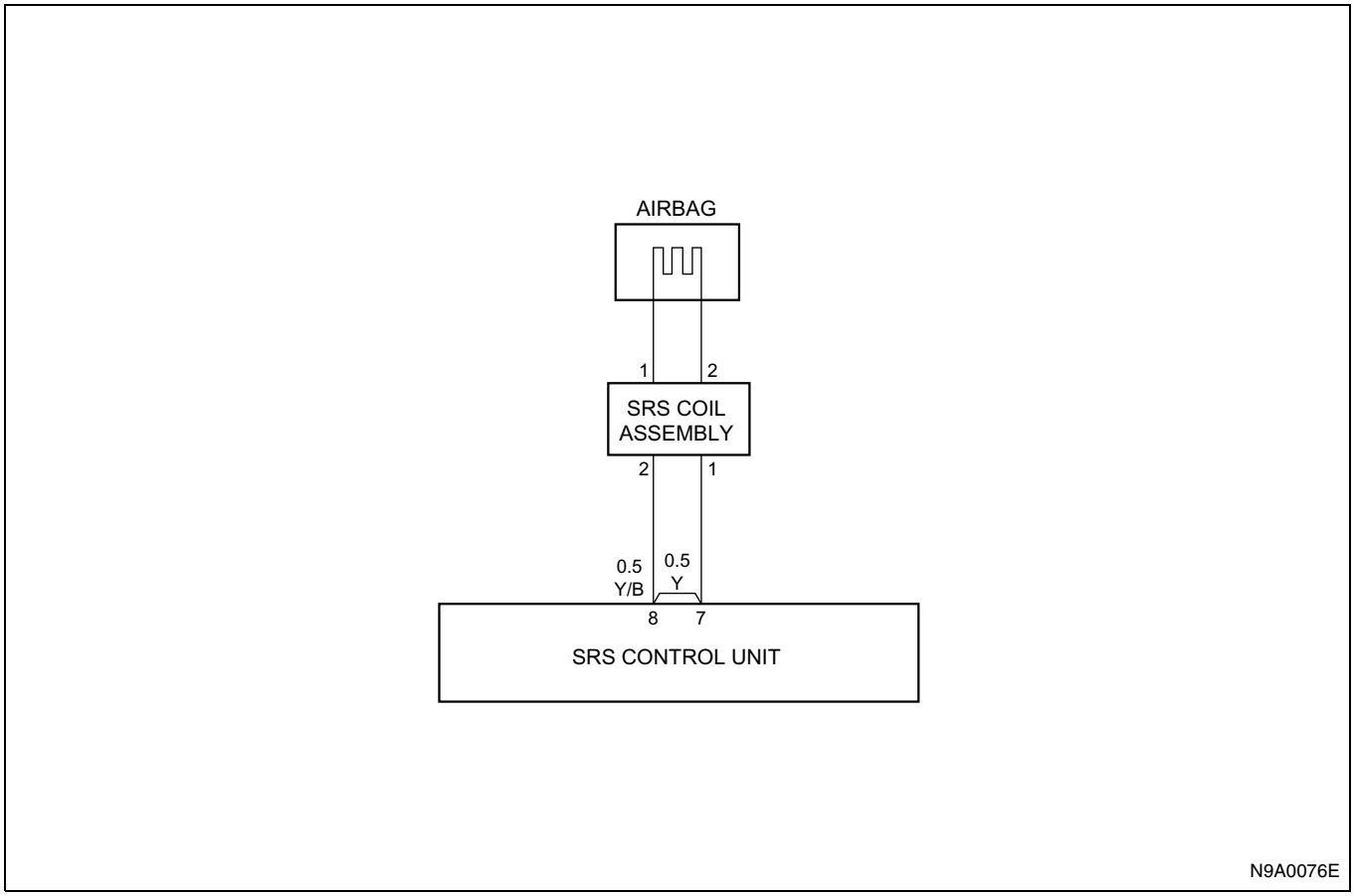
In the situations that the trouble display appears intermittently, it may be caused by improper connection between 2-pole connector terminals “1” and “2” of SRS airbag harness located in the upper portion of steering column, between 2-pole connector terminals “1” and “2” of SRS coil assembly harness, between SRS control unit terminals “7” and “8”, or open circuit in the SRS airbag deployment circuit.

Step	Action	Value	YES	NO
1	Has the “SRS system check” been performed?	—	Go to Step2	Go to “SRS system check”.
2	1. When measurement is required in this chart, use 5-8840-0366-0 DMM and appropriate terminal adapter in 5-8840-0385-0 Connector test adapter kit. 2. Turn the starter switch to OFF. 3. Check the 2-pole connector (yellow) of SRS coil assembly located in the lower portion of steering column for proper connection. Is the 2-pole connector (yellow) connected properly?	—	Go to Step3	Connect the 2-pole connector of SRS coil assembly properly.Go to Step6
3	1. Remove the 2-pole connector (yellow) of SRS coil assembly located in the lower portion of steering column for inspection. 2. If it is normal, reconnect the 2-pole connector of SRS coil assembly properly. 3. Turn the starter switch to ON. Is DTC 26 detected as current trouble?	—	Go to Step4	Go to Step7
4	1. Turn the starter switch to OFF. 2. Remove the 2-pole connector (yellow) of SRS coil assembly located in the lower portion of steering column. 3. Connect the 5-8840-2421-0 SRS substitute load and an appropriate terminal adapter in 5-8840-0385-0 Connector test adapter kit to the SRS harness side connector which connects to SRS coil assembly. 4. Turn the starter switch to ON. Is DTC 26 detected as current trouble?	—	Go to Step5	Go to Step6
5	1. Turn the starter switch to OFF. 2. Driver’s airbag deployment circuit is open. 3. Inspect the SRS airbag deployment circuit and SRS control unit connector terminals “7” and “8”, and use high-resolution resistance meter mode of DMM to detect the cause. Is the trouble detected?	—	Replace the SRS harness.Go to Step7	Go to Chart A SRS control unit function check.

Step	Action	Value	YES	NO
6	1. Turn the starter switch to OFF. 2. Remove the 5-8840-2421-0 SRS substitute load from SRS coil assembly harness connector. 3. Connect the 5-8840-2421-0 SRS substitute load to the upper portion of steering column. 4. Reconnect the SRS coil assembly harness connector to the lower portion of steering column. 5. Turn the starter switch to ON. Is DTC 26 detected as current trouble?	—	Turn the starter switch to OFF. Replace the SRS coil assembly by referring to “SRS Coil Assembly” in SRS section. Go to Step7	Turn the starter switch to OFF. Replace the SRS airbag. Go to Step7
7	1. Reconnect all the parts, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Repeat the “SRS system check”.	Go to Step7

DTC: 51 SRS Airbag Deployment Current Had Output

Outline



Description of Circuit

A sensor is equipped to this circuit to convert the impact applied to SRS control unit into an electrical signal.
The electrical signal generated at this time will be processed in the SRS control unit to compare with the value stored in the memory. When the generated signal exceeds the setting value, SRS control unit sends current to the SRS airbag assembly for deployment, and set the DTC 51.

Condition when DTC is Set

When the control unit detects the front collision over certain degree of impact.

Action to be Taken

SRS control unit turns the “SRS” warning lamp ON, record the “collision data”, and set the DTC 51.

Condition when DTC is Cleared

When SRS control unit is replaced.

Description of DTC Chart Test

Numbers below indicate step numbers in the diagnostic chart.
2. In case the DTC 51 appears even when the collision did not result in SRS airbag assembly deployment, the DTC 51 may have been set erroneously.
3. In case the DTC 51 appears without any deformation caused by front collision, the DTC may have been set erroneously.

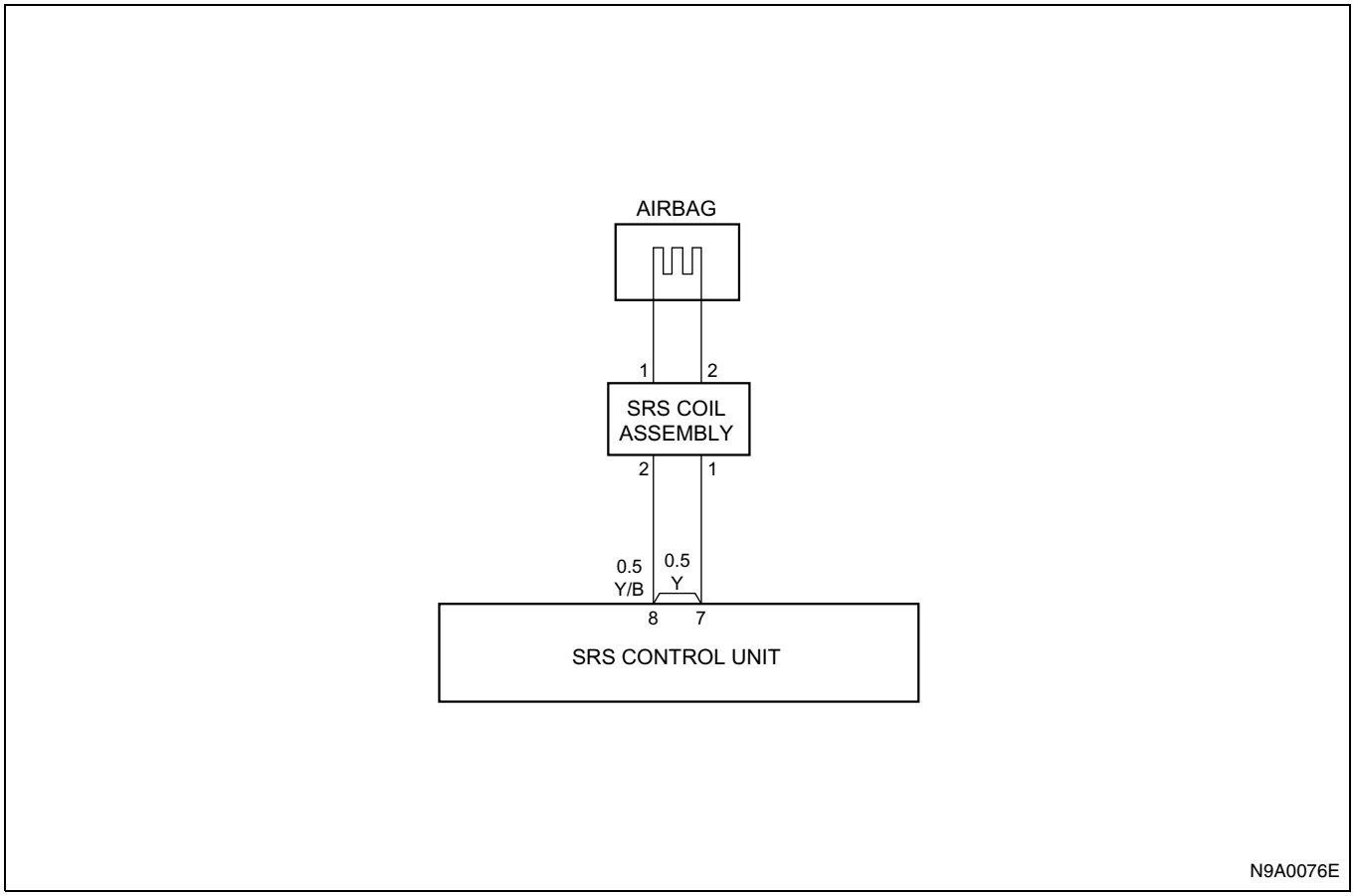
WARNING:
DURING SERVICE WORK, BE CAREFUL NOT TO TAP OR SHAKE THE SRS CONTROL UNIT. ALSO, FAILURE TO INSTALL THE SRS CONTROL UNIT TO VEHICLE PROPERLY MAY LEAD TO MALFUNCTION OF THE UNIT WHEN THE STARTER SWITCH IS TURNED TO ON. THIS MAY RESULT IN INJURY DUE TO SUDDEN DEPLOYMENT OF SRS AIRBAG.

Step	Action	Value	YES	NO
1	Has the “SRS system check” been performed?	—	Go to Step2	Go to “SRS system check”.

Step	Action	Value	YES	NO
2	Turn the starter switch to OFF. Is the airbag assembly deployed?	—	Inspect according to “repair and inspection required after collision” in this section. Clear the DTC. Perform “SRS system check”.	Go to Step3
3	Check front area of the vehicle for deformation caused by front collision. Is any deformation found?	—	Replace the parts, and inspect according to “repair and inspection required after collision” in this section. Clear the DTC. Perform “SRS system check”.	Turn the starter switch to OFF. Replace the SRS control unit. Reconnect all the SRS system parts, and check that those are installed properly. Perform “SRS system check”.

DTC: 53 Specific Trouble when SRS Airbag Deployment Current Had Output

Outline



Description of Circuit

A sensor is equipped to this circuit to convert the impact applied to SRS control unit into an electrical signal.
The electrical signal generated at this time will be processed in the SRS control unit to compare with the value stored in the memory. When the generated signal exceeds the setting value, SRS control unit sends current to the airbag assembly for deployment, and set the DTC 53 and 51.

Condition when DTC is Set

When the SRS control unit detects the front collision over certain degree of impact.

Action to be Taken

SRS control unit turns the “SRS” warning lamp ON, record the “collision data”, and set the DTC.

Condition when DTC is Cleared

When SRS control unit is replaced.

Description of DTC Chart Test

Numbers below indicate step numbers in the diagnostic chart.
2. In case the DTC 53 appears even when the collision did not result in SRS airbag assembly deployment, the DTC 53 may have been set erroneously.
3. In case the DTC 53 appears without any deformation caused by front collision, the DTC may have been set erroneously.

Point of Diagnosis

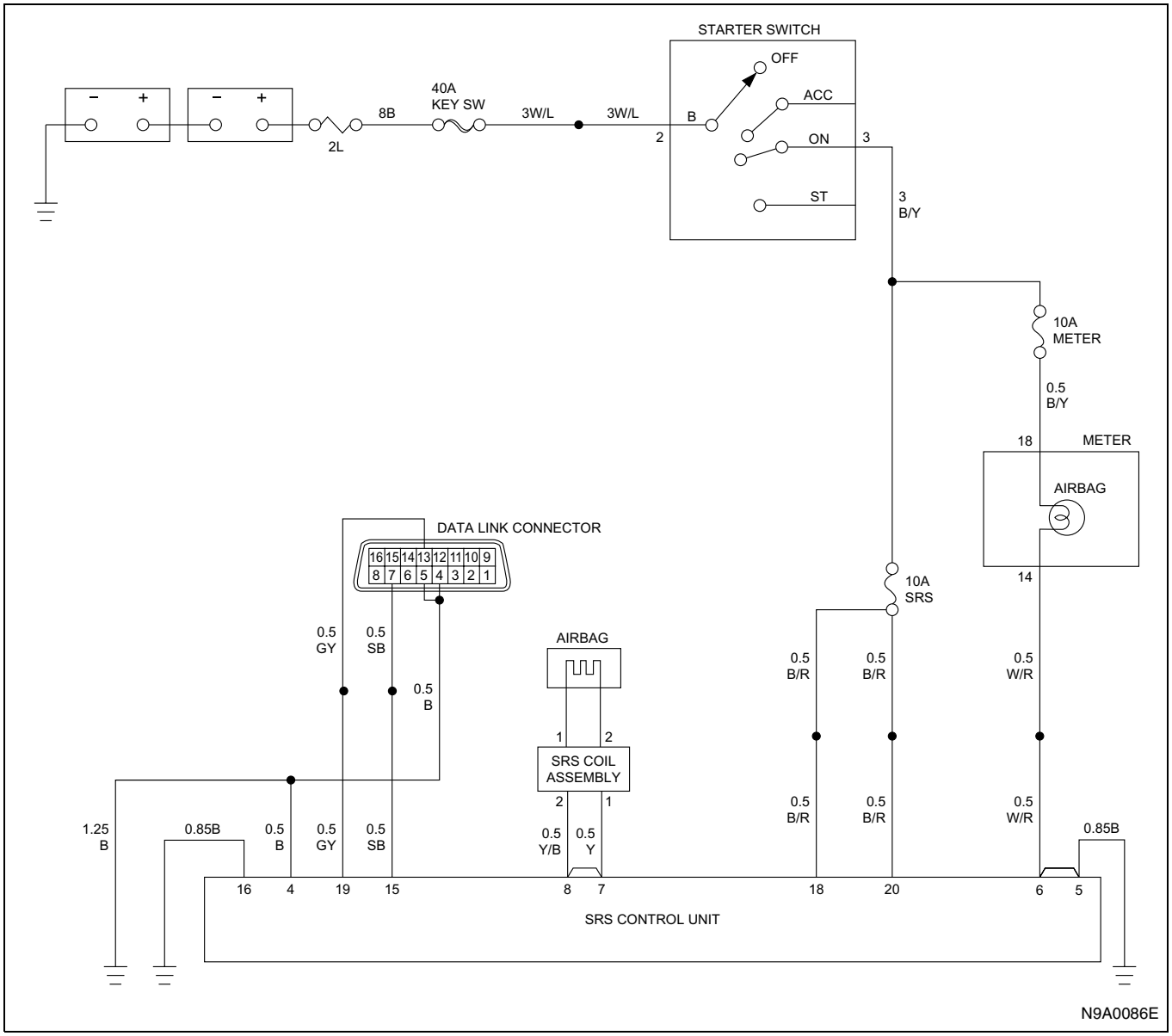
When the DTC 53 is set, more than one DTC is added to be set. The function faults which set the DTCs (expect DTC 71) must be corrected before new SRS control unit installation, in order to prevent the DTCs to be set again.

WARNING:
DURING SERVICE WORK, BE CAREFUL NOT TO TAP OR SHAKE THE SRS CONTROL UNIT. ALSO, FAILURE TO INSTALL THE SRS CONTROL UNIT TO VEHICLE PROPERLY MAY LEAD TO MALFUNCTION OF THE UNIT WHEN THE STARTER SWITCH IS TURNED TO ON. THIS MAY RESULT IN INJURY DUE TO SUDDEN DEPLOYMENT OF SRS AIRBAG.

Step	Action	Value	YES	NO
1	Has the “SRS system check” been performed?	—	Go to Step2	Go to “SRS system check”.
2	Turn the starter switch to OFF. Is the airbag assembly deployed?	—	Inspect according to “repair and inspection required after collision” in this section. Clear the DTC. Perform “SRS system check”.	Go to Step3
3	Check front area of the vehicle for deformation caused by front collision. Is any deformation found?	—	Replace the parts, and inspect according to “repair and inspection required after collision” in this section. Clear the DTC. Perform “SRS system check”.	Turn the starter switch to OFF. Replace the SRS control unit. Reconnect all the SRS system parts, and check that those are installed properly. Perform “SRS system check”.

DTC: 54 Deployment Output by Onboard Deployment System Communication

Outline



Description of Circuit

DTC 54 indicates that the SRS airbag has been deployed by SRS airbag onboard deployment system.

Condition when DTC is Set

When SRS airbag has been deployed by SRS airbag onboard deployment system.

Condition when DTC is Cleared

This DTC code cannot be cleared. Replace the SRS control unit.

Caution:

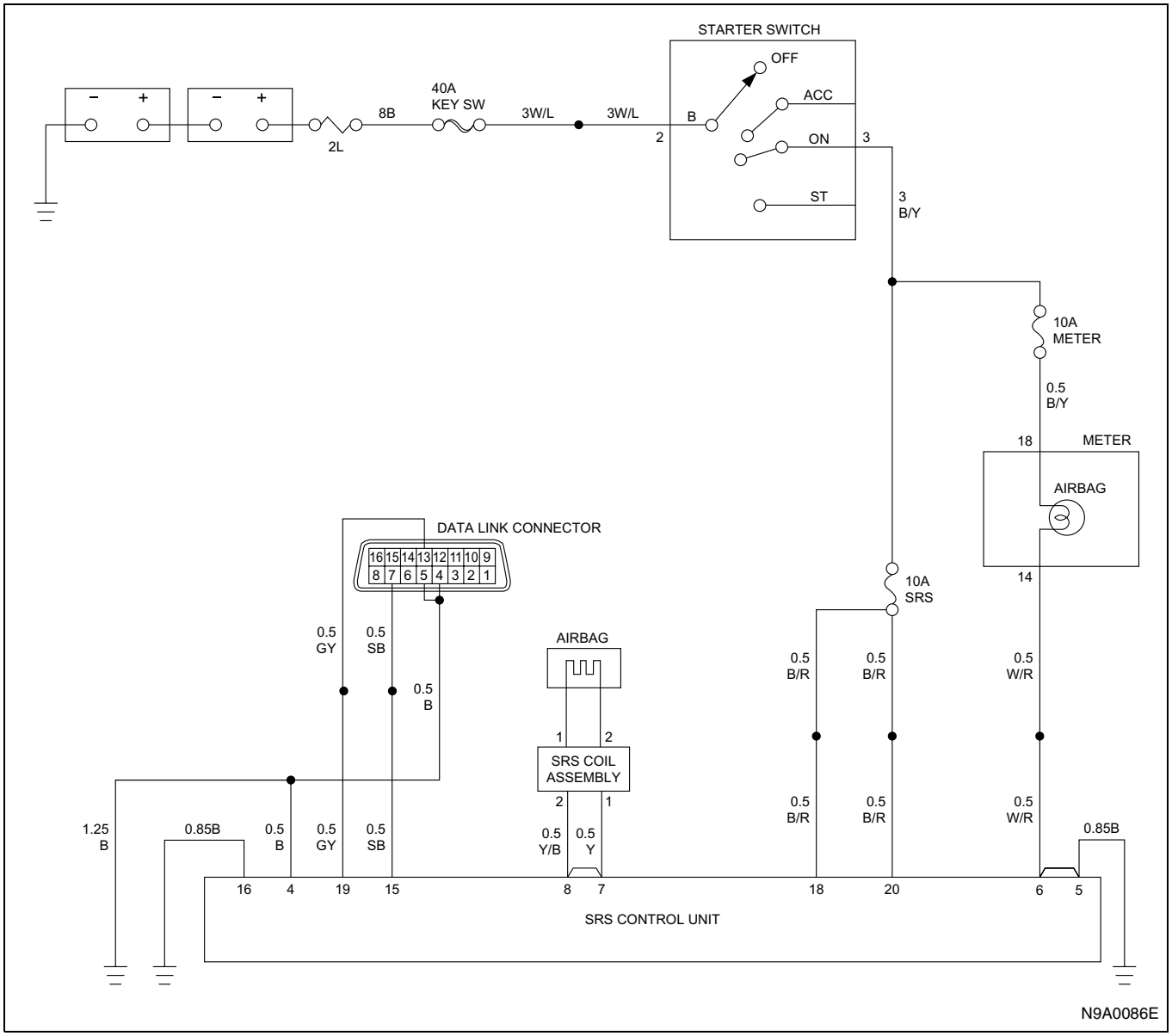
When this DTC is set, all the SRS system parts (SRS control unit, airbag, etc.) must be replaced. In addition, This DTC cannot be cleared. Be sure to disconnect the battery cable before replacement, otherwise it will result malfunction of replaced SRS system parts or cause battery short circuit.

Step	Action	Value	YES	NO
1	Has the “SRS system check” been performed?	—	Go to Step2	Go to “SRS system check”.
2	Is the DTC 54 detected?	—	Go to Step3	Go to Step1

Step	Action	Value	YES	NO
3	Replace the SRS system parts. Is the procedure completed?	—	Check the repair.	—

DTC: 55 Vehicle Type Error

Outline



Description of Circuit

DTC 55 is set when unmatched SRS control unit or SRS harness installation is suspected.
Turn the starter switch to “ON”. SRS control unit reads the condition of vehicle type identification terminals 3, 4, 13, 14 for judgment.

Condition when DTC is Set

It is correct when the terminal 4 only is connected to ground. If the harness is proper, the DTC is set when unmatched SRS control unit is installed. Also, if the SRS control unit is proper, the DTC is set when unmatched harness is installed.

Action to be Taken

SRS control unit turns the “SRS” warning lamp blinking and set the DTC 55.

However, when both of SRS control unit and SRS harness are faulty, the DTC may not be set.

Condition when DTC is Cleared

When turning the starter switch to OFF with correct matching of SRS control unit and SRS harness.

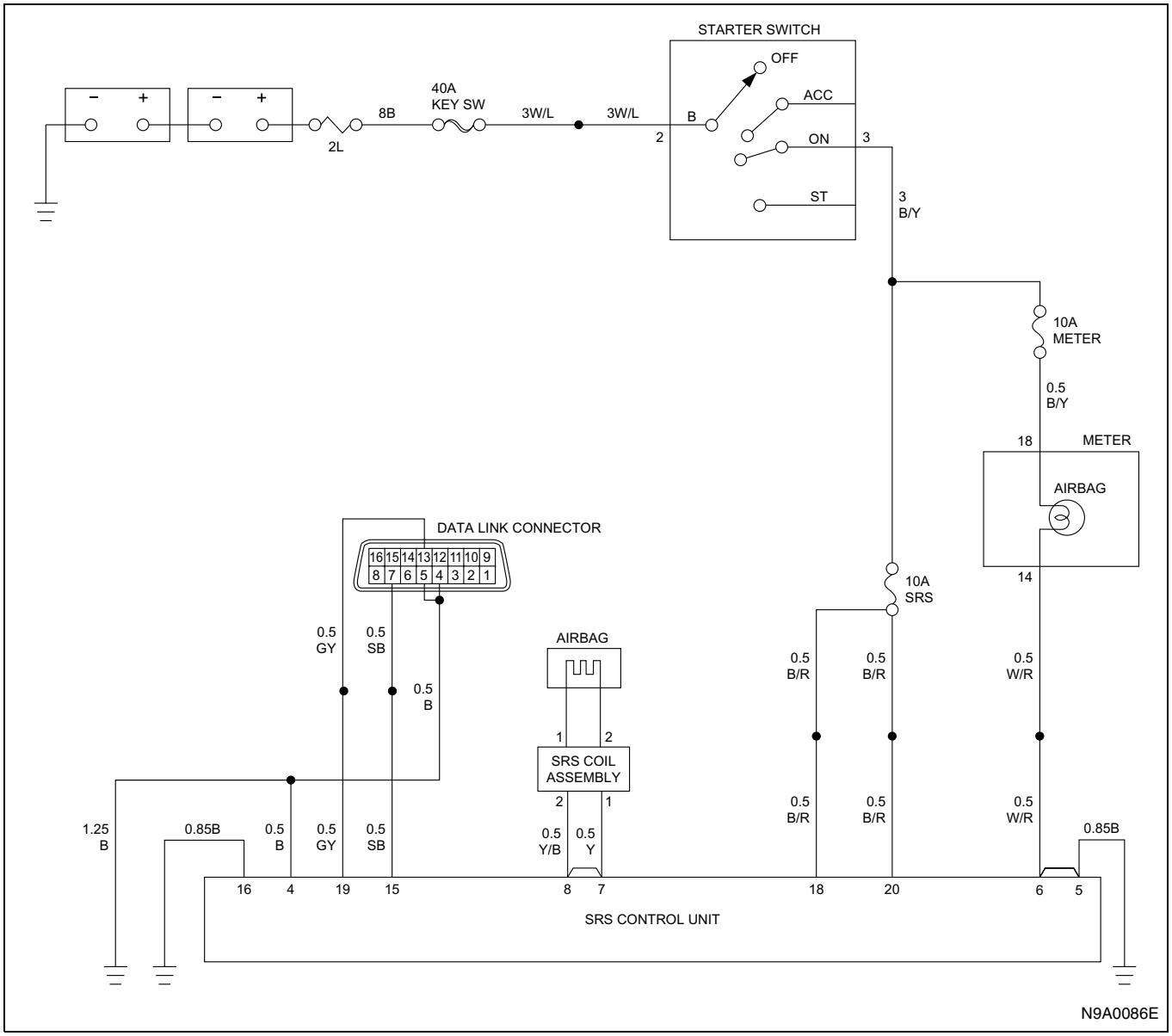
Point of Diagnosis

It is correct when the terminal 4 only is connected to ground. At first, make sure the SRS harness A3, A4, A13, A14 have no terminal.

Step	Action	Value	YES	NO
1	Has the “SRS system check” been performed?	—	Go to Step2	Go to “SRS system check”.
2	1. Turn the starter switch to OFF. 2. Remove the harness connector from SRS control unit. 3. Make sure the “3”, “4”, “13”, “14” of harness connector are in proper condition. Are the “3”, “4”, “13”, and “14” proper?	—	Replace the SRS control unit. Perform “SRS system check”.	Replace the SRS harness. Perform “SRS system check”.

DTC: 61 Warning lamp circuit trouble

Outline



Description of Circuit

Turn the ignition switch to “ON”. Battery voltage is applied to the “SRS” warning lamp and the “Ignition 1” input terminals “18” and “20”.
SRS control unit responds by blinking “SRS” warning lamp seven times. SRS control unit monitors lamp driver output by comparing output condition of the “SRS warning lamp” terminal “6” with the condition ordered to the microprocessor.
When the “Ignition 1” is within the specified range, and the output condition does not match with the condition ordered by the lamp driver, the DTC 61 is set.

Condition when DTC is Set

1. When no voltage is applied to the SRS control unit terminal “6” due to open circuit in the meter, burnt out bulb, or broken harness.
2. When the SRS warning lamp does not go off although the SRS control unit ordered to do so. This test is performed within 6 seconds after starter switch is “ON”.

Action to be Taken

SRS control unit sets the DTC 61, and the “SRS” warning lamp comes ON if its power source and ground line are normal.

Condition when DTC is Cleared

When turning the starter switch to OFF.

Description of Chart Test

2. Make sure the harness is not broken.
3. Detect if the warning lamp is faulty, and if the SRS control unit is faulty.

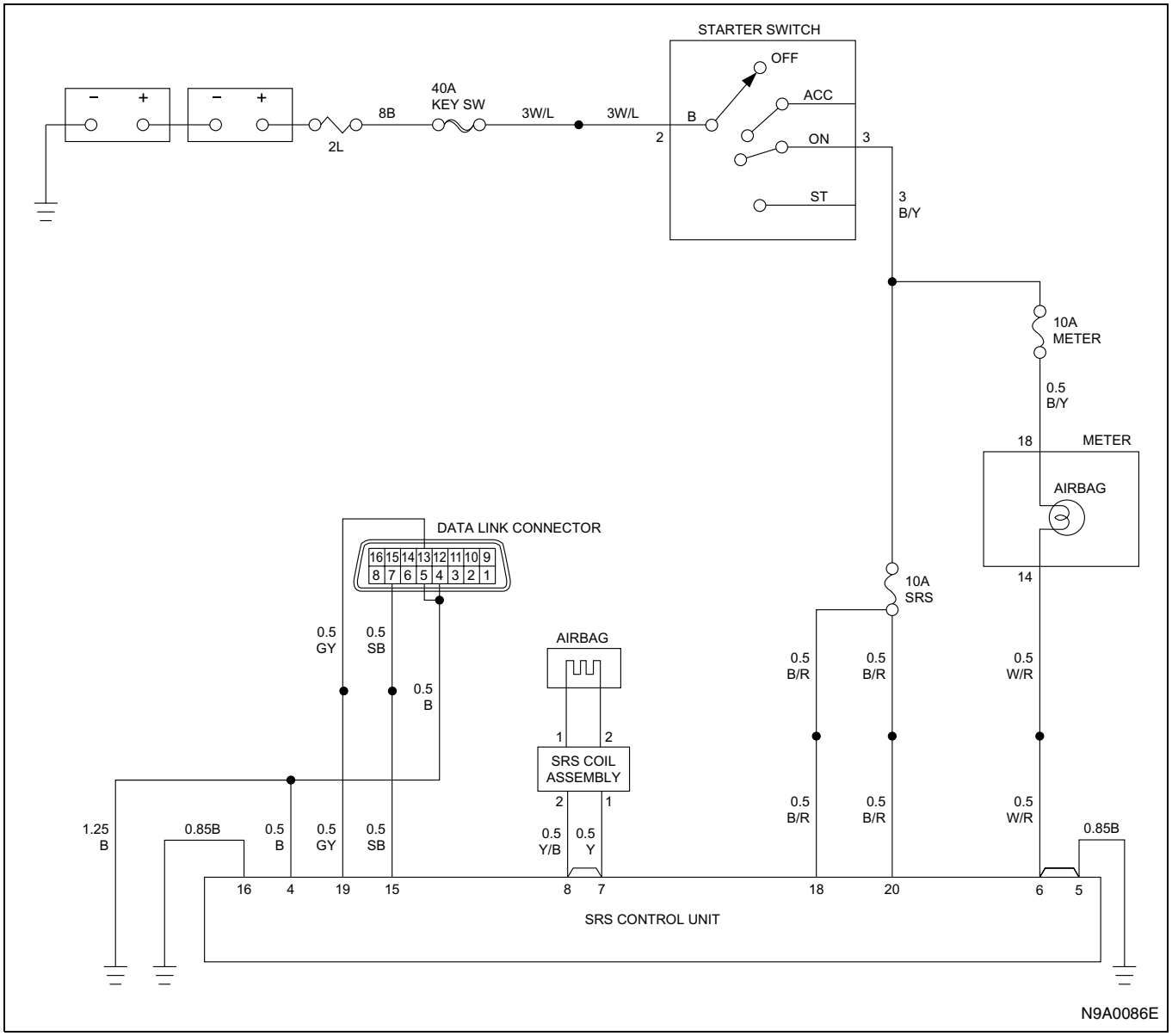
Point of diagnosis

Warning lamp comes on regardless of SRS control unit directly, and turns off when the SRS control unit sends current. Therefore, the warning lamp comes on even when the SRS control unit fuse is blown out if there is no other trouble.

Step	Action	Value	YES	NO
1	Has the “SRS system check” been performed?	—	Go to Step2	Go to “SRS system check”.
2	Turn the starter switch to OFF. Do warning lamps other than “SRS” operate properly?	—	Go to Step4	Go to Step3
3	Replace the meter assembly. Is this step completed?	—	Go to Step5	Go to Step3
4	1. Wiring is open between SRS control unit and SRS warning lamp, or it is shorted with body, or “SRS” warning lamp is blown out. 2. Find the trouble location. 3. Replace the SRS harness, if it has problem. Has the cause been detected and repaired?	—	Go to Step5	Go to Step4
5	1. Reconnect all the parts, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Check the repair.	Go to Step5

DTC: 63 Power Supply Voltage Failure

Outline



Description of Circuit

Turn the starter switch to “ON”. SRS control unit checks if the ignition voltage is in proper range.

Condition when DTC is Set

When ignition voltage is within or 10V to 18V for 30 seconds continuously.

Action to be Taken

SRS control unit turns the “SRS” warning lamp ON and set the DTC 63.

Condition when DTC is Cleared

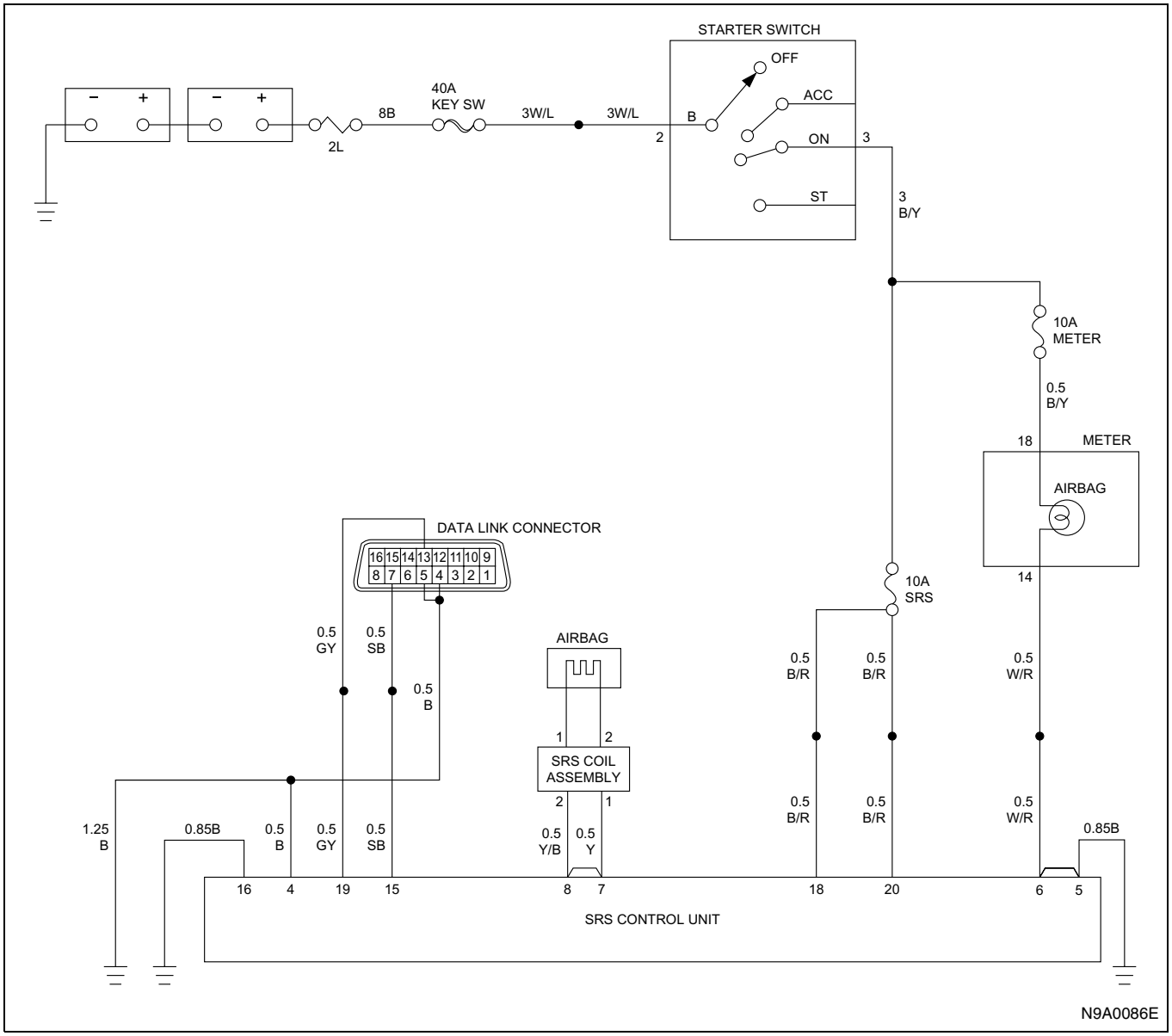
When ignition voltage goes back to more than 18V.

Step	Action	Value	YES	NO
1	Has the “SRS system check” been performed?	—	Go to Step2	Go to “SRS system check”.
2	Read the ignition voltage using Tech 2. Is the ignition voltage less than 18V?	—	Go to Step3	Go to Chart A SRS control unit function check.

Step	Action	Value	YES	NO
3	1. Turn the starter switch to OFF. 2. Check the battery voltage, specific gravity, and power supply system circuit. Correct if faulty. Is this step completed?	—	Go to Step4	Go to Step3
4	1. Reconnect all the parts, and check that those are installed properly. 2. Clear the DTC. Is this step completed?	—	Check the repair.	Go to Step4

DTC: 71 SRS Control Unit Internal Trouble

Outline



Description of Circuit

DTC 71 indicates possibility of function fault inside the SRS control unit.

Condition when DTC is Set

When the function fault is detected inside the SRS control unit.

Action to be Taken

SRS control unit turns the “SRS” warning lamp ON and set the DTC.

Condition when DTC is Cleared

This DTC code cannot be cleared. Replace the SRS control unit.

WARNING:
DURING SERVICE WORK, BE CAREFUL NOT TO TAP OR SHAKE THE SRS CONTROL UNIT. ALSO, FAILURE TO INSTALL THE SRS CONTROL UNIT TO VEHICLE PROPERLY MAY LEAD TO MALFUNCTION OF THE UNIT WHEN THE STARTER SWITCH IS TURNED TO ON. THIS MAY RESULT IN INJURY DUE TO SUDDEN DEPLOYMENT OF SRS AIRBAG.

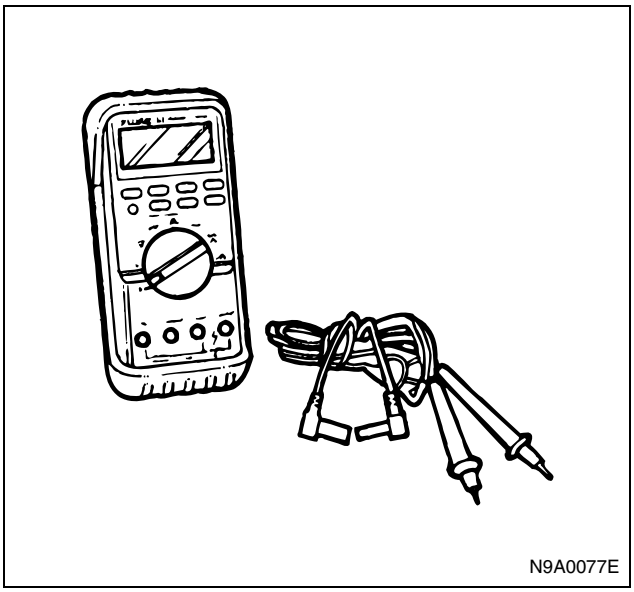
Caution:
When this DTC is set, all the SRS system parts (SRS control unit, airbag, etc.) must be replaced. In addition, This DTC cannot be cleared. Be sure to disconnect the battery cable before replacement, otherwise it will result malfunction of replaced SRS system parts or cause battery short circuit.

Step	Action	Value	YES	NO
1	Has the “SRS system check” been performed?	—	Go to Step2	Go to “SRS system check”.
2	Are DTCs 25, 51, 53 also set as current code or history code (See notes mentioned above)?	—	If DTC 25 is set, go to DTC 25 chart. If DTC 51 is set, go to DTC 51 chart. If DTC 53 is set, go to DTC 53 chart.	Turn the starter switch to OFF. Replace the SRS control unit. Perform “SRS system check”.

Special Tool

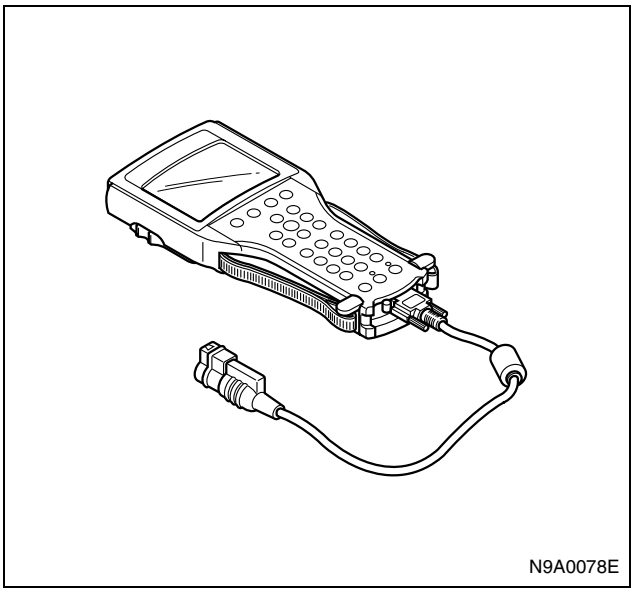
5-8840-0366-0 DMM (digital multi-meter)

5-8840-0366-0 DMM is preferable for use of SRS diagnostics and repair. Use of other DMM is not authorized for SRS diagnostic and repair.
Use of other DMM may lead SRS parts deployment.


N9A0077E

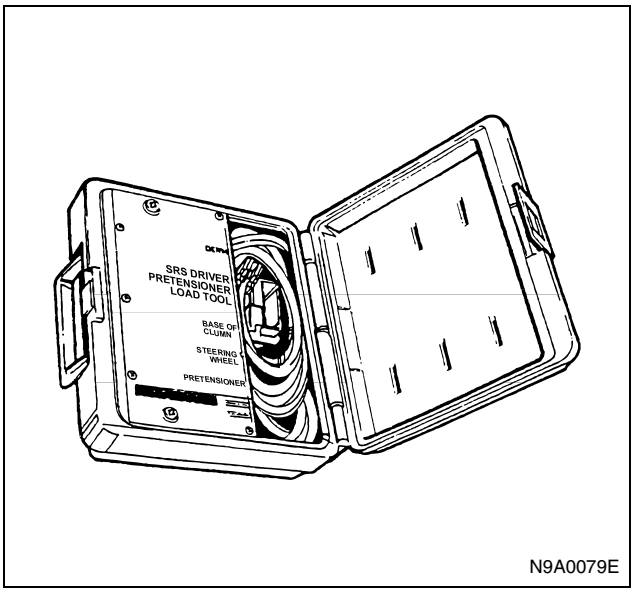
Tech 2

Use Tech 2 to read and clear SRS diagnostic trouble code.


N9A0078E

5-8840-2421-0 SRS substitute load

This tool is used for diagnostic aid and for safety device to prevent unnecessary SRS airbag deployment.
Three yellow connectors are provided to the SRS substitute load case.
These small three connectors work as substitute for resistance load device electrically.
One of the small connector substitutes the load of SRS coil assembly by connecting to the SRS coil assembly located in the upper portion of steering column. Another small connector substitutes the load of driver's airbag assembly by connecting to the SRS harness connector located in the lower portion of steering column.
Use of substitute load in place of inflator circuit resistance when necessary enables to judge if the parts in the inflator circuit cause the system function fault, and also enables to detect which part causes the function fault.
Substitute load must be used only when it is necessary in the diagnostic procedure.



N9A0079E

5-8840-0385-0 Connector test adapter kit

Connector test adapter kit is necessary whenever terminal inspection or detail inspection is requested in the diagnostic procedure. Use appropriate adapter to prevent terminals from damage such as bending by DMM probe. It is also useful to find poor contact caused by insufficient pressure by checking if sufficient pressure is applied to the terminal.

N9A0080E

LGSRS-WE-0551

You are requested to order this manual using the manual number that is shown above.

This manual is applicable for vehicles in all countries except the USA and Canada.

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Issued by

ISUZU MOTORS LIMITED

INTERNATIONAL SERVICE DEPARTMENT

Tokyo, Japan

Second edition February, 2006

No.LGSRS-WE-0551 PRINTED IN JAPAN

WORKSHOP MANUAL

N-SERIES

SEAT BELT, SRS AIRBAG

SECTION 9

ISUZU

ISUZU

International Service & Parts

Tokyo, Japan

NOTICE

Before using this Workshop Manual to assist you in performing vehicle service and maintenance operations, it is recommended that you carefully read and thoroughly understand the information contained in Section-0A under the headings "GENERAL REPAIR INSTRUCTIONS" and "HOW TO USE THIS MANUAL".

All material contained in this Manual is based on latest product information available at the time of publication.
All rights are reserved to make changes at any time without prior notice.

Applicable Model:

N-Series

This manual is applicable to 2005 year model.

THIS MANUAL INCLUDES THE FOLLOWING SECTIONS:

SECTION No.	CONTENTS
9A	SEAT BELT
9B	SRS
9C	SRS CONTROL SYSTEM